A first characterization of NaI-37

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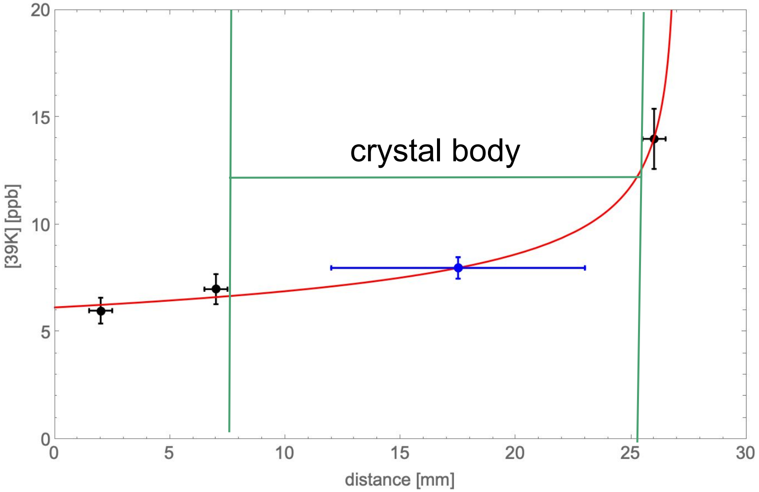
The NaI-37 crystal

- Arrived @LNGS by plane at the end of March 2022;
- Grown with Astrograde powder (batch 113065 produced by EMD);
- Cut, polishing and crucible preparation by the RMD Company;
- Final mass: 4.35 kg.

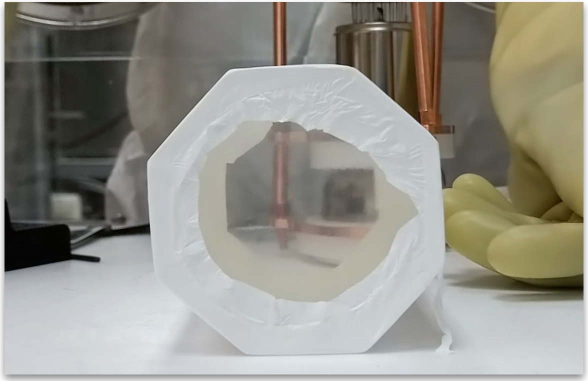
^{39}K from ICP-MS measurements

Powder [ppb]	Crystal samples [ppb]
14.5	7.8 ± 0.5



NaI-37 assemblies

1. **December 7th, 2022**
   - No optical grease;
   - Air gap between PMT window and crystal due to a problem in delrin holders design;
   - 3 layers of PTFE (~150-240 μm).

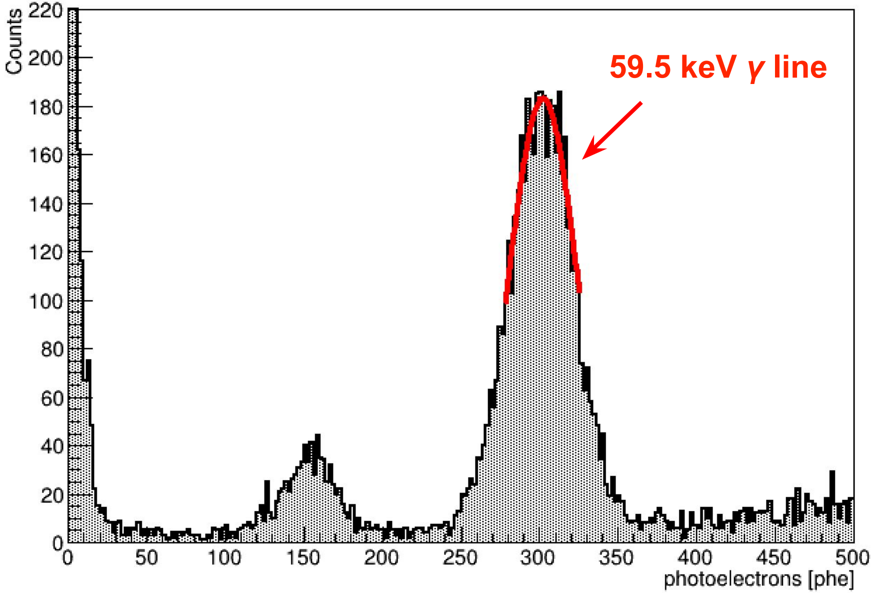


2. **January 24th, 2023**
   - Optical grease (Saint Gobain 630);
   - No air gap between PMT window and crystal (new delrin holders);
   - 5 layers of PTFE (~250-400 μm).

Light yield - assembly 1

^{241}Am source to measure **light yield (LY)**on the 59.5 keV gamma line

- Source positioned on the copper enclosure in correspondence with the crystal centre.

