

Fundamental Physics @ ESS



G. Konrad, *SMI and TU Wien, Austria*

T. Soldner, *ILL, Grenoble, France*

PSI2016 Workshop
Villigen, Switzerland
October 16 – 20, 2016

16/09/2016

Fundamental & Particle Physics

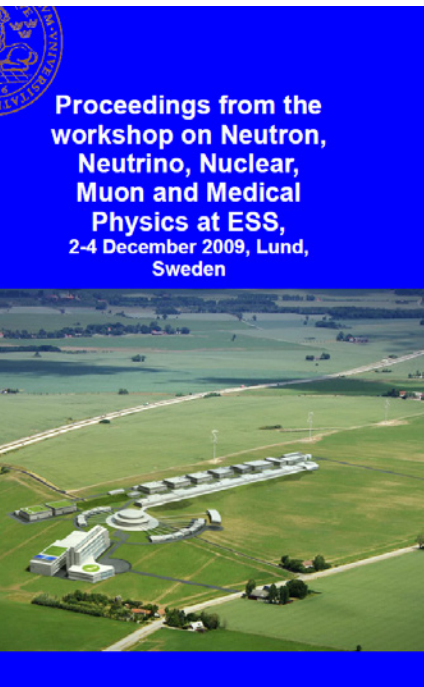


- Preceding presentations:
- Neutron EDM
 - Neutron β -decay
 - Hadronic weak interaction
 - n - \bar{n} Oscillations
 - Quantum mechanics (gravity)

Overview

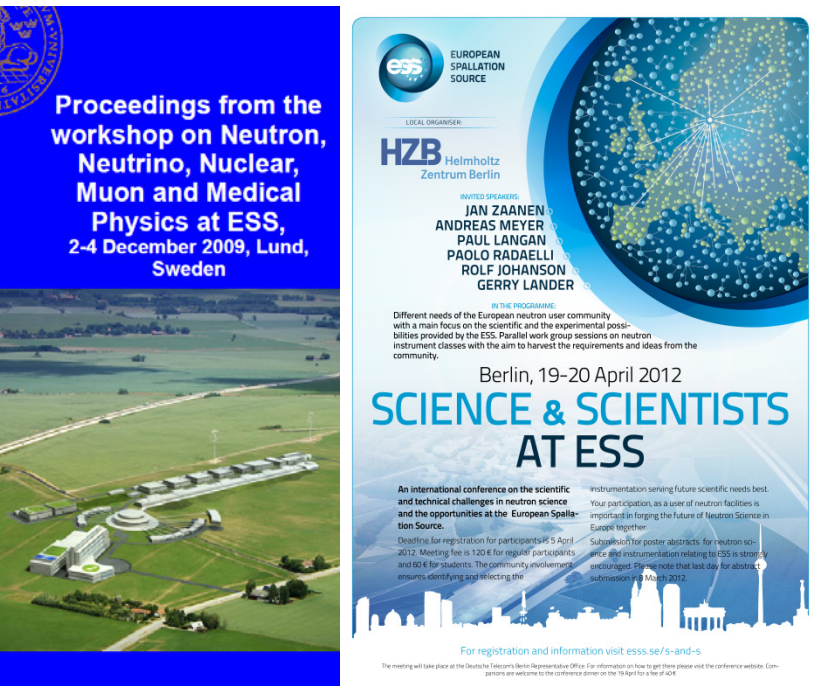
- A bit of `history' (2009 – 2015)
- Strategy meeting (July 2016)
- Next steps
- More information
- Summary
- Q&A Session

A bit of `history` (2009)



