Status on ^{25}Mg(n,©) and neutron flux in 2012

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Outline

- 2012 Flux
  - Detectors & data
  - Flux and its uncertainty
- Mg(n,©)
  - RSA, examples
  - MACS, preliminary
- Conclusions

2012 Flux – Available data

Capture collimator (1.8 cm)

Experiment	RUNS	Total protons	Usable protons	DST available ?
^{238}U(n,©)	13499-13836	2.44×10^{18}	1.53×10^{18}	✔
^{92,93}Zr(n,©)	13866-14302	3.15×10^{18}	2.46×10^{18}	✔
^{87}Sr(n,©)	14325-14577	2.00×10^{18}	-	✗
^{235}U Fiss.Tag.	14579-15388	4.28×10^{18}	3.61×10^{18}	✔
^{59}Ni(n,〈)	15569-15703	1.5×10^{18}	1.26×10^{18}	✔
TOTAL		1.34×10^{19}	8.86×10^{18}	

Experiment	Total protons	Used protons
Fission angular distribution	2.0×10^{18}	1.72×10^{18}

Fission collimator (8 cm)

2012 Flux – Available data

Capture collimator (1.8 cm)

Experiment	SiMon	MicroMegas ^{10}B	MicroMegas ^{235}U	PTB
$^{238}U(n,\gamma)$	✔	✗	✗	✗
$^{92,93}Zr(n,\gamma)$	✔			✗
$^{87}Sr(n,\gamma)$	✔	✗		✗
^{235}U Fiss.Tag.	✔	✗	✔	✗
$^{59}Ni(n,\alpha)$	✔	✗	✗	✗

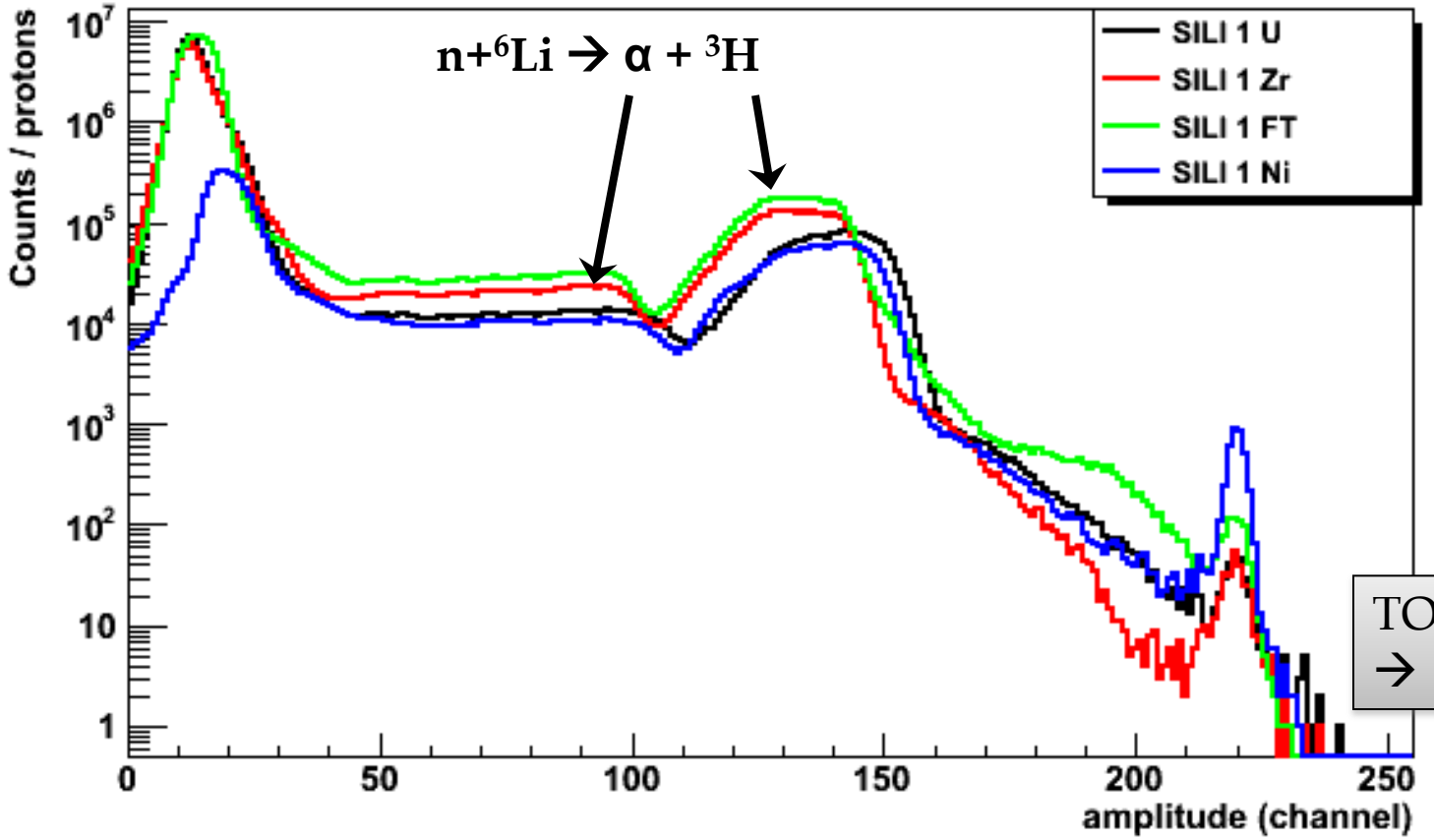
Experiment	PPAC ^{235}U
Fission angular distribution	✔

Fission collimator (8 cm)

