Study of High-Spin States in ^{48}Ca Region Induced by Secondary Fusion Reactions

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Secondary fusion reaction for high-spin study

- High-spin study established

  Fusion reaction:
  Stable isotope beam + Stable isotope target

  → High-spin states in proton-rich nuclei

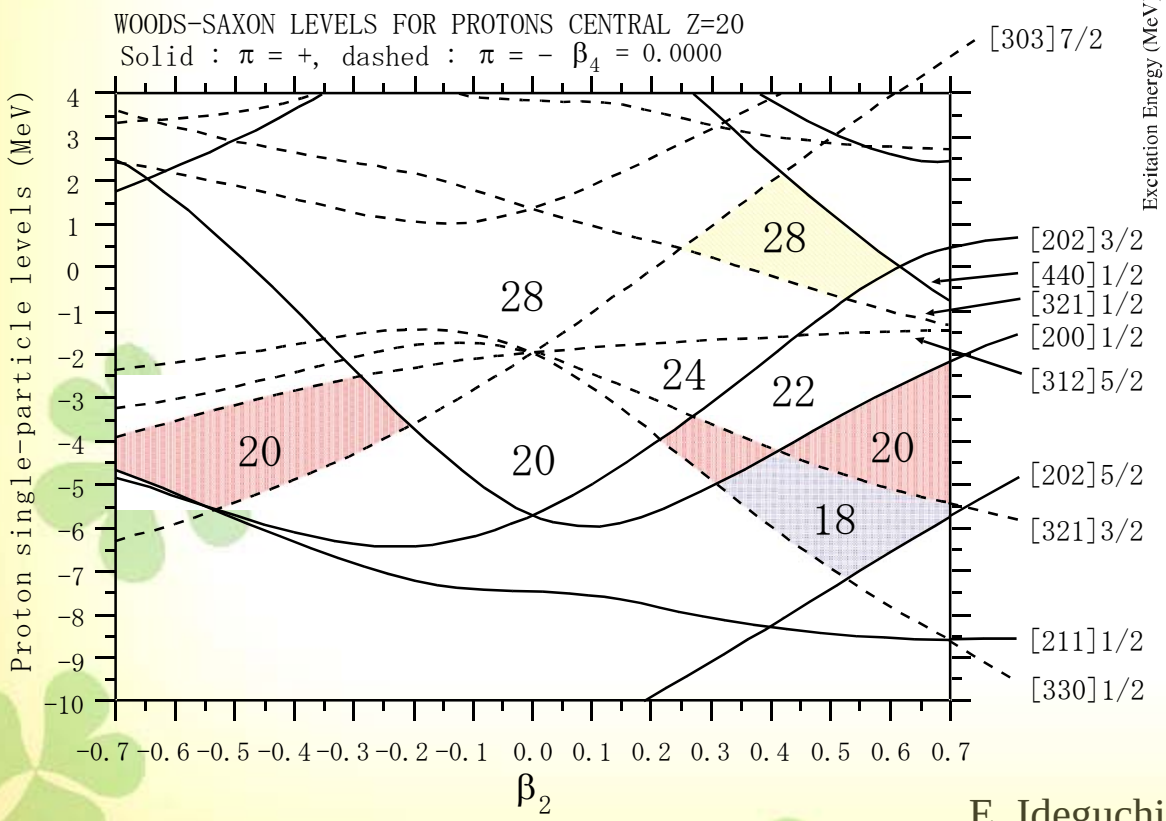
- High-spin study induced by RI beam

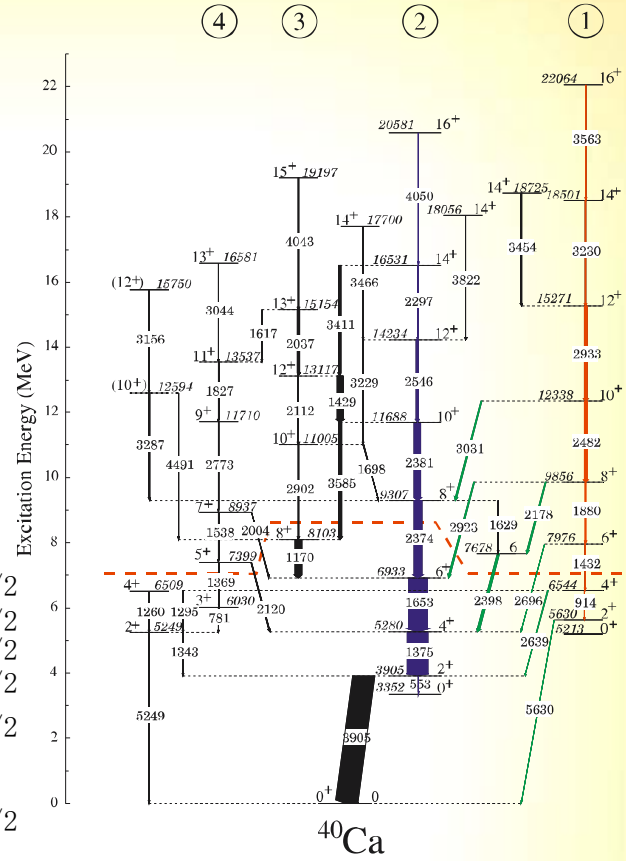
  Fusion reaction:
  RI beam + Stable isotope target

  → High-spin states in Stable | Neutron-rich nuclei

