Knockout experiments at GANIL with the EXOGAM+NaI array @ SPEG

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Campaign EXOGAM+NaI @SPEG (Sept-Oct 2006)

- ✓ **E452 : (M. Chartier, N. Orr et al.)**

  "Spectroscopy of neutron-rich Oxygen, Fluorine nuclei by single-neutron knock-out"

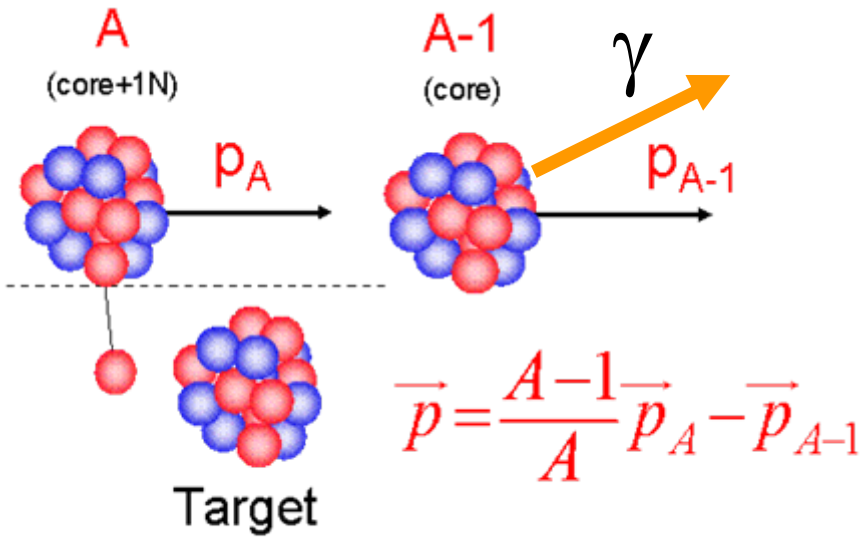
- ✓ **E491 : (L. Trache, F. Carstiou et al.)**

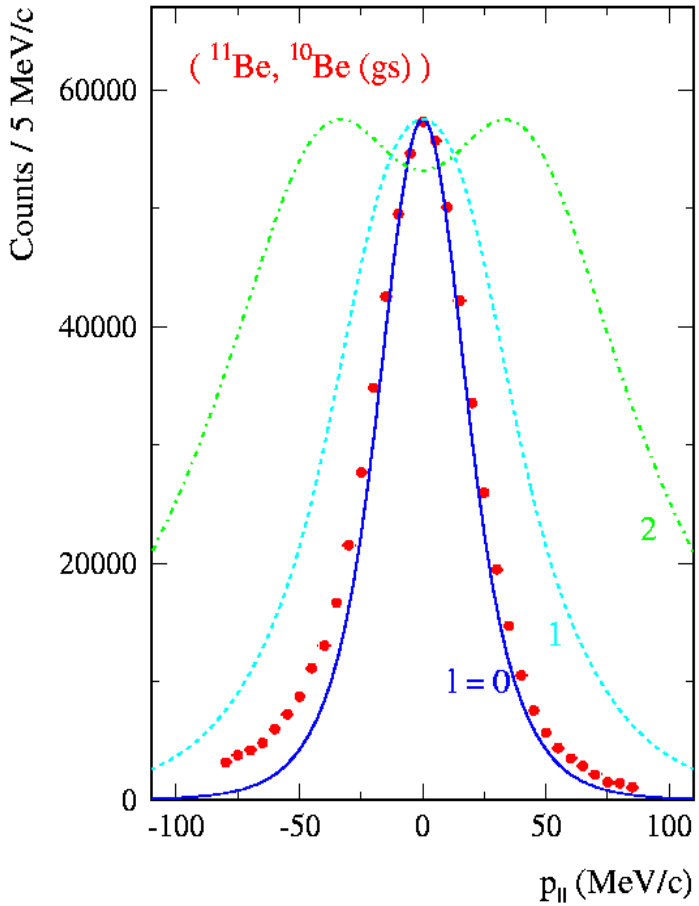
  "Search of a possible $1d_{5/2}$ and $2s_{1/2}$ level inversion in ^{23}Al and its consequences on the $^{22}Mg(p,\gamma)^{23}Al$ stellar reaction rate"

Spectroscopic tool : KNOCKOUT

REVIEW: Hansen & Tostevin, Ann. Rev. Nucl. Part. Sci. (2003)

Exclusive measurements





Navin A. et al PRL 85:266 (2000).

