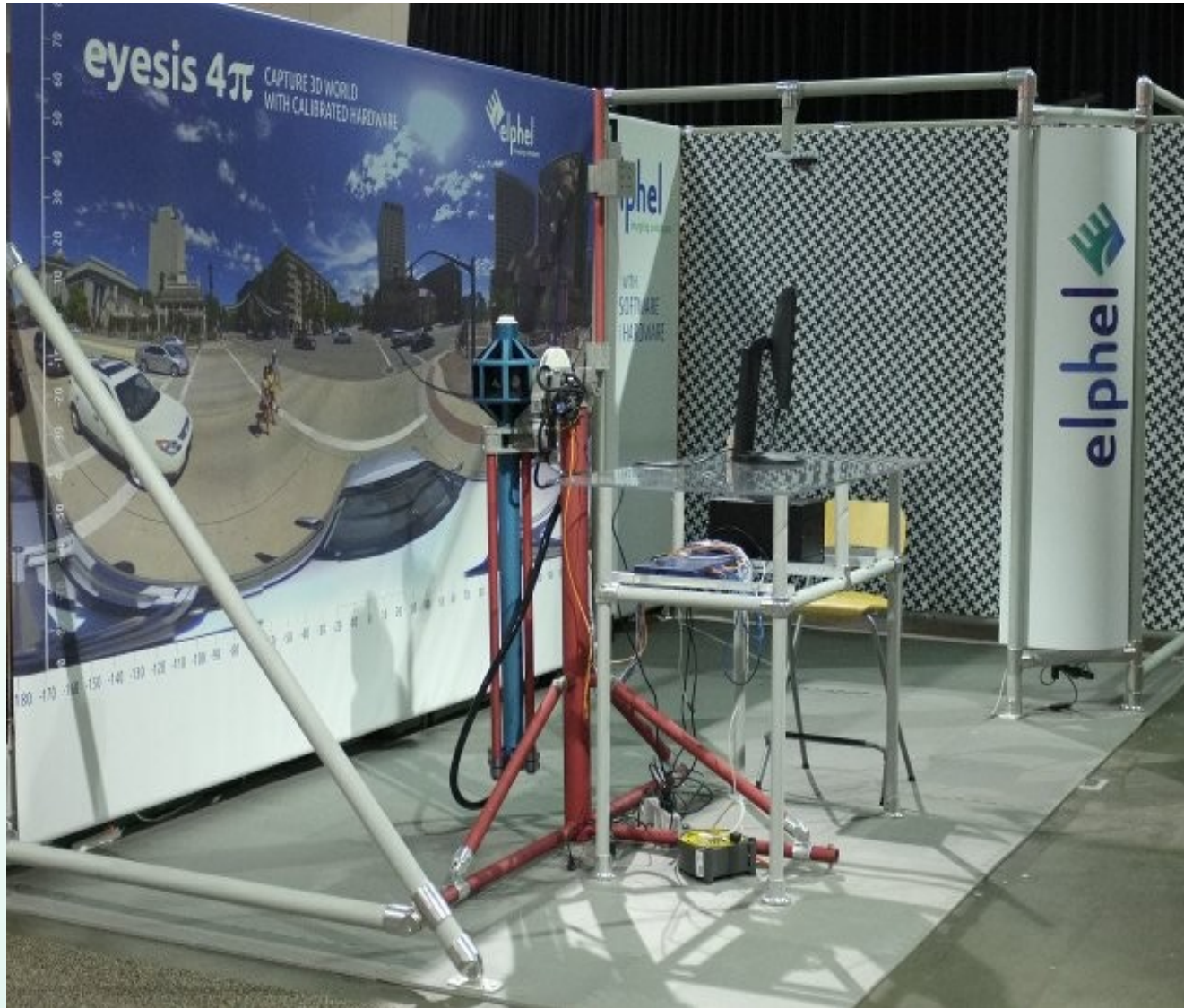
