Compact ADNS as tools for Nuclear Data

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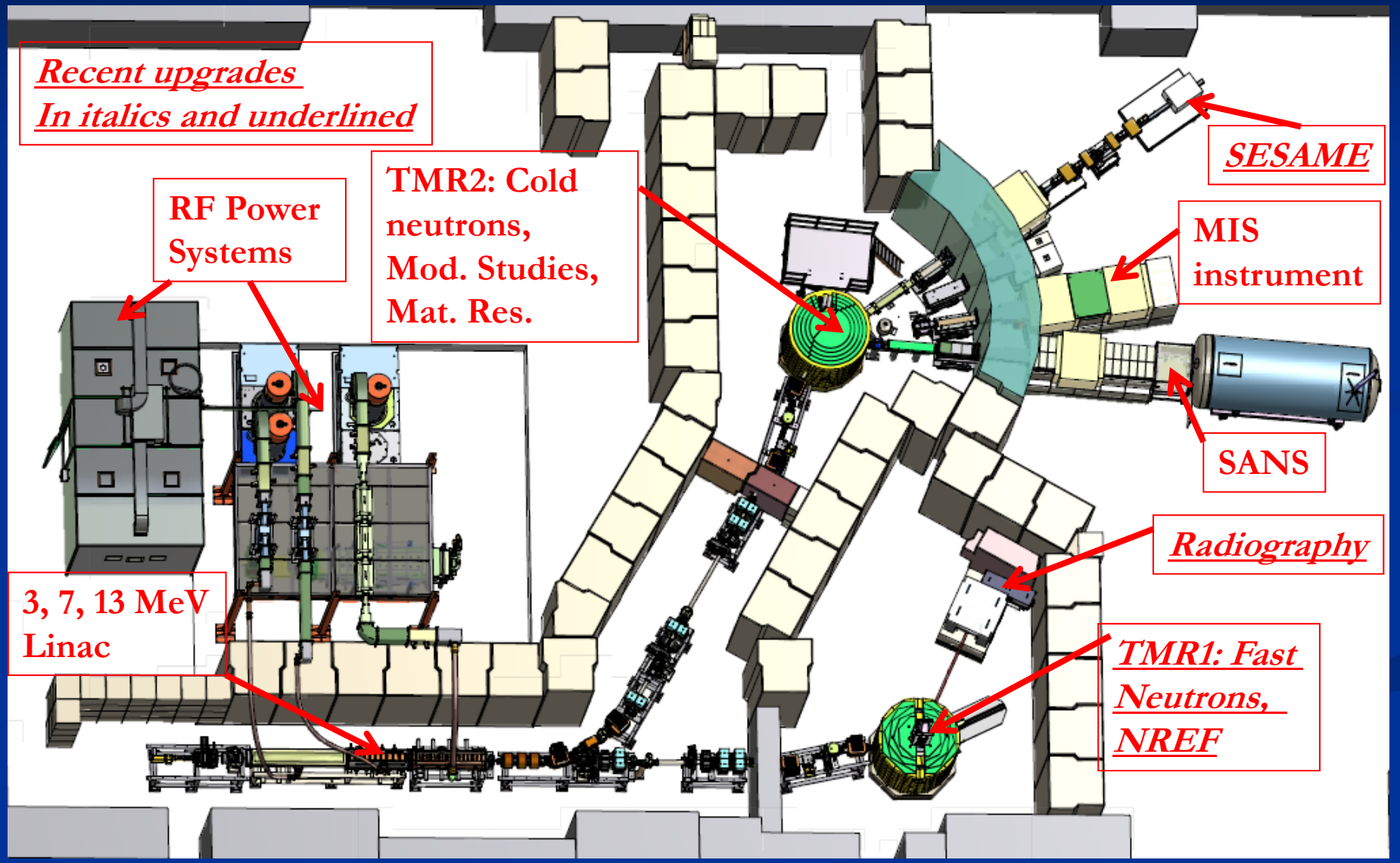
OUTLINE

- LENS Overview:
  - Facility capabilities and missions
- Transmission measurements
  - from <0.1 meV to >1eV
  - H_2O, D_2O, …
- Moderator neutronics opportunities.
  - CH_4 kernel development
- Conclusions

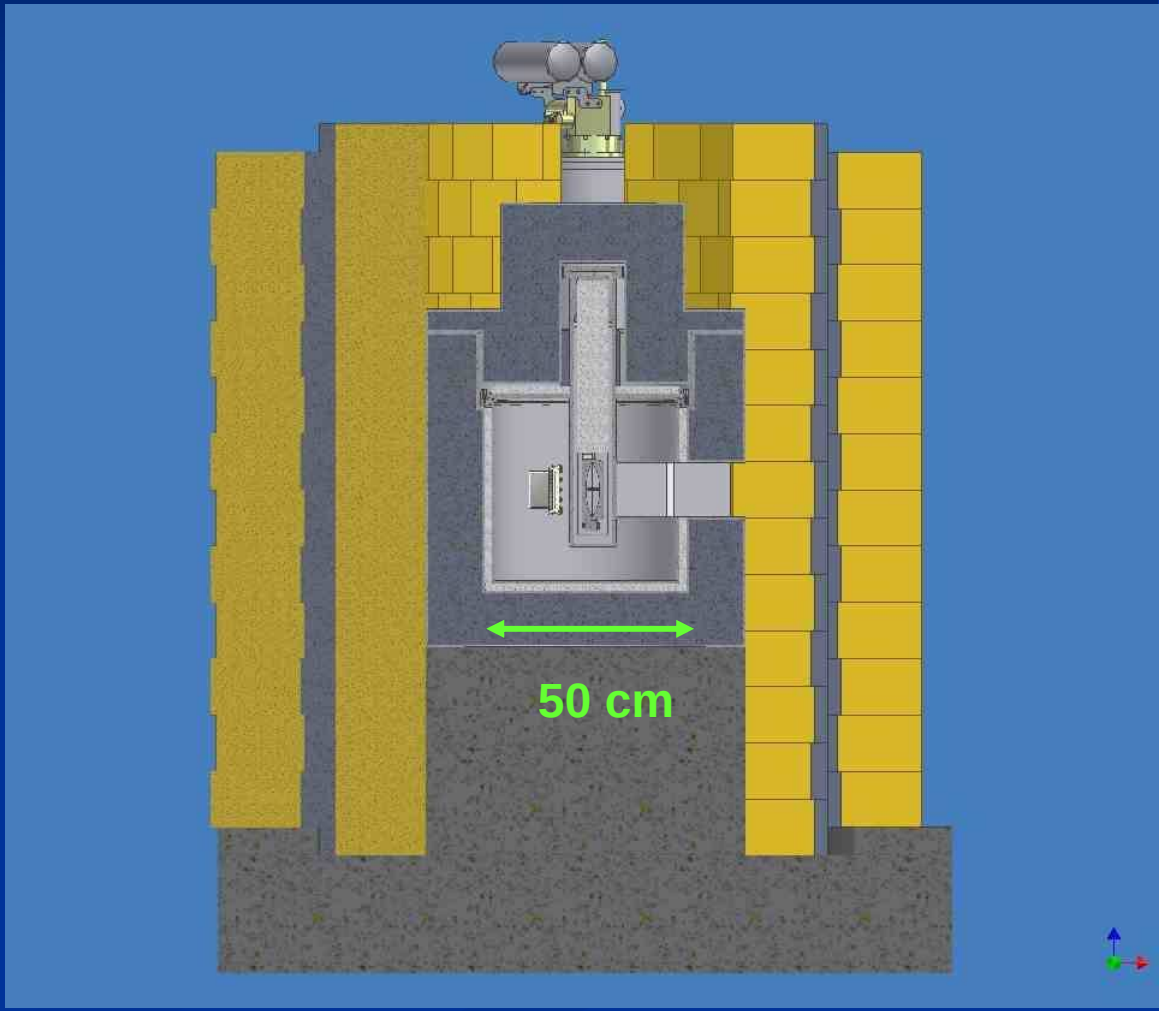
LENS: 2014


Recent upgrades
In italics and underlined
RF Power Systems
TMR2: Cold neutrons, Mod. Studies, Mat. Res.
SESAME
MIS instrument
SANS
Radiography
TMR1: Fast Neutrons, NREF
3, 7, 13 MeV Linac

