OCULA

USER GUIDE

VERSION 4.0V1

THE FOUNDRY.

Ocula 4.0 User Guide

Special thanks to Disney Enterprises, Inc. for use of the TRON: LEGACY images throughout this user guide.

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1 Introduction

Welcome to this User Guide for Ocula 4.0 on Nuke. Ocula is a collection of tools that solve common problems with stereoscopic imagery, improve productivity in post production, and ultimately help to deliver a more rewarding 3D-stereo viewing experience.

All Ocula nodes integrate seamlessly into Nuke. They are applied to your clips as any other node and they can all be animated using the standard Nuke animation tools.

About this User Guide

This User Guide will tell you how to install and use the Ocula 4.0 nodes and tools. Each node or tool is described in detail in later chapters. Licensing Ocula is covered in the separate Foundry Licensing Tools (FLT) User Guide, which you can download from http://www.thefoundry.co.uk/licensing.

This guide assumes you are familiar with Nuke and the machine it is running on.

NOTE: For the most up-to-date information, please see the Ocula on Nuke product page and the latest Ocula 4.0 user guide on our website at http://www.thefoundry.co.uk.

Special thanks to Disney Enterprises, Inc. for use of the TRON: LEGACY images throughout this user guide.

What's New?

Have a look at the new features and improvements in Appendix A.

Example Images

Example images are provided for use with Ocula. You can download these images from our website at http://www.thefoundry.co.uk/support/user-guides#ocula and try Ocula out on them.

Installation

Installing Ocula 4.0 will NOT overwrite any versions of Ocula 3.x, Ocula 2.x, or Ocula 1.x.

To see the installation instructions for your operating system, go to:

- Installation on Windows
- Installation on Mac
- Installation on Linux

NOTE: You can put the Ocula nodes anywhere as long as you set the environment variable NUKE_PATH to point to it.

Installation on Windows

Ocula is distributed as a software download from our website at http://www.thefoundry.co.uk/. To install Ocula on a computer running Windows, follow these instructions:

NOTE: Throughout the following instructions, please replace **<version>** with the Nuke release you're using.

1. Download the following file from our website at http://www.thefoundry.co.uk/:
   `Ocula_4.0v1_Nuke_<version>-win-x86-release-64.zip`
2. Unzip the file you downloaded.
3. Double-click on the exe file to launch the installer. Follow the on-screen instructions to install Ocula.
4. Proceed to Licensing Ocula.

Installing Ocula from the command line

To install Ocula from the command line, do the following:

NOTE: Throughout the following instructions, please replace **<version>** with the Nuke release you're using.

1. Download and unzip the following file from our website at http://www.thefoundry.co.uk/:
   `Ocula_4.0v1_Nuke_<version>-win-x86-release-64.zip`
2. To open a command prompt window, select **Start** > **All Programs** > **Accessories** > **Command Prompt**.
3. Use the **cd** (change directory) command to move to the directory where you saved the installation file. For example, if you saved the installation file in C:\Temp, use the following command and press **Return**:

```
cd \Temp
```

4. To install Ocula, do one of the following:
   - To install Ocula and display the installation dialog, type the name of the install file without the file extension and press **Return**:
     `Ocula_4.0v1_Nuke_<version>-win-x86-release-64`
   - To install Ocula silently so that the installer does not prompt you for anything but displays a progress bar, enter **/silent** after the installation command:
     `Ocula_4.0v1_Nuke_<version>-win-x86-release-64 /silent`
   - To install Ocula silently so that nothing is displayed, enter **/verysilent** after the installation command:
     `Ocula_4.0v1_Nuke_<version>-win-x86-release-64 /verysilent`

NOTE: By running a silent install of Ocula, you agree to the terms of the End User License Agreement. To see this agreement, please refer to Appendix D or run the installer in standard, non-silent mode.

Installation on Mac

Ocula is distributed as a software download from our website at http://www.thefoundry.co.uk/. To install Ocula 4.0 on a Mac, follow these instructions:

NOTE: Throughout the following instructions, please replace **<version>** with the Nuke release you're using.

1. Download the following file from our website at http://www.thefoundry.co.uk/:
   `Ocula_4.0v1_Nuke_<version>-mac-x86-release-64.dmg`
2. Double-click on the downloaded dmg file.
3. Double-click on the pkg file that is created.
4. Follow the on-screen instructions to install Ocula.
5. Proceed to Licensing Ocula.

Installing Ocula silently from the command line

NOTE: Throughout the following instructions, please replace **<version>** with the Nuke release you're using.

1. Download the following file from our website at http://www.thefoundry.co.uk/:
   `Ocula_4.0v1_Nuke_<version>-mac-x86-release-64.dmg`
2. Launch a Terminal window.
3. To mount the dmg installation file, use the **hdiutil attach** command with the directory where you saved the installation file. For example, if you saved the installation file in Builds/Ocula, use the following command:

```
hdiutil attach /Builds/Ocula/Ocula_4.0v1_Nuke_<version>-mac-x86-release-64.dmg
```

4. Enter the following command:
   ```
   pushd /Volumes/Ocula_4.0v1_Nuke_<version>-mac-x86-release-64/
   ```
   This stores the directory path in memory, so it can be returned to later.
5. To install Ocula, use the following command:
   ```
   sudo installer -pkg Ocula_4.0v1_Nuke_<version>-mac-x86-release-64.pkg -target "/"
   ```
   You are prompted for a password.
6. Enter the following command:
   ```
   popd
   ```
   This changes to the directory stored by the pushd command.
7. Finally, use the following command to eject the mounted disk image:
   ```
   hdiutil detach /Volumes/Ocula_4.0v1_Nuke_<version>-mac-x86-release-64/
   ```

NOTE: By running a silent install of Ocula, you agree to the terms of the End User License Agreement. To see this agreement, please refer to Appendix D or run the installer in standard, non-silent mode.

Installation on Linux

Ocula is distributed as a software download from our website at http://www.thefoundry.co.uk/. To install Ocula 4.0 on a computer running Linux, follow these instructions:

NOTE: Throughout the following instructions, please replace **<version>** with the Nuke release you're using.

1. Download the following file from our website at http://www.thefoundry.co.uk/:
   ```
   Ocula_4.0v1_Nuke_<version>-linux-x86-release-64.tgz
   ```
2. Move the downloaded file to the following directory (create the directory if it does not yet exist):
   ```
   /usr/local/Nuke/
   ```
3. In the above mentioned directory, extract the files from the archive using the following command.
   ```
   tar xvzf Ocula_4.0v1_Nuke_<version>-linux-x86-release-64.tgz
   ```
   This will create the **<version>/plugins/Ocula/4.0** subdirectory (if it doesn't already exist), and install Ocula in that directory.
4. Proceed to Licensing Ocula.

Licensing Ocula

About Licences

If you simply want to try out Ocula, you can obtain a trial licence, which allows you to run Ocula for free for 15 days.

To use Ocula after this trial period, you need either a valid **license key** or a **floating license** and server running the Foundry Licensing Tools (FLT):

- **Licence Keys** - These can be used to install and activate **node locked** (also known as **uncounted**) licences. Node locked licences allow you to use Ocula on a single machine. This licence will not work on a different machine and if you need it to, you'll have to transfer your licence. Node locked licences do not require additional licensing software to be installed. See Licensing Ocula on a Single Machine for more information.
- **Floating Licences** - also known as **counted** licences, enable Ocula to work on any networked client machine. The floating licence should be put on the server and is locked to a unique number on that server. Floating licences on a server require additional software to be installed. This software manages those licences on the server, giving licences out to client stations that want them. The software you need to manage these licenses is called the Foundry License Tools (FLT) and it can be freely downloaded from our website. Floating licences often declare a port number on the server line and a port number on the vendor line. See Licensing Ocula over a Network for more information.

WARNING: If there is an interruption between the licence server and Ocula, rendering aborts with an exit code of 1. You can use the **--cont** command line argument to force Ocula to continue rendering on failure, producing black licence failure frames rather than aborting the whole render.

The instructions below run through both licensing methods, and you can find a more detailed description in the Foundry Licensing Tools User Guide available on our website: http://www.thefoundry.co.uk/support/licensing/

Licensing Ocula on a Single Machine

Obtaining a Licence Key

You can purchase licence keys by:

- going to our website at http://www.thefoundry.co.uk/,
- e-mailing us at sales@thefoundry.co.uk,
- phoning our London office at +44 20 7479 4350 or our Los Angeles office at +1 (310) 399 4555.

To generate a licence key, we need to know your System ID. The System ID (sometimes called Host ID or rlmhostid) returns a unique number for your computer. We lock our licence keys to the System ID.

To display your System ID, do the following:

- On Windows and Mac

  Download the Foundry License Utility (FLU) from www.thefoundry.co.uk/support/licensing/ and run it. The System ID is displayed at the bottom of the window.

- On Linux

  Download the Foundry License Utility (FLU) from www.thefoundry.co.uk/support/licensing/ and run it from the command line:

  ```
  <download location>/FoundryLicenseUtility -i
  ```

NOTE: The <download location> refers to the location where you saved the Foundry Licensing Utility.

Just so you know what a System ID number looks like, here's an example: 000ea641d7a1.

Installing the Licence

Once a license has been generated for you, we e-mail you the license key and instructions on how to obtain the correct version of the Foundry License Utility (FLU). Gunzip or untar the file and save the FLU and your license key to a folder of your choice. The instructions below tell you what to do with these.

On Windows and Mac

Just drop the licence key on the Foundry License Utility (FLU) application to install it. This checks the licence key and copies it to the correct directory.

On Linux

1. Navigate to the location of the FLU_[version]_linux-x86-release-64.tgz file.
2. Type the following commands to extract and install the FLU. Note that you need to replace **[version]** with the version of FLU you are using and **[my licence]** with the location of your licence key.

   ```
   tar xvzf FLU_[version]_linux-x86-release-64.tgz
   cd FLU_[version]_linux-x86-release-64
   ./FoundryLicenseUtility -l [my license]
   ```

   For example, if you saved your licence key to **/tmp/Foundry.lic**, the last line should be:

   ```
   ./FoundryLicenseUtility -l /tmp/foundry.lic
   ```

   This checks the licence key and copies it to the correct directory.

Licensing Ocula over a Network

Obtaining Floating Licences

You can purchase a floating licence key by:

- going to our website at http://www.thefoundry.co.uk/,
- e-mailing us at sales@thefoundry.co.uk,
- phoning our London office at +44 20 7479 4350 or our Los Angeles office at +1 (310) 399 4555.

To generate you a licence key, we need to know the System ID of the machine that will act as the server. The System ID (sometimes called Host ID or rlmhostid) returns a unique number for the computer. We lock our licence keys to the System ID. See Installing Floating Licences.

To display your System ID, do the following:

- On Windows and Mac

  Download the Foundry License Utility (FLU) from www.thefoundry.co.uk/support/licensing/ and run it. The System ID is displayed at the bottom of the window.

- On Linux

  Download the Foundry License Utility (FLU) from www.thefoundry.co.uk/support/licensing/ and run it from the command line:

  ```
  <download location>/FoundryLicenseUtility -i
  ```

NOTE: The <download location> refers to the location where you saved the Foundry Licensing Utility.

NOTE: The System ID needs to be from the machine that will act as the server and not one of the client machines.

Just so you know what a System ID number looks like, here's an example: 000ea641d7a1.

Installing Floating Licences

Once a floating licence has been created for you, we e-mail you a file containing the license key and instructions on how to obtain the correct version of the Foundry License Utility (FLU). Gunzip or untar the file and save the FLU and your license key to a folder of your choice.

Having installed a floating licence key, you need to install some additional software (FLT) to manage the licences on your network. Then you need to tell the client machines where to find the licences.

On Windows and Mac

1. Just drop the licence key on the Foundry License Utility (FLU) application to install it. This checks the licence key and copies it to the correct directory.

   The licence server address is displayed on screen:

   <number>@<licence server name>

   You should make a note of the address as you'll need it to activate the client machines.
2. In order for the floating licence to work, you need to install the Foundry Licensing Tools (FLT) on the licence server machine (not the client machines). For more information on how to install floating licences, refer to the FLT user guide, which you can download from our website: http://www.thefoundry.co.uk/support/licensing/tools/.
3. Once your licence server is up and running, you need to direct your client machines to the server in order to obtain a licence. See Telling the Client Machines Where to Find the Licences.

On Linux

1. Navigate to the location of the FLU_[version]_linux-x86-release-64.tgz file.
2. Type the following commands to extract and install the FLU. Note that you need to replace **[version]** with the version of FLU you are using and **[my licence]** with the location of your licence key.

   ```
   tar xvzf FLU_[version]_linux-x86-release-64.tgz
   cd FLU_[version]_linux-x86-release-64
   ./FoundryLicenseUtility -l [my license]
   ```

   For example, if you saved your licence key to **/tmp/Foundry.lic**, the last line should be:

   ```
   ./FoundryLicenseUtility -l /tmp/Foundry.lic
   ```

   This checks the licence key and copies it to the correct directory.

   The licence server address is displayed on screen:

   <number>@<licence server name>

   You should make a note of the address as you'll need it to activate the client machines.
3. In order for the floating licence to work, you need to install the Foundry Licensing Tools (FLT) on the licence server machine (not the client machines). For more information on how to install floating licences, refer to the FLT user guide, which you can download from our website: http://www.thefoundry.co.uk/support/licensing/tools/.
4. Once your licence server is up and running, you need to direct your client machines to the server in order to obtain a licence. See Telling the Client Machines Where to Find the Licences.

Telling the Client Machines Where to Find the Licences

In order for the client machines to get a licence from the server, they need to be told where to look.

On Windows and Mac

1. Launch the Foundry License Utility (FLU).
2. Make sure you are viewing the **License Install** tab and copy and paste in an RLM server line:
   `HOST <server name> any <port>`
   For example: **HOST red any 4101**
   This creates and installs both a FLEXlm and an RLM client license.
3. Repeat this process for each machine you wish to have access to licenses on the server.

On Linux

1. Launch a shell and navigate to the location of the FLU_[version]_linux-x86-release-64.tgz file.
2. Type the following commands, replacing **[version]** with the version of FLU you are using:
   ```
   tar xvzf FLU_[version]_linux-x86-release-64.tgz
   cd FLU_[version]_linux-x86-release-64
   ./FoundryLicenseUtility -c <port>@<server name>
   ```
   For example, the last line may be:
   ```
   ./FoundryLicenseUtility -c 4101@red
   ```
   This creates and installs both a FLEXlm and an RLM client license.
3. Repeat this process for each machine you wish to have access to licenses on the server.

Further Reading

There is a lot to learn about licenses, much of which is beyond the scope of this manual. For more information on licensing Ocula, displaying the System ID number, setting up a floating license server, adding new license keys and managing license usage across a network, you should read the *Foundry Licensing Tools (FLT) User Guide*, which can be downloaded from our website, www.thefoundry.co.uk/support/licensing/

Other Foundry Products

The Foundry is a leading developer of visual effects and image processing technologies for film and video post production. Its stand-alone products include Nuke, Modo, Mari, Hiero, Katana, and Flix. The Foundry also supplies a suite of plug-ins, including Ocula, CameraTracker, Keylight, Kronos, and Furnace and FurnaceCore for a variety of compositing platforms, including Adobe® After Effects®, Autodesk® Flame®, Avid® DS™, and Apple's Final Cut Pro®. For the full list of products and supported platforms, visit our website at http://www.thefoundry.co.uk.

Nuke is an Academy Award® winning compositor. It has been used to create extraordinary images on scores of feature films, including Avatar, District 9, The Dark Knight, Iron Man, Quantum of Solace, The Curious Case of Benjamin Button, Transformers, and Pirates of the Caribbean: At World's End.

Modo brings you the next generation of 3D modeling, animation, sculpting, effects and rendering in a powerful integrated package.

Mari is a creative texture-painting tool that can handle extremely complex or texture-heavy projects. It was developed at Weta Digital and has been used on films, such as District 9, The Day the Earth Stood Still, The Lovely Bones, and Avatar.

Hiero is a collaborative, scriptable timeline tool that conforms edit decision lists and parcels out VFX shots to artists, allowing progress to be viewed in context, and liberating your finishing systems and artists for more creative tasks.

Katana is a look development and lighting tool, replacing the conventional CG pipeline with a flexible recipe-based asset workflow. Its node-based approach allows rapid turnaround of high-complexity shots, while keeping artists in control and reducing in-house development overheads. Extensive APIs mean it integrates with a variety of renderers and your pre-existing shader libraries and workflow tools.

Flix is a collaborative, visual story-development tool. It allows directors, editors, cinematographers, storyboard artists, and pre-visualization artists to explore ideas quickly, saving valuable time, and to easily collaborate on the visual story development of a film.

Ocula is a collection of tools that solve common problems with stereoscopic imagery, improve productivity in post production, and ultimately help to deliver a more rewarding 3D-stereo viewing experience.

CameraTracker is an After Effects plug-in allowing you to pull 3D motion tracks and matchmoves without having to leave After Effects. It analyses the source sequence and extracts the original camera's lens and motion parameters, allowing you to composite 2D or 3D elements correctly with reference to the camera used to film the shot.

Keylight is an industry-proven blue/green screen keyer, giving results that look photographed, not composited. The Keylight algorithm was developed by the Computer Film Company who were honoured with a technical achievement award for digital compositing from the Academy of Motion Picture Arts and Sciences.

Kronos is a plug-in that retimes footage using motion vectors to generate additional images between frames. Utilising NVIDIA's CUDA technology, Kronos optimises your workflow by using both the CPU and GPU.

Furnace and FurnaceCore are collections of film tools. Many of the algorithms utilise motion estimation technology to speed up common compositing tasks. Plug-ins include wire removal, rig removal, steadiness, deflicker, degrain and regrain, retiming, and texture tools.

2 DisparityGenerator

Description

The O_DisparityGenerator node is used to create disparity maps for stereo images. A disparity map describes the location of a pixel in one view in relation to the location of its corresponding pixel in the other view. It includes two sets of disparity vectors: one maps the left view to the right, and the other maps the right view to the left.

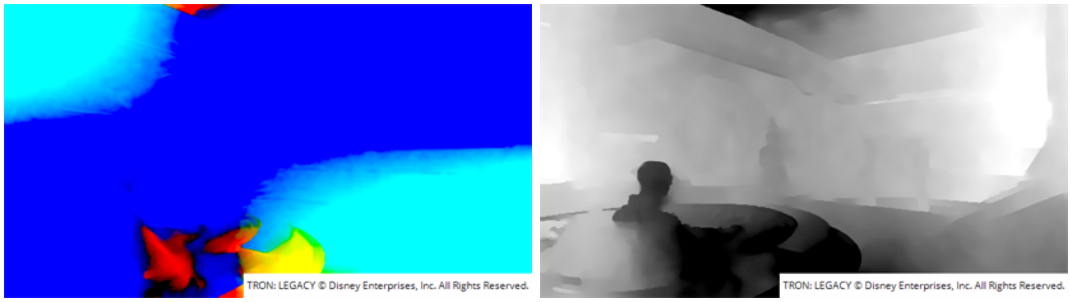
NOTE: O_DisparityGenerator only requires an O_Solver node as one of its inputs if you intend to use the **Alignment** control. Alignment defaults to **0**, but increasing it forces the disparity map to match the camera geometry to remove noise on the vertical component of disparity. You might want to do this if your plates don't contain much detail, such as bluescreen images with markers in the background or plates with a lot of featureless areas like sky.

The following Ocula nodes rely on disparity maps to produce their output:

- O_OcclusionDetector
- O_ColourMatcher
- O_FocusMatcher
- O_VerticalAligner (in **Local Alignment** mode)
- O_NewView
- O_InteraxialShifter
- O_DisparityToDepth, and
- O_DisparityViewer.

If you have more than one of these nodes in the Node Graph with one or more of the same inputs, they might well require identical disparity map calculations. O_DisparityGenerator is a utility node designed to save processing time by allowing you to create the disparity map separately, so that the results can then be reused by other Ocula nodes.

The final disparity vectors are stored in disparity channels, so you might not see any image data appear when you first calculate the disparity map. To see the output inside Nuke, select a disparity channel from the **channel** controls in the top-left corner of the Viewer. Examples of what a disparity map might look like using the RGB and R channels, after adjusting the Viewer **gain** and **gamma** controls, are shown below. As you can see, the RGB layers on the left are harder to read than the single R channel.



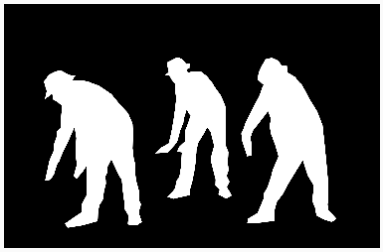
In general, once you have generated a disparity map that describes the relation between the views of a particular clip well, it will be suitable for use in most of the Ocula nodes. We recommend that you insert a Write node after O_DisparityGenerator to render the original images and the disparity channels as a stereo **.exr** file (sometimes referred to as **.sxr**). This format allows for the storage of an image with multiple views and channel sets embedded in it. Later, whenever you use the same image sequence, the disparity map is loaded into Nuke together with the sequence and is readily available for other Ocula nodes. For information on how to render disparity in to an **.exr** file, see Writing Disparity into a Clip.

If you have a CG scene with camera information and a z-depth map available, you can also create disparity maps using the O_DepthToDisparity node. For more information, see DepthToDisparity.

Inputs

O_DisparityGenerator has the following inputs:

Source	A stereo pair of images. If you intend to use the **Alignment** control, O_DisparityGenerator requires an O_Solver node as one of its inputs. Alignment defaults to **0**, but increasing it forces the disparity map to match the camera geometry to remove noise on the vertical component of disparity.

Mask	An optional mask that specifies areas to exclude from the disparity calculation. You can use this input to prevent distortions at occlusions or to calculate disparity for a background layer by ignoring foreground elements. Note that masks should exist in both views, and O_DisparityGenerator treats the alpha values of 1 as foreground and blurs to the 0 value using nearby disparity to recreate object boundaries, rather than image data. When you create a mask using Roto or RotoPaint, you can use the **feather** control to extend the calculation. For example, the disparity map may have a sharper transition at depth edges with a binary mask, but applying feather on the mask can help smooth the resulting image.  The left view.  A mask to select the dancers in the left view.

To see a table listing the nodes or channels each Ocula node requires in its inputs, turn to Appendix B.

Generating Disparity Maps

To generate a disparity map, do the following:

1. Launch Nuke and press **S** on the Node Graph to open the project settings. Go to the **Views** tab and click the **Set up views for stereo** button.
2. From the Toolbar, select **Image** > **Read** to load your stereo clip into Nuke. If you don't have both views in the same file, select **Views** > **JoinViews** to combine them, or use a variable in the Read node's file field to replace the name of the view (use the variable **%V** to replace an entire view name, such as **left** or **right**, and **%v** to replace an initial letter, such as **l** or **r**). For more information, refer to the *Nuke User Guide*.
3. Select **Ocula** > **Ocula 4.0** > **O_DisparityGenerator** to insert an O_DisparityGenerator node after the Read node.

NOTE: If you intend to use the **Alignment** control, O_DisparityGenerator requires an O_Solver node as one of its inputs. Alignment defaults to **0**, but increasing it forces the disparity map to match the camera geometry to remove noise on the vertical component of disparity. See Generating Disparity Using Alignment for more information.

4. Open the O_DisparityGenerator controls. O_DisparityGenerator renders using the Local GPU specified, if available, rather than the CPU. The output between the GPU and CPU is identical, but using the GPU can significantly improve processing performance.

   If no suitable GPU or the required NVIDIA CUDA drivers are available, O_DisparityGenerator defaults to the CPU. You can select a different GPU Device, if available, by opening Nuke's **Preferences** and selecting an alternative card from the **GPU Device** dropdown.

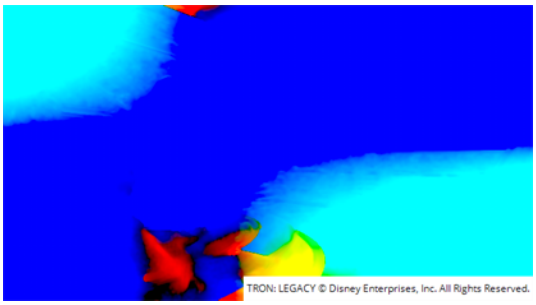
NOTE: Selecting a different GPU requires you to restart Nuke before the change takes effect.

5. From the **Views to Use** menu or buttons, select which views you want to use for the left and right eye when creating the disparity map.
6. If there are areas in the image that you want to ignore when generating the disparity map, supply a mask either in the **Mask** input or the alpha of the **Source** input. In the O_DisparityGenerator controls, set **Mask** to the component you want to use as the mask.

   Note that masks should exist in both views, and O_DisparityGenerator treats the alpha values of 1 as foreground and blurs to the 0 value using nearby disparity to recreate object boundaries, rather than image data. When you create a mask using Roto or RotoPaint, you can use the **feather** control to extend the calculation. For example, the disparity map may have a sharper transition at depth edges with a binary mask, but applying feather on the mask can help smooth the resulting image.
7. Attach a Viewer to the O_DisparityGenerator node, and display one of the disparity channels in the Viewer by selecting it from the **channels** dropdown above the Viewer.

   O_DisparityGenerator calculates the disparity map and stores it in the disparity channels.

The Source clip.



A disparity map.

TIP: Reading depth in disparity maps can be tricky in RGB. There are a number of ways to make the depth easier to read, but the simplest is to:

- Set the Viewer **channels** control to **disparityL** and the **R** layer within the channel.
- Move the pointer around the image to locate the highest positive or negative red value using the Viewer info bar.
- Set the **gain** field to **+/-1** divided by the red value. For example, **1/20** for positive values or **-1/20** for negative values.

- Adjust the **gain** and **gamma** controls to reveal edges and areas of contrast. Darker areas of the image are closer to the camera and lighter areas farther away. If you use a positive gain, the light and dark colours are flipped.

8. If the calculated disparity map does not produce the results you're after (and you have already checked the quality of the solve as described in Reviewing and Editing the Results), use the O_DisparityGenerator controls to adjust the way the disparity map is calculated. You can either adjust the controls manually or use the **Preset** dropdown to automatically make adjustments for you:
   - **Custom** - automatically selected when you adjust the controls manually,
   - **Normal** - the default values for all controls.
   - **Strong** - reduces match **Stabilisation** between images and concentrates on the **Strength** of image matching.
   - **Aggressive** - increases the **Strength** to reconstruct images as close as possible to the source, but reduces **Stablilisation** in favour of accuracy.
   - **Smooth** - reduces match **Strength** between images and concentrates on **Stabilisation**.
   - **Aligned** - enables the **Alignment** control, which requires an O_Solver upstream. See Solver and Generating Disparity Using Alignment for more information.
   - **Fast** - disables the **Stabilisation** control, speeding up processing time.

   The available controls are described in O_DisparityGenerator Controls.
9. You can also use the **Parallax Histogram** display in O_DisparityViewer to review the disparity range. For more details, see DisparityViewer.

TIP: To check the quality of the generated disparity map, you can add a DisparityReviewGizmo from the **Ocula** > **Ocula 4.0** menu. This gizmo allows you to view the disparity in each view using the **output** and **background** dropdowns to control what is displayed in the Viewer. See Quality Control Tools for more information.

You can then use a RotoPaint (**Draw** > **RotoPaint**) node to edit the generated disparity channels. For example, if a specific region in the image is producing incorrect disparity vectors and you know that those vectors should match the vectors in the surrounding areas, you can use the **Clone** tool to clone out the problematic area.

You can also use O_MultiSample to fill or replace problematic areas. See MultiSample for more information.

Generating Disparity Using Alignment

Using O_DisparityGenerator in conjunction with O_Solver alignment data allows you to constrain the resulting disparity vectors to match global plate alignment. You might want to do this if your plates don't contain much detail, such as bluescreen images with markers in the background or plates with a lot of featureless areas like sky.

Using the O_Solver alignment data can reduce changes in vertical disparity with depth that are required for **Local alignment** in O_VerticalAligner and cause a vertical shift in O_NewView, where disparity doesn't pick up the local vertical shift required to match the images.

To generate a disparity map using O_Solver alignment data, do the following:

1. Start Nuke and press **S** on the Node Graph to open the project settings. Go to the **Views** tab and click the **Set up views for stereo** button.
2. From the Toolbar, select **Image** > **Read** to load your stereo clip into Nuke. If you don't have both views in the same file, select **Views** > **JoinViews** to combine them, or use a variable in the Read node's file field to replace the name of the view (use the variable **%V** to replace an entire view name, such as **left** or **right**, and **%v** to replace an initial letter, such as **l** or **r**). For more information, refer to the *Nuke User Guide*.
3. Select **Ocula** > **Ocula 4.0** > **O_Solver** to insert an O_Solver node after either the stereo clip or the JoinViews node.

NOTE: Solve data passed downstream to O_VerticalAligner is updated to match the aligned plates, except when **Vertical Skew** or **Local Alignment** is enabled. See VerticalAligner for more information.

O_Solver calculates the geometrical relationship between the two views in the input clip and requires at least one keyframe. For more instructions on how to use O_Solver, see Solver.

4. Select **Ocula** > **Ocula 4.0** > **O_DisparityGenerator** to insert an O_DisparityGenerator node after the Read node.
5. Set the **Alignment** control to a value greater than 1, so that disparity requires solve data upstream.

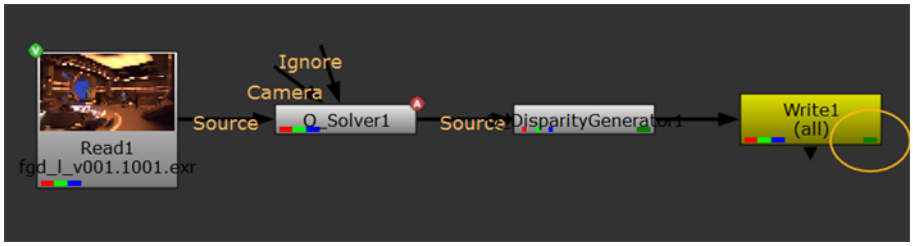
6. Continue from step 4 in Generating Disparity Maps to generate disparity vectors, including alignment data from the solve.

Writing Disparity into a Clip

When you're happy with the disparity map generated, you can save time down the line by writing the disparity into a new clip combining the source and disparity channels.

1. Select the O_DisparityGenerator node in the Node Graph.
2. Select **Image** > **Write** (or press **W** on the keyboard) to insert a Write node after O_DisparityGenerator.
3. In the Write node controls, select **all** from the **channels** dropdown and set **file type** to **exr**.
4. Enter a name for the clip in the **file** field (for example, **my_clip.####.exr**), and click **Render**.

   The newly created disparity channels are saved in the channels of your stereo clip. When you need to manipulate the same clip again later, the disparity vectors are loaded into Nuke together with the clip. The disparity channels are represented on nodes in the Node Graph by the dark green chip on the right of the node.



Rendering the output to combine the clip and the disparity channels for future use.

O_DisparityGenerator Controls

Use GPU

Open the O_DisparityGenerator controls. O_DisparityGenerator renders using the Local GPU specified, if available, rather than the CPU. The GPU may significantly improve processing performance.

If there is no suitable GPU, or the required NVIDIA CUDA drivers are unavailable, O_DisparityGenerator defaults to using the CPU. You can select a different GPU Device, if available, by opening Nuke's **Preferences** and selecting an alternative card from the **GPU Device** dropdown.

NOTE: Selecting a different GPU requires you to restart Nuke before the change takes effect.

Views to Use

From the views that exist in your project settings, select the two views you want to use to create the disparity map. These views are mapped for the left and right eye.

Preset

Use the **Preset** dropdown to automatically make adjustments to the disparity results by changing the appropriate refinement controls:

Custom	Automatically selected when you adjust the controls manually,
Normal	The default value for all controls.
Strong	Increases match **Strength** between images at the expense of **Stabilisation**. You can use **Strong** when picture building is poor using O_NewView, O_ColourMatcher, and O_FocusMatcher.
Aggressive	Increases the **Strength** used to reconstruct images as close as possible to the source, but reduces **Stablilisation** in favour of accuracy. This option gives the best result in O_NewView to reproduce the appearance of one view from another and is useful for colour or focus matching.  NOTE: Aggressive calculation can produce poor stability, which makes it unsuitable for copying fixes from one view to the other.
Smooth	Reduces match **Strength** between images and concentrates on **Stabilisation**. This option produces smoother, temporally stable vectors. Use **Smooth** to generate clean depth maps and to prevent flicker when copying a fix from one view to the other.  NOTE: Smooth vectors are cleaner and stable from one frame to the next, but the image may not reconstruct well with O_NewView.
Aligned	This option enables the **Alignment** control, which requires an O_Solver upstream.
Fast	This option disables the **Stabilisation** control, reducing processing time.

Mask

An optional mask that specifies areas to exclude from the disparity calculation. You can use this input to prevent distortions at occlusions or to calculate disparity for a background layer by ignoring all foreground elements.

Note that masks should exist in both views, and O_DisparityGenerator treats the alpha values of 1 as foreground and blurs to the 0 value using nearby disparity to recreate object boundaries, rather than image data. When you create a mask using Roto or RotoPaint, you can use the **feather** control to extend the calculation. For example, the disparity map may have a sharper transition at depth edges with a binary mask, but applying feather on the mask can help smooth the resulting image.

None	Use the entire image area.
Source Alpha	Use the alpha channel of the **Source** clip as an ignore mask.
Source Inverted Alpha	Use the inverted alpha channel of the **Source** clip as an ignore mask.
Mask Luminance	Use the luminance of the **Mask** input as an ignore mask.
Mask Inverted Luminance	Use the inverted luminance of the **Mask** input as an ignore mask.
Mask Alpha	Use the alpha channel of the **Mask** input as an ignore mask.
Mask Inverted Alpha	Use the inverted alpha channel of the **Mask** input as an ignore mask.

Vector Detail

Adjusts the density of the calculated disparity vectors. Higher detail picks up finer disparity changes, but takes longer to calculate.

Strength

Sets the strength applied when matching pixels between the left and right views. Higher values allow you to accurately match similar pixels in one image to another, concentrating on detail matching even if the resulting disparity map is jagged. Lower values may miss local detail, but are less likely to provide you with the odd spurious vector, producing smoother results.

Often, it is necessary to trade one of these qualities off against the other. You may want to increase **Strength** to force the views to match where fine details are missed, or decrease it to smooth out the disparity map.

Low **Strength** values smooth the disparity map, but can miss local detail.

High **Strength** values add detail, but can cause jagged disparity.

Consistency

Sets how accurately the same points in the left and right views are mapped to each other. Increase the value to encourage the left and right disparity vectors to match.

Smoothness

Controls how image edges are used as clues for sharp transitions in depth in the scene. The higher the value, the smoother the transition between depths at edges in the image.

Low **Smoothness** can produce better depth definition at edges.

High **Smoothness** produces smoother disparity maps, but can lose depth detail at edges.

Alignment

Sets how much to constrain the disparities to match the vertical alignment defined by an upstream O_Solver node. Increasing the value forces the disparities to be aligned and requires at least one keyframe match.

NOTE: The default **Alignment** value of **0** calculates the disparity using unconstrained motion estimation, and therefore, does not require O_Solver data.

Using O_DisparityGenerator in conjunction with O_Solver alignment data allows you to constrain the resulting disparity vectors to match global plate alignment. You might want to do this if your plates don't contain much detail, such as bluescreen images with markers in the background or plates with a lot of featureless areas like sky.

NOTE: Using the O_Solver alignment data can reduce changes in vertical disparity with depth that are required for **Local alignment** in O_VerticalAligner and cause a vertical shift in O_NewView, where disparity doesn't pick up the local vertical shift required to match the images.

Stabilisation

Sets how heavily vectors are forced to be temporally consistent by generating disparity over multiple frames, rather than a single stereo frame. Increasing the value produces smoother vectors, which are more stable over time, but at the expense of increased processing time.

TIP: Decreasing the value can produce more accurate results when rebuilding views using O_NewView. See NewView for more information.

