MAGNEX-EDEN

Working group in Catania

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Working group in Orsay

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1. EDEN
2. SPEG
3. Decay and Break-up…
4. MAGNEX
5. New electronics for EDEN
6. Future and already present experiments…

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EDEN

EDEN : a neutron time-of-flight multidetector
for decay studies of giant states, H. Laurent et al. NIM A326 (**1993**) 517

EDEN, a neutron time-of-flight multidetector, has been constructed by the IPN (Orsay, France) and KVI (Groningen, The Netherlands) for the study of the decay of giant states.

The system is made of 40 individual detectors.
Neutrons are detected using a liquid scintillator which allows neutron gamma-ray pulse shape discrimination.

The scintillator cells are 5 cm thick and have a diameter of 20 cm. The energy resolution, for the adopted length of the flight path of 1.75 m, is 60 keV, 500 keV and 900 keV for 1 MeV, 6 MeV and 10 MeV neutron energies, respectively. The overall solid angle is 3.3% of 4π for this flight path. The overall efficiency for 6 MeV neutrons is 1%.

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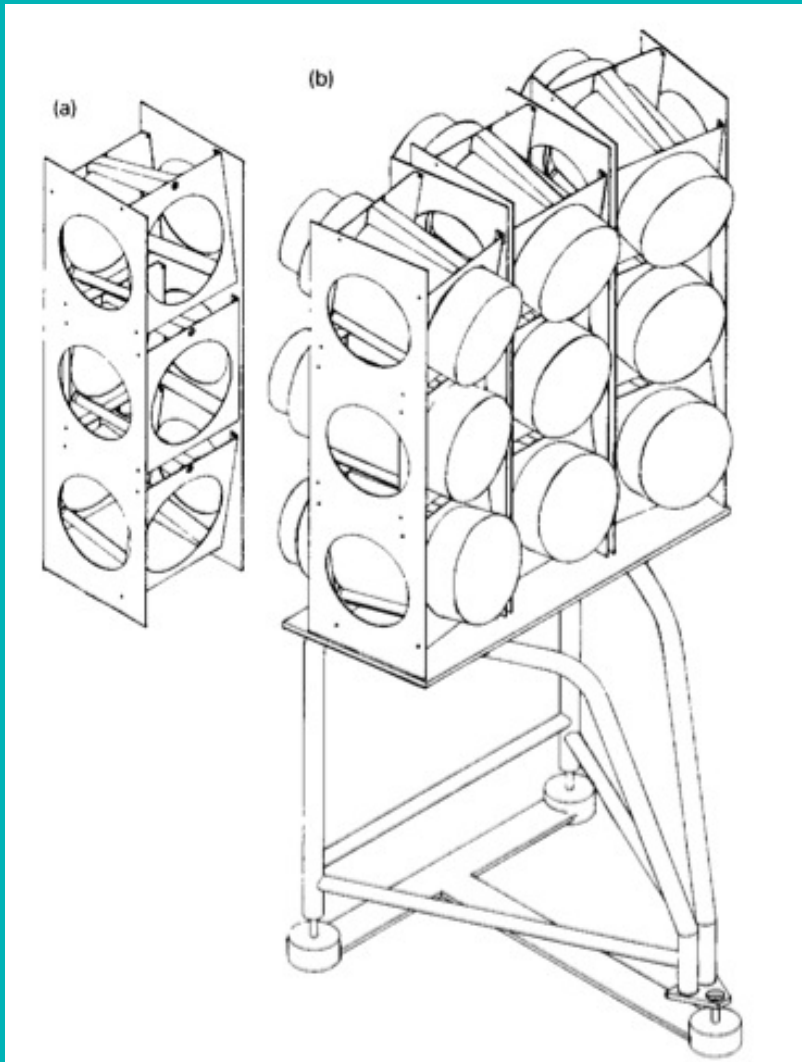


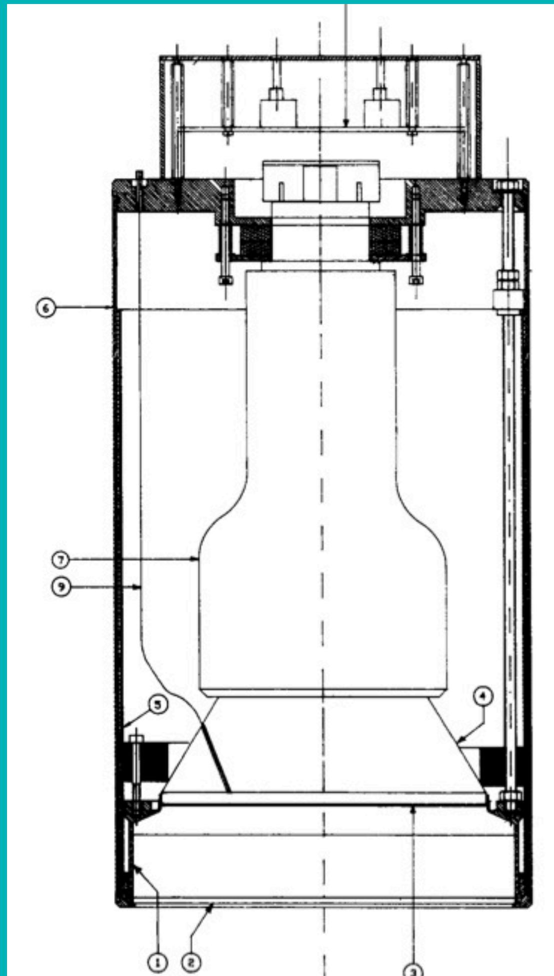
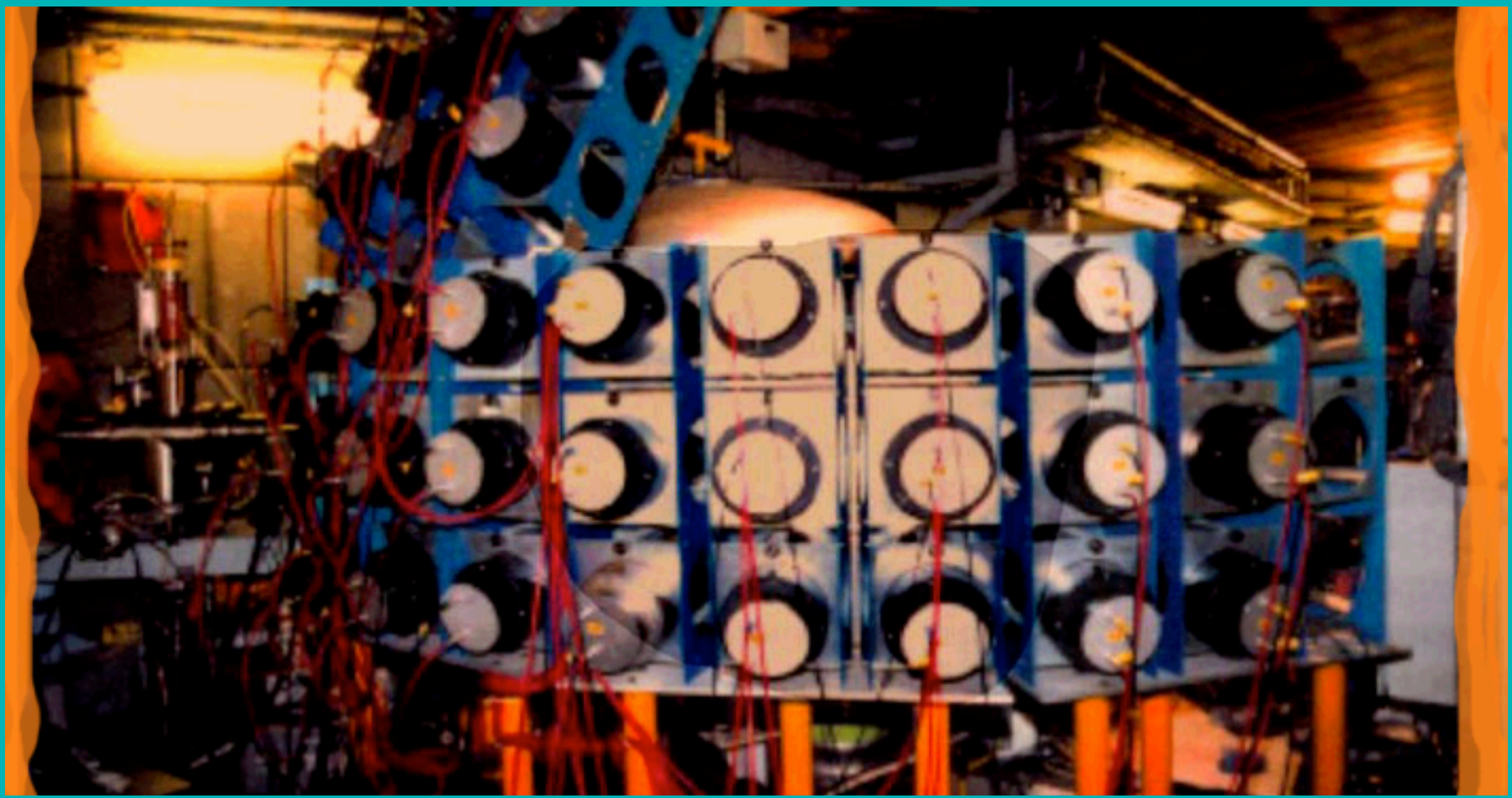