V. Maddalena et al. PRC 63 (2001) 024613

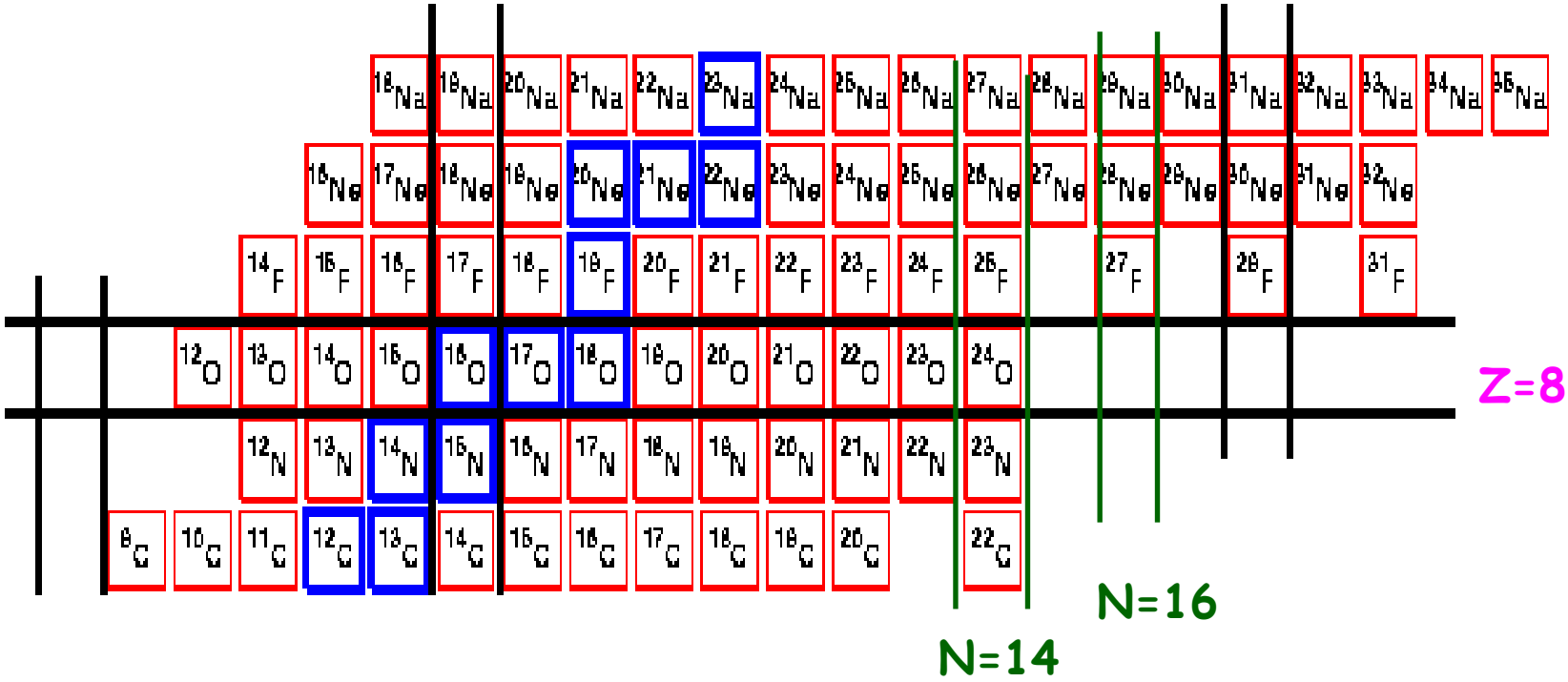
Measurements ⇒ Observables

$d\sigma/dp \Rightarrow \ell_n$

$\gamma \Rightarrow E^x_{core}$ $\sigma_{-1n}(J^\pi_{core}) \Rightarrow C^2S$

E452 : Single-neutron knockout around N=16

Study of the structure of light n-rich nuclei



- ^{25}O unbound
- F-isotopes extend beyond N=14

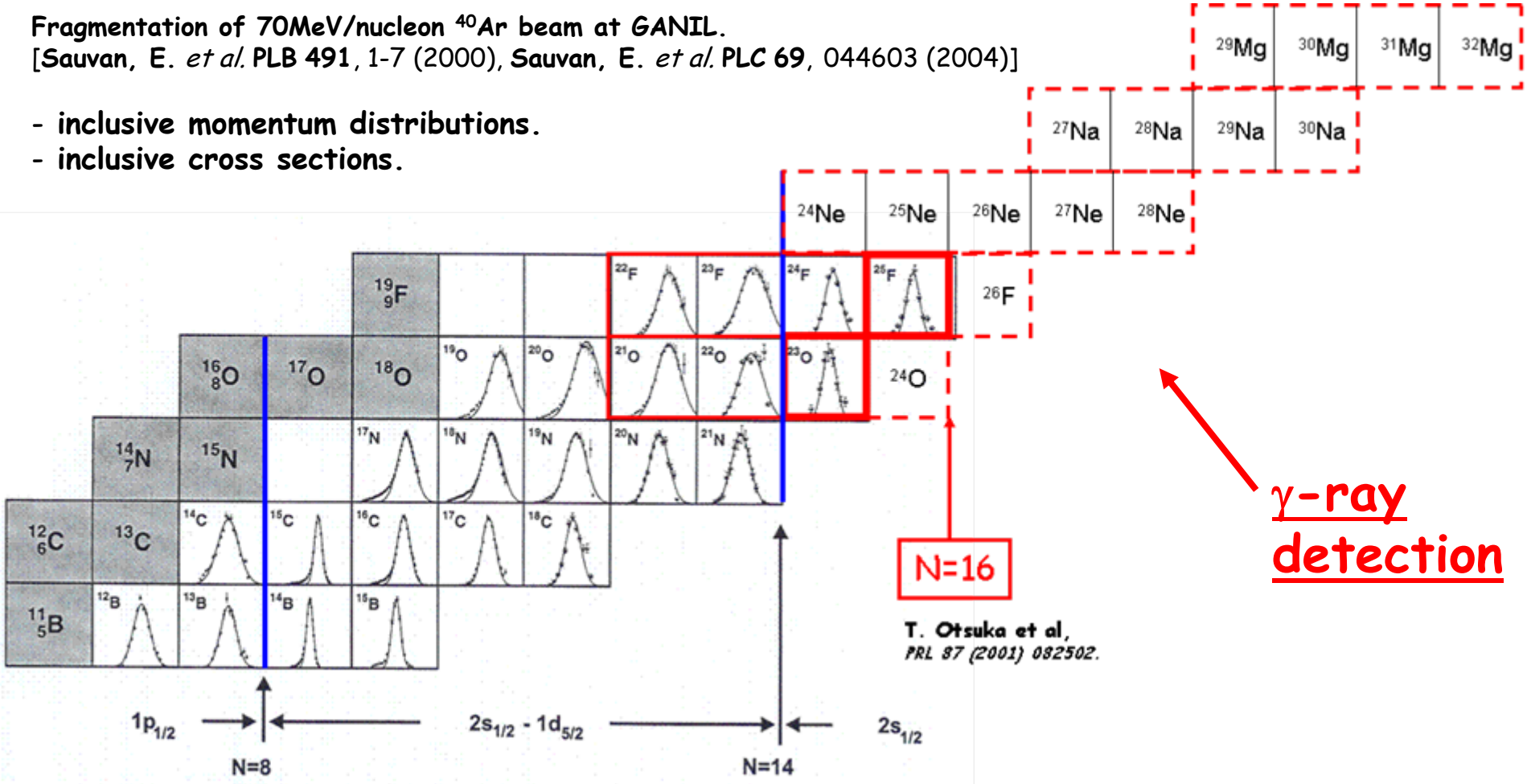
→ n-drip line just known for the ligth nuclei up to oxygen

E452 : Single-neutron knockout around N=16

Inclusive measurements

Fragmentation of 70MeV/nucleon ^{40}Ar beam at GANIL.
[**Sauvan, E.** *et al.* **PLB 491**, 1-7 (2000), **Sauvan, E.** *et al.* **PLC 69**, 044603 (2004)]

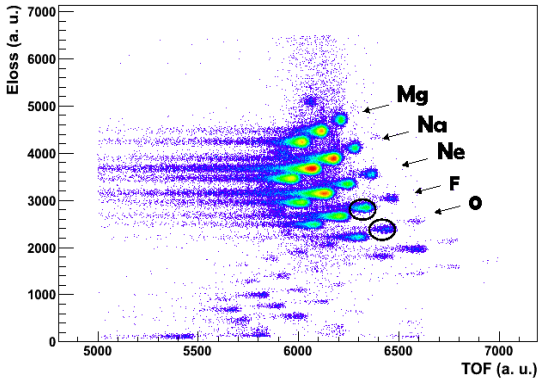
- **inclusive momentum distributions.**
- **inclusive cross sections.**



Exclusive measurements

Fragmentation of 77MeV/nucleon ^{36}S beam at GANIL.

