

The Diamond-II Science Case

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Diamond-II: challenges and novel solutions for upgrading
the national synchrotron light facility

Rutherford Appleton Laboratory

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Past

The 80s

The laptop and mobile phone



The tv



The video recorder



Now



2009 Nobel Prize in Physics
Willard Boyle and George E. Smith
"for the invention of an imaging semiconductor circuit – the CCD sensor"



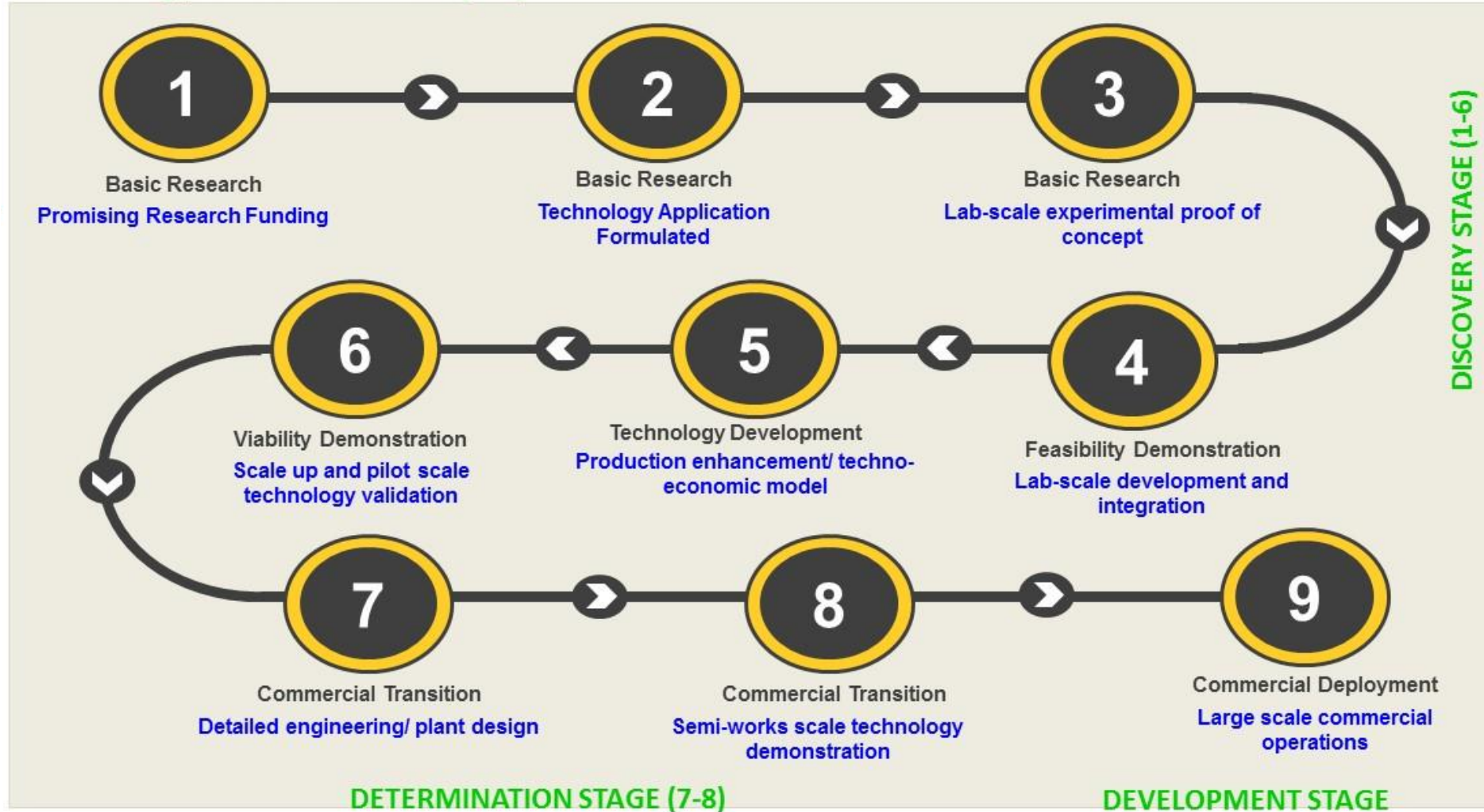
2014 Nobel Prize in Physics
Isamu Akasaki, Hiroshi Amano and Shuji Nakamura
"for the invention of efficient blue light-emitting diodes which has enabled bright and energy-saving white light sources"



