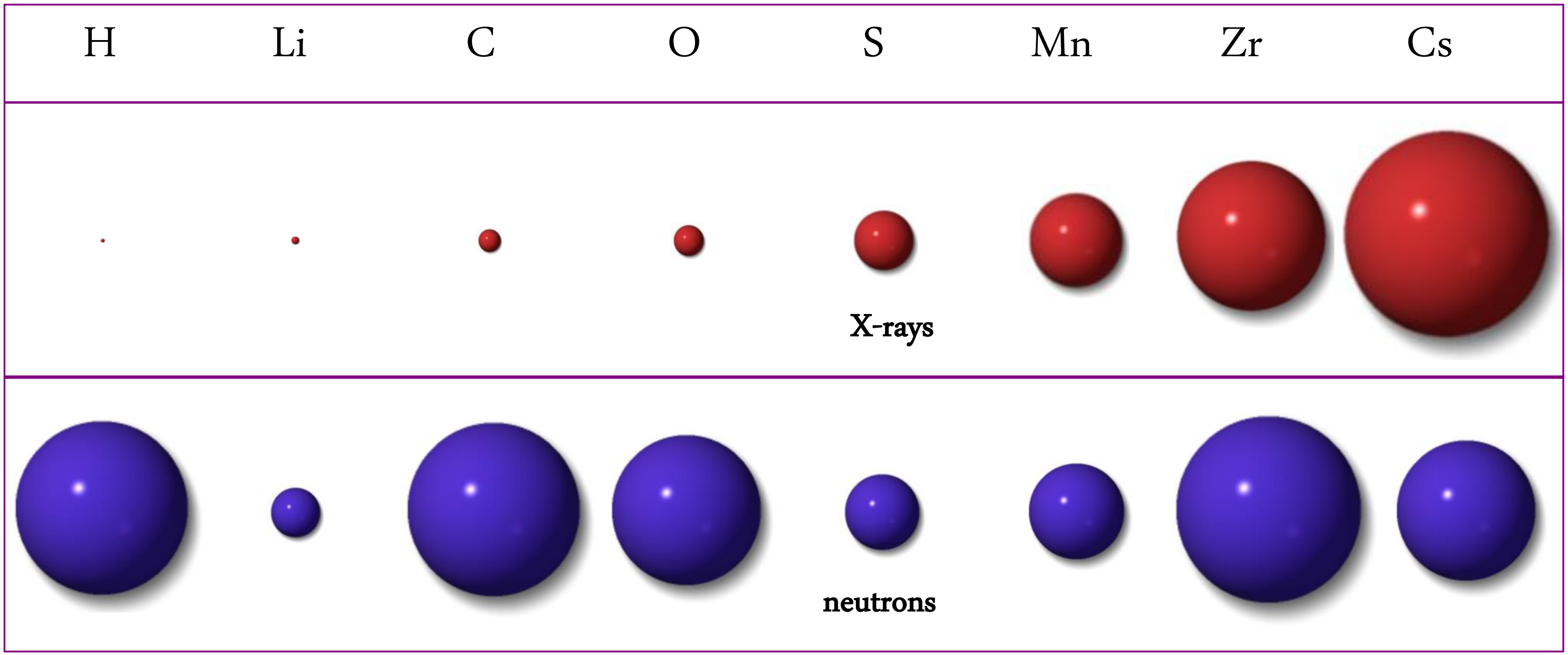
ESS

Mats Lindroos on behalf of the ESS

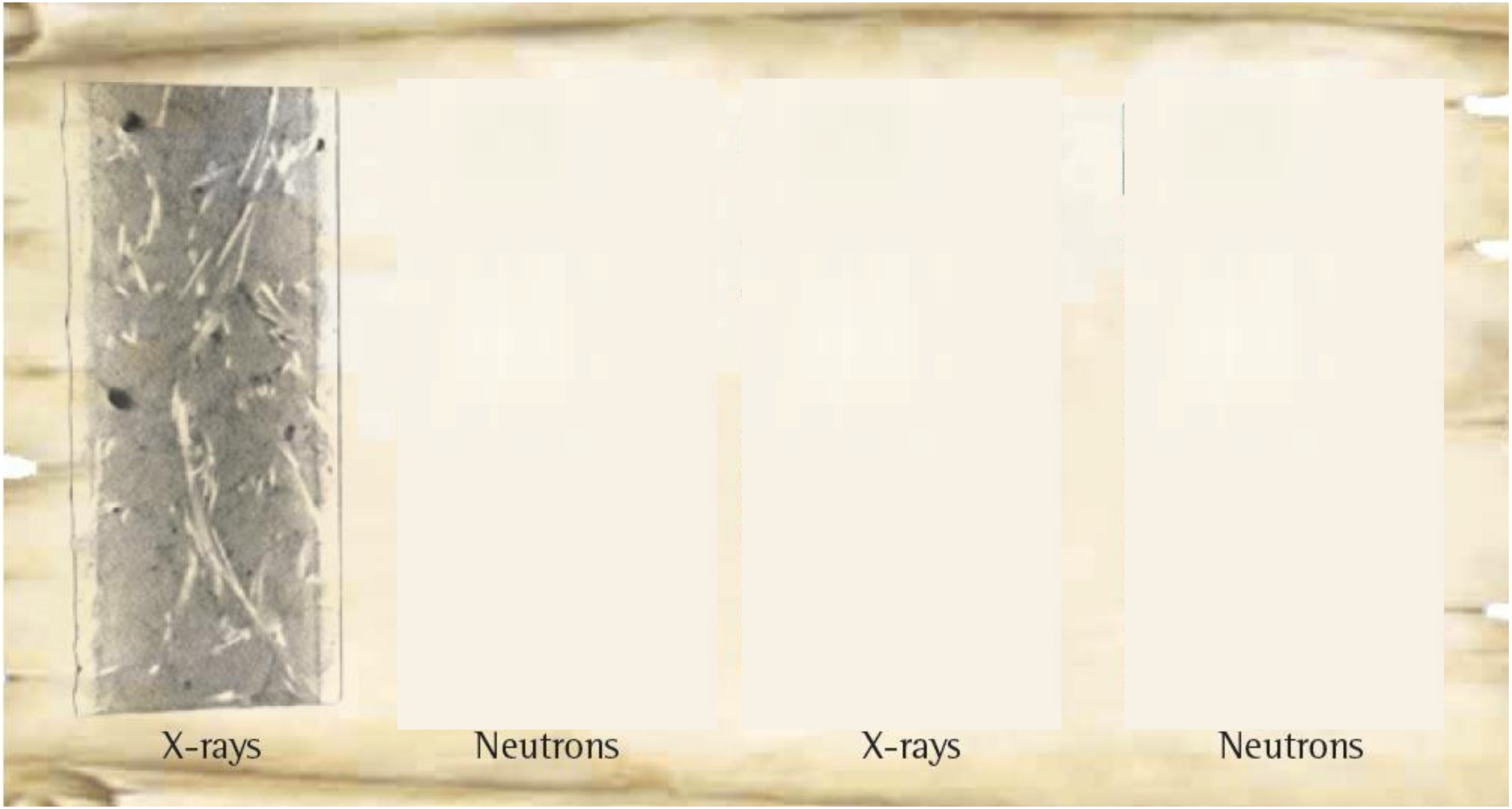
19 March 2014

A European research center

Light and neutrons



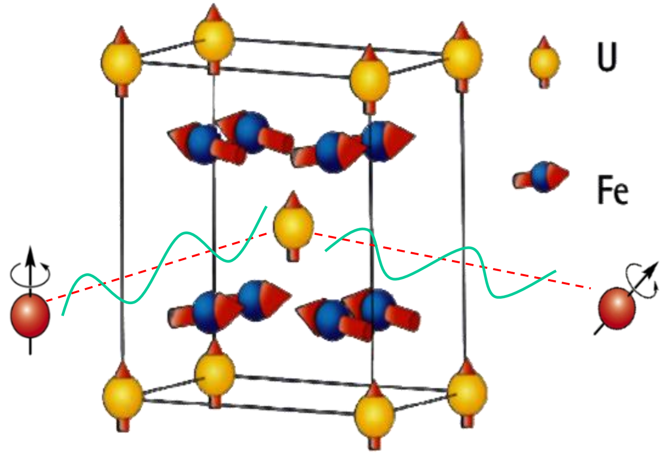
Engineering materials



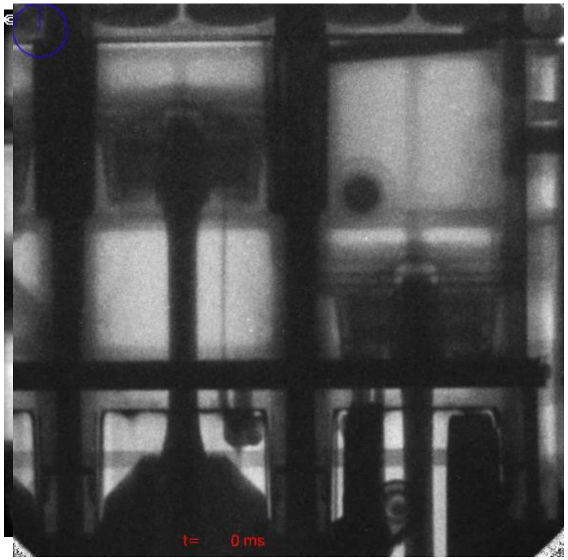
Non-destructive analysis of a steel armed concrete block with neutron imaging and X-ray tomography.

