

Update on ESS / HighNess[👑] / NNbar

HighNess Collaboration meeting
meeting at ESS • Lund • 21 June 2022



NNbar Collaboration meeting at ESS •
Lund • 22 June 2022



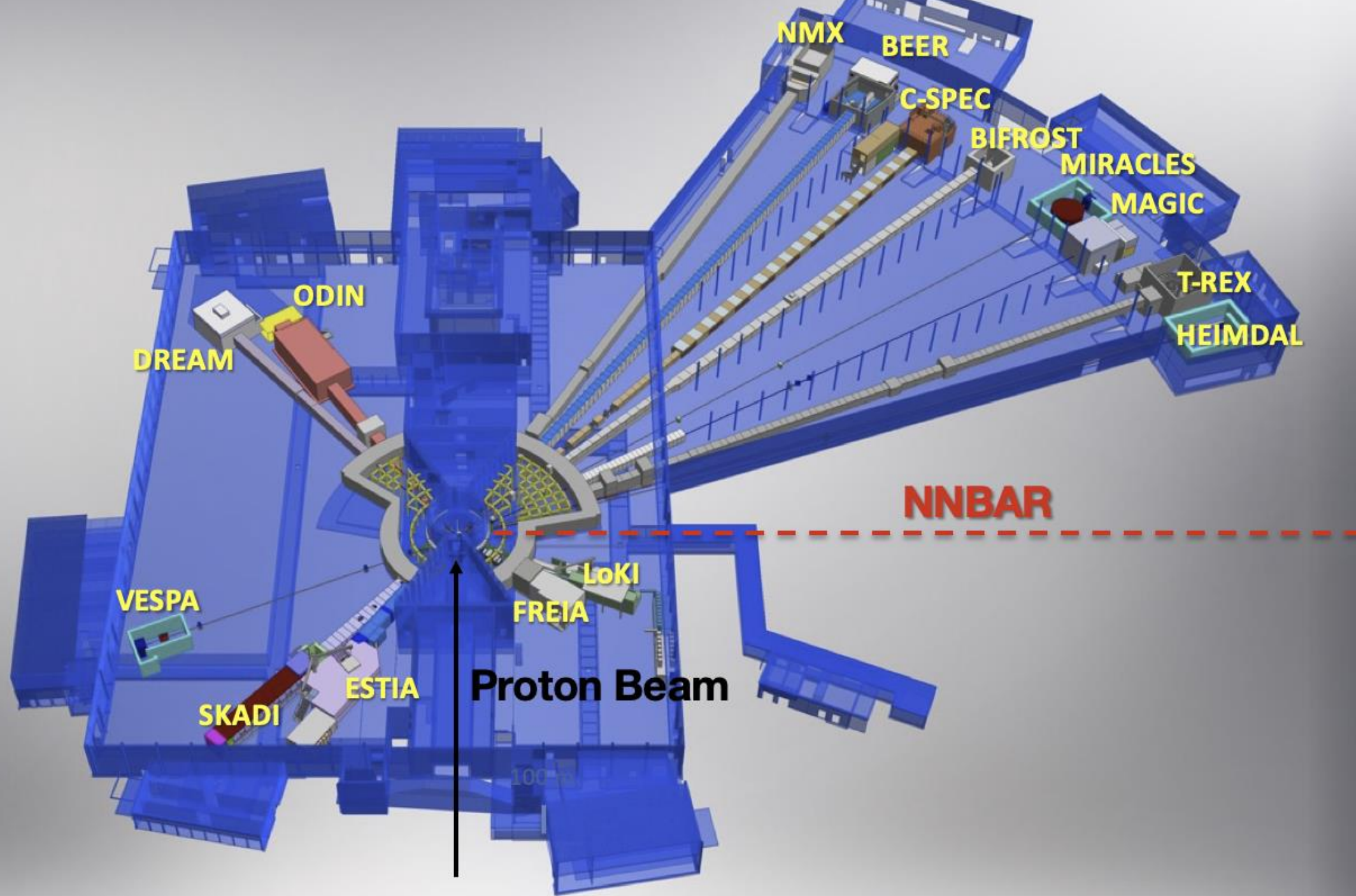
ESS now. First neutrons will be in 2026 used by “test beamline”

