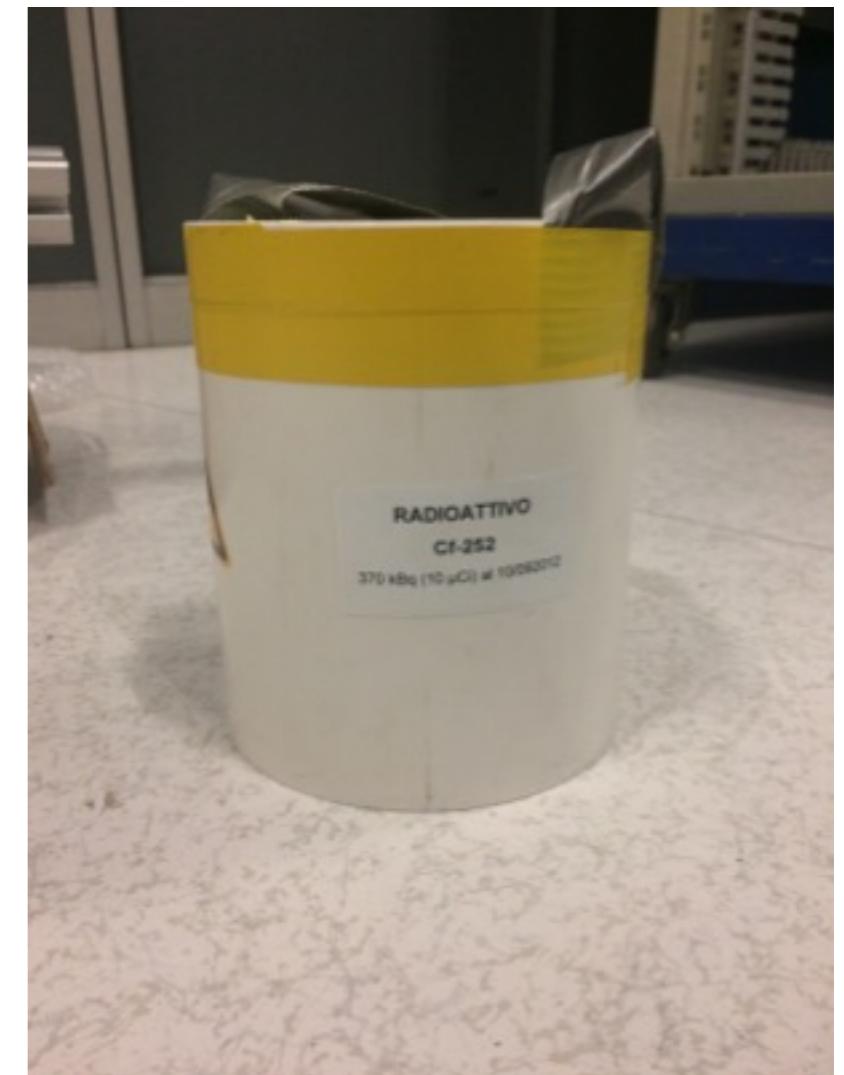
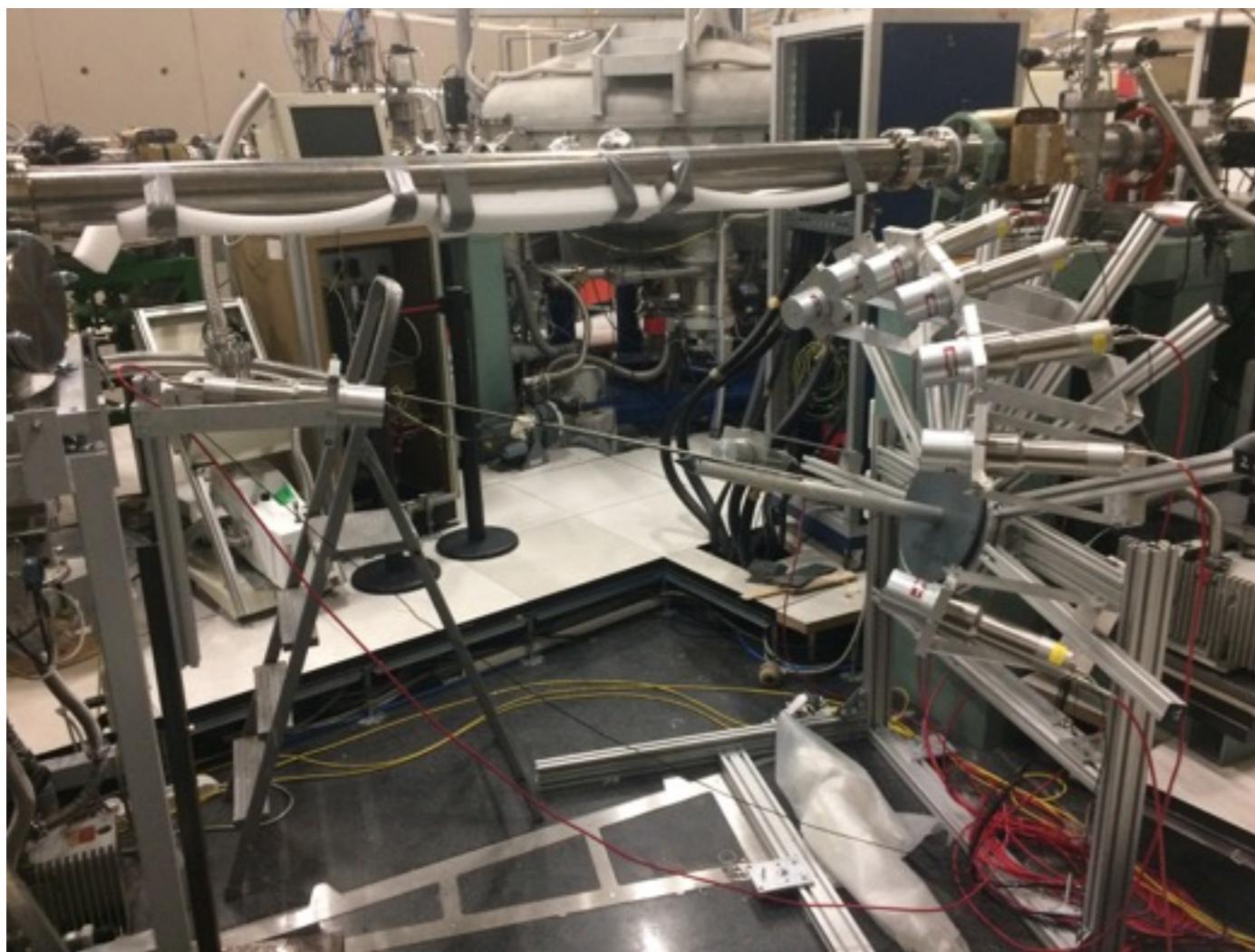


LSci Calibration campaign at LNS

ReD call 24-02-19

Simone Sanfilippo, Marisa Gulino, Luciano Pandola and Marco Rescigno

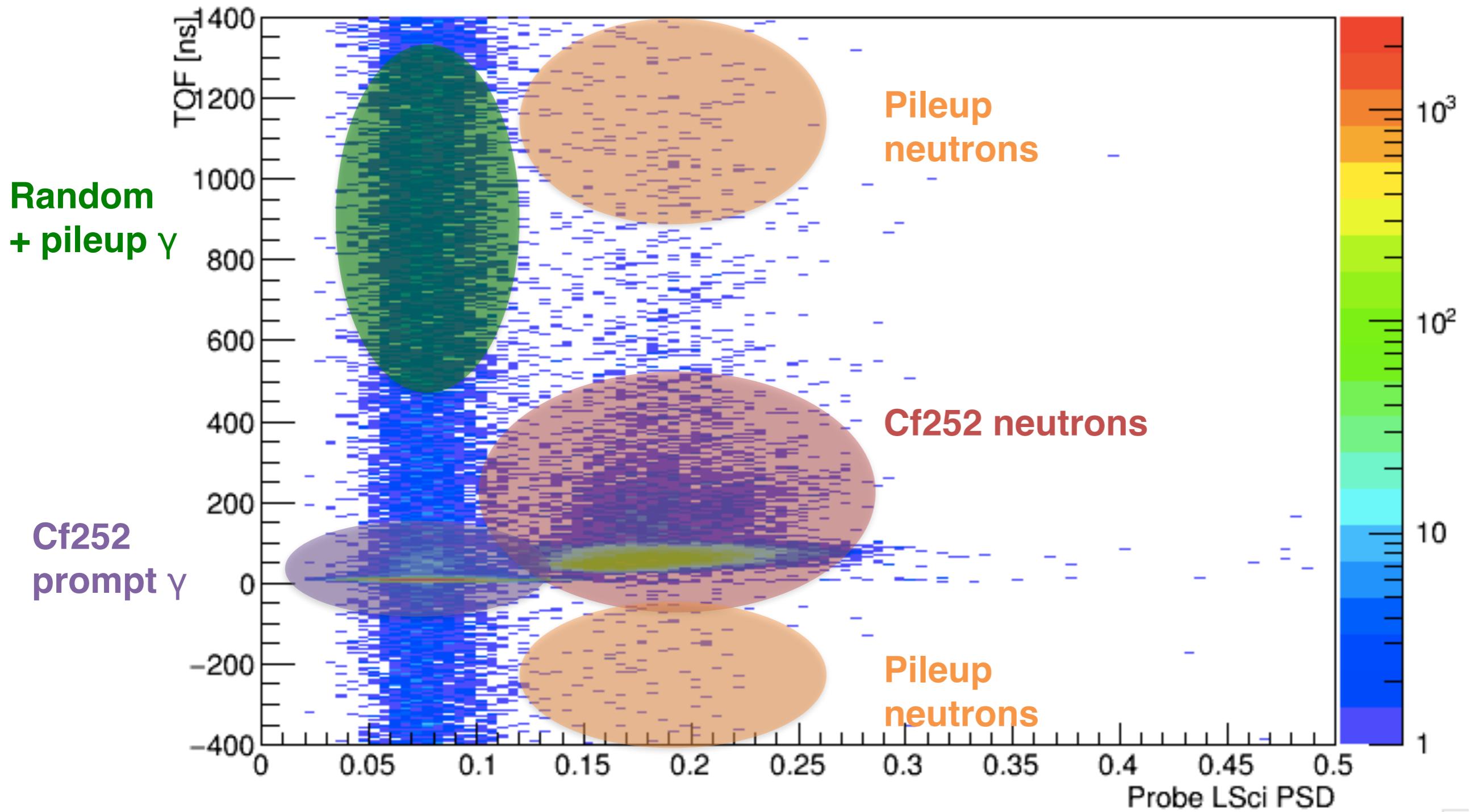
- Goal: to measure the absolute efficiency of ReD Liquid Scintillator's cells (9x3" Scionix 76/3M - EJ309);
- How: using a ^{252}Cf source (Stevanato et al. - 2014) on the ReD “wheel” setup at LNS.



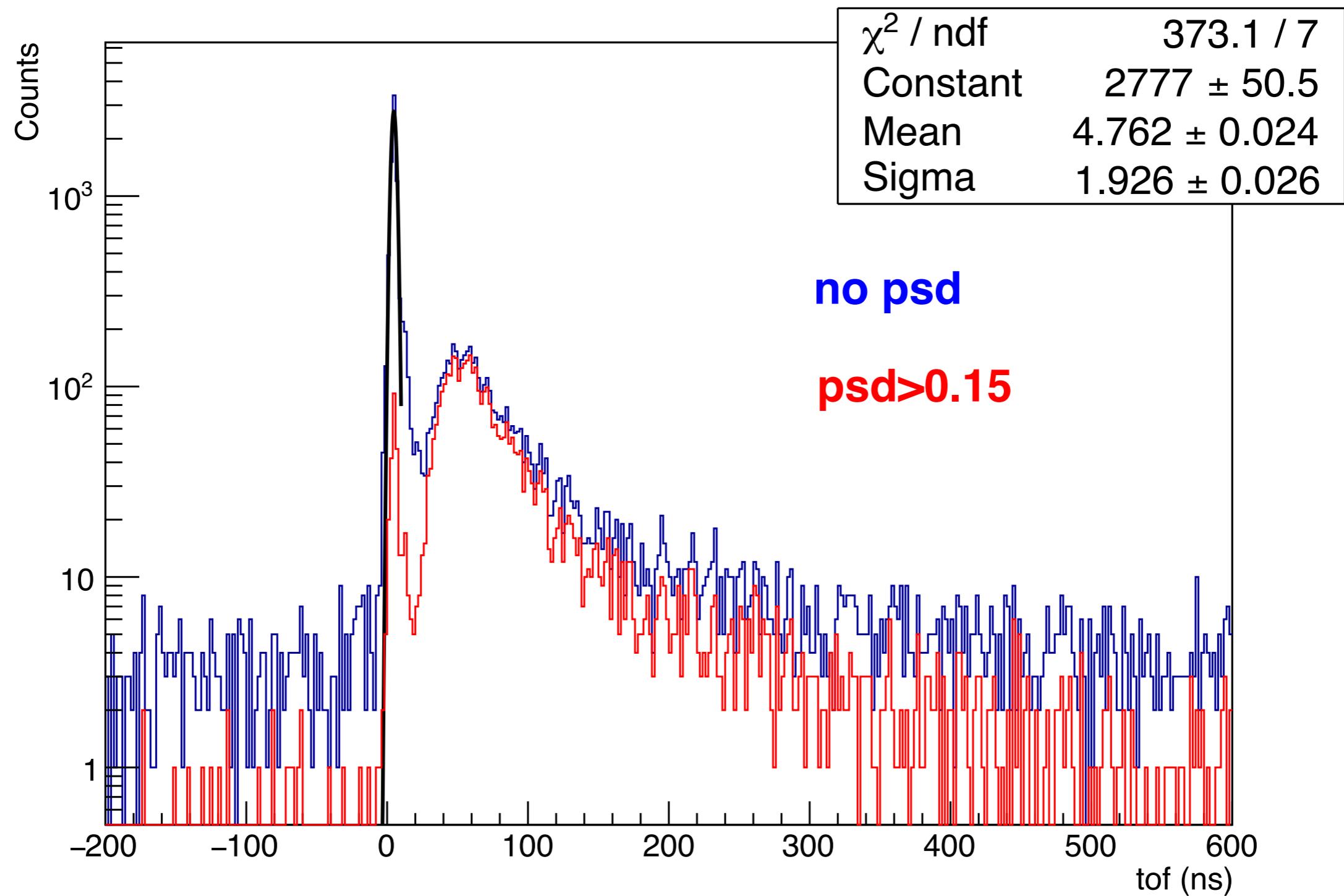
- About 80 runs taken in different trigger and hw conditions, with neutrons (²⁵²Cf) and g-sources (²⁴¹Am, ¹³⁷Cs and ²²Na);
- data list available at: https://docs.google.com/spreadsheets/d/1uLuPBQw_VRyD-pg9_WpvleZYWbOU8juT501R-5jCheM/edit#gid=0

	74	168k	²⁵² Cf	t_start: 23:43 t_stop: 09:54	channelmapping_lsci swapped	PMT1 (near) in coincidence with (PMT0 or PMT2)				
23/02/19 Simone	75	3.8M	²⁵² Cf	t_start: 10:10 t_stop: 10:59	channelmapping_lsci swapped	trigger on PMT1 in single mode only PMT0 and PMT2 on board1 acquired in slave mode changed FILE_MAX_EVENTS from 10000 to 50000				
	76	3.9M	²⁵² Cf	t_start: 11:02 t_stop: 11:53	channelmapping_lsci swapped	trigger on PMT1 in single mode only PMT0 and PMT2 on board1 acquired in slave mode changed FILE_MAX_EVENTS from 10000 to 50000				
	77	3.9M	²⁵² Cf	t_start: 11:58 t_stop: 13:04	channelmapping_lsci swapped	trigger on PMT1 in single mode only PMT0 and PMT2 on board1 acquired in slave mode changed FILE_MAX_EVENTS from 10000 to 50000	BKG	t_start: 11:57 t_stop:	channelmapping_lsci	trigger on PMT1
	78	3.9M	²⁵² Cf	t_start: 16:14 t_stop: 17:03	channelmapping_lsci swapped	trigger on PMT1 in single mode only PMT0 and PMT2 on board1 acquired in slave mode changed FILE_MAX_EVENTS from 10000 to 50000	241Am	t_start: 12:09 t_stop: 12:14	channelmapping_lsci	trigger on PMT1
	79	3.8M	²⁵² Cf	t_start: 17:08 t_stop: 17:57	channelmapping_lsci swapped	trigger on PMT1 in single mode only PMT0 and PMT2 on board1 acquired in slave mode changed FILE_MAX_EVENTS from 10000 to 50000	137Cs	t_start: 12:16 t_stop: 12:20	channelmapping_lsci	trigger on PMT1
							22Na	t_start: 12:23 t_stop: 12:27	channelmapping_lsci	trigger on PMT1
							BKG	t_start: 12:31 t_stop: 12:39	channelmapping_lsci	trigger on PMT2
							241Am	t_start: 12:46 t_stop: 12:49	channelmapping_lsci	trigger on PMT2
							137Cs	t_start: 12:52 t_stop: 12:55	channelmapping_lsci	trigger on PMT2
								t_start: 12:59 t_stop: 13:02	channelmapping_lsci	trigger on PMT2
								t_start: 13:05 t_stop: 13:14	channelmapping_lsci	trigger on PMT3
								t_start: 15:24 t_stop: 15:29	channelmapping_lsci	trigger on PMT3
								t_start: 15:31 t_stop: 15:36	channelmapping_lsci	trigger on PMT3

PROBE TOF vs PSD (all LSci)



