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Photon Beam Diagnostics @ SESAME

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DEELS 2021

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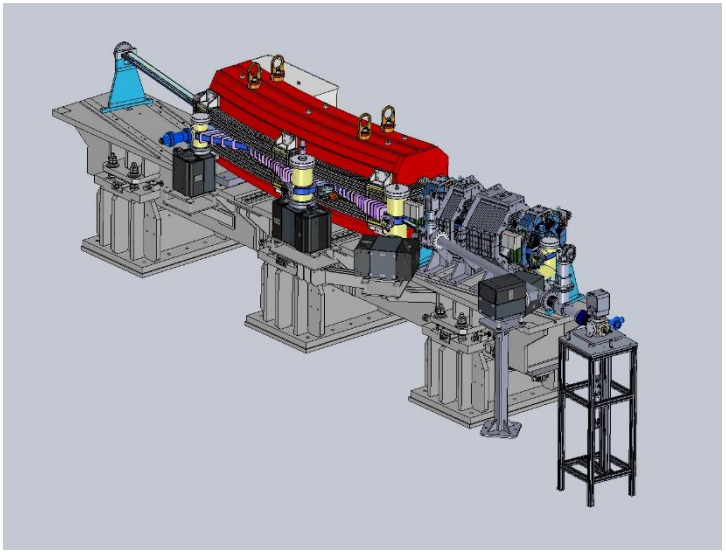
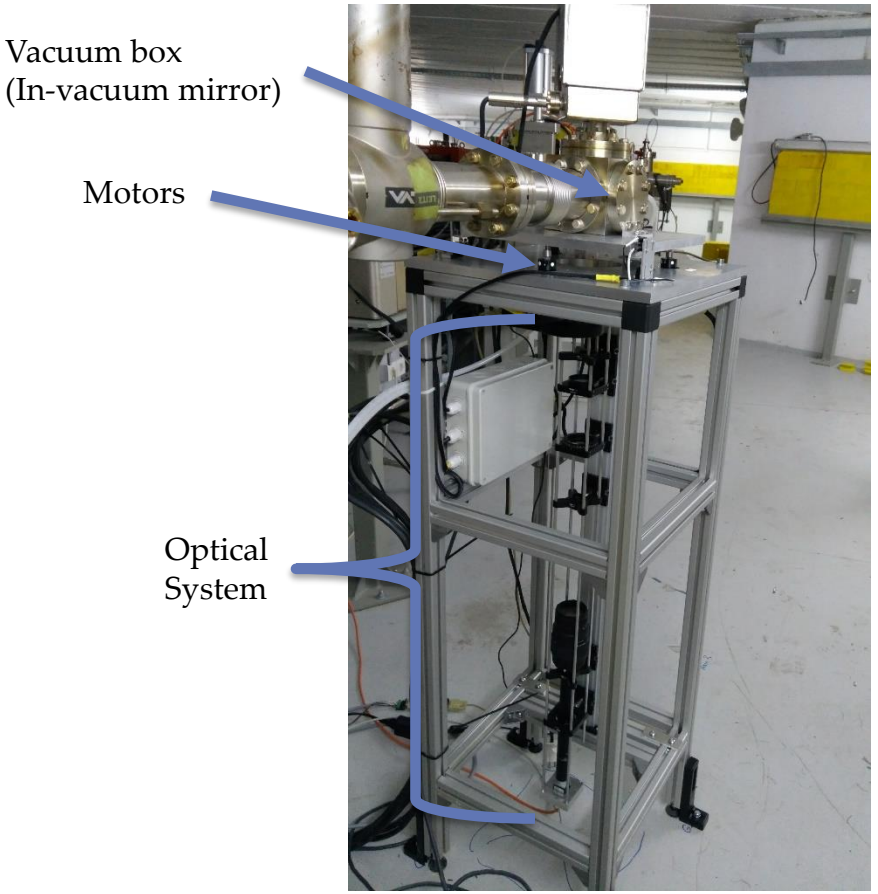
Outline

- SRM
  - Design
  - SRM Incident
  - SRM Upgrade
  - Results
- IAXD
  - Design
  - Results
  - Optimization
- Pinhole
  - Design
  - What's Next ?
- Conclusion

SRM

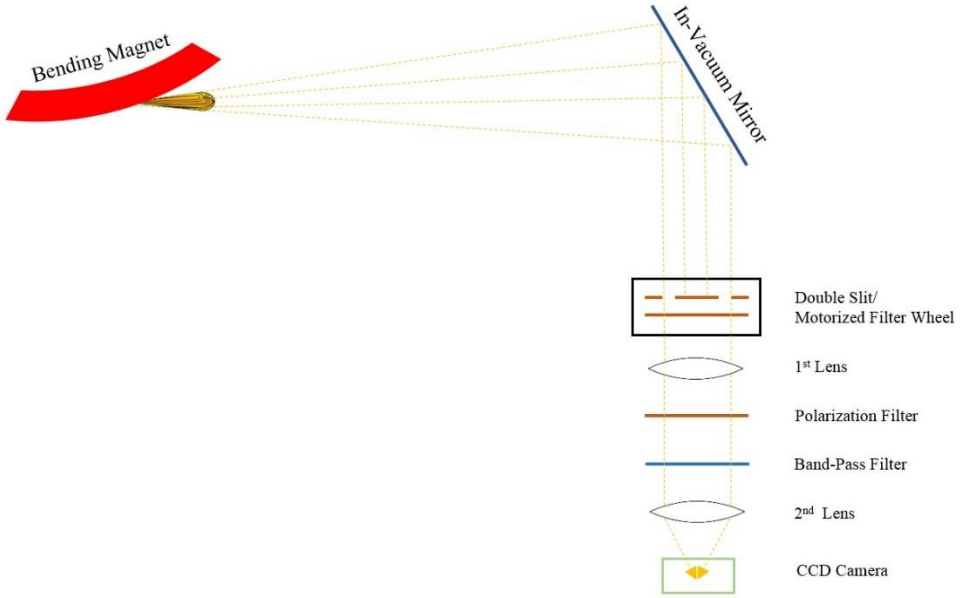
- At first, the SRM was designed and commissioned as a single branch, direct imaging synchrotron radiation monitor

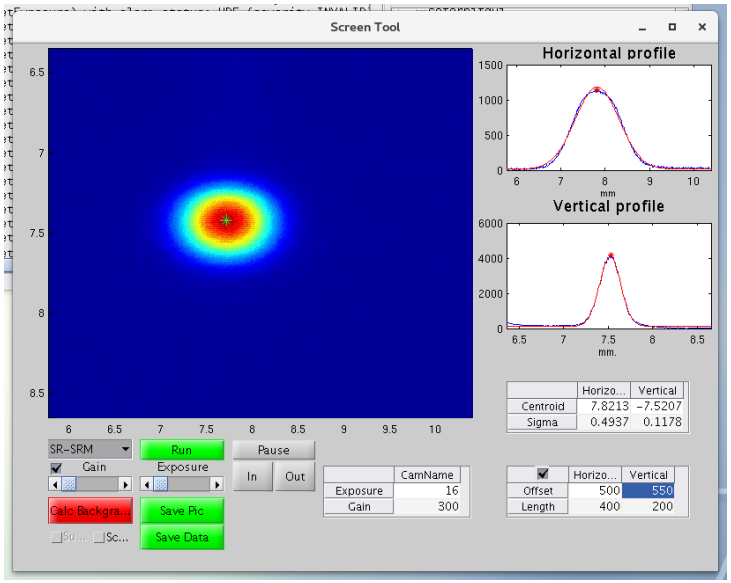




SRM

Beam size and position (on camera) archived for more detailed studies .
Measured beam size: σy = 117.8 um
Diffraction: $\Delta_y = \frac{1.797X550n}{8m} = 123\ \mu m$ of the crotch absorber





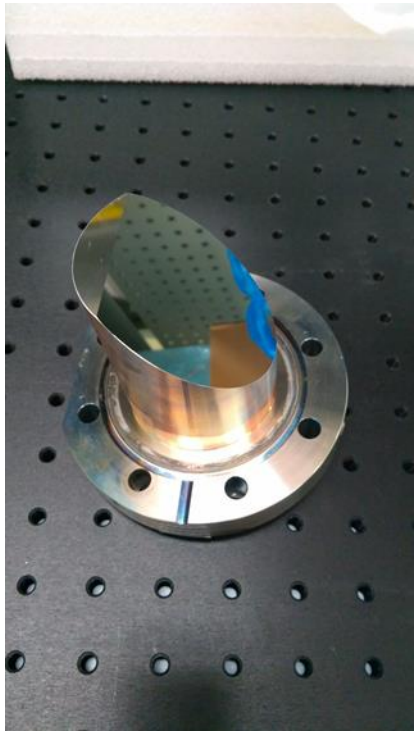
SRM Incident

- An incident happened in the SR Synchrotron Radiation Monitor (Diagnostics Beamline) on 29/7/2020 at 19:42 after ~20 minutes of killing the beam to turn off the machine.

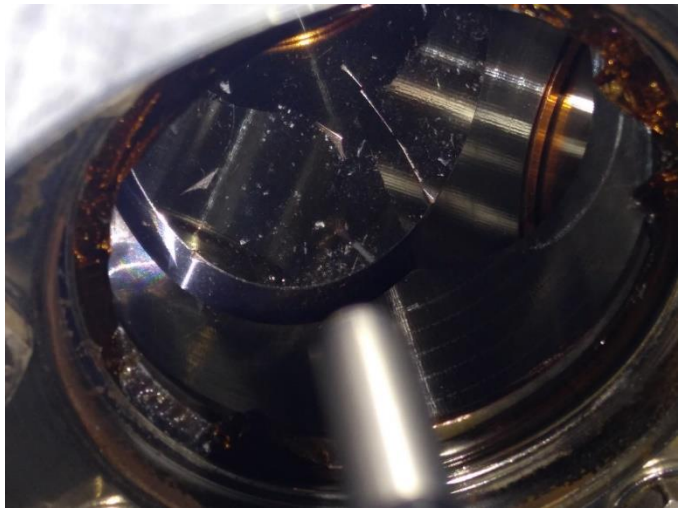
- The vacuum view port (glass window) was broken, so a vacuum level breakdown happened in cell 14.

- The whole glass parts went inside the vacuum chamber, and the in-vacuum mirror was damaged as well.

