SCIENCE AT SYNCHROTRON RADIATION FACILITIES

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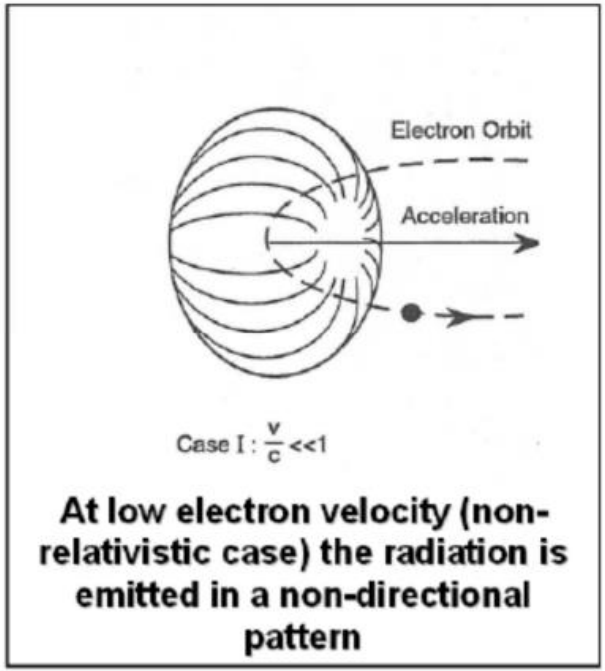
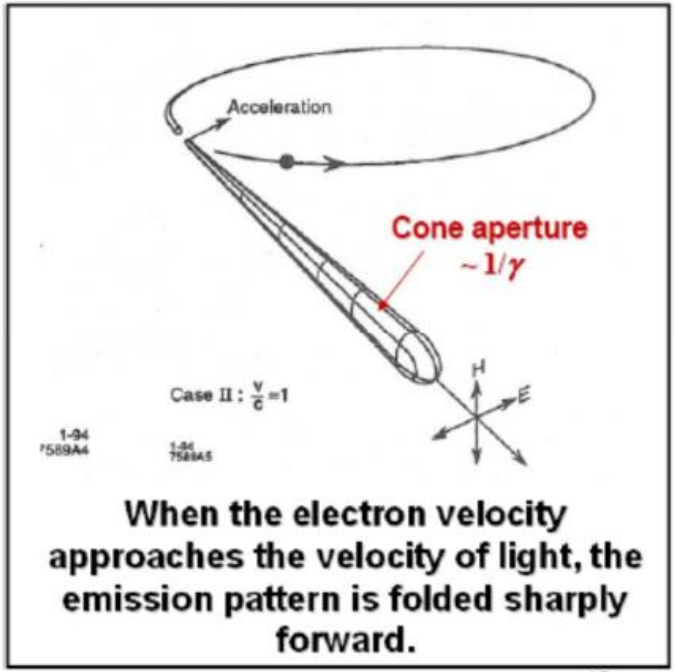
What is Synchrotron Radiation

relativistic effect on accelerated charged particles



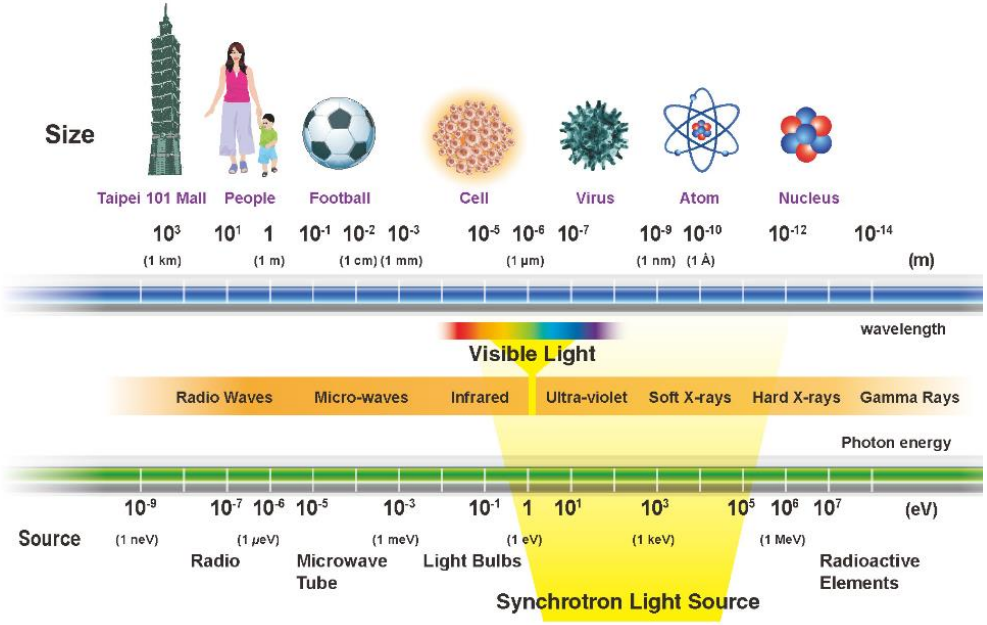
At low electron velocity (non-relativistic case) the radiation is emitted in a non-directional pattern

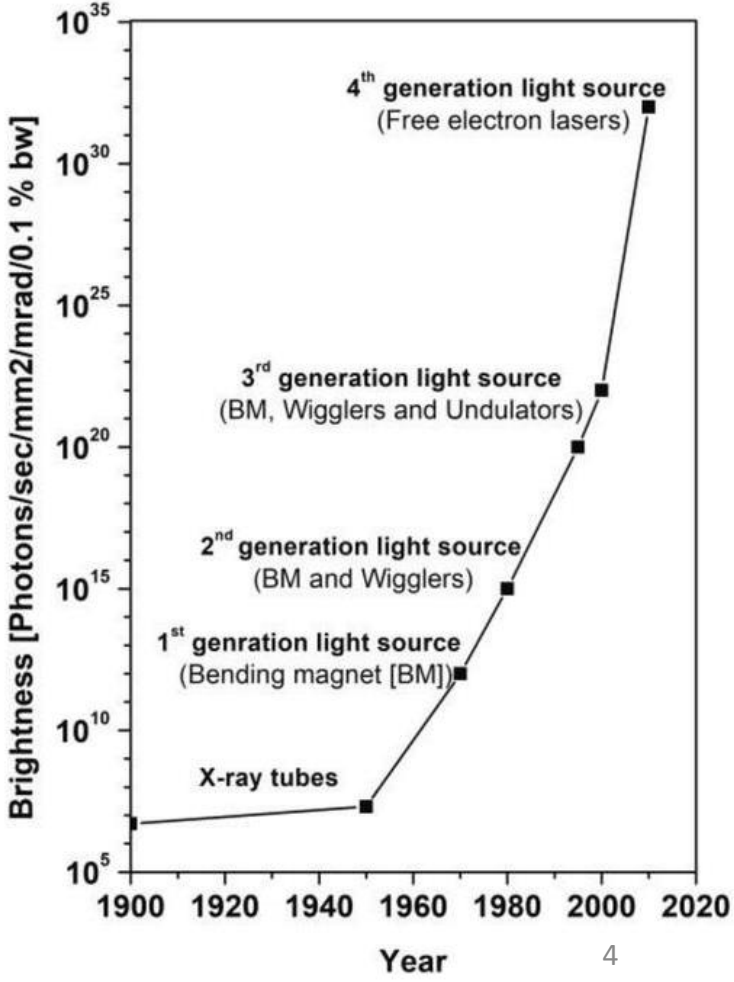


When the electron velocity approaches the velocity of light, the emission pattern is folded sharply forward.

