European XFEL
SASE3 Photon Beam Commissioning and Lesson Learned

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MEDSI2018 – Paris, France

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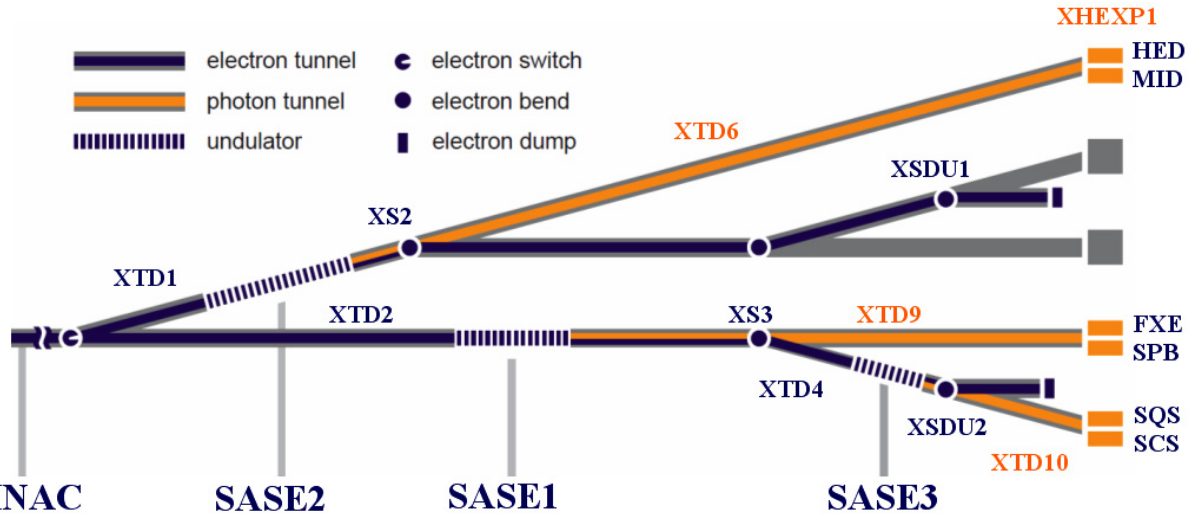
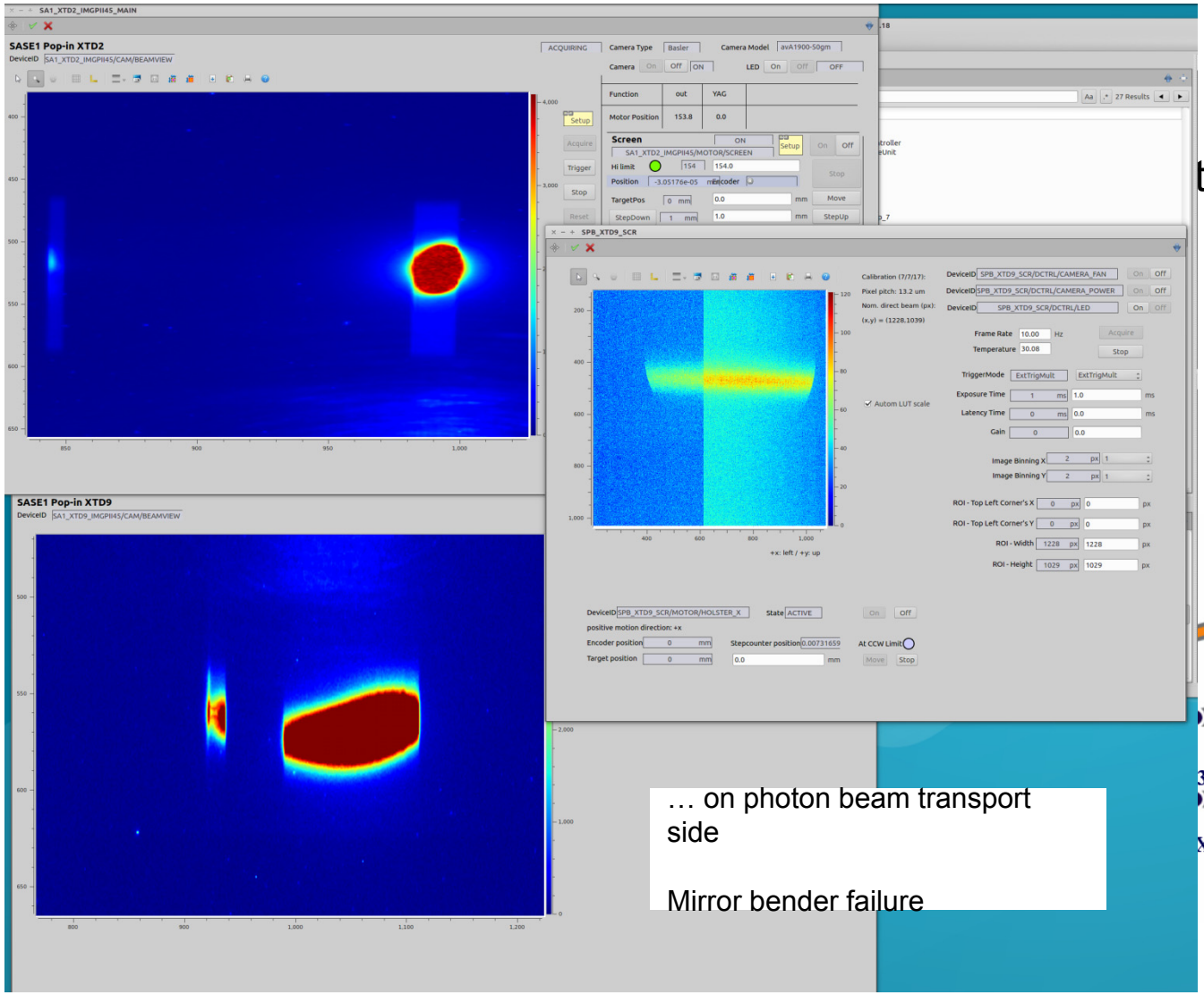
XFEL recent achievements

- First lasing in May 2017 on SASE1 beamline
- First users in September 2017 on SPB and FXE instruments
- SASE3 first lasing in February 2018
- SASE2 first lasing in May 2018
- Really exiting period … not “trouble-free”

