Requirements for bimorph mirrors at the European XFEL

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DESY/XFEL, Hamburg

ACTOP 2008, Oct 9-11, 2008

- Status European XFEL
- Beamline design
- Requirements for (distribution) mirrors

European XFEL, Hamburg www.xfel.eu

- 10-15 experiments
- 30,000 pulses/sec
- 10^{12} - 3.7×10^{14} phts/pulse @ 1Å – 49 Å
- flux: 1.5×10^{16} phts/(0.1% sec) @ 12.3 keV
- **divergence: 1 µrad !**

Timeline:

June 5, 2007: Official funding of project by Germany and 12 international partners

Nov. 2008: Award of construction contracts

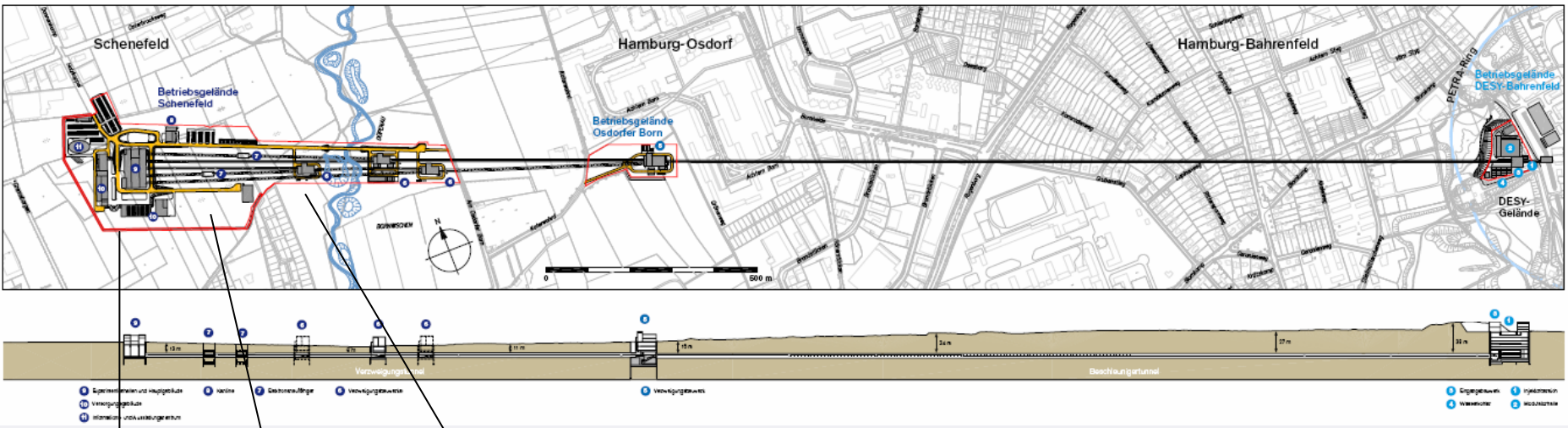
Feb. 2009: Foundation of XFEL Company (Ger, Rus, …)

