COMPLEX MATERIALS SCATTERING (CMS)

BROOKHAVEN NATIONAL LABORATORY

NATIONAL SYNCHROTRON LIGHT SOURCE II

SCIENTIFIC SCOPE

CMS is a three-pole wiggler beamline at sector 11-BM dedicated to studies of the bulk and interfacial structures of complex materials, including nanomaterials, soft matter, and biomolecular materials. The beamline will provide instrumentation for simultaneous small- and wide-angle x-ray scattering (SAXS, WAXS) as well as scattering in grazing incidence geometry (GISAXS, GIWAXS), giving access to complementary information at multiple length scales ranging from Angstroms to submicrons. The beamline will also enable automation-aided intelligent exploration of vast parameter spaces to facilitate materials discovery.

BEAMLINE CHARACTERISTICS

TECHNIQUES:

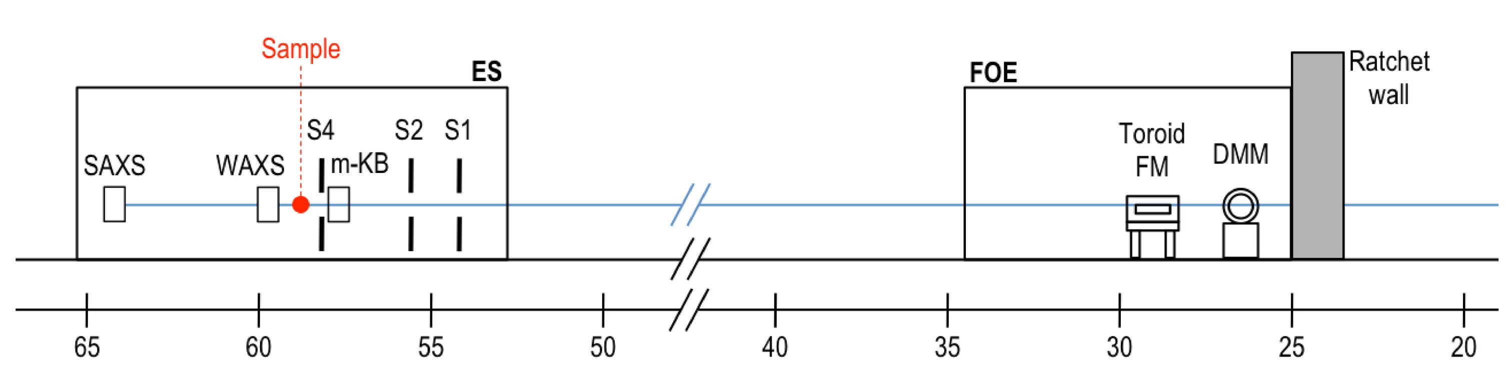
- SAXS/WAXS
- GISAXS/GIWAXS

ENDSTATION DETAILS:

- KB mirrors for microbeams
- Sample manipulation control
- In-vacuum operation for weakly scattering materials
- Dedicated area detectors

CMS at NSLS-II:

- **Broad q-range** to study complex, hierarchical materials
- Microbeams for heterogeneous **sample mapping**
- **Versatile** sample environment for *in-situ* experiments
- **Intelligent exploration** of vast parameter spaces via automation



Overview

PORT: 11-BM

SOURCE: Three pole wiggler

ENERGY RANGE: 10 – 17 keV

ENERGY RESOLUTION: $\Delta E/E = 10^{-2}$

WAVEVECTOR RANGE: 3×10^{-3} to 5 $Å^{-1}$

BEAM SIZE: 0.05 – 0.8 mm (H); 0.02 – 0.3 mm (V)

