LA-UR- 12-01482

Approved for public release; distribution is unlimited.

Title:	Low energy detectors : 6Li-glass scintillators
Author(s):	Hye Young Lee
Intended for:	Attending the Fission Workshop meeting for the Chi-Nu project at Los Alamos National Laboratory

Los Alamos
NATIONAL LABORATORY
EST. 1943

Form 836 (7/06)

Low energy detectors : ^{6}Li-glass scintillators

Hye Young Lee

I will present the detector response study done for the 6Li-glass detectors in the Chi-Nu project. The calibration work with 252Cf source and in–beam test on 235U will be discussed for charactering the detector response and establishing the analysis method for the convoluted neutron output data.

Low energy detectors : ^{6}Li-glass scintillators

Hye Young Lee
Terry Taddeucci (MCNP calculations)

Los Alamos Neutron Science Center
-Neutron and Nuclear Science
(LANSCE-NS)

Los Alamos National Laboratory

Contents

- **Detector Response Calibration using ^{252}Cf source**
  - Establish the analysis method for low energy neutron measurements
  - Comparison with MCNP calculations
  - Sensitivity of Li-glass measurements to the underlying fission spectra
- **Calculated Detector Response for New Li-glass detector assembly**
  - Reduced room-induced background
- **Preliminary Prompt Fission Neutron Spectrum from ^{235}U(n,f) at FIGARO setup**
- **Outlook**

How to determine the detector response

Detector response function

- Yield =
  Neutron distribution X Detector response function X Detector solid angle
- Neutron distribution = Watt distribution
- Detector response function =
  $^{6}Li(n,\alpha)t$ cross section X light response in glass & PMT
- Yield (^{252}Cf) / Watt distribution (^{252}Cf) =
  Detector response function at a fixed position for one detector

Lajtai measurement using a ^{252}Cf source

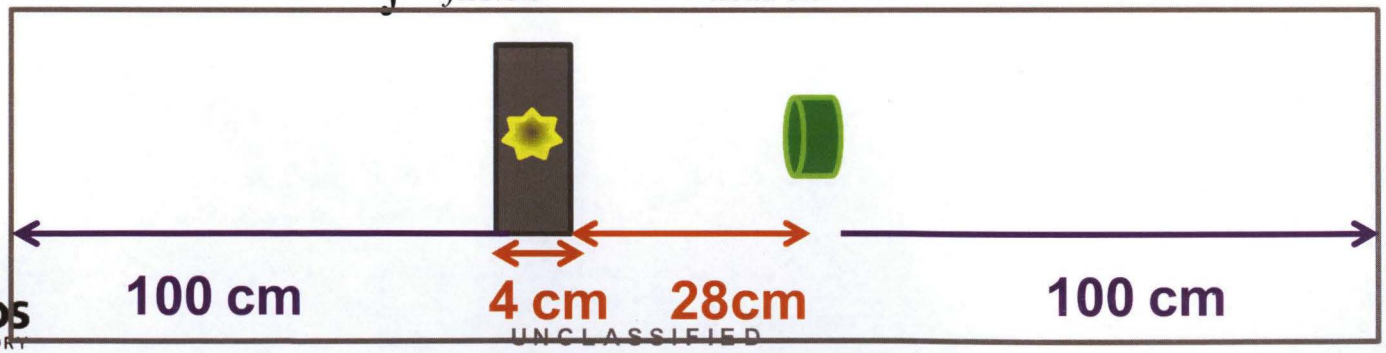
1. Triggers were selected by "slow" signal discrimination (1-dim. cut); for fission fragments from the alphas and for neutrons from gammas+background
2. Correction factor a(t) :

$$a(t) = \frac{\int \delta[t - t(E)]\varepsilon'(E)\phi(E)dE}{\int F(E,t)\phi(E)dE}$$

where *f(E)* is a Maxwellian distribution with a T=1.42, e'(E) is the theoretical efficiency of the neutron detector calculated on the basis of e'(E) = int F'(E,t)dt, where F'(E,t) is the probability of recording at instant *t* of neutrons emitted from the source with energy *E* and travelling towards the detector and back within the solid angle.

