

360 video

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Agenda

Examples from authors projects

Image projections

(Perspective - Fisheye - Cylindrical panorama - Cube maps - Equirectangular panorama)

Camera summary

(One - Two - More than two)

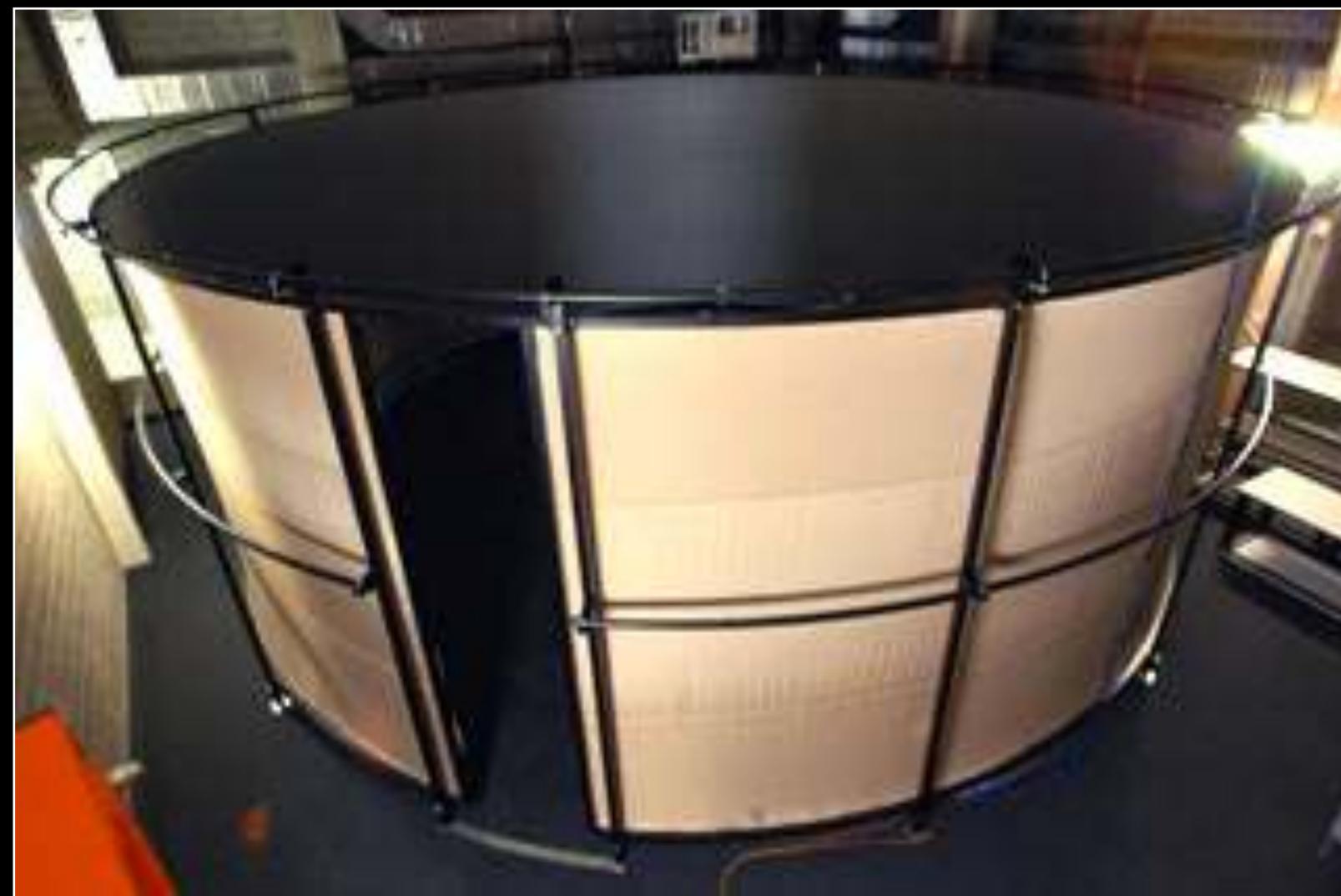
The fundamental problem
(Parallax)

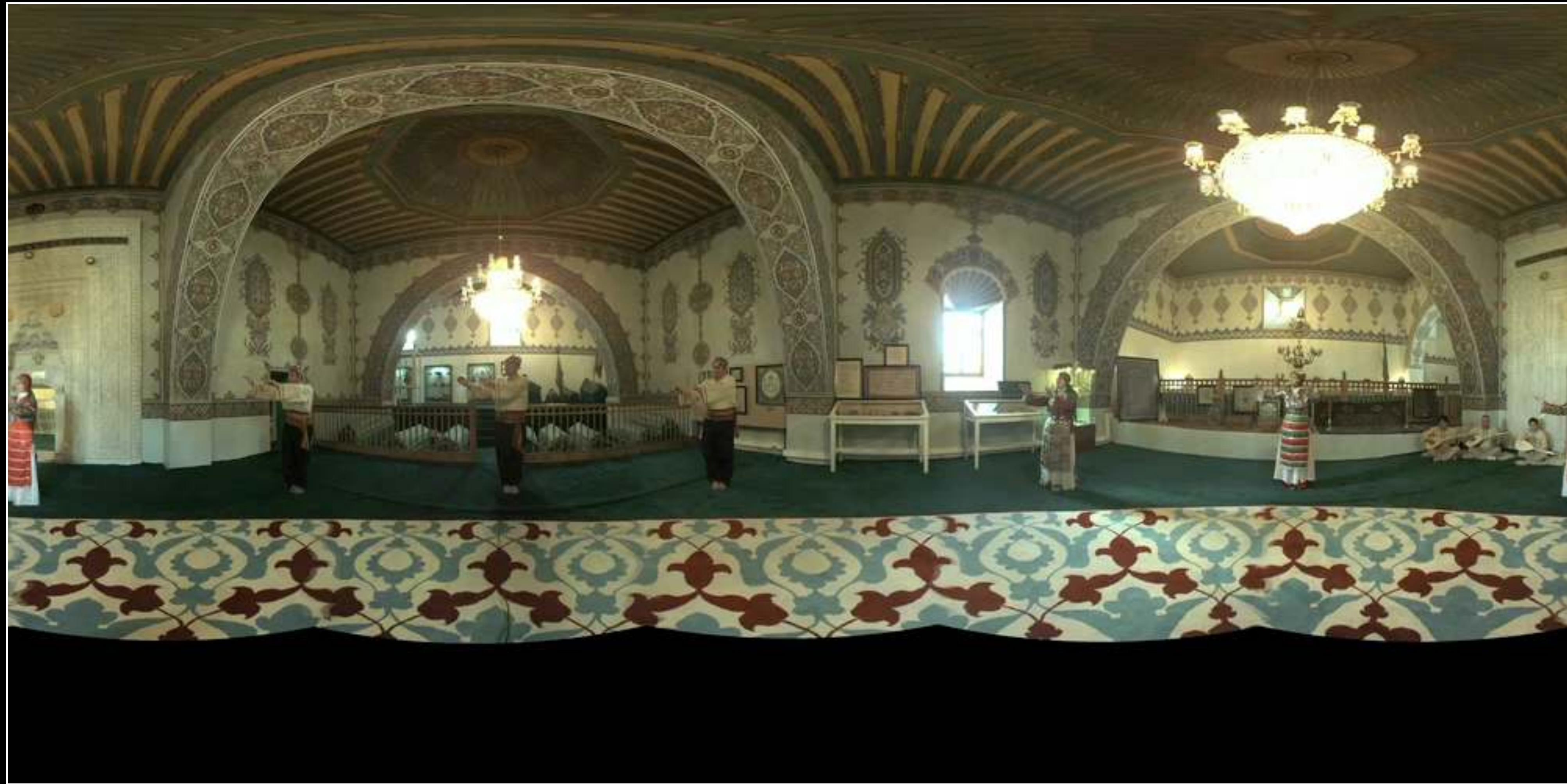
Solutions to the fundamental problem
(Mirrors - Optics - Optical flow)