BEAM FLUX: 10^{10} – 10^{13} ph/s

CONSTRUCTION PROJECT: NxtGen

BEAMLINE STATUS: Construction

AVAILABLE TO USERS: 2016

Beamline Team

STAFF

Masa Fukuto: lead beamline scientist

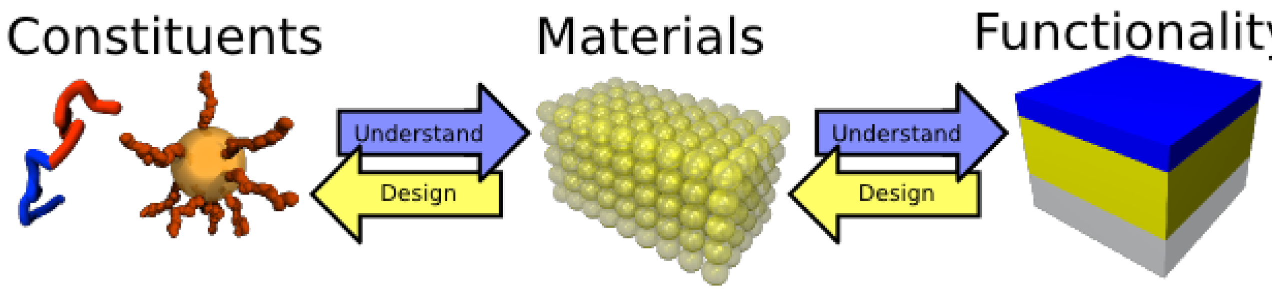
Lukas Lienhard: mechanical engineer

Mike Johanson: designer

BEAMLINE DEV. PROPOSAL LEAD

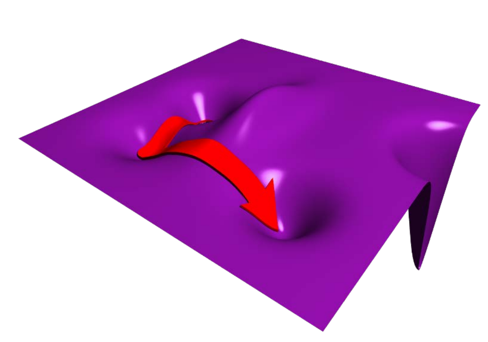
Kevin Yager (Brookhaven Nat'l Lab)

KEY CONCEPTS



Rational Materials Design:

- New materials are hierarchical, nanoscale, and multi-component
- More sophisticated materials science requires *design*
- Need understanding at all length-scales

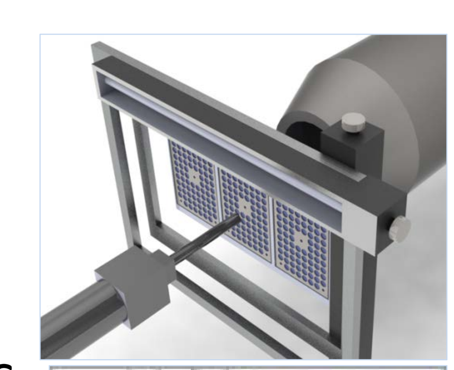


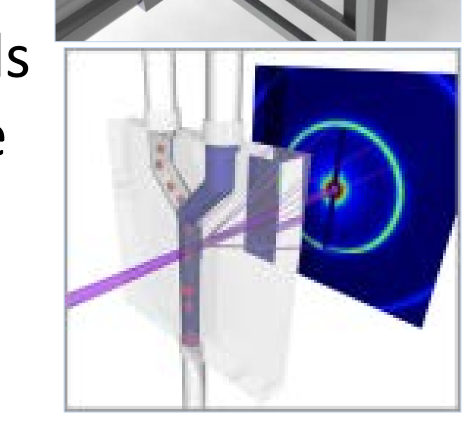
Non-Equilibrium Science:

- Path-dependent effects
- Processing history
- Stimuli/responsive
- Engineering the energy landscape to *control order*

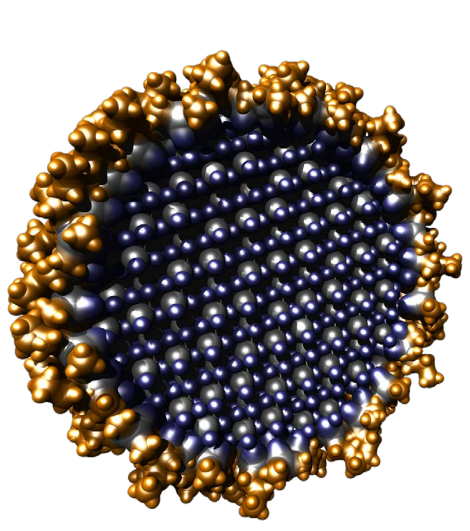
Automated Materials Discovery:

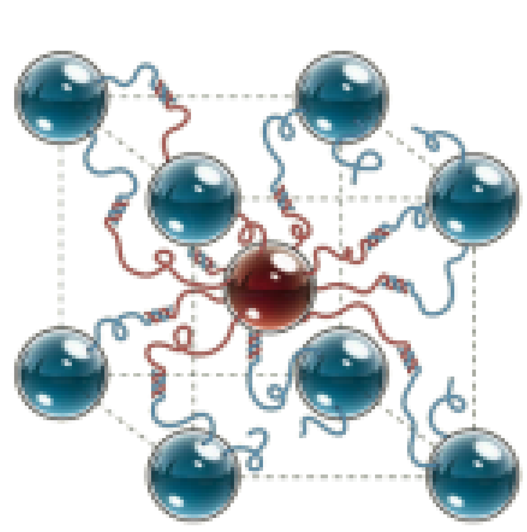
- Robotics for increased throughput
- Automated data feedback and integrated experimental controls (microfluidics, mapping, sample environment)
- Instrument autonomously explores parameter spaces





