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Fly Elise-ng
Immersive Designer + Calibration PRO Interop
Designer Assisted Auto-alignment

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1 Introduction

Fly Elise-ng PRO software stack (Designer, Calibration, Display, Player and Presenter) has become de-facto software stack for designing, auto-aligning and edge-blending a multi-projector setup for games, simulators, presentations, digital signage and other applications.

Thousands of multi-projection setups have been successfully designed and provisioned using our Immersive PRO software.

In this tutorial we will reveal an advanced workflow and integration between Immersive Designer PRO software and Immersive Calibration PRO software. This workflow has been used by our field engineers and high-end users to optimally design and auto-align any projector setup with or without using a camera for auto-alignment.

Our core software for accurate and optimal design and evaluation of any projection setup is Immersive Designer PRO.

<https://fly.elise-ng.net/immersive-designer-pro/>

This is the most versatile and user friendly software for visually designing a projector setup using off-the-shelves projectors on any projection surfaces. The software supports built-in parametric projection surfaces for the most common projection setups.

In this post we will show you how you can master the fine details of the process of end-to-end design and auto-alignment of any projection setup.

Note: Immersive Designer PRO – Ultimate License is required for this advanced workflow.

As an example we will use a set of requirements posed by our end-customer:

Use 3 x BenQ BenQ LK953ST 5000lms 4K

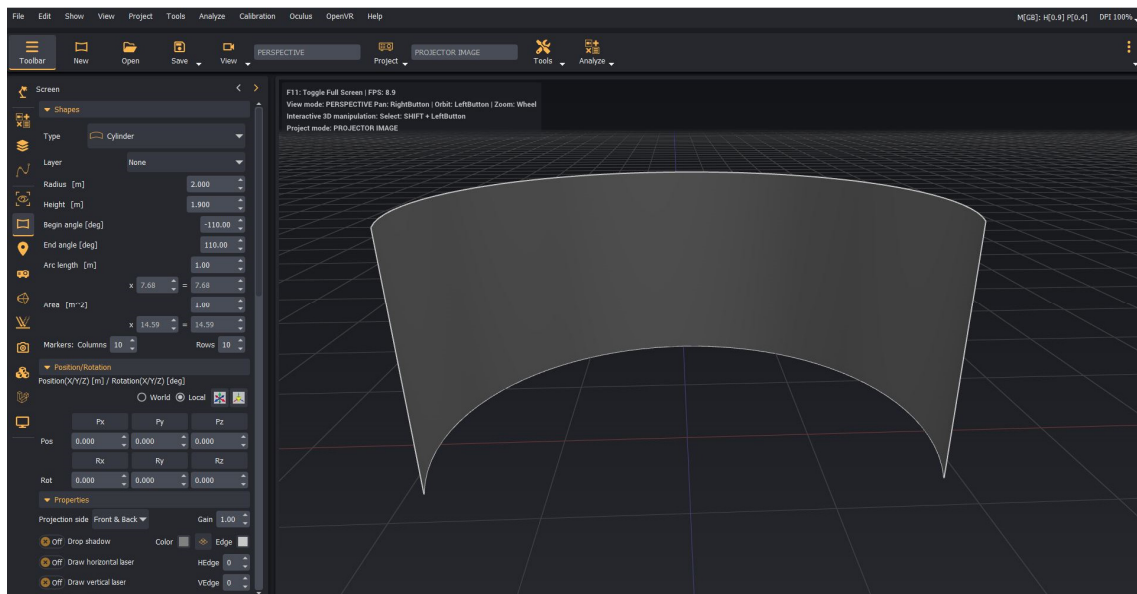
Use a Cylindrical projection screen with a radius of 2 meter, height 1.9 meter and total horizontal angle of 220 degrees

This is a clear set of requirements to start our initial design and Immersive Designer PRO. At this moment we don't need to have the real projectors connected or to have access to the projection screen.

2 Projection design

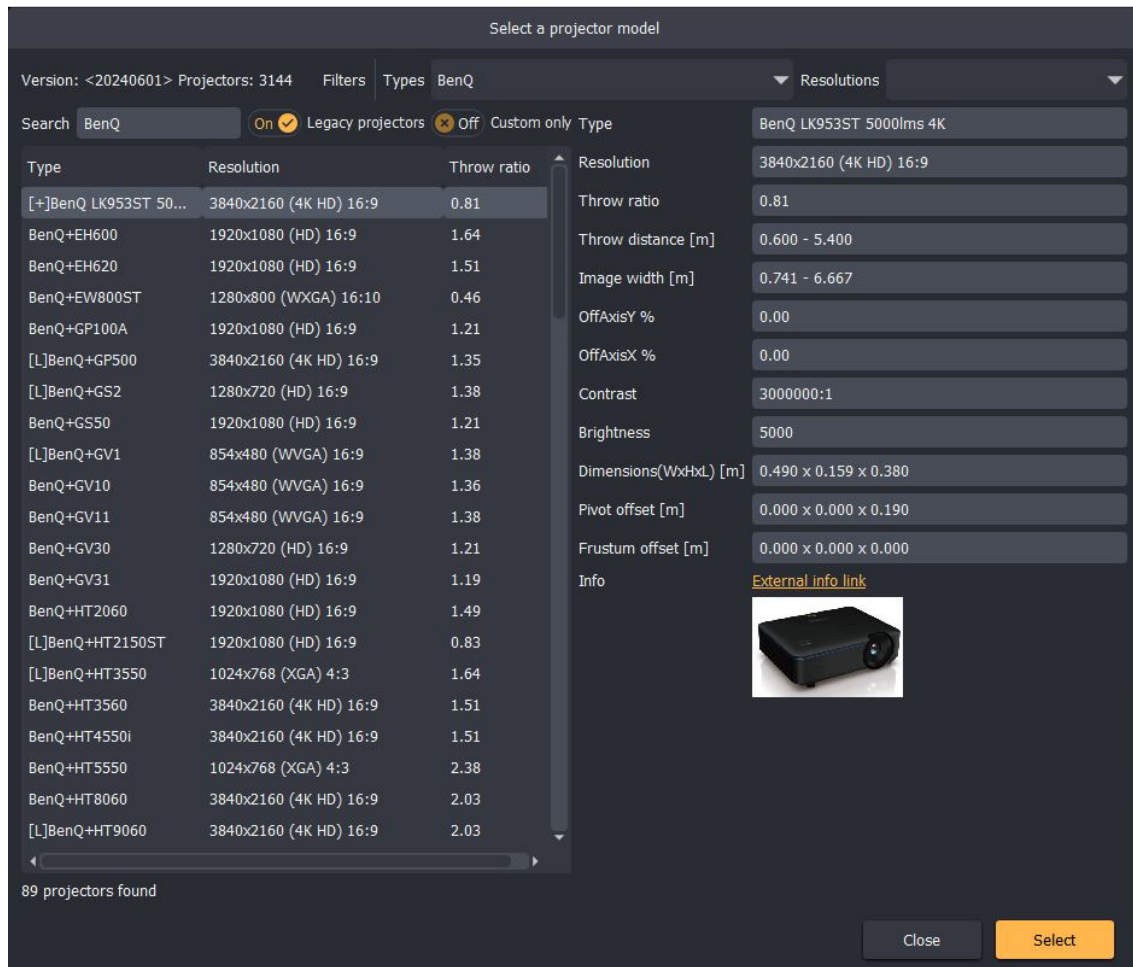
Just use Immersive Designer PRO to create a virtual projection setup using the provided requirements and constraints.

Select and configure the projection screen:

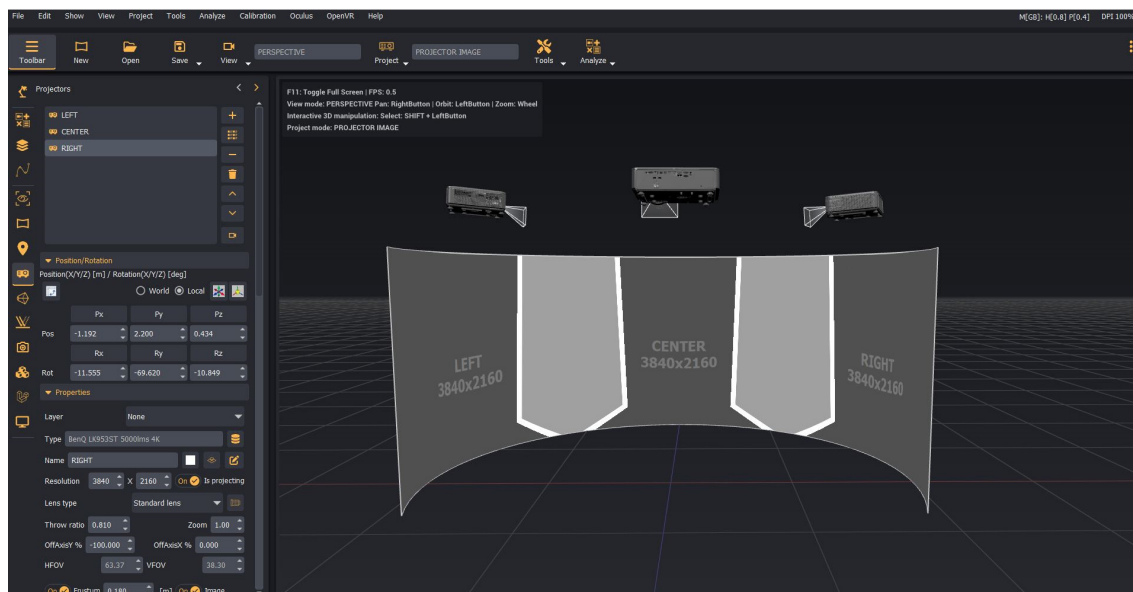


Add 3 BenQ LK953ST projectors.

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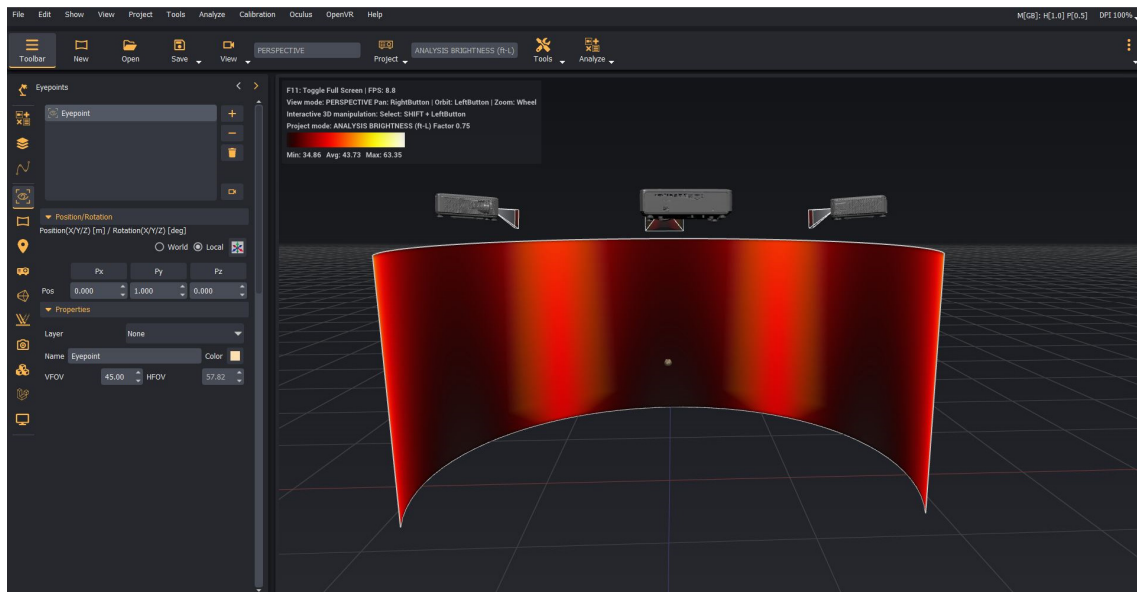
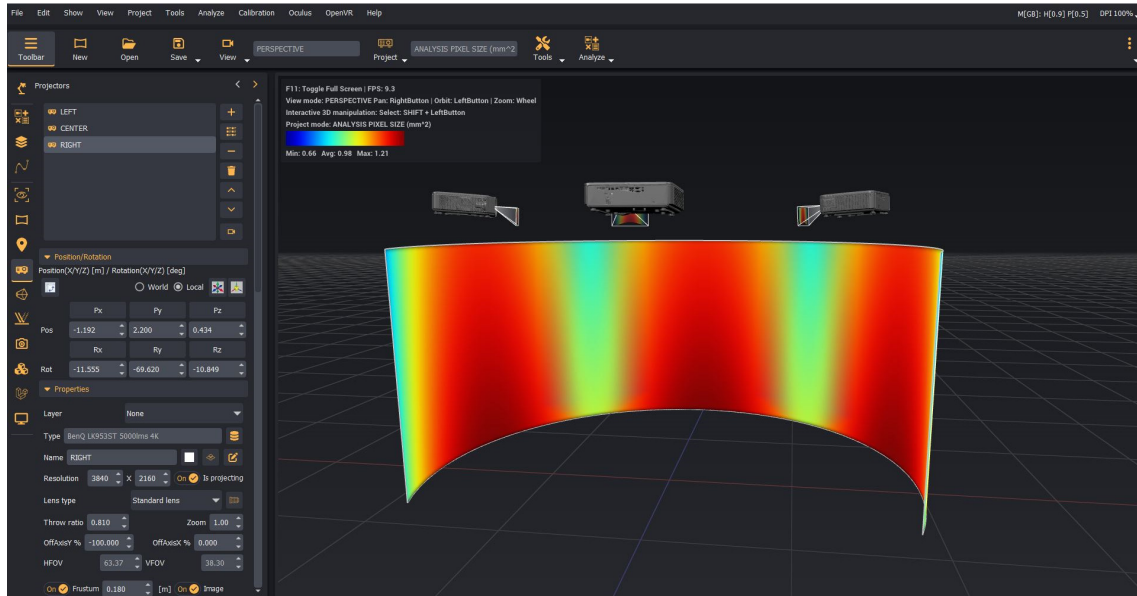


Arrange the projectors to cover the complete projection surfaces taking into account the required projector image overlap and image overshoot.

