



New Swedish Research Infrastructures - MAX IV and ESS

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Slides courtesy of:

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Arno Heiss and Sindra Petersson (ESS)

 webbkameror.se



2011

Construction begins!



Environmental court approval received.

Successful project review.

Conventional Facilities Preliminary Design under review.

Ground break took place Sept. 2.

Foundation Stone Ceremony and Science Symposium scheduled on Oct. 9.

Construction begins!

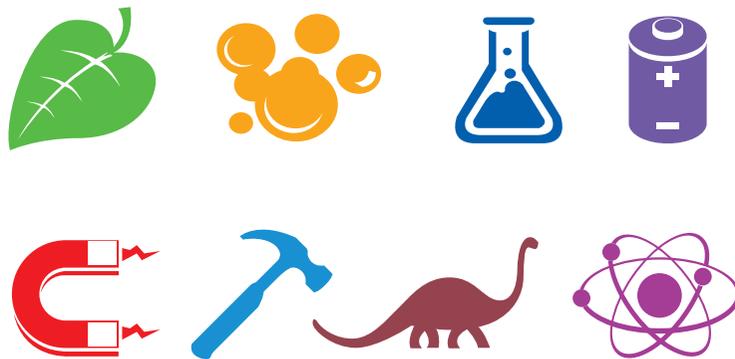


- Funding is secured.
 - Construction cost 1843 M€
 - 17 member countries, contributing cash and in-kind.
- Technical Design Report published.

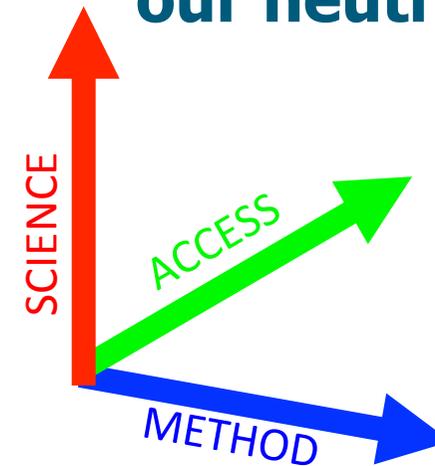
NOW:

- Engaging building partners at all levels of the project.
- Finalizing a balanced suite of instruments for science.
- Neutrons & first instruments by the end of the decade.
- Moving towards an ERIC.

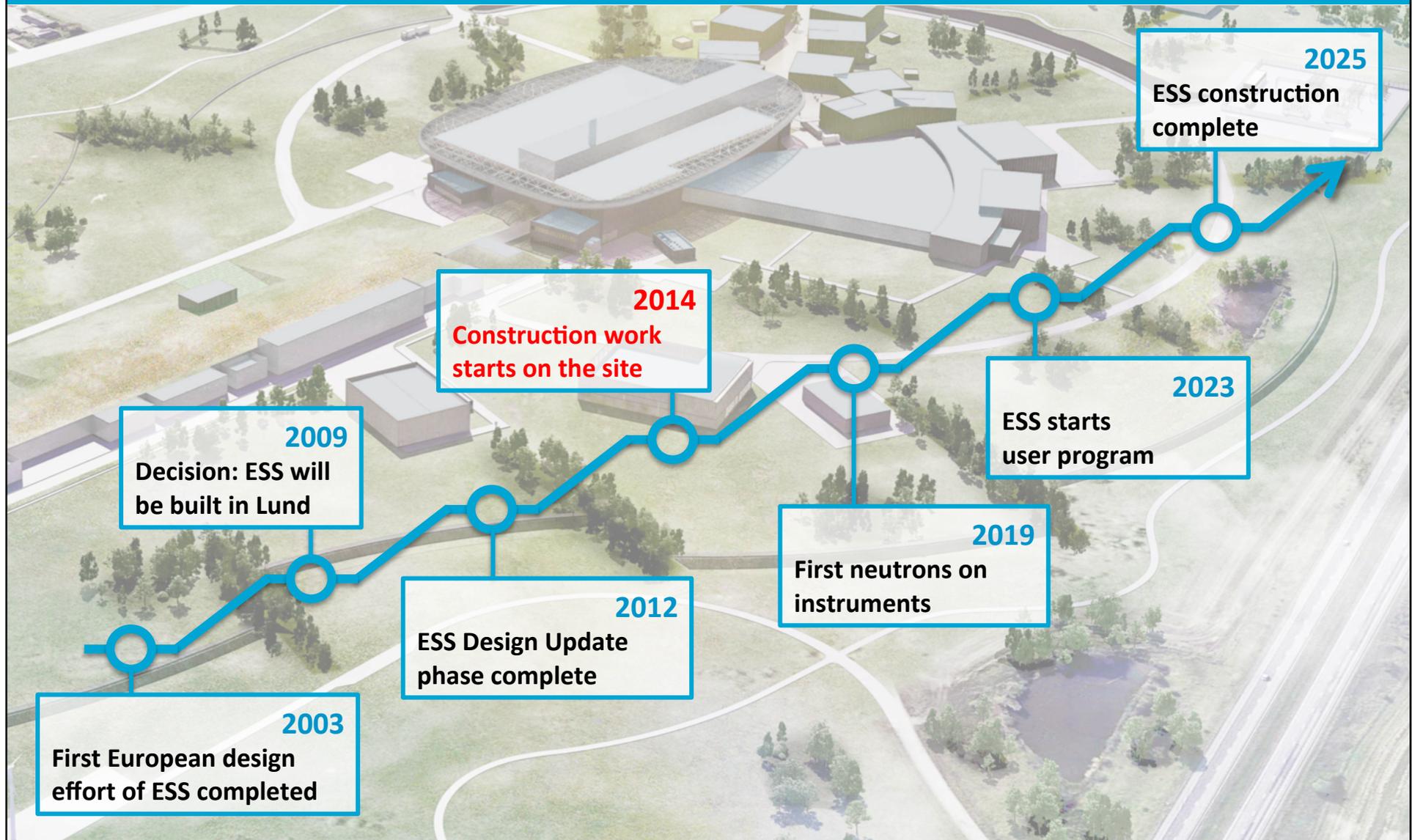
“A partnership of 17 European nations committed to the goal of collectively building and operating the world’s leading **user facility** for **research** using **neutrons** by the second quarter of the 21st century.”



How to best use our neutrons ...



The road to realizing the world's leading facility for research using neutrons



Project Commitments



- ✓ **5 MW accelerator capability, 30 times brighter than existing facilities**
- ✓ **22 Instruments, state of the art technologies**
- ✓ **Construction cost of 1,843 B€**
- ✓ **Steady-State Ops at 140 M€/year**

Funding is cash and in-kind deliverables

Sweden and Denmark:

47,5% Construction

15-20% Operations

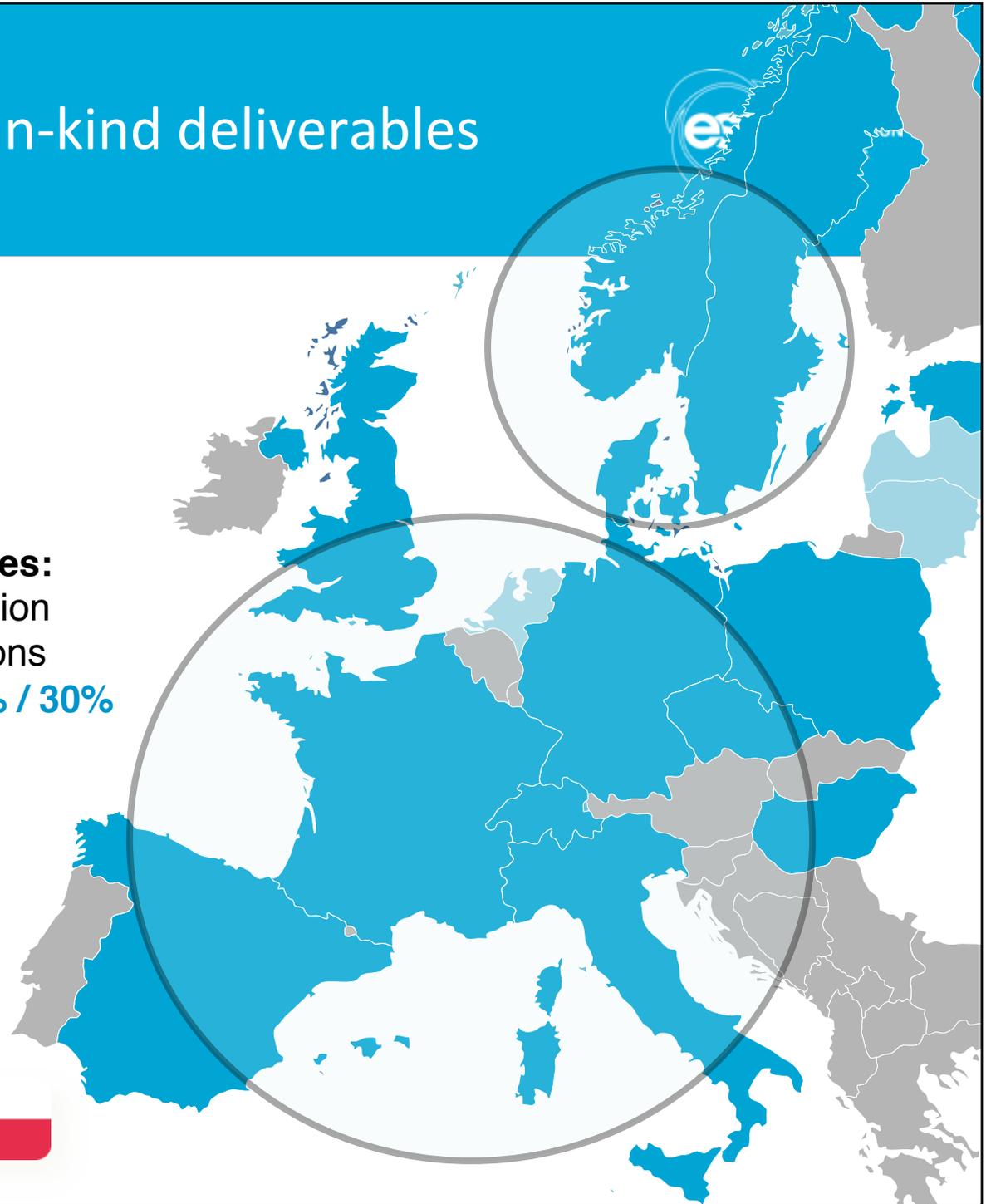
Cash ~100%

Partner Countries:

52,5% Construction

80-85% Operations

IKC/Cash ~ 70% / 30%



ESS construction funding status



Contributions by Member Country (August 2014)

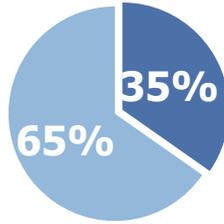
Country	Percentage
Sweden	35.0%
Denmark	12.5%
Germany	11.0%
United Kingdom	10.0%
France	8.0%
Italy	6.0%
Spain	5.0%
Switzerland*	3.5%
Norway	2.5%
Poland	2.0%
Hungary	1.5%
Czech	0.3%
Estonia	0.25%
To Be Determined **	2.5%
Total	100%

* 3.5% planned share. 1.4% adopted for the period 2014-2019.

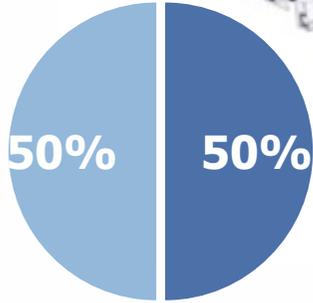
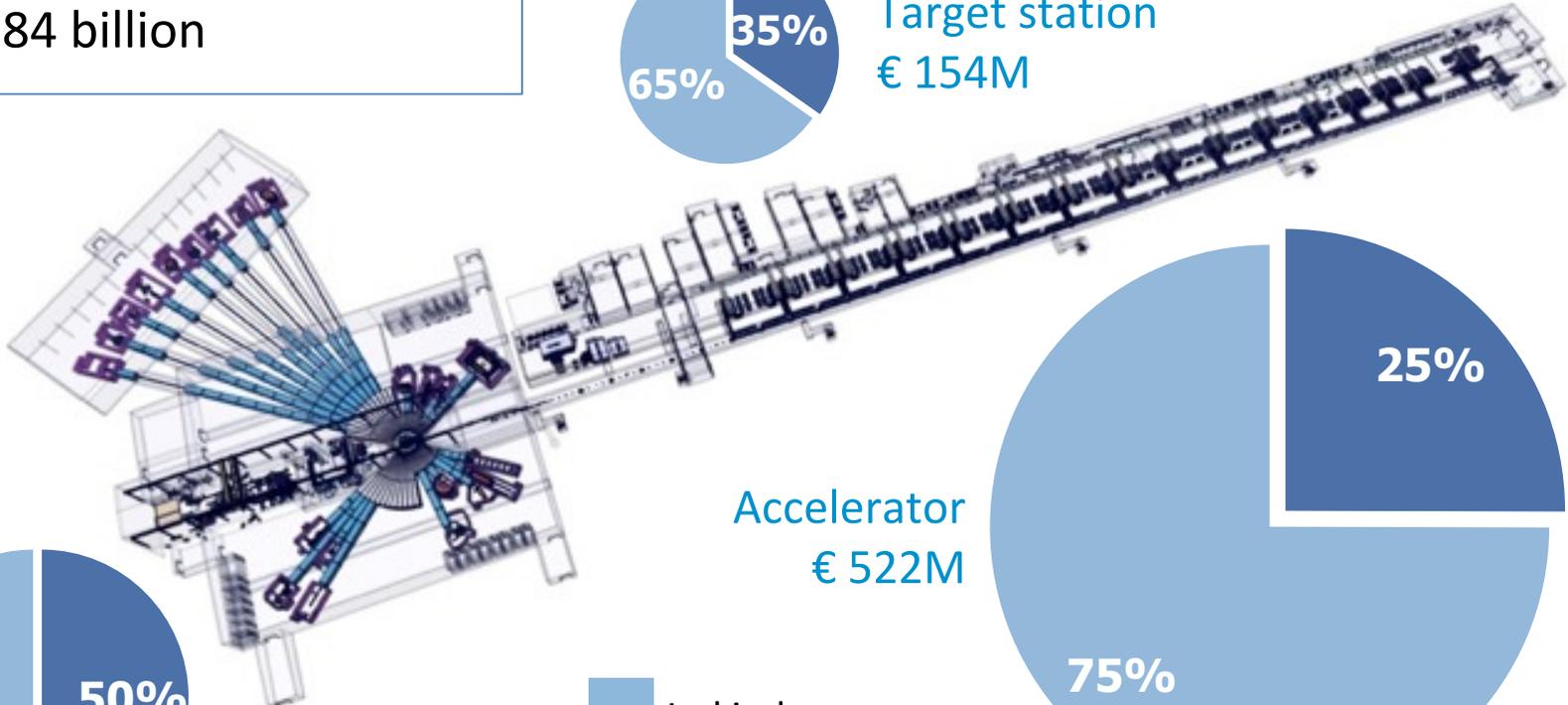
** Discussion ongoing with the Netherlands, Latvia, Lithuania and Iceland. JY 9/2014

