



EUROPEAN
SPALLATION
SOURCE



The European Spallation Source

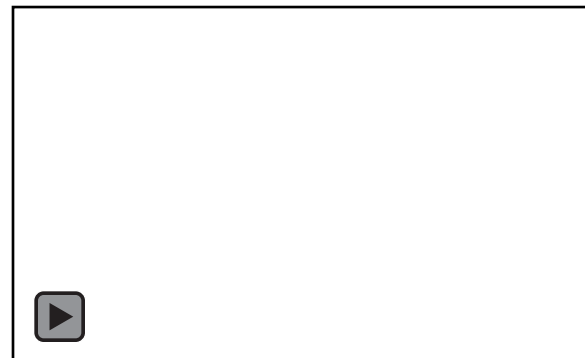
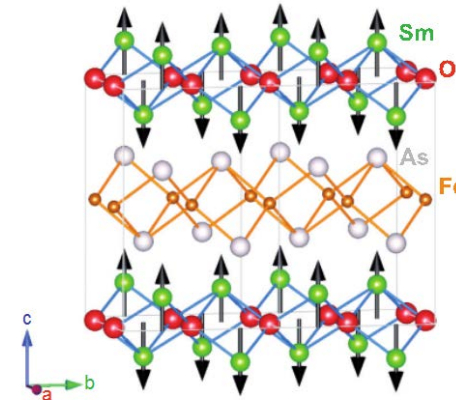
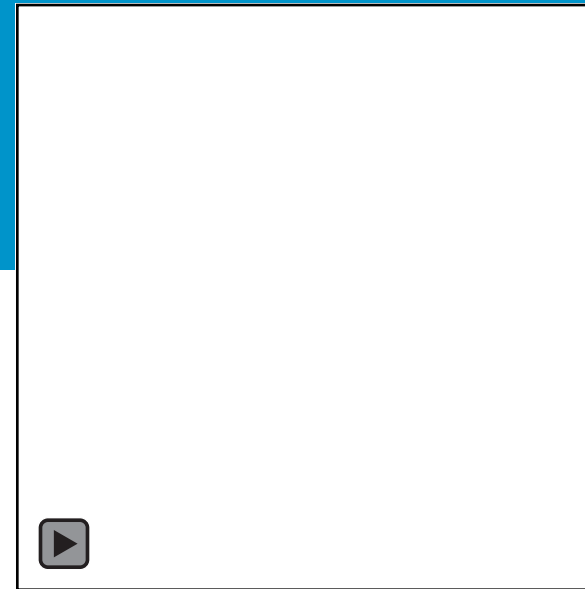
John Womersley, Director General

February 2017

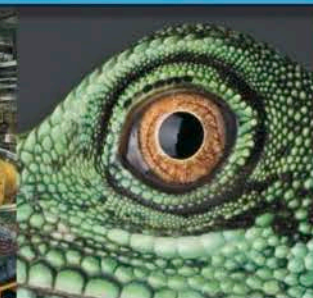
Neutrons are special

- **Electrically neutral** - deeply penetrating ... except for some isotopes
- **Nuclear interaction:** cross section depending on isotope (not Z), sensitive to light elements and water
- **Spin $\frac{1}{2}$** probing magnetism and quantum properties
- **Mass $n \sim p$** ; thermal energies, non-relativistic velocities
 $E = 293\text{K} = 25 \text{ meV}$, $\lambda = 1.8 \text{ \AA}$
 $v = 2 \text{ km/s}$

Neutrons tell us where are the atoms and what do they do



Neutron Science



Energy

Environment and climate

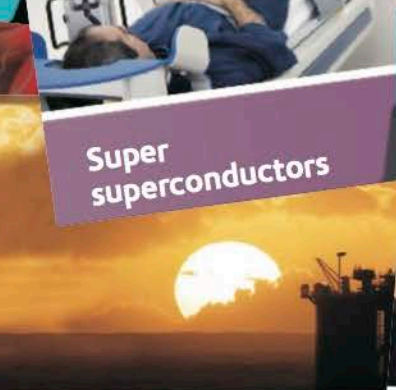
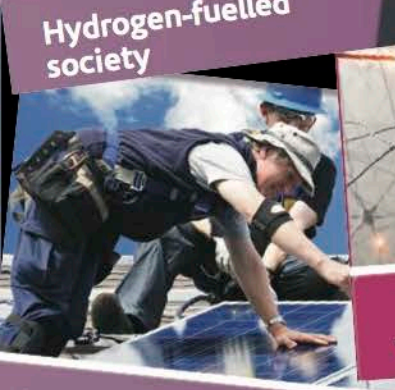
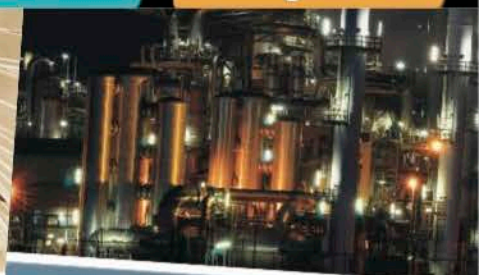
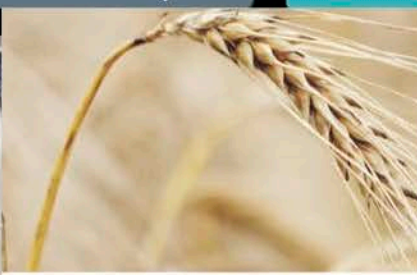
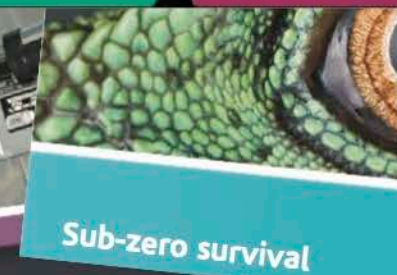
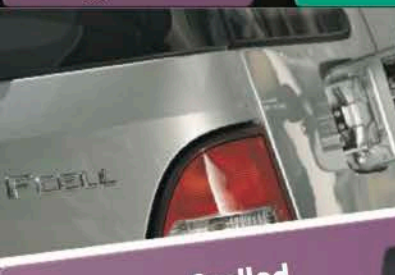
Medicine and health