Set-Up



Thin degrader

α

n-rich ⇒ ↑ A/q

↑ E ⇒ ↑ v

$B\rho_{max}$ = 2.88 Tm

Drift chambers
+Thin Plastic

EXOGAM
+ NaI

Secondary target : Carbon 183 mg/cm²

SPEG

Drift chambers

Ion. chamber & Plastic

^{23}O ~ 0.6 pps

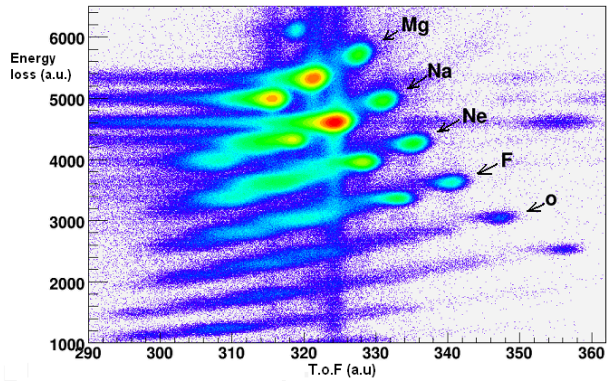
^{25}F ~ 8.4 pps

SISSI

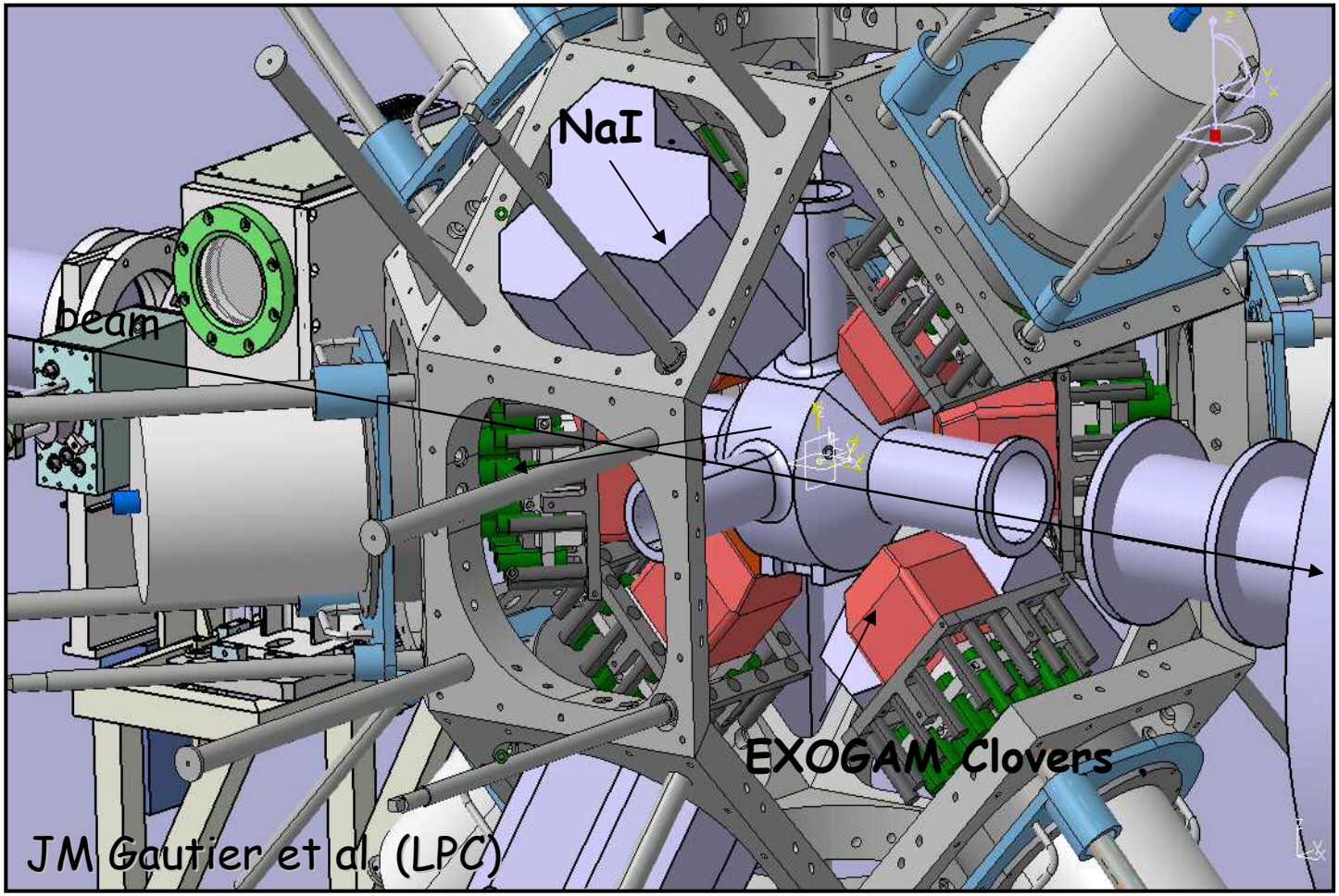
Carbon production target ~500 mg/cm²

^{36}S primary beam

77.5 MeV/nucleon, ~1 kW



EXOGAM @ SPEG: 8 Ge Clovers + 4x3 NaI Clusters



EXOGAM+NaI setup @ SPEG:

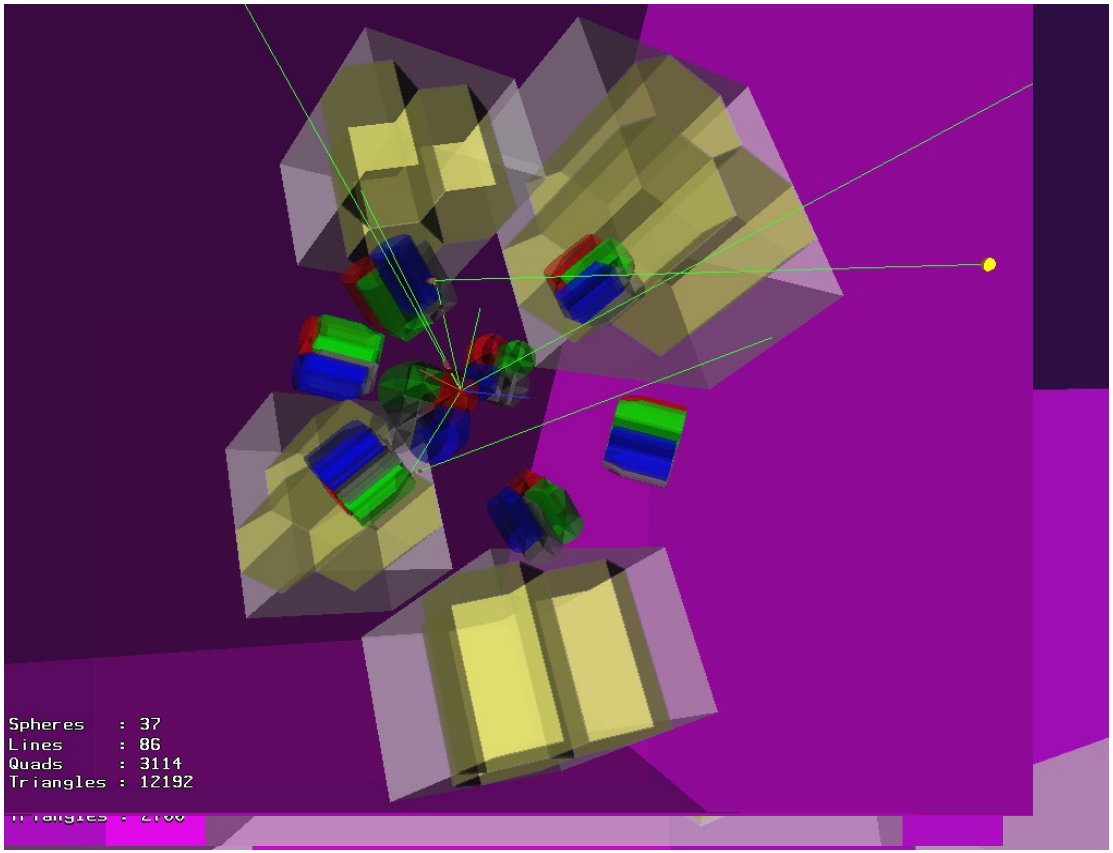
GANIL
LPC Caen
STFC Daresbury Laboratory
Univ. Birmingham
Univ. Liverpool
Univ. Surrey
Univ. York