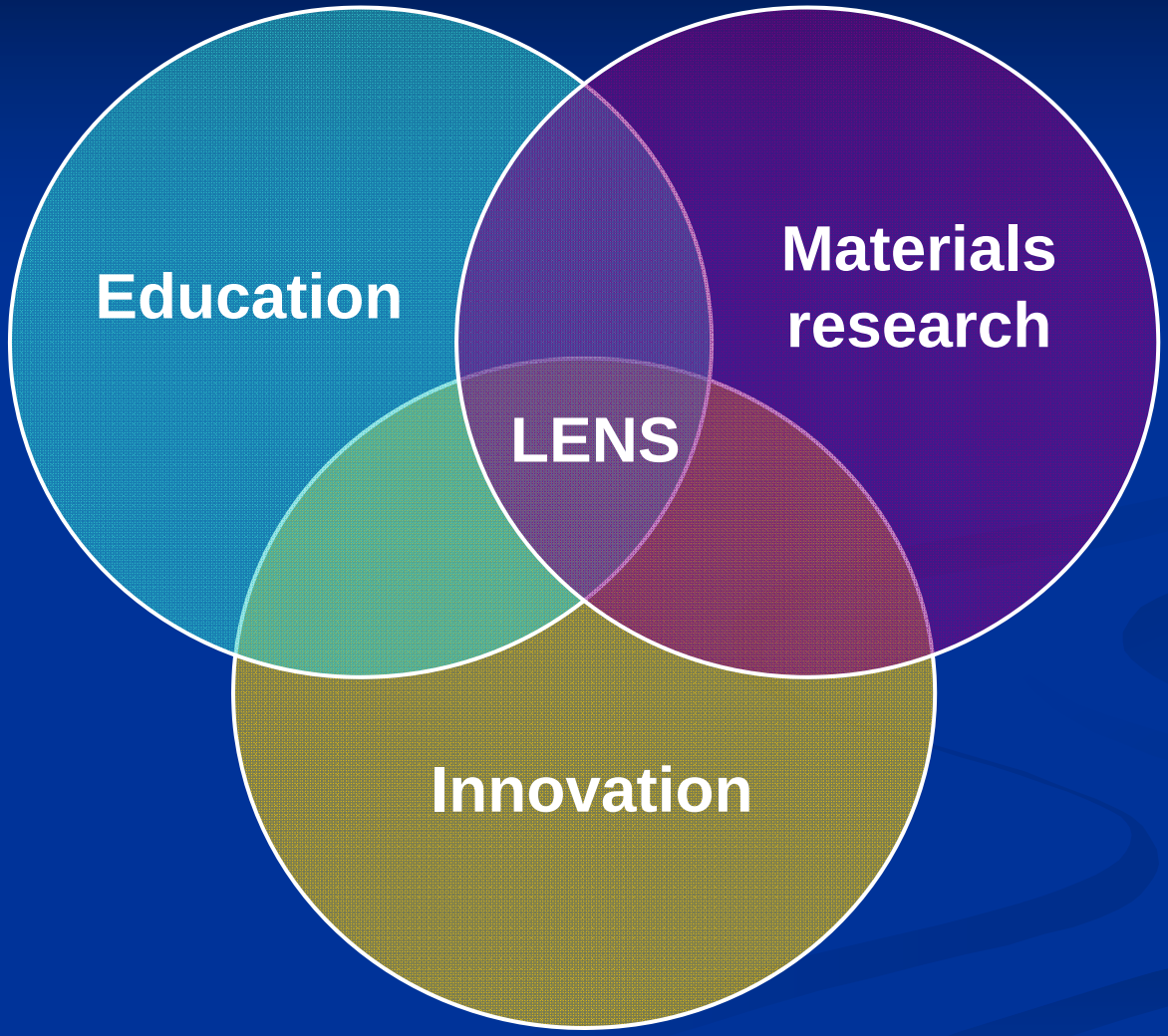
Target Moderator Reflector (TMR)

Source Details

- 13 MeV protons incident from the left on a Be target
- 2-4 kW average power
- 10-40 (20 normally) Hz
- Reflector/premoderator:
  - Water (300K) +polyethylene (~70K)
- 1 cm-thick CH_4 moderator (6K)



