Application of the A/E pulse shape discrimination method to first Ge-76 enriched BEGe detectors operated in GERDA

Andrea Lazzaro, Dušan Budjáš, Matteo Agostini, Stefan Schönert
on behalf of the GERDA collaboration

Chair for Experimental Physics
and Astroparticle Physics

DPG
Physik der Hadronen und Kerne
Astroteilchenphysik
February 2013

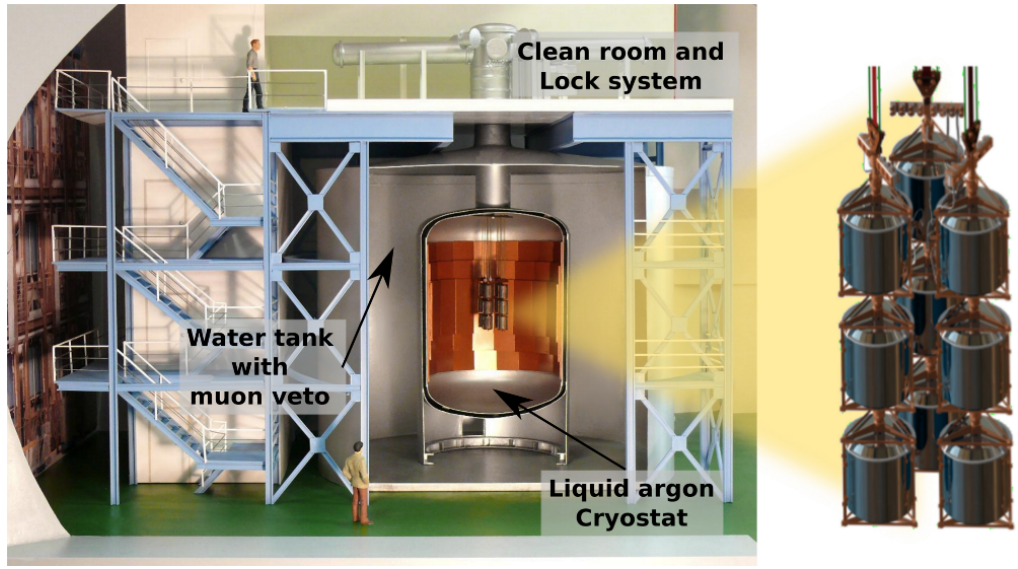
BEGe detectors in GERDA phase I

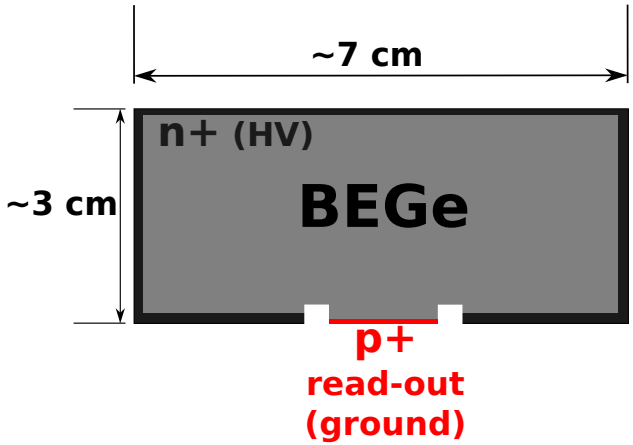
GERDA Phase I:

Data taking since nov 2011
blinded windows 2019–2059 keV
unblinding in June 2013

5 BEGe detectors (3.6 Kg)
deployed in July 2012
with Phase I set-up and electronics

Total exposition of $\sim 20\, Kg \cdot yr$
(∼10% from BEGe)





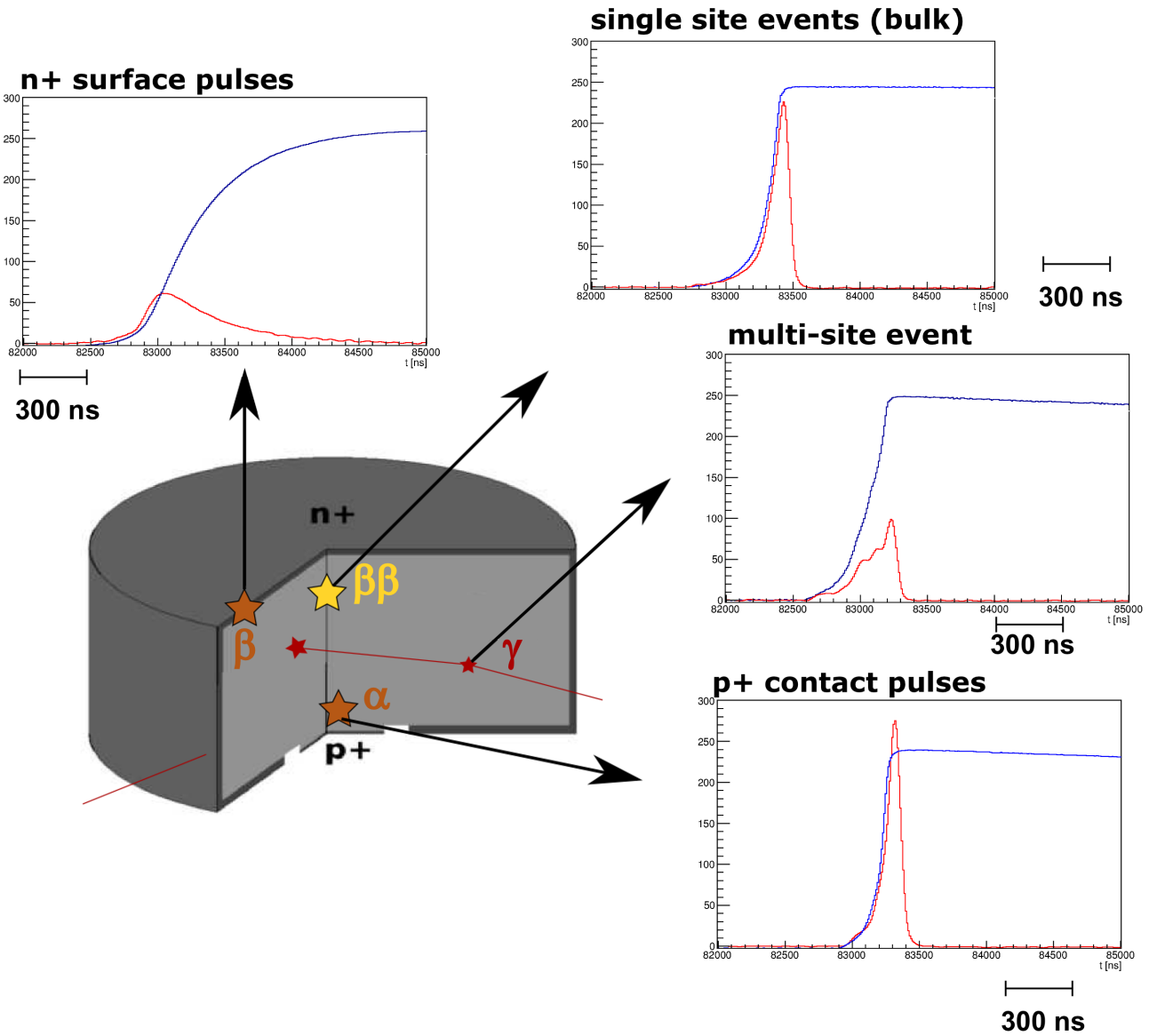
Broad Energy Germanium detectors:

p-type HpGe

low capacitance and high energy resolution

$\sim 1\, mm$ lithium infused HV electrode
$\sim 0.5\, \mu m$ boron implanted read out electrode

A/E Method



JInst, 4 2009, P10007

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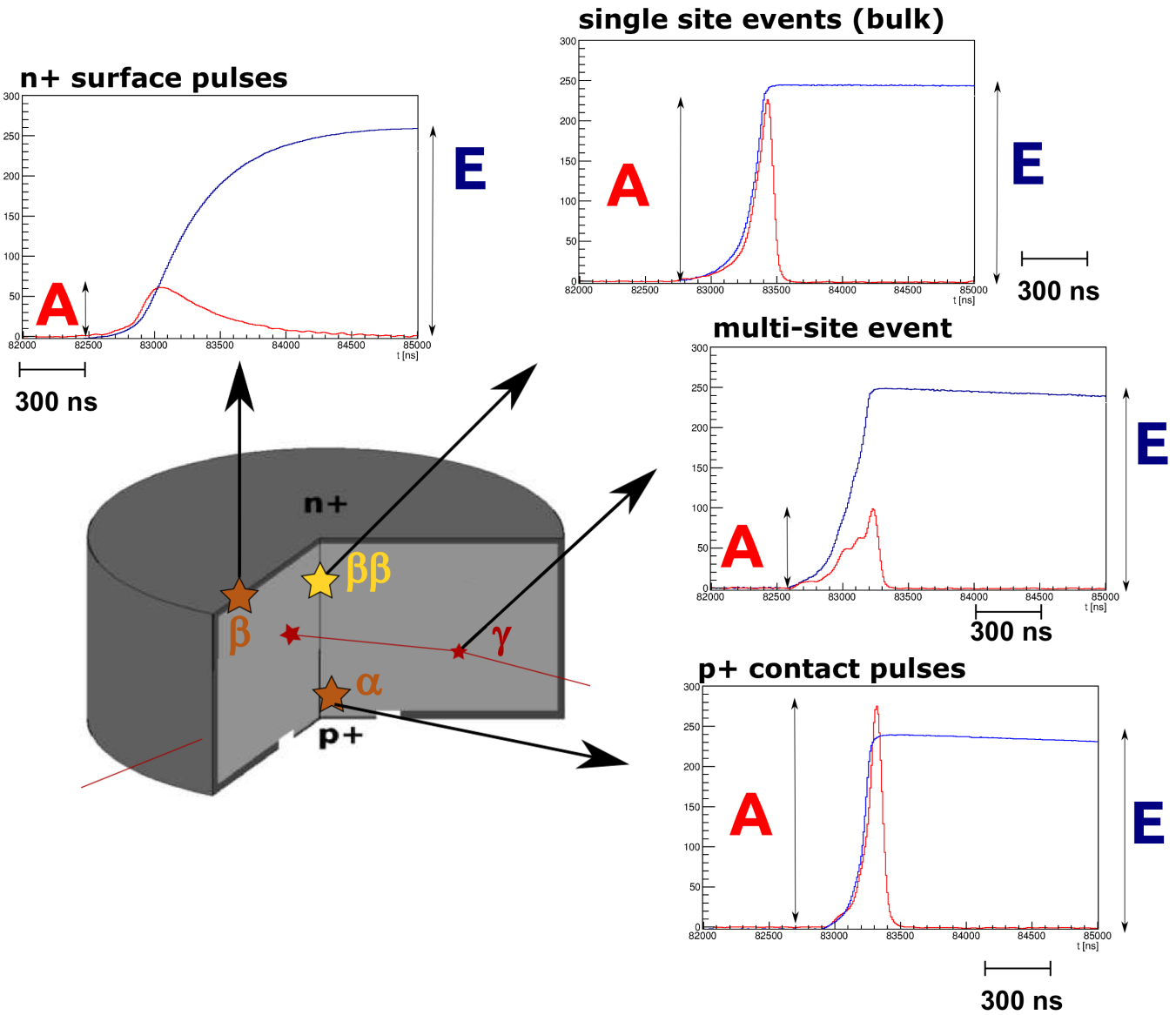