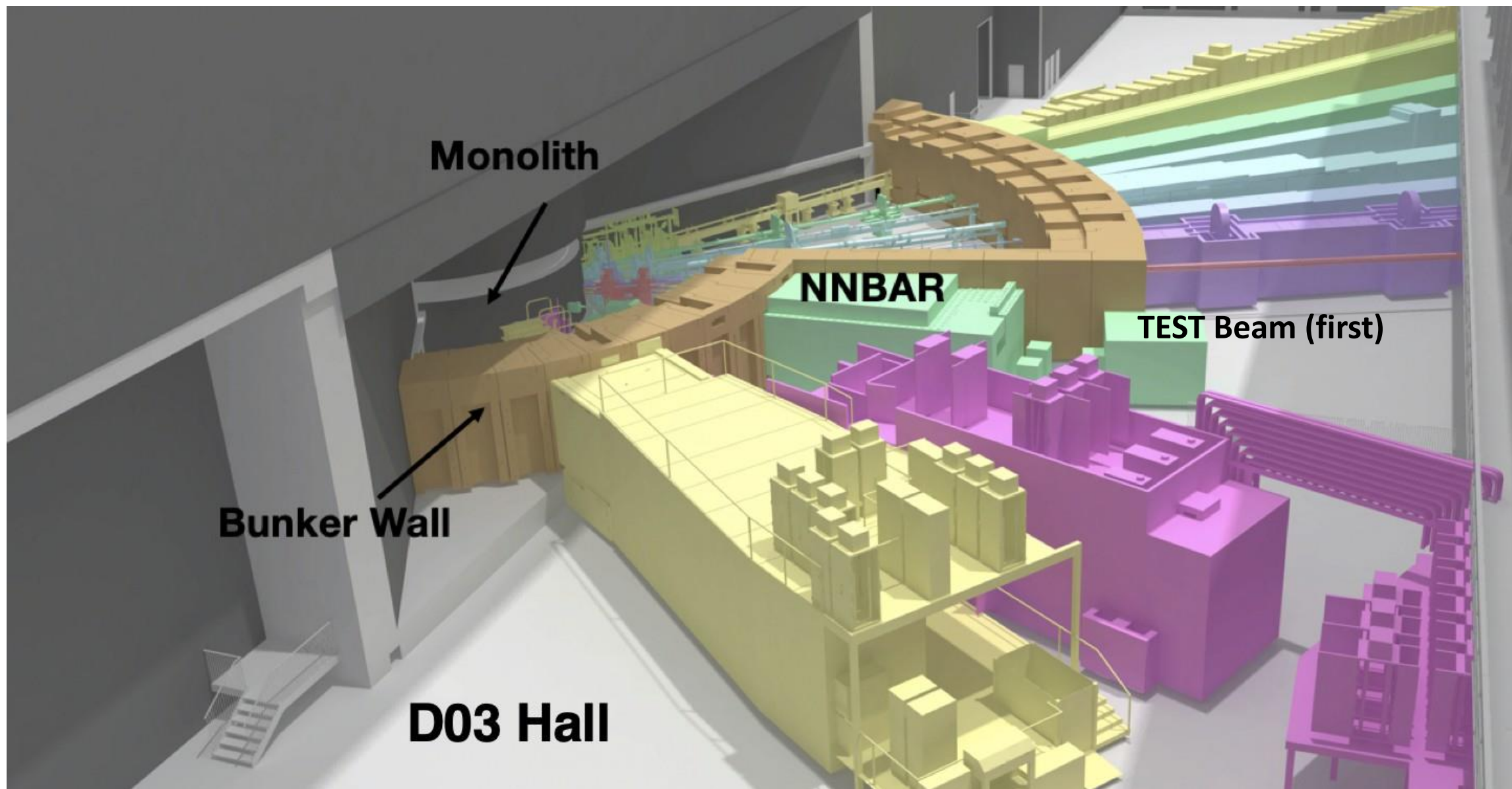




Future NNbar beamline

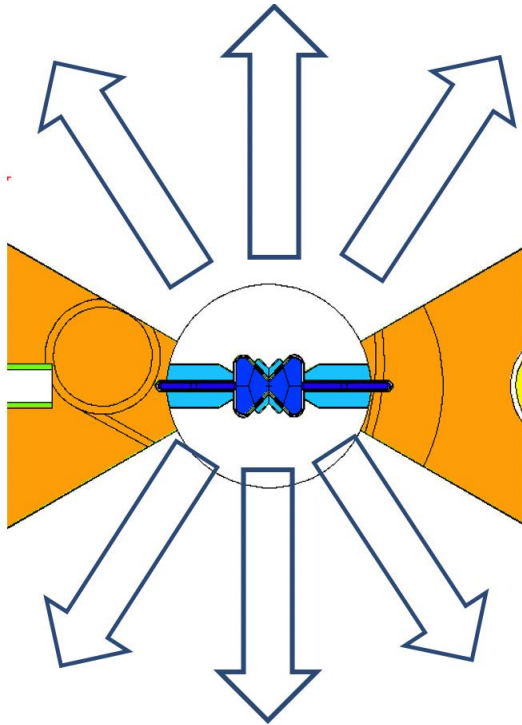






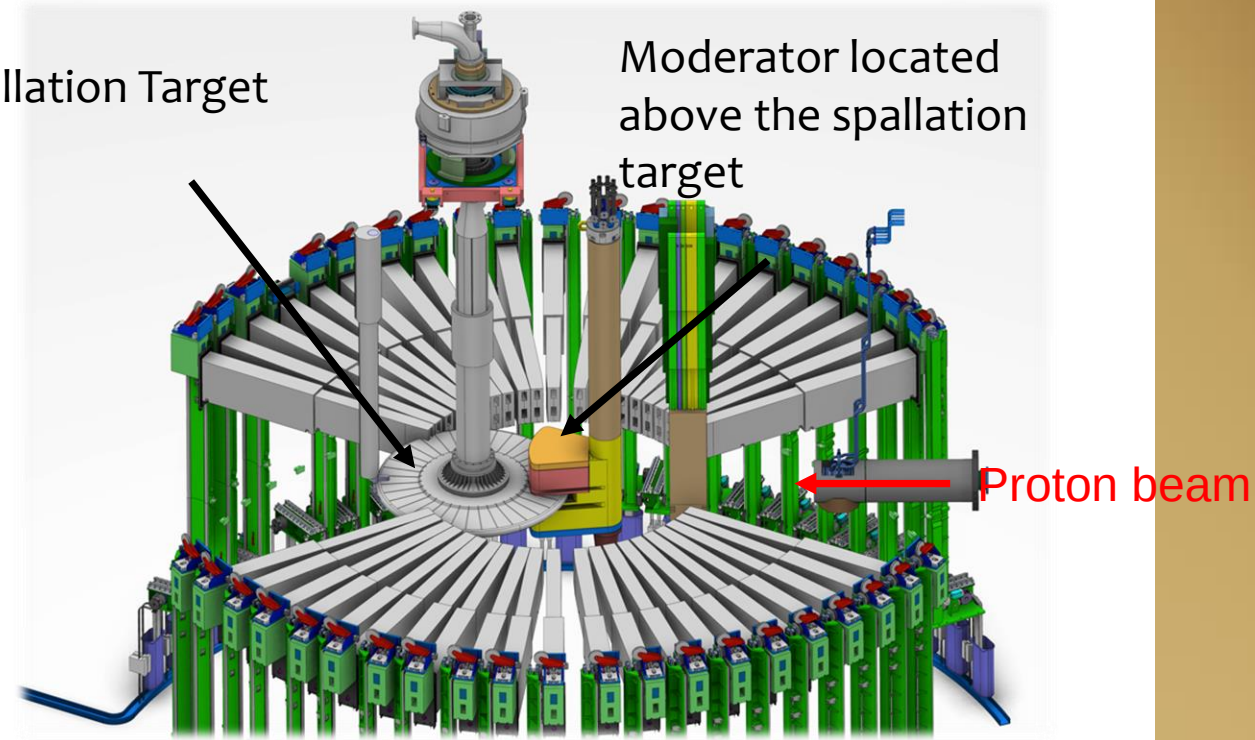
- The design of ESS moderator was based on the novel concept of low-dimensional moderators
- It is a single **high-brightness** moderator system placed on top of the spallation target
- All the first 15 instruments currently under construction, plus a test beam line, will view the upper moderator
- The space below the target is available for future upgrade → HighNESS project