Characteristics of Synchrotron Radiation

- Intense
- Highly collimated
- Continuous

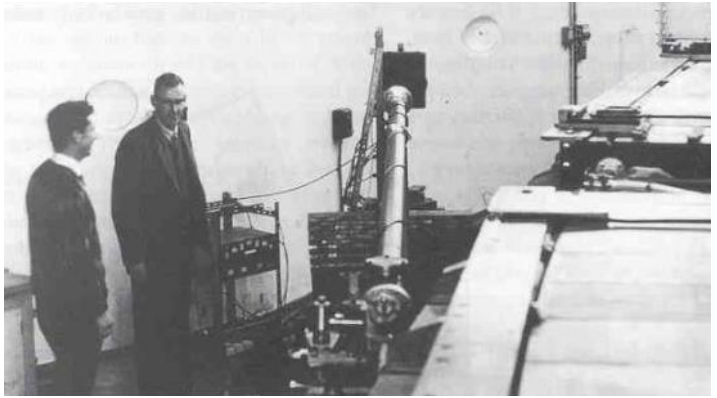




History of Synchrotron Radiation Facilities

Ciclotrons: built for high energy Physics experiments→ As particle accelerators!!!

<u>Interest in using the "Wasted" emitted radiation</u>



The first users are parasitic

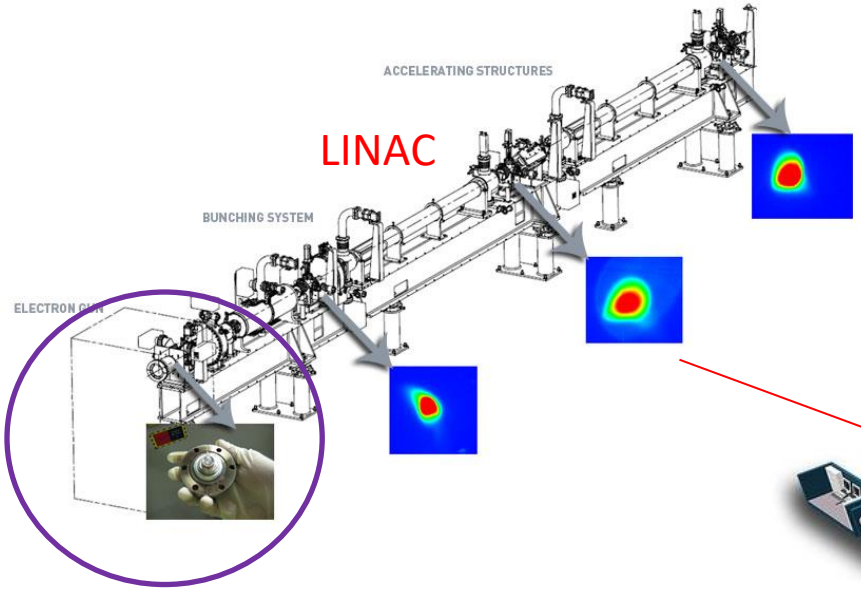
Synchrotron Radiation Facilities (SRF)


ALBA-Barcelona (ES)


ESRF-Grenoble (FR)

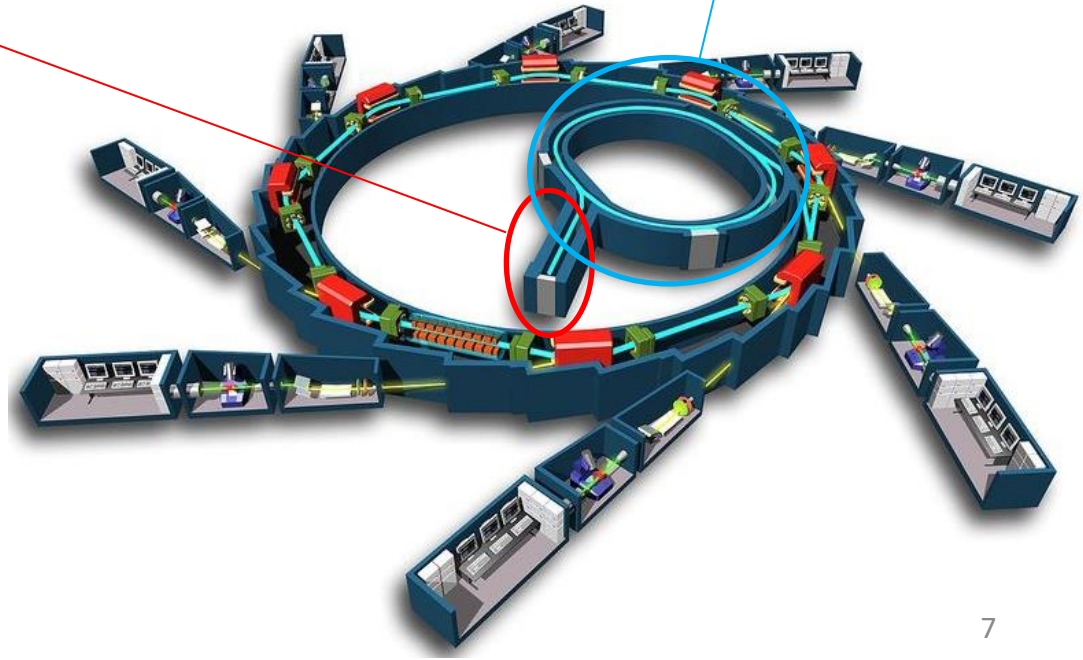

Diamond Light Source Didcot (UK)

