Preliminary analysis

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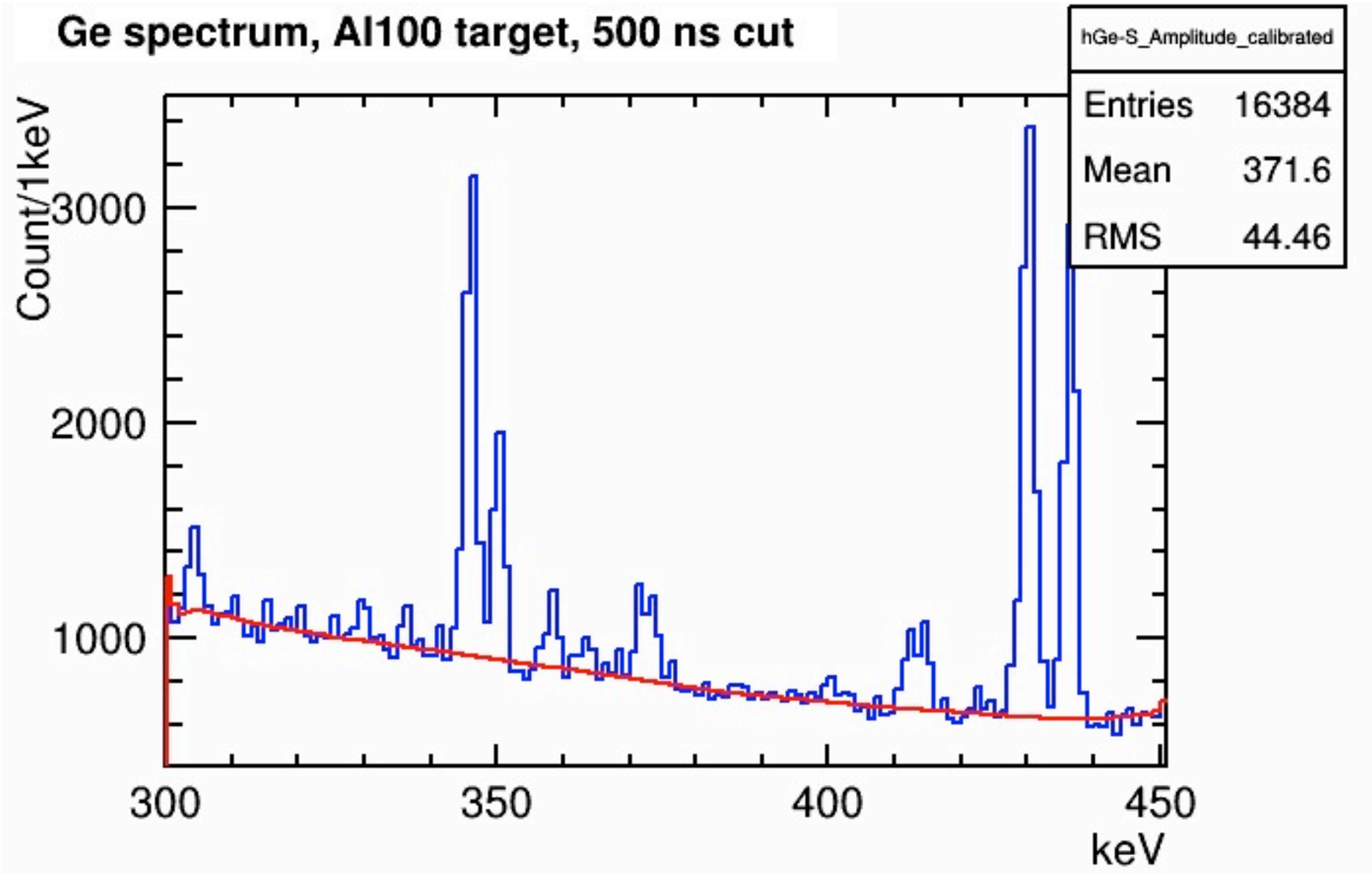
Outline

- Data sets
- X-rays
- PID
- Proton rate (naive) estimation
- Unfolding scheme
- Summary

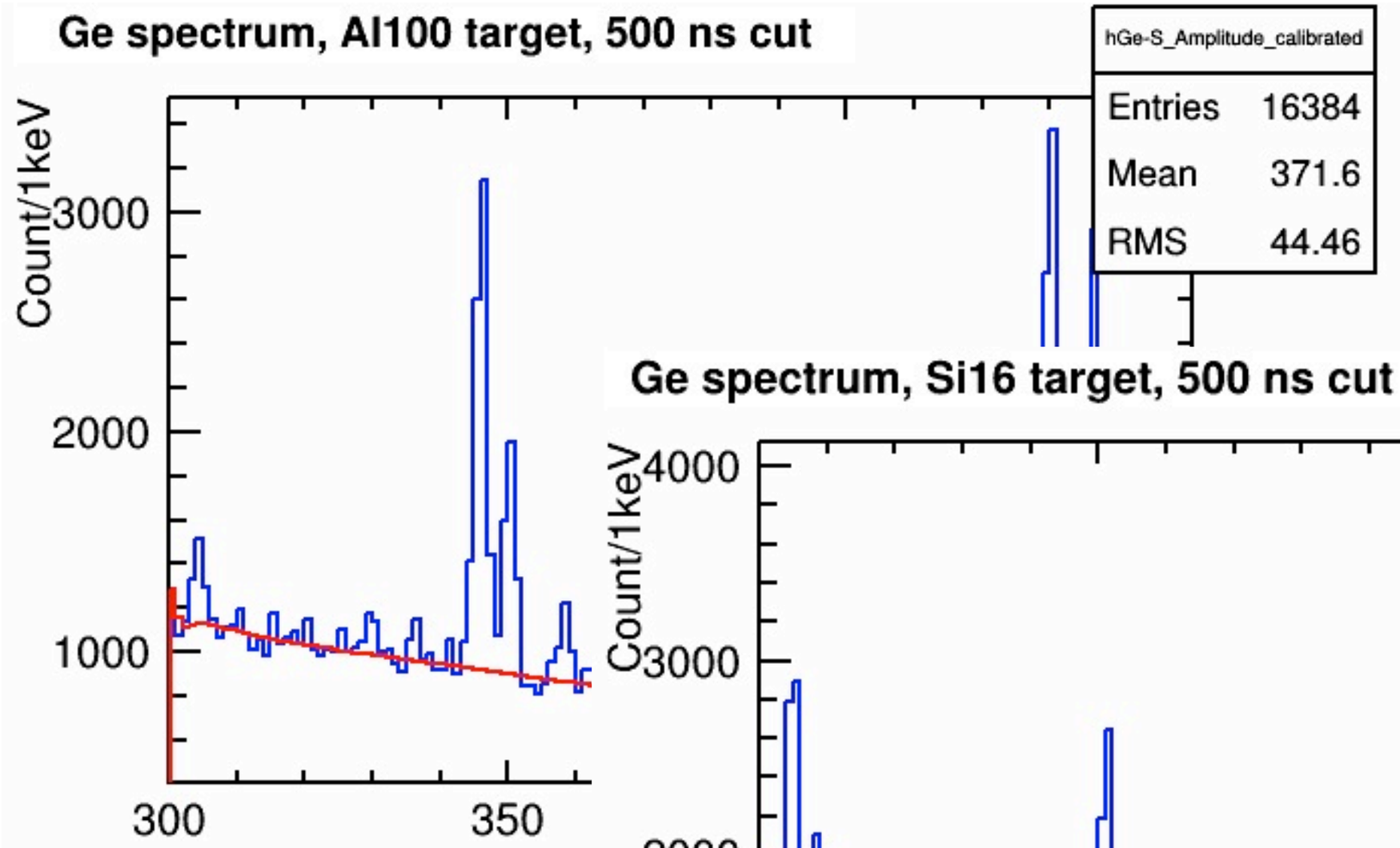
Datasets

- passive Si 65 μm, 1.06 (29.7 MeV/c):
  - runs 3474 - 3540, 100% data at this momentum
  - check actual thickness (62 μm?)
- Al100, 1.09 (MeV/c):
  - runs 2808 - 2813, 2826 - 2858; 28 % data (? 39/141 runs)

X-rays


Ge spectrum, Al100 target, 500 ns cut
hGe-S_Amplitude_calibrated
Entries 16384
Mean 371.6
RMS 44.46
Count/1keV
3000
2000
1000
300
350
400
450
keV

X-rays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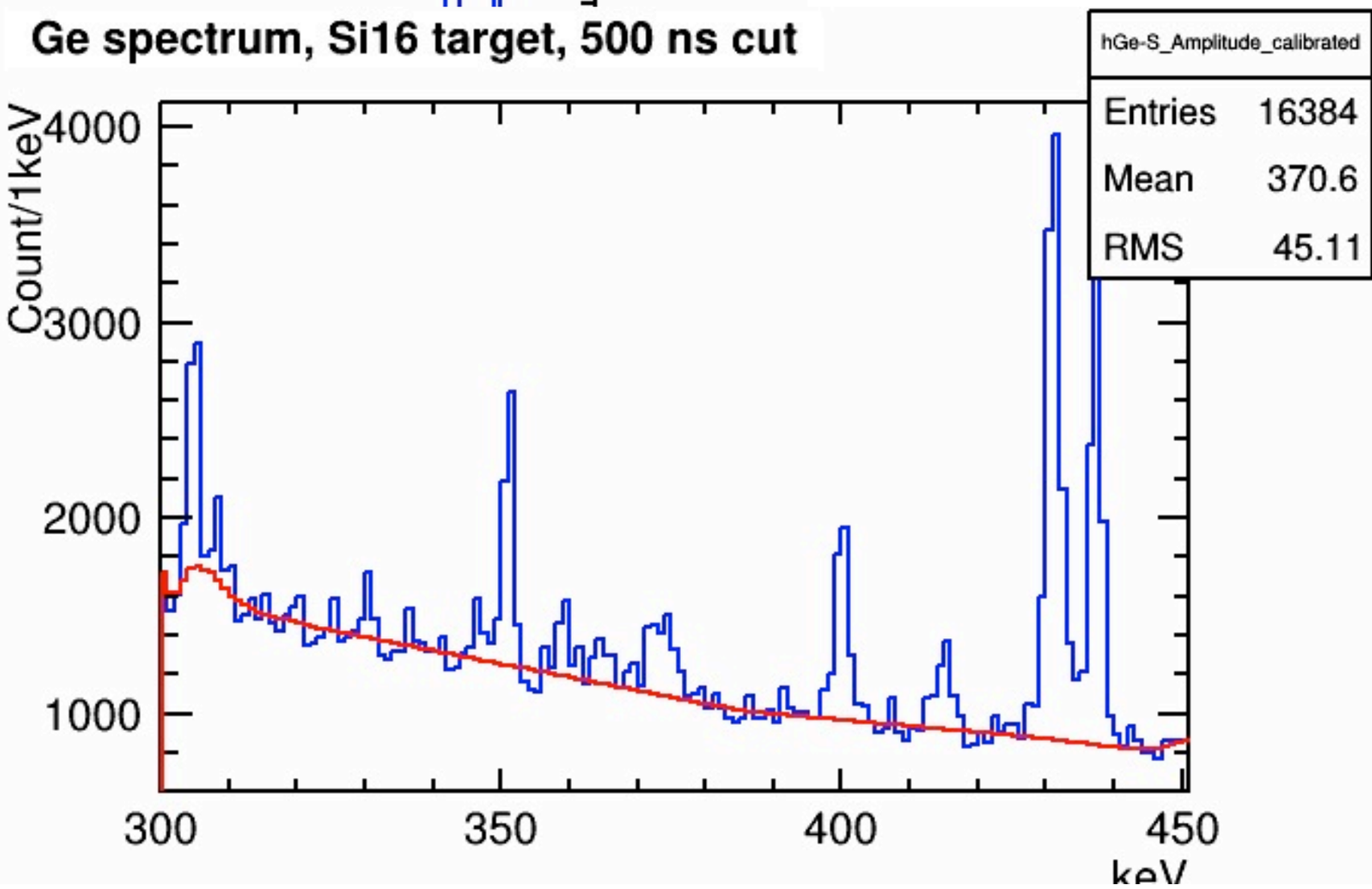

