

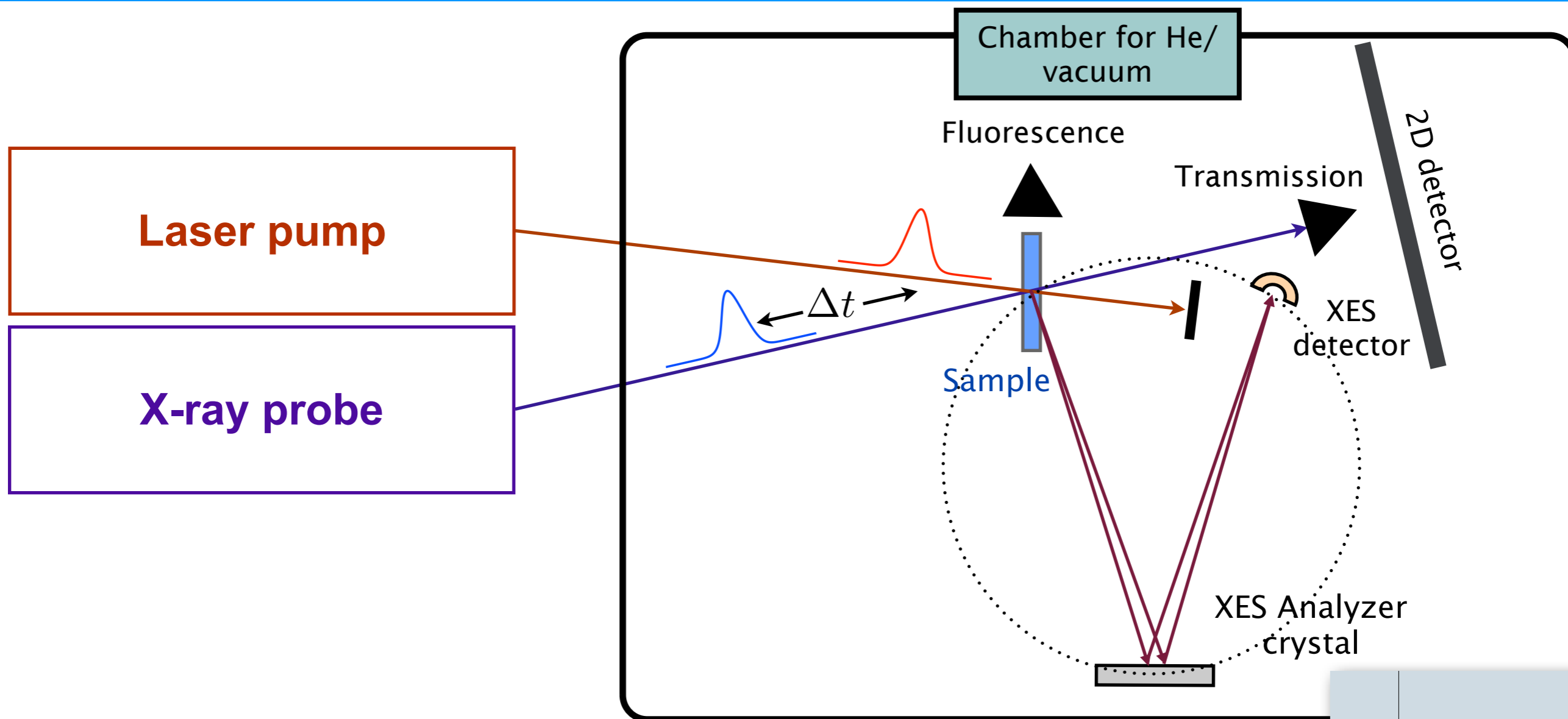


Wir schaffen Wissen – heute für morgen

Paul Scherrer Institut

Chris Milne

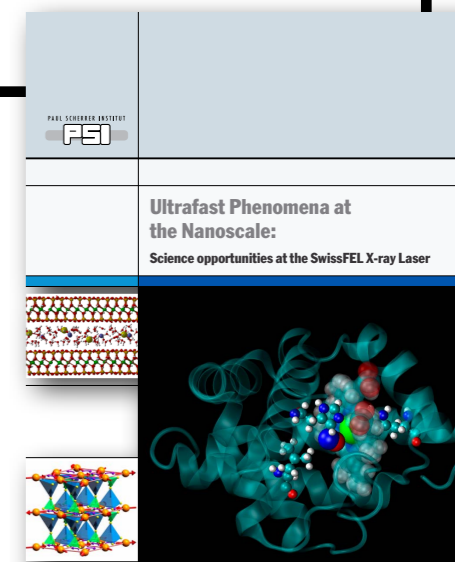
**Ultrafast pump-probe X-ray scattering and spectroscopy at SwissFEL's
Experimental Station A**



It's a multi-purpose pump-probe station which will specialize in systems in solution

