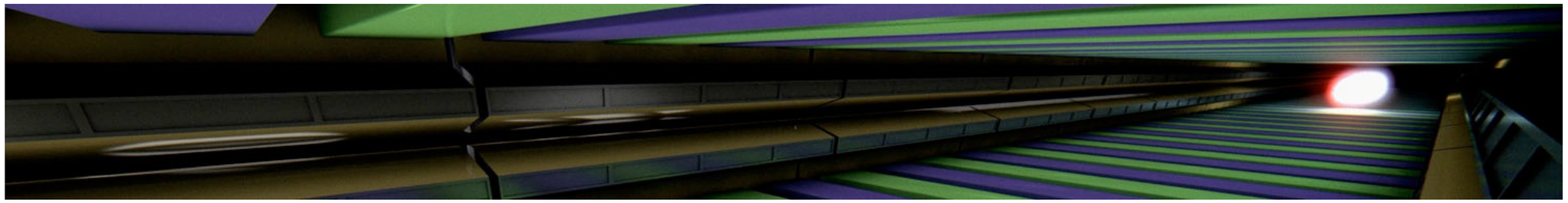
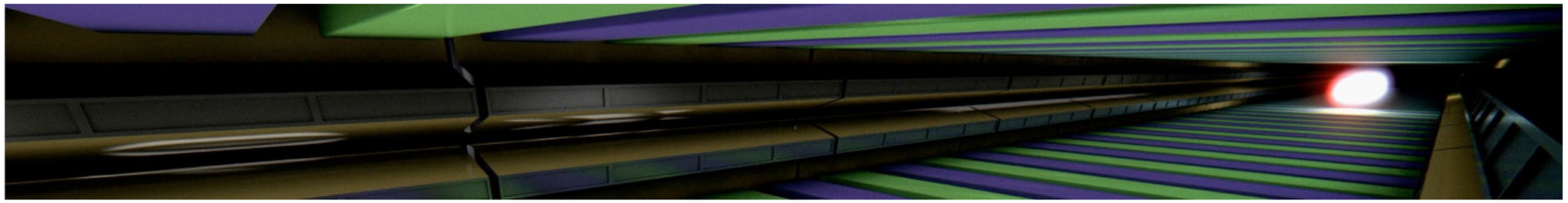


The SPB/SFX Instrument: An update

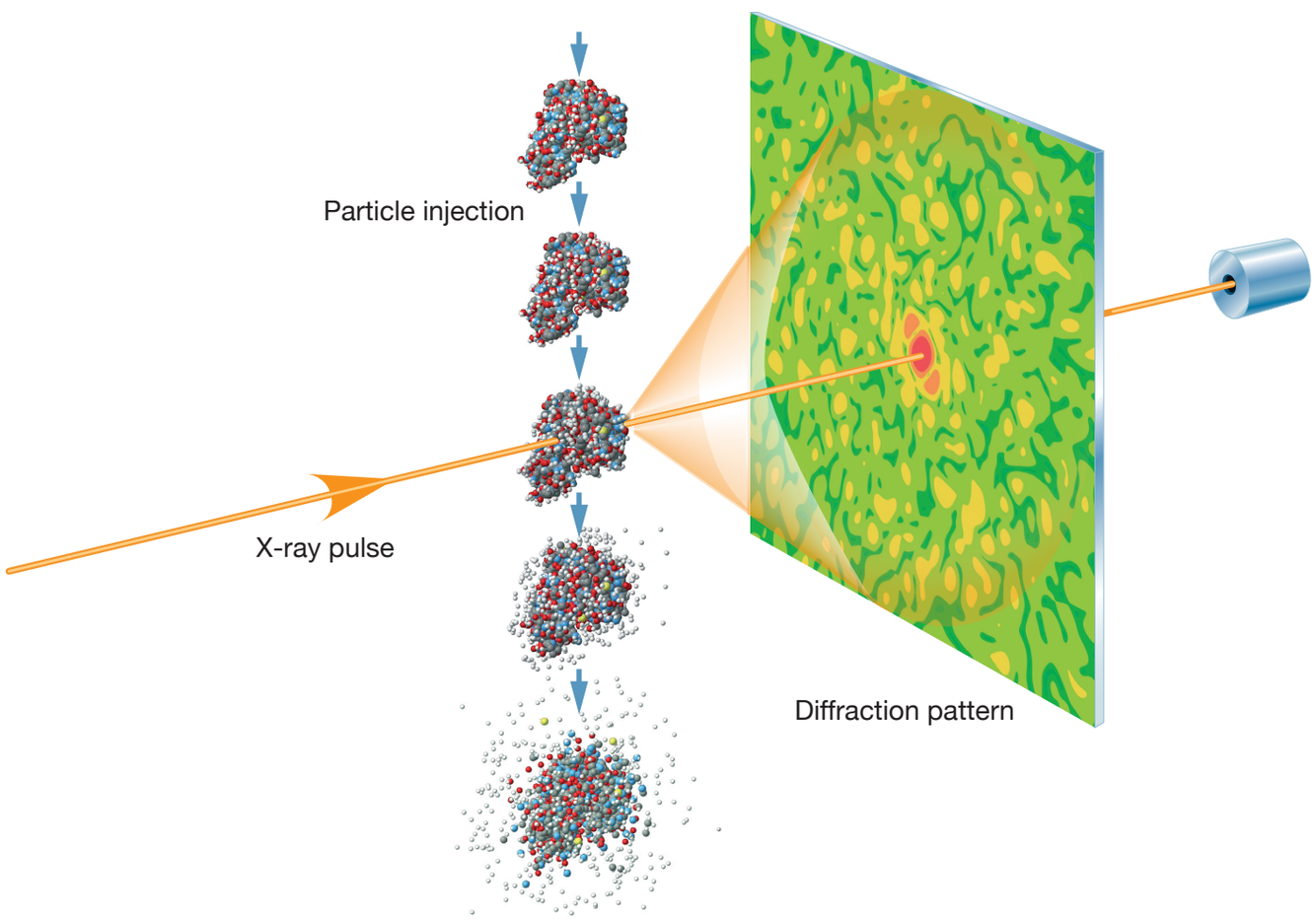
Adrian Mancuso



The Single Particles, Clusters and Biomolecules and Serial Femtosecond Crystallography Instrument

