Istituto Nazionale di Fisica Nucleare
LABORATORI NAZIONALI DI LEGNARO

ACC 2024, Milano

Report on ^{56}Ni & ^{60}Zn

M. Balogh on behalf of 23.07 & 23.09

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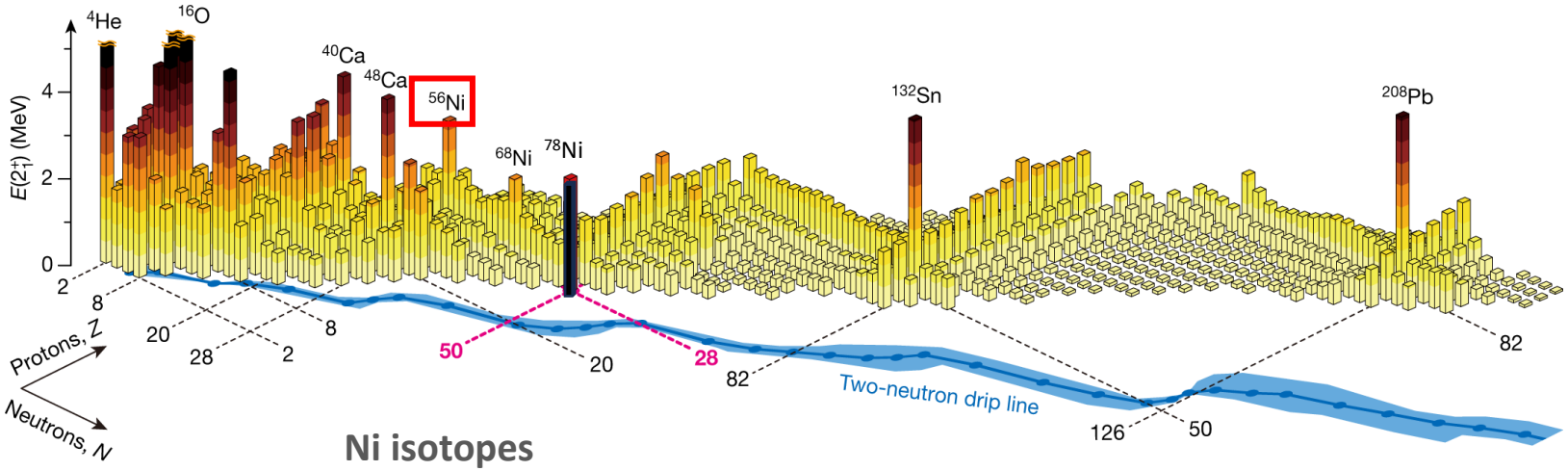
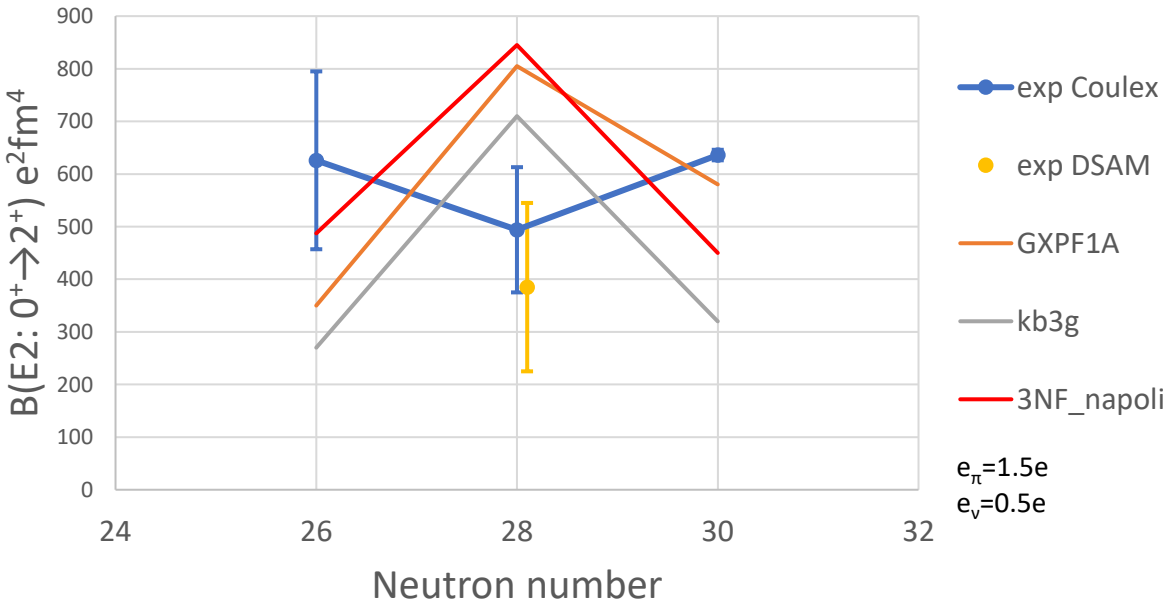
Physics motivation

N = Z = 28: the (not so) doubly-magic ^{56}Ni nucleus

Soft doubly-magic nucleus, with large **core-breaking** components already in the ground state.



^{56}Ni B(E2) ≤ ^{58}Ni B(E2):
at odd with intuitive expectations and shell-model predictions!



Intermediate-energy Coulomb excitation – entangled nuclear + Coulomb contributions

K. L. Yurkewicz et al., Phys. Rev. C 70 (2004)

DSAM – unresolved feeding

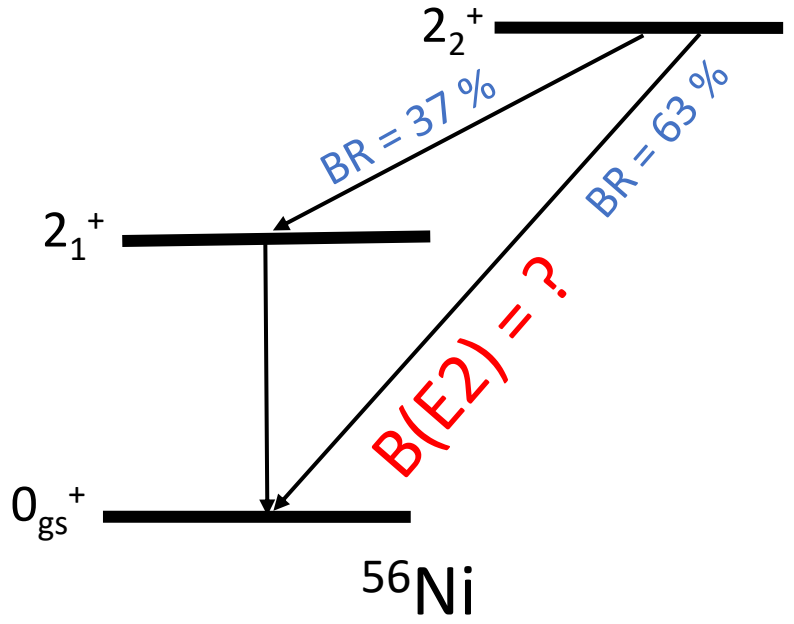
N. Schulz et al., Phys. Rev. C **8** (1973) 1779

Shell model overestimates the B(E2)?

- wrongly modeled core-breaking?
- isospin symmetry breaking?

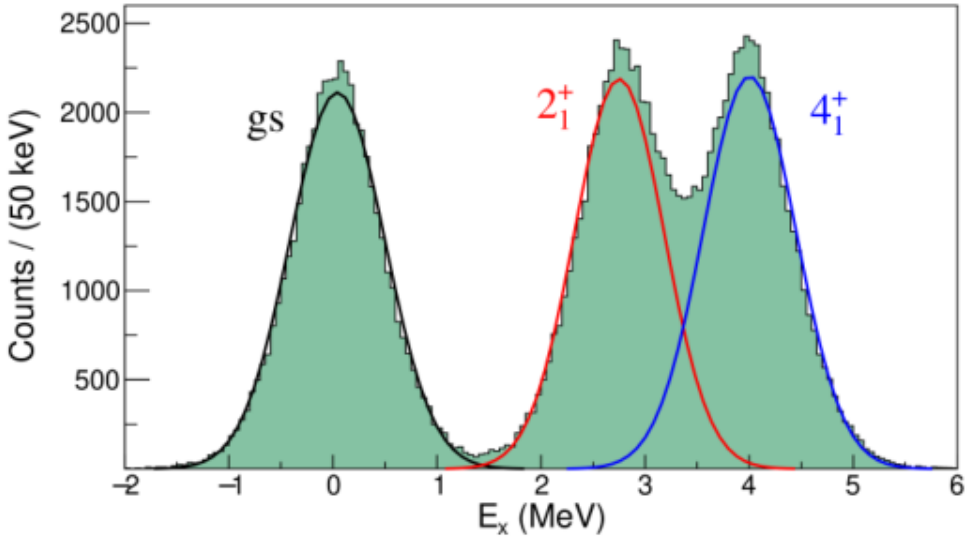
Goals

- **Investigate spherical and deformed structures, and their possible mixing, in ^{56}Ni by determining B(E2) transition probabilities via lifetime measurement.**
- **Put a more stringent constraint on the experimental B(E2; $2_1^+ \rightarrow 0_1^+$) and investigate the degree of mixing between the deformed and spherical bands, suggested by the large BR of the $2_2^+ \rightarrow 0_1^+$ transition.**