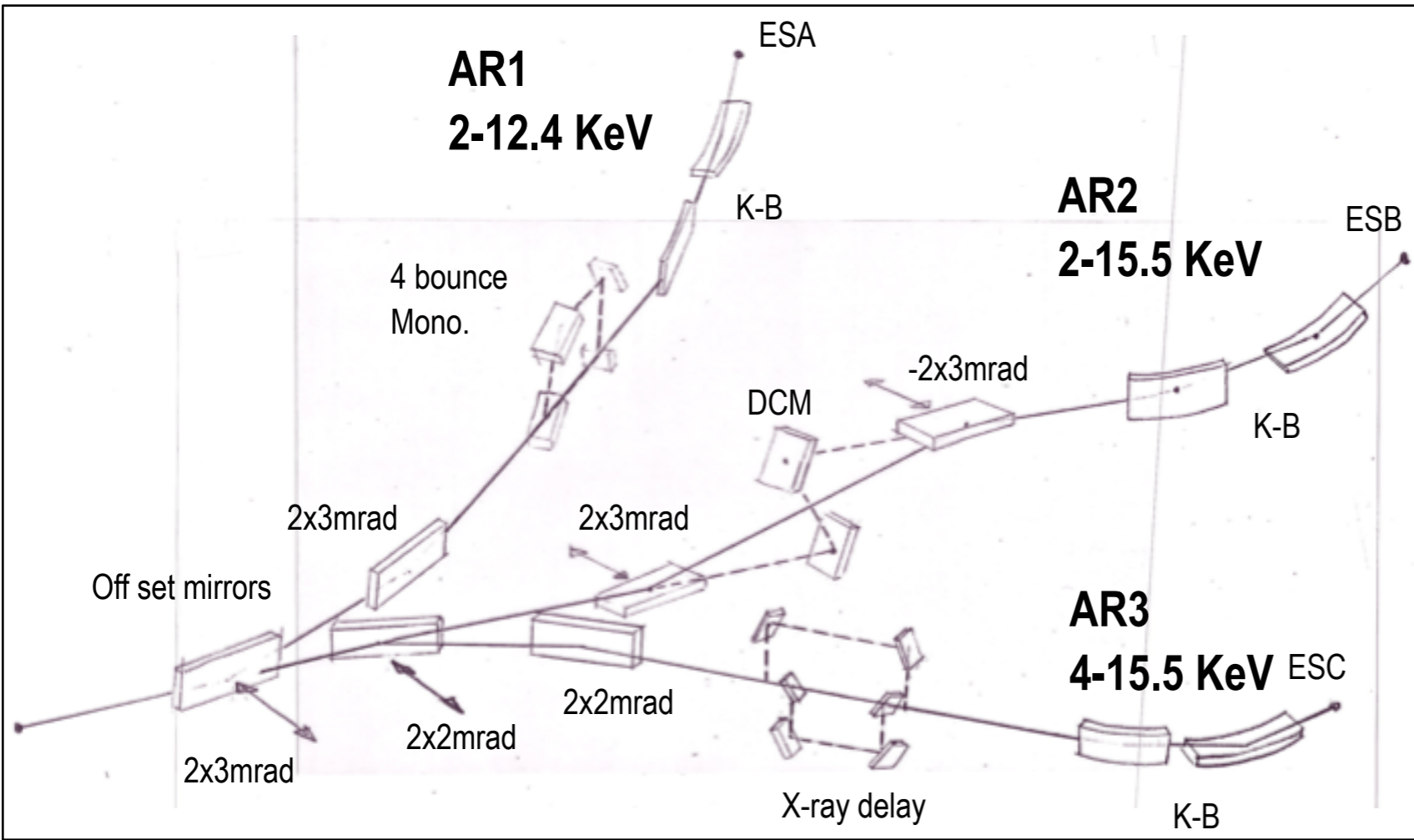
The envisioned techniques available will be:

- X-ray absorption (XANES, perhaps EXAFS)
- X-ray emission (XES, RIXS)
- Diffuse scattering (SAXS, WAXS)
- Nanocrystal diffraction using a liquid jet delivery system



