Characteristics of the SNS Source

Phil Ferguson

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Outline

- Target System overview
- Calculational method
- Target station neutronics
  - mesh tallies
  - time averaged spectra
  - pulse shapes
- Other issues
- Summary

The Spallation Neutron Source

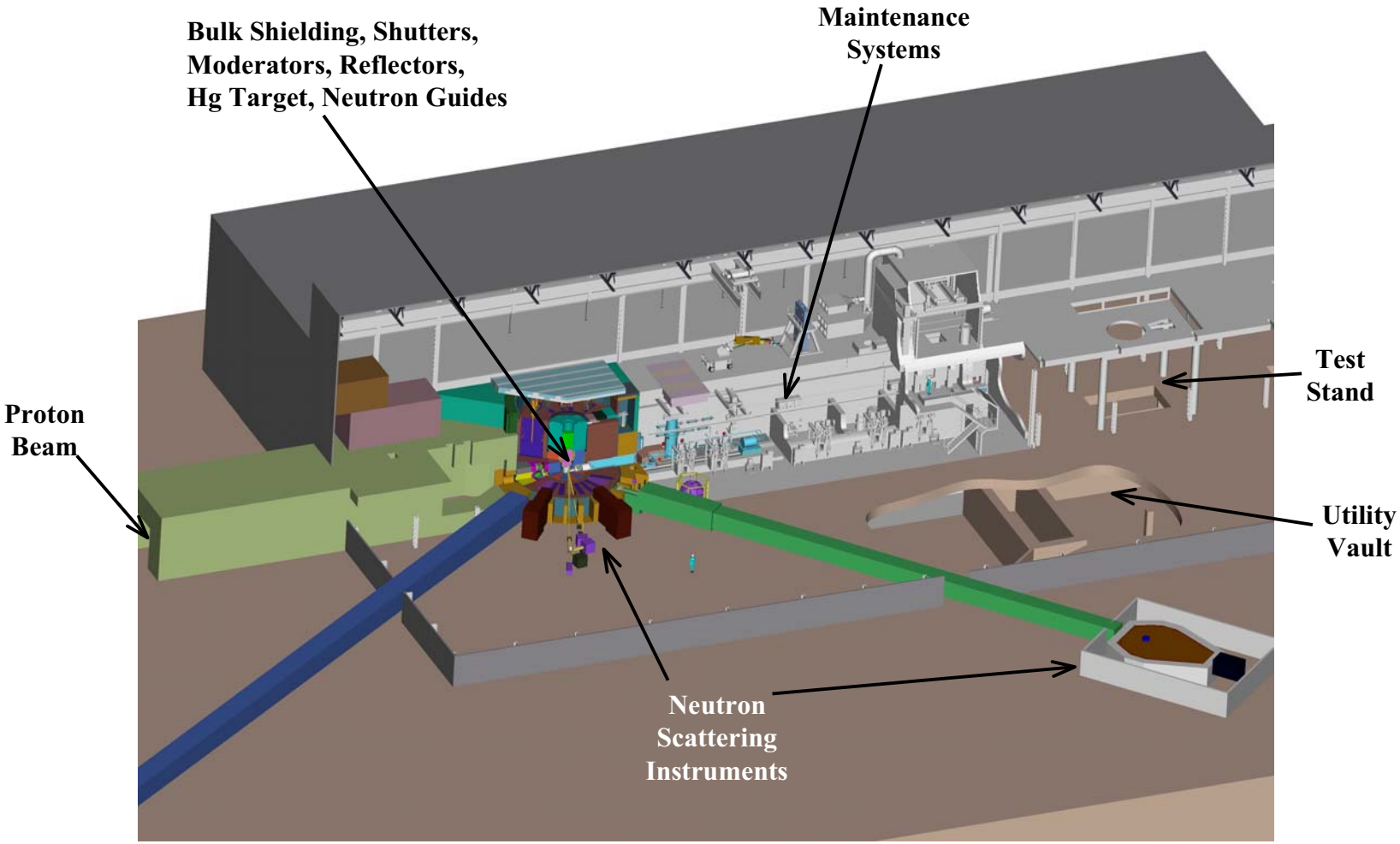
- The SNS will begin operation in 2006
- An order of magnitude higher power than ISIS, the world's leading pulsed spallation neutron source
- The peak thermal neutron flux will be ~50-100x ILL
- SNS will be the world's leading facility for neutron scattering
- It will be a short drive from HFIR, a reactor source with a flux comparable to the ILL

Construction is well underway

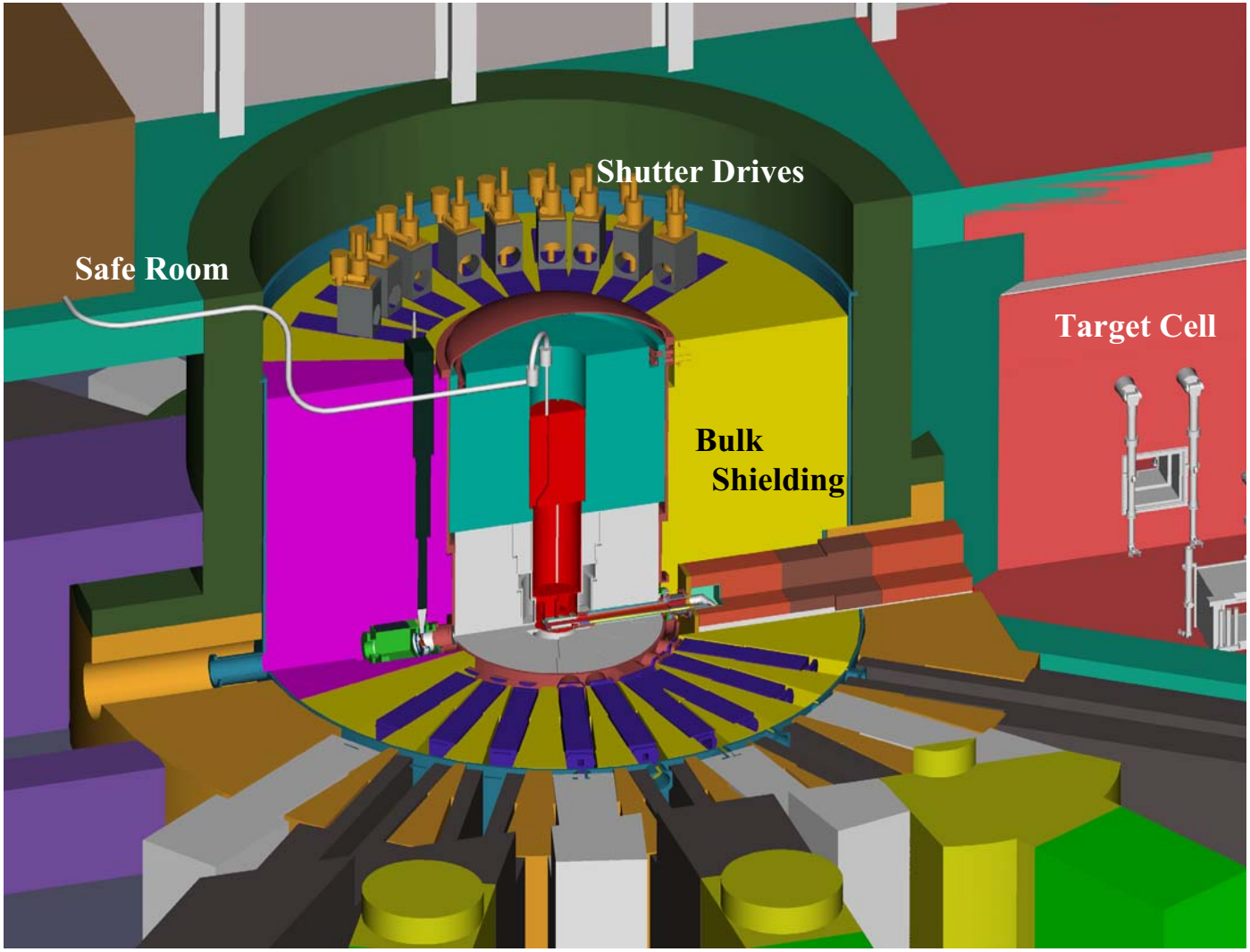
- Completed Linac tunnel excavation
- Completed Target Building deep foundation installation

•Front End and Linac Tunnel concrete installation under way!