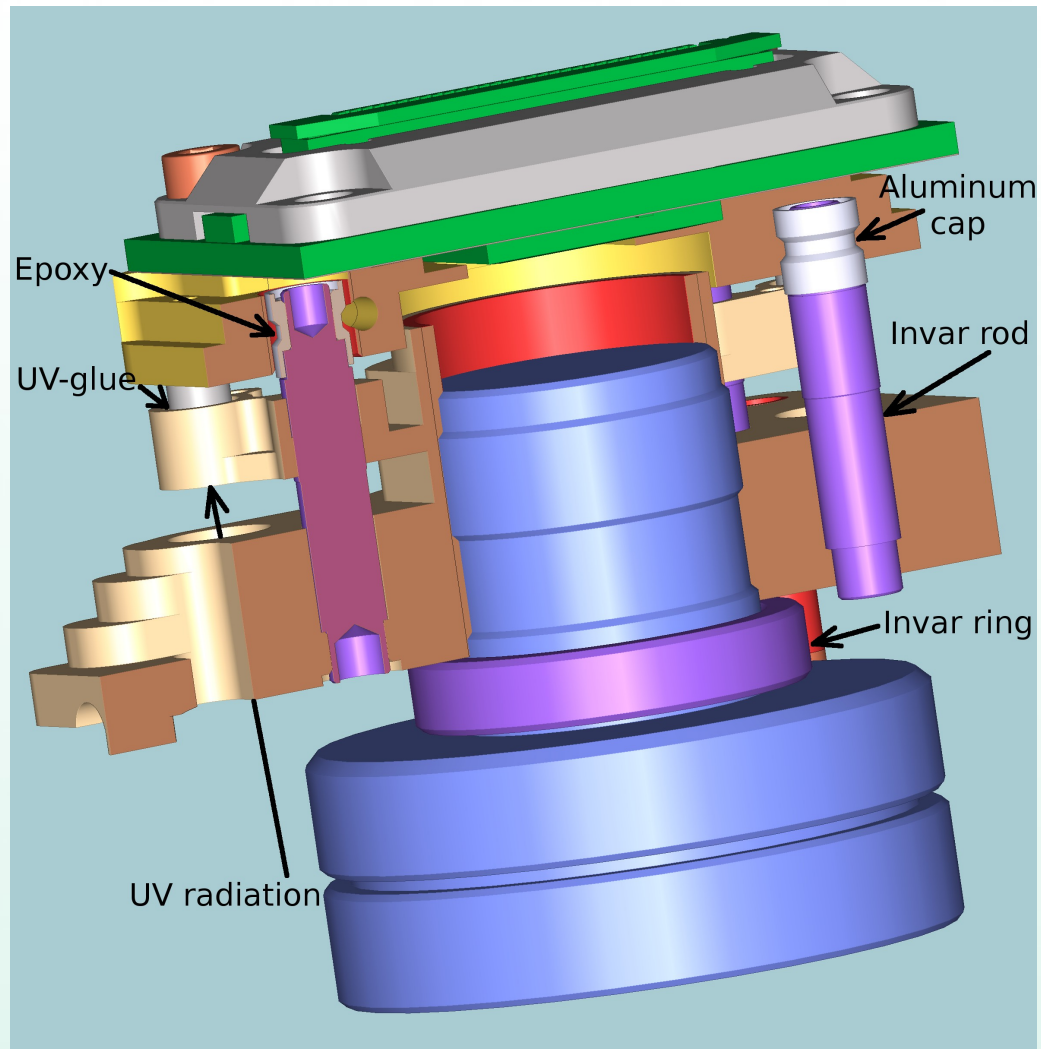