SRM Incident



Before installation



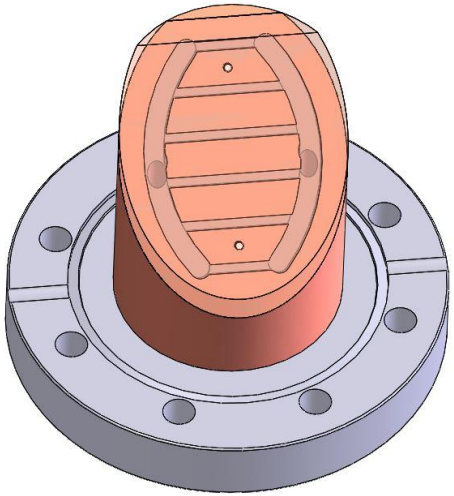
After incident

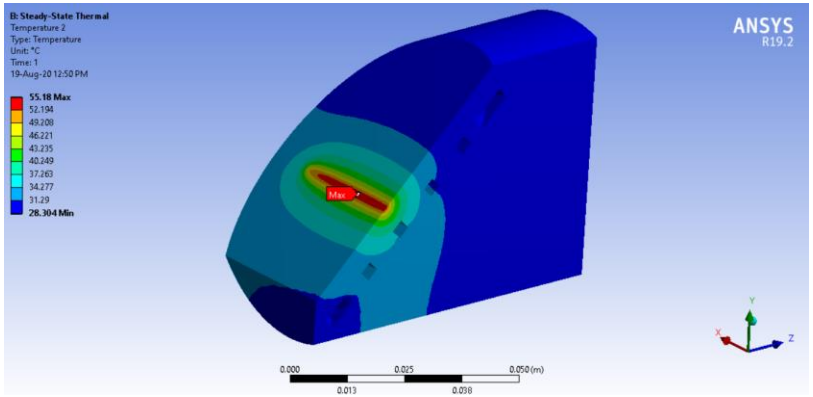
SRM Incident

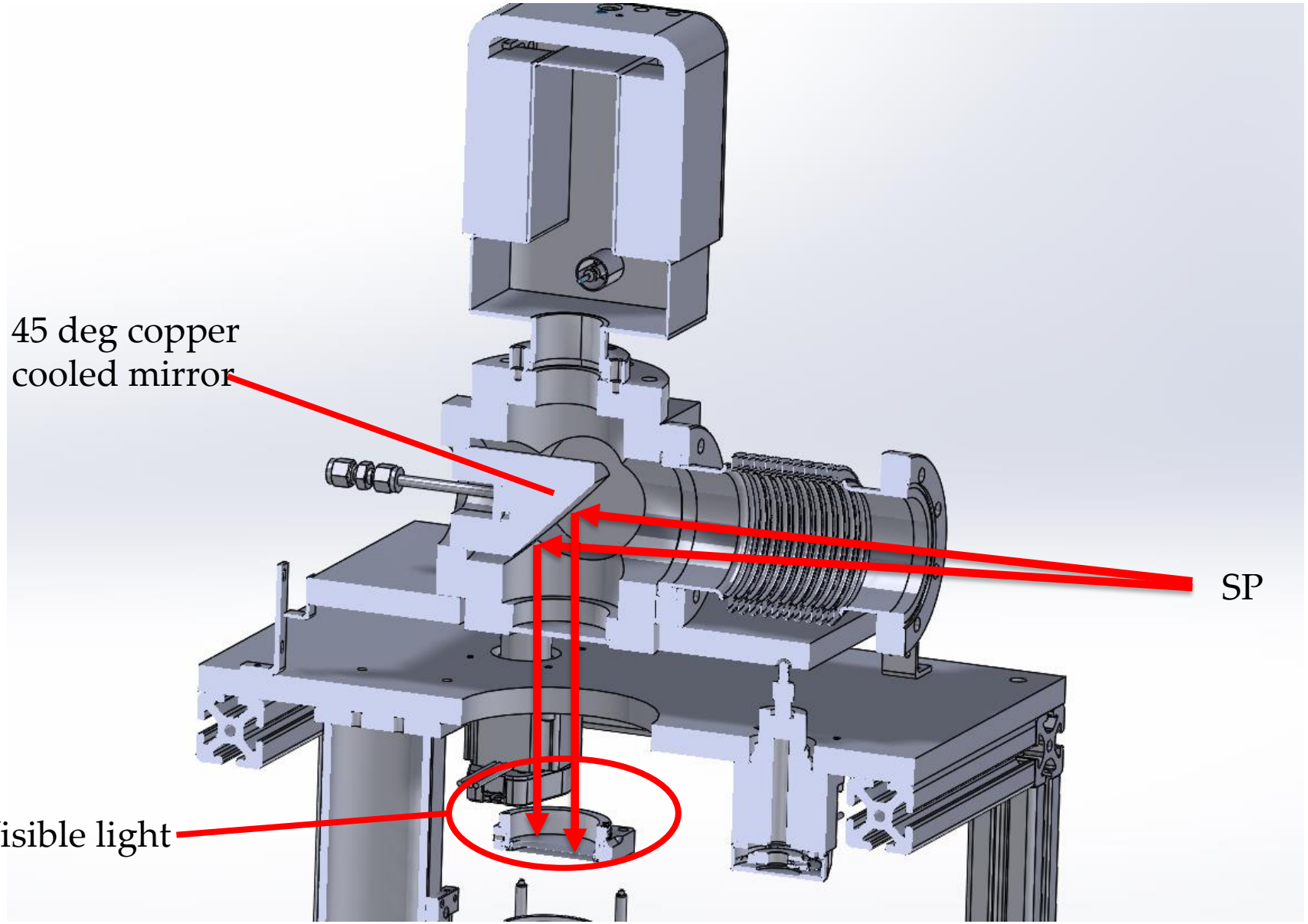
- Possible scenarios to cause this incident:
  - Reflected power / scattering / radiation heat from the in-vacuum mirror to the glass window(simulated in the design stage)
  - Radiation damage?
  - Aging? It’s a very old viewport from BESSY I (+30 years old)

SRM Incident

- The mirror has a protection layer optimized for visible light, suitable for NIR, IR and designed for 400mA beam current.
- Vacuum group have done FEA for that case and they found that the maximum possible mirror temperature would be 55 deg @ 400mA
- Max. measured temperature from the thermocouple on the outside body of the mirror ~28 C @250mA
- The mirror reflection and absorption was simulated and calculated on XOP






45 deg copper
cooled mirror
SP
Visible light

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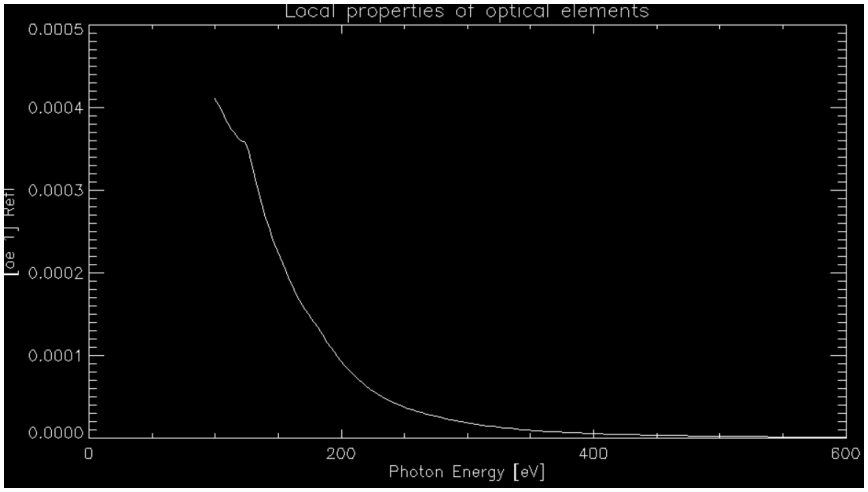
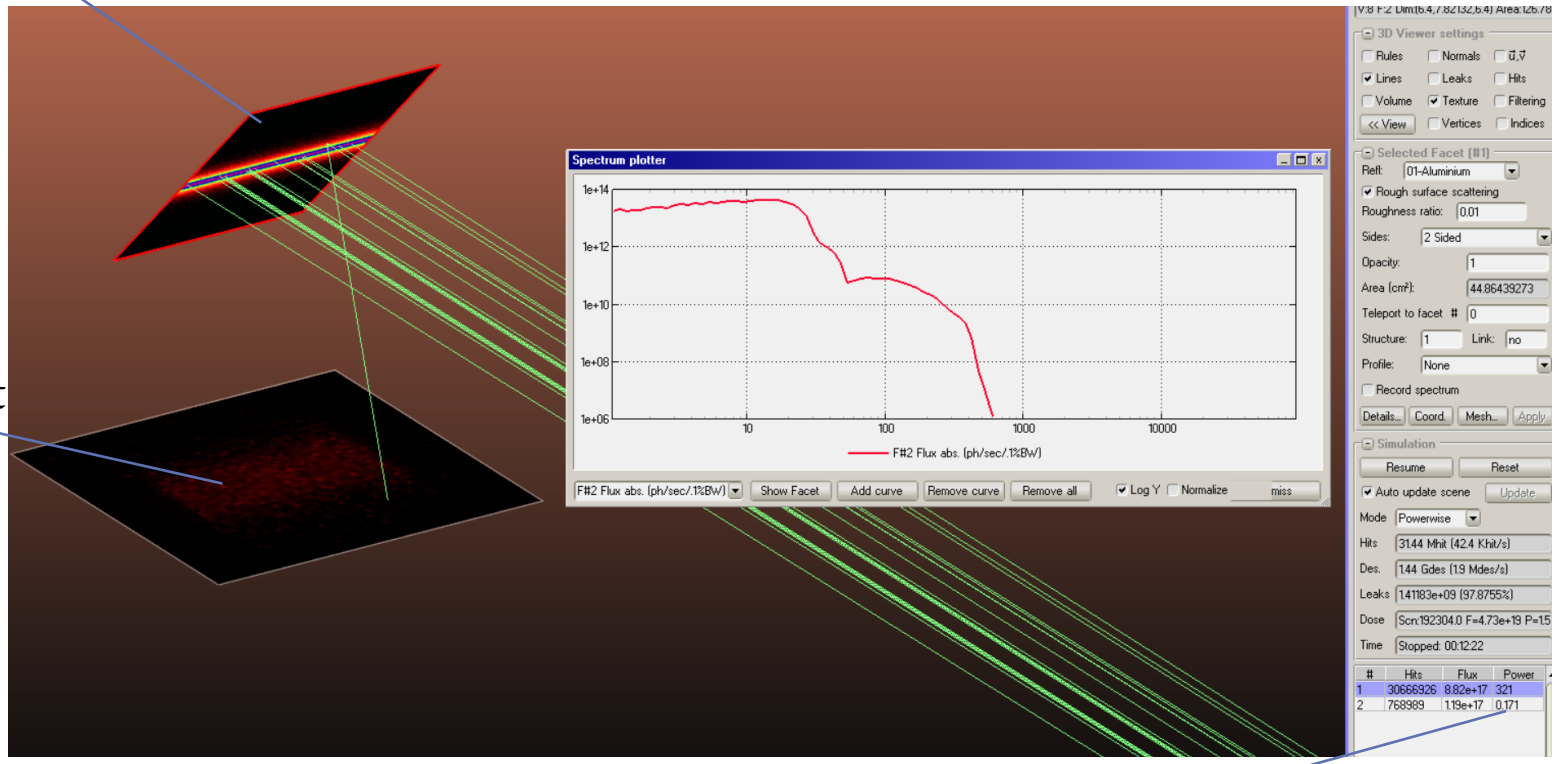


