The ESS Moderators

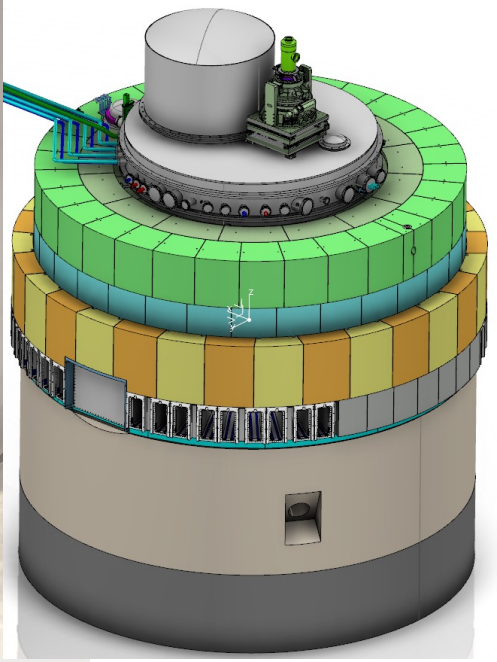
LUCA ZANINI

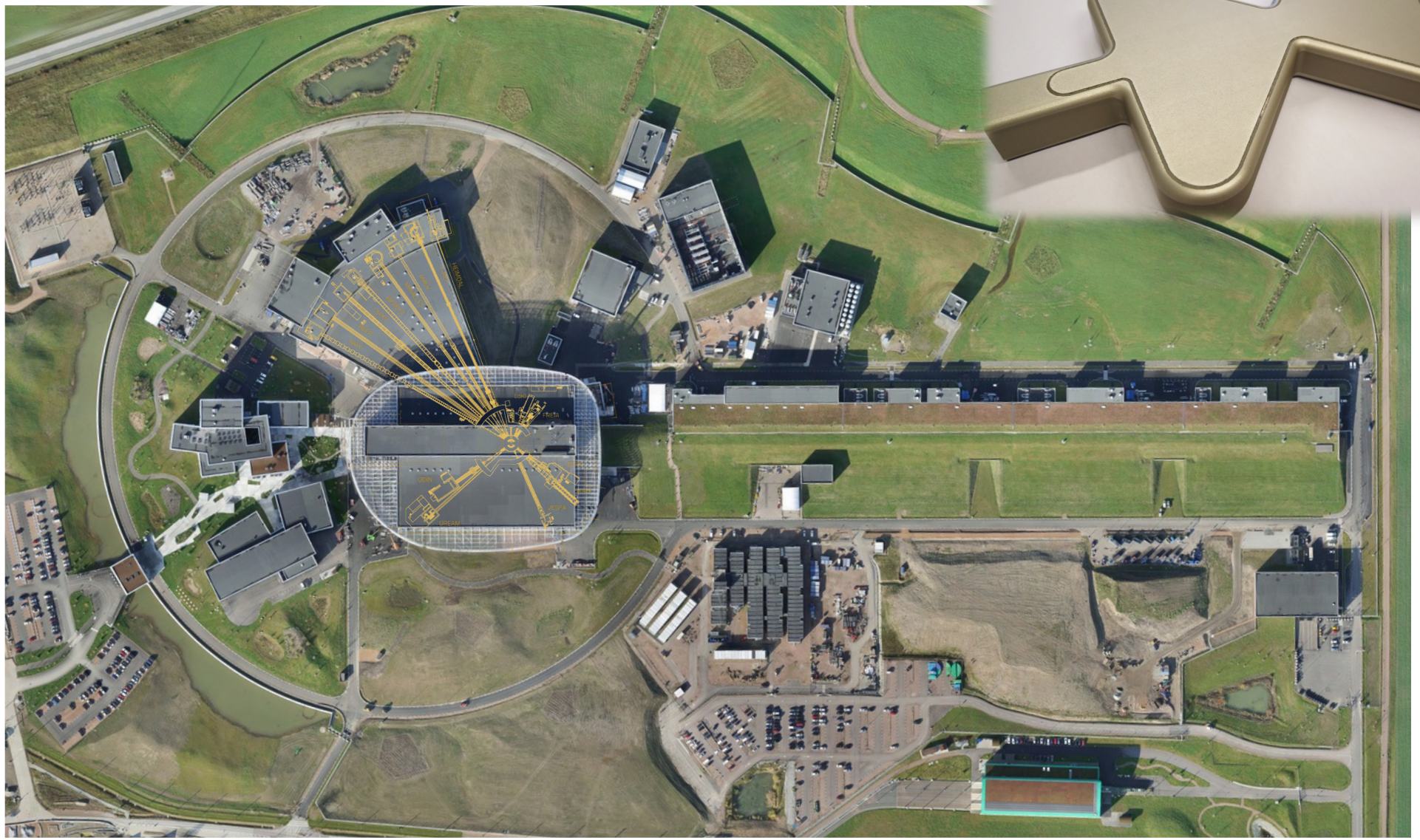
Neutron Delivery Systems NDS 2023, 10-12 July 2023

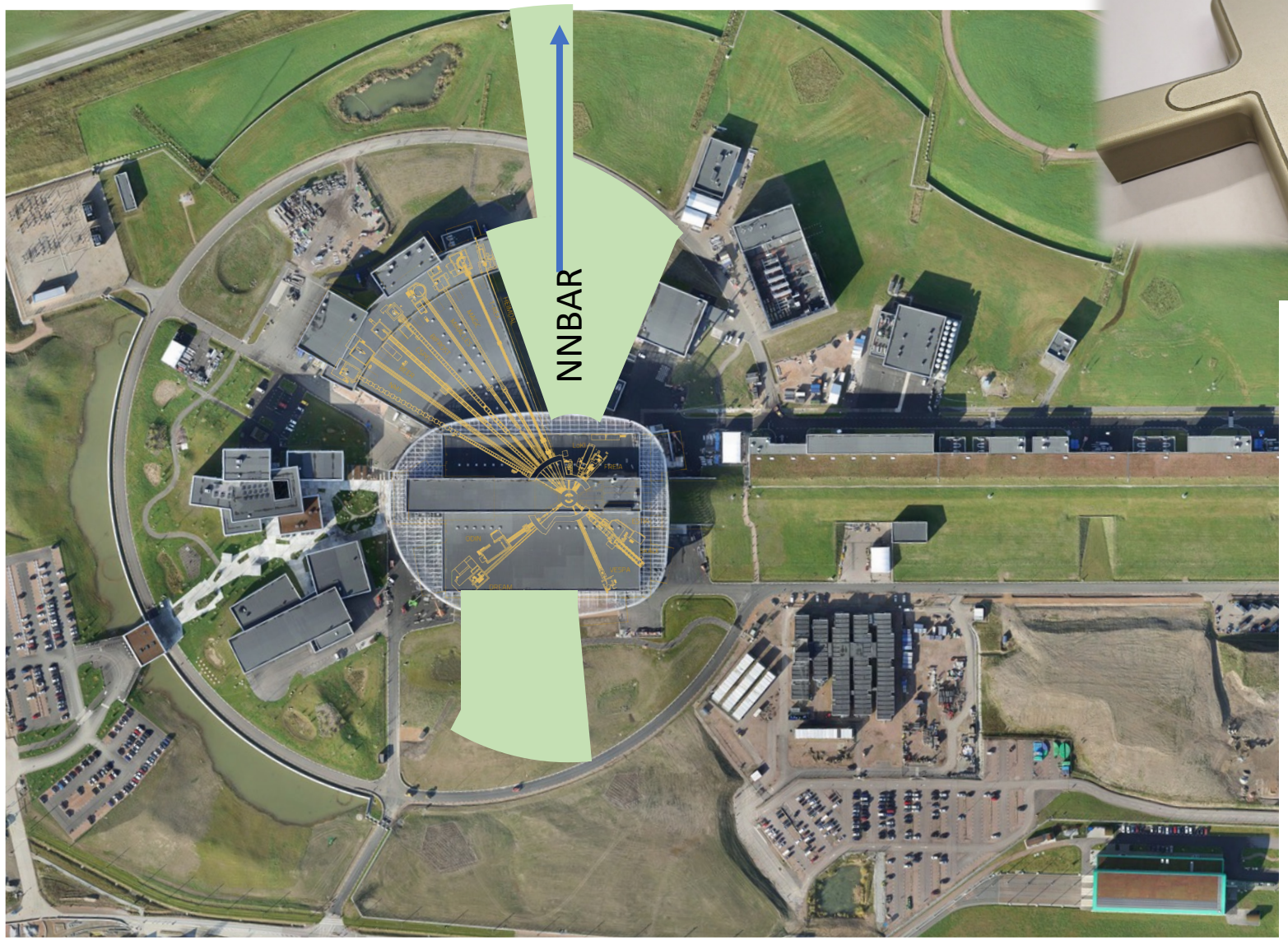
Contents

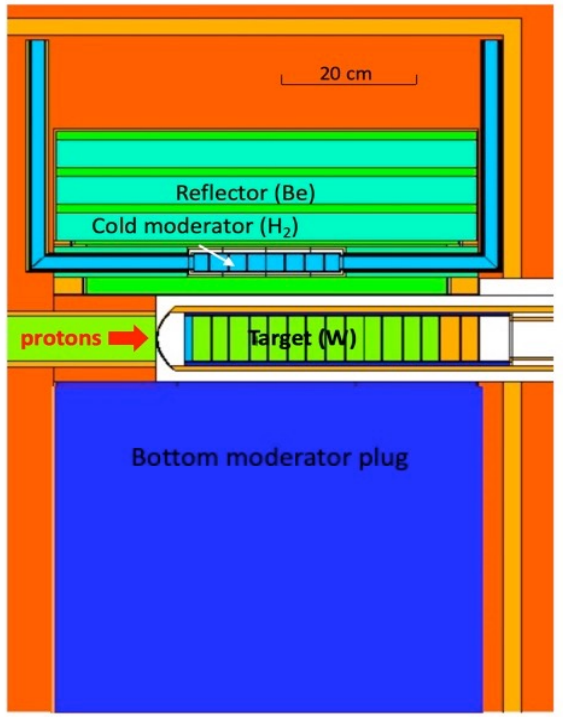
- ESS main source : upper moderator
- ESS upgrade : HighNESS moderators

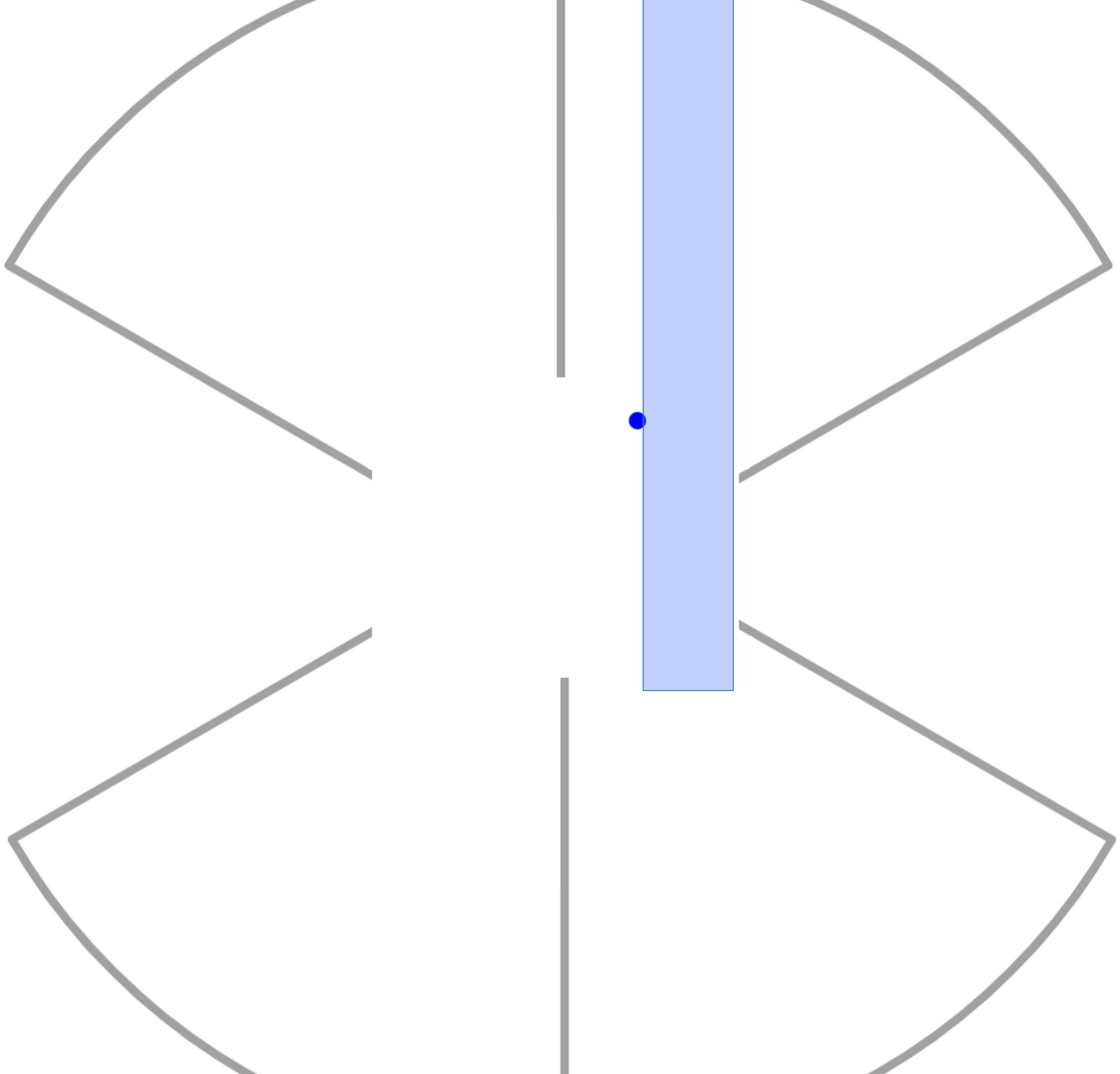

LARGE BEAMPORT






NNBAR


20 cm
Reflector (Be)
Cold moderator (H_2)
protons
Target (W)
Bottom moderator plug