High-spin study of most neutron-rich nuclei

Study in Ca region





E. Ideguchi *et al.*, PRL87, 222501 (2001)
C. J. Chiara *et al.*, *PRC67*, 041303(R) (2003)

Developmental item

- Production of low-energy secondary beam

$^{40}Ar + {}^{9}Be \rightarrow {}^{37}P \rightarrow {}^{9}Be(^{37}P, xn)\ {}^{46-x}K$

$^{48}Ca + {}^{9}Be \rightarrow {}^{44}S \rightarrow {}^{9}Be(^{44}S, xn)\ {}^{53-x}Ca$

$^{45}Cl \rightarrow {}^{9}Be(^{45}Cl, xn)\ {}^{54-x}Sc$

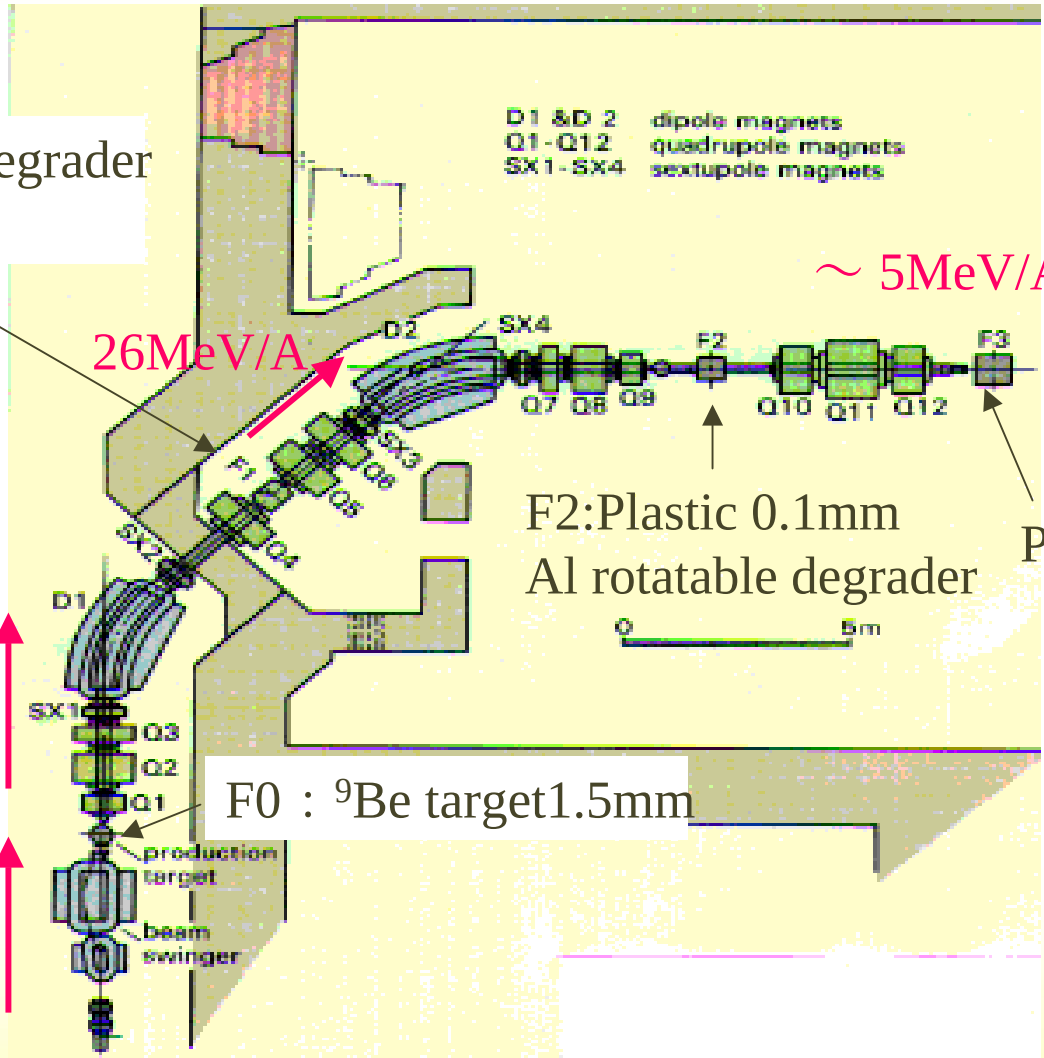
$^{46}Ar \rightarrow {}^{9}Be(^{46}Ar, xn)\ {}^{55-x}Ti$