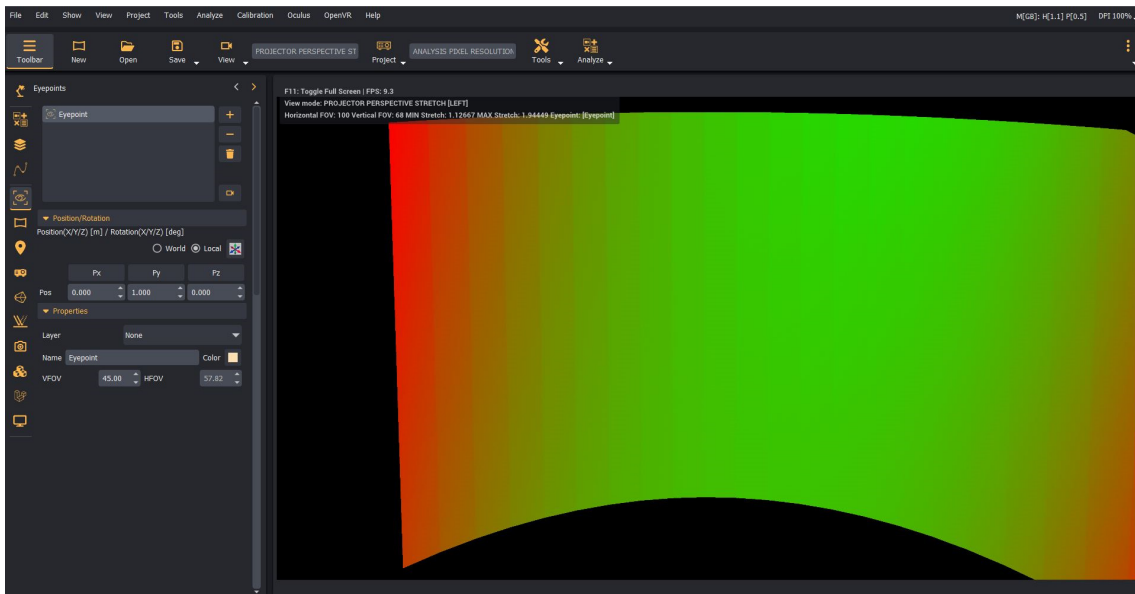
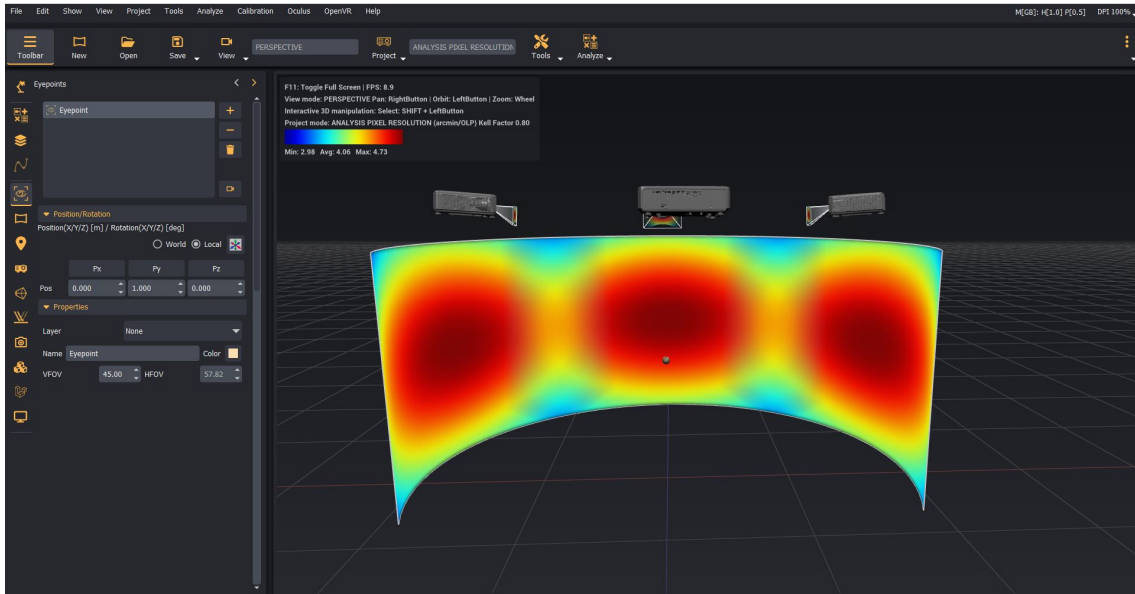


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Once the initial design is done, perform the required analyst to evaluate the projection setup and where needed adjust the projectors positions for optimal projector image coverage, minimal pixel loss and minimal perspective stretch.



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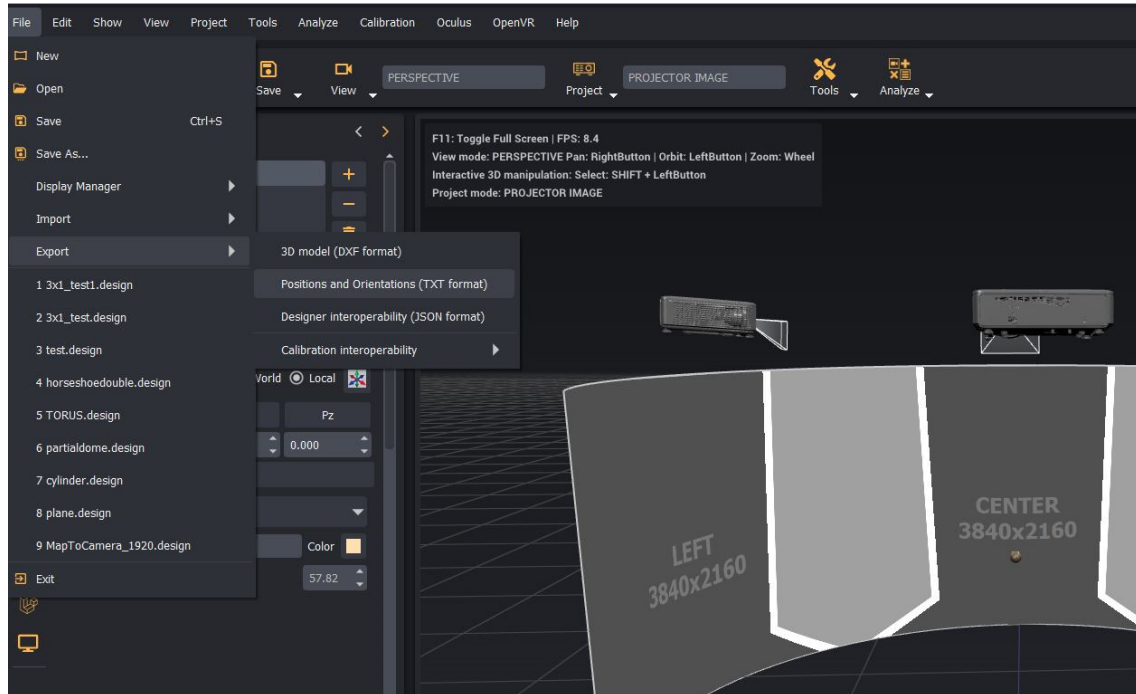


Important: Spend enough time and do a couple of iterations in Designer PRO to find the optical suite–spot of the projector positions and the results of the available analysis modules.

A proper and optimal design phase is of crucial importance for the end result after the auto–alignment and edge blending. A bad (not–optimized) design, will result in stretched and pixelated images on the projection screen, bad blending in the overlapped projector images and bad overall projection quality.

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Once satisfied with the designed project projection setup, we can proceed with the building of the real projection setup. Immersive Designer PRO – Ultimate offers the export option to export the projectors positions for positioning the projectors in the real setup.



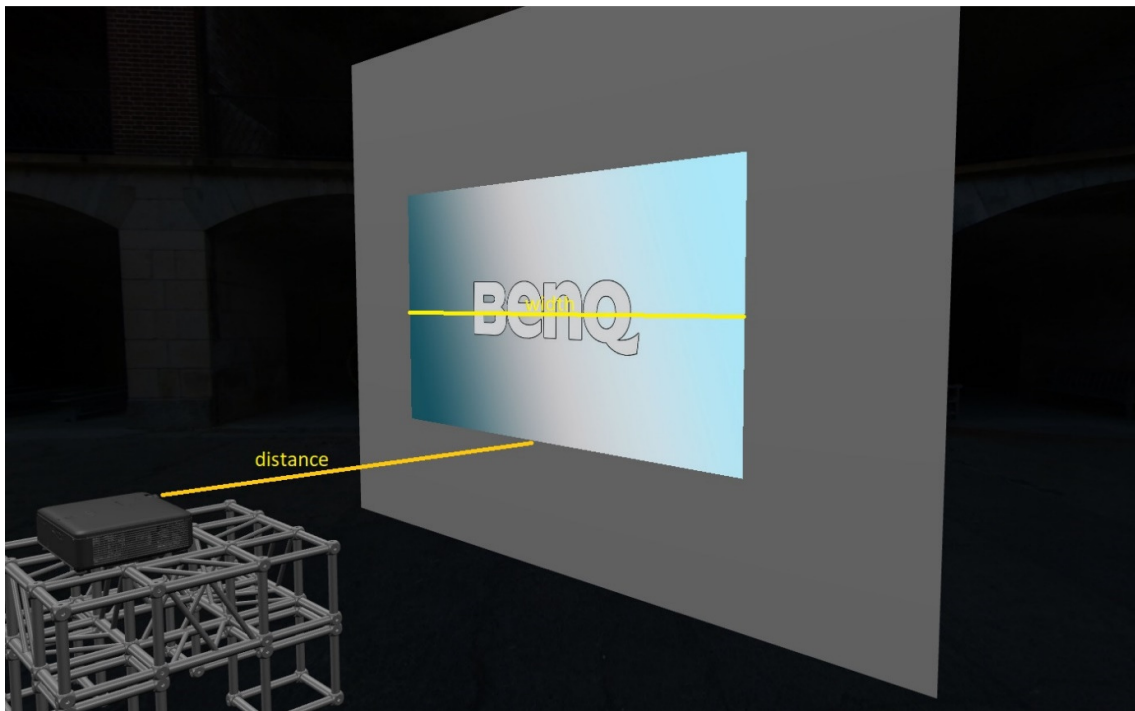
```
|-----  
Screen  
-----  
Shape : Cylinder  
Position : x=0 [m] y=0 [m] z=0 [m]  
Orientation : rX=0 [deg] rY=0 [deg] rZ=0 [deg]  
-----  
Projectors  
-----  
Name : LEFT  
Type : BenQ LK953ST 50001ms 4K  
Resolution : 3840 x 2160  
Position : x=1.19247 [m] y=2.2 [m] z=0.434024 [m]  
Orientation : rX=-11.555 [deg] rY=69.62 [deg] rZ=10.8494 [deg]  
-----  
Name : CENTER  
Type : BenQ LK953ST 50001ms 4K  
Resolution : 3840 x 2160  
Position : x=0 [m] y=2.2 [m] z=1.269 [m]  
Orientation : rX=-4 [deg] rY=0 [deg] rZ=0 [deg]  
-----  
Name : RIGHT  
Type : BenQ LK953ST 50001ms 4K  
Resolution : 3840 x 2160  
Position : x=-1.19247 [m] y=2.2 [m] z=0.434024 [m]  
Orientation : rX=-11.555 [deg] rY=-69.62 [deg] rZ=-10.8494 [deg]
```

3 Projection setup

Now we have all the information to build our projection setup. Before we commit and place the projectors, let's verify that the lens parameters of the selected projector during the design phase match the real projector lens parameters.

We will do this using a simple measurement setup. Place the projector on a flat surface and point the projector beam to a wall. Measure the distance from the projector lens to the wall. This is the line from the lens perpendicular to the wall. Also measure the width of the center image of the projector on the wall. Measuring the distance along the line in the middle of the project image. The distance to the wall and the projector image width on the wall will allow us to enter the real projector lens parameters in Immersive Designer PRO.

3.1 Measuring the projector throw ratio

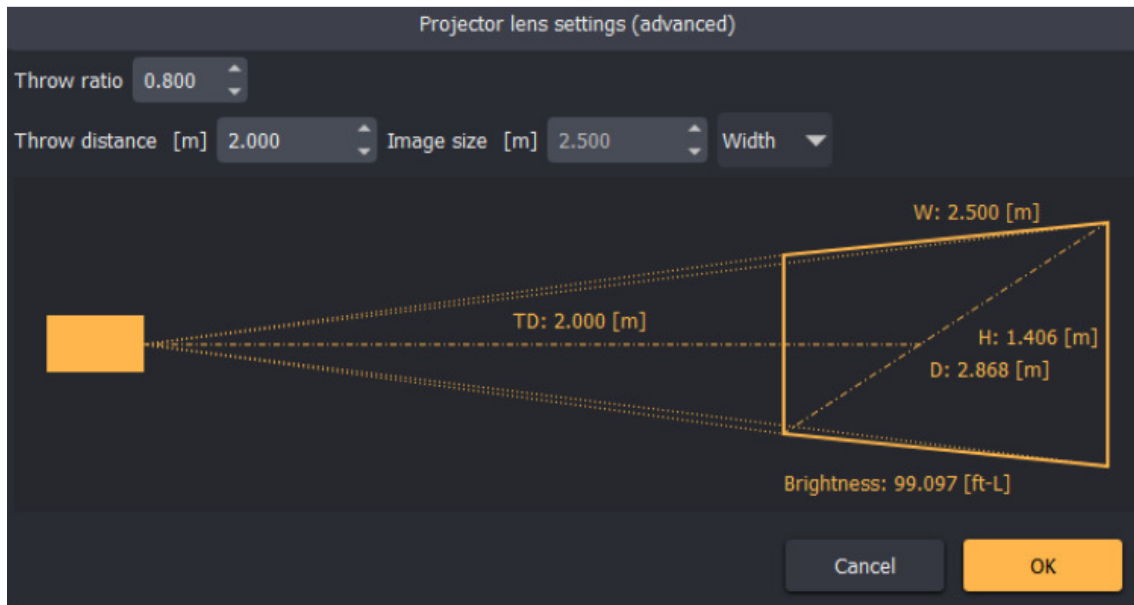


Note: If the projectors are available early in the design phase, this step can also be done before or during the design phase.

Now, open the projector lens properties in Designer PRO to verify that the Design projector has the same properties as the real projector. This is essential for later steps to facilitate the projector positioning.

In our case, the measured projector distance to the wall is 2 meters and we measured the projector image width to be 2.5 meters.

Enter the distance of 2 meters and change the value of the throw ratio until the width of the projected image becomes 2.5 meters.



In this case, the real projector lenses have a throw ratio of 0.8, which is different from the designed throw ratio of 0.8.