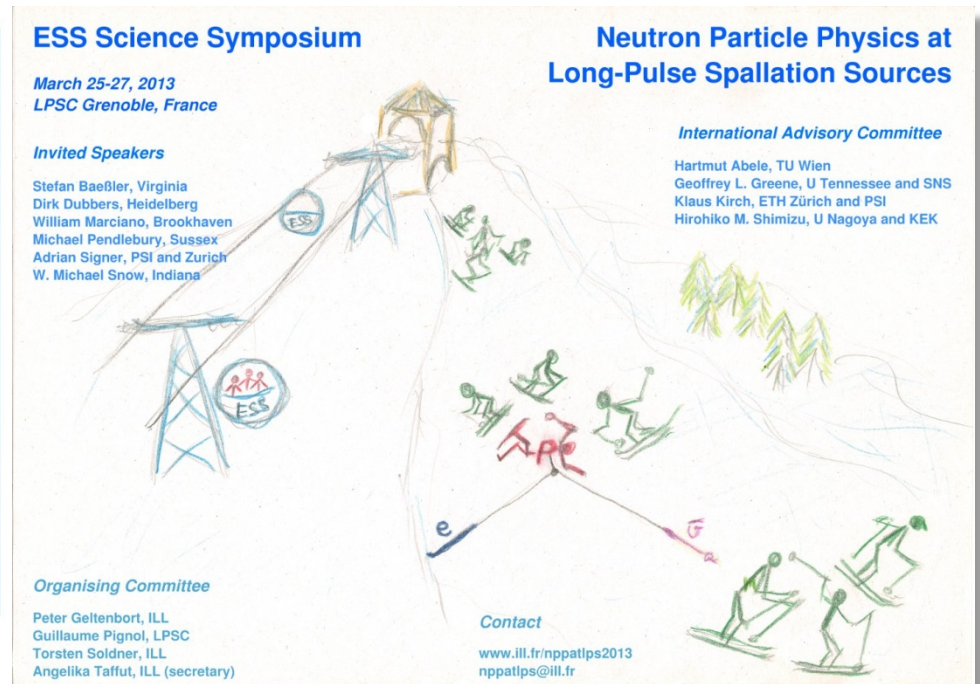
- Particle physics with **cold neutrons**: beam station
- Particle physics with **UCNs**: beam station
- QM with **thermal neutrons**: beam station

A bit of 'history' (2012)



- Particle physics with **cold neutrons**: beam station
- Particle physics with **UCNs**: in-pile UCN source
- QM with **thermal neutrons**: beam station
- Neutron bound β -decay: through-going beam port

A bit of 'history' (2013)



- Particle physics with **cold neutrons**: beam line
- Particle physics with **UCNs**: UCN sources
- QM with **thermal neutrons**: beam station
- Neutron bound β -decay: through-going beam port

A bit of `history' (2014)



**Proceedings from the
workshop on Neutron,
Neutrino, Nuclear,
Muon and Medical
Physics at ESS,
2-4 December 2009, Lund,
Sweden**



EUROPEAN
SPALLATION
SOURCE

LOCAL ORGANISER:

HZB Helmholtz
Zentrum Berlin

INVITED SPEAKERS:
JAN ZAAENEN
ANDREAS MEYER
PAUL LANGAN
PAOLO RADAELLI
ROLF JOHANSON
GERRY LANDER

BY THE PROGRAMME:

Different needs of the European neutron user community with a main focus on the scientific and the experimental possibilities provided by the ESS. Parallel work group sessions and neutron instrument facilities will be aimed to harvest the requirements and ideas from the community.

Berlin, 19-20 April 2012

SCIENCE & SCIENTISTS AT ESS

An international conference on the scientific and technical challenges in neutron science and the opportunities at the European Spallation Source.

Deadline for registration for participants 5 April 2012. Meeting fee is 120 € for regular participants and 60 € for students. The community involvement ensures identifying and selecting the instrumentation serving future scientific needs.

Your participation, as a user of neutron facilities is important in forging the future of Neutron Science in Europe together.

Submit your poster abstracts for neutron science and instrumentation relating to ESS as strongly encouraged. Please note that last day for abstract submission is 8 March 2012.

For registration and information visit ess.se/s-and-s

The meeting will take place at the Deutsche Telekom Berlin Representative Office. For information on how to get there please visit the conference website. Participants are welcome to the conference dinner on the 19th April for a fee of 40 €.