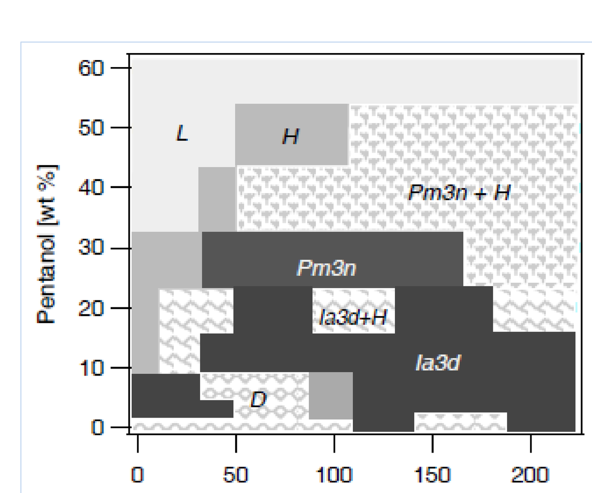
SCIENTIFIC APPLICATIONS

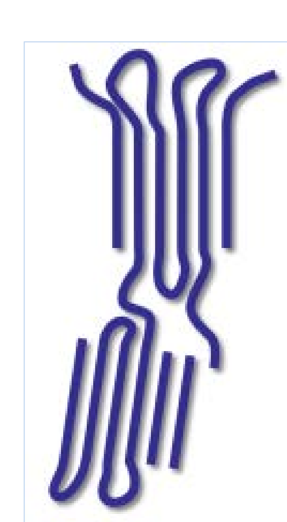




Synthesis: Using x-ray probes of structure to control reagent feeds, CMS will autonomously optimize synthesis (e.g. of nanoparticles)

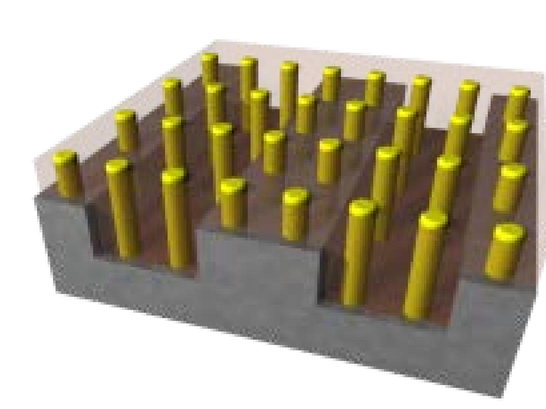
Assembly: Tuning the self-assembly energy landscape with applied stimuli; understanding the resultant 3D hierarchical structures

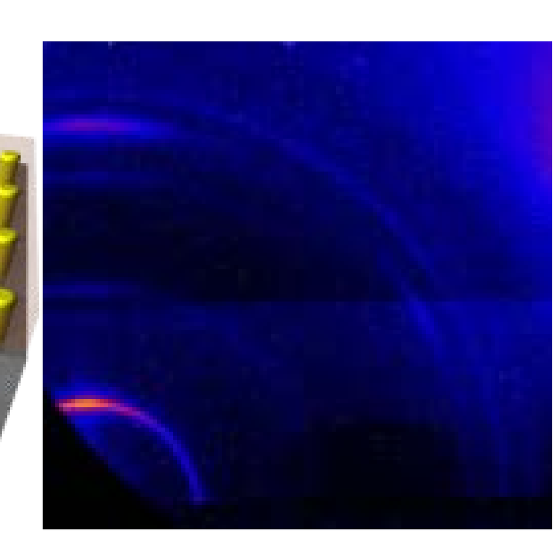




Complexes and formulations: Massive parameter spaces will be explored to understand assembly and control formulation properties

Polymers: *In-situ* study of polymers under stress and flow will shed light on polymer crystallization





Devices: Studies of stimulated and direct self-assembly, e.g. in DNA lattices or block-copolymer nano-lithography, will pave the way for next-generation device architectures

Energy: High-performance materials for, e.g., organic solar cell, batteries, supercapacitors, fuel cells