HighNess

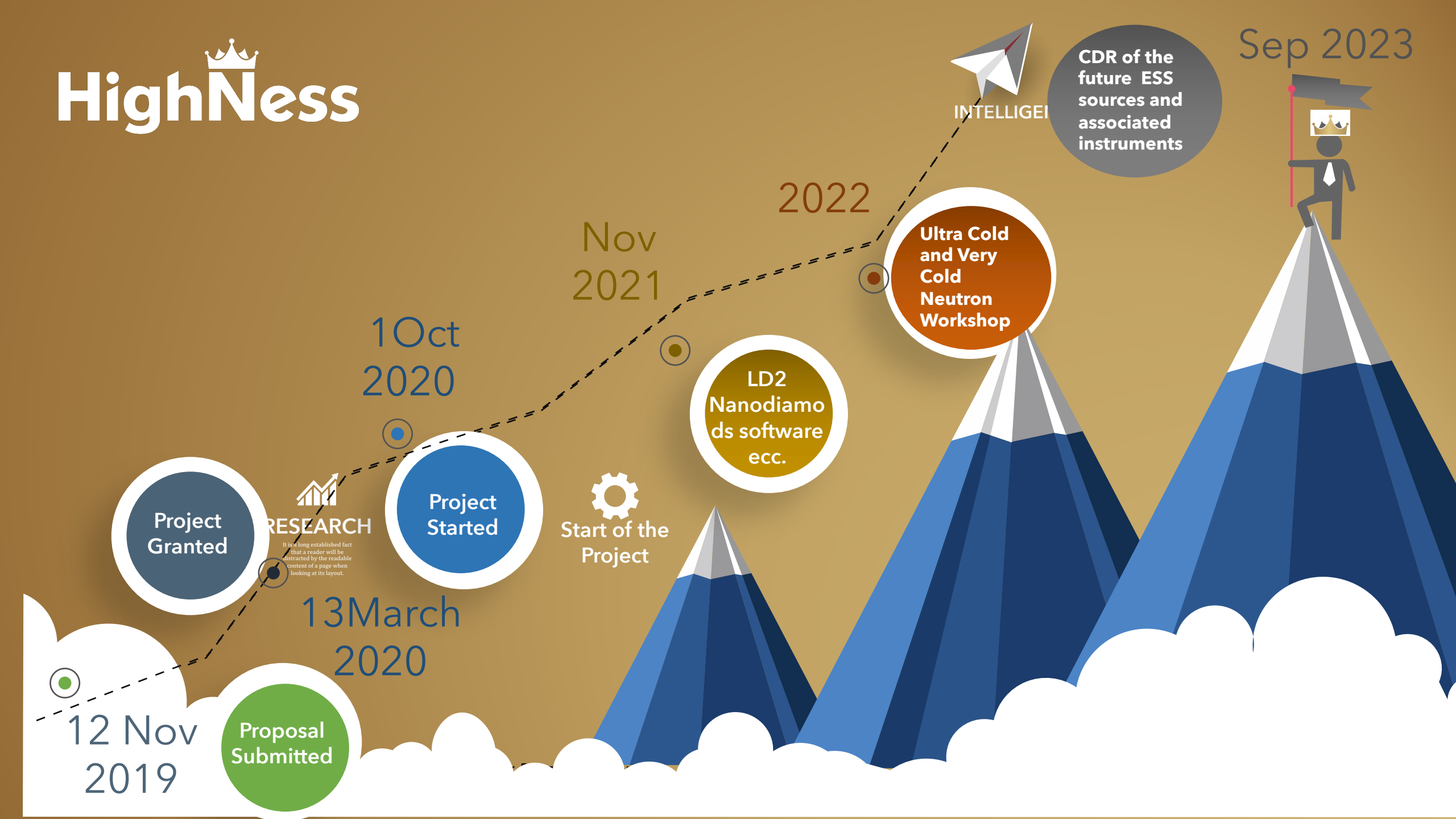
ESS progress on moderators

Luca Zanini

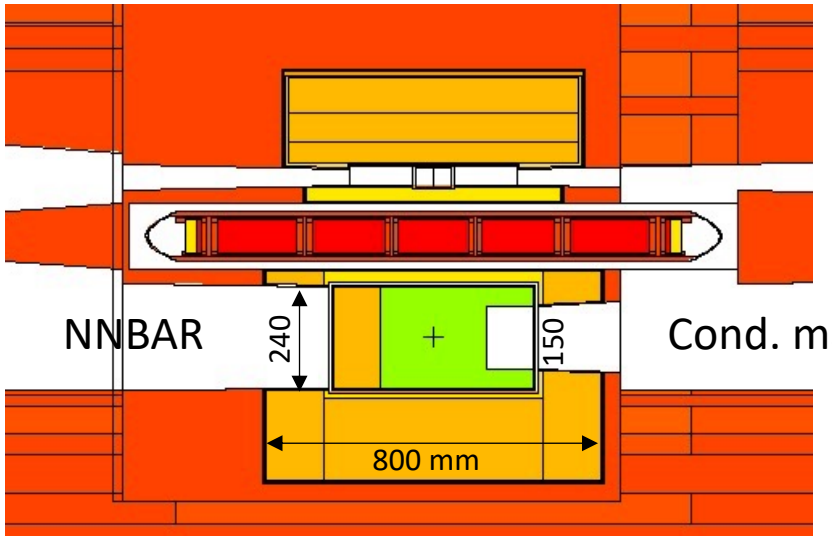
for the HighNESS consortium

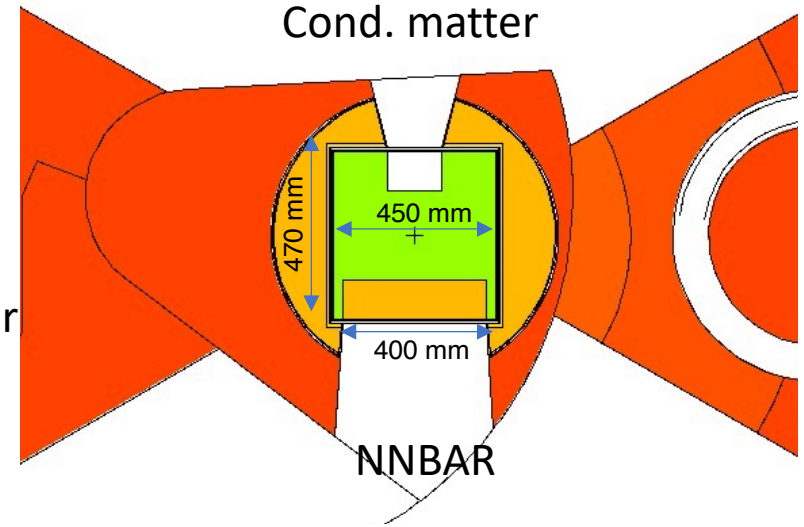
LENS/ELENA WG3 meeting 23-24 March 2023, Garching