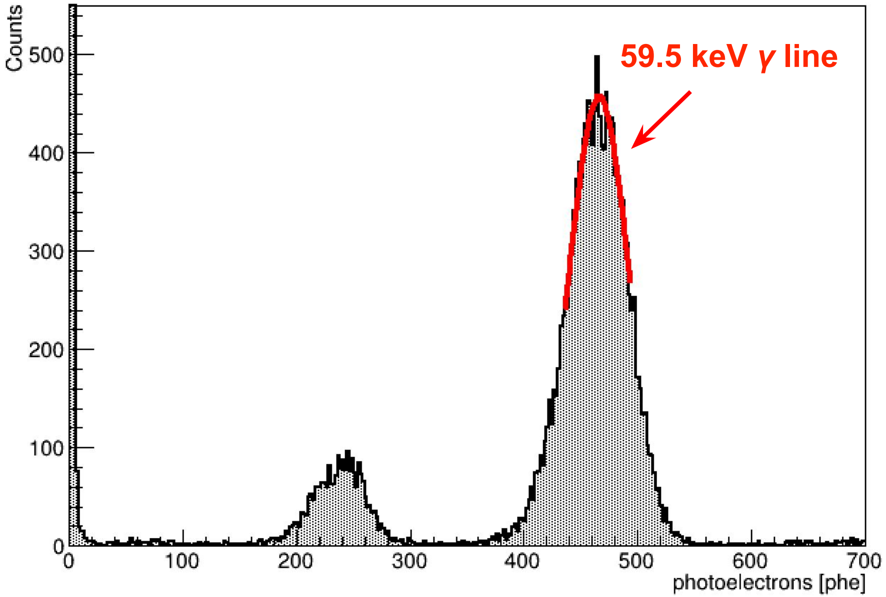


LY = 5.0 phe/keV
(~2.5 phe/keV for each channel)

Light yield - assembly 2

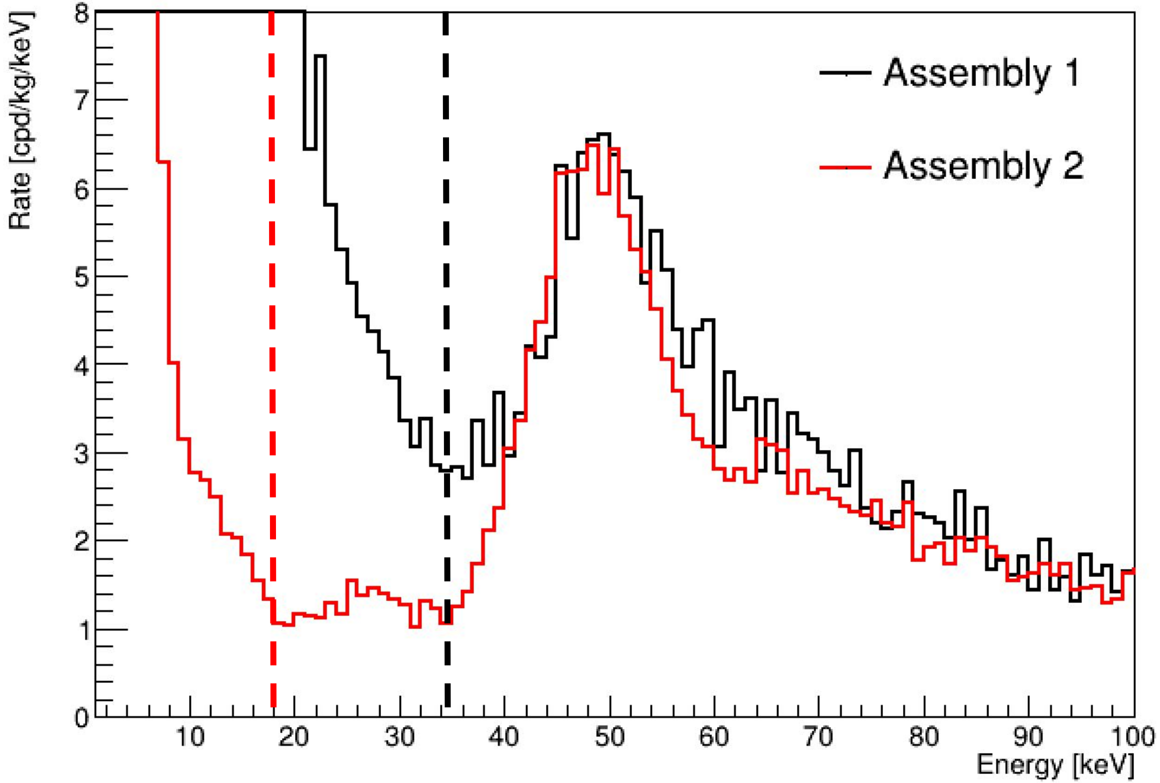
^{241}Am source to measure **light yield (LY)**on the 59.5 keV gamma line

- Source positioned on the copper enclosure in correspondence with the crystal centre.



LY = 7.8 phe/keV
(~3.7 phe/keV for PMT “Top” and
~4.1 phe/keV for PMT “Bottom”)