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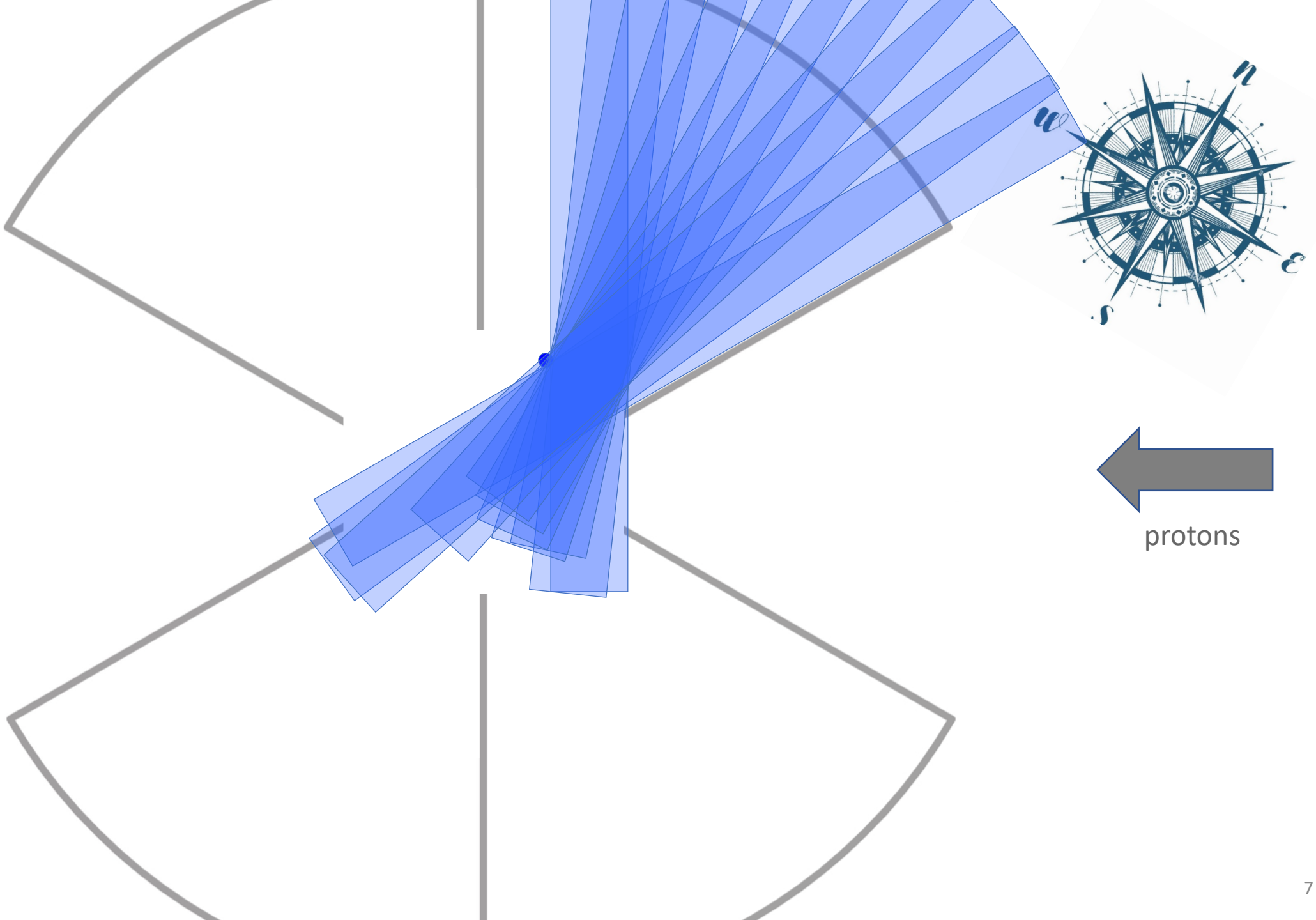
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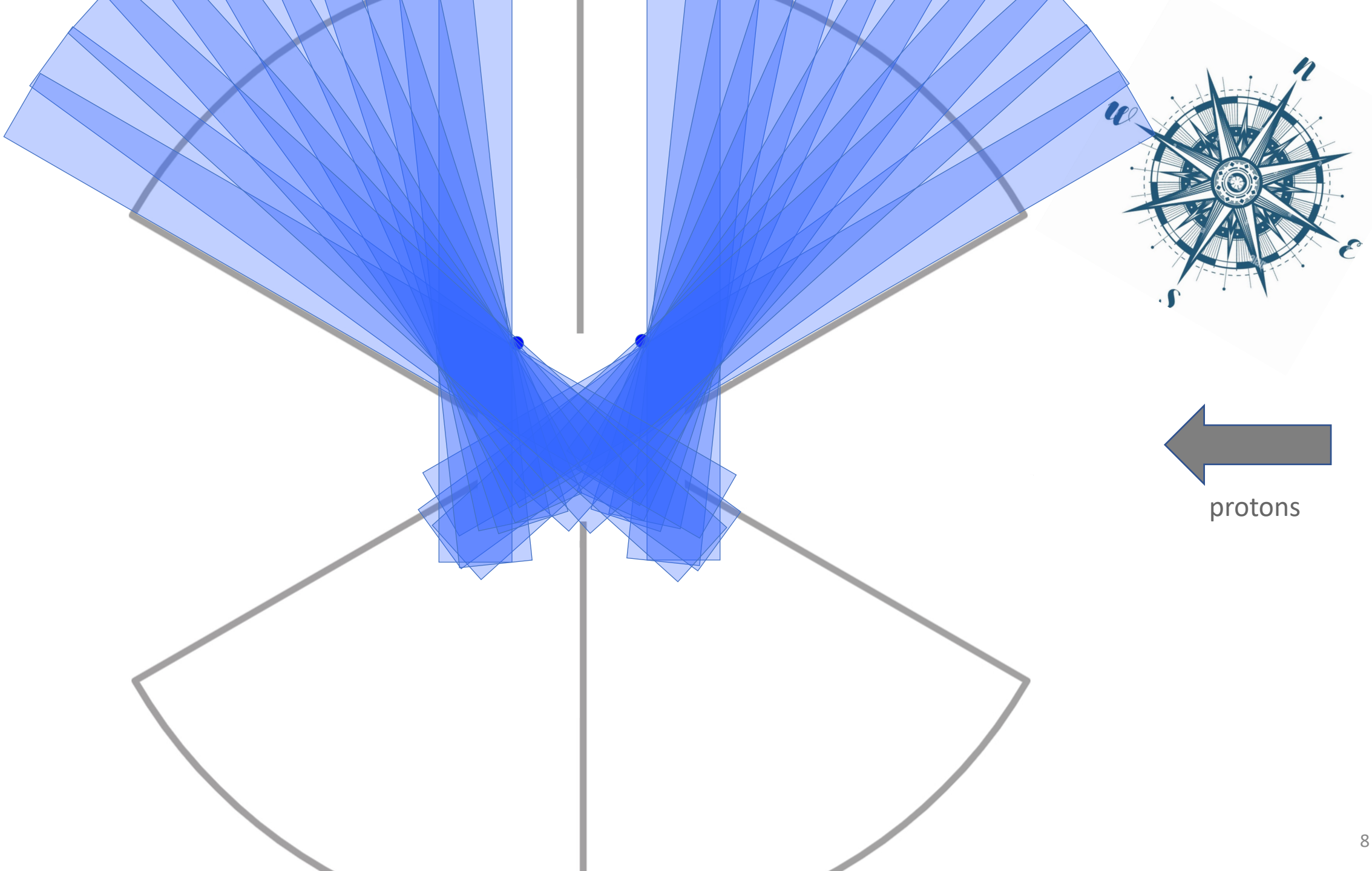
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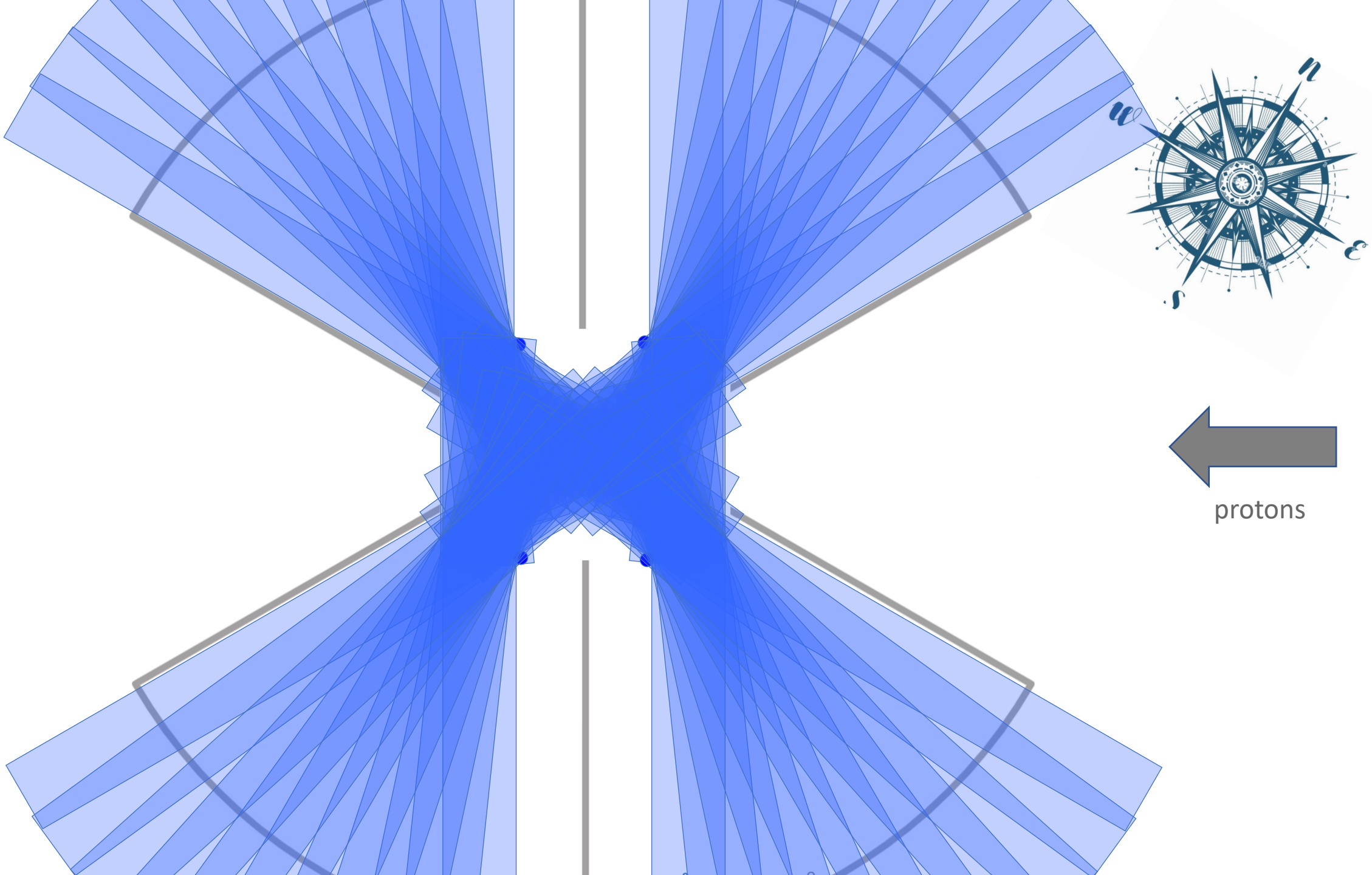