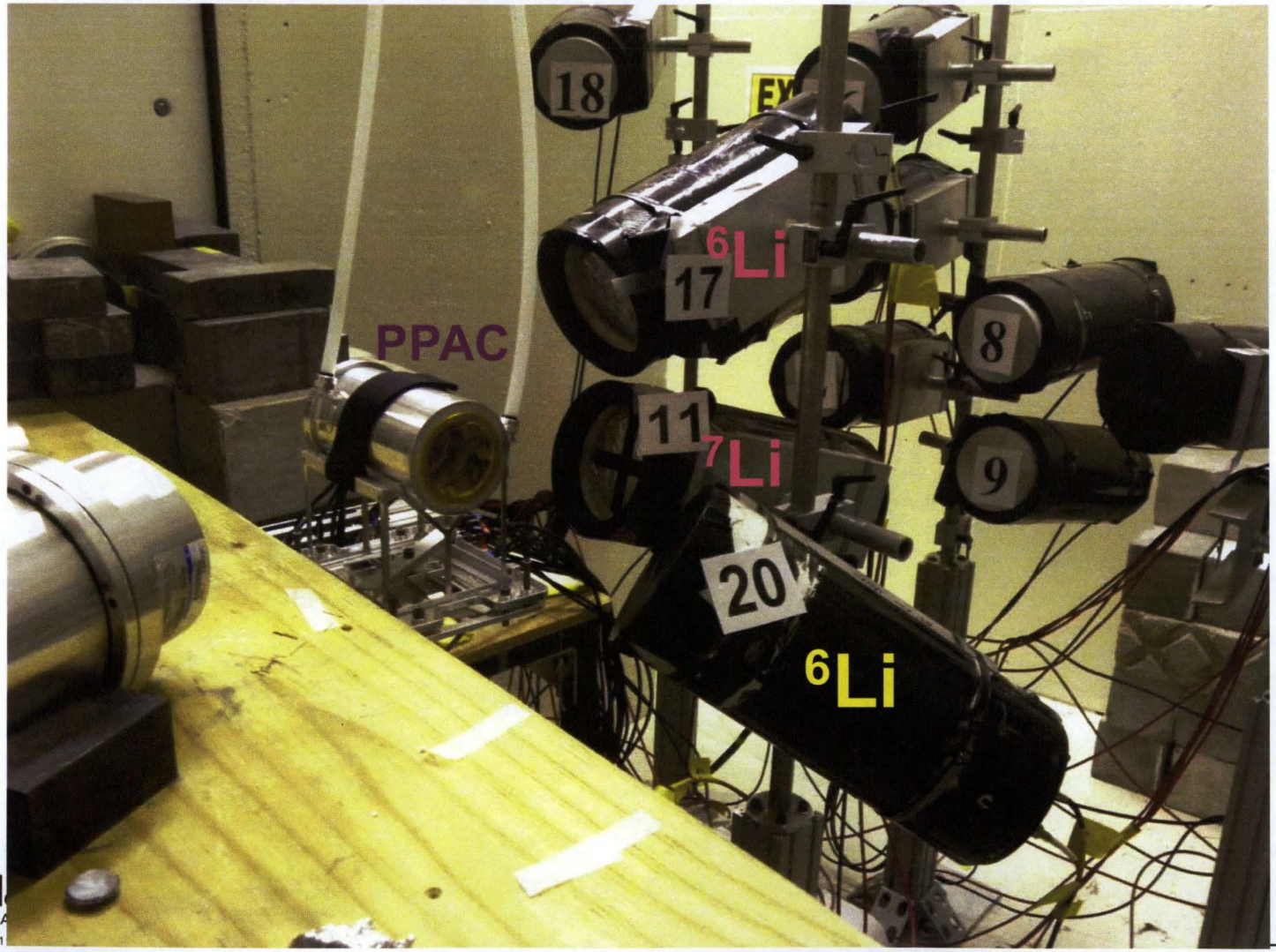
3. The realistic response function F(E,t) :
where F"(E,t) is identical to F'(E,t), except that real experimental conditions were assumed for both source and detector; F'(t,t') is the instrument portion.

