



ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

The capture cross section of ^{154}Gd

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Department of Physics and Astronomy

Outline

Motivation: Why? How? Where? When?

Data reduction

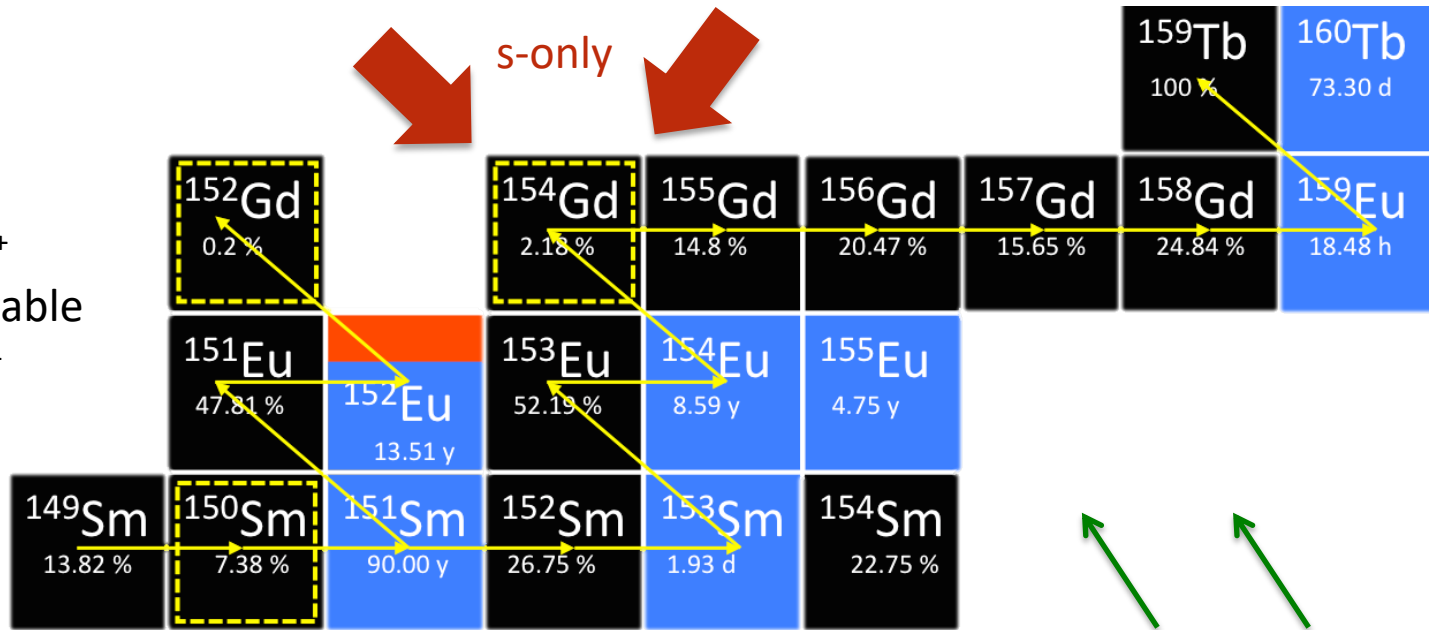
- Stability, calibration, background subtraction
- Yield, correction for multiple scattering

Analysis of

- Resolved Resonance Region (RRR) up to 2.7 keV
- Unresolved Resonance Region (URR) up to 200 keV

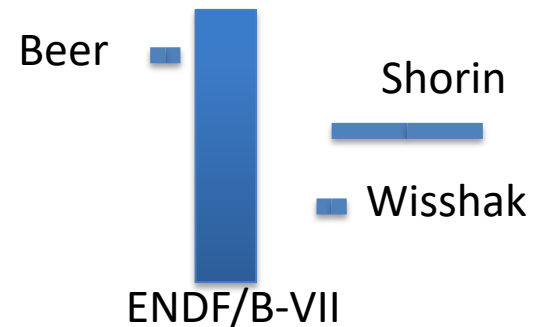
Why

- β^+
- stable
- β^-

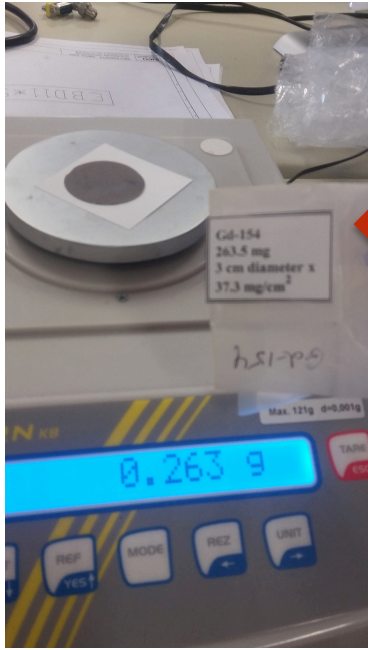


r process

Author / library	MACS @ 30 keV (mb)
ENDF/B-VII (2011)	953.3 +/- 37.0
JENDL-4.0 (2010)	992
JEFF-3.1 (2005)	862
Wisshak (1995)	1028 +/- 12 → 1088
Beer (1988)	878 +/- 27
Shorin (1974)	1278 +/- 102 → 1184



How, where, when

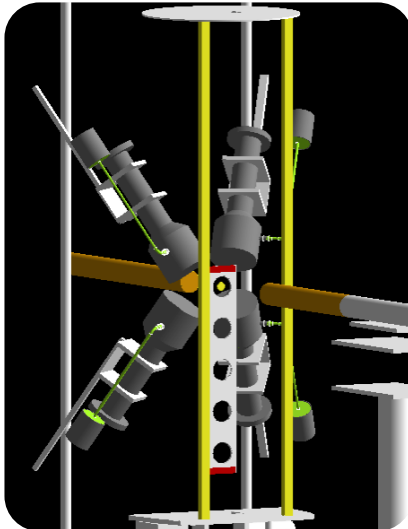


ORNL
0.263 g - 1.414E-4 a/b
metal disc
 $^{154}\text{Gd} \sim 66,78 \%$
main contaminant ^{155}Gd
 $\sim 17.52\%$
Radius = 1.5 cm



GOODFELLOW
8.749 g
Natural Gd
99%

Measurement
14th August 2017
10th September 2017

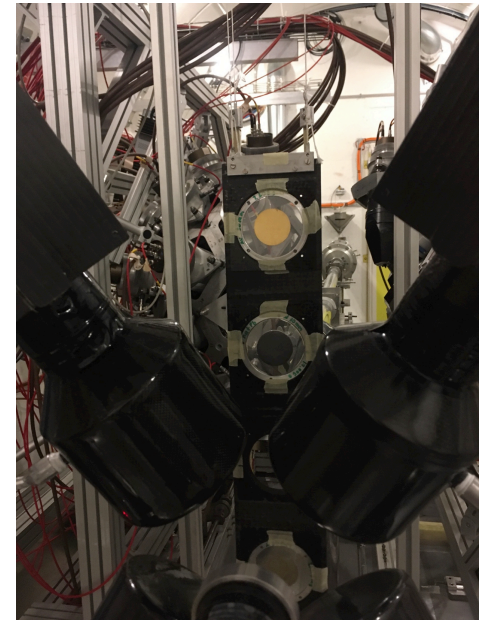


@ EAR1

Total detection energy system:

- PHWT
- 4 C_6D_6 from LNL

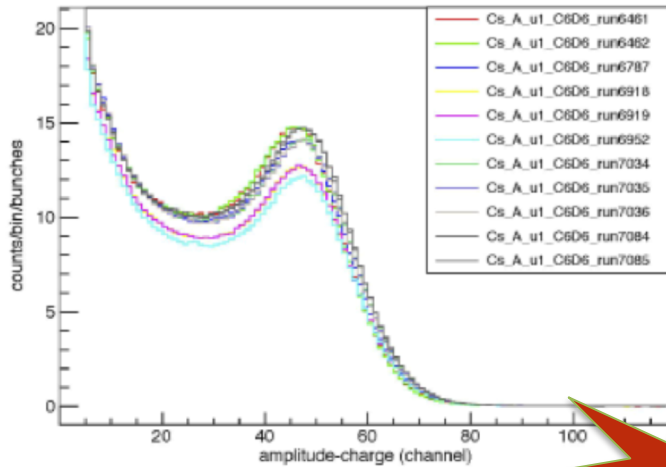
Normalization and Background:
Au, C, Pb, Gd with FILTERS