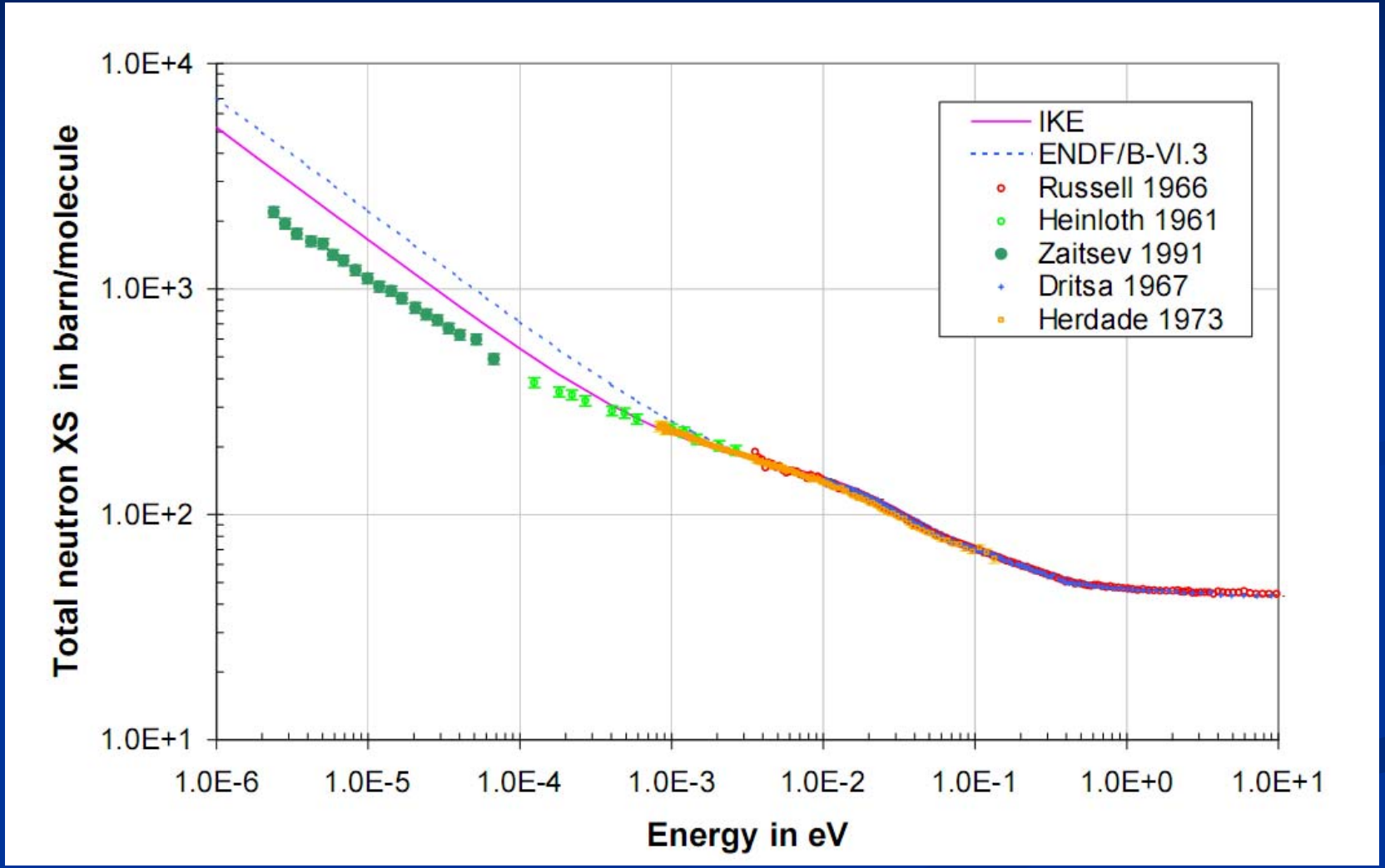
LENS Missions



LENS Connections to the International Neutron Community

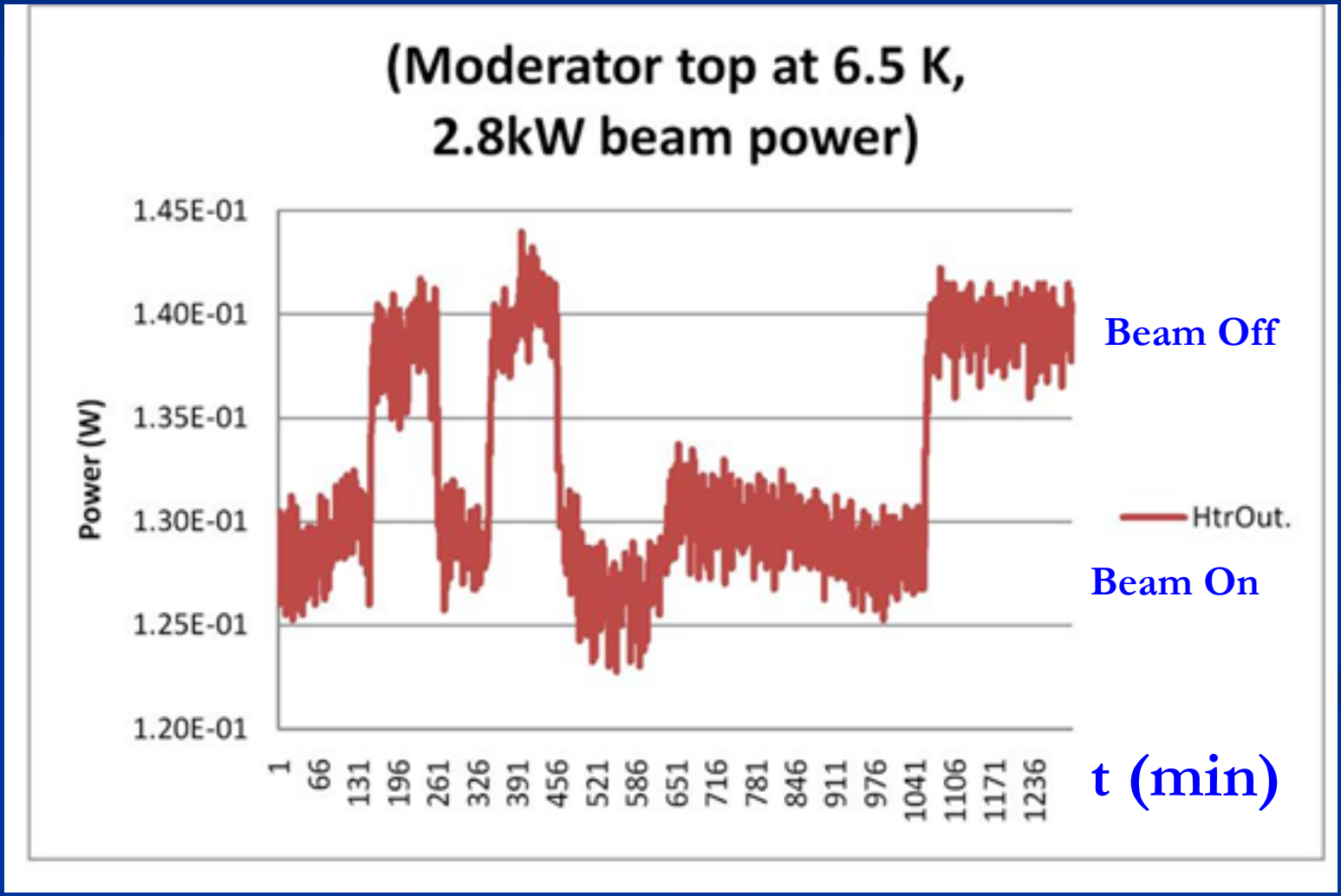
- **Technological:**
  - Instrumentation development (moderators, spin manipulation, …)
- **Education**
  - IGERT: neutron graduate education program with an emphasis on hand-on instrumentation exposure and project-based learning in the classroom. (with U. Missouri and SNS).
  - Joint convening of workshops on neutron education (ORNL) and instrumentation development (NIST), summer schools, …
- **Financial/programmatic**
  - Pynn joint appointment between IU/ORNL
  - LENS/NCNR collaborative agreement
  - Joint research projects/proposals in areas such as ^{3}He neutron polarizer development (NIST/SNS), instrumentation (LANL, SNS, ESS,NIST)
- **Looking for new opportunities (e.g. nuclear data)**

VCN Kernel development: H_2O



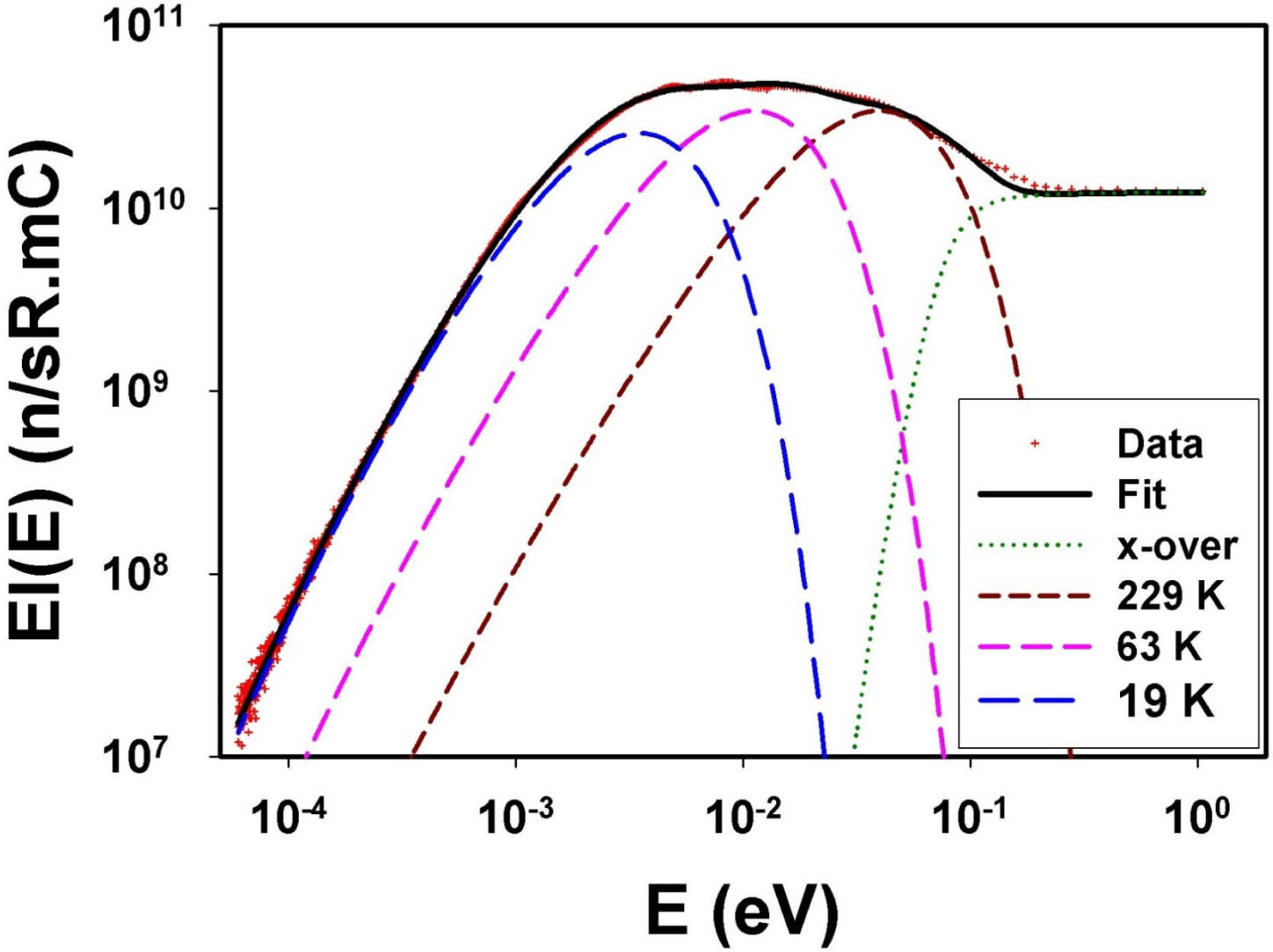
IAEA report: INDC(NDS) -0470

Moderator Thermal load (~25μW/ml.kW)



Fit to the Spectrum 13 MeV

(2011)