Default **Stabilisation** can lose detail at edges in the image.

High **Stabilisation** produces smoother vectors, which are more stable over time.

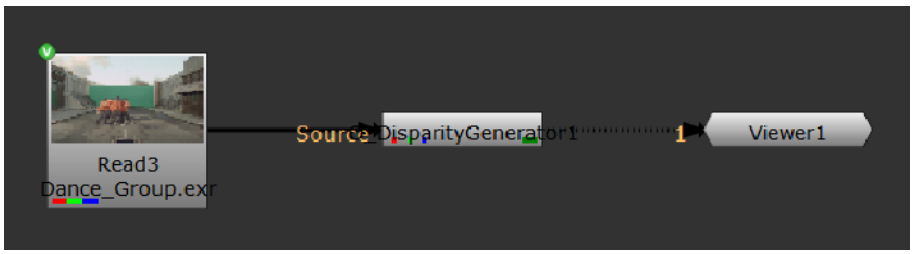
O_DisparityGenerator Example

In this example, we read in a stereo image, use O_DisparityGenerator to calculate its disparity map, review the results using DisparityReviewGizmo, and render the result as a single **.exr** file that contains the left and the right view and the newly created disparity channels. Later, whenever you use the same image, the disparity map is loaded into Nuke together with the image. This makes the disparity map readily available for the other Ocula nodes, many of which need it to produce their output.

The stereo image used in this example can be downloaded from our website at http://www.thefoundry.co.uk/support/user-guides#ocula.

Step by Step

1. Start Nuke and press **S** on the Node Graph to open the project settings. Go to the **Views** tab and click the **Set up views for stereo** button.
2. Select **Image** > **Read** to import **Dance_Group.exr**. The **.exr** format allows both views to exist in a single file, so Nuke reads in both the left and the right view using the same Read node.
3. Select **Ocula** > **Ocula 4.0** > **O_DisparityGenerator** to insert an O_DisparityGenerator node.



The node tree with O_DisparityGenerator.

4. Display one of the disparity channels by selecting it from the channel set and channel menus in the upper-left corner of the Viewer.

   O_DisparityGenerator calculates the disparity map. You will probably see something colourful and seemingly unreadable, much like the image below. Don't worry - that's what the disparity channels are supposed to look like.

   Reading depth in disparity maps can be tricky in RGB. There are a number of ways to make the depth easier to read, but the simplest is to adjust the Viewer controls to display the results:

   - Set the Viewer **channels** control to **disparityL** and the **R** layer within the channel.
   - Move the pointer around the image to locate the highest negative red value using the Viewer info bar.
   - Set the Viewer **gain** numeric field to **-1/<red value>**, such as **-1/40**.
   - Adjust the Viewer **gain** and **gamma** controls to reveal edges and areas of contrast. Darker areas of the image are closer to the camera and lighter areas farther away.

The calculated RGB disparity map.

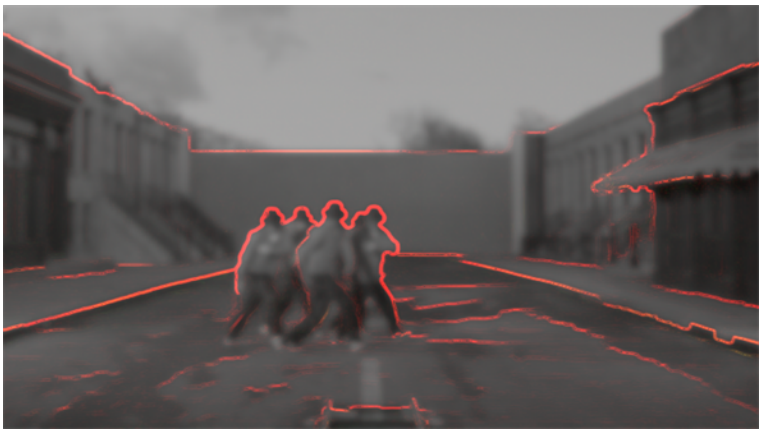
The same map, but with the Viewer adjusted.

Ocula also ships with a disparity checking gizmo, called DisparityReviewGizmo, to help you check that your disparity calculations are correct before you pass the data down the Node Graph.

5. Select **Ocula** > **Ocula 4.0** > **DisparityReviewGizmo** to insert the gizmo after the O_DisparityGenerator node.

NOTE: To use the gizmo's full toolset, you'll also need an occlusion map. See OcclusionDetector for more information on how to generate occlusion maps.

6. The gizmo's default settings display your stereo source image, desaturated so that the overlay generated by the gizmo is easily visible. Disparity on the X and Y axes are displayed in red and green, respectively, and occlusions are displayed in blue (if you've generated an occlusion map).



In our example, we haven't added occlusion data (blue) and there isn't any appreciable Y axis displacement (green). The red overlay is generally picking out the changes in depth pretty well.

7. Select **Image** > **Write** to insert a Write node between the O_DisparityGenerator and the Viewer.
8. In the Write node controls, select **all** from the **channels** menu to include the disparity channels in the rendered file.
9. In the **file** field, enter a file name and location for the new **.exr** file. Make sure **file type** is set to **exr**. Then, click the **Render** button to render the image as usual.
10. Import the **.exr** file you created. Using the Viewer controls, check that it contains the left and the right view and the disparity channels.

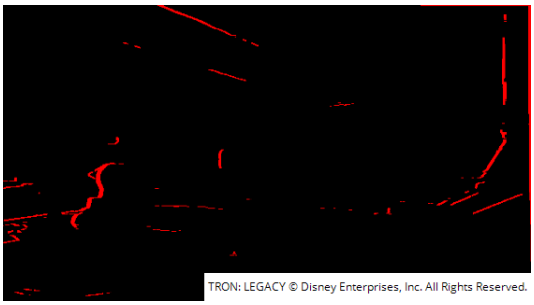
    You can now use the **.exr** file you created together with many of the other Ocula nodes without having to insert an O_DisparityGenerator node before them.

3 OcclusionDetector

Description

O_OcclusionDetector generates a mask for the occluded regions in each view. Occluded regions are pixels that are visible in one view but not the other.

The left view of a stereo image.



The occlusion mask generated for the left view (pixels occluded in the left view).

An occlusion mask identifies areas that cannot be rebuilt as some of the pixels in one view are not visible in the other. You can use it to quality check the result of O_DisparityGenerator and to identify image regions that are likely to fail when using the Ocula nodes that rely on rebuilding one view from the other. If the pixel information isn't there in one view, it cannot be generated for the other. After you have identified the areas which are not suitable for picture building, you can choose how to handle these in order to get the best possible result.

You may want to generate an occlusion mask for each view when using the following nodes:

FocusMatcher	This node requires an occlusion mask upstream to produce its output.
ColourMatcher	This node requires an occlusion mask upstream to produce its output.
DisparityGenerator	This node does NOT require an occlusion mask, but you can use one downstream to quality check the generated disparity map.

NewView	This node requires an occlusion mask upstream to produce its output.
InteraxialShifter	This node requires an occlusion mask upstream to produce its output.
Retimer	This node does NOT require an occlusion mask to produce its output, but you can use one upstream to preview where they may struggle to generate a new view.

The final occlusion masks for each view are stored in the **mask_occlusion** channel. You can view them in Nuke by setting the alpha channel menu to **mask_occlusion.alpha** and pressing **M** on the keyboard with the Viewer selected. This superimposes the occlusion mask for the current view as a red overlay on top of the image's RGB channels as shown below.

An occlusion mask displayed on top of the colour channels.

After you have generated an occlusion mask, you can use a Write node to render the mask into the channels of your stereo **.exr** file along with the colour and disparity channels. When you use the same image sequence at a different time, the occlusion mask is loaded into Nuke along with the sequence.

The O_OcclusionDetector requires upstream disparity channels to produce its output. For an in-depth explanation of how to create disparity channels, refer to the DisparityGenerator chapter.

Inputs

O_OcclusionDetector has one input:

Source	A stereo pair of images. If disparity channels are not embedded in the images, you need to add an O_DisparityGenerator node after the image sequence.

To see a table listing the nodes or channels each Ocula node requires in its inputs, turn to Appendix B.

Creating and Editing Occlusion Masks

Creating an Occlusion Mask

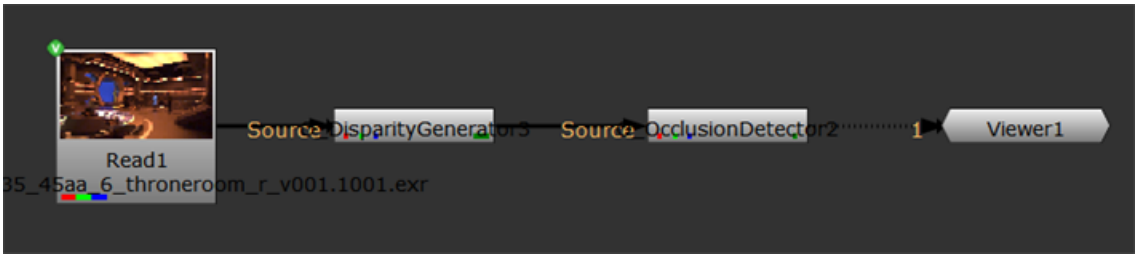
NOTE: Disparity vectors are required to generate an occlusion mask.

To generate an occlusion mask, do the following:

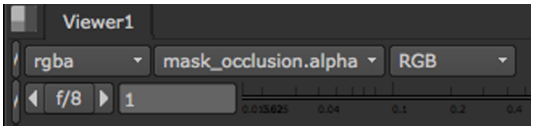
1. If disparity vectors do not yet exist in the script, insert an O_DisparityGenerator node after your image sequence to calculate the disparity vectors. See DisparityGenerator for more information.

NOTE: Disparity vectors may already exist in the image sequence, in which case you do not need to insert an O_DisparityGenerator node to generate an occlusion mask.

2. From the toolbar, select **Ocula** > **Ocula 4.0** > **O_OcclusionDetector** to add an O_OcclusionDetector node. Insert the O_OcclusionDetector node either after the O_DisparityGenerator node (if you added one in the previous step), or the stereo image sequence. Your node tree should now look something like this:



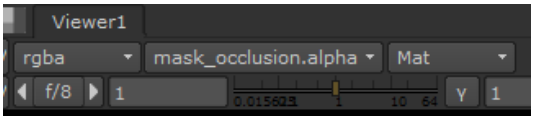
3. Open the O_OcclusionDetector controls. O_OcclusionDetector renders using the Local GPU specified, if available, rather than the CPU. The output between the GPU and CPU is identical, but using the GPU can significantly improve processing performance. See O_OcclusionDetector Controls for more details.
4. In the O_OcclusionDetector controls, you can see all the views that exist in your project settings under **Views to Use**. Select the two views you want to use to calculate the occlusion mask. The two views you select are mapped for the left and right eye. O_OcclusionDetector calculates the occlusion mask and stores it in the **mask_occlusion.alpha** channel.
5. In the Viewer controls, set the alpha channel menu to **mask_occlusion.alpha** as shown below.



Set this menu to **mask_occlusion.alpha**.

This sets the occlusion mask that O_OcclusionDetector generated as the channel displayed in the alpha channel.

6. Next, you can either select **Matte overlay** from the **RGB** dropdown or press **M** on the keyboard with the Viewer selected, to superimpose that channel as a red overlay on top of the image's RGB channels.



Set **RBG** to **Matte overlay**

The red overlay indicates occluded regions where picture building operations are likely to fail.

7. Adjust the **Gradient Threshold**, **Consistency Threshold** and **Dilate Occlusions** controls as required to generate the best possible result. See O_OcclusionDetector Controls for information about the controls.
8. When you're happy with the results, press **M** again to return to the RGB display.

Manually Editing an Occlusion Mask

If there are occluded regions in the mask, which have not been marked correctly, you can manually edit the mask by doing the following:

1. Press **P** on the Node Graph to add a RotoPaint node after O_OcclusionDetector.
2. To add regions to the occlusion mask, set **output** to **mask_occlusion** in the RotoPaint controls, and use the paint tools to mark additional regions.
3. To remove or correct existing occluded regions, set **output** to **mask_occlusion** in the RotoPaint controls, and set the paint brush colour to black to manually paint out or correct the occluded areas.

Rendering Out and Loading Occlusion Masks

To render and save the colour channels, disparity channels and occlusion mask into the channels of a stereo **.exr** file, insert a Write node after the O_OcclusionDetector node. When you load the image sequence at a different time, the occlusion mask is loaded with it.

NOTE: If you correct occlusions using RotoPaint, insert a Write node after the RotoPaint node to include your corrections in the occlusion channel.

Editing Rendered Occlusion Masks

You can edit the rendered occlusion mask that you have loaded for use with O_FocusMatcher or O_ColourMatcher, using two different methods:

- Insert a RotoPaint node to adjust the occlusions manually with paint.
- Replace the occlusions by inserting a new O_OcclusionDetector. This overwrites the original occlusion mask. However, you can disable or delete the new O_OcclusionDetector node to revert back to the original mask.

O_OcclusionDetector Controls

Use GPU

Open the O_OcclusionDetector controls. O_OcclusionDetector renders using the Local GPU specified, if available, rather than the CPU. The GPU may significantly improve processing performance.

If there is no suitable GPU, or the required NVIDIA CUDA drivers are unavailable, O_OcclusionDetector defaults to using the CPU. You can select a different GPU Device, if available, by opening Nuke's **Preferences** and selecting an alternative card from the **GPU Device** dropdown.

NOTE: Selecting a different GPU requires you to restart Nuke before the change takes effect.

Views to Use

From the views that exist in your project settings, select the two views you want to use to generate an occlusion mask. These views are mapped for the left and right eye.

Gradient Threshold

The gradient measures the change in depth from horizontal disparity. You can use the **Gradient Threshold** control to define where occlusions occur at depth changes. The lower the gradient threshold, the greater the number of occluded regions.

The occlusion mask with the default **Gradient Threshold**.

The occlusion mask with a low **Gradient Threshold** set.

Consistency Threshold

The **Consistency Threshold** control allows you to set occlusions where the left and right disparities are not consistent. A low **Consistency Threshold** value, detects more inconsistencies.

The occlusion mask with a low **Consistency Threshold** set.

The occlusion mask with a high **Consistency Threshold** set.

Dilate Occlusions

You can use the **Dilate Occlusions** control to expand the occluded regions by a specified number of pixels. The maximum you can dilate the occlusions by is 20 pixels.

Occlusion Dilate = 1.

Occlusion Dilate = 15.

O_OcclusionDetector Example

See O_FocusMatcher Example for an example of how to use O_OcclusionDetector with O_FocusMatcher.

4 NewView

Description

You can use the O_NewView node to reconstruct a view – either left or right – using the pixels from the other view. For example, you can choose to reconstruct the left view using the pixels from the right view. This can be useful if you want to manipulate one view (with a gizmo, node, or graphics editor for example) and replicate the changes into the other view.

NOTE: The O_NewView node requires disparity vectors that relate the two views. If they don't already exist, you can use the O_DisparityGenerator node to calculate these vectors. See DisparityGenerator for how to do this.

If there are no occlusions (features visible in one view but not the other), O_NewView generally produces a good result. When there are occlusions, the result may require further editing but can often save you time over not using the node at all.

If you use O_NewView to reproduce changes made to one view in the other view, you may want to create the disparity vectors using either the modified view and its corresponding view, or the original views with no changes applied. It's recommended to choose the views that produce the best disparity vectors. For example, the former method may be preferable if you are correcting an unwanted colour shift between views. The latter method may be preferable if your changes in one view produce an occlusion or a change in texture appearance, which makes the process of finding correspondences between the modified images harder.

When you are using Ocula to update one view to match another, it is advised to quality check the updated view using the DisparityReviewGizmo. See DisparityReviewGizmo for more information.

NOTE: To reproduce changes you have made using Nuke's Roto node, RotoPaint node, or any node or gizmo that has controls for x and y coordinates, see the *Stereoscopic Projects* chapter in the *Nuke User Guide*.

Inputs

O_NewView has the following inputs:

CleanPlate	A clean background plate used to fill areas of occlusion when **Correction** is set to **Use CleanPlate**. NOTE: If no image is connected, a **Channels missing at CleanPlate input. Please connect RGB input to CleanPlate** error is displayed.
Source	A stereo pair of images. If disparity channels are not embedded in the images, you need to add an O_DisparityGenerator node after the image sequence. O_NewView also requires an occlusion mask, which you can generate using an O_OcclusionDetector node.

To see a table listing the nodes or channels each Ocula node requires in its inputs, see Appendix B.

Creating a New View

NOTE: O_NewView requires disparity vectors and an occlusion mask to operate correctly.

To create a new view, complete the following steps:

1. If disparity vectors don't yet exist in the script, you can insert an O_DisparityGenerator node to calculate the disparity vectors.
2. Select **Ocula** > **Ocula 4.0** > **O_OcclusionDetector** to insert an O_OcclusionDetector node. Insert the O_OcclusionDetector node after either the O_DisparityGenerator node (if you added one in the previous step) or the stereo image sequence.
3. Select **Ocula** > **Ocula 4.0** > **O_NewView** to insert an O_NewView node after the O_OcclusionDetector node.
4. Attach a Viewer to the O_NewView node. Your node tree should now look something like this:

5. In the O_NewView controls, select the two views you want to use under **View to Use**. The two views you select are mapped for the left and right eye.
6. From the **View to build** dropdown menu, select either **Left from Right** or **Right from Left**, depending on which view you want to rebuild.
7. Adjust the required controls to get the best possible result. See O_NewView Controls for more information.

O_NewView Controls

Use GPU

Open the O_NewView controls. O_NewView renders using the Local GPU specified, if available, rather than the CPU. The GPU may significantly improve processing performance.

If there is no suitable GPU, or the required NVIDIA CUDA drivers are unavailable, O_NewView defaults to using the CPU. You can select a different GPU Device, if available, by opening Nuke's **Preferences** and selecting an alternative card from the **GPU Device** dropdown.


NOTE: Selecting a different GPU requires you to restart Nuke before the change takes effect.

Views to Use

From the views that exist in your project settings, select the two views you want to use to generate the new view. These views are mapped for the left and right eye.

View to Build

Select which inputs to use to generate the new view.

Left from Right	Use the pixels from the right view to build a new left view.
Right from Left	Use the pixels from the left view to build a new right view.

Pass through other view

Select the **Pass through other view** checkbox to output both views; the new view and the original source view. If this checkbox is disabled, only the new view is output.

Occlusions

Output occlusions to alpha

Select the **Output occlusions to alpha** checkbox to output the occlusions to the alpha channel. Occlusions occur when some pixels are not visible in the source view, and therefore cannot be used to create the new view. You can use the alpha channel as an overlay to determine where the occlusion correction is applied.

Correction

You can use the **Occlusions** – **Correction** control to determine how occluded regions are dealt with.

Use original	Select this option to retain the original view in the occluded regions. For example, if you are using the original left view to build a new right view, the original right view is retained in the occluded regions to help build the new right view.
Expand foreground	Select this option to fill occluded regions by expanding the surrounding area from the original source view. For example, if you are using the original left view to build a new right view, the foreground of the original left view is expanded to help build the new right view.  NOTE: Expanding the foreground may offset the edges.
Use CleanPlate	Select this option to fill occluded areas using a clean background which is connected using the **CleanPlate** input.  NOTE: If no image is connected, a **Channels missing at CleanPlate input. Please connect RGB input to CleanPlate** error is displayed.
None	Select this option to avoid filling the occluded regions.

Edges

Output edges to alpha

You can use the **Output edges to alpha** checkbox to output the edges to the alpha channel. Use the alpha channel as an overlay to determine where the edge correction is applied.

Correction

You can use the **Edges** – **Correction** control to determine how image edges at depth boundaries are handled.

Match original	Select this option to match the appearance of the original view at the edges. For example, if you are using the original left view to build a new a right view, the edges are matched from the original right view to help build the new right view.
Match foreground	Select this option to match the edges from the original source view that was used to build the new view. For example, if you are using the original left view to build a new right view, the edges are matched from the original left view to help build the new right view.
None	Select this option to avoid applying edge correction.

Adjust Edges

You can use the **Adjust Edges** control to set the extent of the region where the edge correction is applied. To blend the correction into the background, use a positive value. To restrict the correction to the edges, use a negative value.

O_NewView Example

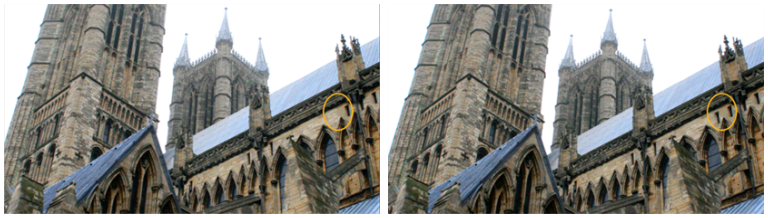
In this example, we have a stereo image of a cathedral. In the left view, one of the cathedral windows is missing. Our aim is to reproduce the missing window from the right view into the left view using O_NewView. To do this. we can use O_NewView to produce a completely new left view, using the pixels from the right view.

The stereo image used in the example can be downloaded from our website. For more information, see Example Images.

The necessary disparity channels have been embedded in the download image, so you don't need to insert an O_Solver node and an O_DisparityGenerator node in this example.

Step by Step

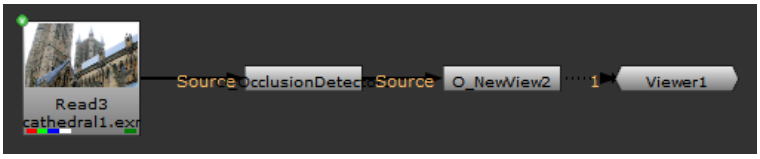
1. Launch Nuke and open the project settings (press **S** on the Node Graph). Go to the **Views** tab and click the **Set up views for stereo** button.
2. Import **cathedral1.exr** and attach a Viewer to the image. Switch between the left and the right view using the Viewer controls (or the **;** and **'** hotkeys). Notice that the cathedral is missing a window in the left view, as shown below.



The left view. The right view.

We want to build a new left view to replicate the additional window, using the O_NewView node.

3. Select **Ocula** > **Ocula 4.0** > **O_OcclusionDetector** to insert an O_OcclusionDetector node after the stereo image.
4. Select **Ocula** > **Ocula 4.0** > **O_NewView** to insert an O_NewView node after the O_OcclusionDetector node.



5. In the O_NewView controls, select **Left from Right** from the **View to Build** menu to generate the new left view using the right view as a source. The image below shows the new left view. As you can see, it now includes the window that was previously missing.

6. Select the **Pass through other view** checkbox. This means both the new view and the original source view are output.
7. Using the Viewer controls, switch between the left and the right views. The window that was previously missing from the left view, is now present in both views.

The new left view.

The original right view.

5 ColourMatcher

Description

The O_ColourMatcher node enables you match the colours of one view with those of another. It has been specifically designed to deal with the subtle colour differences that are sometimes present between stereo views.

The original left view.

The original right view.

The colour corrected right view.

Colour discrepancies between views can be caused by several factors. For example, stereo footage may have been shot with cameras which had different polarisation, or there may have been slight differences between the physical characteristics of the two camera lenses or image sensors. If the colour differences are not corrected, viewers may experience difficulty in fusing objects and as a result may not enjoy the viewing experience.

Correcting colour differences manually in post-production can be a time-consuming process and requires considerable skill. O_ColourMatcher enables you to automate the colour grading required.

O_ColourMatcher has two different modes you can use to perform a colour match; **Basic** mode and **Local Matching** mode. Both modes require an O_DisparityGenerator node and an O_OcclusionDetector node upstream of the O_ColourMatcher node.

Basic Mode

The **Basic** colour matching mode takes the colour distribution of one entire view and modifies it to match the distribution of the other view.

Local Matching Mode

The **Local Matching** mode first divides the two images into square blocks according to the **Block Size** control. Then, it matches the colour distribution from the view that want to modify to a reconstructed version of the same view, which has been constructed using the pixels of the source view. When an occluded pixel is detected by an upstream occlusion mask, O_ColourMatcher finds the closest unoccluded pixel and then uses this to make the colour match for the occluded pixel.

Local Matching mode can be useful if there are local colour differences between the views, such as highlights that are brighter in one view than the other.

Inputs

O_ColourMatcher has the following inputs:

Source	A stereo pair of images. If disparity channels and occlusion masks are not embedded in the images and you are using the **Local Matching** mode, you need to add an O_Solver, an O_DisparityGenerator, and an O_OcclusionDetector node after the image sequence.
Mask	An optional mask that determines where to take the colour distribution from. For example, if you have a clip showing a person in front of a green screen, you might want to use a mask to exclude the green area so the node concentrates on matching the person. In the **Basic** mode, O_ColourMatcher calculates the transform on the masked area of the source view but applies it to the whole of the view it's correcting. In the **Local Matching** mode, it calculates the transform on the masked area and applies it to that area only.

To see a table listing the nodes or channels each Ocula node requires in its inputs, turn to Appendix B.

Performing a Colour Match

O_ColourMatcher has two different modes you can use to perform a colour match; **Basic** mode and **Local Matching** mode. Both modes require an O_DisparityGenerator and an O_OcclusionDetector node upstream of the O_ColourMatcher node.

To perform a colour match, complete the following steps:

1. If they don't exist already, insert an O_DisparityGenerator node and an O_OcclusionDetector node after your stereo clip. See DisparityGenerator and OcclusionDetector
2. Select **Ocula** > **Ocula 4.0** > **O_ColourMatcher** to insert an O_ColourMatcher node after the O_DisparityGenerator and O_OcclusionDetector nodes.
3. Connect a Viewer to the O_ColourMatcher node. Your node tree should now look something like this:

O_ColourMatcher node tree.

4. In the O_ColourMatcher controls, select the two views you want to use for the colour match under **View to Use**. The two views you select are mapped for the left and right eye.
5. From the **Match** menu, select either **Left to Right** or **Right to Left** depending on the direction in which you want to perform the colour match.
6. Select the required mode from the **Mode** dropdown in the O_ColourMatcher controls. See O_ColourMatcher Controls for more information about the different modes.
7. Adjust the O_ColourMatcher controls to get the best possible result. See O_ColourMatcher Controls for more information about the controls.

Editing Colour Match Results

If you can see areas where the colour match is wrong, make sure they are included in the upstream occlusion mask. You can edit the occlusion mask in two ways:

- Adjust O_OcclusionDetector controls.
- Use a RotoPaint node before O_ColourMatcher and manually edit the mask by using the paint tool to add occluded regions into the **mask_occlusion** channel.

O_ColourMatcher Controls

Use GPU

Open the O_ColourMatcher controls. O_ColourMatcher renders using the Local GPU specified, if available, rather than the CPU. The GPU may significantly improve processing performance.

If there is no suitable GPU, or the required NVIDIA CUDA drivers are unavailable, O_ColourMatcher defaults to using the CPU. You can select a different GPU Device, if available, by opening Nuke's **Preferences** and selecting an alternative card from the **GPU Device** dropdown.


NOTE: Selecting a different GPU requires you to restart Nuke before the change takes effect.

Views to Use

From the views that exist in your project settings, select the two views you want to use to generate an occlusion mask. These views are mapped for the left and right eye.

Match

The Match control allows you specify the direction in which to perform the colour match.

Left to Right	Adjust the colours of the left view to match with those of the right.
Right to Left	Adjust the colours of the right view to match with those of the left.

Mode

You can use two different modes to perform a colour match:

Basic	This mode takes the colour distribution of one entire view and modifies that to match the distribution of the other view.
Local Matching	This mode first divides the two images into square blocks according to the **Block Size** control. Then, it matches the colour distribution from the view that want to modify to a reconstructed version of the same view, which has been constructed using the pixels of the source view. This can be useful if there are local colour differences between the views, such as highlights that are brighter in one view than the other.


NOTE: Both modes require an O_DisparityGenerator node and an O_OcclusionDetector node upstream of the O_ColourMatcher node.

Mask

If there are areas in the image that you want to ignore when calculating the colour transformation, you can use the **Mask** control to supply a mask. In the O_ColourMatcher controls, set **Mask** to the component you want to use as the mask. The following **Mask** settings are available:

None	Use the entire image area.
Source Alpha	Use the alpha channel of the **Source** clip as a mask.
Source Inverted Alpha	Use the inverted alpha channel of the **Source** clip as a mask.
Mask Luminance	Use the luminance of the **Mask** input as a mask.
Mask Inverted Luminance	Use the inverted luminance of the **Mask** input as a mask.
Mask Alpha	Use the alpha channel of the **Mask** input as a mask.
Mask Inverted Alpha	Use the inverted alpha channel of the **Mask** input as a mask.

NOTE: You can also use the alpha channel of the **Source** input to supply a mask.

View Menu Button 

The **View menu** button allows you to select different settings for the left and right view. It is displayed to the right of a control that it can be applied to. See **Block Size** further in this section for an example of how to use it.

Local Matching

NOTE: These settings are only available with the **Local Matching** mode selected.

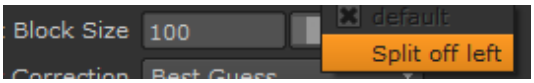
Preview colour correction

Enable this control to preview the areas of colour correction applied to the original image as a difference overlay.

Block Size

This control defines the width and height (in pixels) of the square blocks that the images are divided into when calculating the colour match. You can set different block sizes for each view by doing the following:

1. Click the **View menu** button to the right of the block size.
2. Select **Split off left**.



This displays two fields for **Box Size**, one for the left view and one for the right view.

3. To revert back to using the same size for both views, click the **View menu** button again and select **Unsplit left**.

Scale

Set the image scale for local colour matching. You can increase the **Scale** to broaden the colour update and preserve the image structure, helping to prevent image shift and wobble. Decrease the **Scale** to pick up highlights and detailed colour changes.

Limit

Sets a limit on local colour matching against the average correction in a region. If you notice excessive colour changes in areas of highlight, try reducing the **Limit**.

Noise

The **Noise** control allows you to set how much noise to retain from original image. If the colour matching smooths the input noise, increase the **Noise** value. If the value is too high, colour differences at very fine details are retained.

Occlusions

NOTE: These settings are only available with the **Local Matching** mode selected.

Output corrected area to alpha

Select the **Output corrected area to alpha** checkbox to output the corrected area to the alpha channel. The corrected area can consist of the occlusion mask and the disparity edge mask set using the **Adjust Edges** control, depending on what the **Correction** control is set to (**Occlusions**, **Occlusions and Edges**, or **None**).

Correction

Defines which areas receive the colour correction when local colour matching is not valid.

Occlusions	Fill occluded pixels only, where colour is missing from the other view.
Occlusions and Edges	Fill occluded pixels, where colour is missing from the other view, and compensate for disparity changes at edges where matching and/or reconstruction can fail.
None	Apply no occlusion or edge correction.

Adjust Edges

The **Adjust Edges** control allows you to set the threshold for treating image edges as occlusions to reduce haloing and edge flicker. The higher the value, the more image edges are considered occlusions even if they are not marked as such in the upstream occlusion mask.

Colour Tolerance

The **Colour Tolerance** control allows you to set the amount of blurring across edges in the colour match at occluded regions. Decrease this to restrict the colour correction in occluded regions to similar colours. Increase the value to blur the colour correction.

Support Size

Use the **Support Size** control to set the size of the region (in pixels) of unoccluded pixels used to calculate the colour correction at an occluded pixel. O_ColourMatcher first finds the closest unoccluded pixel and then expands that distance by this number of pixels to determine the amount of unoccluded pixels to use.

Stabilise occlusions

Enabling this control can reduce flicker in occluded areas by using data from multiple frames.

O_ColourMatcher Example

In this example, there is a subtle colour discrepancy between our stereo views and reflections that are present in one view but not the other. To fix this, we need to match the colours of the right view with those of the left using the **Local Matching** mode. The stereo image used in the example can be downloaded from our website. For more information, please see Example Images.

Step by Step

1. Start Nuke and open the project settings by pressing **S** on the Node Graph. Select the **Views** tab and click the **Set up views for stereo** button.

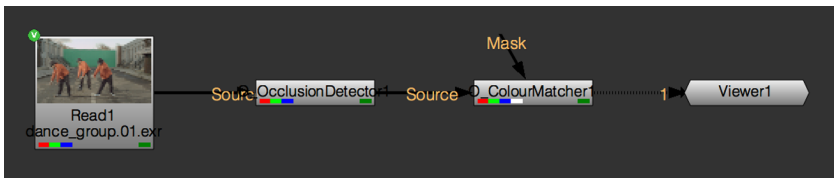
2. Import the **dance_group_disp.exr** footage. This image already includes both the left and the right view, and the necessary disparity channels.
3. Attach a Viewer to the image. Using the Viewer controls (or the **;** and **'** hotkeys), switch between the left and the right view. As you can see, there is a subtle colour difference between the views.

The original left view.

The original right view.

We are going to match the colours of the left view with those of the right.

4. Select **Ocula** > **Ocula 4.0** > **O_OcclusionDetector** to add an O_OcclusionDetector node after the stereo images.
5. Insert an O_ColourMatcher node after O_OcclusionDetector by selecting select **Ocula** > **Ocula 4.0** > **O_ColourMatcher**.



The node tree with O_ColourMatcher.

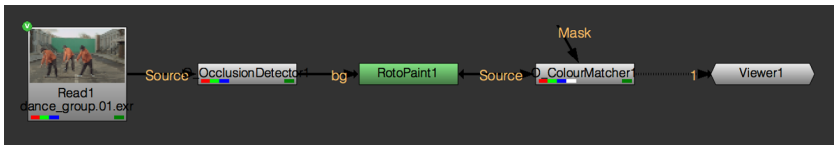
6. In the O_ColourMatcher controls, you can select either **Left to Right** or **Right to Left** from the **Match** dropdown, depending on the direction in which you want to perform the colour match. The **Match** menu is already set to **Left to Right**, which is what we want.
7. Set **Mode** to **Local Matching**.

   In this mode, O_ColourMatcher first divides the two images into square blocks according to the **Block Size** control. Then, it matches the colour distributions between corresponding blocks in the two views.

   As the **Occlusion** options are enabled in the **Local Matching** mode, O_ColourMatcher can produce better results in the occluded areas defined by the upstream occlusion mask. In these areas, O_ColourMatcher cannot correct the colour in one view by using the colour from the other. Instead, it looks for similar colours in the nearby unoccluded areas that it has already been able to match and uses the closest colour it finds.
8. View the result and switch between the two views again. Compare the new left view to the original left view by displaying the left view in the Viewer, selecting the O_ColourMatcher node, and pressing **D** a couple of times to disable and enable the node. Notice that the colours of the left view now match those of the right, but there are some artefacts in the middle of the image.

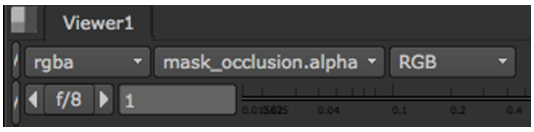
The colour corrected left view.

9. To fix this, we are going to add more areas to the occlusion mask. Press **P** on the Node Graph to add a RotoPaint node after O_OcclusionDetector.



The node tree with RotoPaint.

10. In the Viewer controls, set the alpha channel menu to **mask_occlusion.alpha** as shown below.



This sets the occlusion mask that O_OcclusionDetector generated as the channel that is displayed in the alpha channel.

Next, press **M** on the keyboard with the Viewer selected to superimpose that channel as a red overlay on top of the image's RGB channels.

The occlusion mask in a Viewer overlay.

11. Open the RotoPaint controls and set **output** to **mask_occlusion**. Activate the Brush tool in the Viewer toolbar and paint over any areas that were producing poor results. If it helps, press **D** on the O_ColourMatcher node to disable it and stop it updating after each paint stroke. Pressing **D** again re-enables the node.

Adding more areas to the occlusion mask.

12. Press **M** on the Viewer to hide the occlusion mask overlay.
13. Enable and disable O_ColourMatcher to compare the original and the colour corrected view. The results should now be more accurate. If you still see some problematic areas, you can add them to the occlusion mask too or adjust the **Local Matching** and **Occlusion** controls in the O_ColourMatcher Properties.

