Dear Colleagues,

The preparation of the official presentation of the ESS project in May 2002 Discussions is making good progress and the plans are taking shape. The main contribution expected from the Instrumentation Task Group is now to provide a "User guide" style description of the instruments selected for the "day 1" reference suite. (Actually the ESS Council wants us to invent another name instead of "day 1"): This user guide will be part of the set of documents to make up the ESS project proposal. It has been agreed, that it should be 2 pages per instrument and follow the style of latest version of the HMI user guide (see e.g. http://www.hmi.de/bensc/instrumentation/instrumentation_en. html).

Beam extraction, moderators

Please also find attached the incomplete draft of the chapter on general instrumentation issues (update of a similar contribution in the Engelberg ESS SAC report), which will be part of the scientific case section of the ESS project documents. A major novelty is the new "multi-spectral" beam extraction concept. It will allow us to break with the practice that was the rule since the beginnings: choosing the spectrum of a moderator with a given temperature. Instead we will have the choice to e.g. combine thermal and cold spectra in a single beam. This can offer enhanced performance in a number of cases, such as:

- experiments that can take advantage of a broader dynamic range of incoming neutron energy (e.g. powder diffraction in general, many inelastic scattering studies,...)

- provide an alternative to "cool" moderators, by giving a good coverage of the whole spectrum form < 1 Å to the longest practical wavelengths from a cold source (e.g. protein crystallography with a most valuable wavelength range of some 1.5 to 5 Å)

The other main enhanced instrument design opportunity offered by supermirror optical beam extraction techniques is to allow us to get around the $1/r^2$ flux decrease for all wavelengths above some 0.3 Å. This opens up the possibility to take more often advantage of the higher flux of un-poisoned moderators or to achieve better resolutions.

On the basis of the novel approaches at ESS, including the long pulse target station, (which will make the efficiency of using the proton beam power at ESS quite superior to that achieved or planned by now) the instruments will tend to be longer than usual today and poisoned moderators will play a lesser role. All this leads us to propose the following moderator configurations for the two target stations at ESS:

Moderator faces:

- Short pulse TS:

    1) Coupled cold (H_2) moderator effective surface 12 cm high, 12 – 20 cm wide
    2) Coupled cold-thermal multi-spectral beam, cold moderator of 12 x 12 cm^2 effective surface, the thermal moderator is the H_2O premoderator, extended on one side to about 10 cm width.
    3) Thin (about 25 mm), de-coupled cold moderator, 12 cm high, 12 – 20 cm wide
    4) Thick (about 50 mm) de-coupled thermal (ambient H_2O) moderator, same dimensions as 3)

All of these moderators are at the brightest position, 1) and 2) the two opposite faces of one moderator unit, and 3) and 4) the two faces of a second unit.

    5) Optional additional moderator downstream (lower flux), in the case it does not negatively impact the flux of 1) – 4)

- Long pulse TS:

    6) and 7) Coupled cold moderator, 12 x 12 cm^2 effective surface
    8) and 9) Coupled cold-thermal multi-spectral beam, as 2)

All of these moderators are at the brightest position, 6) and 7) are back to back in one unit, similarly form 8) and 9) the other ensemble.

The angle between neighboring beam lines looking at the same moderator face: 9°, number of beam lines (nearly all of them guides) 6 to 7 per moderator face.

Moderator performances

The results of further neutronics calculations for a large variety of design options investigated in the framework of an optimization effort by the ESS Target / Moderator Team have shown, that no dramatic changes in moderator performance are to be expected compared to the current ESS reference from "Dec. 2000" (ESS-Instr-31-12-00) we have used by now. The Target / Moderator Team is in the process of refining the calculations by including all engineering details as they get specified. This is a quite large job. It was concluded, that in view of the above results it is not worthwhile to modify the ESS reference moderator performance data base before the results for the full engineering models become available, i.e. before the second half of 2002. On this basis the spectra of the above listed primary moderator faces 1)-4) and 6)-9) will be assumed to be described as follows:

1): Coupled cold SPTS moderator

2): A weighted sum of Coupled Cold and Coupled Thermal SPTS moderators:

$$f_C(\lambda)\Phi_C(\lambda) + f_{Th}(\lambda)\Phi_{Th}(\lambda) \qquad (1)$$

where the weight functions are given by the following purely empirical approximations of the Monte Carlo results: (wavelength λ measured in units of Å)

$$f_{Th}(\lambda) = 0.86*\exp(-.01677\lambda^4) + 0.14(1-(\lambda^4/(\lambda^4+40000)^{1/4})$$

and

$$f_C(\lambda) = \begin{cases} 0 \text{ if } \lambda < 1.4 \text{ Å} \\ 0.95 - f_{Th}(\lambda) \text{ if } \lambda \geq 1.4 \text{ Å} \end{cases}$$

This refers to the particular realization of multi-spectral beam extraction described in the attached draft using a supermirror "switch", which is adequate for feeding a Ni coated guide up to 7-8 cm wide, assuming the moderator dimension defined above under 2). The multi-spectral extraction system in this case just is a more fancy guide, starting at 1.5 m from the source. The neutron spectrum and distribution in the Ni coated guide can be calculated by using eq. (1) above as the effective source spectrum for a usual straight Ni coated guide, without a multi-spectral extraction rig.

3): Cold poisoned, de-coupled SPTS moderator

4): Thermal un-poisoned, de-coupled SPTS moderator

6) and 7): Cold coupled LPTS moderator

8) and 9): Weighted sum Cold and Thermal coupled LPTS moderator with the same weight functions defined above.

Schedule

We suggest that teams are formed with the aim to prepare the 2 page "user guide" style descriptions for teach "Day 1" instrument specified in our list. In the 3 cases, where the potential combination of two instruments was suggested, the team should decide, if the combination is reasonable and provide one description, or not reasonable and then provide two. Priorities of the so defined larger number of instruments will be set in later discussions with the ESS Scientific Advisory Council. These two page descriptions should include a short comparison of the ESS instrument performance to existing, widely known top of the line instruments.
We ask the Instrument Group Conveners to help the emergence of these instrument teams, and to facilitate communication let Thomas Gutberlet have the lists of people involved. The **first draft of the**

"two-pagers" is requested by March 5, by e-mail to Thomas Gutberlet (gutberlet@hmi.de), in view of a summary presentation at the ESS SAC Workshop, 14 –16 March.
These drafts, together with feedback from the SAC workshop will be discussed in detail at our Instrumentation Task Workshop, March 17-19. **Final version will have to be submitted for preparation of printing** within a week after the workshop, i.e. **March 26 sharp**.

As repeatedly stressed by the Council and SAC, innovation should receive particular attention in our work. The new tools we have now at our disposal could e.g. allow for unprecedented high resolution and stability by using LPTS moderators 8) and 9) combined with fast choppers and long flight paths, say 10 μs and 200 m, respectively. Around 3 Å wavelength this could open up new opportunities in material science by powder diffraction.

Thank you very much for your contribution and effort, with best regards

Feri Mezei Roger Eccleston Thomas Gutberlet

Berlin, Feb. 12. 2002