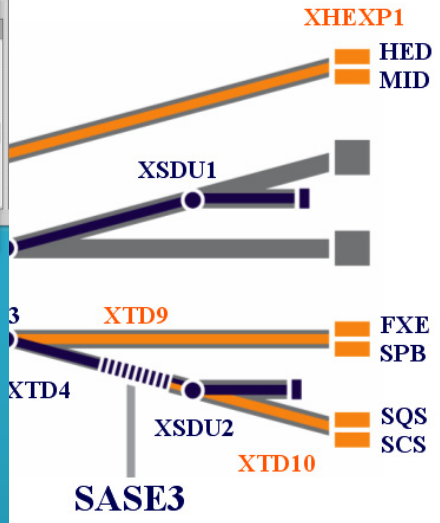


XFEL recent achievements

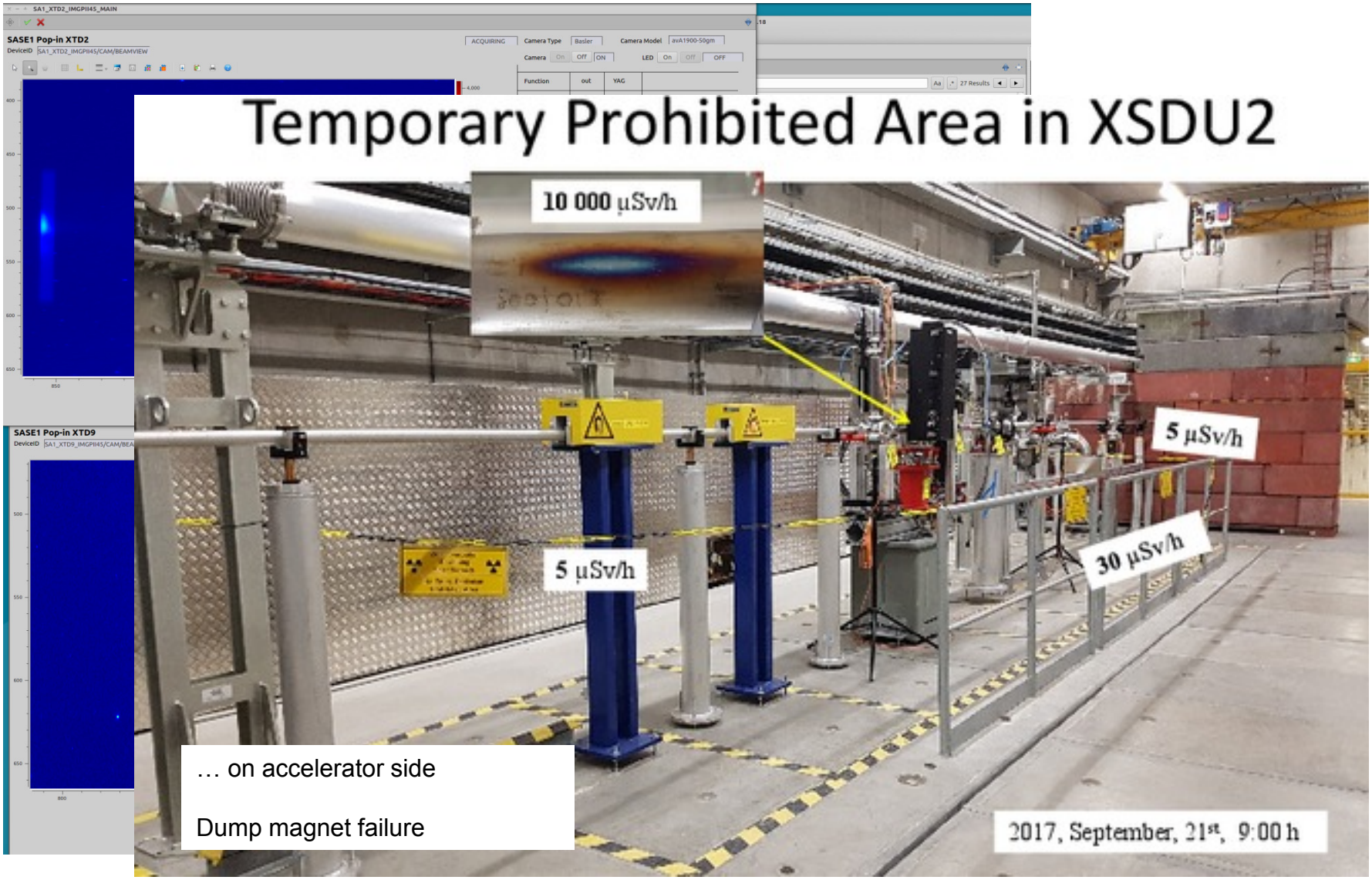


… on photon beam transport side

Mirror bender failure



XFEL recent achievements



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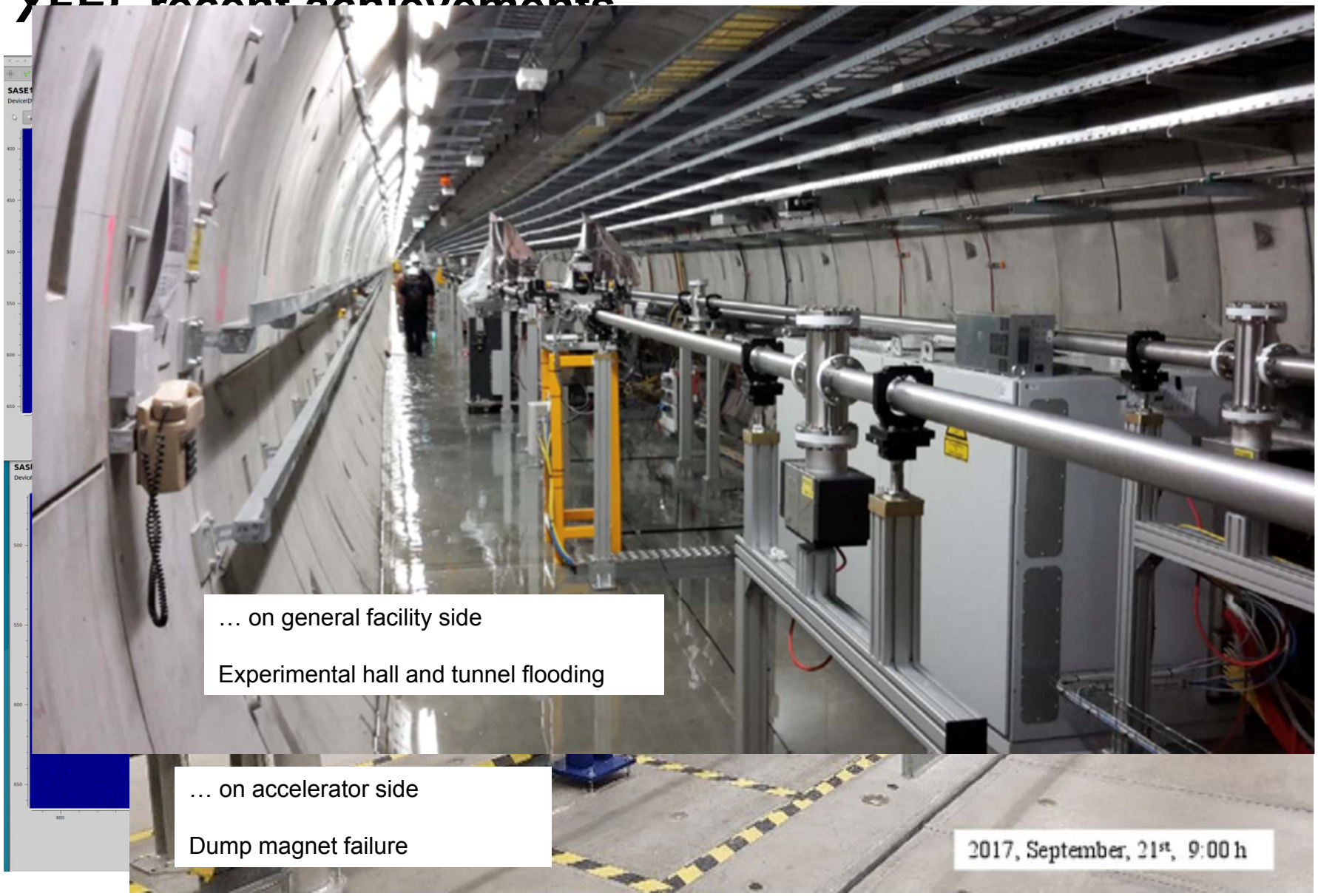
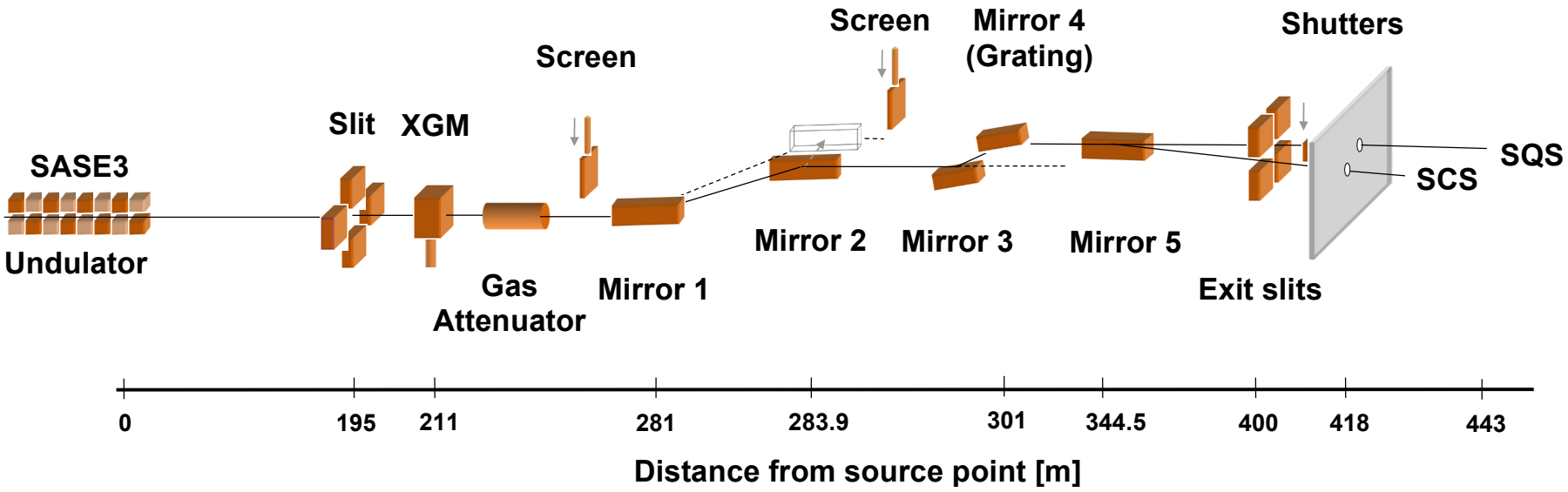


SASE3 Photon Commissioning

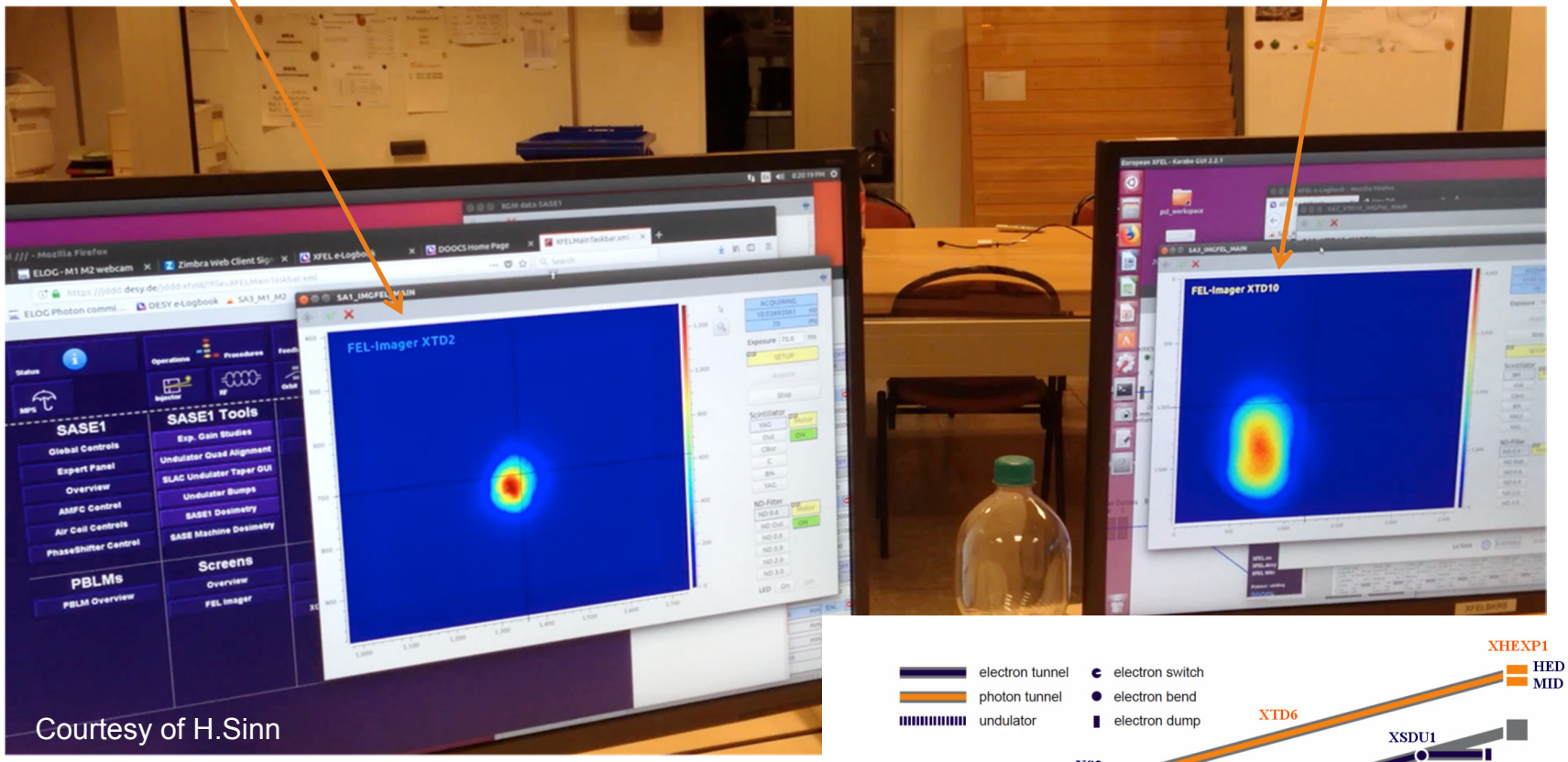
- Photon commissioning team: 20 persons from 6 groups + run coordinators
- Organized in 3 shifts to cover 24/7 from 07.02.18 until 04.03 (528 hours)
- Goal: transmit and shape the beam in order to allow user-time

