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IPNS Chopper Spectrometer Improvements

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Abstract

We report the status of the IPNS chopper spectrometers and describe a number of projects underway and planned for their improvement.

I. Status of IPNS Chopper Spectrometers

Three chopper spectrometers are working at IPNS, the Low Resolution Medium Energy Chopper Spectrometer (LRMECS), the High Resolution Medium Energy Chopper Spectrometer (HRMECS) and the Pulsed High Energy Neutron Inelastic Chopper Spectrometer (PHENICS). LRMECS and HRMECS are general purpose machines and have operated as user instruments since 1982. Built in 1986, PHENICS was designed explicitly for and is used mostly for deep inelastic scattering, that is momentum distribution studies, and is equipped with a dedicated dilution refrigerator to enable studies of quantum fluids; it is operated by a Participating Research Team. Table I summarizes the essential features of the IPNS instruments as defined in Figure 1.

Table I
IPNS Chopper Spectrometer Parameters

Instrument	d_1, m	d_2, m	d_3, m	$\Delta E/E_0$	ϕ
LRMECS	7.0	1.1	2.5	6-8 %	-10° to -2°, 2° to 120°
HRMECS	12.7	1.1	4.0	3-4 %	-20° to -1°, 1° to 20°, 87° to 140°
PHENICS	12.6	1.0	2.5	4-5 %	57° to 62°,
			3.8	3-4 %	135° to 145°

Choppers are available which nearly optimally provide neutrons with incident energies between 5 meV and 2 eV and are fully interchangeable among the instruments.

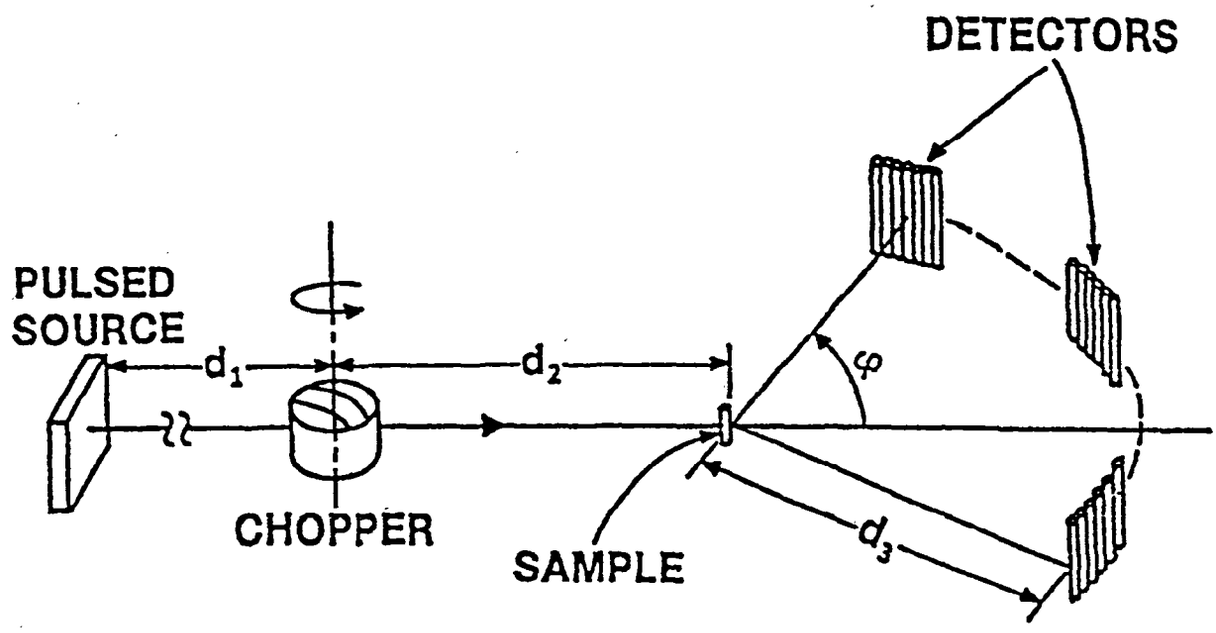

Figure 1. Schematic diagram of a pulsed source chopper spectrometer.

