Current Plan of SIPAT LYSO

- SIPAT thinks that they know the origin of the problem reported on February 24.
- Assuming no surprises, SIPAT plans to finish the growth by the end of April using four furnaces. All crystals will be delivered by May 20, 2010, assuming that LYSO mechanical processing takes 20 days.
- This schedule seems rather tight to catch the June test beam at Frascati. Need a re-assessment.

The Mechanical Processing at SIPAT

SIPAT has difficulty in mechanical processing for tapered SuperB crystals. It has only a very cumbersome, lapping-based slow processing technology to process tapered crystals presently. Michel Lebeau offered suggestions, and recommended a precision circular saw based cutting machine from LGB, Villeurbanne, Lyon, which was developed by Michel and was used by SIC and BTCP for the PWO processing for CMS.

SIPAT, on the other hand, has already allocated and tested a diamond wire saw RTS880 from a vendor DIAMONDWIRE TECHNOLOGY, USA, and is going to procure this machine for the LYSO processing. Michel will make comment about this machine.

Miscellaneous

CMS ECAL readout: Caltech graduate students took over

VFE Board: some additional detailed drawings allocated, which may help the modification of shaping time.

APD cables: standard length is 8 cm. Appointment is made to find longer cables in the CMS APD lab on Friday. May have to make new ones if the number is not sufficient.

Neutron Induced Nuclear Counter Effect in a Pair of Hamamatsu APD

Rihua Mao, Liyuan Zhang and Ren-yuan Zhu

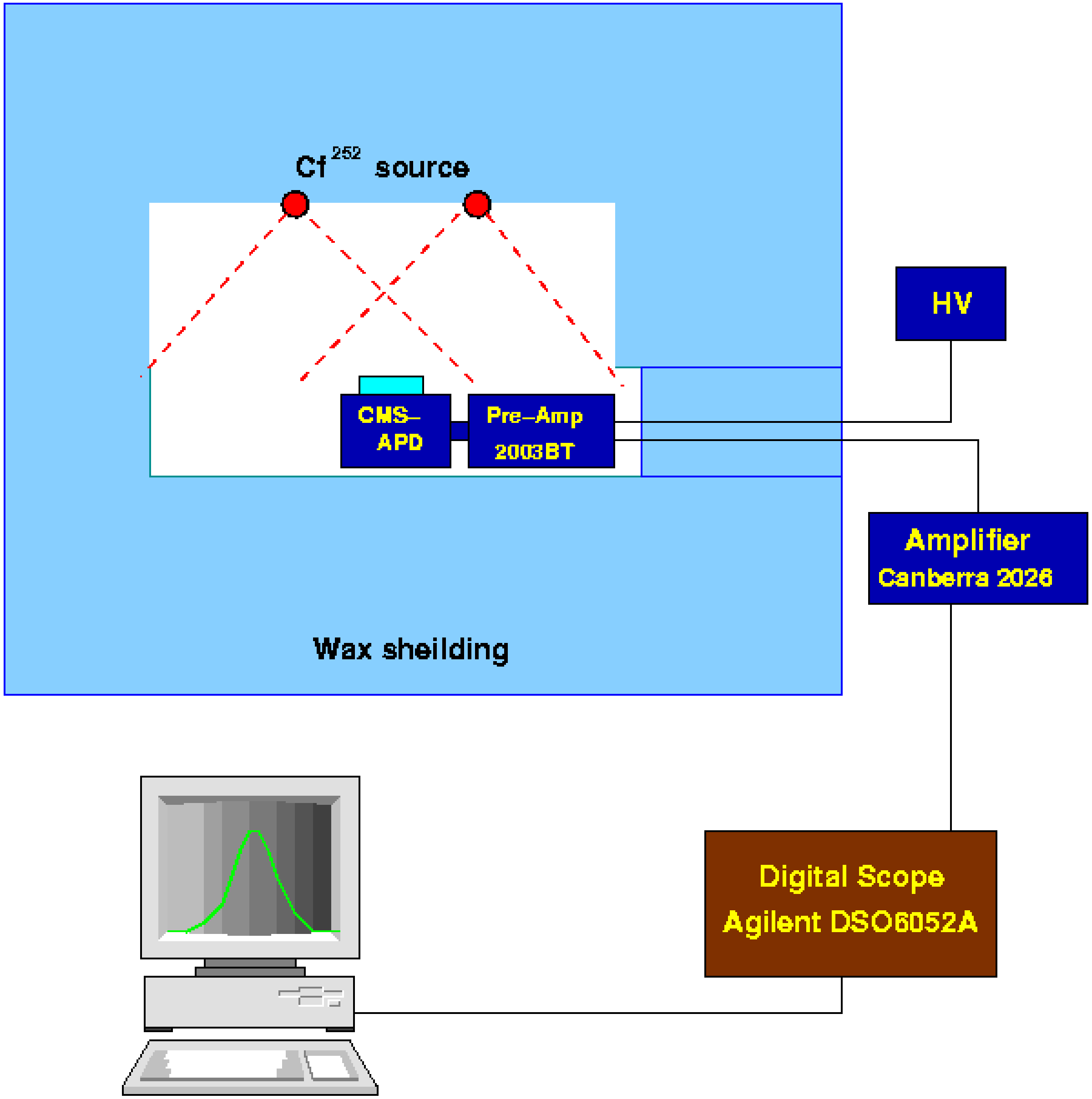
California Institute of Technology

March 17, 2010

Outline

- Calibration of the readout system for APD gains of 10, 35, 50, 100 and 200:
  - Use the Fe-55 source (24.4% 5.9 keV) .
  - Corrections provided by using Fe-55/LED ratio at each gain setting.
- Neutron spectra for ^{252}Cf and ^{241}Am-Be for APD gains of 35, and ^{252}Cf for APD gain of 10,100 and 200.
- Background from a ^{241}Am source (43% 14 keV, 2% 26 keV and 36% 60 keV) and a ^{60}Co source (1.17 and 1.33 MeV).

The ^{252}Cf Setup

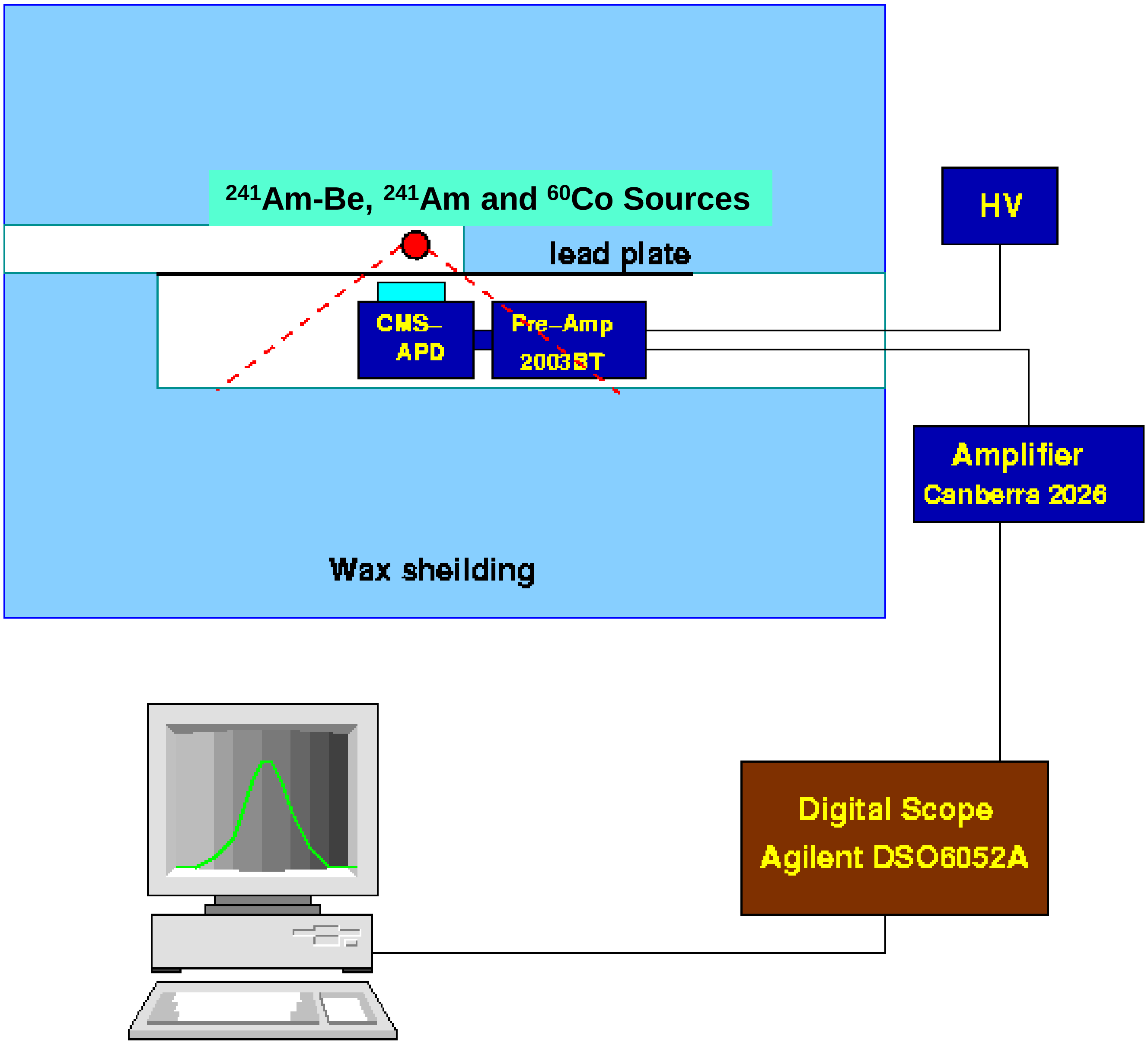


A pair of Hamamatsu APD in a capsule (33102000077940) placed at 8 cm from a pair of ^{252}Cf sources with neutron flux of 1.4×10^4 n/cm^2/s at the APD surface.

