VIOSO AUTOALIGNMENT
for domes and spherical screens

Document version 1.0

# Dome Autoalignment Quickstart (1)

VIOSO®

## A. Setup and connect projectors and image generators
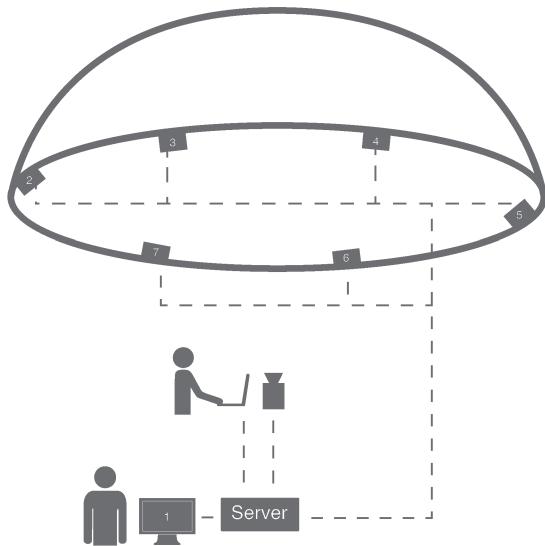
setup and wiring
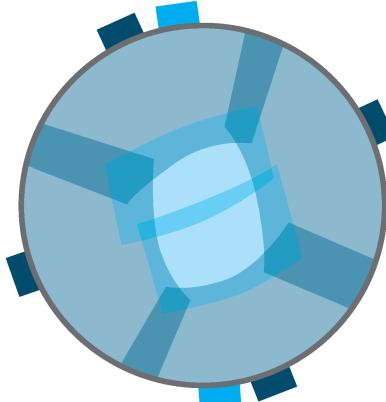
image alignment
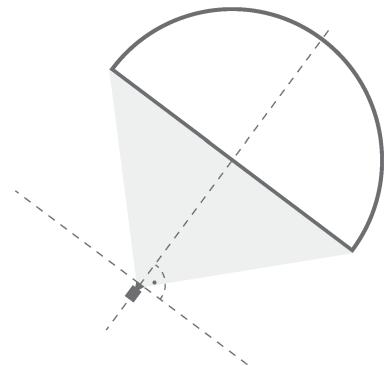
camera position

B. Configure Display Spanning

1	2	3
	4	5
	6	7

→
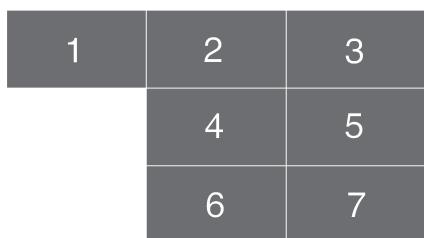
monitor | dome screen

1	
	2

Use these feature of the graphics card driver to configure display spanning:

GPU	Feature
NVIDIA	Mosaic
AMD Firepro	Eyefinity

C. Calibration software: Configuration


mask

camera image
with projectors
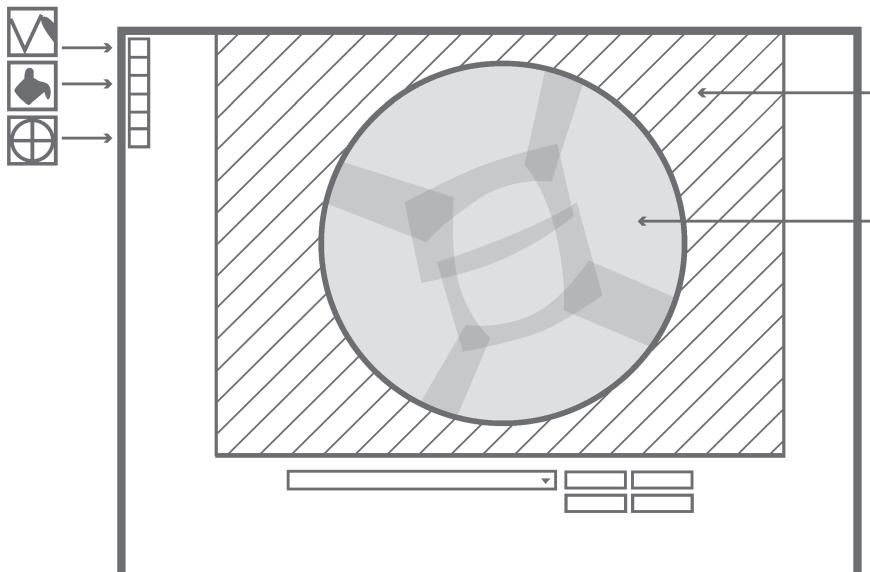
fine tune camera position and lens - set calibration parameters - draw mask

Dome Autoalignment Quickstart (2)

VIOSO

D. Scan each projector
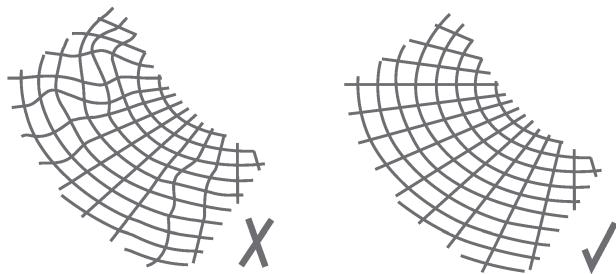
Check the „dots" **before** scan:
Must be as small as possible while still being green

Check the testing pattern **after** scan:
Must not contain obvious errors

If failures happened:
Go **back** and repeat scan
Going **back** several times enables fine tuning of scan parameters

E. Align blend image to the dome
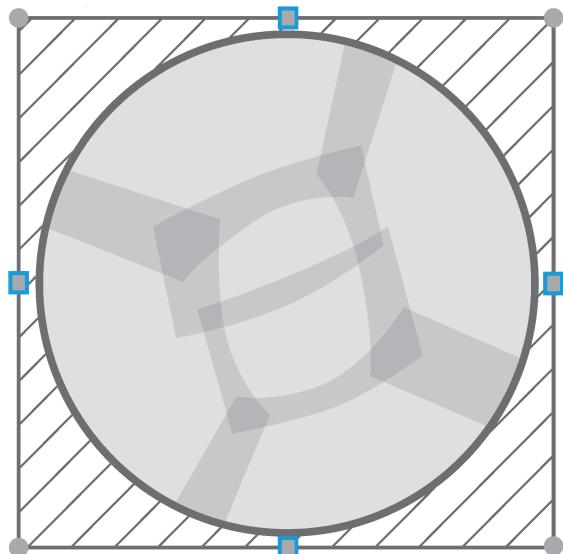
Toggle border tool

Click and move all four borders to make the blended image fit to the dome screen

Use the arrow keys on the keyboard for more precise control

F. Save result and continue with content related application

Easy and versatile playback solution for 2K domemaster content

Integrating autoalignment results with third party applications, warping boxes, etc

Sophisticated media server solution for displaying 4K domemaster content

Main manual

Table of Contents

1. Preface

Projection into a dome, i.e. onto a spherical segment, is regarded as the supreme discipline of projection. It requires the images to be aligned and deskewed in a most accurate way. Using Vioso calibration all this is done with the highest precision and within a much shorter time than with other systems. The essential advantages of Wings Vioso are as follows:

- It requires no CAD model.
- One camera is enough, no complicated camera array needs to be set up.
- No markers are necessary.
- The setup times are very short: less than 10 minutes for 5 projectors and less than 20 minutes for 12 projectors.