Miscellaneous topics

Examples

iCinema





Hashibektashi, Turkiye



Whirling Dervish, Turkiye



Jiao festival, Hong Kong



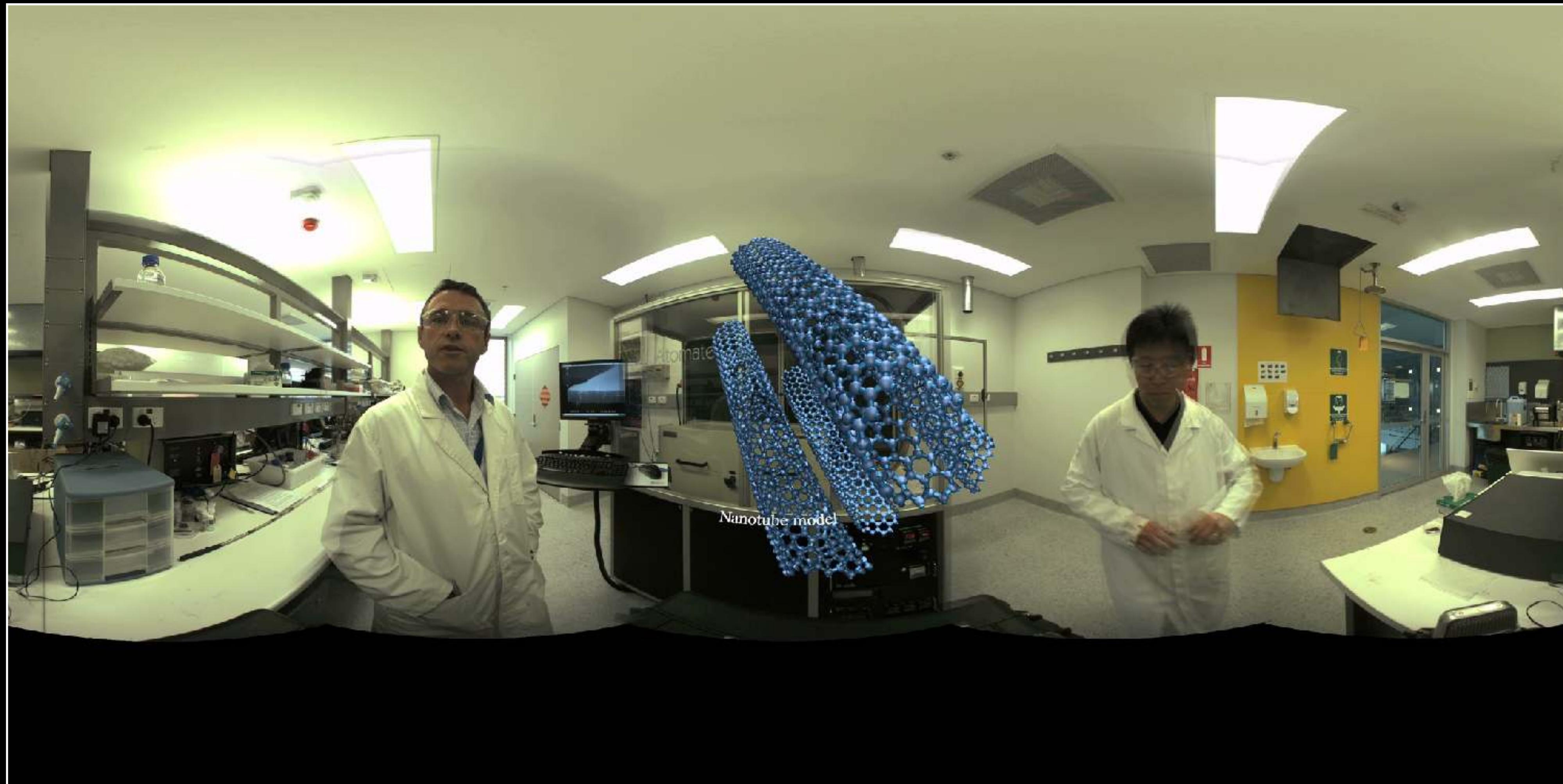
Karratha iron ore ship loader



Mah Meri, Malaysia



Endeavour replica entering Freemantle



Nanotechnology, Wollongong



Sheep shearing, Barossa valley



Pig farming in Hong Kong



Sahet-Jetavana, India

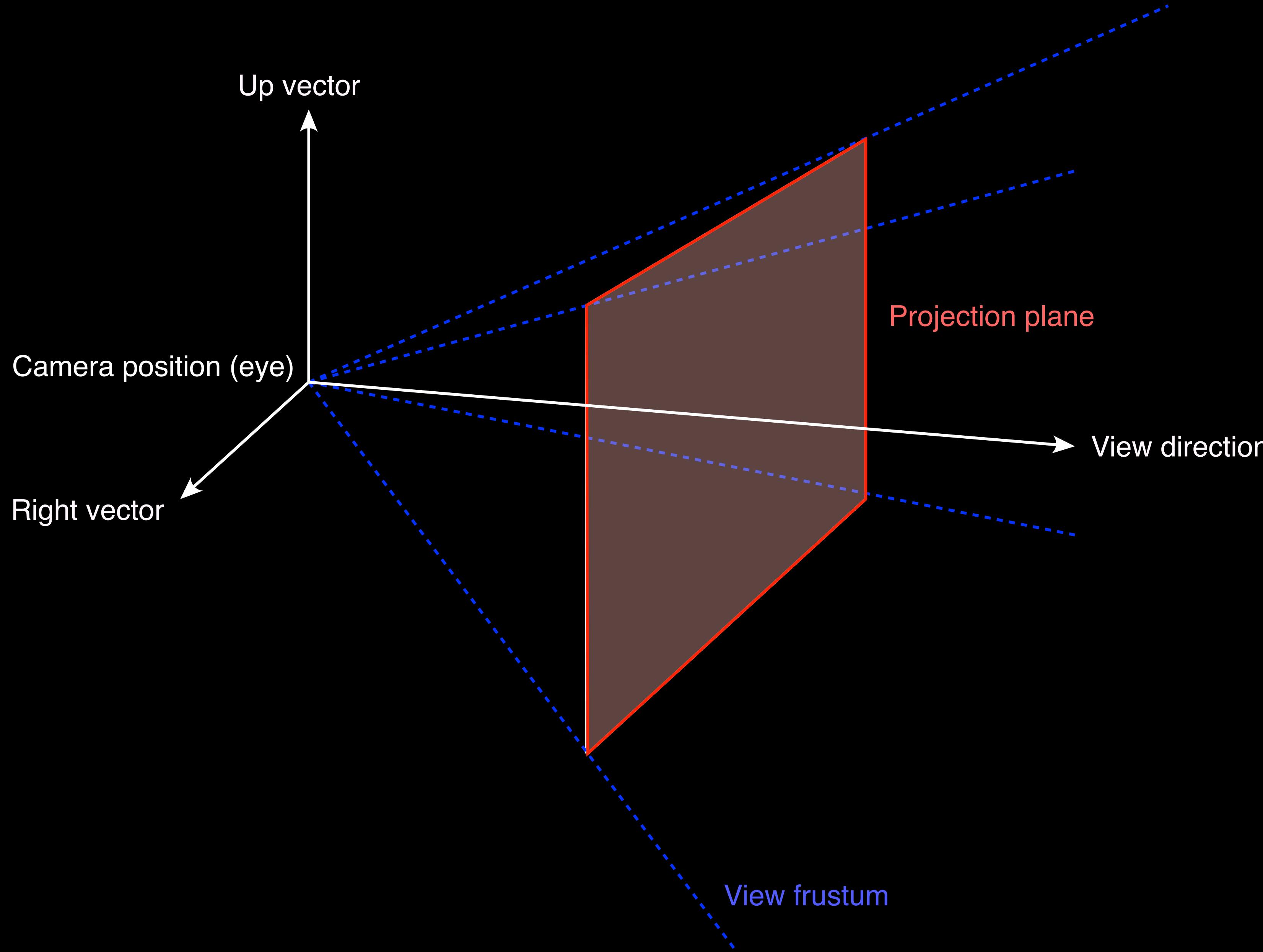


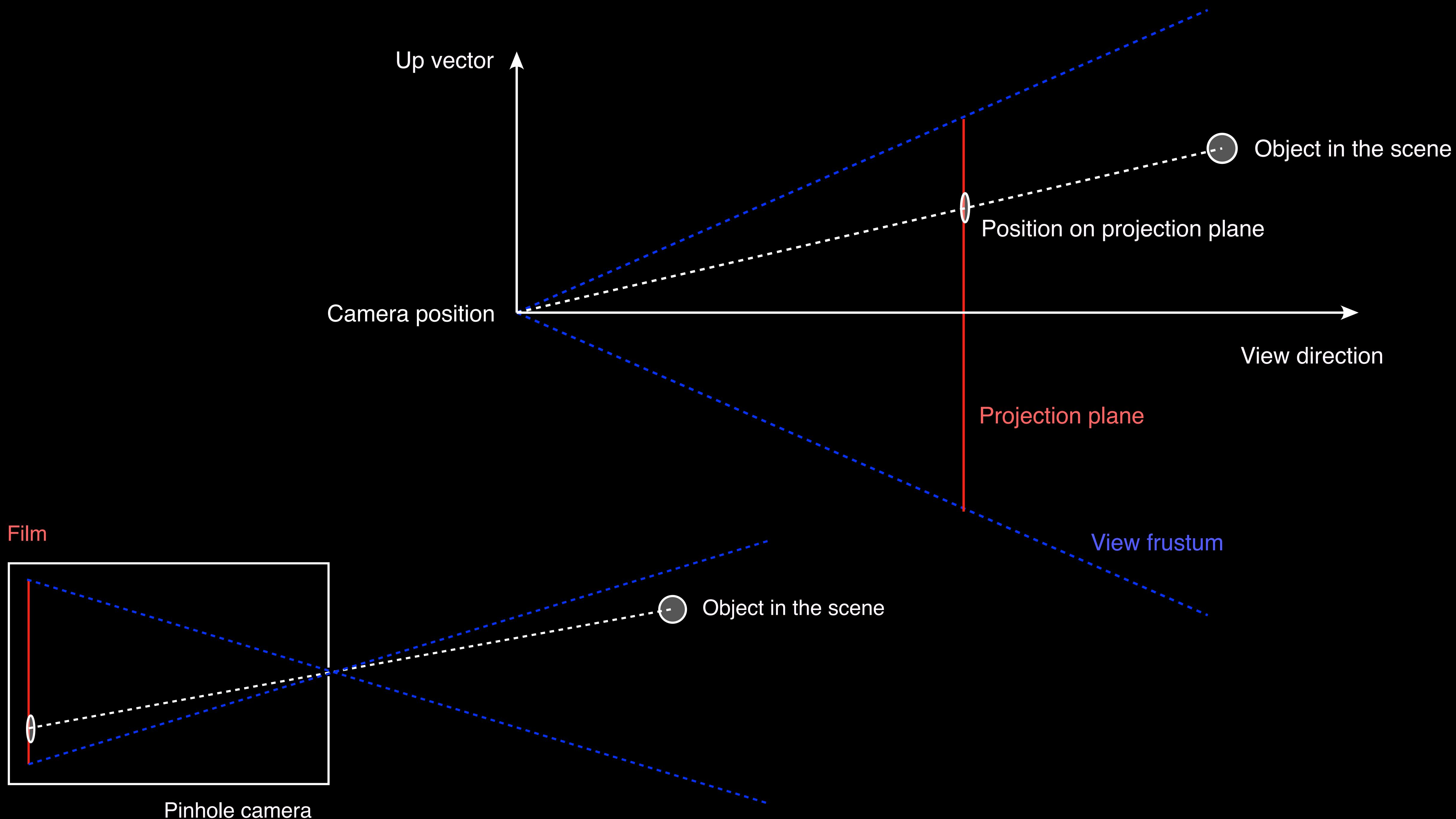
Clothing Buddha, India

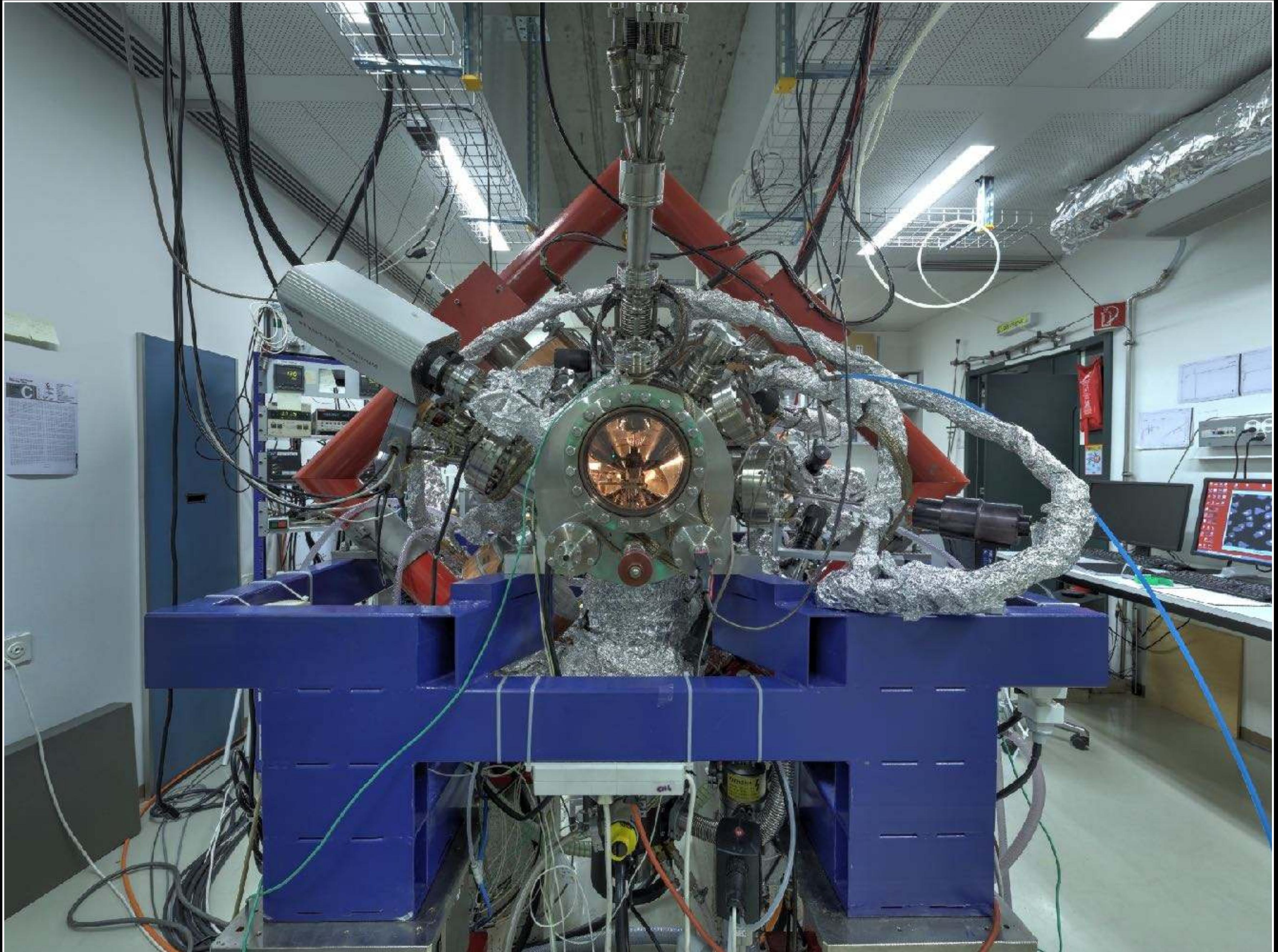


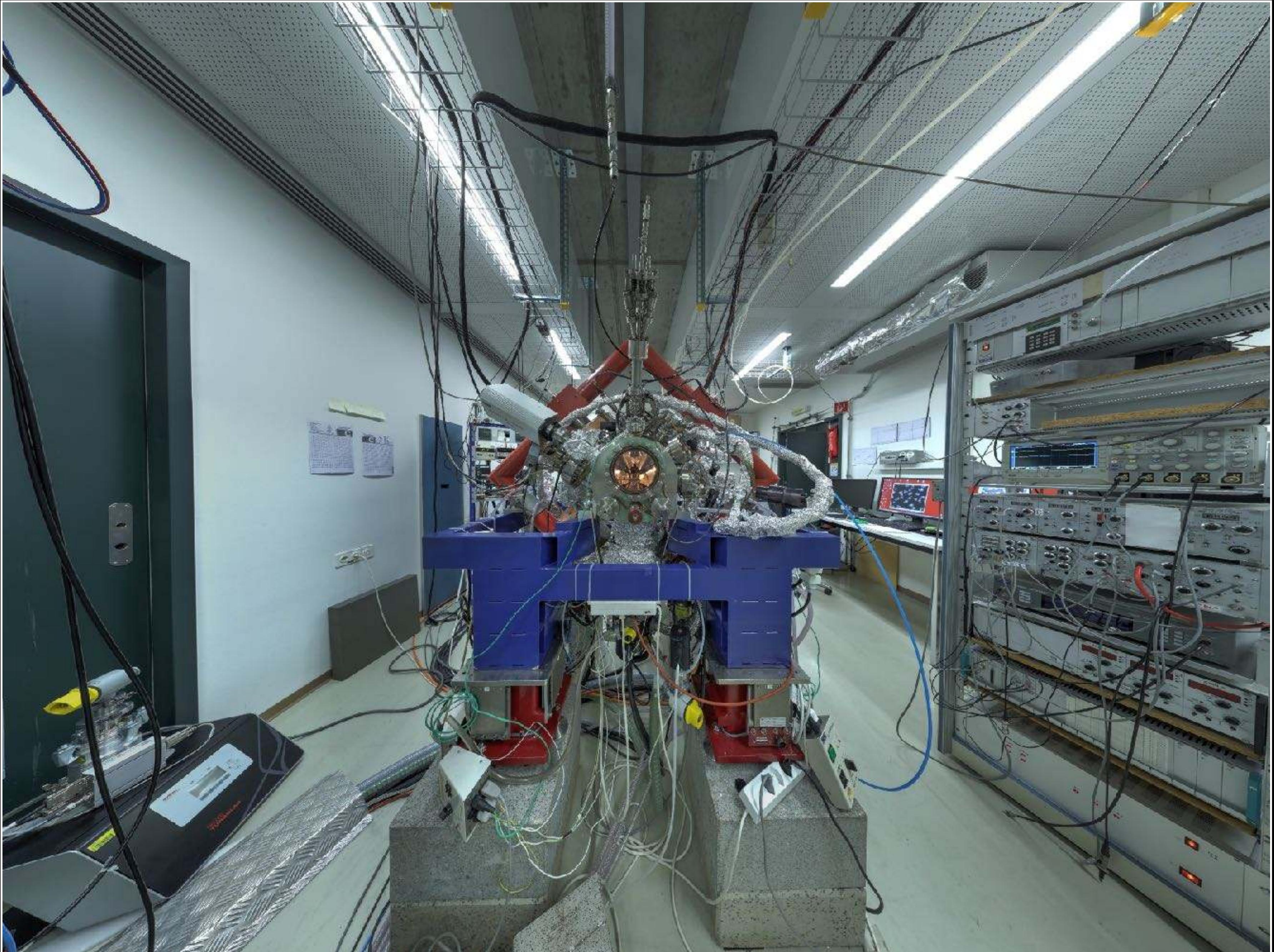
Micro and Nano Technology, EPFL, Switzerland

Image projections - Perspective









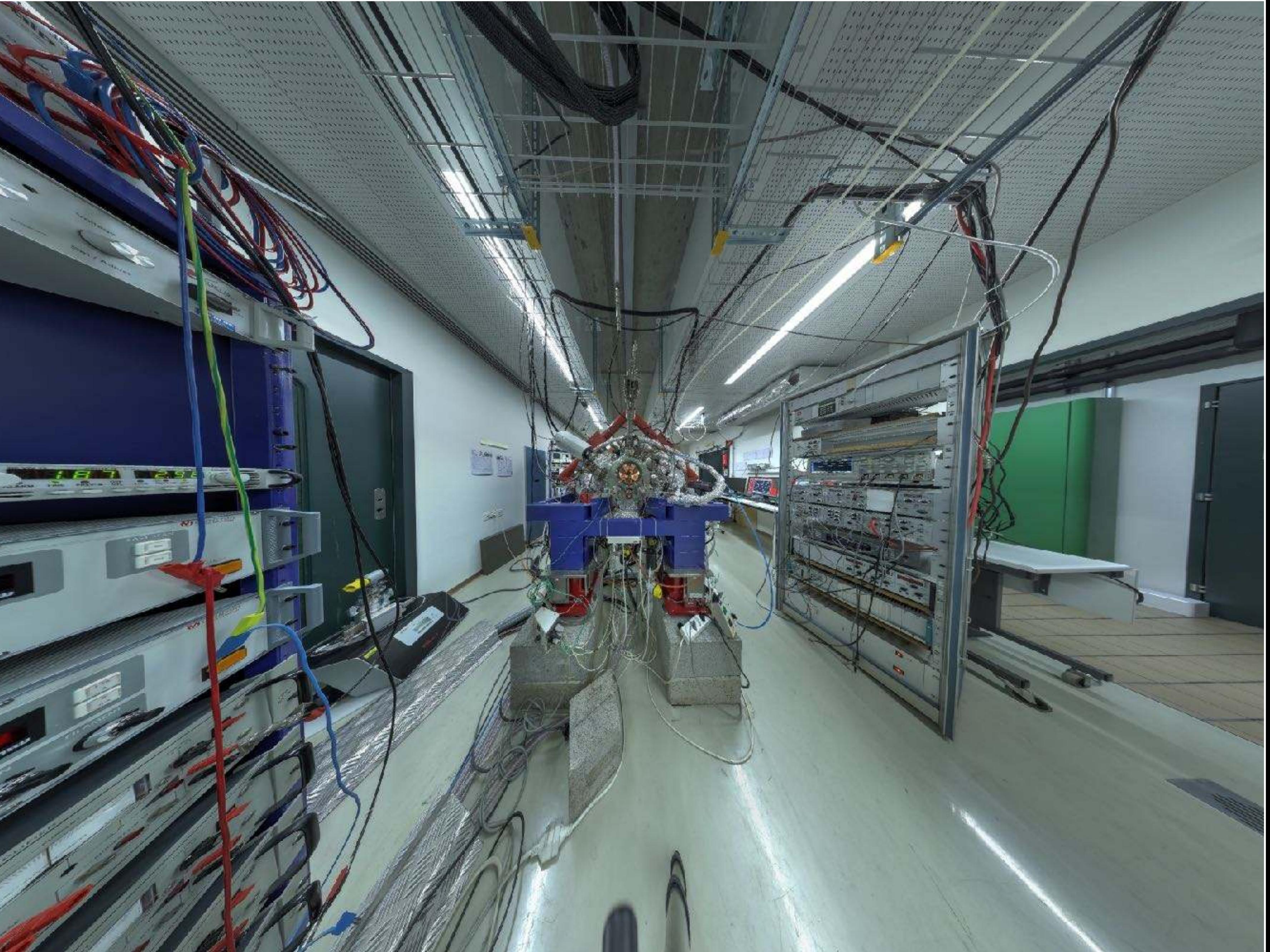
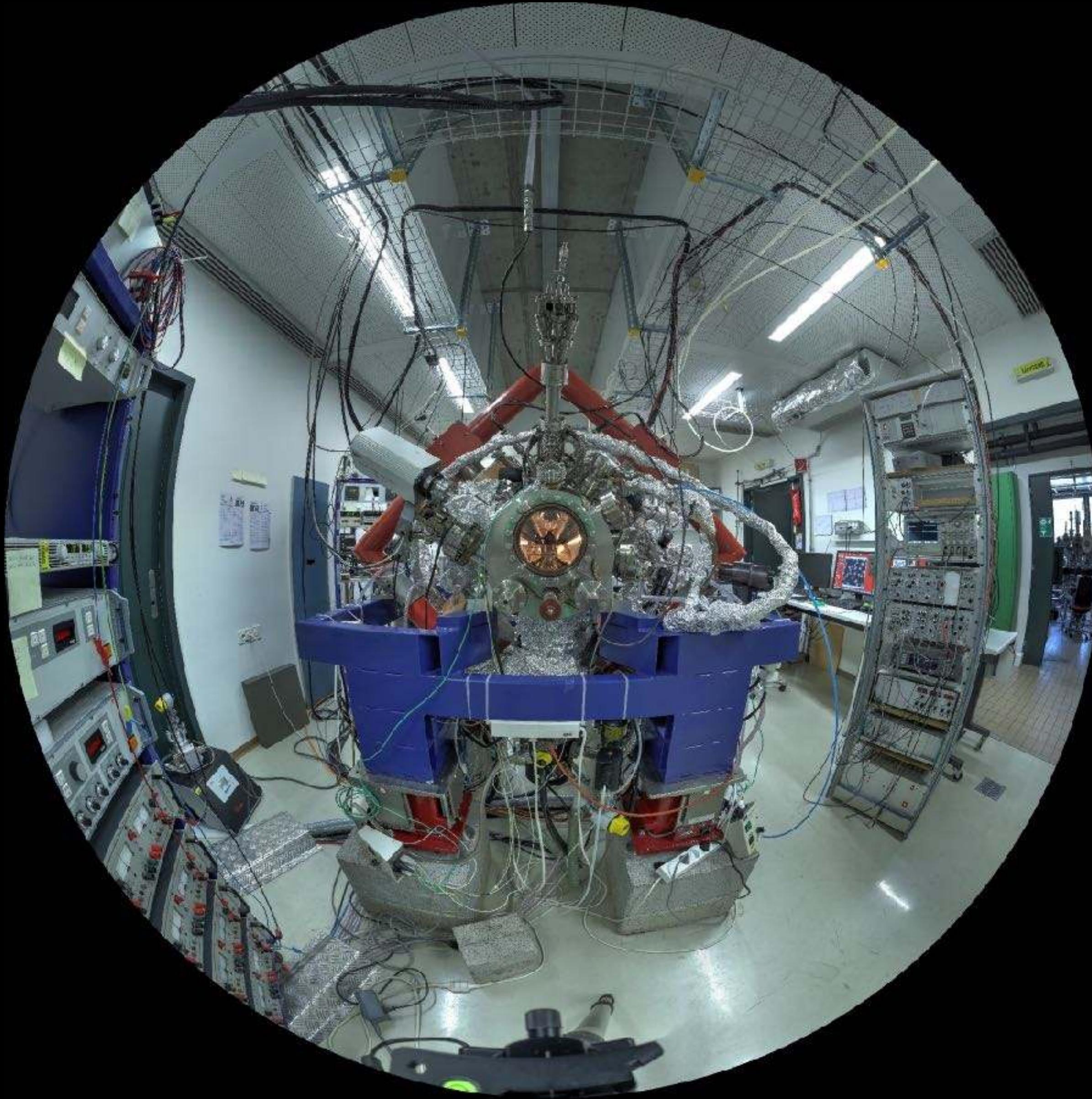
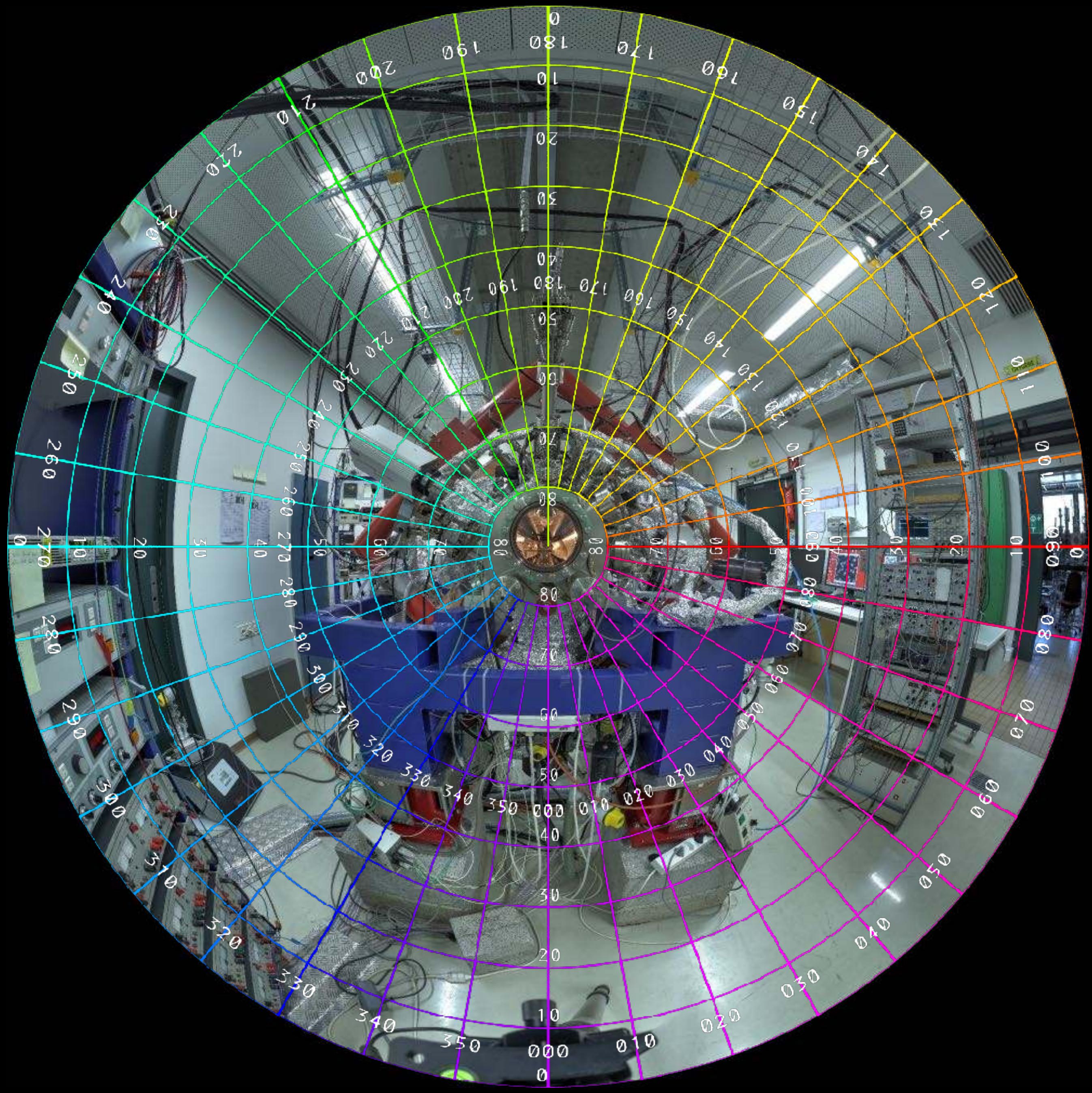