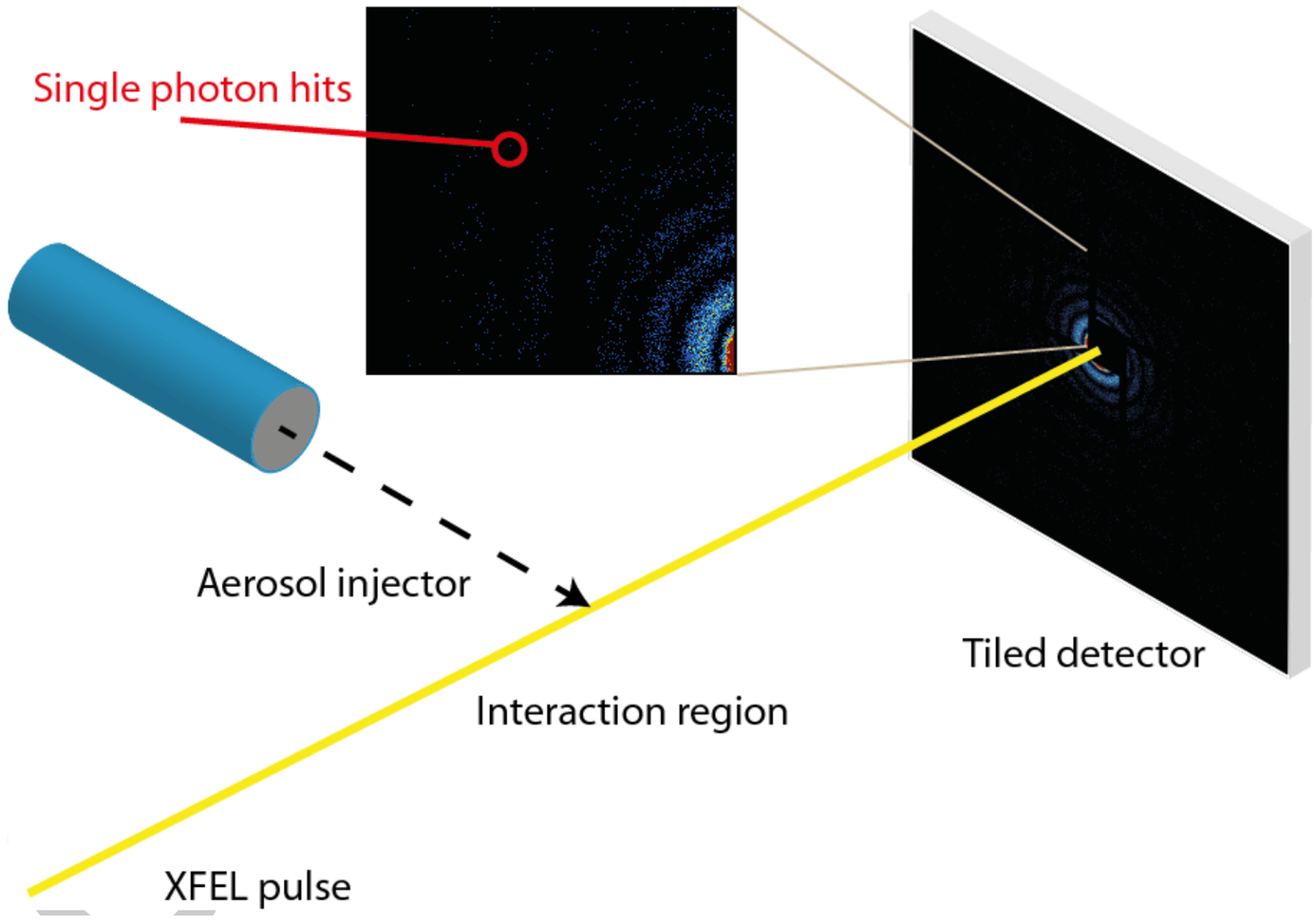
Adrian Mancuso

Reminder: SPB/SFX Science



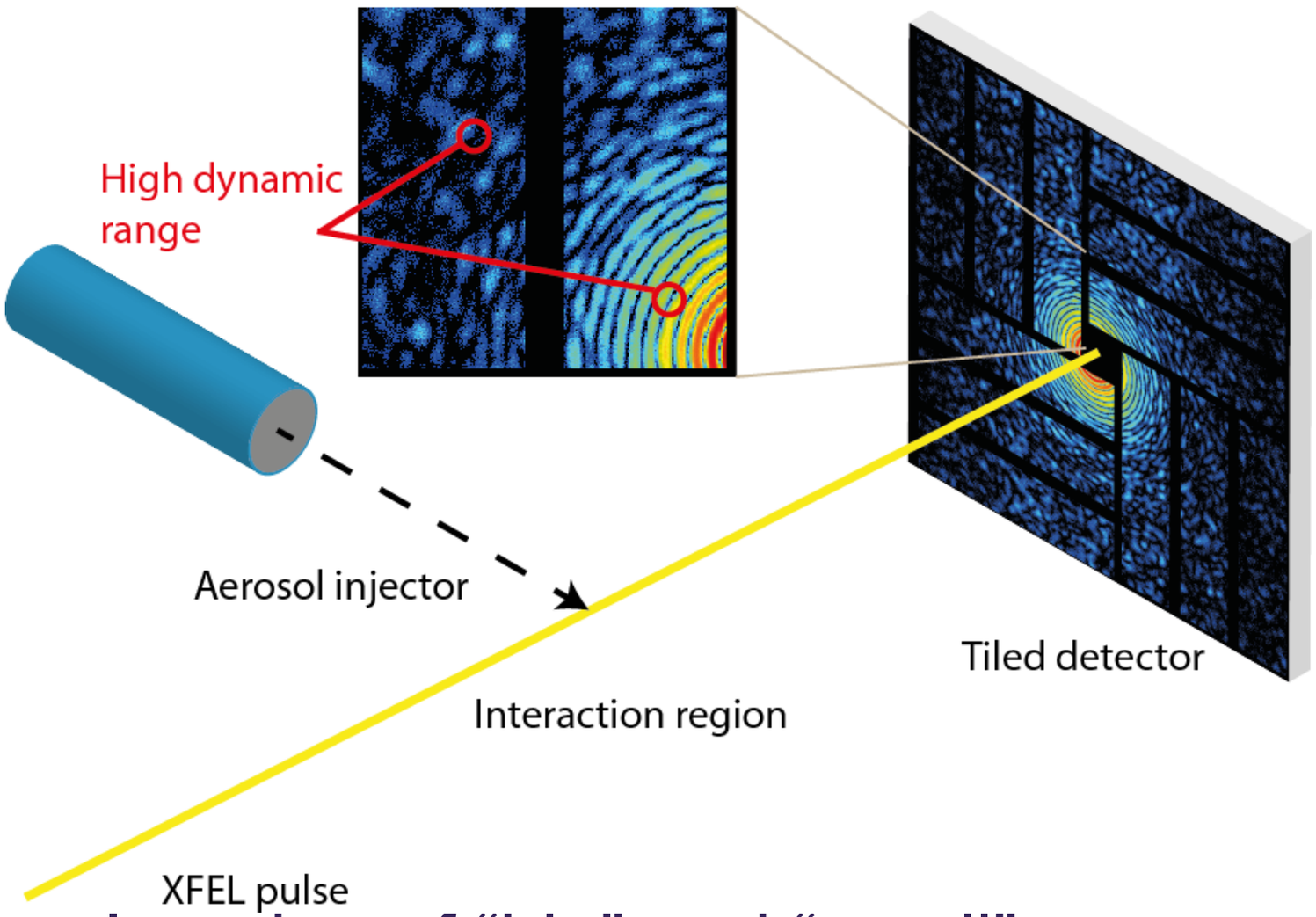
Imaging of “big” and “small” non-crystalline samples

Reminder: SPB/SFX Science



Imaging of “big” and “small” non-crystalline samples

Reminder: SPB/SFX Science

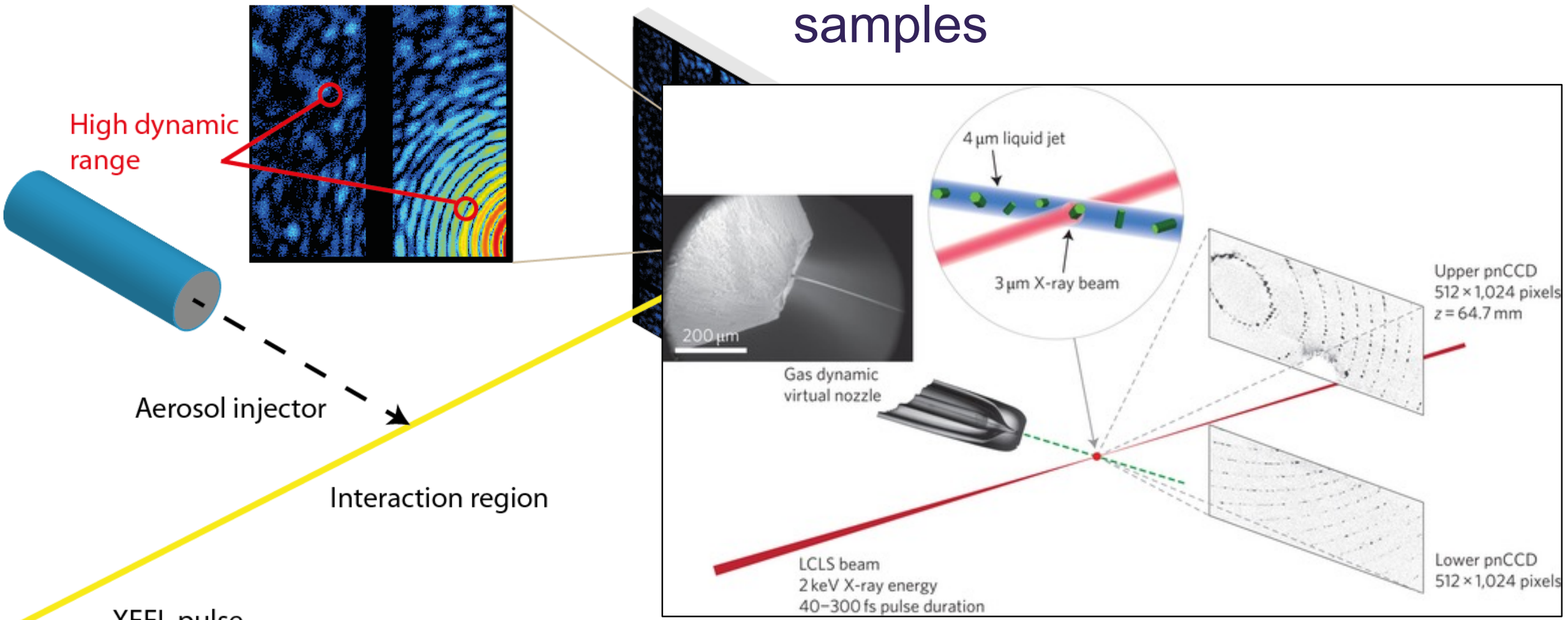


Imaging of “big” and “small” non-crystalline samples

European XFEL

Reminder: SPB/SFX Science

Crystallography of “small”, “radiation sensitive” or “dynamic” samples

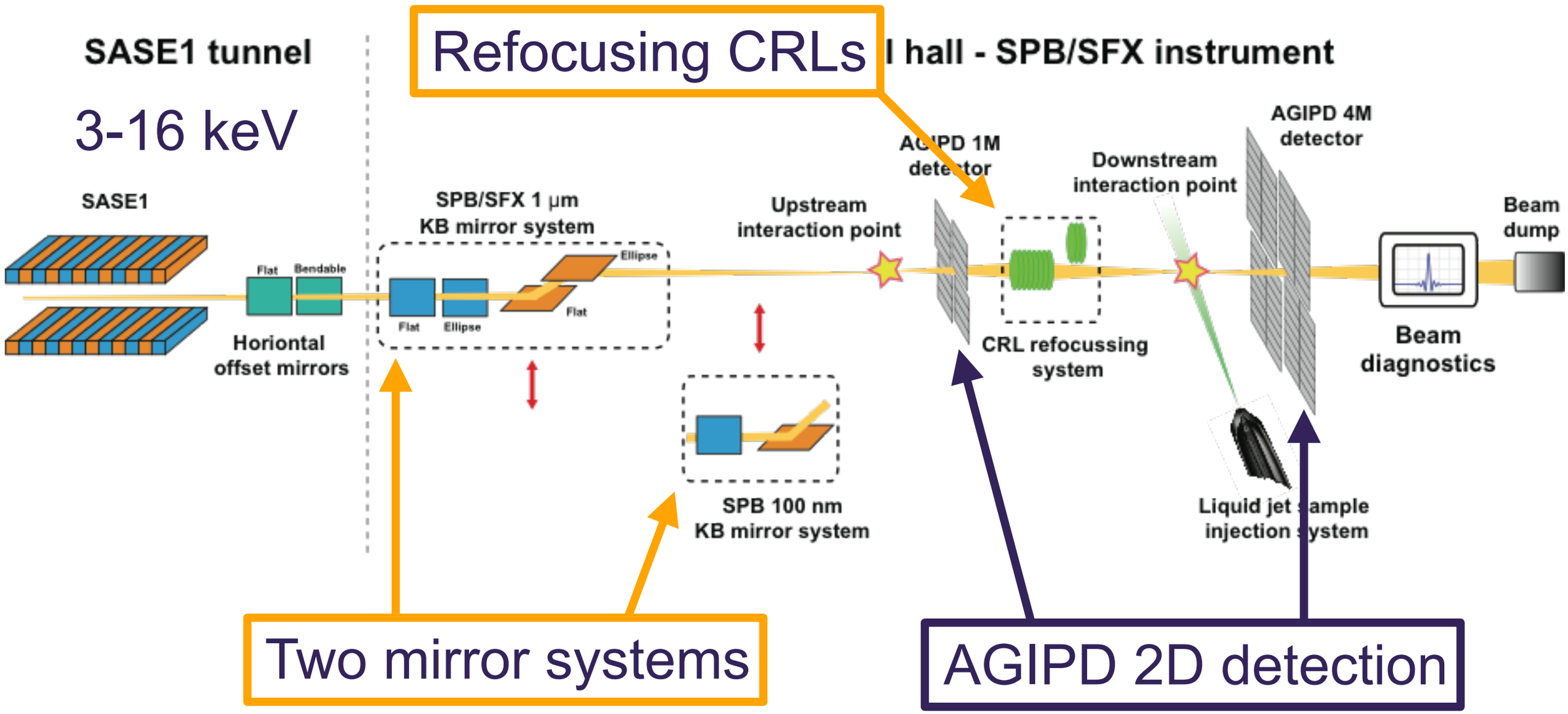


Imaging of “big” and “small” non-crystalline samples

Image from: Barty, et al, Nature Photonics 6, 35–40 (2012)