$$F'(t,t') = \int F_{fission}(t,t'')F_{neutron}(t',t'')dt''$$



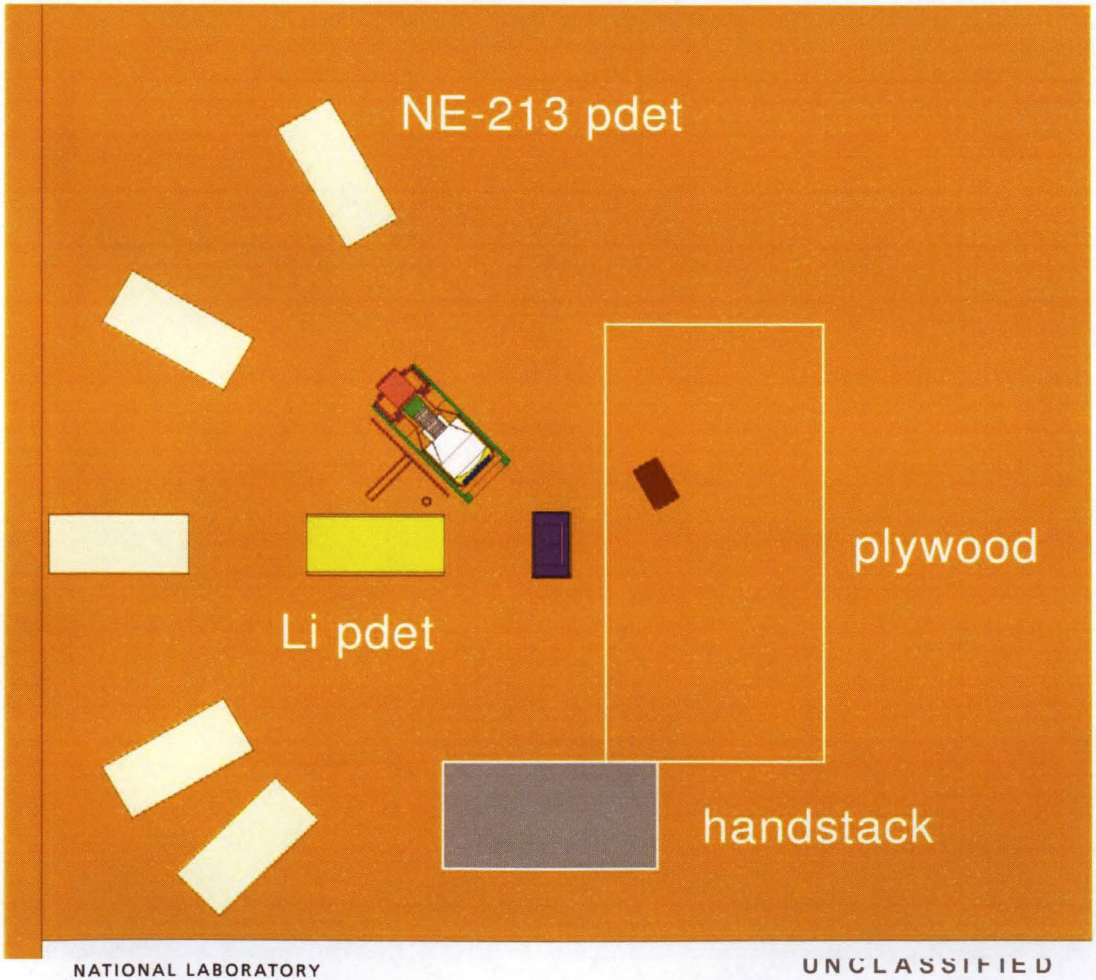
^{252}Cf source measurement

Experimental setup with ^{6}Li-glass detector and PPAC ^{252}Cf source