2012 Flux – SiMon data

DST version 11, an improved routine exists but not used yet

Amplitude Spectrum Silicon 1

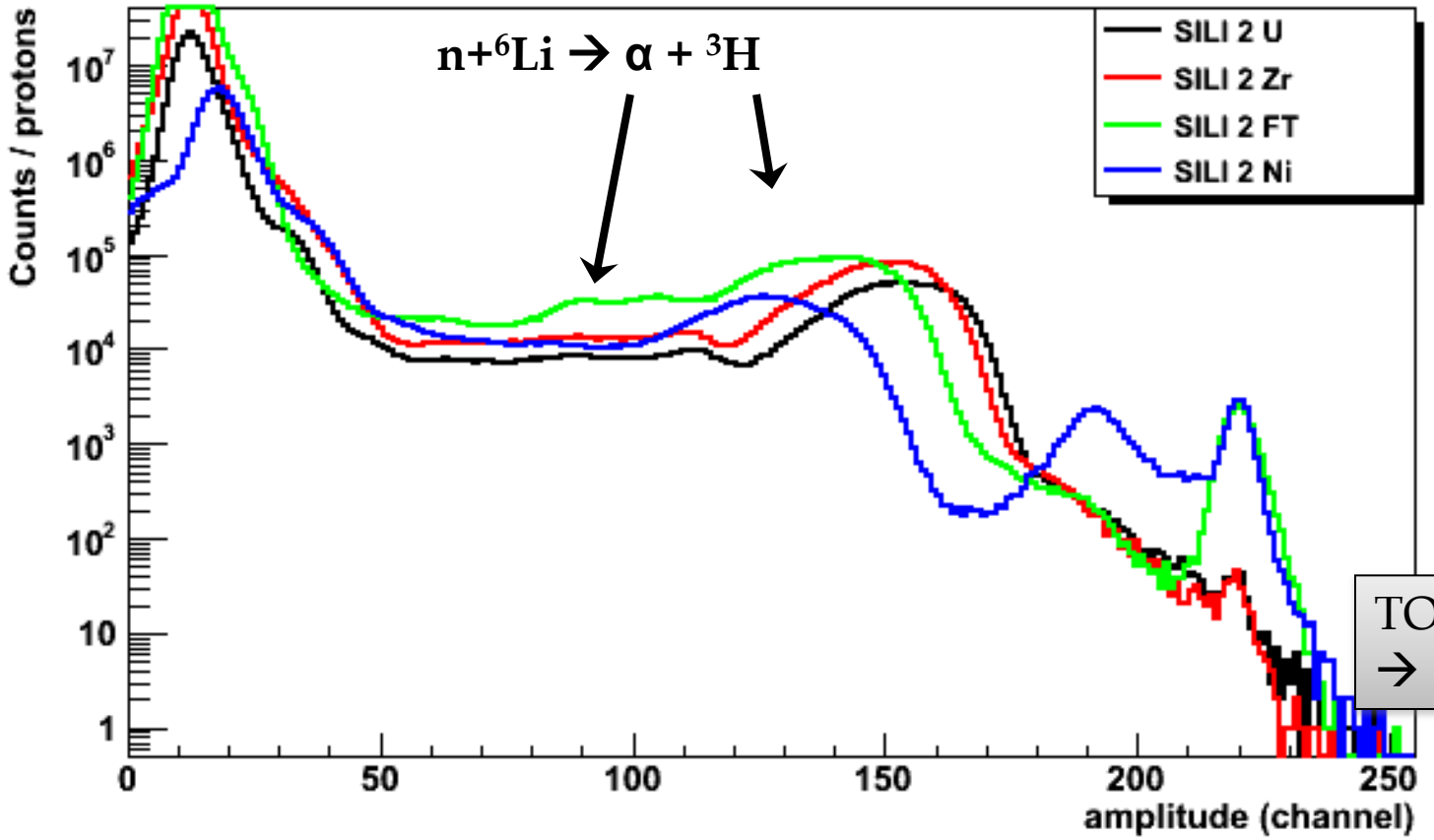


TOF > 10^4 ns
→ No ©-flash

2012 Flux – SiMon data

DST version 11, an improved routine exists but not used yet

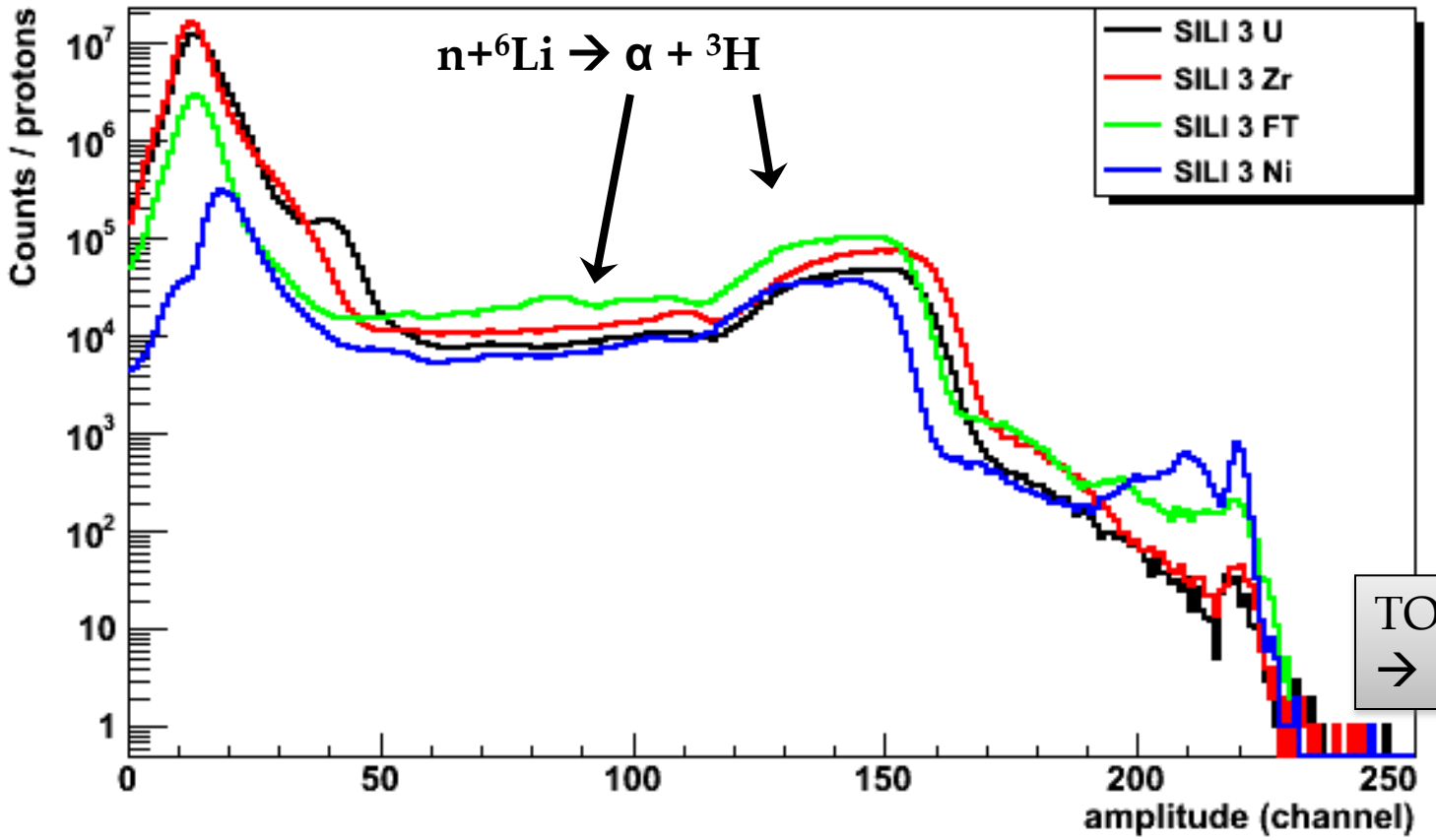
Amplitude Spectrum Silicon 2



2012 Flux – SiMon data

DST version 11, an improved routine exists but not used yet

Amplitude Spectrum Silicon 3

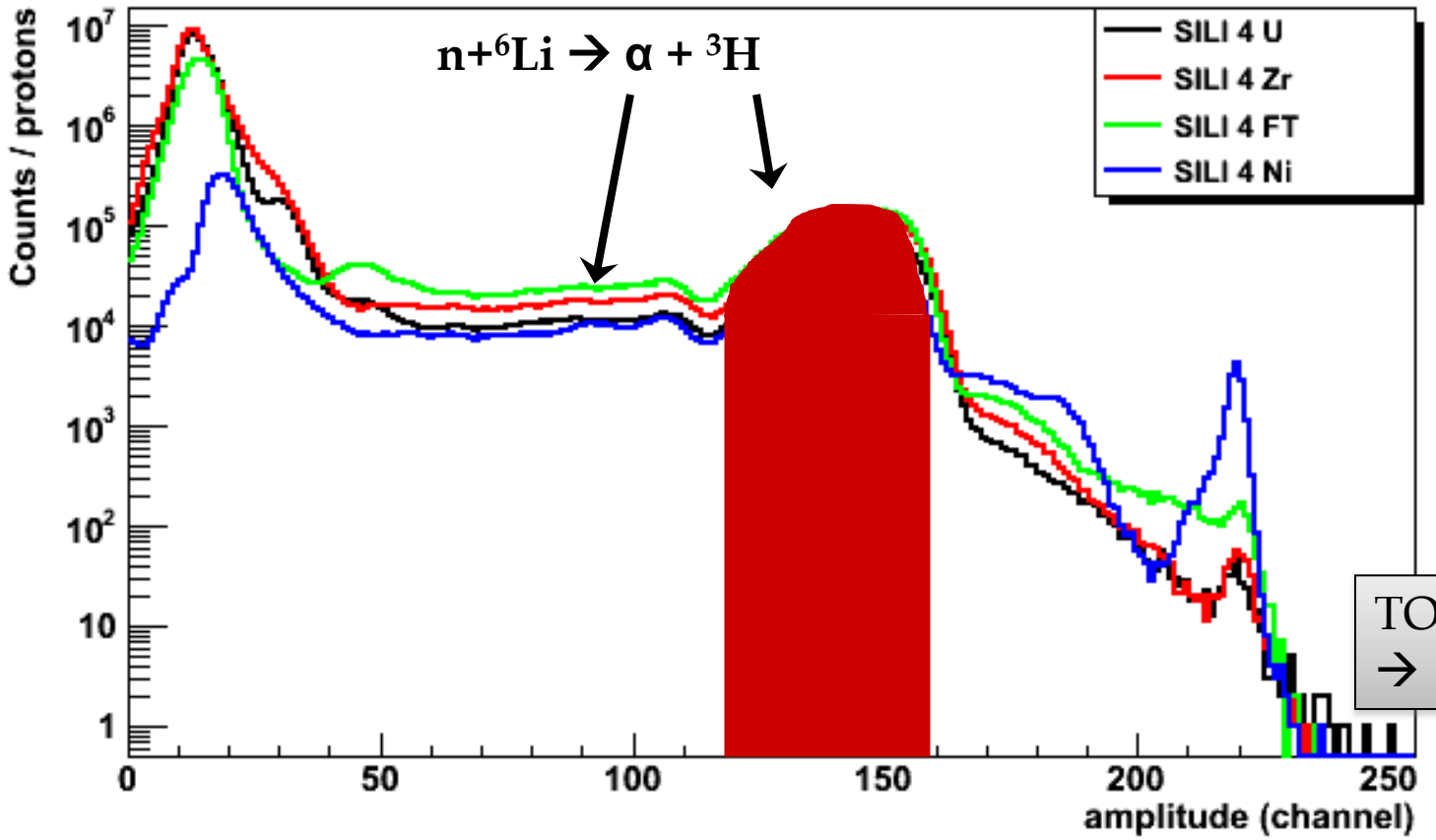


TOF > 10^4 ns
→ No ©-flash

2012 Flux – SiMon data

DST version 11, an improved routine exists but not used yet

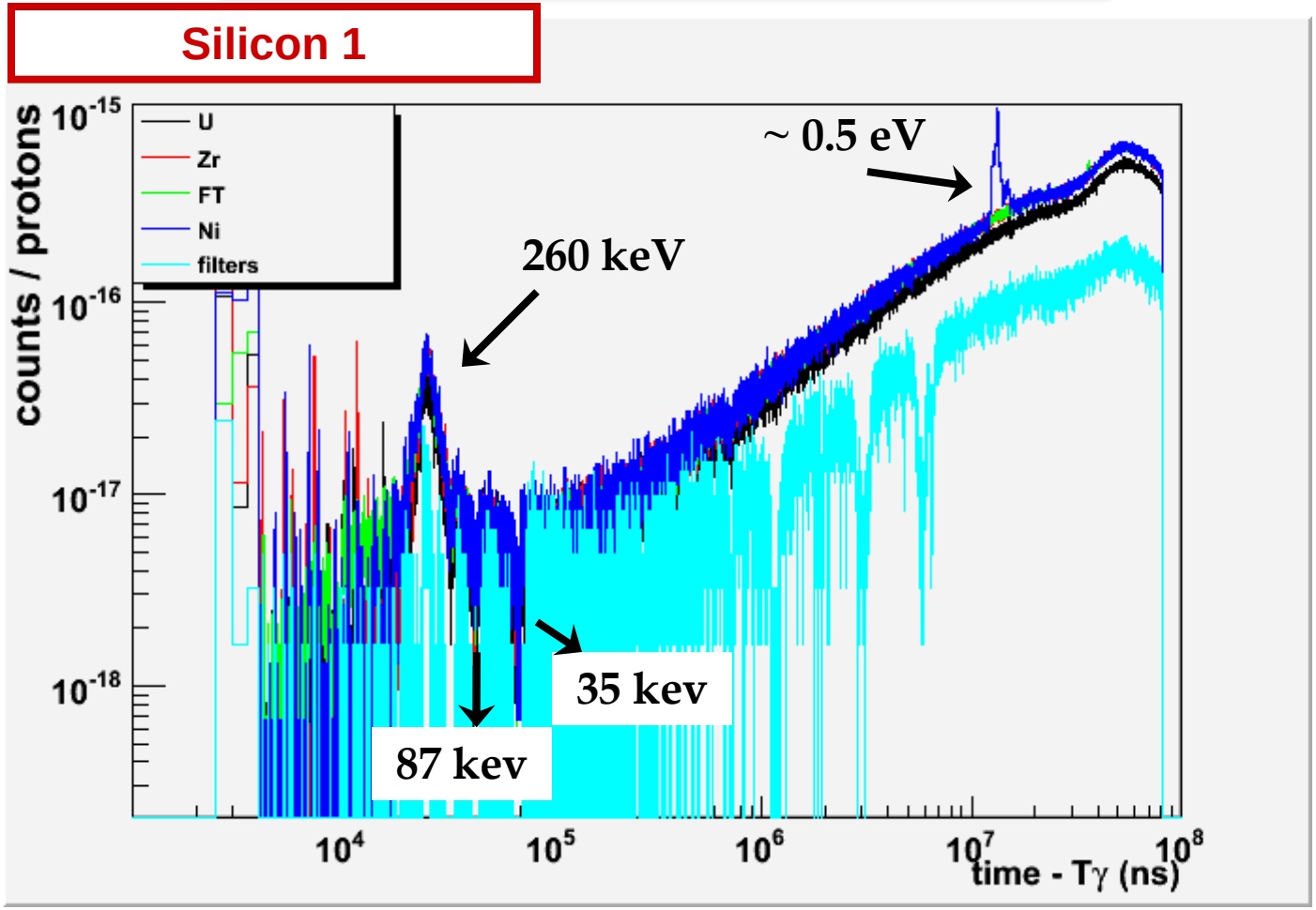
Amplitude Spectrum Silicon 4



TOF > 10^4 ns
→ No ©-flash

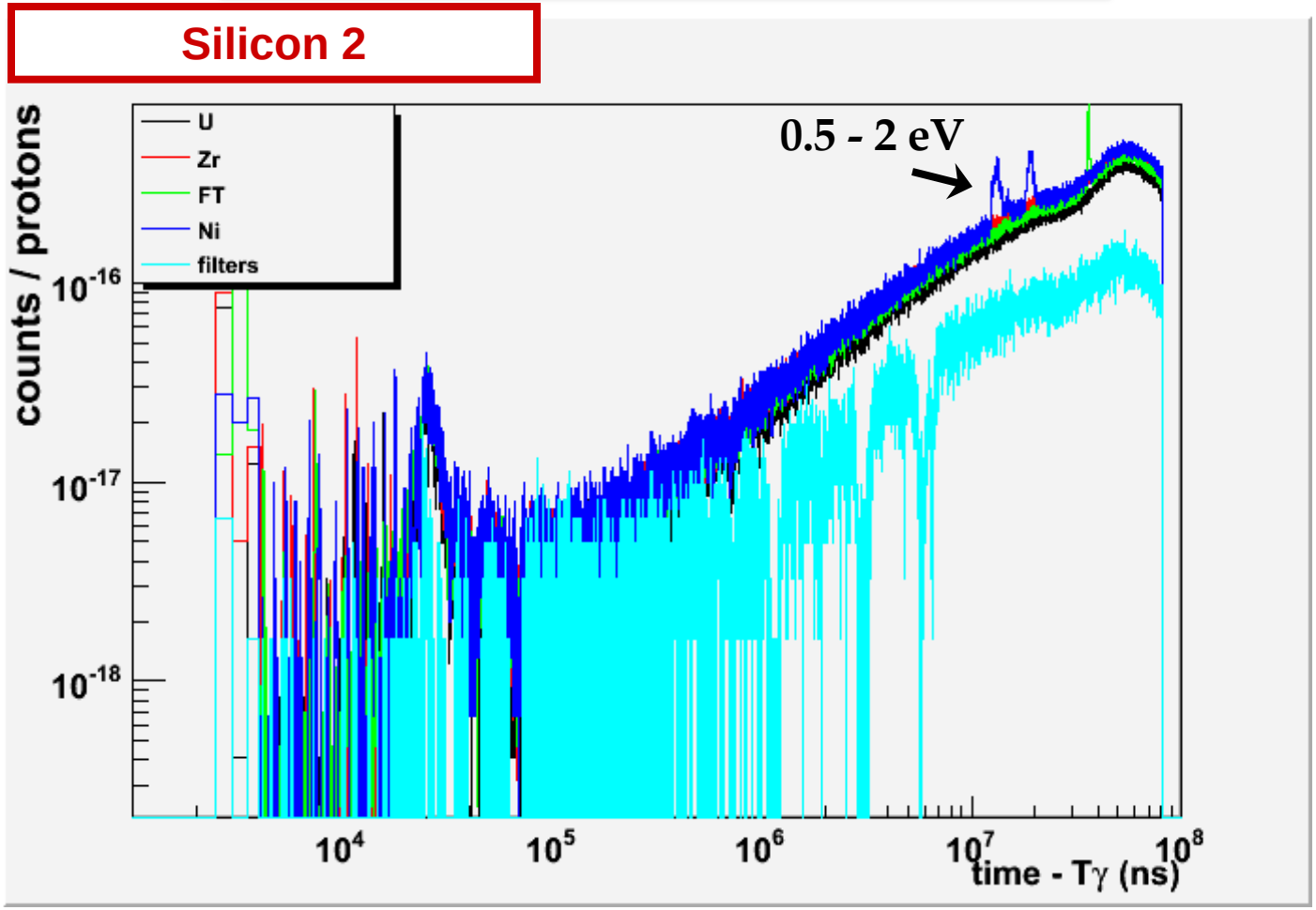
2012 Flux – SiMon data

TOF spectrum, gate on ^{3}H peak



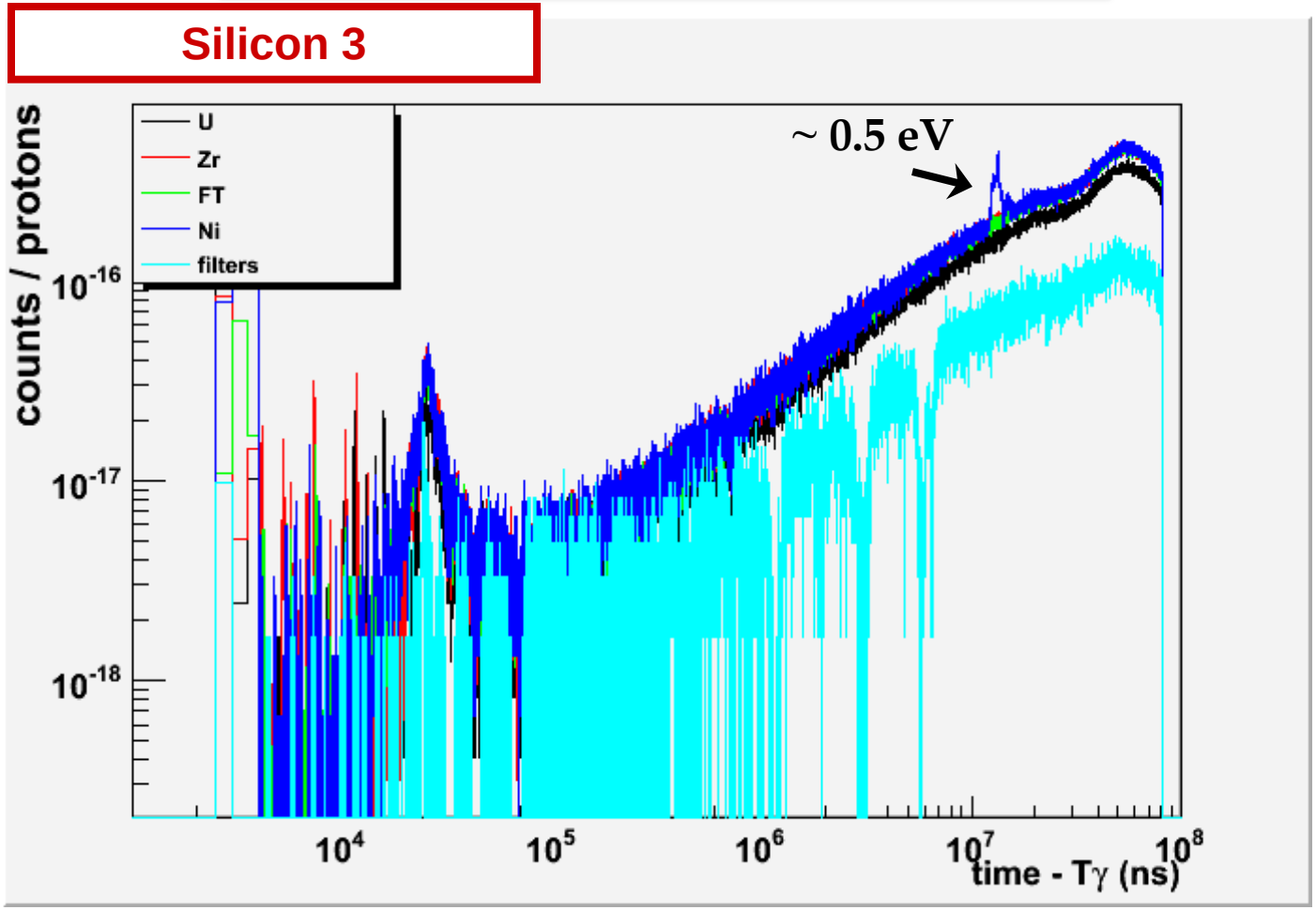
2012 Flux – SiMon data

TOF spectrum, gate on ^{3}H peak



2012 Flux – SiMon data

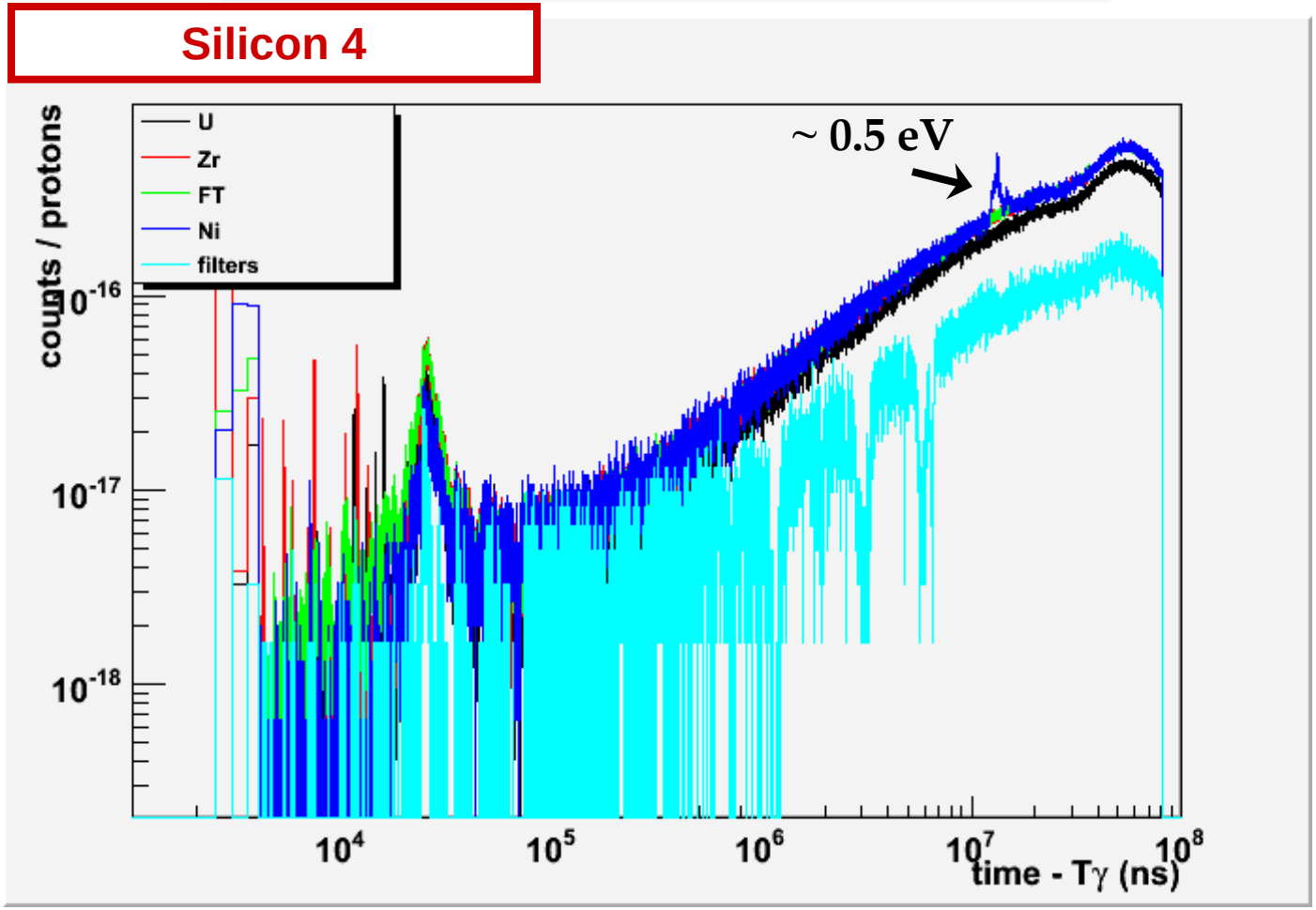
TOF spectrum, gate on ^{3}H peak



2012 Flux – SiMon data

TOF spectrum, gate on ^{3}H peak

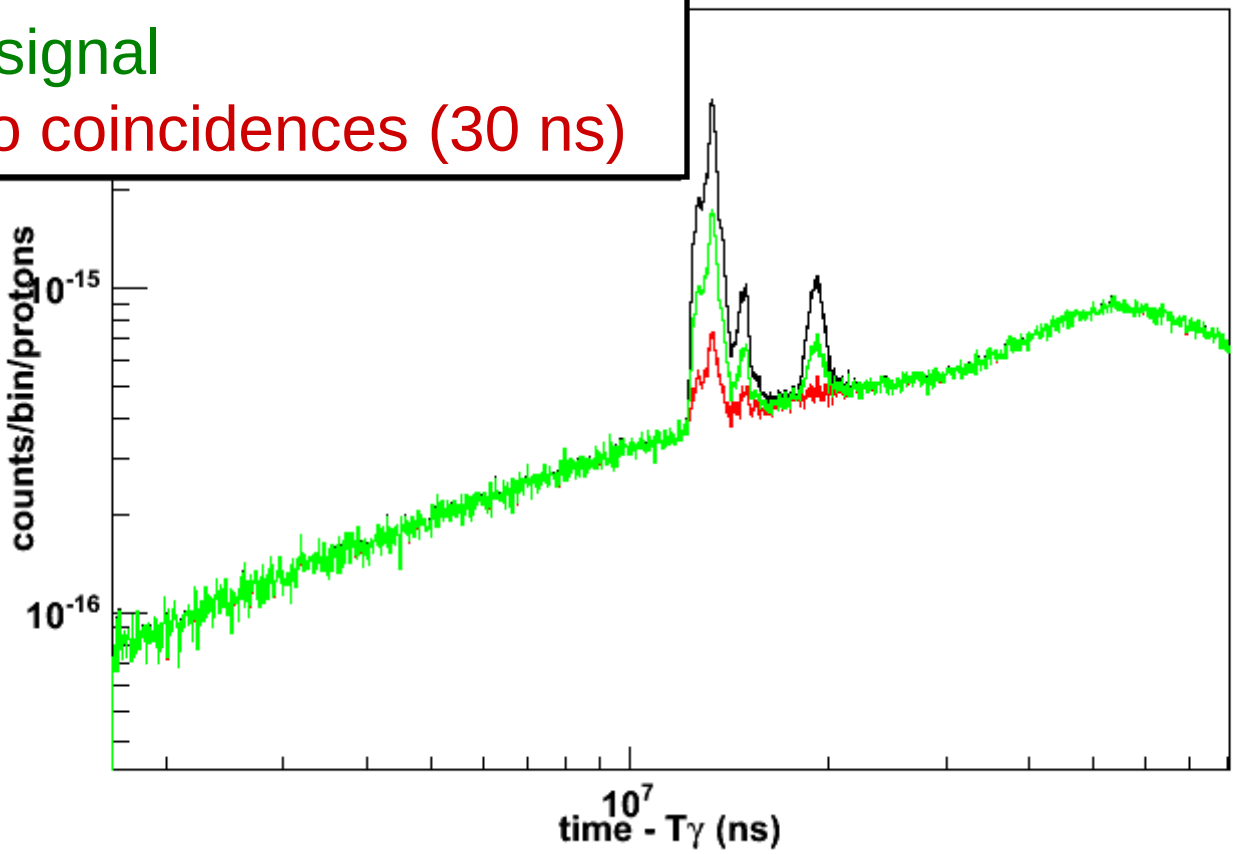
Silicon 4



2012 Flux – SiMon data

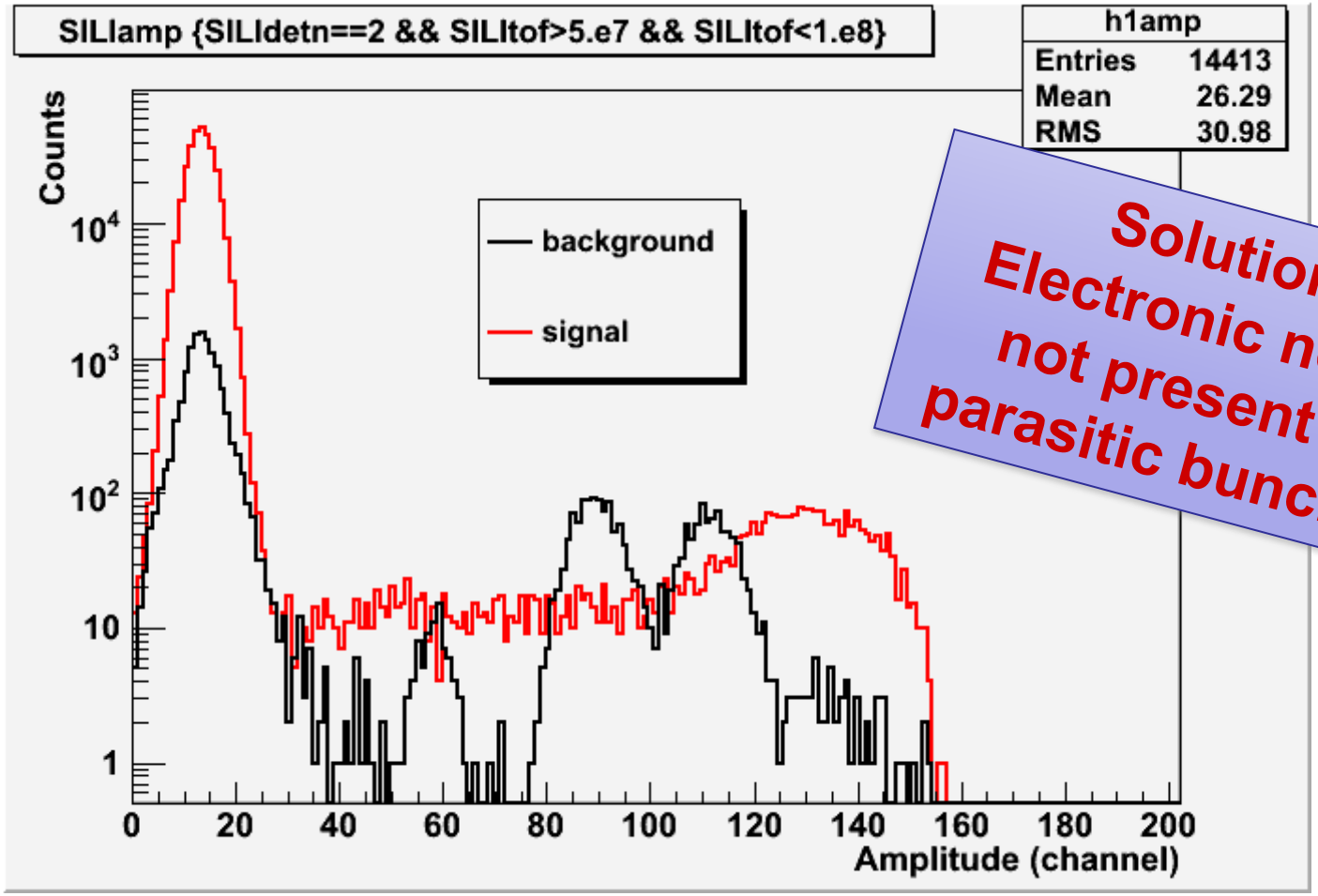
Rejection of radiofrequency(?) → signals in coincidence

--- No conditions
--- 1 signal
--- No coincidences (30 ns)