In this document you will find notes and considerations on how to implement a dome projection for the products Wings AV, VIOSO Player and VIOSO Anyblend.

2. Contents for the dome projection

Typically, Domemaster content is used. These are videos or picture sequences with an aspect ratio of 1:1 with a circular image detail embedded in it. This content is frequently rendered in a fish eye perspective so that the proportions in the dome are accurate - usually based on a 180° dome (with the lower edge of the image at the equator)

Typical resolutions are powers of 2 due to historic and IT reasons. In the table below you will find typical characteristics of domemaster contents.

Resolution	Playback as	Notes
1K domemaster, 1024 x 1024 pixels (1 MP)	1x MPEG2 stream or 1x H.264 stream	Frequently used for 1-projector planetariums, using projectors with 180° fish eye lenses or spherical mirrors.
2K domemaster, 2048 x 2048 pixels (4.1 MP)	1x H.264 stream	All current Vioso server solutions are usually able to display videos with H.264 coding and 2048 x 2048 pixels quite well. A 2K dome projection is therefore realized best using one overall video.
3K domemaster, 3072 x 3072 pixels (9.4 MP)	2x H.264 stream (2.4 MP each)	3k can no longer be packed into one single video file. It requires two split videos so that the load on the processor cores is more efficiently distributed during decoding. Therefore Wings AV is required to display such content.
4K domemaster, 4096 x 4096 pixels (16.8 MP)	2x H264 stream with 4096 x 2048 pixels each	4k domemaster content means four times 2k playback, i.e. the content is divided into two split videos with classic 4k content. Therefore Wings AV is required to display such content.

2.1. Encoding content for 1K - 2K domemaster resolution

Encoding raw domemaster footage (e.g. from an image sequence) is straight forward: Up to 2048 x 2048 pixel resolution a single video can be created and played by current servers without performance issues or hickups.

Suggested encoding settings:

- Container: MP4
- Codec: H.264 AVC
- Bit rate: 10-20 MBit/s CBR
- Level: 5.1 or unrestricted

2.2. Encoding content for 3K - 4K domemaster resolution

Contents with higher resolutions than 2K domemaster should not be encoded in a single video file – there is a risk of lack in performance.

Using Wings AV as playback solution, such content can be split in two parts, that are decoded and synchronized frame by frame.

Example: Splitting 4K domemaster content for playback with Wings AV:

Source: native composition or image sequence   target: H.264/AVC encoded in MP4
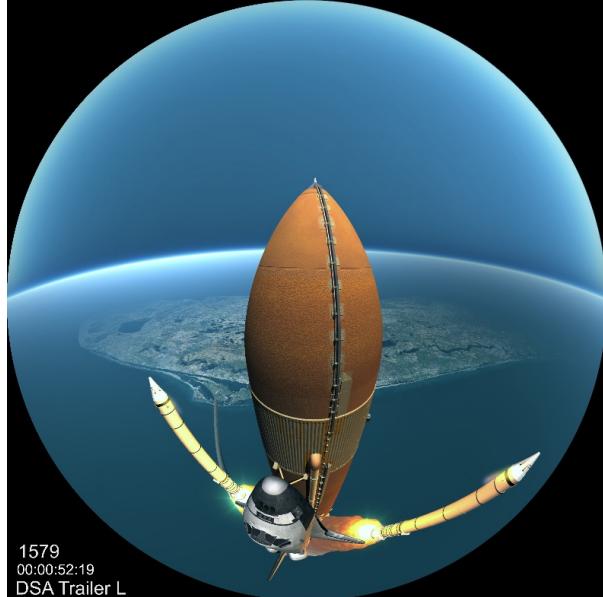
video_top.MP4: 4096 x 2048

SPLIT!

Source: 4096 x 4096

video_bottom.MP4: 4096 x 2048
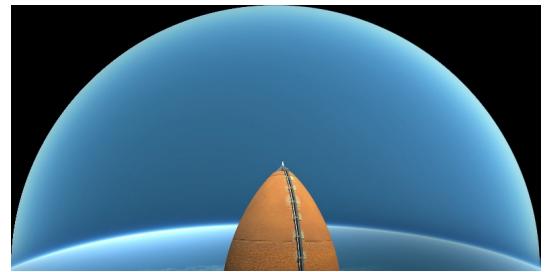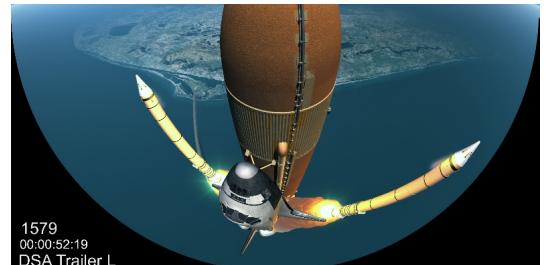
Suggested encoding settings:

- Container: MP4
- Codec: H.264 AVC
- Bit rate: 20-25 MBit/s CBR
- Level: 5.1 or unrestricted

3. Hardware for the dome projection

3.1. Media Server

Fulldome video projections are very demanding in GPU performance, require a well built and adjusted computer system and must usually fit to mission critical requirements. Therefore we recommend dedicated products, customized to fit this requirements.

As an overview, several media server configurations are listed with their suggested usage:

| Projectors		Content	Recommended Server and Playback
Number	Max. Resolution		
1-2	WXGA (1280x800)	**2K domemaster,** 2048 x 2048 pixels (4.1 MP)	VIOSO Domemaster Micro x4 running VIOSO Player
	WUXGA (1920x1200)		
	UHD/4K (4096x2160)	**4K domemaster,** 4096 x 4096 pixels (16.8 MP)	VIOSO Domemaster Performer x4 running WingsAV
3-4	WXGA (1280x800)	**2K domemaster,** 2048 x 2048 pixels (4.1 MP)	VIOSO Domemaster Micro x4 running VIOSO Player
	WUXGA (1920x1200)	**3K domemaster,** 3072 x 3072 pixels (9.4 MP)	VIOSO Domemaster Performer x4 running WingsAV
5-6	WXGA (1280x800)	**2K domemaster,** 2048 x 2048 pixels (4.1 MP)	VIOSO Domemaster Micro x6 running VIOSO Player
5-8	WXGA (1280x800)	**3K domemaster,** 3072 x 3072 pixels (9.4 MP)	VIOSO Domemaster Performer x8 running WingsAV
	WUXGA (1920x1200)	**4K domemaster,** 4096 x 4096 pixels (16.8 MP)	

3.2. Projectors

For dome projections, the choice and arrangement of the projectors requires a lot of thought and the following aspects need to be considered:

- All the projector images should possibly be projected onto the dome surface at the same size since identical brightness of the projector images plays an important role.