Source: PSI, CEMNET workshop 2007

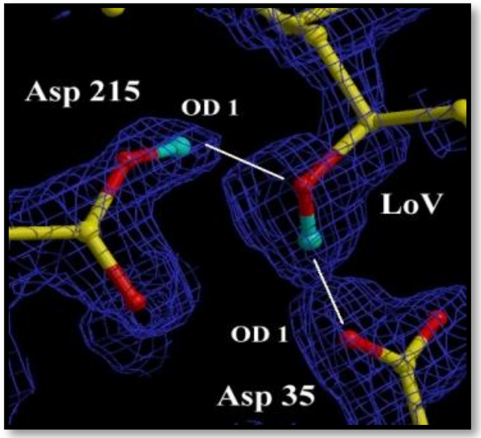
Neutrons and x-rays are complementary - neutrons…



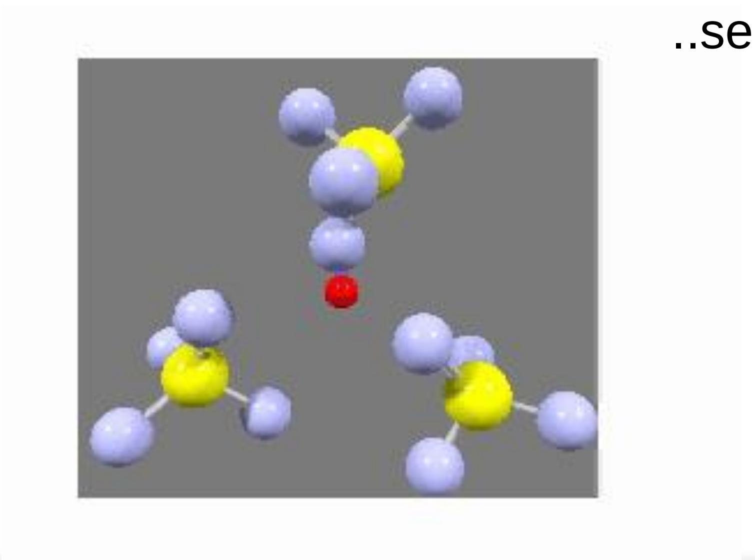
..see magnetic atoms

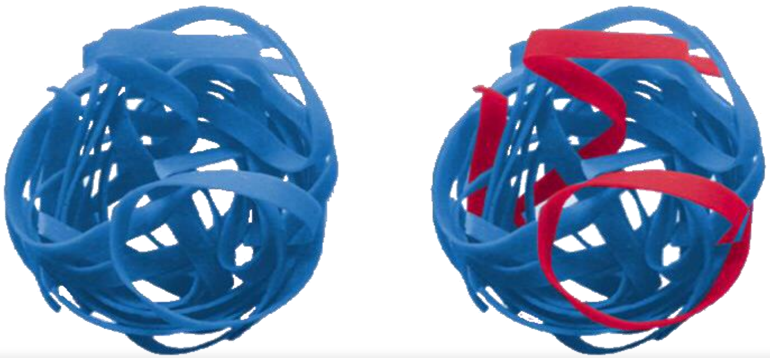


..see inside materials



..see light atoms



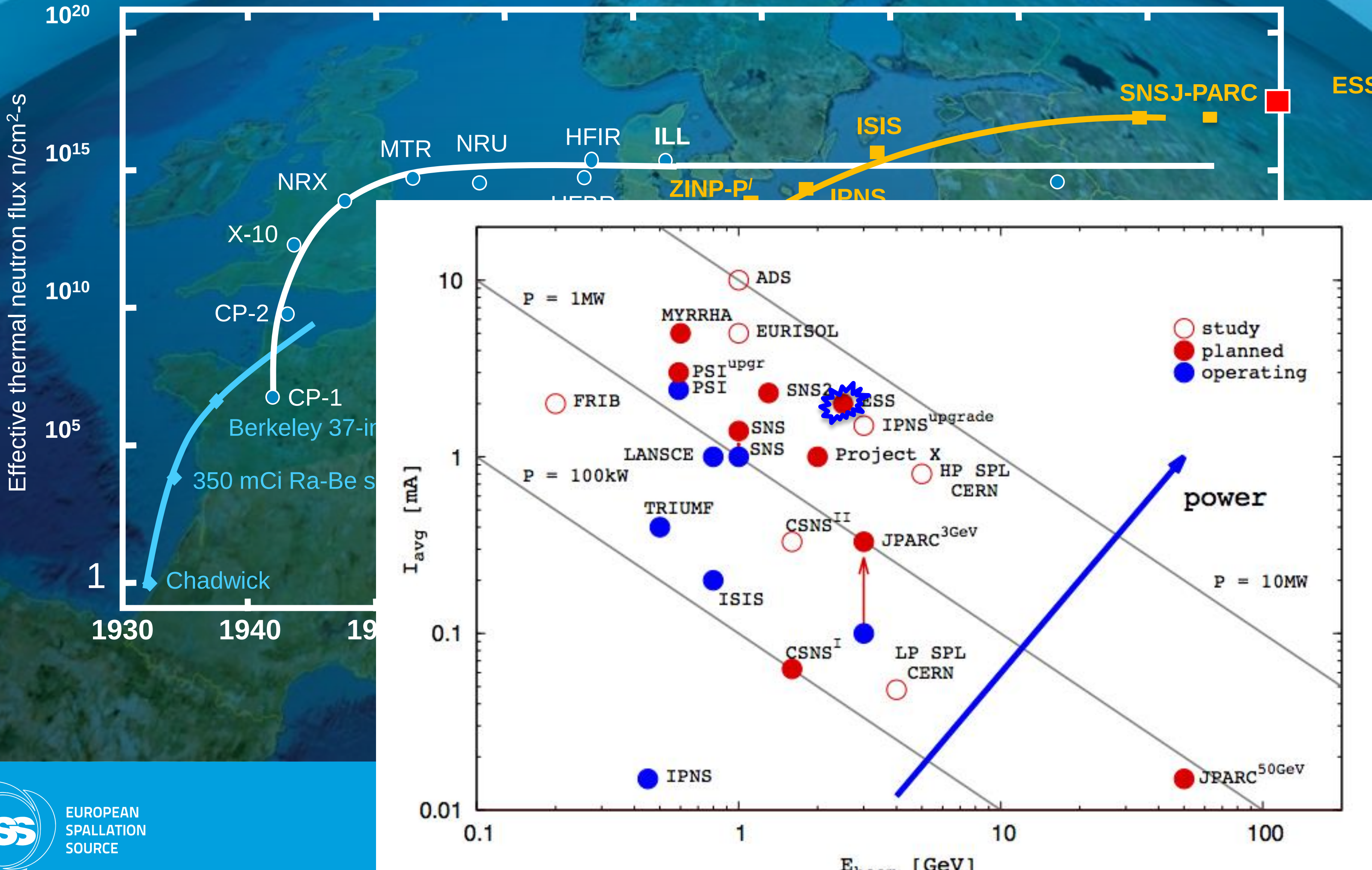


..see atoms move

