Workgroup 1: Instrumentation

Convener: Henry Chapman, CFEL, DESY / U.H.

Agenda

14:30 – Introduction, Henry Chapman

14:50 – Sample preparation and delivery.

Mike Bogan: Requirements for injector
Franz Pfeiffer: Requirements for fixed samples

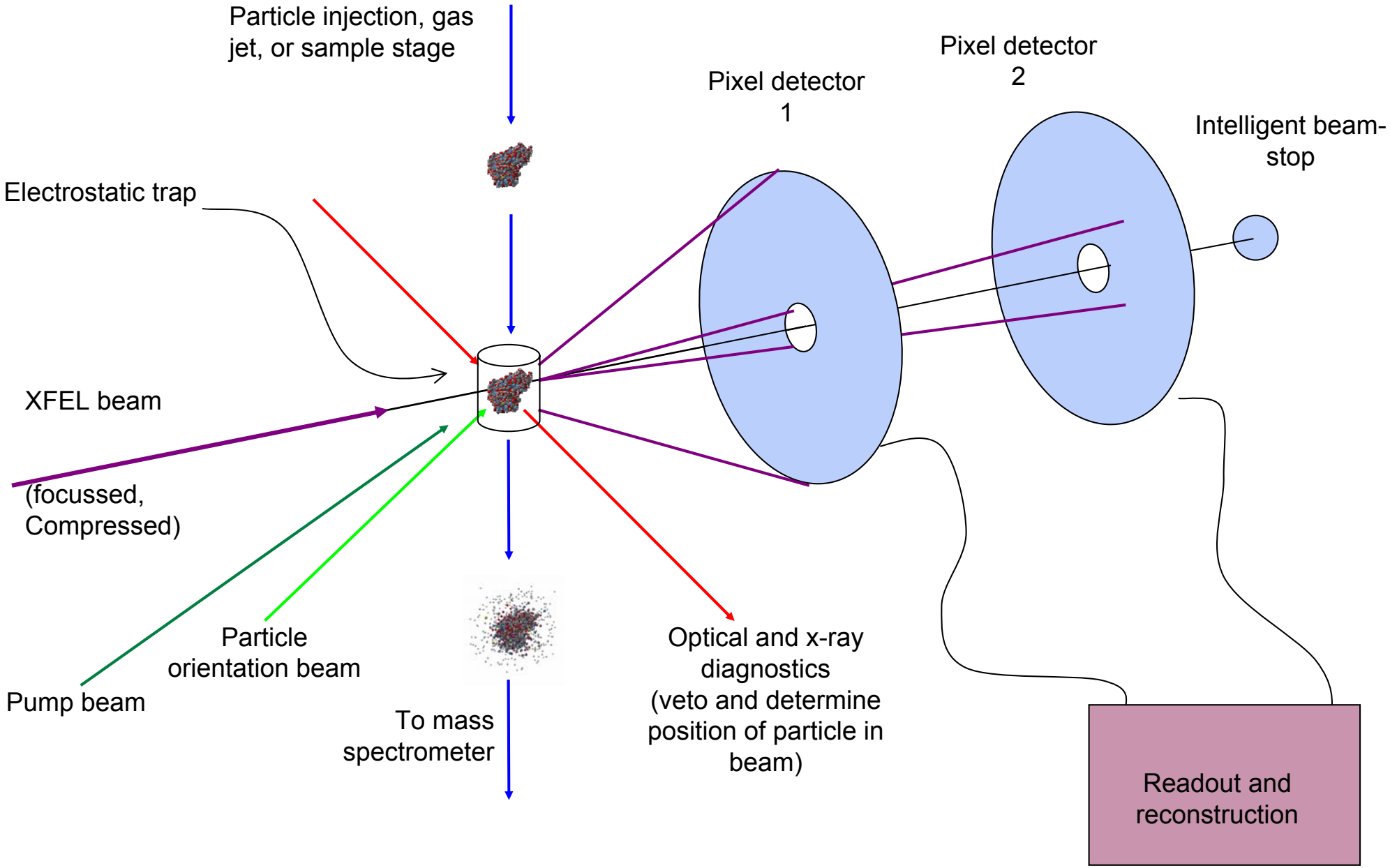
16:00 – Detectors and diagnostics, Heinz Graafsma
16:45 – X-ray focus and beamline, Sebastien Boutet
17:30 – Opportunities for Soft-x-ray imaging and other experiments

Janos Hajdu – cells;

Stefan-Hau-Riege – time-resolved imaging;

17:45 – Review points for Draft report

The diffraction imaging interaction chamber and detector arrangement



Source and Beamline

Single particle imaging is dominated by noise (counting statistics of quanta)
scattered counts per Shannon pixel is proportional to λ^2
number of incident photons per pulse fluence proportional to λ

6 keV (0.2 nm) is 8 times better than 12 keV (0.1 nm)
3 keV (0.4 nm) is 64 times better than 12 keV (0.1 nm)

We should work at the longest wavelength that supports the desired resolution
This requires highest angles possible on detector

e.g. 2 theta = 60º: d = λ

$$d = \frac{\lambda}{2 \sin \theta}$$

Problem: SASE 1 is fixed at 12 keV

Source and Beamline

Longer mirrors required for longer wavelength

State of art mirrors are 75 nm focus at 15 keV (Rev. Sci. Instrum. **79** 083104 (2008))

Assume largest reproducible objects are about 0.2 micron

Require 5, 2 micron focus (f = 20 m) and 0.1 micron focus (f = 1 m)

don't work too far out of focus

There could be a desire to use unfocused beam (aligned molecules)

There will be a need for perfect optics (zone plates) even if inefficient

- need an estimation of the effect of variable wavefront error on reconstruction

Need a longer, wider, and taller hutch

For nanocrystals (with conventional analysis) need spectrum every shot

Need a dedicated laser

Sample delivery and manipulation

Many potential particle injection methods

- aerodynamics lensing of aerosols (e.g. with cell sorter)
- electrospray ionization and trapping
- synchronized droplets
- pulsed molecular beams, quantum-state selected

Common chamber with CF250 flange

Test setup nearby

Isolate beamline mirrors and CCD from sample

Some injectors could replenish sample at MHz

Require tunable laser / laser ports
Require hit diagnostics, such as TOFS / VMI

Fixed bio samples (on TEM grids or larger arrays) require cryogenic stage
Sample chamber could be an SEM (allows larger grids of samples)

- Xradia is developing a large-travel cryo stage
- BESSY XRM has guts of an FEI

Detectors

AGIPD detector is designed for SASE1 (12 keV)

- 200 micron pixels
- 200 stored frames
- linearity can be calibrated

There may be a use for photon counting detectors operating at pulse frequency (e.g. for aligned molecules)

Number of pixels required: limited by the bandwidth $N = \frac{2s\lambda}{\Delta\lambda}$ $\frac{w}{d} = \frac{N}{2s}$

N < 2000 for unmonochromatised

N > 2000 for monochromatised

500 x 500 for 0.3 nm resolution of (75 nm)^2 object s=1 (not safe)

2k x 2k for 0.2 nm resolution of 0.2 micron object s=1

2k x 2k for 0.4 nm resolution of 0.2 micron object s=2 (safer)

2k x 2k for 0.1 nm resolution of 0.05 micron object s=2 (safer)