ESS In-Kind contribution potential

Total construction cost:
€ 1,84 billion

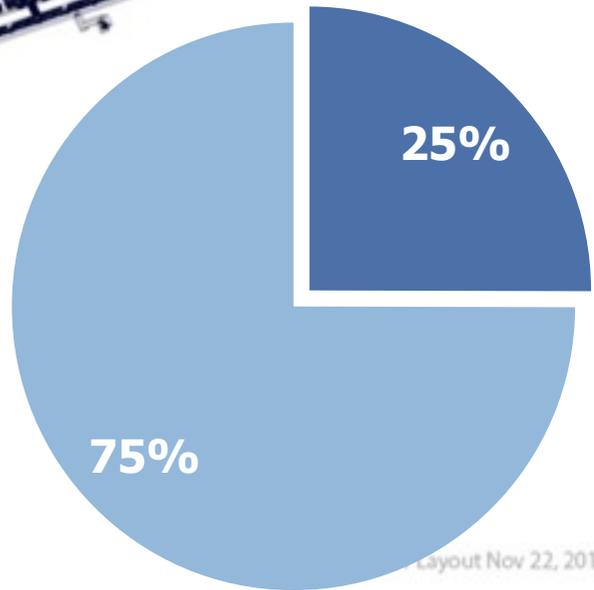


Target station
€ 154M



NSS/Instruments
€ 350M

Accelerator
€ 522M

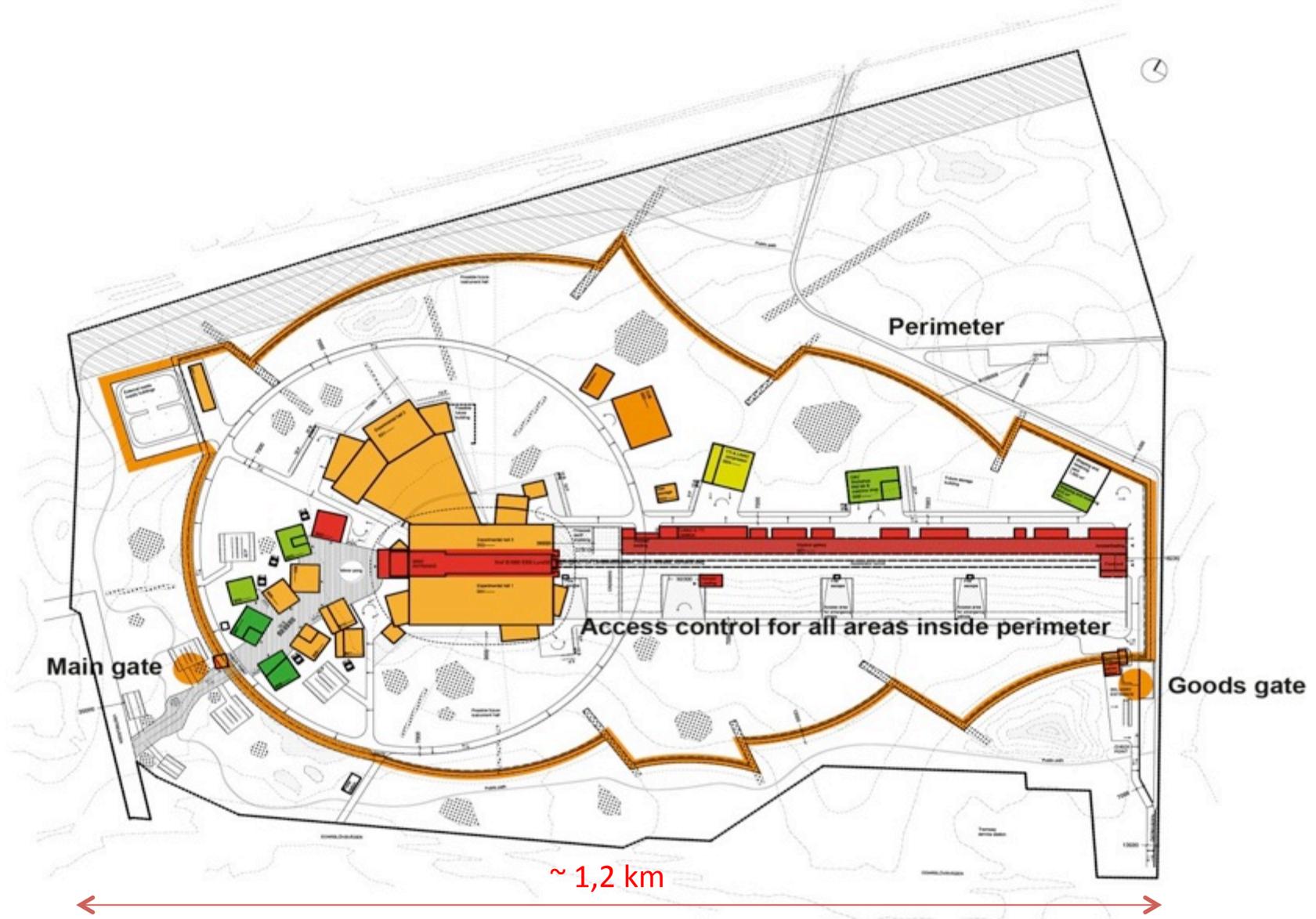


In-kind
Cash

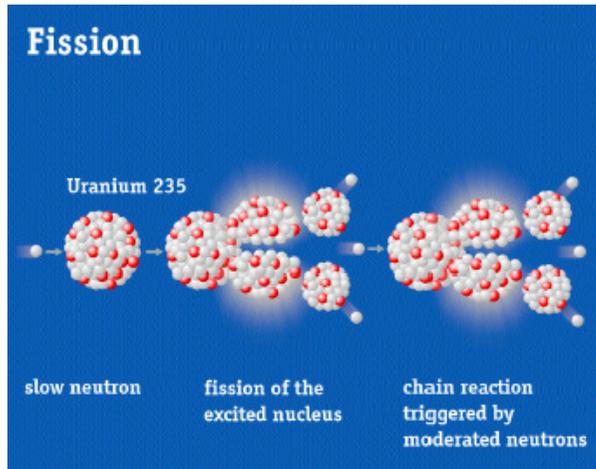
Layout Nov 22, 2012

- <http://europeanspallationsource.se/eoi>
- 683 Proposals from 115 Respondents
- 52% Companies
- 48% Organisations

