Moderators at LENS: Performance and Research

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OUTLINE

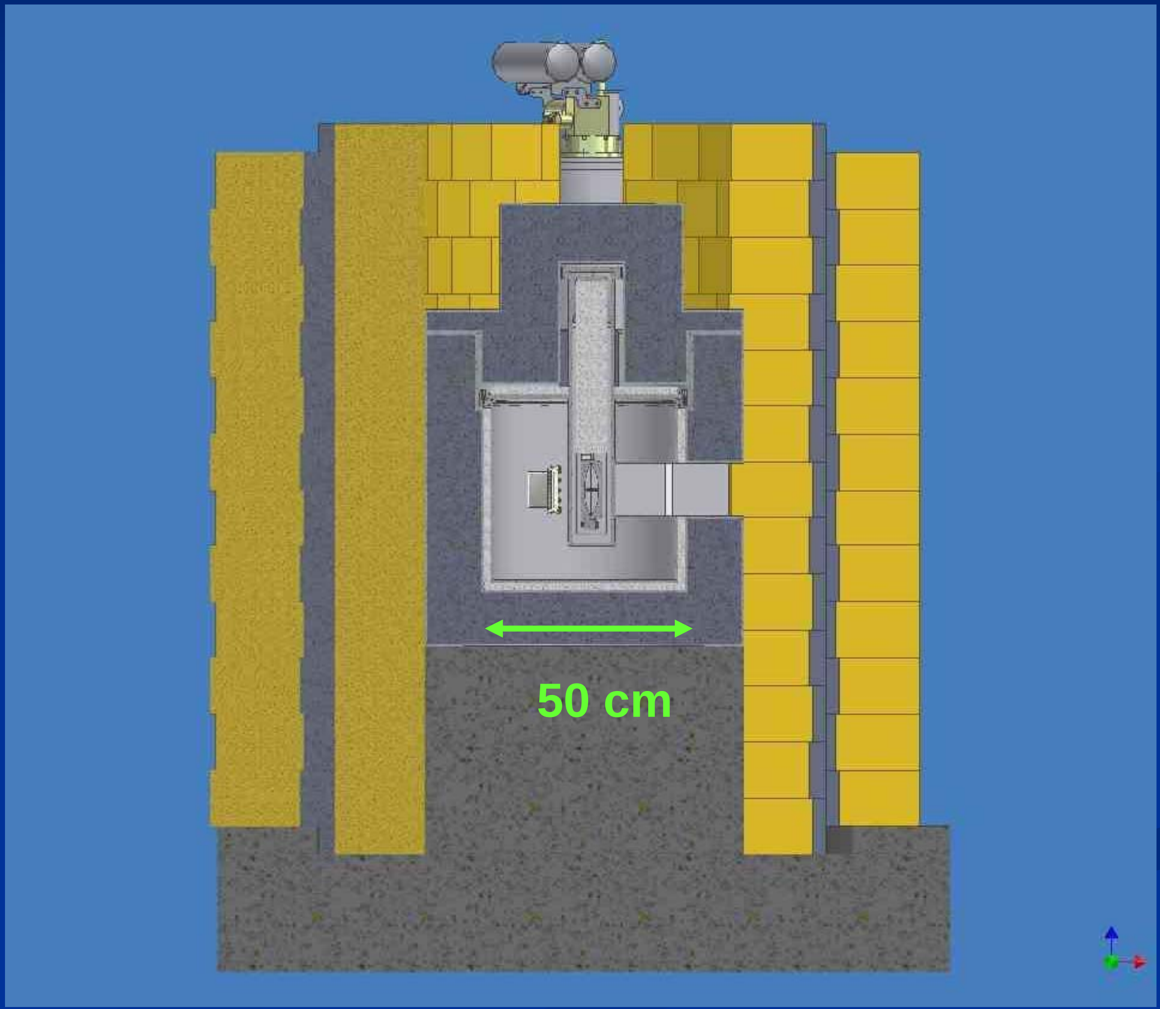
- Evolution of the LENS neutronic design/performance
  - Pay attention to proton normalization.
  - Gain in going to 13 MeV was essentially as expected
- Capabilities for Moderator Research
  - Multiple moderators measured within a short time
  - Emission time distributions
- Anisotropic moderators
  - Angular dependence in PE/Si
  - Absence of an effect in H_2O/Si or Mesitylene/Si
- Conclusions

Facility Layout: 2009

Target Moderator Reflector (TMR)

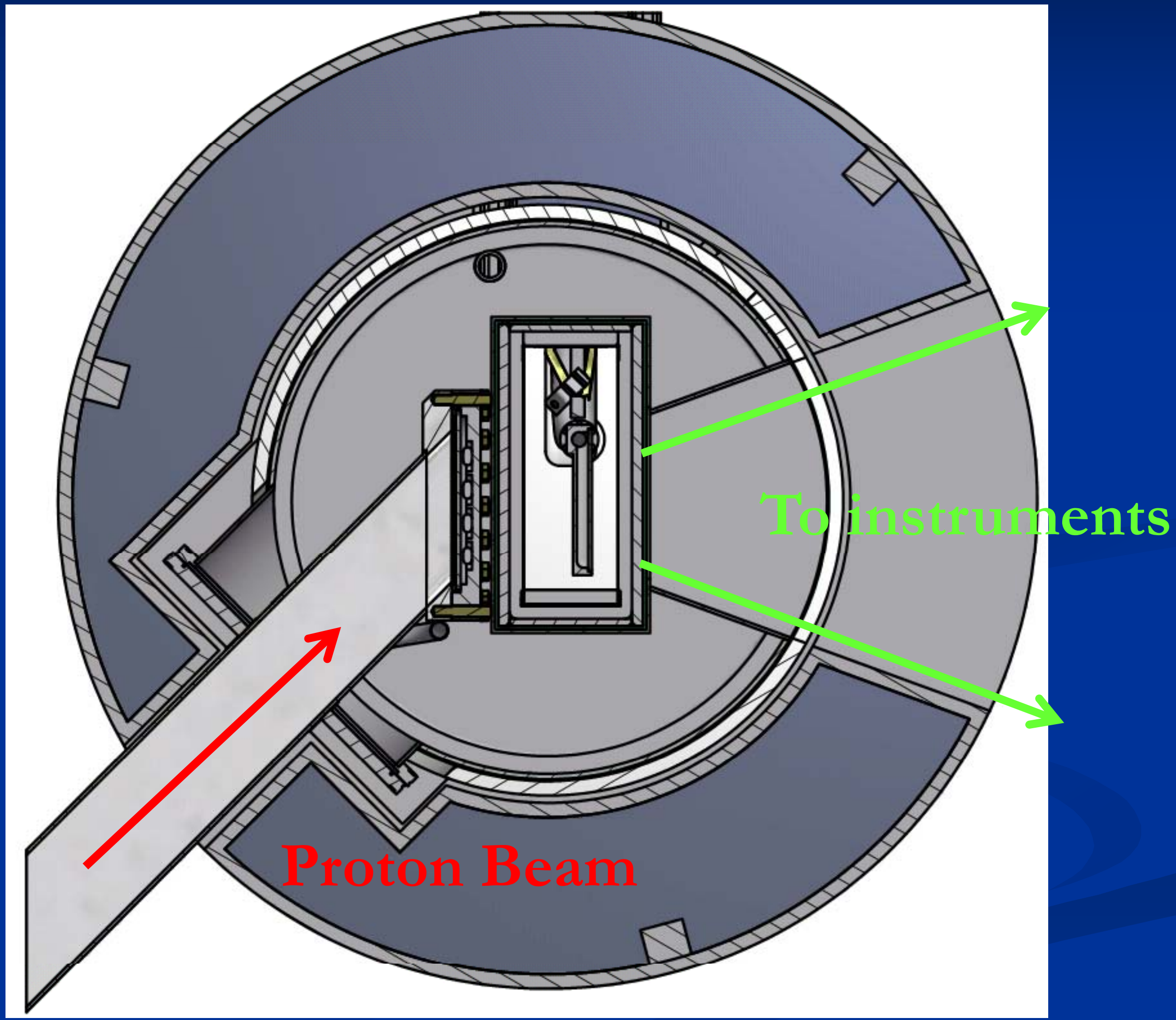
Source Evolution

- 7 MeV to 13 MeV
- Add poly to vacuum to enhance coupling
- Change target config.



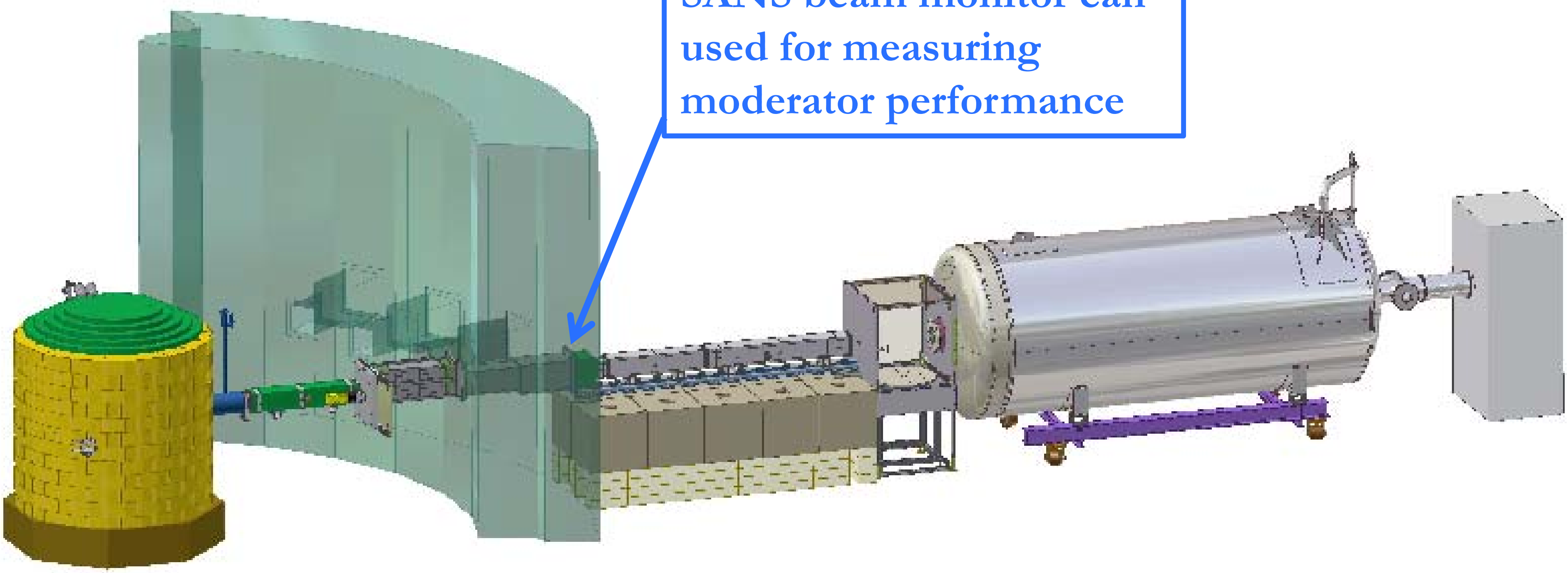
Original Target/Moderator design

•Original target was thick and at 45 degrees to the beam to minimize heat load and maximize geometric coupling to the moderator.
•Vacuum vessel around moderator is oversized to accommodate thicker test moderators.
•The water between target and moderator was thinner than optimal for premoderation
•SANS instrument viewed parts of the target directly

