

## The SPB/SFX Instrument: An update

**Adrian Mancuso** 



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

**Adrian Mancuso** 

### **XFEL** Aim of this (short) talk



Reminder of the possible science at SPB/SFX

Reminder of the basic instrumentation at SPB/SFX

Describe the key elements of the "day one" instrumentation

Describe the key elements of the "full" instrumentation

Provide information about where you can find more detail about each part of the instrument

- Documentation (papers & posters)
- People

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#### Imaging of "big" and "small" non-crystalline samples

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# Single photon hits Aerosol injector Interaction region

XFEL pulse

## Imaging of "big" and "small" non-crystalline samples

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XFEL pulse Imaging of "big" and "small" non-crystalline samples





### **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

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

### **XFEL** Overview SPB/SFX instrument



SFX UC Contribution

### **XFEL** Overview SPB/SFX instrument



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### **XFEL** The SPB/SFX instrument at a glance





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

Micron-scale

**KB** mirror system

**FMB** Oxford

### **XFEL** Optics: Focusing mirror systems



Beam

shutter

- 3—16 keV operation range
  - 3-8 keV B<sub>4</sub>C coating
  - 8-16 keV Ru Coating
- 100 nm scale and 1µm scale focal spots
- 2 nm height error specs
- In production
- Probably not day one Beam conditioning (slits, etc.)

R. Bean, A. Aquila, L. Samoylova, A. P. Mancuso, "Design of the mirror optical systems for coherent diffractive imaging at the SPB/SFX instrument of the European XFEL", submitted



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### **XFEL** Optics: Compound Refractive Lenses (CRLs)



Day one focusing system To be installed in tunnel to produce ~f µm/focal spot at the upstream interaction region



Delivery dates: Lenses — delivered Mechanics — Q1 2016





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Simplified subset of instrumentation for day one
Initially single photon energy, 60 bunches per train
One interaction region to start
Well suited to supporting serial crystallography experiments
Time schedule compatible with end 2016/start 2017



Both delivery and diagnostic systems are included within the sample chamber

Test chambers: now Chamber delivery date: Nov '16 Sample delivery systems: earlier

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### **XFEL Detection — AGIPD**

#### AGIPD 1Mpix

- Currently:
  - Final design for integration into the beamline (by SPB/SFX)
  - Assembly of 1Mpix (FS-DS)



- Downstream, for crystallography and 2<sup>nd</sup> detection plane for upstream experiments
- In-vacuum motion (transversal (x) and longitudinal (z)), two movable halves, area 40x40 cm<sup>2</sup>
- Mechanical design with FS-DS, SPB/SFX, and external company















# European Boring but important: XFEL Hutch and infrastructure





#### The Single Particles, Clusters and Biomolecules, and Serial Femtosecond Crystallography (SPB/SFX) Instrument Boring but important: Hutch and infrastructure





DEMAG

#### and a whole lot more...

### XFEL Day one summary

Limited, day one beam properties

- 60 bunches / train, ~ 8-9 keV E<sub>ph</sub>
- 1 µm scale focal spot from CRLs
- Sample delivery
  - Liquid jet sample delivery
  - Aerosol injection
  - Basic fixed target sample delivery
- I Mpx AGIPD for 2D detection
- Essential diagnostics (inc screens)

First "early user" experiments to exploit these parameters

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3–16 keV instrument, 100 nm scale and 1 µm scale focal spots

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

CRL refocussing for 2nd interaction region

Two 2D detectors (AGIPD 1Mpx and 4Mpx)

Additional "nice to have" diagnostics

Transition from "day one" to "full" (two interaction regions) will occur over one (1) year from "early user experiments"

Tight but feas

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) Instrument, European XFEL







conditioning (slits, etc.)

### **XFEL** Do you want to know more?

- There's much more to know:
  - See on Friday:
    - Poster #2 S. Stern, et al, SPB/SFX Instrument
- Poster #19 P. Thute, et al, SPB/SFX Sample environment



- Poster #66 V. Lyamayev, et al, Photon Beam-stop for the SPB/SFX Instrument
- Poster #78 P. Vagovic, et al, Monitoring the wave front by means of single 2D phase grating
- Poster #136 T. Sato, et al, Instrument laser hutch of SPB/SFX
- Poster #254 C. Fortmann-Grote, et al, Start-to-End Simulation of Experiment
- Or anytime this week:
  - Talk to any of the team—at the posters, dinner, lunch, etc
- Or talk to us anytime
  - For more details contact: <u>adrian.mancuso@xfel.eu</u>







### **XFEL** Even more relevant posters...

- Poster #27 A. Allahgholli, et al, AGIPD - The Adaptive Gain Integrating Pixel Detector
- Poster #122 J. Sztuk-Dambietz, et al, Laboratory Infrastructure for Detector Calibration and Characterization at <u>XFEL.EU</u>



Poster # 123 – S. Hauf, et al, Calibration Processing at the European XFEL



Poster #11 – K. Giewekemeyer, et al, Tomography of a Cryo-immobilized Yeast Cell Using Ptychographic Coherent X-Ray Diffractive Imaging



 Poster #12 – K. Giewekemeyer, et al, Towards 3D Single Particle Imaging using a model, non-crystalline system with weak 3D diffraction data



Poster #348 – R. Kurta, et al,

X-ray cross-correlation analysis of single-particle scattering with an XFEL

and much more...

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#### European XFEL SPB/SFX

### **SPB/SFX Instrument team & friends**

- Zunaira Ansari
- Richard Bean
- Gannon Borchers
- Carsten Fortmann-Grote
- Klaus Giewekemeyer
- Oliver Kelsey
- Luis Lopez Morillo
- Masoud Mehrjoo
- Marc Messerschmidt (Sci computing & controls)
- Steffen Raabe
- Nadja Reimers
- Tokushi Sato
- Andrew Stawniczy
- Stephan Stern
- Prasad Thute (Sample environment)
- Patrik Vagovic

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





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### European **XFEL** Questions?