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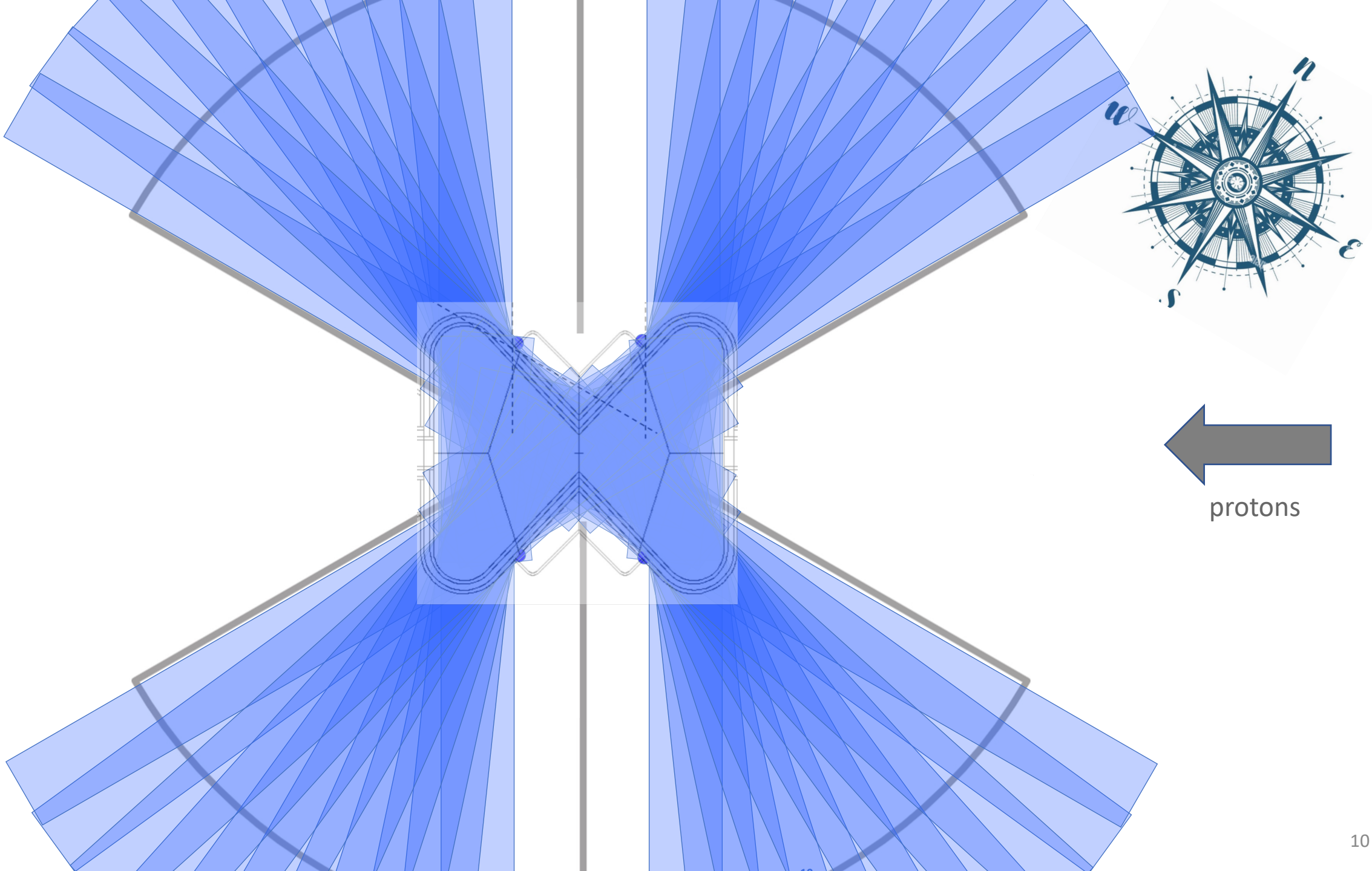
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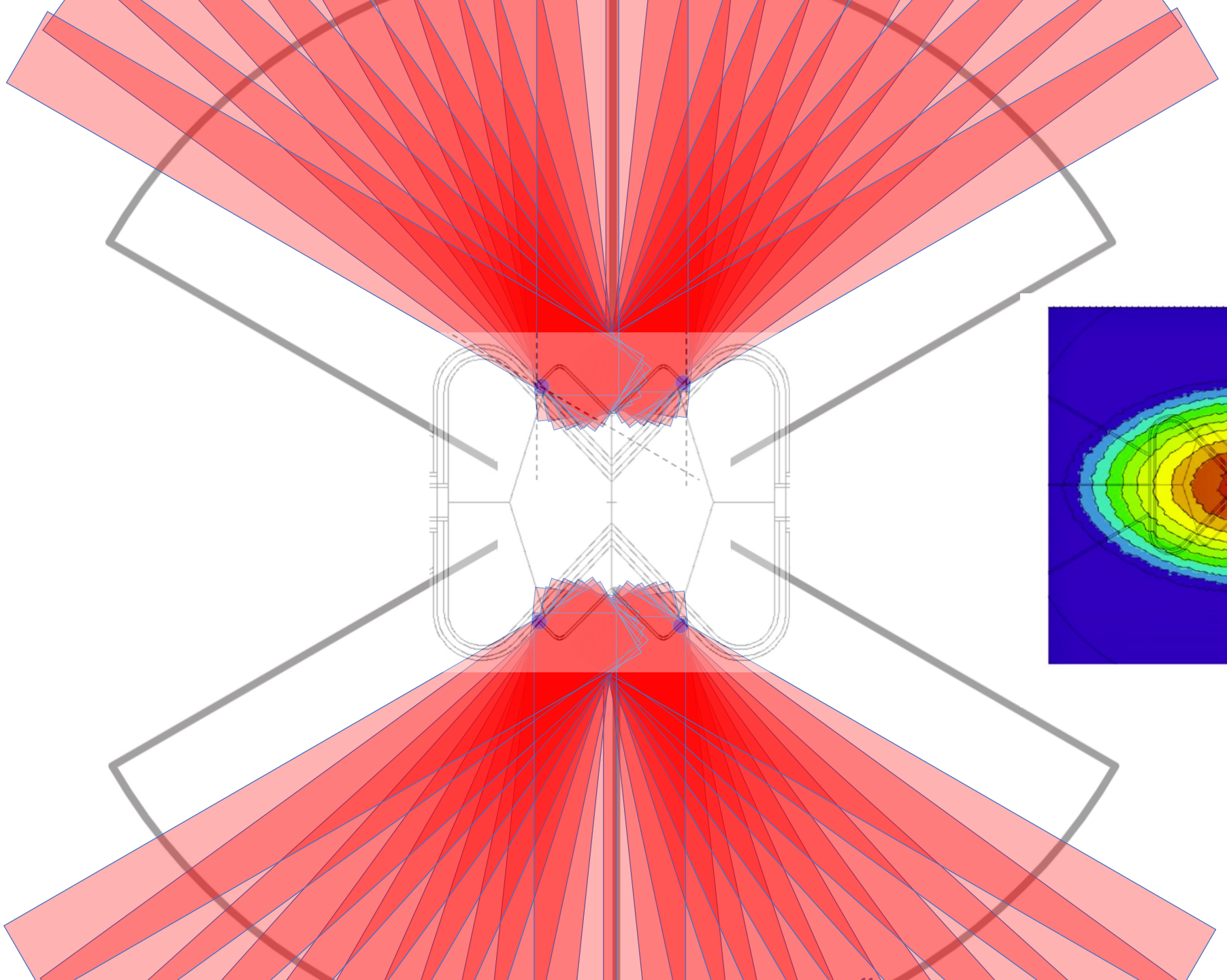
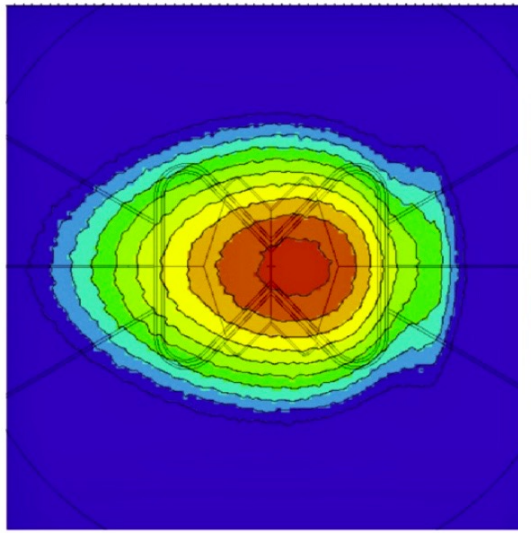
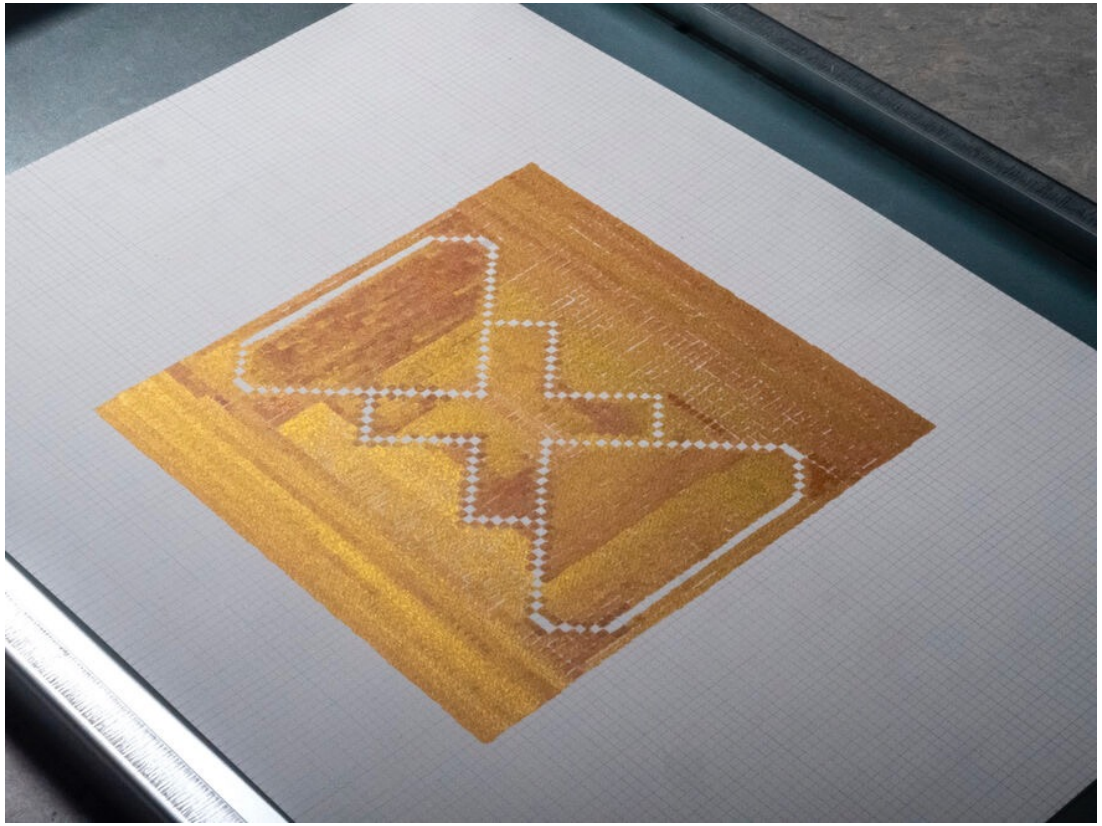