SRF (1): LINAC & booster



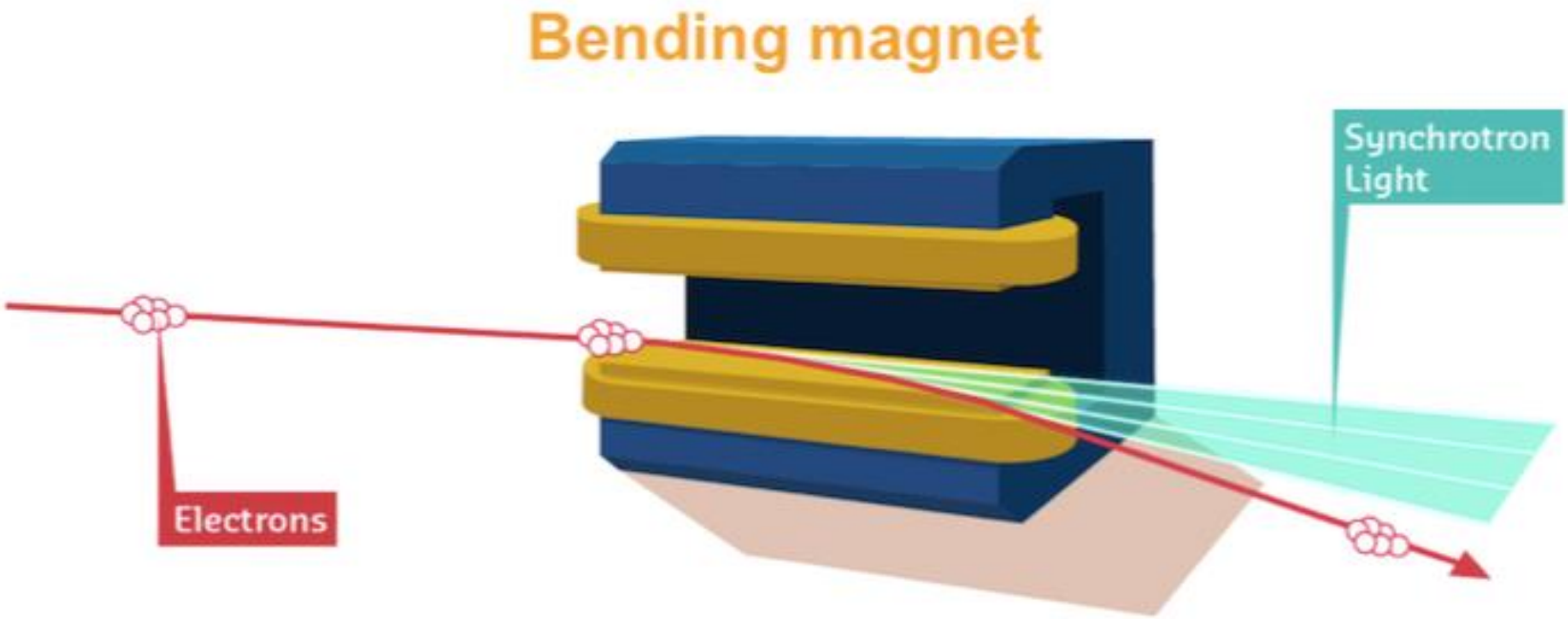
Electron gun

booster

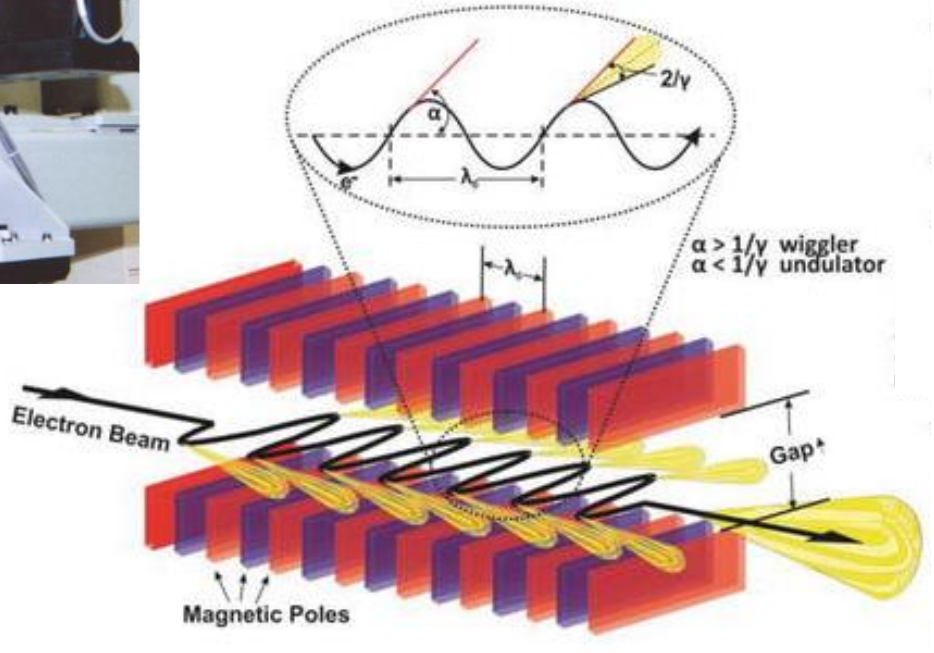


SRF (2): The ring

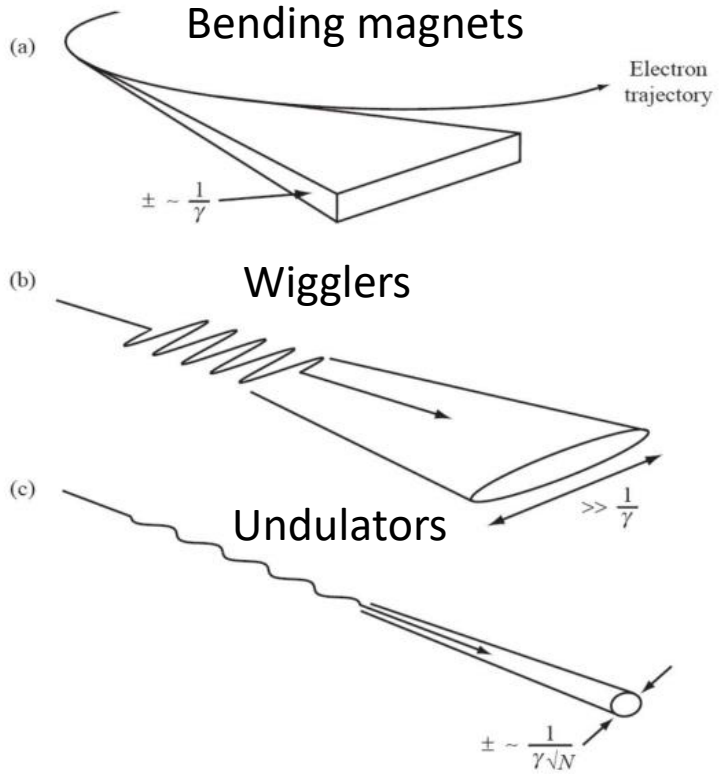
SRF (3): Bending Magnets

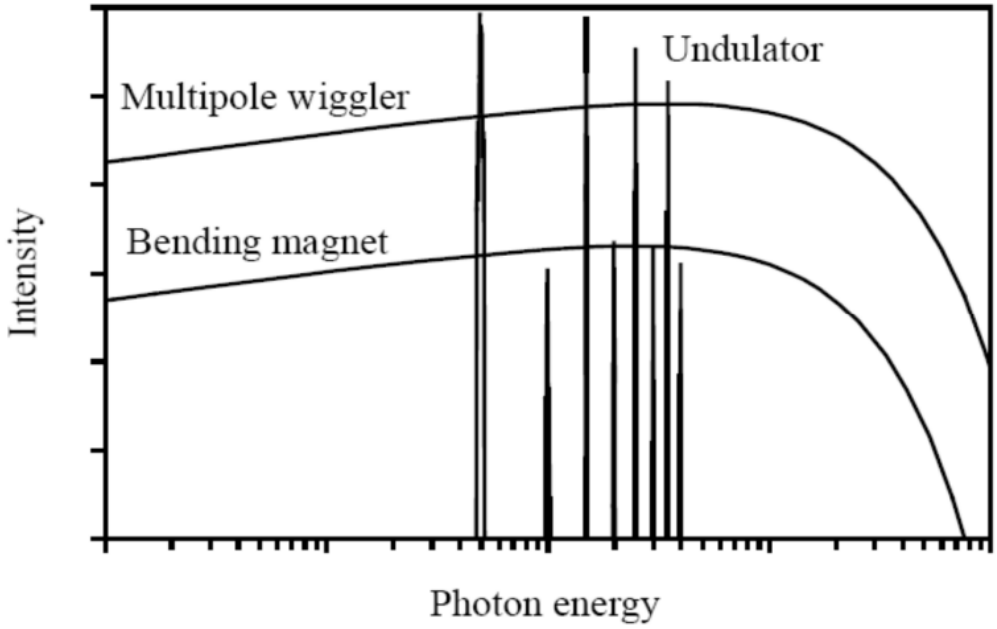