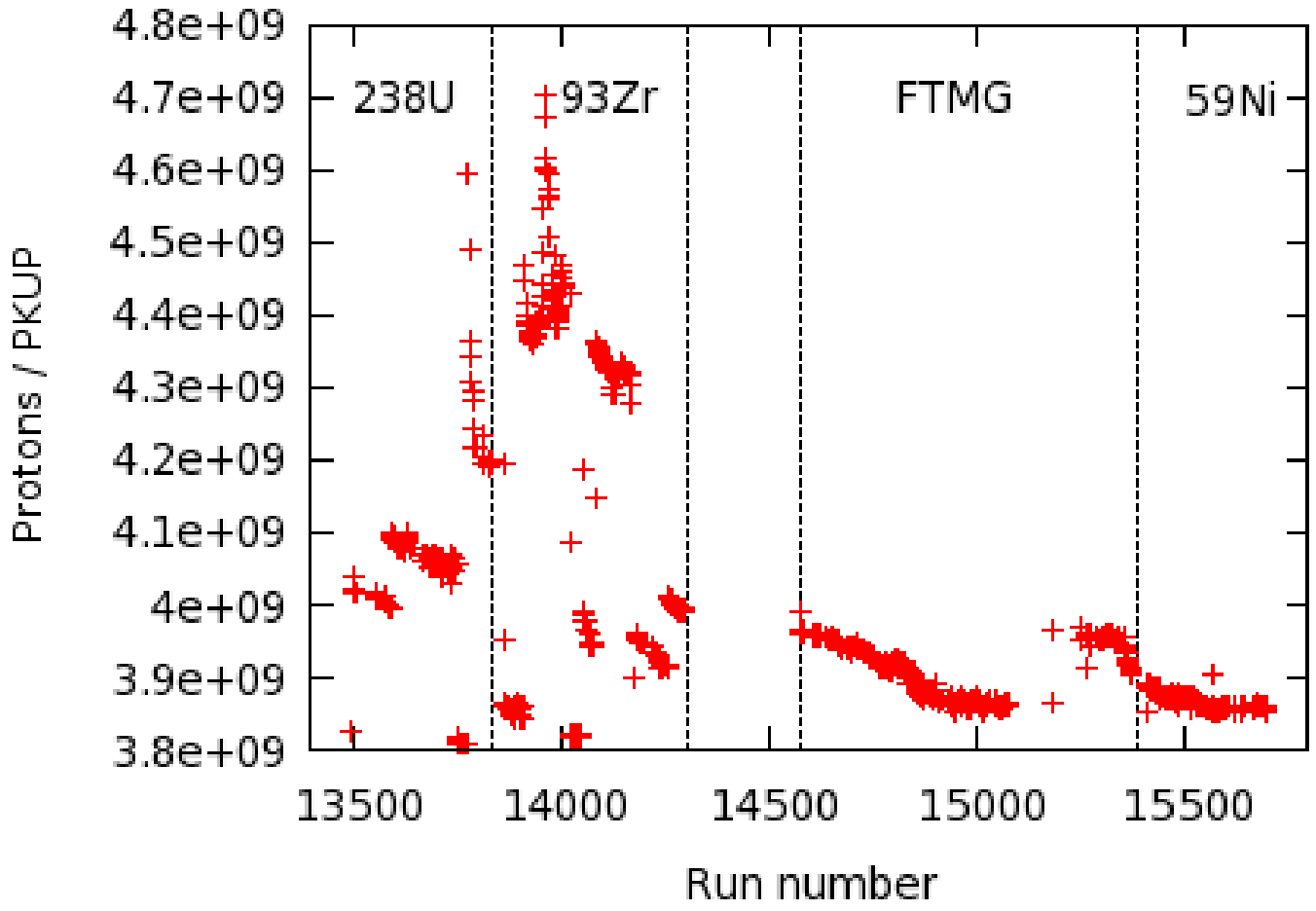
2012 Flux – SiMon data

Rejection of radiofrequency(?) → Energy deposition



2012 Flux – SiMon data

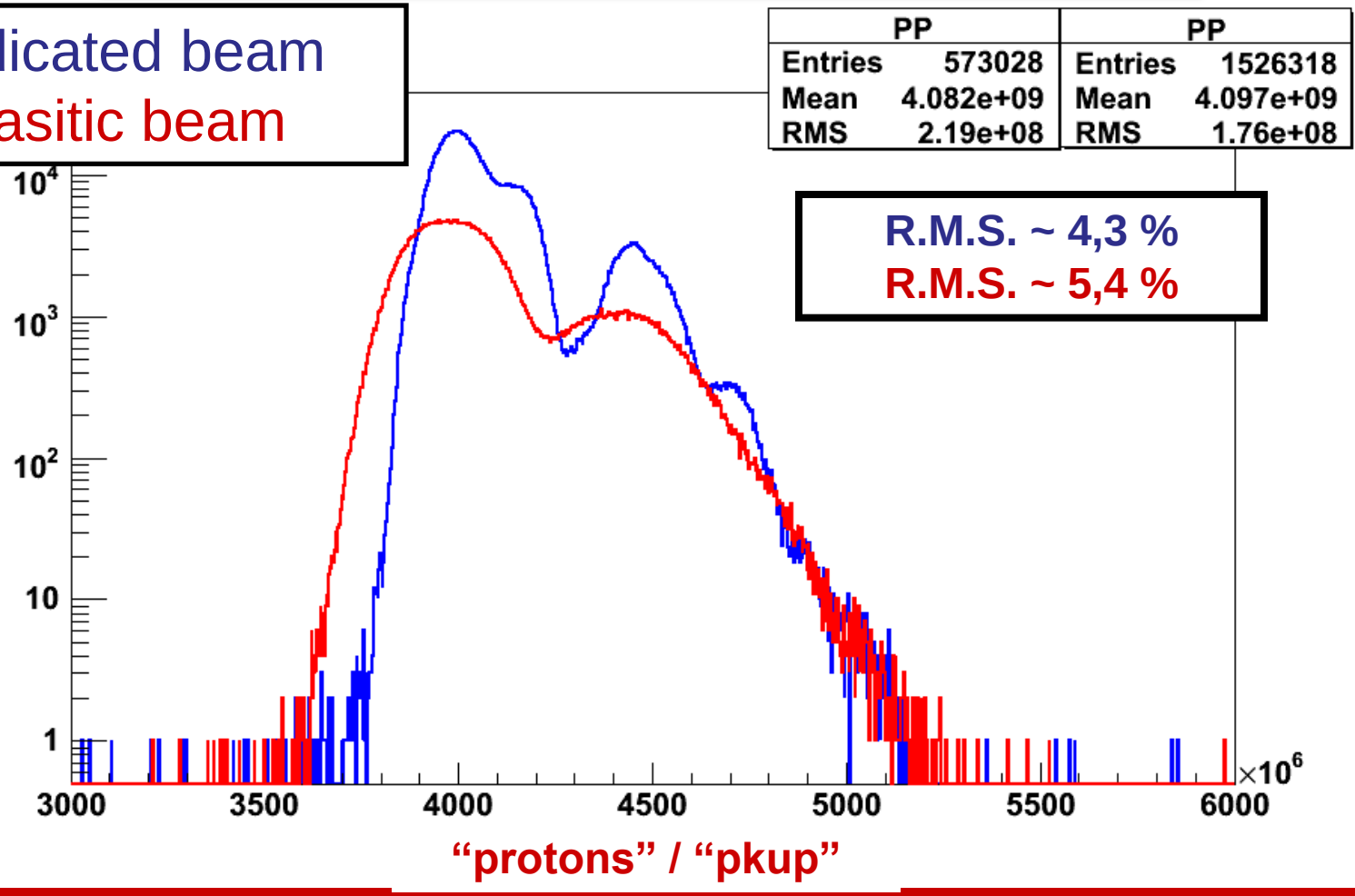
Beam stability → Ratio of beam monitors



2012 Flux – SiMon data

Beam stability → Ratio of beam monitors

--- Dedicated beam
--- Parasitic beam



2012 Flux – SiMon data

Detector stability → Ratios of Sili counts Vs …

Ratio	Average Before rej.	R.M.S. Before rej.	Average After rej.	R.M.S. After rej.
SILI 1 / PROT	1.82×10^{-13}	**10%**	1.85×10^{-13}	**3.2%**
SILI 2 / PROT	1.43×10^{-13}	**15%**	1.47×10^{-13}	**5.3%**
SILI 3 / PROT	1.32×10^{-13}	**6%**	1.33×10^{-13}	**3.6%**
SILI 4 / PROT	1.68×10^{-13}	**11%**	1.69×10^{-13}	**4.1%**

Conditions:
1. Amplitude → ^{3}H peak
2. TOF → thermal region

2012 Flux – SiMon data

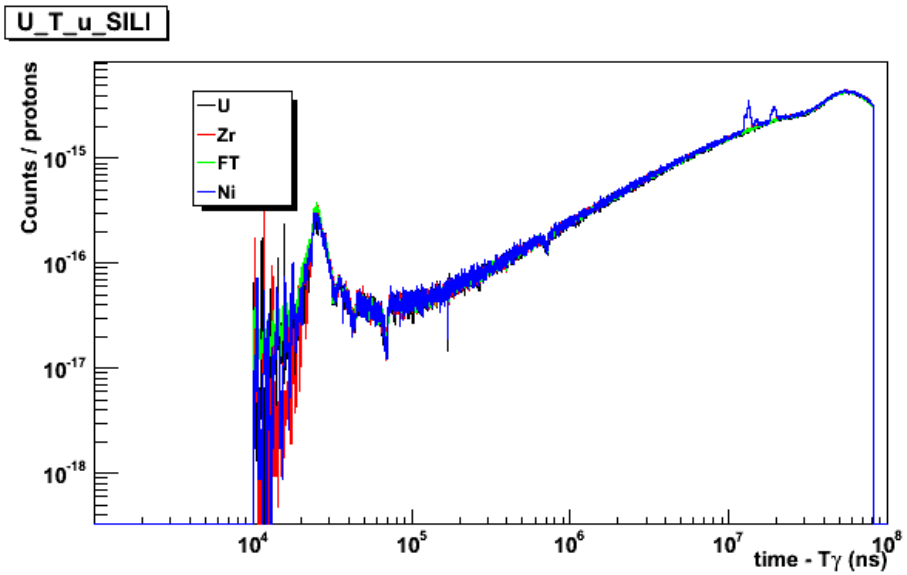
Detector stability → Ratios of Sili counts Vs …

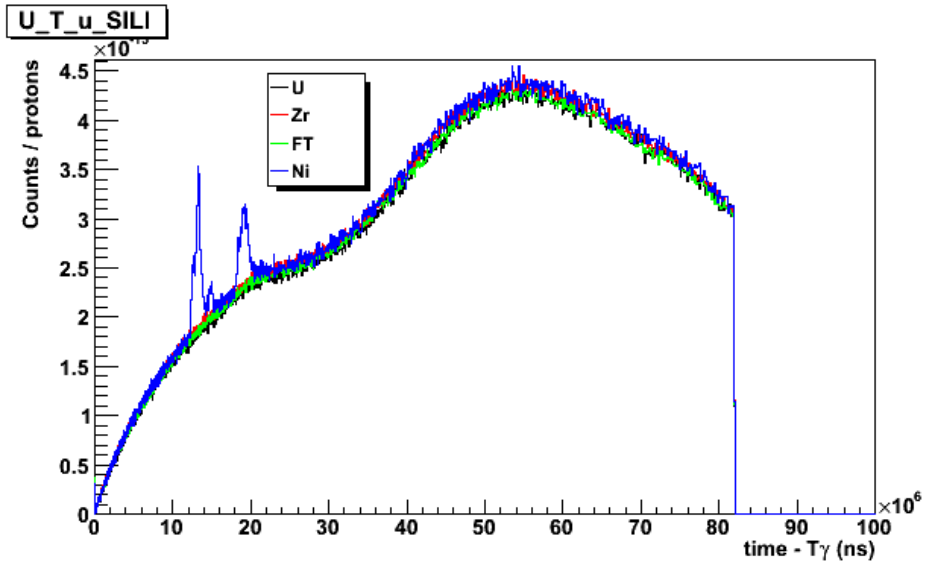
Ratio	Average Before rej.	R.M.S. Before rej.	Average After rej.	R.M.S. After rej.
SILI 1 / SILI 2	1.29	**12.0%**	1.27	**6.0%**
SILI 1 / SILI 3	1.39	**4.5%**	1.39	**4.5%**
SILI 1 / SILI 4	1.09	**4.2%**	1.27	**4.1%**
SILI 2 / SILI 3	1.09	**8.0%**	1.10	**5.1%**
SILI 2 / SILI 4	0.86	**8.5%**	0.86	**5.6%**
SILI 3 / SILI 4	0.78	**4.3%**	0.78	**4.2%**

