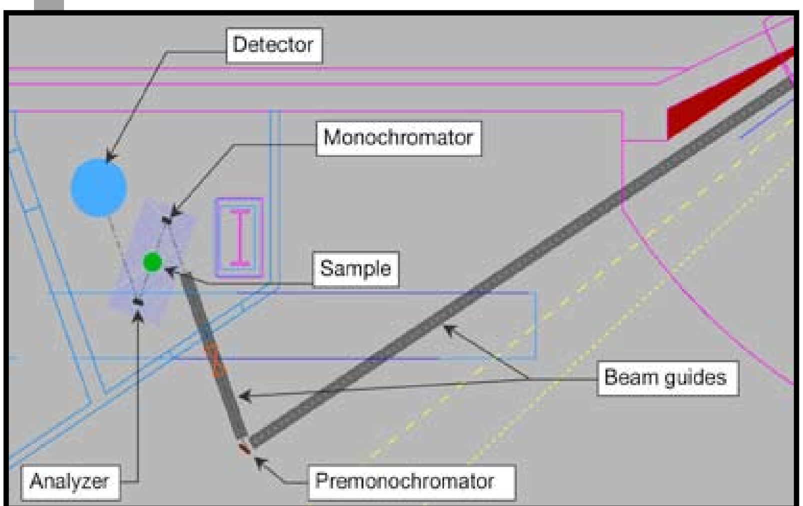
Instrument Fact Sheet

Beam Line 1A

Spallation Neutron Source

TOF-USANS — Time-of-Flight Ultra-Small-Angle Neutron Scattering Instrument

The TOF-USANS instrument is designed for the study of hierarchical structures in natural and man-made materials. It can be considered an advanced version of the classical Bonse-Hart Double-Crystal Diffractometer (DCD), which, in contrast with its single-wavelength reactor-based analog, will operate with the discrete multiwavelength spectrum of Bragg reflections. The optical scheme of the TOF-USANS instrument is similar to that of the conventional Bonse-Hart DCD; however, the pulsed nature of SNS offers an opportunity to separate the orders of Bragg reflection in time space using the time-of-flight technique. Thus, the concept of the TOF-USANS technique allows optimization of the neutron flux and the Q resolution, following the principles of dynamical diffraction theory.



Discrete multiwavelength spectrum created by a family of Bragg reflections.

Specifications

Moderator	Decoupled poisoned hydrogen
Source-detector distance	30 m
Focusing premono-chromator	Germanium mosaic Ge(220) crystal
Monochro-mator and analyzer	Si(220) channel-cut, triple-bounce crystals
Bragg angle	70°
Wavelength spectrum	4 Bragg reflections at 3.6, 1.8, 1.2, 0.9 Å
Q range	$7\ 10^{-6}$ Å^{-1} < Q < $5\ 10^{-3}$ Å^{-1}

Status:
To be commissioned in 2014

Applications

Ultra-small-angle neutron scattering provides a new way to solve a broad range of scientific problems such as:

- Supramolecular structure of polymer blends
- Macroscale self-similarity of rocks
- Structure of colloidal crystals and alloys
- Hydration of cement pasts
- Aggregation in colloidal dispersions
- Self-assembling of polymers
- Mesoscopic structure of natural composites
- Structure of granular powders
- Morphology of colloidal reinforcing fillers
- Structure and morphology of complex fluids
- Rheology and morphology of hydrogels

For more information, contact

Instrument Scientist: Michael Agamalian, magamalian@ornl.gov, 865.576.0903

SNS

February 2009

06-G01637C/arm

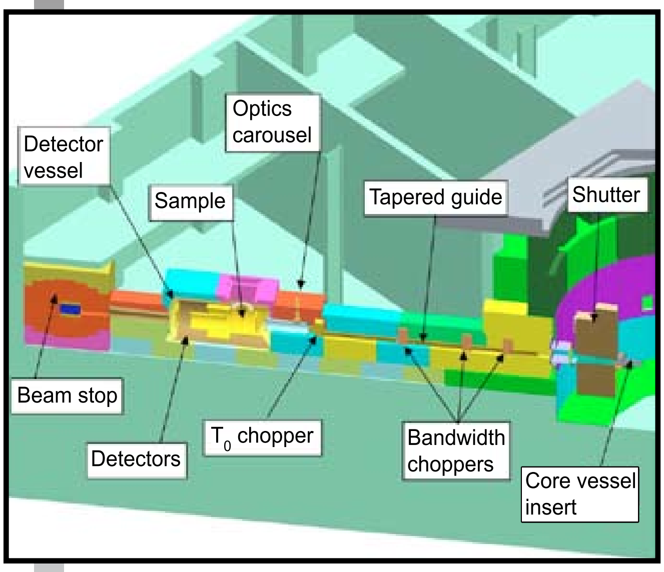
INSTRUMENT Fact Sheet

BEAM LINE 1B

SPALLATION NEUTRON SOURCE

NOMAD – NANOSCALE-ORDERED MATERIALS DIFFRACTOMETER

NOMAD is a high-flux, medium-resolution diffractometer that uses a large bandwidth of neutron energies and extensive detector coverage to carry out structural determinations of local order in crystalline and amorphous materials.The instrument enables studies of a large variety of samples, ranging from liquids and solutions, glasses, and nanocrystalline materials to long-range-ordered crystals. The enhanced neutron flux at SNS, coupled with the advanced neutron optics and detector features, allows for unprecedented access to high-resolution pair distribution functions, small-contrast isotope substitution experiments, small sample sizes, and parametric studies.



SPECIFICATIONS

Moderator	Decoupled poisoned supercritical hydrogen
Moderator-to-sample distance	19.5 m
Sample-to-detector distance	0.5–3 m
Wavelength range	0.1–3 Å
Momentum transfer range	0.04–100 $Å^{-1}$
Detector angular range	1–175° scattering angle
Detector coverage	~10.5 sr
Flux on sample	~1 x 10^8 neutrons cm^{-2} sec^{-1}

Status:
To be commissioned in 2010

APPLICATIONS

- Environmental (e.g., solvent) effects on and direction of nanoscale structure formation
- In situ structural changes in nanoscale oxide catalysts used in automobile catalytic converters
- Structure of hydrogen storage materials under in situ conditions
- Transient structures of materials under extreme conditions (e.g., at high temperature or high pressure under the influence of transient fields or in metastable states)

FOR MORE INFORMATION, CONTACT

Instrument Scientist: Jörg Neuefeind, neuefeindjc@ornl.gov, 865.241.1635

http://neutrons.ornl.gov/instrument_systems/beamline_01b_nomad

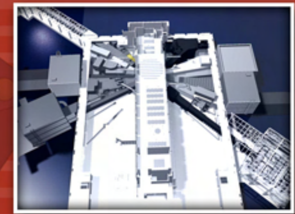
May 2008

06-G01633A/arm

Instrument Fact Sheet

Beam Line 2

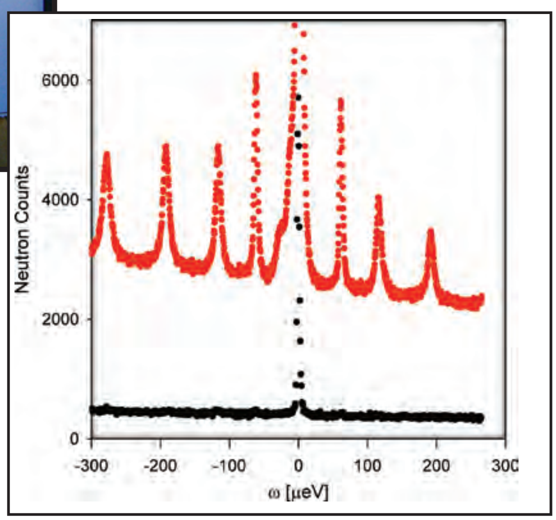
Spallation Neutron Source



BASIS – Backscattering Spectrometer

BASIS is designed to provide extremely high-energy resolution near the elastic peak, enabling studies of the diffusive dynamics of molecules on the atomic length scale (quasi-elastic neutron scattering). This instrument features very high flux and a dynamic range in energy transfer that is approximately five times greater than what is available on comparable instruments today. In addition, this instrument provides the unique capability of shifting the incident neutron bandwidth, enabling inelastic scattering to 18 meV of energy transfer, with a resolution of 0.1% of the energy transfer.

Backscattering spectrometer large evacuated final flight path.



Measurement of the quantum tunneling peaks in 4-methyl pyridine N-oxide (N-oxy gamma-picoline, C_6H_7NO) at 4 K.