The final left view.

The original right view.

6 FocusMatcher

Description

O_FocusMatcher is designed to correct subtle focus differences that are sometimes present between the left and right views of a stereo image. It does this by matching the focus distribution of one view to the other, based on the disparity vectors upstream. For details on how to calculate disparity vectors, see DisparityGenerator.

The original left view.

The corrected left view.

The focus matching can be done using two different modes; the **Match Edges** mode and the **Reconstruct Edges** mode.

NOTE: Both modes require an O_DisparityGenerator node and an O_OcclusionDetector node upstream of the O_FocusMatcher node.

Match Edges Mode

The **Match Edges** mode matches the appearance of the edges from one view to the other. If you want to preserve the original image structure, it is recommended to use this mode. Also, if the blurring in your input images is subtle, the **Match Edges** mode may produce the best result.

Reconstruct Edges Mode

The **Reconstruct Edges** mode rebuilds the edges in one view from scratch, using the pixels from the other. If you want to rebuild focus exactly, or if the blurring in your image is heavy or varying, it is recommended that you use this mode.

NOTE: The result of this mode depends on the accuracy of the existing disparity vectors.

Inputs

O_FocusMatcher has the following inputs:

Source	A stereo pair of images. If disparity channels and occlusion masks are not embedded in the images, you need to insert an O_DisparityGenerator and an O_OcclusionDetector node after the image sequence.
Mask	An optional mask that determines where to perform the focus matching calculation.

To see a table listing the nodes or channels each Ocula node requires in its inputs, turn to Appendix B.

Performing a Focus Match

O_FocusMatcher has two different modes you can use to perform a colour match; **Match Edges** mode and **Reconstruct Edges** mode. Both modes require an O_DisparityGenerator node and an O_OcclusionDetector node upstream of the O_FocusMatcher node.

To perform a focus match, complete the following steps:

1. If they don't exist already, insert an O_DisparityGenerator node and an O_OcclusionDetector node after your stereo clip. See DisparityGenerator and OcclusionDetectorfor more information.
2. From the toolbar, select **Ocula** > **Ocula 4.0** > **O_FocusMatcher** to insert an O_FocusMatcher node after the O_OcclusionDetector node. Your node tree should now look something like this:

3. Select the required mode from the **Mode** dropdown in the O_FocusMatcher controls. You can use the **Match Edges** mode or the **Reconstruct Edges** mode. See O_FocusMatcher Controls for more details about the different modes.
4. Select the two views you want to use for the colour match under **View to Use**. The two views you select are mapped for the left and right eye.
5. From the **Match** menu, select either **Left to Right** or **Right to Left** depending on the direction in which you want to perform the focus match.
6. Adjust the **Local Matching** and **Occlusion** controls to get the best possible result. See O_FocusMatcher Controls for more information about the controls.

O_FocusMatcher Controls

Use GPU

Open the O_FocusMatcher controls. O_FocusMatcher renders using the Local GPU specified, if available, rather than the CPU. The GPU may significantly improve processing performance.

If there is no suitable GPU, or the required NVIDIA CUDA drivers are unavailable, O_FocusMatcher defaults to using the CPU. You can select a different GPU Device, if available, by opening Nuke's **Preferences** and selecting an alternative card from the **GPU Device** dropdown.

NOTE: Selecting a different GPU requires you to restart Nuke before the change takes effect.

Views to Use

From the views that exist in your project settings, select the two views you want to use to generate an occlusion mask. These views are mapped for the left and right eye.

Match

The Match control allows you specify the direction in which to perform the focus match in.

Left to Right	Deblur or rebuild the left view to match the right.
Right to Left	Deblur or rebuild the right view to match the left.

Mode

You can use two different modes to perform a focus match:

Match Edges	The **Match Edges** mode matches the appearance of the edges from one view to the other. If you want to preserve the original image structure, it is recommended to use this mode. If the blurring in your input images is subtle, the **Match Edges** mode may produce the best possible result.
Reconstruct Edges	The **Reconstruct Edges** mode rebuilds the edges in one view from scratch using the pixels from the other. If you want to rebuild focus exactly, or if the blurring in your image is heavy or varying, it is recommended that you use this mode. The result of this mode depends on the accuracy of the existing disparity vectors.

Mask

If there are areas in the image that you want to ignore when calculating the focus calculation, you can use the **Mask** control to supply a mask. In the O_FocusMatcher controls, set **Mask** to the component you want to use as the mask. The following **Mask** settings are available:

None	Use the entire image area.
Source Alpha	Use the alpha channel of the **Source** clip as a mask.
Source Inverted Alpha	Use the inverted alpha channel of the **Source** clip as a mask.
Mask Luminance	Use the luminance of the **Mask** input as a mask.
Mask Inverted Luminance	Use the inverted luminance of the **Mask** input as a mask.
Mask Alpha	Use the alpha channel of the **Mask** input as a mask.
Mask Inverted Alpha	Use the inverted alpha channel of the **Mask** input as a mask.

NOTE: You can also use the alpha channel of the **Source** input to supply a mask.

Local Matching

Edge Scale

This allows you to scale the edges where focus matching is performed. To restrict matching to sharp edges, use a small scale value. To match wider edges in the image, increase the scale value.

Strength

You can use the **Strength** control to set the amount of focus correction to apply. Set this to **0** for no correction, or **1** for complete correction.

Noise

NOTE: This option is only available when the **Reconstruct Edges** mode is selected.

The **Noise** control allows you to preserve the noise of the original image when using the **Reconstruct Edges** mode. To ignore noise, set this control to a low value. This matches the focus of fine details and can reconstruct noise from the other view. To retain as much of the original noise as possible, use higher values. This ensures that noise is not coherent between views, but may not match the focus at fine details in the image.

Occlusions

Output occlusions to alpha

Select the **Output occlusions to alpha** checkbox to output the corrected area to the alpha channel.The corrected area can consist of the occlusion mask and the disparity edge mask set using the **Adjust Edges** control, depending on what the **Correction** control is set to (**Occlusions**, **Occlusionsand Edges**, or **None**).

Correction

Defines which areas receive the focus correction when local focus matching is not valid.

Occlusions	Fill occluded pixels only, where colour is missing from the other view.
Occlusions and Edges	Fill occluded pixels, where colour is missing from the other view, and compensate for disparity changes at edges where matching can fail.
None	Apply no occlusion or edge correction.

Adjust Edges

The **Adjust Edges** control allows you to set the threshold for treating image edges as occlusions to reduce haloing and edge flicker. The higher the value, the more image edges are considered occlusions, even if they aren't marked as such in the upstream occlusion mask.

Colour Tolerance

The **Colour Tolerance** control allows you to set the amount of blurring across edges in the focus match at occluded regions. Decrease this to restrict the colour correction in occluded regions to similar colours. Increase the value to blur the focus correction.

Support Size

Use the **Support Size** control to set the size of the region (in pixels) of unoccluded pixels used to calculate the focus correction at a corrected pixel.

Stabilise occlusions

Enabling this control can reduce flicker in occluded areas by using data from multiple frames.

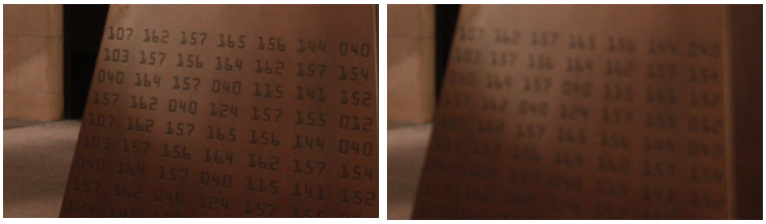
O_FocusMatcher Example

In this example, we correct the focus distribution in the right view of a stereo image by rebuilding it using the pixels from the left view.

You can download the stereo image used here from our website - please see Example Images.

Step by Step

1. Launch Nuke. Open the project settings (press **S** on the Node Graph), select the **Views** tab, and click the **Set up views for stereo** button.
2. Import **lobby.exr**. This image already includes both the left and the right view as well as the necessary disparity channels.
3. Attach a Viewer to the image and zoom in. Switch between the left and the right view using the Viewer controls (or the **;** and **'** hotkeys). As you can see, the focus distribution of the right view doesn't match that of the left.



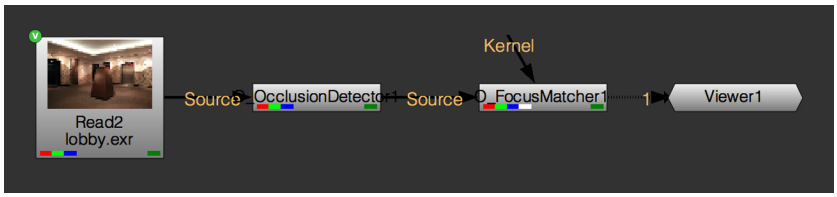
The left view. The right view.

O_FocusMatcher can fix this by rebuilding the right view using pixels from the left. In order to do so, it needs an upstream occlusion mask that identifies occluded pixels in each view. You can generate an occlusion mask using the O_OcclusionDetector node.

4. From the toolbar, select **Ocula** > **Ocula 4.0** > **O_OcclusionDetector** to insert an O_OcclusionDetector node between the image and the Viewer.

O_OcclusionDetector calculates a mask for the occluded pixels in each view and stores it in the **mask_occlusion** channel. You can adjust the mask using the O_OcclusionDetector controls, but for this example, we're going to go with the default settings.

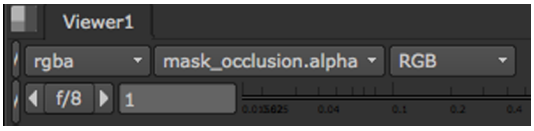
5. Next, add an O_FocusMatcher node after O_OcclusionDetector.



6. By default, O_FocusMatcher is set to rebuild the left view to match the focus of the right. We need it to do the opposite, so set the **Match** menu to **Right to Left**.

   O_FocusMatcher now rebuilds the right view using pixels from the left. If the upstream disparity map is accurate and there are no occlusions (pixels visible in one view but not the other), this generally produces good results. We have already generated an occlusion mask in step 4, so we can use it to check which areas are occluded.

7. To see the occlusion mask for the right view, select the right view from the Viewer controls and set the alpha channel menu to **mask_occlusion.alpha**. Then, press **M** on the Viewer.



The occlusion mask is shown in a red overlay on top of the colour channels. Any pixels highlighted in red are only visible in the right view but not the left.

Because these pixels don't exist in the left view, they cannot be used to rebuild the right view. In other words, O_FocusMatcher is likely to produce poor results in these occluded areas.

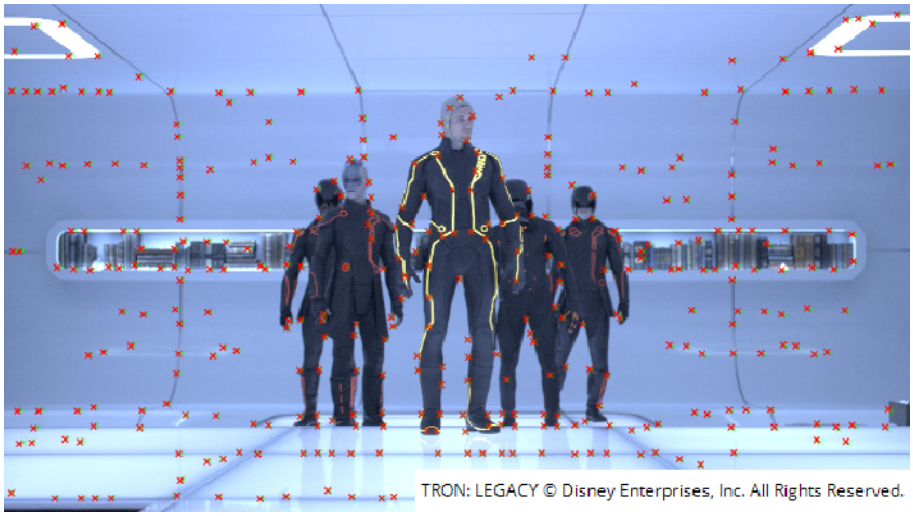
8. To get the best result, adjust the **Local Matching** and **Occlusion** controls. If required, you can manually edit the occlusion mask using a RotoPaint node (see Creating and Editing Occlusion Masks).
9. You now have your final result, so compare the rebuilt right view to both the original right view and the left view in the Viewer. You should see that the focus distribution of the right view better matches that of the left.

7 Solver

Introduction

The O_Solver node defines the geometric relationship between the two views in the input images (that is, the camera relationship or solve). This is necessary when aligning footage with O_VerticalAligner. It is also required to calculate aligned disparity vectors, when using the alignment control inDisparityGenerator. O_Solver data is not necessary for colour and focus matching using O_ColourMatcher and O_FocusMatcher.

To define the camera relationship, O_Solver detects a number of features in one view and locates the corresponding features in the other (see the image below). The feature matches and analysis data are not available until you have set at least one analysis key on O_Solver. Any frames set as analysis keys show up on the Viewer timeline and can be visualised in the Curve Editor and Dope Sheet.



O_Solver detects features in each view and tries to match them.

O_Solver calculates alignment data at the keyed analysis frames. Alignment at other frames is created by interpolating between the results at the analysis frames. This ensures that the alignment data delivered to O_DisparityGenerator and O_VerticalAligner varies smoothly across the sequence.

TIP: If you have an interactive licence (ocula_i and nuke_i), you can run O_Solver from the terminal to automatically set up analysis frames. Running from the terminal also removes the need to manually set up an Ocula node tree. See Solving Using Python for more information.

The output of the O_Solver node consists of:

- the unaltered input images, and
- the results of the feature detection and analysis, which are passed down the node tree as hidden metadata.

Because the results of the analysis are available downstream, you can use multiple Ocula nodes in the tree without having to re-analyse the camera relationship. However, if a node generates or modifies views, the current metadata becomes invalid and is removed from the tree from that point forward.

To get the best possible results, you can identify features to ignore in the analysis. This can be done by supplying a mask in the **Ignore** input.

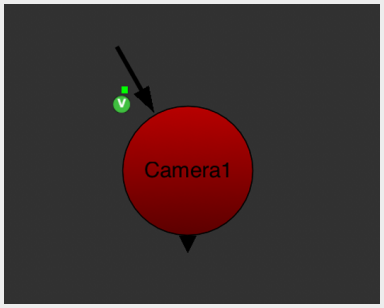
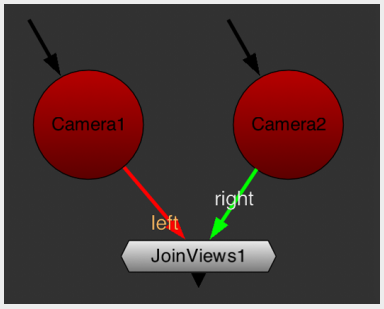
You can also add your own feature matches to the automatically detected ones. O_Solver considers any feature matches you've added yourself superior to the ones it detects automatically and pays them more attention. This can also influence which of the automatically detected features are included in the final solve. To force the feature matches to be recalculated based on the manual feature matches, use the **Re-analyse Frame** button.

If you have a pre-tracked camera that describes the camera setup used to shoot the images, you can also supply this in the **Camera** input. If you connect the Camera node before adding a keyframe, the automatically-detected feature matches are validated against the input camera. Alternatively, you can add the Camera node after the analysis and use the **Re-analyse Frame** button to recalculate matches based on the input camera. For more information, see Inputs below.

TIP: You can improve the alignment data calculated by O_Solver by adding user matches. This can be used to correct O_VerticalAligner in tricky shots, where there are few automatic matches, such as on bluescreen or greenscreen footage. See Solver for more information.

Inputs

O_Solver has the following inputs:

Camera	A pre-tracked Nuke stereo camera that describes the camera setup used to shoot the **Source** image. This can be a camera you have tracked with the CameraTracker node or imported to Nuke from a third-party camera tracking application. This input is optional. TIP: In Nuke, a stereo camera can be either: • a single Camera node in which some or all of the controls are split, or  • two Camera nodes (one for each view) followed by a JoinViews node (**Views** > **JoinViews**). The JoinViews node combines the two cameras into a single output. 
Ignore	A mask that specifies areas to ignore during the feature detection and analysis. This can be useful if an area in the **Source** image is producing incorrectly matched features. This input is optional.
Source	A stereo pair of images. These can either be the images you want to work on, or another pair of images shot with the same camera setup.

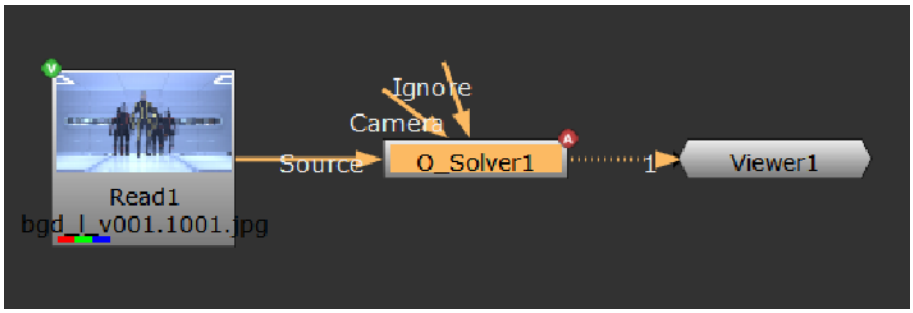
To see what data each Ocula node requires in its inputs, turn to Appendix B.

Solving the Camera Relationship

1. Launch Nuke and press **S** on the Node Graph to open the project settings. Go to the **Views** tab and click the **Set up views for stereo** button.

2. From the Toolbar, select **Image** > **Read** to load your stereo clip into Nuke. This can either be the clip you want to work on, or another clip shot with the same camera setup.

   If you don't have both views in the same file, select **Views** > **JoinViews** to combine them, or use a variable in the Read node's **file** field to replace the name of the view (use the variable **%V** to replace an entire view name, such as **left** or **right**, and **%v** to replace an initial letter, such as **l** or **r**). For more information, refer to the *Nuke User Guide*.
3. Select **Ocula** > **Ocula 4.0** > **O_Solver** to insert an O_Solver node after either the stereo clip or the JoinViews node (if you inserted one in the previous step).
4. Connect a Viewer to the O_Solver node.



The node tree with O_Solver.

5. Open the O_Solver controls. Under **Views to Use**, you can see all the views that exist in your project settings. Select the two views you want to use for the left and right eye when calculating the camera relationship.

   The two views you selected are mapped for the left and right eye.
6. If you have a pretracked Nuke stereo camera that describes the camera setup used to shoot the **Source** image, connect that to O_Solver's **Camera** input. O_Solver uses the camera information to calculate the relationship between the two views.
7. Set keyframes on your sequence for O_Solver to analyse:
   - **Key Frame** - if the camera rig doesn't change, you can set analysis keys only on one or two frames (for example, on the first and last frames). If you do set a few analysis keys, you can also check **Single Solve From All Keys** in the O_Solver controls. This tells O_Solver to calculate a single solve using all keyframes, which can improve the results.
   - **Key Sequence** - click to analyse the whole sequence automatically. This adds analysis keys where a change in camera alignment is detected.
   - **Key Nominated** - click to analyse the frames specified in the **Render** dialog. You can specify frames using Nuke's regular frame expressions. For example, if you enter "1-5 8 10 15 22-25", only those 12 frames are keyed.

     If you know there is a zoom or change in the camera setup on certain frames, you need to add more keyframes in between. Leave **Single Solve From All Keys** unchecked to use a separate solve for each analysis key, and place keyframes where the camera alignment changes.

NOTE: You can remove analysis keys one at a time by scrubbing the playhead to the required frame and clicking **Delete Key** or remove all the analysis keys from the sequence by clicking **Delete All**.

O_Solver analyses the frames you added and, if it finds more than one analysis key, it interpolates the results between them. Interpolating between analysis keys ensures that the calculated camera relationship varies smoothly across the sequence.

To visualise the analysis in the Curve Editor or Dope Sheet, right-click on the **Analysis Key** field and select **Curve editor** or **Dope sheet**. Note, however, that you cannot edit the curve in either.

8. Proceed to Reviewing and Editing the Results.

NOTE: Once O_Solver has detected feature matches, they are fixed and do not update in response to changes in the node tree. You can edit them manually, however, or click **Re-analyse Frame** to force O_Solver to recalculate the current frame.

Solving Using Python

If you have an interactive licence (ocula_i and nuke_i), you can run O_Solver using Python. Running from the command line, with the **-i** argument for interactive licences, allows you to automate the setup of O_Solver for different shots without having to open the UI and manually analyse frames.

WARNING: If there is an interruption between the licence server and Ocula, rendering aborts with an exit code of 1. You can use the **--cont** command line argument to force Ocula to continue rendering on failure, producing black licence failure frames rather than aborting the whole render.

Using Python, you can:

- Scan the entire sequence automatically, adding keyframes when a change in camera is detected using **analyseSequence**.

```
# Create an O_Solver to analyse the whole sequence
def autoKeyOculaTree(filename, first_frame, last_frame):

  # set up views
  nuke.root()["setlr"].execute()

  # create the read and set up for the frame range
  reader = nuke.createNode("Read",inpanel=False)
  reader.knob("file").setValue(filename)
  reader.knob("first").setValue(first_frame)
  reader.knob("last").setValue(last_frame)

  # set up the O_Solver node and create a key
```

```
    solver = nuke.createNode('O_Solver4_0',inpanel=False)
    solver.setInput(0, reader)
    solver['analyseSequence'].execute()

# set the file path and frame range
autoKeyOculaTree('/myFilePath/myFootage.####.sxr',1,206)

# save the script once complete
nuke.scriptSaveAs('/Users/OculaExpert/shot001.nk', True)
```

- Script the analysis of a specific set of frames through python.

```
frameList = [25, 73, 123]
frameRanges = nuke.FrameRanges( frameList )
nuke.execute(solver, frameRanges)
```

O_Solver also has a **Python** tab in the Properties panel, allowing you to call Python functions automatically when various events happen in Nuke. See **Help** > **Documentation** > **Python Developers Guide** for more information.

Reviewing and Editing the Results

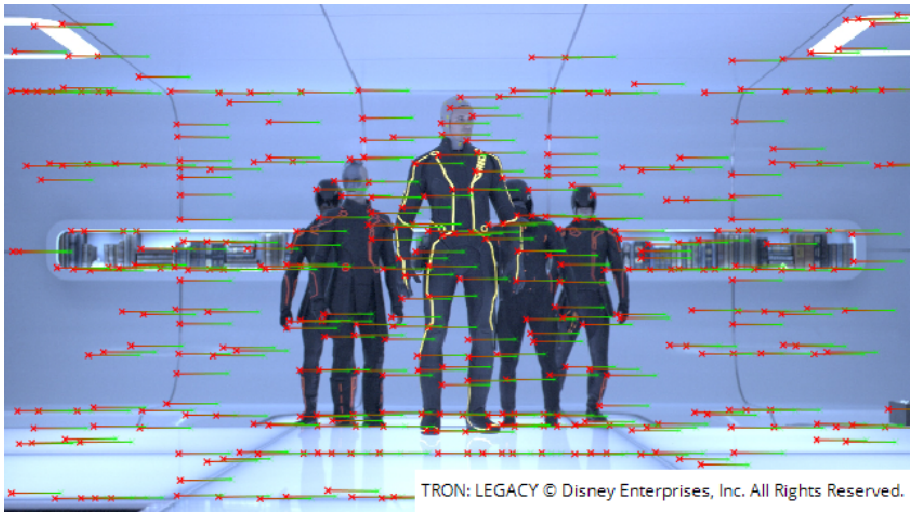
1. Set **Display** to **Keyframe Matches**, if it's not displaying them already, and make sure you are viewing a keyframe.

   The features and matches used to calculate the camera relationship are shown in a Viewer overlay. The views set up in the **Project Settings** dictate the colour of the features in the overlay. If you used **Set up views for stereo** to create the views, red indicates a feature in the left view and green a feature in the right view.
2. You can specify areas of the footage to ignore using a mask in either the **Ignore** input or the alpha of the **Source** image. In the O_Solver controls, set **Mask** to the component you want to use as the mask.

NOTE: Features generated on reflections often produce bad feature matches, but you can add user matches around reflective areas if the auto-matches are poor. See Adding User Matches for more information.

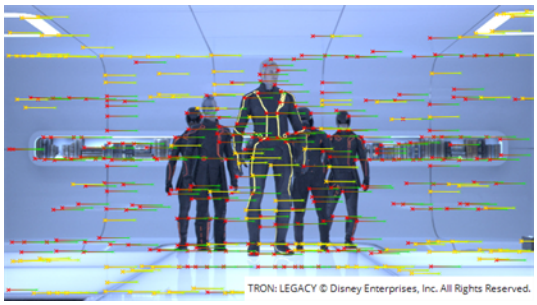
3. To preview how well the detected features describe the alignment of the stereo camera, set **Display** to **Preview Alignment**.

   Preview Alignment shows the aligned matches at keyframes, but also calculates matches at non-keyframes. This allows you to review how well the interpolated solve works and whether additional keyframes are required.



Display set to **Preview Alignment.**

4. Ideally, most lines in the overlay should be horizontal. Any matches that aren't horizontal and have a vertical error greater than **Error Threshold** are pre-selected and displayed in yellow. These are considered poor matches. If you scrub through the timeline and find frames with a lot of yellow matches, add more keyframes for O_Solver to analyse or add user matches manually. See Adding User Matches for more information.



Matches displayed with a low **Error Threshold**.

Matches displayed with a high **Error Threshold**.

5. Increase the **Match Offset** value to artificially increase the disparity, so you can better see how horizontal the feature matches are. Again, if you scrub through the timeline and find frames with a lot of yellow matches, add more keyframes for O_Solver to analyse or add user matches manually. See Adding User Matches for more information.
6. Next, decrease **Match Offset** to examine different points in the image. Accurate feature matches should sit on top of each other when you converge on them. If you can see a vertical offset between any feature matches, add more keyframes for O_Solver to analyse or add user matches manually. See Adding User Matches for more information.

Adding User Matches

User matches assist O_Solver when calculating the camera relationship. The solve considers these manually added matches superior to the ones detected automatically by Ocula, and pays them more attention when calculating the final results.

You can add more feature matches manually if the automatic feature detection didn't produce enough matches in some parts of the image. In cases like this, it's a good idea to add at least four user matches (one in each corner of the image), but the more (accurate) matches you have, the better.

This is a feature you've added manually.

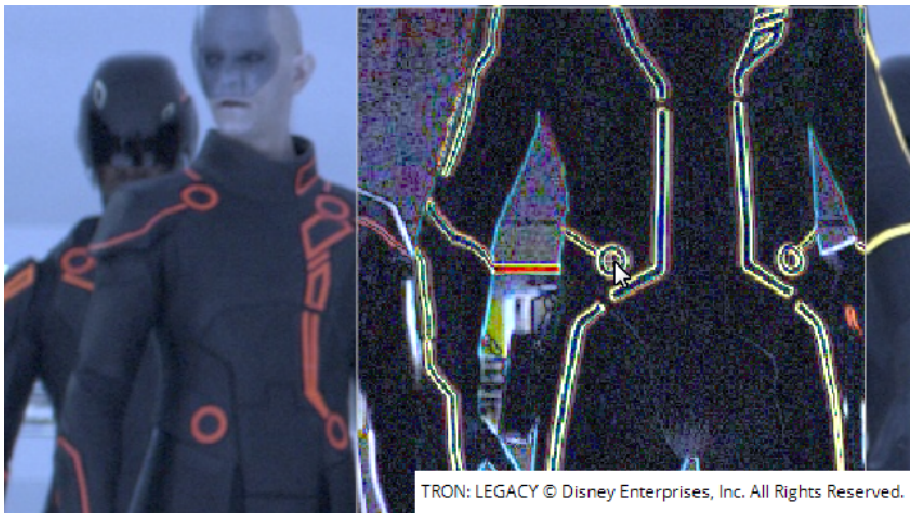
This is a feature O_Solver has detected automatically.

To add a feature match:

1. Click the **Add User Match** button above the Viewer to enable add mode.
2. Locate a feature in either view that is easily recognisable in both views (for example, edges or areas of high contrast), and then click in the Viewer to place the user match. The **Add User Match** button stays enabled so you can continue adding user matches.

TIP: You can also add user matches by holding **Ctrl**/**Cmd**+**Alt** and clicking in the Viewer.

   A cross is placed in the Viewer, representing the user match in that view, and then O_Solver automatically adds a corresponding match in the other view.
3. You can fine-tune matches by dragging a user match in one view to its corresponding position in the other view. By default, the two views are overlaid using a difference merge, in a **256px** texture at **x2** magnification.



You can change the size of the overlay and magnification using the **texture size** and **magnification** dropdowns above the Viewer.

TIP: Holding **Ctrl**/**Cmd** displays the left view and **Ctrl**/**Cmd**+**Shift** the right view, allowing you to ping-pong between views. Holding **Shift** displays a left/right mix, using an over merge, to help you locate bad matches.

4. If you're not happy with the results, you can try using O_Solver on another sequence shot with the same camera setup.

WARNING: If you use another sequence to calculate the solve, check **Single Solve From All Keys** or you'll be taking the interpolated solve from one sequence and applying it to the frames on the other.

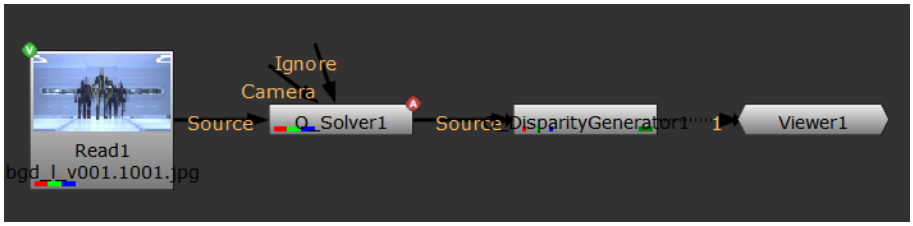
5. Then, connect the O_Solver node to the **Solver** input of O_DisparityGenerator, if you intend to use the camera **Alignment** to generate disparity, or O_VerticalAligner.
6. Once you are happy with the results of O_Solver, proceed to Feeding the Results to Other Ocula Nodes.

Feeding the Results to Other Ocula Nodes

You can use the same O_Solver output throughout your script, so you don't have to calculate the camera relationship several times.

Do one of the following:

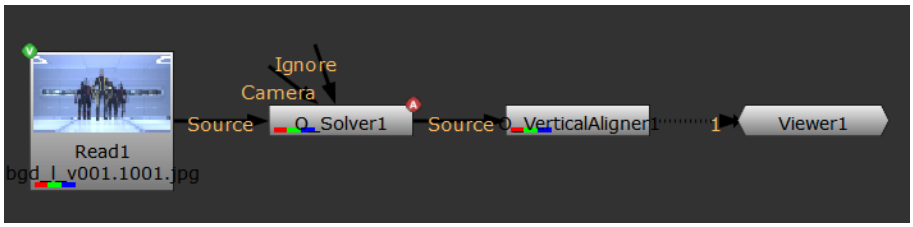
- Select **Ocula** > **Ocula 4.0** > **O_DisparityGenerator** to insert an O_DisparityGenerator node after O_Solver. This is necessary if you want to use O_DisparityGenerator's **Alignment** control to constrain the resulting disparity vectors to match global plate alignment. You might want to do this if your plates don't contain much detail, such as bluescreen images with markers in the background.



O_Solver followed by O_DisparityGenerator.

NOTE: If you don't intend to use O_DisparityGenerator's **Alignment** control, you don't need an O_Solver node. See DisparityGenerator for more information.

- Select **Ocula** > **Ocula 4.0** > **O_VerticalAligner** to insert an O_VerticalAligner node after O_Solver. This node can be used to correct the vertical alignment of either O_Solver's input clip or another clip shot with the same camera setup.



O_Solver followed by O_VerticalAligner.

NOTE: If you intend to use O_VerticalAligner's **Local alignment** control, you also need an O_DisparityGenerator node. See DisparityGenerator for more information.

To learn more about O_DisparityGenerator and O_VerticalAligner, review the chapters on DisparityGenerator and VerticalAligner.

O_Solver Controls

O_Solver Tab

Views to Use

From the views that exist in your project settings, select the two views you want to use to calculate the features and the camera relationship. These views will be mapped for the left and right eye.

Analysis

Mask

If an area in the **Source** clip is producing poor feature matches, you can use this control to select areas of the image to ignore during the feature detection and analysis.

NOTE: Masks should exist in both views, and O_DisparityGenerator expects alpha values of either 0 (for regions to use) or 1 (for regions to ignore).

None	Use the entire image area.
Source Alpha	Use the alpha channel of the **Source** clip as an ignore mask.
Source Inverted Alpha	Use the inverted alpha channel of the **Source** clip as an ignore mask.
Mask Luminance	Use the luminance of the **Ignore** input as an ignore mask.
Mask Inverted Luminance	Use the inverted luminance of the **Ignore** input as an ignore mask.
Mask Alpha	Use the alpha channel of the **Ignore** input as an ignore mask.
Mask Inverted Alpha	Use the inverted alpha channel of the **Ignore** input as an ignore mask.

Analysis Key

This shows the analysis keys that have been created. When you add an analysis key, O_Solver calculates feature matching and analysis and then sets an analysis key. The solves for all other frames are created by interpolating between the results on the analysis keys on either side. This field is for display only. To edit the keyframes, use **Key Frame** and **Delete Key**.

NOTE: Keyframe interpolation helps to ensure smooth changes in the calculated camera relationship between views. We recommend using **Key Sequence** to analyse the entire sequence, and then adding additional analysis keys where the offsets between matches occur. You can visualise how well the interpolated geometry matches the images by setting **Display** to **Preview Alignment** in the O_Solver controls. If you see a lot of yellow matches (matches that have a vertical error greater than the **Error Threshold**), you may need to add more keyframes.

TIP: Alternatively, you can quality check the interpolated geometry by using O_VerticalAligner followed by an Anaglyph node. Enable **Global** > **Preset** > **Full** to interpolate the calculated camera relationship and check whether there is any vertical displacement between the aligned views in the anaglyph view. See O_VerticalAligner Example for an example of how to use O_Solver, O_VerticalAligner, and Anaglyph.

Delete Key	Delete an analysis key at the current frame.
Delete All	Delete all analysis keys.
Key Frame	Set an analysis key at the current frame.
Key Sequence	Analyse the whole sequence automatically and set analysis keys when a change in camera alignment is detected. TIP: **Key Sequence** detects changes in camera alignment automatically, but can be time-consuming on longer sequences.
Key Nominated	Set analysis keys at the frames specified in the **Render** dialog. You can specify frames using Nuke's regular frame expressions. For example, if you enter "1-5 8 10 15 22-25", only those 12 frames are keyed.
Single Solve From All Keys	When enabled, O_Solver calculates a single solve using all the keyframes you have set. Use this for rigs that don't change over time to get more accurate results than when using a single keyframe or when the O_Solver analysis is performed on one clip and then re-used for another clip. Do not use this if there is jitter in the alignment or there is a change in separation, convergence, or zoom. Instead, use a separate solve for each keyframe and place keys where the alignment changes.

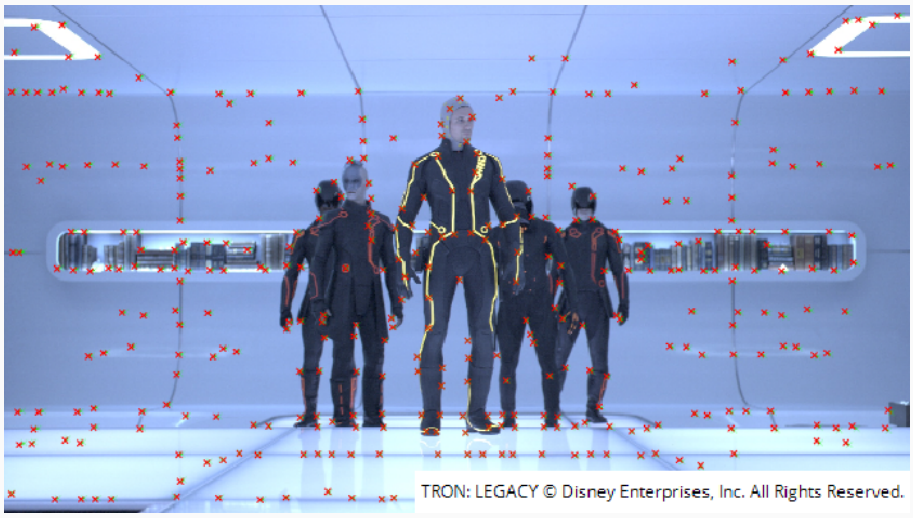
Display

Display Dropdown

Change the display mode:

Nothing	Only show the **Source** image.

