Anti-Compton Shield Characterization for Clover and $CeBr_3$ Detectors of ELIADE

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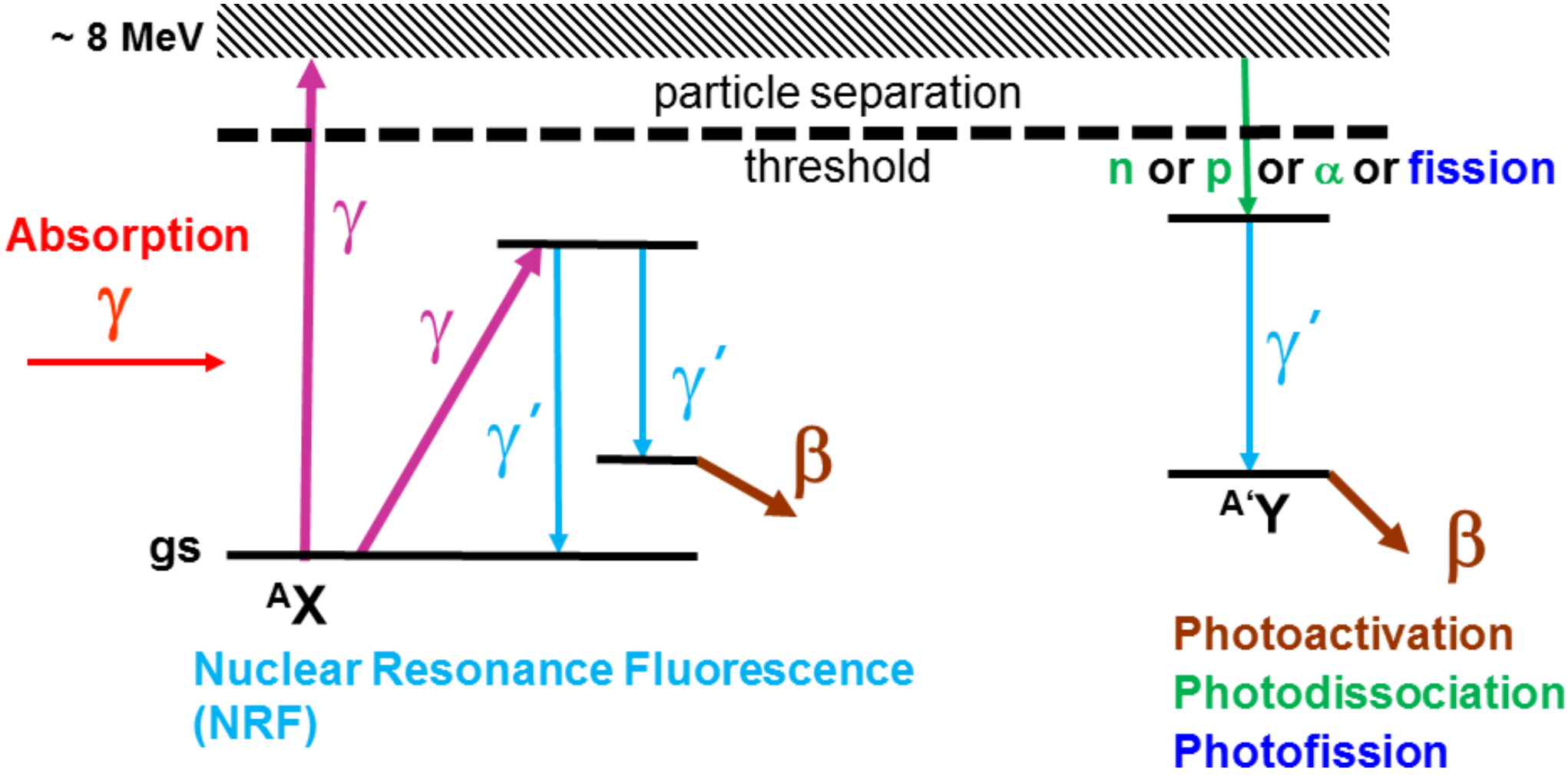
Introduction

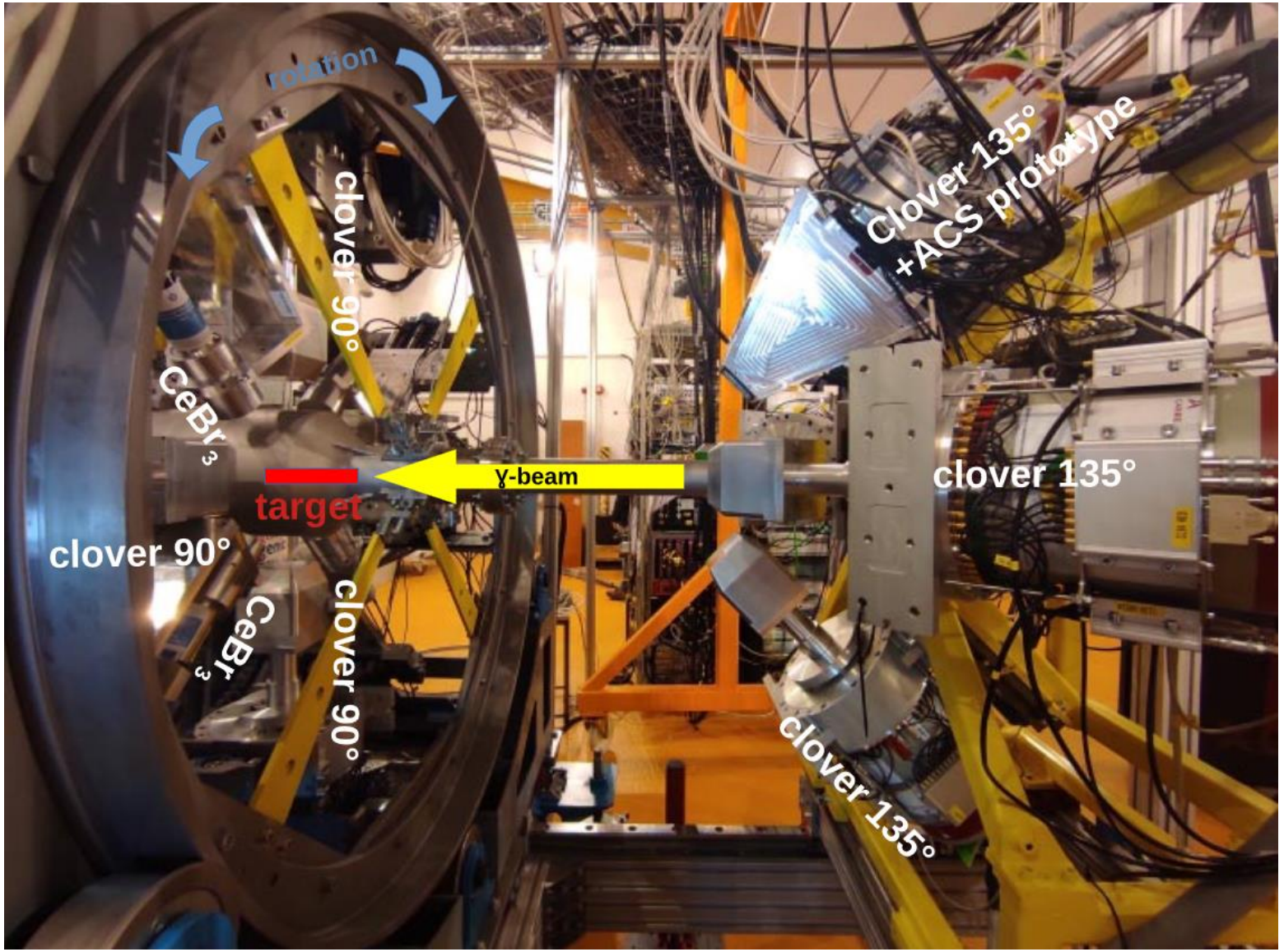


https://cds.cern.ch/record/2775917/plots

Introduction

ELIADE (**ELI**-NP **A**rray of **DE**tectors):