ESS current moderator
unprecedented
brightness to all
the available
beamport

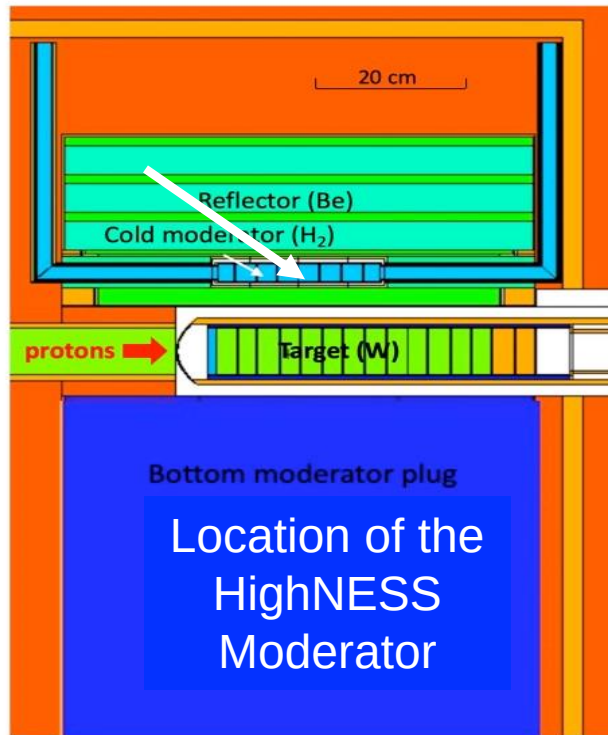


Spallation Target

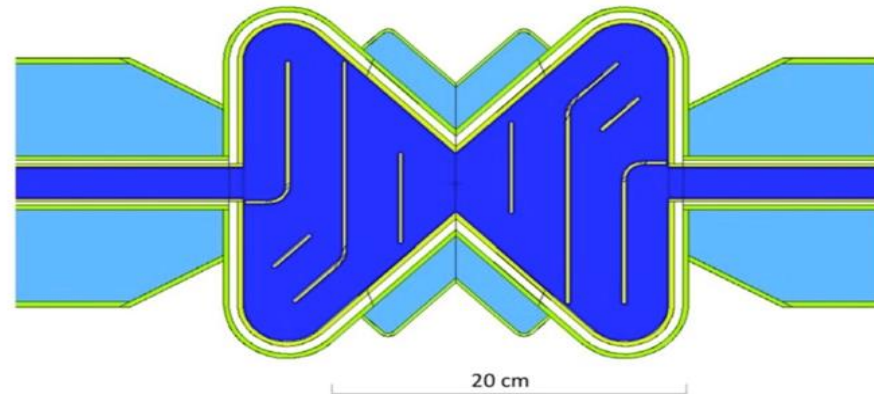
Moderator located
above the spallation
target



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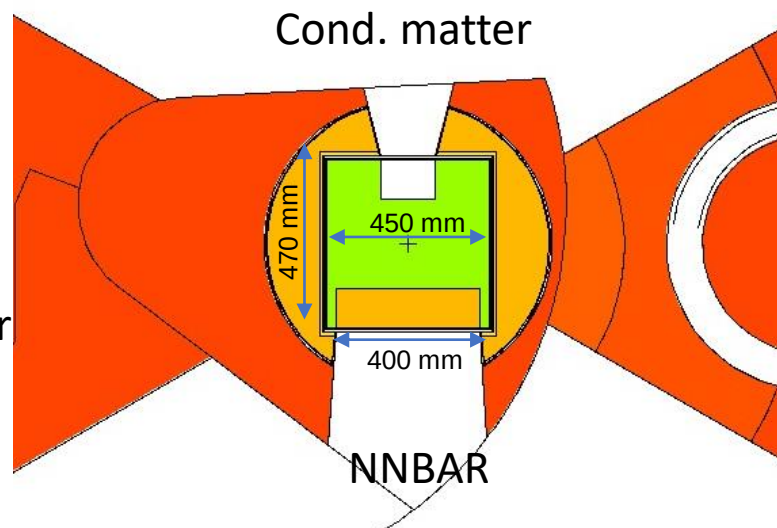
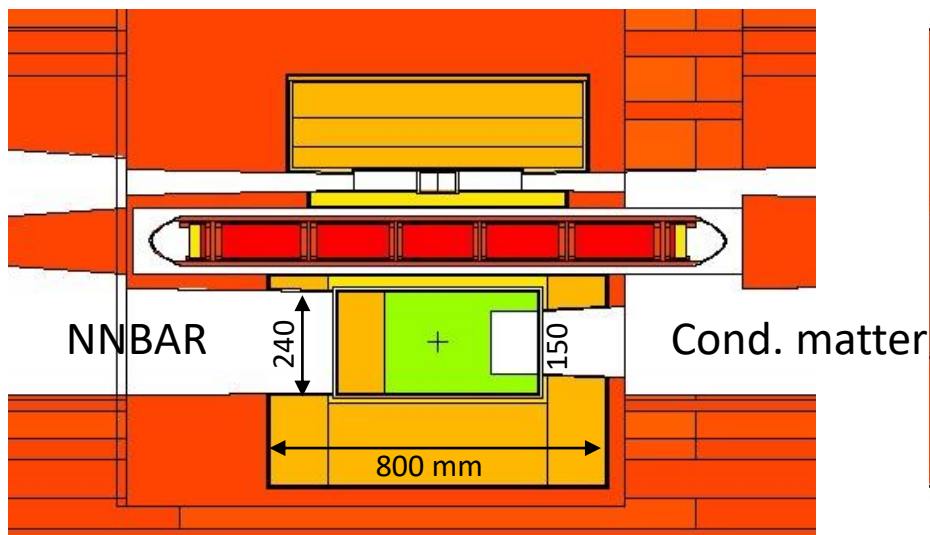
ESS current moderator
Located above the spallation target