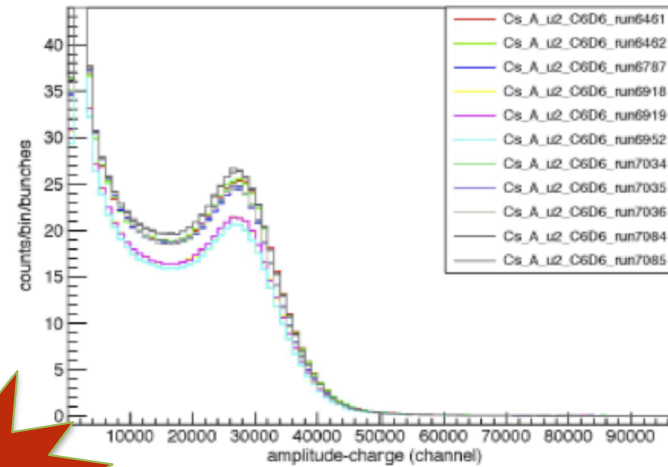
Data reduction

Detector

detector 1

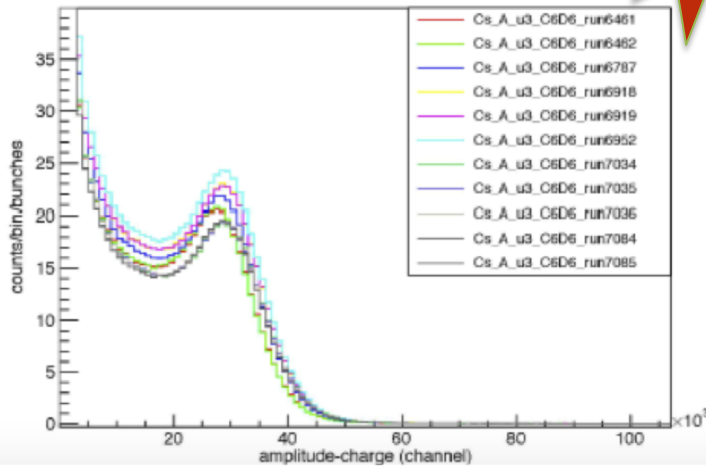


detector 2

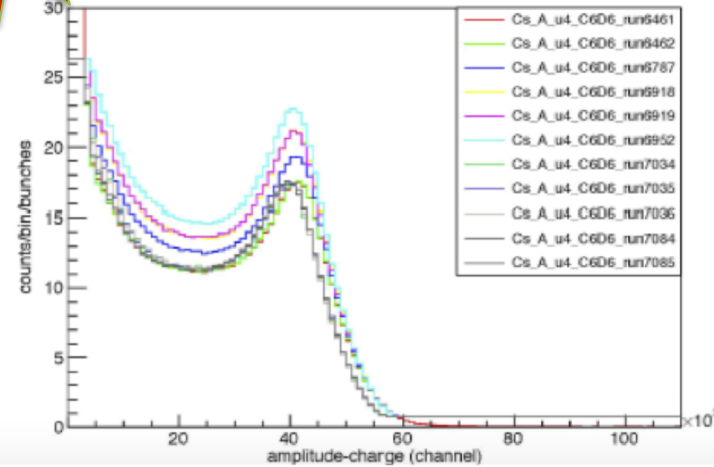


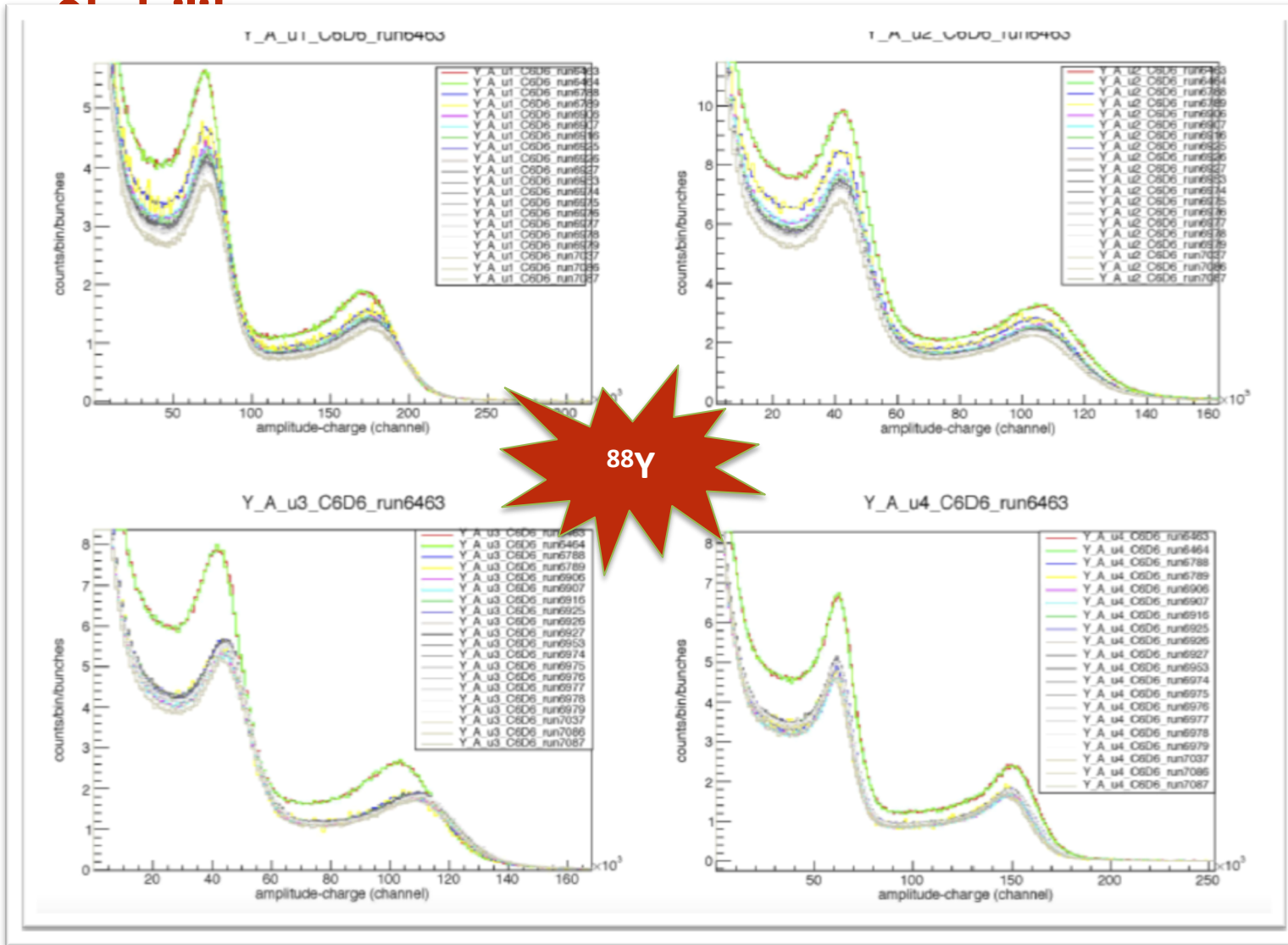
^{137}Cs

detector 3



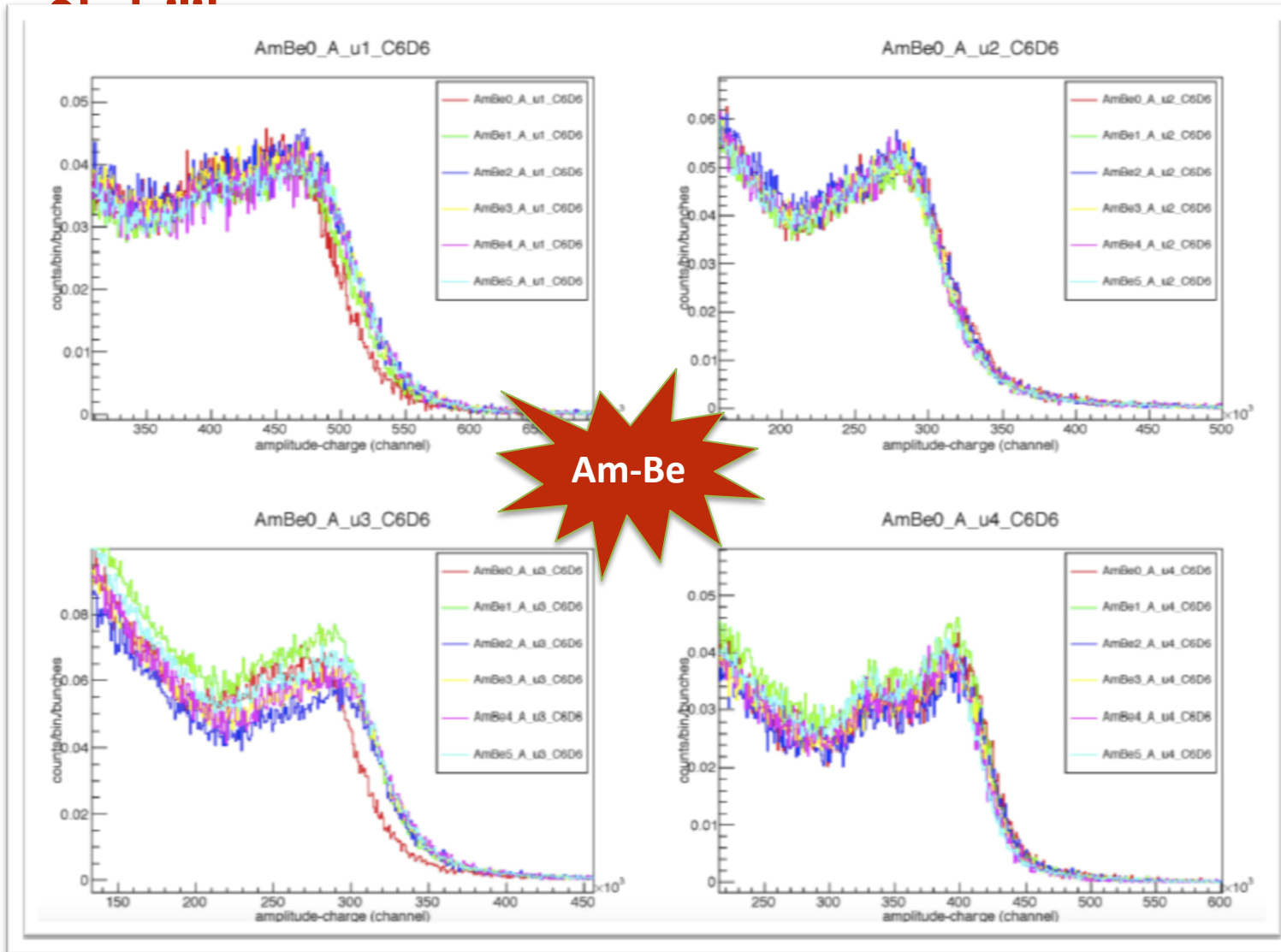
detector 4





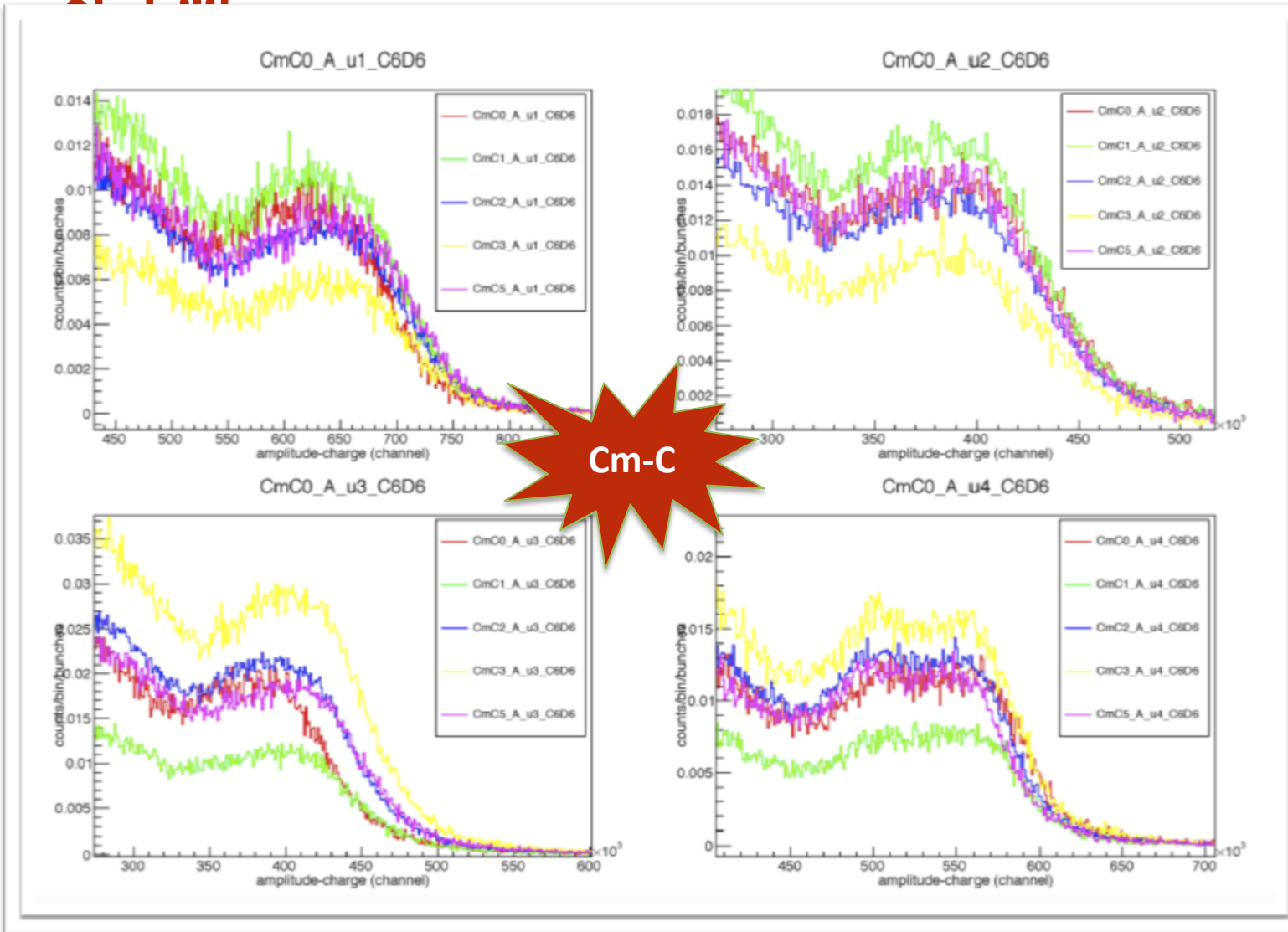
Data reduction

Detector



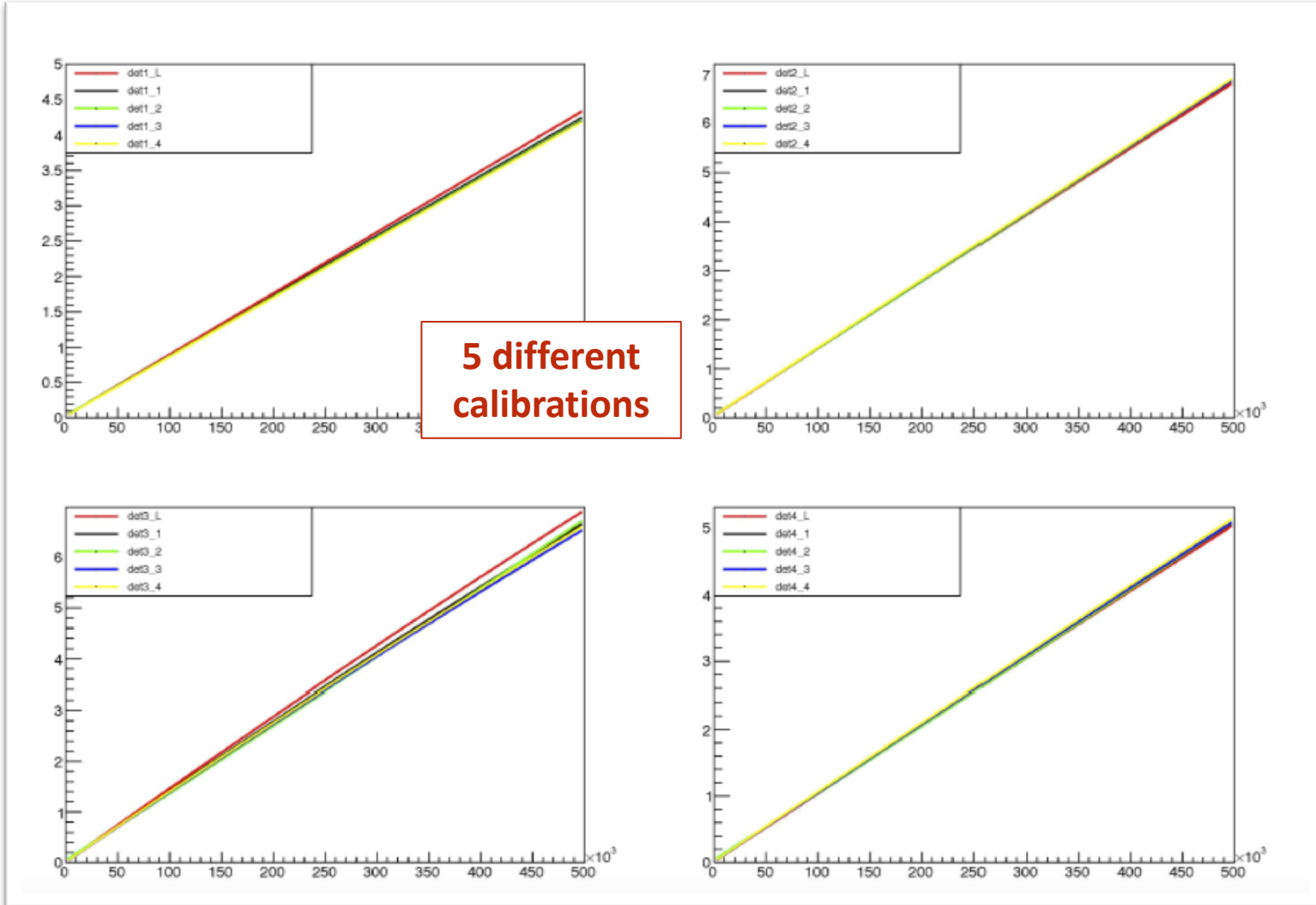
Data reduction

Detector



Data reduction

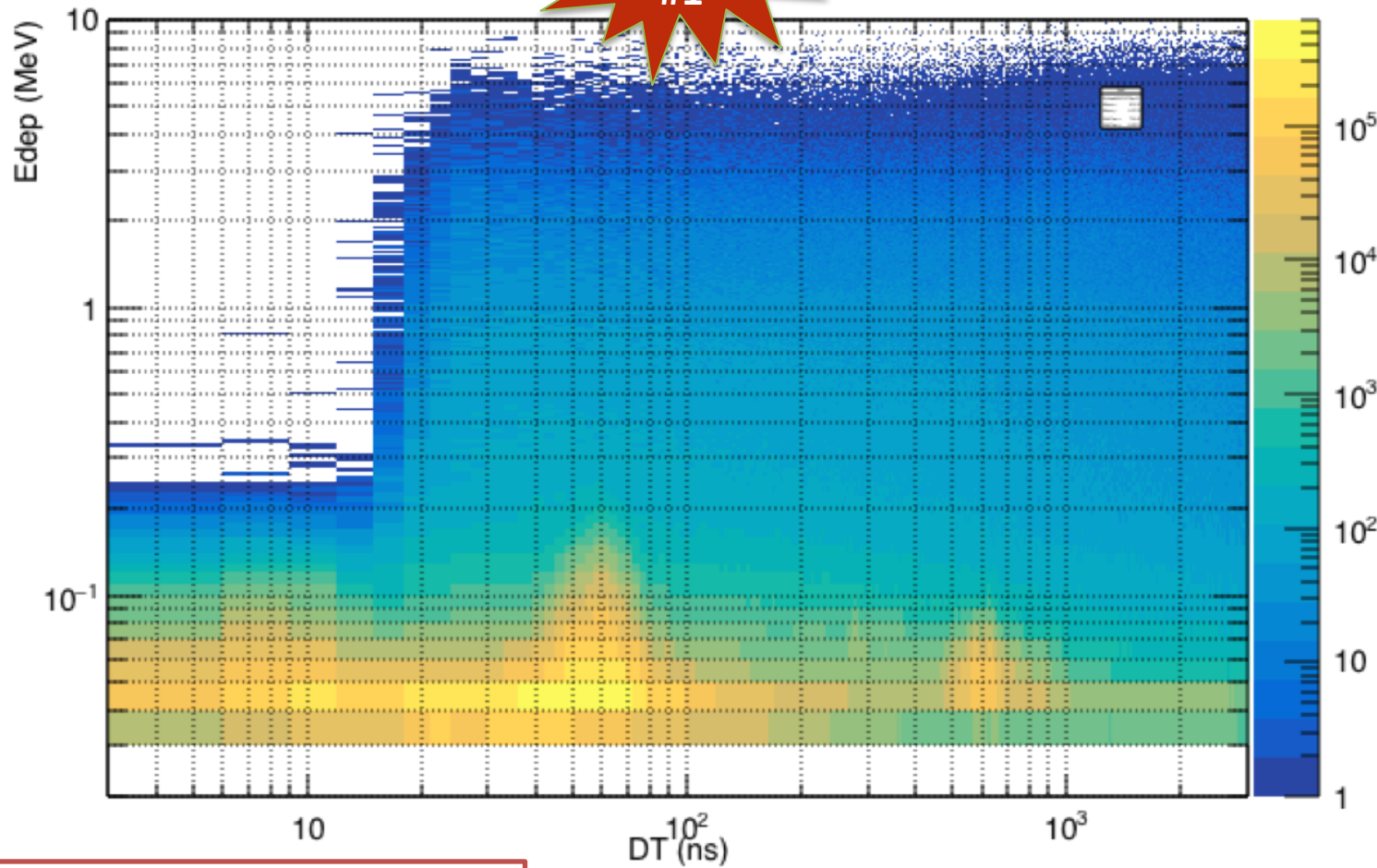
Calibration



Data reduction

Dead Time & other

C6D6
#1



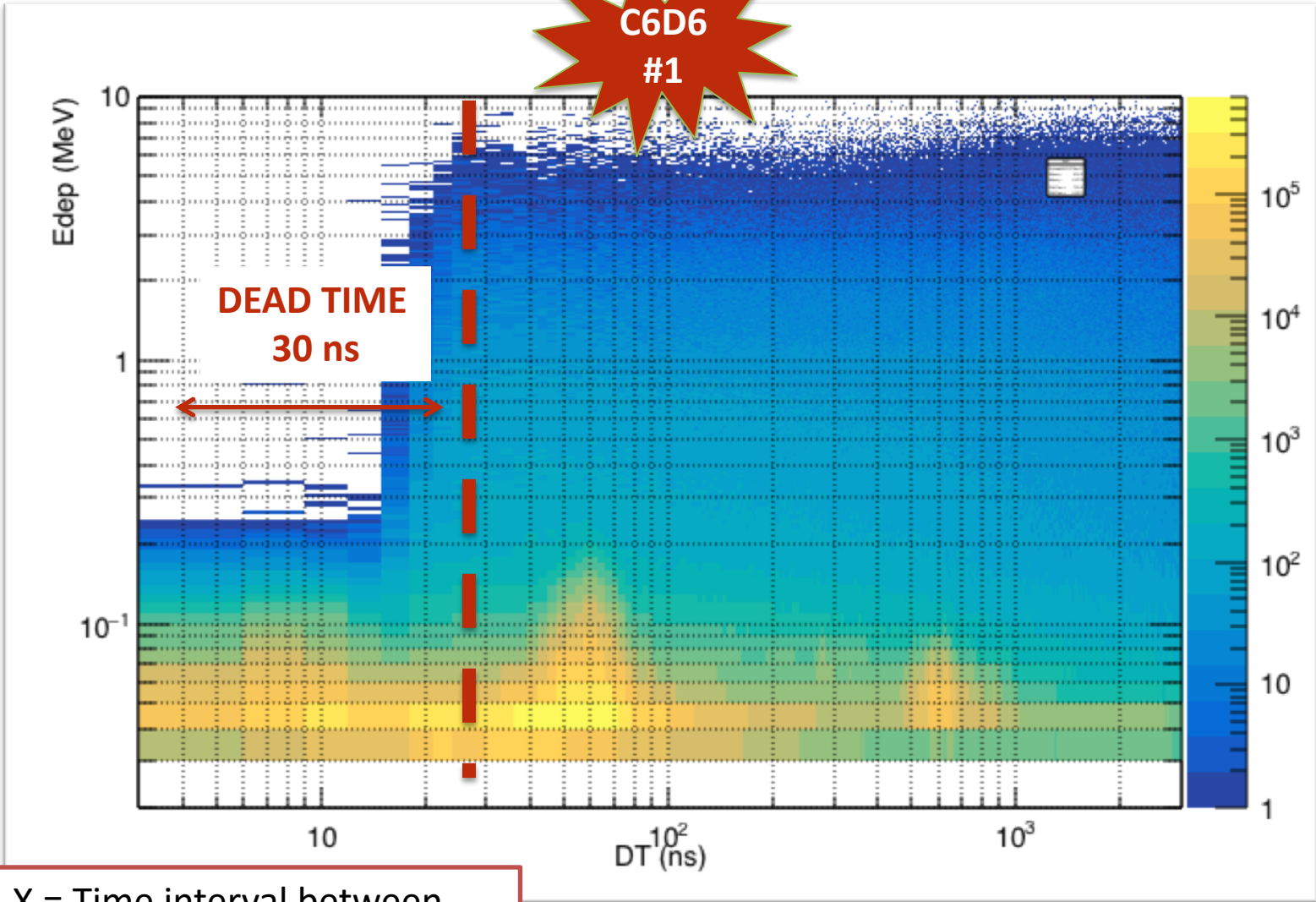
Y = Area of the **second** signal

X = Time interval between two **consecutive** events in the same detector

Data reduction

Dead Time & other

C6D6
#1



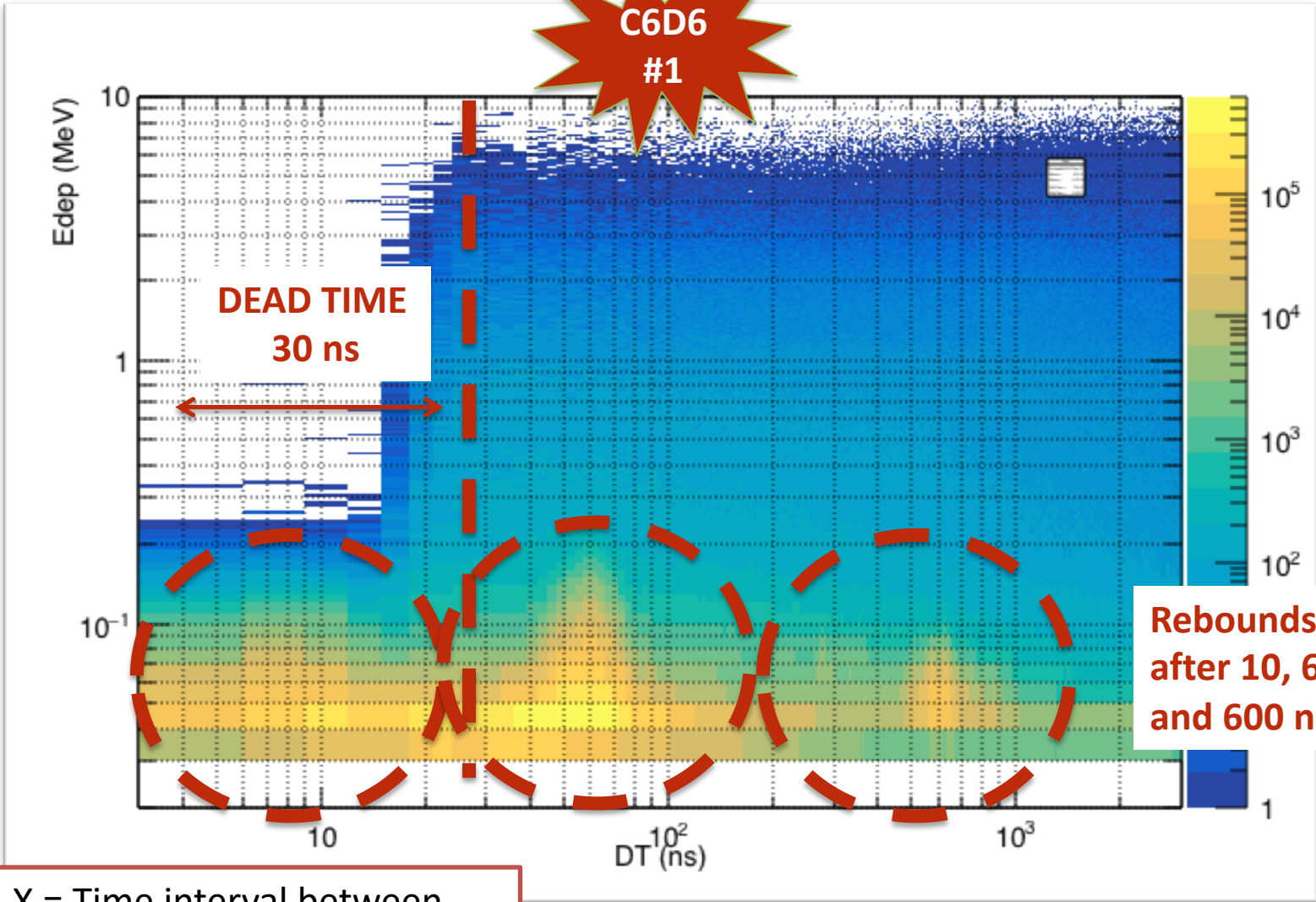