Keyframe Matches	Show the features and matches for the camera relationship calculation in a Viewer overlay. Feature matches are only calculated for the keyframes.

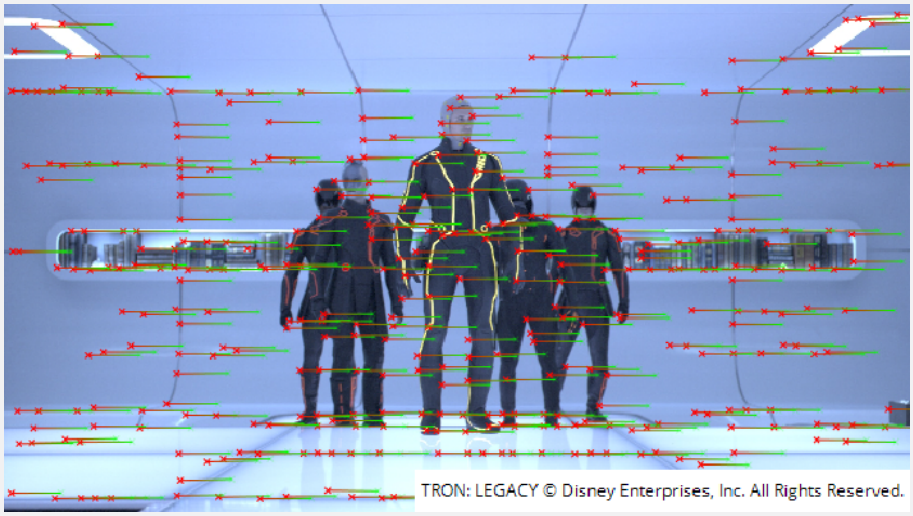


Features and **Keyframe Matches** for the camera relationship calculation in a Viewer overlay.

You can use this mode to see where O_Solver has found features and matches, and evaluate how accurate they are. You can also edit the feature matches manually. To delete a poor match, right-click on it and select **delete selected**. To add matches manually, see Adding User Matches.

You can also activate this mode by selecting **display matches** from the Viewer's right-click menu.

Preview Alignment	Preview how well the calculated feature matches describe the alignment of the stereo camera. This shows the aligned matches at keyframes, but also calculates matches at non-keyframes, allowing you to review how well the interpolated solve works and whether additional keyframes are required. If the lines between feature matches are horizontal, they describe the alignment of the camera rig well. If any lines are skewed (and displayed in yellow), you may want to delete the feature matches in question. If necessary, you can also add manual feature matches to replace them and preview the effect of the manual matches in the overlay.



Visualising the alignment of the calculated feature matches.

You can also activate this mode by selecting **preview alignment** from the Viewer's right-click menu.

Match Offset

The offset (in pixels) applied to the aligned feature matches. You can:

- increase this value to artificially increase the disparity, so it's easier to see how horizontal the feature matches are.
- decrease this value to set the disparity of particular matches to zero and examine the vertical offset at each feature. The matches should sit on top of each other.

NOTE: If you find a lot of yellow matches, you can add user matches manually. See O_Solver Controls for more information.

The **Match Offset** control is only available when **Display** is set to **Preview Alignment**. You can also adjust it by selecting **decrease offset** or **increase offset** from the Viewer's right-click menu.

Error Threshold

The threshold on the vertical alignment error in pixels. When **Display** is set to **Preview Alignment**, any matches with a vertical error greater than the threshold are highlighted in the Viewer. This allows you to easily delete poor matches with large errors when previewing alignment at keyframes - adjust the **Error Threshold** to highlight poor matches and press **Backspace** to remove them.

Current Frame

Re-analyse Frame	Clear the automatic feature matches from the current frame and recalculate them. This can be useful if there have been changes in the node tree upstream from O_Solver, you have deleted too many automatic feature matches, or you want to calculate the automatic matches based on any user matches you have created.
Delete Auto Matches	Delete all automatically generated matches added to the current frame.
Delete User Matches	Delete all user matches you have manually added to the current frame.

Python Tab

These controls are for Python callbacks and can be used to have Python functions automatically called when various events happen in Nuke.

before render	These functions run prior to starting rendering in execute(). If they throw an exception, the render aborts.
before each frame	These functions run prior to starting rendering of each individual frame. If they throw an exception, the render aborts.
after each frame	These functions run after each frame is finished rendering. They are not called if the render aborts. If they throw an exception, the render aborts.
after render	These functions run after rendering of all frames is finished. If they throw an error, the render aborts.
render progress	These functions run during rendering to determine progress or failure.

O_Solver Example

In this example, we read in a stereo image, use O_Solver to calculate the camera relationship, review the results, and add a user match to improve the solve data.

Step by Step

1. Start Nuke and press **S** on the Node Graph to open the Project Settings. Go to the **Views** tab and click the **Set up views for stereo** button.
2. Select **Image** > **Read** to import **Dance_Group.exr**. The **.exr** format allows both views to exist in a single file, so Nuke reads in both the left and the right view using the same Read node.
3. Insert an O_Solver node after the stereo image by choosing **Ocula** > **Ocula 4.0** > **O_Solver** from the Toolbar.

   The purpose of this node is to define the geometrical relationship between the two views in the input image (that is, the camera relationship or solve). The solve information can then be fed to an O_DisparityGenerator, if you want to use the alignment information to create a disparity map, or to an O_VerticalAligner to correct vertical offset between views.

   For now, we'll concentrate on creating an accurate solve using O_Solver.
4. Attach a Viewer to the O_Solver node.
5. In the O_Solver controls, click **Key Frame** to set a keyframe for O_Solver to analyse.

   Our example here consists of just one frame, but if you were using a sequence, click **Key Sequence** to automatically analyse the sequence and add keyframes when the camera setup changes. If the setup doesn't change, you can get away with using just one or two keyframes. Remember that keyframes should be placed on frames that are easy to match between views - ideally, with enough picture detail, but no motion blur, occluding fog, or dust.

   Every time you add a keyframe, O_Solver analyses the footage and calculates the solve.
6. O_Solver displays **Keyframe Matches** by default, but you can change modes using the right-click menu in the Viewer or the **Display** dropdown on the Viewer toolbar.

NOTE: Matches are only displayed when the playhead is on a keyframe, marked with a blue chip.

The calculated feature matches are displayed in a Viewer overlay, and you can switch between views to compare them.

Display set to **Keyframe Matches**.

7. Now, set **Display** to **Preview Alignment**. This allows you to check the quality of your solve by previewing the alignment of the calculated feature matches in the Viewer.

   Ideally, the lines should all be horizontal. If they have a vertical error greater than the **Error Threshold**, they are considered poor matches and displayed in yellow.

8. To help guide the solve, we can add feature matches manually. It's a good idea to do this if you have a particularly tricky part of a shot where the automatic feature matching has produced a few yellow matches.

   There's an area in the top-right of the frame containing bad matches, so zoom in on it.

9. Locate a feature in either view that is easily recognisable in both views (for example, edges or areas of high contrast).

10. Hold **Ctrl**/**Cmd**+**Alt** and then click in the Viewer to place the user match.

> TIP: You can also click the **Add User Match** button above the Viewer to enable add mode.

   A cross is placed in the Viewer, representing the user match in that view, and then O_Solver automatically adds a corresponding match in the other view.

11. You can align views by dragging a user match in one view to its corresponding position in the other view. By default, the two views are overlaid using a difference merge, in a **256px** texture at **x2** magnification.

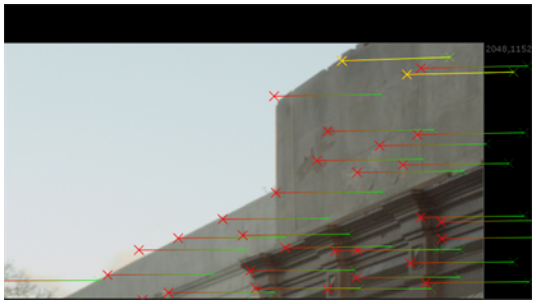
    You can change the size of the overlay and magnification using the texture size (in pixels) and magnification dropdowns above the Viewer.

> TIP: Holding **Ctrl**/**Cmd** displays the left view and **Ctrl**/**Cmd**+**Shift** the right view, allowing you to ping-pong between views. Holding **Shift** displays a left/right mix, using an over merge, to help you locate bad matches.

   You can add as many manual feature matches as you like, so if you see any other areas that might benefit from them, feel free to add more.

   O_Solver considers any feature matches you've added yourself superior to the ones it detects automatically and pays them more attention. This can also influence the automatic matches displayed in the **Preview Alignment**

mode. Any automatic matches that don't agree with the alignment defined by your user matches are highlighted in yellow and should be deleted.



Poor auto-match alignments are highlighted yellow in the Viewer.

Adding user matches allows you delete poor matches by pressing **Backspace**.

12. Next, decrease the **Match Offset** value gradually until some matches have no horizontal offset. This sets the disparity of those matches to zero, which means accurate feature matches should sit on top of each other. You may need to zoom in to see if they do.

    The matches in the top-left of the Viewer display vertical offset between the feature matches, and are highlighted in yellow. Place a user match on the corner of the building to correct them.

13. Fine-tune matches by dragging the user match in one view to its corresponding position in the other view. By default, the two views are overlaid using a difference merge, in a **256px** texture at **x2** magnification.

    You can change the size of the overlay and magnification using the texture size (in pixels) and magnification dropdowns above the Viewer.

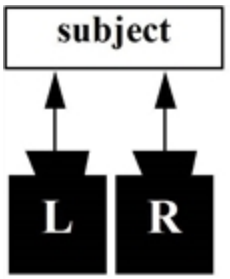
TIP: Holding **Shift** when lining up the user match displays a left/right mix of the views, using an over merge, holding **Ctrl**/**Cmd** shows the left view, and **Ctrl**/**Cmd**+**Shift** shows the right view in the overlay.

14. The yellow matches can be deleted by pressing **Backspace** to improve the solve. We recommend adding at least five user matches, one toward each corner of the image to correct the overall alignment, and one at the centre on the subject to focus alignment where it is important.

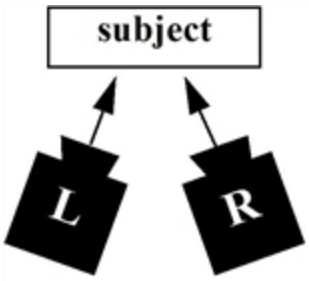
8 VerticalAligner

Description

If the cameras used to shoot stereoscopic images are poorly positioned or converge (point inwards), some features in the resulting two views may be vertically misaligned. In the case of converging cameras, the misalignment may be due to keystoning. Unlike converging cameras, parallel cameras do not produce keystoning.

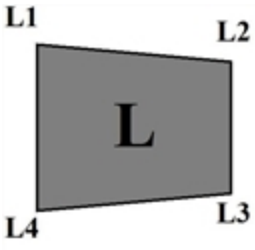


Parallel cameras do not cause keystoning.

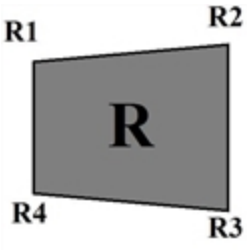


Converging cameras do cause keystoning.

Keystoning is when an image is distorted because the angle created by converging cameras affects the perspective in the two views. As a result, corresponding points in the two views are vertically misaligned.



The left image.

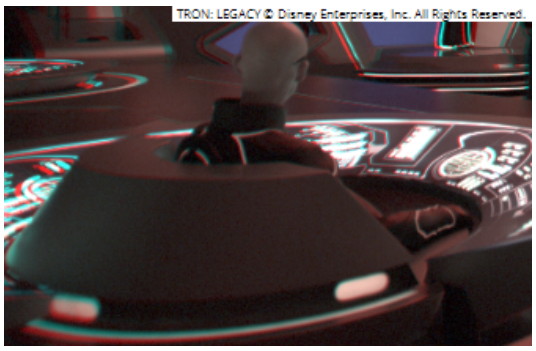


The right image.

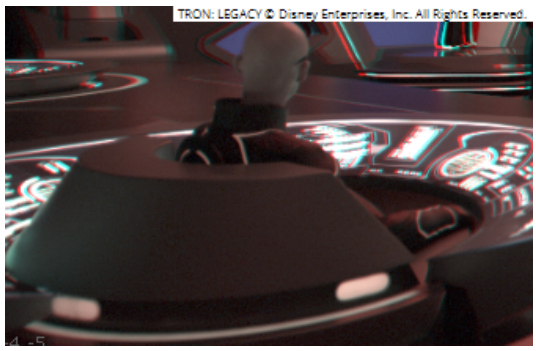
Whether the vertical misalignment was caused by poorly positioned or converging cameras, it can result in an unpleasant 3D stereo viewing experience. When a vertically misaligned stereo image is viewed with 3D glasses, the

viewer's brain attempts to line up the corresponding points in the images, often causing eye strain and headaches. To avoid this, stereo images should only contain horizontal disparity, not vertical.

O_VerticalAligner allows you to warp views vertically so that their corresponding features align horizontally. The **Vertical Skew** and **Local Alignment** options allow you to warp the views, while keeping the horizontal position of each pixel the same so that there is no change in convergence.



Before O_VerticalAligner. Notice that the curved line at the bottom of the image and the controls on the left are misaligned.



After O_VerticalAligner. Notice that the curved line at the bottom of the image and the controls on the left have now been aligned.

There are several modes: **Global Alignment**, **Local Alignment**, **Fix Scale** and **Fix Offset**. If the none of the method checkboxes are selected in the **Local**, **Fix Scale**, or **Fix Offset** sections of the O_VerticalAligner controls, the **Global Alignment** mode is on by default.

Global Alignment Mode

In the Global Alignment mode, O_VerticalAligner performs a global transform to align the views. You can choose between several alignment types. All methods concatenate. This means that if you select several alignment types from the Global section in the O_VerticalAligner controls, their functions are combined. See O_VerticalAligner Controls for information about each alignment type.

If you have a pre-tracked Nuke stereo camera that describes the camera setup used to shoot the **Source** images, you can attach it to the O_Solver node and use O_VerticalAligner in the **Global Alignment** mode to analyse the sequence and output a vertically-aligned camera pair. This works with all global methods except **Vertical Skew** (which can't be represented by a camera transform). For more information, see Using O_VerticalAligner.

Local Alignment Mode

In the **Local Alignment** mode, O_VerticalAligner rebuilds the image per-pixel to account for any local distortions in the mirror or lens, and changes in alignment with depth using O_Solver data.

The **Local Alignment** mode always requires a disparity map upstream. You can create one using an O_DisparityGenerator node upstream of the O_VerticalAligner node.

NOTE: You can create disparity once and it is aligned to match the aligned plate. There is no need to recalculate disparity.

Fix Scale Mode

The **Fix Scale** method allows you to zoom the plate if the original footage was not over-scanned, and the alignment pulls black into the format.

You can scale the image to prevent pulling pixels from outside the input image. To minimise the scale change, align **Both Views**.

WARNING: The scale has to be applied to both images, even when aligning **Left to Right** or **Right to Left**.

Fix Offset Mode

The **Fix Offset** method allows you to correct any convergence change that has happened on the subject to preserve the original subject parallax and hence depth.

You can shift the image to preserve the parallax at the fix-point.

NOTE: The **Fix Offset** mode requires upstream disparity vectors. If they do not already exist in the image sequence, insert an O_DisparityGenerator node to calculate them.

Inputs

O_VerticalAligner has the following inputs:

Source	A stereo pair of images. **Global Alignment** mode is on by default. In all modes the images should be followed by an O_Solver node. If you are using the **Local Alignment**, or **Fix Offset** mode, you also need an O_DisparityGenerator node (if disparity vectors do not already exist) upstream of O_VerticalAligner.

To see a table listing the nodes or channels each Ocula node requires in its inputs, see Appendix B.

Using O_VerticalAligner

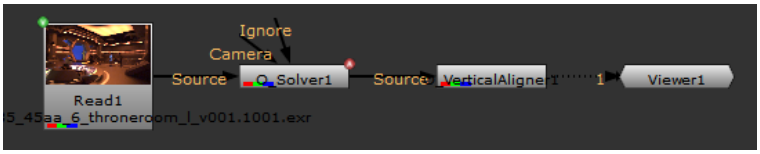
To vertically align a pair of stereo images, you can several modes: **Global Alignment**, **Local Alignment**, **Fix Scale**, and **Fix Offset**. You can choose to use a mixture of these modes, for example, you can perform a global alignment and a local alignment which are concatenated into a single filter operation.

You can apply a global image transform to align the feature matches generated by an upstream O_Solver node, or you can rebuild the view(s) to remove vertical disparity calculated by an upstream O_DisparityGenerator using the **Local Alignment** mode.

NOTE: The **Global Alignment** mode is on by default.

To use the O_VerticalAligner, complete the following steps:

1. Select **Ocula** > **Ocula 4.0** > **O_Solver** to insert an O_Solver node after your stereo clip. For more information on how to use O_Solver, see Solver.
2. Select **Ocula** > **Ocula 4.0** > **O_VerticalAligner** to insert an O_VerticalAligner node after either O_Solver.
3. Connect a Viewer to the O_VerticalAligner node. Your node tree should now look something like this:



4. Open the O_VerticalAligner controls. Under **Views to Use**, you can see all the views that exist in your project settings. Select the two views you want to use for the left and right eye when correcting the alignment. The two views you select are mapped for the left and right eye.
5. From the **Align** menu, select how to move the images to align the views: **Both Views**, **Left to Right**, or **Right to Left**. See O_VerticalAligner Controls for information about the **Align** options.
6. Select the **filter** to handle the vertical alignment transform, or use the default **Lanczos6**, which is a good sharpening and scaling down filter. For more information on the available filters, see Filter under O_VerticalAligner Controls or *Choosing a Filtering Algorithm* in the *Nuke User Guide*.
7. Enable **Output STMap** to include the **Global** or **Local** correction as a uv coordinate map along with alignment information.
8. From the **Global** section, select types of alignment you want to use. You can select preset options including **Transform**, **Match Camera**, **Keystone Only**, and **Full**. You can also select **Custom** and manually select the types of alignment you want to include. See O_VerticalAligner Controls for more information about the types of alignment.
9. If you want to perform a local alignment, insert an O_DisparityGenerator node after O_Solver, and select the **Local Alignment** checkbox in the **Local** section of the O_VerticalAligner controls. You can now adjust the **Local** controls. See O_VerticalAligner Controls for more details.
10. To view the effect of O_VerticalAligner more accurately, you can:

• Insert an Anaglyph node between the O_VerticalAligner node and the Viewer,

OR

• Add a StereoReviewGizmo to view alignment. See StereoReviewGizmo for more information.

11. Adjust the required settings to get the best possible result. See O_VerticalAligner Controls for information about the settings.

Analysing and Using Output Data

In all global methods except **Vertical Skew**, you can use the **Analyse Sequence** control to create output data and use the data for the following:

- Vertically align a pre-tracked Nuke stereo camera. This allows you to continue using pre-tracked cameras after your footage has been vertically aligned. Note that you can only create a vertically aligned stereo camera when a pre-tracked camera is connected to the **Camera** input of O_Solver.
- Create a Nuke CornerPin2D node that produces the same result as O_VerticalAligner.

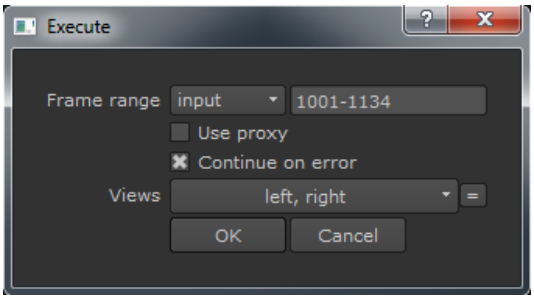
The output data is also stored on the **Output** tab of the node controls, where you can see the transform represented as a four-corner pin and a transform matrix per view.

To analyse and use the output data, complete the following steps:

1. After performing a vertical alignment, click **Analyse Sequence** under the **Analysis** section in the O_ VerticalAlignet controls.

NOTE: You cannot use **Analyse Sequence** with the **Local Alignment** checkbox selected.

2. When prompted, enter a frame range to analyse. O_VerticalAligner analyses the sequence.



3. You can now use the output data in the following ways:
   - To output a vertically aligned camera pair, click either **Create Camera** or **Create Rig**. **Create Camera** produces a single Camera node with split controls to hold the left and right view parameters. **Create Rig** produces two Camera nodes and a JoinViews node that combines them.
   - To create a Nuke CornerPin2D node that represents the result of O_VerticalAligner, click **Create Corner Pin**. A CornerPin2D node that produces the same result as O_VerticalAligner appears in the Node Graph.

Scripting Analysis and CornerPin Creation

Given a standard Node Graph containing your footage, an O_Solver, and an O_VerticalAligner, Ocula allows you to automate the setup of a CornerPin for a range of frames without having to manually create the required analysis frames.

The following Python script examines feature matches in the entire sequence, analyses the vertical alignment for a given frame range for both views, and then creates a CornerPin node containing **to** data for the four pinned points in the Viewer.

TIP: If you don't want the analysis to continue on failure, remove the **1** after the frame range in the second Python call.

```
# Run the analysis pass on the Solver
nuke.toNode('O_Solver1')['analyseSequence'].execute()

# Run the analysis pass on the VerticalAligner between frames 1001 and 1085
nuke.execute("O_VerticalAligner1", 1001, 1085, 1, ['left','right'])

# Create the cornerPin
nuke.toNode('O_VerticalAligner1')['createPin'].execute()
```

O_VerticalAligner also has a **Python** tab in the Properties panel, allowing you to call Python functions automatically when various events happen in Nuke. See **Help** > **Documentation** > **Python Developers Guide** for more information.

O_VerticalAligner Controls

O_VerticalAligner Tab

Views to Use

From the views that exist in your project settings, select the two views you want to use to generate an occlusion mask. These views are mapped for the left and right eye.

Align

Select how to move the views to align the images.

Both Views	Move both the left and right views so that they are aligned.
Left to Right	Move the left view only to line up with the right.
Right to Left	Move the right view only to line up with the left.

Filter

Select the filtering algorithm you want to use when remapping pixels from their original positions to new positions. This helps avoid problems with image quality, particularly in high contrast areas of the frame (where highly aliased, or jaggy, edges may appear if pixels are not filtered and retain their original values).

Impulse	This option means no filtering is done. Each output pixel equals an input pixel.
Cubic	Remapped pixels receive some smoothing.
Keys	Remapped pixels receive some smoothing and minor sharpening.
Simon	Remapped pixels receive some smoothing and medium sharpening.
Rifman	Remapped pixels receive some smoothing and significant sharpening.
Mitchell	Remapped pixels receive some smoothing and blurring to hide pixelation.

Parzen	Remapped pixels receive the greatest smoothing of all filters. Use this option to prevent ringing on sharp edges.
Notch	Remapped pixels receive flat smoothing (which tends to hide Moiré patterns).
Lanczos4	This filter is good for scaling down.
Lanczos6	Remapped pixels receive some sharpening. This filter is good for scaling down and image warping.  NOTE: Note that this option is not ideal for vertical alignment; instead **Cubic** or **Parzen** are recommended for this.
Sinc4	Remapped pixels receive a lot of sharpening. This filter is good for scaling down.

Output STMap

When enabled, this allows you to output an STMap along with an aligned image and disparity vectors.

Global

Select the types of alignment you want to use to vertically align the images. You can select preset options, or you can select **Custom** and manually define the types of alignment you want to include. See the table below for the types of alignment each preset option includes.

Preset Option	Description	Camera Correction	Focal Length	Vertical Shift	2D Rotation	Perspective Warp	Vertical Skew
Transform	Use this option to perform a 2D correction without any change in pixel aspect or skew.		●	●	●		
Match Camera	Use this option to correct using a match move camera connected to the upstream O_ Solver.	●					

Keystone Only	Use this option to correct vertical alignment without changing the parallax.						●
Full	Use **Full** to include all the alignment options except **Vertical skew**.	●	●	●	●	●	

All alignment methods concatenate. This means that if you select several alignment types, their functions are combined. You can also analyse the data to create corner pin and camera information in all methods except **Vertical Skew**. See the table below for a description of what each alignment type does. The alignment types are applied in the following order.

Camera correction	Correct the vertical alignment for a match-move camera connected to an upstream O_Solver. If there is no camera connected, this uses the internal camera calculated by O_Solver. The correction is refined by other alignment options that are selected.
Focal length	Align the features by calculating a 2D scale to correct focal length differences.
Vertical shift	Align the features vertically by moving the entire image up or down. Calculate a 2D vertical shift to correct a global offset.
2D rotation	Align the features vertically by rotating the entire image around a point. The centre of the rotation is determined by the algorithm.This helps correct in-plane camera roll.
Perspective warp	Do a four-corner warp on the images to align them on the y axis. This may move the features slightly along the x axis. **Perspective warp** can help correct camera tilt as well as roll.  NOTE: A perspective change can alter pixel aspect ratio and introduce pixel skew.
Vertical skew	Align the features along the y axis using a skew. This does not move the features along the x axis. **Vertical skew** allows you to correct keystoning without changing horizontal disparity. This varies the vertical shift across the image without changing the horizontal position of pixels. However, this may also introduce pixel skew.

NOTE: If you select or deselect an alignment type after selecting a preset option, the preset **Type** dropdown, automatically updates to **Custom**.

Local Options

There are two modes you can use for vertical alignment. The **Global Alignment** method is on by default. Select the **Local Alignment** checkbox to perform a local alignment in addition to the global alignment.

Global Alignment	This applies a global image transform to align the feature matches generated by an upstream O_Solver node.
Local Alignment	This rebuilds the view(s) to remove vertical disparity calculated by an upstream O_DisparityGenerator. Use this mode to create a per-pixel correction if there are any local distortions in the mirror or lens and changes in alignment with depth.

Pre-blur

The **Pre-blur** control allows you to set the size of the blur applied to the disparity before performing a local alignment. To smooth out the correction across depth boundaries, increase the blur size.

Correction

The **Correction** control allows you to set the amount of local correction to apply between the global transform at **0** and the full correction at **1**. This would be useful, for example, if you want to tone down the local distortion that is applied.

Fix Scale Options

Zoom to Prevent Black in the Frame

Select the **Zoom to prevent black in frame** checkbox to scale the image in order to prevent pulling pixels from outside the input image. To minimise the scale, change the **Align** dropdown to **Both Views**.

WARNING: The scale has to be applied to both images, even when aligning **Left to Right** or **Right to Left**.

Calculate Scale

The **Calculate scale** control allows you to calculate the scale at the current frame. If the alignment options change, the scale needs to be recalculated. You can lock the scale correction to prevent any changes by selecting the **Lock scale** checkbox.

Scale

The **Scale** control allows you to set the global scale that is applied to prevent black in the frame. You can set a key to interpolate the scale calculated at different frames.

WARNING: Animating the **Scale** control creates a dynamic zoom on the shot, which may not be the stereographer's original intent. In this case, it is recommended to use a static zoom from a single frame, to preserve the original intent of the shot.

Fix Offset Options

Preserve Subject Parallax

Select the **Preserve subject parallax** checkbox to shift the image in a way that preserves the parallax at the specified **Fix Point**. This requires the input to have disparity vectors. If disparity vectors do not already exists, you need to add an O_Solver node and an O_DisparityGenerator node upstream of O_VerticalAligner.

Fix Point

You can move the **Fix Point** to sample the input disparity and update the applied offset to preserve the parallax. View the output of O_VerticalAligner to set the **Fix Point** when the **Output** is set to **Image**. You can lock this to prevent any changes by selecting the **Lock offset** checkbox.

To change the **Fix Point**, drag the **fixPoint** widget from the bottom-left corner of the Viewer and drop it in the new position. Disparity is then recalculated according to the new **Fix Point**. You can also use the user matches determined by O_Solver to set the **Fix Point**.

Offset

You can use the **Offset** control to set the correction in pixels, that is applied to prevent parallax changes at the **Fix Point**. To interpolate the offset calculated at different frames, set a key.

NOTE: Note that you can re-converge the views after you have aligned the plates to preserve depth.

Analyse Sequence

Analyse the sequence to create a corner pin or an aligned camera output. Use **Analyse Sequence** to create the output data in all global methods except **Vertical Skew** (the default). Then, you can apply the data to the **Create Corner Pin**, **Create Camera**, or **Create Rig** controls.


NOTE: You cannot use **Analyse Sequence** with the **Local alignment** checkbox selected.

Create Corner Pin	Click this to create a corner pin representing the result of O_VerticalAligner after you have clicked **Analyse Sequence**. This works in all global methods except **Vertical Skew**.
Create Camera	If you have a pre-tracked Nuke stereo camera connected to the **Camera** input of the O_Solver up the tree and you click **Analyse Sequence**, you can then click **Create Camera** to create a vertically aligned camera from the analysis. This gives you a single Camera node with split controls to hold the left and right view parameters. This works in all global methods except **Vertical Skew**.
Create Rig	If you have a pre-tracked Nuke stereo camera connected to the **Camera** input of the O_Solver up the tree and you click **Analyse Sequence**, you can then click **Create Rig** to create a vertically aligned camera rig from the analysis. This gives you two Camera nodes and a JoinViews node that combines them. This works in all global methods except **Vertical Skew**.

Output Tab

Four Corner Pin	This represents the 2D corner pin that can be applied to the input image to create the same result as O_VerticalAligner (in all global methods except **Vertical Skew**). This allows you to do the analysis in Nuke, but take the matrix to a third-party application – such as Baselight – and align the image or camera there.
Transform Matrix	This provides the concatenated 2D transform for the vertical alignment. The matrix is calculated when you click **Analyse Sequence** on the **O_VerticalAligner** tab. There is one matrix for each view in the source.

Python Tab

These controls are for Python callbacks and can be used to have Python functions automatically called when various events happen in Nuke.

before render	These functions run prior to starting rendering in execute(). If they throw an exception, the render aborts.
before each frame	These functions run prior to starting rendering of each individual frame. If they throw an exception, the render aborts.
after each frame	These functions run after each frame is finished rendering. They are not called if the render aborts. If they throw an exception, the render aborts.
after render	These functions run after rendering of all frames is finished. If they throw an error, the render aborts.
render progress	These functions run during rendering to determine progress or failure.

O_VerticalAligner Example

In this example, we correct the vertical alignment of a stereo image using the **Global Alignment** mode. The image used here can be downloaded from our website. For more information, please see Example Images.

Step by Step

1. Launch Nuke. Open the project settings (press **S** on the Node Graph), select the **Views** tab, and click the **Set up views for stereo** button.
2. Import the **steep_hill.exr** image and connect it to a Viewer. The image includes both the left and the right view.
3. Select **Ocula** > **Ocula 4.0** > **O_Solver** to insert an O_Solver node after the stereo clip. See Solver for more information.
4. Click **Key Frame** to set at least one keyframe.
5. Insert an O_VerticalAligner (**Ocula** > **Ocula 4.0** > **O_VerticalAligner**), followed by an Anaglyph node (**Views** > **Stereo** > **Anaglyph**) after O_Solver.

NOTE: The Anaglyph node is for illustrative purposes in this example. You could just as easily use the DisparityReviewGizmo to view the alignment.

6. By default, O_VerticalAligner is in **Global** alignment mode with the **Local alignment** checkbox disabled. In this mode, O_VerticalAligner applies a global image transform to align the feature matches generated by the upstream O_Solver node. In **Global** alignment mode, O_VerticalAligner does not need disparity vectors upstream.
7. To see the effect more accurately, select the O_VerticalAligner node and press **D** repeatedly to disable and enable the node. With the node disabled, the views remain vertically misaligned. However, when you enable the O_VerticalAligner node, the views align nicely.

The zoomed in image with the O_VerticalAligner node disabled.

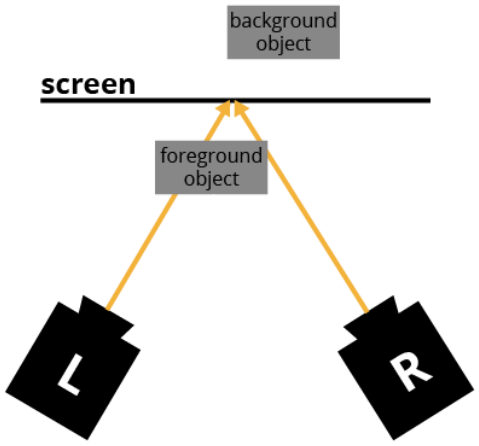
The zoomed in image with O_VerticalAligner enabled.

9 InteraxialShifter

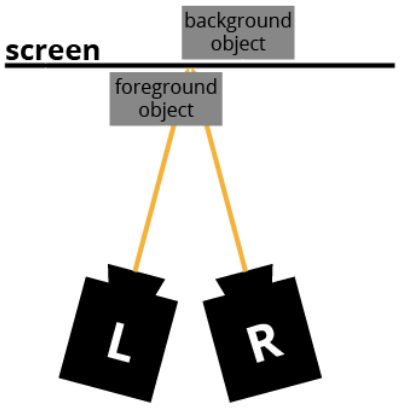
Description

The O_InteraxialShifter node allows you to adjust the interaxial distance of stereo images. Interaxial distance is the distance between the left and right cameras. Using this O_InteraxialShifter node, you can generate two new views at specified positions between the left and right images.

Changing interaxial distance is the equivalent of moving the cameras closer together or further apart. The greater the interaxial distance, the greater the depth perception. This is illustrated below, where the grey rectangles represent elements depicted in a stereo image.



When the 3D image was shot with the cameras far apart, objects on the screen seem further apart from each other; the foreground objects look closer to you, and the background objects look further away.



When the 3D image was shot with cameras closer together, objects on the screen seem close to each other; the foreground objects don't look much closer to you than the background objects.

You may want to change interaxial distance during post-production for a variety of reasons. For example, it can be useful when trying to match the depths between scenes in order to make transitions more comfortable for the viewer, or simply because the desired depth of a shot has been reconsidered as the final film evolves. It might also

help in the process known as depth grading, where the depth of field is adjusted in order to ensure the stereo effect can be comfortably viewed on the intended screen size. The apparent depth of the scene depends upon a combination of the screen size and the distance from the screen to the viewer.

To generate new views with a different interaxial distance, the O_InteraxialShifter node requires upstream disparity vectors that relate the two views. You can use the O_DisparityGenerator node to calculate these vectors. See DisparityGenerator for how to do this.

NOTE: This node does not pass through any disparity channels fed into it. This is because, after warping the input images, the original disparity map is no longer valid. If you need disparity channels further down the tree, add another O_DisparityGenerator node after O_InteraxialShifter.

TIP: Changing interaxial distance is different to changing convergence (the inward rotation of the cameras). You can change convergence using Nuke's ReConverge node. This way, you can have any selected point in the image appear at screen depth when viewed with 3D glasses.

Inputs

O_InteraxialShifter has the following inputs:

Source	A stereo pair of images. If disparity channels and occlusion masks are not embedded in the images, you need to insert an O_DisparityGenerator and an O_OcclusionDetector node after the image sequence.

To see a table listing the nodes or channels each Ocula node requires in its inputs, turn to Appendix B.

Using O_InteraxialShifter

NOTE: O_InteraxialShifter requires disparity vectors and an occlusion mask to operate correctly.