SRF (4): Insertion Devices

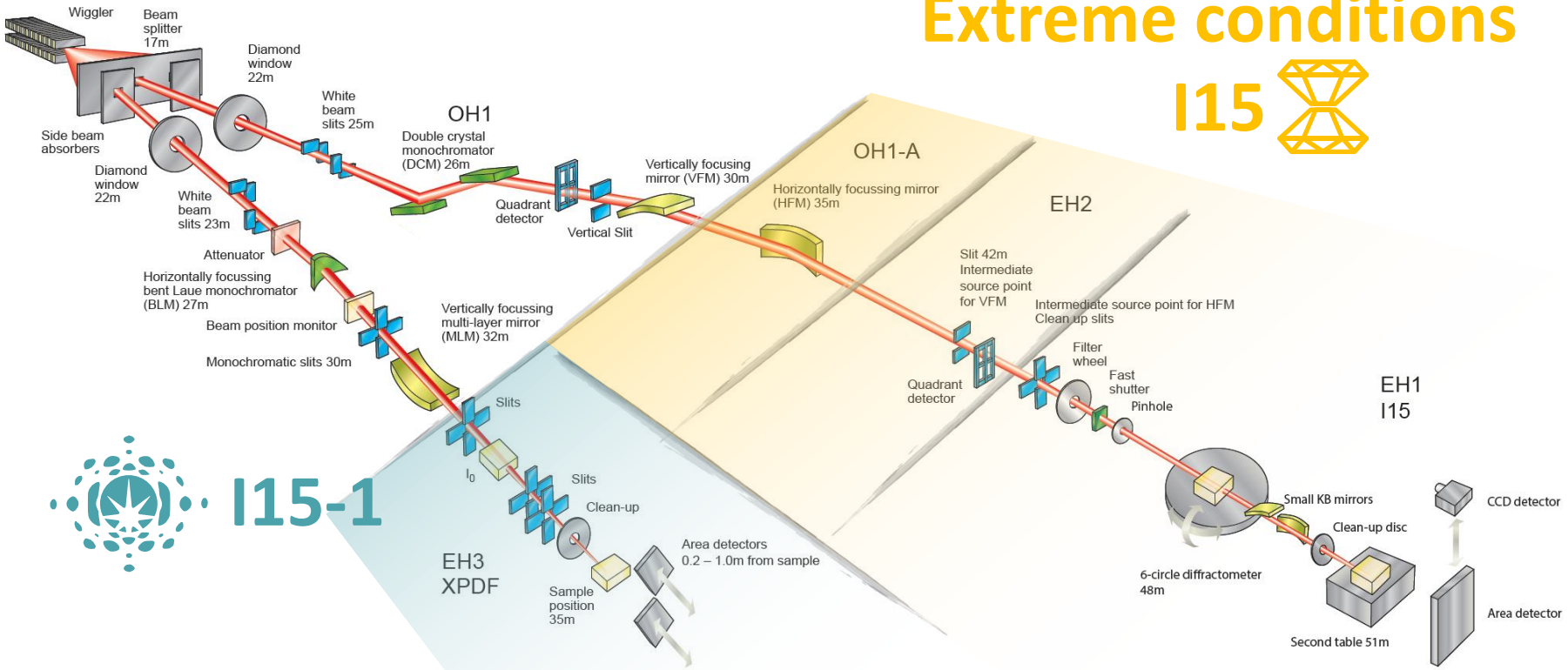


SRF (5): Sources comparison

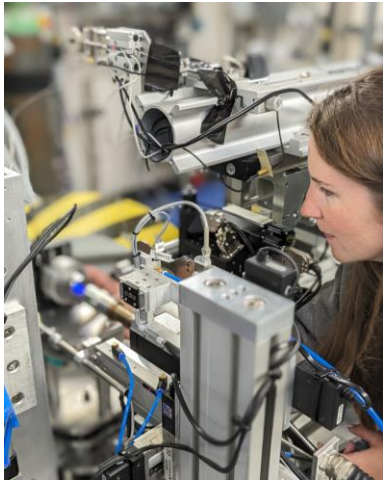


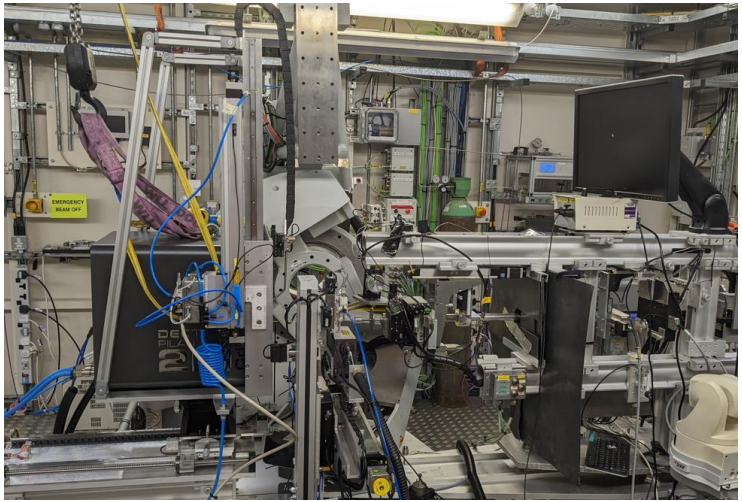


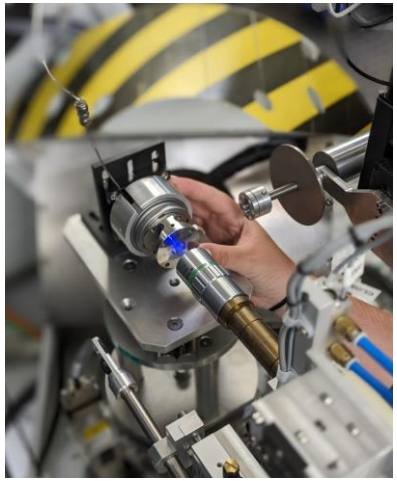
SRF (6): Optical Hutch