Low energy spectrum w/o cuts

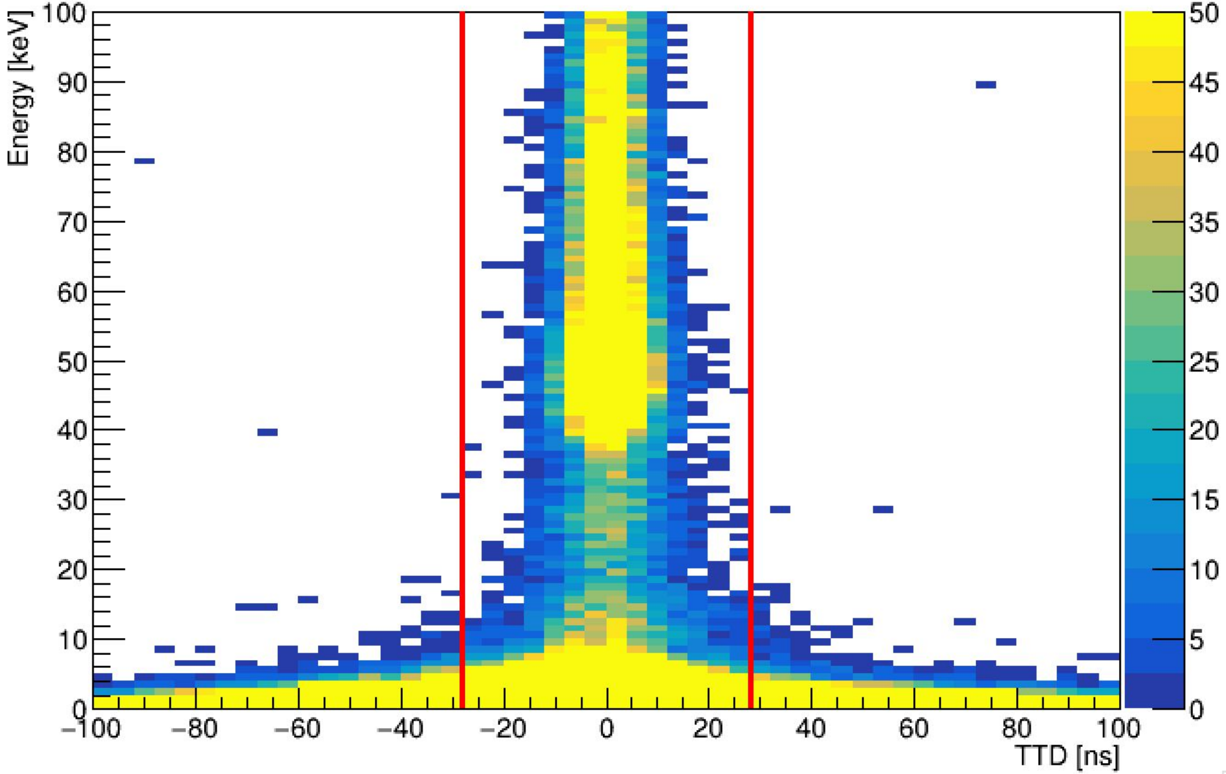


- Trigger threshold assembly 1 data: 25 mV, ~1 of photoelectron pulse height;
- Trigger threshold assembly 2 data: 10 mV, ~1/3 of photoelectron pulse height.

Extremely different noise condition

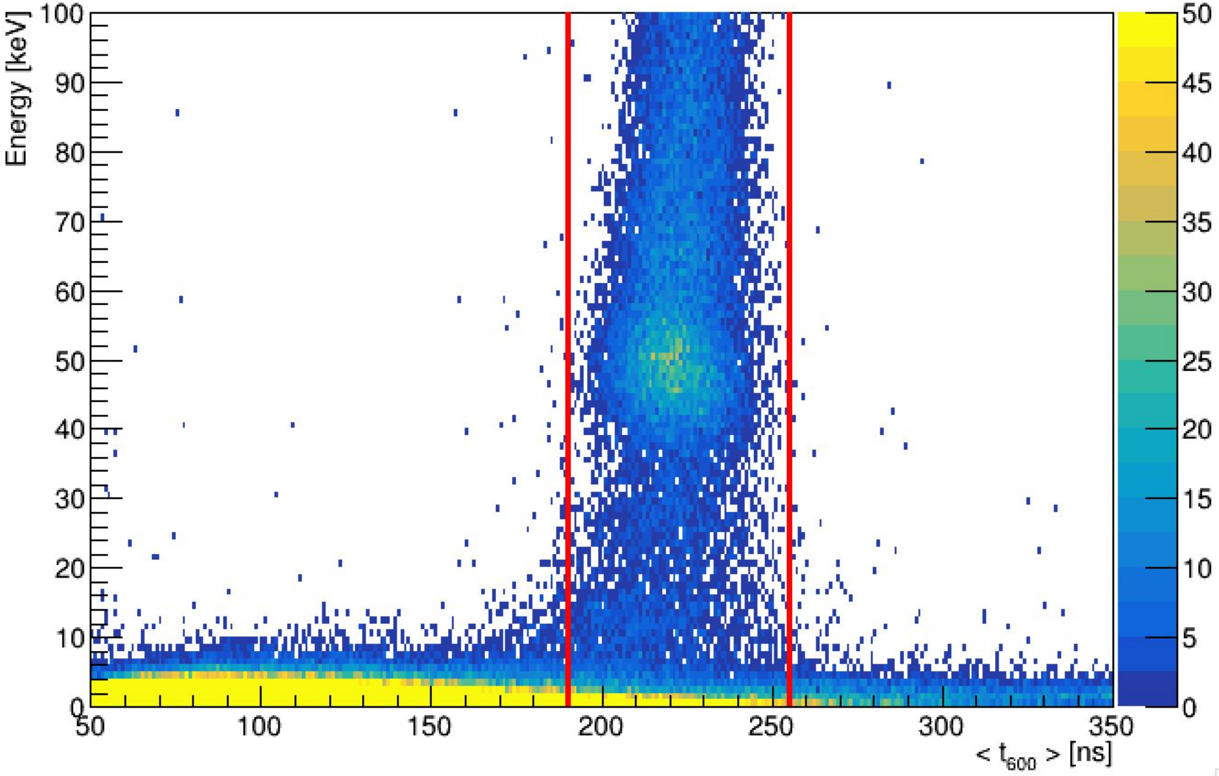
Low energy data analysis with rectangular cuts (assembly 2 dataset)