n/cm²/s
8.000E+14
6.858E+14
5.879E+14
5.040E+14
4.320E+14
3.703E+14
3.175E+14
2.722E+14
2.333E+14
2.000E+14



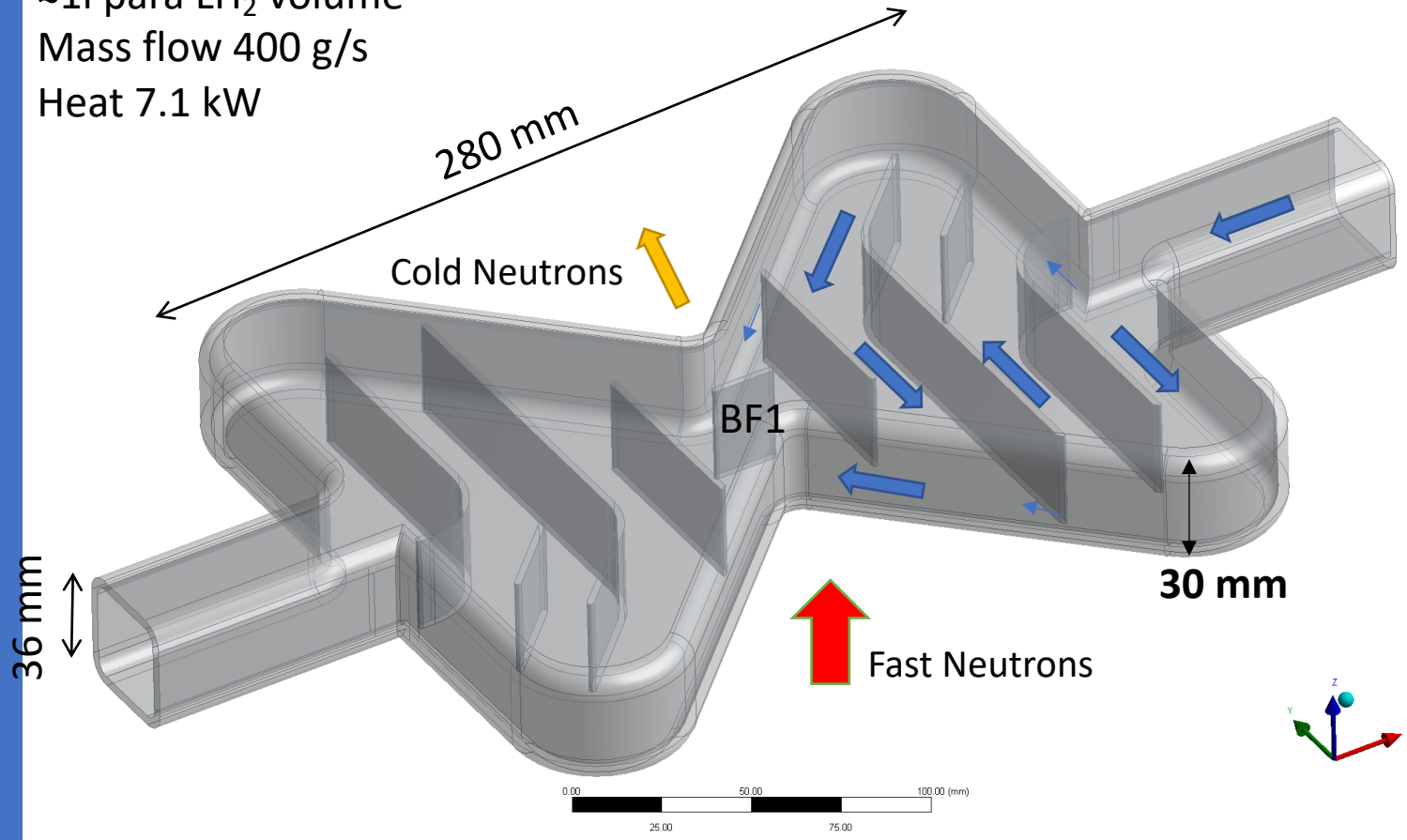
Axel Straschnoy

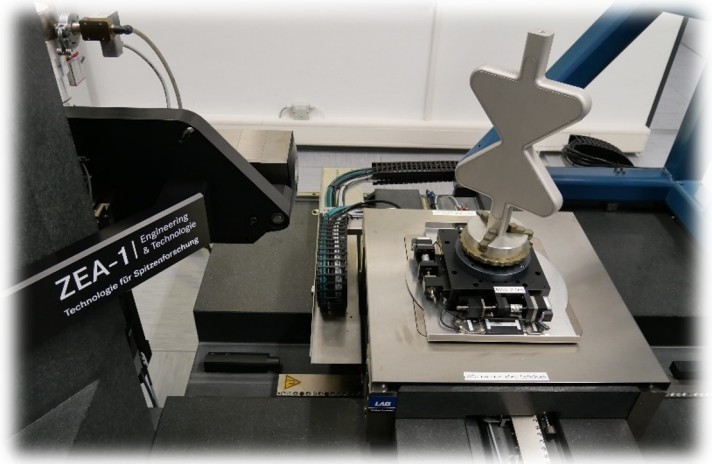
Construction of first generation of parahydrogen moderators (BF2) –Twister

(in-kind FZJ Jülich)

Second generation of parahydrogen moderator (BF1) – under construction

≈1l para LH_2 volume
Mass flow 400 g/s
Heat 7.1 kW





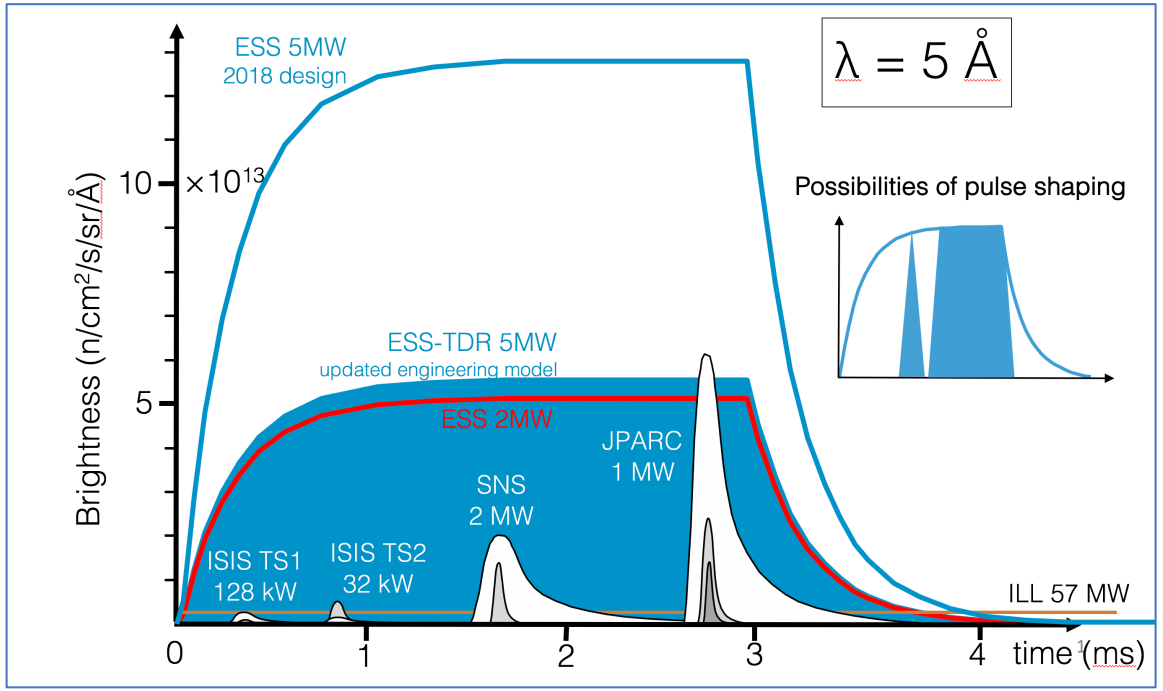
NDT of first prototype

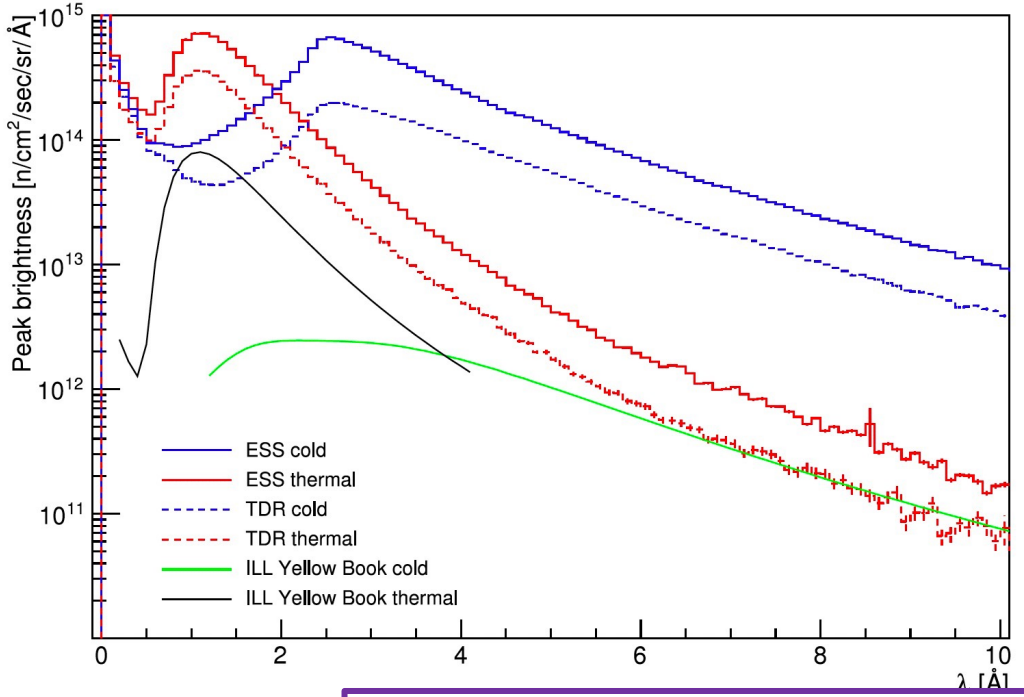
First prototype

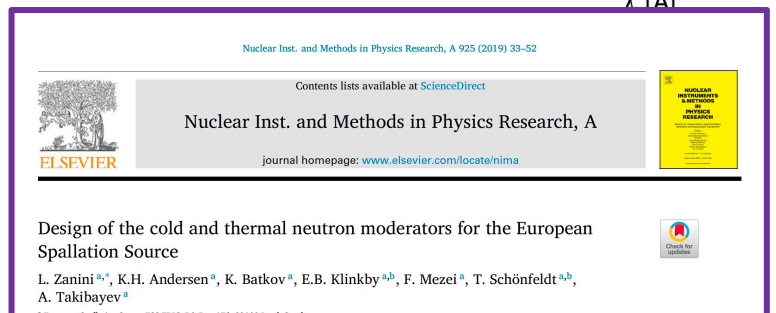
(courtesy U. Odén)

How bright is ESS?

With the new moderator, the ESS performance at 2 MW is equivalent to the original (from Technical Design Report of 2013) expected performance at 5 MW






Nuclear Inst. and Methods in Physics Research, A 925 (2019) 33–52

Contents lists available at ScienceDirect

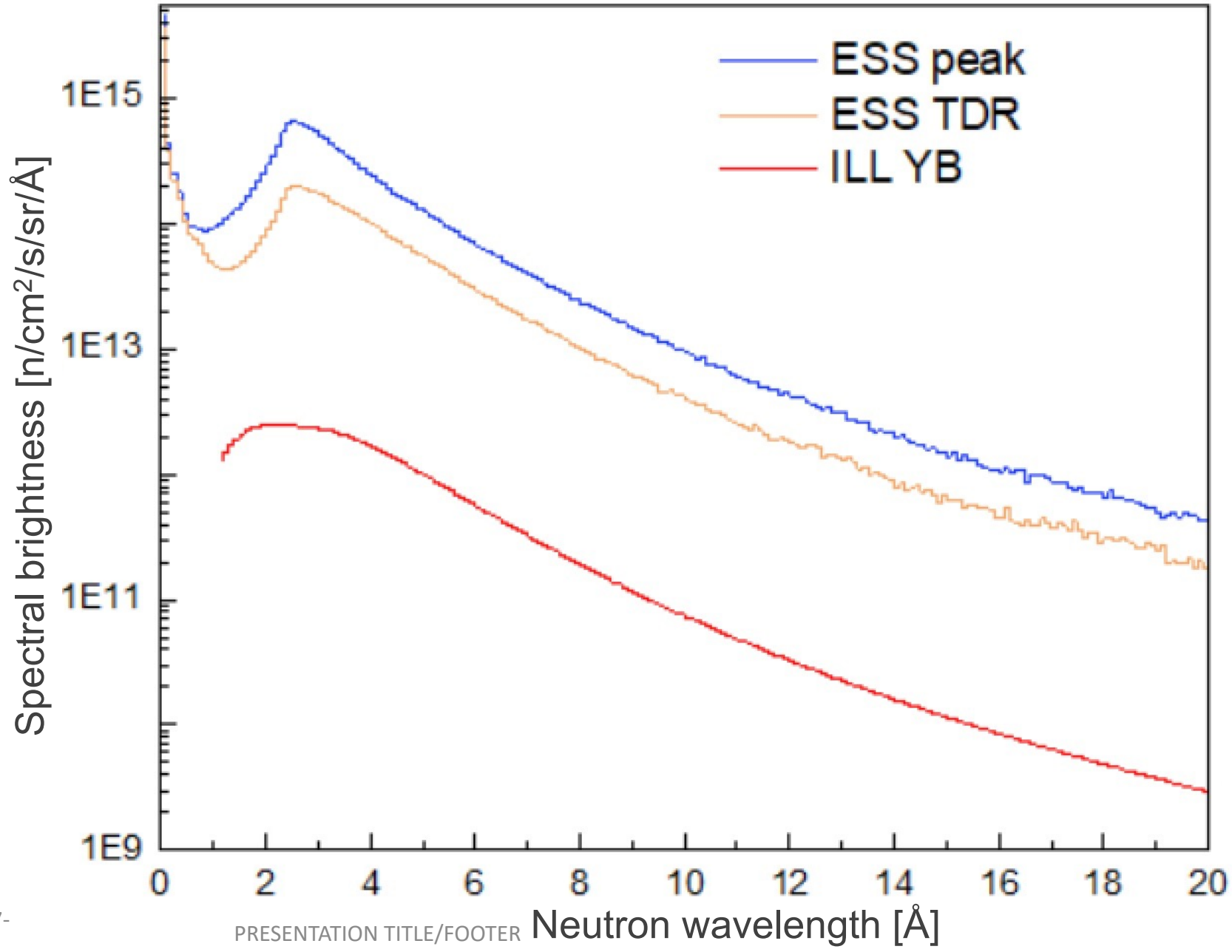
Nuclear Inst. and Methods in Physics Research, A

journal homepage: www.elsevier.com/locate/nima

Design of the cold and thermal neutron moderators for the European Spallation Source

L. Zanini [a,*], K.H. Andersen [a], K. Batkov [a], E.B. Klinkby [a,b], F. Mezei [a], T. Schönfeldt [a,b], A. Takibayev [a]