Conditions:
1. Amplitude → ^{3}H peak
2. TOF → thermal region

2012 Flux – SiMon data

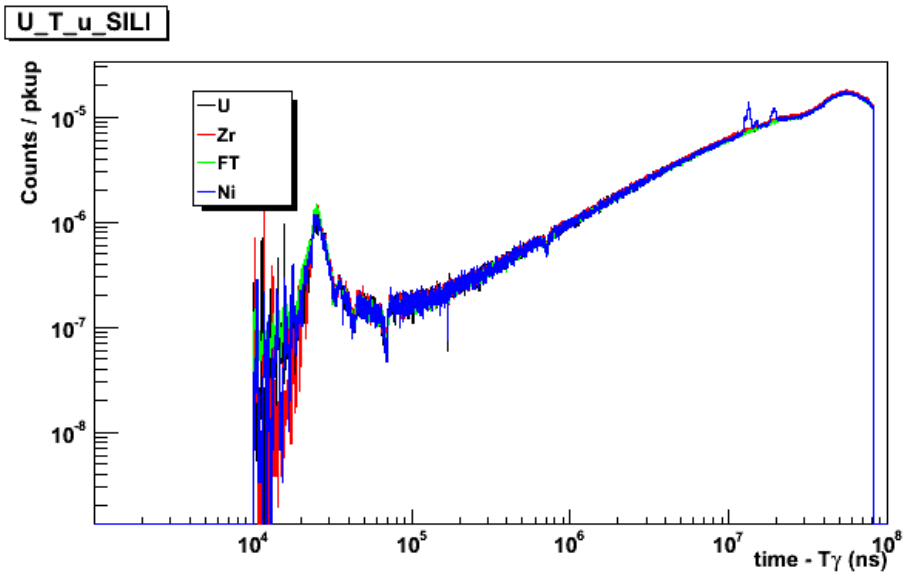
SiMon Counts normalized to protons

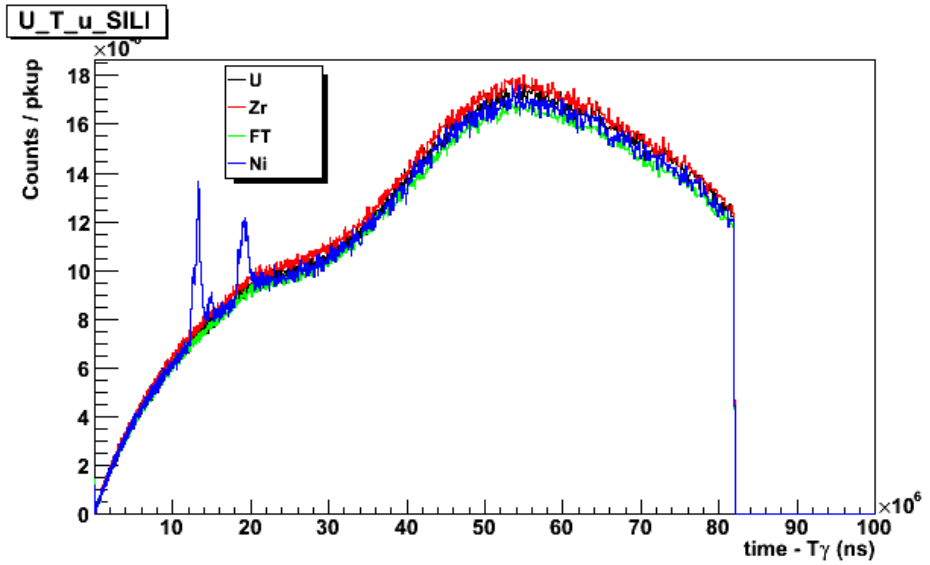




2012 Flux – SiMon data

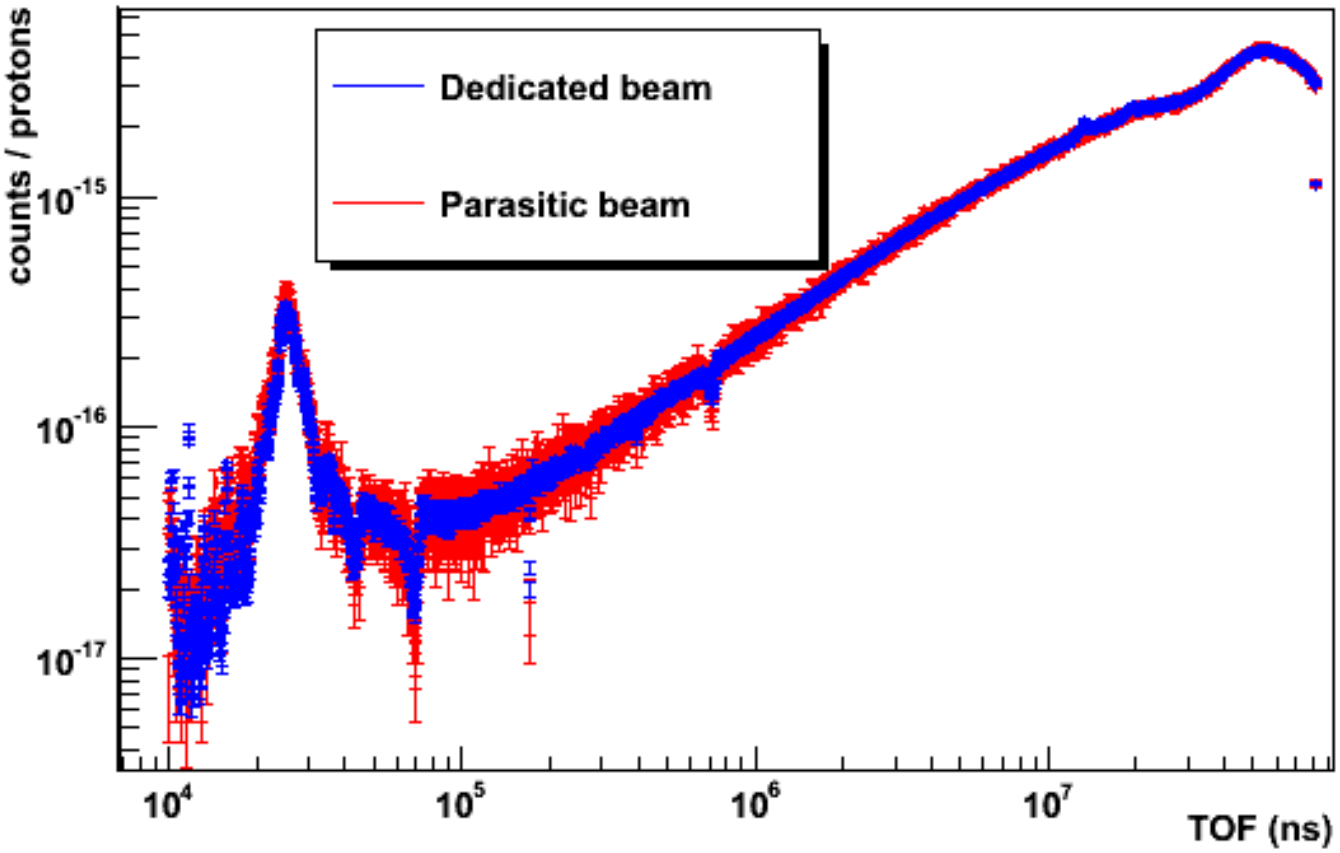
SiMon Counts normalized to pkup





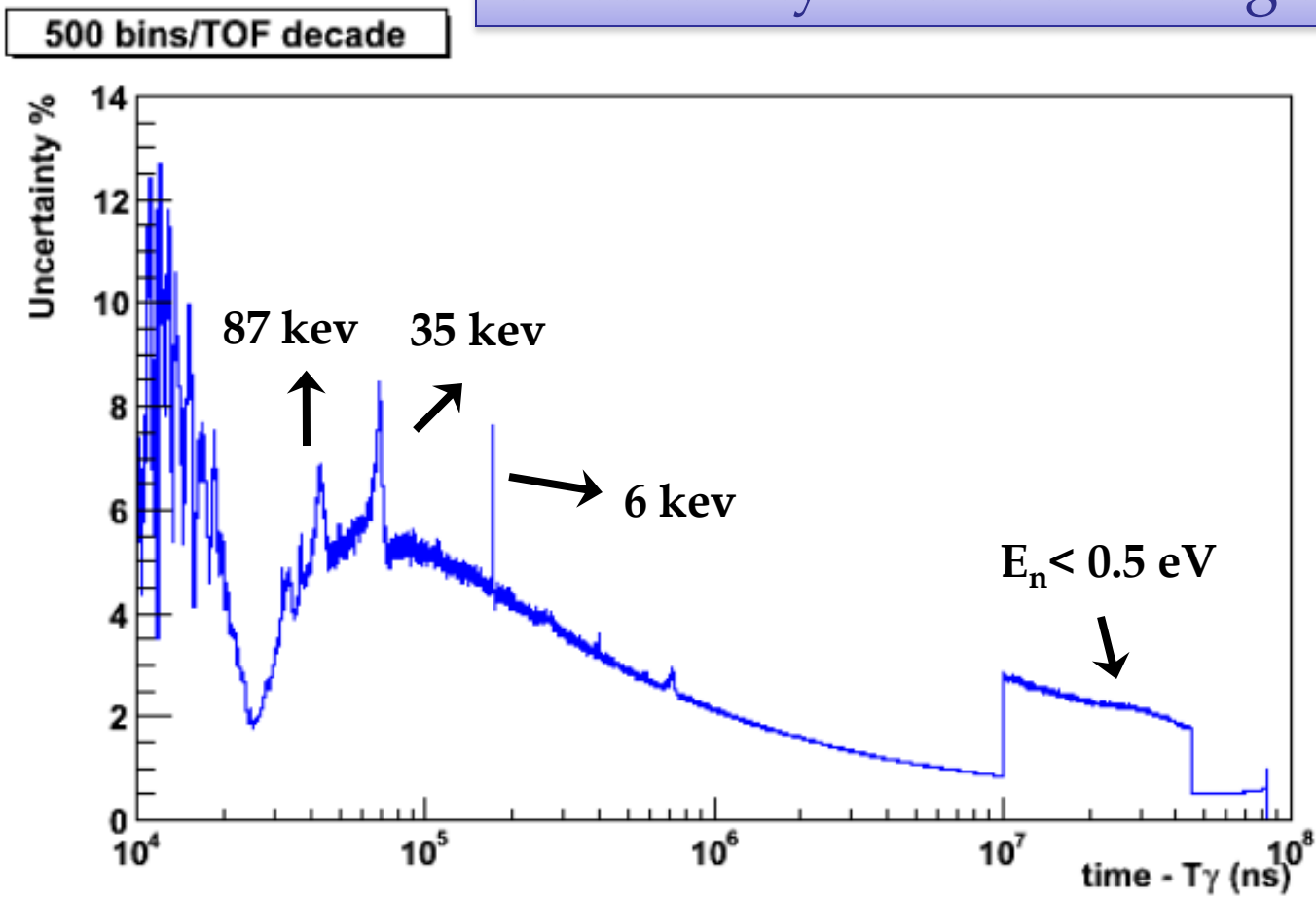
2012 Flux – SiMon data

SiMon Counts normalized to protons



2012 Flux – SiMon data

Uncertainty due to counting statistic

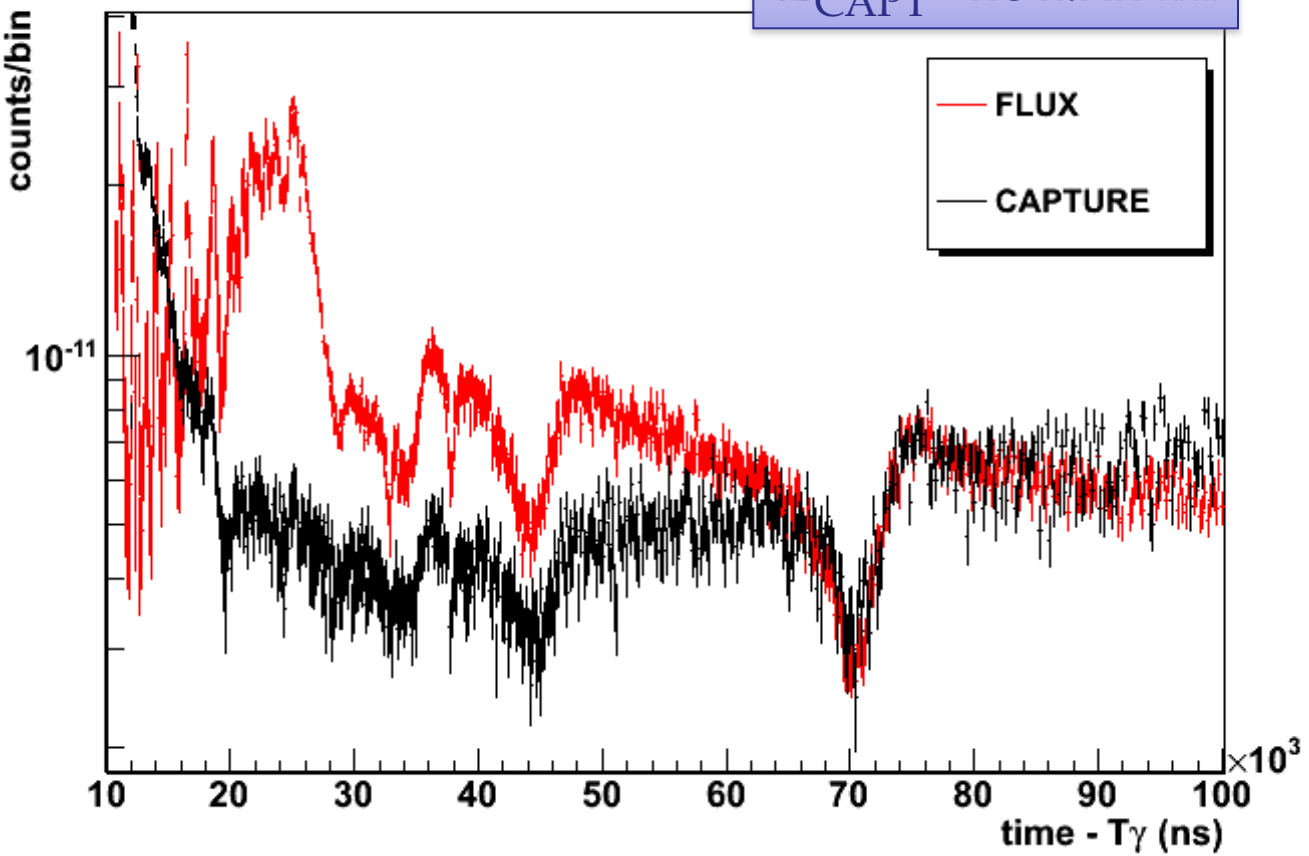


2012 Flux – SiMon data

$$t' = t\left(1 + \frac{\Delta L}{L}\right)$$

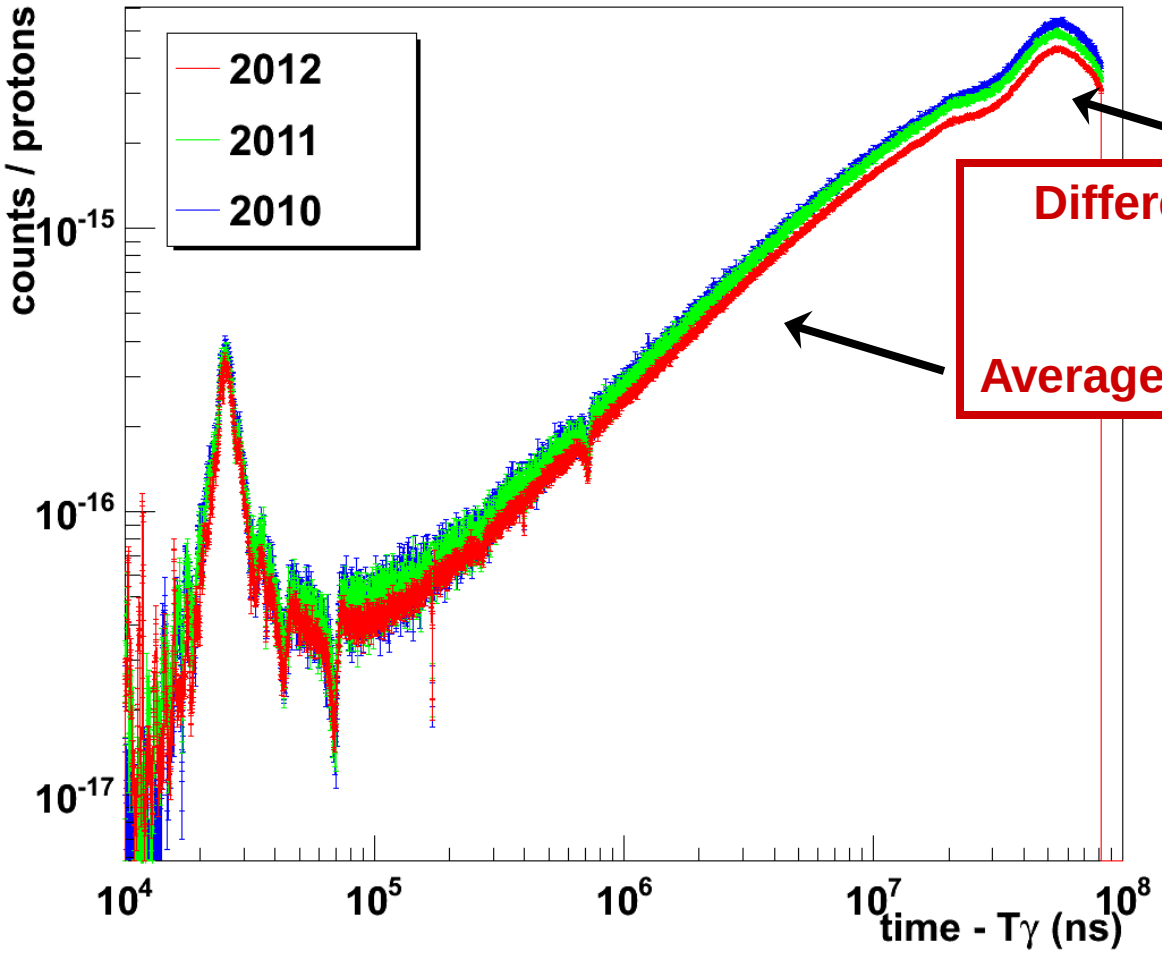
From flux to capture

L_{FLUX}=182.35 m
L_{CAPT}=184.21 m



2012 Flux – SiMon data

Comparison with previous years

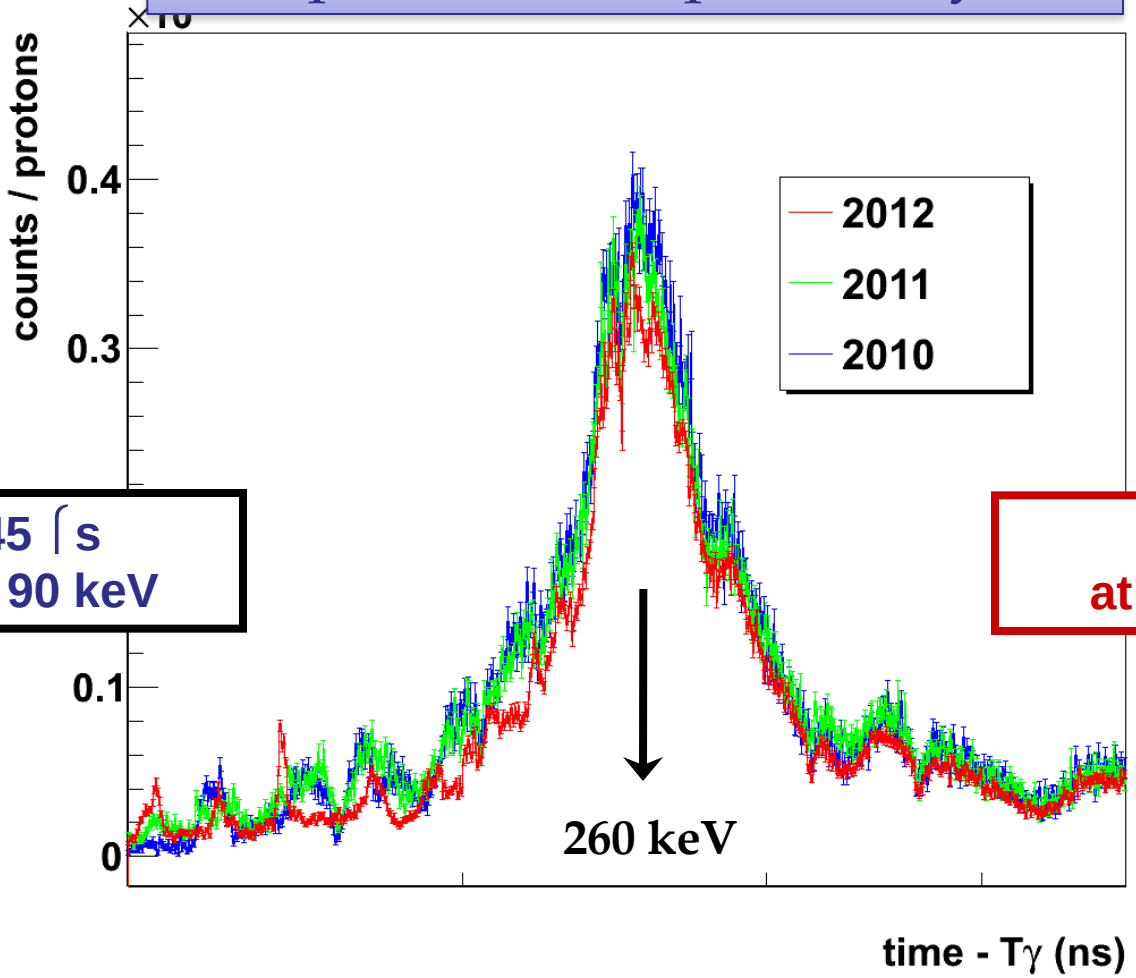


Difference at thermal > 10%

Average difference 10%

2012 Flux – SiMon data

Comparison with previous years

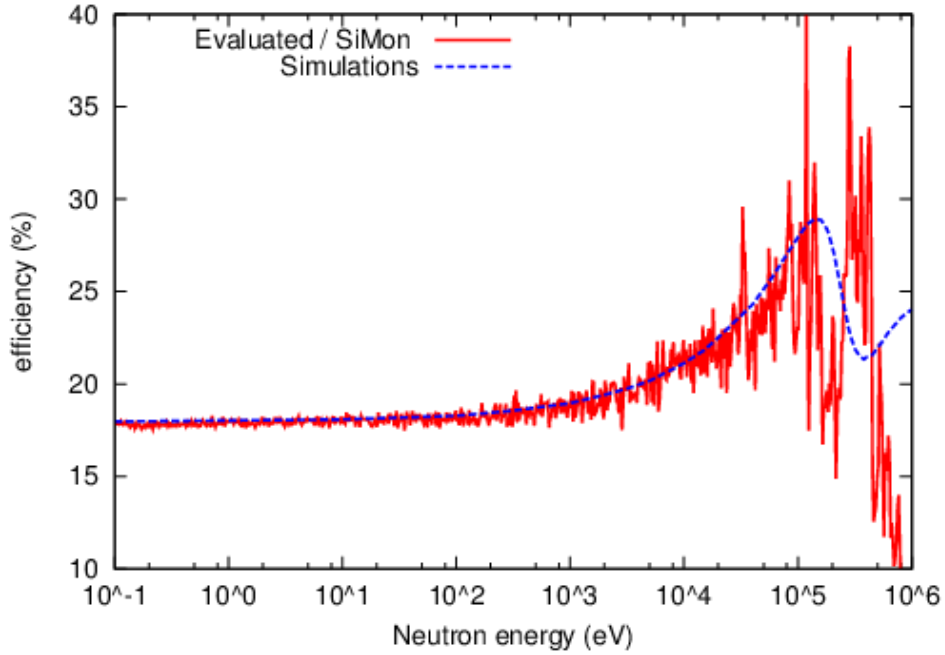


12 – 45 ⌈s
1 MeV – 90 keV

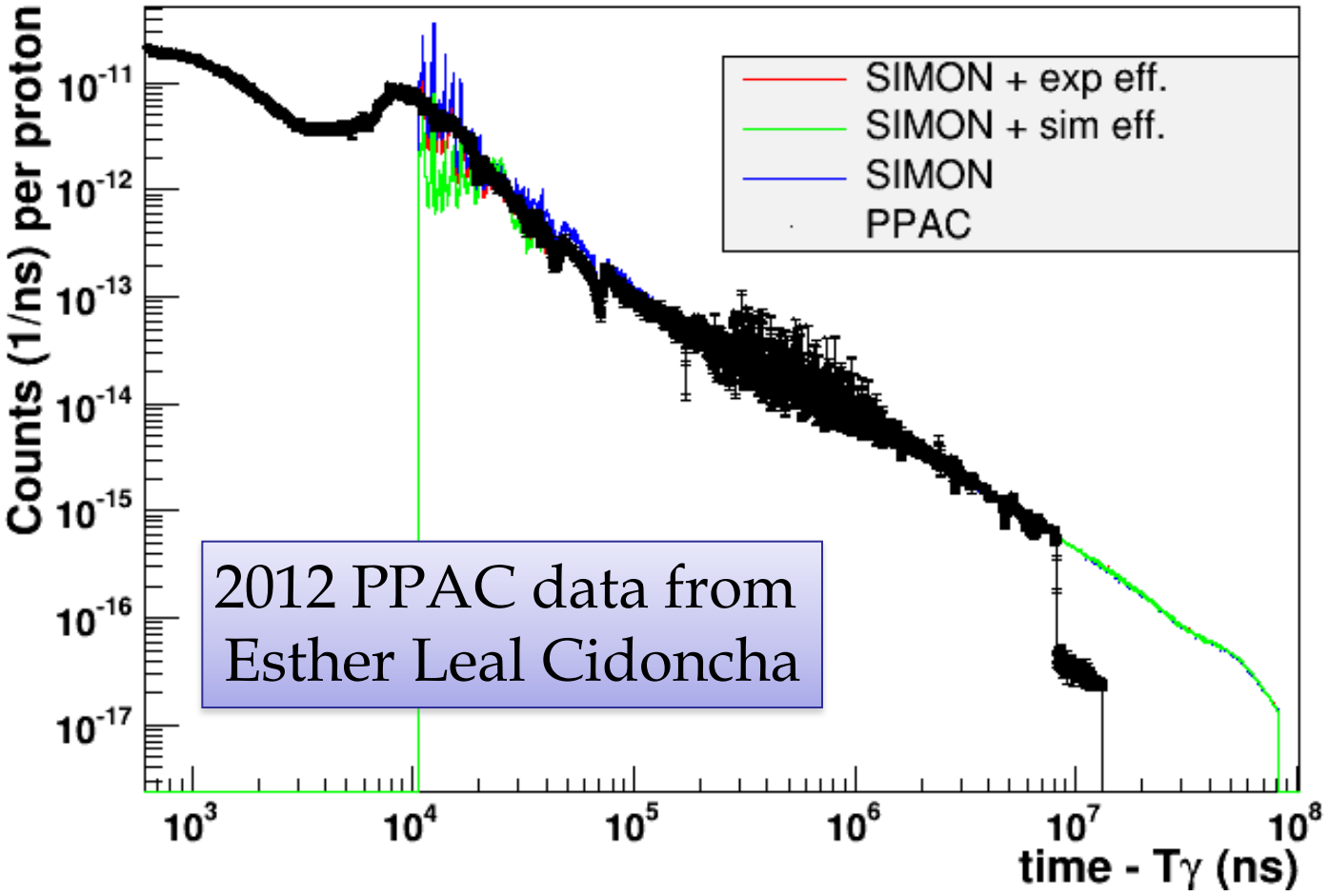
Difference
at high energy ?

SiMon data not enough

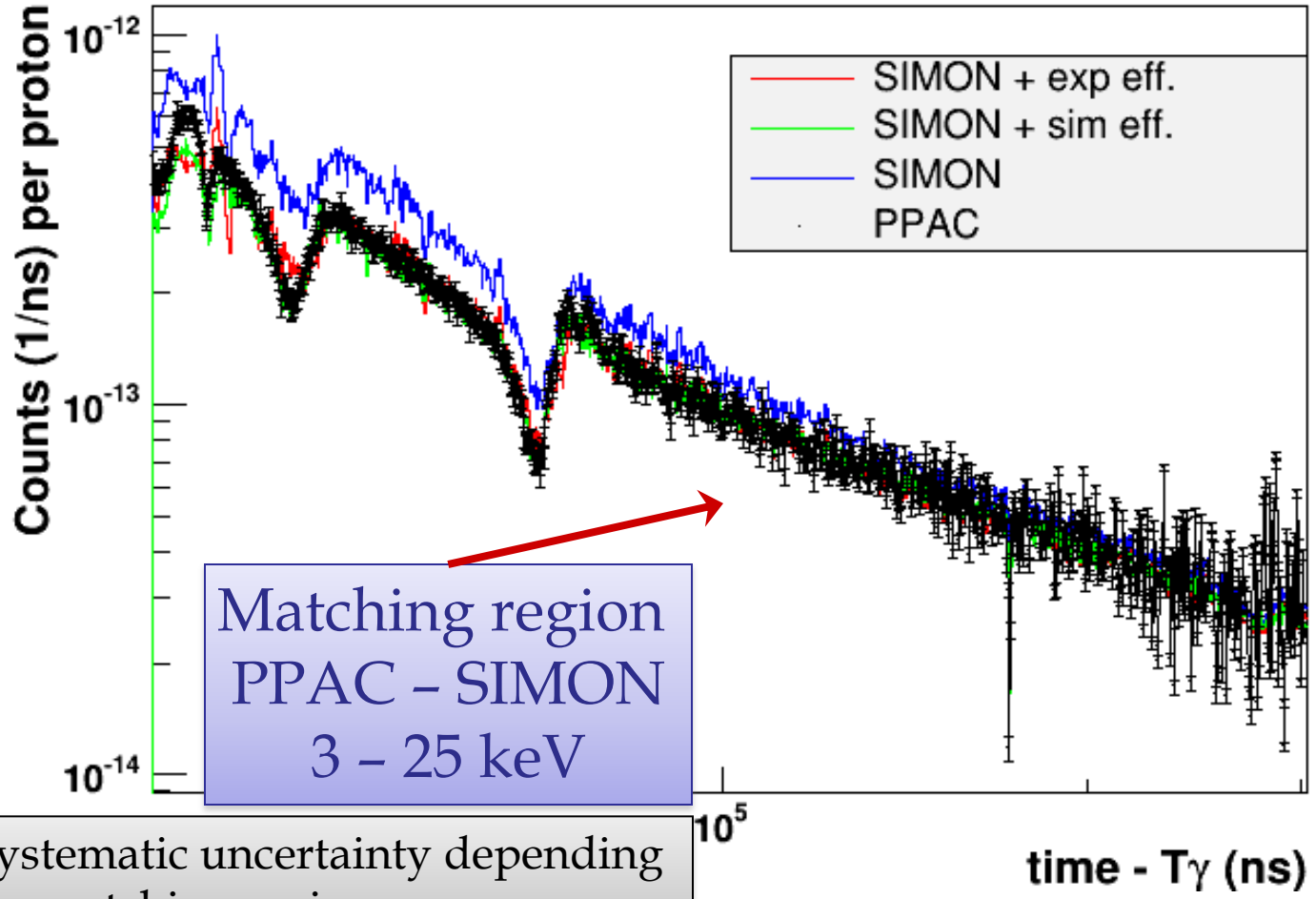
E_n > few keV
SiMon efficiency not well known
simulation or experimental ratio (2011 data)?



