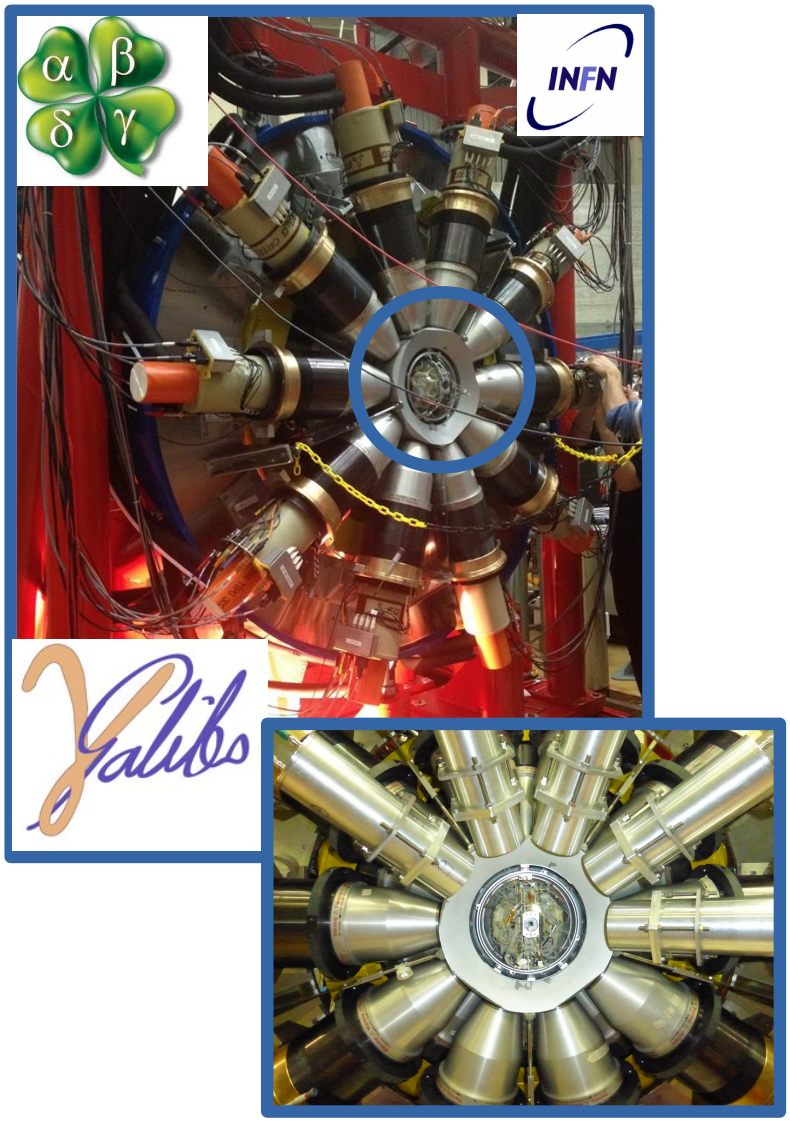
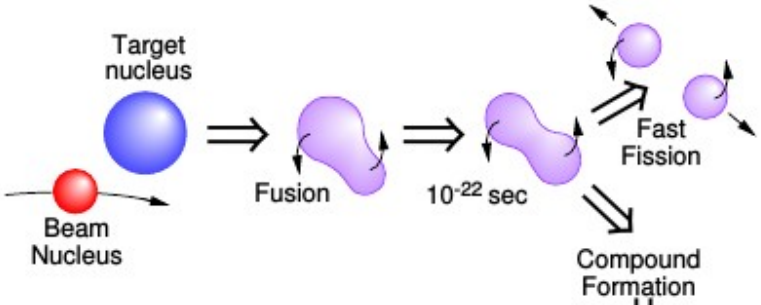
Highly efficient 4π light charged particle segmented detector EUCLIDES for in-beam γ spectroscopy at GALILEO array

Dmitry Testov

San Servolo, 29 June 2016

Fusion-evaporation reactions





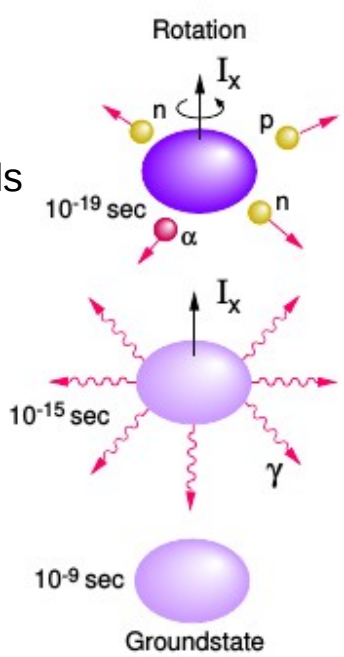
Ancillary detector for light charged particle

- Particle discrimination
- Hight detection efficiency
Discrimination between channels
- High Granularity
(correction for Doppler effects)

$$E'_\gamma = E_\gamma \frac{\sqrt{1-\beta^2}}{1-\beta\cos\theta} \approx E_\gamma(1+\beta\cos\theta)$$

$$|\Delta E_\gamma| \approx \left|2\Delta\theta \frac{\partial E'_\gamma}{\partial\theta}\right| = 2\Delta\theta E_\gamma \beta\,|\sin\theta|$$

- Transparency for γ-rays



Philipp R. John ***The GALILEO Array at LNL and its first physics campaign*** 11h55 tomorrow

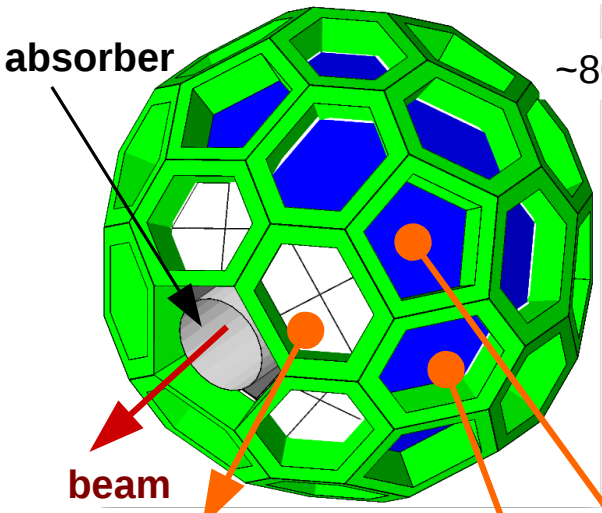
Euclides Si-ball light charged particle detector

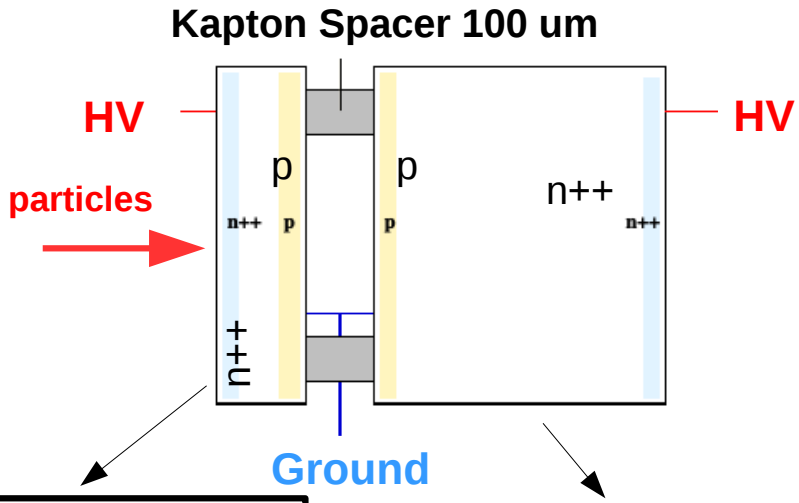
Self-supported structure
55 dE-E telescopes

$$\frac{dE}{dx} \propto \frac{mZ^2}{E}$$

Bethe-Bloch

~80% of 4π





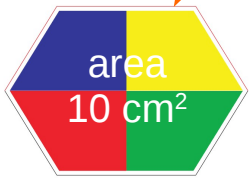
ΔE

Thickness: 150 µm
Bias :~40-50 V
Leakage Current: ~100 nA
Lab resolution: ~50 keV
Capacitance: 850pF

E

Thickness: 1000 µm
Bias :~140-180 V
Leakage Current: ~500 nA
Lab resolution: ~25 keV
Capacitance: 130pF