Fig. 2. An EDEN detector. (1) Scintillator cell. (2) Deformable face. (3) Glass window. (4) Light pipe. (5) μ-metal shielding. (6) Soft-iron shielding. (7) 5 in. Photomultiplier. (8) Socket. (9) Optical fiber.

EDEN around the SPEG chamber



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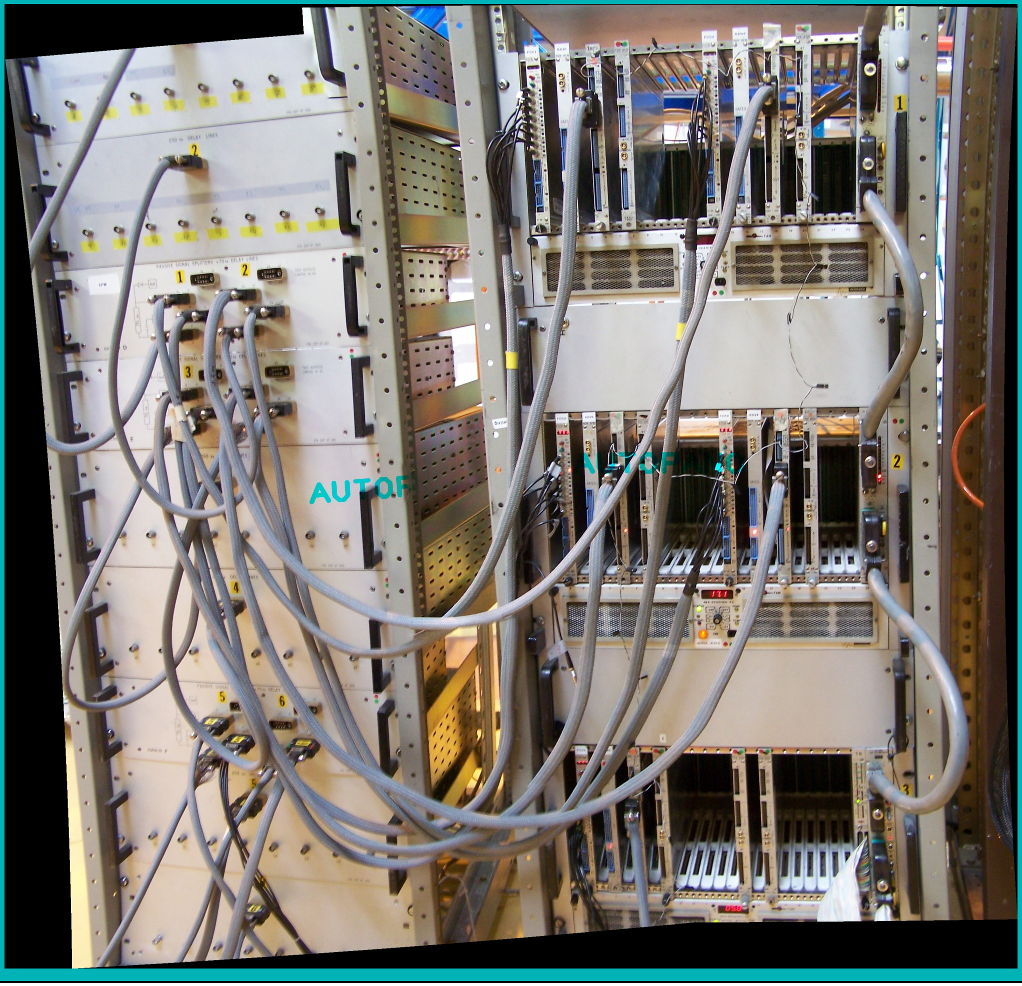
Original Electronics

Passive splitters

3 Camac crates → 2CFD + 2 Gate generators + 2 TDCs + 2 ADCs (16 channels)



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Neutron-gamma discrimination

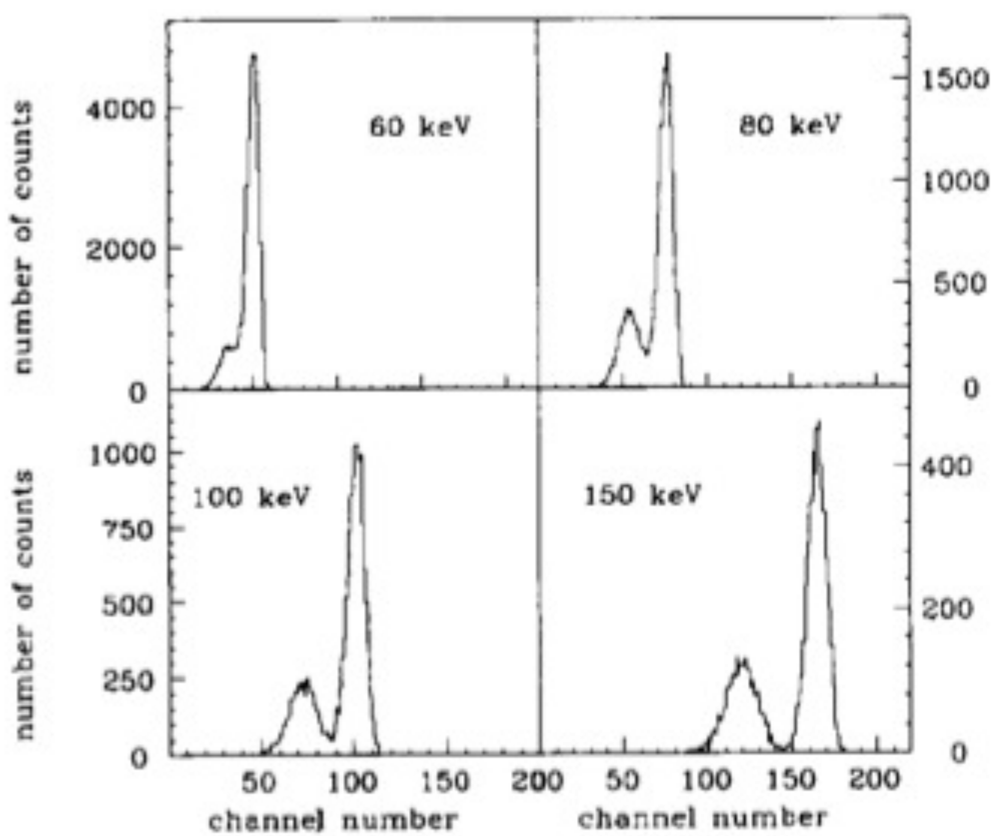
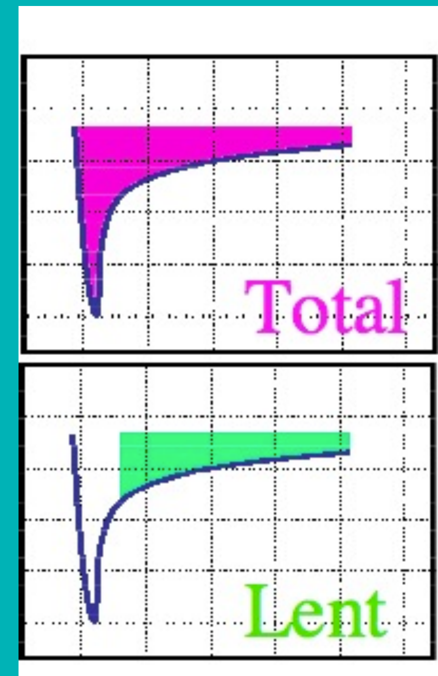
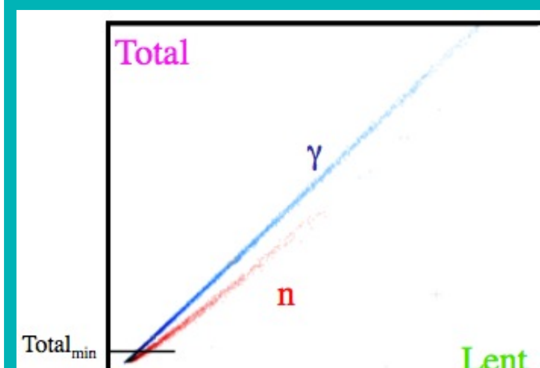