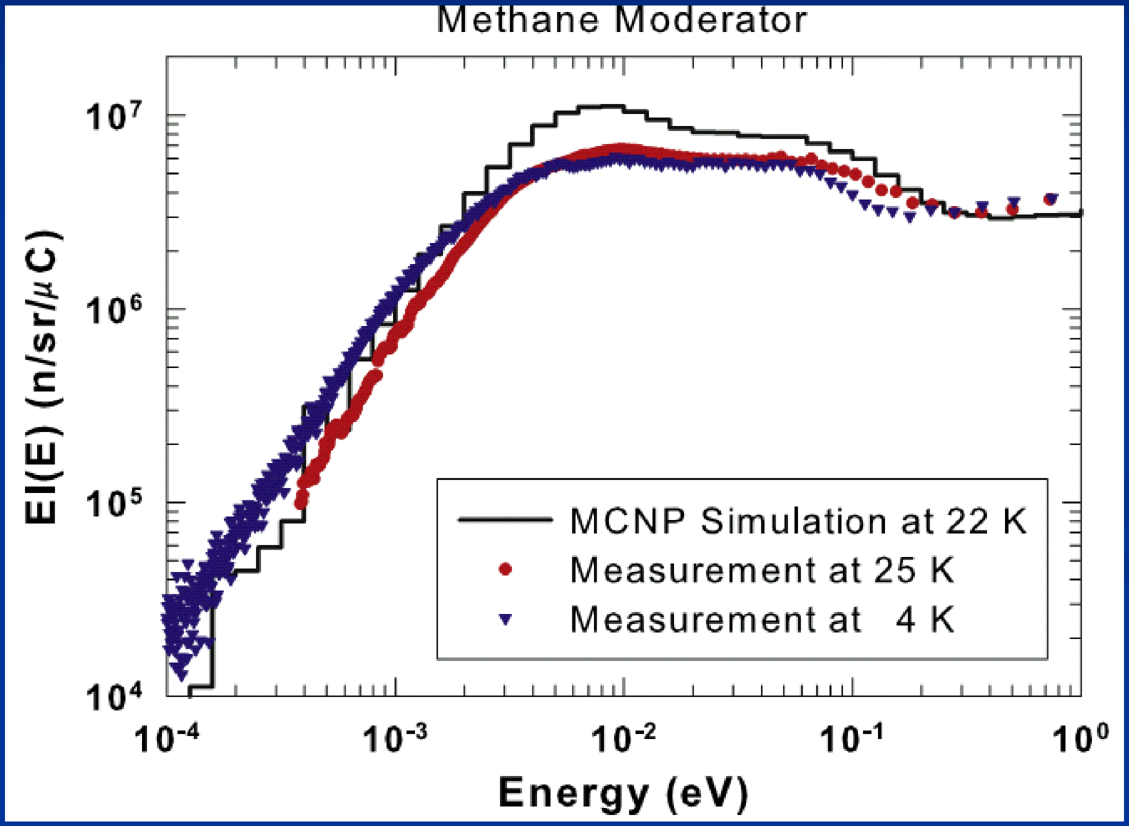


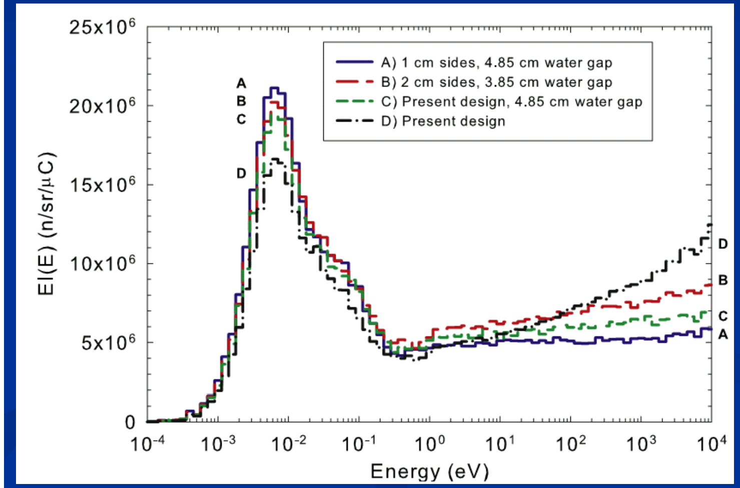
SANS Layout

SANS beam monitor can used for measuring moderator performance



Flux comparison: Effect of coupling increase with PE

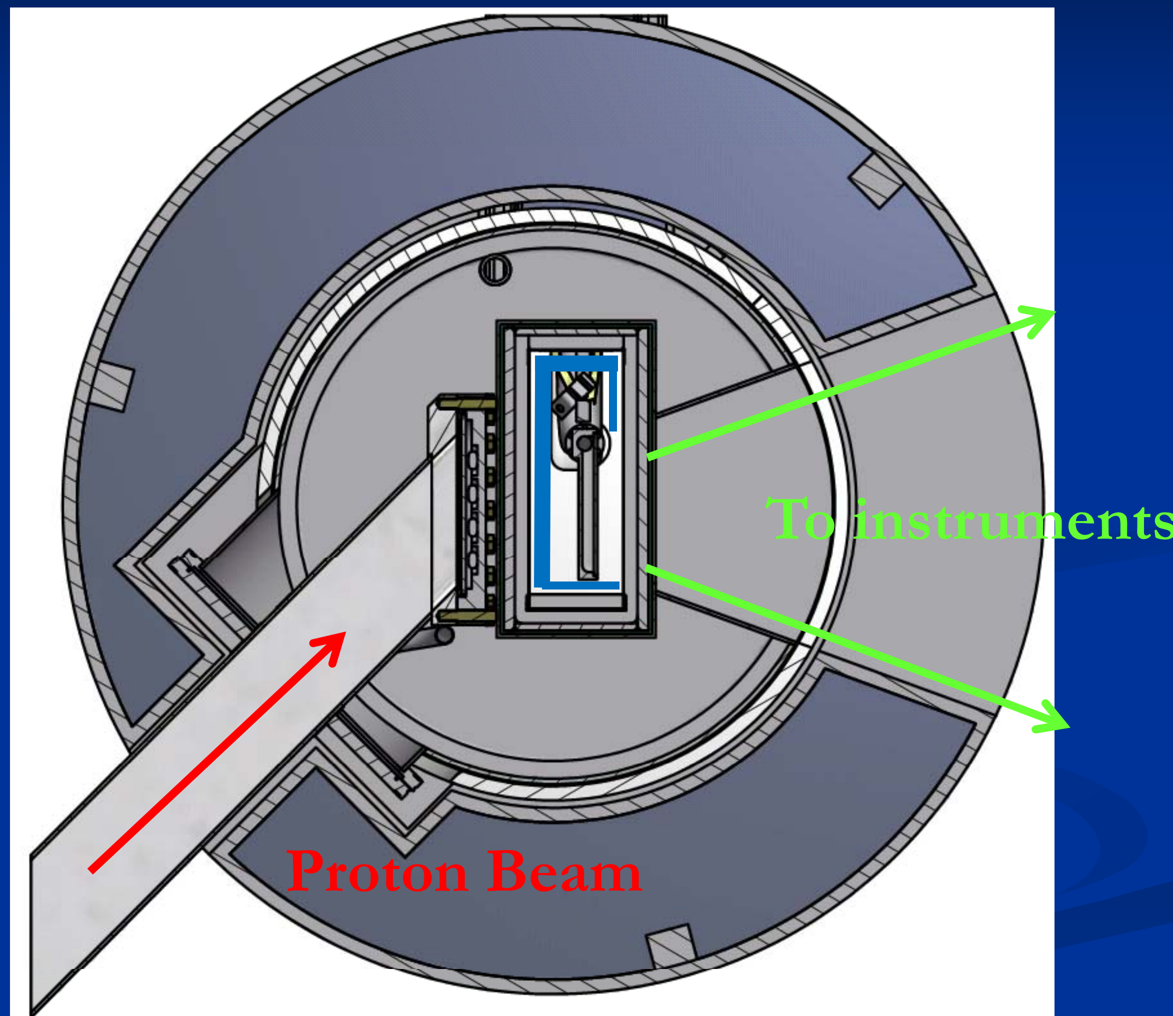




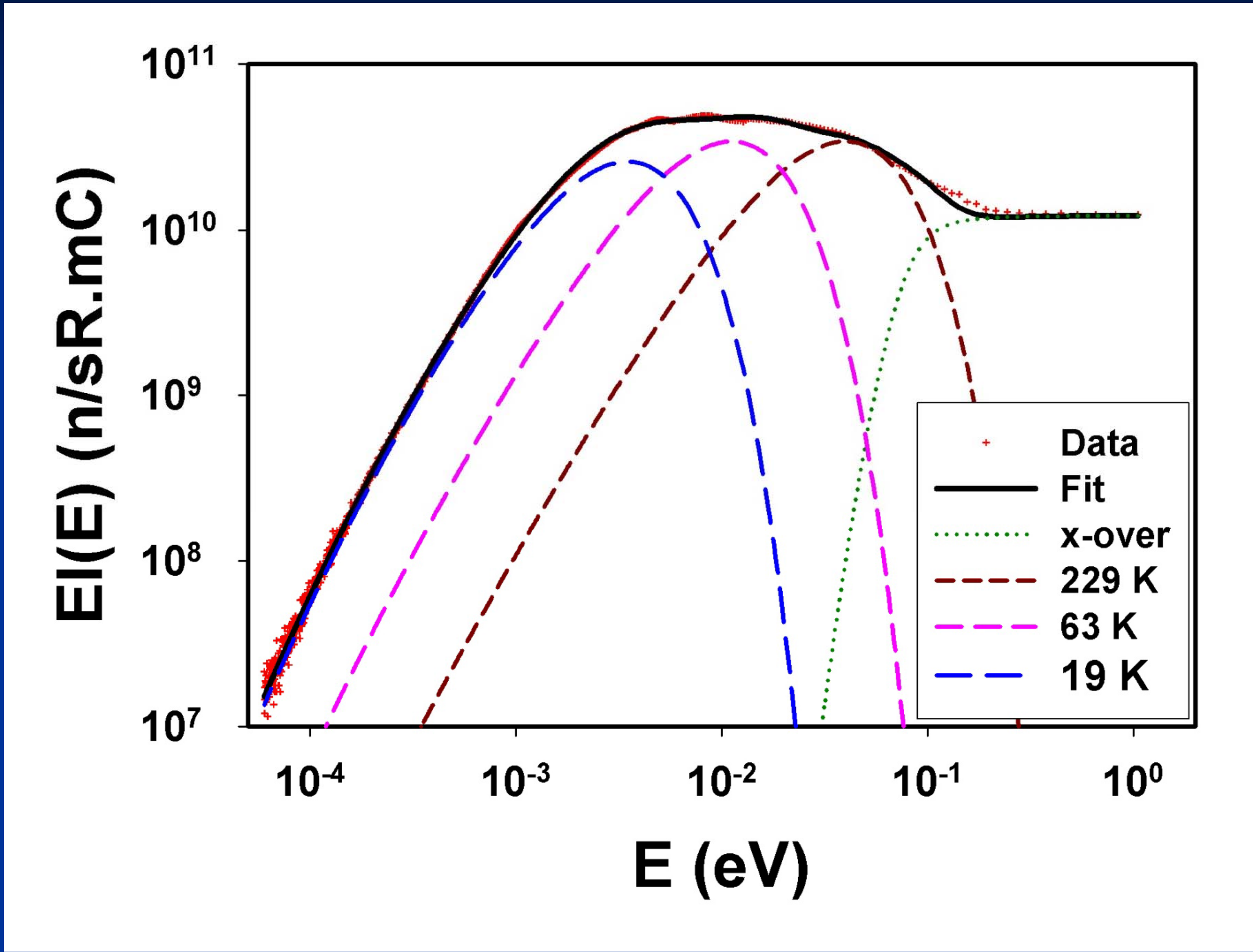
C. M. Lavelle et al. NIMA 587, 324 (2008)