Specifications

Si 111	
Elastic energy	2.08 meV
Bandwidth	±250 μeV
Resolution (elastic)	3.5 μeV
Q range (elastic)	0.2 Å^{-1} < Q < 2.0 Å^{-1}
Solid angle	1.2 sr 2.4 sr (upgrade)

Si 311 (upgrade)	
Elastic energy	7.64 meV
Bandwidth	±1700 μeV
Resolution (elastic)	10 μeV
Q range (elastic)	0.38 Å^{-1} < Q < 3.8 Å^{-1}
Solid angle	1.2 sr

Status: Operational

Applications

BASIS can be used to probe dynamic processes in various systems on the pico- to nanosecond time scale. It is well suited for probing diffusive and relaxational motions but can also be effectively used for studying some types of collective excitations in condensed matter. Applicable fields of study include, but are not limited to, biology, polymers, small molecules, complex fluids, magnetism, and materials science.

For more information, contact

Instrument Scientist: Eugene Mamontov, mamontove@ornl.gov, 865.574.5109
Instrument Scientist: Michaela Zamponi, zamponimm@ornl.gov, 865.576.5119
Scientific Associate: Stephanie Hammons, hammonsse@ornl.gov, 865.300.8100

http://neutrons.ornl.gov/instrument_systems/beamline_02_basis

May 2008

05-03083B/arm

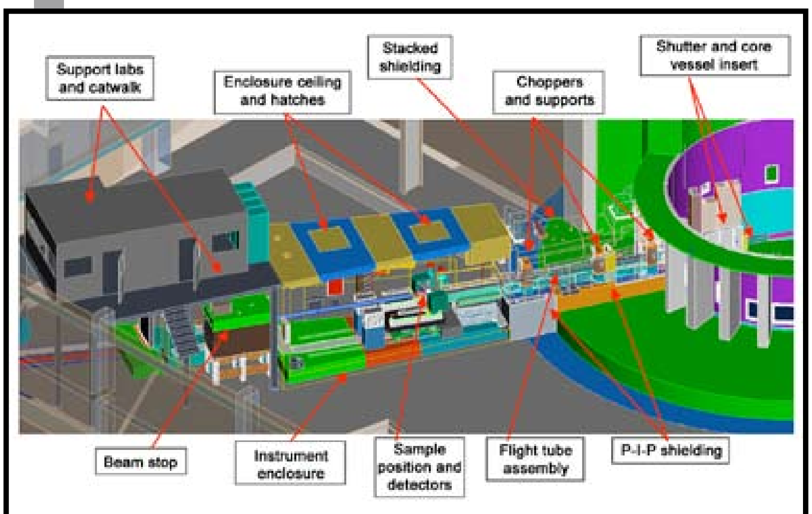
Instrument Fact Sheet

Beam Line 3

Spallation Neutron Source

SNAP – Spallation Neutrons and Pressure Diffractometer

The SNAP Diffractometer allows studies of a variety of powdered and single-crystal samples under extreme conditions of pressure and temperature. The increased neutron flux, coupled with large-volume pressuring cells using large synthetic single-crystal opposed anvils, allows significant advances in the pressure range accessible to neutron diffraction. The pressure goal is 50 to 100 GPa on an ~1-mm^3 sample on a routine basis. We are currently working with powdered samples up to 15 GPa and are developing the ultrahigh-pressure capabilities. In addition, recent advances in next-generation detectors will allow the incident beam-focusing optics, pressure chamber, and detector array to be highly integrated, providing a highly flexible facility for materials studies under extreme conditions.



Specifications

Moderator	Decoupled poisoned supercritical hydrogen
Source-to-sample distance	15 m
Sample-to-detector distance	50 cm
Angular coverage	381–42º \ 981–50º horizontal ±34° vertical
Wavelength range (bandwidth)	
Frame 1	0.5–3.65 Å
Frame 2	3.7–6.5 Å
Pressure range	From ambient pressure to >50 GPa (500 kbar)
Focused beam size	From 1 cm to <100 μm

Status: Operational

Applications

SNAP offers new opportunities for scientific studies involving the following:

- Hydrogen under extreme conditions
- Elastic anisotropy of ε-iron at Earth core conditions
- Real-time in situ monitoring of "real rocks" as an analogue to the down-going slab in the subduction context
- Planetary ices—structure and strength of ices under pressure
- Silicate melts—glasses at high pressure and temperature and the dynamical changes occurring during heating and pressurization
- Strength and rheology of materials and the relationship to brittle and ductile failure, including stress release as a function of time
- Structural changes accompanying transitions in Fullerenes and their derivatives
- Hydrogen bonding in organic and inorganic systems as a function of pressure and temperature, including liquids

For more information, contact

Instrument Scientist: Chris Tulk, tulkca@ornl.gov, 865.576.7028
Scientific Associate: Jamie Molaison, molaisonjj@ornl.gov, 865.206.0478

http://neutrons.ornl.gov/instrument_systems/snap.shtml

SNS

February 2009

06-G00803C/arm

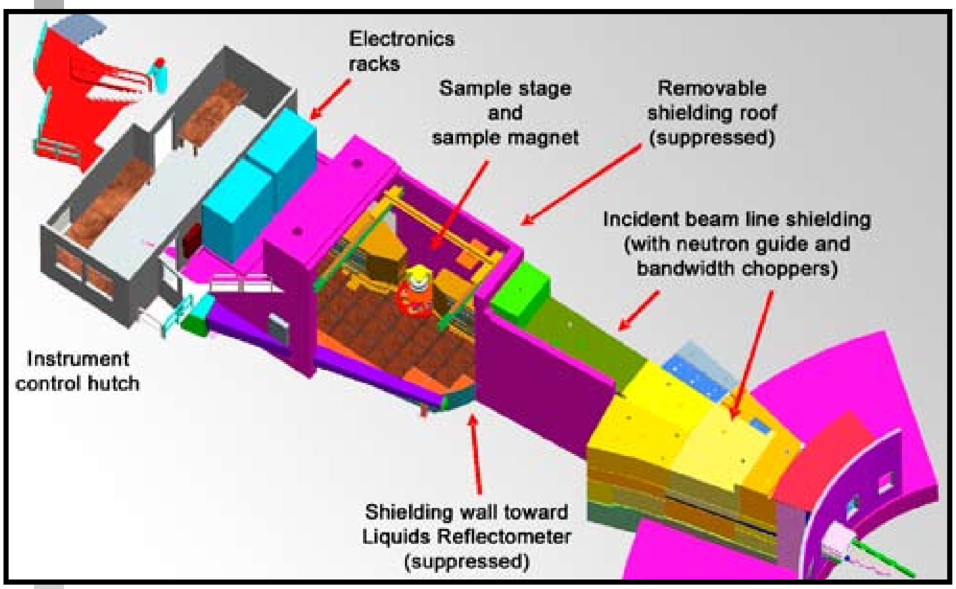
Instrument Fact Sheet

BEAM LINE **4A**

SPALLATION NEUTRON SOURCE

Magnetism Reflectometer

The Magnetism Reflectometer is dedicated to reflectometry studies of magnetic thin films, superlattices, and nanoscale structures. The combination of the high-power SNS and the use of advanced neutron optics allows for off-specular scattering studies of in-plane magnetic and nonmagnetic structures. High-angle diffraction geometry is available for experiments on thin films and multilayers. The availability of polarized neutrons and polarization analysis suggests that this instrument can also be used for specific studies of nonmagnetic thin-film samples. Examples of the latter include contrast variation, incoherent background reduction, and phase determination for direct inversion of reflectivity data into real-space scattering-length density profiles.



Specifications

Source-to-sample distance	18.64 m
Sample-to-detector distance	0.5–6 m
Detector size	18 x 18 cm^2
Detector resolution	1.5 mm
Moderator	Coupled supercritical hydrogen
Bandwidth	$\Delta\lambda = 3.1$ Å
Wavelength range	1.8 Å < λ < 14.0 Å
Q range	0 $Å^{-1}$ < Q < 7.0 $Å^{-1}$
Magnetic field	Max 1.2 T with a gap of 50 mm
T range	5 - 300 K
Minimum reflectivity	10–7

Status: Operational

Applications

The Magnetism Reflectometer is applicable primarily to studies with thin magnetic films, an increasingly important area of solid-state physics. Experiments could also benefit engineering, metallurgy, or biological problems. Instrument capabilities allow, for example, studies of magnetic recording media and magnetic sensors, as well as depth-dependent studies of structural/magnetic nanoparticles or domains. The instrument's unique capabilities provide for multilength-scale experiments, and it has sufficient beam intensity for detailed structural/magnetic phase-diagram determinations. In situ studies on ultrathin films in an ultrahigh-vacuum environment are planned as a future upgrade capability.

