Recommendations of the SNS Backscattering Instrument Advisory Team (IAT): Preliminary Design and Operating Parameters

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Background

On 14 May 1999 the IAT for the SNS backscattering instrument held its organizational meeting at Argonne National Laboratory. An executive committee was formed and was charged with the responsibility of summarizing the recommendations of the IAT regarding the preliminary design and operating parameters for the backscattering instrument proposed by Ken Herwig. Ken's preliminary instrument design and operating parameters can be found on the instrument web page at http://www.sns.anl.gov/instrume3.htm.

Recommendations

- The design and operating parameters presented by Ken for the SNS backscattering instrument were approved enthusiastically by the IAT. Specifically, the emphasis on high energy resolution at low momentum transfer was strongly supported. The instrument as presented represents a major improvement over those currently available and its unique capabilities will lead to a plethora of novel science.

- It was recommended that robustness and simplicity of design be important design considerations in order to minimize maintenance effort and maximize instrument availability. In this light, it was specifically recommended that

  --- neutron choppers be placed close in to the target monolith. This simplifies the design and minimizes the number of choppers required. The trade-off is that this arrangement precludes including additional instruments on the beamline.

  --- the analyzer be divided into two hemispheres, one for the high resolution measurements (2 μeV resolution, $0.1\ Å^{-1} \leq Q \leq 2.0\ Å^{-1}$) and one for high-Q measurements (10 μeV resolution, $0.2\ Å^{-1} \leq Q \leq 3.8\ Å^{-1}$). In a worst-case scenario this arrangement reduces neutron flux to the detectors by a factor of two, but has the important advantage of eliminating the need for moving the analyzer arrays.

- While not recommended for inclusion in the initial instrument capabilities, the ability to use polarized neutrons was acknowledged as important. It was therefore recommended that the instrument be designed so as not to preclude the use of polarized neutrons as a future option.

- It was recommended that Ken investigate options for utilizing the diffraction capabilities of the instrument. Specifically,

  ----inclusion of a frame elimination chopper(s) in order to provide larger bandwidth for diffraction studies should be explored.

  ----requirements for a diffraction detector need to be determined.

- The option of including extra focussing optics should be explored particularly to increase the neutron beam divergence onto the sample for inelastic scattering experiments.

- The sample chamber should be as large as possible to allow for inclusion of other measuring probes (e.g., FTIR) and ancillary equipment.

- The sample dimensions should have a large cross-sectional area (3 cm X 3 cm) and the instrument design should not preclude a variety of sample geometries (cylinders, slabs).

- While detectors are not expected to be a major technological challenge, it was recommended that some R&D effort be spent on detector development. It was specifically recommended that

  ----emphasis be placed on ^{3}He based position sensitive detectors.

  ----the detectors have good gamma discrimination capability.

  ----the instrument be equipped with a spare detector.

  ----ease of access to the detectors should be maintained.

- It was recommended that the instrument be designed for operation with high magnetic fields at the sample position.

- Analyzer development was considered to be the major technological and engineering challenge. The analyzer is the centerpiece of the instrument. The IAT strongly recommends that significant R&D effort be spent on analyzer development, and that oversight of analyzer crystal development be provided by the IAT. Specifically, it was recommended that

  ----while strained silicon should be considered the primary option, some effort should be spent on exploring other options.

  ----the option of vibrating crystals (ultrasound) in order to control the analyzer response should be explored.

  ----Monte Carlo investigations of the influence of deviation of the silicon analyzer from the ideal geometry should be undertaken.

  ----the engineering issues faced in obtaining the required $\Delta d/d$, particularly bending the crystals of appropriate thickness and holding them in place should be examined.

- It was recommended that Ken explore the implications of an improved (shorter pulse width) moderator on instrument performance.

- It was recommended that the instrument be designed in order to minimize the number of components placed in vacuum.

- Neutron choppers, while not posing a major technological or engineering challenge, are an important aspect of instrument performance. In this regard, it was recommended that

  ----control of the neutron chopper phasing be automated and user friendly.

  ----a contingency design for inclusion of a T_0 chopper be developed in case this proves necessary in addition to the bent guide for background suppression.

- The IAT strongly recommends that the IOC consider development of intermediate (25 μeV) and low (100 μeV) resolution high-flux spectrometers with large dynamic ranges in order to the complement the high resolution backscattering instrument.