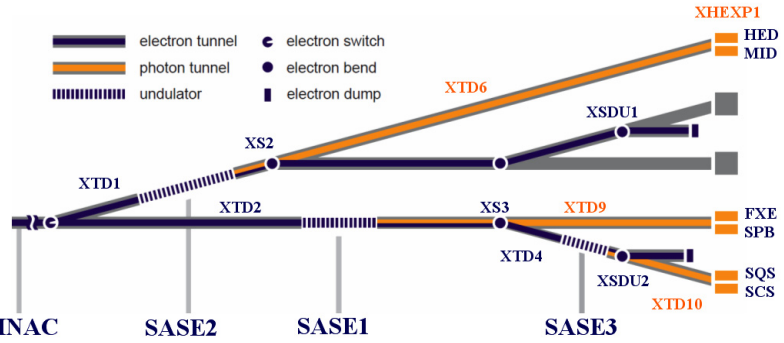


SASE1 and SASE3 simultaneous lasing Feb.8th, 2018

SASE1 imager

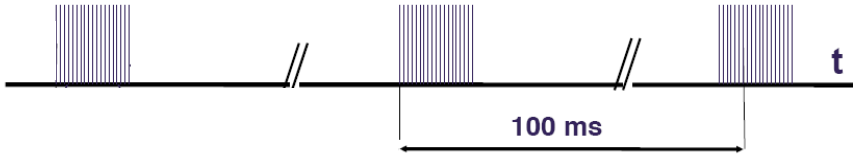
SASE3 imager



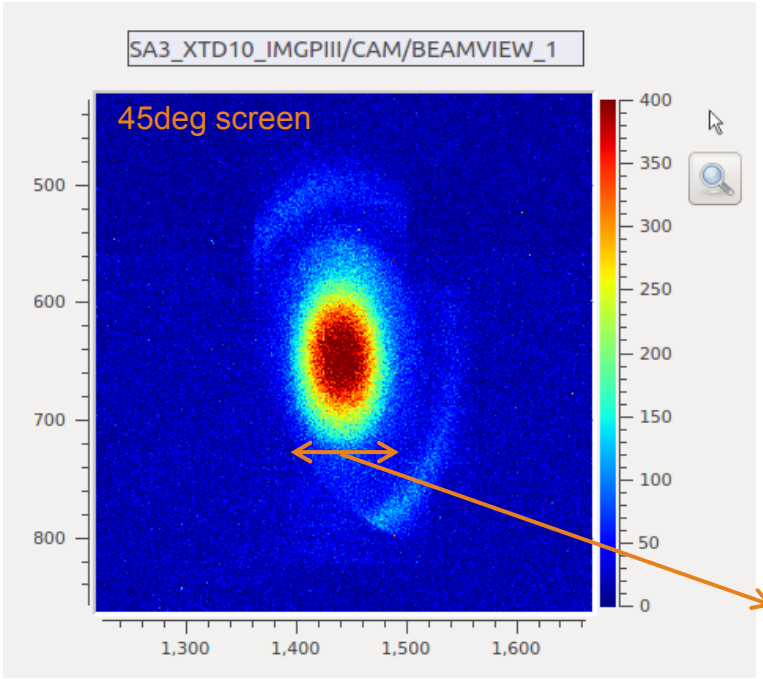


First lasing

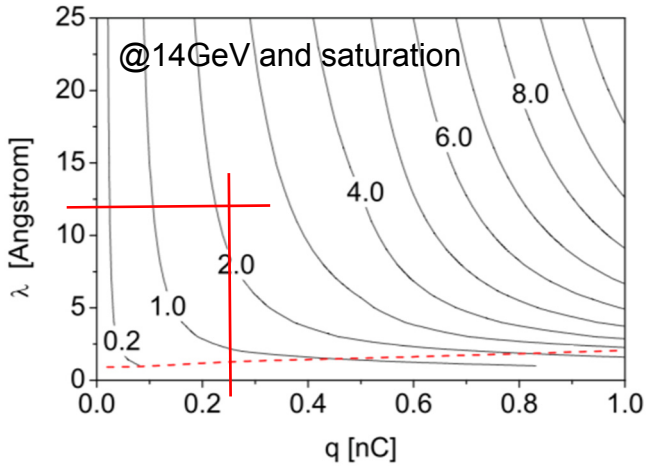
- on February 8th, at the first attempt!!!
- 14GeV, 0.25nC, 2 bunches, 1MHz



- 900eV, more than 1mJ energy (relatively quite fast tuning)

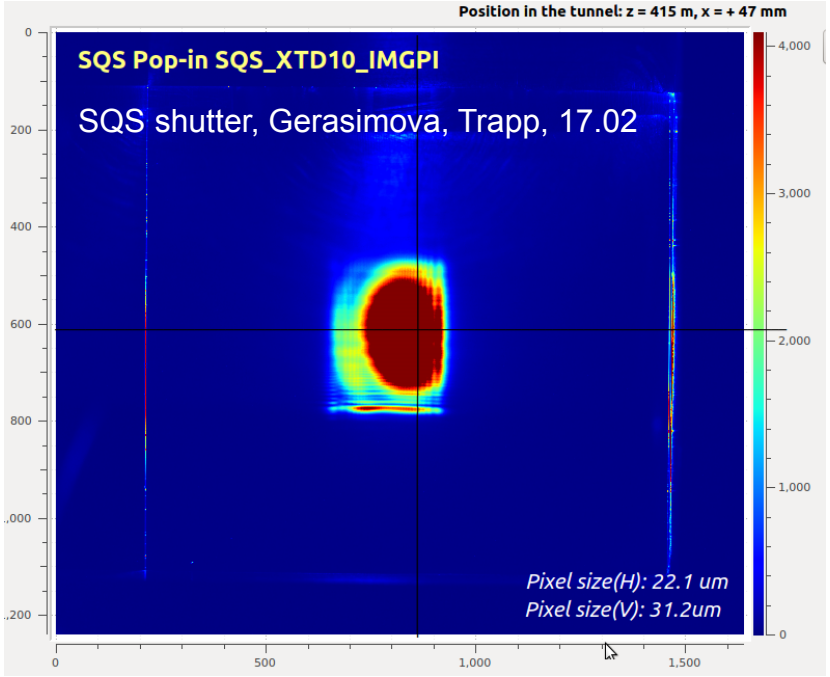


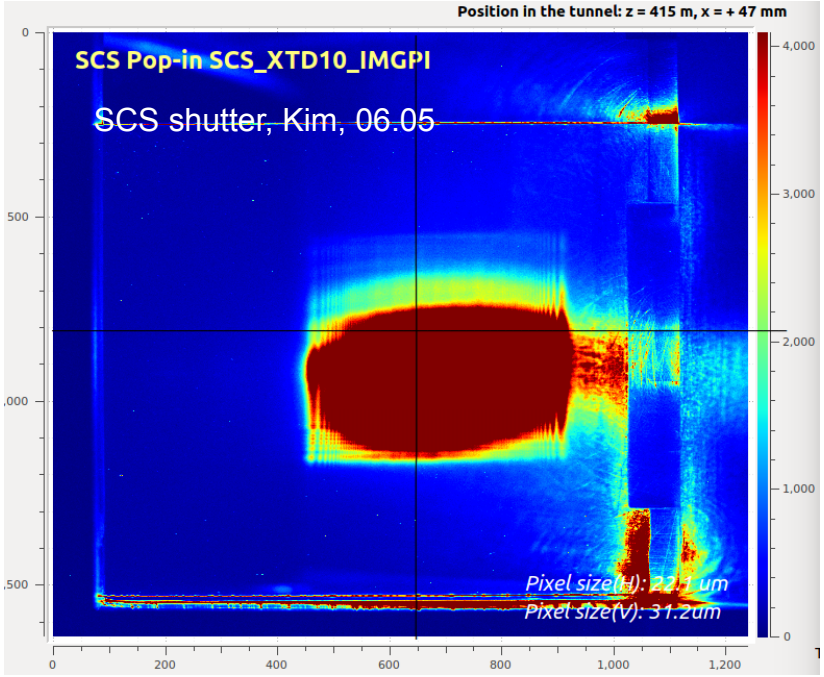
Almost round spot
4σ beam 5.4mm

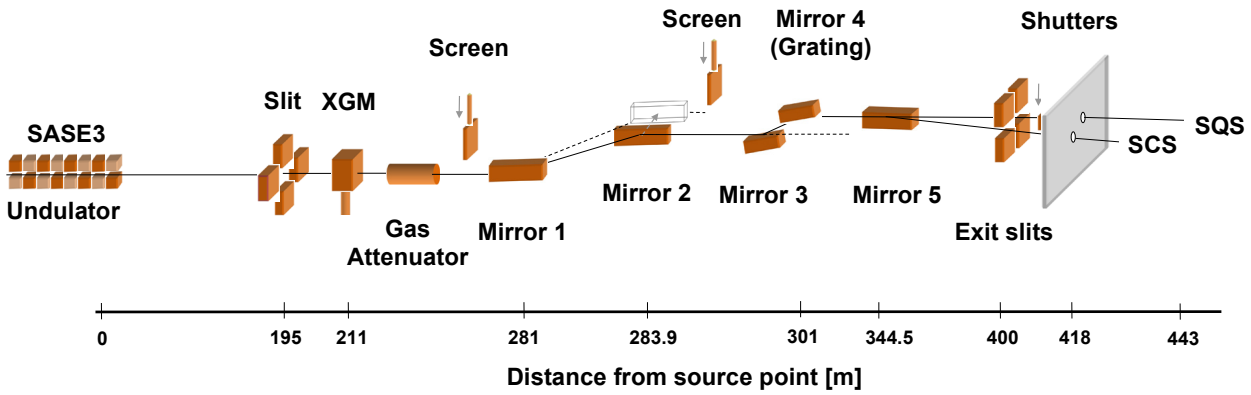


Schneidmiller, Yurkov, TR-2011-006, Sept 2011.