European XFEL

Overview SPB/SFX instrument



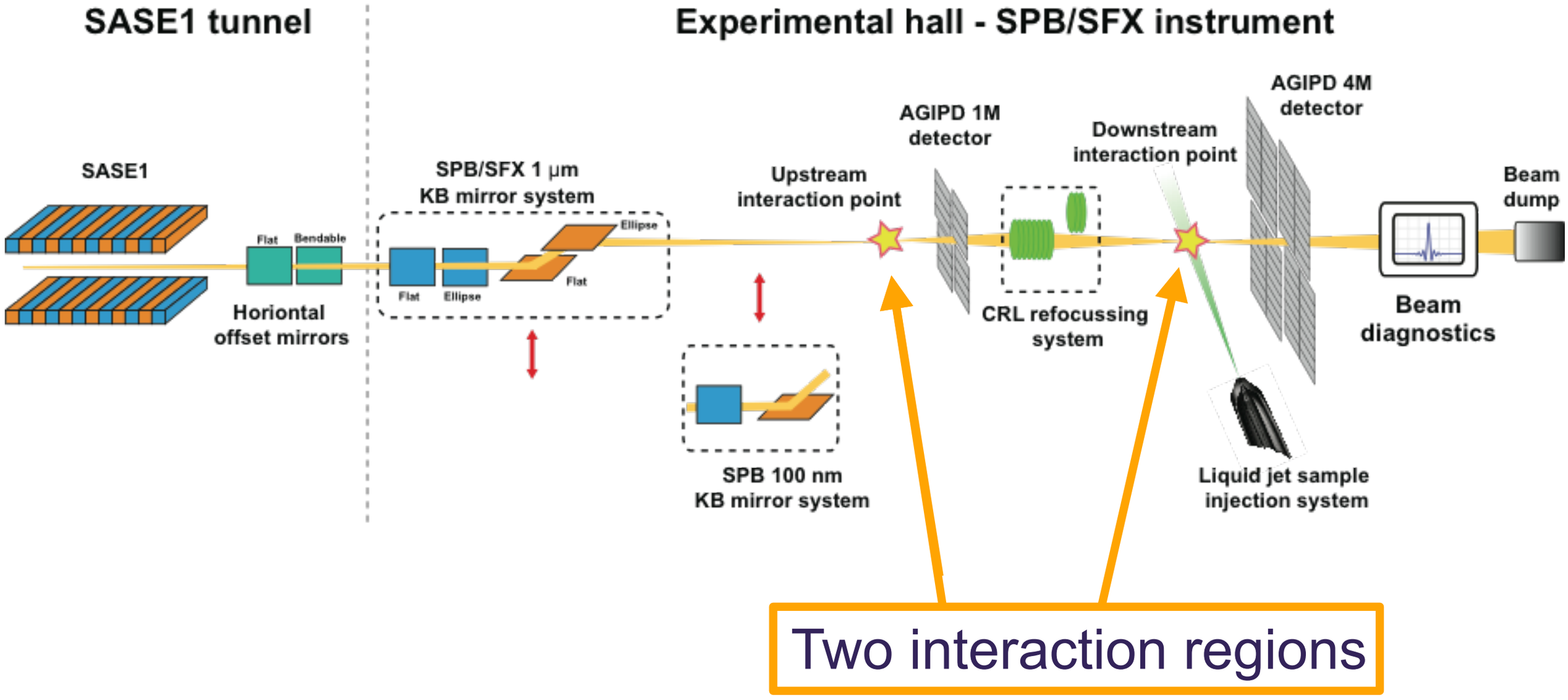
[1] A. P. Mancuso and H. N. Chapman, International Workshop on Science with and Instrumentation for Ultrafast Coherent Diffraction Imaging of Single Particles, Clusters, and Biomolecules (SPB) at the European XFEL (2011).

[2] A. P. Mancuso, Conceptual Design Report: Scientific Instrument SPB, 2011. dx.doi.org/10.3204/XFEL.EU/TR-2011-007

[3] A. P. Mancuso, et al, Technical Design Report: Scientific Instrument SPB, 2013. dx.doi.org/10.3204/XFEL.EU/TR-2013-004