Ge spectrum, Si16 target, 500 ns cut
hGe-S_Amplitude_calibrated
Entries 16384
Mean 370.6
RMS 45.11
Count/1keV
4000
3000
2000
1000
300
350
400
450
keV

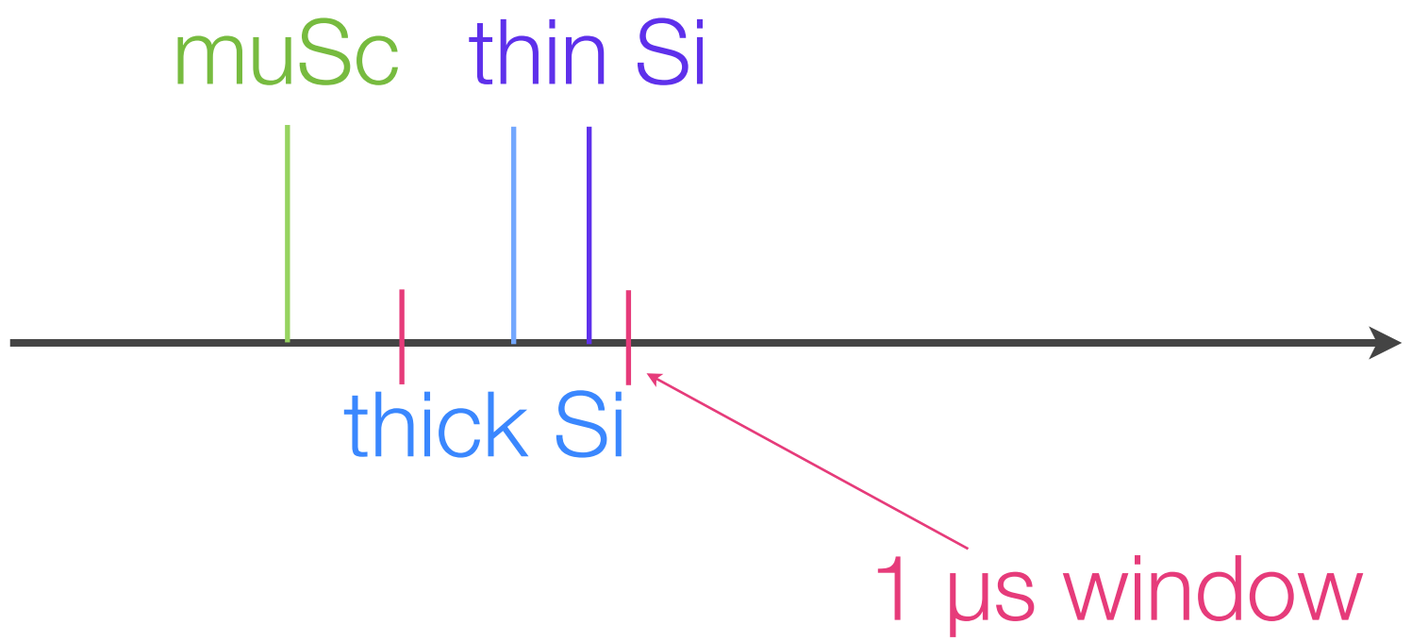
X-rays

- simple calculation based on calibration data
- no self absorption correction (should be small)
- number of incoming muons from number of muSc hits over the threshold

Target	f_{cap}	E_x [keV]	I_{Ex} [/stoped μ]	ε_{Ex} (by elog 665)	N_{Ex}	$N_{\mu\text{-capture}}$	$N_{\mu\text{-stop}}$	muSc	stopping %
Al100	0.609	346.8	0.797	3.58E-04	4479	1.57E+07	2.58E+07	1.05E+08	24.5
passive Si65	0.658	400.2	0.826	3.16E-04	2207	8.46E+06	1.29E+07	1.72E+08	7.5

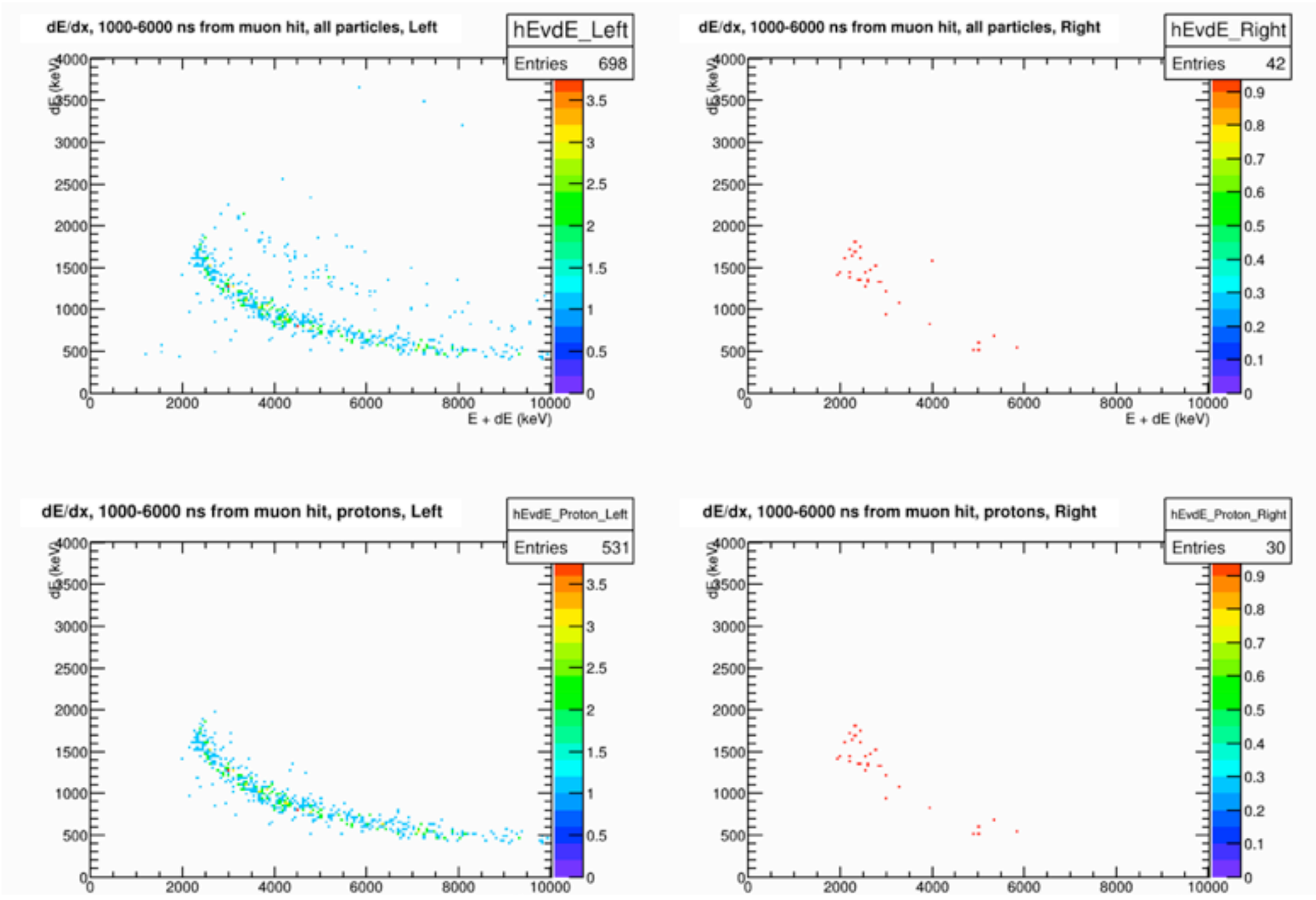
Particle identification: dE/dx

- using John's EvdE rootana module, convert adc value to energy
- only muSc and Si hits are used
- energy cut: >200 keV for silicon hits
- pile-up protection: 10 μs
- coincidence between thick and thin silicons: 1 μs
- searching range: 0 - 6 μs from muSc hit