The ESS Site Covers 75 Hectares



Production of neutrons



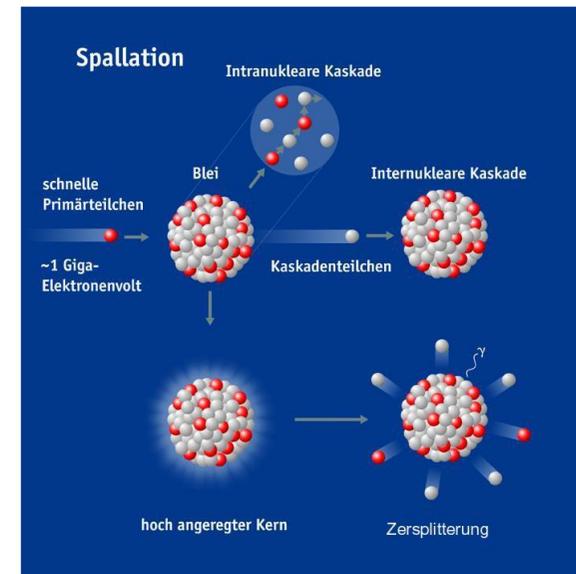
Fission of uranium in nuclear reactor

2-3 neutrons per process



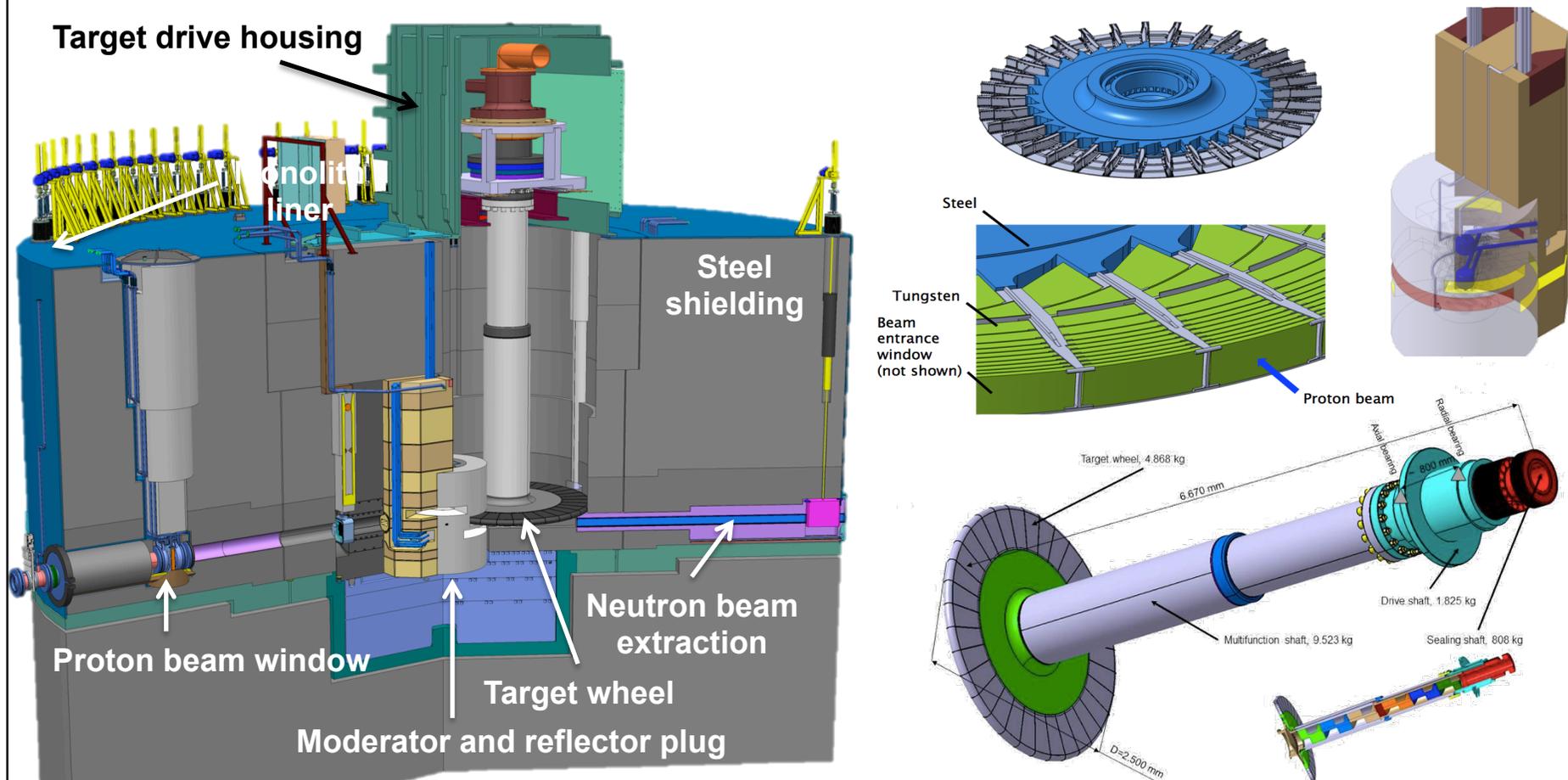
Spallation on target using proton accelerator

30+ neutrons per process

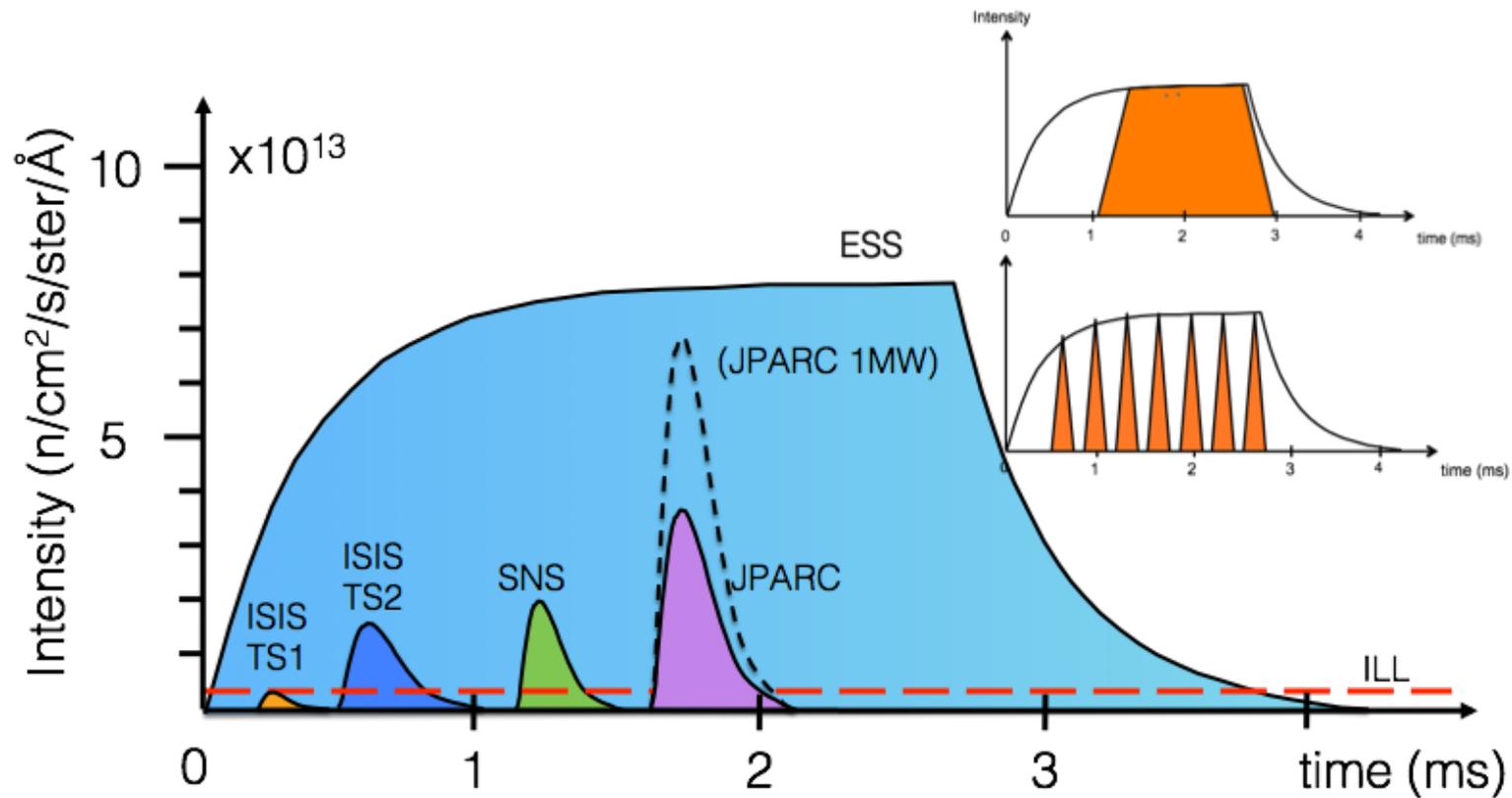


Helium-cooled rotating tungsten target and optimised neutron moderators

Converting protons into neutrons and slowing them down results in ...
... peak brightness 30x times leading steady state source

