EUROPEAN
SPALLATION
SOURCE

A 50-year forward-look for neutrons...

Greetings from Lund !

Colin Carlile
on behalf of the ESS team

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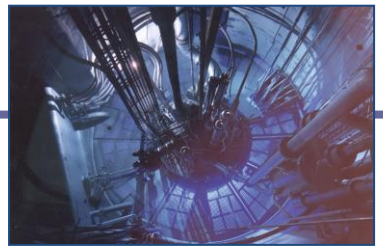
Neutron Sources

Neutron sources are rather rare.

Source strengths are weak

Evolution of the performance of neutron sources



utron Scattering, K. Skold and D. L. Price, eds., Academic Press, 198

Neutron sources globally

- There are 230 research reactors in 32 countries
- There are 5 spallation sources in 4 countries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ISIS
ILL
Dubna
FRM-II
PSI Zurich
Neutrons in Europe in 2025 ?

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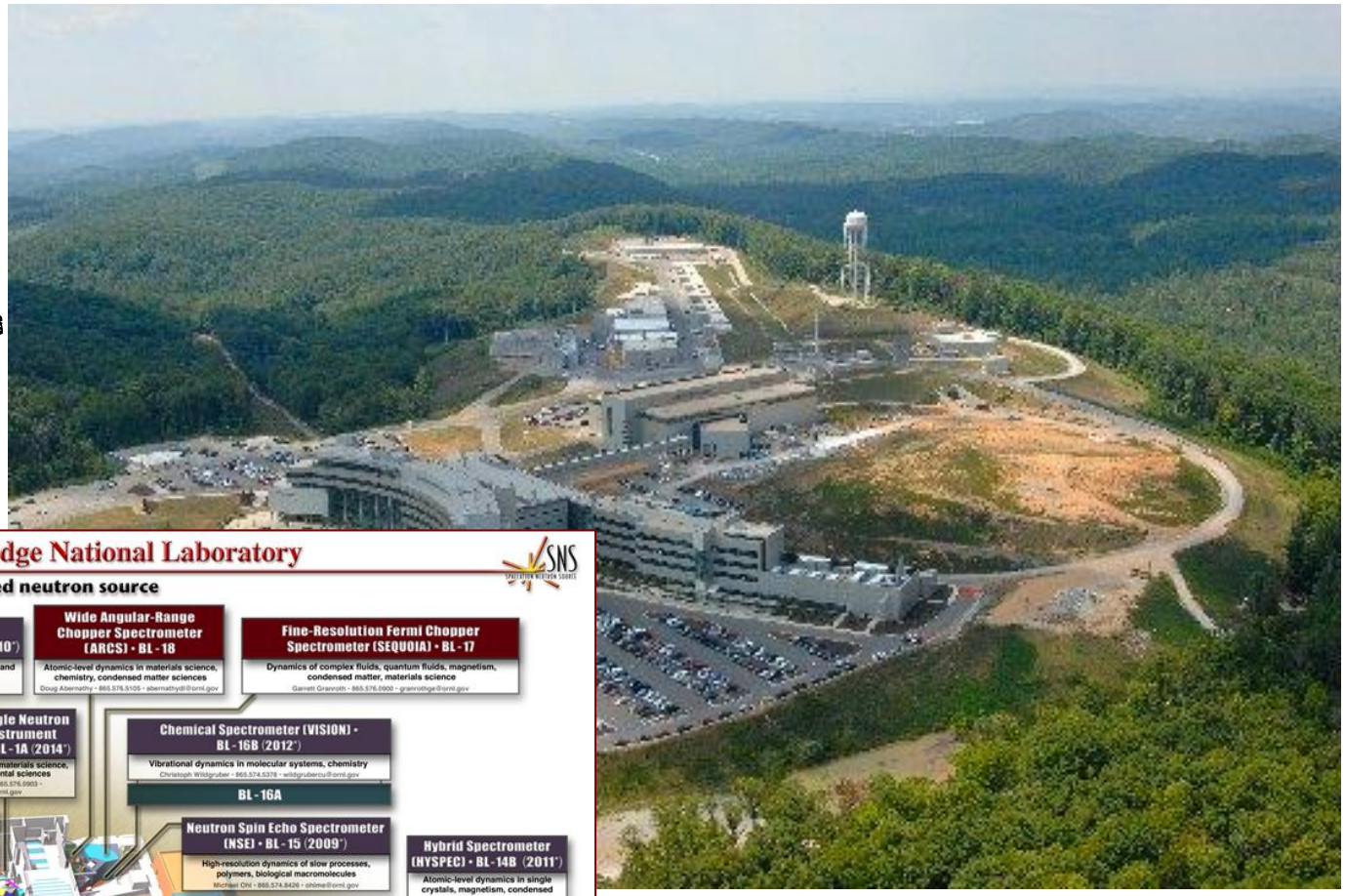
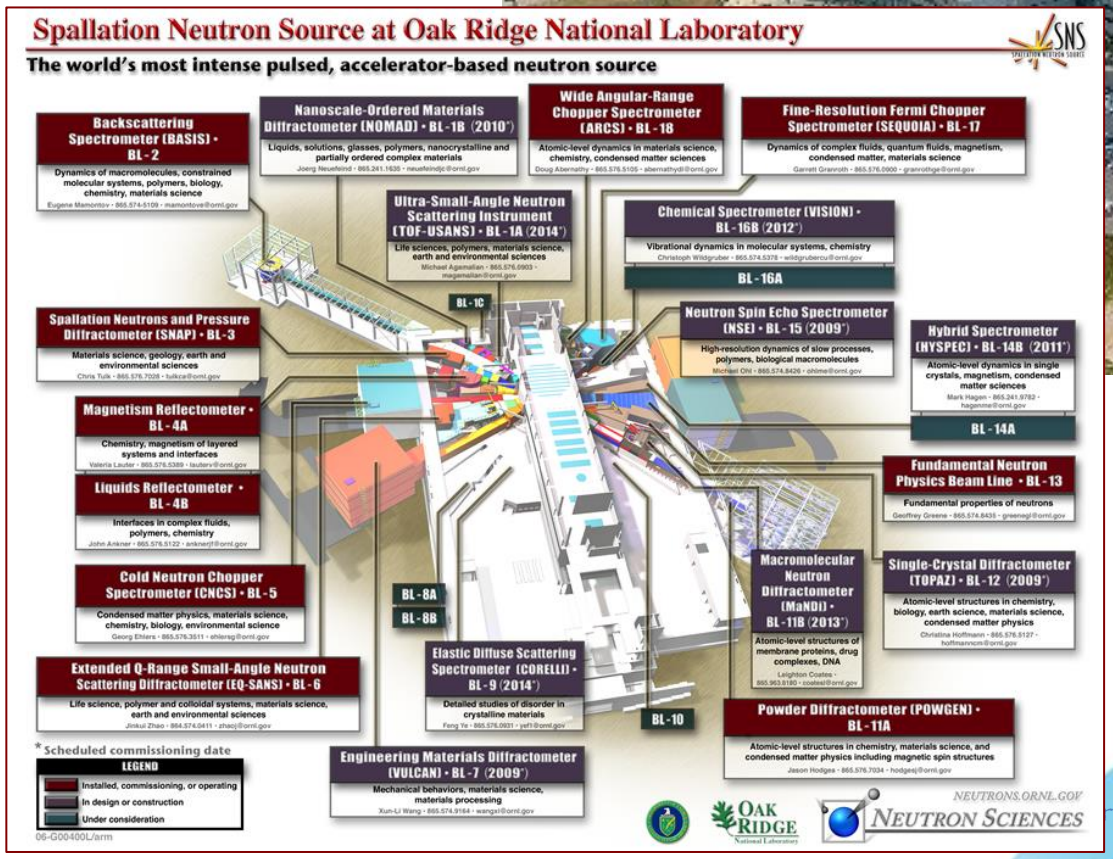
SNS
1.4 MW spec^{n}