Enhanced Coupling using PE

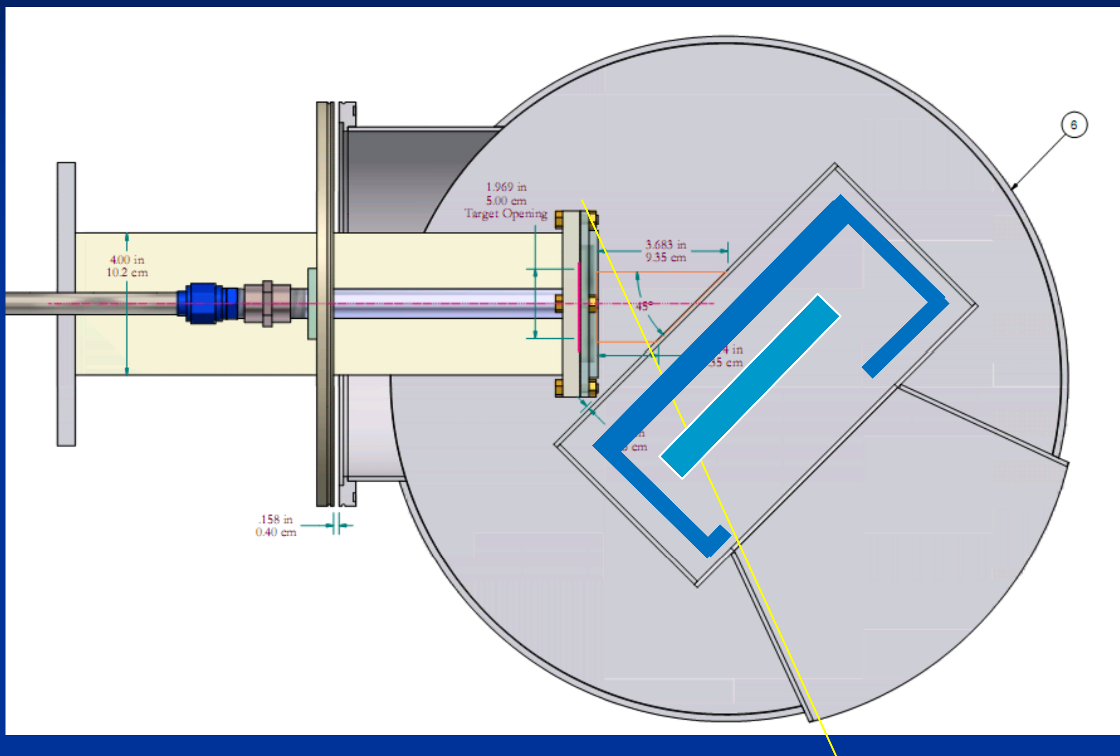
- Vacuum vessel around moderator is oversized to accommodate thicker test moderators.
- Added PE in the vacuum vessel and attached to the cold shield in order to increase reflector/premoderator material near the moderator



Fit to the Spectrum 13 MeV



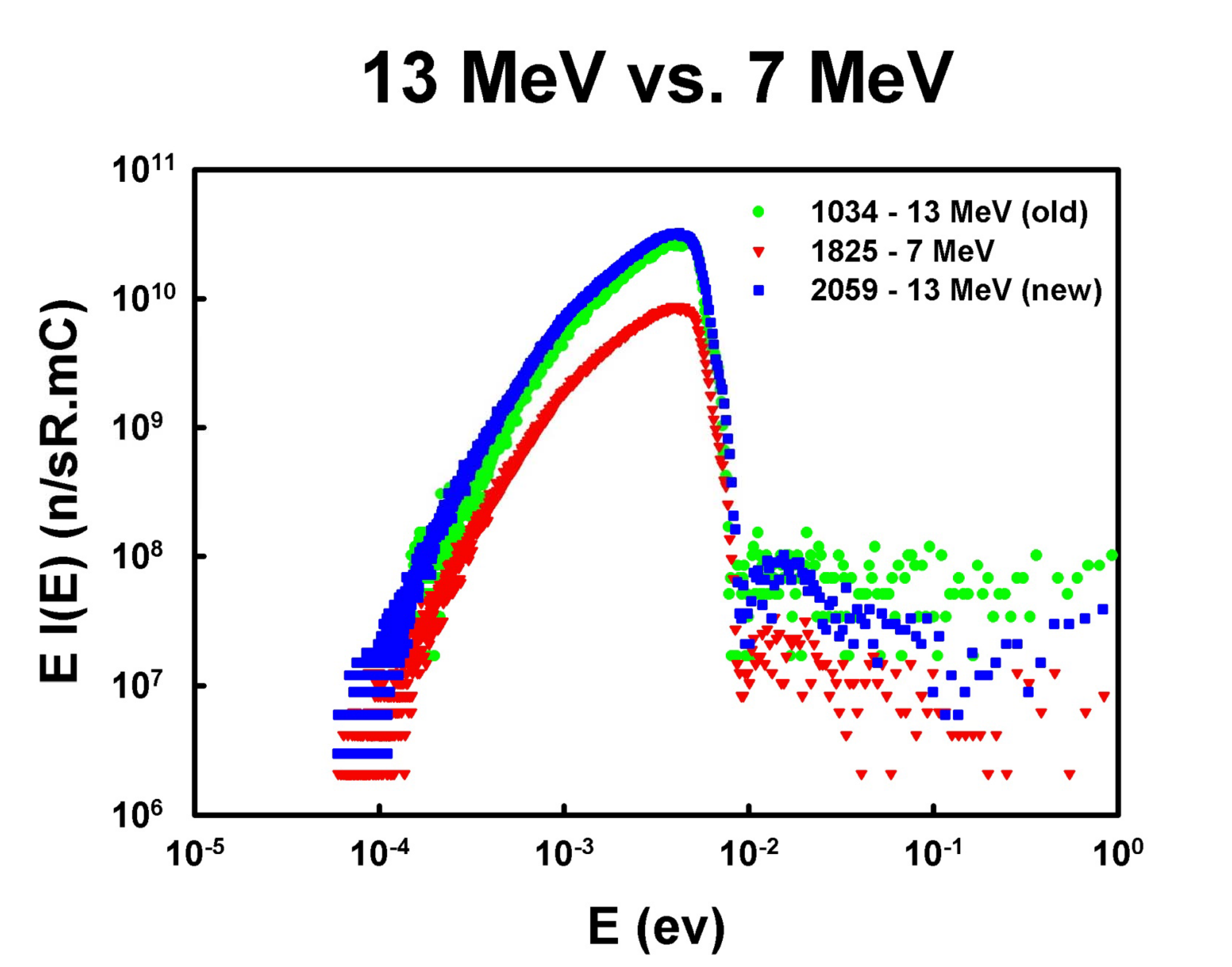
New Target Configuration



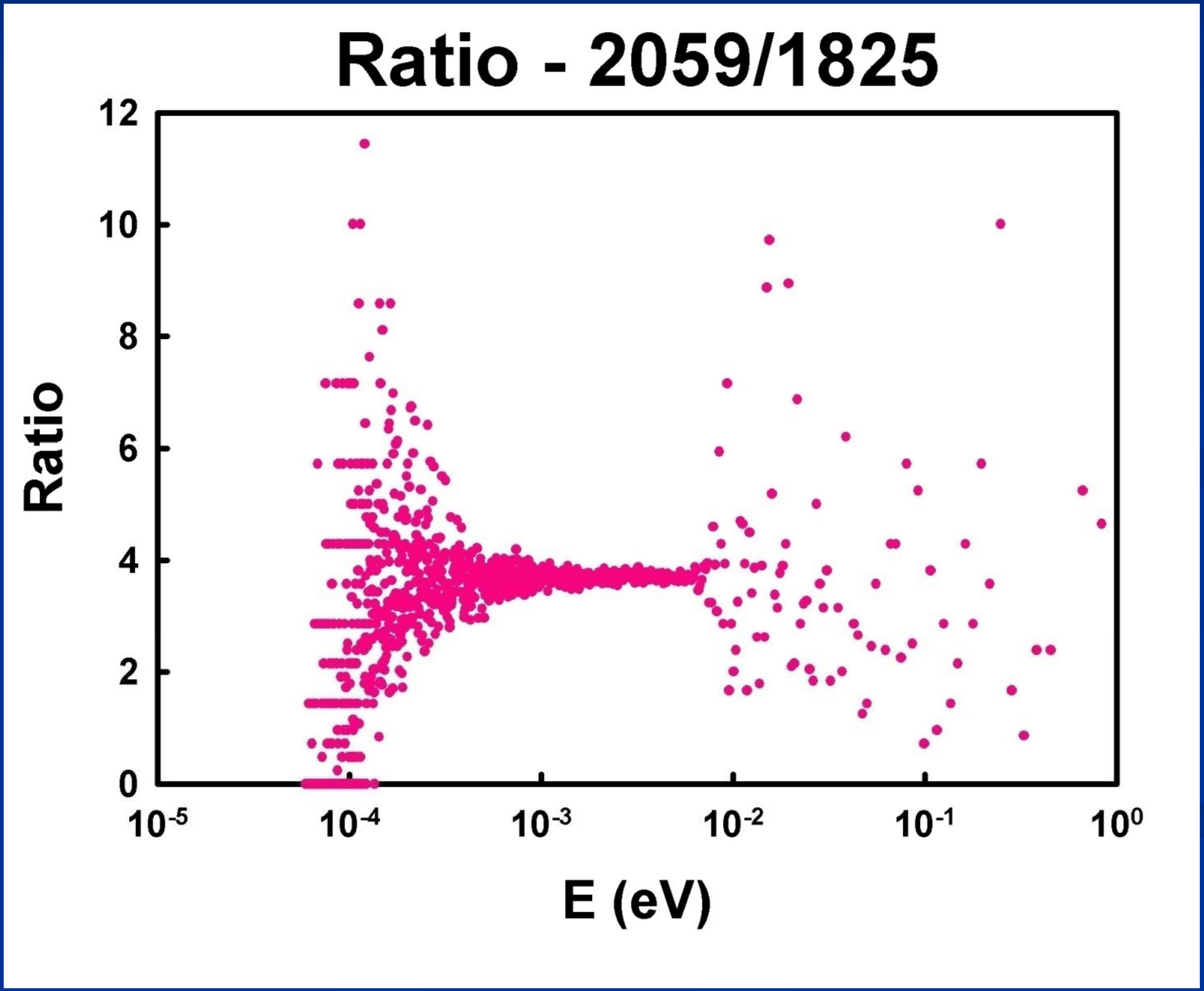
Thinner target gives longer life, but slightly reduced primary neutron production. Increased water between the target and moderator improves coupling; no change in cold flux was seen.

SANS instrument no longer views the illuminated portion of the target directly! Beam dose-rate fell from 1.6 R/hr.kW to 1.0 R/hr.kW after this change. This reduces the fast-neutron contribution to instrument background.

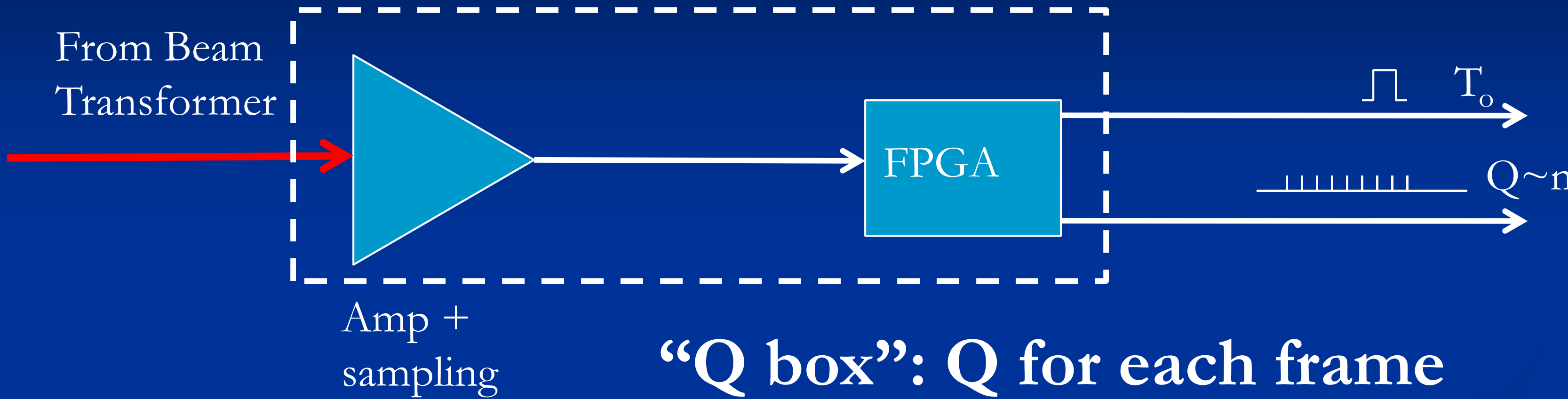
Neutronic Changes



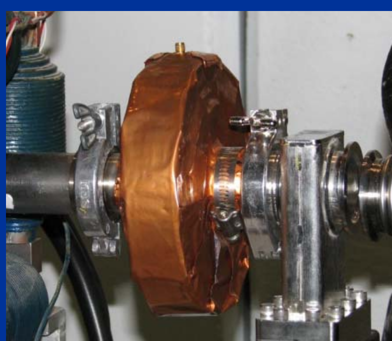
Factor of 3.7 gain from 7 to 13 MeV
(~3.0 from E, ~1.26 from target change)