The APDs were biased for gains of 10, 35, 50, 100 and 200.

The readout of the APDs consists of a preamplifier, (Canberra 2003 BT) a shaping amplifier (Canberra 2026), and a DSO (Agilent 6052A).

The ^{241}Am-Be, ^{241}Am and ^{60}Co Setup



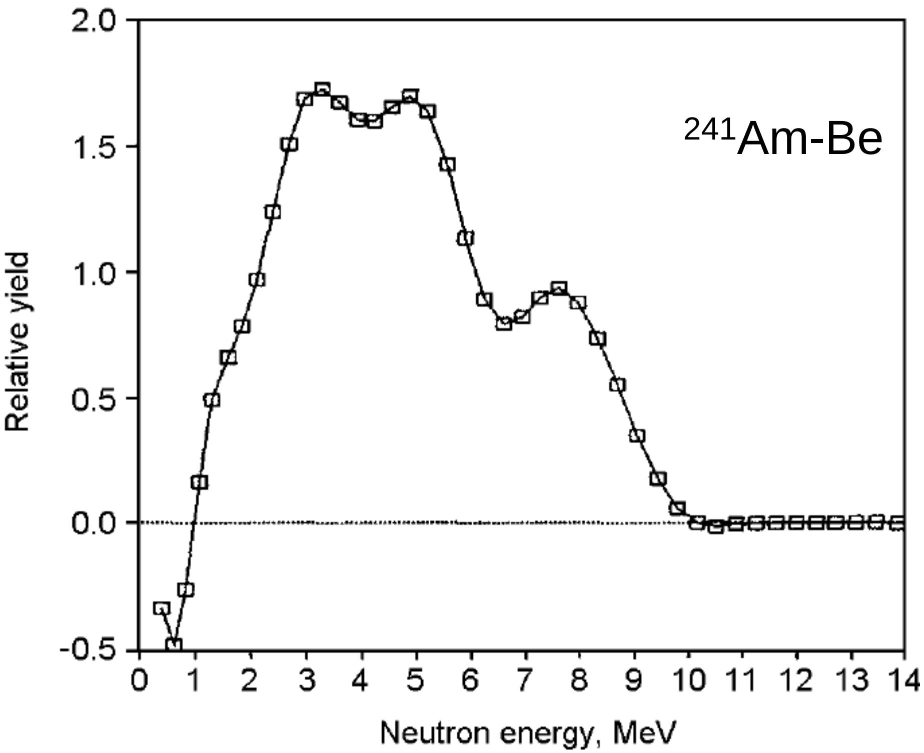
A pair of Hamamatsu APD in a capsule (33102000077940) placed at 2 cm from several sources: ^{241}Am-Be, ^{241}Am and ^{60}Co with the neutron and γ-ray flux of 6 × 10^4, 1.06 × 10^7 and 1.54 × 10^6 /cm^2/s.

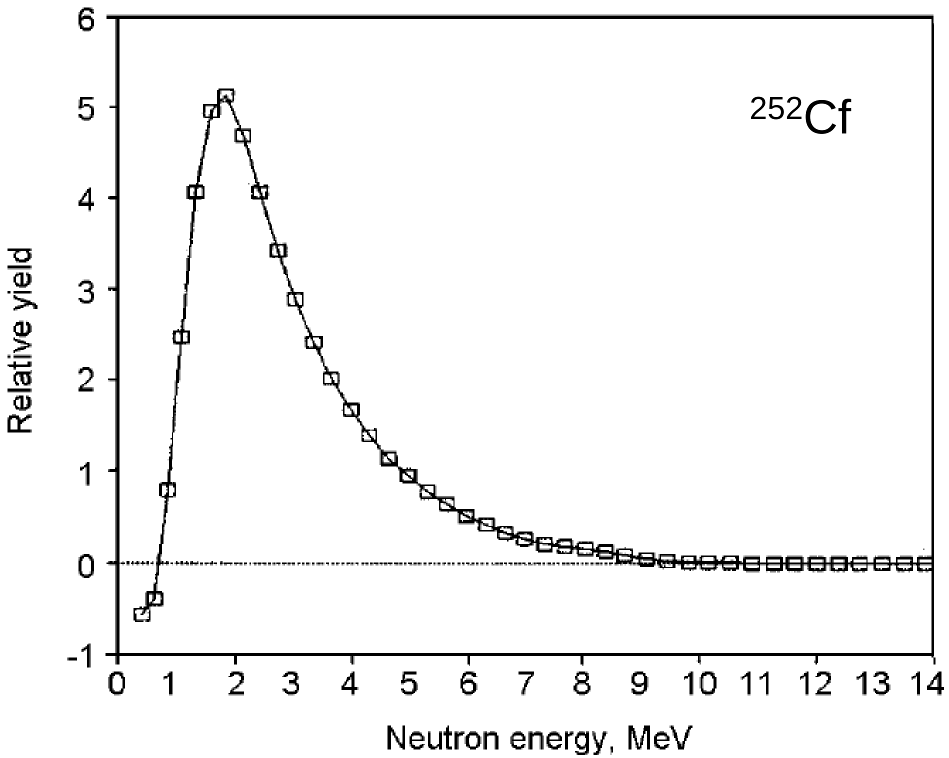
The APD was biased for the gain of 35.

The readout is the same as that for the ^{252}Cf source.

$E_{Neutron}$ from ^{241}Am-Be and ^{252}Cf Sources

Neutrons from ^{241}Am-Be source has a broad distribution from 2 to 9 MeV with an average energy of 4.5 MeV. The energy of neutrons from ^{252}Cf source is peaked at 2.2 MeV.