New support structure & C-fibre reaction chamber

NIM + VME based electronics

γ-array EXOGAM+NaI (simulations)

- **Geant4 simulations determine optimum target – detector distance for Ge clovers and NaI clusters.**
- **EXOGAM Germanium clovers – good energy resolution.**
- **NaI clusters – high efficiency.**



Distance to Target :

4 x Ge's @ 45 ° = 215 mm

4 x Ge's @ 135 ° = 134 mm

10 x NaI @ 90 ° = 310 mm

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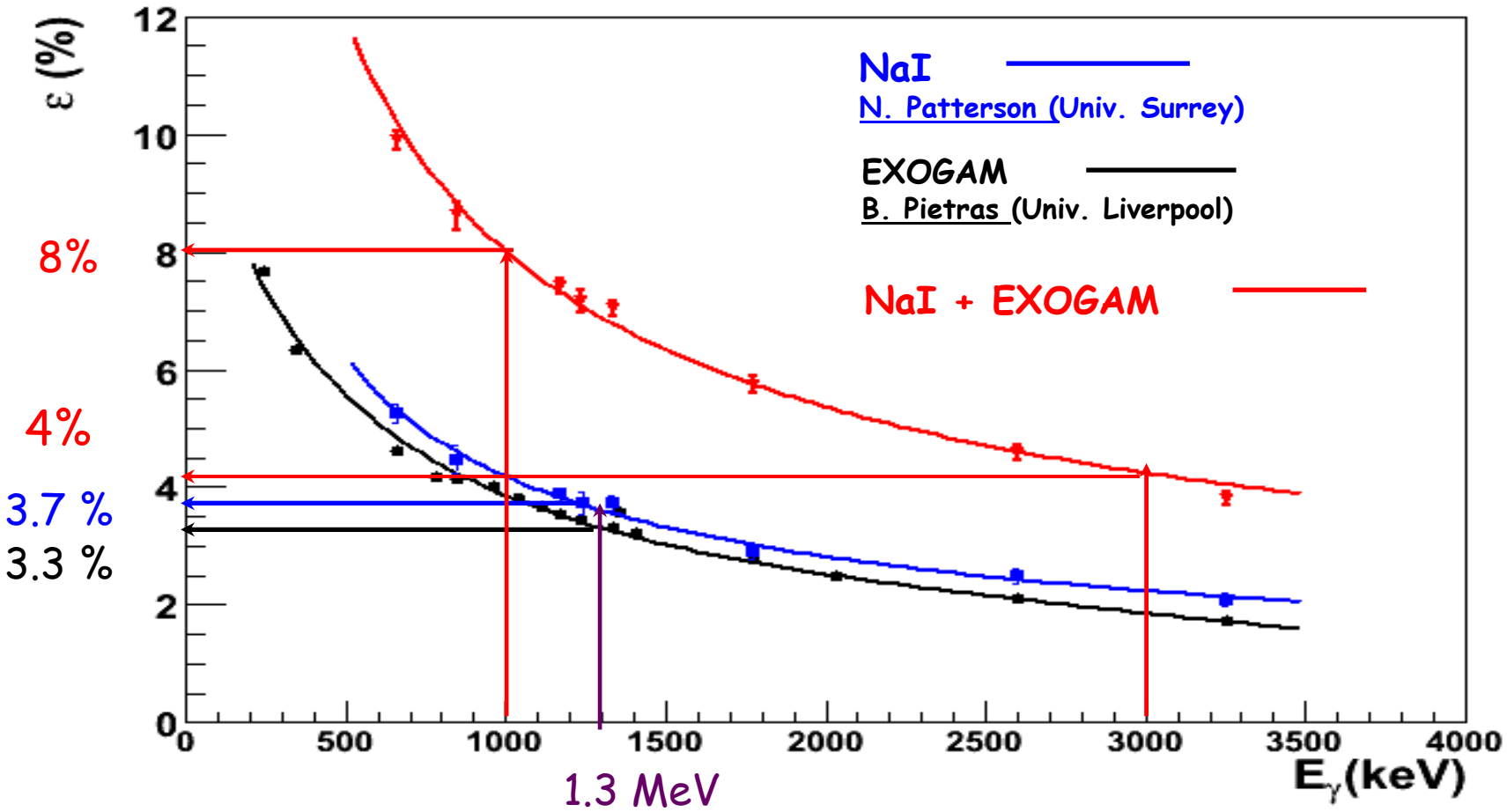
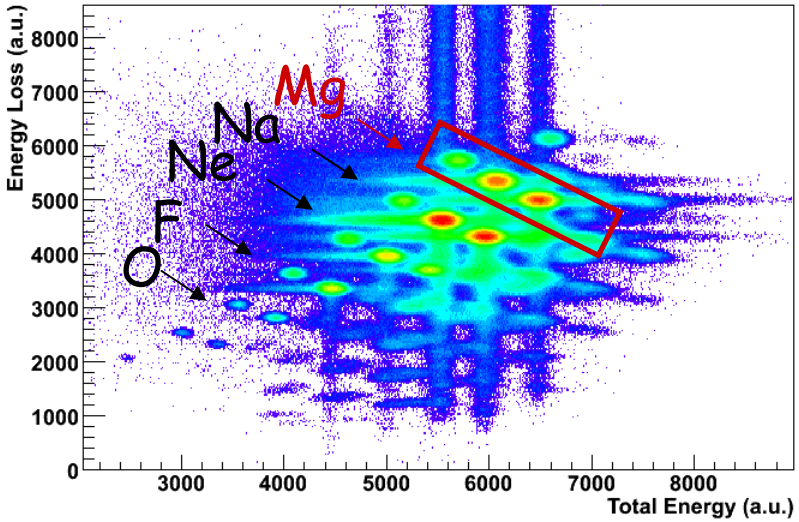
γ-array EXOGAM+NaI (experimental performance)