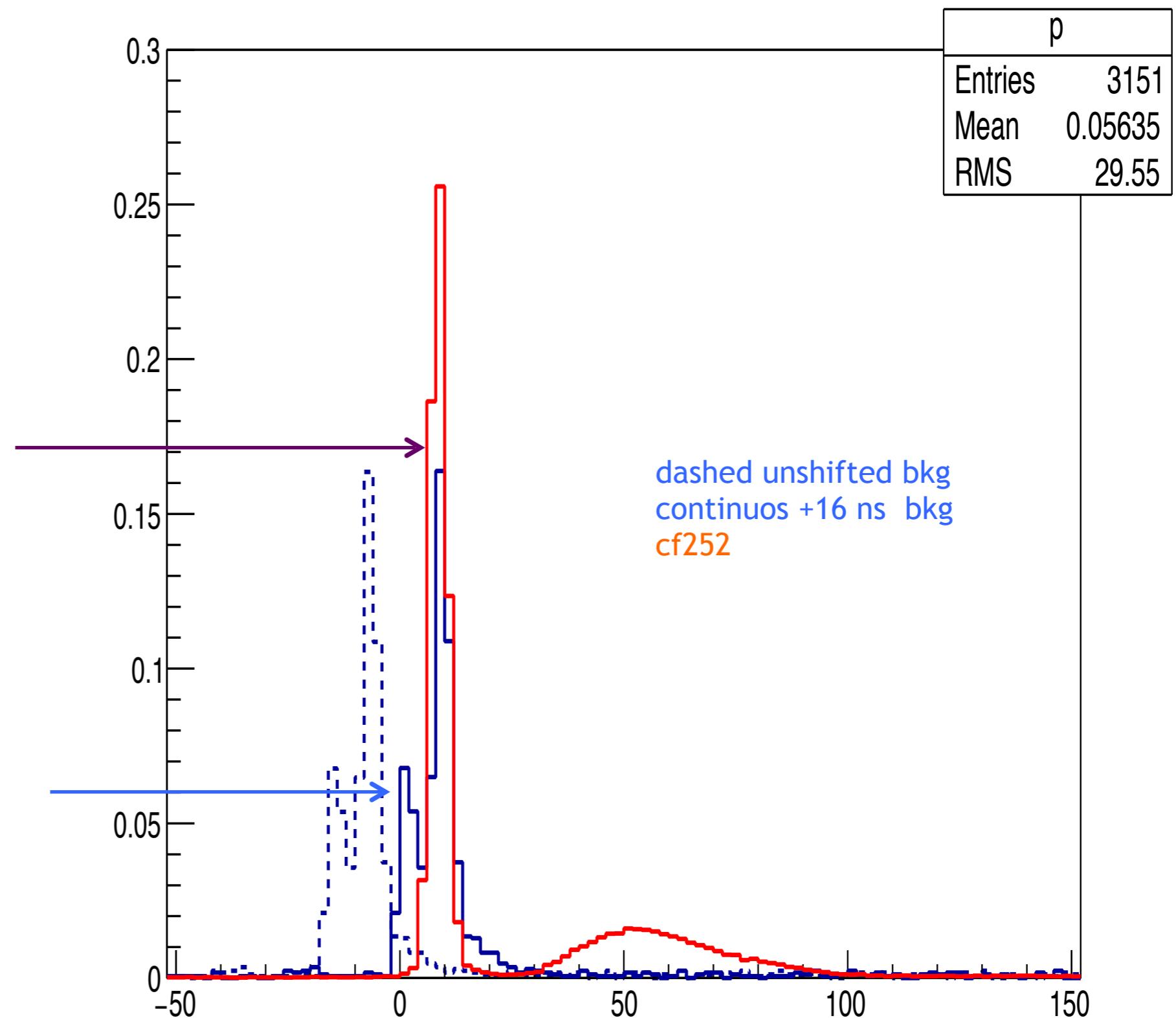
TOF distribution run_75



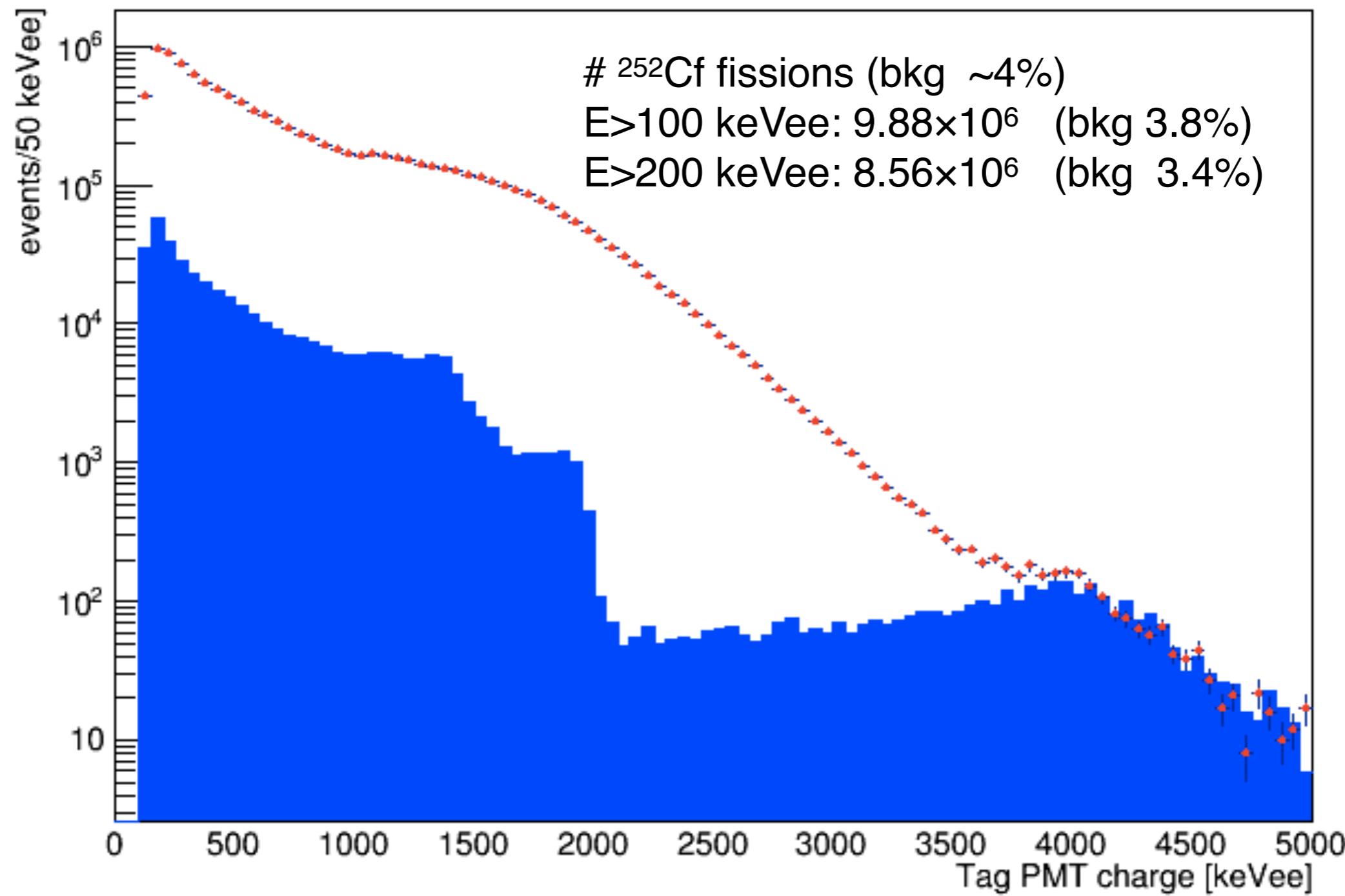
bkg and ^{252}Cf TOF compared

bkg γ hitting first trigger LSci
and then one of the LSci
counters on the wheel

bkg γ hitting first one of the LSci
counters on the wheel and then
the trigger LSci

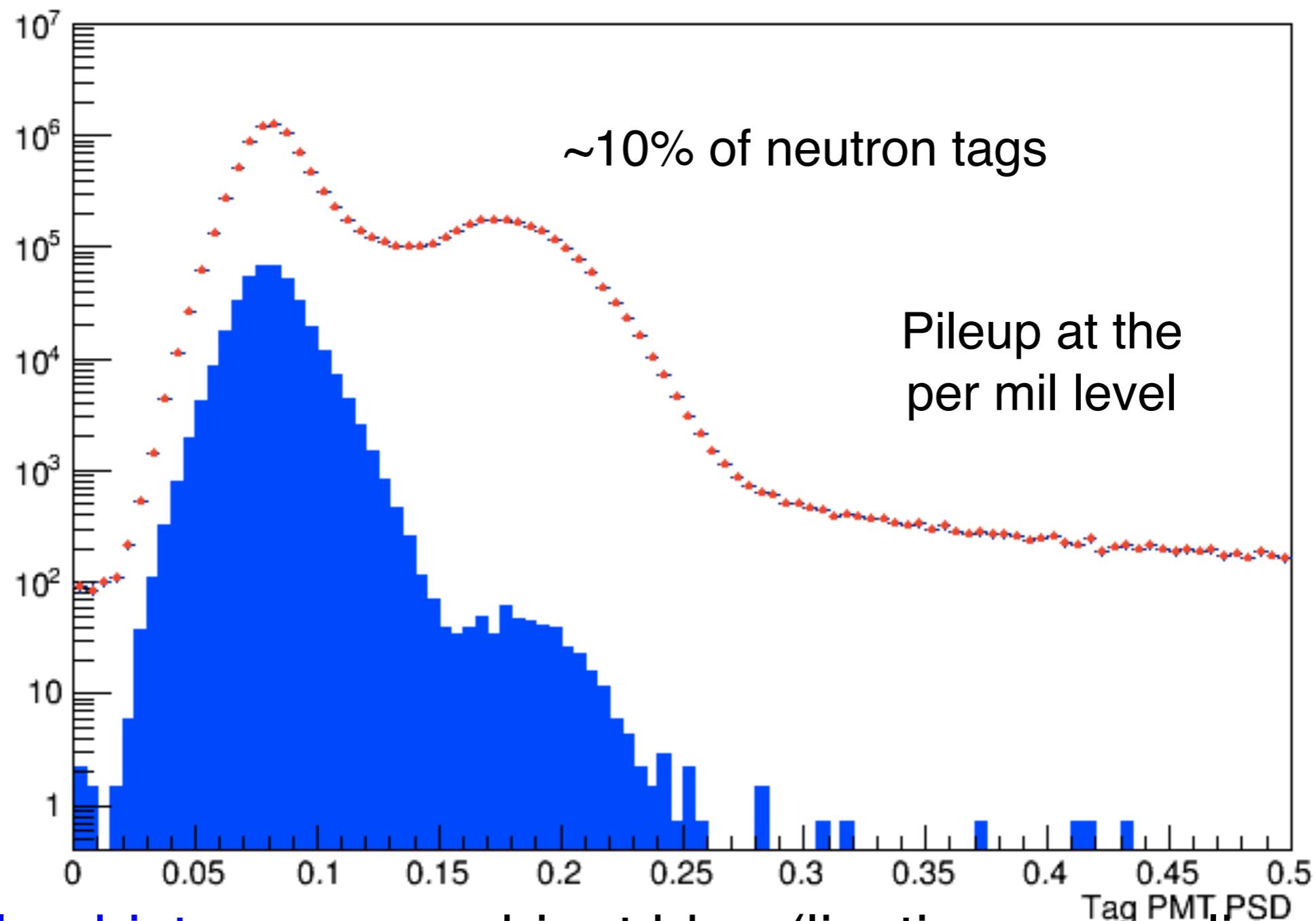


Tag PMT Charge Cf252 and bkg

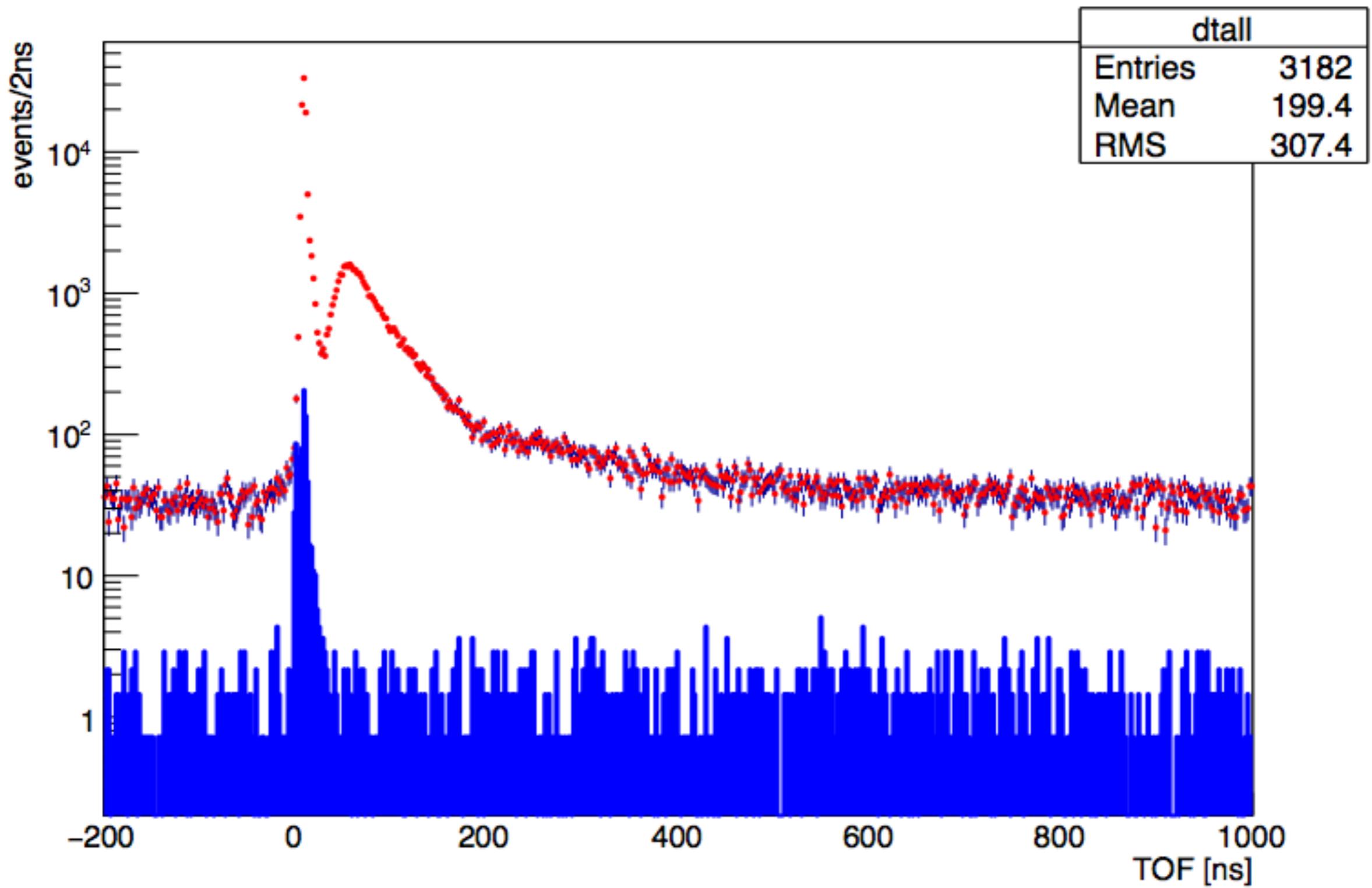


Blue histogram: ambient bkg (livetime normalized)

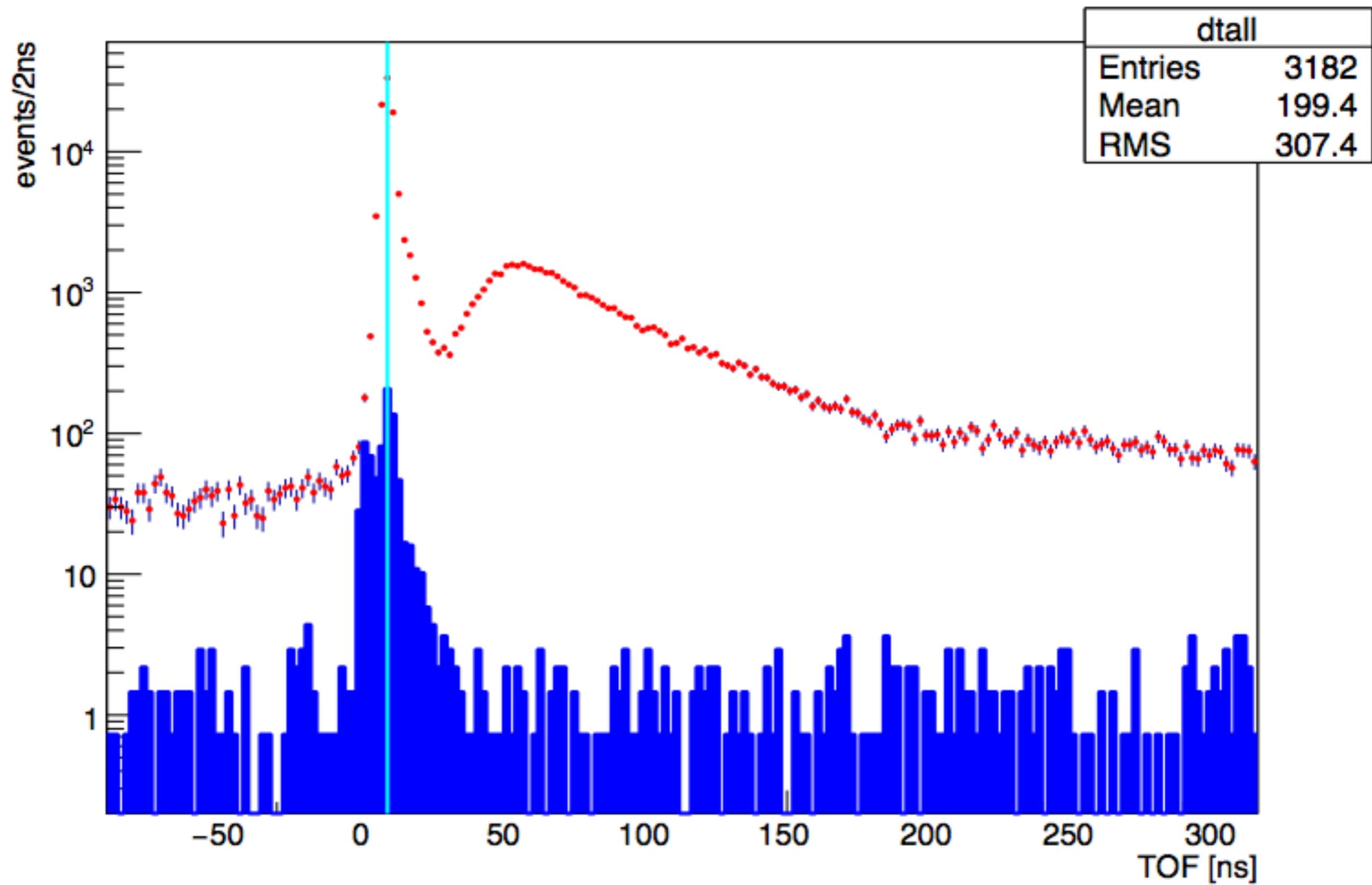
Tag LSci PSD



252Cf with bkg Normalized



252Cf with bkg Normalized (zoom)



Neutron Efficiency

(in progress)

- Trigger on detector close to ^{252}Cf
- Select events with deposited energy $> 200 \text{ keVee}$: n_{fiss}
- Find coincidences in far detectors ($\sim 100 \text{ cm}$)
- Select neutrons in TOF vs PiD plane: n_{det}
- Use:

$$n_{\text{det}} = n_{\text{fiss}} \times n_{\text{multi}} \times \Delta\Omega/4\pi \times n_{\text{Lsci}} \times \varepsilon_{\text{Lsci}}$$

- where $n_{\text{multi}}=3.76$ is the neutron multiplicity per fission (quoted in Stevanato et al.), $\Delta\Omega$ is the solid angle covered by each of the n_{Lsci} liquid scintillators at 100 cm distance ($\pi \times (3 \times \frac{1}{2} \times 2.54)^2/100^2 = 4.56 \times 10^{-3} \text{ sr}$), and $\varepsilon_{\text{Lsci}}$ is the neutron efficiency averaged over the Cf252 spectrum and over the 8 LSci detectors;
- With our numbers (9.88×10^6 fissions) : $\varepsilon_{\text{Lsci}}=25.1\%$

Flowchart and cuts

Run #	Run Type	Run Time [s]	Scaler [triggers]	DAQ events	Live time [%]
13	241Am	300	n.a	107834	n.a
14	137Cs	214	639385	200460	31.35
15	22Na	222	116657	114648	98.28
74	252Cf	36650	168690	168638	99.96
75	252Cf	2948	3949242	3809897	96.47

- $16 * (\text{evheader.boardtimes}[1] - \text{evheader.boardtimes}[0]) / 2.$
- Iteration\$>=16 && Iteration\$<24 //in case of coincidence
- $(\text{start_time}[0] - 500) < 50$ //in case of single mode
- $\text{charge}[0] / 7399 * 59.6 > 100 \text{ && } \text{charge}[] / 7399 * 59.6 > 20$
- $f90[] < 0.15$
- **Data are available on Roma3 cluster**, both reco and rawdata:
 - /storage/DATA-02/darkside/red/rawdata/lsci (rawdata)
 - /storage/DATA-02/darkside/red/reco/rm3reco/lsci (reco)

γ -calibration sources **(in progress)**

Updates for ReD call 04-03-19

γ Sources

Type	γ peak [keV]	Compton edge* [keV]	Activity [Bq]
241Am	59.54	11.25	34.2k
137Cs	661.66	477.34	24.8k
22Na	511 1274.54	340.67 1061.71	2k

* <https://userswww.pd.infn.it/~fontana/project/software/2018/03/16/compton-edge.html>

Flowchart

Run #	Run Type	Run Time [s]	Scaler [triggers]	DAQ events	Live time [%]
12	Bkg	561	n.a	102967	n.a
13	241Am	300	n.a	107834	n.a
14	137Cs	214	639385	200460	31.35
15	22Na	222	116657	114648	98.28
16	Bkg	454	107376	105038	97.82
17	241Am	183	108669	105094	96.71
18	137Cs	215	683230	207640	30.39
19	22Na	133	112492	103541	92.04
20	Bkg	521	101721	101107	99.40
21	241Am	261	103907	102826	98.96
22	137Cs	243	734816	232844	31.69
23	22Na	188	146134	137257	93.92

