HighNess

General HighNESS Meeting

WP4 Neutronic Studies of In-Pile and In-Beam UCN-Sources

Wagner, Richard, Institut Laue-Langevin

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Motivation

- Outcome of working groups: Recommendations for UCN Sources based on:
  - ➔ Superfluid Helium
  - ➔ Solid Deuterium
- V. Nesvizhevsky contribution:

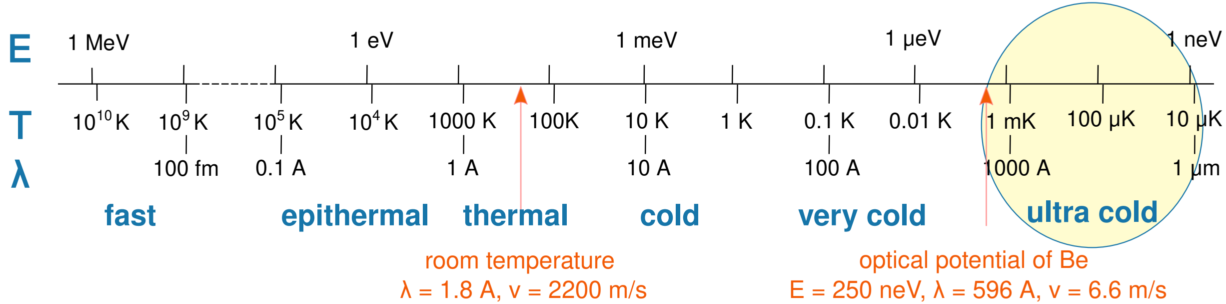
"Production of ultracold neutrons in a decelerating runaway trap"

- Utilizes the pulse structure of the ESS

Ultra Cold Neutrons I

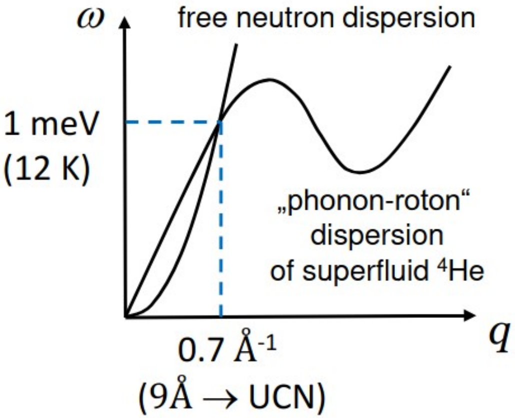
- **General definition:**
  UCNs are neutrons whose energy is so low that they are reflected under any angle of incidence
  - ➔ can be contained in traps

- UCNs are important tools for fundamental physics experiments as:
  - ➔ Neutron lifetime measurements
  - ➔ Neutron Dipole Moment
  - ➔ Gravitational interactions
  - ➔ n-$\bar{n}$ and n-n' oscillations

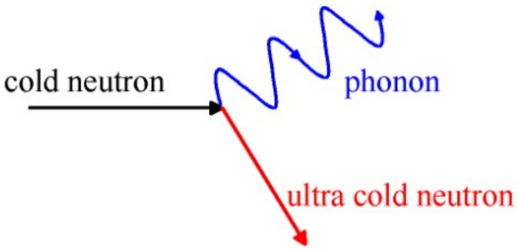


Ultra Cold Neutrons II

One possibility: UCN production in superfluid Helium



Golub & Pendlebury, PL **53A** (1975) 133



Spectrum of incident neutrons evaluated at E^* (= 9Å)

<u>Production Rate:</u>

$$P\left(E_{\mathrm{UCN}}\right) = \frac{d\phi(E^*)}{dE} \cdot 1.44 \times 10^{-7} \quad \mathrm{UCN/sec/cm^3}$$

9Å flux at source will convert to UCN flux

UCN Objectives in WP4

- Task 4.3. Neutronic study of in-beam UCN
  - design of a UCN converter placed at the monolith exit
- Task 4.4. Neutronic study of in-pile UCN
  - the study of a UCN source placed inside the ESS monolith