- Overlaps should have the same minimum widths. Equidistant projector arrangement helps to create uniform overlaps.

- Use many small projector images instead of few big ones. The smaller the projector image the more uniform is its sharpness and the more homogenously distributed is the brightness. On the other hand, the presentation system is getting bigger and more complex.

- Avoid widescreen formats as much as possible. Images projected by 4:3 projectors can be arranged more easily in the dome as the image height is the most relevant factor for arranging the images in the dome and lighting it.

Note: If you have no experience in projector configuration in a dome turn to a system house with experience in selecting projectors and lenses.
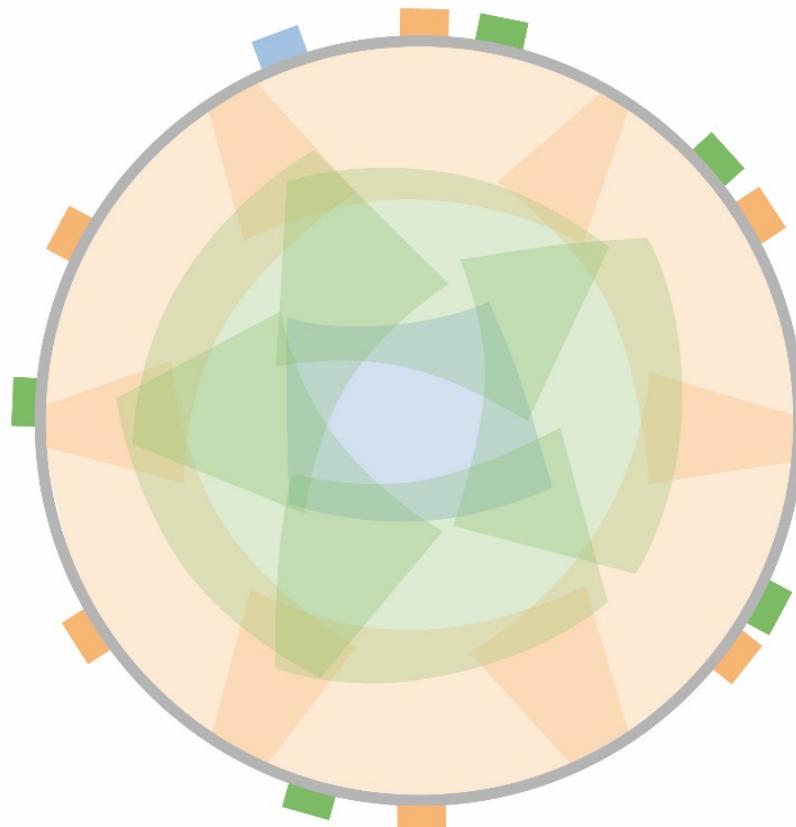
Example: projector image position in a 12-channel fulldome

3.3. Camera for Vioso Calibration

It requires a 180° fish eye camera located in the center of the dome which must be able to capture the entire dome surface, i.e. there must not be any rods or bar in the field of vision.

Various Camera types can be used:

- High-resolution IP cameras, e.g. IDS uEye UI-5480 series with 180° fish eye lens (e.g. Fujinon FE185C046HA-1); the advantage of this IP camera solution is the fact that it can very easily be connected to every presentation computer via a jointly used GBit switch. This way these cameras are highly suitable for presentation networks using Wings Engines. They allow up to 5 Mega pixels resolution which are transferred at a speed of 10 to 12 fps via Ethernet and allow a fair scan speed. A slight disadvantage is the fact that these cameras need to be configured individually for every computer, e.g. alignment requires access to every computer in the presentation network (e.g. via KVM Switch or TeamViewer).

- SLR cameras with at least full HD live output connected via HDMI, e.g. Canon EOS 5D Mark III with 180° fish eye. This produces a full HD signal which displays the dome as an embedded circle. Although the test images have a low resolution by comparison a very good dome result can usually be achieved at a high scanning speed. Note: The fish eye lenses must be an exact fit for the video image size of the sensor to prevent the circular image from being cropped.

- (Semi-) professional HD cams with at least full HD output and 180° lenses. If the signal is to be transferred via HD-SDI a Wings Engine Stage is required turning this configuration into a good but expensive solution.

4. Preparation of a fulldome setup

A proper selection of projector and lenses, dome screen and lighting is mandatory for a good full dome projection. If in doubt how to accomplish this, please consult VIOSO or experienced system integrators.

Basic system setup and wiring scheme of a typical dome projection:
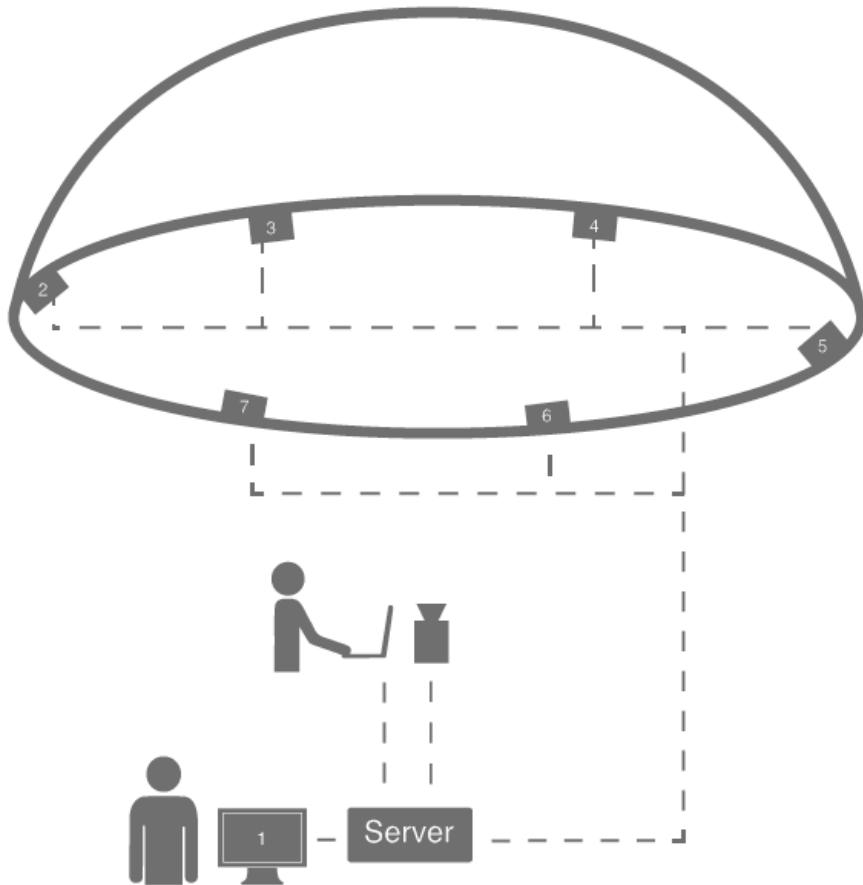
Recommended system setup:

- projectors equidistant mounted
- IP camera in the center of the dome
- monitor for operator
- mobile access via remote access (KVM, Teamviewer, etc.)

