Sparkle and graininess facilities at CMI

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Sparkle Facility

- Robot based (6 axis Mitsubishi to set the sample orientation)

- Motorized circular ≈70 cm diameter ring to hold the detector

- Collimated broad band source (W lamp) distance from the sample > 3 m

- Typical spot size on the sample 25 mm

- Detector : Luminance camera (LMK 5 color)

- Shutter

- Automated software to set the measurement geometrical conditions and acquiring HDR images of the sample (dark and light)

- Data analysis
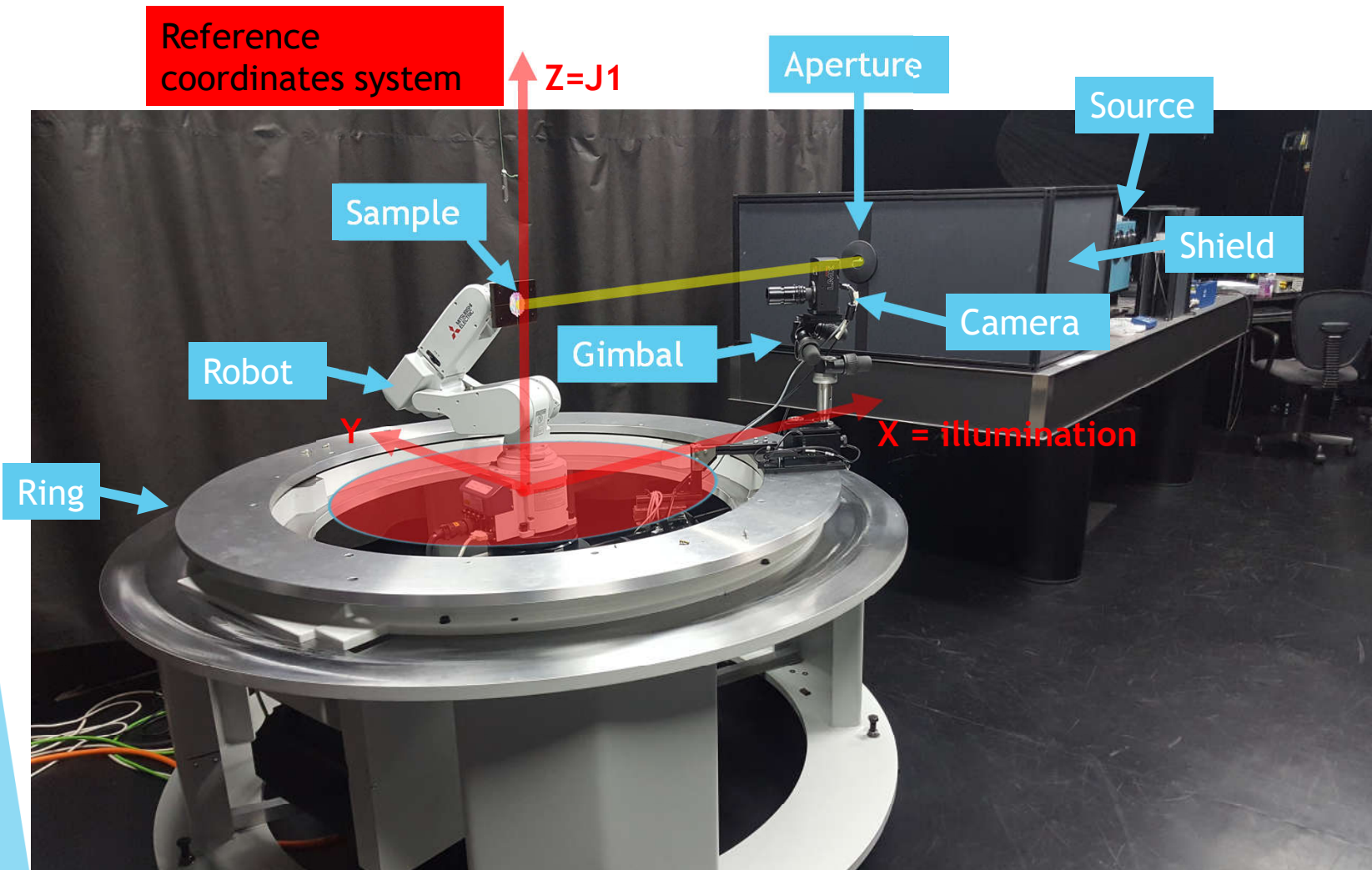
X robot axis = illumination direction
Z robot axis = first robot joint (J1) = rotation axis ring