2013: All buildings finished, start commissioning

mid 2014: first SASE

June 2015: User operation, SASE 1 Å

The European XFEL

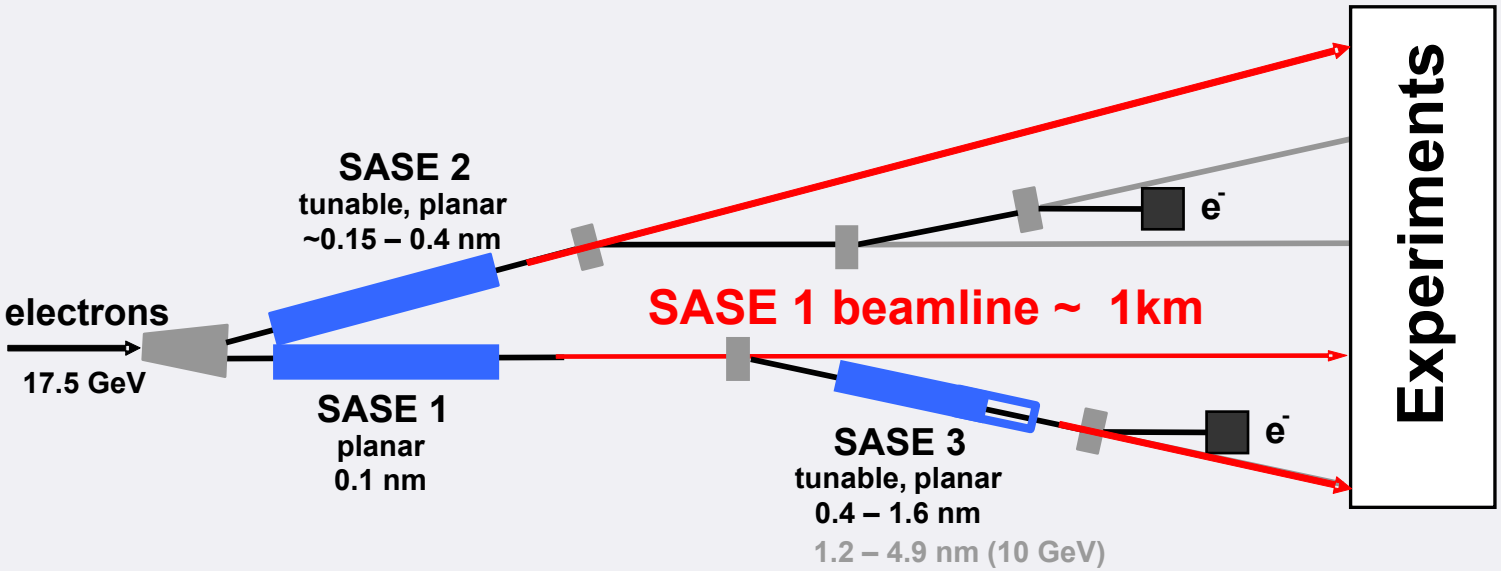


5 Undulators (3 SASE) LINAC Injector

5 Photon Beamlines

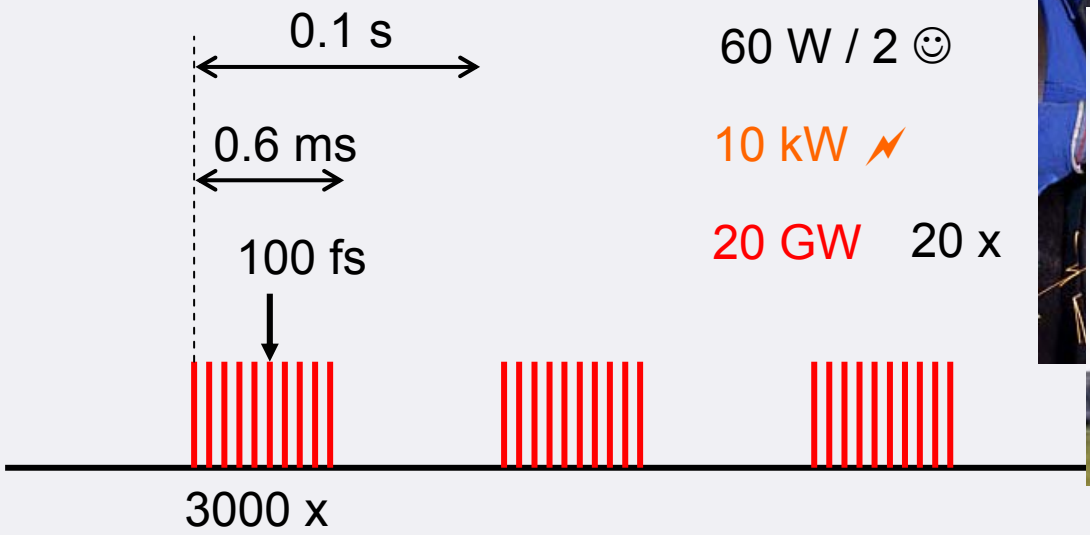
10 Experiments; Start up: 6 Exp.: Coherence, Plasma, Atomic physics …