Mirror

Viewport



Total power at viewport=0.17 W

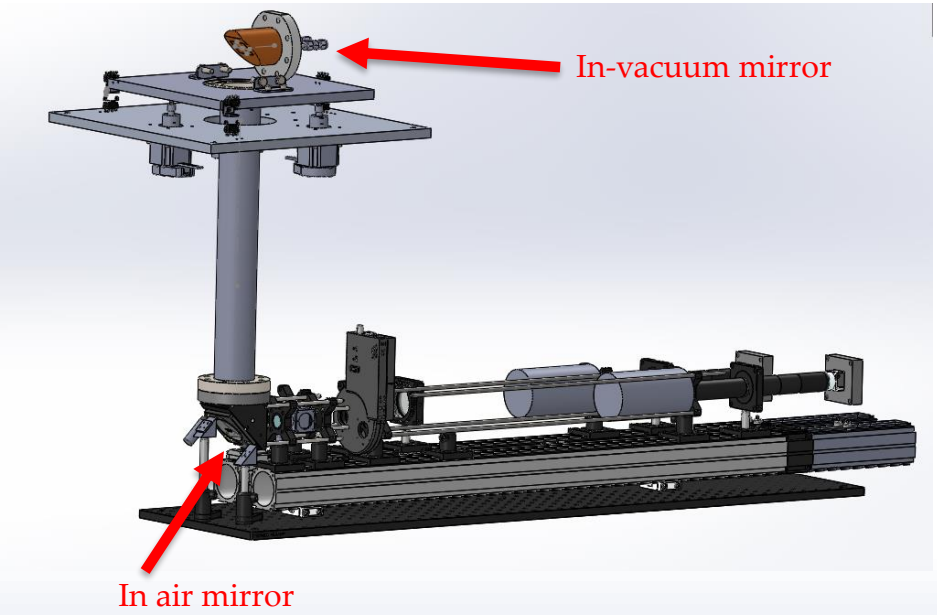
SRM Incident

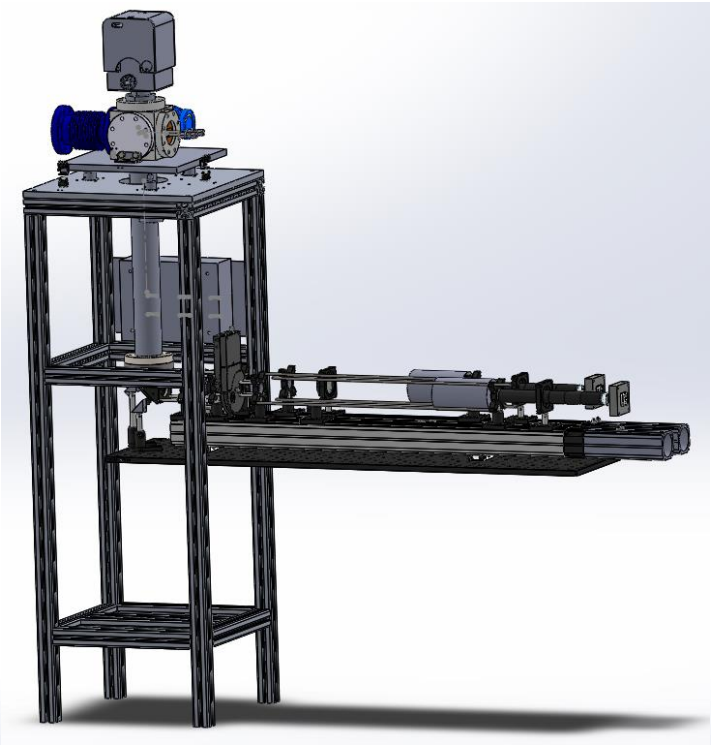
	Fused Silica (Quartz)		Sapphire
Seal Type	Bonded	Brazed	Brazed
Max Temp	120	250	450
Flatness	λ/8	λ/4 @60%	2λ-4λ
Price ($)	655	750	1500

- After doing some analysis on different types of viewports, we have concluded that the most suitable option to go for is the Bonded Fused Silica window, due to its better flatness and relatively cheaper cost.
- Quartz viewports feature high radiation resistance while sapphire is used in high temperature applications (up to 450 °C).

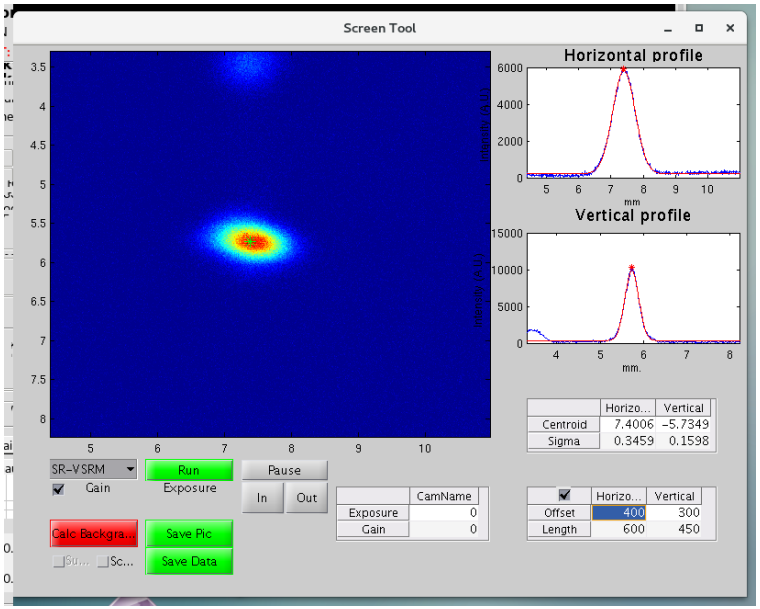
SRM Upgrade

- The orientation of the optical beamline changed to horizontal instead of vertical.
- A fused Silica mirrors is used to have higher flatness and avoid darkening.
- Realignment is done to the whole beamline.
- The mirrors will be motorized , the motors were used in some optical lenses in the MS beamline and we've built a driver for it.
- The spare in-vacuum mirror will be used

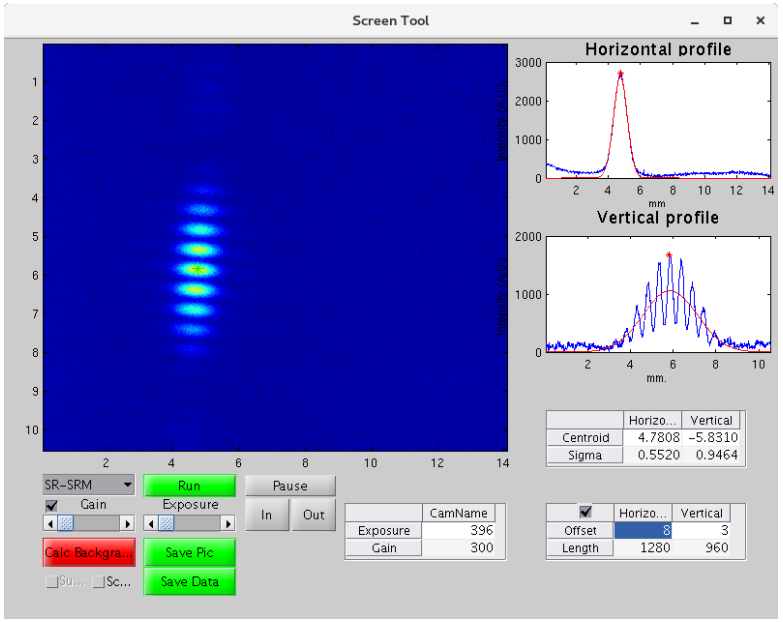




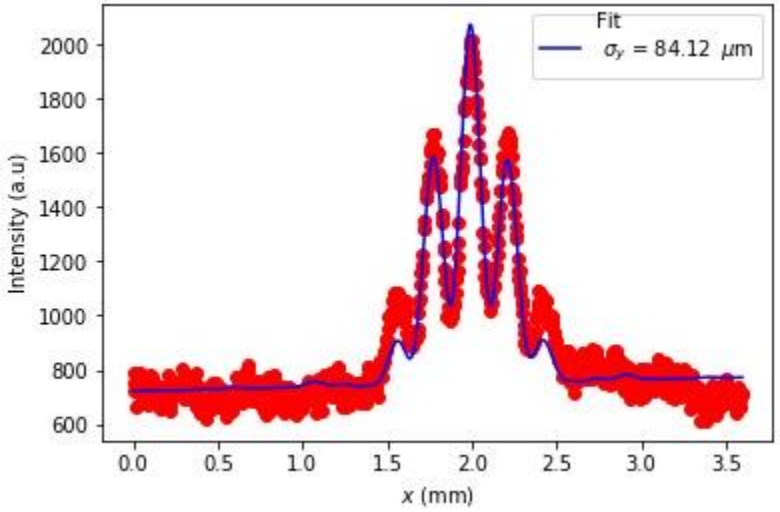
SRM Upgrade (Results)