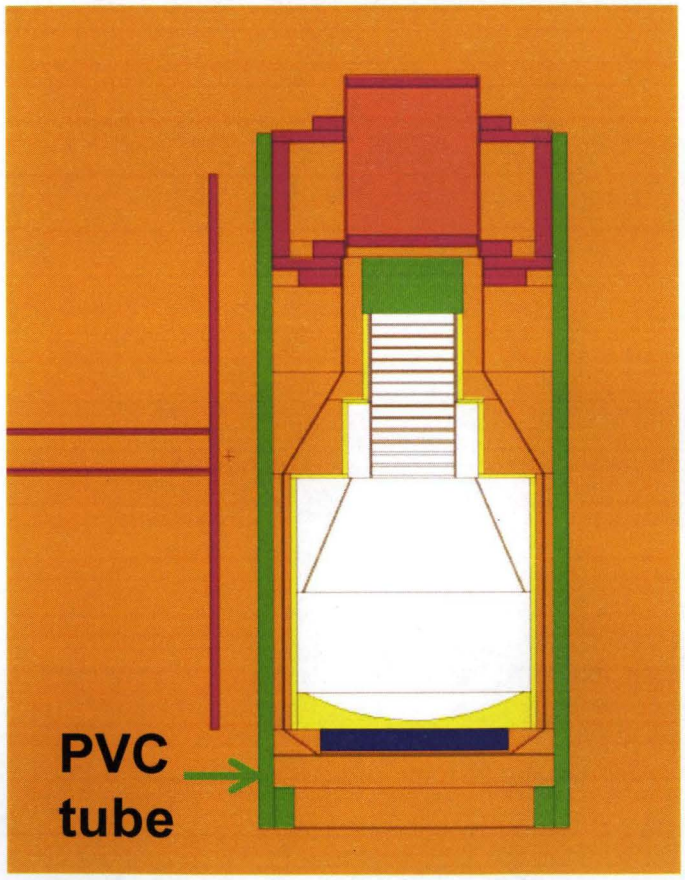


MCNP geometry for FIGARO target room

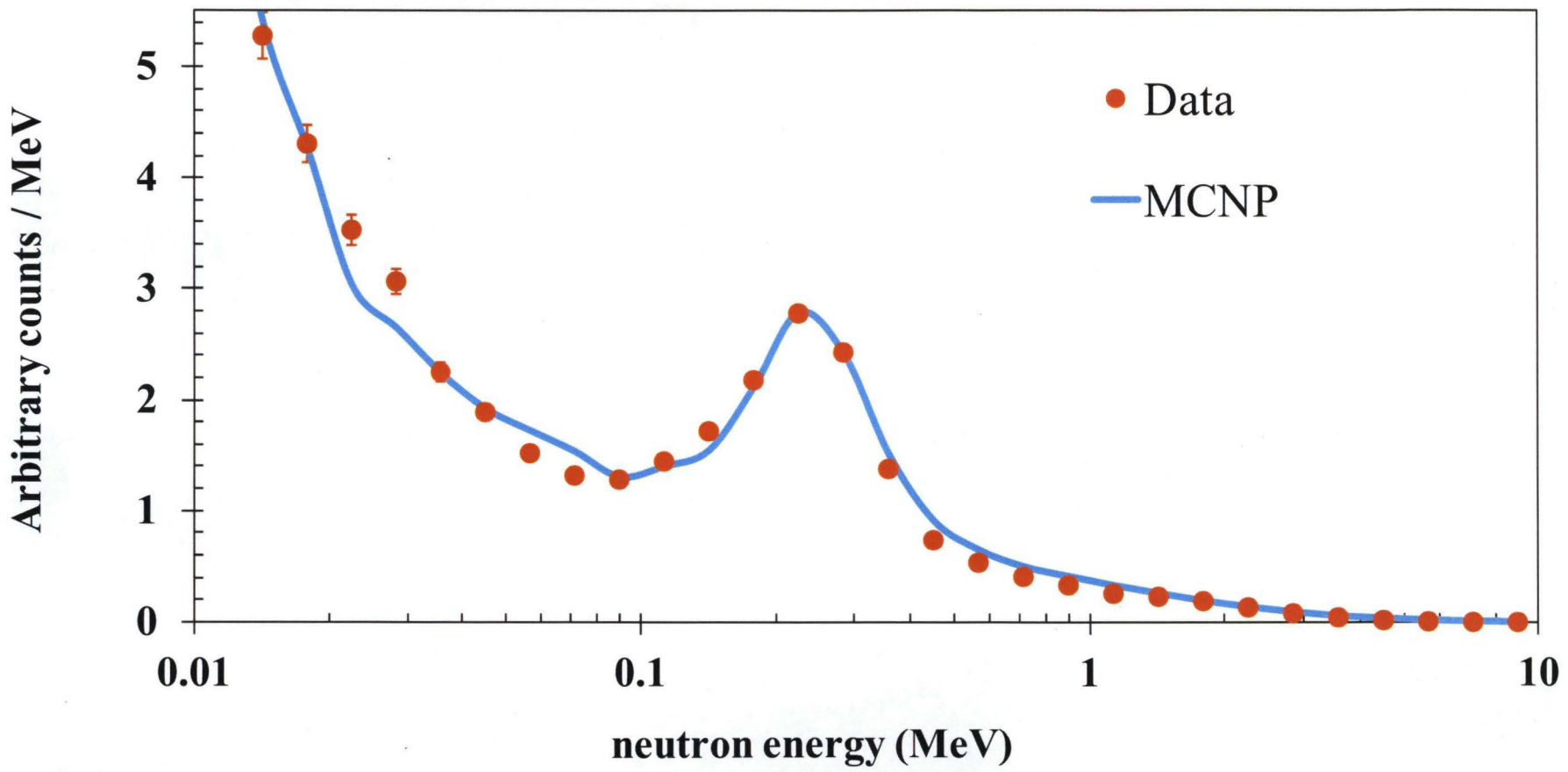
central 3 meters



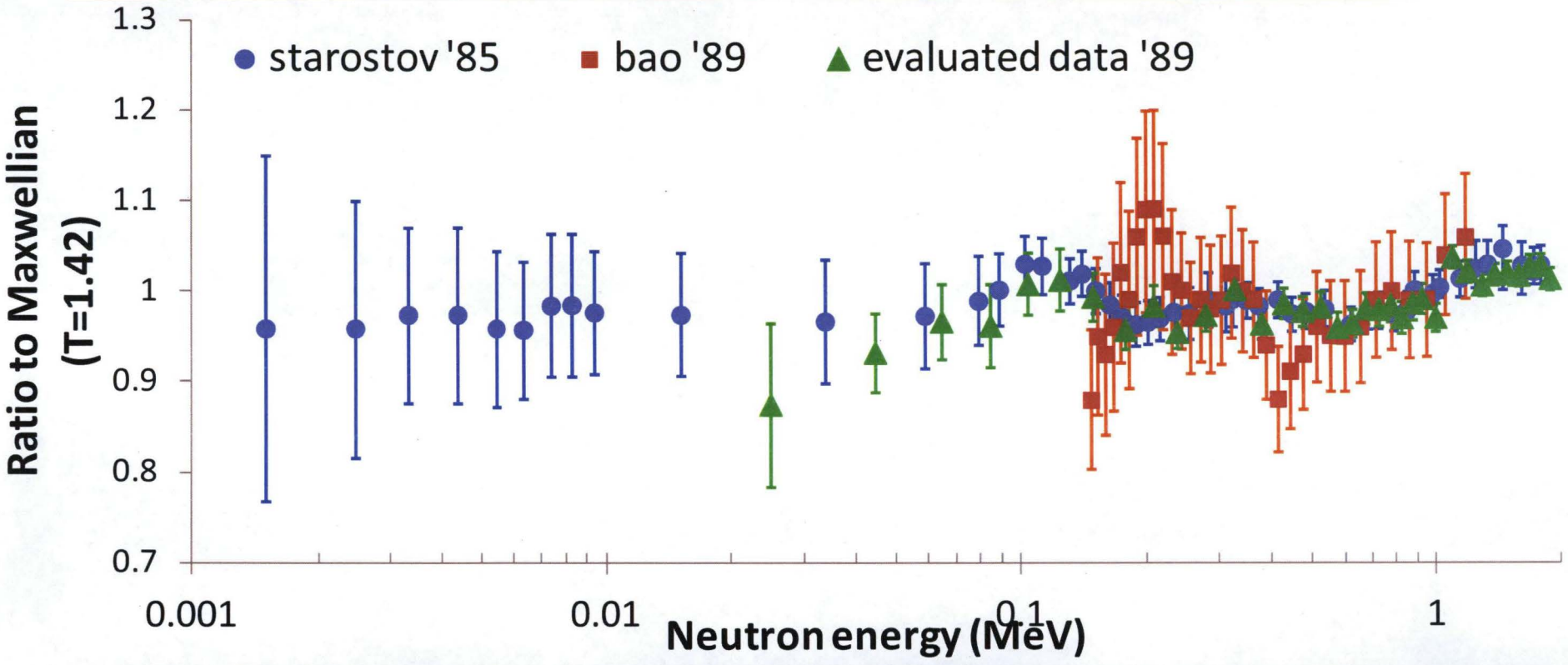
Complete geometry for ^{6}Li-glass detector and PMT