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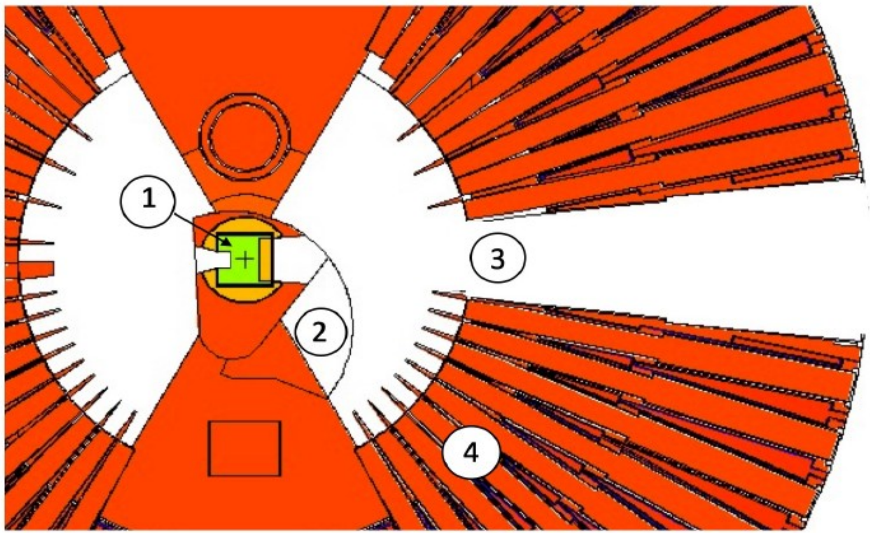
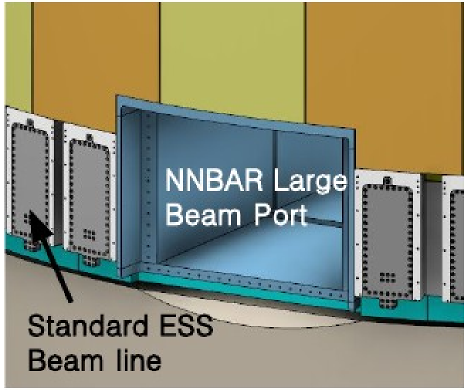
Current work