Image projections - Fisheye





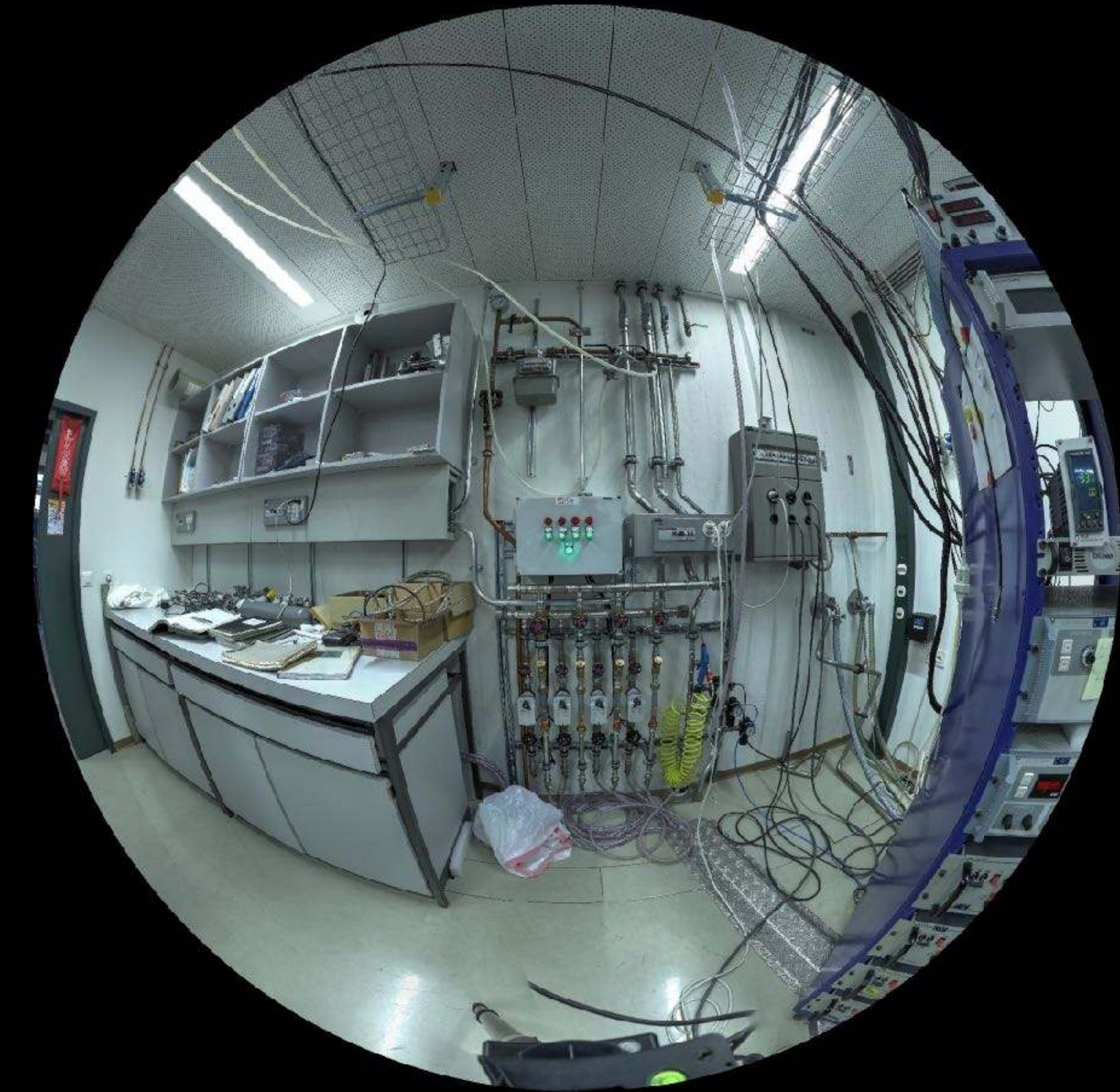
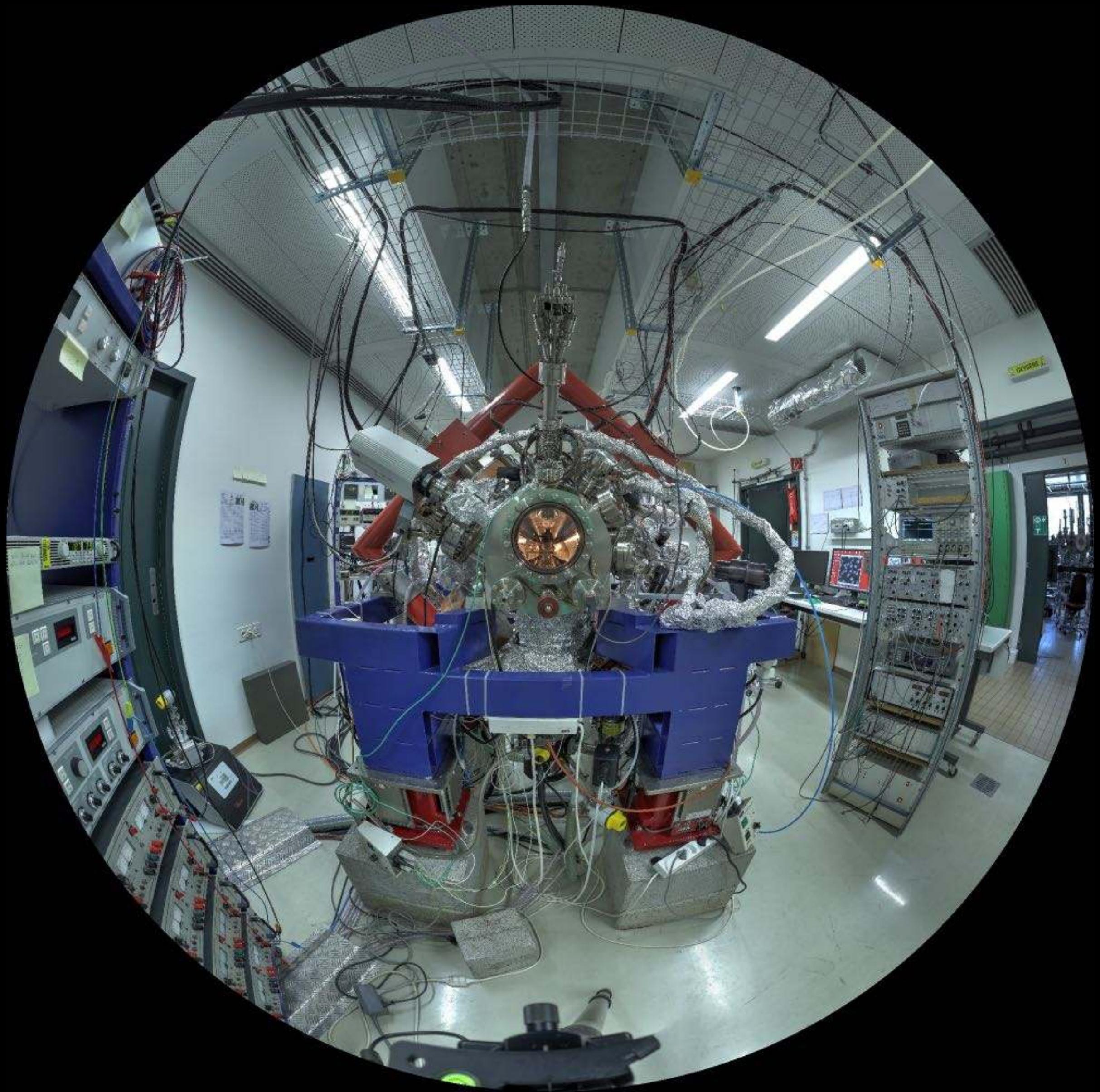
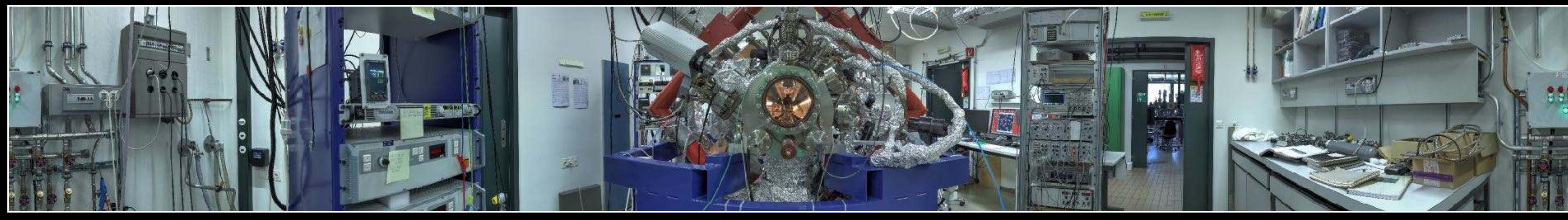
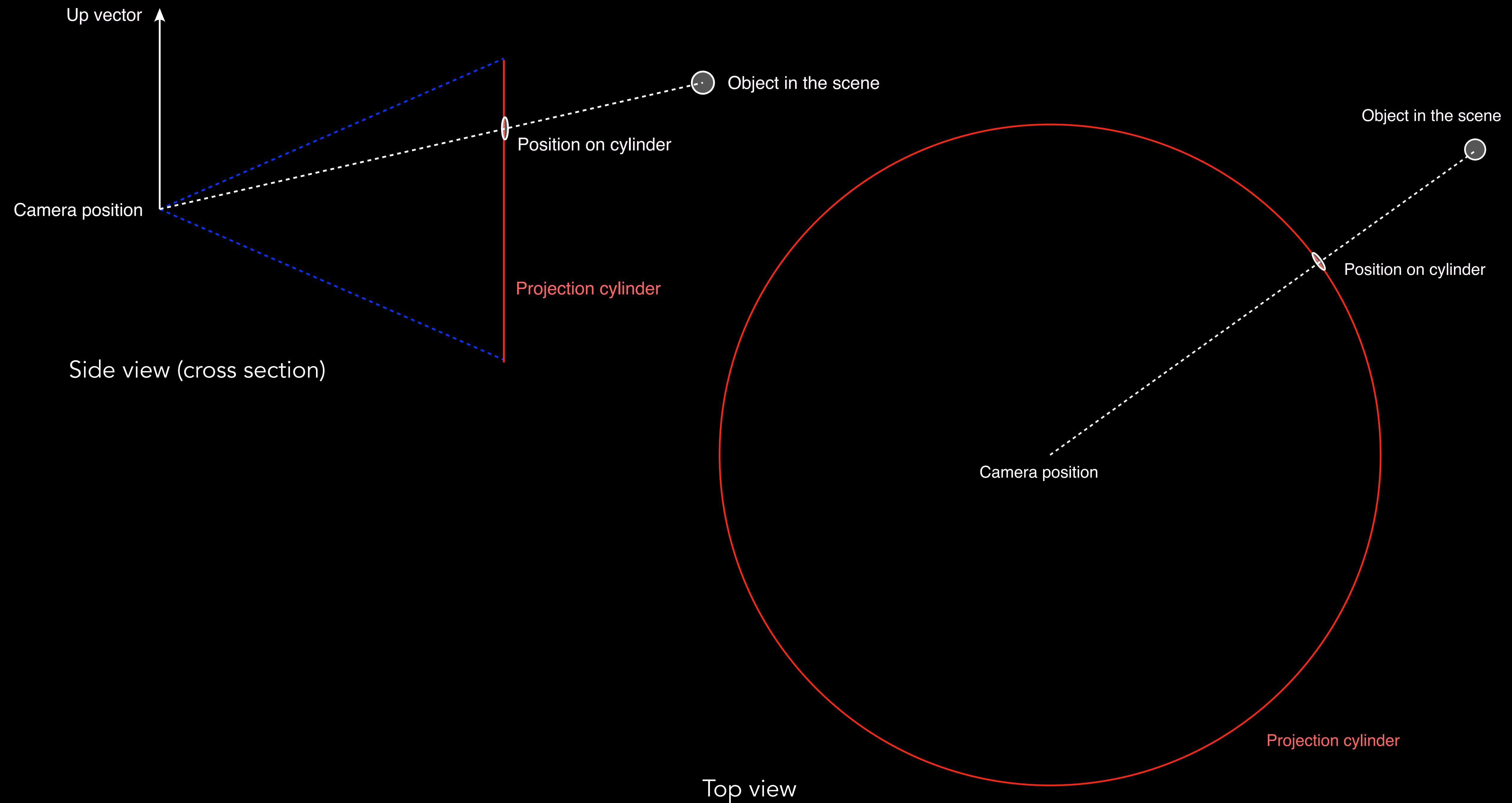


Image Projections - Cylindrical panorama



360 degrees



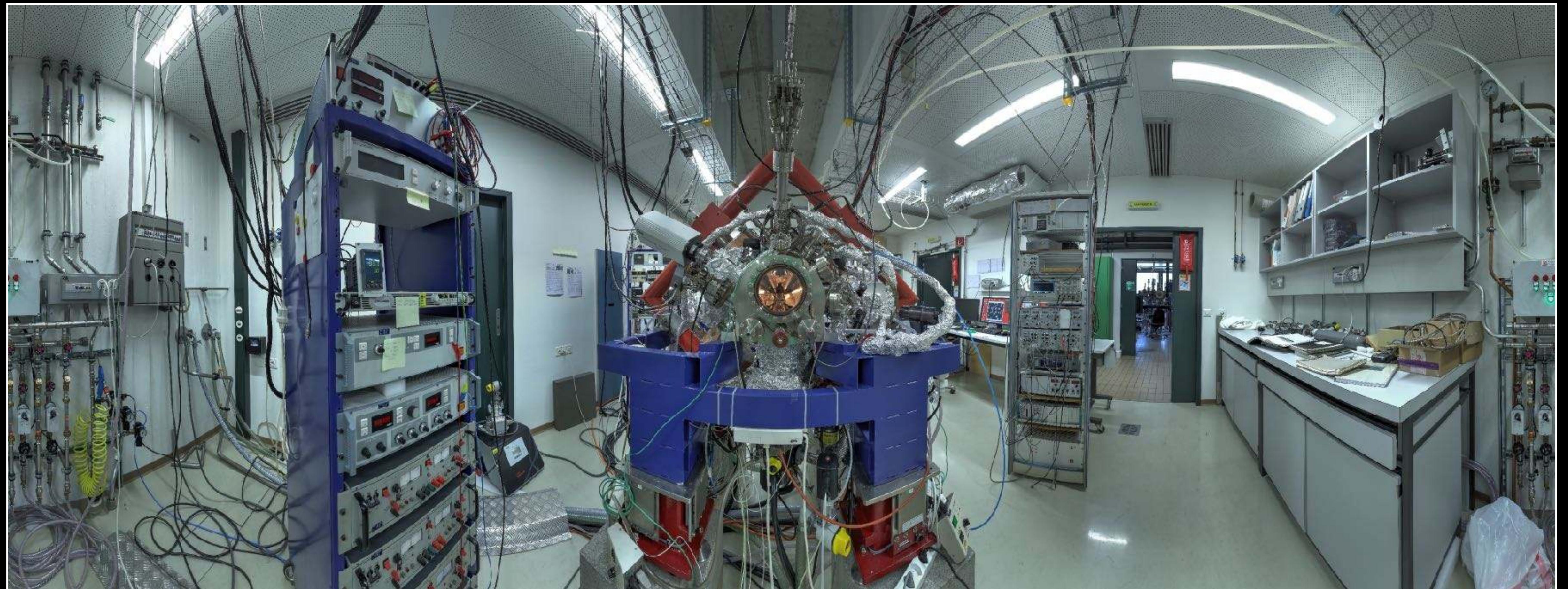
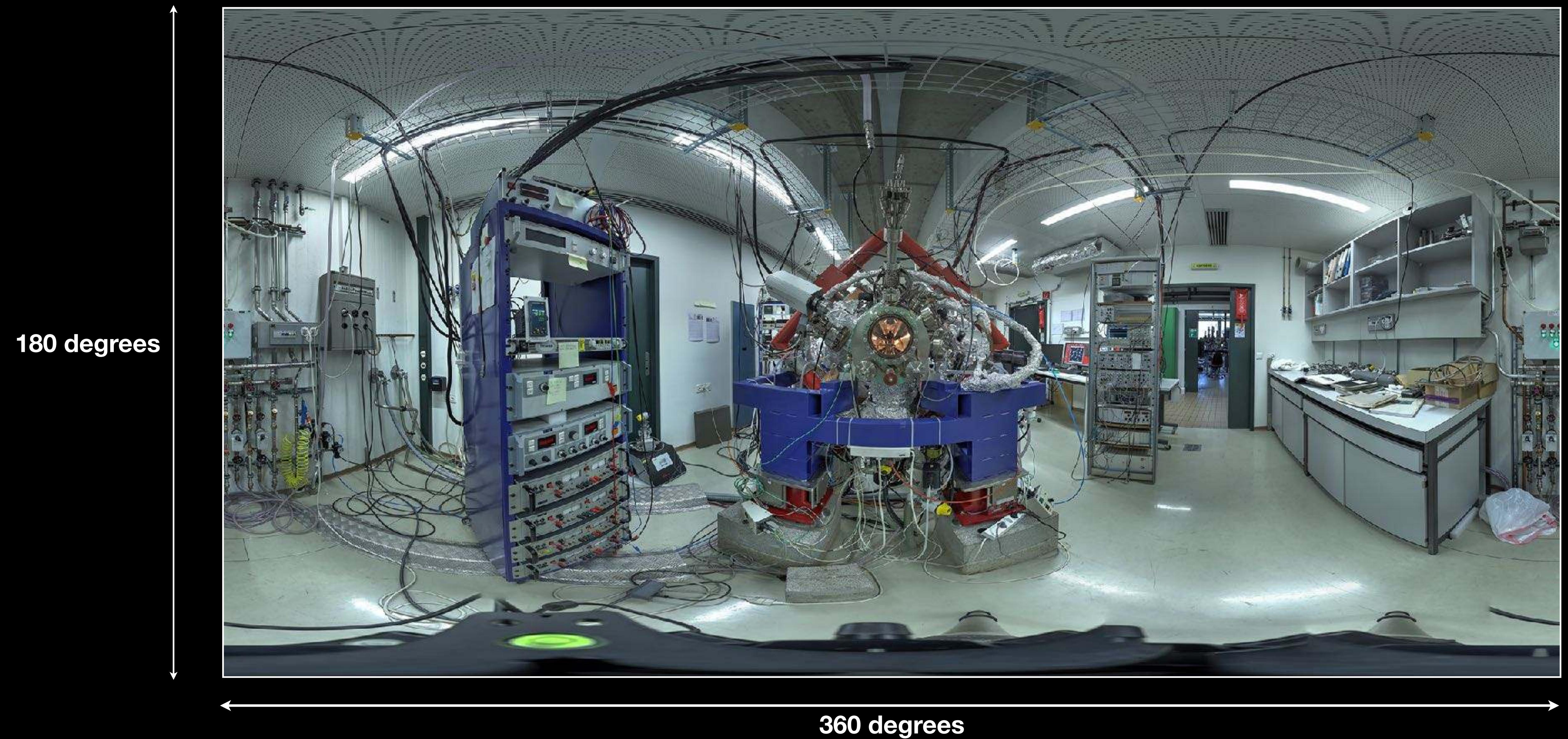