2007 Nobel Prize in Physics
Albert Fert and Peter Grünberg
"for the discovery of Giant Magnetoresistance"

Future

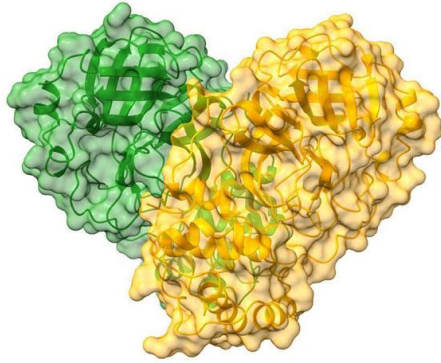
Technology Readiness Level (TRL)



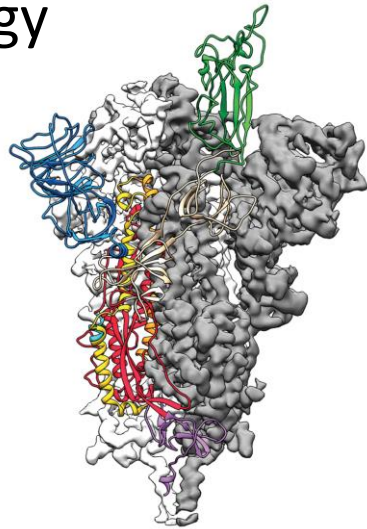
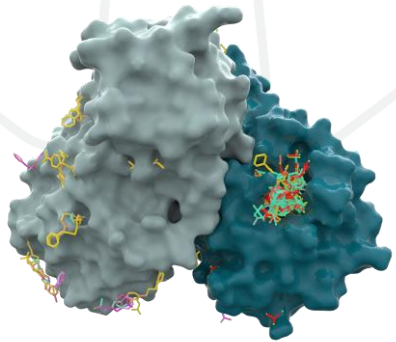
Advancing Science

