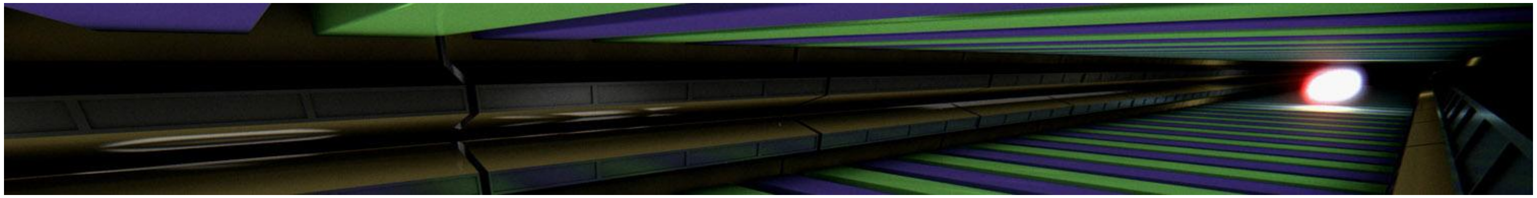


Design of Photon Beamlines at the European XFEL

Harald Sinn (THOCI1)

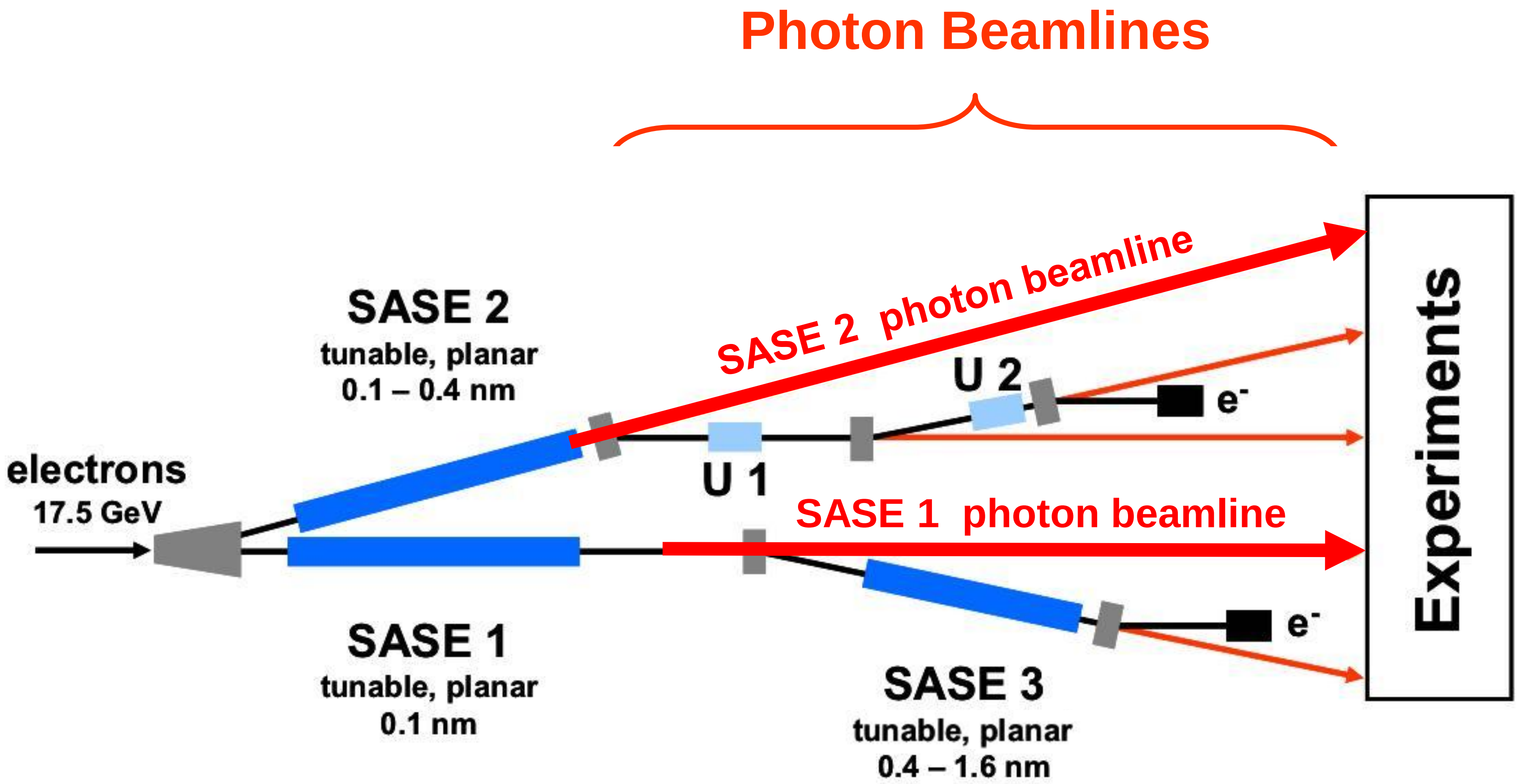
FEL 2010 Malmö

August 26, 2010

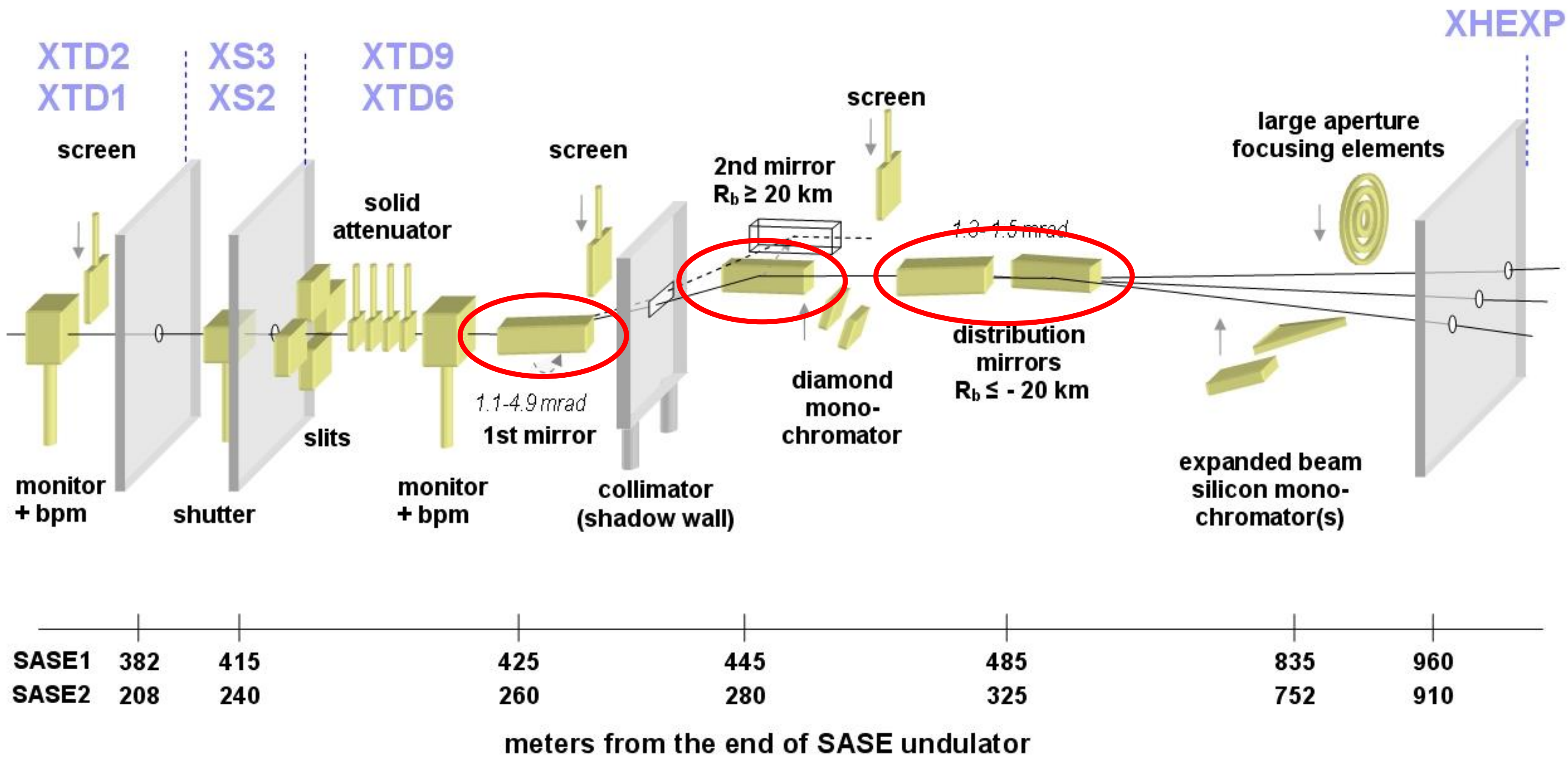
Construction progress at the European XFEL

