Cryo Scanning Transmission X-ray Microscope at the Canadian Light Source

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Science and Technical Requirements

CLS already has an ambient-STXM (130 – 2700 eV, E/ΔE >3000, 30 nm nominal spatial res.) in user operation since 2007

Science drivers for new CLS cryo-STXM

- Spectro-tomography on soft matter
  - Fuel cells
  - Organic, biological, medical
  - Polymers
- Electron yield detection
- Long acquisition time measurements
  - Ptychography
  - Light element X-ray fluorescence

Cryo-STXM will compliment, not replace the CLS ambient-STXM
Dirty samples, development of new techniques, wet and in-situ cells, etc., will continue in CLS ambient-STXM

Major design requirements

- Ability to load a previously frozen sample, through an air lock, and rotate it ±80° in the beam, all at LN2 temperature
- Clean, near-UHV vacuum environment, to suppress ice build up and carbon contamination on the sample
- Nominal spatial resolution and data acquisition rates comparable to other modern soft X-ray STXMs with laser interferometers

Project start: July 2013
- Adam Leontowich joins CLS to lead technical design of cryo-STXM

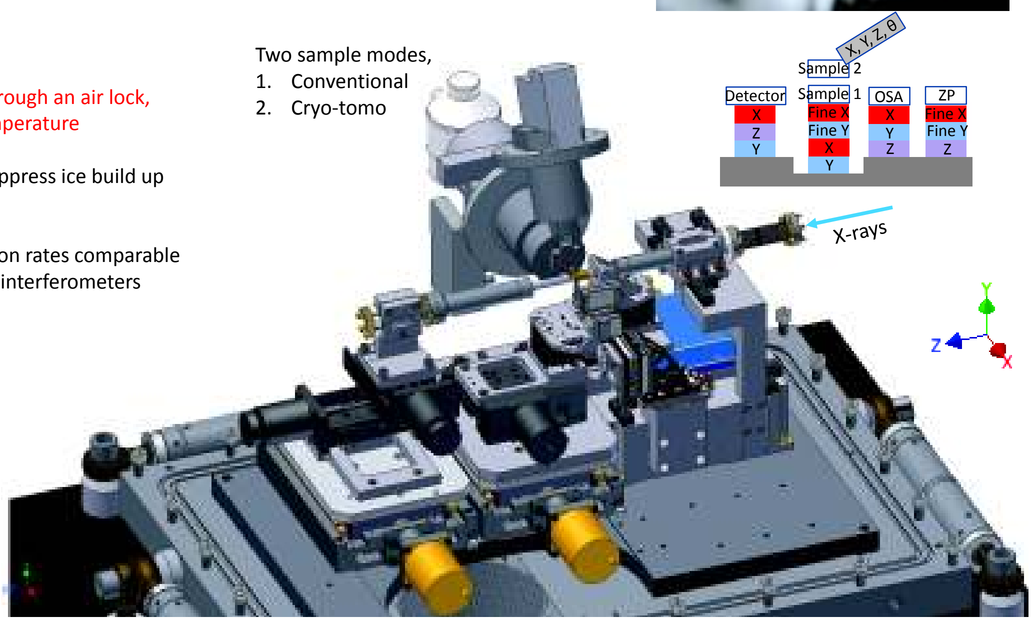
- Clean sheet design, essentially built around a goniometer from a commercial TEM (provided by Chris Jacobsen) and zone plate scanning

Design finalized: February 2014

Electron Microscope Goniometer

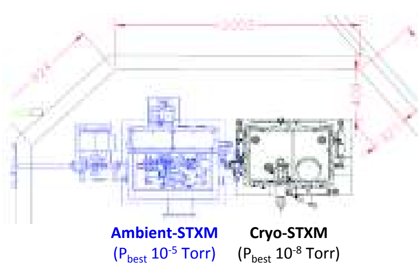
- Provides motion in X, Y, Z, θ
- Integrated air lock, sample always remains at LN2 temperature

Two sample modes,
1. Conventional
2. Cryo-tomo



Near-UHV Environment

- Target base pressure: $2{\times}10^{-8}$ Torr, with focus on water and hydrocarbons
- All UHV rated internals
- 15 cm ID maglev turbopump, two cold traps
- Mostly conflats and pumped double o-rings
- Internal bakeout with infrared bulbs
- Eliminated or reduced internal sources of carbon
- Compatible with in-situ plasma cleaning



New SM beamline hutch layout

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