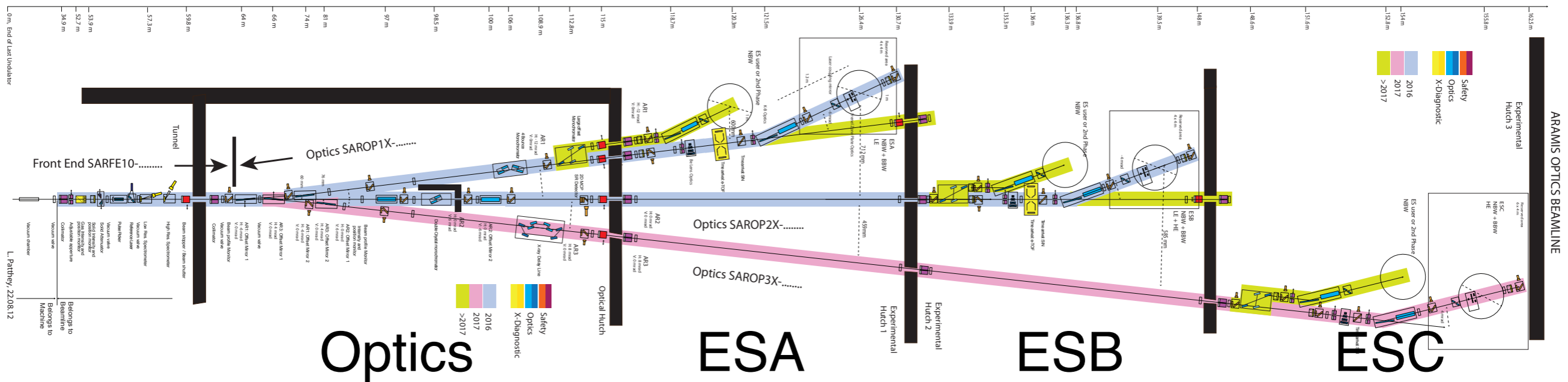
<http://www.psi.ch/swissfel/>

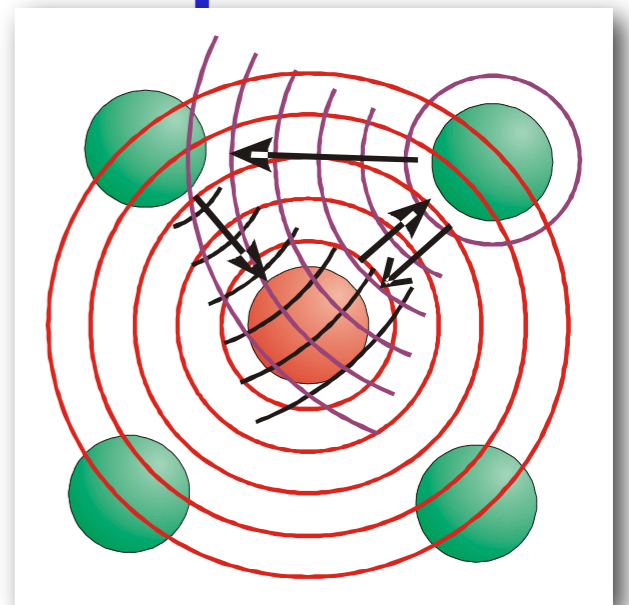
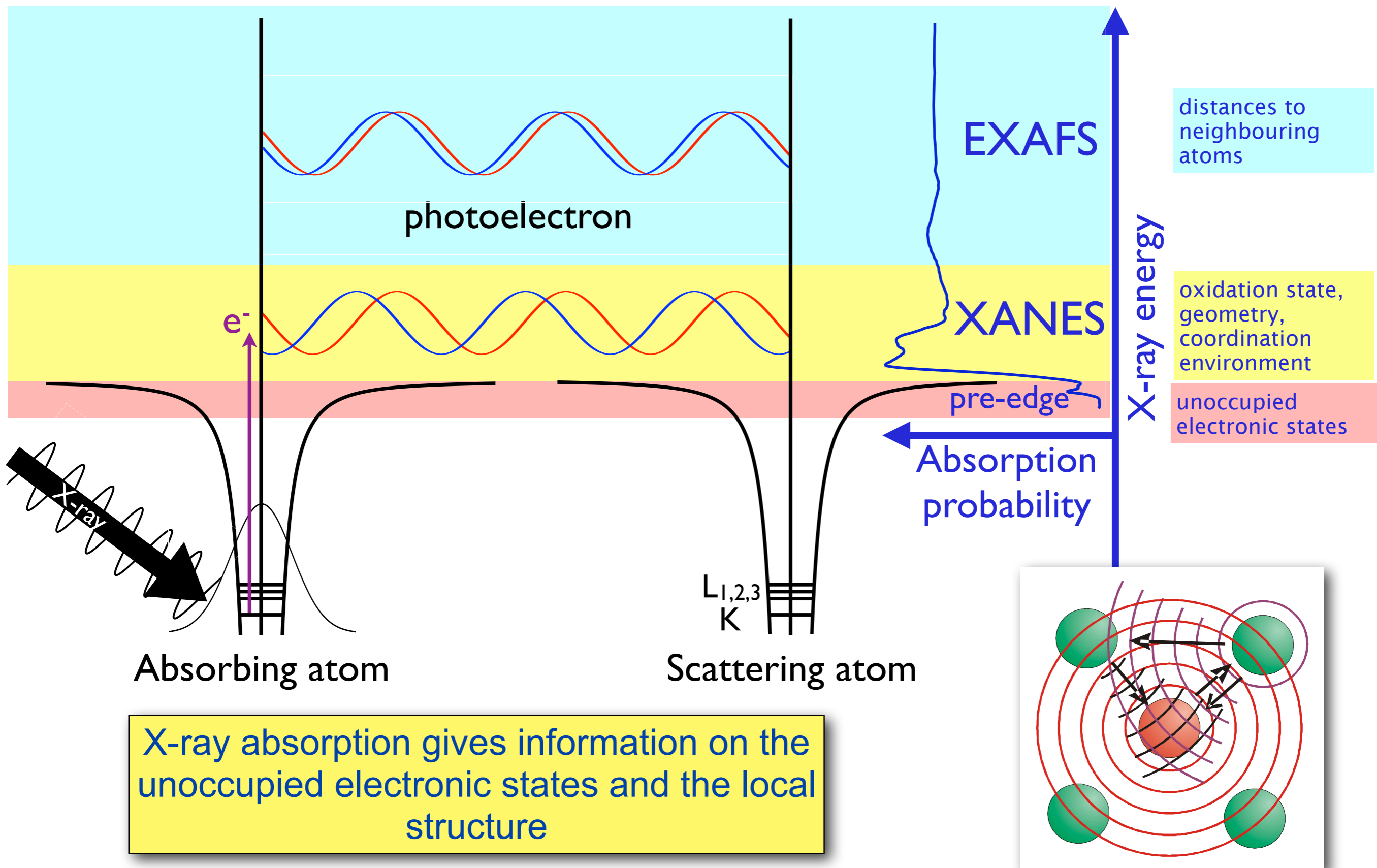
Photonics Beamlines
 Luc Patthey
 Uwe Flechsig
 Rolf Follath
 Peter Wiegand
 Pavle Juranic
 and co-workers