Electronics and IT

Manufacturing and industry

Natural world

Heritage science



Hydrogen-fuelled society

Sub-zero survival

Superconductors

Disease resistant crops

Tackling chemical waste in the pharmaceutical industry

Flexible plastic solar cells

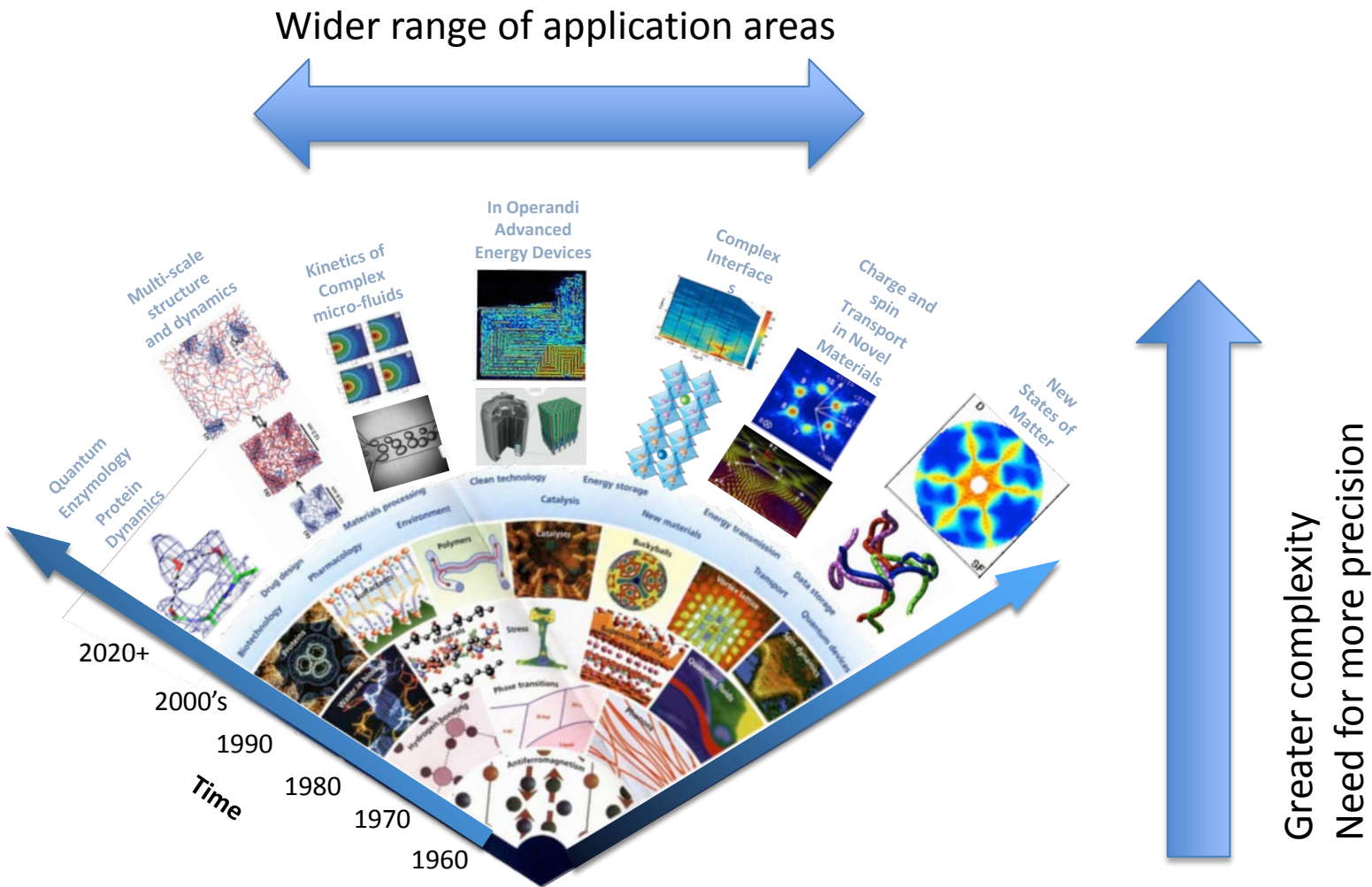
Tracking cholesterol

Enhanced oil recovery

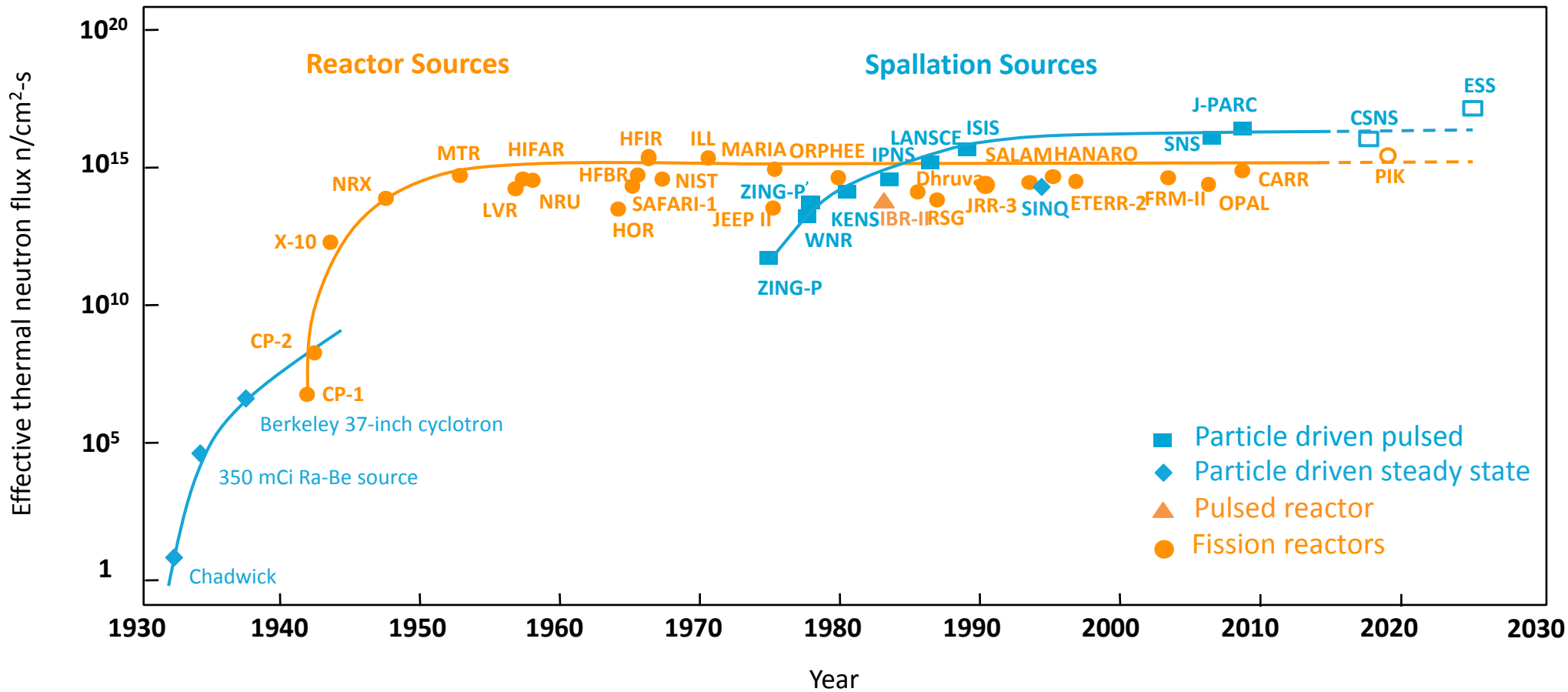
Infection sensors

Stress relief in the air

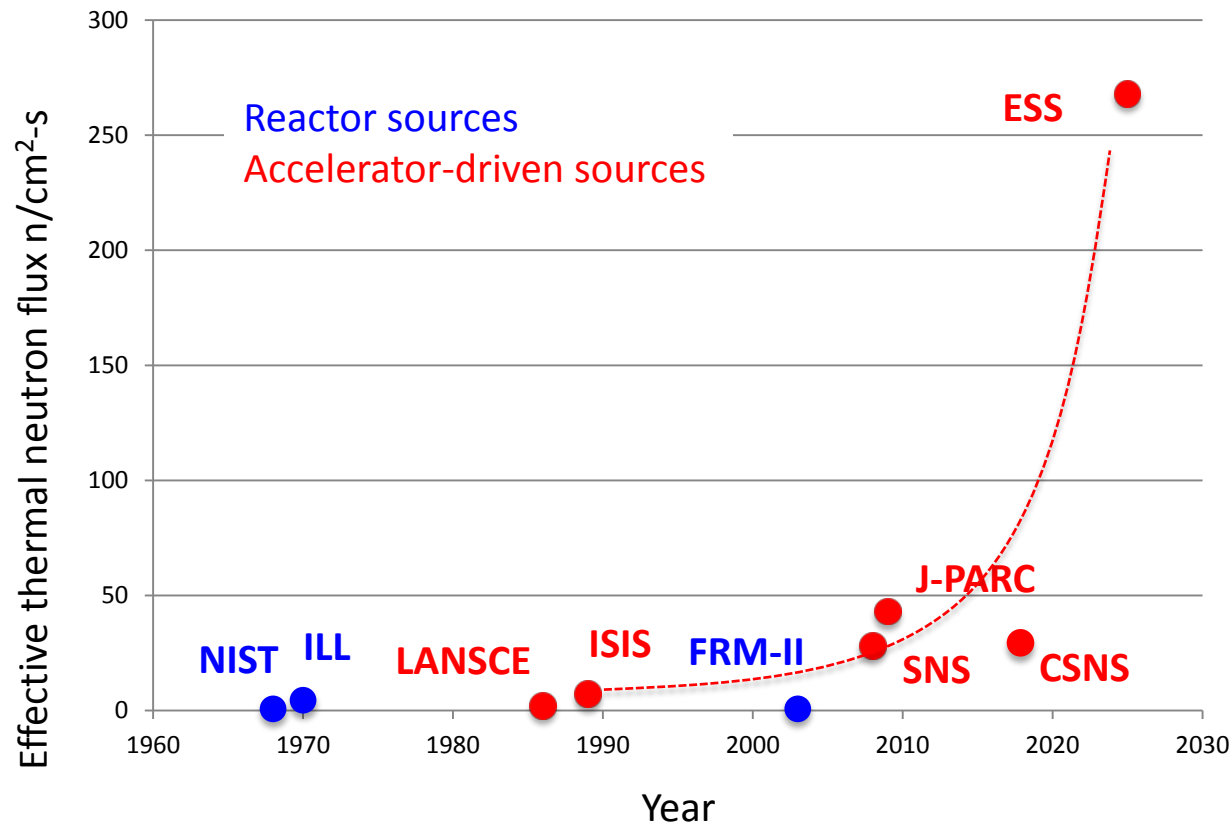
Neutron Science Needs to Push the Boundaries