ESS Science Symposium

**Neu-
Long-Pu**

March 25-27, 2013
LPSC Grenoble, France

Invited Speakers

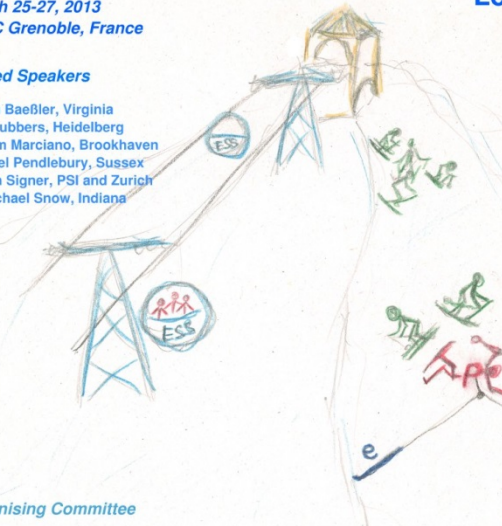
Stefan Baeßler, Virginia
Dirk Dubbers, Heidelberg
William Marciano, Brookhaven
Michael Pendlebury, Sussex
Adrian Signer, PSI and Zurich
W. Michael Snow, Indiana

Organising Committee

Peter Geltenbort, ILL
Guillaume Pignol, LPSC
Torsten Soldner, ILL
Angelika Taffut, ILL (secretary)

Contact

www.ill.fr/nppatps2013
nppatps@ill.fr



Neutron-Anti-Neutron Oscillations at ESS

12-13 June 2012, CERN, Geneva, Switzerland



Neutral particle oscillations have proven to be extremely valuable probes of fundamental physics. Kaon oscillations provided us with our first insight into CP-violation. First B-meson decays provided the first indication that the top quark is extremely heavy. B oscillations form the most fertile ground for the continued study of CP-violation, and neutrino oscillations suggest the existence of a new, important energy scale well below the GUT scale. Neutrons oscillating into antineutrons could offer a unique probe of baryon number violation.

The construction of the European Spallation Source in Lund, with its first beam expected in 2019, together with modern neutron optical techniques, offers an opportunity to conduct an experiment with at least three orders of magnitude improvement in sensitivity to the neutron oscillation probability.

At this workshop the physics case for such an experiment will be discussed, together with the main experimental challenges and possible solutions. We hope the workshop will conclude with the first steps towards the formation of a collaboration to build and perform the experiment.

Organising committee:

- A. Brashers-Krugman (University)
- S. Chaturvedi (University of Oxford)
- B. Haid (University of Copenhagen)
- A. Karpachuk (European Spallation Source)
- S. Knapik (University of Tennessee)
- B. Knie (University of Jyväskylä)
- J. Kopp (University of Jyväskylä)
- M. Lindner (European Spallation Source and Lund University)
- L. Haxel (CERN)
- M. Mavropoulos (CERN)
- M. Stenlund (European Spallation Source)
- M. Stenlund (University)
- T. Sjöstrand (University of Lund)
- C. Thompson (University of Jyväskylä)

**Register before
19 May on
www.nmba-at-ess.org**



- Particle physics with **cold neutrons**: beam line
- Particle physics with **UCNs**: UCN sources
- QM with **thermal neutrons**: beam station
- Neutron bound β -decay: through-going beam port
- n - \bar{n} Oscillations

Instrument proposals 2014/2015

- 4 Instruments within NSS budget available
- 9 Instrument proposals
 - 8 Neutron scattering instruments
 - **ANNI: *A cold neutron beam facility for particle physics***

Category	[k€]
Guide & Polarizers	1 000
Radiation shielding	2 000
Magnetic shielding	500
Flux & background monitors	150
Chopper system	2 000
ep/n separator	4 000
Infrastructure	1 850
Manpower	2 300
Total	13 800

- 2 Letters of interest
 - In-beam UCN facility
 - n - \bar{n} Oscillations

STAP Report to SAC (2015)

We recommend that the full instrument suite at ESS should include two beamlines for particle physics. 1) a cold beamline (ANNI) as well as 2) a beam line which allows the extraction of a broad angular divergence. **The STAP strongly recommends approval of the ANNI proposal now**. Furthermore we recommend a second particle physics beamline with broad angular divergence for a UCN facility and/or an nnbar experiment, as demonstrated by the letters of interest, with proposals to be submitted in the tranche 3 cycle.