S.-T. Park, J. Rad. & Nucl. Chem., **Vol 256** (2003) 163

Neutron Energy Spectrum at LHC

Simulation shows that neutrons at LHC peaked at ~1 MeV

M. Huhtinen *et al,* NIM **A545** (2005) 63

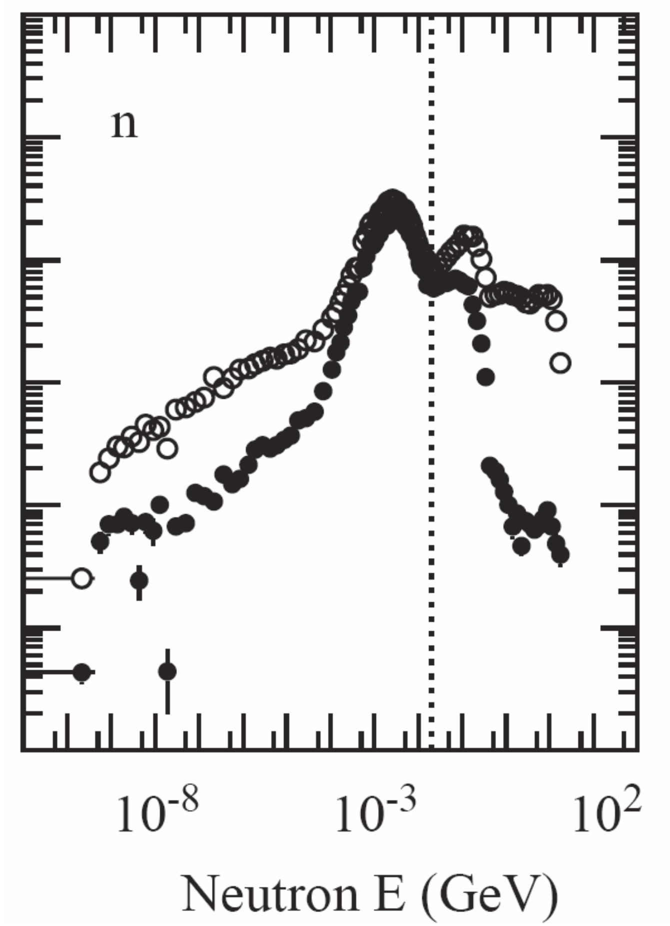
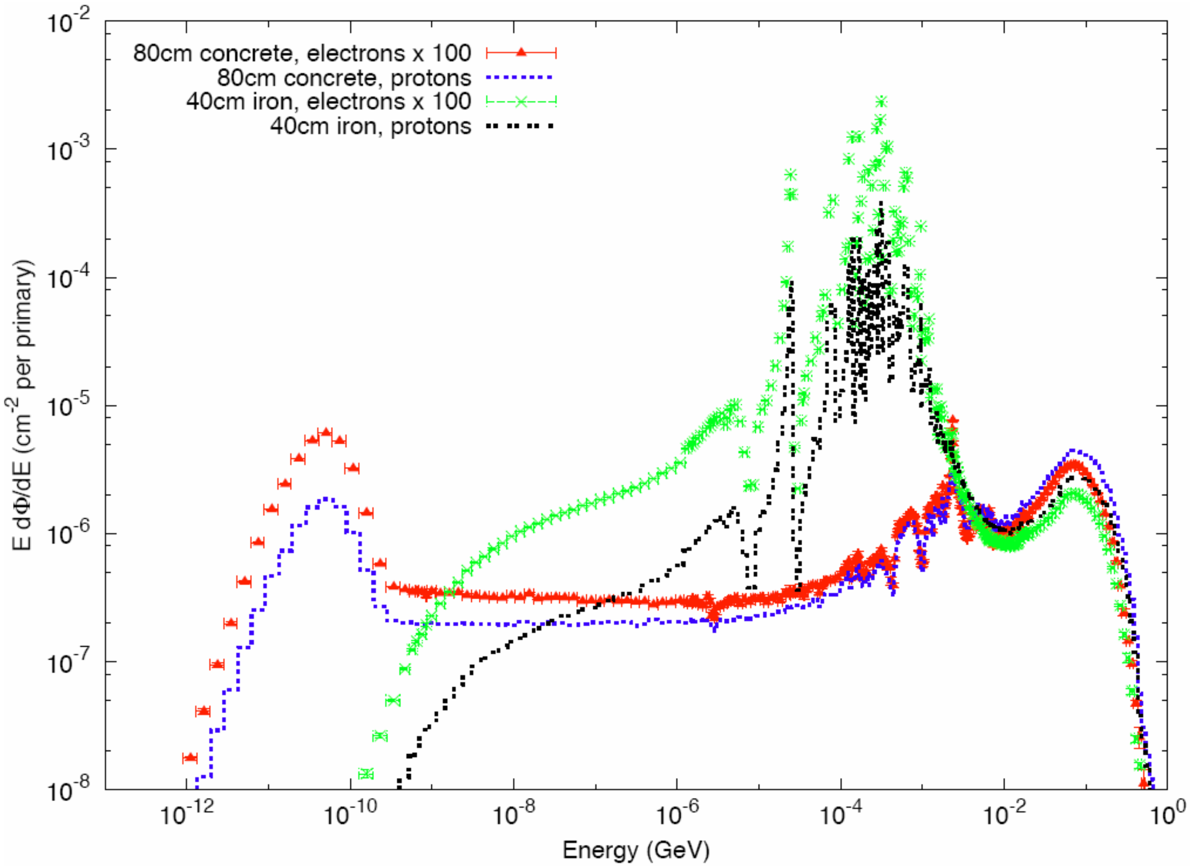
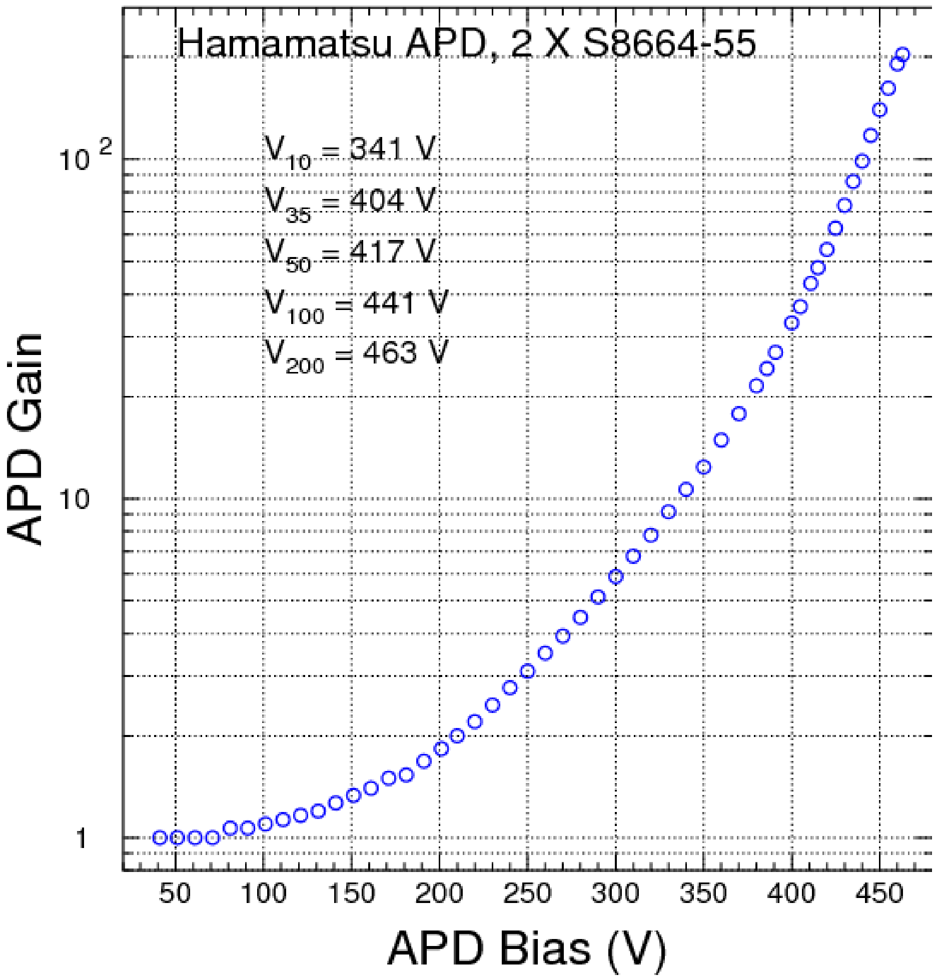


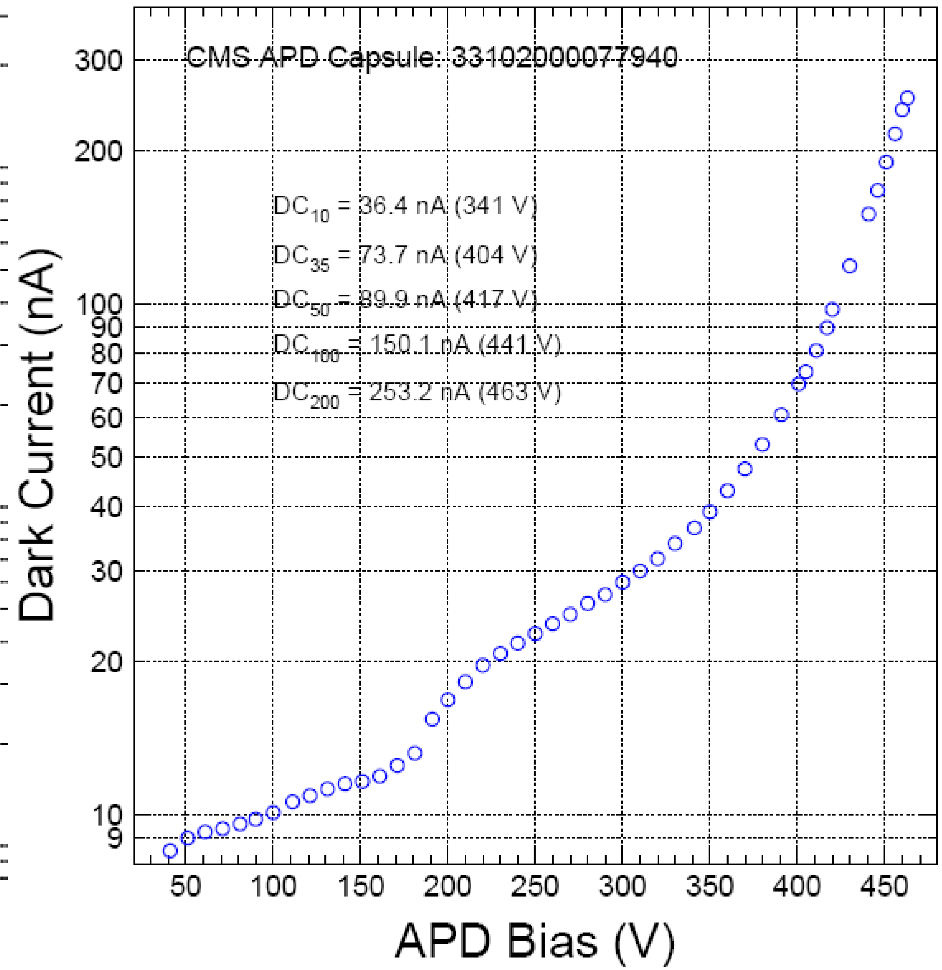
Fig. 29.2 of PDB, Simulations with FLUKA



