CSX1 (23ID1)

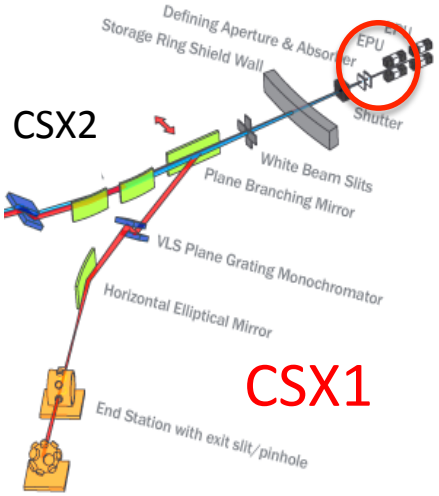
Coherent Soft X-ray Scattering beamline

C. Mazzoli & S. Wilkins

NSLS-II, MIT-BNL meeting, 2017/07/24-26

Online capabilities

- **Coherent, resonant scattering**:
  investigation of electronic order, dynamics, inhomogeneity



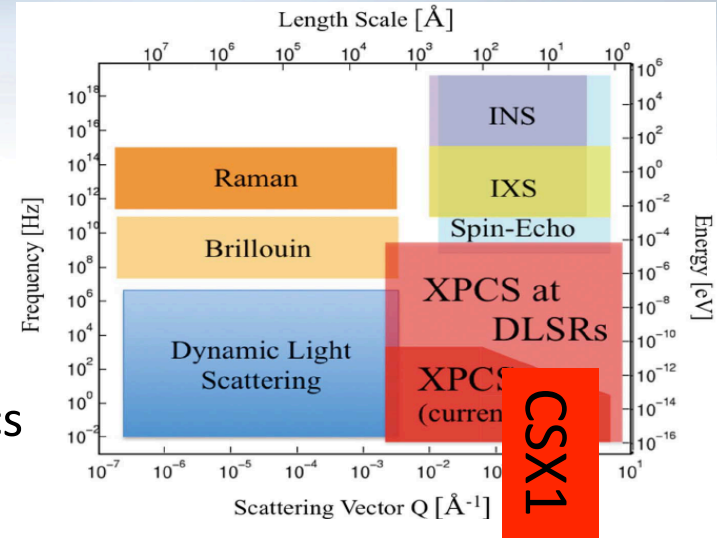
  1 EPU in canted C23 straight section
  any linear and elliptical polarization
  200-2000 eV, R ~ 2500
  TARDIS endstation
  reduced version of 6-circle, high stability, detector access >2π
  2D fast CCD detector
  1k x 1k, up to 100 Hz, Frame store, continuous readout mode for long time stability

  Cryostat (~5 – 350K), UHV loadlock (4 slots, air sensitive sample load option), Analysis suite (image correction, RS projections, cuts, …)

Online capabilities

- **XPCS**

  spanning ~6 orders of magnitude in time
  e.g. structural and electronic ordering dynamics