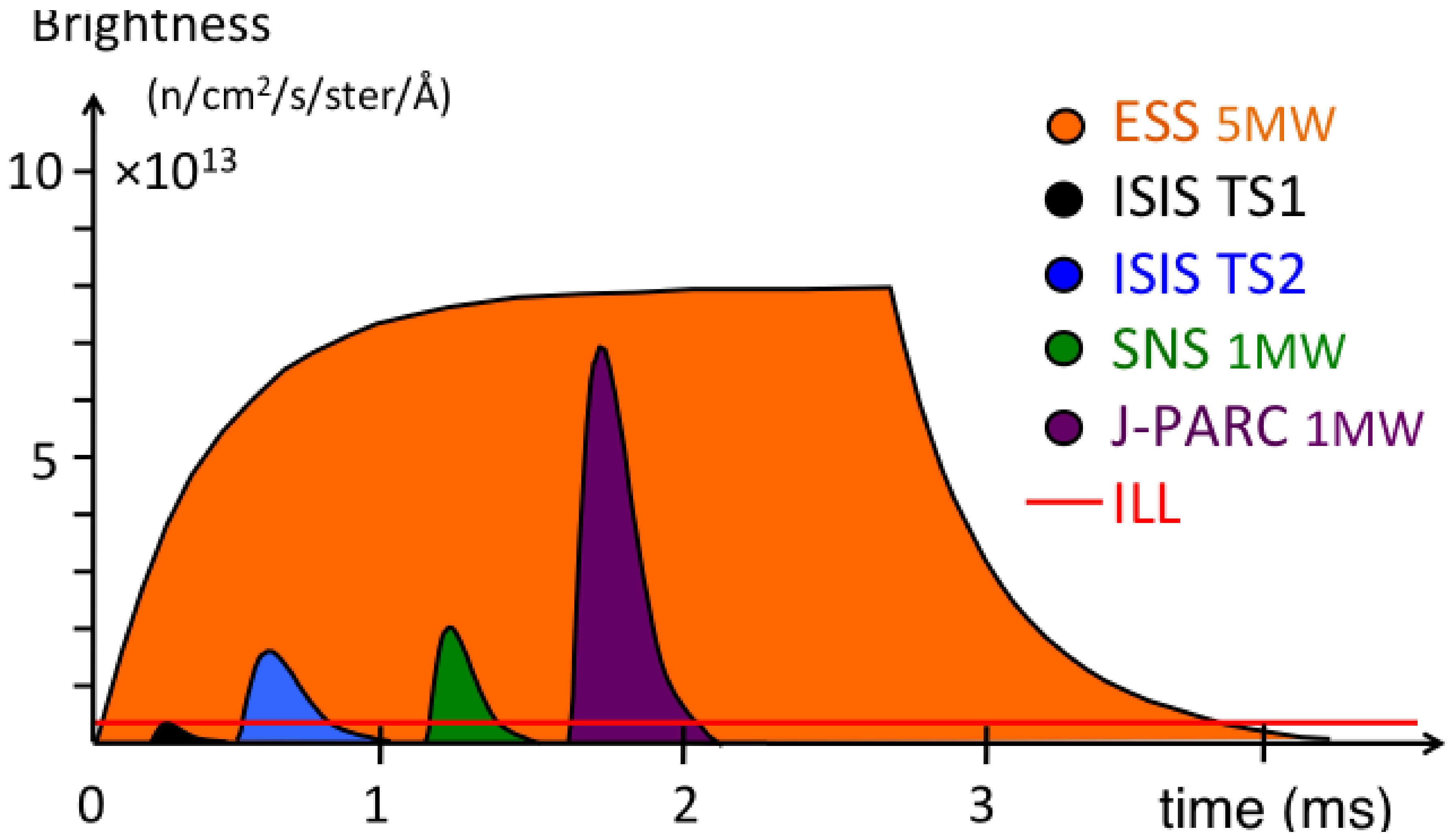
..see isotopes

Courtesy of Ian S. Anderson

ESS - Bridging the neutron gap



ESS is a long pulse source



17 nations committed to build ESS

Cash contributions from Sweden, Denmark and Norway
50% of construction and 15-20% of operations costs

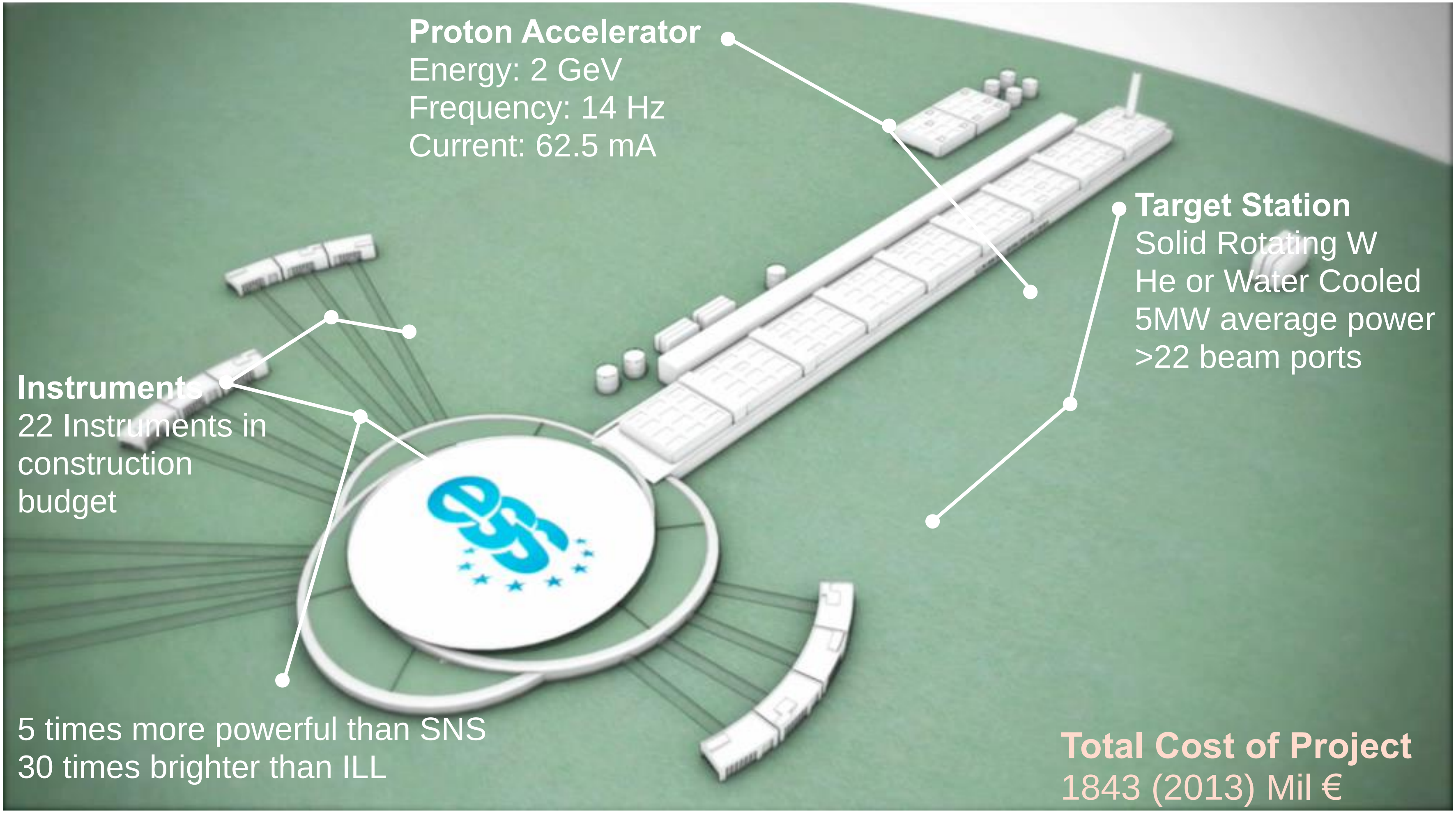
In-kind contributions from the other 14 nations