European XFEL
www.xfel.eu

X-ray Beam Transport



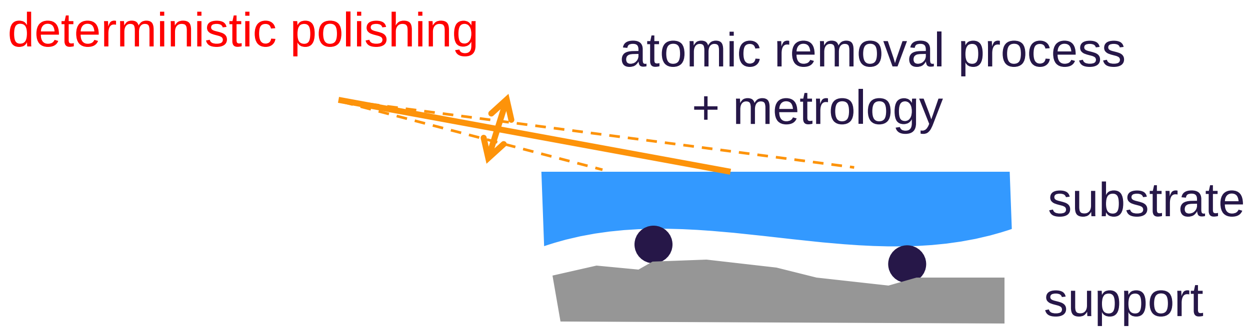
Beamline Layout for SASE1 and SASE2



Mirror technology

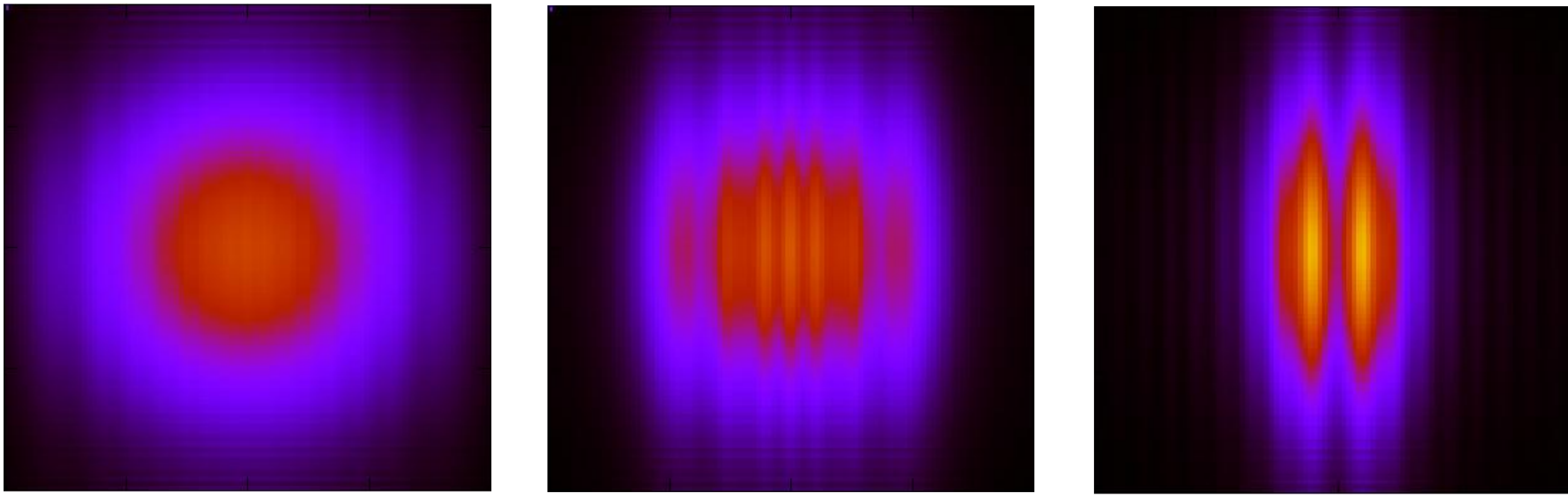
Problem: Mirrors are too short!

- Coherent beams require height-height correlation (absolute shape error) of less than 2 nm PV over entire length (Strehl-ratio 0.8)
- Currently only two suppliers (JTEC and ZEISS) with proven record of deterministic polishing to nm-scale
- Only few (short) mirrors on nm-flatness scale existing. Upper length limitation 500 mm-800 mm



Mirror technology: Finite lengths

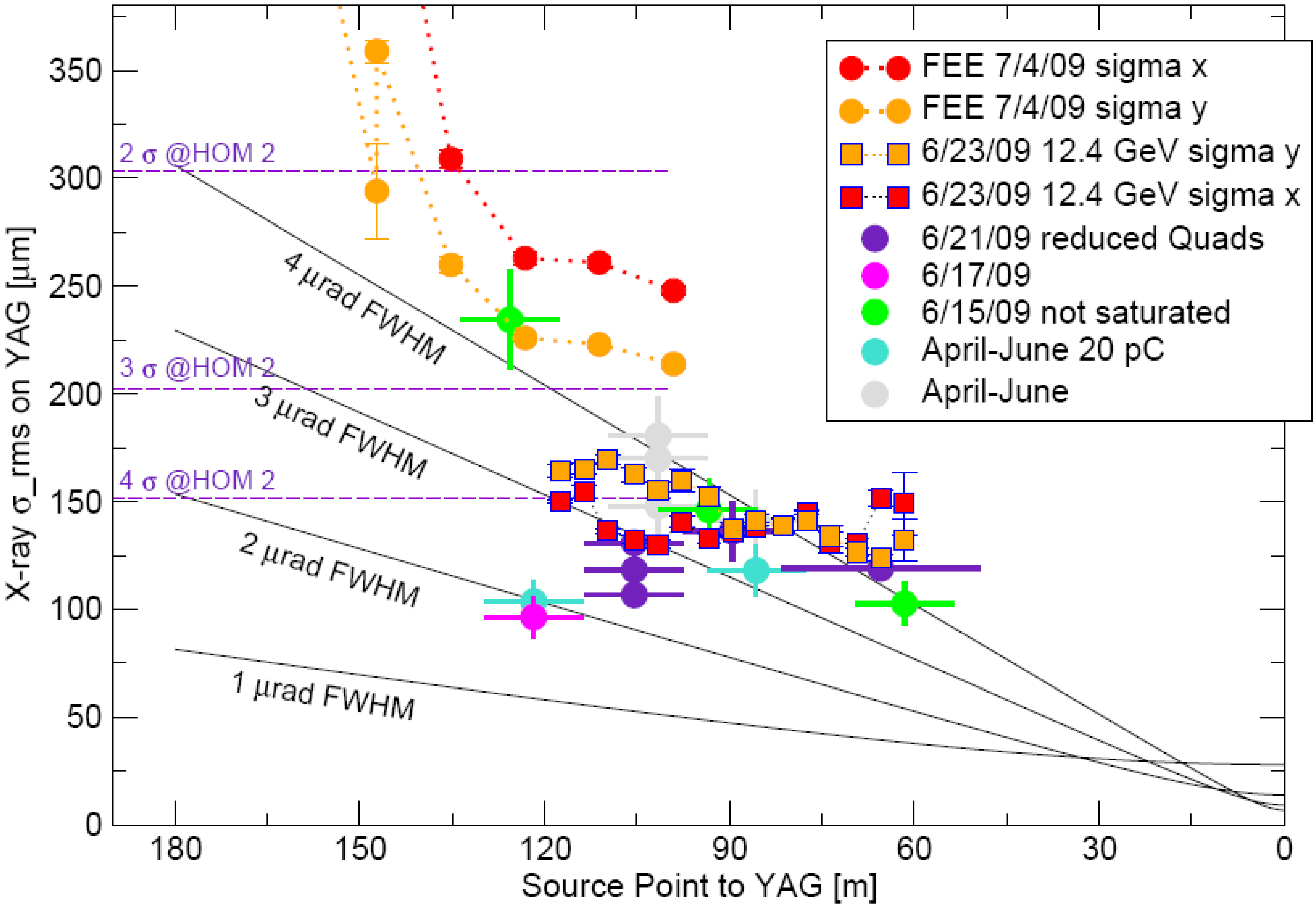
Simulation of beam spot in experimental hall



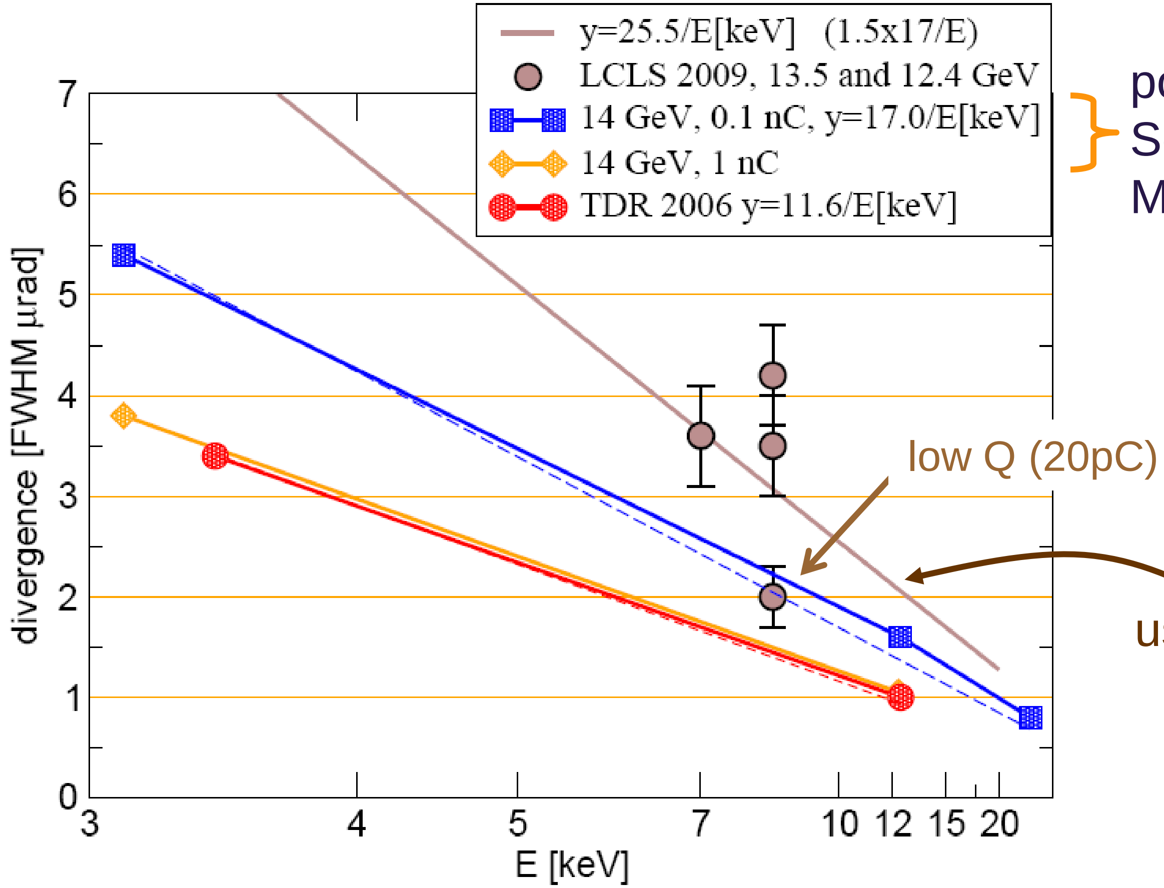
6 σ   4 σ   2 σ

≈ 2 nm PV flatness

Measurements of Beam Divergence at LCLS in 2009 (8.3 keV)
(Welch, Turner, Emma, Sinn, …)



