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ScienceDirect

Physics Procedia 51 (2014) 8 – 12

Physics Procedia

ESS Science Symposium on Neutron Particle Physics at Long Pulse Spallation Sources, NPPatLPS 2013

Status of the European Spallation Source ESS AB, the instrument selection process, and a fundamental physics beamline at the ESS.

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Abstract

A general introduction to the status of the European Spallation Source ESS AB is given. As well as a general overview, the status of instruments and instrument design is presented. Particular attention is given to the instrument selection process, and how a proposal for a fundamental neutron physics beamline should be submitted. The contents of this presentation closely reflect the recently completed Technical Design Report for the ESS.

Keywords: neutrons ; spallation ; fundamental physics ; instrument ; ESS.

1. Introduction to the European Spallation Source

The European Spallation Source [1] aims to be the world's leading neutron source for the study of materials. It is a pan-European project, with presently 17 countries signatory to the MoU for construction, which was signed in 2011. The site decision was made in 2009 to be Lund in Sweden. The design update phase has just ended, culminating in a Technical Design Report (TDR) [2], which was completed in early 2013. The TDR itself builds upon the Conceptual Design Report (CDR), which was published in February 2012 [3]. The contents presented

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doi:10.1016/j.phpro.2013.12.004

here are based closely upon the TDR. The site itself is literally a green field, and is undergoing archeological investigations presently. Conditional on all the necessary permits being granted, official ground-breaking will take place during spring 2014.

The TDR presents details of a baseline suite of instruments that could address suitably a broad range of science, suggested by the ESS science case. This baseline reference suite is used for budget estimates and to determine, for example, what the detector requirements would be for such a suite. The actual instruments themselves will be selected during a yearly proposal round process; therefore the baseline suite should be seen as broadly representative as to how ESS instruments will look rather than an authoritative guide. The first such instruments have been selected in the 2012-2013 selection round. The result was that three instruments were chosen: an Imaging instrument, a SANS instrument and a Macromolecular Crystallography instrument. The 2013-2014 selection round is about to start; 12-16 proposals instruments are expected to be submitted for consideration.

The instruments themselves will be public and ESS will be operated as a user facility, similar to the fashion in which facilities such as ILL [4] and ISIS [5] and ESRF [6] operate now. There are foreseen to be 22 such public instruments, 7 of which are intended to be operational by 2019, when first neutrons will be delivered. In the longer term, e.g. during the 2030s, it can be imagined that a fully operational ESS may have eventually more 30 instruments.

A unique feature of the ESS neutron production will be that it is a long pulse spallation source; that is the length of the pulse is as long as 2.86 ms, with a repetition rate of 14 Hz. The long pulse means that the instrument designs will be somewhat intermediate to those of continuous flux sources, such as reactor sources and those of short pulse spallation sources, such as SNS, ISIS, JPARC. The typical single pulse structure and brightness are shown in figure 1. The high level parameters of ESS are given in table 1.

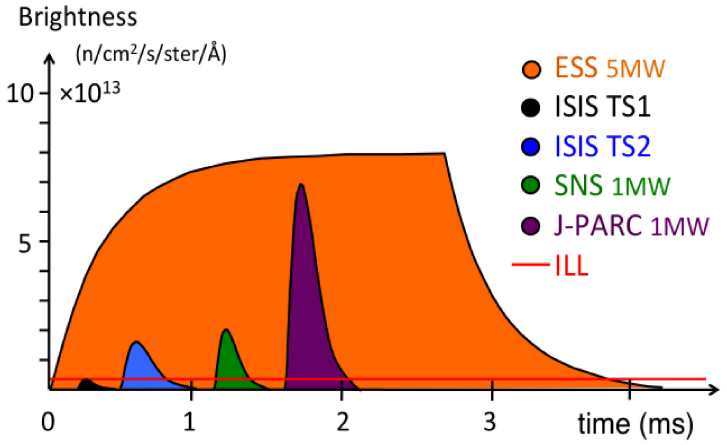

Fig. 1. Single-pulse source brightness as a function of time at a wavelength of 5 Å at ESS, ILL, SNS, J-PARC and ISIS target stations 1 and 2 [2]. In each case, the cold moderator with the highest peak brightness is shown.