Trigger Time Delay (TTD)



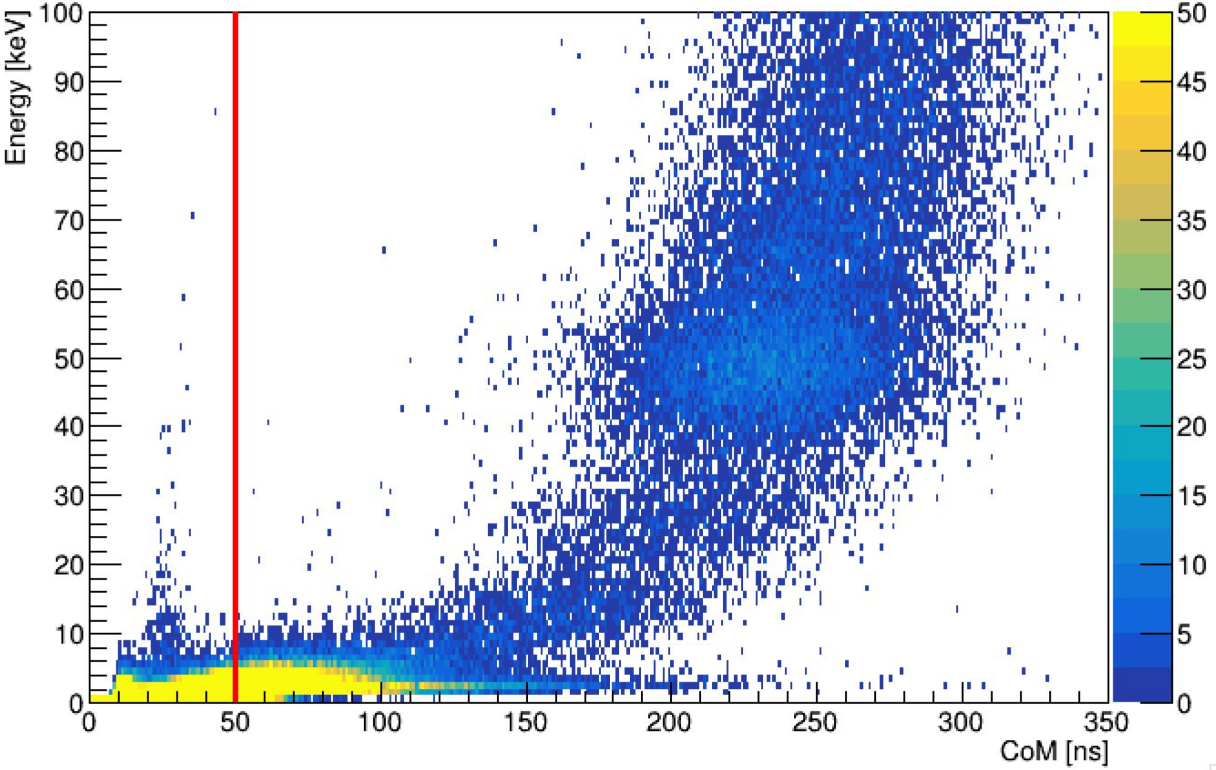
-28 ns < TTD < 28 ns

Mean Time ($< t >_{600}$)