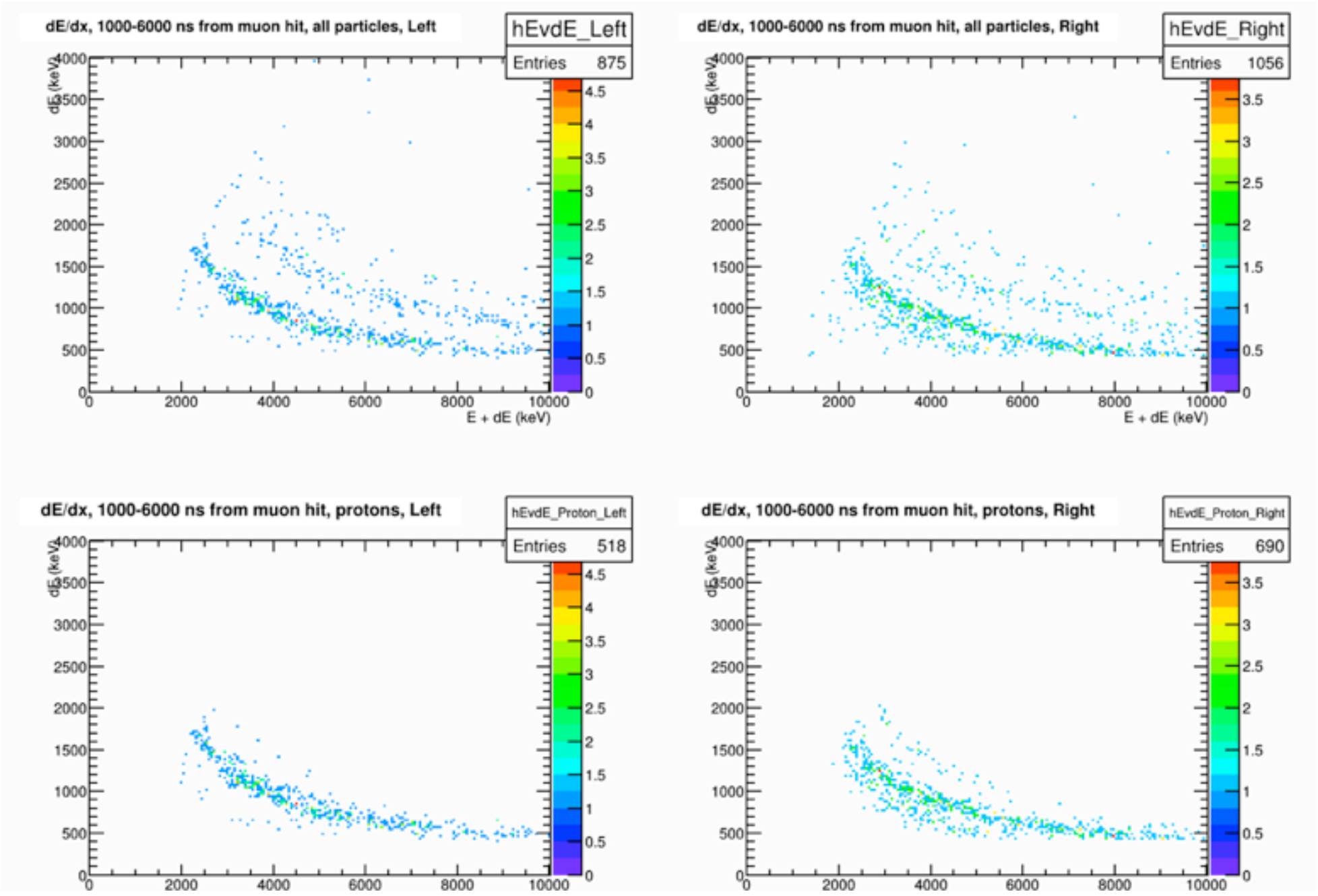
Particle identification: dE/dx

- passive Si: mostly stopped at the upstream side

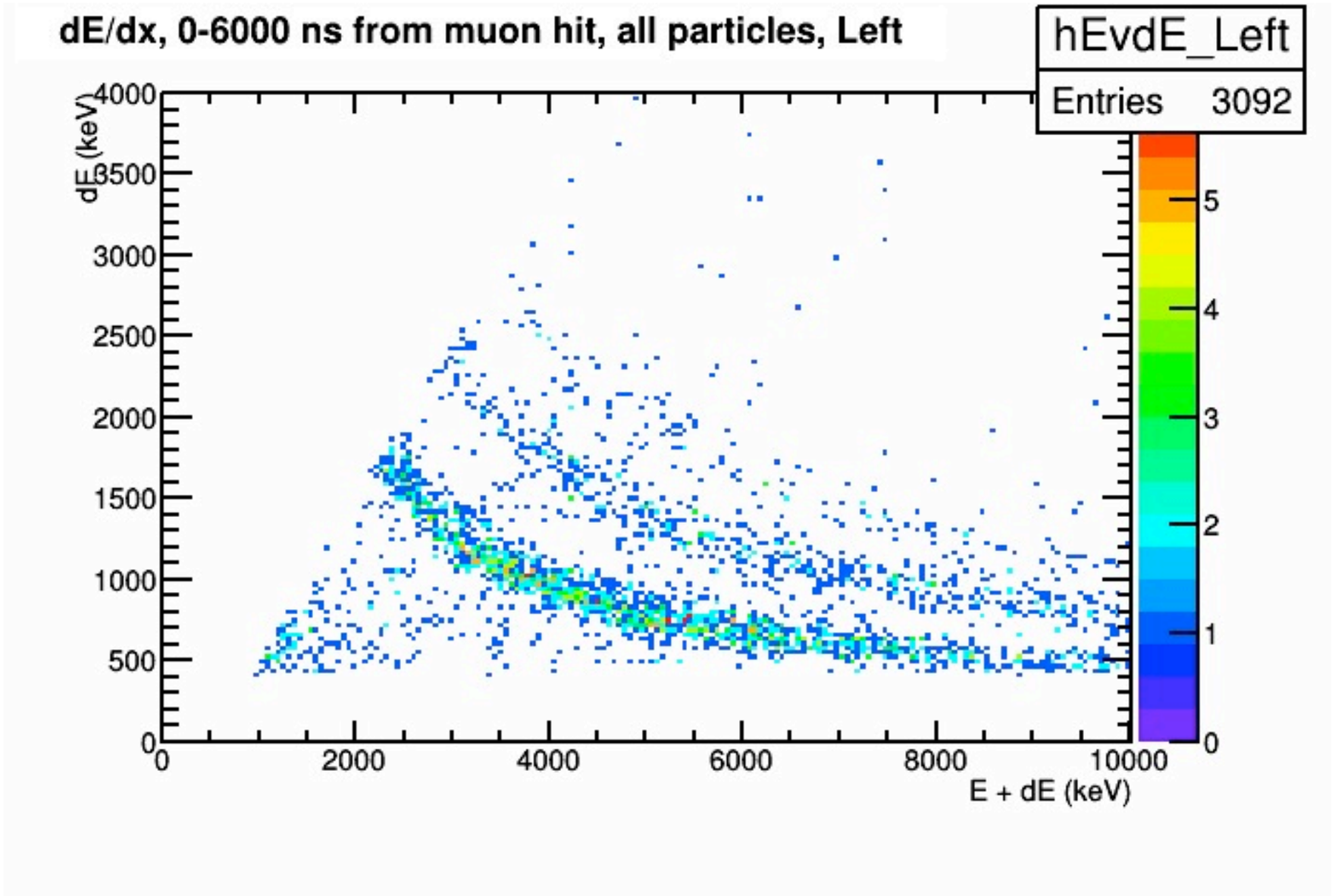


Particle identification: dE/dx

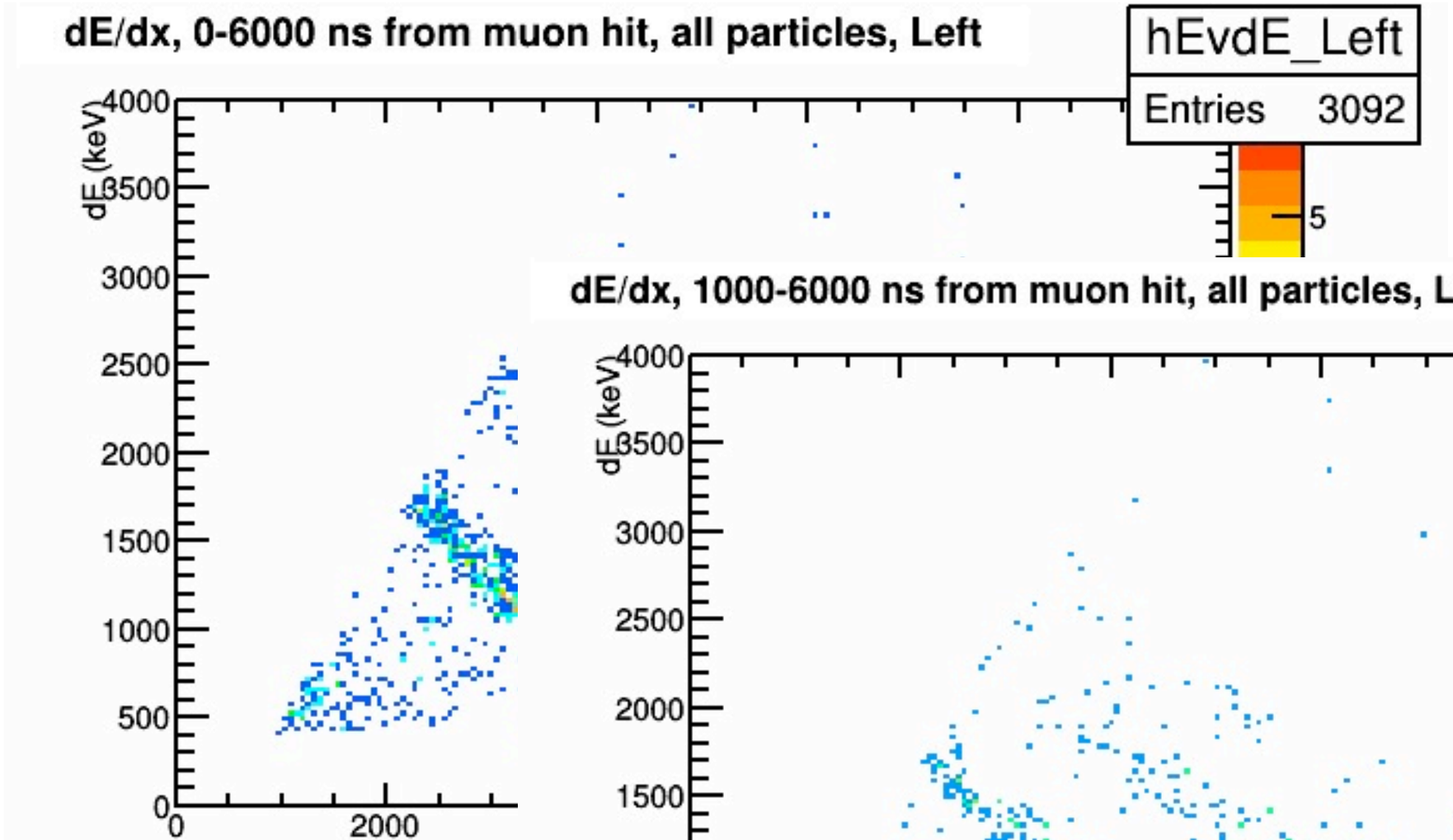
- Al100: more at downstream side

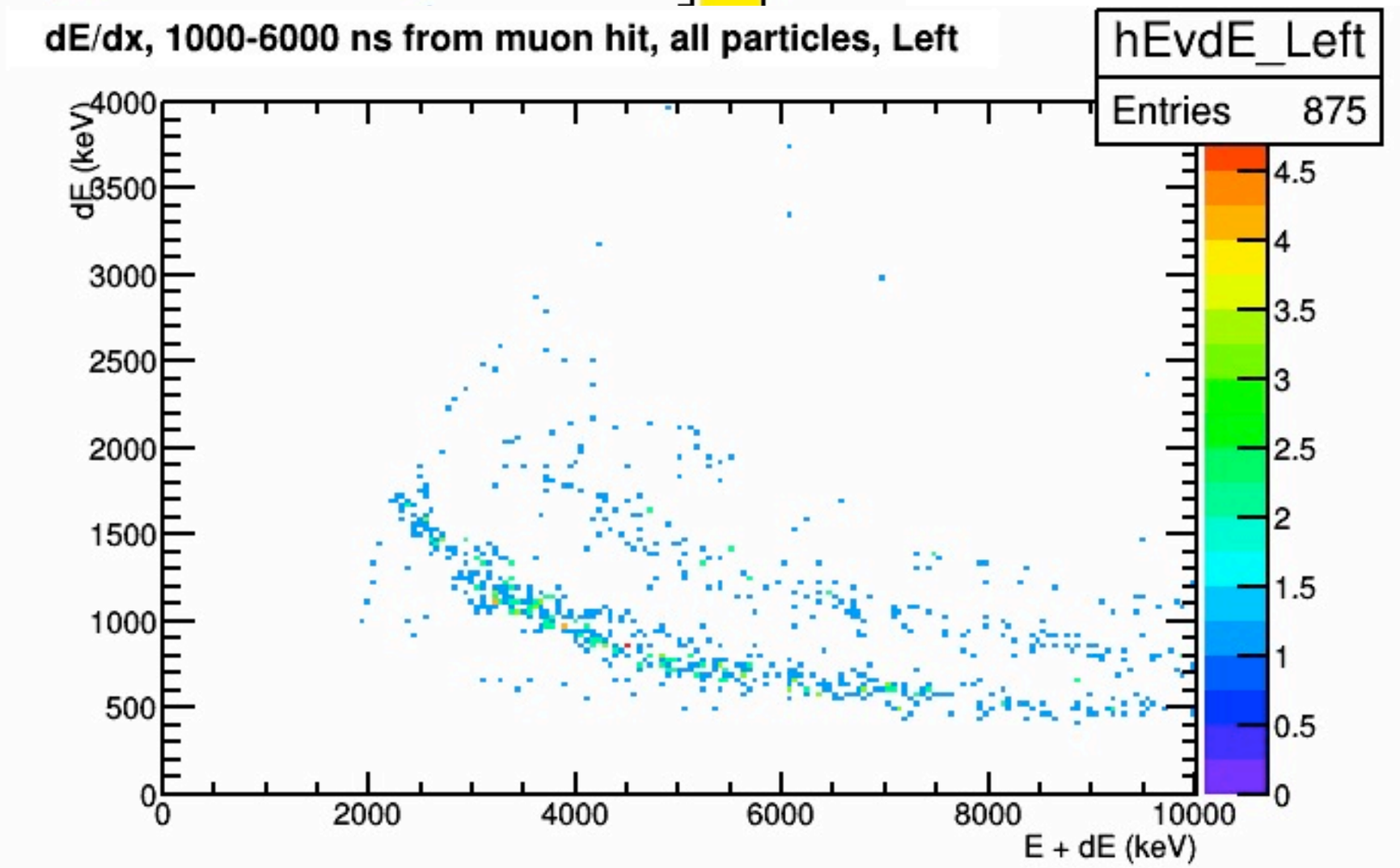