Hg target difficulties limit to 900kW

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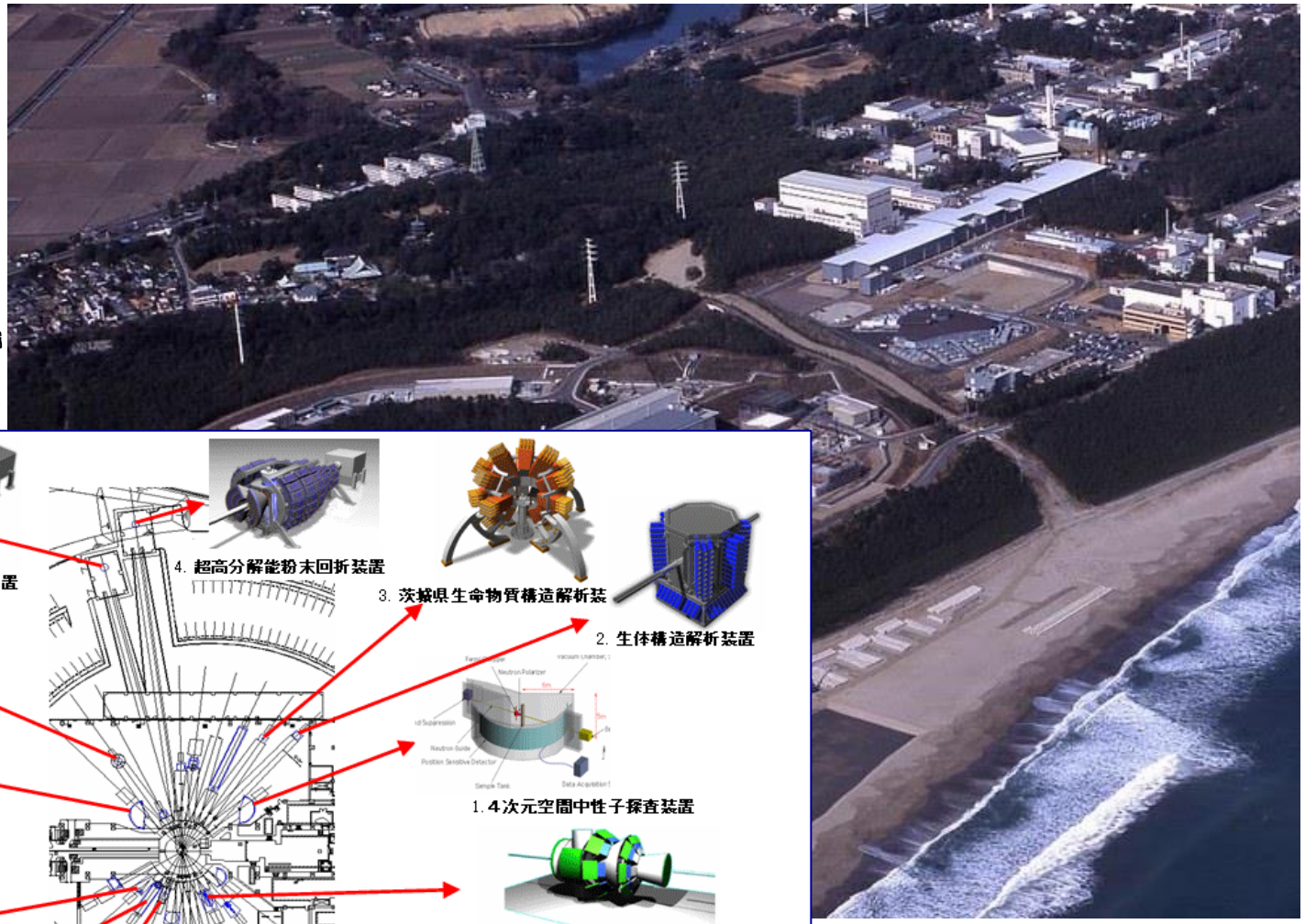
J-PARC
1 MW specⁿ