SAC Ranking & Arguments (2015)

- 4 Neutron scattering instruments recommended
- ANNI ranked 8th out of 9:

ANNI is a cold neutron beam facility for investigations in fundamental physics. The proposers presented a technically sound and solid proposal and addressed the broad user base that is present in fundamental neutron physics. The ANNI proposal was well conceived and the support from the STAP to move forward is apparent. ANNI would make full use of the brightness and pulse structure, which are unique to the ESS. This enables an order of magnitude of improvement over a similar instrumentation at other neutron sources, which would be an important leap forward for this community. The SAC strongly supports the view of including fundamental physics instrumentation as well as this vibrant scientific community at the ESS. However, given the limited number of instruments available within the first 16 to be constructed, the SAC felt that the project could not be prioritized to be among the first 16 instruments.

Strategy meeting (July 2016)

Particle Physics at the ESS

Friday, 8 July 2016 from **09:00** to **18:00** (Europe/Stockholm)
at **European Spallation Source ERIC (Linneasalen)**
Tunavägen 24, Lund, Sweden

The meeting addresses proposers, STAP* and representatives of groups that may be interested in neutron particle physics projects at the ESS. The proposal for a fundamental physics beam line at the ESS was well-supported by the STAP but received low priority in the SAC*. The main aim of the meeting is to prepare for successful particle physics projects at the ESS in future. This includes coordination of activities within the scientific community as well as discussions with ESS representatives on how to assure particle physics as part of the ESS.

STAP: Scientific and Technical Advisory Panel for fundamental physics at the ESS

SAC: ESS Scientific Advisory Committee

Organizers:

Hartmut Abele (TU Wien)
Gustaaf Brooijmans (Columbia University)
Mats Lindroos (ESS)
Bastian Märkisch (TU München)
Anders Oskarsson (Lund University)
Torsten Soldner (ILL)
Camille Theroine (TU München)

Particle Physics (PP): STAP, proposers and interested members of the particle physics community.

ESS: ESS science director and further ESS representatives

Friday, 8 July 2016

09:00 - 10:45	PP: Analysis of experience with beamline proposal Material: slides
10:45 - 11:00	Coffee break
11:00 - 13:00	PP: Particle Physics projects at ESS. Discussion of competition, synergies and possible coordination and cooperation Material: slides
13:00 - 14:00	LUNCH (Ljussgården outside the conference room) <i>Catering lunch will be served</i>
14:00 - 16:15	PP and ESS: How to implement particle physics instruments at the ESS. Discussion with ESS representatives Material: slides
16:15 - 16:30	Coffee break
16:30 - 17:30	PP: Discussion and decision on next steps Material: slides

Participants:
7 ESS, 15 Particle Physics

Presentation by Prof. Schreyer (new ESS science director)

The ESS Neutron Instruments revised layout (June 2016)