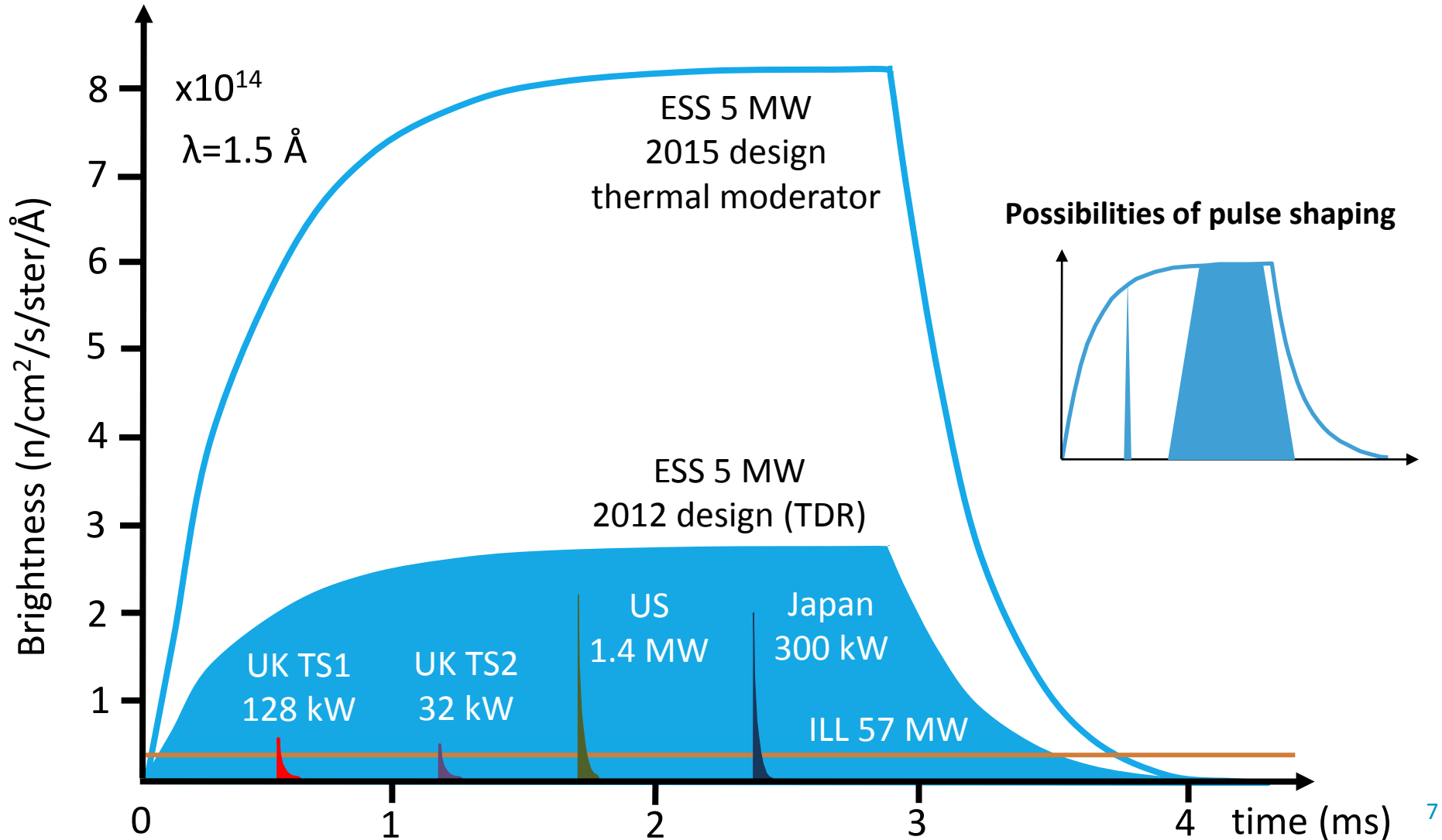
Neutron facilities – reactors and particle driven



Neutron facilities



ESS long pulse potential



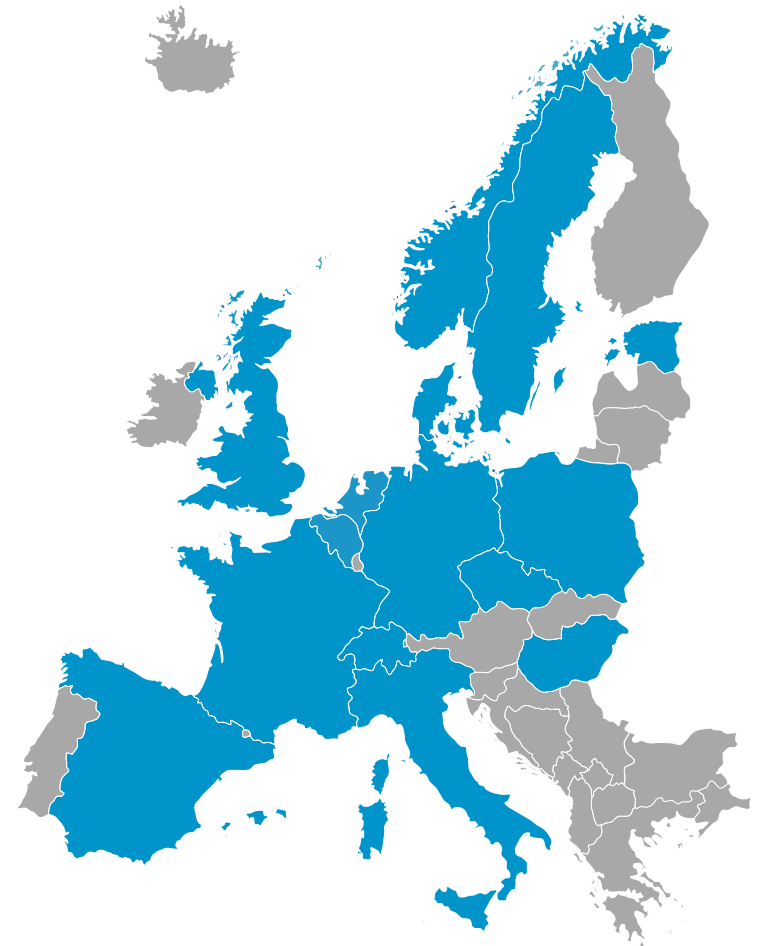
Financing includes cash and deliverables