Fragment separator (RIPS) + Energy degrader

- Gamma-ray detector

CNS Ge Array : GRAPE (Gamma-Ray detector Array with Position and Energy sensitivity)

Production of Low-energy 2ndary beam using RIPS



F1：Wedge degrader
221mg/cm^2

26MeV/A

～ 5MeV/A

Ge array

F2:Plastic 0.1mm
Al rotatable degrader

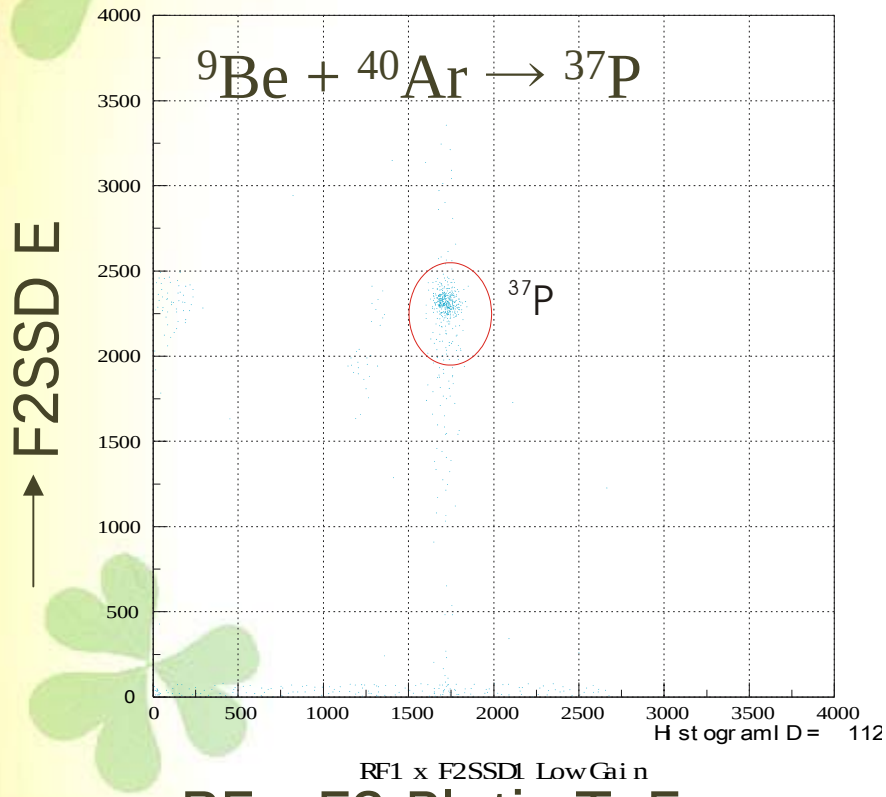
PPAC× 2

^{37}P
43MeV/A

^{40}Ar
63MeV/A
31pnA

F0：^{9}Be target1.5mm

Beam identification at F2

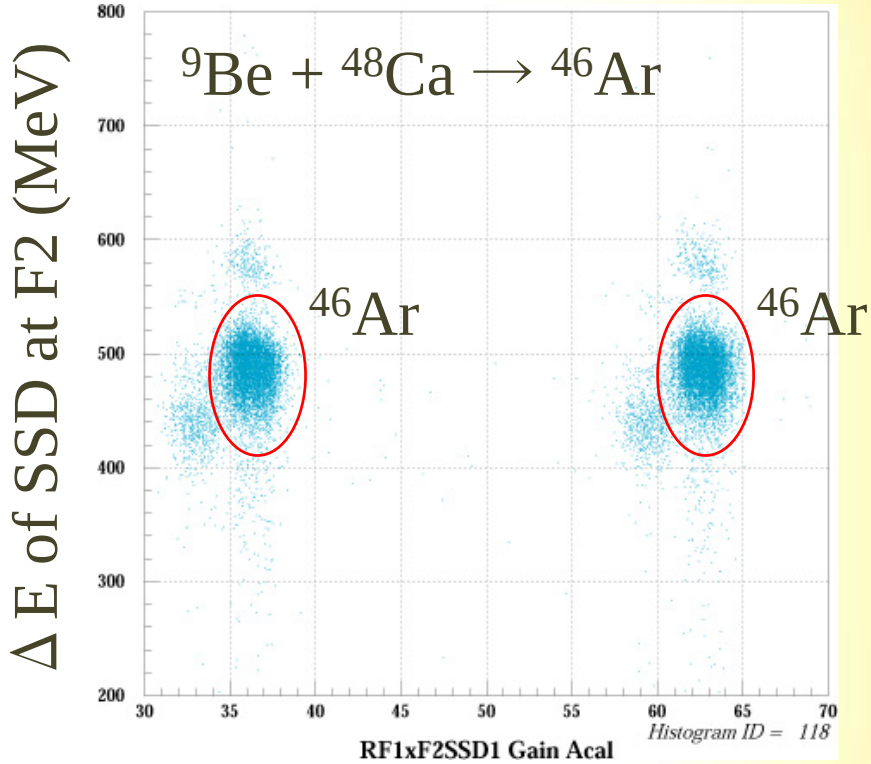


RF - F2 Platic ToF ⟶

~100% ^{37}P beam

2.0×10^5 cps at F2

1.0×10^5 cps at F3



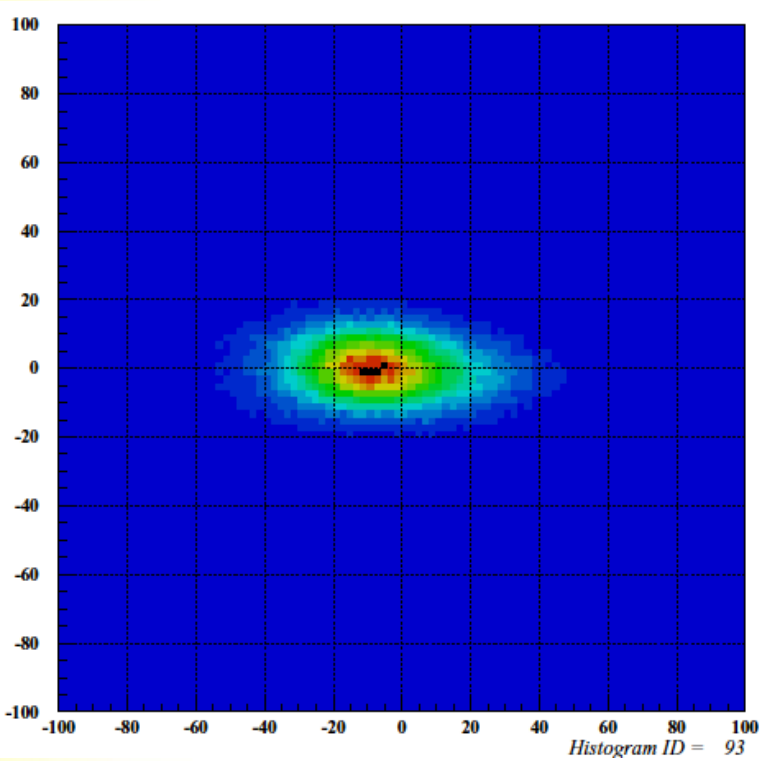
RF - F2 Plastic TOF (ns)