Construction cost: 1843 M€
Operation cost: 140 M€
Decommissioning cost: 177 M€

ESS AB 2014, ca 250 personer, 32 nationaliteter

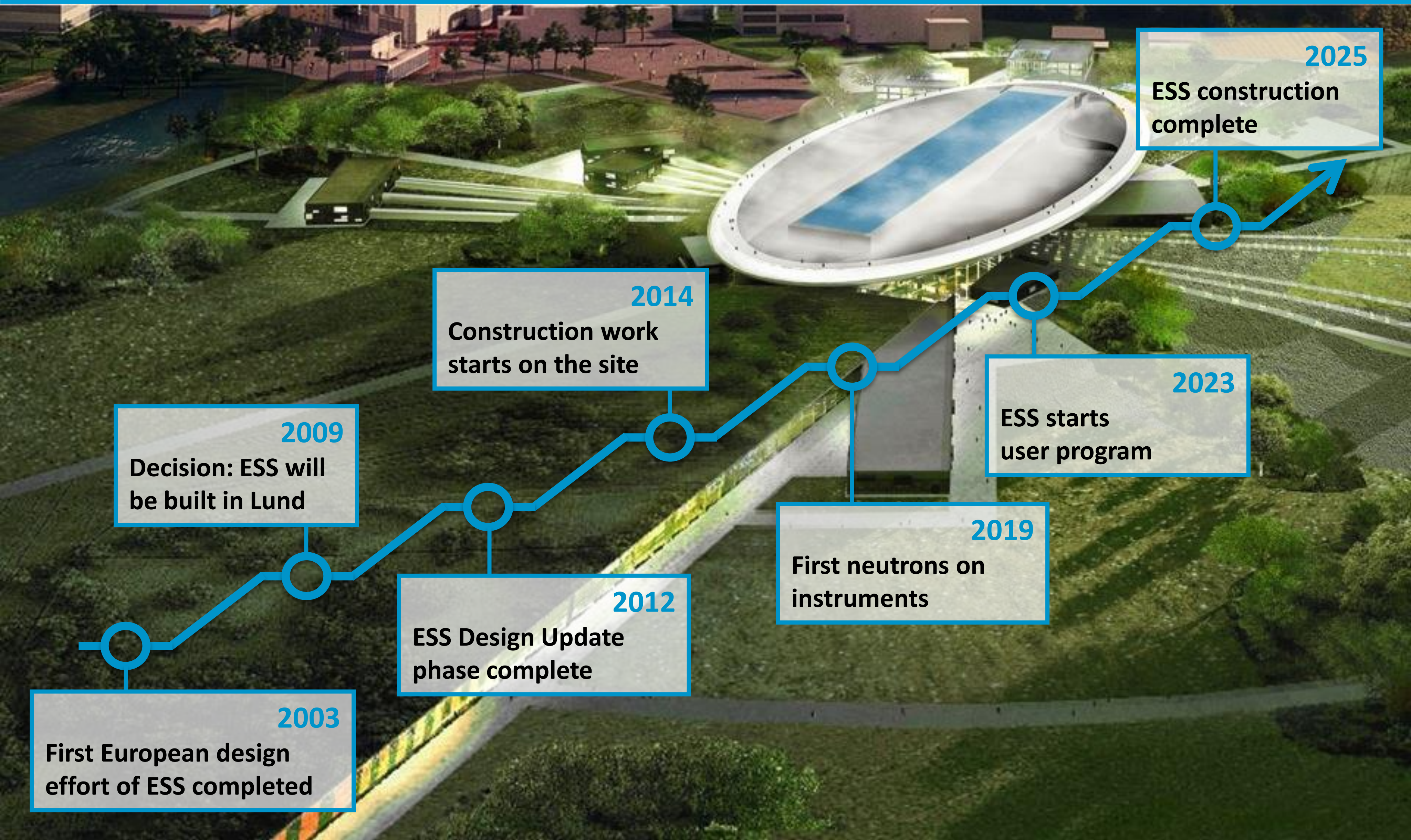
EUROPEAN SPALLATION SOURCE

Helicopter view of ESS



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

EUROPEAN SPALLATION SOURCE



2003
First European design effort of ESS completed

2009
Decision: ESS will be built in Lund

2012
ESS Design Update phase complete

2014
Construction work starts on the site

2019
First neutrons on instruments

2023
ESS starts user program

2025
ESS construction complete

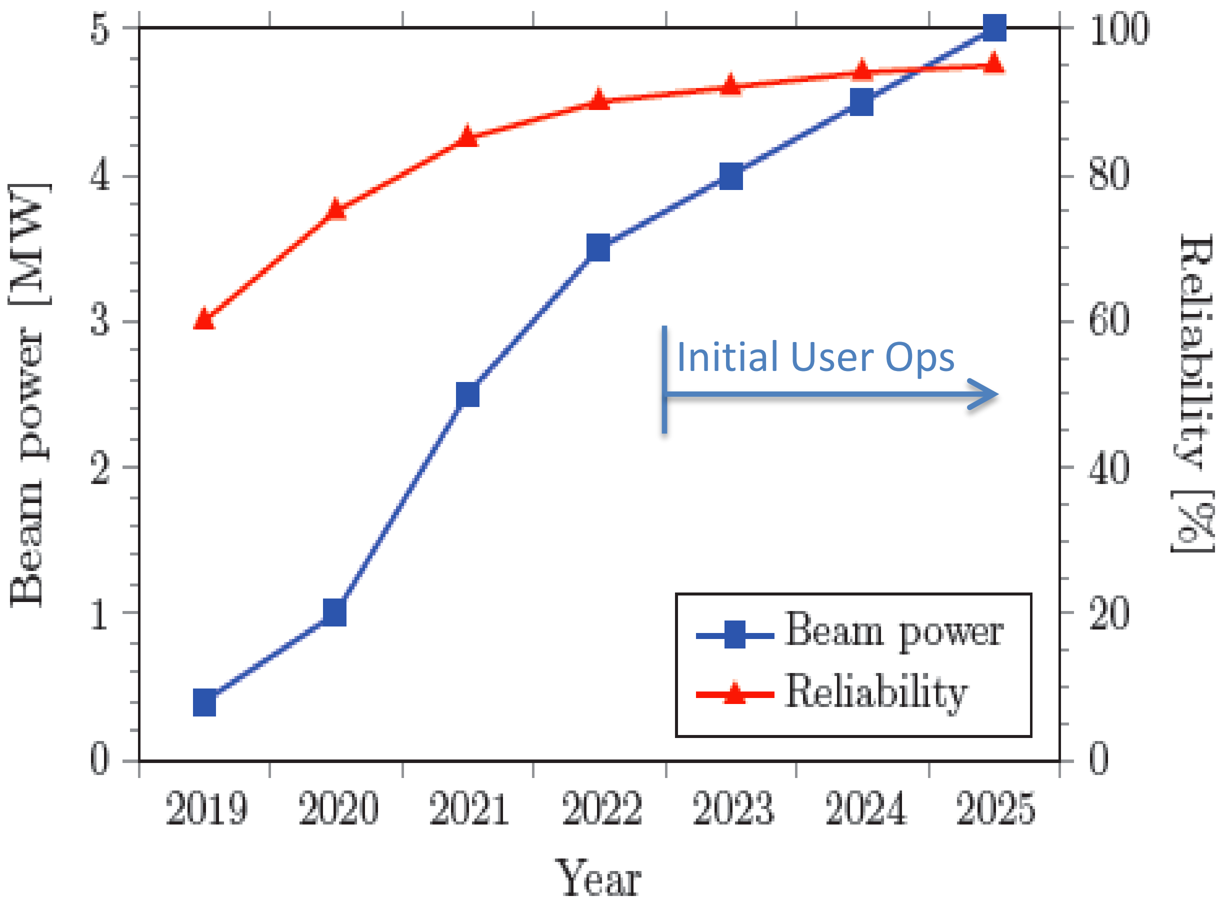
Commissioning and operations

Criteria for start of Initial Operations:
Deliver a measurable number of moderated neutrons to an instrument.

Strategy

- Initially keep radioactivity and doses low to allow hands on maintenance.
- Ramp up power quickly to find limitations and increase reliability before user operations start.

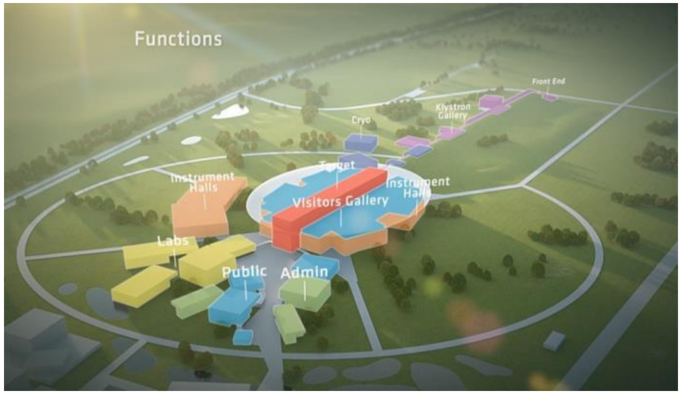
TDR Performance Goals



ESS accelerator

Design Drivers:

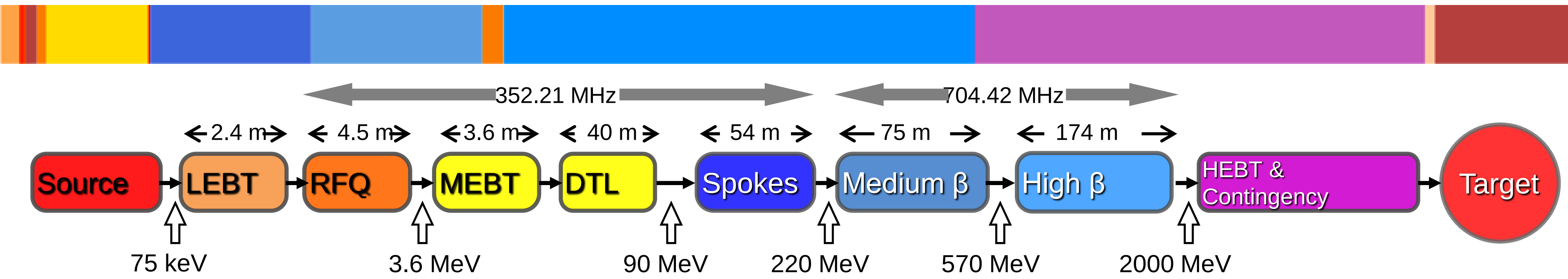
- High Average Beam Power
  - 5 MW
- High Peak Beam Power
  - 125 MW
- High Availability
  - > 95%



Key parameters:

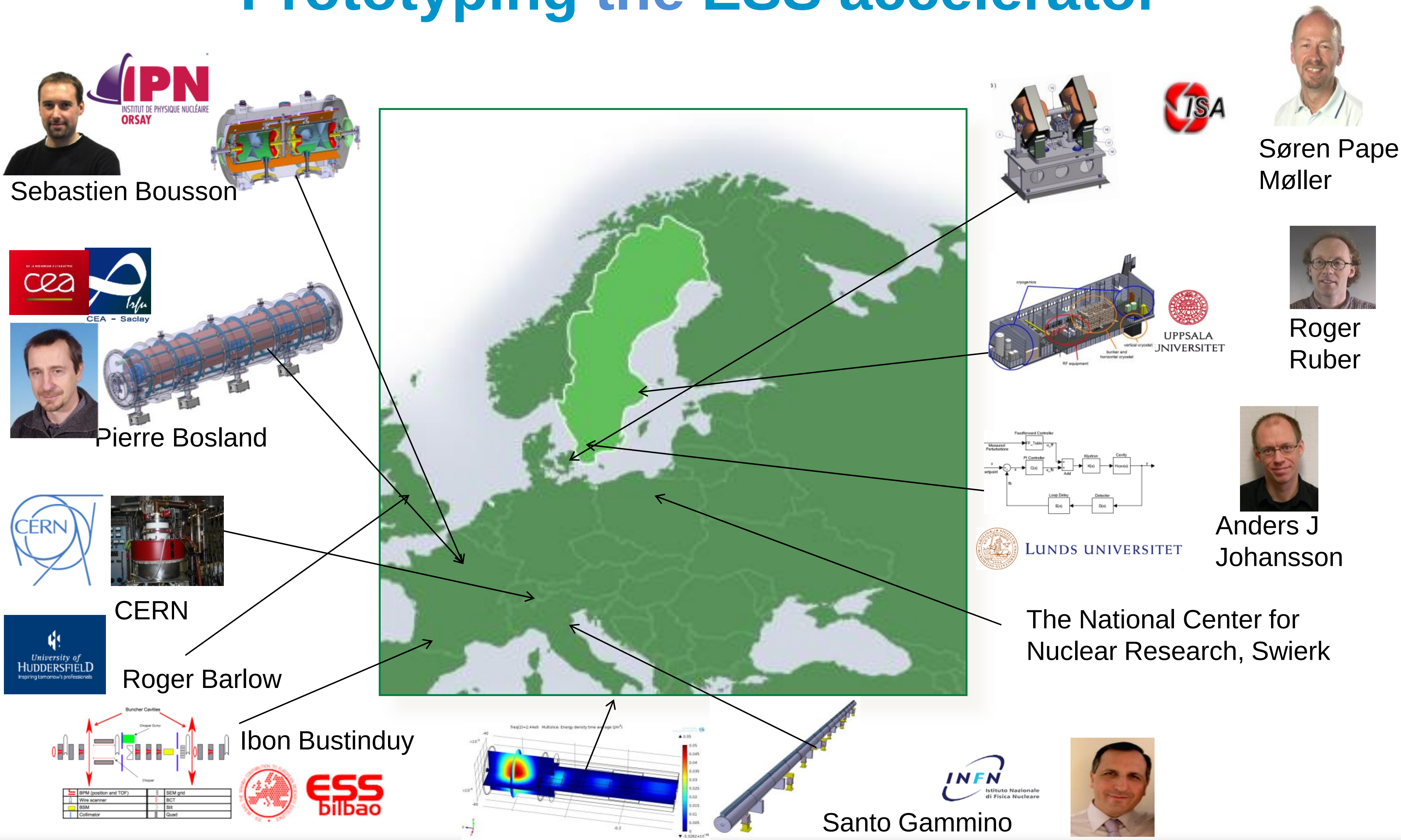
-2.86 ms pulses
-2 GeV
-62.5 mA
-14 Hz
-Protons (H+)
-Low losses
-Attention is paid to cryoplant turn down capabilities to minimize use of electrical heaters at low temperatures and proper cryogenic design techniques to minimize static heat leaks
-Flexible design for future upgrades

ESS Linac

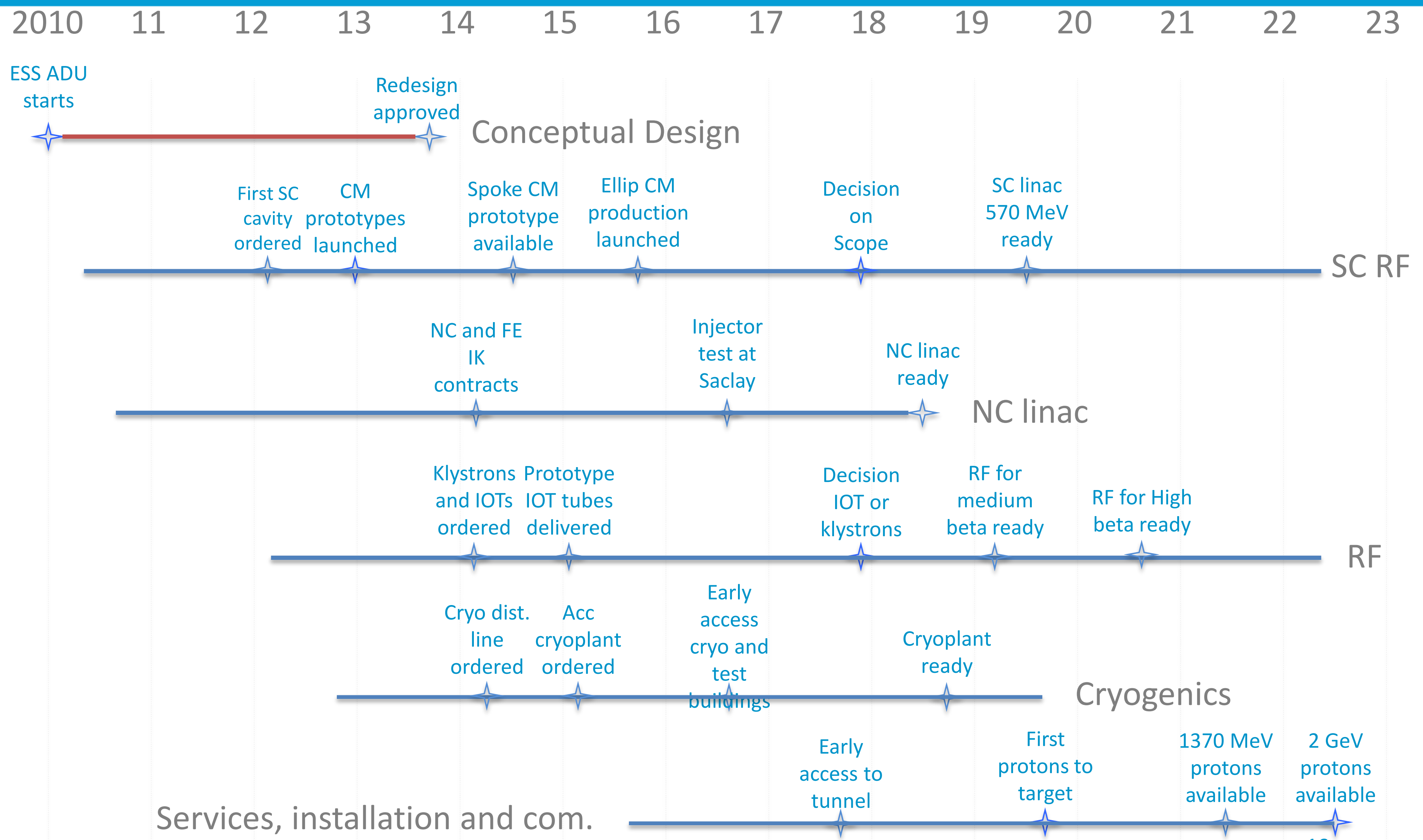


	Energy (MeV)	No. of Modules	No. of Cavities	βg	Temp (K)	Cryo Length (m)
Source	0.075	1	0	–	~300	–
LEBT	0.075	–	0	–	~300	–
RFQ	3.6	1	1	–	~300	–
MEBT	3.6	–	3	–	~300	–
DTL	90	5	5	–	~300	–
Spoke	220	13	2 (2S) × 13	0.5 β_{opt}	~2	4.28
Medium β	570	9	4 (6C) × 9	0.67	~2	8.52
High β	2000	21	4 (5C) × 21	0.86	~2	8.52
HEBT	2000	–	0	–	~300	–

