# The alignment of the $C^3$ accellerator structures and Quads with Rasnik

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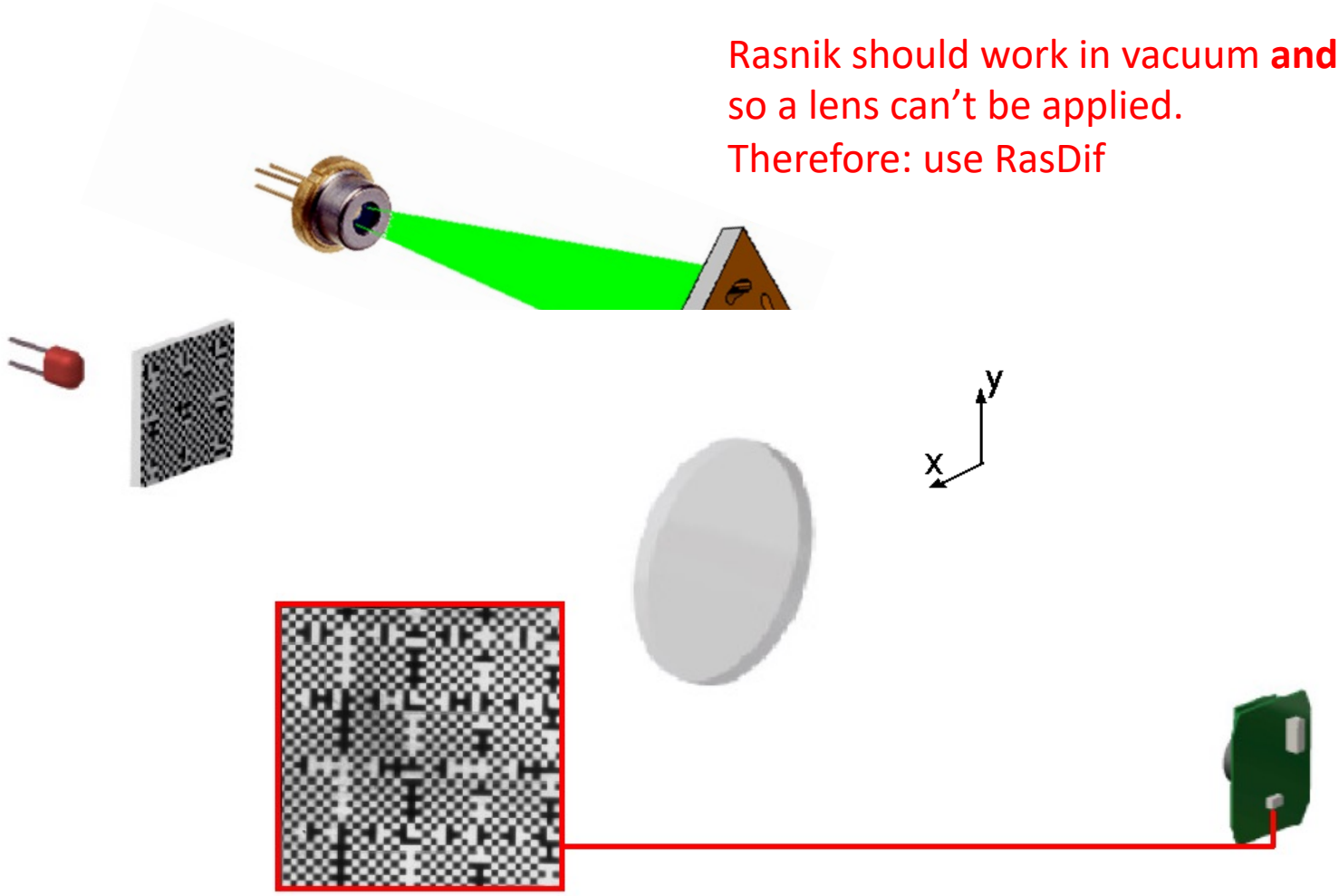
$C^3$ Workshop SLAC
Feb 13 2024
13:30 – 13:50 h

Nikhef

University of Antwerp
Faculty of Science

# Long distance Rasniks: RasDif

Rasnik should work in vacuum **and** in $LN_2$,
so a lens can't be applied.
Therefore: use RasDif



Alignment over long distance ( > 100 m):
RasClic, later RasDif:

- replace lens by zone plate (diffraction plate)

- replace coded mask by monochromatic spherical-wave light source (4 $ laser diode)

H. Manaud Durand et al., *RASCLIC: a long baseline* 3-*point alignment system for particle accelerators*, presented at the 10th *International Workshop on Accelerator Alignment*, KEK, Tsukuba, Japan February 2008.

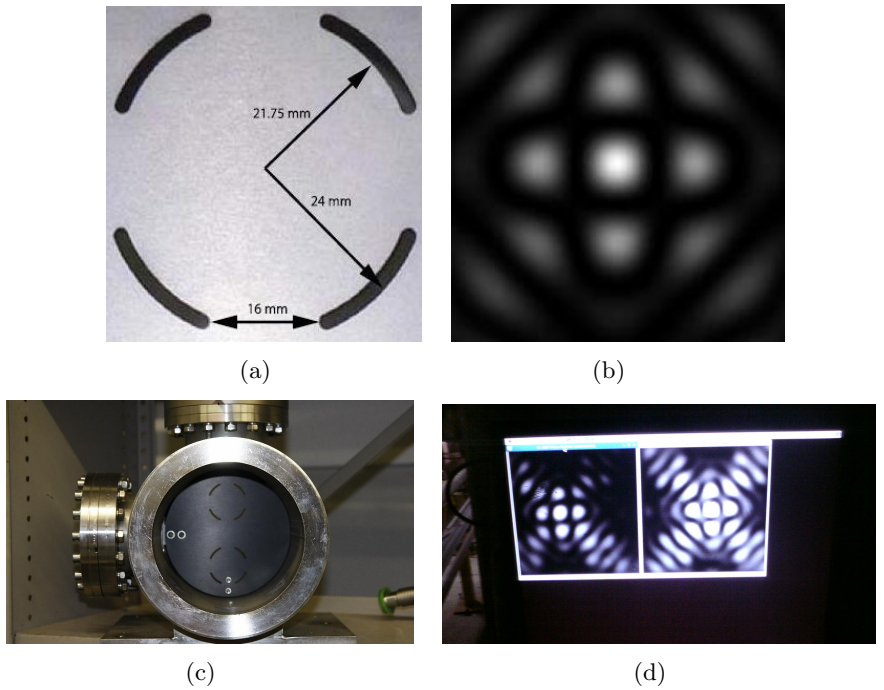



Figure 4.8: (a) Design and dimensions of the diffraction pattern, (b) simulations of the resulting diffraction pattern, (c) a photograph of the plate holder and (d) a photograph of the pixel image sensor read-out at the PC

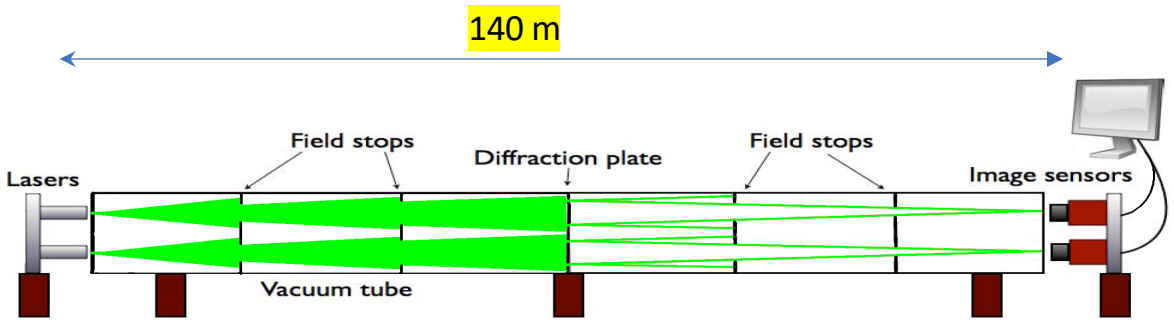
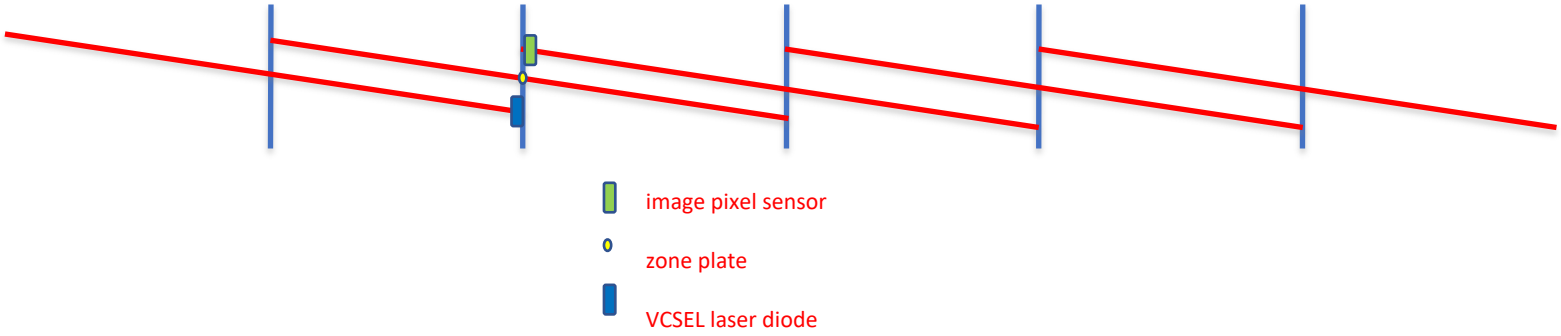



Figure 4.7: Schematic overview of the RasCLiC set-up, showing the operation of the field stops