“Pink beam” on the shutters







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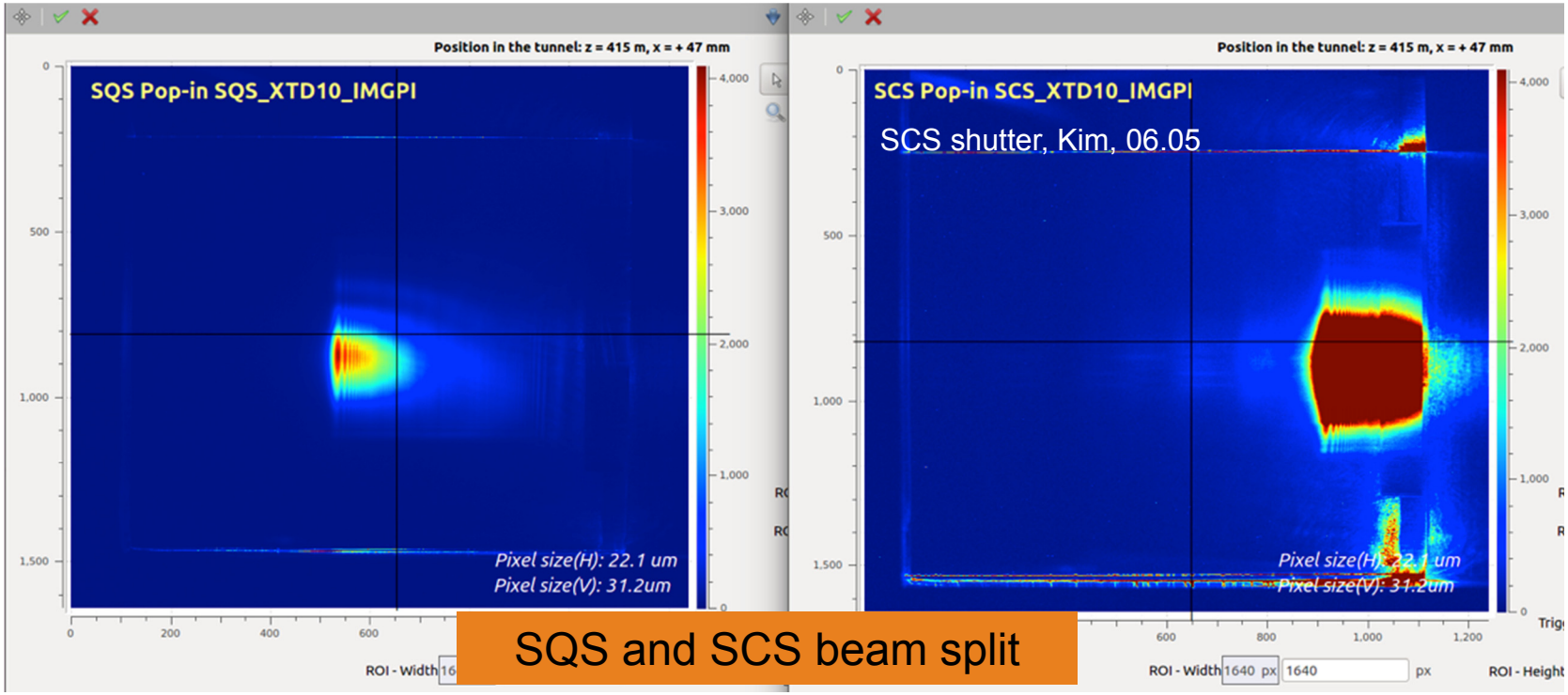
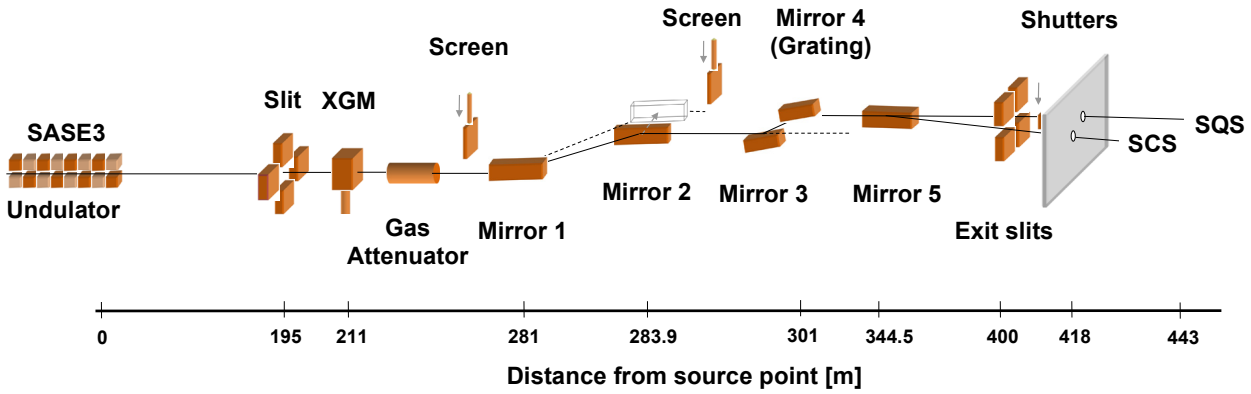
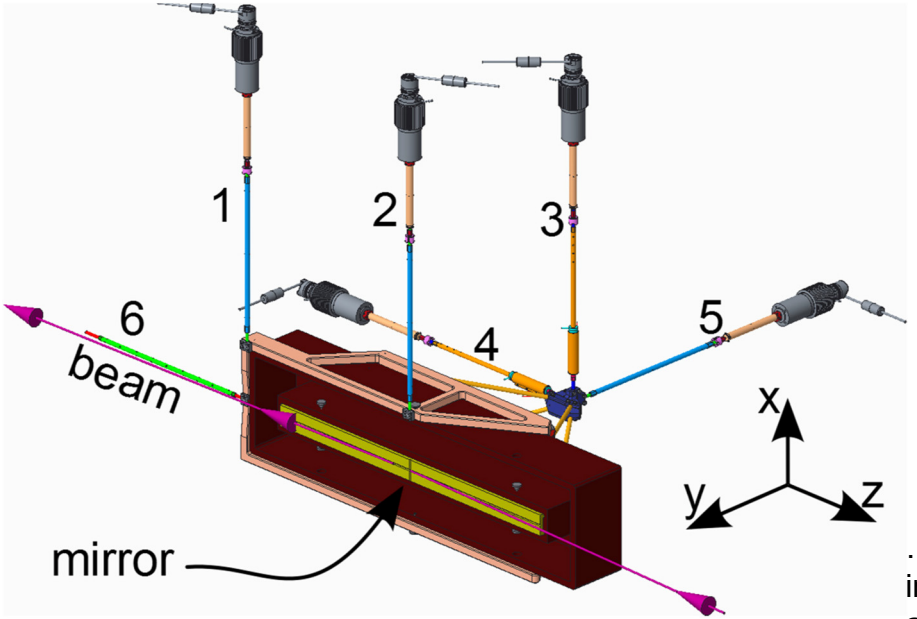


SQS and SCS beam split



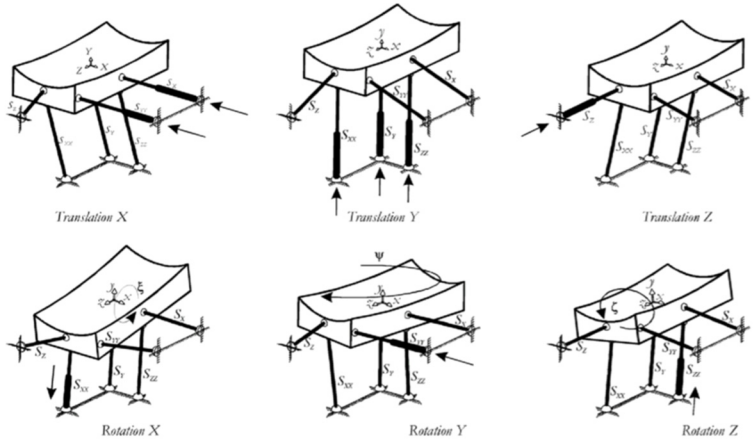
Mirror system

- Noll, Trapp, Sinn design: mirror supported by semi-rigid struts
- Large horizontal travel range due to variable offset chicane ➔ parasitic pitch

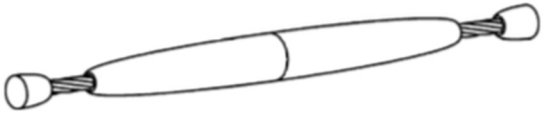


Noll, MEDSI2016 TUBA03

Noll et al., Precision Engineering 33 (2009)



… the bending and torsional flexibility is extremely high but in the axial direction this material is very stiff. Even in the axial push direction the stiffness is surprisingly high because the rope segment is short and does not buckle.