dE/dx with timing cut



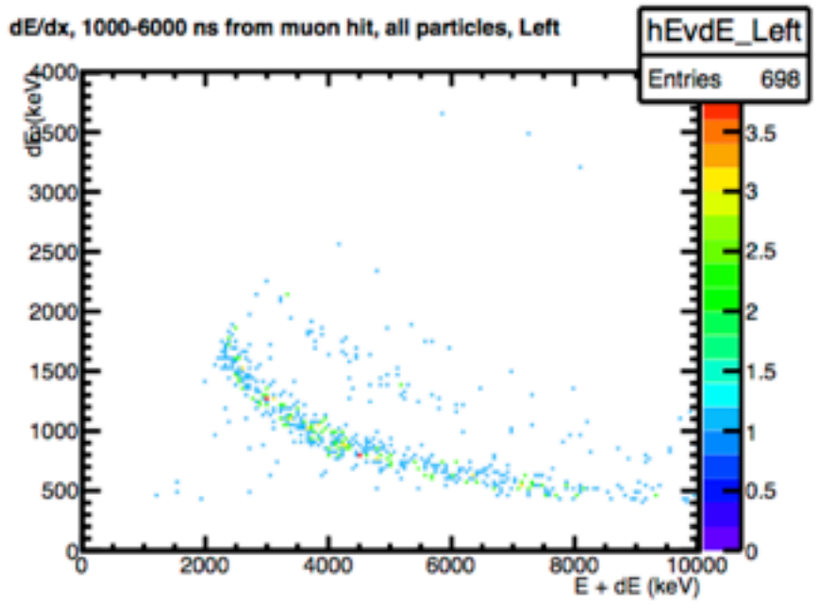
dE/dx with timing cut

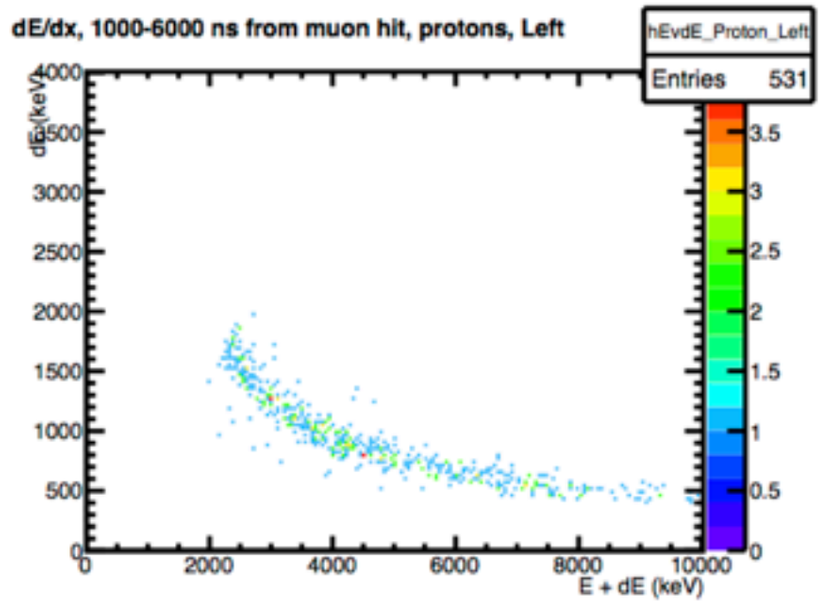




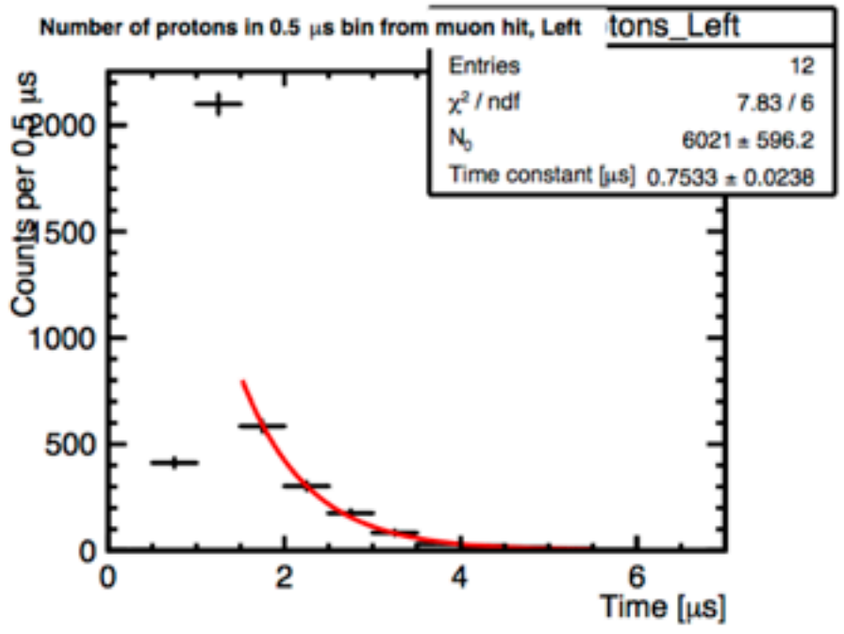
Proton numbers with timing cut

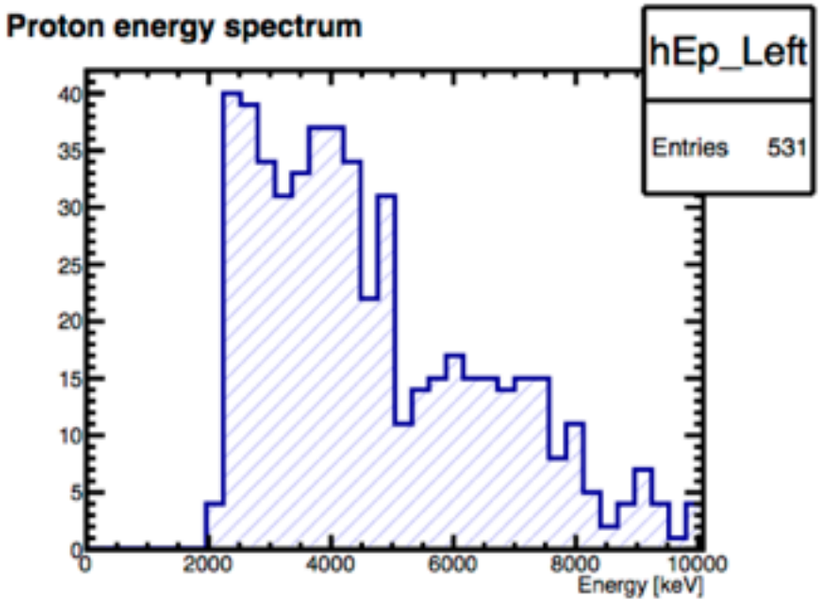
- Passive Si 65 μm, left arm:





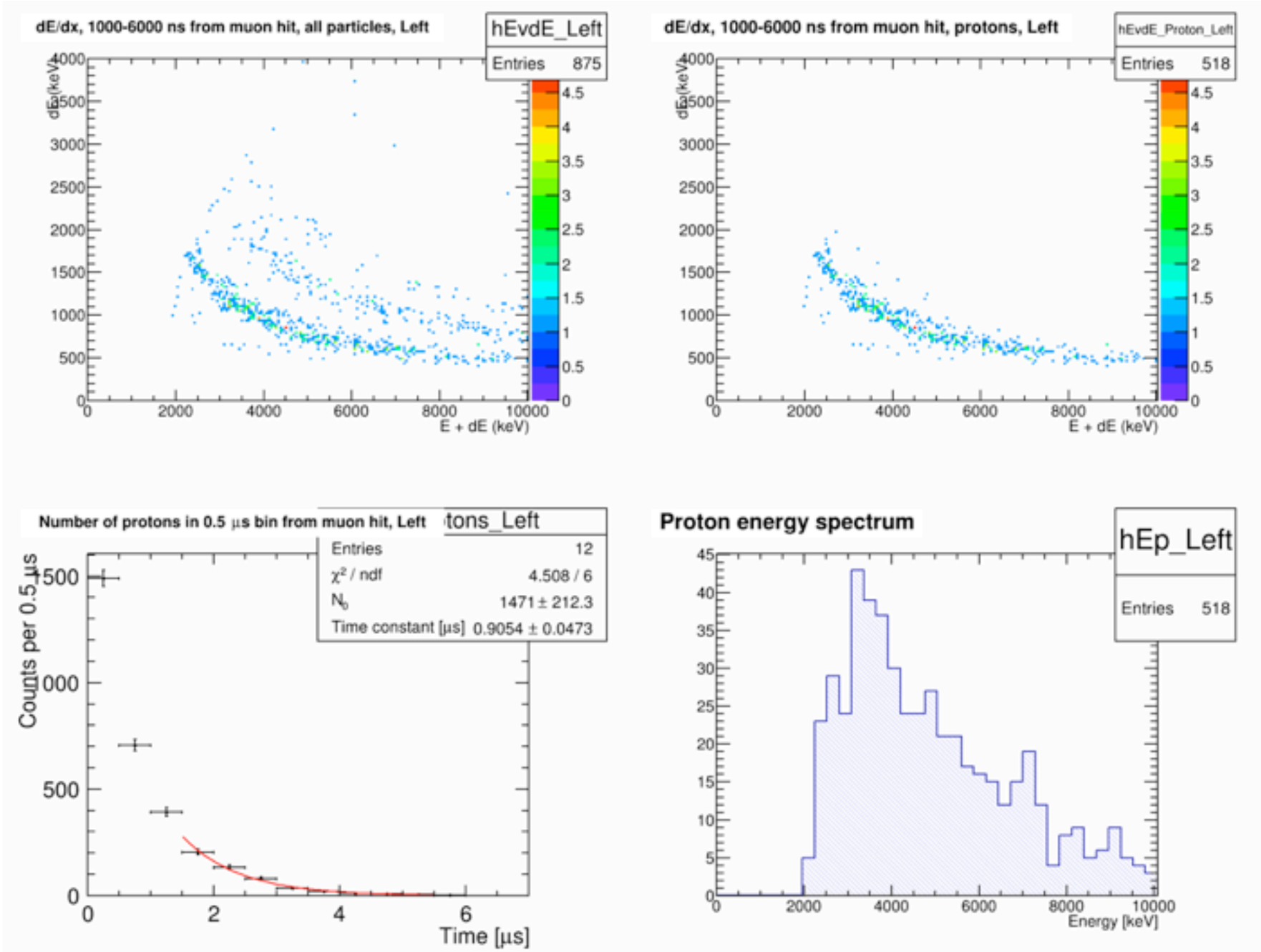
Lifetime in Si 758 ns





Proton numbers with timing cut

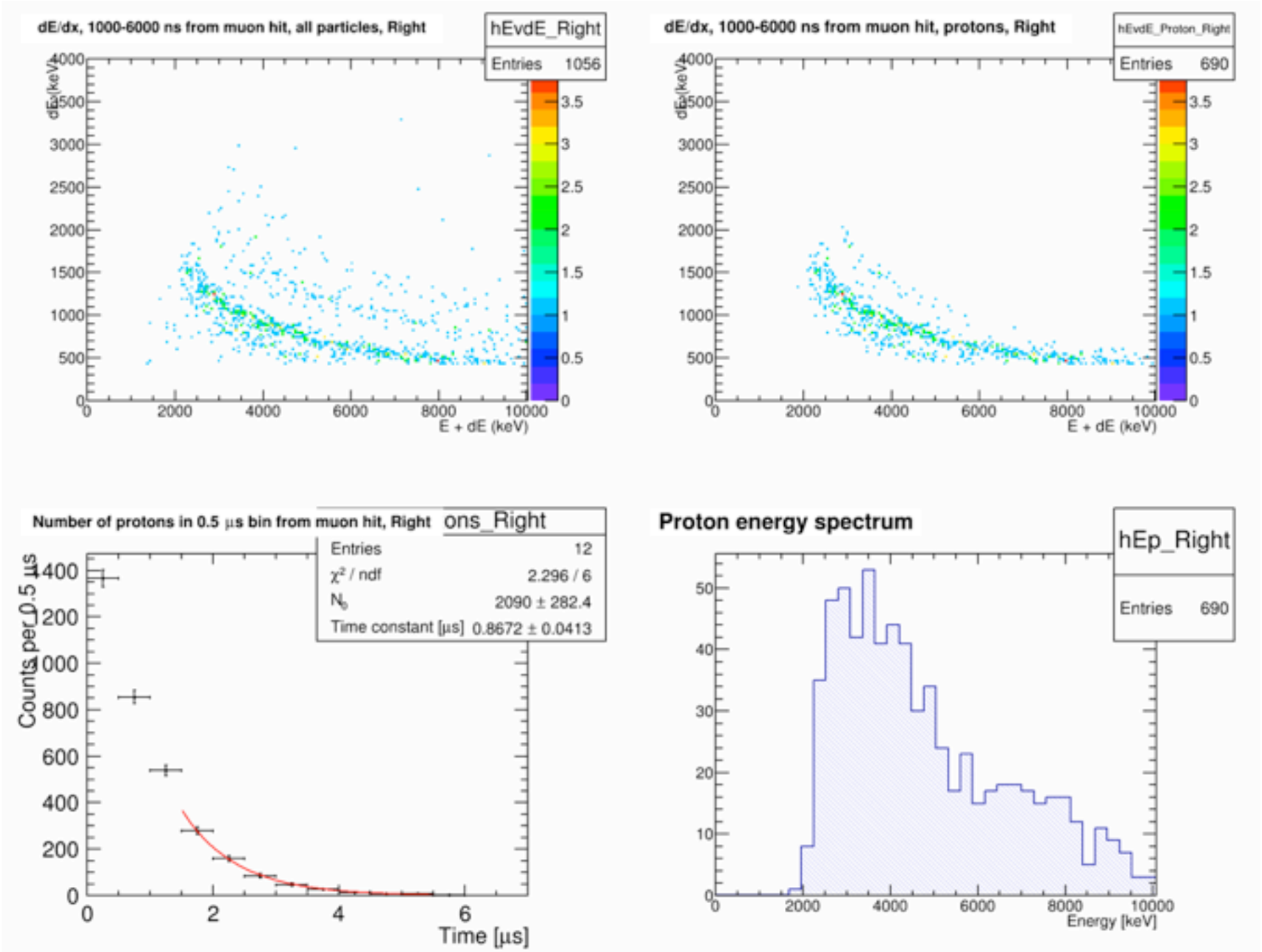
- Al100, left arm:



Lifetime in Al 864 ns

Proton numbers with timing cut

- Al100, right arm:



Lifetime in Al 864 ns

Proton rate estimation

- Shortcomings:
  - no absorption/distribution correction
  - protons/all other charged particles behave the same way

Proton rate estimation

- Acceptance of the left arm from passive Si, left arm:
  - in 1-6 μs window: 531
  - from 0: 531 * exp(1[μs]/0.758[μs]) = 1986
  - acceptance of the left arm:

$$\frac{N_p}{N_{\mu-stopped} \times \epsilon_{all-particles} \times \epsilon_{proton}} = \frac{1986}{1.35 \times 10^7 \times 0.15 \times \frac{531}{698}} = 1.35 \times 10^{-3}$$

Proton rate from Al

- in 1 - 6 μs time window: 518
- from 0: 518*exp(1[us]/0.864[us]) = 1648
- number of protons at target: $1648/(1.35\text{x}10^{-3}) = 1.22\text{x}10^{6}$
- proton emission prob: $1.22\text{x}10^{6}/(1.57\text{x}10^{7}) = 7.77\text{x}10^{-2}$

Unfolding scheme

- Assume some distribution of protons inside the target:
  - gaussian in a 50×50×0.1 mm^3 target
- Generate protons with a flat energy distribution, build a response matrix:

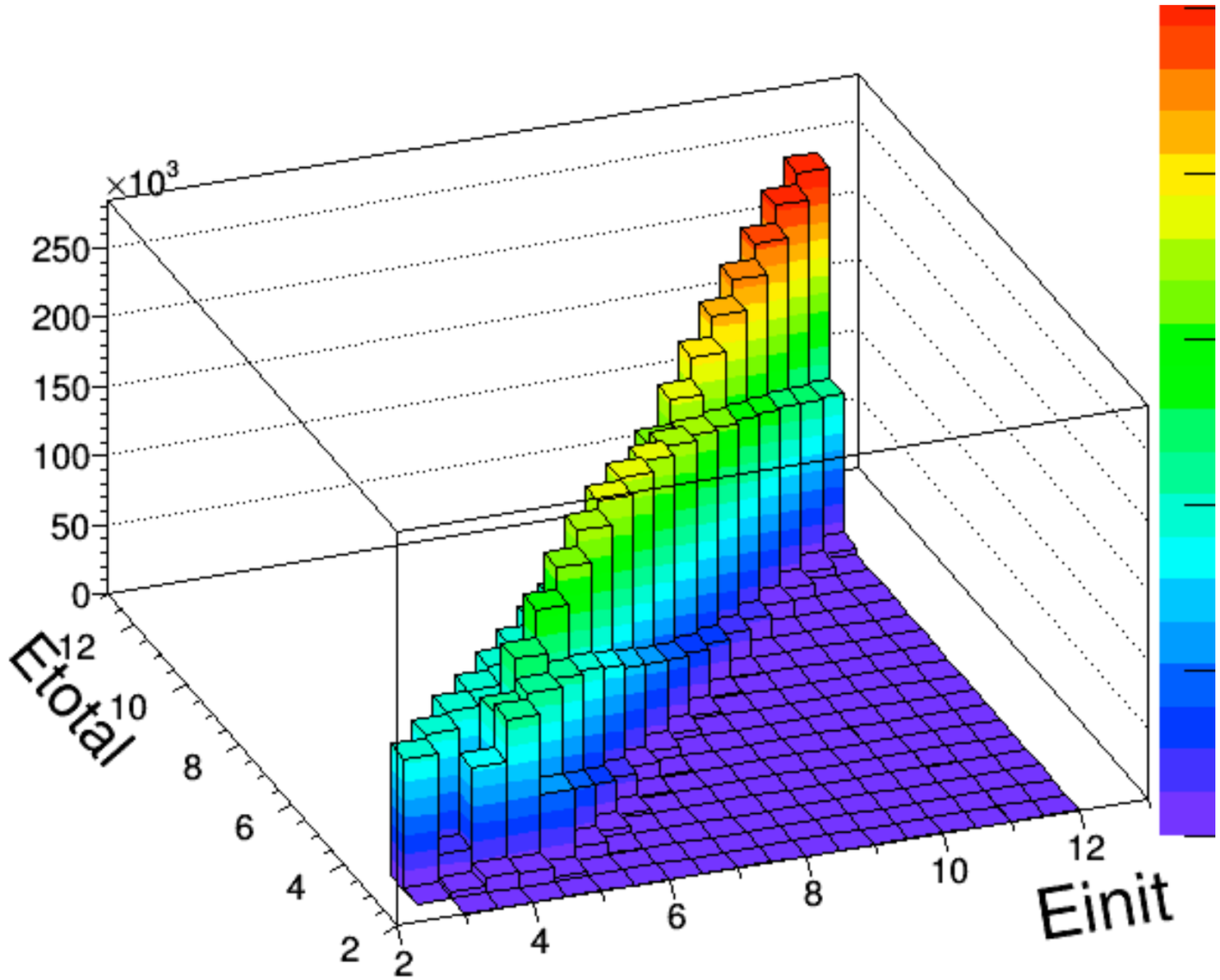
  * flat initial energy in 500 keV bins: $E_i^{org} = \begin{bmatrix} 0 & 0 & .. & 0 & 1 & 0 & .. & 0 \end{bmatrix}$
  * response for that initial energy bin, E + dE: $E_i^{det} = \begin{bmatrix} e_j \end{bmatrix}$
  * response matrix: $R = \begin{bmatrix} E_i^{det} \end{bmatrix} = \begin{bmatrix} e_{ij} \end{bmatrix}$,