For more information, contact

Instrument Scientist: Valeria Lauter, lauterv@ornl.gov, 865.576.5389
Scientific Associate: Richard J. Goyette Jr., goyetterj@ornl.gov, 865.241.9991

http://neutrons.ornl.gov/instrument_systems/beamline_04a_mr

SNS

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05-03085D/arm

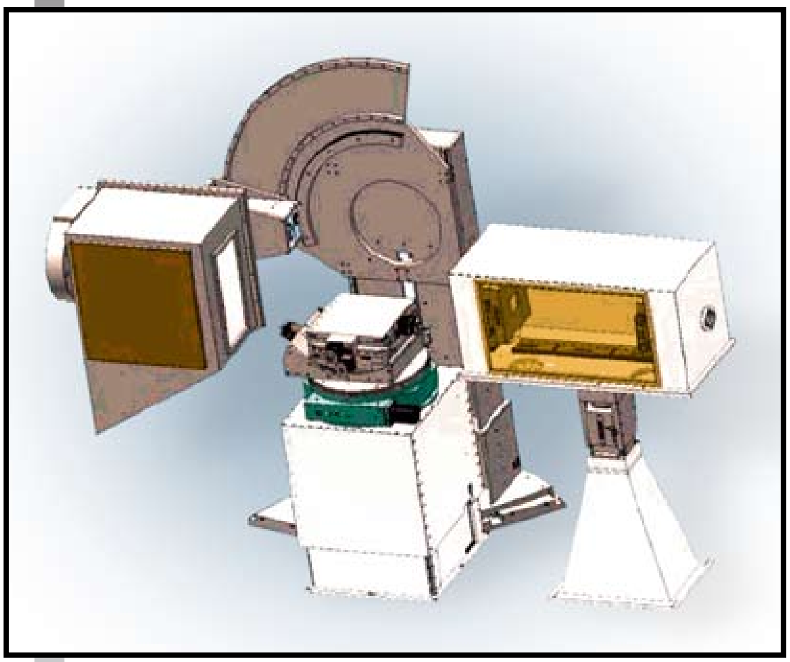
Instrument Fact Sheet

BEAM LINE **4B**

SPALLATION NEUTRON SOURCE

LIQUIDS REFLECTOMETER

The Liquids Reflectometer features a horizontal sample geometry and thus can accommodate air/liquid surfaces in addition to air/solid and liquid/solid interfaces. Active vibration isolation minimizes capillary-wave production by the external environment. Data rates and Q range covered at a single scattering angle setting will be sufficiently high to permit "real-time" kinetic studies on many systems. Time-resolved experiments include investigations of chemical kinetics, solid-state reactions, phase transitions, and chemical reactions in general.



Liquids Reflectometer goniostat.

SPECIFICATIONS

Source-to-sample distance	13.6 m
Sample-to-detector distance	1.5 m
Detector size	20 x 20 cm^2
Detector resolution	1.3 x 1.3 mm^2
Moderator	Coupled supercritical hydrogen
Bandwidth	$\Delta\lambda$ = 3.5 Å
Wavelength range	2.5 Å < λ < 17.5 Å
Q range (air/liquid)	0 $Å^{-1}$ < Q < 0.3 $Å^{-1}$
Q range (air/solid)	0 $Å^{-1}$ < Q < 0.3 $Å^{-1}$
Minimum reflectivity	1 x 10^{-7}

Status: Operational

APPLICATIONS

The Liquids Reflectometer is useful for a wide range of science. Current areas of interest include biomaterials, polymers, and chemistry involving thin layers of surfactants or other materials on the surfaces of liquids, such as cell-membrane analogs. These systems provide a flexible platform to study structure-property relationships at the boundary between hard and soft matter, with applications in biomimetics, bio-sensing, and bio-compatible films; hydrogen storage and fuel cells; and polymers.

FOR MORE INFORMATION, CONTACT

Instrument Scientist: John Ankner, anknerjf@ornl.gov, 865.576.5122
Instrument Scientist: Jim Browning, browningjf@ornl.gov, 865.241.3905
Scientific Associate: Candice Halbert, halbertce@ornl.gov, 865.574.9255

http://neutrons.ornl.gov/instrument_systems/beamline_04b_lr

SNS
February 2009
05-03086E/arm

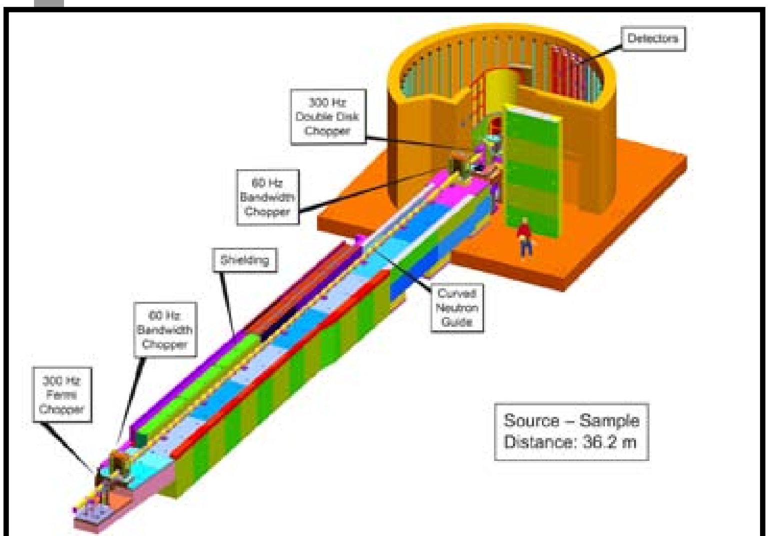
INSTRUMENT Fact Sheet

BEAM LINE 5

SPALLATION NEUTRON SOURCE

CNCS – COLD NEUTRON CHOPPER SPECTROMETER

CNCS is a high-resolution, direct-geometry, multichopper inelastic spectrometer designed to provide flexibility in choice of energy resolution and to perform best at low-incident energies (2–50 meV). Although the initial detector coverage around the sample is 1 sr, a later upgrade to 3 sr is possible. CNCS experiments typically use an energy resolution between 10 and 500 μeV. A broad variety of scientific problems, ranging from complex and quantum fluids to magnetism and chemical spectroscopy, can be addressed through experiments on the CNCS.



Engineering design of the CNCS beam line from the target monolith to the instrument satellite building.

SPECIFICATIONS

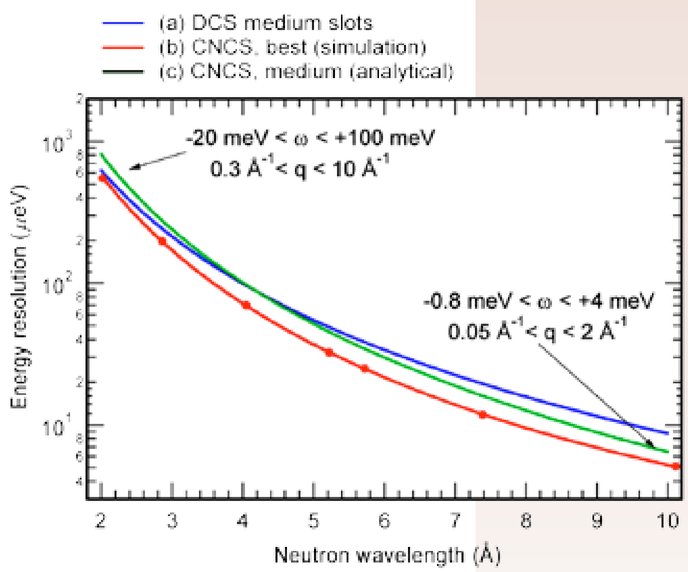
Source-to-sample distance	36.2 m
Sample-to-detector distance	3.5 m
Angular coverage	-90 … +140° horizontally ± 25° vertically
Energy resolution	10-500 μeV
Incident energy range	2–50 meV
Momentum transfer range	0.05–10 Å^{-1}

Status: Operational

APPLICATIONS

CNCS is applicable primarily to studies in the following:

- Complex fluids: dilute protein solutions, biological gels, selective absorption of molecules on surfaces
- Dynamics in confined geometries
- Magnetism: low-dimensional systems; non-Fermi liquids; frustrated, disordered, or molecular magnets