HEXAGON

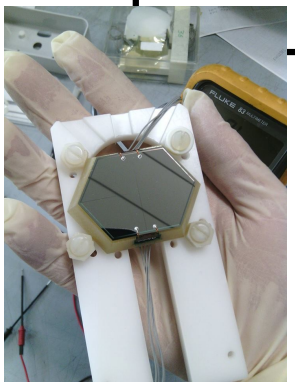


Segmented x5
v/c≈5%
- higher count rate
- correction for Doppler effects

single plate x15

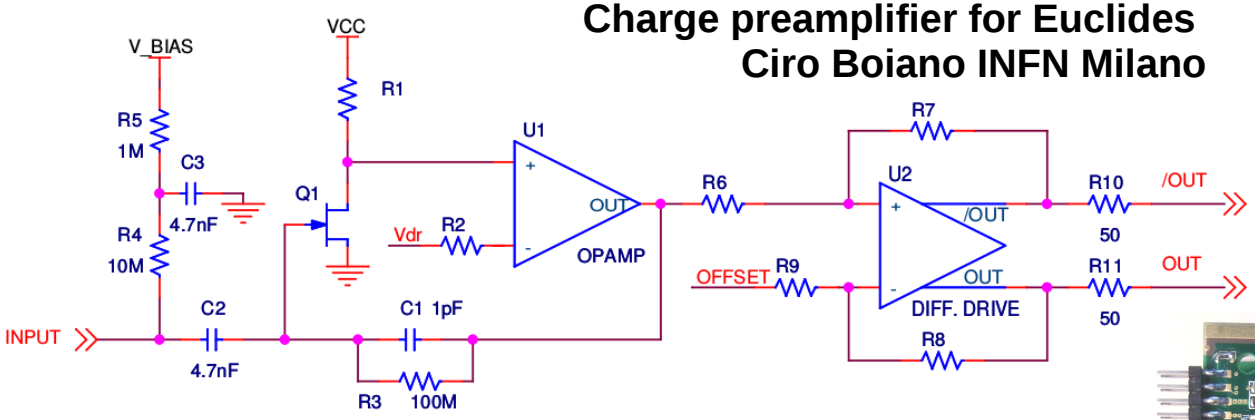
PENTAGON

single plate
x20

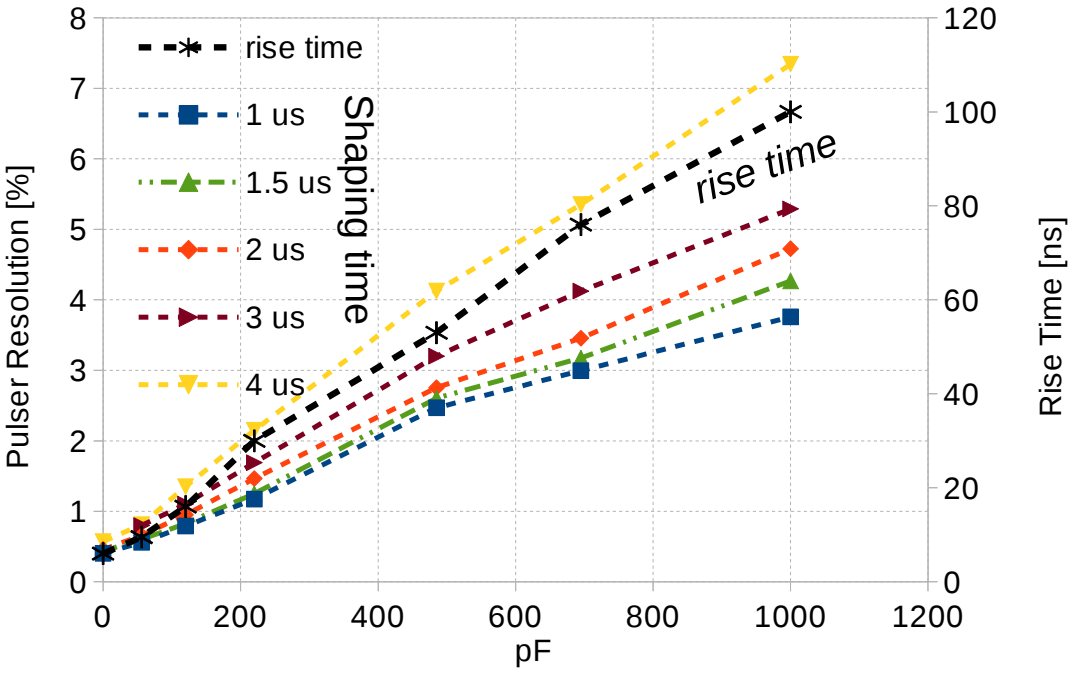


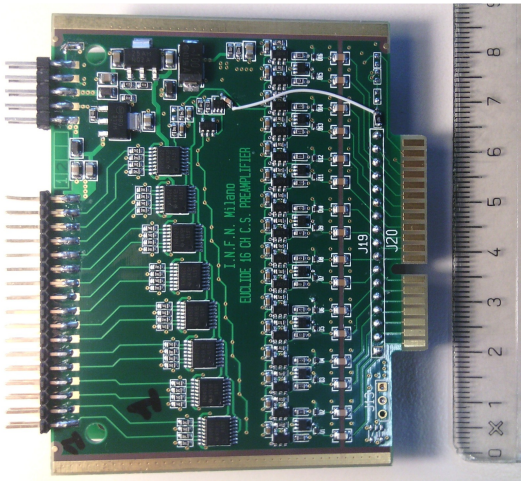
Charge Sensitive preamplifier

Charge preamplifier for Euclides
Ciro Boiano INFN Milano



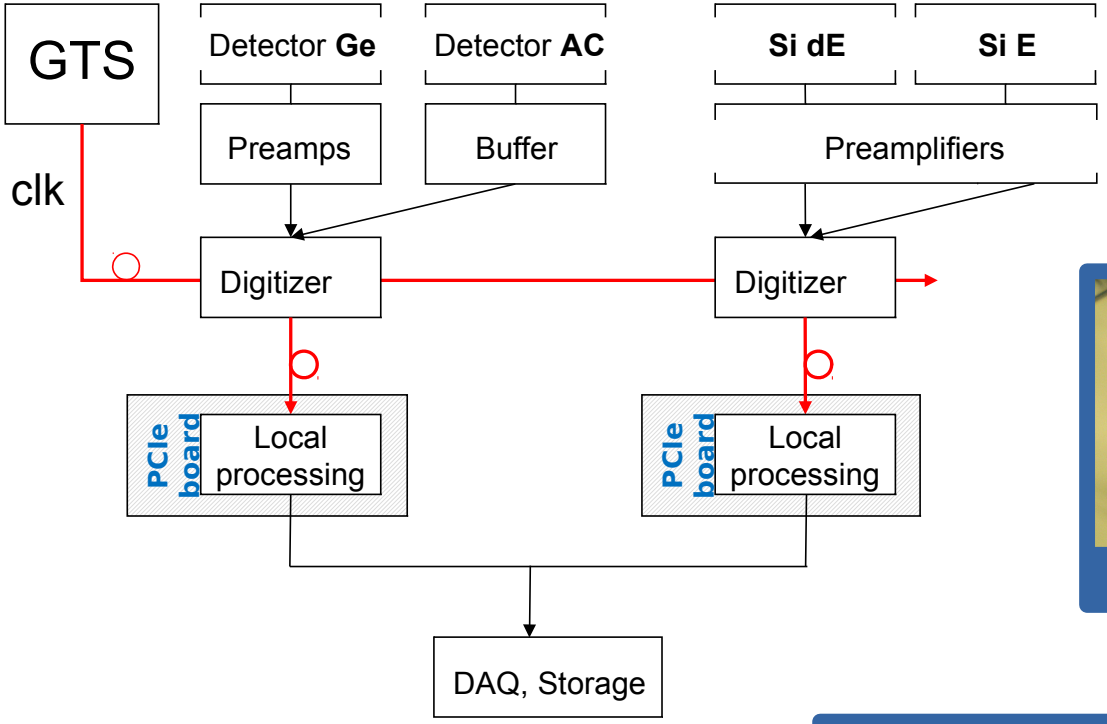
differential output



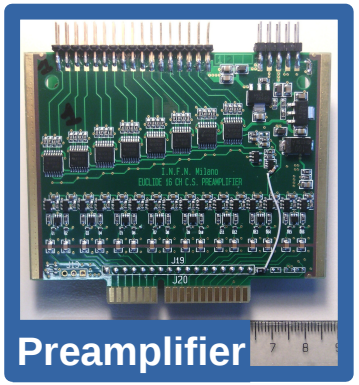


- → 16-channel preamplifier (8x dE det; 8xE det)
- → 112 channels total
- → rise time <50 ns
- → fall time <50 us
- → sensitivity 15mV/MeV
- → also for SPIDER (next talk of Marco Rocchini) and TRACE

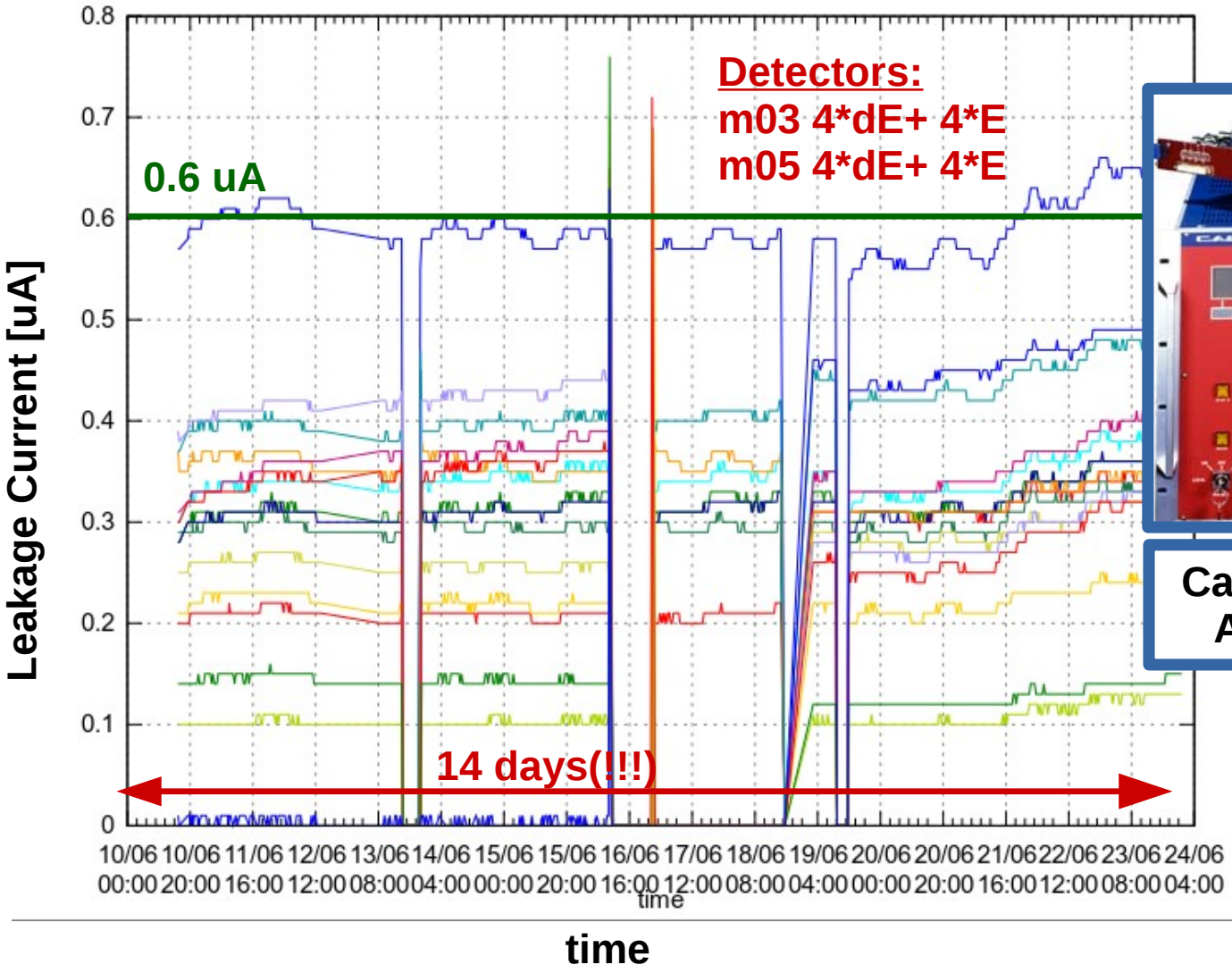
GALILEO digital electronics



- → **HPGe, AC, Ancillary digitized**
- → **Branches are sync by GTS**
- → **Trigger-less operation**
- → **240 channels available (<u>112 for EUCLIDES</u>)**
- → **Typical rate ~ 20 kHz/det**
- → **Max rate ~ 50 kHz/det**