high coherence

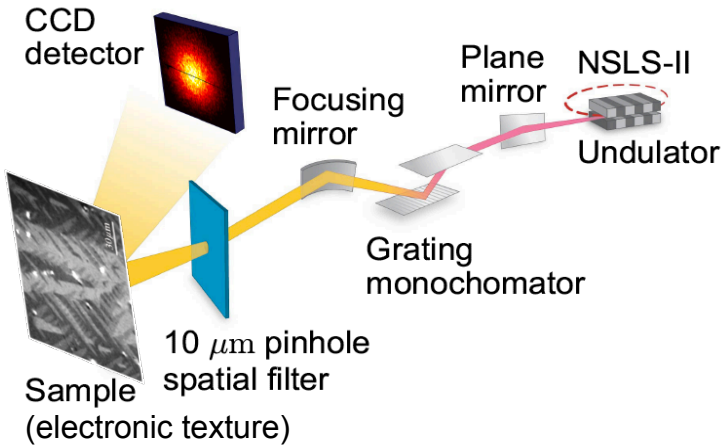
diffraction limited up to ~500eV

fast CCD detector

down to 10^{-2} s

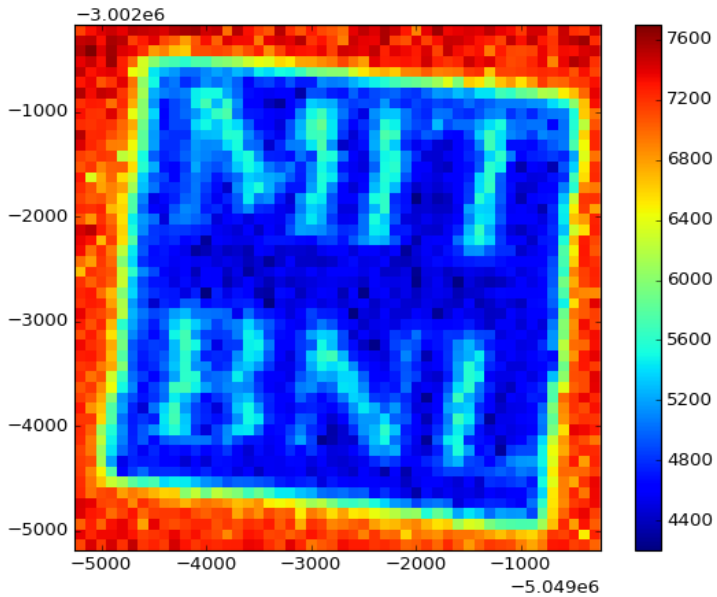
source and beamline stability

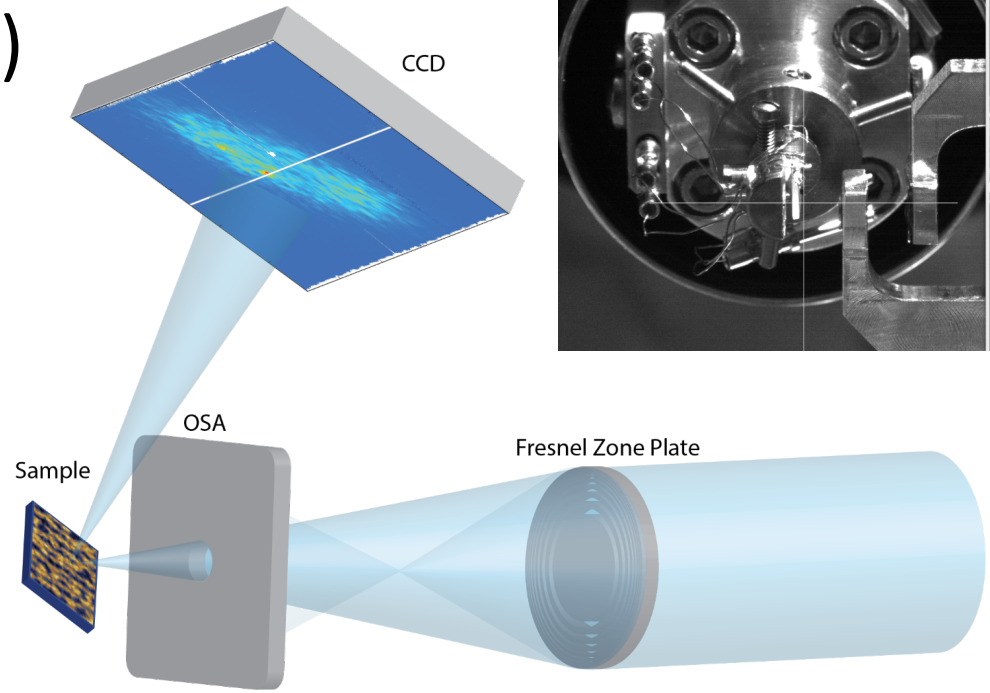
measured up to ~10^4 s

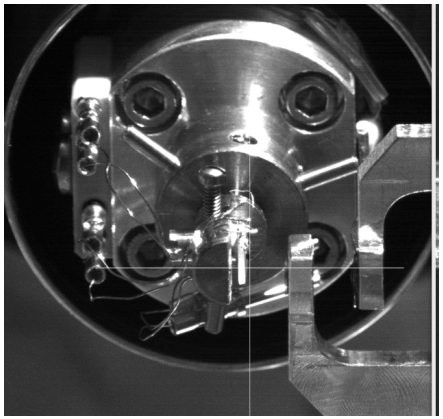


Coming soon (under commissioning, with MIT):

- **Imaging** (Zone Plates)