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


HighNess
12 Nov 2019
Proposal Submitted
13March 2020
Project Granted
RESEARCH
It is a long established fact that a reader will be distracted by the readable content of a page when looking at its layout.
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

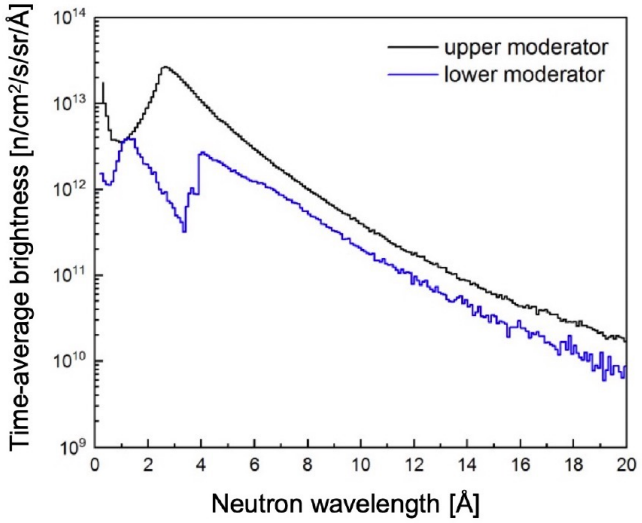
Design of the Cold Source



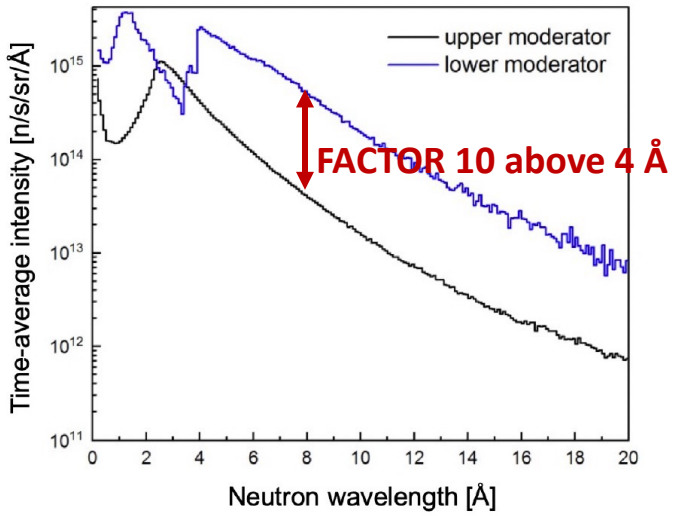


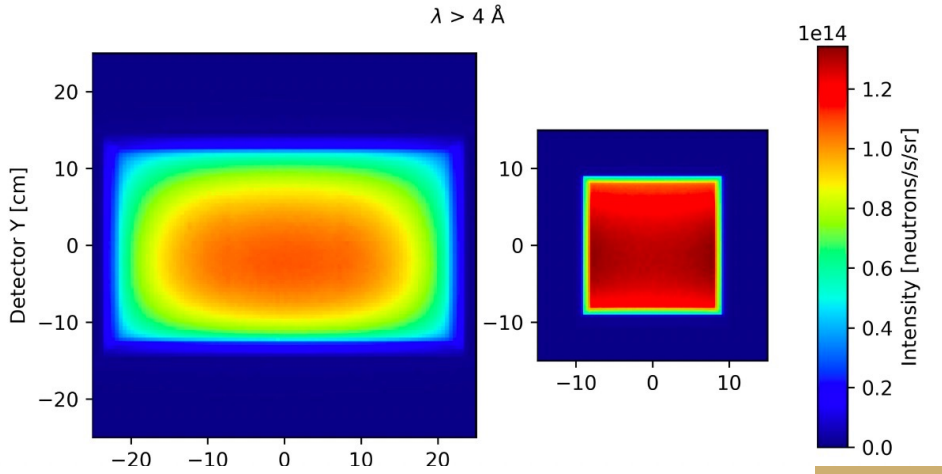
The high-intensity liquid deuterium moderator has been designed with two openings, for NNBAR and neutron scattering instruments

Brightness

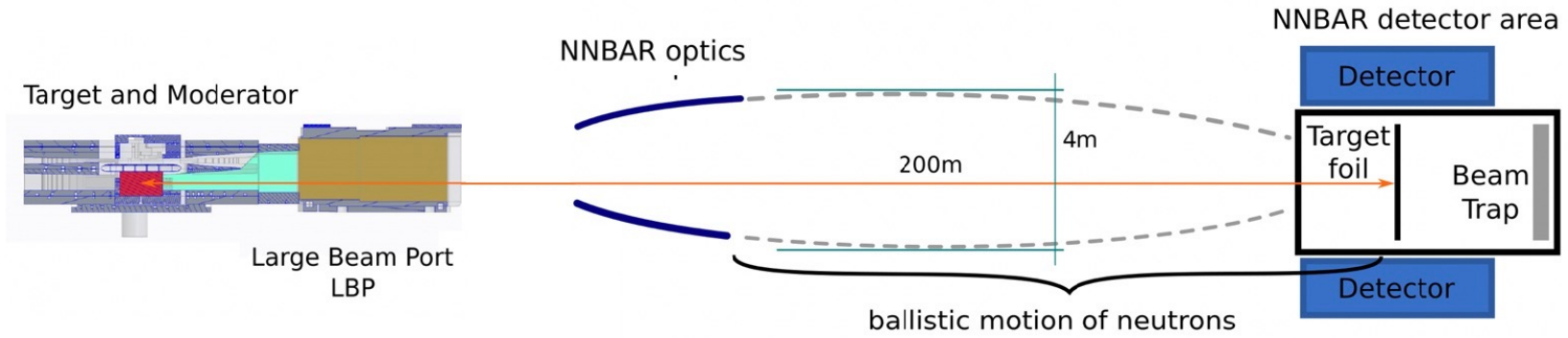


Intensity





Sensitivity increase of factor 1000 in search for neutron-antineutron oscillation compared to previous experiment (M. Baldo-Ceolin et al, 1994).