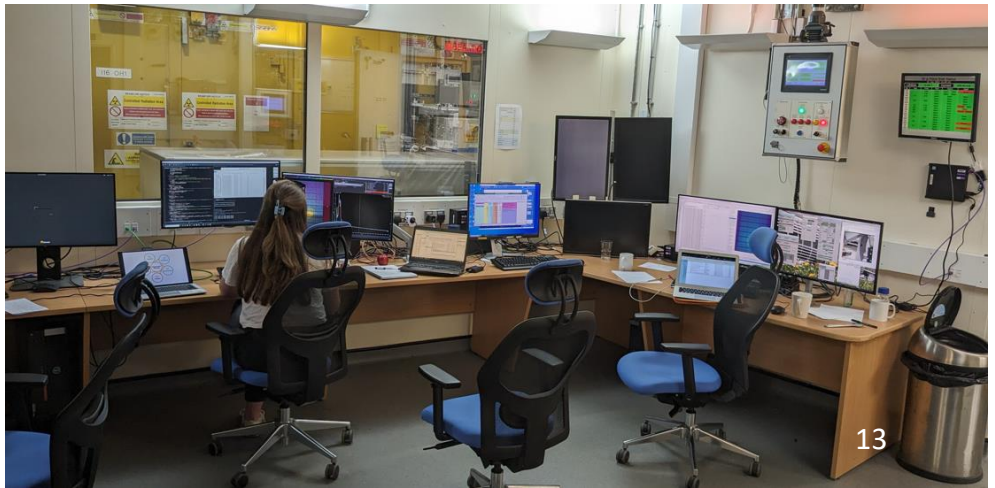


SRF (7): Experimental Hutch & Control Room

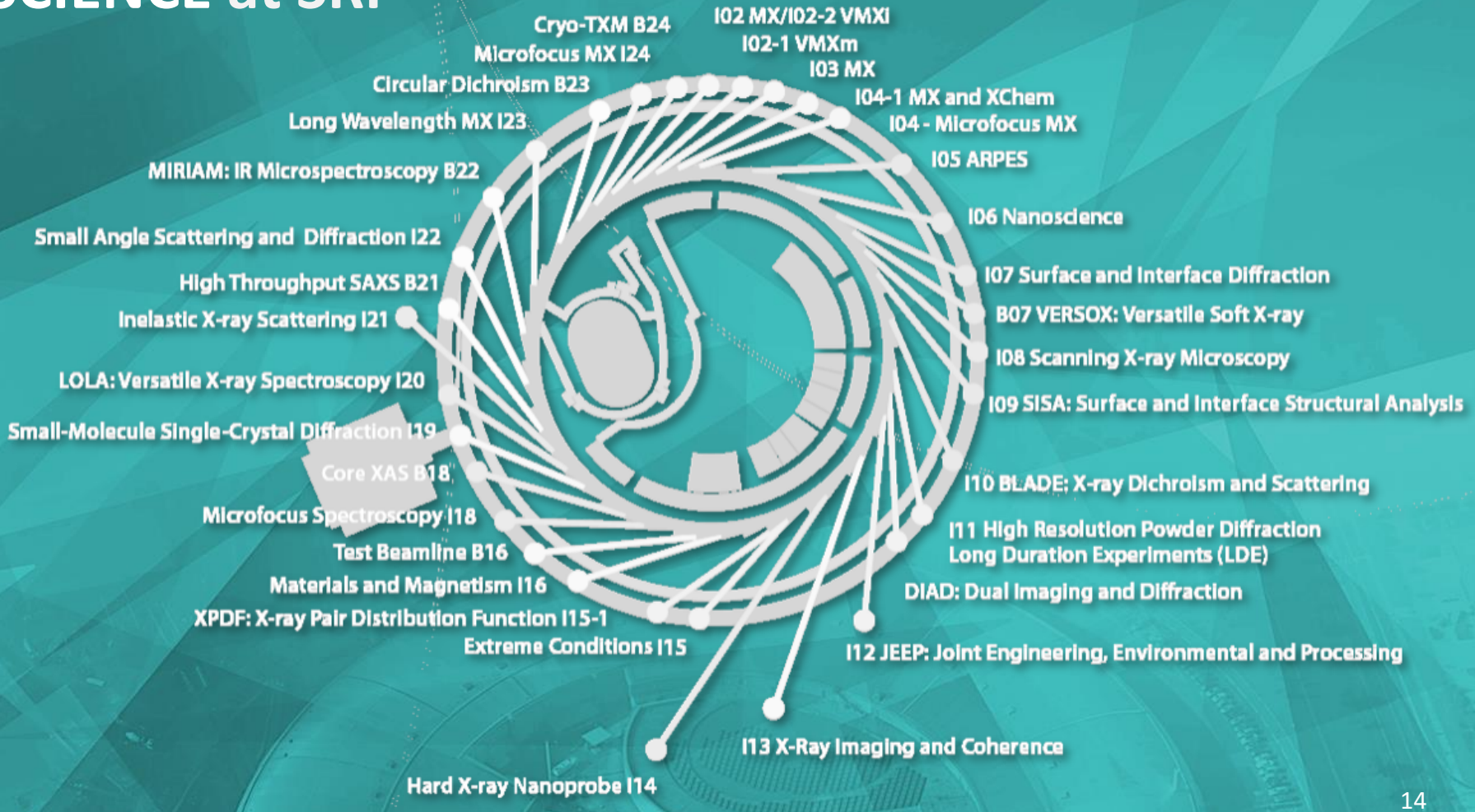








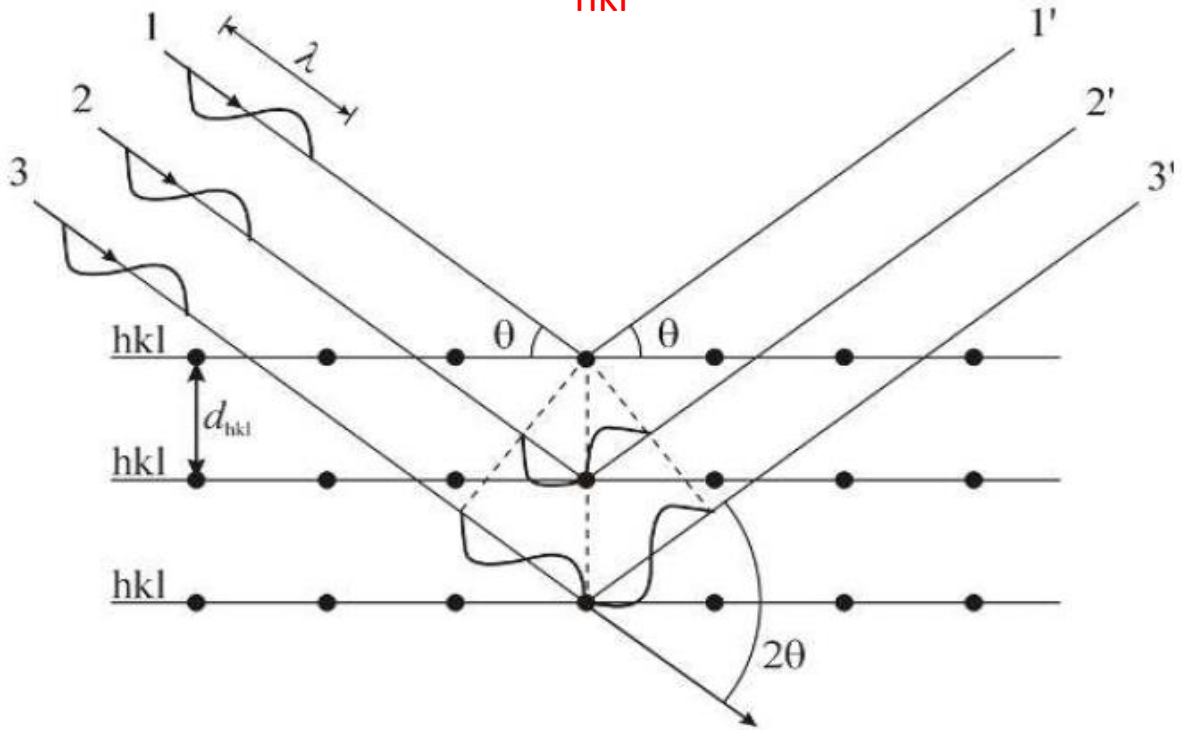
SCIENCE at SRF



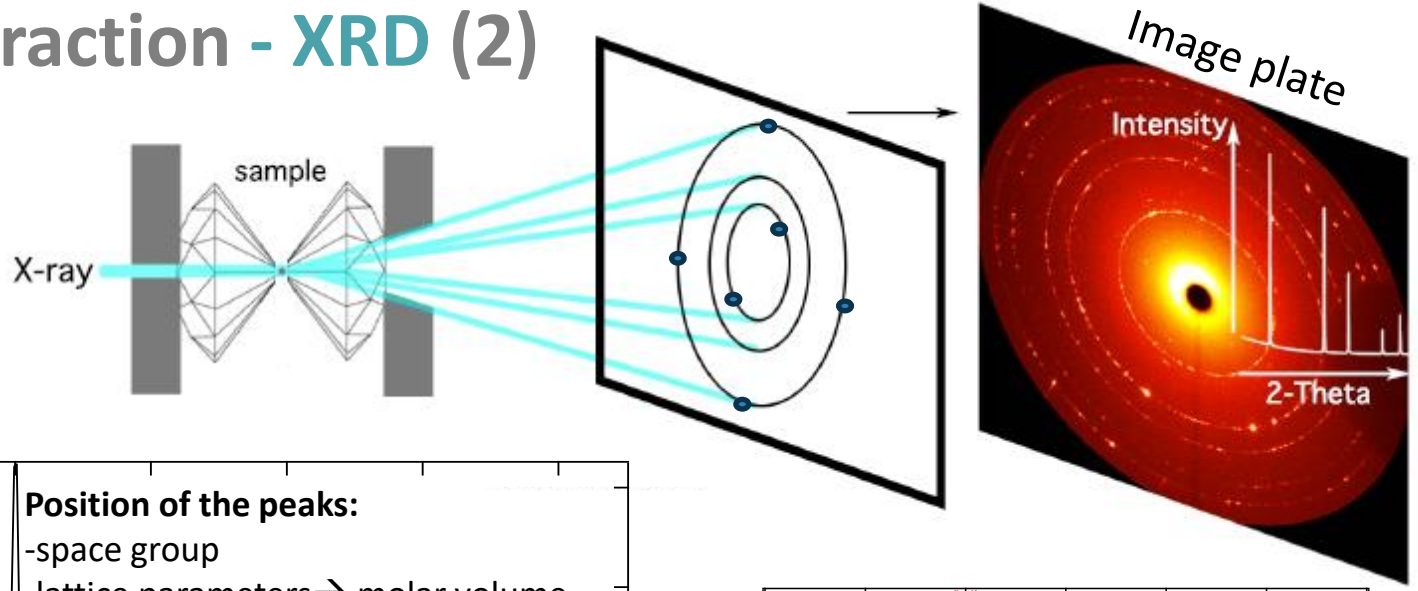
X-ray Diffraction - XRD (1)