Luminance camera (LMK 5 color)

- V lambda filter
- *luminance distributions in measuring images L(x,y)*
- 14 bit CCD sensor 1380x1030 pixel
- Fixed lens aperture
- At about 70 cm a pixel corresponds to 31μm on the sample plane
- *Exposure time 100 μs...15 s*
- *HDR pictures*
- *Fully integrated in the facility software*

Aligning the sample


Aperture

Sample

Camera

X

Y
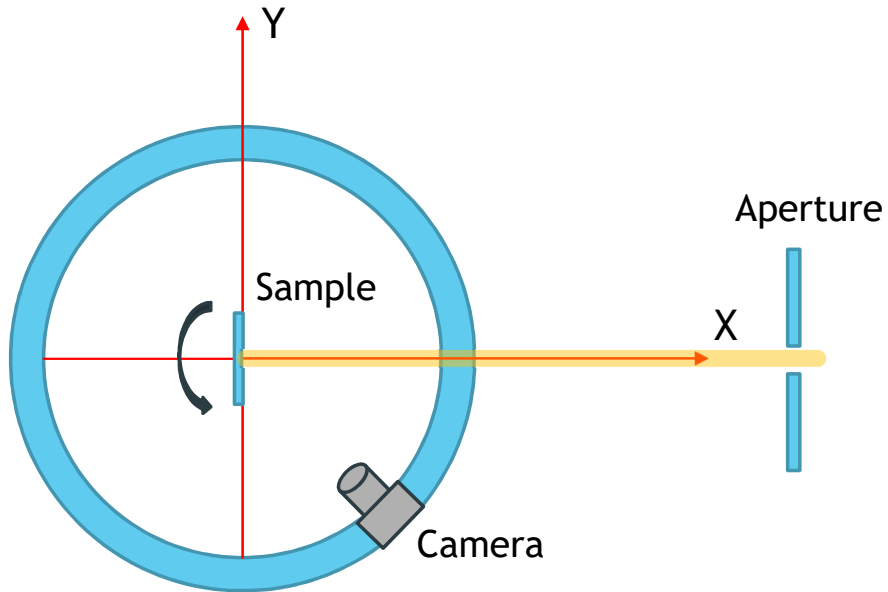
3d printed sample holder with visual target