Noll et al., Precision Engineering 26 (2002)

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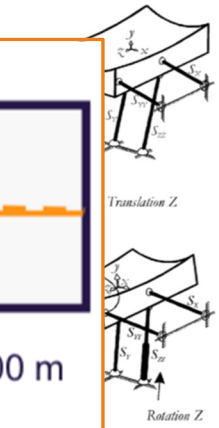
Figure 19: *Changing the incidence angle of the offset mirrors will require moving the second offset mirror horizontally. The beam displacement is compensated by beam steering with the second offset mirror.*

Sinn et al., XFEL Beam Transport CDR, 2011



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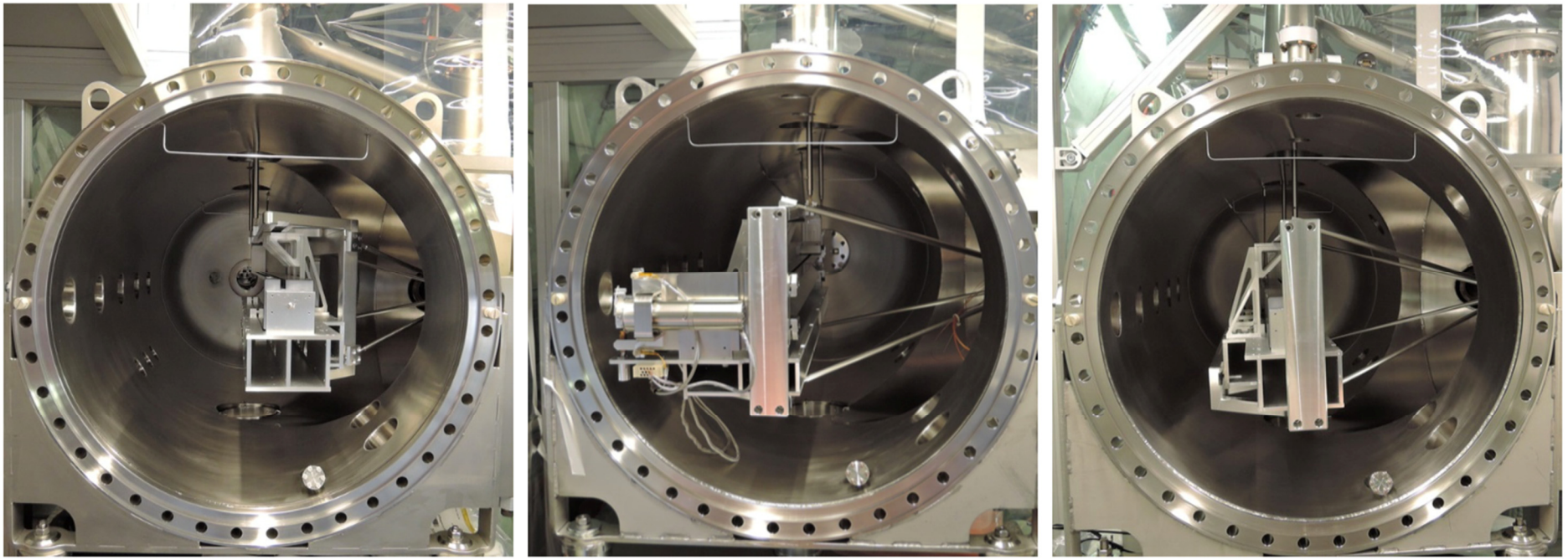
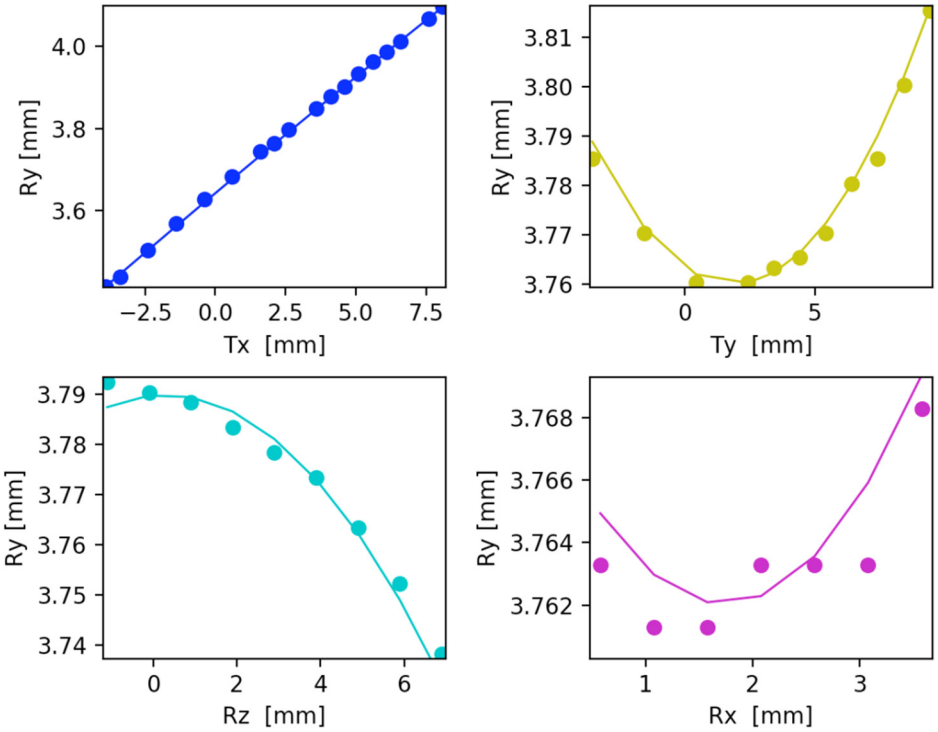
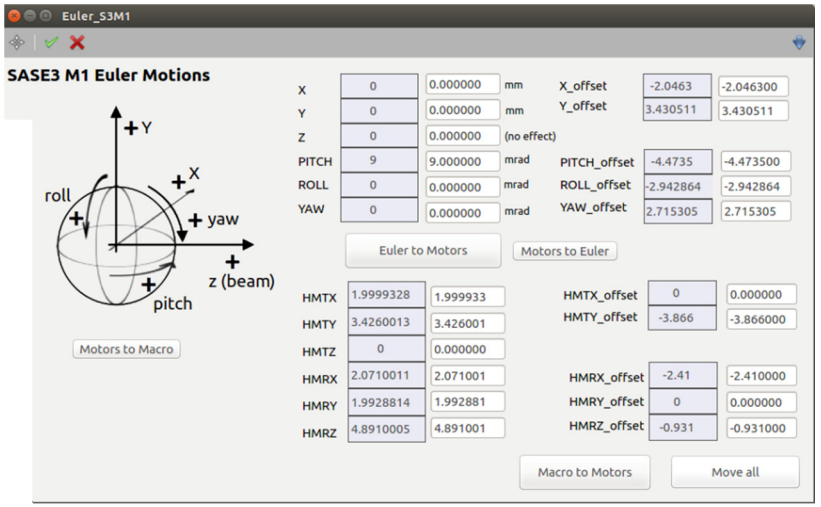


Music, Master degree thesis, Characterization of X-ray Optics at the European XFEL SASE1 Beamline