~90% ^{46}Ar beam

7.3×10^5 cps at F2

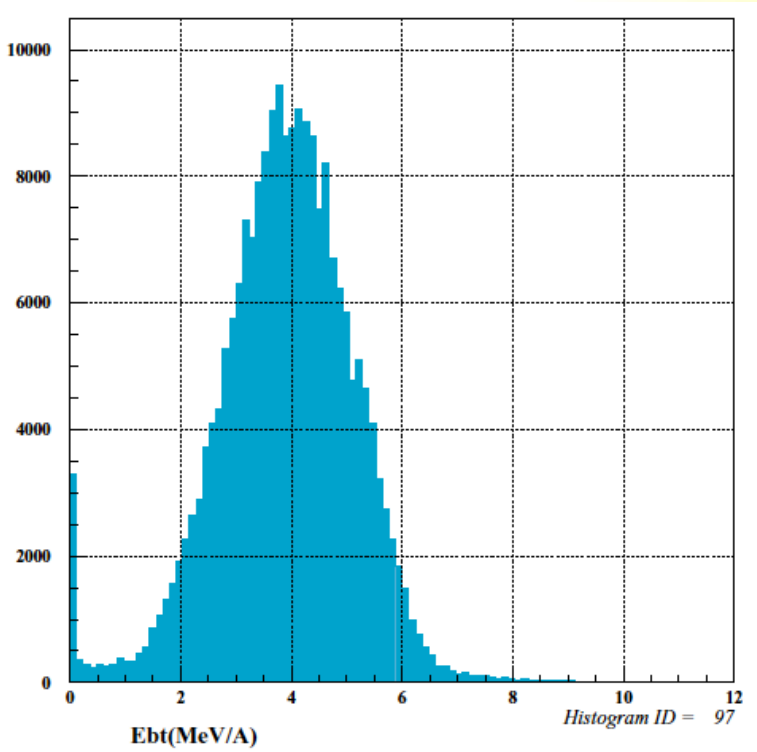
3.2×10^5 cps at F3

Low energy ^{46}Ar beam at F3



X-Y at Target (mm)