Instruments 1-16; funded by NSS construction project

Instruments 17-22; funded by initial operations

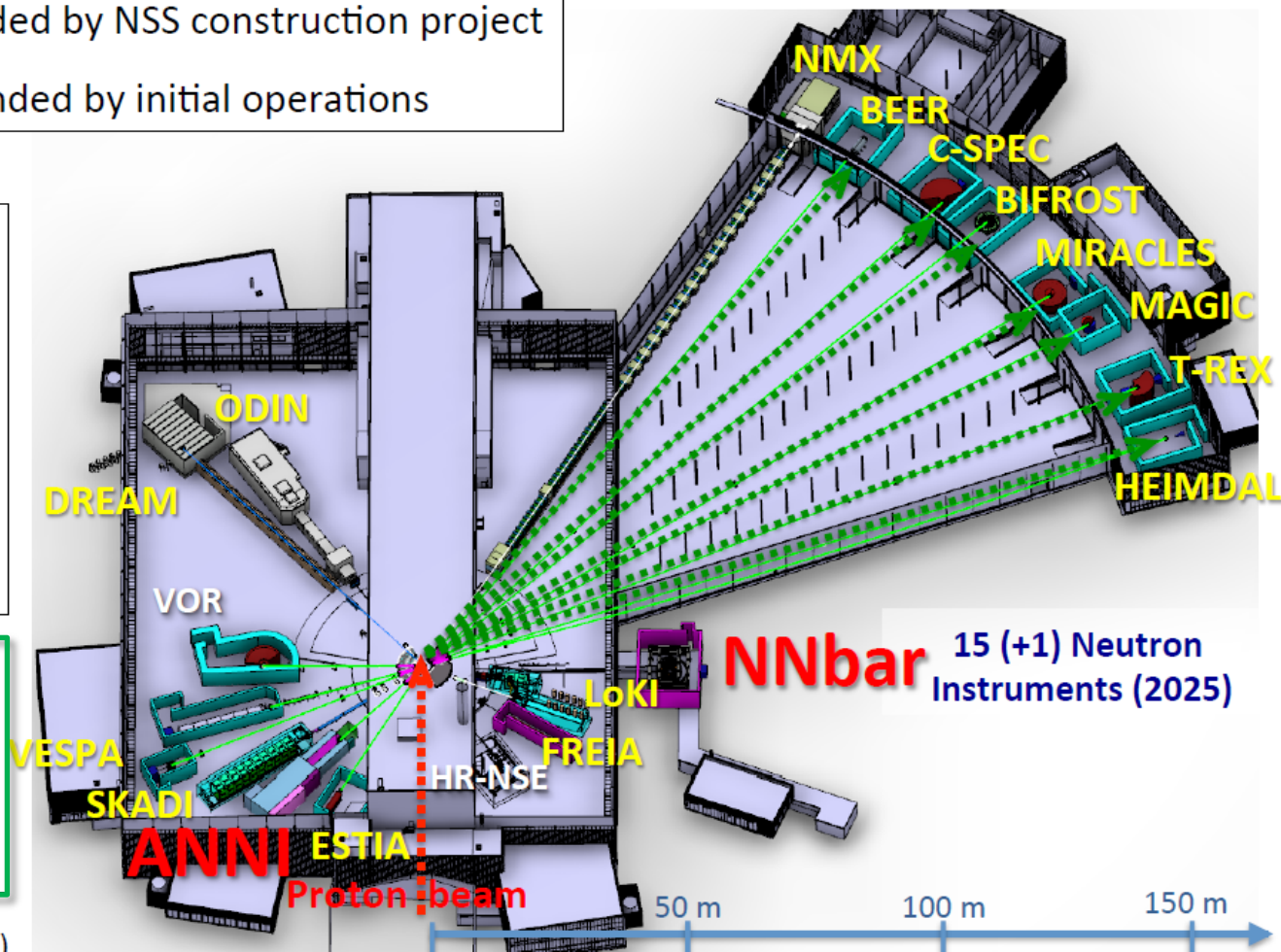
Two instruments have moved;

- ESTIA; E1 -> E2 – for cleaner view of source
- SKADI ; E8 -> E5 – for more space (= lower technical risk)