Tab. 1. ESS high-level parameters [2].

Parameter	Unit	Value
Average beam power	MW	5
Number of target stations		1
Number of instruments in construction budget		22
Number of beam ports		48
Number of moderators		2
Separation of ports	degrees	5
Proton kinetic energy	GeV	2.5
Average macro-pulse current	mA	50
Macro-pulse length	ms	2.86
Pulse repetition rate	Hz	14
Maximum accelerating cavity surface field	MV/m	40
Maximum linac length (without 100 m upgrade space)	m	482.5
Annual operating period	h	5000
Reliability	%	95

2. Reference Instrument Suite

The ESS instruments will be selected as part of an open selection process. However, to enable a suitable site layout for ESS, to focus technological developments to areas where they are critically needed, and to indicate the likely balance of instruments and range of science addressed, a reference instrument suite has been constructed for the Technical Design Report. Whilst the final choice of instruments may differ, the broad picture is expected to look similar to this reference suite.

The TDR reference suite is shown in figure 2. For the purposes of this workshop, it should be noted that a Fundamental Physics instrument is considered as part of the TDR reference suite. Issues such as the possibility of through-going beampipes, and in-pile ultra-cold neutron sources were raised as part of this workshop; this has since led to developments on this since the workshop.

As can be seen from the diagram, there are four distinct areas for instruments – roughly referred to as the NW, NE, SW, SE halls. Each of these halls is foreseen to have a different set of policies; though these policies are presently at a very early stage in the planning process. The NW hall houses the longer instruments, ca. 150m long. The NE hall houses those instruments that may require special magnetic field policies, such as Spin Echo. The concrete in this hall will be with non-magnetic reinforcement. The SW and SE halls are physically one large hall, sharing a crane. It can also be seen that there is plenty of areas foreseen in each hall for future upgrades. Support labs will be located close to the instruments in each hall. As the construction design is presently being worked upon, the details are subject to change.

In all quadrants, each instrument will be able to view either the cold or the thermal moderator, or both.