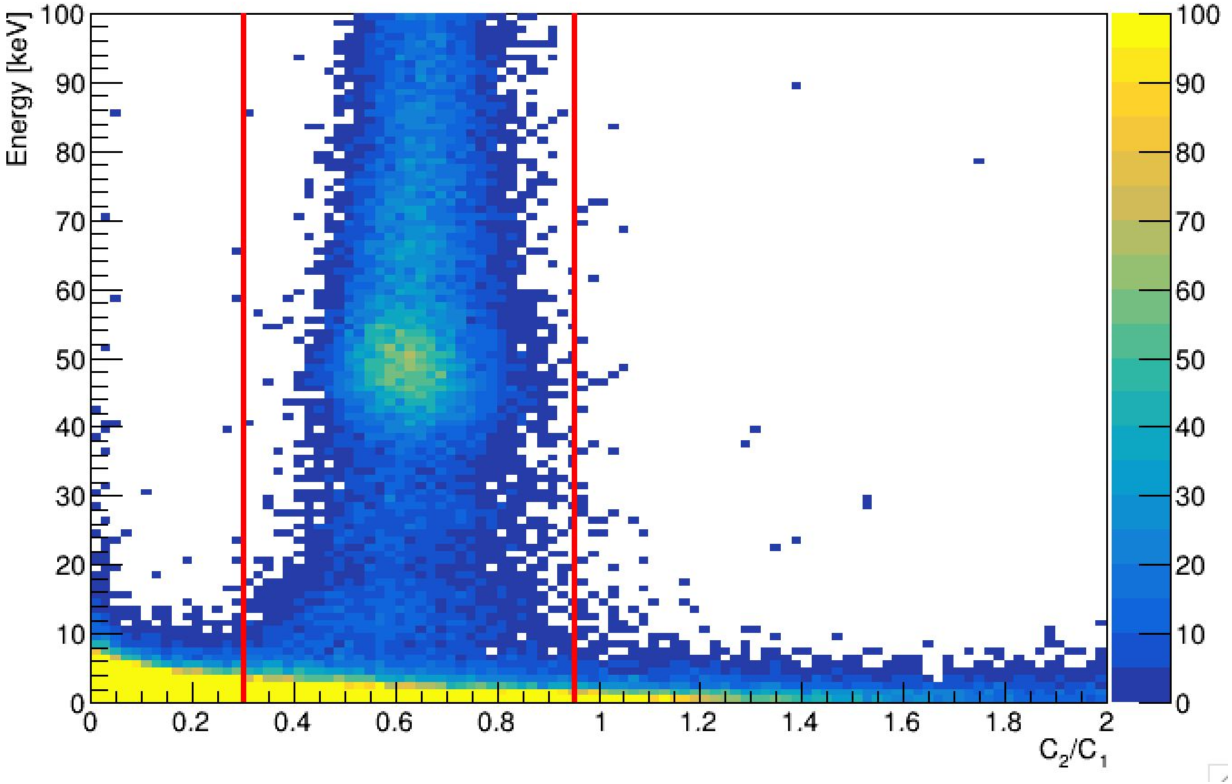
190 ns < $< t_{600} >$ < 255 ns

Charge over Maximum (CoM)