FOR MORE INFORMATION, CONTACT

Instrument Scientist: Georg Ehlers, ehlersg@ornl.gov, 865.576.3511
Scientific Associate: Jennifer Niedziela, niedzielajl@ornl.gov, 865.748.5814

http://neutrons.ornl.gov/instrument_systems/beamline_05_cncs

SNS

February 2009

06-G00801B/arm

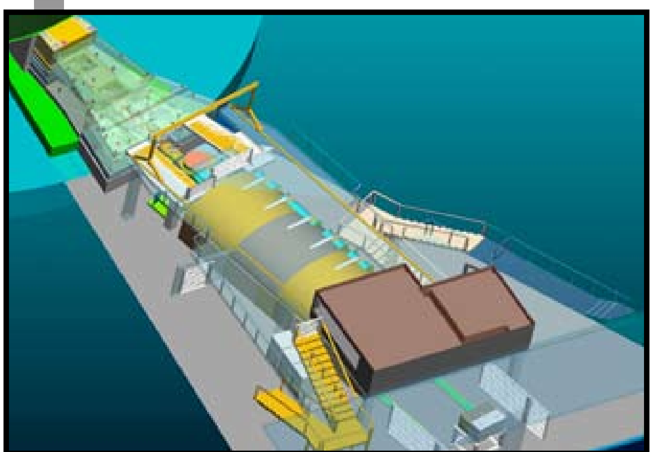
Instrument Fact Sheet

BEAM LINE 6

Spallation Neutron Source

EQ-SANS — Extended Q-Range Small-Angle Neutron Scattering Diffractometer

The EQ-SANS Diffractometer is designed to study noncrystalline, nanosized materials in solid, liquid, or gas forms such as polymers, proteins in solution, and micelles. EQ-SANS has very high intensity and wavelength resolution. It also has a wide Q coverage, allowing simultaneous data collection in both low-and high-Q regions. Scattering from nanomaterials is concentrated mostly in a forward direction, or small angles. These scattering data yield information about the size and shape of the nanoparticles. Applications include the study of polymers, better detergents and soaps from improved micelles, proteins for better drug design, and materials of interest to the oil industry.



Applications

The unique capabilities of the EQ-SANS offer new opportunities for scientific studies in the following:

Life science

- Solution structures of proteins, DNA, and other biological molecules and molecular complexes
- Protein-protein and protein-ligand interactions, kinase regulation
- Protein-membrane interaction

Polymer and colloidal systems

- Block copolymers and dendrimers
- Micelles, aerosols, and emulsions
- Polyelectrolytes and electric double-layer and ion distribution at solid-liquid interfaces

Materials science

- Simultaneous study of domain and crystalline structures
- Crystallization and precipitation
- Nanoparticles

Earth and environmental sciences

- Pore structure in soil
- Absorption of contaminants by soil
- Fractal structure of rocks

Specifications

Source-to-sample distance	14 m
Bandwidth	3–4.3 Å
Moderator	Coupled supercritical hydrogen
Integrated flux on sample	~10^7–10^9 n/cm^2/s
Q range	0.004 $Å^{-1}$ < Q < 10 $Å^{-1}$

Low-Angle Detector	
Sample-to-detector distance	1–8 m
Detector size	1 x 1 m
Detector resolution	8 mm

High-Angle Detector	
Sample-to-detector distance	1 m
Angular coverage	~35–150°
Detector resolution	8 mm

Status: In commissioning

For more information, contact

Instrument Scientist: J. K. Zhao, zhaoj@ornl.gov, 865.574.0411
Scientific Associate: Carrie Gao, gaoy1@ornl.gov, 865.576.5296

http://neutrons.ornl.gov/instrument_systems/beamline_06_eqsans

February 2009

05-03084D/arm

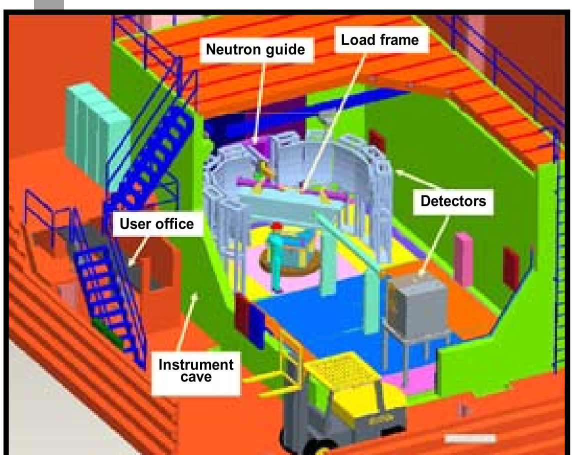
INSTRUMENT Fact Sheet

BEAM LINE 7

SPALLATION NEUTRON SOURCE

VULCAN – ENGINEERING MATERIALS DIFFRACTOMETER

VULCAN helps users understand a broad range of engineering and materials science problems. Characteristics of the instrument include stress mapping of engineering components with a 1-mm^3 sampling volume, in situ loading with 10 to 20 reflections, and real-time studies of the kinetics of materials on subsecond time scales. The basic design allows users to determine stress distribution in engineering components and to understand more about the deformation of materials under multiaxial loading. VULCAN can help scientists and engineers test the reliability of structural components and better understand how materials deform. The flux on sample will reach 1 x 10^8 neutrons/cm^2/s, providing a high intensity for fast kinetic studies. The instrument team plans to have a small-angle detector to allow users to conduct simultaneous measurements of small-angle scattering, thereby enabling studies of the evolution of material structures at multiple-length scales.



SPECIFICATIONS

Moderator	Decoupled poisoned water
Source-to-sample distance	43.5 m
Sample-to-detector distance	1.5–2 m
Detector angular coverage	60º < 2θ < 150º
Wavelength bandwidth	~1.3 Å
Resolution	0.2% in high-resolution mode
Flux on sample (n/s/cm^2)	3 x 10^7 in high-resolution mode 1.2 x 10^8 in high-intensity mode
Gauge volume	3D strain mapping: 1 mm^3 1D strain mapping: 0.1 mm
SANS Q range	0.01–0.2 (Å^{-1})

Status:
To be commissioned in 2009

APPLICATIONS

VULCAN is designed to tackle a variety of problems in materials science and engineering, ranging from determining residual stress in engineering components to understanding the fundamental aspects of materials behaviors during processing and use. Although it is difficult to predict the kinds of new science that will be enabled by instruments like VULCAN, some research areas that VULCAN could benefit include the following:

- In situ studies of materials behavior during processing: temperature distribution, texture changes, stress development, precipitation
- In situ loading studies at high or cryogenic temperatures: fatigue damage, deformation in nanostructured materials, creep behaviors, piezoelectric and shape-memory alloys
- Residual stress and microstructure changes in surface-engineered materials
- Deformation in amorphous materials
- Phase transformation kinetics

FOR MORE INFORMATION, CONTACT

Instrument Scientist: Xun-Li Wang, wangxl@ornl.gov, 865.574.9164
Instrument Scientist: Ke An, kean@ornl.gov, 865.241.1899
Scientific Associate: Harley Skorpenske, skorpenskehd@ornl.gov, 865.228.8460

http://neutrons.ornl.gov/instrument_systems/beamline_07_vulcan

SNS

February 2009

06-G00801C/arm

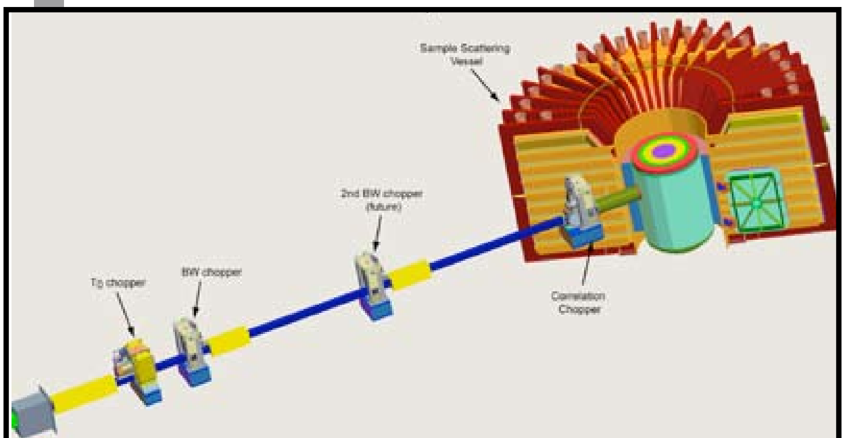
Instrument Fact Sheet

Beam Line 9

Spallation Neutron Source

CORELLI – Elastic Diffuse Scattering Spectrometer

CORELLI is a statistical chopper spectrometer with energy discrimination. The momentum transfer ranges from 0.5 to 12 Å^{-1}, and the energy of incident neutrons ranges from 10 to 200 meV. This instrument combines the high efficiency of white-beam Laue diffraction with energy discrimination by modulating the beam with a statistical chopper. A cross-correlation method is used to reconstruct the elastic signal from the modulated data. Accurate modeling of the short-range order associated with the diffuse scattering requires measurements over large volumes of three-dimensional reciprocal space, with sufficient momentum resolution to distinguish the diffuse signal from the strong Bragg peaks.