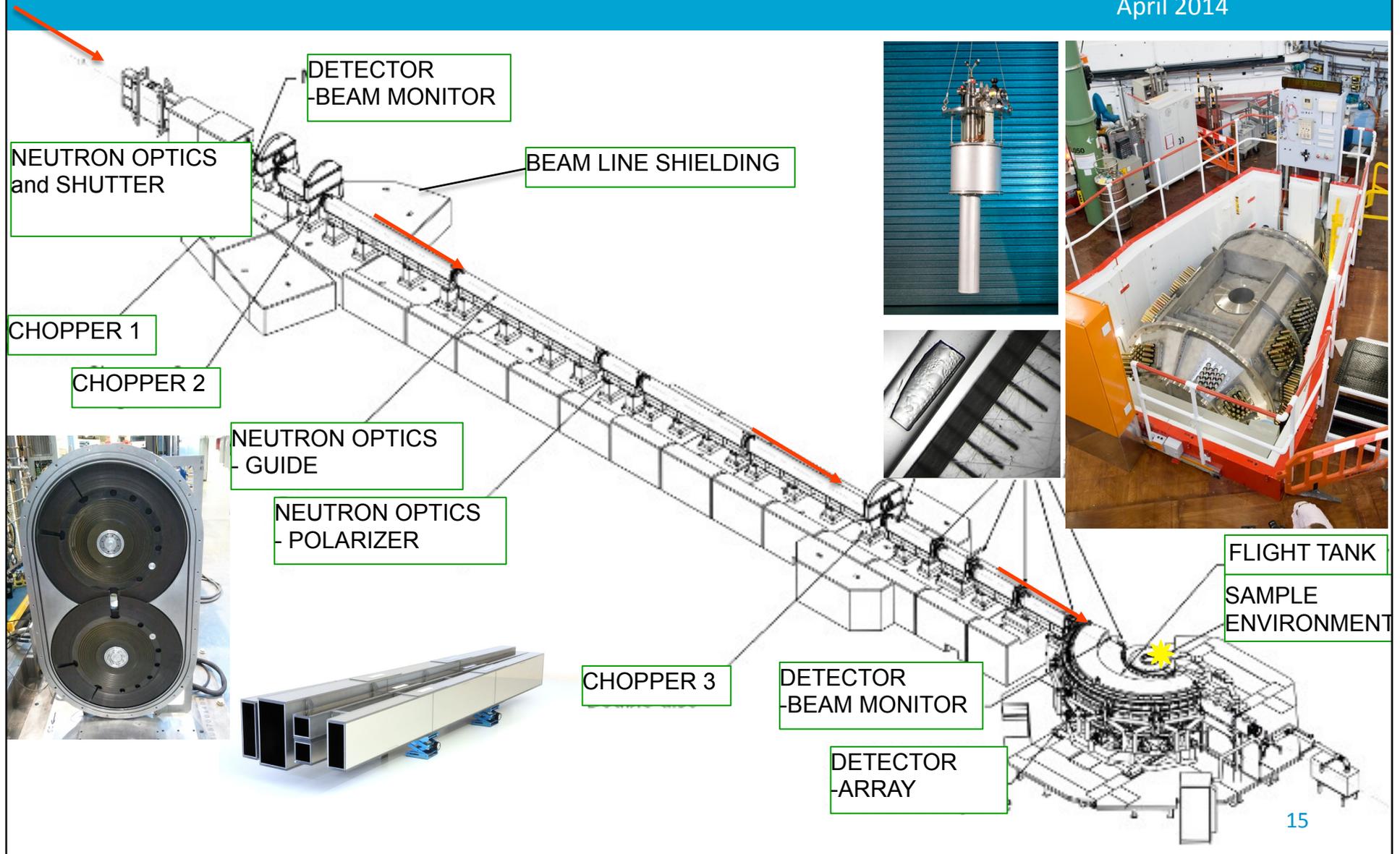


The Long Pulse of ESS



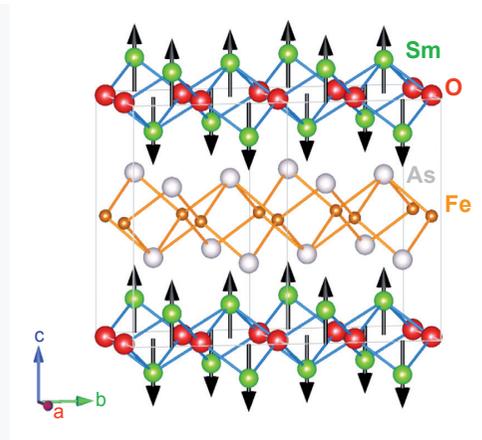
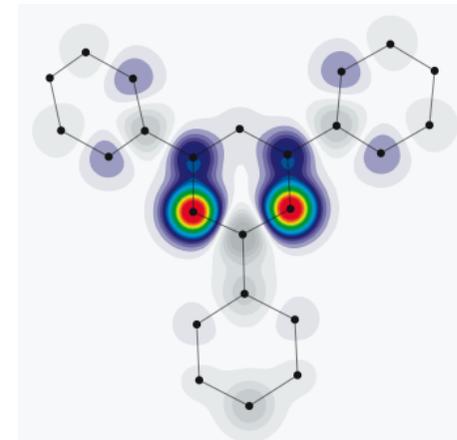
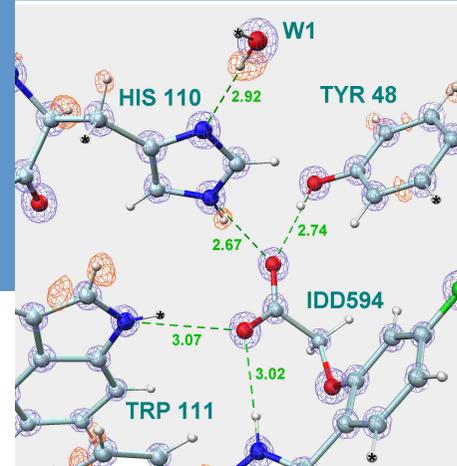
more neutrons per second than any steady state source ...
... with higher brightness than any other spallation source