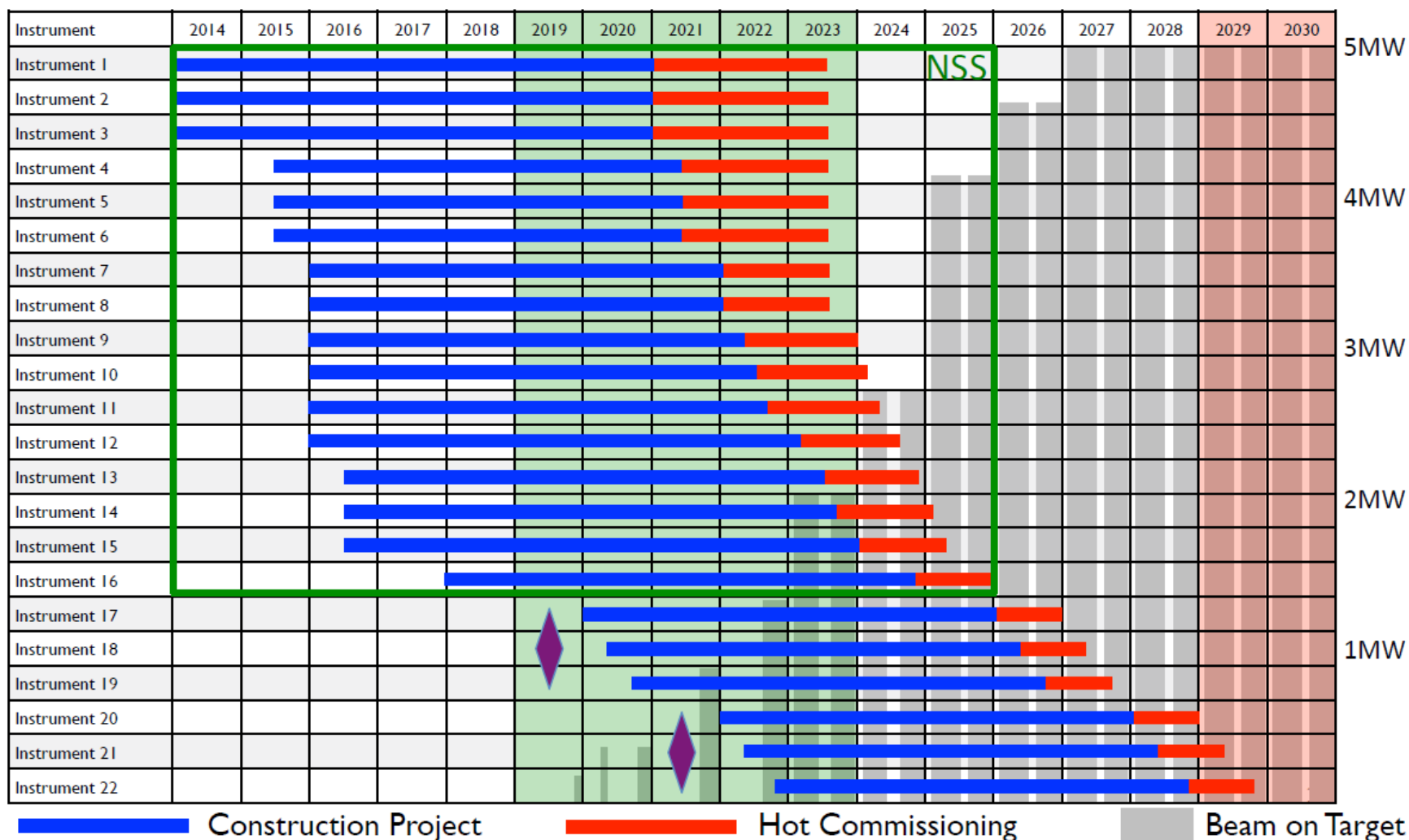
Space for ANNI between SKADI and ESTIA reserved

NNbar: possible

Instrument Layout (June 2016)



Proposed New Timeline



ESS Statements

- A fundamental physics beamline is missing in the approved ESS instrument portfolio. All other fields of science are already covered.
 - **Fundamental physics should be part of it!**
- Decisions on instruments 17 – 22 could take place from 2019 onwards (tbd)
 - Strategic decision by ERIC council in December 2016
 - **No ESS operations funding available for concept development until 2021**
 - Enter user programme between start-2027 and end-2028
- ESS requests more SAC members from fundamental physics

Next steps

- Instrument proposals:
 - Update ANNI proposal, *based on new framework conditions*
 - Convert letters of interest into full proposals
 - Explore external funding options
- Further actions:
 - Form task force
 - Write strategy white paper
 - Attend conferences etc., *to involve larger user community*
 - Organize satellite meetings, symposia, & dedicated workshops

→ You are very welcome to join/support FP at ESS!