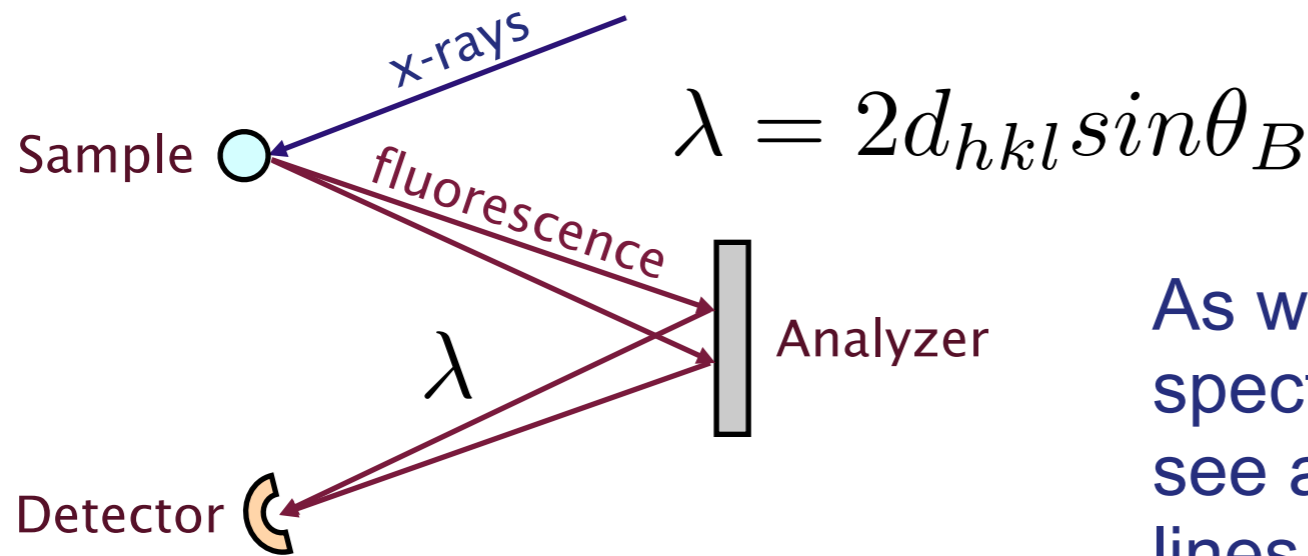


Timeline

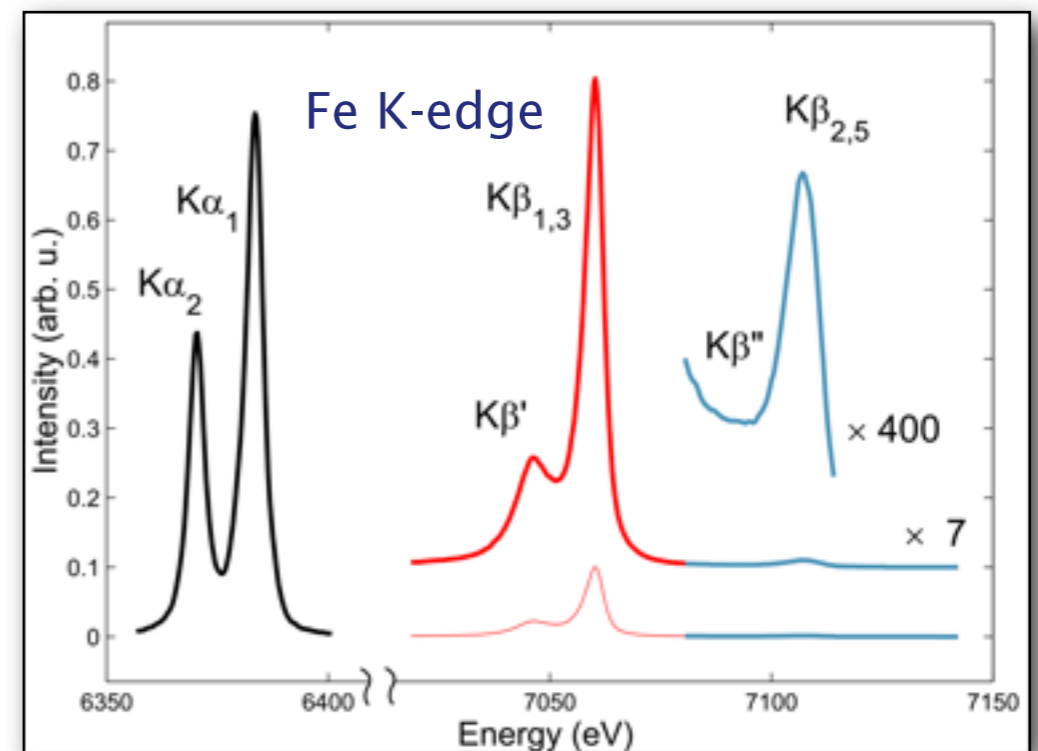
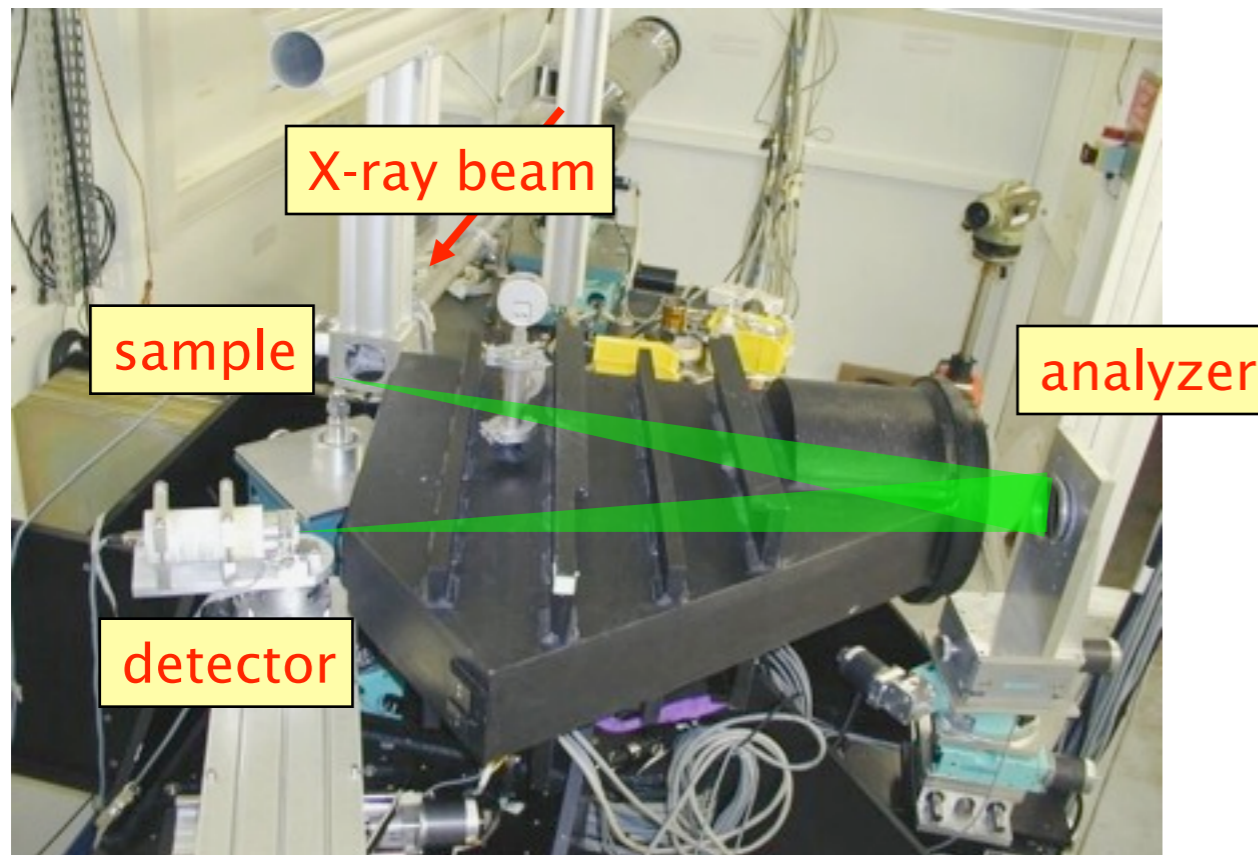
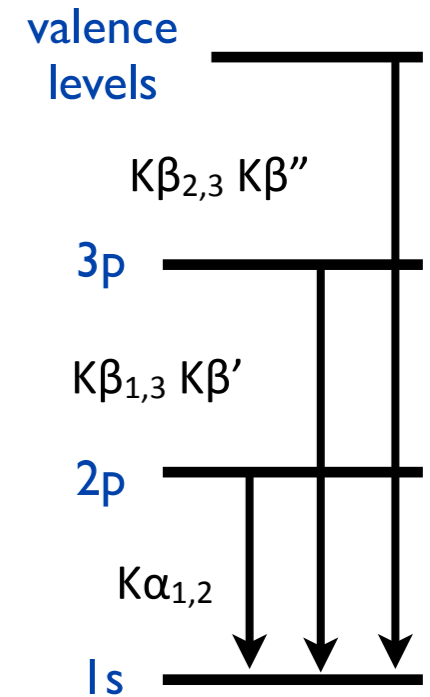
- 2012 initial parameters
- 2013 definition and design
- 2014 design and production
- 2015 production and installation
- 2016 installation and commissioning







As with optical spectroscopy you will see all the emission lines if you're above the absorption edge