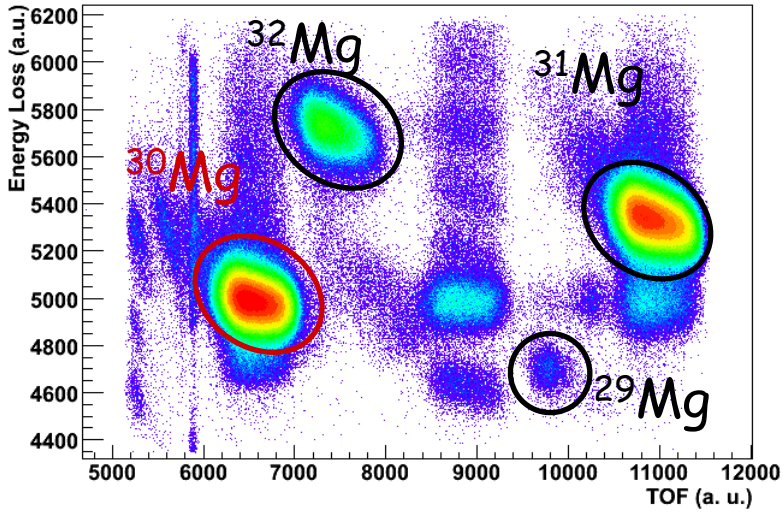
E452: PRELIMINARY RESULTS : Identification

Charge Separation : ΔE-E

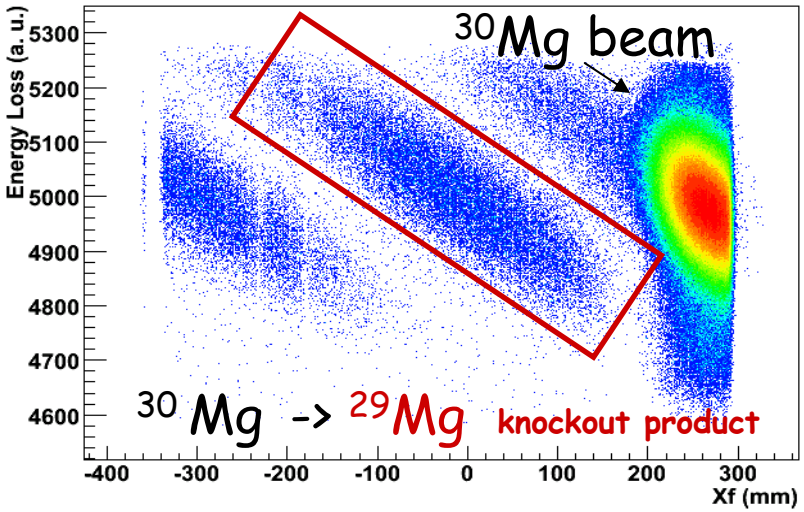


Mg

Isotopic Identification : ΔE-TOF



Remove Beam contribution : ΔE-Xf



SPEG : Focal Plane Detectors

Ionisation Chamber : ΔE

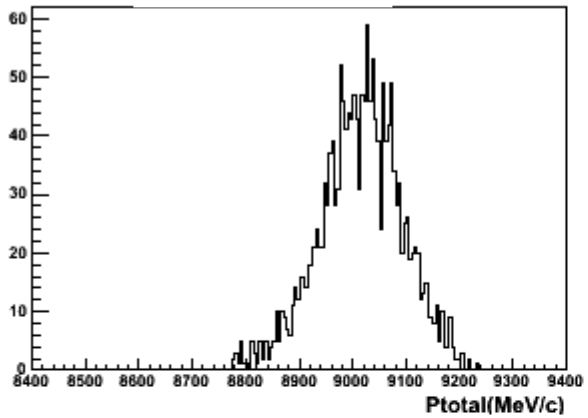
Plastic : E & TOF (HF-Plastic)

Drift Chambers : Xf

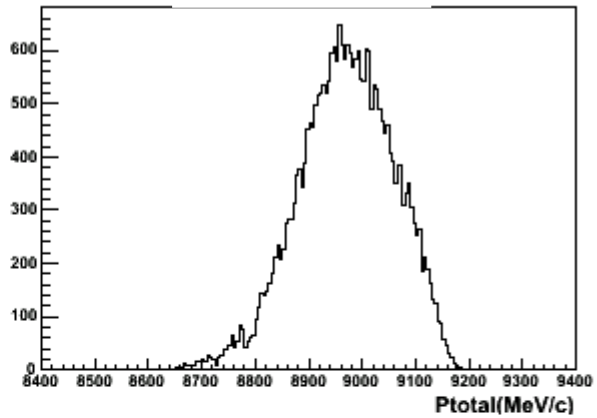
E452: PRELIMINARY RESULTS : Mg-isotopes (P_{total} dist)

Inclusive Momentum Distributions (SPEG –Focal Plane)

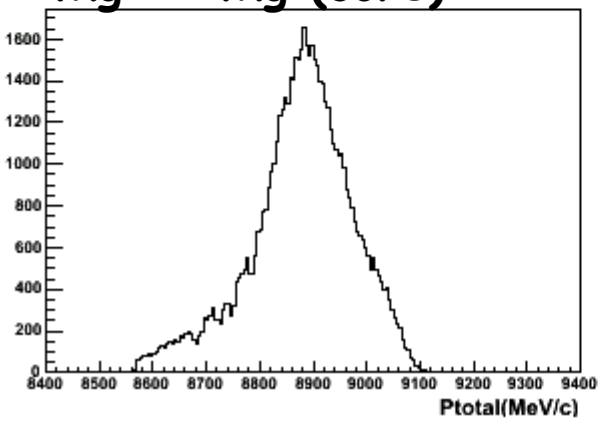
^{29}Mg->^{28}Mg (core)



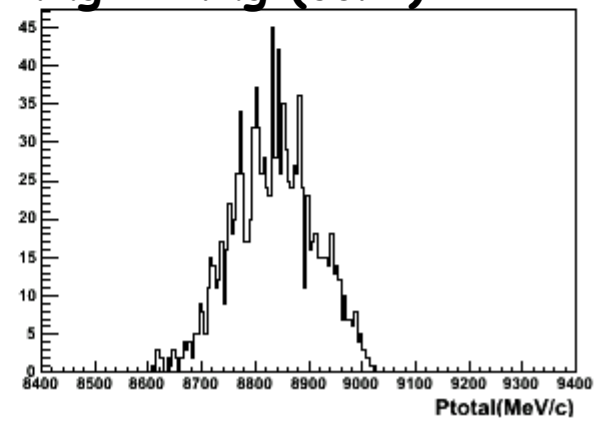
^{30}Mg->^{29}Mg (core)



^{31}Mg->^{30}Mg (core)



^{32}Mg->^{31}Mg (core)



-Systematic measurements of the ground state wave-function from ^{29}Mg to ^{32}Mg

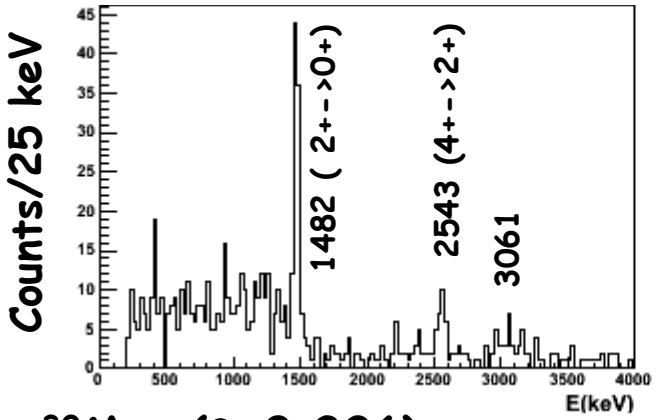
Spectroscopic factors along the island of inversion

Systematic investigation of changes in single-particle structure along the Mg chain.