Lower Emittance: Higher Divergence

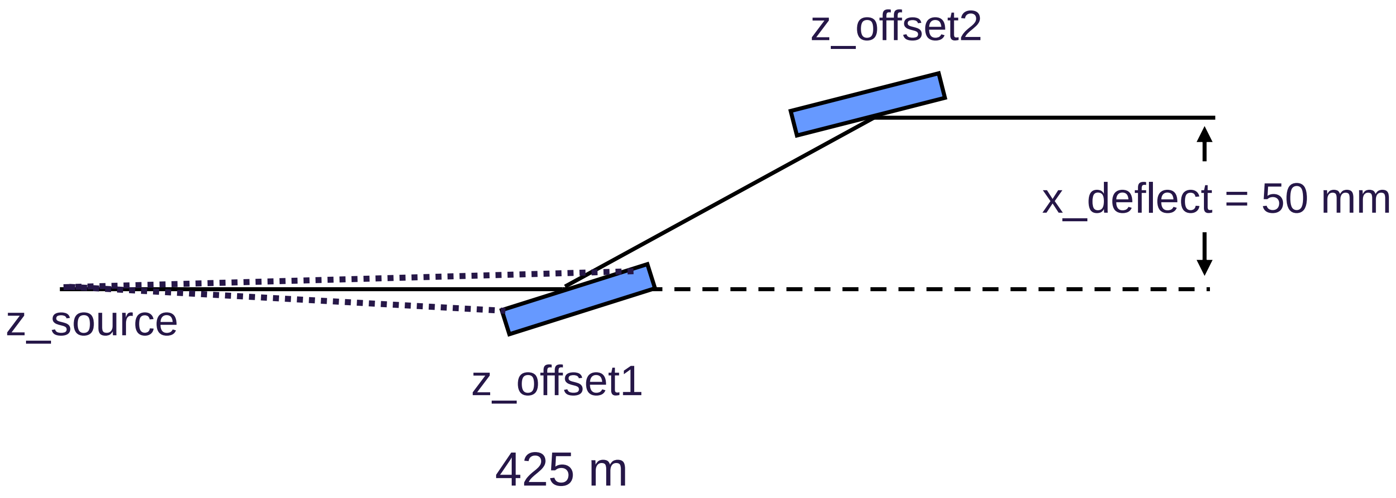


poster MOPC05 E. Schneidmiller and M.V. Yurkov

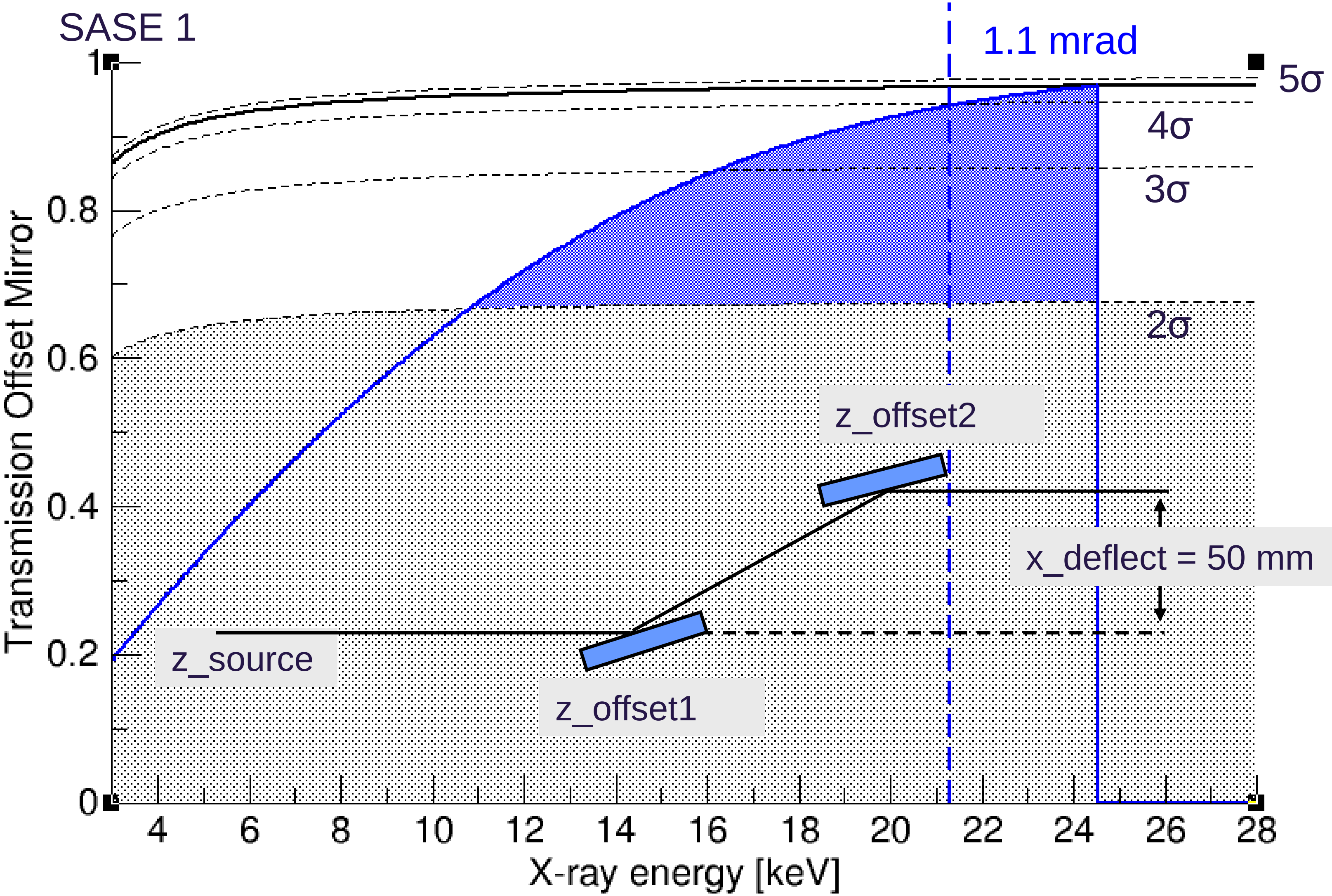
used for beam line optimization (1.5 × theory)

Offset mirror geometry (SASE 1)

Try to get mirrors as close as possible to source to maximize beam coverage

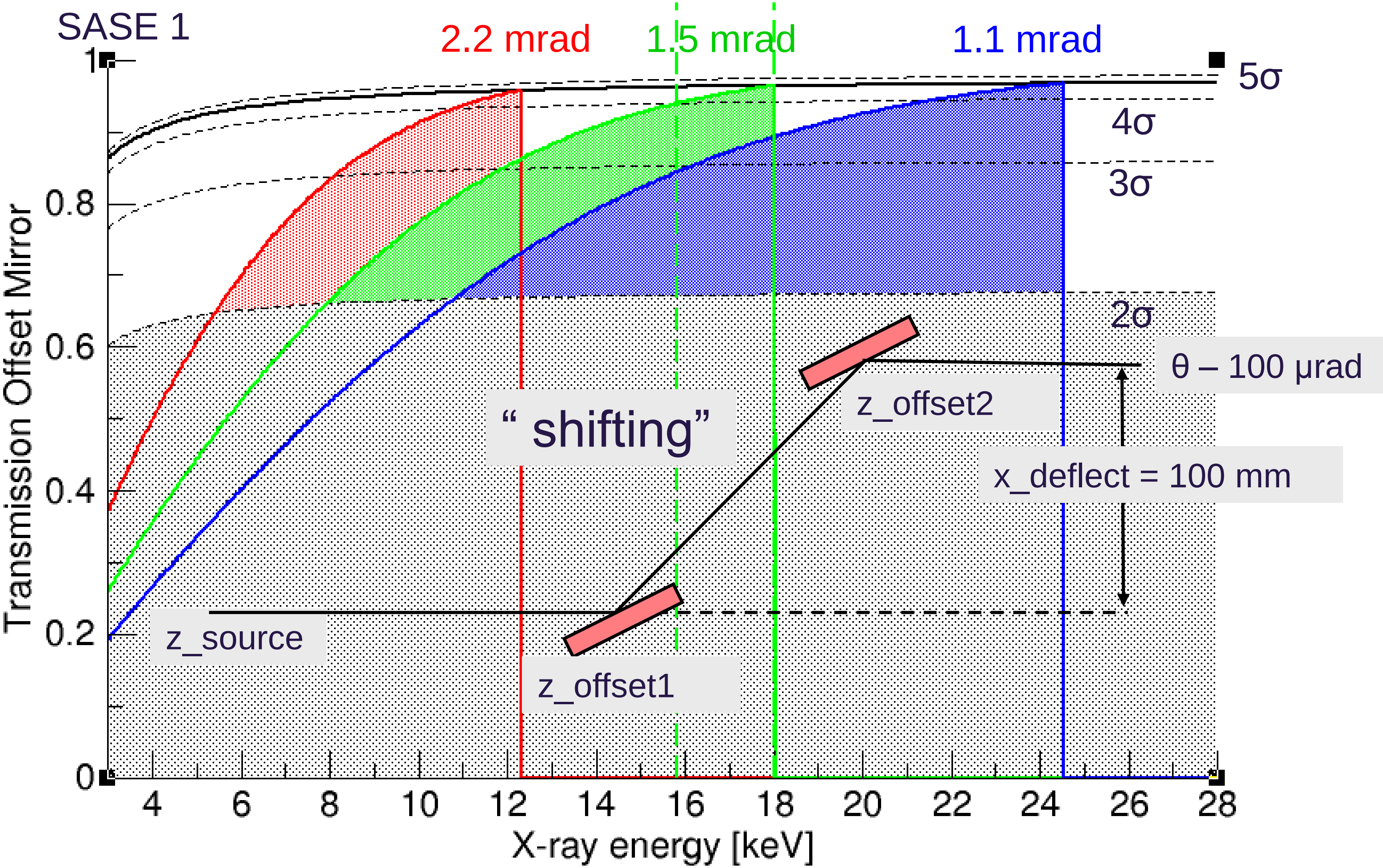


Offset mirror geometry (SASE 1)