Biotechnology

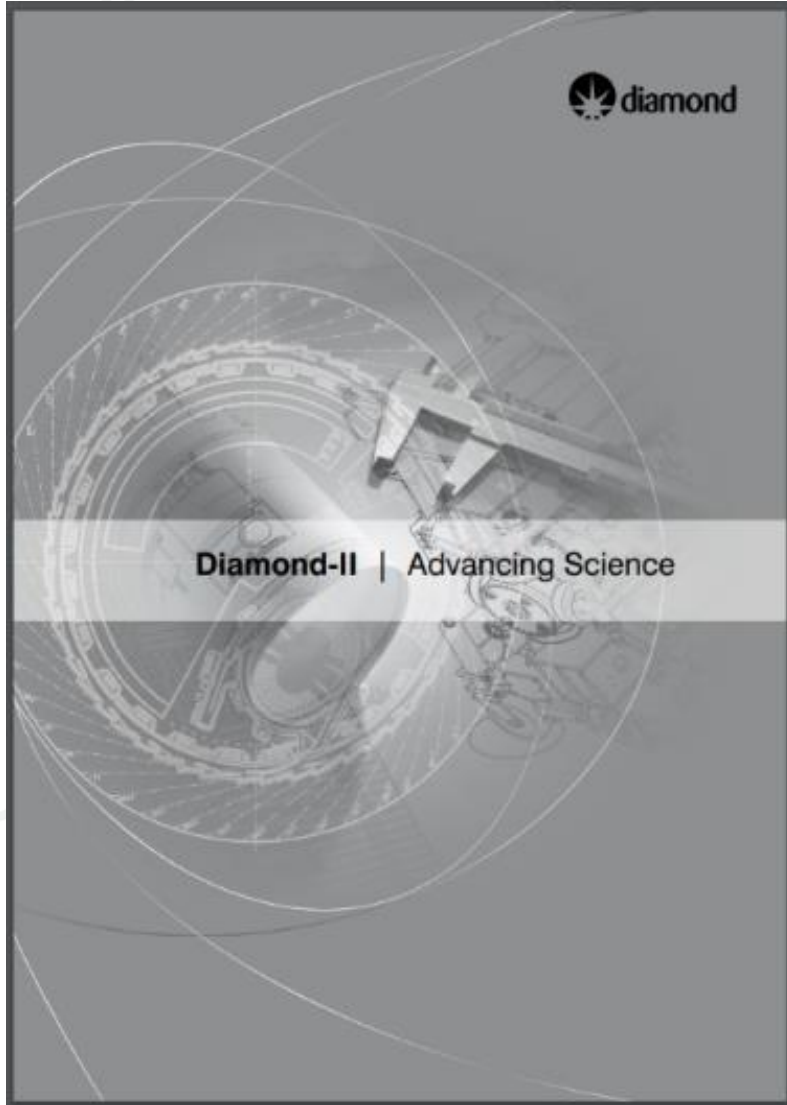
Health and
Well-being



Integrated structural
Biology



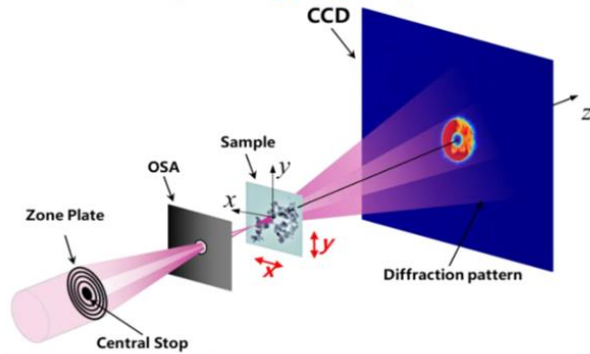
Diamond-II Advancing Science



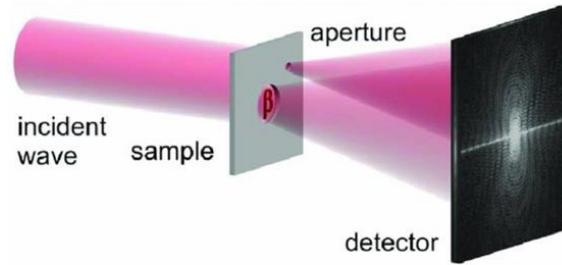
- September 2018 – User engagement to explore science opportunities using a new diffraction limited source with 388 researchers attending across 6 workshops.
- November 2018 – SAC and DISCo endorse the science case.
- May 2020 – SAC and DISCo review expressions of interest for new beamlines and beamline upgrades
- December 2020 – SAC and DISCo review new beamline proposals and beamline upgrade proposals. 1561 statements of support received for the proposals.
- June 2021 – 3 new flagship beamlines announced (CSXID, SWIFT and K04) along with upgrades to existing beamlines.

Science Opportunities - CSXID

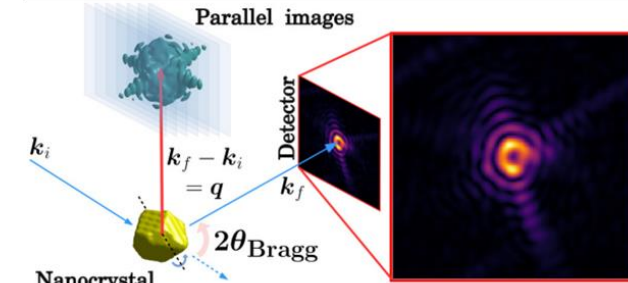
Ptychography



Holography

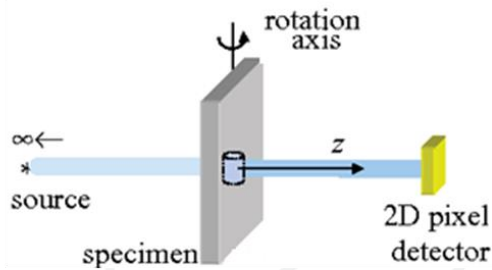


Bragg CDI

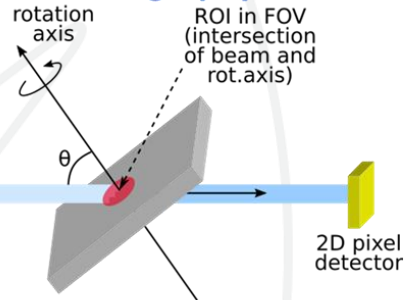


Phys. Rev. A 99, 053838 (2019)