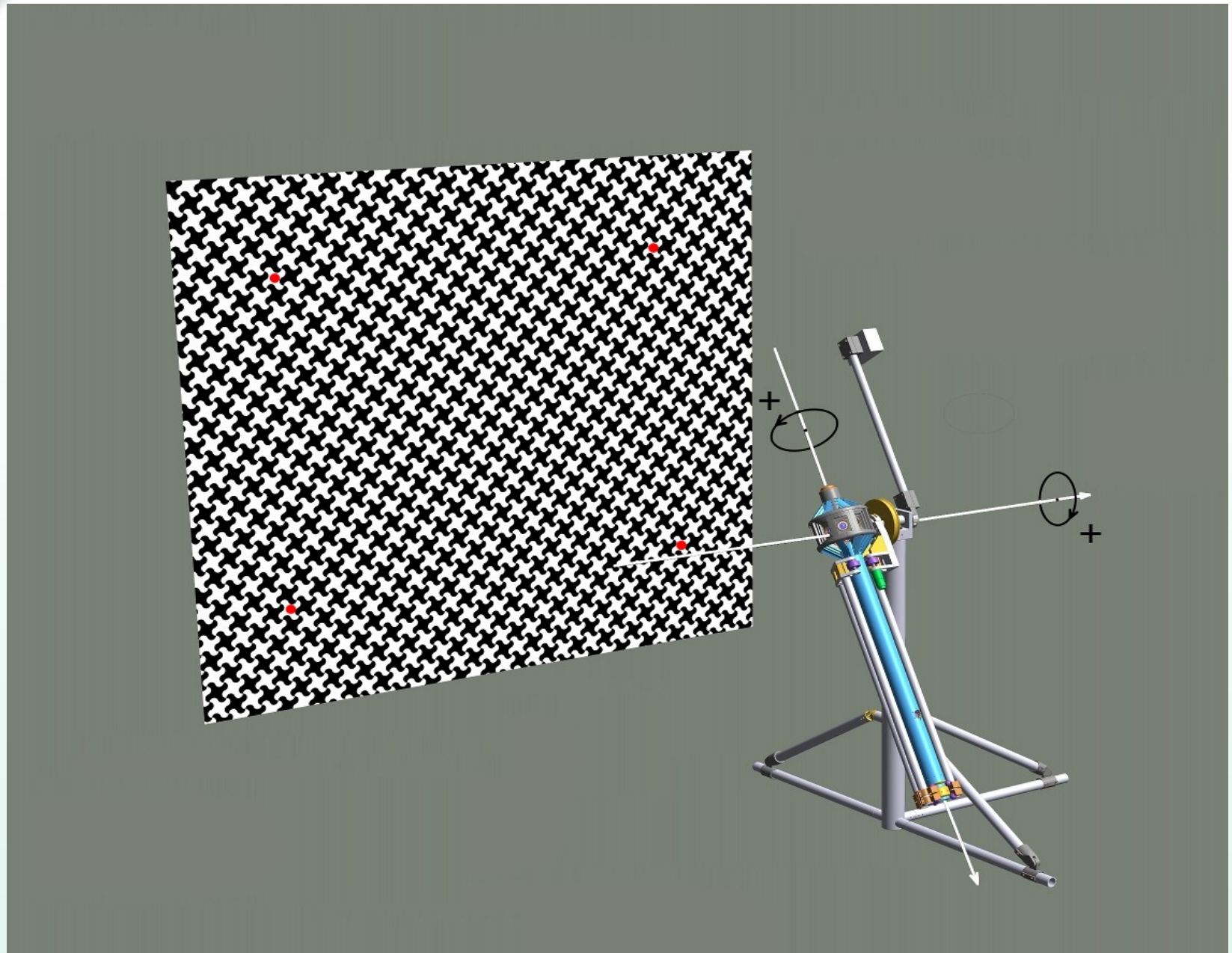
Spherical View Multi-Camera System Calibration