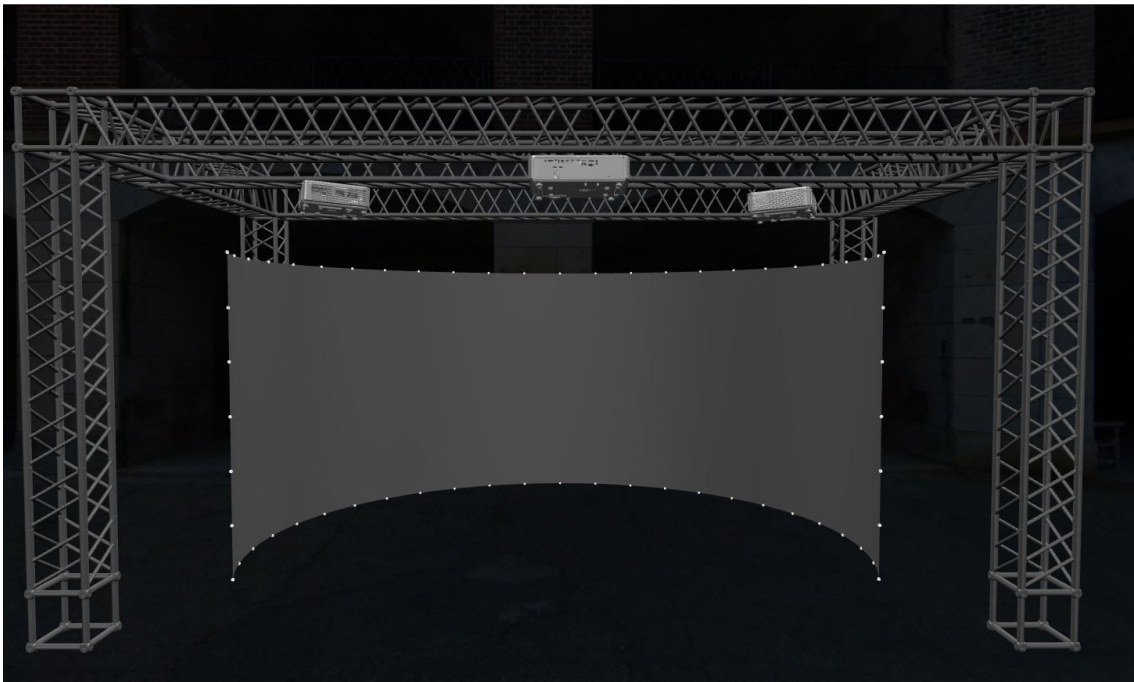
Now, before we continue with the physical setup, for each projector in designer PRO, make sure that the throw ratio is set to the measured 0.8.



Now we will continue and we will use Designer PRO to assist us to position and orient the projectors to the designed position and orientation.

Before we continue, we will divide the screen in equidistance rows and columns. Markers will be put on the screen edges to help us with the pre-alignment of the real projector and later in the auto-alignment.

For this setup we will divide the screen edges in 24 columns and 6 rows and put the markers on the edge of the screen.

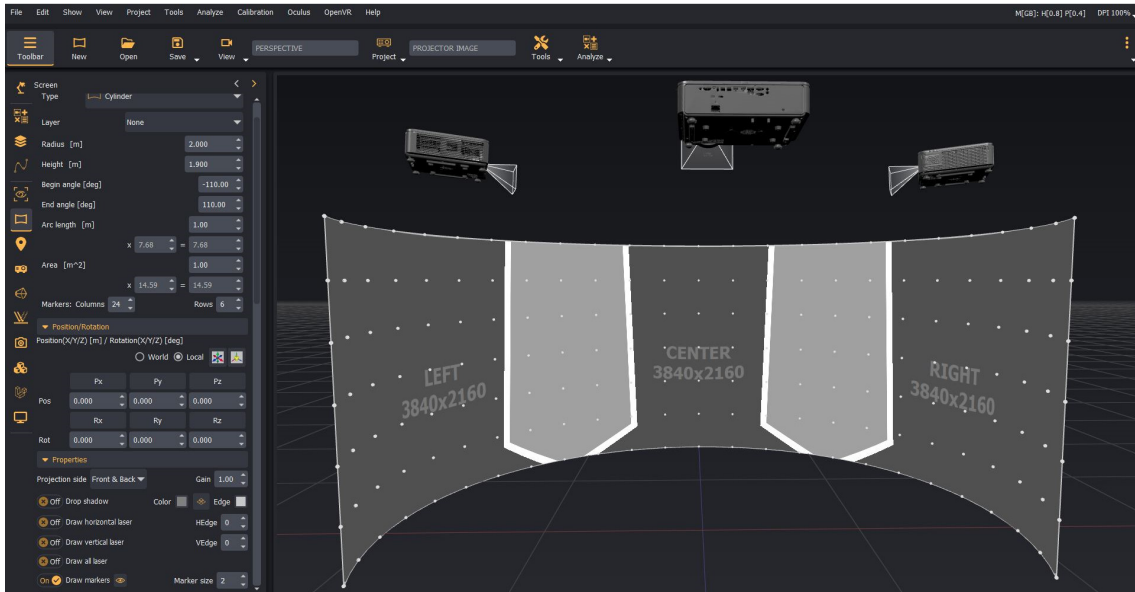


Position the real projectors approximately, according to the exported data from Designer PRO.

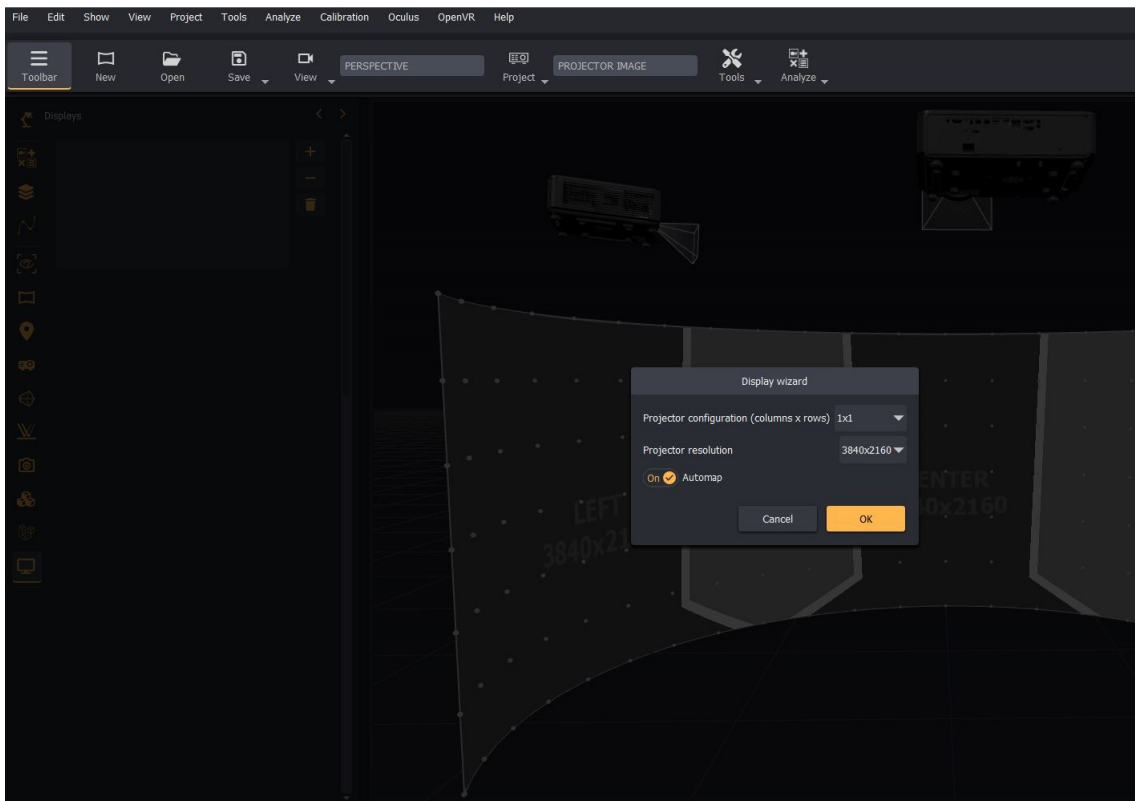
We will use a special software tool RemoteDisplay to send an image from the designer to the real projector and project this image on the real projection screen. Perform the following steps to prepare Designer PRO for real projector positioning:

- In Designer PRO, enter the rows and columns for the designed screen (24 columns, 6 rows)

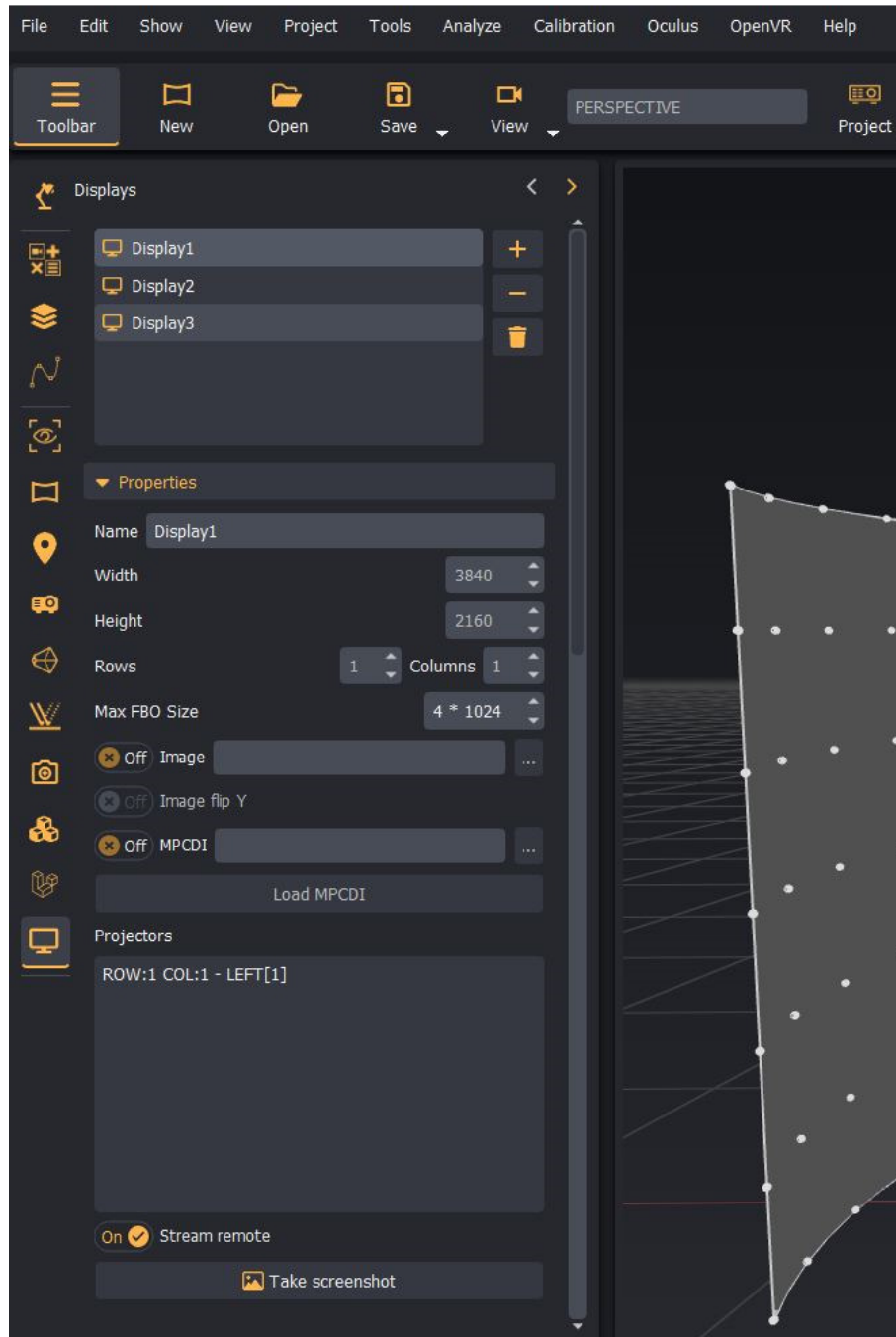
Immersive Designer + Calibration PRO Interop



- Open the Displays panel. If there are other displays created, press the RemoveAll button to remove all previous displays. Now, press the Add display button, and in the popup dialog make sure that 1x1 is selected and the Automap checkbox is checked, and press OK.



This will create a Display per projector.

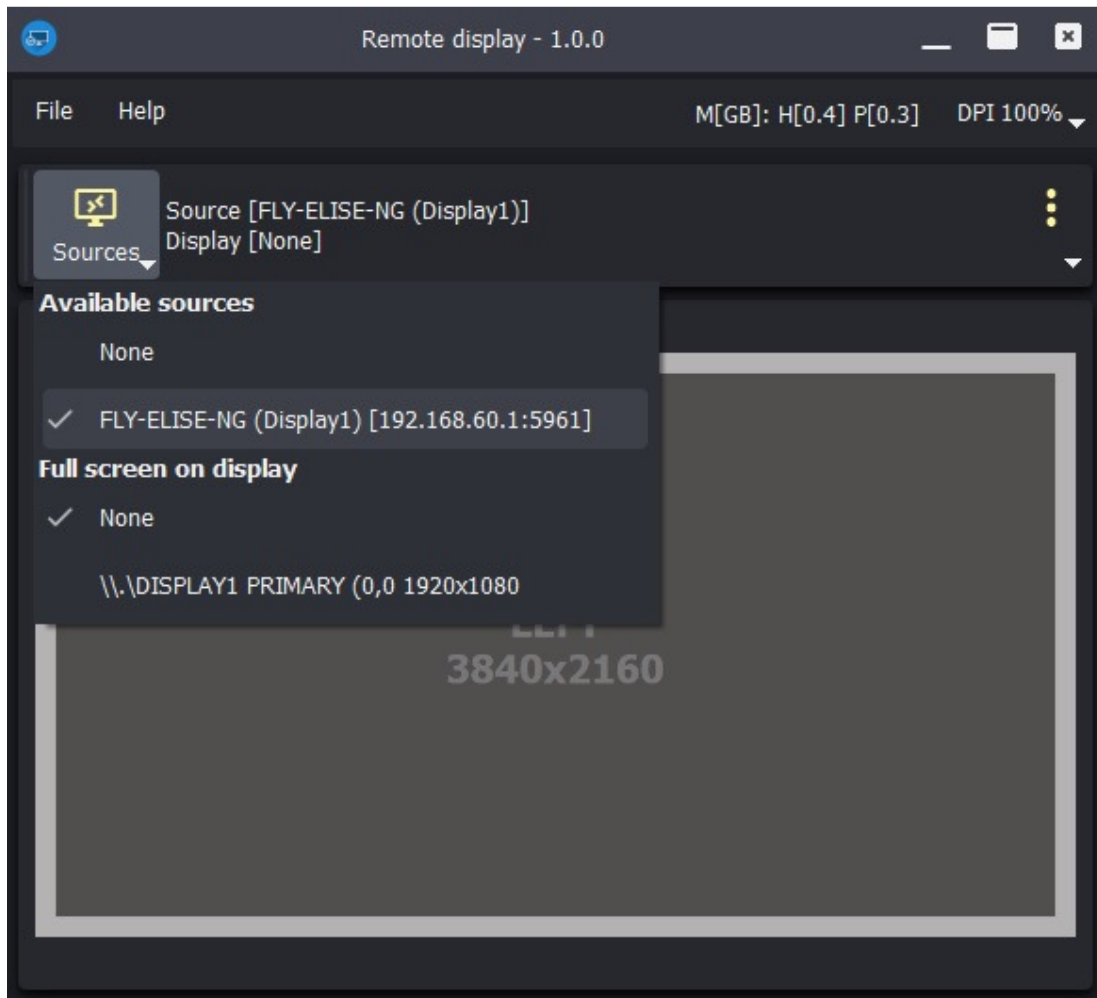


Select Display1 and make sure that the Stream remote checkbox is checked. This will make sure that the projector image in Designer PRO will be streamed