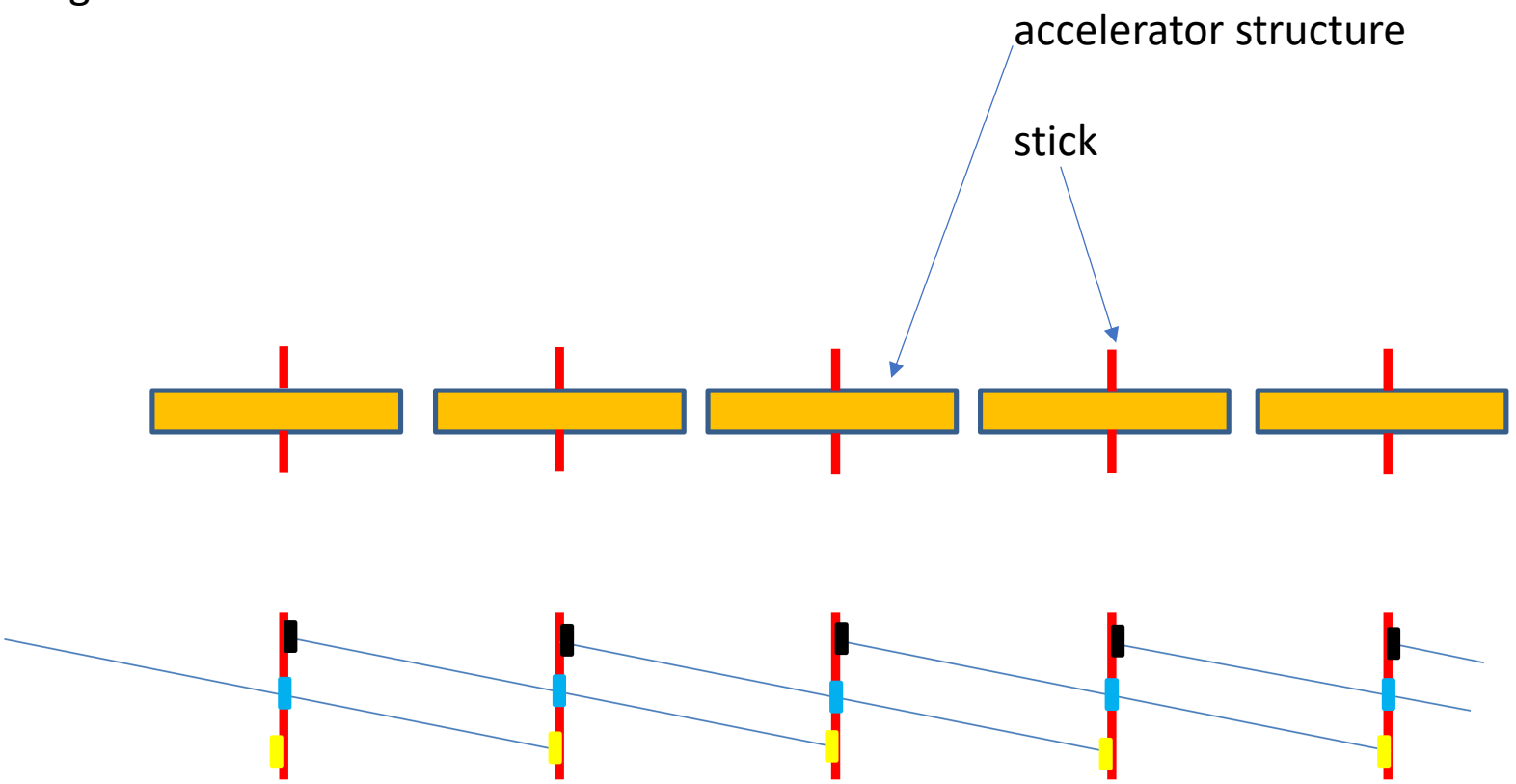
Pioneered by A. Seryi, SLAC:
Investigation of slow motions of the SLAC linac tunnel, SLAC-PUB-8597 8597 (1) (2000) P06034, arXiv:physics/0008195.

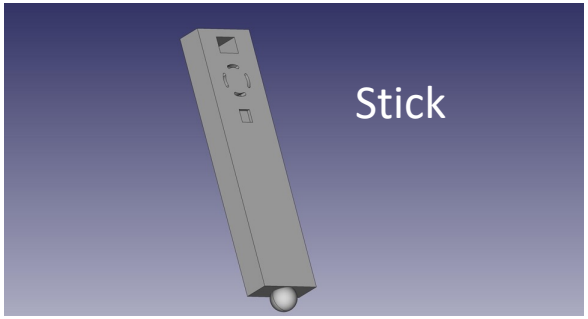
From 3-point alignment system to n-point alignment system:

***sticks***



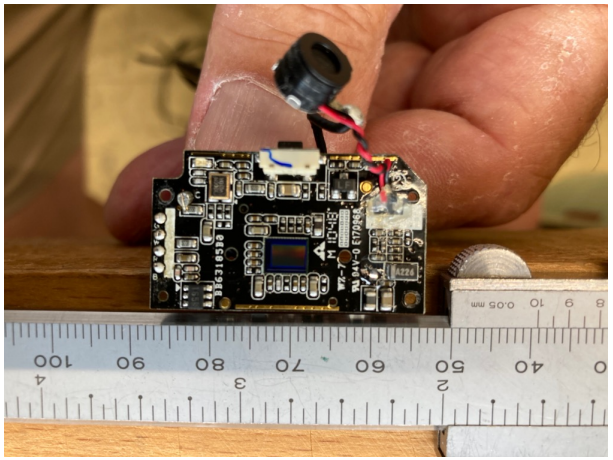
C3: alignment of ~2100 accelerator structures



# Cam: CMOS image pixel sensor + supporting pcb


Microsoft webcam HD-3000
Model 1456 or earlier (2012)
has been reported to operate in $LN_2$

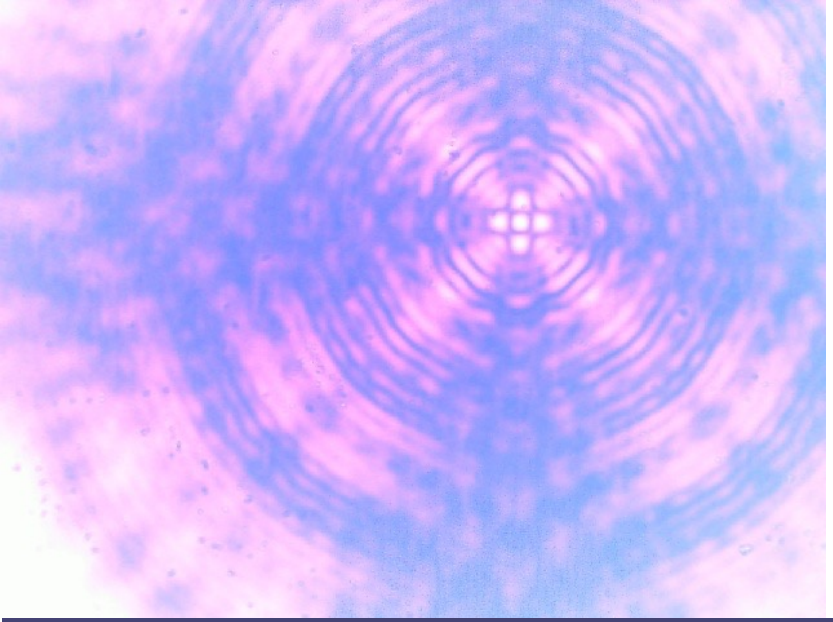


after being demolished carefully

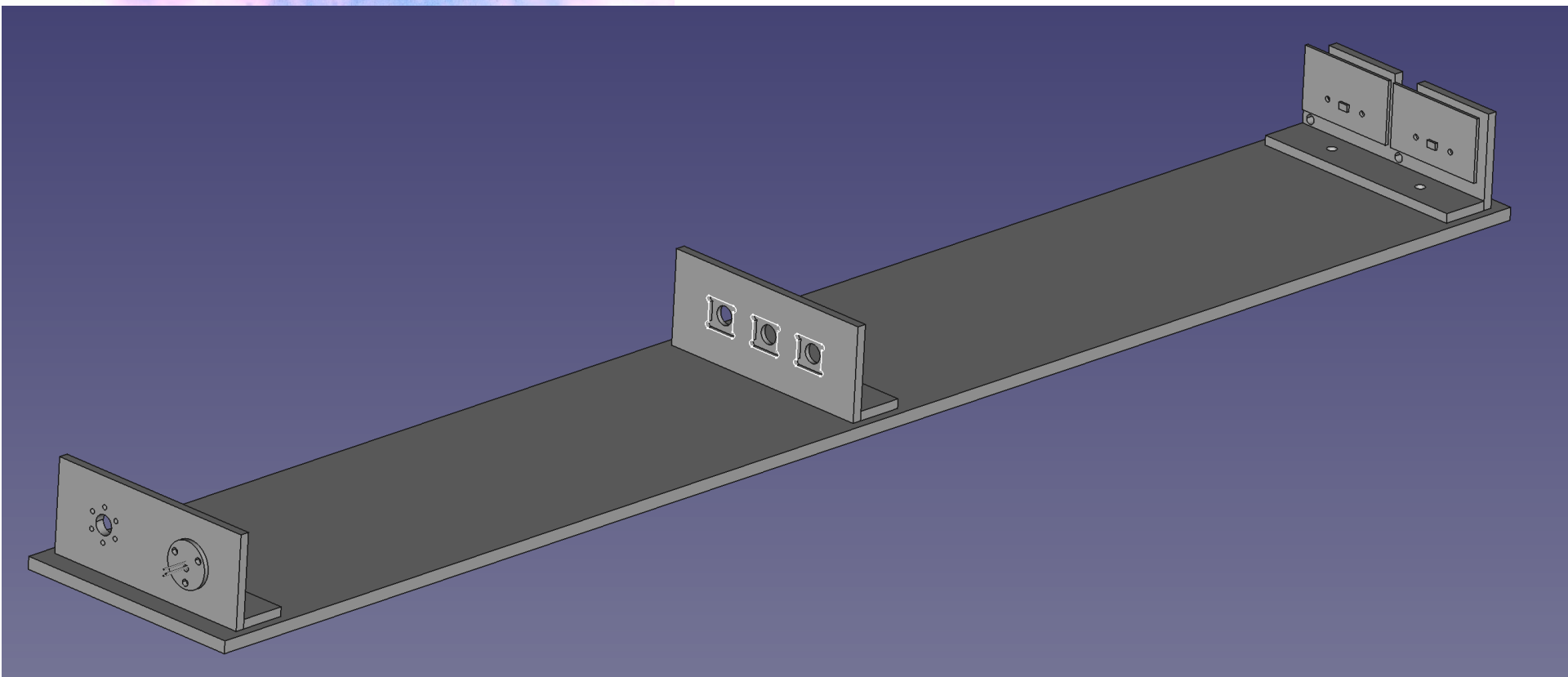
Since this webcam works in $LN_2$, it can be well applied in R & D studies inside cryostats (i.e. bubble formation)! Frame rate 30 Hz

