Overview of the Nanoscale Ordered Material Diffractometer (NOMAD)

INSTRUMENT TEAM

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What is NOMAD?

- NOMAD is a diffractometer using a large bandwidth of neutron energies and extensive detector coverage to do structural determinations of local order in crystalline and amorphous materials.

- NOMAD was designed for studies of a large variety of samples ranging from liquids, solutions, glasses, polymers and nanostructured materials to long-range ordered crystals.

- NOMAD gives an access to high-resolution pair distribution functions (PDF), small-contrast isotope substitution experiments, small sample sizes, parametric studies and in-situ diffraction.
Currently, 50 out of 99 packs with eight $^3$He linear position sensitive detectors are installed. 51200 pixels are grouped into six “banks”.

3 Managed by UT-Battelle for the Department of Energy
NOMAD (as seen from the sample position)
# Resolution \( \Delta d/d \)

<table>
<thead>
<tr>
<th>Bank</th>
<th>( \langle 2\theta \rangle ) /degree</th>
<th>( \Delta d/d ) FWHM</th>
<th>approx. d-range /Å (60Hz*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>0.029</td>
<td>0.5-13</td>
</tr>
<tr>
<td>2</td>
<td>31</td>
<td>0.019</td>
<td>0.3-6.5</td>
</tr>
<tr>
<td>3</td>
<td>67</td>
<td>0.0137</td>
<td>0.3-3</td>
</tr>
<tr>
<td>4</td>
<td>122</td>
<td>0.0069</td>
<td>0.2-1.9</td>
</tr>
<tr>
<td>5</td>
<td>154</td>
<td>0.0036</td>
<td>0.2-1.5</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>0.039</td>
<td>0.5-28</td>
</tr>
</tbody>
</table>

Measured pixel by pixel resolution (FWHM) vs. scattering angle \( 2\theta \)

*30 Hz operation roughly doubles the d-range to longer d. Some sample environments (cryostat /furnace) restrict the accessible d range.
Sample environment

Standard

- Sample translation stage combined with Cobra temperature controller.
  
  http://sns.gov/equipment/equip-detail.cfm?recordID=OSE-001&facility=All

- Orange Cryostat (2- 300K)
  
  http://sns.gov/equipment/equip-detail.cfm?recordID=CRYO-004&facility=SNS

- ILL furnace (300K- 1400K)
  
  http://sns.gov/equipment/equip-detail.cfm?recordID=HOT-001&facility=SNS

Special requirements

- Aerodynamic levitator (800 -3500K + room temperature)
  
  http://sns.gov/equipment/equip-detail.cfm?recordID=HOT-018&facility=SNS

- High voltage set-up (10kV)
  
Sample size considerations

- Neutron sized samples = synchrotron sized data acquisition times
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Rule of thumb: Fill a 2mm dia. capillary 2 cm high (~60mm$^3$), if 100K < T < 500K (cryostream/Cobra), fill 6mm dia. vanadium can 2 cm high (0.5cm$^3$) for cryostat/furnace. Count for 1h per sample and temperature.
Diffraction from a very strong scatterer (0.6 g diamond) obtained in 1 second.
20 min data on glassy SiO$_2$

\[ \rho_{\text{SiO}_2} \sigma_{\text{SiO}_2} / \rho_{\text{V}} \sigma_{\text{V}} \]
Sample with hydrogen

⇒ H is bad, but not completely excluded. If you can, substitute for D and the data quality will be better. It will save you a lot of time on data analysis.