Rescoping of first 15 instruments

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Conclusion from benchmarking with existing facilities that have undergone upgrades since science case for ESS instruments was presented

The document ESS-5290872, submitted to SAC32, provides an overview of the ESS instrument performance at the time of their proposal and today, after descoping at the ESS and upgrades at our partner laboratories.

The conclusion of the analysis is that in many instances a rescoping of the instruments is necessary to ensure the competitiveness of ESS worldwide.

(1) The rescoping of the instruments can be performed in a staged approach with current priority placed on the components outlined for each instrument to be completed for first science on each instrument.

(2) Reaching a stable 2 MW operational mode will be necessary to perform adequately.

(3) Further instrumental upgrades can be completed shortly after the instruments are in full operation ensuring a limited downtime.

It is noted that the support facilities are of paramount importance and these also need to be carefully considered and funded to optimise scientific output and the user experience.

Diffraction and Imaging instruments

The item list below was prioritised purely on Scientific Impact, not figure of merit (FOM).

Instrument	Rescoping option	Procured by:	A: Scientific Impact (5: high, 1: low)	B: Manpower (1:high, 5:low)	C: Technical Risk (1:high, 5:low)	B: Cost (M€)	FOM A*B*C
DREAM	Full detector coverage (CDT)	Q1 2025	5	Significant (Detector group) 3	4	4.7	60
MAGIC	Full detector coverage (CDT)	Q3 2025	5	Significant (Detector group) 3	4	1.8 Including collimator & support	60
HEIMDAL	Full detector coverage (CDT)	Q3 2026	5	Significant (Detector group) 3	4	3.6	60
BEER	Texture detectors	Q1 2026	5	Significant (Detector group) 2	3	2.6	30
BEER	Multiplication Choppers	Q4 2025	4	Significant (Chopper group) 1	2	0.74	8
ODIN	Grating interferometer	Q1 2026	4	1, additional staff member to run the setup	1	>1.5 (TBC)	4
HEIMDAL	SANS option	Q2 2027	4	2	2	3.4	16
BEER	SANS option	Q3 2027	3	Significant (Detector group) 3	2	2.5	18
ODIN	SEMSANS	Q1 2026	3	Significant (Detector group) 3	2	0.8	18
MAGIC	Spectroscopy chopper	Q2 2026	3	Significant (Choppers group) 3	4, design was agreed with Choppers group	0.47	36
BEER	Additional sample stage	Q1 2027	3	4	4	0.8 (TBC)	48
ODIN	Diffraction detectors	Q2 2027	3	3	3	3.0	27

ODIN Descoping

Starting Point

Descoping on ODIN (at TG2) included:

- 1. High resolution imaging detectors
- 2. X-ray imaging capabilities
- 3. Diffraction detector(s)
- 4. Grating interferometry (NGI)
- 5. Time-of-Flight Three Dimensional Polarimetric Neutron Tomography (ToF 3DPNT)
- 6. Spin Echo Modulated Dark Field Imaging (SEMSANS)

ODIN Rescoping

Discussion & Conclusion during Open Discussion

Discussion Items: Detectors are key for the success of neutron imaging. A lot of development around novel event mode detectors (example LumaCam) – ESS should exploit the possibilities and bring imaging detectors to diffraction beamlines and also consider to use that technology for diffraction detectors. Agreement that key to success for any of the modalities is dedicated personnel.

1. High resolution imaging detectors

Should receive highest priority. Can nowadays be done at lower cost than anticipated at TG2 (infinity corrected optics approach).
A dedicated setup is preferable (instead of rebuilding the standard detector each time; that means a dedicated camera).

- 2. X-ray imaging capabilities

Source and detector already funded from external grant covers. But mechanical integration still missing – ESS should provide the resources to enable this. ESS Science Director supportive of that idea.

- 3. Diffraction detector(s)

The event mode imaging system (LumaCam) can be used as diffraction detector (see https://doi.org/10.1107/S1600576724004448).

- 4. Grating interferometry (NGI)

Crucial for several scientific applications for ODIN. Hardware not that expensive. But needs dedicated personnel. Collaborate with e.g. TUM and PSI.

- 5. Time-of-Flight Three Dimensional Polarimetric Neutron Tomography (ToF 3DPNT)

Will enable new and unique scientific applications for ODIN and can make use of long pulse. Needs dedicated personnel.

- 6. Spin Echo Modulated Dark Field Imaging (SEMSANS)

While this is a technique with high potential. Probably the lowest priority among the list for ODIN (for now).

- 7. High Flux TOF Neutron Imaging Detector

While event mode imaging with TPX3cam is extremely powerful; it is currently limited by maximum flux. The next generation (TPX4cam) should overcome this or the proven MCP detector should be considered. Otherwise ODIN cannot make use of its flux.