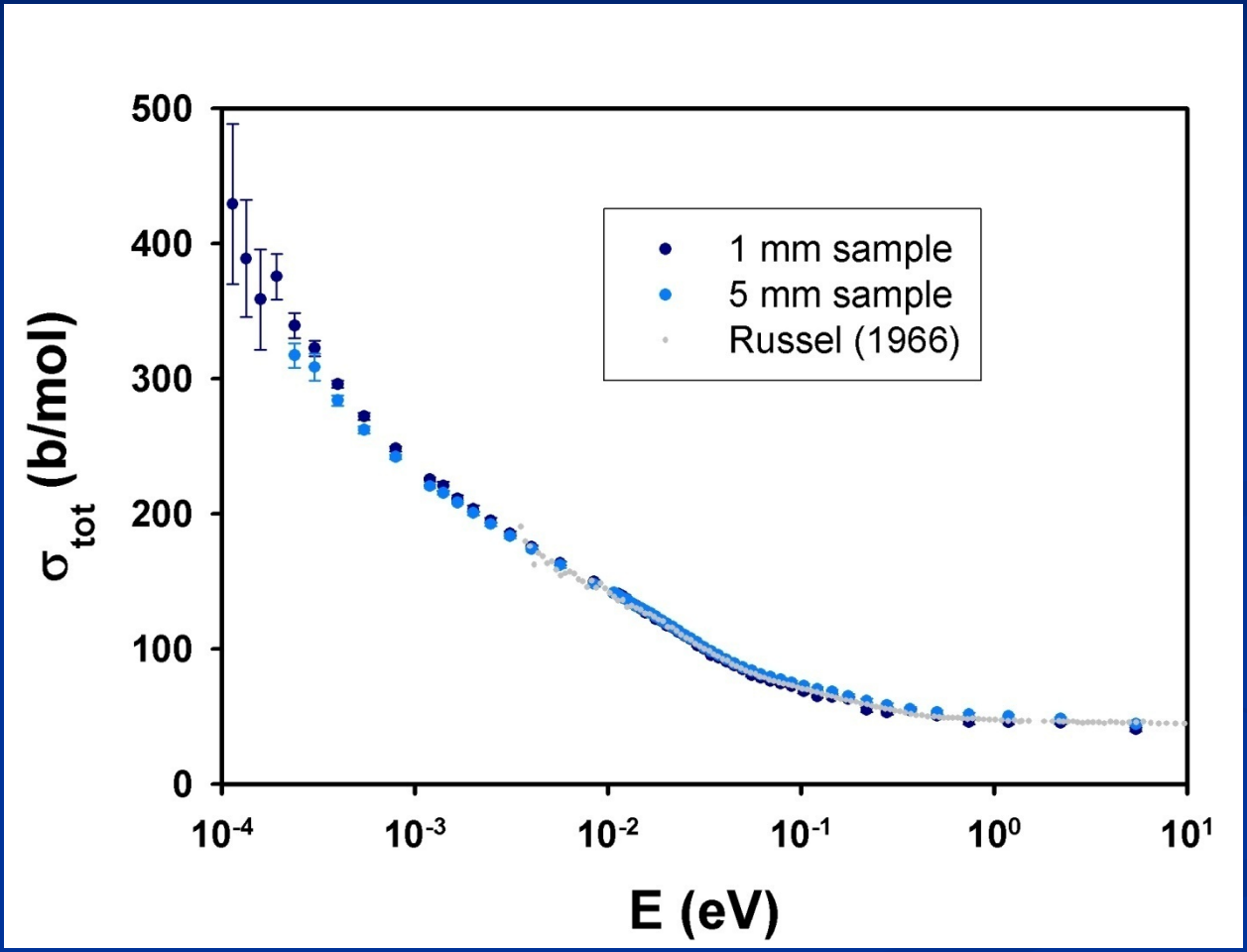
Total Cross-Section Expt. Setup

SANS instrument for Σ_{tot}

SANS instrument for Σ_{tot}

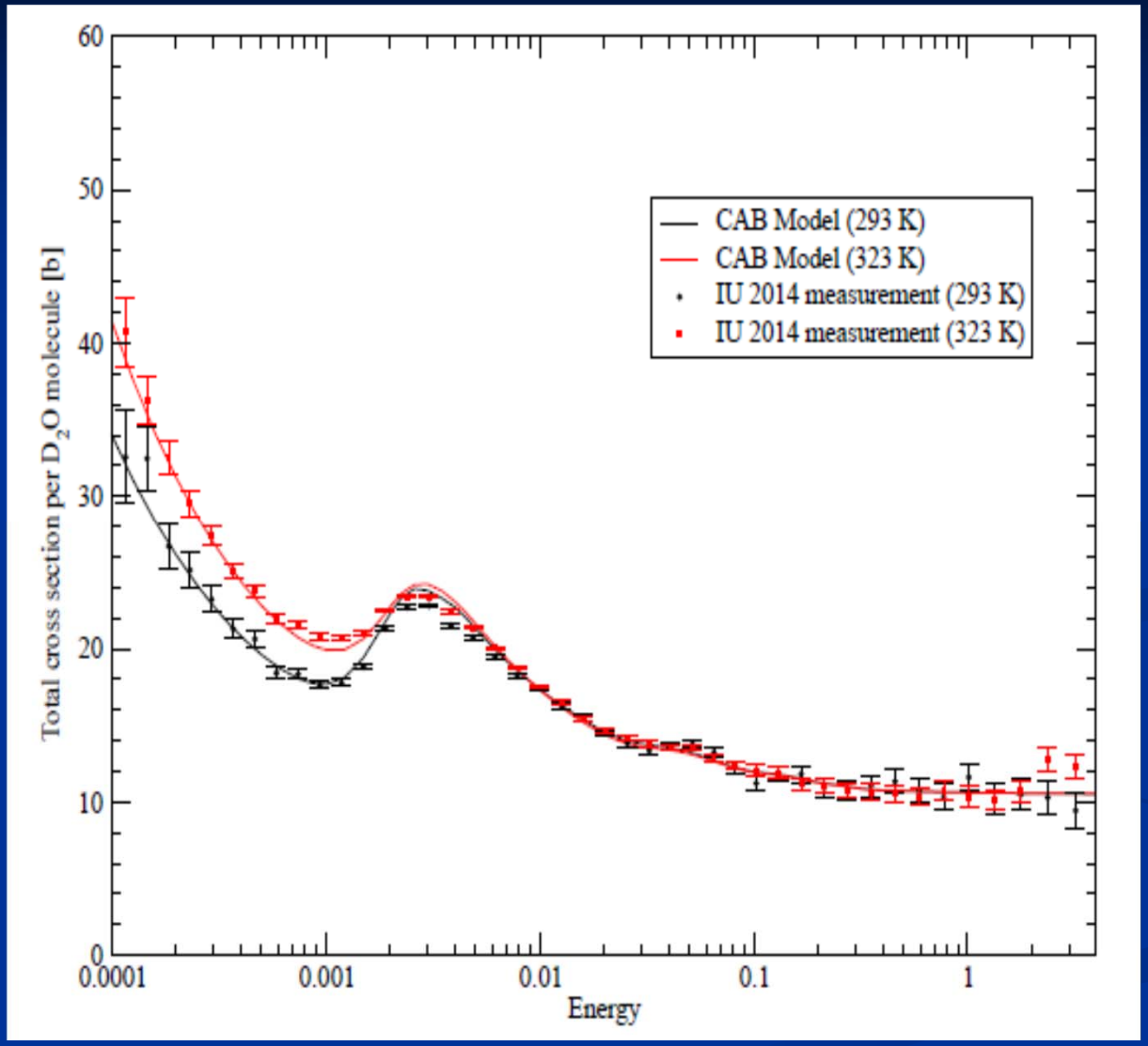
SANS instrument for Σ_{tot}

Σ_{tot} for H_2O



2 hour for 1mm
5 hour for 5 mm
(0.5kW beam power)

Total Cross section of D_2O



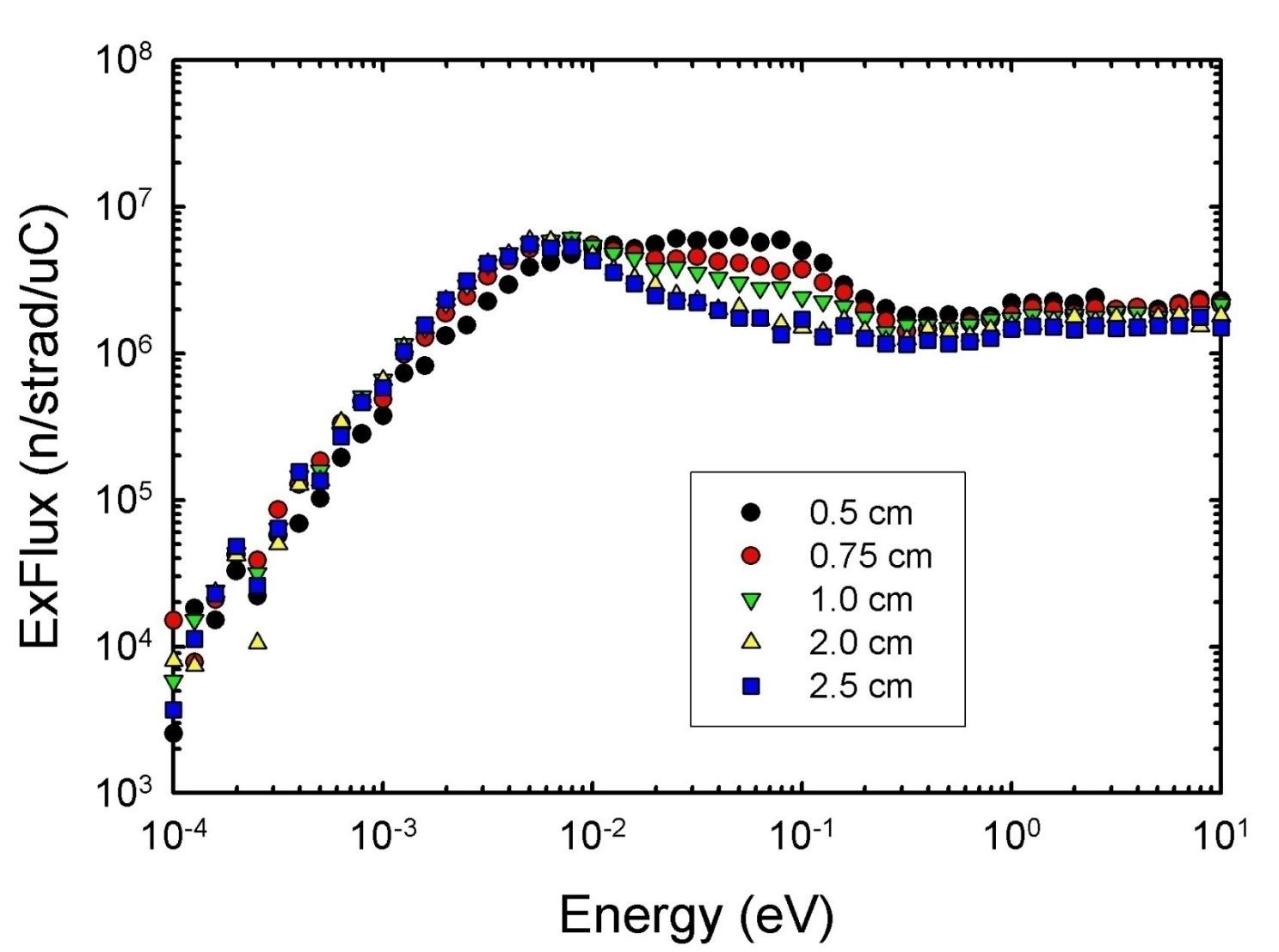
Data collected at 10Hz with 0.15ms pulse width for full energy range.
12 hour data collection(6 hour sample in, 6 hour sample out).

