The European Spallation Source Project

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ESS is the next generation European neutron source, to be built at Lund in Sweden. It entered its pre-construction phase as a Collaboration of by now 14 countries: Denmark, Estonia, France, Germany, Hungary, Iceland, Italy, Latvia, Lithuania, Norway, Poland, Spain, Sweden and Switzerland.

Artists conception of ESS on a green field site outside the university town Lund. It will consist of a linear proton accelerator, a target station as the neutron beam source and a host of neutron scattering instruments at 15 – 100 m distance from the target.

Pulsed Spallation Sources: the most energy/costs efficient way to produce neutron beam

40 MeV proton beam energy per fast neutron produced (cf. 190 MeV for fission in conventional reactors)

Equally efficient slowing down of MeV neutrons to the sub-eV range for neutron scattering research

Pulsed sources produce monochromatic neutrons at the instruments at any instant of time, due to the energy dependent neutron flight times (principal neutron velocity range 200 – 2000 m/s)

Most powerful neutron sources today:
ILL (Gernoble, France: 58 MW reactor)
SNS (Oak Ridge, US: 1.4 MW pulsed spallation s.)
J-PARC (Tokai, Japan: 0.5 MW pulsed spallation s.)

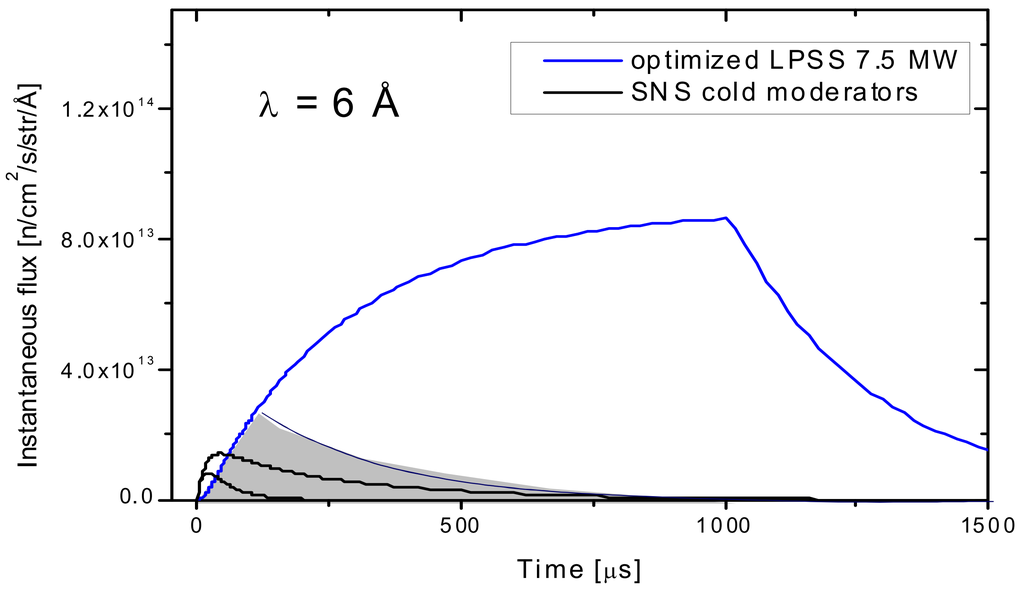
ESS: new concept in pulsed spallation source design for increased beam power at lower costs

Conventional short pulse spallation sources:
~ 1 μs proton pulses → ring accelerator needed, very high instantaneous power on target (~ 10 GW)

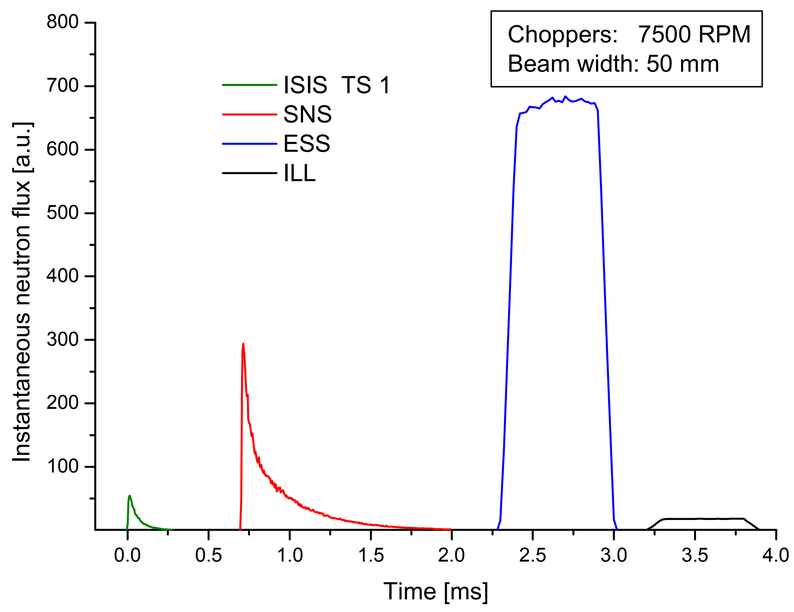
New concept: LONG PULSE Spallation Source:
~1 ms long proton pulses can deliver 10 times more protons (i.e. neutrons) per pulse at 100 times less instantaneous power on target

Simplified accelerator and target system :
- only linear accelerator is needed
- higher neutron beam performance at comparable costs and technical challenges
- 5 MW (and more) proton beam power feasible

Compared to the conventional short pulse spallation sources, here SNS, Oak Ridge, USA, the Long Pulse concept of ESS offers a simplified accelerator system: H^+ linear accelerator without accumulator ring reduces technical challenges (injection, space charge, target fatigue) and offers superior neutron beam performance by more neutrons /pulse.



A linac driven long pulse source can emulate with proton pulses of ~ 100 μs duration the slow neutron pulses of a short pulses source (grey area vs. black lines), and produce order of magnitude more neutrons per pulse with higher peak brilliance with proton pulse lengths in the ms range.



Innovative fast rotating mechanical neutron chopper systems allow us to cut out shorter pulses for better definition of the neutron velocity (energy) from the long ESS pulses. The area of the pulses gives in the figure in this example the performance gain of ESS compared to the existing most powerful neutron sources (J-PARC is about equivalent to SNS).

Conclusion: With its innovative Long Pulse approach, using a high power, state-of-the-art linear proton accelerator and novel neutron instrument concepts to shape the neutron pulse lengths to individual user needs, the 5 MW beam power ESS will offer – at comparable costs – an order of magnitude enhanced scientific opportunities relatíve to existing neutron scattering facilities worldwide.