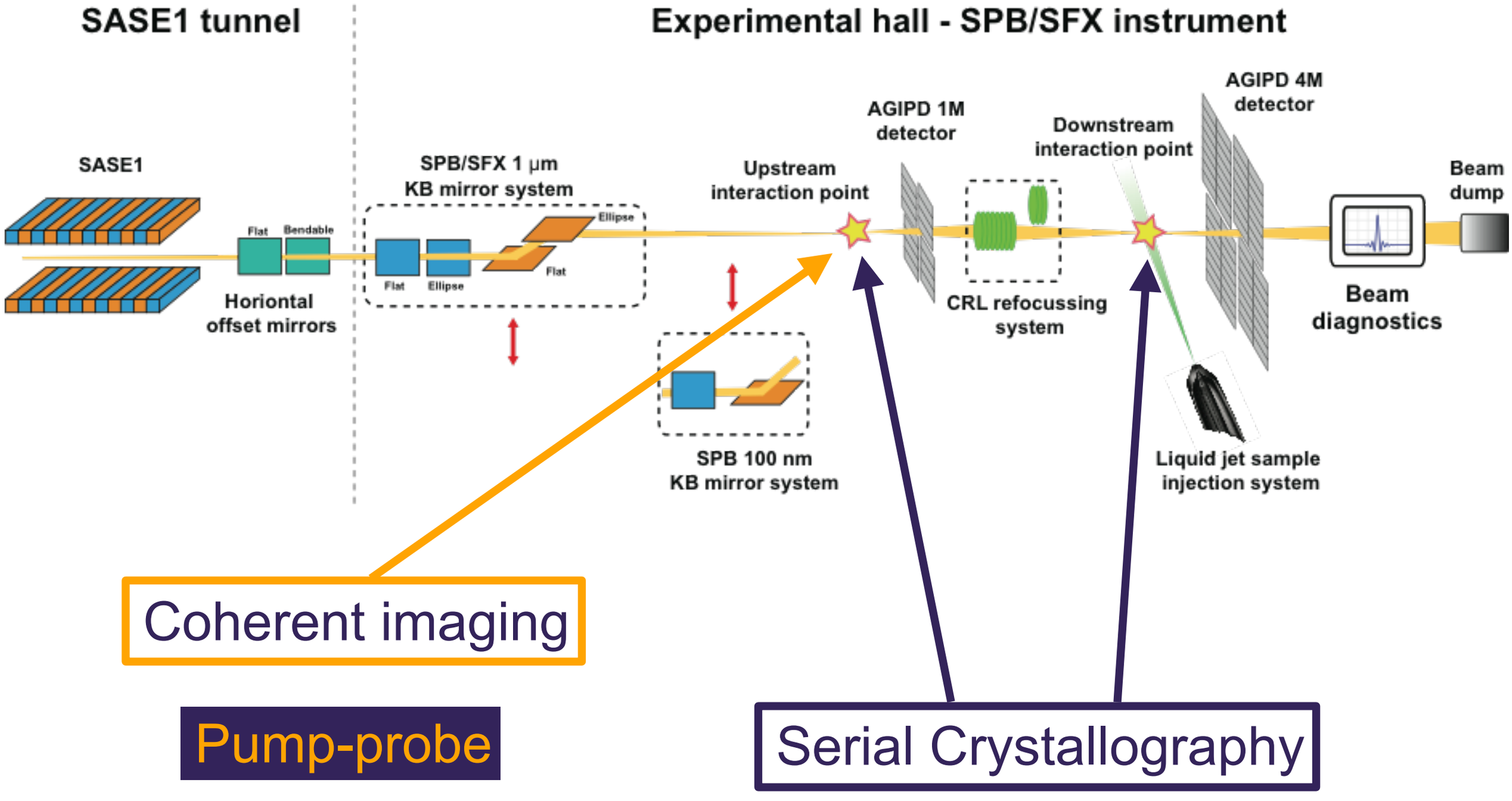
European XFEL

Overview SPB/SFX instrument



European XFEL

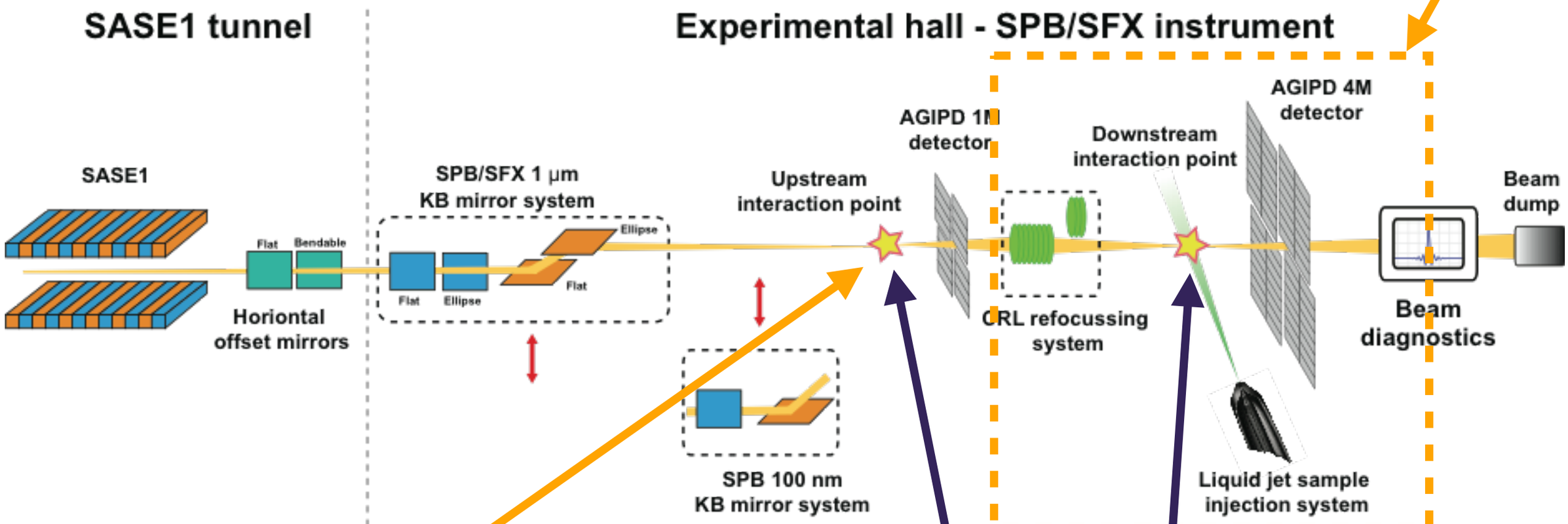
Overview SPB/SFX instrument



European XFEL

Overview SPB/SFX instrument

SFX UC Contribution



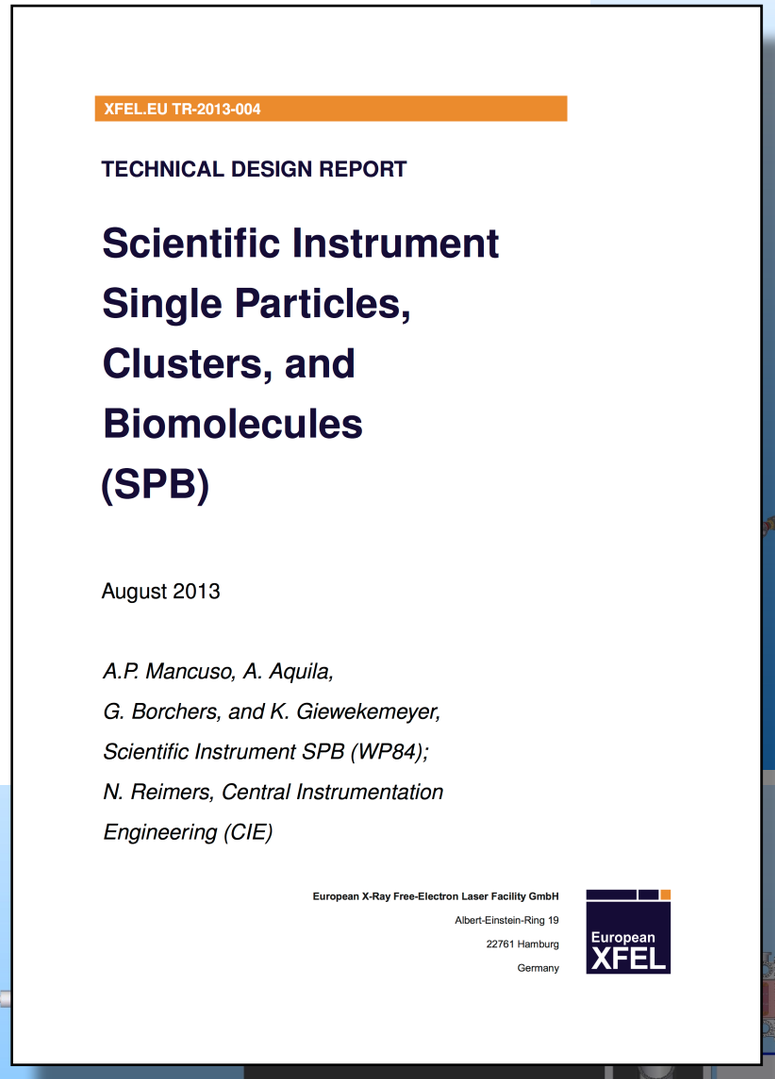
Coherent imaging

Pump-probe

Serial Crystallography

European XFEL

The SPB/SFX instrument at a glance


XFEL.EU TR-2013-004

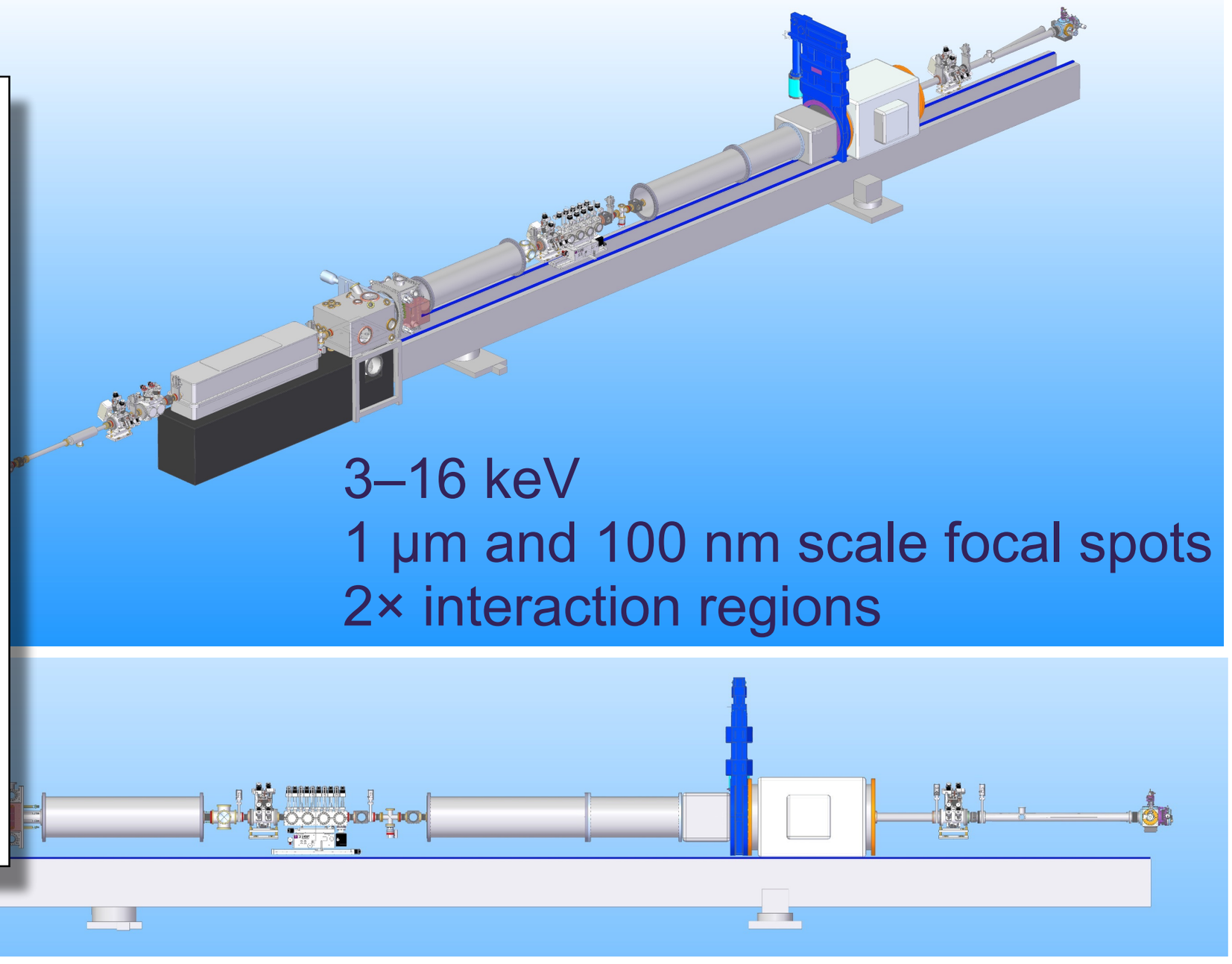
TECHNICAL DESIGN REPORT

Scientific Instrument Single Particles, Clusters, and Biomolecules (SPB)

August 2013

A.P. Mancuso, A. Aquila, G. Borchers, and K. Giewekemeyer, Scientific Instrument SPB (WP84); N. Reimers, Central Instrumentation Engineering (CIE)

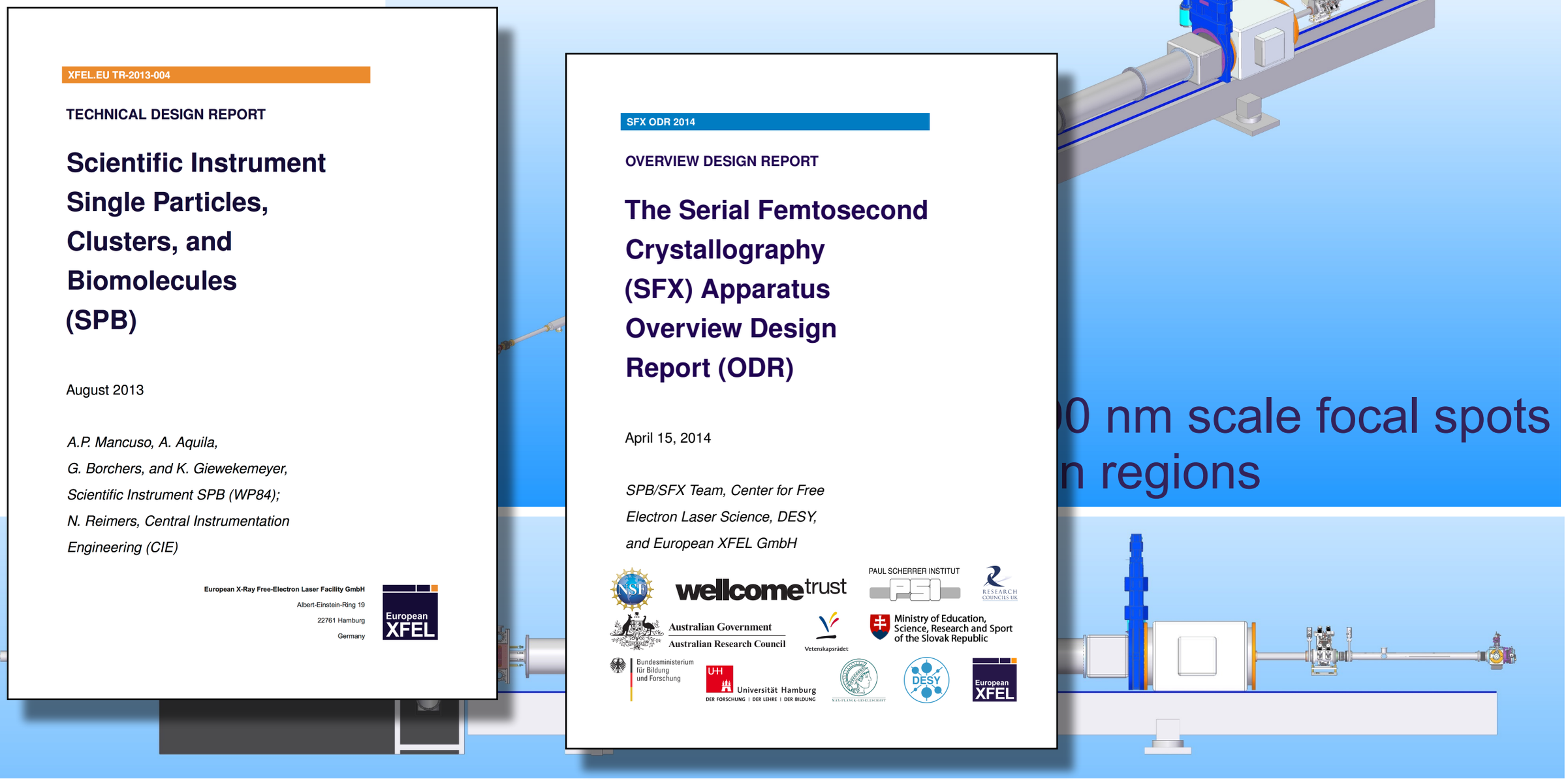
European X-Ray Free-Electron Laser Facility GmbH
Albert-Einstein-Ring 19
22761 Hamburg
Germany