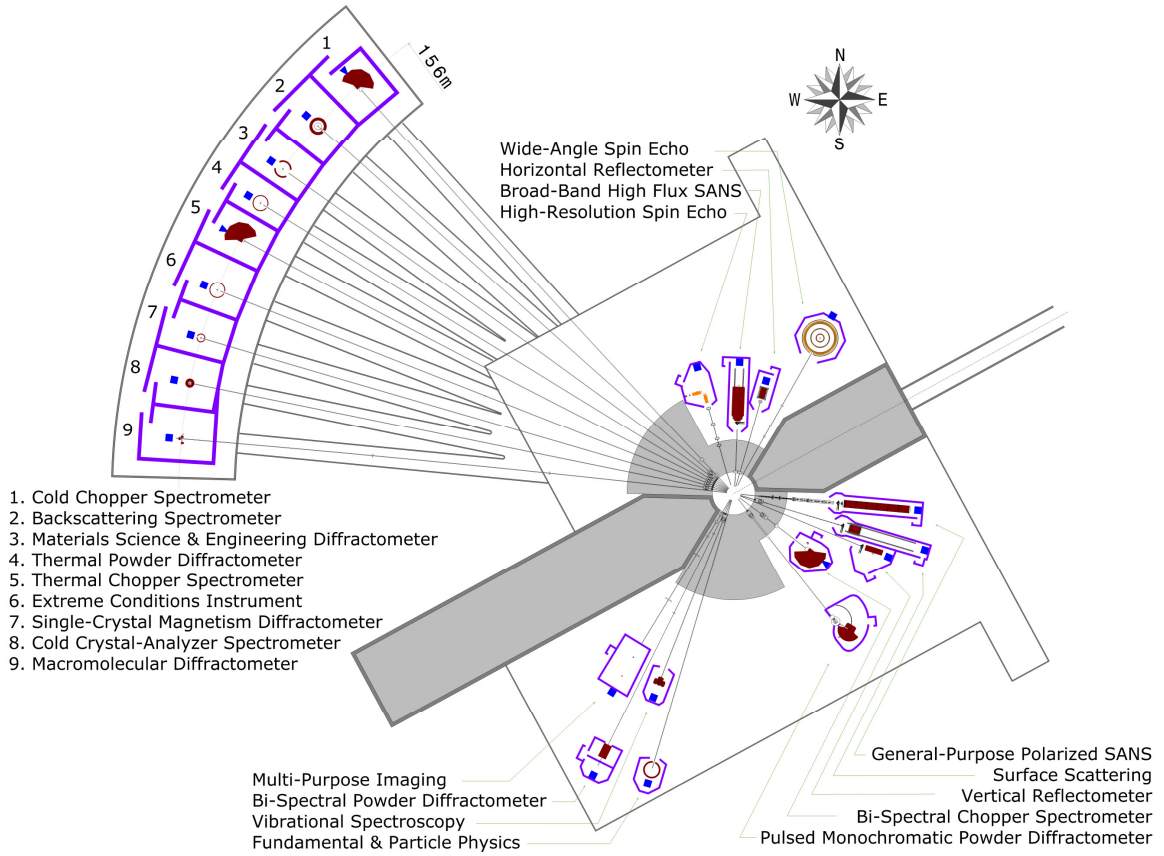

Fig. 2. Possible layout for the ESS reference instrument suite as presented in the ESS Technical Design Report [2].

3. Instrument Selection Process

The ESS instruments will be selected by an open selection process. Both instruments led by in-house teams and those by external teams are encouraged to submit conceptual proposals. These proposals are then reviewed by technical teams within ESS, and by external scientific and technical experts. Revised conceptual proposals are then submitted for final recommendation and consideration.

For the purpose of considering the technical and scientific merits of a concept, 11 instrument classes are defined. One of these instrument classes is the fundamental physics beamline.

The first round of the selection process was 2012-2013. Despite it being an early stage, in this round 4 concepts were submitted, of which three were selected to proceed to the construction phase. In the 2013-2014 round, upcoming soon, 12-16 concepts are expected to be submitted. A similar number can be expected in the 2014-15 round. For this reason, the majority of instruments for the initial instrument suite will probably have been considered by that point.

The construction process then proceeds for the selected instruments with 2 rounds of progressively more detailed engineering work; phase 1 and phase 2; termed the conceptual and detailed engineering. Each has a

nominal period of 1 year. Following phase 2, construction proper starts; this is anticipated to take in the order of 4 years.

It should be noted that due to the nature of the funding structure for ESS, most instruments are expected to have an in-kind component. This means that a broad base of parties interested in its construction would be helpful. Partners for the design and construction period are also needed.

4. Outlook

The process for approval of a fundamental physics beamline was outlined in this contribution.

It became clear through the course of the workshop that work on defining a fundamental physics beamline was already proceeding well, with a workable basic design already existing. It looks feasible to submit a proposal during the 2014-2015 instrument concept proposal round. Given the number of instrument concepts that will have been considered by that stage, this goal looks to be appropriate – and in fact necessary – to ensure that the fundamental physics beamline is part of the initial instrument suite.

The in-kind nature of ESS instruments means that it will be necessary to find partners in the process to build the instrument. As such, the community is encouraged to gather together suitable partners and collaborators, so that such a consortia can be found for the instrument proposal and construction.

The point was also raised during the workshop that it was to ESS advantage that the fundamental physics beamline might be one of the initial instruments in 2019 and during commissioning, due to the advantage of additional experienced help during the commissioning stage of the facility.

It should also be noted that a couple of presently existent and running experimental setups at other facilities already expressed an interest as to whether it would be possible to relocate to an ESS fundamental physics beamline after 2019. This is a positive indication, and should be emphasized during the proposal process.

As the policies regarding each instrument hall are at a basic stage, factors that affect instrument performance should be raised and discussed as soon as possible. These policies are still possible to change at this stage.

In summary, the basics for a proposal for a fundamental physics beamline at the ESS seem to be in a good state; however the community now needs to gather a suitable set of (primarily) European collaborators for in-kind funding purposes to push the concept.

Acknowledgements

The authors would like to thank the workshop organisers, hosts and participants for their time and effort resulting in an excellent and productive workshop.

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