Meeting the Technical Challenges for Instrument Technologies together

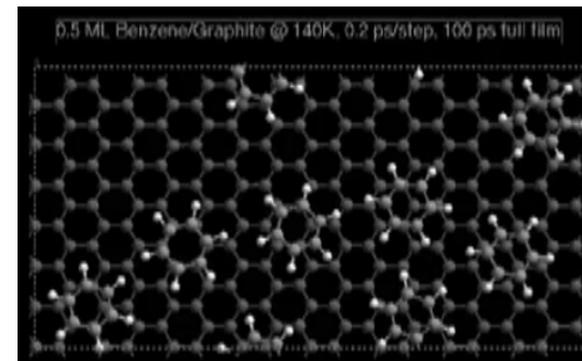


Neutrons are special

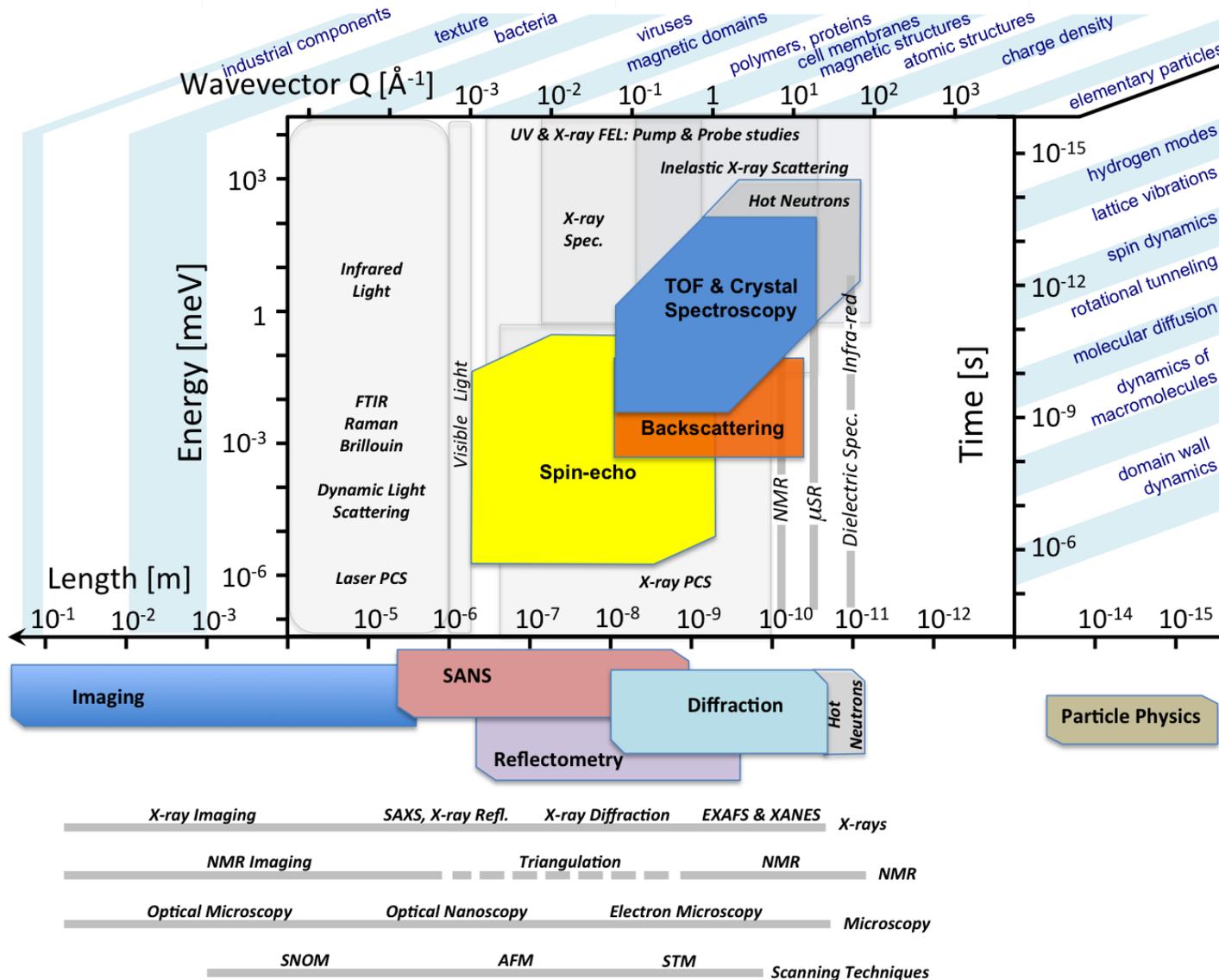
- **charge neutral:** deeply penetrating ... except for some isotopes
- **nuclear interaction:** cross section depending on isotope (not Z), sensitive to light elements.
- **spin $S = 1/2$:** probing magnetism
- **unstable** $n \rightarrow p + e + \bar{\nu}_e$ with life time $\tau \sim 900s$, $I = I_0 e^{-t/\tau}$
- **mass:** $n \sim p$; thermal energies result in non-relativistic velocities.
 $E = 293 \text{ K} = 25 \text{ meV}$, $v = 2196 \text{ m/s}$, $\lambda = 1.8 \text{ \AA}$



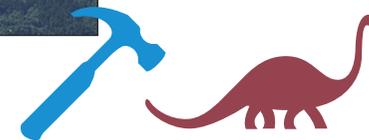
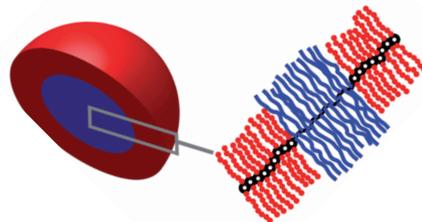
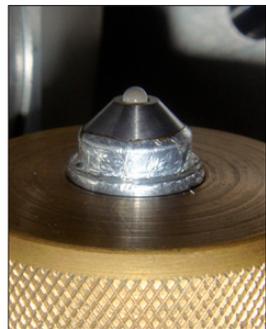
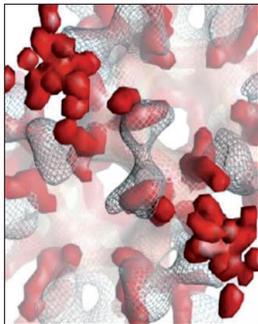
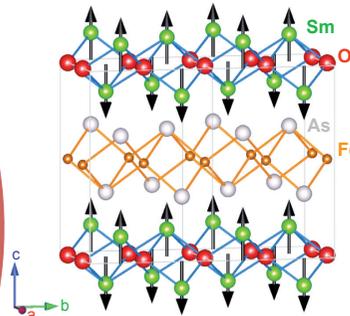
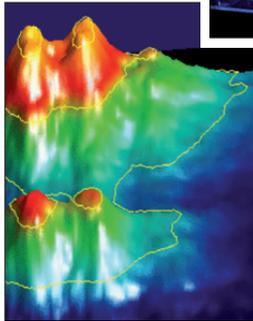
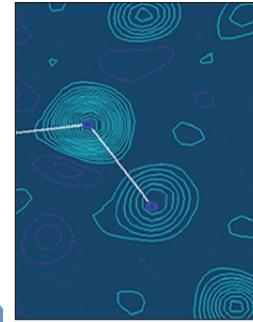
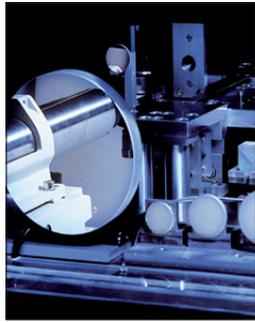
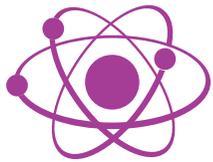
WHERE ARE THE ATOMS
AND WHAT DO THEY DO?