APD Gain and I_{dark} versus Bias

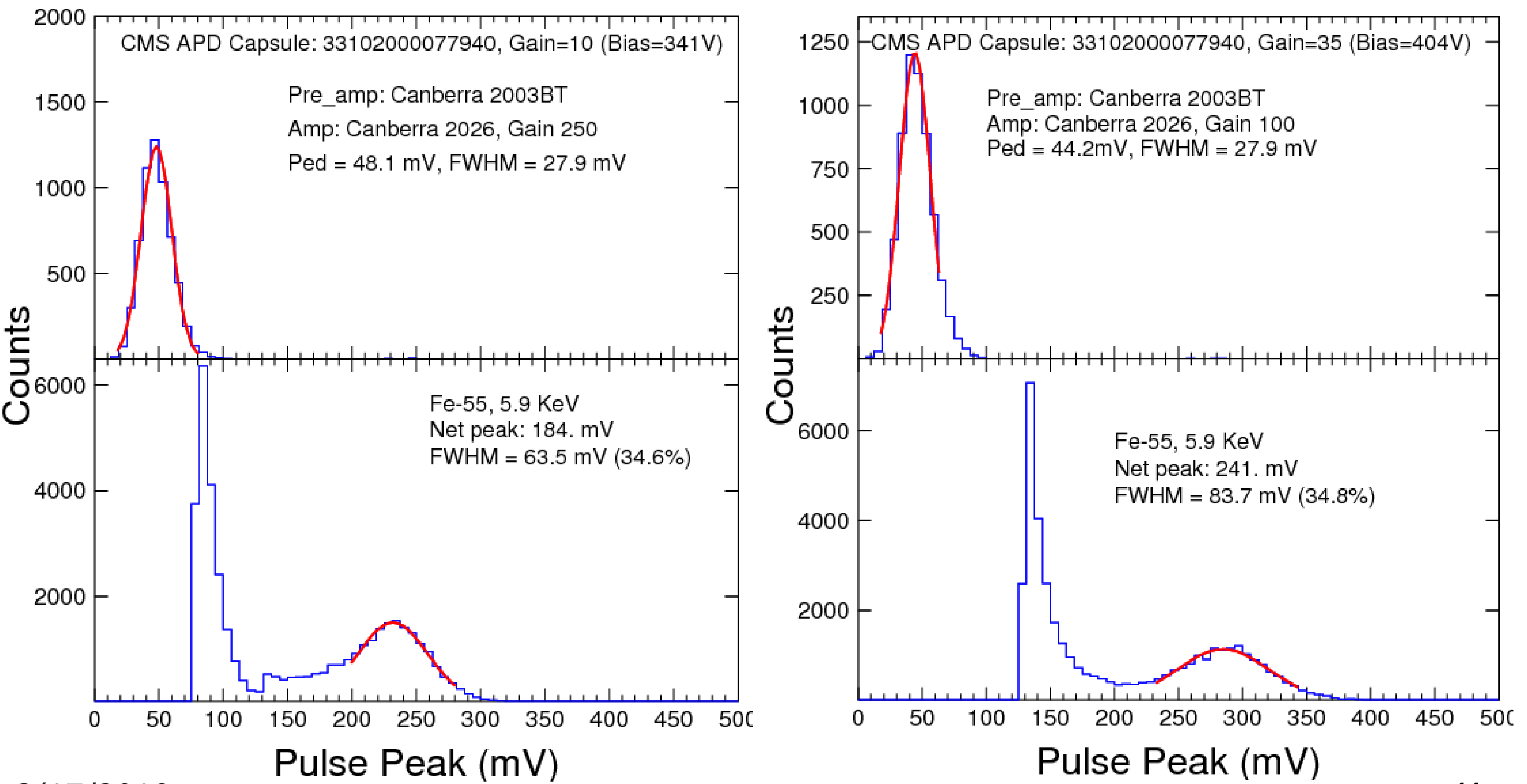
Actual APD gain measured with LED





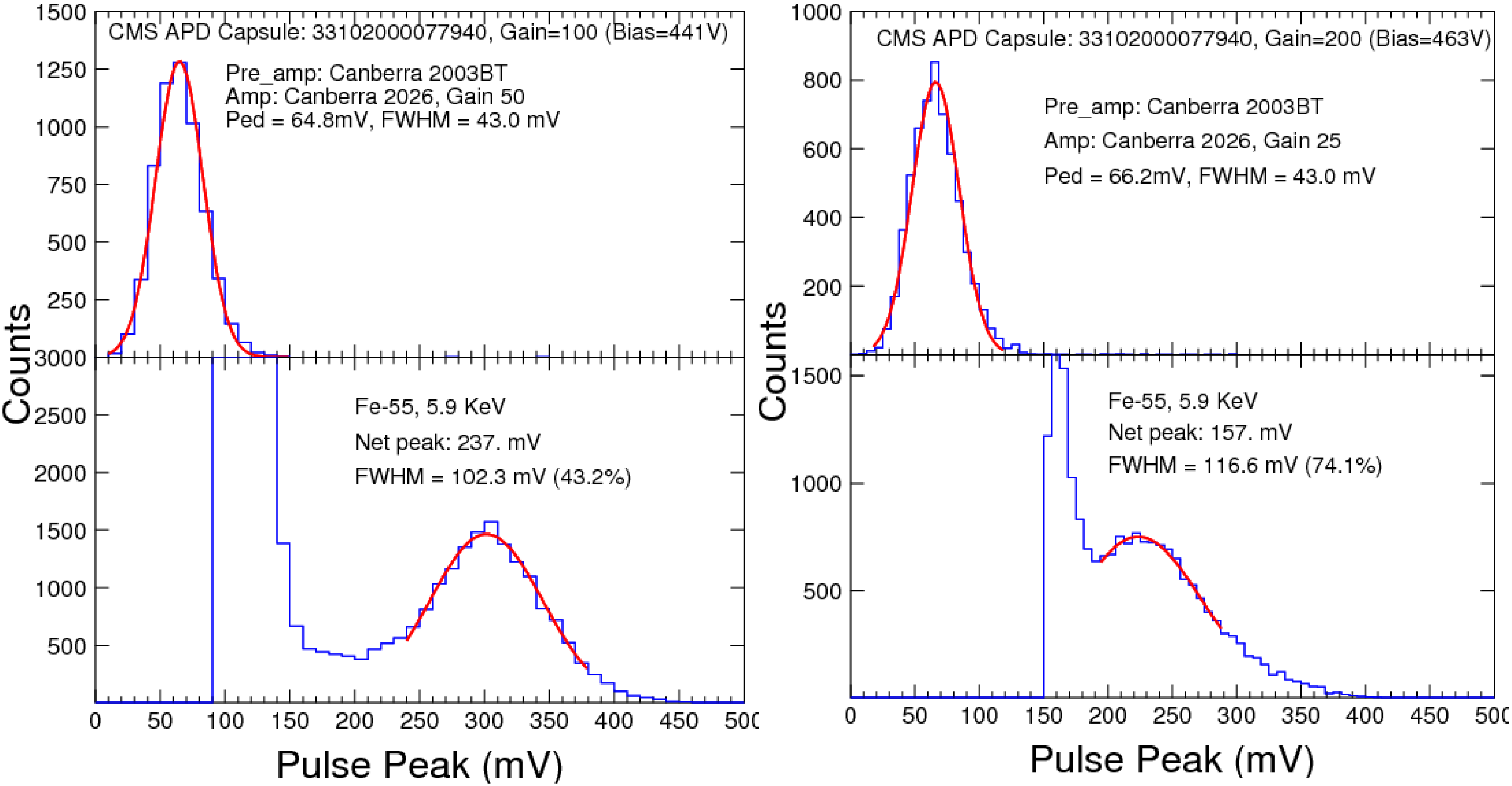
Fe-55 Calibration *in situ* (I)

APD gain was set at 10 and 35

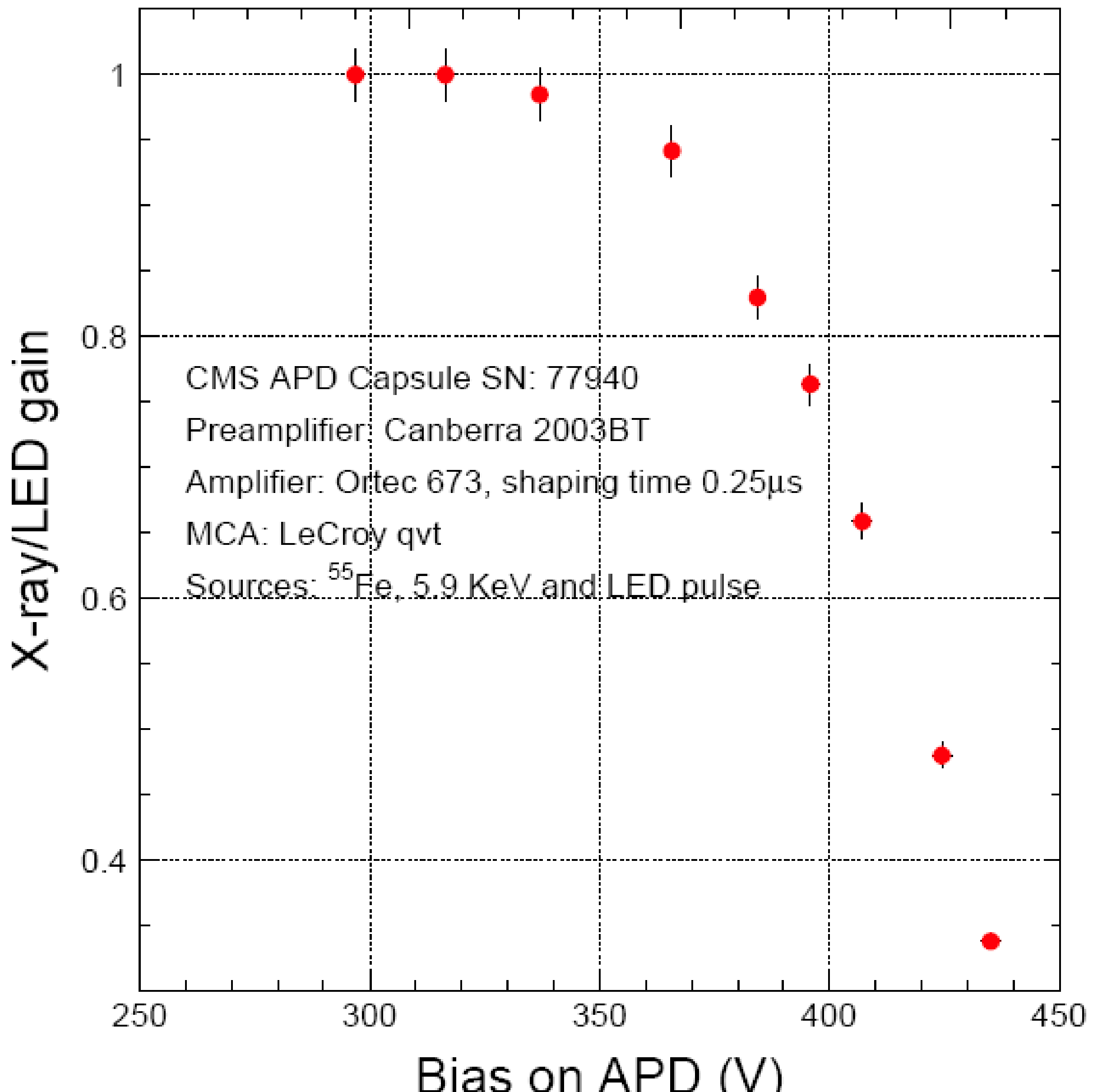


Fe-55 Calibration *in situ* (II)

APD gain was set at 100 and 200



Fe-55/LED Corrections



Large correction factors are noticed for high APD gain.