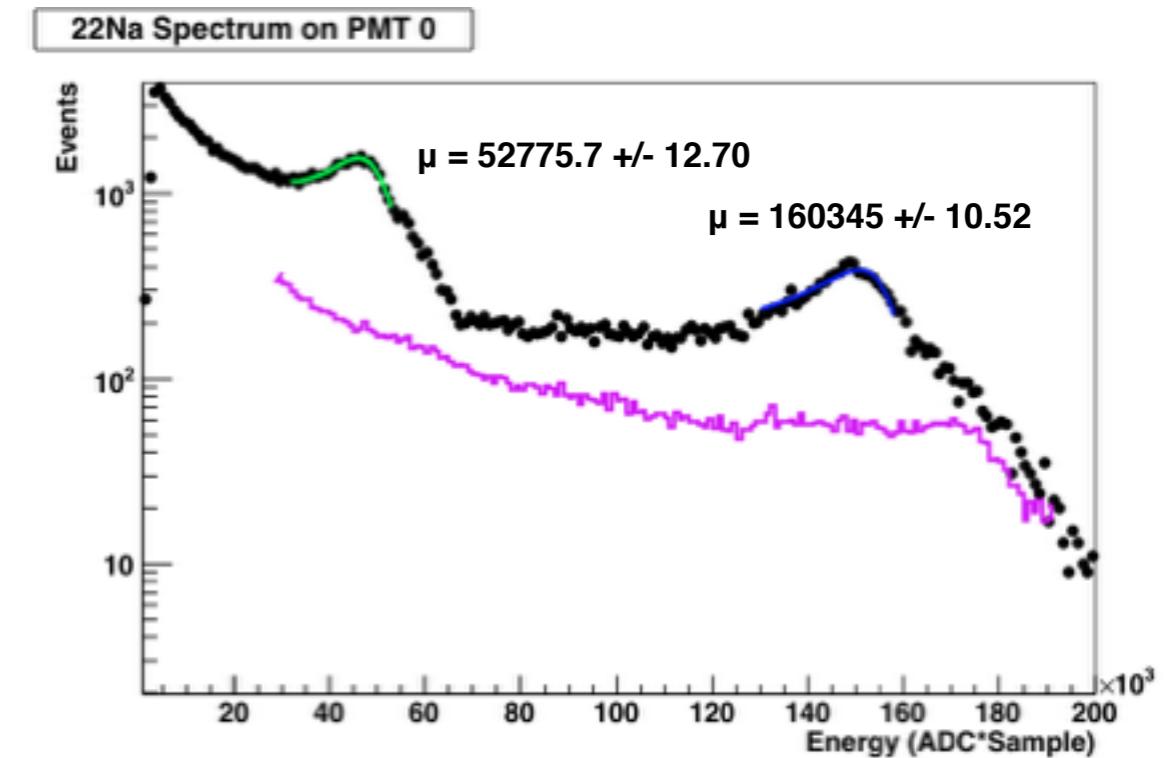
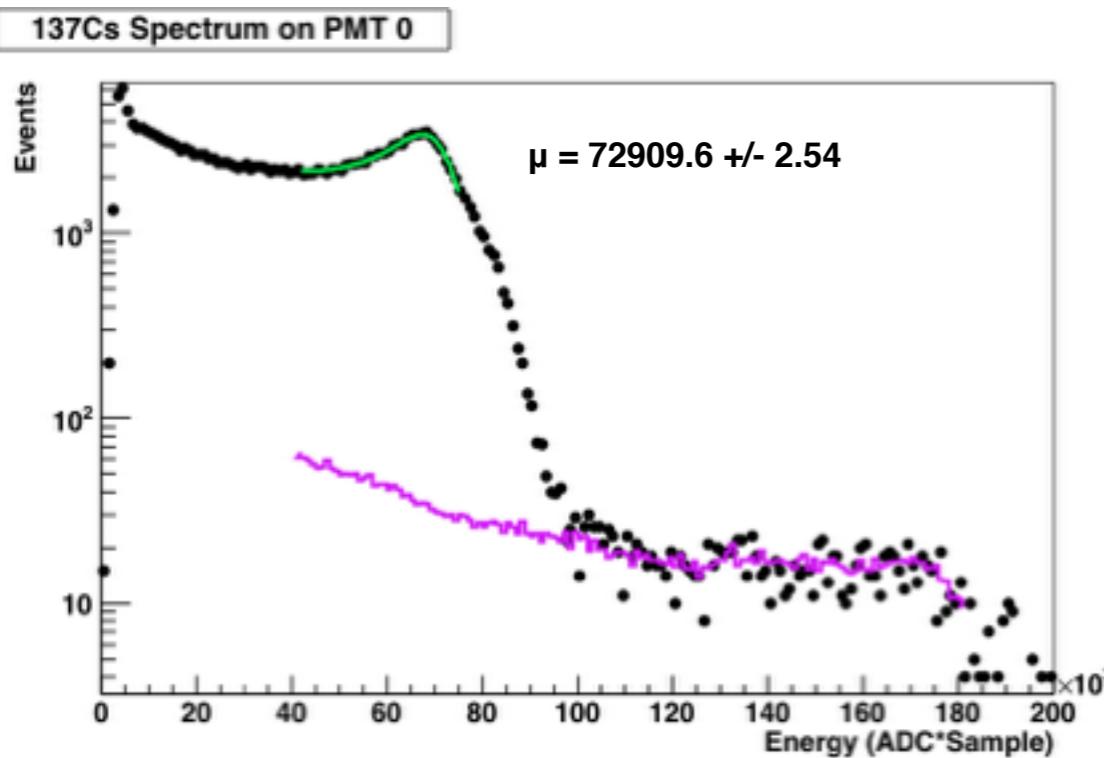
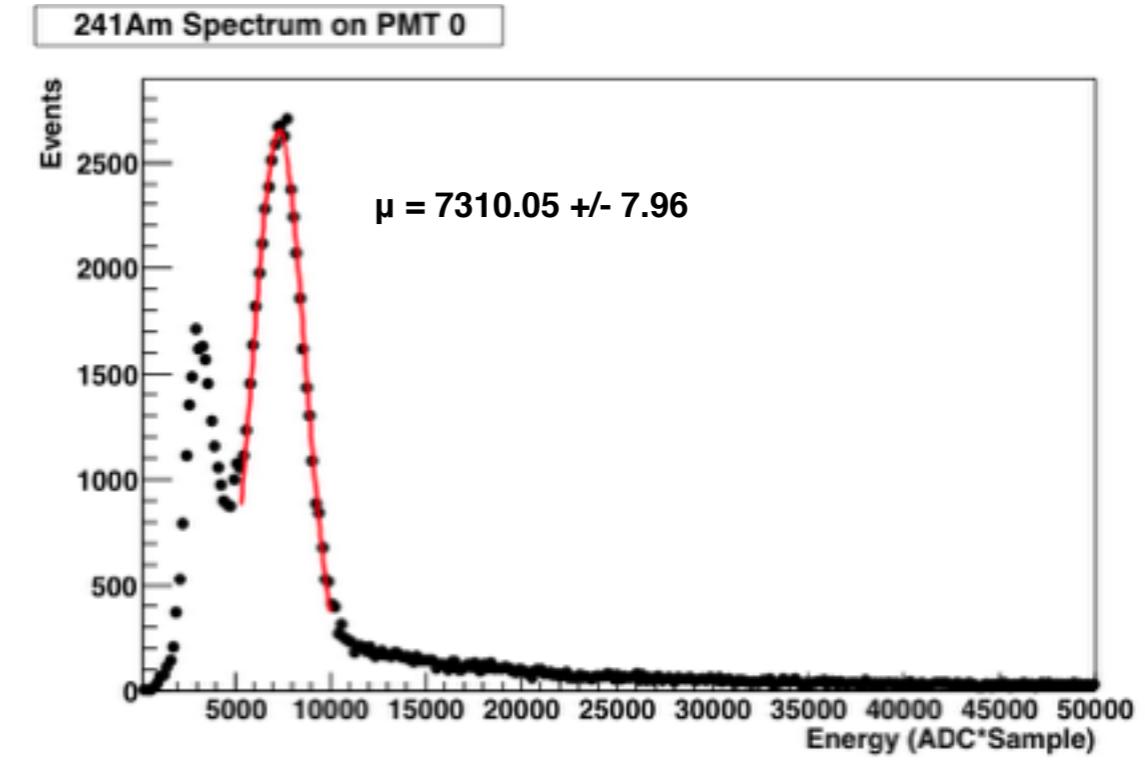
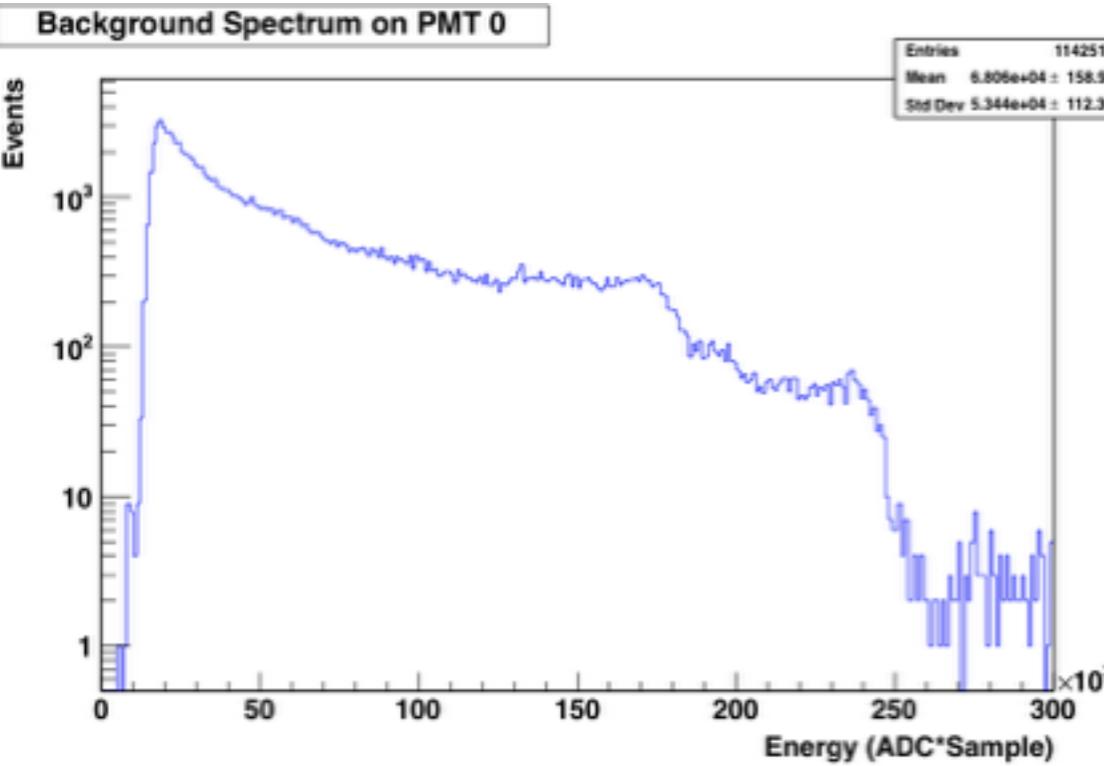
Flowchart

Run #	Run Type	Run Time [s]	Scaler [triggers]	DAQ events	Live time [%]
27	Bkg	557	101625	101530	99.91
28	241Am	301	103024	102067	99.07
29	137Cs	354	1055832	246784	23.37
30	22Na	263	107182	104301	97.31
32	Bkg	528	103415	101479	98.13
33	241Am	348	139256	102796	73.82
34	137Cs	231	715252	206860	28.92
35	22Na	178	139669	103948	74.42
36	Bkg	518	107070	103309	96.49
37	241Am	308	140813	135175	96
38	137Cs	403	1246344	211084	16.94
39	22Na	203	126734	101207	79.86

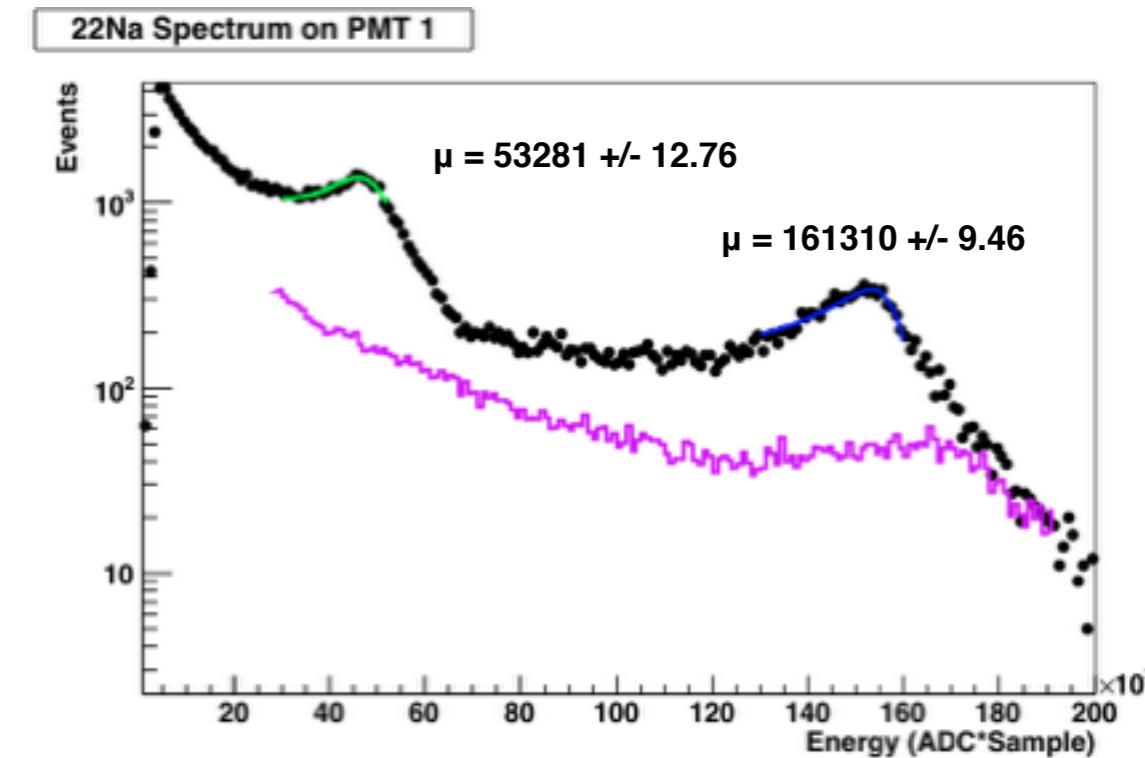
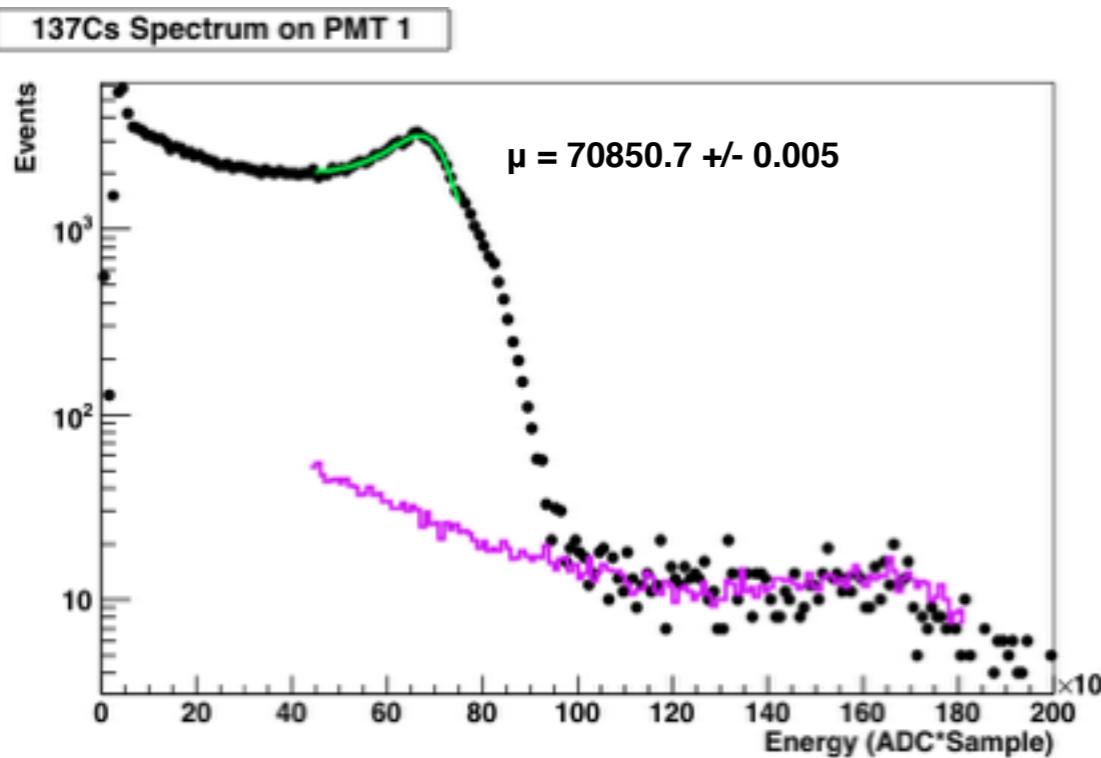
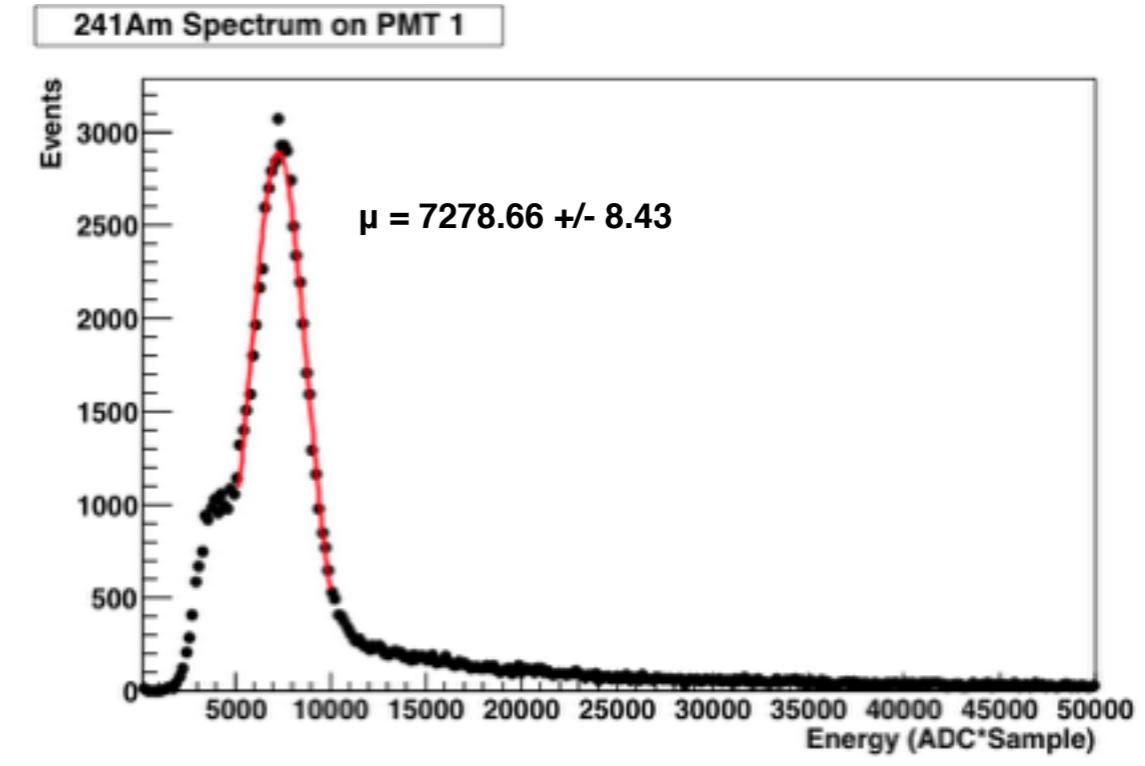
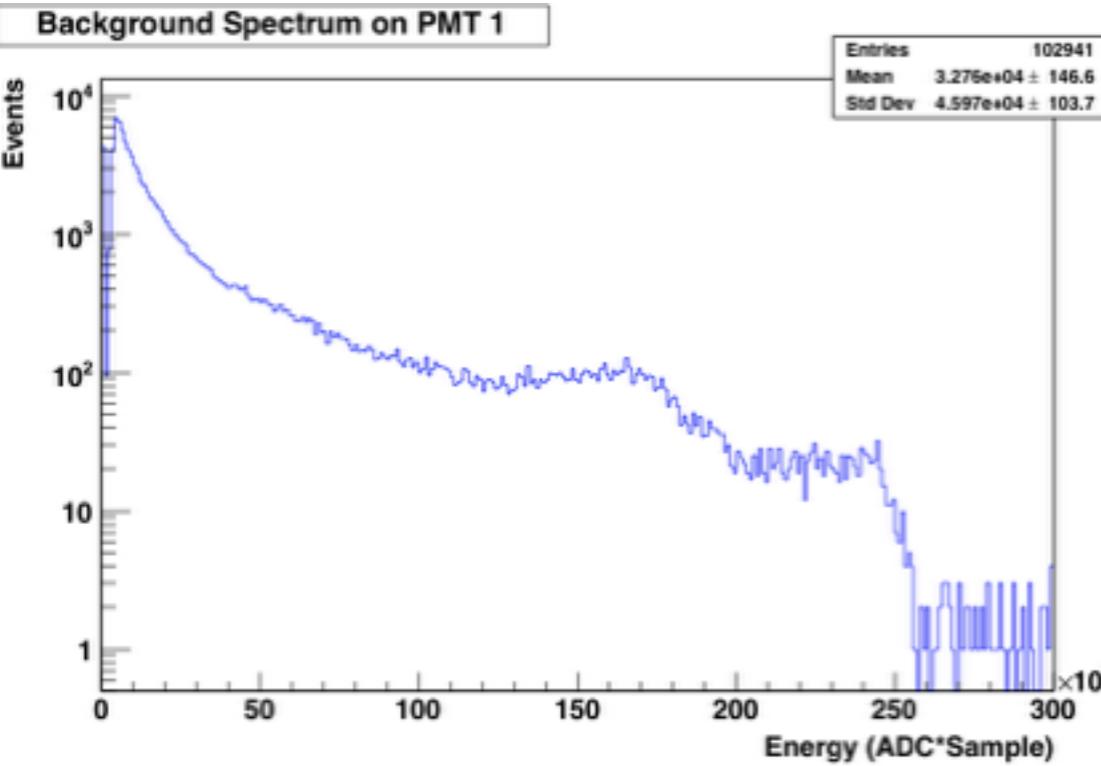
Flowchart

Run #	Run Type	Run Time [s]	Scaler [triggers]	DAQ events	Live time [%]
40	Bkg	559	104037	101541	97.60
41	241Am	330	233560	103015	44.11
42	137Cs	310	922653	220184	23.86
43	22Na	207	157657	106343	67.45
44	Bkg	527	103266	101908	98.68
45	241Am	284	218540	102812	47.04
46	137Cs	226	698254	212760	30.47
47	22Na	148	115254	105476	91.52
50	Bkg	1290	114297	114254	99.96
52	241Am	413	176466	102155	57.89
53	137Cs	960	2964162	214670	7.24
54	22Na	473	368906	115978	31.44

