Beamline 11-BM at the Advanced Photon Source:

Synchrotron Powder Diffraction Simplified…

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MOTIVATION & GOALS: Why 11-BM at the APS ?

Many powder diffraction studies are information starved - - the structural detail one can extract is limited by the detail in the experimental measurement.

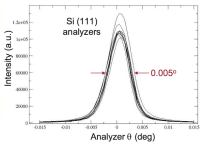
- **High-resolution diffraction** - allows peaks to be resolved, essential for indexing, improves structure solution and provides optimal detail in crystal structures
- **High-sensitivity diffraction** - allows weak peaks to be seen above background, essential for structural details (also more observations)
- **High-Energy diffraction** - provides more accurate data and a wider Q range energy (more observations), less sample absorption for high Z samples
- **High-Throughput diffraction** - allows these capabilities to be made available to the appropriate research communities in chemistry, materials, condensed matter physics, geosciences, pharmaceutical science, structural biology…

GOALS:

1) Operate a world-class powder diffraction program for APS users, centered around a user-friendly, high-resolution, high-throughput instrument designed for a diverse multi-disciplinary user community.
2) When appropriate, offer above as a **Rapid Access Mail-in Service**, to expand the size & scope of user community, reduce travel time and costs, and expedite access to routine powder diffraction measurements. Enable superior crystallography with convenient and timely access to world-class powder diffraction data.

SPECIFICATIONS: 11-BM Facts & Figures

- **Energy range:** 6 - 39keV (2.5 – 0.3Å)
  Mail-in service optimized @ 27 keV (~ 0.45 Å)
- **Q range:** $Q_{max} \approx 25$ Å^{-1}
  1 hour mail-in scan: 2Θ range 0.5°→ 50° (d ≥ 0.5 Å)
- **Resolution:** Δd/d (ΔQ/Q) ≈ 2×10^{-4}
  Equivalent to best-in-world (ESRF, Diamond etc.)
  Highest Resolution Powder Diffraction in North America
- **Beam Size:** 0.5 mm (V) x 1 mm (H)
- **Non-Ambient Scans:** Cryostream 700+ (80 K - 500 K)
- **Robotic Arm:** Automated sample changes, 150+ sample tray



Future Plans: *Hot-Air Blower → 1200 K, Cryo device < 80 K, in-situ reaction cells…*

RAPID ACCESS MAIL-IN PROGRAM:

How to access 11-BM for your research….

The 11-BM user program supports mail-in operation with fixed energy (~27 KeV), fixed temperature (100 K or ambient), fixed data range (~0.1/Å ≤ Q ≤ ~12/Å) and fixed data collection time (1 hr). Rapid access is encouraged for projects that require less than one shift (8 hours) for data collection. Receive convenient proposal and sample status updates by email; target data delivery is within 3 weeks of sample receipt at the APS.

Additional flexibility in data collection conditions (protocols for beam sensitive samples, other data collection temperatures, and on-site instrument usage) are offered to users upon request as staffing and development resources permit.

Rapid access to 11-BM beamtime in 6 simple steps

- ***Proposal approval in days (or hours!)***
- ***1 shift (~ 8 runs) per cycle & project***
- ***Mail-in service or on-site (ANL) drop-off***
- ***Standard 1 hr scans at select temps***
- ***Receive data by email (now & later)***
- ***Quick Response: data in ~ 3 weeks***

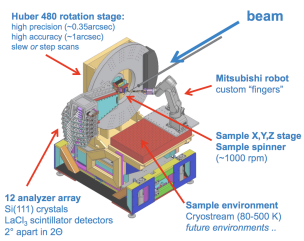
LOOKING FOR MORE INFORMATION ?

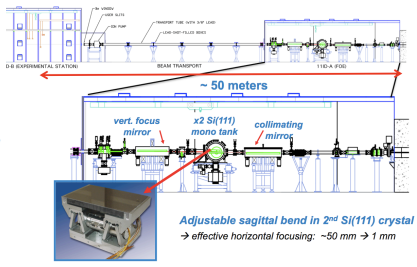
11-BM webpage: ***http://11bm.xor.aps.anl.gov/***

APS users: ***http://www.aps.anl.gov/users/***

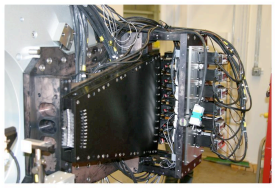
email contact: ***11BM@aps.anl.gov***

BEAMLINE LAYOUT & DESIGN





APS designed analyzer/detector system:

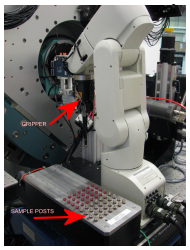


12 analyzers with independently adjustable orientations on two axes

Wide analyzer θ range (0-24.5º) for full energy range with millidegree alignment

Analyzers are rigid and stable with respect to detector rotation during the 2θ scan

Sample changing robot:



Capacity: 152 samples (56 individual and 96 in magazines)

Small footprint allowing easy access to sample area

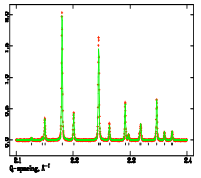
Integrated with Cryostream 700+ for combined use of robotic operation with temperature control

Proven reliability of industrial Mitsubishi robot

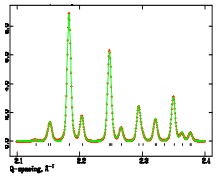
Locally designed Robot-Human Safety System (RHSS) to ensure safe operation

INSTRUMENT PERFORMANCE

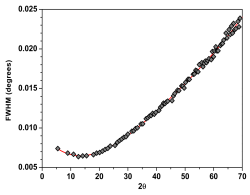
Comparison of 11-BM data to synchrotron area detection data



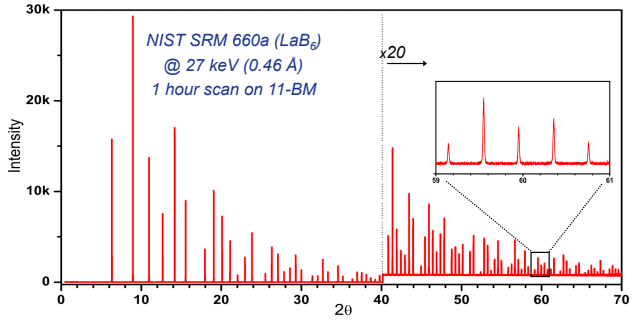
High resolution: 11-BM
10 min scan



High throughput: MAR345,
1 sec exposure (1-BM)



11-BM Instrument Resolution
Function @ 27 keV (0.46 Å)



ACKNOWLEDGEMENTS

We acknowledge the hard work of all those at the APS who shared in the design, construction and commissioning of the 11-BM, most especially Mohan Ramanathan, Yeldez Amer & Deming Shu (AES), Jun Wang, Peter Lee, Sytle Antao, Jennifer Doebler (MC/XOR), Charles Kurtz & Mark Engbretson (CEP/XOR), Curt Preissner (MED/AES), Xuesong Jiao, David Cline & Tim Mooney (BCDA/AES), Yu Huang (IS/AES), Bill Sheehan & Dave Cyl (IT/AES) and Mark Beno, Gabrielle Long & George Srajer (XSD). We also thank John Mitchell & the late James Jorgenson (Argonne/MSD) as well as Helen Kerch (BES/DOE) for their work.

Work performed at the Advanced Photon Source was supported by the U.S. Department of Energy, Office of Science, Basic Energy Sciences, under Contract No. W-31-109-Eng-38. The 11-BM instrument was made possible through DOE-BES LAB-03 instrument construction program funding.