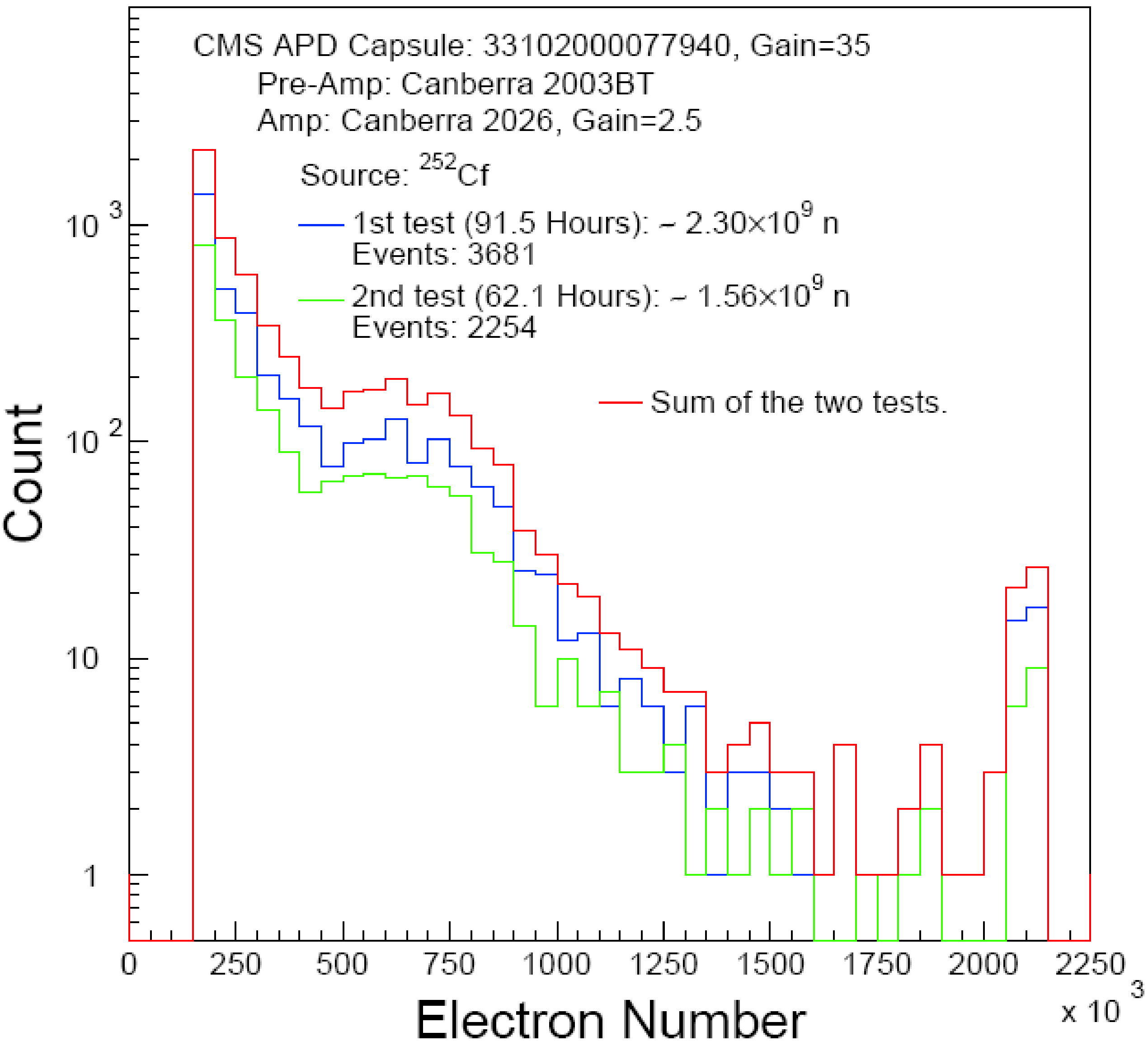
The correction factors are consistent with published data in J. Chen *et al, IEEE Trans. Nucl. Sci. Vol 54* (2007) 718.

The Calibration

This system provides very good noise performance

APD Gain	10	35	50	100	200
Bias (V)	341	404	417	441	463
Nominal SA Gain	250	100	50	50	25
$\text{Corrections}_{\text{SA Gain}}$	26.851	11.330	5.481	5.481	2.772
PED (mV)	48.1	44.2	26.0	64.8	66.2
FWHM_{PED} (mV)	27.9	27.9	18.2	43.0	43.0
Fe-55 (mV)	184	241	151	237	157
$\text{FWHM}_{\text{Fe-55}}$ (mV)	63.5	83.7	43.7	102.3	116.6
Calibration (e/mV)	8.858	6.763	10.794	6.877	10.381
$\text{Corrections}_{\text{Fe-55/LED}}$	0.9845	0.7736	0.6796	0.4949	0.3481
Calibration (e/mV)	**8.720**	**5.232**	**7.335**	**3.403**	**3.614**
σ_{Noise} (e)	104	62	57	62	66
$\sigma_{\text{Fe-55}}$ (e)	236	186	136	148	179

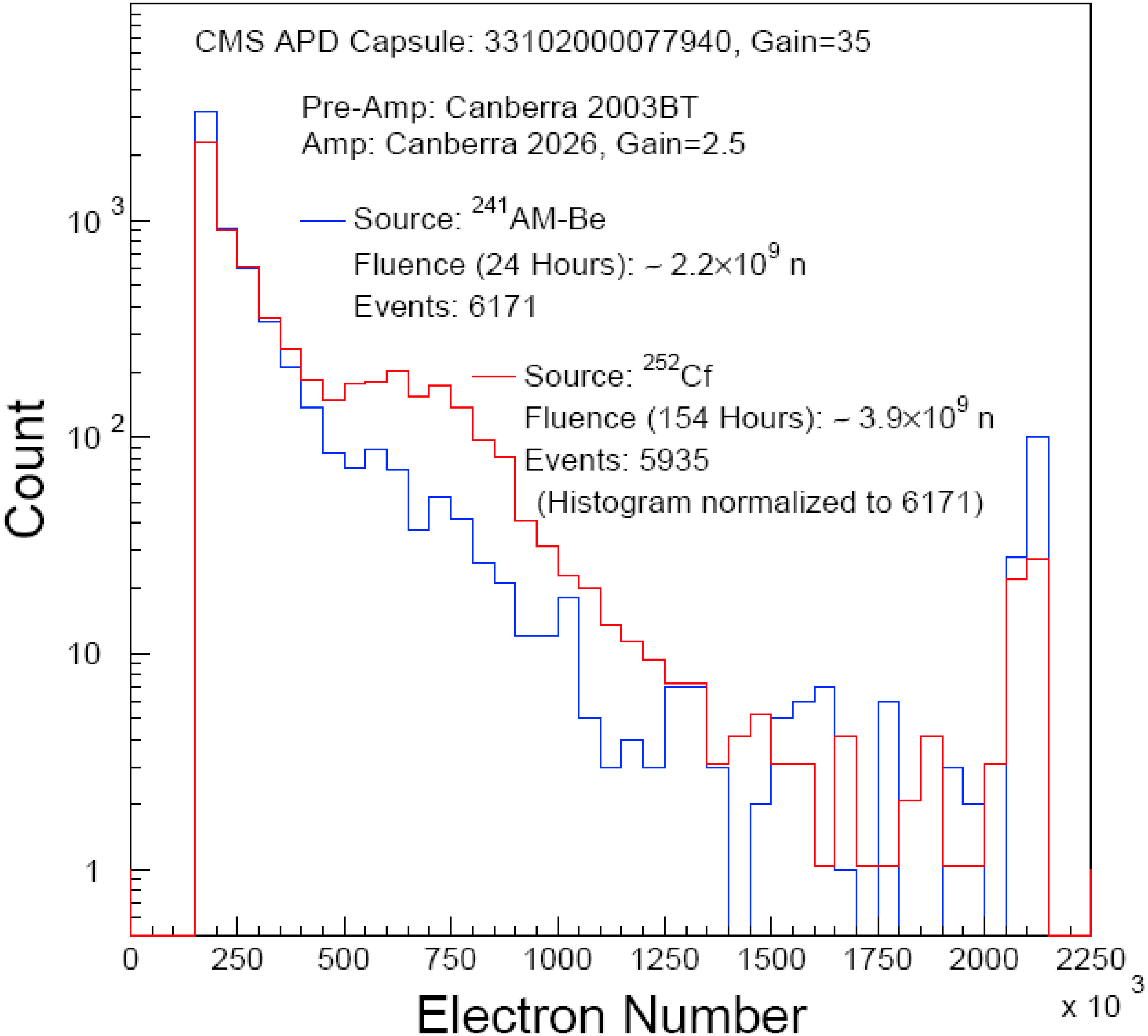
^{252}Cf Source Spectra with APD Gain = 35



Data were taken with the SA gain at 2.5. The up-limit of the pulse height distribution is 2 M electrons, or 7.2 MeV deposition in APD, which corresponds to 1000/ 500 GeV, assuming the light yield is 2/4 p.e./MeV.

There are a few tens overflow events with higher energy deposition, indicating energy deposition higher than 7.2 MeV.