Experimental yield compared with MCNP yield

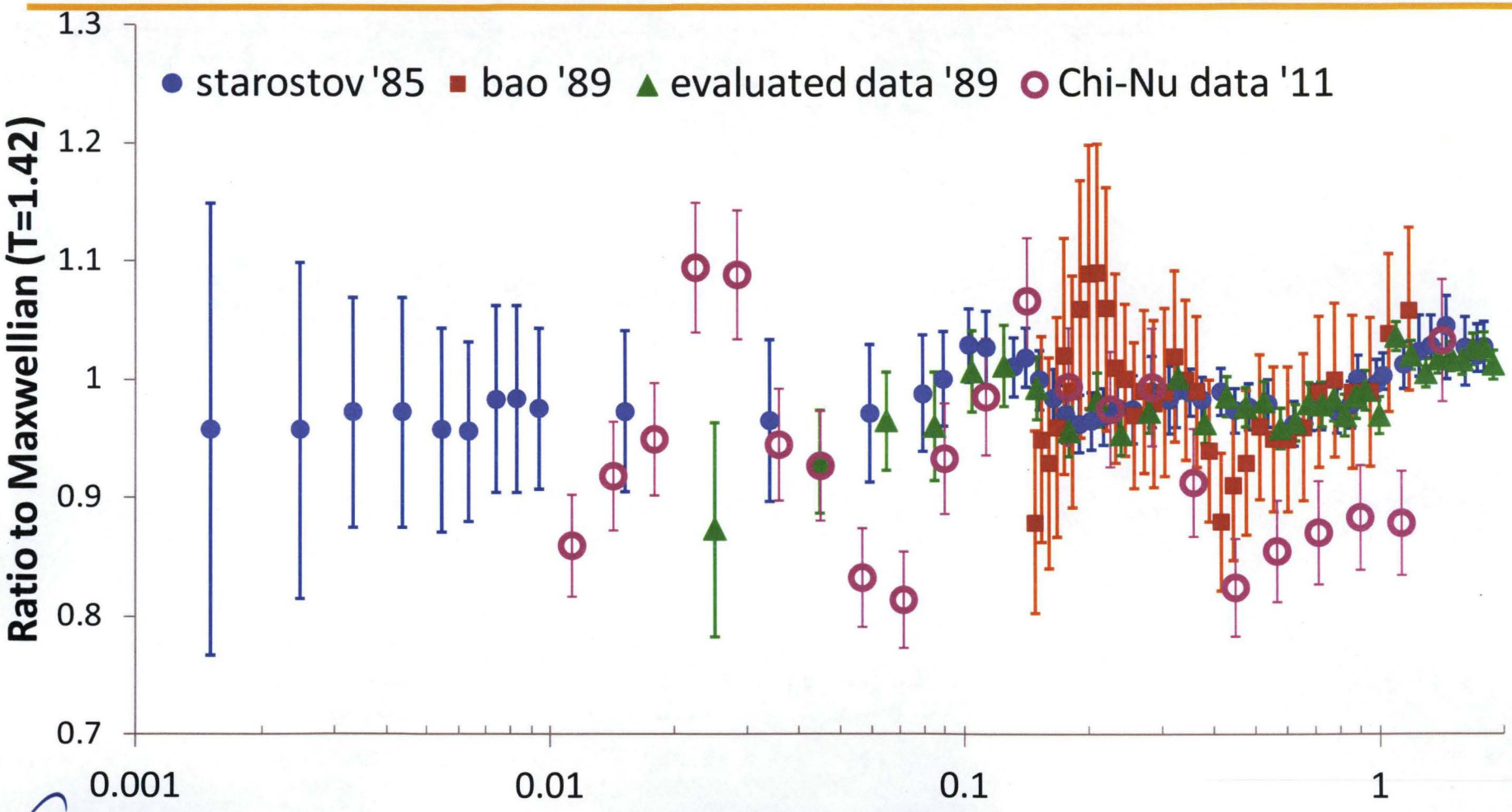


Compilation of Prompt Fission Neutron Spectrum on ^{252}Cf (Presentation by Mannhart at IAEA Consultants' Meeting 2008)