Host Countries Sweden and Denmark

Construction	47.5%	Cash Investment ~ 97%
Operations	15%	

Non Host Member Countries

Construction	52.5%	In-kind Deliverables ~ 70%
Operations	85%	



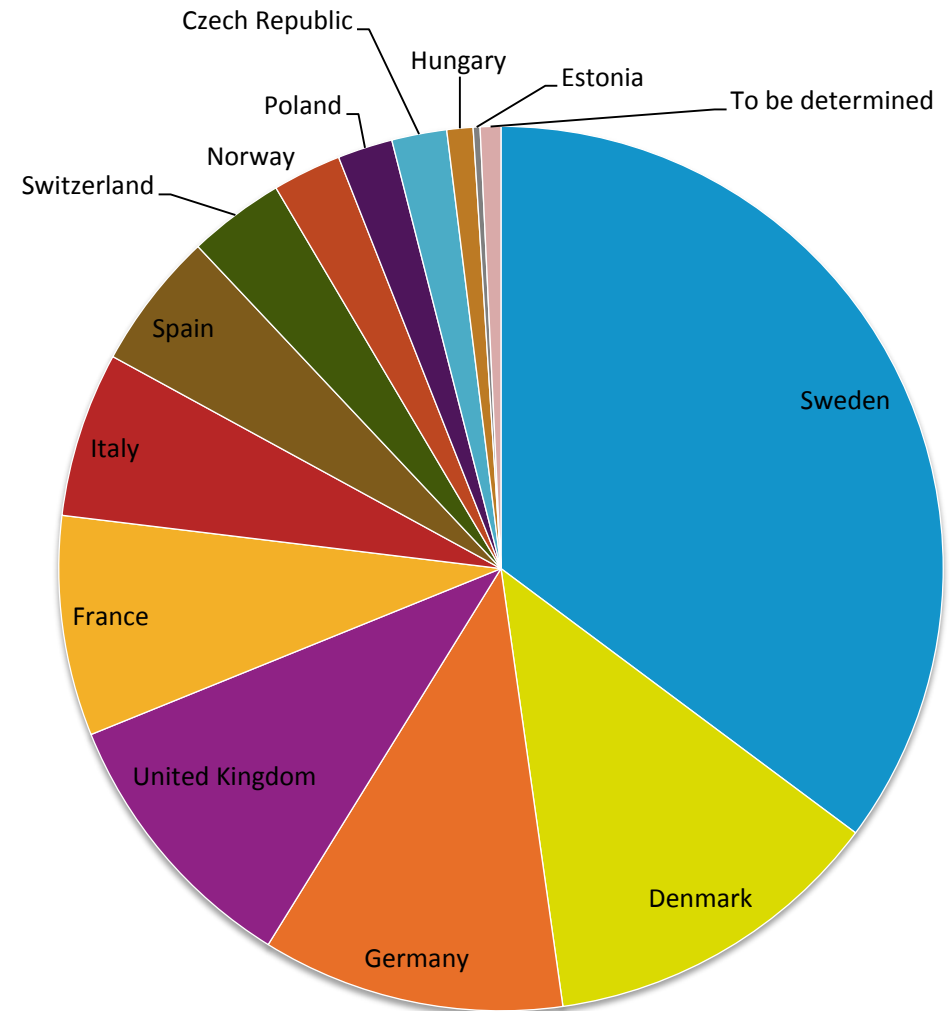
Construction investment

CURRENT

Sweden (member)	35.0 %
Denmark (member) *	12.5 %
Germany (member) *	11.0 %
United Kingdom (member)	10.0 %
France (member)	8.0 %
Italy (member)	6.0 %
Spain (founding observer) *	5.0 %
Switzerland (member)	3.5 %
Norway (member)	2.5 %
Poland (member)	2.0 %
Czech Republic (member)	2.0 %
Hungary (member)	0.95 %
Estonia (member)	0.25 %
Total *	~98.7 %

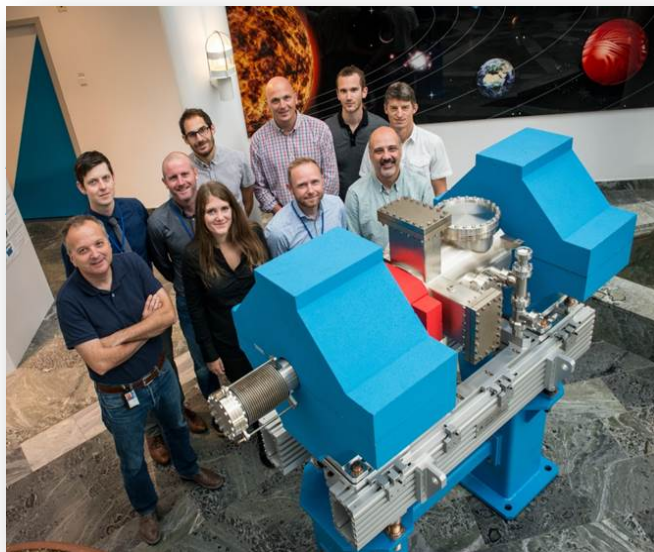
FUTURE

Belgium (founding observer)	<i>tbd</i>
Netherlands (founding observer)	<i>tbd</i>



* Includes Pre-construction Costs, Current Construction Commitment

ESS In-kind Partners



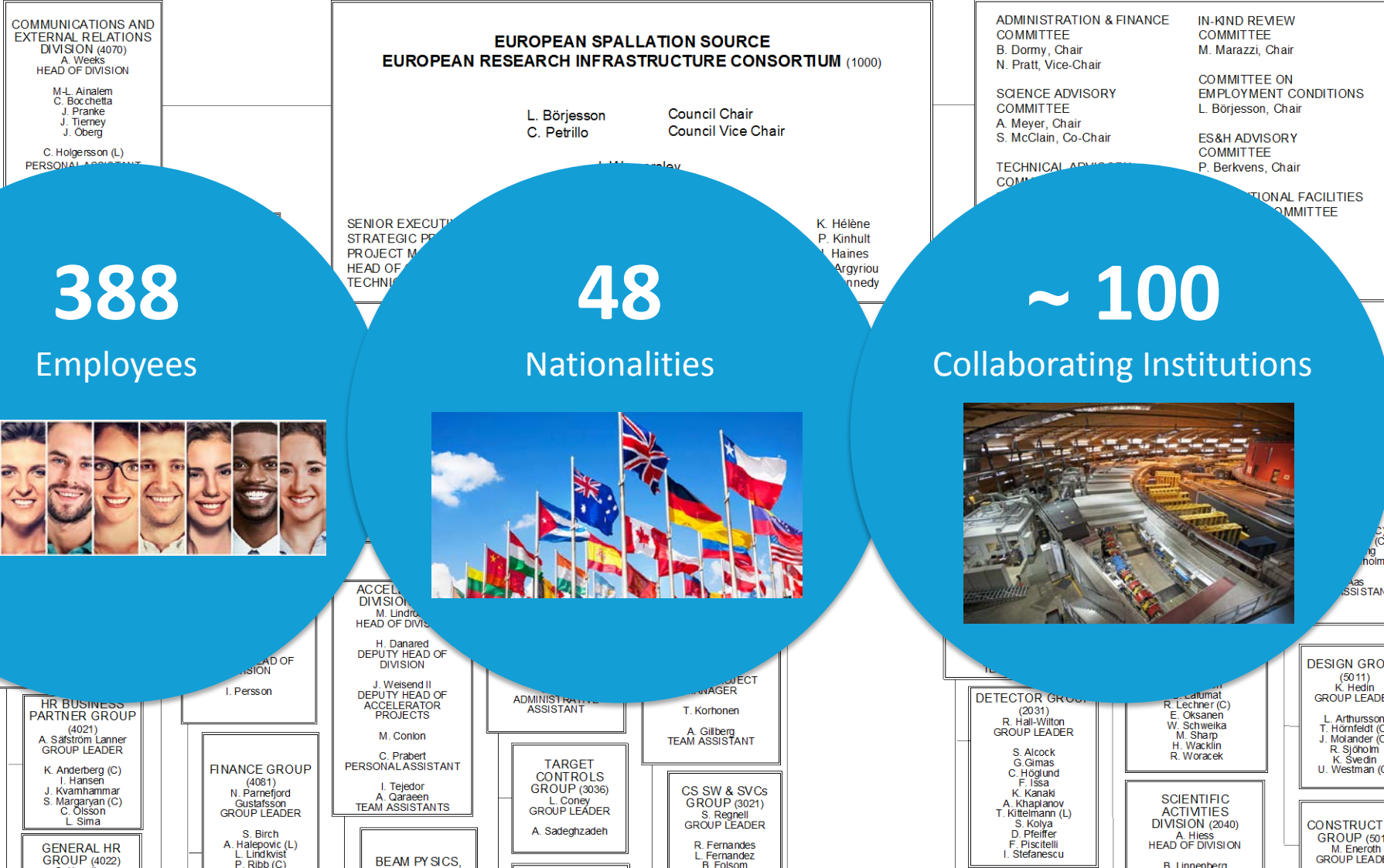
Elettra – Sincrotrone Trieste
ESS Bilbao
Forschungszentrum Jülich
Helmholtz-Zentrum Geesthacht
Huddersfield University
IFJ PAN, Krakow
INFN, Catania
INFN, Legnaro
INFN, Milan
Institute for Energy Research (IFE)



Rutherford-Appleton Laboratory, Oxford (ISIS)
Copenhagen University
Laboratoire Léon Brillouin (LLB)
Lund University
Nuclear Physics Institute of the ASCR
Oslo University
Paul Scherrer Institute (PSI)
Polish Electronic Group (NCBJ, TU Warsaw, TU Lodz)
Roskilde University
Tallinn Technical University



Organisation and People



Civil construction groundbreaking



September 2014



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August 2015



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September 2016

December 2016



Central Utilities
Building (CUB)