Please perform these actions when setting up a projection system for fulldomes:

- Align the projectors in a way which ensures that all images are equal in size, brightness and sharpness. The projector images must overlap to a sufficient extent; it's always the location with the lowest overlap that is decisive.
- In the projector menus disable any automatic settings:
- No Keystoning
- No Digital Zooming
- No Overscan, etc..
- Check: Use a screen filling testpattern as background of the Windows Desktop. Every boundary line in the test pattern must be displayed fully and in the native projector resolution.
- Adjust the projector images in terms of brightness and color behavior via the various projector menus on the basis of white and gray images.

4.1. Graphics card configuration

Supply of content to the projectors differs distinctly from a classic multidisplay show due to the multiple overlap of the projector images that makes different demands to the graphics card. This is why a professional GPU like NVIDIA Quadro Kepler GPU (K4200 or better) or AMD Firepro (W7100 or better) is required.

Connect your projectors to the outputs of the performance GPU(s) and switch them on.

a) On the **Windows Des**ktop desktop right click at some empty spot to open a context menu followed by clicking on **Display Settings**. Check whether all connected projectors have been correctly identified in addition to the control monitor. If everything is ok close the dialog again.
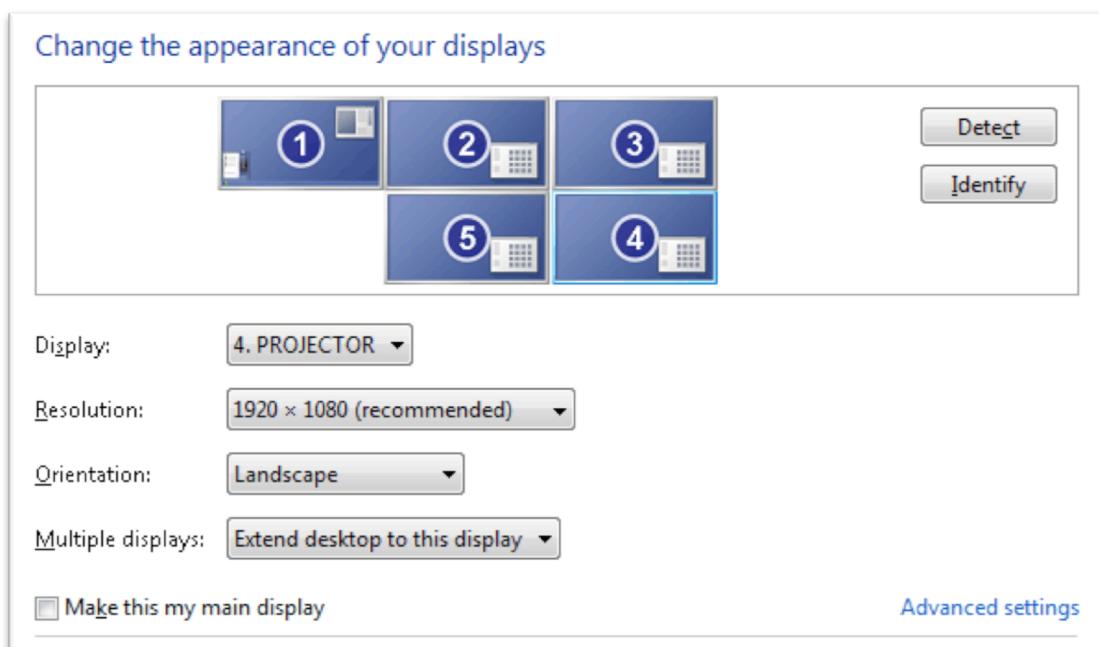
b) Using NVIDIA Quadro Kepler GPU:
   o Open the Nvidia Control Center. In the tree structure on the left below **Workstation** choose item **Set up Mosaic** and and click **Create new configuration** on the right.