The development of the NNBAR experiment

To cite this article: F. Backman *et al* 2022 *JINST* **17** P10046

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

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

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

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

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

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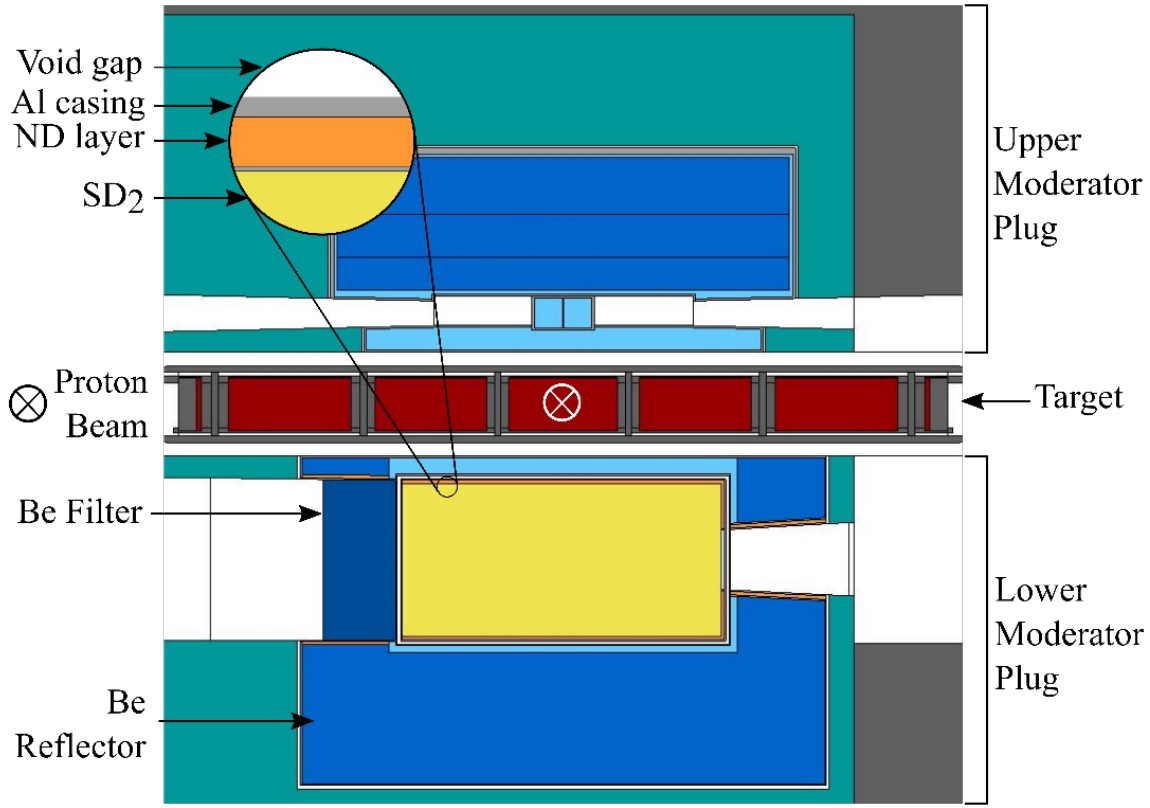
VERY COLD SOURCE



Work in HighNESS concentrated on in-pile SD2 VCN source. **See presentation N. Rizzi tomorrow**.
Additional ideas using ND reflectors under study

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Advantage of VCN for SANS - Inputs from M. Strobl and F. Mezei

Journal of Neutron Research 24 (2022) 205–210

- In a SANS experiment, the beam must be well collimated
- The beam divergence is proportional to $k=2\pi/\lambda$
  - Therefore, for longer wavelengths, there are less stringent beam collimations
- A monocromaticity $\delta\lambda/\lambda$ of the incoming beam allows for a larger used wavelength band $\delta\lambda$ for an incoming beam with larger λ.
- These factors combined imply that the fraction of the beam selected for a given resolution $\delta\lambda/\lambda$ is proportional to λ^5.
- However, the typical cold spectrum has a Maxwellian tail that goes like λ^{-5} which therefore makes irrelevant the choice of the λ.


Journal of Neutron Research 24 (2022) 205–210
DOI 10.3233/JNR-220012
IOS Press

Very cold neutrons in condensed matter research

Ferenc Mezei

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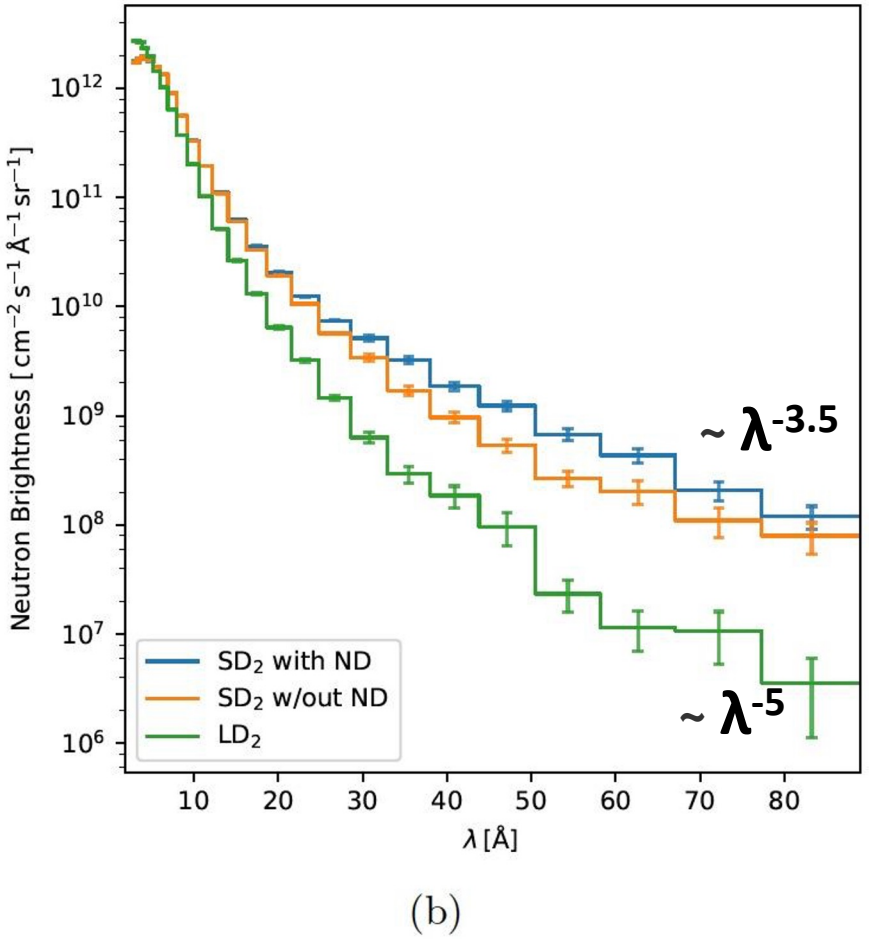
VCN option: dedicated SD2 source

- Within the HighNESS project we have designed a source based on solid deuterium, where the brightness dependence is significantly above λ^{-5}, i.e., close to $\lambda^{-3.5}$
- This means a theoretical gain at 40 Å, compared to 6 Å, of a factor $(40/6)^{-3.5}$ / $(40/6)^{-5}$ =17.
- This does not consider negative effects at longer wavelengths such as gravity and neutron absorption.