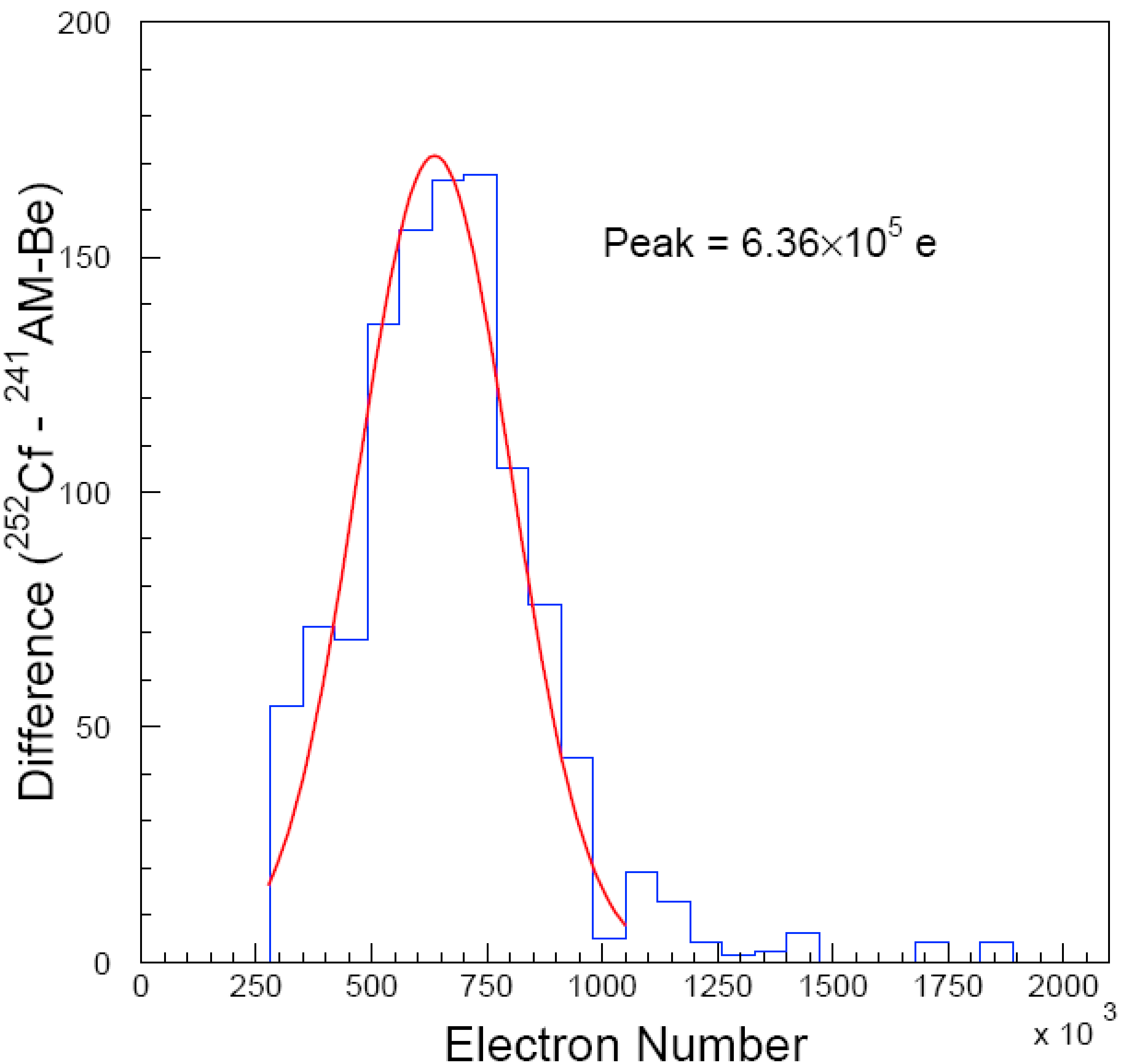
^{241}Am-Be and ^{252}Cf for APD Gain = 35



The overall PHS from both sources are consistent with the high end at 2M electrons and some overflow events.

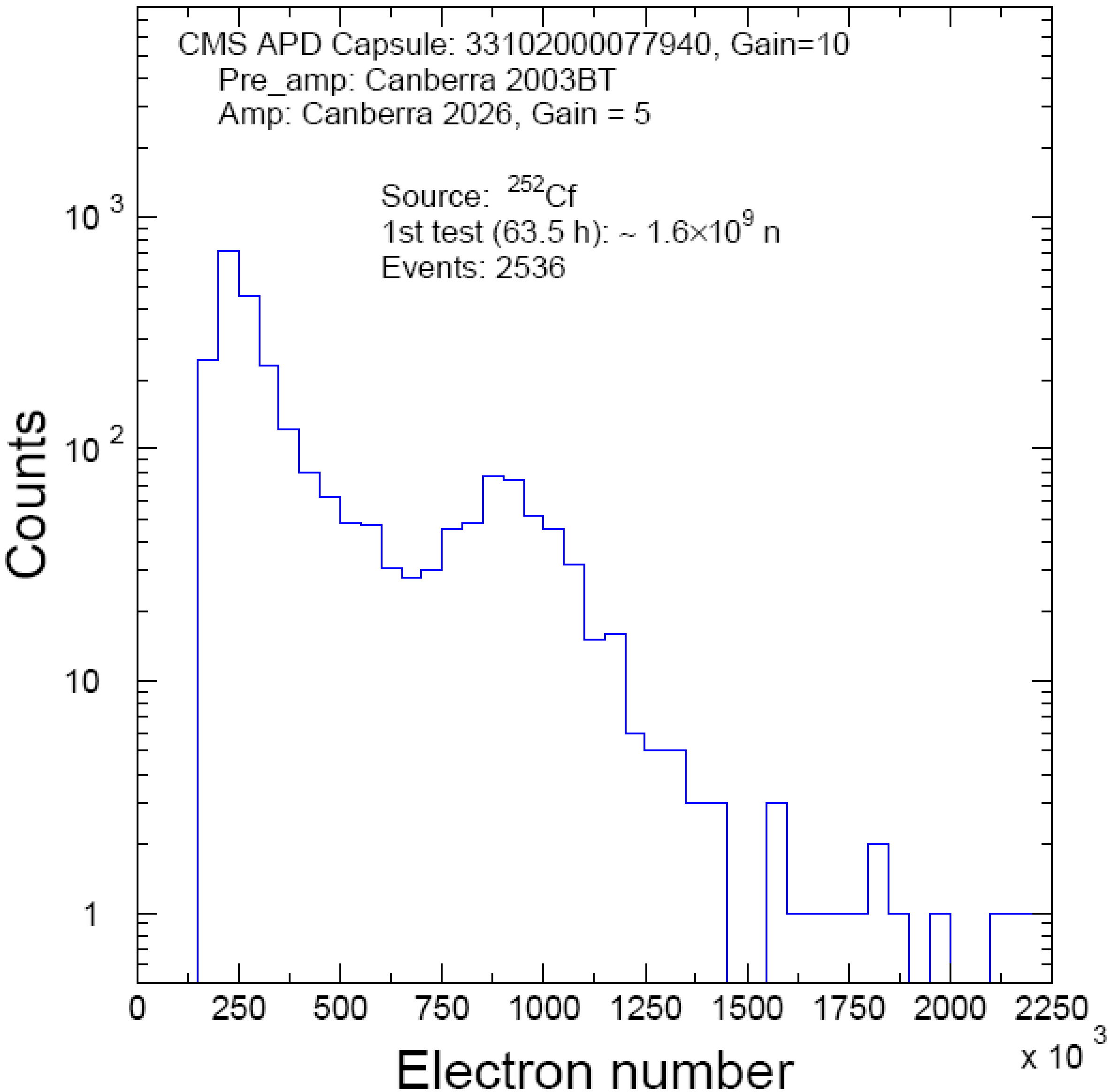
The PHS of ^{252}Cf shows a peak at ~640k electrons as compared to the ^{241}Am-Be source.

^{252}Cf – ^{241}Am-Be for APD Gain = 35



The excess events in the ^{252}Cf PHS shows a peak at 636k electrons, or 2.30 MeV, which is consistent with the peak of neutron energy from the ^{252}Cf source, indicating that the neutrons may deposit their entire energy in the APD.