Statistics could be improved by using different accel. settings for large and small energy portions of the data.

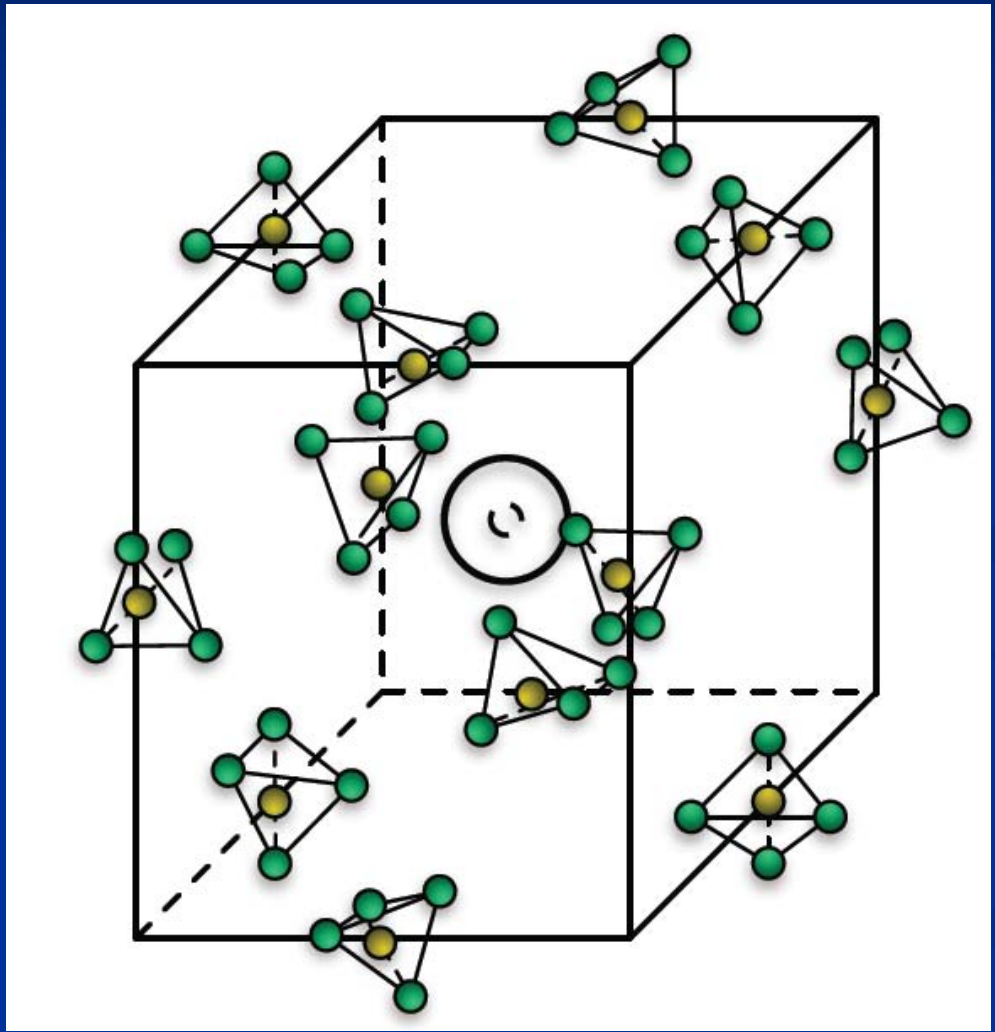
Background rate in the ^{3}He detector is very small.

Preliminary results,
J. I. M. Damian et al. (2014),UCANS-V

MCNP: Thickness study (smeth22K)

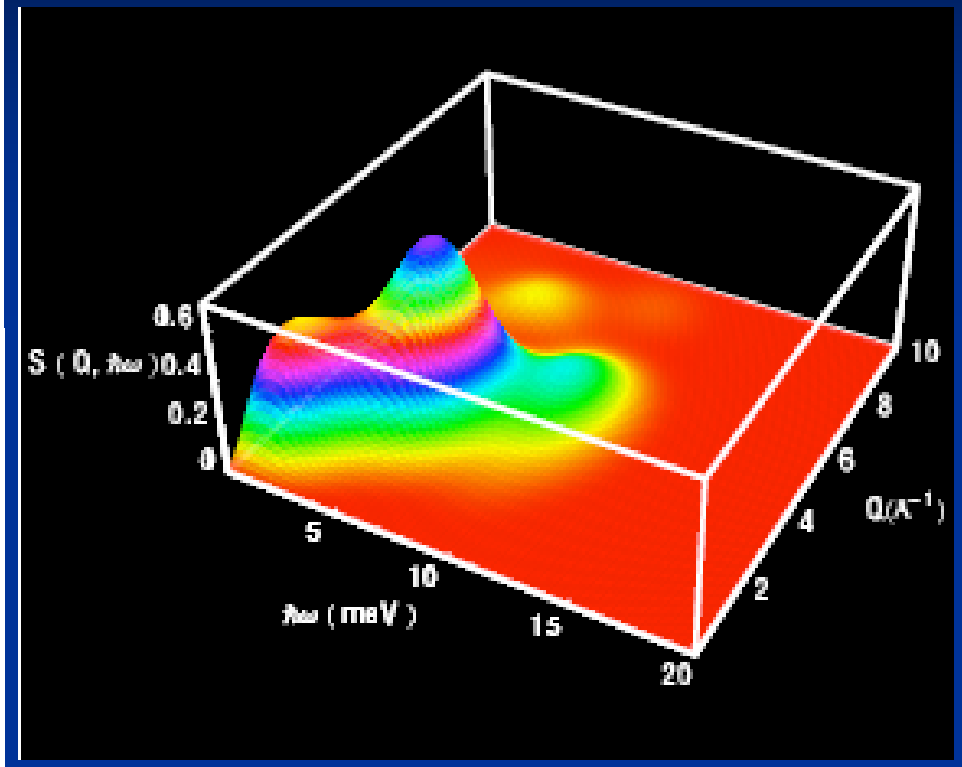


Phase II Structure of Methane

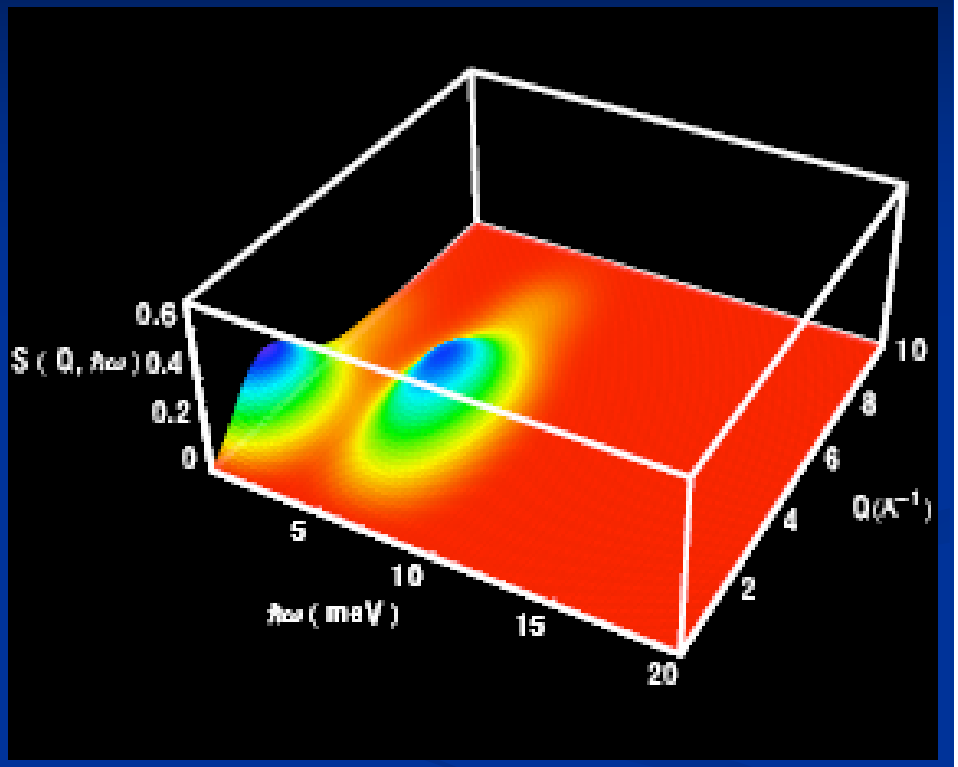


Circle at the center represents an essentially freely rotating molecule, all others are hindered rotors that librate in place.