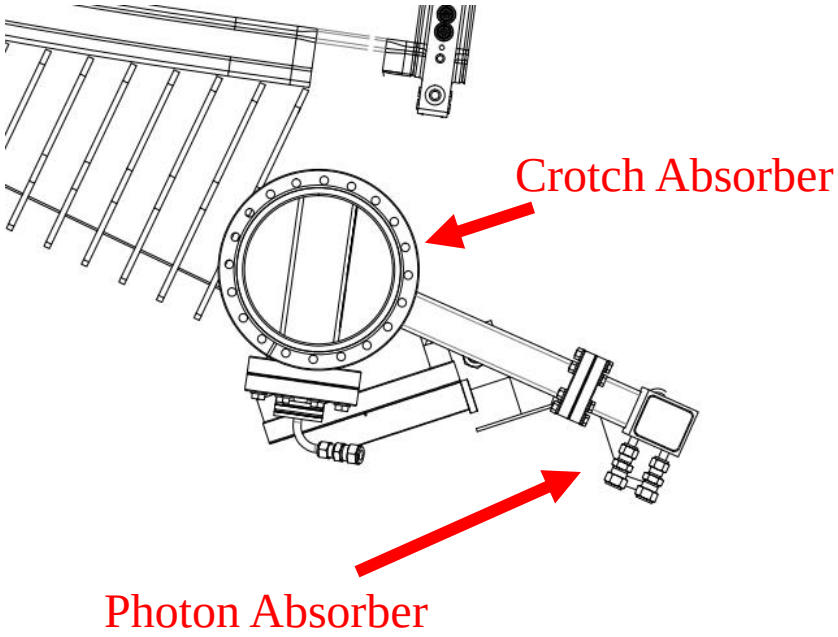
Direct Imaging

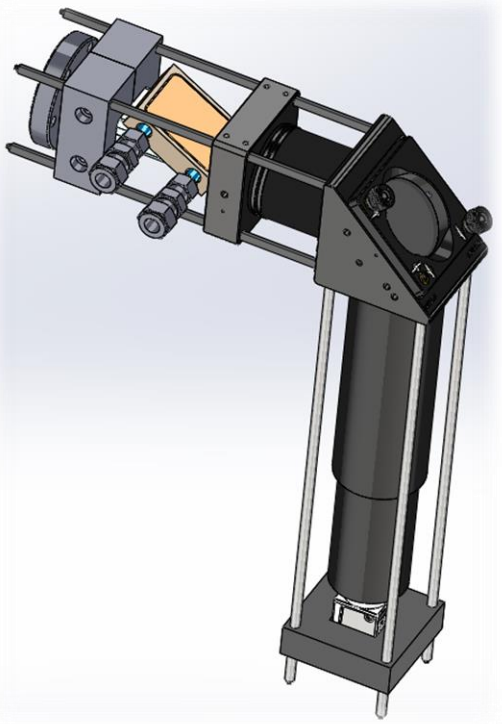


Interferometry

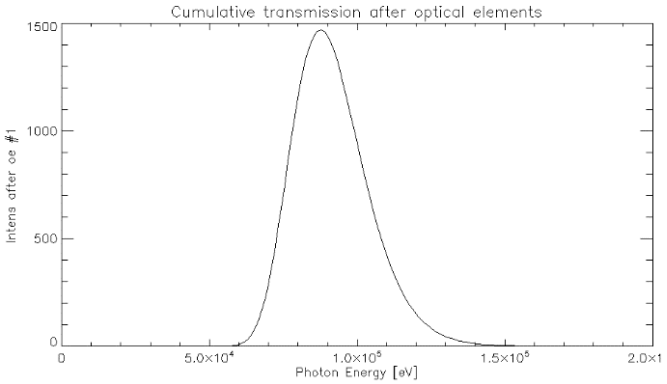


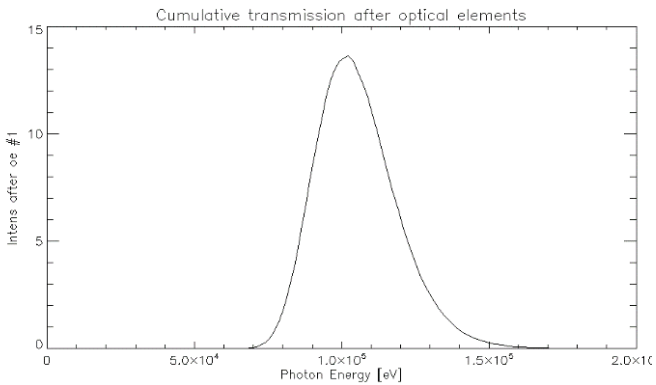
IAXD

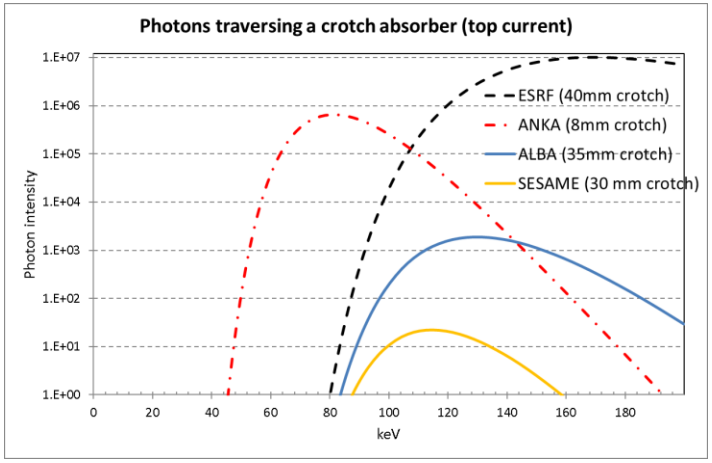




IAXD



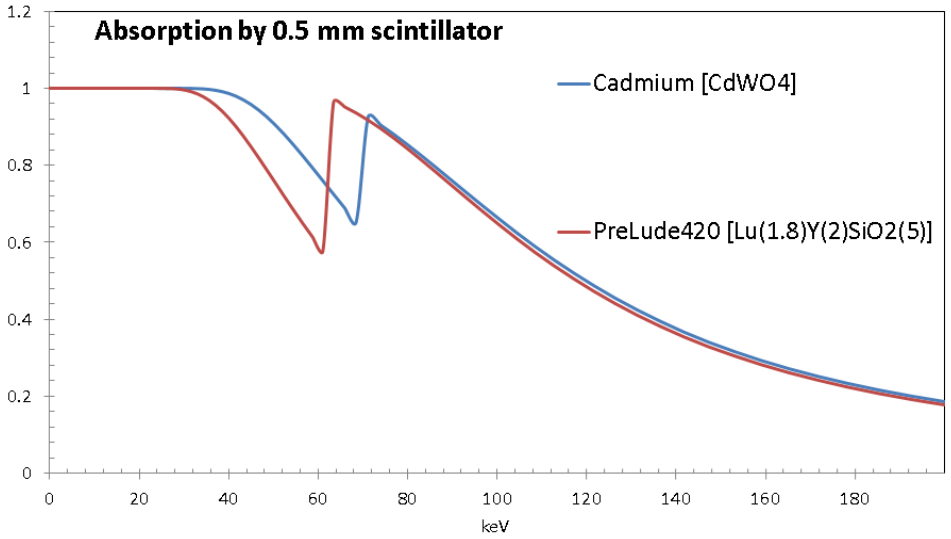


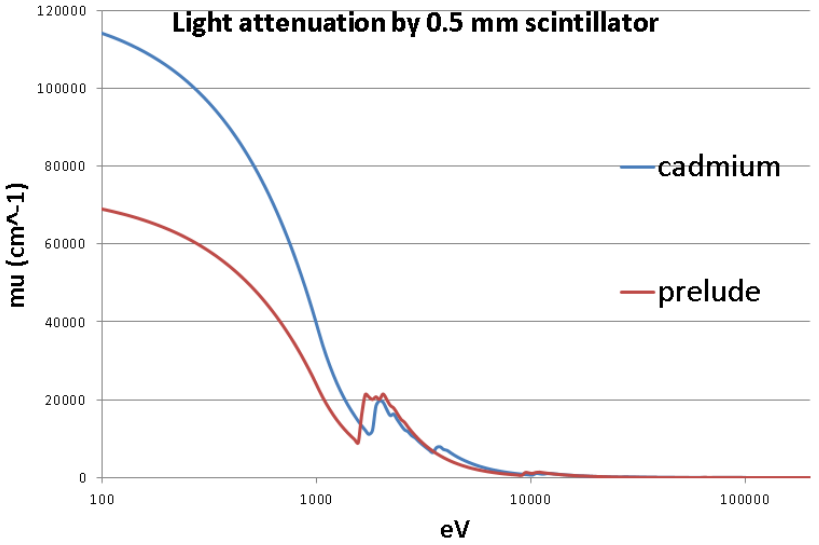


courtesy of A. Nosych, ALBA DI Group

IAXD

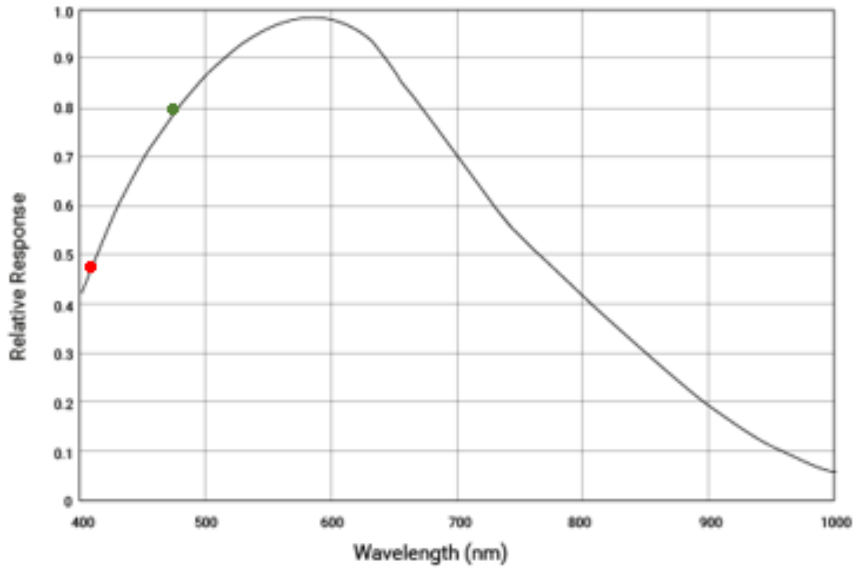
- Comparison of different screens were done on XOP.
- The best screens are Prelude and Cadmium Tungstenate on 86-100KeV.
- Wavelength of emission 420 nm for Prelude - Lu 1.8Y.2SiO5 and 475 nm for Cadmium Tungstenate – CdWO4





IAXD

- Basler acA1300-30gm with Sony ICX445 CCD Sensor is used for the IAXD.



Sony ICX445 spectral response

420 nm for Prelude - Lu $^{1.8}$Y.^{2}SiO^{5} 475 nm for Cadmium Tungstenate – CdWO4