   o Start with tab **Select topology**. Select the **Number of Displays** (=projectors connected tot he server) and **Topology** (rows x columns). The topology should result in a grid with the best match between width and height. In field **Configuration Name** enter an arbitrary configuration name and click **Next**.
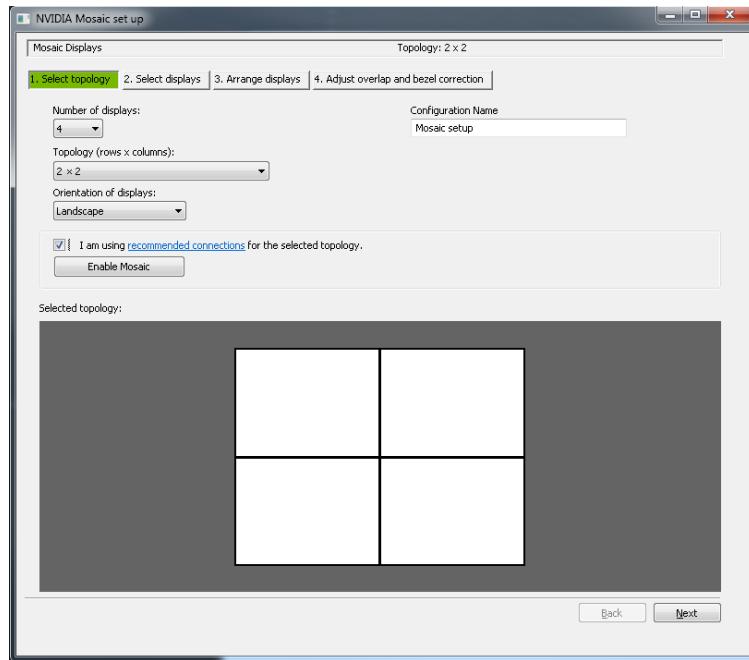
   o Now select all projectors connected to a syncronized Quadro Keper GPU (e.g. K4200 and above) projectors providing them with a checkmark and click **Next**.
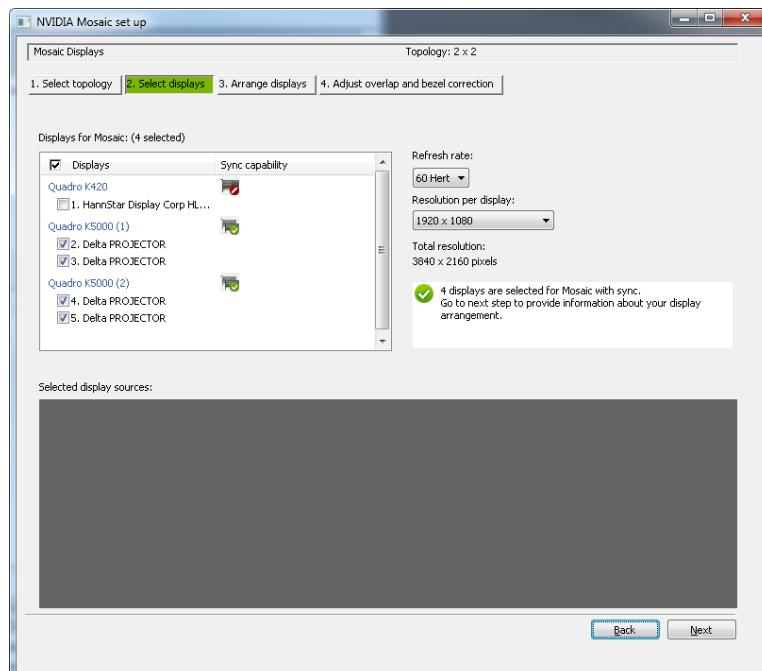
- o Drag one projector after the other down and drop it onto the mosaic field so that every field is assigned. The assignment can be arbitrary. Finish by clicking **Apply** and wait until configuration of the graphics card is complete. This may take more than a minute and give the impression that the server has crashed - be patient!
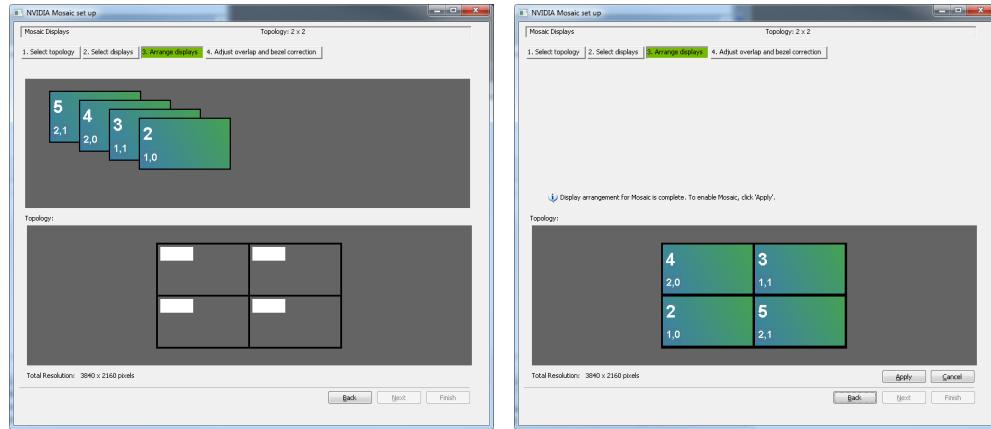
- o When dialog **Arrange** displays reappears click **Finish**. No additional settings are required on the fourth tab.

c) Using AMD Firepro GPU
  - o Tbd.

After reopening **Display Settings** a single „logic display" is shown next to the control monitor:
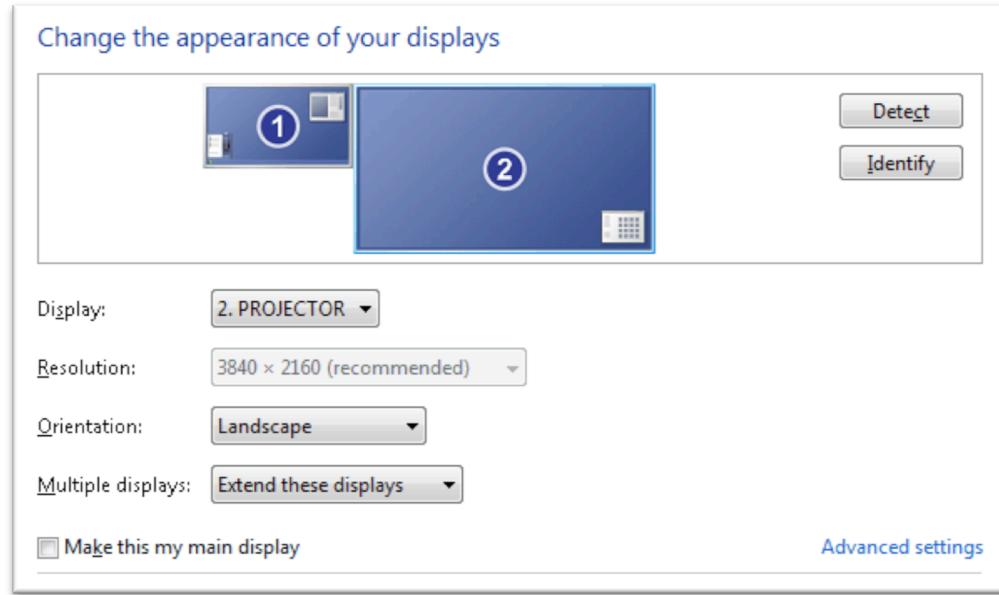
Note for WingsAV users on multiple servers:

For Master/Slave configurations the slaves' graphics cards are set up as exactly as explained above. With a setup of seven projectors, for example, you leave one output unused. In order for the graphics card to detect a projector there you need to load the projector EDID for this output.

5. Calibration

In principle, a Vioso calibration is performed as described in the dedicated manual of „VIOSO Calibrator" – a software tool which is complemenatry to WingsAV or VIOSO Anyblend and also in the manual of „VIOSO Player" – a video playbaclk solution available stand alone or bundled with VIOSO Domemaster servers.

Below you will find the most important steps of a dome calibration:

Part1: Before starting the calibration software

1. Connect the camera and test whether the camera signal is received correctly. If necessary, use the corresponding camera software.

2. Place the camera a close to the center of the dome as possible. If the dome is tilted, the inclination of the camera should be parallel to the dome horizon (dome equator), otherwise at 90 degrees to the floor. The dome must be completely visible in the camera image.
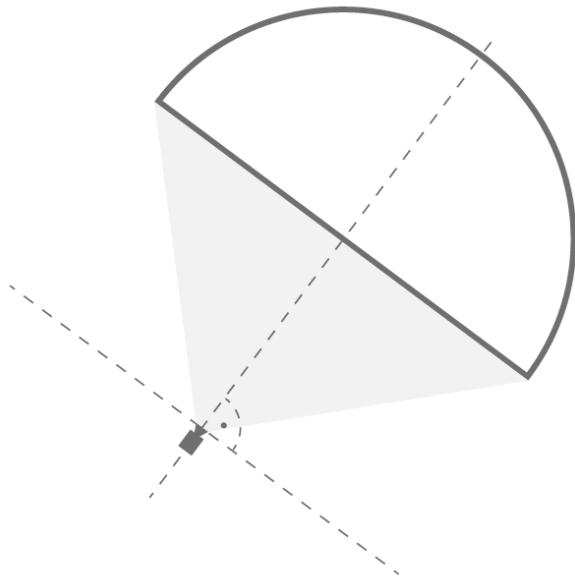
Position of a fisheye lens camera for fulldome calibration

3. Show test images on all projectors; assigning a testing pattern as background picture oft he Windows Desktop is a good way to do this. Make all the necessary camera settings for a camera-based Vioso calibration, e.g. manual adjustment of focus, shutter, etc. See also the manual of VIOSO Calibrator or VIOSO Player.