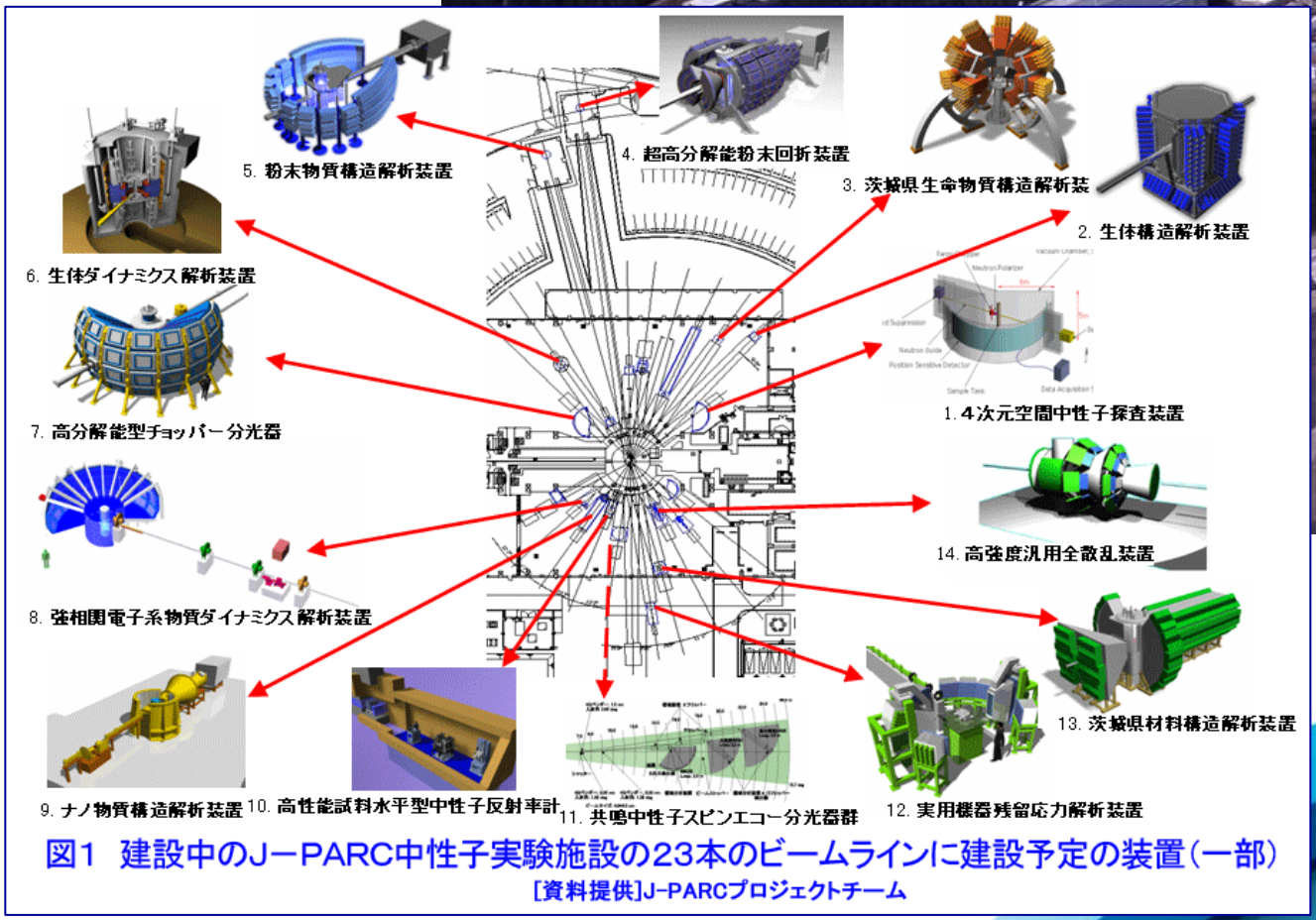


図1　建設中のJ−PARC中性子実験施設の23本のビームラインに建設予定の装置（一部）

[資料提供]J-PARCプロジェクトチーム

300 kW
Fukushima
Gold vaporisation

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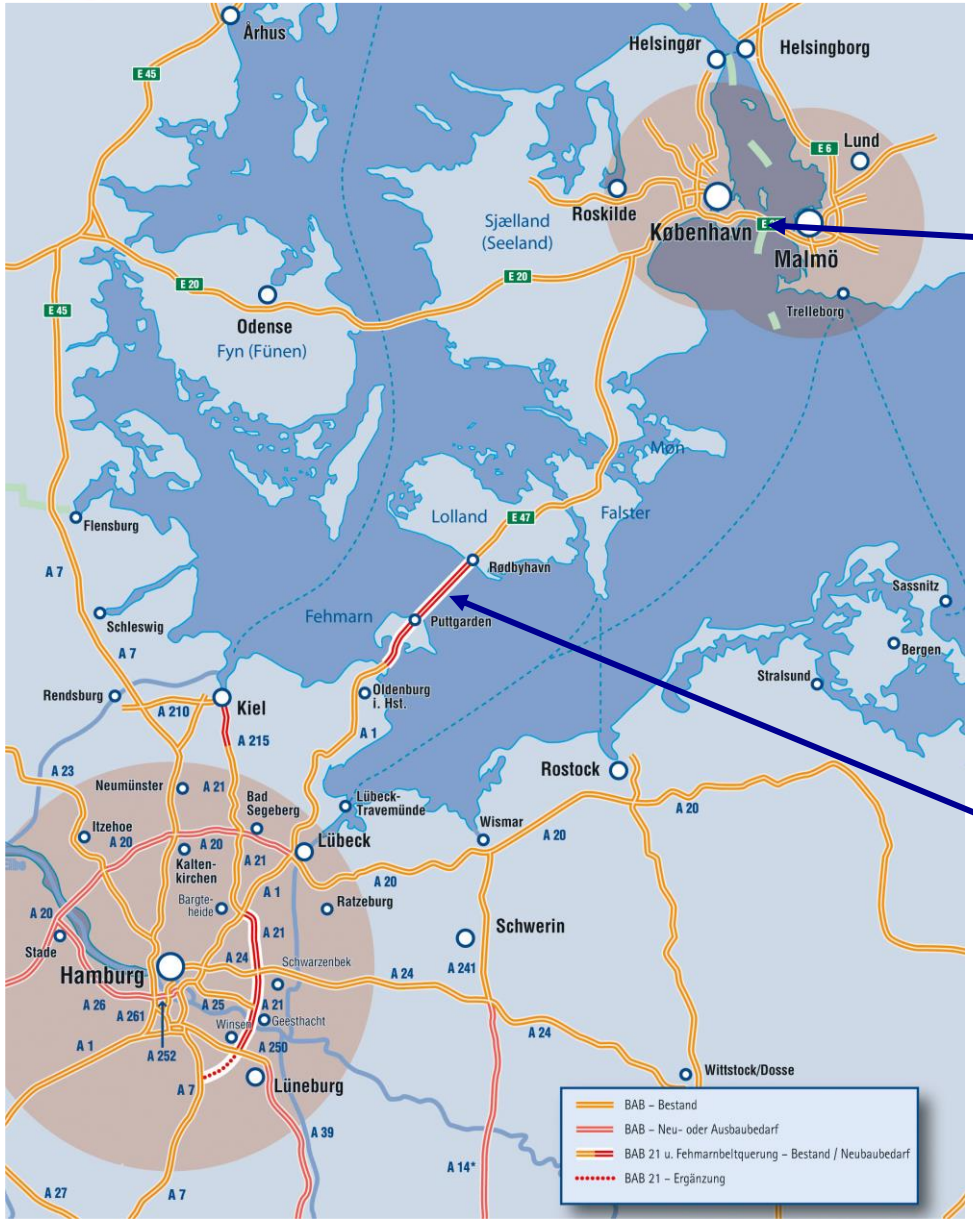
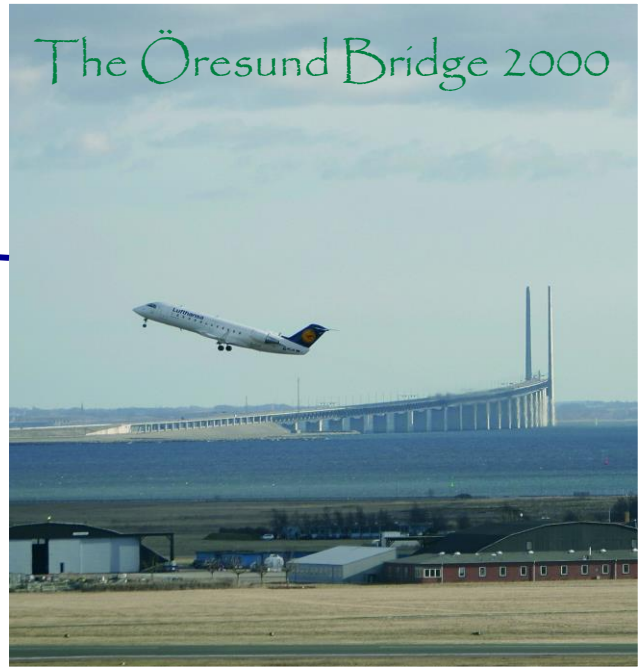
The European Spallation Source