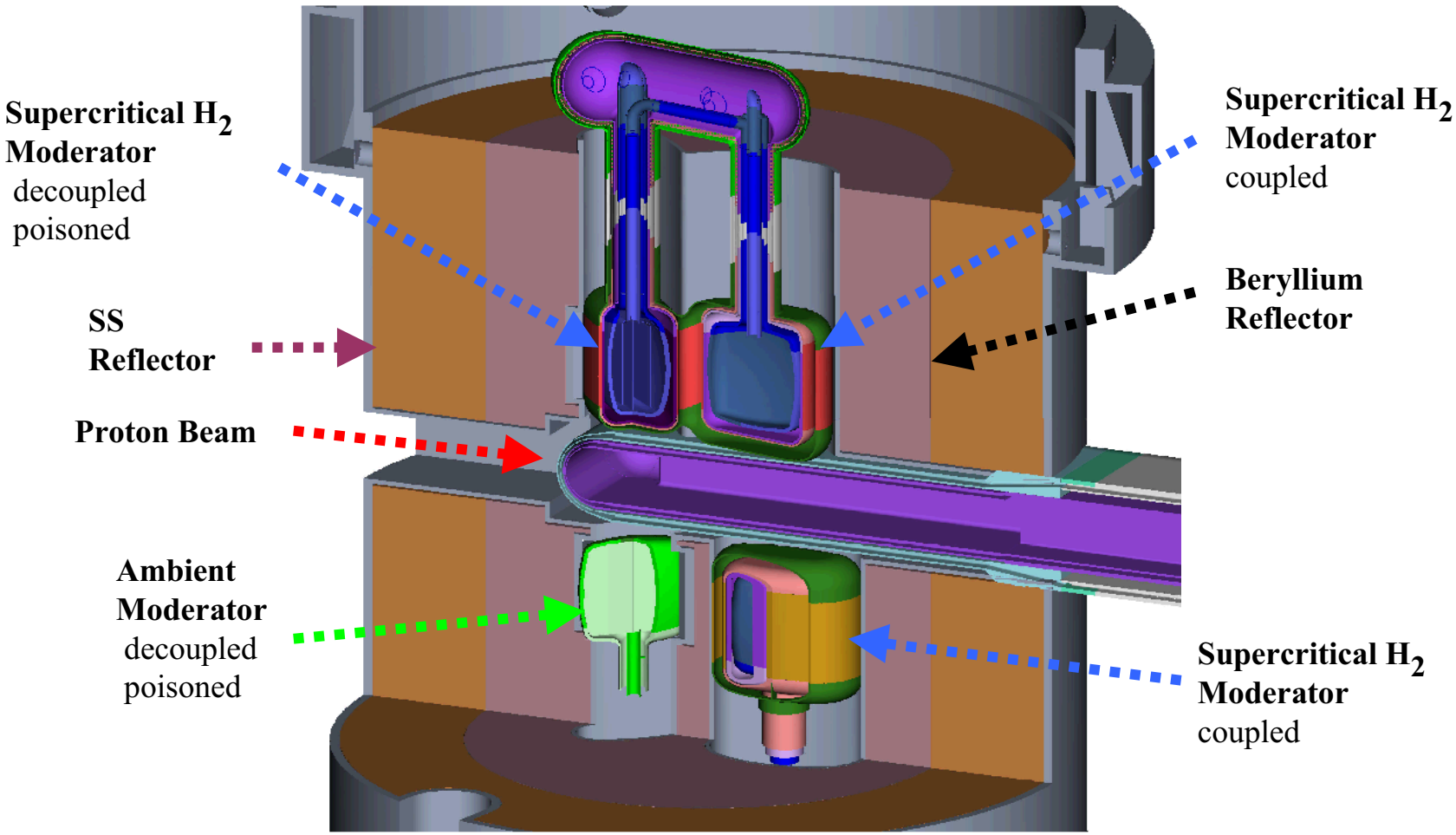
Global view of the SNS target station



Target station cut away



Elevation view of SNS target station



Key parameters

Proton Beam :	1-Gev, 1.4 MW, 60 Hz, < 1 μsec/pulse
Target/Container:	Hg / SS316
Moderators:	3 supercritical hydrogen, 1 ambient water
Reflector:	Be/SS 316 cooled with heavy water
Neutron Beam Lines:	18 Shutters - 24 beams