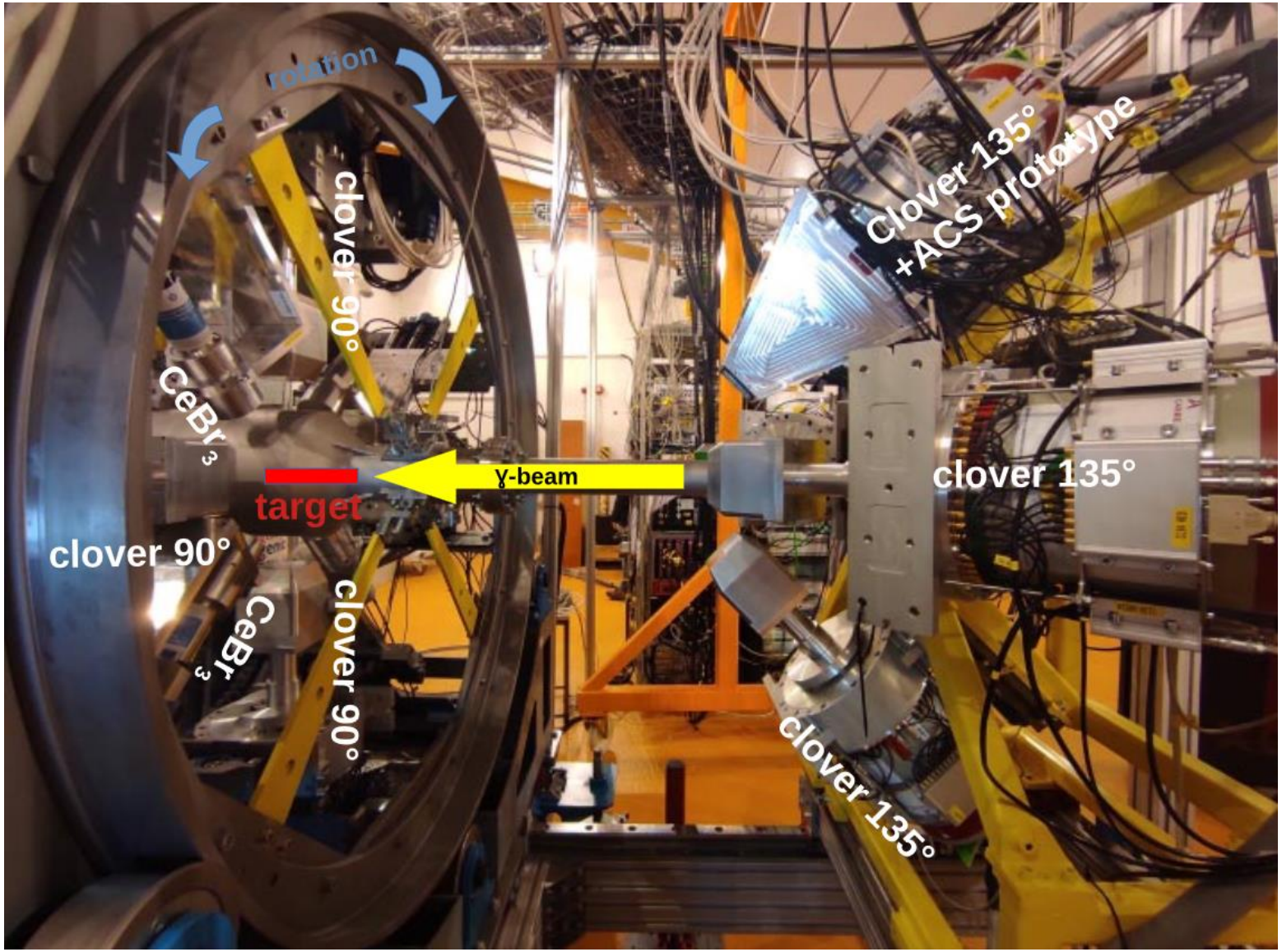
- Built for NRF studies;
- 8x HPGe Clover detectors (4x positioned at 90° and 4x at 135° w.r.t. beam axis);
- 4x CeBr3 scintillator detectors positioned at 135° w.r.t. beam axis.



D.A.Testov et al.: Status of the ELIADE γ-ray spectrometer for NRF Experiments at ELI-NP, Il Nuovo Cimento 47C (2024)

Introduction

Data has a large background (mostly Compton scattering from surrounding materials) => we use **Anti-Compton Shields (ACS)** around the detectors.



D.A.Testov et al.: Status of the ELIADE γ-ray spectrometer for NRF Experiments at ELI-NP, Il Nuovo Cimento 47C (2024)

BGO Anti-Compton Shields for HPGe Clover detectors; Characterization procedure

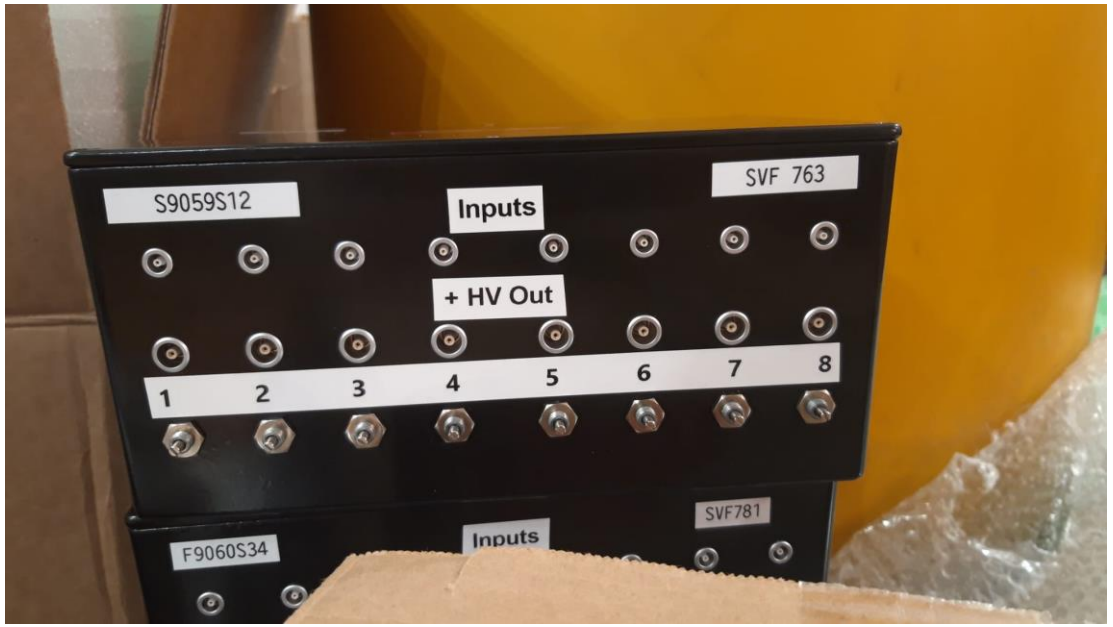
4 existing units + 4 more to be added

Components per unit:

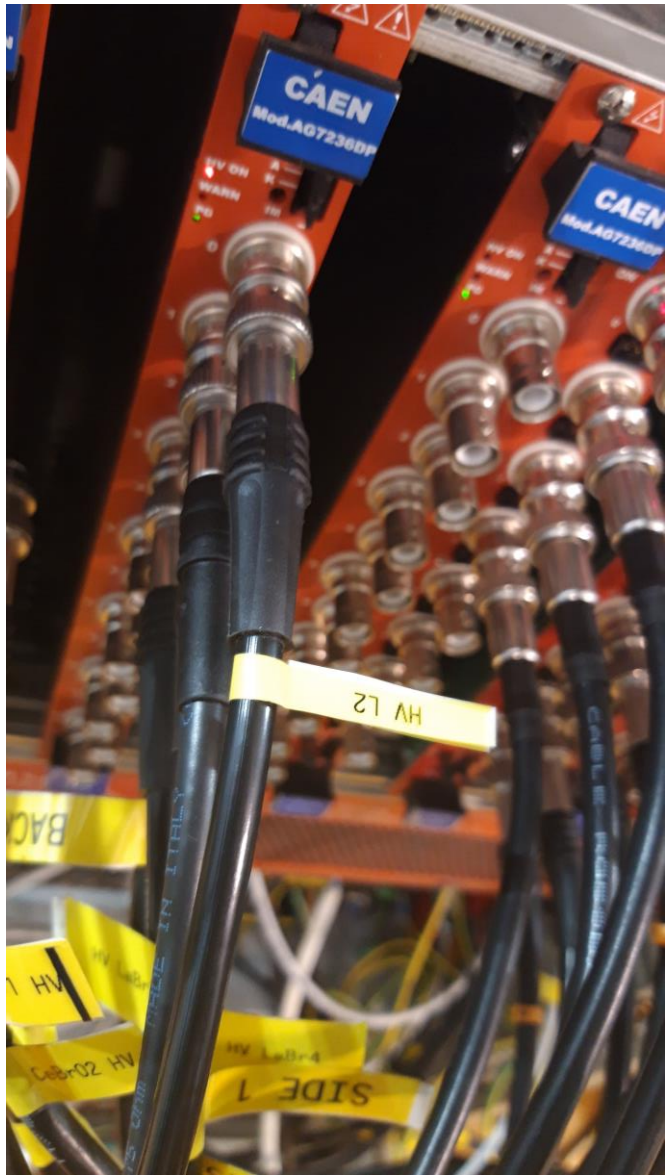
- 1x Front Shield VS-1412-10
  - Divided in 4x segments, each containing:
    - 2x BGO scintillators
    - 4x Hamamatsu ½” Type R647 Photomultiplier tubes (PMT)
- 1x Side Shield VS-1412-30
  - Divided in 4x segments, each containing:
    - 2x BGO scintillators
    - 4x Hamamatsu ¾” Type R5611 PMTs