SiMon Vs PPAC data

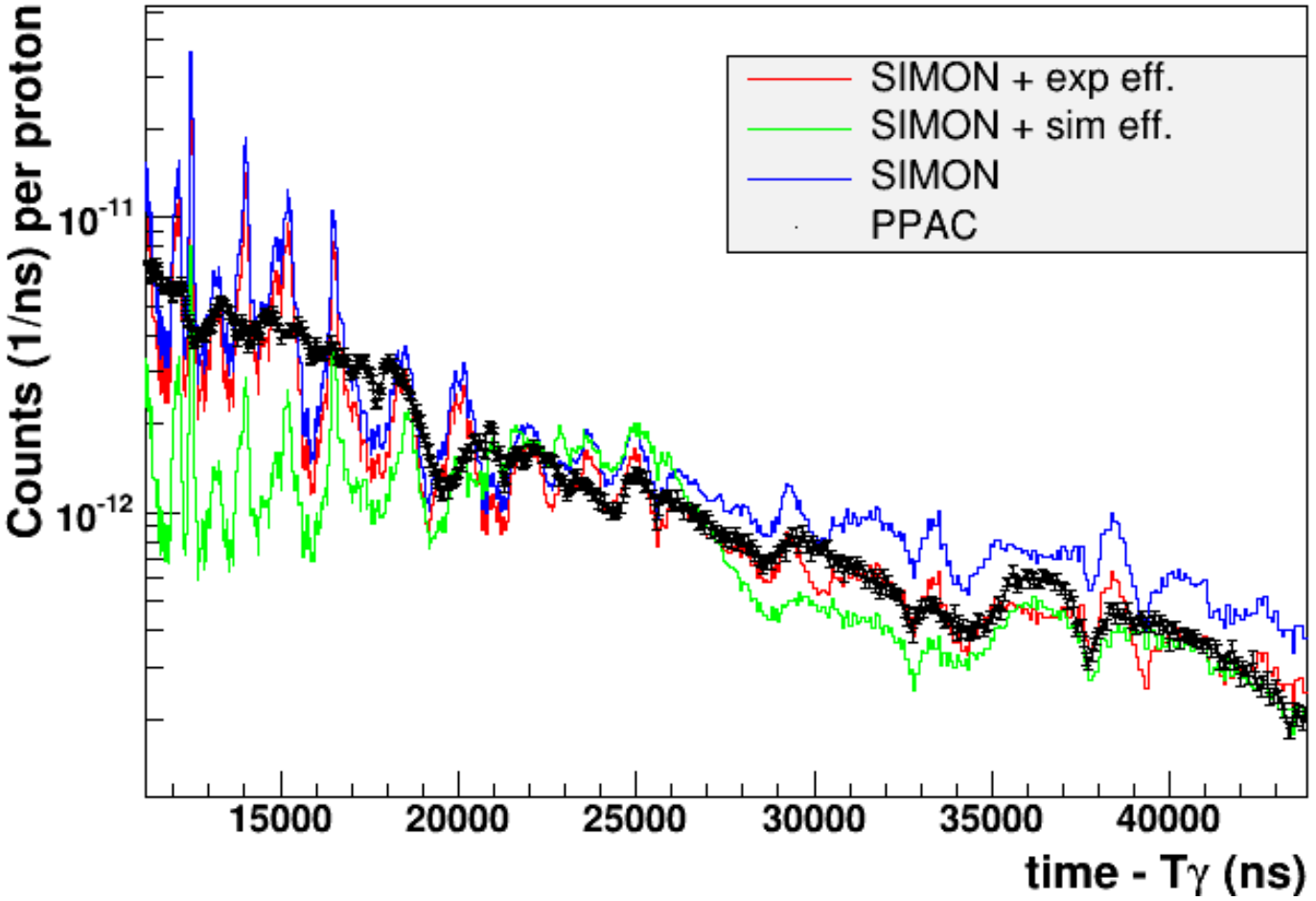


SiMon Vs PPAC data

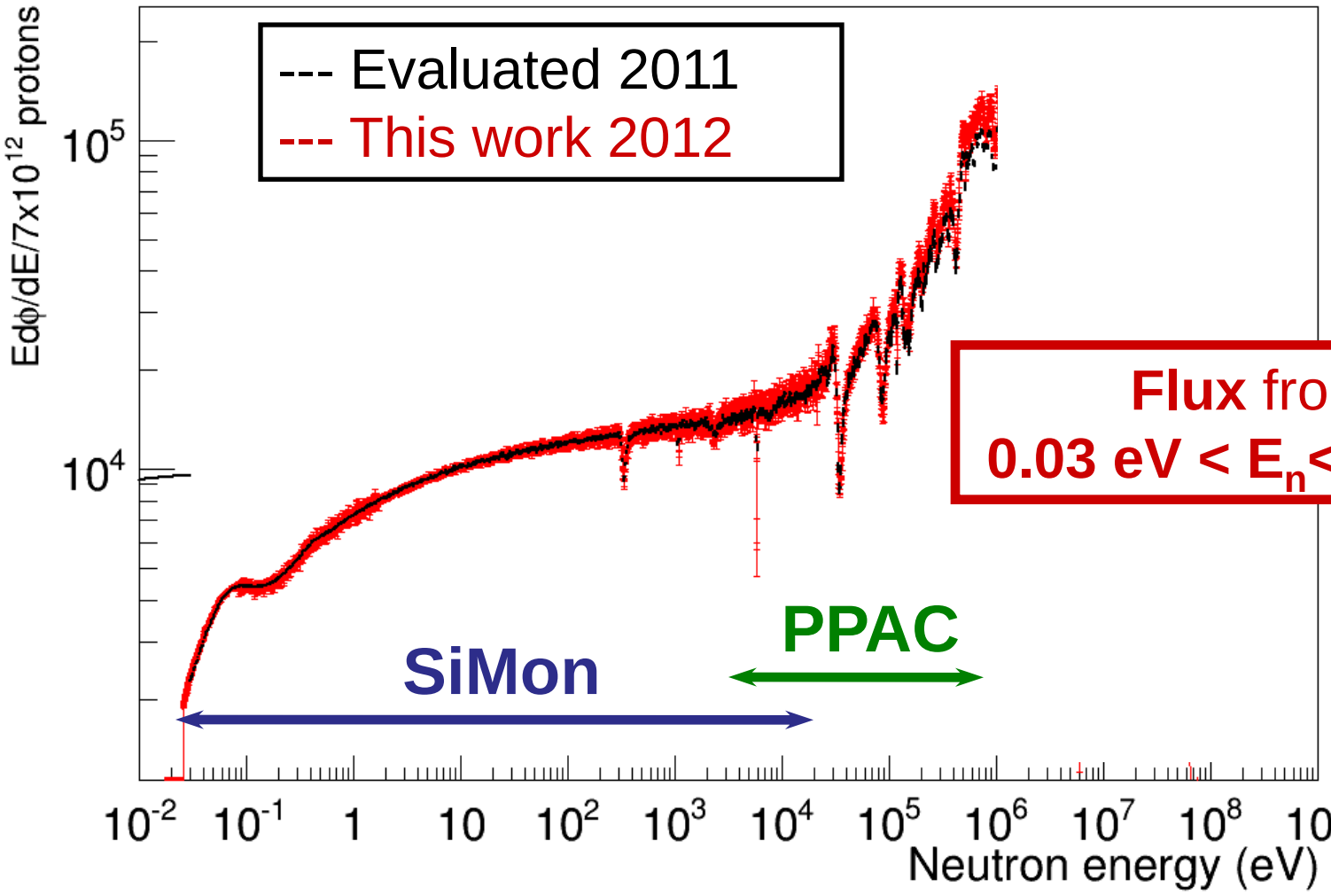


3% systematic uncertainty depending on the matching region

SiMon Vs PPAC data

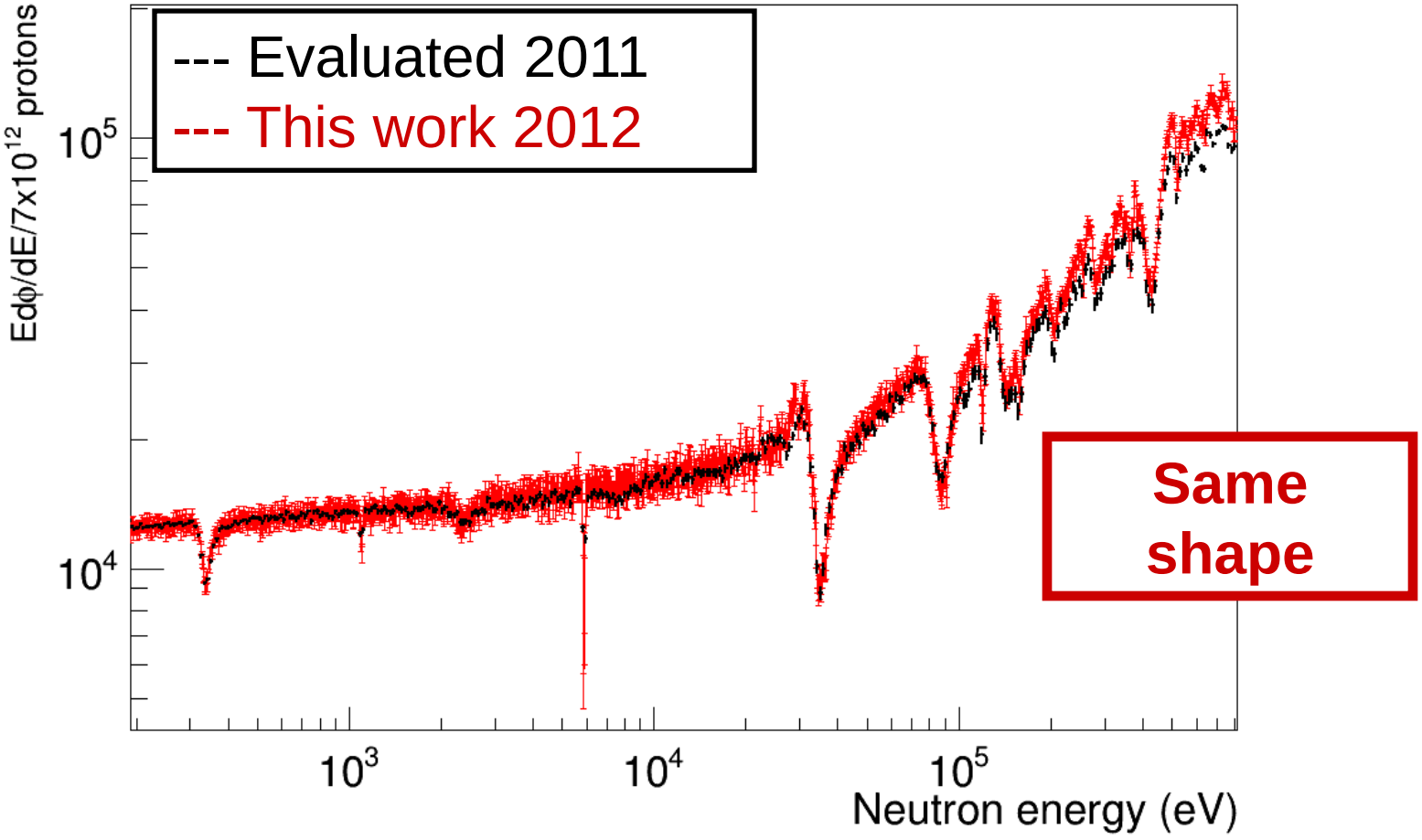


SiMon + PPAC data



Flux from
0.03 eV < E_n < 1 MeV

SiMon + PPAC data

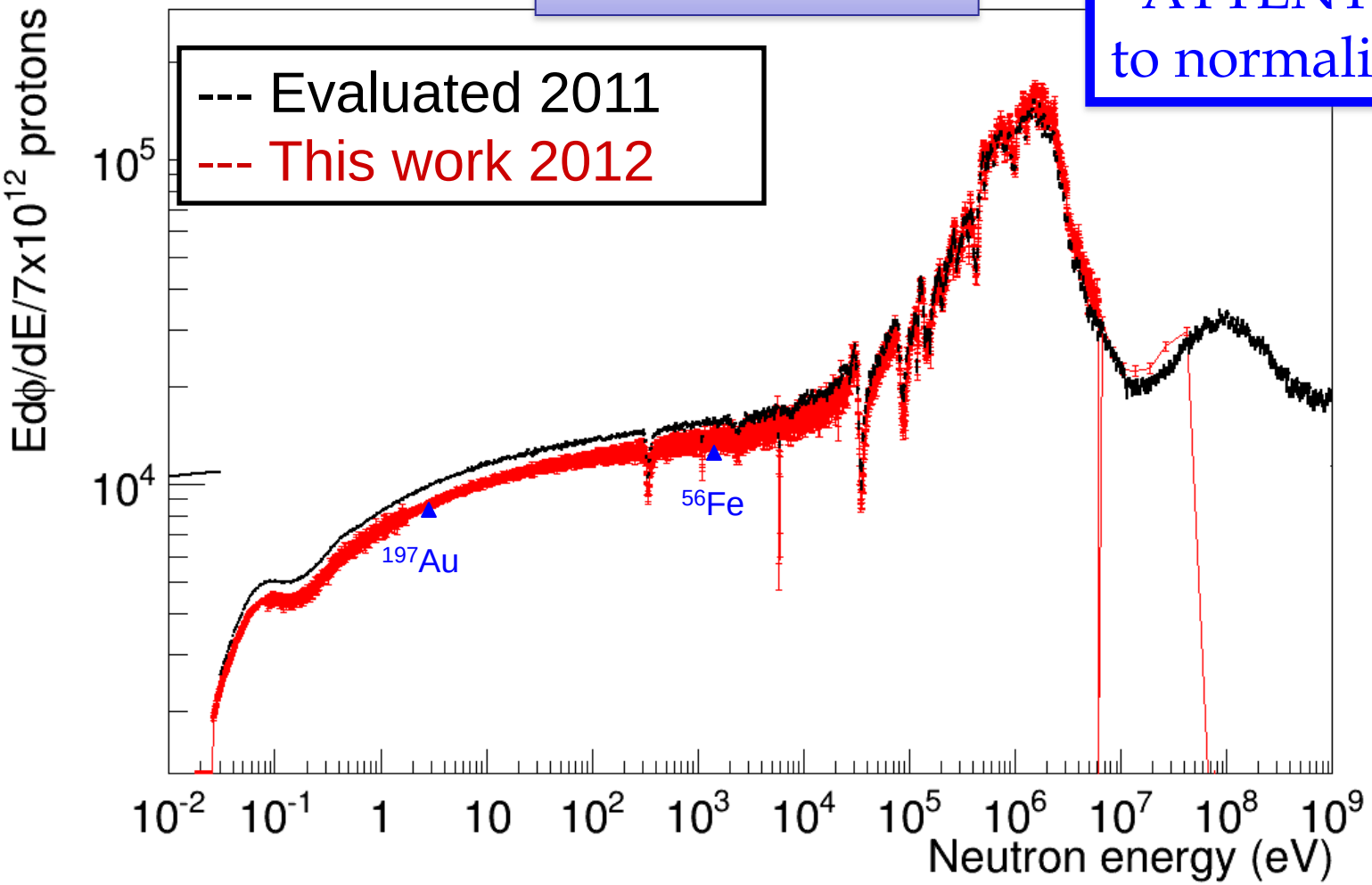


3% systematic uncertainty depending on the matching region

Flux 2011 – 2012

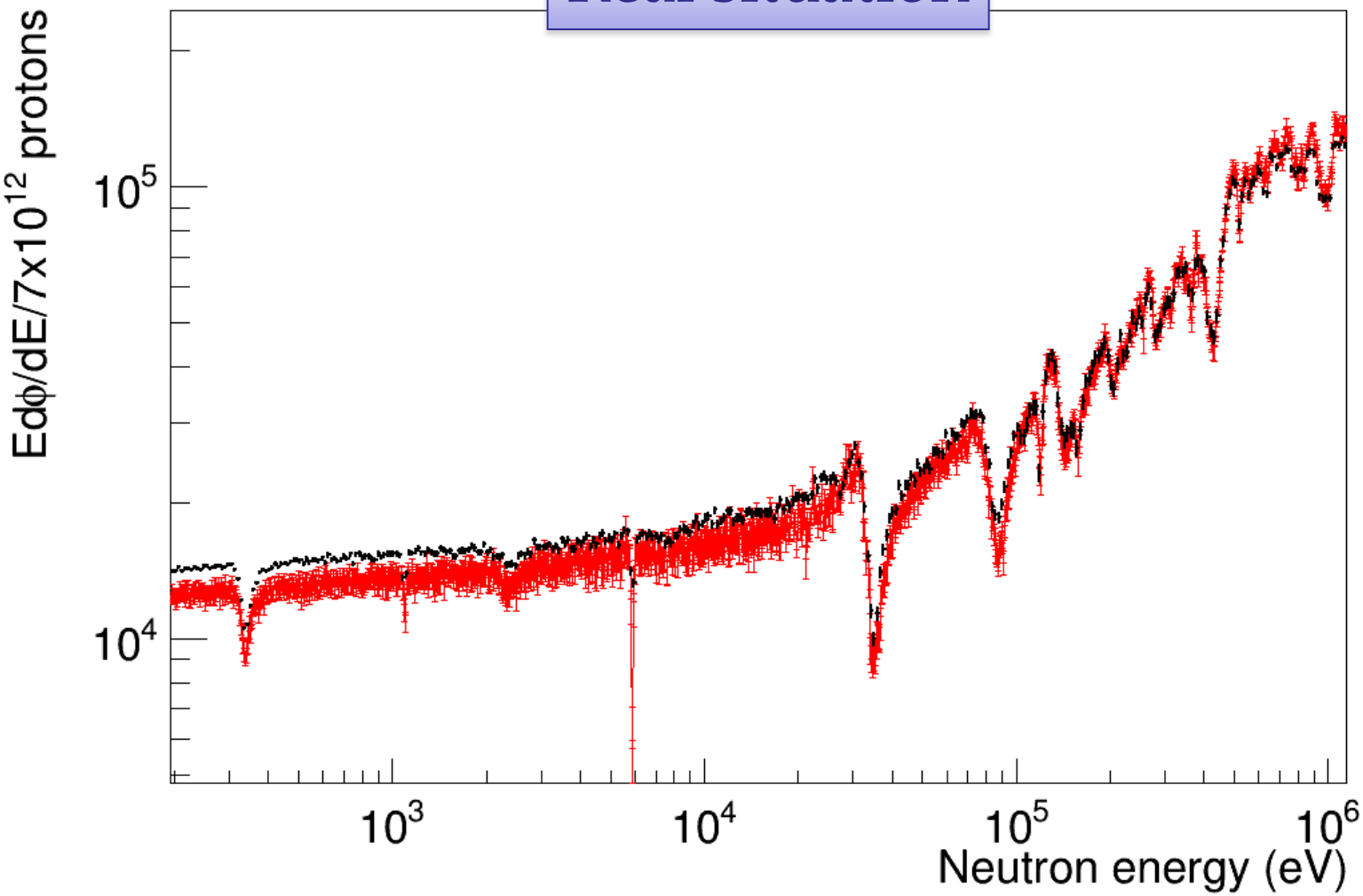
Real situation

ATTENTION
to normalization



Flux 2011 – 2012

Real situation



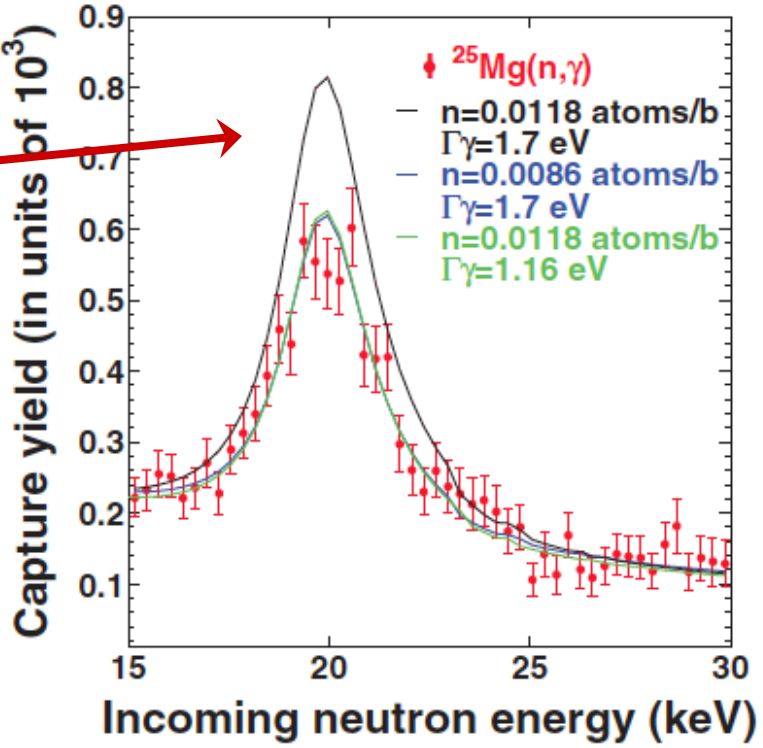
New ^{25}Mg(n,©) measurement

… why ?
Because of the limitations in 2003 measurement

1. **Sample**
   - MgO, powder sample
   - Transmission experiment on ^{nat}Mg sample

2. **n_TOF facility Phase-I**:
   - Water as neutron moderator

3. **Measurement**
   - Few data collected



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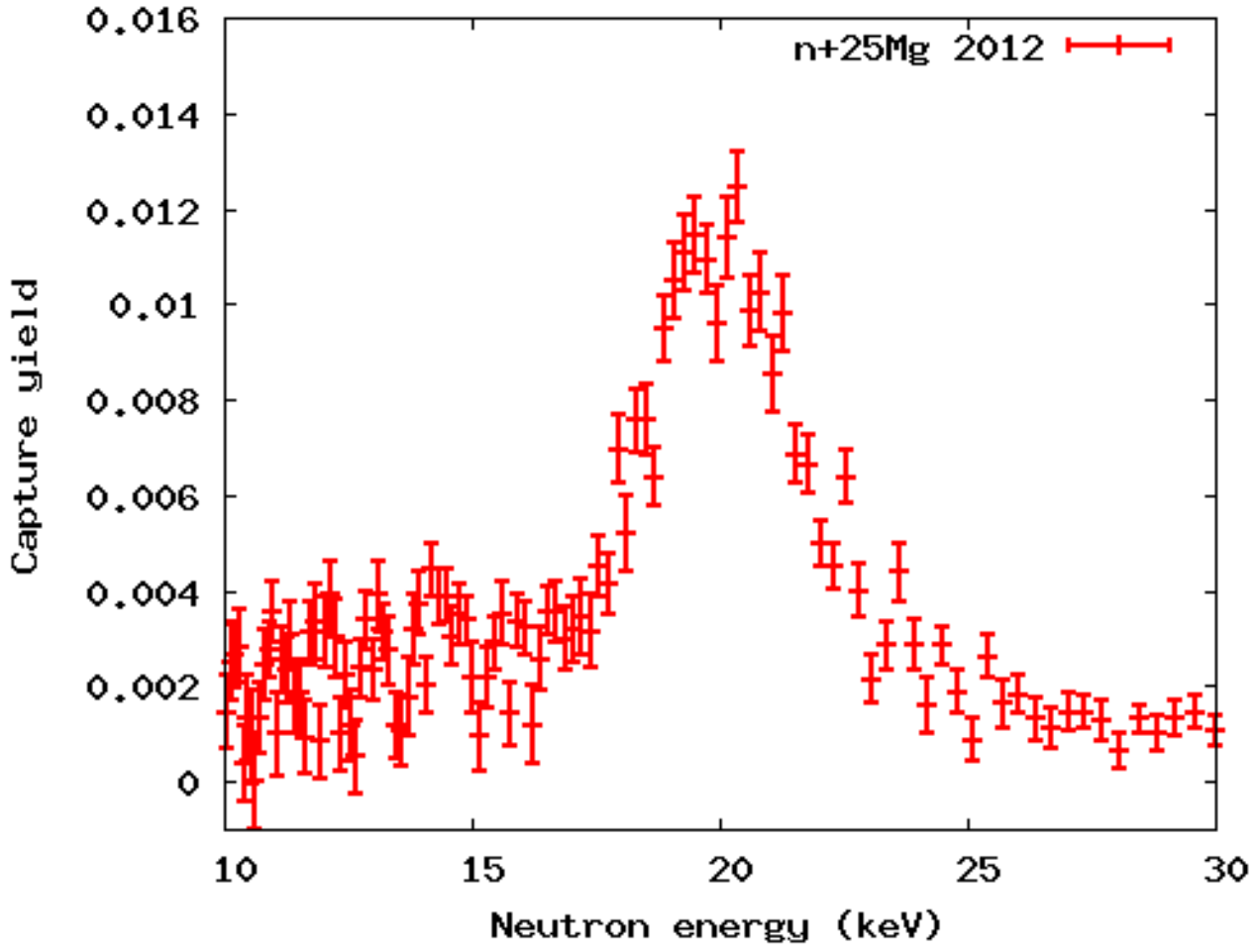
New ^{25}Mg(n,©) measurement

… why ?
Because of the limitations in 2003 measurement
… did we improve?