Applications

CORELLI is designed and optimized to probe complex disorder in crystalline materials through diffuse scattering of single-crystal samples. Studies at this instrument encompass a wide range of novel materials.

- Diffuse scattering in material science, including colossal magnetoresistance materials, ferroelectric relaxors, and fast ion conductors.
- Diffuse scattering in condensed matter physics, including high-temperature superconductors, geometrically frustrated systems, and quantum critical phenomena.
- Diffuse scattering in molecular systems including molecular solids and microporous framework systems.

Specifications

Moderator	Ambient H_2O decoupled poisoned
Source-to-sample distance	20 m
Sample-to-detector distance	2.5 m
Anular coverage	-23° to +152° horizontally ±28.5° vertically
Energy resolution	1 meV at 10 Å^{-1}
Momentum resolution	ΔQ/Q~0.005
Incident energy range	10–200 meV
Momentum transfer	0.5–12 Å^{-1}
Beam size at sample position	~ 1 cm^2

Status:
To be commissioned in 2014

For more information, contact

Instrument Scientist: Feng Ye, yef1@ornl.gov, 865.576.0931

SNS

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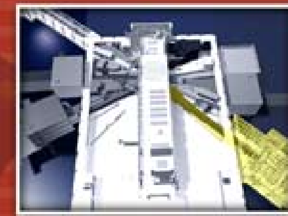
09-G00161/arm

Instrument Fact Sheet

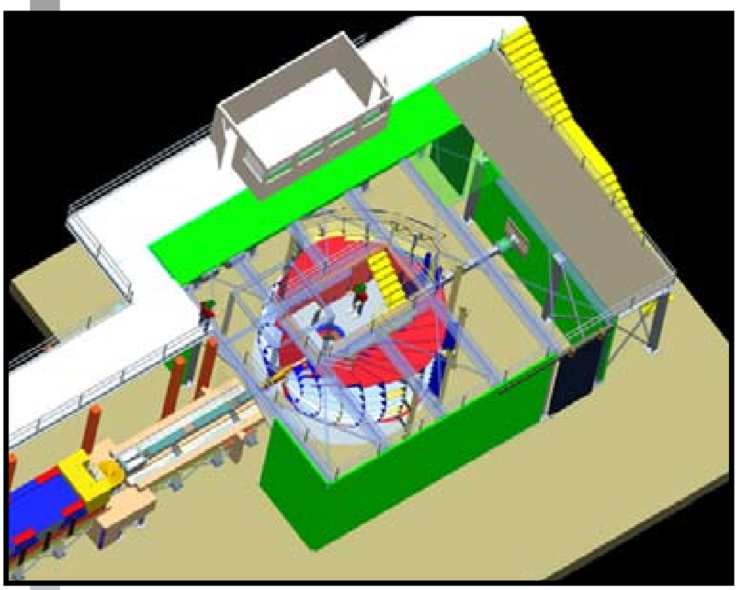
BEAM LINE 11A

SPALLATION NEUTRON SOURCE



POWGEN – Powder Diffractometer

POWGEN is designed to study polycrystalline materials. This versatile diffractometer enables users to collect typical Rietveld statistics in ~20 minutes from a 0.6-cm^3 sample with ~0.1% resolution at short d-spacings and <1% resolution for nearly all d-spacings of interest. Adjustment of the phase of the bandwidth choppers in this instrument also allows collection of diffraction data for d-spacings as large as 66 Å. Because of the third-generation conceptual design of POWGEN, users can choose the wavelengths for data collection and have complete freedom in selecting the subset of data to be included in analysis. These alternatives allow greater flexibility than most existing neutron diffractometers. In addition, this standard tool provides faster and higher precision than other diffractometers in the United States.



Secondary flight path for the Powder Diffractometer. The sample is 60 m from the moderator, necessitating a satellite building outside the Target Building for the secondary flight path.

Specifications

Moderator	Decoupled poisoned supercritical hydrogen
Source-to-sample distance	60 m
Sample-to-detector distance	1–6 m
Detector angular coverage	$6 < 2\theta < 170°$
Wavelength bandwidth	~1 Å
Frame 1	0.3 Å < d < 10 Å
Frame 6	3 Å < d < 66 Å
Resolution	$0.001 < \Delta d/d < 0.016$
Resolution at 90°	$\Delta d/d = 0.0015$

Status: In commissioning

Applications

Scientific studies at this instrument encompass a wide range of novel materials. These include, but are not limited to, structural studies of magnetic materials such as high-Tc superconductors, metal-insulator phase transitions, charge and orbital ordering transitions, and molecular magnets. Additional possibilities include nonmagnetic materials such as Zeolite and aluminophosphate frameworks; metals and semiconductors; dielectrics, ferroelectrics, and thermoelectrics; and ab initio structure solutions of polycrystalline materials such as pharmaceutical compounds. In addition, POWGEN is capable of acquiring refineable data sets in rapid data collection mode, making it an ideal instrument for parametric studies and time-resolved in situ studies of the electrochemistry of catalysts, ceramic membranes, hydrogen storage materials, and charging and discharging of battery materials.

For more information, contact

Instrument Scientist: Jason Hodges, hodgesj@ornl.gov, 865.576.7034
Instrument Scientist: Ashfia Huq, huqa@ornl.gov, 865.574.7923
Instrument Scientist: Olivier Gourdon, gourdonoa@ornl.gov, 865.576.6629
Scientific Associate: Luke Heroux, herouxla@ornl.gov, 865.771.7123

http://neutrons.ornl.gov/instrument_systems/beamline_11a_powgen

SNS
February 2009
05-03082C/arm

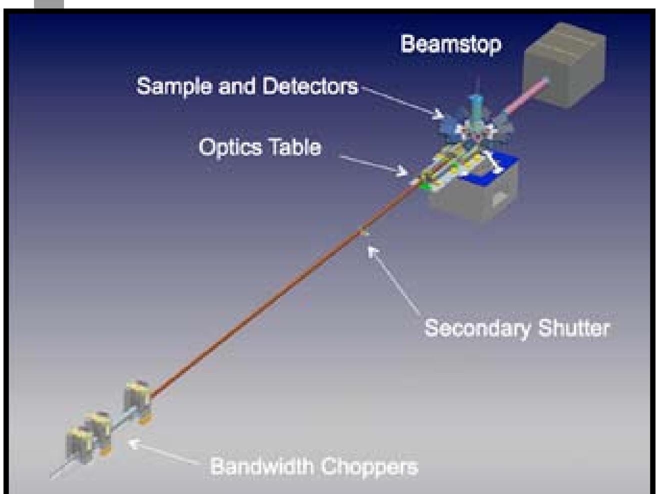
INSTRUMENT Fact Sheet

BEAM LINE **11B**

SPALLATION NEUTRON SOURCE

MaNDi – Macromolecular Neutron Diffractometer

MaNDi allows the study of single crystals and is optimized for rapid data collection from large macromolecular structures. MaNDi will achieve 1.5-Å resolution from crystal volumes between 0.1 and 1.0 mm^3, with lattice repeats on the order of 150 Å. With larger crystals (>1 mm^3), it will be possible to obtain useful data in the resolution range of 2.0 to 2.5 Å for unit-cell repeats of up to 300 Å, a revolution in neutron macromolecular crystallography (NMC). Experimental duration times are to be between one and seven days, which will revolutionize NMC for applications in the fields of structural biology, enzymology, and computational chemistry.



The MaNDi detectors are designed to cover a large solid angle to record most of the neutrons scattered from a single-crystal sample, regardless of the reflection angle. This capability is accomplished through the instrument design, which places the detectors approximately spherically around the sample. The detector design follows a modular approach. A spherical detector mount will be constructed to accommodate the appropriate number of individual modules of two-dimensional, time-sensitive detectors with front face dimensions of 150 × 150 mm, leaving openings for the sample orienter/environment (top) and the incident and exiting direct neutron beam (horizontal plane). The spatial resolution of the detector is 1 mm, with a minimal sensitivity to gamma rays, hence preserving the signal-to-noise ratio of the Bragg peaks. The efficiency of this type of detector using a 1.5-mm-thick scintillator is 78% for neutrons with a wavelength of 1 Å. An increase in neutron wavelength is coupled with an increase in detection efficiency.