Photon beamlines



Special requirements for E-XFEL optics

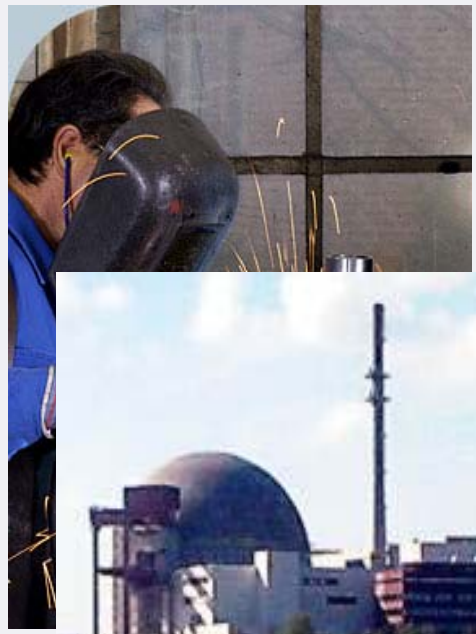
XFEL pulse pattern: 99.4 % empty



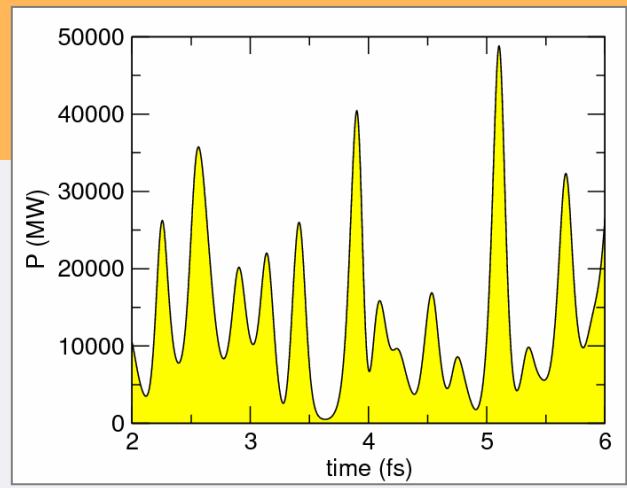
60 W / 2 ☺

10 kW

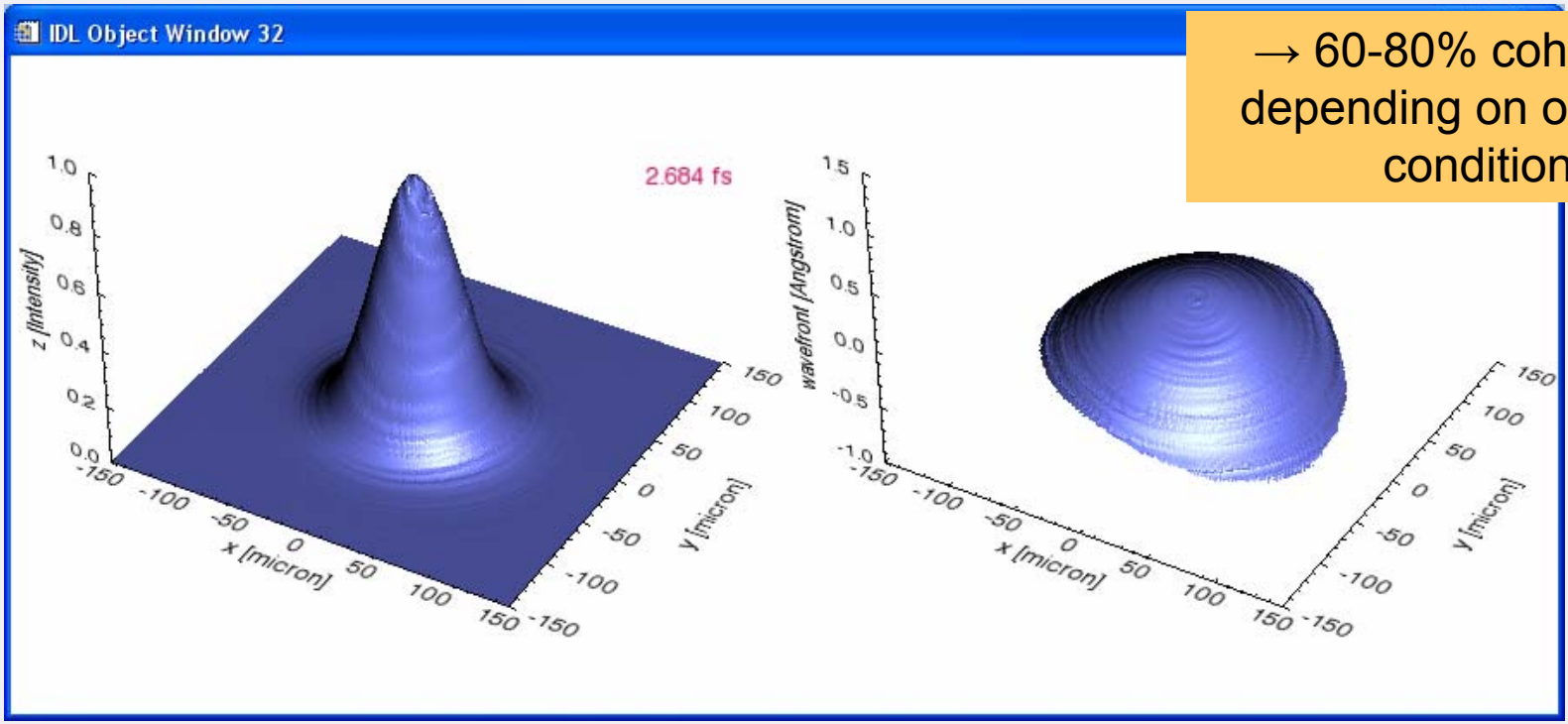
