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## Preparing for the Next Instruments

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## 1. PREAMBLE

The ESS must become Europe's flagship neutron user facility. We, therefore, have the clear obligation to achieving world-leading performance. This performance will be measured by the success of our user community both from academia and industry. This success will be determined by many factors of which the primary ones within the control of ESS are the performance of the neutron source and the performance of the instrument suite. The instrument suite must be designed such as to maximize the opportunities of the ESS user community to do outstanding experiments that lead to highly impactful scientific results. This is achieved when combining new capabilities - allowing to pursue scientific questions that so far have not been accessible to investigation with neutrons - with high capacity.

The necessity for a powerful instrument suite geared towards the needs of the user community has been realized from the very inception of the ESS. The 2008 ESFRI roadmap [1] that constituted an important step in making the ESS a reality included a 22-instrument suite, as did the 2013 ESS Technical Design Report [2], which is the basis of what we are building now. The ESS Statutes from 2015 [3] also specify 22 instruments and the facility is built in such a way that it actually can accommodate even more instruments than this.

The current project will deliver 15 instruments for science by the end of 2027 [4]. It is part of the project duty to prepare the continuation of capability and capacity build-up during the initial Steady State operations phase. Given the considerable lead times required to choose, design, construct, install and commission a new instrument this preparatory work has to start now.

The most important first step in this process is the choice of the next instruments. Getting this choice right requires identifying the areas in which both the user community needs are highest and where innovative and highly performing instrument realizations can respond optimally to these needs.

ESS management proposes in this paper a process securing the success of this important first step. The process will be conducted by the ESS Science Directorate and aims at capturing essential input from the neutron community in the most complete and transparent way. The expected outcome is a clear roadmap for the build-up of the instrument suite as a basis for the discussion with our funders.

## 2. EXPANDING THE SUITE - CAPABILITY & CAPACITY

Deciding on the next instruments requires that we analyse the needs of the user community, both in terms of what types of experiments the 15-instrument suite cannot offer, but also how we can most effectively meet user demands in terms of volume of experiments. This analysis may lead to the conclusion that instead of closing gaps in capability it is more judicious to add extra capacity in a field already covered. In this context, societal relevance and, in particular, the use of ESS aimed directly at increasing European economic competitiveness, must be part of the principles that guide us.

It is important to realize that the definition of future scientific avenues cannot be done in isolation from the actual advances in instrument development. In other words, ambition must meet reality. For this reason, the exploration of scientific avenues must go in parallel with the exploration of concretely realizable instrument concepts.

## 3. CONTEXT

### **3.1. Previous Calls**

In order to be capable of delivering the ambitious scope of ESS, it was realized from the beginning that expertise must be pooled from across Europe. This held particularly true for the instruments, the development of which relies on very specific and uncommon expertise.

To assure this influx of know-how the first 15 instruments were selected through a series of calls held in 2013, 2014 and 2015. The calls concerned proposals for designing, building and installing the instruments and were in the absence of a pre-defined overall scientific strategy unconstrained: there were no scientific guidelines except for a strategy for scientific success [6], and no hard funding limit for the proposals.

On the basis of the received visionary and ambitious proposals a scientific strategy was organically developed that lead to the 15 instruments implemented today.<sup>1</sup> The community engagement and use of the competence present around Europe were assured by executing the selected instrument projects as in-kind projects involving a variety of partner laboratories.

### **3.2. Focus of the Current Call**

In updating our scientific strategy, the underlying principles of the previous exercise will be maintained. As with the series of calls a decade ago, ESS will closely involve the user community. However, the new process must take into account the context of ESS as a built facility and, based on our collective experience of the in-kind process, all options with regard to the framework for design and construction must be left open.

Managing instrument projects fully in-kind has been successful in tying large parts of the European community close to the ESS project, but it has been challenging in many ways – both for the partners and for ESS. There is, therefore, agreement on the fact that the way we will build the next instruments will differ substantially from the current in-kind model.

Whatever model is used, it is obvious that the role of managing the projects will be retained by ESS. The fact that ESS is now an established organization with continuously growing in-house competence drives this approach. The ESS organization has, in particular, acquired considerable skills and experience in designing and building instruments, and by ensuring that the next batch of instrument concepts are ready for implementation once the first 15 are up and running, we leverage this strength to our benefit.

Therefore, the next call will be focused solely on capturing ideas for instruments without requiring a concrete consortium proposal for their realization. These calls will be accompanied by work with the community on the evolution of the scientific landscape.

### **3.3. Relation of Current call to Future Funding Process**

The funding of the public instruments beyond the current 15 is not yet agreed upon. For ESS to fulfil its mission resources will have to be allocated for continuous expansion and development of the experimental capabilities at ESS in the steady-state budget, and by implementing these new instruments along an incremental schedule we make sure they are eligible to be included in such a funding stream.