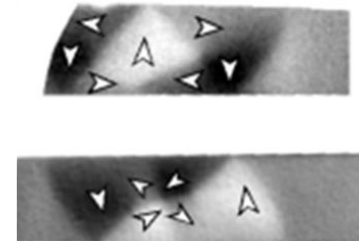
Tomography



Laminography

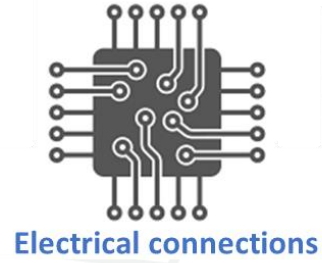
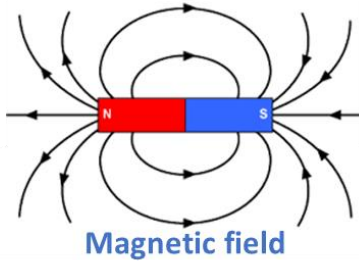
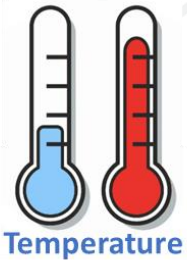
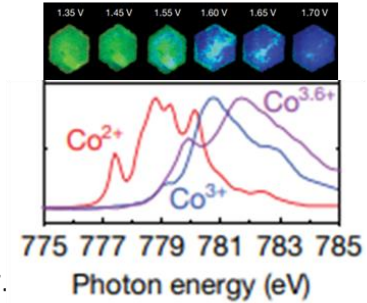


Magnetic contrast



M. Klaui, et.al. Appl. Phys. Lett. 88 (2006) 232507.

Chemical contrast



Science Opportunities - SWIFT

SWIFT will enable studies of dynamic phenomena with X-ray Absorption Spectroscopy using hard X-rays

Materials in any physical form and operational conditions:

Disordered systems and liquids

Element-specific insights into ultra-dilute components

Operando environment: High temperatures / gas / pressure / electrochemical potentials ...

SWIFT will provide

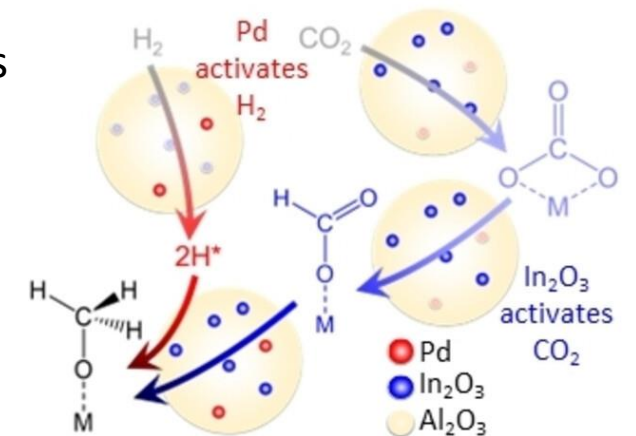
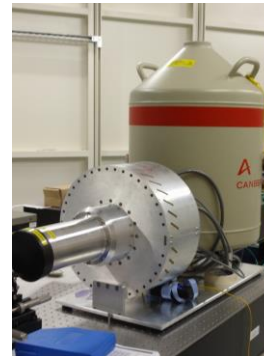
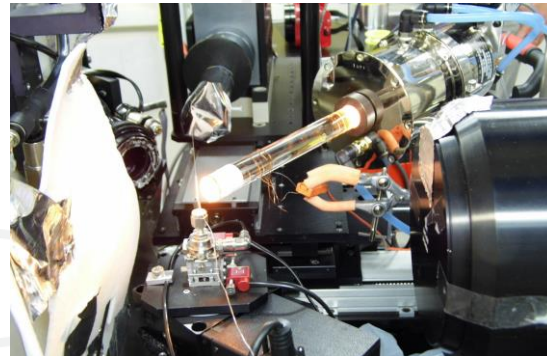
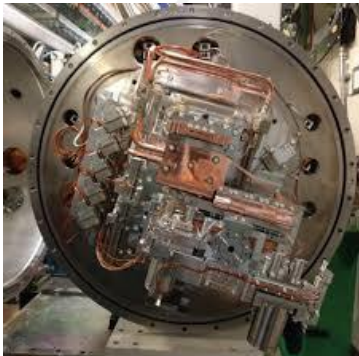
High photon flux over a wide energy range to cover a broad range of elements