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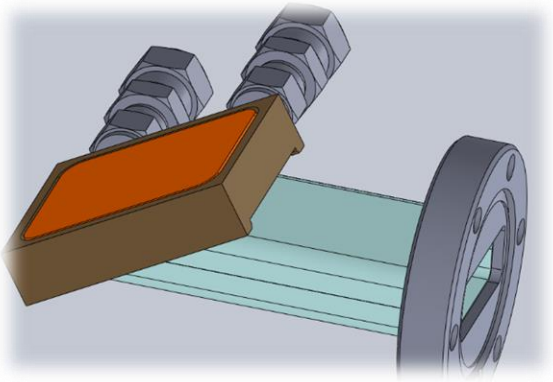
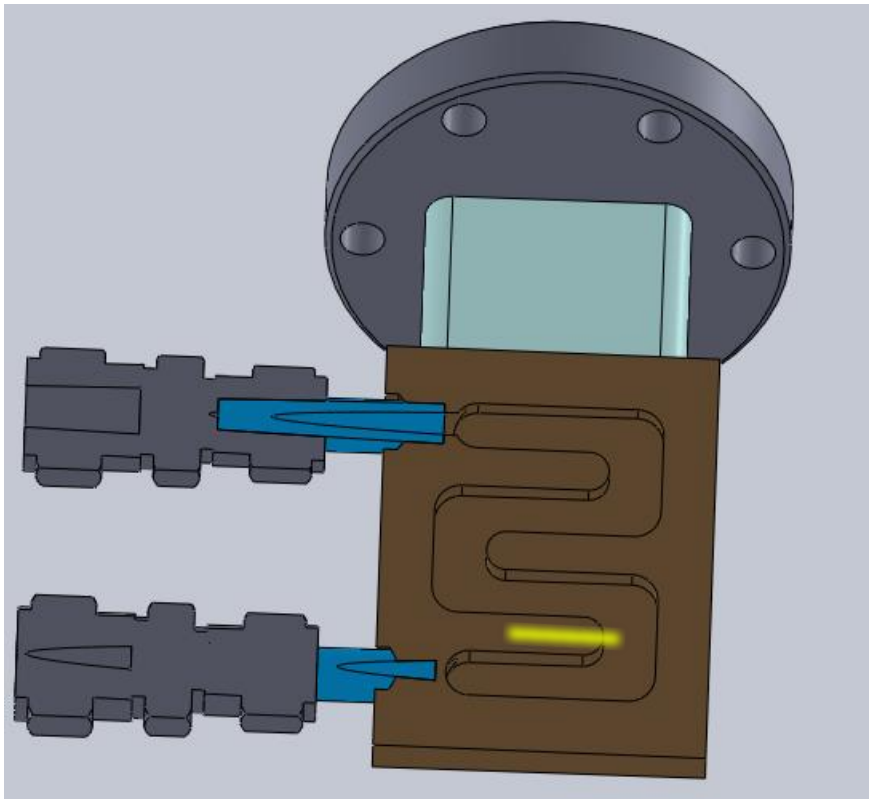
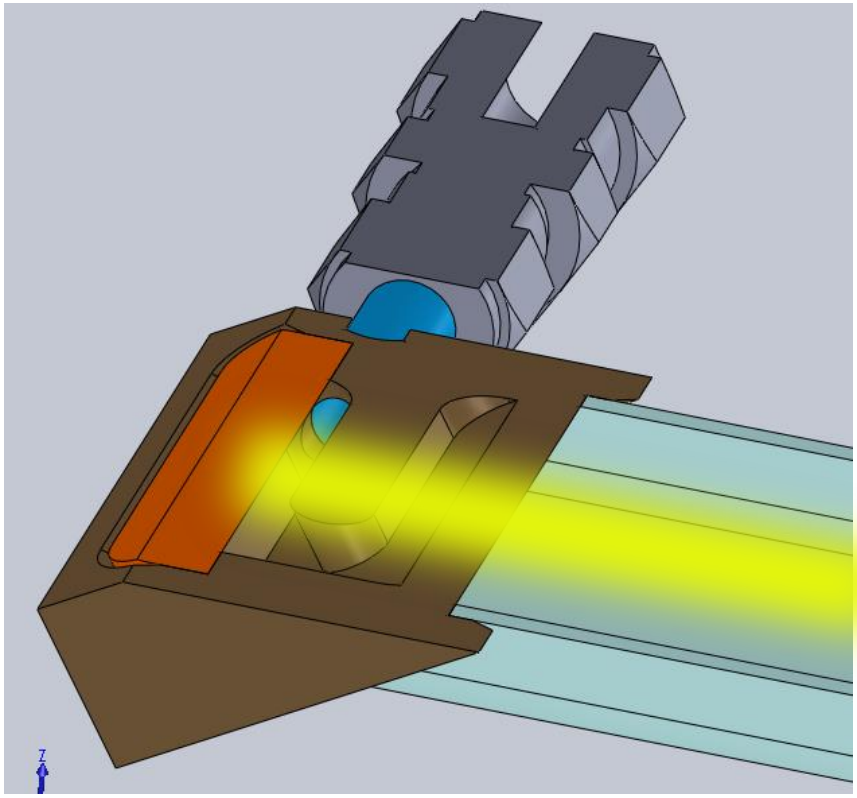
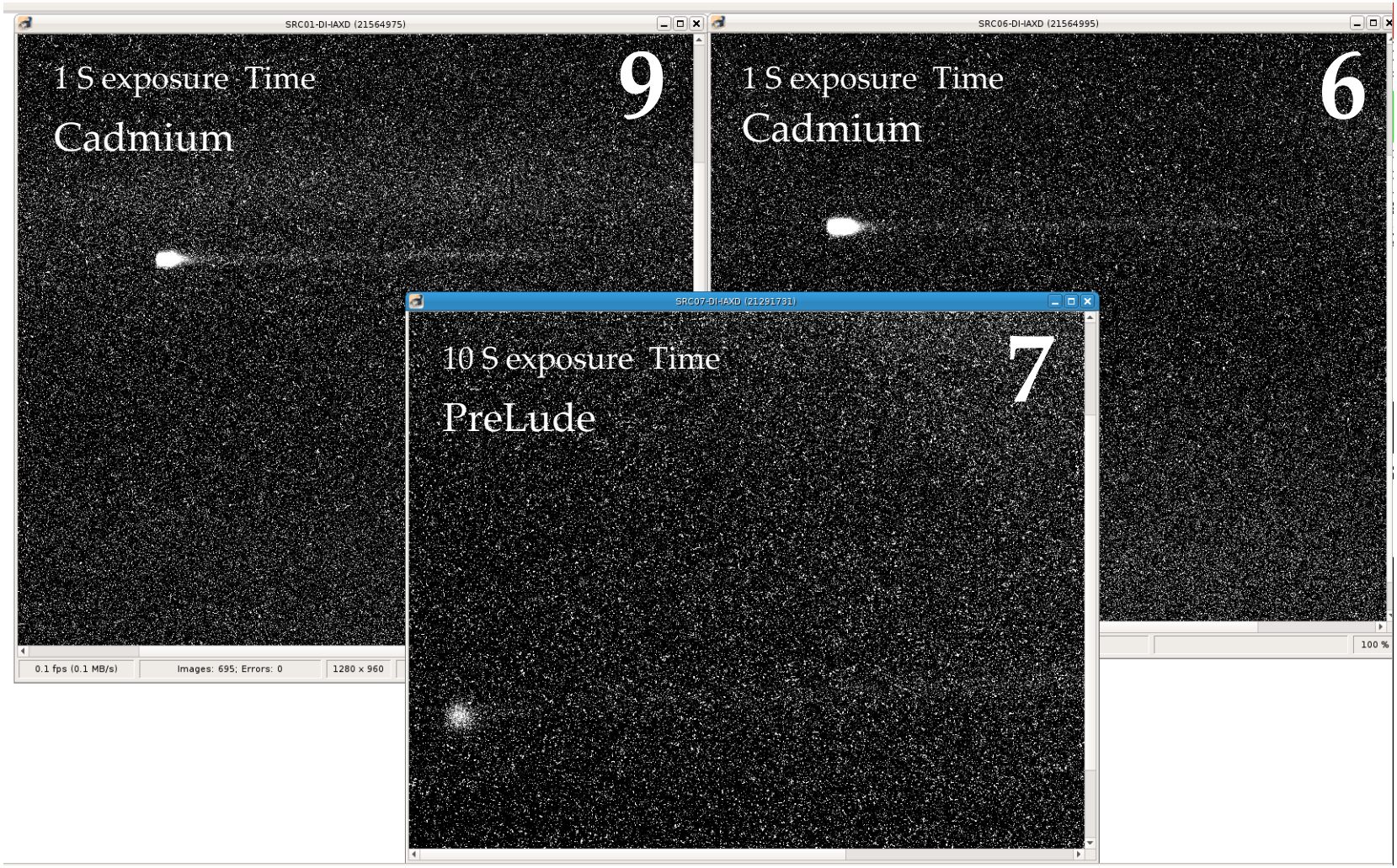
IAXD



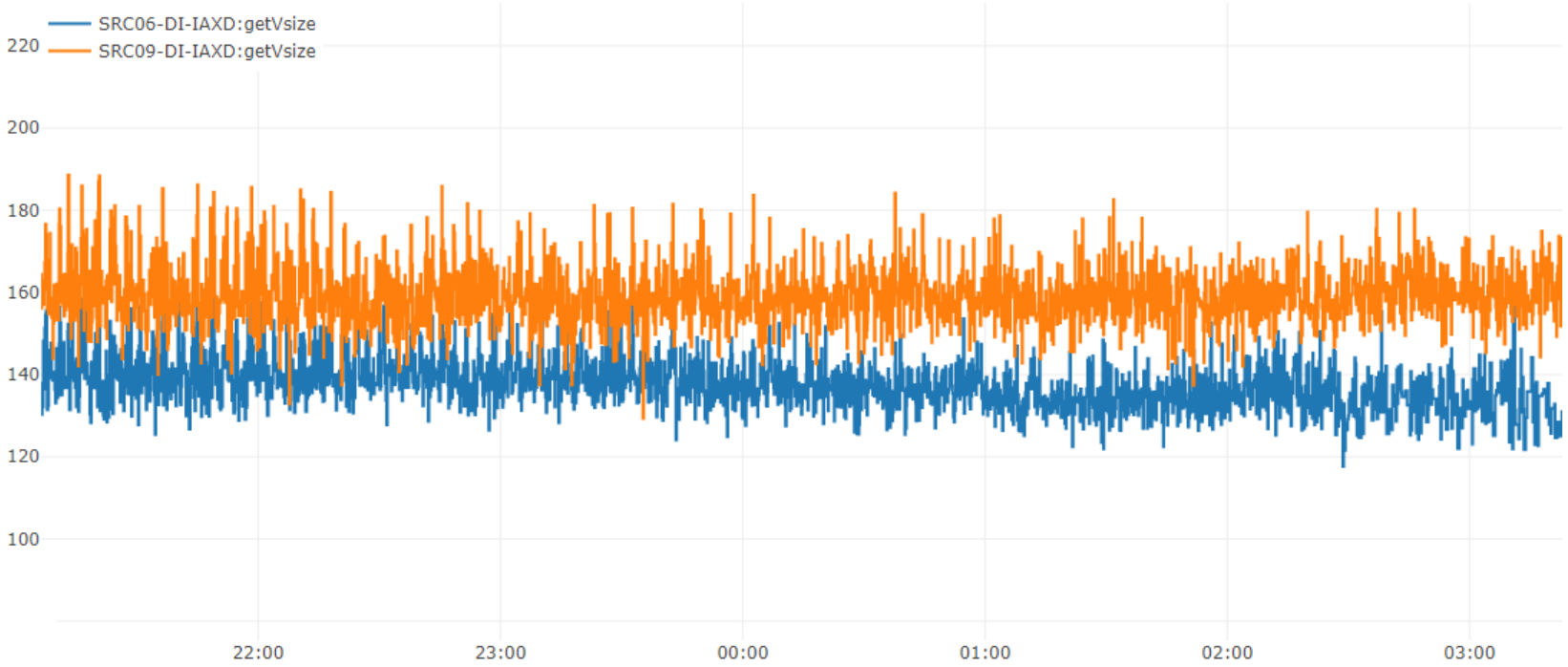




IAXD


SRC01-DI-IAXD (21564975)
1 S exposure Time
Cadmium
9
0.1 fps (0.1 MB/s)
Images: 695; Errors: 0
1280 x 960
SRC06-DI-IAXD (21564995)
1 S exposure Time
Cadmium
6
100 %
SRC07-DI-IAXD (21291731)
10 S exposure Time
PreLude
7