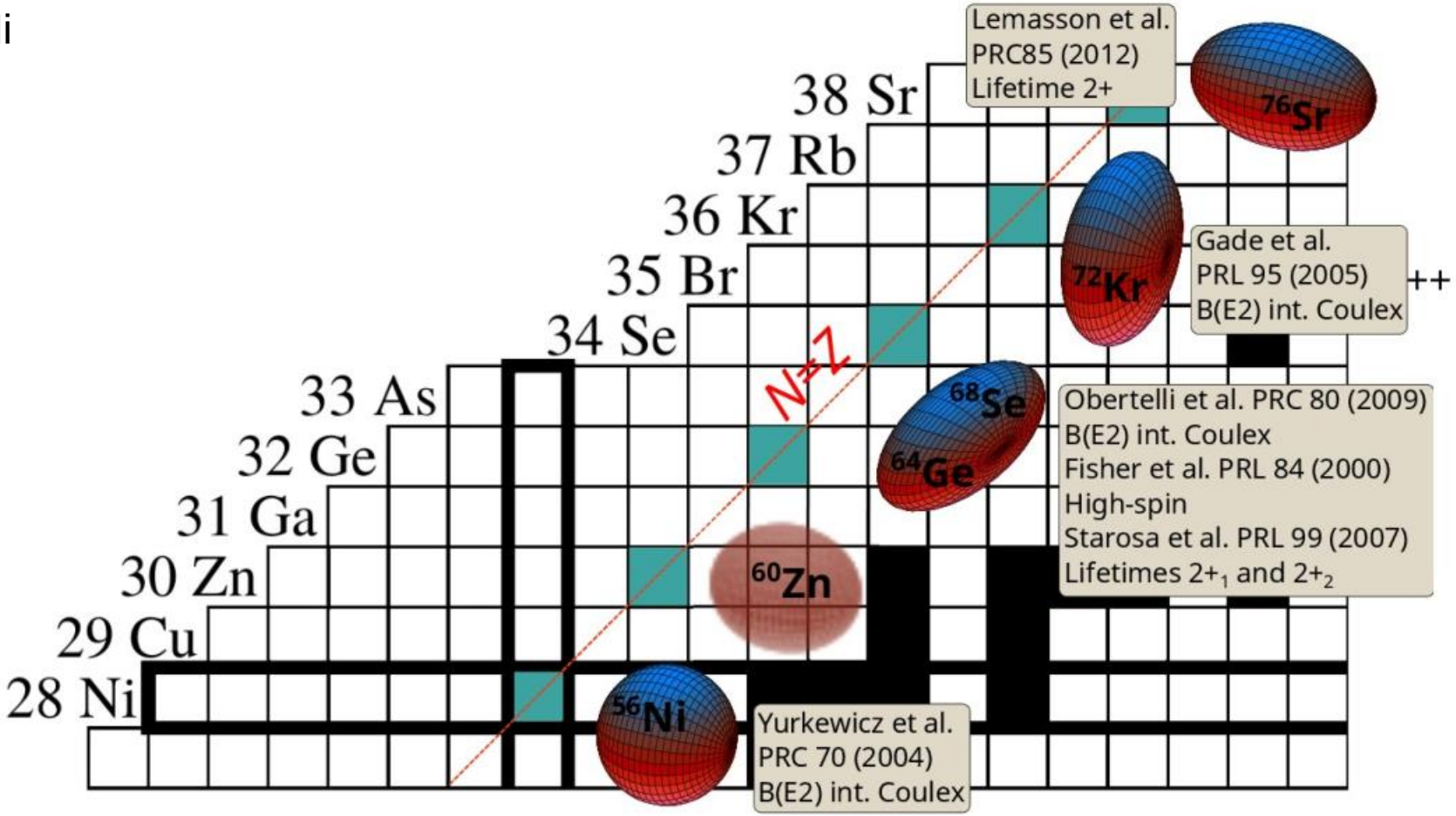
A strongly suppressed B(E2; $2_2^+ \rightarrow 0_1^+$), as predicted by GXPF1A, would imply no mixing between spherical and deformed configurations but difficult to account for the experimental BR.

A large B(E2; $2_2^+ \rightarrow 0_1^+$) of several W.u. would imply significant mixing between spherical and deformed configurations.



N = Z = 30: shell and shapes of ^{60}Zn nucleus

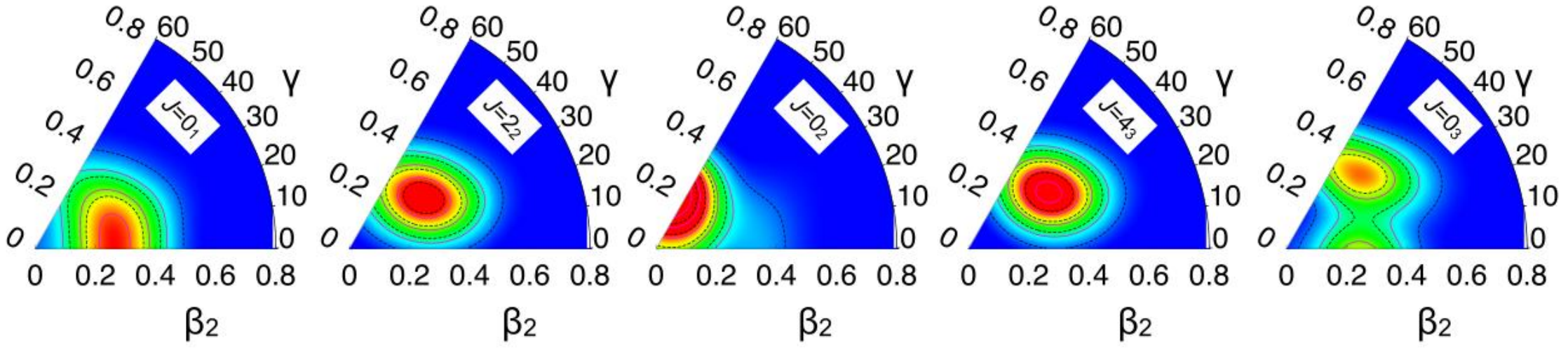
Shape evolution of N=Z above ^{56}Ni



N = Z = 30: shell and shapes of ^{60}Zn nucleus

- **Investigate the shape evolution in the region of transitional N = Z nuclei laying just above the doubly-magic nucleus 56Ni.**

- **First lifetime measurement in gs and side band**

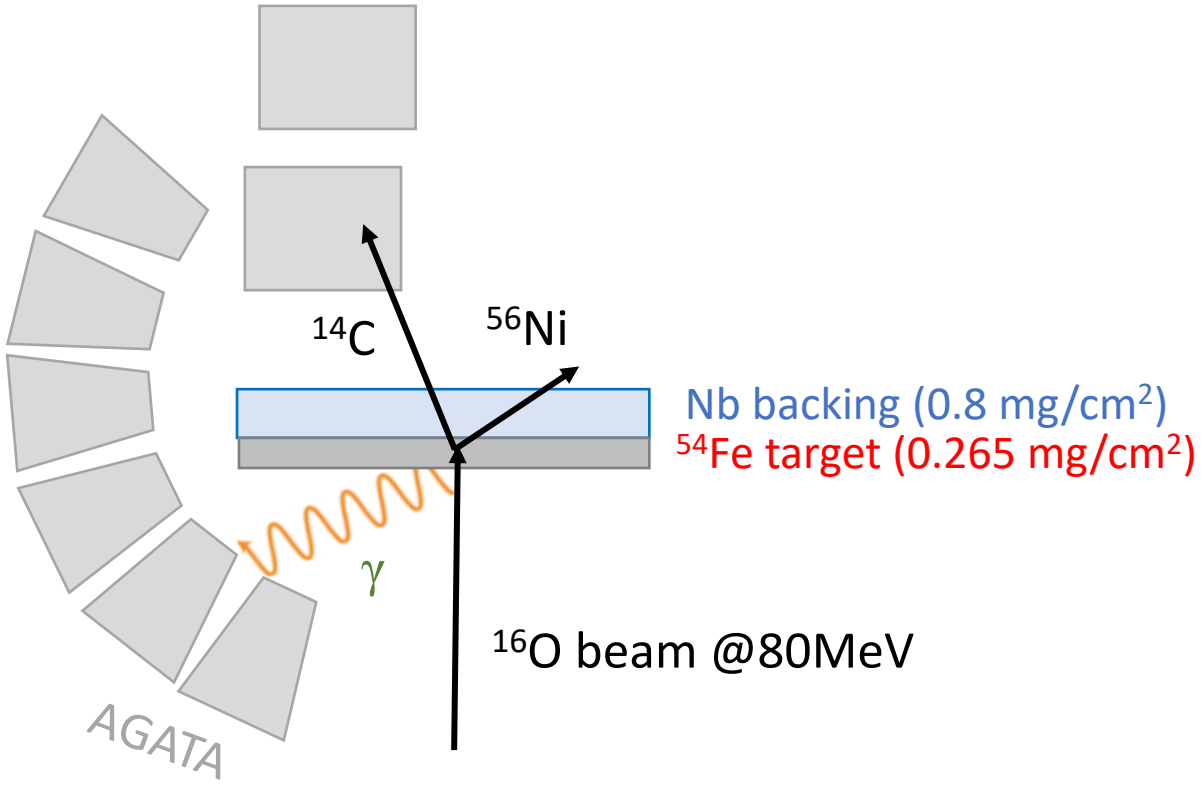


T. Rodriguez, private communication

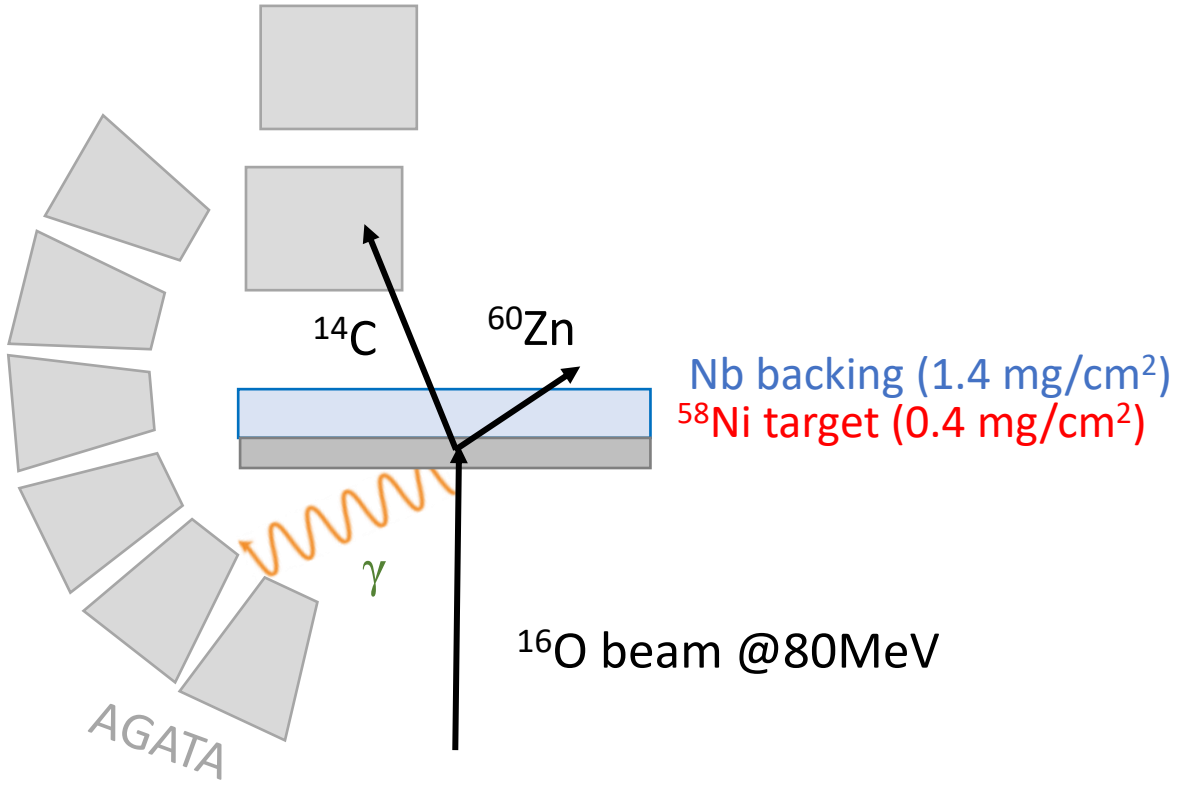
Experiments

Setup

OSCAR ΔE-E telescopes



OSCAR ΔE-E telescopes



+ Rutherford scattering monitors @12° & 17°

Timeline

Nov 29, 2023

AGATA efficiency runs (Eu, Ra, Co) + 3α source calibration for OSCAR

↓

Exp 23.07 (^{56}Ni)