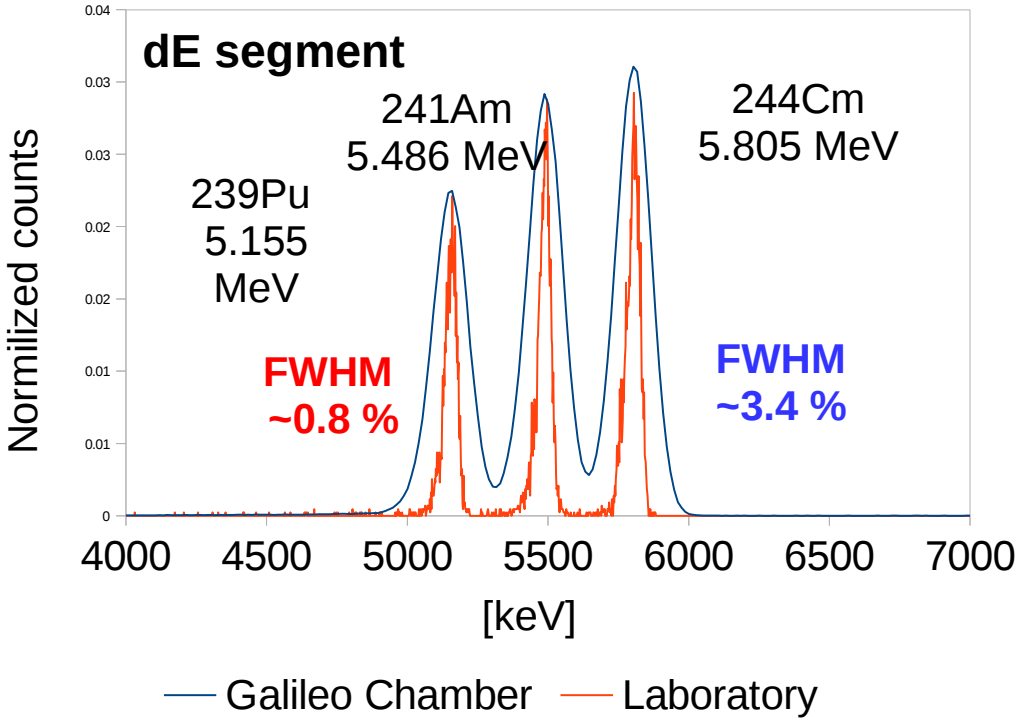
HV stability Real-Time Current Monitor

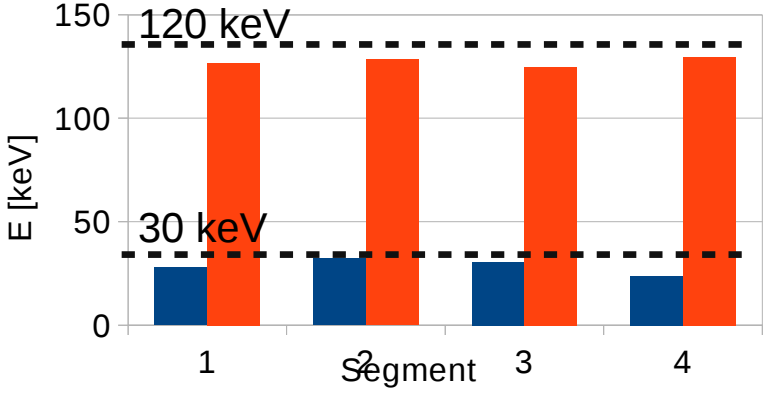


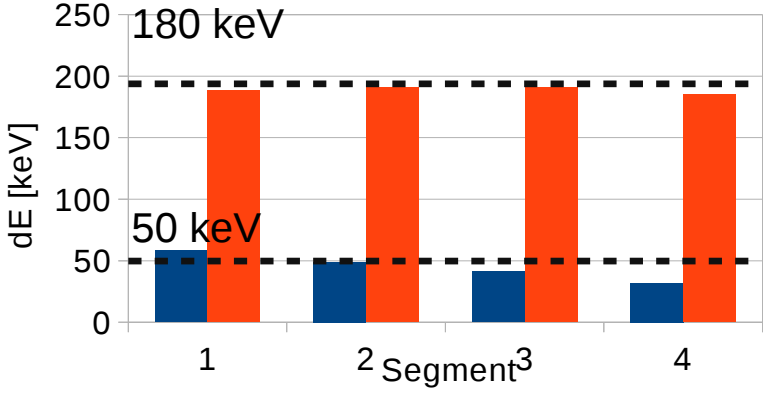
Caen SY527 rack
A519 modules

time

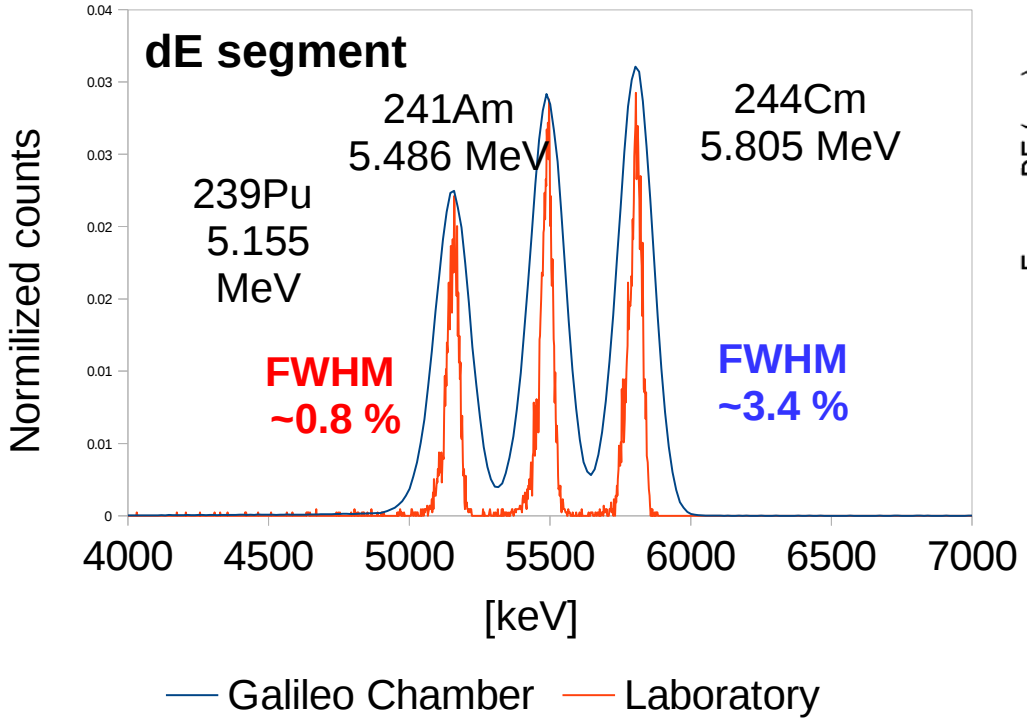
Resolution measurements, dE-E matrix

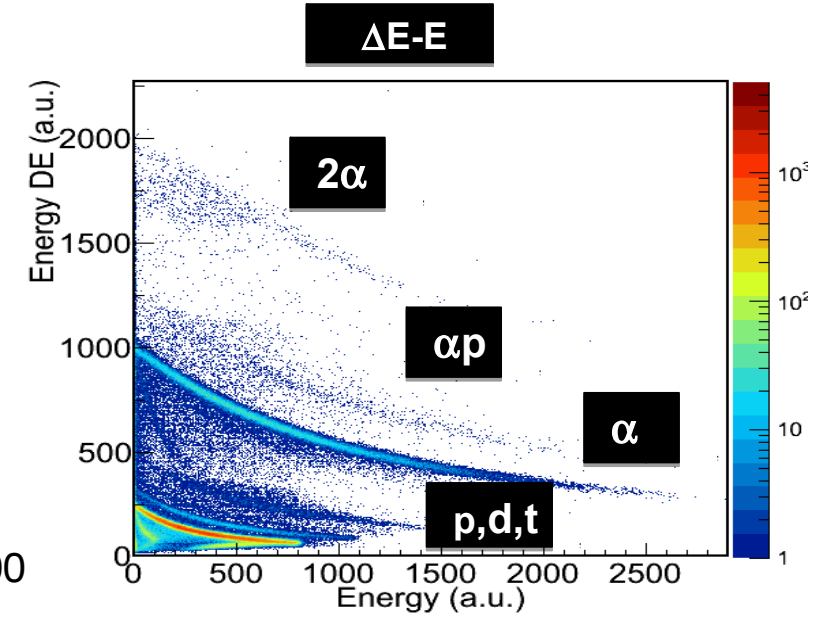


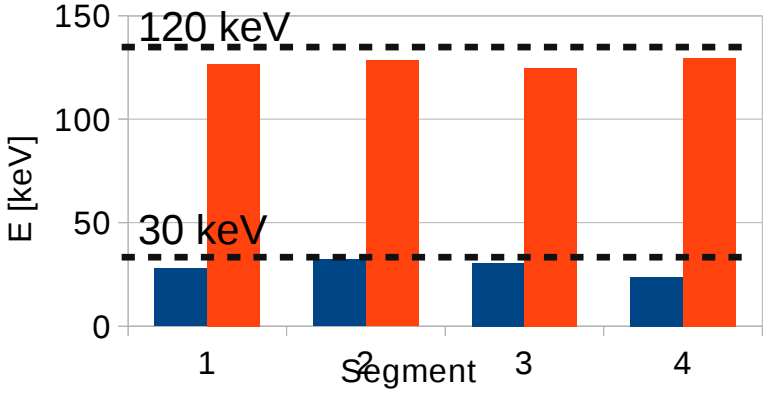