The proximity of ESS to XFEL

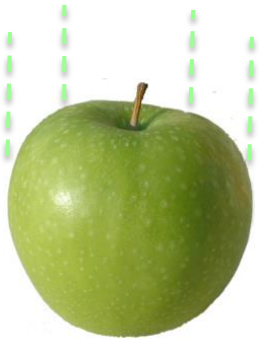




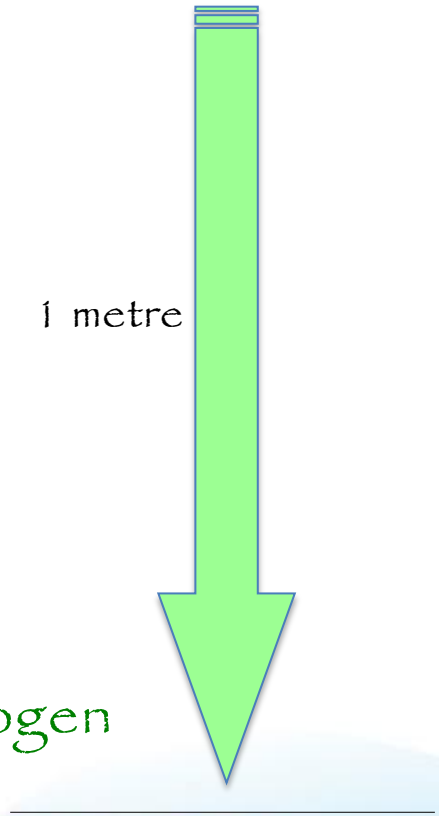
CJ Carlile

The ESS Site in Lund, Southern Swede

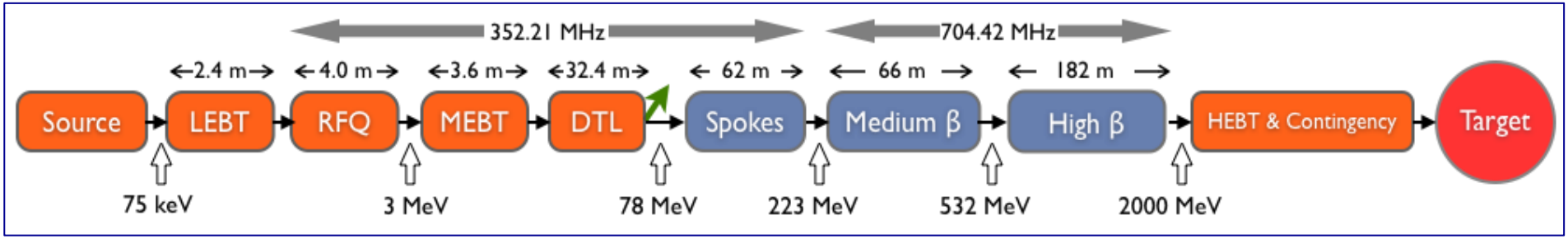
ESS – some numbers



- Superconducting Proton Linear Accelerator
  - 2.0 GeV proton energy
- 62.5mA (2.5mA) peak (average) proton current
  - 5MW proton beam power
- 2.86 msec pulse length
  - 14 Hz pulse frequency
- 71.4 msec periods between pulses
  - 357 kJ/pulse
- Single Target Station
  - Rotating tungsten, helium cooled, liquid hydrogen
- 22 instruments
  - High reliability, low beam loss



Linear Accelerator layout



	Length (m)	Input Energy (MeV)	Frequency (MHz)	Geometric β	# of Sections	Temp (K)
RFQ	4.7	75×10^{-3}	352.2	--	1	≈ 300
DTL	19	3	352.2	--	3	≈ 300
Spoke	58	50	352.2	0.57	14 (2c)	≈ 2
Low Beta	108	188	704.4	0.70	16 (4c)	≈ 2
High Beta	196	606	704.4	0.90	15 (8c)	≈ 2
HEBT	100	2500	--	--	--	--