↓

Preamp replacement of OSCAR's E layer (nero)

AGATA efficiency calibration

↓

OSCAR energy calibration using 80,70,60,55,50 MeV beam and 0.1mg/cm^2 ^{197}Au target

↓

Exp 23.09 (^{60}Zn)

↓

AGATA efficiency runs (Eu, Ra, Co)

↓

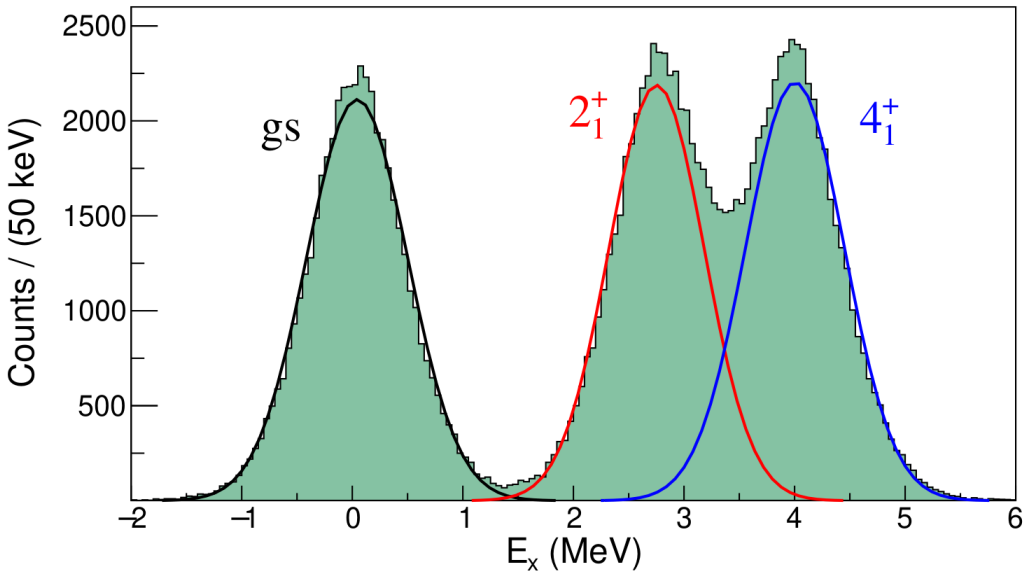
OSCAR position measurement (laser tracker)

Dec 22, 2023

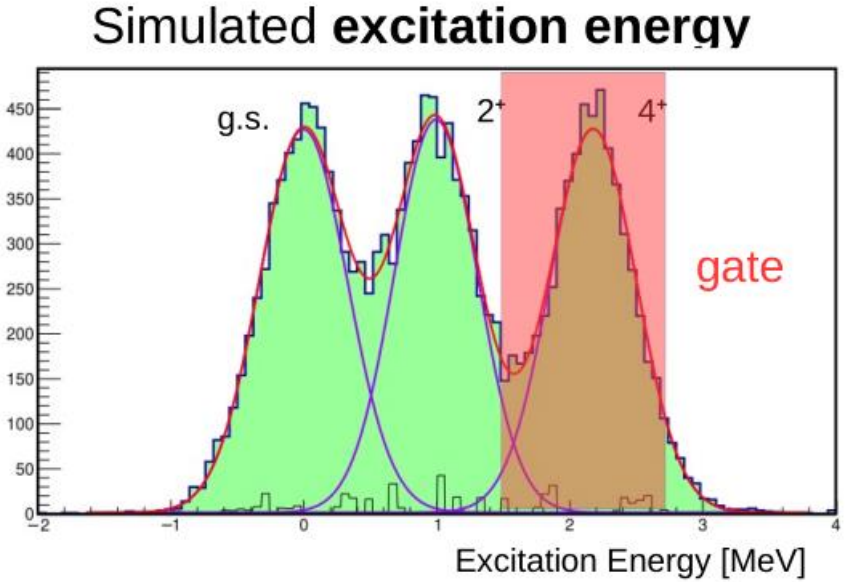
OSCAR calibration(s)

Excitation energy resolution is crucial!