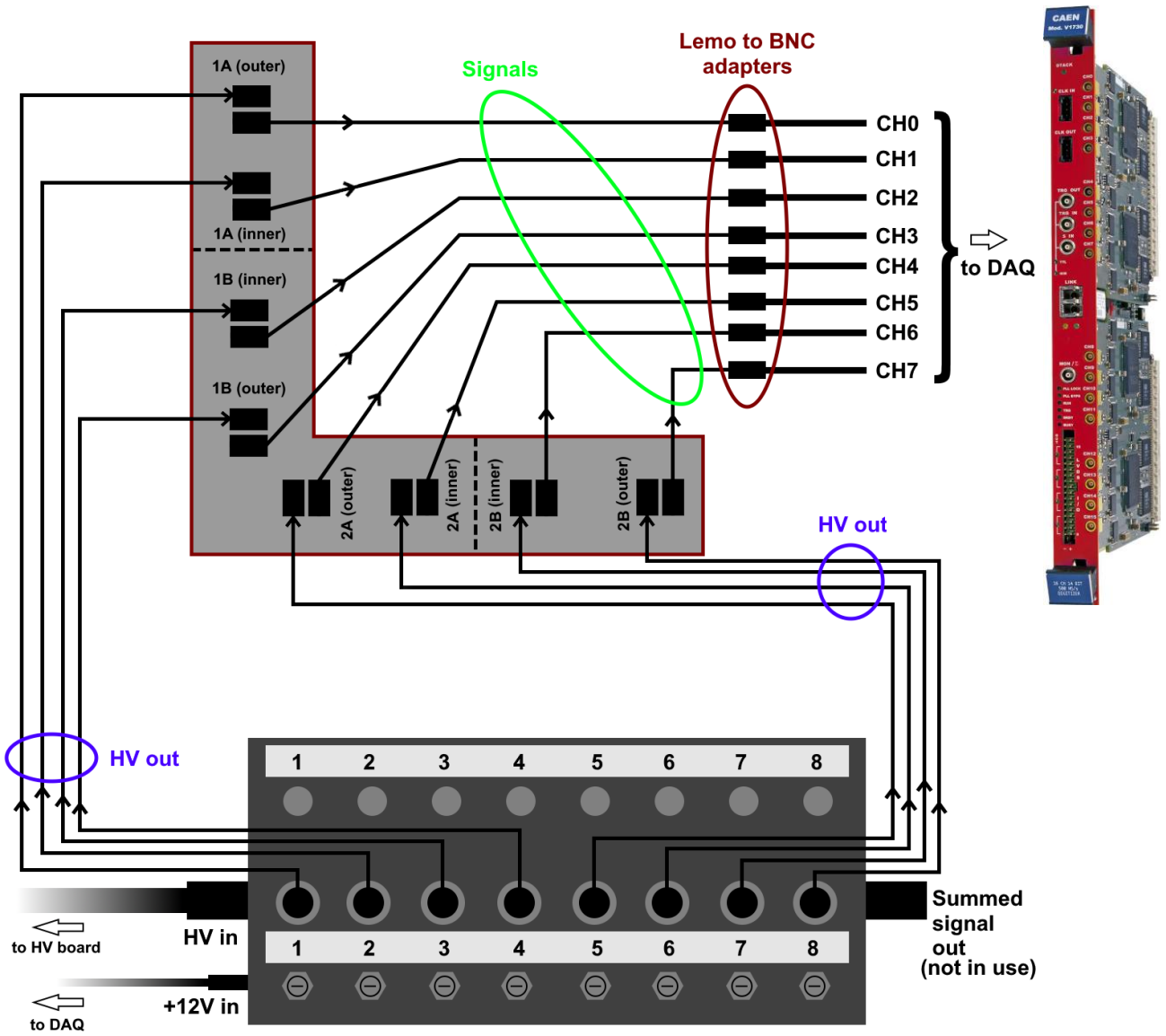
BGO Anti-Compton Shields for HPGe Clover detectors; Characterization procedure

ACS ⟶ digitizers ⟶ Too many channels (160 so far) ⟶ Arranging signals in groups of 8 using OR logic ⟶ centroids & amplitudes within a group need alignment



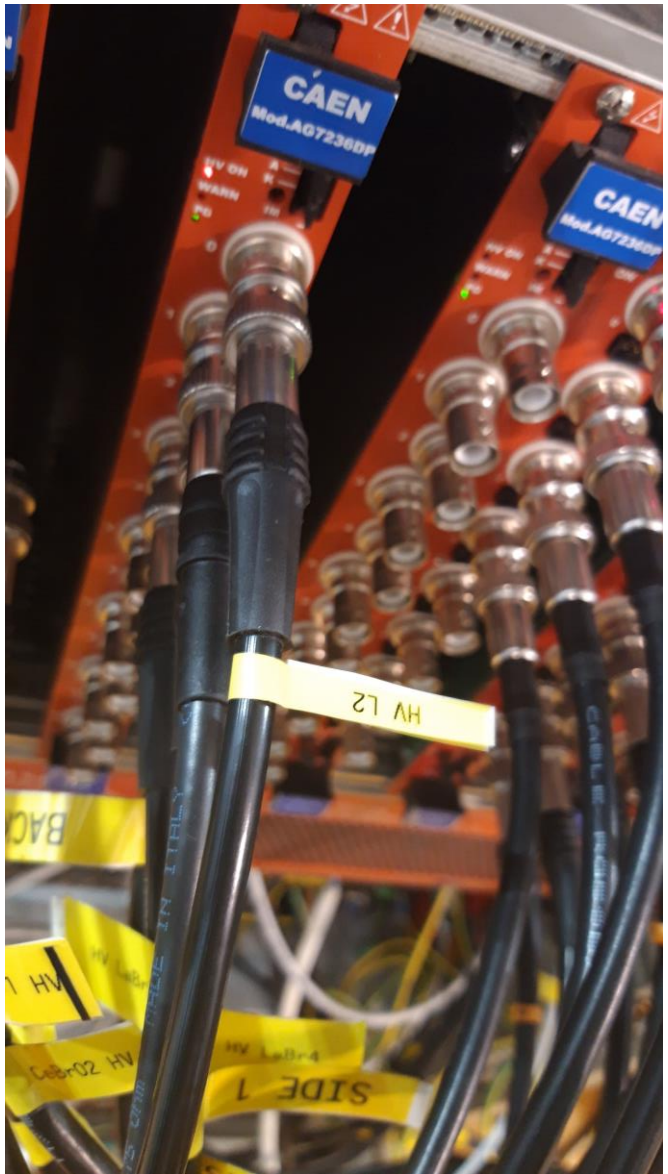
BGO Anti-Compton Shields for HPGe Clover detectors; Characterization procedure