(b)

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ULTRA COLD SOURCE

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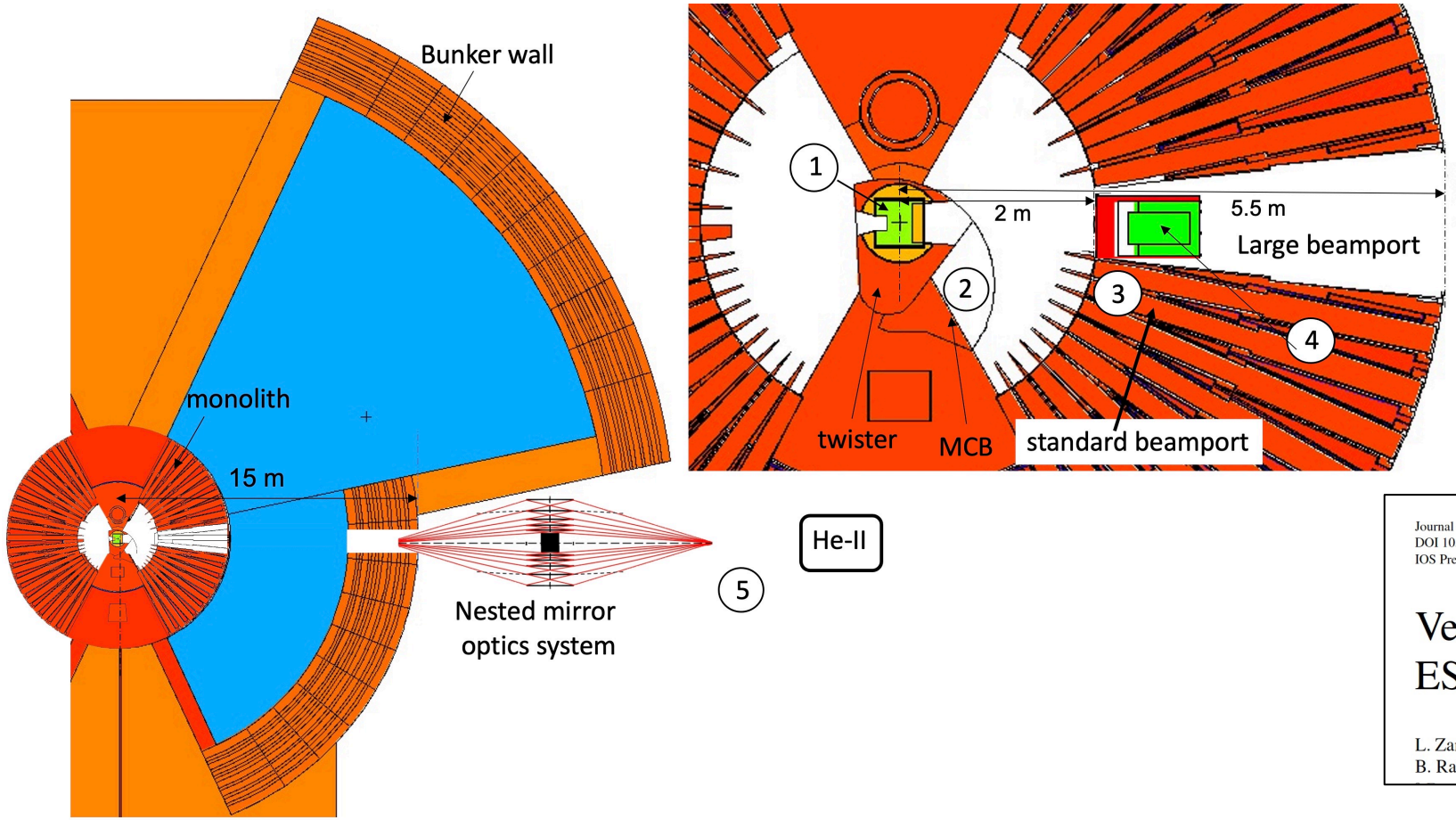
UCN sources: 5 possible locations identified at the workshop are currently under study

Journal of Neutron Research 24 (2022) 95–110
DOI 10.3233/JNR-220045
IOS Press

In-beam superfluid-helium ultracold neutron source for the ESS

Oliver Zimmer [a,*], Thierry Bigault [a], Skyler Degenkolb [b], Christoph Herb [c], Thomas Neulinger [a], Nicola Rizzi [d], Valentina Santoro [d], Alan Takibayev [d], Richard Wagner [a] and Luca Zanini [d]



Journal of Neutron Research 24 (2022) 77–93
DOI 10.3233/JNR-220040
IOS Press

Very cold and ultra cold neutron sources for ESS

L. Zanini [a,*], E. Dian [b,c], D.D. DiJulio [a], B. Folsom [d], E.B. Klinkby [e], Z. Kokai [a], J.I. Marquez Damian [a], B. Rataj [a], N. Rizzi [e], V. Santoro [a], M. Strothmann [f], A. Takibayev [a], R. Wagner [g] and O. Zimmer [g]

Research and Innovation Horizon 2020, under grant agreement 951782

Potential world-leading UCN densities compared to other facilities under design or construction

Facility	Production density $\dot{\rho}[\mathrm{cm^{-3}s^{-1}}]$	UCN density $\rho[\mathrm{cm^{-3}}]$
ILL/H523 SUPERSUN (ILL)	14	1.7×10^3
Gatchina (Russia)	380	2.2×10^3
LEUNG (inverted geometry)	5×10^4	1×10^4
SHIN (compact source)	80	4×10^3
ESS/LBP (5MW)	209	6.3×10^4

LOCATION 5

Source: O. Zimmer, UCN/VCN workshop 2022

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UCN source in large beamport (location 4)