To change the interaxial distance, do the following:

1. If disparity vectors don't yet exist in the script, insert an O_DisparityGenerator node after your image sequence to calculate the disparity vectors. See DisparityGenerator for how to do this.
2. O_InteraxialShifter requires an occlusion mask. Insert an O_OcclusionDetector node after either the O_DisparityGenerator node (if you added one in the previous step) or the stereo image sequence.
3. From the toolbar, select **Ocula** > **Ocula 4.0** > **O_InteraxialShifter** to insert an O_InteraxialShifter node after the O_OcclusionDetector node.

4. In the O_InteraxialShifter controls, select the two views you want to use for creating the new views under **View to Use**. The two views you select are mapped for the left and right eye.
5. Use the **Left Position** and **Right Position** sliders to indicate where you want to build the new left and right views. The values are expressed as a fraction of the distance between the two views. For example, if the **Left Position** is set to 0.25, it is at a quarter of the total distance between the cameras.
6. Attach a Viewer to the O_InteraxialShifter node. Your node tree should now look something like this:

7. Adjust the **Edges** settings to get the best possible result. See O_InteraxialShifter Controls for more information.

O_InteraxialShifter Controls

Use GPU

Open the O_InteraxialShifter controls. O_InteraxialShifter renders using the Local GPU specified, if available, rather than the CPU. The GPU may significantly improve processing performance.

If there is no suitable GPU, or the required NVIDIA CUDA drivers are unavailable, O_InteraxialShifter defaults to using the CPU. You can select a different GPU Device, if available, by opening Nuke's **Preferences** and selecting an alternative card from the **GPU Device** dropdown.

NOTE: Selecting a different GPU requires you to restart Nuke before the change takes effect.

Views to Use

From the views that exist in your project settings, select the two views you want to use to create the new views. These views are mapped for the left and right eye.

Left Position

Select a position between the views where you want to generate the new left view. The position is expressed as a fraction of the distance between the views.

Right Position

Select a position between the views where you want to generate the new right view. The position is expressed as a fraction of the distance between the views.

Edges

Output edges to alpha

You can use the **Output edges to alpha** checkbox to output the edges to the alpha channel. Use the alpha channel as an overlay to determine where the edge correction is applied.

Adjust Edges

Use the **Adjust Edges** slider to change the size of the edge mask. To dilate the mask, use a positive value. You can use a negative value to erode the mask.

Feather

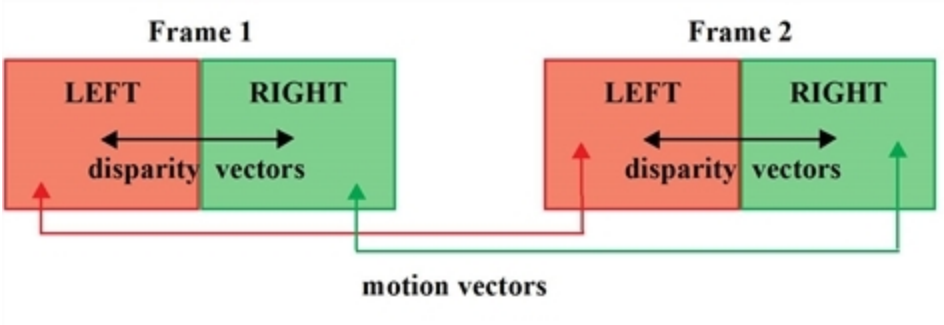
You can use the **Feather** slider to specify how much feathering to apply to the edges. Increasing the **Feather** value, softens the edges; decreasing the value, sharpens the edges.

10 VectorGenerator

Description

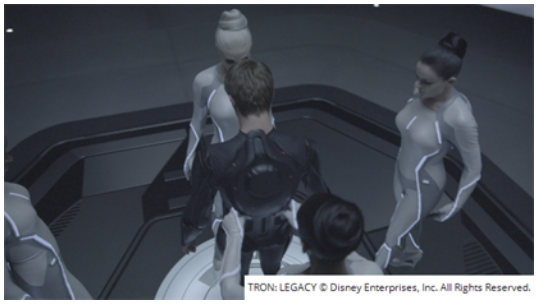
O_VectorGenerator generates motion vector fields for each view in a stereo image. Motion vectors map the location of a pixel on one frame to the location of the corresponding pixel in a neighbouring frame. It has the same dimensions as the image, but contains an (x,y) offset per pixel. These offsets show how to warp a neighbouring image onto the current image.

Clearly, as most of the images in a sequence have two neighbours, each can have two vector fields. These are called the **forward** motion vectors where they represent the warp of the next frame on to current frame, and **backward** motion vectors where they represent the warp of the previous frame on to current frame.



Disparity vectors map pixels between *views*, whereas motion vectors map them between *frames*.

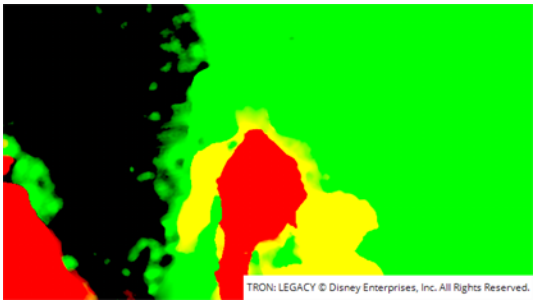
O_VectorGenerator stores the motion vectors in the backward and forward motion channels. To view these in Nuke, select **motion**, **forward**, or **backward** from the channel set menu in the top left corner of the Viewer.



Source frame.

The **motion** channel generated by Ocula.

Forward motion vectors.



Backward motion vectors.

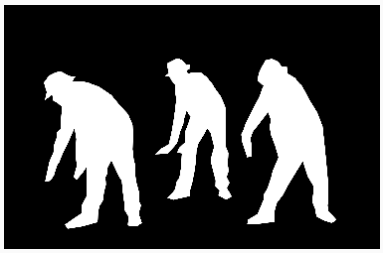
If you want to use pre-calculated motion vectors rather than generate vector fields each time you need them, you can use a Write node to render them into the channels of your stereo **.exr** file along with the colour and disparity channels. Later, whenever you use the same image sequence, the motion vectors are loaded into Nuke together with the sequence.

Ocula's Retimer node relies on motion vectors to produce its output, but you may also want to use O_VectorGenerator for other purposes (for example, for generating motion blur).

Inputs

O_VectorGenerator has the following inputs:

Source	A stereo pair of images.

Mask	An optional mask that specifies areas to exclude from the motion calculation. You can use this input to prevent distortions at occlusions or to calculate motion for a background layer by ignoring all foreground elements. Note that masks should exist in both views, and O_VectorGenerator treats the alpha values of 1 as foreground and blurs to the 0 value using nearby vectors to recreate object boundaries, rather than image data. When you create a mask using Roto or RotoPaint, you can use the **feather** control to extend the calculation. For example, the vector map may have a sharper transition at edges with a binary mask, but applying feather on the mask can help smooth the resulting image.  The left view.  A mask to select the dancers in the left view.

To see a table listing the nodes or channels each Ocula node requires in its inputs, turn to Appendix B.

Generating Motion Vectors

To generate motion vectors for a stereo pair of images, do the following:

1. Select **Ocula** > **Ocula 4.0** > **O_VectorGenerator** to add an O_VectorGenerator node after either a stereo clip or a JoinViews node.
2. Make sure you are viewing the output from O_VectorGenerator.
3. In the O_VectorGenerator controls, you can see all the views that exist in your project settings under **Views to Use**. Select the two views you want to use to calculate the motion vectors. The two views you selected are mapped for the left and right eye.
4. If there are areas in the image that you want to ignore when generating the motion vector field, supply a mask either in the **Mask** input or the alpha of the **Source** input. In the O_VectorGenerator controls, set **Mask** to the component you want to use as the mask.

   If there are areas in the image that you want to ignore when generating vectors, supply a mask either in the **Mask** input or the alpha of the **Source** input. In the O_VectorGenerator controls, set **Mask** to the component you want to use as the mask.

The white areas of the image have their vectors calculated as normal, whereas black areas take their vectors from nearby areas. When you create a mask using Roto or RotoPaint, you can use the **feather** control to tune the calculation.

5. Set the Viewer's channel set menu to **motion**, **forward**, or **backward**.

   O_VectorGenerator calculates the motion vectors and displays them in the Viewer.

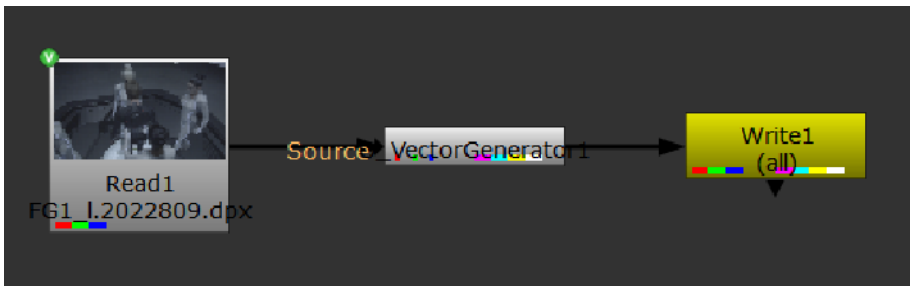
6. If necessary, adjust **Vector Detail**, **Strength**, **Consistency**, and **Smoothness** and view their effect on the motion vector field. For more information on these parameters, see O_VectorGenerator Controls.

Writing Motion Vectors into a Clip

When you're happy with the motion vectors generated, you can save time down the line by writing the vectors into a new clip combining the source and motion channels.

1. Select the O_VectorGenerator node in the Node Graph.
2. Select **Image** > **Write** (or press **W** on the keyboard) to insert a Write node after O_VectorGenerator.
3. In the Write node controls, select **all** from the **channels** dropdown and set **file type** to **exr**.
4. Enter a name for the clip in the **file** field (for example, **my_clip.####.exr**), and click **Render**.

   The newly created motion channels are saved in the channels of your stereo clip. When you need to manipulate the same clip again later, the motion vectors are loaded into Nuke together with the clip.



Rendering the output to combine the clip and the motion channels for future use.

O_VectorGenerator Controls

Use GPU

Open the O_VectorGenerator controls. O_VectorGenerator renders using the Local GPU specified, if available, rather than the CPU. The GPU may significantly improve processing performance.

If there is no suitable GPU, or the required NVIDIA CUDA drivers are unavailable, O_VectorGenerator defaults to using the CPU. You can select a different GPU Device, if available, by opening Nuke's **Preferences** and selecting an alternative card from the **GPU Device** dropdown.


NOTE: Selecting a different GPU requires you to restart Nuke before the change takes effect.

Views to Use

From the views that exist in your project settings, select the two views you want to use to calculate the motion vectors. These views are mapped for the left and right eye.

Mask

An optional mask that specifies areas to exclude from the motion calculation. You can use this input to prevent distortions at occlusions or to calculate motion for a background layer by ignoring all foreground elements.

Note that masks should exist in both views, and O_VectorGenerator treats the alpha values of 1 as foreground and blurs to the 0 value using nearby vectors to recreate object boundaries, rather than image data. When you create a mask using Roto or RotoPaint, you can use the **feather** control to extend the calculation. For example, the vector map may have a sharper transition at edges with a binary mask, but applying feather on the mask can help smooth the resulting image.

None	Use the entire image area.
Source Alpha	Use the alpha channel of the **Source** clip as an ignore mask.
Source Inverted Alpha	Use the inverted alpha channel of the **Source** clip as an ignore mask.
Mask Luminance	Use the luminance of the **Mask** input as an ignore mask.

Mask Inverted Luminance	Use the inverted luminance of the **Mask** input as an ignore mask.
Mask Alpha	Use the alpha channel of the **Mask** input as an ignore mask.
Mask Inverted Alpha	Use the inverted alpha channel of the **Mask** input as an ignore mask.

Vector Detail

Adjusts the detail of the calculated motion vectors. Higher detail picks up finer movement, but takes longer to calculate.

Strength

Sets the strength in matching pixels between frames. Higher values allow you to accurately match similar pixels in one image to another, concentrating on detail matching even if the resulting motion field is jagged. Lower values may miss local detail, but are less likely to provide you with the odd spurious vector, producing smoother results. Often, it is necessary to trade one of these qualities off against the other. You may want to increase this value to force the images to match, for example, where fine details are missed, or decrease it to smooth out the motion vectors.

Consistency

Sets how heavily the forward and backward vectors are forced to match. Increase the **Consistency** to make the forward and backward vectors more similar to each other, but this may cause the vectors to match the image less.

Smoothness

Applies extra smoothing to the motion vector field as a post-process, after image matching. The higher the value, the smoother the result.

O_VectorGenerator Example

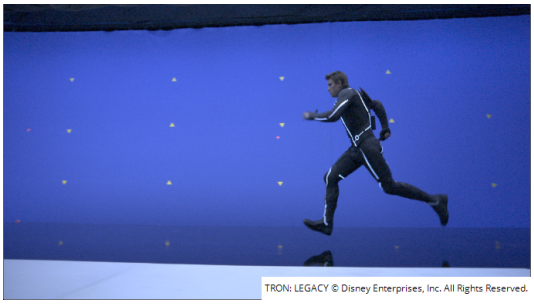
See O_Retimer Example for an example of how to use O_VectorGenerator and O_Retimer to calculate a motion vector field for a stereo image and use it to retime the sequence.

11 Retimer

Description

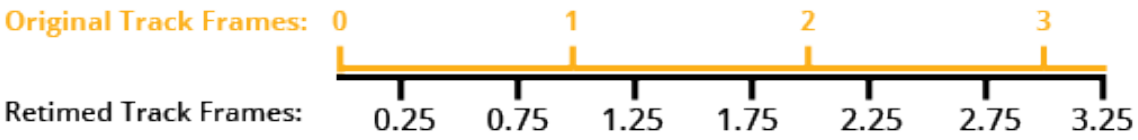
O_Retimer is designed to retime footage so that it plays back faster or in slow-motion. O_Retimer uses upstream motion vectors generated by an O_VectorGenerator node to retime the footage. These motion vectors describe how each pixel moves from frame to frame (see VectorGenerator). With accurate motion vectors, it is possible to generate an output image at any point in sequence timeline by interpolating along the direction of the motion.

Simple mix of two frames to achieve an in-between frame.



O_Retimer vector interpolation of the same two frames.

By default, O_Retimer is set to perform a half-speed slow down. This is achieved by generating new frames at quarter and three-quarter positions (.25 and .75) between the original frames at 0 and 1. In this way, none of the original frames are used in the retimed sequence, as shown in the following diagram:



Timing Methods

You can retime footage using two different methods; the **Speed** method and the **Source Frame** method. By default, the **Timing** control is set to the **Speed** method.

The **Speed** method allows you to set a new speed at which to play the footage back. A speed value below 1 slows the clip down; and a speed value above 1, speeds it up. The default value is **0.5**, which creates a half-speed retime.

NOTE: When using the **Speed** method, we recommend adding a FrameRange node before the O_Retimer to control the input frame range. This allows you to visualise the retime using the Curve Editor more easily.

Alternatively, you can perform a retime using the **Source Frame** method. This retimes the footage in terms of specifying source frames at different outputs on the timeline. For example, you can specify frame 1 in the output clip to read frame 1 of the source clip, and specify frame 100 in the output clip to read frame 50 of the source clip. This is the equivalent of doing a half-speed retime.

Inputs

O_Retimer has the following inputs:

Motion	If a vectors are supplied here, O_Retimer uses them and does not require motion in the **Source** input. This can be useful if, for example, your input sequence is very noisy, as too much noise interferes with the motion estimation. In that case, you should supply a smoothed version of the sequence and an O_VectorGenerator node here.
Source	A stereo pair of images. If motion vectors are not embedded in the images, you need to insert an O_VectorGenerator node after the image sequence to calculate them.

To see a table listing the nodes or channels each Ocula node requires in its inputs, see Appendix B.

Using O_Retimer

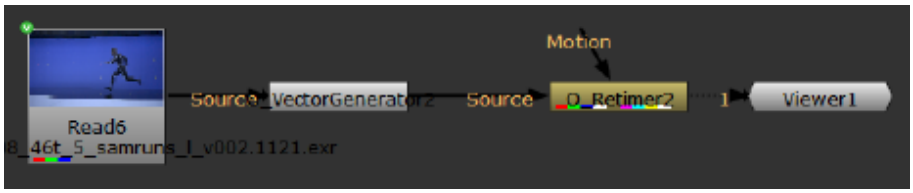
NOTE: O_Retimer requires upstream motion vectors to operate correctly.

Retiming Stereo Footage Using Speed

To perform a linear retime using the **Speed** method, do the following:

1. If motion vectors don't yet exist in the script, you can use the O_VectorGenerator node to calculate them. See VectorGenerator for information on how to do this.

2. Select **Ocula** > **Ocula 4.0** > **O_Retimer** to insert O_Retimer either after the O_VectorGenerator node if you added one in the previous step, or after the stereo image sequence.
3. In the O_Retimer controls, select the two views you want to use for retiming under **View to Use**. The two views you select are mapped for the left and right eye.
4. Connect a Viewer to the O_Retimer node. Your node tree should now look something like this:



5. Select a new speed value by either entering it the **Speed** box or dragging the **Speed** slider to the required value.
6. Play through the clip to calculate the retiming for all the frames.

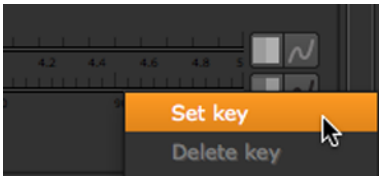
NOTE: Constant retimes produce a number of frames equal to last frame - first frame / speed. For example, a 10 frame clip at half speed would produce 10-1/0.5 = 18 frames.

Retiming Stereo Footage Using Source Frame

NOTE: You need to set a minimum of two keyframes to retime footage using the **Source Frame** method.

To perform a linear retime using the **Source Frame** method, do the following:

1. Repeat steps 1 to 4 in the Retiming Stereo Footage Using Speed section.
2. Select **Source Frame** from the **Timing** dropdown.
3. Move the playhead to the first frame you want to change the output for on the Viewer timeline.
4. Set the source frame number that you want to appear at the selected output position by either entering it in the **Frame** box, or dragging the **Frame** slider to the required frame.
5. Set a keyframe for this by selecting the animation menu next to the **Frame** parameter, and clicking **Set key**. A keyframe is indicated by a blue marker.



6. Move the playhead on the Viewer timeline to the next frame you want to change the output for.
7. Set the source frame number that you want to appear at the selected output position by either entering it in the **Frame** box, or dragging the **Frame** slider to the required frame. A keyframe is set automatically, identified with a blue marker.
8. Play through the clip to calculate the retiming for all the frames.

NOTE: Constant retimes produce a number of frames equal to last frame - first frame / speed. For example, a 10 frame clip at half speed would produce 10-1/0.5 = 18 frames.

Varying the Retime Speed

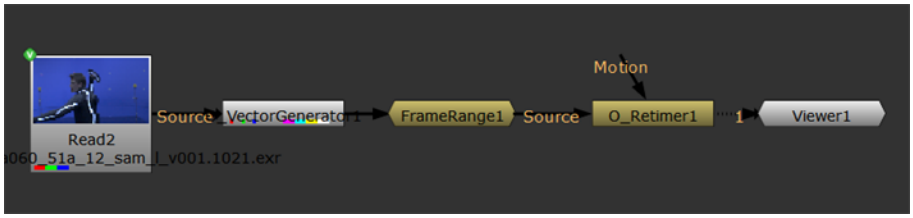
To vary the speed in your sequence, you can use either of the **Timing** methods. As with the **Source Frames** method, you add keyframes at different points on the Viewer timeline and specify varying speeds. This means, the speed changes at every keyframe, varying the speed throughout the clip.

NOTE: When you are retiming footage using the **Speed** method, ensure that you set the keyframes on the input frames by using a FrameRange node, as setting keyframes on the input frames alters the number of output frames.

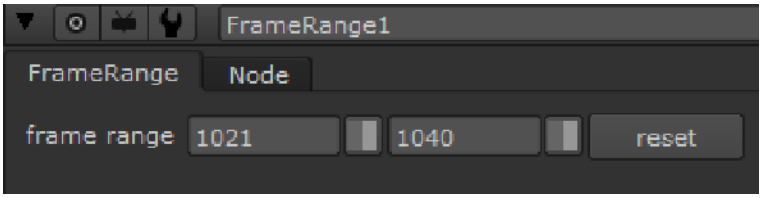
Varying Retimes Using Speed

To vary the speed throughout the footage using the **Speed** method, do the following:

1. Repeat steps 1 to 4 in the Retiming Stereo Footage Using Speed section.
2. Add a FrameRange (Time > FrameRange) node between the O_VectorGenerator and O_Retimer.



3. Set the timeline range to **Input** using the dropdown under the Viewer.
4. In the FrameRange node's Properties, specify the first and last frames you want to retime. For example, 1021 - 1040. This sets the input frames and allows you to visualise the retime using the Curve Editor more easily.



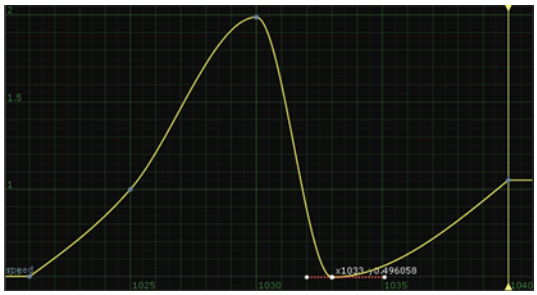
5. Set a keyframe on the first frame specified by the FrameRange node and then set the required keyframes to retime the footage as required.
6. In the O_Retimer Properties, right-click the keyframed Speed control and select **Curve editor**.

   The **Curve Editor** tab displays the keyframes you added to retime the footage.

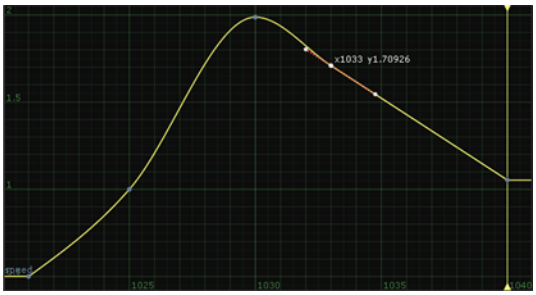
7. If you move points on the curve, you can see the out point on the Viewer timeline updates to show you how many frames of output are created from the input frames.

TIP: You can add points to a curve by holding **Ctrl**/**Cmd**+**Alt** and clicking on the curve. This also adds a corresponding keyframe to the Viewer timeline.

The left-hand curve creates 1042 output frames, whereas the shallower retime curve on the right produces fewer output frames - just 1035 frames. However, the input frames displayed on the **x** axis of the **Curve Editor** remain constant between 1021 and 1040.



Frames 1021 to 1040 with a steep slowdown curve produces 1042 frames output in the Viewer.

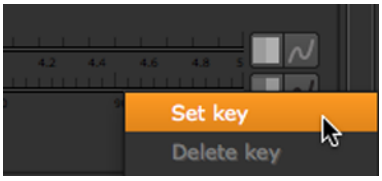


Frames 1021 to 1040 with a shallow slowdown curve produces 1035 frames output in the Viewer.

Varying Retimes Using Source Frames

To vary the speed throughout the footage using the **Source Frames** method, do the following:

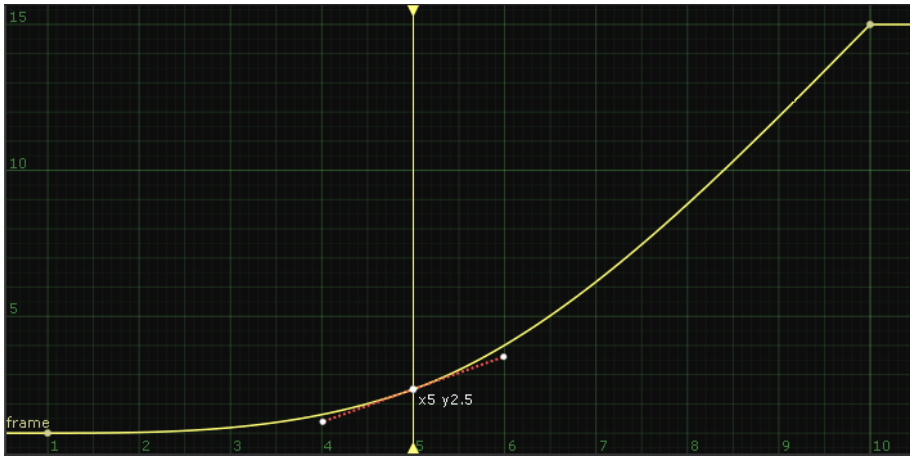
1. Repeat steps 1 to 4 in the Retiming Stereo Footage Using Speed section.
2. Select **Source Frame** from the **Timing** dropdown.
3. Move the playhead to the first frame you want to change the output for on the Viewer timeline.
4. Set the source frame number that you want to appear at the selected output position by either entering it in the **Frame** box, or dragging the **Frame** slider to the required frame.
5. Set a keyframe for this by selecting the animation menu next to the **Frame** parameter, and clicking **Set key**. A keyframe is indicated by a blue marker.



6. Move the playhead on the Viewer timeline to the next frame you want to change the output for.
7. Set the source frame number that you want to appear at the selected output position by either entering it in the **Frame** box, or dragging the **Frame** slider to the required frame. A keyframe is set automatically, identified with a blue marker.

8. Add as many keyframes as necessary to produce the required retime. For example, if you had a clip consisting of 15 frames, you could:
   - Set frame 1 to output frame 1, and frame 5 to output frame 2.5, resulting in a half-speed retime.
   - Set frame 10 to output frame 15, resulting in a third speed up.

   This creates a retime curve, which you can see if you right-click the **Frame** control and select **Curve editor** or **Dope sheet** from the animation menu. The graph would look something like this:



   The **y** axis shows the source frames, and the **x** axis shows the output frames. By using the **Curve Editor** or **Dope Sheet** to adjust this curve, you can create an arbitrarily changing speed for the sequence.

TIP: You can add points to a curve by holding **Ctrl**/**Cmd**+**Alt** and clicking on the curve. This also adds a corresponding keyframe to the Viewer timeline.

O_Retimer Controls

Use GPU

Open the O_Retimer controls. O_Retimer renders using the Local GPU specified, if available, rather than the CPU. The GPU may significantly improve processing performance.

If there is no suitable GPU, or the required NVIDIA CUDA drivers are unavailable, O_Retimer defaults to using the CPU. You can select a different GPU Device, if available, by opening Nuke's **Preferences** and selecting an alternative card from the **GPU Device** dropdown.

NOTE: Selecting a different GPU requires you to restart Nuke before the change takes effect.

Views to Use

From the views that exist in your project settings, select the two views you want to use to perform the retime. These views are mapped for the left and right eye.

Timing

Use the **Timing** control to set the retiming method.

Speed	Select this method if you want to define the retiming in terms of speed of playback and total duration: double-speed halves the duration of the clip and half-speed doubles the duration of the clip.  NOTE: When you are retiming footage using the **Speed** method, ensure that you set the keyframes on the input frames, as setting keyframes on the input frames alters the number of output frames.
Source Frame	Select this method if you want to define the retiming in terms of specifying source frames at different output points in the Viewer timeline. You need to set a minimum of two keyframes to use the **Source Frame** method.

Speed

The **Speed** control is only available when the **Timing** method is set to **Speed**. Use this to alter the playback speed. Values below 1 slow down the clip. Values above 1 speed up movement. For example, to slow down the clip by a factor of two (half speed), set this value to 0.5. Quarter speed would be 0.25.

Frame

The **Frame** control is only available when the **Timing** method is set to **Source Frame**. Use this to specify the source frame at the currently selected output frame on the Viewer timeline. For example, to slow down a 50 frame clip by half, set the **Source Frame** to 1 at frame 1 and the **Source Frame** to 50 at frame 100. The default expression results in a half-speed retime.

Edges

Output edges to alpha

You can use the **Output edges to alpha** checkbox to output the edges to the alpha channel. Use the alpha channel as an overlay to determine where the edge correction is applied.

Adjust Edges

Use the **Adjust Edges** slider to change the size of the edge mask. To dilate the mask, use a positive value. You can use a negative value to erode the mask.

Feather

You can use the **Feather** slider to specify how much feathering to apply to the edges. Increasing the **Feather** value softens the edges; decreasing the value, sharpens the edges.

O_Retimer Example

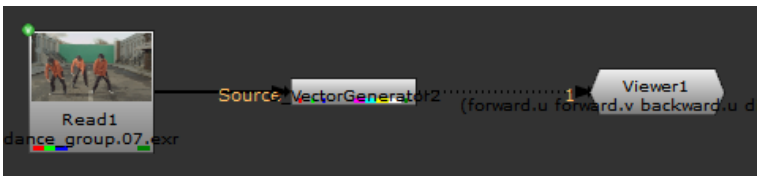
In this example, we generate motion vectors using O_VectorGenerator and feed them to O_Retimer in order to vary the speed throughout the clip.

You can download the image used here from our website. For more information, please see Example Images.

Step by Step

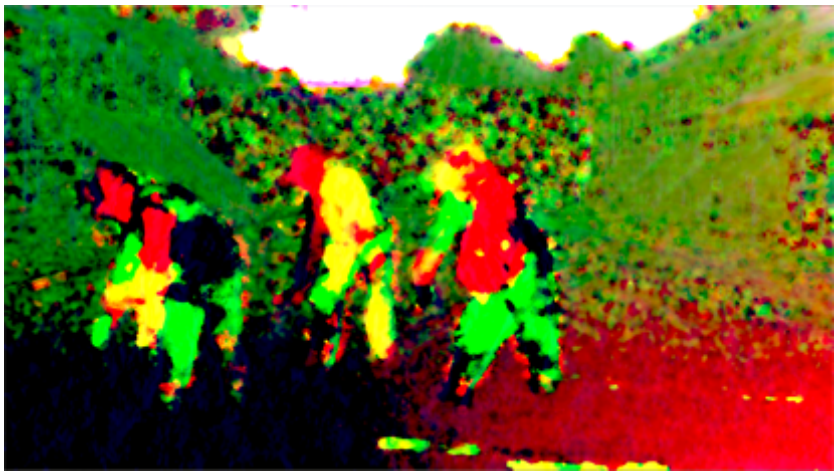
Generating Motion Vectors

1. Launch Nuke and open the project settings by pressing **S** on the Node Graph. Go to the **Views** tab and click the **Set up views for stereo** button.
2. Import **dance_group.##.exr**. This image already includes both the left and the right views.
3. Add a Viewer to the image.
4. Select **Ocula** > **Ocula 4.0** > **O_VectorGenerator** to insert an O_VectorGenerator node after the image sequence.



The purpose of O_VectorGenerator is to calculate the motion vectors required later for retiming the sequence.

5. In the Viewer, select **motion** from the channel dropdown. The calculated forward and backward motion vectors are displayed in the Viewer.

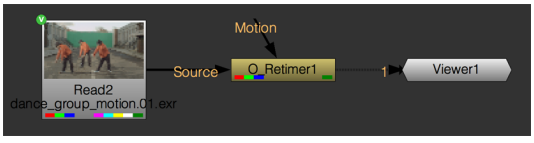


6. You can render out the motion vectors with the image by selecting **Image** > **Write** to insert a Write node after O_VectorGenerator. In the Write node controls, select **all** from the **channels** dropdown menu. Choose **exr** as the **file type**. Select a location for the clip in the **file** field and enter **dance_group_motion.##.exr** as the name. Click **Render**. The newly created motion vectors are saved in the channels of the clip.
7. Continue to the next section to retime the sequence using these motion vectors.

Retiming the Sequence

1. Import the **dance_group_motion.##.exr** clip you rendered in the previous step and connect a Viewer to it.

2. Play through the clip in the Viewer to get a sense of the motion.
3. Insert an O_Retimer node after the clip.



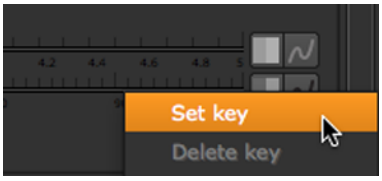
By default, this node is set to perform a half speed slow down. However, in this example, we want to speed up the sequence.

4. Instead of changing the clip's playback speed in terms of overall duration, we are going to define the retiming by specifying source frames at selected output frames in the Viewer timeline. In order to do this, set **Timing** to **Source Frame** in the O_Retimer controls.

Notice that the **Speed** control is not available and the **Frame** control is activated. The default **Frame** setting is 1, which sets the first frame on the timeline to frame 1 of the input image.

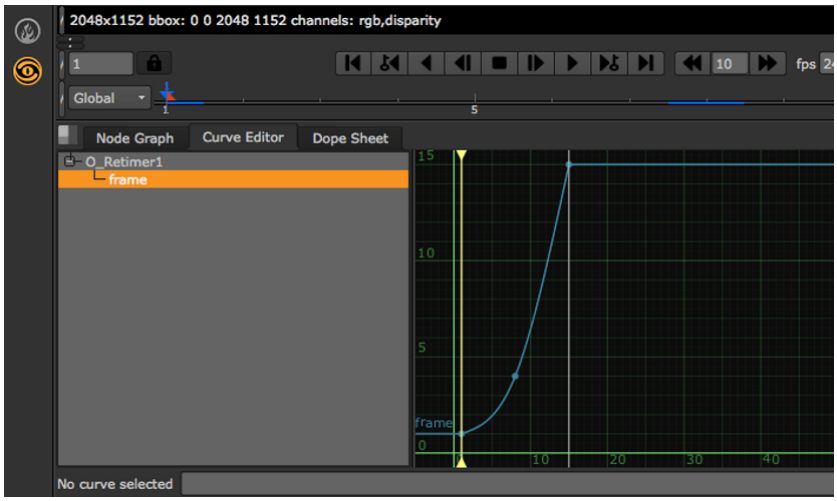
NOTE: You need to set a minimum of two keyframes to use the **Source Frame** method.

5. Click the animation menu next to **Frame** and select **Set key** in order to set a keyframe at the first frame on the timeline.



A keyframe is indicated by a blue chip.

6. Move the playhead to frame 8 and set the **Frame** value to 4. A keyframe is set automatically. O_Retimer sets frame 8 on the timeline to frame 4 of the source image, effectively reducing the playback speed by half leading up to frame 8.
7. Move the playhead to frame 15 and set the **Frame** value to 15. O_Retimer sets frame 15 on the timeline to the last frame of the input clip, effectively returning the playback speed to normal at frame 15.
8. Press Play in the Viewer to process and review the results. After the process is complete, you are able to see the result of the retime. You may have to reduce the **fps** control to see the result clearly.
9. Return to the beginning of the clip and play through each frame with the Next Frame arrow in the Viewer. You should notice that the **Frame** value changes over time – slowly up to frame 8 and more quickly towards the final frame.



12 DepthToDisparity

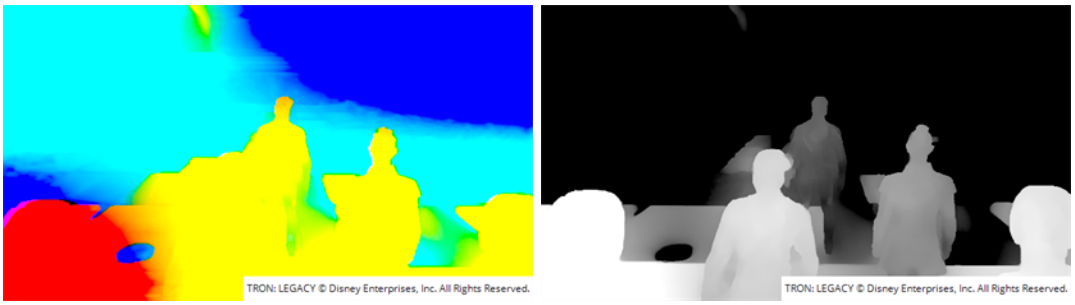
Description

Many Ocula nodes rely on disparity maps to produce their output. Usually, disparity maps are created using a combination of the O_Solver (see Solver) and O_DisparityGenerator (see DisparityGenerator) nodes.