JInst, 4 2009, P10007

A/E distribution

Single Site Event

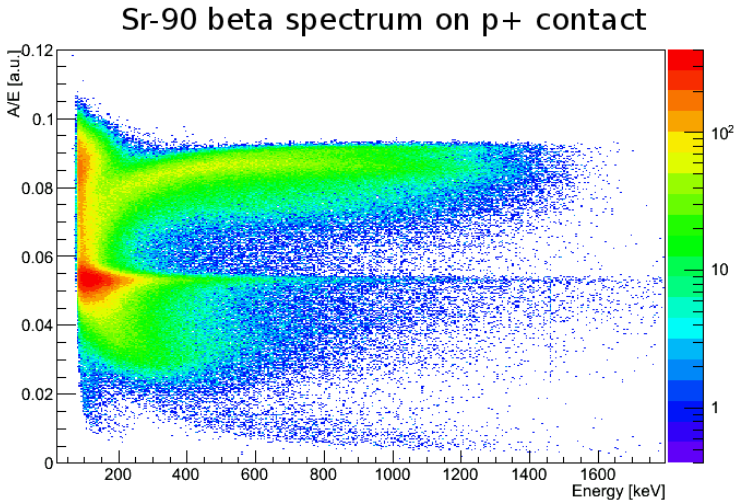
narrow band, constant A/E

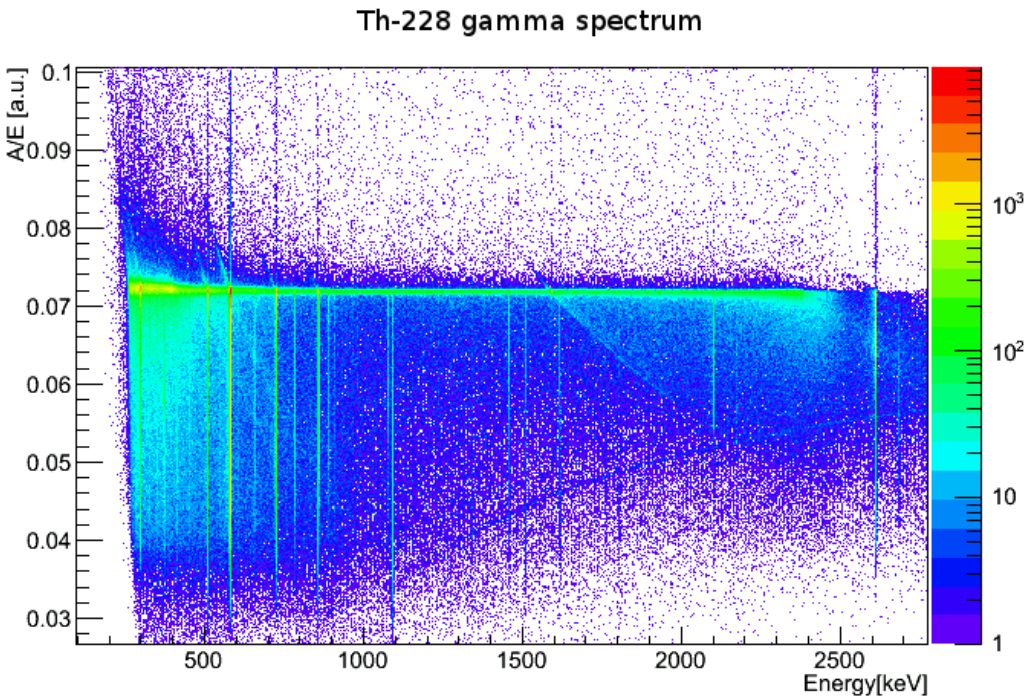
Multi-site & n+ Surface Pulses

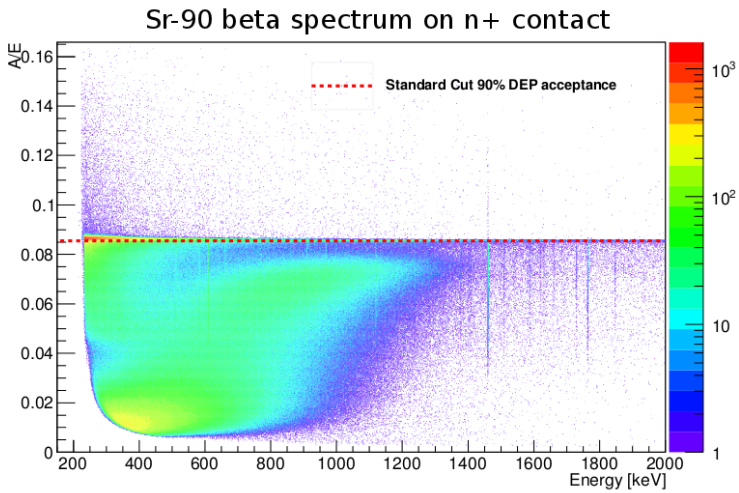
$A/E <$ SSE-band

p+ Surface Pulses

$A/E >$ SSE-band







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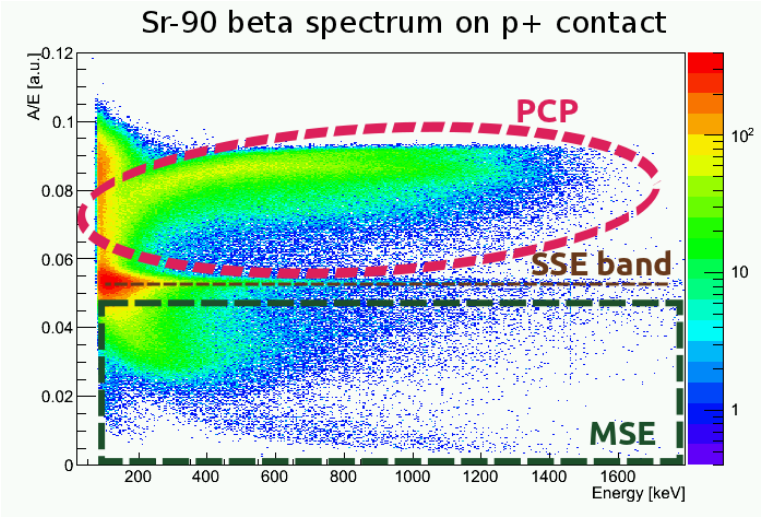
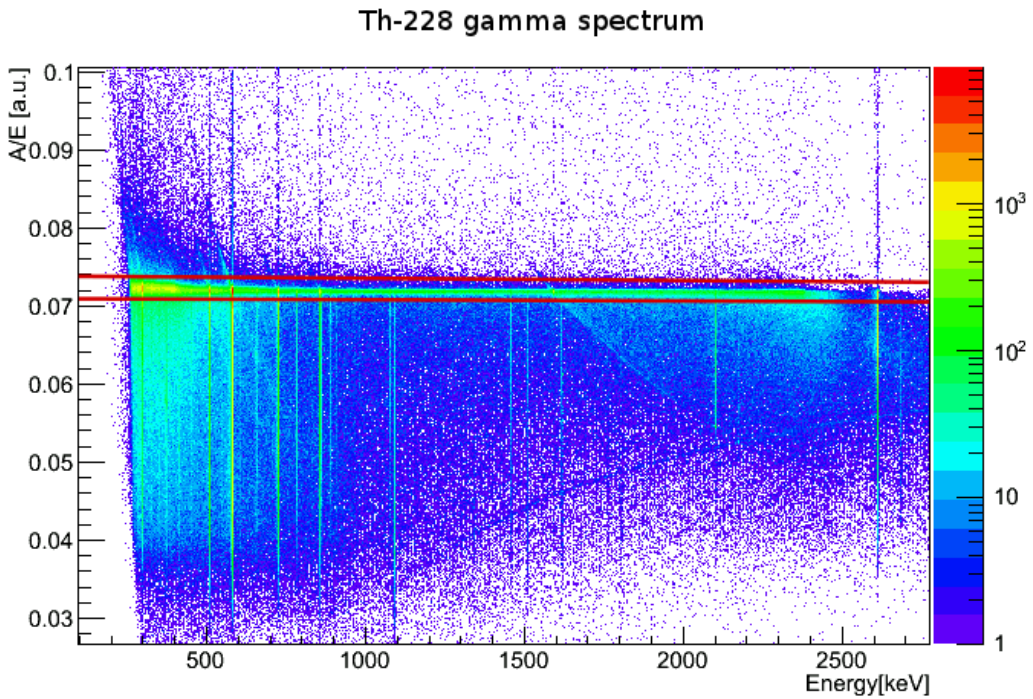
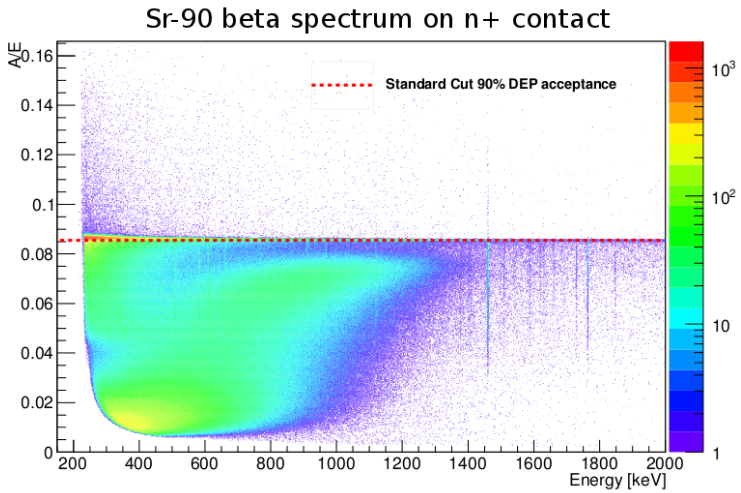