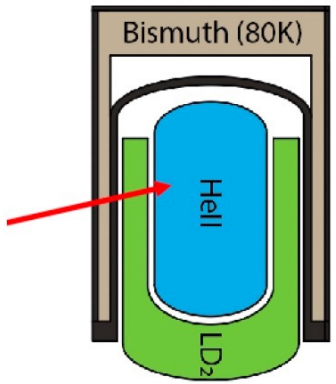
concept by A. Serebrov

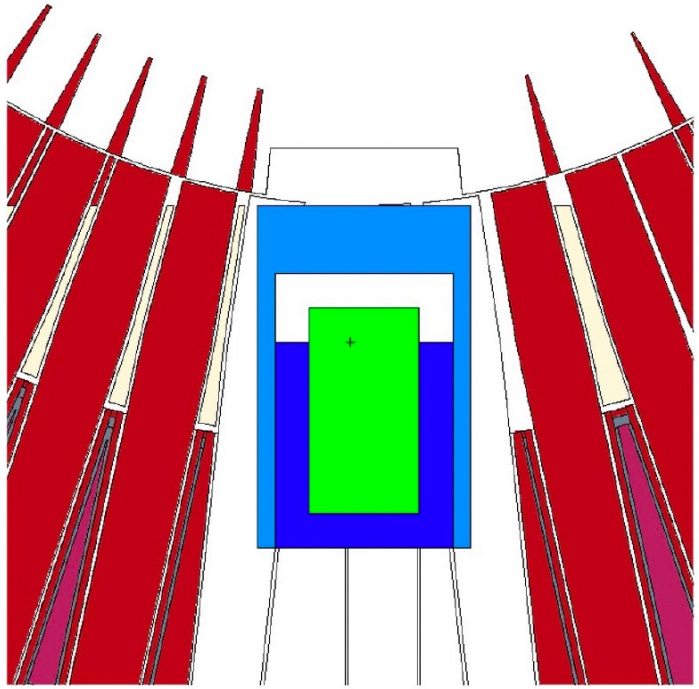
Journal of Neutron Research 24 (2022) 145–166
DOI 10.3233/JNR-220007
IOS Press

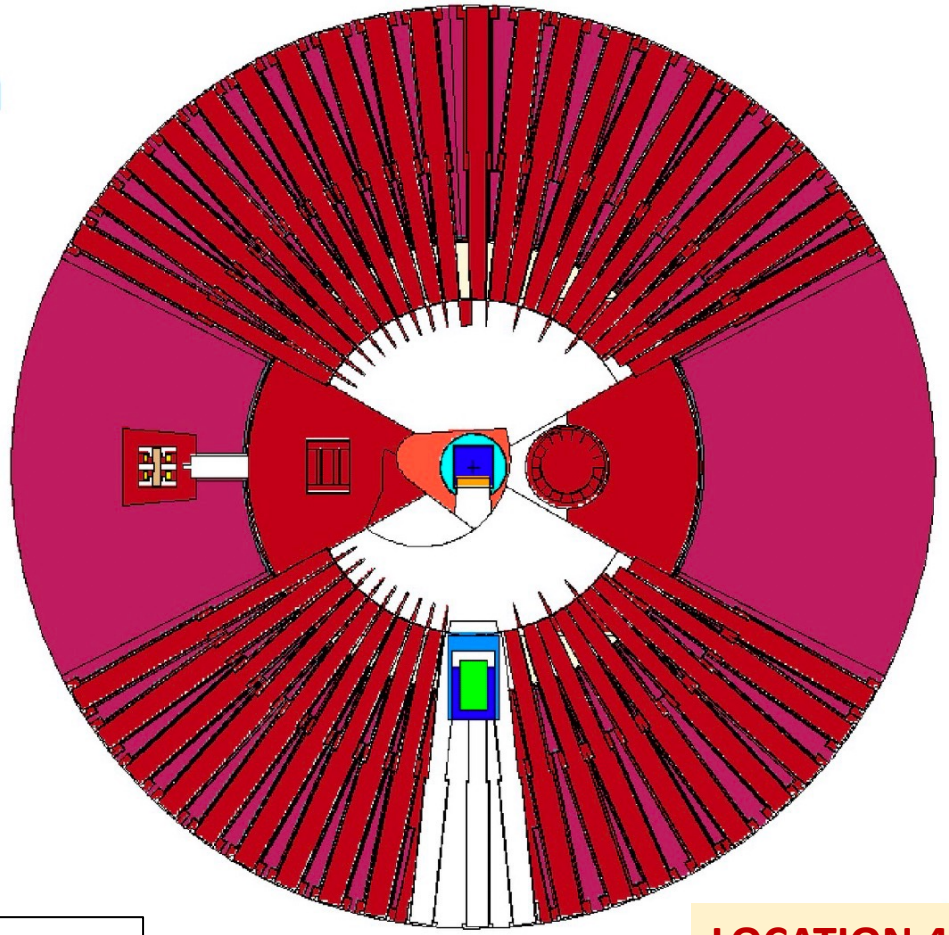
Development of UCN sources at PNPI

Anatolii Serebrov * and Vitaliy Lyamkin

He4 Box: 60 cm x 30 cm x 32 cm







SIMILAR PERFORMANCE AS IN-BEAM

LOCATION 4

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FOR SD2 based sources, see presentations tomorrow by B. Rataj and N. Rizzi