A. P. Mancuso, et al, Technical Design Report: Scientific Instrument Single Particles, Clusters, and Biomolecules (SPB) http://dx.doi.org/10.3204/XFEL.EU/TR-2013-004

European XFEL

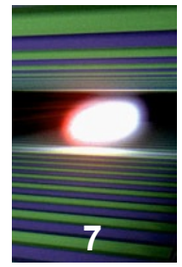
The SPB/SFX instrument at a glance



A. P. Mancuso, et al, Technical Design Report: Scientific Instrument Single Particles, Clusters, and Biomolecules (SPB) http://dx.doi.org/10.3204/XFEL.EU/TR-2013-004

European XFEL

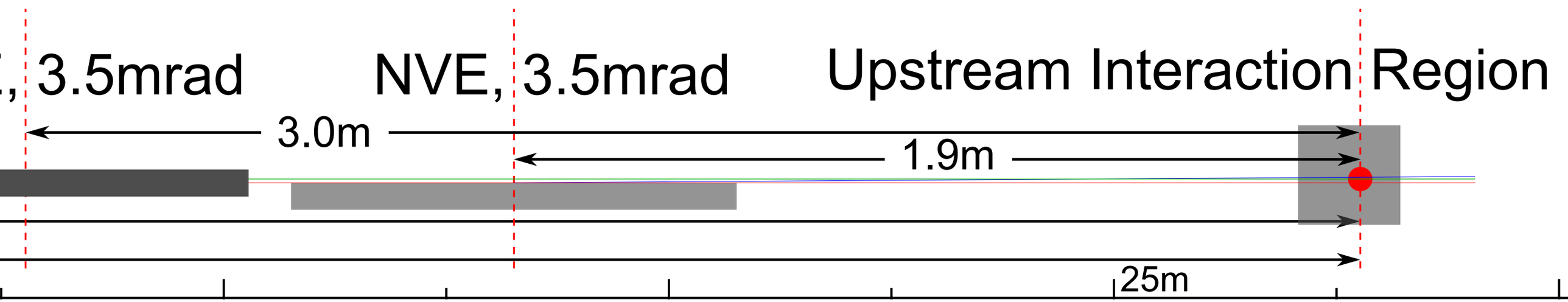
Optical considerations



SPB/SFX Optical Layout

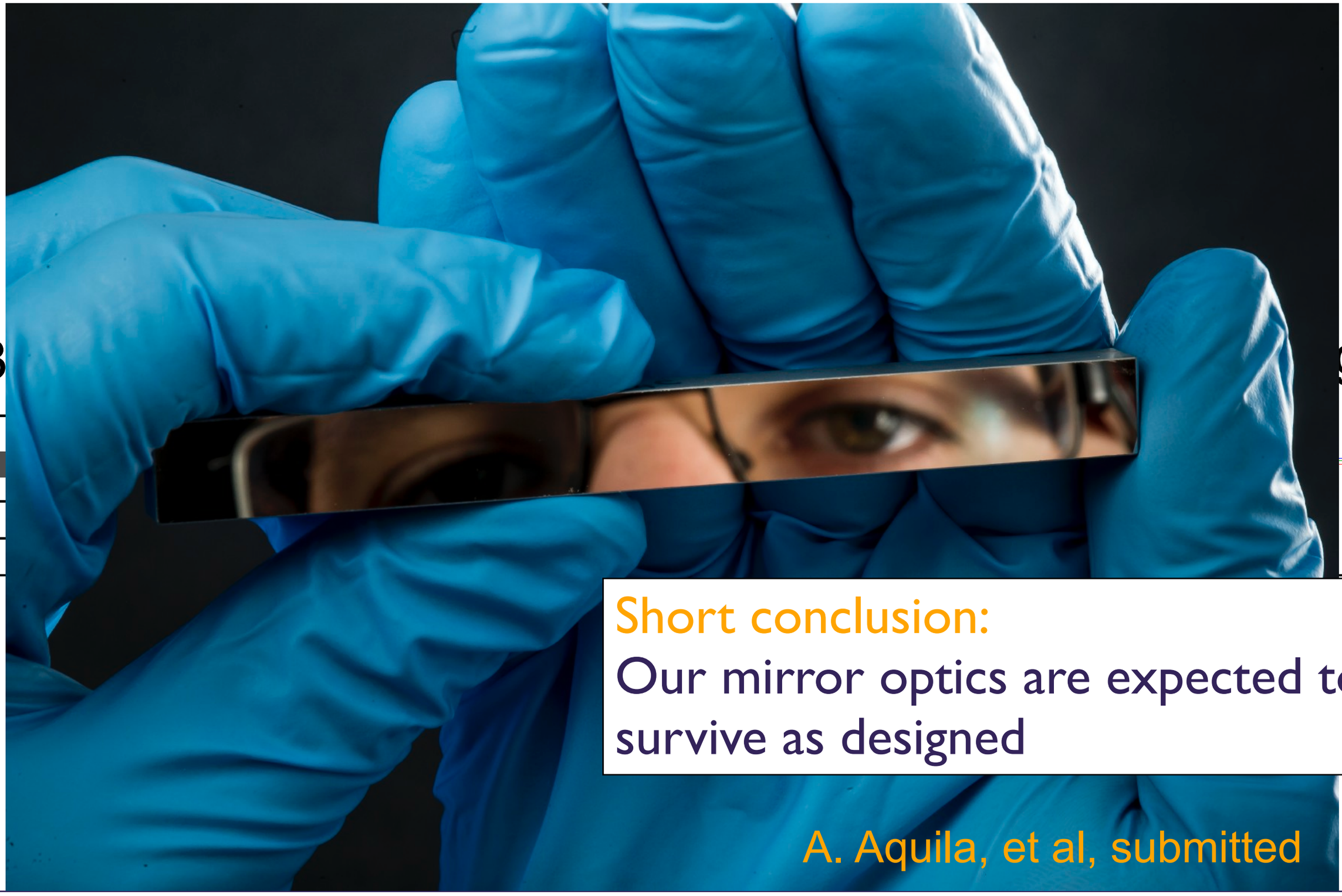
European XFEL

Optical considerations



European XFEL

Optical considerations



Short conclusion:

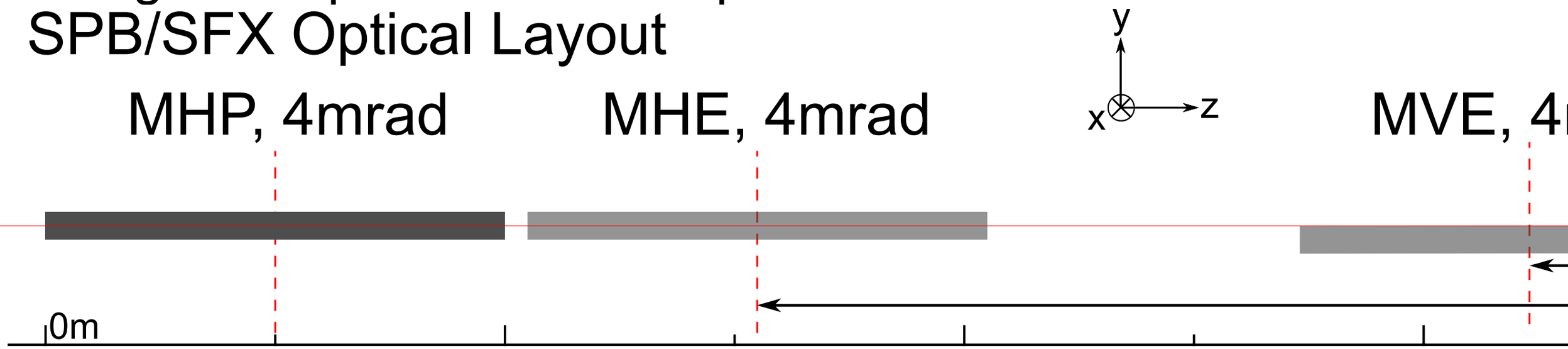
Our mirror optics are expected to survive as designed

A. Aquila, et al, submitted

Mirrors and mechanics (with commercial partners)

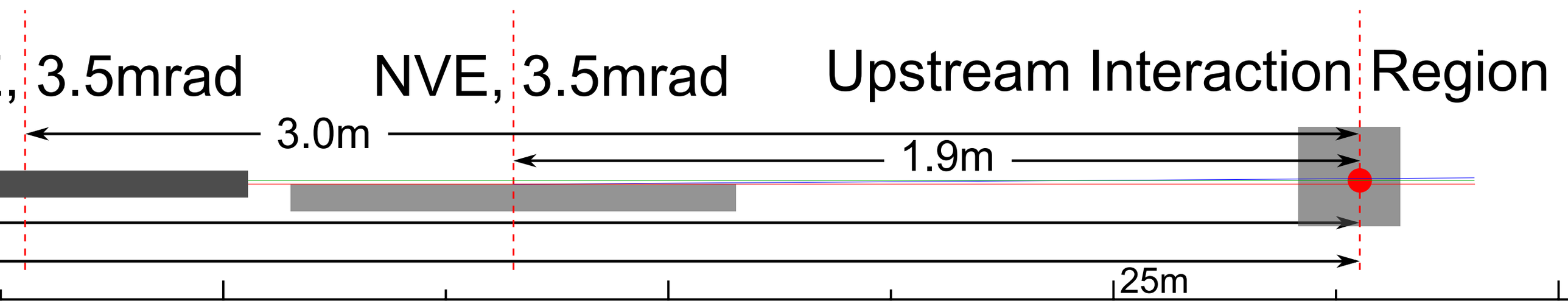
- Key issues:
  - Mirror stability (vibrational)
  - Alignment procedure and spot characterisation

SPB/SFX Optical Layout



Mirrors and mechanics (with commercial partners)

- Key issues:
  - Mirror stability (vibrational)
  - Alignment procedure and spot characterisation

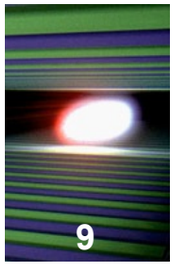


Mirrors and mechanics (with commercial partners)

- Key issues:
  - Mirror stability (vibrational)
  - Alignment procedure and spot characterisation

- Key progress:
  - Continuous vibrational monitoring of experimental hall
    - ➔Allows identification of vibrational noise sources
  - Development of wavefront measurement techniques
    - ➔Aids focal spot characterisation
  - Vendor Finite Element Analysis of static and thermal