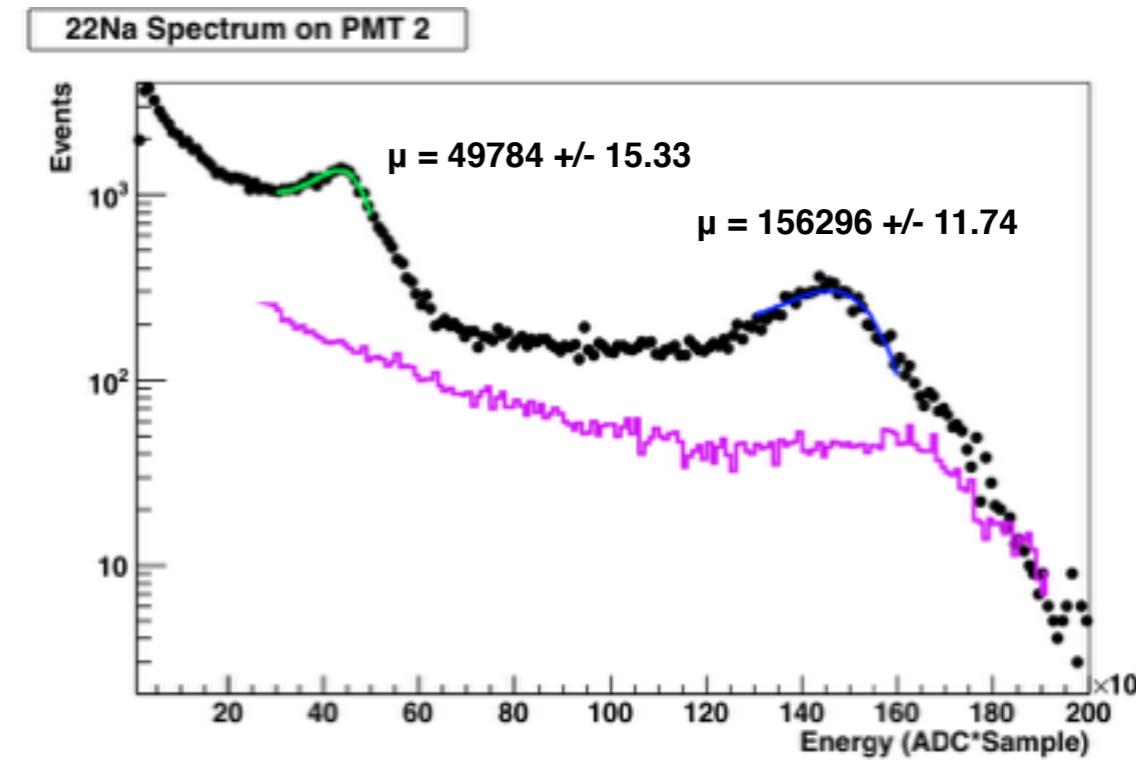
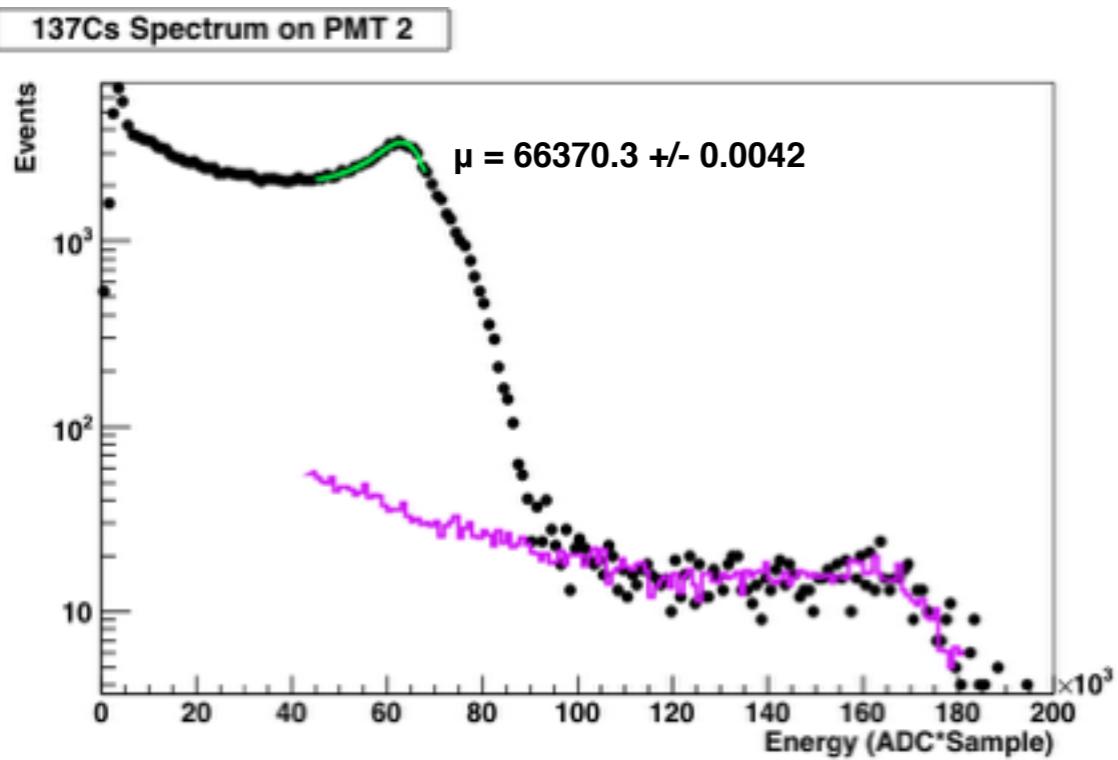
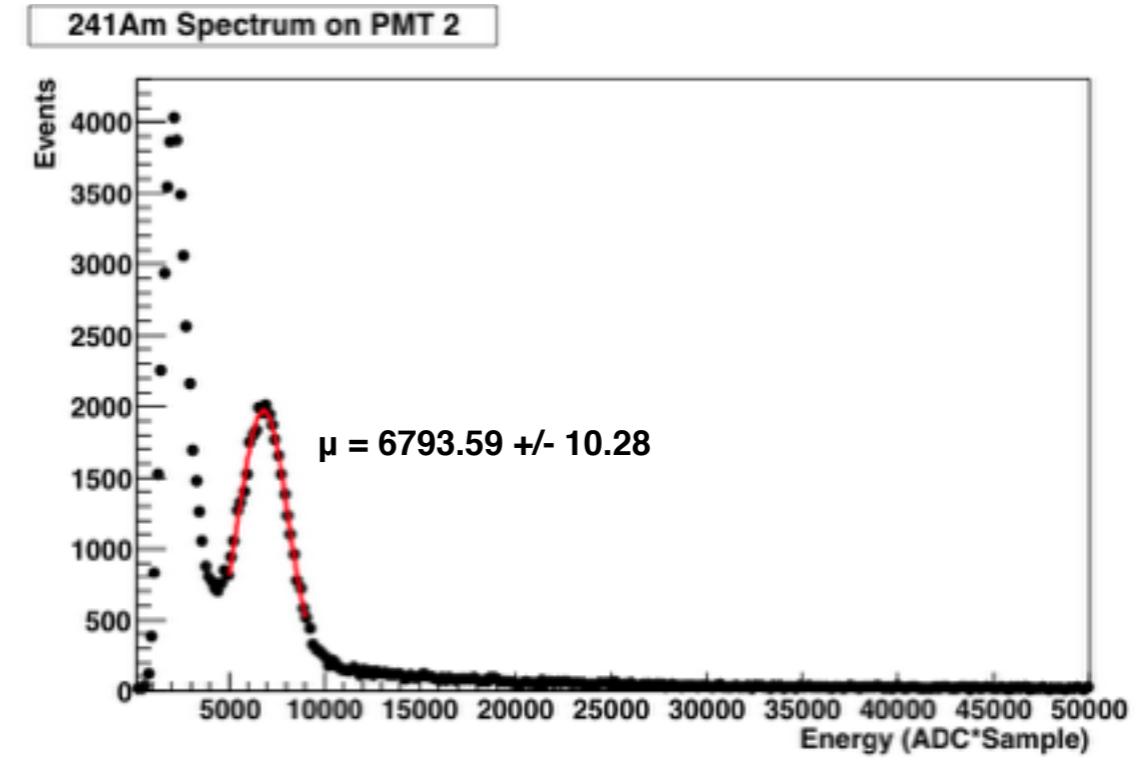
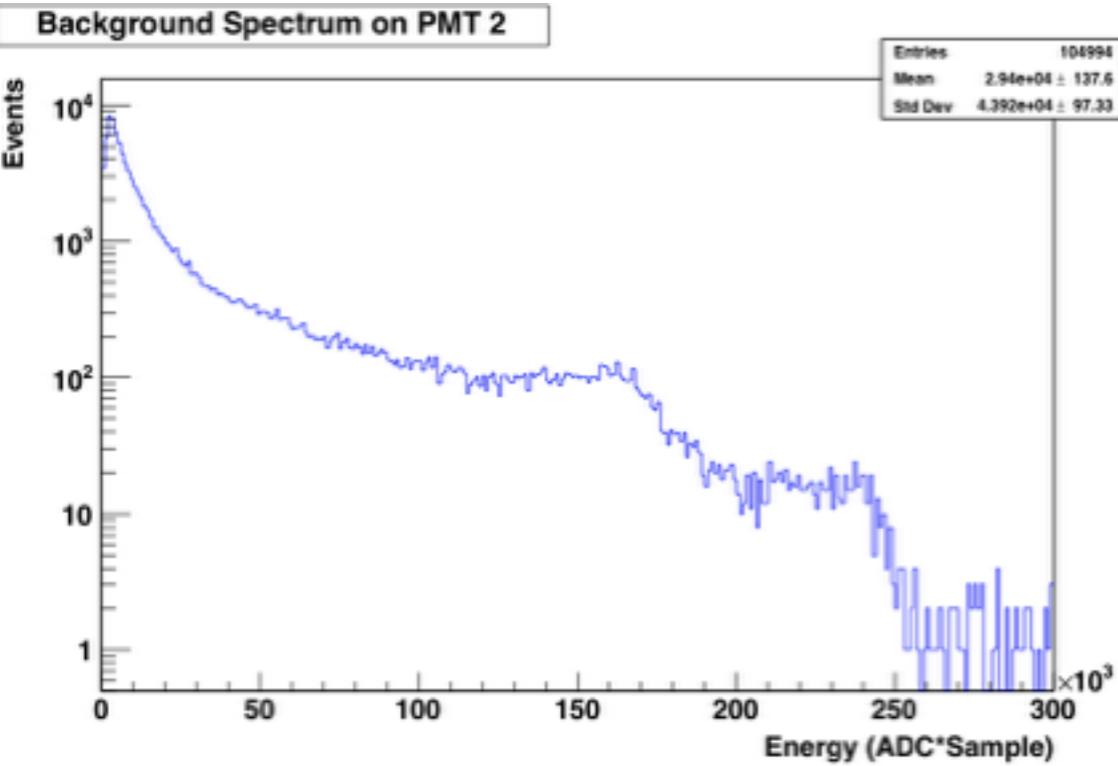
PMT0 Calibration