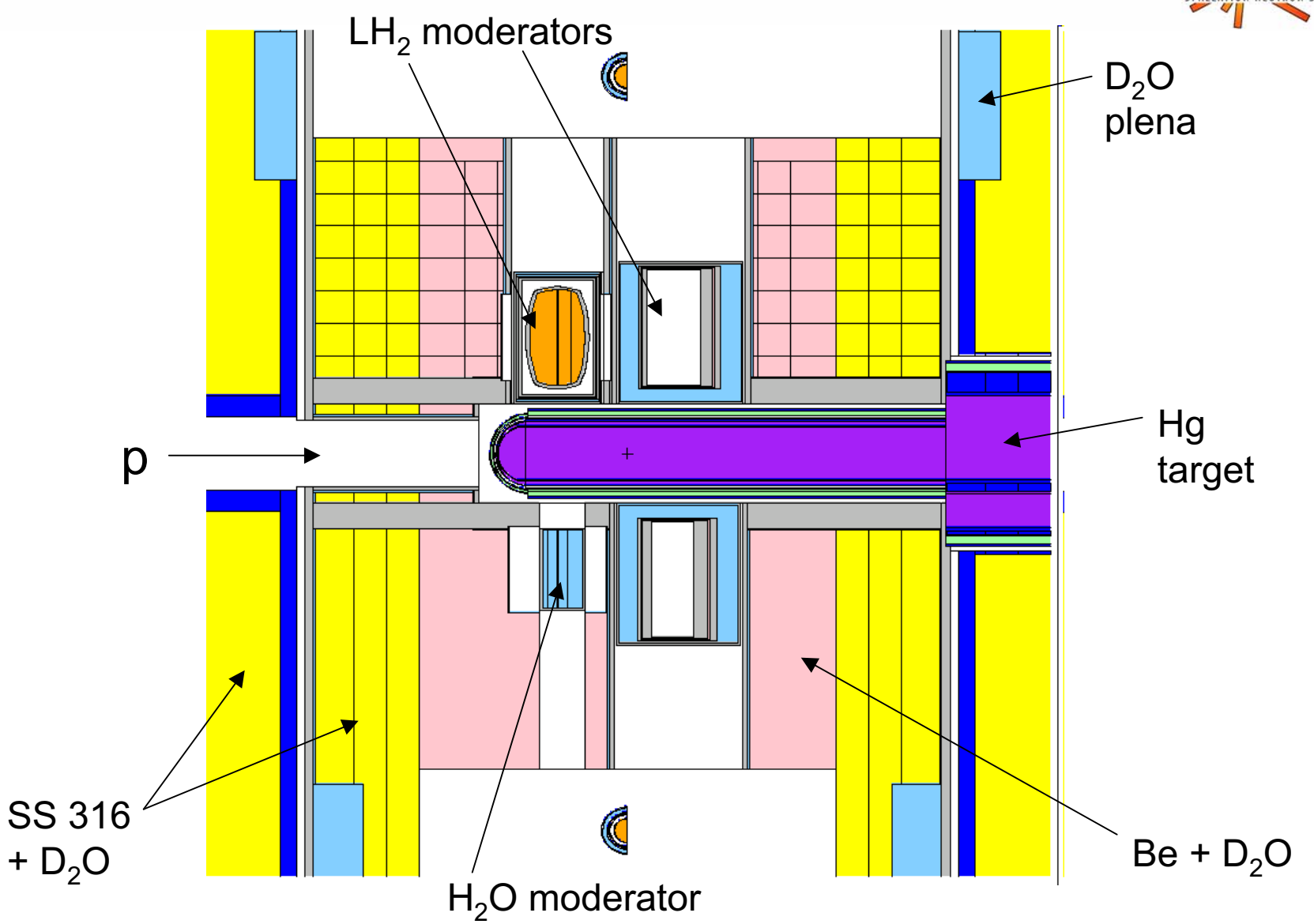
Calculational methodology

- Monte Carlo (MCNPX Code System)
  - complex geometries in three dimensions
  - computationally intensive
  - general usage
- Discrete ordinates (DOORS system)
  - shielding applications
  - 1, 2, or 3 dimensions as applicable
  - fast
- Hybrid calculations
  - MCNPX for source definition
  - DOORS for deep penetration

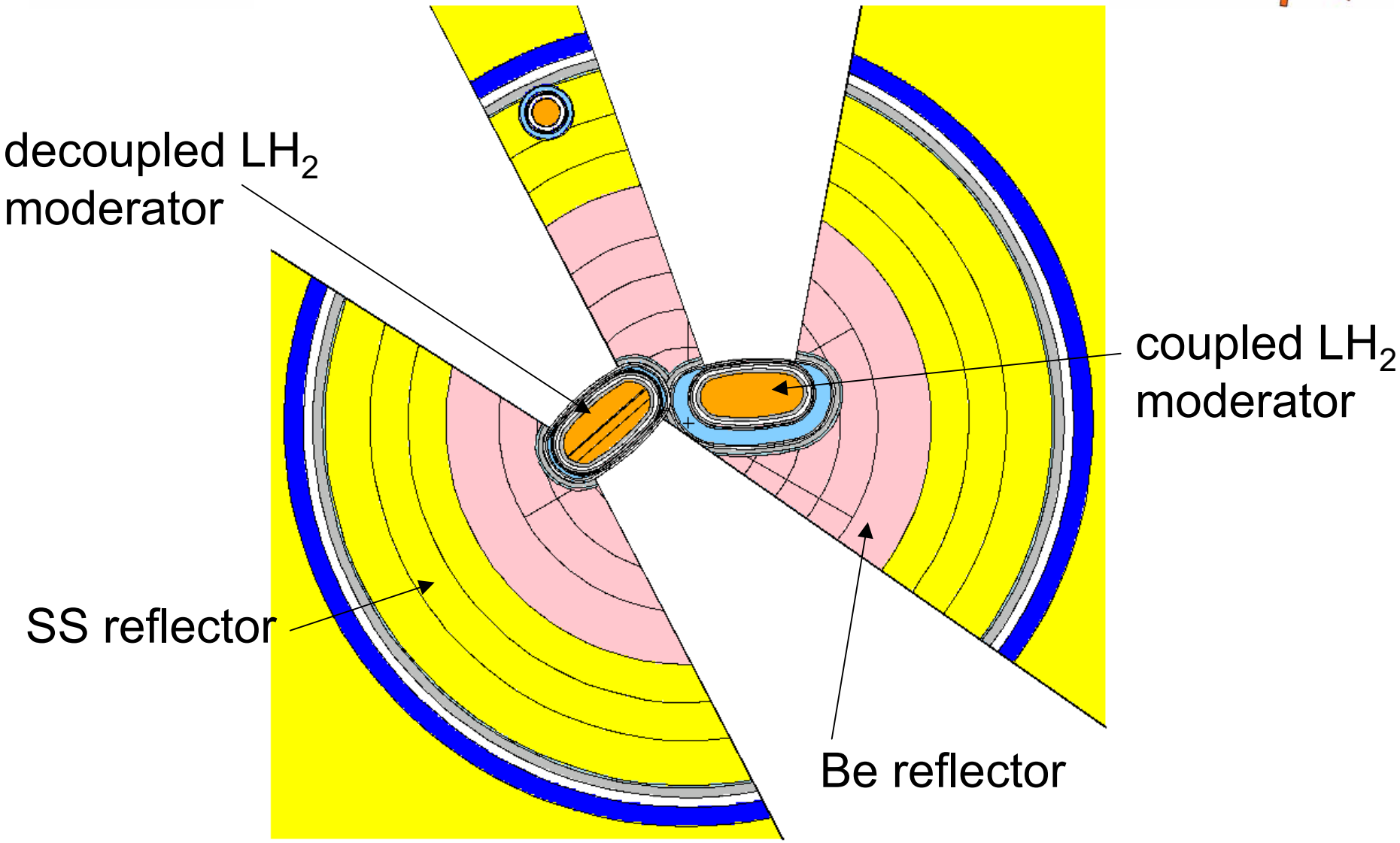
How good are the calculations ?

- Integral neutron production compares well to measurements
- Relative variations are better than absolute values
  - optimization studies give the right magnitude of the trends, not always the right value
- Prediction of LH_2 moderator performance is not as good as H_2O
  - ortho/para-hydrogen concentration is not well known
  - scattering kernels for liquid hydrogen are not well known
  - integrals are still probably OK, but time distributions are suspect
- For coupled moderator, long time tails depend more on reflector structure than moderator details
- Nothing beats measurements, physics, and intuition
  - if we don't believe the calculations, design conservatively