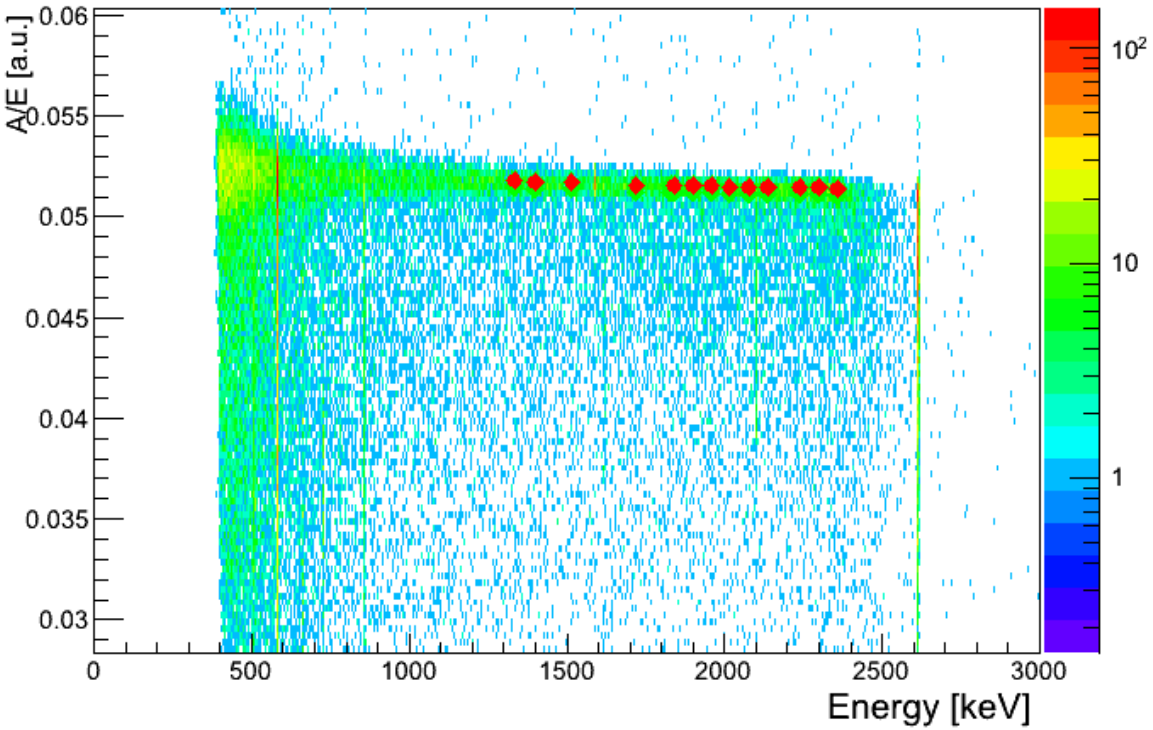


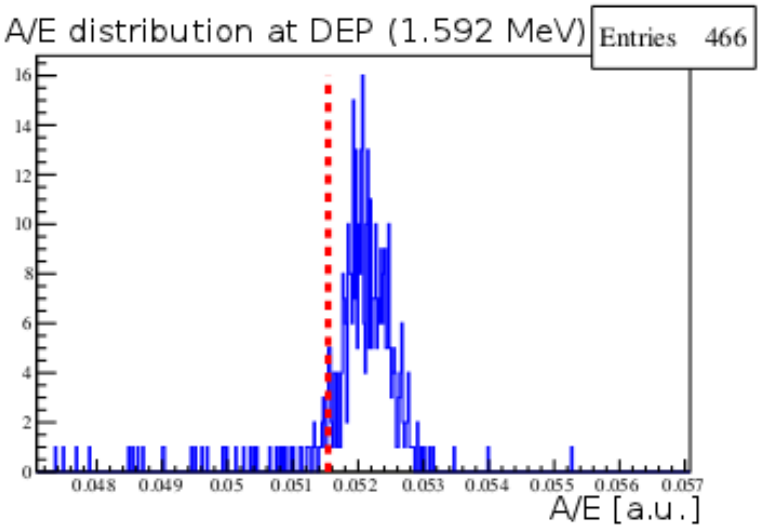


The A/E cut calibration

$$LowCut < \frac{A}{E_{uncal}} - E_{cal} \cdot \text{slope} < HighCut$$

1. Find the SSE-band position for Compton continuum intervals
2. Linear fit of the energy dependence
3. Set the cut value fixing the acceptance of the DEP at 90%





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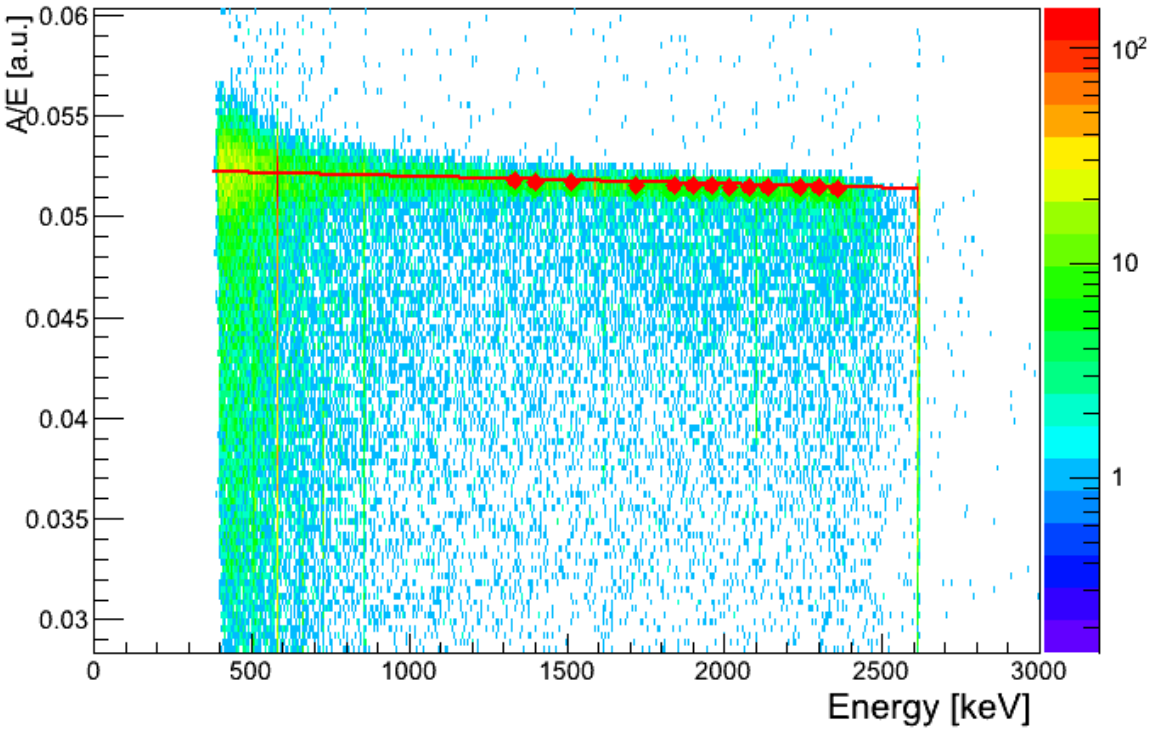
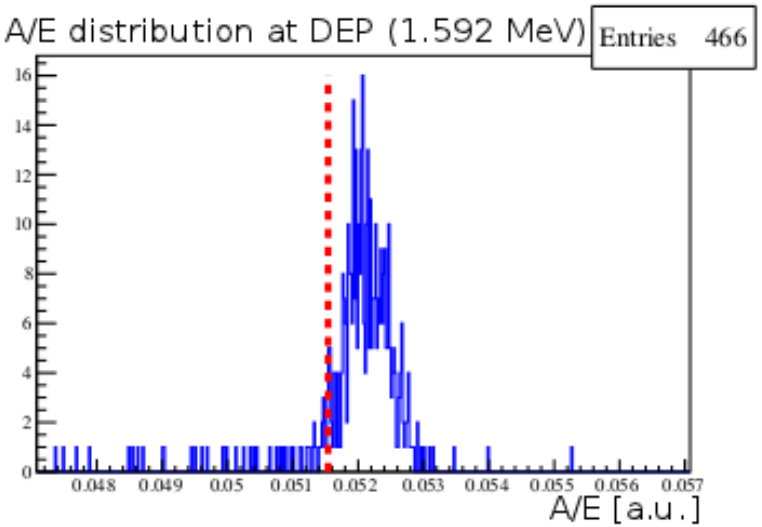
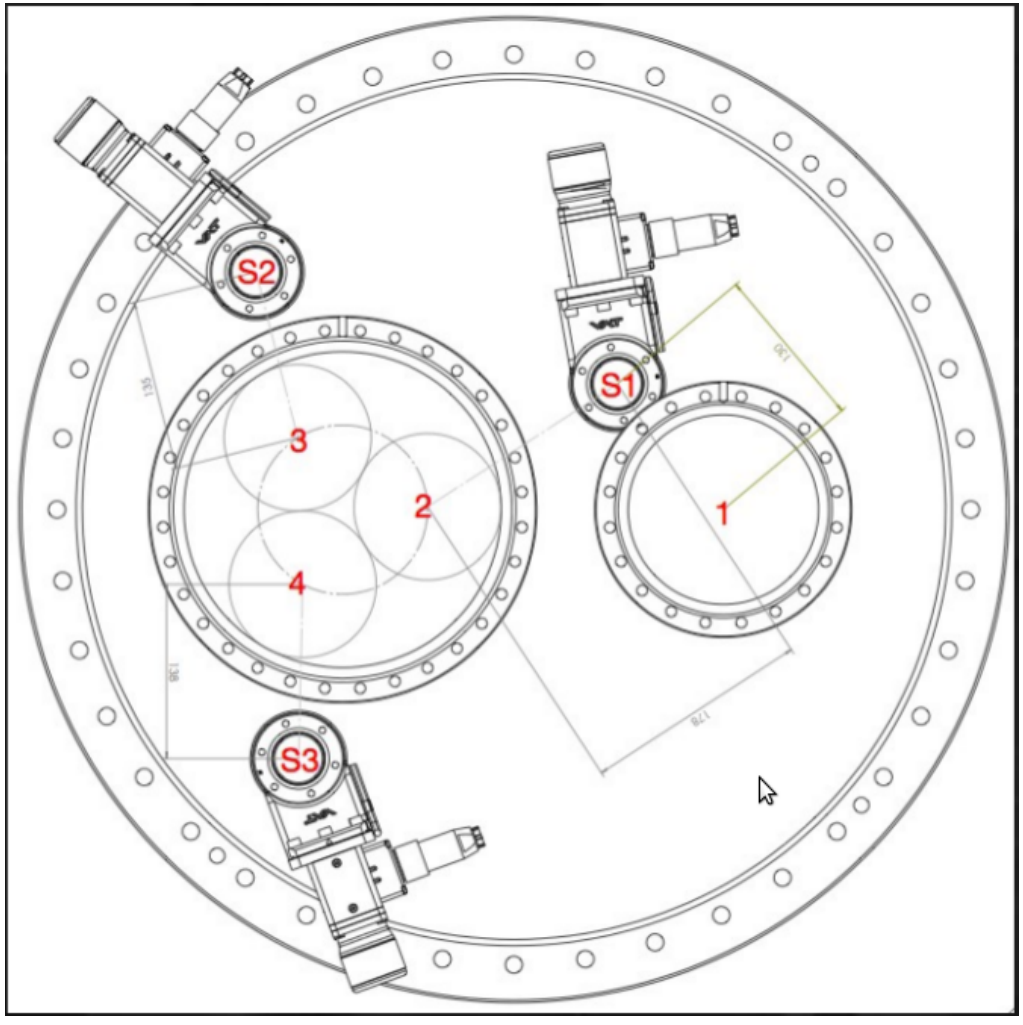