PMT1 Calibration

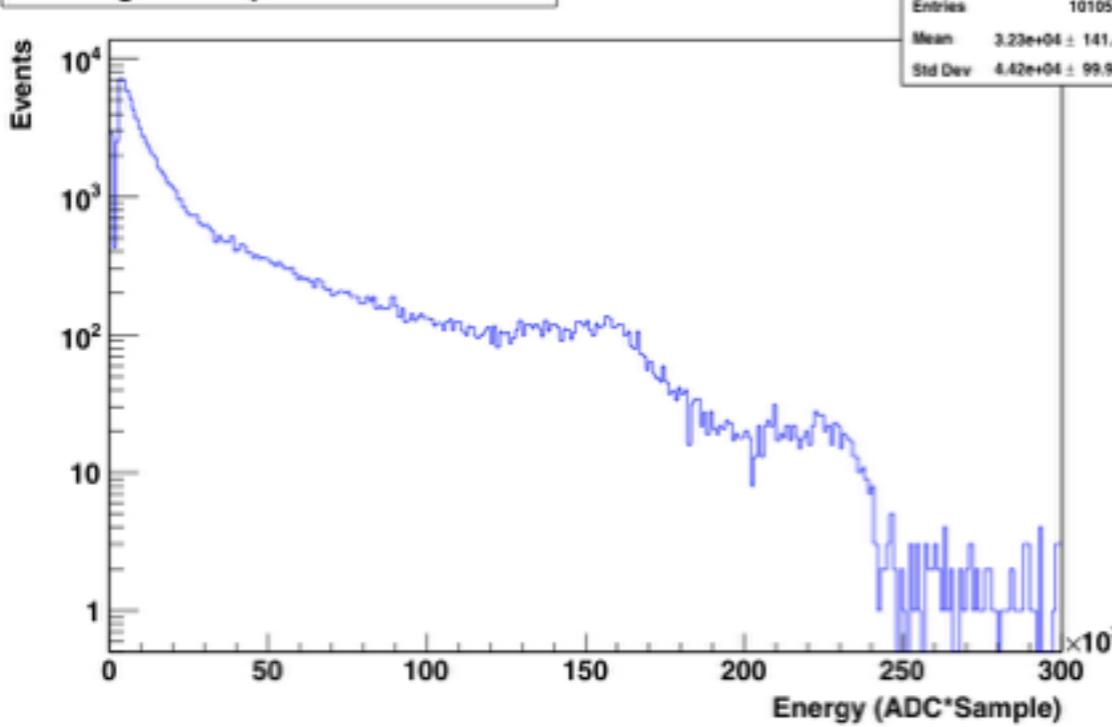


PMT2 Calibration

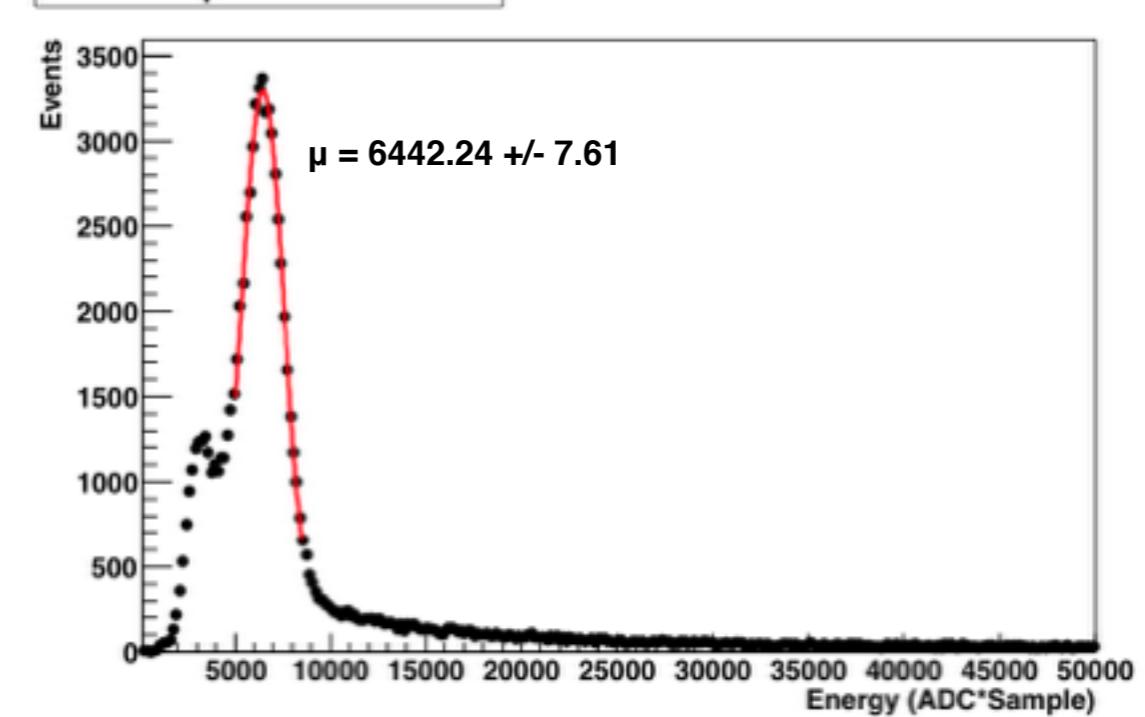


PMT3 Calibration

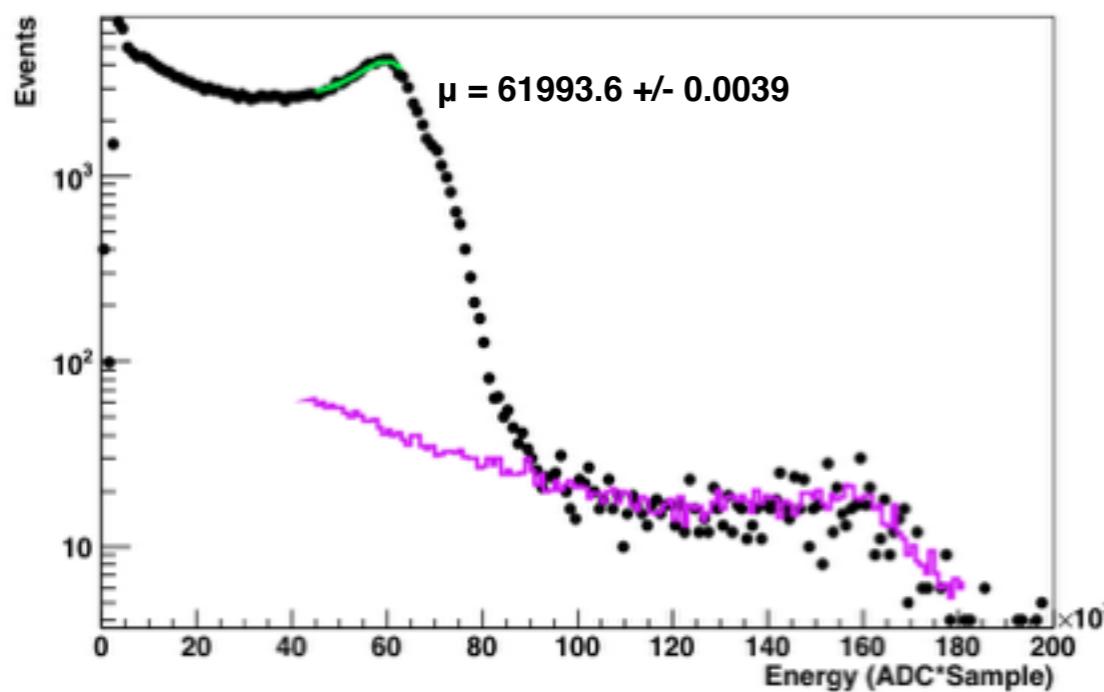
Background Spectrum on PMT 3



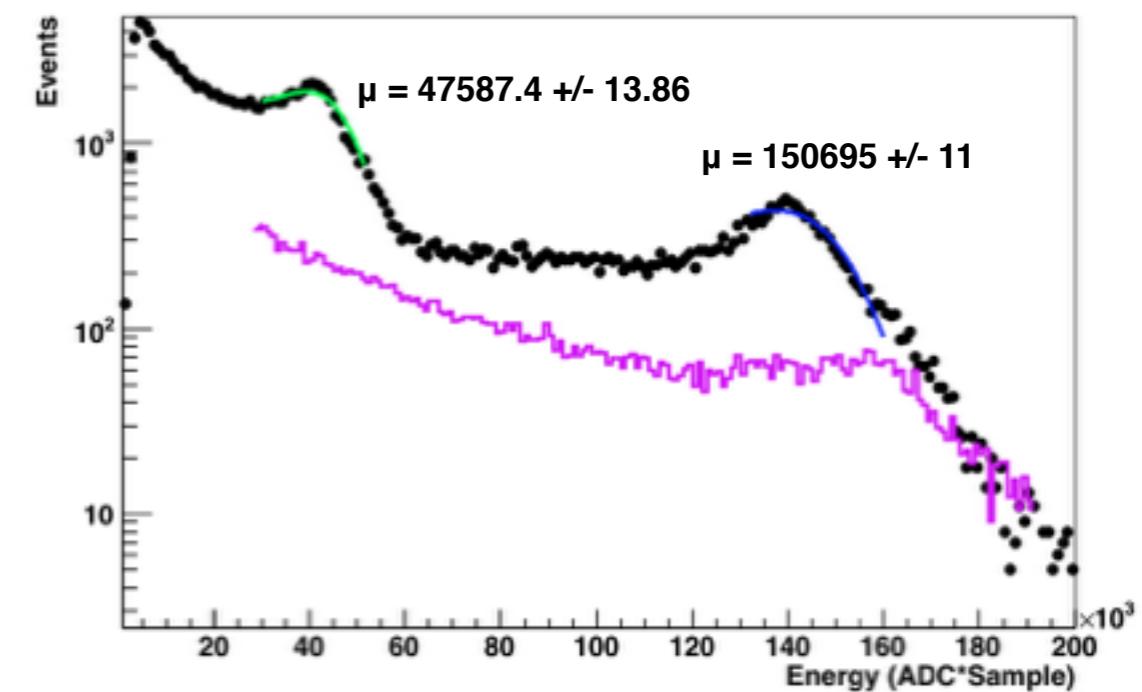
241Am Spectrum on PMT 3



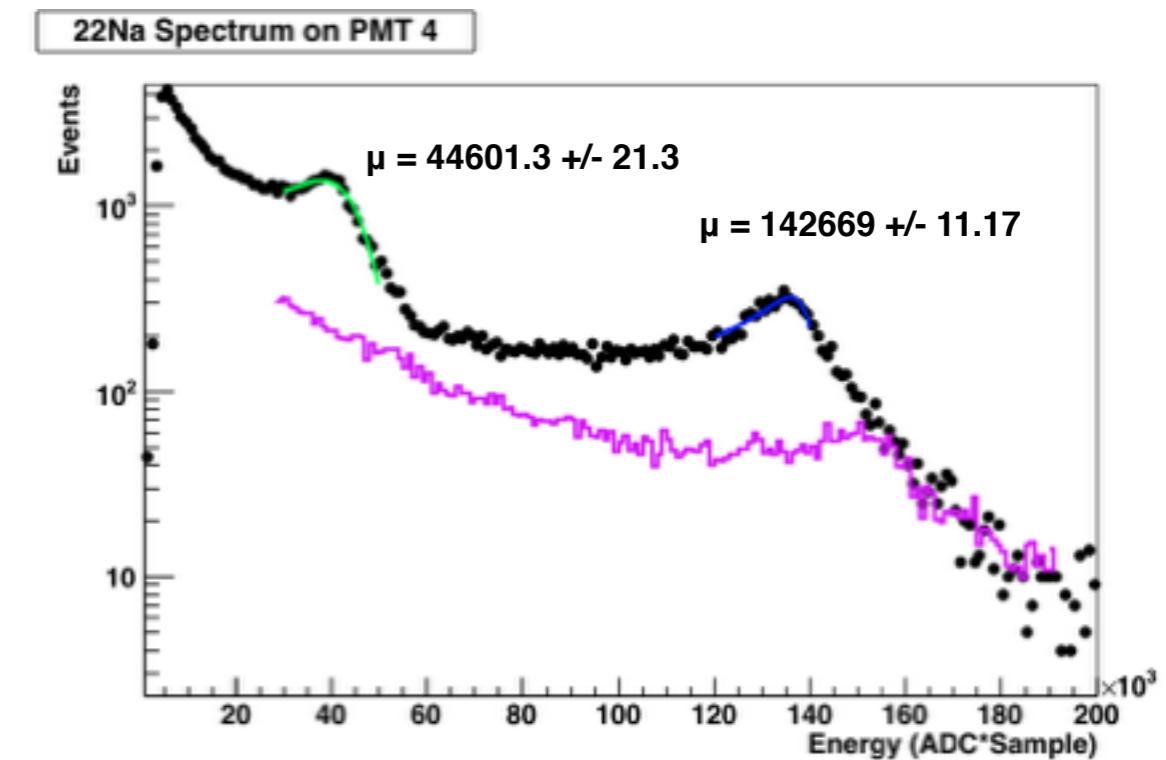
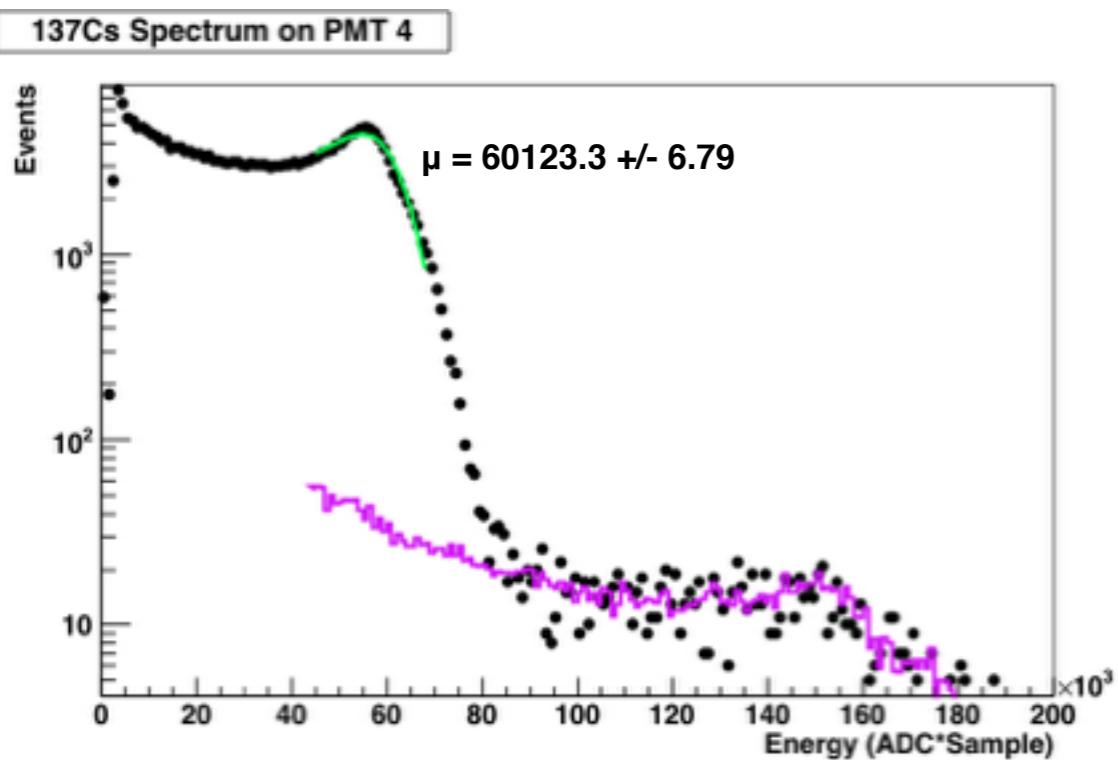
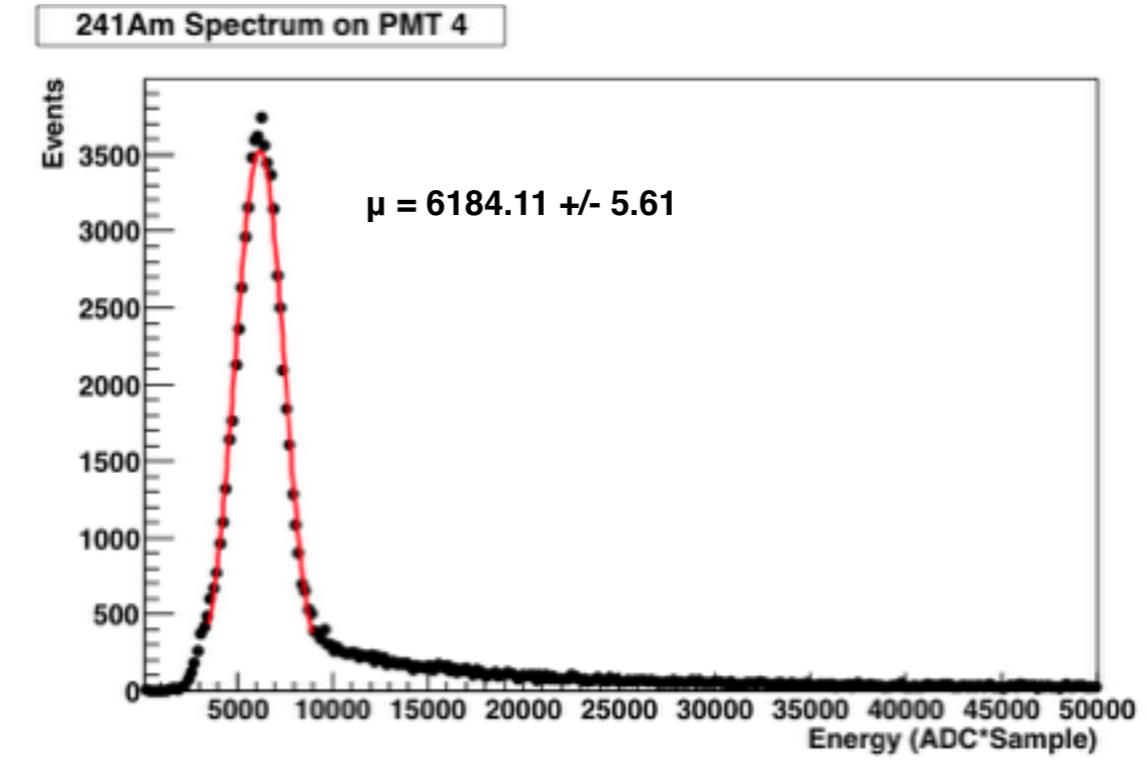
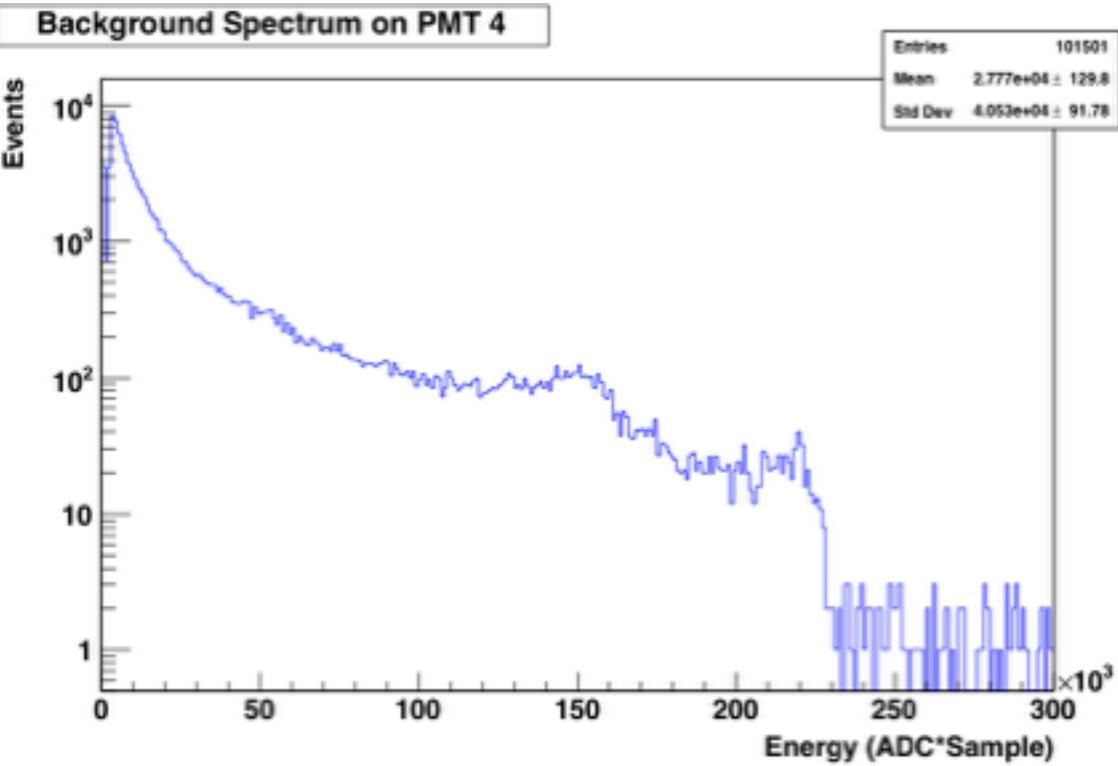
137Cs Spectrum on PMT 3



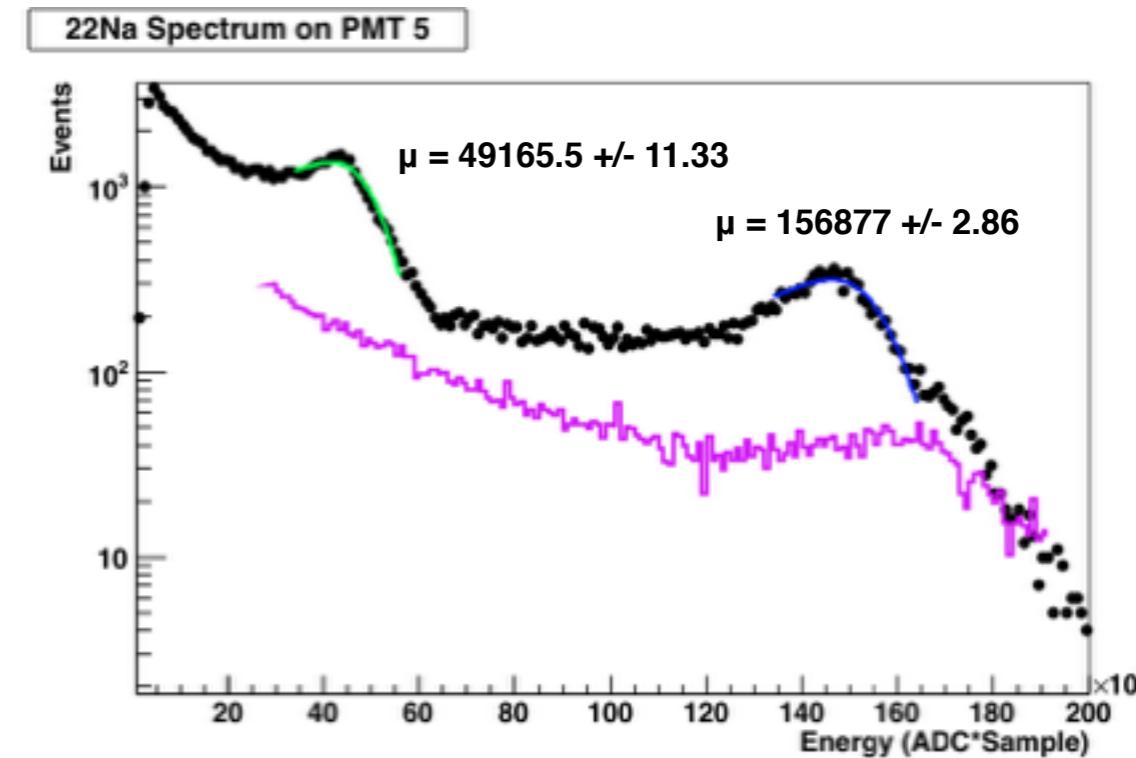
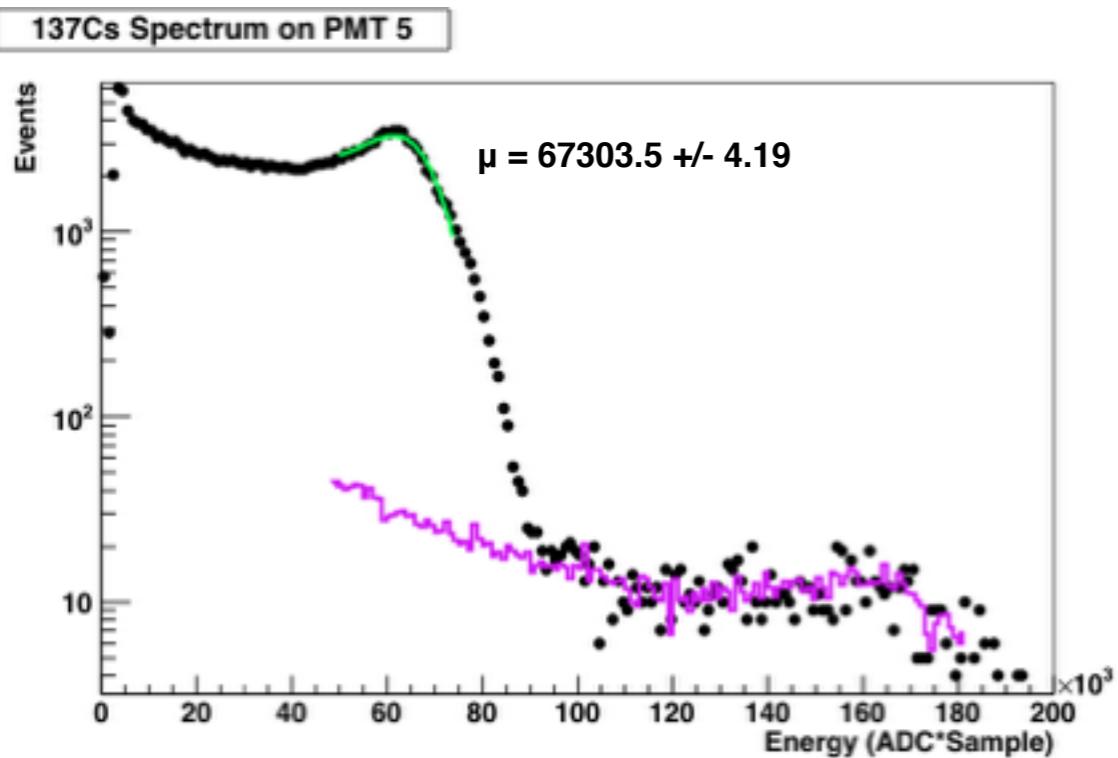
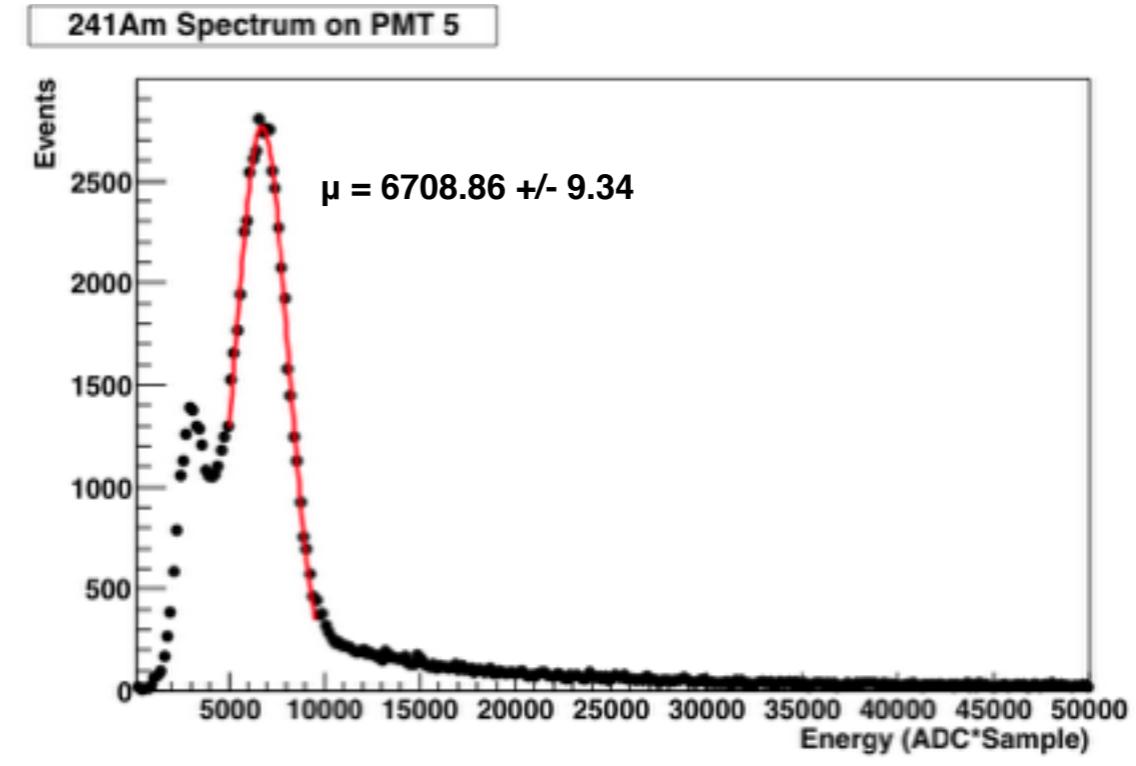
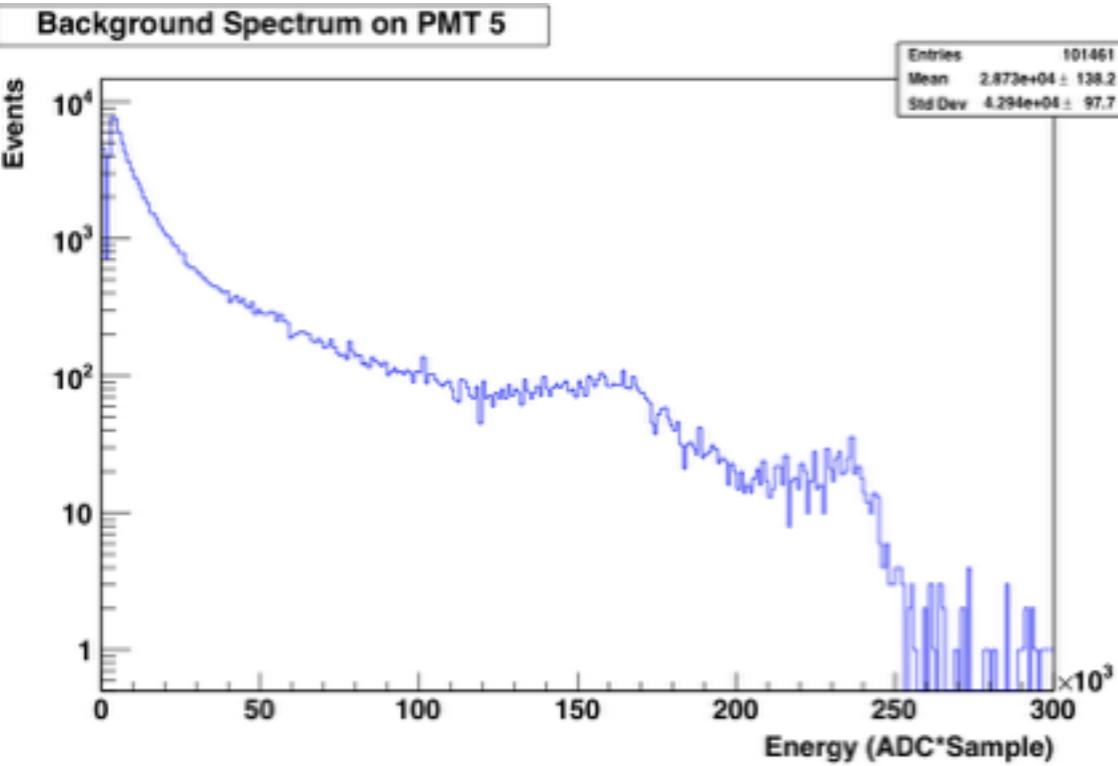
22Na Spectrum on PMT 3