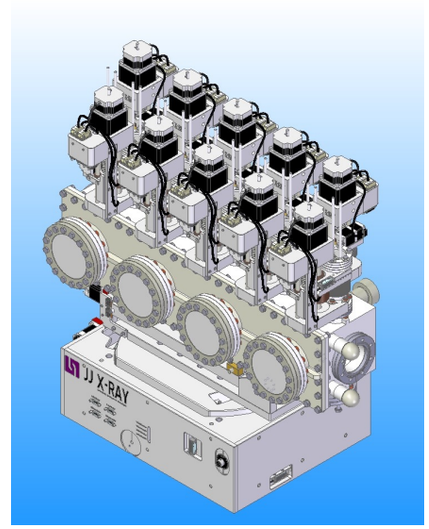
Key progress 2014 – SFX Integration: Optics, sample delivery and detector



- Optics
  - CRL refocusing optics at advanced stage of design
  - Design optimised for continuous photon energy coverage
- Sample delivery
  - SFX sample delivery work package led by J. Schulz, XFEL
  - Both sample environments will accommodate a number of sample delivery methods (allowing all to capitalise on the SFX UC's sample delivery expertise)
- Detector: AGIPD 4Mpx
  - Integration goals defined (sampling, resolution, etc)
  - First steps to mechanical integration begun

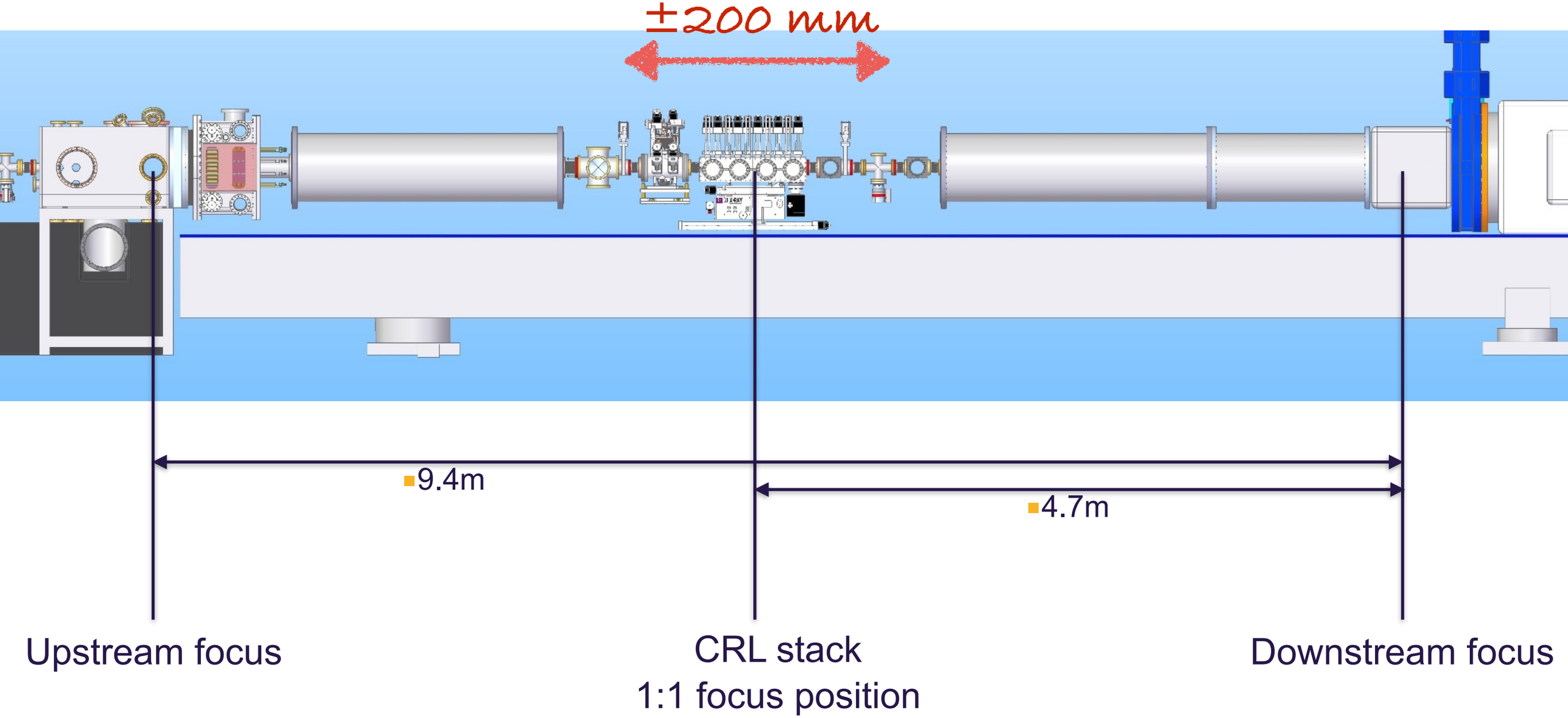
Key progress 2014 – SFX Integration: Optics, sample delivery and detector

- Optics
  - CRL refocusing optics at advanced stage of design
  - Design optimised for continuous photon energy coverage



European XFEL

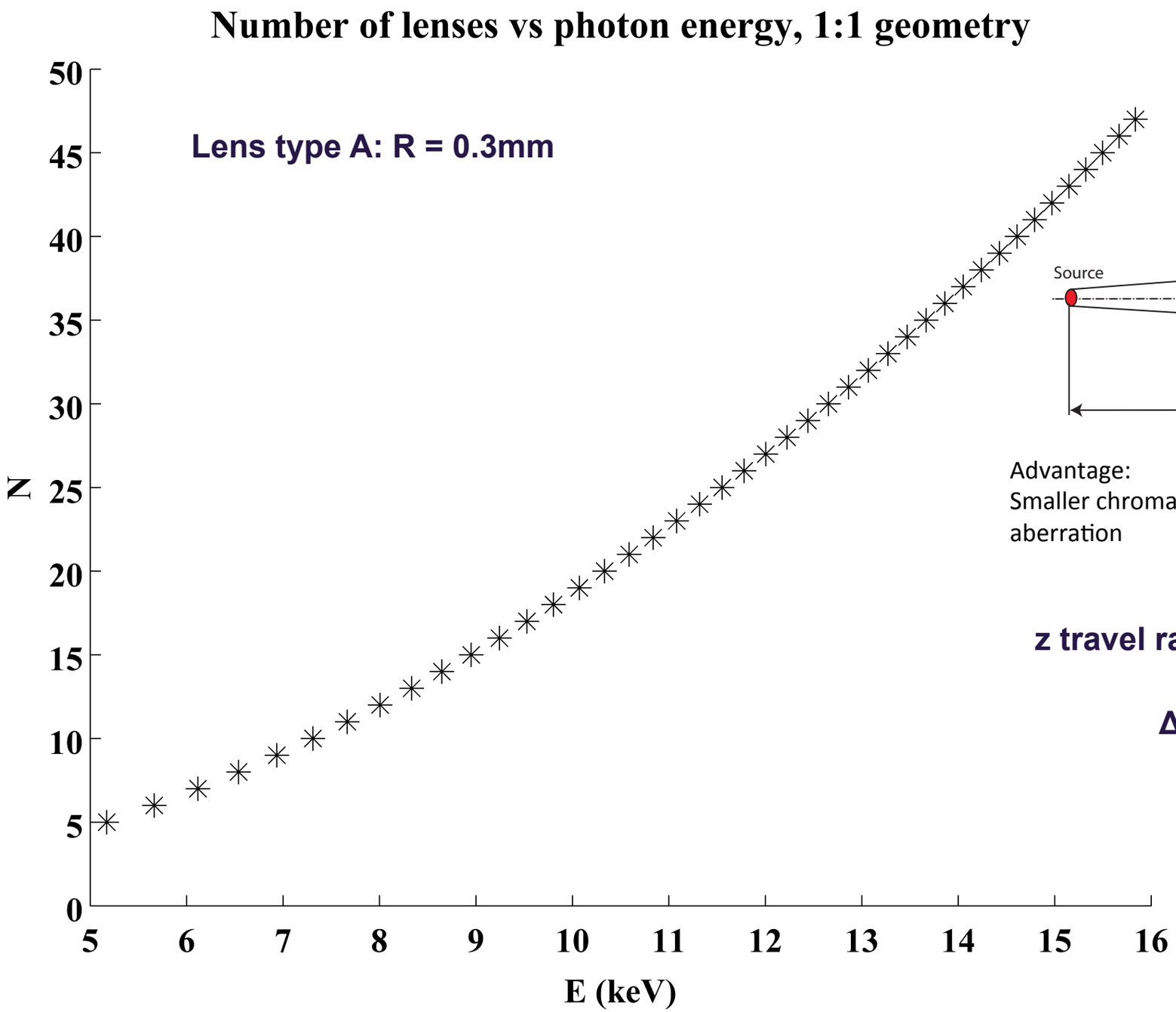
Compound Refractive Lens Refocusing System



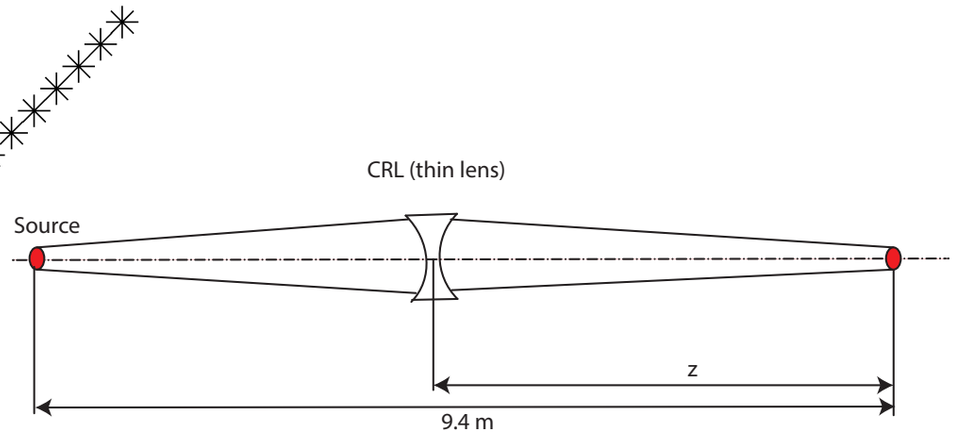
- Travel range limited to 400mm (without manual repositioning)