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The User Community

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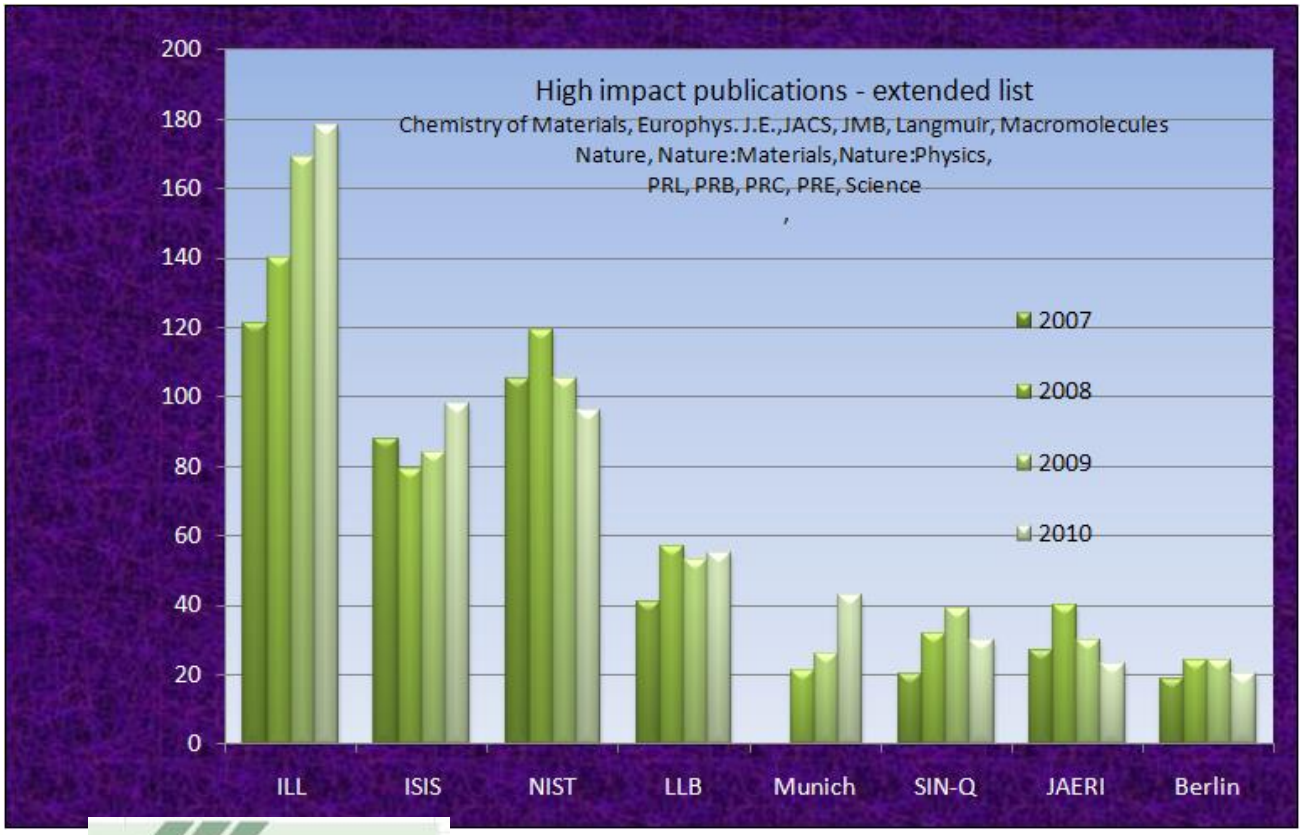
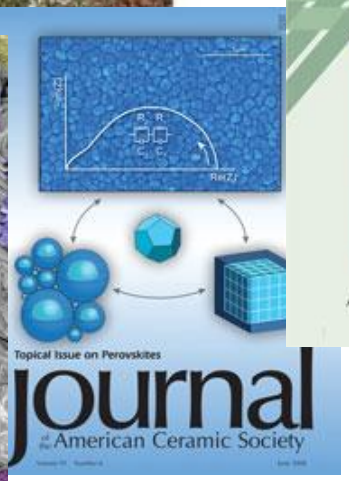
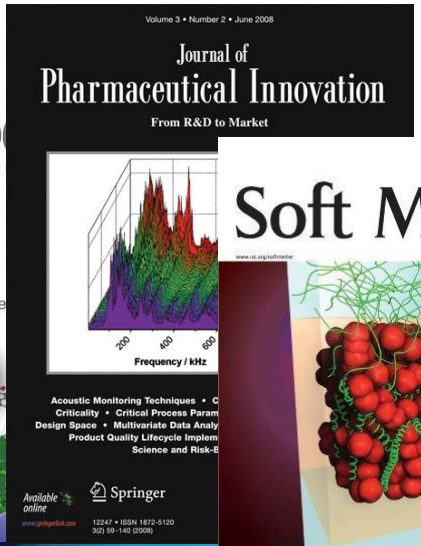
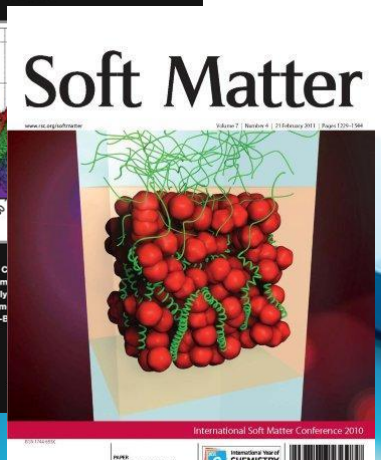
This is our primary product

"Small science at big facilities"









Neutrons are the Swiss Army Knife of Analytic techniques

Thanks to Dimitri Argyriou

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"The stone Age didn't end for lack of stone"

Today
2012

Ahmed Zaki Yamani

my phone, my email, my notebook, my calculator, my atlas, my weather,
my camera, my star map, my music, my calendar, my address book...
& my training routine for Lundaloppet !

We have to build the best facilities
with the best instruments
if we are to develop, understand, and harness
New Materials

...and ESS is a centre for materials research with ~6000 external users as our customers

The past
1995

...the future ?
2030

ESS - Driven by the User Experience

As Henry Ford correctly said,

"If I had asked my customers what they wanted they would have said faster horses"

Planning Horizon Gap

Researchers	5 years
Facility builders	20 years

We must avoid
the "faster horses" syndrome

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The next 50 years...

The view of ESS from the North-East in 2025

Where do we go next...?

The Goldilocks solution

Not too small,
not too big,
but just right !

The Goldilocks solution

Proton pulse length not too short, not too long, but just right !

A δ-function proton pulse creates a δ-function fast neutron pulse which will take ~22λ[Å] μs to moderate to thermal energies.