Moderator thickness is 3 cm

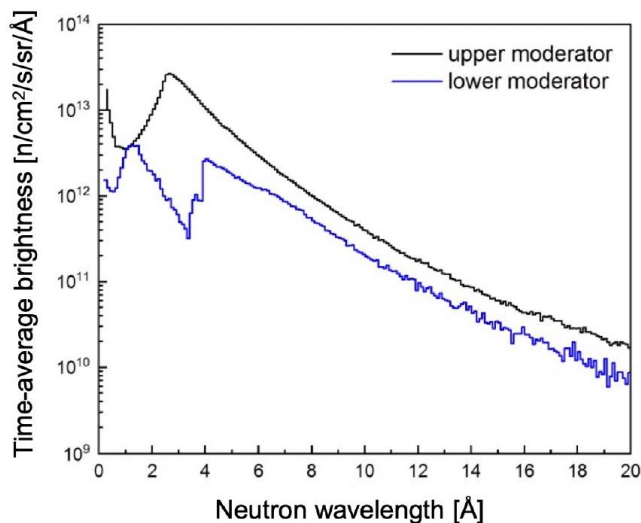
Design of the Cold Source

cold	2-20 Å
very cold	10-120 Å
ultracold	> 500 Å

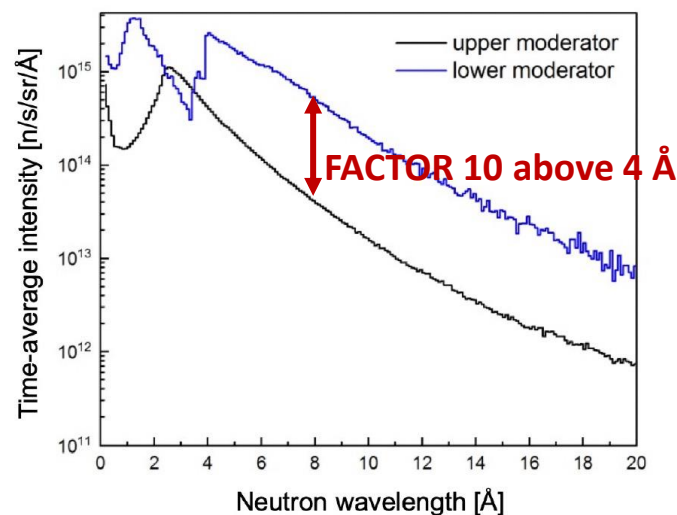


The high-intensity liquid deuterium moderator has been designed with two openings, for NNBAR and neutron scattering instruments