Length and Energy Scales

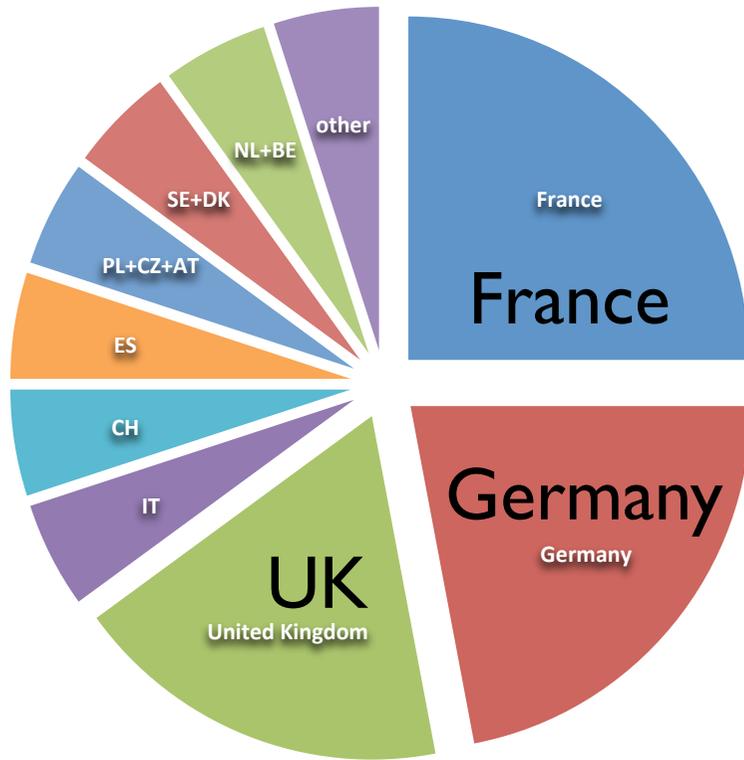


Science Topics Today

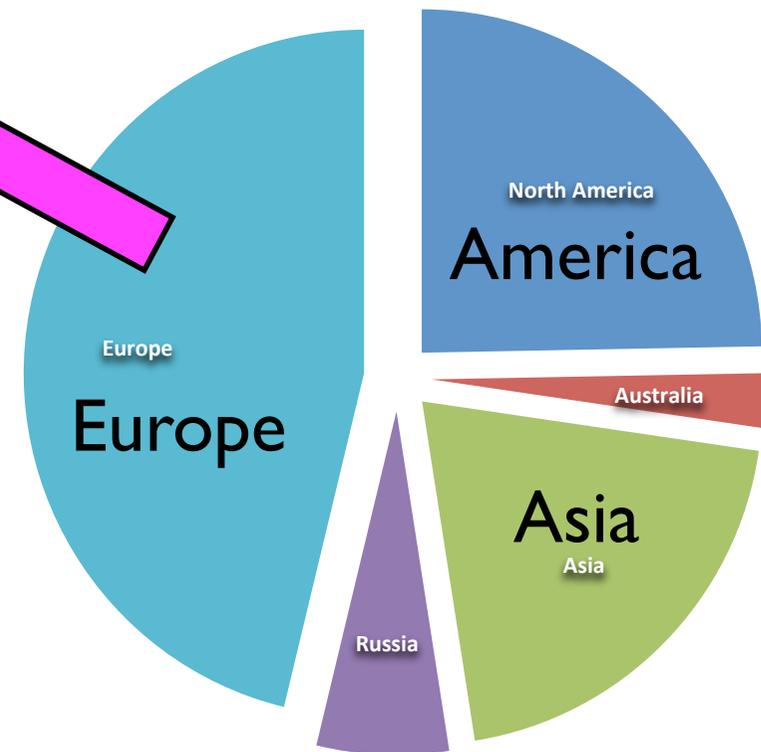
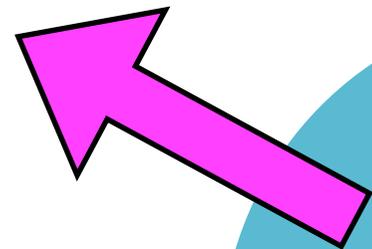


data: ILL

publications european



5000 - 6000 researchers
2000 publications per year



ILL (80M€, 500p) per year:
7500 days requested
3500 days allocated
1000 visitors
1000 experiments
650 publications

data: ESFRI, KFN

Neutron Scattering Systems Project Scope



The scope:

Construct the 22 “public” instrument suite of ESS together with a technical and scientific support infrastructure that enables scientific excellence and high quality scientific user service with reliable and sustainable operations.



22 Instruments



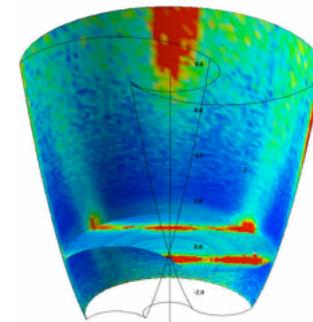
Sample Environment



Science Support Laboratories



Analysis and Visualisation Software



Early Success Strategy

- Coherent and balanced suite in science and method considering inherent strength of ESS source, needs of user community and resources available.
- Early public and scientific attention ensures scientific programme supported through on-going construction.
- World-class instruments with broad science for bulk of users from magnetism, chemistry, soft condensed matter research.
- Instruments that couple to specialist community with potentially high impact science in fundamental physics, extreme environment research, structural biology.

Science Drivers for the Reference Instrument Suite



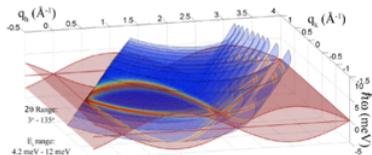
Multi-Purpose Imaging	
General-Purpose SANS	
Broadband SANS	
Surface Scattering	
Horizontal Reflectometer	
Vertical Reflectometer	
Thermal Powder Diffractometer	
Bispectral Power Diffractometer	
Pulsed Monochromatic Powder Diffractometer	
Materials Science Diffractometer	
Extreme Conditions Instrument	
Single-Crystal Magnetism Diffractometer	
Macromolecular Diffractometer	

Cold Chopper Spectrometer	
Bispectral Chopper Spectrometer	
Thermal Chopper Spectrometer	
Cold Crystal-Analyser Spectrometer	
Vibrational Spectroscopy	
Backscattering Spectrometer	
High-Resolution Spin-Echo	
Wide-Angle Spin-Echo	
Fundamental & Particle Physics	