This is ~100 to 200 μs for cold neutrons

ISIS, SNS, J-PARC each has a 0.6 μs proton pulse length

ESS has a 2.86 ms proton pulse length

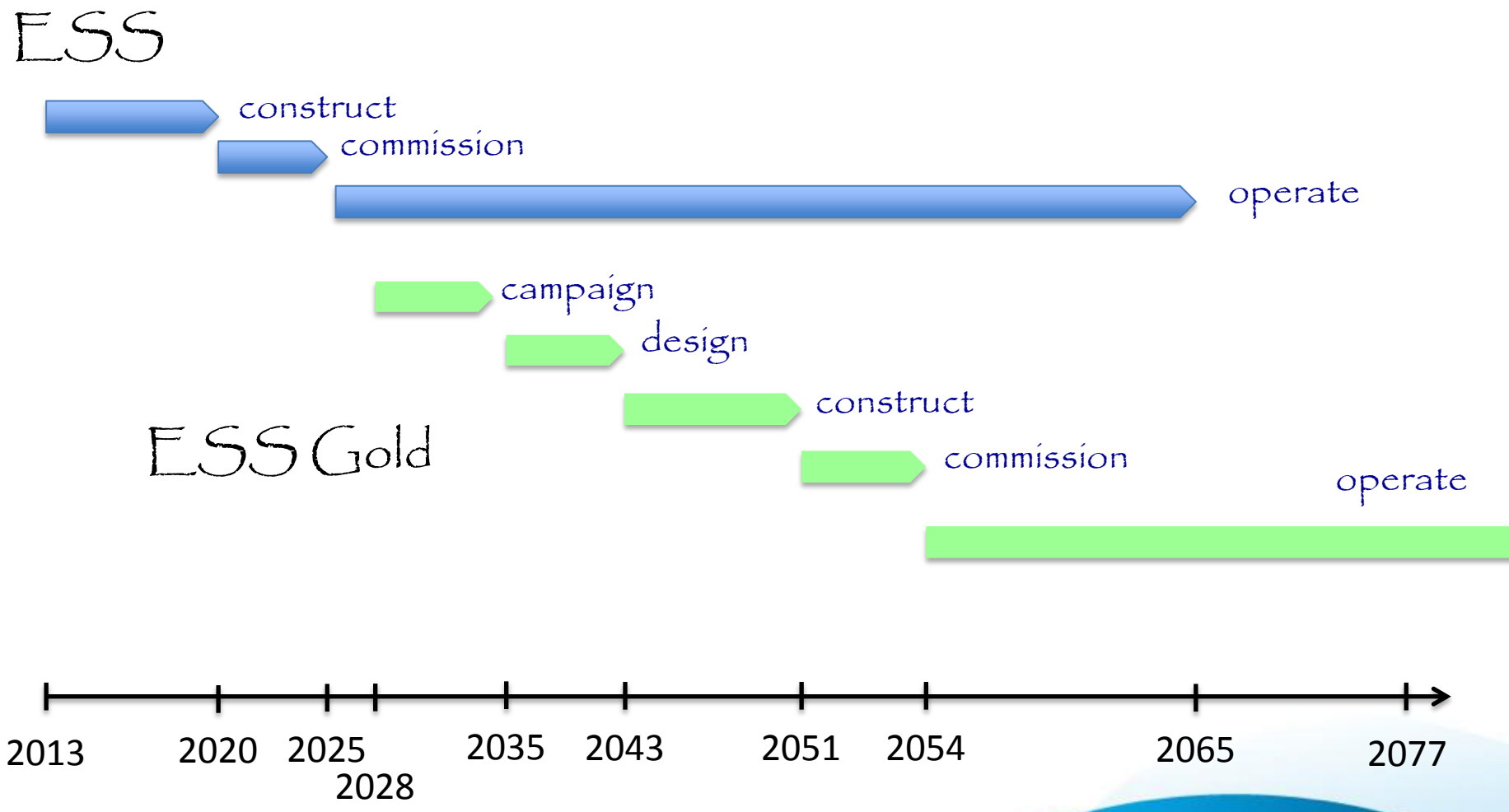
Both kinds of source are therefore seriously mismatched

Short-pulse sources are mismatched by 100/0.6 = 170 times
Long-pulse sources are mismatched by 2860/100= 28 times

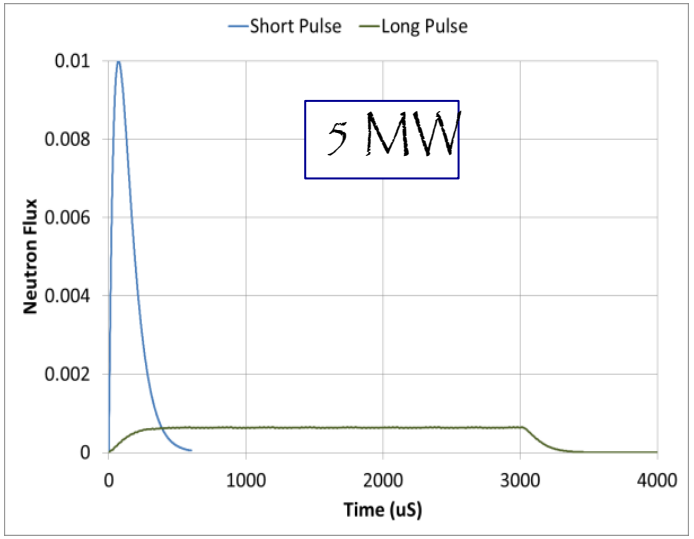
Long-pulse sources are ~6 times less mismatched, hence the long/short advantage

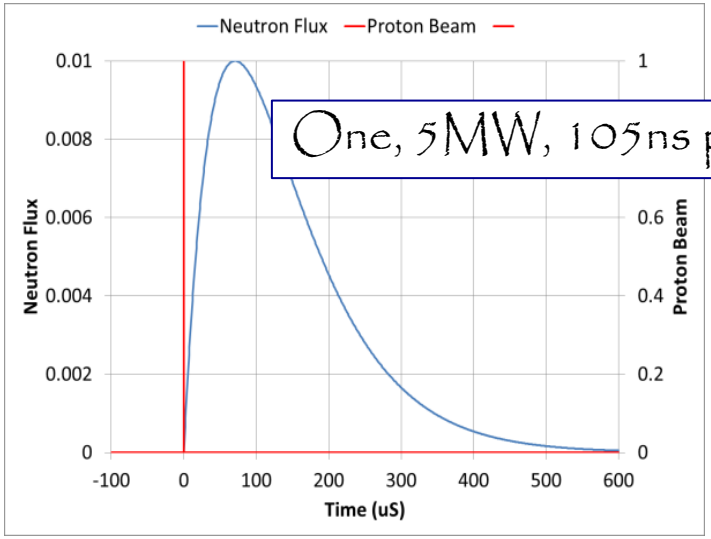
Note E (meV) = [81/λ(Å)^2] so 5 meV = 4 Å

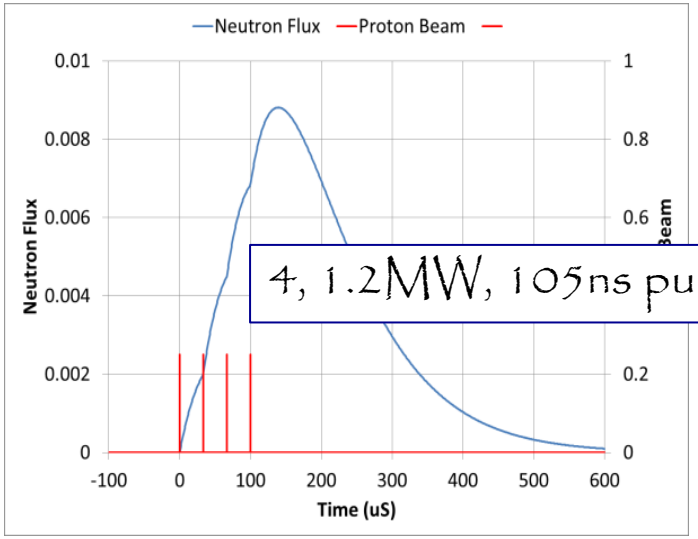
The next 50 years...