However, if you have a CG scene with stereo camera information and a z-depth map available, you can also use the O_DepthToDisparity node to generate the disparity map. Provided that the camera information and z-depth map are correct, this is both faster and more accurate than using the O_Solver and O_DisparityGenerator nodes.

Using one of the camera transforms and the corresponding depth map, O_DepthToDisparity does a back projection from one view to find the position of each image point in 3D space. It then projects this point with the other camera transform to find the position of the point in the other view. The difference between the two positions gives the disparity in one direction.

As with the O_DisparityGenerator node, the final disparity vectors are stored in disparity channels, so you might not see any image data appear when you first calculate the disparity map. To see the output inside Nuke, select the disparity channels from the channel set and channel controls in the top left corner of the Viewer. Examples of what a disparity map might look like using the RGB and R channels are shown below. As you can see, the RGB layers on the left are harder to read than the single R channel.



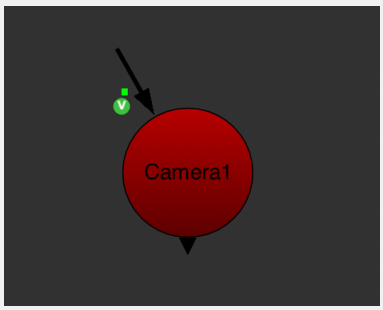
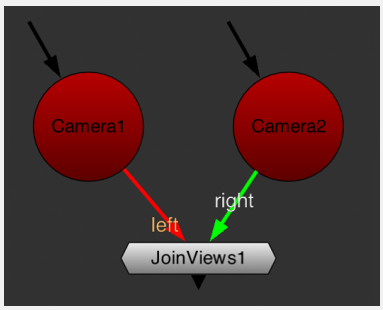
Once you have generated a disparity map that describes the relation between the views of a particular clip well, it is suitable for use in most of the Ocula nodes. We recommend that you insert a Write node after O_DepthToDisparity to render the original images and the disparity channels as a stereo **.exr** file. This format allows for the storage of an image with multiple views and channel sets embedded in it. Whenever you use the same image sequence, the

disparity map is loaded into Nuke together with the sequence and is readily available for the Ocula nodes. For information on how to generate a disparity map using O_DepthToDisparity and render it as an **.exr** file, see Generating a Disparity Map from Depth.

NOTE: To use O_DepthToDisparity, you need the positions of the stereo camera rig for the two views.

Inputs

O_DepthToDisparity has the following inputs:

Camera	A Nuke stereo Camera node. This is the camera the scene was rendered with. In most cases, you would import this into Nuke from a third-party 3D application. For information on how to do this, see the *Nuke User Guide*. In Nuke, a stereo camera can be either: • a single Camera node in which some or all of the controls are split, or • two Camera nodes (one for each view) followed by a JoinViews node (**Views** > **JoinViews**). The JoinViews node combines the two cameras into a single output.  A single Camera node with split controls.  Two cameras combined using Nuke's JoinViews node.
Depth	This is a stereo pair of images (usually, a scene you've rendered from a 3D application). In the depth channel, there should be a z-depth map for each view. NOTE: If this input is an **.exr** file, the z-depth map may already be embedded in the clip. If you're using another file format and have saved the depth map as a separate image, you can use a Nuke Shuffle node (**Channel** > **Shuffle**) to get the z-depth map in the depth channel of the **Depth** image. For information on how to do this, see the *Nuke User Guide*.

To see a table listing the nodes or channels each Ocula node requires in its inputs, turn to Appendix B.

Generating a Disparity Map from Depth

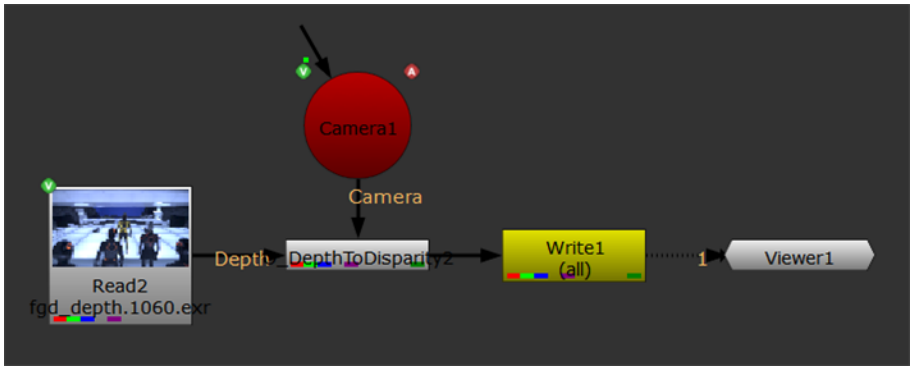
To generate a disparity map from a depth channel, do the following:

1. Start Nuke and press **S** on the Node Graph to open the Project Settings. Go to the **Views** tab and click the **Set up views for stereo** button.
2. From the Toolbar, select **Image** > **Read** to load your stereo clip (usually, a rendered 3D scene) into Nuke. If you don't have both views in the same file, select **Views** > **JoinViews** to combine them, or use a variable in the Read node's file field to replace the name of the view (use the variable **%V** to replace an entire view name, such as **left** or **right**, and **%v** to replace an initial letter, such as **l** or **r**). For more information, refer to the *Nuke User Guide*.

   Make sure the stereo clip contains a z-depth map for each view in the depth channels. If this is not the case and you have saved the depth maps as separate images, you can use a Nuke Shuffle node (**Channel** > **Shuffle**) to shuffle them into the depth channels.
3. Select **Ocula** > **Ocula 4.0** > **O_DepthToDisparity** to insert an O_DepthToDisparity node after either the stereo clip or the JoinViews node (if you inserted one in the previous step).
4. Connect the camera that the scene was rendered with to the **Camera** input of O_DepthToDisparity. It is important the camera information is correct for the scene.
5. Open the O_DepthToDisparity controls. From the **Views to Use** menu or buttons, select which views you want to use for the left and right eye when creating the disparity map.
6. Attach a Viewer to the O_DepthToDisparity node, and display one of the disparity channels in the Viewer.

   O_DepthToDisparity calculates the disparity map and stores it in the disparity channels.
7. Select **Image** > **Write** to insert a Write node after O_DepthToDisparity. In the Write node controls, select **all** from the **channels** dropdown menu. Choose **exr** as the **file type**. Render the clip.

   The newly created disparity channels are saved in the channels of your stereo clip. When you need to manipulate the same clip again later, the disparity vectors are loaded into Nuke together with the clip.



Rendering the output to combine the clip and the disparity channels for future use.

O_DepthToDisparity Controls

Views to Use

From the views that exist in your Project Settings, select the two views you want to use to create the disparity map. These views are mapped for the left and right eye.

O_DepthToDisparity Example

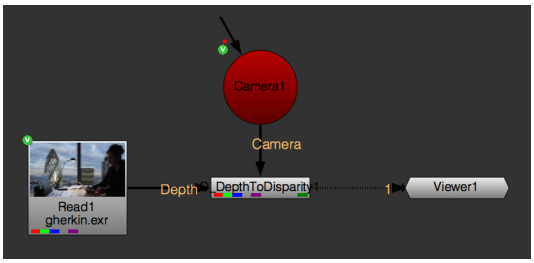
This example shows you how to calculate a disparity map for a stereo pair of images using O_DepthToDisparity.

You can download the script used here from our website. For more information, please see Example Images.

Step by Step

1. Start Nuke and select **File** > **Open** to import the **gherkin.nk** script.
2. This script has the left and the right view set up in the Project Settings. In the Node Graph, there is a stereo camera node.
3. Select **Image** > **Read** to import **gherkin.exr** and attach a Viewer to the image.

   The image is a render of a 3D scene. It already includes the left and the right view, and a depth channel for both views.
4. Select **Ocula** > **Ocula 4.0** > **O_DepthToDisparity** to insert an O_DepthToDisparity node between the Read node and the Viewer. Make sure the Read node is connected to the **Depth** input of O_DepthToDisparity.
5. Connect the Camera node to the **Camera** input of O_DepthToDisparity. This node is the camera the 3D scene was rendered with. Your node tree should now look something like the one shown below.



6. Use the channel menus in the top left corner of the Viewer to display one of the disparity channels.

   O_DepthToDisparity calculates the disparity map and stores it in the disparity channels.
7. Temporarily decrease the **gain** value in the Viewer to see detail in the disparity channels and then switch back to viewing the **rgba** channels.
8. To evaluate the quality of the disparity map, select **Ocula** > **Ocula 4.0** > **DisparityReviewGizmo**.

The default settings show that the disparity map is pretty good, with clearly defined depth edges picked out in red. See DisparityReviewGizmo for more information.

It is worth noting that the results achieved with O_DepthToDisparity are usually better than those achieved with O_Solver and O_DisparityGenerator for rendered 3D scenes, though this is not the case with non-CG footage.

13 DisparityToDepth

Description

The O_DisparityToDepth node produces a z-depth map for each view of a stereo clip, based on the clip's disparity map and stereo camera setup.

A z-depth map is an image that uses the brightness of each pixel to specify the distance between the 3D scene point and the virtual camera used to capture the scene. For example, you may use a z-depth map if you want to introduce fog and depth-of-field effects into a shot. In Nuke, the ZDefocus node (**Filter** > **ZDefocus**) requires a depth map in its input.

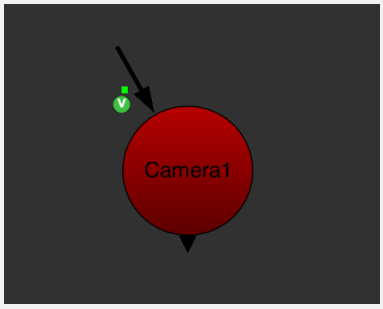
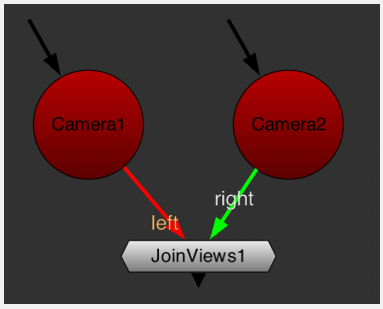
O_DisparityToDepth stores the final z-depth map in the **depth** channel. Select **depth** from the channel dropdown above the Viewer to display the z-depth map. You can then select the red only channel (R) and adjust the **gain** and **gamma** sliders above the Viewer to display the depth map more clearly.

The left view of a stereo image.

The associated depth map of the left view.

Inputs

O_DisparityToDepth has the following inputs:

Camera	A pre-tracked Nuke stereo camera that describes the camera setup that is used to shoot the **Source** images. This can be a camera you have tracked with the CameraTracker node or imported to Nuke from a third-party camera tracking application. In Nuke, a stereo camera can be either: • a single Camera node in which some or all of the controls are split, or • two Camera nodes (one for each view) followed by a JoinViews node (**Views** > **JoinViews**). The JoinViews node combines the two cameras into a single output.  A single Camera node with split controls.  Two cameras combined using Nuke's JoinViews node.
Disparity	A stereo pair of images. O_DisparityToDepth requires upstream disparity vectors. If they do not already exist, insert an O_DisparityGenerator node after the image sequence to calculate them. See DisparityGenerator for more information.

To see a table listing the nodes or channels each Ocula node requires in its inputs, see Appendix B.

Using O_DisparityToDepth

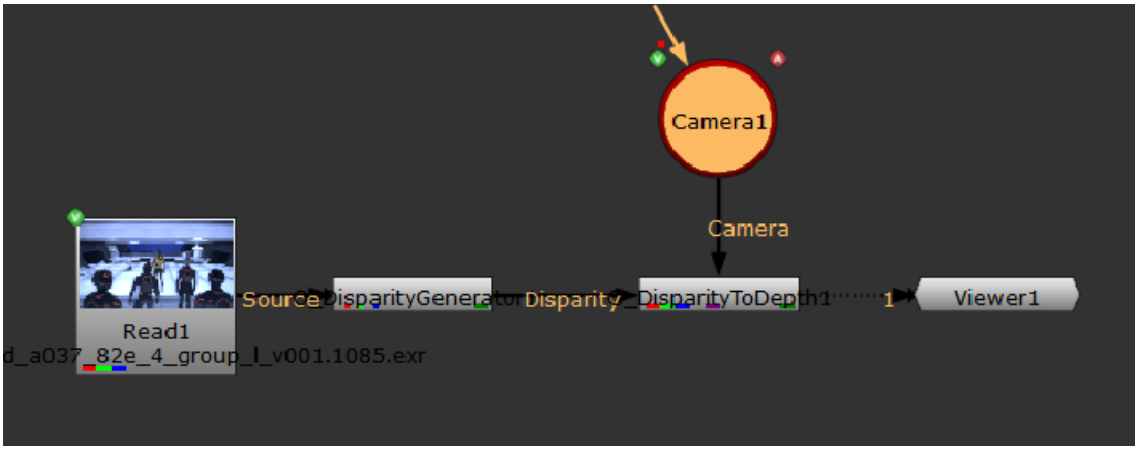
NOTE: O_DisparityToDepth requires upstream disparity vectors to operate correctly.

To generate a z-depth map for a stereo clip, do the following:

1. If disparity vectors do not yet exist in the script, you need to insert an O_DisparityGenerator node after your image sequence to calculate the disparity vectors. See DisparityGenerator for how to do this.

TIP: O_DisparityGenerator's **Alignment** control can reduces noise on the vertical component of disparity and produce smoother variations in depth, but requires solve data upstream. See Solver for more information on calculating solve data.

2. Select **Ocula** > **Ocula 4.0** > **O_DisparityToDepth** to insert an O_DisparityToDepth node either after the O_DisparityGenerator node if you added one in the previous step, or after the image sequence.
3. Connect a pre-tracked Nuke stereo camera to the **Camera** input of O_DisparityToDepth.
4. Open the O_DisparityToDepth controls. From the **Views to Use** menu, select which views you want to use for the left and right eye when creating the z-depth map.
5. Connect a Viewer to the O_DisparityToDepth node. Your node tree should now look something like this:



6. Select **depth** from the channel dropdown above the Viewer.
7. Select the red channel (**R**) from the **RGB** dropdown.
8. Adjust the **gain** and **gamma** controls to display the z-depth map more clearly.
9. To render out the stereo clip with the depth map stored in the depth channel, select **Image** > **Write** to insert a Write node after O_DisparityToDepth. In the Write node controls, select **all** from the **channels** dropdown menu. Choose **exr** as the **file type**. Render the clip.

   When you need to use the same clip again later, the z-depth map is loaded into Nuke along with the clip. To view it, select **depth** from the channel dropdown.

Using O_DisparityToDepth with DeepMerge

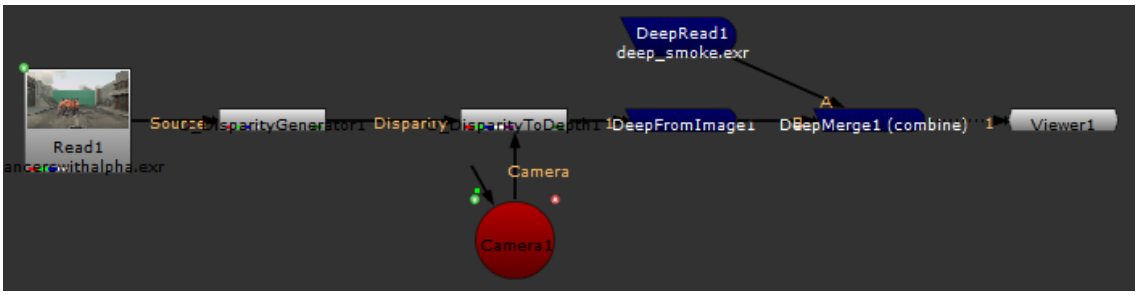
You can use choose to use DeepMerge with O_DisparityToDepth to insert objects at specific depth positions. For example, if you have an image of dancers, you may want to add in smoke around them.

NOTE: The original image or image sequence you are using must contain an alpha channel for DeepMerge to operate correctly.

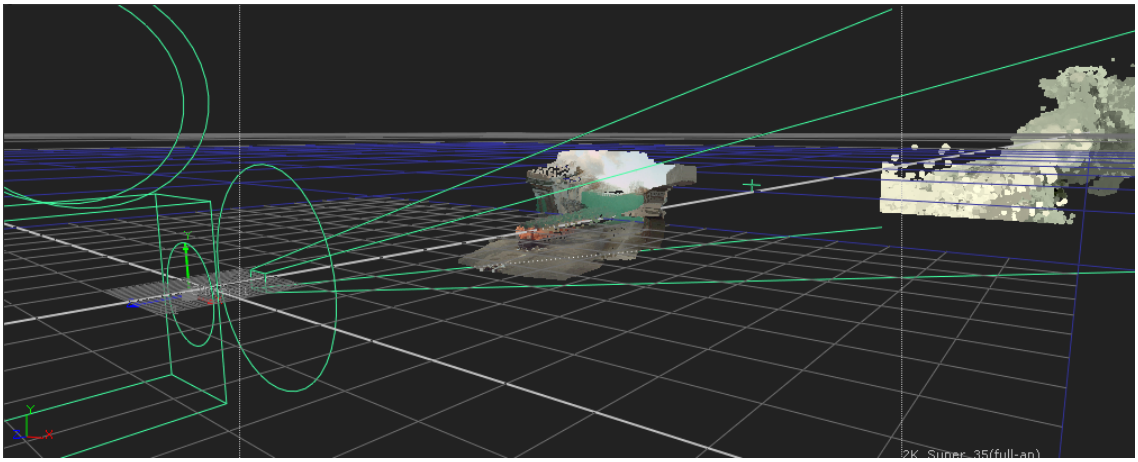
To use O_DisparityToDepth with DeepMerge, you can do the following:

1. Ensure your footage has an alpha channel and repeat steps 1 to 5 from the previous section to calculate the depth from disparity.
2. Insert a DeepFromImage node after the O_DisparityToDepth node by selecting **Deep** > **DeepFromImage**.

3. Insert a DeepMerge node after the DeepfromImage node, and change the input from the DeepMerge node so that the DeepFromImage node is connected using the **B** input.
4. Now, insert a separate DeepRead node by selecting **Deep** > **DeepRead** and navigate to the deep footage that you want to insert into your original image. In this case, we are inserting smoke around dancers in a stereo scene.
5. Attach the DeepRead node to the **A** input of DeepMerge. Your node tree should now look something like this:

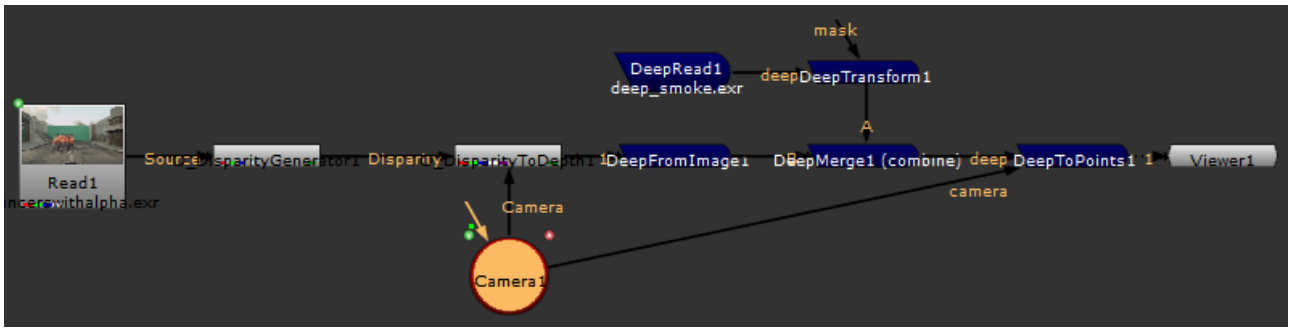


6. The smoke does not appear in the image. This must mean that the depth values of the image and the deep smoke are vastly different; one is too far in front of the other to be visible.
7. You can visualise the different depth positions by using a point cloud. To do this, insert a DeepToPoints node after the DeepMerge node.
8. Attach the camera input of the DeepToPoints node to the existing camera. This shows you a 3D view with a camera detailing the xyz coordinates of the footage in space.

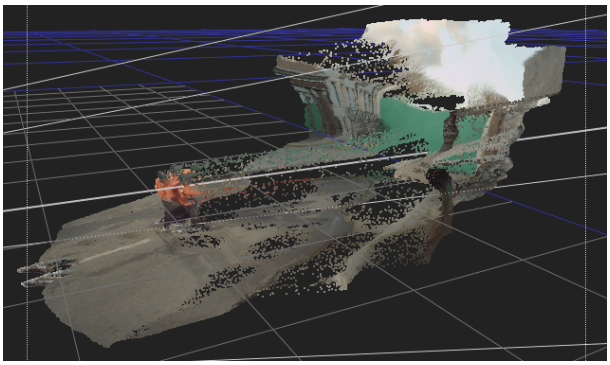


As you can see, the smoke footage is much too far back and also too large.

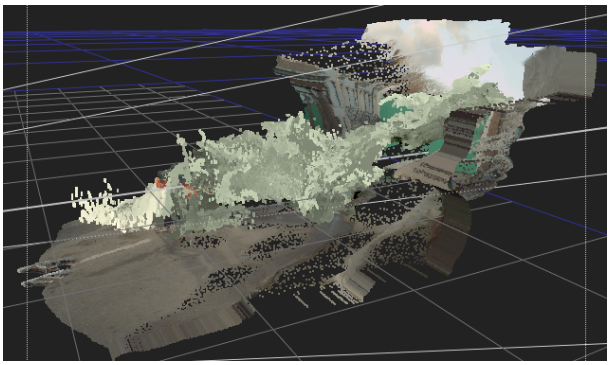
9. To change the position and scale of the smoke footage, insert a DeepTransform node after the smoke footage DeepRead node and before the DeepMerge node. Your node tree should now look something like this:



10. Open the DeepTransform controls. To move the position of the smoke footage forward, you need to increase the **z** value in the **translate** control. To decrease the depth of the smoke footage, you need to increase the **zscale** value. This is a divisor, so numbers above 1 decrease the depth.

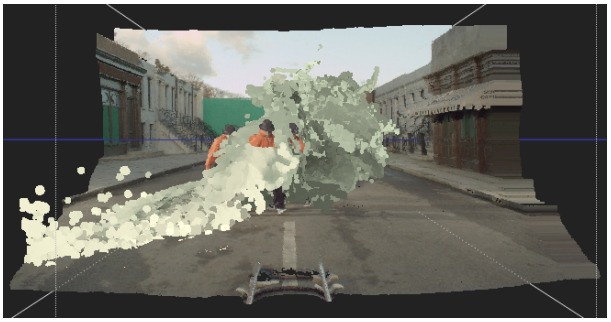


The DeepToPoints view of the original stereo image from the side .



The DeepToPoints view of the smoke footage and the original stereo image from the side .

The same DeepToPoints view of the original stereo image from the front.



The same DeepToPoints view of the smoke footage and the original stereo image from the front.

11. Press **D** over the DeepToPoints node to disable it and display the result. Press **Tab** to revert back to 2D.

O_DisparityToDepth Controls

Views to Use

From the views that exist in your project settings, select the two views you want to use to generate the z-depth map. These views are mapped for the left and right eye.

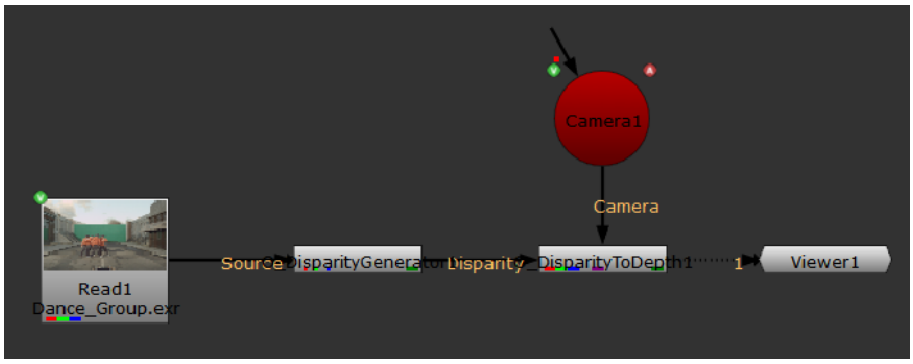
O_DisparityToDepth Example

In this example, we first generate a depth map for a stereo pair of images using O_DisparityToDepth. Then, we blur the image according to the depth map.

Step by Step

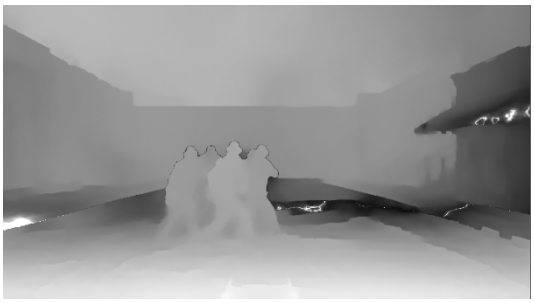
1. Launch Nuke and select **File** > **Open** to import the **depth.nk** script. This script has the left and the right view set up in the Project Settings. In the Node Graph, there is a stereo Camera node.
2. Select **Image** > **Read** to import **Dance_Group.exr** into Nuke.
3. To calculate disparity vectors, insert an O_DisparityGenerator node after the image. See DisparityGenerator for more information.

4. Select **Ocula** > **Ocula 4.0** > **O_DisparityToDepth** to insert an O_DisparityToDepth node after the O_DisparityGenerator node. Ensure the O_DisparityGenerator node is connected to the **Disparity** input of O_DisparityToDepth.
5. Connect the Camera node to the **Camera** input of O_DisparityToDepth. Your node tree should now look something like this:



6. Select **depth** from the **channel** dropdown above the Viewer to display the z-depth map.
7. Select the red channel (**R**) from the **RGB** dropdown, and adjust the **gain** and **gamma** sliders above the Viewer to see the depth map more clearly.

The left view of a stereo image.



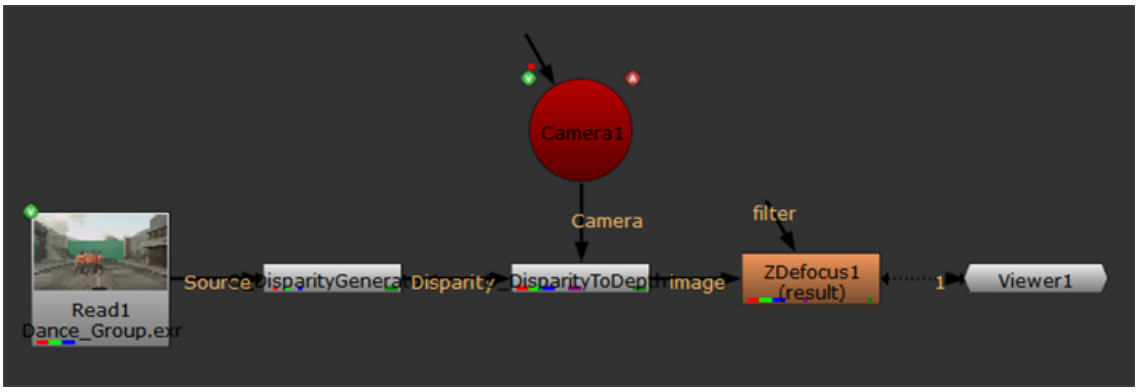
The red channel of the depth map (with adjusted gain and gamma).

8. To use O_DisparityToDepth with ZDefocus, continue to the next section.

An Example of Using O_DisparityToDepth with ZDefocus

The ZDefocus node blurs the image background according to the depth channels we've just created in the previous section.

1. Continue with the node tree you created in the previous section.
2. If you inserted a DisparityReviewGizmo node, either disable or delete it.
3. Select **Filter** > **ZDefocus** to add a ZDefocus node between O_DisparityToDepth and the Viewer. Your node tree should now look something like this:



4. Open the ZDefocus controls. A **focal_point** widget is displayed in the Viewer. Click and drag the **focal_point** widget to the area on the image you want to be in focus. In this case, we want the dancer at the front to be the focus point.
5. Then set the ZDefocus controls as follows:
   - **channels** to **rgba**
   - **math** to **far=0**
   - **size** to **63**
6. View the output. To see the effect of the ZDefocus node more accurately, select the node in the node tree and press **D** once to disable and again to enable it.

The left view when the ZDefocus node is disabled.

The left view when the ZDefocus node is enabled.

7. You can save the depth in the channels of the input clip for later use. To do this, select **Image** > **Write** to insert a Write node between O_DisparityToDepth and ZDefocus. In the Write node controls, select **all** from the **channels** dropdown menu. Use the **file** control to give the file a location and a new name. Choose **exr** as the **file type** and click **Render** to render the image.

14 MultiSample

Description

The O_MultiSample node allows you to use a **Sample** input to sample a selected area for one of the following uses:

- Fill the whole image with a smooth interpolation of the data from the sample area. Any channels can be used including depth, colour, disparity, and so on. For example, if you like the disparity vectors in a certain area, you can expand them to fill the rest of the image by selecting the area you like in the **Sample** input and choosing **disparity** from the **Channels** dropdown.
- Fill the area defined in the **Sample** input with the surrounding channel data. This allows you to fill holes or replace unwanted areas. Any channels can be used including depth, colour, disparity, and so on. For example, if you had an irregular area in a depth map, you can select the irregular area and input it as a sampled area. You can then invert the sampled area to fill it with the surrounding depth data.

The original left view of the depth map with an irregularity in the top-right area.

A bezier is drawn around the irregular area so that it can be input as a sampled area.

O_MultiSample fills the selected area by expanding the surrounding pixels.

- Fill a different area specified in the **Mask** input, with the channel data from the area specified in the **Sample** input. This allows you to correct areas that have not been rebuilt correctly, or replace any irregular areas. Any channels can be used including depth, colour, disparity, and so on. For example, if you had an area that has not been rebuilt correctly when using O_NewView, you can correct it using O_MultiSample. See Using O_MultiSample with the Sample and Mask Inputs for more information.

Inputs

O_MultiSample has the following inputs:

Sample	An input that defines an area to sample channel data from. This can be used for filling the whole image with a smooth interpolation of the data from the sample area, inverting the sampled area and therefore filling the it with the surrounding channel data, or using the sample channel data to fill another area specified in the optional **Mask** input.
Source	An image or a stereo pair of images.
Mask	An optional mask to define an area that you want to fill or replace using the channel data from the area defined by **Sample** input.

To see a table listing the nodes or channels each Ocula node requires in its inputs, see Appendix B.

Using O_MultiSample

You can use O_MultiSample with only the **Sample** input to fill in holes or replace data, or you can use O_MultiSample with the **Mask** and **Sample** input, to apply the sample data to a different area specified in the **Mask** input.

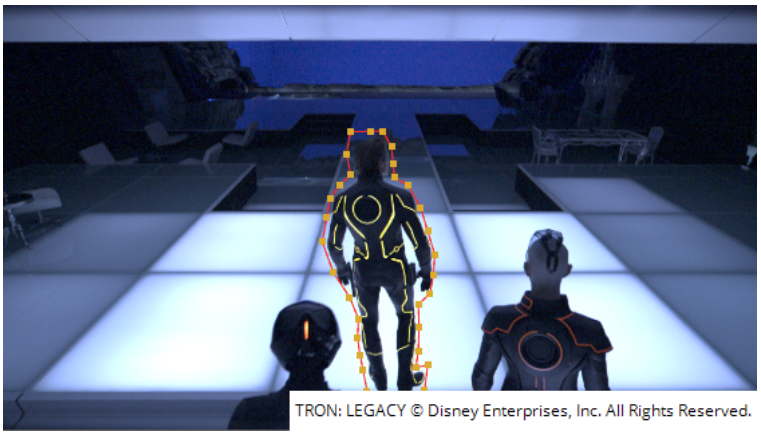
Using O_MultiSample with the Sample Input

You can use O_MultiSample to replace an area of channel data that is not accurate. For example, if you have generated a disparity map and there is a section that you are not happy with, you can use O_MultiSample to fill the specified shape with the surrounding disparity vector data from the whole image. This means that the disparity vectors in the selected area are replaced.

To use O_MultiSample to remove an area of disparity, you can do the following:

1. If disparity vectors do not already exist in the image sequence, insert an O_DisparityGenerator node after your image sequence to calculate the disparity vectors. See DisparityGenerator for more information.
2. Select **Ocula** > **Ocula 4.0** > **O_MultiSample** to insert an O_MultiSample node, either after the O_DisparityGenerator node if you added one in the previous step, or after the image sequence.
3. Create a Roto node and connect it to the **Sample** input of the O_MultiSample node.
4. Connect a Viewer to the O_MultiSample node. Your node tree should now look something like this:

5. Open the Roto controls. Draw a bezier around the area of disparity you want to remove.



6. Select **disparity** from the **channel** dropdown. Select **Luminance** from the **RGB** dropdown.
7. Adjust the **gain** and **gamma** controls to display the disparity map more clearly.
8. Open the O_DisparityGenerator controls. You can set the **Strength** control to 2, and the **Smoothness** control to 3.
9. Open the O_MultiSample controls and set the **Channels** control to **disparity**.
10. Set the **Sample** control to **Sample Inverted Alpha**. This removes the disparity from the selected area by filling it using the surrounding disparity vector data.

The original left view disparity map.

The left view with the selected area of disparity removed.

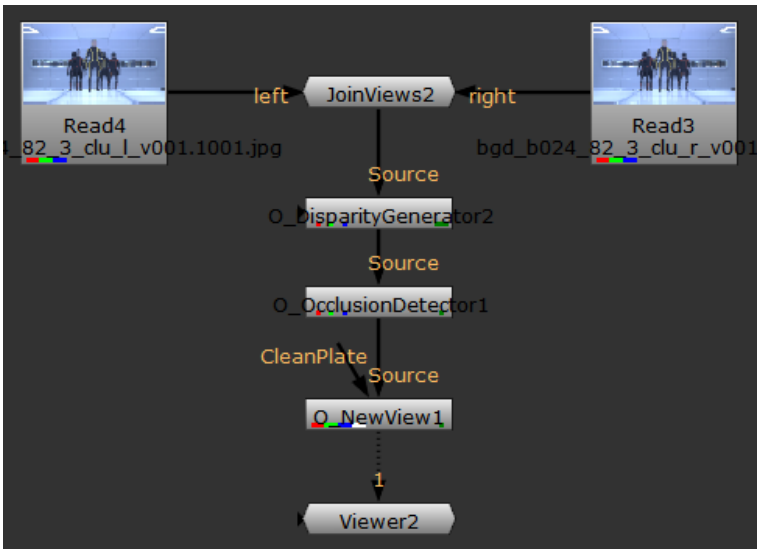
Using O_MultiSample with the Sample and Mask Inputs

You can use O_MultiSample to correct a specific area with data from the defined sample area. For example, if you use O_NewView to create a new left view and an area of it doesn't build correctly, you can use O_MultiSample to correct it.

In this case, you first create a new view:

1. O_NewView requires disparity vectors to operate correctly. If disparity vectors do not exist already, insert an O_DisparityGenerator to calculate them either after the image sequence, or – if you added one – the JoinViews node.

2. O_NewView also requires an O_OcclusionDetector node. Insert this after the O_DisparityGenerator node.
3. Select **Ocula** > **Ocula 4.0** > **O_NewView** to insert an O_NewView node and attach a Viewer to the O_NewView node. Your node tree should now look something like this:



4. In the O_NewView controls, select **Left from Right** from the **View to Build** dropdown to rebuild the left view using the pixels from the right.