SNS target station Monte Carlo model, elevation view

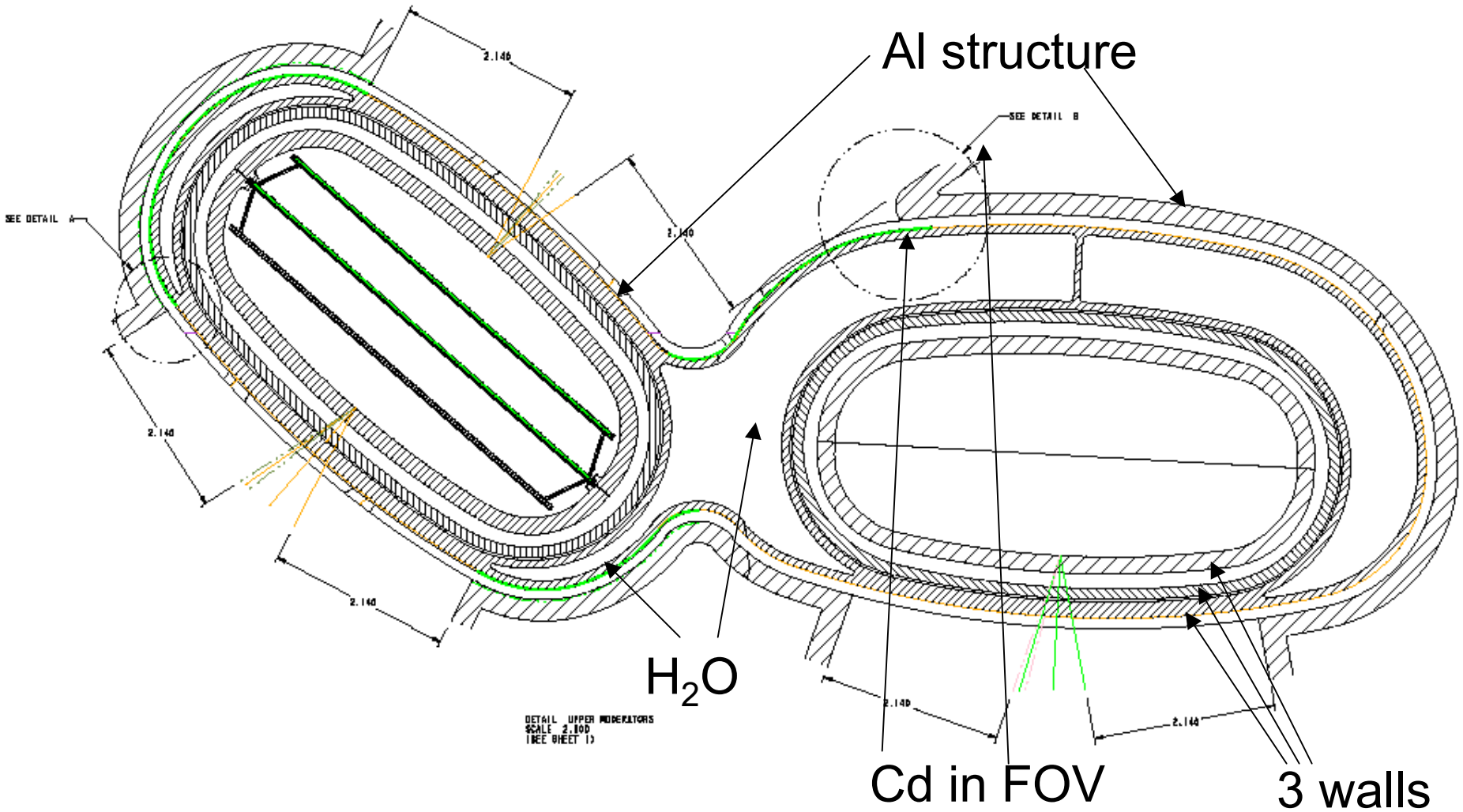


SNS target station Monte Carlo model, plan view through upper moderators



What do the moderators physically look like ?

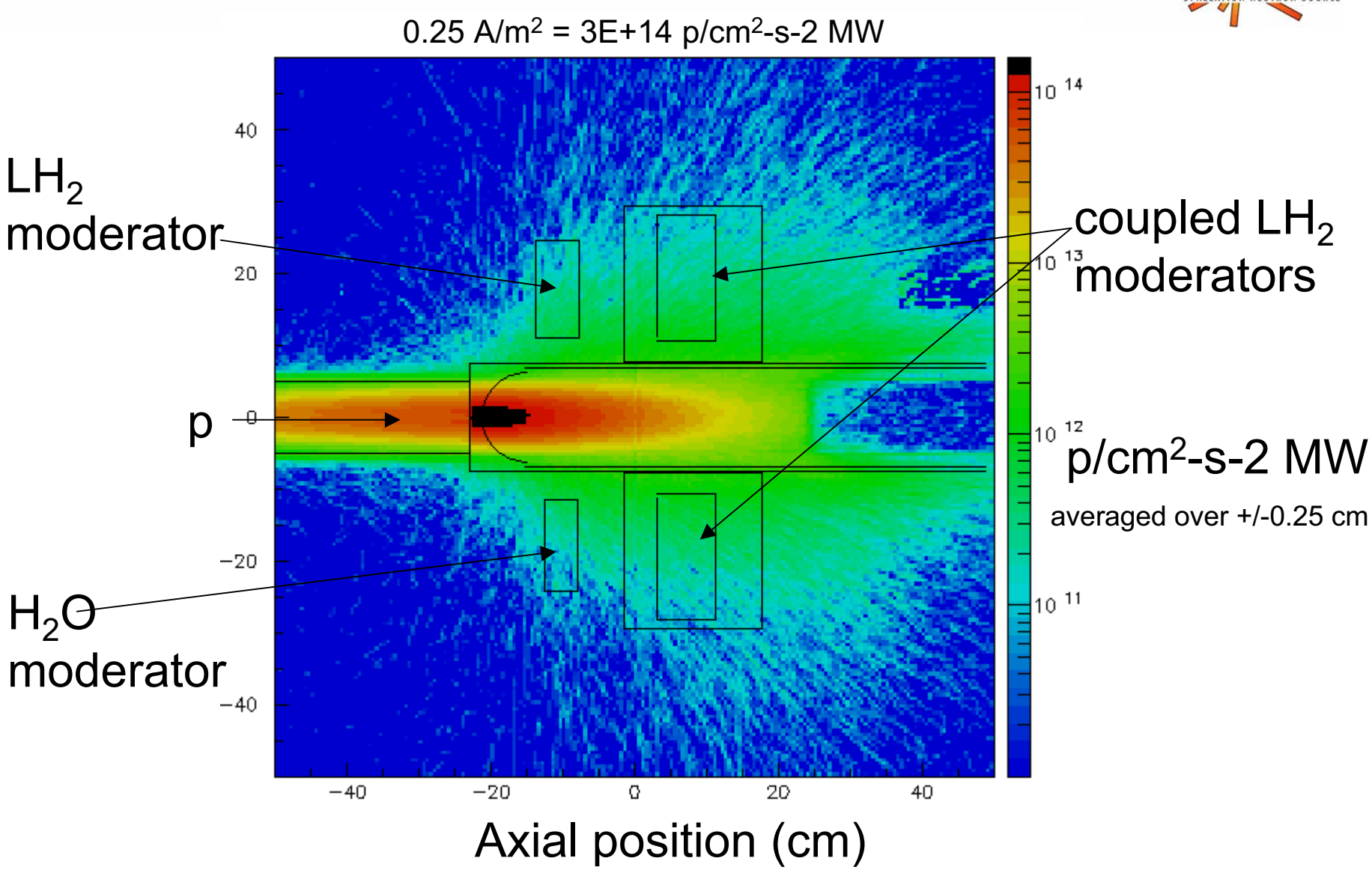
Top moderators (bottom coupled LH_2 is similar)