1. The thickness of the holder + sample is measured (X offset)
2. Sample is moved on YZ to be illuminated in the middle (using a target in the sample holder)
3. Sample is oriented to have its back reflection aligned with the illumination
4. The resulting sample position and orientation data is stored
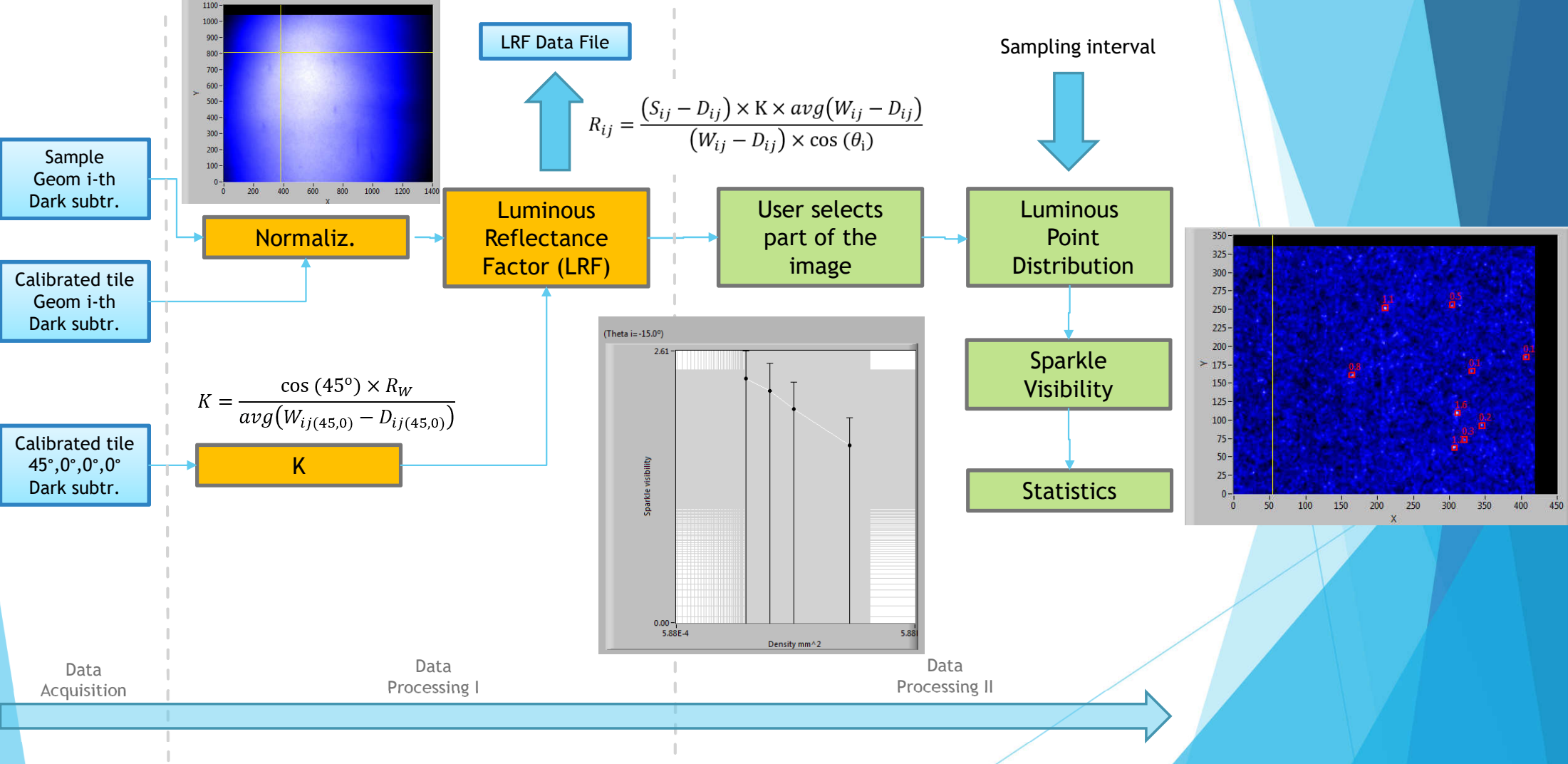
Aligning the detector
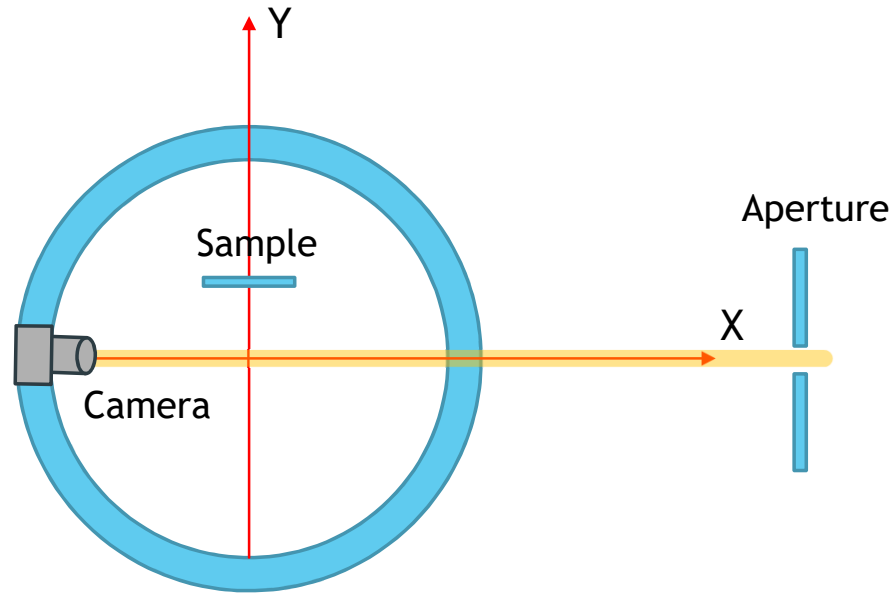
1. The sample is moved in a position to not obstruct the illumination beam
2. The camera is set to face the illumination beam and its height adjusted
3. The ring angle is adjusted to illuminate the camera objective in the middle
4. The camera roll pitch angles are adjusted to have the back reflection aligned with the illumination beam