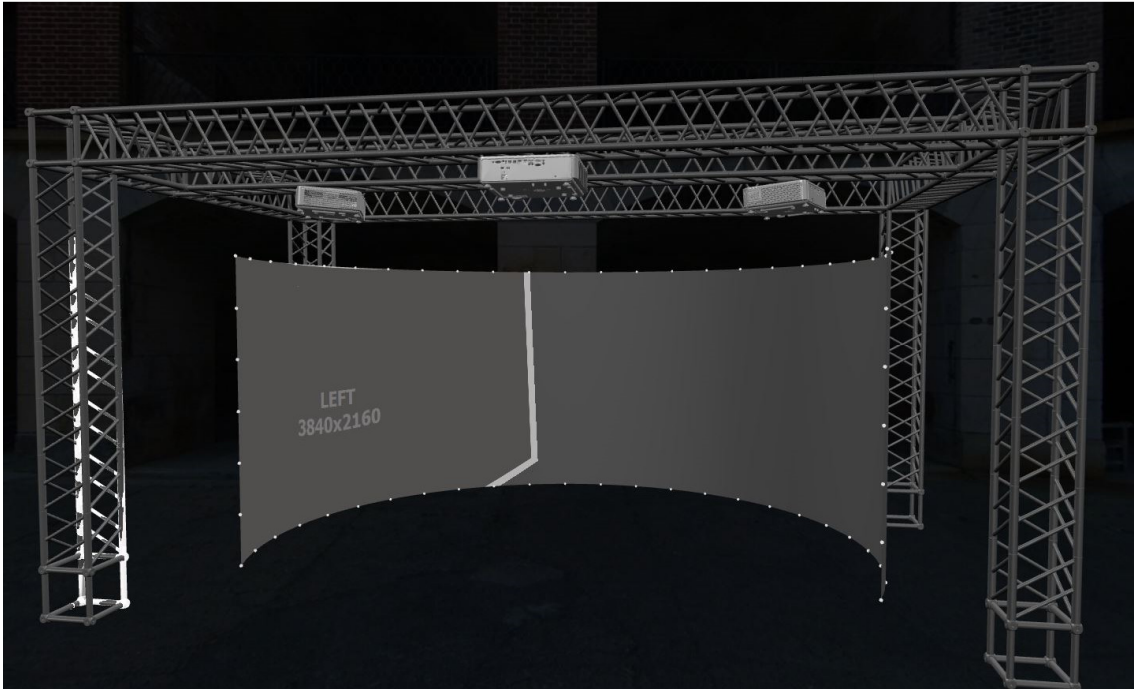
and will be available in the same or a remote PC where the real projector is connected.

– Configure the real projector and real PC. On the PC which is connected to the projectors, start the RemoteDisplay software, and press on the Sources button.

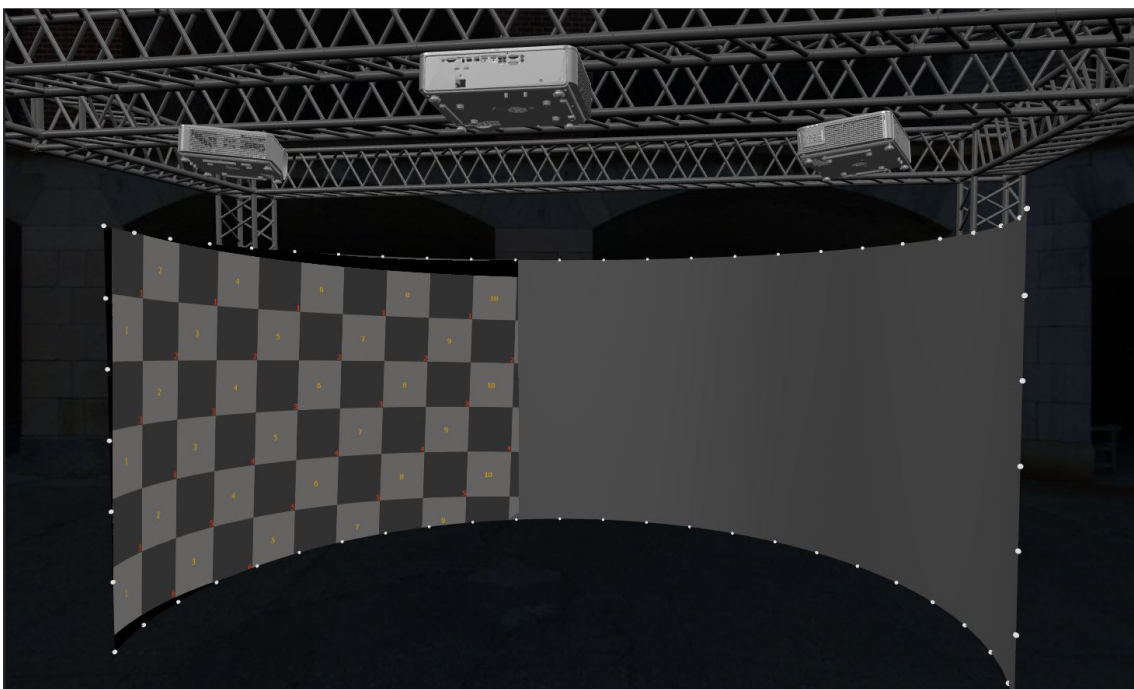
From the available sources selected the display name from Designer for the first projector.



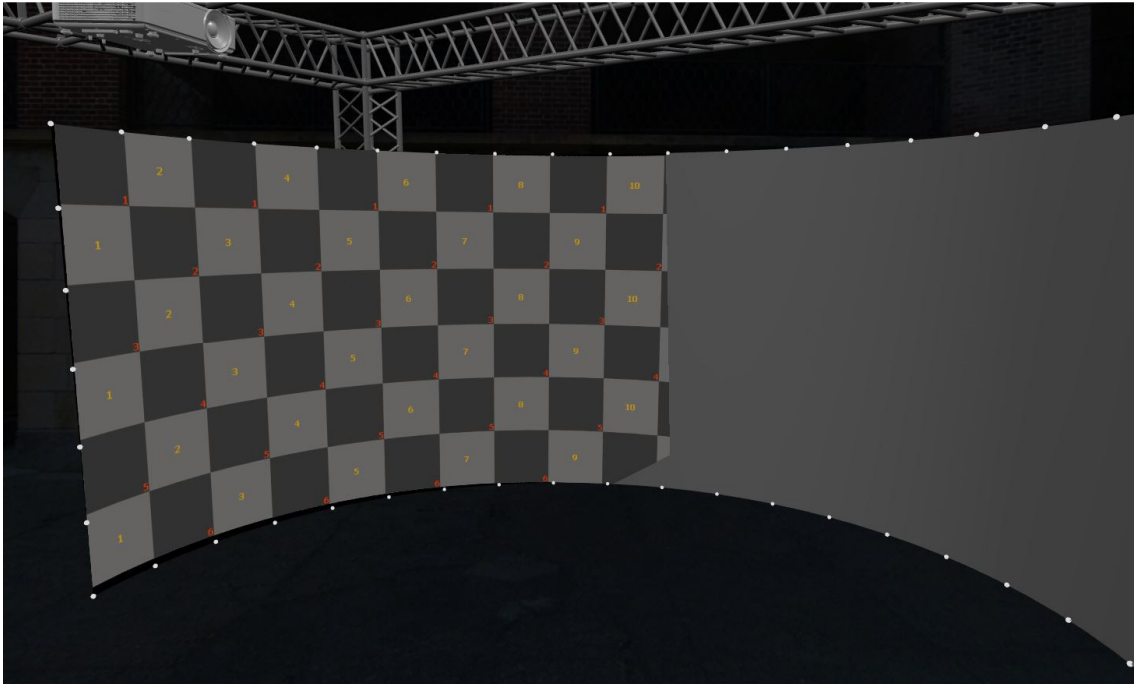
This will find and show the image from the projector in Designer PRO. Press the Sources button again and select the PC display output to which this projector is connected. Now, the projected image from Designer PRO will appear on the projector and projection screen on the real setup.



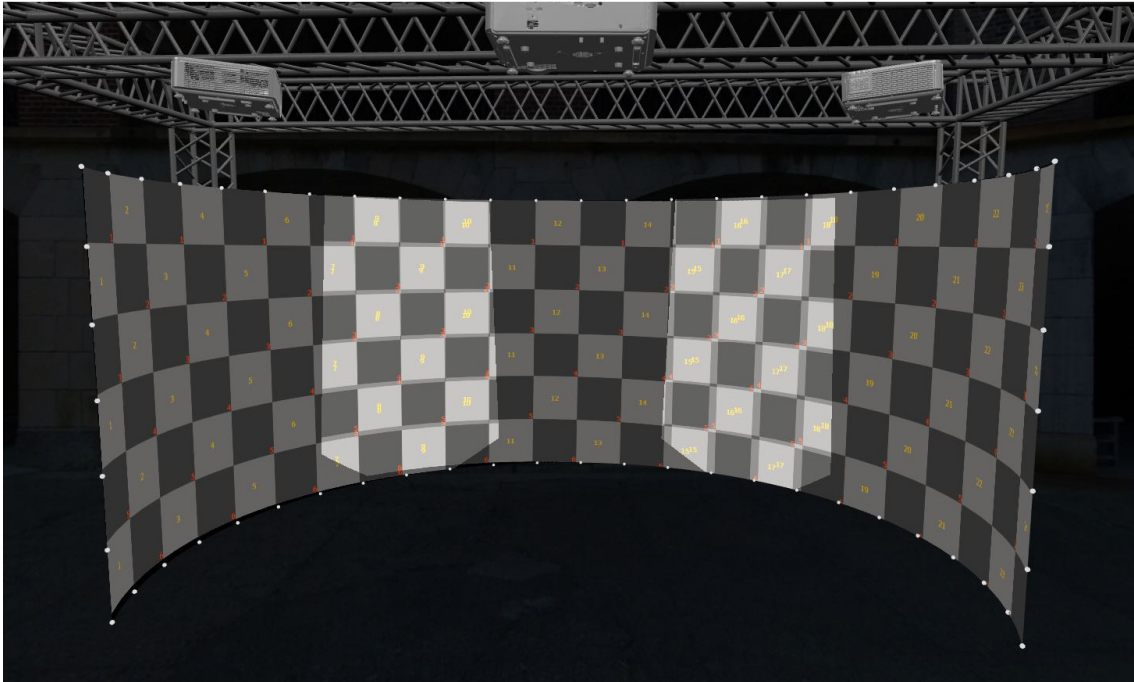
Prepare designer for assisted projector positioning. In Designer PRO, select the Analysis menu and select the option “Re-align projectors” This will ensure that the Designer projectors project images which are aligned to the screen rows and columns. The same image will also be sent and shown on the real projector.



Due to the approximate positioning of the real projector or the imperfect projection surface shape or size, the projected rows and columns might not align with the screen markets. In such a case, do manual readjustments of the real projector to make the projected image align as good as possible with the markers on the screen edge. Do this alignment as accurately as possible using the real projector position, rotation and zoom possibilities.



Repeat the same steps for all 3 projectors.



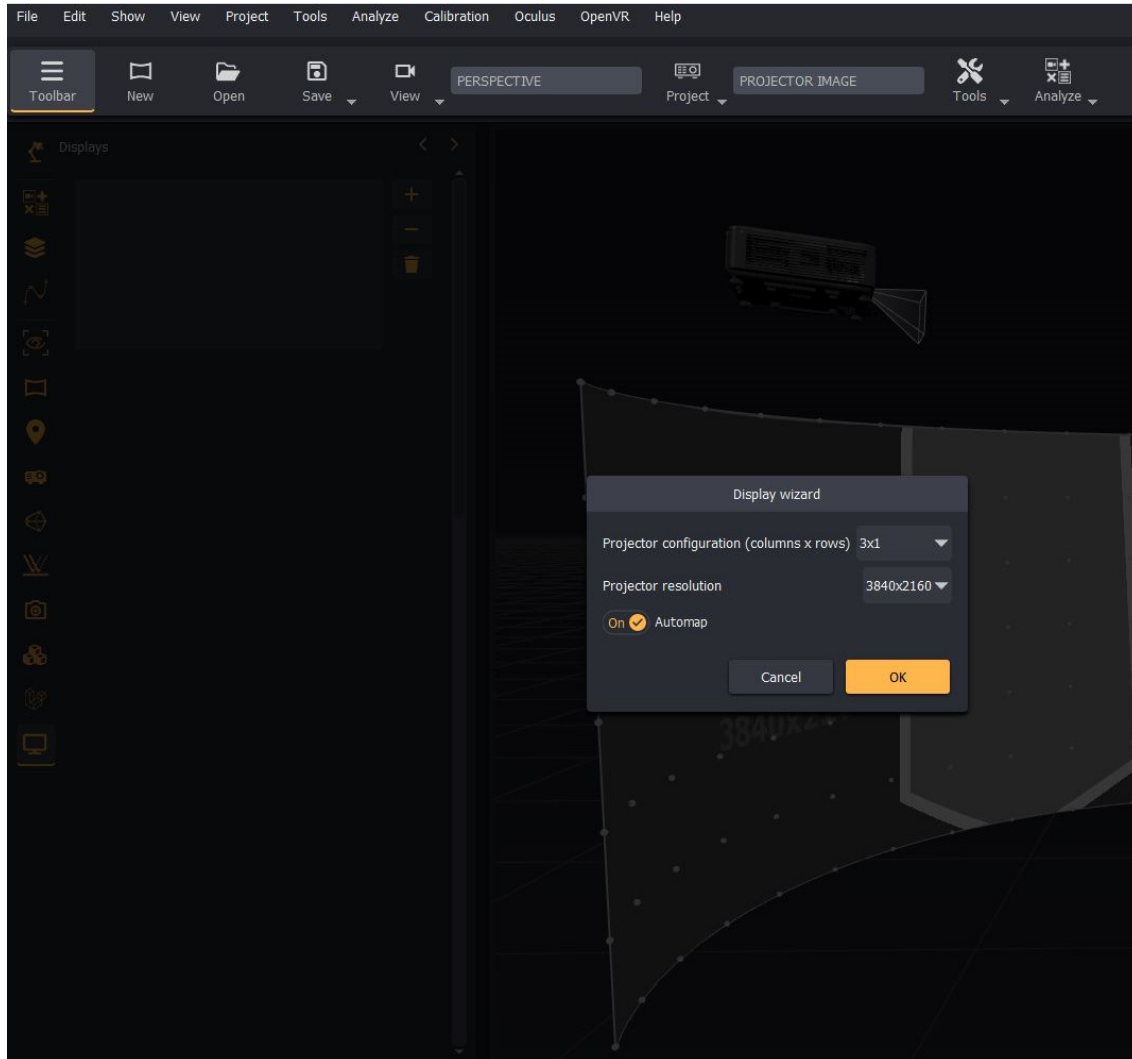
This finishes the most important part of the projection setup.

Measuring and using the real projector throw ratio to design the projection setup, and using the Designed PRO in a feedback loop to physically position and orient the real projectors, we ensured that the real projection setup is as close as possible to the designed projection setup. This will be important for the next step of auto-aligning the projectors.