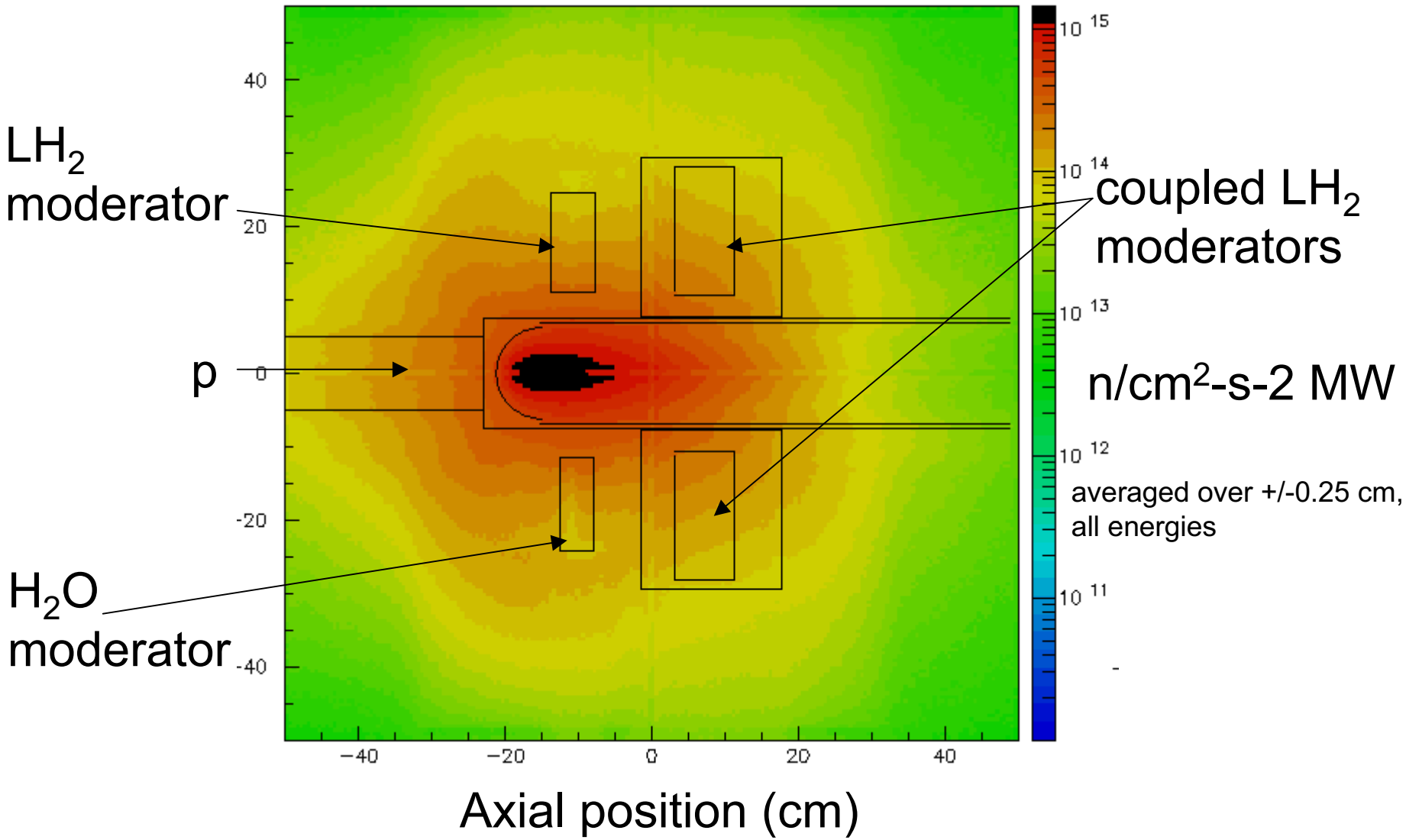
Moderator details

- Upstream moderators are decoupled, poisoned, and viewed from two surfaces
  - LH_2 is symmetrically poisoned at ~2.7 cm
  - H_2O is asymmetrically poisoned
    - high intensity face (upstream face) poisoned at 2.5 cm
    - high resolution face (downstream face) poisoned at 1.5 cm
  - Poison material is Gd, decoupler is Cd
- Downstream moderators are coupled LH_2, premoderated, and viewed from one surface
  - decoupler material is in the field of view behind Be and D_2O