Precision mounting will place the 0.1-mm^3 crystals within the neutron beam, and the sample-positioning system will allow translation and rotation in x, y, and z to precisely align the sample. These operations will be remotely controlled and motor driven by a user-friendly graphical user interface.

Applications

MaNDi offers radical new opportunities for scientific studies involving the following:

- Molecular magnets, computational chemistry, and fibers
- Protein studies to provide better drug molecules for the treatment of cancer and HIV
- Studies of enzyme mechanisms to accelerate important industrial reactions
- Mechanisms used by plants to convert light into energy

Specifications

Moderator	Decoupled hydrogen
Source-to-sample distance	30 m
Sample-to-detector distance	0.45 m
Initial angular detector coverage	3 sr
Optional angular detector coverage	7 sr
Detector pixel size	6.2 x 10^{-6} sr (>1 mm)
Detector angles	0–180°
Wavelength bandwidth	2.16 Å
Resolution	$\Delta d/d = 0.0015$
Sample size	0.1 mm^3
Divergence	6–16 mrad

Status:
To be commissioned in 2012

For more information, contact

Instrument Scientist: Leighton Coates, coatesl@ornl.gov, 865.241.3427

http://neutrons.ornl.gov/instrument_systems/beamline_11b_mandi

SNS

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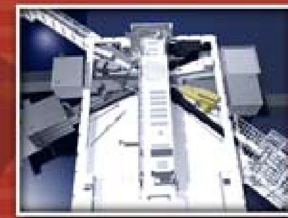
07-G00833A/arm

INSTRUMENT Fact Sheet

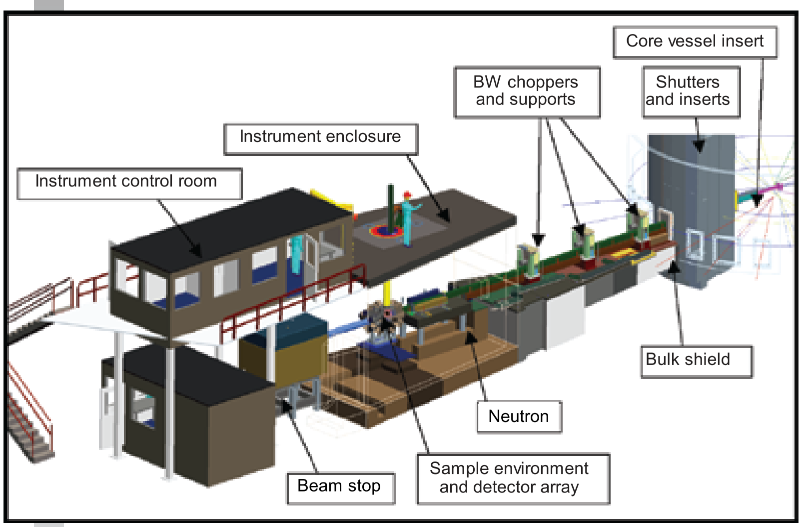
BEAM LINE 12

SPALLATION NEUTRON SOURCE



TOPAZ – SINGLE-CRYSTAL DIFFRACTOMETER

The TOPAZ Single-Crystal Diffractometer (SCD) is designed to perform elastic scattering experiments under controlled environmental conditions to probe material structures and responses. Use of the same single-crystal sample for X-ray and neutron diffraction was the guiding design principle of TOPAZ, a versatile and variable-environment SCD for neutron scattering. Data are collected on samples between 0.001 and 0.1 mm^3, and expected average unit cell dimensions are around 50 x 50 x 50 $Å^3$ for compounds of moderate complexity. The goal for TOPAZ is the capability to collect data in a matter of hours rather than days. Materials investigated include functional materials of the high-Tc superconductor perovskite family; magnetic superstructures in perovskites and spinels; the molecular basis of future high-density, three-dimensional storage materials; and catalytic precursors, metalhydrides, and organometallics. Options to polarize the neutron beam for magnetic scattering experiments are included, as well as the ability to record Bragg intensities and diffuse scattering at cryogenic and elevated temperatures. A polarized incident neutron beam and magnetic field option on the sample will help scientists decipher complex and directional magnetism and magnetic transitions.



APPLICATIONS

TOPAZ can address problems and greatly expand the range of materials explored in chemistry, earth sciences, materials science and engineering, solid-state physics, and biology. It can also assist in studies of therapeutics and medical compounds, such as aspirin and paracetamol, to show differences in hydrogen locations and bonding, helping scientists better understand a material's individual effectiveness.

SPECIFICATIONS

Moderator	Decoupled poisoned hydrogen
Source-to-sample distance	18 m
Sample-to-detector distance	39–45 cm
Initial angular detector coverage	2 sr
Optional angular detector coverage	4 sr
Detector pixel size	6.2×10^{-6} sr (1 mm)
Detector angles	0–180°
Wavelength bandwidth	3.35 Å
Frame 1	0.5–3.85 Å
Resolution	0.1–0.2%
Sample size	0.001 mm^3 < S < 1 mm^3
Neutron beam divergence on sample	10 mrad < d < 25 mrad

Status:
To be commissioned in 2009

FOR MORE INFORMATION, CONTACT

Instrument Scientist: Christina Hoffmann, hoffmanncm@ornl.gov, 865.576.5127
Instrument Scientist: Xiaoping Wang, wangx@ornl.gov, 865.576.1953
Scientific Associate: Matthew Frost, frostmj@ornl.gov, 865.576.2033

http://neutrons.ornl.gov/instrument_systems/beamline_12_topaz

SNS

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06-G00805C/arm

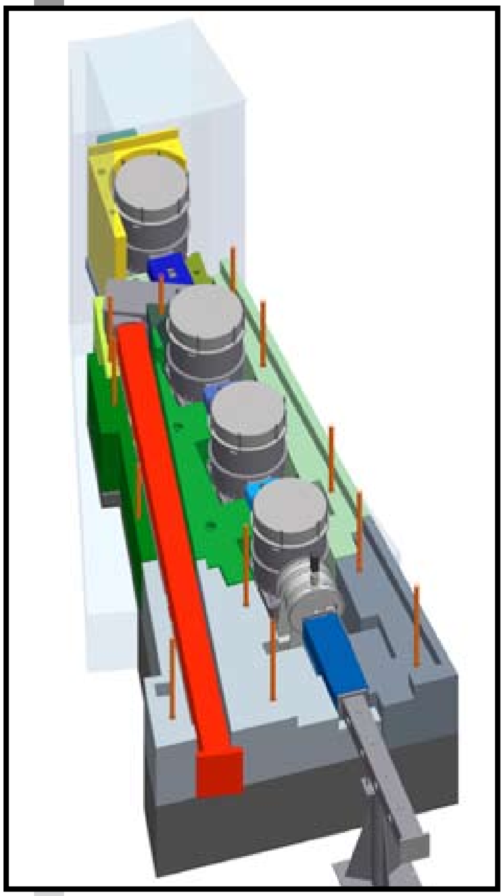
Instrument Fact Sheet

Beam Line 13

Spallation Neutron Source

FNPB – Fundamental Neutron Physics Beam Line

The FNPB provides neutron beams for a variety of experiments in nuclear and particle physics. This facility is designed to accommodate two classes of experiments: (1) cold neutron experiments that require intense, broad-spectrum beams and (2) ultracold neutron experiments in which neutrons of ~1 meV are "down-converted" to near zero energy in superfluid liquid helium. Experiments at the FNPB include precise measurements of the parameters that describe neutron beta decay, studies of the weak interaction between quarks, and a search for a non-zero neutron electric dipole moment. Each of the experiments at the FNPB requires the development, construction, and installation of major pieces of experimental equipment, and each experiment could take beams for periods of several months to a few years.



Design model of the FNPB guide system showing the curved cold beam with four frame overlap choppers, as well as the monochromator housing and the ballistic ultracold neutron guide. The cold guide and choppers share a common vacuum to reduce window losses.

Applications

The FNPB is designed to address questions of interest in cosmology, nuclear and particle physics, and astrophysics. Among the questions that will be addressed are the origin of the light elements (big bang nuclear synthesis), the source of the cosmic matter-antimatter asymmetry, and the origin of parity violation.