Fig. 5. Neutron–gamma-ray pulse shape dicrimination. Cuts in the (total charge)×(fast component) two-dimensional spectrum. The energies labelled on the spectra are the electron-equivalent energies corresponding to the cut.





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Time of Flight measurement

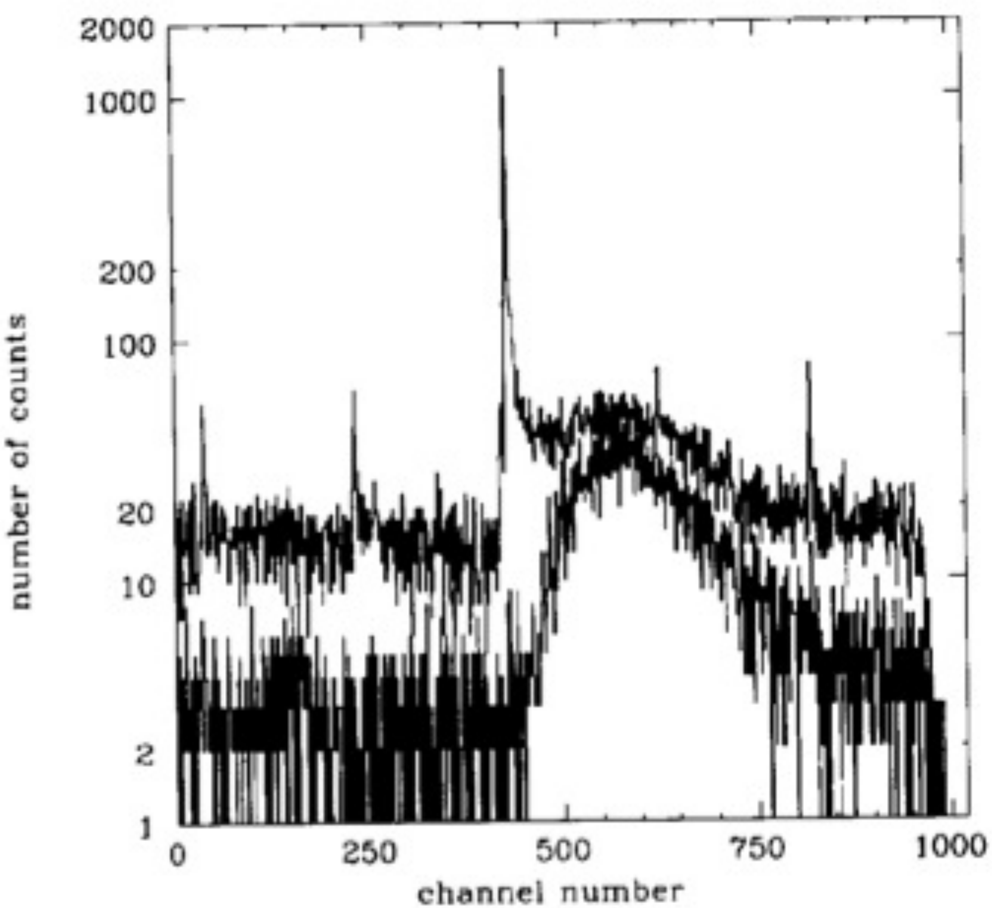
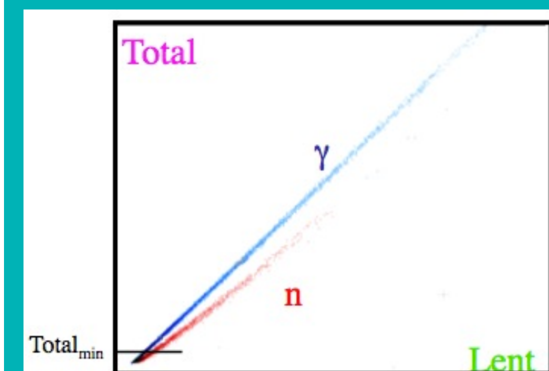


Fig. 7. Time-of-flight spectra. Upper spectrum: n + γ time-of-flight spectrum. Lower spectrum: time-of-flight gated on neutrons. Electron-equivalent energy threshold: 60 keV.