Calibration Data

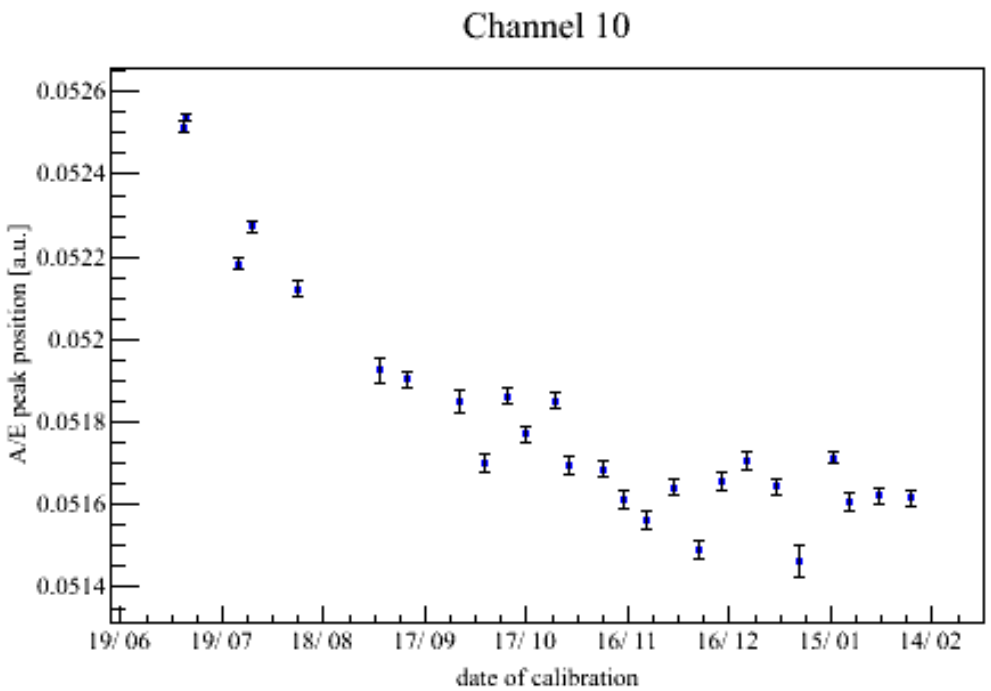


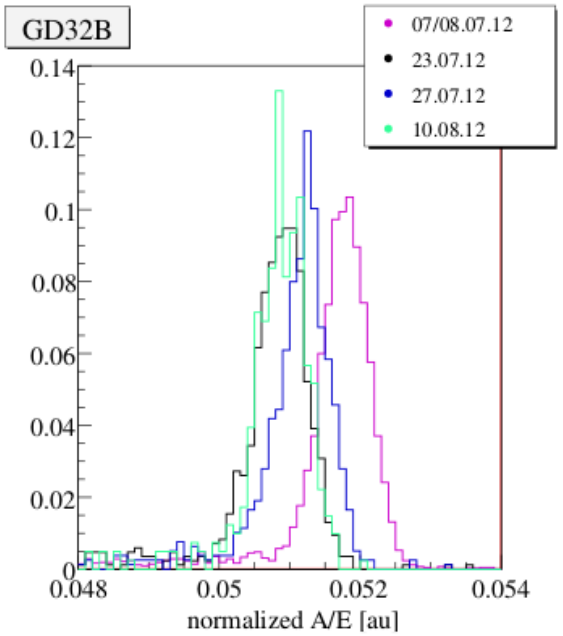
Long Term Stability

The SSE-Band is monitored with ^{228}Th calibrations.

For the preliminary analysis we selected two stable set of data.

After the deploy of the detectors, the A/E reached stable values after some weeks.
This is currently under investigation.





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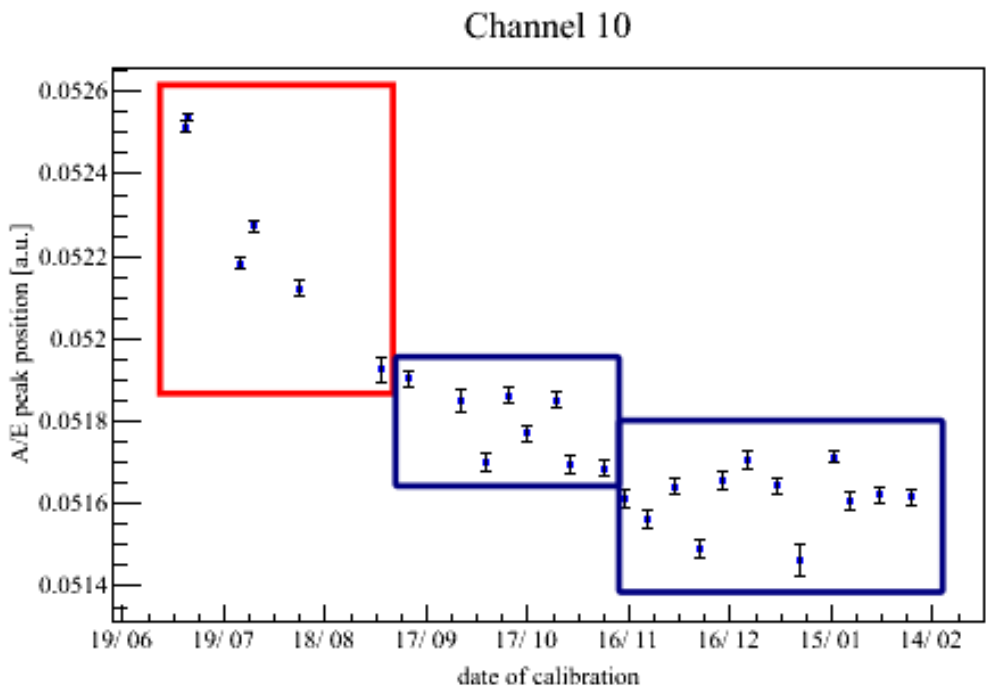

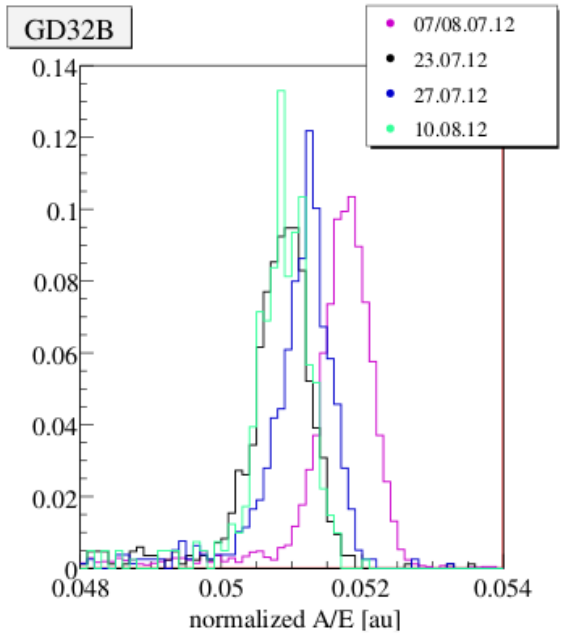

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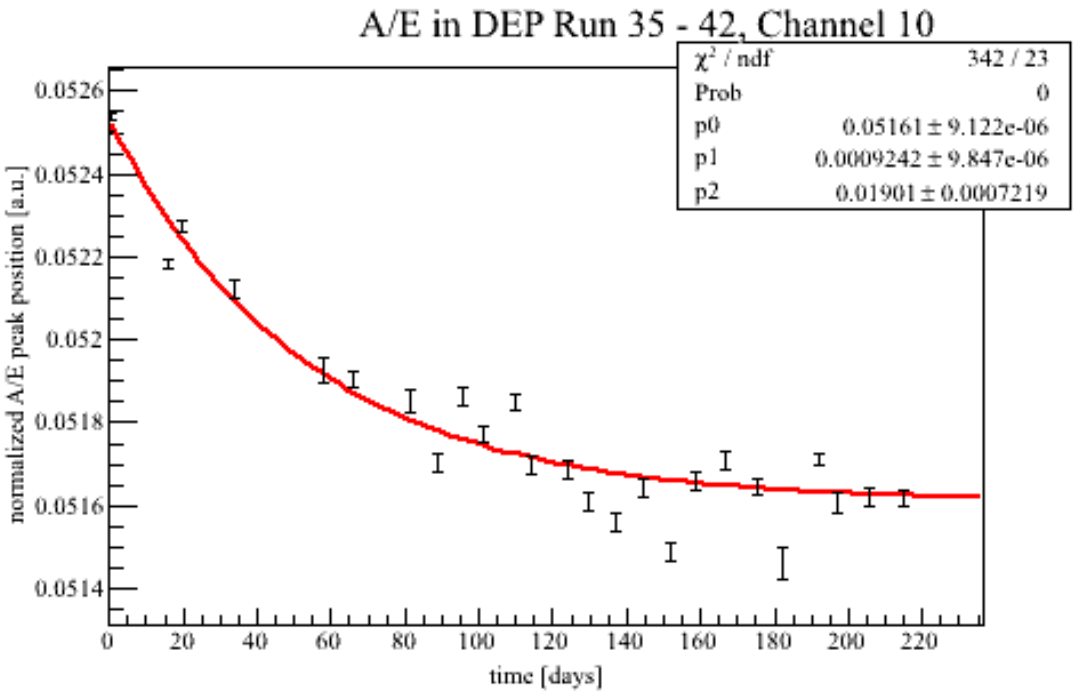
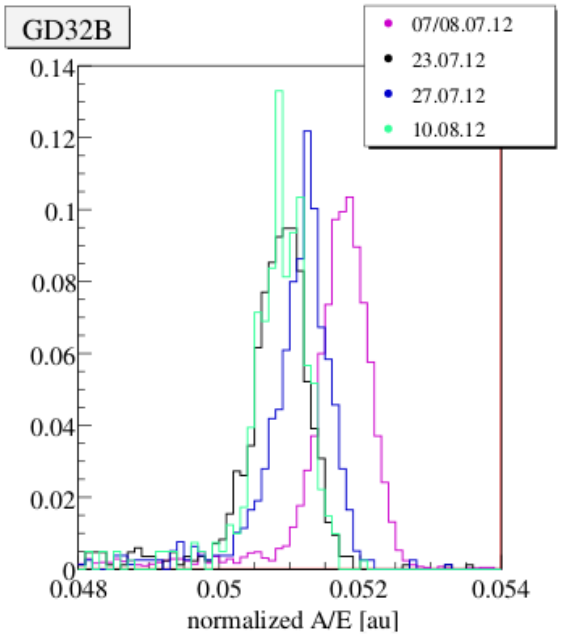