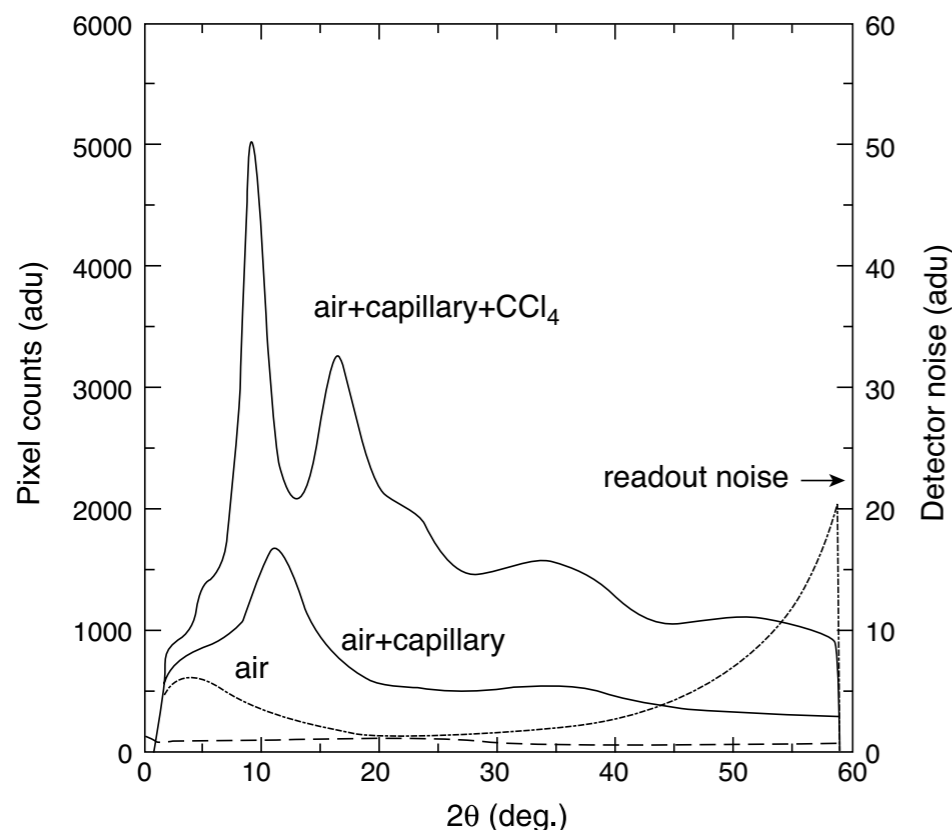


P. Glatzel et al. *Coord. Chem. Rev.* **249**, 65 (2005)
G. Vankó et al. *JPCB* **110**, 11647 (2006)

X-ray emission gives information on the occupied electronic states

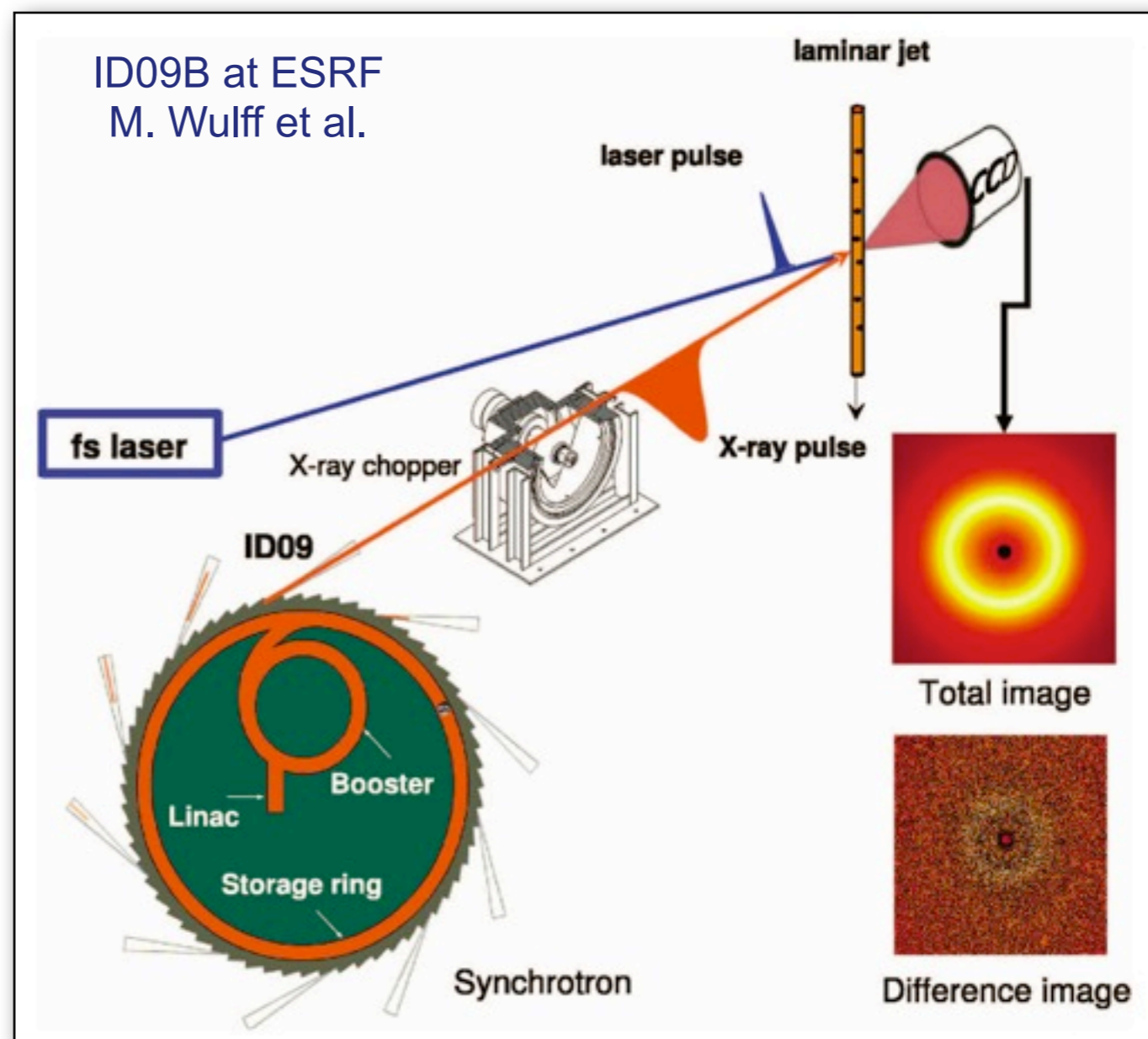
X-ray scattering is sensitive to all the atoms in the sample