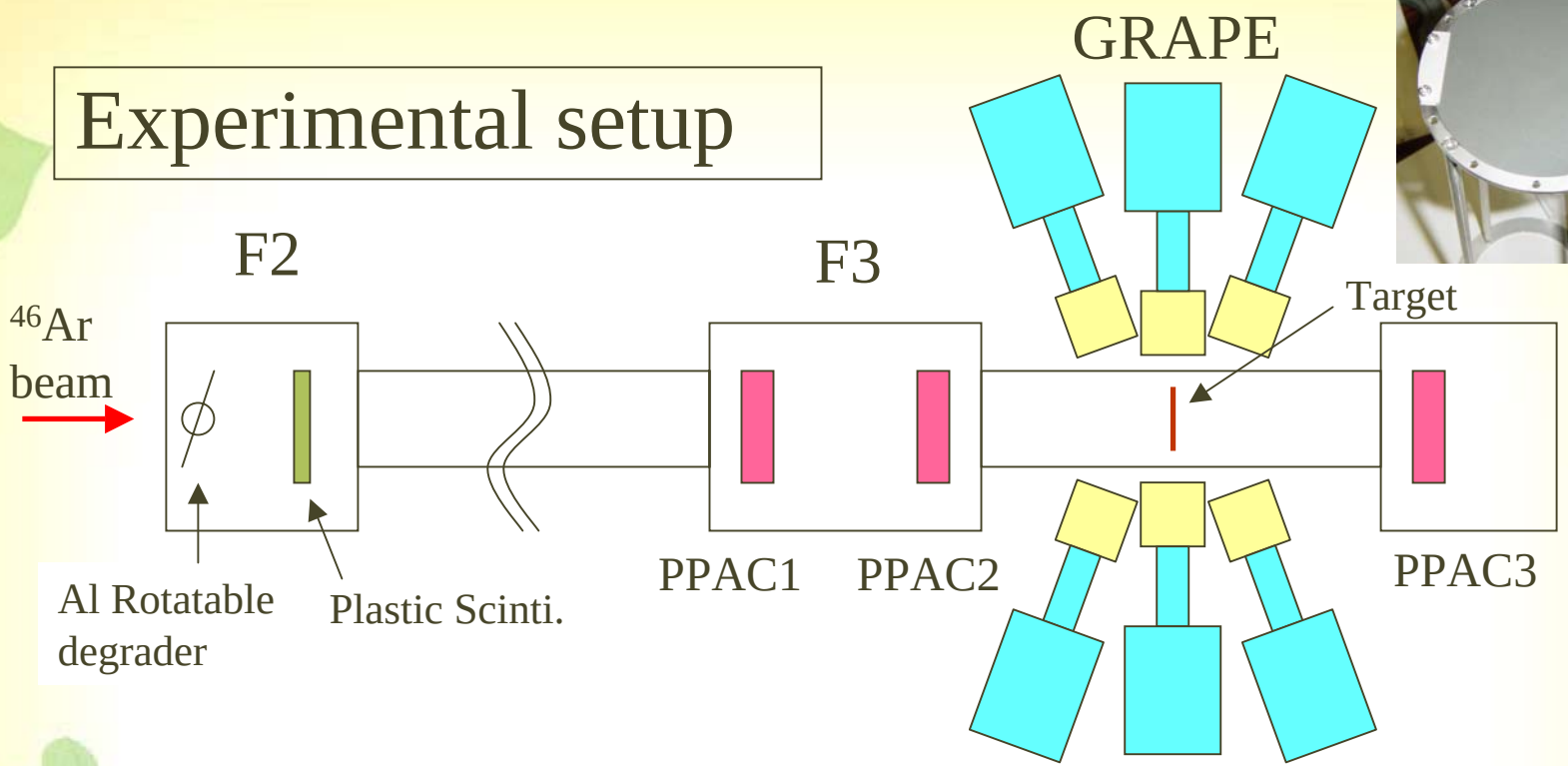
X: ±17mm, Y: ±8mm



Eenergy of ^{46}Ar on target

4.0±1.1 (MeV/A)

Experimental setup



Secondary target ： ^{9}Be 10 μ m (1.8mg/cm^2) thick、10cm ϕ

2 PPAC's before 2ndary target

→ Beam Image, incident angle on target

F2 Plastic－F3PPAC TOF → Doppler correction

→ Beam Energy

GRAPE(CNS Ge Array, about 5% for 1MeV γ ray)