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Calibration setup



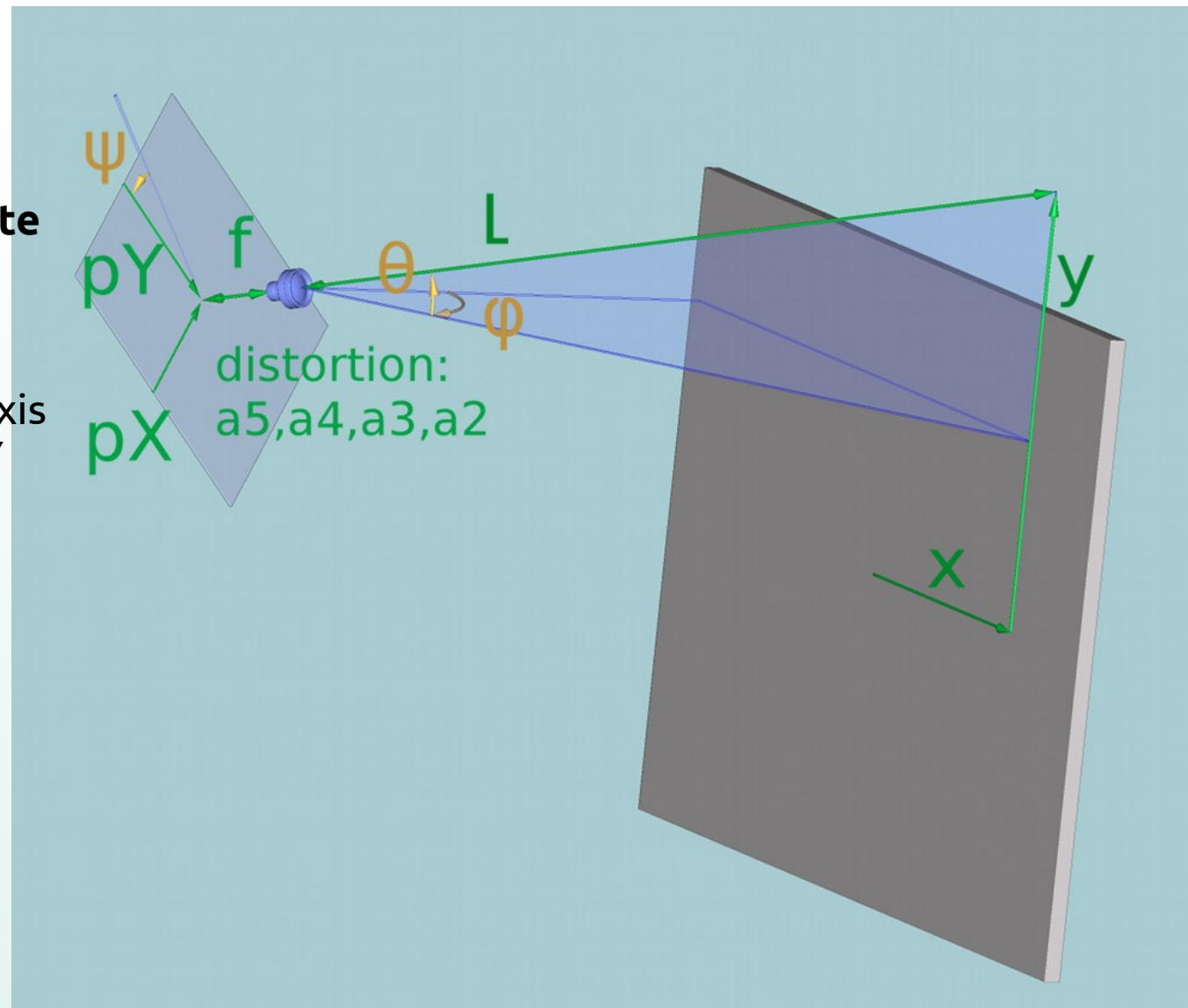
Individual sensor front end (SFE) parameters (13)

6 extrinsic SFE parameters (relative to the target coordinate system):

- X – lens axis on target plane X
- Y – lens axis on target plane Y
- L – distance from target along axis
- ϕ – axis rotation around target Y
- θ – axis elevation from XZ plane
- ψ - camera roll around lens axis

7 intrinsic SFE parameters:

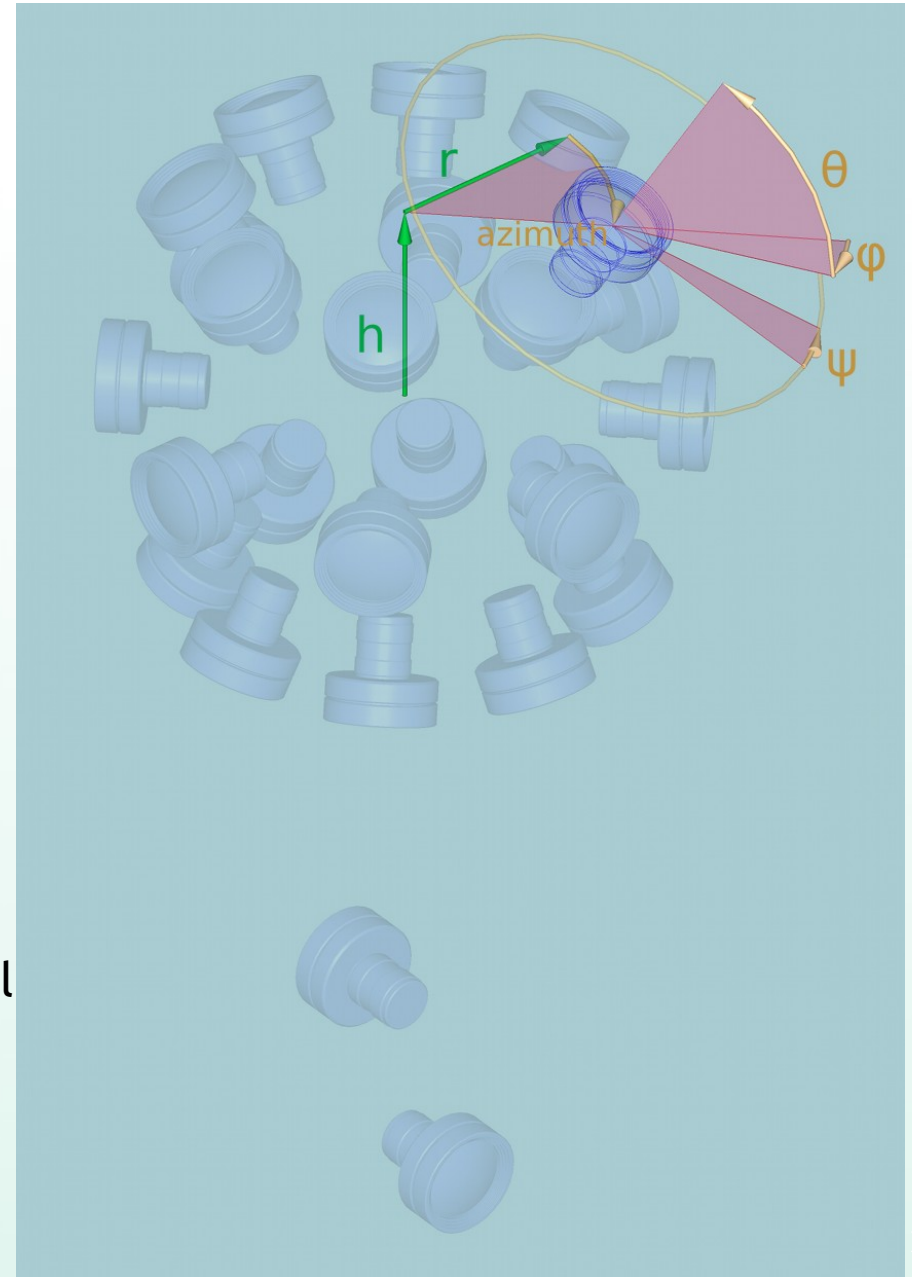
- f – lens focal length
- pX – pixel X of the lens axis
- pY – pixel Y of the lens axis
- $a2..a5$ - four radial distortion model polynomial coefficients