II. T_0 Choppers

The intense flash of fast neutrons that occurs at the time of the accelerator pulse (T_0) increases the background of neutrons in the scattered neutron detectors and is principally responsible for the personnel radiation background around the monochromating ("E_0") choppers. To reduce these effects, we are installing auxiliary "T_0" choppers before the E_0 choppers which are phased to be closed at the time of the prompt fast neutron pulse and open rapidly to pass the desired neutrons.

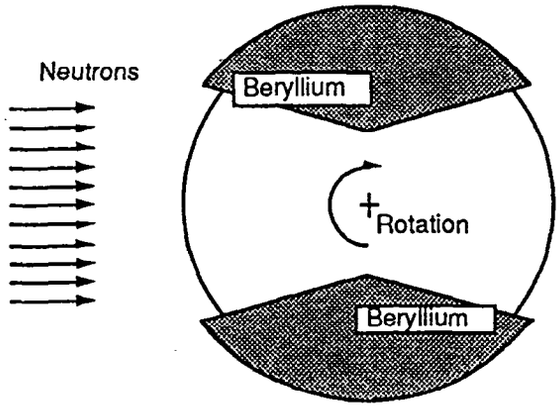

Figure 2. Schematic drawing of a T_0 chopper.

The drive, control and support systems of our T_0 choppers are of basically of the same design as those of the E_0 choppers, but the choppers have a wide, tapered, keyhole-shaped opening, as shown in Figure 2. For choppers of this form the fraction of the beam area that is open is a trapezoidal function of the time, although the fraction of the beam that penetrates the chopper is a more complicated function. Figure 3. illustrates the action of the T_0 choppers. For the case

shown the E_0 chopper is rotating at 210 Hz and the T_0 chopper is turning at 90 Hz, optimal for 100 meV neutrons which the system is phased to select.

T_0 choppers also reduce the number in the incident beam of fast and epithermal delayed neutrons which are emitted continuously between source pulses. These can pass through the Boron fiber-Aluminum slats in the E_0 choppers twice each revolution, and contribute to the background during the useful time interval at the detectors, roughly 3000- 6000 microseconds.