Prototyping the ESS accelerator

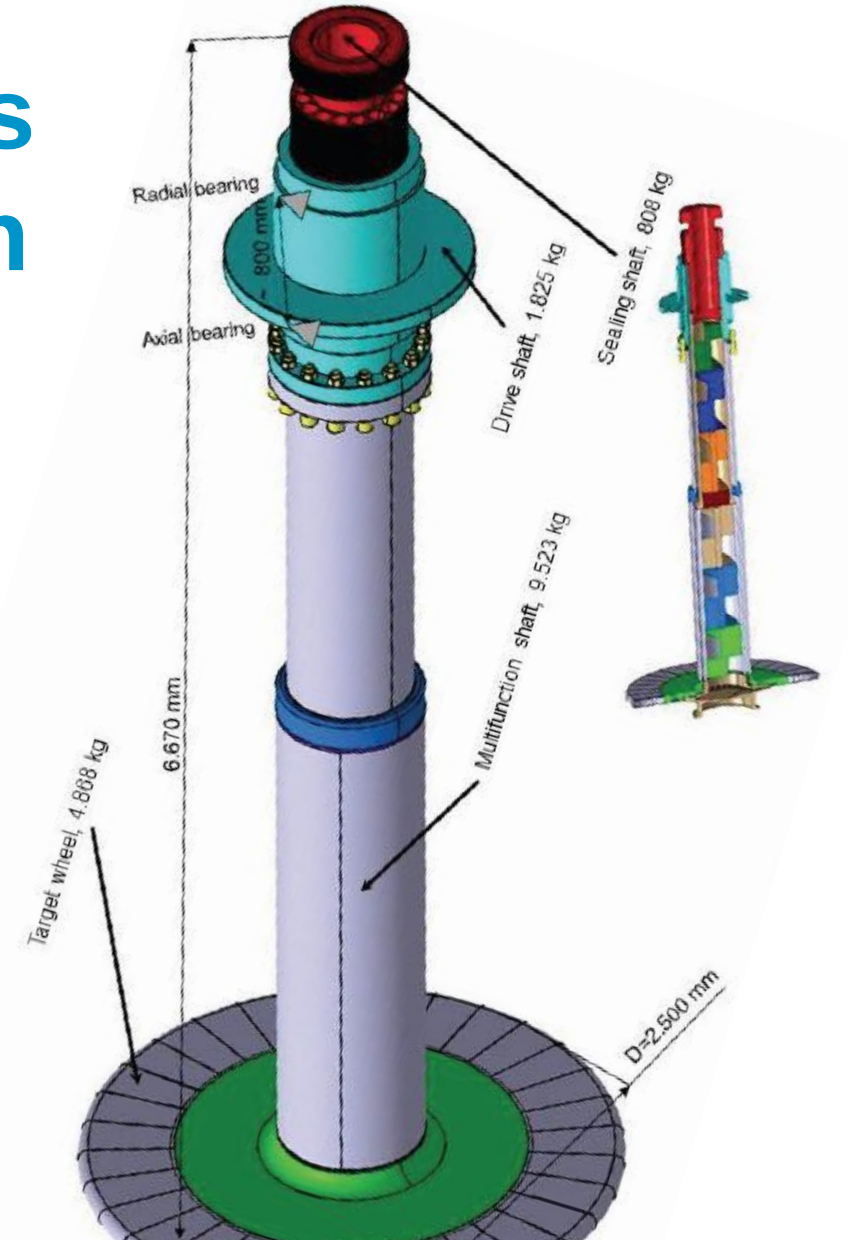


Very high level Schedule



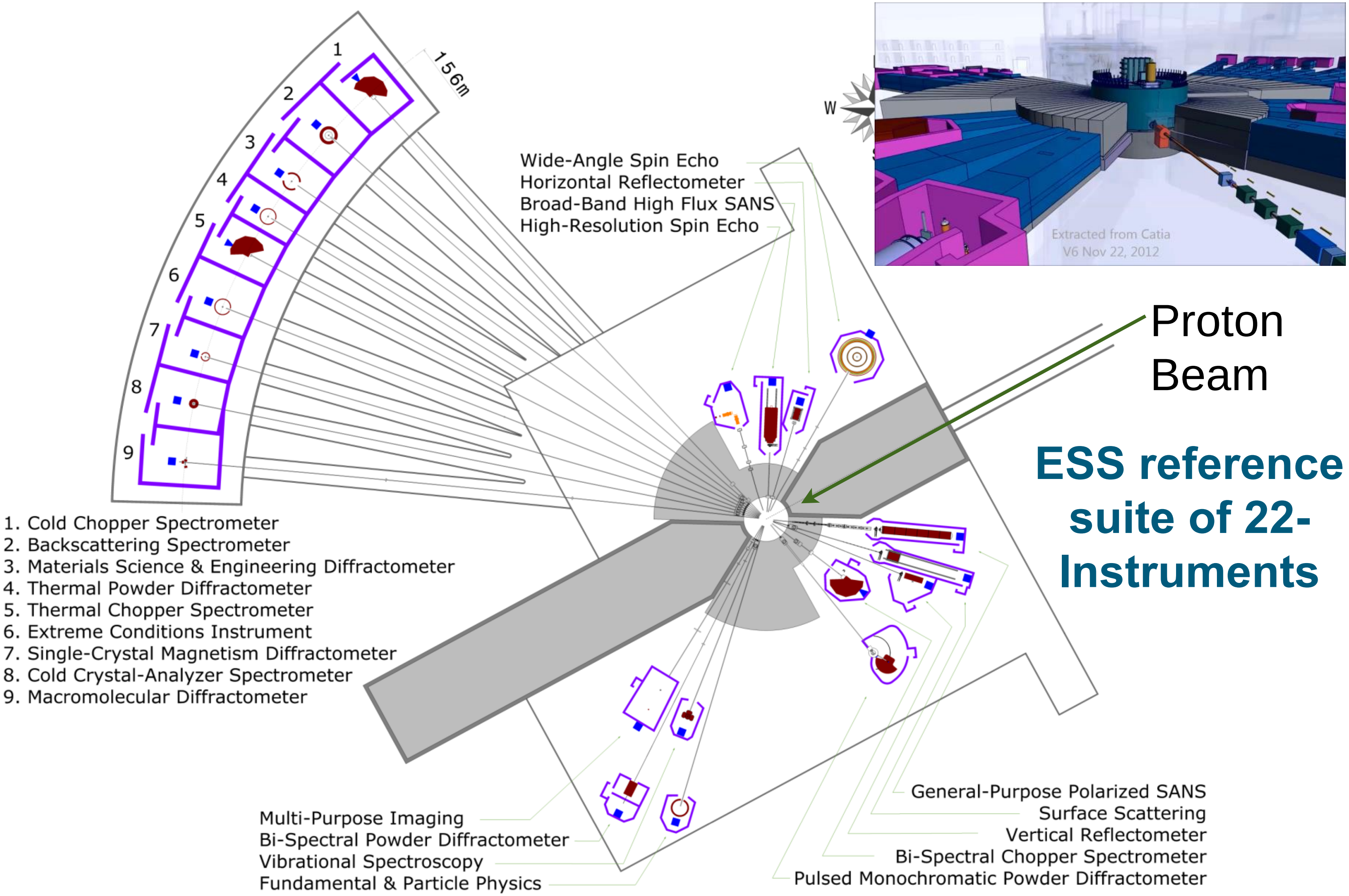
High beam power leads to an innovative design

- Rotating tungsten target
  - 2.5 m diameter
  - 33 sectors
  - Suspended on a 6 m shaft
  - Total mass: 17 tonnes
  - Rotational speed = 0.42 Hz
  - Estimated lifetime = 5 years
- Helium coolant
  - 3 kg/s flow rate
  - 4 bar inlet, 1 bar ΔP
  - 20°C inlet, 200°C ΔT