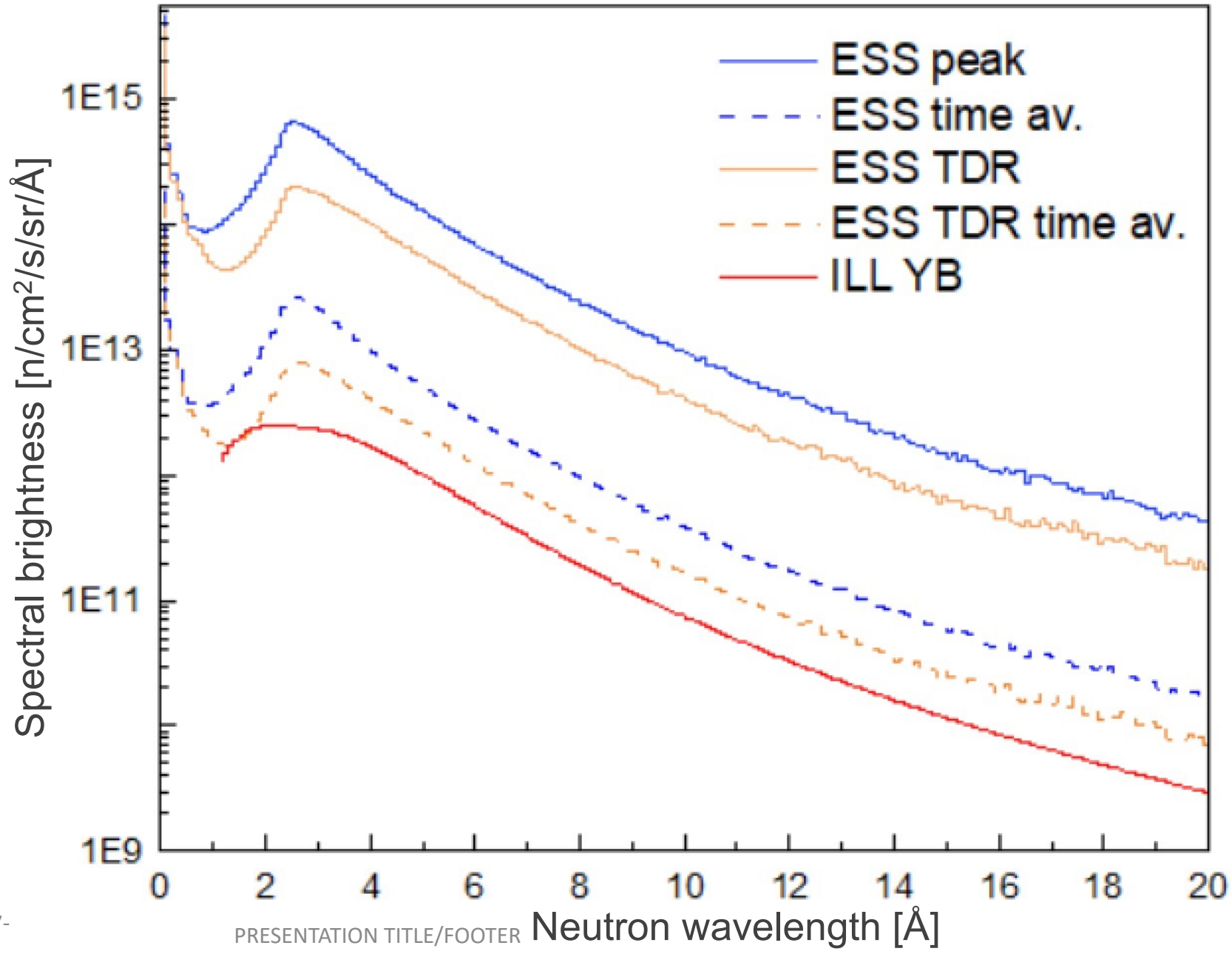
Comparison with ILL cold brightness



peak

Time average

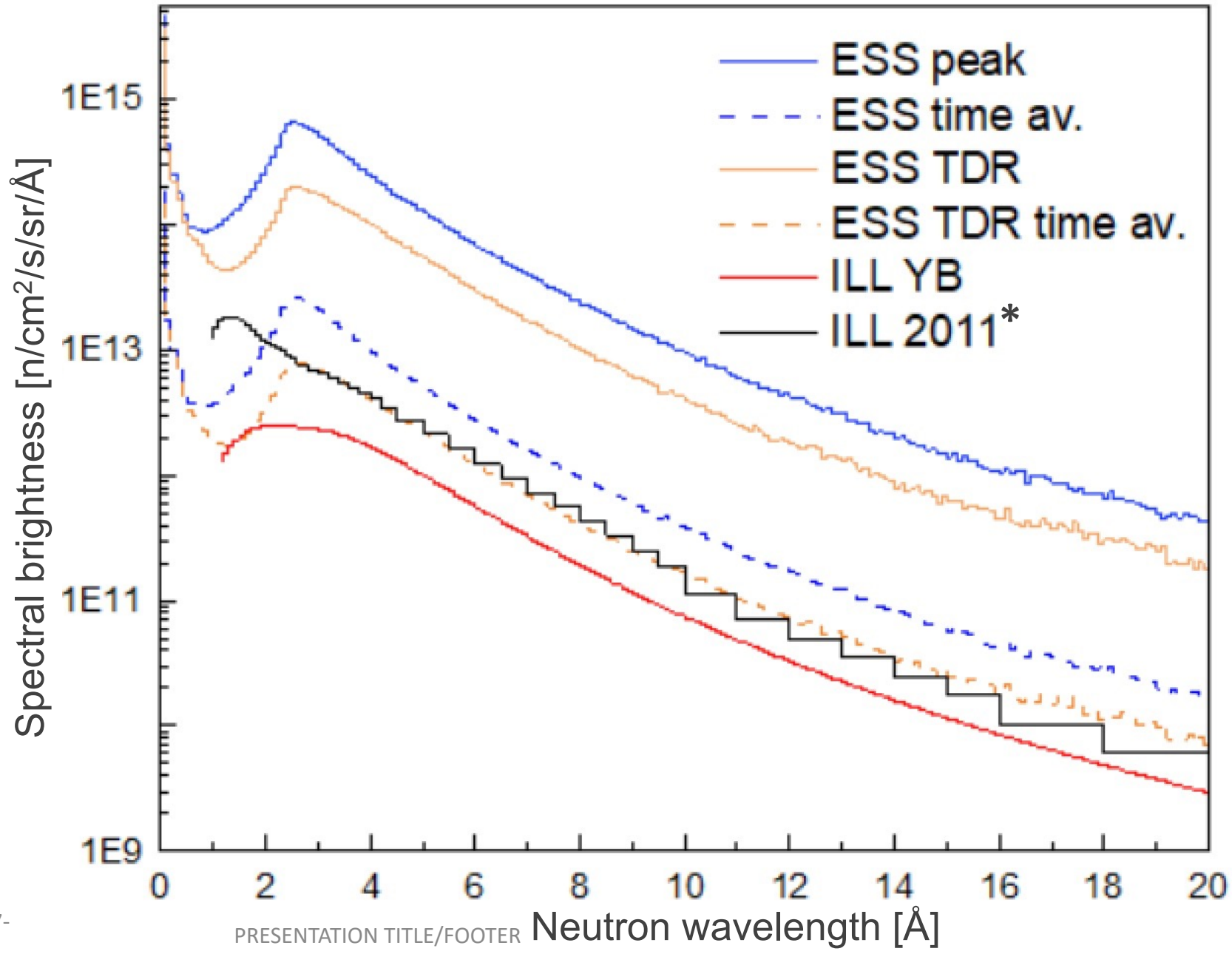
Comparison with ILL cold brightness



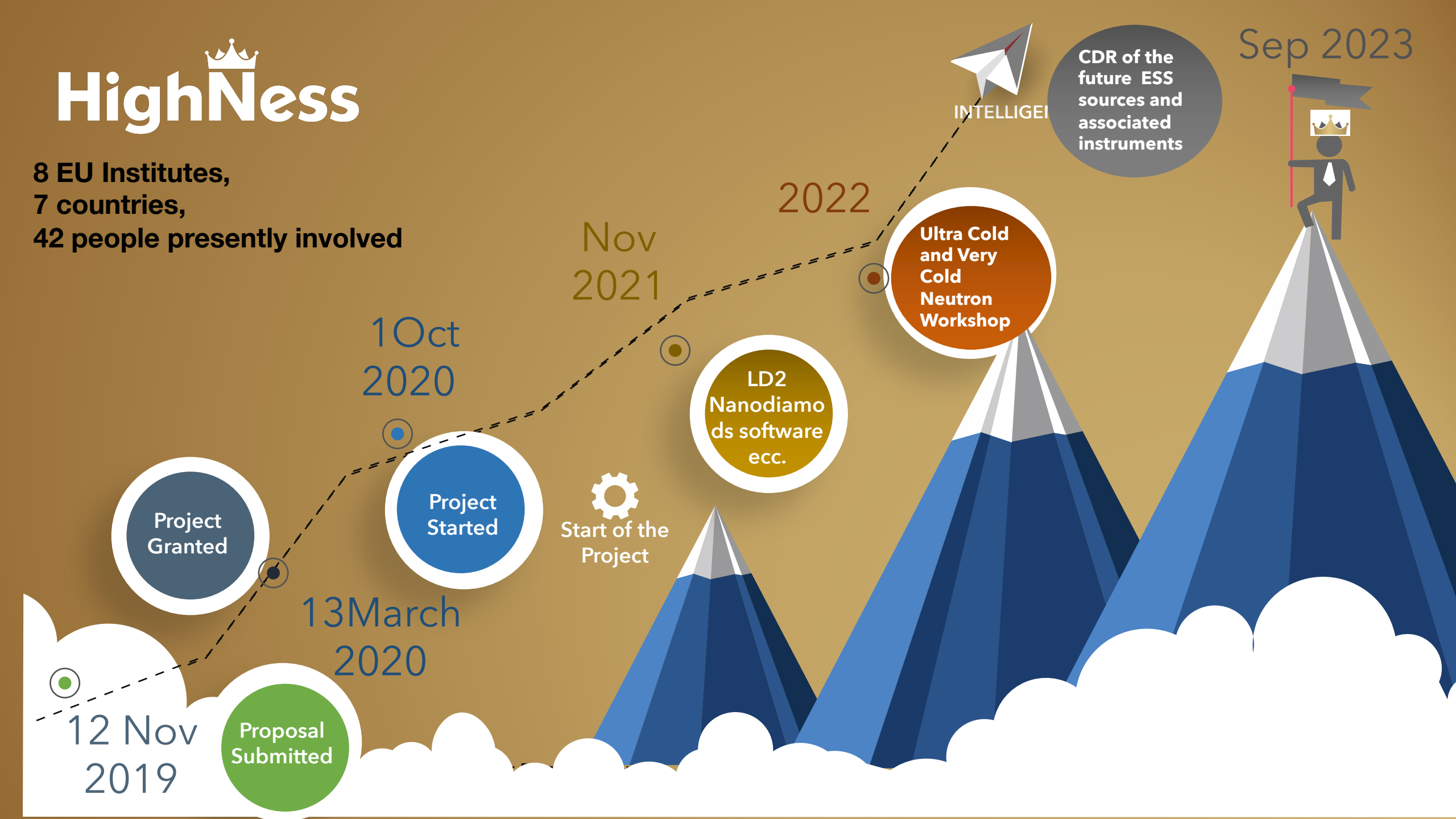
peak

Time average

Comparison with ILL cold brightness



*Farhi, Calzavara (unpublished)


HighNess
8 EU Institutes,
7 countries,
42 people presently involved
12 Nov 2019
Proposal Submitted
13March 2020
Project Granted
1Oct 2020
Project Started
Start of the Project
Nov 2021
LD2 Nanodiamonds software ecc.
2022
Ultra Cold and Very Cold Neutron Workshop
INTELLIGEI
CDR of the future ESS sources and associated instruments
Sep 2023

HighNESS aims at complementing the ESS current moderator in **two** different aspects

High Intensity

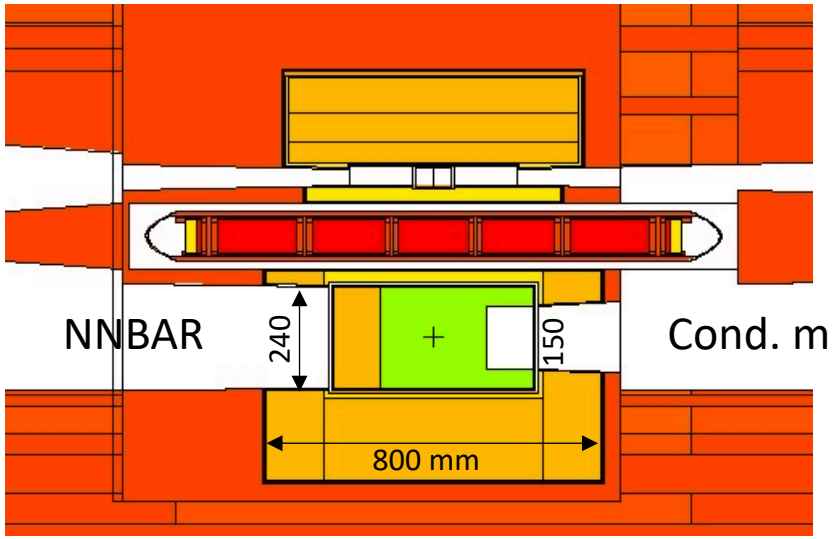
larger emission surface and bigger moderator