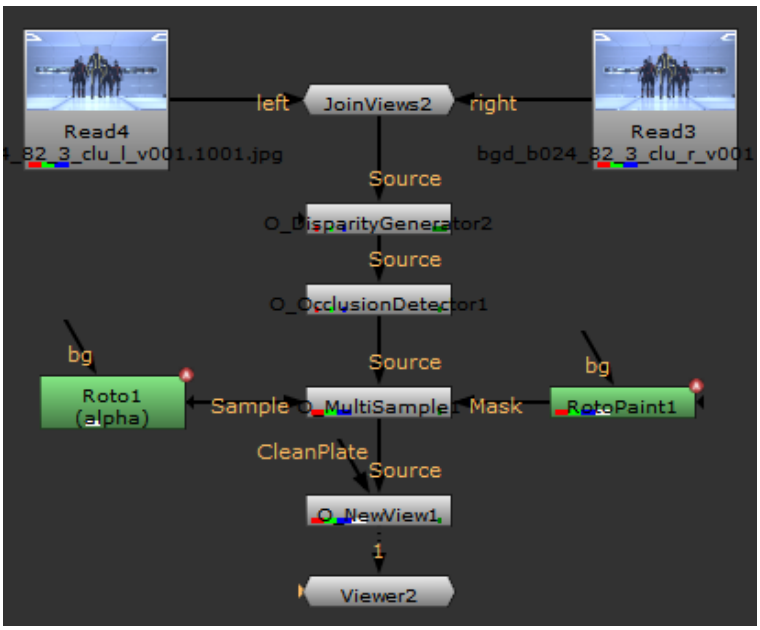
The rebuilt left view from the right. Notice the shoulder has not been reconstructed correctly.

The original right view.

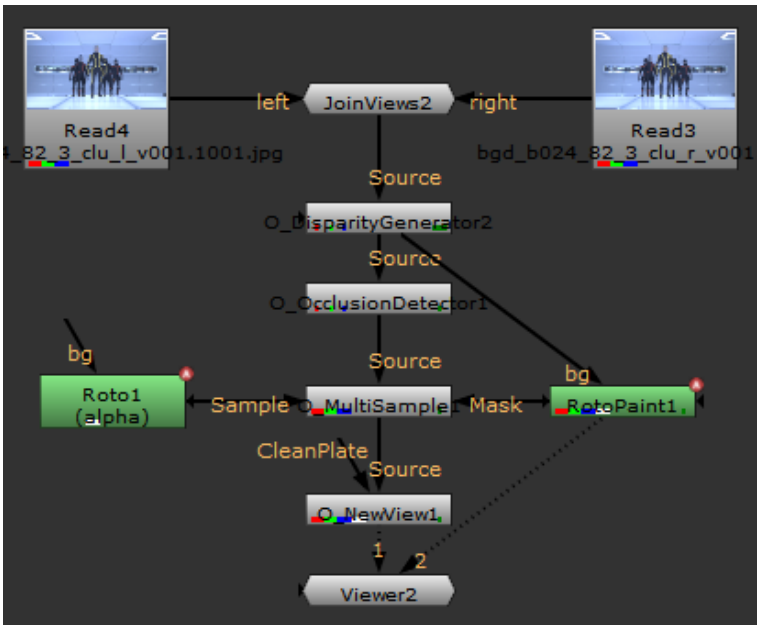
In this case, the left view has not been reconstructed correctly as a result of an irregular area in the disparity. This can be corrected by using O_MultiSample:

5. Insert an O_MultiSample node before the O_NewView node.
6. Create a Roto node and attach it to the **Sample** input of O_MultiSample. Draw a bezier around an area of disparity that you want to sample. In most cases, sampling the disparity from an area that is close produces the best results (see screenshot below). In this case, we need to sample the disparity from a close area at the same depth / or surface to get the best result.

7. Create a RotoPaint node and attach it to the **Mask** input of O_MultiSample. Your node tree should now look something like this:



8. From the RotoPaint node, use a paint brush to paint a stroke over the area of disparity that you want to correct. To view the stroke on the image, connect the **bg** input of the RotoPaint node to the O_DisparityGenerator node and then attach the RotoPaint to Viewer. Choose to display Viewer input **2**. Your node tree should now look something like this:



In this case, when you have the node tree set up like this and you display Viewer input **2**, this is what you see:

9. Choose to display Viewer input **1**.
10. Open the O_MultiSample controls, set the **Channels** control to **disparity**.
11. Set the **Sample** control to **Sample Alpha**, and the **Mask** control to **Mask Alpha**. This now fills the area specified area in the **Mask** input, with the data sampled from the specified area in the **Sample** input. In the image, the painted area is now rebuilt correctly. To compare the result to the original, press **D** several times with the O_MultiSample node selected, to disable and re-enable it.

The image with the O_MultiSample node disabled, showing the incorrectly built shoulder.

The image with the O_MultiSample node enabled, showing the correctly rebuilt view.

O_MultiSample Controls

Use GPU

Open the O_MultiSample controls. O_MultiSample renders using the Local GPU specified, if available, rather than the CPU. The GPU may significantly improve processing performance.

If there is no suitable GPU, or the required NVIDIA CUDA drivers are unavailable, O_MultiSample defaults to using the CPU. You can select a different GPU Device, if available, by opening Nuke's **Preferences** and selecting an alternative card from the **GPU Device** dropdown.

NOTE: Selecting a different GPU requires you to restart Nuke before the change takes effect.

Channels

You can use the **Channels** control to select the channels you want to sample from the Source input. For example, you can select **disparity** to sample the disparity vector data only in the selected area. The sample data can then be applied to the whole image, or the selected area can be filled (replaced) using the surrounding channel data. When you select a channel set, the individual channels within that set are displayed to the right as checkboxes. You can toggle these on and off to view selected channels.

When you select an additional channel from the second channel dropdown, the checkbox beside it is automatically enabled. You can then toggle this on and off to use the additional channel.

Sample

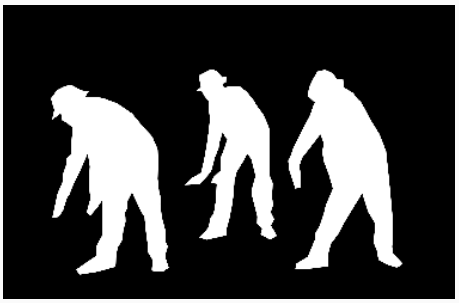
The **Sample** control defines the area to sample. You can connect a RotoPaint or Roto node to define an area, and connect it to the **Sample** input, or you can use the source alpha channel.

NOTE: Areas with non-zero values in the **Sample** input are sampled. Pixels with higher values are given more weight when they are expanded.

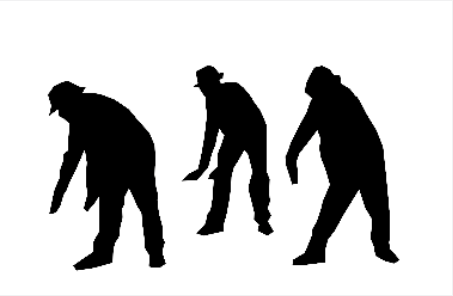
Select one of the following options:

None	Use the entire image area.
Source Alpha	Use the alpha channel of the **Source** input to define the area of the **Source** input that is sampled and expanded. The selected area is embedded in the image sequence.

The left view.



A matte overlay of the **Source** alpha. White pixels define where the **Source** input is sampled.

Source Inverted Alpha	Use the inverted alpha channel of the **Source** input to define the area of the **Source** input that is sampled and expanded. The selected area is embedded in the image sequence.  The left view.  A inverted matte overlay of the inverted **Source** alpha. White pixels determine where the **Source** input is sampled.
Sample Luminance	Use the luminance of the **Sample** input to define the area of the **Source** input that is sampled and expanded.
Sample Inverted Luminance	Use the inverted luminance of the **Sample** input to define the area of the **Source** input that is sampled and expanded.
Sample Alpha	Use the alpha channel of the **Sample** input to define the area of the **Source** input that is sampled and expanded.
Sample Inverted Alpha	Use the inverted alpha channel of the **Sample** input to define the area of the **Source** input that is sampled and expanded.

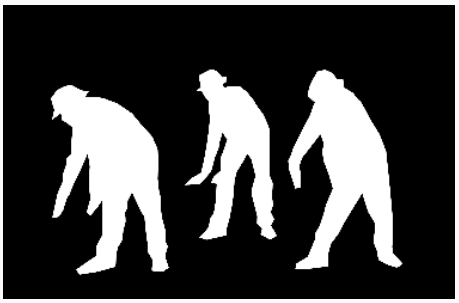
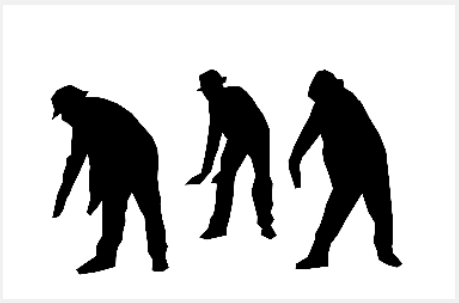
Mask

The **Mask** control defines the area in which to expand the sample data. You can connect a RotoPaint or Roto node to define an area, and connect it to the **Mask** input, or you can use the source alpha channel.

NOTE: The **Mask** input is used to perform a keymix between the **Source** input and the expanded result.

Select one of the following options:

None	The **Mask** input is not used, and therefore the sample data is expanded to fill the whole image.

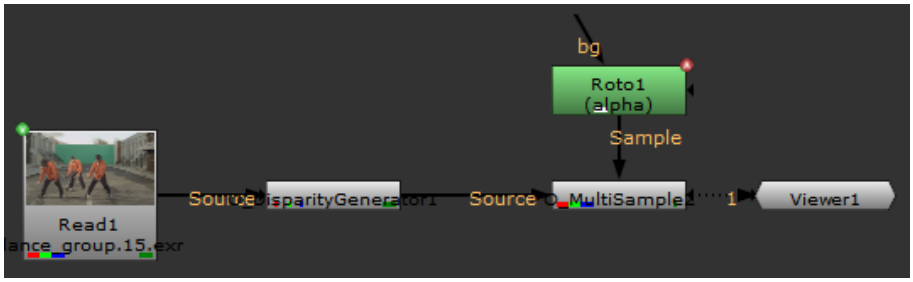
Source Alpha	Use the alpha channel of the **Source** input to define the area that is replaced by the expanded data. The selected area is embedded in the image sequence.  The left view.  A matte overlay of the **Source** alpha. White pixels define the area to be replaced by the expanded data.
Source Inverted Alpha	Use the inverted alpha channel of the **Source** input to define the area that is replaced by the expanded data. The selected area is embedded in the image sequence.  The left view.  A matte overlay of the **Source** alpha. White pixels define the area to be replaced by the expanded data.
Mask Luminance	Use the luminance of the **Mask** input to define the area that is replaced by the expanded data.
Mask Inverted Luminance	Use the inverted luminance of the **Mask** input to define the area that is replaced by the expanded data.
Mask Alpha	Use the alpha channel of the **Mask** input to define the area that is replaced by the expanded data.
Mask Inverted Alpha	Use the inverted alpha channel of the **Mask** input to define the area that is replaced by the expanded data.

O_MultiSample Example

In this example, we first generate a disparity map for a stereo pair of images using O_DisparityGenerator. Then, we use O_MultiSample to remove an area of the disparity and fill it using the surrounding disparity vector data.

Step by Step

1. Launch Nuke. Open the Project Settings (press **S** on the Node Graph), select the **Views** tab, and click the **Set up views for stereo** button.
2. Select **Image** > **Read** to import **Dance_Group.exr**.
3. To calculate disparity vectors, insert an O_DisparityGenerator node after the image sequence. See DisparityGenerator for more information.
4. Select **Ocula** > **Ocula 4.0** > **O_MultiSample** to insert an O_MultiSample node after the O_DisparityGenerator node.
5. Insert a Roto node and connect it to the **Sample** input of the O_MultiSample node.
6. Attach a Viewer to the O_MultiSample node. Your node tree should now look something like this:



7. Select **disparity** from the **channel** dropdown above the Viewer to display the disparity map.
8. Select the red channel (**R**) from the **RGB** dropdown, and set the **gain** control to **-1/45**.
9. Adjust the **gamma** slider above the Viewer to display the disparity map more clearly.
10. Open the Roto controls and select **Bezier** to the left of the Viewer. Draw a bezier around the dancer on the right.
11. Open the O_MultiSample controls. Select **disparity** from the **Channels** control.
12. Set the **Sample** control to **Sample Inverted Alpha**. The selected area of disparity is now filled using the surrounding disparity vector data, replacing the disparity in the selected area.

The original left view of the disparity map with a bezier marking the selected area.

The left of view of the disparity with the selected area removed.

15 Quality Control Tools

Description

There are several tools in Ocula that you can use to check the quality of stereo footage and disparity in an image sequence. These tools include O_DisparityViewer, DisparityReviewGizmo and StereoReviewGizmo.

DisparityViewer

Description

The O_DisparityViewer node allows you to visualise the disparity vectors in your node tree, display a histogram detailing positive and negative parallax, or overlay the Viewer with parallax violations.

NOTE: All three O_DisparityViewer modes are baked into your render if the node is enabled when you write your sequence out. This allows you to render the output alongside disparity for review.

You can add O_DisparityViewer after any node in the Node Graph. As long as there is a disparity channel at that point in the tree, O_DisparityViewer produces a Viewer overlay with arrows showing the disparity vectors at regular intervals, a histogram, or parallax violations depending on the **Display** control.

O_DisparityViewer allows you to view diagnostic tools to help you determine where your stereo footage needs work:

- DisparityViewer - the disparity vectors at any given point in your node tree for a selected view or both views.
- Displaying Parallax Histograms - a histogram showing the parallax, in pixels, on the **x** axis, the number of image pixels on the **y** axis, and the negative and positive parallax violation areas in red and green, respectively.
- Displaying Parallax Violation Overlays - highlights the areas of negative and positive parallax violation - that is, areas outside the limits specified in the **Negative Limit** and **Positive Limit** controls.

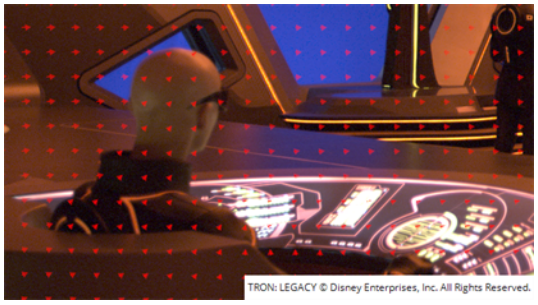
Displaying Disparity Vectors

To visualise the disparity vectors at any given point of your node tree, do the following:

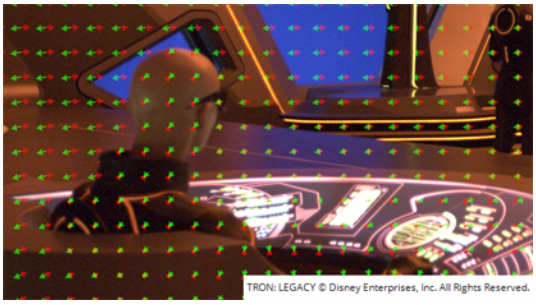
1. Select a node at any point in the node tree where there is a disparity channel.

   If you don't have a disparity channel in the data stream, you can add one using an O_DisparityGenerator node. See DisparityGenerator for more information.
2. Choose **Ocula** > **Ocula 4.0** > **O_DisparityViewer** from the Toolbar.

   This inserts an O_DisparityViewer node in your node tree.
3. Under **Views to Use**, select the views you want to use to visualise the disparity vectors. These views are mapped for the left and right eye.
4. Using the **Display** menu, select **DisparityVectors**.
5. If you want to display the vectors for both views rather than just the current view, check **Show Both Directions**.



Vectors for the left view.



Vectors for both views.

6. Zoom in to better see the disparity vectors in the overlay.
7. If the Viewer seems too cluttered or the arrows overlap, increase the **Vector Spacing** value.
8. If necessary, use the **disparityR** and **disparityL** parameters to change the colour of the arrows. You may want to do this, for example, if the default colour is very close to the colours in your input image, or if you want to compare disparity methods and have more than one O_DisparityViewer overlay displayed at once. See O_DisparityViewer Controls for more information.

NOTE: Disparity vectors are baked into your render if the node is enabled when you write your sequence out.

Displaying Parallax Histograms

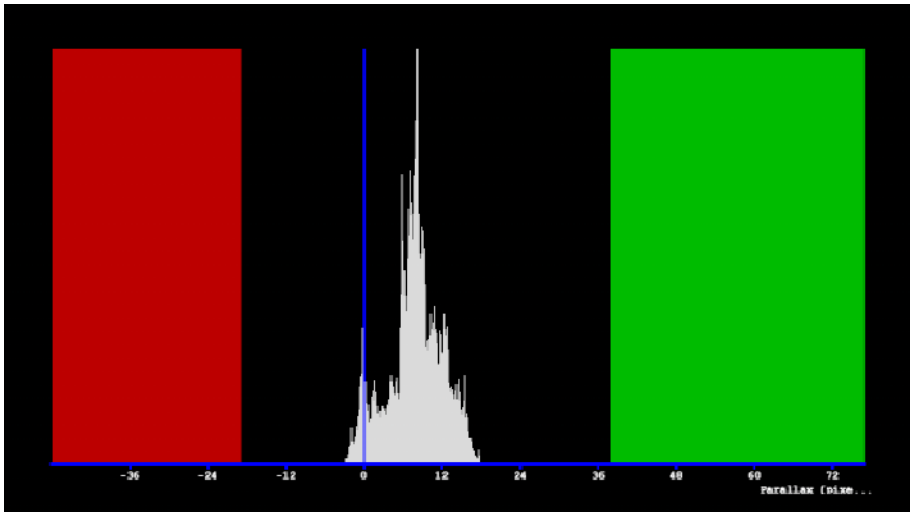
To view a parallax histogram for any given point of your node tree, do the following:

1. Select a node at any point in the node tree where there is a disparity channel.

   If you don't have a disparity channel in the data stream, you can add one using an O_DisparityGenerator node. See DisparityGenerator for more information.
2. Choose **Ocula** > **Ocula 4.0** > **O_DisparityViewer** from the Toolbar.

   This inserts an O_DisparityViewer node in your node tree.
3. Under **Views to Use**, select the views you want to use to visualise as a histogram. These views are mapped for the left and right eye.

4. Using the **Display** dropdown menu, select **Parallax Histogram**.



Parallax histogram.

The Viewer displays a histogram showing Parallax (in pixels) on the x axis, the number of image pixels on the y axis, and the negative and positive parallax violation areas in red and green, respectively.

The screen is placed at zero on the x axis, so negative parallax refers to parts of the image that are in front of the screen and positive parallax to the parts that are behind the screen.

5. Use the **Histogram** controls to define your histogram as necessary. See O_DisparityViewer Controls for more information.

NOTE: Histograms are baked into your render if the node is enabled when you write your sequence out.

Displaying Parallax Violation Overlays

To view a parallax violation overlay for any given point of your node tree, do the following:

1. Select a node at any point in the node tree where there is a disparity channel.

   If you don't have a disparity channel in the data stream, you can add one using an O_DisparityGenerator node. See DisparityGenerator for more information.

2. Choose **Ocula** > **Ocula 4.0** > **O_DisparityViewer** from the Toolbar.

   This inserts an O_DisparityViewer node in your node tree.

3. Under **Views to Use**, select the views you want to use to visualise parallax violation. These views are mapped for the left and right eye.

4. Using the **Display** dropdown menu, select **Parallax Violation**.

Parallax violation overlay.

The parallax violation overlay appears in the Viewer, highlighting the areas of negative and positive parallax violation - that is, areas outside the limits specified in the **Negative Limit** and **Positive Limit** controls.

5. Use the **Parallax** controls to define your overlay parameters as necessary. See O_DisparityViewer Controls for more information.

NOTE: Parallax violation overlays are baked into your render if the node is enabled when you write your sequence out.

Inputs

O_DisparityViewer has the following inputs:

Source	This is any node in the node tree with a disparity map in the disparity channels.

To see a table listing the nodes or channels each Ocula node requires in its inputs, see Appendix B.

O_DisparityViewer Controls

Views to Use

From the views that exist in your project settings, select the two views you want to use when visualising the disparity vectors. These views are mapped for the left and right eye.

Display

Select the display mode from the dropdown menu:

Disparity Vectors	Overlays the disparity vectors at any given point in your node tree for a selected view or both views.
Parallax Histogram	Displays a histogram showing the parallax, in pixels, on the **x** axis, the number of image pixels on the **y** axis, and the negative and positive parallax violation areas in red and green, respectively.
Parallax Violation	Highlights the areas of negative and positive parallax violation - that is, areas outside the limits specified in the **Negative Limit** and **Positive Limit** controls.

Vectors

disparityR	Colour of the arrows used for displaying left-to-right disparity. You may want to change this, for example, if the colour of the arrows is very close to the colours in your input image, or if you want to compare the vectors from multiple O_DisparityViewers in the same Viewer.
disparityL	Colour of the arrows used for displaying right-to-left disparity. You may want to change this, for example, if the colour of the arrows is very close to the colours in your input image, or if you want to compare the vectors from multiple O_DisparityViewers in the same Viewer.
Show Both Directions	Check this to show the disparity vectors for both views rather than just the current view.
Vector Spacing	How often a disparity vector is drawn. If necessary, you can increase this value to make the display less cluttered. You may want to do so, for example, if the disparities are large and you don't want neighbouring vectors to overlap one another.

Histogram

Histogram Range	Use this menu to select the histogram range: • **Automatic** - the range is scaled to fit the range of disparity. • **User Defined** - the range is defined using the **Histogram Min** and **Max** controls as a percentage of screen width.
Histogram Min	Controls the lower limits of the histogram as a percentage of screen width, that is, the left-most points on the x axis.  NOTE: This control is only active when **Histogram Range** is set to **UserDefined**.
Histogram Max	Controls the upper limits of the histogram as a percentage of screen width, that is, the right-most points on the x axis.  NOTE: This control is only active when **Histogram Range** is set to **UserDefined**.

Parallax

Negative Limit	Sets the amount of negative parallax allowed as a percentage of screen width. Areas outside this negative limit are marked by the overlay in the colour specified in the **Negative Violation** control.
Pixels	Displays the number of pixels allowed by negative parallax.
Positive Limit	Sets the amount of positive parallax allowed as a percentage of screen width. Areas outside this positive limit are marked by the overlay in the colour specified in the **PositiveViolation** control.
Pixels	Displays the number of pixels allowed by positive parallax.
Negative Violation	Sets the overlay colour for pixels outside the specified **Negative Limit** value.
Positive Violation	Sets the overlay colour for pixels outside the specified **Positive Limit** value.

O_DisparityViewer Example

In this example, we use O_DisparityViewer to evaluate the disparity map produced by O_DisparityGenerator. For information on where to get the sample footage, please see Example Images.

Step by Step

1. Start Nuke and press **S** on the Node Graph to open the Project Settings. Go to the **Views** tab and click the **Set up views for stereo** button.
2. Select **Image** > **Read** and browse to where you saved the tutorial files. Go to the **O_DisparityGenerator** directory, select **Dance_Group.exr**, and click **Open**.

   A Read node is added to the Node Graph.

> TIP: If you've already run through the O_DisparityGenerator Example to create a disparity map, you can open the image you rendered earlier and skip to step 4.

3. Select **Ocula** > **Ocula 4.0** > **O_DisparityGenerator** from the Toolbar.

   This inserts an O_DisparityGenerator node.
4. Select the O_DisparityGenerator node (or the Read node pointing to your own pre-rendered image) and choose **Ocula** > **Ocula 4.0** > **O_DisparityViewer** from the Toolbar.

   This inserts an O_DisparityViewer node and forces Ocula to calculate the disparity channel.
5. Connect a Viewer to the O_DisparityViewer node so we can see what's happening. Your node tree should look similar to the image shown.

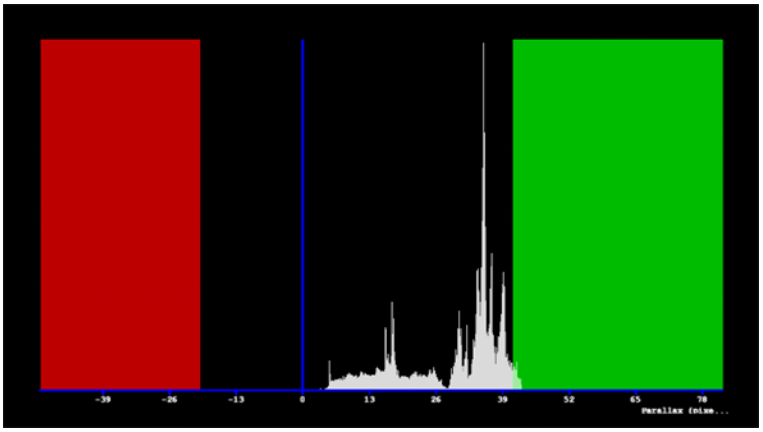
6. Using the default O_DisparityViewer settings, the Viewer is a little crowded. To make the display less cluttered, set **Vector Spacing** to 80.
7. To display vectors for both views, check **Show Both Directions** in the O_DisparityViewer controls. The vectors for the left-to-right disparity are shown in red, and the vectors for the right-to-left disparity in green.

The main purpose of this tutorial is to show you how to use the **Parallax Histogram** and **Parallax Violation** display modes.

8. In the O_DisparityViewer controls, click on the **Display** dropdown menu and select **Parallax Histogram**.

   The Viewer displays a histogram showing parallax (in pixels) on the **x** axis, the number of image pixels on the **y** axis, and the negative and positive parallax violation areas in red and green, respectively.

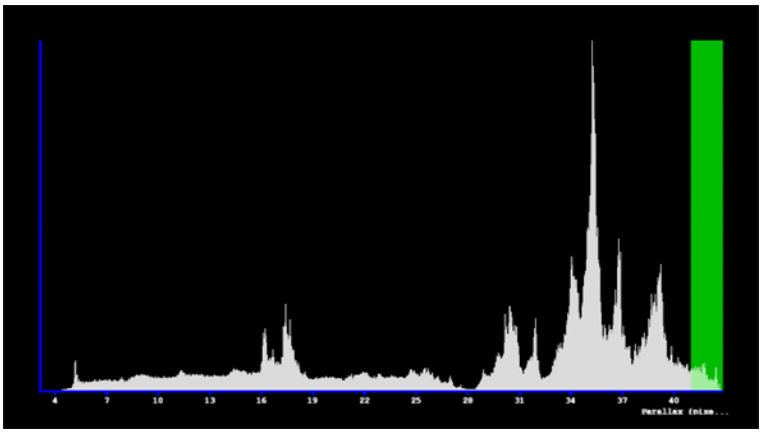
NOTE: The screen is placed at zero on the x axis, so negative parallax refers to parts of the image that are in front of the screen and positive parallax to the parts that are behind the screen.



HistogramRange defaults to **UserDefined**, so the graph produced may not contain all the pixels in the image.

9. Click the **Histogram Range** menu and select **Automatic**.

   The histogram is re-rendered to automatically fit the range of disparities in the image.



As you can see in this example, a small proportion of the image exceeds the positive violation threshold (green) and none of the image exceeds the negative threshold (red).

10. In the O_DisparityViewer controls, click on the **Display** menu and select **ParallaxViolation**.

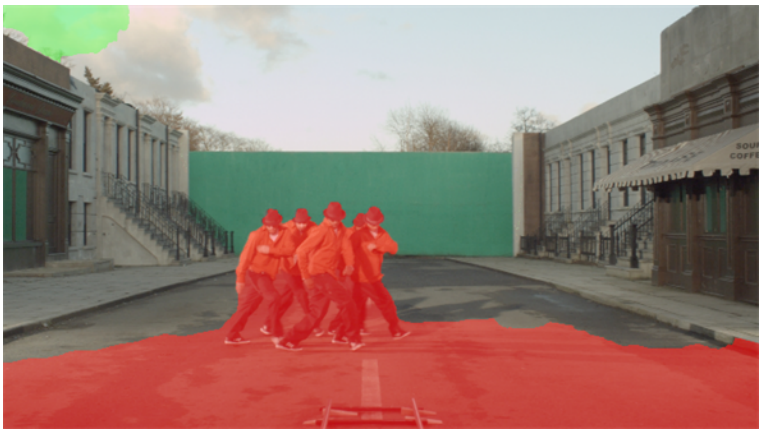
    The parallax violation shown in the histogram is overlaid on the Viewer highlighting, in this case, the areas of positive parallax violation.

11. If you adjust the **Positive Limit** slider down to **1.4** and up to **3**, you can see the changing extent of the positive violation limit. In the right-hand image, the violation has disappeared completely.

Low Positive Limit.

High Positive Limit.

12. You can adjust the **Negative Limit** in the same way, though in this case you'll need to input a figure greater than **0** to see any violation.

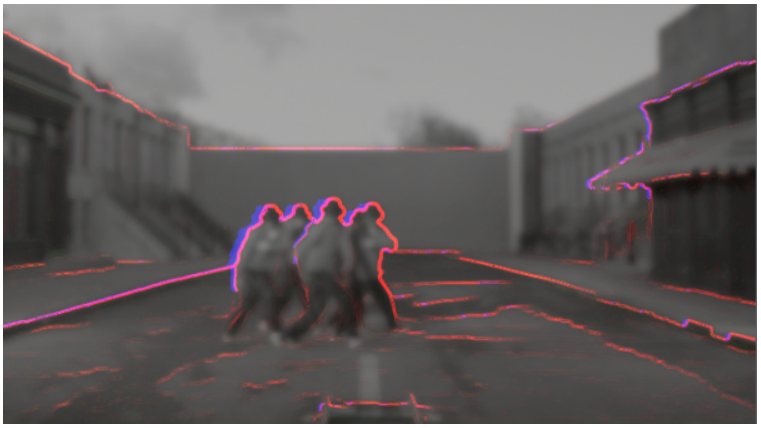


DisparityReviewGizmo

Description

The DisparityReviewGizmo node allows you to check the quality of the disparity vectors. The DisparityReviewGizmo node is inserted before the Viewer in the node tree. This displays the image with a desaturated background by default, and highlights any depth changes, alignment changes, and occluded regions.

NOTE: To detect the occluded regions, you need to insert an O_OcclusionDetector node upstream in the node tree.



Inputs

O_DisparityReviewGizmo has the following inputs:

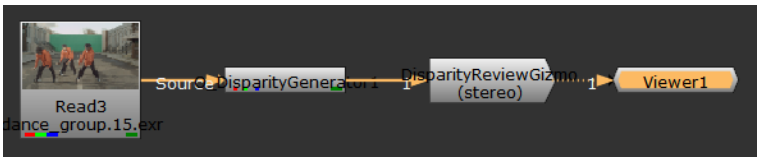
Source	A stereo pair of images. DisaprityReviewGizmo requires upstream disparity vectors. If they do not already exist, insert an O_DisparityGenerator node after the image sequence to calculate them. See DisparityGenerator

To see a table listing the nodes or channels each Ocula node requires in its inputs, see Appendix B.

Using DisparityReviewGizmo

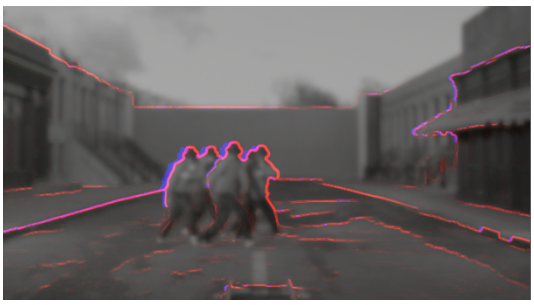
NOTE: DisparityReviewGizmo requires upstream disparity vectors to operate correctly.

1. If disparity vectors do not yet exist in the script, you need to insert an O_DisparityGenerator node after your image sequence to calculate the disparity vectors. See DisparityGenerator for how to do this.
2. Select **Ocula** > **Ocula 4.0** > **DisparityReviewGizmo** to insert an DisparityReviewGizmo node either after the O_DisparityGenerator node if you added one in the previous step, or after the image sequence.
3. Connect a Viewer to the O_DisparityReviewGizmo node. Your node tree should now look something like this:



4. In the DisparityReviewGizmo controls, **output** is set to **stereo** by default. You can also change this to **disparityR (right)**, **disparityL (left)**, or **side-by-side**. See the Controls section for more information.
5. You can choose different backgrounds to view including **image**, **desaturated** and **disparity**. By default, the **background** control is set to **desaturated**. This displays the image with a desaturated background and highlights the following:
   - Depth changes are highlighted in red.
   - Alignment changes are highlighted in green.
   - Occluded pixels are highlighted in blue. To detect the occluded regions, you need to insert an O_OcclusionDetector node upstream in the node tree.

The original left view of a stereo image.



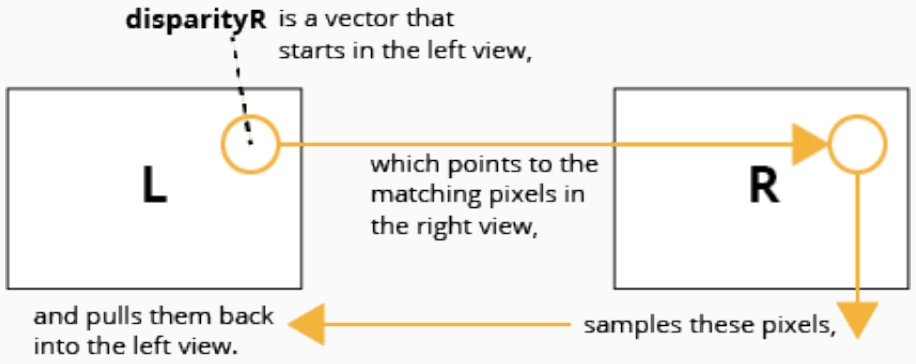
The left view with DisparityReviewGizmo node highlighting any depth changes, alignment changes, and occluded regions.

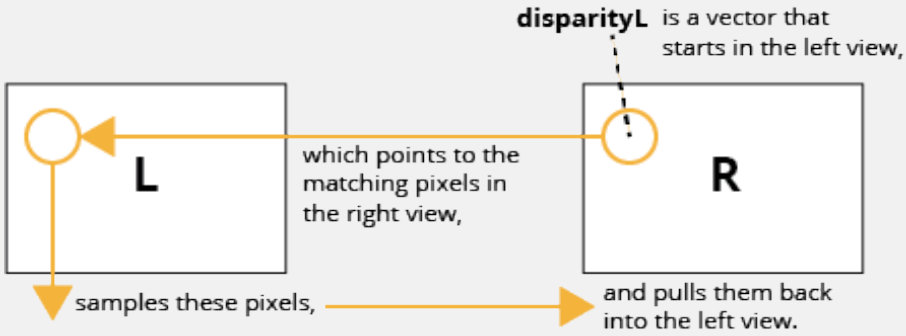
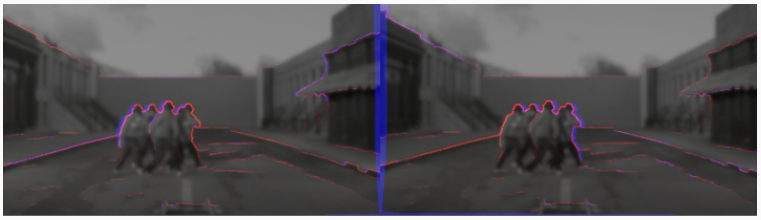
6. Adjust the DisparityReviewGizmo controls to get the required overlay. See the following Controls section for more information.