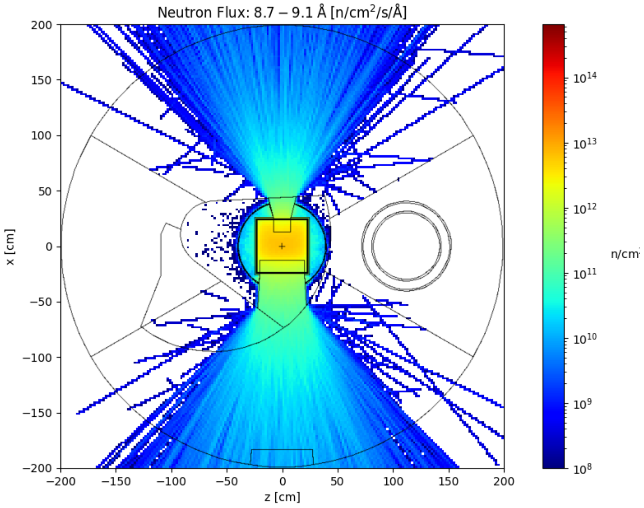
UCN Source Locations In-Pile

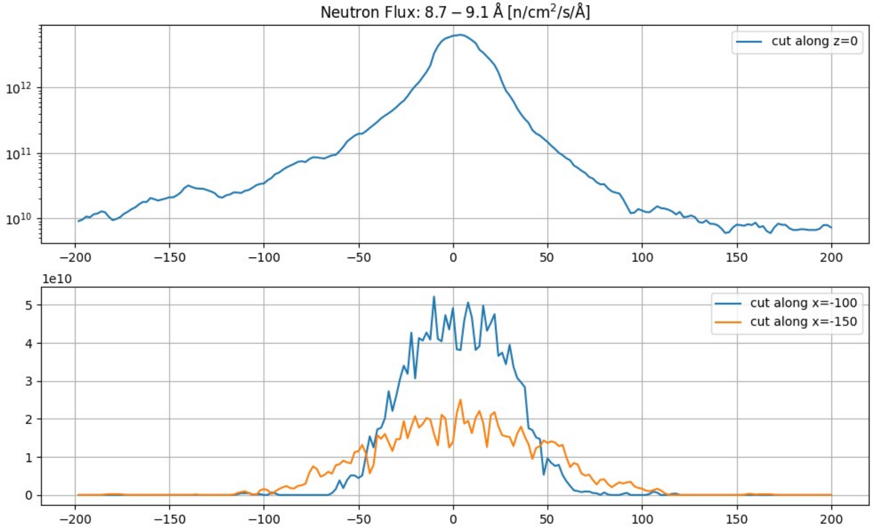


1) Inside Twister
2) In Moderator Cooling Block (MCB)
3) In Large Beam Port (LBP)
4) In Standard Beam Port