^{252}Cf Spectrum with APD Gain = 10

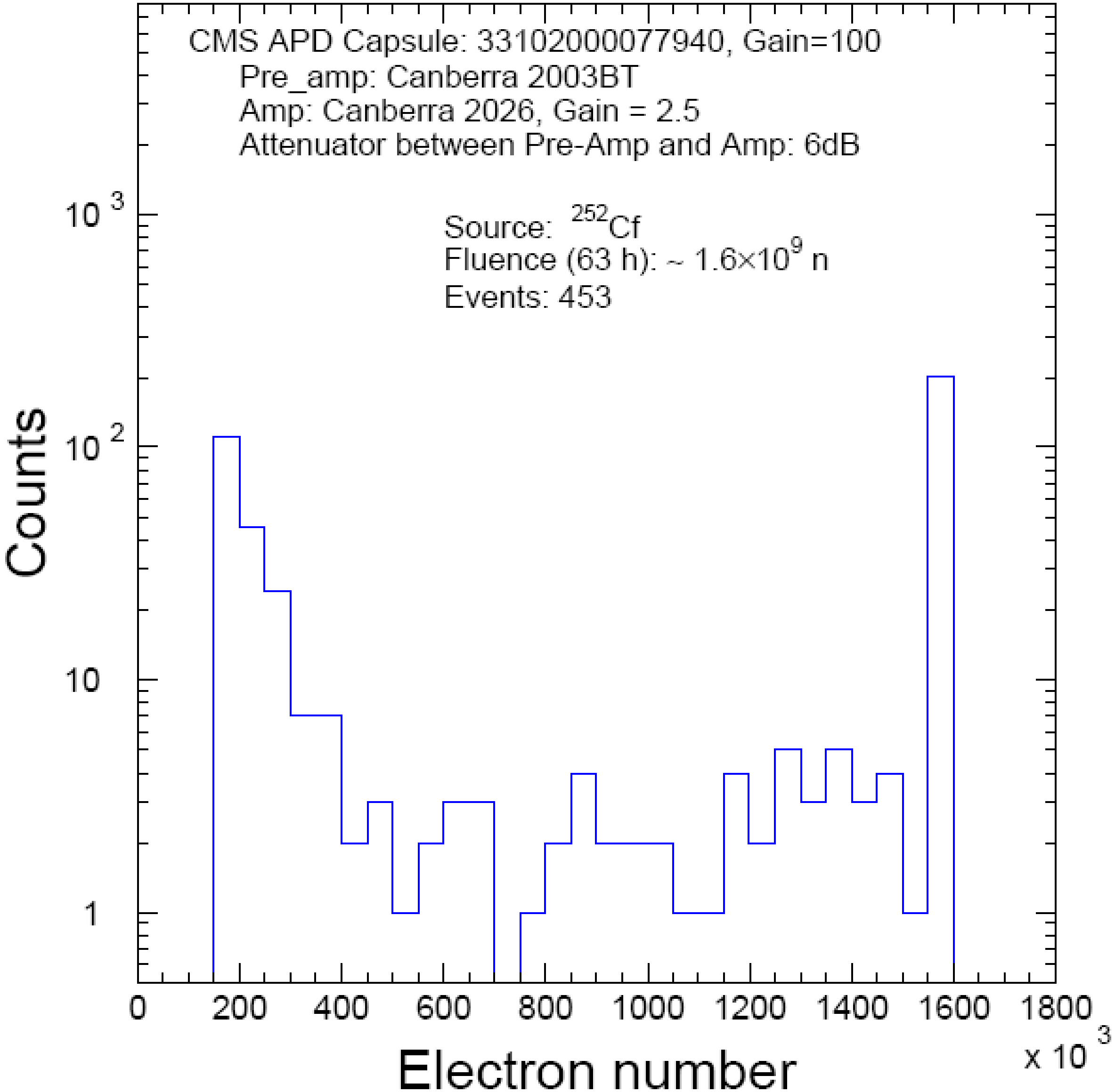


Data were taken with the SA gain at 5. The up-limit of the pulse height distribution is 2.2 M electrons, or 7.2 MeV deposition in APD, which corresponds to 1000/500 GeV, assuming the light yield is 2/4 p.e./MeV.

The ^{252}Cf peak is higher than 640 ke.

There are not much overflow events with more than 7.2 MeV.

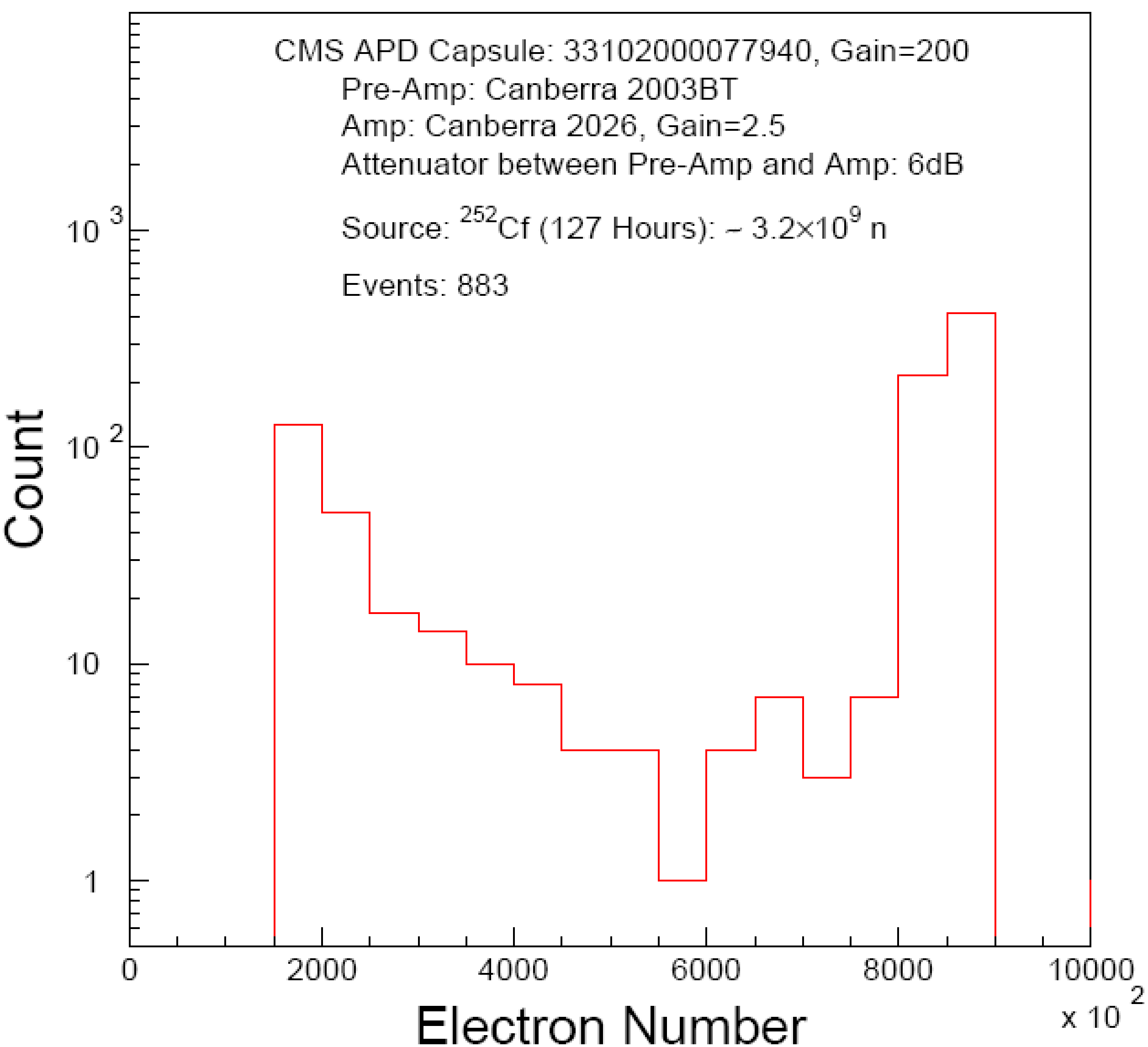
^{252}Cf Spectrum with APD Gain = 100



Data were taken with the SA gain at 2.5 and an attenuator of 6 dB. The up-limit of the pulse height distribution is 1.6 M electrons, or 5.8 MeV deposition in APD, which corresponds to 800/400 GeV, assuming the light yield is 2/4 p.e./MeV.

Overall nuclear counter effect reduced. About 200 overflow events observed with energy of more than 5.8 MeV.

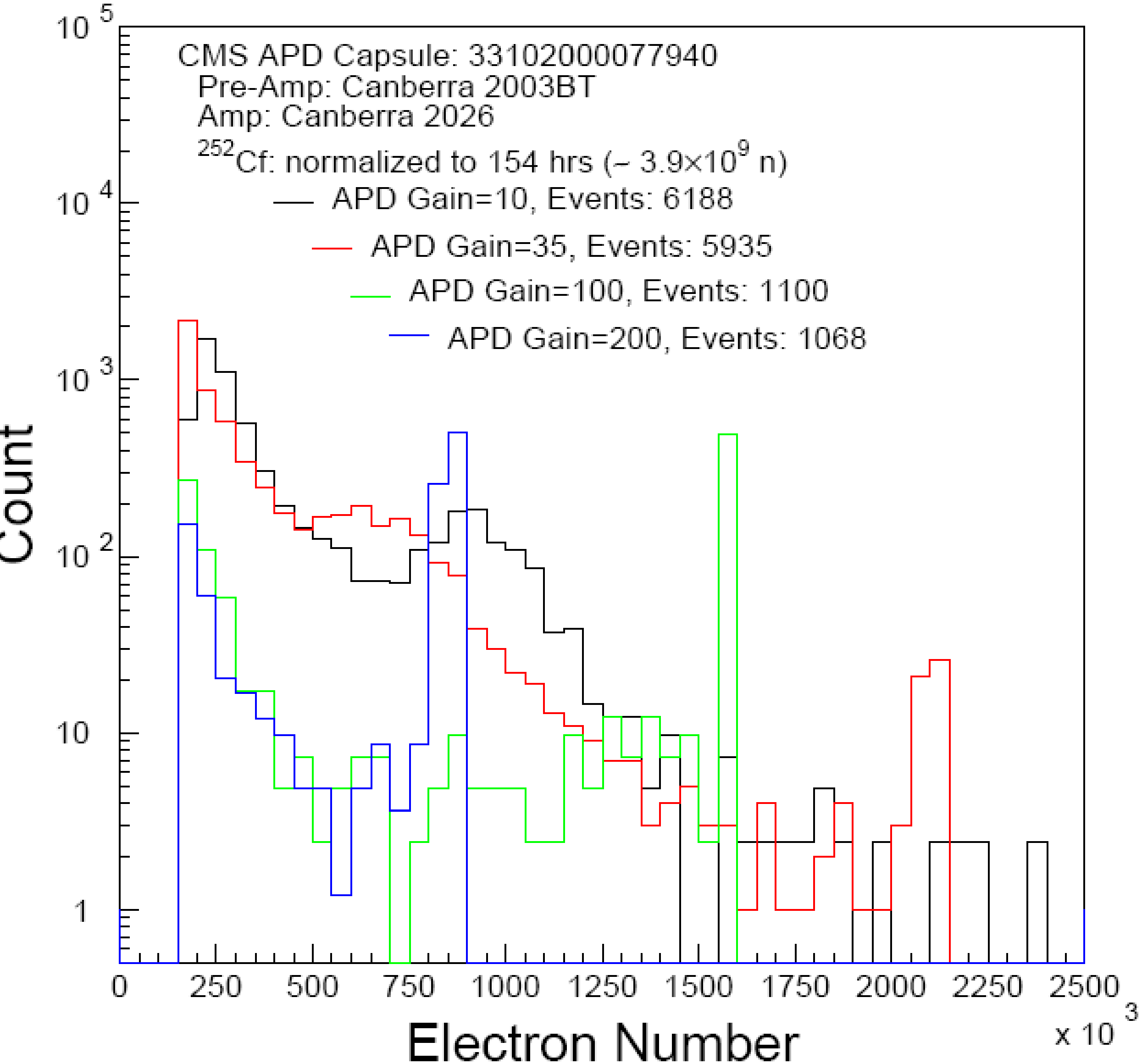
^{252}Cf Spectrum with APD Gain = 200



Data were taken with the SA gain at 2.5 and an attenuator of 6 dB. The up-limit of the pulse height distribution is 0.9 M electrons, or 3.3 MeV deposition in APD, which corresponds to 450/225 GeV, assuming the light yield is 2/4 p.e./MeV.