^{56}Ni



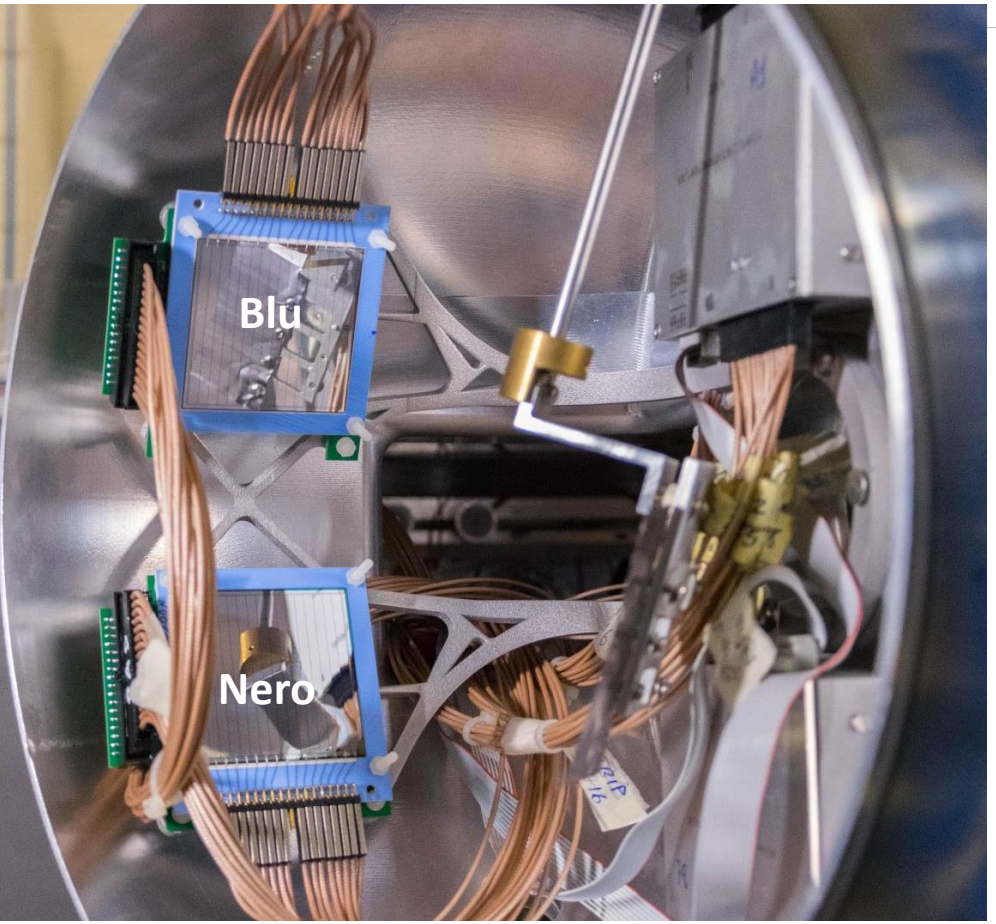
^{60}Zn



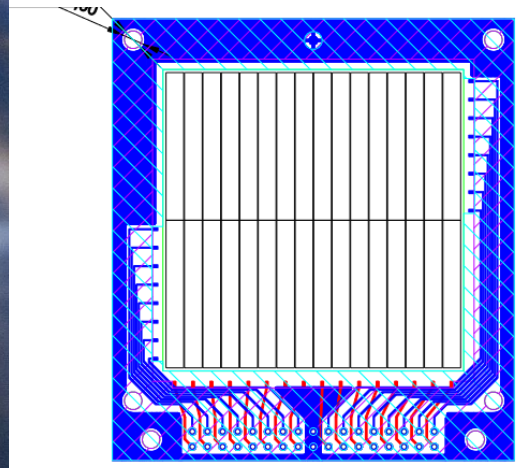
FWHM ~ 700 keV

Position calibration

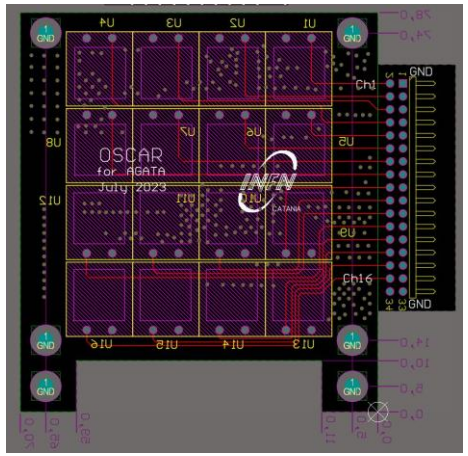
OSCAR: 128 pseudo-telescopes

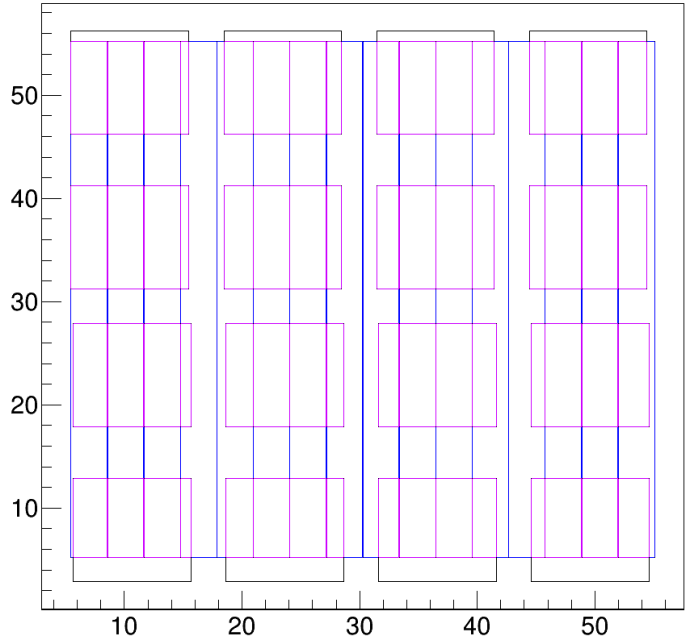


dE layer

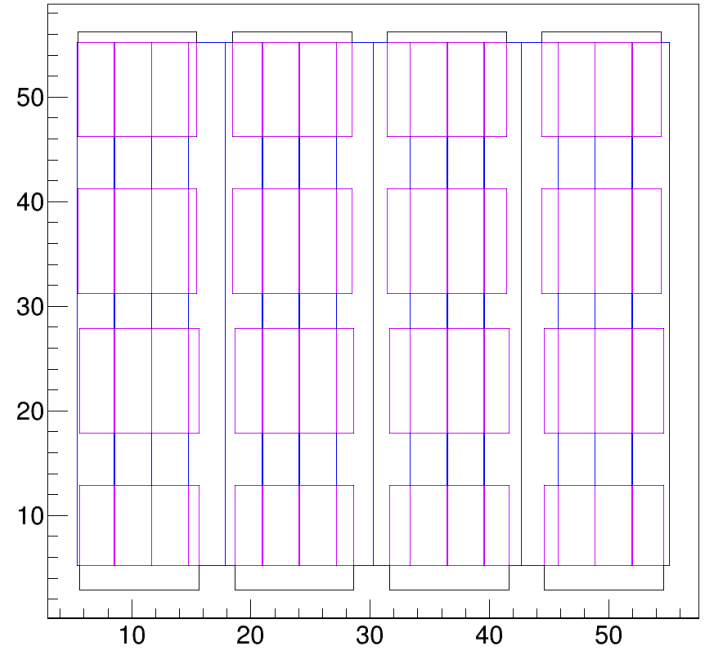


E layer





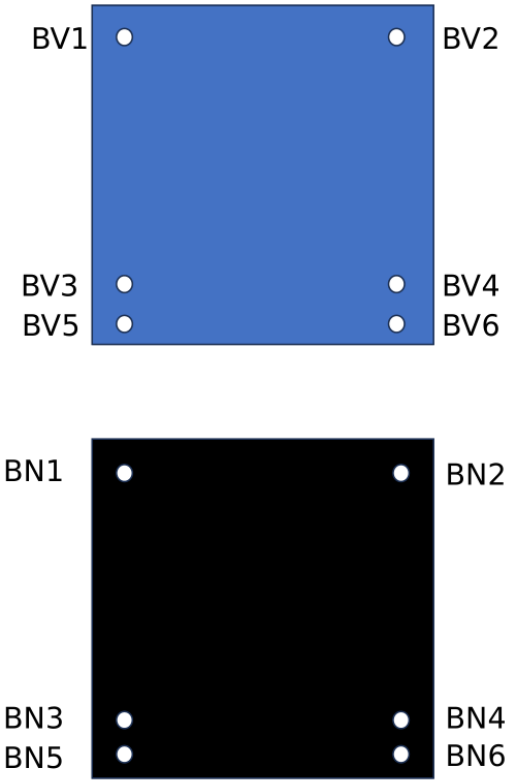
Blu

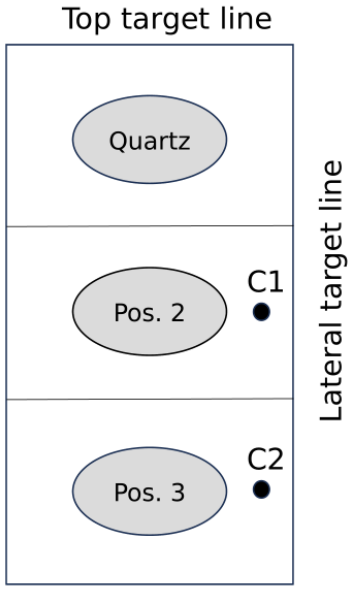


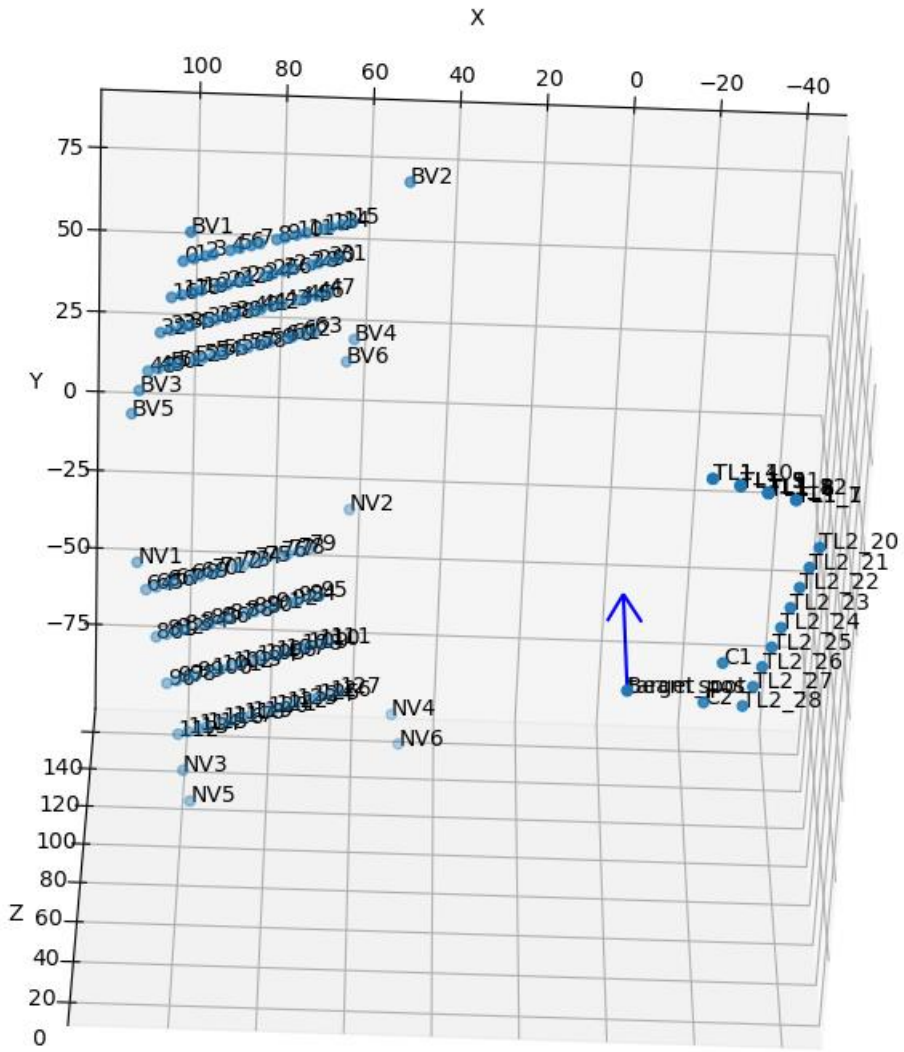
Nero

Position calibration

Laser measurements



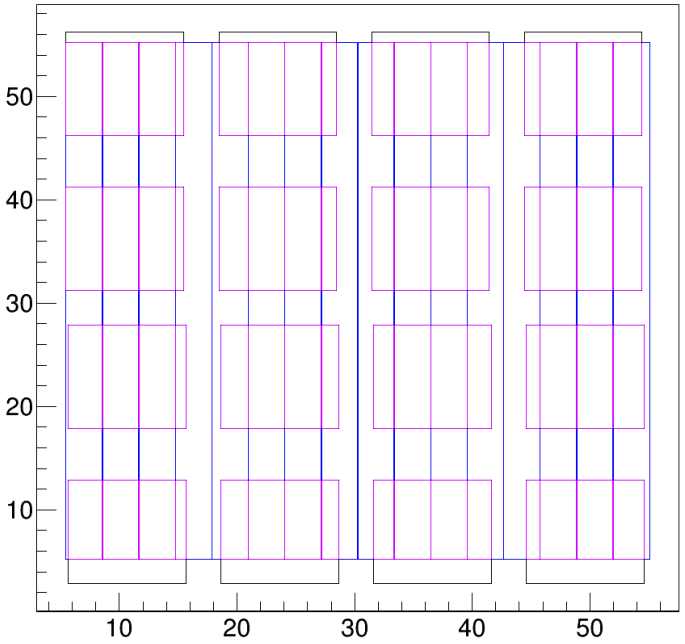




Energy calibration

Energy calibration using 80, 70, 60, 55, 50 MeV beam on 100µg/cm^2 ^{197}Au → 640 points

- linear energy calibration parameters for dE and E detectors → 128 parameters
- front dE dead layer thickness → 128 parameters
- **dE active layer thickness** → 128 parameters
- back dE + front E dead layer thickness: → 128 parameters



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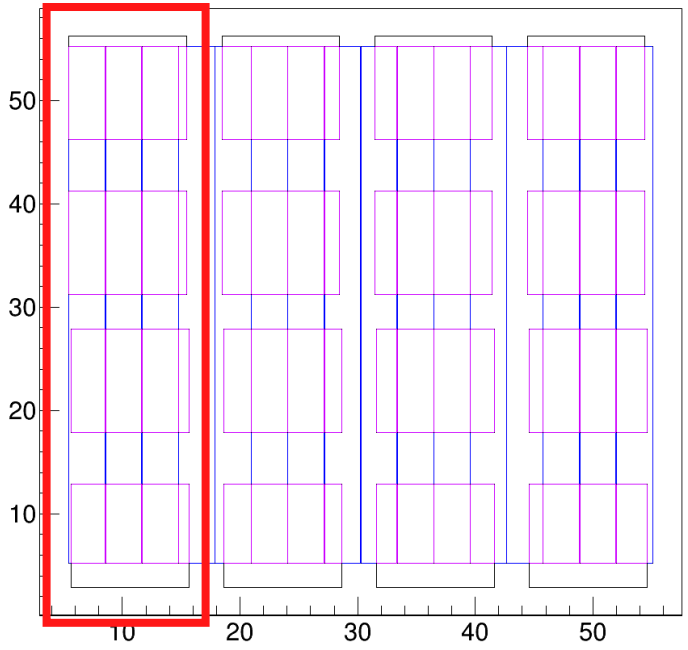
8 independent minimization blocks