Longer wavelengths

Cold, Very Cold and Ultra Cold neutrons

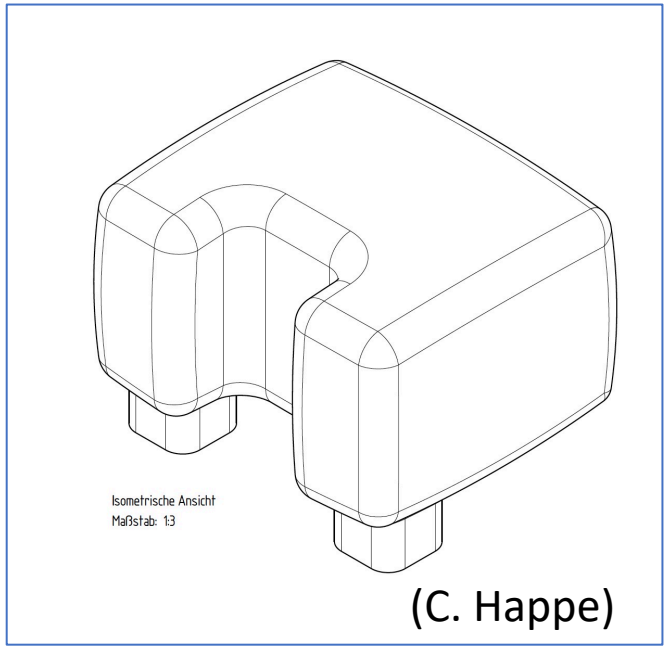
HighNESS is funded by the European Union Framework Programme for Research and Innovation Horizon 2020, under grant agreement 951782

The High-Intensity Cold Source



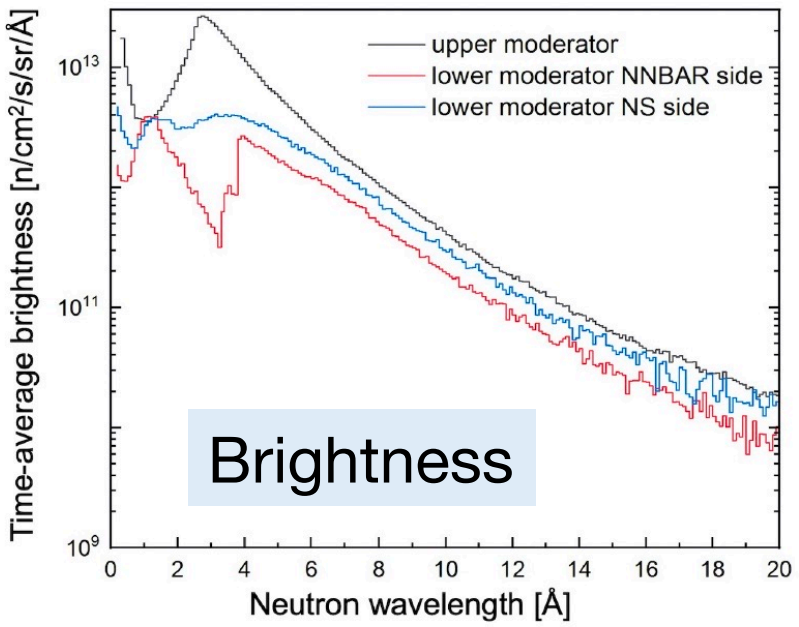
liquid deuterium moderator
two openings,

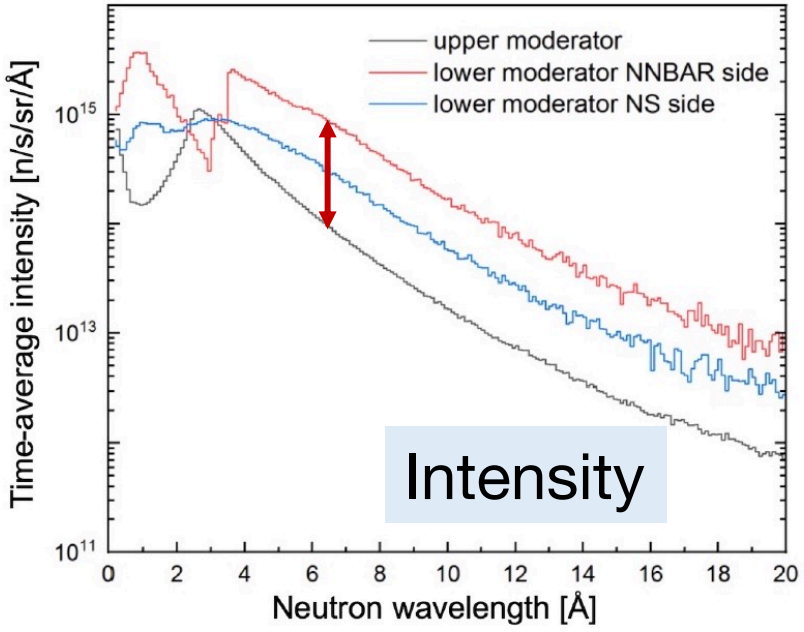
- NNBAR
- neutron scattering



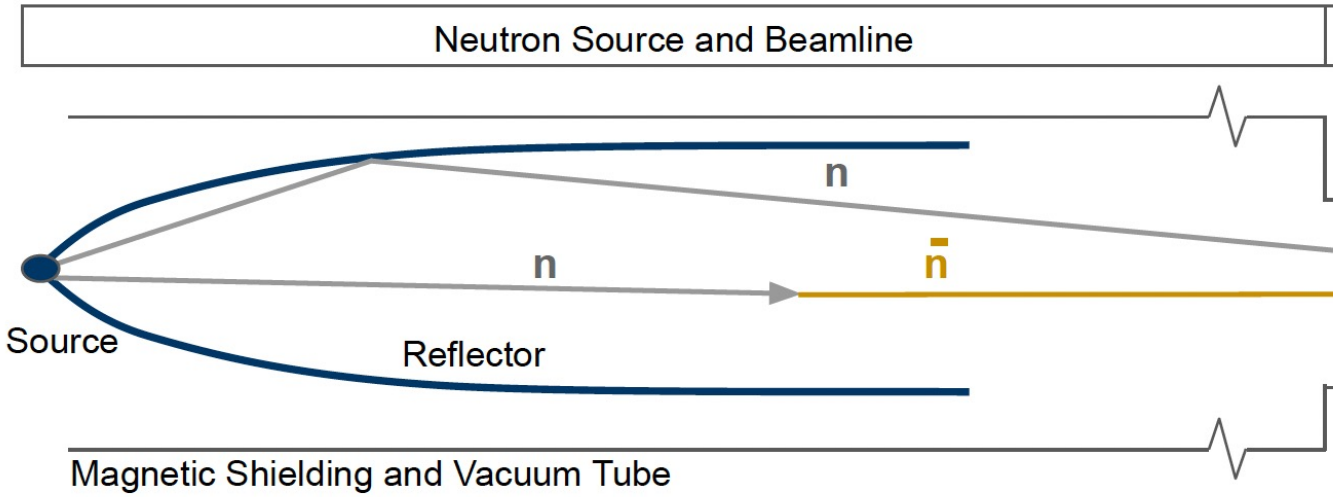
(C. Happe)