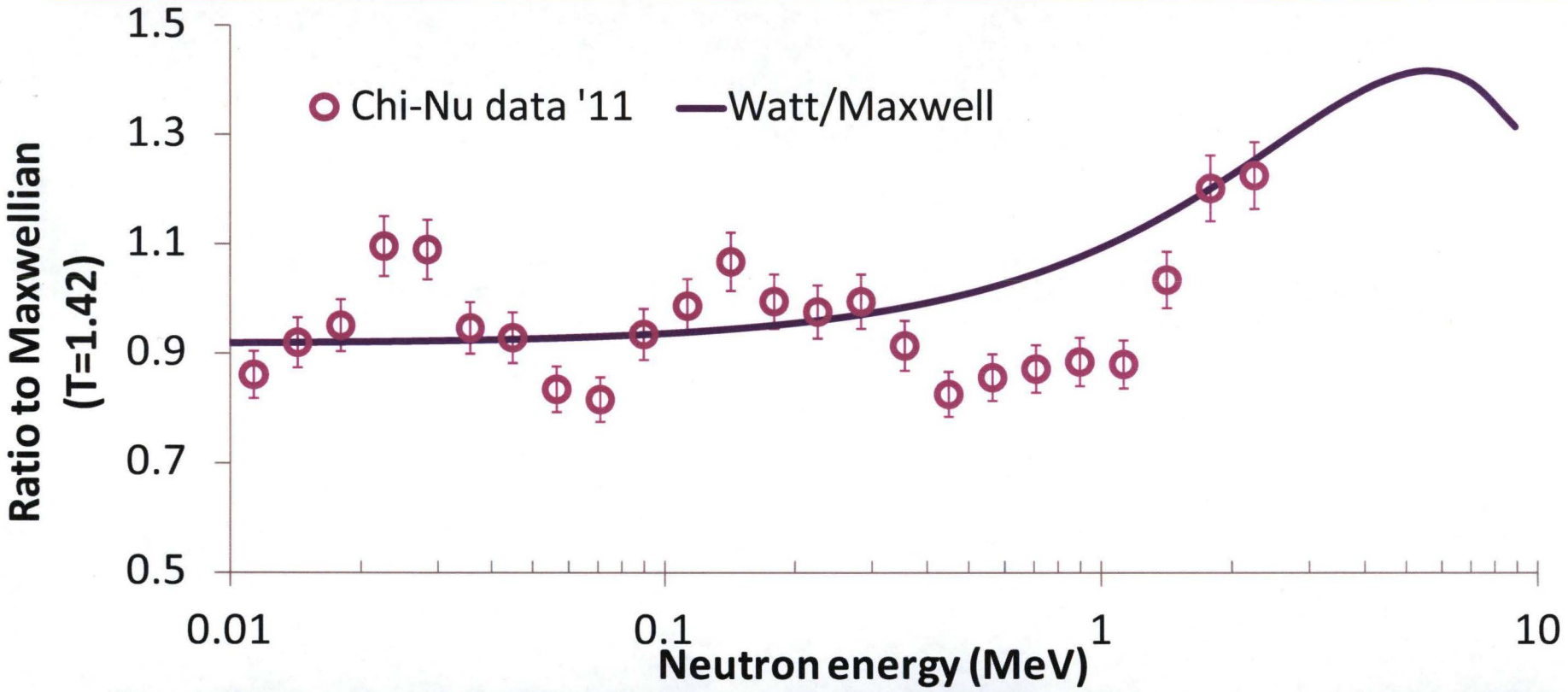


- Evaluation '89 : Lajtai (> 25 keV), Boldeman, Blinov (> 40 keV), Poenitz
- Starostov data were excluded due to failing the criteria, i.e. TOF data, detailed documentation, proper corrections for random coincidence events and non-isotropic fissions detection.
- No recent experiment has been performed after 1990.

Comparison of FIGARO data with the compilation



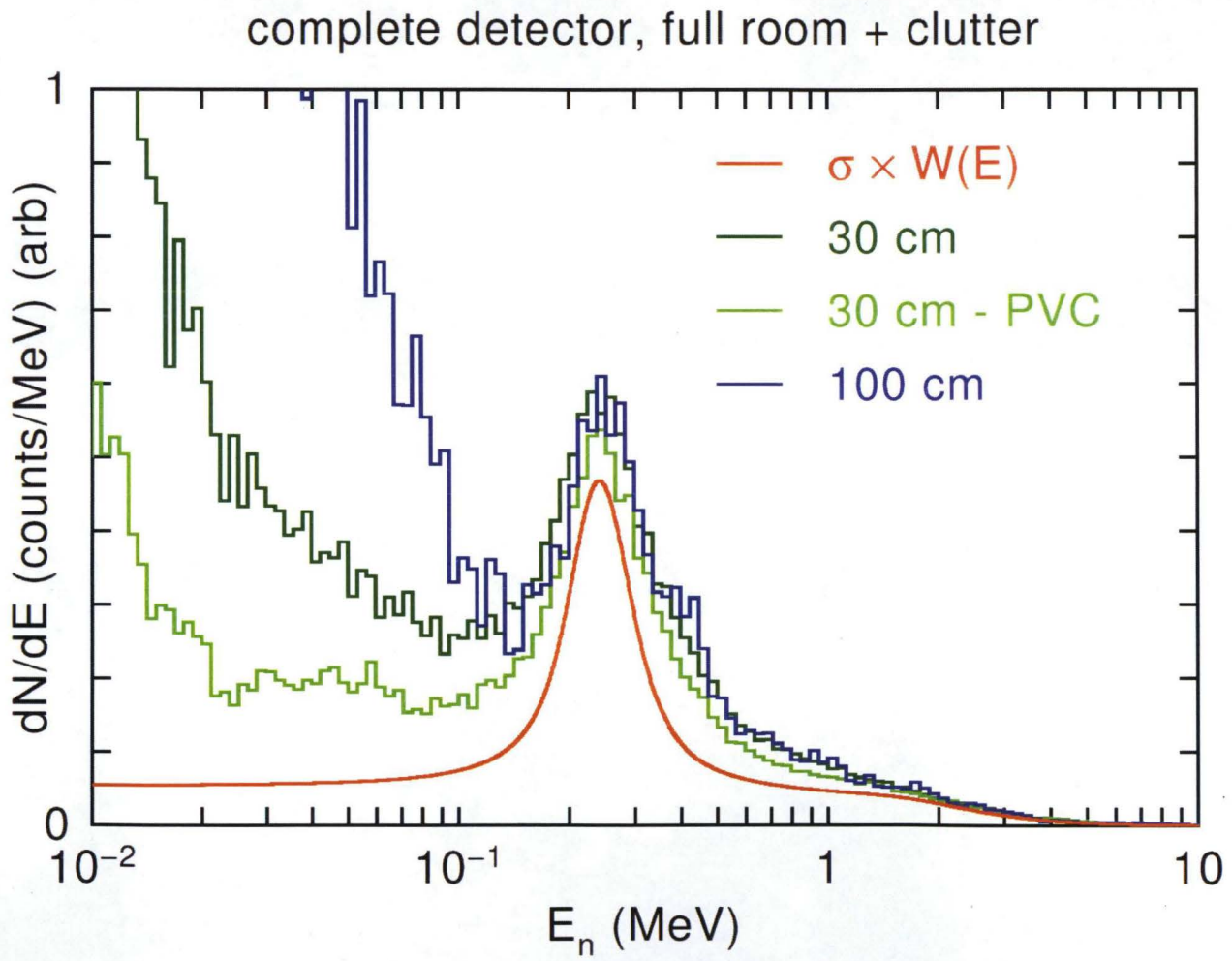
Data vs. Analytical ratios to Maxwellian