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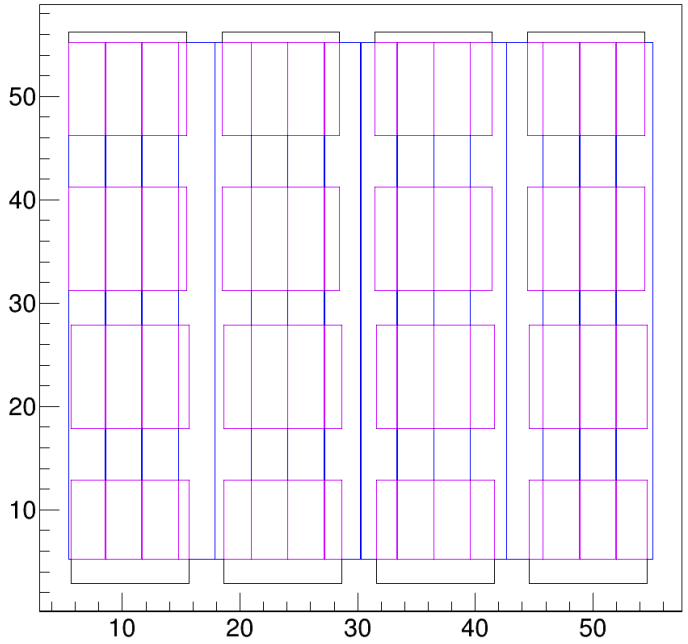
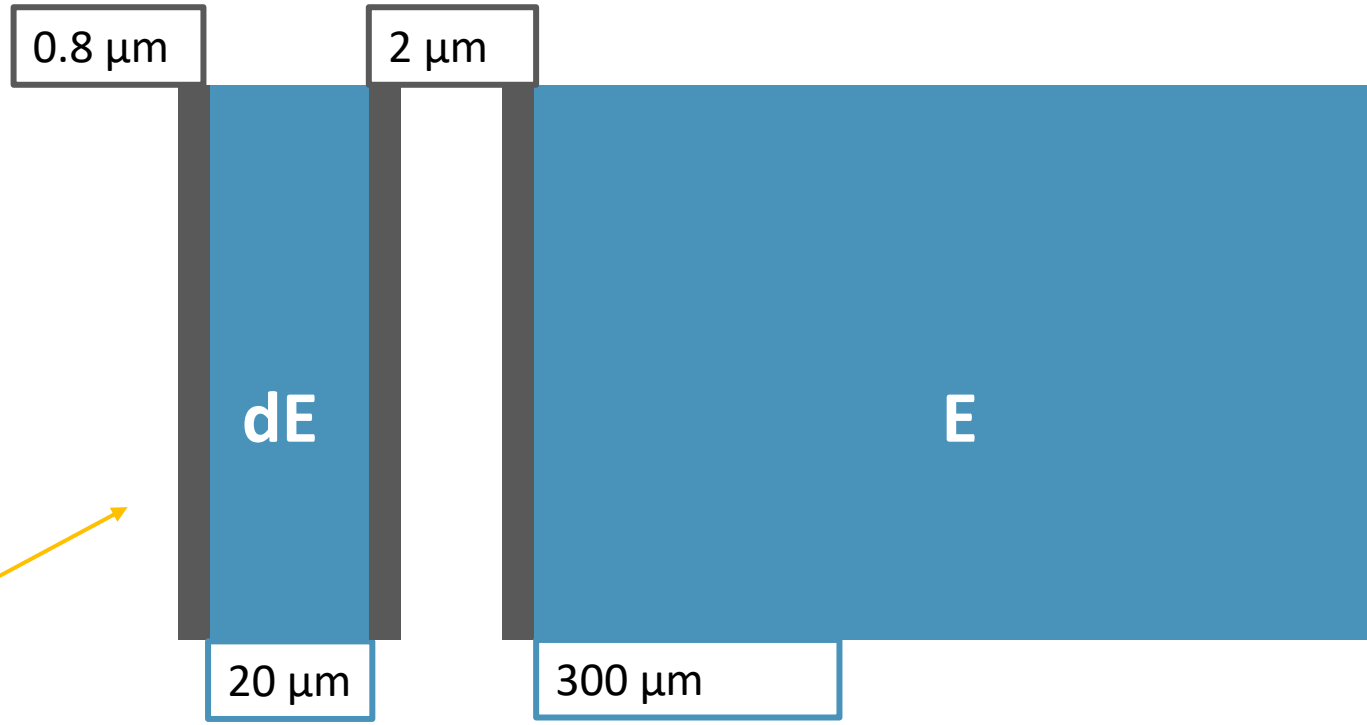
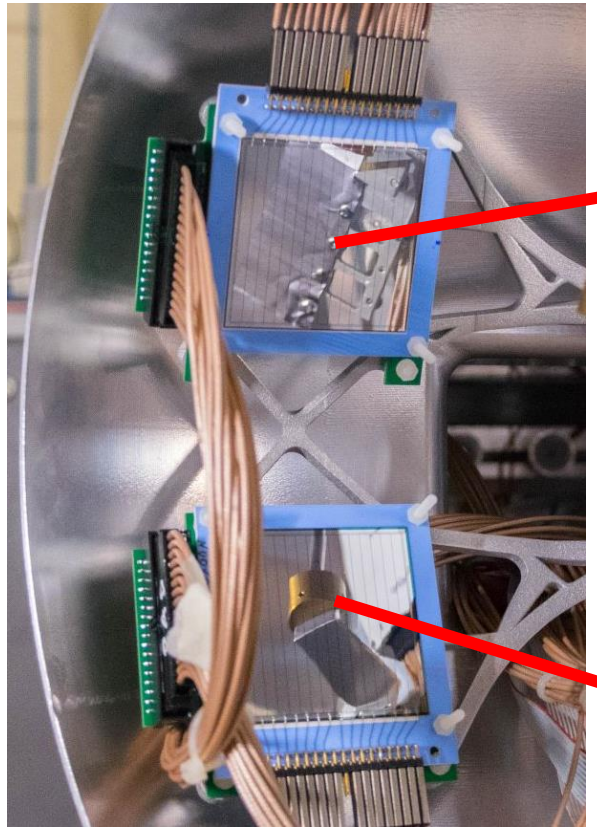
$$(\Delta E_{th} - \Delta E_{cal})^2 + (E_{th} - E_{cal})^2$$