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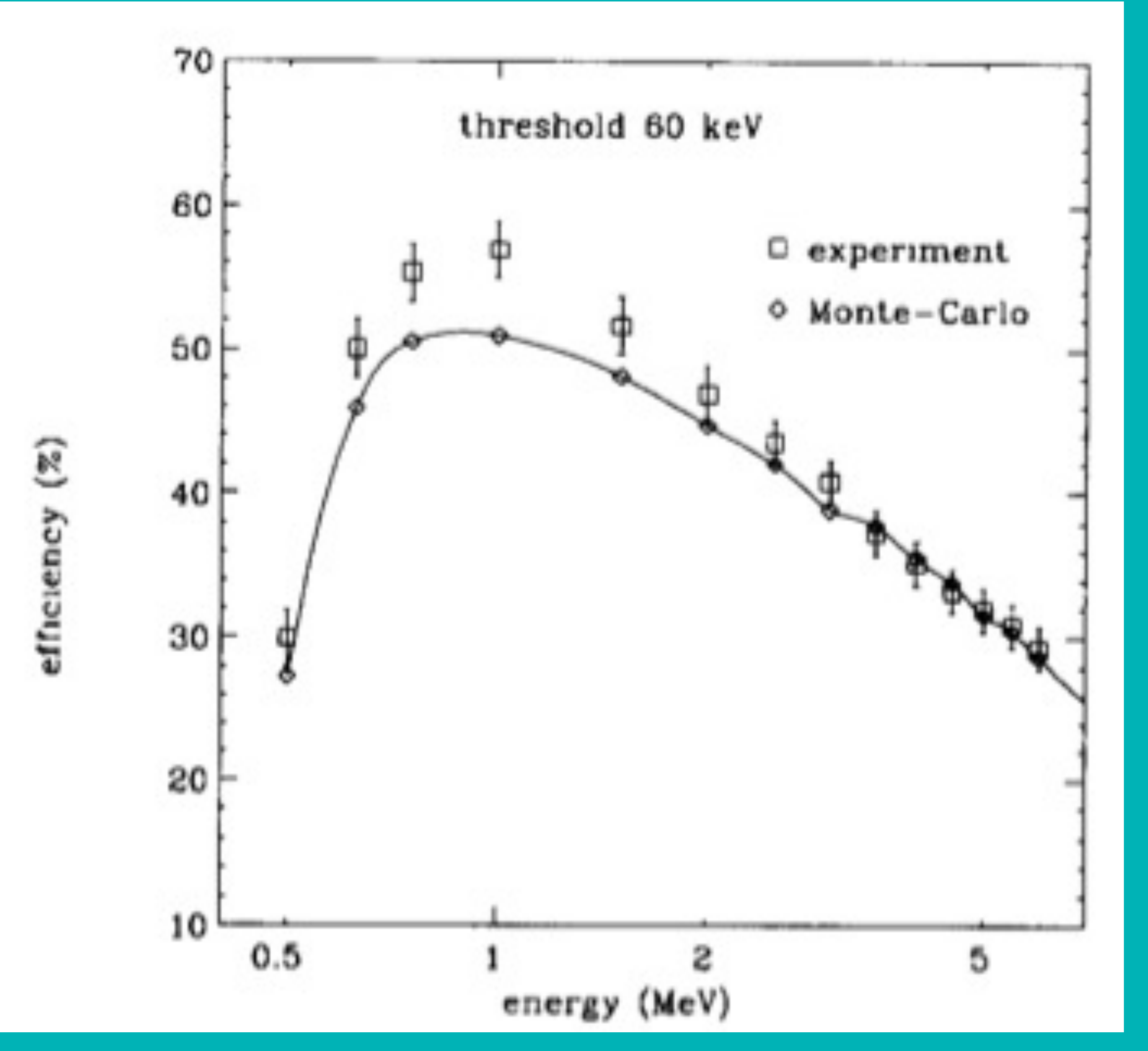
Efficiency



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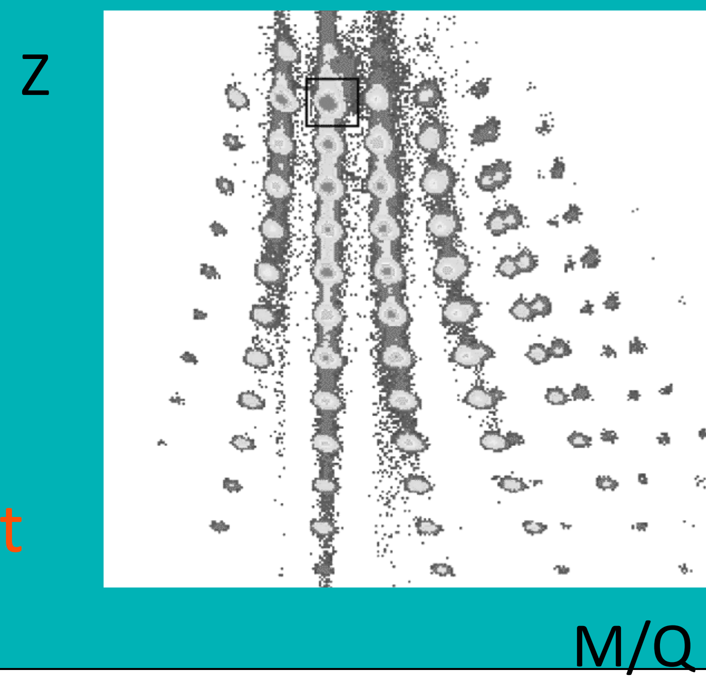
SPEG Detection

The SPEG Spectrometer
and its Detection System

Identification Plot



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What we Measured

SPEG : X_1, Y_1, X_2, Y_2 ΔE, T → Xfoc, θ, φ Z, M/Q

$\Delta E/E = 2 \cdot 10^{-4}$ $\Delta\theta = 0.2°$

EDEN : E_{tot}, E_{fast}, T → Identification Energy

$\Delta E =$ 60 keV at 1 MeV
500 keV at 6 MeV

Missing Energy

$$E_{miss} = E^* - E_n - E_{recoil} \quad (-Q)$$

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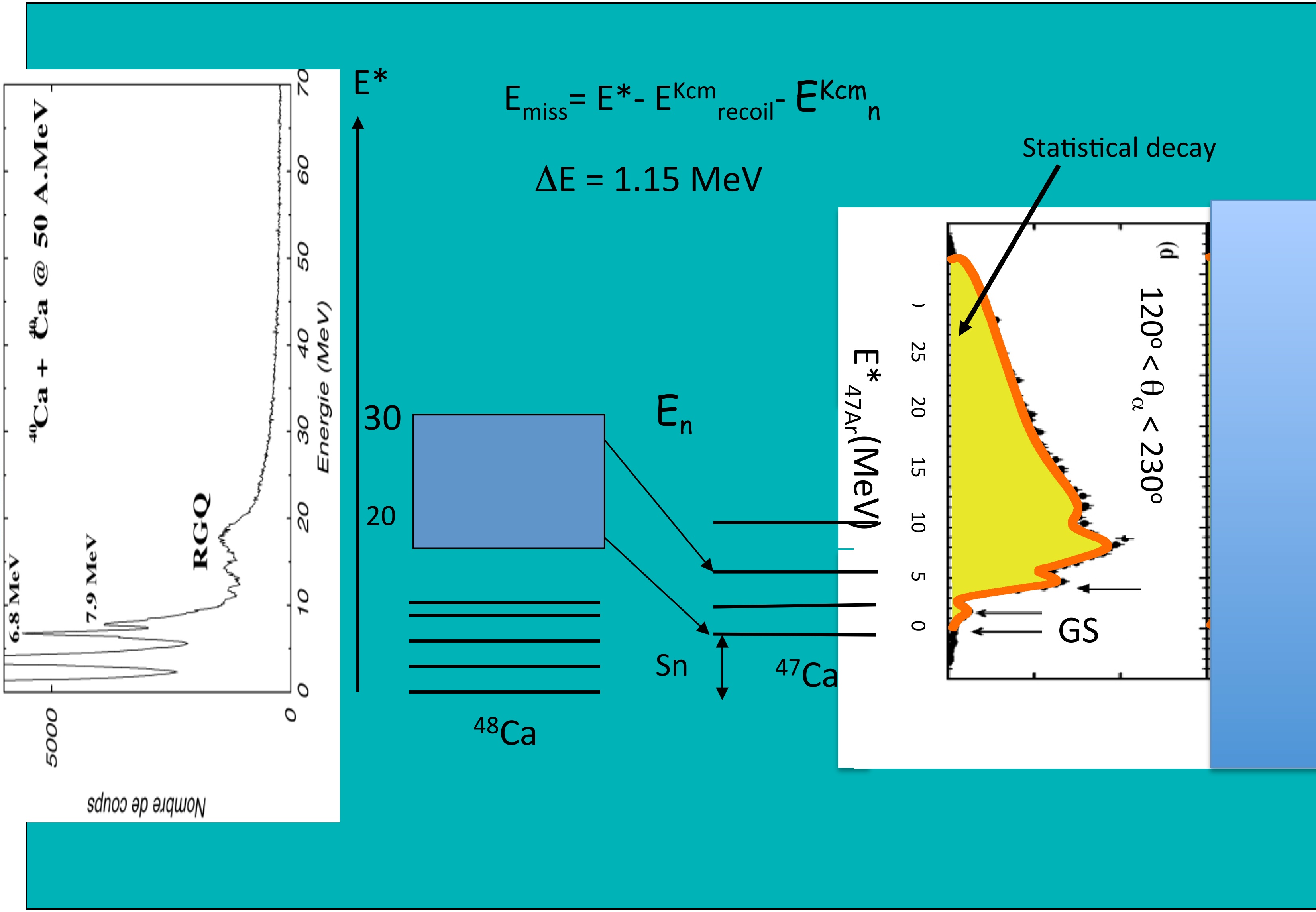
Missing energy spectra



