

CG-4C U.S.-Japan Cold-Neutron Triple-Axis Spectrometer at the High Flux Isotope Reactor Cold Guide Hall

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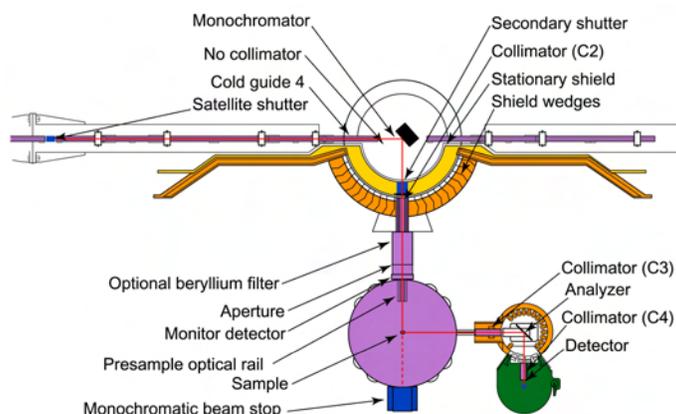
The US-Japan Cooperative Research Program

A successful scientific collaboration. Between 1980 and 2005, hundreds of researchers produced 500 publications in this program.

Partners include the Japan Atomic Energy Research Institute, the Institute for Solid State Physics at the University of Tokyo, Brookhaven National Laboratory and Oak Ridge National Laboratory.

Japan supplies instruments and personnel to US reactor-based neutron scattering facilities. One of these instruments is H4M, a polarized beam triple-axis spectrometer (TAX) formerly at Brookhaven's HFBR.

In turn, the US supplies neutrons for Japanese research at reactor facilities. This TAX will find new life at a new cold source guide (CG-4) at Oak Ridge's High Flux Isotope Reactor.



Cold-Neutron TAX's (~2-5 meV) are complementary to

Thermal neutron TAX's (~10-80 meV). Cold neutrons have higher energy and momentum resolution, and reduced spurious and multiple scattering. They also have greater sensitivity to magnetic phenomena, due both to larger magnetic scattering intensities for smaller Q and a matching energy scale to achievable magnetic fields at the sample.

Neutron Time of Flight Spectrometers, with comparable momentum, energy range and resolution. A TAX allows powerful focusing techniques, more flexible manipulation of the resolution function, and an effective reduction of neutron background via neutron transport.

Inelastic X-Ray Spectrometers, because of its higher energy resolution and lower momentum resolution; because of different cross section criteria (electron scattering for x-rays, and nuclear and magnetic scattering for neutrons); and because of the relative penetration depth of the two techniques.

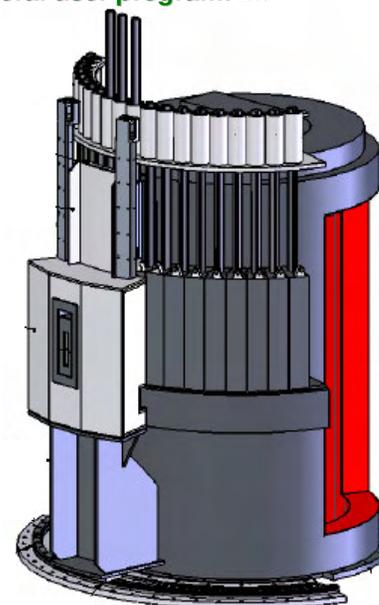
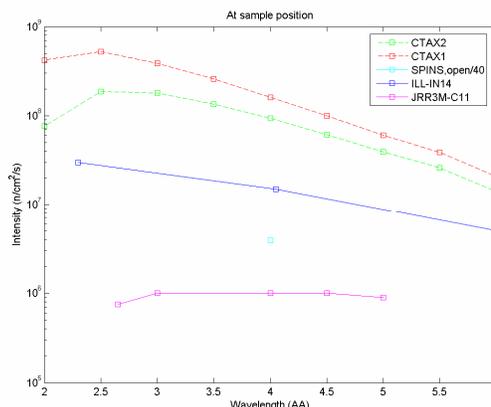
More than a Relocation

Provides great neutron intensity at the sample, which is comparable with that of the highest intensity cold TAX in the world, Institut Laue Langevin's IN14. The figure to the right displays measured (solid lines and isolated points) and estimated (dotted lines) neutron rates in one square centimeter at the sample, for some of the most intense TAX's in the world.

Allows strong magnetic fields at the sample.

Due to careful material selection, this TAX shall be compatible with Brookhaven's vertical field 11 Tesla magnet, which produces the highest available field in the US for neutron scattering experiments. It shall also be compatible with Oak Ridge's horizontal field 5 Te magnet.

Possible future upgrades include polarization capability, RITA/SPINS style analyzer/detector assembly, and zero field spin echo capability.



Examples of science planned

Study of field-induced spin-density waves (stripes) of copper-oxide superconductors.

Study of quasi-1D S=1 antiferromagnets; our logo shows sample results from this kind of study.

Instrument Details		
Beam Spectrum	Liquid Hydrogen Moderator	
Monochromator Range	Vertically Focusing PG (002)	$2 \text{ \AA} < \lambda_M < 5.4 \text{ \AA}$ $2 \text{ meV} < E_i < 20 \text{ meV}$
Sample Scatter Range	$-170^\circ < 2\theta_s < 170^\circ$	Variable arm lengths Location-dependent
Analyzer Range	PG (002)	$\lambda_A < 5.4 \text{ \AA}$, $E_f > 2.8 \text{ meV}$ Location-dependent
Collimation (FWHM)	α_1 open (20' @ 2 \AA, 40' @ 6.4 \AA) α_2 80', 40', 20', 10' α_3 80', 40', 20', 10' α_4 80', 40', 20', 10'	Before Monochromator Monochromator-Sample Sample-Analyzer Analyzer-Detector
Beam Size	25 mm x 15 mm at sample	Vertically focused
Filters	Cooled Beryllium PG	CG-4 bender removes most higher order
Flux at sample	$3E7 \text{ n/s/cm}^2$ at 3 \AA (est.)	
Detector	^3He	
Polarization	Polarizing supermirrors, Transmission (not yet)	

Additional Features of US-Japan TAX

Source: The cold neutron moderator is the new HB4 supercritical hydrogen moderator (505 ml). The neutron guide CG4, with dimensions at the monochromator of 19mm X 150 mm, contains an 8° bend over 15 m that eliminates high energy neutrons and gammas and makes room for our instrument in the guide hall, and has been optimized for reasonable transmission in the 2-20 meV range.

Sample: The sample table can support a wide variety of sample handling equipment, for example allowing for extreme temperatures and magnetic fields at the sample. Also, we can vary the distance between monochromator and sample, and between sample and analyzer, with the use of air-pad tables and a Tanzboden. We therefore can maximize the count rate by minimizing the distance between axes, for a given set of optical components. We can also minimize the impact of strong magnetic fields at the sample by increasing distances.

SPICE: The same TAX user control system currently used on other TAX's at HFIR.

Current Status

Shield design: nearly complete

Shield delivery: expected early summer 2006

Introduced to general user program: 2008