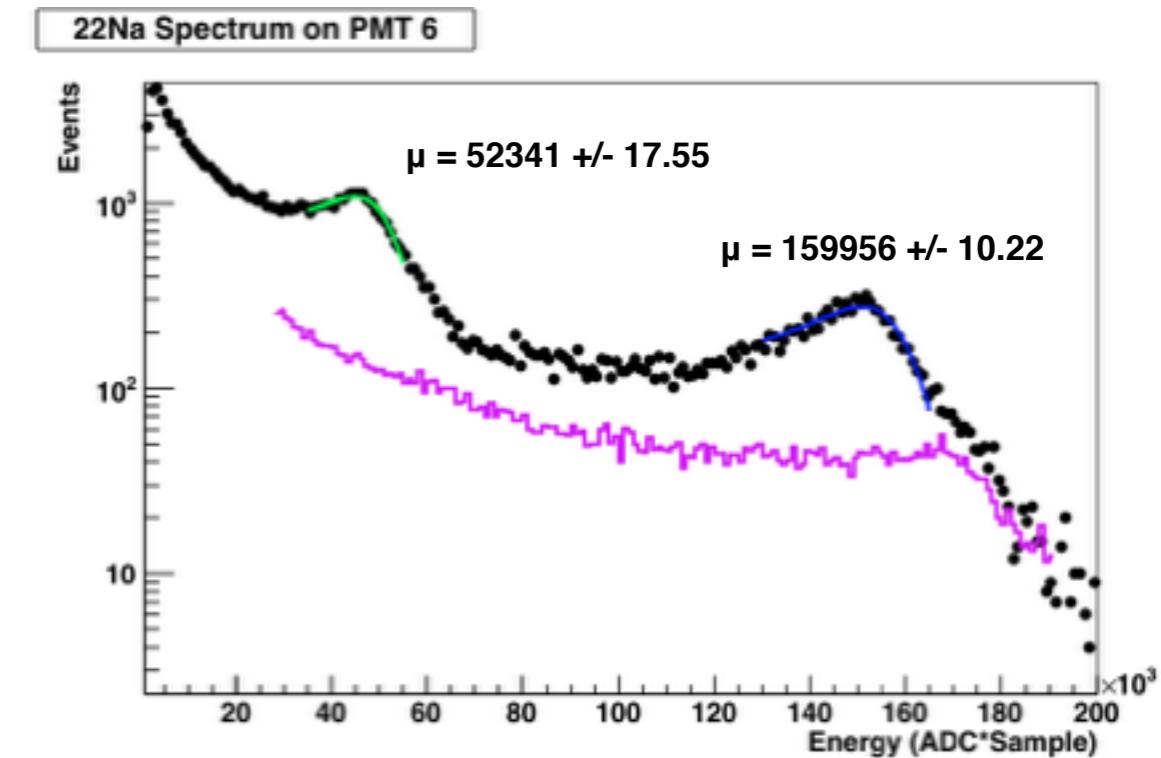
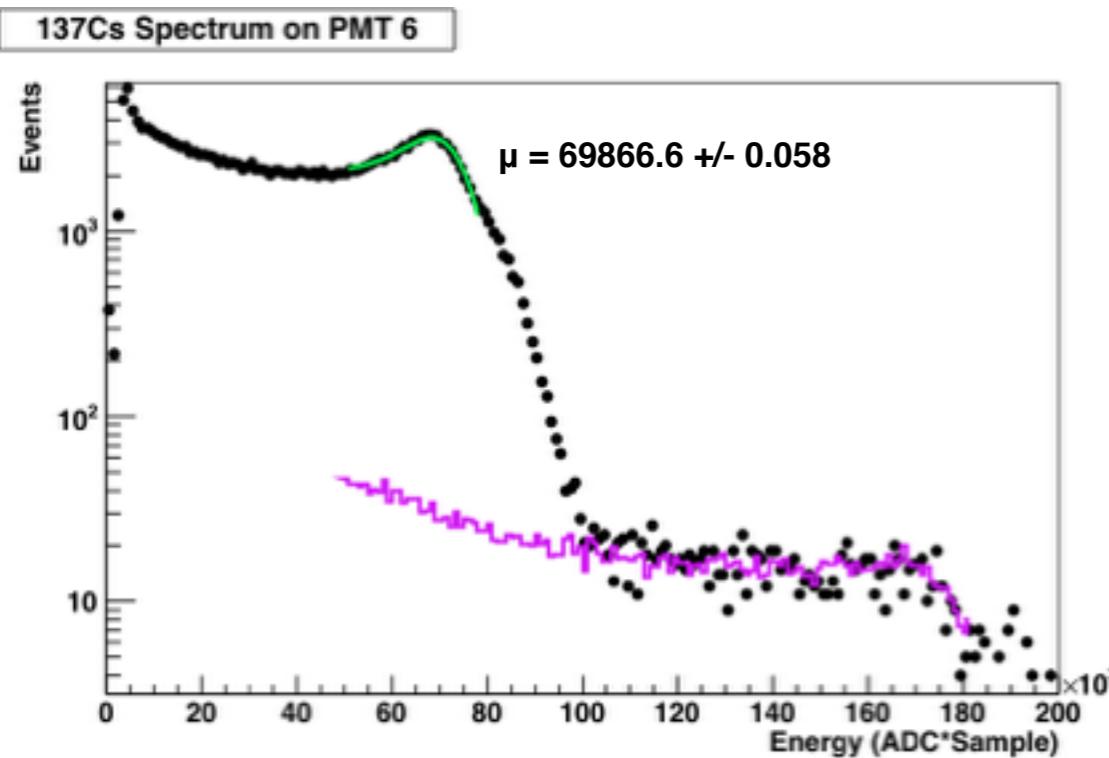
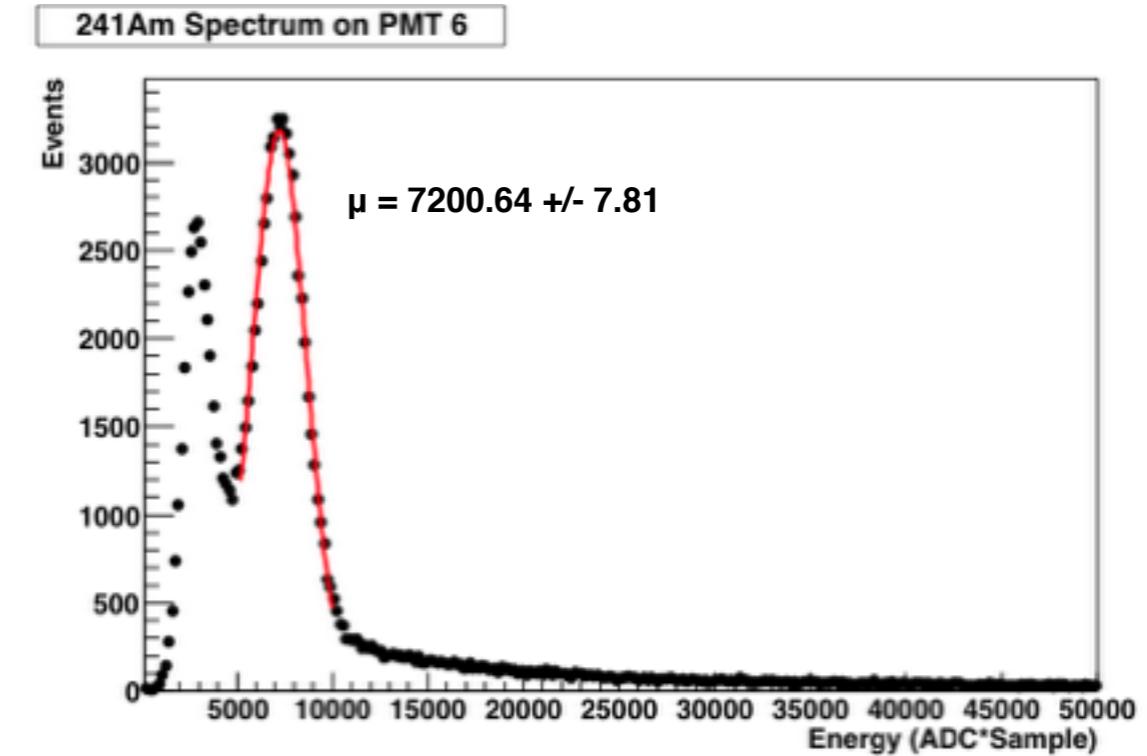
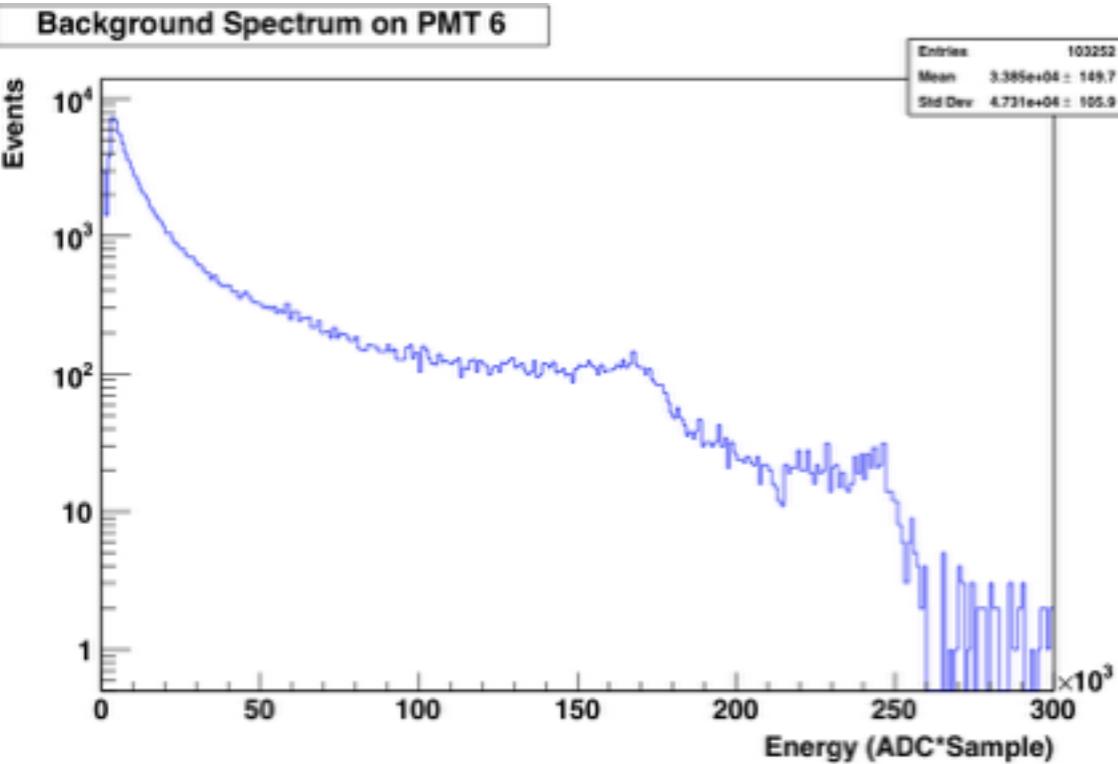
PMT4 Calibration