MCNP kernel at 4K (Y. Shin)

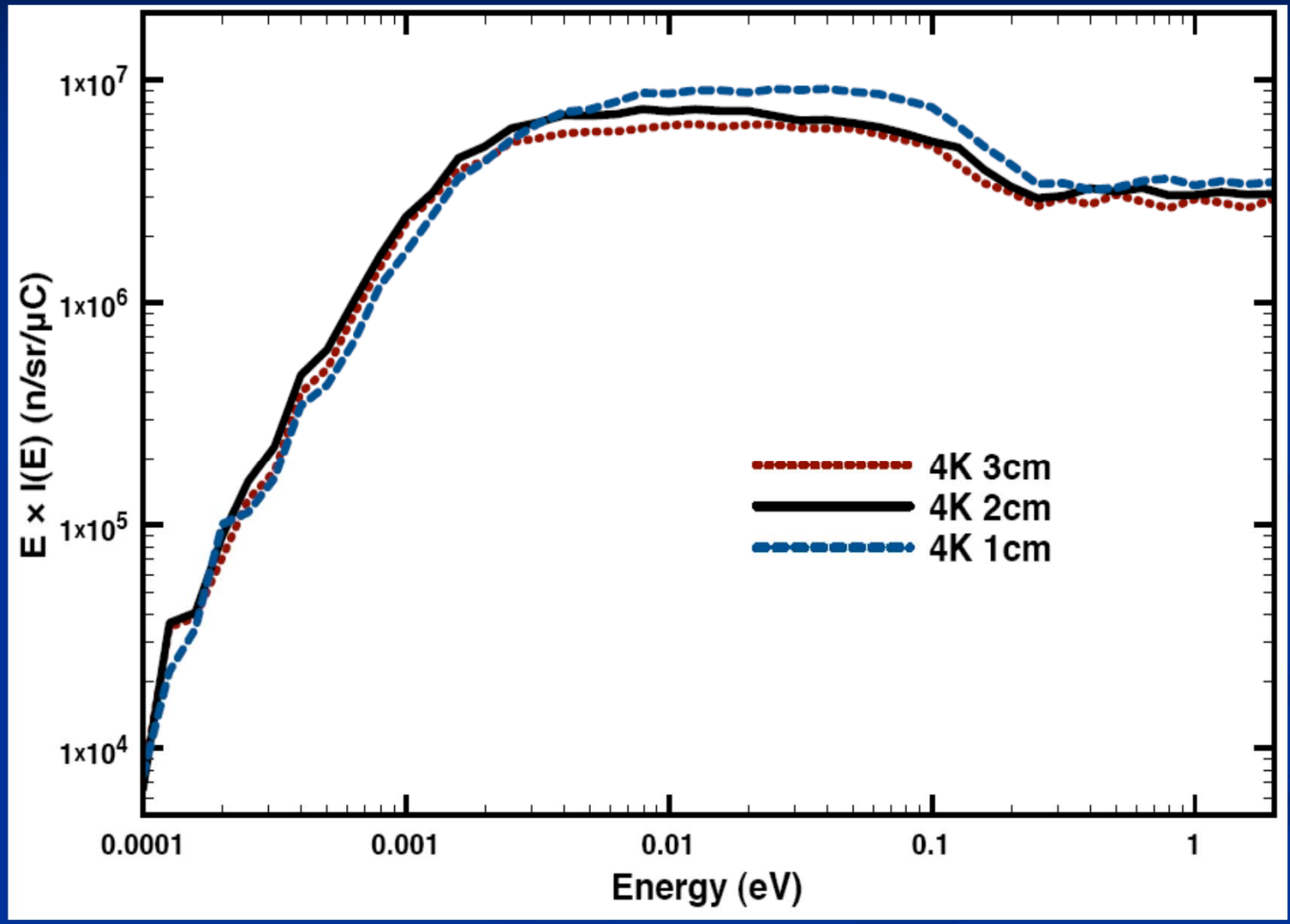


Free Rotational modes

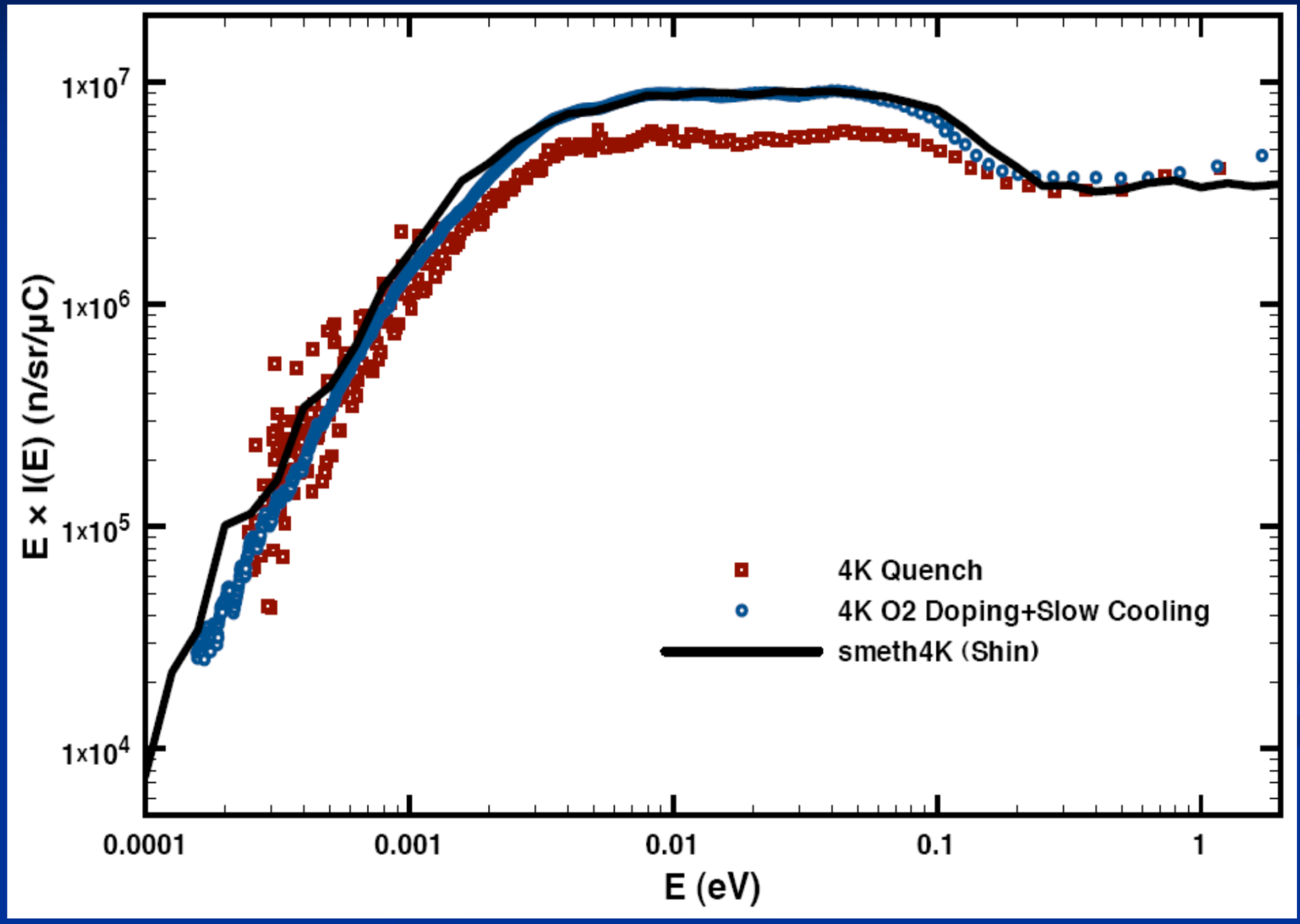


Tunneling, Librational modes

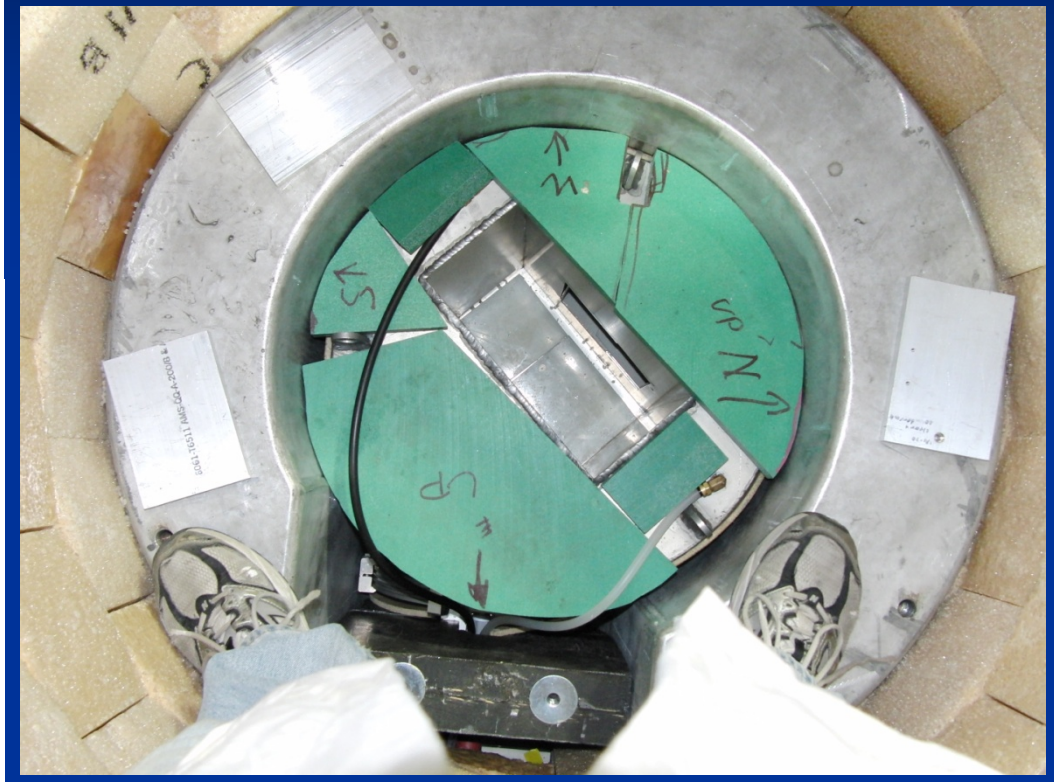
Shin Kernel: Thickness study



Shin kernel: 4K CH_4 neutron spectra

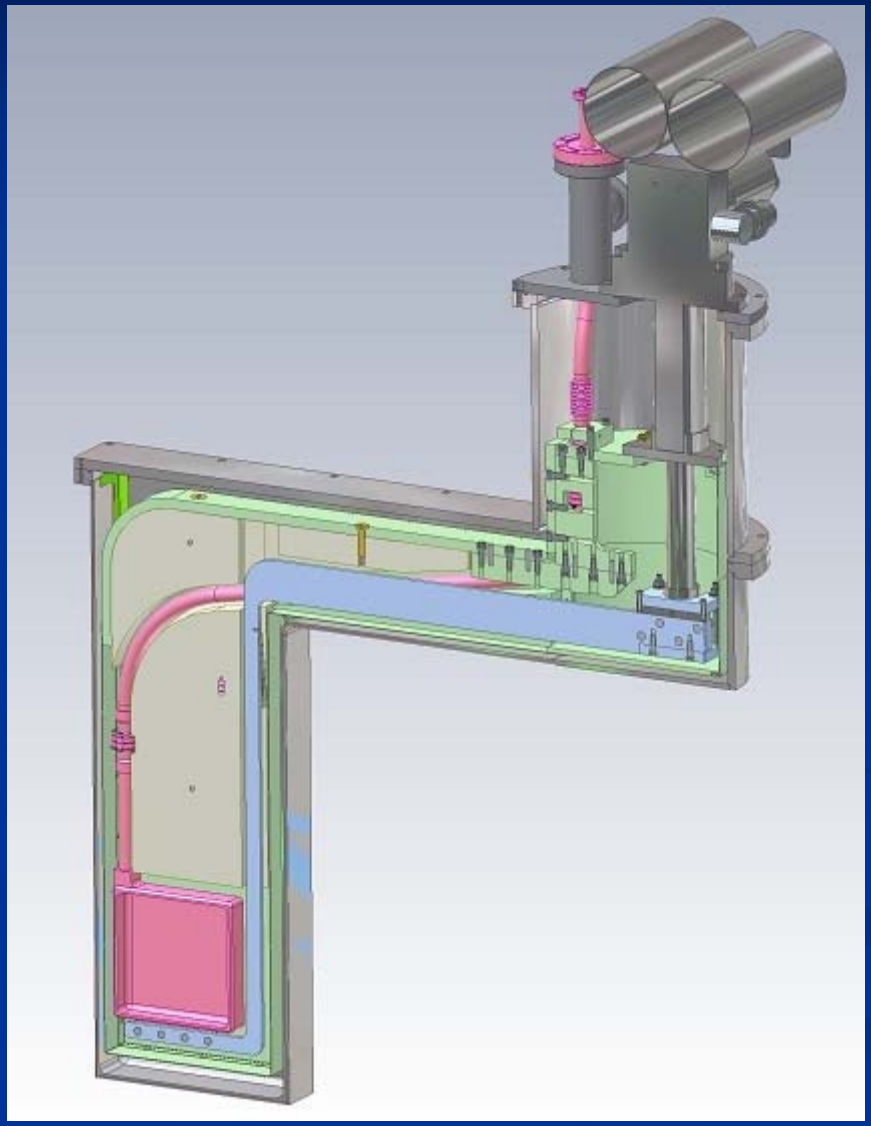


Experimental Neutronics