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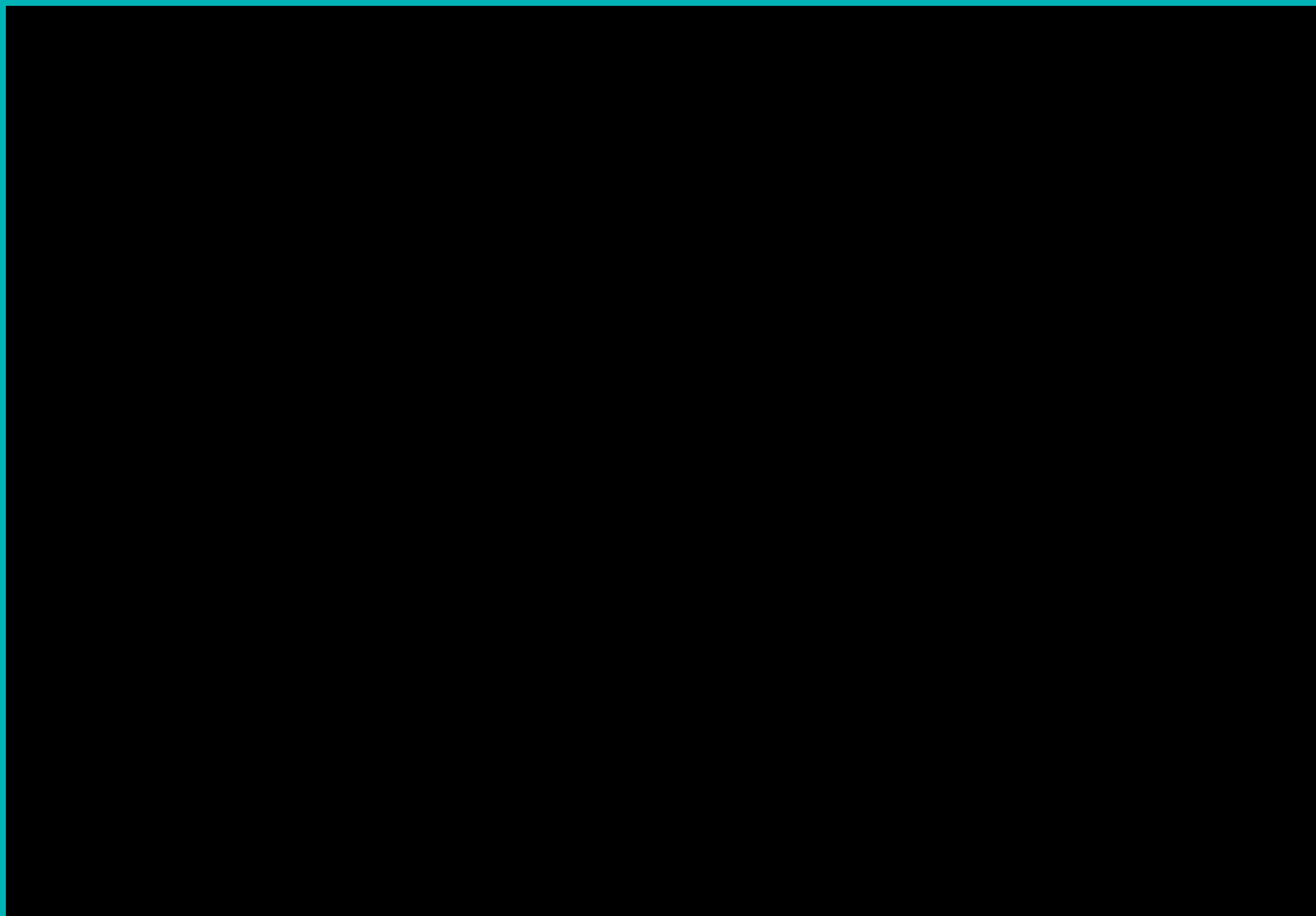
Decay of Giant Resonances

$^{48}Ca \rightarrow {}^{47}Ca+n$ $^{94}Zr \rightarrow {}^{93}Zr+n$



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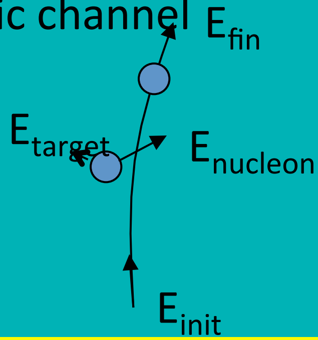
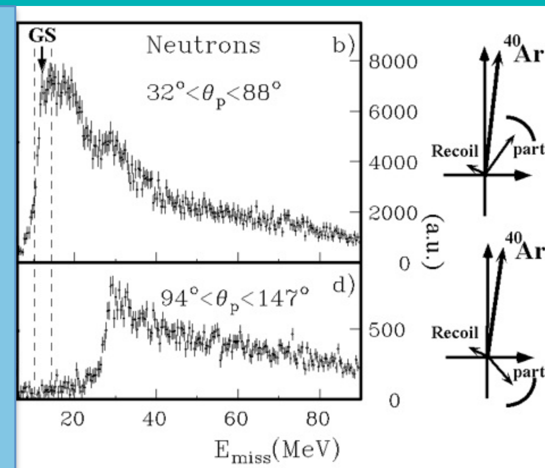
Decay or break-up…

$^{40}Ar+^{58}Ni$ @ 44 MeV/A Proton & neutron

Inelastic channel



J.A.Scarpaci et al.,
Physics Letters B428 (1998) 241



$E_{miss} = E_{init} - E_{fin} - E_{target} - E_{nucleon}$

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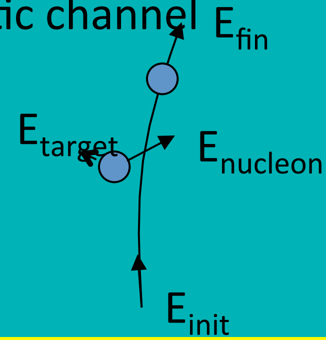

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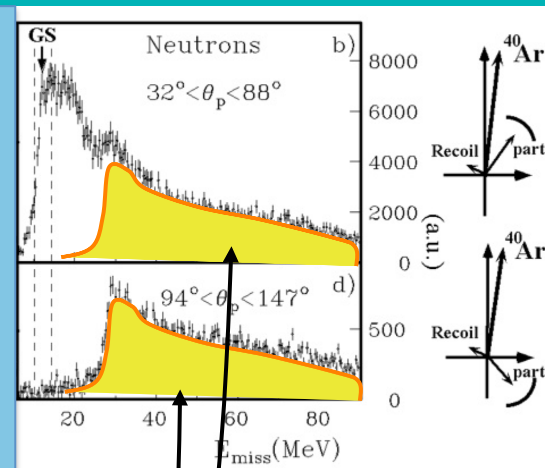