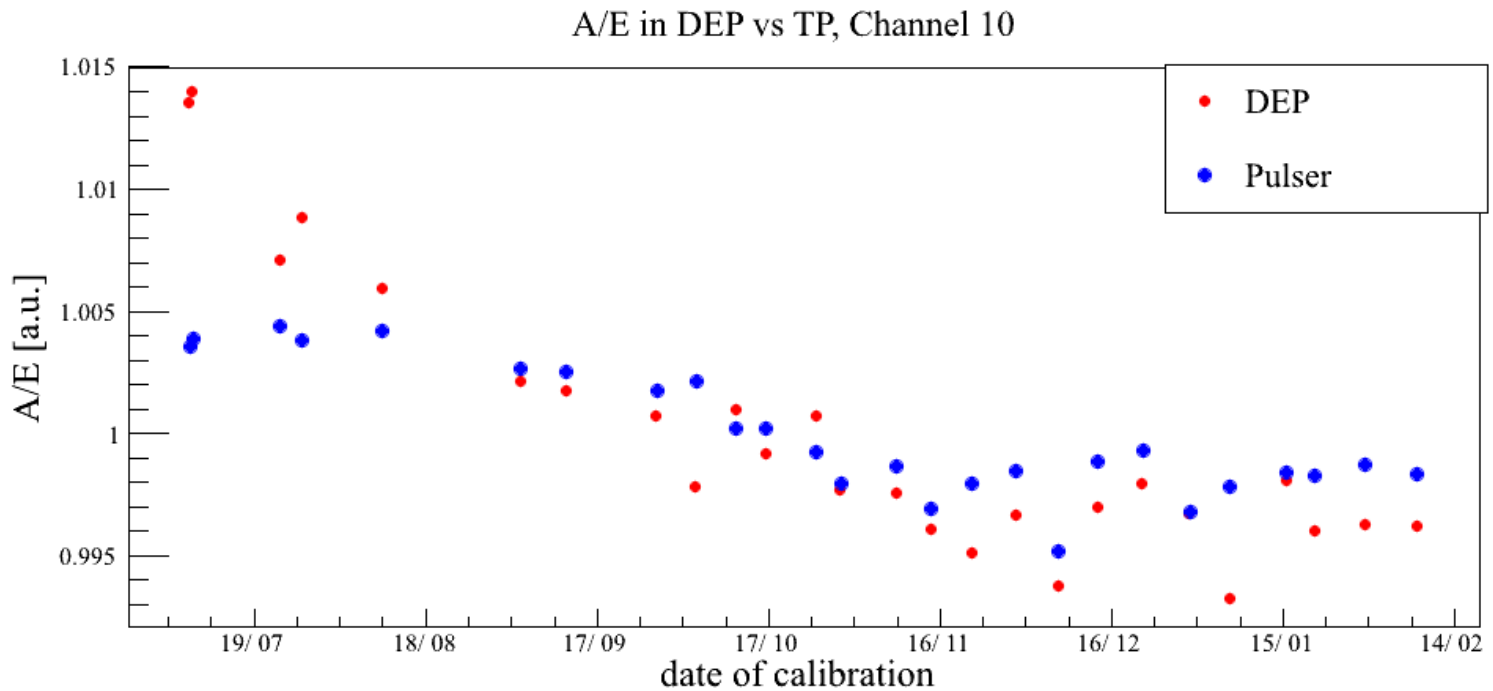
Electronic fluctuations

The pulse shape discrimination can be affected by fluctuations on the read-out electronic.

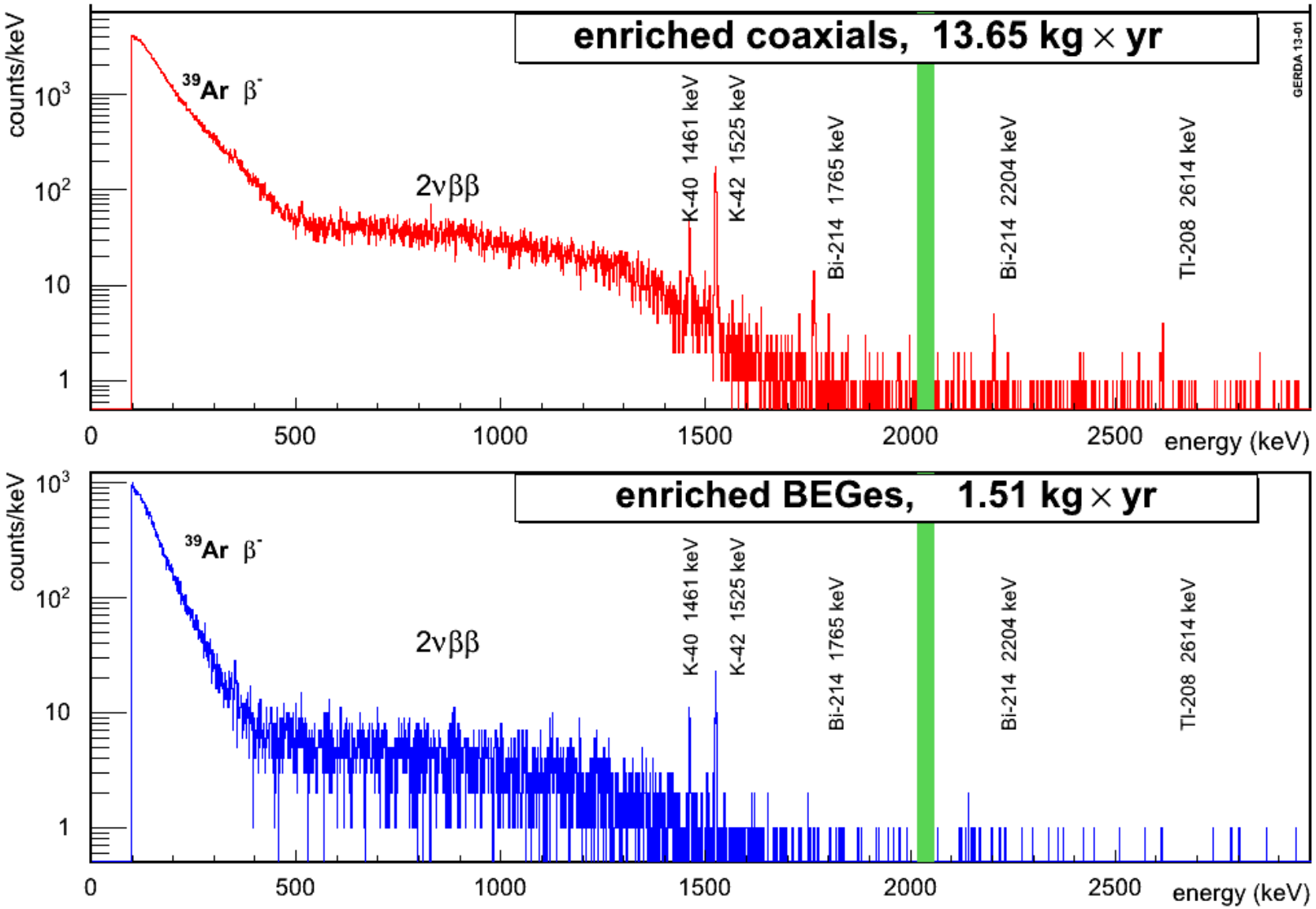
We need to monitor the stability during the data taking.

The pulser has high rate but shows intrinsic instabilities not correlated with the physical pulses.

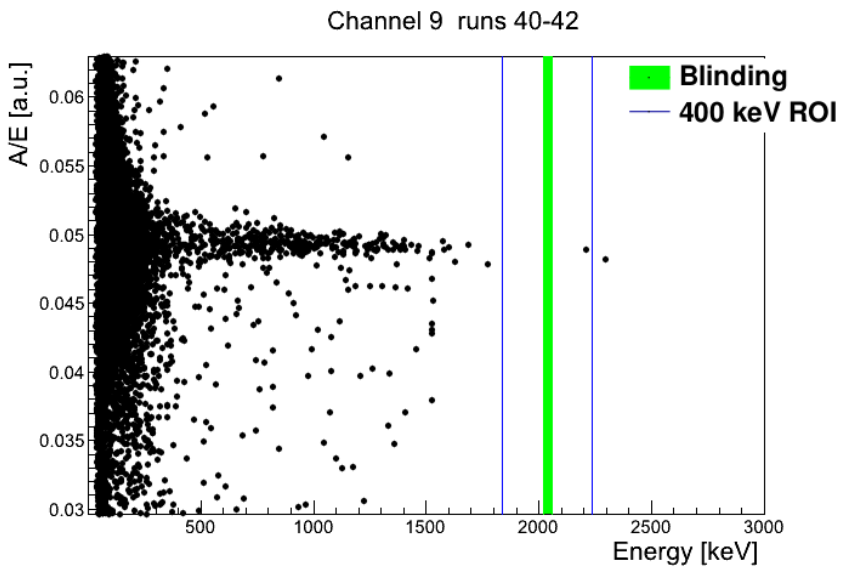
The $2\nu\beta\beta$ spectrum is a good proxy of our signal but the rate is very low.