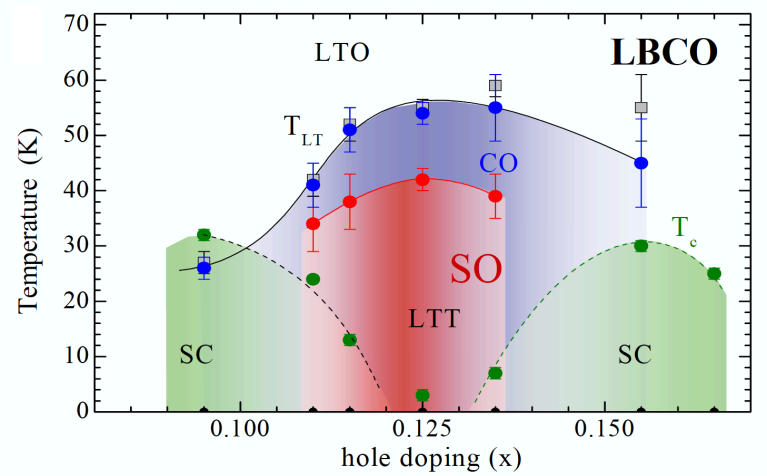
Science Commissioning experiments:
AFM domain imaging in LSMO bulk
Ni AFM domains in $NdNiO_3$ thin films

Resolution ~100nm
currently limited by
the beam shape/size

Science @ CSX1

- **Electronic order**:
  nickelates, cuprofluorides, iron oxides, oxyclorates, selenates and tantalates, …
- **XPCS**:
  CDW in HTSC
  Artificial Spin Ice structures
  Magnetic fluctuations in alloys
- **Science commissioning**:
  ZP imaging of AFM domains in SCES
  Surface scattering, CDI, BCDI, ptychography, …

CDW dynamics in LBCO

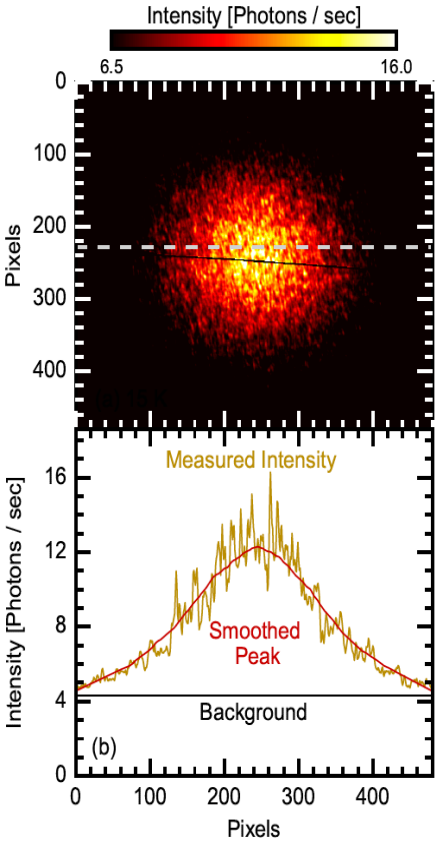


Which pairing mechanism supports HTSC?

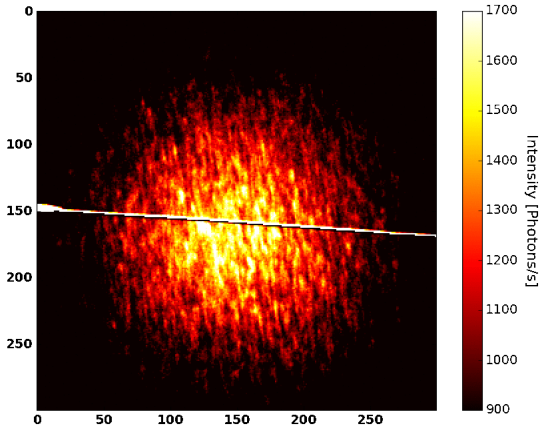
CDW fluctuation are an option?