Proton Pulse monitoring

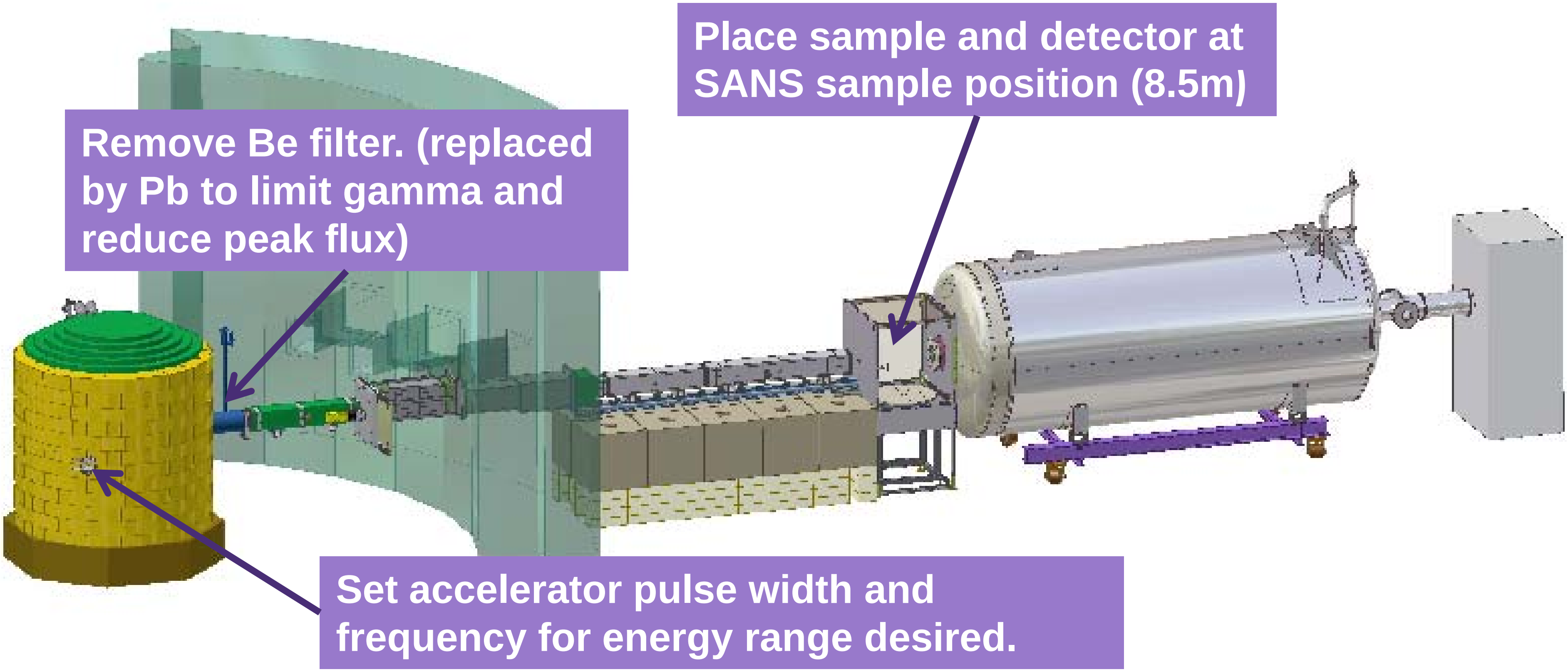


"Q box": Q for each frame

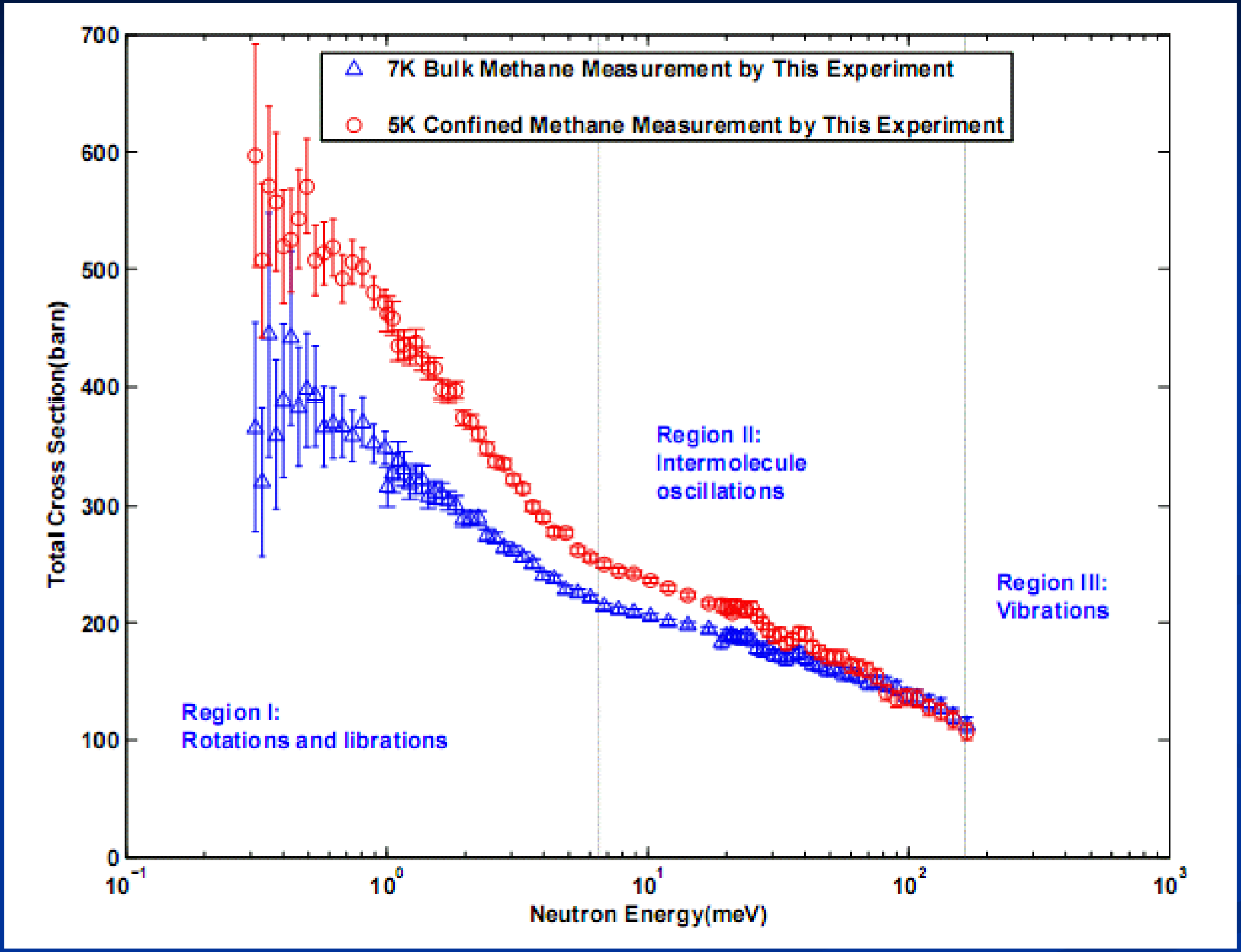


PBL scope monitor, pulse shape every 30 sec or so.