Source: KIT

ESS Reference suite of instruments

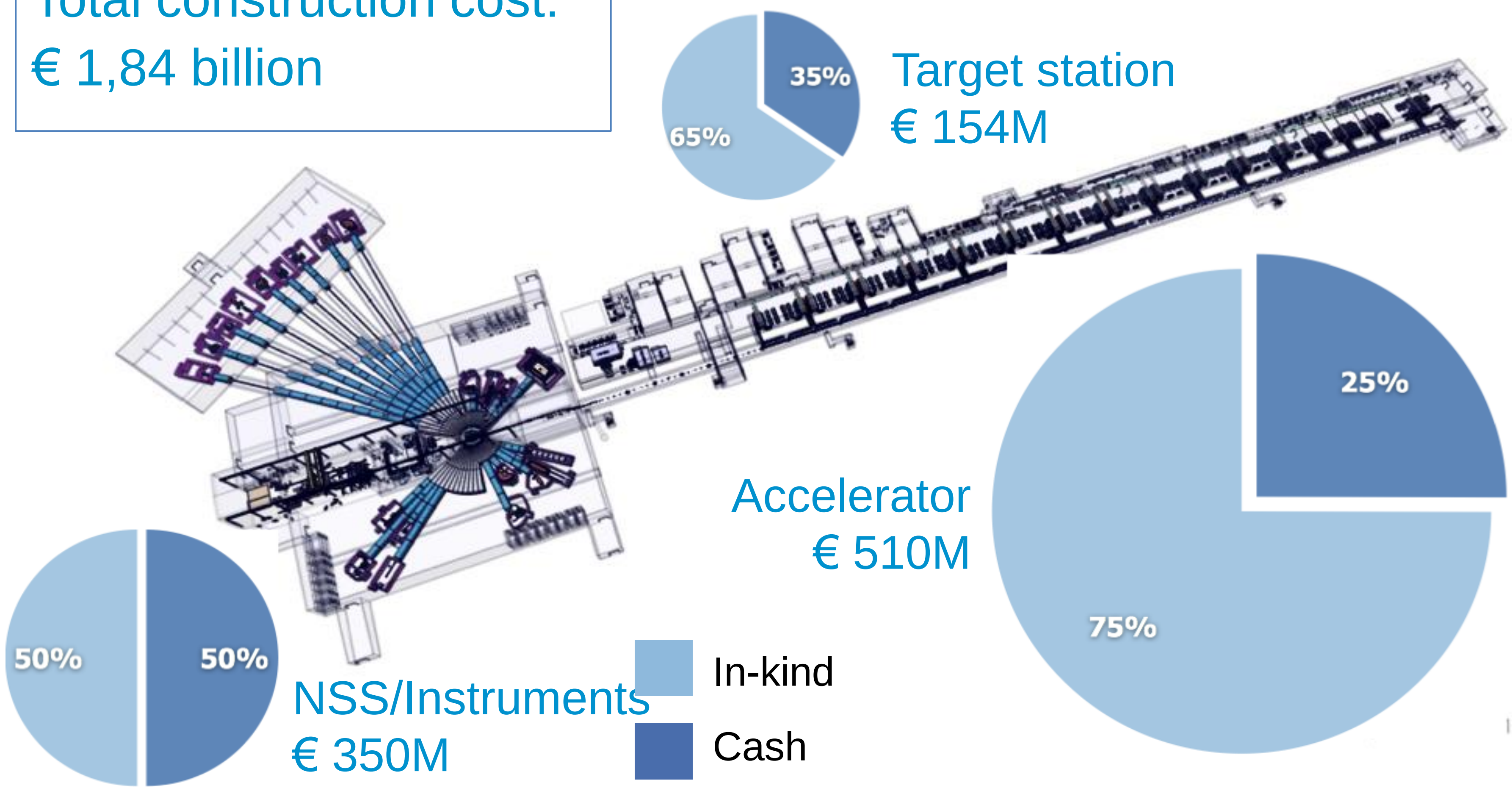


Proton Beam

ESS reference suite of 22-Instruments

ESS In-kind contributions potential

Total construction cost:
€ 1,84 billion



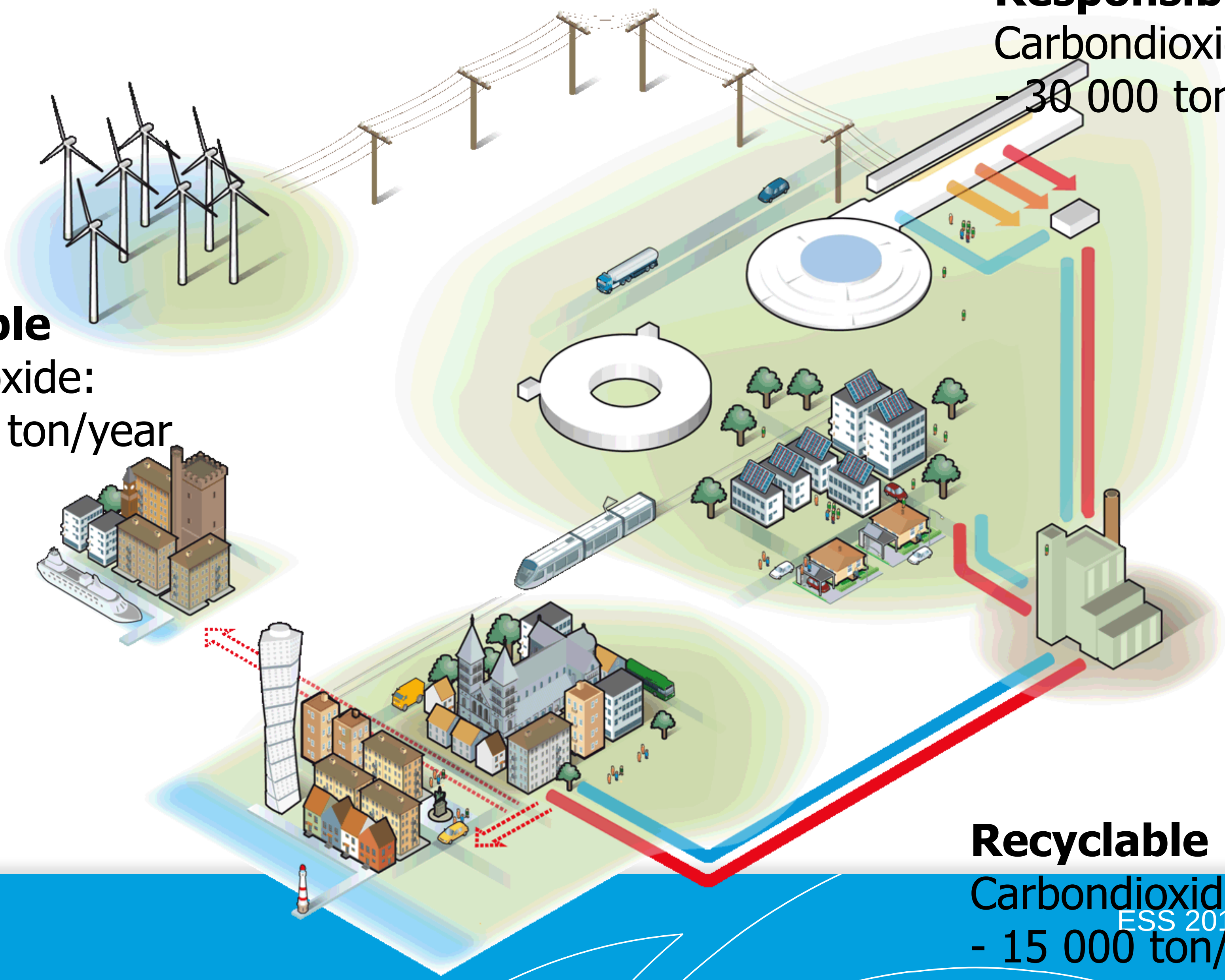
Fundamental physics at ESS

- The ESS **Scientific and Technical Advisory Panel (STAP) on fundamental physics** is charged to evaluate the scientific opportunities at the ESS for experiments that address questions in nuclear, particle, and astrophysics, as well as those that probe the character of the fundamental symmetries of nature and search for physics beyond the Standard Model.
- The STAP reports to **the ESS Scientific Advisory Committee (SAC)**.
- *Last report "there are **extraordinary opportunities for a class of fundamental neutron physics experiments that require the highest possible integrated neutron flux**. Particularly notable among these is the proposed search for neutron-antineutron oscillations"*
- In addition to the neutron measurements relevant for fundamental physics possible at ESS the construction of **a proton high intensity frontier accelerator** also open possibilities for many other experiments such as **neutrino oscillation measurements**. The STAP recognized that this is beyond the competence of this committee to give recommendations.
- ESS looking forward to **relevant bodies in particle physics** to study the case for neutrino physics (ESSnuSB proposal) and make recommendations