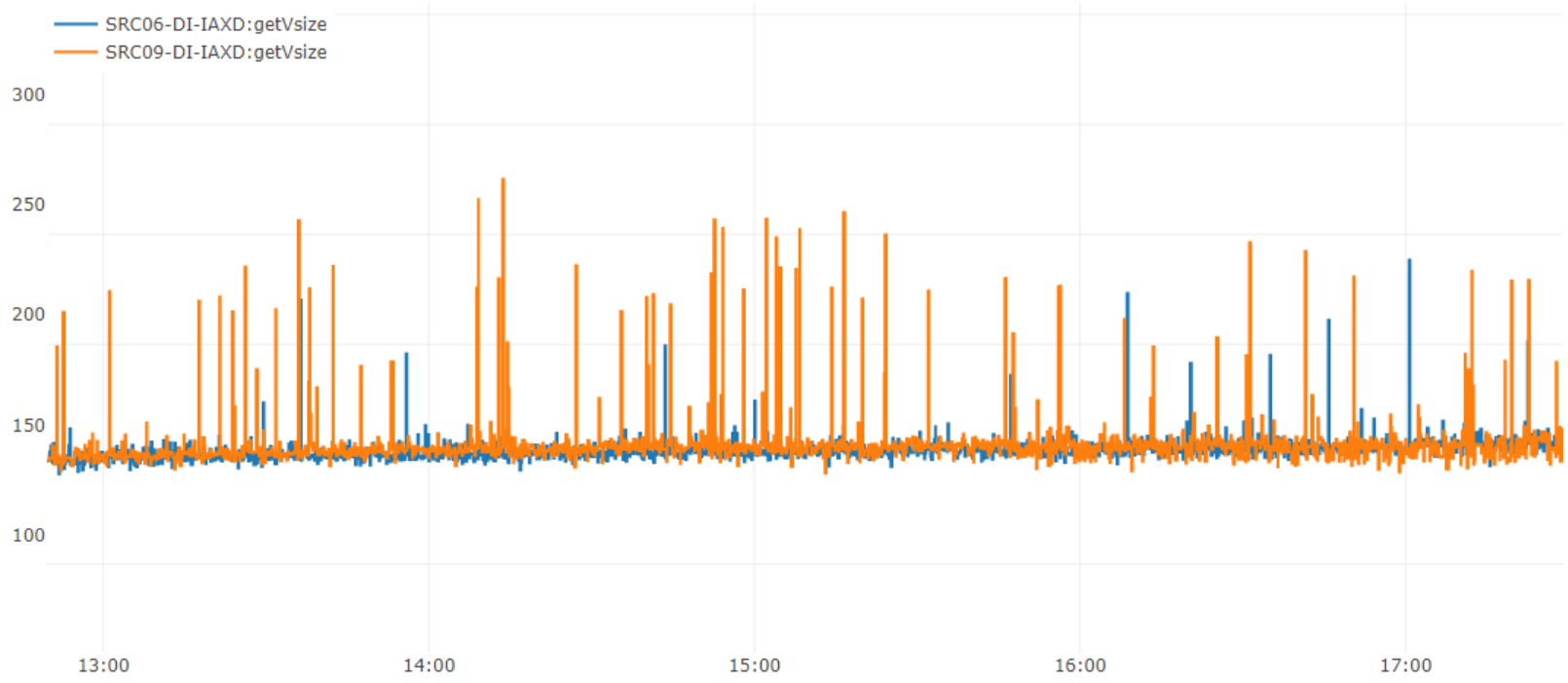
IAXD Results Correlation



- Data showed that IAXD9 image is noisier than IAXD6 due to non-beam dependent issues (i.e. dead pixels on CCD sensor)
- In order to compensate this noisy image, we took a “base” image without beam and each time we acquire data, we subtract this base image from the obtained one with beam.

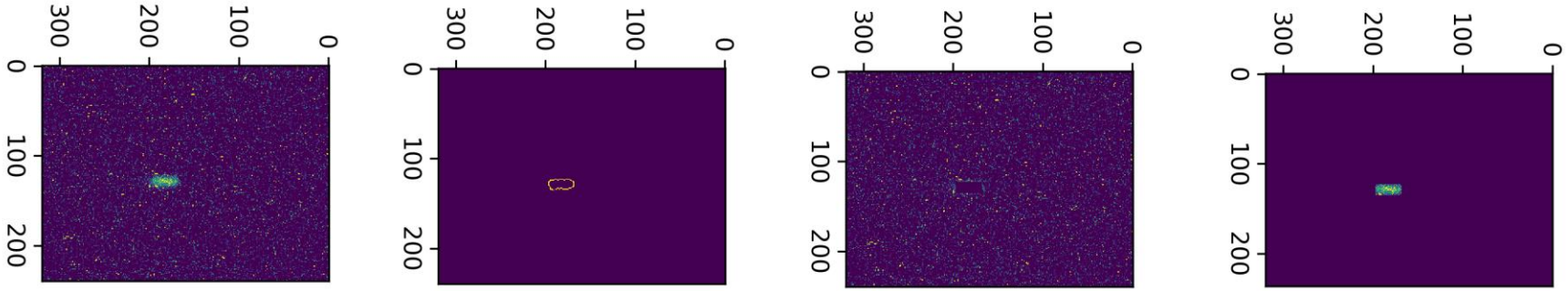
IAXD Noise Reduction (Result)

- IAXD6 vs IAXD9 (After noise reduction in IAXD9)

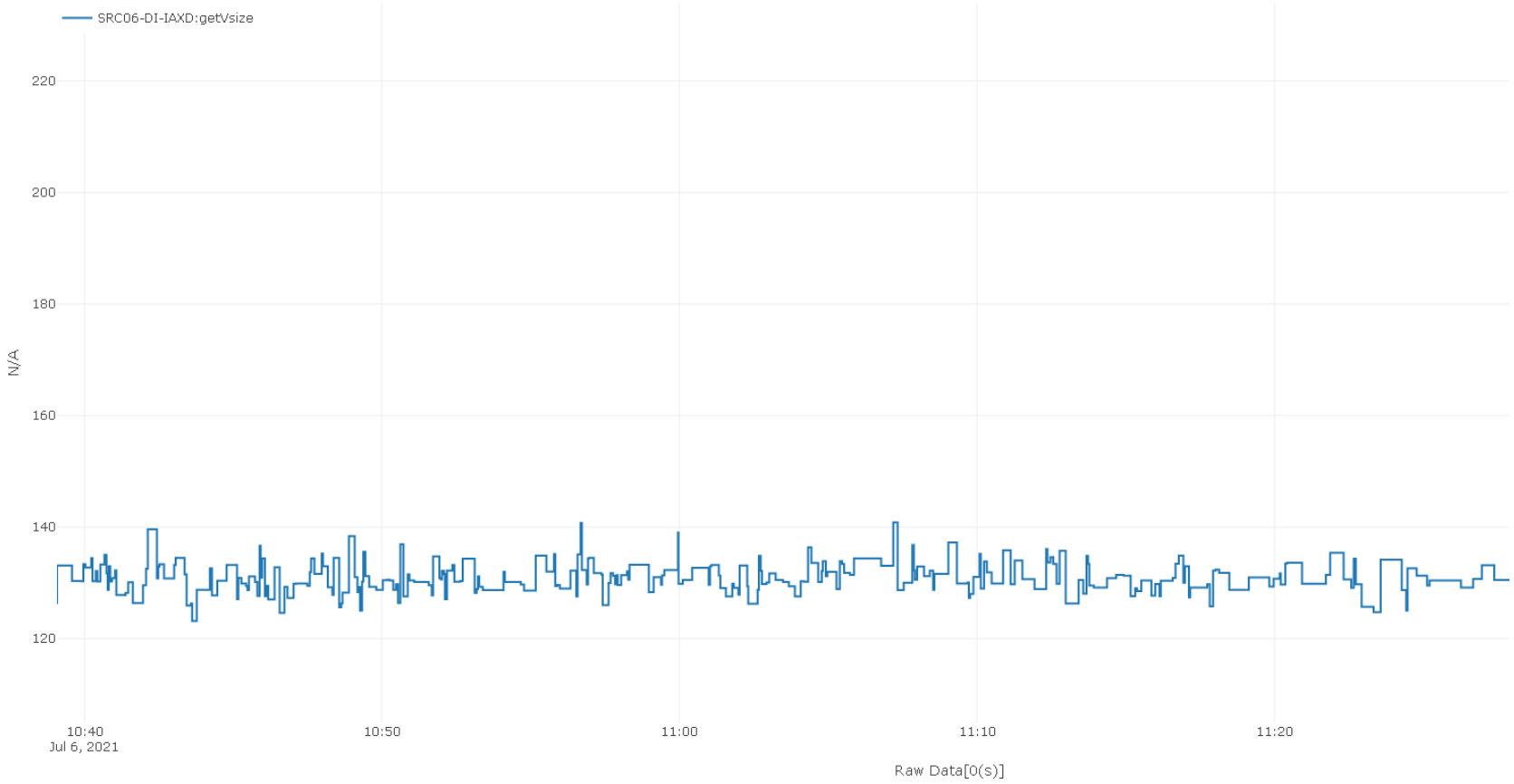


IAXD Optimization

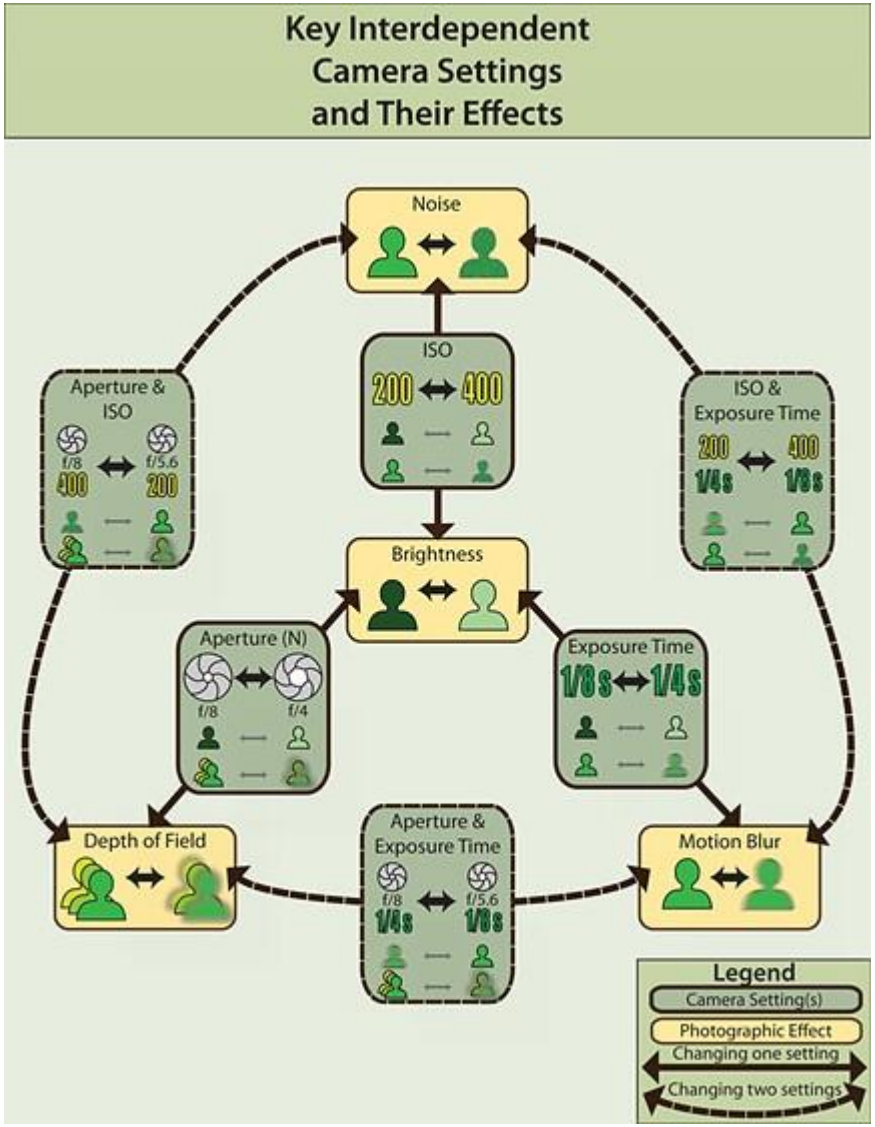
- An improvement has been done on IAXD's script by the control group which analyzes the data in more precise way through certain filters.
- Topology of eliminating the undesired fetched data
- In addition to only archiving the data with high fitting efficiency (>95%).