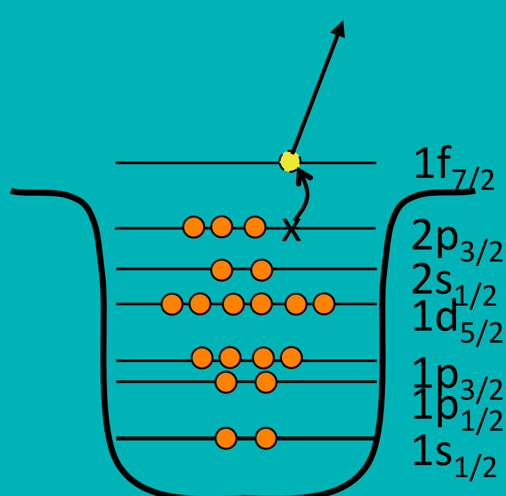

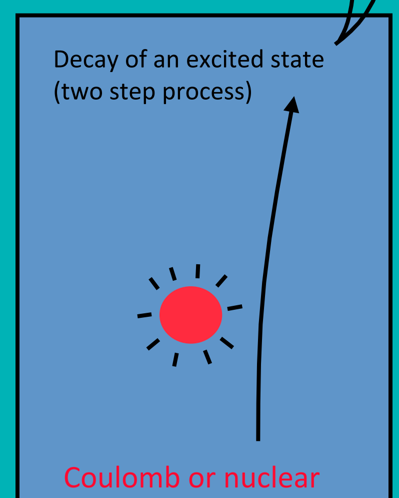

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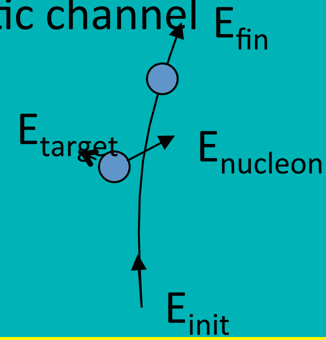

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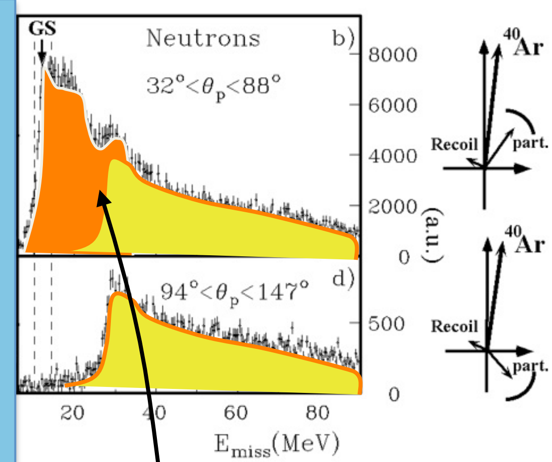
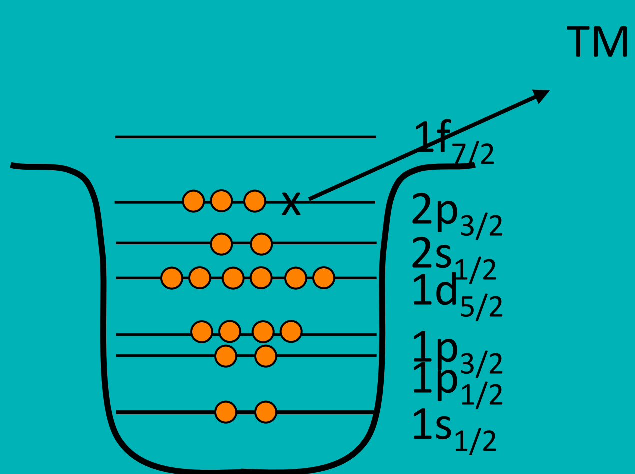
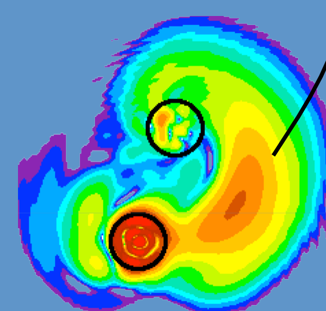




Direct decay through the Towing Mode (one step process)



Nuclear only

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Decay or break-up…

$^{40}Ar+^{58}Ni$ @ 44 MeV/A Proton & neutron

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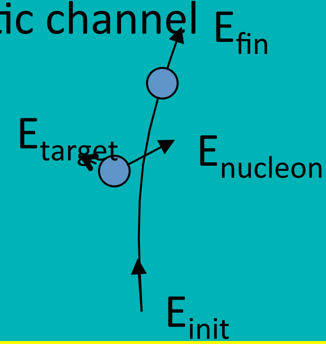
Inelastic channel



J.A.Scarpaci et al.,
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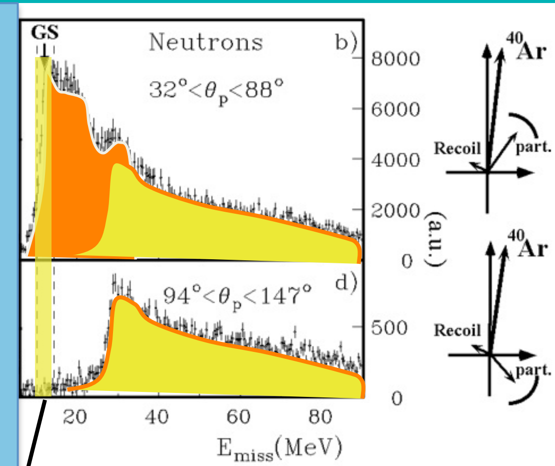
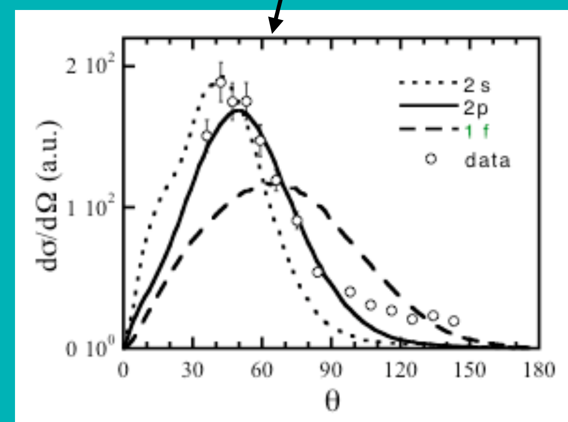
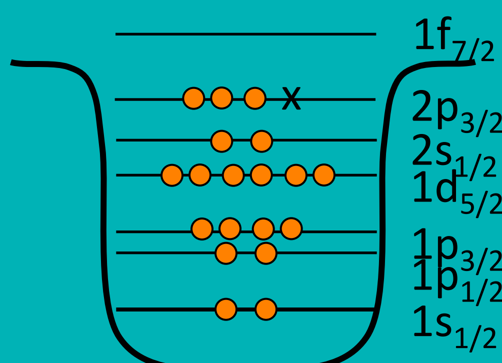




D.Lacroix et al., Nuclear Physics A658 (1999) 273



The TM probes the GS

The TM is sensitive to the initial WF

MAGNEX

Optical characteristics	Actual values
Maximum magnetic rigidity	1.8 T m
Solid angle	50 msr
Momentum acceptance	± 13%
Momentum dispersion for $k = -0.104$ (cm/%)	3.68
First order momentum resolution $R_p = \frac{D}{M_x \Delta x}$	5400