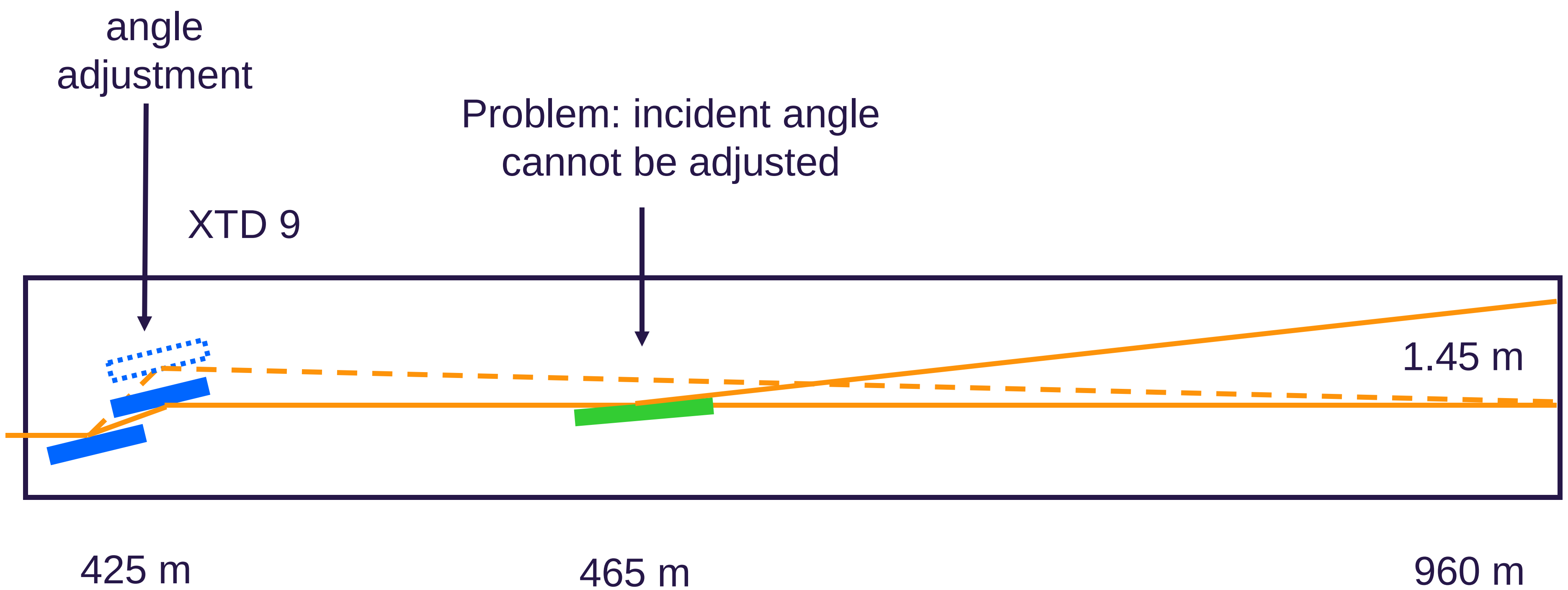
theoretical divergence (0.1 nC) x 1.5

Offset mirror geometry (SASE 1)

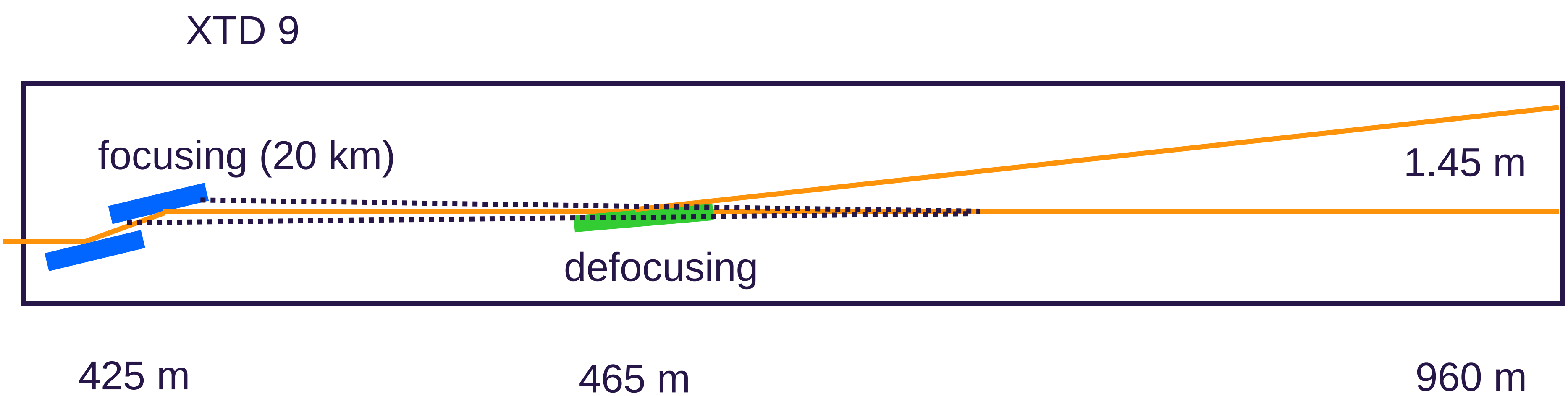


theoretical divergence (0.1 nC) x 1.5

Distribution mirror geometry (SASE 1)

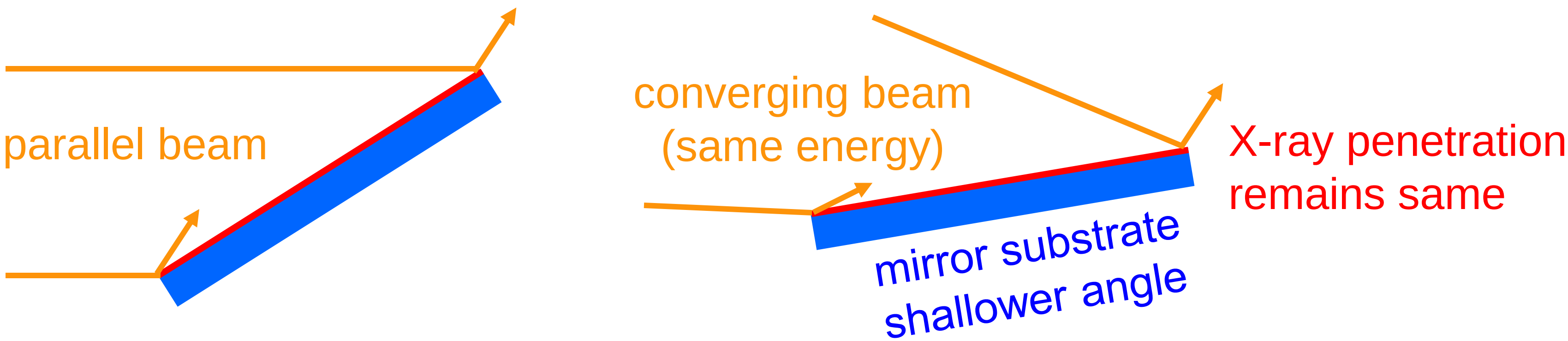


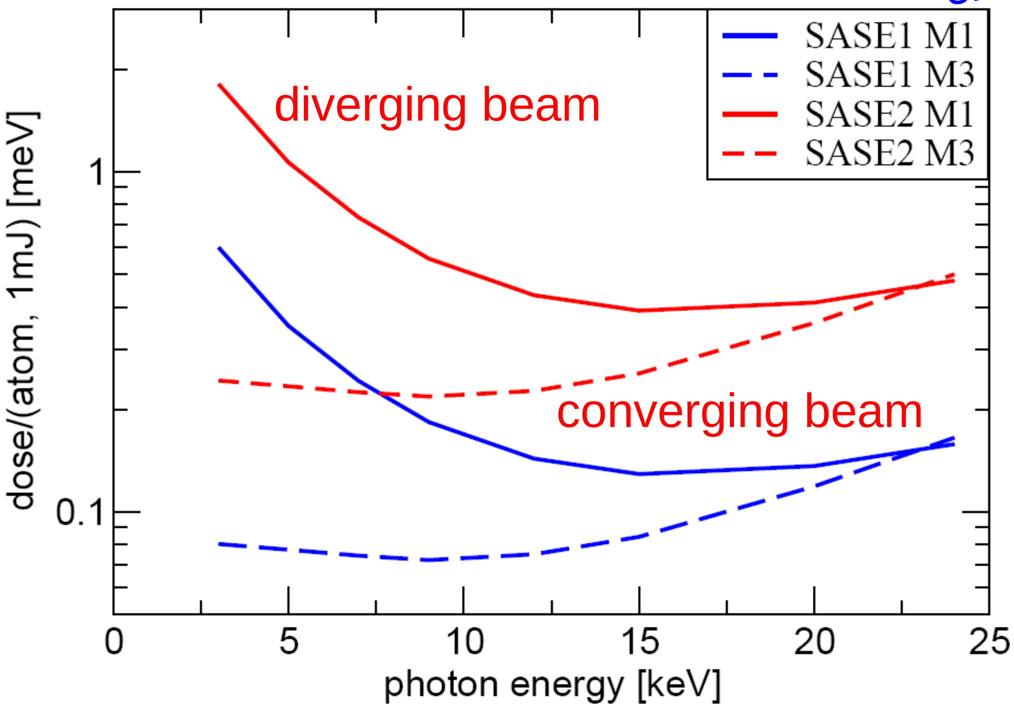
Distribution mirror geometry (SASE 1)