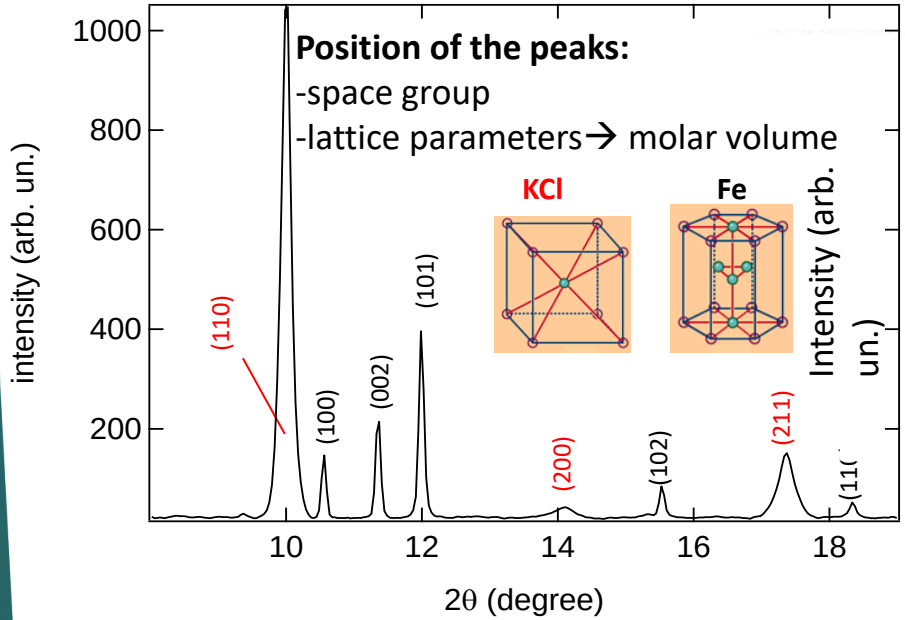
X-ray beam diffracted by a crystalline solid according to the Bragg law

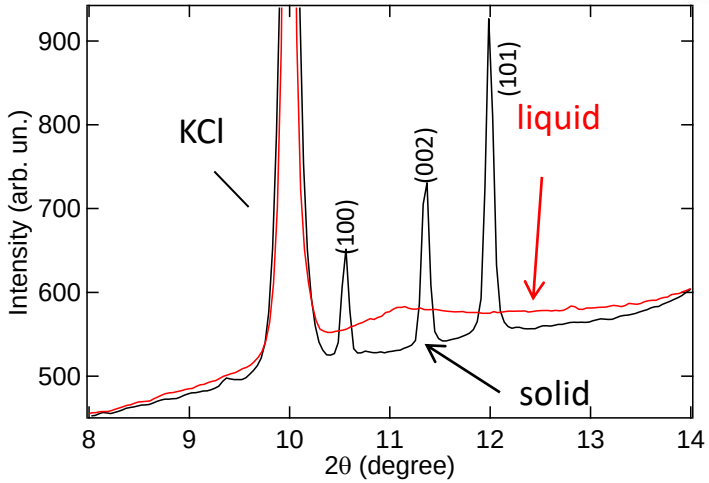
$$l = 2d_{hkl}\sin\theta$$



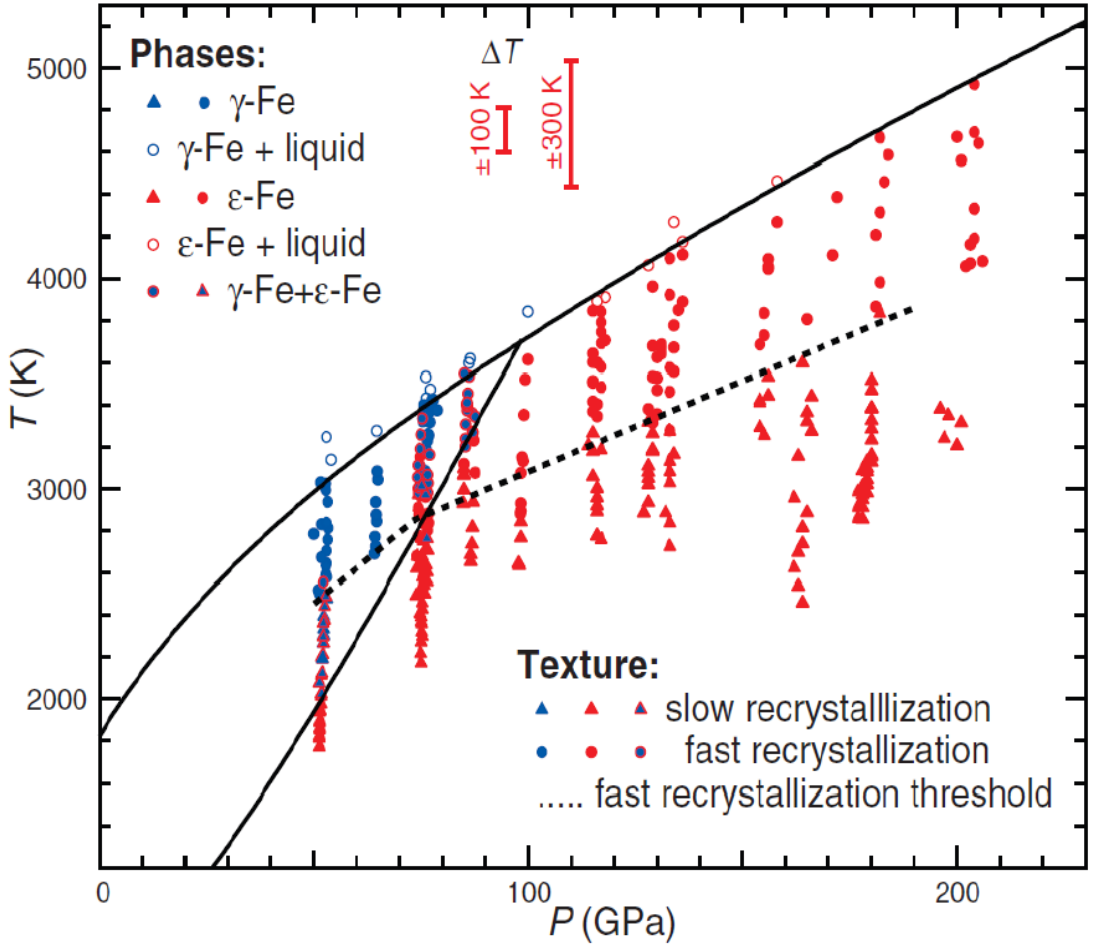
X-ray Diffraction - XRD (2)