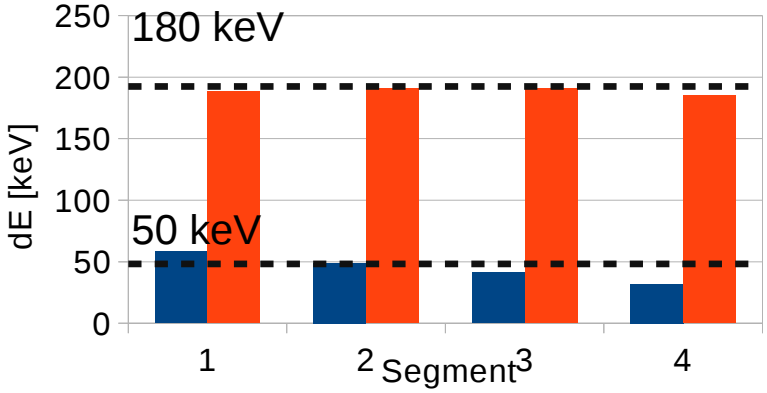


Resolution measurements, dE-E matrix









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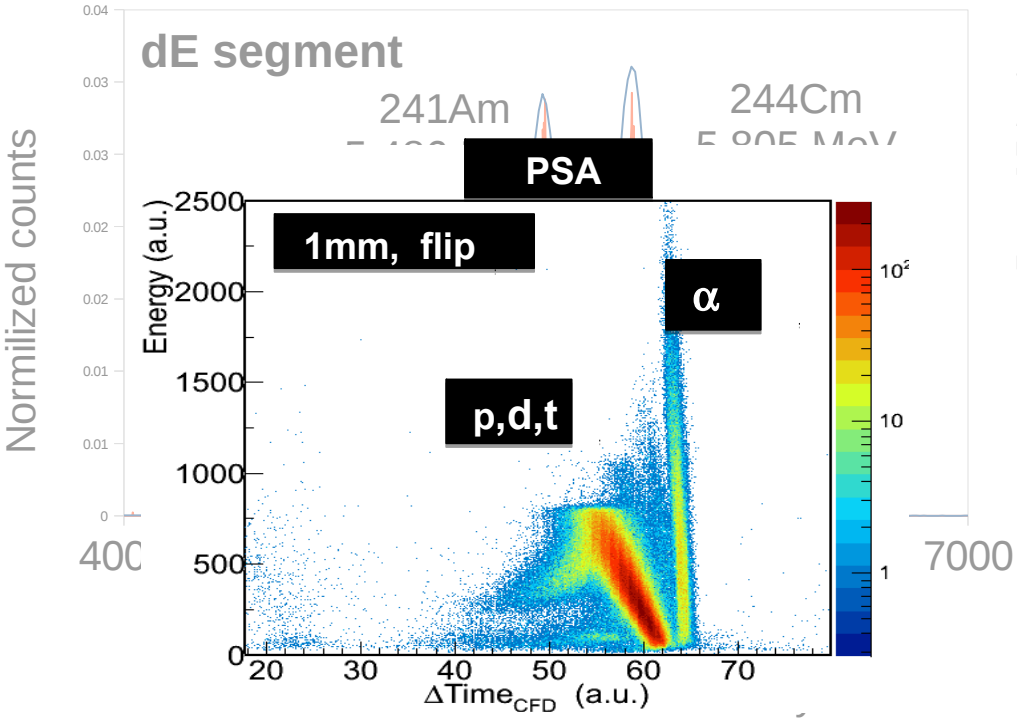
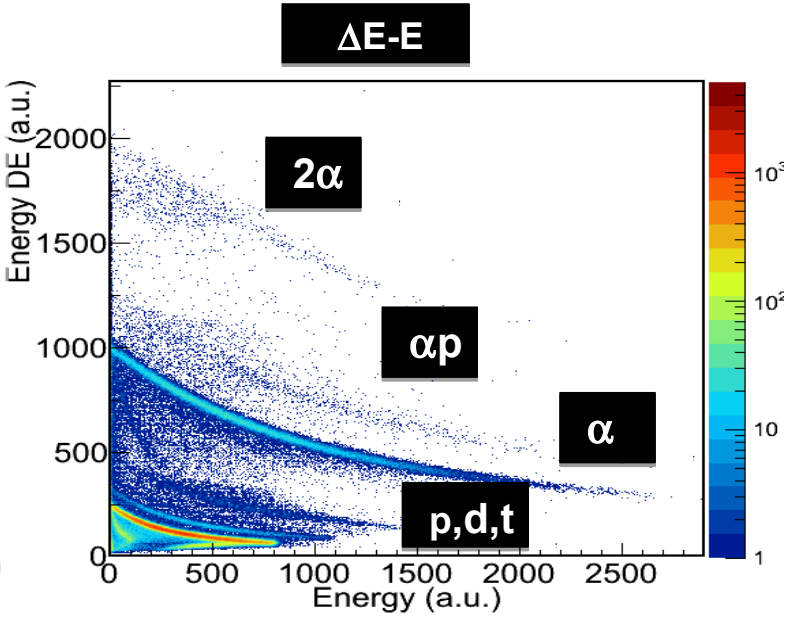
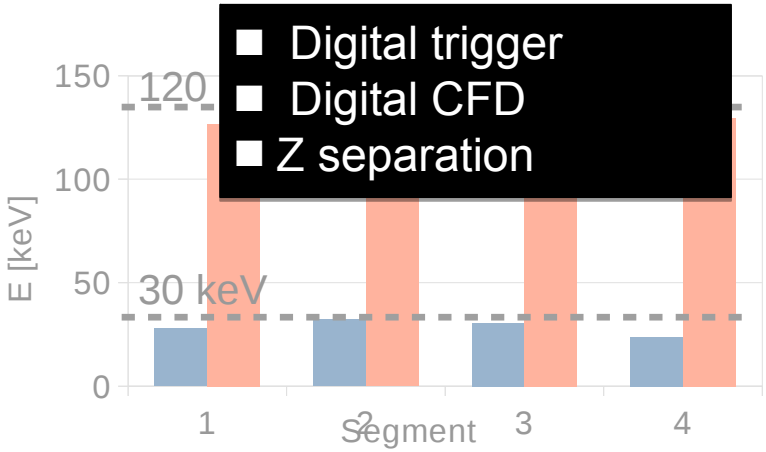
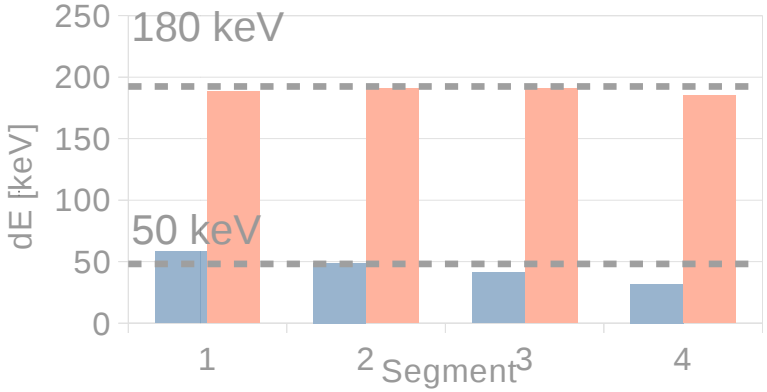
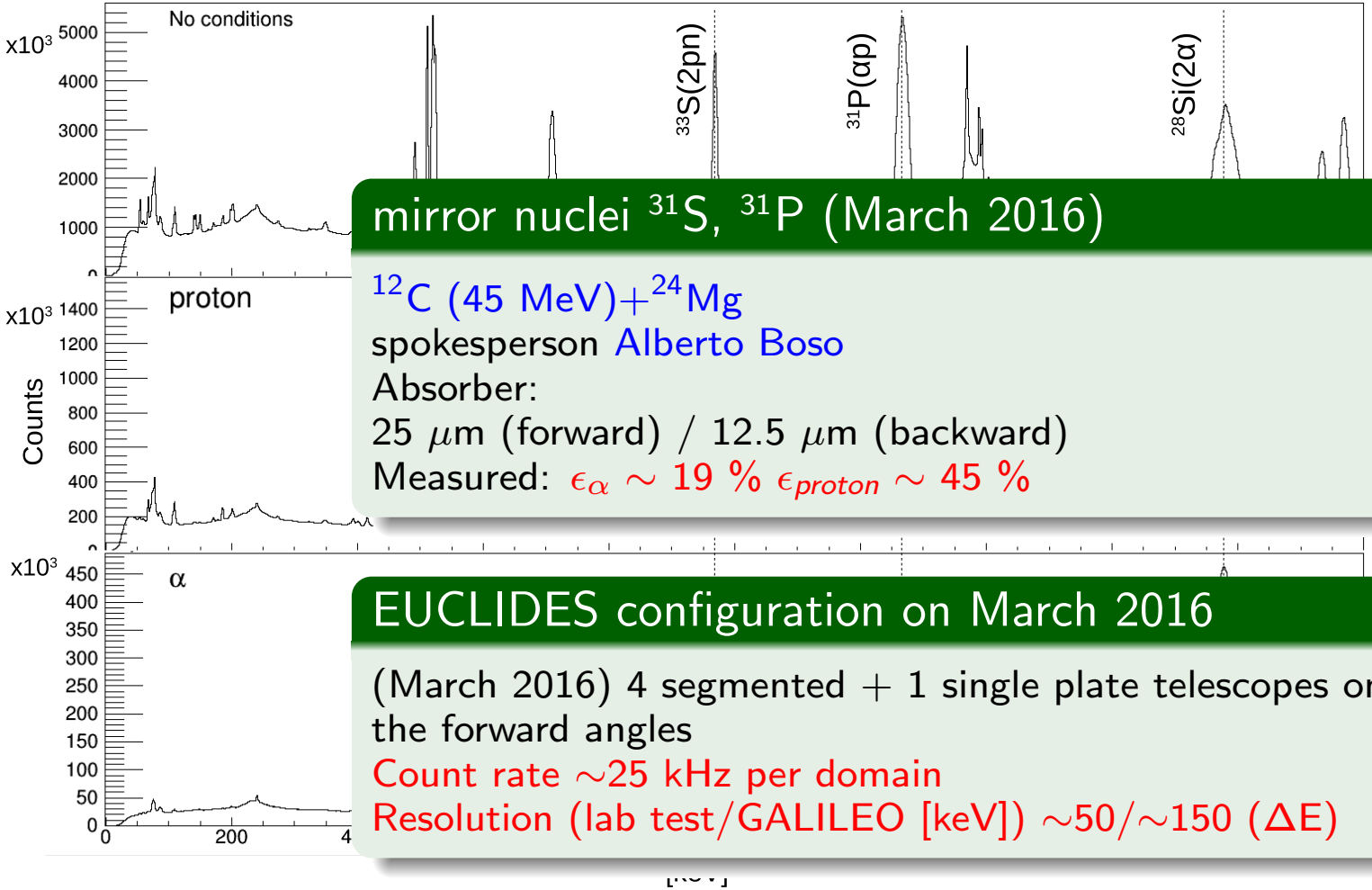