Y = Area of the **second** signal

X = Time interval between two **consecutive** events in the same detector

Data reduction

Dead Time & other

C6D6
#1



Y = Area of the **second** signal

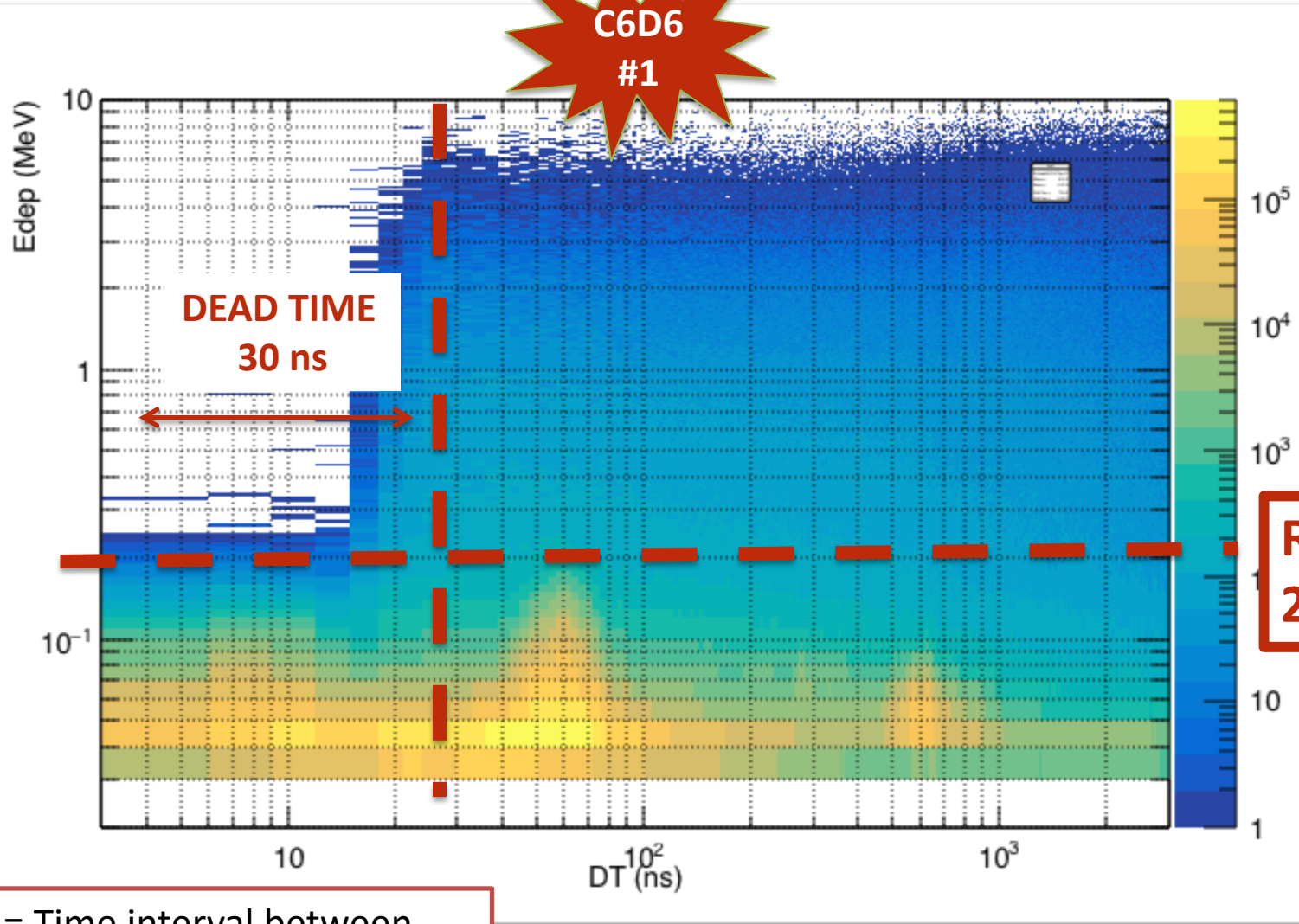
Rebounds after 10, 60 and 600 ns

X = Time interval between two **consecutive** events in the same detector

Data reduction

Dead Time & other

C6D6
#1



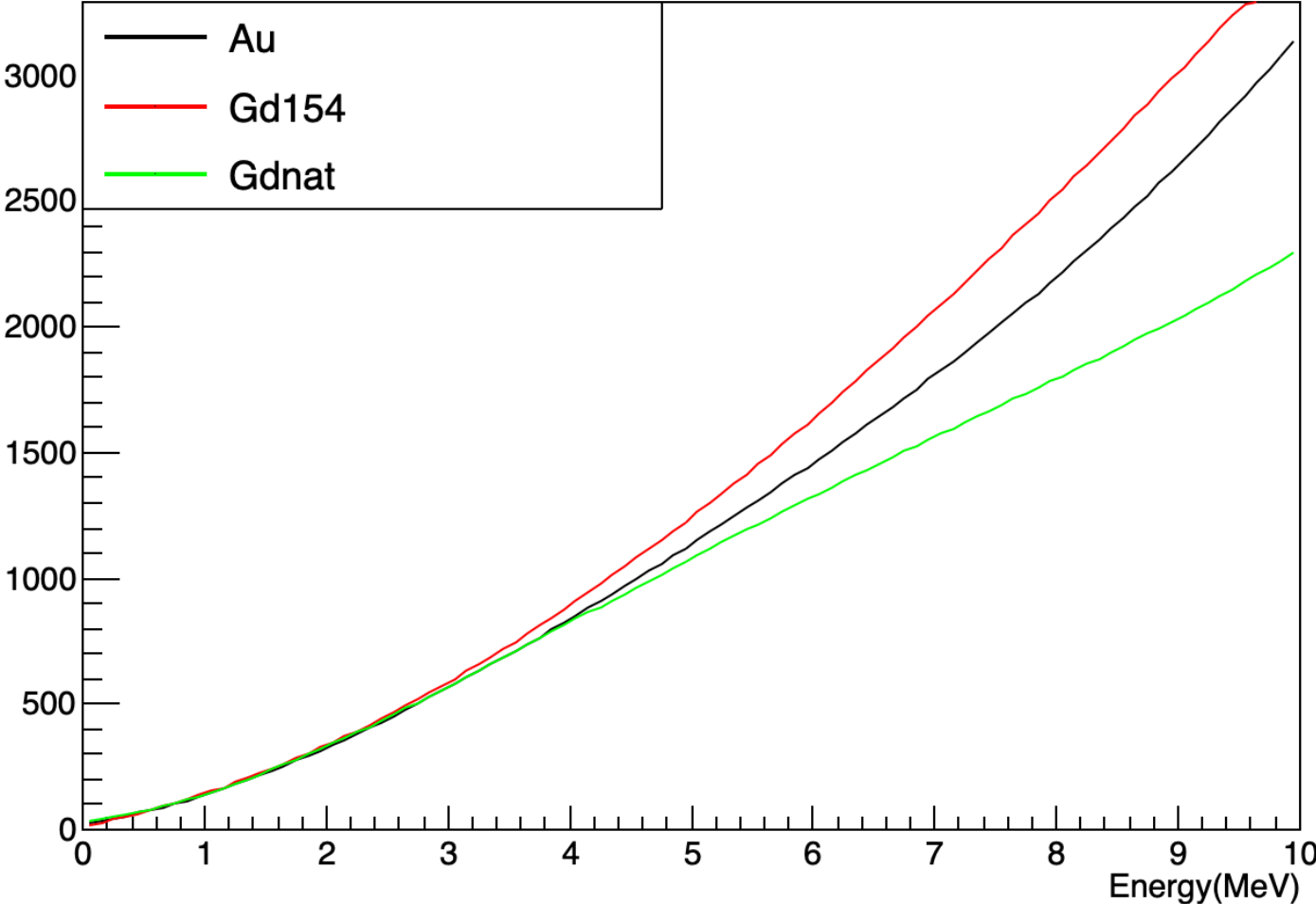
Y = Area of the **second** signal

Rebound < 200 keV

X = Time interval between two **consecutive** events in the same detector

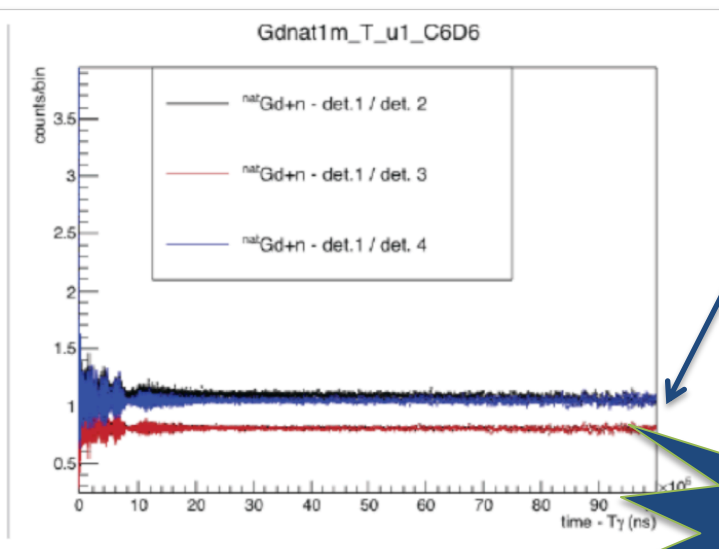
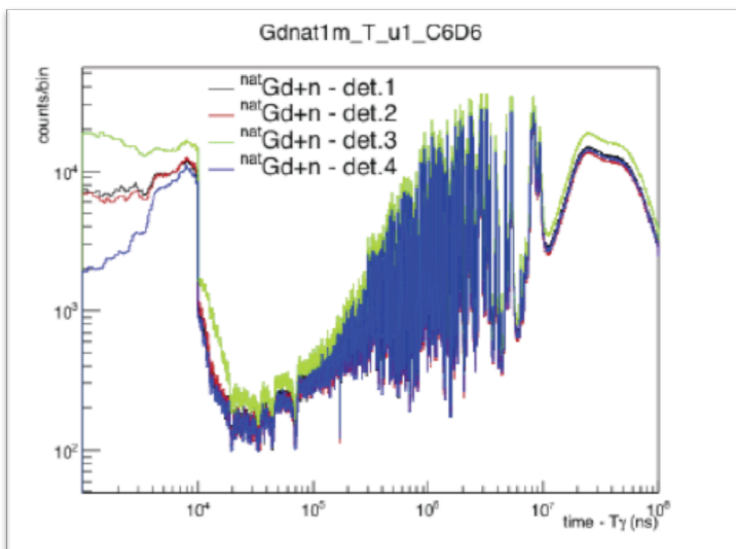
Data reduction

PWHT



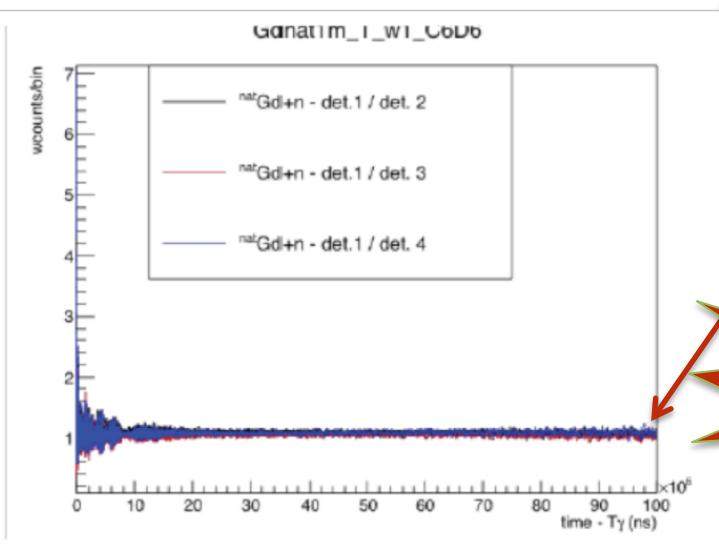
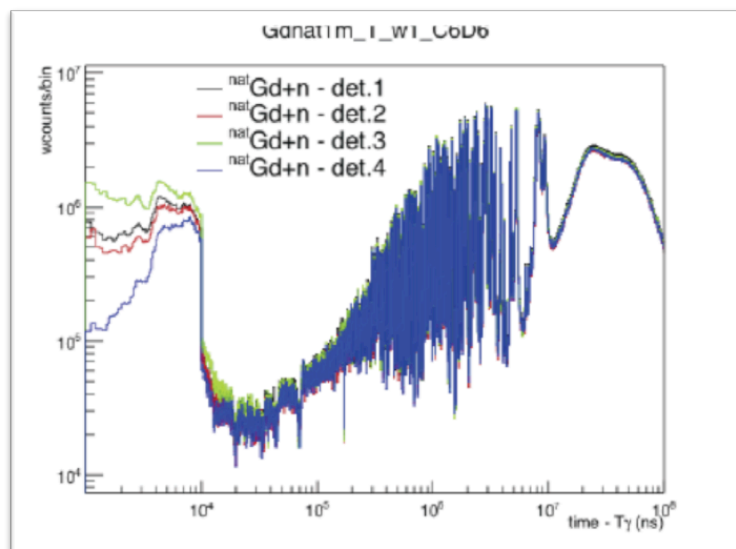
Data reduction