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

12 (out of 22) instruments in construction or recommended for construction

Spectroscopy



Name

ESS + Partners*

Description

VOR



Wide Bandwidth Spectrometer

C-SPEC



Cold Chopper Spectrometer

CAMEA



Indirect Geometry Spectrometer

Imaging

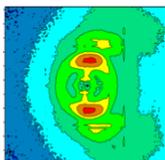


ODIN



Multi Purpose High Resolution Imaging

SANS



LOKI



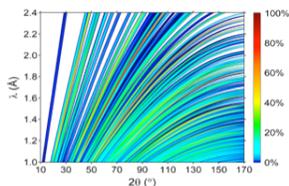
Broad Band SANS

SKADI



High Intensity SANS

Diffraction



NMX



Macromolecular Diffractometer

BEER



Engineering Diffractometer

HEIMDAL



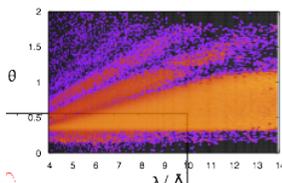
Thermal Powder Diffractometer

DREAM



Bi-Spectral Powder Diffractometer

Reflectometry



FREIA



Reflectometer for liquid interfaces

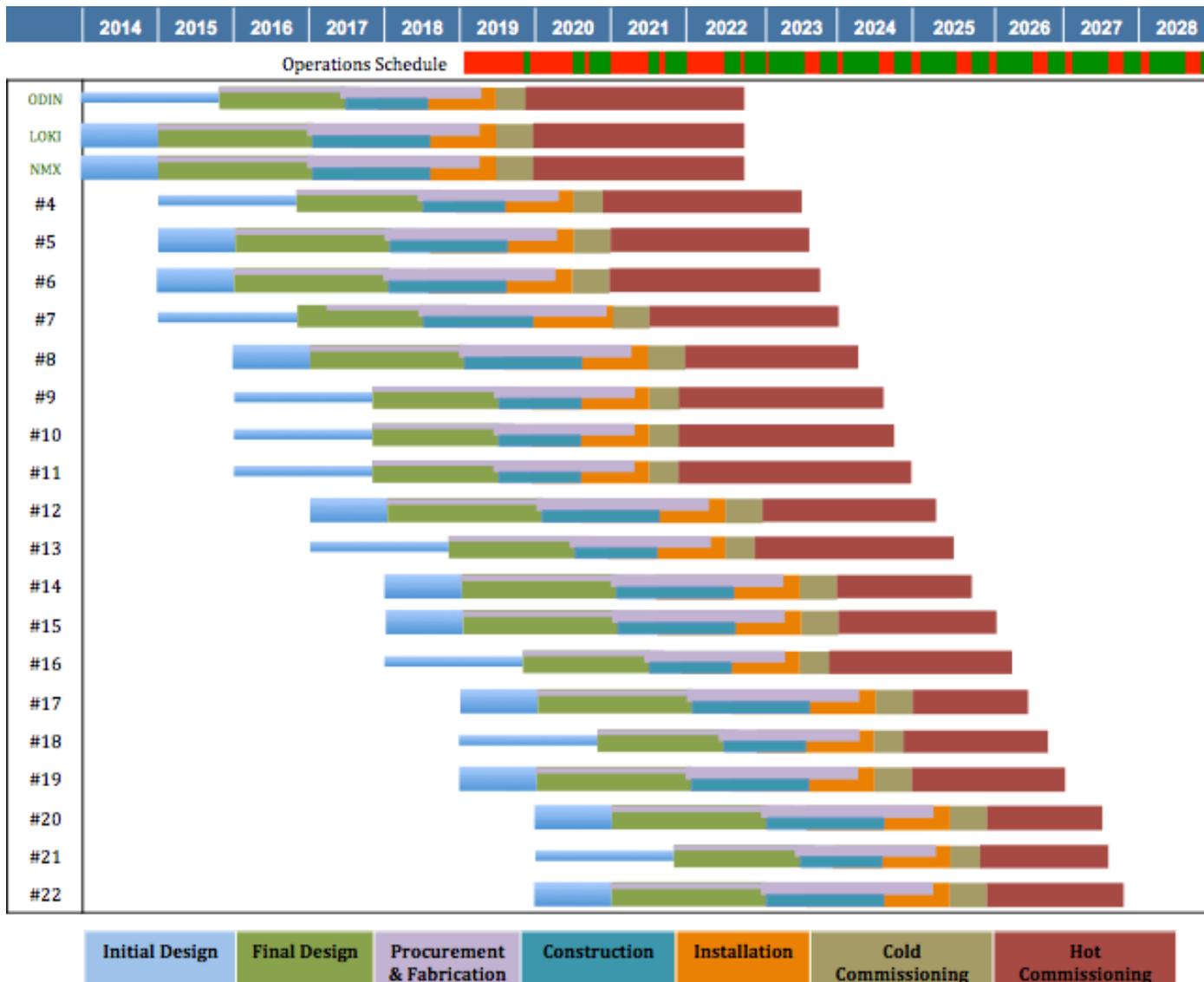
ESTIA



Focusing Reflectometer

* constantly updated

Instrument Construction Time Plan – a few at a time



Bird's eye view looking towards MAX IV/LU



Maximizing the R&D potential of the facilities through outstations



SCIENCE VILLAGE SCANDINAVIA

- Companies
- Universities
- Joint labs and functions
- Lab hotel



Initiatives for synergies by third parties



Support labs will be catalytic for maximizing and optimizing usage of the facilities. If they are run by external groups, even better!

Support laboratories for deuteration and biocrystallization

Will benefit life science and soft matter – both academy and industry

Working with LP3 at LU

MAX IV

Mass spectroscopy and NMR communities

Lund



Protein-Production Platform

Nanotechnology production facility

Discussions run by the LU Nanometer Structure Consortium



Medicon Valley Alliance

Life science industry in the Öresund region; seek ways to benefit from ESS & MAX IV.

medicon valley alliance

Creating Opportunities

SP Technical Research Institute

Portal for handling **industry access** to facilities?



Region Skåne

Strategic initiative for growth: **Smart Materials**



Conclusions

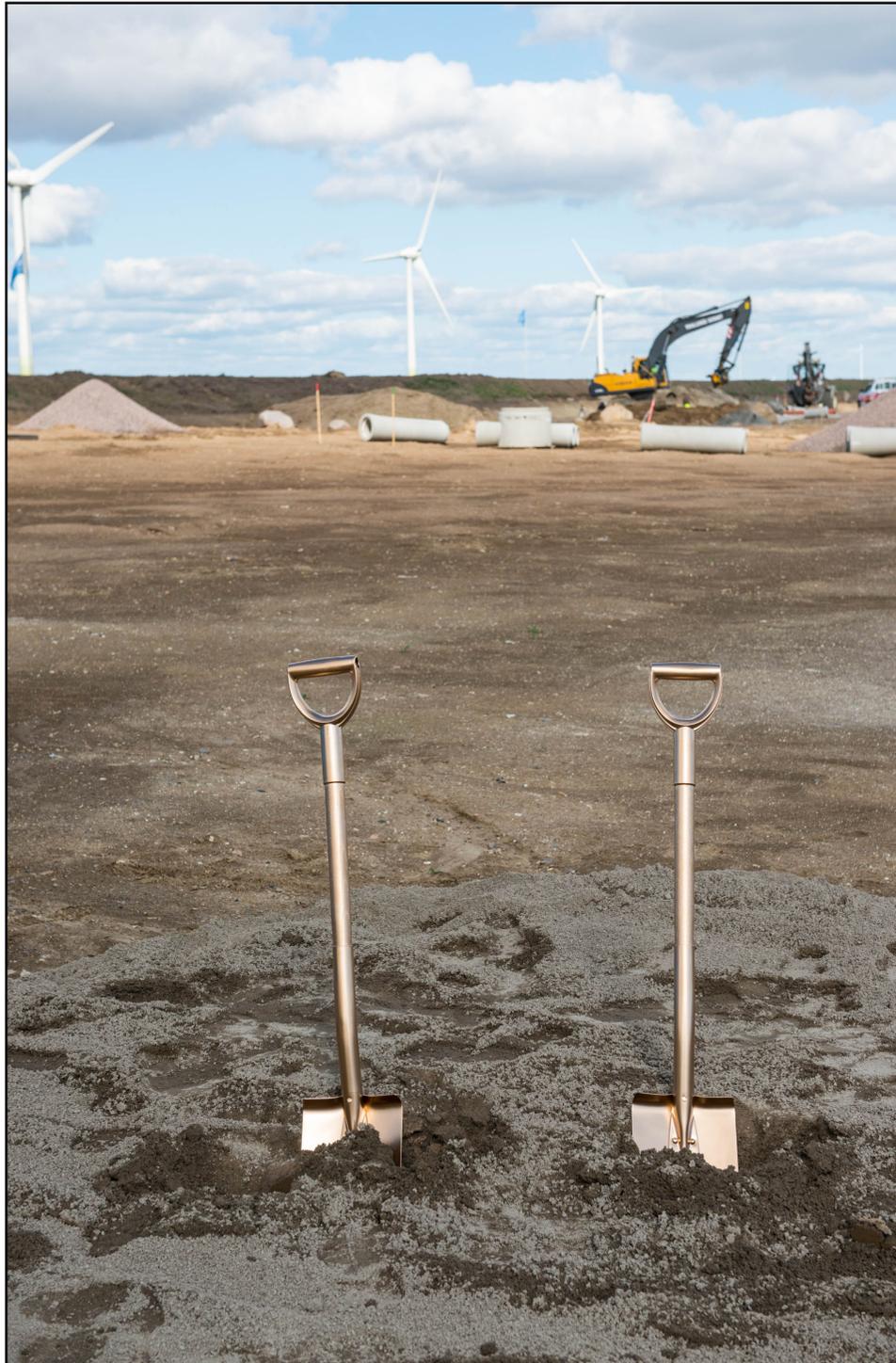


- **European Scientific Community is mobilised and awaits ESS.**
- **ESS is moving into construction at a rapid rate.**
- **ESS can only be realised by harnessing European knowhow and capabilities - at research institutes and industry.**
- **ESS defines project framework and management, partners take leadership and responsibility in delivering projects.**





EUROPEAN
SPALLATION
SOURCE



Thank you!