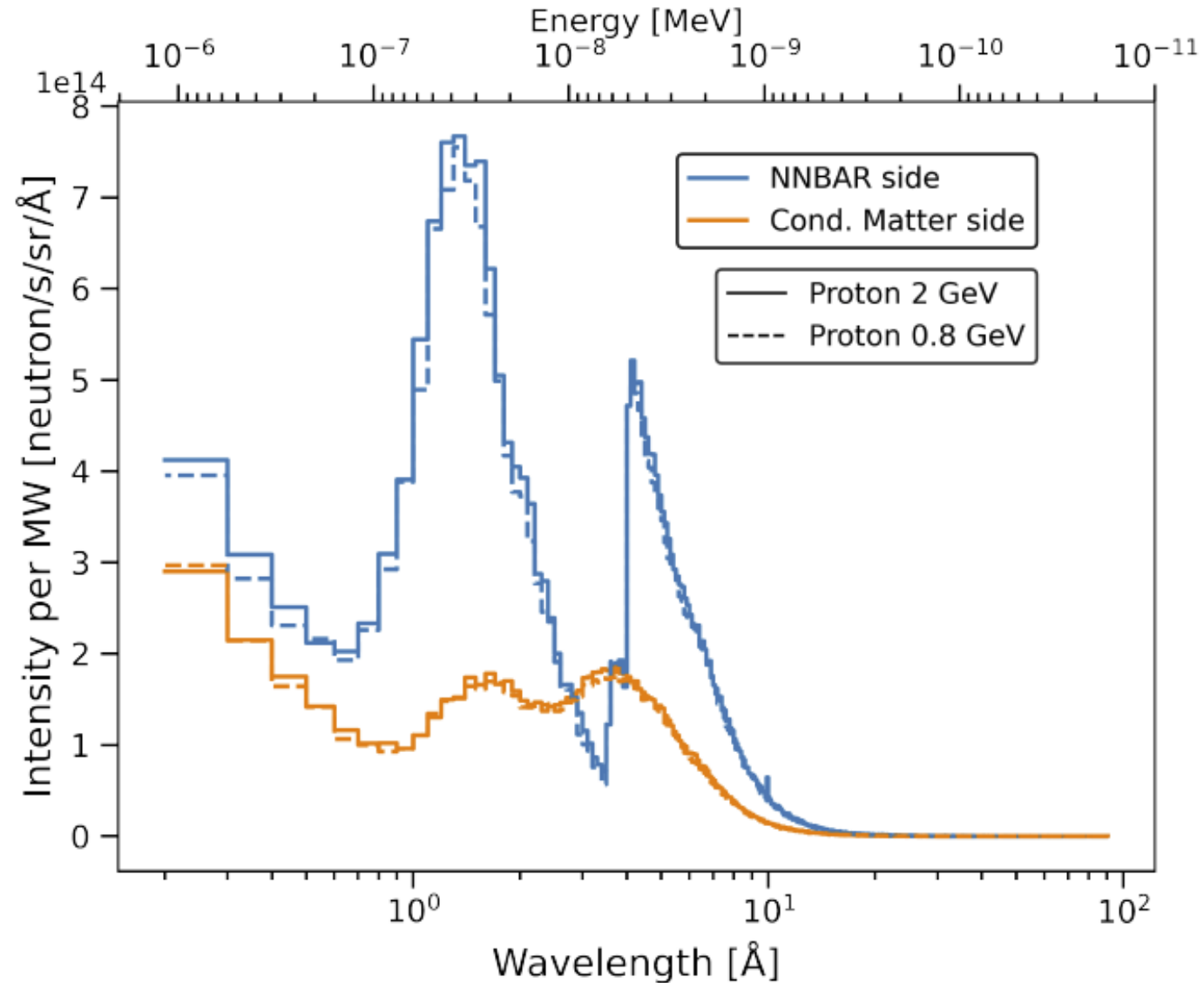
Brightness



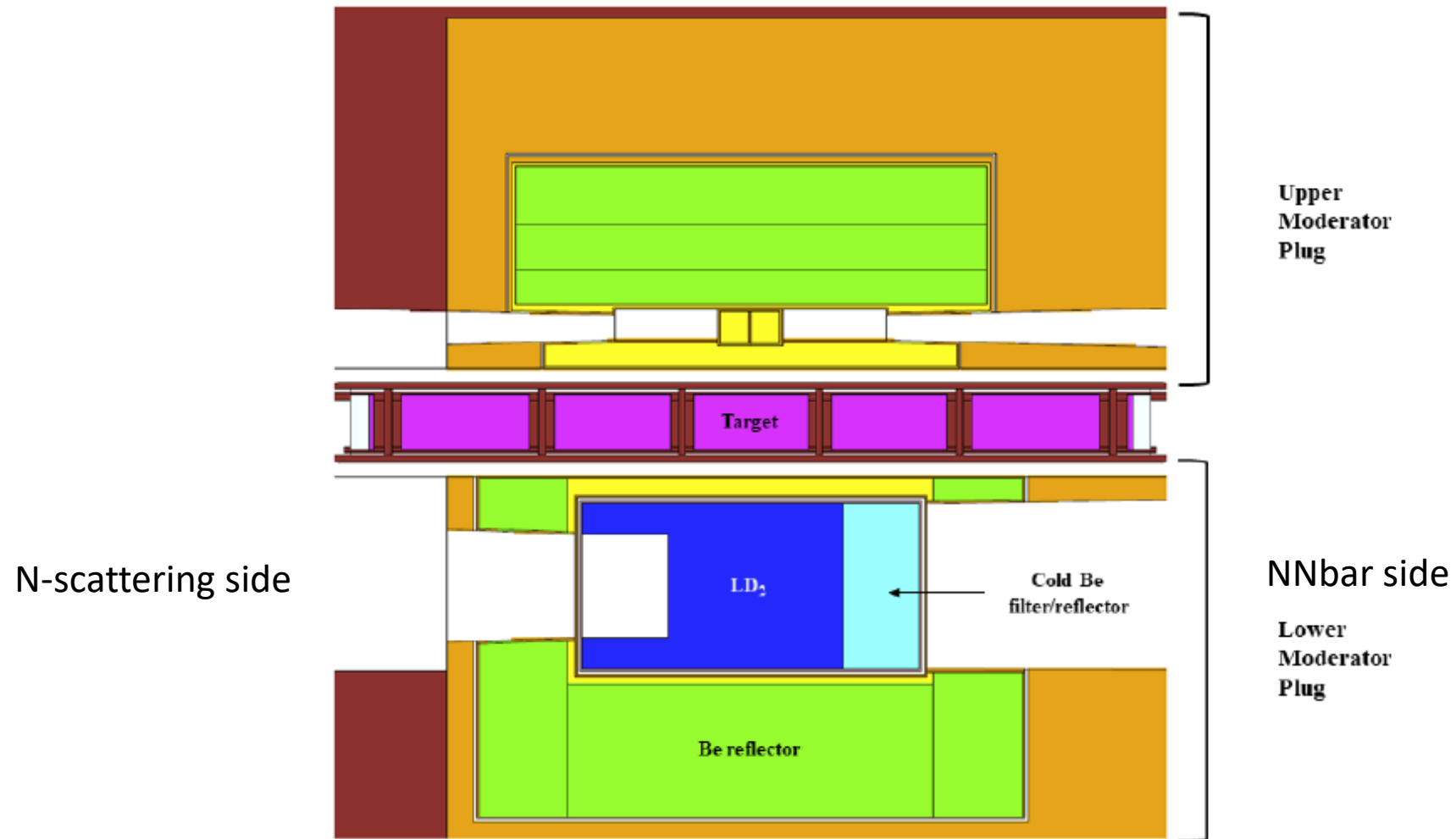
Intensity



Spectrum of intensity through LBP in current design

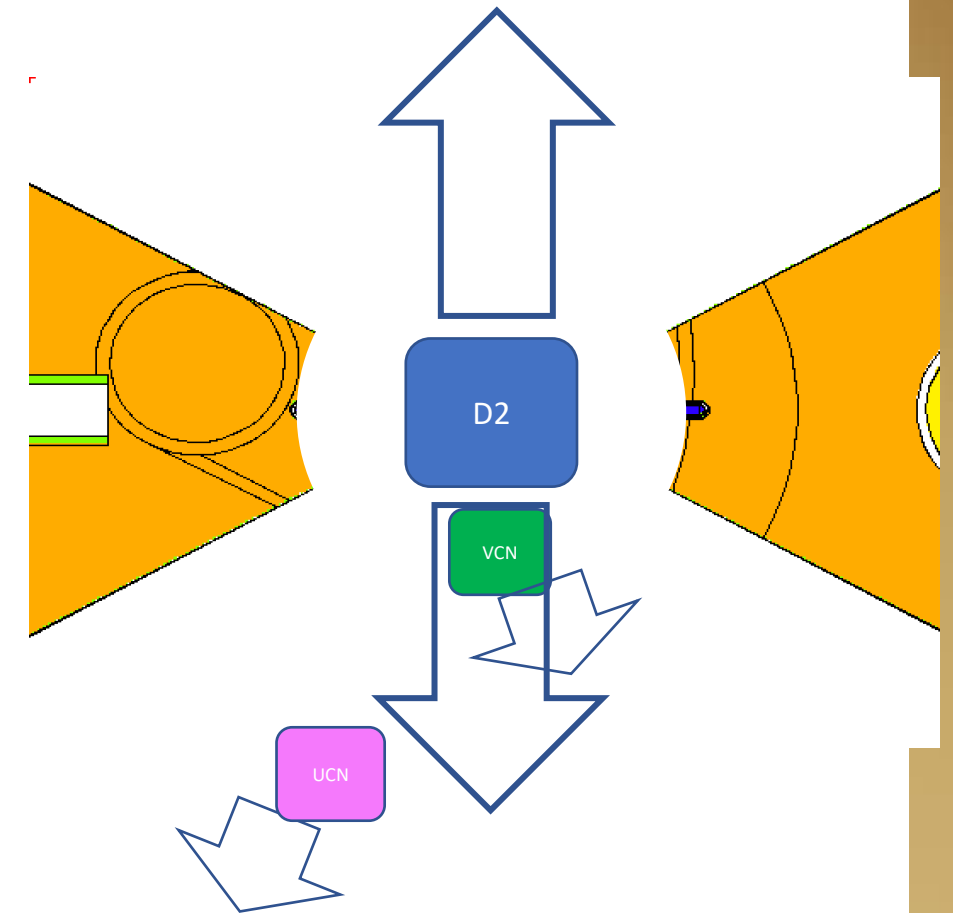


Lower LD_2 moderator design is goal of HighNESS Collaboration



Development of High Intensity Neutron Source at the European Spallation Source

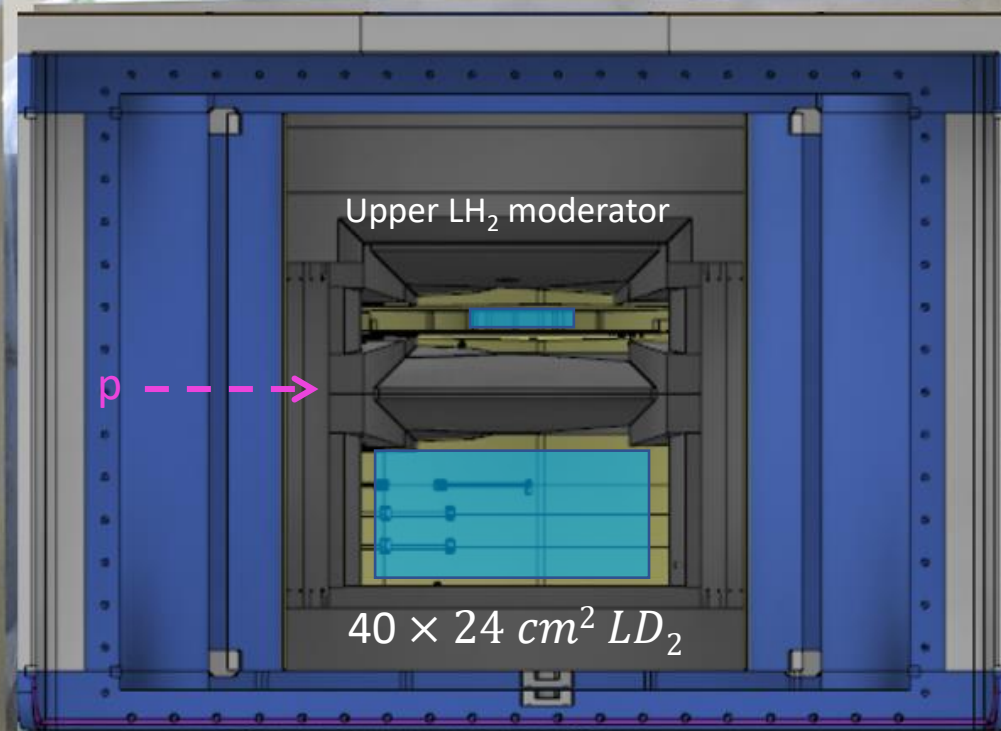
- The HighNess project (3 MEURO funded by the European Commission) has as purpose the development of the new source that will be installed at ESS >2030
- The new source will be composed by Liquid deuterium moderator D2
- The liquid deuterium will feed UCN moderator and VCN source
- The associated condensed matter instruments and the neutron antineutron oscillation experiment NNBAR will also developed in the project
- **Conceptual Design Report of the ESS upgrade is expected by the end of 2023**