DisparityReviewGizmo Controls

Output

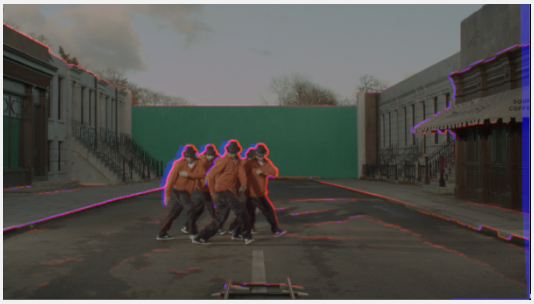
This is set to **stereo** by default. When you are using Ocula to update one view to match another, it is advised to check the quality of the view that has been updated. Set the **output** to one of the following:

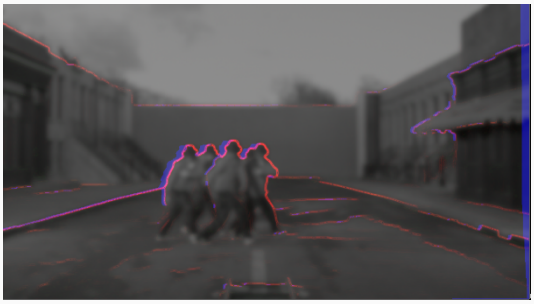
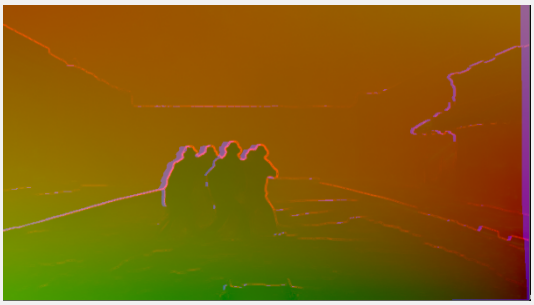
stereo	Select **stereo** to check the quality of both views (left and right) at the same time.
disparityR (right)	Select this to check the quality of the right view and **disparityR** only.  So the **R** in **disparityR** means that it samples from the right view and the vectors originate in the left view. They define how to match the right view and rebuild the left just from the right pixels.

disparityL (left)	Select this to check the quality of left view and **disparityL** only.  So the **L** in **disparityL** means that it samples from the left view and the vectors originate in the right view. They define how to match the right view and rebuild the left just from the right pixels.
side-by-side	Select **side-by-side** to output both views beside each other. 

Background

Use the **background** control to set the image displayed in the background, which the highlights are then displayed on top of. This is set to **desaturated** by default.

image	Select **image** to display the original image in the background.	

desaturated	Select **desaturated** to display a greyscale version of the original image. This makes the highlights more visible.	
disparity	Select **disparity** to view the disparity vectors for the selected view. This is useful for when you are tuning or editing upstream disparity as it helps you understand how the vectors change as well as allowing you to quality check the output. Set the disparity **Limits** controls to grade the disparity vectors.	

Intensity

Use the **intensity** control to set the intensity of the background image. To make the quality check highlights more visible, reduce the **intensity** control.

xDisparity

You can use the **xDisparity Intensity** control to set the amount of horizontal disparity changes (depth changes) displayed. These changes are highlighted in red. This is useful when you are tuning O_DisparityGenerator to ensure depth changes are correct, or when checking a disparity precomp to determine if there are any irregularities that need to be corrected.

yDisparity

Use the **yDisparity Intensity** control to set the amount of vertical disparity changes (alignment changes) displayed. These changes are highlighted in green. This is useful to check the quality of vertical disparity when performing a vertical alignment, or to check vertical alignment along with depth to see if there is a misalignment in the camera rig.

Occlusion

NOTE: To detect the occluded regions, you need to insert an O_OcclusionDetector node upstream in the node tree.

You can use the **occlusion** control to set the amount of occluded regions displayed. In DisparityReviewGizmo, these changes are highlighted in blue. Occluded regions are pixels that are visible in one view and not the other. This is useful to quality check occluded regions when rebuilding or updating one view from another.

Limits

NOTE: These controls are only available when the **background** control is set to **disparity**.

xMinimum	Set the minimum parallax used to grade horizontal disparity.
xMaximum	Set the maximum parallax used to grade horizontal disparity.
yMinimum	Set the minimum pixel offset used to grade the vertical disparity.
yMaximum	Set the maximum pixel offset used to grade the vertical disparity.

Set Limits

Click **Set Limits** to automatically set the minimum and maximum parallax and vertical offset, by sampling the input disparity at the current frame. You can keyframe the limit settings at different frames in the sequence.

Reset Limits

Click this to reset the disparity limits to the default values.

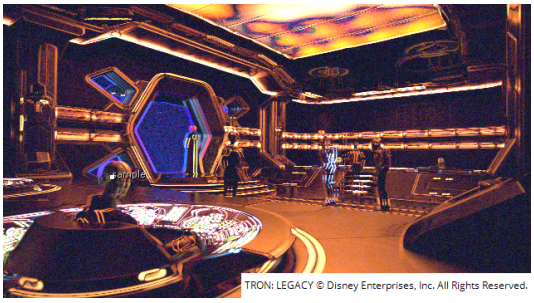
StereoReviewGizmo

Description

You can use the StereoReviewGizmo node to perform a quick quality check on stereo footage. StereoReviewGizmo requires upstream disparity vectors. If disparity vectors do not already exist in the image sequence, the StereoReviewGizmo node calculates disparity.

The StereReviewGizmo can display a difference view to show the differences in the stereo sequence more clearly. You can set the point of interest using the **Parallax** controls and you can set a sample subject to focus on by dragging and dropping the **sample** widget in the Viewer.

The original left view of a stereo image.



The difference view created by the StereoReviewGizmo node.

You can use StereoReviewGizmo to quickly toggle between the difference view, the stereo view, and the left and right views to do quick comparisons. Perform a short playback in any view to check temporal stability, or animate the depth rack to display the difference between the specified **near** and **far** settings.

Inputs

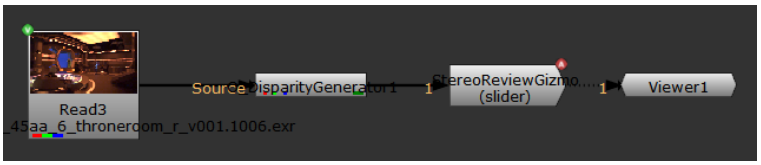
O_StereoReviewGizmo has the following inputs:

Source	A stereo pair of images. StereoReviewGizmo uses disparity vectors. However, if there are no disparity vectors available, StereoReviewGizmo calculates the disparity.

To see a table listing the nodes or channels each Ocula node requires in its inputs, see Appendix B.

Using StereoReviewGizmo

1. Select **Ocula** > **Ocula 4.0** > **StereoReviewGizmo** to insert an StereoReviewGizmo node either after the O_DisparityGenerator node if you added one, or after the image sequence.
2. Connect a Viewer to the O_StereoReviewGizmo node. Your node tree should now look something like this:



3. Adjust the **Parallax** controls to re-converge on points of interest. You can either set the **Parallax** controls manually, or you can click **Auto Near/Far** to automatically set the parallax range. The **output** control is

automatically updated to **far** and a difference view is displayed in the Viewer, allowing you to adjust the settings until the point is aligned. This makes it easier to line up the left and right view.

4. You can then use **Toggle Left/Right** to review the footage at this point with the left and right output.
5. Use **Start Playback** to play a 10 frame sequence for the current output. This allows you to review the point of interest defined by the **Parallax** controls, for any temporal issues. This control now toggles to **STOP Playback**. Click this to restore the timeline.
6. By default, **subjectPt** is enabled in the StereoReviewGizmo controls. With this enabled, you can drag and drop the **subjectPt** widget in the Viewer to select a point of interest. To disable **subjectPt**, select the **hide** checkbox to the right of the **subjectPt** controls.
7. Adjust the **Parallax** settings and toggle between different views using the **output** controls to examine the differences.
8. Select **Start Depth Rack** to animate the through depth between the specified **near** and **far** settings. See the following Controls section for more information.

StereoReviewGizmo Controls

Output

Use the **output** control to select the Viewer output. Select one of the following:

stereo	The **stereo** output shows the input re-converged at the depth defined by slider.
left	The **left** output shows the re-converged left view only.
right	The **right** output shows the re-converged right view only.
slider	Select this to show a difference view, re-converged by the **Parallax** controls. Adjust the controls until the image becomes aligned on the point of interest.
near	Select this to show a difference view, re-converged by the **Parallax** controls. Adjust the controls until the image becomes aligned on the point of interest.
subject	Select this to show a difference view, re-converged by the **Parallax** controls. Adjust the controls until the image becomes aligned on the point of interest.
far	Select this to show a difference view, re-converged by the **Parallax** controls. Adjust the controls until the image becomes aligned on the point of interest.

Align Input Checkbox

Select the **Align input for colour match review** checkbox to align the input using disparity to review colour differences only. You can toggle this option on and off to review the colour match if the input has not been aligned, and to detect where there is misalignment in the shot.

View Slider

Use **View Slider** to change the output to show the difference view, set by the **Parallax – slider** control.

Toggle Left/Right

Click **Toggle Left/Right** multiple times to toggle between the left and right views. You can use this to review the footage at a particular point of interest, after re-converging using the **Parallax – slider** control.

Start Playback

Use **Start Playback** to play a 10 frame sequence of the current output. You can use this to review temporal stability. After you click the **Start Playback** control, it toggles to **STOP Playback**; press this to restore the timeline.


NOTE: You can use **Ctrl**/**Cmd** + **click** on the Viewer timeline to change the playback range.

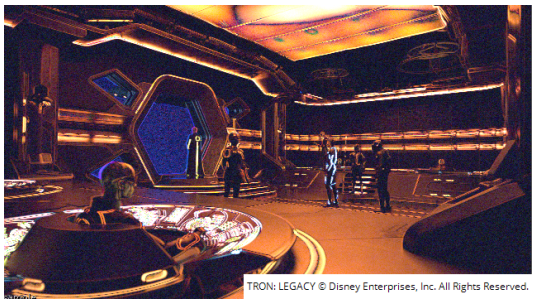
Start Depth Rack

You can click **Start Depth Rack** to activate a FrameHold and animate through depth between the defined near and far settings, showing the image difference. You can use this to check for alignment errors and colour differences across depth. After you have press the **Start Depth Rack** control, it toggles to **STOP Depth Rack**; press this to restore the timeline and disable the FrameHold.


NOTE: You can manually scrub through the depth changes by dragging the **Parallax – slider** control.

Parallax Controls

Use the **slider**, **near**, **subject** and **far** controls to zero disparity and re-converge at a point of interest. When you adjust one of these controls, the **output** is automatically updated to reflect it. For example, when you adjust the **near** control, the **output** control is updated to **near** and a difference view is displayed in the Viewer.



The difference view showing the automatically specified **near** and **far** controls.

The difference view with the **Parallax** controls greatly increased.

Adjust the **Parallax** controls until the image is aligned at the point of interest. You can then use the **Toggle Left/Right** control to switch between the input views at this point to review the input footage. You can also use the **Start Playback** control to review the input at this depth.

Setup

Auto Near/Far

You can use the **Auto Near/Far** control to automatically set the **near** and **far** parallax controls by sampling the input disparity at the current frame. You can optionally key this at different frames in the shot.

subjectPt

By default, **subjectPt** is enabled. To disable it, select the hide checkbox to the right of the **subjectPt** controls. Use this control to set the subject position at the current frame. Adjust the position to sample the input disparity and automatically set the **subject** parallax. You can adjust the position by either entering the x and y coordinates of the point, or by dragging and dropping the **subjectPt** widget in the Viewer.

NOTE: The subject point must be defined in the left view.

Bake Samples

Click **Bake Samples** to automatically sample the subject disparity at the animated sample position. You can use this control when you are importing a track as the sample point in the left view. Use **Bake Samples** to sample the subject disparity and parallax for a specific frame range.

Export Controls

Create Subject Transform

Use this control to export a Transform node to align left and right views, using sampled subject disparity. First enable the **sample subject** checkbox to sample the subject disparity. You can then use **Create Subject Transform** to create a separate transform node that aligns the left and right views to quality check the subject.

You can create a transform for a tracked point by setting the track on the sample point and using **Bake Samples**. The track has to be defined for the left view.

Views

Use the **Views** dropdown to set how the transform is applied, to line up the subject in the left and right view,

Appendix A

Release Notes

This section describes the requirements, new features, improvements, fixed bugs, known bugs, and workarounds for each release of Ocula.

Ocula 4.0v1

This is a major new release of Ocula. The nodes have been rewritten to increase the stability and accuracy as well as the ease of use in setting up and quality checking:

- **New algorithms** - the algorithms have been completely re-written producing state-of-the-art levels of accuracy, saving a huge amount of clean-up time in post. Disparity vectors are cleaner and more stable and image rebuilds are sharper.
- **GPU acceleration** - the new algorithms now run on the GPU using BLINK technology to accelerate calculations, producing the same results as the CPU, giving you piece-of-mind when rendering on a CPU farm.

  See Requirements for GPU Acceleration for more information.
- **Improved tools** - this release also includes major feature updates to reduce iterations and speed-up shot turn-around, making sure fixes are correct first time. New stream-lined controls enable you to easily tune results manually, and Ocula now includes the ability to automate fixes offline using Nuke's python API.
- **Toolsets and QC** - new production tested Ocula templates have been included to push through production footage with new QC tools, making it easy to review corrections to get the best results from Ocula.

See New Features and Enhancements for detailed information on individual tools.

Release Date

June 2014

Minimum System Requirements

- A version of Nuke 8.0 on:
  - Windows 7 64-bit or Windows 8 64-bit
  - Mac OS X 10.7 “Lion“, 10.8 “Mountain Lion“, or 10.9 “Mavericks“

NOTE: Nuke is expected to function correctly under Mac OS X Mavericks (10.9), but we are seeing UI performance degradation compared to previous OS X versions. We are working on resolving these issues.

  - Linux CentOS/RHEL 5 or CentOS/RHEL 6
- Foundry Licensing Tools (FLT 7.0v2 or later) for floating licenses.

Requirements for GPU Acceleration

To take advantage of GPU acceleration, you must have:

- an NVIDIA GPU with compute capability 2.0 (Fermi) or above. A list of the compute capabilities of NVIDIA GPUs is available at www.nvidia.co.uk/object/cuda_gpus_uk.html

NOTE: The compute capability is a property of the GPU hardware and can't be altered by a software update.

- graphics drivers capable of running CUDA 4.2 or above.
  - On Windows and Linux, CUDA graphics drivers are bundled with the regular drivers for your NVIDIA GPU. Drivers from April 2012 onward support CUDA 4.2.

    Go to http://www.nvidia.com/Download/Find.aspx?lang=en-us for more information.
  - On Mac, the CUDA driver is separate from the NVIDIA graphics driver and must be installed, if you don't have it already. The minimum requirement for CUDA 4.2 is driver version 4.2.5 which can be downloaded from www.nvidia.com/drivers.

NOTE: We recommend using the latest graphics drivers, where possible, regardless of operating system.

New Features and Enhancements

O_DisparityGenerator

O_DisparityGenerator has been rewritten from the ground up to provide cleaner, sharper vectors and use GPU acceleration to perform the necessary complex processing, where available. The new vector engine is designed to

provide clean separation in depth so that there is no roll-off between foreground and background regions, ensuring that background corrections do not get dragged along with the foreground.

Ocula's O_DisparityGenerator no longer requires O_Solver alignment data by default. The Properties panel **Alignment** control is set to 0 by default, which performs better when detecting changes in vertical alignment with depth. Ocula also performs better with O_VerticalAligner's **Local alignment** mode and produces better results when picture building in O_NewView.

- BUG ID 42056 - A new **Presets** dropdown has been added to automatically adjust the refinement controls depending on your selection.

O_OcclusionDetector

Occlusion detection has been rewritten to make best use of the new clean, sharp disparity vectors. Occlusion regions are now clearly defined in the **mask_occlusion** channel to identify where attention is required.

O_NewView

O_NewView now produces sharper images with greater fidelity to the original footage. O_NewView has been updated to just rebuild one view from the other, including controls to handle occlusion and edge treatment.

- BUG ID 40303 - A new **CleanPlate** input has been added to allow you to supply a background for occlusion filling.

O_ColourMatcher

Colour matching has been rewritten to make best use of the new clean, sharp disparity vectors and to simplify the controls. The matched results now have greater fidelity to the original image, allowing for smaller block sizes to produce more detailed colour updates, while preserving the noise of the source.

- BUG ID 40300 - A new **Stabilise occlusions** check box has been added to the properties panel. When enabled, Ocula uses occlusion data from multiple frames to reduce flickering.
- BUG ID 42719 - A new control, **Correction Scale**, has been added to define the scale of colour matching. Lower values perform very local matching to preserve highlights in the reconstructed image. Higher values use a more global correction, which better preserves the structure of the original image.

O_FocusMatcher

Focus matching has been rewritten to explicitly match high-frequency edges between views. O_FocusMatcher now looks and feels more like O_ColourMatcher and no longer has issues with ringing, pixel shifts that change parallax, and correlated noise when compared to Ocula 3.

- BUG ID 22995 - A new **Stabilise occlusions** check box has been added to the properties panel. When enabled, Ocula uses occlusion data from multiple frames to reduce flickering.

O_Solver

A new **Key Sequence** button has been added to automatically analyse the source and place keys where a change in camera alignment is detected.

Adding and aligning user matches in O_Solver is now more accurate with the addition of a zoom window and single click workflow to create user matches while viewing an image difference. Hotkeys have been added to toggle the display between the left view and right views or display a mix of both views. You can now click **Delete Auto Matches** and solve the camera alignment with only user matches.

If you have an interactive licence (ocula_i and nuke_i), O_Solver can now be executed from the terminal. You can execute multiple frames, using Nuke's standard expressions and Python scripts, to automatically set up Ocula trees and render corrections without the use of Nuke's interface. You can also set user matches using Python.

O_VerticalAligner

The O_VerticalAligner workflow has been streamlined, allowing you to perform several alignment calculations using a single node in a fixed order. New controls have been added to enable you to fix plate scale and offset, change the filter used to transform pixels, and output a **vaSTMap** channel containing uv data for use in an STMap node.

- BUG ID 21783 - All alignment options have now been incorporated into a single node to make it easier to select and choose the best alignment correction.
- BUG ID 41700 - A new **Zoom to prevent black in frame** control has been added to correct areas pulled from outside the bounding box after vertical alignment.
- BUG ID 42857 - You can now automate the setup of a CornerPin for a range of frames without having to manually create the required analysis frames.

O_VectorGenerator

O_VectorGenerator has been rewritten from the ground up to provide cleaner, sharper vectors and use GPU acceleration to perform the necessary complex processing, where available. The new vector engine is designed to provide clean separation in depth so that there is no roll-off between foreground and background regions.

O_MultiSample

A brand new node, O_MultiSample, has been introduced. O_MultiSample uses the **channels** controls and **Sample** and **Mask** inputs to expand the sampled channels to fill the image or **Mask**. This node can be used for different tasks, such as:

- Expanding colours into black regions when aligning a plate.
- Removing and in-filling colour corrections at unreliable pixels.
- Painting corrections into disparity/motion vectors at unreliable pixels.

Toolsets

Several pre-built Node Graph templates have been added to automatically set up Nuke and Ocula to perform certain tasks. The toolsets, accessed from **Ocula 4.0** > **Toolsets**, provide example node trees with Backdrops to isolate various parts of the workflow and StickyNotes containing important information.

- **FullPipeline** - creates an entire workflow pipeline from reading in your stereo source, through various precomp steps to add the required disparity and corrections, to reviewing corrections before handing off to the next stage of post.
- **InputReview** - a simple pre-processing Node Graph to read in your source and check colour and alignment.
- **Output Review** - a simple post-processing Node Graph using the StereoReviewGizmo to performing some depth correction review.
- **Precomp_Alignment** - creates a section of the FullPipeline toolset dealing with aligning views and rendering out the results.
- **Precomp_Disparity** - creates a section of the FullPipeline toolset dealing with creating disparity and rendering out the results.
- **Precomp_PlateMatch** - creates a section of the FullPipeline toolset dealing with colour and focus matching and rendering out the results.

QC Tools

Ocula now includes a new quality control gizmo, DisparityReviewGizmo, located in the Ocula tool bar. The existing StereoReviewGizmo has been rewritten to make it quick and easy to review colour and alignment at different depths, review flicker and changes in depth, and bake out transforms to line up views for detailed review.

Miscellaneous

- The End User Licensing Agreement (EULA) that accompanies all The Foundry products has been amended. Please see the Ocula installer or *Appendix D* in the *Ocula User Guide* for more information.
- BUG ID 35608 - Ocula did not fail to render from the command line when there was an interruption in licence serving. In Ocula 4.0, if there is an interruption between the licence server and Ocula, rendering aborts with an exit code of 1. You can use the **--cont** command line argument to force Ocula to continue rendering on failure, producing black licence failure frames rather than aborting the whole render.

Bug Fixes

- BUG ID 25662 - Ocula 3.0v4: Setting the O_FocusMatcher **Defocus** size above 1 resulted in blank frames.
- BUG ID 30715 - O_Solver: The Viewer hotkey **M** (Matte overlay) clashed with the **Display** mode hotkey.
- BUG ID 39910 - **Mask** inputs ignored the **stereo offset** control and split shapes in Roto nodes.

- BUG ID 41688 - O_VerticalAligner: The bounding box was not updated after alignment corrections.
- BUG ID 42867 - O_Retimer: Retiming in **Timing** > **Speed** mode did not compute the retimed sequence length correctly.

Known Issues and Workarounds

- BUG ID 43090 - Ocula's ReviewGizmos and Toolsets require standard left and right views to operate correctly.
- BUG ID 42742 - O_Solver: Deleting or manipulating feature matches does not currently create an undo stack.
- BUG ID 42324 - O_Solver: The Viewer doesn't update after enabling downstream nodes with postage stamps enabled.
- BUG ID 41952 - O_Solver: The **Preview Alignment** overlay is not displayed until you mouse-over the Viewer.

Ocula 3.0v4

This release adds support for Nuke 8.0 and includes a bug fix.

Release Date

January 2014

Minimum System Requirements

- A version of Nuke 7.0 on:
    - Windows XP Professional x64 Edition or Windows 7 Home Premium x64
    - Mac OS X 10.6 “Snow Leopard”, 10.7 “Lion”, or 10.8 “Mountain Lion“
    - Linux CentOS/RHEL 5 or CentOS/RHEL 6
- A version of Nuke 8.0 on:
    - Windows 7 64-bit or Windows 8 64-bit
    - Mac OS X 10.7 “Lion“, 10.8 “Mountain Lion“, or 10.9 “Mavericks“

NOTE: Nuke is expected to function correctly under Mac OS X Mavericks (10.9), but we are seeing UI performance degradation compared to previous OS X versions. We are working on resolving these issues.

    - Linux CentOS/RHEL 5 or CentOS/RHEL 6
- Foundry Licensing Tools (FLT 7.0v2 or later) for floating licenses.

New Features

- Ocula is now supported on Nuke 8.0 for all platforms.

- The End User Licensing Agreement (EULA) that accompanies all The Foundry products has been amended. Please see the *User Guide Appendices* for more information.

Feature Enhancements

There are no enhancements this release.

Bug Fixes

BUG ID 39980 - O_Retimer: Setting **Warp Mode** > **Simple** when rebuilding views in Ocula caused Nuke to crash if the input had an expanded bounding box that forced the bottom left of the image away from (0,0).

Known Issues and Workarounds

BUG ID 22755 - O_Solver: Feature selection does not work with multiple Viewers.

Ocula 3.0v3

This release adds support for Nuke 7.0 and contains two improvements.

Release Date

December 2012

Minimum System Requirements

- A version of Nuke 6.3 or 7.0 on:
    - Windows XP Professional x64 Edition or Windows 7 Home Premium x64
    - Mac OS X 10.5 “Leopard” (Nuke 6.3 only), 10.6 “Snow Leopard”, or 10.7 “Lion” (Nuke 7.0 only), 64-bit
    - Linux RHEL 5.4 for Intel64 or AMD64
- Foundry Licensing Tools (FLT 7.0v2 or later) for floating licenses.

New Features

There are no new features in this release.

Feature Enhancements

- BUG ID 22779 - Output from all Ocula nodes is now cached to prevent recalculation, improving the usability of Ocula node trees considerably.
- BUG ID 32272 - O_DisparityGenerator and O_VectorGenerator now have a **Noise** parameter. This sets the amount of noise these nodes should ignore in the input footage when calculating their results. The higher the value, the smoother the results. You may want to increase this value if you find that your disparity or motion vector field is noisy in low-contrast image regions.

Bug Fixes

- BUG ID 24486 - O_DisparityGenerator: Connecting inputs with different bounding boxes caused Nuke to crash.
- BUG ID 26425 - The **disparity** channel was cropped to the bounding box even when **rgba** data existed outside the bounds.
- BUG ID 29273 - O_DisparityViewer: Displaying the **Parallax Histogram** for images with a larger bounding box than the format caused Nuke to crash.
- BUG ID 33006 - Ocula output was cropped when the bounding box was larger than the format.
- BUG ID 33022 - O_NewView: The view generated was incorrect when the inputs contained vertically offset bounding boxes.

Known Issues and Workarounds

- BUG ID 22755 - O_Solver: Feature selection does not work with multiple Viewers.

Ocula 3.0v2

This release changes the licensing system used by Ocula.

Release Date

January 2012

Requirements

- a version of Nuke 6.3 on
    - Windows XP 64-bit or Windows 7 64-bit
    - Mac OS X 10.5 “Leopard” or 10.6 “Snow Leopard”, 64-bit
    - Linux RHEL 5.4 64-bit
- Foundry Licensing Tools (FLT) for floating licenses.

New Features

The licensing system used by Ocula has changed. Ocula now uses RLM licensing instead of FLEXlm. For more information, see Licensing Ocula on page 13.

Feature Enhancements

There are no improvements to existing features in this release.

Bug Fixes

There are no fixed bugs in this release.

Known Issues and Workarounds

- BUG ID 22755 - O_Solver: Feature selection does not work with multiple Viewers.

Ocula 3.0v1

This is a major new release of Ocula. The plug-ins have been rewritten to increase the stability and accuracy as well as the ease of use in setting up and quality checking. This release also introduces four new plug-ins and one new gizmo.

Release Date

November 2011

Requirements

- a version of Nuke 6.3 on
    - Windows XP 64-bit or Windows 7 64-bit
    - Mac OS X 10.5 “Leopard” or 10.6 "Snow Leopard", 64-bit
    - Linux RHEL 5.4 64-bit
- Foundry FLEXlm Tools (FFT 5.0v1 or later) for floating licenses.

New Features

Ocula 3.0 introduces four new plug-ins:

- O_OcclusionDetector

This plug-in outputs an occlusion mask for the left and right view to define where picture building with disparity is incorrect.

The occlusion mask is required by O_ColourMatcher and the new O_FocusMatcher node to identify image regions where local matching will fail. The occlusion layer can be edited to change how these plug-ins operate.

- O_FocusMatcher

  This is a new plug-in that lets you rebuild one view from the other to match focus. Matching is based on a combination of image rebuilding and deblurring.

  You can also use this node to sharpen out-of-focus images.

  There is an optional **Kernel** input to define the shape of the aperture causing the image blur.

- O_VectorGenerator

  This plug-in calculates consistent left and right motion vectors for retiming. The motion estimation algorithm is based on the new disparity engine in O_DisparityGenerator and delivers vectors that maintain stereo alignment.

- O_Retimer

  This plug-in lets you speed up or slow down a stereo clip based on the left and right motion vectors calculated by O_VectorGenerator. You can control the new timing of the clip using either the **Speed** or the **Frame** control. Both controls are animatable.

- StereoReviewGizmo

  This gizmo lets you compare left and right views in various ways. For example, you can use it for testing vertical alignment and colour matches or measuring parallax. You can also convert it to a group to copy and edit the internals. The gizmo is undocumented, but there are tool tips for all the controls.

Feature Enhancements

Ocula 3.0 includes key improvements to the quality and accuracy of existing plug-ins:

- All Ocula nodes
  - BUG ID 22303 - Ocula nodes now cache results to disk to prevent recalculations and to reduce memory overhead.
- O_Solver
  - O_Solver has been rewritten to increase the accuracy and the ease of use.
  - The controls have been simplified.
  - The node now uses a new, improved feature matching algorithm. This delivers more accurate alignment data to downstream Ocula nodes.
  - The **Feature Matches** display option has been renamed to **Keyframe Matches**. As before, this shows matches at keyframes only.
  - There's a new **Preview Alignment** display option that lets you preview the alignment of feature matches at both keyframes and non-keyframes. This allows you to review how well the interpolated solve works and whether additional keyframes are required. It also makes it simpler to delete bad matches and preview the effect of user matches.

- In the **Preview Alignment** mode, there's a new **Match Offset** control that allows you to set the offset (in pixels) applied to the aligned feature matches. You can also interactively control the offset using the **<** and **>** keys on the Viewer. Increase the offset to view the matches with large disparities and spot bad matches. Decrease the offset to set the disparity of matches to zero to examine the vertical offset at each feature. Increase and decrease the offset interactively to view which matches do not move horizontally and are bad matches.
- There is now an **Error Threshold** control that lets you select matches with a vertical error greater than the threshold when **Display** is set to **Preview Alignment**. This allows you to delete bad matches with large errors at keyframes and recalculate the alignment.
- The influence of user matches has been increased and can now be previewed directly in the **Preview Alignment** display.
- The right-click menu in the Viewer has been changed to provide access to the **Display** options and the **Match Offset** value. Shortcut keys have also been added.

• O_DisparityGenerator

- O_DisparityGenerator has been rewritten to deliver cleaner and more accurate disparity vectors. This leads to improved results in picture building operations, such as O_ColourMatcher, O_NewView, and O_InteraxialShifter.
- The controls have been simplified.
- Disparity vectors now have a user-controlled weighting to match the alignment data from an upstream O_Solver.
- BUG ID 21787 & 22331 - Added new **Parallax Limits** with **Negative** and **Positive** controls. **Negative** sets the maximum negative parallax in pixels. **Positive** sets the maximum positive parallax. There is also an **Enforce Disparity Limits** control, which is off by default. The workflow is to review the disparities (you can use O_DisparityViewer histograms). If there are some incorrect disparities that are too large, switch on **Enforce Disparity Limits** and set the limits in terms of pixels.
- BUG ID 22430 - This node now has **Fg** and **Ignore** mask inputs. Use the foreground mask to calculate vectors for a specific foreground element and the ignore mask to exclude regions from the vector calculations.

• O_ColourMatcher

- There's a new **3D LUT** algorithm to calculate local colour updates in occluded regions defined by the new O_OcclusionDetector plug-in.
- There is a new **Export 3D LUT** button. When you use O_ColourMatcher in **3D LUT** mode, this allows you to output the colour correction to a .vf file that you can use in Nuke's Vectorfield node.
- In the **Local Matching** mode, there is a new **Occlusion Compensate** checkbox that allows you to correct the colour in occluded regions using the valid colour match from unoccluded pixels. You can use the **Edge Occlusions**, **Colour Sigma**, and **Region Size** controls to define how this is done. **Occlusion Compensate** replaces the **Halo Correct** option in Ocula 2.
- The **Pre-blur Disparity** control has been removed.

• VerticalAligner

- If cameras are attached to O_Solver, the camera data is used per frame in the **Camera Rotation** method in O_VerticalAligner. Previously, it was only taken from keyframes.

    - O_VerticalAligner has a new **Warp Mode** menu. **Local Alignment** can be used to rebuild a per-pixel vertical alignment to remove the vertical disparity calculated by an upstream O_DisparityGenerator.
- O_DisparityViewer
    - BUG ID 21784 - Instead of displaying disparity information in a Viewer overlay, O_DisparityViewer now renders it to the image.
    - BUG ID 21786 - O_DisparityViewer has a new **Display** control, which you can set to show **Disparity Vectors**, **Parallax Histogram**, or **Parallax Violations**. **Parallax Histogram** and **Parallax Violations** also have associated **Histogram** and **Parallax** controls. The limits and ranges are all defined as a percentage of screen width, that is:

      horizontal disparity (in pixels) * 100 / format width (in pixels).
- Correlate

  The option to **Correlate with Ocula** has been removed. Curves can be correlated from one view to another using **Correlate points** or **Correlate average** based on the improved disparity delivered by O_DisparityGenerator.

Bug Fixes

- BUG ID 21147 - O_DisparityGenerator didn't work with cropped images.
- BUG ID 21770 - O_Solver: The influence of user matches has been increased.

Known Issues and Workarounds

- BUG ID 22755 - O_Solver: Feature selection does not work with multiple Viewers.

Appendix B

Node Dependencies

This appendix lists the data each Ocula node requires in its inputs (in addition to a stereo pair of images).

Node and Settings	Required Input Data or Channels					
	Solve Data	Disparity Map	Occlusion Mask	Vector Generator	Depth Channel	Stereo Camera
O_Solver						
All modes						
O_DisparityGenerator						
With **Alignment** = **0** (the default setting)						
With **Alignment** > **0**	●					
O_OcclusionDetector						
All modes		●				
O_ColourMatcher						
All modes		●	●			
O_FocusMatcher						
All modes		●	●			

Node and Settings	Required Input Data or Channels					
	Solve Data	Disparity Map	Occlusion Mask	Vector Generator	Depth Channel	Stereo Camera
O_VerticalAligner						
Global mode	●					
Local mode	●	●				
O_NewView						
All modes		●	●			
O_InteraxialShifter						
All modes		●	●			
O_VectorGenerator						
All modes						
O_Retimer						
No Motion input				●		
O_DepthToDisparity						
All modes					●	●
O_DisparityToDepth						
All modes		●				●
O_DisparityViewer						
All modes		●				
O_MultiSample						
All modes						

Appendix C

Third Party Licences

This appendix lists third party libraries used in Ocula, along with their licences.

Library	Description	Licence
Boost	Source code function / template library	Boost Software License - Version 1.0 - August 17th, 2003 Permission is hereby granted, free of charge, to any person or organization obtaining a copy of the software and accompanying documentation covered by this license (the "Software") to use, reproduce, display, distribute, execute, and transmit the Software, and to prepare derivative works of the Software, and to permit third-parties to whom the Software is furnished to do so, all subject to the following: The copyright notices in the Software and this entire statement, including the above license grant, this restriction and the following disclaimer, must be included in all copies of the Software, in whole or in part, and all derivative works of the Software, unless such copies or derivative works are solely in the form of machine-executable object code generated by a source language processor. THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, TITLE AND NON-INFRINGEMENT. IN NO EVENT SHALL THE COPYRIGHT HOLDERS OR ANYONE DISTRIBUTING THE SOFTWARE BE LIABLE FOR ANY DAMAGES OR OTHER LIABILITY, WHETHER IN CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

Library	Description	Licence
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FreeType	Font support	Portions of this software are copyright © 2008 The FreeType Project (www.freetype.org). All rights reserved.

Library	Description	Licence
FTGL	OpenGL support	FTGL - OpenGL font library Copyright © 2001-2004 Henry Maddocks ftgl@opengl.geek.nz Copyright © 2008 Sam Hocevar sam@zoy.org Copyright © 2008 Sean Morrison learner@brlcad.org Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the “Software”), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions The above copyright notice and this permission notice shall be included in all copies or substantial portions of the Software. THE SOFTWARE IS PROVIDED “AS IS”, WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

Library	Description	Licence
VXL	Computer vision	Copyright © 2000-2003 TargetJr Consortium GE Corporate Research and Development (GE CRD) 1 Research Circle Niskayuna, NY 12309 All Rights Reserved Reproduction rights limited as described below. Permission to use, copy, modify, distribute, and sell this software and its documentation for any purpose is hereby granted without fee, provided that (i) the above copyright notice and this permission notice appear in all copies of the software and related documentation, (ii) the name TargetJr Consortium (represented by GE CRD), may not be used in any advertising or publicity relating to the software without the specific, prior written permission of GE CRD, and (iii) any modifications are clearly marked and summarized in a change history log. THE SOFTWARE IS PROVIDED “AS IS” AND WITHOUT WARRANTY OF ANY KIND, EXPRESS, IMPLIED OR OTHERWISE, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL THE TARGETJR CONSORTIUM BE LIABLE FOR ANY SPECIAL, INCIDENTAL, INDIRECT OR CONSEQUENTIAL DAMAGES OF ANY KIND OR ANY DAMAGES WHATSOEVER RESULTING FROM LOSS OF USE, DATA OR PROFITS, WHETHER OR NOT ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, OR ON ANY THEORY OF LIABILITY ARISING OUT OF OR IN CONNECTION WITH THE USE OR PERFORMANCE OF THIS SOFTWARE.

Appendix D

End User License Agreement (EULA)

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