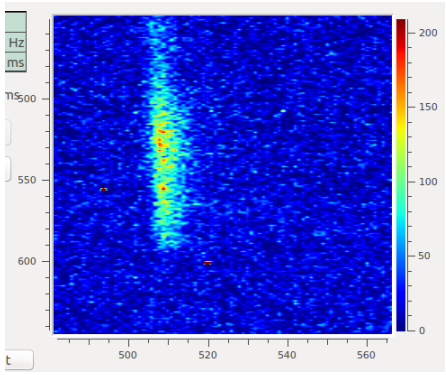
Mirror parasitic motion

- Measurements with beam parasitic pitch (Ry)
- Macro development



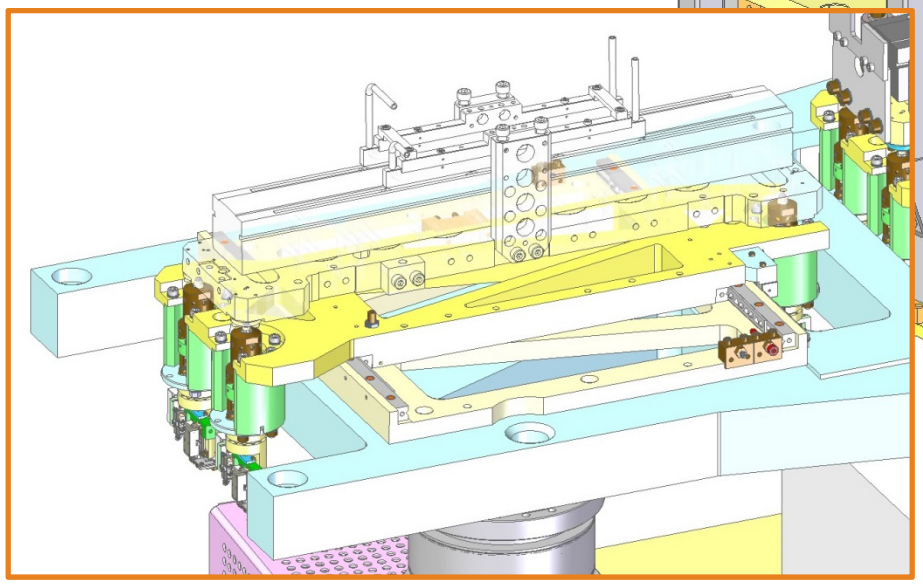


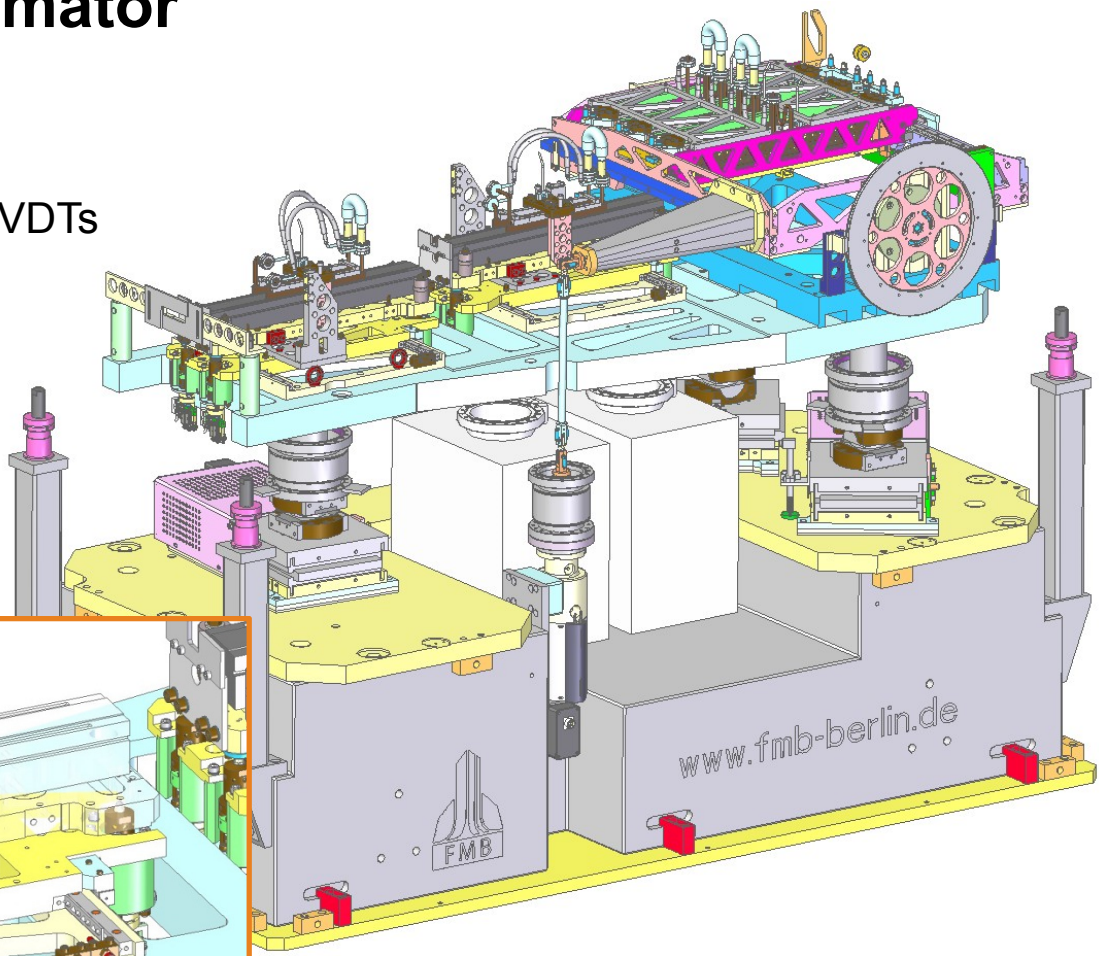
Trapp, Gerasimova, Sinn



Soft X-ray monochromator

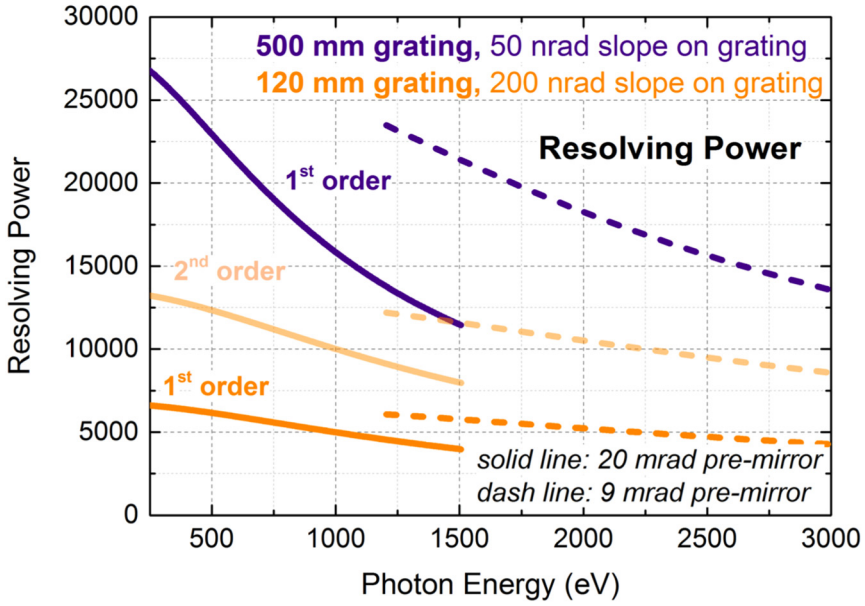
- 13 Axes
- Absolute, relative encoders, LVDTs
- Stepper motors, piezo motors

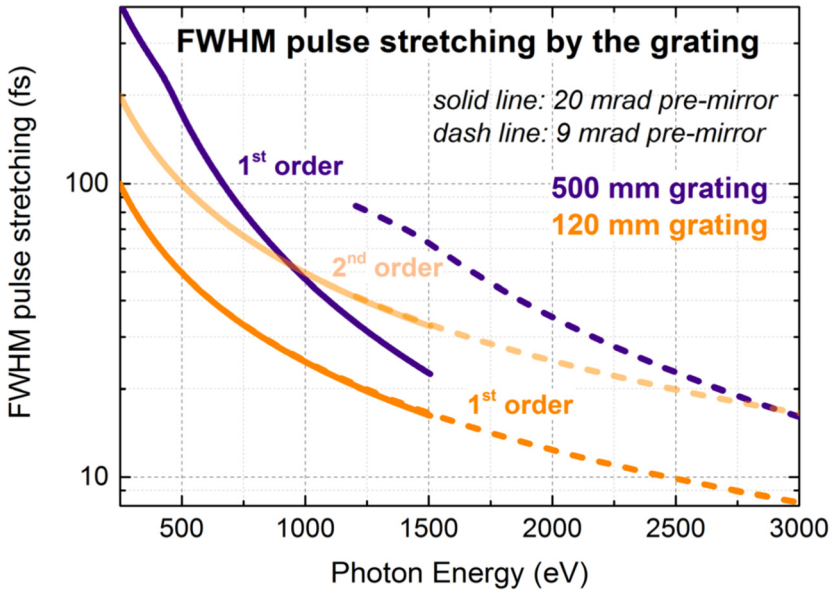




FMB Berlin

"Short" grating

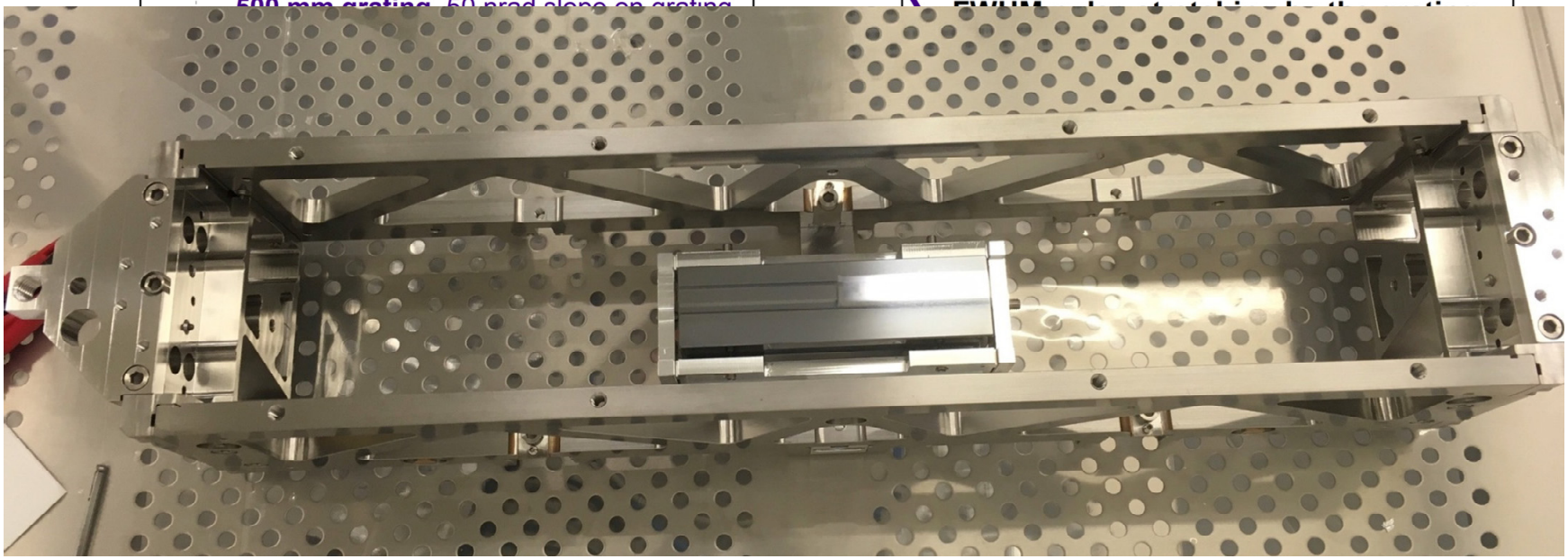




Gerasimova, TR-2018-001

- Clear aperture 120mm long (original 500mm)
- Laminar VLS grating from Jobin Yvon (Horiba)
- 50l/mm - VLS parameters are challenging
- R&D project for the long grating