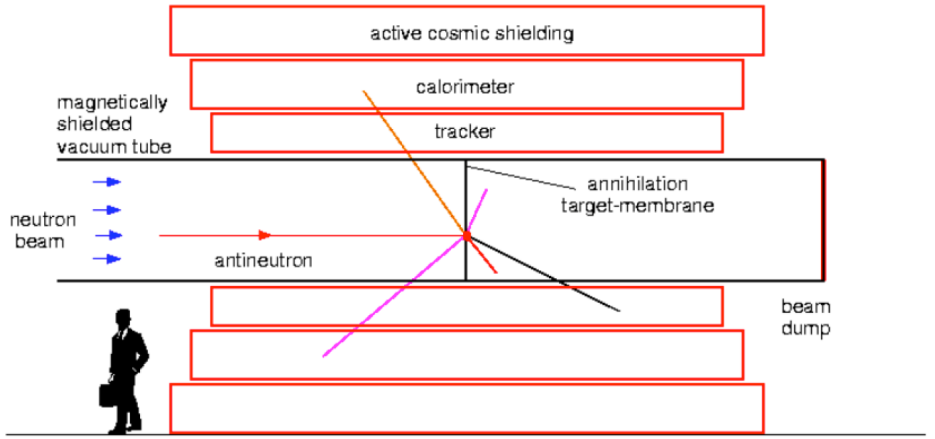
FACTOR 10 above 4 Å

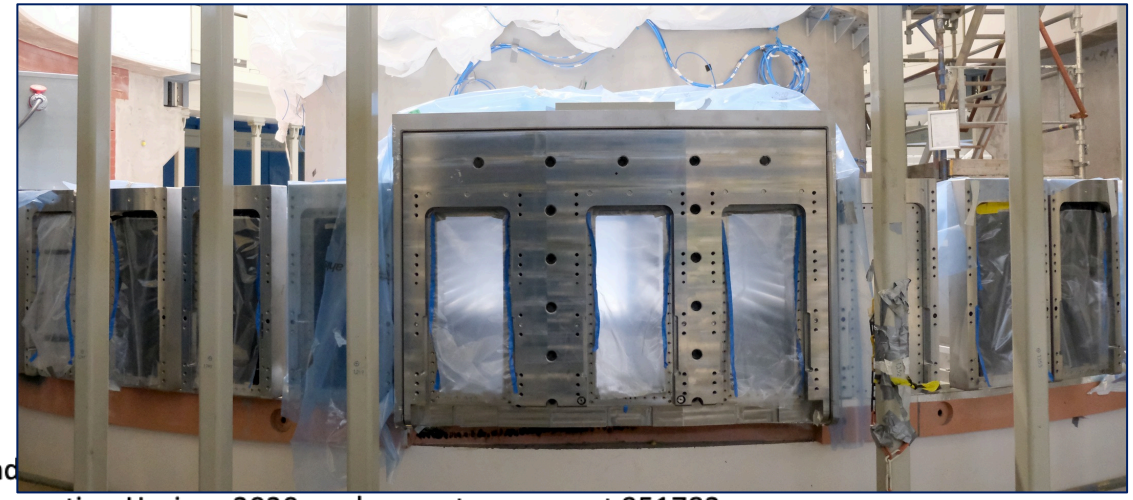


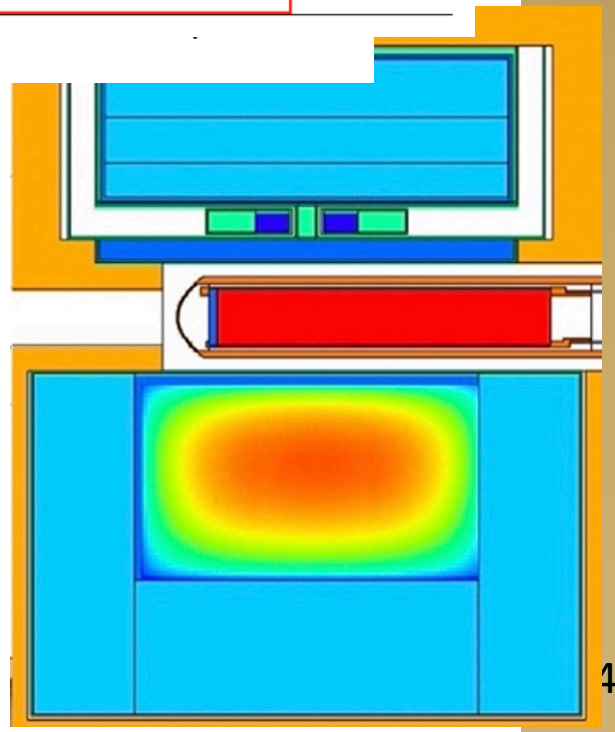


NNBAR at the large beamport a 1000 gain wrt previous (ILL, 1994) experiment









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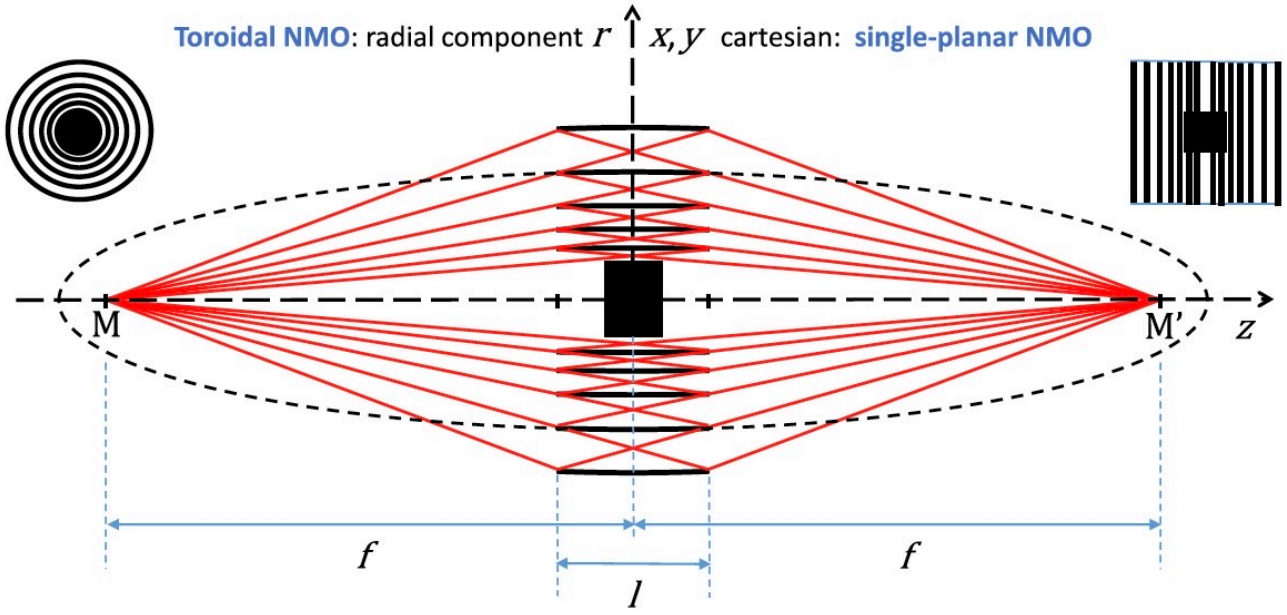
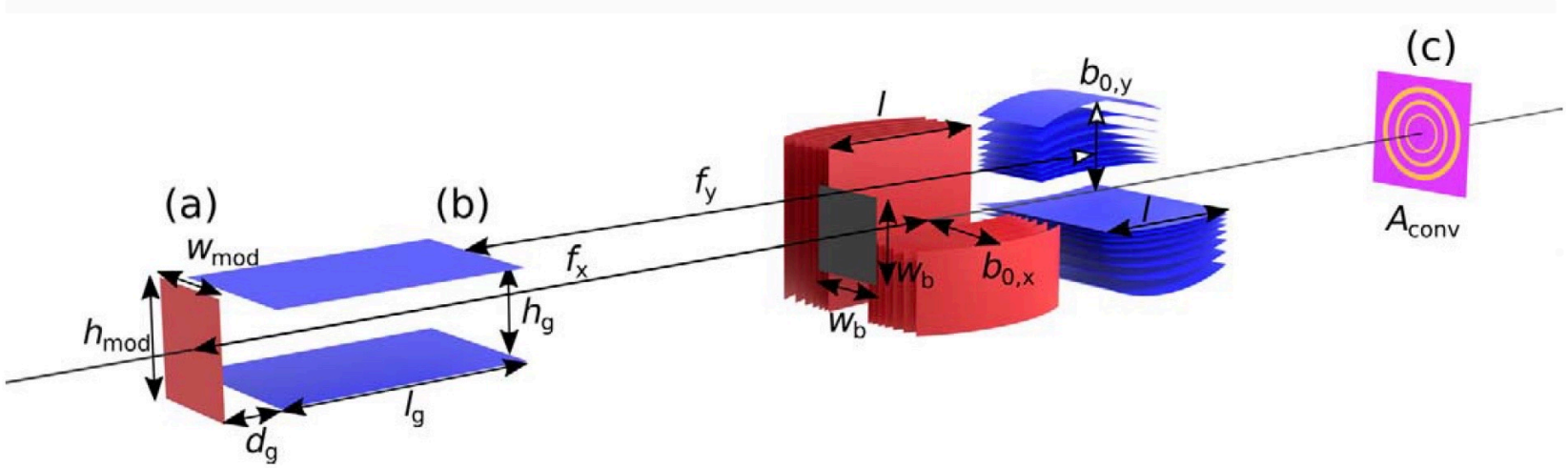
Research and Innovation Horizon 2020, under grant agreement 951782

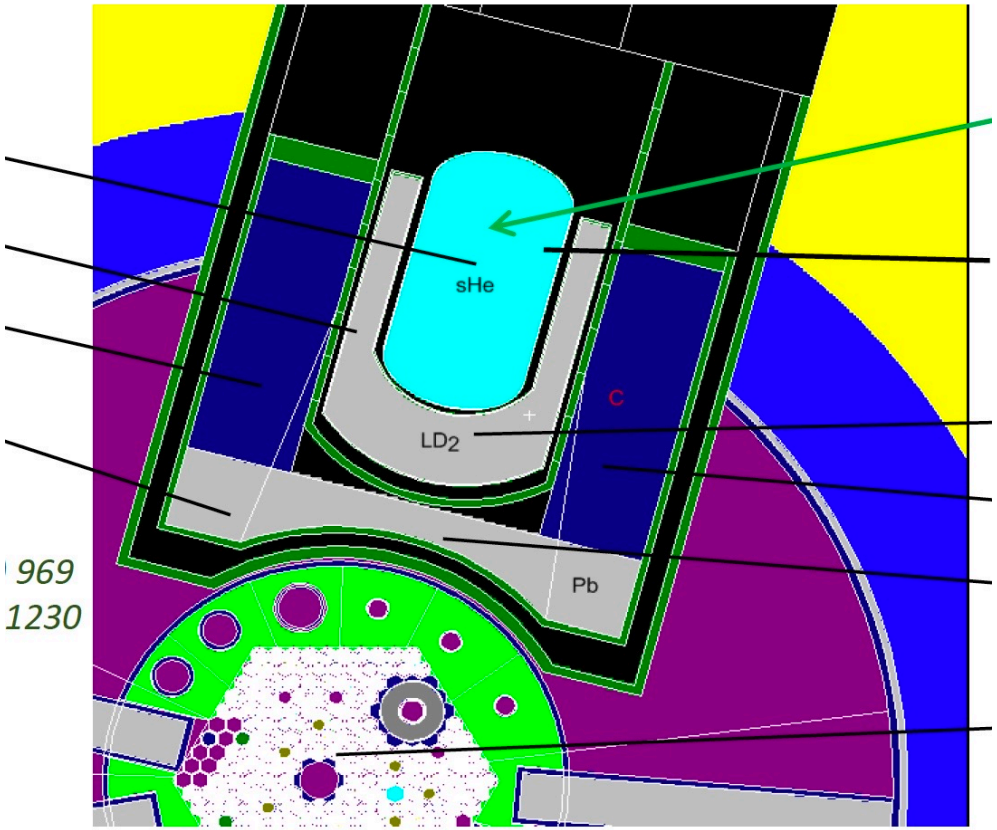
NMO for UCN in beam source

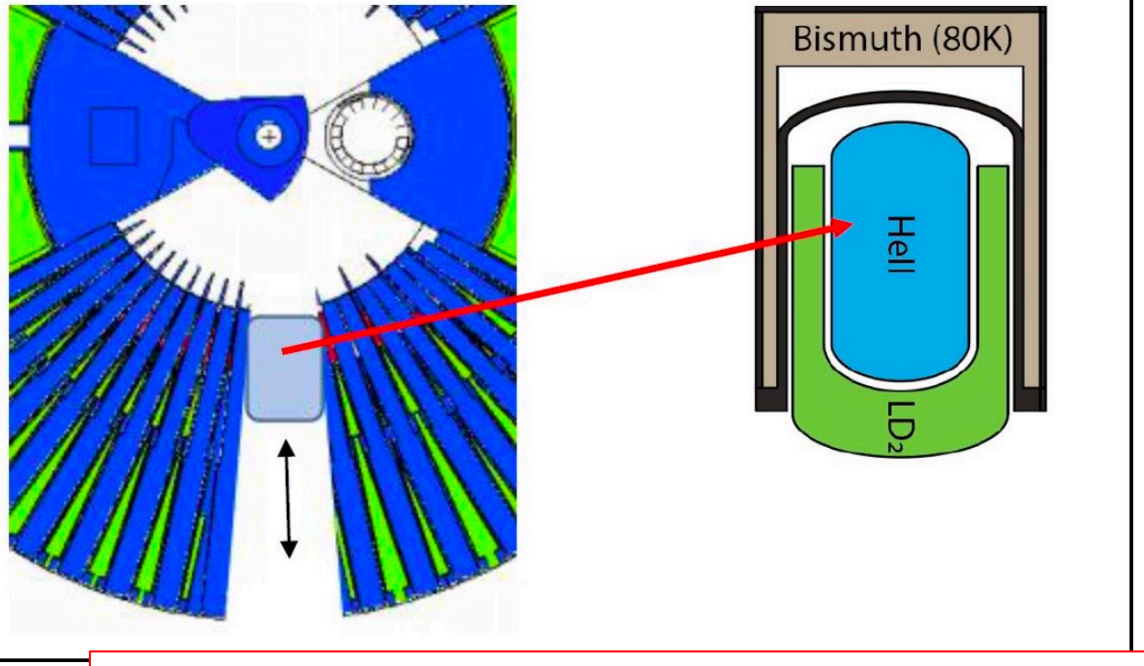
(see talk R. Wagner)





Serebrov-Lyamkin UCN concept for ESS





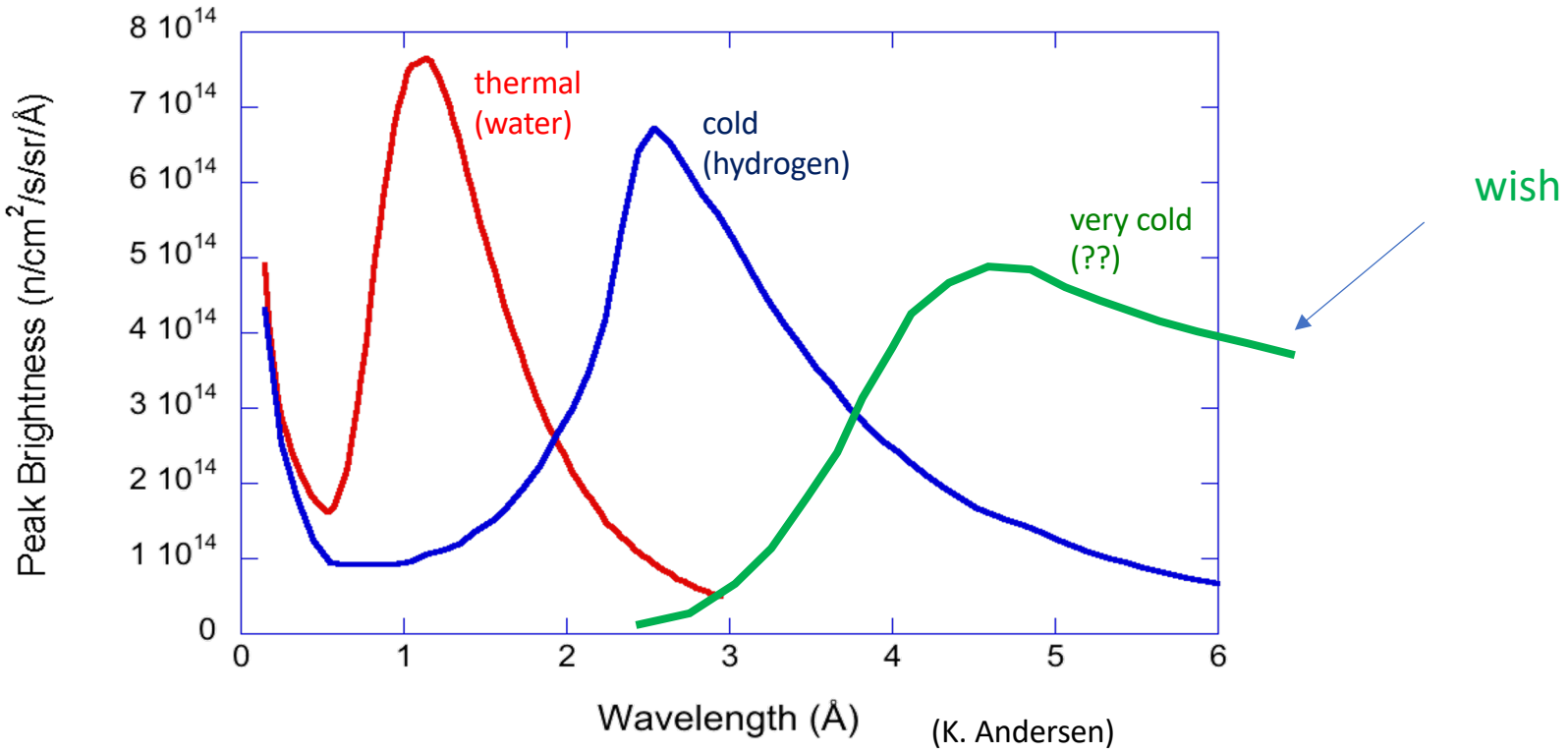
Journal of Neutron Research 24 (2022) 145–166
DOI 10.3233/JNR-220007
IOS Press

Development of UCN sources at PNPI

Anatolii Serebrov * and Vitaliy Lyamkin

HighNESS is funded by the European Union Framework Programme for Research and Innovation Horizon 2020, under grant agreement 951782