PWHT



Nominal
 C_6D_6
positions:
initial
guess

**C_6D_6 #3
20% off**

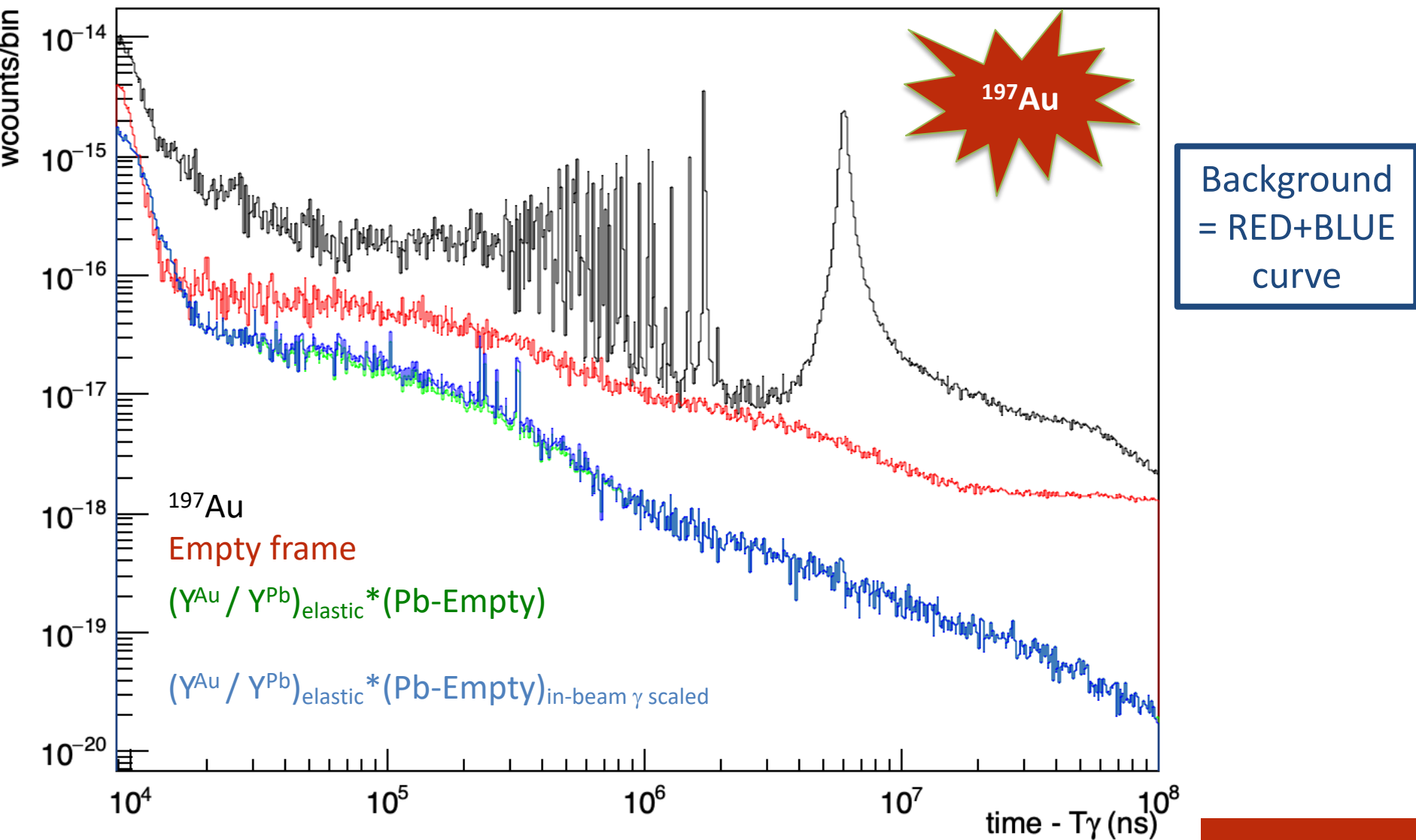


Final
configuration

**Good
agreement**

Data reduction

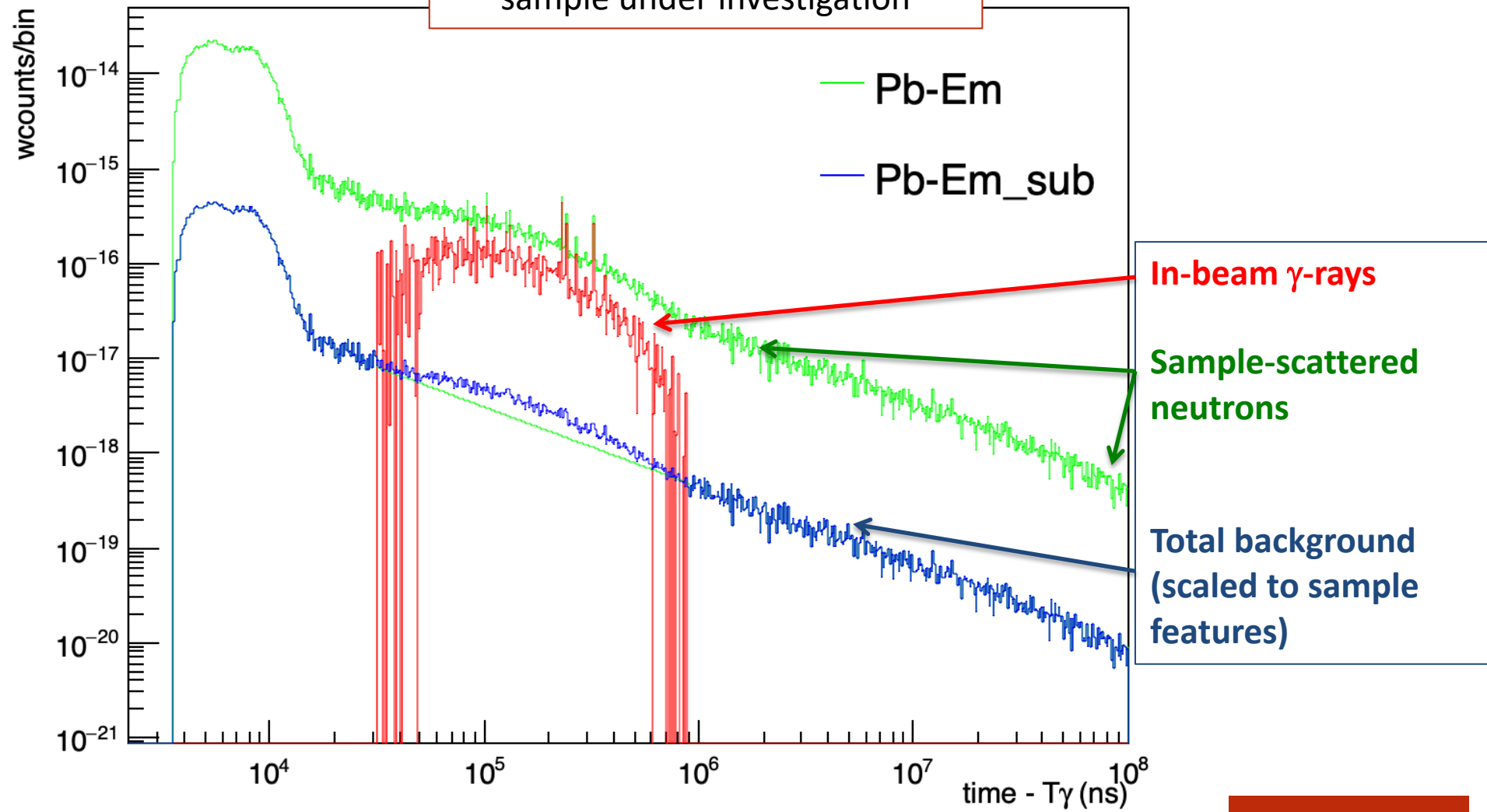
Background



Data reduction

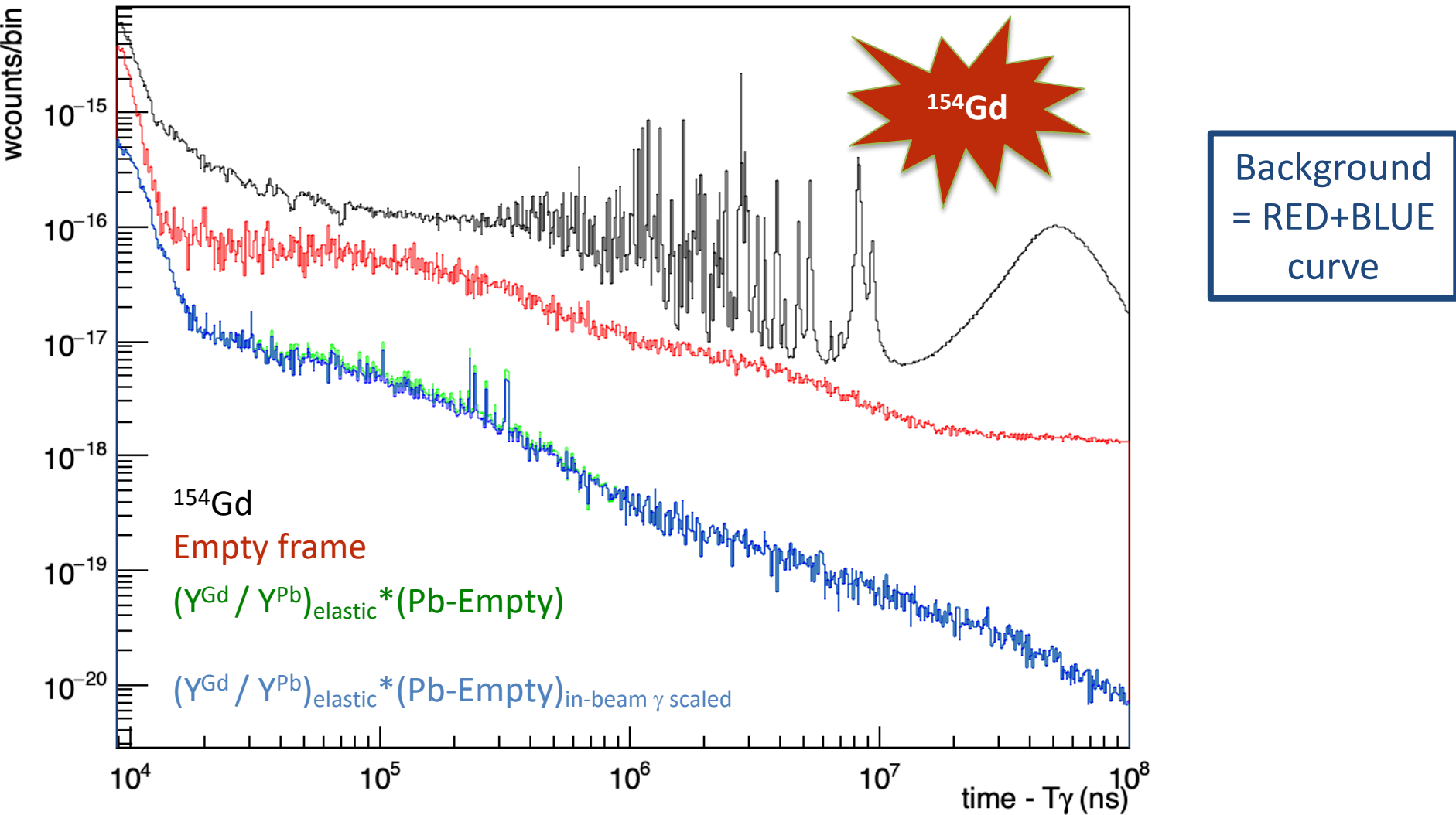
Background

In-beam γ -rays scaled to z of the sample under investigation



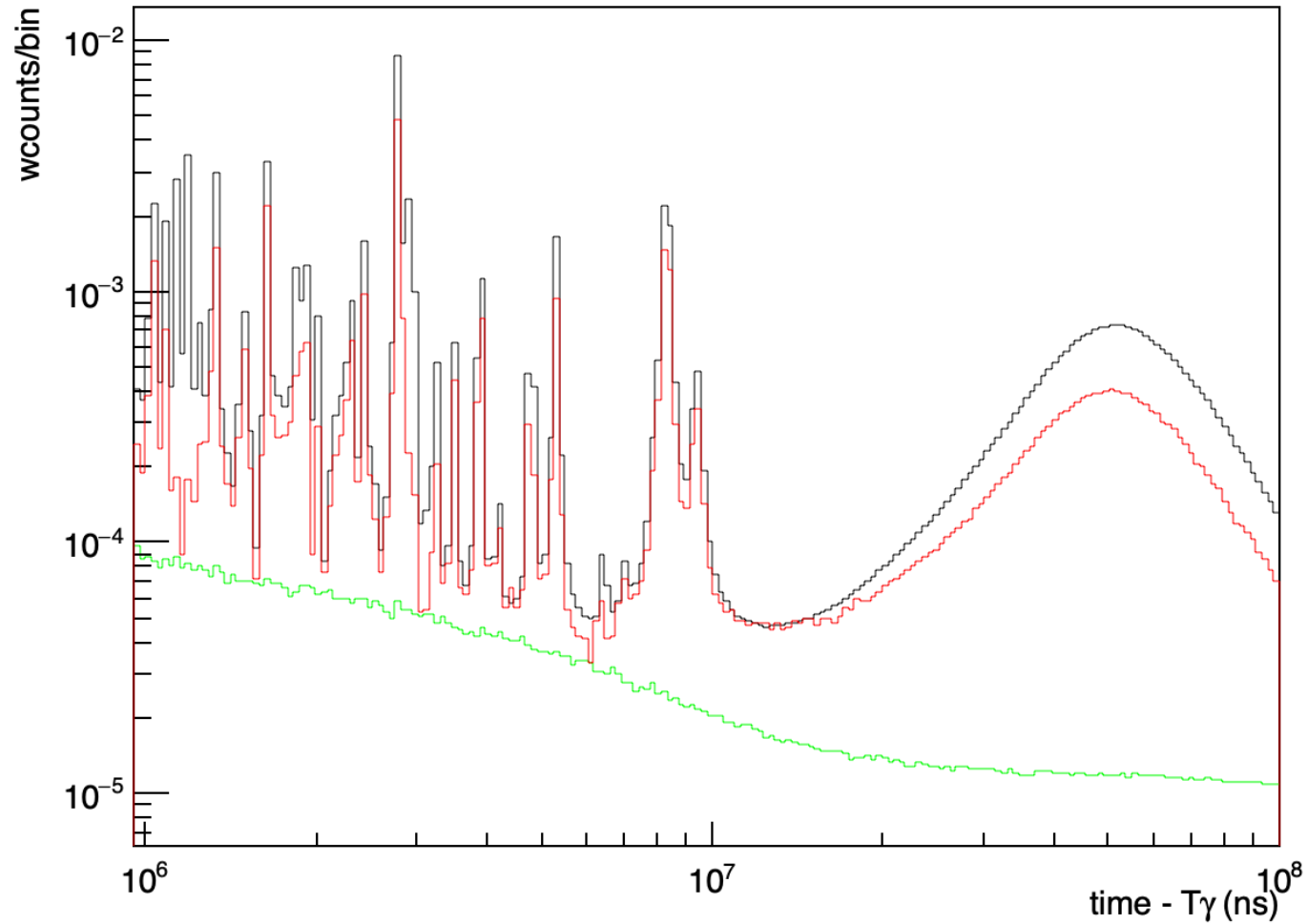
Data reduction

Background



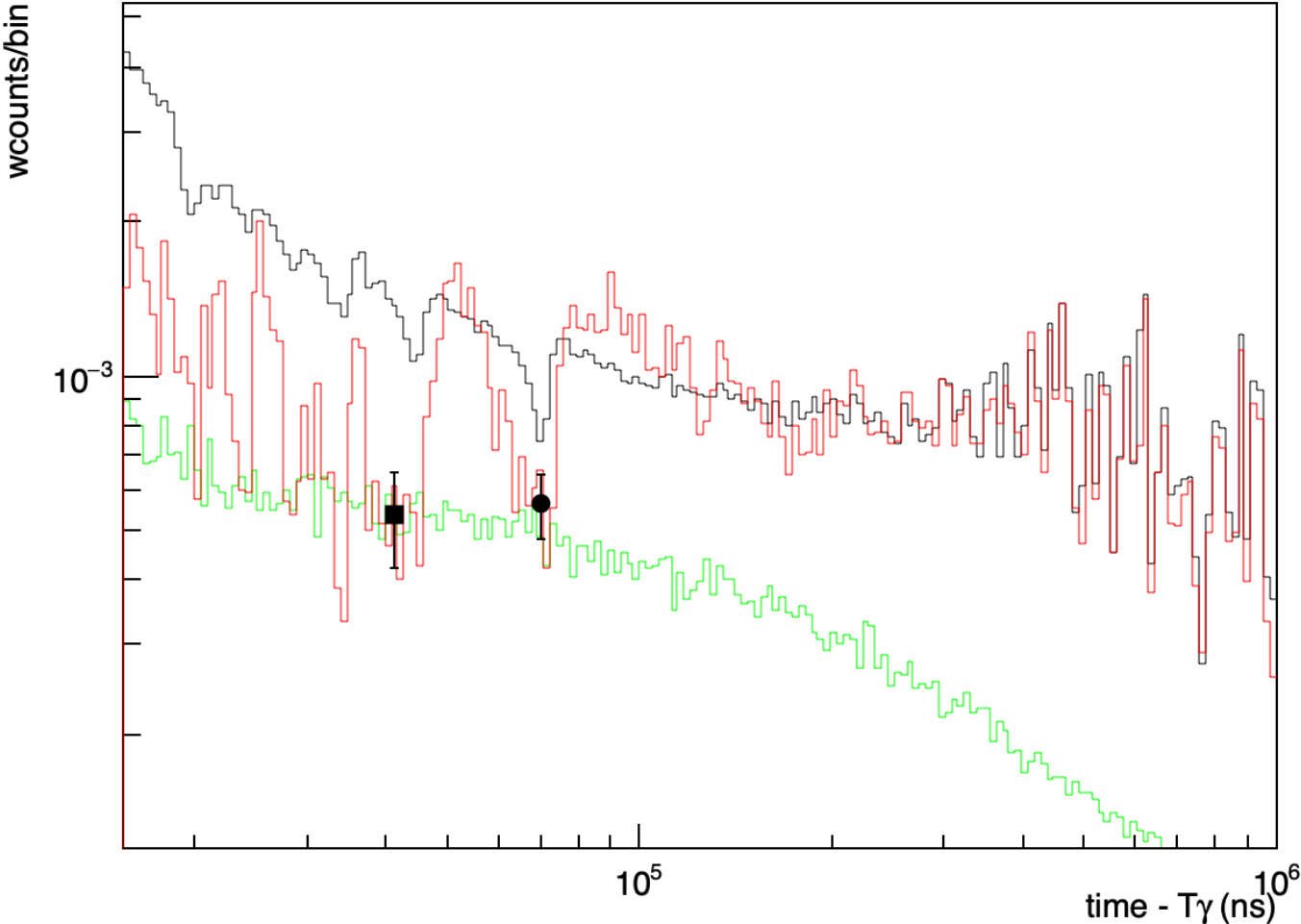
Data reduction

Normalizzazione ad Alte energie



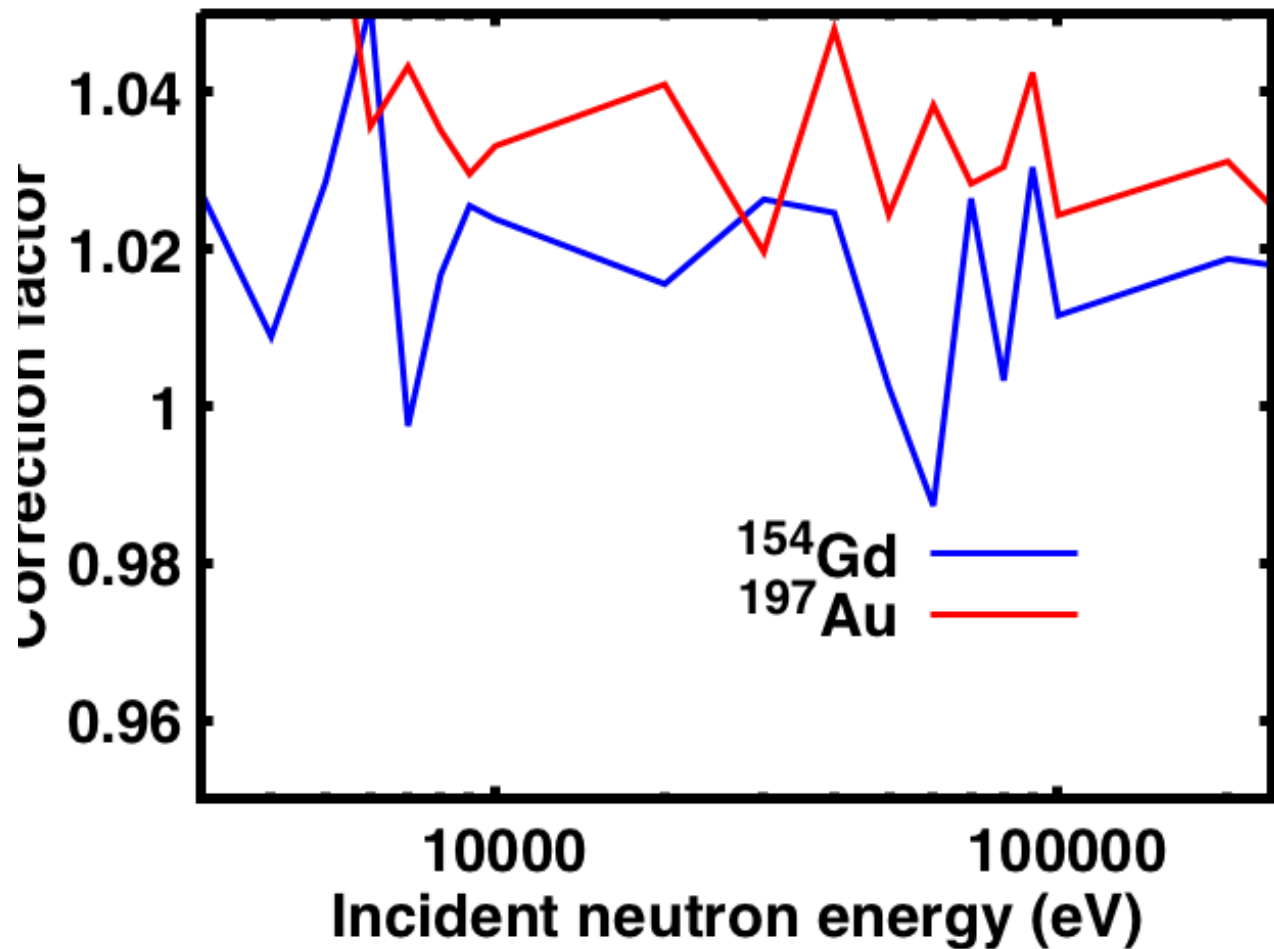
Data reduction

Normalizzazione a basse energie



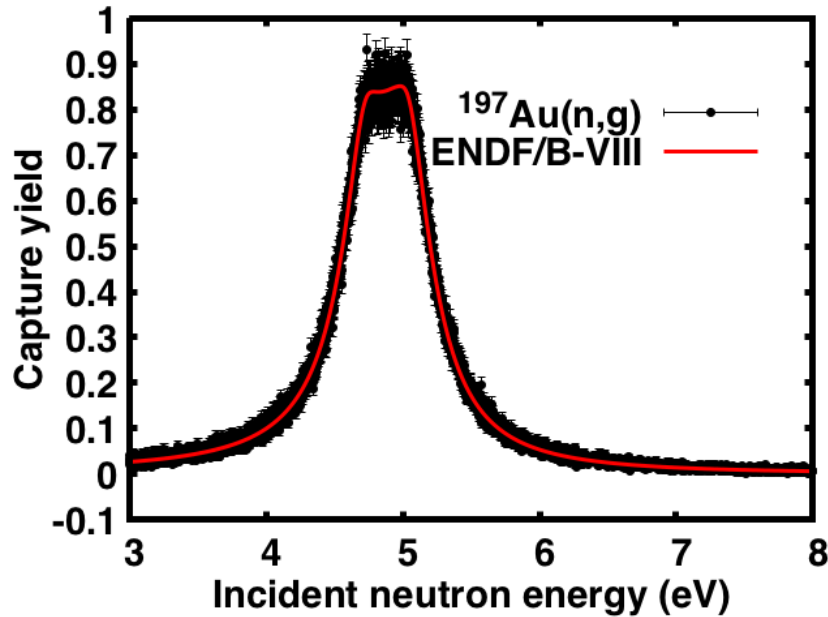
Data reduction

Multiple scattering

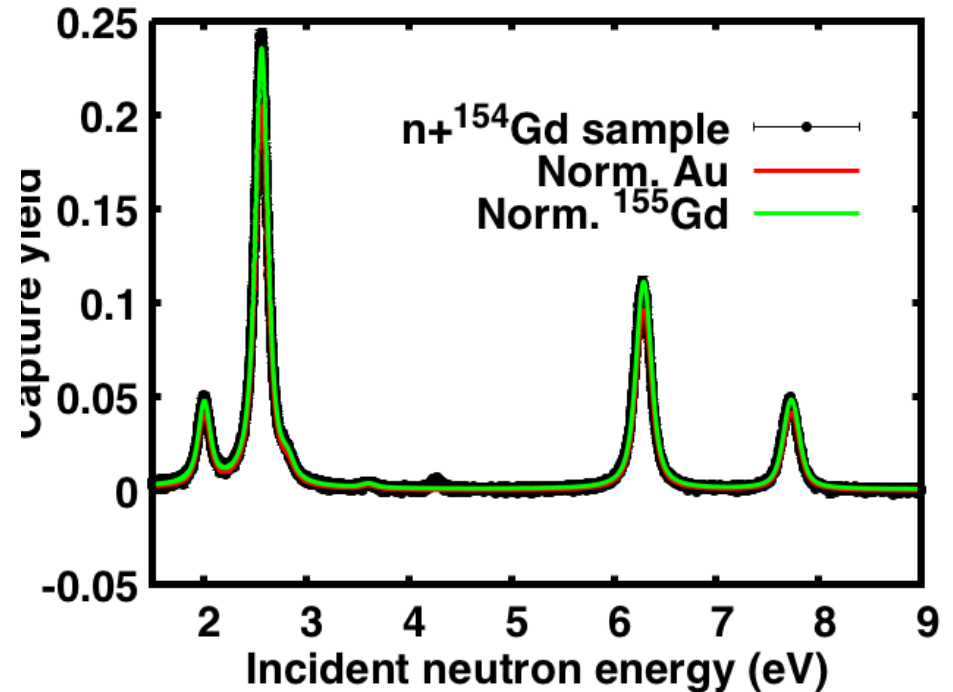