High spin states in mirror nuclei ^{31}S and ^{31}P



mirror nuclei ^{31}S, ^{31}P (March 2016)

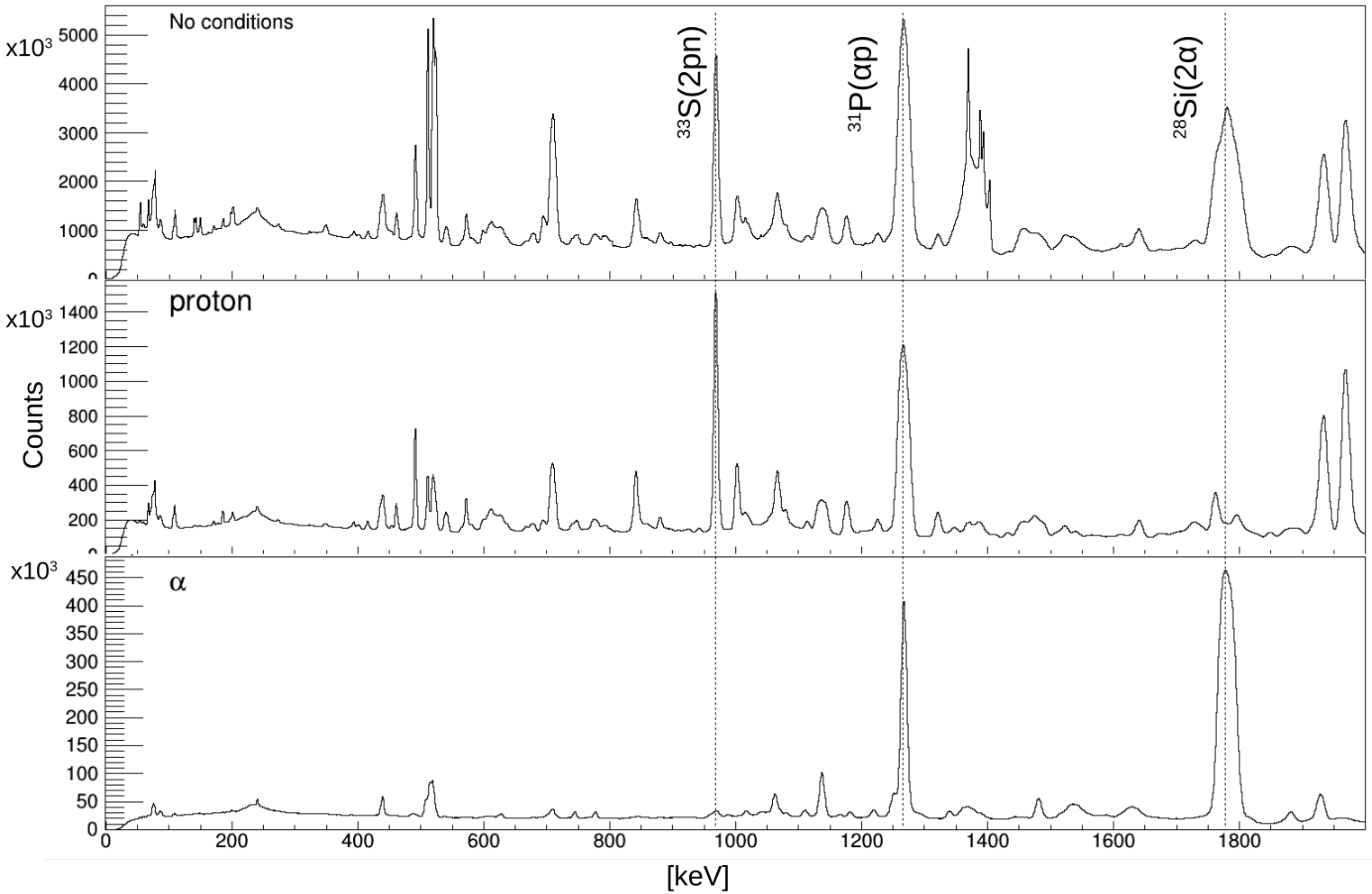
^{12}C (45 MeV)+^{24}Mg
spokesperson Alberto Boso
Absorber:
25 μm (forward) / 12.5 μm (backward)
Measured: $\epsilon_\alpha \sim 19$ % $\epsilon_{proton} \sim 45$ %

EUCLIDES configuration on March 2016

(March 2016) 4 segmented + 1 single plate telescopes on the forward angles
Count rate ∼25 kHz per domain
Resolution (lab test/GALILEO [keV]) ∼50/∼150 (ΔE)

Partial γ-spectra measured with the GALILEO γ-spectrometer in coincidence with EUCLIDES for the reaction ^{12}C (45 MeV)+^{24}Mg. α and proton conditions on the detected particles were requested