20 GW 20 x



The XFEL beam

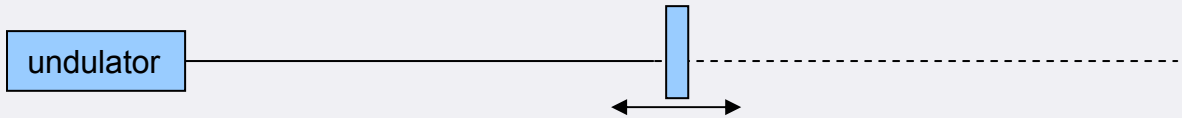


from M. Yurkov, H. Sinn, XFEL 2008

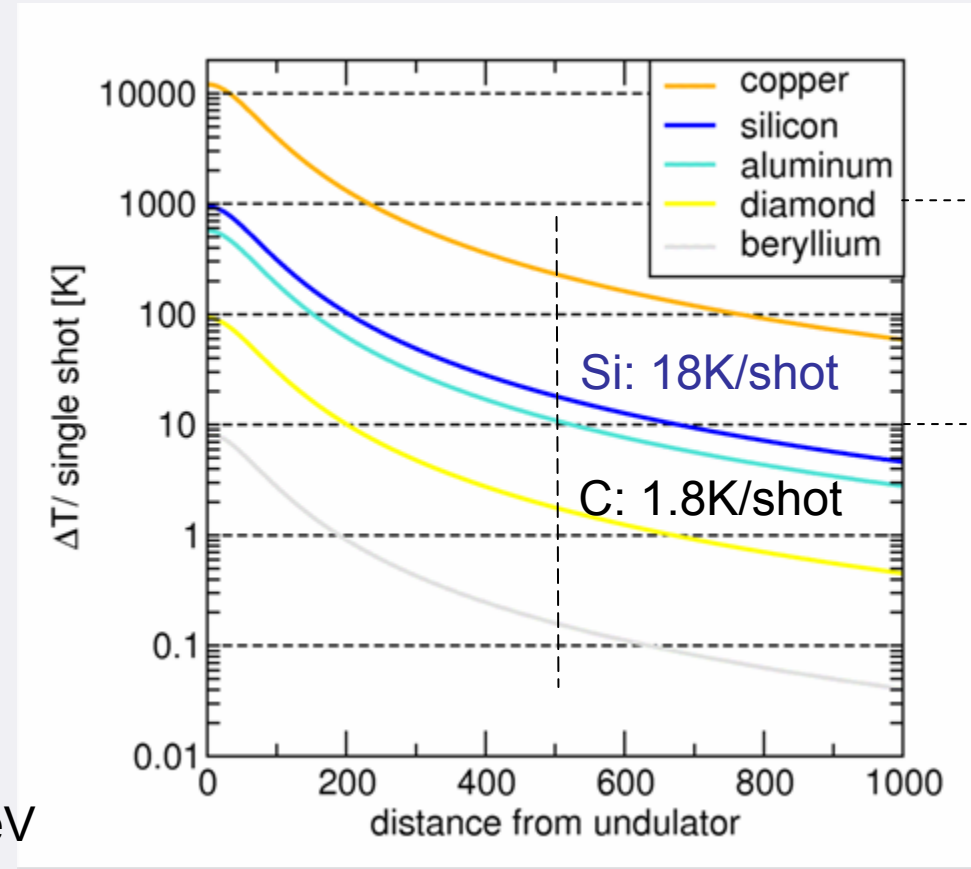


→ 60-80% coherence, depending on operation conditions