~ negligible correction in the URR for ^{154}Gd

Data reduction



Normalization



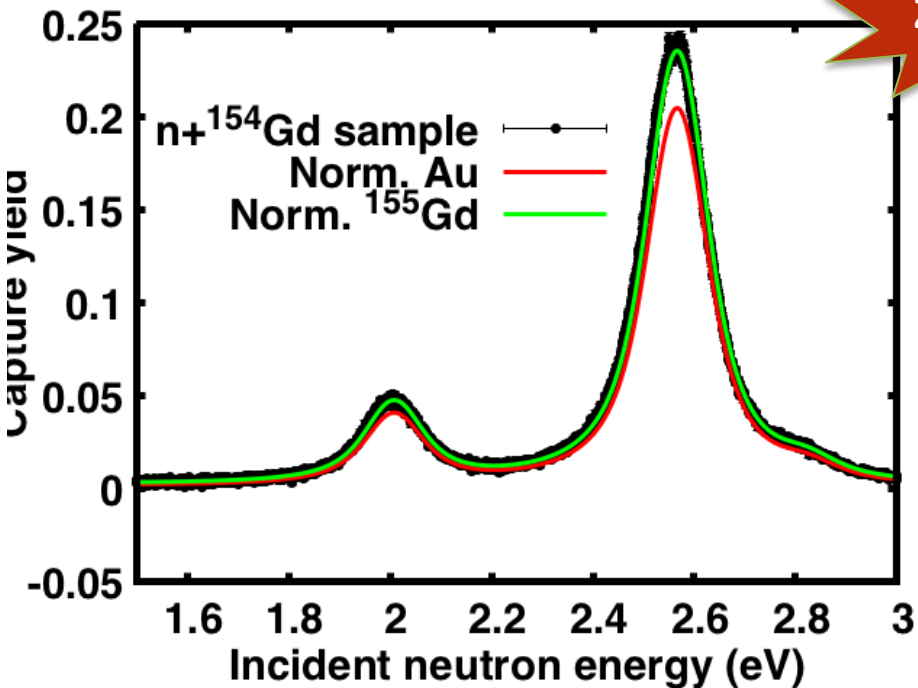
- Expected normalization ~
Interception factor ~
0.96 from simulation
- From Au, **N= 0.86**

**10%
difference
!!!**

Time to energy using L(E); L₀ calibrated with Au resonances

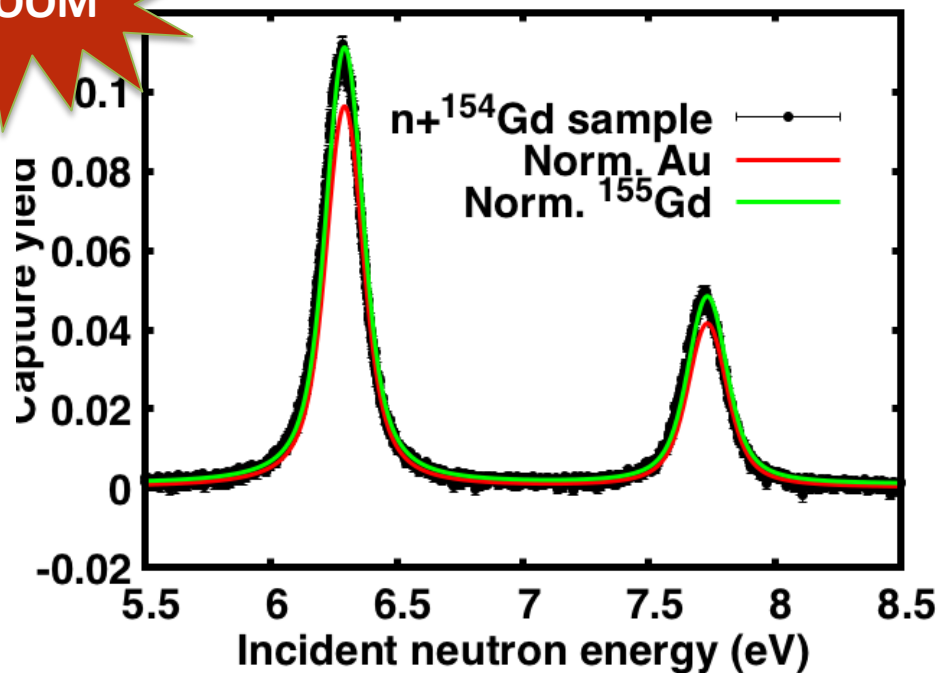


Data reduction



ZOOM

Normalization



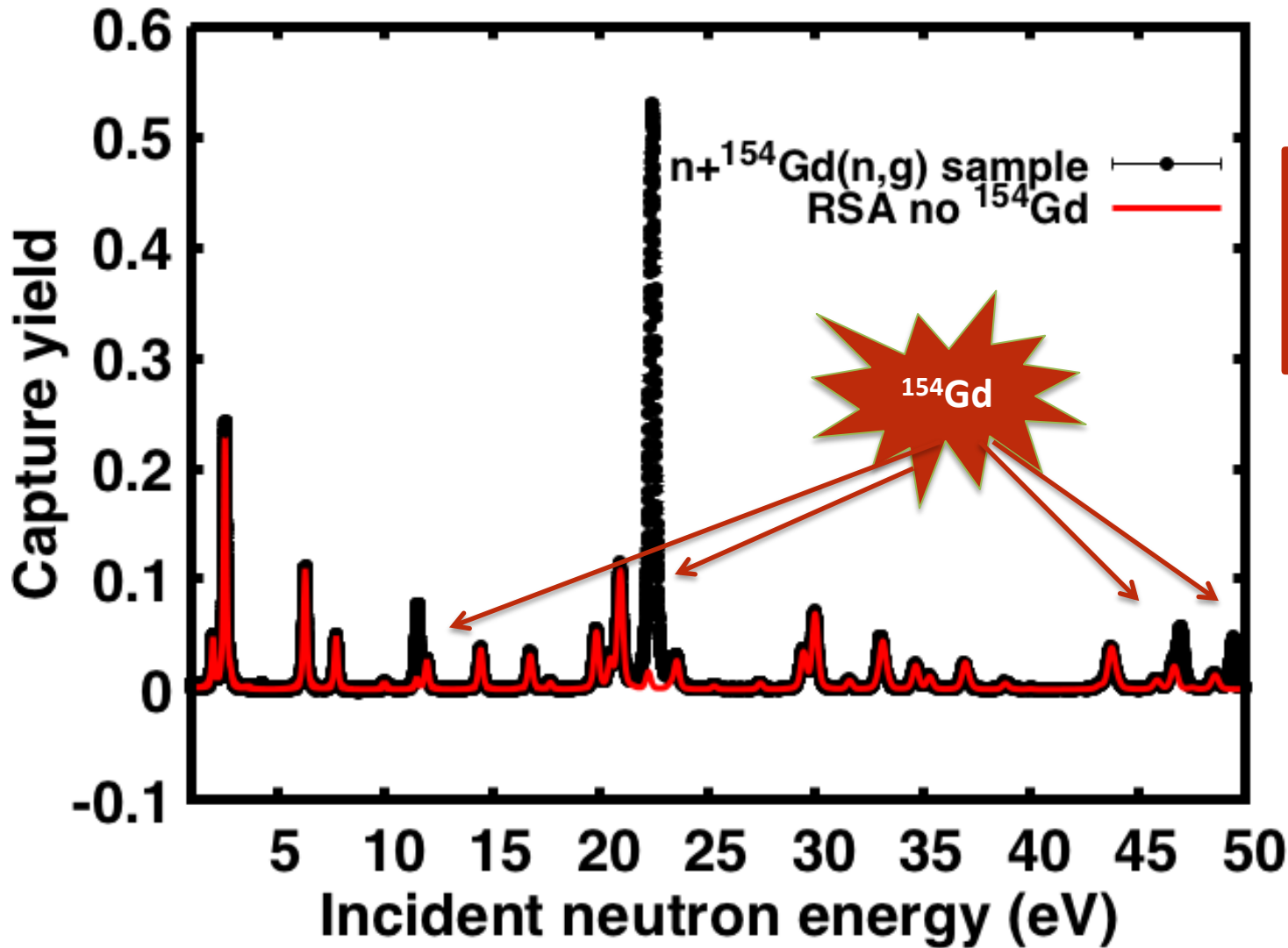
method	Normalization
Au	0.86
^{155}Gd (23%) in ^{154}Gd sample	0.95-0.97
^{155}Gd (15%) in $^{\text{nat}}\text{Gd}$ sample	0.92 – 0.97

- Different WFs
 - Different discrimination levels
 - Different upper cuts
 - Normalization (SiMom, protons)
- Were checked... what else?