European XFEL

Optimisation of CRL stack



Lens type A: R = 0.3mm

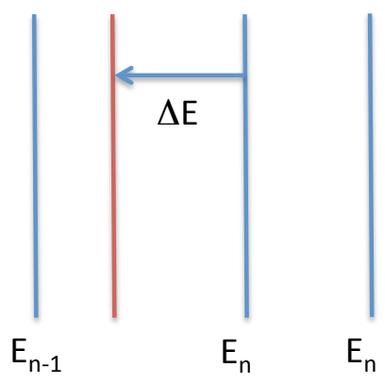


Advantage:
Smaller chromatic aberration

Advantage:
Smaller focal spot

z travel range Δz = 400 mm

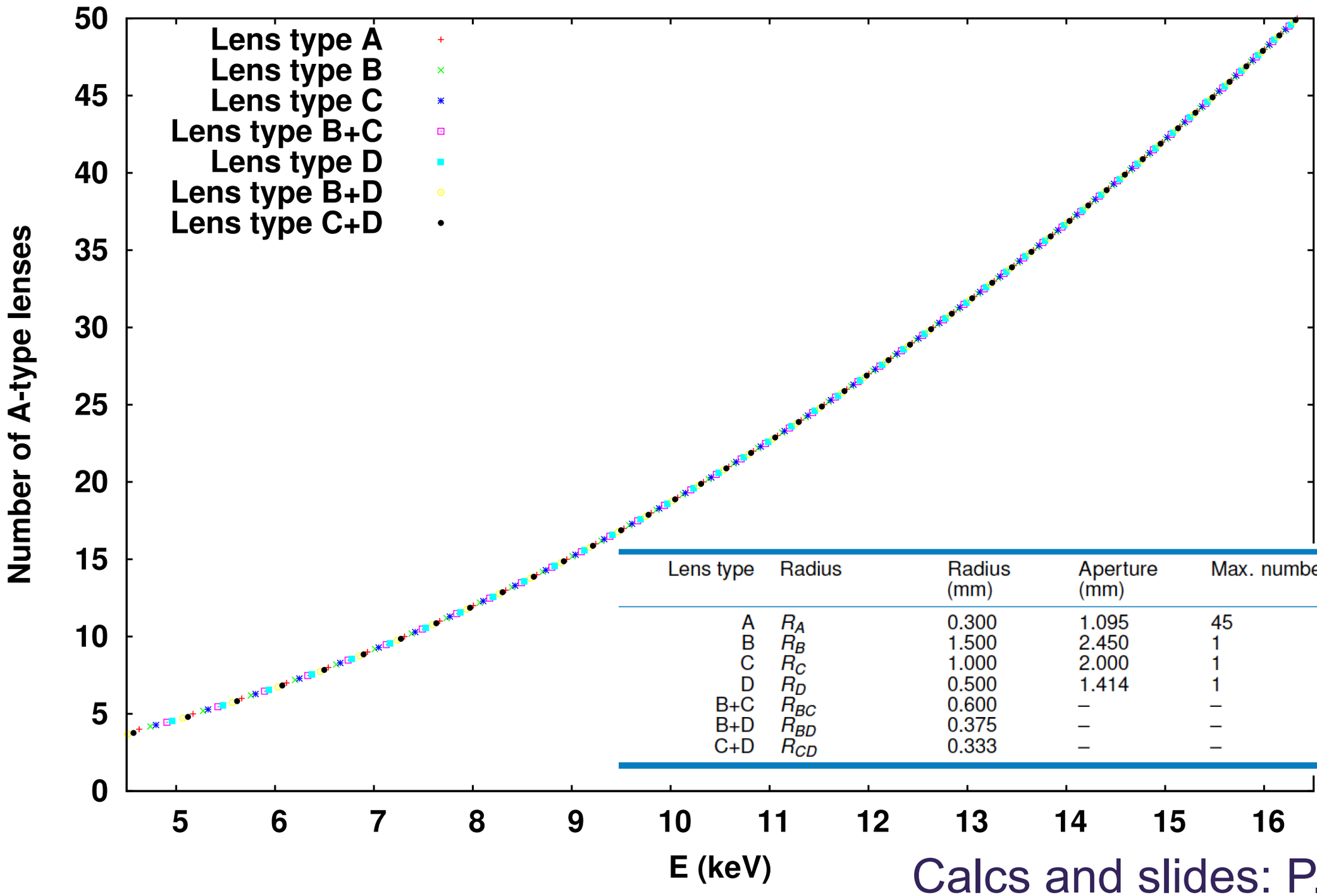
ΔE ?



Calcs and slides: P. Vagovič

European XFEL

Optimisation of CRL stack

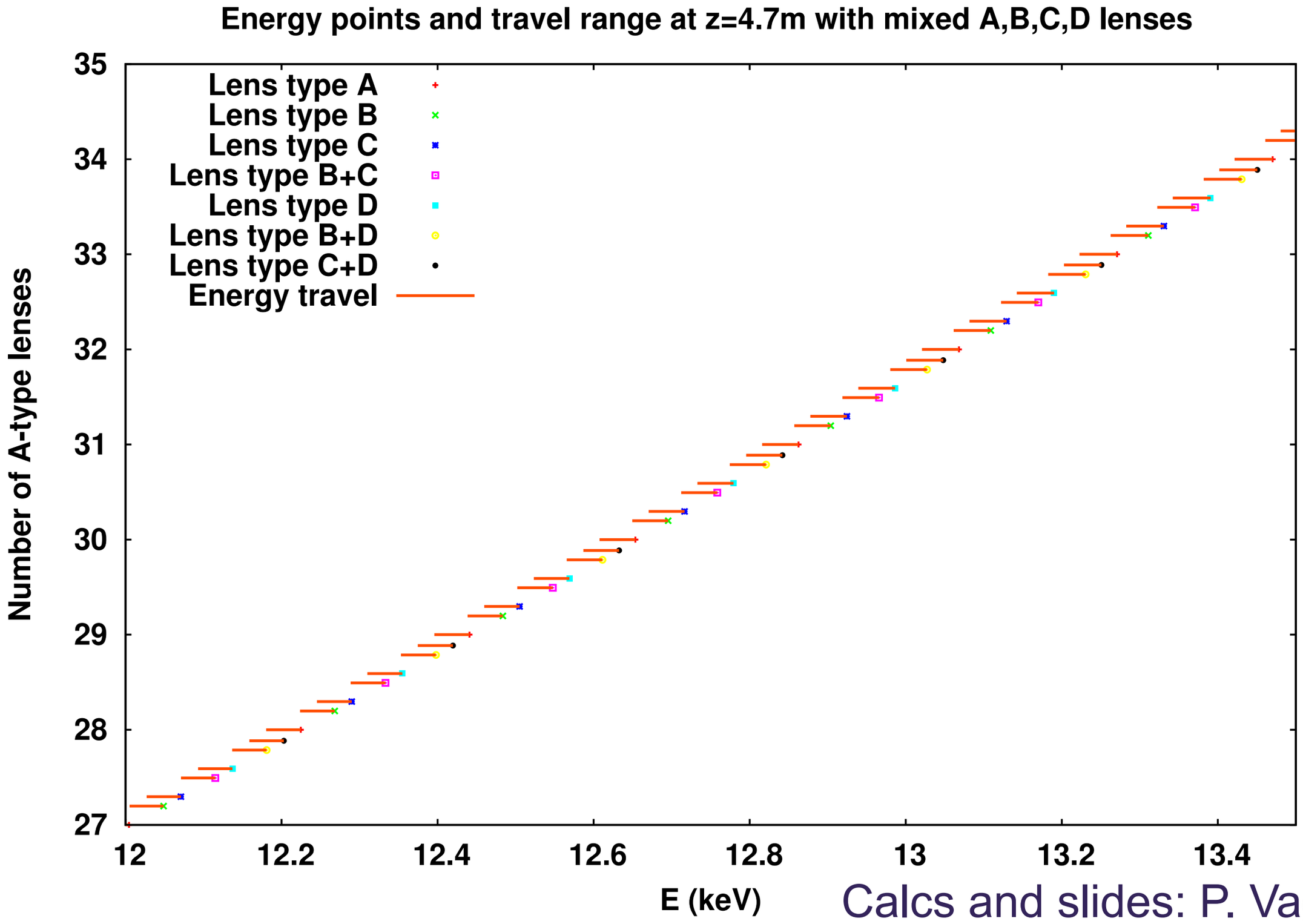


Lens type	Radius	Radius (mm)	Aperture (mm)	Max. number of lenses
A	R_A	0.300	1.095	45
B	R_B	1.500	2.450	1
C	R_C	1.000	2.000	1
D	R_D	0.500	1.414	1
B+C	R_{BC}	0.600	–	–
B+D	R_{BD}	0.375	–	–
C+D	R_{CD}	0.333	–	–