ODIN Rescoping

Discussion & Conclusion during Open Discussion

Discussion Items: Detectors are key for the success of neutron imaging. A lot of development around novel event mode detectors (example LumaCam) – ESS should exploit the possibilities and bring imaging detectors to diffraction beamlines and also consider to use that technology for diffraction detectors. Agreement that key to success for any of the modalities is dedicated personnel.

1. High resolution imaging detectors

Item 3.2 in rescoping document. Planned to be procured by division budget. (70kEuro without dedicated camera; 270kEuro with dedicated camera)

Should receive highest priority. Can nov s approach).
A dedicated setup is preferable (instead of rebuilding the standard detector each time, that means a dedicated camera).

- 2. X-ray in

Not included in rescoping document. Supported by RAC and division budget. (160kEuro)

Source and c chanical integration still missing – ESS should provide the resources to enable this. ESS Science Director supportive

- 3. Diffraction detector(s)

Item 3.3 in rescoping document. Option 1: Traditional diffraction detector solution: 1.5 Meuro. Option 2: Event mode imaging camera solution: 250 kEuro

The event mode imaging system (LumaCam) can be used

- 4. Grat

Not included in rescoping document. HW procured division budget. (50kEuro)

Crucial fo Hardware not that expensive. But needs dedicated personnel.

- 5. Time-of-Flight Three Dimensional Polarimetric

Item 3.4 in rescoping document. Polarimetric setup + development: 600 kEuro

Will enable new scientific applications for ODIN and

- 6. Sp

Item 3.5 in rescoping document. SEMSANS setup + development: 400 kEuro

While t t priority among the list for ODIN (for now).

- 7. High Flux TOF Neutron Imaging Detector

Item 3.1 in rescoping document. MCP detector: 220 kEuro (TPX4cam not yet available)

While event mode imaging with TPX3cam is extrem next generation (TPX4cam) should overcome this or the proven MCP detector should be considered. Otherwise ODIN cannot make use of its flux.

Spectroscopy instruments

Instrument	Rescoping option	A: Scientific Impact (5: high, 1: low)	B: Manpower (1: high, 5: low)	C: Technical Risk (1: high, 5: low)	B: Cost	FOM: A*B*C
MIRACLES	Complete Analyser/collimator/detector coverage Si (1 1 1) & (3 1 1)	2	Can be included and delivered within current instrument construction: 2	5	1.67 M€	20
CSPEC	^{3}He full detector coverage (2.5 bar)	5	Minimal: 5	5	2.025 M€	125
CSPEC	^{3}He full detector coverage (5 bar)	2	Minimal: 5	5	+4.375 M€	50
T-REX	Full detector coverage	5	Significant (Detector group) 2	4	>5 M€	40
T-REX	Extra blades for P chopper	2	Julich chopper group: 3	2	0.5 M€	12
T-REX	T0 chopper	x	x	x	0.85 M€	?
VESPA	T0 chopper	5	Some (Chopper group) 4	4	0.85 M€	80
VESPA	Increase analyser modules	4	Can be included and delivered within current instrument construction: 4	4	3.6 M€ for 10 (0.36 each)	64

Large Scale Structures instruments

This approach does not cover in what order the rescoping should be done as some of the items should not be done until the base configuration of the instrument is proven – so some time after start of the user programme on the instrument. In the case of NMX there is also a supply issue for the components needed – giving an additional need to wait on execution.

Instrument	Rescoping option	A: Scientific Impact (5: high, 1: low)	B: Manpower (1:high, 5:low)	C: Technical Risk (1:high, 5:low)	B: Cost	FOM: A*B*C
LoKI	Complete detector coverage (add ~4 m^2)	5	Minimal : 5 (installation technician)	5	1.04 $M€_{2013}$	125
	Resolution choppers	1	High : 1 (chopper group, new guide)	1	2.16 M€ for 10 (0.36 each)	1
SKADI	Full detector coverage (add 1m^2)	5	High: 2 (cabling, installation technician, detector group scientist and technician, ECDC staff)	5	2.5 to 4 M€	50
	High Resolution Choppers	2	High : 2 (chopper group, mechanical designer, installation technician)	5	1 M€	20
Estia	Various options	5	Limited: 4	4	1 M€	80
	Second beam path with analysers	5	Very High: 1 (design, manufacturing oversight, disassembly/reassembly of Estia)	1	5 M€	5
Freia	Fast Shutter System	5	Moderate: 3 (MCA primarily)	5	0.35 M€	75
	Resolution enhancing choppers	2	High: 2	4		16
	Polarised beam	2	Minimal: 5 (installation technician, polarisation team support)	5	0.5 M€	20
	GISANS option	1	Very high : 1	1	>5 M€	1
NMX	Isotopic Gd converter for detectors	5	Limited : 4 (detector group)	5	1 M€ - 4M€ (depending on source of 157Gd)	75
	Additional detector module	5	Moderate : 3 (detector group)	5	1 M€	75

Rescoping has started already….