Angular acceptance

Setting $\theta = 6°$ → $0° < \theta_{lab} < 14°$

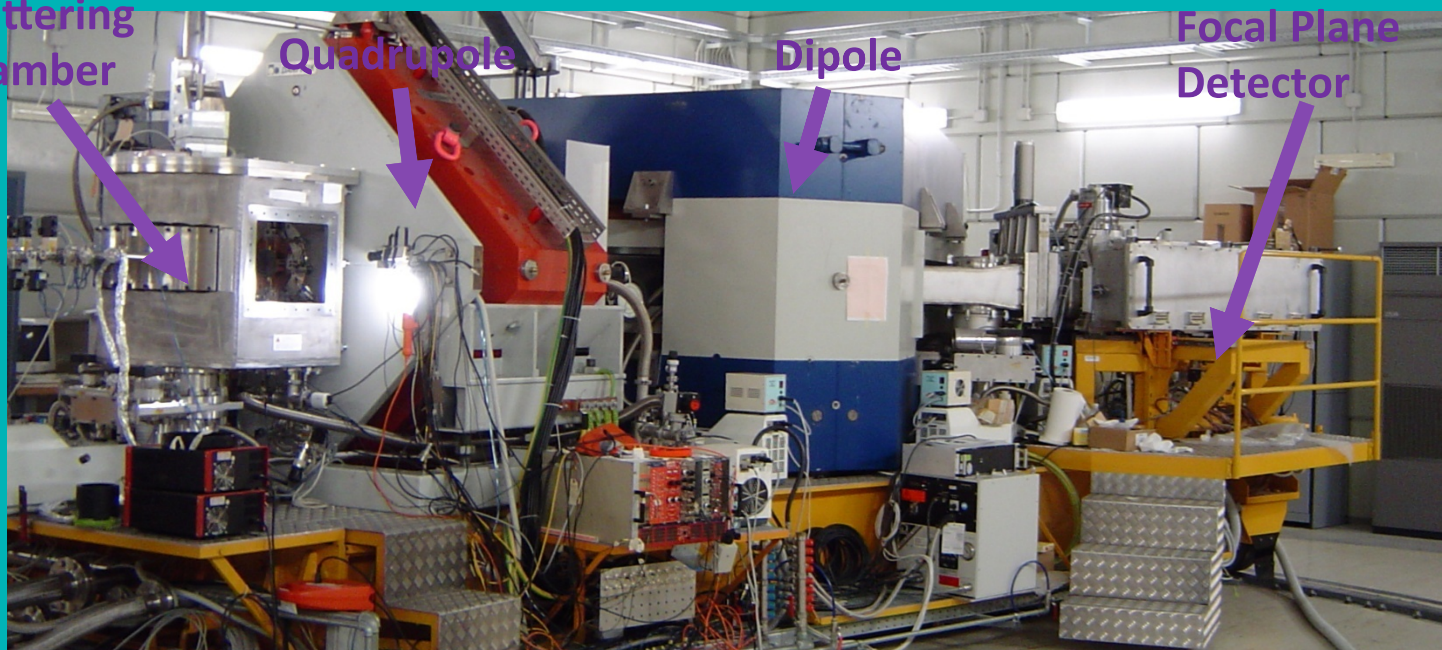
Setting $\theta = 90°$ → $85° < \theta_{lab} < 96°$

Measured resolution

Energy $\Delta E/E \sim 1/1000$

Angle $\Delta\theta \sim 0.3°$

Mass $\Delta m/m \sim 1/100$ (not optimized)



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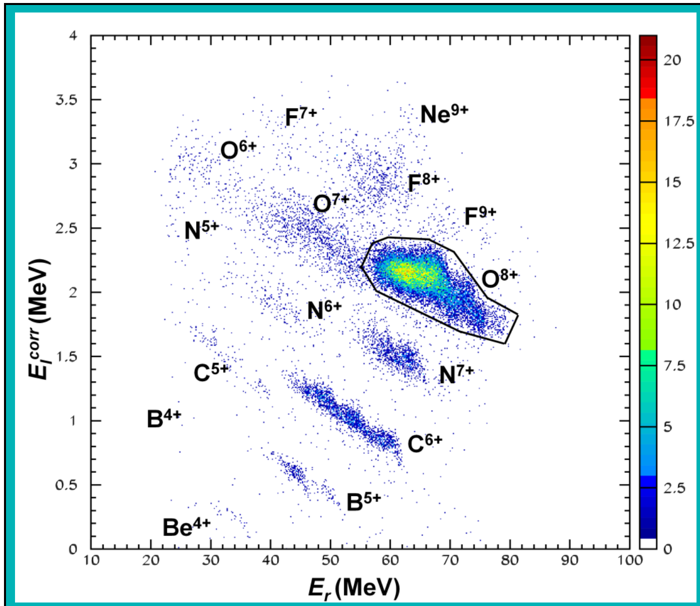
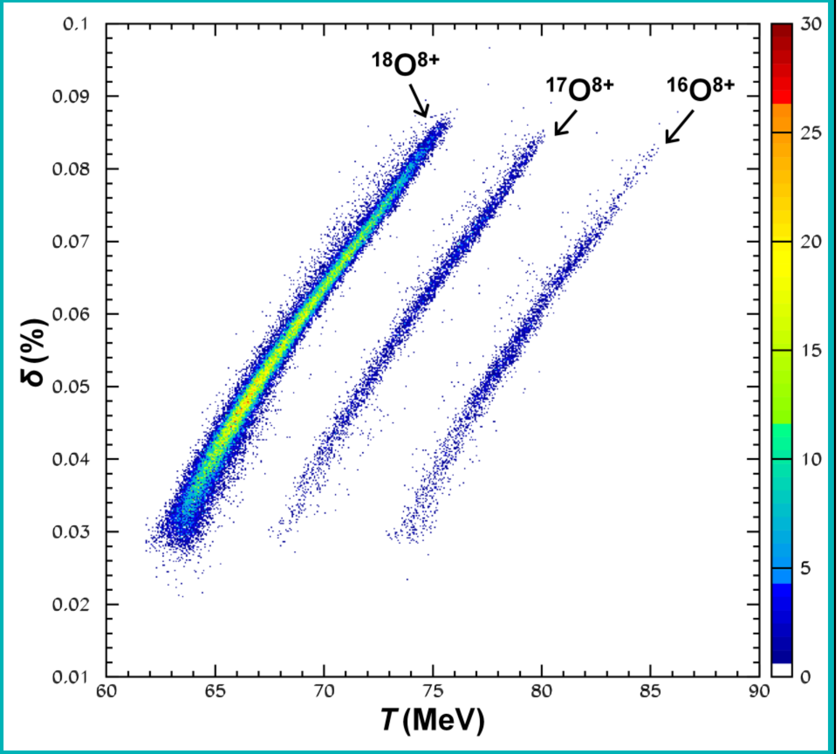
Identificazione degli eiettili



$$B\rho = \frac{p}{q} \rightarrow \frac{\sqrt{m}}{q} = \frac{p_0(\delta+1)}{q\sqrt{2T}}$$



$$E_l^{corr} = E_l \frac{\cos\theta_{tilt}}{\cos\theta_{foc}}$$

Risoluzione in massa
Δm/m ~ 1/160

$$T = E_r + E_l + E_d$$

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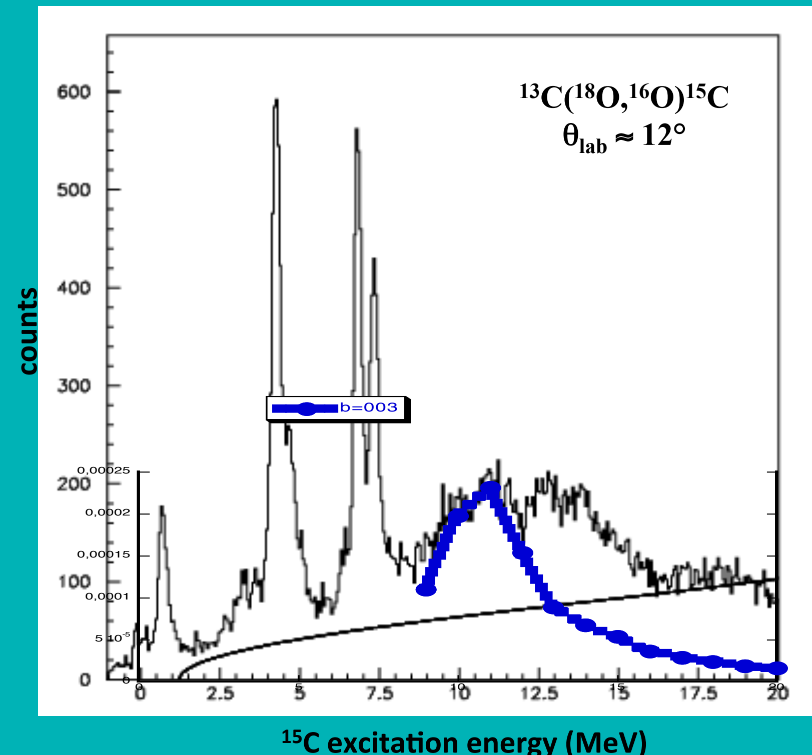
F. Cappuzzello et al., NIMA621 (2010) 419