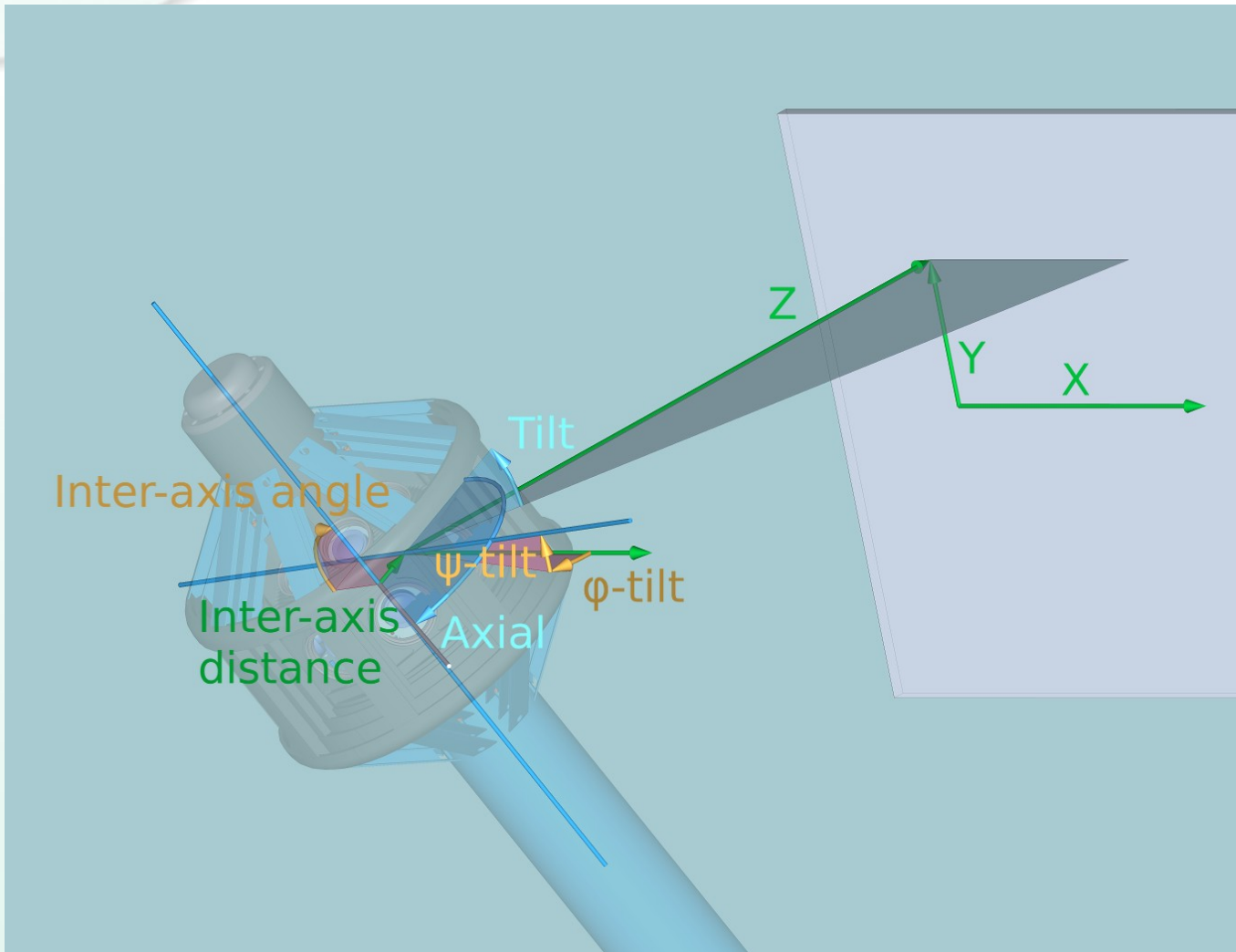
Sensor front end (SFE) location relative to the camera coordinate system

Camera has rotational symmetry around the vertical axis so cylindrical coordinates are convenient

- **h** – SFE (lens center) height from the camera center
- **r** – SFE distance from the camera vertical axis
- **azimuth** – SFE angular position
- **ϕ** – SFE optical axis rotation around the vertical camera axis from directly outwards
- **θ** – SFE optical axis elevation from the plane perpendicular to the camera axis
- **ψ** – SFE roll angle