Fast Energy Scanning : QUICK-EXAFS (50Hz)

High speed data acquisition chain, and fast detectors

Integration of sample environments and laboratory instrumentation

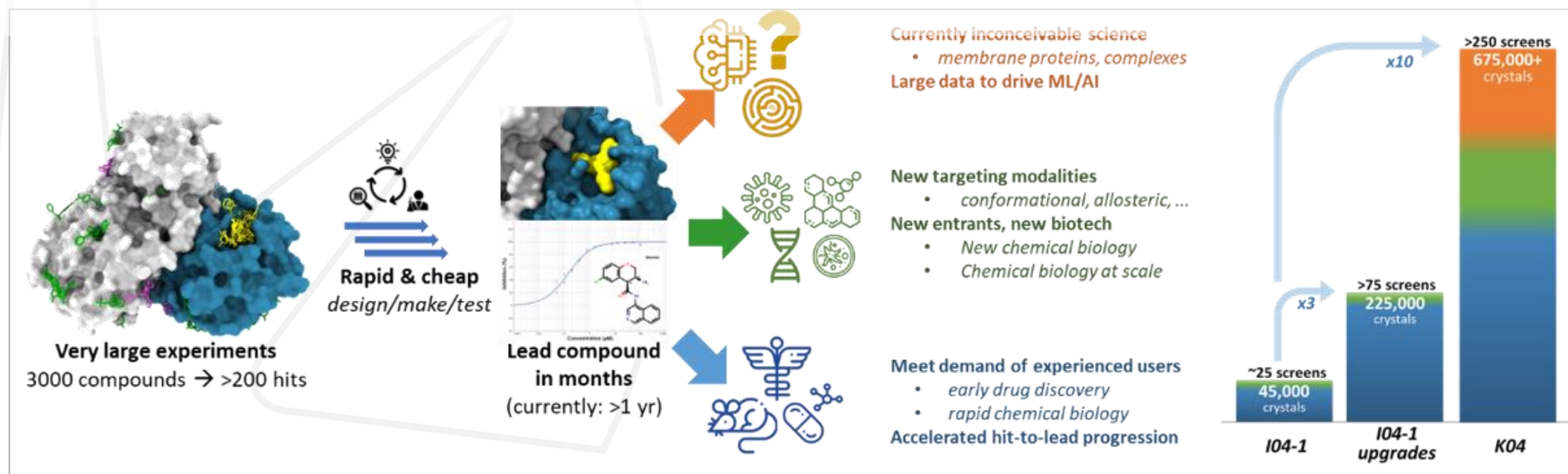
Multiple techniques (XAS, XRF, XRD, FTIR) on with a 20 um spot size