IAXD Optimization (Results)

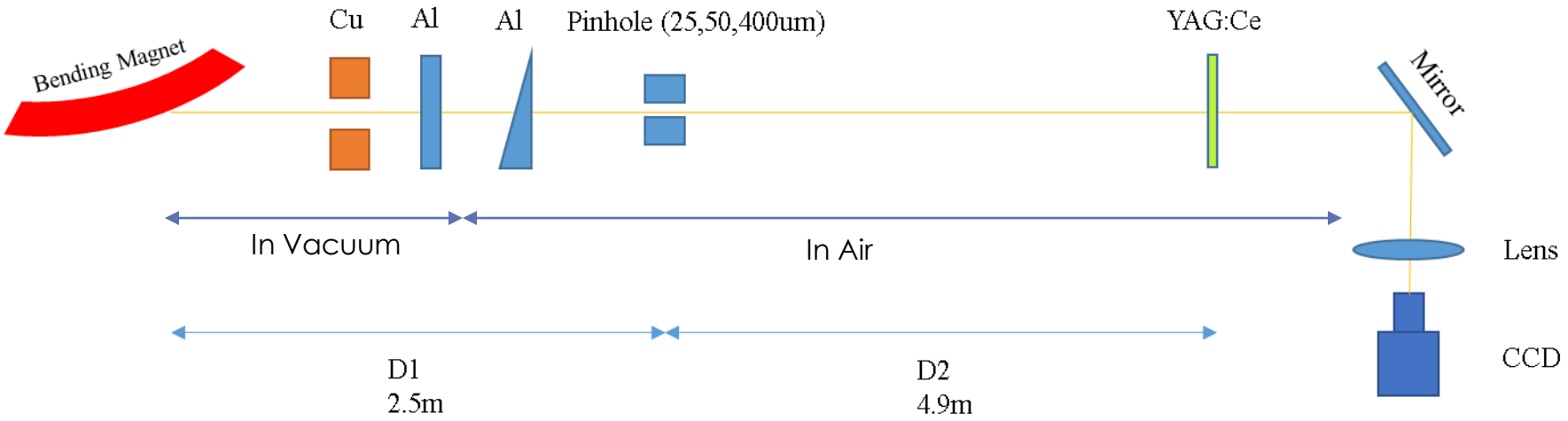


Optical System Trade-off

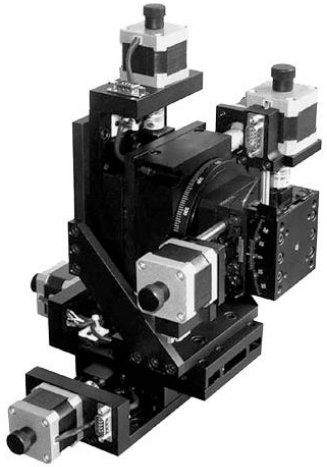


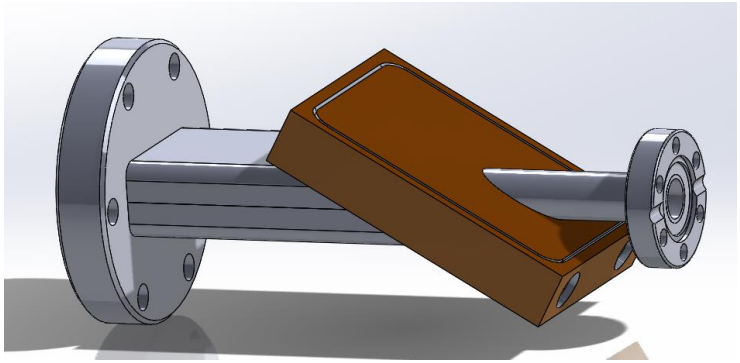
Pinhole

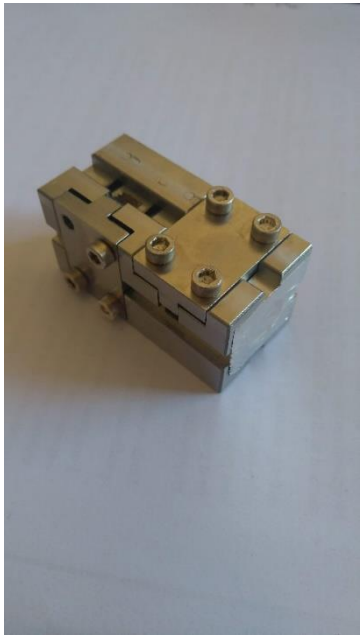
- Phase 1 will have one pinhole located in cell 15.
- Magnification factor : D2/D1 = 1.96
- Modified absorber is under design with mechanical group
- Project postponed due to lack of fund