View of the reflector (inside a lead cask to shield gammas) and the cavity available for test moderators. On right is shown the opening to the beam lines, into which we insert Cd-coated liners to reduce interference from the reflector. The proton beam enters from bottom of left-hand image.

Test bed Assembly

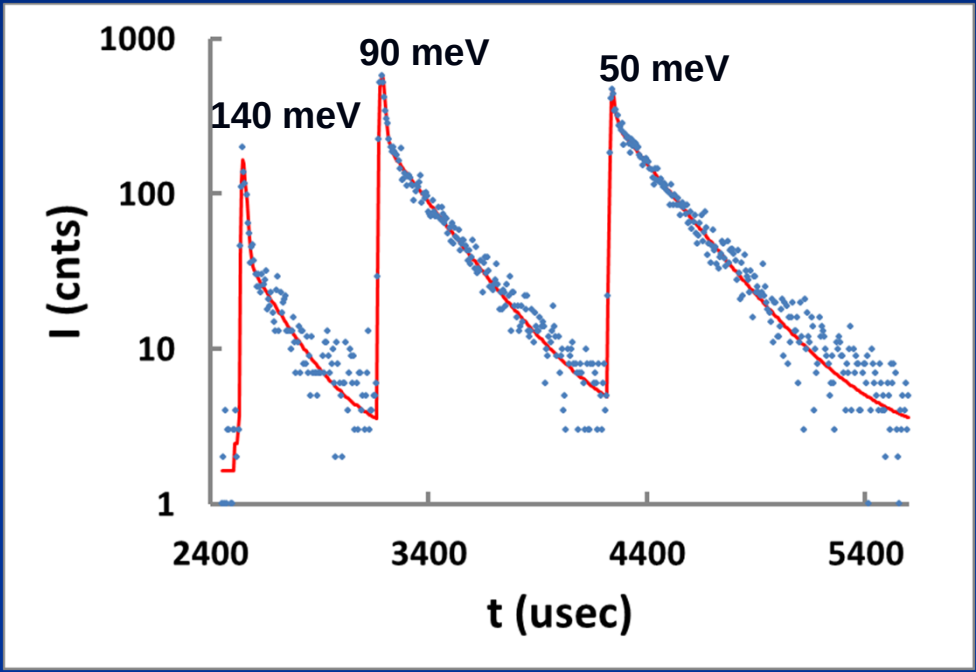


PT-410

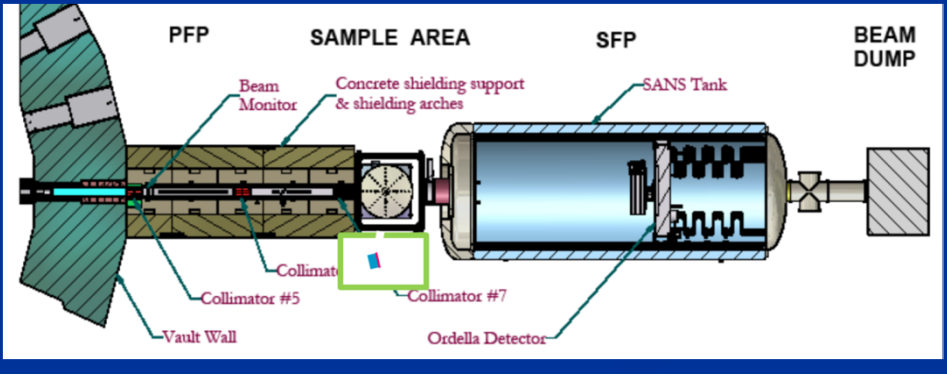
Moderators: Emission time Distr.