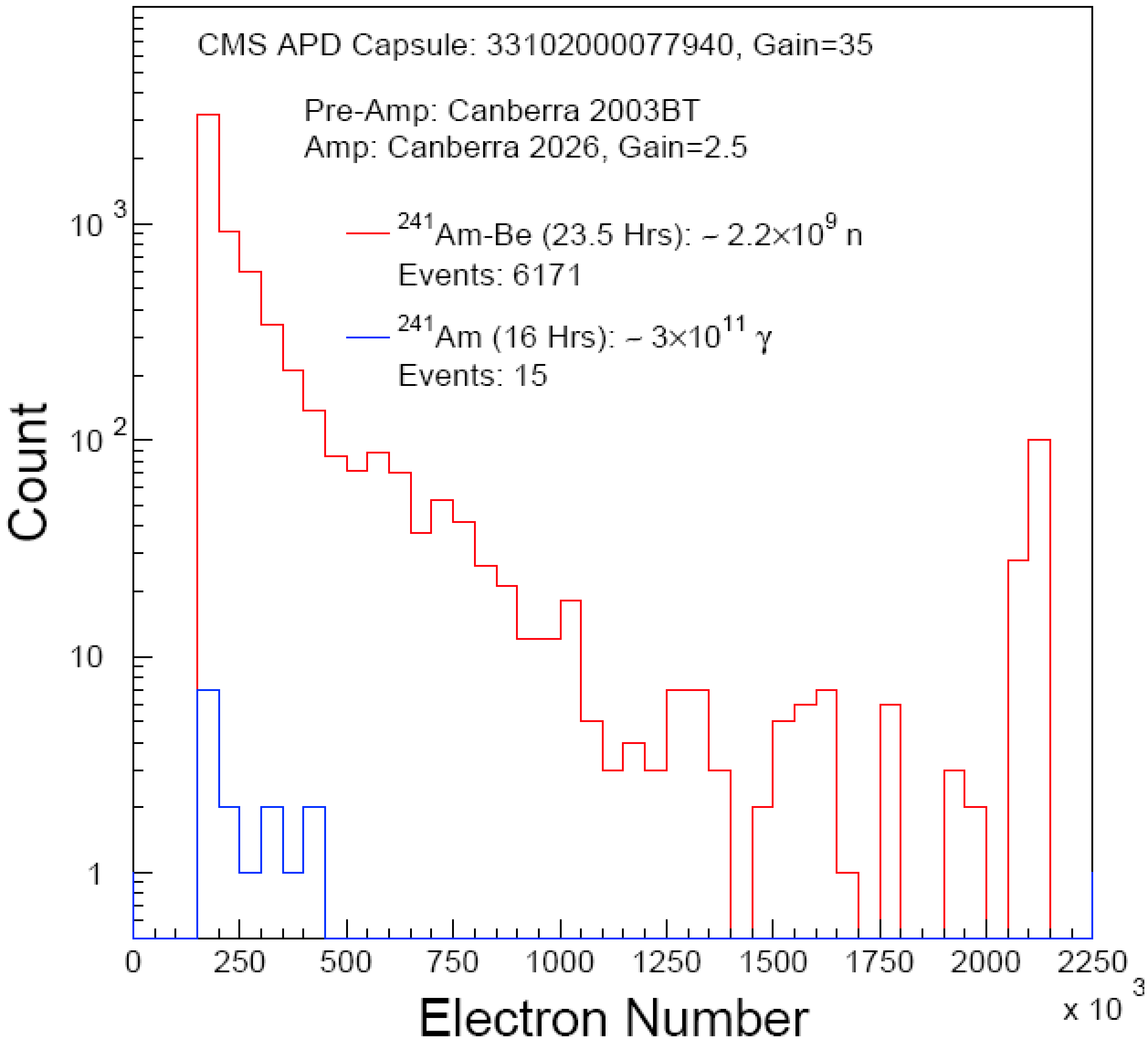
Overall nuclear counter effect reduced. About 1000 overflow events observed with energy of more than 3.3 MeV.

^{252}Cf Spectrum Comparison



^{252}Cf spectra are observed for the APD gains of 10, 35, 100 and 200. The lower response for the high APD gain indicates a bulk nature of the nuclear counter effect induced by MeV neutrons.

PHS for ^{241}Am-Be and ^{241}Am Source



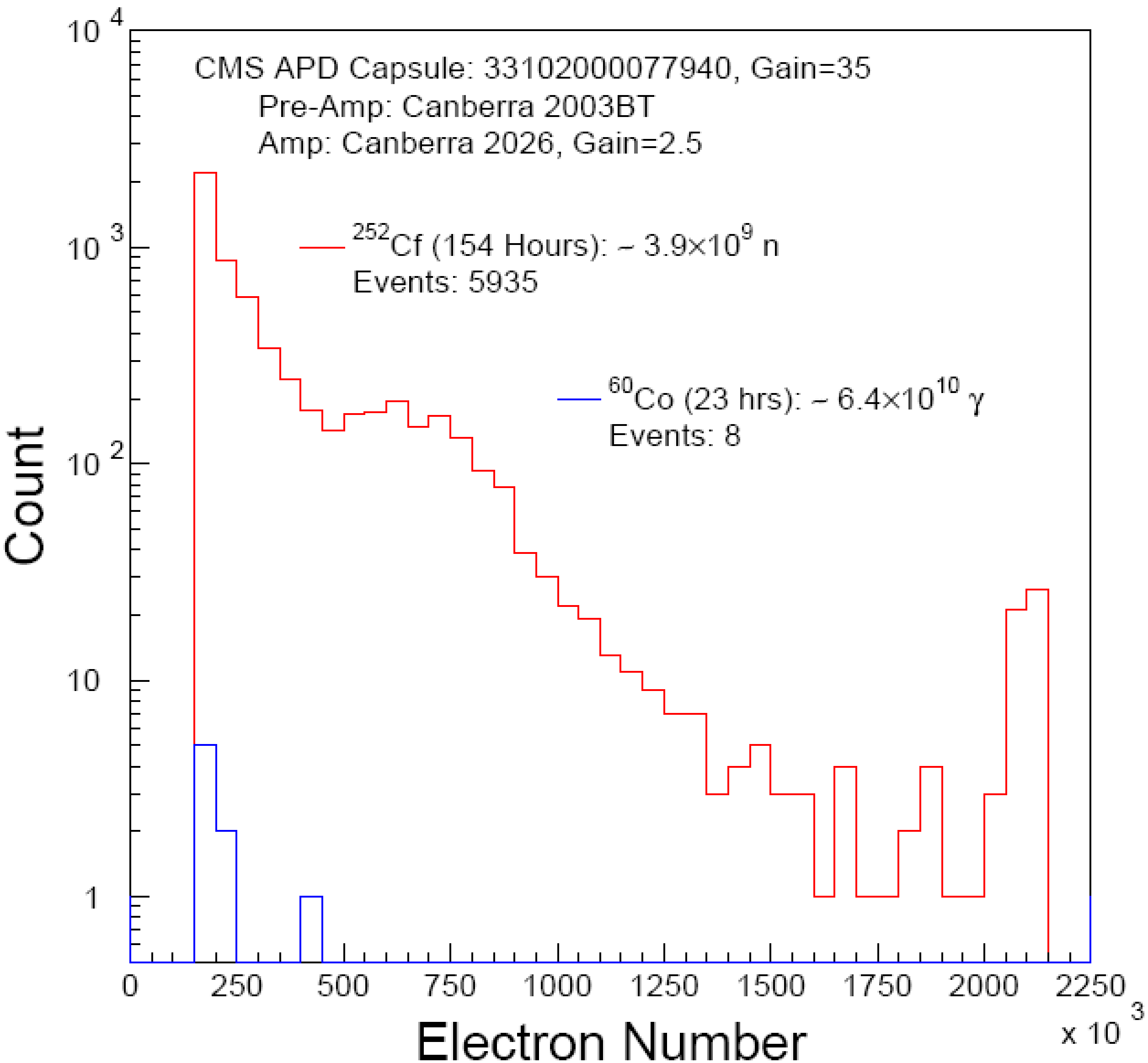
The trigger rate of 15 and 60 keV X-rays from an ^{241}Am source is five orders of the magnitude smaller compared to ^{241}Am-Be neutrons, indicating negligible contamination from X-rays.

Trigger Rate for >150k electrons or 0.54 MeV:

^{241}Am-Be: 2.8×10^{-6}

^{241}Am: 5.0×10^{-11}

PHS for ^{252}Cf and ^{60}Co Source



The trigger rate of MeV ɣ-rays from an ^{60}Co source is 4 orders of the magnitude smaller than ^{252}Cf neutrons, indicating that the contamination from ɣ-rays in negligible.

Trigger Rate for >150k electrons or 0.54 MeV:

^{252}Cf: 1.5×10^{-6}

^{60}Co: 1.3×10^{-10}

Summary

MeV neutrons from ^{252}Cf and ^{241}Am-Be source causes serious nuclear counter effect in APD. The signal extends to more than 2 M electrons or 7.2 MeV, corresponding to equivalent energy of 1000/500 GeV and more, assuming the light yield of the PWO/APD system is 2/4 p.e./MeV.

Increasing the APD gain reduces the neutron induced nuclear counter effect in APD. This may be explained by a portion of the neutron energy deposited in the APD is amplified less than the scintillation photons. This seems an interesting option for real application.

Signal induced by keV X-rays and MeV ɣ-rays are negligible as compared to MeV neutrons.