# LaserDiode: ROHM RDL 65 MZT7

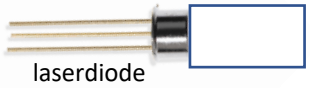
and **many others** work in $LN_2$. Supply voltage raises from 2.2 V @ room temp to 7.4 V @ 77 K for a current of 50 mA

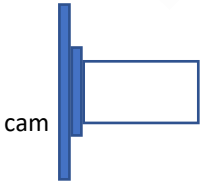


Typical Rasnik image (in air)

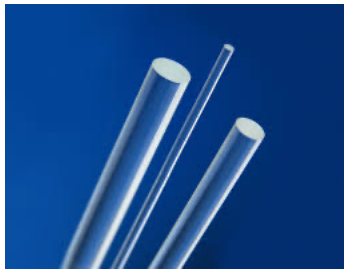



Updater
for this comp
finitions
Camera:
0: 640x480 30.0fps
No Flip
Re-Scan Cameras
Output Directory
/home/rasnikpc/Desktop
Take Photo
Record Video



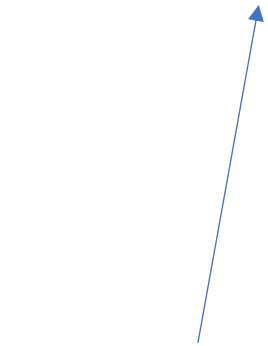

Solution for self-bubbling:
glass cylinder (Schott)



## Sources of disturbances

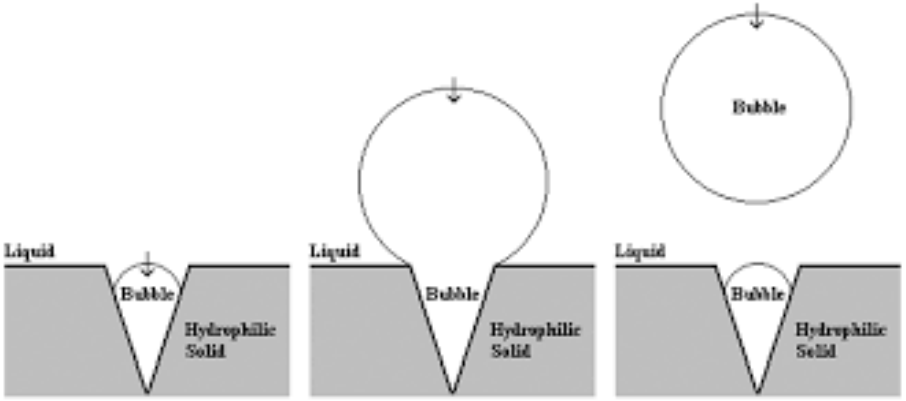
- bubbles:
    - big bubbles, due to boiling, passing light path
    - small bubbles due to nucleation points

- density fluctuations: due to
    - thermal convection
    - induced by passing bubbles)

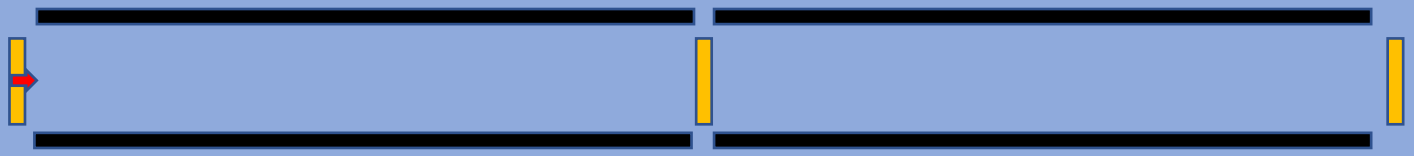


Possibly of no importance

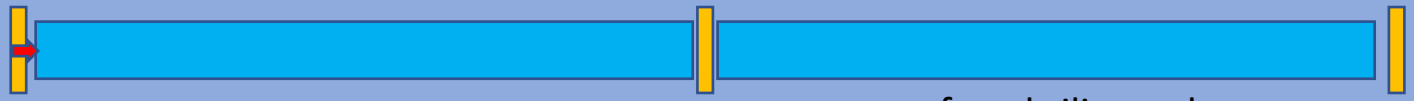
Nucleation: spontaneous bubble formation



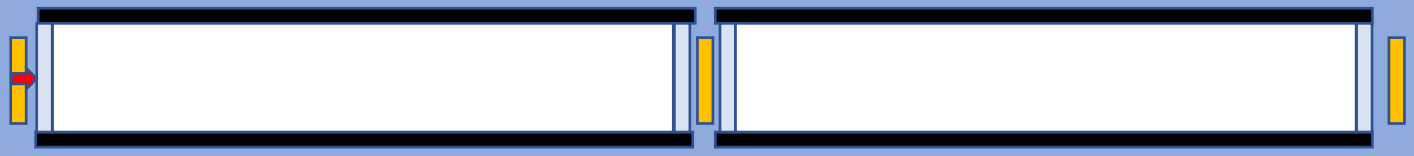
metal base plate under optical axis



open tube (filled with quiet $LN_2$)