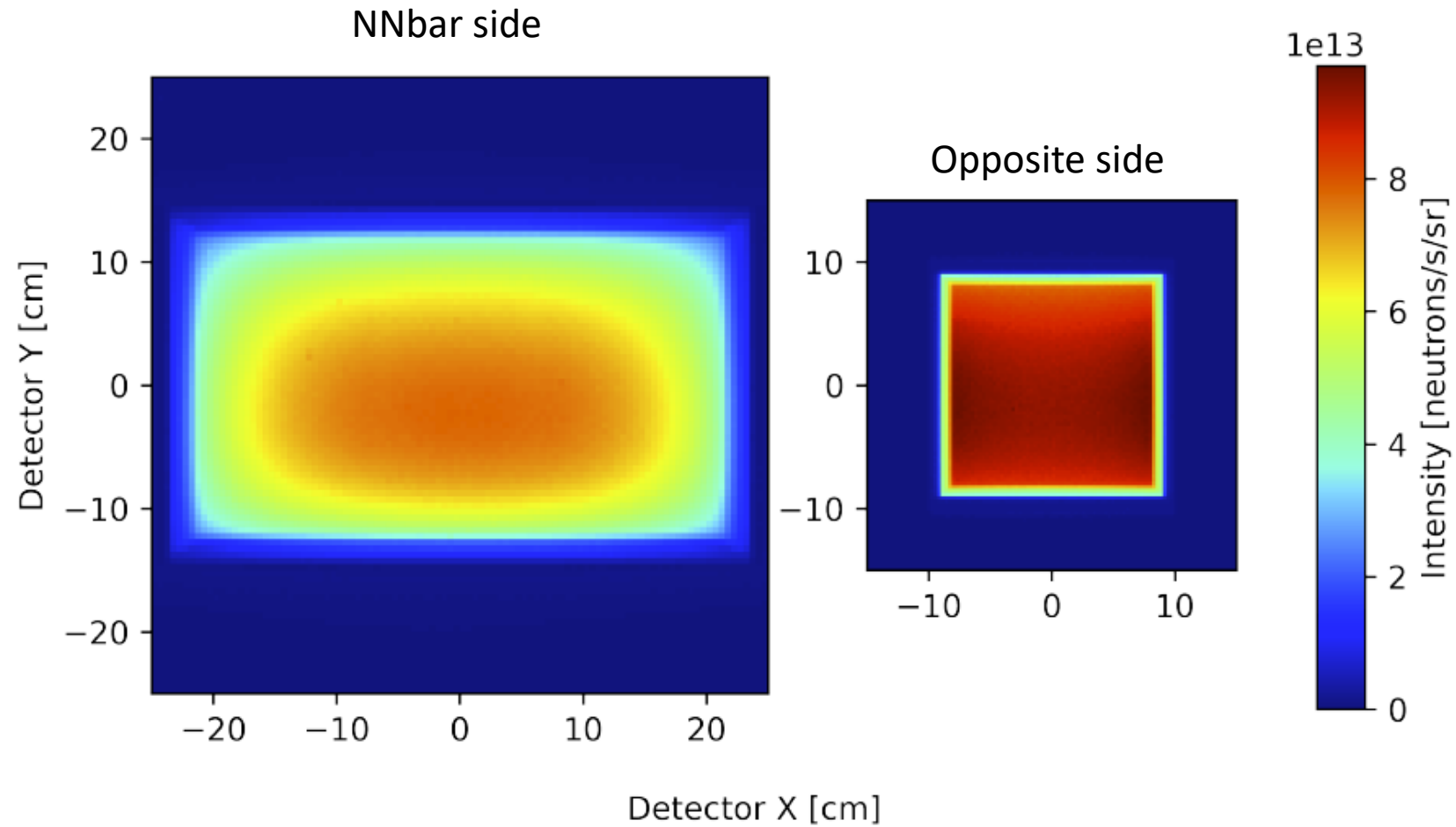
LARGE BEAM PORT (LBP)



What one will see through LBP

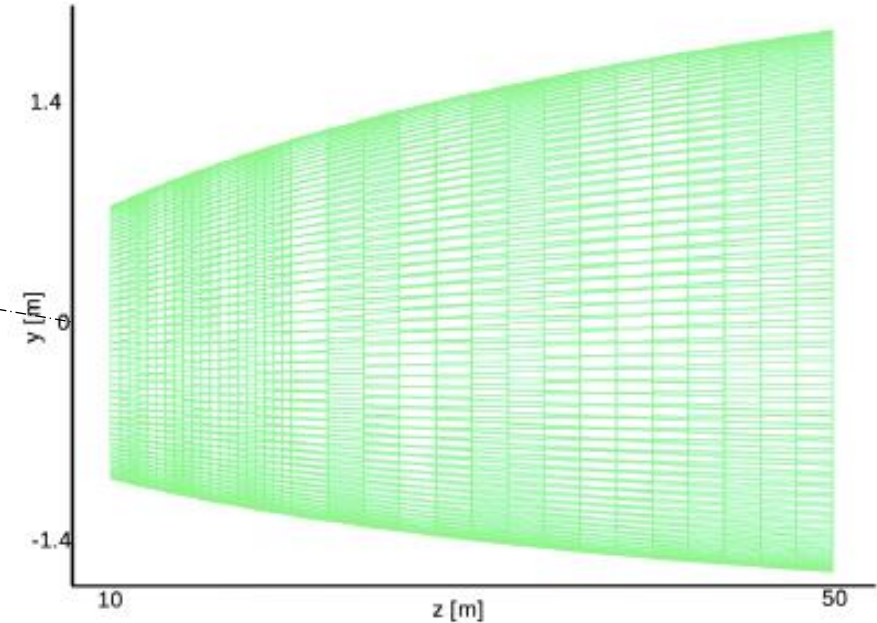
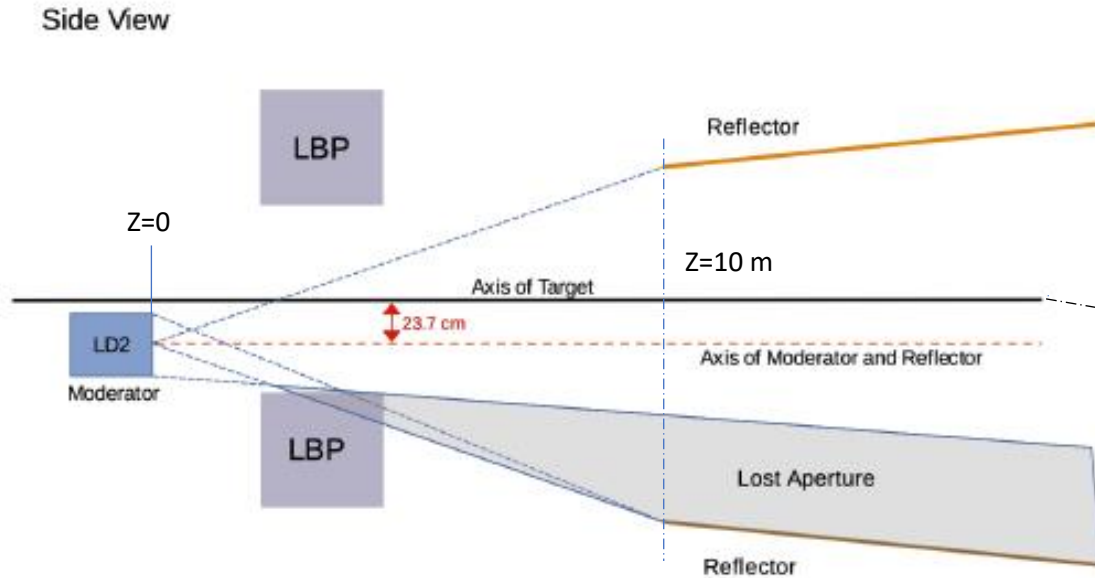