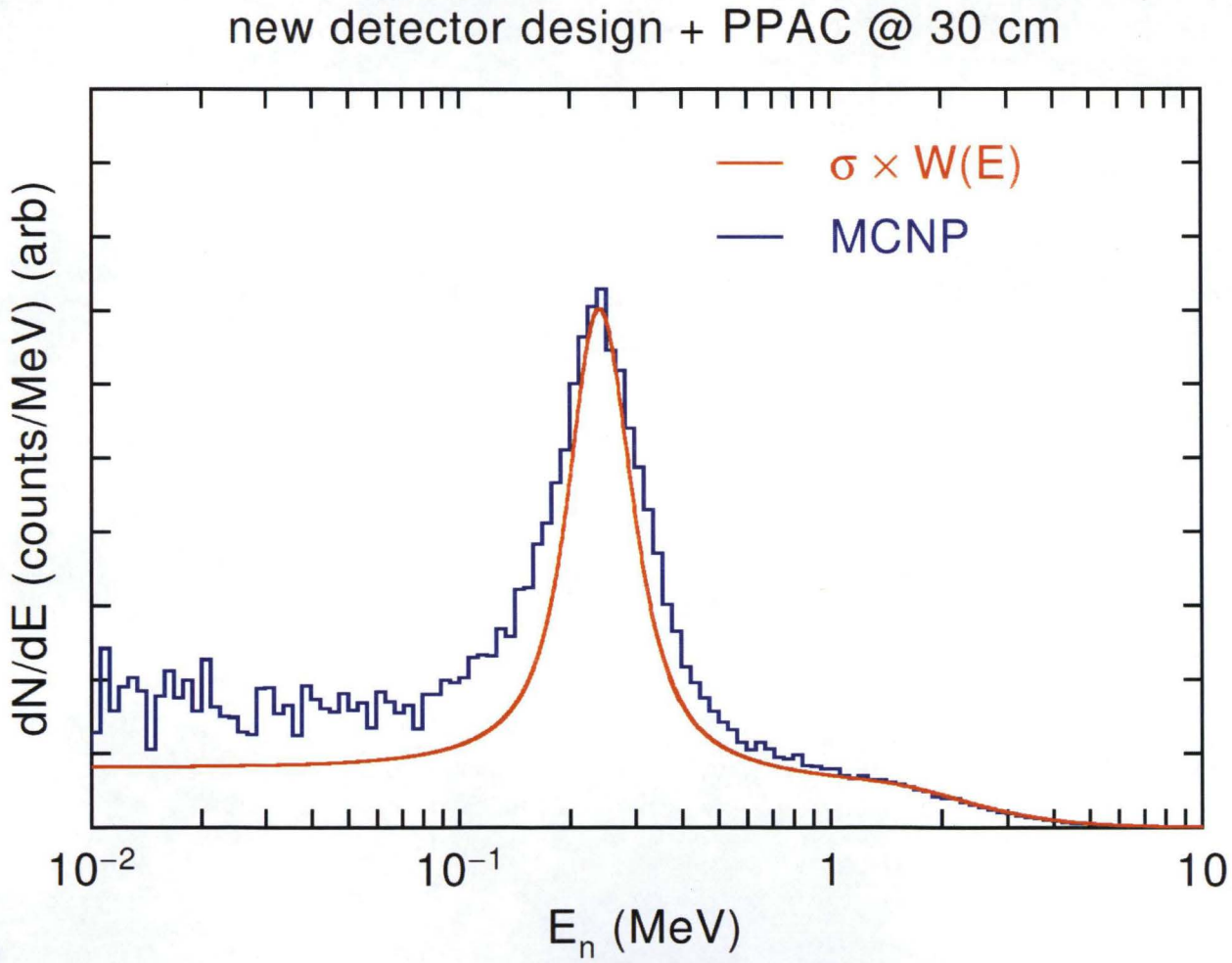
E < 100 keV : missing room geometry in estimating the down-scattered neutrons

E > 500 keV : Further investigation in consistency of data and Physics in MCNP

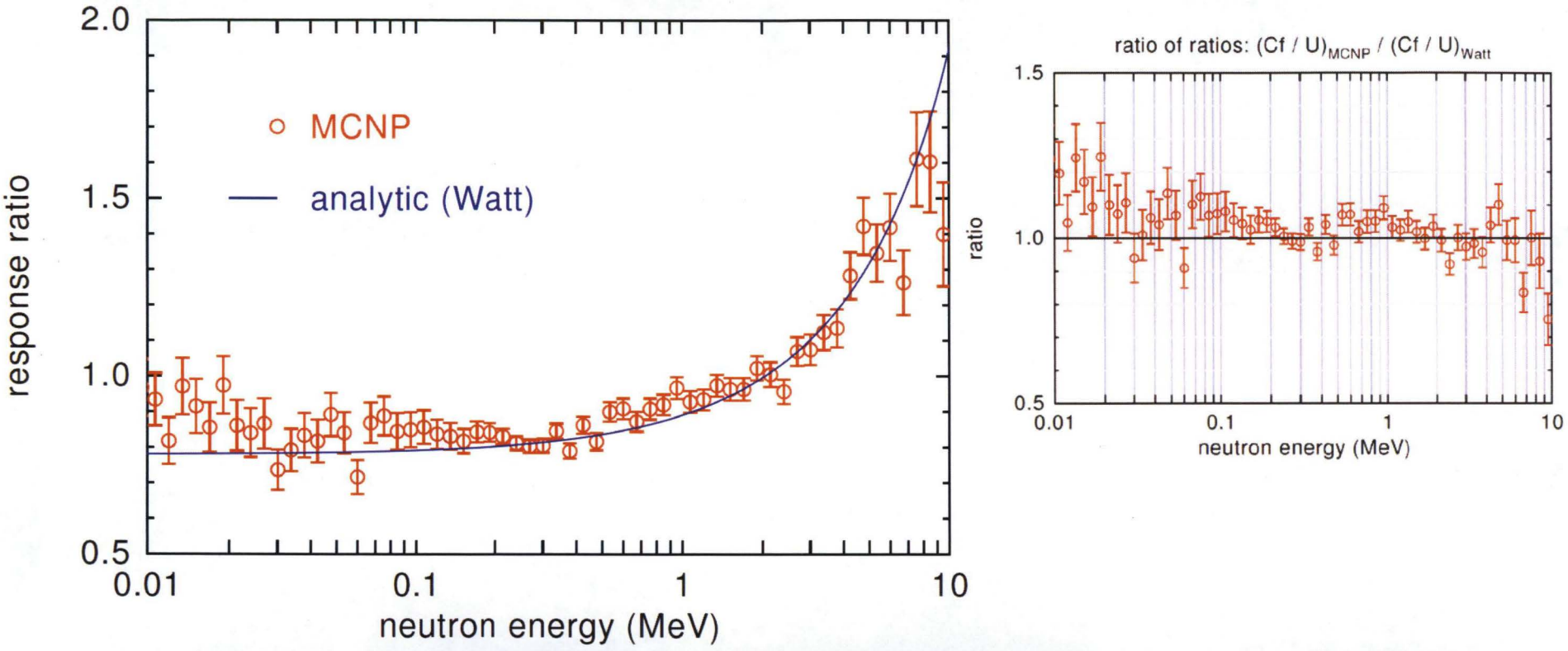
Current ^{6}Li-glass detector response at the FIGARO room