In the last two years the possibility has arisen for starting some rescoping and decision was taken to profit from opportunities that might have not been possible in the future.

The full compliment of detectors for Loki has been procured (installation pending)

The production by the ILL of the full compliment of detector tubes for CSPEC has been ensured allowing the possibility of full detector coverage (pending provision of ^{3}He for pressure increase)

We see some new opportunities now and your support would be useful.

Implementation times depend on many factors and should not be your preoccupation, a strong assessment on the scientific case of a given upgrade will allow us to jump on next opportunity quickly and in a non-controversial fashion.

NEEDED RESCOPING TO ENSURE WORLD LEADING CAPABILITIES

- FREIA shutters
- DREAM full coverage detectors

Internal push to move ahead – support form SAC beneficial

- VESPA T0 chopper
- CSPEC ^{3}He 2.5/5 bar (full detector coverage)
- HEIMDAL detectors
- VESPA analyser modules
- ESTIA upgrades
- T-REX full coverage detector
- SKADI full coverage detector (pending validation of detector technology)
- NMX Gd coated detectors (to be started after instrument validation)
- MAGiC full coverage detector
- BEER texture detectors
- BEER multiplication choppers
- ODIN 3D Polarimetric Neutron Tomography

Under discussion:

Validity of the scientific impact analysis

We want to ensure world leading capabilities but avoid options that risk to undermine the overall performance of the instrument

Choice between options for already highly performing instruments (*i.e. ESTIA*) vs. upgrades that would allow increase of capability but not exceedingly overperform compared to existing facilities

High impact publication vs. high throughput vs. unique information ….

We hope to continue pursuing rescoping when opportunities arise under the condition of minimal disruption to current scope realisation.

ESS is preparing to open a call for instruments 16-22

Information to be provided at next ESS Council

ESS is preparing to open a call for instruments 16-22

Pending ESS Council approval

Why now?

- Get as much science as possible out of the ESS source as early as possible.
- There are scientific gaps in the suite of 15 instruments, and the ESS mandate is to build 22 public instruments.
- Benefit from current staff competence and experience.
- Pressure from some countries and communities – including Sweden.

Focus of the Call: Science!

The call asks for Expression of Interest for instrument concepts, focussing on the science drivers.

- What science is missing?
- At ESS as well as in the global landscape.
- Scientific capacity as well as capability.

Limitations

- The new instruments have to fit in the existing instrument halls.
- Funding for new instruments has not yet been identified, and start of construction will hinge upon these decisions.
- ESS will not cover costs incurred when developing Expressions of Interest.

The Call as Currently Planned

- Open 15/1 2025 – 15/1 2026.
- Contact ESS before applying; information will be available on ess.eu.
- Submit an Expression of Interest (EoI) for an Instrument Concept.
- These EoI will be reviewed externally and internally at ESS.
- Selected concepts will be developed into instrument designs in close collaboration between ESS and the proposing team.
- Instruments will be built by ESS. Timing hinges on funding.

Draft webpage for call

Call for Expressions of Interest for Instrument Concepts at the European Spallation Source

ESS is pleased to invite interested parties in our member countries to submit Expressions of Interest (**EOI**) for instrument concepts beyond the 15 instruments currently being installed. The next tranche will consist of seven instruments, bringing us up to the 22 instruments specified in the statutes.

Context

ESS is committed to delivering 22 public instruments for science, as stated in the statutes. The first 15 are being installed, and we are now looking to identify the next seven instrument concepts for ESS. The overarching aim of expanding the instrument suite, which will guide the selection of instrument concepts, is to fill the gaps in the ESS instrument suite in terms of both scientific capabilities and capacity.

Since the first calls for instrument concepts, the ESS organization has developed strong competence in designing and constructing instruments at ESS. Therefore, this next batch of instruments will be managed differently than the first 15, and more similarly to other large-scale facilities. After selecting which instrument concepts to move ahead with from this call, design will be done by ESS in collaboration with the proposers and construction of the instruments themselves will be done by ESS. Limited collaborative or in-kind contributions may be possible in the construction process, but this mechanism will constitute a relatively small part of the instrument projects this time around.