LINAC

Site
Offices

Instruments

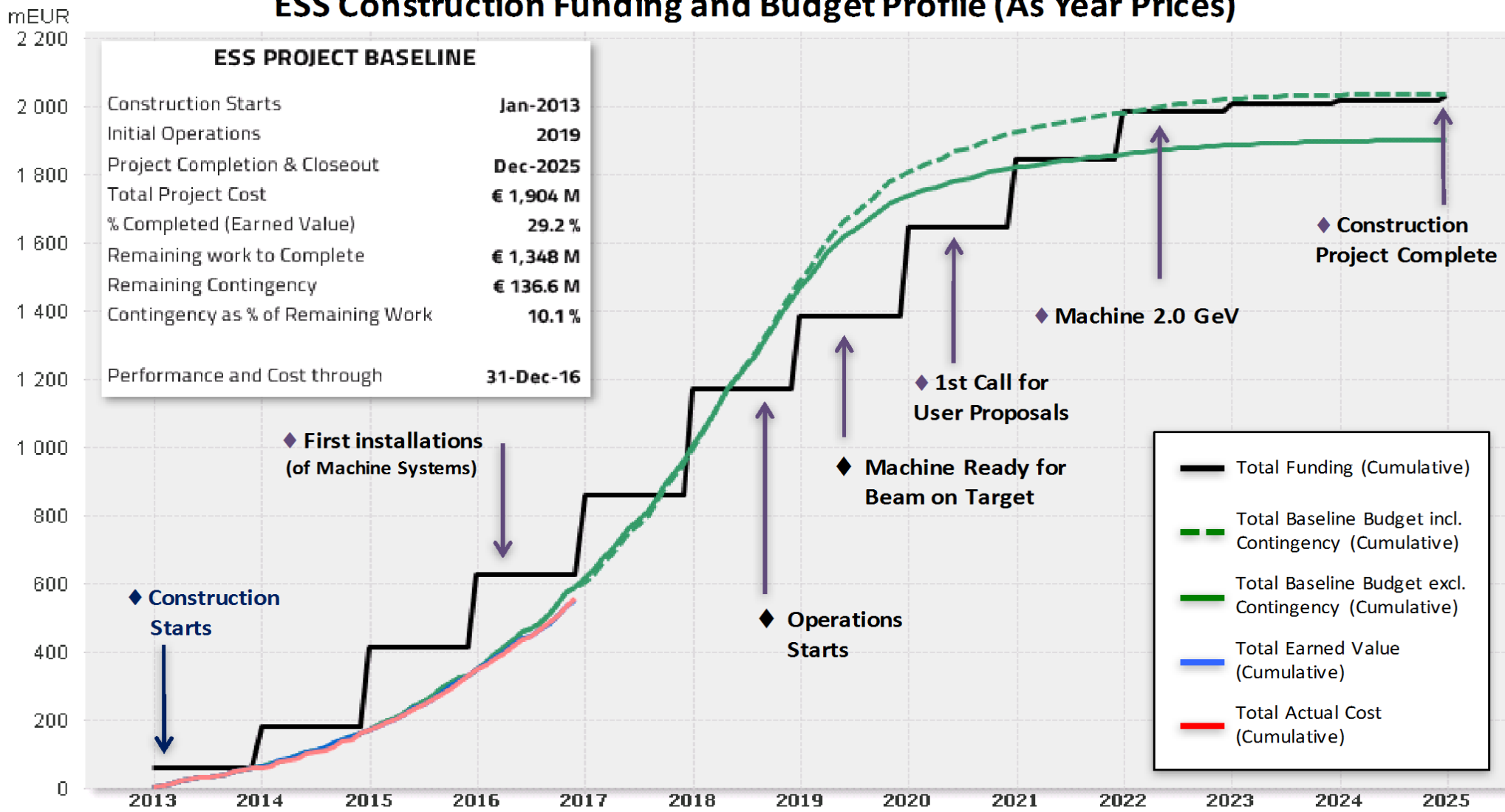
Target

February 2017



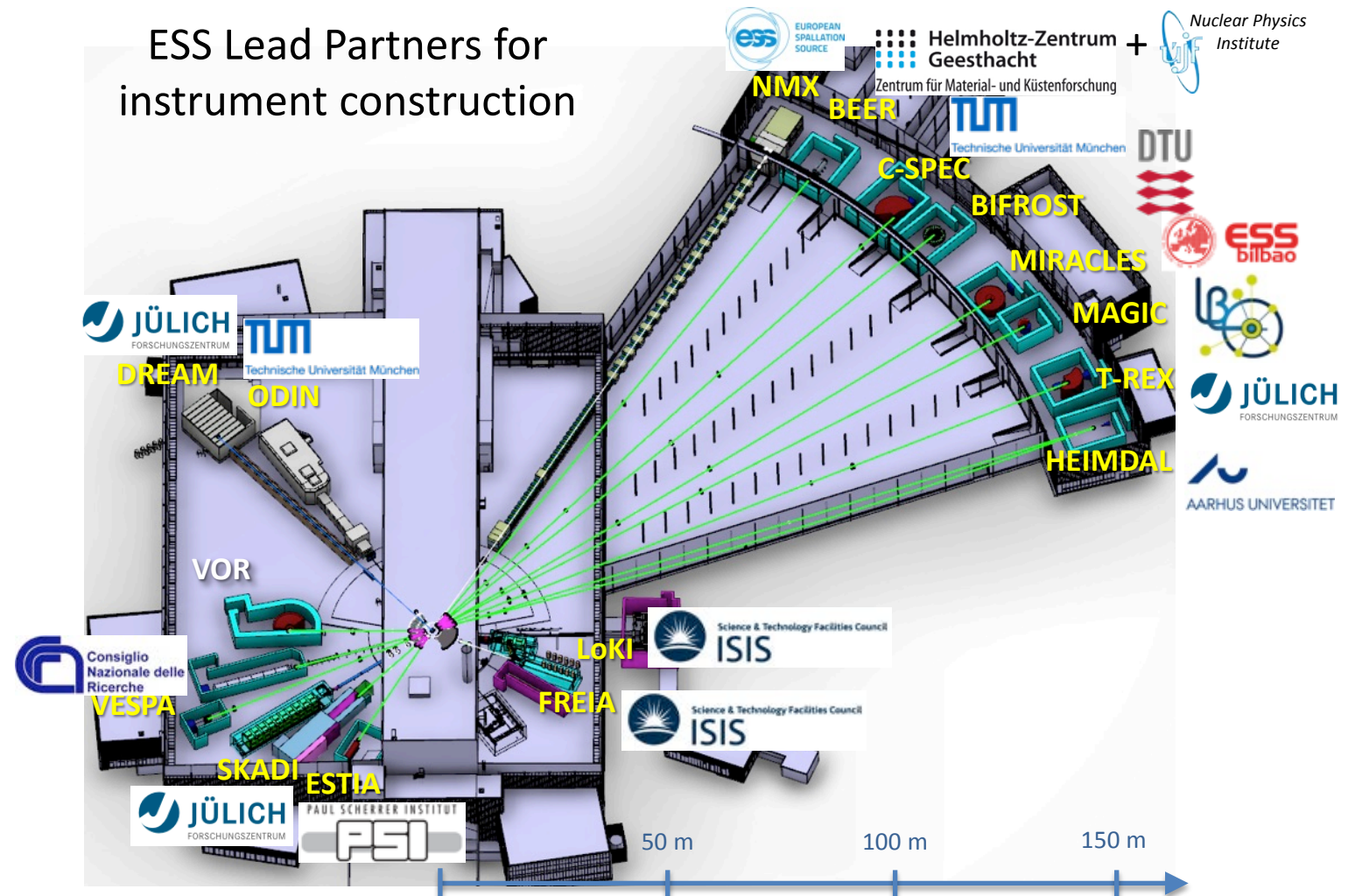
Project progress– December 2016

ESS Construction Funding and Budget Profile (As Year Prices)



ESS Neutron Instruments 1-15

ESS Lead Partners for instrument construction













































ESS Instrument Layout (June 2016)

- Scope, budget, and timelines set for 15 instruments
- Defined which 8 to build first
- All 15 instruments will be world leading at 2 MW +
- Important to move on fast into construction to maintain schedule (preliminary design => detailed design)
- Instruments 15-22 to be funded from initial operations
- User operation in 2023: challenging but realistic goal






























Science Drivers for the Reference Instrument Suite









Large-Scale Structures

Multi-Purpose Imaging ODIN	    
General-Purpose SANS SKADI	   
Broadband SANS LOKI	 
Surface Scattering	   
Horizontal Reflectometer FREIA	  
Vertical Reflectometer ESTIA	   
Thermal Powder Diffractometer HEIMDAL	   
Bispectral Powder Diffractometer DREAM	   
Monochromatic Powder Diffractometer	  
Materials Science Diffractometer BEER	 
Extreme Conditions Diffractometer	  
Single-Crystal Magnetism Diffractometer MAGIC	 
Macromolecular Diffractometer NMX	 

Diffraction

Spectroscopy

Cold Direct Geometry Spectrometer C-SPEC	  
Wide Bandwidth Direct Geom. Spectrometer VOR	   
Bispectral Direct Geometry Spectrometer TREX	  
Cold Crystal-Analyser Spectrometer CAMEA	   
Vibrational Spectrometer VESPA	  
Backscattering Spectrometer MIRACLES	  
<i>High-Resolution Spin-Echo</i>	   
<i>Wide-Angle Spin-Echo</i>	   
Fundamental & Particle Physics	

	life sciences		magnetism & superconductivity
	soft condensed matter		engineering & geo-sciences
	chemistry of materials		archeology & heritage conservation
	energy research		fundamental & particle physics

Data Management and Software Centre

COBIS, Copenhagen University North Campus



Provide world leading scientific software and scientific computing support for neutron scattering at ESS

Scientific Software

ESS experiment control system, Data acquisition, Data correction software, visualization, and software to model and analyze experimental data sets.