Sparkle Measurement sequence

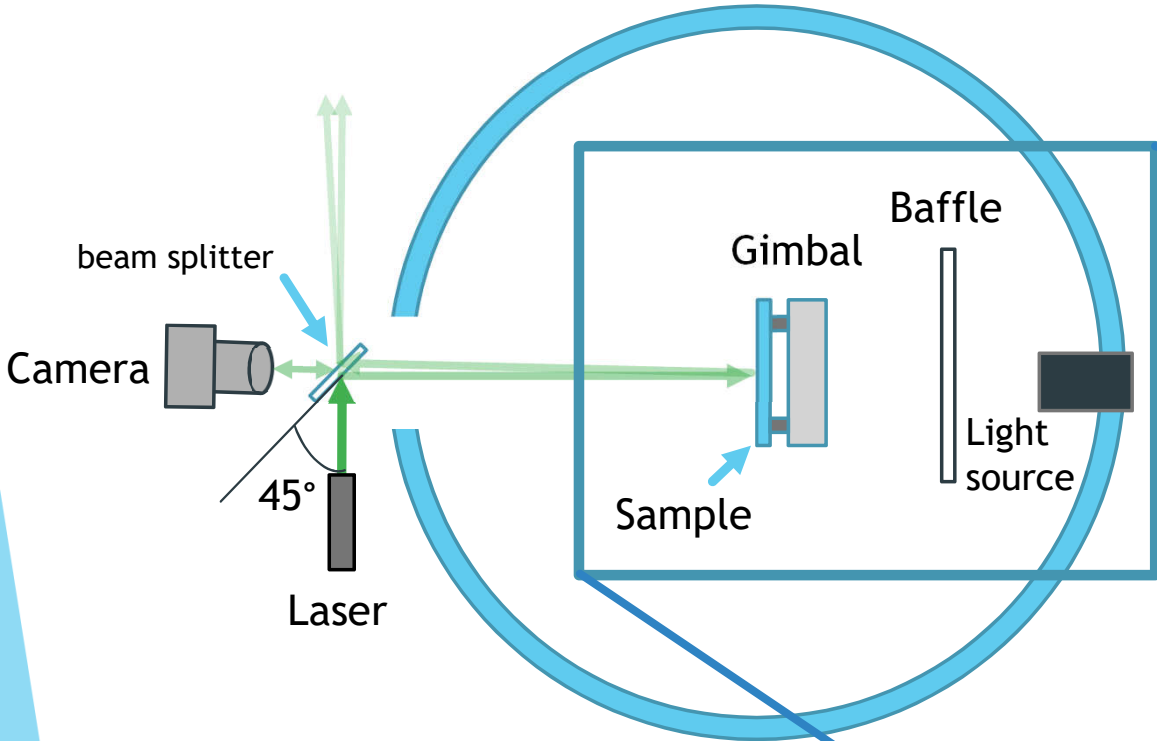1. Sample oriented according the desired measurement geometry i-th