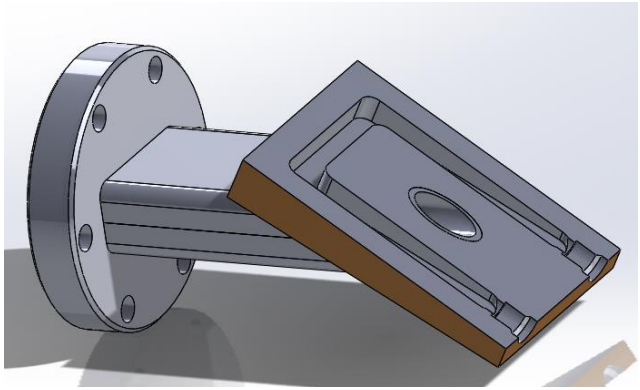


Pinhole

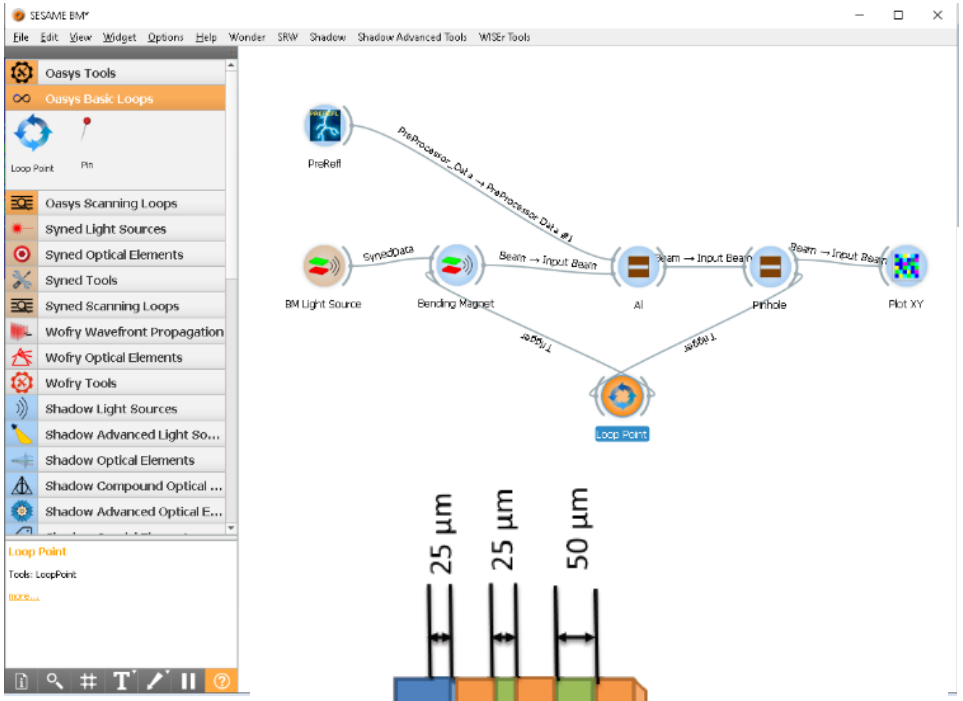


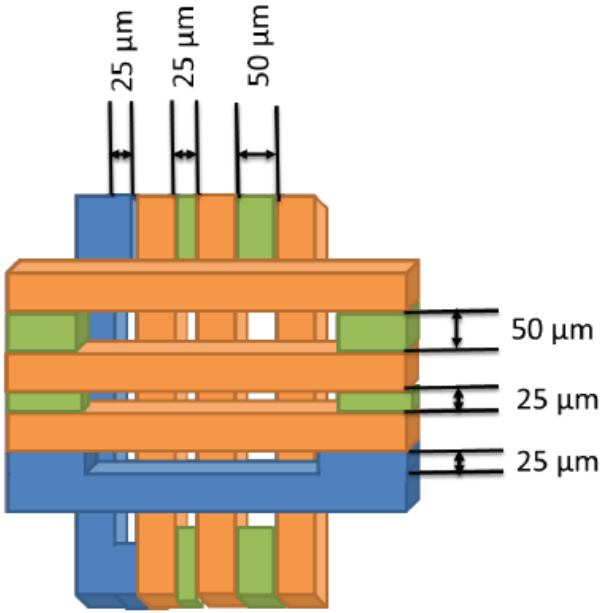


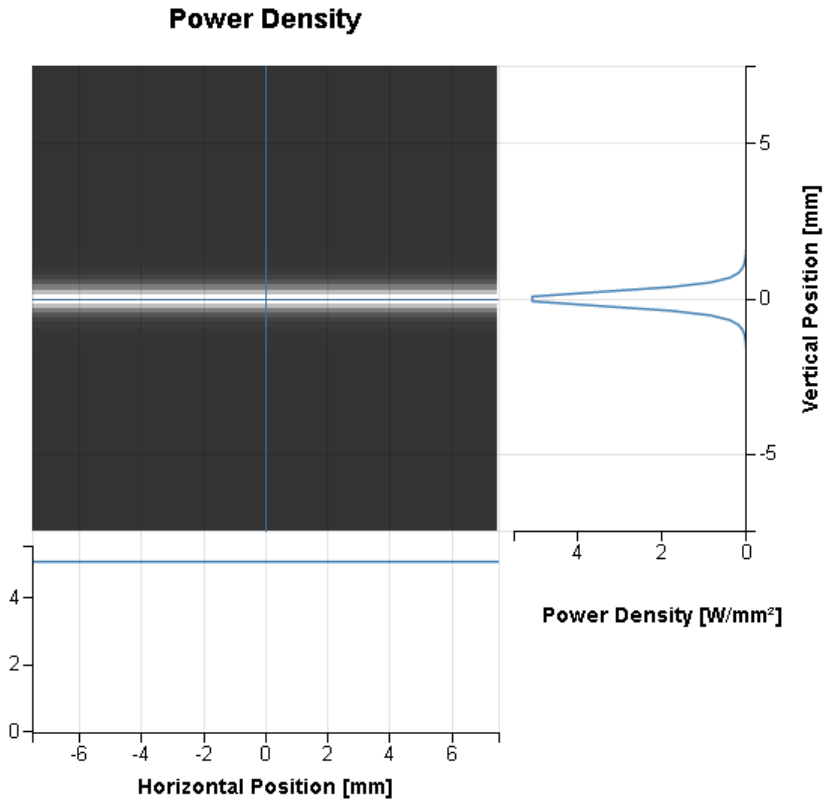




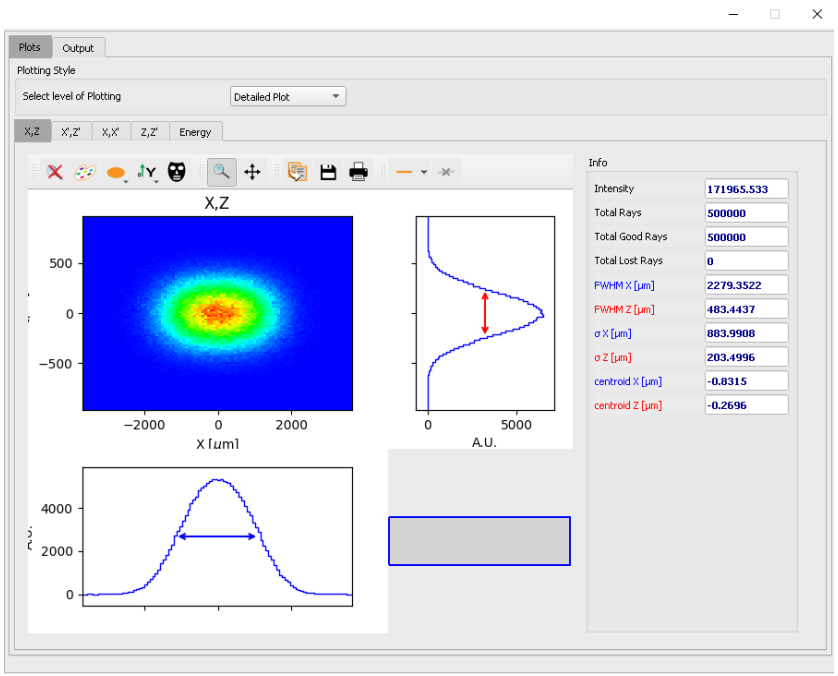
Pinhole


SESAME BM*
File Edit View Widget Options Help Wonder SRW Shadow Shadow Advanced Tools WISEr Tools
Oasys Tools
Oasys Basic Loops
Loop Point
Pin
Oasys Scanning Loops
Syned Light Sources
Syned Optical Elements
Syned Tools
Syned Scanning Loops
Wofry Wavefront Propagation
Wofry Optical Elements
Wofry Tools
Shadow Light Sources
Shadow Advanced Light So...
Shadow Optical Elements
Shadow Compound Optical ...
Shadow Advanced Optical E...
Loop Point
Tools: LoopPoint
more...
PreRefl
PreProcessor_Data → PreProcessor_Data #1
SynedData
BM Light Source
Bending Magnet
Beam → Input Beam
Al
Pinhole
Plot XY
Loop Point

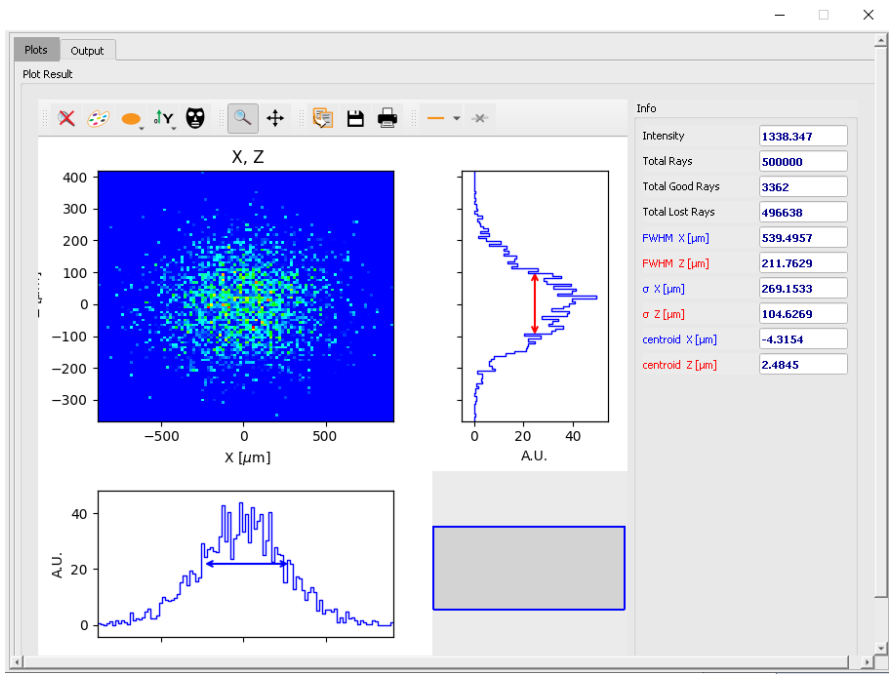

25 µm
25 µm
50 µm
50 µm
25 µm
25 µm


Power Density
Vertical Position [mm]
5
0
-5
4
2
0
Power Density [W/mm²]
4
2
0
-6
-4
-2
0
2
4
6
Horizontal Position [mm]

Pinhole



After Photon Absorber



After Pinhole

Conclusion

- Regarding the SRM, further beamtime (machine development)sessions are needed to do a more detailed study on the results we're getting from the interferometry branch.

- On the other hand, we're currently implementing an additional IAXD to be installed at cell 12 with a different optical system by changing the **zoom lens** to a **telephoto lens**, in order to achieve a wider depth of field, hence, a clearer image.

- As for the Pinhole, we're finalizing the design of the photon absorber to move forward to the procurement stage and afterwards the installation and commissioning.

Acknowledgment

❖ **Internally:**

- **Control Group**: Basil Al-Jamal, Abdullah Al-Dalleh, Anas Al-Abbadi, Mohammad Abu-Gharbieh, Rami Khreis, Amro Al-Jadaa.
- **Mechanical and Vacuum Groups:** Mohammad Al-Najdawi, Maher Shehab, Abdelrahman Hassouneh, Mohammad Iqbal, Adel Amro, Mahmoud Irsheid.

❖ **Externally:**

- **Diamond:** Guenther Rehm, Lorraine Bobb.
- **Alba:** Ubaldo Iriso, Andriy Nosych.

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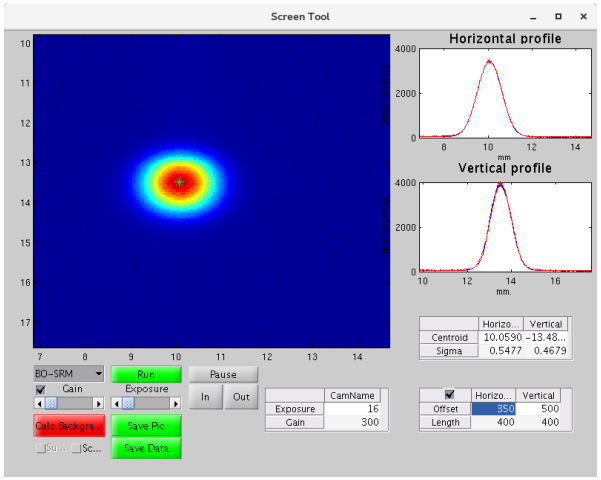
Screen Tool
Horizontal profile
Vertical profile
mm
mm.
Centroid
Sigma
Run
Pause
Exposure
Gain
In
Out
Calc Backgra...
Save Pic
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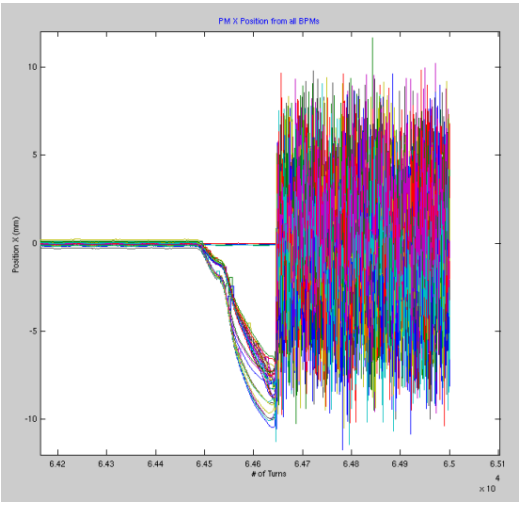
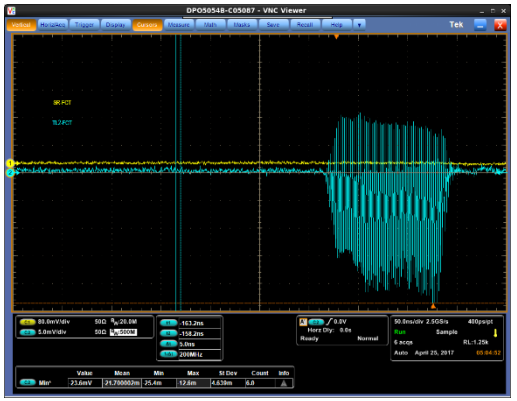
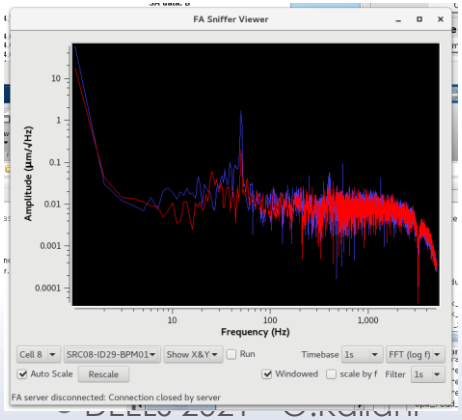
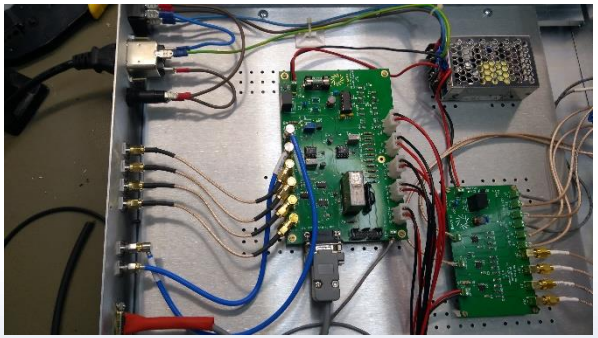
CamName
Offset
Length

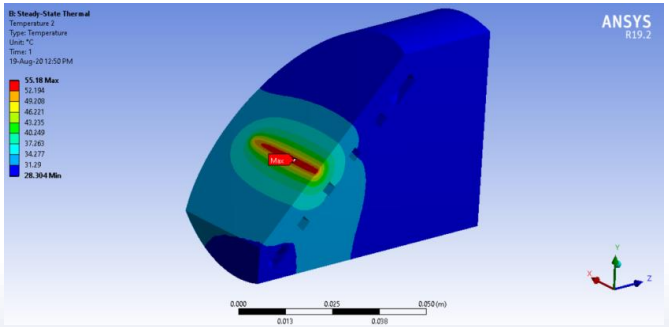

PM X Position from all BPMs
Position X (mm)
# of Turns


thank you
danke
gracias
merci
obrigado
dziękuję
teşekkür ederim
go raibh maith agat
mochchakkeram
sukriya
dakujem
arigatō
спасибо
ngiyabonga
شكراً جزيلاً


DPO5054B-C05087 - VNC Viewer


FA Sniffer Viewer
Amplitude (µm/√Hz)
Frequency (Hz)
FA server disconnected: Connection closed by server

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