Specifications

Cold Neutron Beam Line	
Supermirror guide	Curved, m = 3.6
Beam area	100 x 120 mm
Choppers	4 frame overlap
Peak wavelength	3.5 Å

Independent secondary shutter

Floor pit for superconducting magnet

Ultracold Neutron Beam Line	
Guide	33 m ballistic
Wavelength	8.9 Å
Monochromator	Double-crystal alkalai intercalated graphite

External building experimental area

Status: In commissioning

For more information, contact

Project Manager: Geoff Greene, greenegl@ornl.gov, 865.574.8435

http://neutrons.ornl.gov/instrument_systems/beamline_13_fnpb

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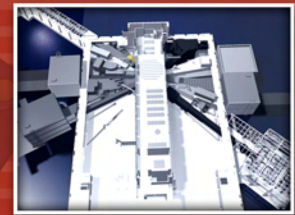
Instrument Fact Sheet

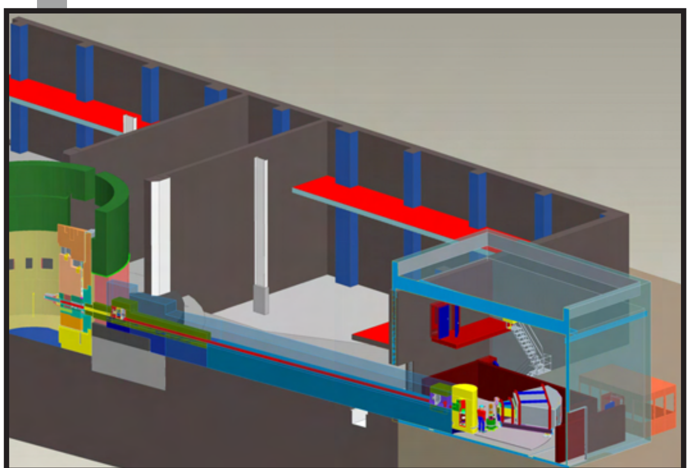
Beam Line 14B

Spallation Neutron Source



HYSPEC – Hybrid Spectrometer

HYSPEC is a high-intensity, direct-geometry instrument optimized for measurement of excitations in small single-crystal specimens. The incident neutron beam is monochromated using a Fermi chopper with short, straight blades and is then focused onto the sample using Bragg scattering optics. Neutrons are detected in a bank of position-sensitive detector tubes that can be positioned over a wide range of scattering angles about the sample axis. This combination of Fermi chopper and Bragg focusing optics, plus a position-sensitive detector bank, leads to a highly flexible instrument in which the energy and wave vector resolution can be independently varied by nearly an order of magnitude. Either full or partial neutron polarization analysis can be deployed on HYSPEC. This is accomplished by using a Heusler crystal array to polarize the incident beam and either a ^{3}He spin filter or supermirror wide-angle polarization analyzers for the scattered beam.



Applications

HYSPEC is applicable primarily to studies in the following:

- Superconductors
- Strongly correlated electron materials
- Ferroelectrics
- Lattice and magnetic dynamics
- Phase transitions
- Quantum critical points
- Complex phases in intermetallic compounds
- Frustrated magnets
- Low-dimensional magnetic excitations
- Transition metal oxides
- Spin and lattice dynamics in nanostructures

Specifications

Moderator	Coupled cryogenic hydrogen
Moderator-to-Fermi chopper distance	37.2 m
Chopper -to-sample distance	3.2 m
Focusing crystals-to-sample distance	1.4–1.8 m
Sample-to-detector distance	4.5 m
Incident energy range	3.6–90 meV
Energy resolution (elastic scattering)	$0.02 < (\Delta E/E_I) < 0.2$
Scattering-angle range	$2° < 2\theta_S < 135°$

Status:
To be commissioned in 2011

For more information, contact

Instrument Scientist: Mark Hagen, hagenme@ornl.gov, 865.241.9782

http://neutrons.ornl.gov/instrument_systems/hyspec.shtml

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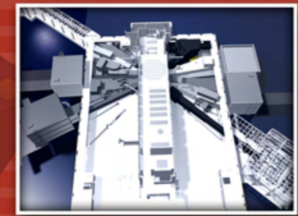
INSTRUMENT *Fact Sheet*

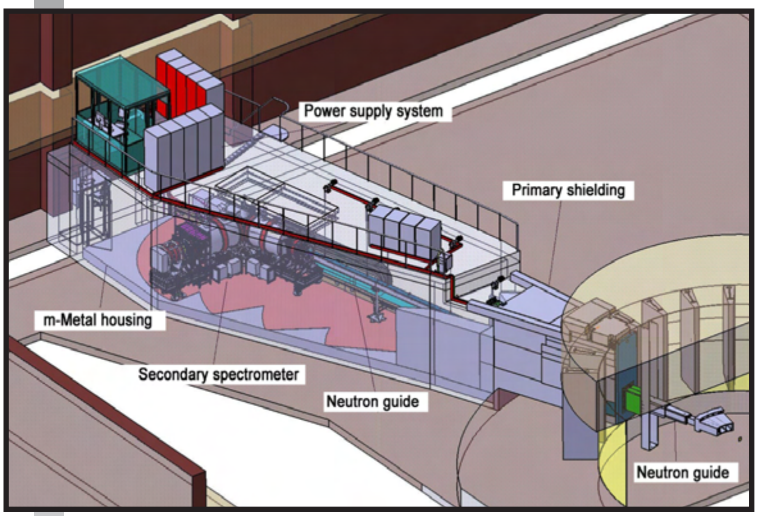
BEAM LINE 15

SPALLATION NEUTRON SOURCE



NSE – NEUTRON SPIN ECHO SPECTROMETER

NSE is the best spectrometer of its class in both resolution and dynamical range. Exploiting superconducting technology and developing novel field correction elements, the maximum achievable Fourier time will be extended to at least 1 μs. Using wavelengths of $0.25 < \lambda/\text{nm} < 2.0$, an unprecedented dynamical range of six decades from 1 ps $< \tau$ to $\tau <$ 1 μs can be achieved. The design of the spectrometer takes advantage of recent progress in neutron optics and polarizing supermirror microbenders, resulting in considerable gains in polarized neutron flux over a wide wavelength range. Performance is also extended by a position-sensitive, two-dimensional detector with a broad detection region. As a result, the effective data rate will gain an additional factor of 5 in addition to the estimated time-averaged sample flux of 10^7 n/cm^{2}s around $\lambda = 1$ nm. This yields the highest available data accumulation rate. In addition, the wavelength distribution width at any time is well below 0.5%, causing the resolution in momentum transfer to increase significantly compared with reactor instruments with 10% or more wavelength distribution width.



APPLICATIONS

Although the NSE spectrometer is designed primarily for soft-matter research, its capabilities also make it useful for all fields of modern condensed matter and materials science. This instrument is especially suited for analyzing slow dynamical processes and thereby unraveling molecular motions and mobilities at nanoscopic and mesoscopic levels. This feature is highly relevant to soft-matter problems in research on the molecular rheology of polymer melts, related phenomena in networks and rubbers, interface fluctuations in complex fluids and polyelectrolytes, and transport in polymeric electrolytes and gel systems. NSE could also aid studies in biophysics and magnetism.

SPECIFICATIONS

Moderator	Cold-coupled hydrogen
Neutron guide *h* × *b*	^{58}Ni coated, 4 × 8 cm^2, m = 1.2
Wavelength selection	Chopper system consisting of four choppers and selecting a wave length band up to 3.66 Å
Accessible wavelength frame	2 Å < λ < 20 Å
Declination angle	3.5°
Maximum scattering angle	≅80°
Q range	0.0025–3.6 Å^{-1}
Maximum field integral	J = 1.8 Tm
Dynamic range	1 ps < τ < 1 μs
Typical sample size	30 × 30 mm
Analyzer	m=3 rotatable supermirror
Detector	^{3}He counter (300 × 300 mm^2)
Typical scanning time with 10% scatterer	5 hours/ spectrum

Status:
To be commissioned in 2009

FOR MORE INFORMATION, CONTACT

Instrument Scientist: Michael Ohl, ohlme@ornl.gov, 865.574.8426

http://neutrons.ornl.gov/instrument_systems/nse.shtml

SNS

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Instrument Fact Sheet

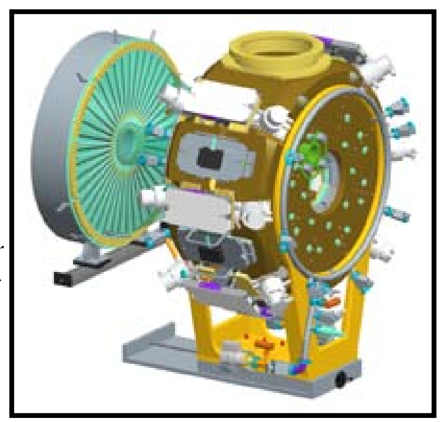
Beam Line 16B

Spallation Neutron Source

VISION – Chemical Spectrometer

VISION is best thought of as the neutron analogue of an infrared-Raman spectrometer. It is optimized to characterize molecular vibrations in a wide range of crystalline and disordered materials over a broad energy range (<5 to >500 meV), while simultaneously recording structural changes using diffraction detectors in the backscattering position and at 90°. This inverted-geometry instrument offers enhanced performance by coupling a white beam of incident neutrons with two banks of eight analyzer modules, equipped with double-focusing crystal arrays, that focus the desired neutrons on a small detector. This arrangement leads to improved signal noise, and the overall count rate in the inelastic signal is at least two orders of magnitude beyond that of similar spectrometers that are currently available.