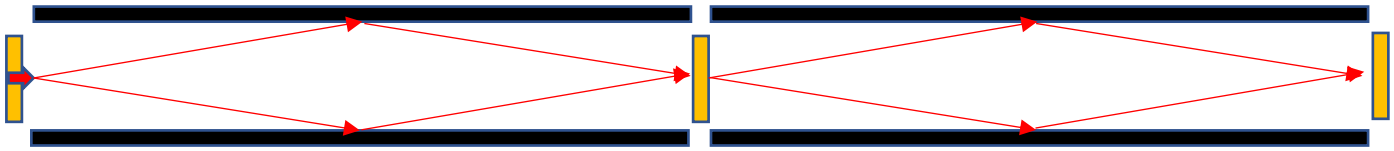


fused silica rod

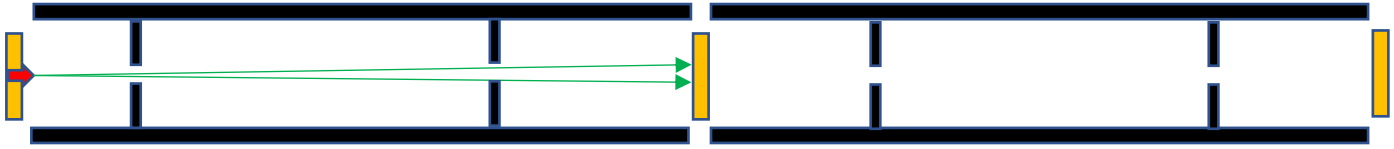


Tube with windows, vacuum or dry $N_2$ gas filled

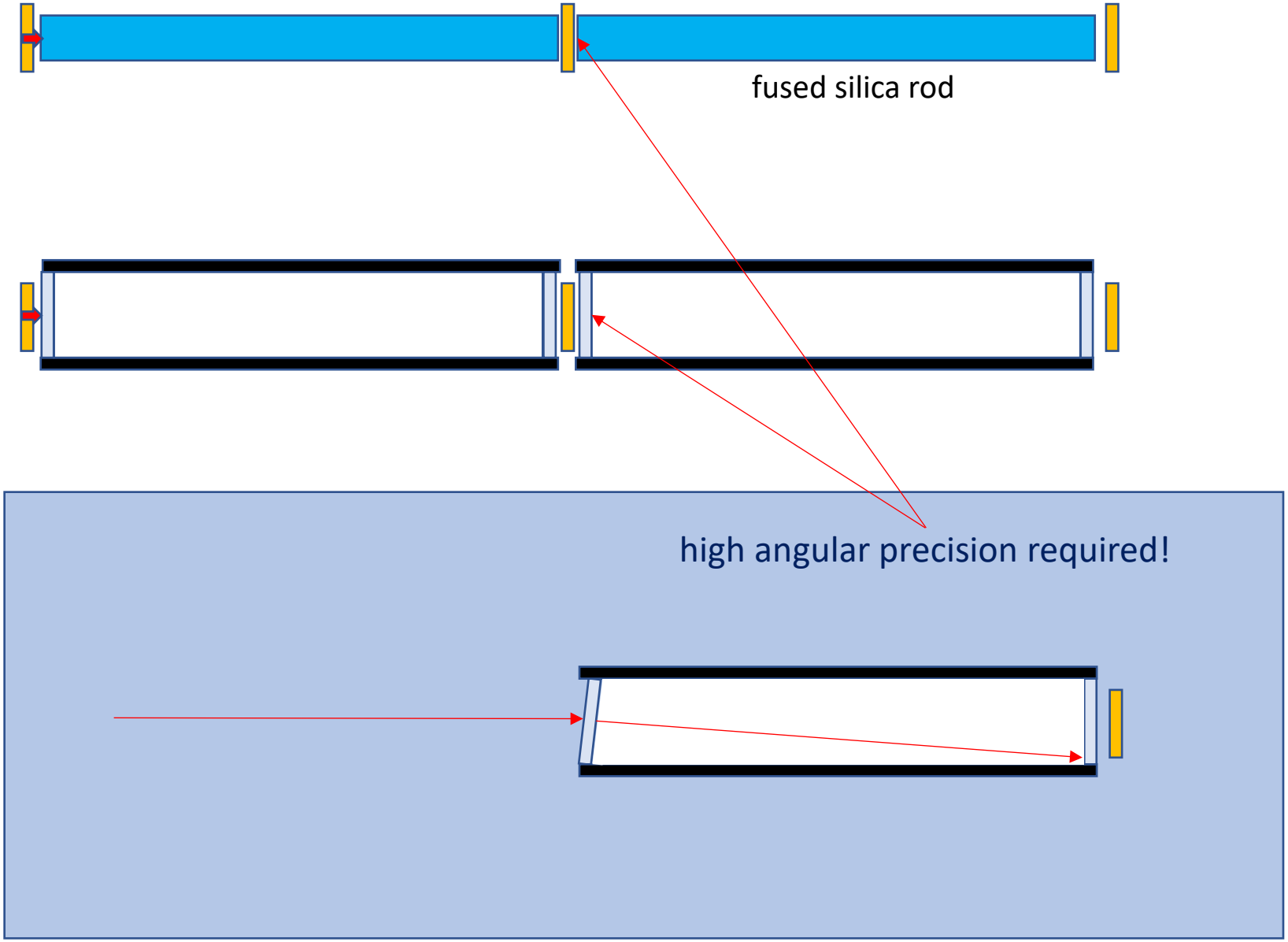
# Shielding with tubes: internal reflection against inside of tube wall