$$q = 4\pi \sin \theta / \lambda$$



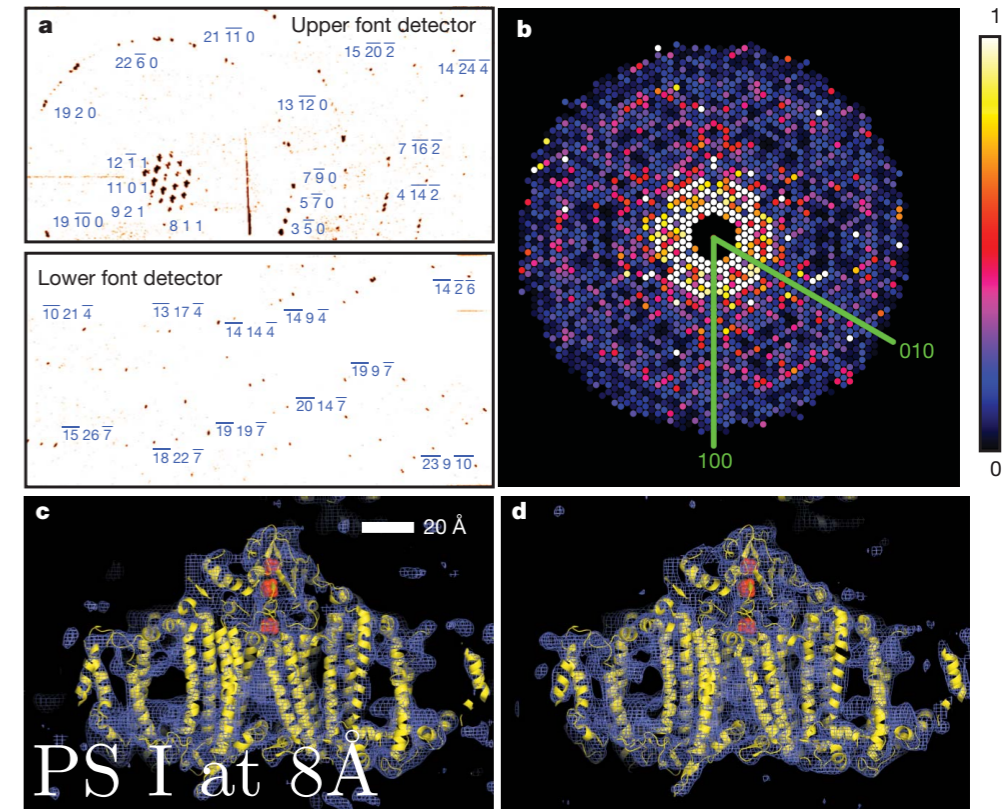
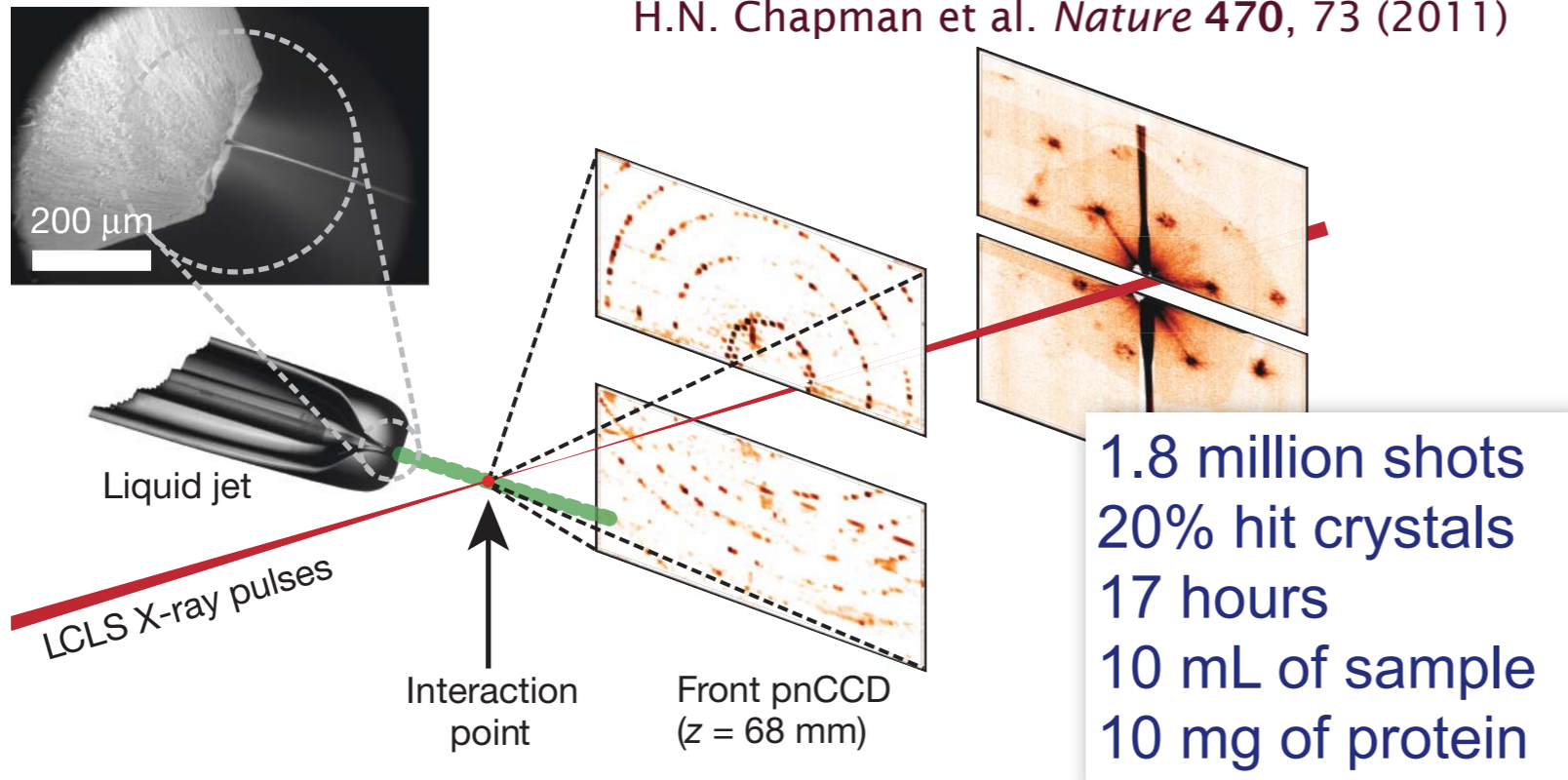
S. Bratos and M. Wulff *Adv. Chem. Phys.* **131**, 1 (2008)
J. Kim et al. *Acta. Cryst. A* **66**, 270 (2010)