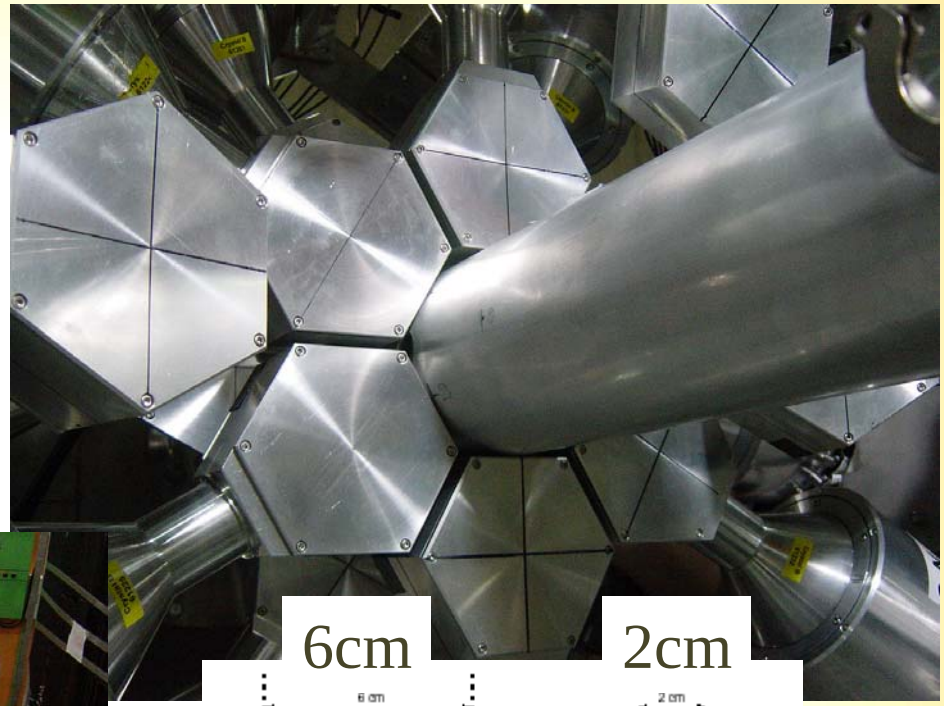
GRAPE

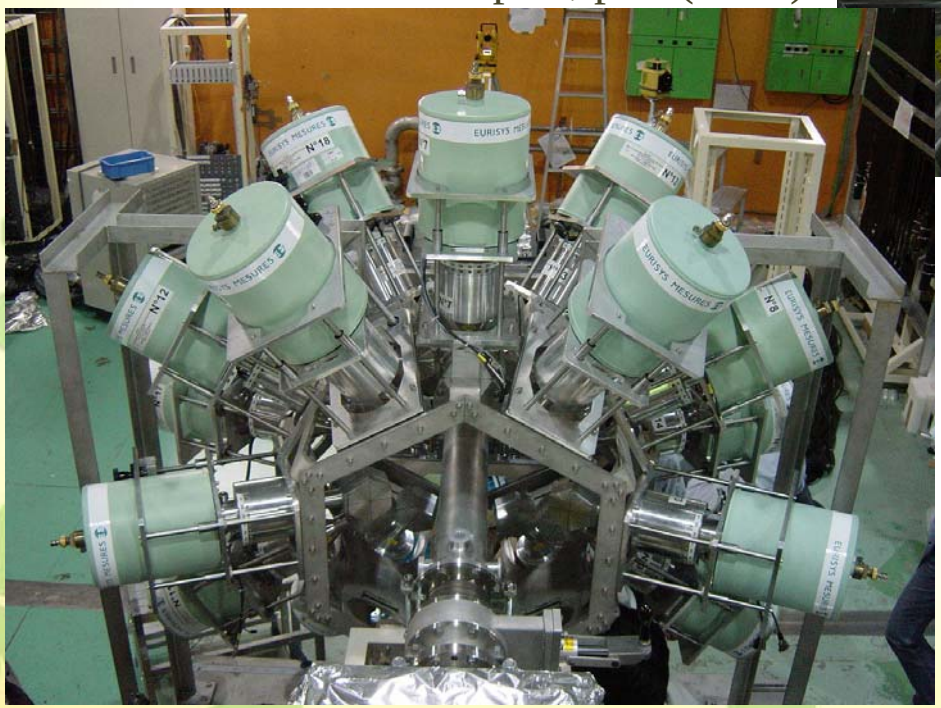
CNS Gamma-Ray detector Array with Position and Energy sensitivity