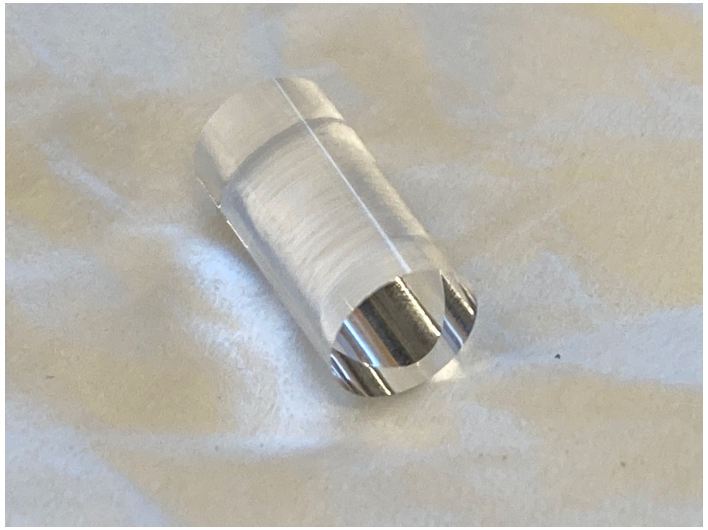


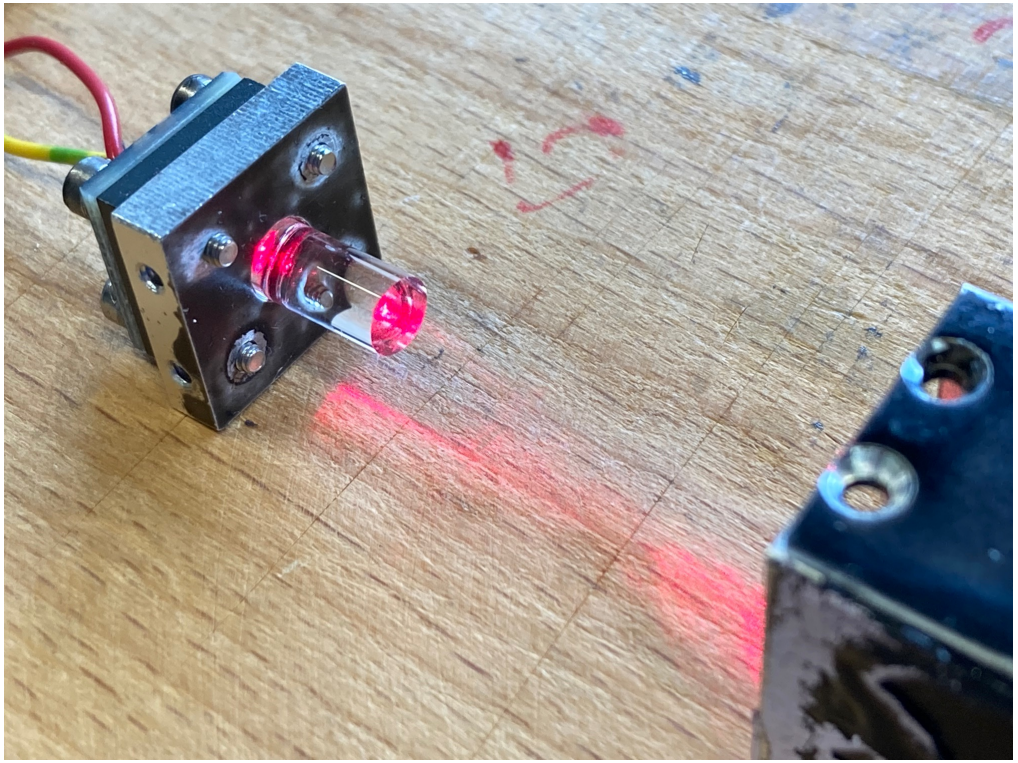
apply ***field stops***

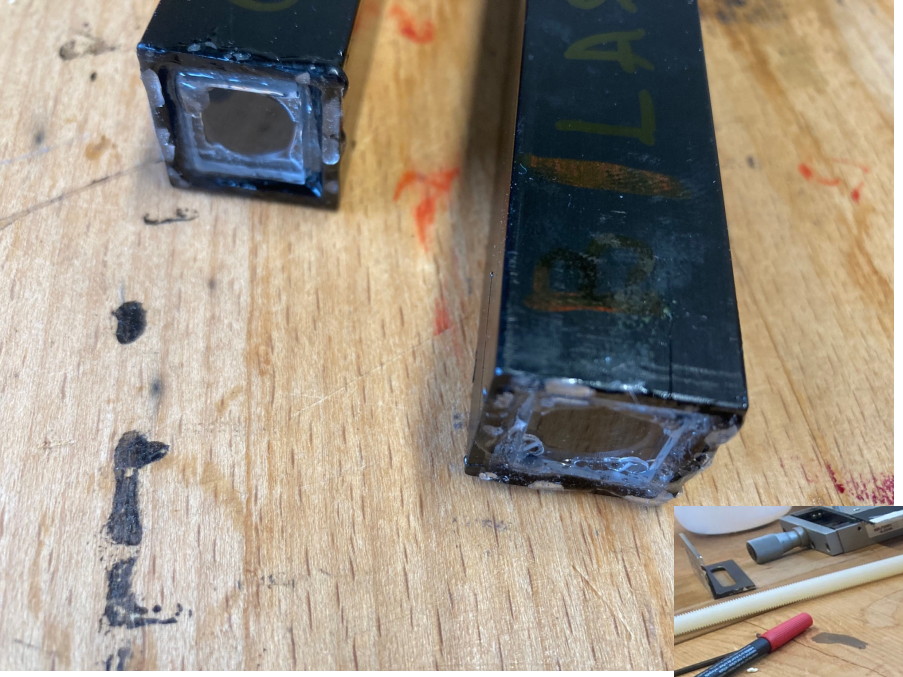


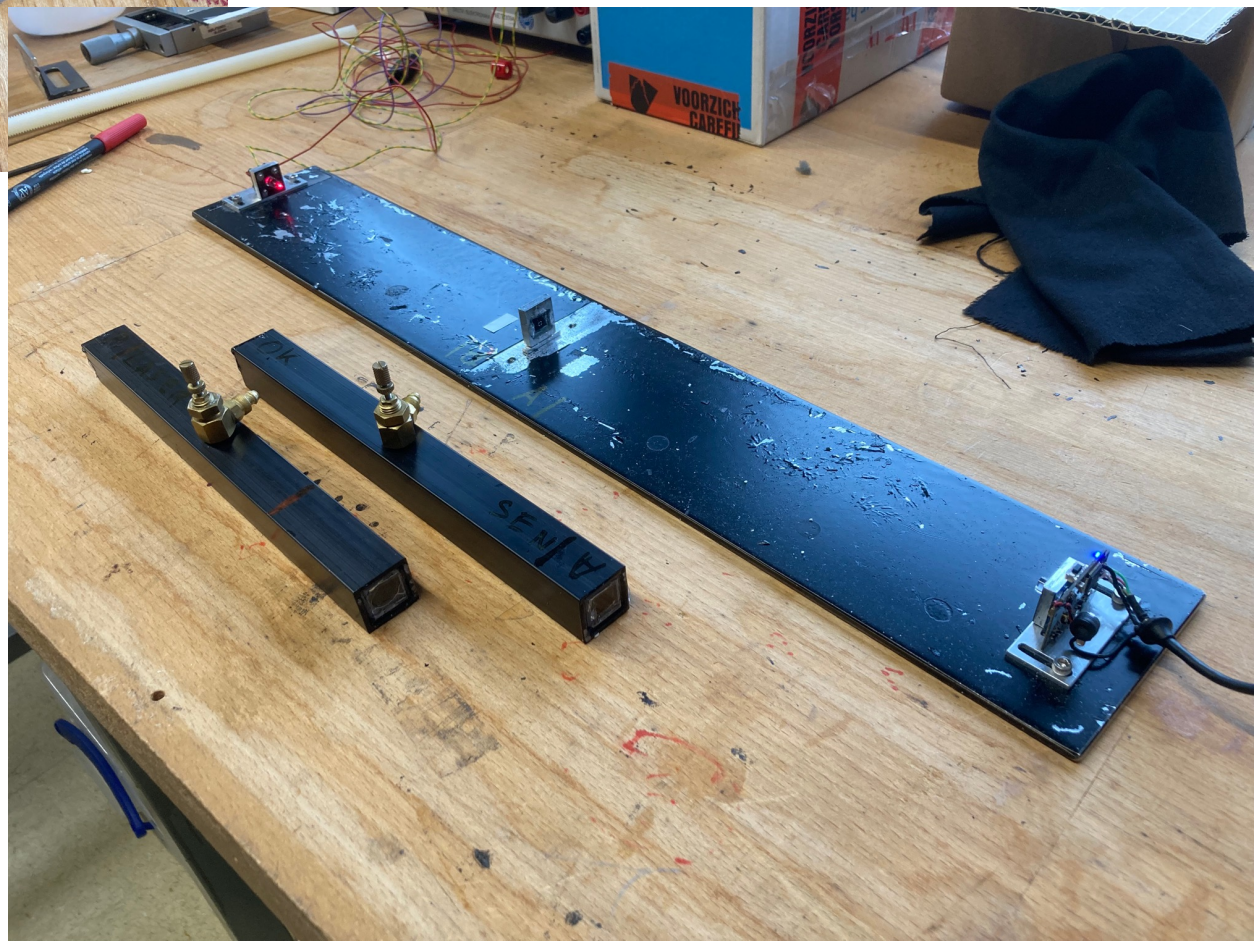
# Shielding with vacuum tubes or with fused silica rod: Snellius boundary crossing