4 Auto-aligning (Map to projector)

Now that we have a real projection setup that matches the Designer PRO projection setup, we will use Designer PRO to export the configuration data for Immersive calibration PRO.

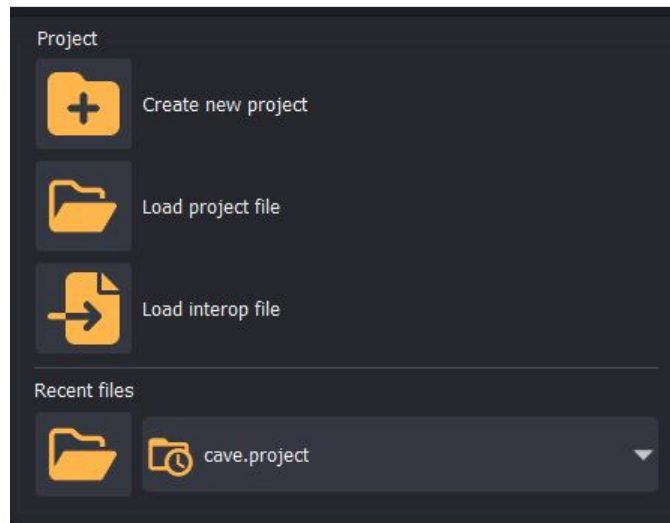
In Designer PRO, go to the Displays panel and delete all displays. Then press the Add button and from the displays dialog select the 3x1 configuration and check the Auto-map checkbox. This will create one 3x1 display with projectors 1,2 and 3.



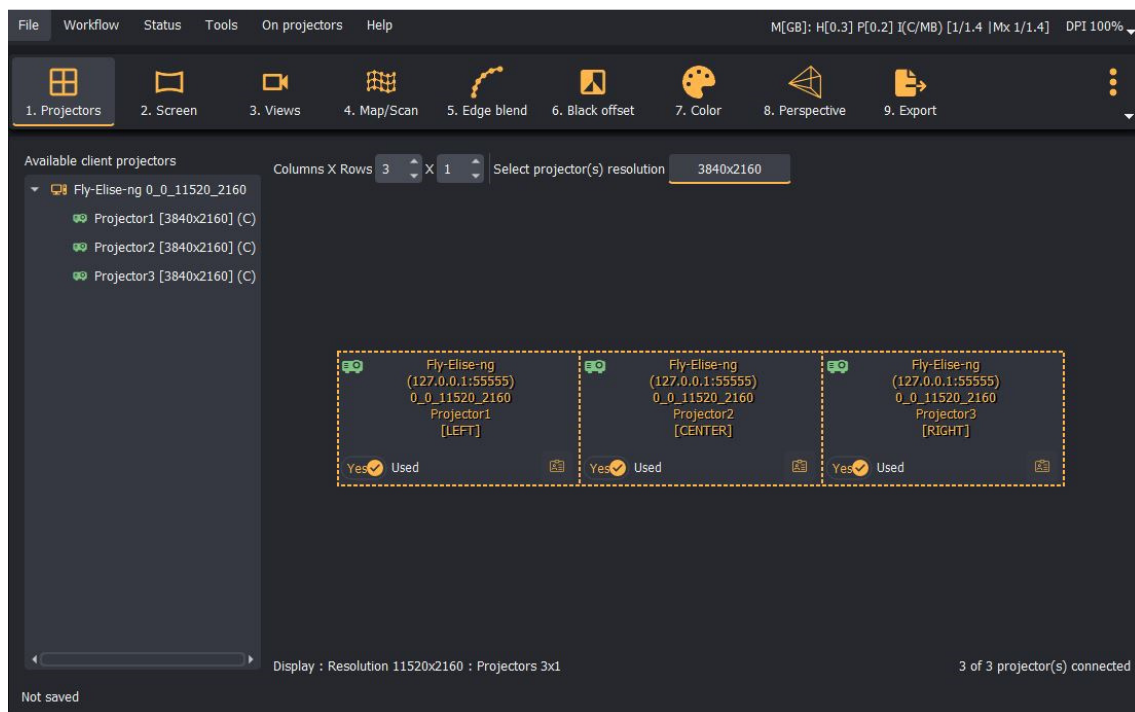
From the File/Export menu select Export to Calibration Interoperability => Map to projector. This will export the .interop data that can be used in Calibration PRO to preconfigure the auto-alignment software. After this step, we are done with Designer PRO and can continue with Immersive Calibration PRO auto-alignment steps.

On the PC connected to the projectors, start the Calibration PRO client and configure the projection setup per display. Check the Calibration PRO user manual.

On a separate PC or laptop Start Calibration PRO server and press the Import button to load the exported .interop file.

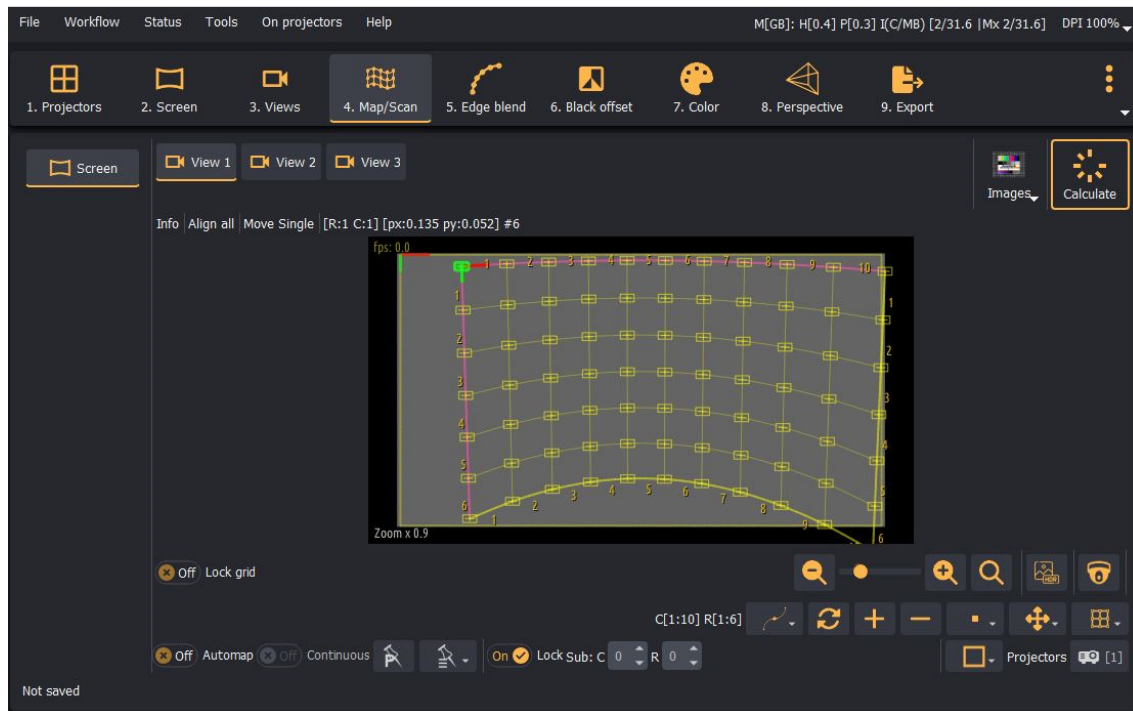


In the projectors section, double click on a projector to connect to the Calibration PRO client projector.



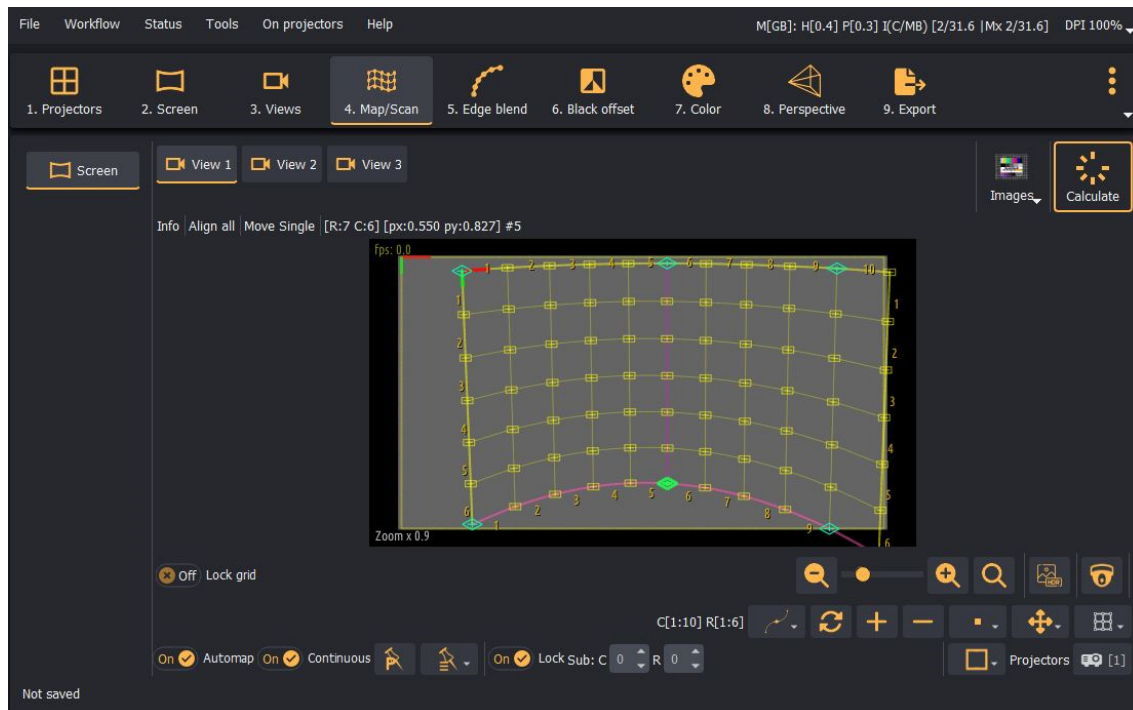
In the Views section, the projector is already mapped to the screen, according to the data from Designer PRO.

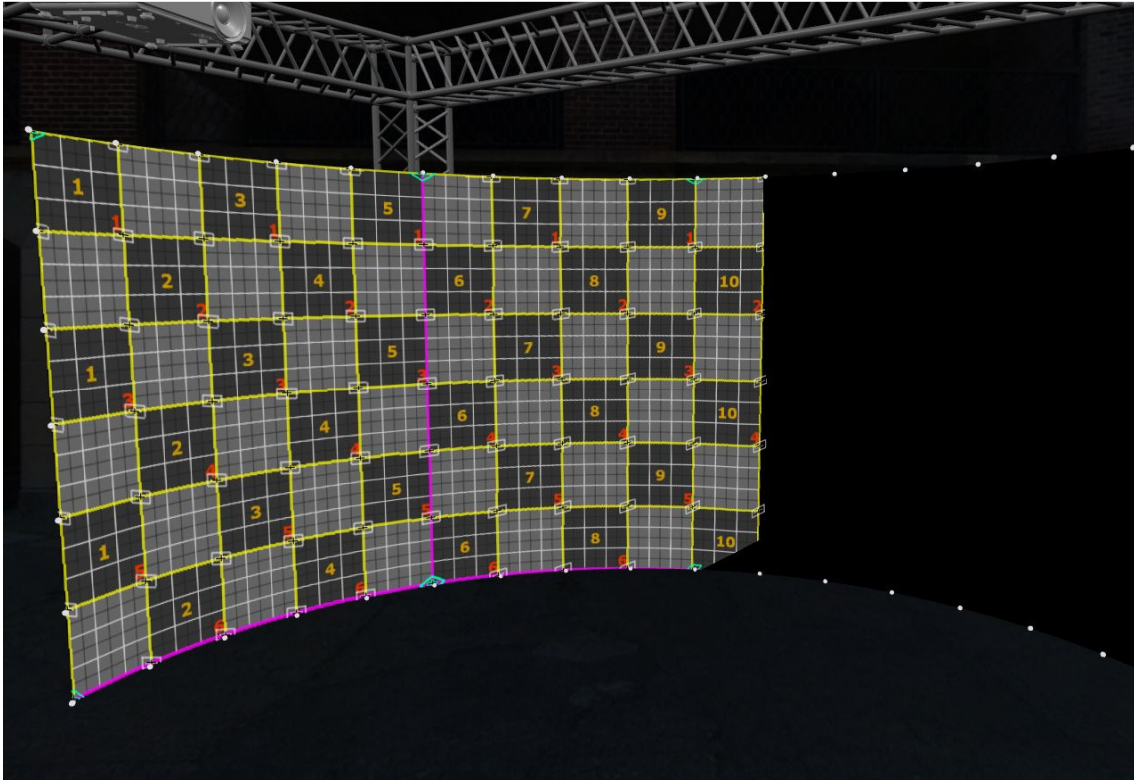
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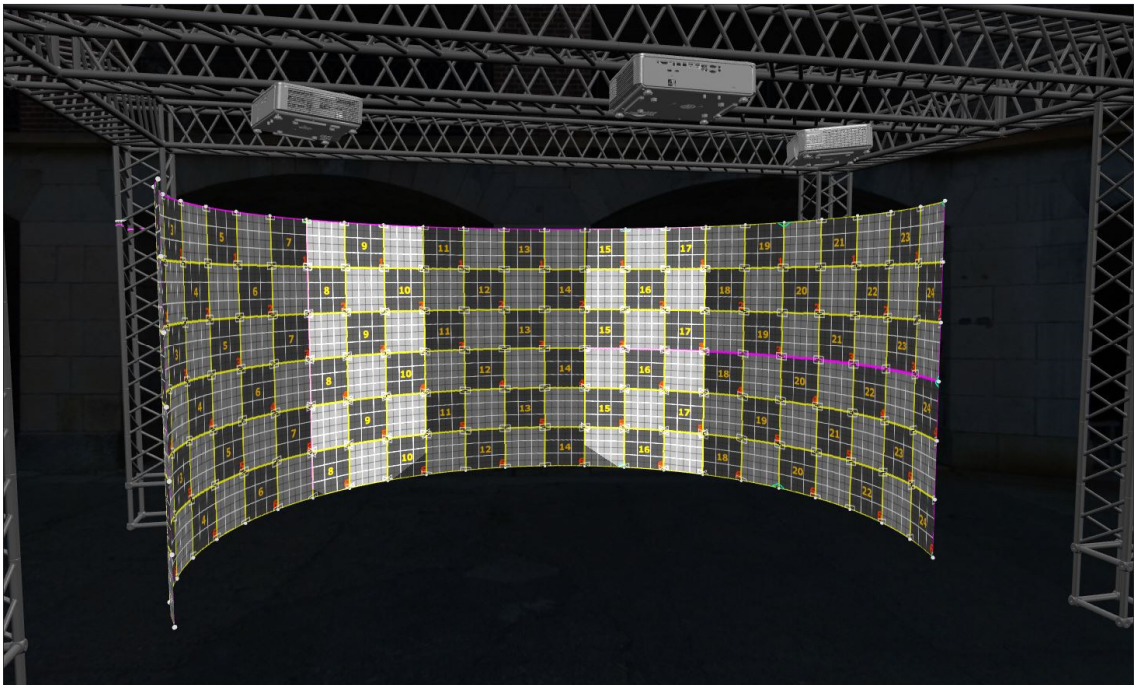
But because of the imperfect positioning, the projector images in the real screen are not perfectly aligned.