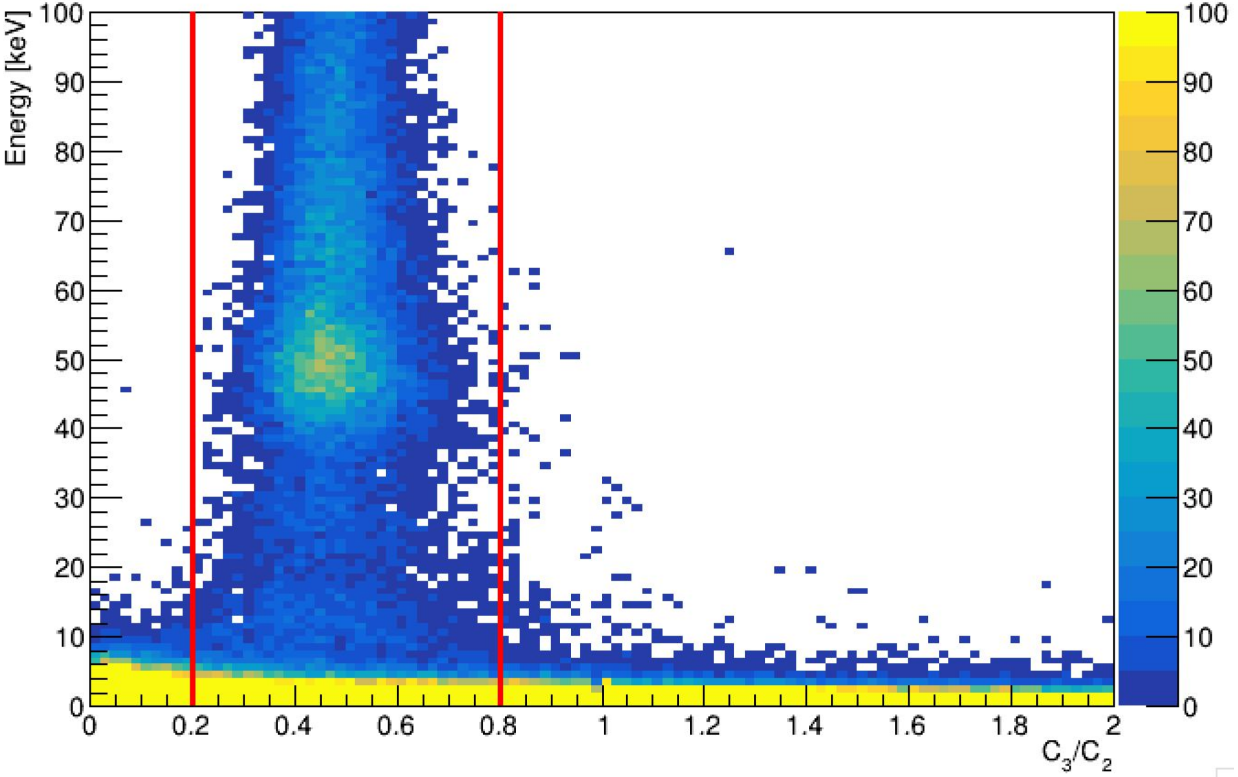
CoM > 50 ns

Head-to-middle pulse shape - C_2/C_1



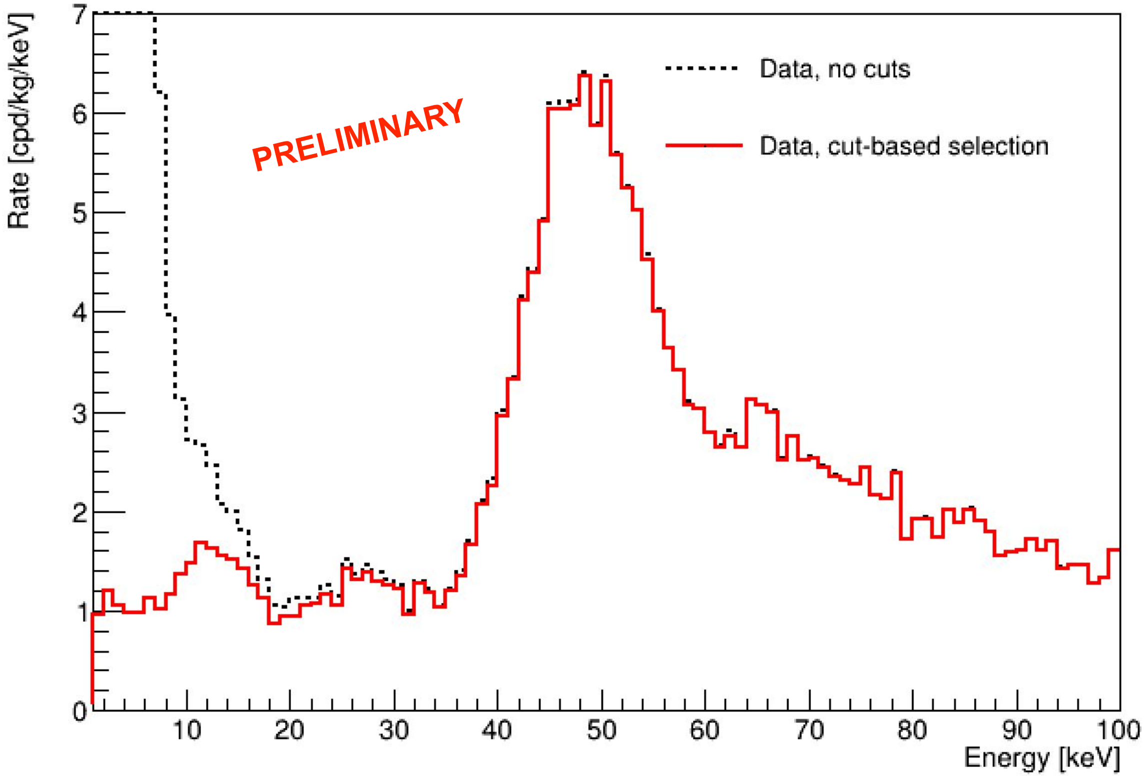
$0.30 < C_2/C_1 < 0.95$

Head-to-middle pulse shape - C_3/C_2



$0.20 < C_3/C_2 < 0.80$

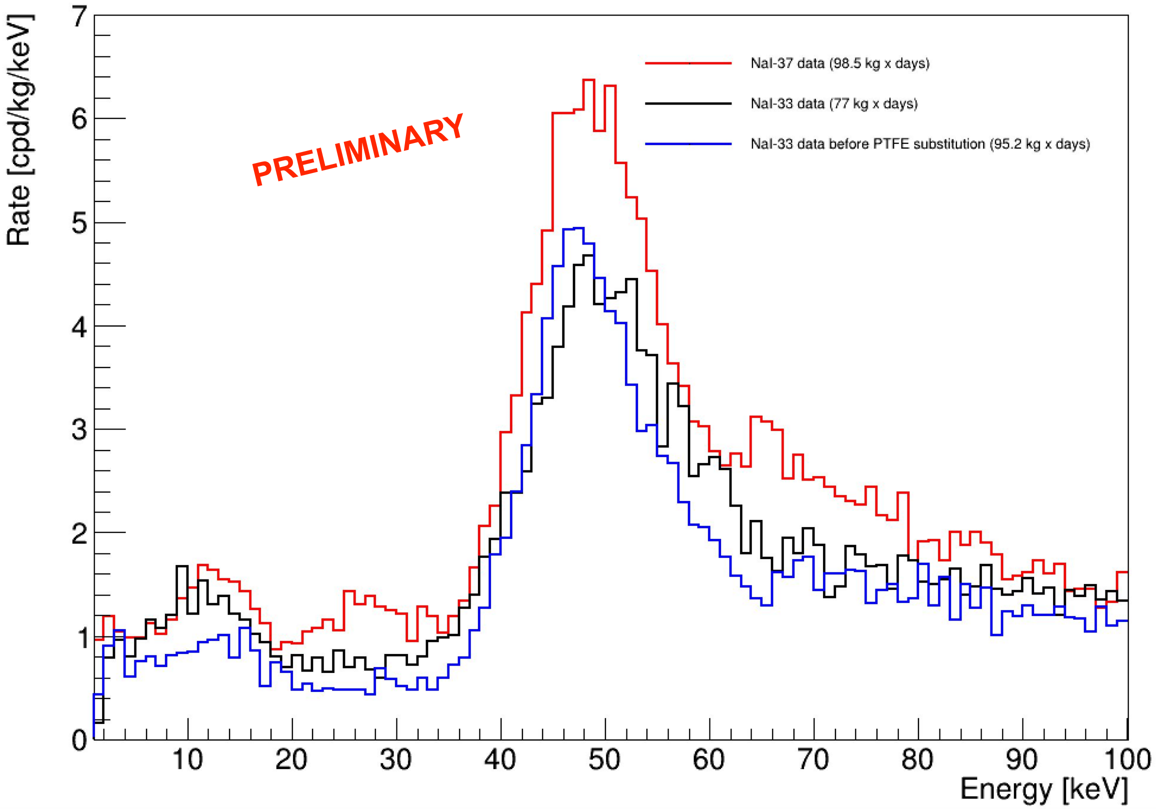
Low energy spectrum w cuts



- Exposure: **98.5 kg x days**;
- Caveat: **no acceptance correction.**

Rate in 1-6 keV:
1.04 ± 0.05 cpd/kg/keV

Low energy spectrum w cuts - NaI-37 vs. NaI-33



- Caveat: **no acceptance correction**;
- Higher ^{210}Pb content of NaI-37 is visible in the 50 keV region;
- Residual cosmogenics in NaI-37 in the regions around 30 keV and 70 keV.