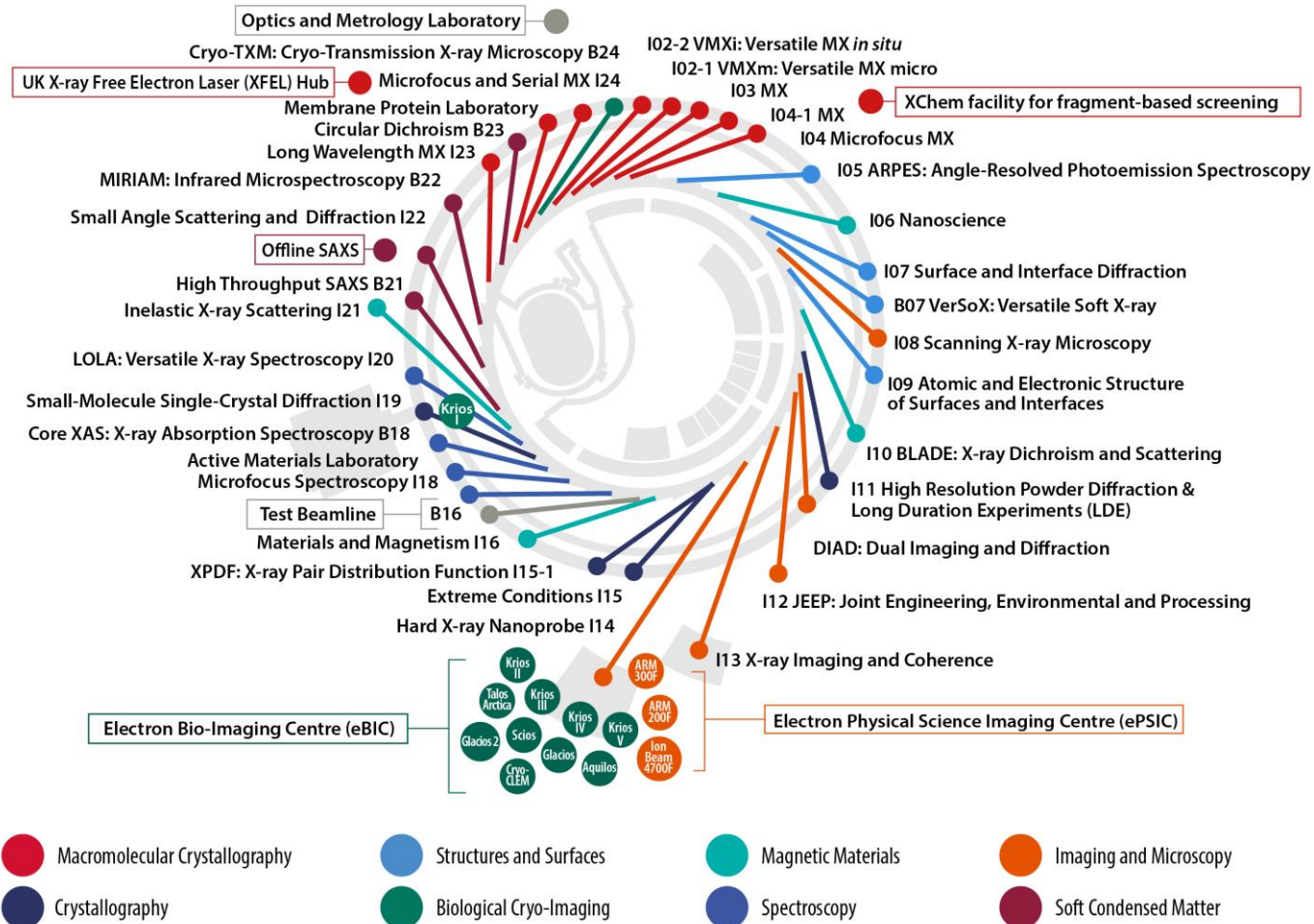
Science Opportunities – K04 for Ultra-XChem

Capacity drives Science: *fast chemical biology and out-of-reach samples*

- Meet both MX and XChem demand
- Develop future modalities, broader screens, complex paradigms, drug viability analysis
- Evolve new user communities (*e.g. non-structural chemical biologists*)
- Drive AI methods: *more relevant chemical biology, improved predictive tools for molecular recognition*



Challenges and Opportunities



Upgrade and commission existing portfolio of beamlines

Install and commission new beamlines

Dark period planning with the user community

Increased stability requirements

Handling larger datasets

Developing state-of-the-art detectors

Developing operando sample environments