4. Close all programs that may block the camera (preview programs, driver interfaces, etc.).

5. Start the calibration software

Part 2: Display and camera configuration

6. Start the calibration procedure.

7. Click **Display Split** and select the logic display to supply the projectors. It can be recognized by it's high resolution.
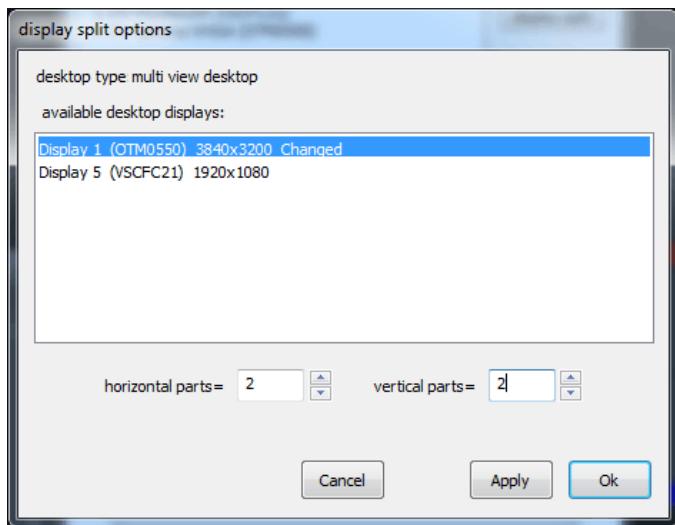

8. Now enter the appropriate numbers to split the combined display (by NVIDIA Mosaic or AMD Eyefinity) for horizontal parts and vertical parts and click **Apply** followed by **OK**. The projectors are now listed in the central field:
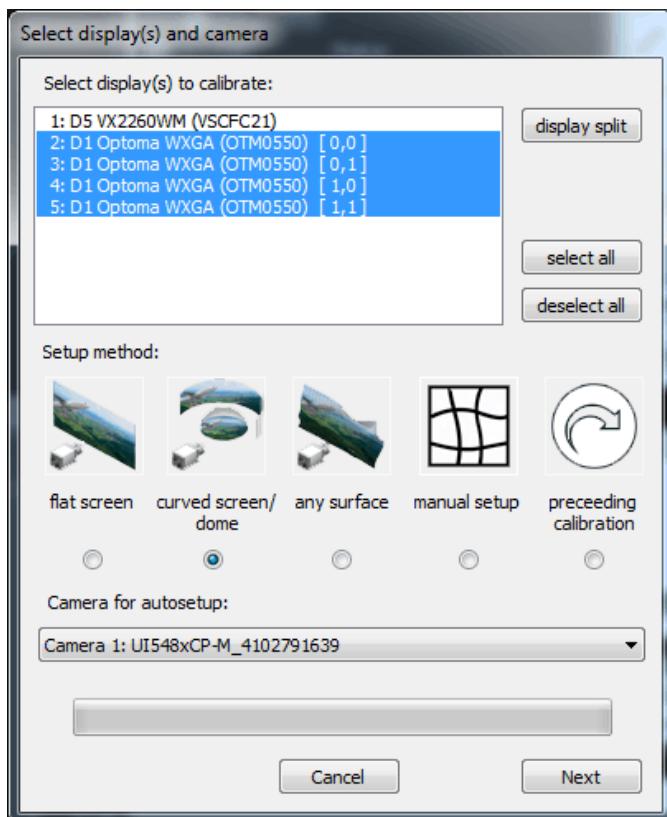
9. For **setup method** select **curved screen/dome** and for **Camera for autosetup** choose your preferred camera from the drop down list. Following this, click **Next**.

10. For **Projector arrangement** choose **Grid/Arbitrary**. Enter a file name for the calibration and click **Set**. Click on **Next** and the camera image will appear.
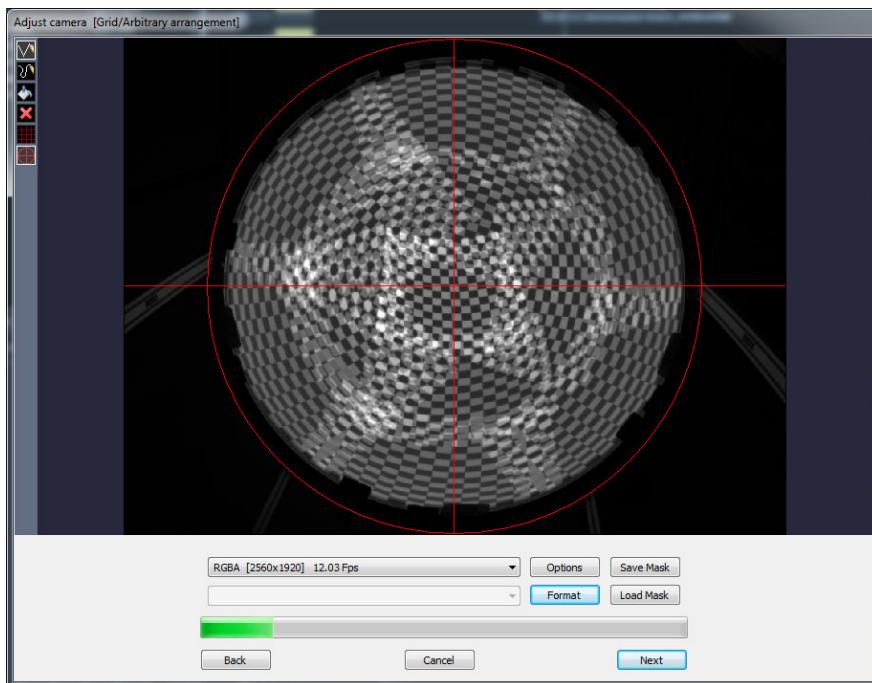