$$E^{det} = E^{org} R$$

$$E^{org} = E^{det} R^{-1}$$

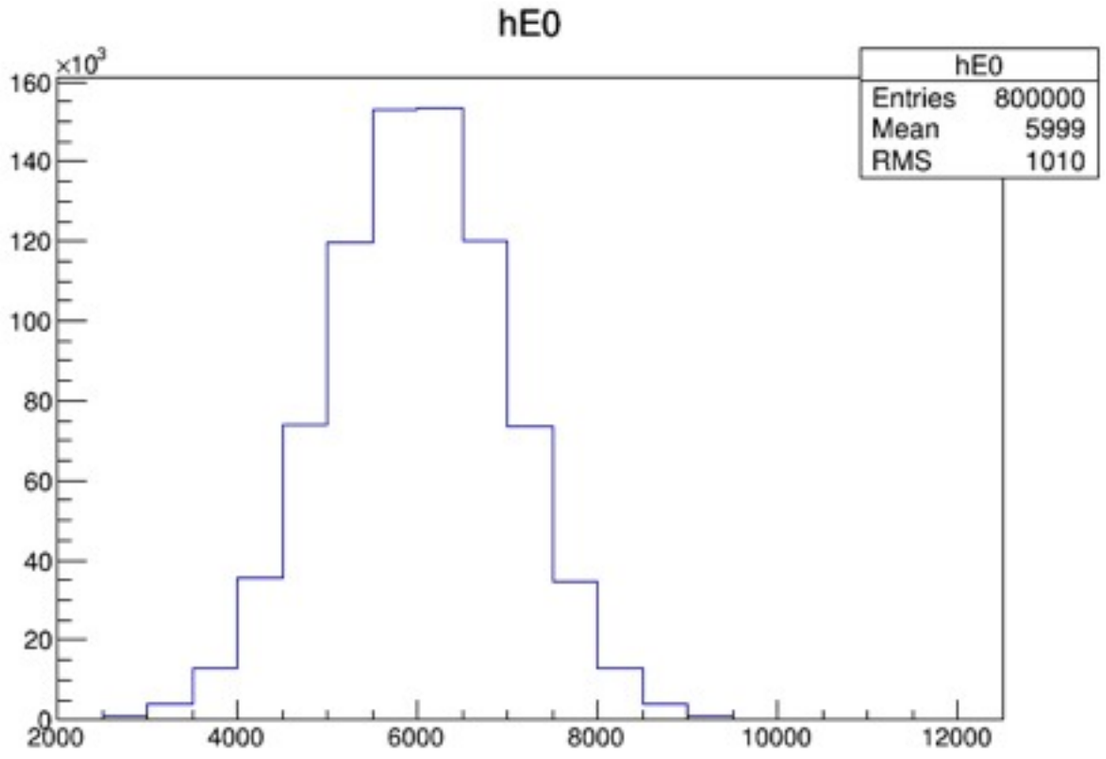
Unfolding scheme

- Response matrix:

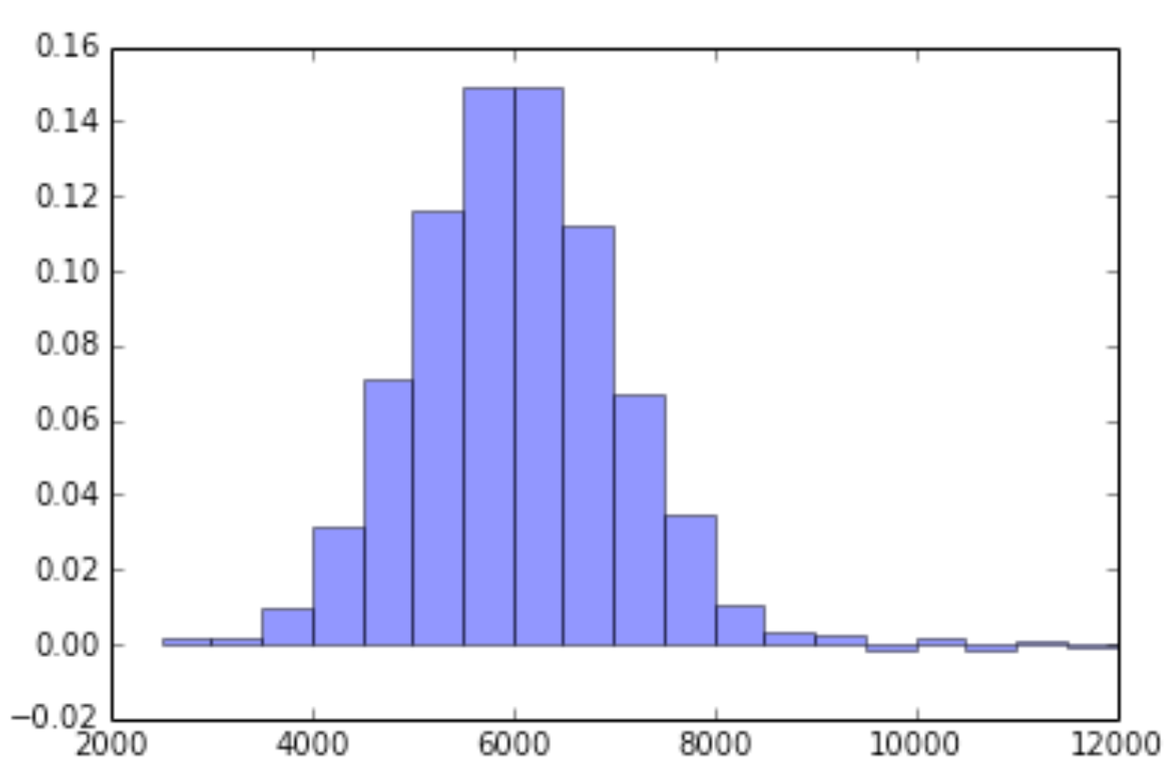


Unfolding scheme

- Test with a gaussian energy distribution: mean 6 MeV, sigma 1 MeV



Generated spectrum

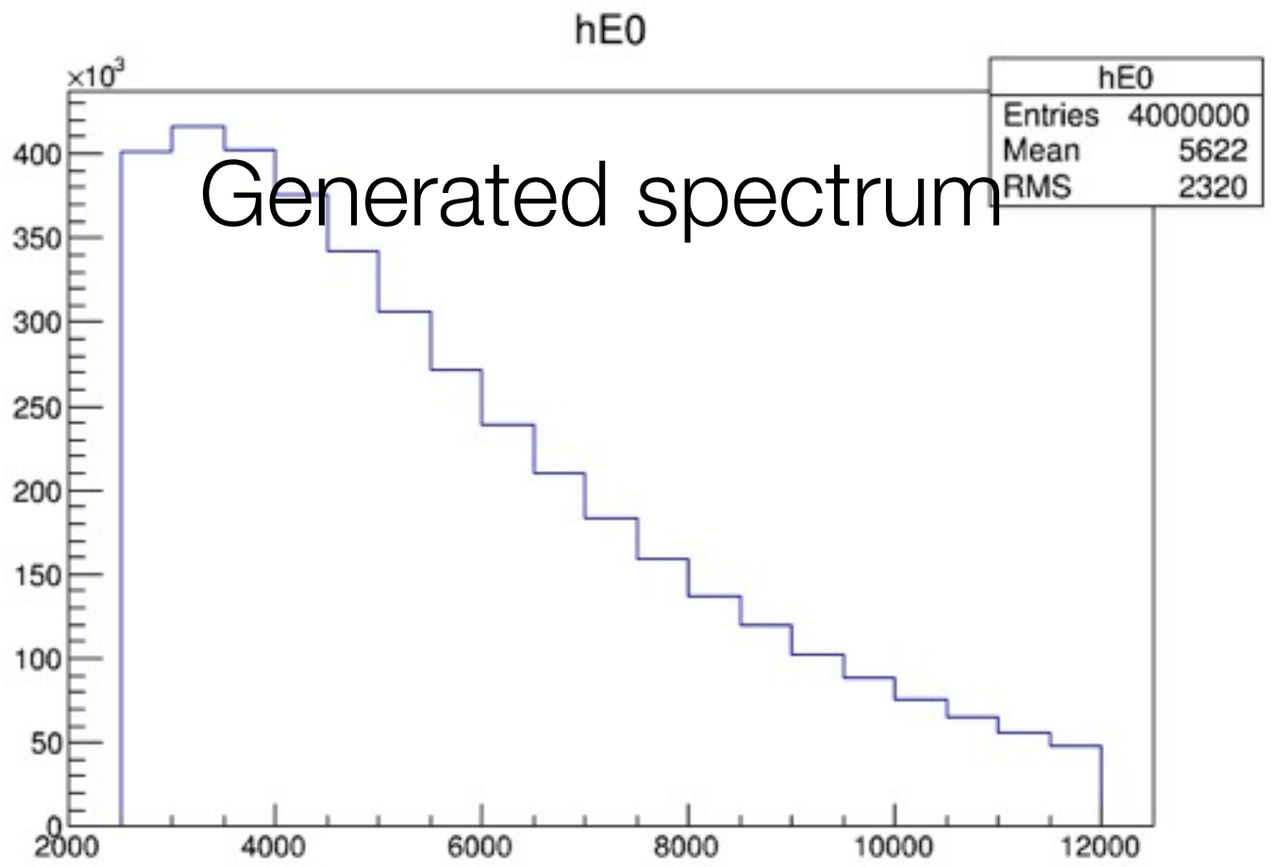


Unfolding spectrum

Unfolding scheme

- Test with EH's pdf:

$$\mathrm{W(T)} = \mathrm{A(1\text{-}T}_{th}/T)^{\alpha} e^{-\mathrm{T}/\mathrm{T}_0};$$