Just use a number of control points (6 or more) and move them on the markets on the screen. Use the auto-map option to auto-map the rest of the points.



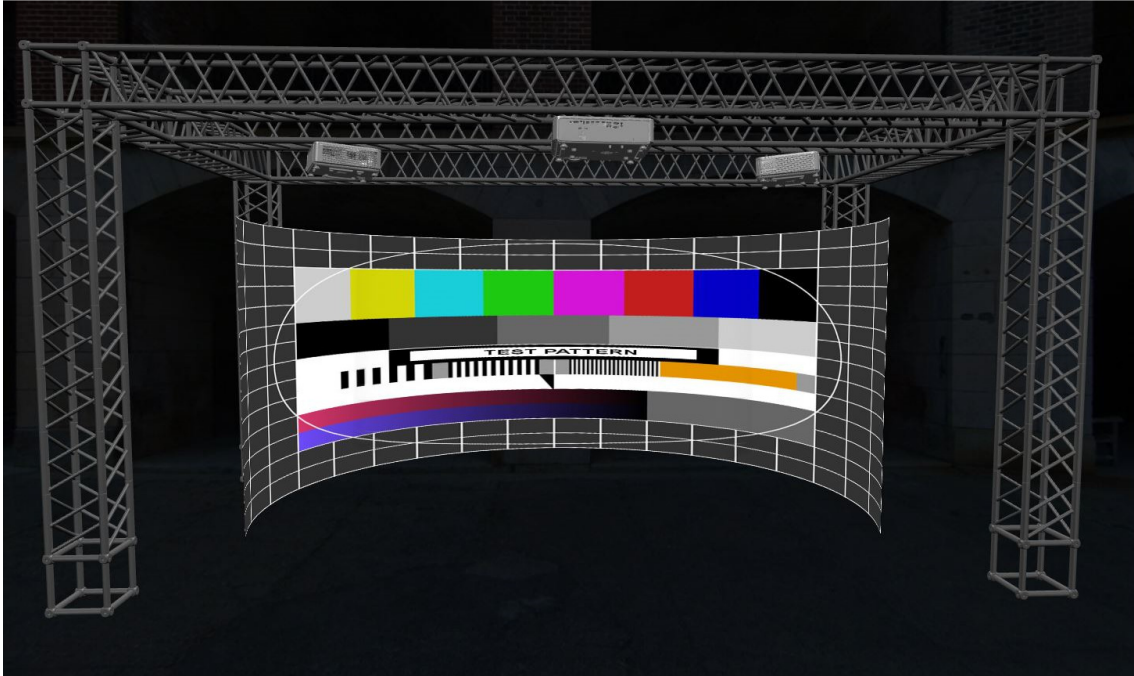


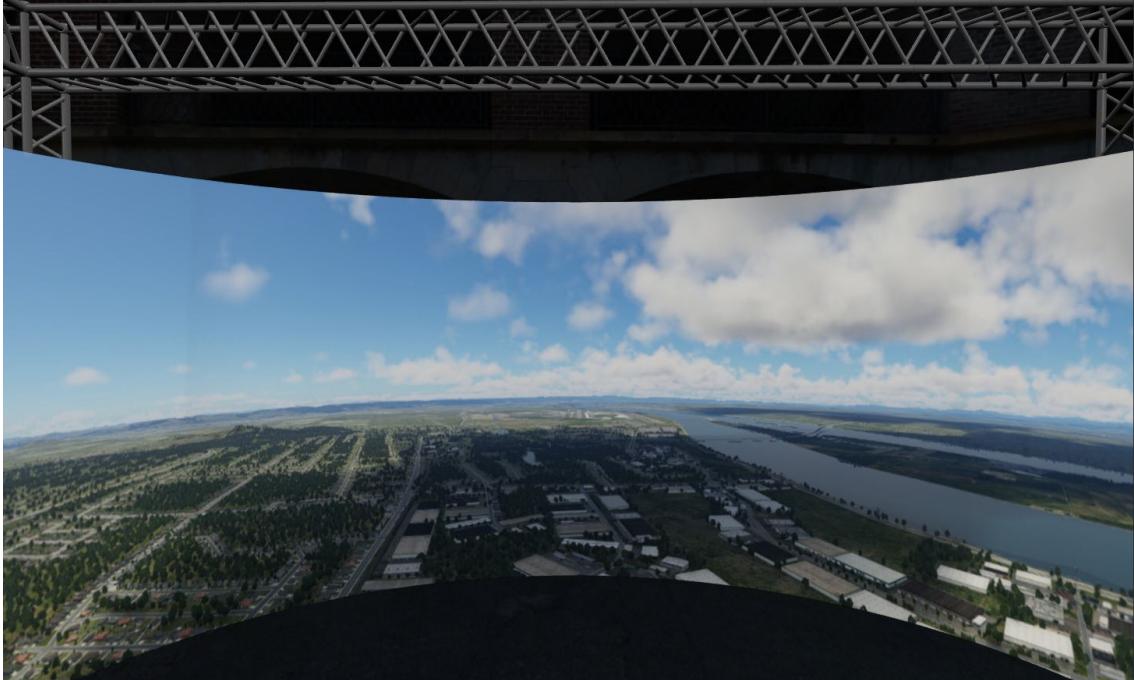
Repeat the same for the rest of the views until the mapping grid is perfectly aligned with the screen markers for all 3 projectors.



Well, this has been the fastest method of auto-aligning 3 projectors without using a camera.

Using the Designer PRO to position the real projectors and export the alignment data, Calibration PRO can be pre-configured with the initial configuration. Only a few minor adjustments are required before the Calculate button can be used in Calibration PRO to calculate the warping and edge blending for both non-perspective and perspective warping.





5 Auto-aligning (Map to camera)

Cameras allow for quick initial alignment and re-alignment with one click of a button. Immersive Calibration PRO supports a wide range of cameras.

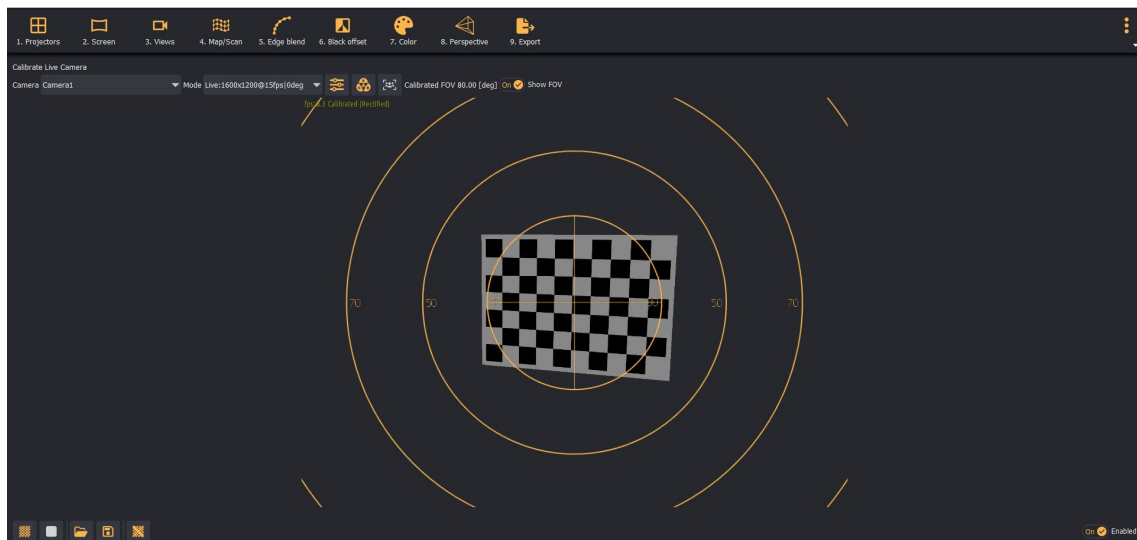
In this chapter we will describe how to use Immersive Designer PRO to select the camera type, total number of cameras and their position and how to export the designed setup to Immersive Calibration PRO.

For the purpose of this document, we will use the previously designed projection setup and will use 2 DSRL cameras to cover the complete projection surface.

The most important information to be able to use the cameras accurately in Designer PRO is to know the cameras horizontal field of view (FOV). Different camera lenses have different FOV. Having the information of the camera FOV will make it possible to accurately position and orient the cameras in both the Designer PRO software (virtual projection setup) as in the real projection setup.

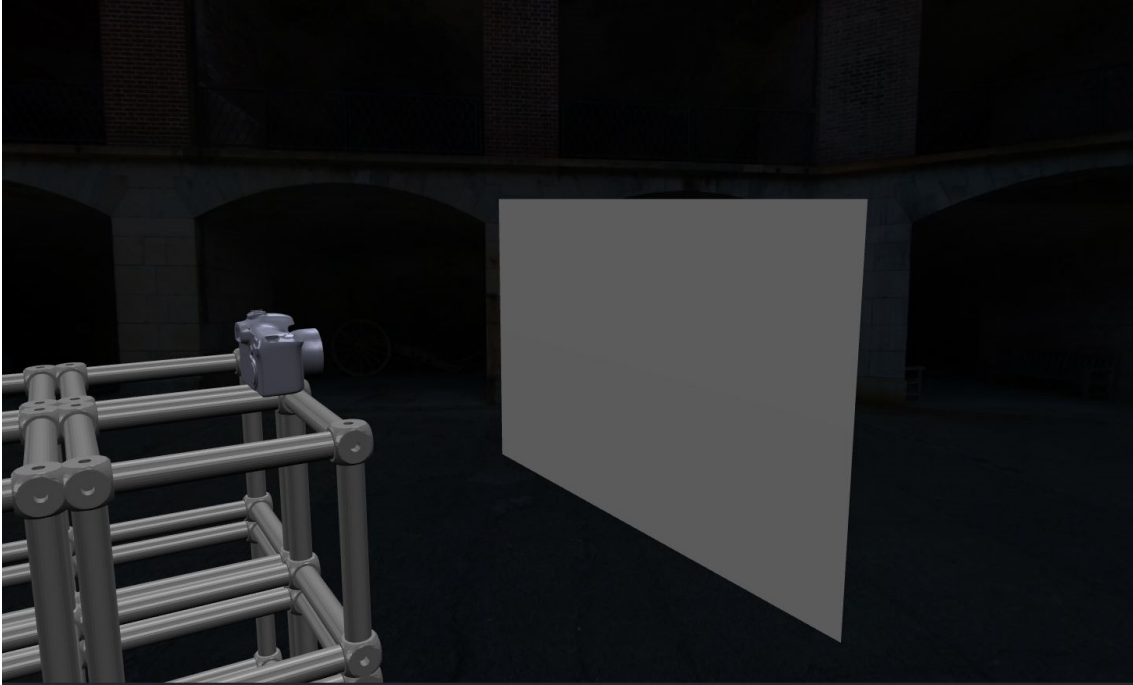
There are several possibilities on how to retrieve the camera FOV. One is to use the camera (lens) technical sheet. But, Calibration PRO offers functionality on how to calibrate the cameras or get the camera FOV without calibration.

The simplest method is to calibrate the camera using the provided calibration pattern. Open Calibration PRO Camera manager and select “Calibrate Live camera”. Select the camera to be calibrated and press on Calibrate button. After a few seconds the software will take several camera images with the moving calibration pattern and at the end it will show the camera FOV.

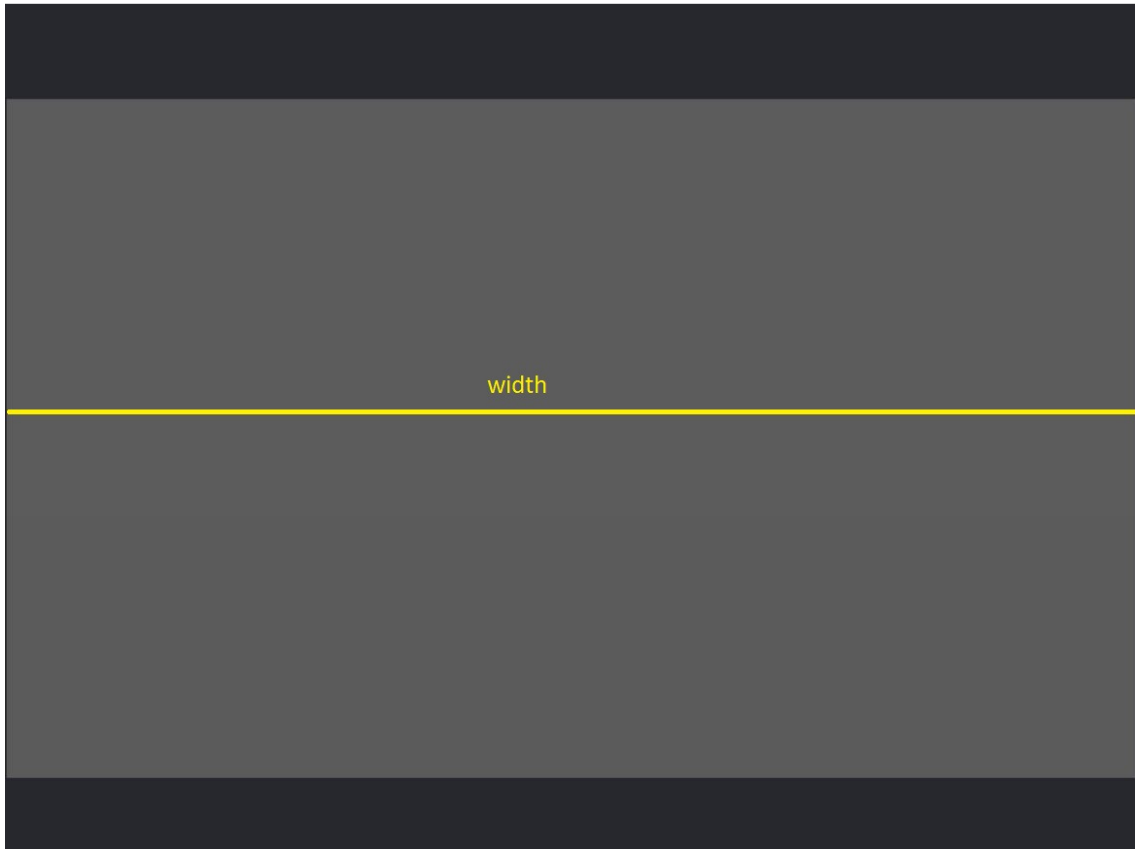


The second method involves estimating the camera FOV based on the known width of an object visible on the complete camera view and the distance of the camera from the object.