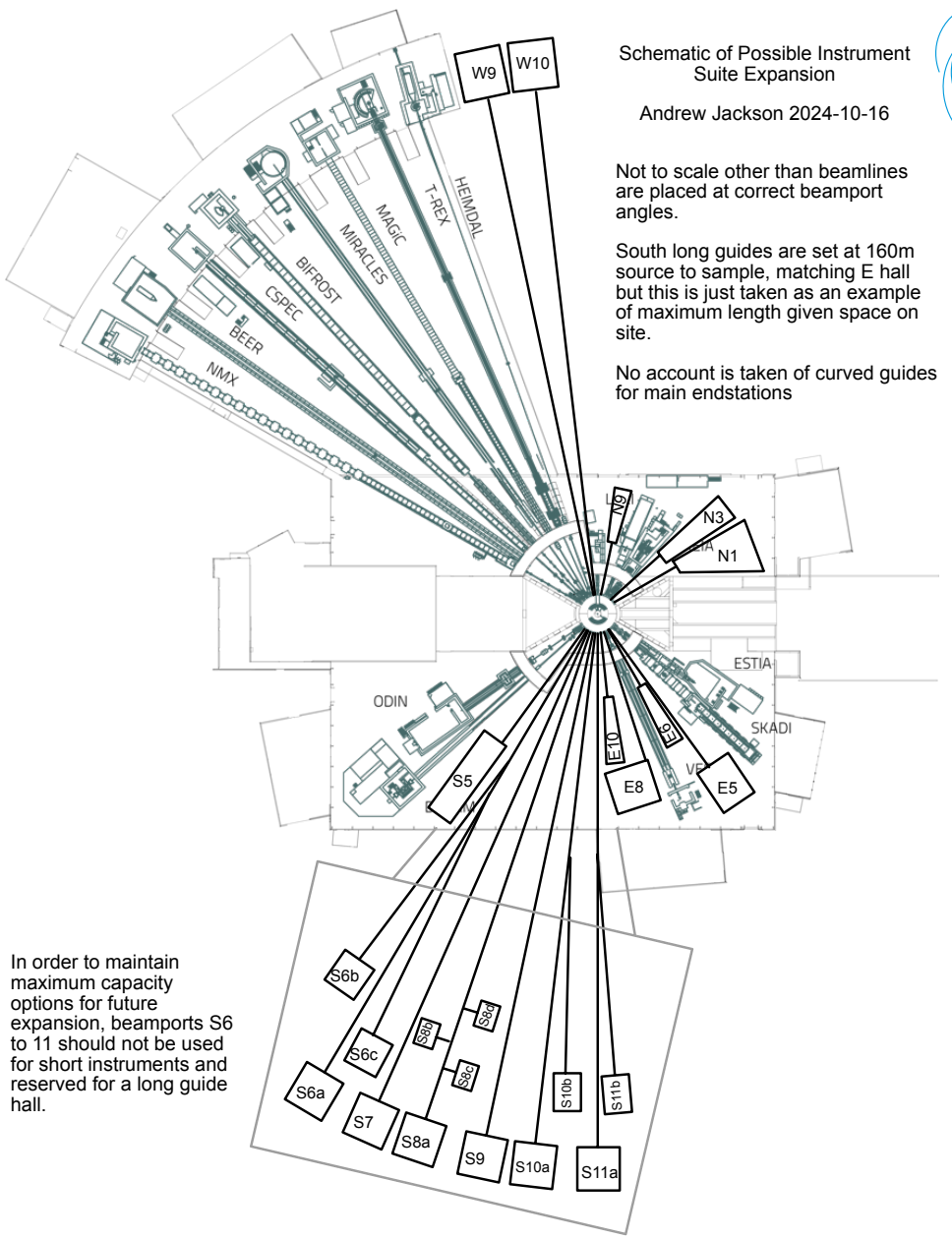
The funding of instruments 16-22 is currently not decided. The focus of the current call is to identify concepts that can contribute to a plan that is ready to be implemented once funding is identified. ESS will not cover costs incurred at the proposing institutes for the development of concepts.

The proposed instrument concepts must fit within the currently available space; no new halls will be built for this batch of instruments. A space allocation map is available.

How to Prepare and Submit an Expression of Interest

The call for EoI will be open January 15 2025 – January 15 2026.
Make sure to contact us well before you submit a proposal, see below.

Your EoI should propose an instrument concept, not a fully designed instrument. Focus on scientific capacity and capability, and how your concept would complement the current instrument suite at ESS as well as the global neutron landscape, and enable ground-breaking science. Explain how technical solutions will make your concept world-leading, but do not provide a full instrument design.



Schematic of Possible Instrument Suite Expansion

Andrew Jackson 2024-10-16

Not to scale other than beamlines are placed at correct beamport angles.

South long guides are set at 160m source to sample, matching E hall but this is just taken as an example of maximum length given space on site.

No account is taken of curved guides for main endstations

In order to maintain maximum capacity options for future expansion, beamports S6 to 11 should not be used for short instruments and reserved for a long guide hall.