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Unfolding scheme

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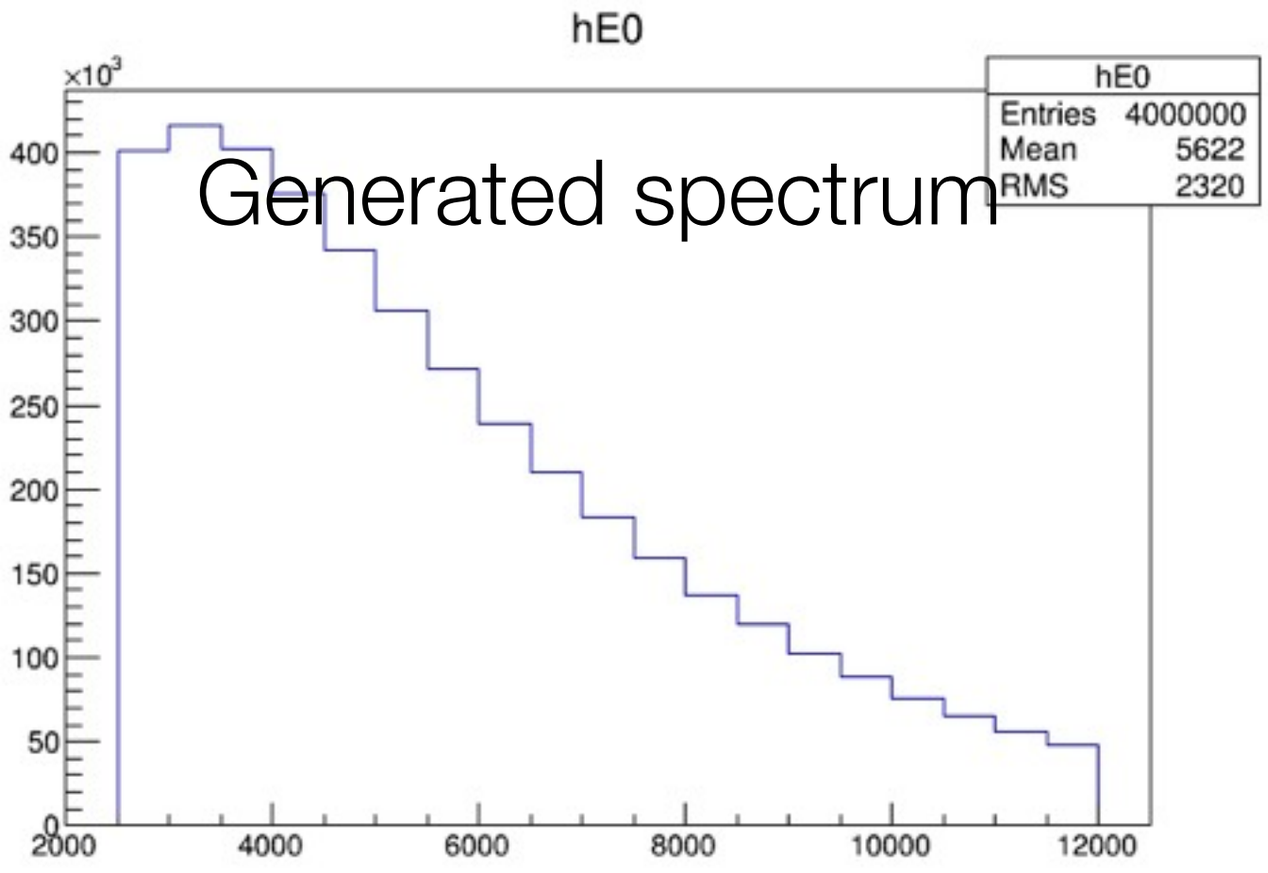
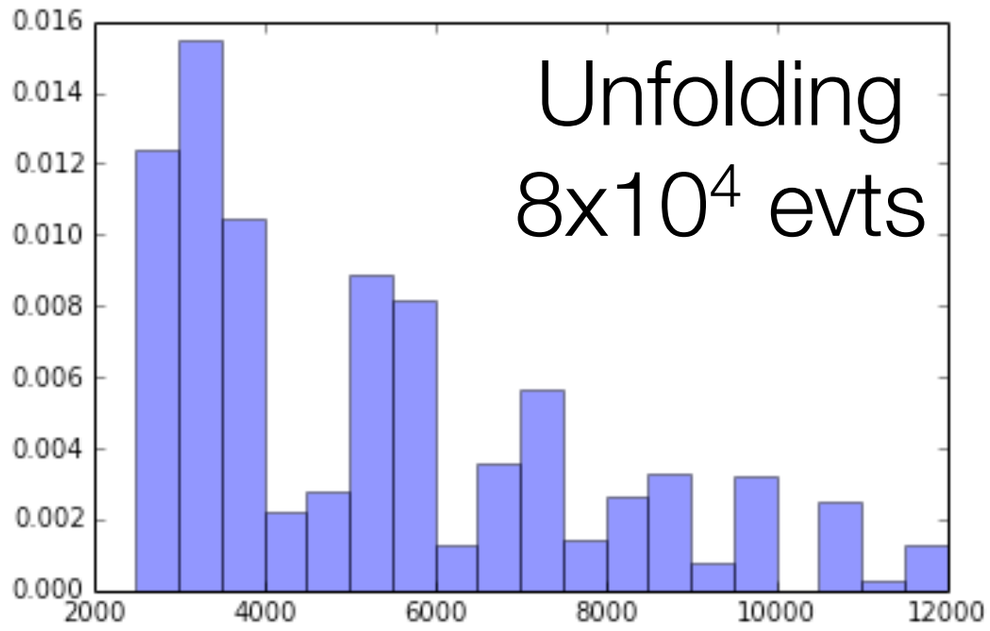


Generated spectrum



Unfolding
8x10^4 evts

Unfolding scheme

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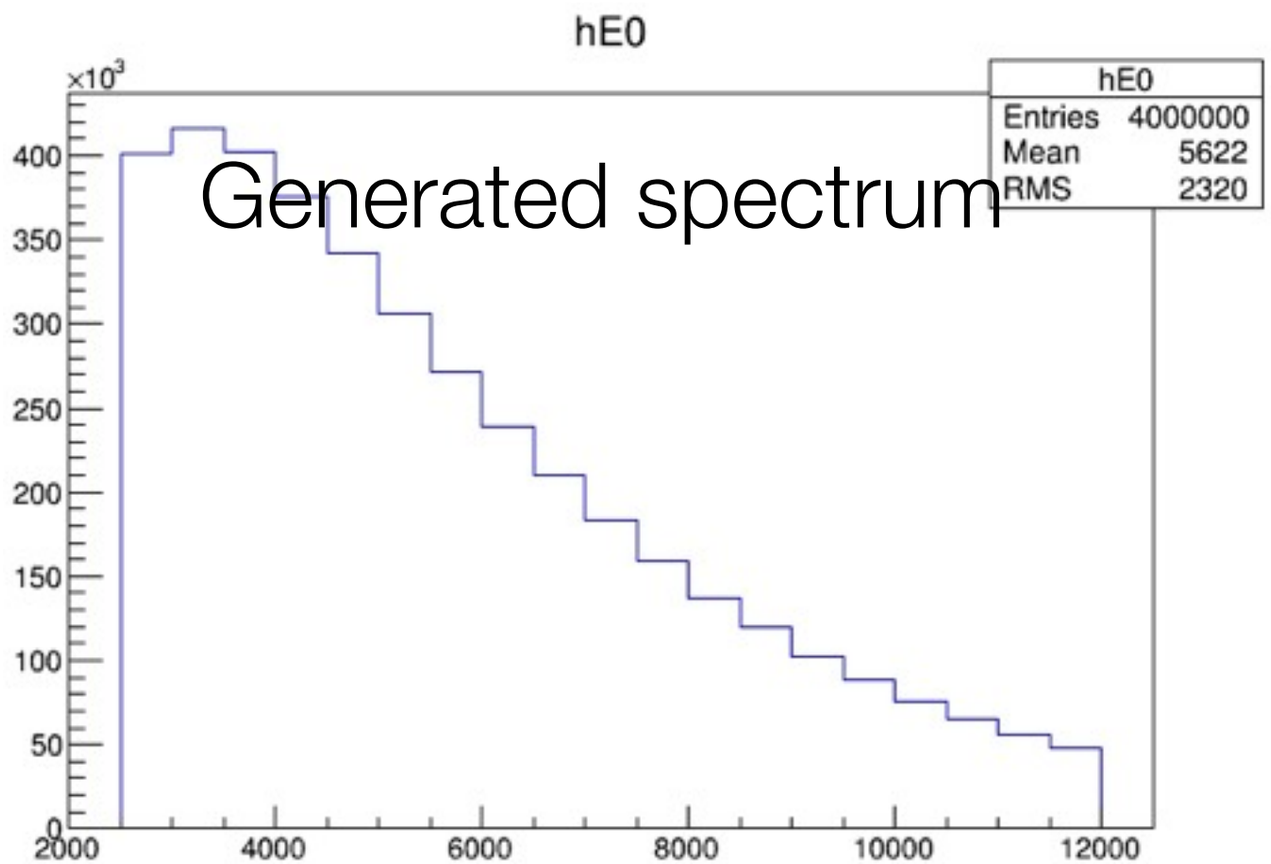
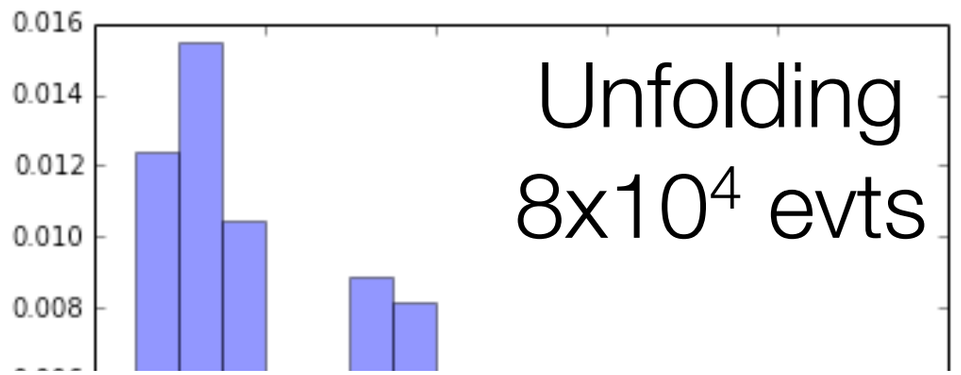
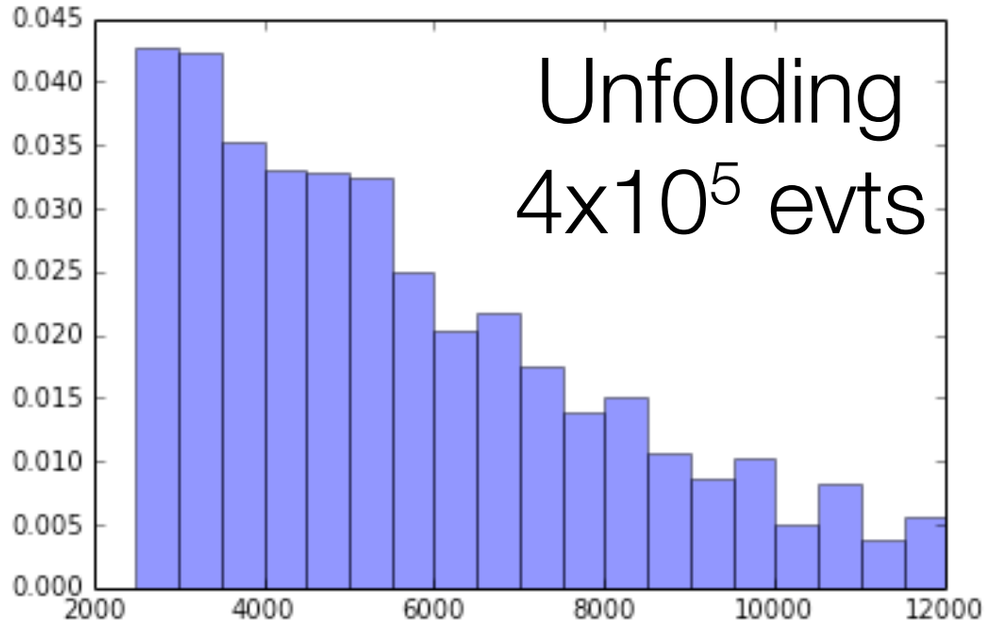