Rate in 2-6 keV:

1.05 ± 0.05 cpd/kg/keV

0.88 ± 0.05 cpd/kg/keV

0.83 ± 0.05 cpd/kg/keV

Low energy spectrum w cuts - NaI-33 first data Hall B

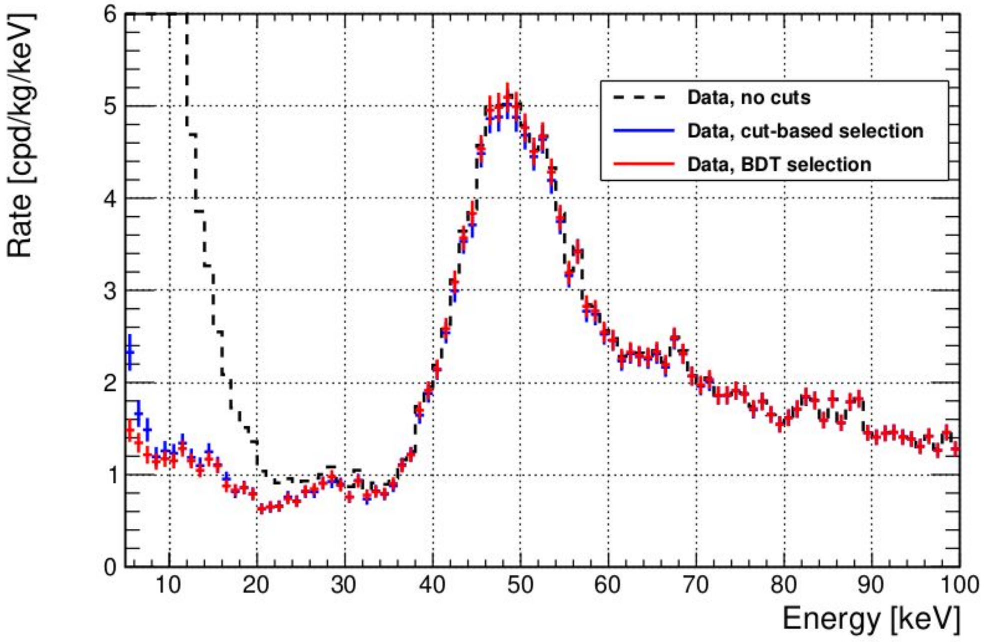
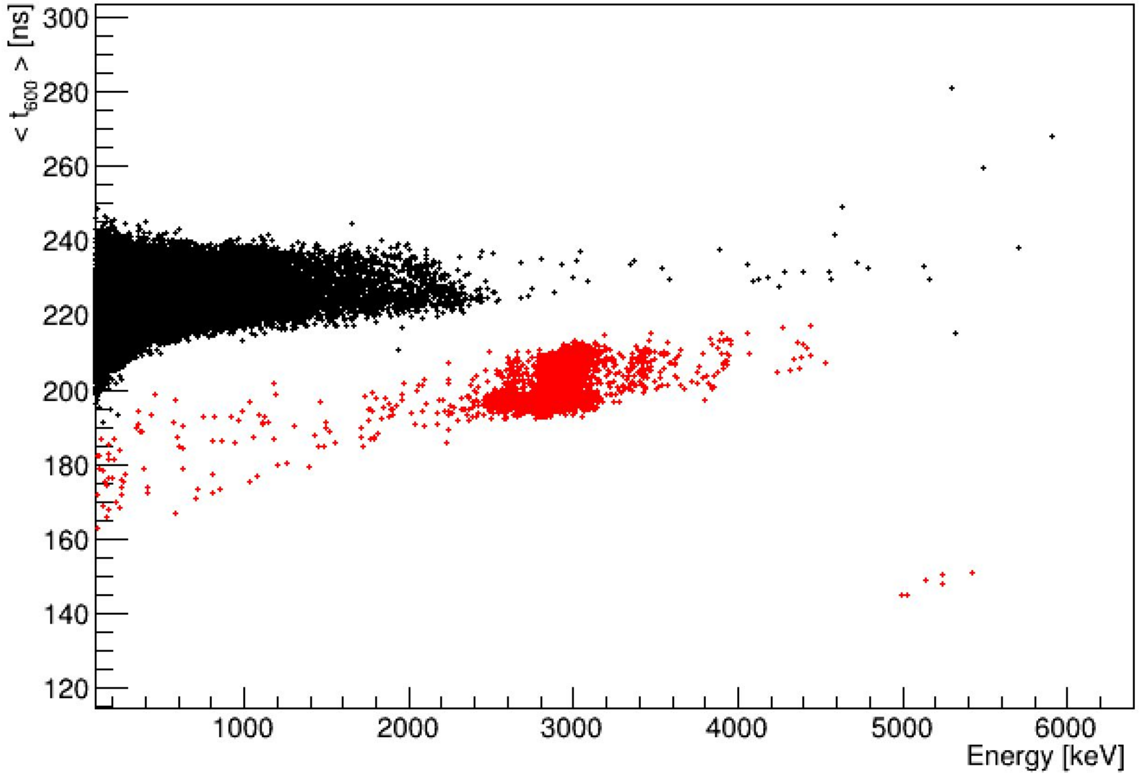


FIG. 6.29: NaI-33 low energy spectrum before (black dashed line) and after noise rejection. The result of the cut-based (blue points) and multivariate BDT (red points) analyses are shown corrected by the respective cut acceptance.