VCN source

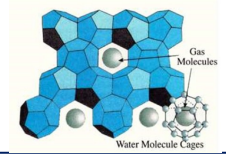


(K. Andersen)

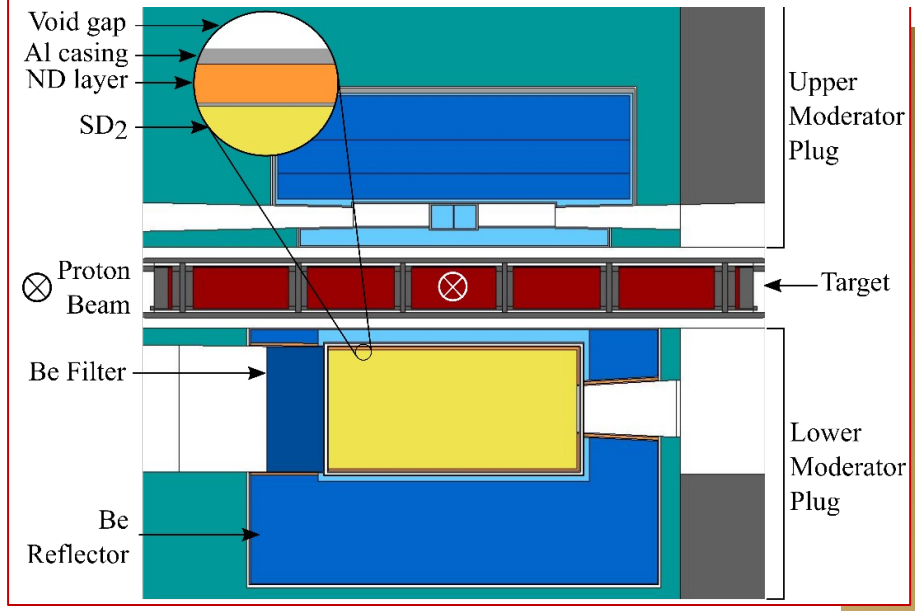
HighNESS is funded by the European Union Framework Programme for Research and Innovation Horizon 2020, under grant agreement 951782

Dedicated VCN moderator

- Full SD2 option
- First results on deuterated clathrate hydrates VCN source



N. Rizzi et al, in preparation
V. Santoro et al, Nucl. Sci. Eng, accepted for publication



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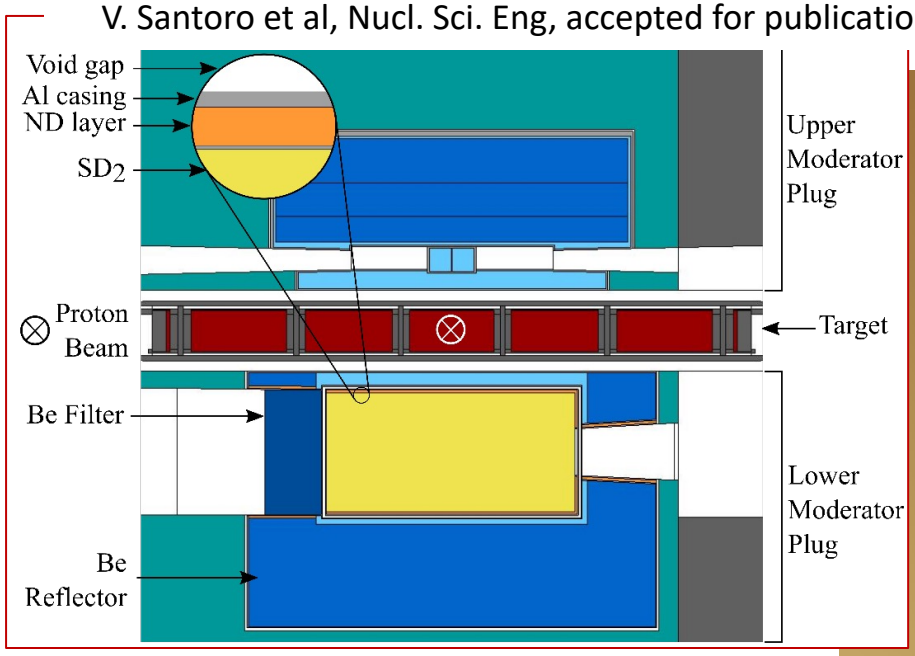

Ferenc Mezei Journal of Neutron Research 24 (2022) 205–210

in order to be advantageous in SANS type of experiments, must therefore provide high intensity at wavelengths $\lambda > 10$ Å, that is above the presumed λ^{-5} dependence of the spectra of current cold moderators (which happens to be only well established in practice for neutron wavelengths below 10–20 Å).

Different, innovative, more sophisticated moderator designs might eventually even offer larger favorable deviation from the λ^{-5} dependence.

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Dedicated VCN moderator

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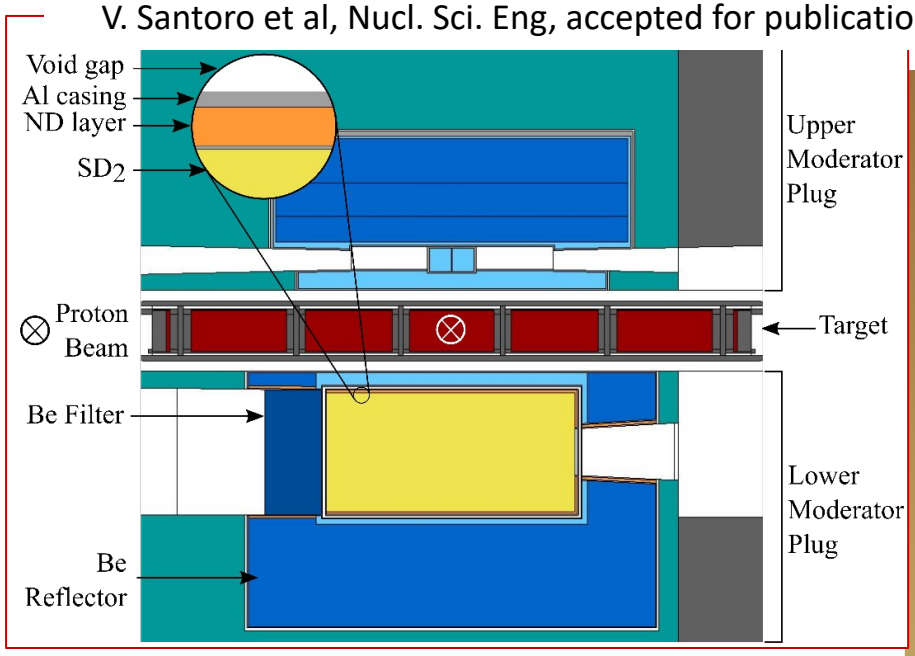

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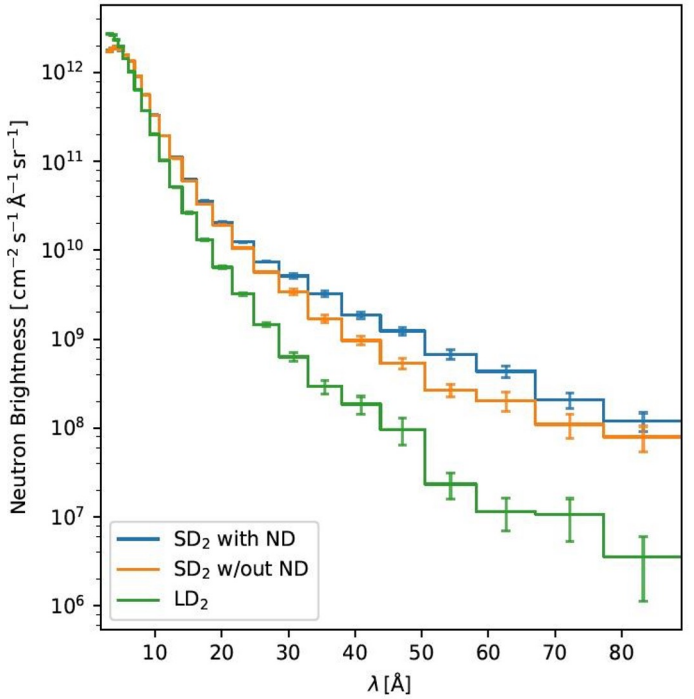

$\sim \lambda^{-3.8}$

λ^{-5}

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The HighNESS/LENS workshops on VCN and UCN sources at ESS

- On February 2-4 2022, more than 100 scientists and experts from 23 nationalities took part in the workshop

- Workshop proceedings to published in a special issue of the Journal of Neutron Research in 2022

https://content.iospress.com/journals/journal-of-neutron-research/24/2

- Follow up workshop 8-9 May 2023 with results

First workshop https://indico.esss.lu.se/event/2810/

2nd workshop https://indico.esss.lu.se/event/3195/

HighNESS is funded by the European Union Framework Programme for Research and Innovation Horizon 2020, under grant agreement 951782

From the HighNESS evaluation letter from the European Commission:

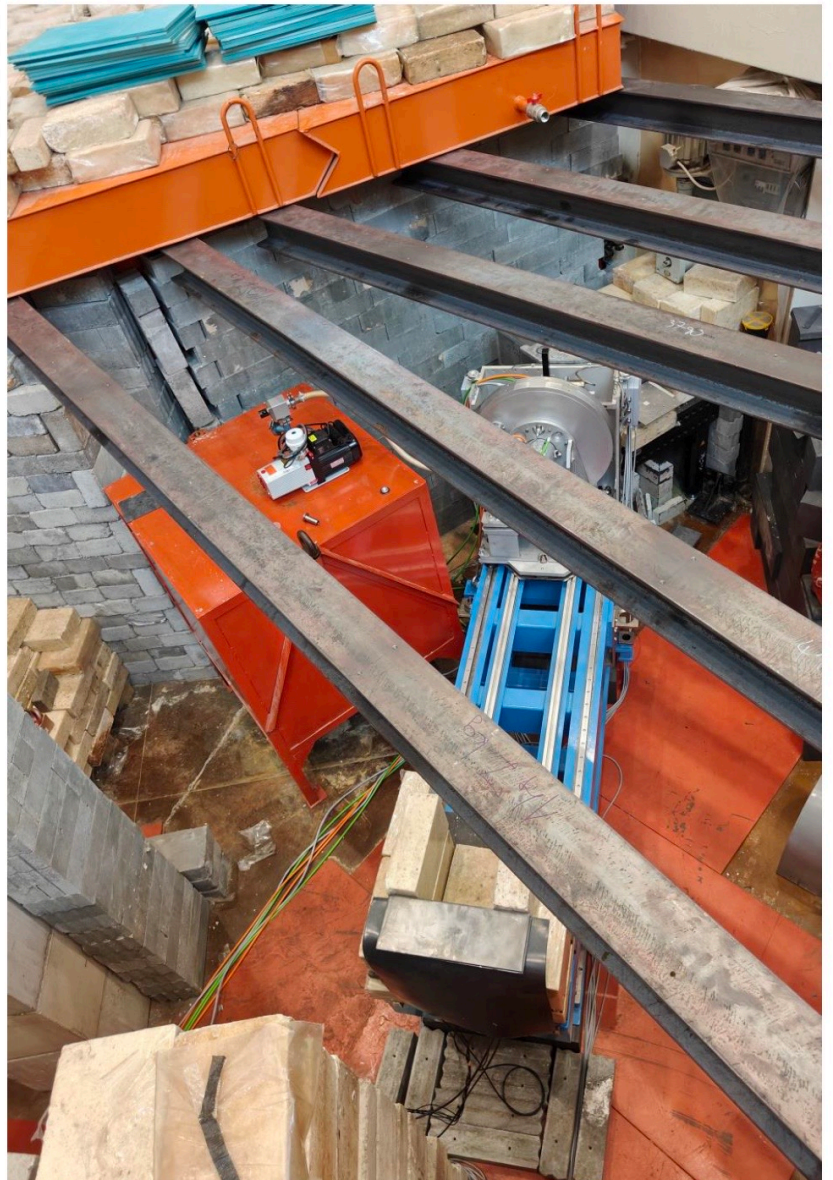
"Offering both unprecedented brilliance, flux, and spectral range in a single facility, this upgrade will make ESS the most versatile neutron source in the world and will further strengthen the leadership of Europe in neutron science"

HighNess

HighNESS is funded by the European Union F
Research and Innovation Horizon 2020, unde

Other activities on moderators

- LENS moderator subgroup
- Annual LENS/ELENA meetings
  - Discussions/collaborations/grants
- Development of moderator test facility in Budapest Research Center (L. Rosta)
  - First measurements Sep 2022
- Moderator test at Big Karl facility
  - Measurement August 2022



HighNESS is funded by the European Union Framework Programme for Research and Innovation Horizon 2020, under grant agreement 951782

HighNESS moderators design team

Mina Akhyani, Mads Bertelsen, Y. Bessler, Tomasz Brys, Amalia Chambon, E. Dian, Ben Folsom, C. Happe, Jose Ignacio Marquez Damian, Blahoslav Rataj, Nicola Rizzi, Valentina Santoro, Ha Shuai, Mathias Strothmann, Alan Takibayev, Richard Wagner, Luca Zanini, Oliver Zimmer

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