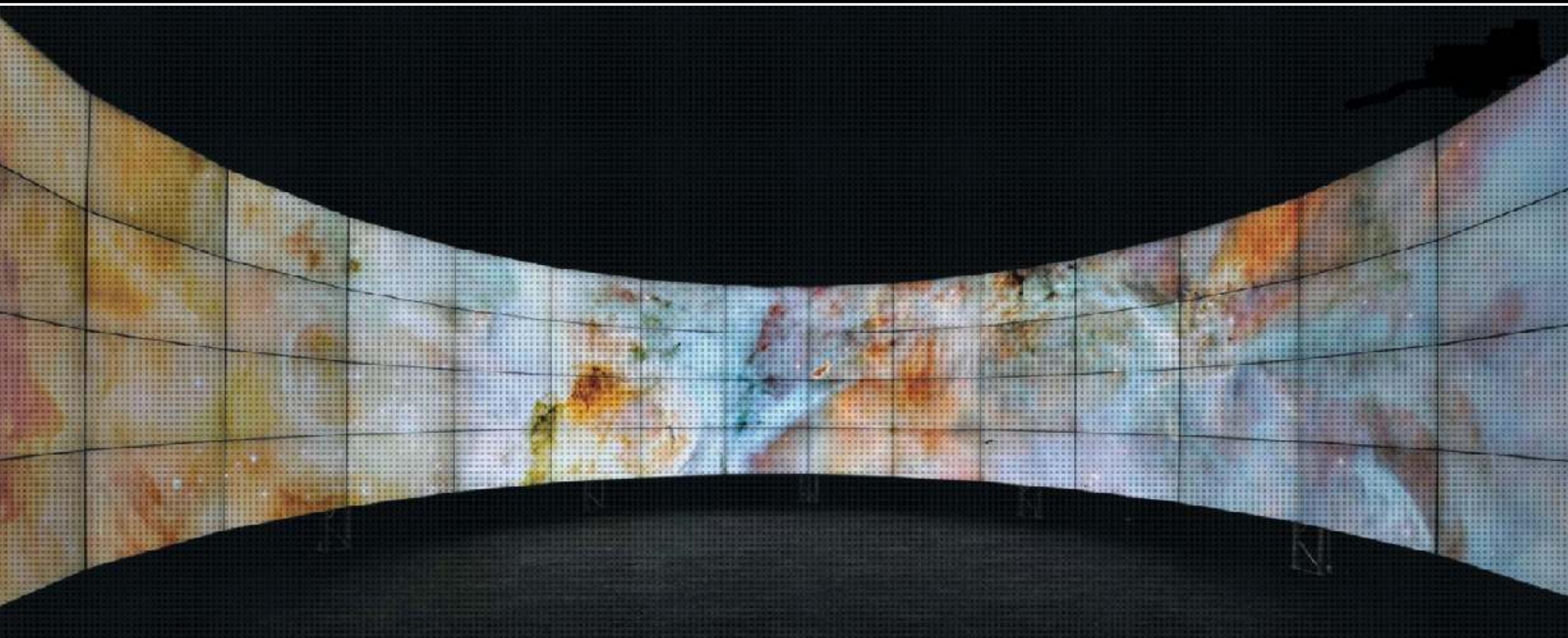
Image projections - Cubemaps



Image Projections - Equirectangular

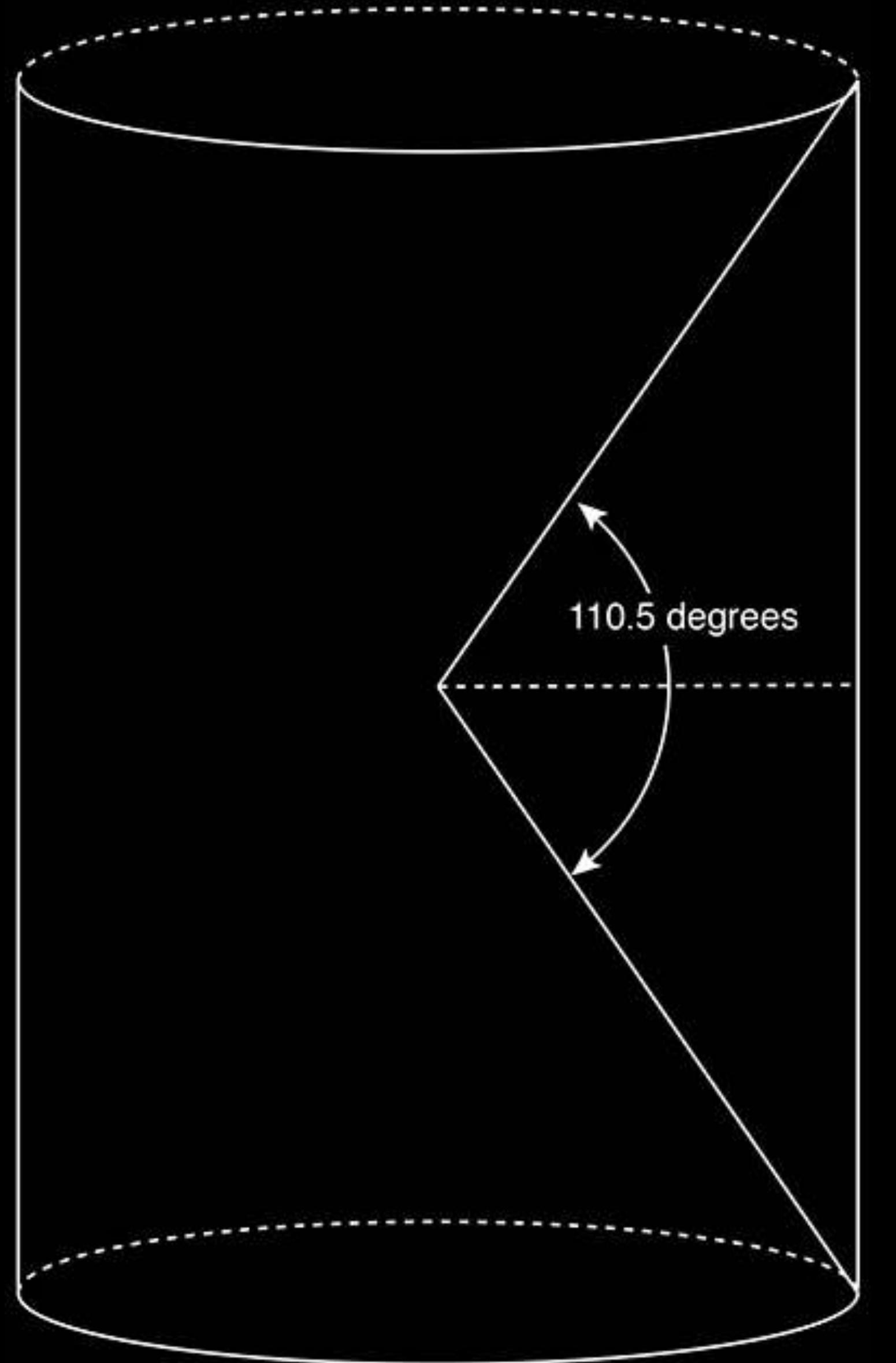


So what ...?



University of the Sunshine Coast





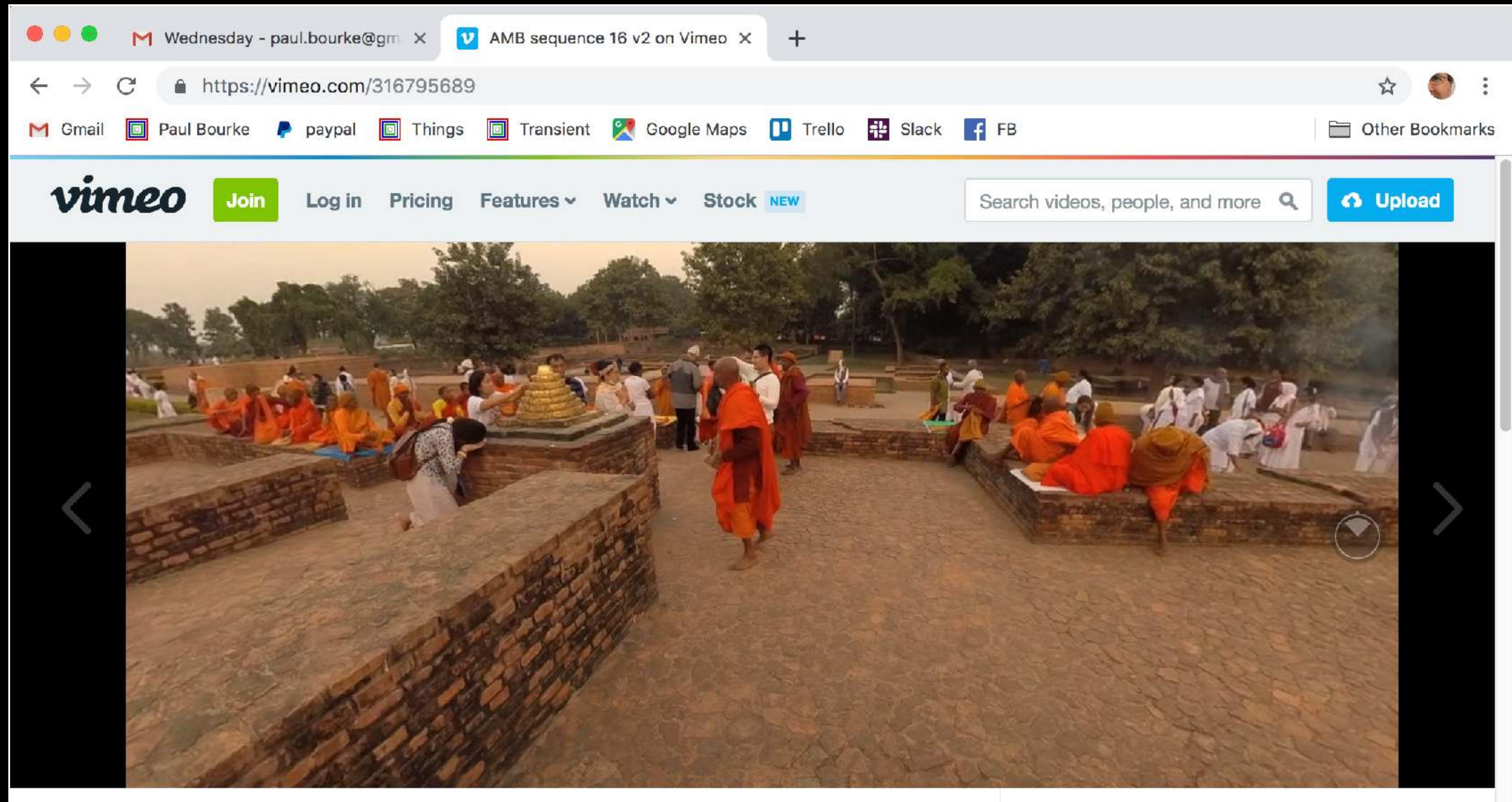
Fisheye







Perspective







Camera summary



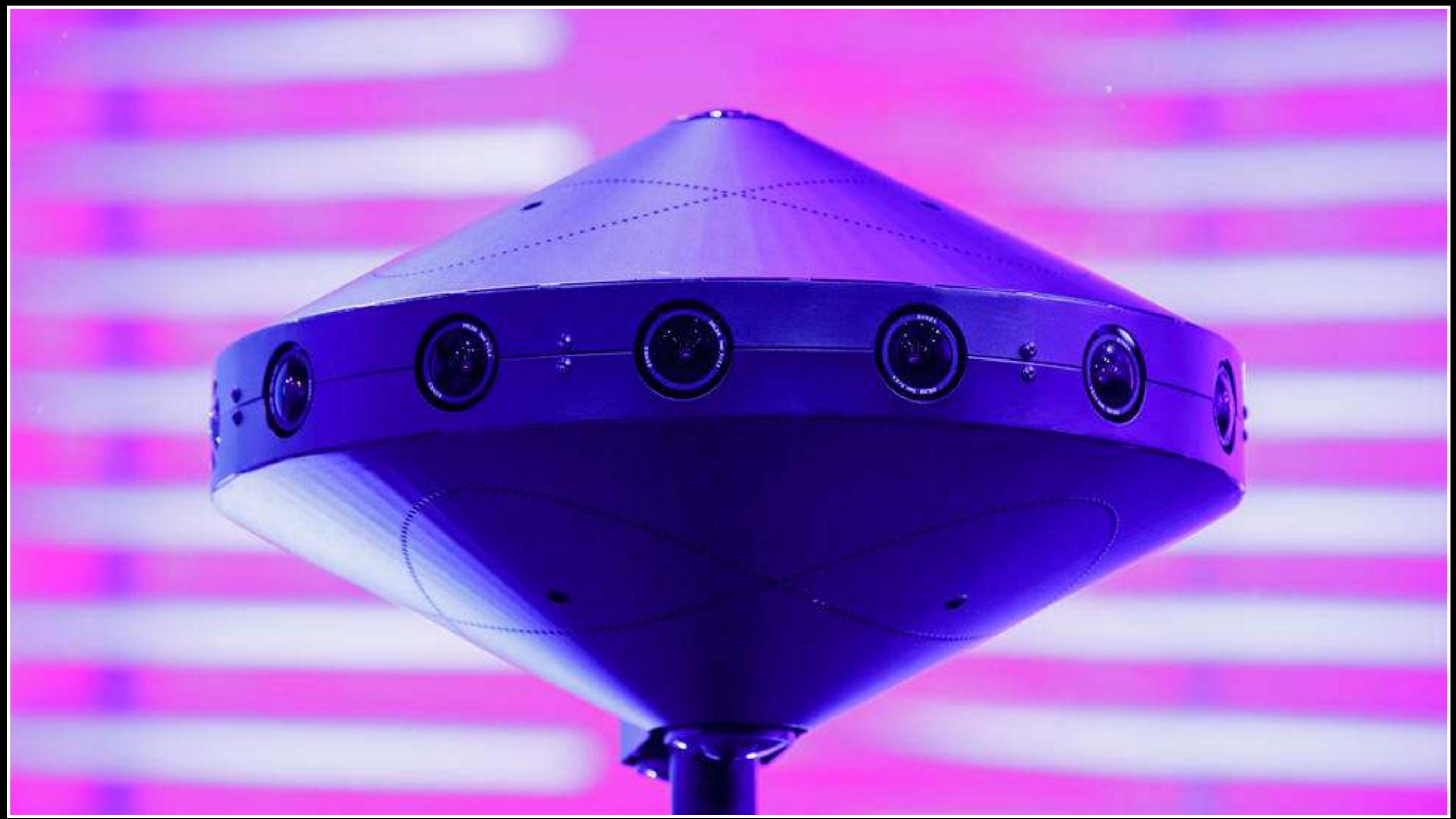














Ladybug-3

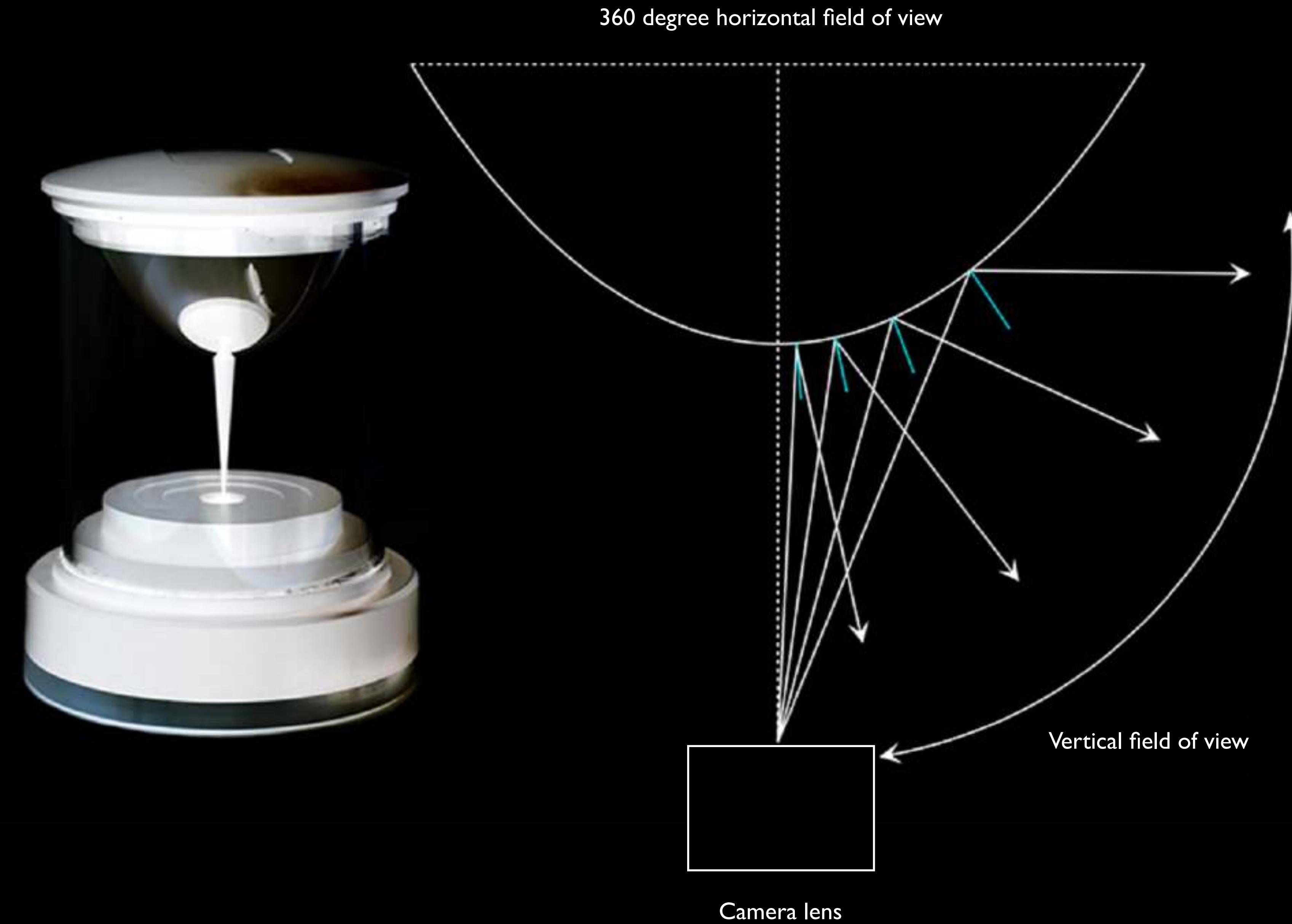


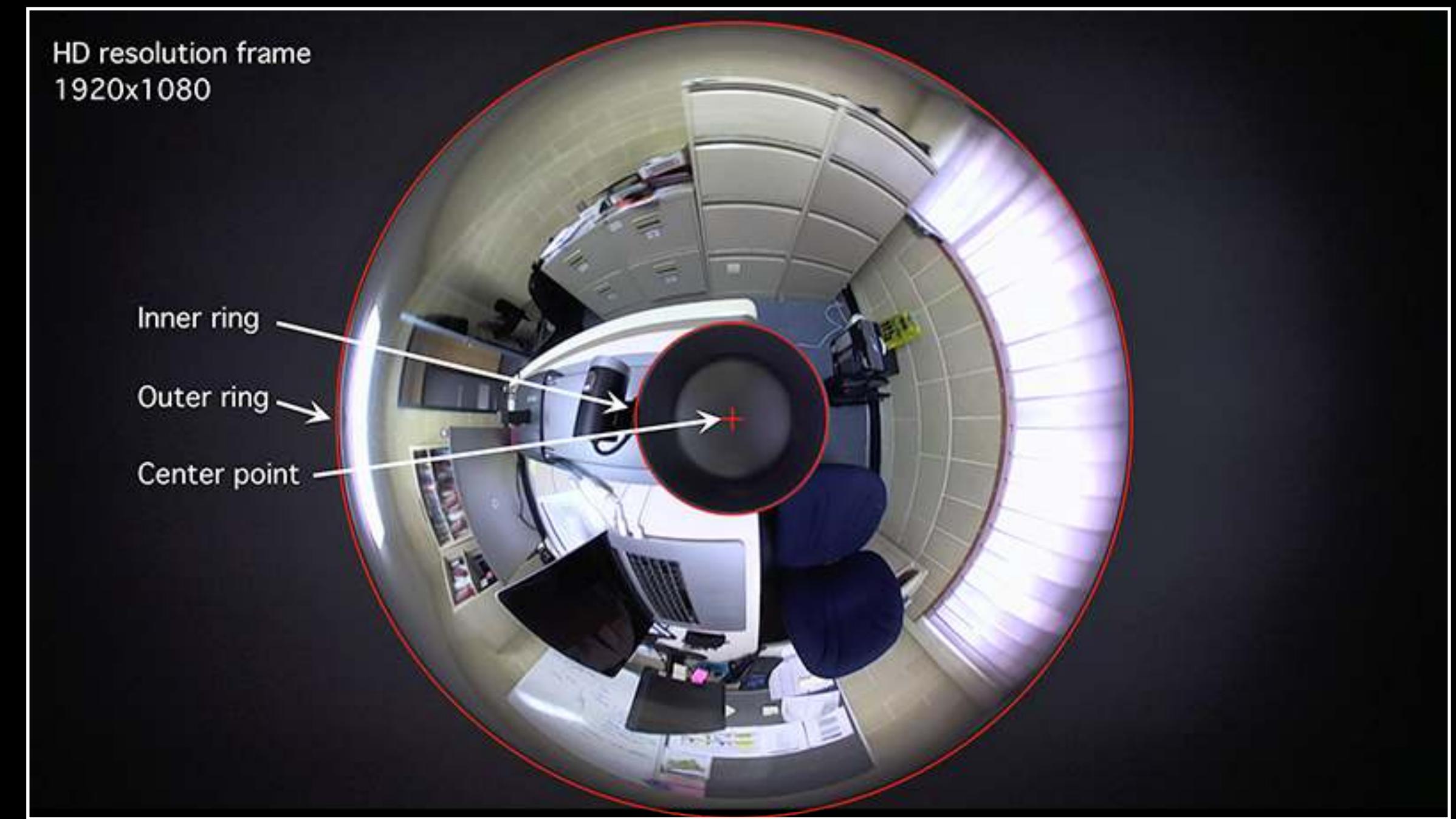
Insta360Pro-2



Garmin Virb

Single camera







Entaniya 250 degree fisheye







Single camera merits

Advantages:

Simple - Small - No blending - No parallax errors

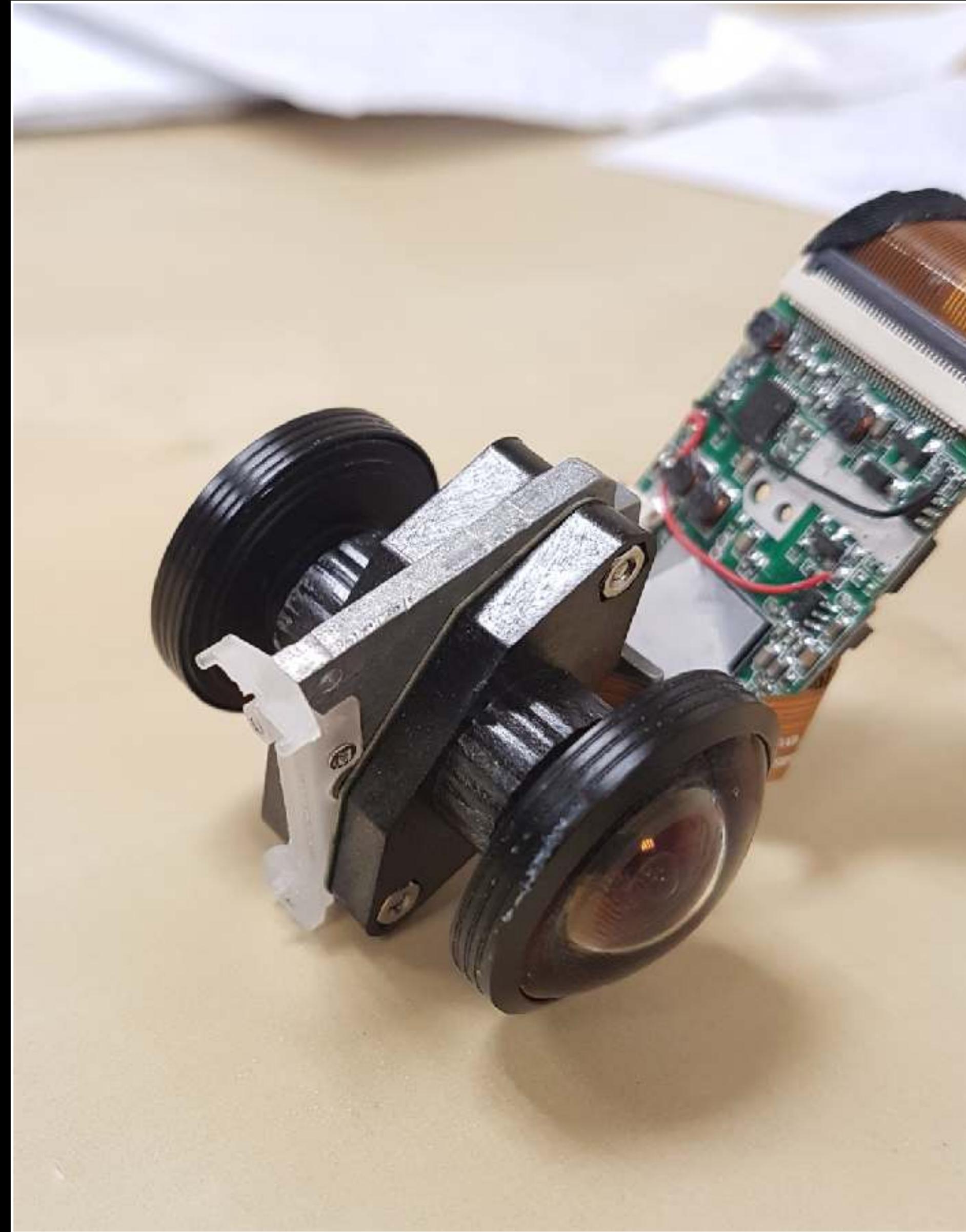
Disadvantages:

Doesn't capture whole 360x180 field of view

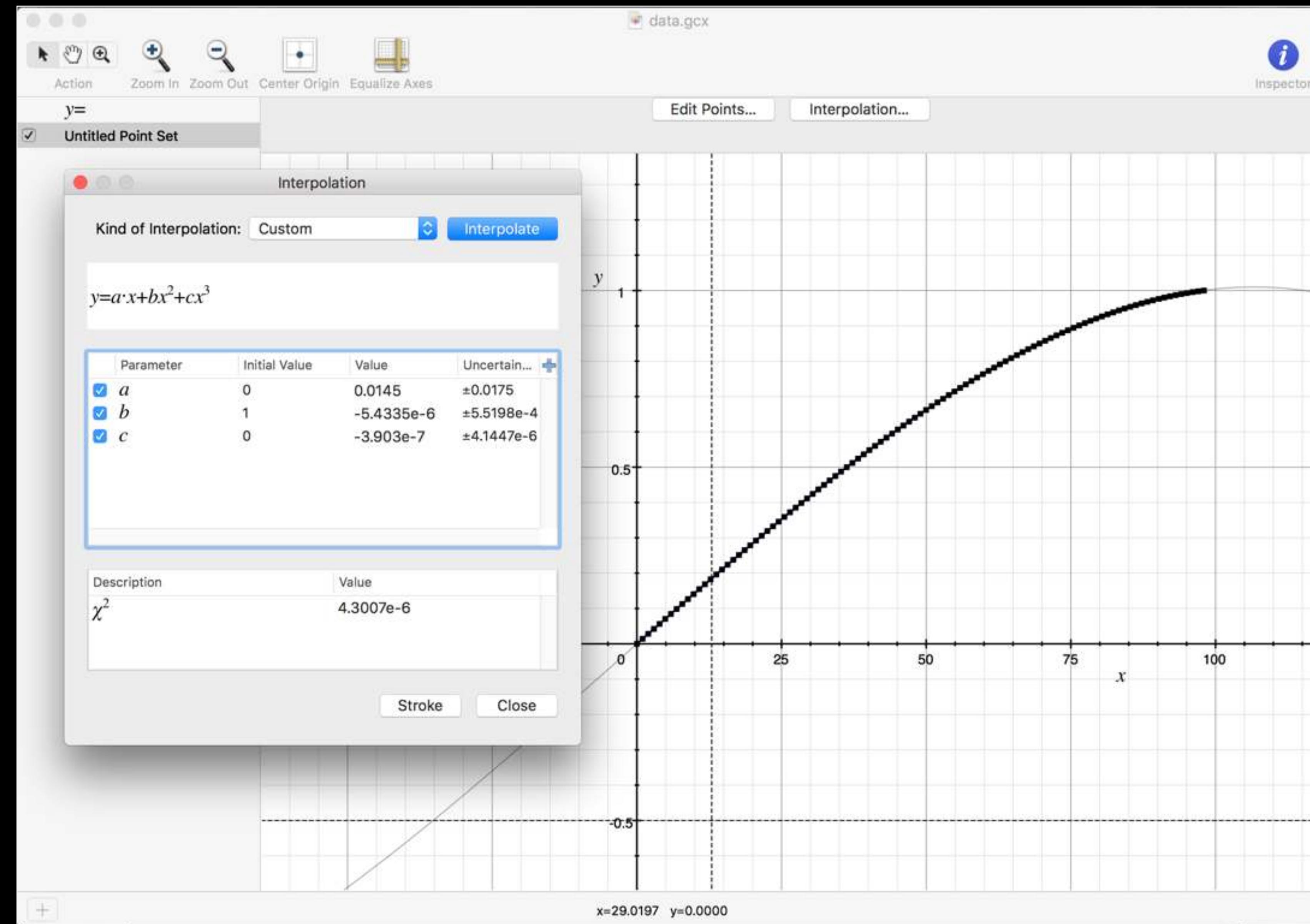
Doesn't scale!

Dual cameras



















Dual camera merits

Advantages:

Small - Single blend line - Higher resolution than single camera

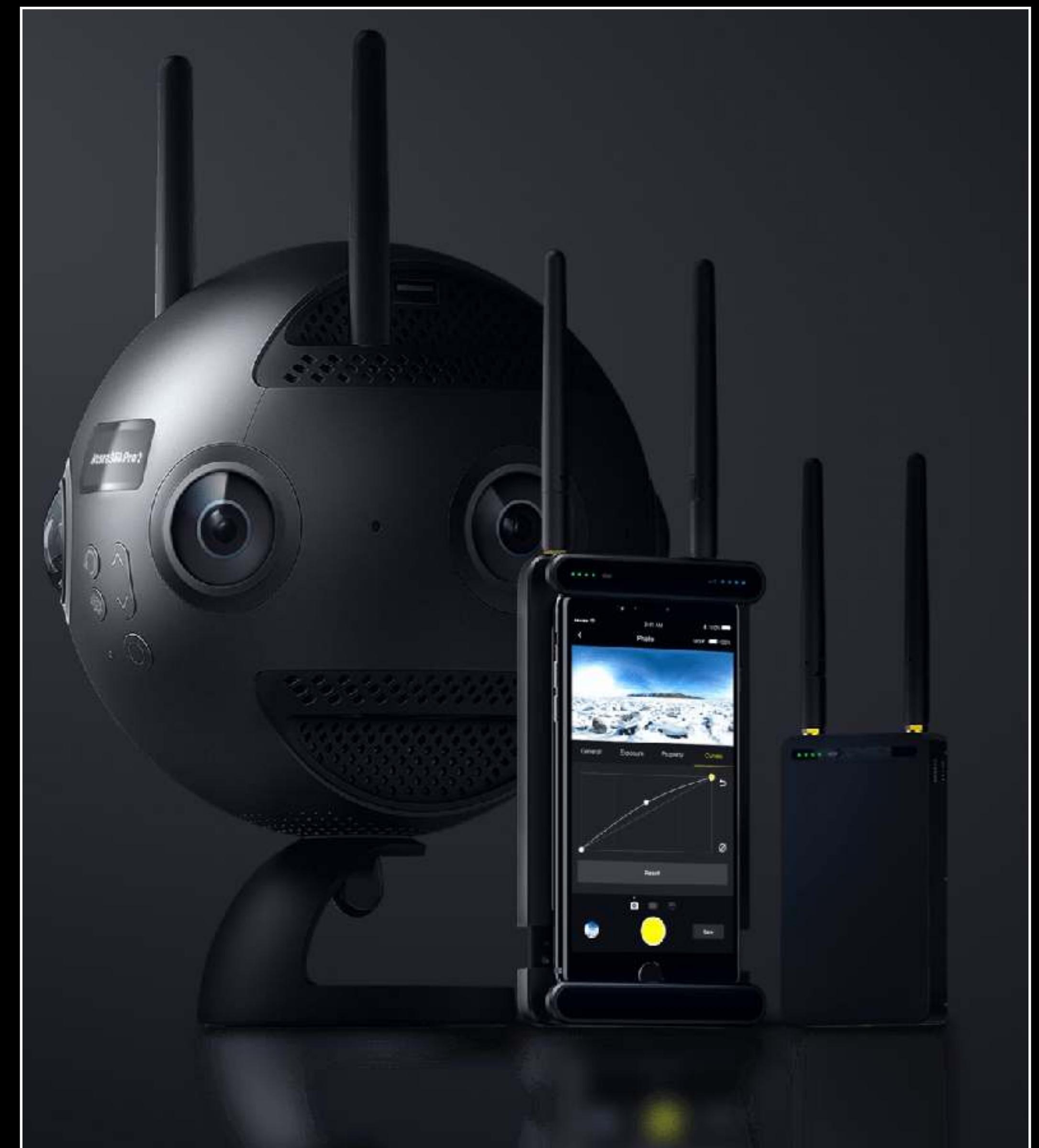
Disadvantages:

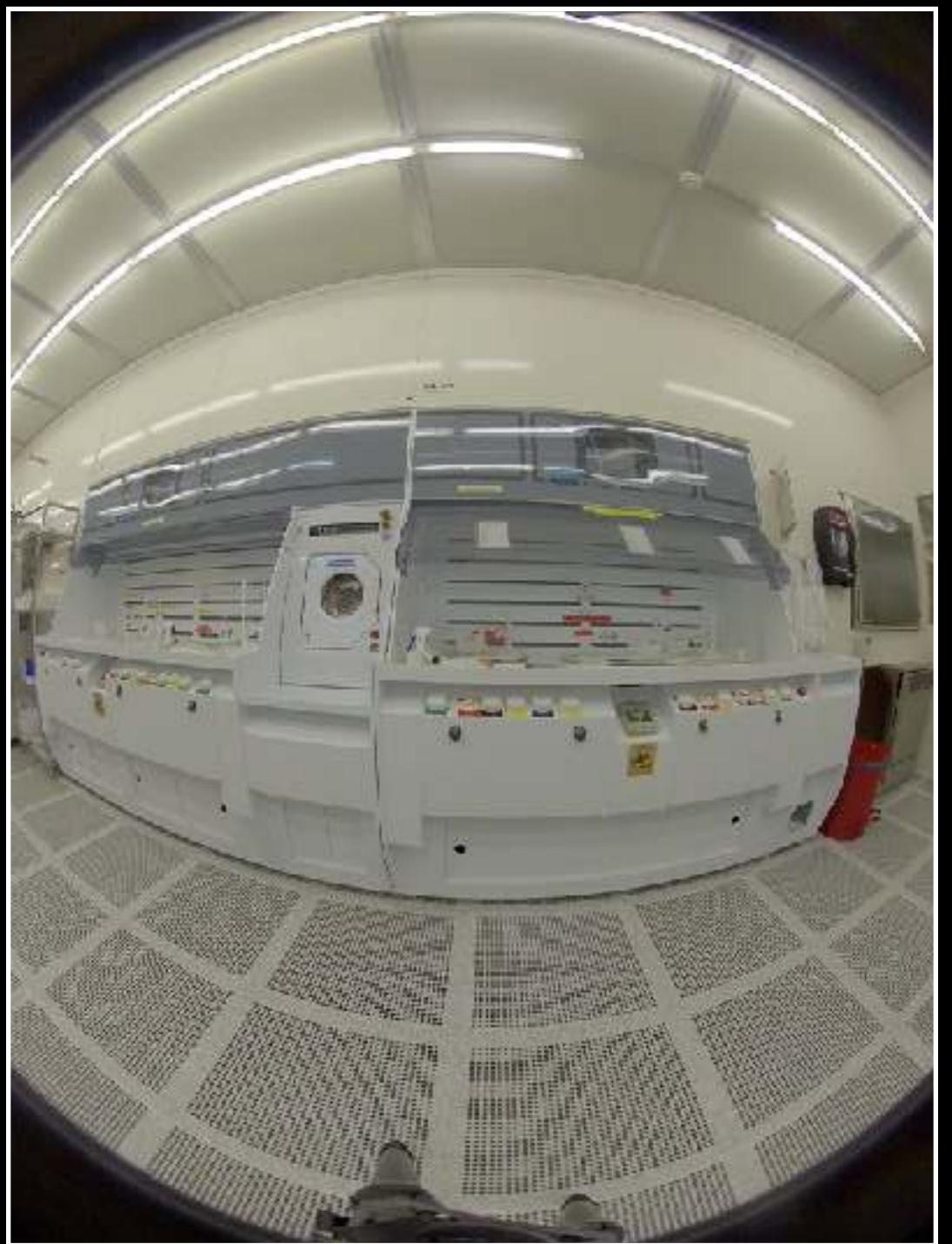
Doesn't scale!

Cannot support stereoscopic 3D

Multiple cameras (>2)

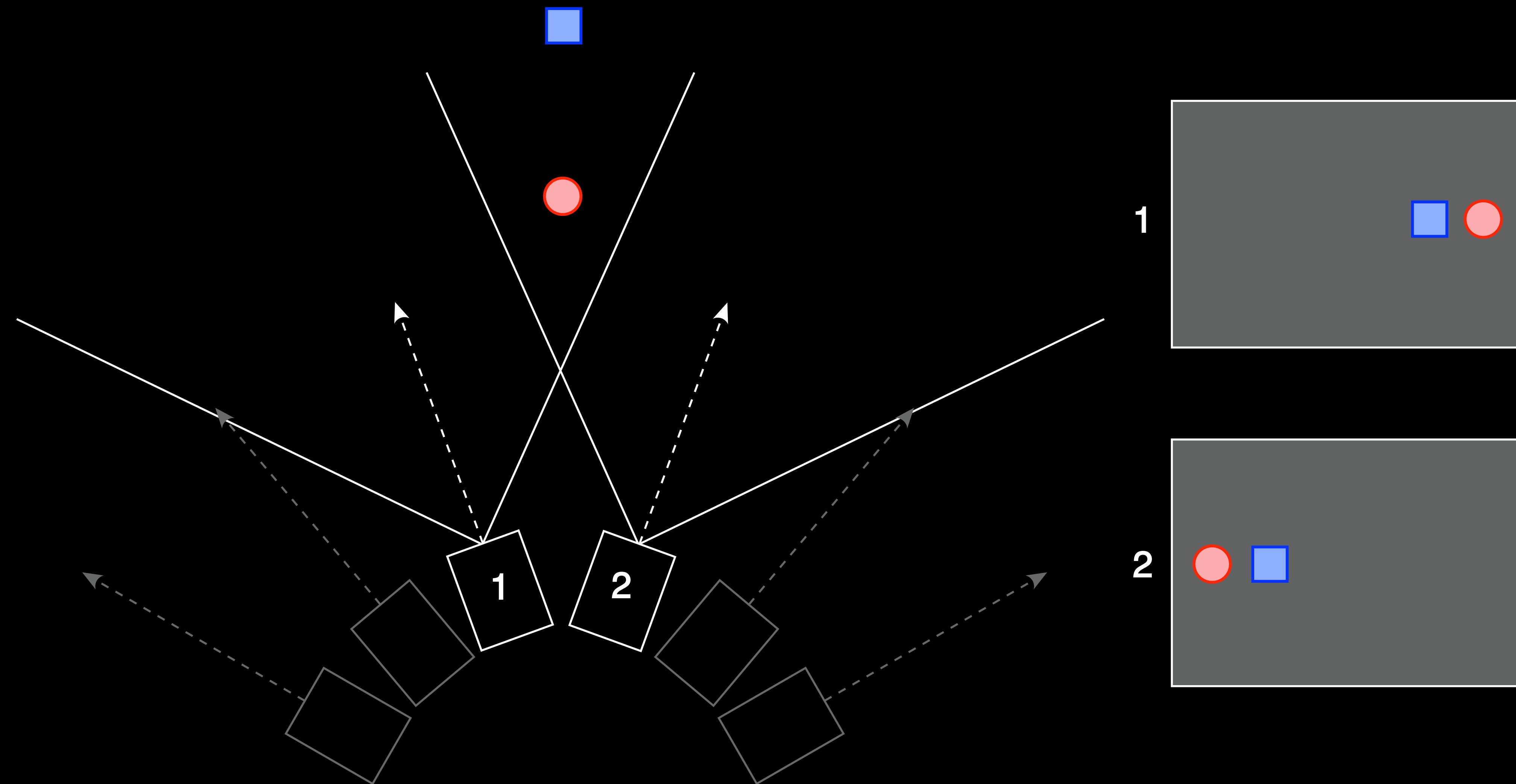
- Will focus on the Insta360Pro2
- 6 Camera/lenses
- One microSD card per camera
- Maximum resolution 7680 x 3840 @ 30fps
- Long range live feed and control
- Built in stabilisation