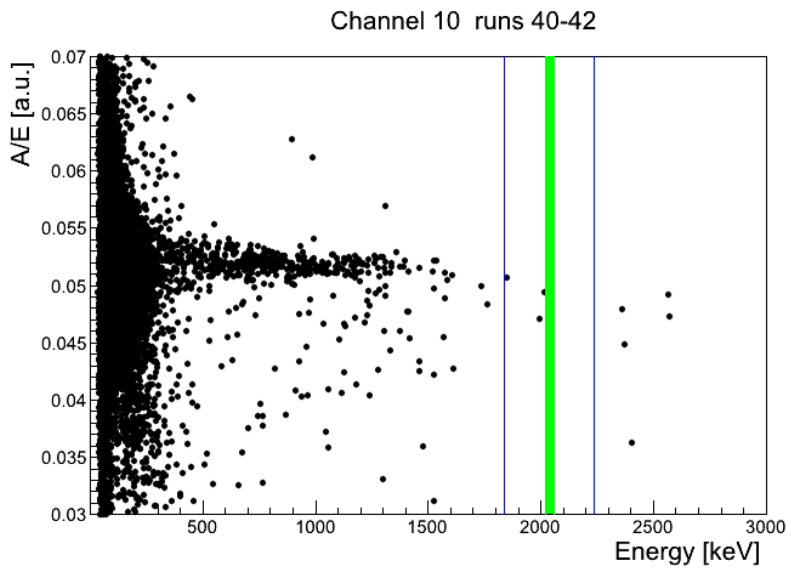


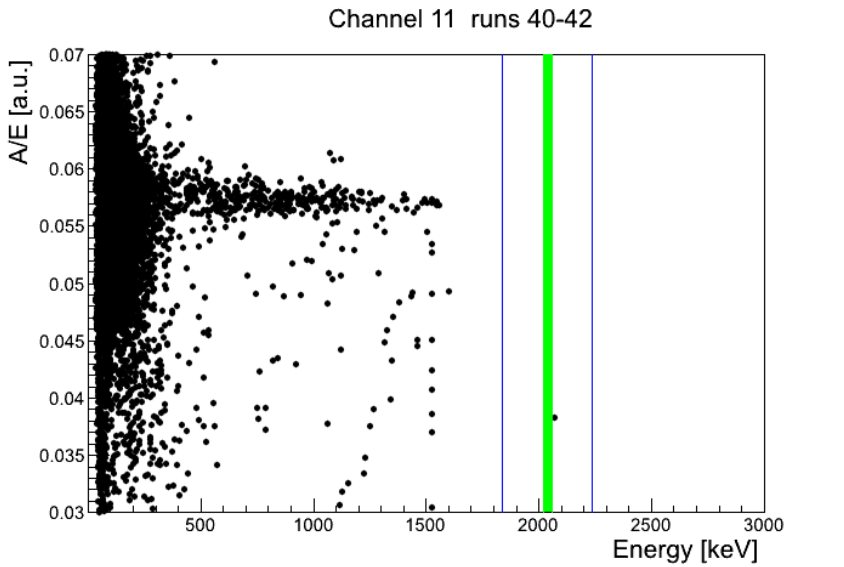
Background Data

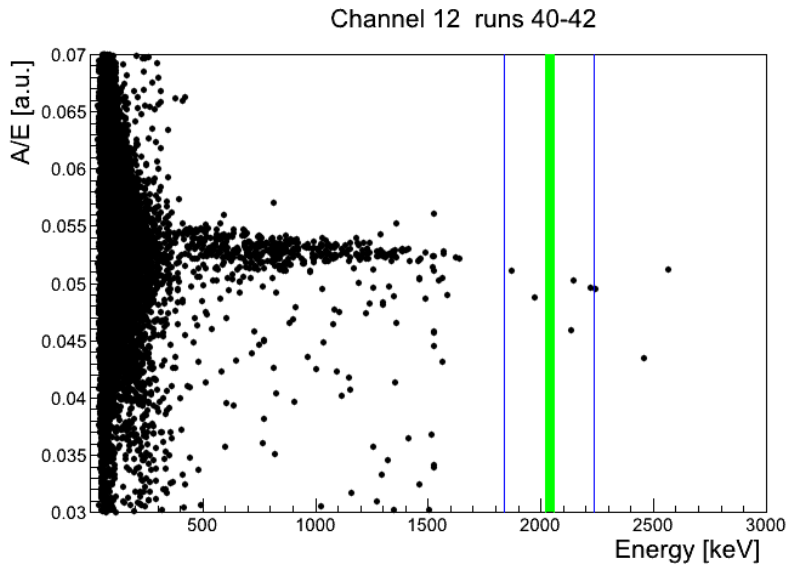


GERDA background data



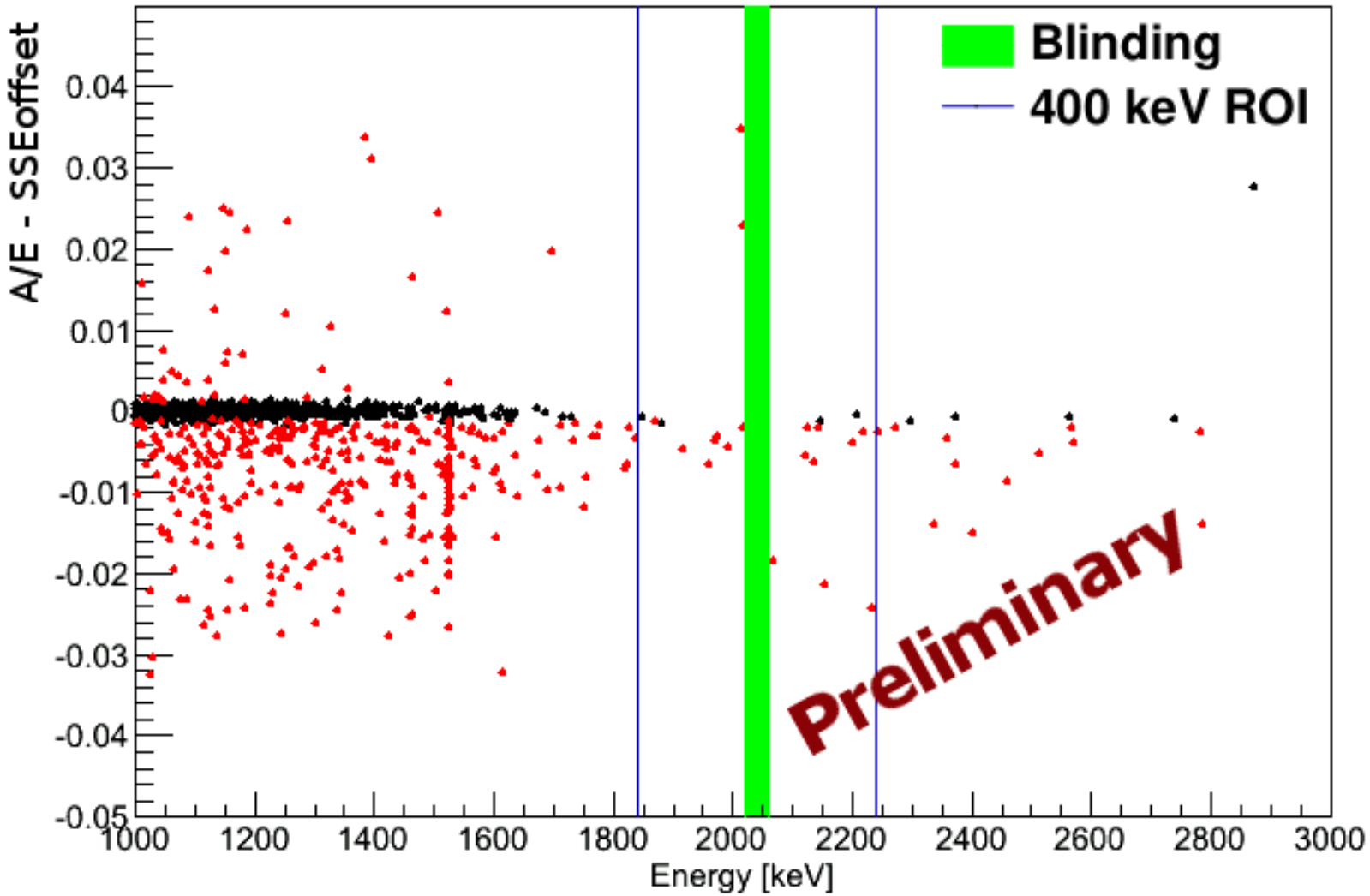






Preliminary application on background data

A/E residual plot
5 BEGes in GERDA
September 2012 - Jannuary 2013



Conclusions and outlook

We are operating 5 BEGe detectors in the GERDA Phase I set-up.

The preliminary pulse shape analysis looks promising but the study is still on going.

A "transient" phase has been found in the first months of data taking in liquid Ar.

Further studies are needed to monitor the A/E stability, in particular during the physical data taking between two following ^{228}Th calibration.

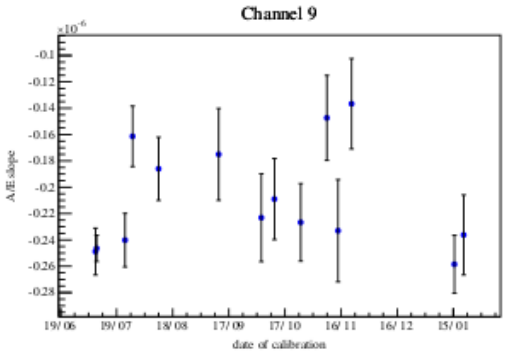
The signal acceptance is defined via DEP of the ^{228}Th calibrations.
It can be cross checked on the $0\nu\beta\beta$ and specific calibrations.

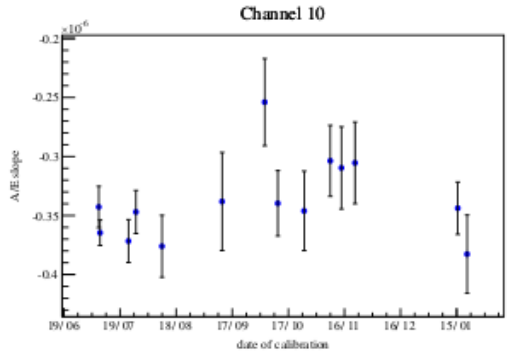
Phase II will employ new front-end electronics with the goal to improve energy and A/E resolution.

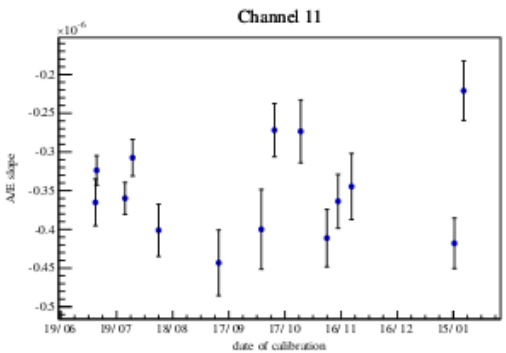
Transition to Phase II will start July 2013.