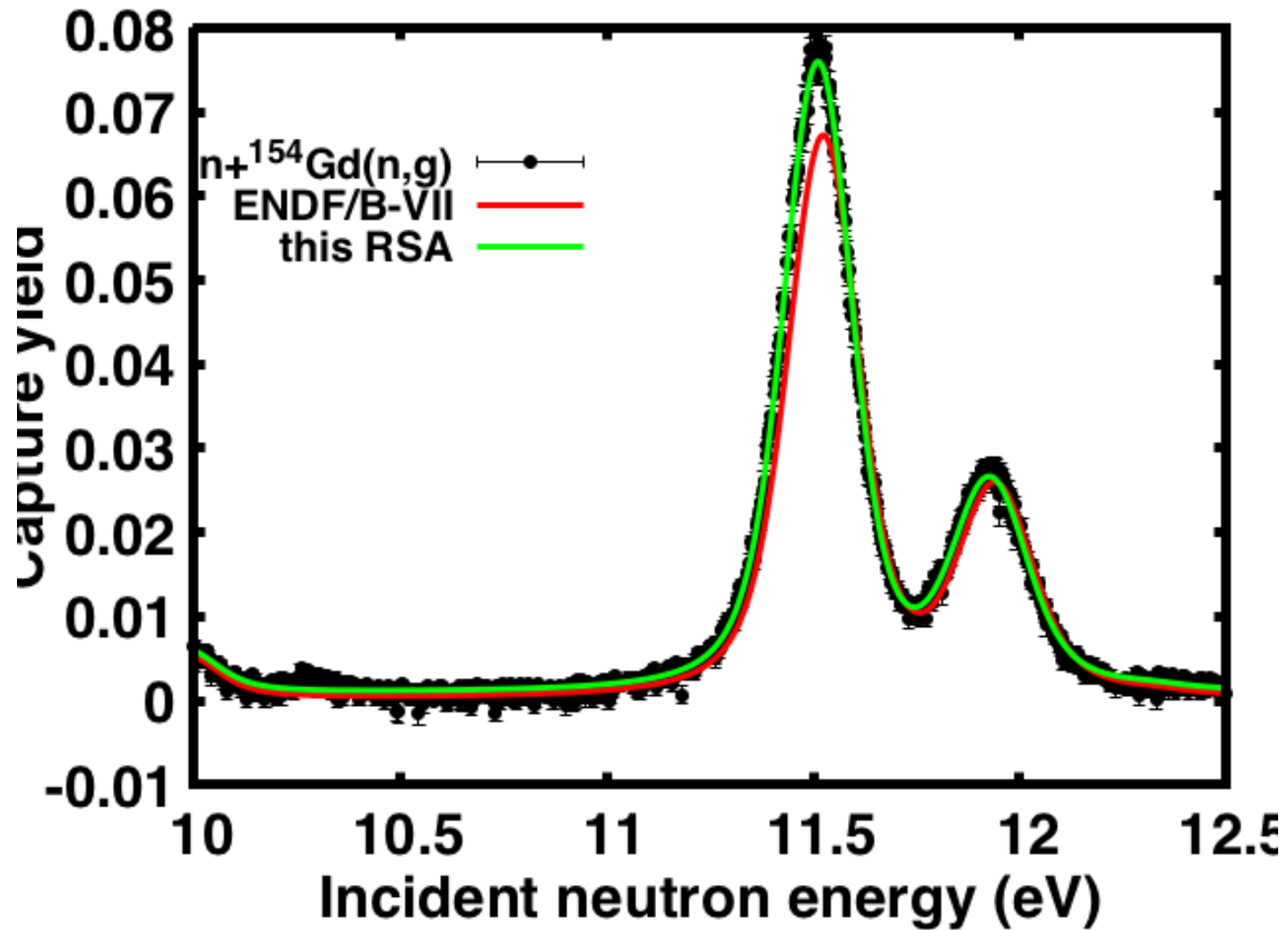


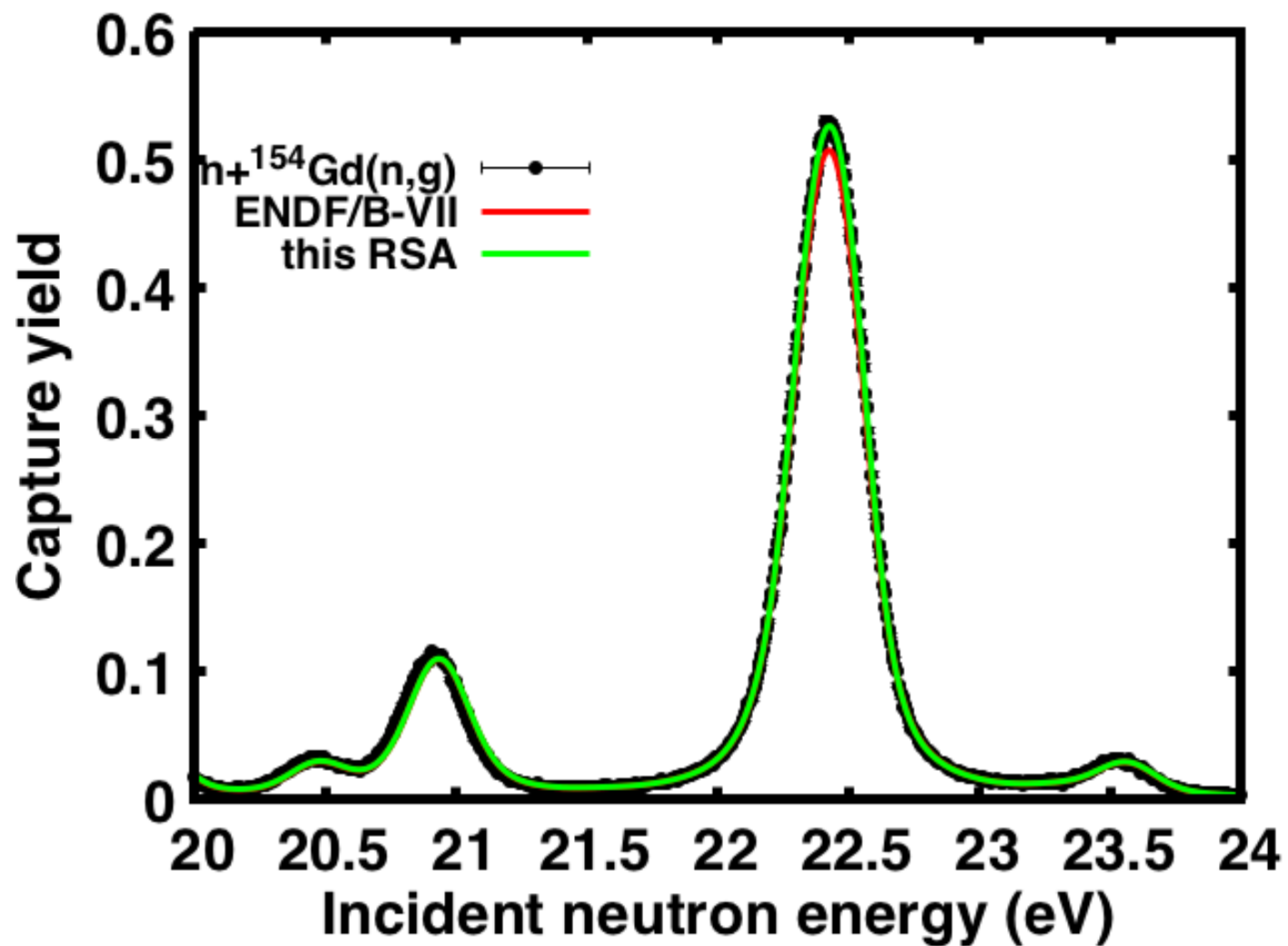
$^{154}\text{Gd}(n,\gamma)$

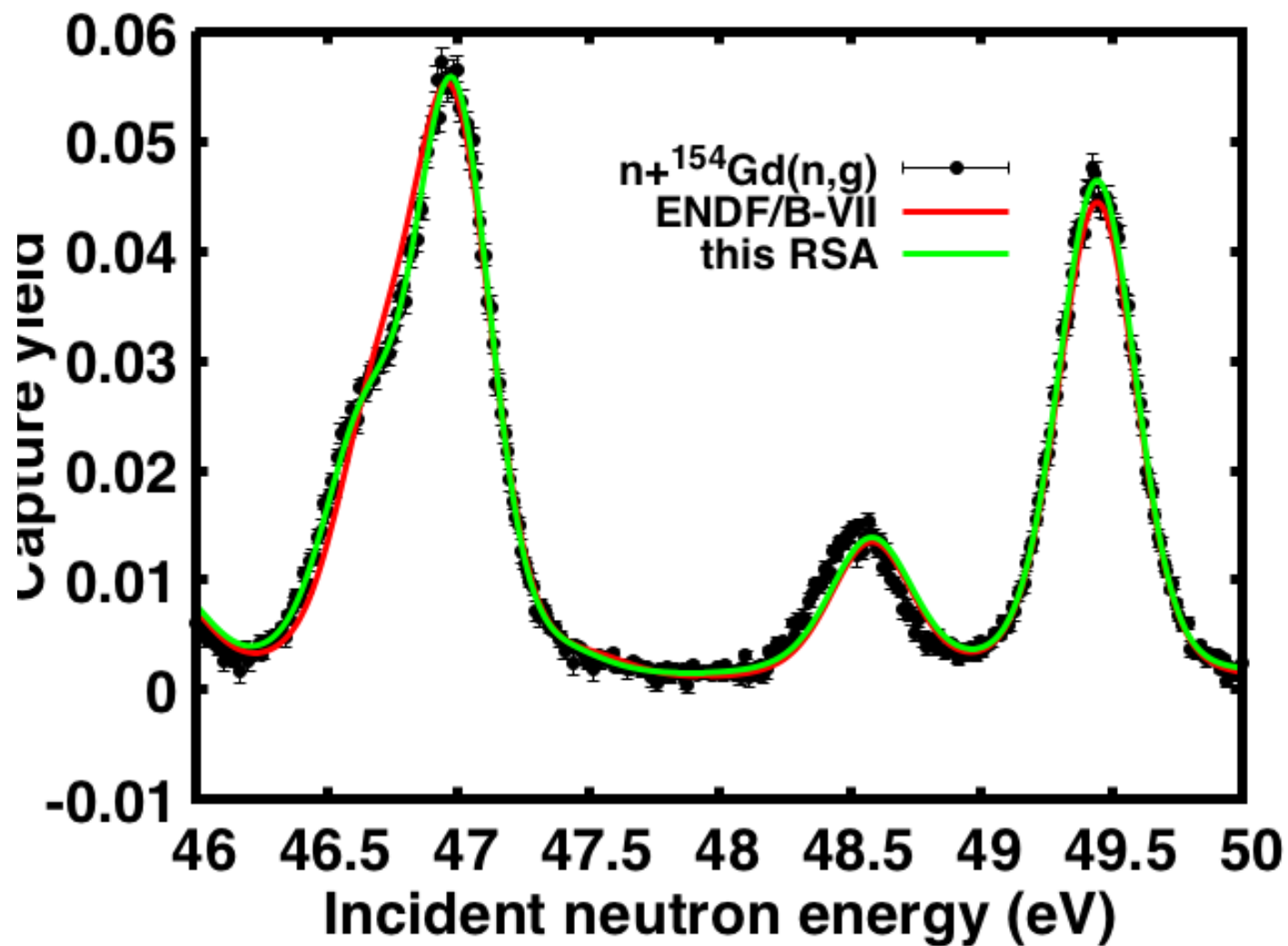
RRR

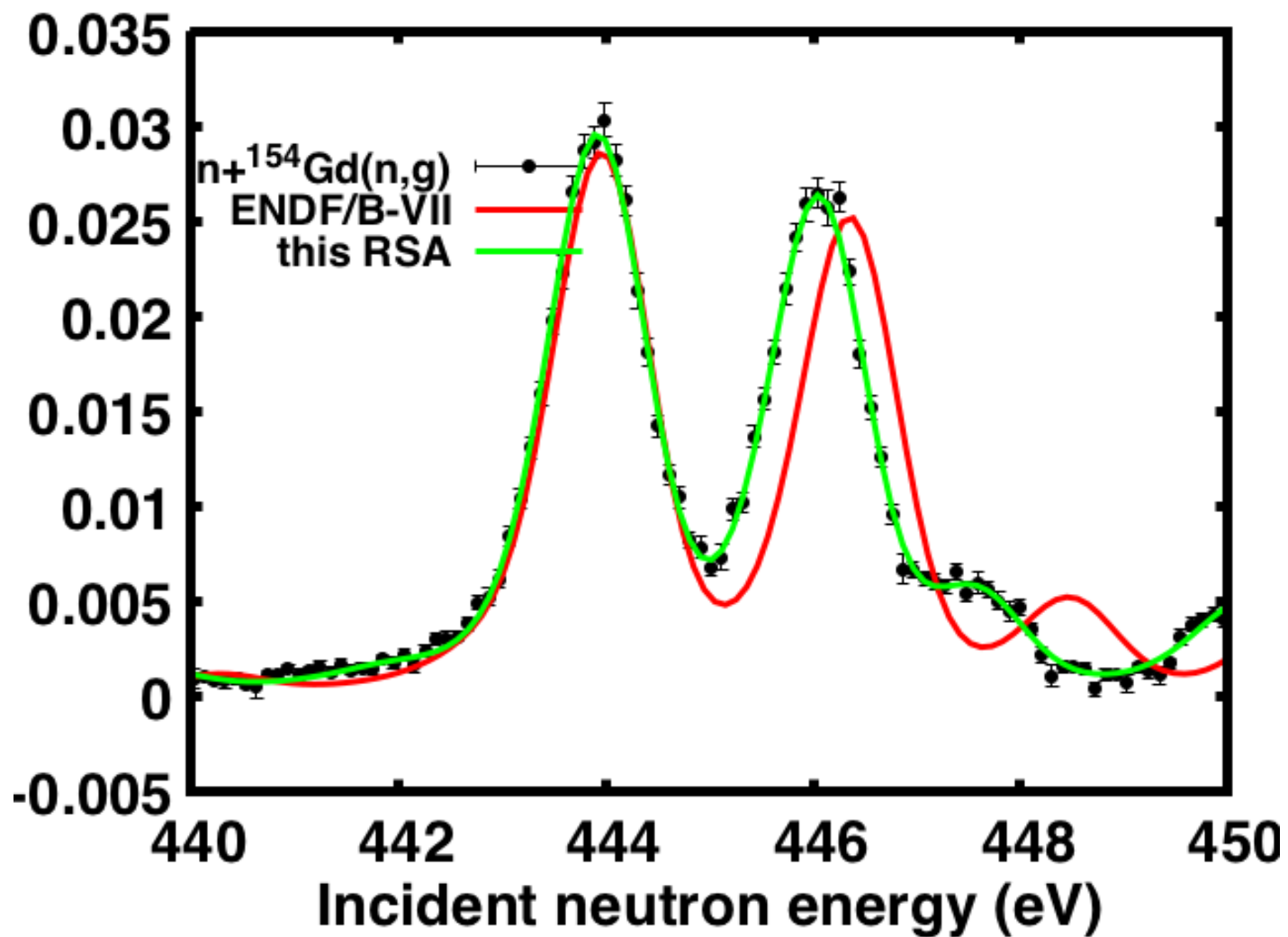


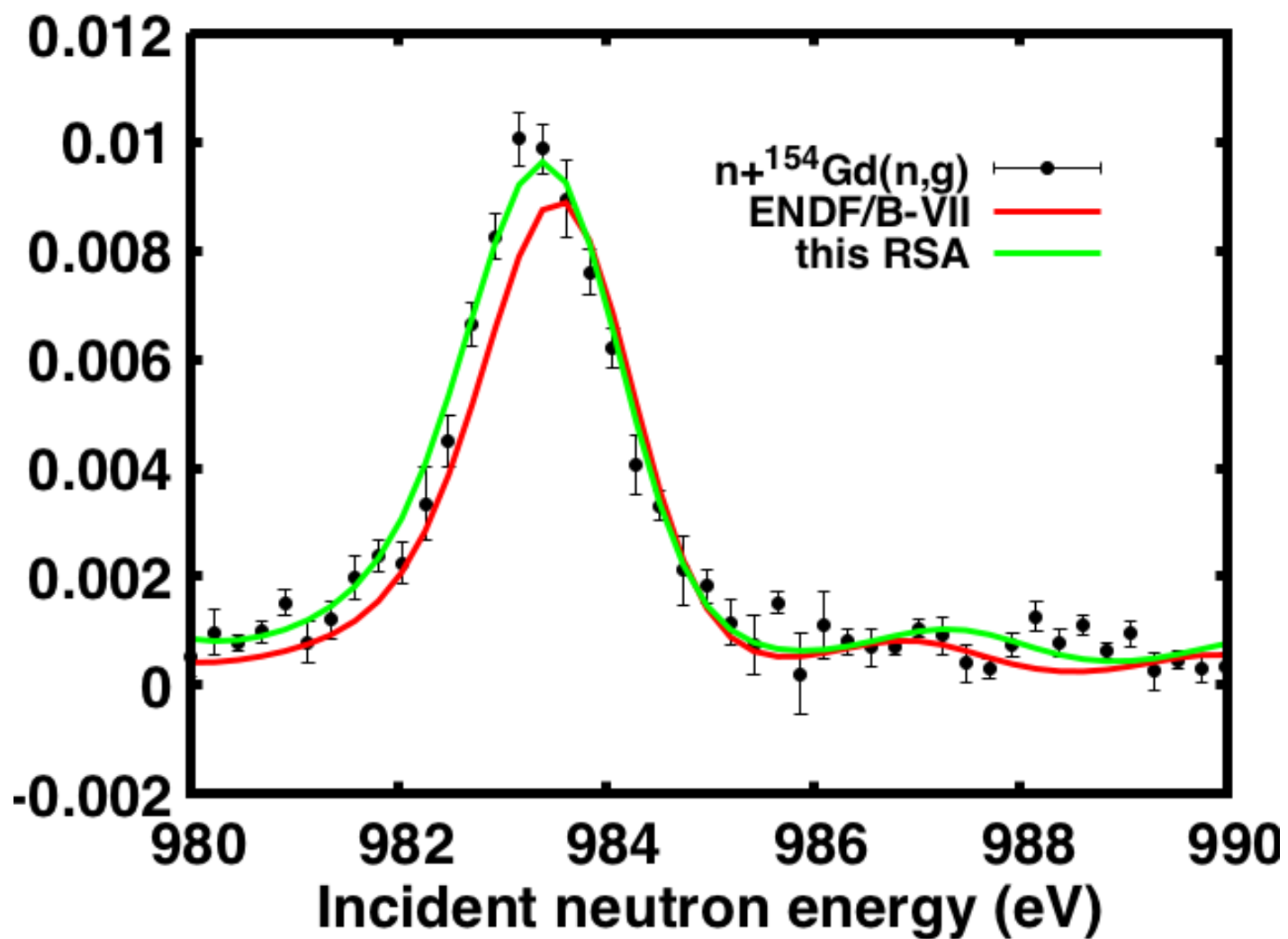
Most of the structures are due to contaminants