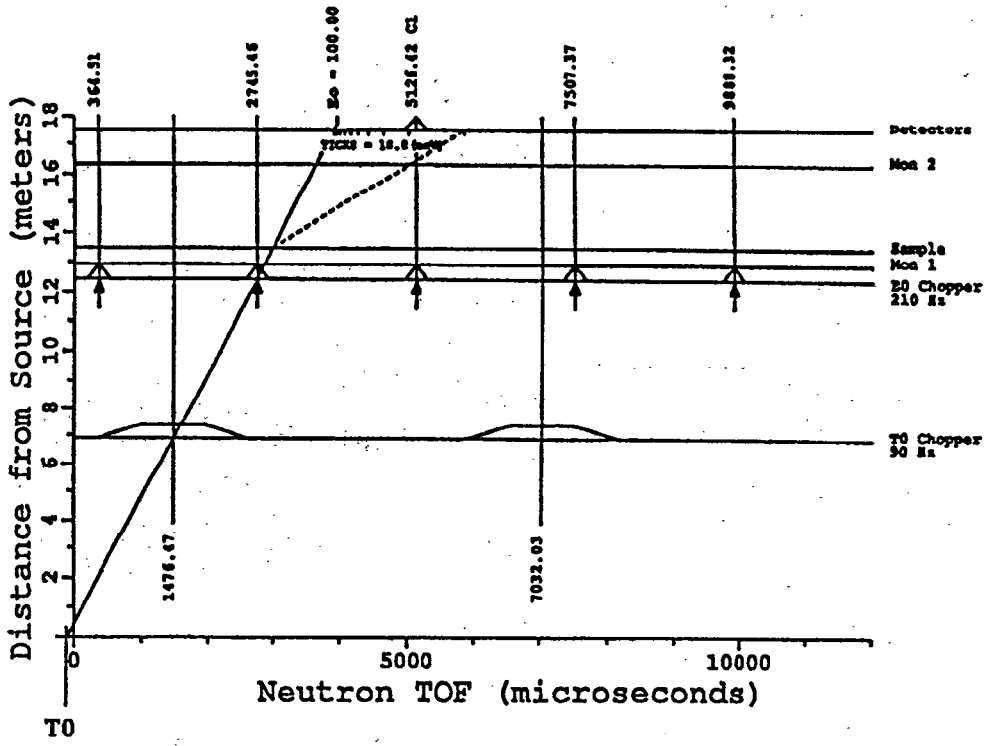

Figure 3. "Neutron time schedule" showing the action of a "T_0" chopper in HRMECS.

III. LRMECS

Figure 4 shows the present configuration of the Low Resolution Medium Energy Chopper Spectrometer. In our recent efforts we have moved the E_0 chopper about 1 meter farther from the source to provide space for the T_0 chopper and have improved the shielding around the E_0 chopper. We have begun design of an optional high resolution chopper and accompanying tighter (20' divergence) Soller collimator along the lines described elsewhere in these Proceedings, to provide energy transfer resolution $\Delta E/E_0 = 3. - 4.$ % in LRMECS. The same new chopper will be able to be used in HRMECS.