PMT5 Calibration

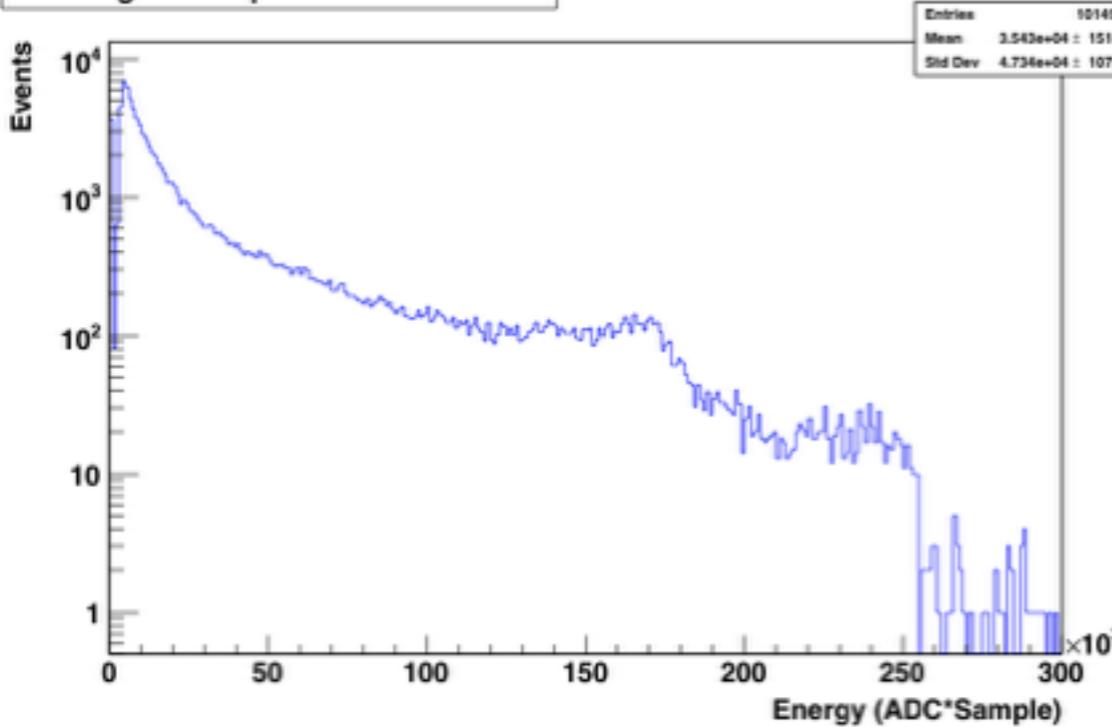


PMT6 Calibration

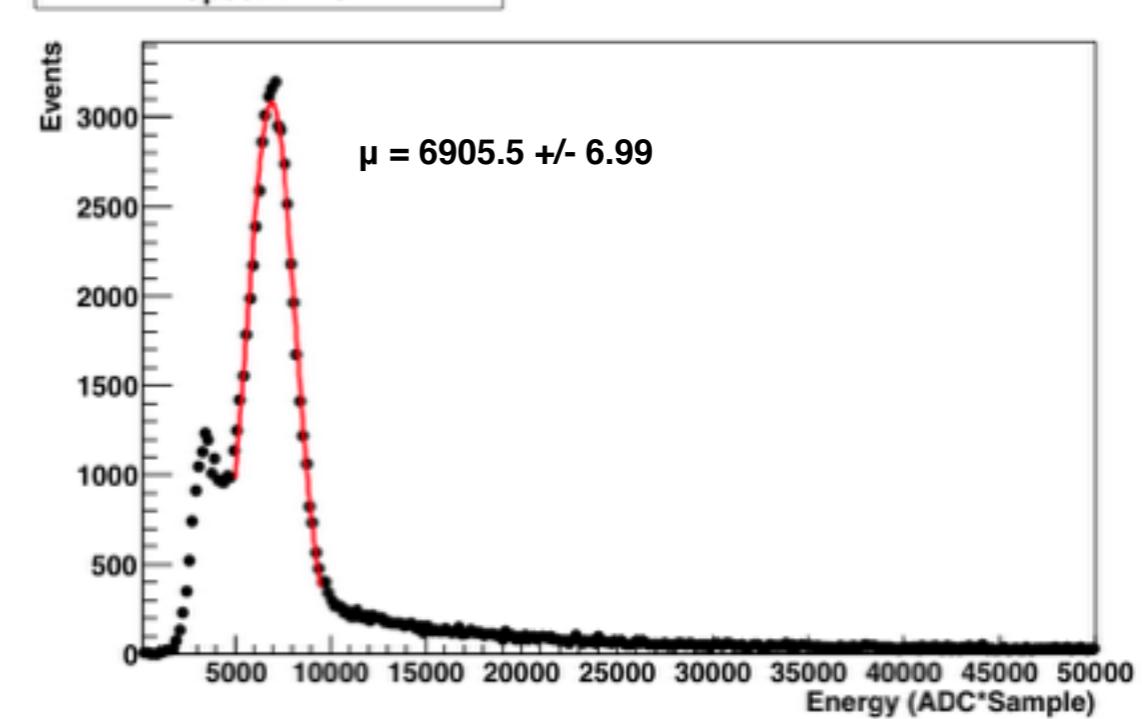


PMT7 Calibration

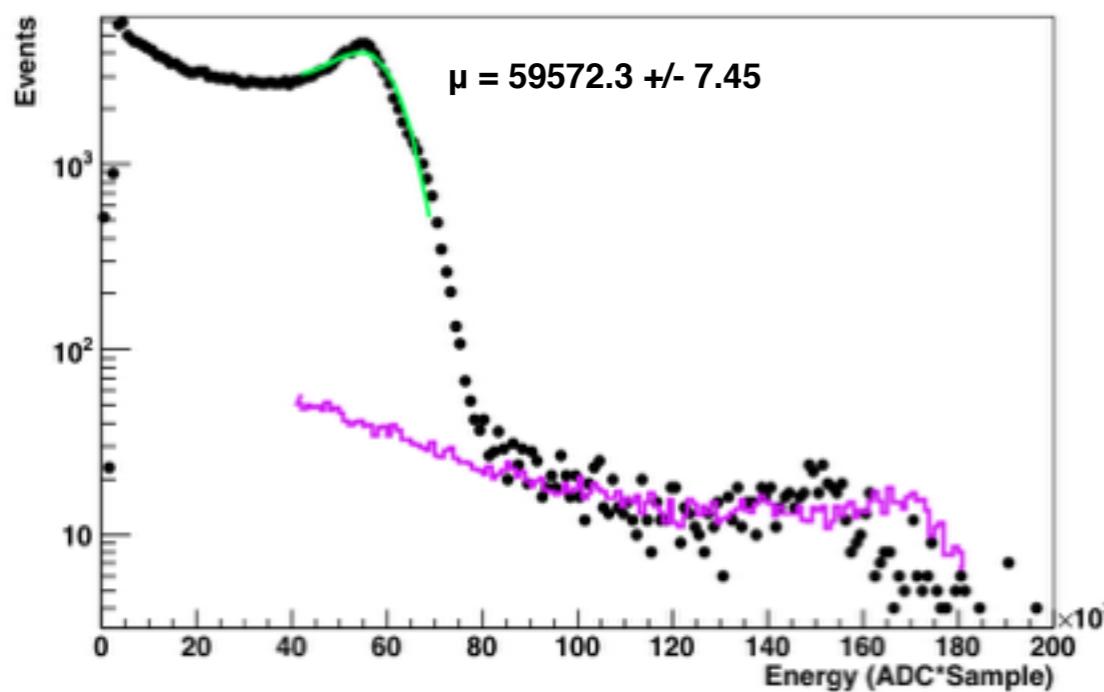
Background Spectrum on PMT 7



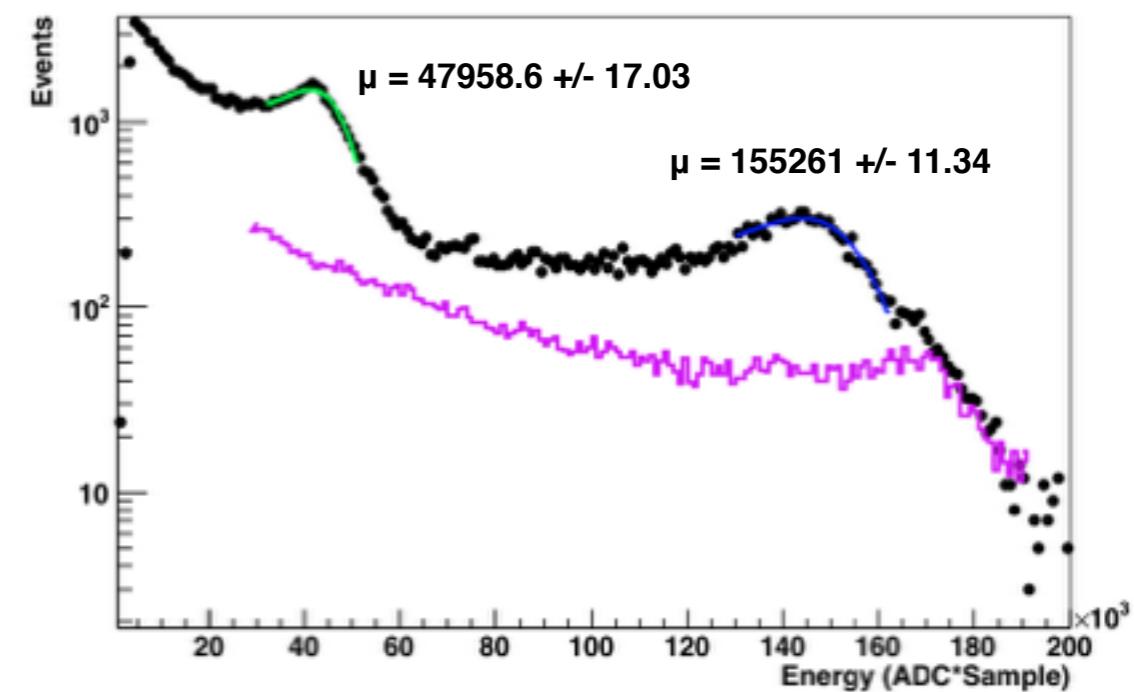
241Am Spectrum on PMT 7



137Cs Spectrum on PMT 7

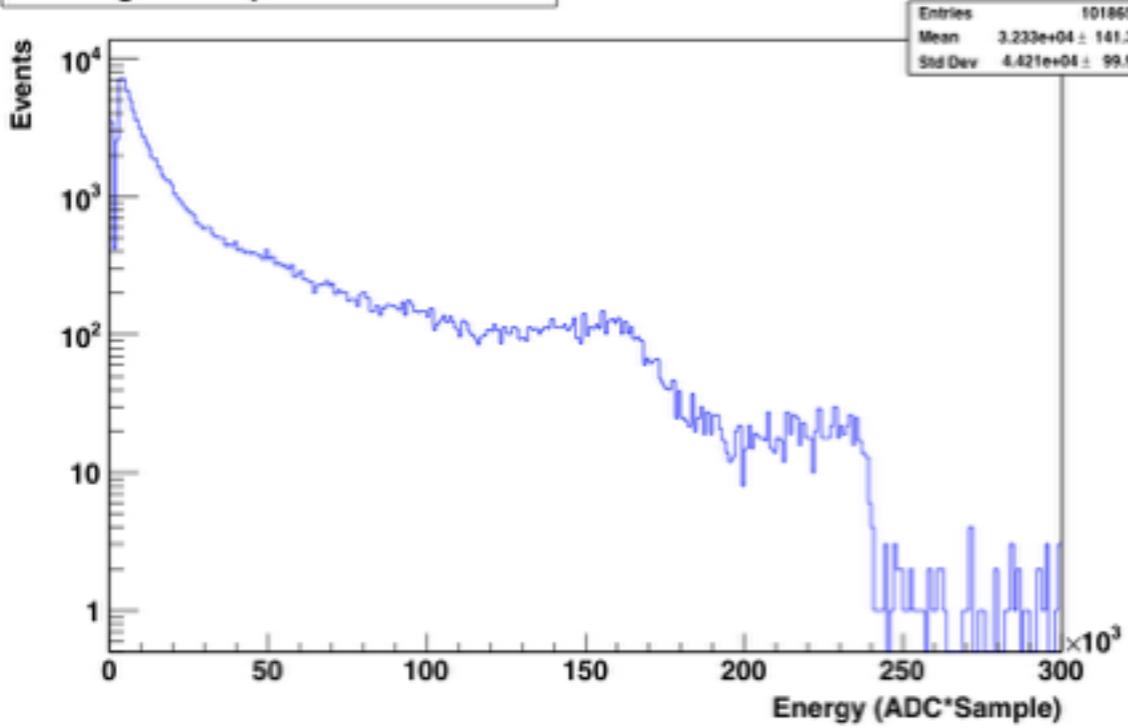


22Na Spectrum on PMT 7

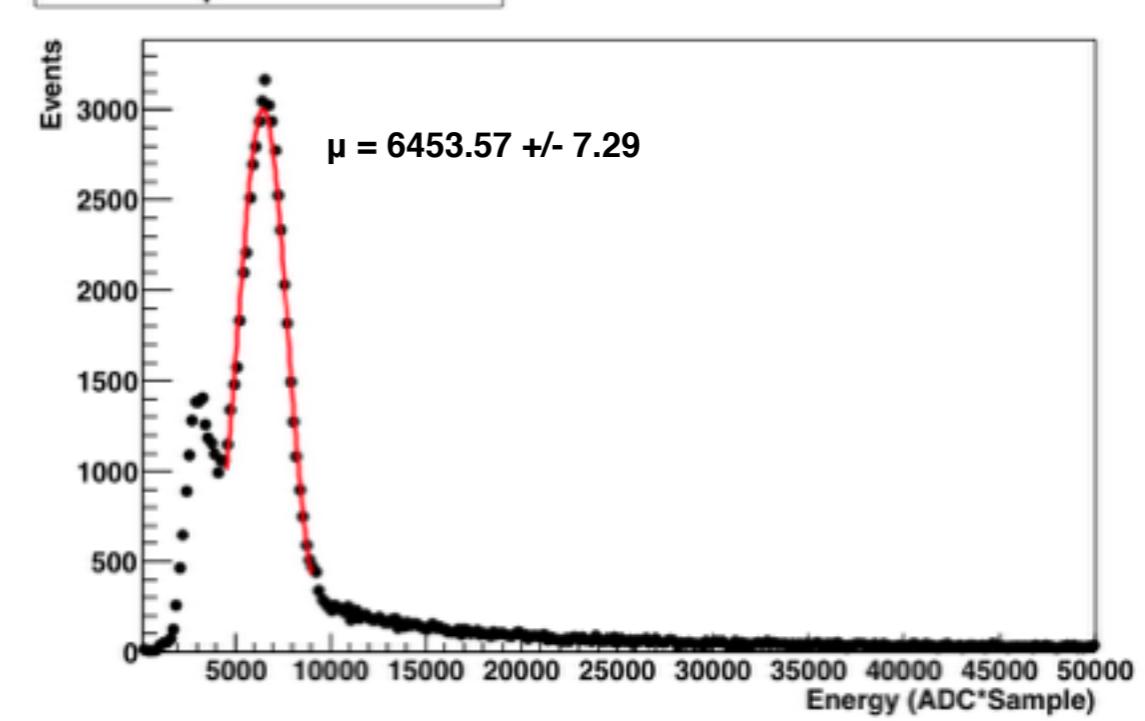


PMT8 Calibration

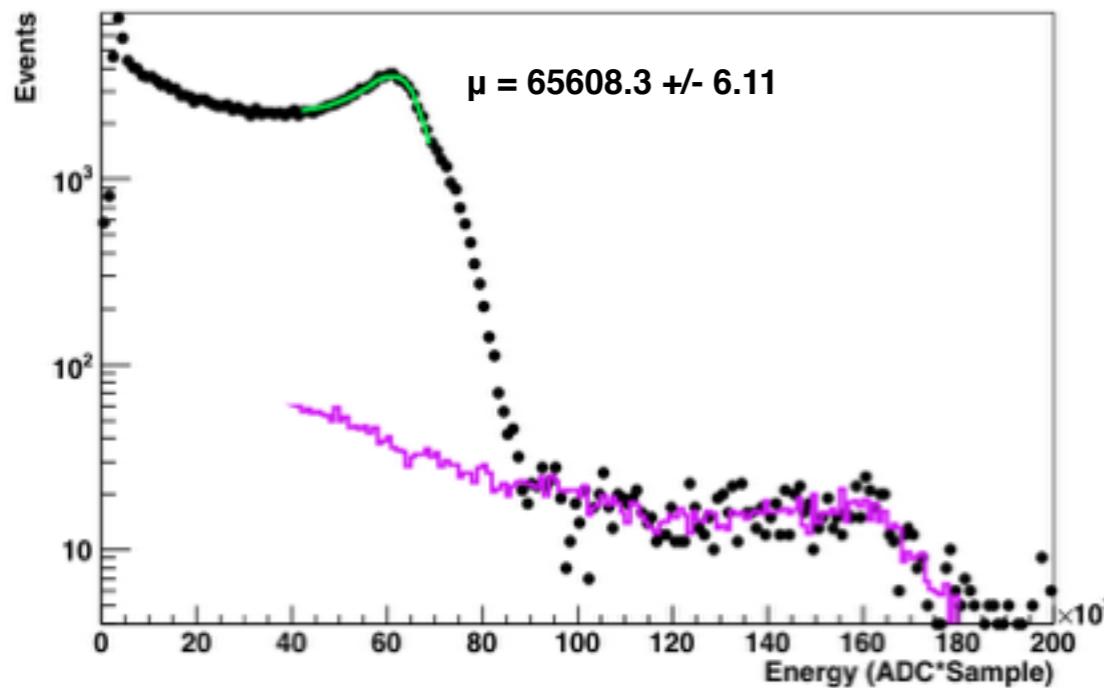
Background Spectrum on PMT 8



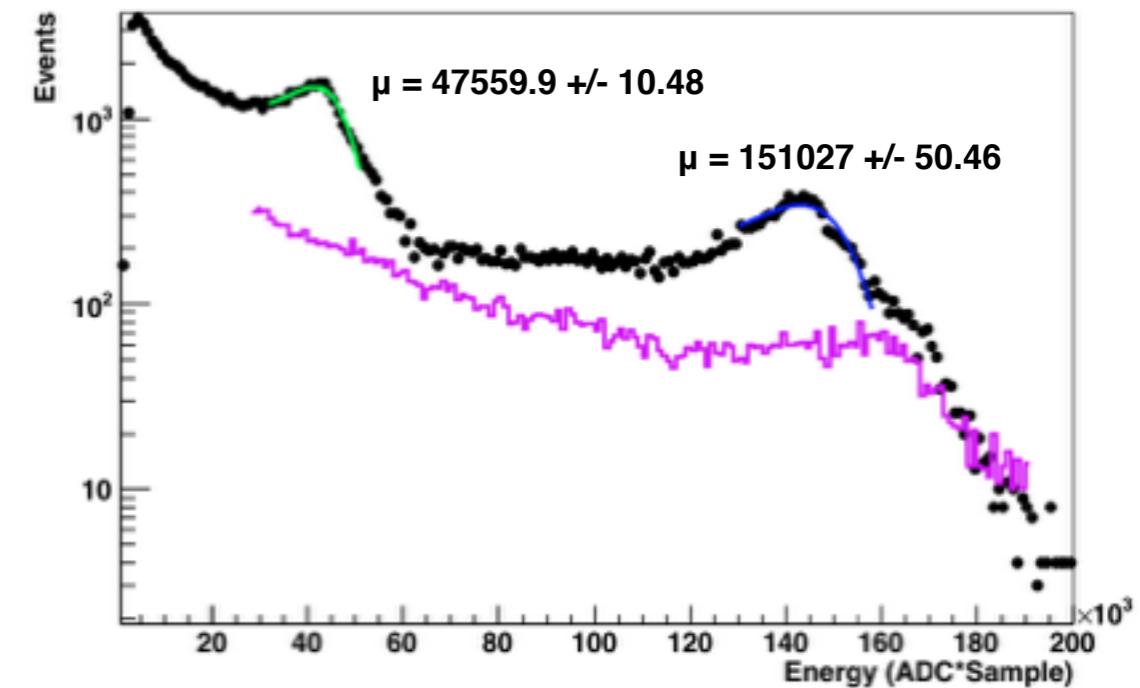
241Am Spectrum on PMT 8



137Cs Spectrum on PMT 8

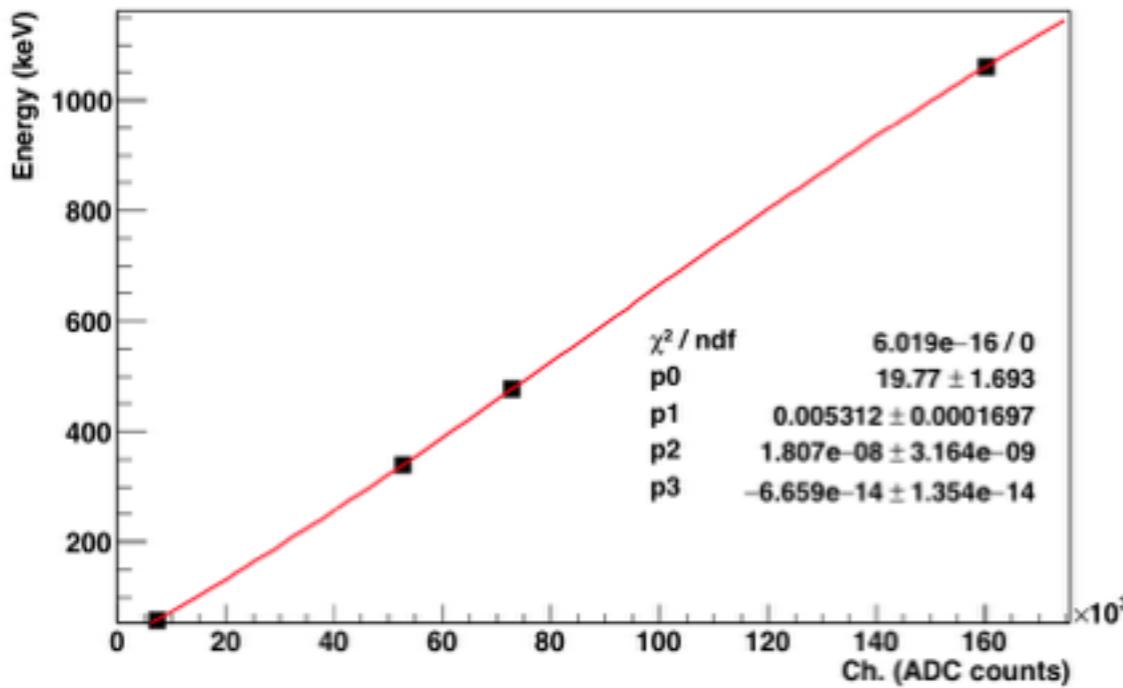


22Na Spectrum on PMT 8

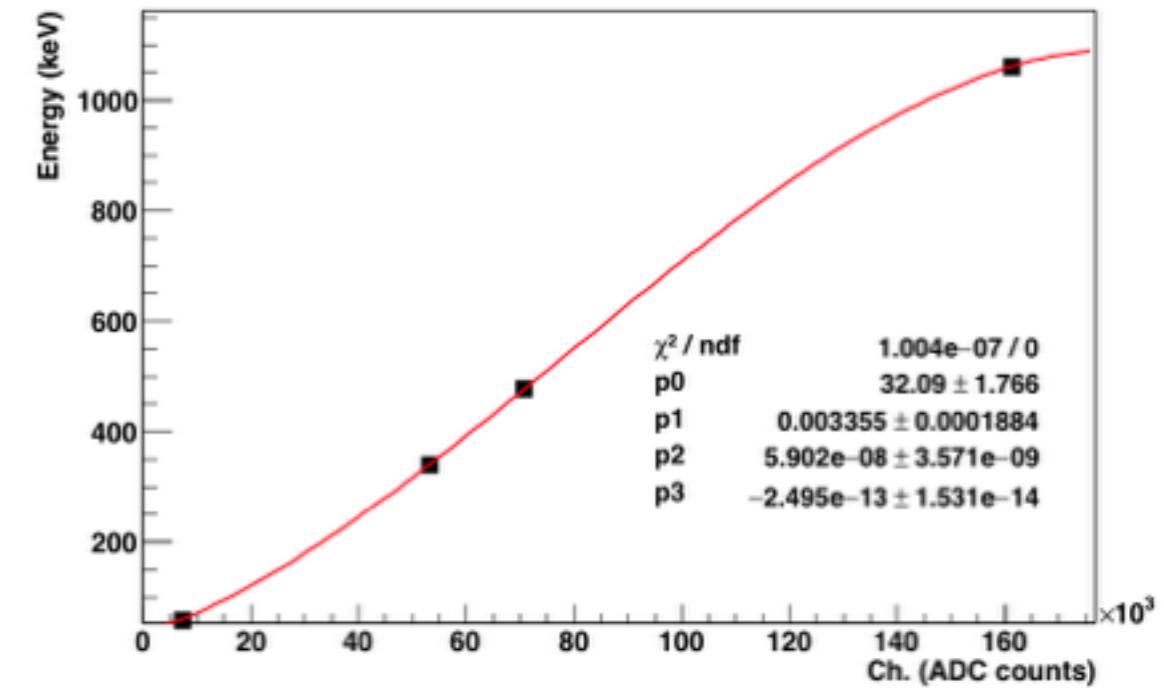


Calibration's curves

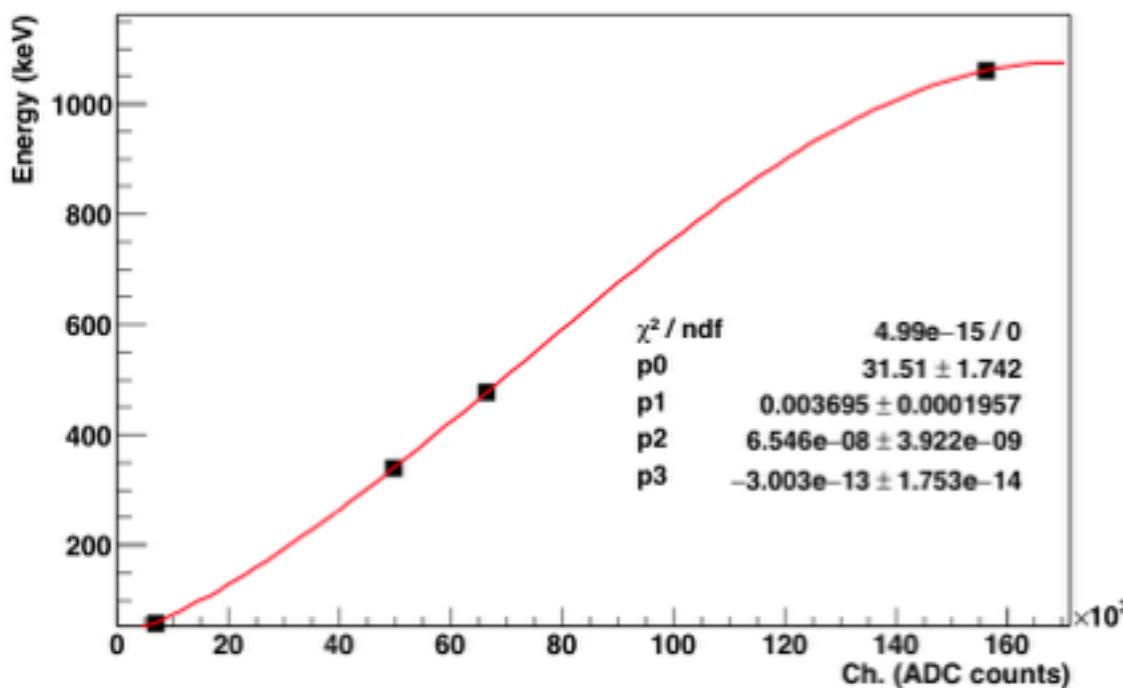