High spin states in mirror nuclei ^{31}S and ^{31}P



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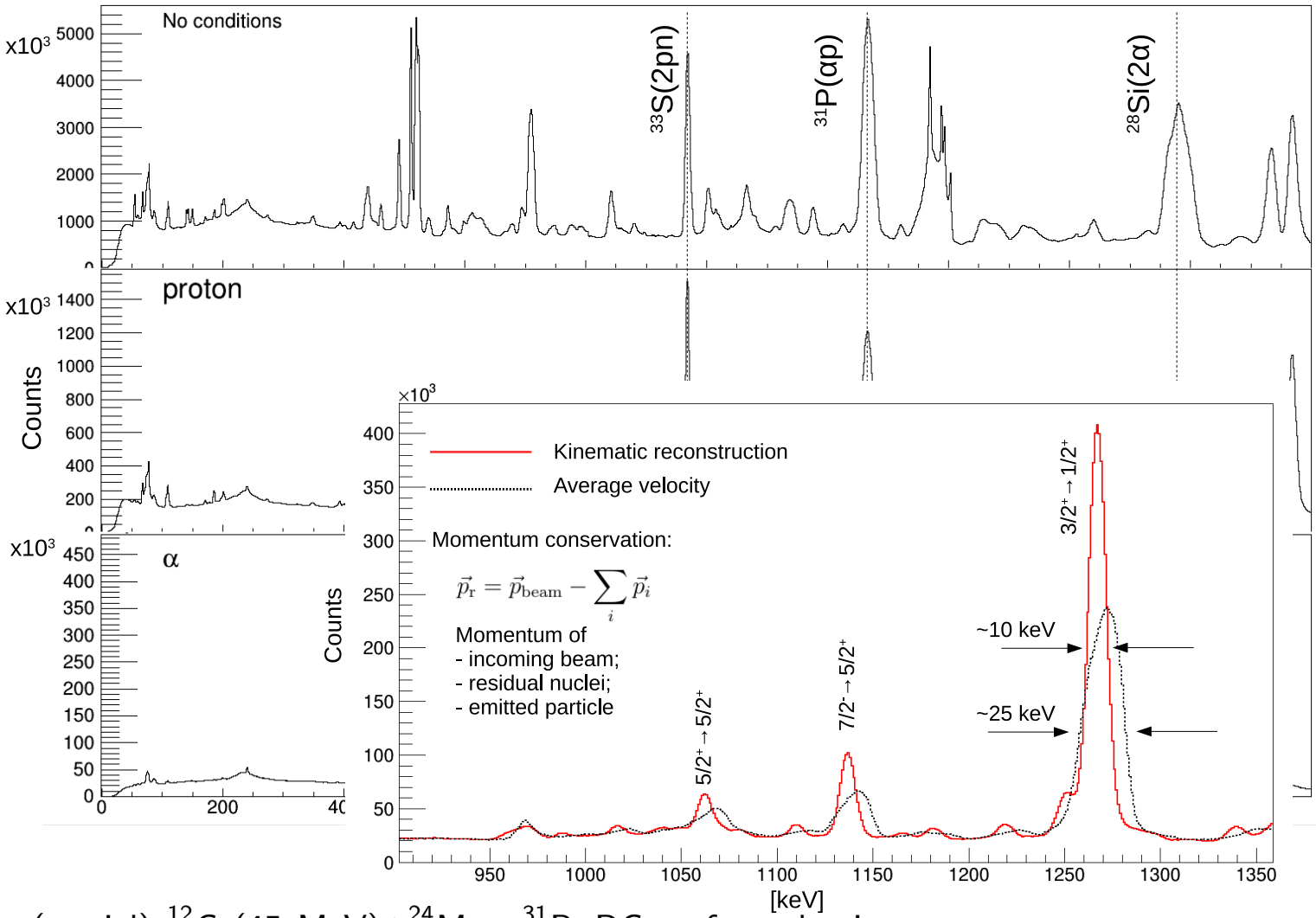
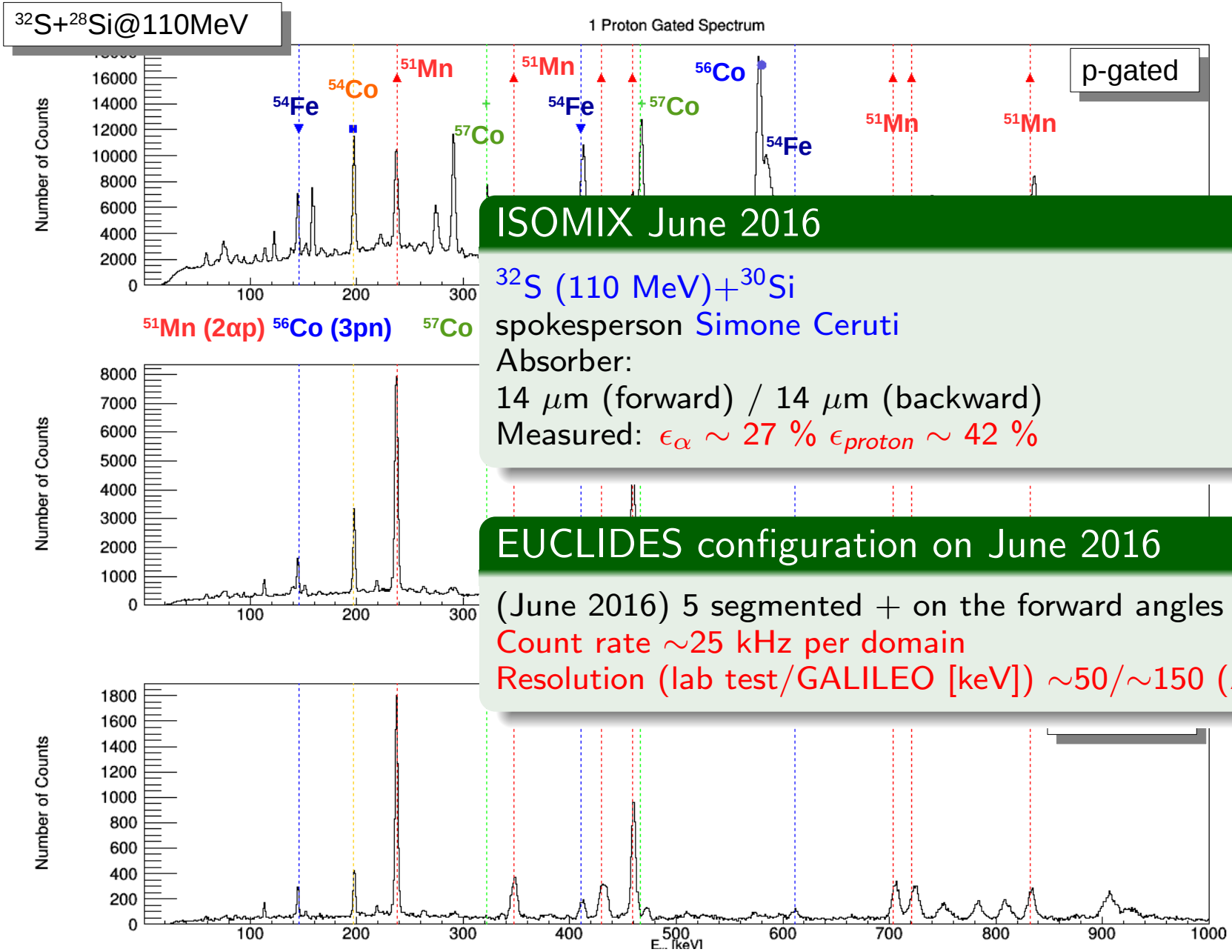


α-gated spectra (partial) ^{12}C (45 MeV)+^{24}Mg→^{31}P. DC performed using an average velocity value vs DC using velocity deduced on an event-by-event basis through the detected charged particles.

Study of the isospin symmetry in ^{60}Zn



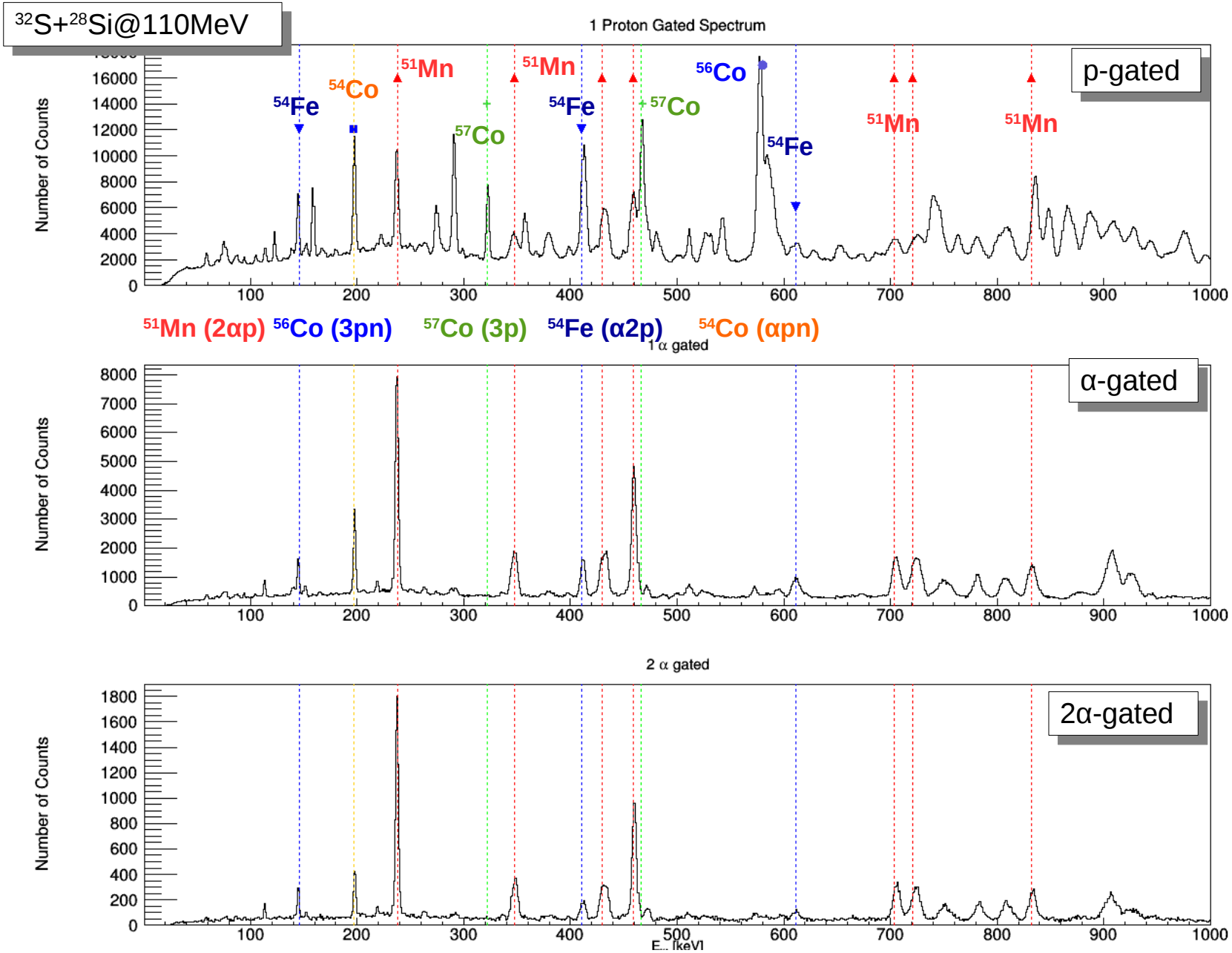
ISOMIX June 2016

^{32}S (110 MeV)+^{30}Si
spokesperson Simone Ceruti
Absorber:
14 μm (forward) / 14 μm (backward)
Measured: $\epsilon_\alpha \sim 27$ % $\epsilon_{proton} \sim 42$ %

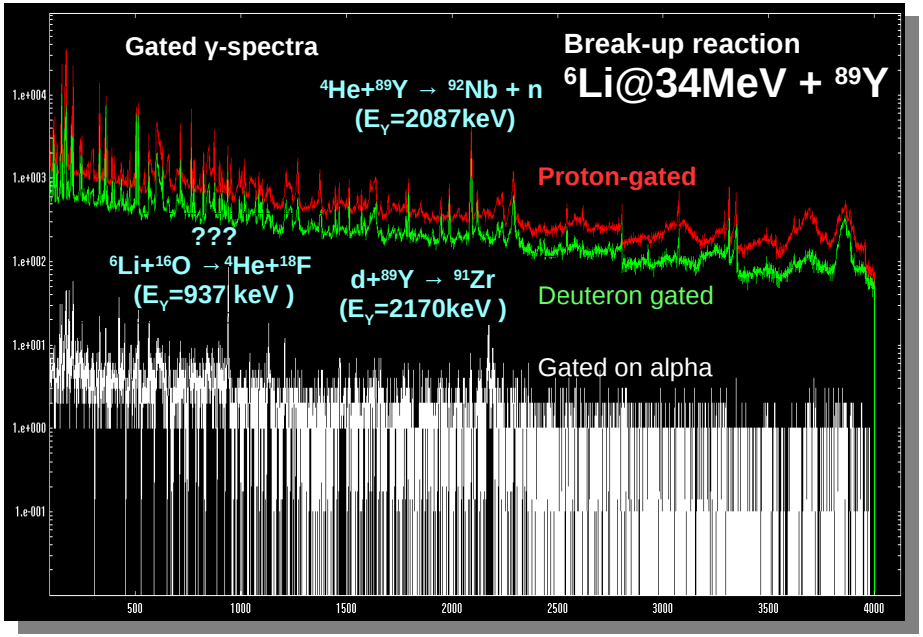
EUCLIDES configuration on June 2016

(June 2016) 5 segmented + on the forward angles
Count rate ~25 kHz per domain
Resolution (lab test/GALILEO [keV]) ~50/~150 (ΔE)