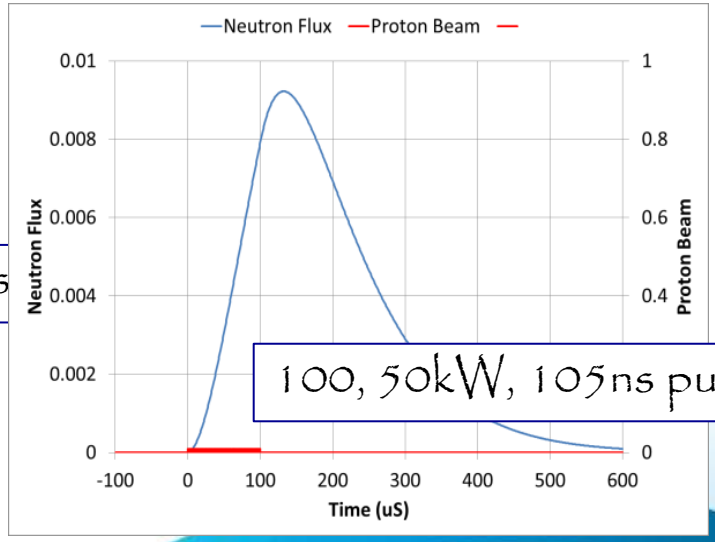


Minimising the effect on the target









D. McGinnis, M. Lindroos, R. Miyamoto IPAC 2013

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The World's Ultimate Slow Neutron Source ?