2. Camera is moved to the resulting observing position

3. The shutter is closed

4. A dark image is acquired

5. The shutter is opened

6. A image is acquired

7. Repeat from step 1 for the following geometry (++i)

8. Repeat from step 1 replacing the sample with a uniform ceramic tile

9. Measure calibrated ceramic tile in the configuration 45°,0° ,0° ,0°

Sparkle Data Analysis flow chart

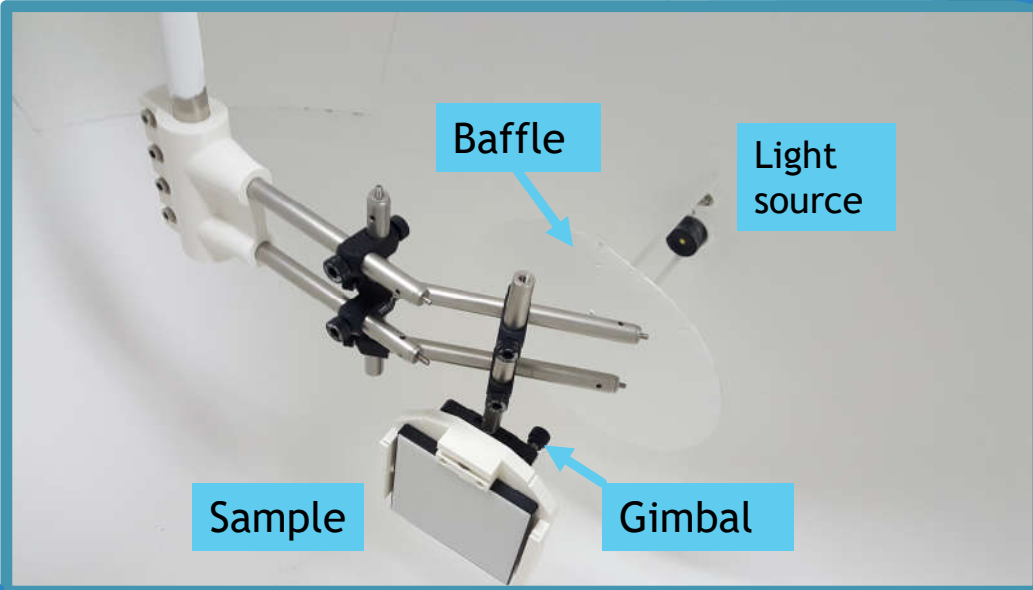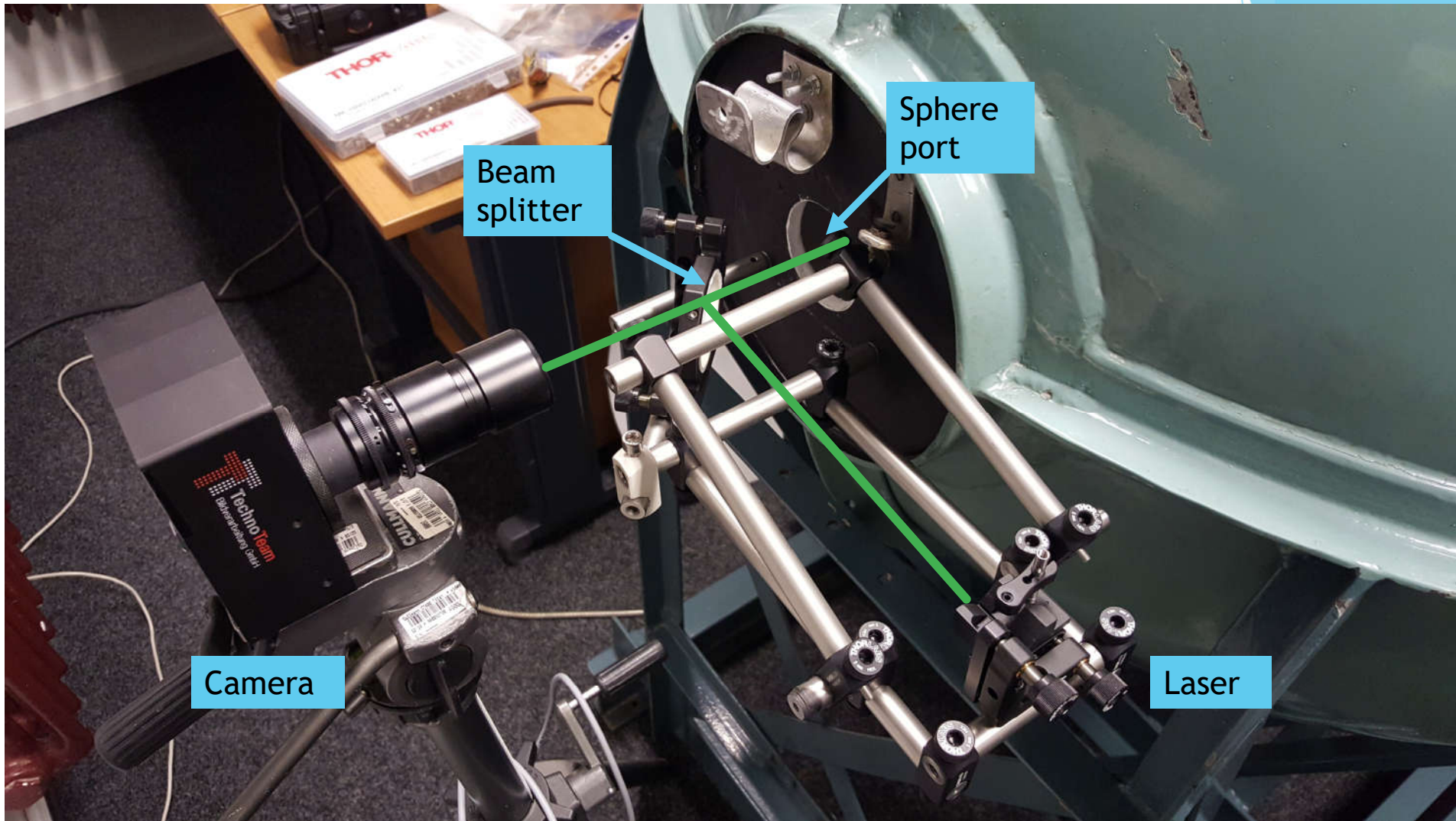**Sample Geom i-th Dark subtr.** → **Normaliz.**

Calibrated tile Geom i-th Dark subtr. → **Normaliz.**

Normaliz. → **Luminous Reflectance Factor (LRF)** → **LRF Data File**

$$R_{ij} = \frac{(S_{ij} - D_{ij}) \times \mathrm{K} \times avg(W_{ij} - D_{ij})}{(W_{ij} - D_{ij}) \times \cos(\theta_i)}$$

$$K = \frac{\cos(45^\circ) \times R_W}{avg(W_{ij(45,0)} - D_{ij(45,0)})}$$

Calibrated tile 45°,0°,0°,0° Dark subtr. → **K** → **Luminous Reflectance Factor (LRF)**

Luminous Reflectance Factor (LRF) → **User selects part of the image** → **Luminous Point Distribution**

Sampling interval → **Luminous Point Distribution**

Luminous Point Distribution → **Sparkle Visibility** → **Statistics**

(Theta i=-15.0°)

Sparkle visibility / Density mm^2

Data Acquisition | Data Processing I | Data Processing II

Graininess Facility

1m integrating sphere

Baffle

Gimbal

beam splitter

Camera

Sample

Light source

45°

Laser

Current setup to measure d:0°

Baffle

Light source

Sample

Gimbal

Beam splitter

Sphere port

Camera

Laser