Σ_{tot} measured at SANS

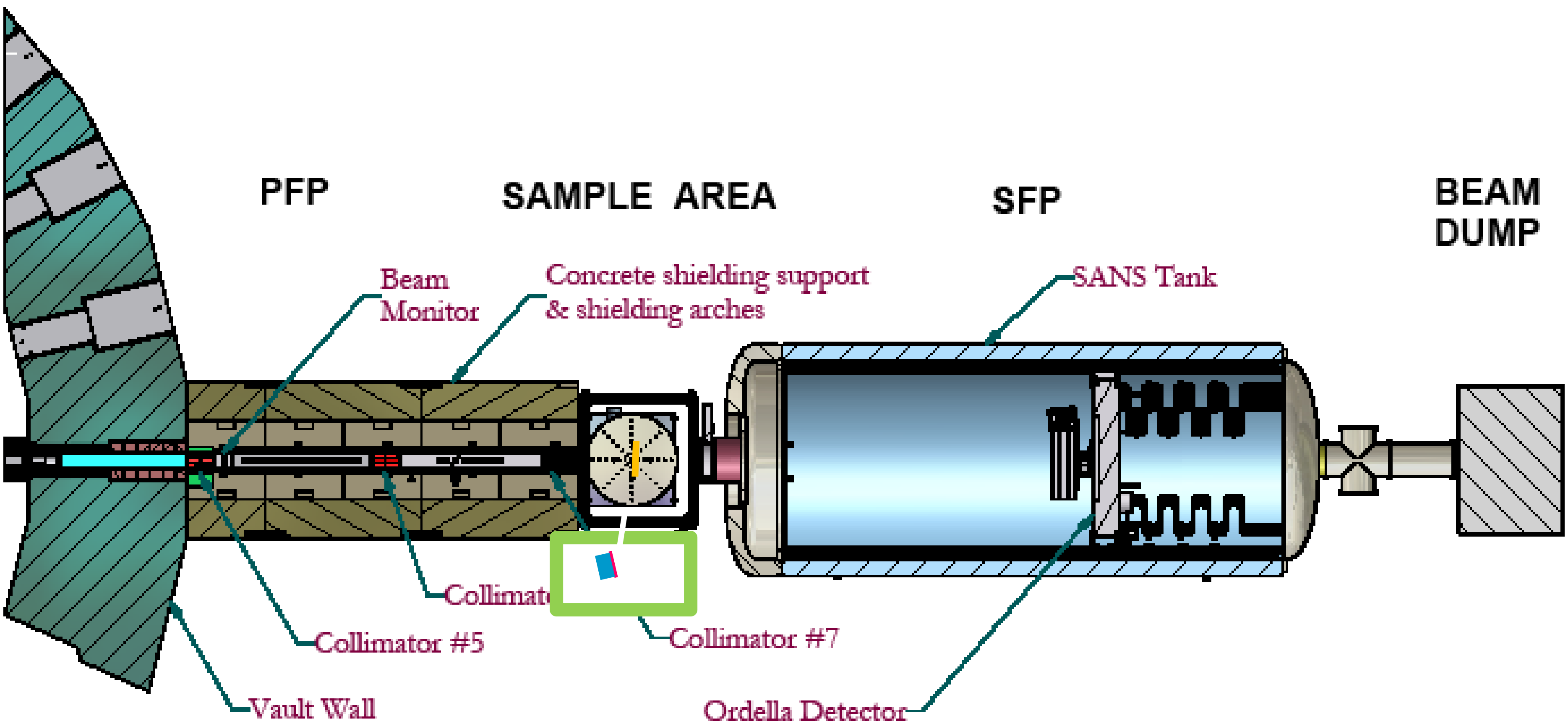


Materials Characterization

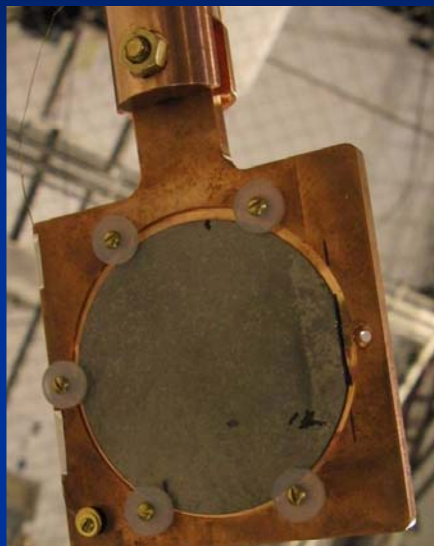


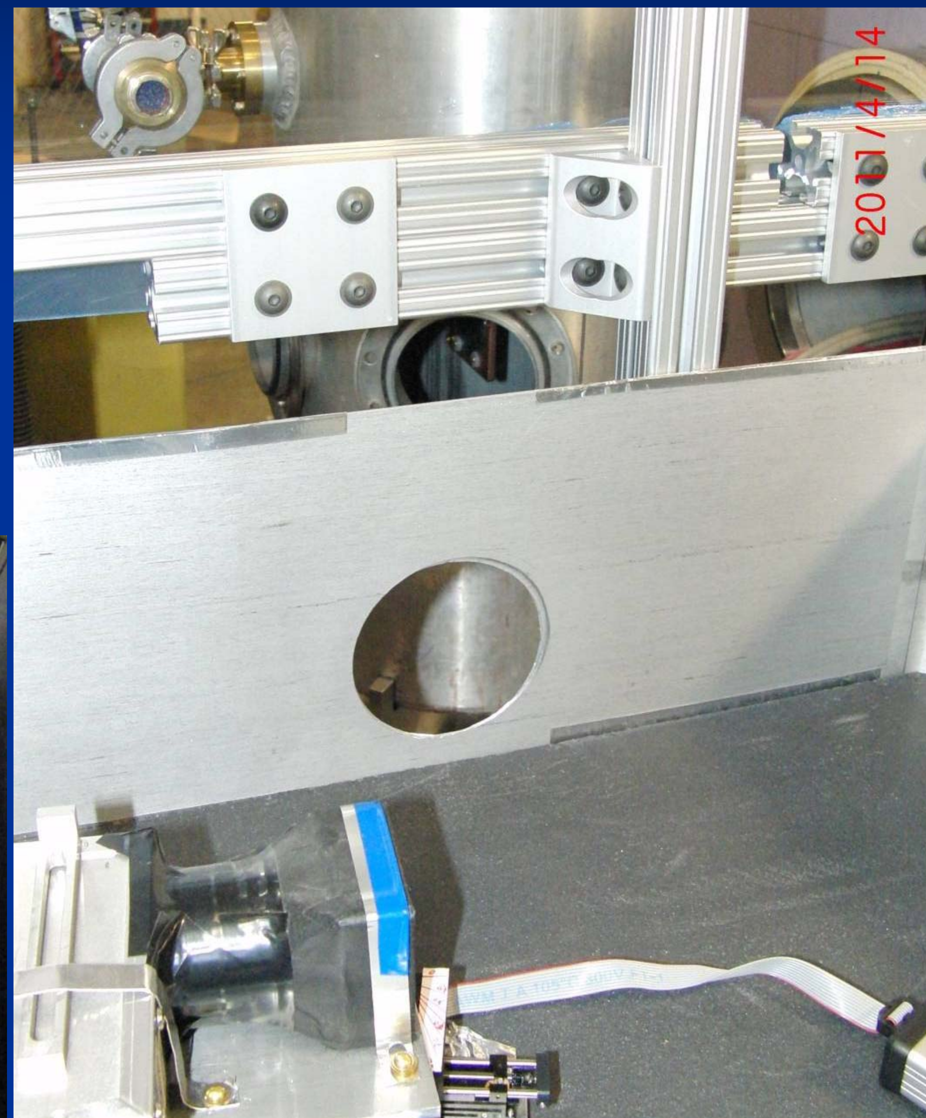
H. Yan et al NIM B269, 425 (2011); Effect of confinement (aeogel) on total cross-section of Methane.