Damage potential of XFEL beam: 1 Shot



footprint [μm]: 70……..260…….500……..750……..1000

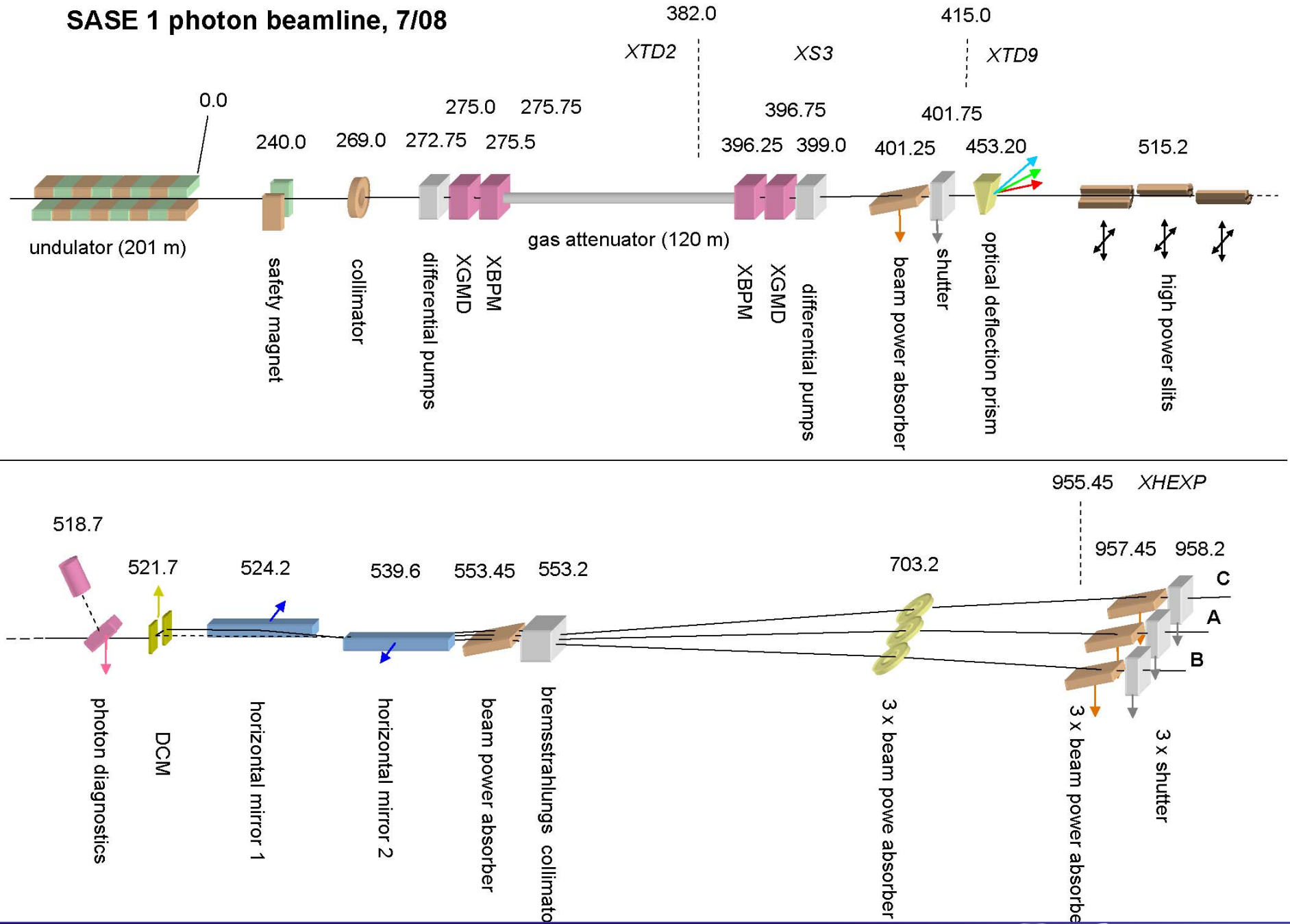


factor 100 reduction at 600 m!

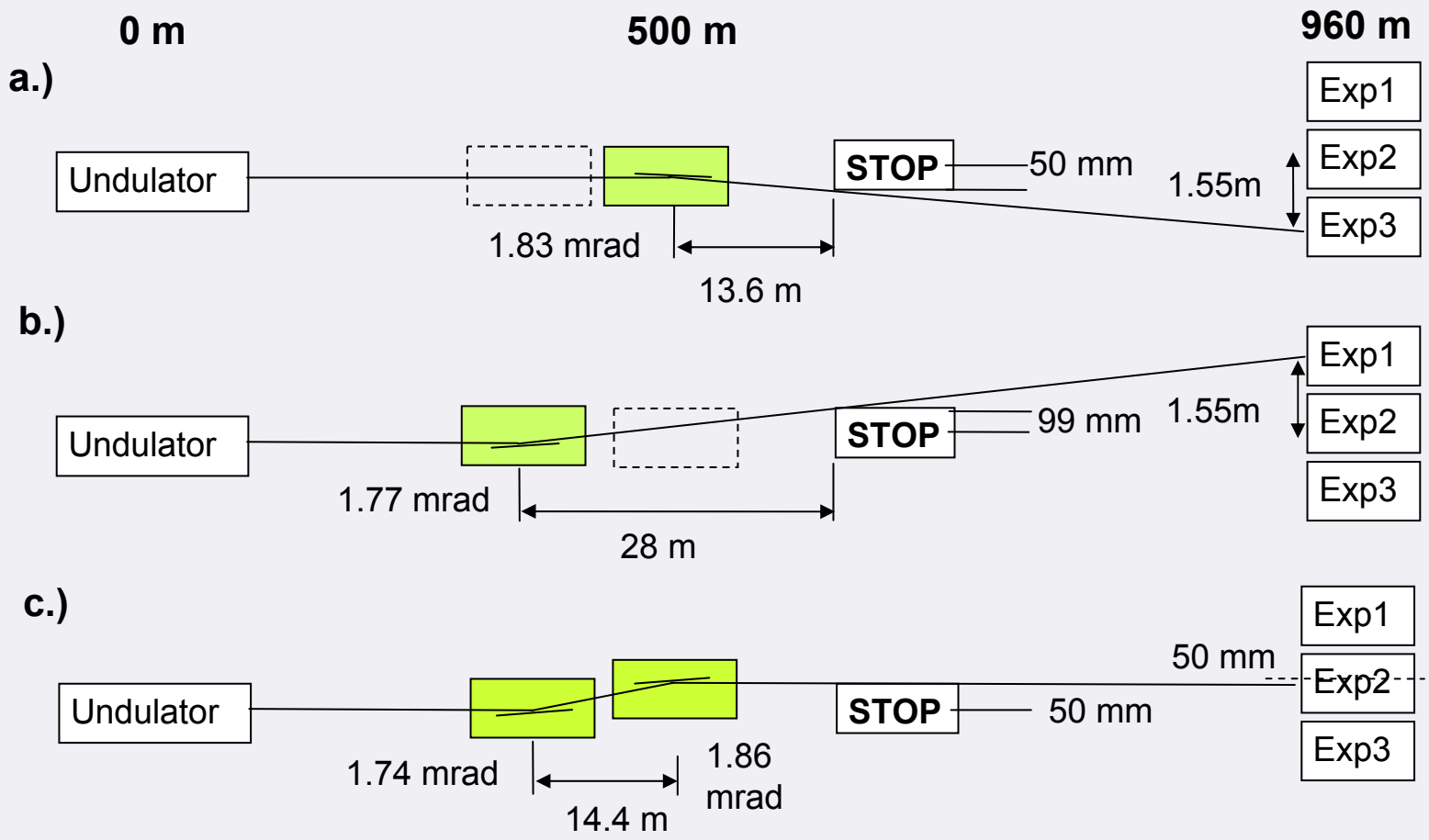
x 3000 during 0.6 ms pulse train!