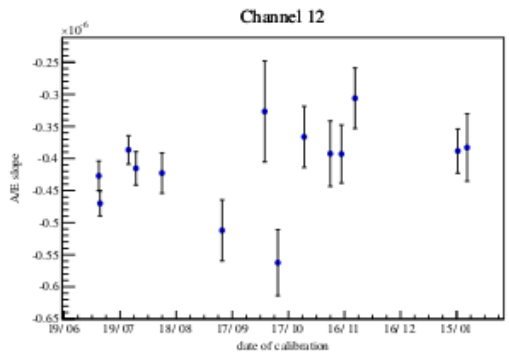
Backup Slides

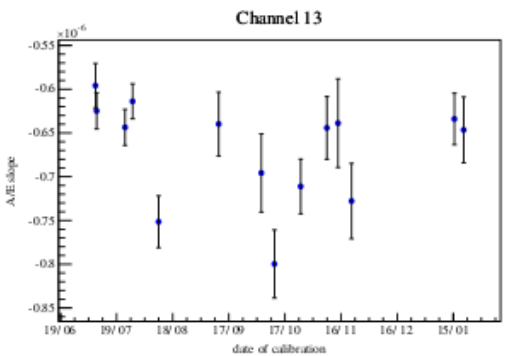
Slope stability



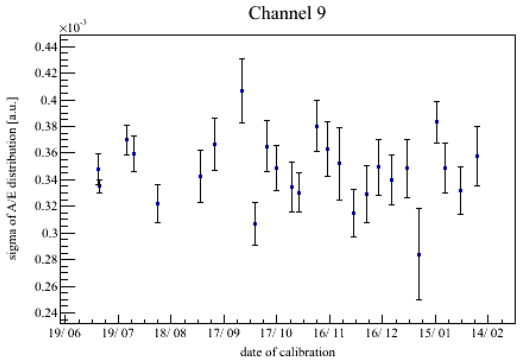


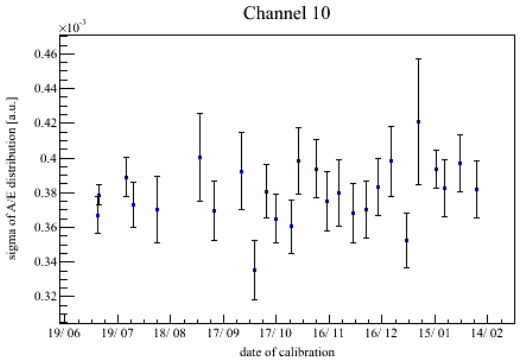


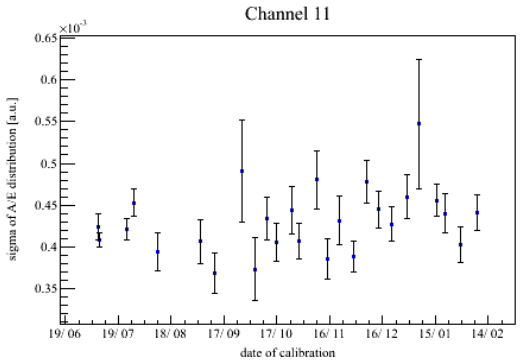


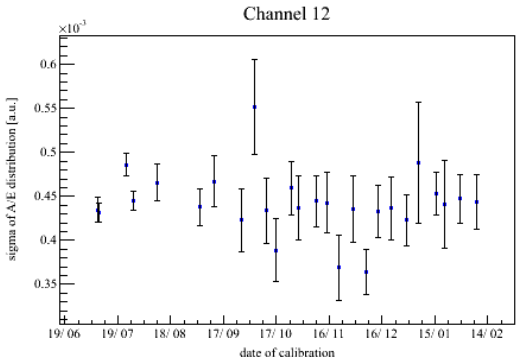


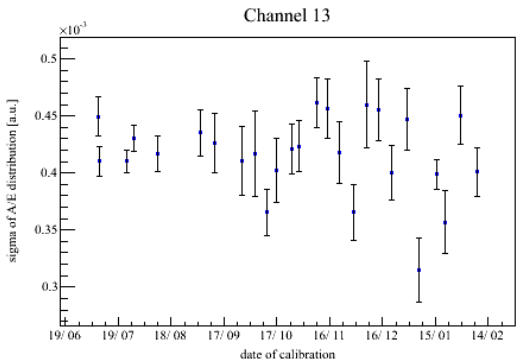
A/E Resolution



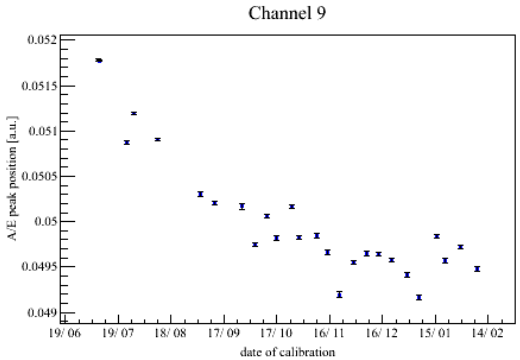


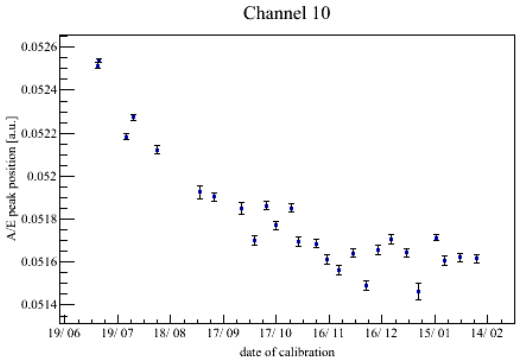


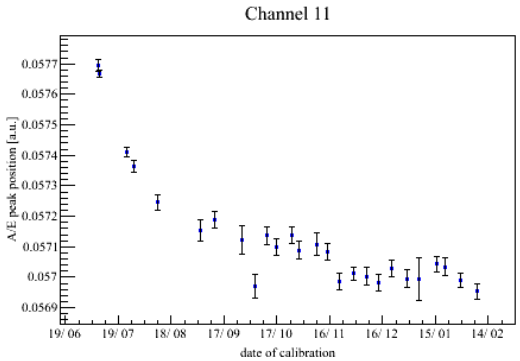


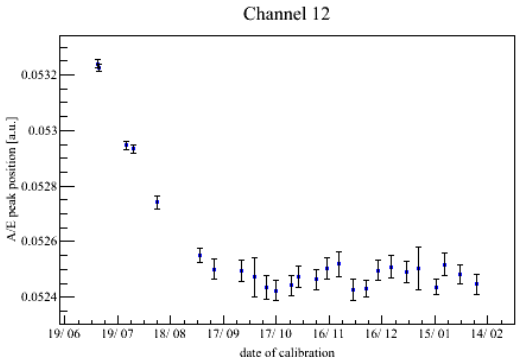


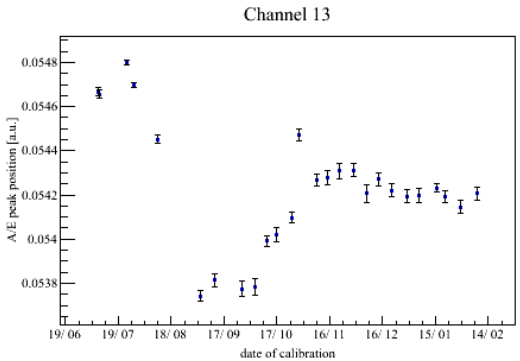
SSE band offset











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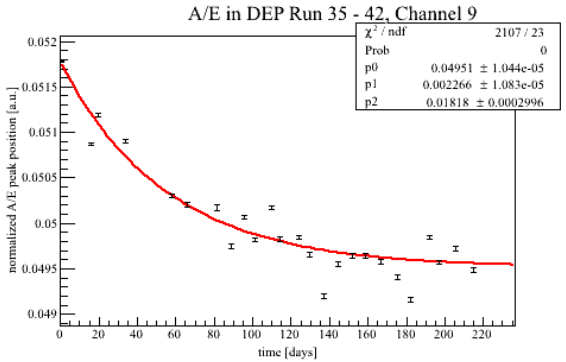

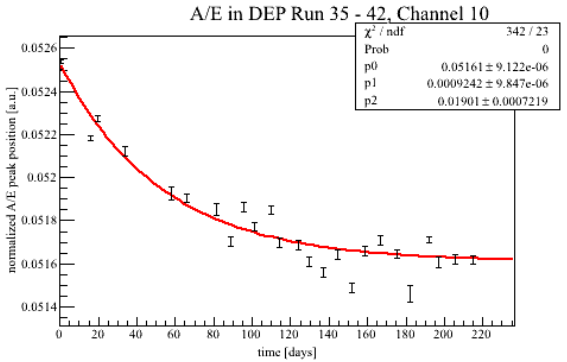

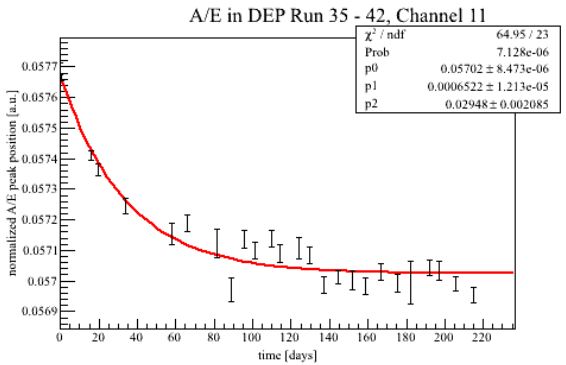

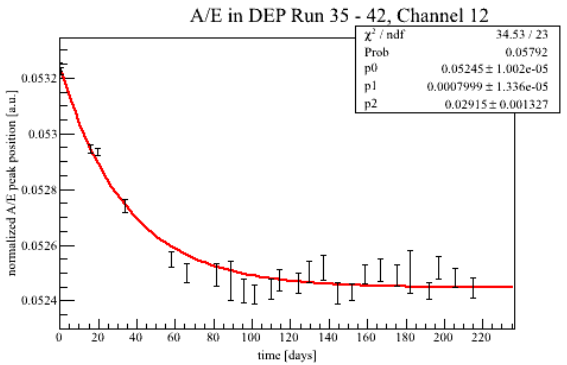

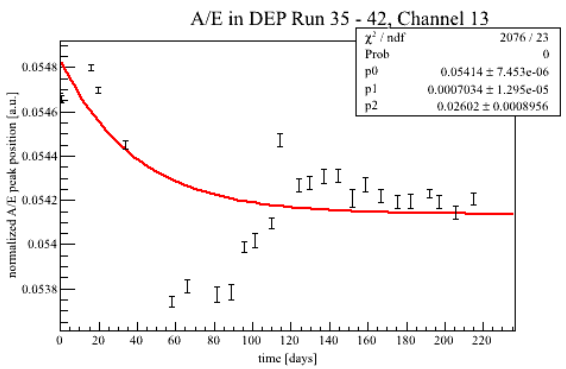

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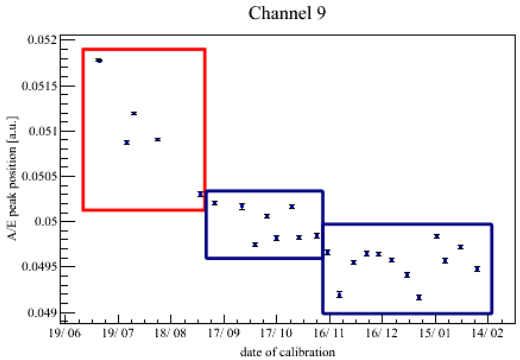
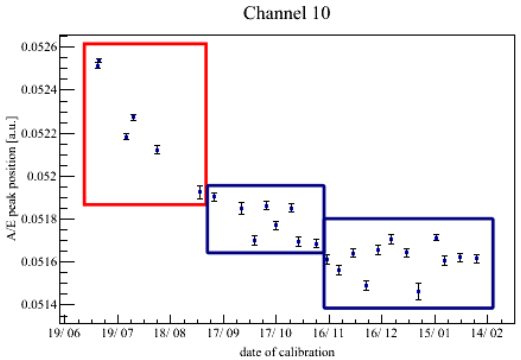
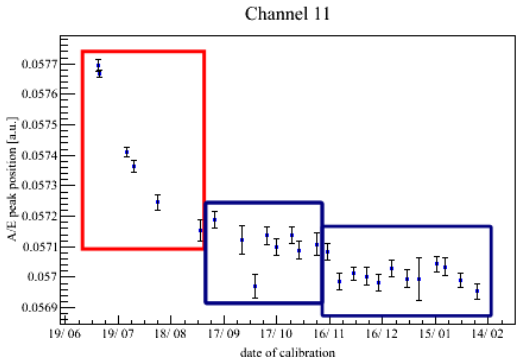
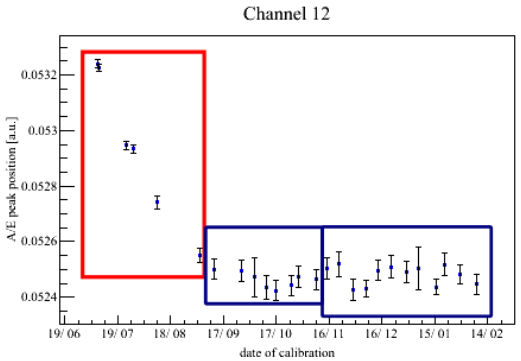
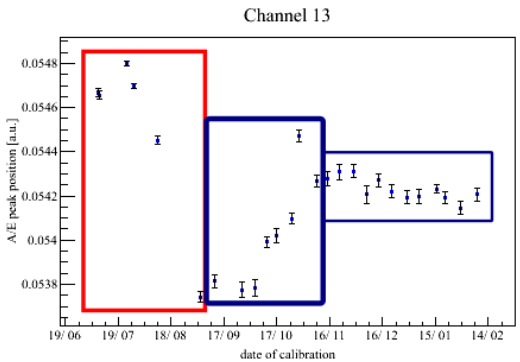