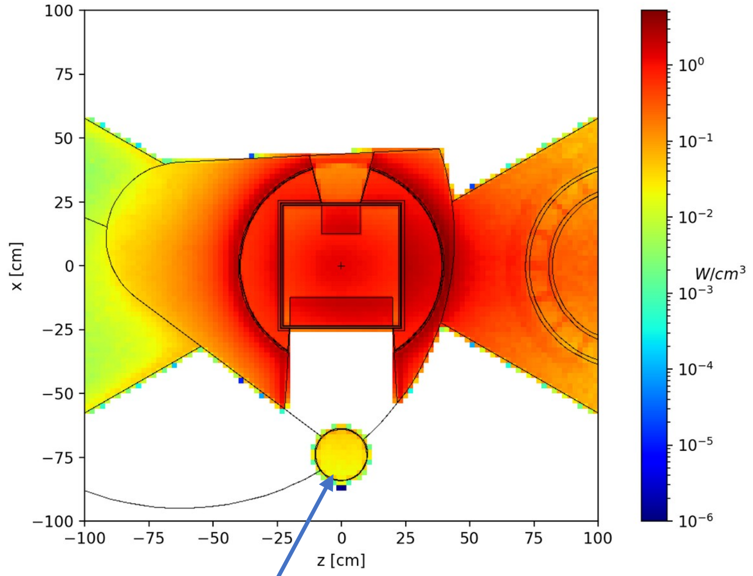
Flux Map in Monolith



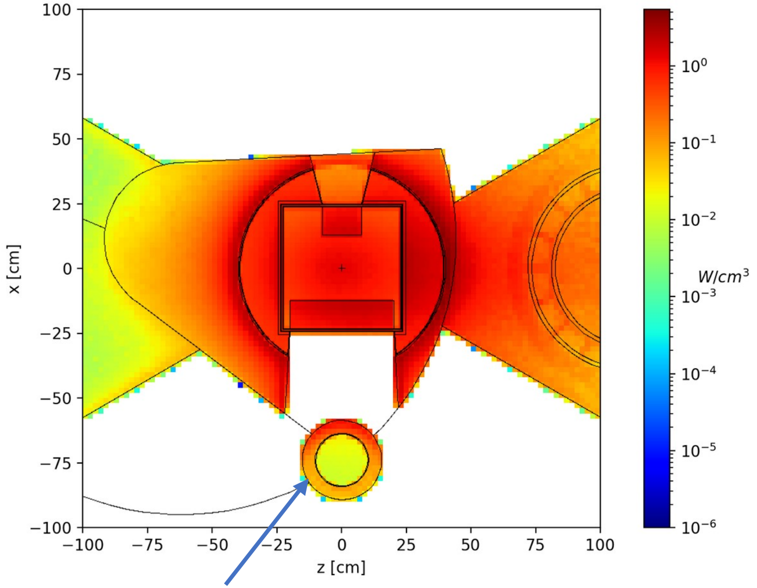


Heat Load on UCN Test Source

Cylinder R=10cm, H= 20cm, wt and wtout a 5cm Bismuth shell



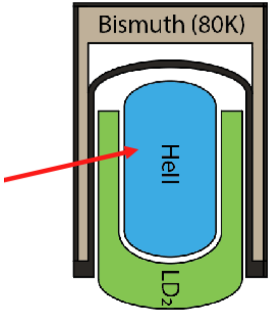
281.75 W, 0.041 W/cm³

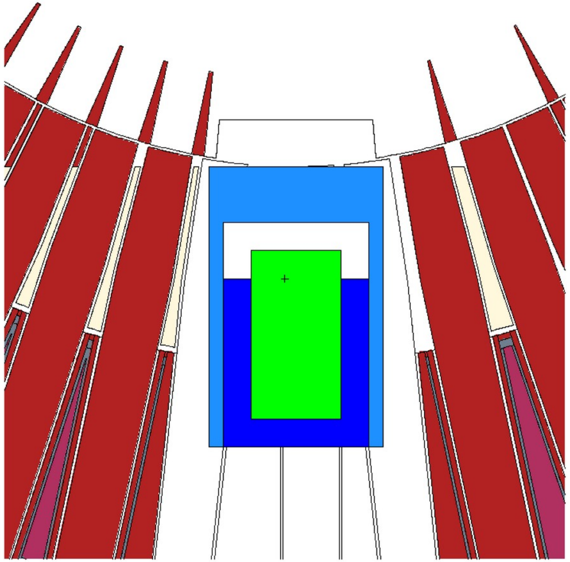


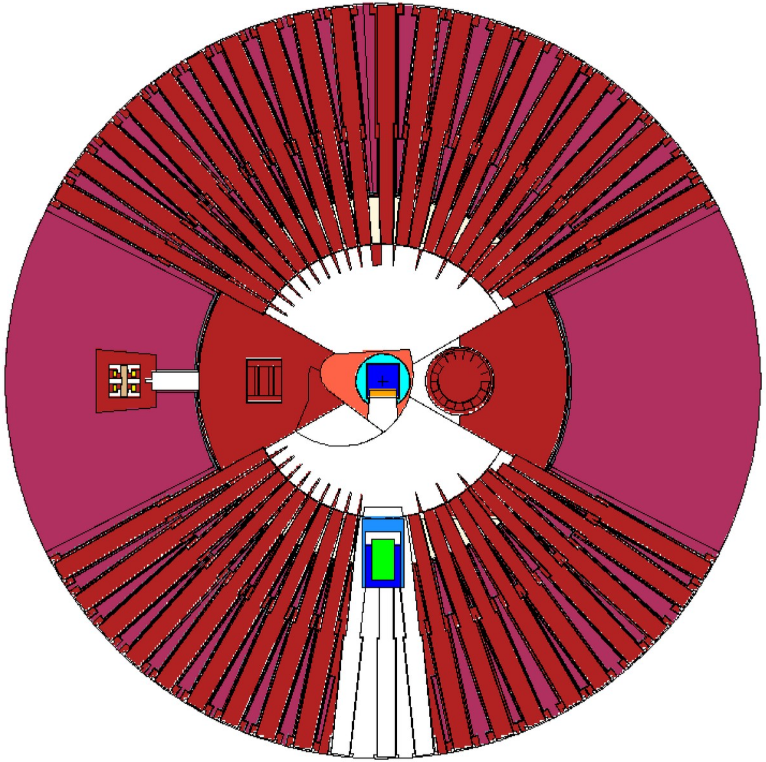
127.75 W, 0.018 W/cm³

UCN In-Pile - Model Serebrov I

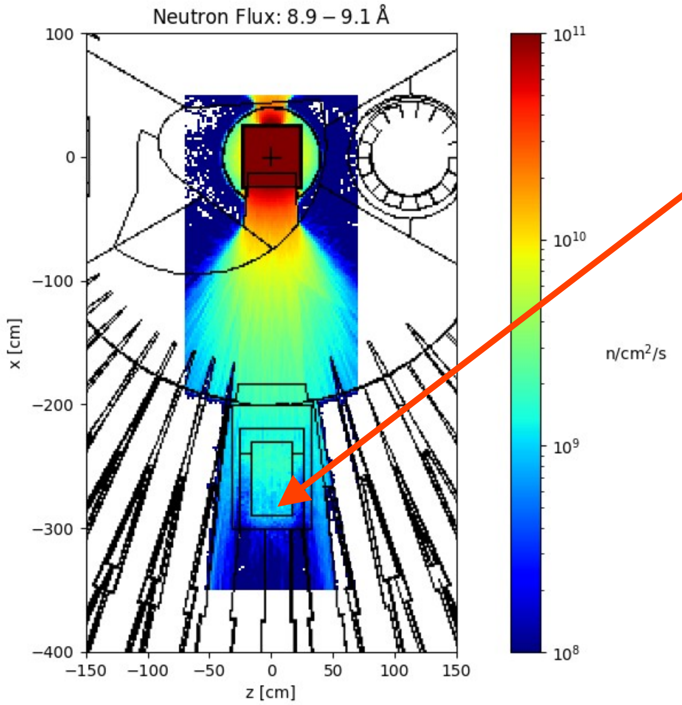
He4 Box: 60 cm x 30 cm x 32 cm







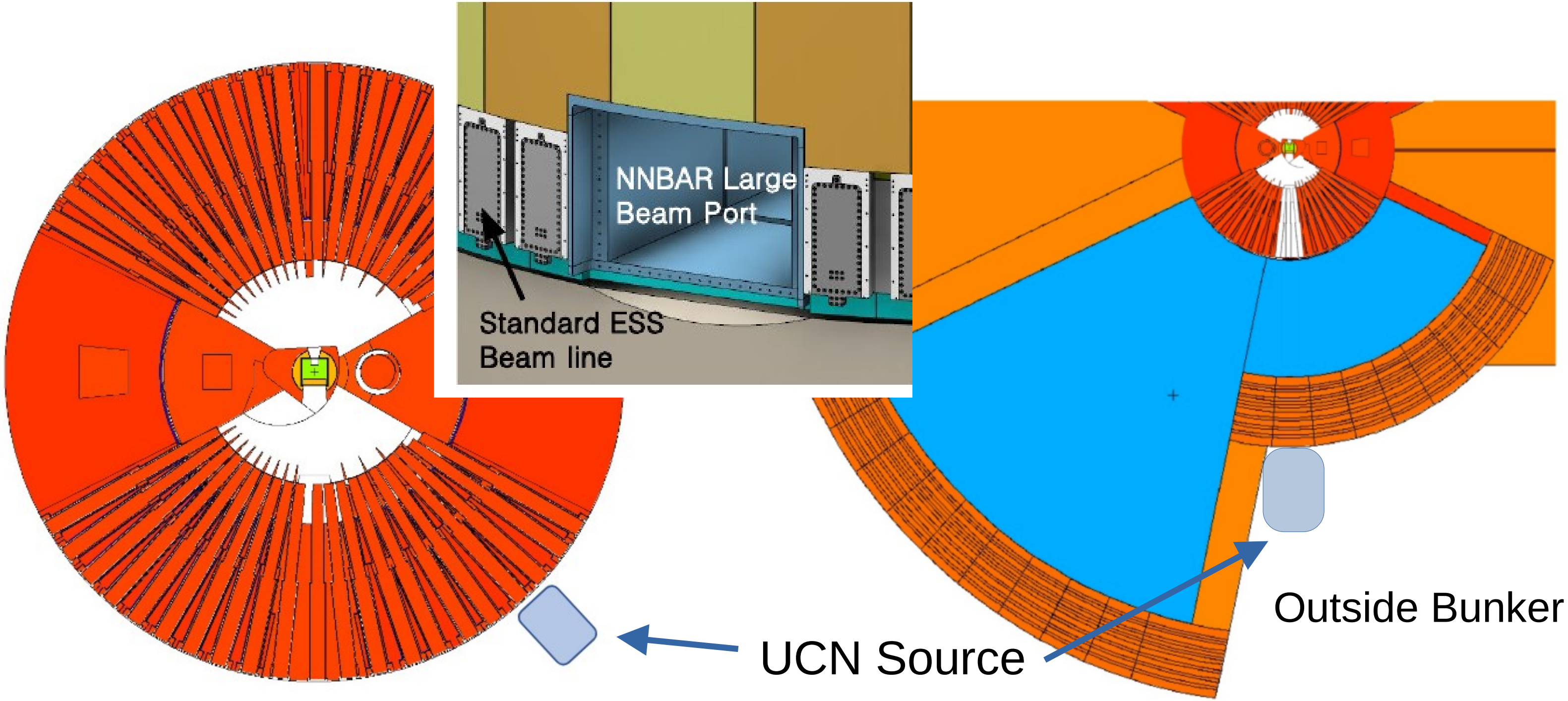