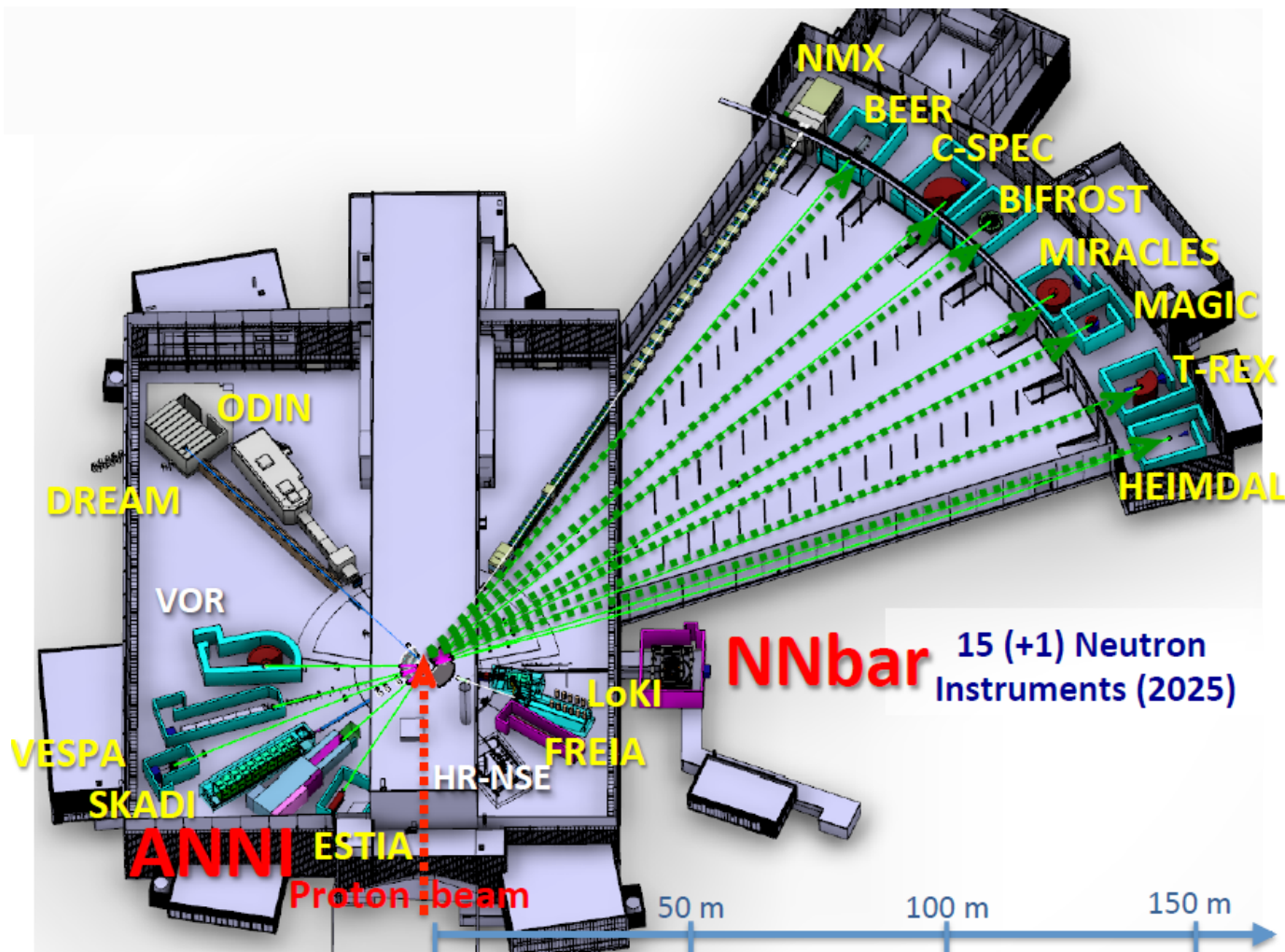
More information

- Poster session:
 - T. Solder et al.: *Design and performance of the proposed cold neutron beam facility for particle physics at the ESS*
 - E. Klinkby: *Neutron moderators for the European Spallation Source*
- Contact data:
 - ESS: *E. Klinkby, DTU & ESS, Sweden (moderators),
V. Santoro, ESS, Sweden (particle physics)*
 - ANNI: *T. Soldner, ILL, Grenoble*
 - UCN: *O. Zimmer, ILL, Grenoble*
 - NNbar: *G. Brooijmans, Columbia University, US*