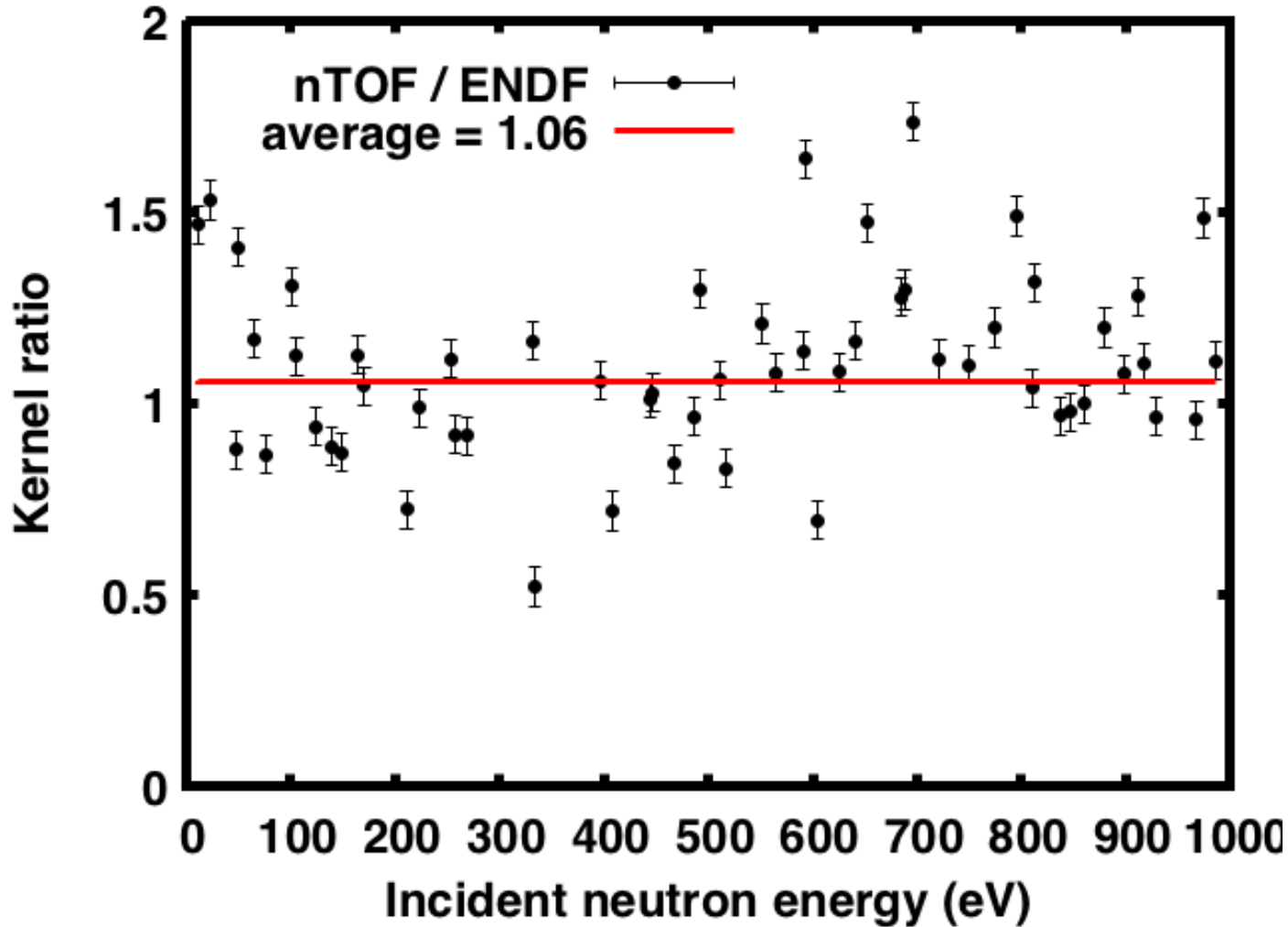






$^{154}\text{Gd}(n,\gamma)$

RRR



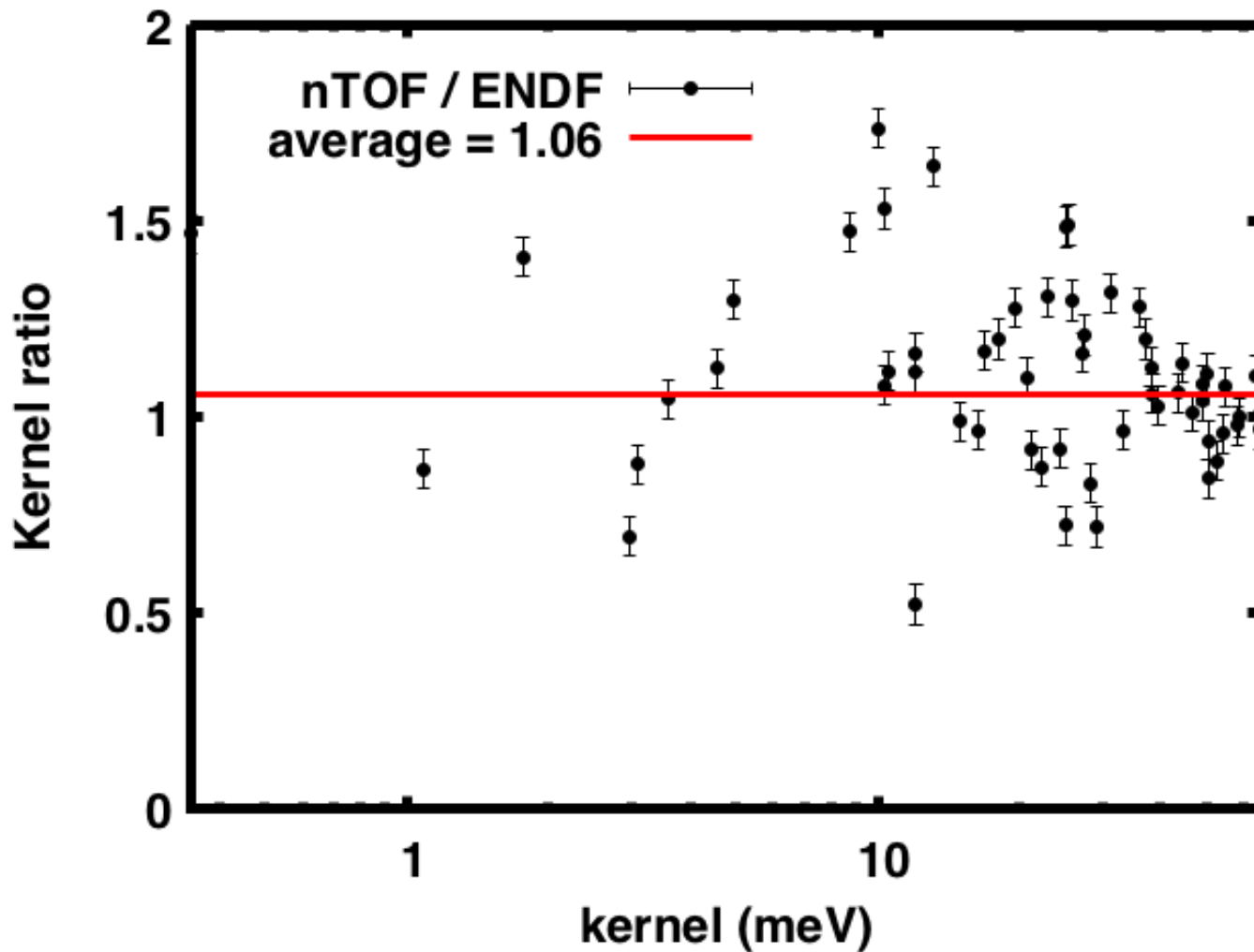
163
resonances
up to 2.7
keV

Few
changes



$^{154}\text{Gd}(n,\gamma)$

RRR



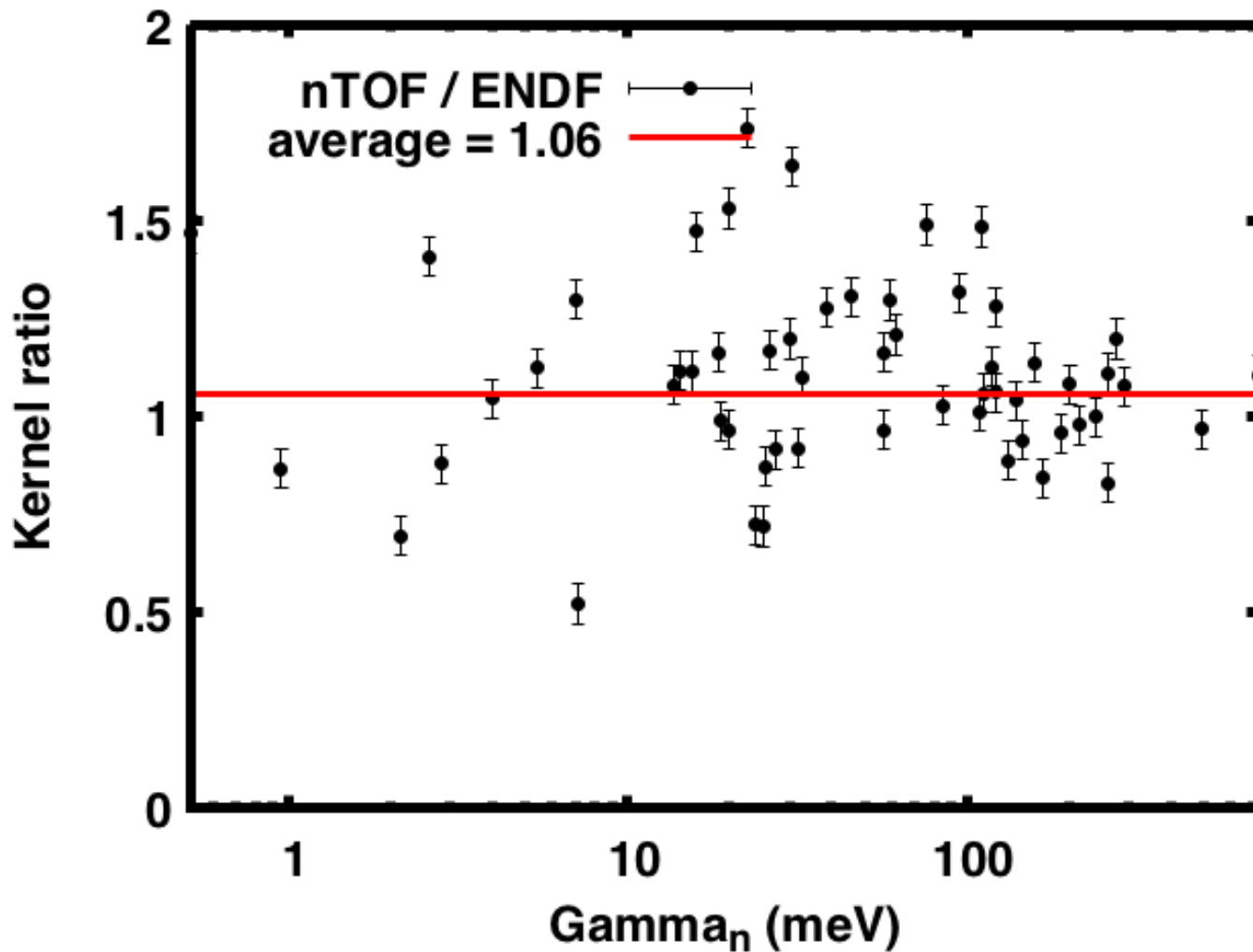
163
resonances
up to 2.7
keV

Few
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$^{154}\text{Gd}(n,\gamma)$

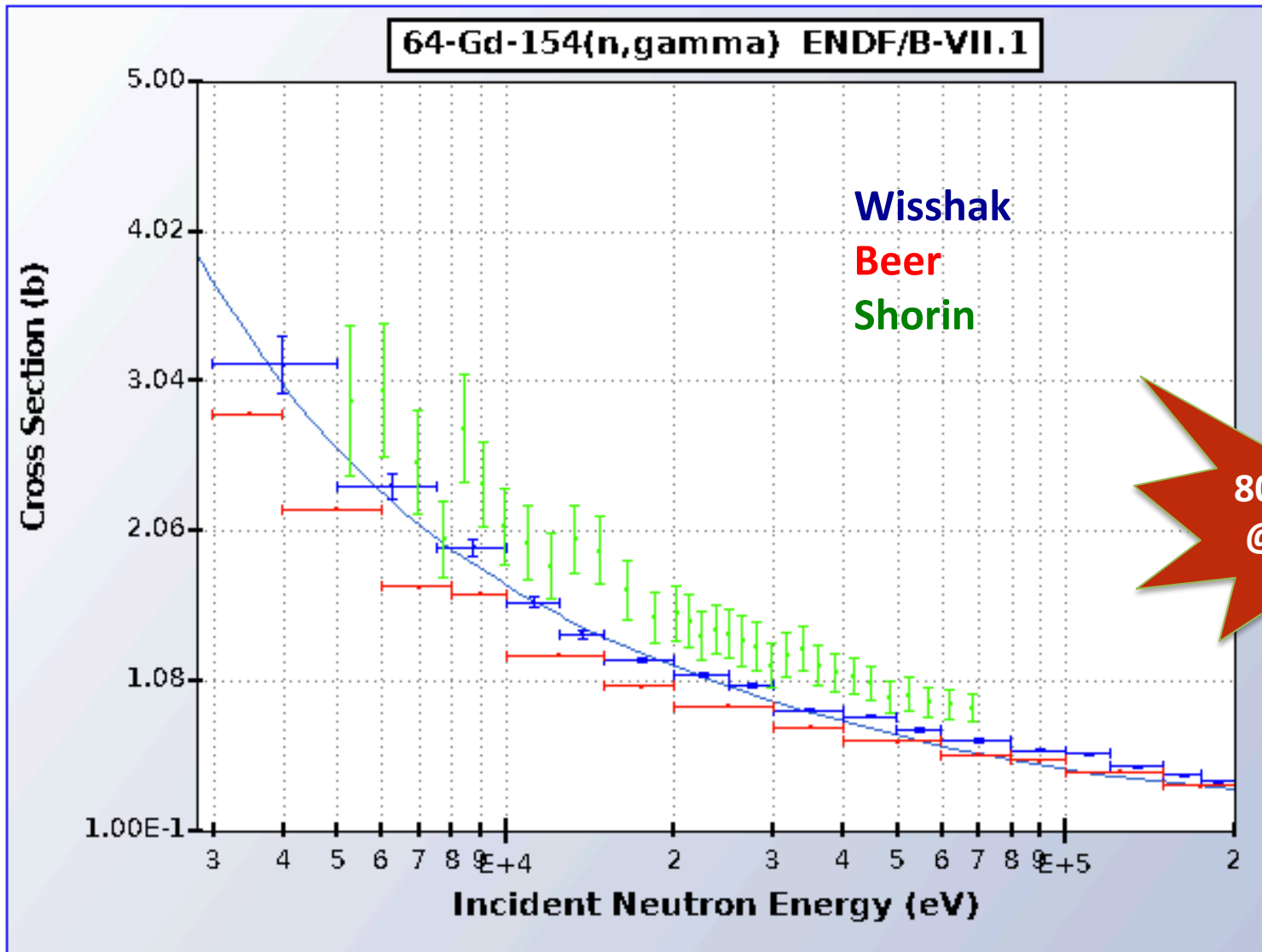
RRR



163
resonances
up to 2.7
keV

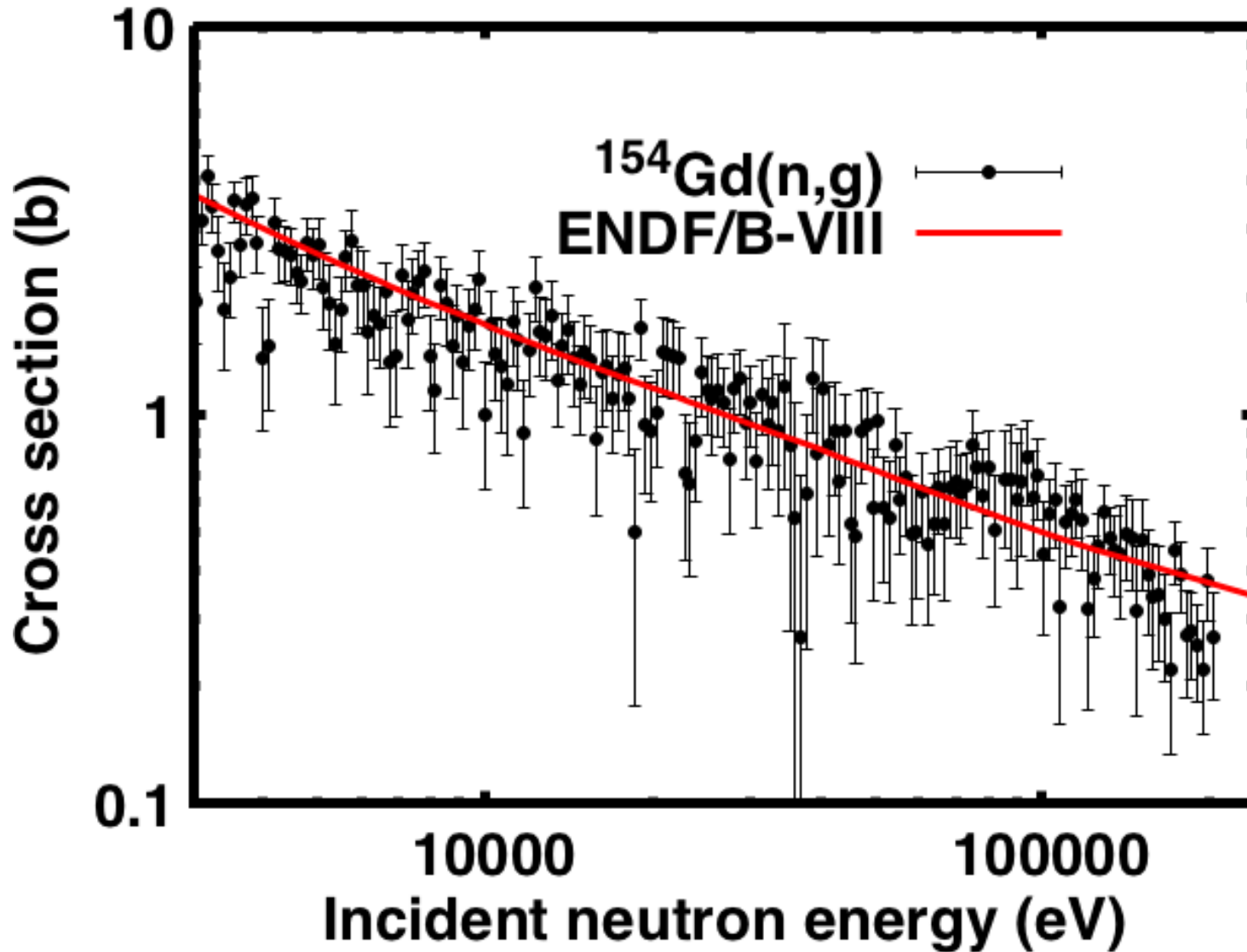
Few
changes





$^{154}\text{Gd}(n,\gamma)$

URR



Conclusions

- C_6D_6 detectors: **stable** during the $n+^{154}Gd$ measuring campaign
- C_6D_6 **rebound: 200 keV** discrimination threshold removed it
- Normalization: $^{197}Au - ^{155}Gd$ **deviation** of $\sim 10\%$ unexplained (alignment?)
- $^{154}Gd(n,\gamma)$ **sizable differences** in RRR and URR (our cross section data is higher in RRR and lower in URR with respect to evaluations)
- MACS: similar to ENDF/B-VII