1. Sample	☑	**Yes a lot**
– MgO, powder sample		– Metal sample
– Transmission experiment on ^{nat}Mg sample		– Transmission experiment on enriched ^{25}Mg sample
2. n_TOF facility Phase-I:	☑	**Yes**
– Water as neutron moderator		– Borated water
3. Measurement	☐	**NO**
– Few data collected		– Again few data collected

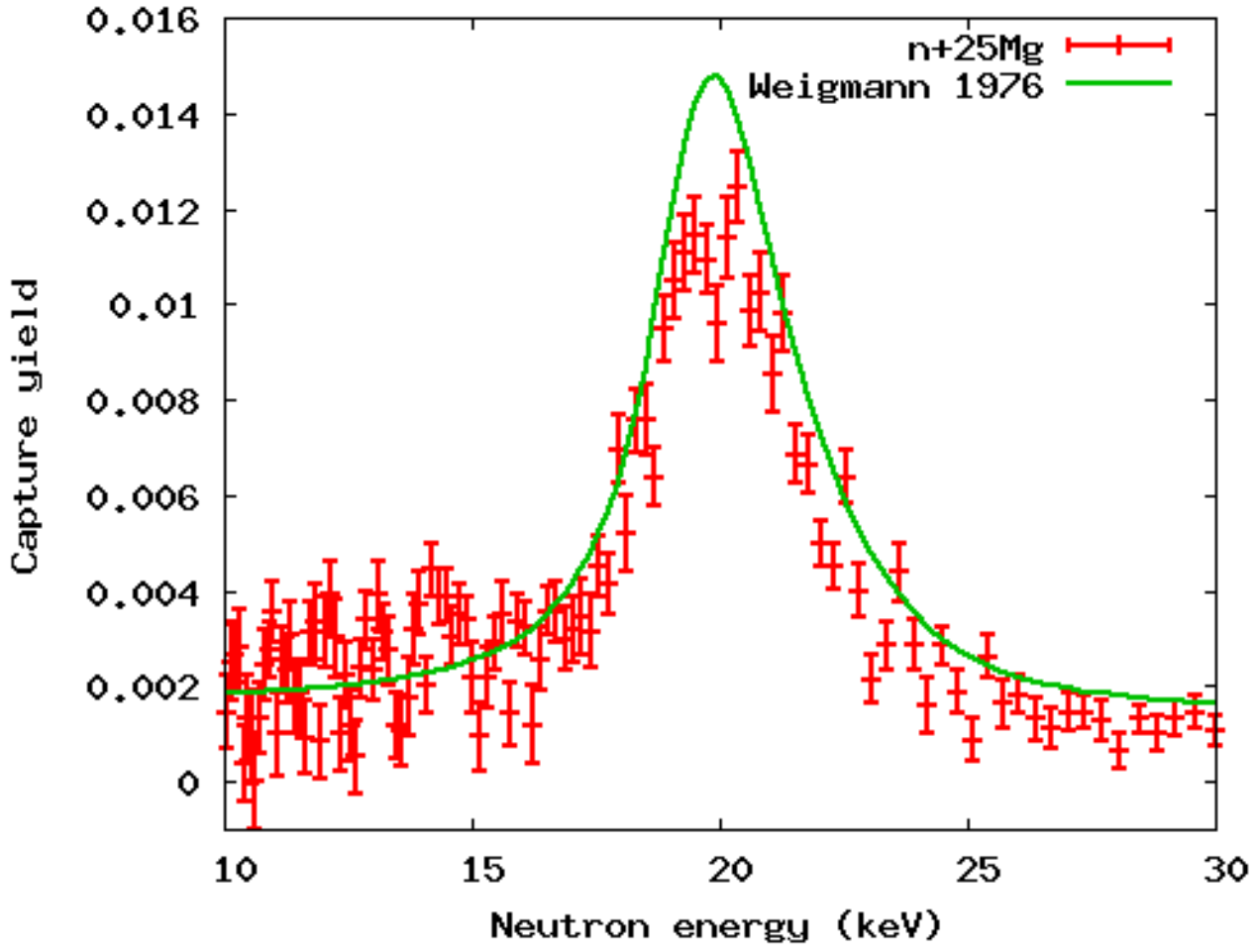
^{25}Mg(n,©) first resonance

Recall: 2003 capture data normalized to this resonance



^{25}Mg(n,©) first resonance

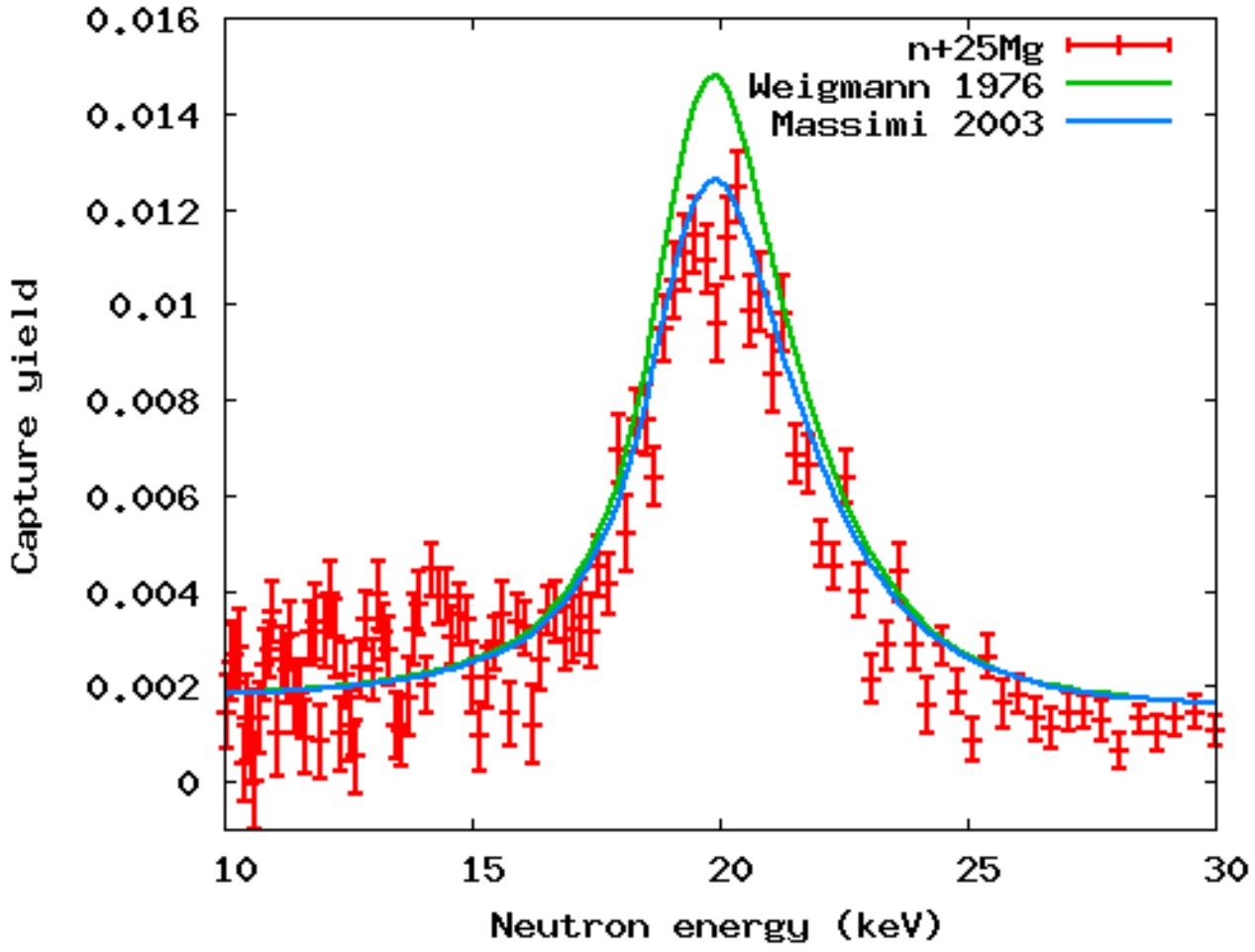
Recall: 2003 capture data normalized to this resonance