big thanks to A. Frei for support and precious advices

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COLLABORATIONS

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

HighNESS-BNC on MODERATOR TEST FACILITY

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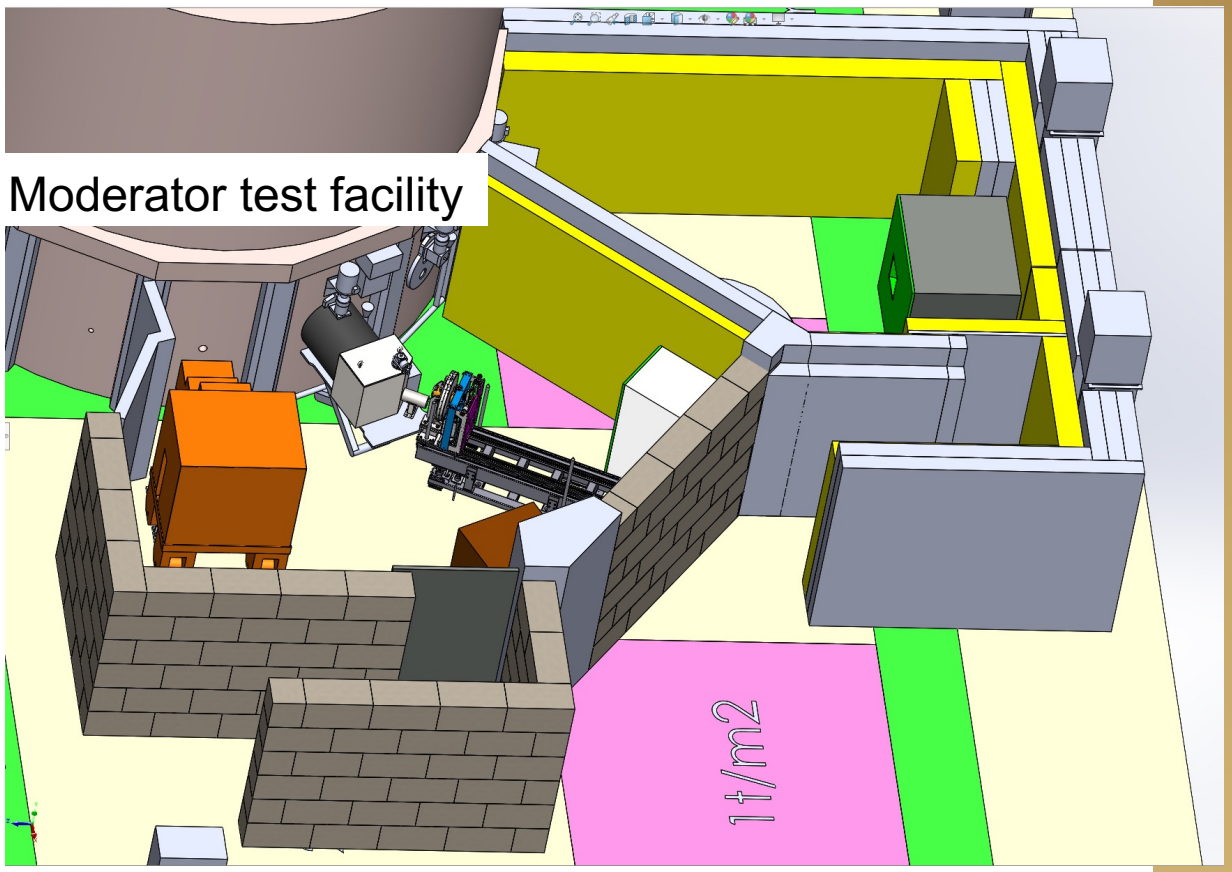
Measurements at the moderator test facility at the Budapest Neutron Center

- **See L. Rosta presentation**

- ❑ BNC currently building Test Beam line at the Budapest reactor
- ❑ HighNESS prototype experiment with advanced reflectors planned for in June 2023
- ❑ Engineering design and construction by Jülich (HighNESS WP5)
- ❑ Background and activation by DTU (HighNESS WP6)
- ❑ ORNL-TS2 recently joined project



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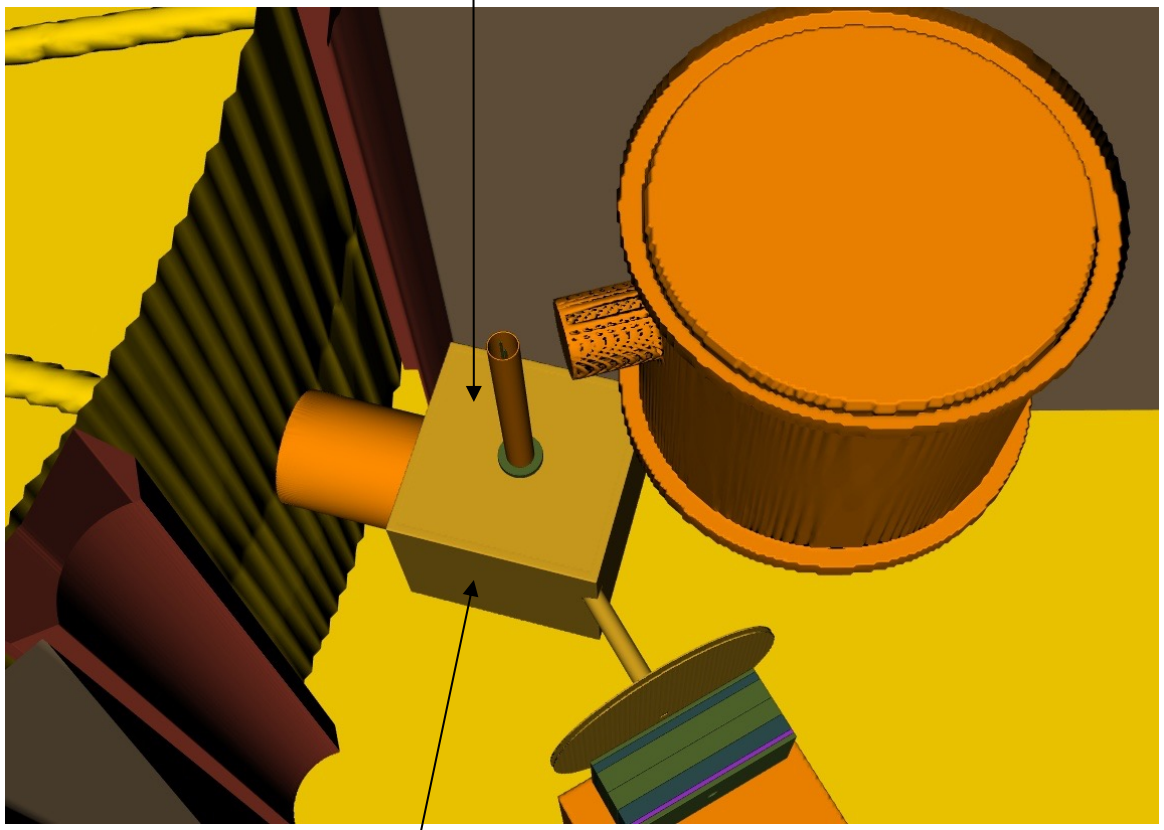
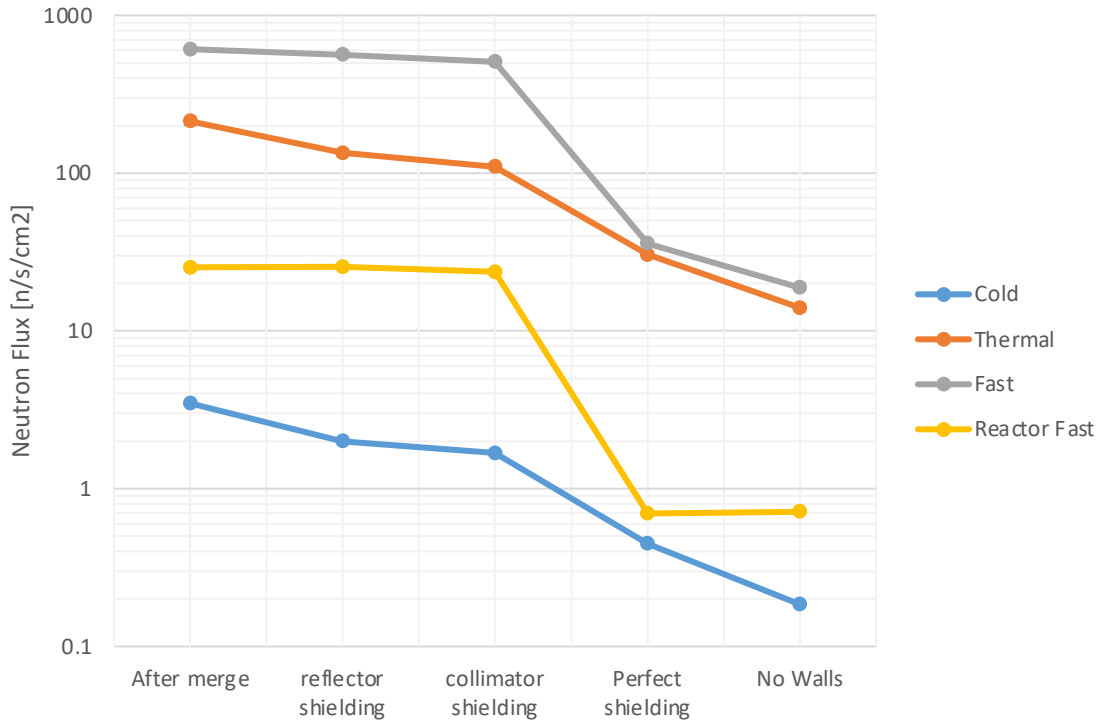
Detailed neutronic studies of background and activation.