LBCO 12.5% shows 2D SC

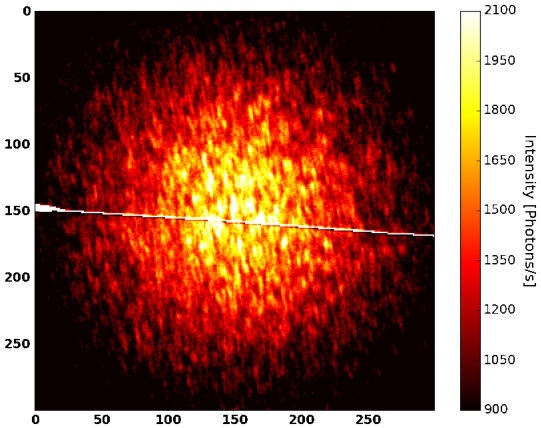
CDW resonant Signal of LBCO 12.5%



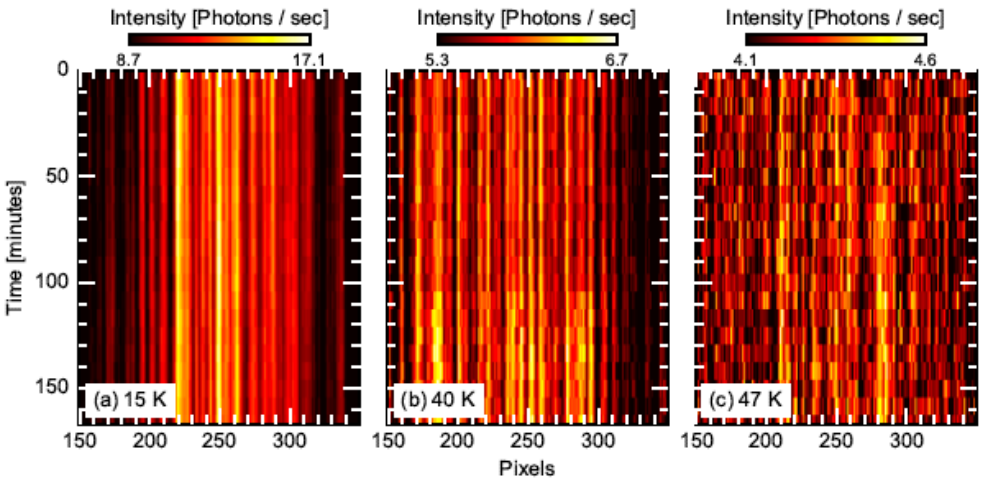
Sample translation (10 μm)



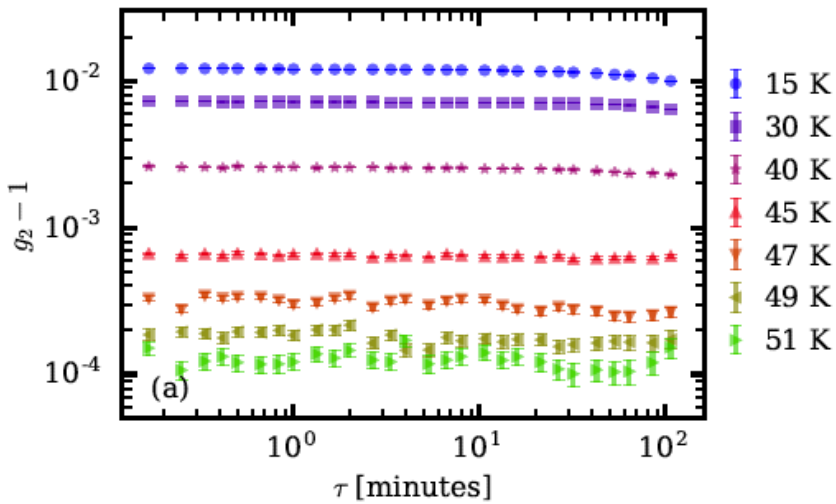
XPCS signal



CDW dynamics in LBCO



LBCO 12.5%, T_C ~ 60K



$$g_2(\boldsymbol{q},\tau) = \frac{\langle I(\boldsymbol{q},t)I(\boldsymbol{q},t+\tau)\rangle}{\langle I(\boldsymbol{q},t)\rangle^2} = 1 + \beta|F(\boldsymbol{q},\tau)|^2.$$

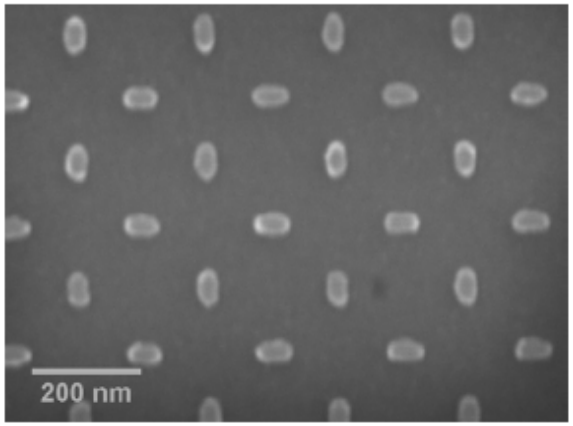
Collaboration with
CMPMSD @ BNL, on SC + PU time:
X. M . Chen et al.
http://arxiv.org/abs/1606.04168
Phys. Rev. Lett. 117 (2016) 167001
Phys. Rev. B 95 (2017) 241111
Phys Rev. Lett. in preparation