$\wp_©$=1.73±0.03 eV

^{25}Mg(n,©) first resonance

Recall: 2003 capture data normalized to this resonance

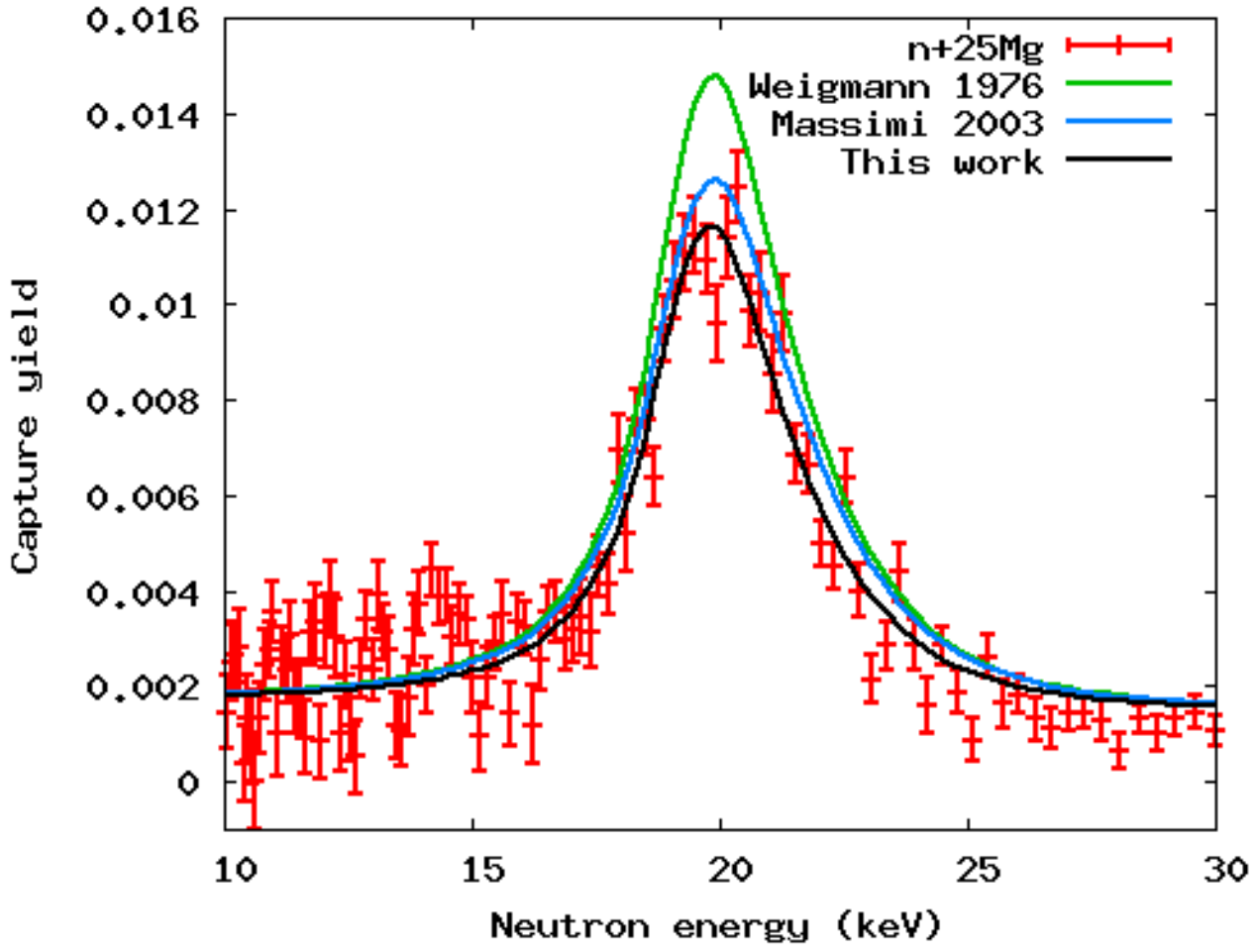


$\wp_{©}$=1.73±0.03 eV

$\wp_{©}$=1.5±0.5 eV

^{25}Mg(n,©) first resonance

Recall: 2003 capture data normalized to this resonance

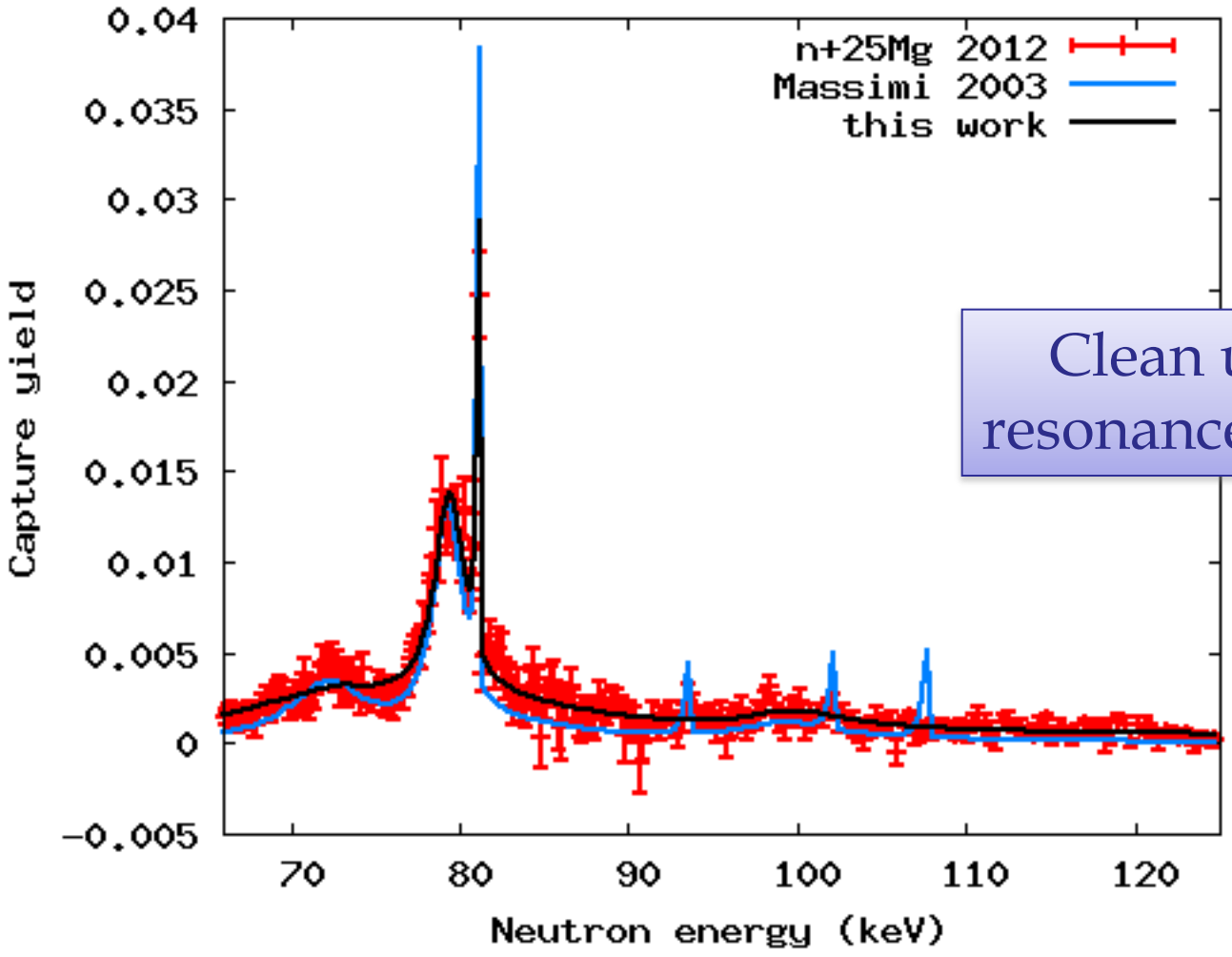


℘©=1.73±0.03 eV

℘©=1.5±0.5 eV

℘©=1.28±0.03 eV

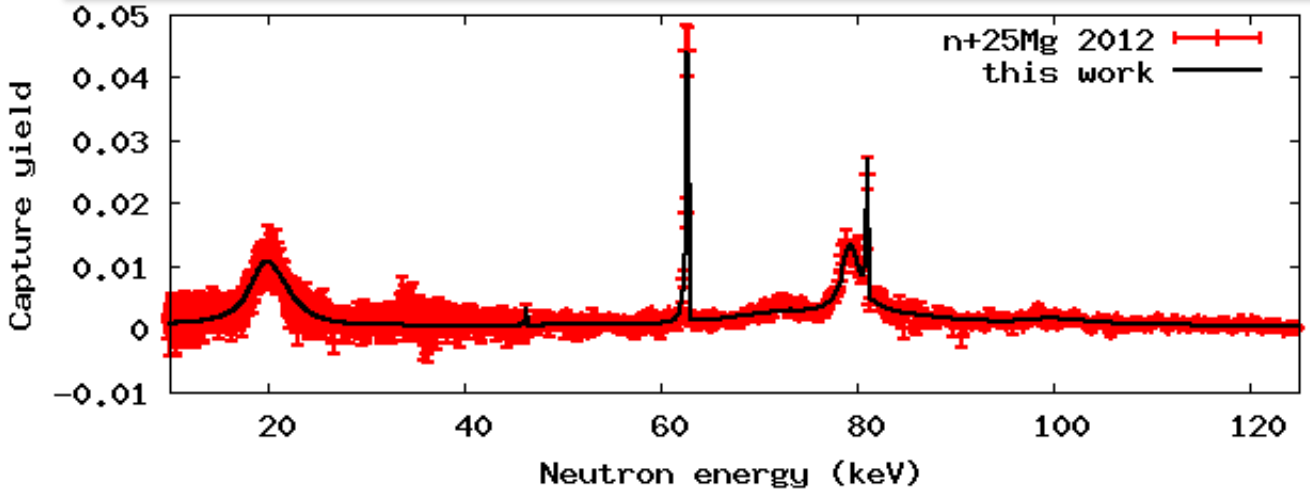
^{25}Mg(n,©) up to 100 keV

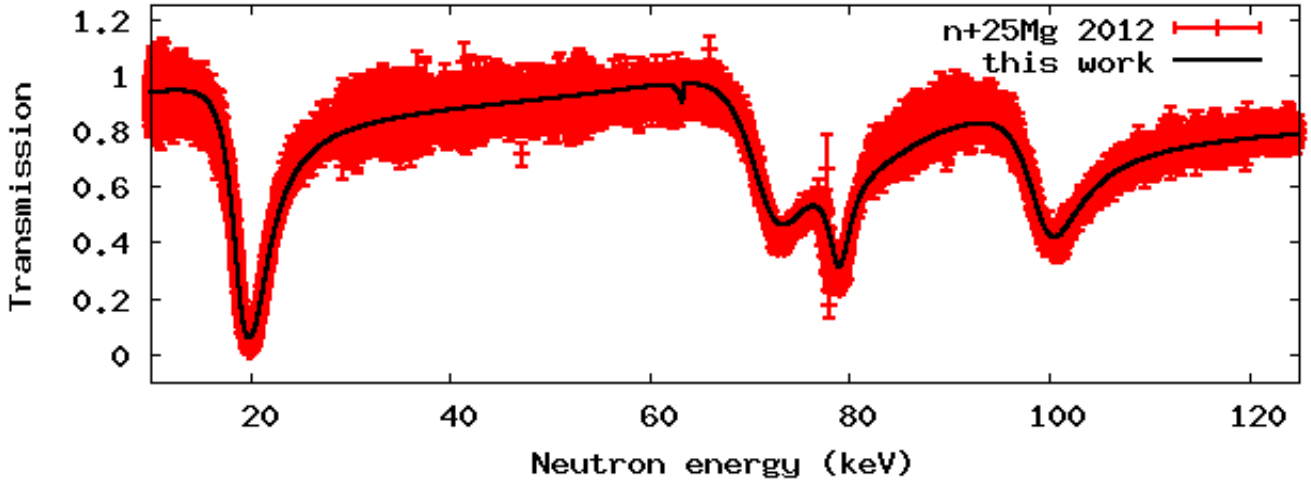


Clean up resonances list

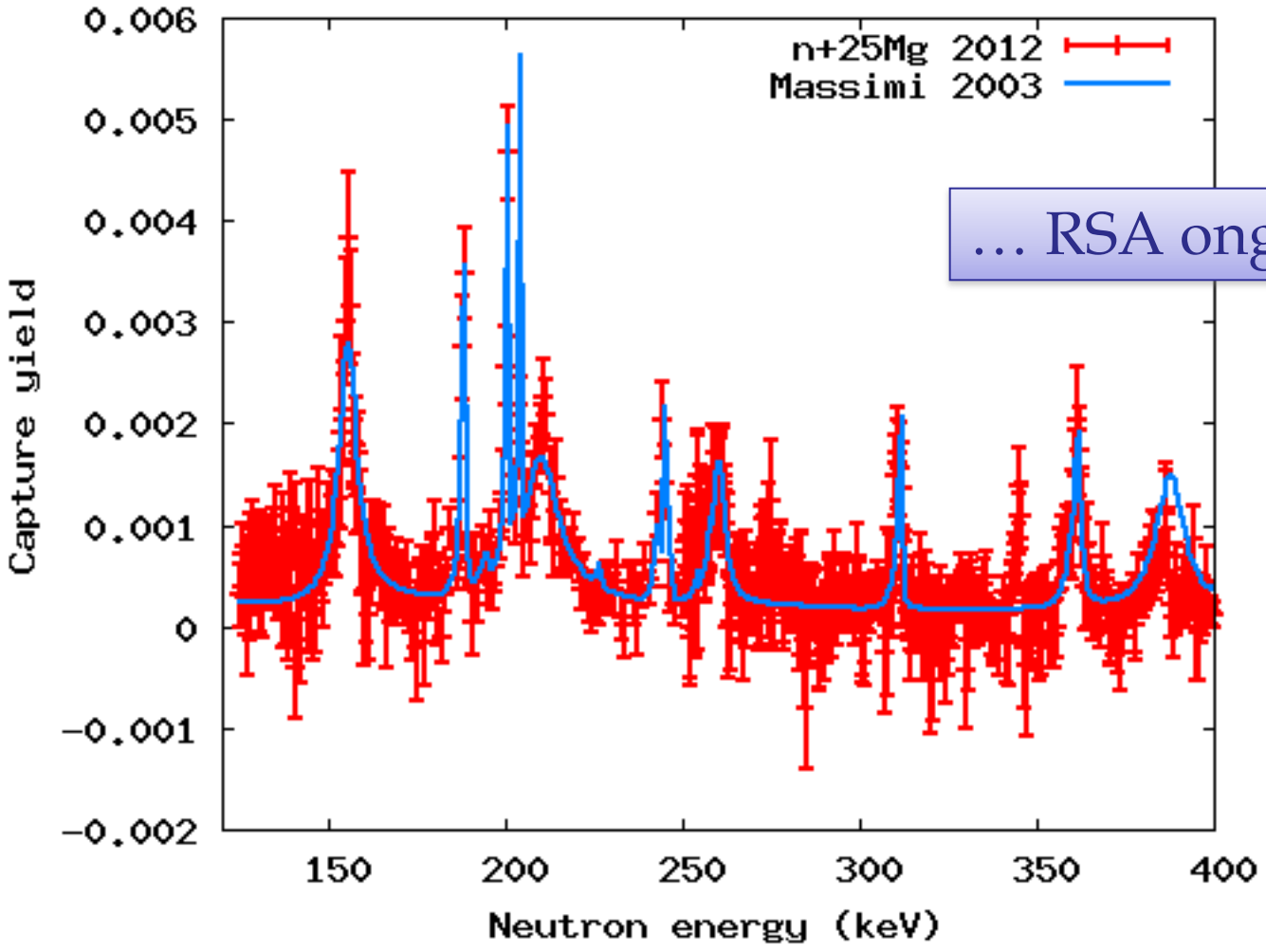
^{25}Mg(n,©) up to 100 keV

Check with transmission data from GELINA





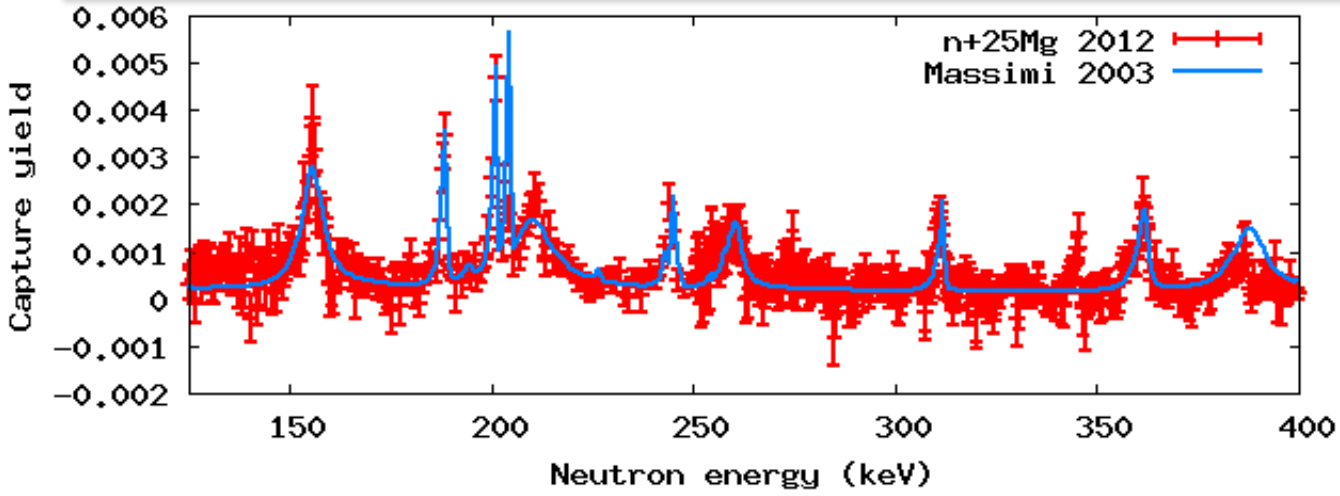
^{25}Mg(n,©) up to 300 keV

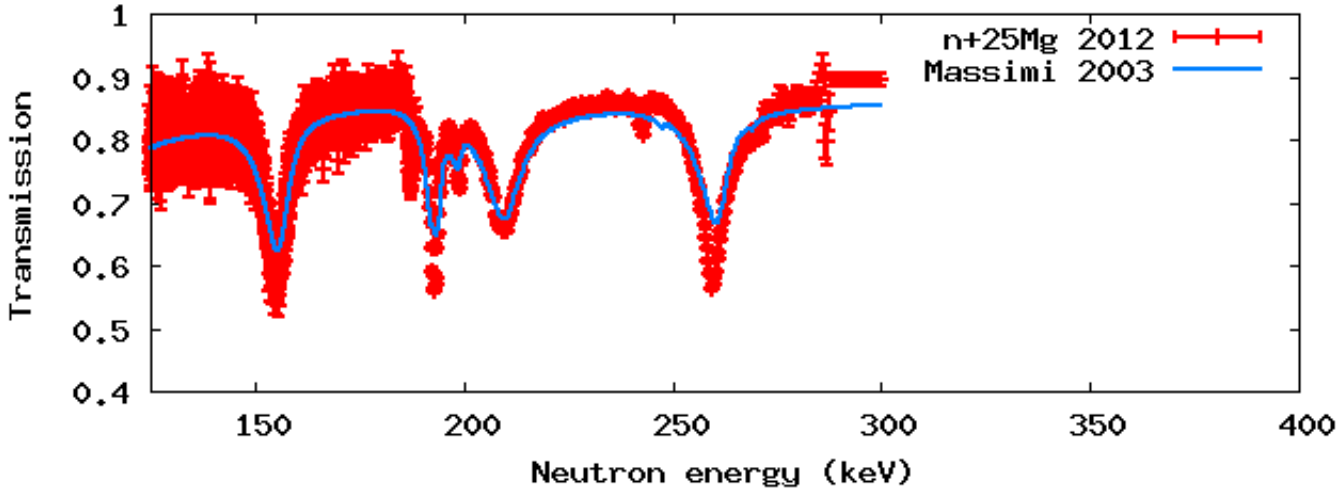


… RSA ongoing

^{25}Mg(n,©) up to 100 keV

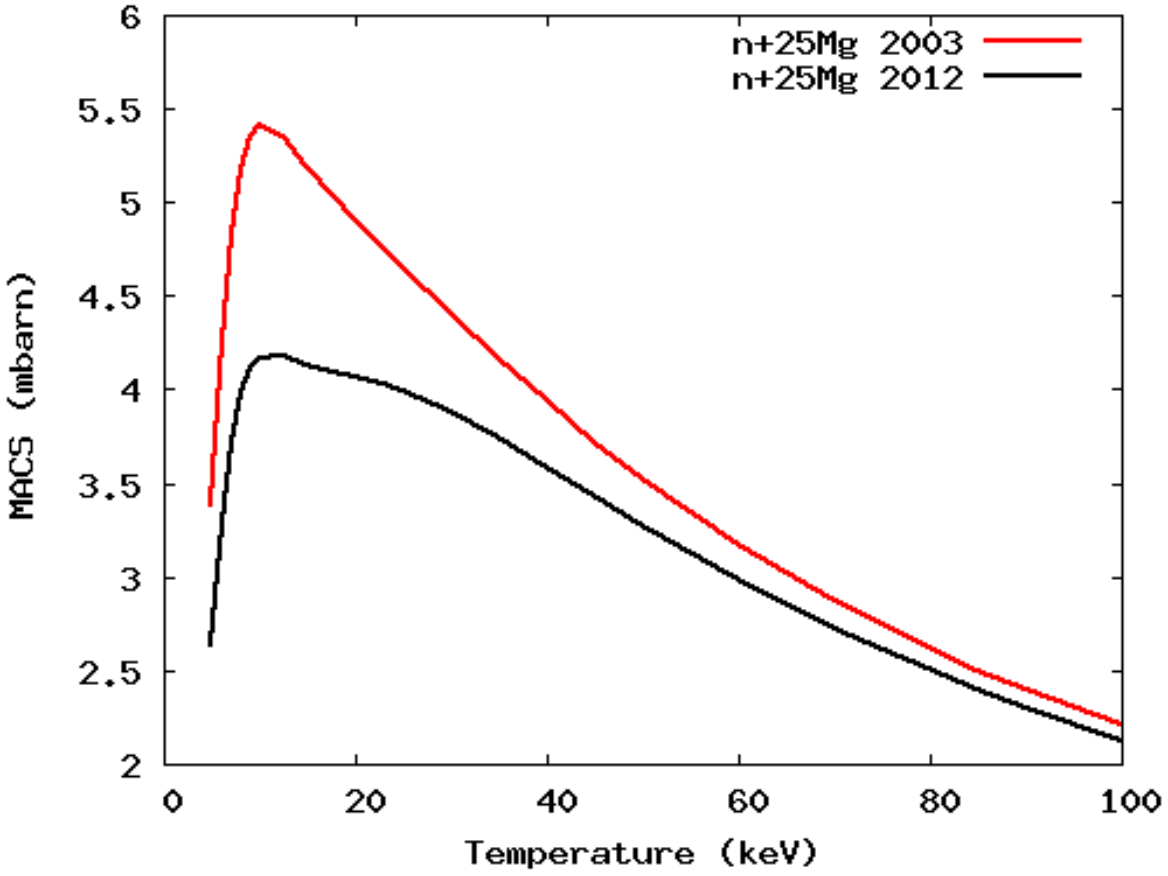
Check with transmission data from GELINA





^{25}Mg(n,©) - MACS

Maxwellian-averaged capture cross section
~ 10 - 20% lower than previously reported



^{25}Mg(n,©) - MACS

Maxwellian-averaged capture cross section
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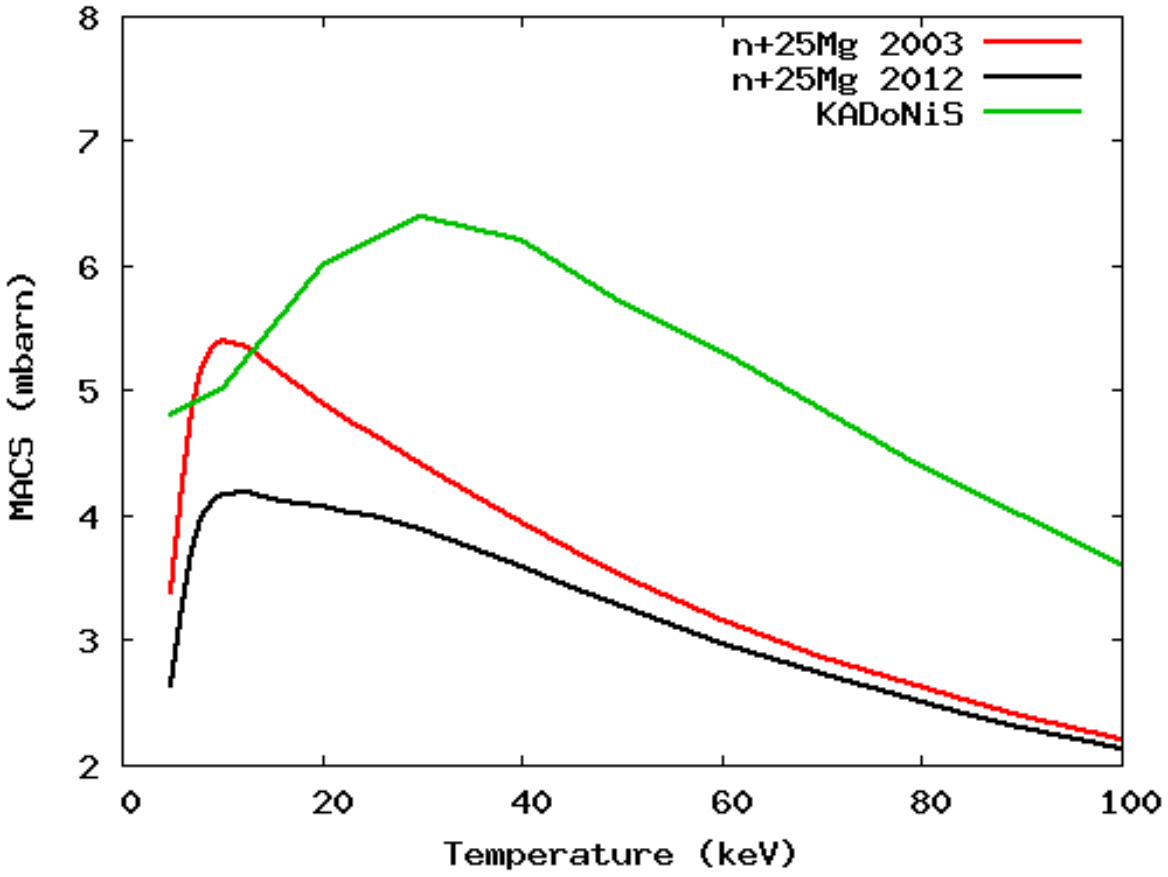

Conclusions

- **2012 flux**, obtained from the combination of SiMon and PPAC data, available:
  - uncertainty due to counting statistic < 4%
  - systematic uncertainty ~ 3% for E_n > 30 keV

- **^{25}Mg(n,©)** measurement at n_TOF
  - RSA, check with transmission data
  - MACS 20% lower than previously reported → important **astrophysical implication**
  - Uncertainty reduced

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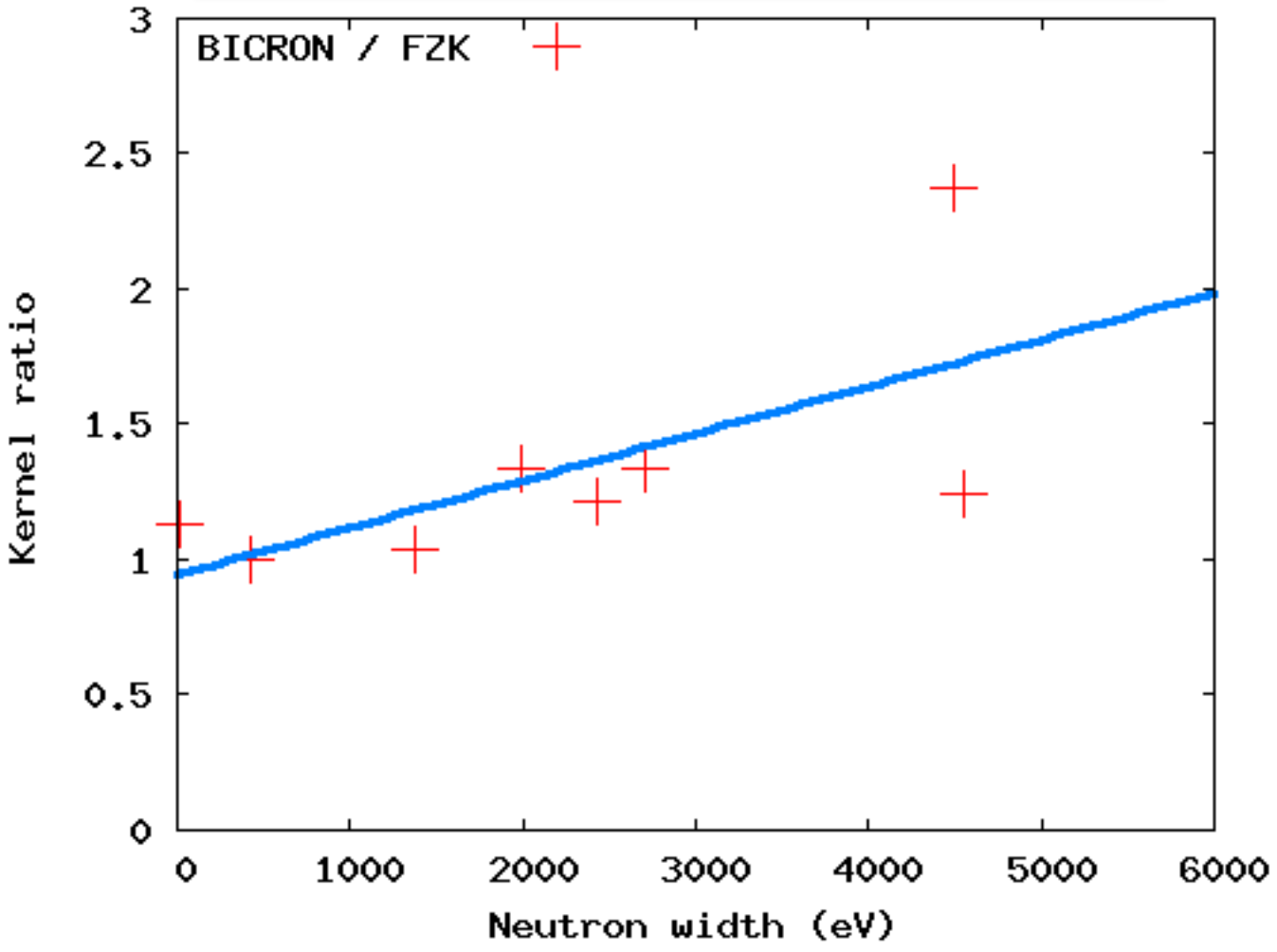
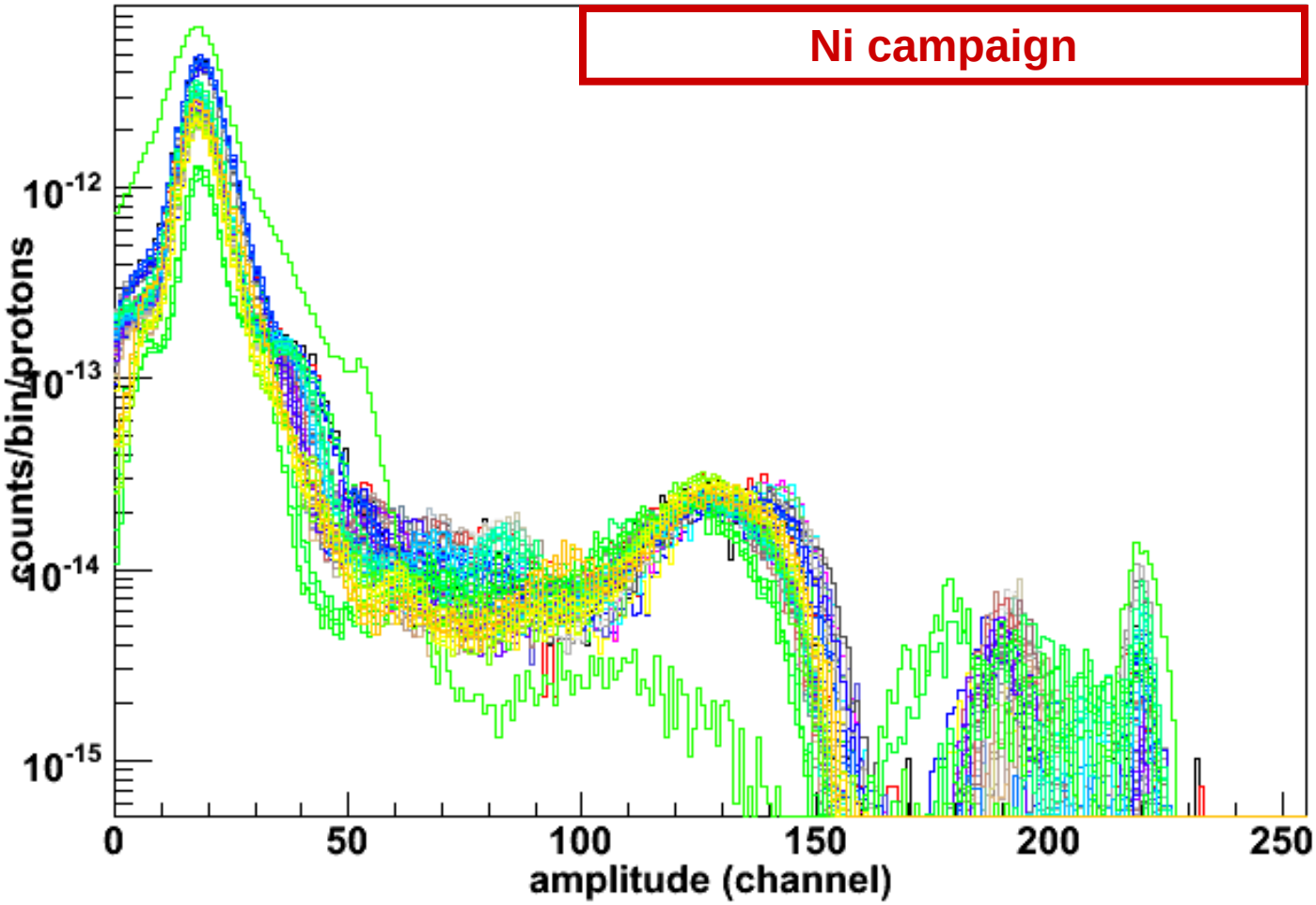
Neutron Sensitivity