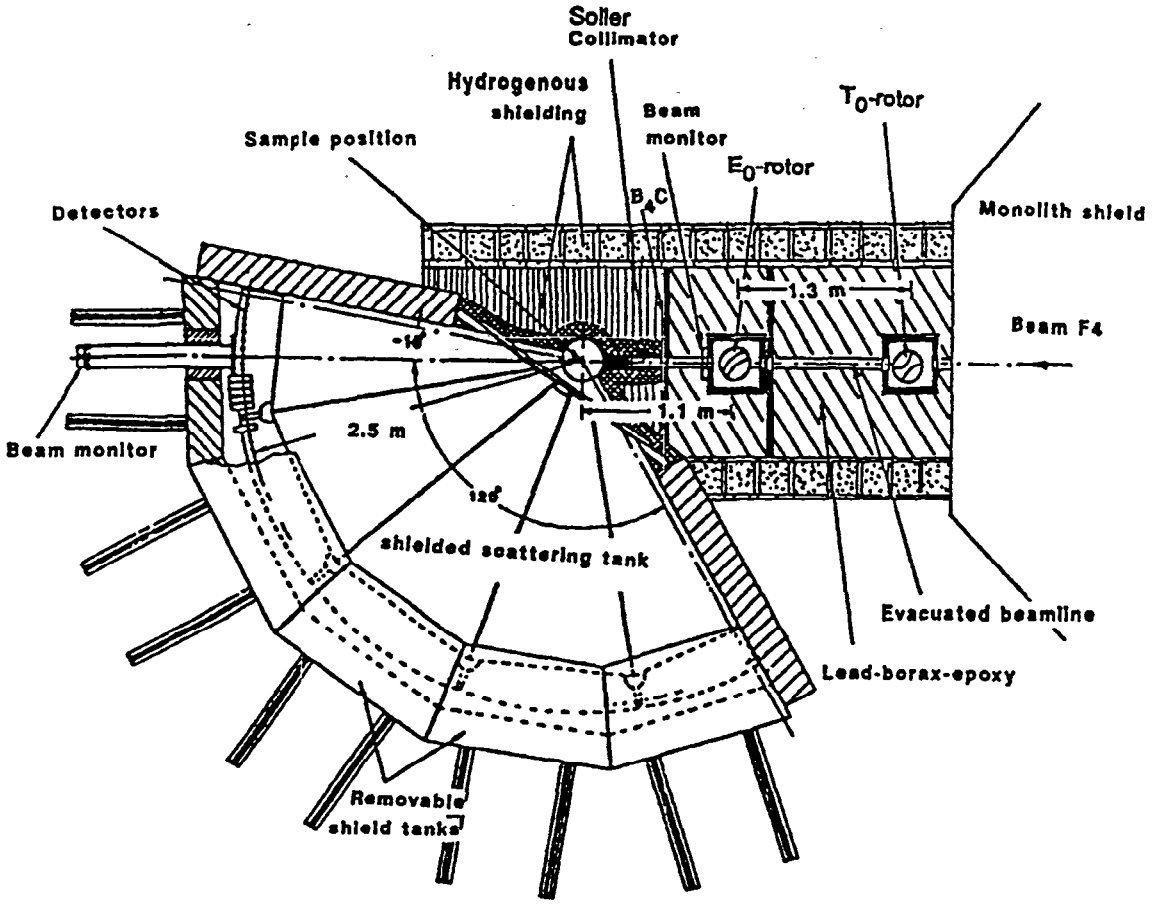

Figure 4. The Low Resolution Medium Energy Chopper Spectrometer.

IV. HRMECS

Figure 5 shows the configuration of the High Resolution Medium Energy Chopper Spectrometer. The intermediate angle flight path between 20° and 85° does not exist; efforts are underway to install the intermediate angle flight path. We have provided a well shielded position for a T0 chopper and work is underway on its design and fabrication. The high resolution chopper and optional tighter (20' divergence) Soller collimator will provide optional energy transfer resolution $\Delta E/E_0 = 1.5 - 2$ % in HRMECS.

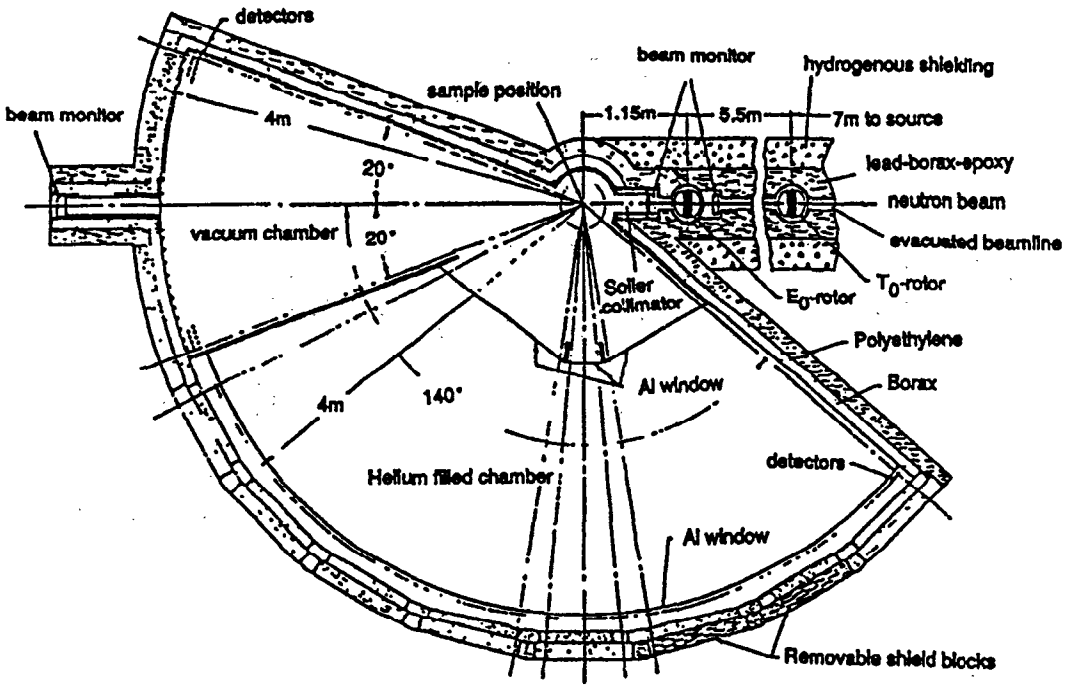

Figure 5. The High Resolution Medium Energy Chopper Spectrometer.