Data center operations

Store and catalogue ESS datasets, provide ESS users remote access to their data, computing for live data correction, and analysis software during and after experiments.

User support

Support ESS users with data treatment and analysis.

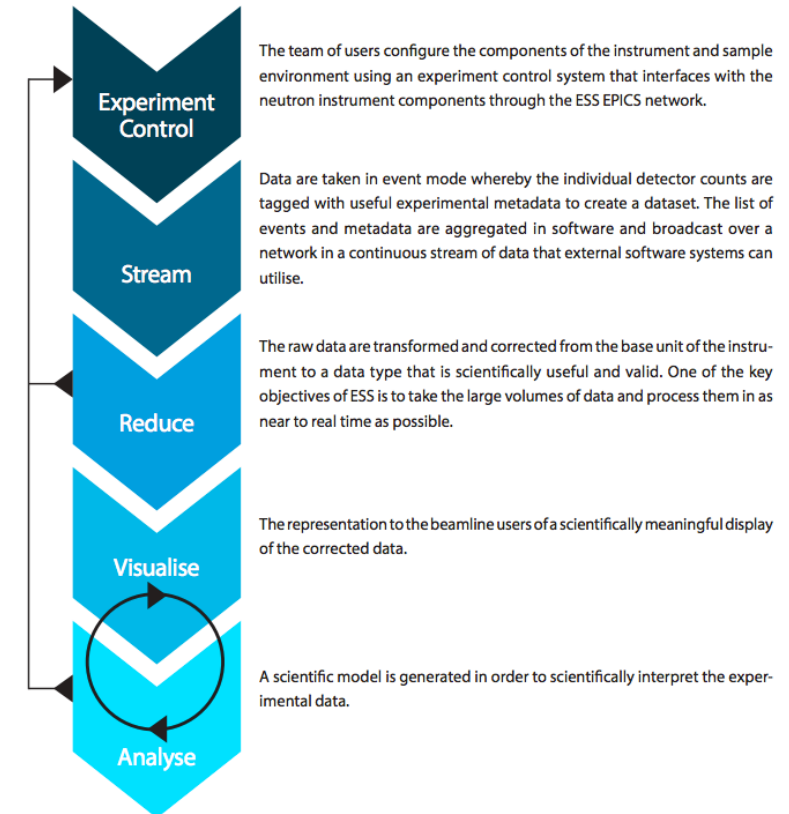
22* DMSC Staff now → 60

(*20 FTEs and 2 part time)



From Lund to Copenhagen, and Back Again

The figure illustrates a typical data flow for a neutron scattering experiment. Each arrow in the graphic corresponds to a key area of scope within the DMSC.



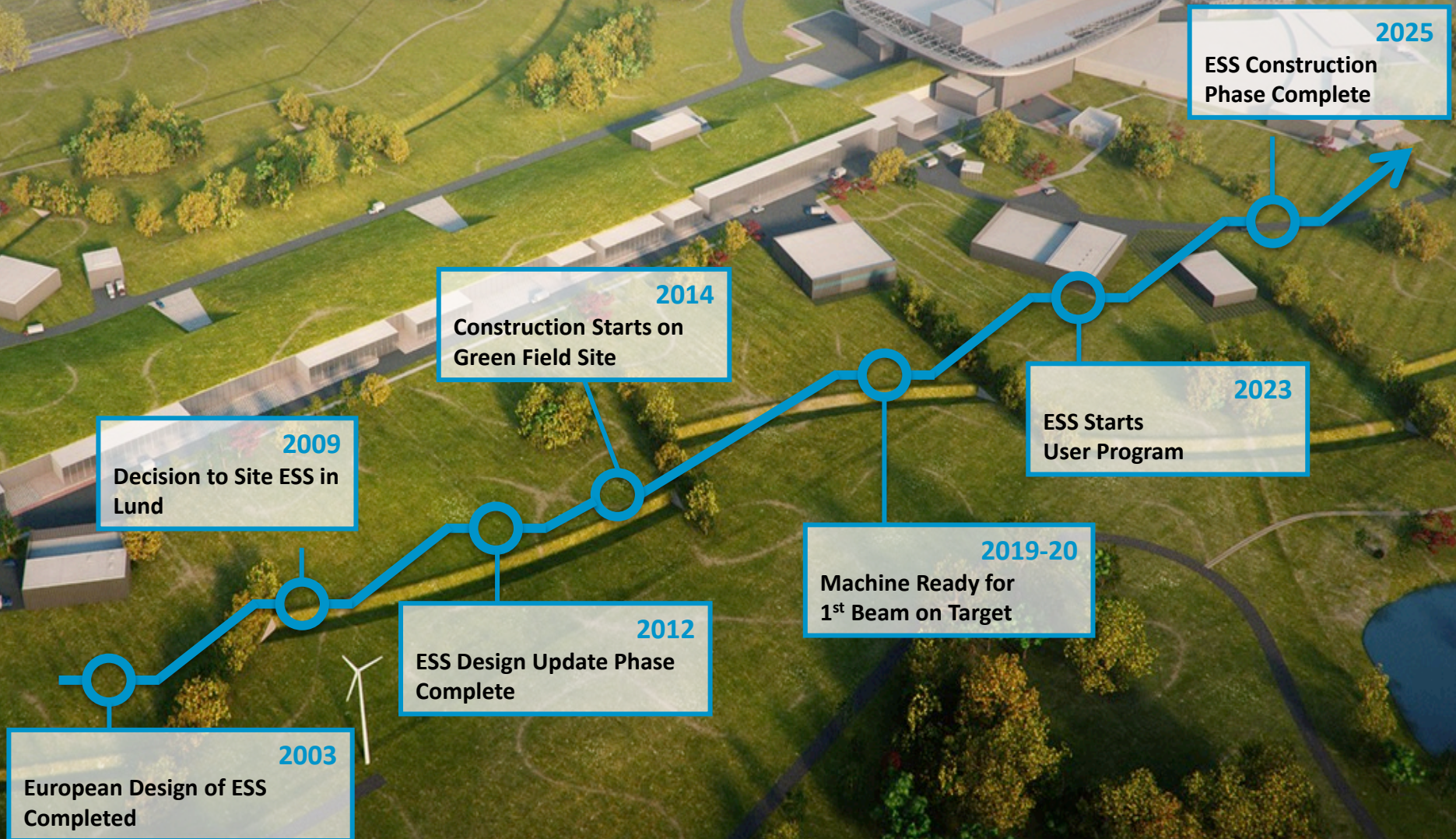
Data Flow / Experiment Control

A key objective is to build in from the start the capability for the interconnected software systems to control the experiment. The lines connecting parts of the data flow to the experiment control represent this functionality.

Iterative Workflow

The circle in the graphic represents the iterative workflow of scientific modelling and visualisation of model and experimental data that is often used.