HighNESS WP2/3 measurements

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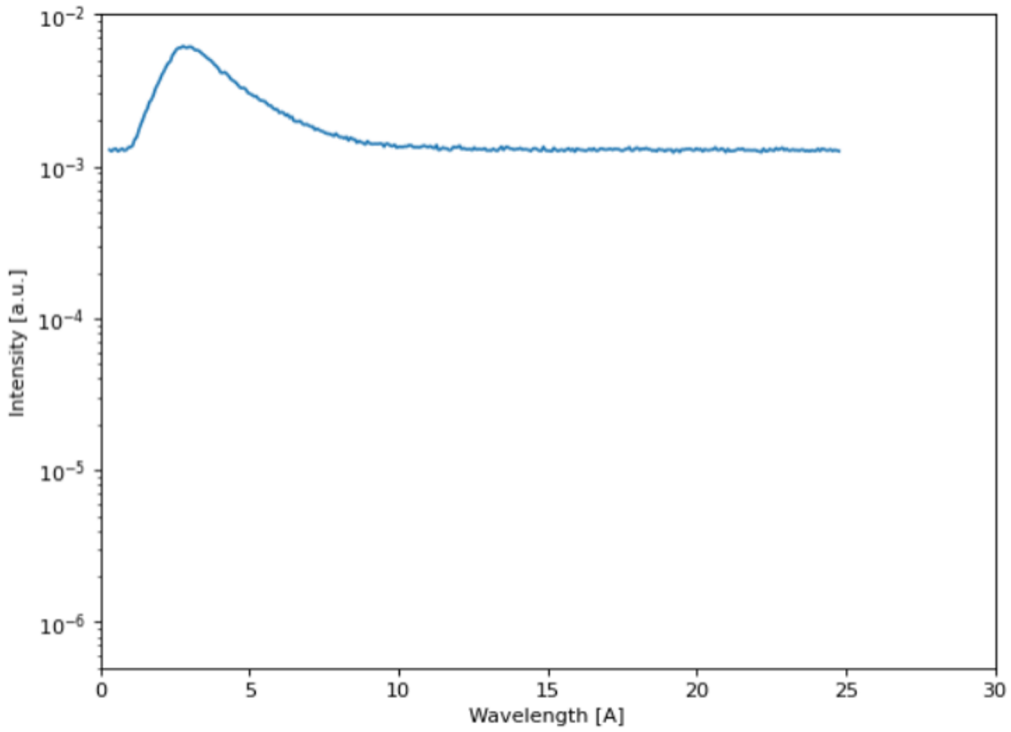
Transmission experiment at BOA-PSI

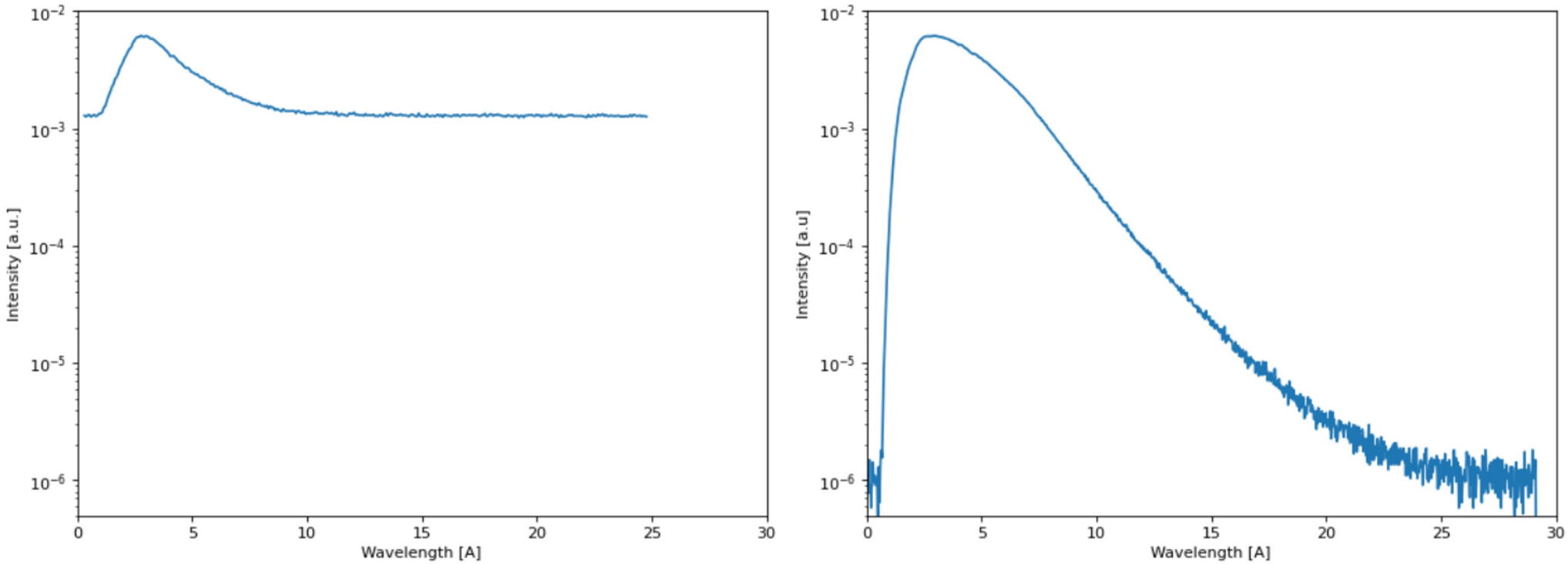
Experimental campaign on graphitic compounds:

- Transmission measurements at BOA:
  - Initial measurements (May 22).
  - Reduced background (Oct 22).
    - Included clathrates
  - More measurements planned (Jul 23).

Huge improvement in Signal/noise ratio



Huge improvement in Signal/noise ratio



Spectrum for the empty cell from previous experiment (left), spectrum of the open beam after adjustment (right).

PLANNED COLLABORATIONS: measurements at ILL

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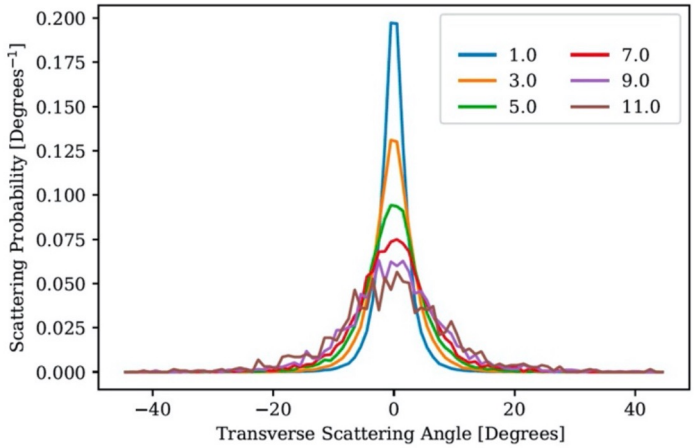
ND reflectivity measurement @PF1B, May 2023

- Measurement of angular distribution in transversal plane perpendicular to scattering plane



Measurement of cross section of VCN and UCN in solid ortho-deuterium at cryogenic temperatures at and above T = 5K

- Proposal submitted at PF2/VCN and PF2/VCN
- New collaboration (ESS,ILL, MLZ, PSI) reviving original proposal by C. Morkel et al.
- No dates defined by if beamtime granted it is good for planning, and possible financial support

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NEXT EVENTS

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Second Workshop on UCN and VCN Source at ESS

9-10 May 2023
Europe/Stockholm timezone

- Overview
- Timetable
- Contribution List
- Registration
- Travel to ESS
- Accomodation in Lund

Contact

ucnvcness@ess.eu

https://indico.esss.lu.se/event/3195/

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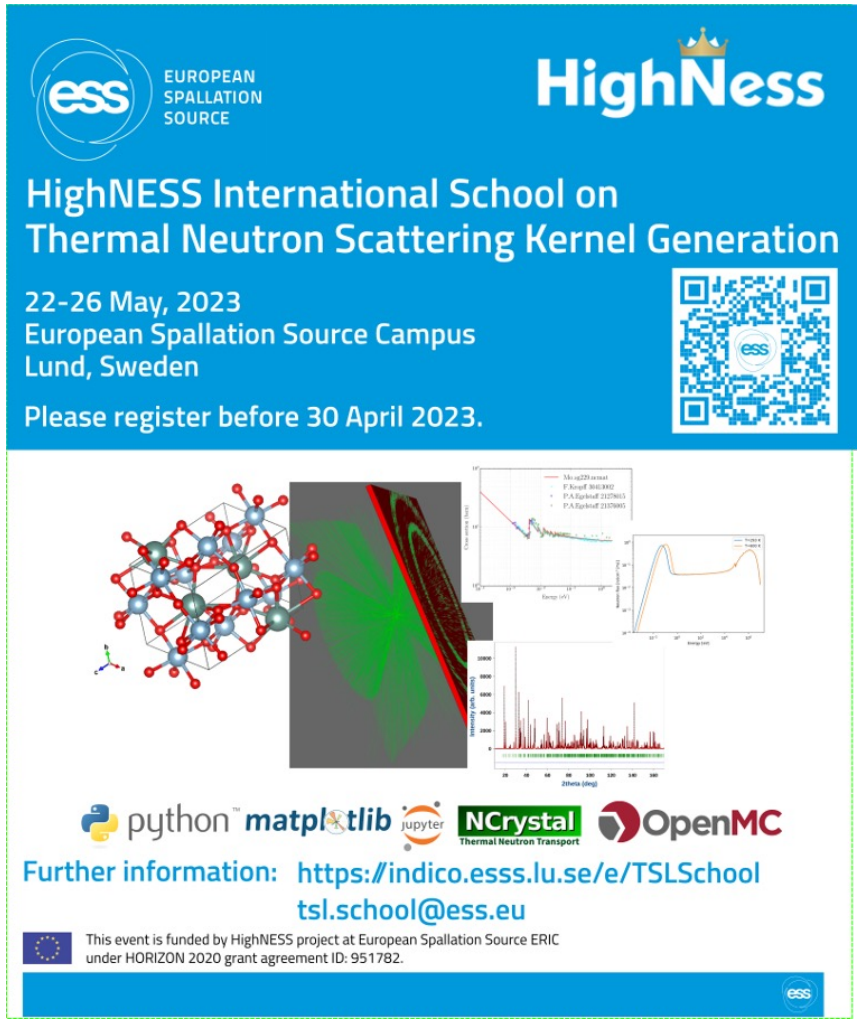

• Planned for one week, May 22-26 2023 at the ESS Campus in Lund, Sweden.

• Likely first school of this kind: we will aim at graduate students and start from the basics.

• It will cover scattering theory, generation of thermal scattering kernels using NCrystal, and application to Monte Carlo simulations using OpenMC.

• We are close to the maximum number of participants. Please contact us to participate:

tsl.school@ess.eu

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Thanks to everybody