The cost profile of an instrument project begins modestly as most of the costs are incurred during the actual construction. Opening a call and supporting the community in discussing scientific

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<sup>1</sup> However, limits have been imposed on funding and implementation, and the original instrument concepts have been revised and descope several times during the construction period (Some of that removed scope is now being reinstated in the instrument projects.).

opportunities and developing conceptual designs are not cost-intensive activities, but they are extremely important, and they require time. It is also necessary for ESS to specify what we want to build in order to motivate the funds required.

ESS will not cover costs incurred at the proposing institutes for the development of concepts and instrument construction will not commence until the necessary funds have been clearly identified.

### **3.4. Space, Infrastructure and Resources**

ESS does not intend to build additional instrument halls to accommodate this new batch of instruments; the proposed instruments must fit within the currently available space.

ESS will make sure that this call does not divert the attention of ESS staff from the prioritized task of delivering the first 15 instruments into the user program. To the contrary, it is to be seen as an integral part of the strategic work required for transitioning into the scientific exploitation phase. This work includes, by definition, evaluating the needs of the user community. It thus directly leads to the identification of opportunities and future research avenues including further instruments.

The work will be mainly orchestrated by the senior management within the Science Directorate. Where the call will require specific coordination and support from ESS staff these tasks will be taken into account as ESS recruits more scientists in accordance with the staff plan. This holds in particular for the last step of the process where the concepts have to be converted into preliminary designs allowing to check feasibility and costs (see below).

### **3.5. Community Engagement**

The success of ESS depends wholly on the scientific community, and ESS values the competence and experience present across Europe highly. For the next batch of instruments, ESS wants to engage the community in the following ways:

- Identifying scientific needs,
- Capturing innovative instrument concepts via an open call,
- Peer-reviewing of the proposed concepts by an external committee,
- Enabling collaborative contributions to the instrument projects.

The later point has to be worked out case by case and taking into account the guidelines provided by Council. It allows for collaborative contributions within the instrument projects even if the overall projects are managed by ESS. It is evident that the teams having proposed successful proposals will be in a privileged position to enter into such collaborations should they desire to do so.

## **4. THE CALL FOR THE NEXT INSTRUMENTS**

### **4.1. An Open Call for Instrument Concepts**

- We will have an open call for instrument concepts.
- We will provide specific information regarding space and other limitations, previously identified scientific gaps and ESS expectations.
- The call will ask for brief, concise, scientifically driven proposals.
- The applicant will be asked for a strong science case, an impact analysis in terms of both capability and capacity, and considerations of technical feasibility.
- To make sure that the latter is done taking ESS specificities into account the proposers are encouraged to make contact with the respective instrument division.

- In-house proposals will be explicitly encouraged.

#### **4.2. Review of the Proposed Instrument Concepts**

- The instrument concepts will be reviewed both by expert committees and internally by ESS.
- The reviews must judge both the scientific potential as well as the technical maturity and innovation potential of the proposals.
- The concepts will be considered in relation to rescoping current instruments, among other things.
- The evaluation of each proposal will be forwarded to ESS management.

#### **4.3. Developing an upgrade roadmap for Council approval**

ESS will cast the outcome of the review into an upgrade roadmap that will be submitted to Council. To this end:

- ESS will engage into preliminary design studies that will allow
  - Establishing reliable costing,
  - Identifying potential technical bottle necks,
  - Setting up a plan for the development, construction, installation and commissioning of each individual instrument project.
  - These preliminary design studies will be executed in close contact with the proposers of the original concepts.

The individual projects will then be cast into an upgrade programme. At this stage we must, in particular, take staff availability and project needs into consideration.

#### **4.4. Building the Selected Instruments**

Once the funding is obtained from Council the selected projects will be included into the ESS Development Plan and executed following ESS practices. These practices will, in particular, allow for collaborative contributions from the proposers or other partners showing interest in such collaboration.

### **5. TIMING**

We intend to open this call for instrument concepts at the beginning of 2025 and keep it open for 12 months. After that, the review and selection process will take place. The selected instrument concepts will be developed further and costed, after which a costed upgrade proposal will be submitted to Council.

We acknowledge the possibility of other, externally funded instrument projects being initiated during the same time period, and in that case, we will integrate them into the staggered instrument construction schedule in a way that creates minimal strain on the organization.

### **6. CONCLUDING REMARKS**

A neutron source like the ESS accelerator-target assembly should be fully instrumented to return as much scientific impact back to its stakeholders as possible. The plan presented here lays out the path to complete the scope set out in the statutes, whilst also setting a structure for future expansions of

the ESS instrument suite. The plan balances the need for strong community engagement with the need for a coherent scientific strategy and project execution efficiency.

The ESS Scientific Advisory Committee was presented with this plan in April 2024. They are fully supportive of the process but urge caution when it comes to the details of the timing.

## 7. REFERENCES

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- [5] *Neutron Science in Europe, Strengthening World-Class Research and Innovation Delivering Economic and Societal Impact* (2022), the League of Advanced Neutron Sources (LENS), ISBN 978-91-527-3846-7, pages 43-44.
- [6] *An Early Success Strategy for ESS, Selecting Instruments and Preparing Support for Early Scientific Success* (2014, updated 2017). ESS document, approved by Council.