$^{13}C(^{18}O,^{16}O)^{15}C$



(^{18}O,^{16}O) on different target have been studied and bumps are always seen around 10-15 MeV (GPV?)
Tentative break-up calculation are being performed, but the answer could come from the neutron detection…

D.Carbone, Master Degree thesis, Catania University, 2009

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EDEN New Electronics

3 BaF-Pro Modules… from Milano lab (Ciro)

BaF-Pro Electronics

- 16 Channels Acquisition System for Scintillation Detectors developed in Milano
- NIM standard module
- Provides:
  - Energy (< 1%)
  - Time (through CFD, < 100 ps)
  - PSD (through fast vs slow technique)
- Designed for BaF_2 scintillators
  - PSD technique matches their signal characteristics very well
- Preliminary results also for $LaBr_3$

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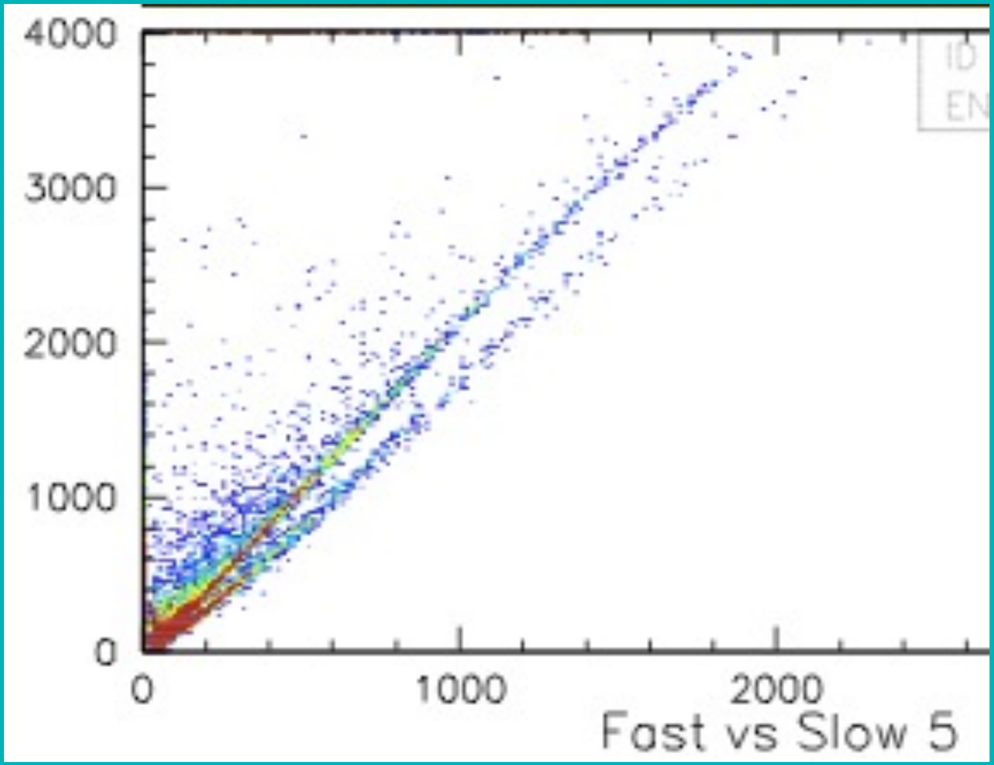

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Time schedule

✓October 2010: arrival of the first two EDEN modules at the LNS

✓October-December 2010: Test of the modules with the new electronics

✓January-February 2011: arrival of the complete EDEN array at the LNS

✓March-April 2011: installation of EDEN on the MAGNEX experimental area

✓May-July 2011: in beam-test of MAGNEX-EDEN

✓September 2011: start the experimental activity

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MAGNEX + EDEN

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Proposal at the LNS PAC for the commissioning

Requested 15 BTU at the Tandem LNS facility for studying the

$^{12}C(^{18}O,^{17}O)^{13}C$ at 84 MeV

$^{16}O(^{18}O,^{17}O)^{17}O$ at 84 MeV

To setup electronics and study efficiency and resolution

and the

$^{13}C(^{18}O,^{16}O)^{15}C$ at 84 MeV

2 neutron coincidences

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Conclusions

- The MAGNEX – EDEN system is now at the LNS

- It will be a unique instrument worldwide opening a very wide range of possibilities in the field of experimental nuclear physics

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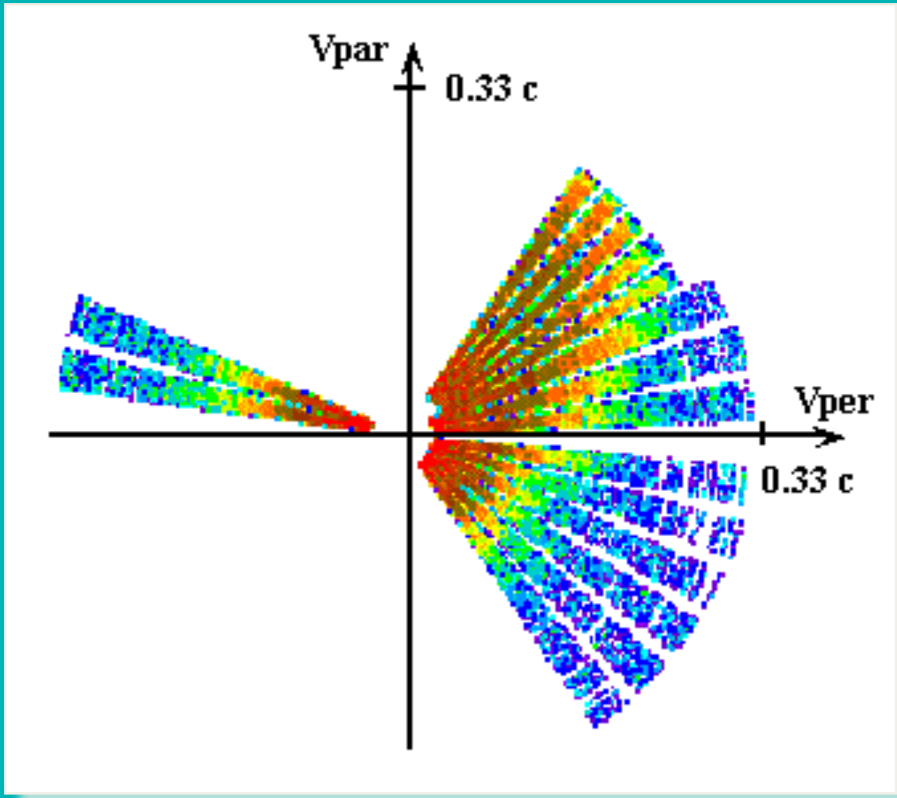

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