“Short” grating



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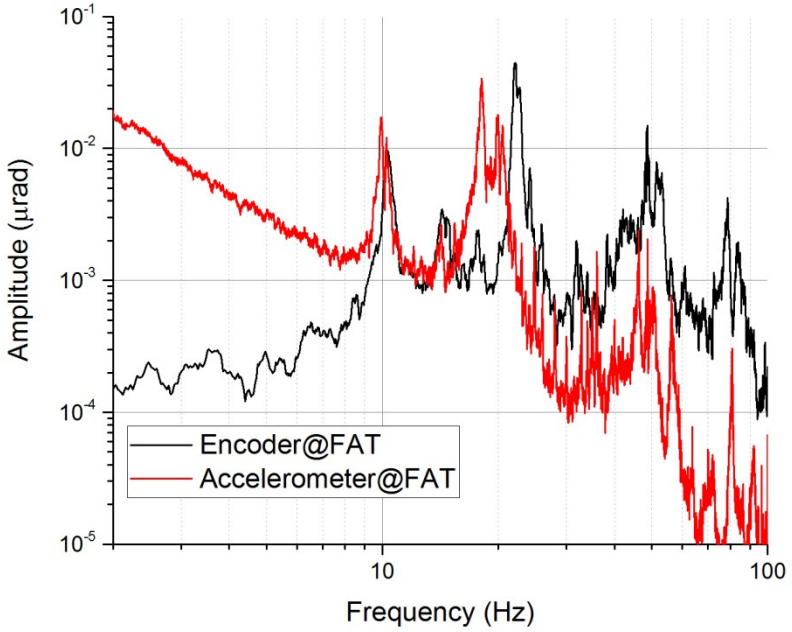
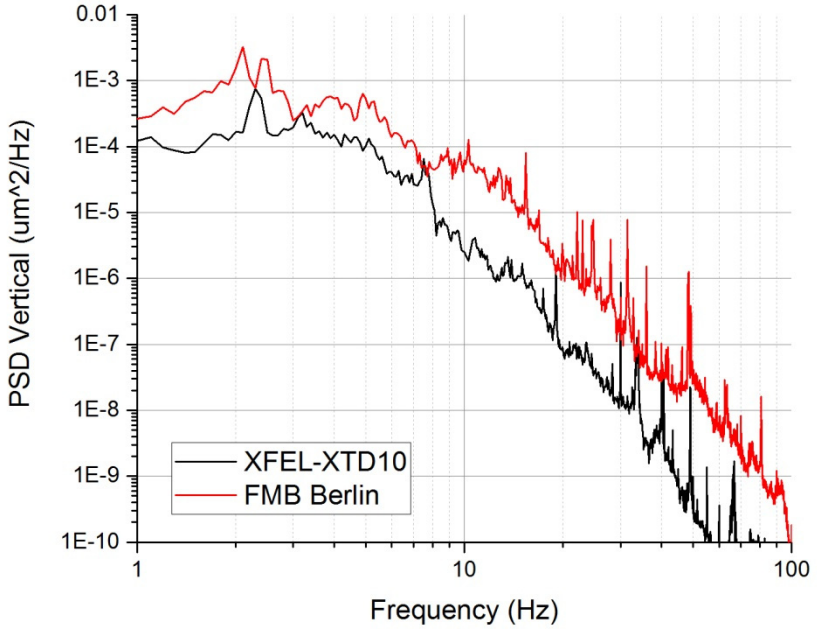
Grating pitch vibration – update from MEDSI16

- FAT showed 150nrad rms – original challenging specification was 50nrad rms
- … hope in the low noise level of the XFEL tunnel





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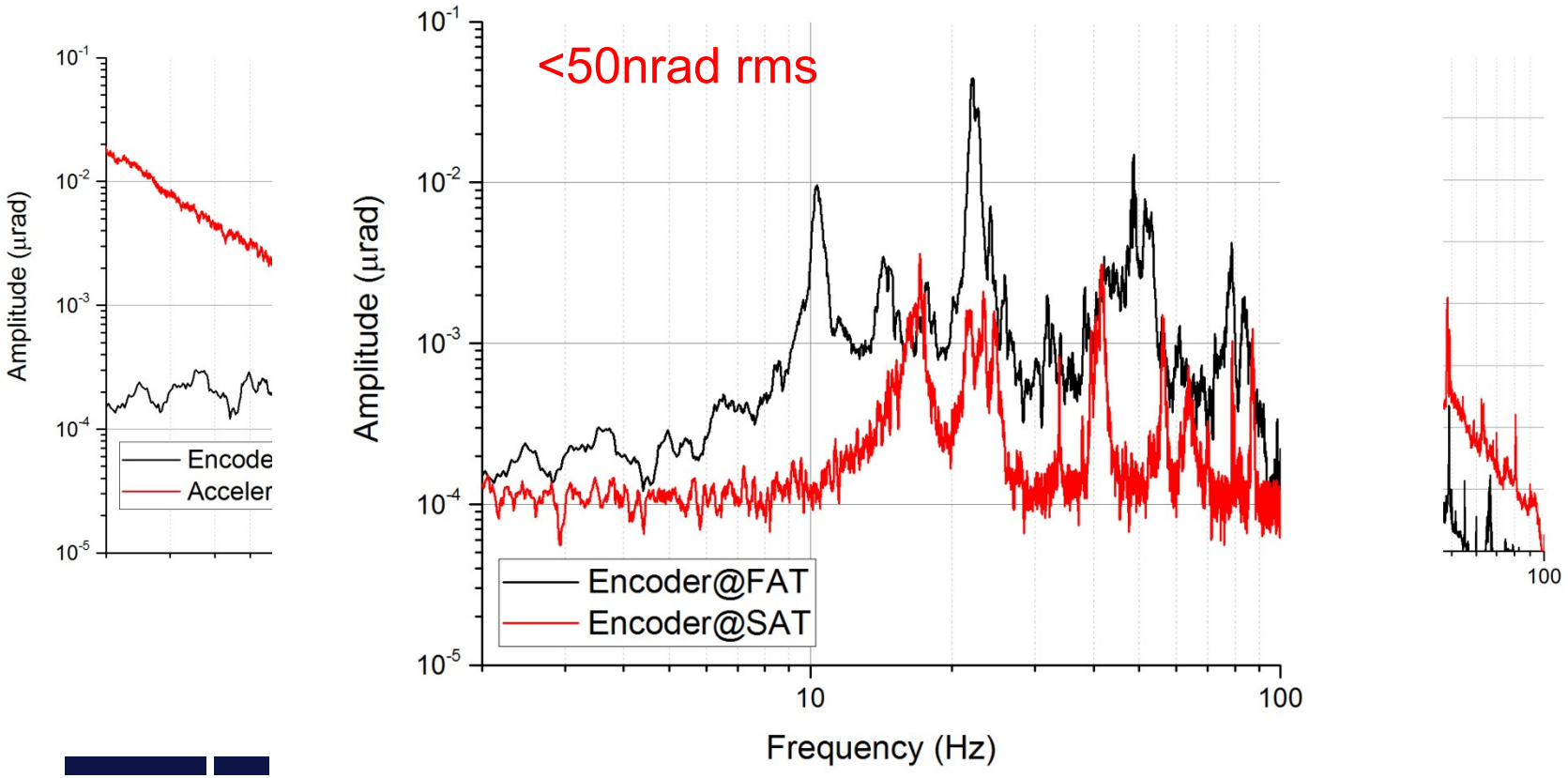

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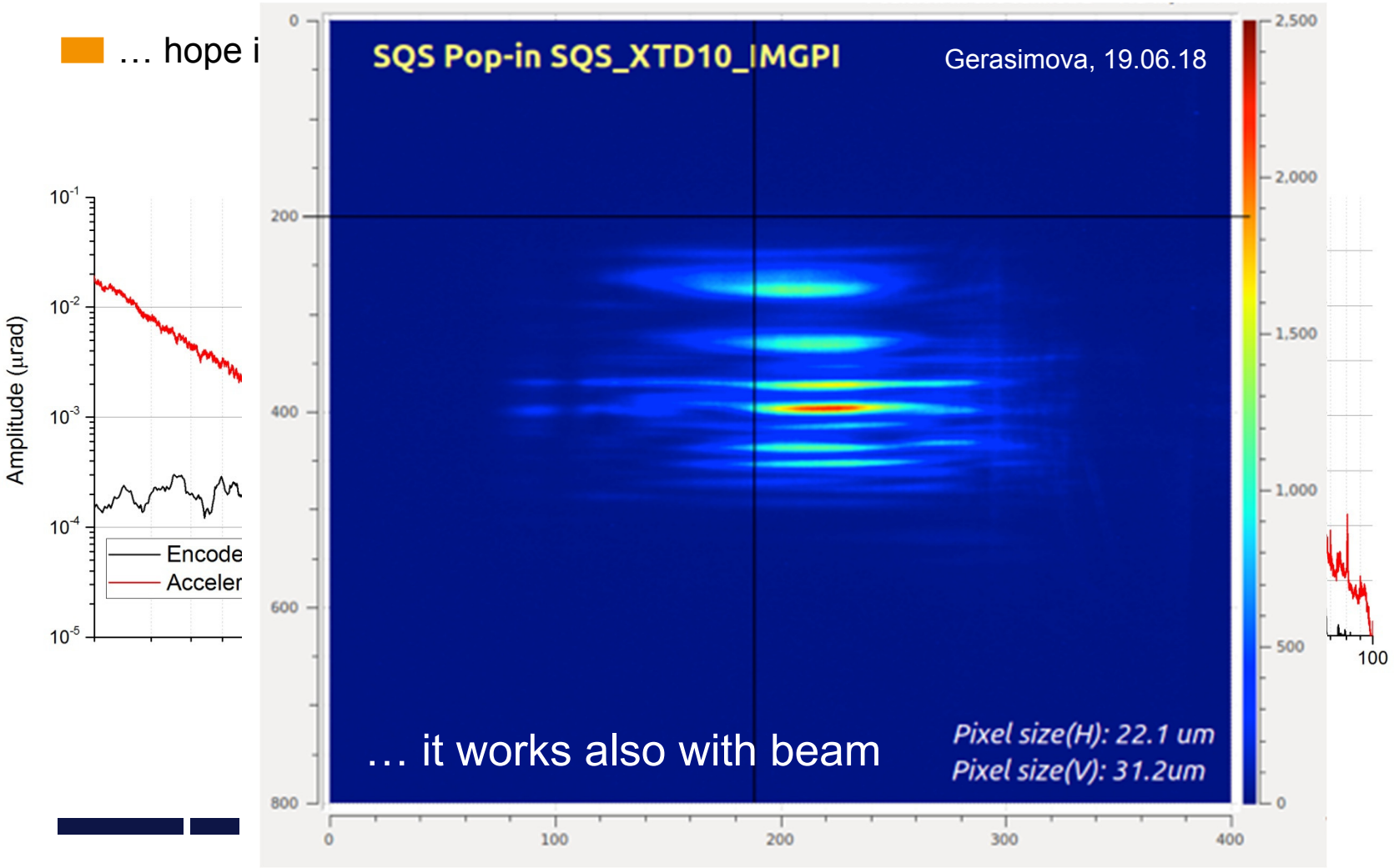
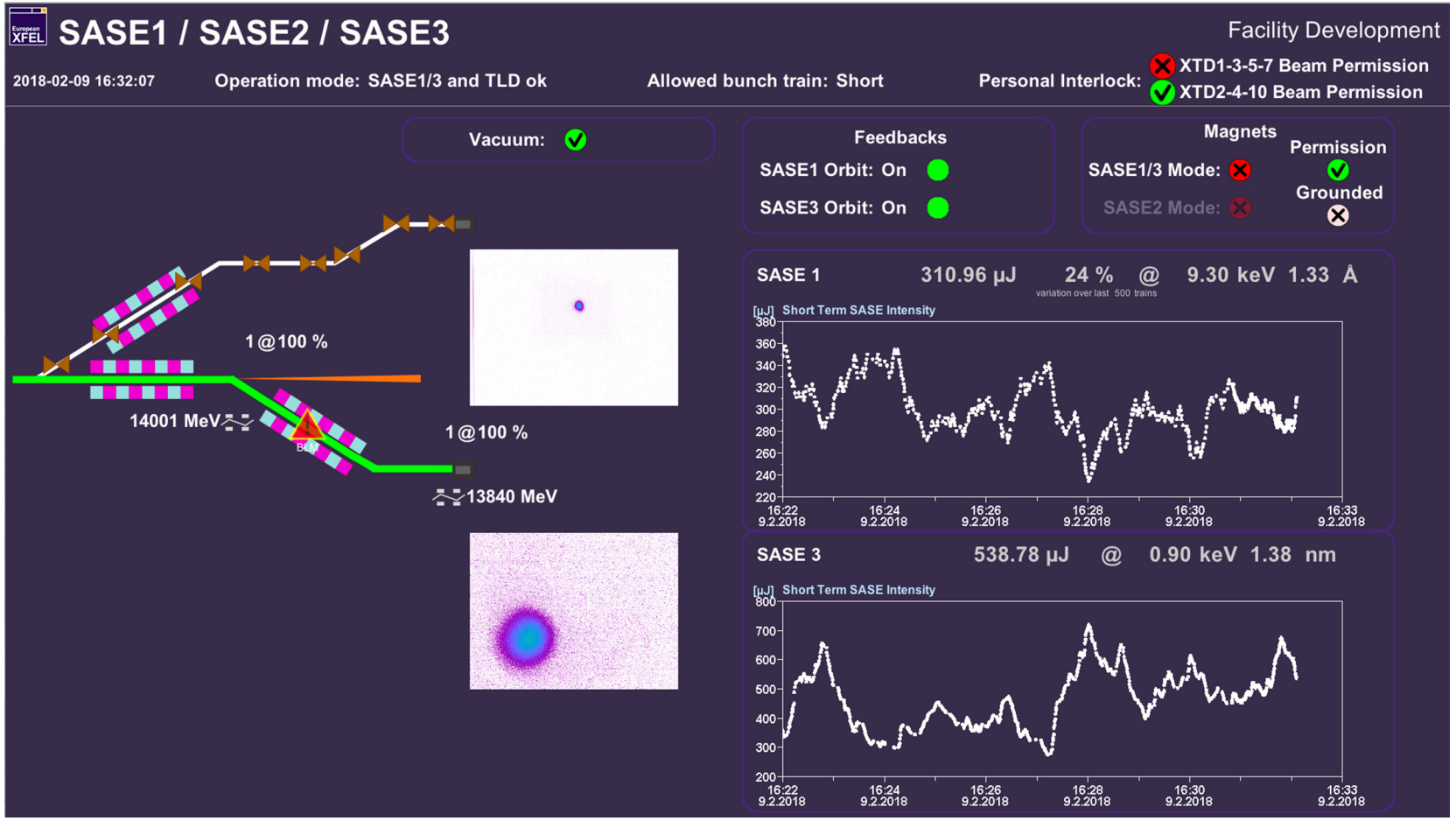