High energy data analysis (assembly 2 dataset)

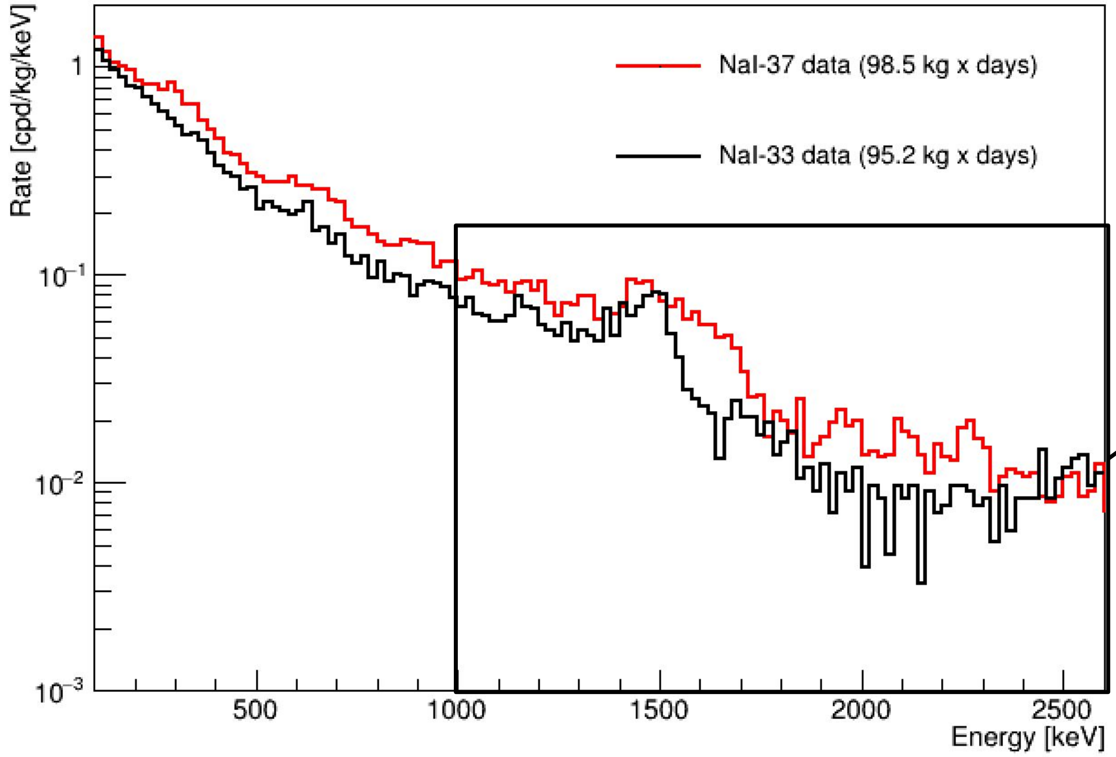
Alpha rate



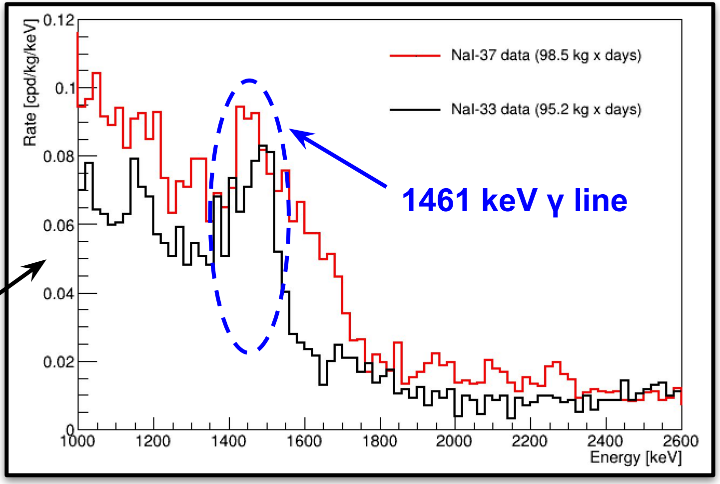
Alpha rate:
0.80 ± 0.01 mBq/kg

Higher than NaI-33 and NaI-35

High energy spectrum - NaI-37 vs. NaI-33



- Higher ^{40}K content of NaI-37 is visible from the 1461 keV γ line.



Conclusions

- The NaI-37 crystal is “still” quite noisy with respect to NaI-33, but **selection cuts** seems to be **effective down to 1 keV**;
- To calculate the “real” rate in 1-6 keV we need acceptance-correction → run with ^{176}Lu radioactive source to be done asap;
- The NaI-37 crystal would seem slightly worse than the NaI-33 in terms of intrinsic backgrounds:
  - **^{nat}K content** is higher: **8.4 ppb** vs. 4.6 ppb (from ICP-MS measurement of ^{39}K);
  - **Alpha rate** is ~1.6 times higher: **0.80 mBq/kg** vs. 0.50 mBq/kg → **Intrinsic ^{210}Pb is higher**.