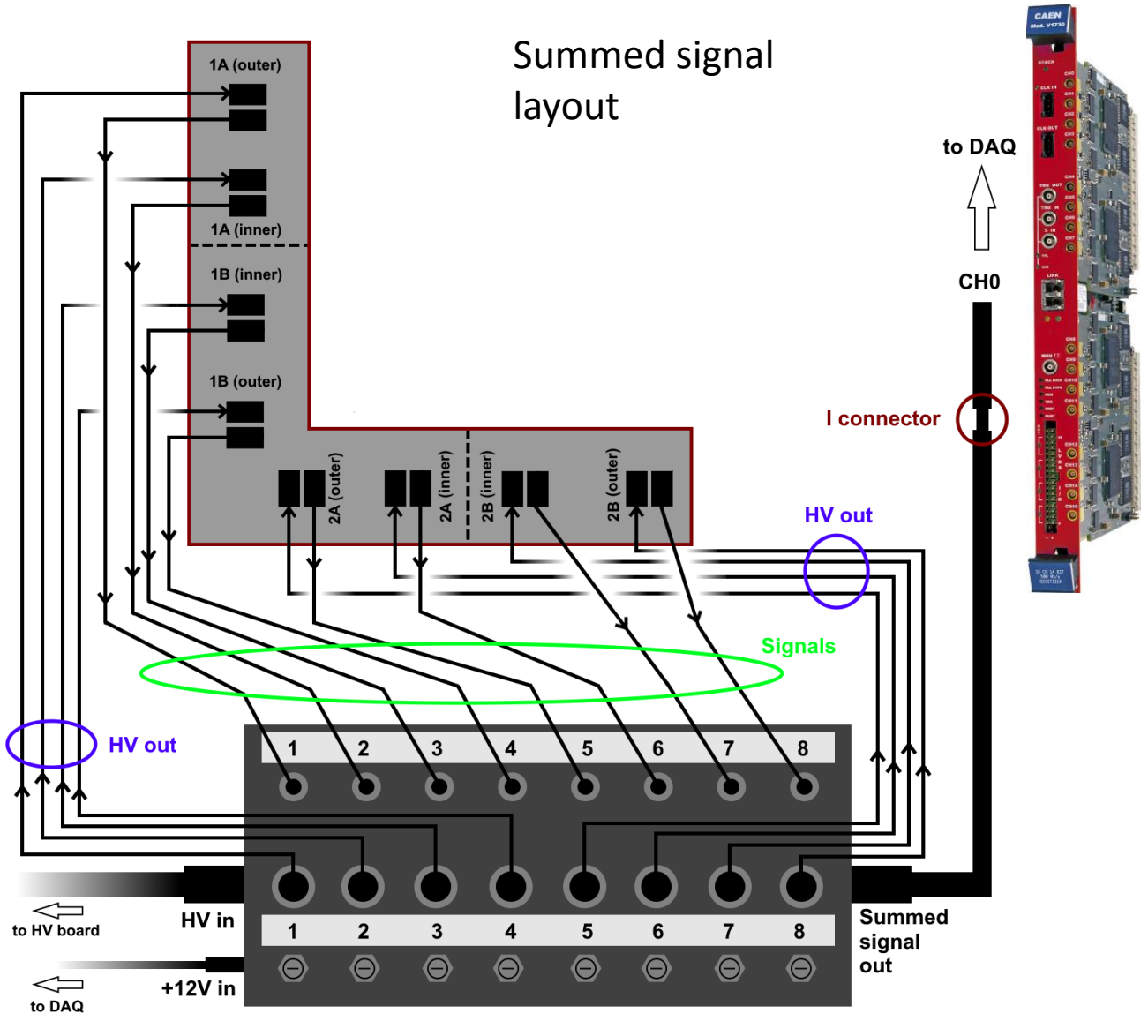




Individual signal spectra

BGO Anti-Compton Shields for HPGe Clover detectors; Characterization procedure





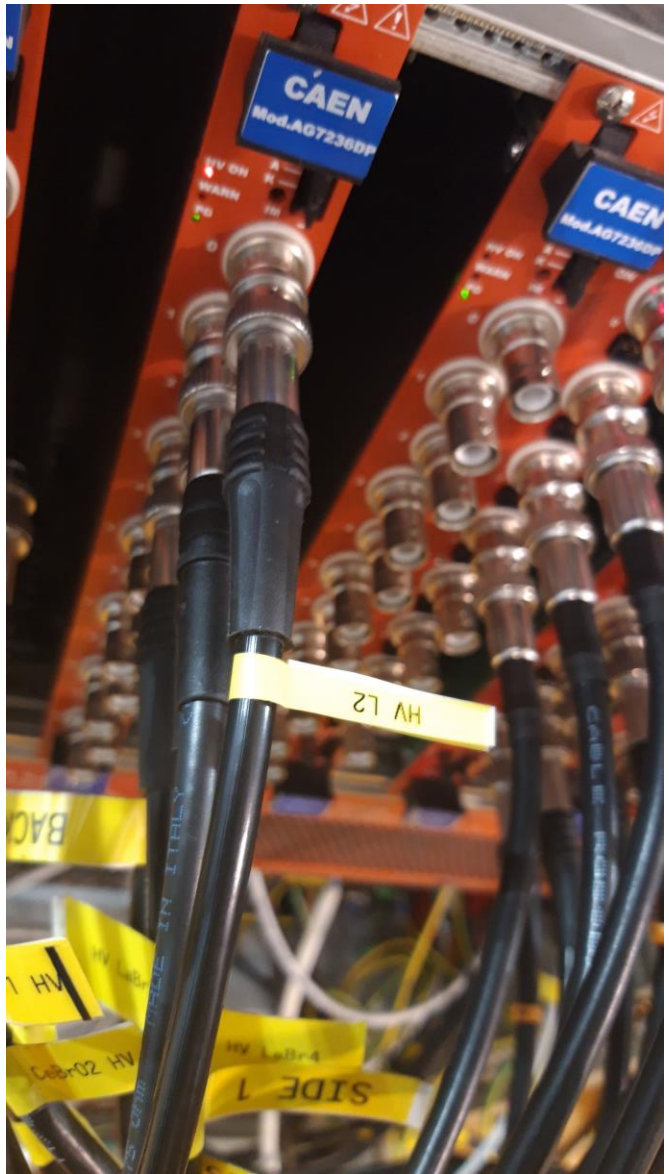
BGO Anti-Compton Shields for CeBr3 detectors; Characterization procedure

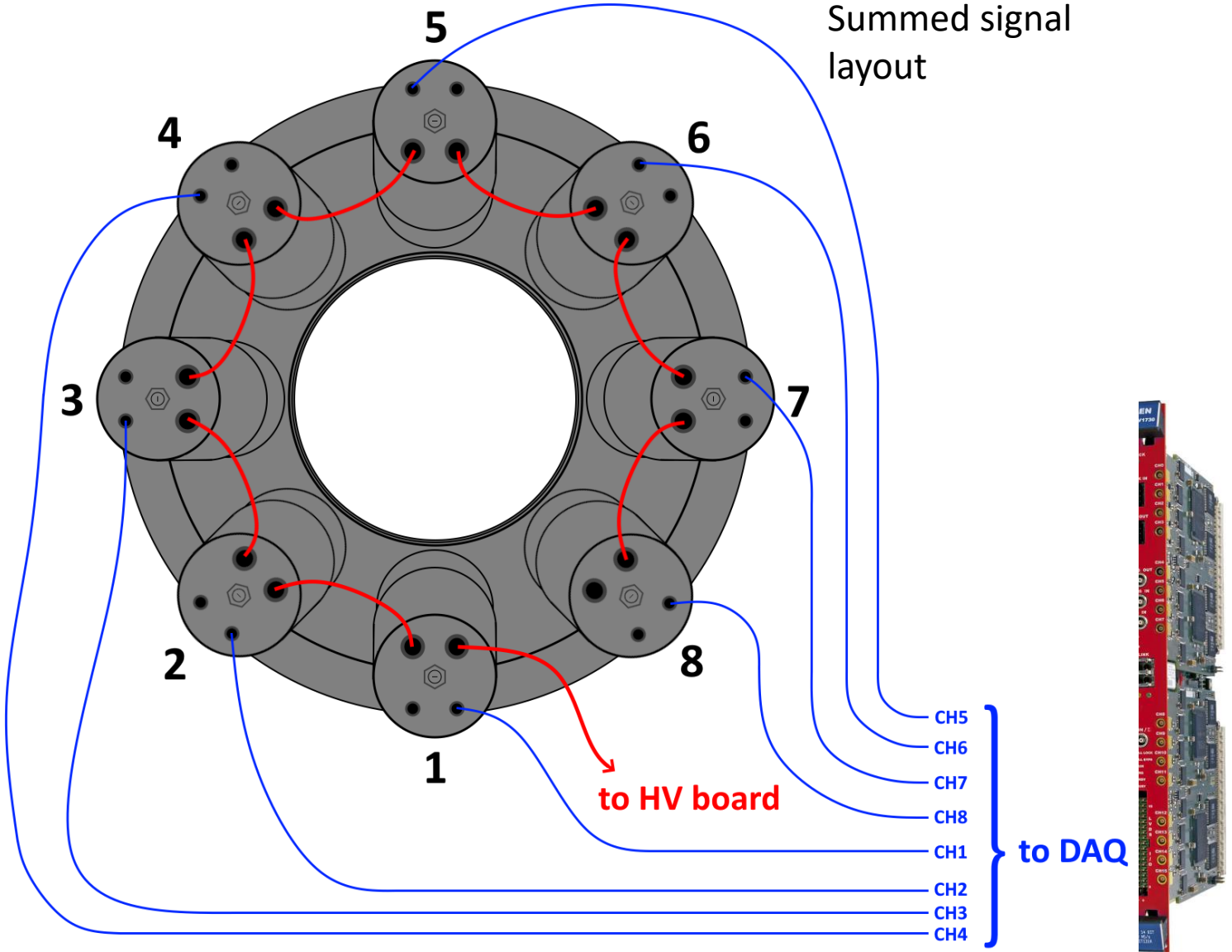
4 units of VS-1401-1 type

Components per unit:

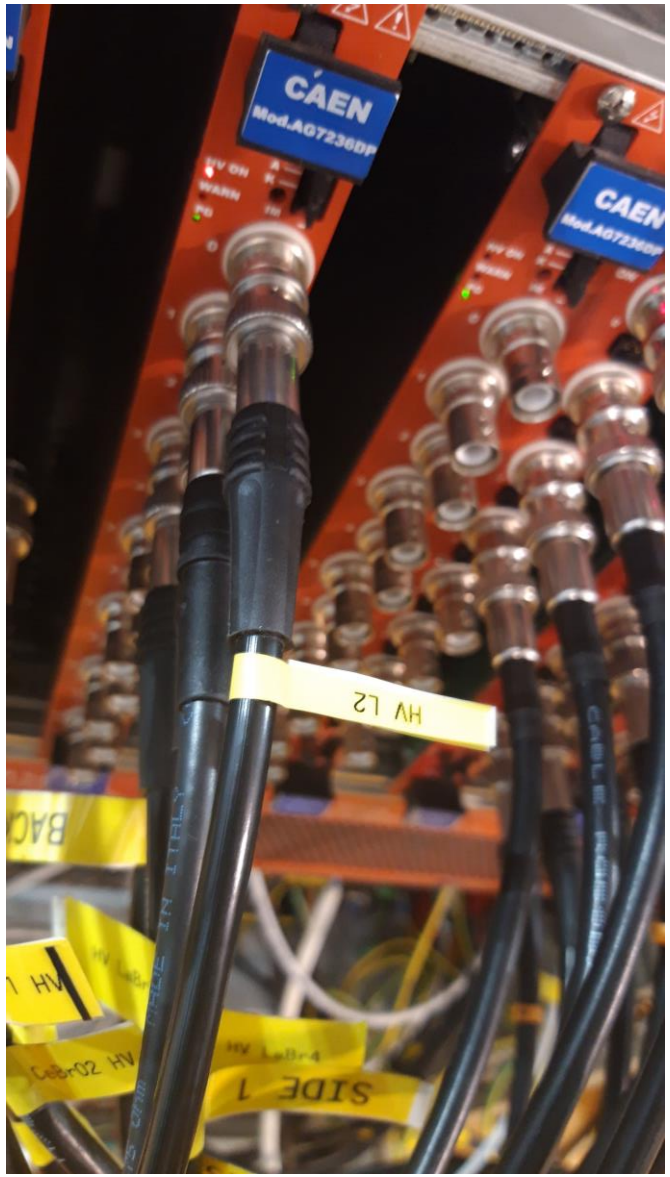
- 8x segments, each containing:
  - 1x BGO scintillator
  - 1x voltage divider (built-in)
  - 1x Hamamatsu 1 1/8” Type R3998 PMT
  - 2x HV ports
  - 2x signal ports
  - 1x gain potentiometer

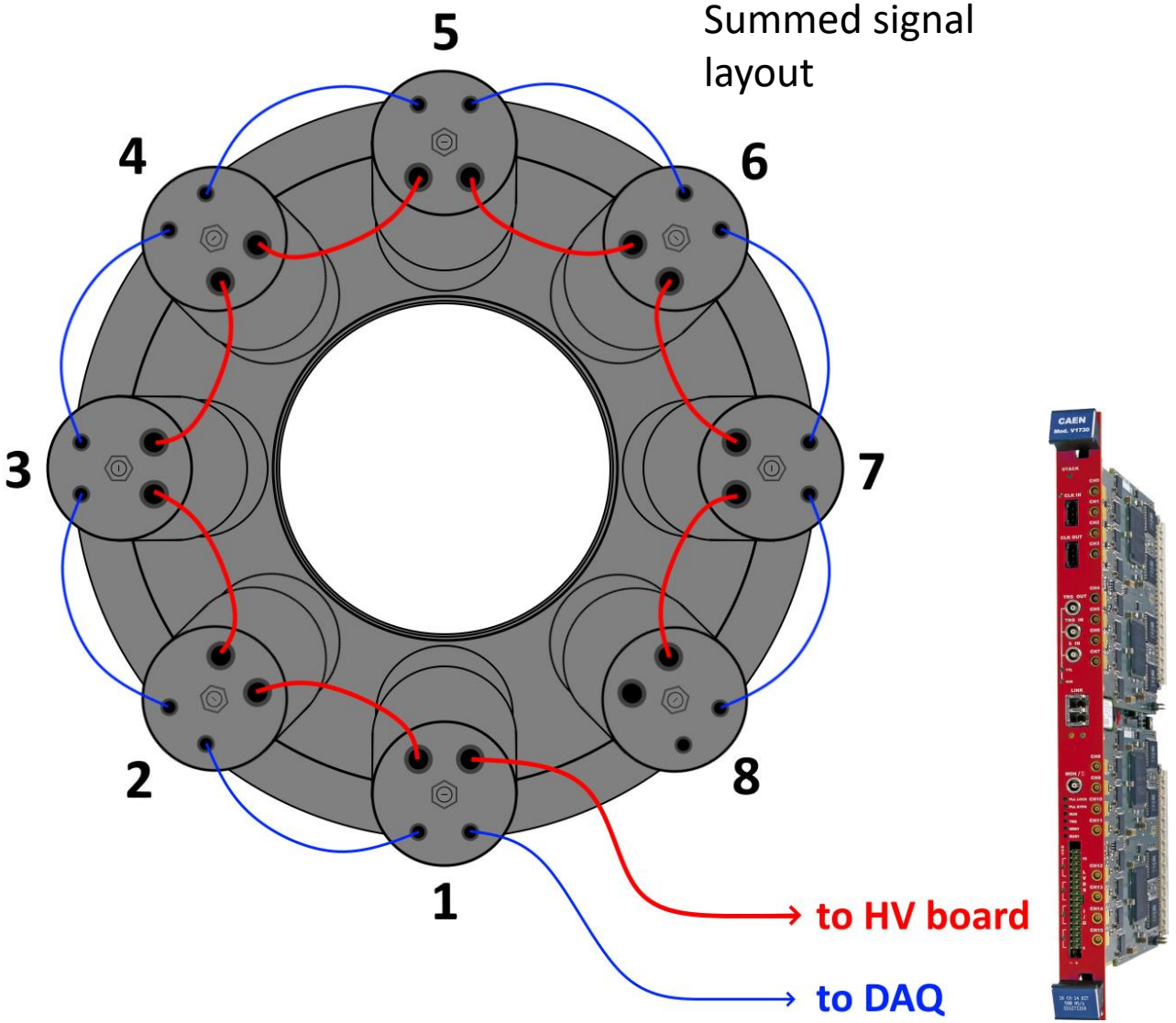
BGO Anti-Compton Shields for CeBr3 detectors; Characterization procedure