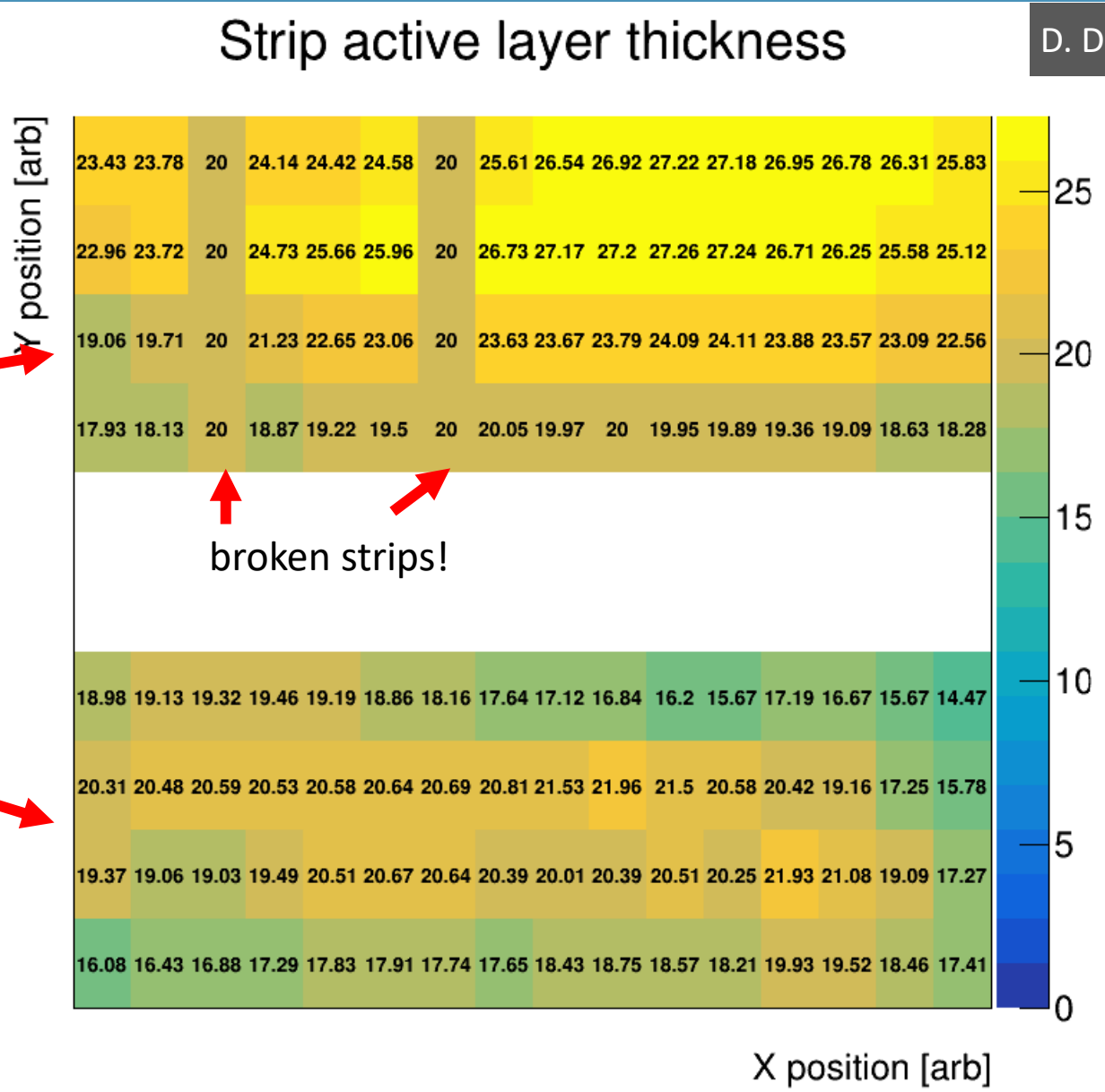


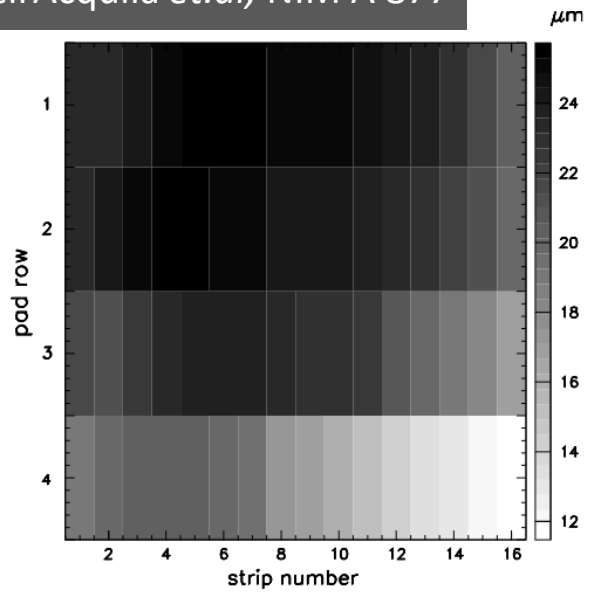


Energy calibration

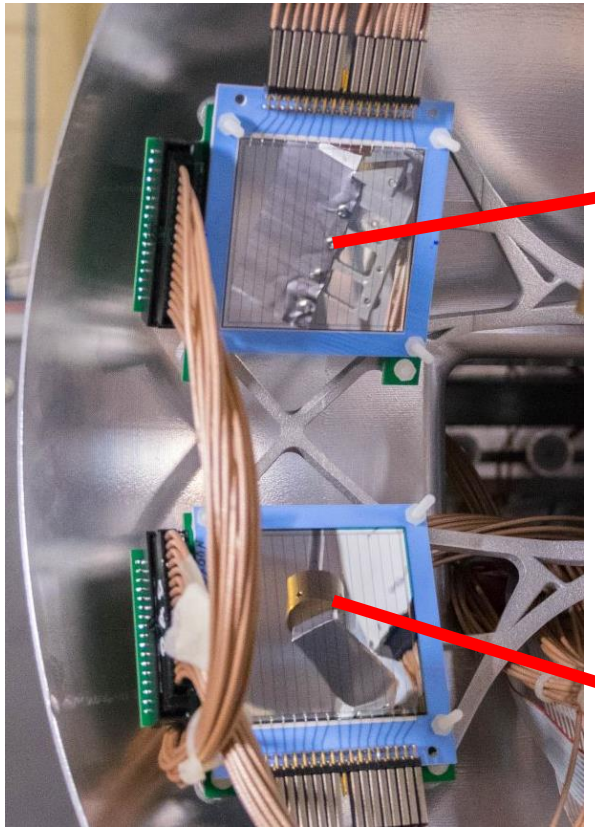


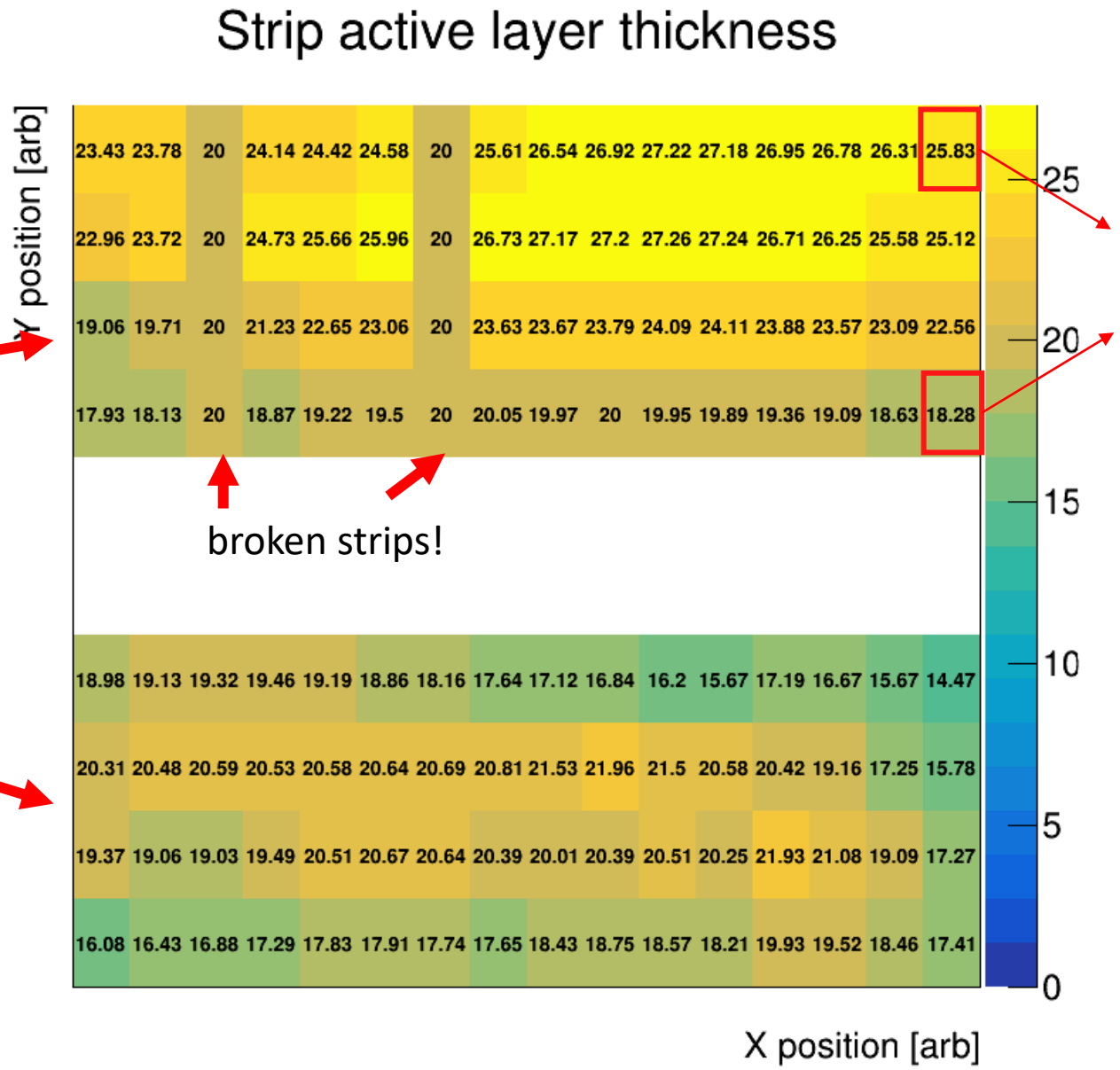
D. Dell'Acquila *et.al,* NIM A 877





Energy calibration



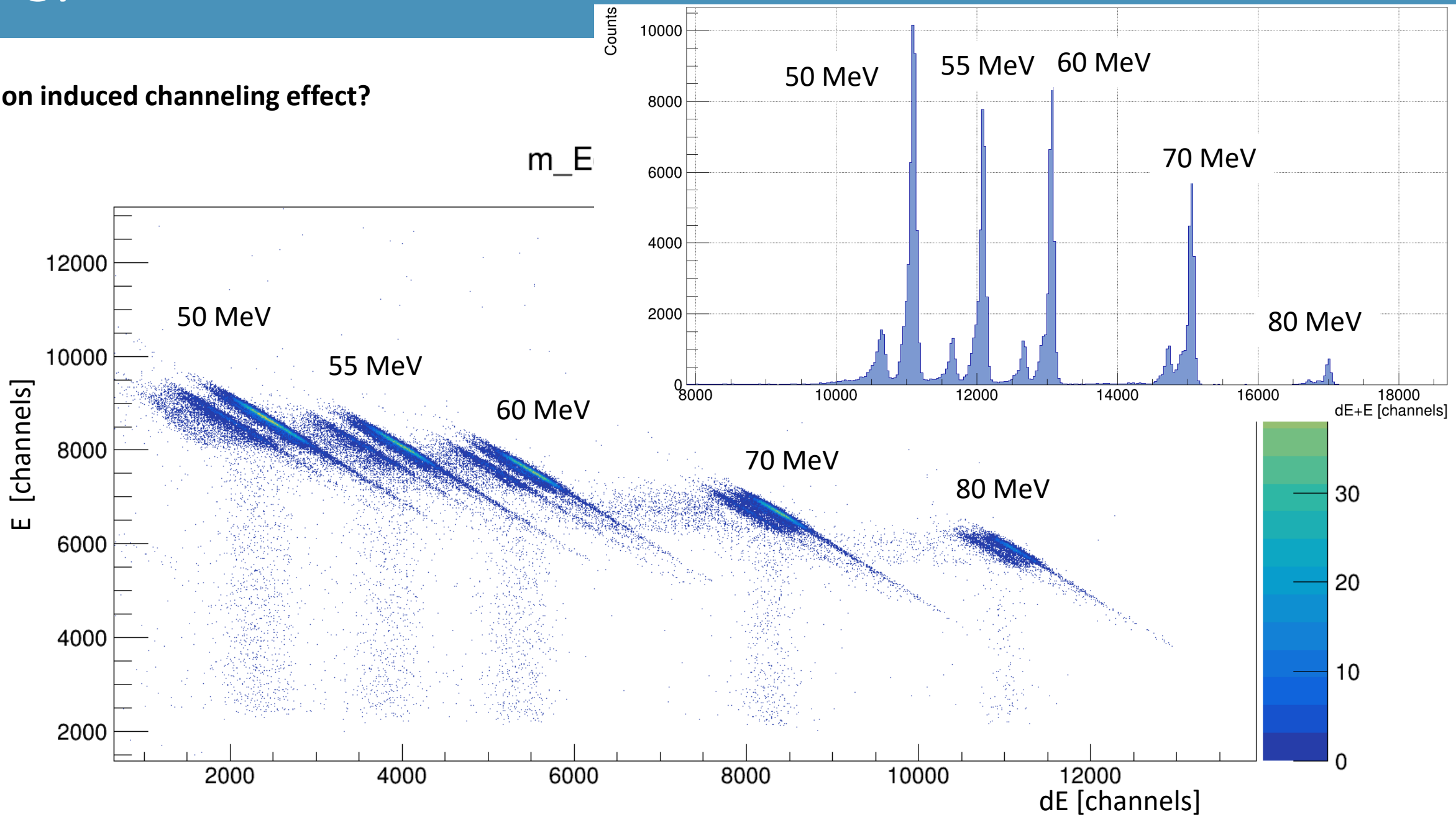


4 MeV difference for ^{14}C@60MeV

6 MeV difference for ^{14}C@40MeV

Energy calibration... difficulties

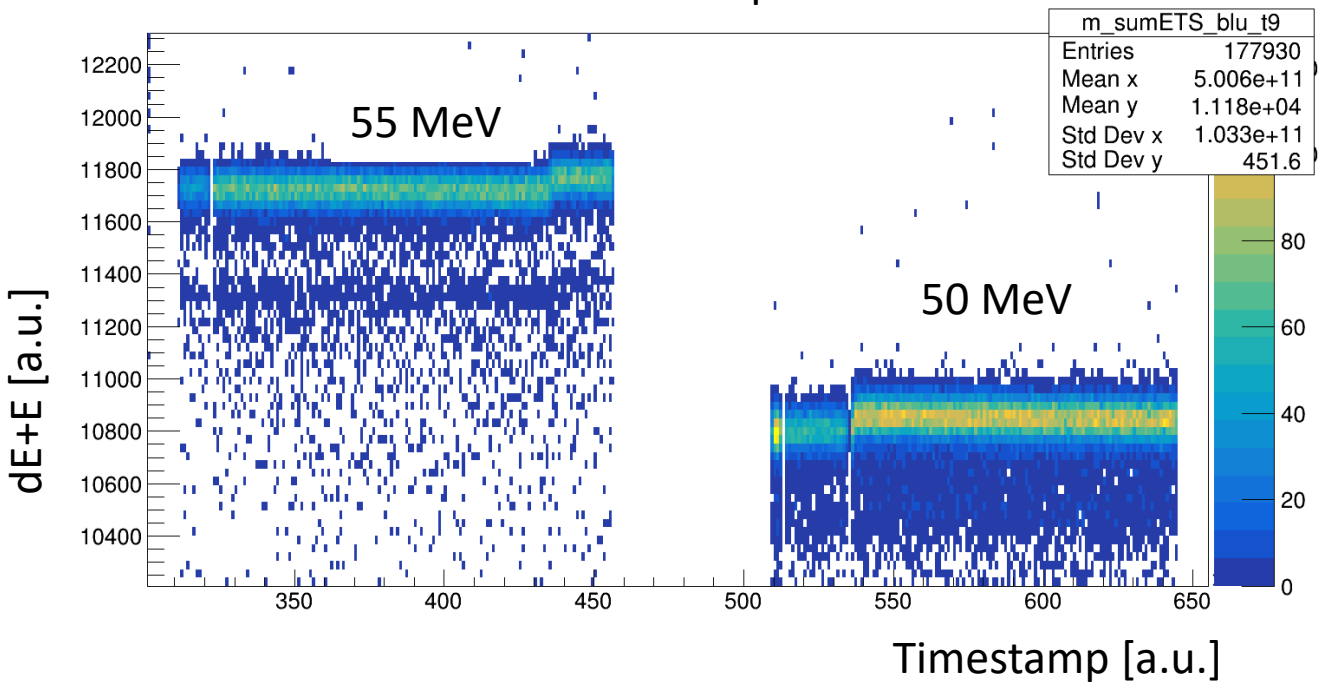
Radiation induced channeling effect?



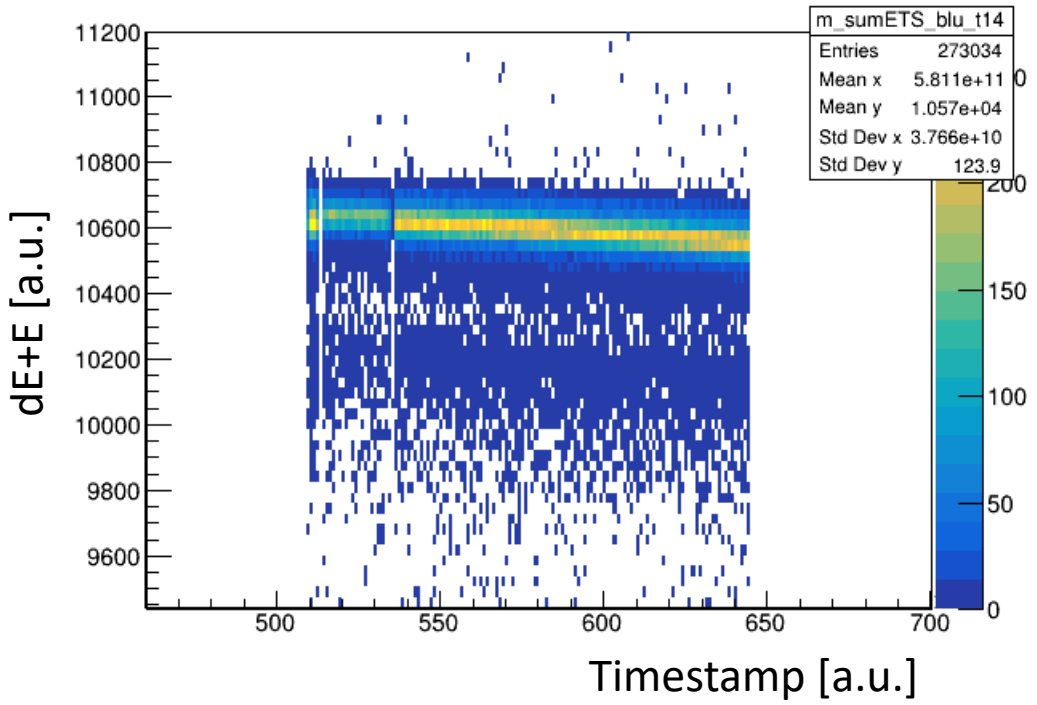
Energy calibration... difficulties

Gain drift during calibration…

Telescope 9



Telescope 14



To do

1. Finish energy calibration of OSCAR
    1. Include 3alpha measurement to evaluate dead layer of dE
    2. Online energy calibration of the E layer of OSCAR nero (before preamp replacement)
    3. Investigate/correct time-dependent energy calibration of OSCAR
2. Modify AGATA selector to accept full set of parameters for a composite ancillary detector
3. Fine tune AGATA (energy, NDC,…)

4. **Analyze experimental data**

^{56}Ni
Exp 23.07

Spokesperson(s): F. Galtarossa and A. Gottardo