11. Activate **Overlay crosshairs** and align the camera so that the image is exactly in the center of the crosshairs

12. Set up your camera using appropriate parameters for getting a clearly visible feed without any automatic treatments. The frame rate in particular has a considerable influence on the calibration.
    o   If you are using an IDS uEye camera: click **Format**. On tab **Timing** set **Pixel clock** and **Frame rate** to get a frame rate of 10-12 fps:
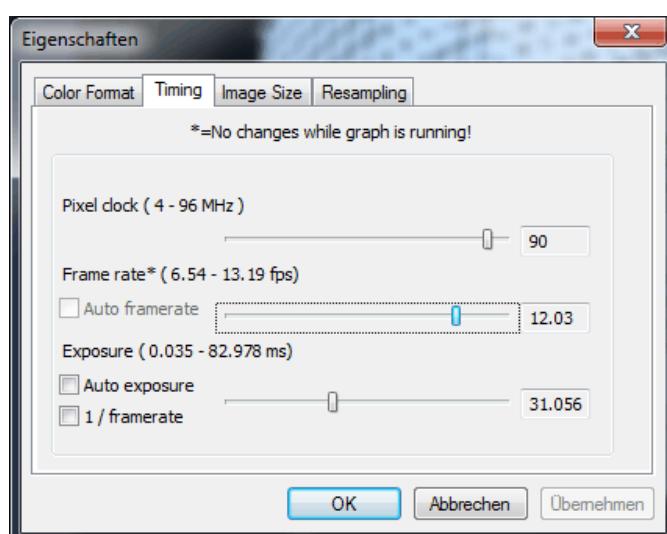
13. Create a mask around the projected image to cut all other light sources (e.g. reflections, projector bulbs, etc.) from being seen while scanning.
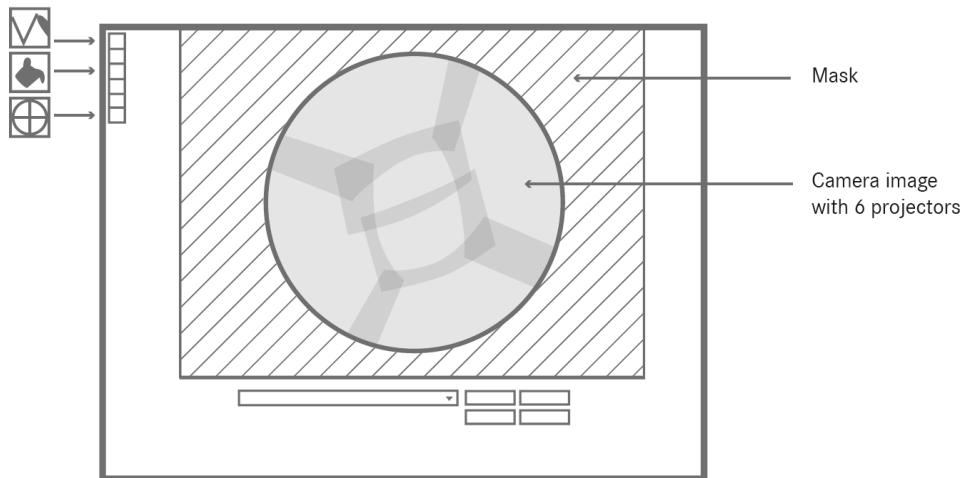

Use the ⋁ **Draw line tool** to draw an outline and the ⬤ **Fill tool** to fill the outline (filled = masked):
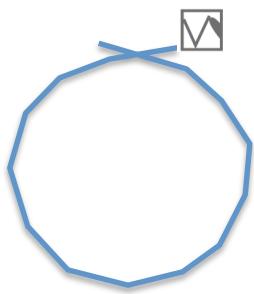

Draw a line without a gap; double-click when done   Fill the area outside; Filled = masked
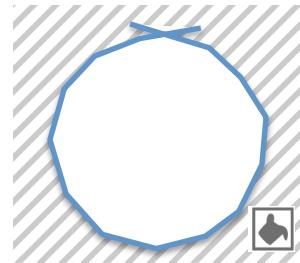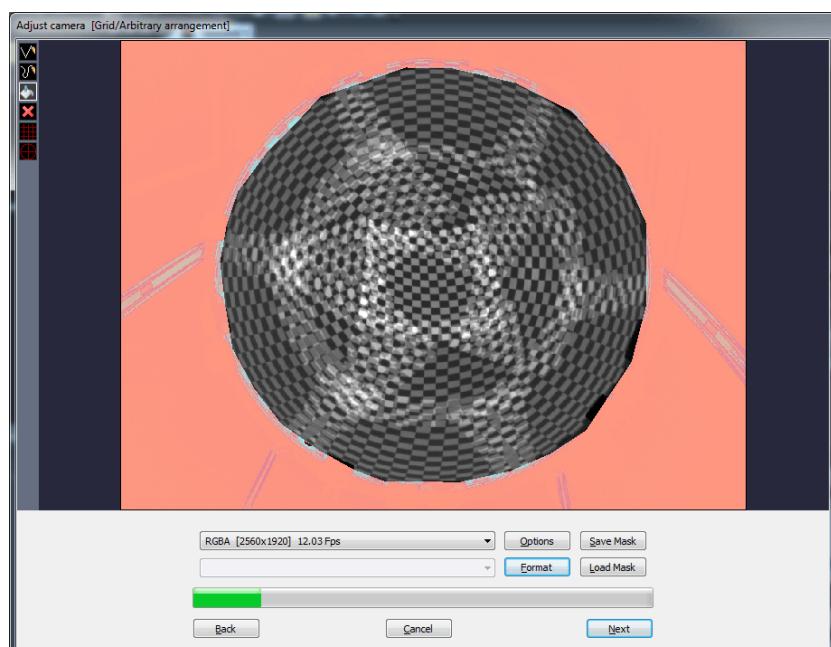

Result: good camera image with proper mask

Part 3: Scanning procedure

14. Start the calibration and follow the subsequent steps until all projectors have been scanned successfully.
    - Several testing patterns are run, an das a result you see a pattern of small dots
    - Try to make all dots displayed as small as possible, whilst still being displayed in green color
    - After each scan, check the resulting verification pattern against visible failures:
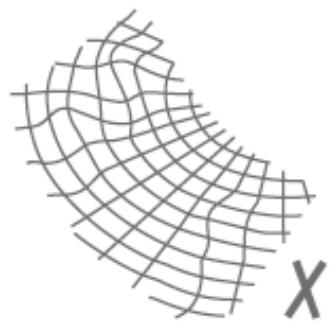
| BAD RESULT	GOOD RESULT
Click **Back** and repeat the scan with changed parameters	Click **NEXT** to continue with the next projector
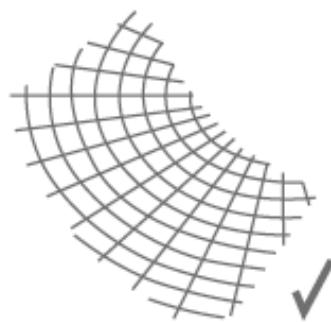
15. In the last calibration step a test image across all projectors is shown by addressing all Wings Engines of the presentation network. Now the mapping is done, i.e. the adjustment of the overall image to the dome geometry

14. Activate **Toggle borders**, following which four „handles" will appear. Highlight one of it and use it to move the outer edge of the test image towards the dome basis.