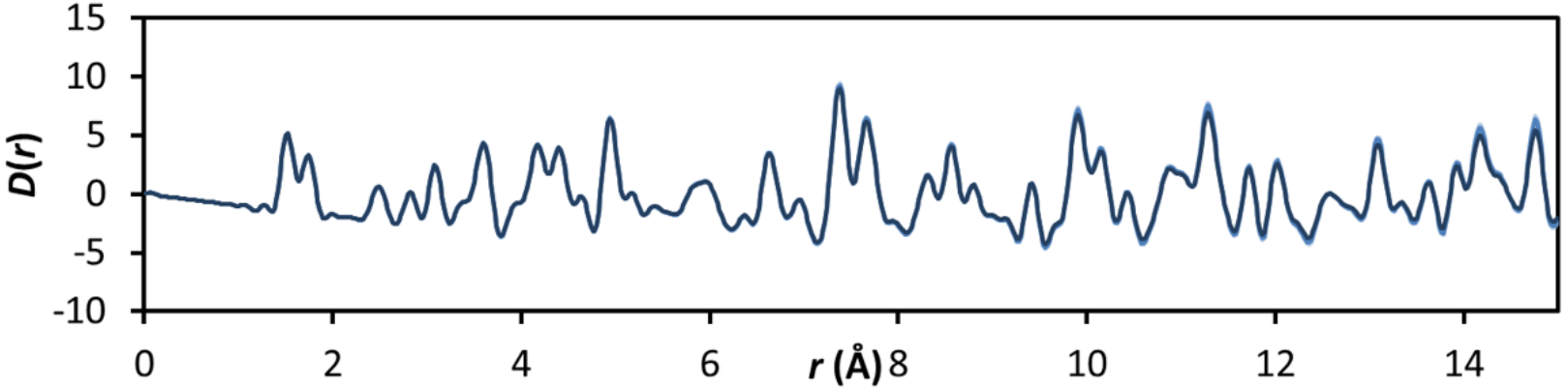




X-ray Diffraction - XRD (3)

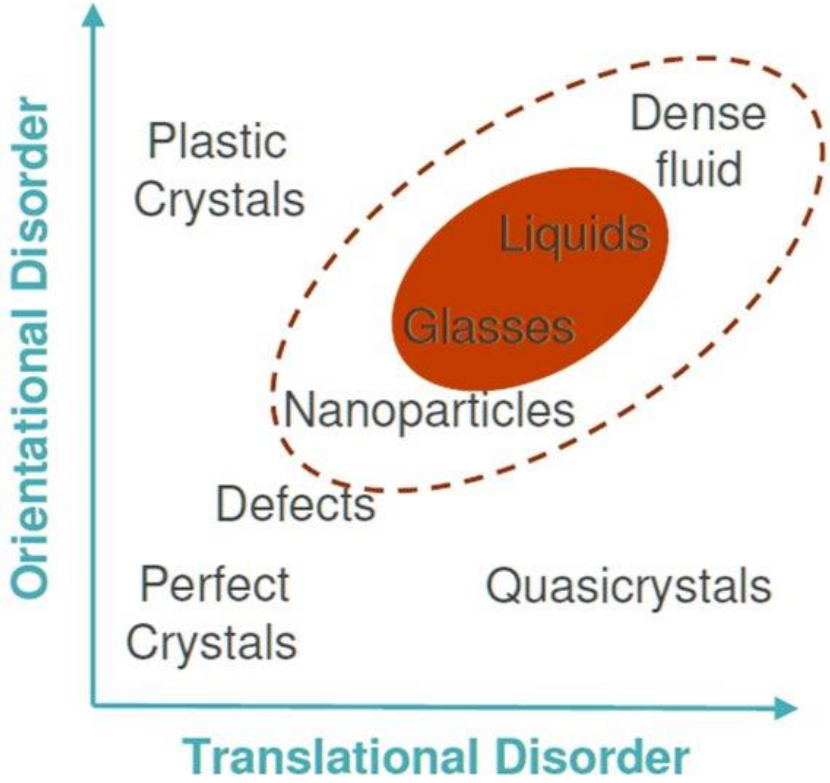


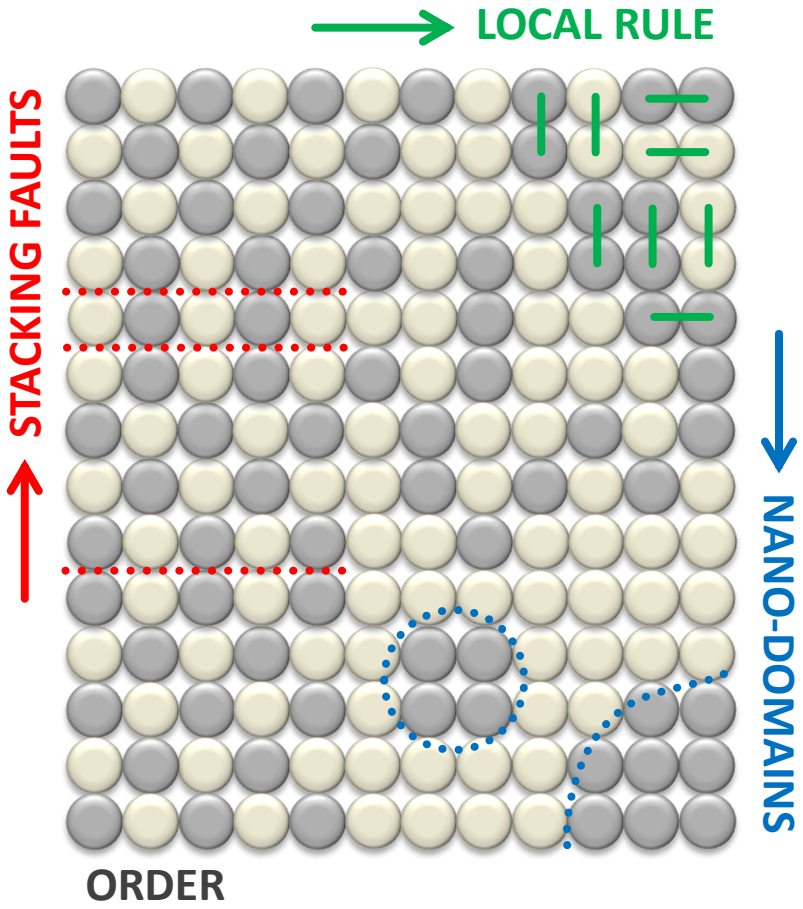
X-ray Pair Distribution Function - XPDF (1)