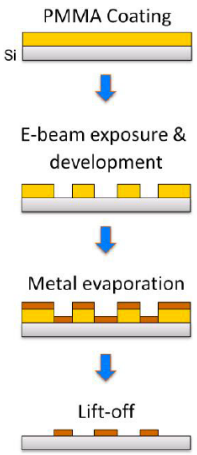
Long time stability of CDW speckles even very close to T_C:

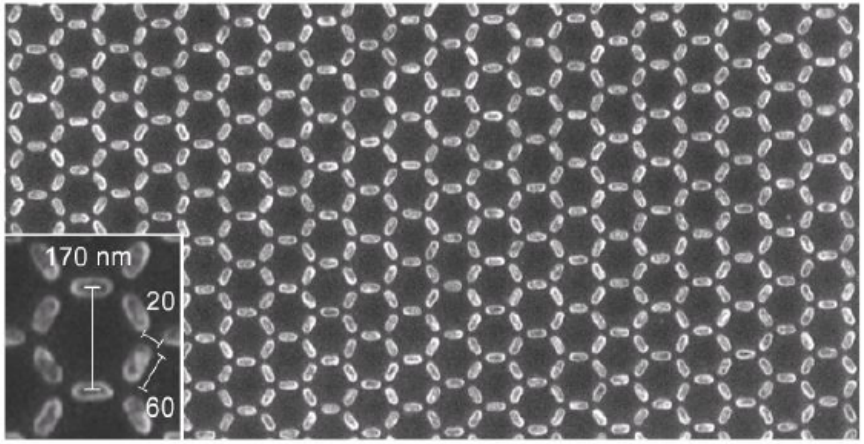
argues against CDW fluctuation-based HTSC models

Artificial Spin Ice structures

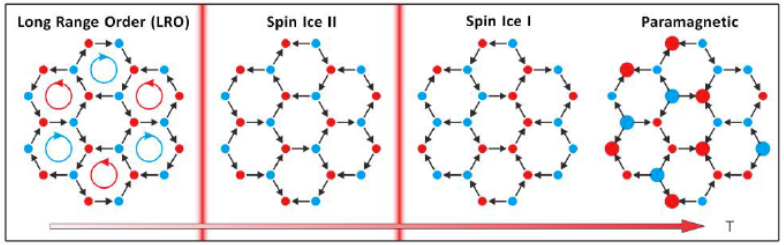
30x70x8nm³ nanomagnets

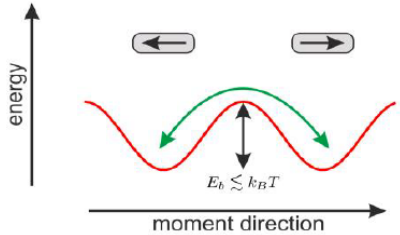






Superparamagnets
Realized at CFN

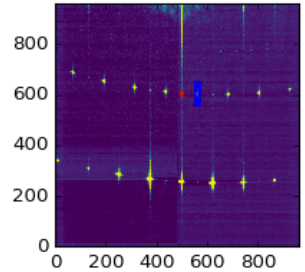




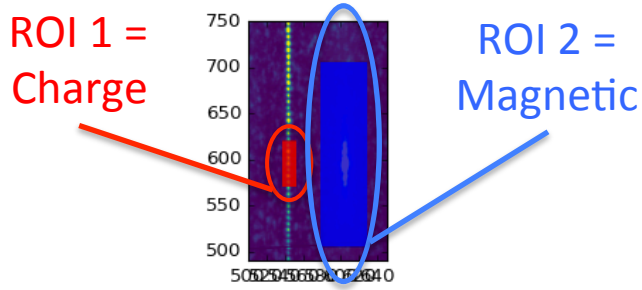
Unique realization of magnetic states
Quantum simulators for dynamics studies
Impact in information technology,
data storage and quantum calculations