Potential Upgradeability

2nd target and neutrino source

Compressing the msec pulse to match the moderating time of cold neutrons

3ms to 150μs

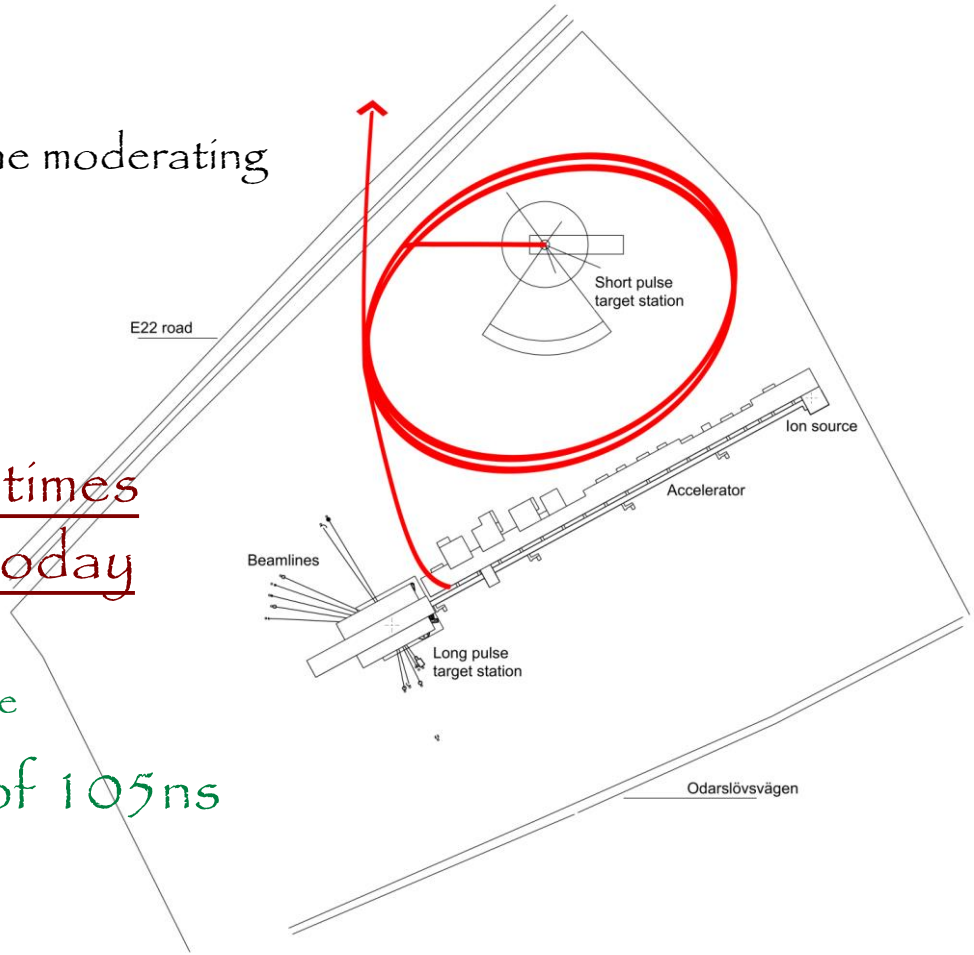
Peak intensity gain of 30 times

Total gain of 900 times today

4 rings of 1100m Oce

Each containing 25 pulses of 105ns

Permanent magnets



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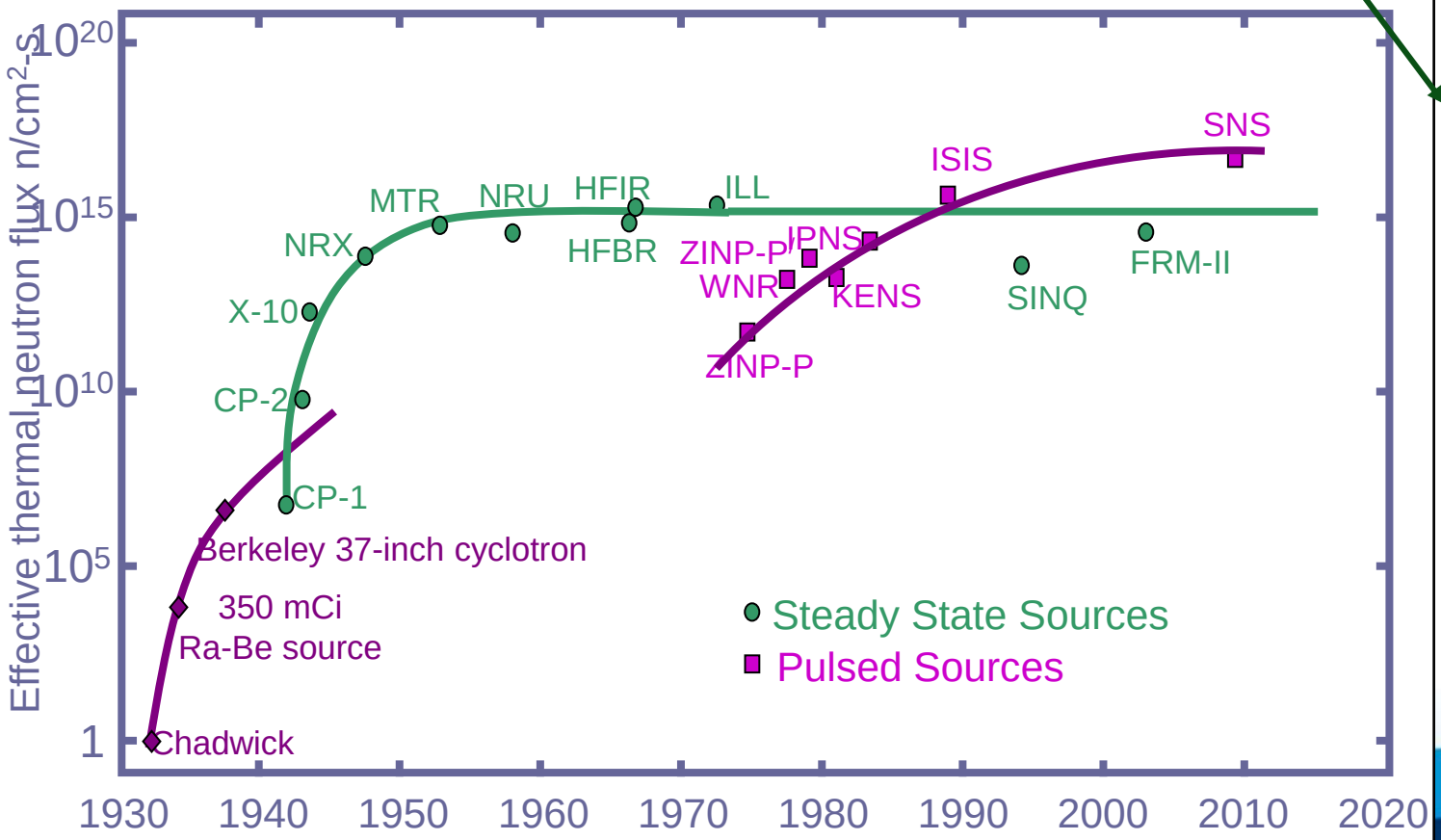
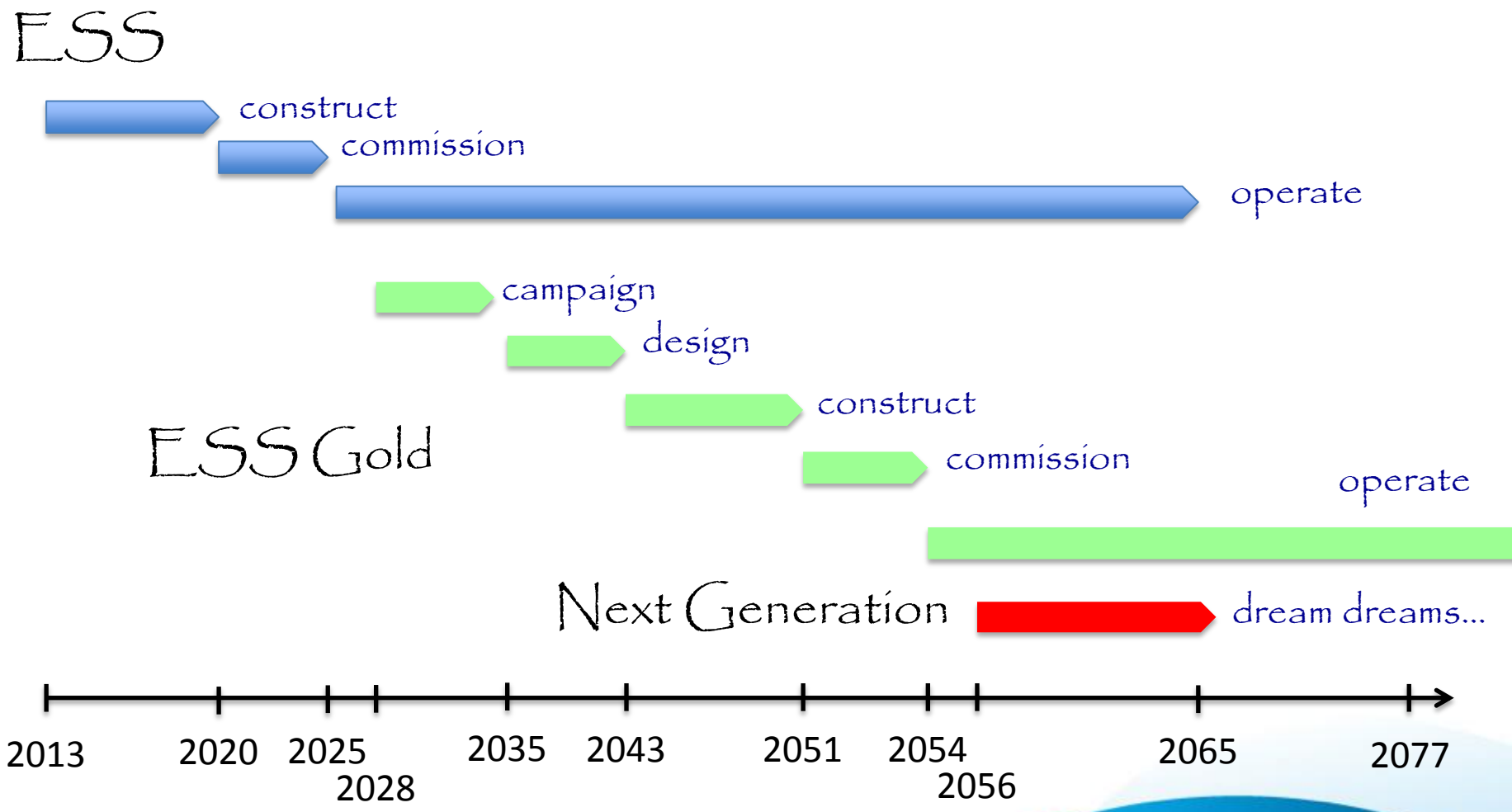
Evolution of the performance of neutron sources



(Updated from *Neutron Scattering*, K. Skold and D. L. Price, eds., Academic Press, 1986)

The next 50 years...



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The Six Stages of a Project

1. Enthusiasm
2. Disillusionment
3. Panic
4. Search for the guilty
5. Punish the innocent
6. Praise and honour for the non-participants

Thanks to Kjell Möller

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Green field site - Green field thinking

Environment, Sustainability, Energy
Reliability
Innovations – use them, harness them
Robots, Automation, Computer control
"ESS – like no other"