Journey to deliver the world's leading facility for research using neutrons



ESS is making rapid progress



Conventional construction moving fast

First in-kind deliveries on site

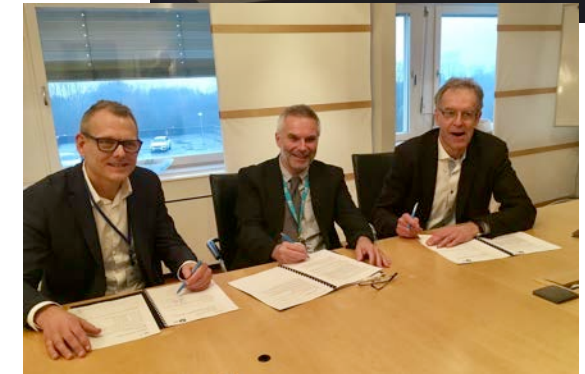
Agreement on Financing with EIB, NIB, SEK [?]

Selection of Initial Instruments [?]

Target price agreed for remaining civil construction [?]

Starting installation of first cryo and electrical systems

Will begin to move ESS staff out to the site in 2017



Our current focus

- Maintaining the schedule and the cost ceiling
- In-kind agreements, member commitments
- Integrated Project Schedule
- Value Engineering exercise
- Understanding the transition to initial operations



ESS is part of an ecosystem



SCIENCE VILLAGE SCANDINAVIA

ESS

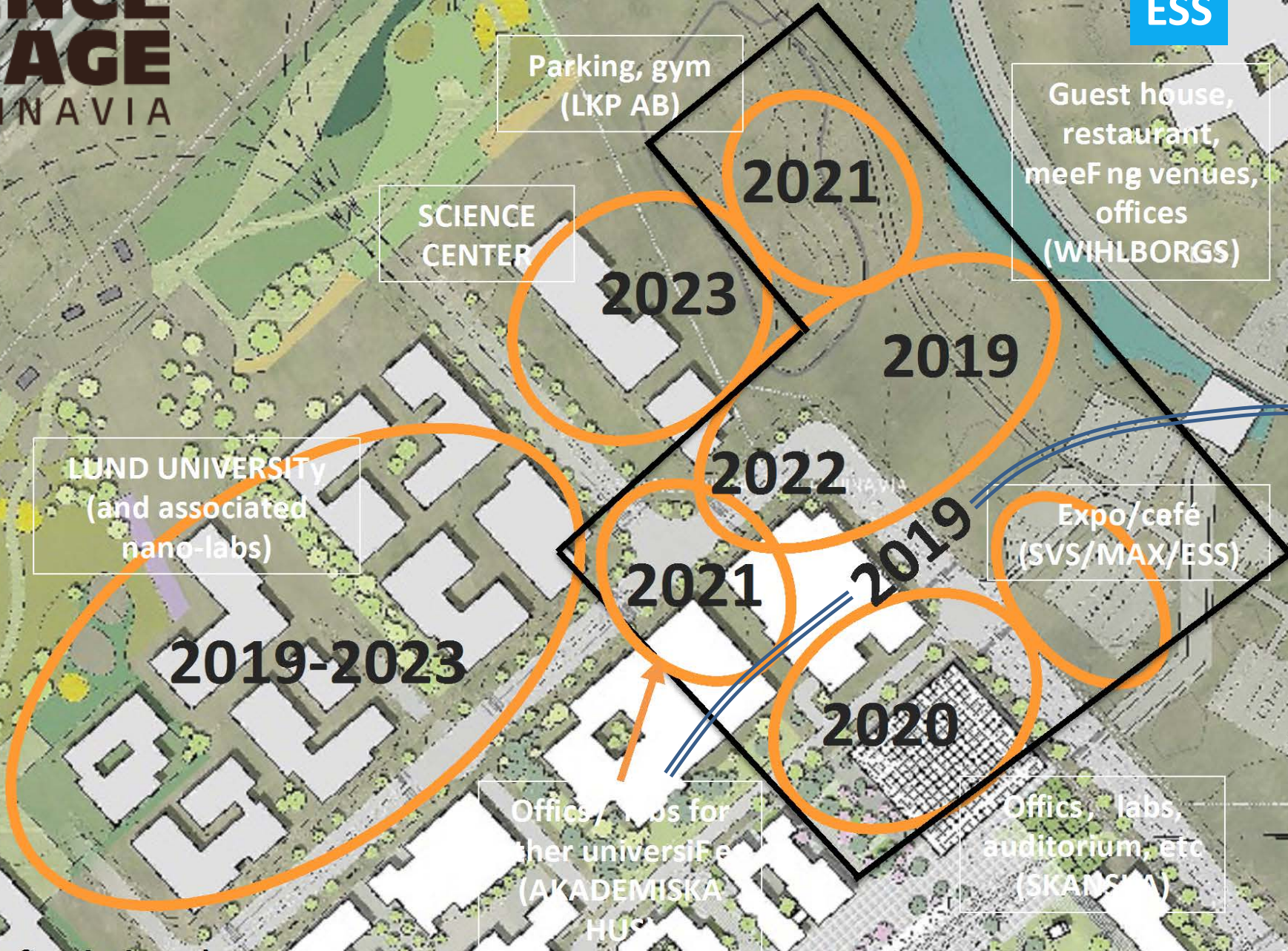
Parking, gym (LKP AB)

Guest house, restaurant, meeting venues, offices (WIHLBORGS)

SCIENCE CENTER

LUND UNIVERSITY (and associated nano-labs)

YNIJARNÄS PARK



(Approximate finish dates)

SCIENCE VILLAGE SCANDINAVIA

SPACE Building: Reception, exhibition space, guest house for MAX IV and ESS (~100 rooms), office and meeting space, restaurant