SASE1: 12.3 keV

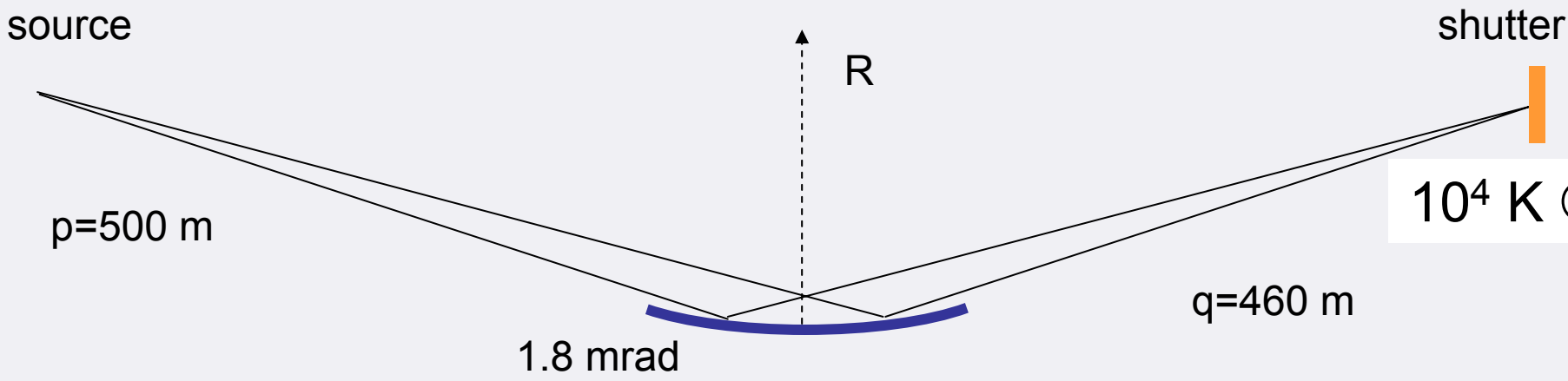
SASE 1 photon beamline, 7/08



SASE 1 beam line layout: Pink beam



How to avoid a focus onto the shutter

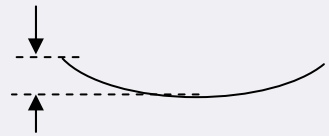


10^4 K ☹

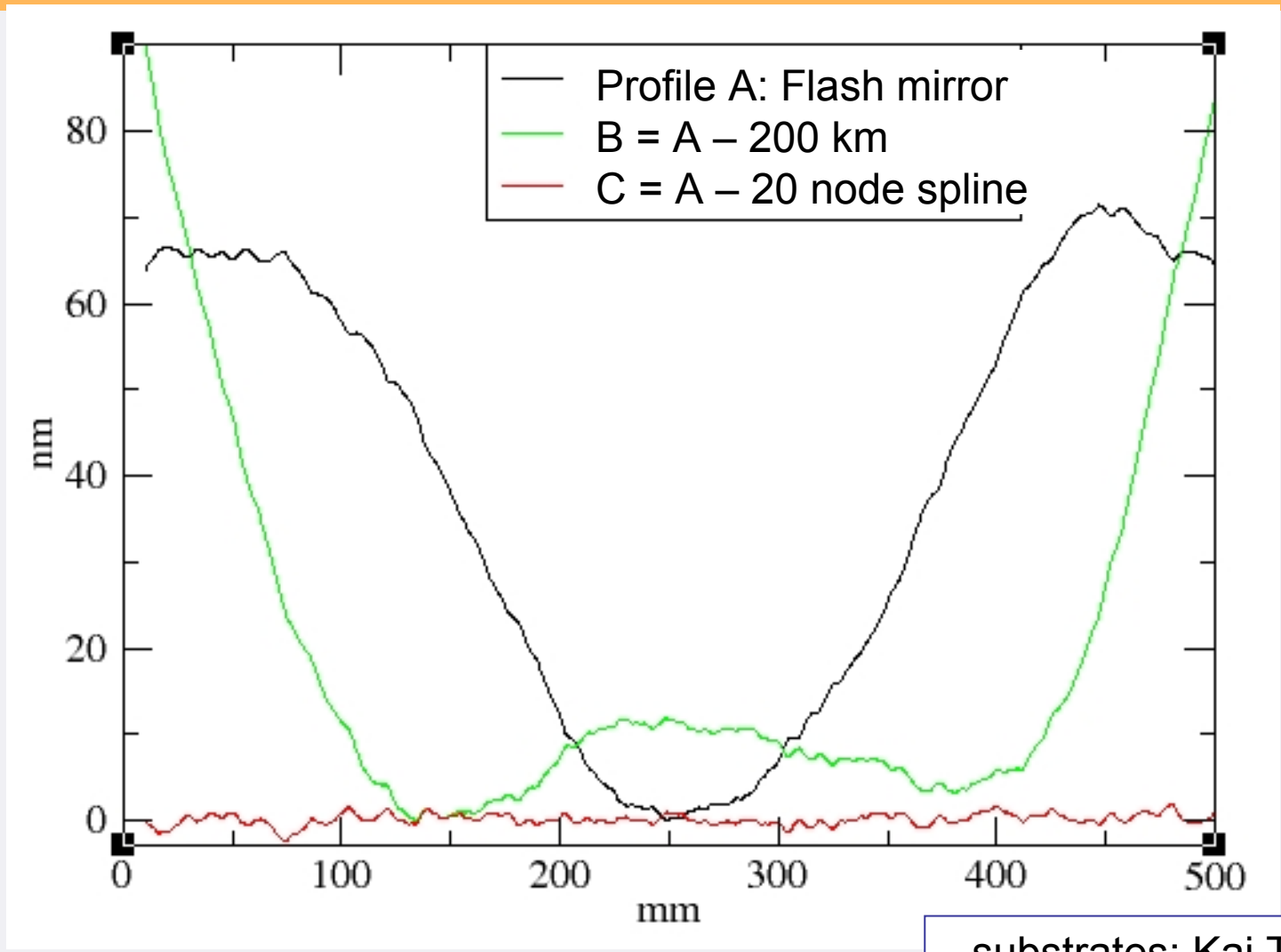
$$2/R = \sin\theta\,(1/p+1/q)$$

$$\rightarrow R \geq 266 \text{ km}$$