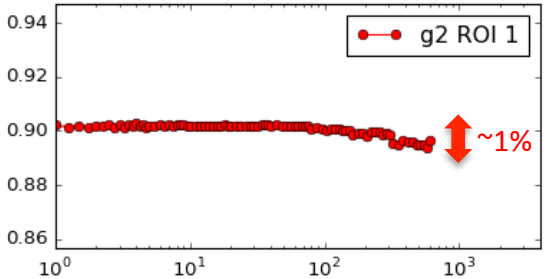
Artificial Spin Ice structures

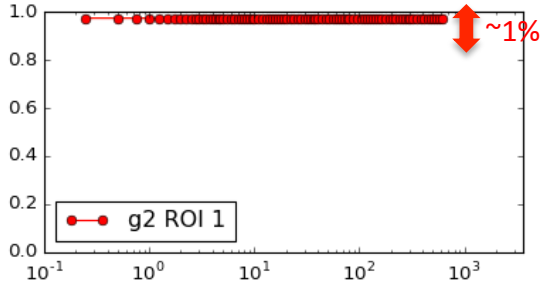
Low T

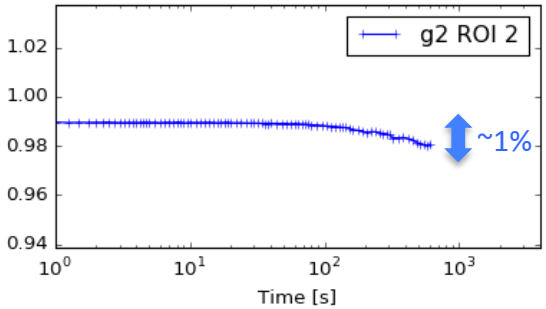


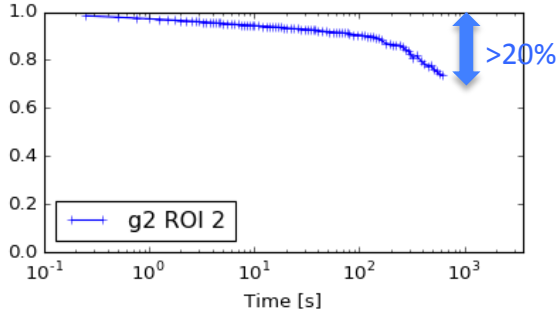
High T

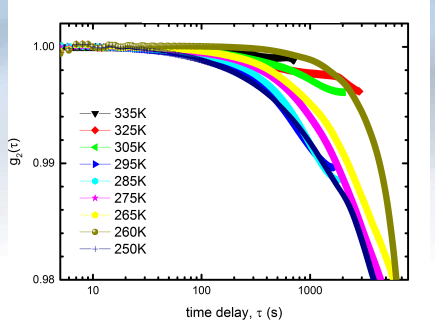


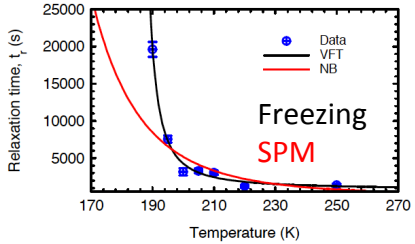


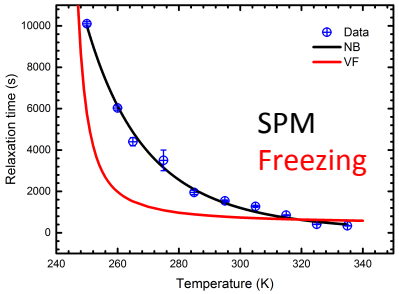












Spin dynamics vs T:

superparmagnetism vs freezing,

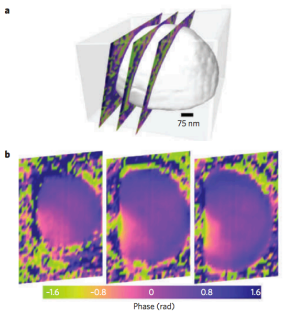
depending on interactions and topology

Collaboration with GU from UK (Univ. Leeds, Diamond and ISIS) and CH (ETH and PSI)

Future plans

- Focus on user community, anticipate their needs
  meetings, workshops and aggregation moments

- CDI (coherent soft diffraction imaging)
  both transmission and Bragg, 3D density profile and electronic order reconstruction



- Surface scattering