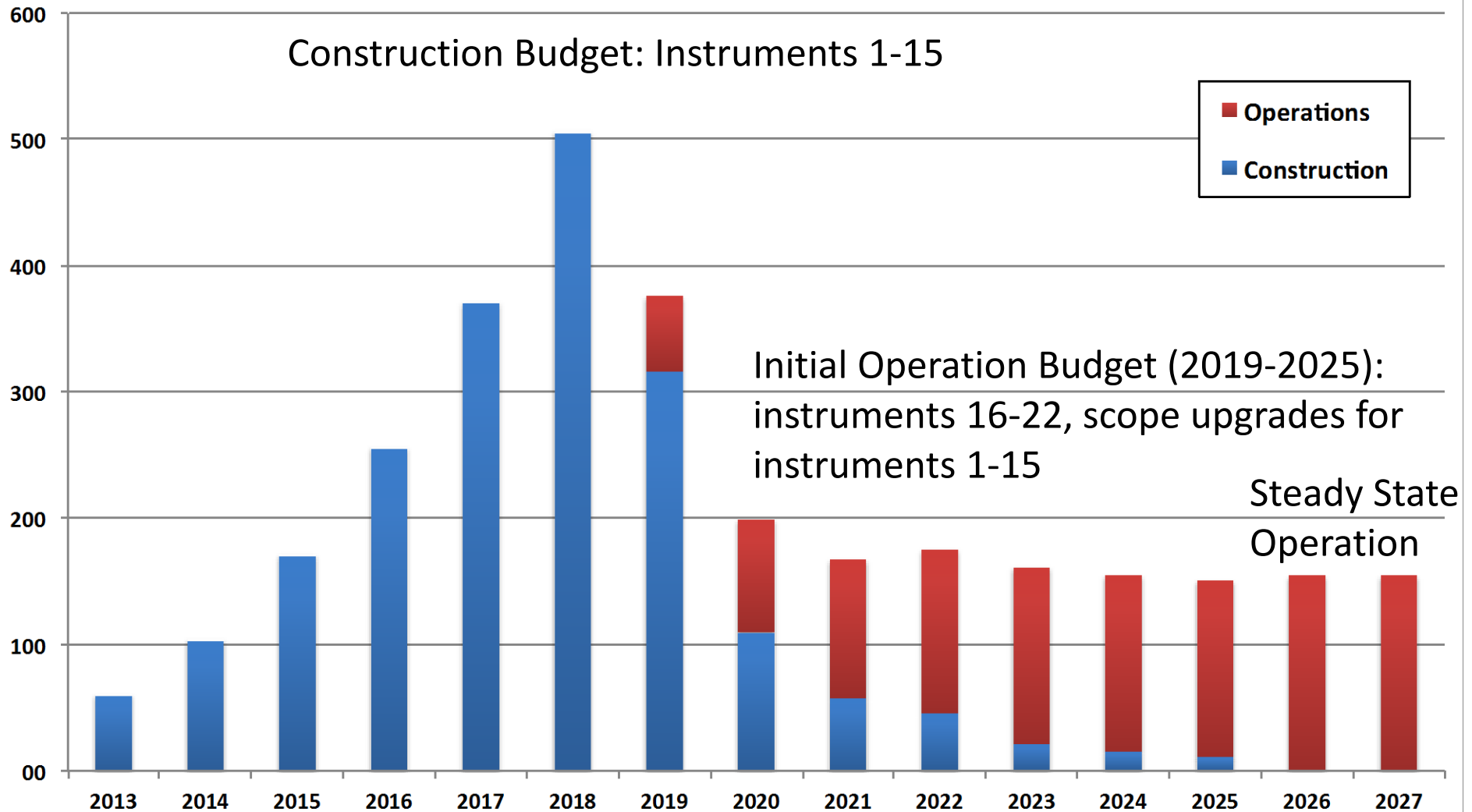


Tramway to Lund C station

Construction and Operations cost

Million Euro

Construction Budget: Instruments 1-15



European Neutron facilities landscape

2016 ESFRI report

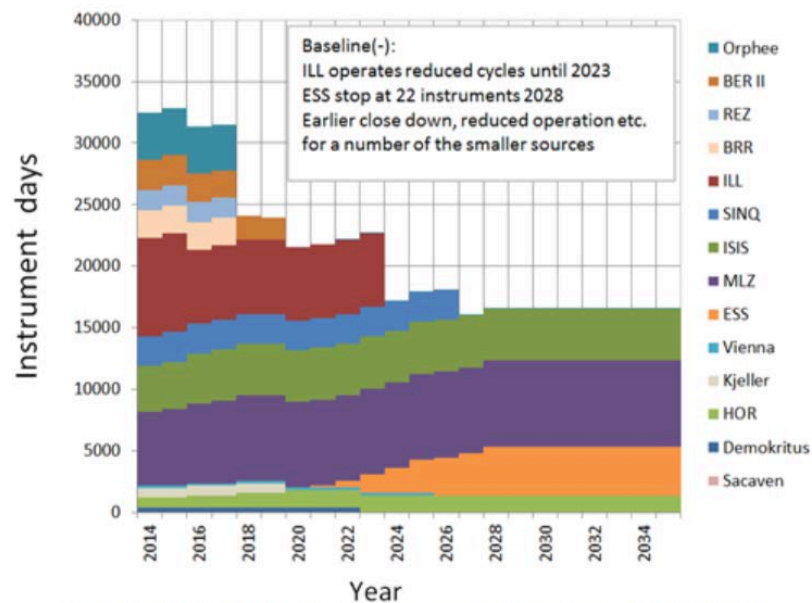


Figure 11. The predicted delivery of instrument beam-days in the Degraded Baseline Scenario.

Pessimistic scenario: ILL operates at reduced output until 2023, ESS with 22 instruments beyond 2028. Earlier closer and/reduced operations for a number of medium power sources

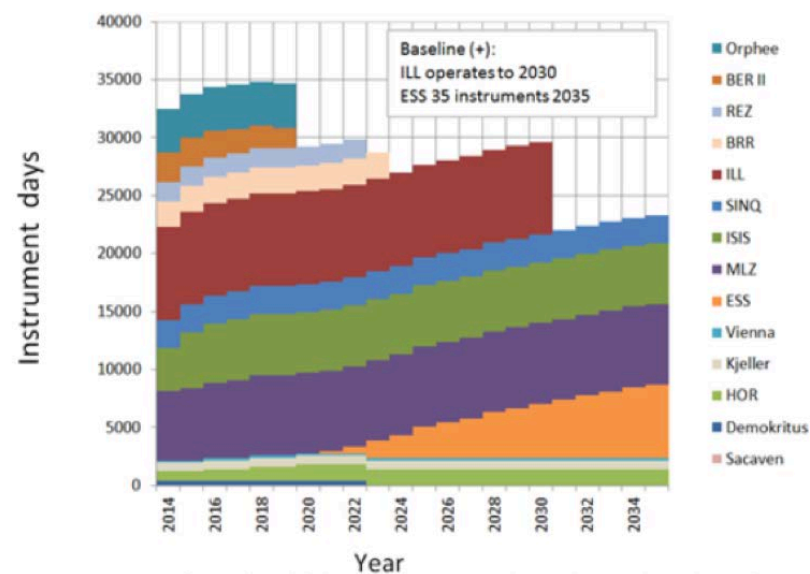


Figure 12. The predicted delivery of instrument beam days in the Enhanced Baseline Scenario

Optimistic scenario: ILL operates until 2030, ESS with 35 instruments beyond 2035.

European Neutron facilities landscape

2016 ESFRI report

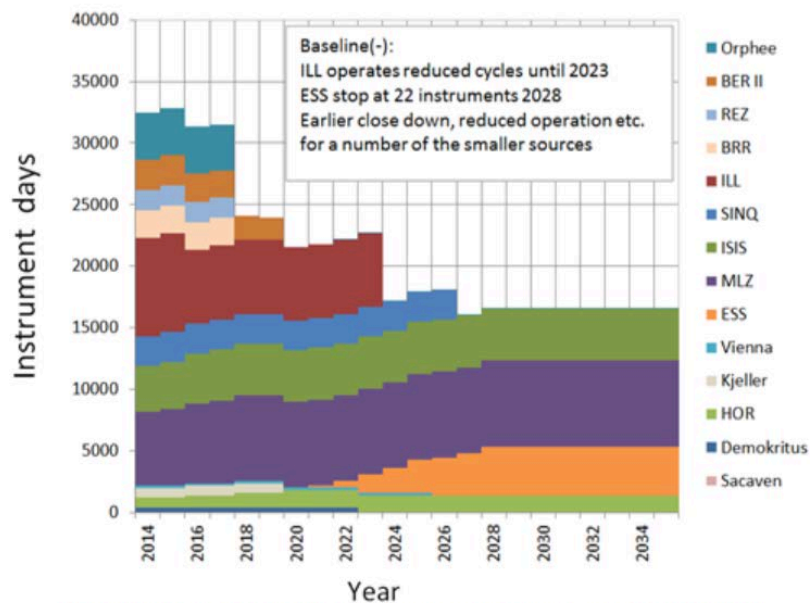


Figure 11. The predicted delivery of instrument beam-days in the Degraded Baseline Scenario.

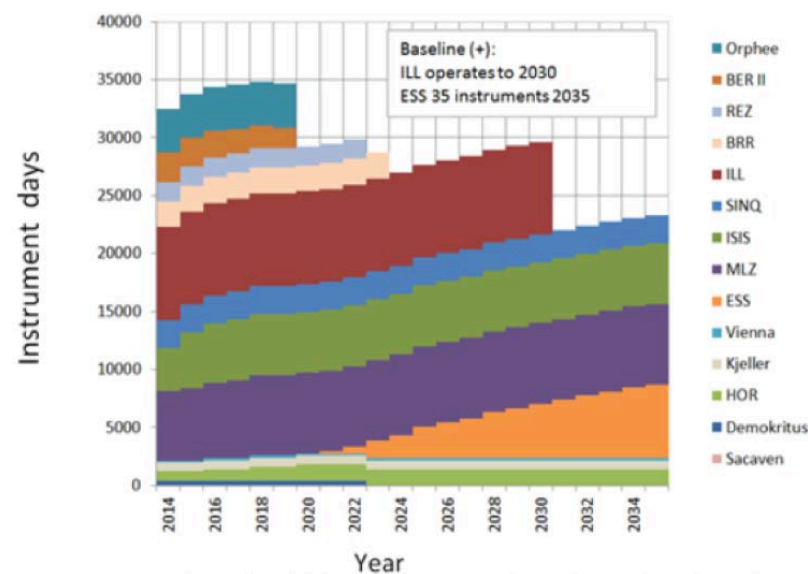


Figure 12. The predicted delivery of instrument beam days in the Enhanced Baseline Scenario

Pessimistic
until 2023,
Earlier close
of medium

ESS needs to build up its research capacity
as soon as at all possible

2030, ESS

Our vision is to build and operate the world's most powerful neutron source, enabling scientific breakthroughs in research related to materials and molecules, and addressing some of the most important societal challenges of our time



To do this, we commit to deliver ESS as a facility that:

- Is built safely, on time and on budget
- Produces research outputs that are best-in-class both in terms of scientific quality and in terms of socioeconomic impact
- Supports and develops its user community, fosters a scientific culture of excellence and acts as an international scientific hub
- Operates safely, efficiently and economically and responds to the needs of its stakeholders, its host states and member states
- Develops innovative ways of working, new technologies, and upgrades to capabilities needed to remain at the cutting edge



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Thank you!