Emission Time measurements

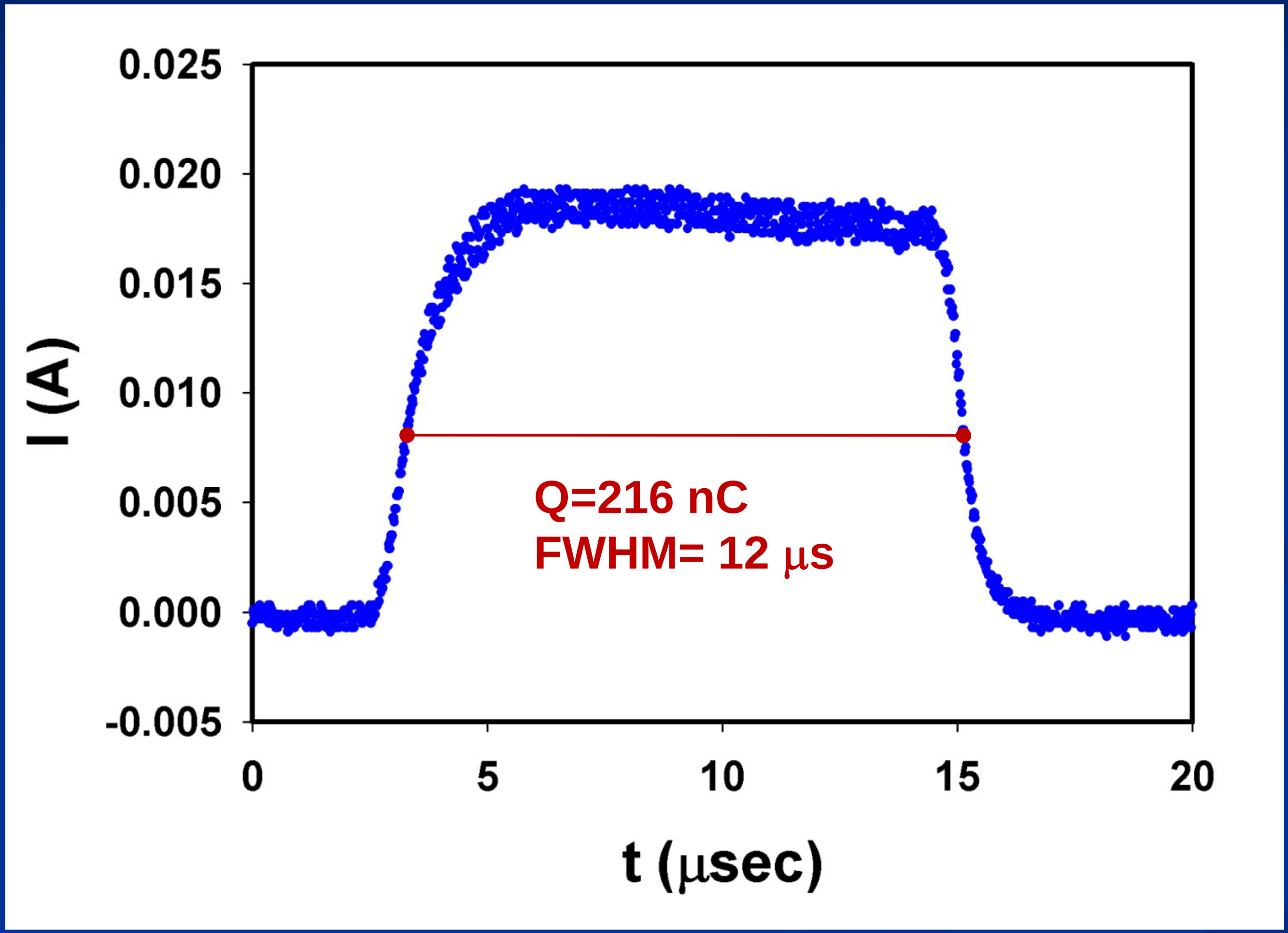


Time-focused spectrometer for Emission time measurements

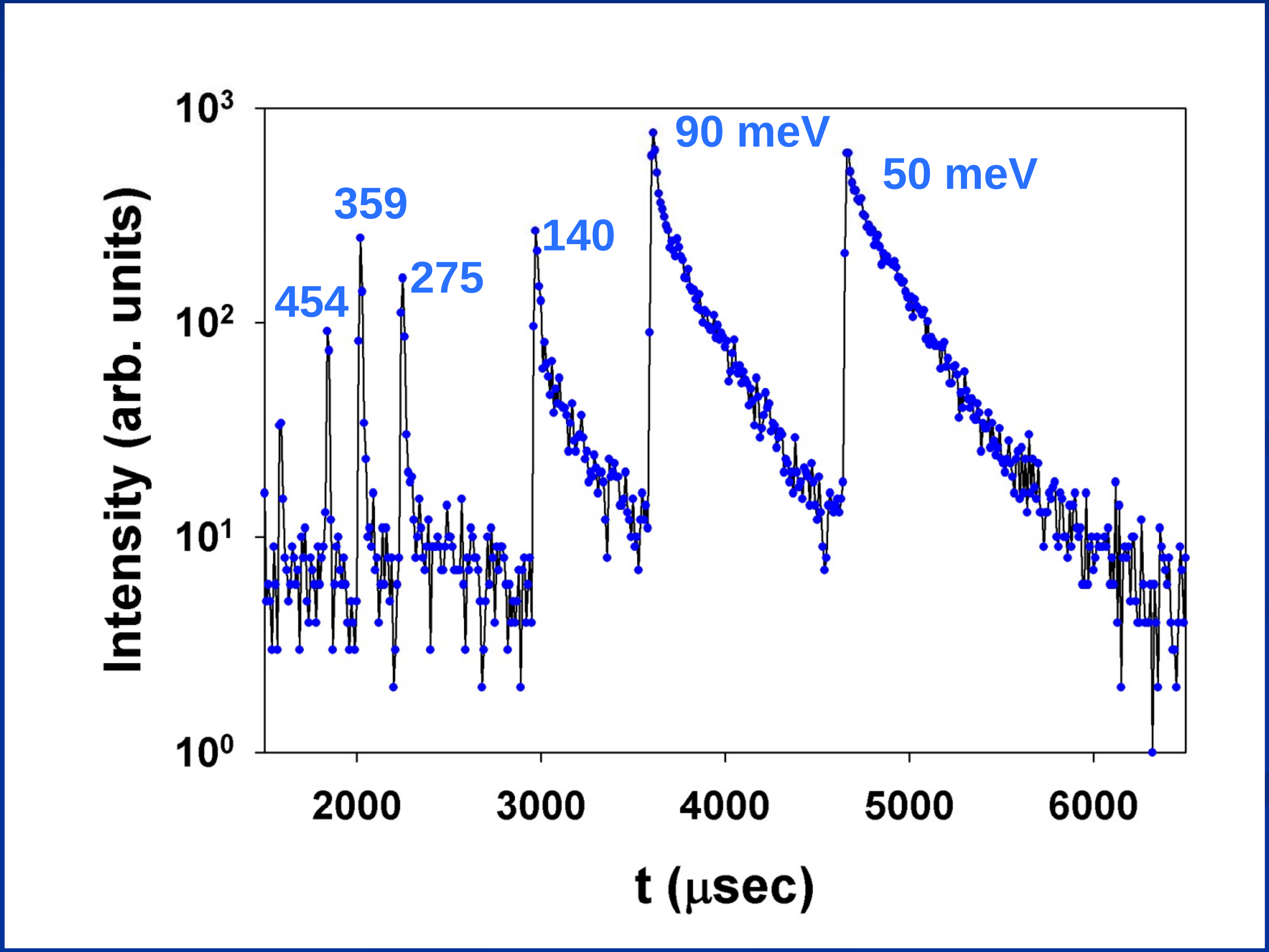




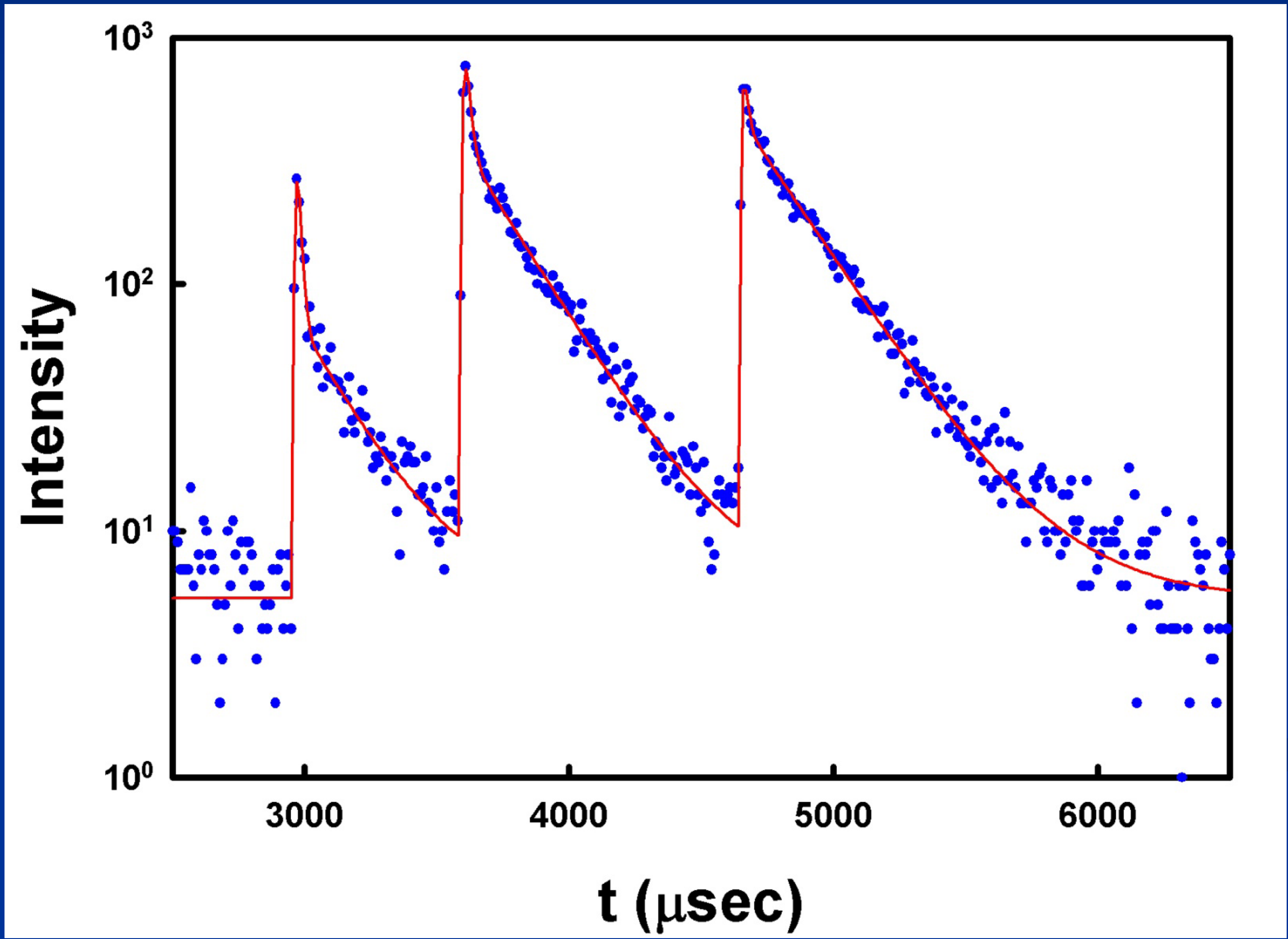
Proton pulse shape



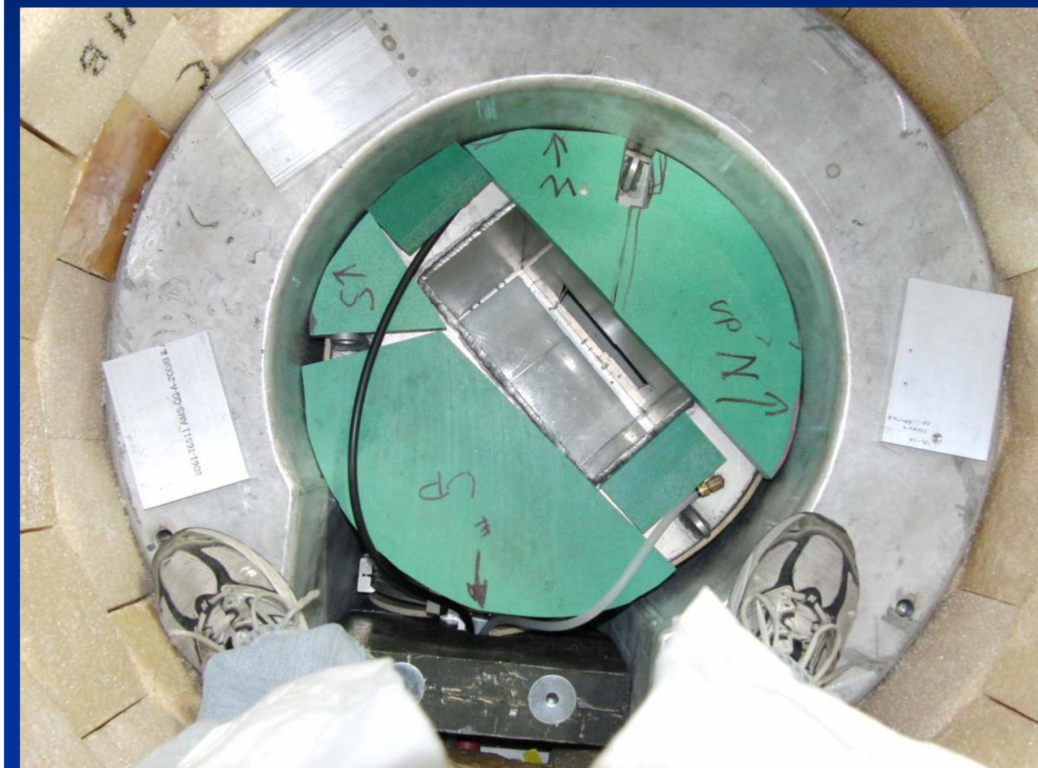
Emission time distr. CH_4 (8 hours at 40 Hz, 150W)



Emission time measurements: CH_4

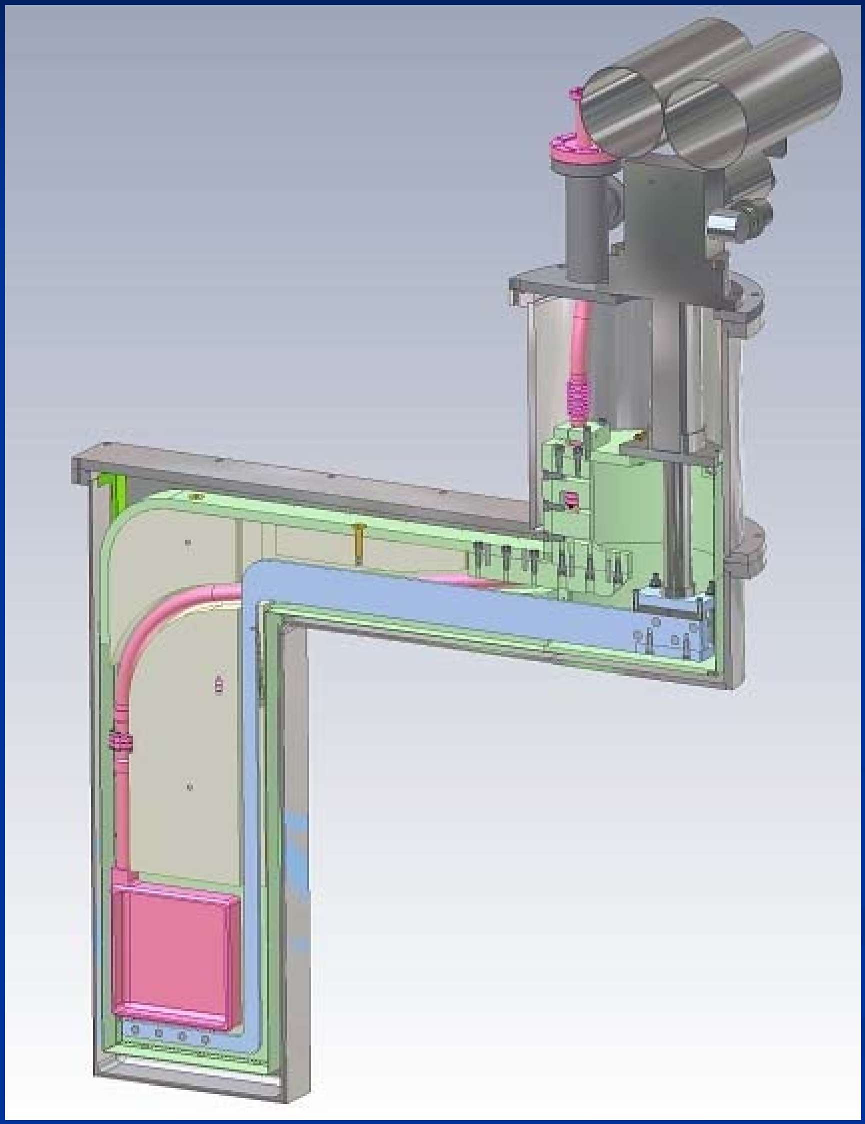


Research on prototype Moderators



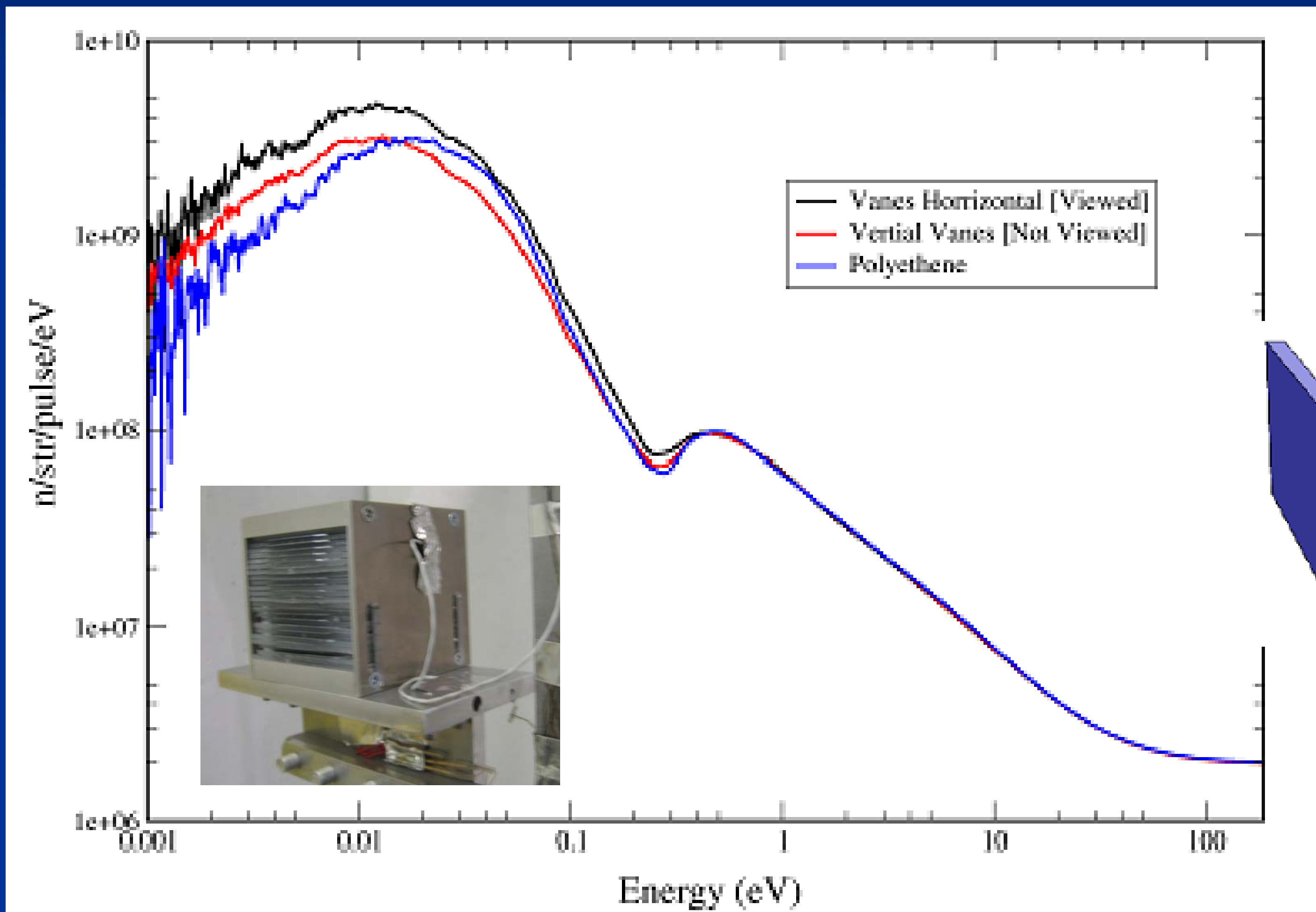
View of the reflector (inside a lead cask to shield gammas) and the cavity available for test moderators. On right is shown the opening to the beam lines, into which we insert Cd-coated liners to reduce interference from the reflector. The proton beam enters from bottom of left-hand image.