Energy Calibration Curve for PMT 0



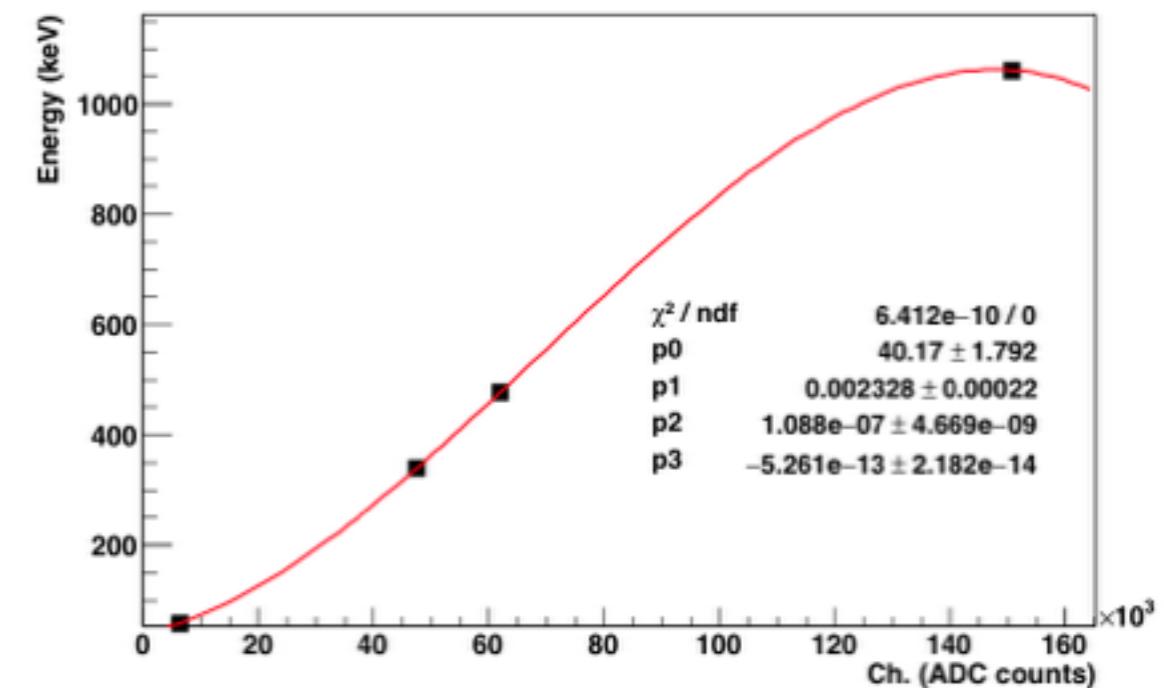
Energy Calibration Curve for PMT 1



Energy Calibration Curve for PMT 2

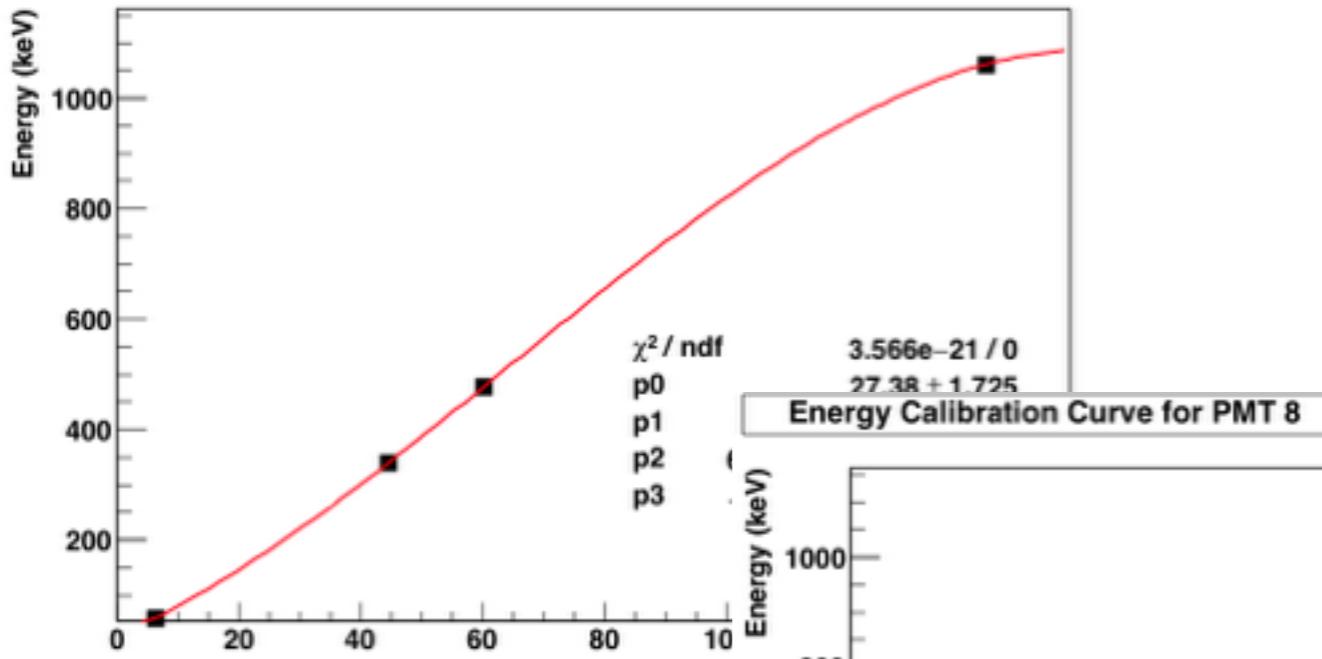


Energy Calibration Curve for PMT 3

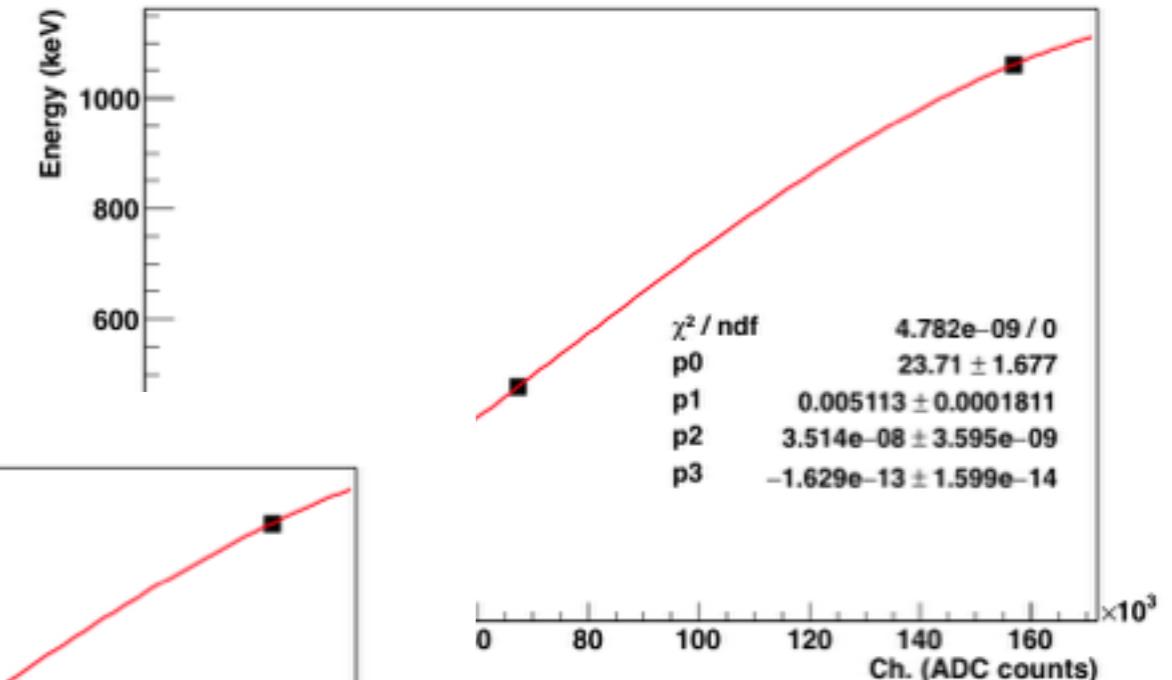


Calibration's curves

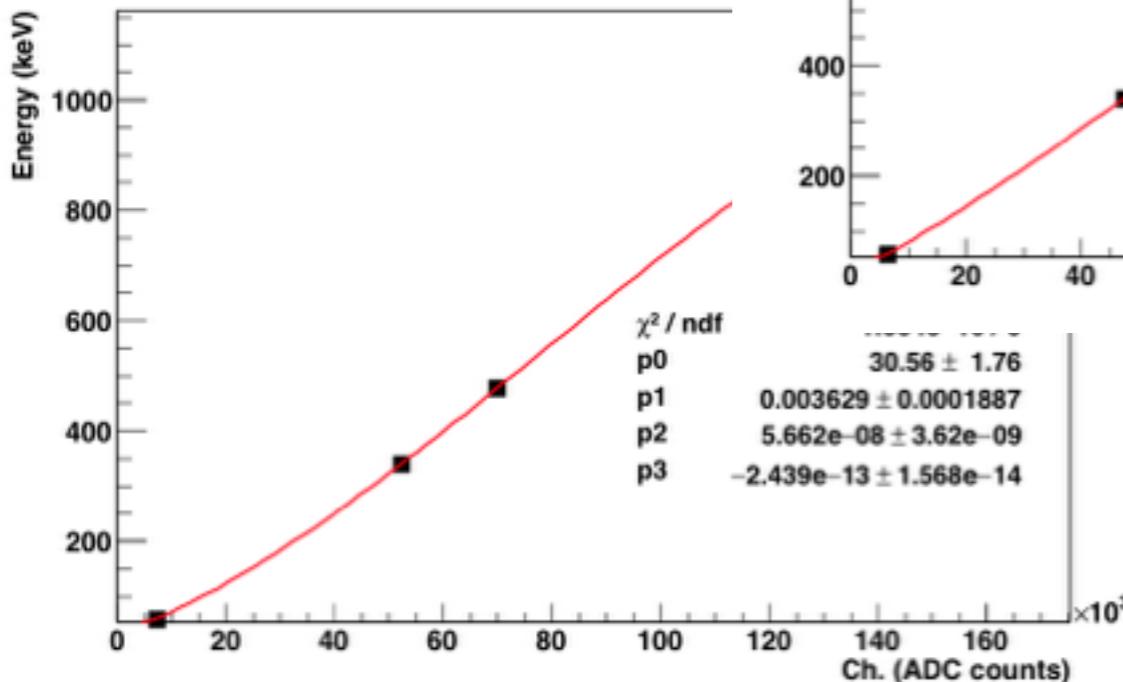
Energy Calibration Curve for PMT 4



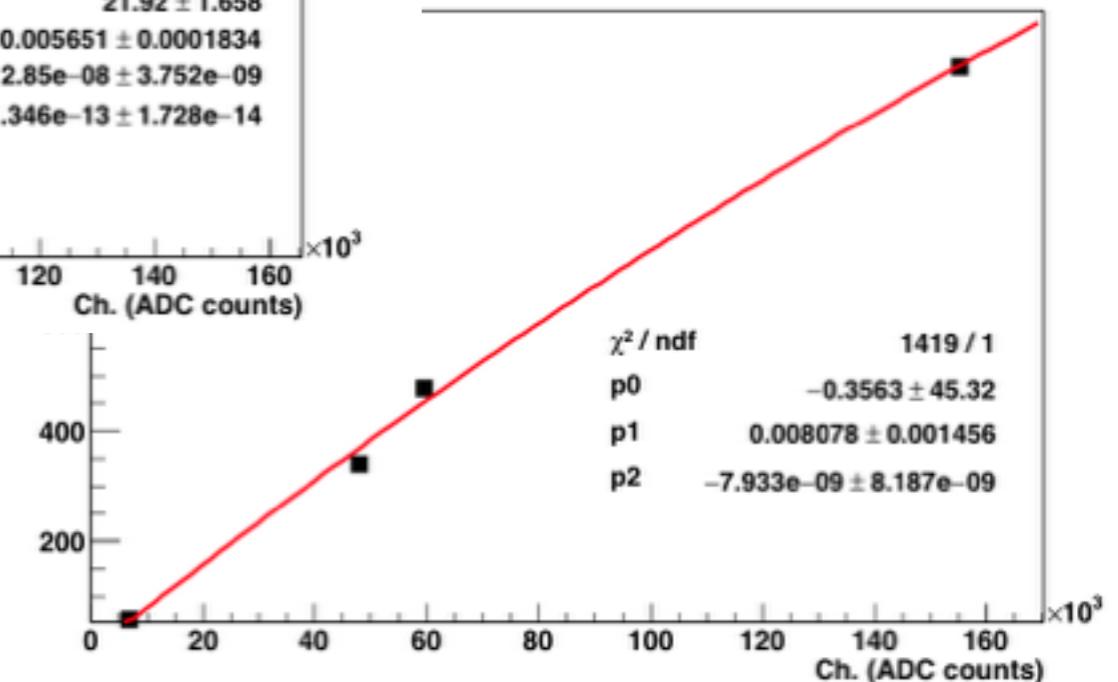
Energy Calibration Curve for PMT 5



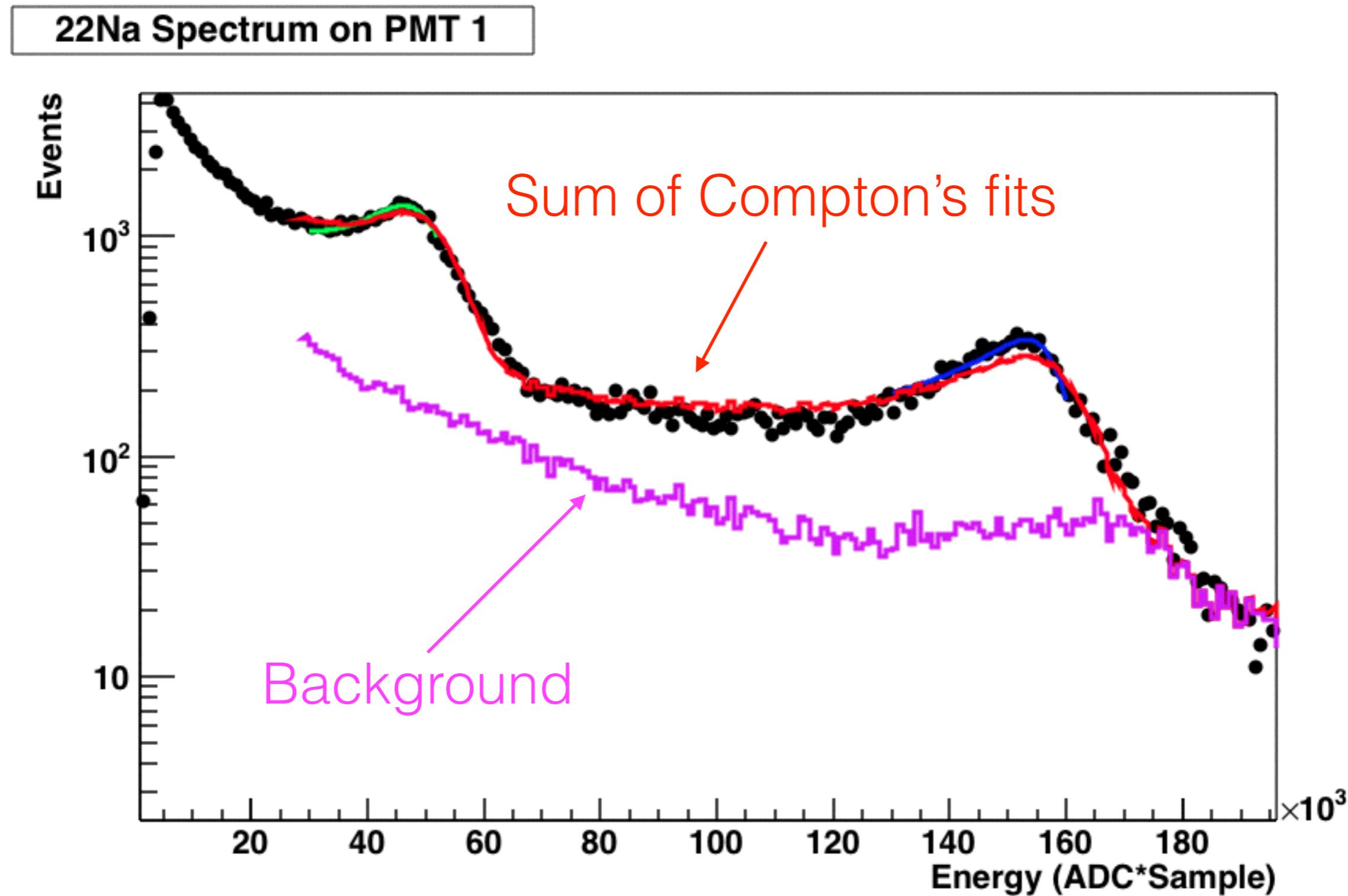
Energy Calibration Curve for PMT 6



Energy Calibration Curve for PMT 7

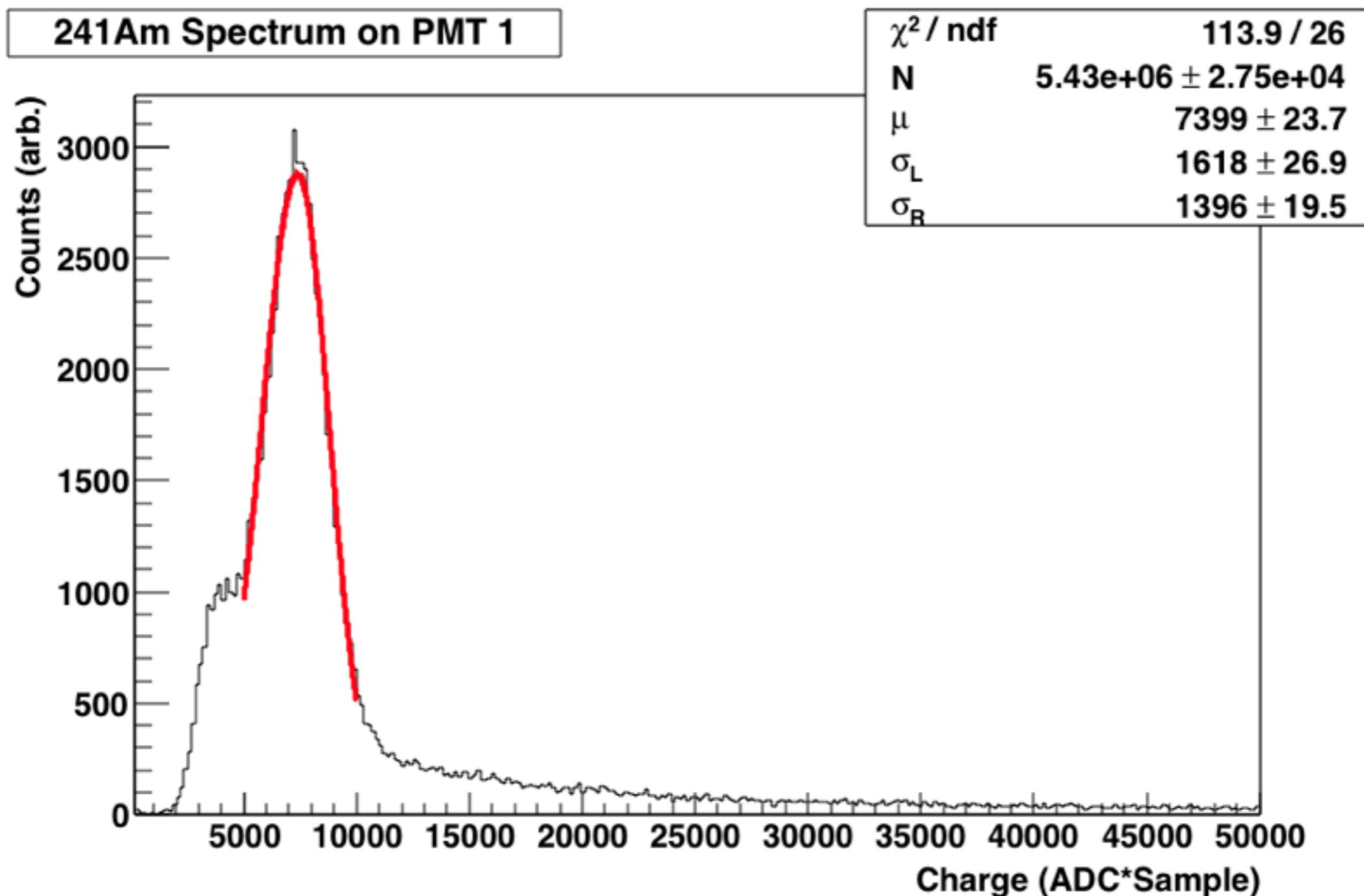


A simple model on ^{22}Na

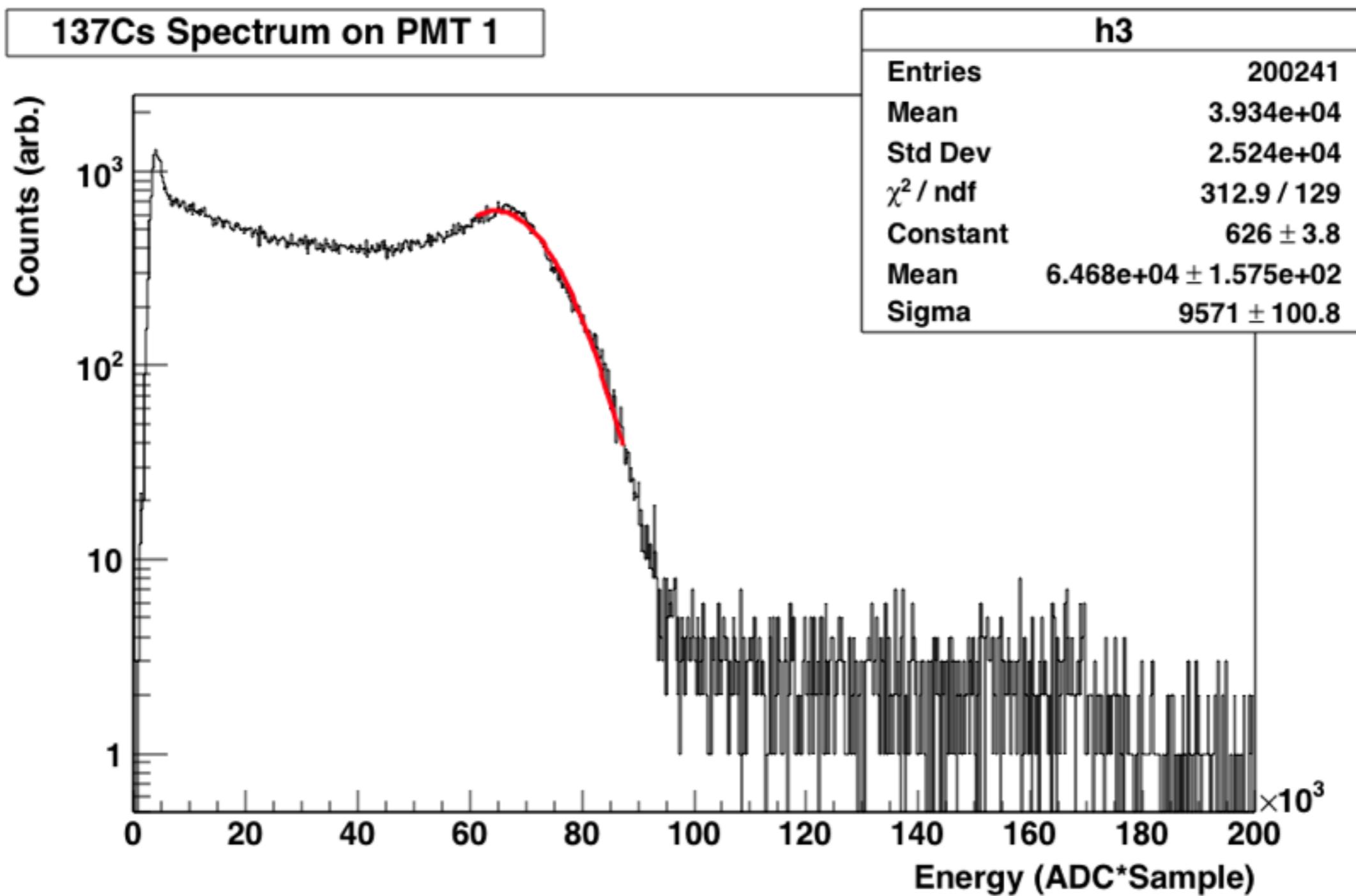


Backup

g-calibration sources (in progress)



g-calibration sources (in progress)



g-calibration sources (in progress)