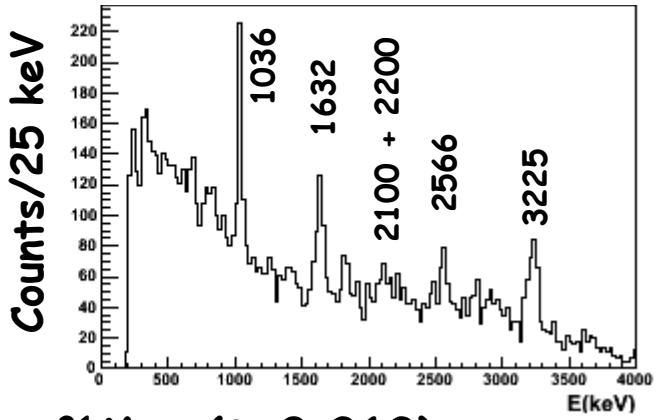
E452: PRELIMINARY RESULTS : Mg-isotopes (γ-spectra)

EXOGAM- Ge array spectra (Doppler corrected) + addback

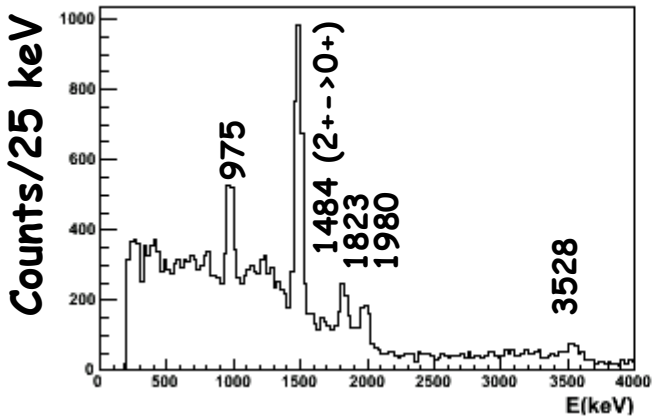
^{28}Mg (β=0.330)



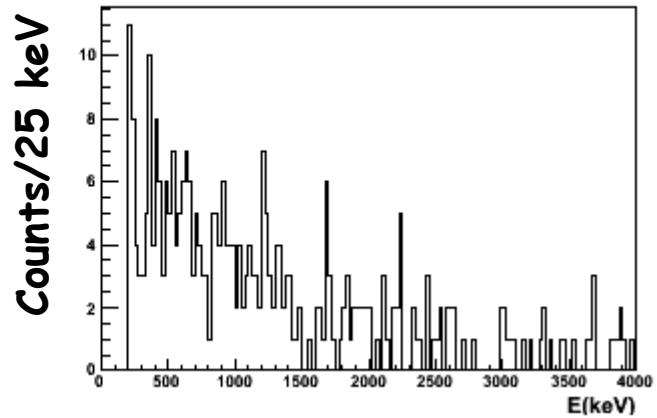
^{29}Mg (β=0.324)



^{30}Mg (β=0.326)

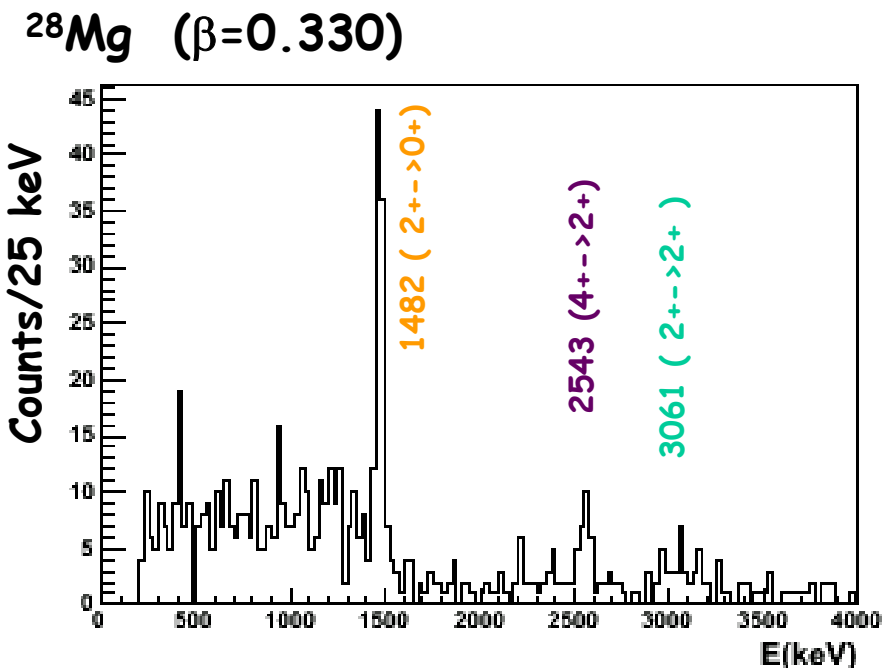


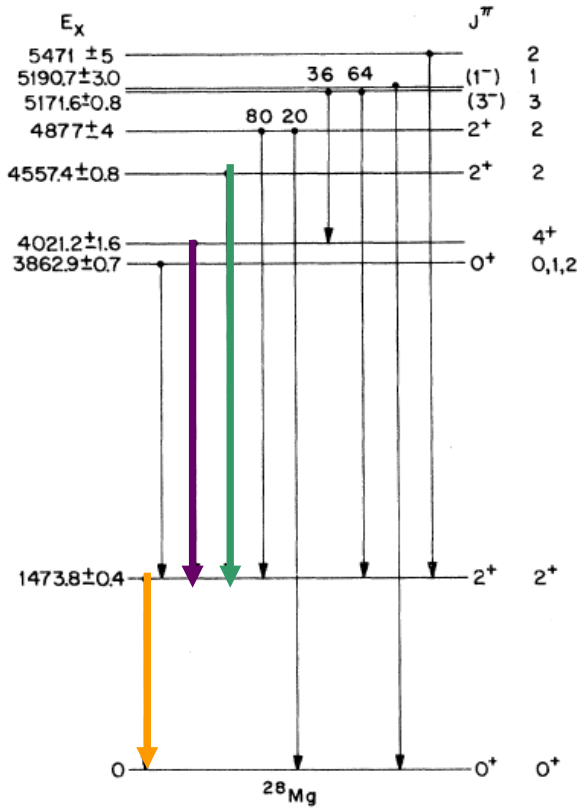
^{31}Mg (β=0.313)



E452: PRELIMINARY RESULTS : ^{28}Mg (γ-spectra)