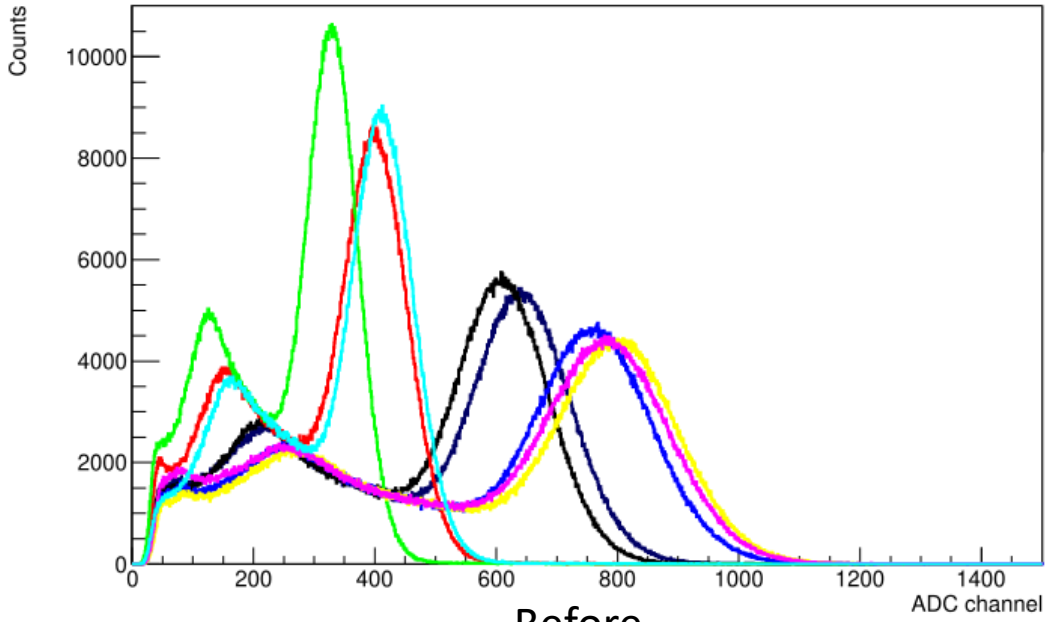
BGO Anti-Compton Shields for CeBr3 detectors; Characterization procedure



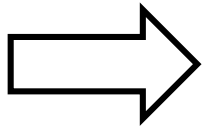


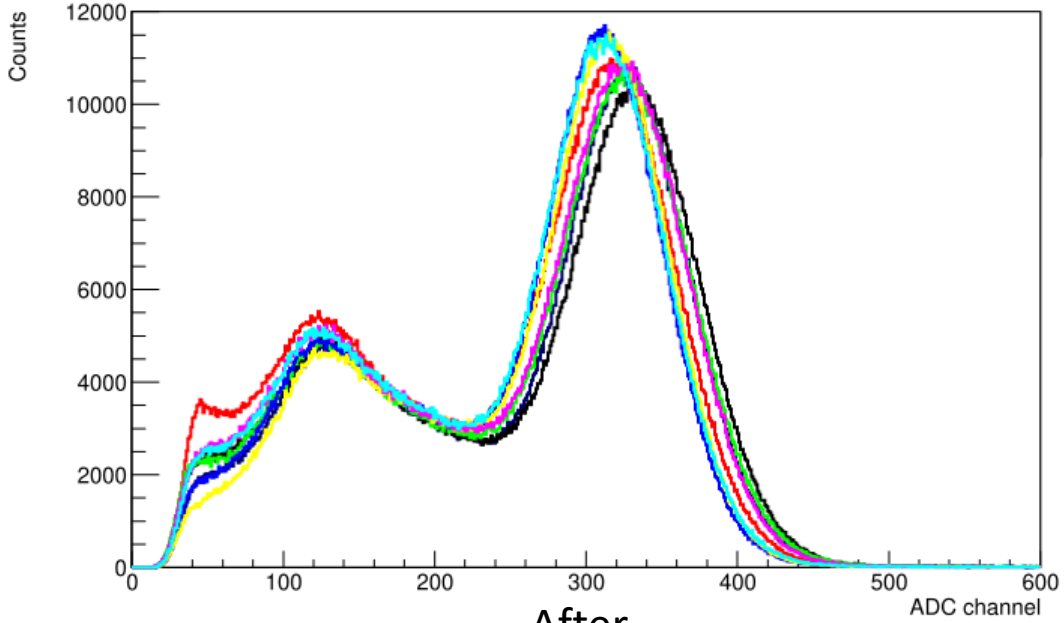
Preliminary results

Front Shield #S2AC9115, Segments 1 and 2 – Individual signal spectra



Before





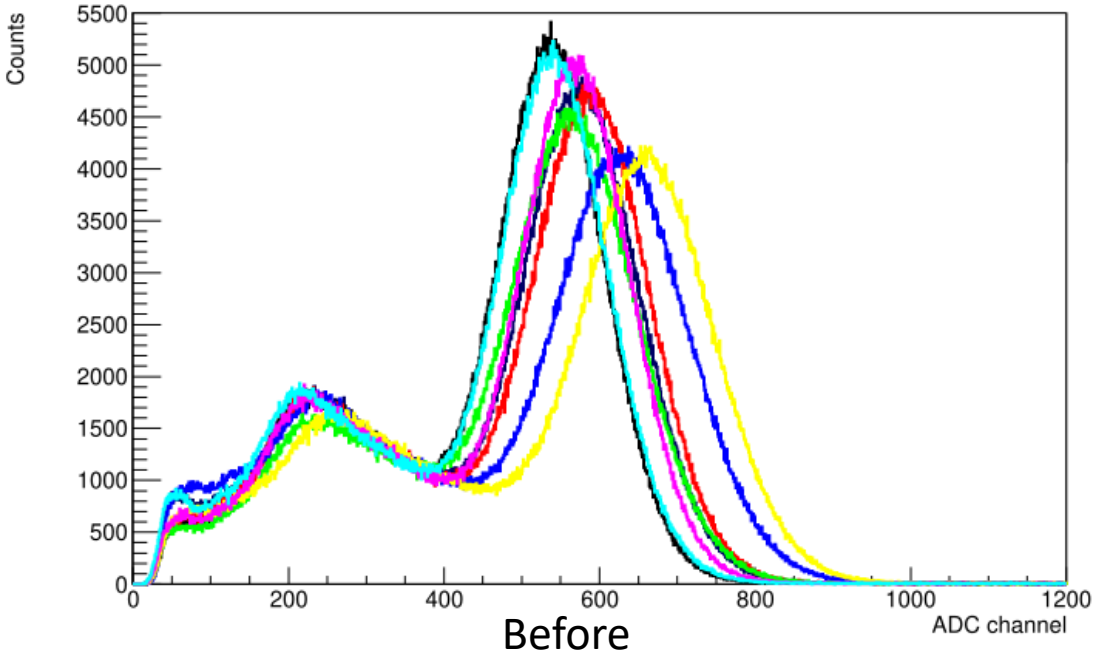
After

CH0
CH1
CH2
CH3
CH4
CH5
CH6
CH7

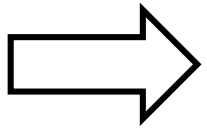
Channel	Seg. No. Side and Half	Centroid	Resolution (%)
0	1A, outer	321.78	33.74
1	1A, inner	324.83	35.66
2	1B, inner	311.60	35.22
3	1B, outer	321.94	34.39
4	2A, outer	309.88	31.20
5	2A, inner	312.25	31.55
6	2B, inner	320.73	33.23
7	2B, outer	307.96	34.08