Generated spectrum



Unfolding
8×10^4 evts

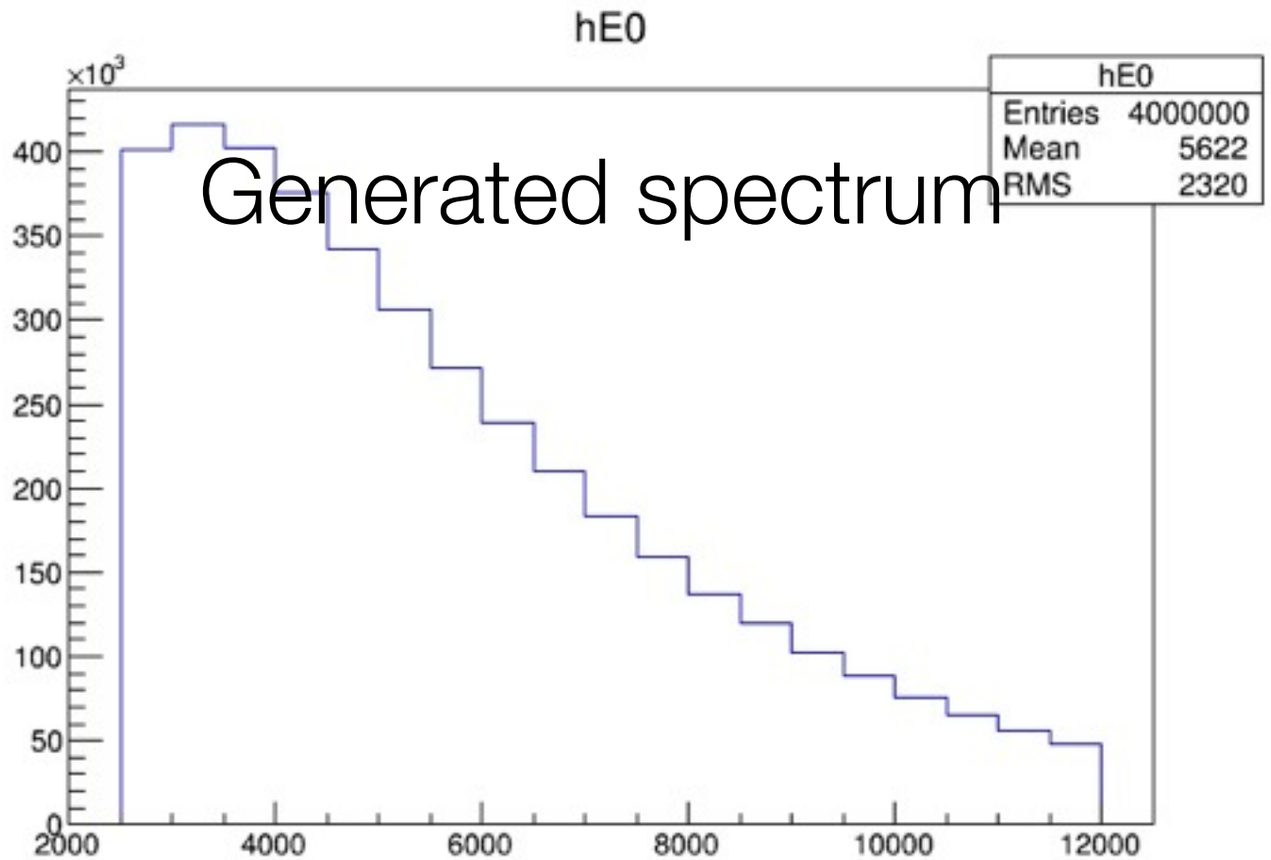


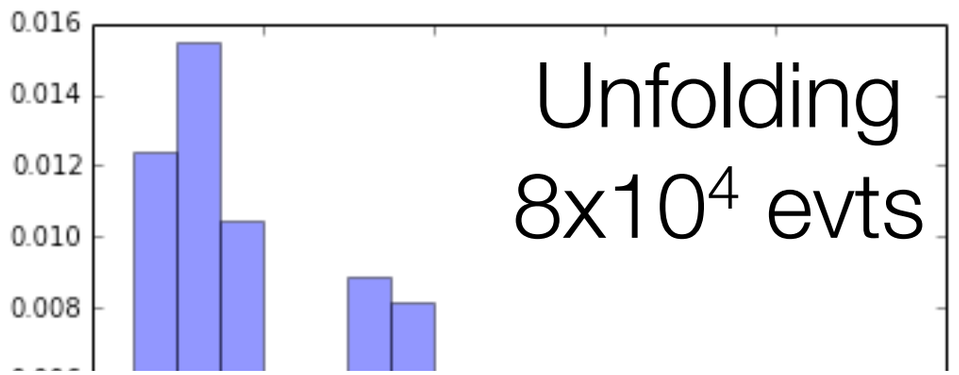
Unfolding
4×10^5 evts

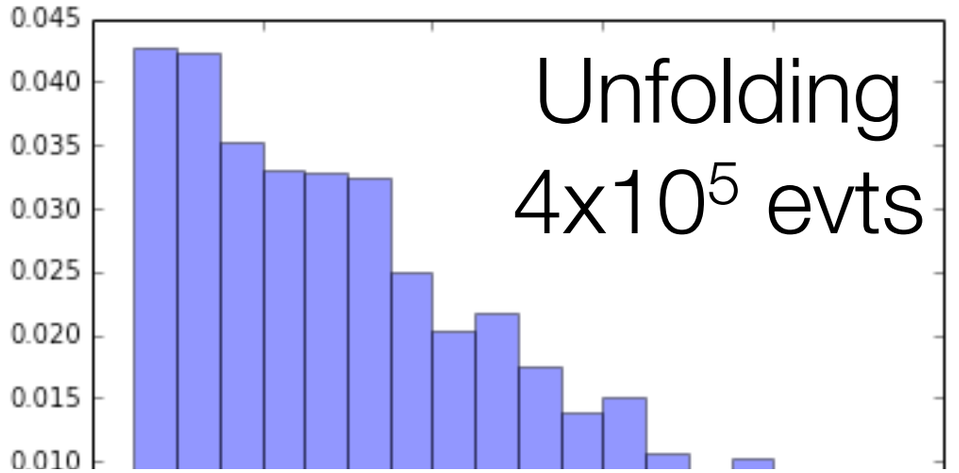
Unfolding scheme

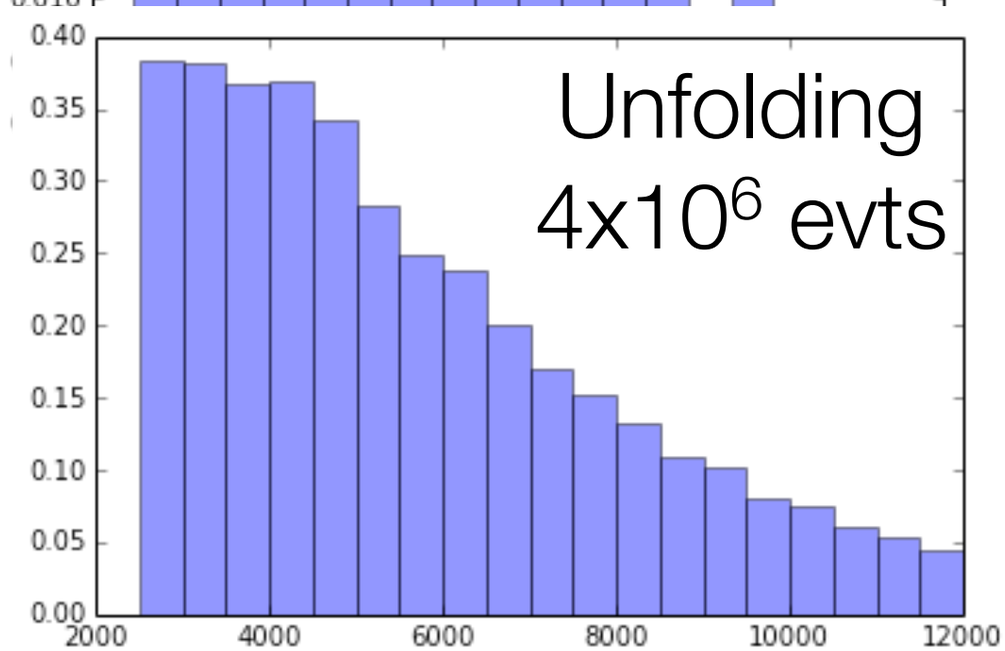
- Test with EH's pdf:

$$\mathrm{W(T)} = \mathrm{A(1\text{-}T}_{th}/T)^{\alpha} e^{-\mathrm{T}/\mathrm{T}_0};$$









Summary

- Attempted to see proton spectrum
- PID was enough up to 10 MeV
- Proton rate vs time looks correct
- Crude estimation of proton emission rate: 7.7%
- Do we have enough stats for a good unfolding?