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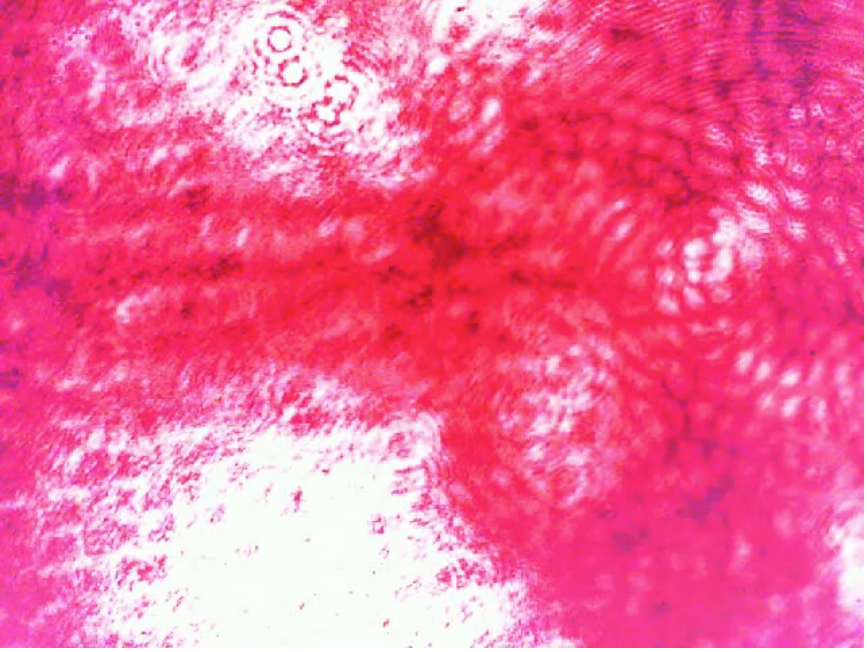
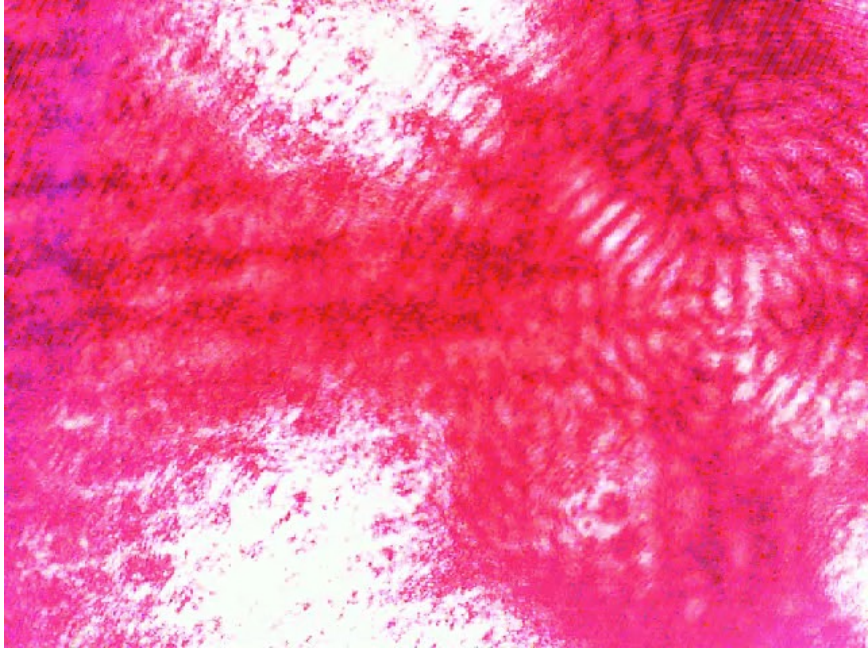
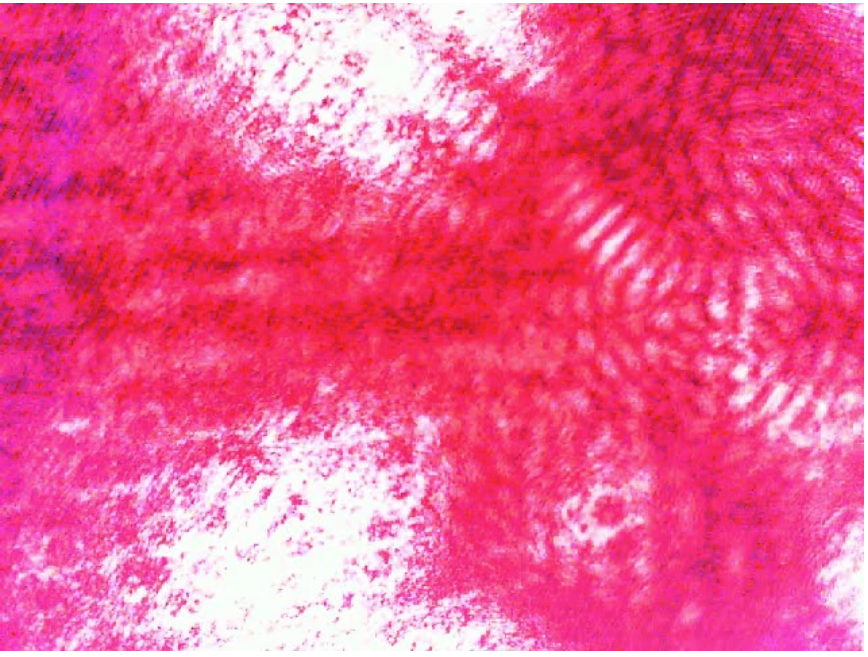
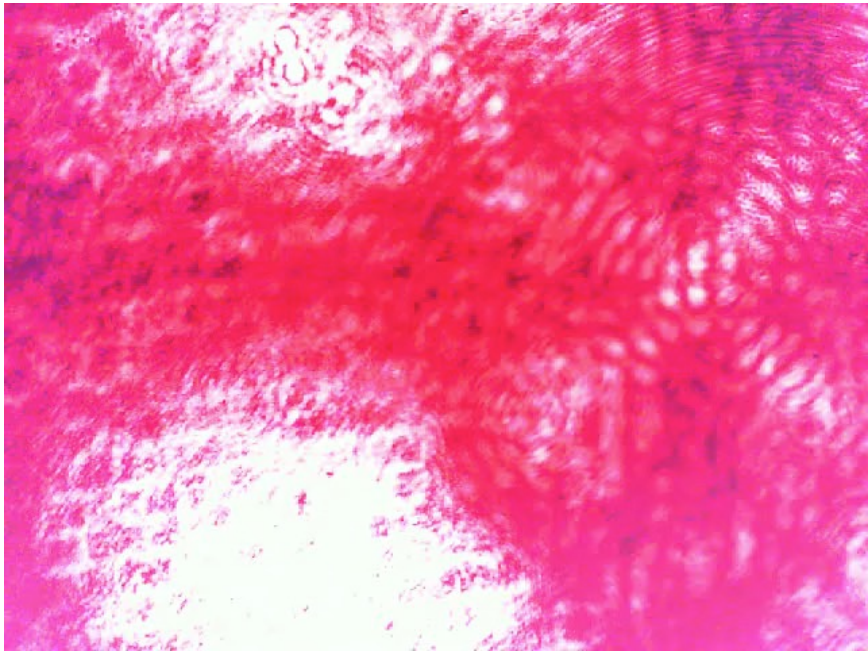
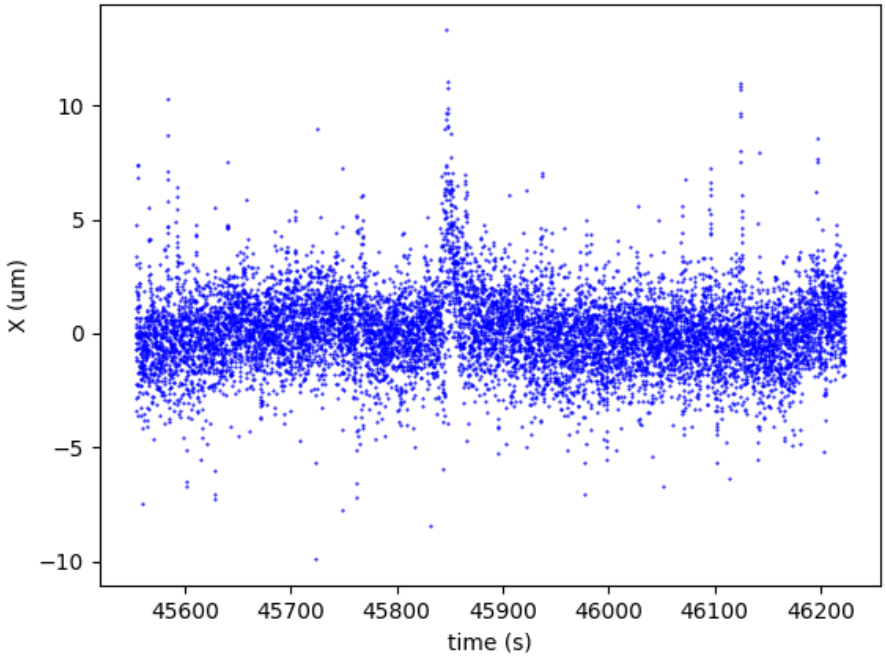
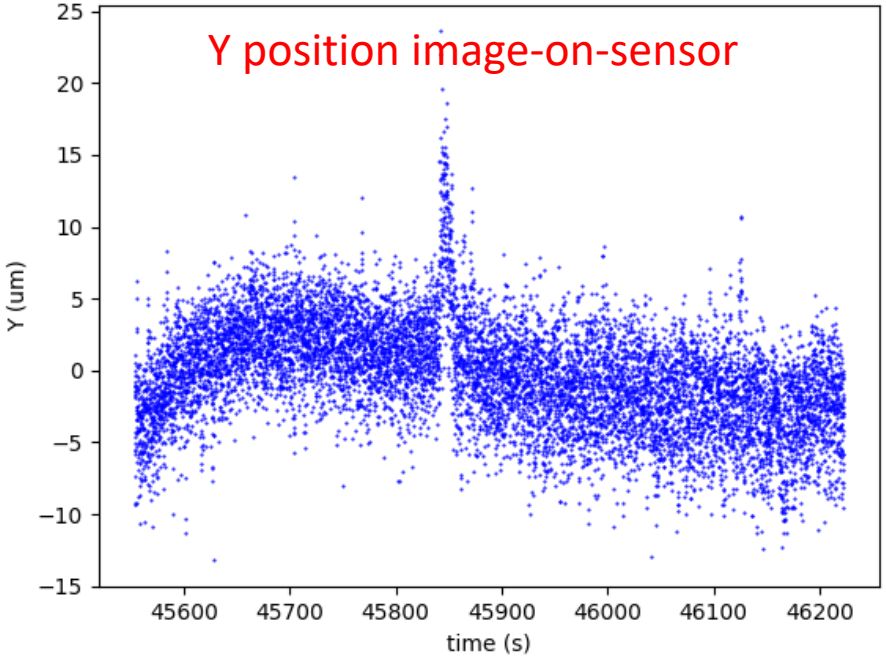