X-ray scattering gives information on relative atomic positions of all atoms in the sample

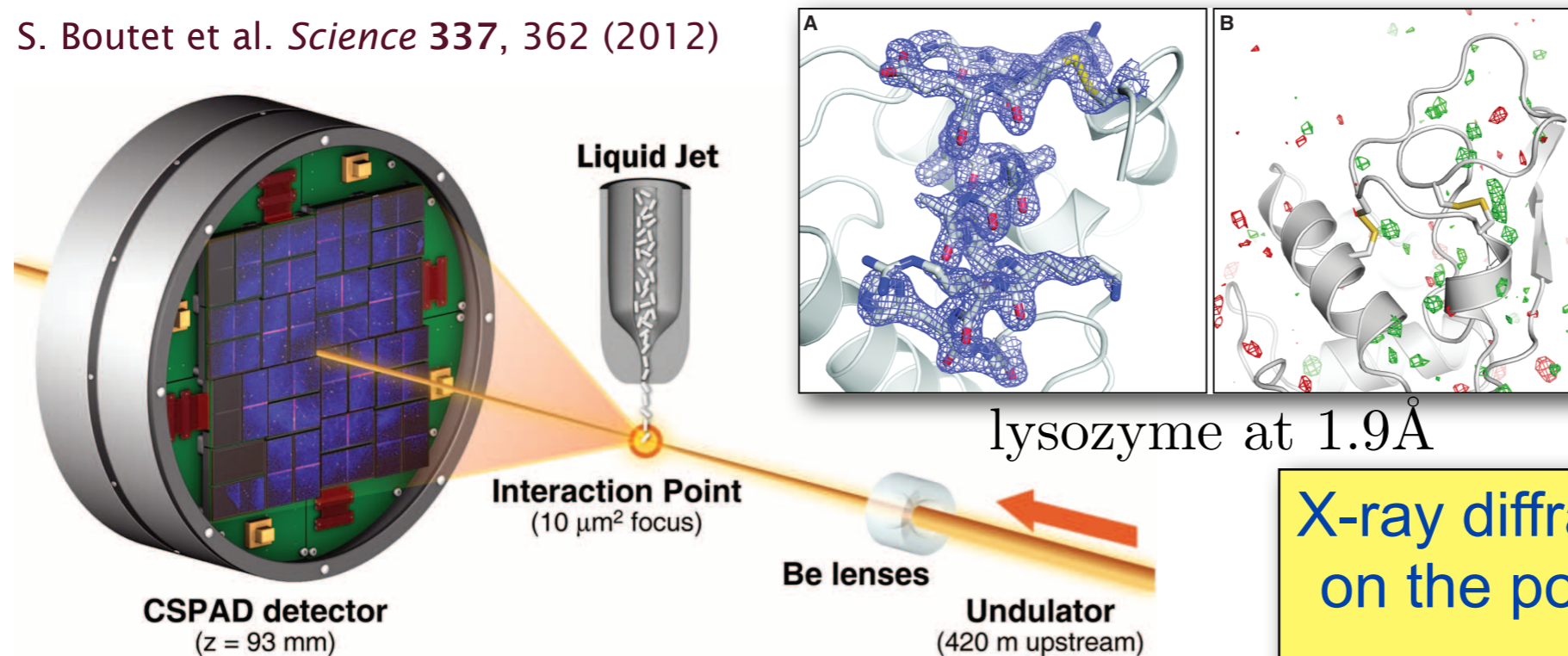


You can retrieve the pair distribution function, giving the distances between two atoms in the sample

H.N. Chapman et al. *Nature* 470, 73 (2011)