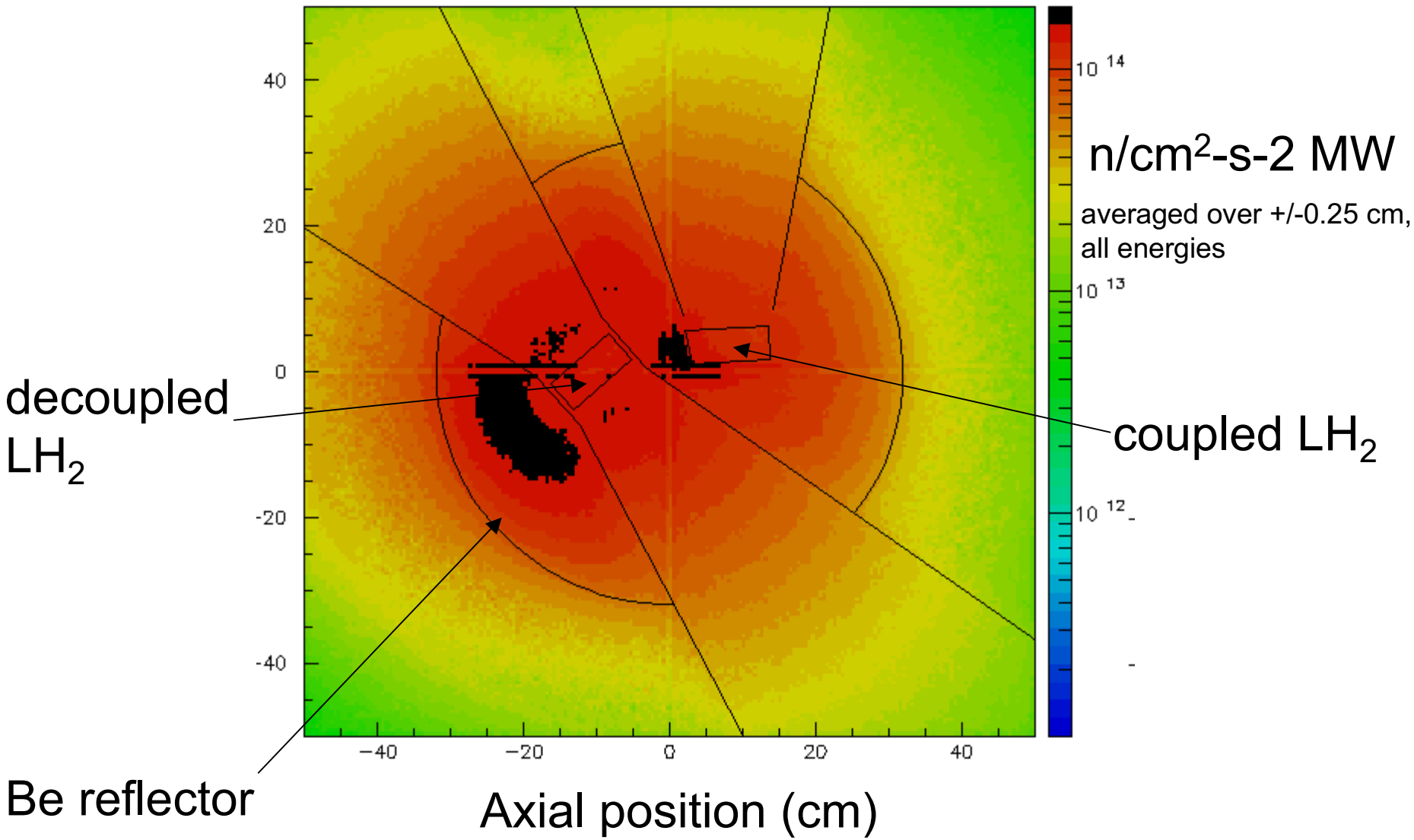
Proton flux, elevation view



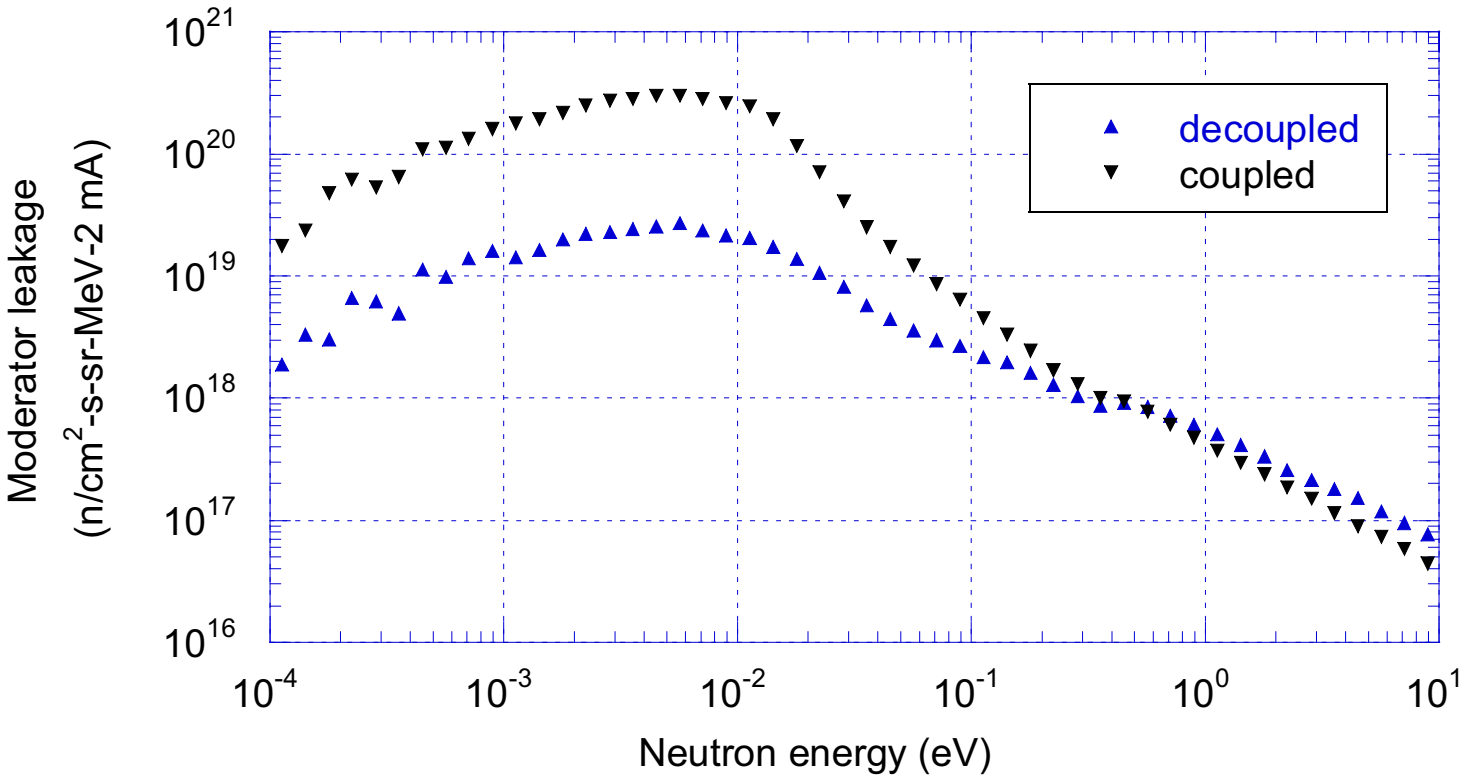
Neutron flux, elevation view



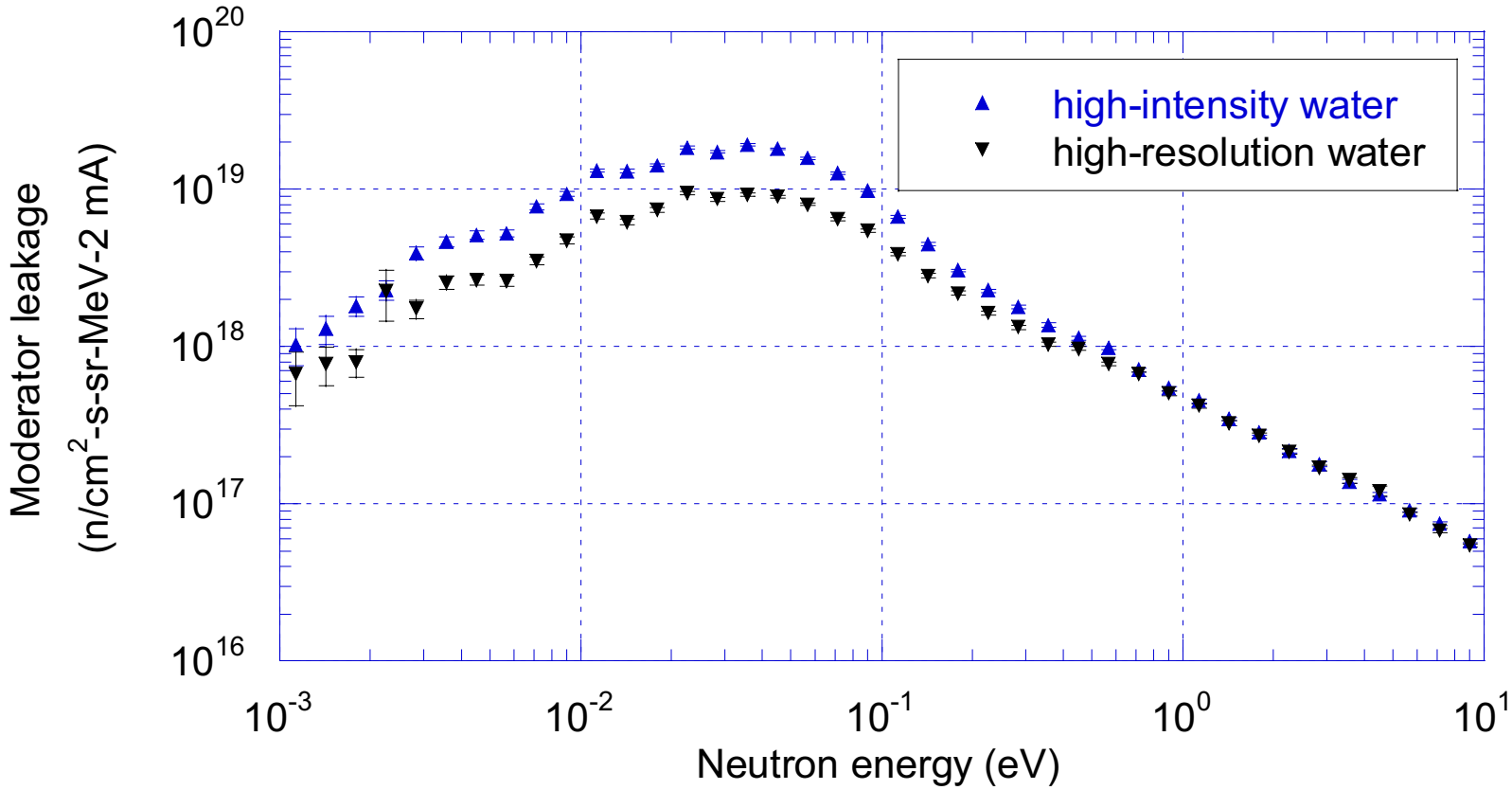
Neutron flux, plan view at elevation of upper moderators