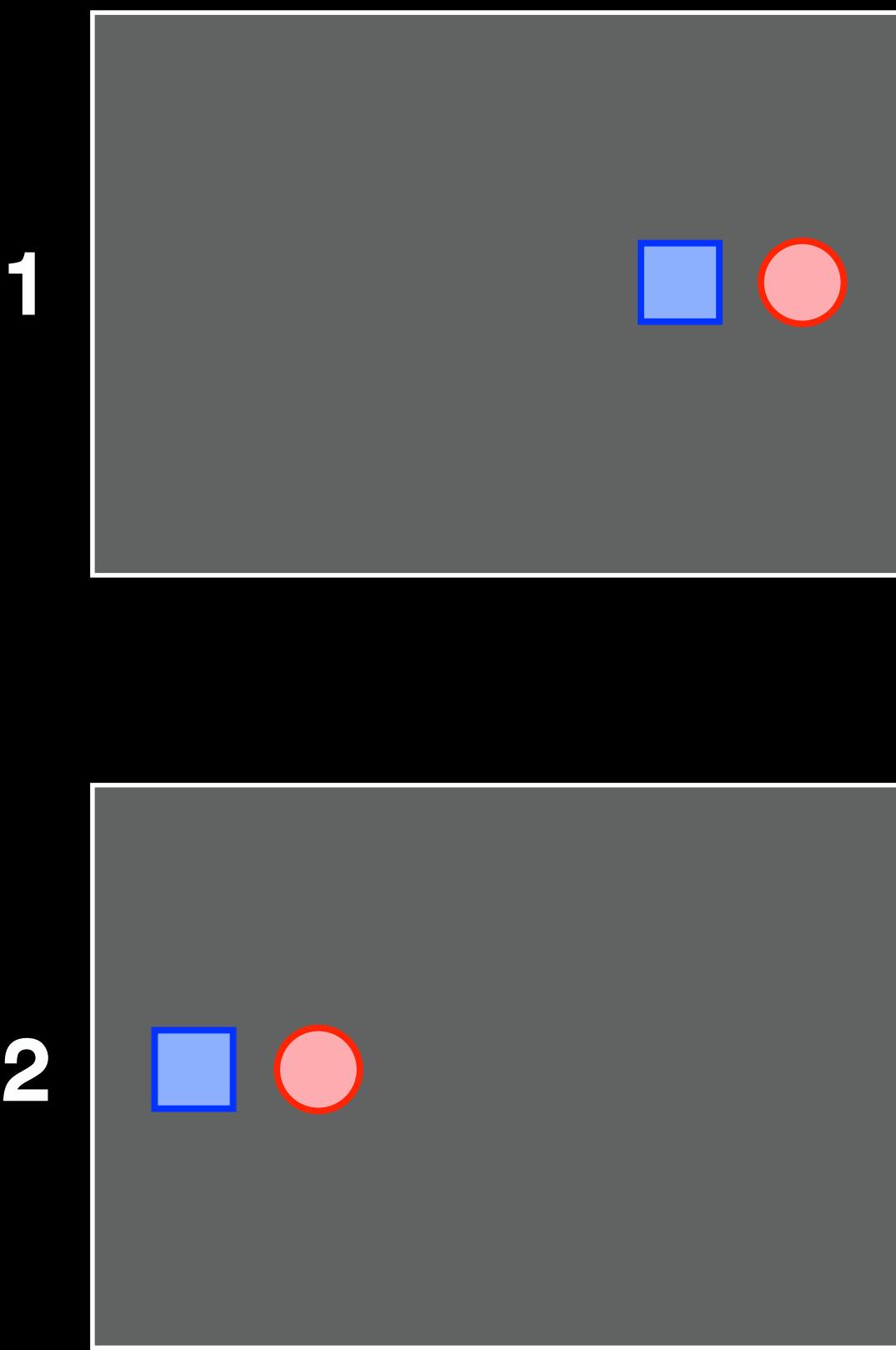
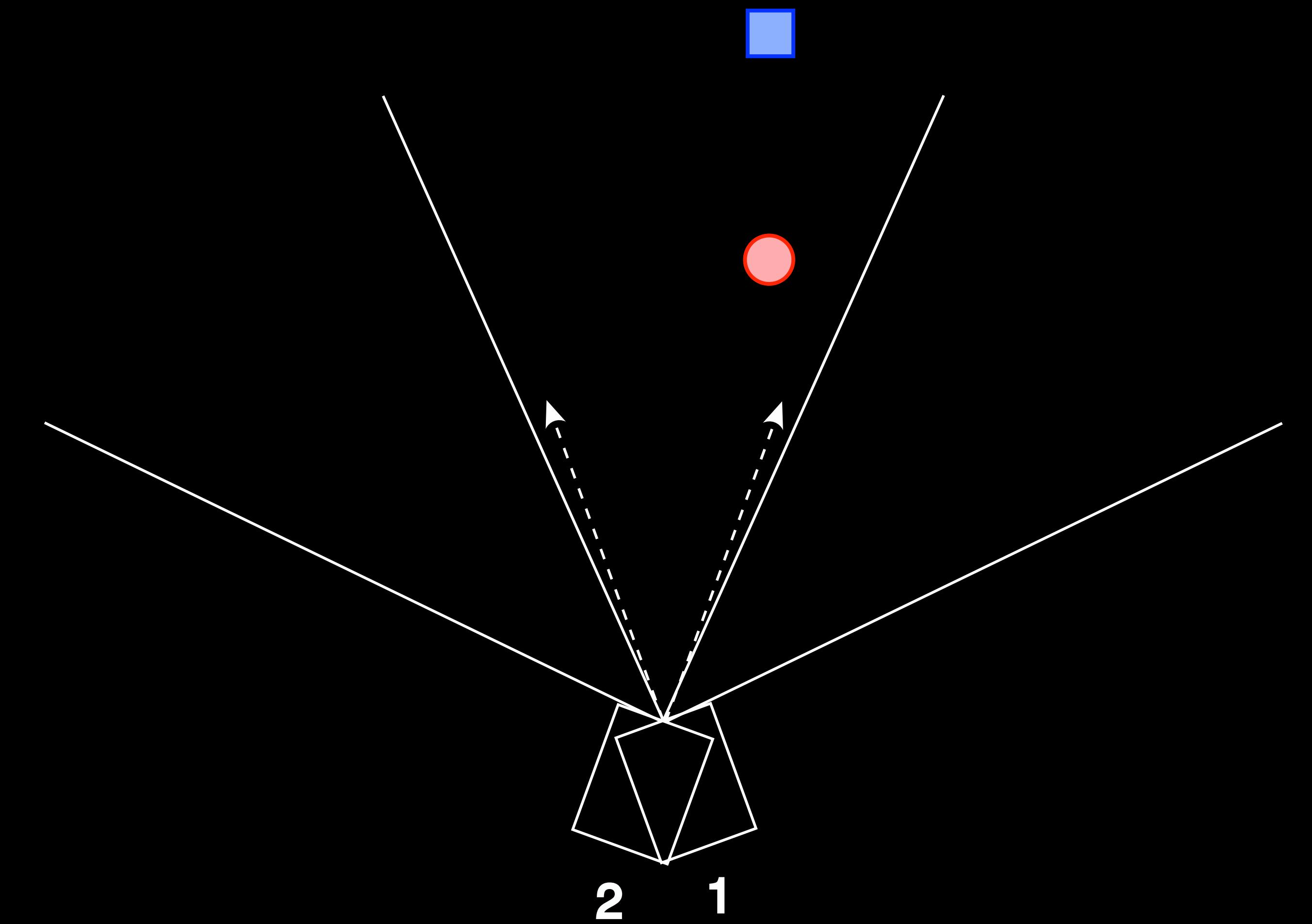




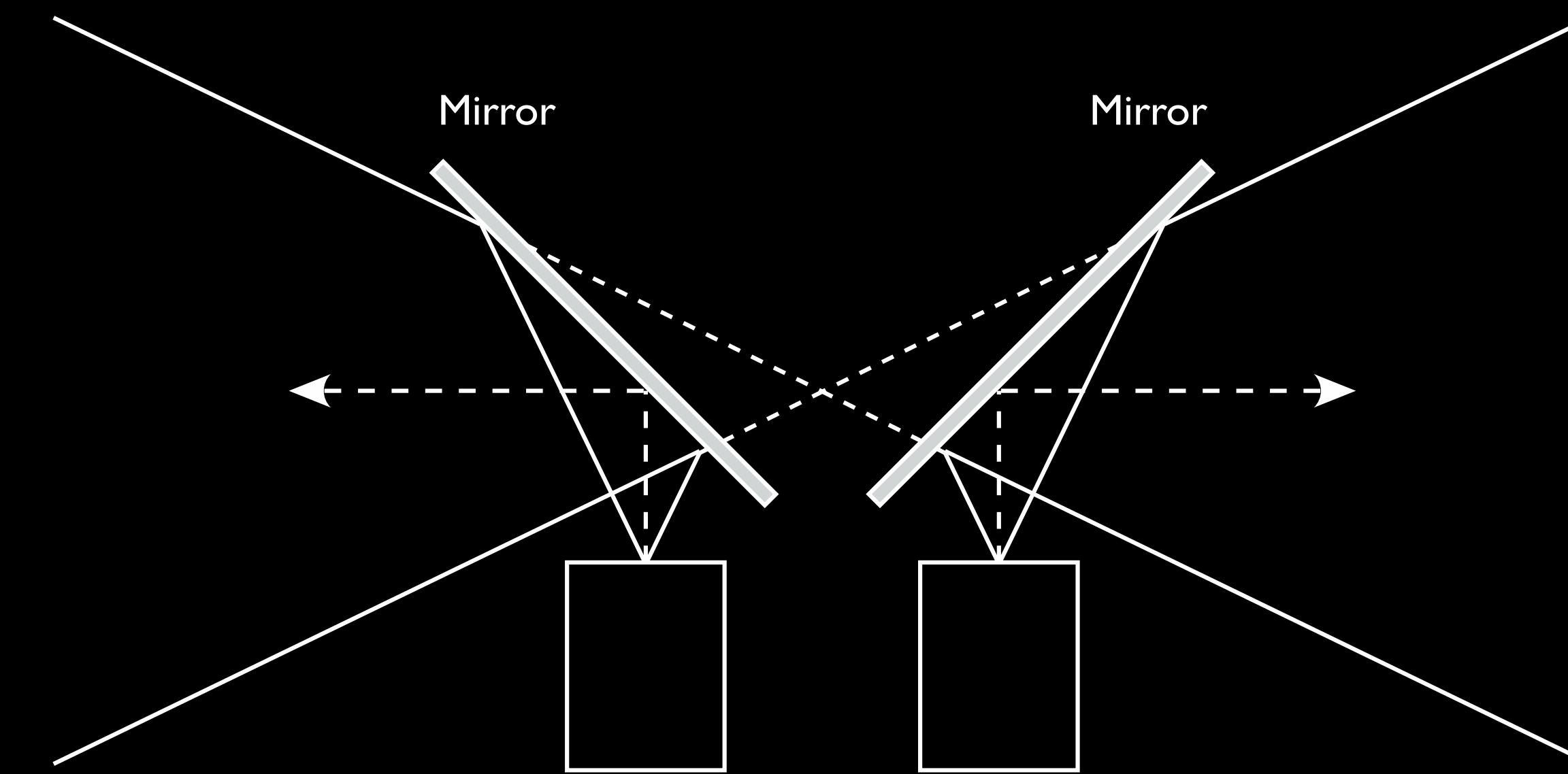
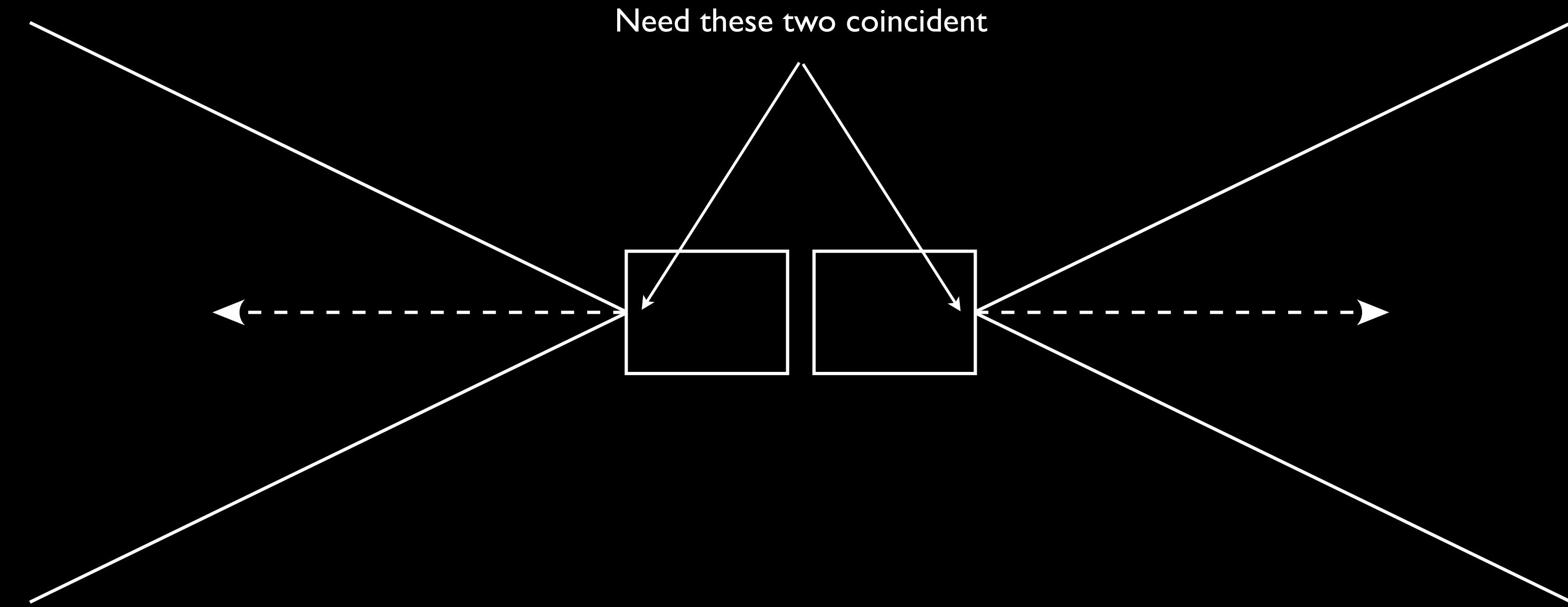