Brightness through LBP

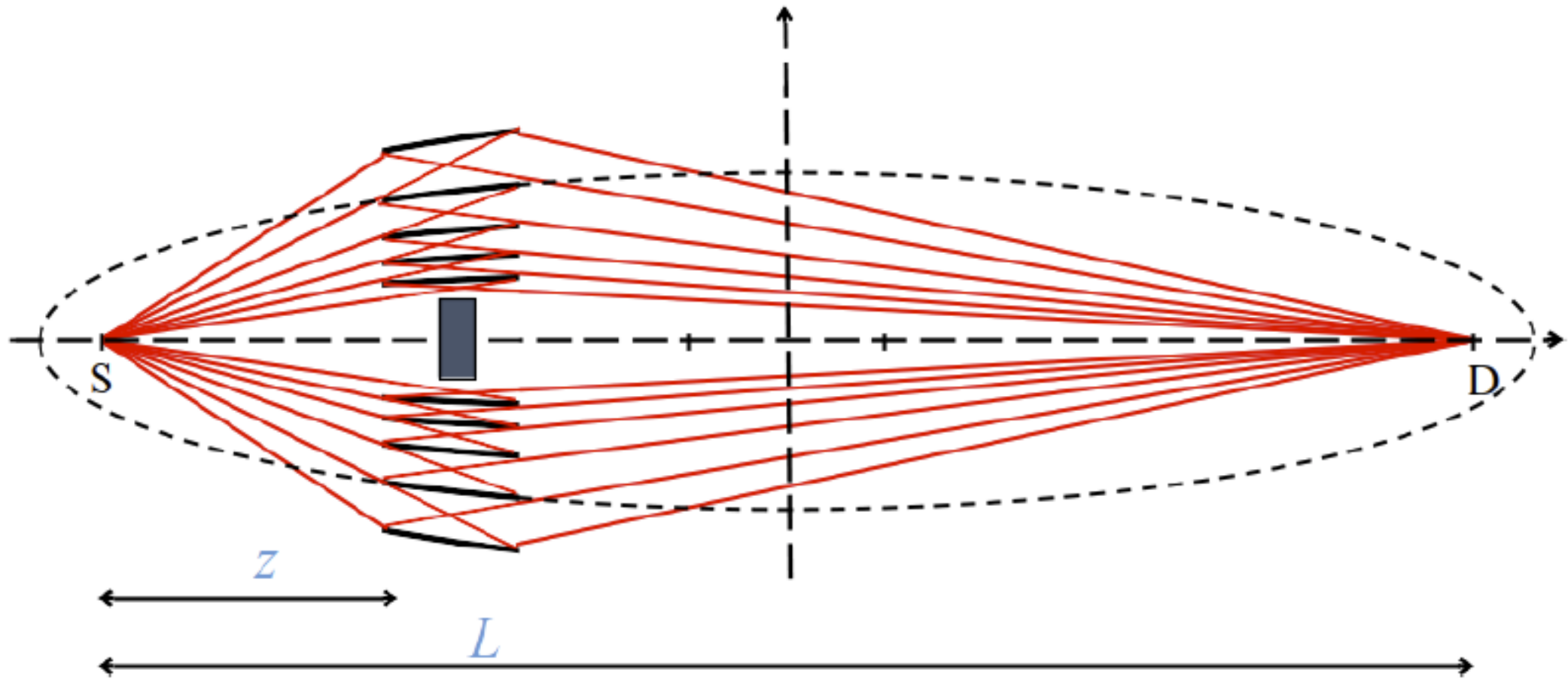


BASELINE NNbar “elliptical” focusing reflector needs to be “differential reflector” [Matt Frost]

By single reflection neutron is sent to the target 200 m away. Differential reflector bend and focus divergent neutron beam



With current LD2 design and baseline differential reflector (50% detector efficiency) at 2 MW ESS Power Figure of Merit $Nt^2 = \text{FOM} = 187$ ILL units per year. Goal of NNbar experiment was 1000 ILL units for 3 years t 5 MW



Nested reflector approach is being developed by Richard Wagner/ILL postdoc

Trends:

1. NEW ESS Director Professor Helmut Schober (from ILL) supports development of NNbar
2. HighNESS needs to produce a Conceptual Design Report for LD2 moderator by fall 2023
3. Goal of NNbar Collaboration to produce CDR for NNbar also by Fall 2023
4. Collaboration ESS/ORNL in Moderator design and fundamental physics (nnbar and nn')
5. Valentina Santoro (spokeswoman of HighNESS) will try to invite Marcel D. to visit ESS and discuss collaboration
6. Pin-hole imaging "Beam Test" will occupy Large Beam Port in 2026-2027 as first running ESS experiments
7. Beam Test should be replaced by HIBEAM for nn' and nnbar search > 2027
8. David Milstead (NNbar spokesman) is trying to make HIBEAM a national Sweden project growing to NNbar
9. ANNI beamline is a spare version of HIBEAM
10. 2 MW power until ~ 2035. There is an attempt to reach FOM = 1000 with 2 MW x 3 years by "optimization"