Solution: focus behind
distribution mirror

Damage at offset mirrors with converging beam

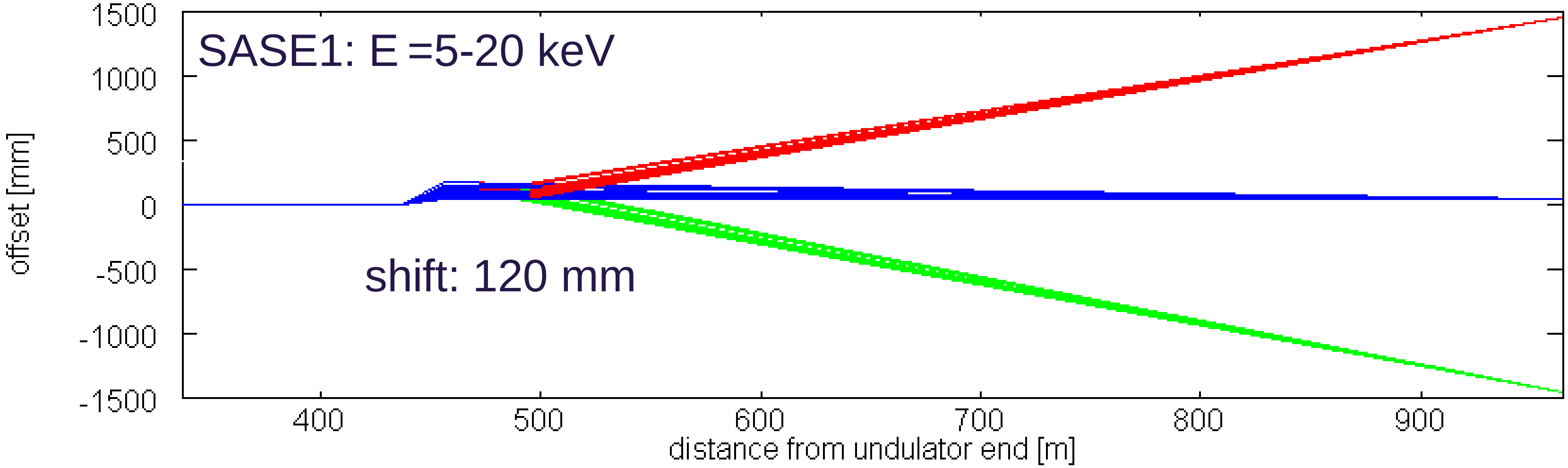




Conclusion: focusing behind distribution mirror does not lead to increased damage, as long as footprint on mirror remains the same

Ray tracing for SASE 1 (800 mm mirrors)