SASE1 & SASE3 lasing / operation

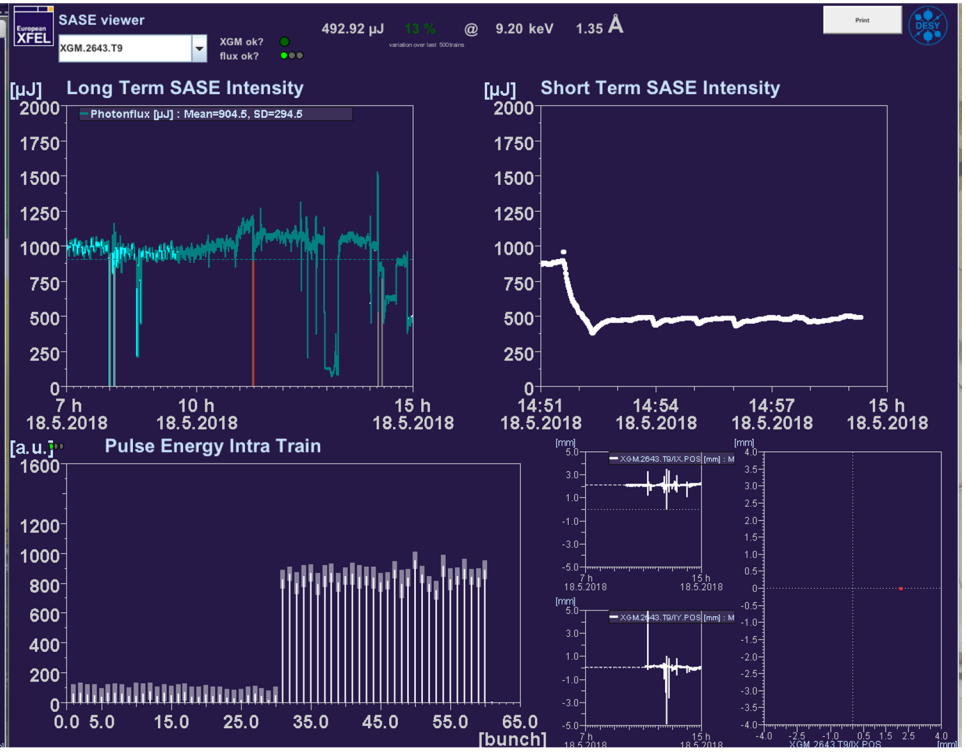
- Without fresh bunch technique (Feb. 9th)



SASE1 & SASE3 lasing / operation

- With fresh bunch technique with 30+30 pulses (May 18th)

XGM in SASE3



XGM in SASE1

The Good

- Beam is available for instrument commissioning and “early users”
- Attenuation, focusing (not with KB), monochromatic capabilities are OK
- SASE1 and SASE3 simultaneous operation is possible

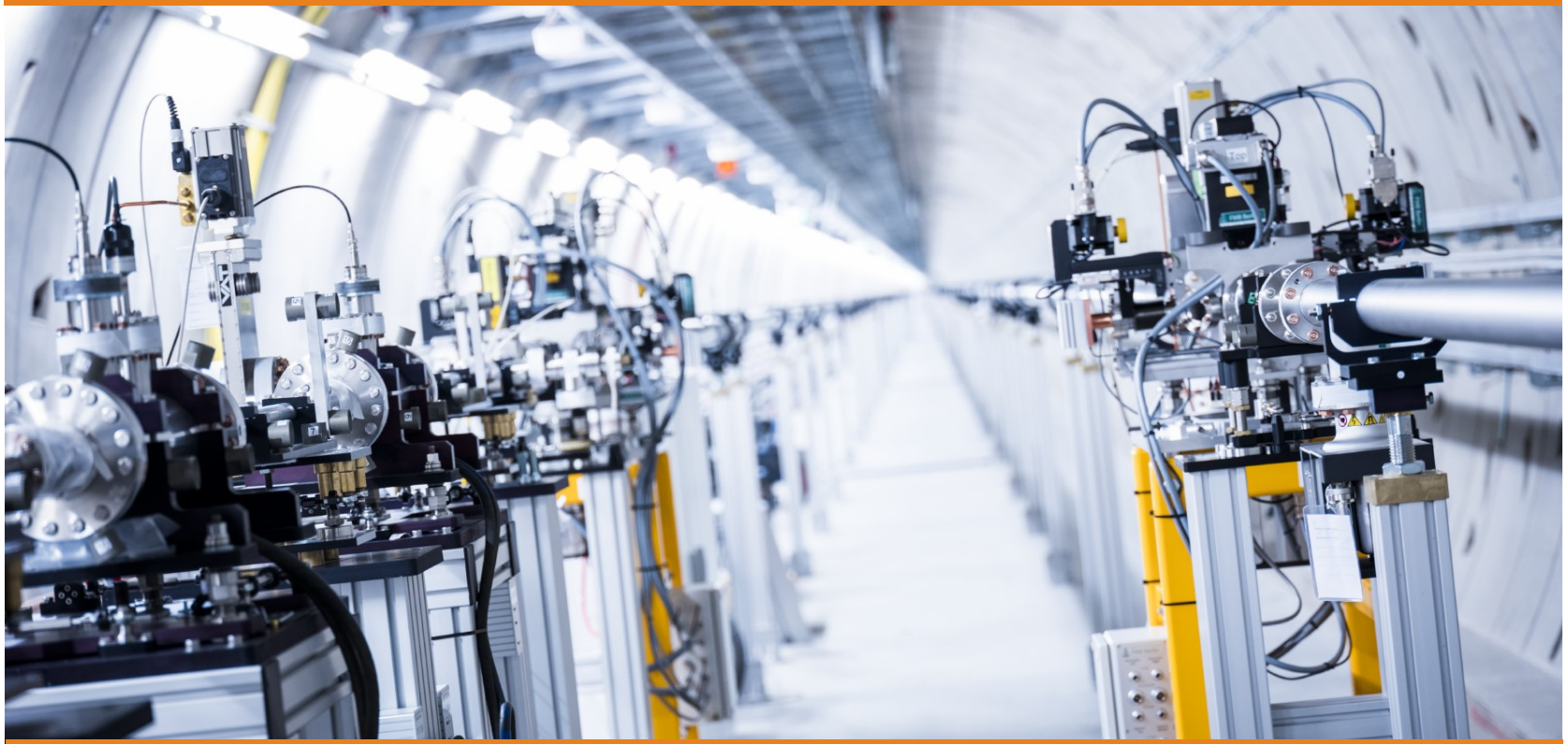
The Bad

- Many important projects to follow at the same time (SASEs + instruments)

The Ugly

- Controls and DAQ not fully implemented, stable and reliable

Stay tuned



Thank you for your attention