Study of the isospin symmetry in ^{60}Zn



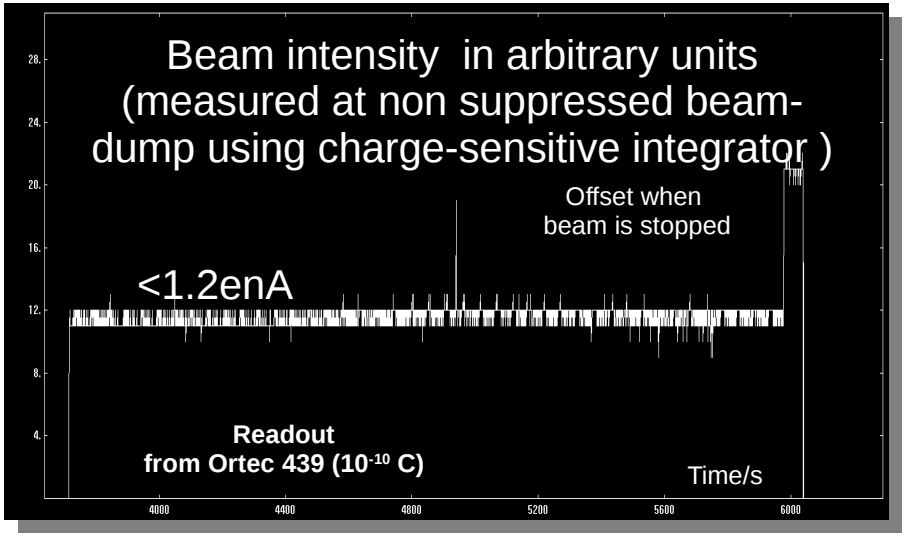
Breakup of weakly bound nucleus 6Li on 89Y

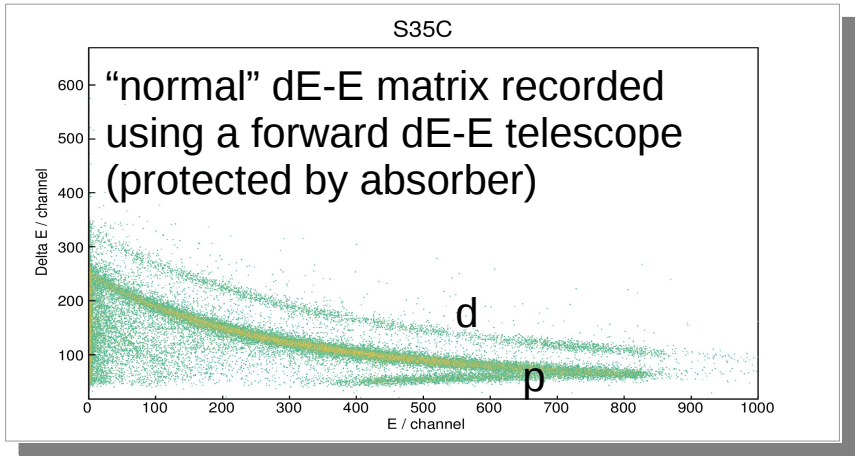


Spokesperson: **Gaolong Zhang. Guangxin Zhang, Shipeng Hu**

(June 2016)

Completed, incomplete fusion or breakup channel can be determined by gamma-particle or particle-particle coincidence.





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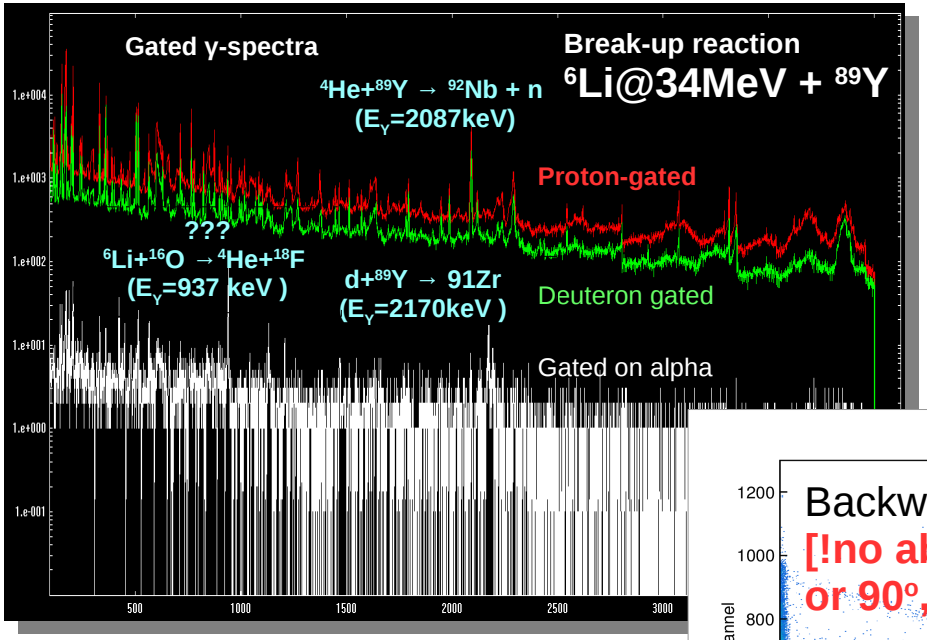

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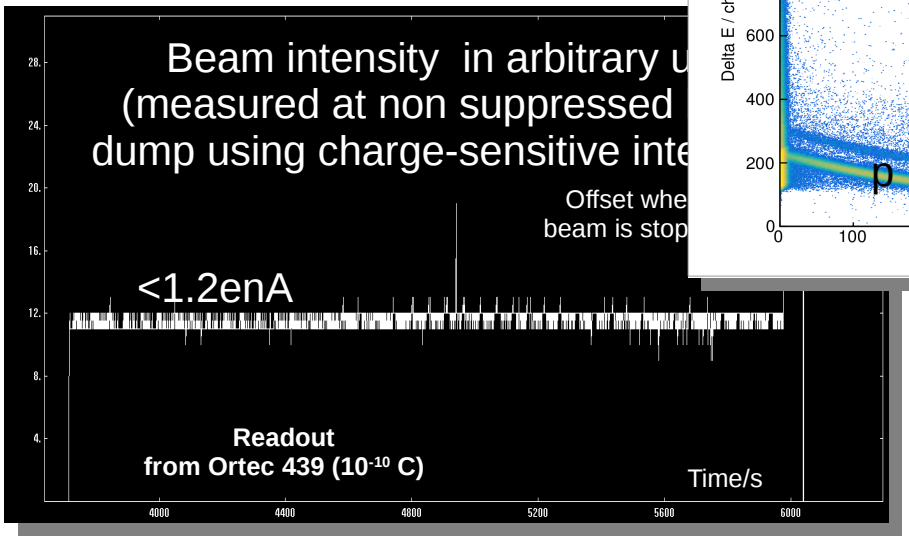
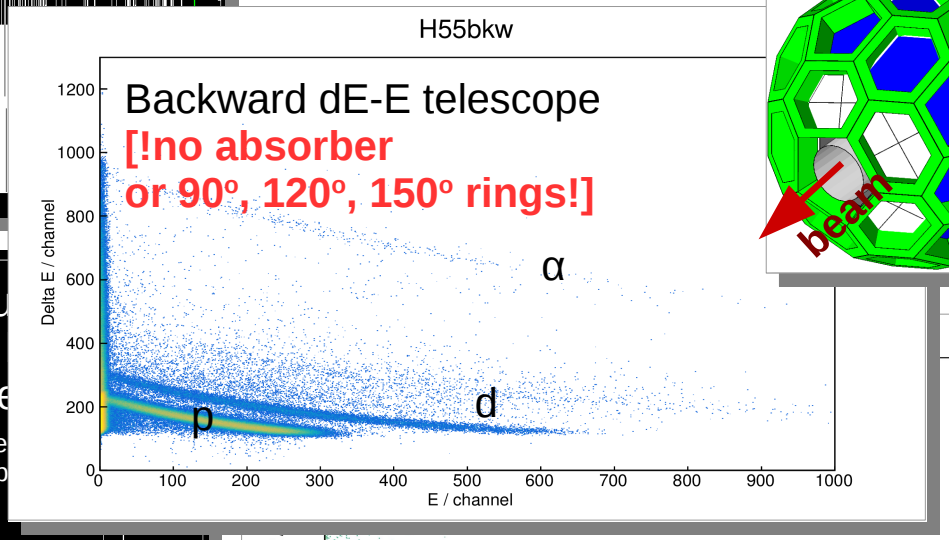
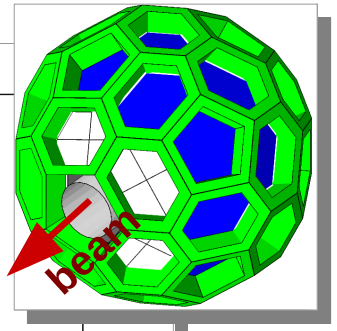
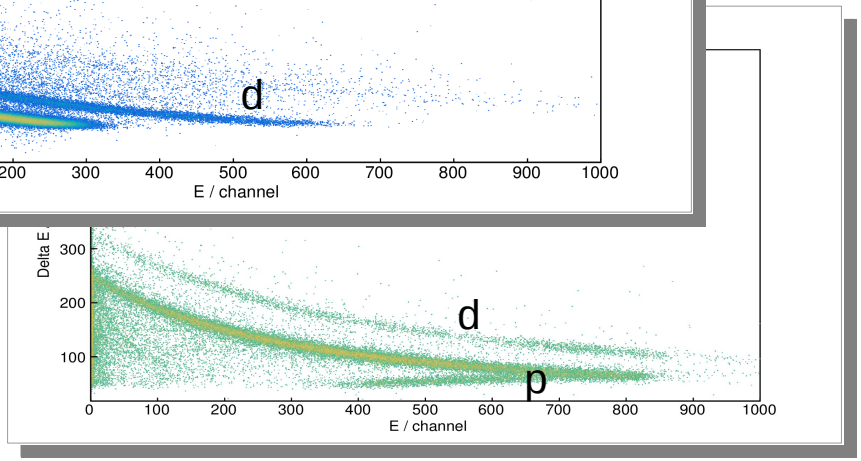