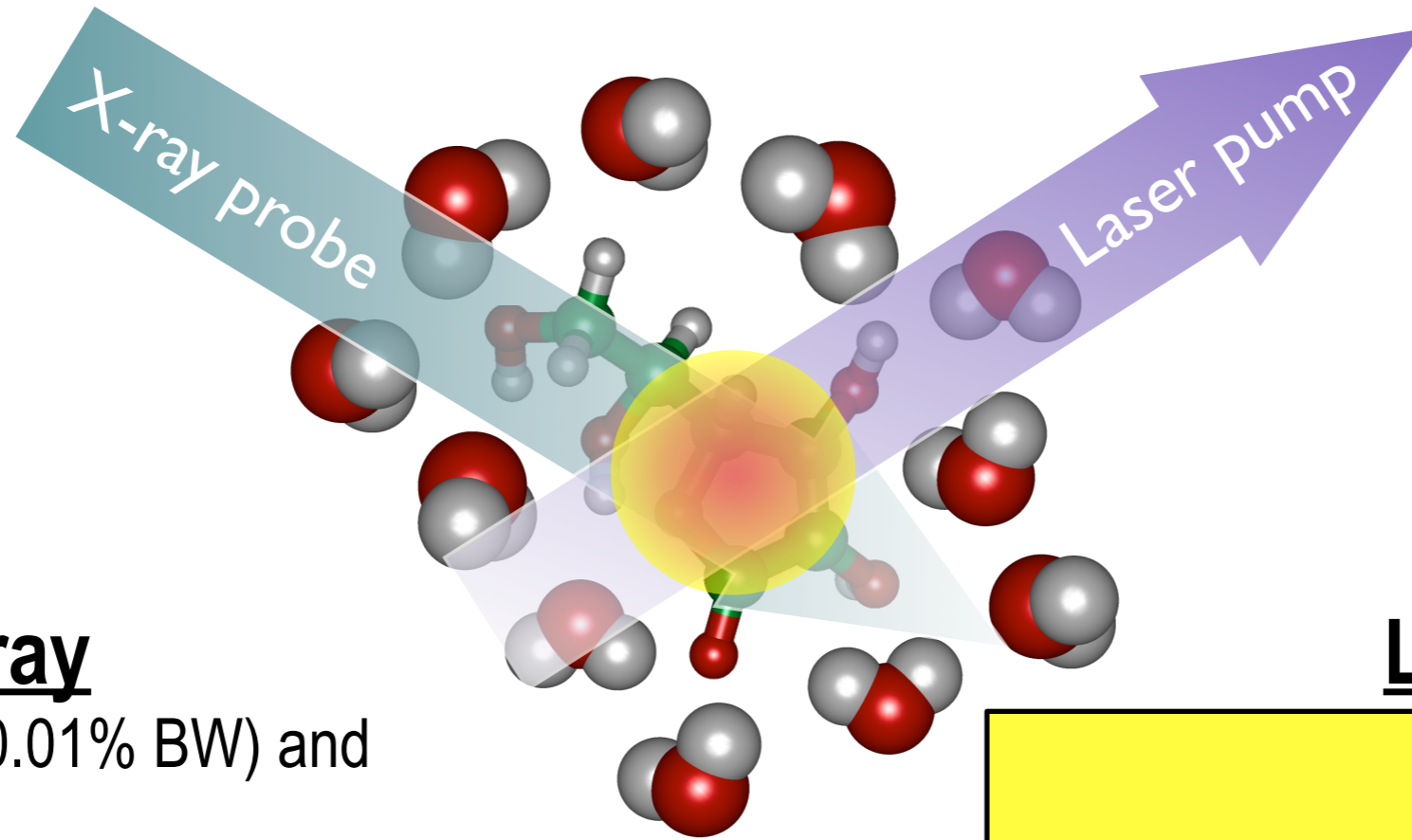


S. Boutet et al. *Science* 337, 362 (2012)



1.5 million shots
4% hit crystals
0.007% were useable
3-4 hours

X-ray diffraction gives information on the positions of all the atoms in the crystal



X-ray

- monochromatic (0.01% BW) and broadband (1-3%)
- variable focus (500 nm -100 μm)
- tuneable energy (2-14 keV)
- ultrashort pulse durations (1-100 fs)
- photons, photons and more photons

Laser

Available equipment

- sample chamber for use at low pressure and He environments
- 2D scattering detector (e.g. Jungfrau, 75 μm pixels, dynamic gain switching)
- Von Hamos x-ray emission spectrometer
- liquid jet for solution samples (100 μm) and nanocrystals (4 μm)

March 1st 2013 **Conceptual design report deadline:** figure out what experiments will be immediately feasible at SwissFEL, and what experiments will be implemented in subsequent stages

Dec. 23rd 2013 **Technical design report deadline:** technical drawings completed, ready for purchase orders/call for tender

2014

Purchasing and component production

2015

Component assembly and commissioning at the SLS

2016

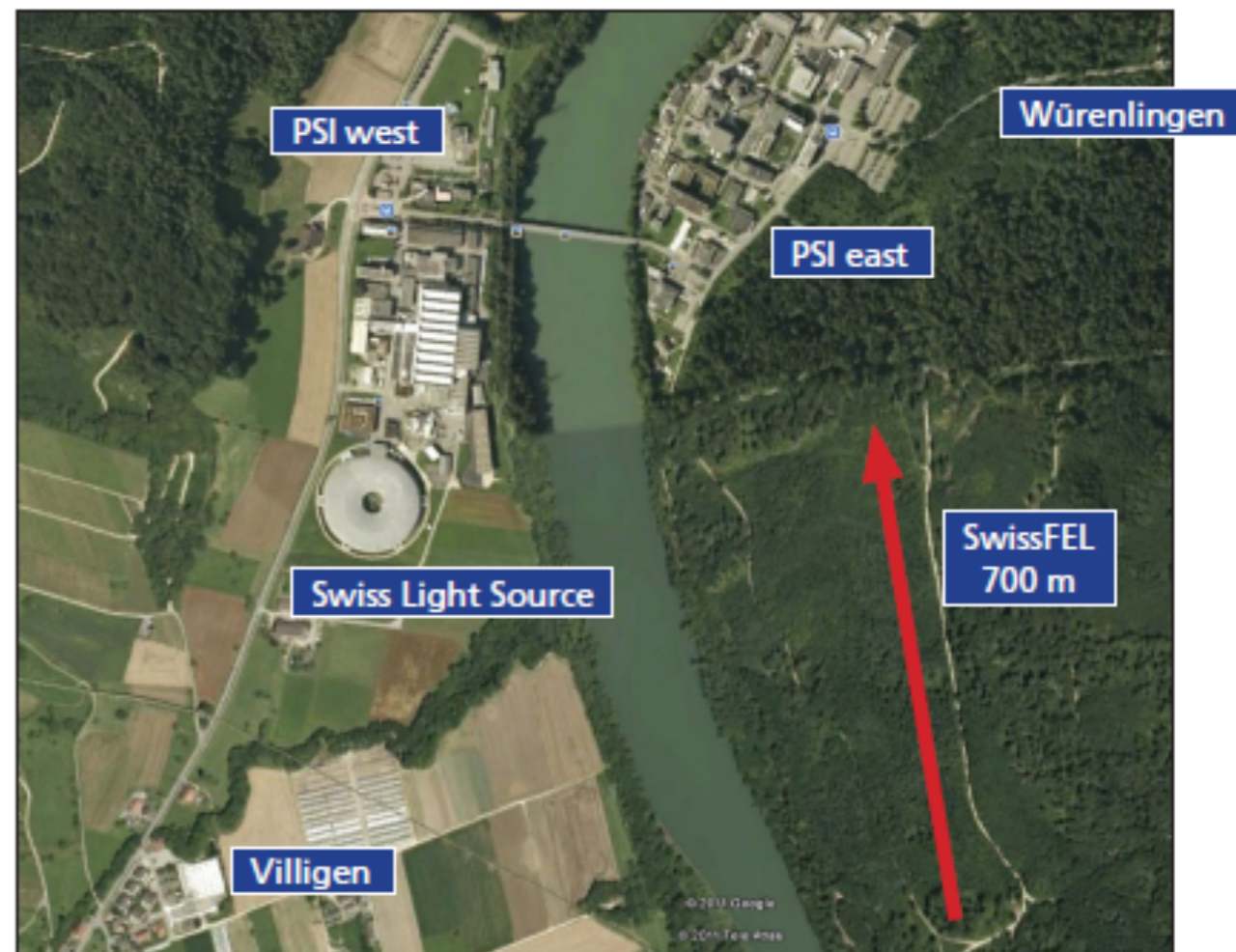
Move into SwissFEL building

2017

First beam and first friendly users

2018

Normal user operation and begin implementation of second stage experimental techniques at ESA



<http://www.psi.ch/swissfel/time-schedule>