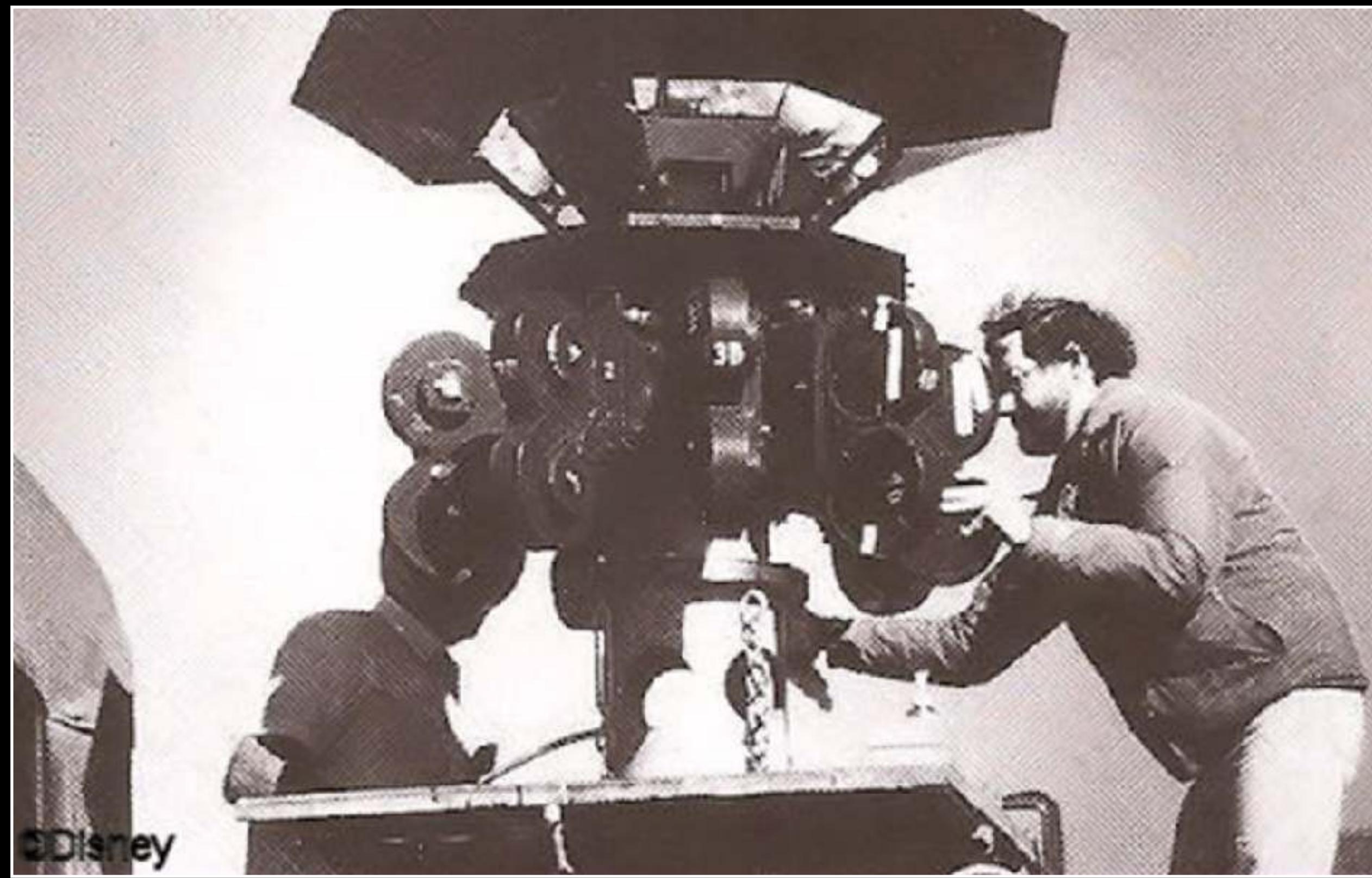
The fundamental problem





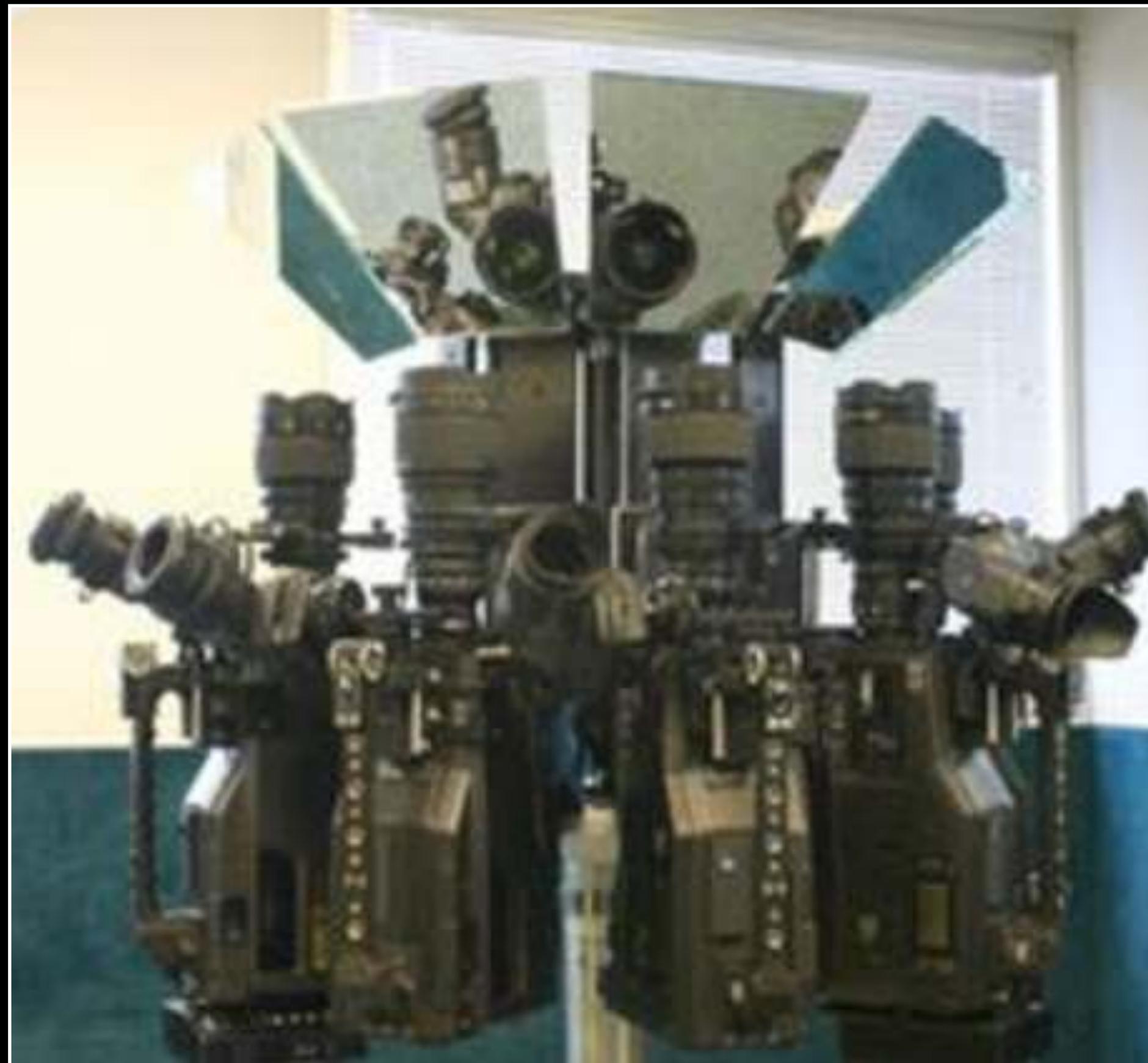
Solutions - Mirrors

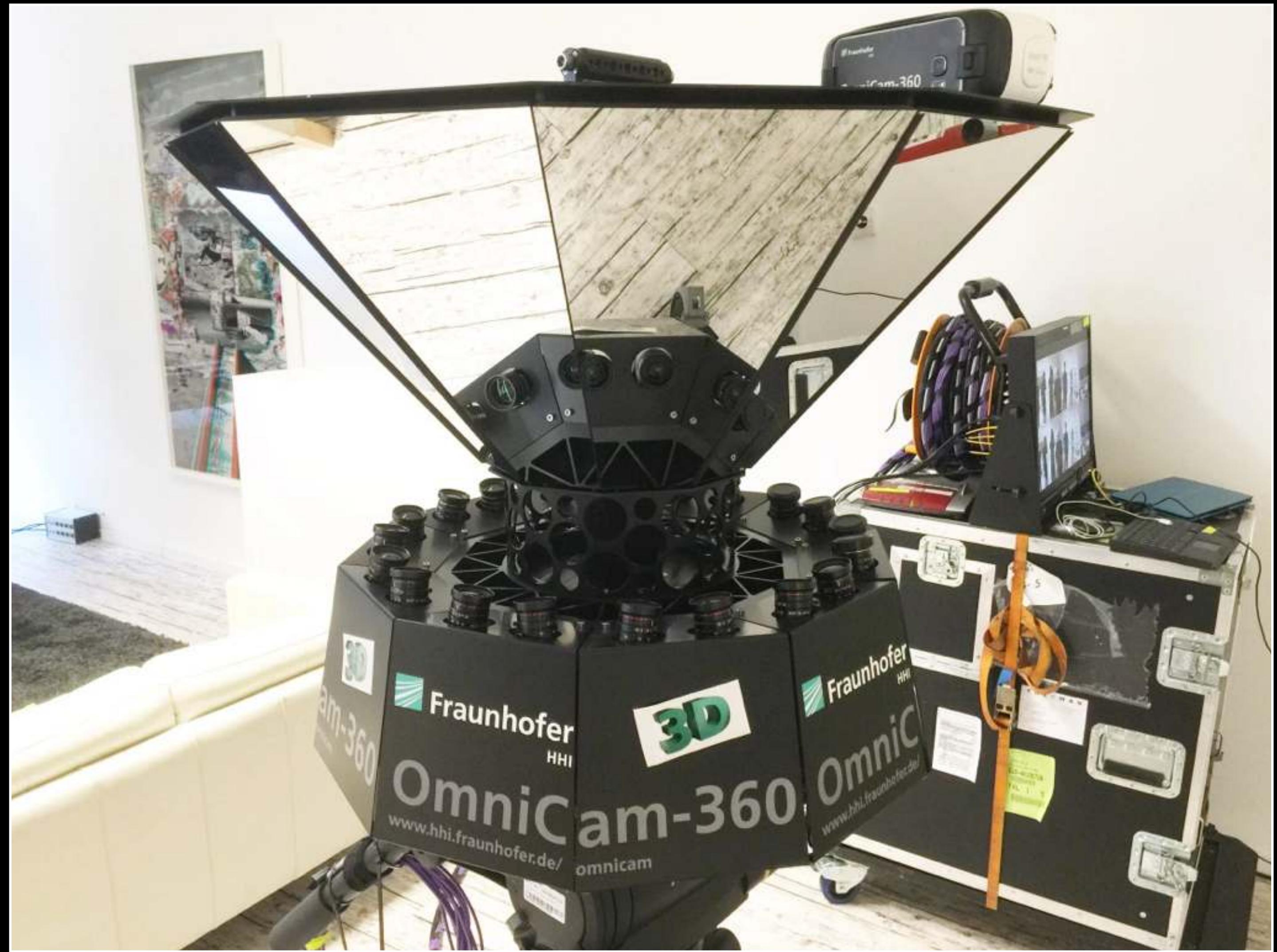




Circlorama camera #2 (Disney)







(12) **United States Patent**
Masuda et al.

(54) **IMAGING SYSTEM AND IMAGING OPTICAL SYSTEM**

(75) Inventors: **Kensuke Masuda**, Kawasaki (JP);
Noriyuki Terao, Sendai (JP); **Yoshiaki Irino**, Kawasaki (JP); **Tomonori Tanaka**, Yokohama (JP); **Nozomi Imae**, Yokohama (JP); **Toru Harada**, Yokohama (JP); **Hirokazu Takenaka**, Kawasaki (JP); **Hideaki Yamamoto**, Yokohama (JP); **Satoshi Sawaguchi**, Yokohama (JP); **Hiroyuki Satoh**, Kawasaki (JP)

(73) Assignee: **RICOH COMPANY, LTD.**, Tokyo (JP)

(10) **Patent No.:** US 9,201,222 B2

(45) **Date of Patent:** Dec. 1, 2015

USPC 348/36, 335; 359/725
See application file for complete search history.

(56)

References Cited

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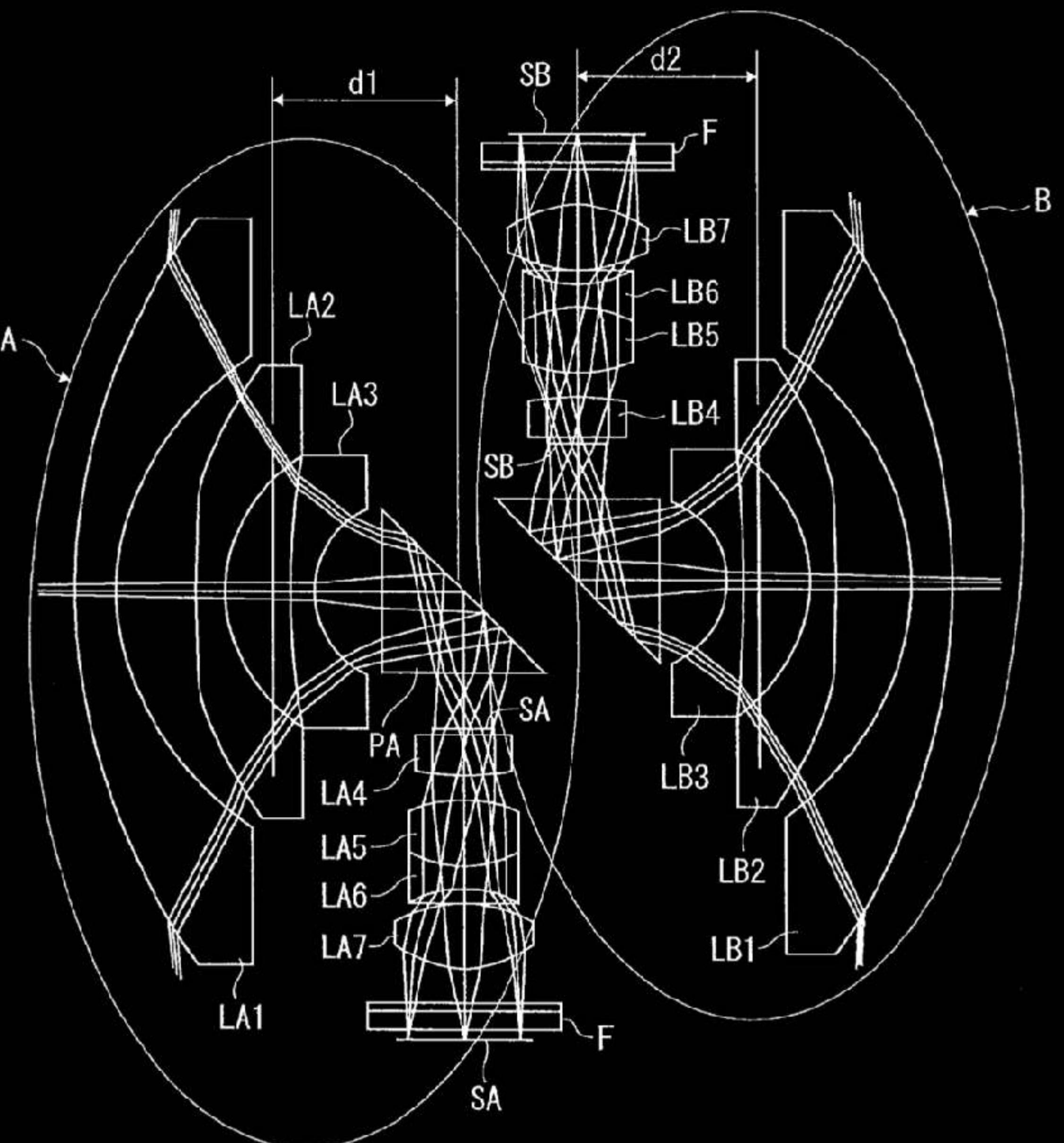
3,283,653 A 11/1966 Tokarzewski
7,154,551 B2 * 12/2006 Kuriyama et al. 348/335
(Continued)

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JP 2006-098942 4/2006
JP 2007-164079 6/2007

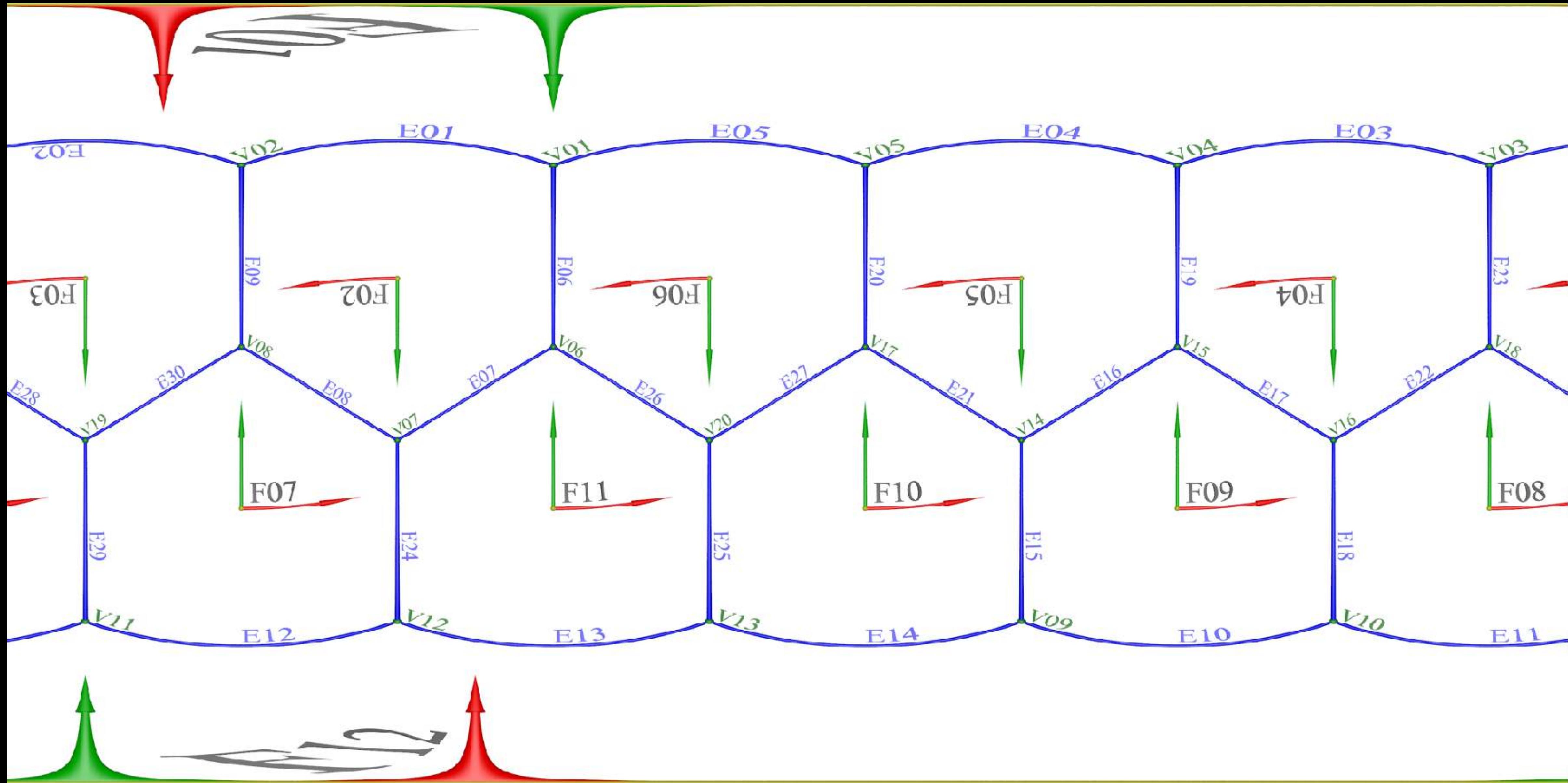
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FIG. 1