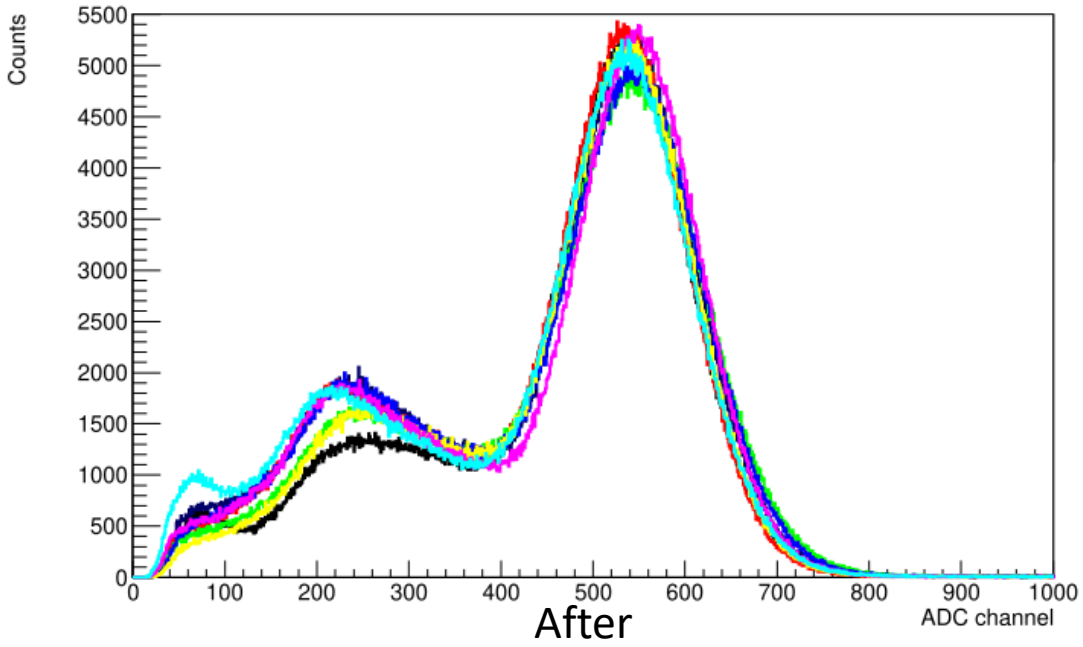
Preliminary results

Side Shield #S2AC9114, Segments 1 and 2 – Individual signal spectra



Before





After

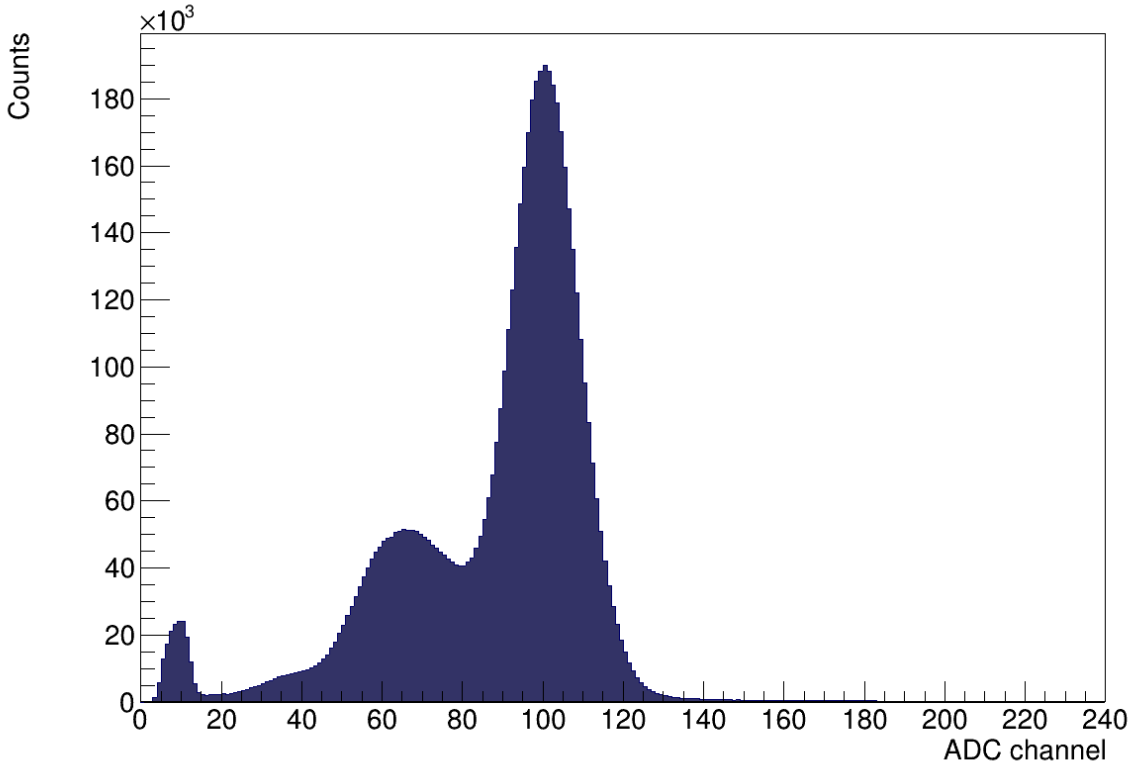
CH0
CH1
CH2
CH3
CH4
CH5
CH6
CH7

Channel	Seg. No. Side and Half	Centroid	Resolution (%)
0	1A, outer	539.18	32.23
1	1A, inner	531.76	32.46
2	1B, inner	530.17	32.40
3	1B, outer	538.97	35.98
4	2A, outer	539.72	34.41
5	2A, inner	535.15	31.74
6	2B, inner	545.66	30.51
7	2B, outer	533.05	32.64