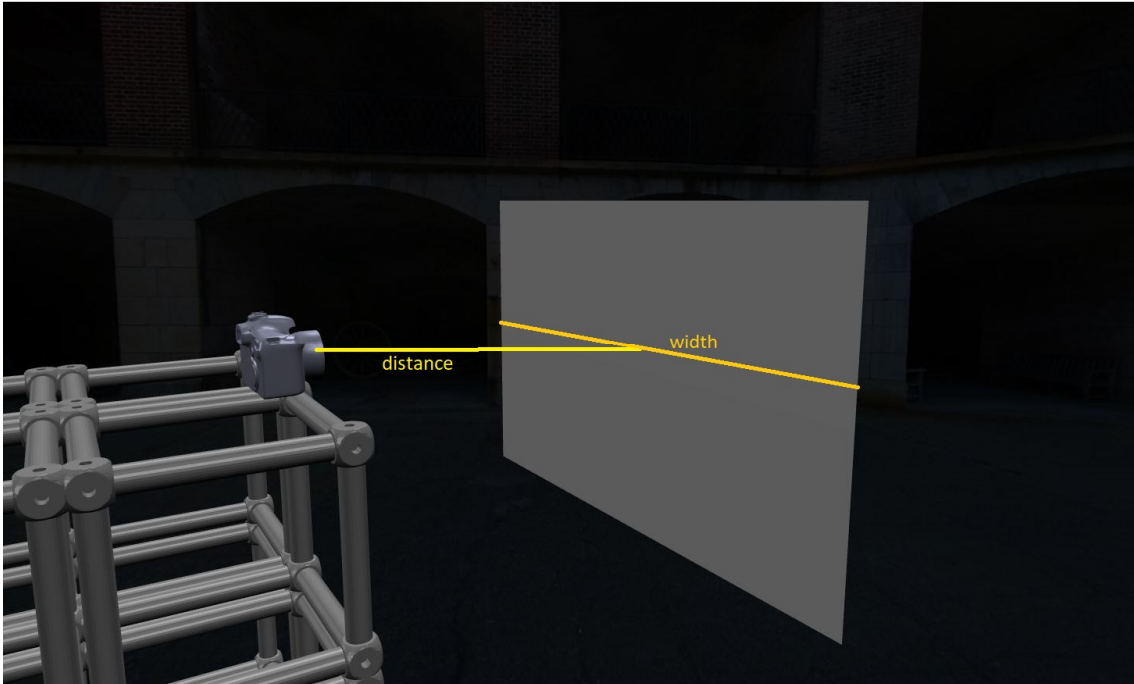
Position the camera on a stable surface. Create a rigid object, measure the object width and place the object in front of the camera.



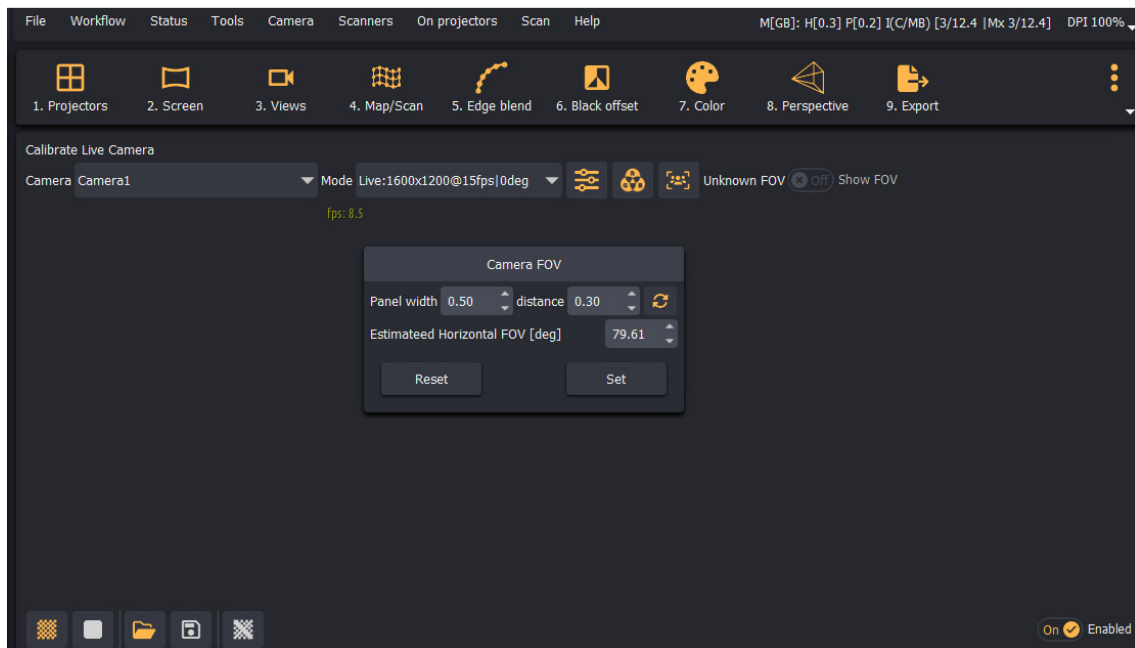
In this case we will use a 0.5 meters wide hard carton surface.
Use the camera viewfinder and move the object until the object horizontally fits in the camera view.



Now measure the perpendicular distance from the camera lens to the object and use the measured data in Calibration PRO camera manager to estimate the camera FOV.



Open the Calibration PRO camera manager, select the camera and press the Estimate FOV button.

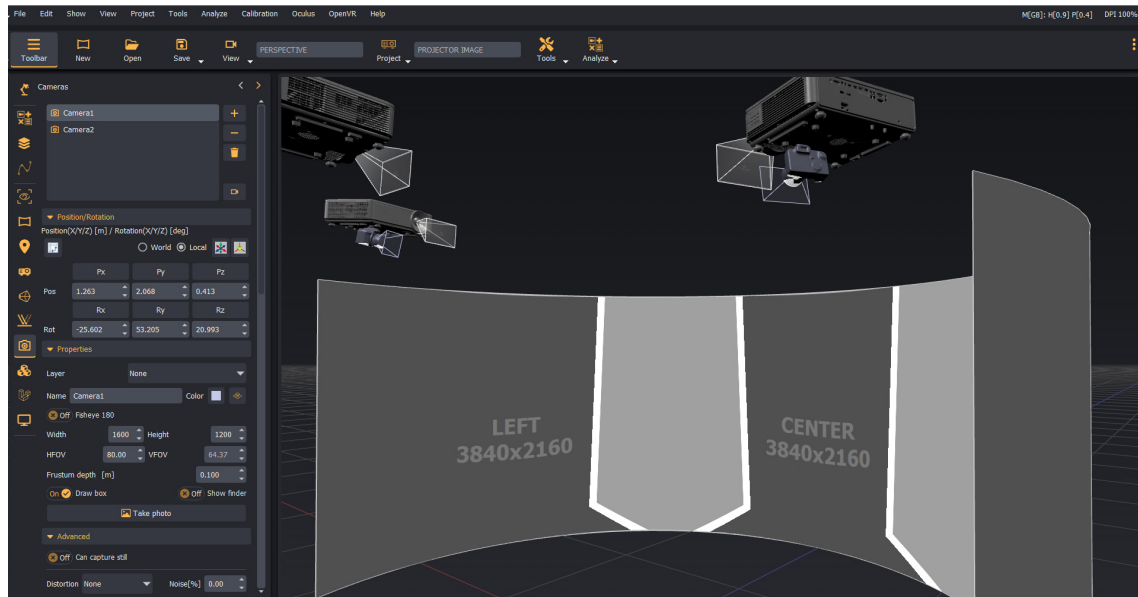


Enter the measured panel width and the measured distance from the camera lens and the software will calculate the camera horizontal FOV. In our case, the estimated wide camera lens has a horizontal FOV of 80 degrees.

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This is all. Now we have all the information to accurately design the camera position and match the real cameras position with the designed camera positions.

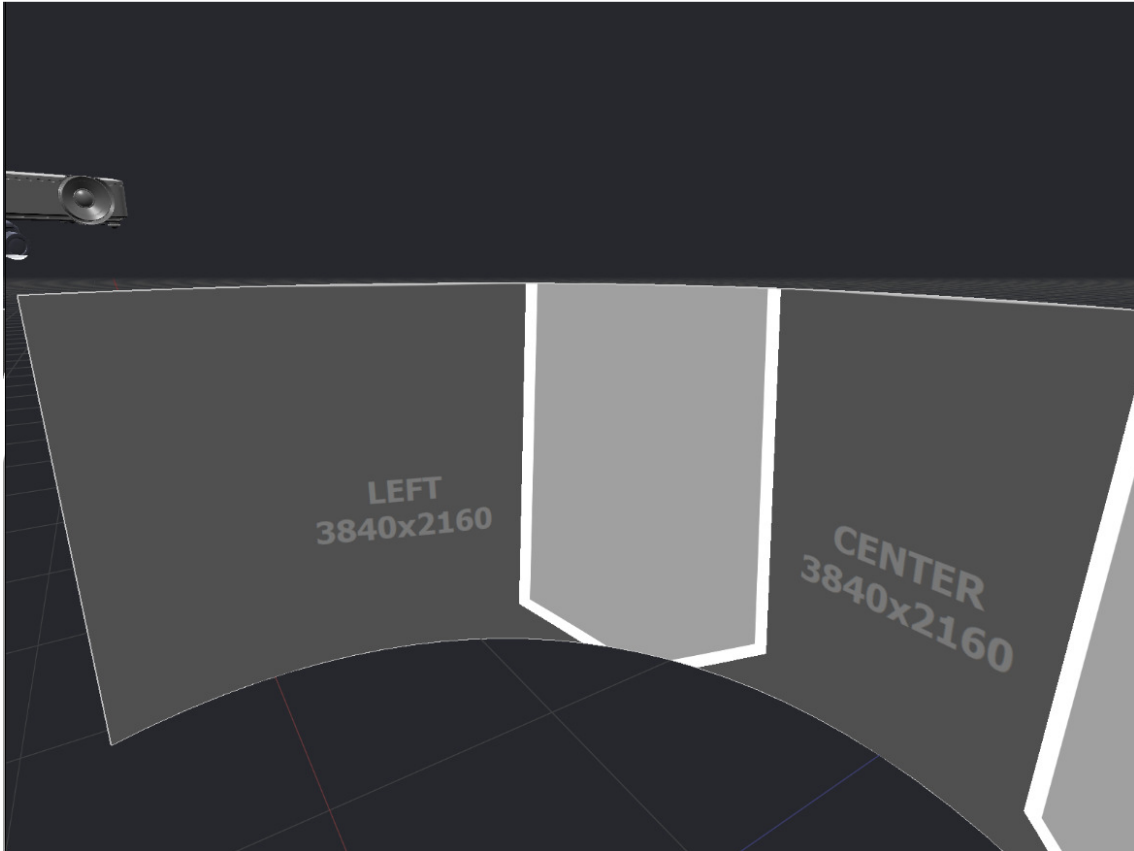
Using the previous 3x1 design, open Designer PRO, add 3 cameras, configure the camera FOV to the measured 80 degrees and position both cases just below the first and the 3rd projector.



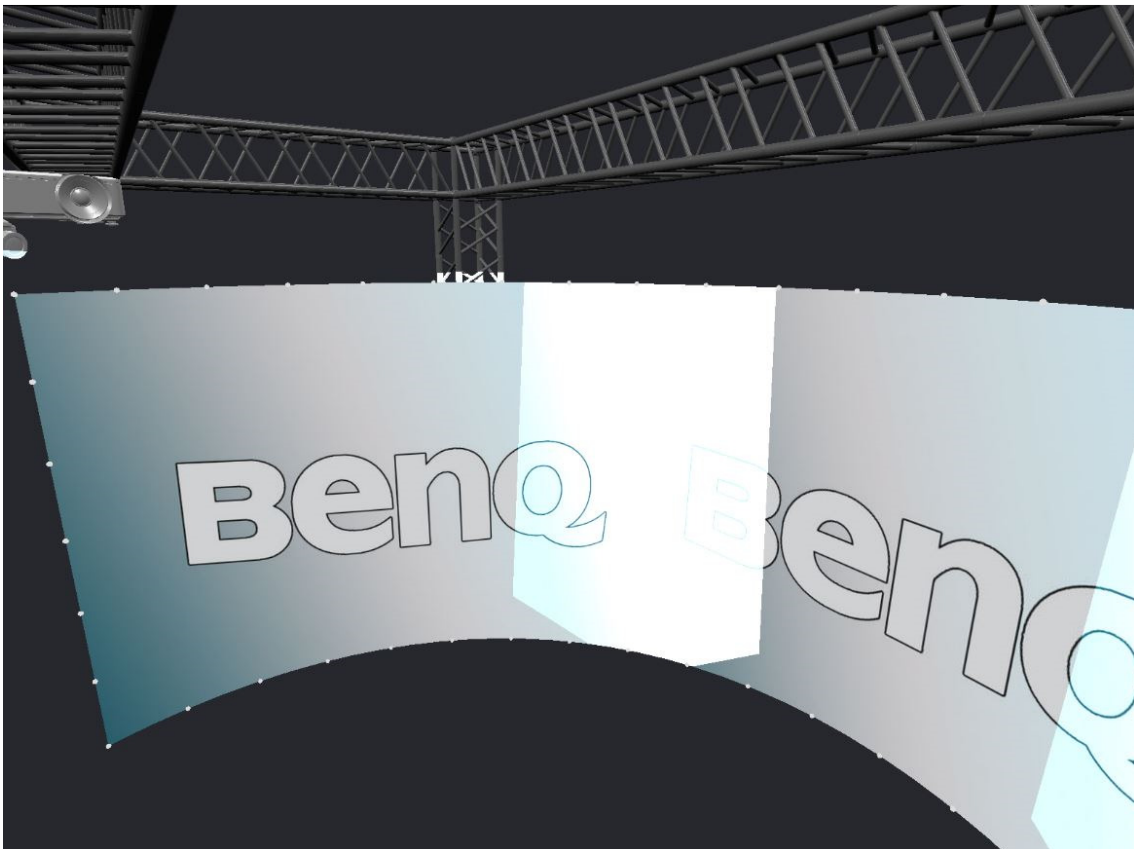
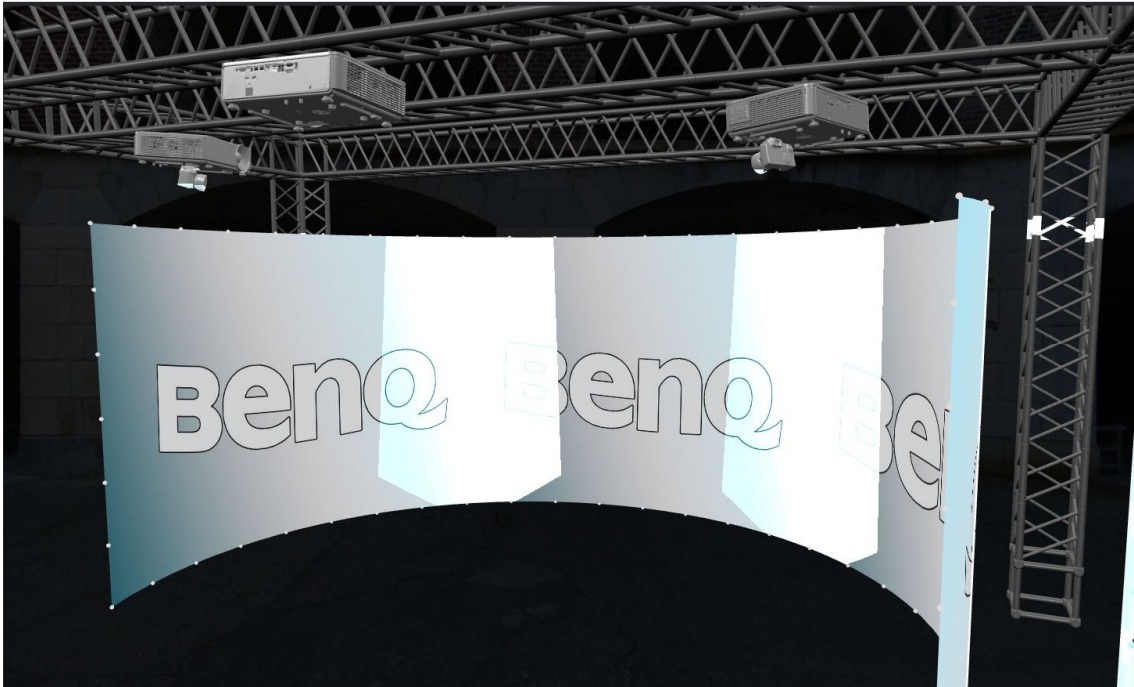
The cameras can capture 2 projectors on the projectors screen.