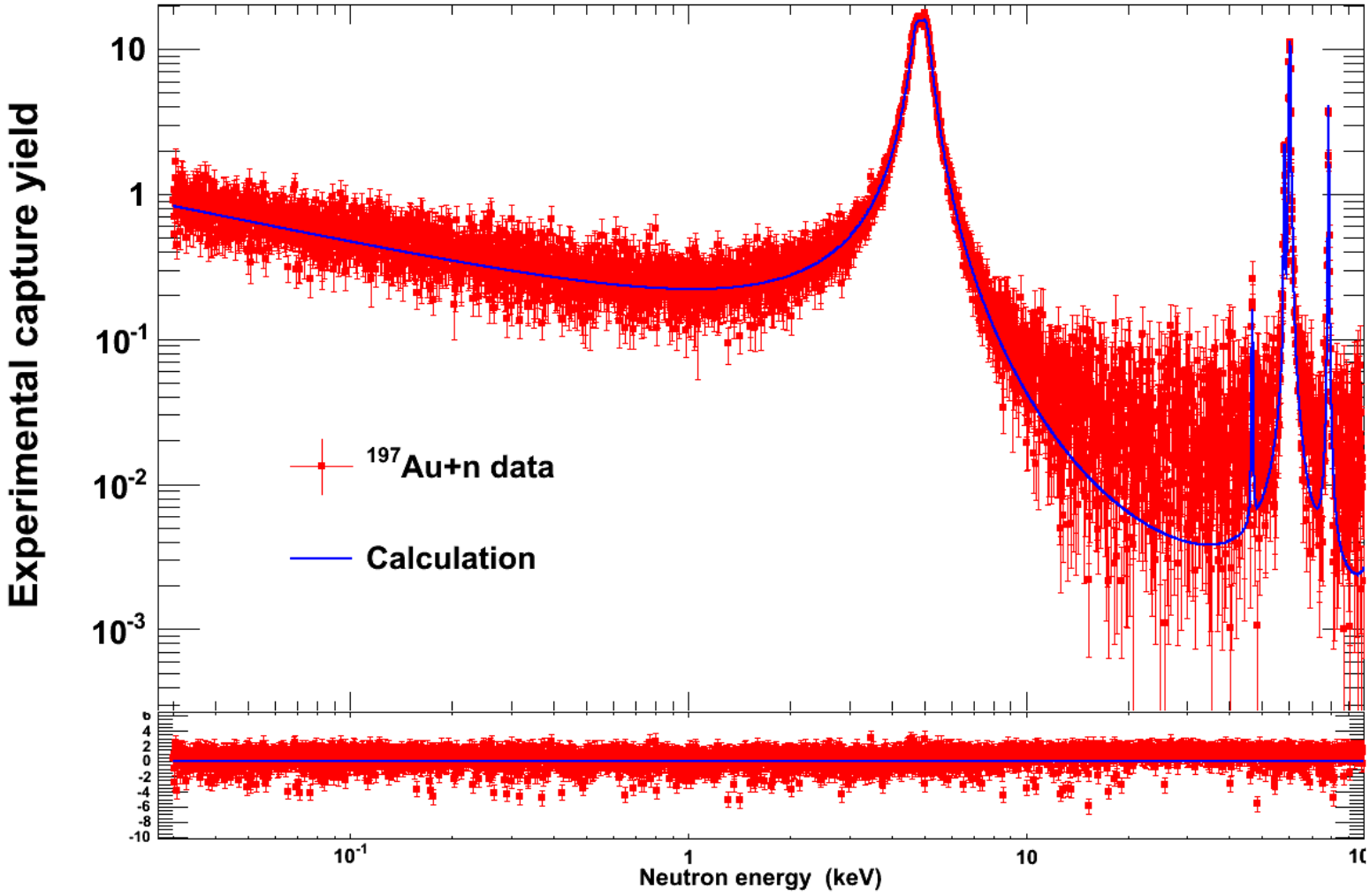
Preliminary study: $\varepsilon_{N,BICRON} \sim 10^{-4}$



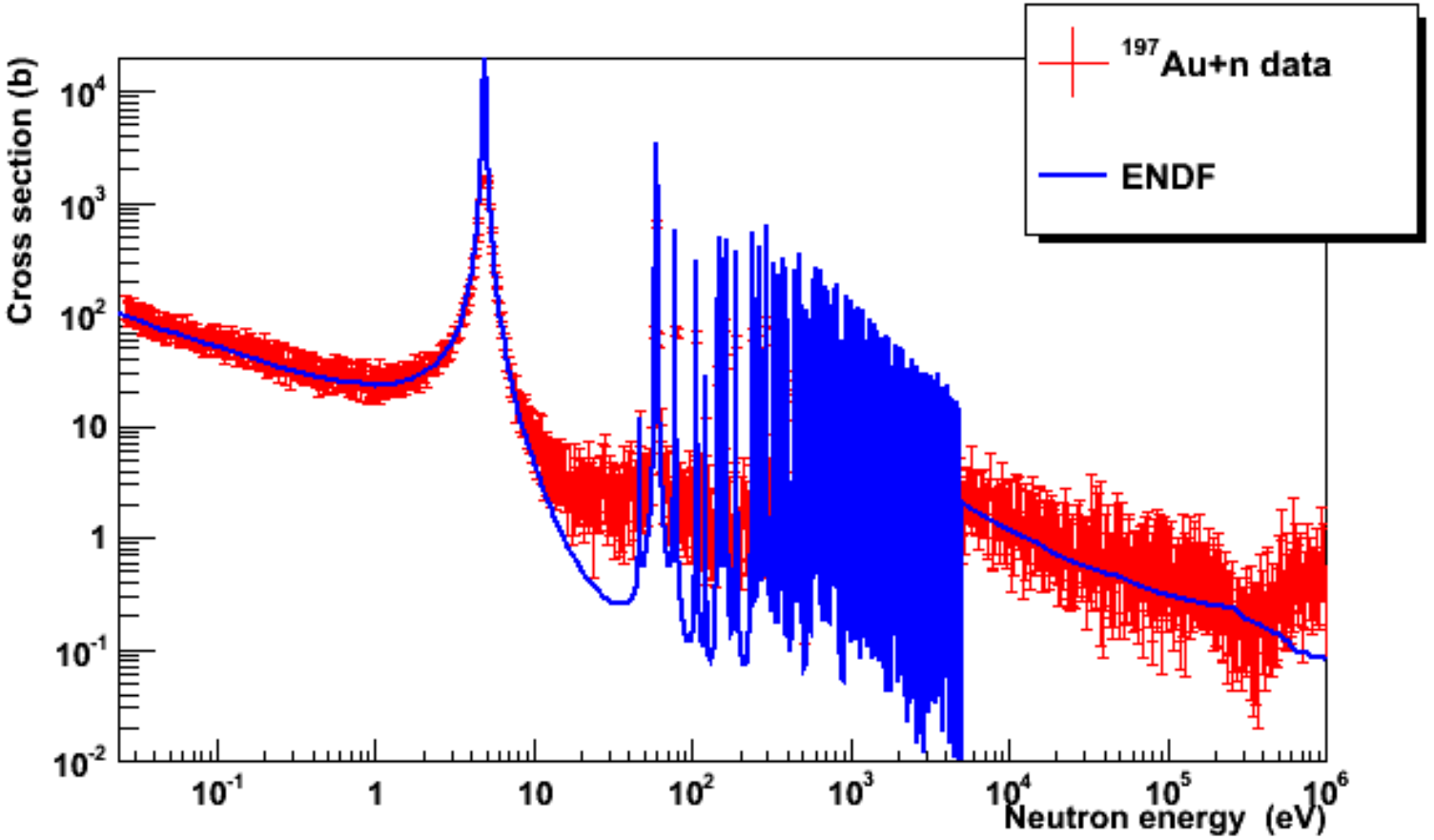
Silicon 2 - stability



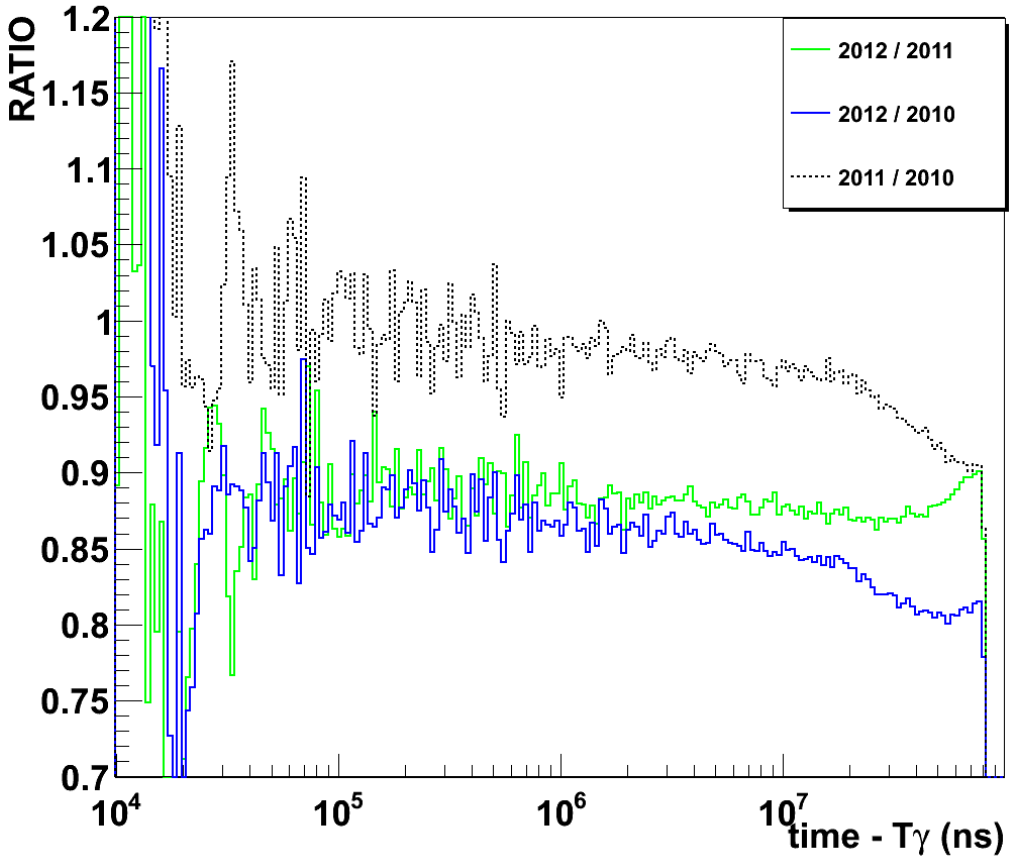
Silicon 2 - stability



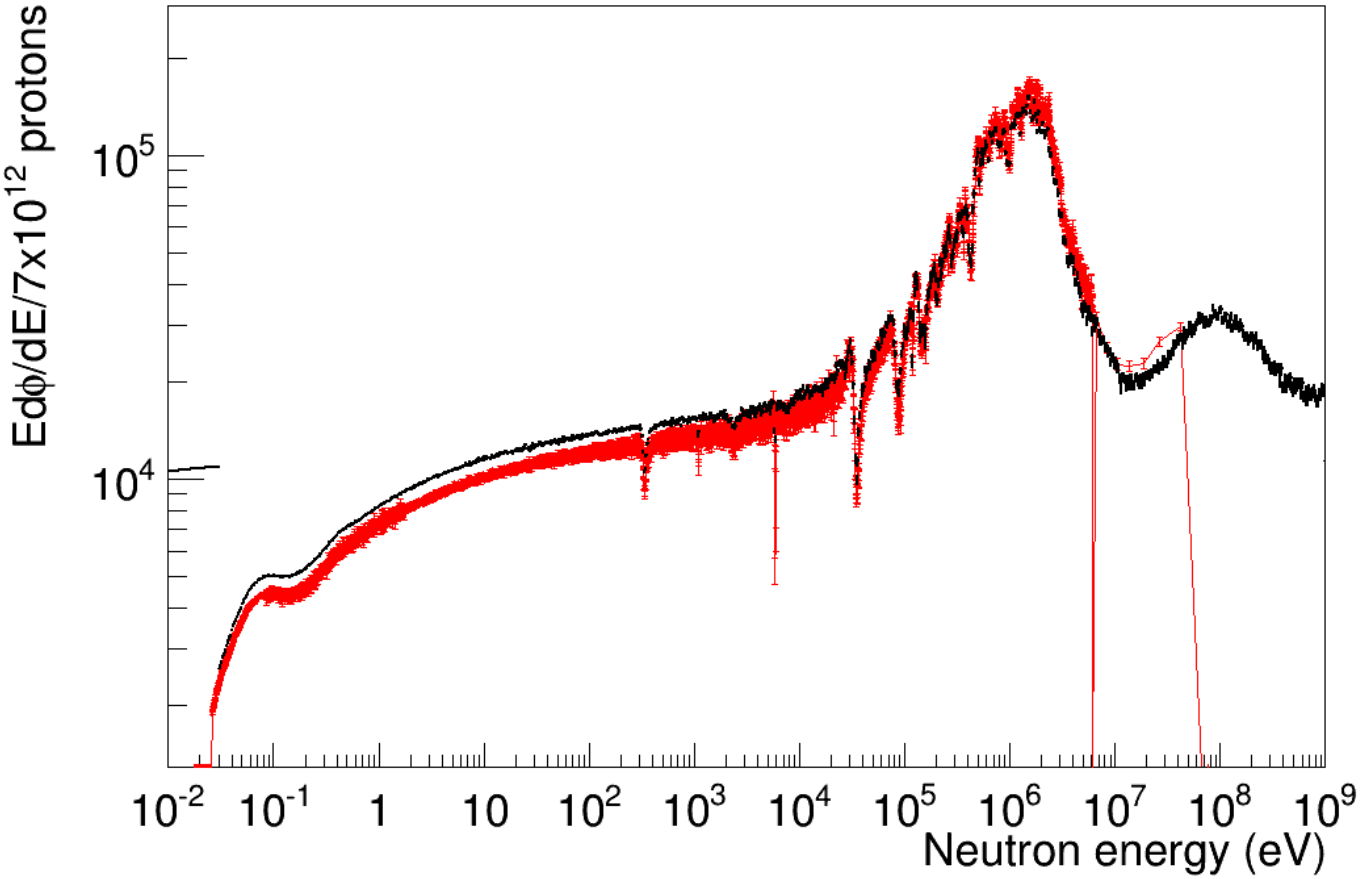
Silicon 2 - stability



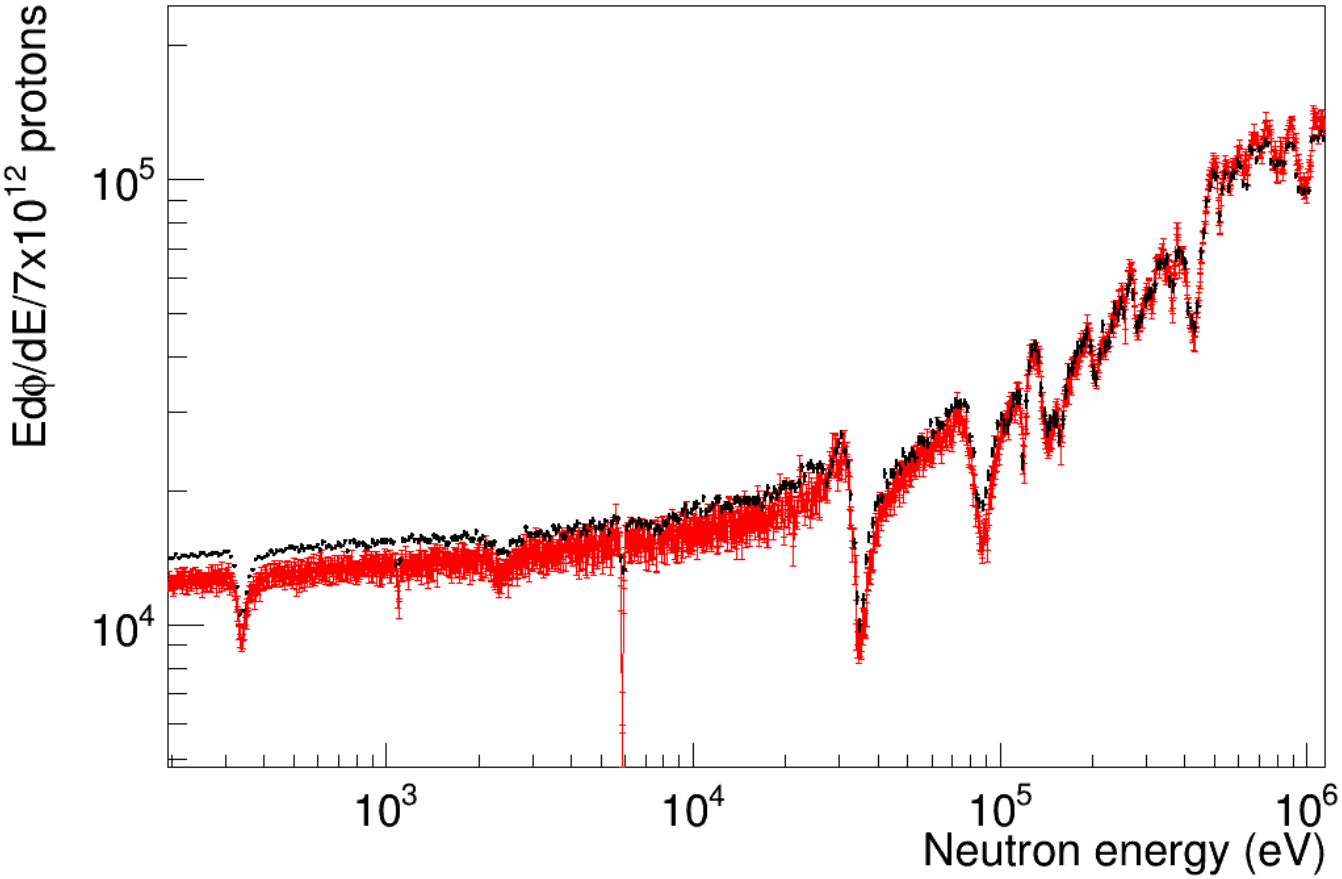
Flux 2010 – 2011 – 2012



Flux 2011 – 2012



Flux 2011 – 2012



Mg sample

OLD sample (powder)

Property	Value
Mass MgO	3.19 g
Diameter	22 mm
Thickness	2.3 mm
Areal density	1.234×10^{-2} at/b

Enrichment 95.75%
^{24}Mg ~ 3%,
^{26}Mg ~ 1.2%

New sample (metallic)

Property	Value
Mass Mg	3.94 g
Diameter	20 mm
Thickness	7 mm
Areal density	3.00×10^{-2} at/b

Enrichment 97.86 %
^{24}Mg ~ 1.83 %
^{26}Mg ~ 0.31 %

INFN paid ~ $13 500