Preliminary results

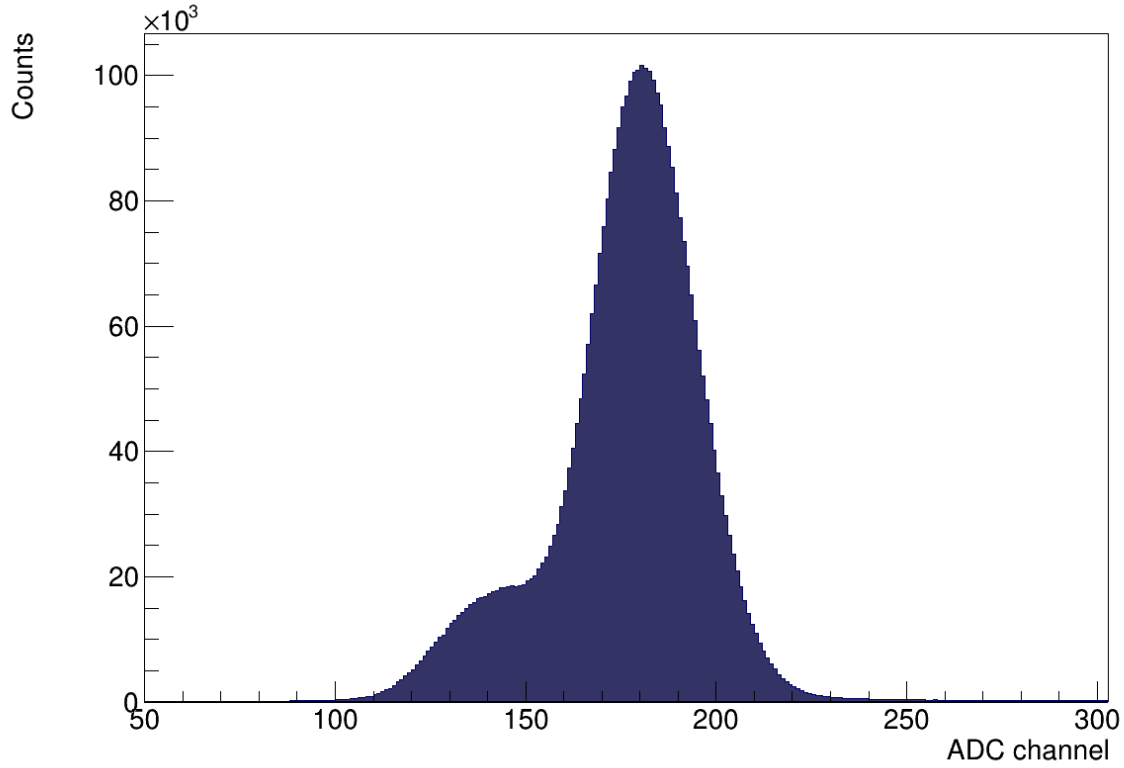
Summed signal spectra

Front Shield #S2AC9115



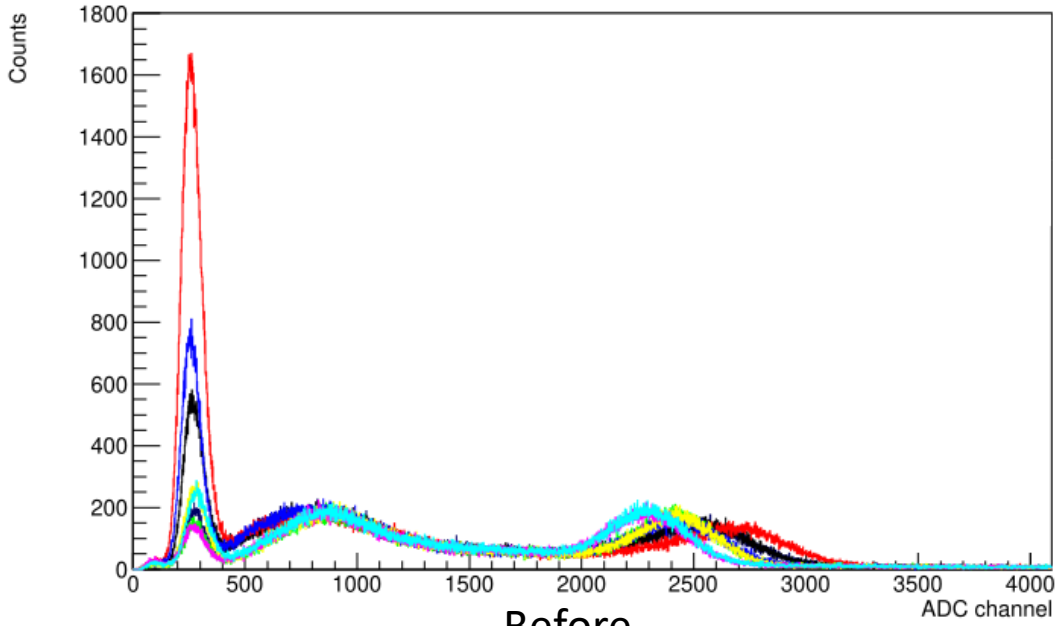
Resolution: 21.7% @ 662 keV

Side Shield #S2AC9114

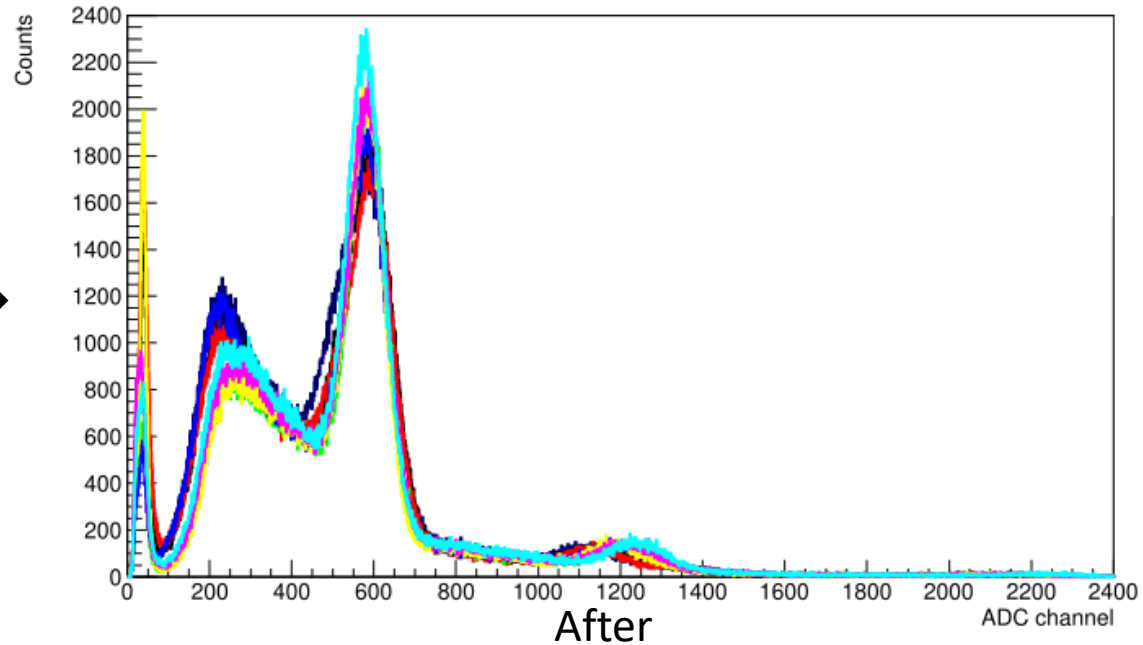


Resolution: 18.5% @ 662 keV

Preliminary results



Before



After

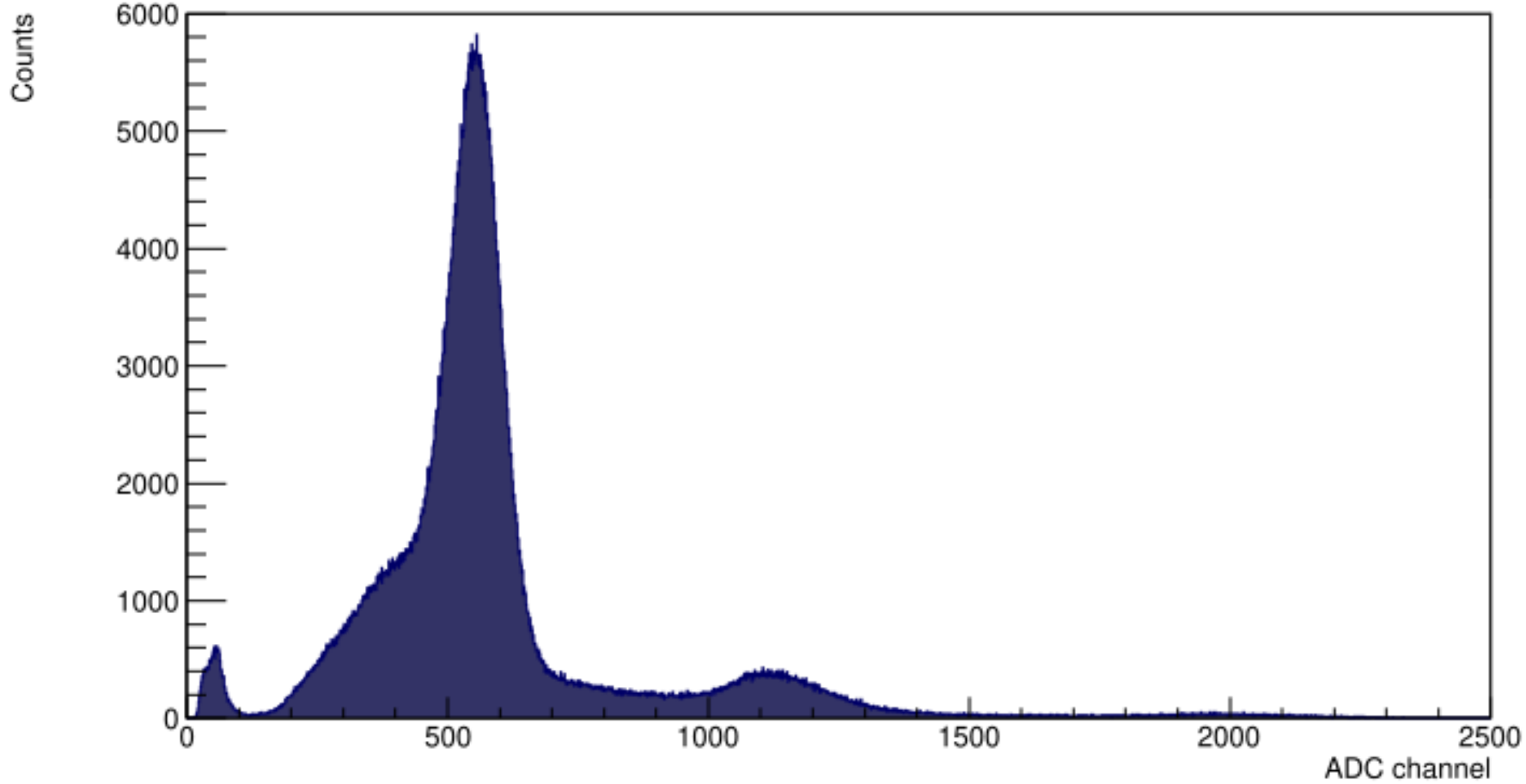
Individual signal spectra of ACS #S2AC8753 for CeBr3 detectors

CH0
CH1
CH2
CH3
CH4
CH5
CH6
CH7

Channel	Seg. No. Side and Half	Centroid	Resolution (%)
0	1A, outer	561.40	18.46
1	1A, inner	569.57	16.87
2	1B, inner	562.52	16.62
3	1B, outer	571.23	16.44
4	2A, outer	572.49	16.51
5	2A, inner	573.51	16.93
6	2B, inner	575.85	18.08
7	2B, outer	573.34	16.91

Preliminary results

Summed signal spectra of ACS #S2AC8753 for CeBr3 detectors



Resolution: 17.7% @ 662 keV

Conclusions

- BGO Anti-Compton Shields for Clover and CeBr3 detectors were characterized and calibrated in testing conditions using 137Cs source;
- Tuning parameters and preliminary results for each shield were gathered into a technical report within NRF group; an overview of the procedure was included in the ELI-NP Annual Report 2022-2024;
- Future plans:
  - Mounting shields on the ELIADE structure and perform final tuning;
  - A systematic study of the ELIADE performance with ACS.


Thank you for your attention!
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