Now is the time to position the real cameras on the real projection system. For this purpose, we will use the camera view in Designer PRO and the real camera view and will match them as good as possible.

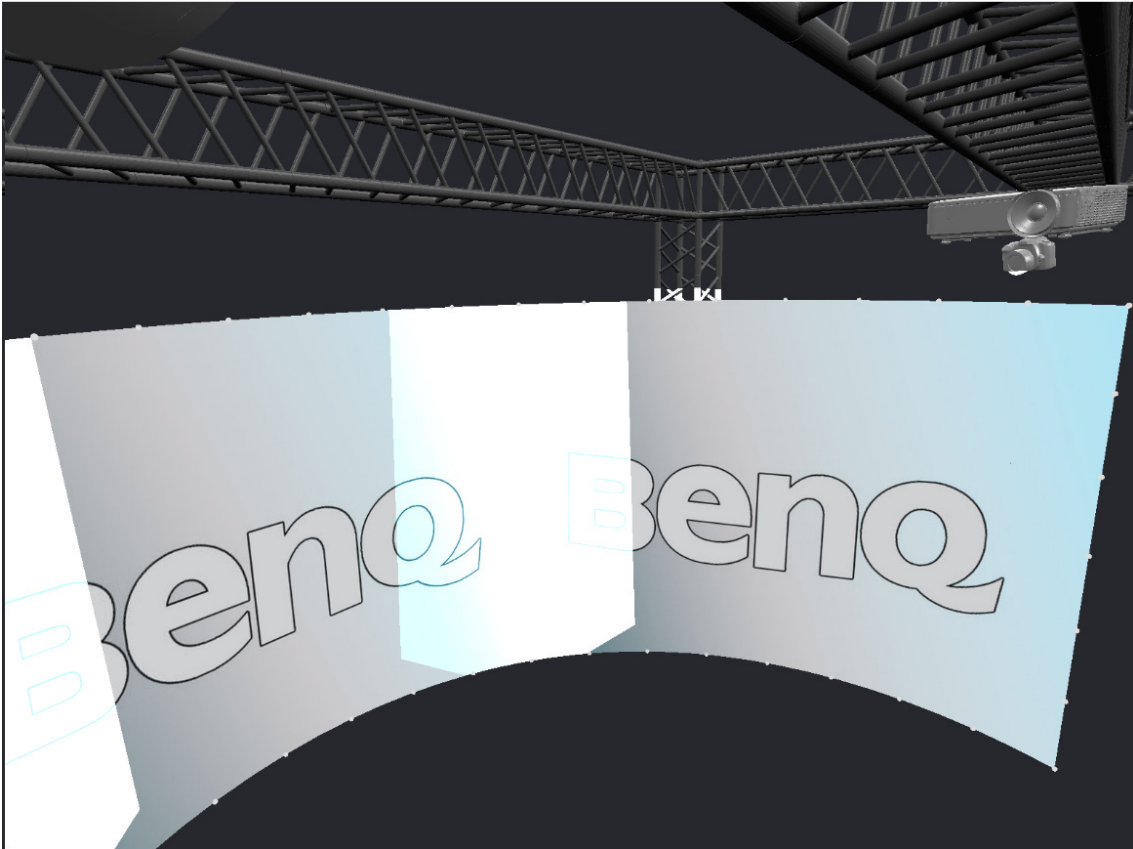
Open Immersive Designer PRO and select the View/Cameras/Camera1 option. This will show the viewfinder image of the first camera.



Open Immersive Calibration PRO Camera Manager, select the first camera and looking on the camera image position and orient the camera to match the image of the camera with the image from Designer PRO.



Repeat the same for Camera2



Now we have an accurate match of the designed projectors and camera setup in Designer PRO and the real projectors and camera setup.

From the File/Export menu select Export to Calibration Interoperability => Map to camera. This will export the .interop data that can be used in Calibration PRO to preconfigure the auto-alignment software.

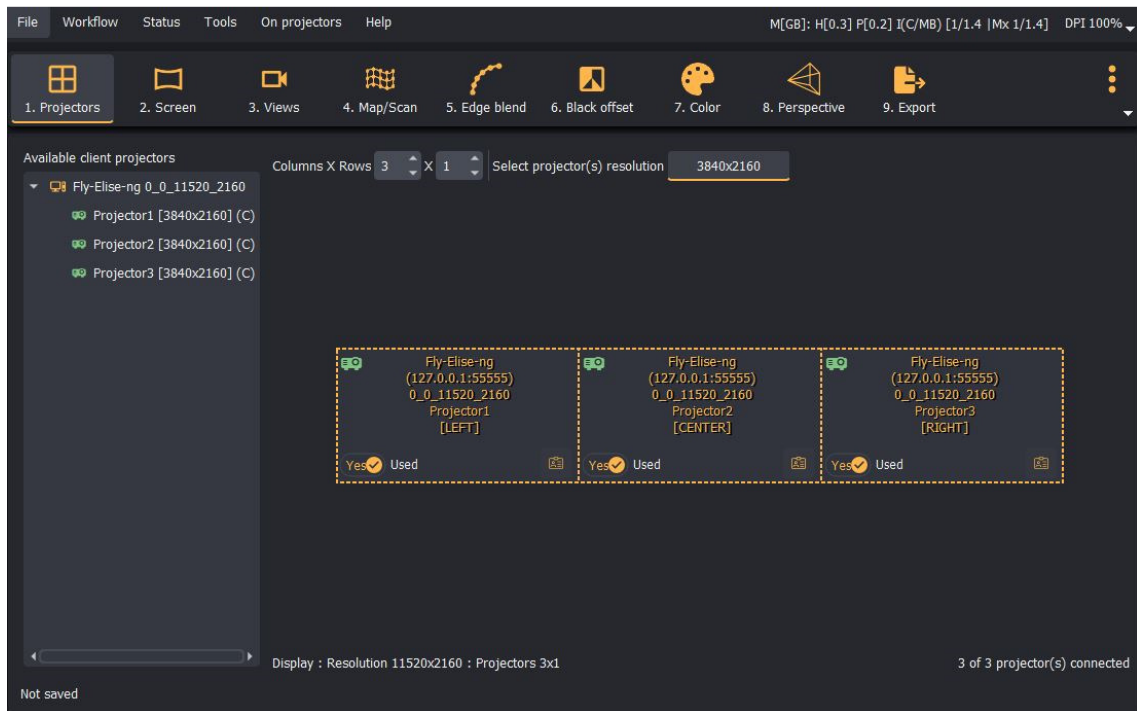
After this step, we are done with Designer PRO and can continue with Immersive Calibration PRO auto-alignment steps.

On the PC connected to the projectors, start the Calibration PRO client and configure the projection setup per display. Check the Calibration PRO user manual.

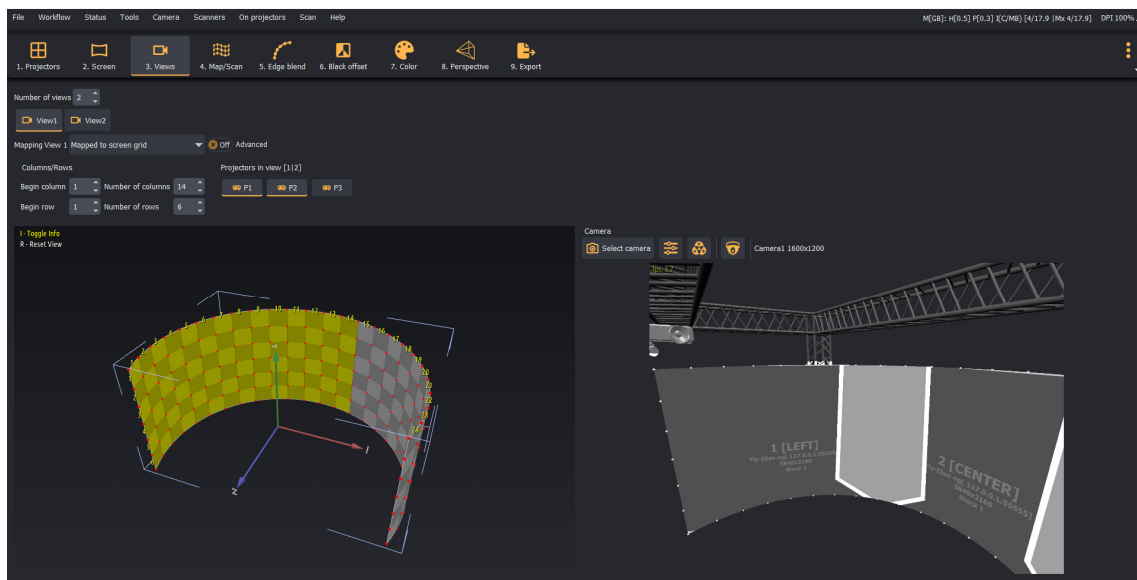
On a separate PC or laptop Start Calibration PRO server and press the Import button to load the exported .interop file.

In the projectors section, double click on a projector to connect to the Calibration PRO client projector.

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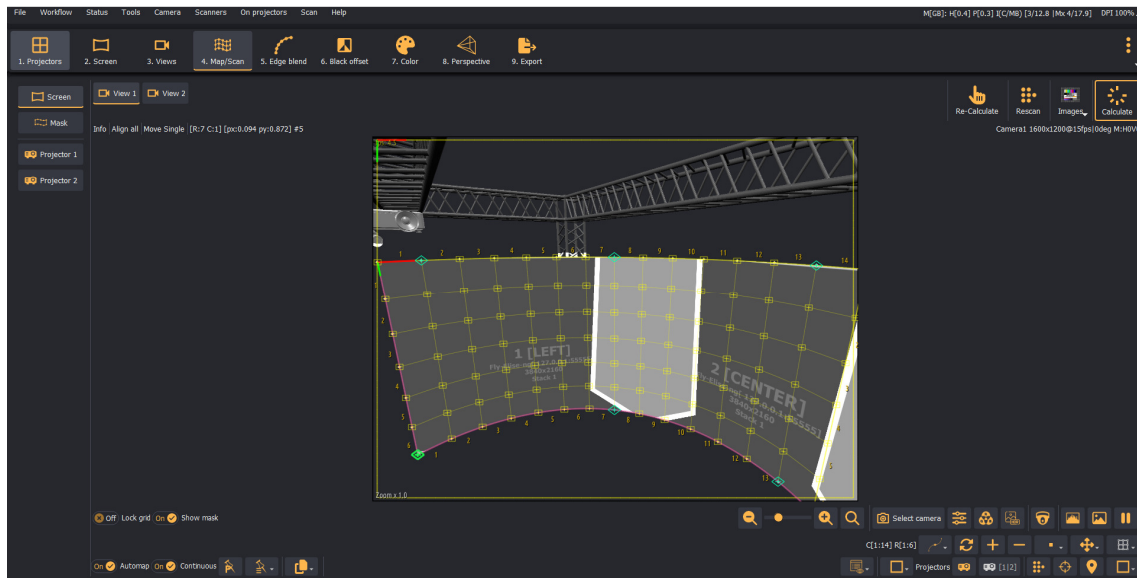


In the Views section, the camera views are already mapped to the screen and projectors according to the data from Designer PRO.

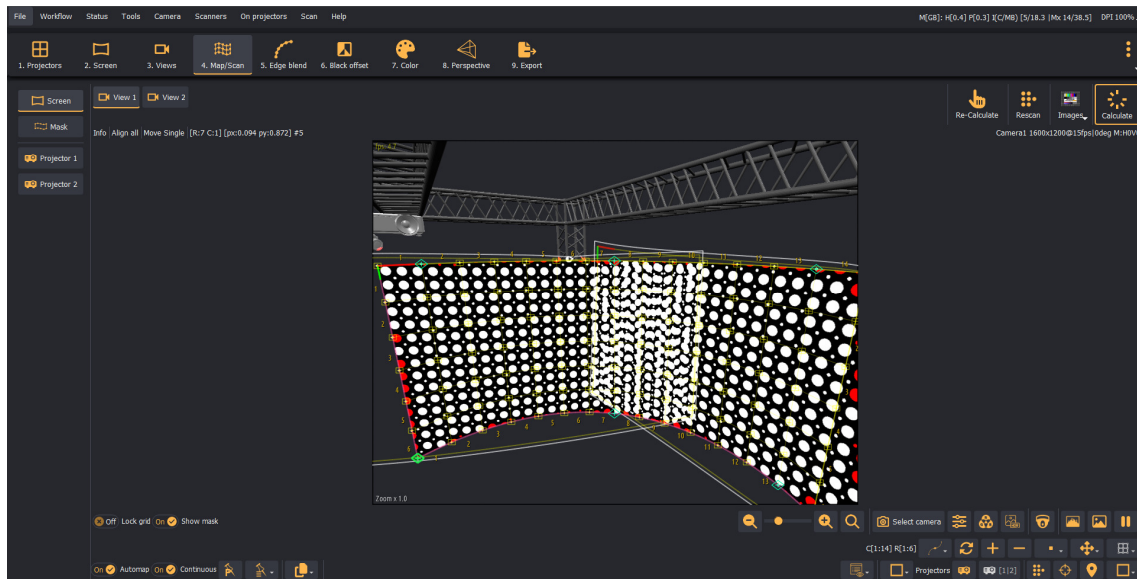


If needed adjust the camera view grid reference points and remap the camera grid in each camera view.

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After that scan the projectors in each camera view.



That is all. Calculate the auto-alignment and edge blending, export the .procalib files and import the .procalib files in Immersive Display PRO or Immersive Player PRO.