UCN In-Pile - Model Serebrov II Flux



Effect of LD2 reflector on flux inside source volume

- TBD: study variants of reflector material
  - ➔ MgH
  - ➔ Intercalated Graphite

UCN Source In-Beam Option



Outside Bunker (15m)

UCN Source

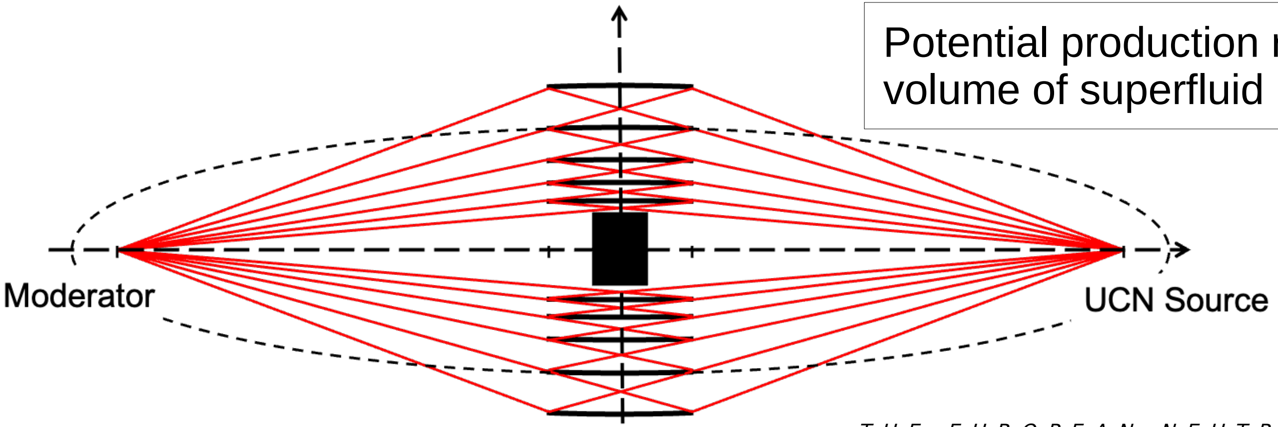
Inside Bunker (6m)

UCN Source In-Beam Option

- Need a neutron delivery system with high brilliance transfer from moderator to UCN source, with largest technically possible solid angle

- Neutron imaging from the moderator to the UCN source via the arrangement of nested mirrors has been identified as possible solution

  ➔ Talk from Oliver Zimmer at UCN/VCN Workshop



Potential production rate in 120 liter source volume of superfluid He: 2.5 x 10^7 n/s

Outlook

- Creation of detailed Flux maps for superfluid Helium Source
- Refinement of the UCN sources in the Beam ports;
  Study different reflector materials
- Work out detailed UCN production rates
- Exploring solid deuterium option
- McStas Simulations for in-beam option

Thank you for our attention!

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