Misure di trasmissione Gd154

Misure di trasmissione sono state fatte a GELINA. La prima misura ha mostrato una statistica troppo bassa quindi il campione è stato sottoposto ad una seconda campagna di misura. Venerdì scorso lo studente che si occupa dell'analisi è arrivato a GELINA e procederà con l'analisi (approx 1 mese).

Saranno fittate 2 /3 risonanze che serviranno per verificare l'accuratezza della rinormalizzazione. Quindi si procederà allo studio delle risonanze per gruppi nella zona RRR (approx 1 settimana).

Una volta calcolati i parametri di risonanza saranno passati ad Alberto Mengoni il quale calcolerà la URR ad alte energie. La sigma così calcolata sarà confrontata con la nostra.



Gd157 – Gd155

Lo studio dei sdati da trasmissione è a buon punto ed ha dato buoni risultati come mostrato nella mail. Cosa ne facciamo????

L'incertezza maggiore per il campione sottile di Gd157 (4.7 mg) era legata alla misura della massa (la bilancia del CERN). Visto che il campione è stato ampiamente utilizzato si potrebbe pensare di mandarlo al PSI per permettere una misura più accurata della massa e quindi ridurre l'errore.

Nel caso del campione spesso (10 mg) l'incertezza è all'1%.



Gd155

Il campione del Gd155 è stato richiesto da ISIS.

Cristian è stato contattato da Romanelli, Instrumentation Scientist di VESUVIO e vorrebbe applicare la sua linea che normalmente si occupa di studiare materiali per fare misure di dati nucleari. Sono in grado di studiare la T all'interno dei materiali attraverso l'analisi dell'allargamento delle strutture nucleari per effetto Doppler. Lavorano a basse energie fino a 100eV.

E' una sorgente a spallazione ma hanno un problema: il picco di protoni che utilizzano è in realtà un doppio picco x aumentare la corrente. L'effetto sui dati è di sdoppiare le risonanze. Fino a 100 eV l'effetto è trascurabile perché domina il contributo del moderatore (1ms contro 7 ns) Il flusso è due ordini di grandezza superiore a quello di n-tof in più il diametro del fascio è 3-5 cm. Sono interessati a misure di cattura e trasmissione e vorrebbero sviluppare dei detector sensibili alla direzione di arrivo dei n. (GEM)

Vogliono usare il Gd 155 (sia sottile fino a 1 eV che doppio fino a 100 eV) per verificare la linea.

Potremmo calcolare la sigma elastica che al momento otteniamo per sottrazione.





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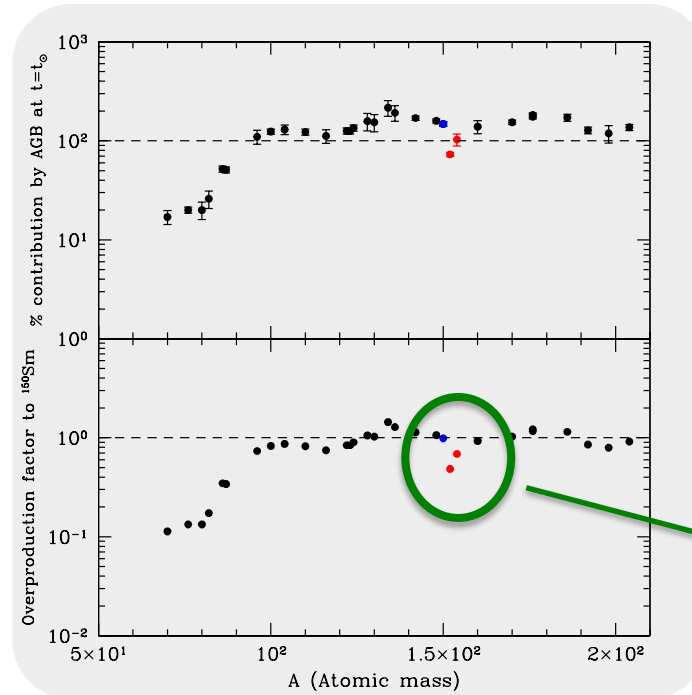
Cristian Massimi

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www.unibo.it

backup Models



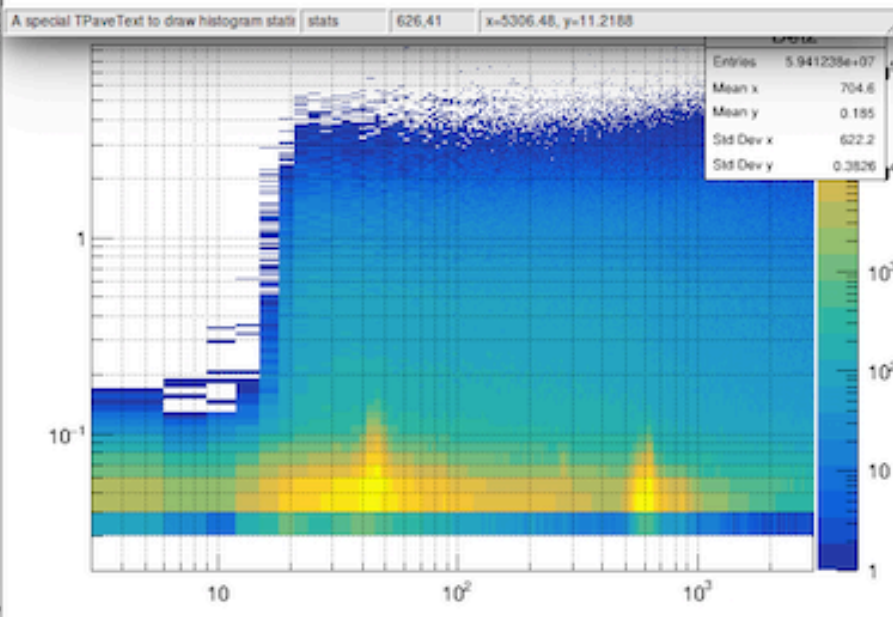
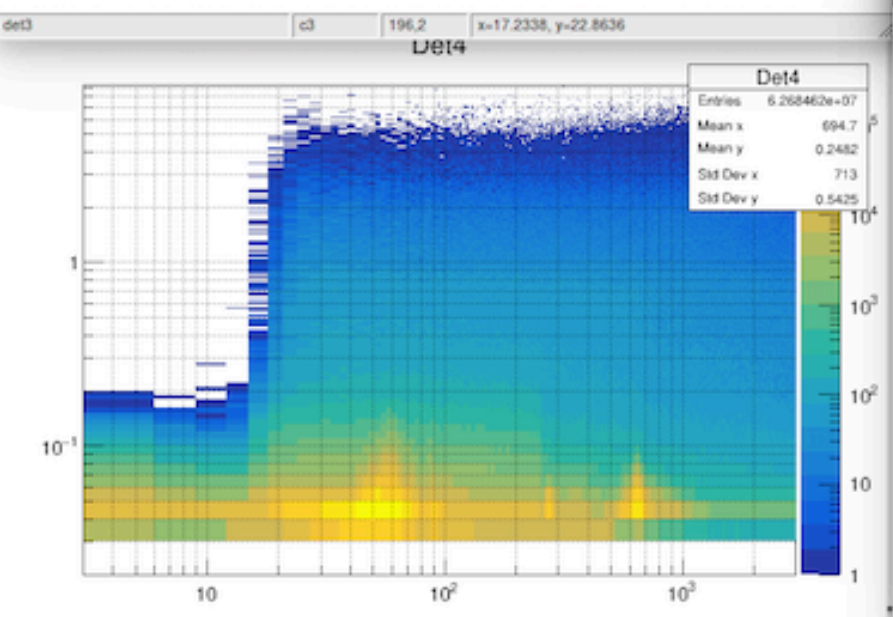
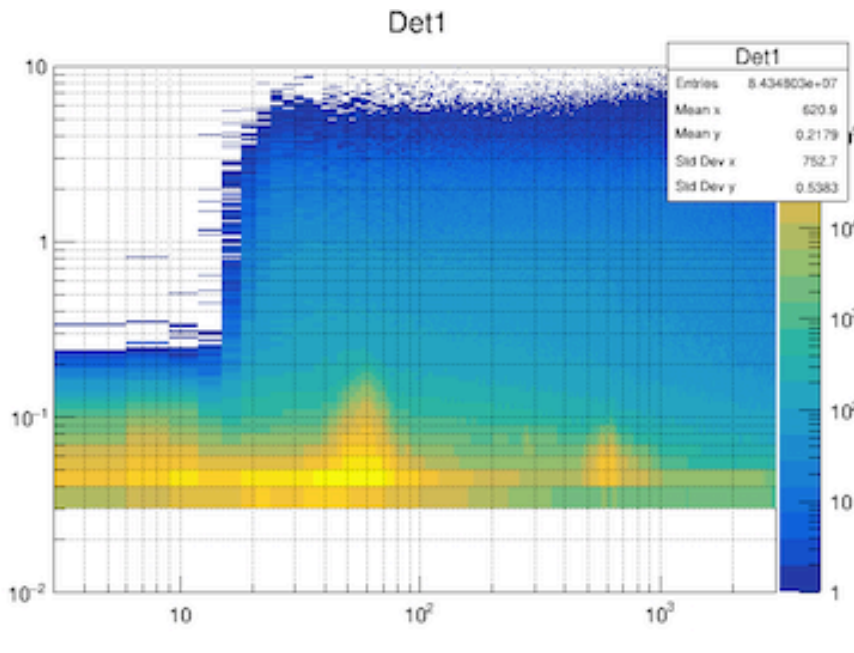
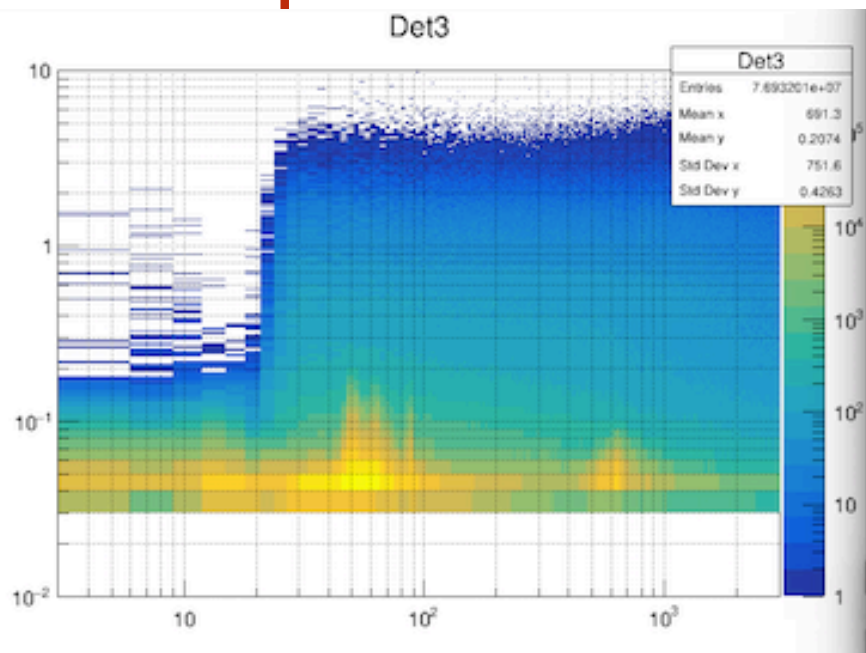
20% is the
difference
we are
looking for

**S. Cristallo, et al.,
The Astrophysical Journal 801 (2015) 53**



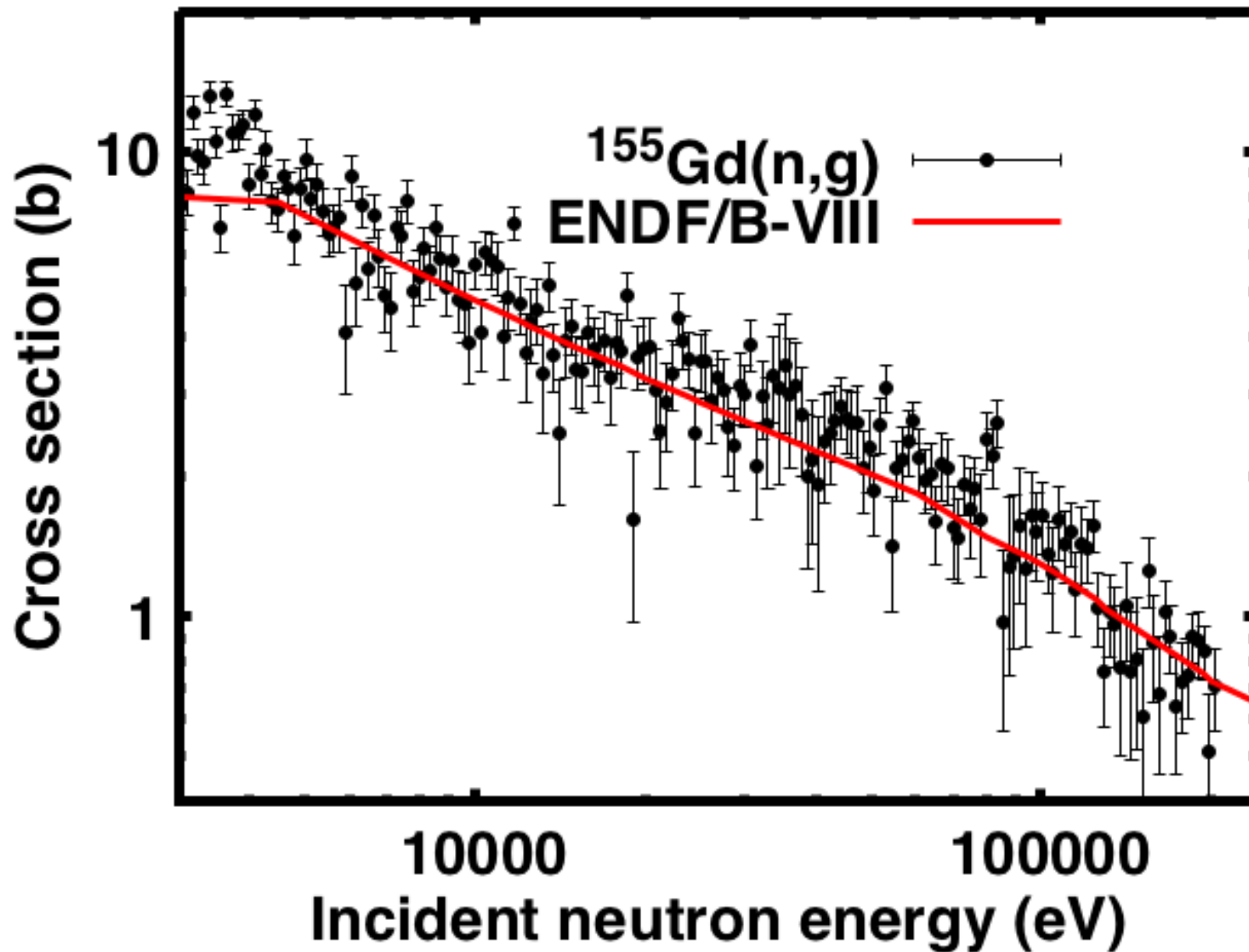
backup

DT



backup

$^{155}\text{Gd}(n,\gamma)$ in URR



backup

$^{155}\text{Gd}(n,\gamma)$ in URR