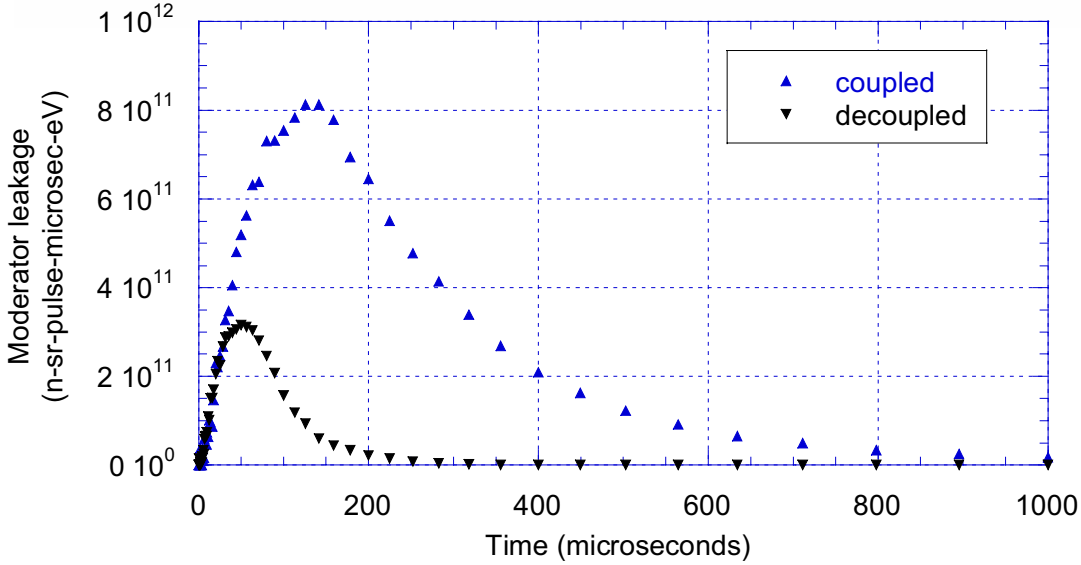
Time averaged spectra, LH_2 moderators

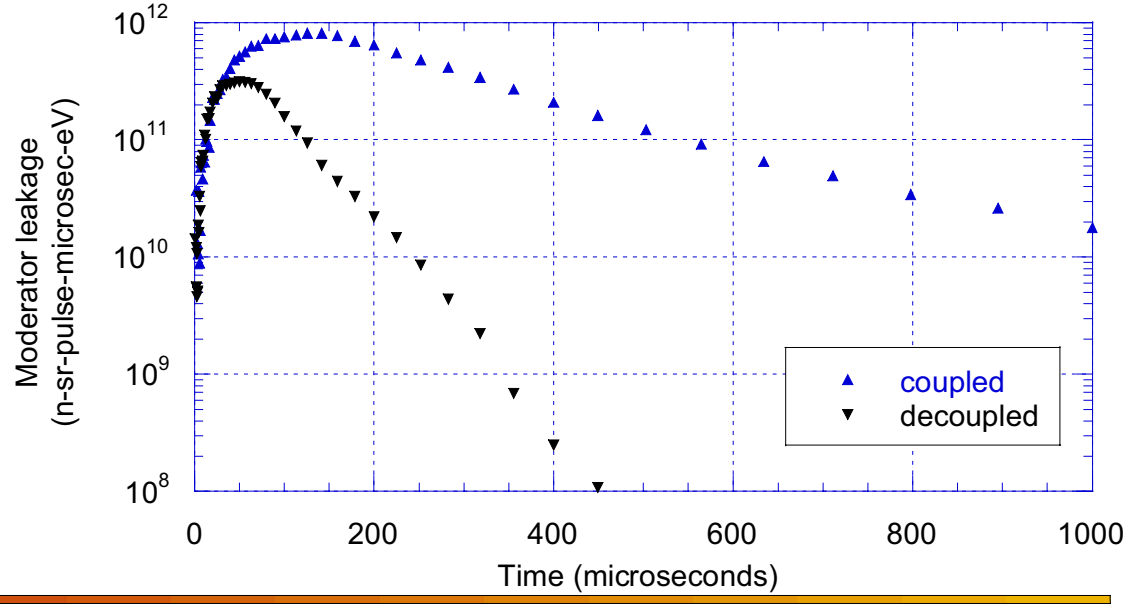


Time averaged spectra, H_2O moderators

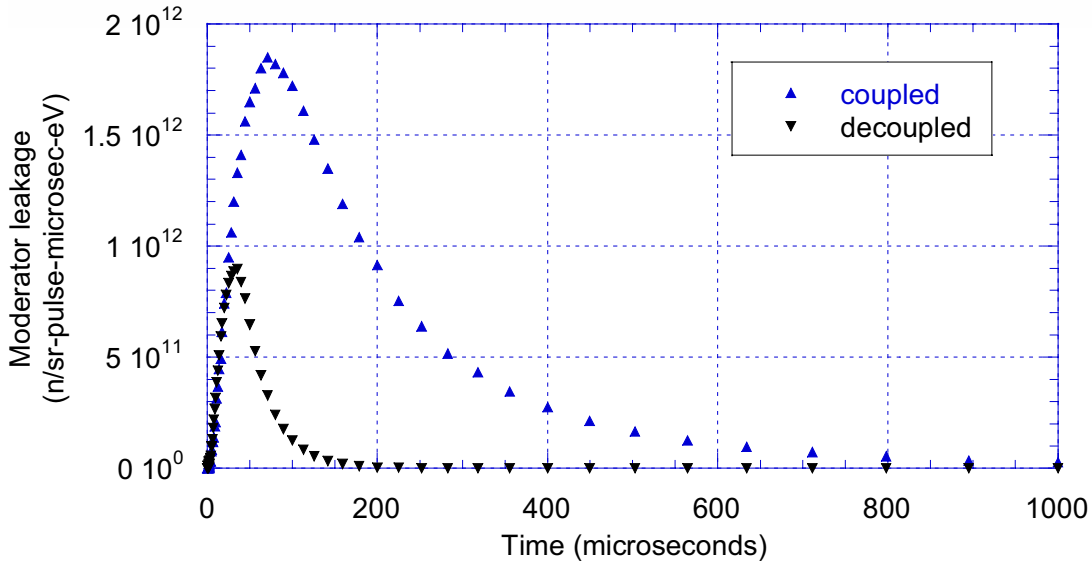


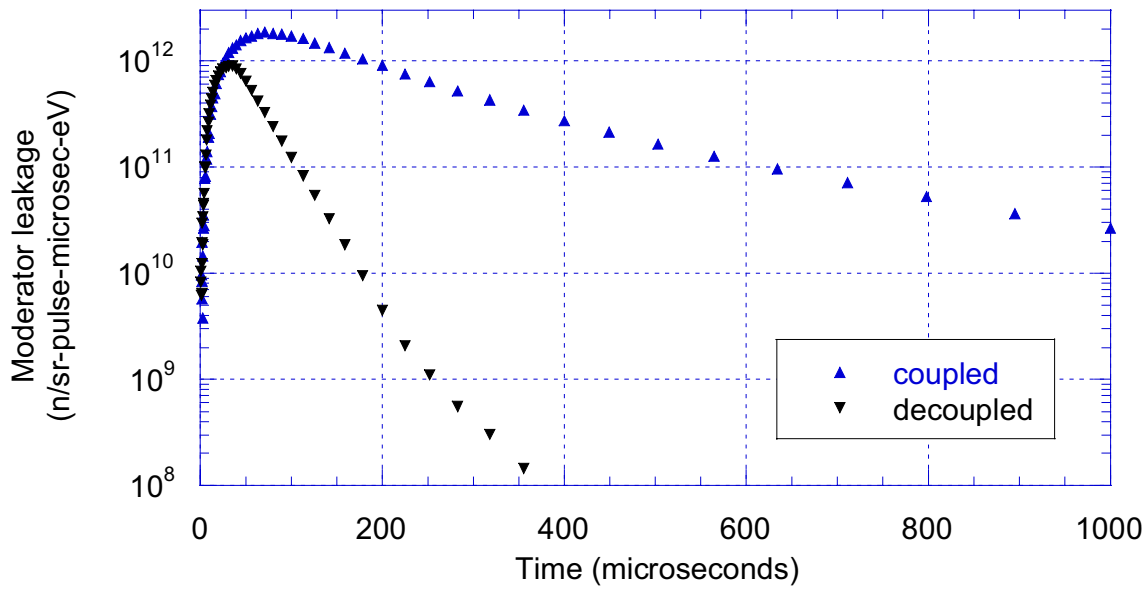
LH_2 time distributions, 9.6 A



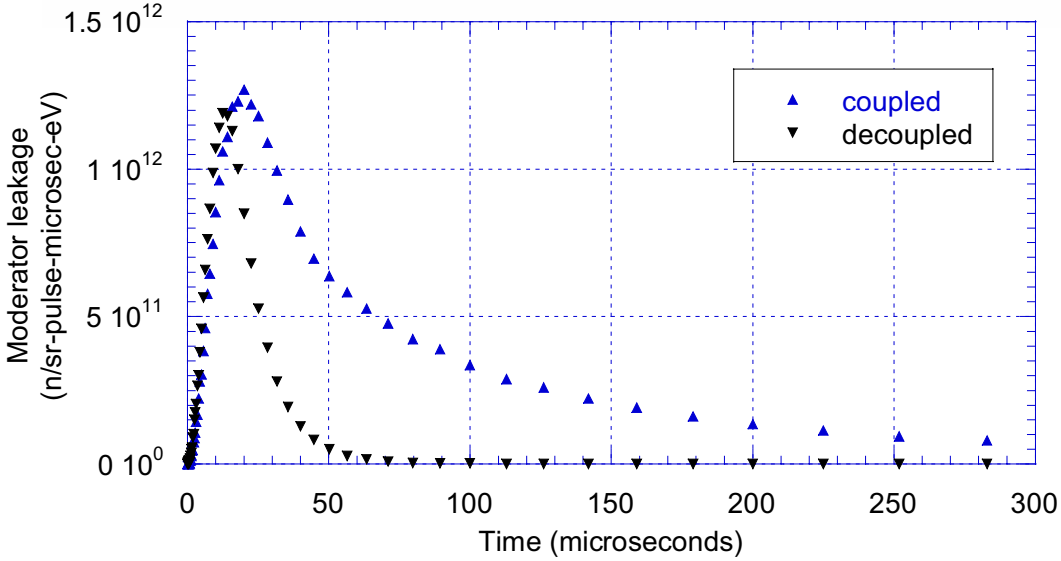


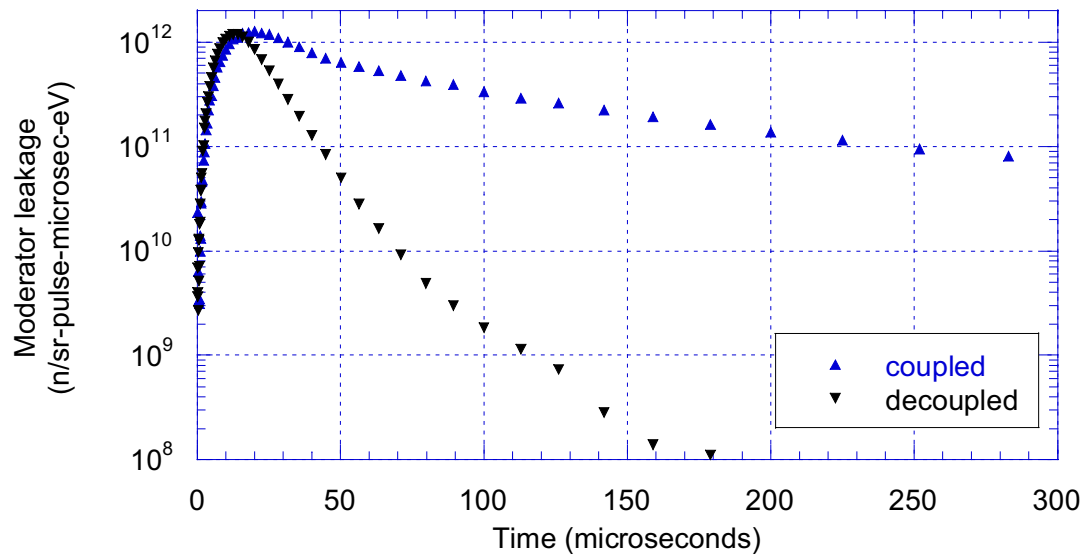
LH_2 time distributions, 4.8 A



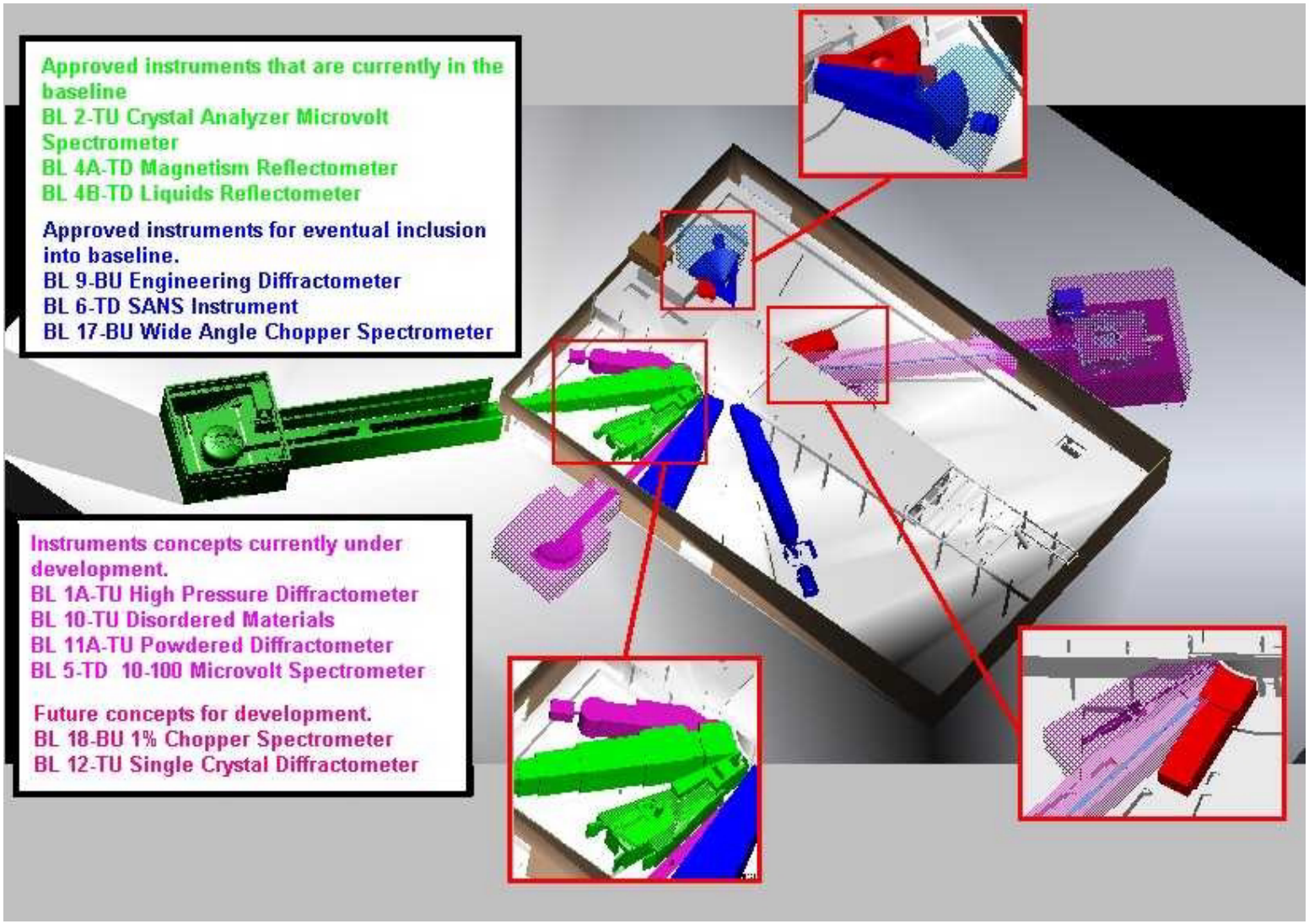


LH_2 time distributions, 1.9 A





Preliminary instrument planning



Other issues must be considered

- Compatibility with other neutron physics experiments
  - if physics is given two instrument locations (2 single channels or one dual channel), would it be two coupled LH_2 lines, or one coupled LH_2 and one H_2O
- Can the UCN beamline be shared efficiently ?
  - efficiently extract the 9 A neutrons and use the rest of the beam for another experiment
- Would future (or current) experiments benefit from symmetry (e.g., being perpendicular to the moderator) ?
- Others ?

Summary

- The SNS moderators will provide unique opportunities for neutron research
- The coupled LH_2 moderators:
  - provide long wavelength neutrons utilized by some fundamental neutron physics experiments
  - are in high demand (6 out of 8 instruments if FNP uses the dual shutter)
  - compromise resolution for intensity (10x more flux at 10 A with an increase in the FWHM of ~2-3x)
- Detailed moderator leakage spectra and time distributions are available on the web
  - we will work to update those regularly, but please collaborate with us on experiment design