EXOGAM- Ge array spectra (Doppler corrected) + addback





-spectroscopic factors under analysis

γ–ray spectroscopy of Low-Lying Levels in ^{28}Mg

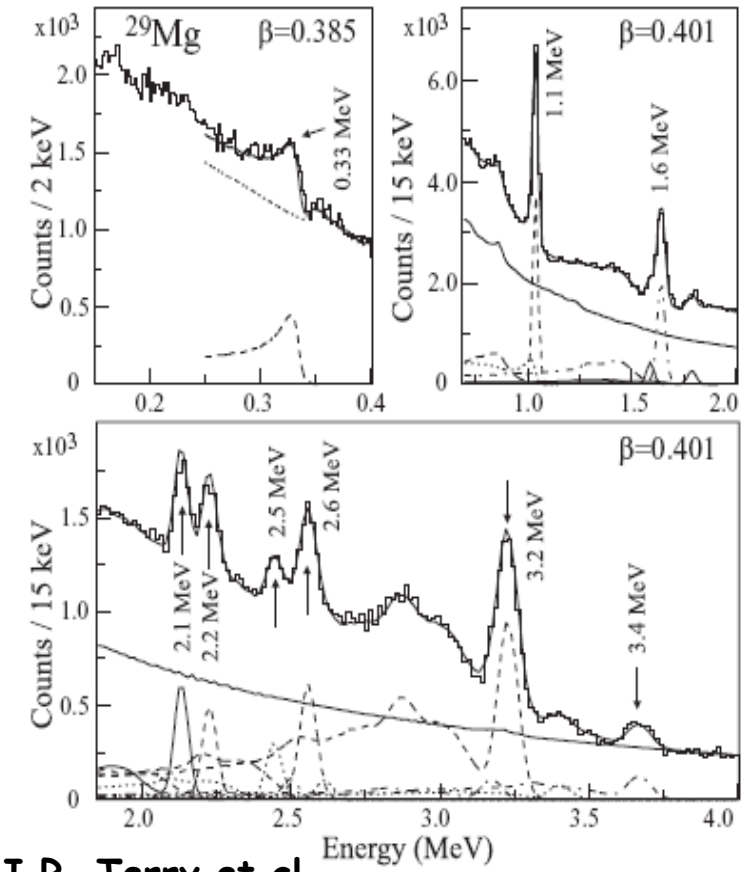
T. R. Fisher *PRC Vol. 7 Num 5. (1973)*

E452: PRELIMINARY RESULTS : ^{29}Mg (γ-spectra)

EXOGAM- Ge array spectra (Doppler corrected) + addback

Single-n removal from ^{30}Mg

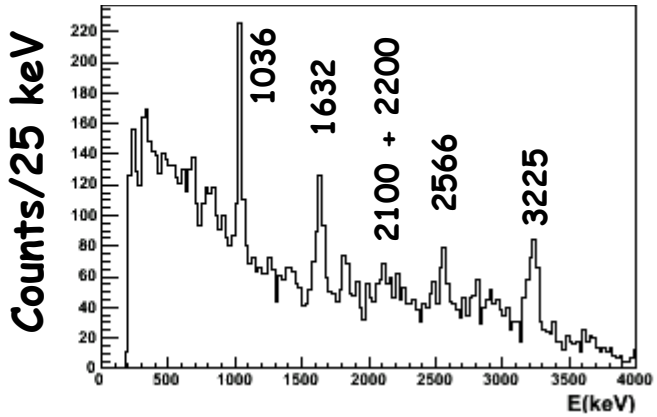
MSU results : ^{29}Mg



J.R. Terry et al.

Phys. Rev. C77, 014316 (2008)

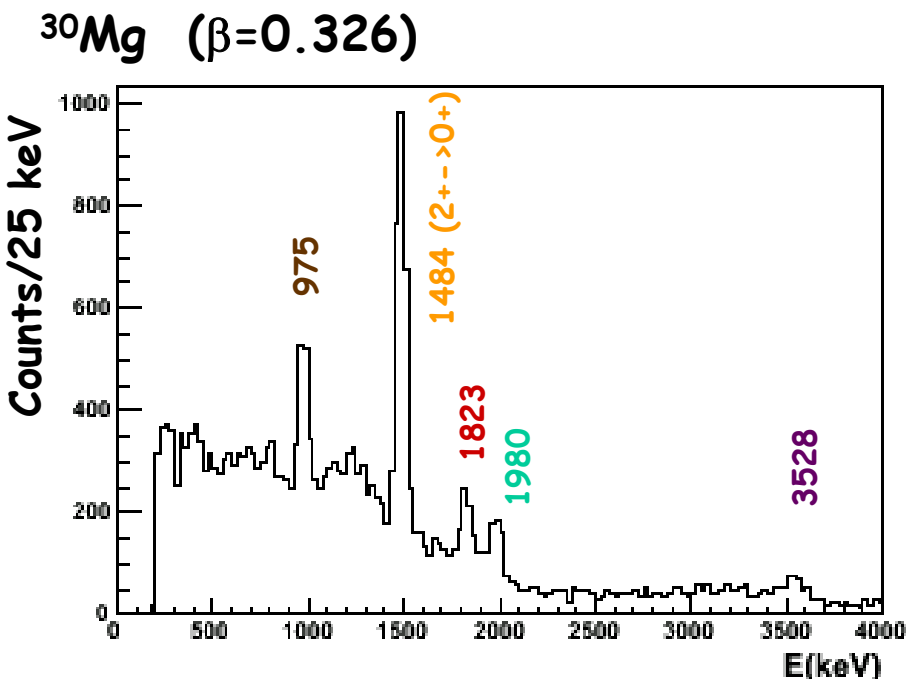
^{29}Mg (β=0.324)

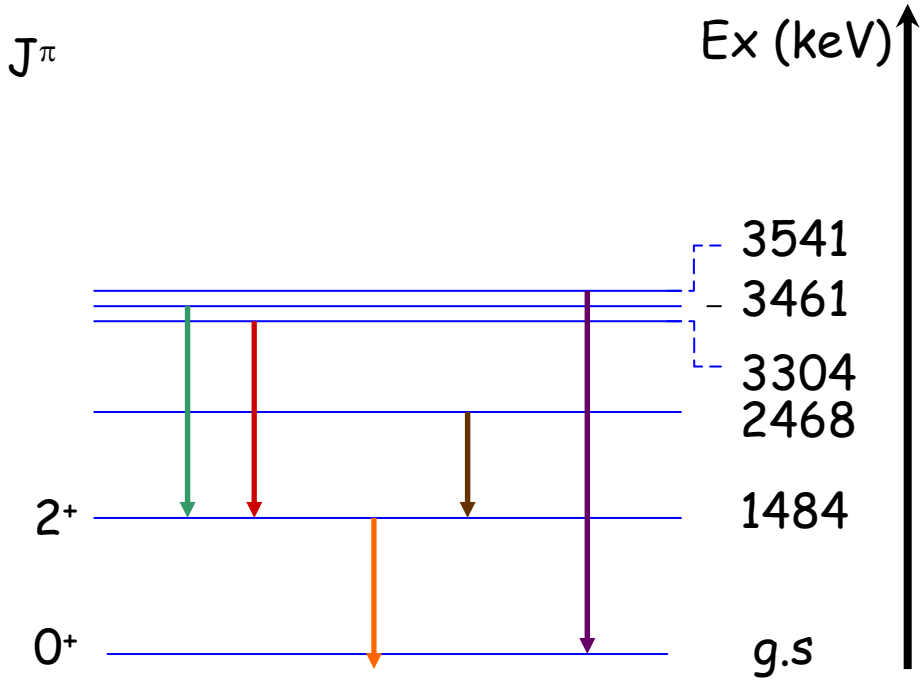


- Observe similar transtions
- Pretty good statistics despite the experiment being focus on F & O
- -Spectroscopic factors

E452: PRELIMINARY RESULTS : ^{30}Mg (γ-spectra)

EXOGAM- Ge array spectra (Doppler corrected) + addback





- Orbital -l value & Parity.