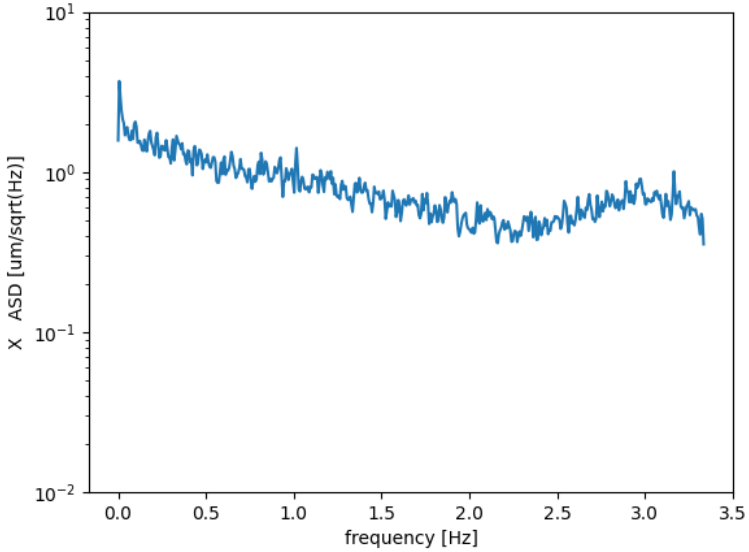




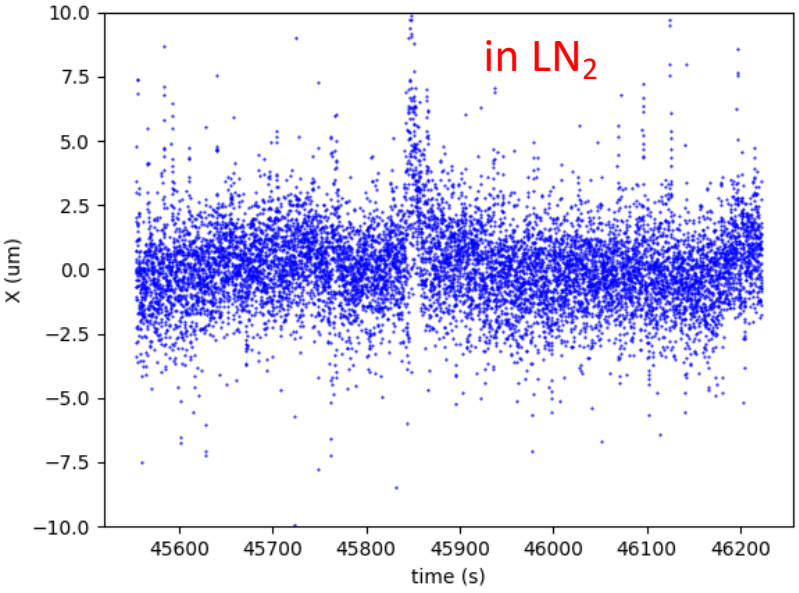


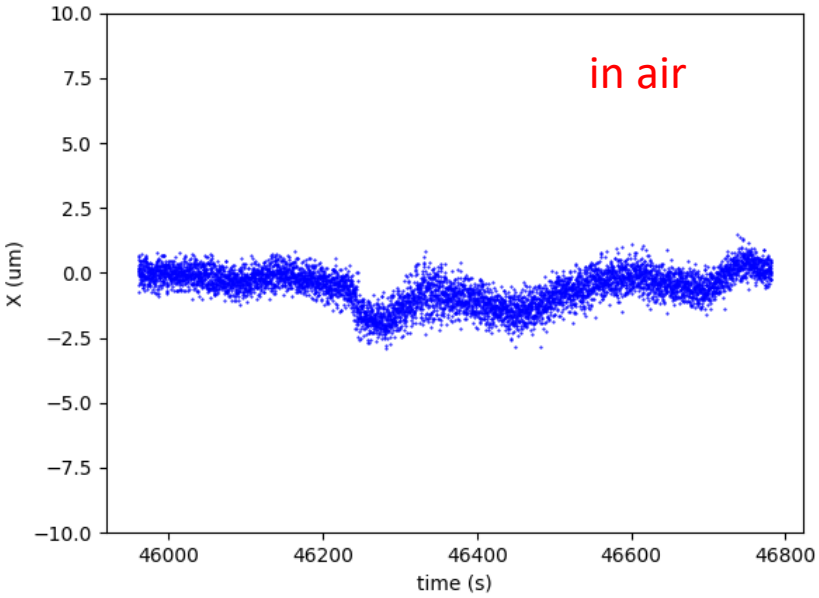


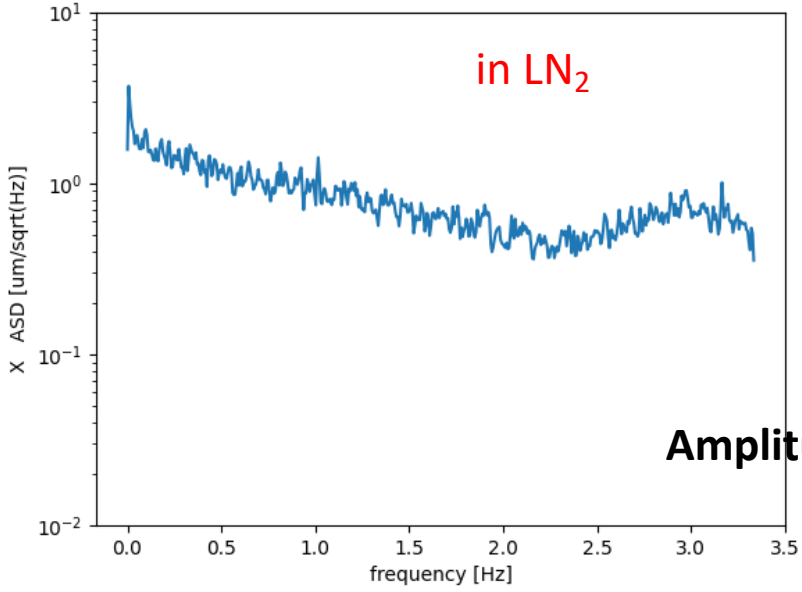



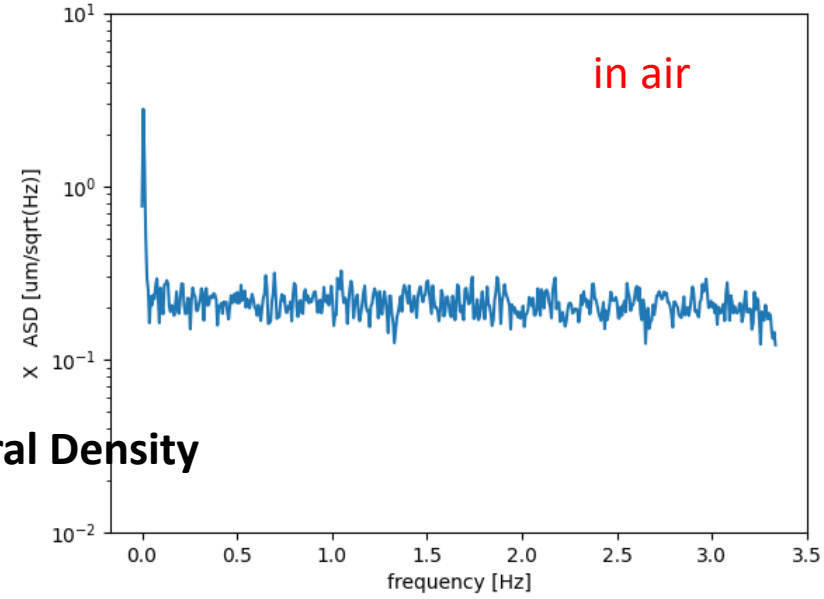




Amplitude Spectral Density:
Welch Plot



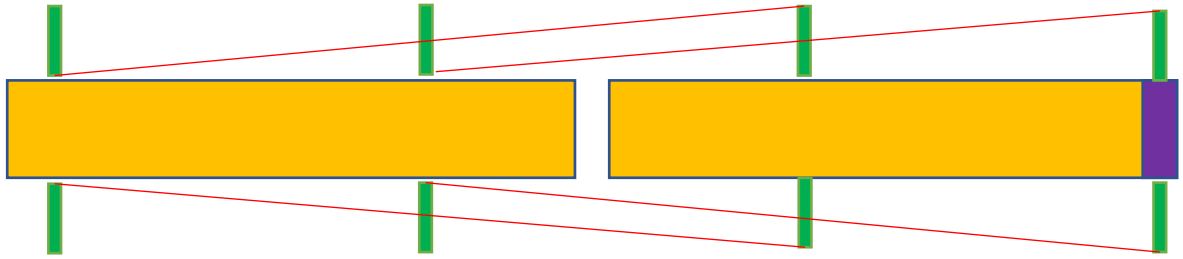



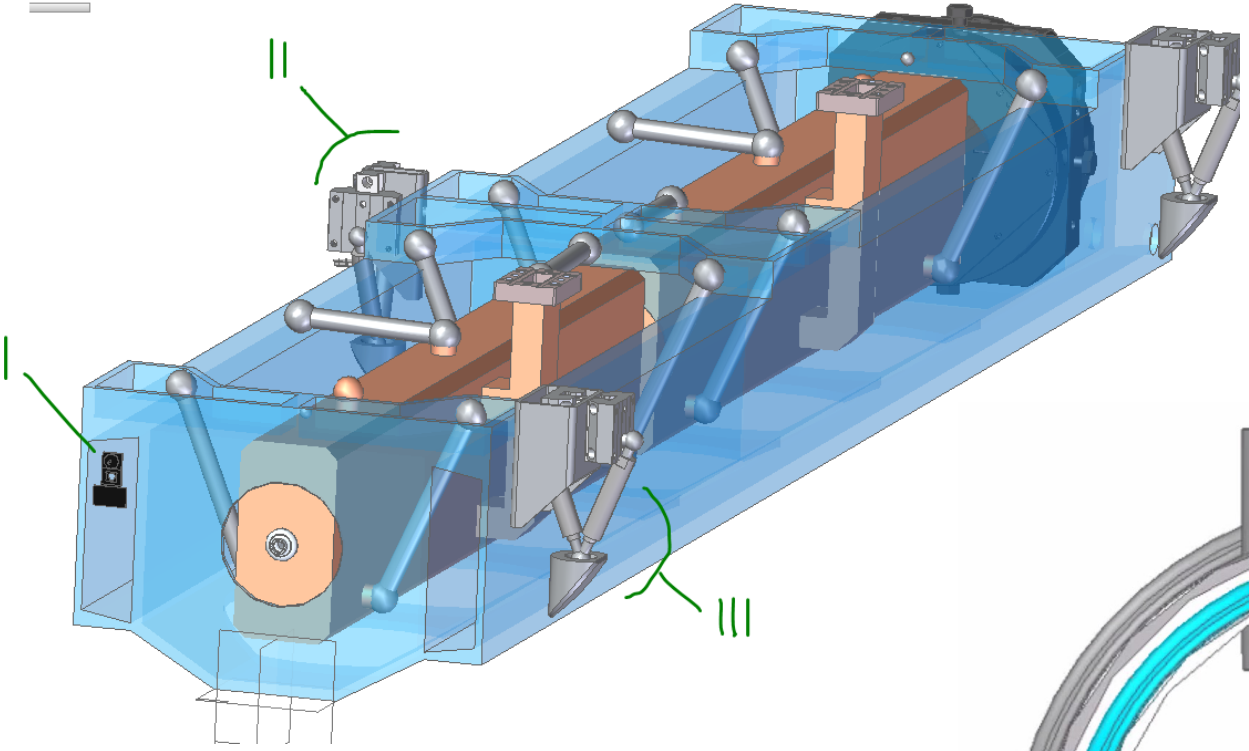



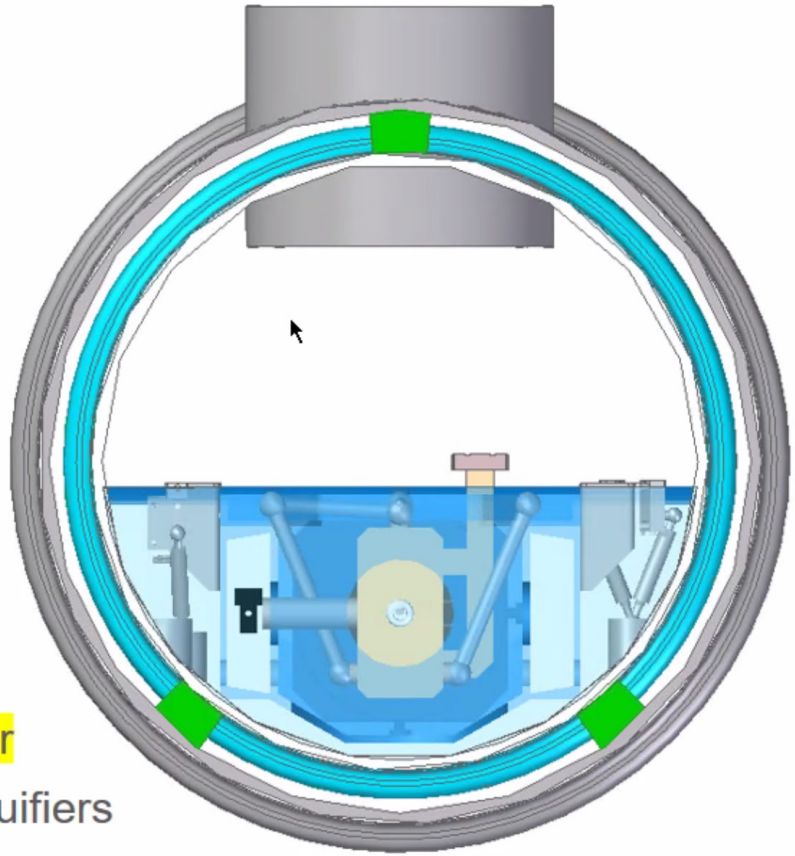




**Amplitude Spectral Density**

Rasnik for Quarter Cryogenic Module QCM





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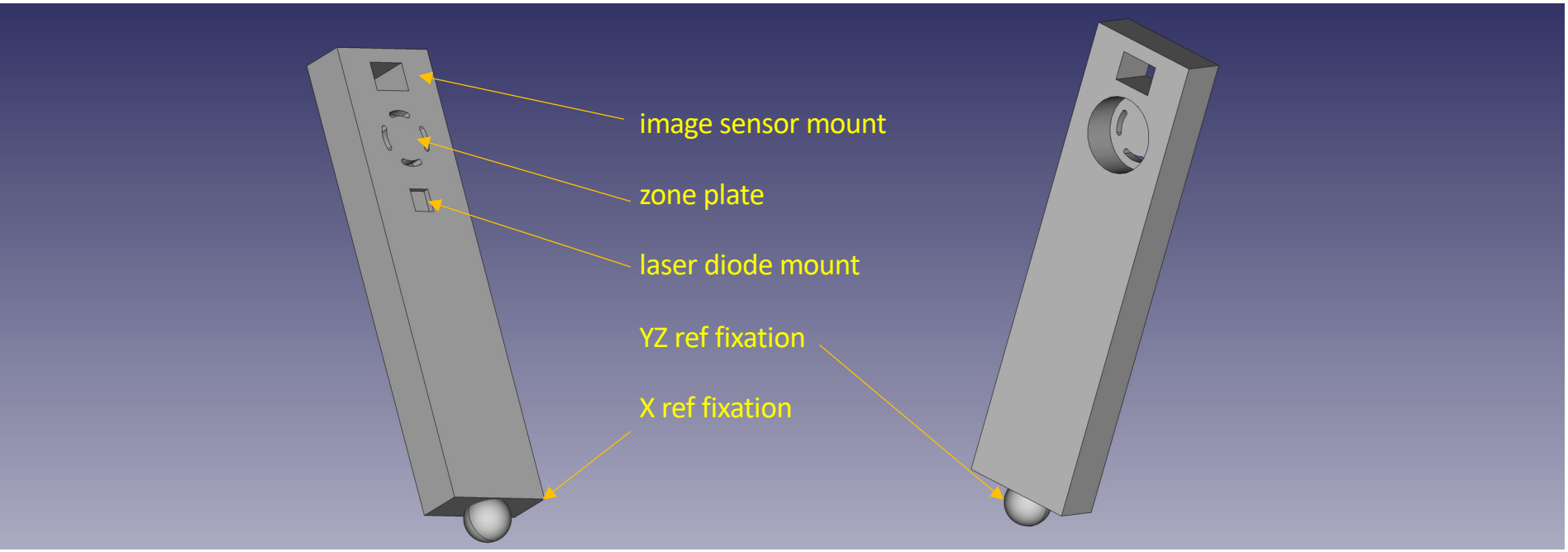
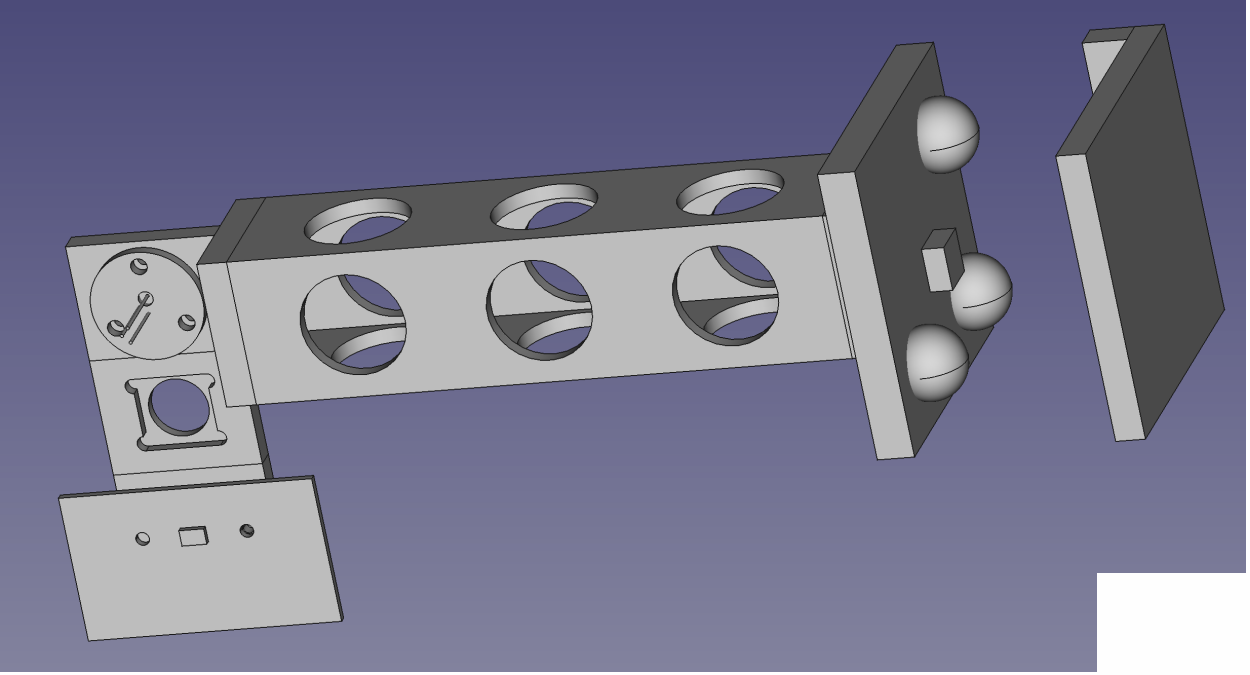
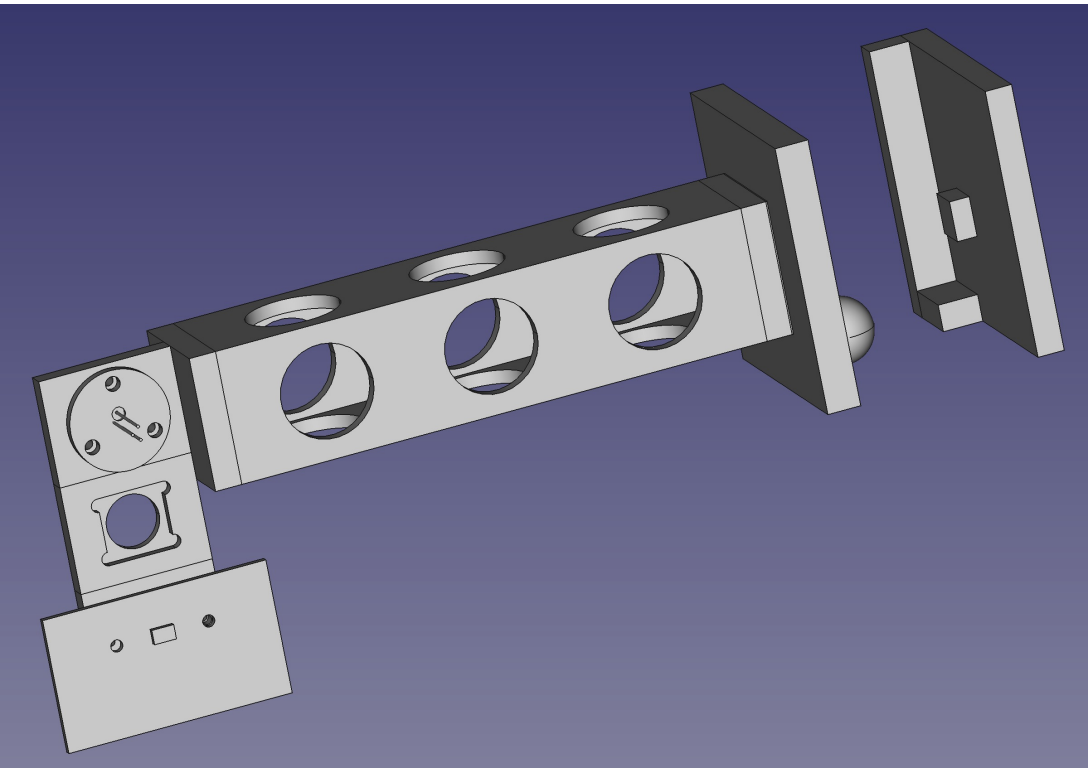


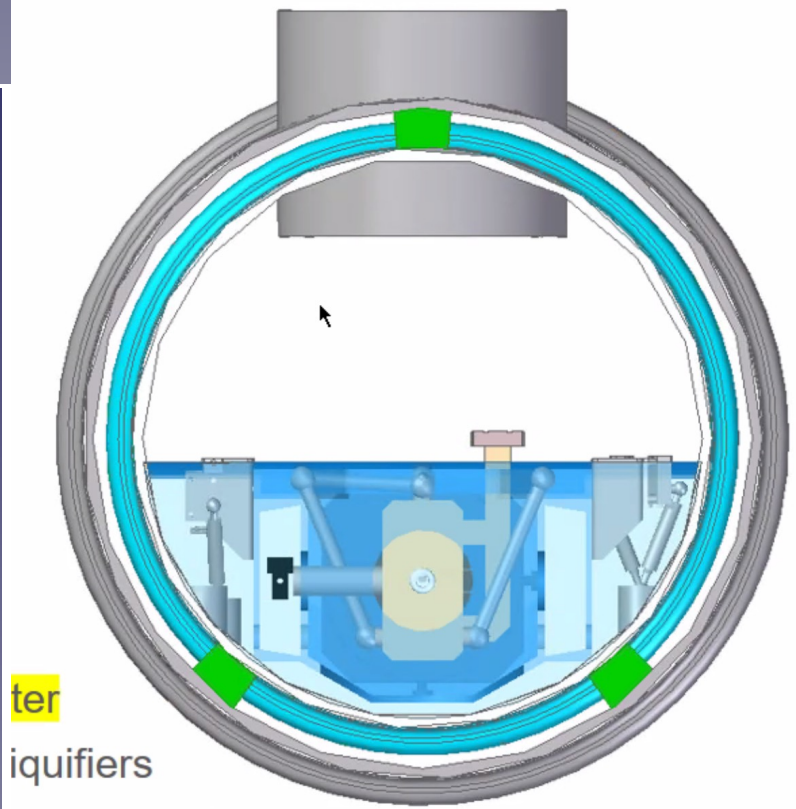

The Stick

A Stick includes 4 items:

- a CMOS image sensor chip
- a transparent pattern forming a zone lens
- a laser diode
- a mounting interface







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## Conclusions

- Rasnik can operate accurately (< 1 μm per image) in $LN_2$ and is applicable for the alignment of the Acc Structures and the Quads of $C^3$

- If ASIC image sensors are applied with frame rates up to 300 Hz, Rasnik can be applied a ‘seismic’ monitor, measuring effectively vibrations of AccStructs.

## Next: Rasnik in QCM

- At Nikhef: improve Nikhef setup:
  - apply Optical Fiber as tip of light source: no local bubbles
  - better mechanics, and smooth surfaces avoiding nucleation bubbling.
  - write paper

- design:
  - agree upon layout of 8 or 12 Sticks in QCM
  - integration of Stick base with AccStruct and Quad
  - How well should the ‘Stick Offset’ be known (‘calibration’)?

- production of 8 – 12 Sticks:
  - test of Sticks in (good quality) cryostat
  - verification of temperature stability of laser diode and cam: multi temperature cycles
  - optimize required shielding

- Readout:
  - SLAC should ask Microsoft for all documentation for the HD-3000 Webcam Model < 1456. Frame rate > 7 Hz possible?
  - Control + DAQ: on/off laser diodes, data sequencing, image analysis

- Start the development of a new CMOS image sensor ASIC, in collaboration with industry (Hamamatsu).