New ^{6}Li-glass detector response

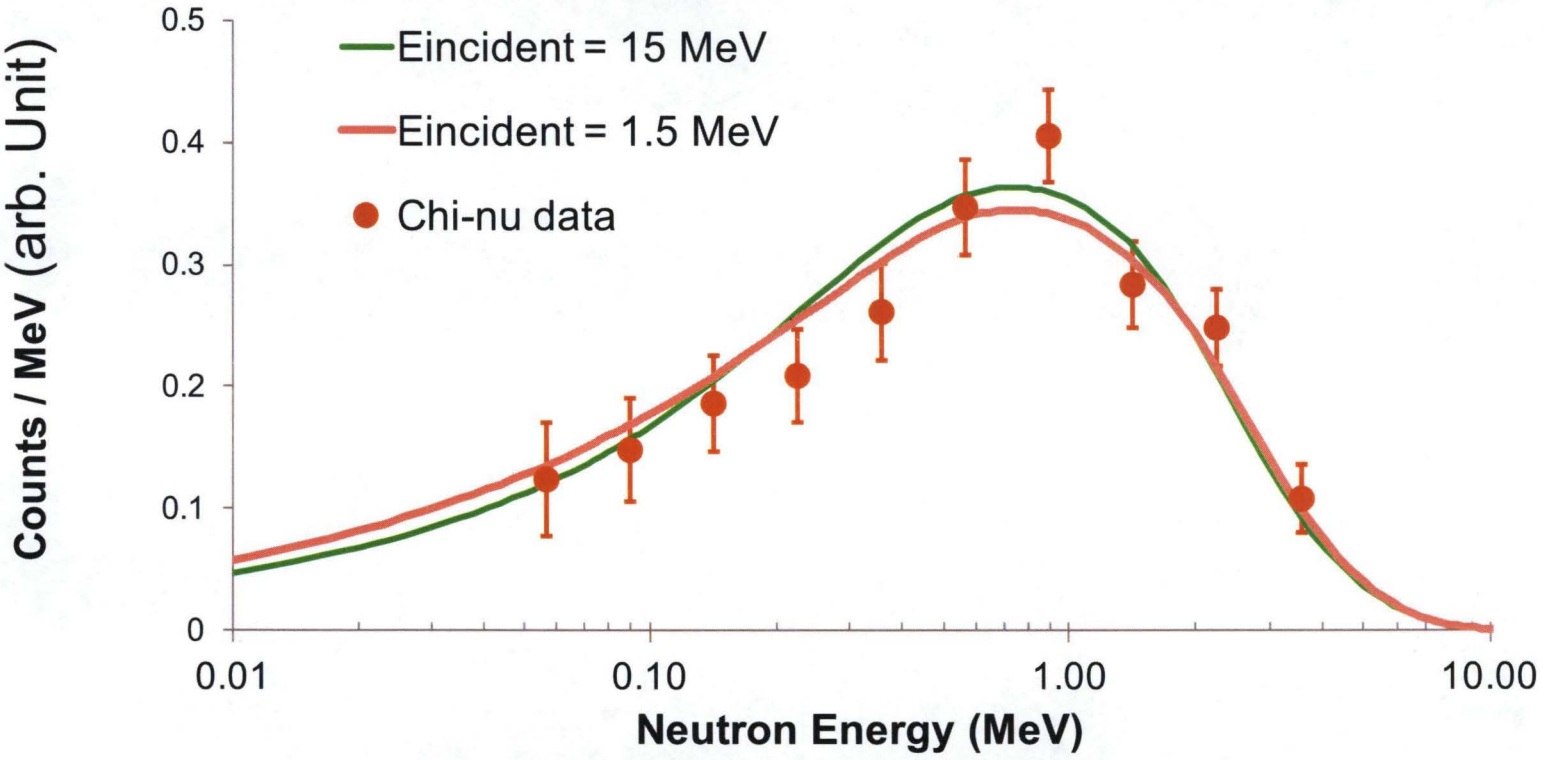


^{6}Li-glass response ratio for ^{252}Cf / ^{235}U



The sensitivity study of 6Li-glass detector regarding different fission yields shows about 10 % different from the analytical Watt distributions at neutron energy of 10-20 keV.

Preliminary Neutron output distributions of $^{235}U(n,f)$ data compared with the LA model (Madland and Nix, 1982)



The Chi-nu data are taken for all incident energies at the previous FIGARO setup, due to limited statistics.

Summary and Outlook

1. Detector response calibration using a ^{252}Cf is compared with a complete MCNP calculation and they showed a good agreement

2. Plan to take data with a ^{252}Cf fission ionization chamber as an independent measurement,
   a. to estimate the systematic uncertainties
   b. to calibrate ^{6}Li-glass detectors absolutely

3. Further investigation on determining the detector response.