(invited) ESS: A neutron source for discovery

D Argyriou
European Spallation Source, Sweden

The European Spallation Source (ESS) with the support of 17 European countries, is set to break ground for construction in 2014 and become operational by the end of the decade.

Powered by one of the world’s most powerful proton accelerators, ESS will be a unique source of neutrons not only in terms of neutron brightness but also because of a novel long pulse time structure that provides for instruments with an easily tunable resolution. A new concept of moderators and beam extraction allows flexibility and adaptability of the facility over a broad and dynamic scientific landscape.

The ESS will offer the brightest neutron fluxes in the world opening new horizons to materials research and fundamental physics. We shall look at our "crystal ball" at current trends in science that ESS can potentially impact and discuss some of the likely experiments that it will carry out.

Current Status of HANARO Neutron Beam Facility

K H Lee
Korea Atomic Energy Research Institute, Korea

In HANARO, there are 11 neutron beam instruments in operation including 3 diffractometers, 3 small angle neutron scattering instruments, reflectometer, neutron imaging, neutron irradiation, disc chopper time-of-flight, prompt gamma activation analysis, and guide test station. The instruments that are under development or in commissioning are 2 diffractometers, 2 triple axis spectrometers, reflectometer, prompt gamma activation analysis, and neutron depth profiling. The cold neutrons are available since Sept. 2009. The neutron beams are allocated twice a year and can be requested through hanaro4u.kaei.re.kr. There are 400 users a year and will be more as more instruments are open to users. HANARO Symposium is holding every year where the users can present their research output using neutron beam. The user training courses and tutorials are open in summer or winter time for students or beginners. The facility is having a periodic meeting with Korea Neutron beam users association and improving the facility environments for users. The current research interests of the facility are energy storage, magnetic structure, polymer, complex fluid, bio materials, and metals. The industrial applications are very active with fuel cell, Li-ion battery, and residual stress investigation. The He-3 replacement detector and polarizing supermirror development are under way. There are 6 cold neutron guide lines installed and one more guide line can be installed in the cold neutron guide hall. A space is reserved for the installation of thermal guide lines for the 2nd stage installation plan.

A second look at the neutronics from ISIS target station 1

S Ansell, G Skoro and F Burge
Rutherford Appleton Laboratory (STFC), UK

The design of ISIS target station one (TS1) is over 25 years old. It was not designed with the benefit of proton to sample Monte Carlo, the detailed multi-temperature cross sections, and experimental discoveries like the use of pre-moderators and material manufacturing procedures like CNC machining.
We present a new model for a TS1 target, moderator and reflector design, which includes the existing void vessel and shutter system out to typical guide positions, and compare it with the existing TS1 target station. The shutter system and instrument view is of particular importance, since if such an upgrade is attempted it would be extremely difficult to change the view of the instruments at the same time. Therefore, both models contain sufficient engineering reality for reasonably accurate comparison, this includes pipeworks, cooling channels, clearance gaps, and shutter inserts.

The existing model has been benchmarked against a number of existing instruments for both flux and time distribution, to give some confidence that nothing critical has been missed. The new model was optimized as part of the CombLayer package allowing extensive parametric and component selection without compromising the detailed engineering requirement. The best models show that significant benefits can be achieved without modification to existing instruments, making the upgrade a quick, inexpensive, low risk project.

The ESS target station: Basic design choices and performance optimization options
F Mezei
ESS, Sweden

The European Spallation Source will operate at 5 MW proton beam power, which exceeds by a factor of 5 the highest spallation beam power achieved by now. At this level of power environmental safety becomes an equally challenging task to neutronic performance optimization. A number of the basic, often innovative design choices adopted for the ESS target station baseline have been determined by environmental considerations of fundamental significance for the regulatory licensing, a prerequisite for starting actual construction. Other novel design choices are motivated by enhancing the neutronic performance at a given proton beam power, which latter is the main cost driver of the facility. Each percent of accelerator power difference implies a cost difference of 10 MEUR for the lifetime of the facility. After the design update phase ended in 2012, the first goal for the target station development in the current construction phase is the completion a final round of the design optimization by mid-2014. The main focus of this work is moderator - reflector geometry, beam extraction, shielding and fast neutron background and reliability. A most significant first result in this process was the optimization of the effective thickness of the liquid hydrogen cold neutron moderator, which resulted in near doubling of the cold neutron beam intensities compared to currently common moderator configurations. Ongoing optimization studies will be reviewed concerning all key aspects: neutronic performance, reliability and safety.

Bi-spectral beam extraction
C Zender¹, H Jacobsen², K Lieutenant³, K Lefmann², M Strobl¹, W Schweika¹ and D Nekrassov¹
¹Helmholtz-Zentrum Berlin, Germany, ²University of Copenhagen, Denmark, ³European Spallation Source, Sweden, ⁴Forschungszentrum Jülich, Germany

Among the instruments that are currently designed for the European Spallation Source, some desire to use neutrons from both the cold and thermal moderator in one beamline in order to expand the utilization possibilities by broadening the available spectral range. A combination of the two moderators such that neutrons of a certain wavelength are taken from that moderator in which they are more abundant is possible by use of a so-called bi-spectral extraction system in which a mirror reflects neutrons from the colder source into a guide aligned with the warmer source. This concept is studied for systems feeding elliptical neutron guides with different lengths up to 150 m and different divergence limits. Furthermore, examples using an eye-of-the-needle concept with a focal point close to the source, combining a shorter extraction system with a focusing feeder guide, are compared. Results were obtained using the software packages McStas and VITESS, showing very good agreement between the two simulation programs. In both kinds of guide concepts, neutron efficiencies of 80% - 90% can be reached for the greater part of the wavelength spectrum, with a minimum of about 70% in the cross-over region.
The first pelletized cold neutron moderator start up at the IBR-2M reactor

S Kulikov, E Shabalin, V Ananiev, A Beliakov, M Bulavin, K Mukhin and A Verhoglyadov
Joint Institute for Nuclear Research, Russia

Start up of the first pelletized cold neutron moderator at the modernized IBR-2 reactor with a maximal power of 2 MW has been successfully done in the frame of a project of development of a complex of cold moderators. The moderator chamber has been completely charged within mesithylene beads. Technological system of moderator worked properly through the whole reactor cycle. The method of "pin-hole" within neutron PSD have been used for monitoring of charging process by taking neutron count picture of moderator in direct geometry. An average moderator’s temperature has been about 30 K. Gain factor up to 13 times has been measured in comparison of cold neutron spectra from the surface of cold moderator and spectra from a water moderator at room temperature.