Engineering model of VISION, including T_0 chopper, bandwidth chopper, secondary spectrometer, and utility rooms.



Secondary spectrometer with detector and analyzer modules.

Applications

Leading-edge studies involving scientific disciplines such as nanotechnology, catalysis, biochemistry, geochemistry, and condensed/soft-matter science will all benefit from the enhanced performance and properties of VISION.

Specifications

Moderator	Decoupled ambient water
Source-to-T_0 chopper distance	7.5 m
T_0 chopper-to-sample distance (primary flight path)	8.5 m
Sample-to-detector distance (secondary flight path)	0.7 m
Incident energy range	3.5–500 meV
Analyzer Bragg angle	45°
Total analyzer area (in 14 identical units)	0.5 m^2
Energy resolution	Exceeds 1.5% (>5 meV) – 5% (<5 meV)
Elastic line width	90 meV
Annular diffraction detector	1.3–14 Å^{-1}
Backscattering diffraction detector	1.5–30 Å^{-1}
delta-d/d	0.001

Status:
To be commissioned in 2012

For more information contact

Principal Investigator: John Larese, jzl@utk.edu, 865.974.3141

Instrument Scientist: Christoph Wildgruber, wildgrubercu@ornl.gov, 865.574.5378

http://neutrons.ornl.gov/instrument_systems/beamline_16b_vision

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06-G01636B/arm

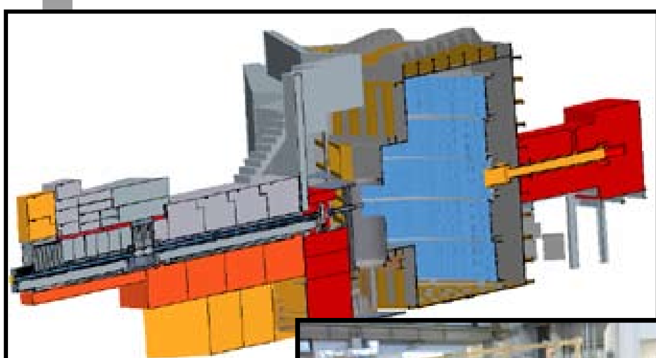
Instrument Fact Sheet

Beam Line 17

Spallation Neutron Source

SEQUOIA – Fine-Resolution Fermi Chopper Spectrometer

SEQUOIA is optimized to provide a high neutron flux at the sample and fine energy resolution. The spectrometer can select neutrons with incident energies from a few hundredths of an electron volt to a couple of electron volts and thus can study excitations over this wide energy scale. An elliptically shaped supermirror guide in the incident flight path boosts the performance at the lower end of this range. The sample and detector vacuum chambers provide a window-free final flight path and incorporate a large gate valve to allow rapid sample changeout. A new T_0 neutron chopper will not only block the prompt radiation from the source but also eliminate unwanted neutrons from the incident beam line. SEQUOIA is a collaboration between Oak Ridge National Laboratory and the Canadian Institute for Neutron Scattering.



Applications

With its capability to acquire data quickly and relate them to three-dimensional momentum transfers, SEQUOIA allows new studies of single crystals and novel systems such as the following:

- High-temperature superconductivity: spin dynamics in superconductors and precursor compounds and incommensurate spin fluctuations at varying doping levels
- Model magnetic systems, such as one-dimensional spin chains and spin ladders, and crossover effects from one- to three-dimensional magnetism
- Excitations in quantum fluids, quantum critical phenomena, and non-Fermi liquid systems
- High-resolution crystal field spectroscopy reaching into the 1-eV range
- Coupling of electronic and spin systems in correlated-electron materials
- Colossal magnetoresistive materials

Specifications

Moderator	Decoupled ambient water
Source-to-Fermi chopper distance	18 m
Chopper-to-sample distance	2.0 m
Sample-to-detector distance	5.5–6.3 m cylindrical geometry
Incident energy range	10–2000 meV
Resolution (elastic)	1–5% E_i
Vertical detector coverage	-30–30°
Horizontal detector coverage	-30–60°
Minimum detector angle	3°

Status: In commissioning

For more information, contact

Instrument Scientist: Garrett Granroth, granrothge@ornl.gov, 865.576.0900

Instrument Scientist: Sasha Kolesnikov, kolesnikovai@ornl.gov, 865.576.9145

Scientific Associate: Todd Sherline, sherlinete@ornl.gov, 865.773.3157

http://neutrons.ornl.gov/instrument_systems/hrcs.shtml

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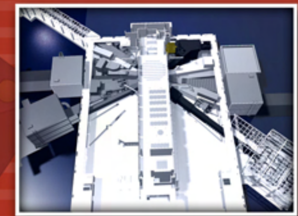
Instrument Fact Sheet

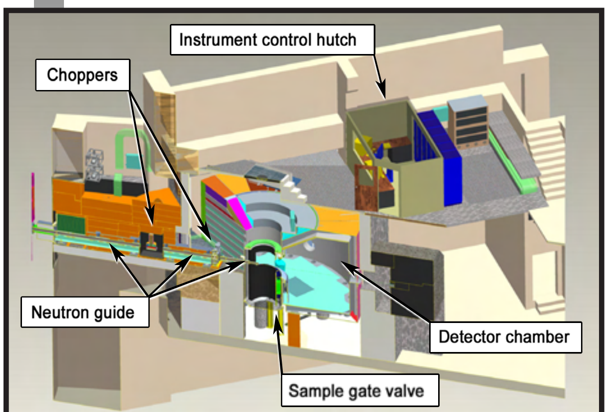
BEAM LINE 18

Spallation Neutron Source



ARCS – Wide Angular-Range Chopper Spectrometer

ARCS is optimized to provide a high neutron flux at the sample and a large solid angle of detector coverage. This spectrometer is capable of selecting incident energies over the full energy spectrum of neutrons, making it useful for studies of excitations from a few to several hundred milli-electron volts. An elliptically shaped supermirror guide in the incident flight path boosts the performance at the lower end of this range. The sample and detector vacuum chambers provide a window-free final flightpath and incorporate a large gate valve to allow rapid sample changeout. A new T_0 neutron chopper is being developed not only to block the prompt radiation from the source but also to eliminate unwanted neutrons from the incident beam line. In addition to the instrument hardware, the ARCS project includes a significant effort for software development.



Cutaway view of the engineering model of the ARCS instrument showing the incident beam line components, sample and detector chamber, and control area.

Applications

Compared with current instruments, the increased sensitivity of ARCS offers new opportunities for scientific studies in the following:

Lattice Dynamics

- Entropy and the effects of vibrational modes on stability and phase transitions of solids
- Excitations in disordered materials; effects of nanoscale features on vibrational entropy and thermodynamic stability
- Equations-of-state from the measured phonon density-of-states versus temperature and pressure
- Phonons in correlated-electron materials; coupling of lattice and electronic degrees of freedom in high-Tc, heavy-fermion, and mixed-valence materials

Magnetic Dynamics

- High-temperature superconductivity—spin dynamics in superconductors and precursor compounds and crystal field spectroscopy
- Low-dimensional systems; one-dimensional quantum magnets and low-dimensional conductors
- Magnetism in actinide materials; heavy-fermion magnetism and superconductivity

Chemical Physics

- Deep inelastic neutron scattering studies of hydrogen

Specifications

Moderator	Decoupled ambient water
Source-to-Fermi chopper distance	11.6 m
Chopper-to-sample distance	2.0 m
Sample-to-detector distance	3.0 to 3.4 m cylindrical geometry
Incident energy range	10–1500 meV
Resolution (elastic)	2–5% E_i
Detector coverage horizontal	-28–135°
Detector coverage vertical	-27–26°
Minimum detector angle	3°

Status: Operational

For more information, contact

Instrument Scientist: Doug Abernathy, abernathydl@ornl.gov, 865.576.5105

Instrument Scientist: Matthew B. Stone, stonemb@ornl.gov, 865.241.0483

Scientific Associate: Mark Loguillo, loguillomj@ornl.gov, 865.235.9000

http://neutrons.ornl.gov/instrument_systems/beamline_18_arcs

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