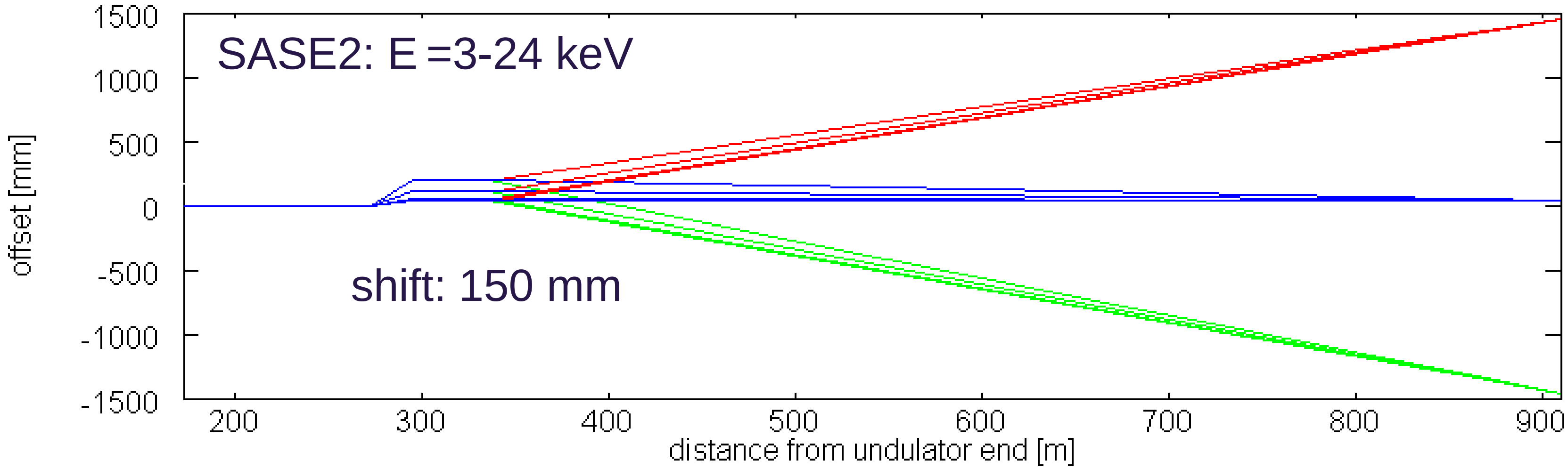
keV range



5-18

5-20

5-17



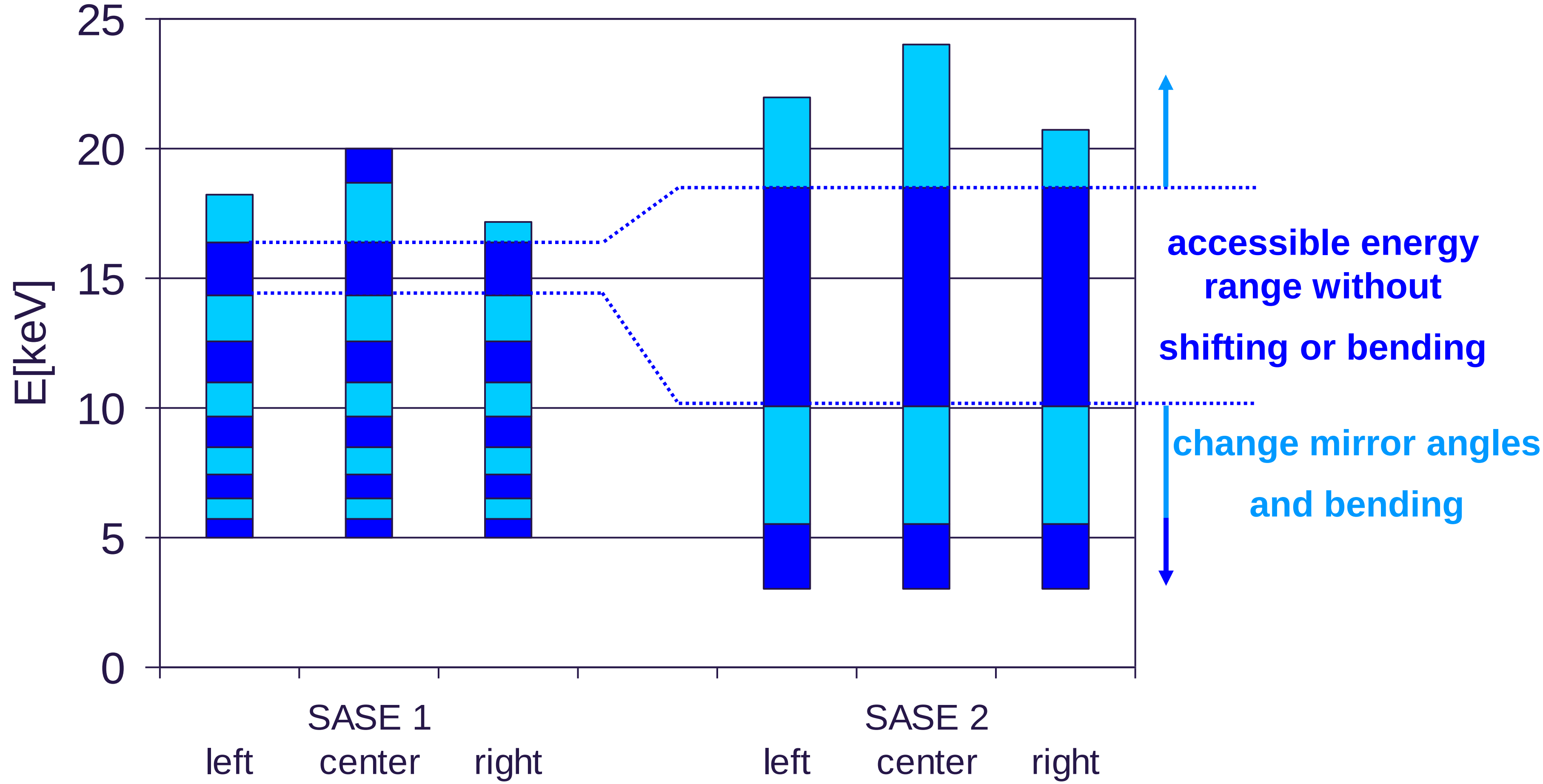
3-22

3-24

3-21

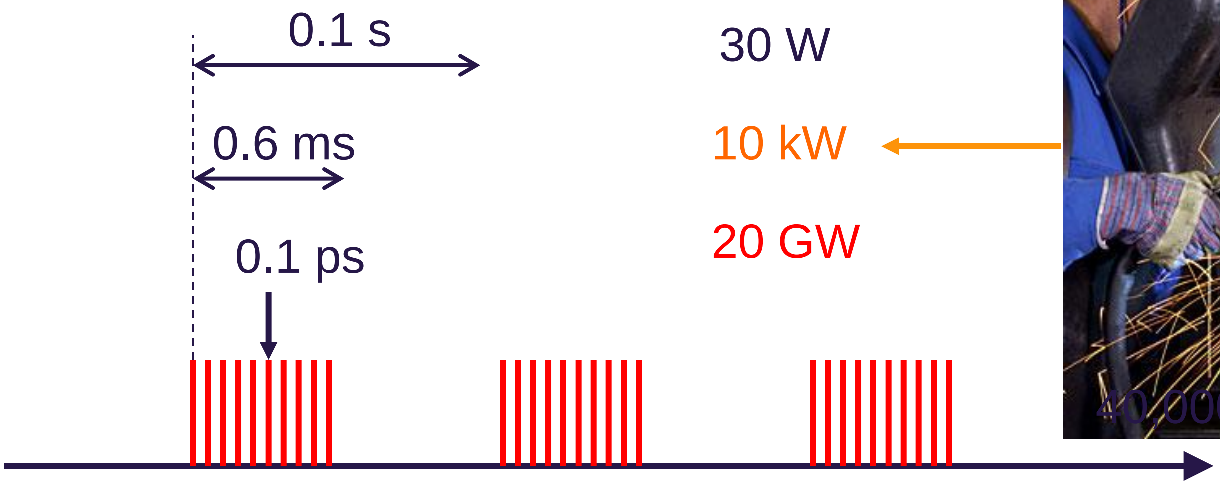
Transmission of proposed SASE1&2 geometries

800 mm (optical length) mirrors, min. 4 σ acceptance

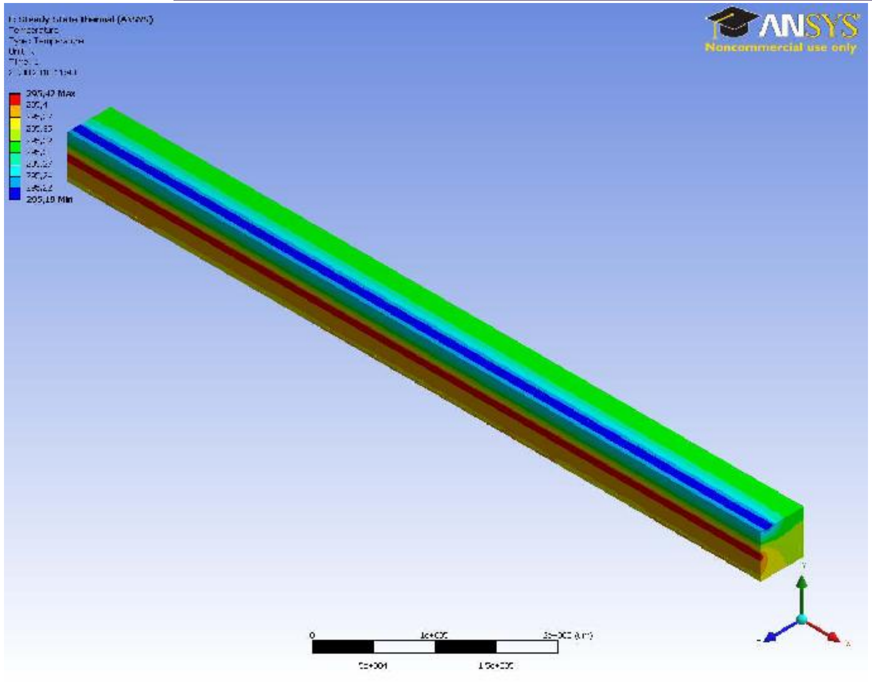


Special requirements optics at European XFEL

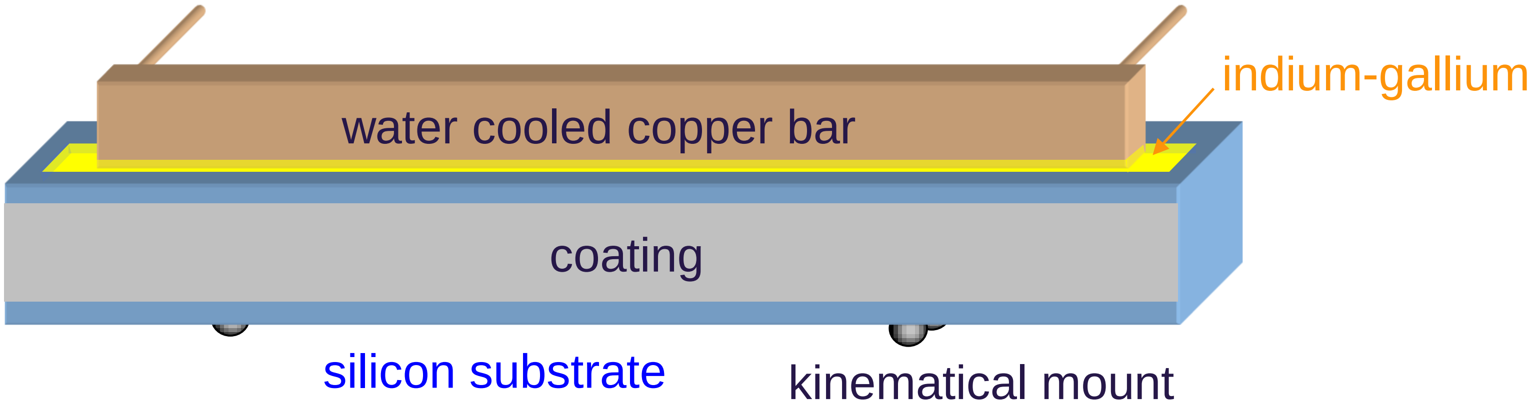
XFEL pulse pattern: 99.4 % empty



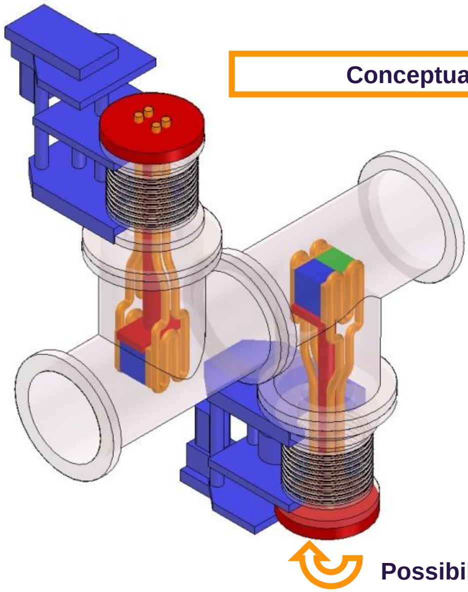
First offset mirror (SASE2)