V. PHENICS

Figure 6 shows the present configuration of the Pulsed High Energy Neutron Inelastic Chopper Spectrometer. The sample position is equipped with a dedicated ^{3}He dilution refrigerator. The T_0 chopper has been in routine operation for more than one year. The low angle, 60° detector bank has recently been installed, which has mainly been used (without the E_0 chopper) for diffraction analysis of cryogenic polycrystalline samples and enables deep inelastic scattering studies of hydrogenous materials.

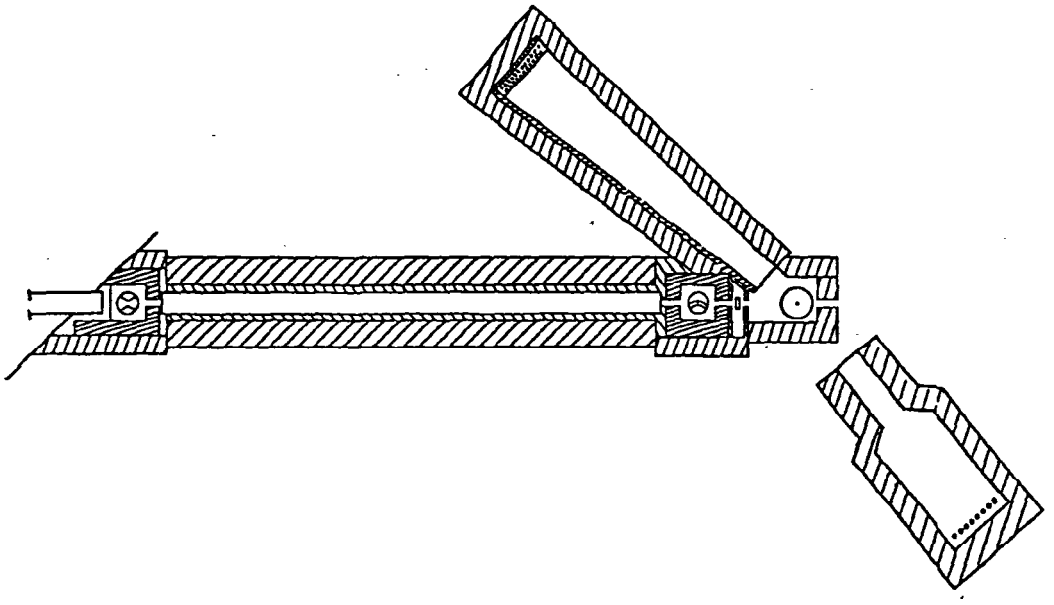

Figure 6. The Pulsed High Energy Neutron Inelastic Chopper Spectrometer.

VI. Summary of IPNS Chopper Spectrometer Improvement Projects

We are designing and preparing to install optional tighter Soller collimators in LRMECS and HRMECS to provide higher energy transfer resolution in those instruments when needed. A T_0 chopper has been installed in PHENICS which operates routinely and provides considerable improvement in the personnel and detector backgrounds. T_0 choppers are being designed and will be installed in LRMECS and HRMECS. The design of the long-needed intermediate angle flight path for HRMECS has been completed; the new flight path will be ready for installation in about one year. New VAX station computers are being installed to replace the PDP11-34 Data Acquisition Computers in all the chopper spectrometers. We are evaluating high speed, magnetic bearing choppers to replace our present 270 Hz, hard bearing designs sometime in the future.

VII. Acknowledgement

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