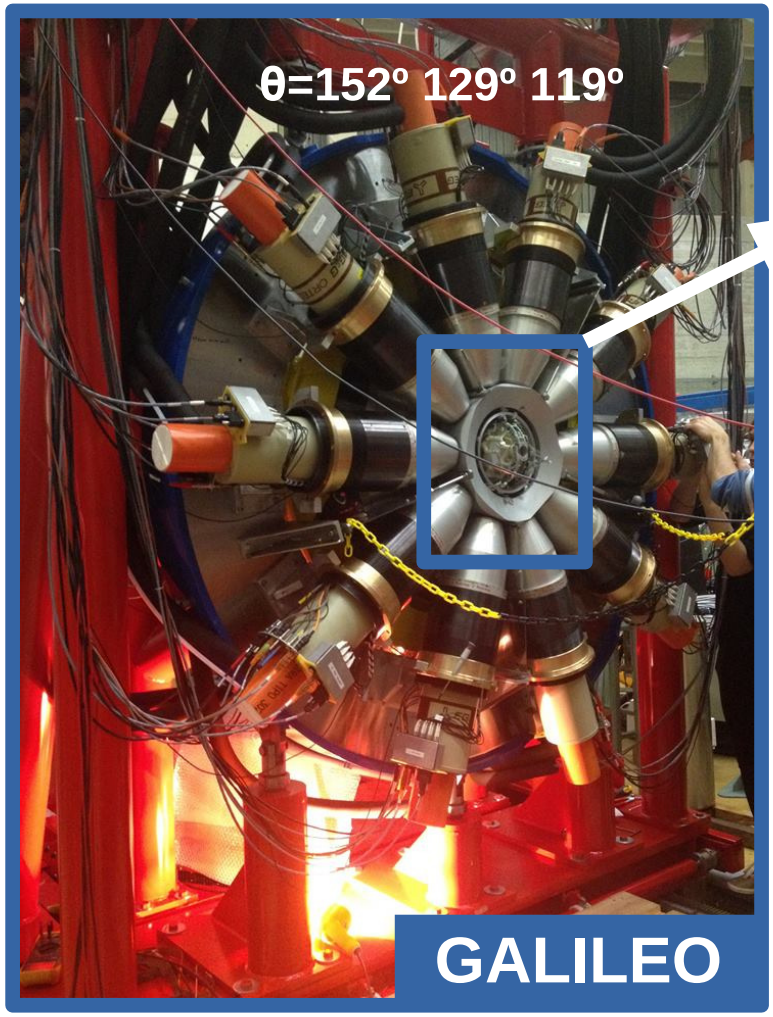


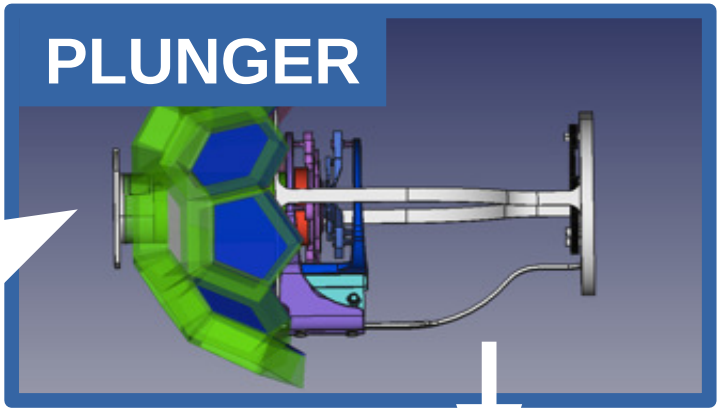


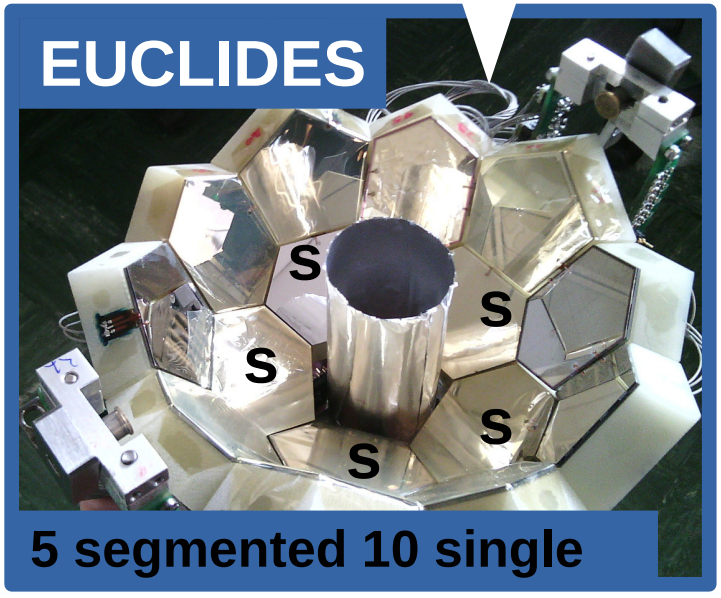


SOON: Plunger coincidence method

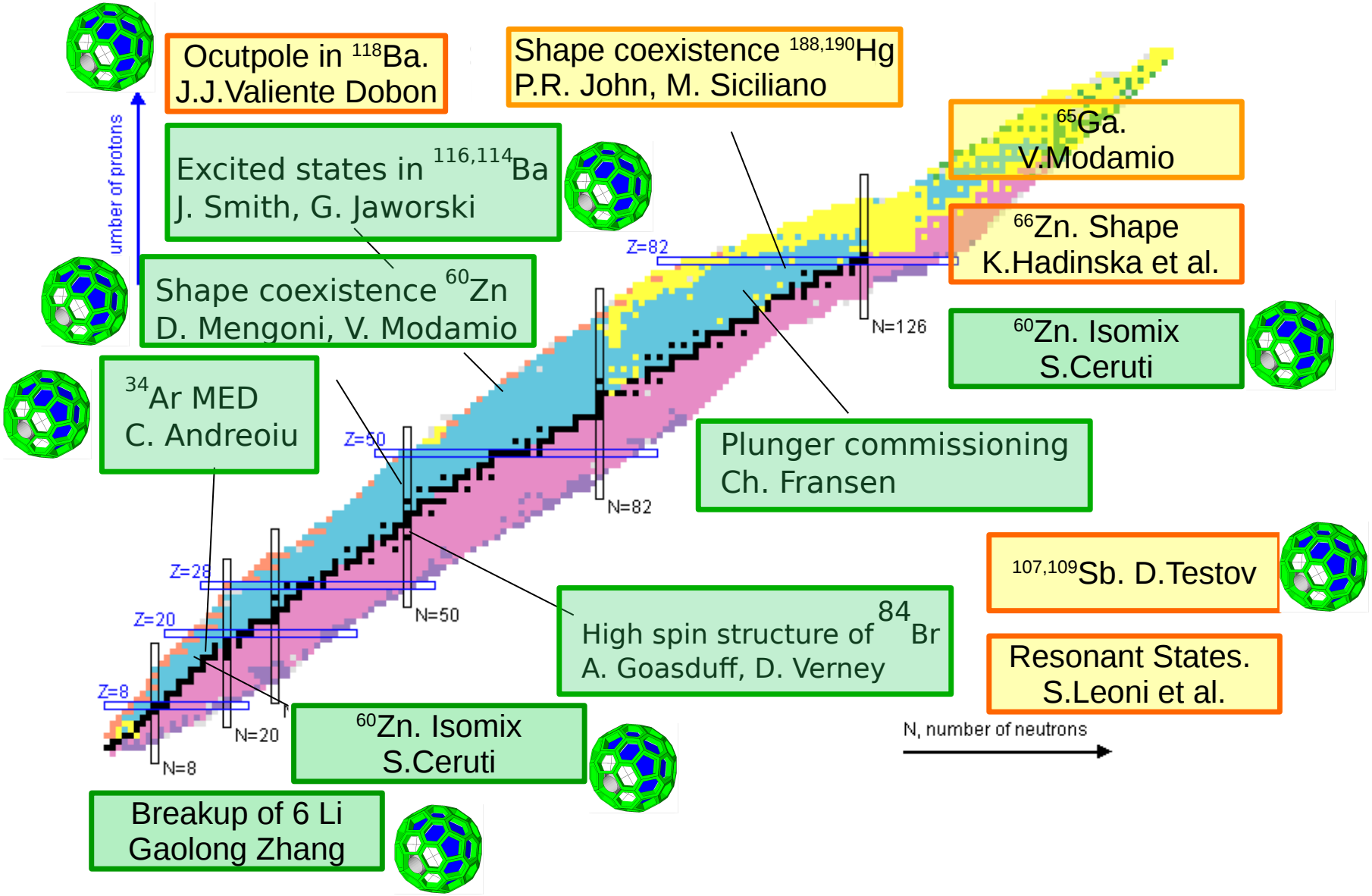
D.Testov (approved at LNL) The nature of the lower-lying $9/2^+$ states of ^{107,109}Sb by lifetime measurements.







Euclides in the Science Campaign: 2015-16



Collaboration

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Thank you! Enjoy NUSPIN-2006 in Venice!