water cooling: ± 20 nm
deformation under 22 W load

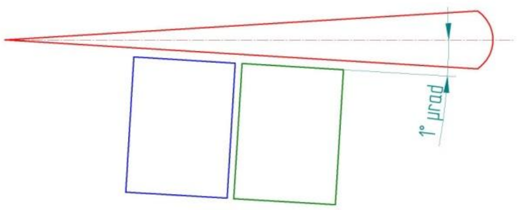


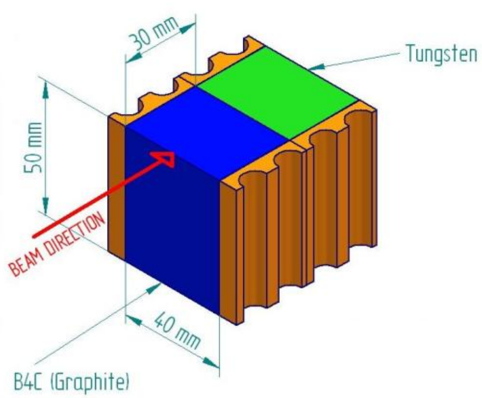
Beam aperture in front of mirrors



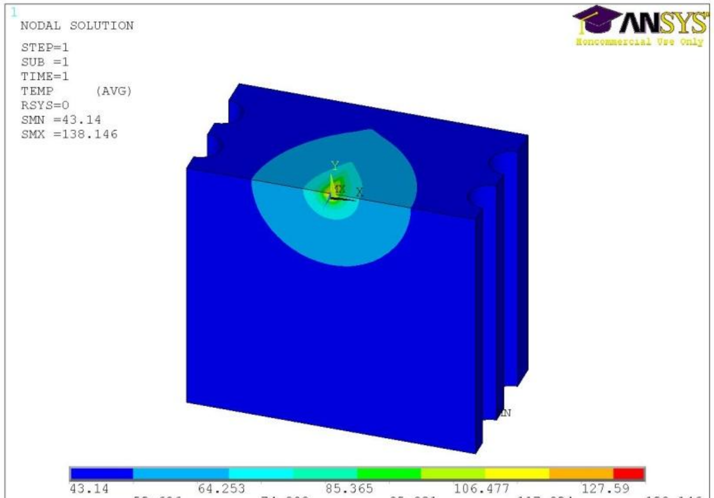
Conceptual Design

Possibility to tilt the blades

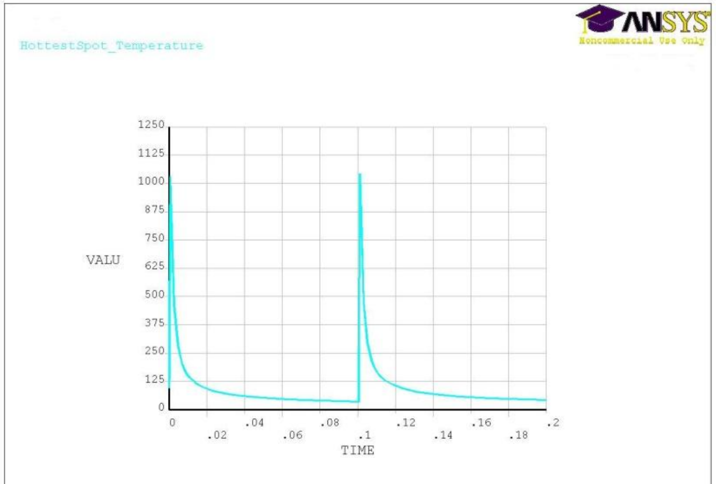




Blade Geometry and Materials

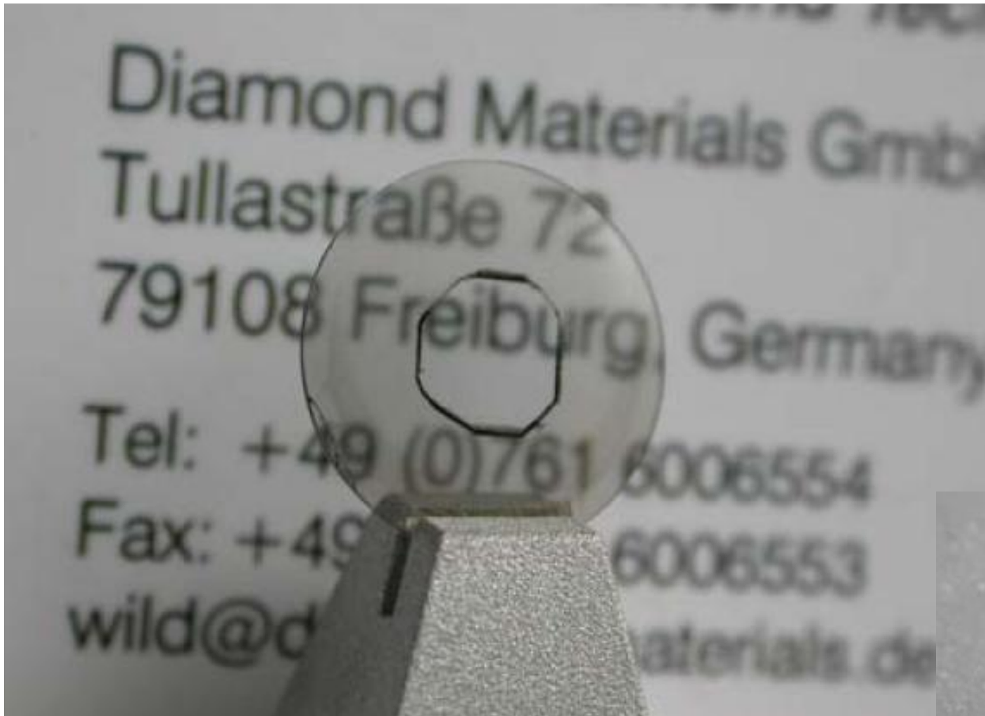


SASE 1. Steady State (Temp at the cooling channels ~43 C)



SASE 1. Transient (Hottest Spot Temp ~1050 C)

Diamond Laue Monochromator

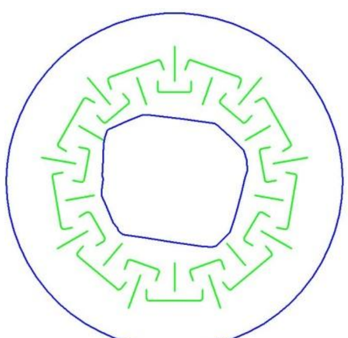


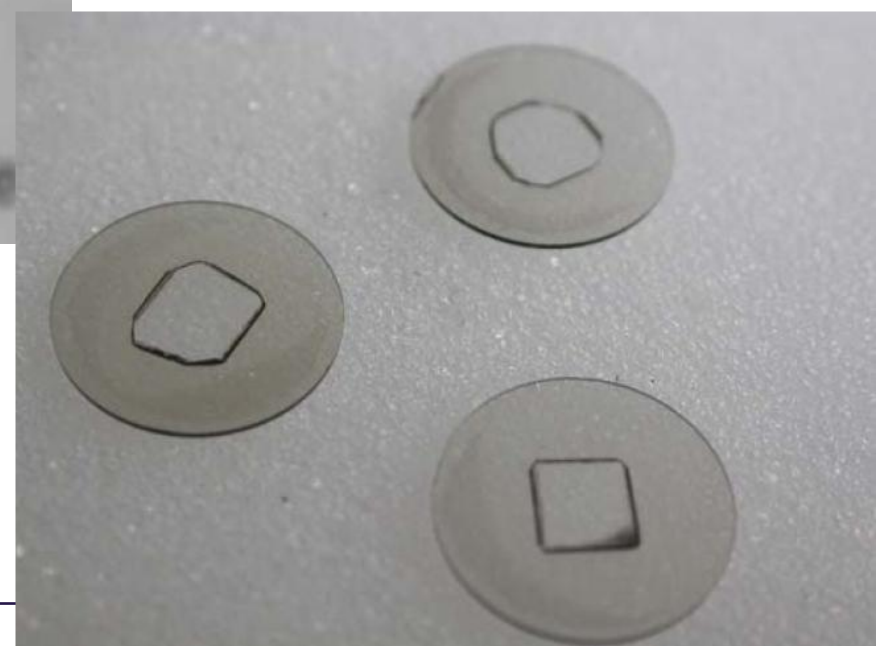
collaboration with:

Diamond Materials,
Fraunhofer Institut Freiburg

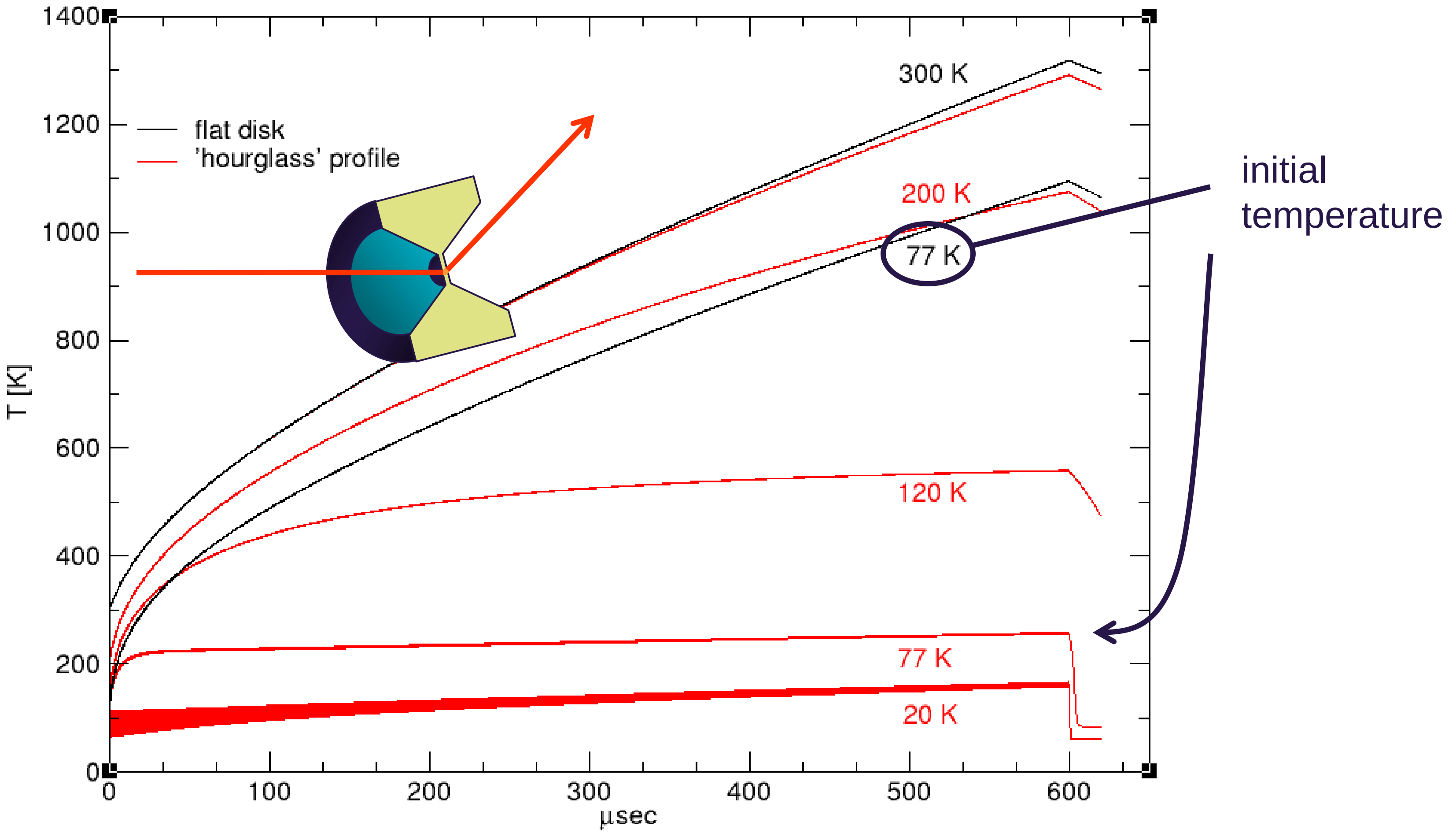
and Element6

Stress relief:
laser cutting

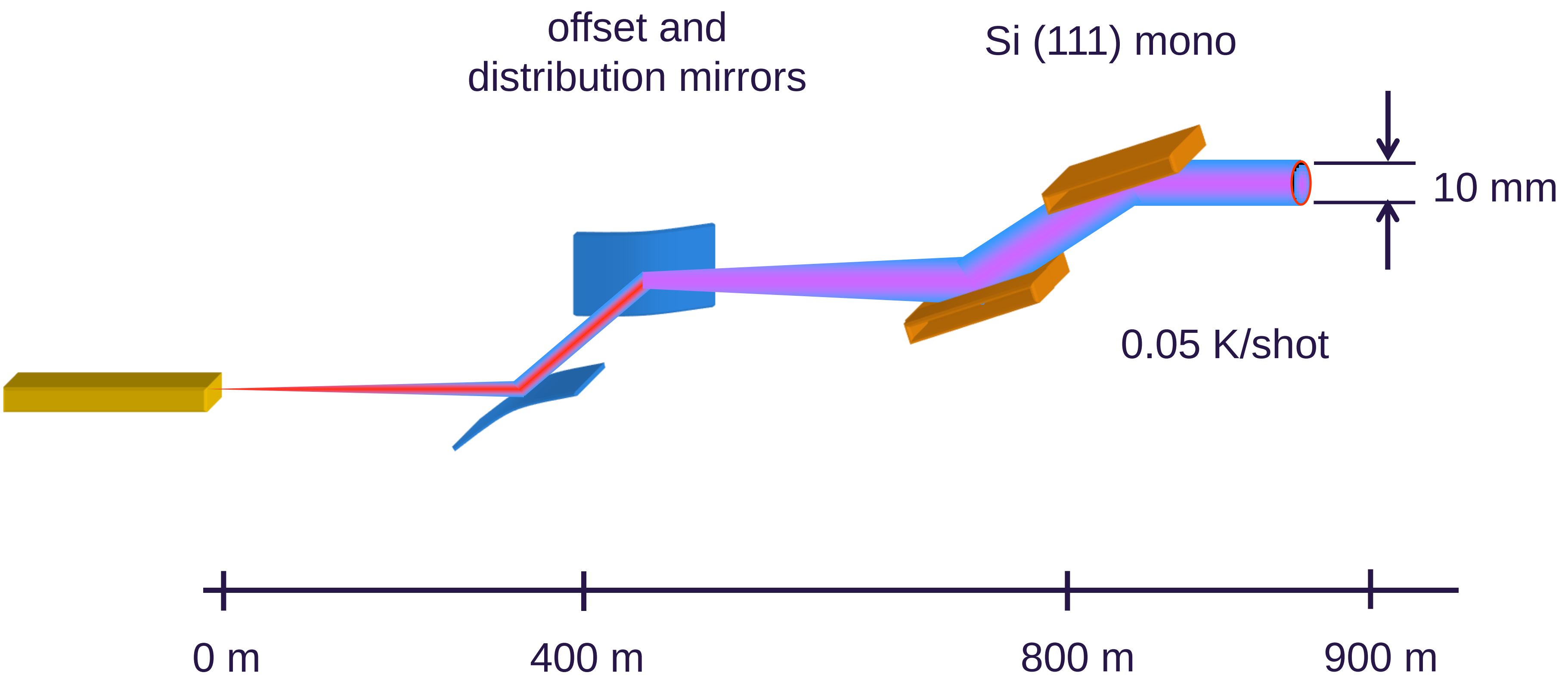




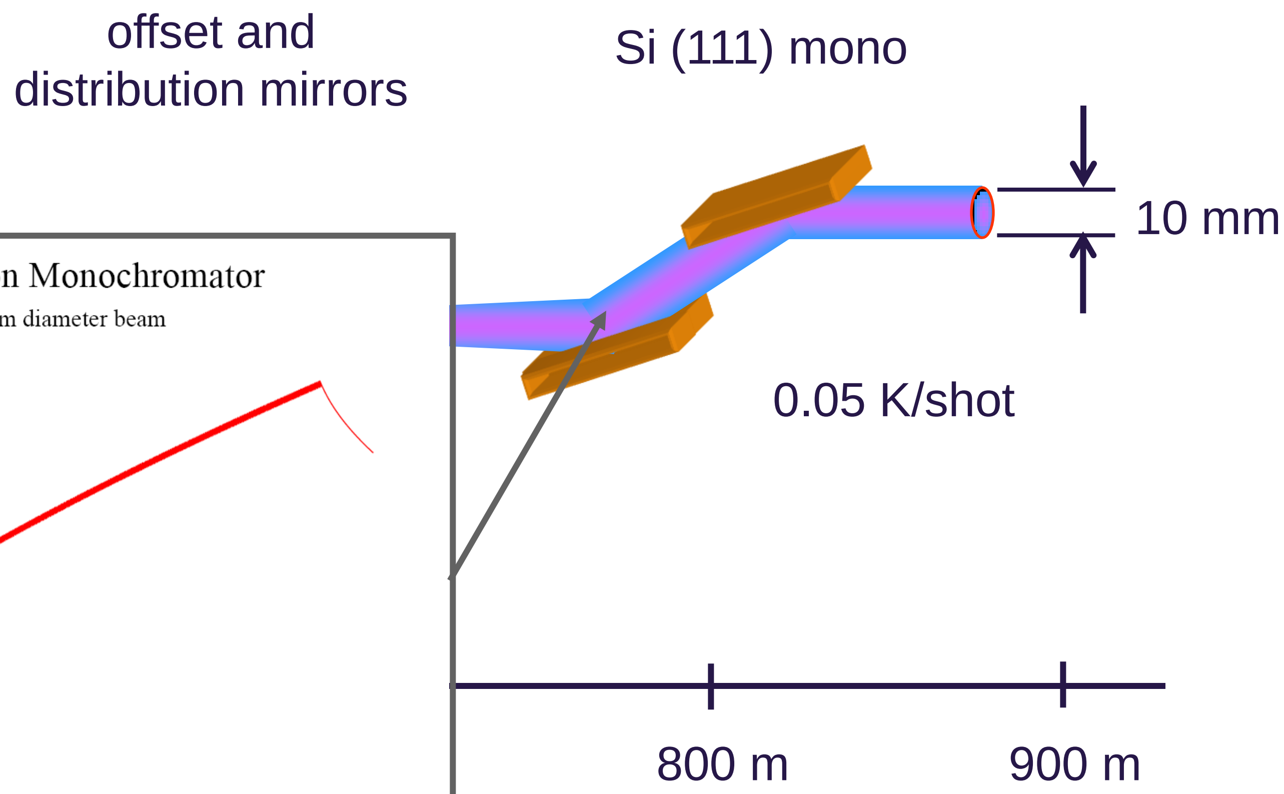
Diamond Laue Monochromator

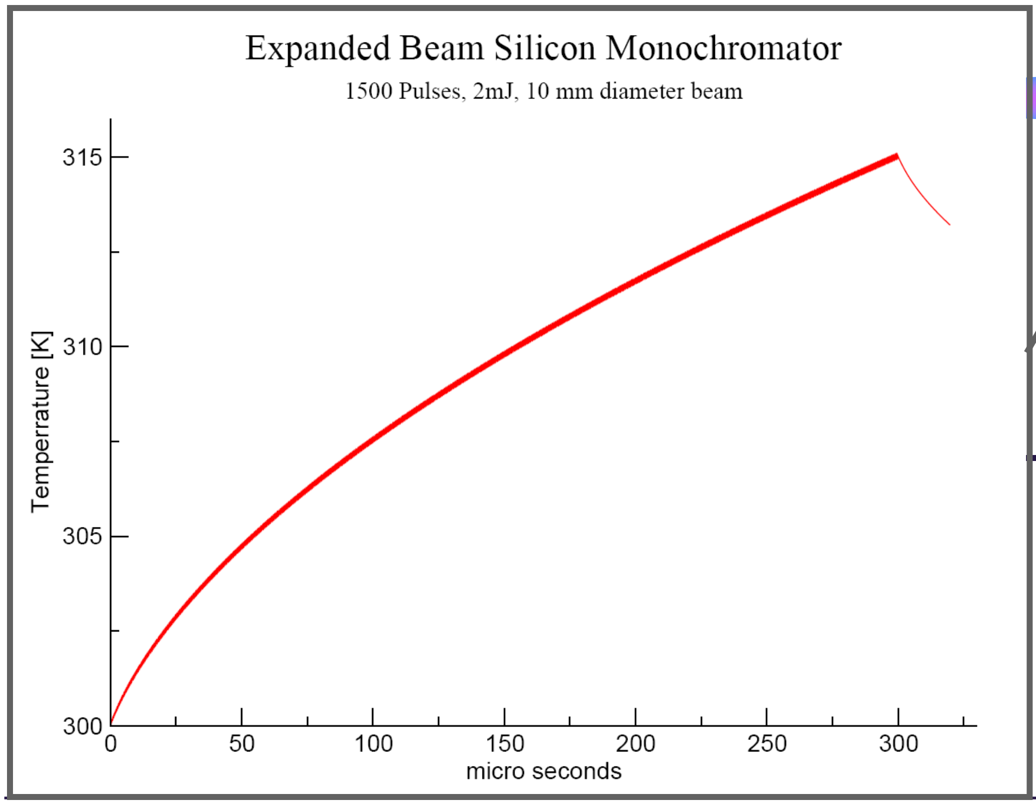


Expanded Beam Monochromator



Expanded Beam Monochromator





Summary

A beam distribution system is proposed that can deliver 3-24 keV beam to central and branch experimental stations based on 800 mm long mirrors:

- Adjustment to beam size by mirror incident angle
- Intermediate focusing on distribution mirrors
- Nice side effects: Cut-off of higher harmonics and defocusing at monochromators possible.

For mirrors, water cooled seems sufficient

Monochromators will be diamond or in the expanded beam silicon (cryo-cooling)

Acknowledgements

- European XFEL Optics group: *Shafagh Dastjani-Farahani, Idoia Freijo-Martin, Germano Galasso, Jerome Gaudin, Liubov Samoylova, Antje Trapp and Fan Yang*
- LCLS commissioning team: *Paul Emma, James Welch + many others*

Thank you for your attention!