(with SNS, LANL, ESS)

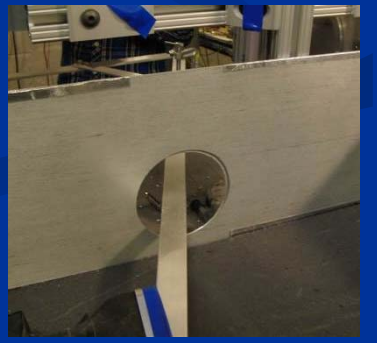
We have reported on numerous moderator measurements in the past



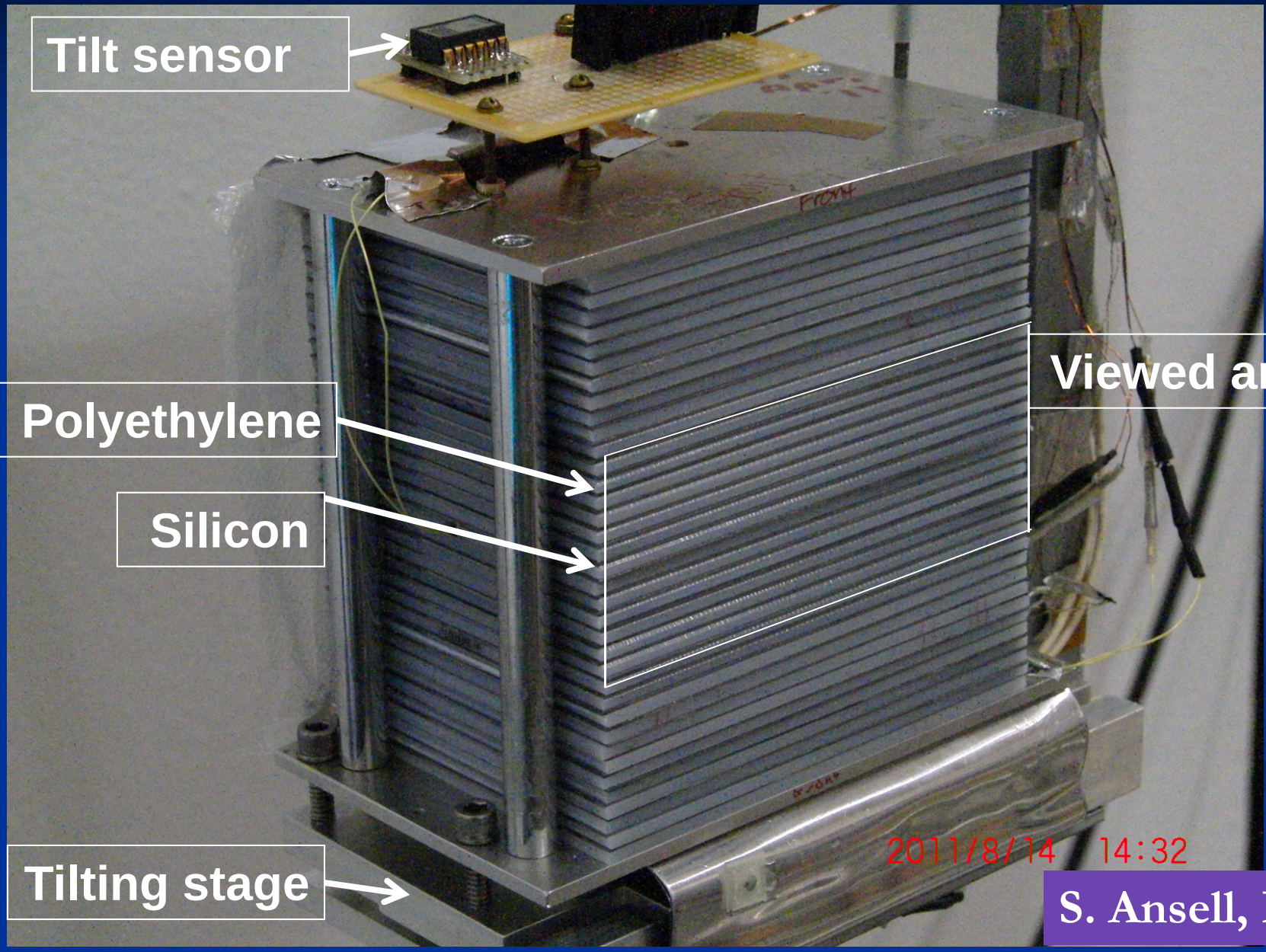
We have continued to refine our emission time measurements. The data on the left were collected from a coupled CH_4 moderator in less than a day with a 12 μs (FWHM) proton pulse, and the fit is to the Ikeda-Carpenter form convolved with the measured proton pulse shape.



Intrinsic resolution of the time-focused spectrometer is ~1 cm. Dynamic range of 10^3 possible near ~50 meV and ~5.5 meV.

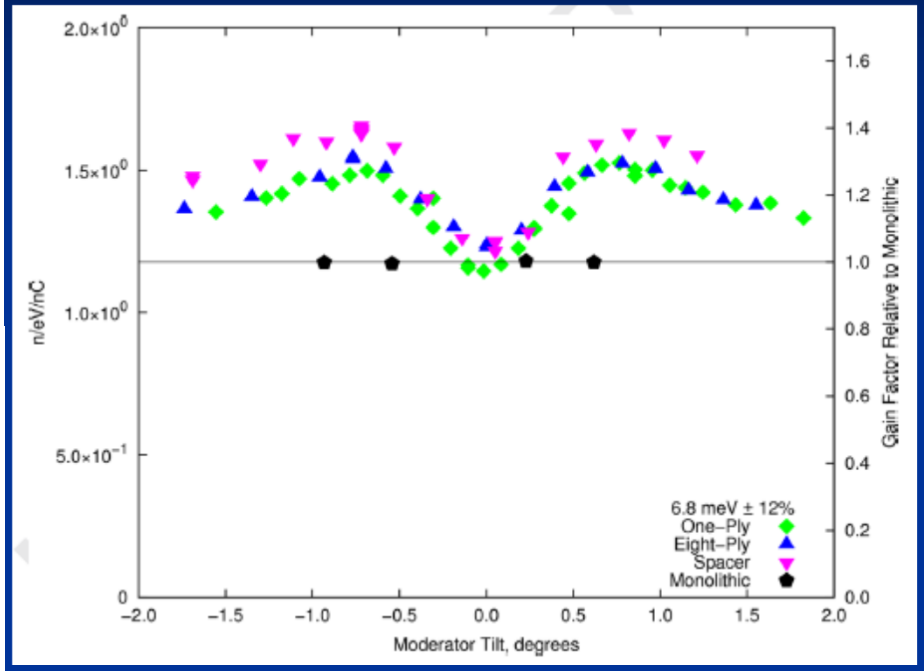


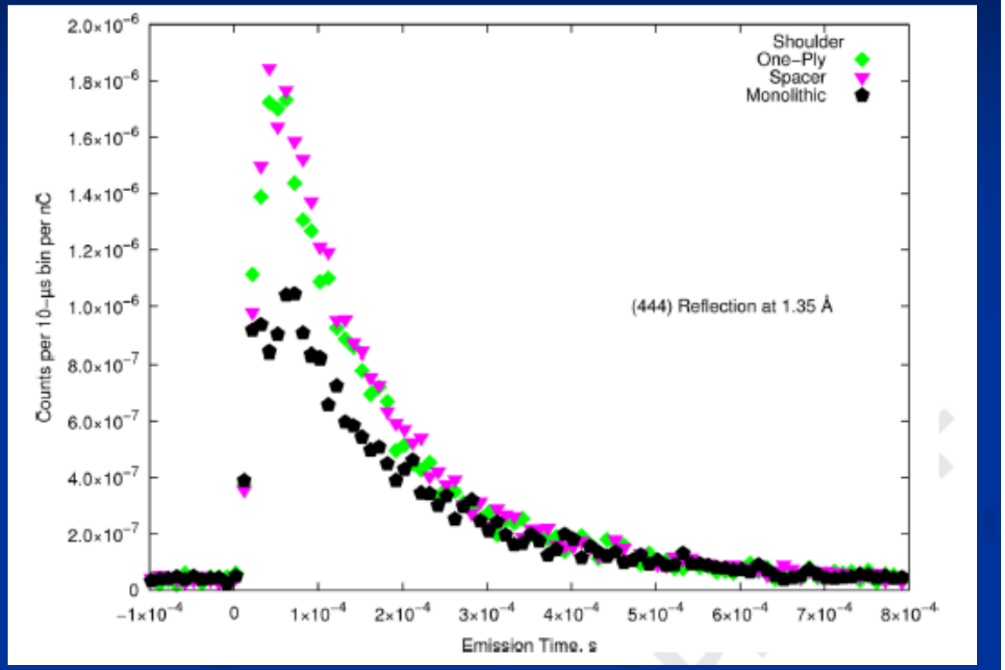
PE/Si Convoluted Moderator



S. Ansell, ISIS

Convoluted moderator
(moderator at room temperature)





Presence of the Si vanes provides an easy escape route for cold neutrons from deep within the moderator volume, this leads to a remarkable directional dependence (left) and increased PEAK intensity. More work still needed to understand how this carries over to a comparison of individually optimized designs (7meV for angular dependence, 45 meV for emission time).

Iverson et al., NIMA **762**, 31 (2014)

CONCLUSIONS

- LENS and other versatile small-scale sources like it can provide useful data to support the mission of increasing our knowledge of low-energy neutron cross sections.
- Key elements in this are:
  - Low spectral temperature and variable pulse rate give access to energies below 0.1meV.
  - Total cross sections can be measured with variable T, P etc. relatively quickly.
  - Moderator prototyping is also a possibility that we are only starting to explore.
  - Spin-dependent cross-sections is something we are starting to explore.