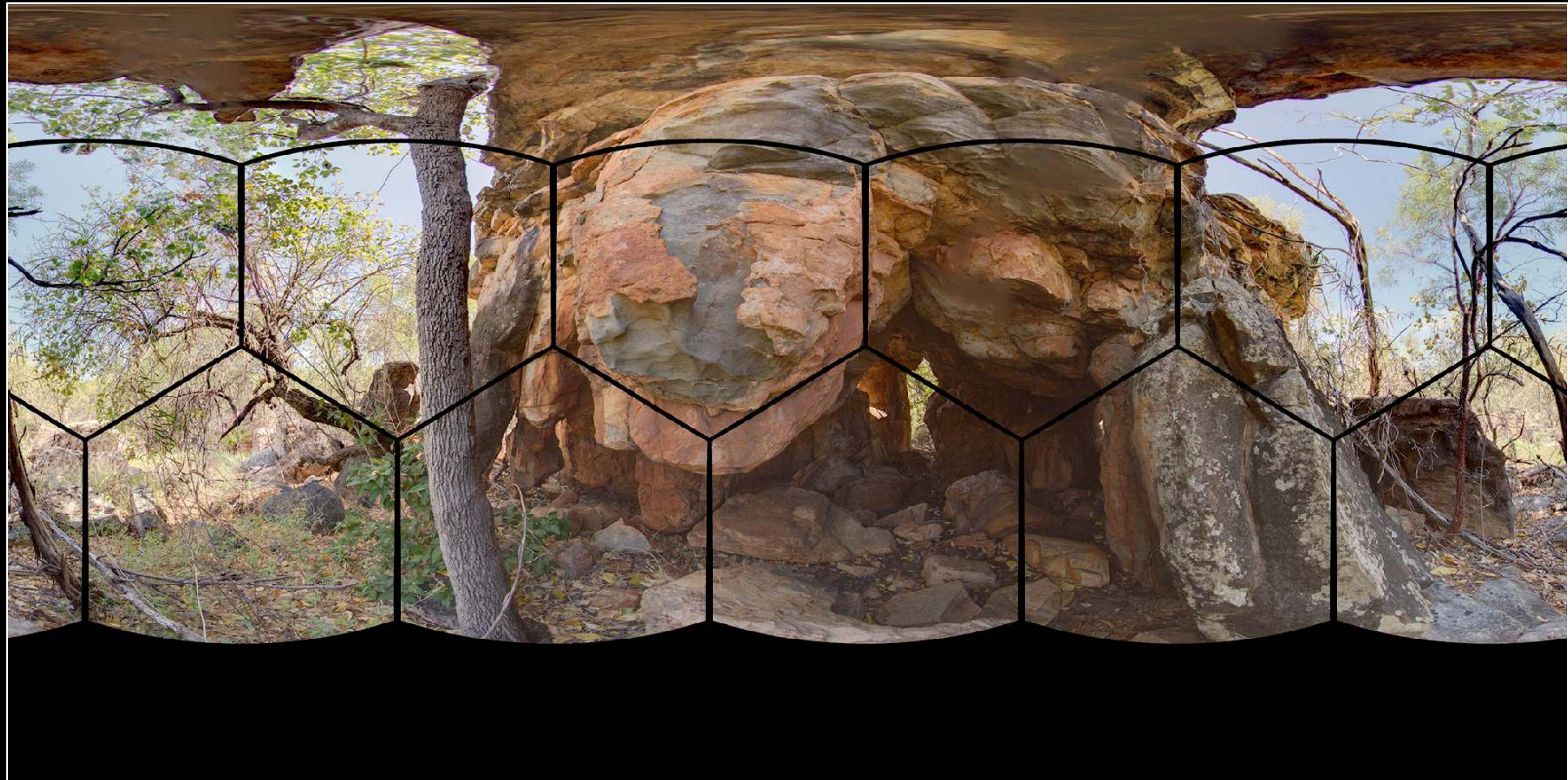


Solutions - Custom Optics







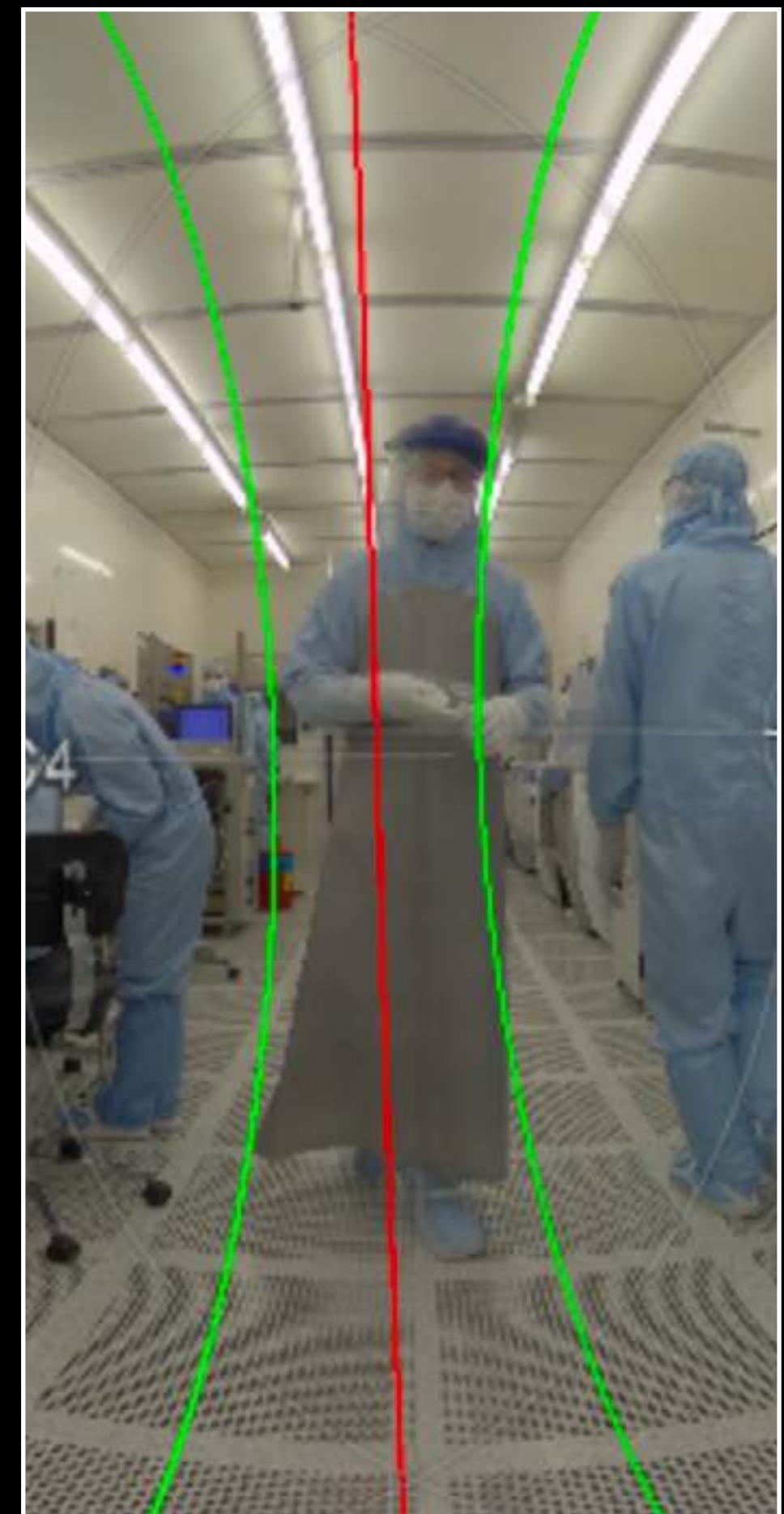
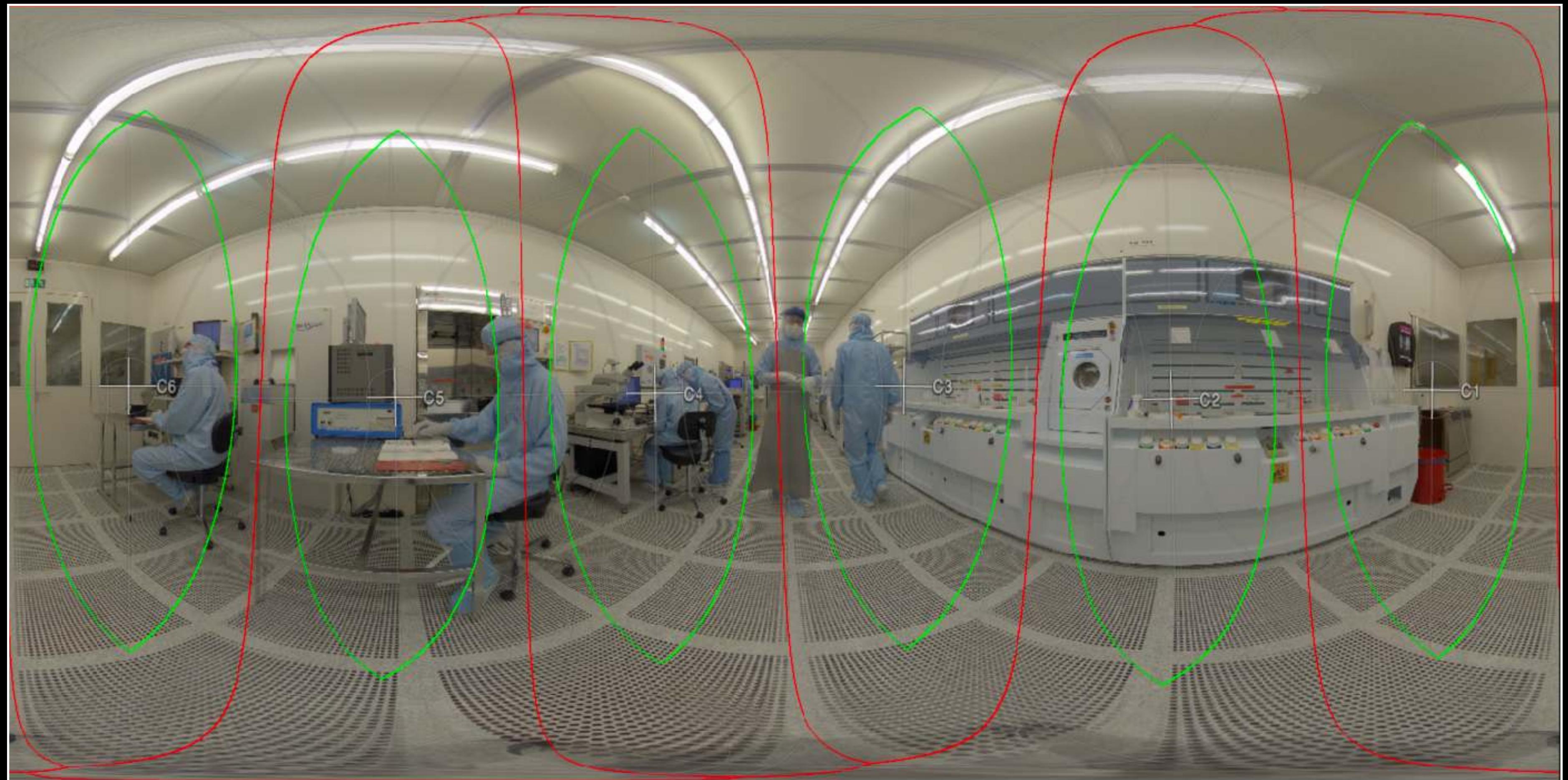


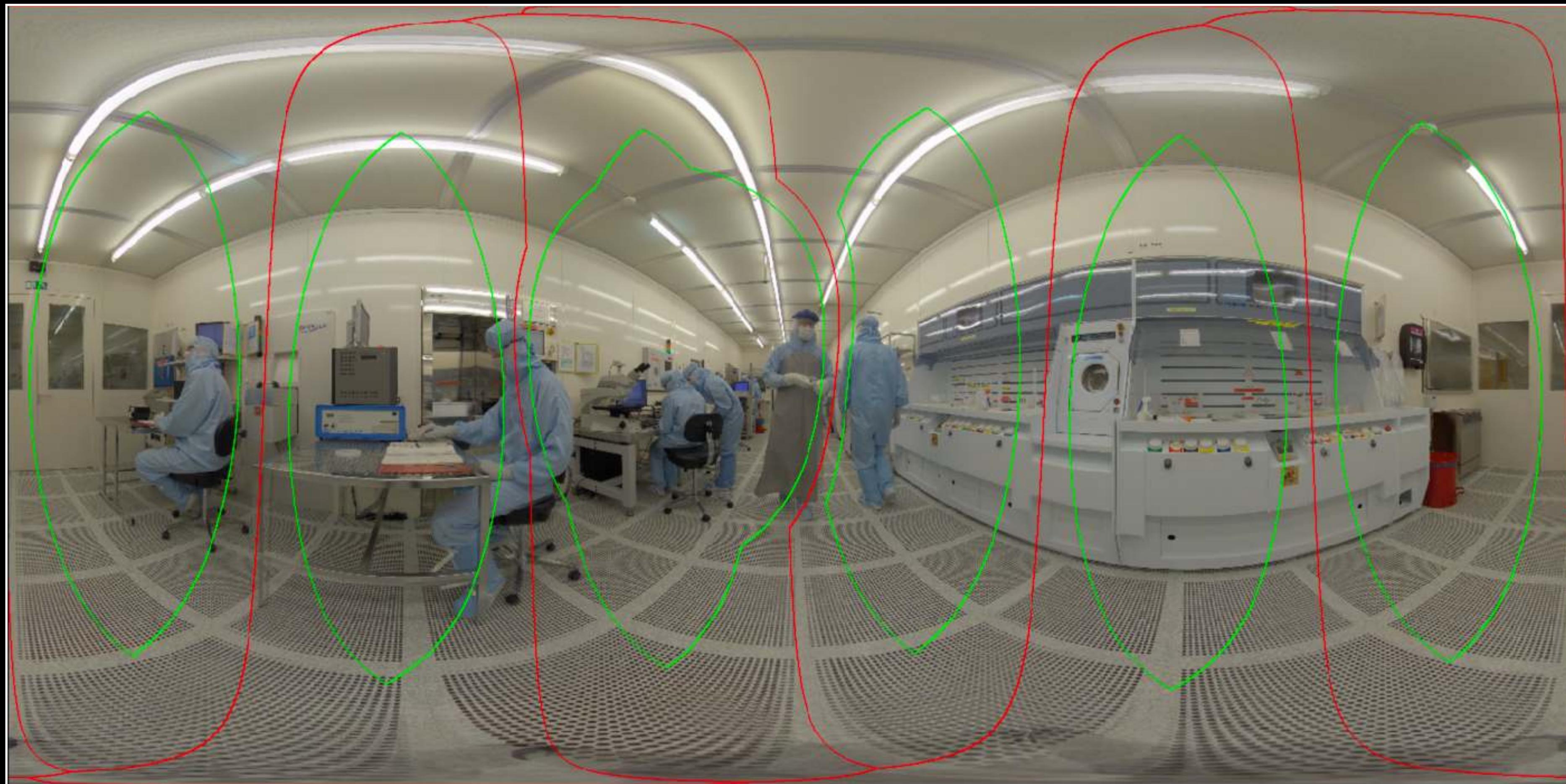


Solutions - Optical Flow

- Tracks image content between frames and performs local warping to maintain continuity.
- Pretty much the standard solution today in all multiple camera rigs and associated software.
- Perhaps one of the leaders is MistakaVR.
- NOTE: It is not perfect, the parallax issue cannot always be corrected/hidden.





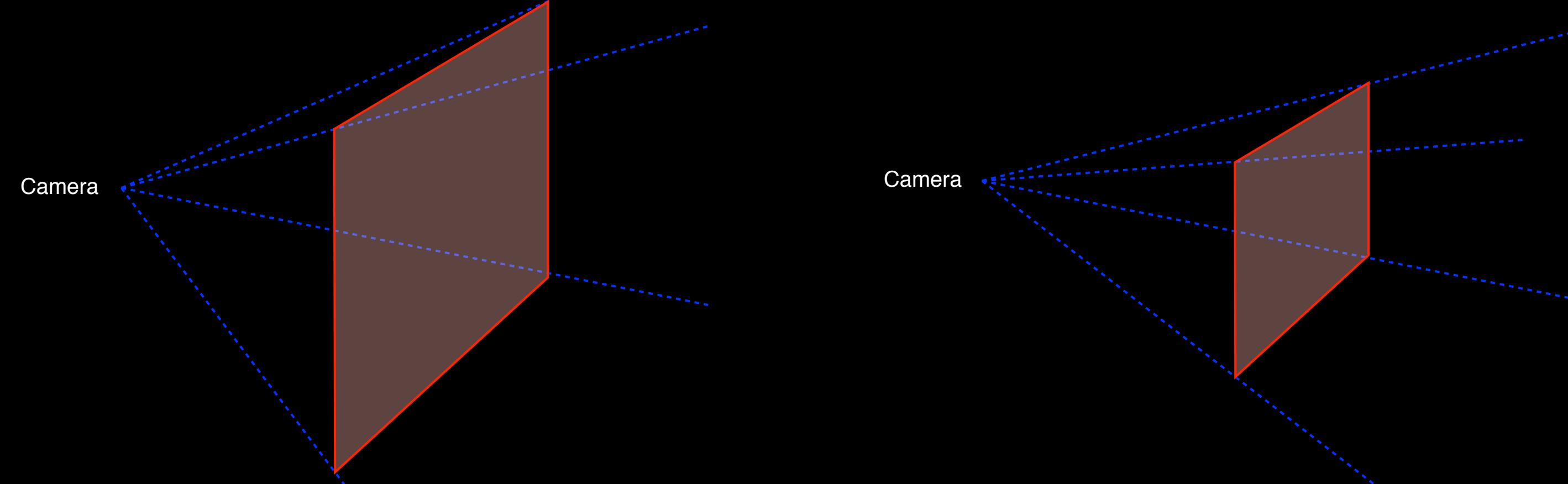


Miscellaneous topics - Resolution

- Currently equirectangular projections are the norm, resolution measured as horizontal pixels.
- Aspect always 2:1, 360 degrees horizontally, 180 degrees vertically.
- Most dual camera rigs are “4K”, 3840 or true 4K 4096.
- Where most of the multiple camera (>2) is at is 8K.
Including 8K in stereo3D.
- A few cameras are starting to be related at 12K.
- Most cameras to date have been just 8 bit, a few now and on the horizon are 10 ro 12 bit.

Miscellaneous topics - Zooming

- There is no such thing as a zoom.
Zoom is achieved in perspective projection by changing the field of view.



- To magnify something or to see more detail the camera needs to move closer towards it.
- Actually it is the notion of zoom in traditional film that is the strange case, our eyes cannot zoom in real life. So when one creates displays that are closer to the way we see the real world, we lose some of the artificial devices ... like zooming.

Miscellaneous topics - Wrapping

- Equirectangular images wrap horizontally so pixels to the right of the right edge are actually on the left edge.
- Need to be careful with imaging effects that affect neighbouring pixels. For example, colour changes generally don't, but operations like sharpening do.
- Compositing also needs to occur across the wrapping zone.
- Note also the expansion at the poles. Editing software needs to be equirectangular aware.



Miscellaneous topics - Nonlinear space



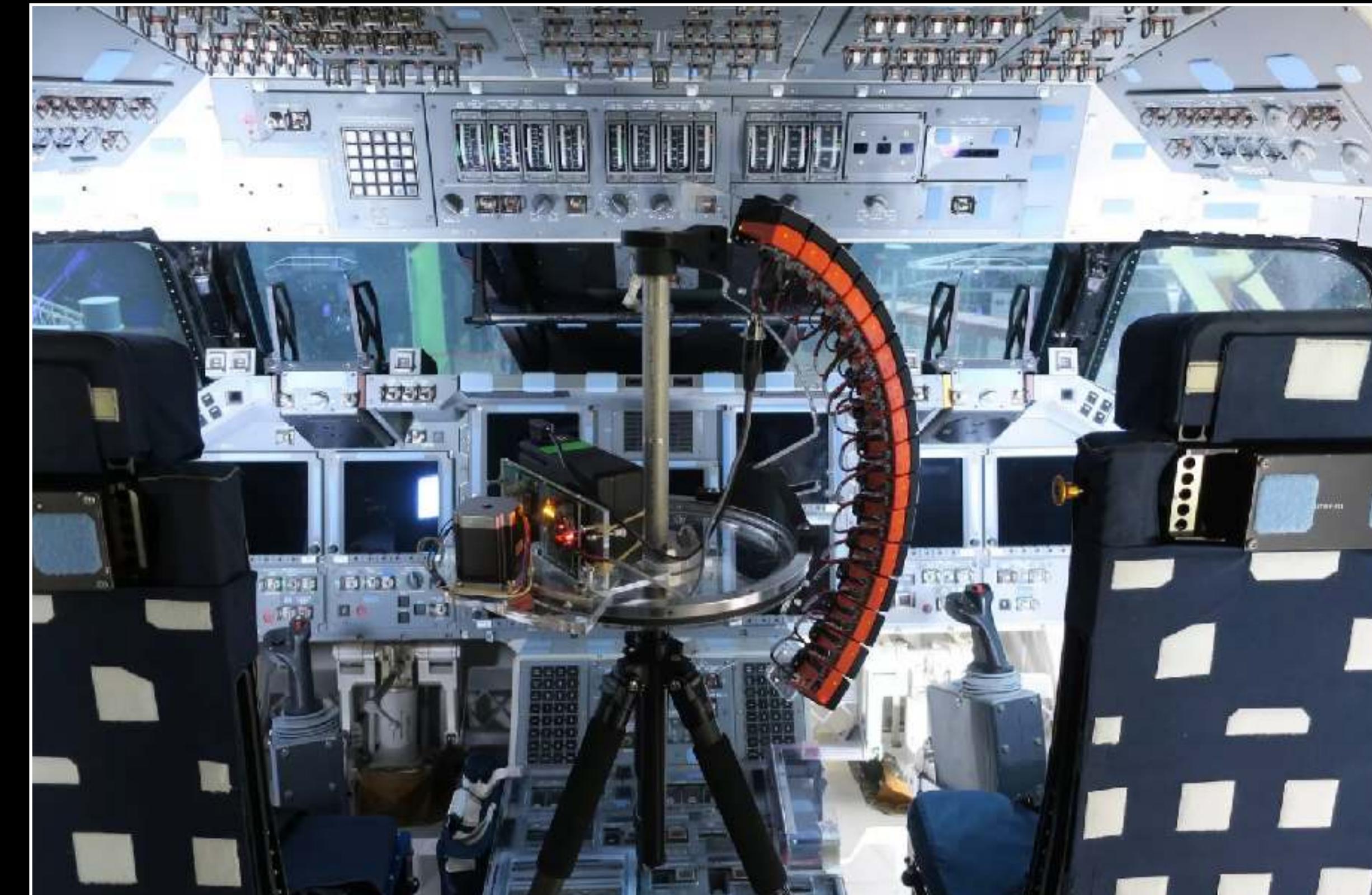
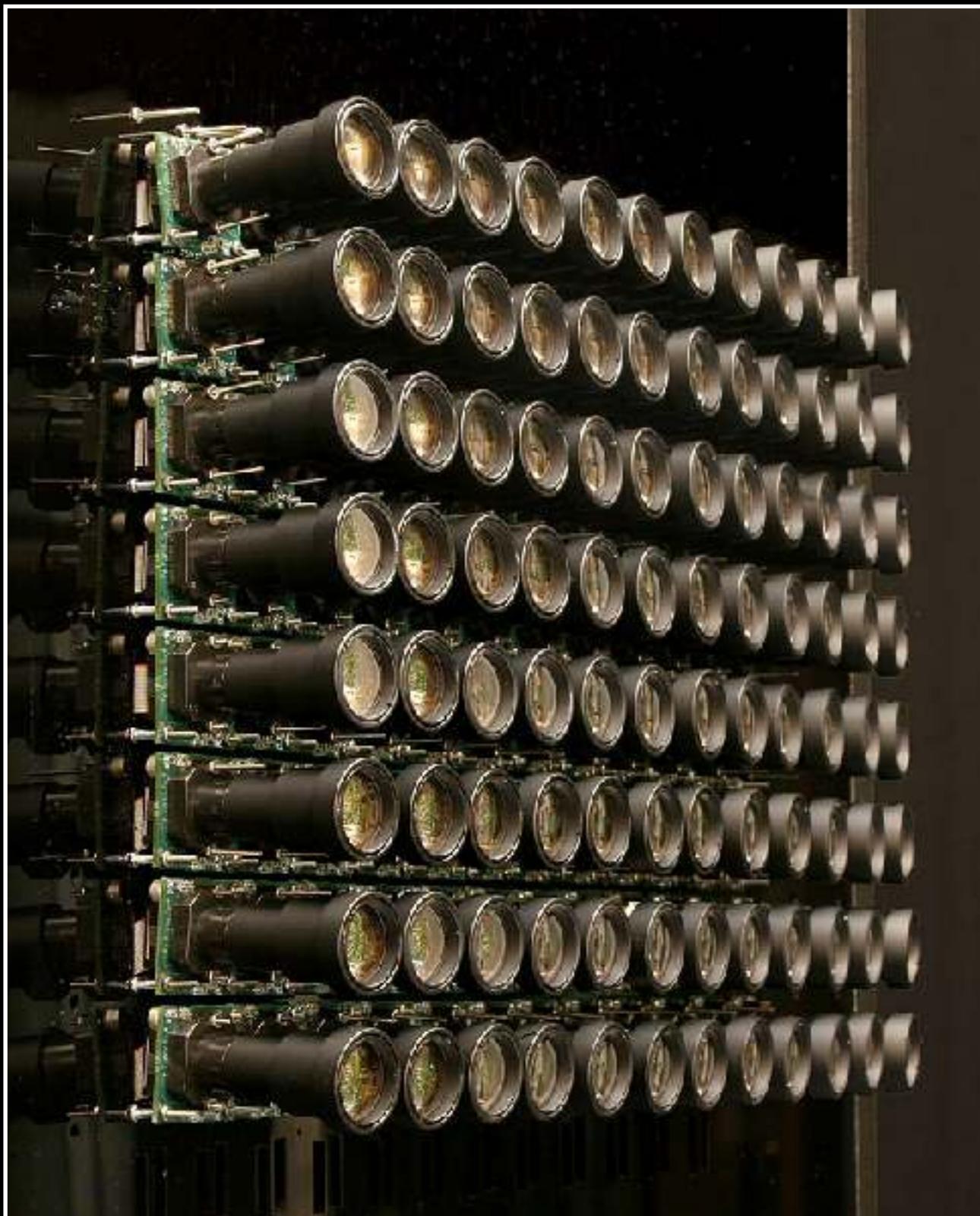


Stereoscopic (VR)

- Stereoscopic filming is a whole topic in itself and should start with a good understanding of stereoscopic theory for flat screens first.
- Obviously head mounted (VR) displays are geared to support this.
- Well understood for computer generated content (still not always done well!).
- Hugely problematic for video recording despite lots of camera rigs (including the Insta360Pro-2) supporting it.
- Quality is generally not of a high standard and is only accepted due to novelty and low user expectations.
- Happy to take questions on this now or later.

The future

- Lightfield capture
 - Not only can one look around, but can move ones head for a different viewpoint.
 - Other magic can occur, like refocussing in post production.
 - Rigs for 360 only for static scenes at this stage.



End - Questions?