   Use the keyboard instead of the mouse to operate more accurate.

    By changing over from to **Keyboard fine** you reduce the step size per key press. Once all four sides are aligned the content should aligned with the dome.
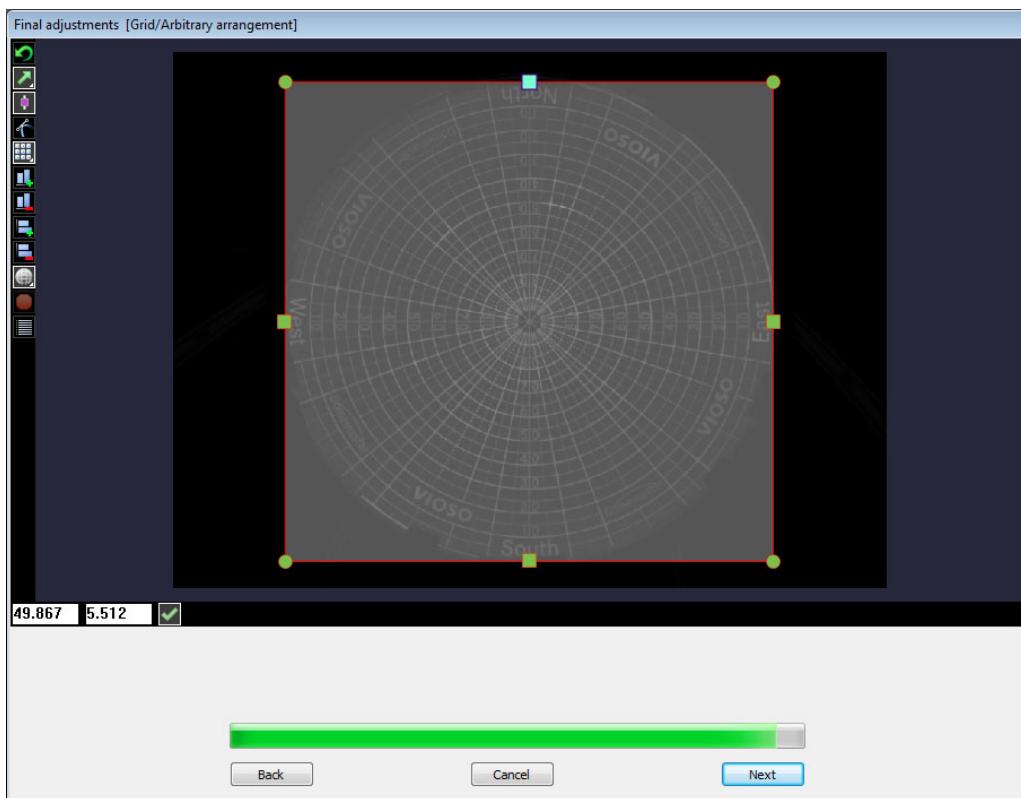
15. Click on **Next** and you return to the main window. Open **Menu – File** and choose **Save all settings** to save the current calibration to an SPS file. Attention: Saving may take several minutes!

DONE!

After saving the calibration, you are ready to use it along with your application: WingsAV, VIOSO Player or VIOSO Anyblend). Please refer tot he product's documentation for further instructions.
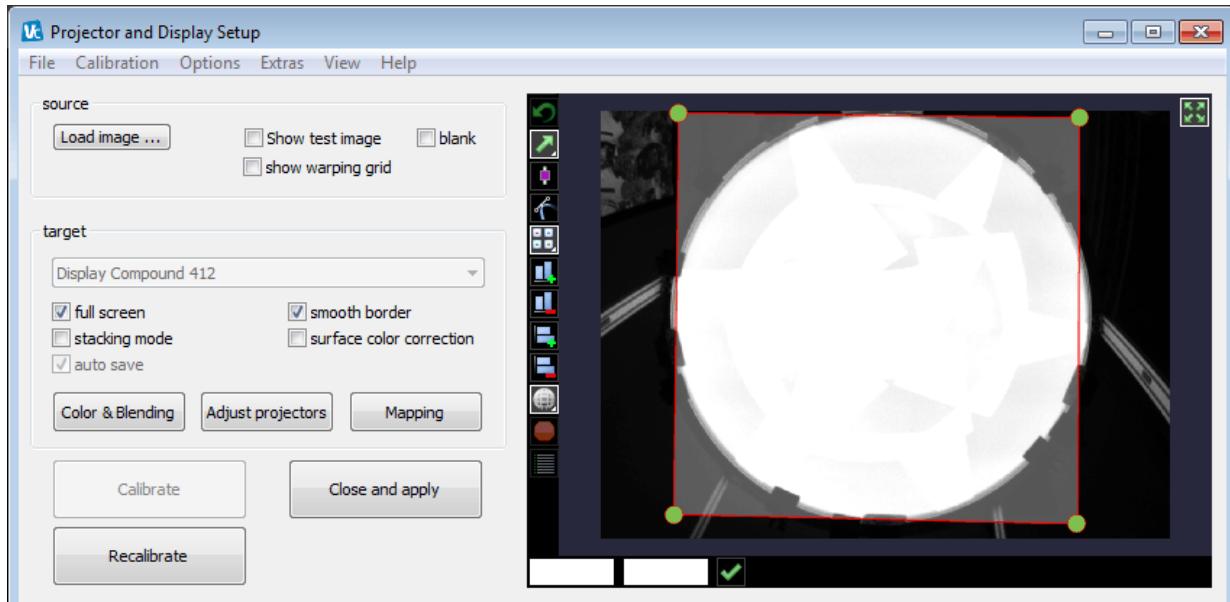
Contine with your selected application to utilize to calibration:

VIOSO PLAYER

Easy and versatile playback solution for 2K domemaster content

VIOSO ANYBLEND

Integrating Autoalignment results with third party applications, warping boxes, etc.

WINGS AV with **WINGS VIOSO**

Sopisticated media server solution for displaying 4K domemaster content

6. VIOSO contacts

Should there be any questions that cannot be answered in the help section, please tell us about them. Please use the Support Function if there are any problems or errors. Wings Platinum can be updated via function Software Update. If you have any questions or suggestions, you can reach also us on the phone on weekdays from 8.00 am to 17.00 pm.

VIOSO GmbH

Ronsdorferstr. 77a
D-40233 Düsseldorf
Tel. +49 211 544 75 33 – 0
Fax: +49 211 544 75 33 – 33
E-mail: info@vioso.com
Internet: www.vioso.com

Documentation Status

Last review: **02.04.2015**
VIOSO Calibrator version: **1.4.2**