→ over footprint (270 mm) PV = 34 nm



Test mirror profiles

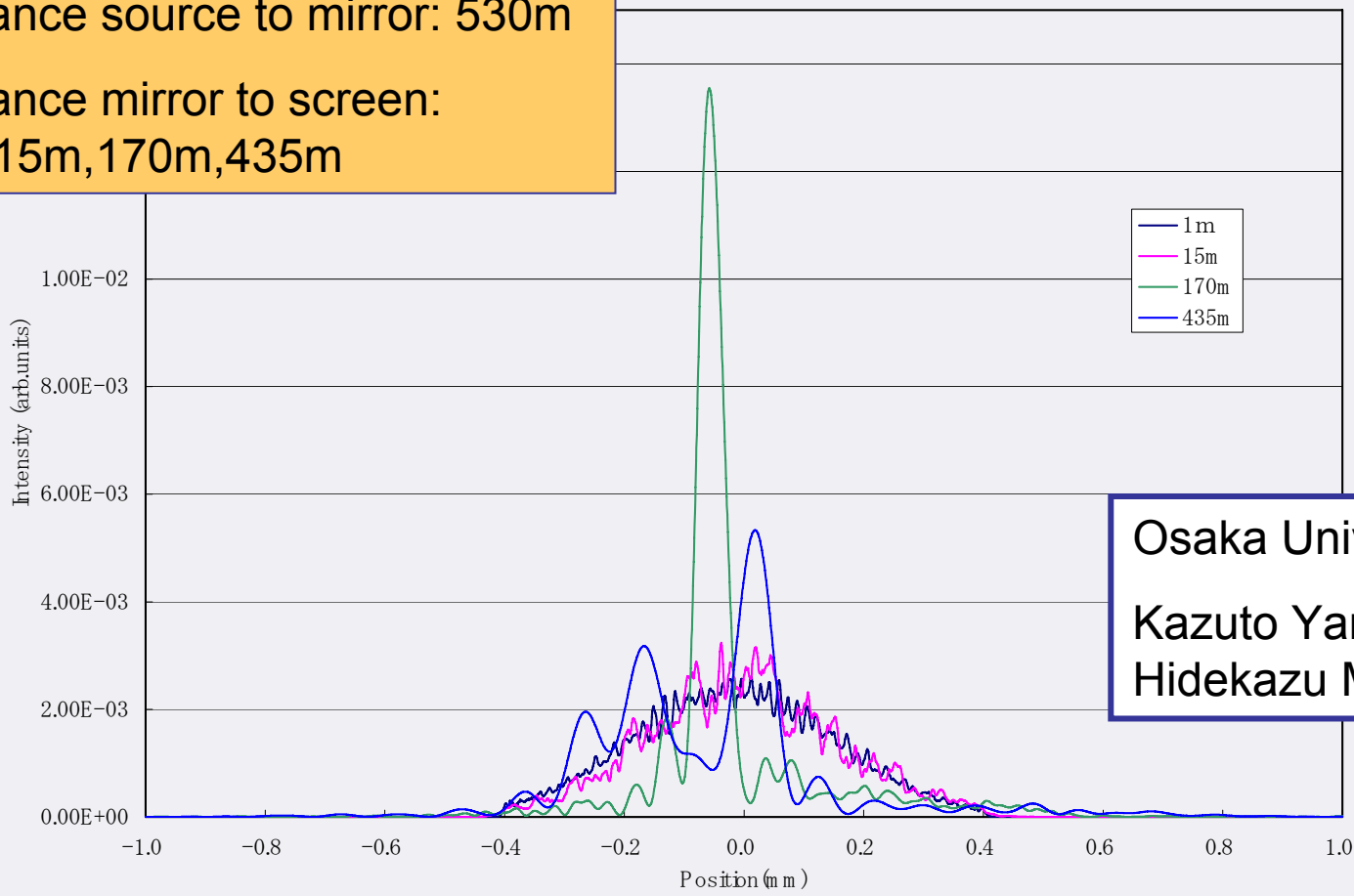


substrates: Kai Tiedtke,
data: Frank Siewert

Wavefront analysis

distance source to mirror: 530m

distance mirror to screen:
1m,15m,170m,435m



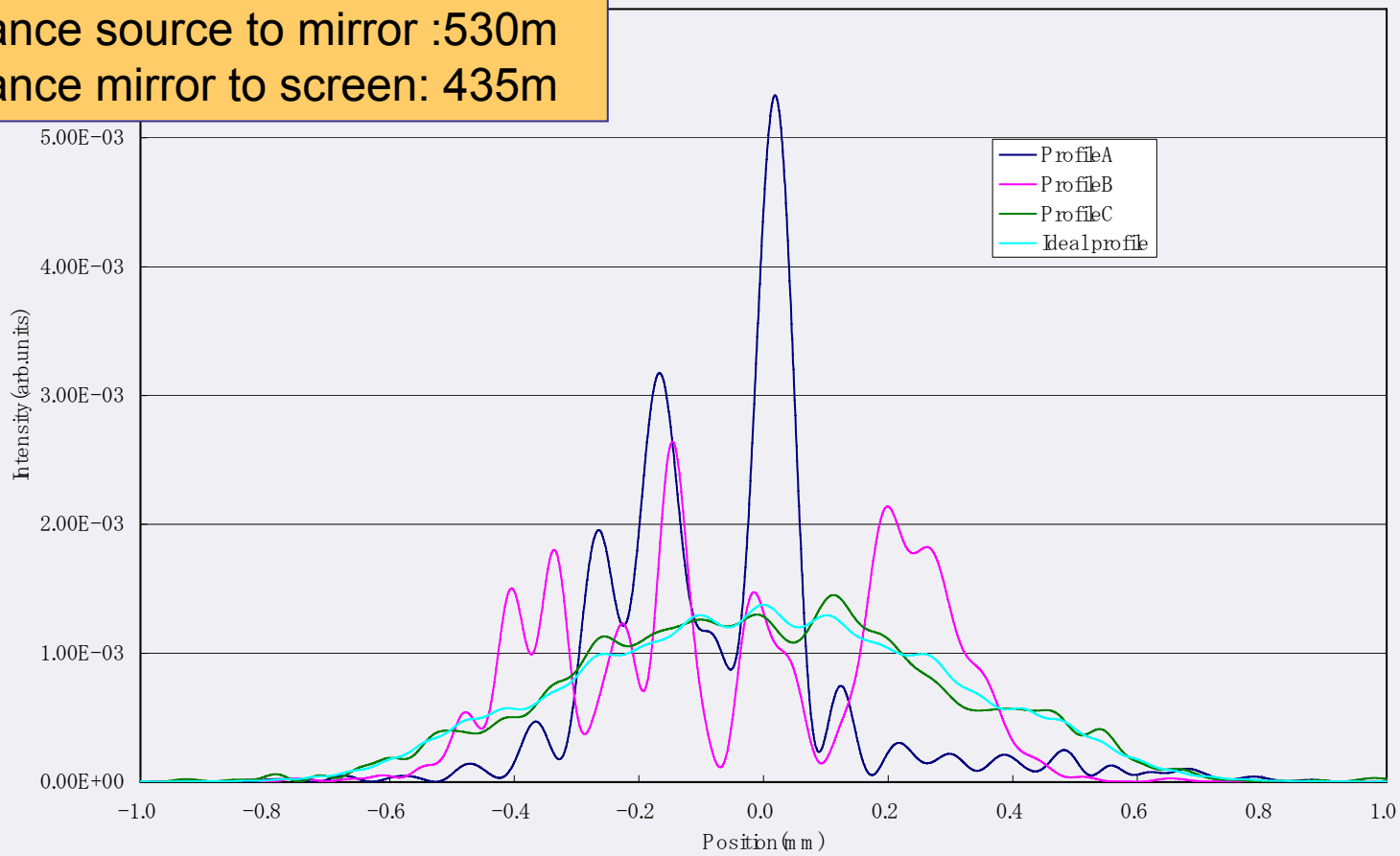
Osaka University:

Kazuto Yamauchi,
Hidekazu Mimura

wavelength:0.1nm, source size: 70micron, incident angle:1.8mrad,

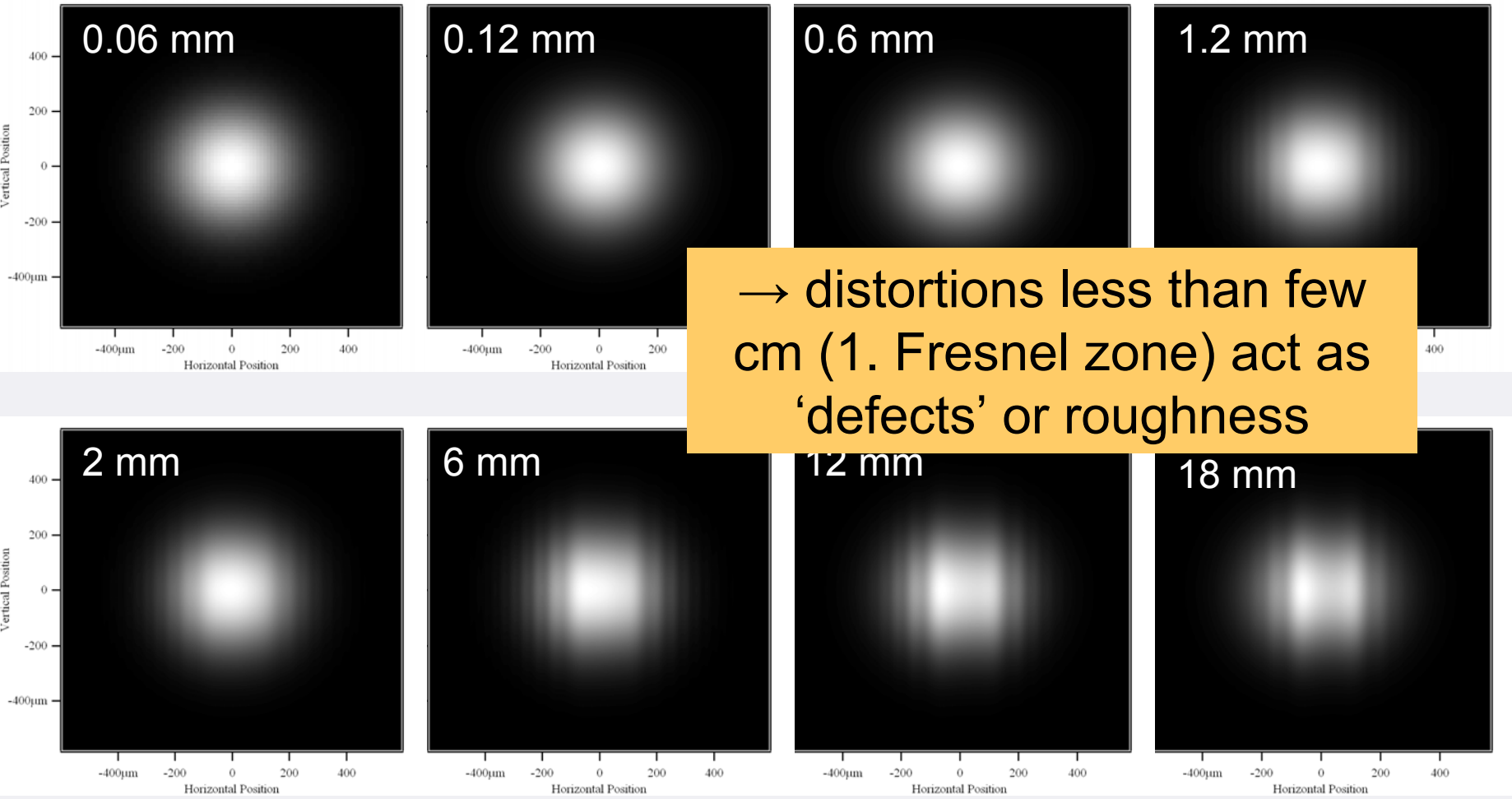
.. at shutter position

distance source to mirror :530m
distance mirror to screen: 435m



wavelength:0.1nm, source size: 70micron, incident angle: 1.8mrad,

Small distortion on perfect mirror

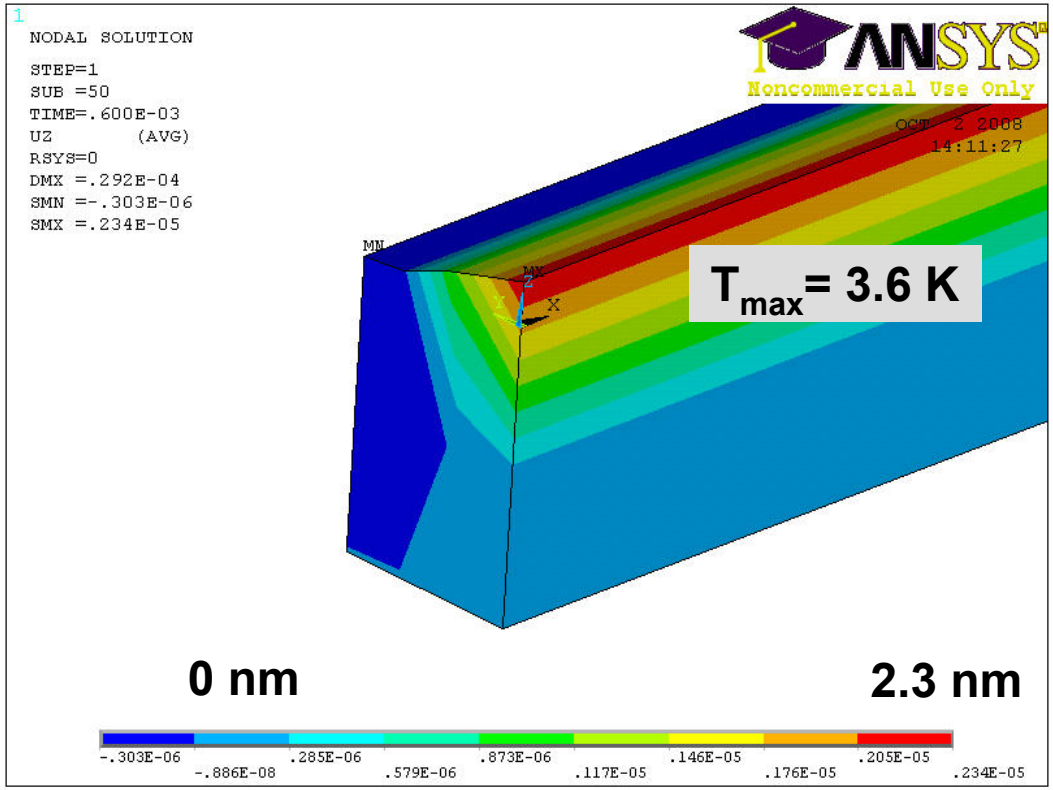


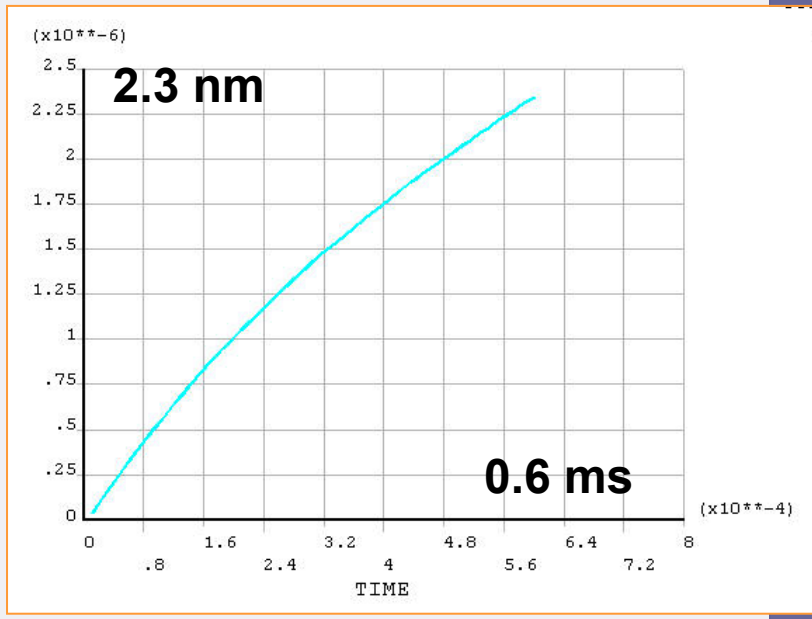
→ distortions less than few cm (1. Fresnel zone) act as 'defects' or roughness

1nm-bump, at 100 m-distance

SRW-results: Liuba Samoylova, XFEL 2008

Mirror deformation during pulse train?





Fan Yang, XFEL 2008

Spezifications for XFEL bimorph mirrors

- Do we really need bimorphs? (→ holder ?)
- 2 nm PV overall flatness (likely value)
- 'roughness' < 10 cm to be determined
- length: 0.5 m … 0.75 m → 1.5 m (C, B_4C – coating !)
- radiation hard (~ 3rd generation WB) → silicon substrates
- vibration level < 10 nrad rms
- at least water cooling (min. 1 W .. max 30 W)
- liquid nitrogen temperature would be nice ☺

Acknowledgements

XFEL optics group: Germano Galasso, Jerome Gaudin, Liuba Samoylova, Antje Trapp, Fan Yang

DESY: Kai Tiedtke

BESSY: Frank Siewert

Osaka University: Prof. Kazuto Yamauchi, Hidekazu Mimura