F. Galtarossa[1], A. Gottardo[2], E. Pilotto[1], M. Polettini[1], I. Zanon[2], P. Aguilera[1], F. Angelini[1,2], M. Balogh[2], J. Benito[1], M. Bentley[3], G. Benzoni[4], S. Bottoni[4], D. Brugnara[2], S. Carollo[1], S. Chen[3], G. de Angelis[2], D. Dell'Aquila[5], J. Diklić[6], A. Ertoprak[2], R. Escudeiro[1], A. Gadea[7], A. Goasduff[2], B. Góngora-Servín[2,8], S. M. Lenzi[1], I. Lombardo[9], N. Marchini[10], R. Menegazzo[1], D. Mengoni[1], T. Mijatović[6], A. Nannini[9], D. R. Napoli[2], G. Pasqualato[11], J. Pellumaj[2,8], R. M. Pérez-Vidal[2], S. Pigliapoco[1], F. Recchia[1], K. Rezynkina[1], M. Rocchini[10], M. Sedlak[2], M. Siciliano[12], R. Taniuchi[3], J. J. Valiente-Dobón[2], F. von Spee[13], L. Zago[1,2]

Thank you for your attention!

^{60}Zn
Exp 23.09

Spokesperson(s): E. Pilotto, G. Pasqualato

E. Pilotto[1], G. Pasqualato[2], D. Mengoni[1], P. Aguilera[1], F. Angelini[2,3], M. Balogh[3], J. Benito[1], G. Benzoni[4], S. Bottoni[4], D. Brugnara[3], S. Carollo[1], G. de Angelis[3], A. Ertoprak[3], R. Escudeiro[1], A. Gadea[5], F. Galtarossa[1], A. Goasduff[3], B. Góngora-Servín[3,6], A. Gottardo[3], S. M. Lenzi[1], I. Lombardo[7], N. Marchini[8], R. Menegazzo[1], A. Nannini[8], D. R. Napoli[3], J. Pellumaj[3,6], R. M. Pérez-Vidal[3], S. Pigliapoco[1], M. Polettini[1], F. Recchia[1], K. Rezynkina[1], M. Rocchini[8], M. Sedlak[3], J. J. Valiente-Dobón[3], L. Zago [1,3], I. Zanon[3]