- **Bragg scattering** | Sharp peaks relating to long-range periodicity
- **Diffuse scattering** | Weak features related to short- and medium-range order
- **Total scattering** | Treating Bragg and diffuse scattering together to look beyond the average structure

X-ray Pair Distribution Function - XPDF (2)





Imaging (1)

No destructive techniques, allowing the visualization of the internal or hidden Parts of samples—can be applied to a huge variety of science fields:

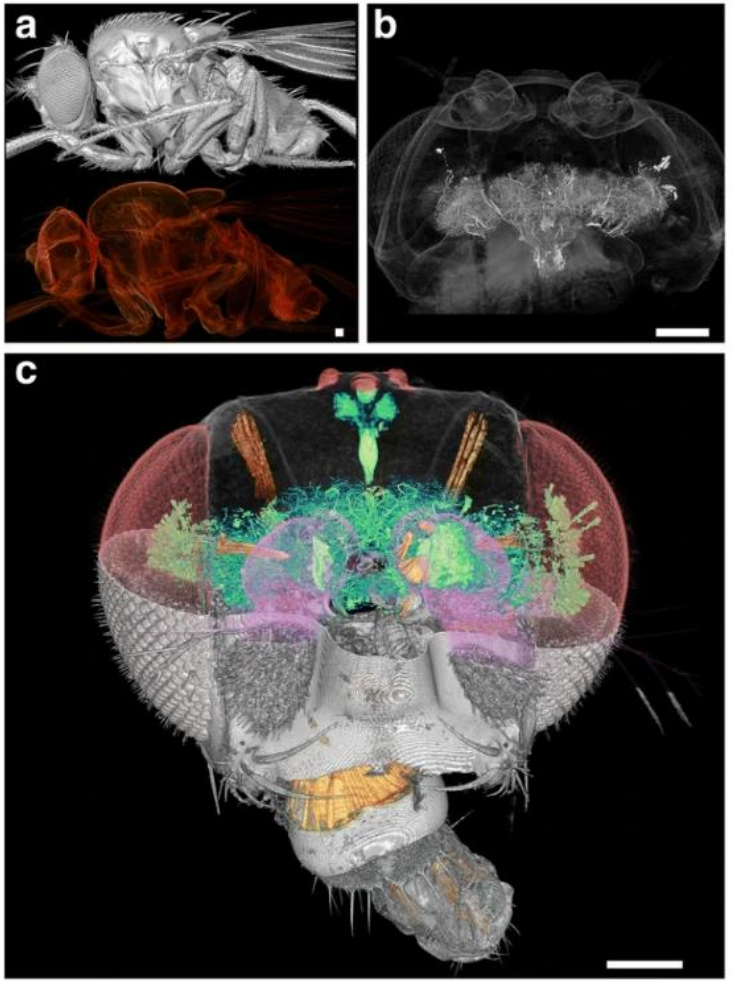
-Life Science
-Cultural Heritage
-Engineering
-Archeology

Imaging (2)

XRF macro-scanning

Bertrad *et al. Appl. Phys. A* **106**, 277 (2011)

micro-tomography

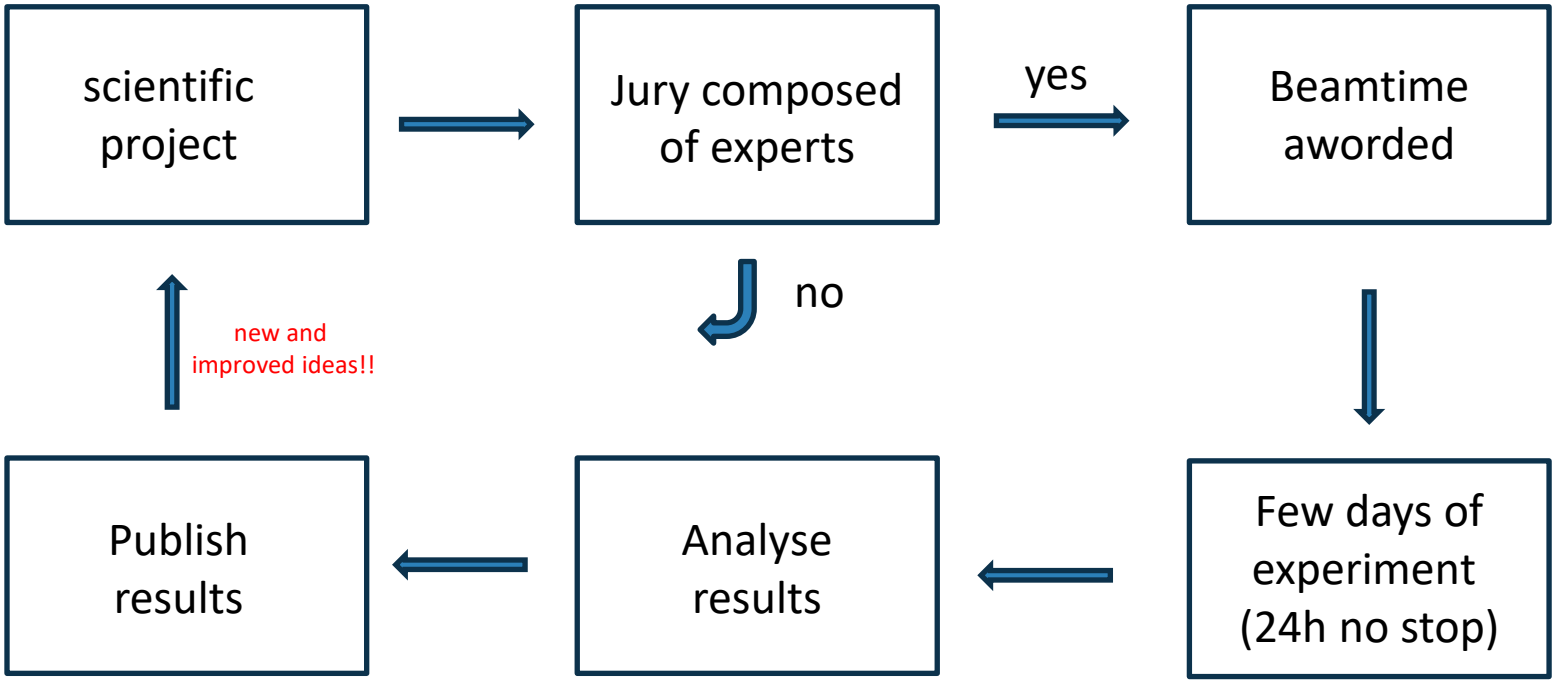


Hwu *et al. BMC Biology* **122** (2017)

Synchrotrons in the World

How is beamtime awarded

the (never ending) process:



QUESTIONS ?