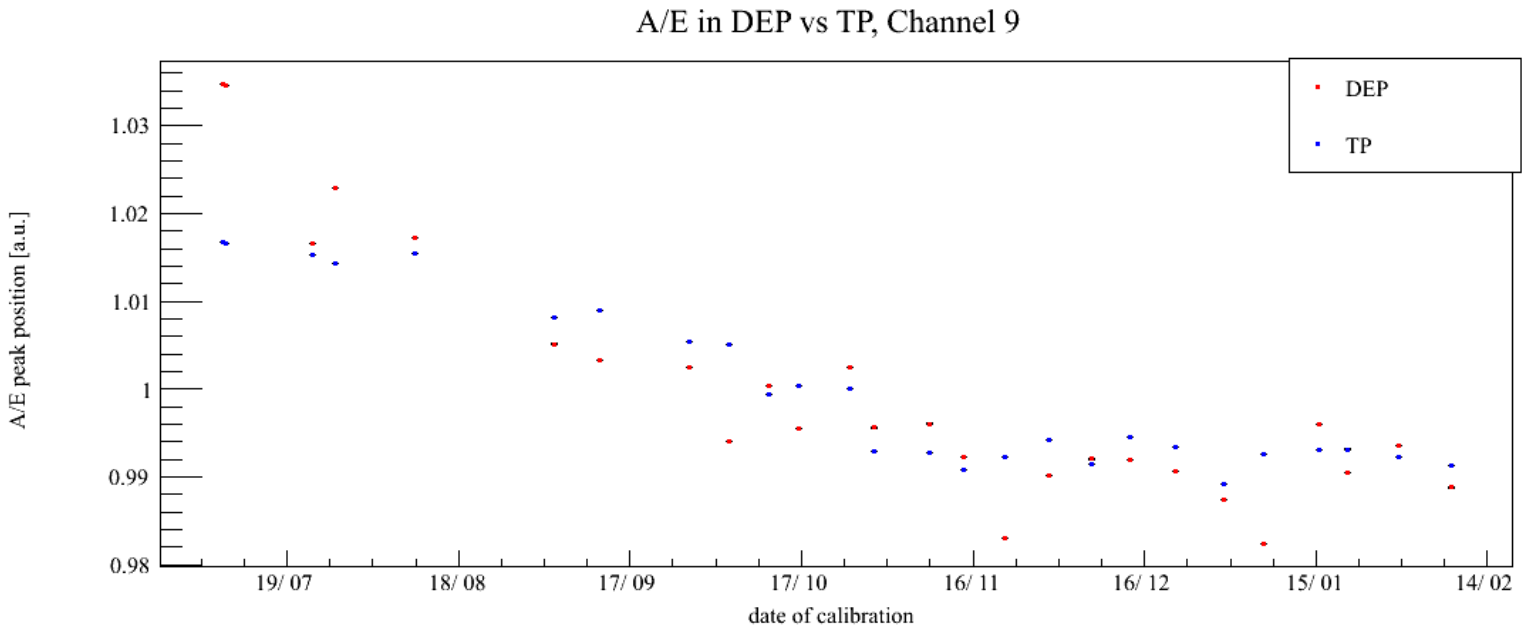




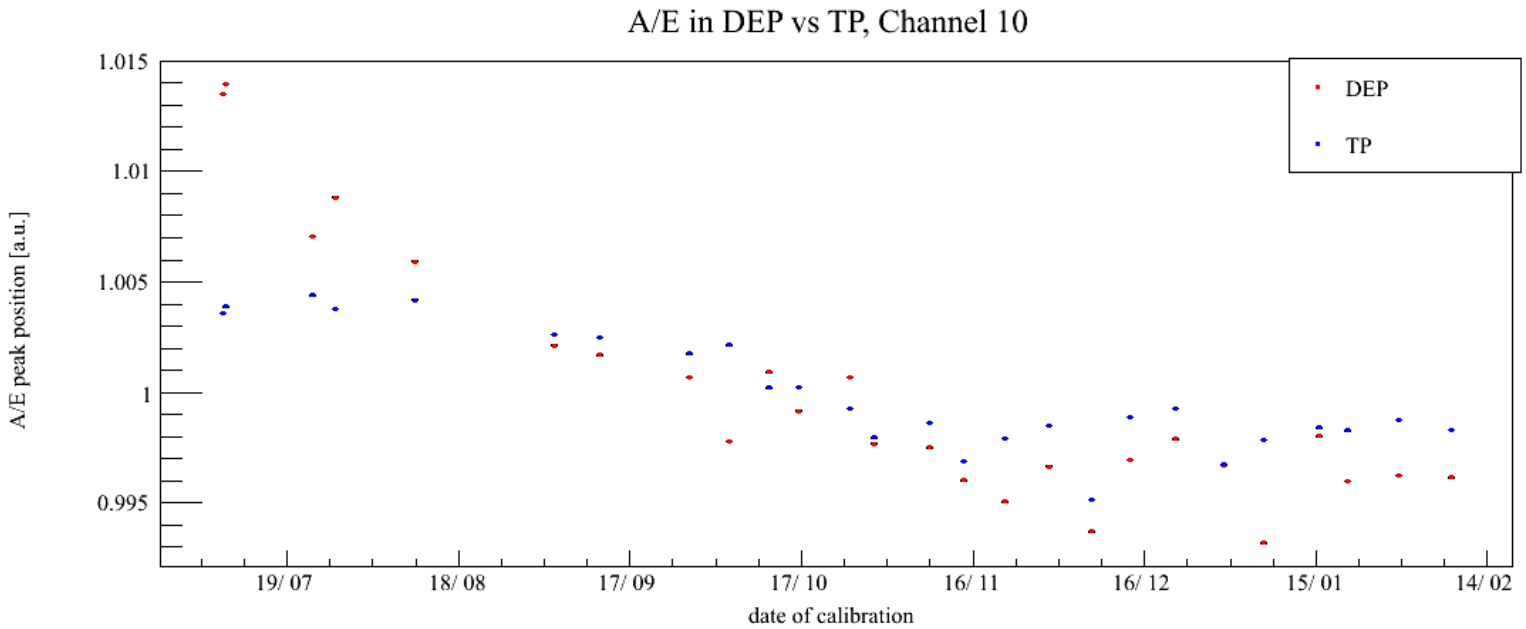




Pulser Stability



Pulser Stability



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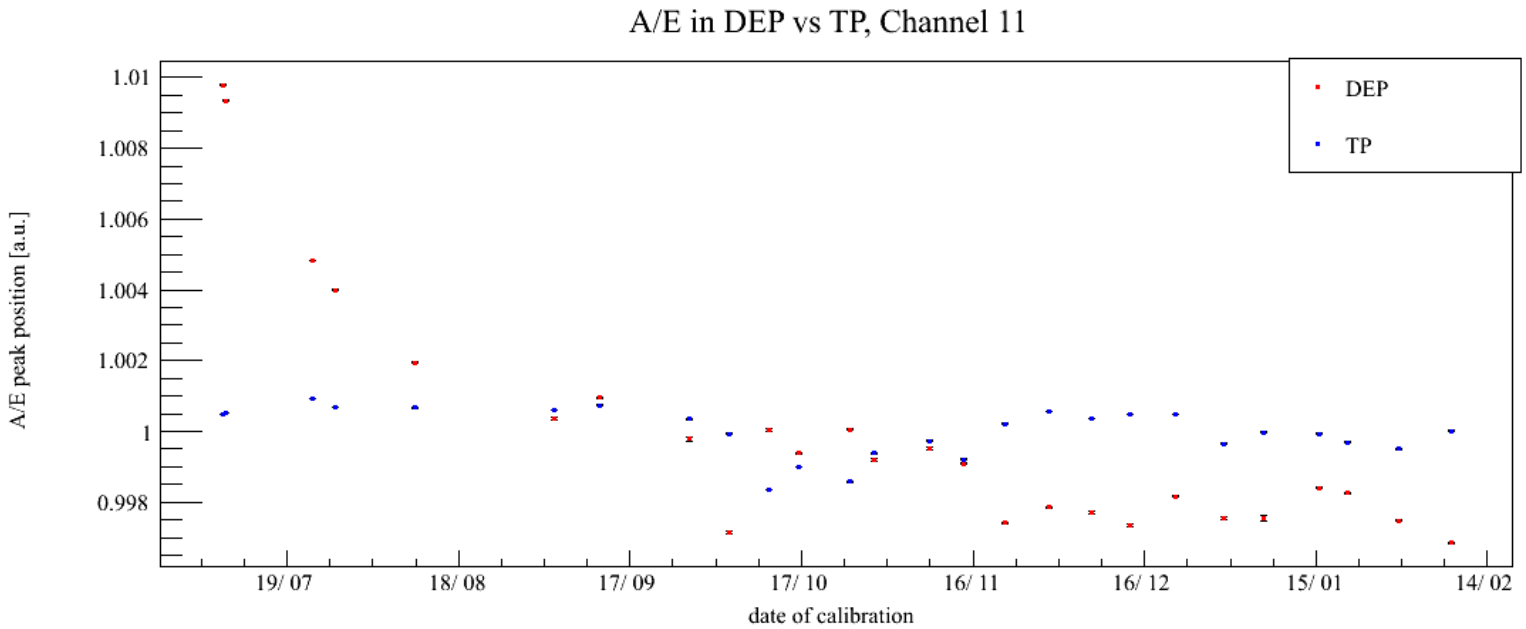
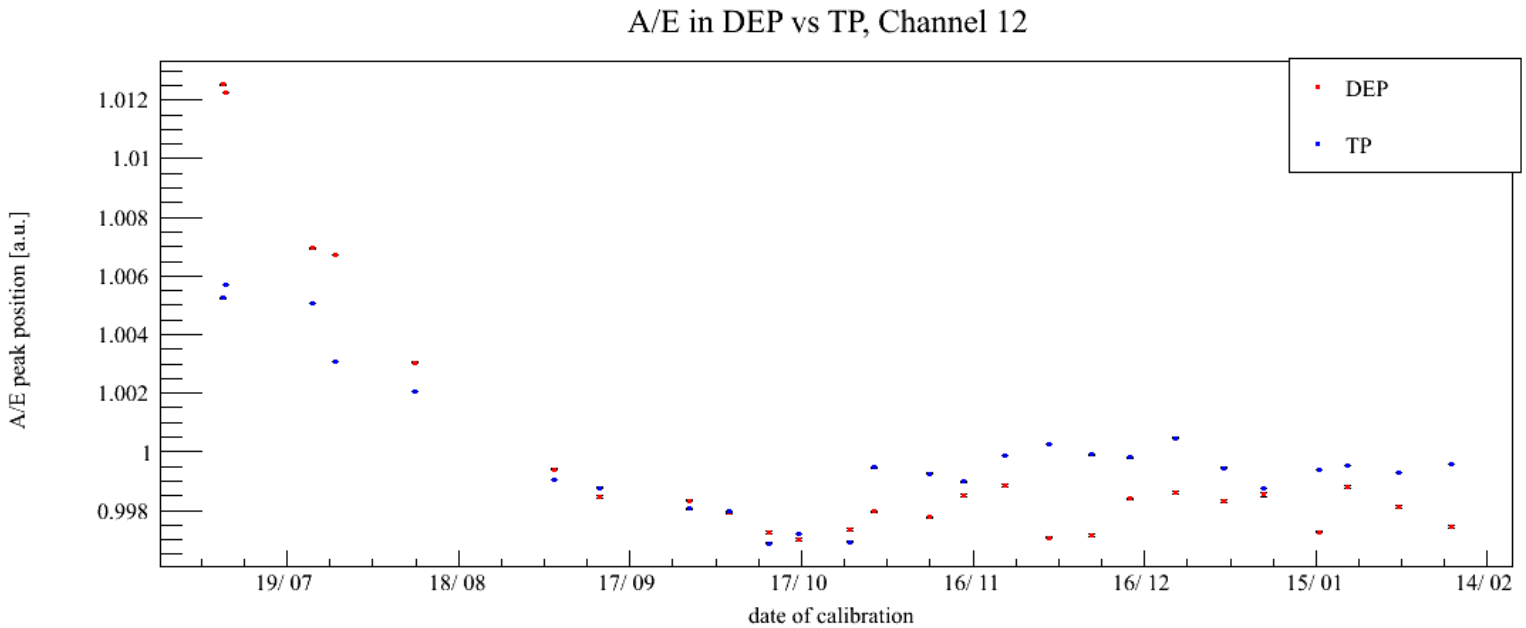


Pulser Stability



Pulser Stability