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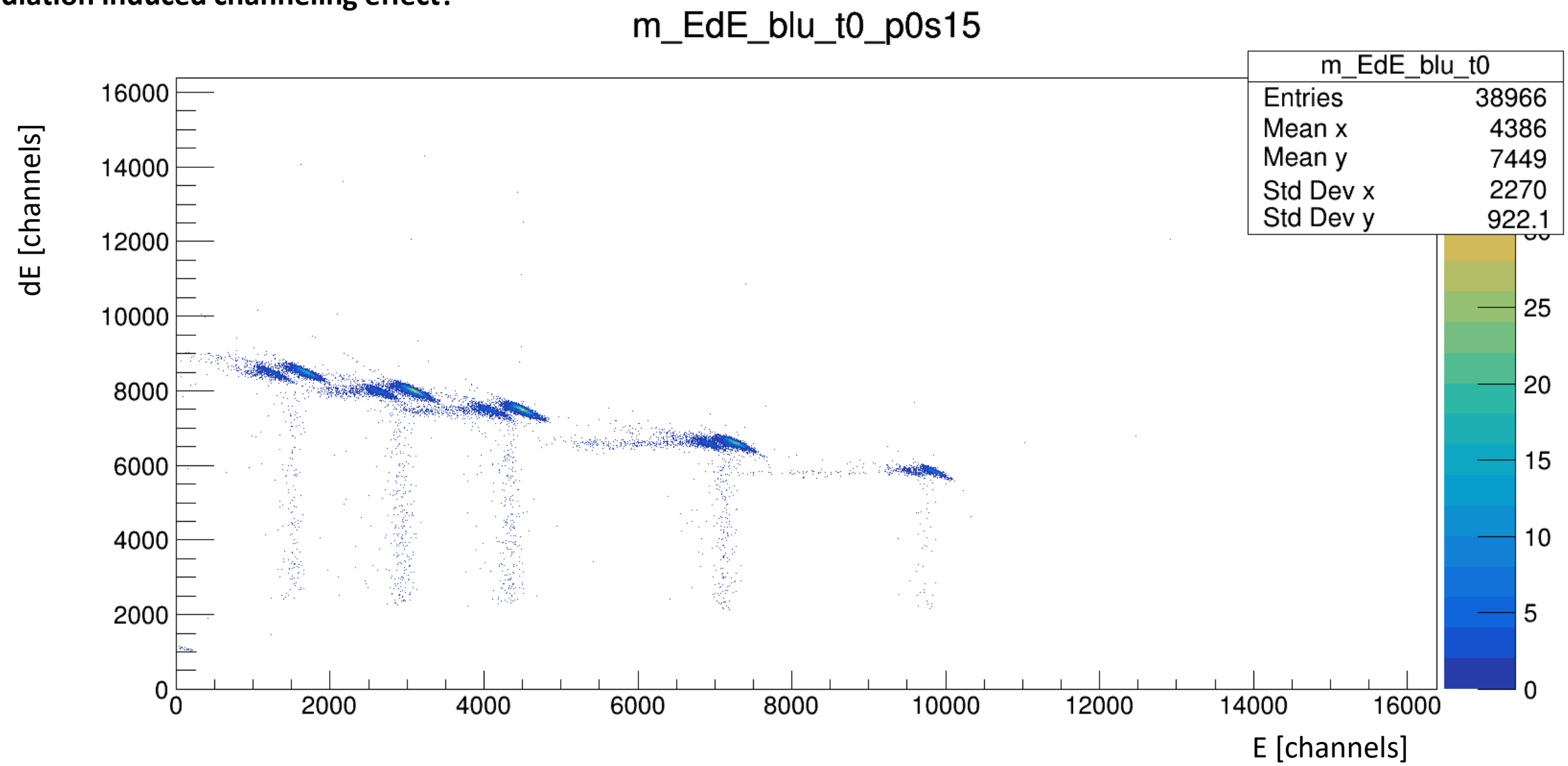
Energy calibration... difficulties

Radiation induced channeling effect?



Energy calibration... difficulties

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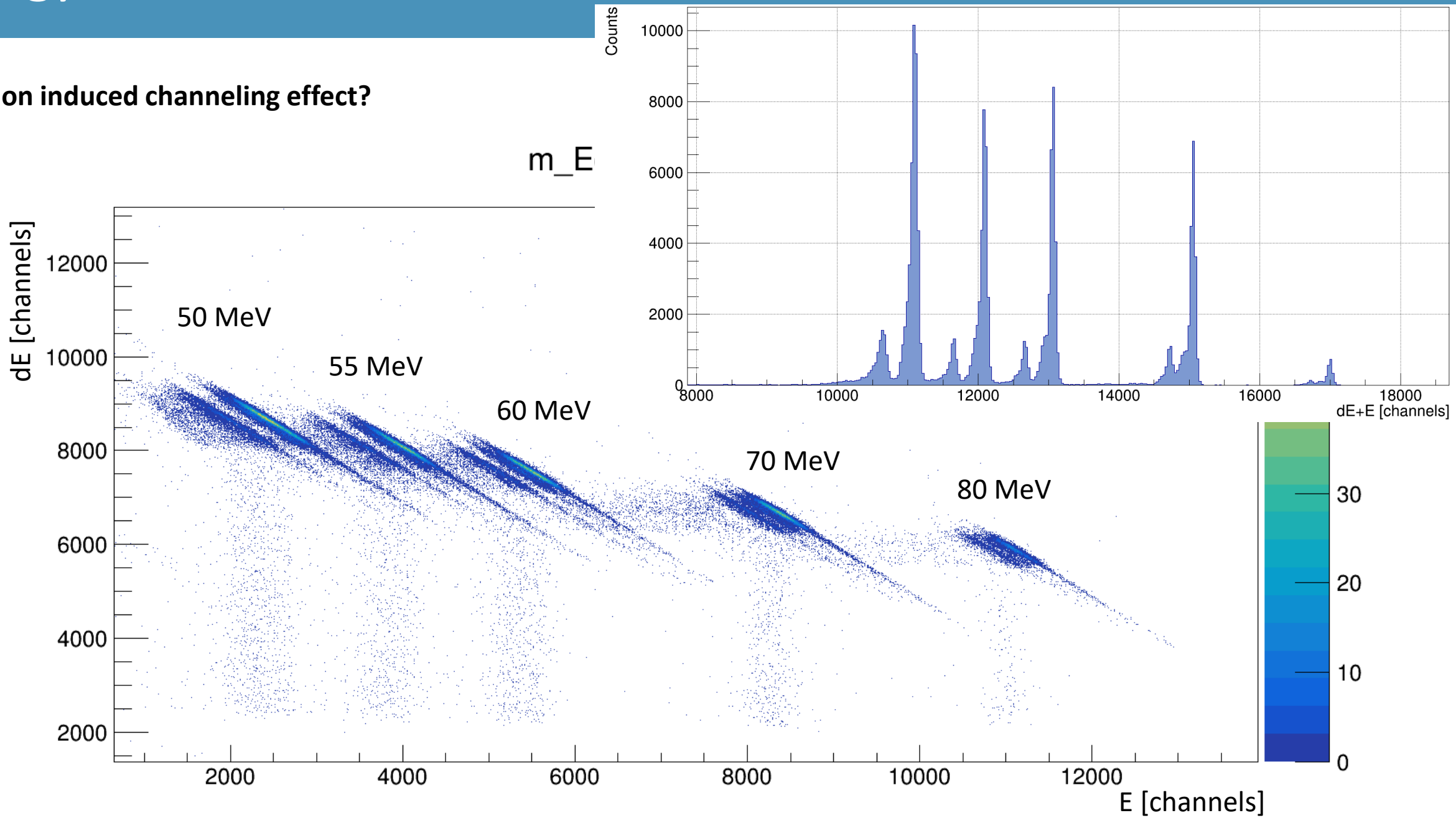
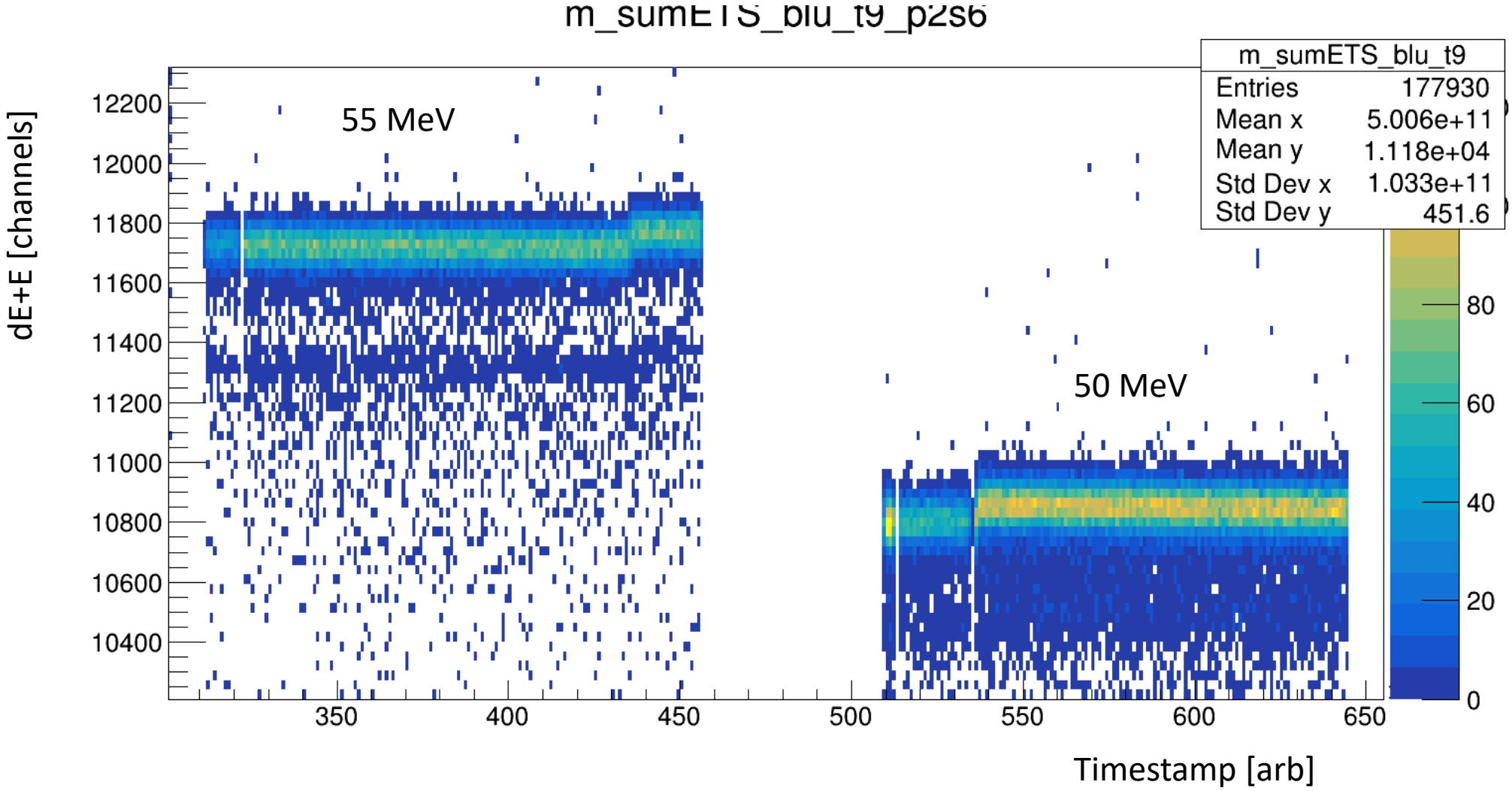


Energy calibration... difficulties

Gain drift during calibration…



Energy calibration... difficulties

In-run drifting dE-E coincidence window