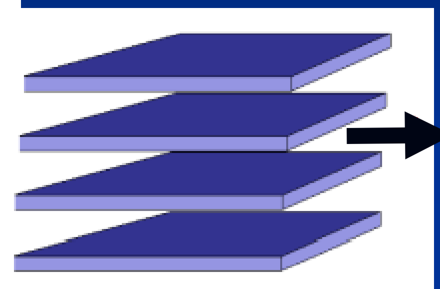
Test bed Assembly

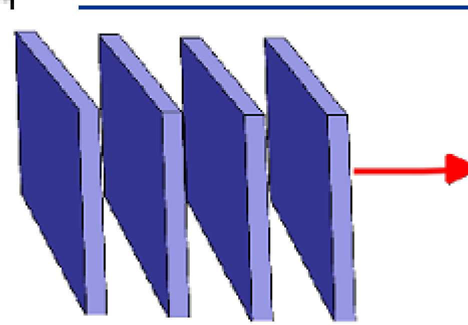


PT-410

Directional Moderators: Si/PE
(60 K

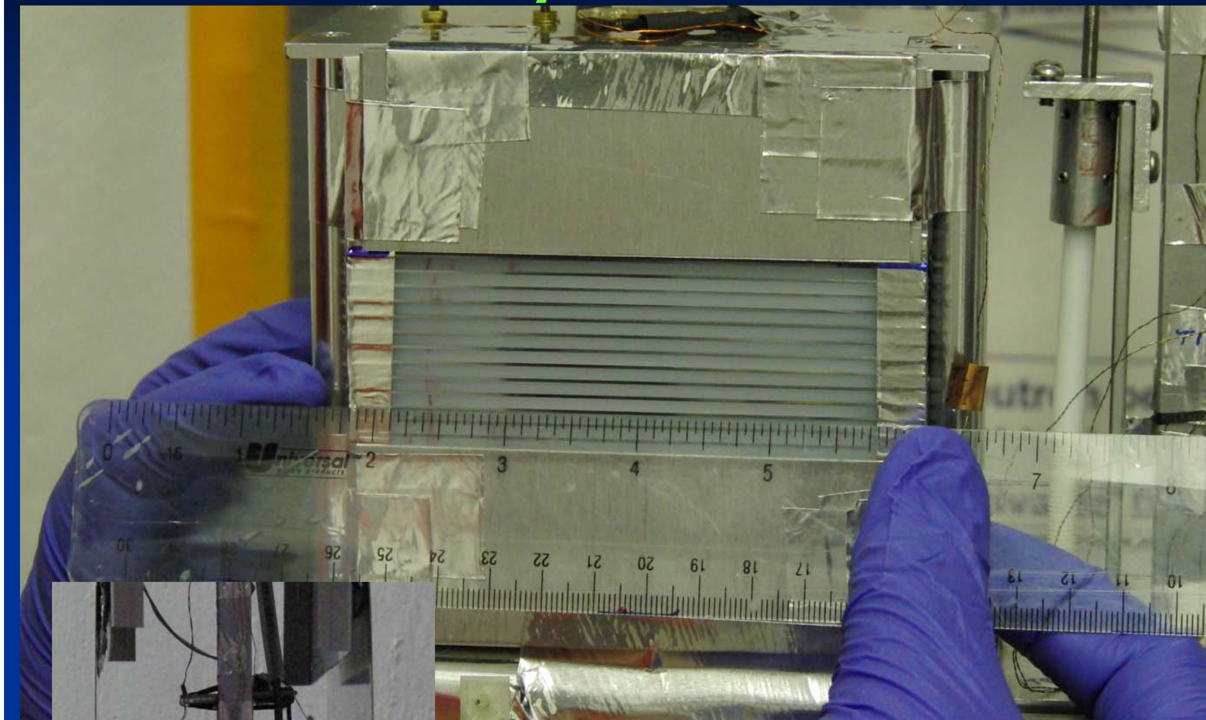


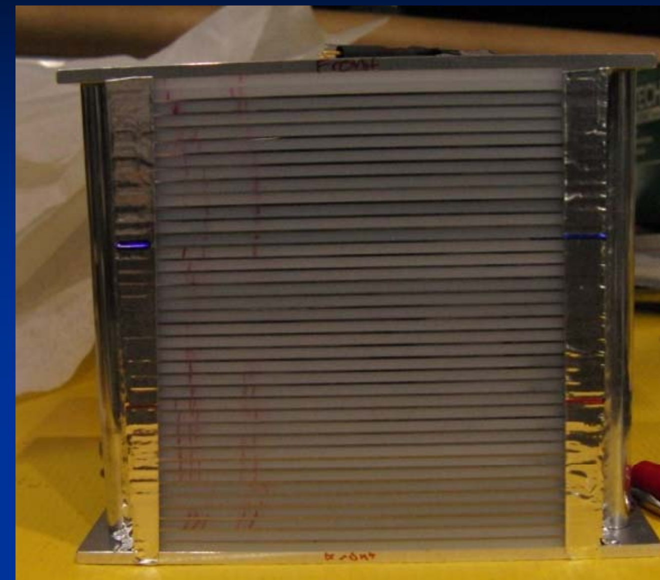


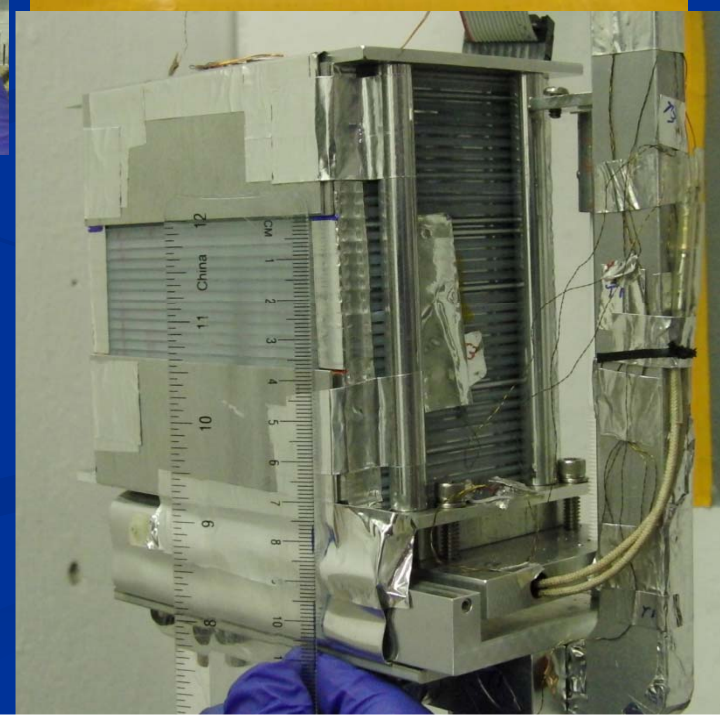


Ansell et al. in preparation.