Calcs and slides: P. Vagovič

European XFEL

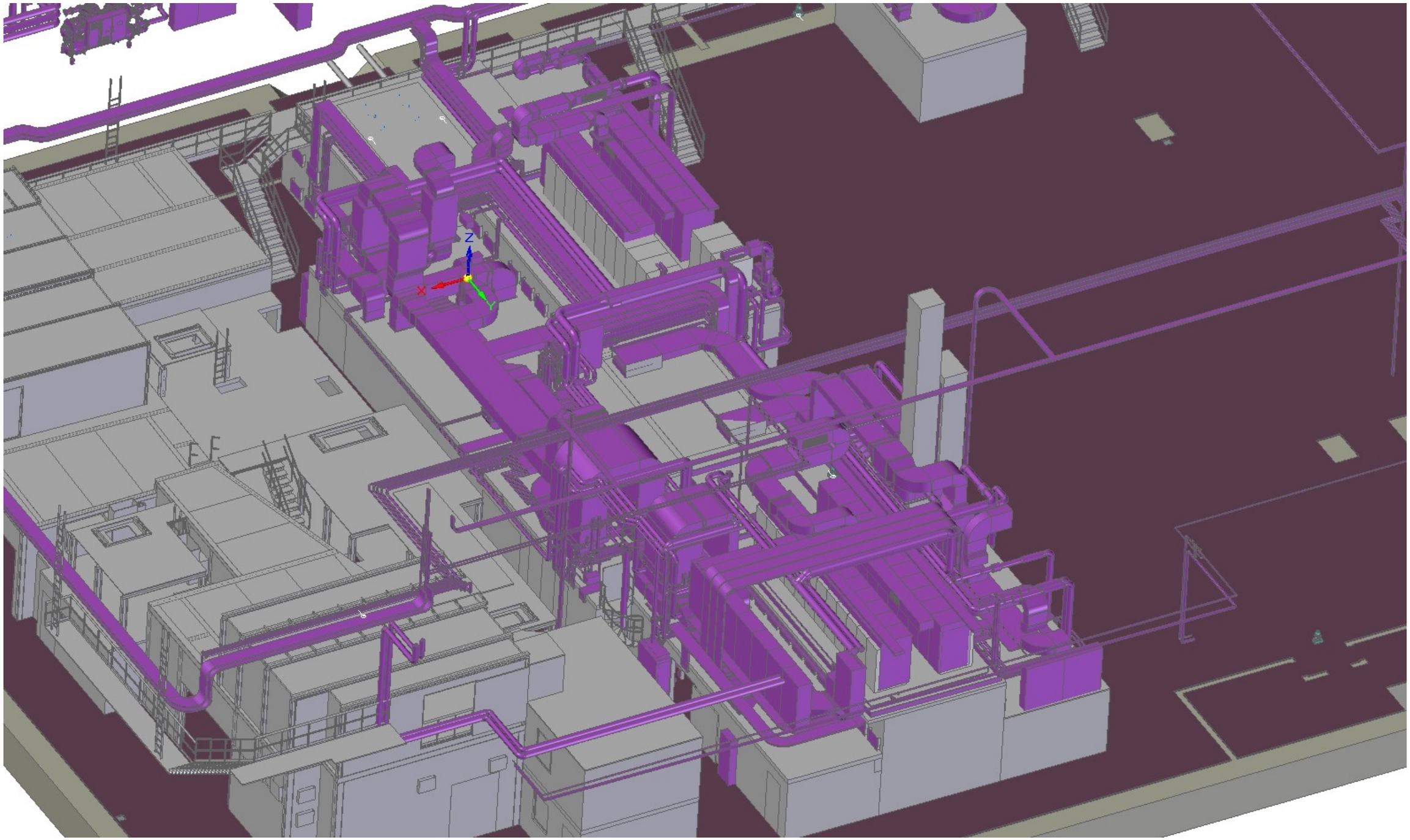
Optimisation of CRL stack



Calcs and slides: P. Vagovič

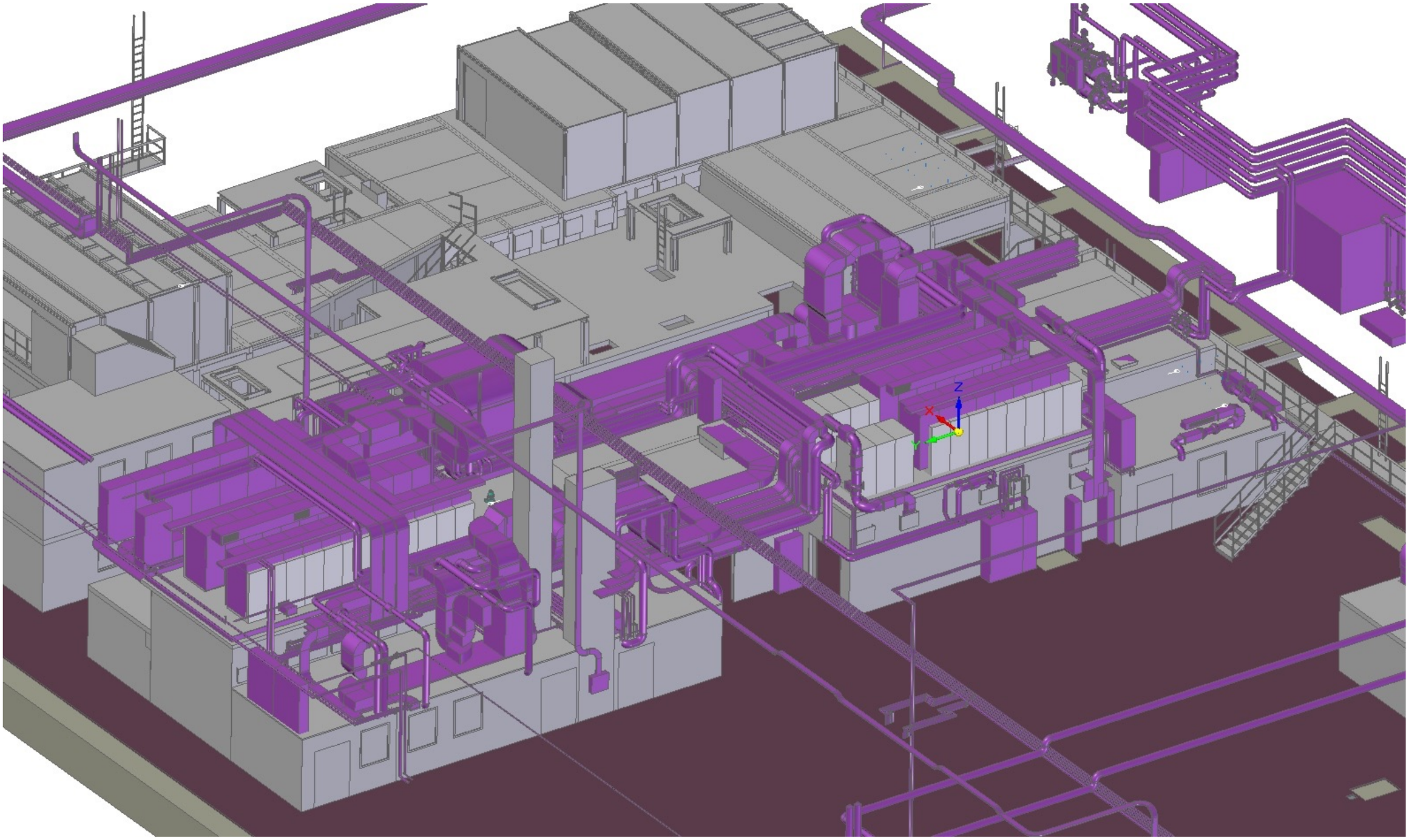
The Single Particles, Clusters and Biomolecules, and Serial Femtosecond Crystallography (SPB/SFX) Instrument

Boring but important: Hutch and infrastructure



European XFEL

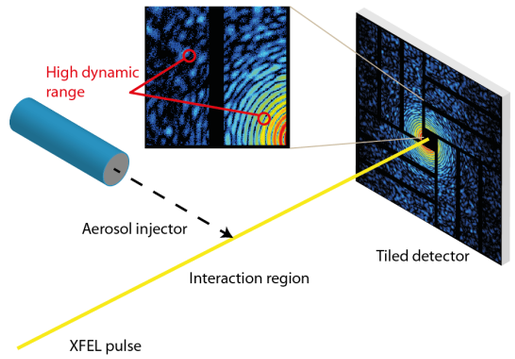
Boring but important: Hutch and infrastructure



and a whole lot more…

Summary of the summary!

- From 3–16 keV, SPB/SFX caters for:
  - Single particle imaging of < 100 nm particles
  - Single particle imaging of < 1μm particles
  - Serial crystallography of small, sensitive or dynamic systems



- SFX UC contributed apparatus now incorporated at the conceptual level
  - CRL refocusing optics at advanced state of design
  - AGIPD 4Mpx integration goals defined
  - Sample delivery options – accommodate multiple efforts from the different UC partners

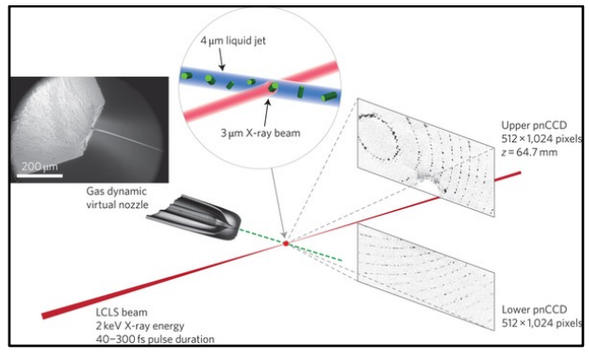


Image from: Barty, et al, Nature Photonics 6, 35–40 (2012)

- Much progress on all instrumentation systems (and even more on the boring systems too!)


SFX ODR 2014

OVERVIEW DESIGN REPORT

The Serial Femtosecond Crystallography (SFX) Apparatus Overview Design Report (ODR)

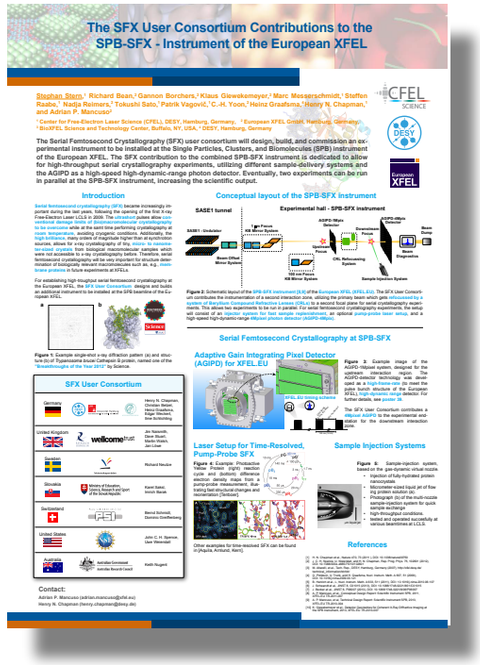
April 15, 2014

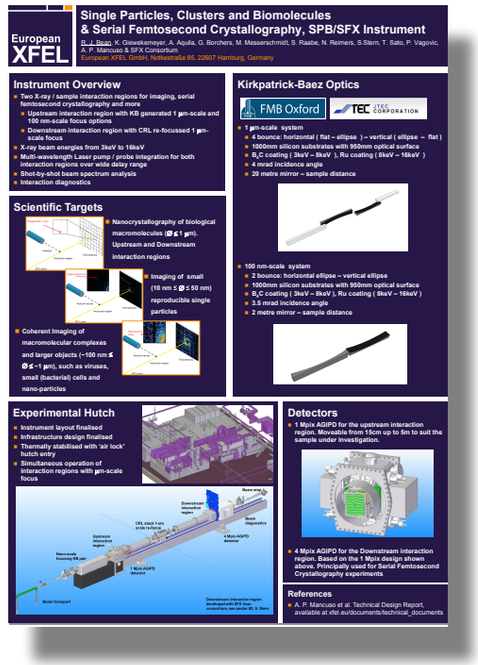
SPB/SFX Team, Center for Free Electron Laser Science, DESY, and European XFEL GmbH

European XFEL

Do you want to know more?

- There's much more to know:
  - See on Friday:
    - Poster #2 – S. Stern, et al, SFX UC contributions
    - Poster #121 – R. Bean, et al, SPB/SFX Instrument
  - Or anytime this week:
    - Talk to any of the team–at the posters, dinner, lunch, etc
- Or join the team: we're (soon) hiring!
  - Scientists, engineers, and more…
  - For more details contact: adrian.mancuso@xfel.eu





SPB/SFX Instrument team

- SPB/SFX
  - Richard Bean
  - Gannon Borchers
  - Klaus Giewekemeyer
  - Masoud Mehrjoo
  - Marc Messerschmidt (Sci computing)
  - Nadja Reimers (Central Instruments Engineering)
  - Stephan Stern
  - Tokushi Sato
  - Steffen Raabe
  - Chun Hong Yoon
  - Andrew Aquila (now at SLAC)

A. P. Mancuso, A. Aquila, G. Borchers, K. Giewekemeyer & N. Reimers, Technical Design Report: Scientific Instrument SPB, 2013. dx.doi.org/10.3204/XFEL.EU/TR-2013-004

Many thanks to Steve Readman for exceptional assistance with the project plan