Summary

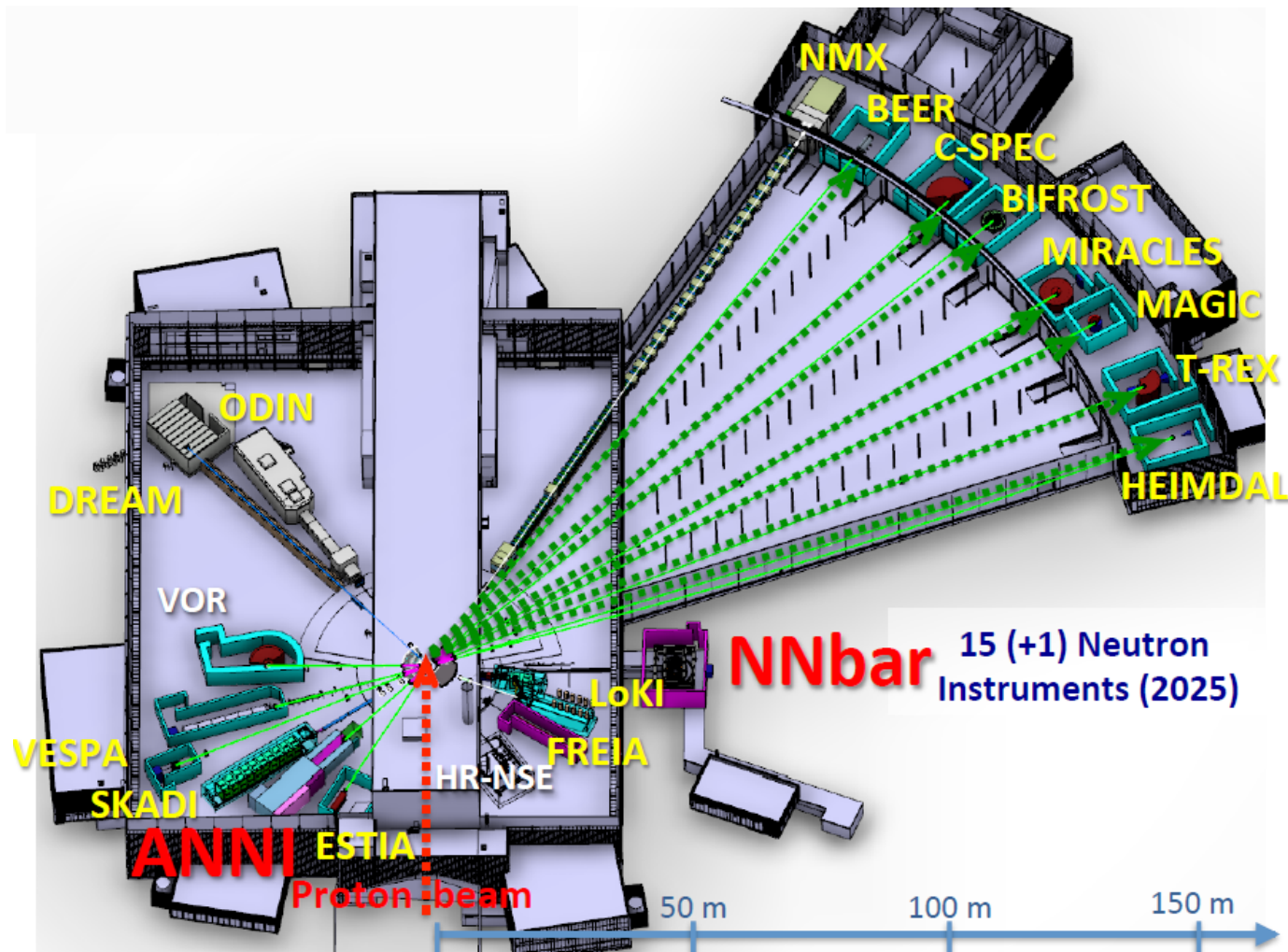
- Instrument proposals 2014/2015
 - ANNI instrument proposal, 2 letters of interest
 - STAP strongly recommended ANNI proposal *now*
 - SAC ranked ANNI proposal 8th out of 9
- Strategy meeting, July 2016
 - Fundamental physics should be part of instrument suite!
 - Next proposal rounds in 2019 & 2021 (tbd)
- Next steps
 - Complete work on instrument proposals
 - Enlarge involvement of community
 - You are very welcome to join/support FP at ESS

Thank you for your attention



Presentation by Prof. Schreyer (new ESS science director)

Do you have any questions?



Presentation by Prof. Schreyer (new ESS science director)