PE/Si vaned moderator

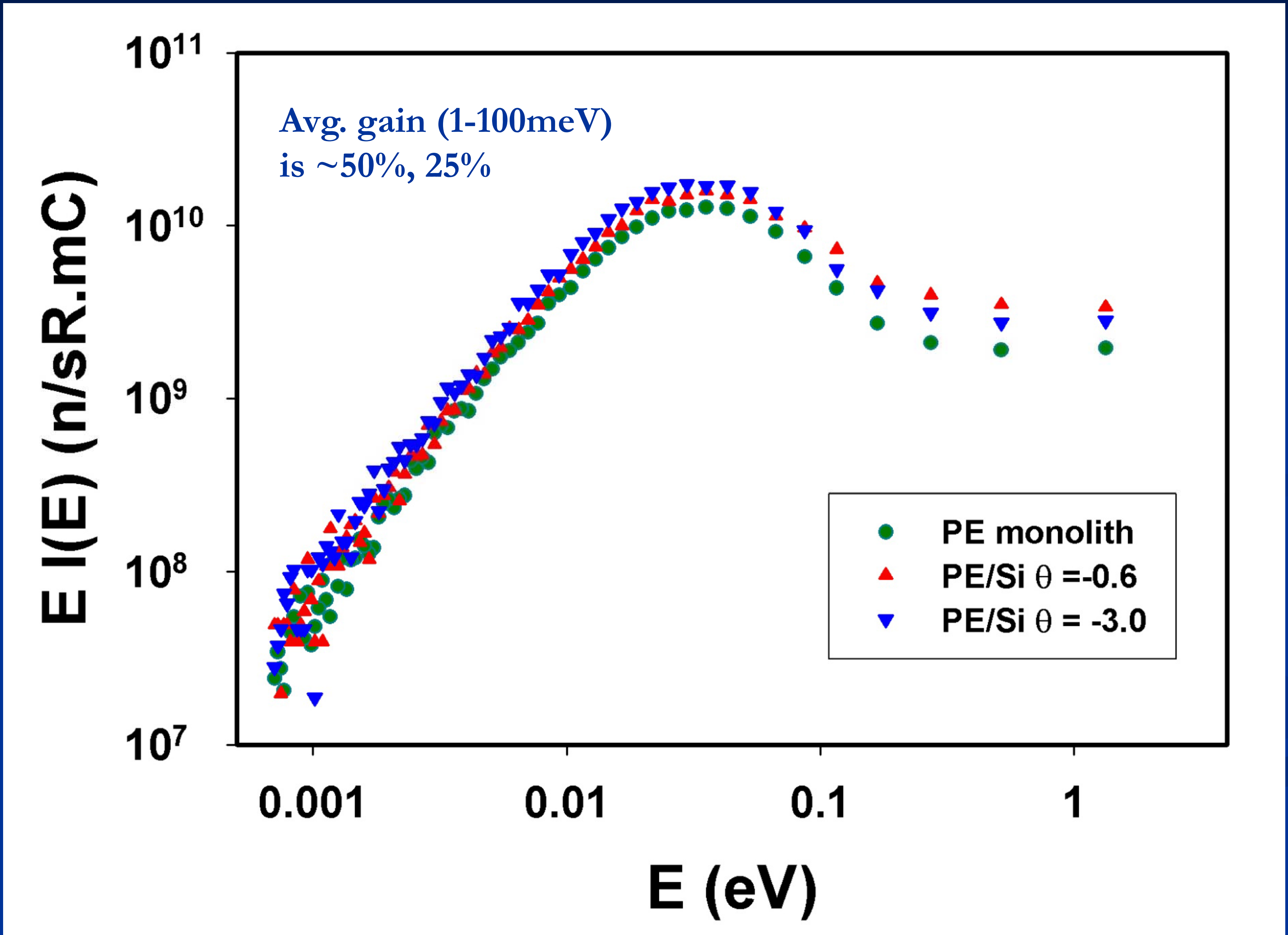




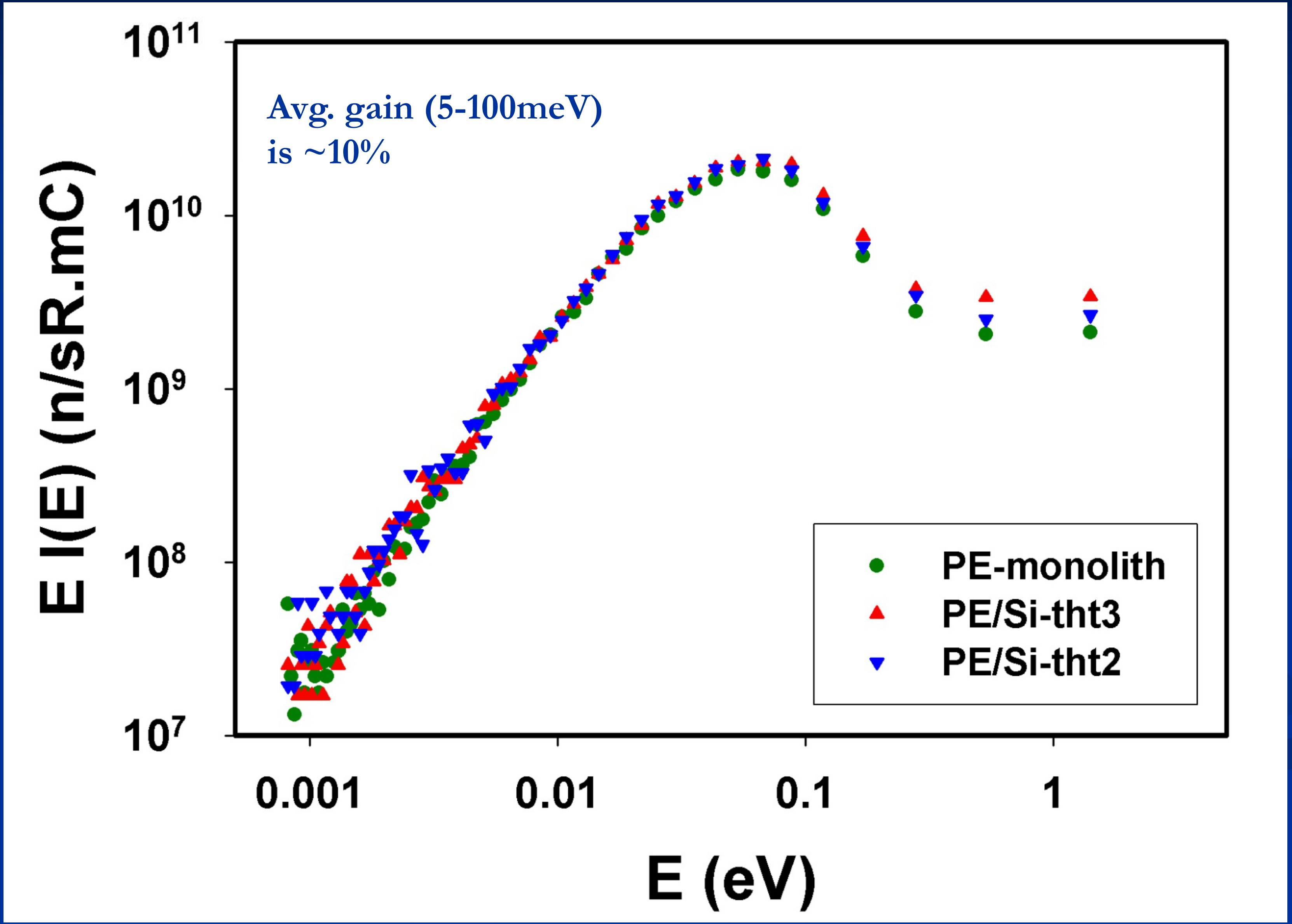


Spectral detector for PE/Si expts.

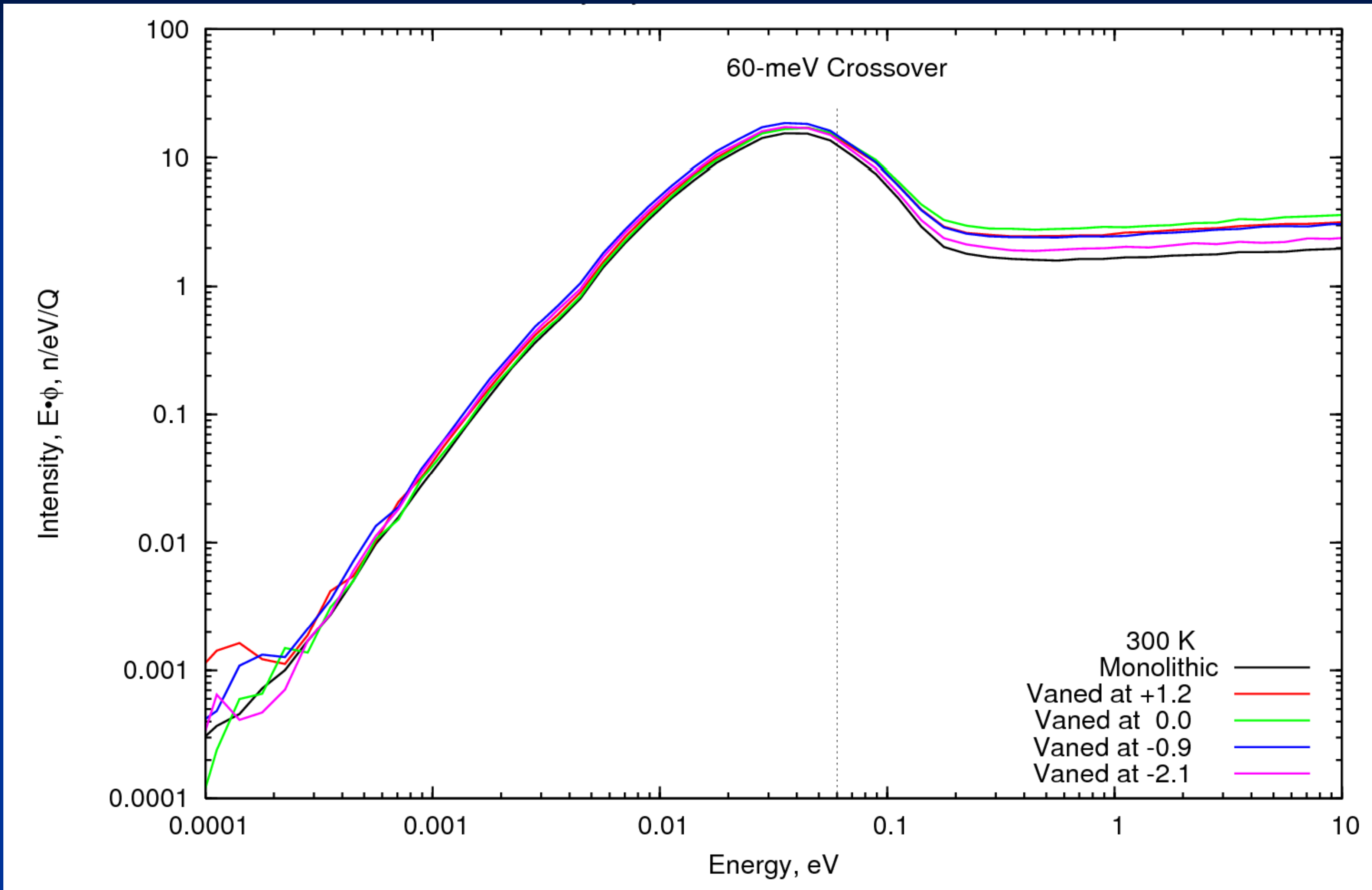
120K Spectra



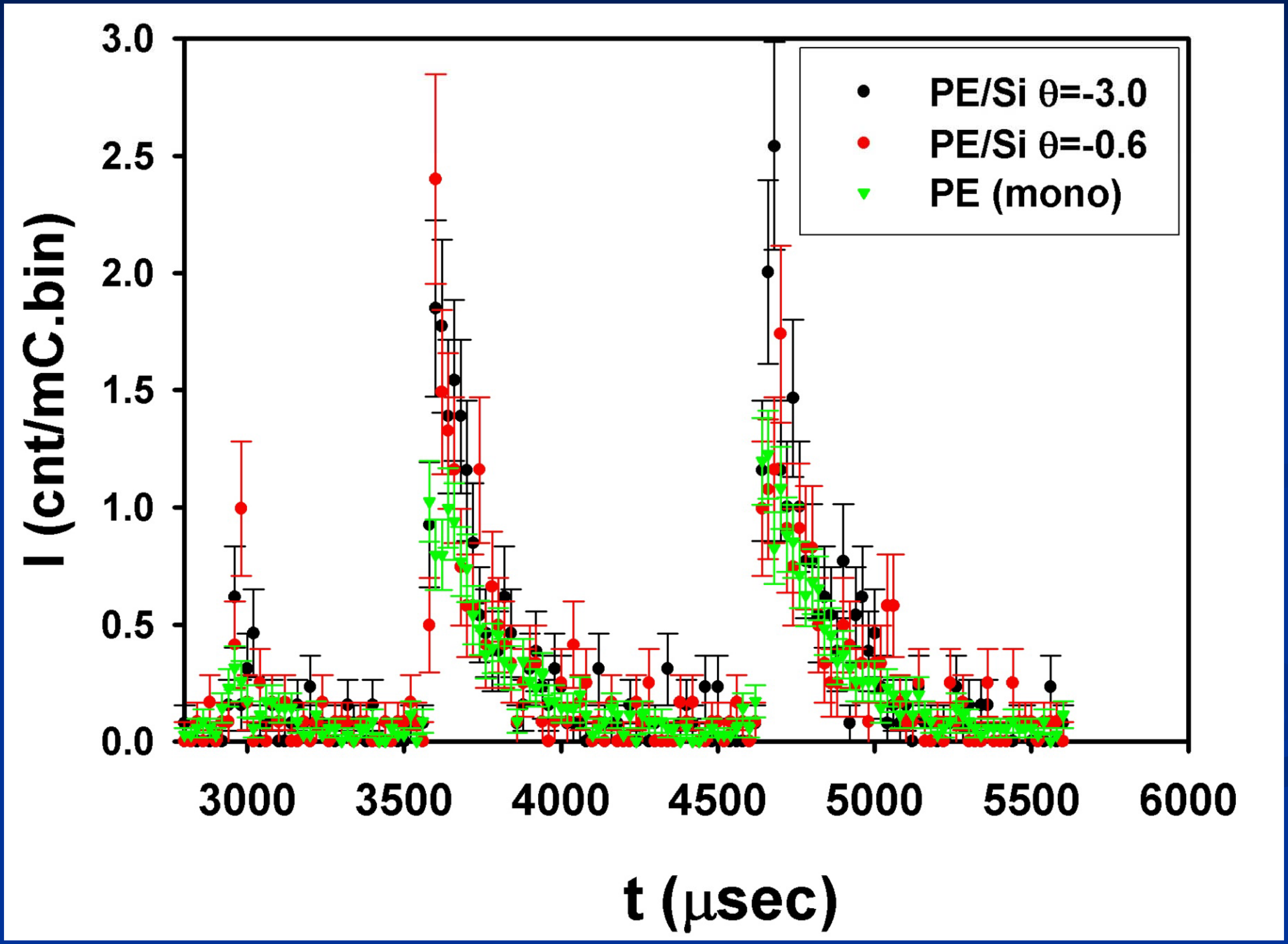
300 K Spectra



Spectral detector for PE/Si expts.



120K Pulse shapes



Pelletized Moderators

C. A. Foster,
Cryogenic Associates

CONCLUSIONS

- LENS has a number of capabilities for moving moderator research forward (modeling, prototyping, materials characterization).
- Our simple approach to moderator exchange without remote handling has been clearly validated in several prototyping experiments.
- We have investigated the angular and temperature dependence of the vaned moderator idea, and confirmed the PE/Si result.
- There is much yet to understand about this idea (e.g. null result with mesitylene/toluene?)!