A sustainable research facility

Responsible
Carbondioxide:
- 30 000 ton/year

Renewable
Carbondioxide:
- 120 000 ton/year



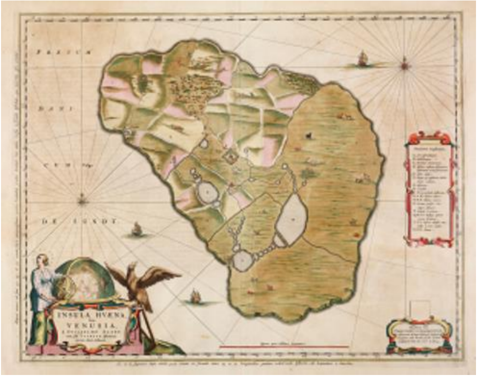
Recyclable
Carbondioxide:
- 15 000 ton/year

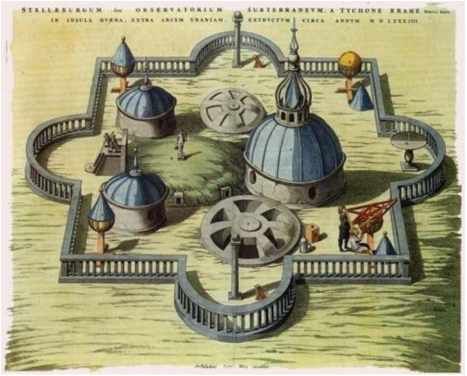
EUROPEAN
SPALLATION
SOURCE

1.8 Billion Euros:
Biggest investment in Science ever in Scandinavia?

In modern time, definitely YES!

However, Tycho Brahe’s Stjärneborg costed the Danish king 1% of the state budget in 1580.





“With better measurements of the stars positions and movements I can make much better horoscopes for you, your majesty!”

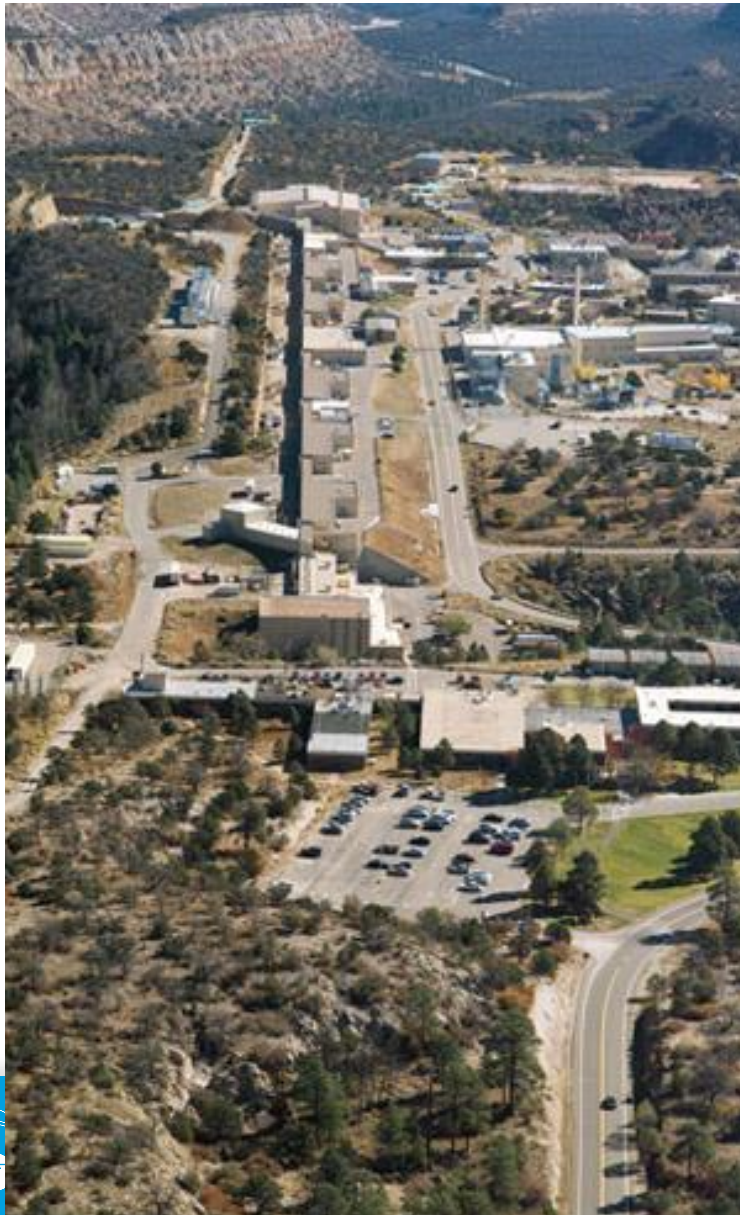
ESS will be at the proton high intensity frontier!

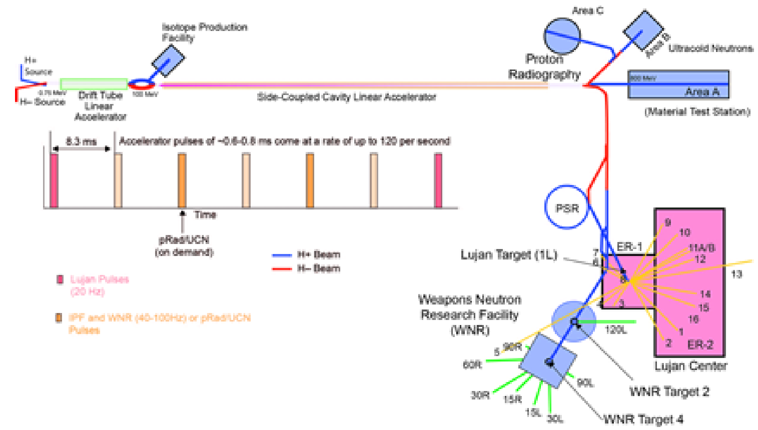
Welcome!

Short pulse neutron sources-SNS

- SNS, SC LINAC/Storage ring, 2007, 1.4 MW, 1 GeV, 26 mA in linac, 627 ns long pulse, 60 Hz
- Examples of challenges: Better understand stripping reaction in linac, accumulation in storage ring

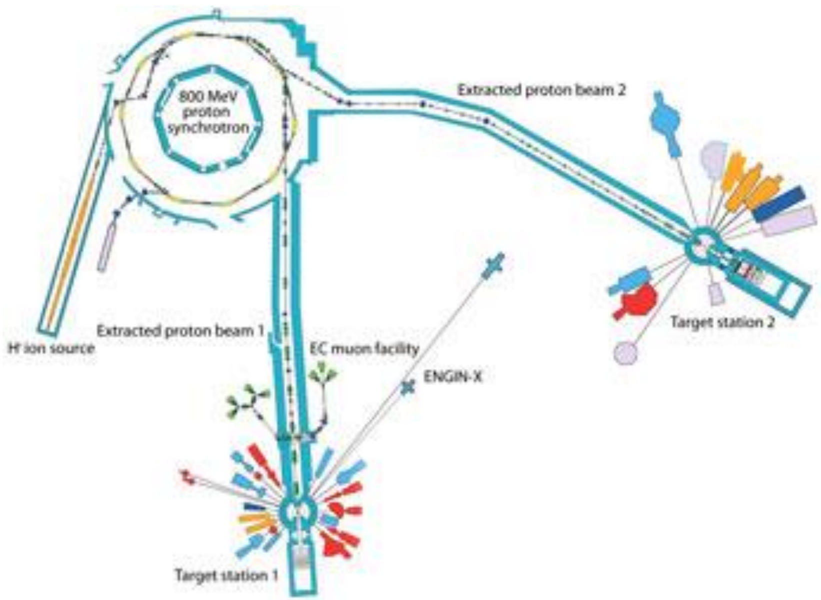
Short pulse sources-LANCSE





- LANCSE, NC LINAC /Storage ring, 1972, 100 kW, 800 MeV, 17 mA in linac, 600 ns, 20 Hz
- Examples: Combined H- and H+ acceleration

Science & Technology Facilities Council
ISIS



Accelerated intensity at 800 MeV:

2.5x10^{13} ppp - 3.75x10^{13} ppp

(200 µA) (300 µA)

- Neutron scattering facility
- Two target stations
- Muon facility

Examples of challenges: Ceramic vacuum chambers, high space charge synchrotron