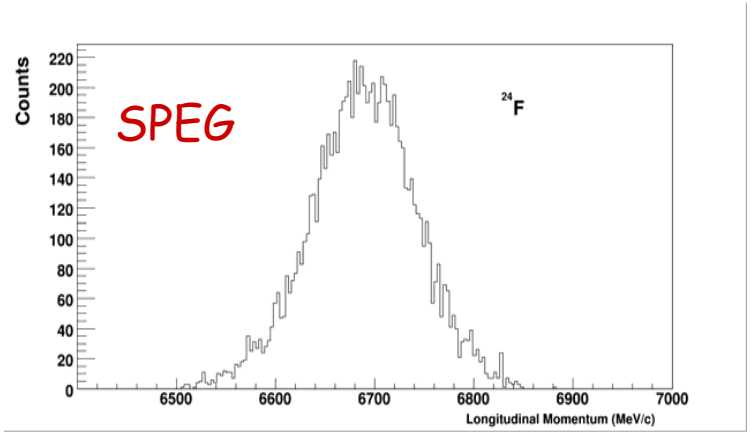
-Spectroscopic factors.

- β-decay of ^{30}Na

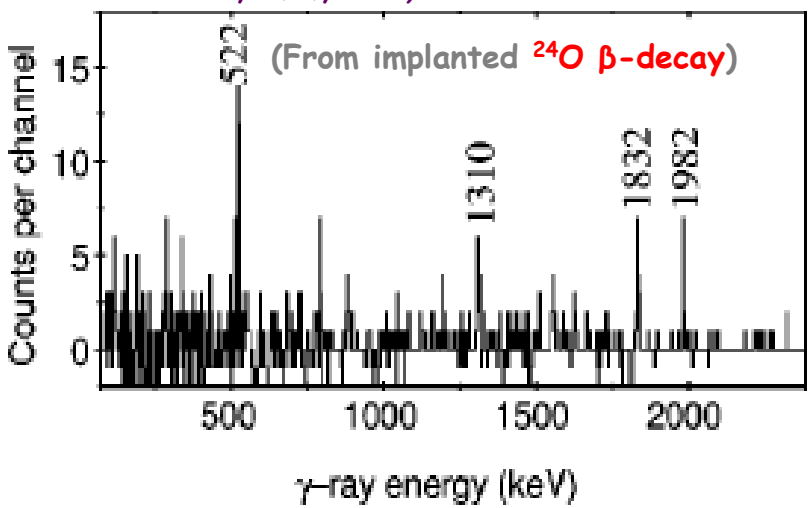
P. Baumann et al.

PRC Vol. 39 N. 2. 1989) 629.

E452: PRELIMINARY RESULTS : ^{25}F -> $^{24}F^*$



Reed, A.T., *et al*, PRC 60 024311



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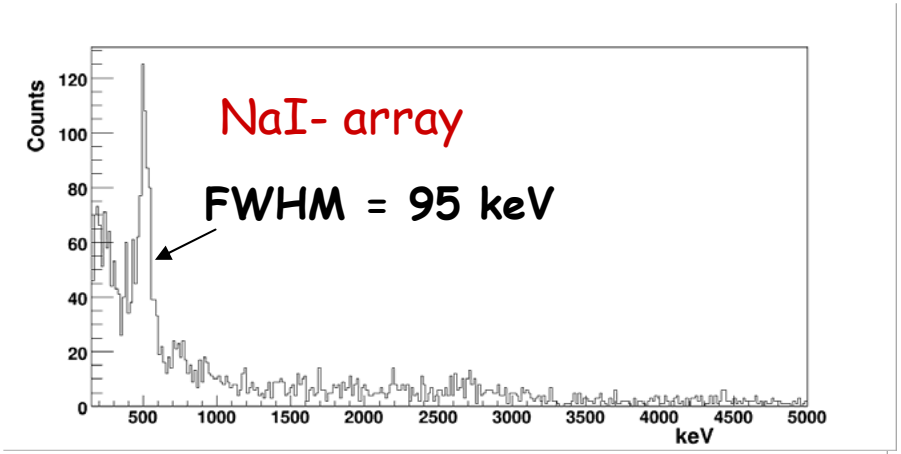

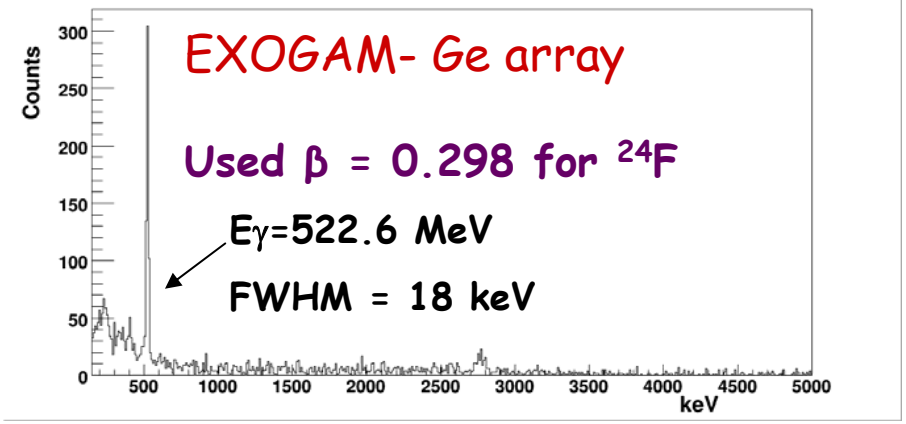

Detailed spectroscopy of the ground-state wave-function of ^{25}F

SUMMARY

✓Exclusive set-up for knockout experiments to probe single-particle structure

✓First EXOGAM+NaI campaign @ SPEG

✓ Systematic spectroscopy from ^{29}Mg up to ^{32}Mg & quantitative measurement of the intruder configuration

✓New spectroscopic information will be obtained from the data on Fluorine (^{25}F,^{24}F), Oxygens (^{24}O,^{23}O), Ne and Na isotopes

COLLABORATION

B. Pietras[1], N. Patterson[2], B. Fernández-Domínguez [1], M. Chartier [1], N.A. Orr [7], L. Achouri [7], J-C. Angélique [7], N. I. Ashwood [5], A. Banu [9], B. Bastin [6], J. Brown [11], R. Borcea [12], W.N. Catford [2], S. Franchoo [8], M. Freer [5], L. Gaudefroy [6], B. Laurent [7], M. Labiche [3], R. C. Lemmon [3],F. Negoita [10], S. Paschalis [1], E. Paul [1], M. Petri [1], P. Roussel-Chomaz [6], M. Staniou [12], M. Taylor [11], J.S. Thomas [2], L. Trache [9].

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** Working on analysis*