Parameters of the camera calibration machine



Camera position parameters (9):

- constant (7) -
- X** – camera center X
- Y** – camera center Y
- Z** – camera center Z
- **ϕ -tilt** – angle between the horizontal camera rotation axis and target X around target Y
- **ψ** – angle between the horizontal camera rotation axis and target X around target Z
- **inter-axis distance** between rotational axes
- **inter-axis angle** between rotational axes
 - variable (2) -
- **tilt** – rotation around horizontal axis
- **axial** – rotation around camera axis

Reprojection error remaining after the radial distortion model

Metadata:

(distortion radius=2.8512mm)

$R_{dist}/R = a_5 \cdot R^4 + a_4 \cdot R^3 + a_3 \cdot R^2 + a_2 \cdot R + (1 - a_5 - a_4 - a_3 - a_2)$

$a_5 = 0.0637$

$a_4 = -0.0844$

$a_3 = 0.0216$

$a_2 = -0.0218$

focal length = 4.520 mm

$px_0 = 1299.49$ pix

$py_0 = 967.02$ pix

height = 0.0 mm

azimuth = 270.0

radius = 54.5 mm

heading = 0.640

elevation = 0.20

roll = 90.73

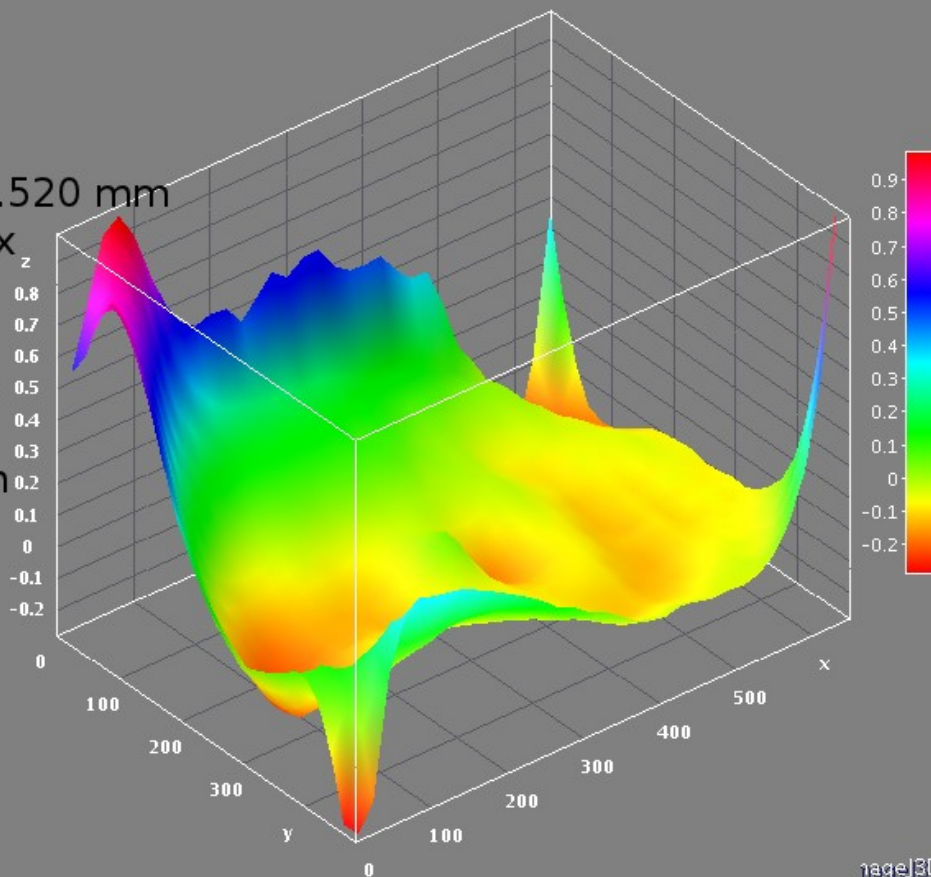
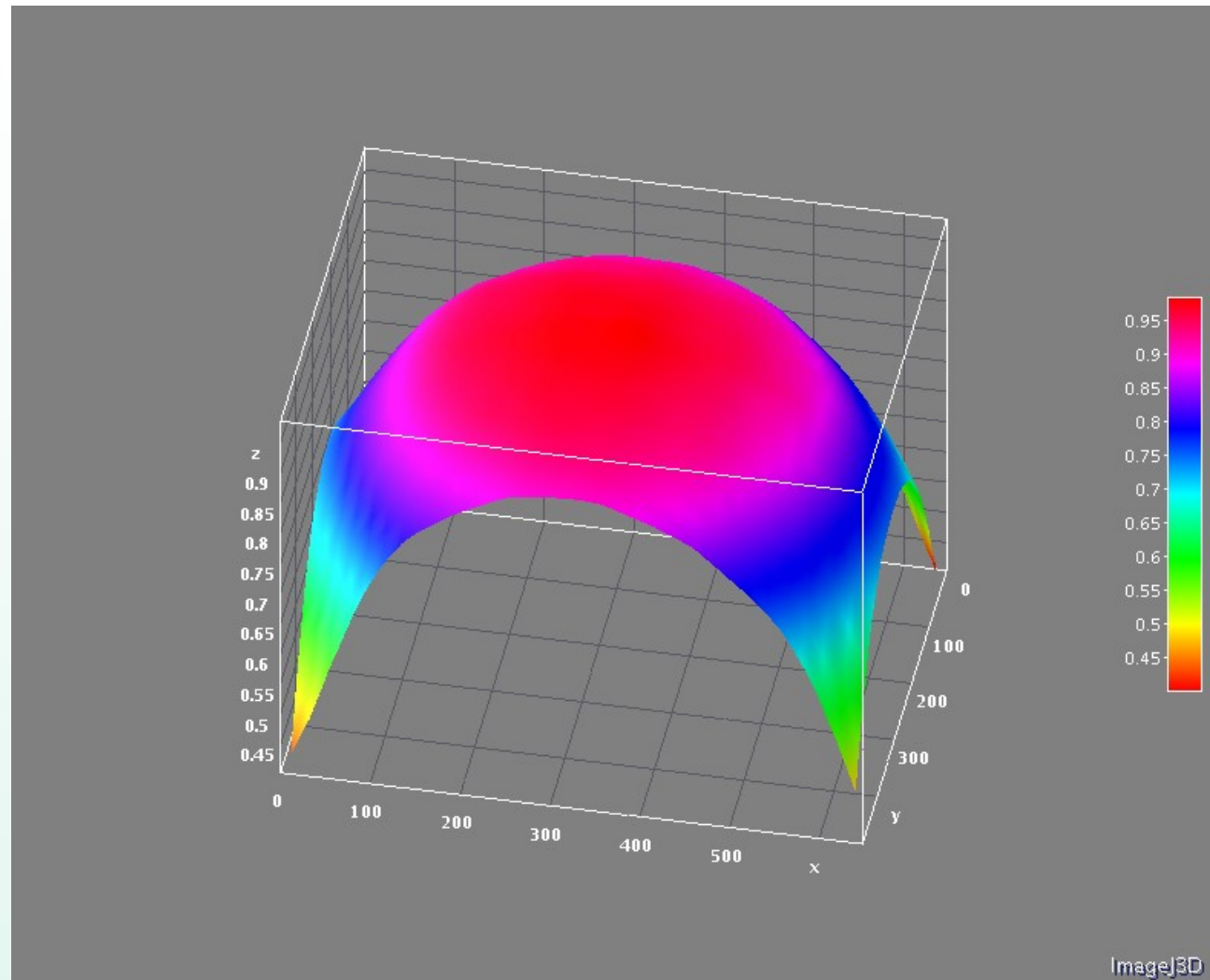


Image vignetting measured for green channel



Overlapping view areas of the 2 subcameras and frequency-domain linear features extraction



Multi-camera setups for controlled depth of field video capturing