18 segmented planar Ge's

$\varepsilon_{photo} \sim 5\%$ at 1MeV

S. Shimoura et al.:
CNS Annual Report, p. 5 (2001).





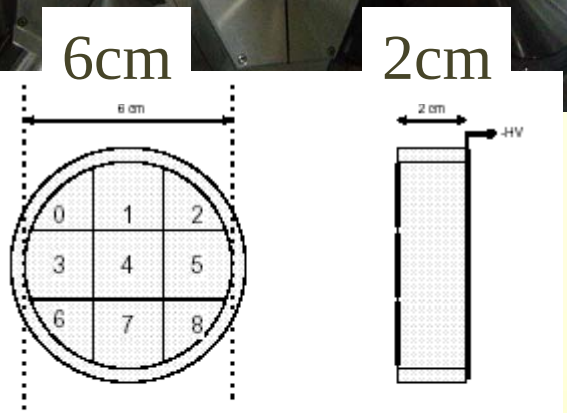
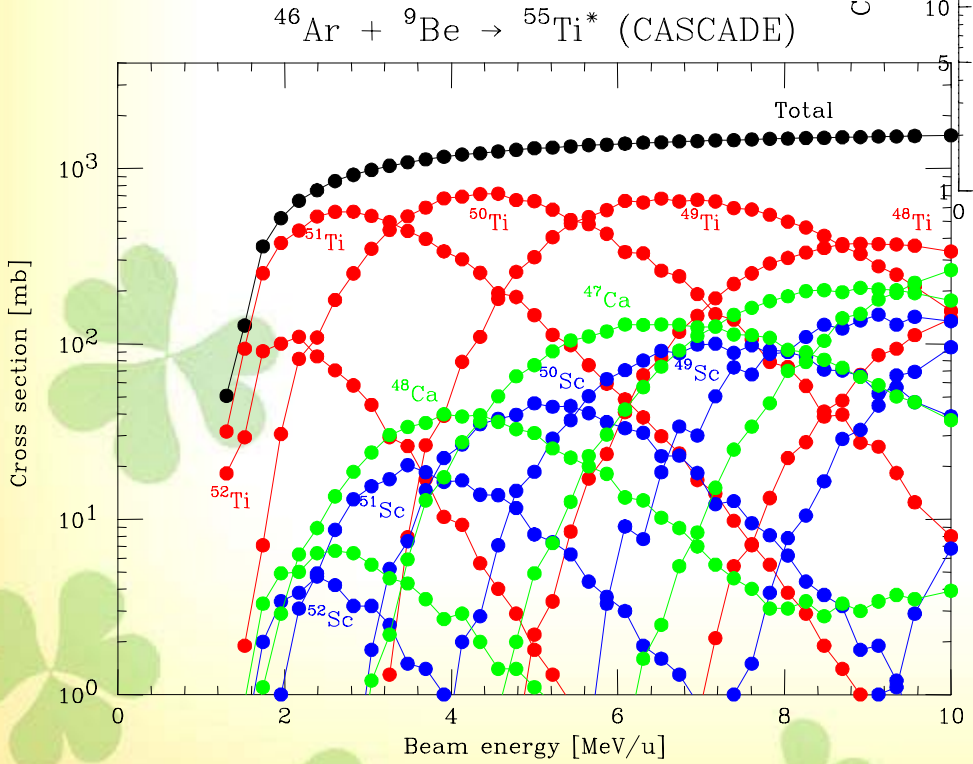
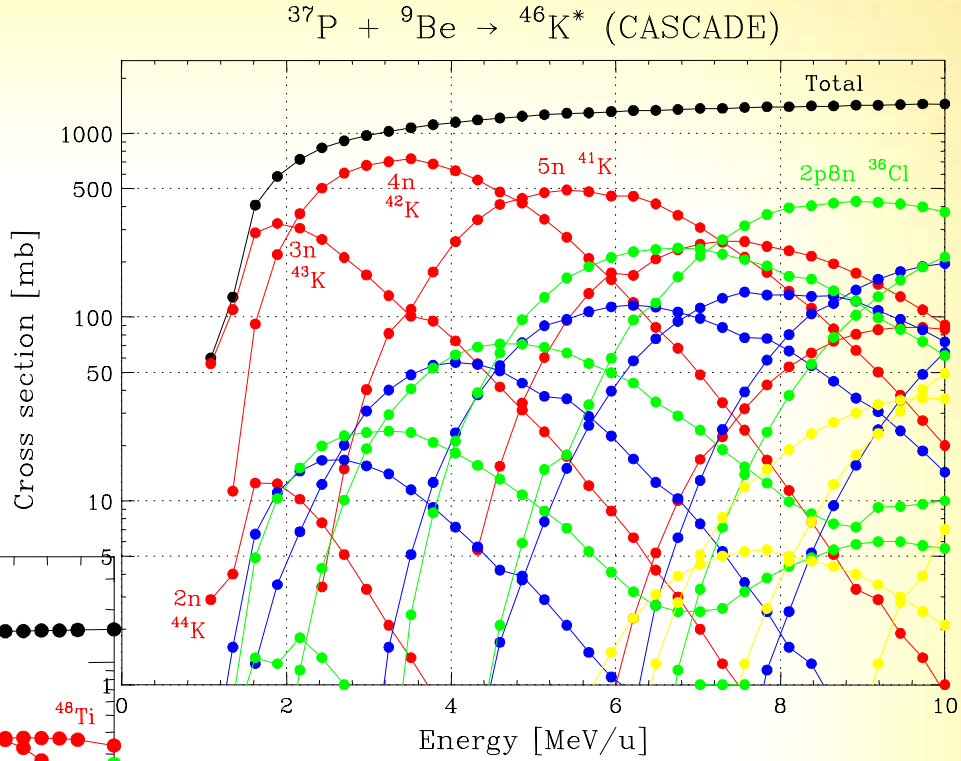


Figure 1: Illustration of a Ge detector.

type	d	ρ (cm^{-3})
p$^+$ (segmented)	0.2 μm	10^{14}
p	2.0 cm	0.8×10^{10}
n$^+$ (high voltaged)	300 μm	10^{14}

Secondary reactions

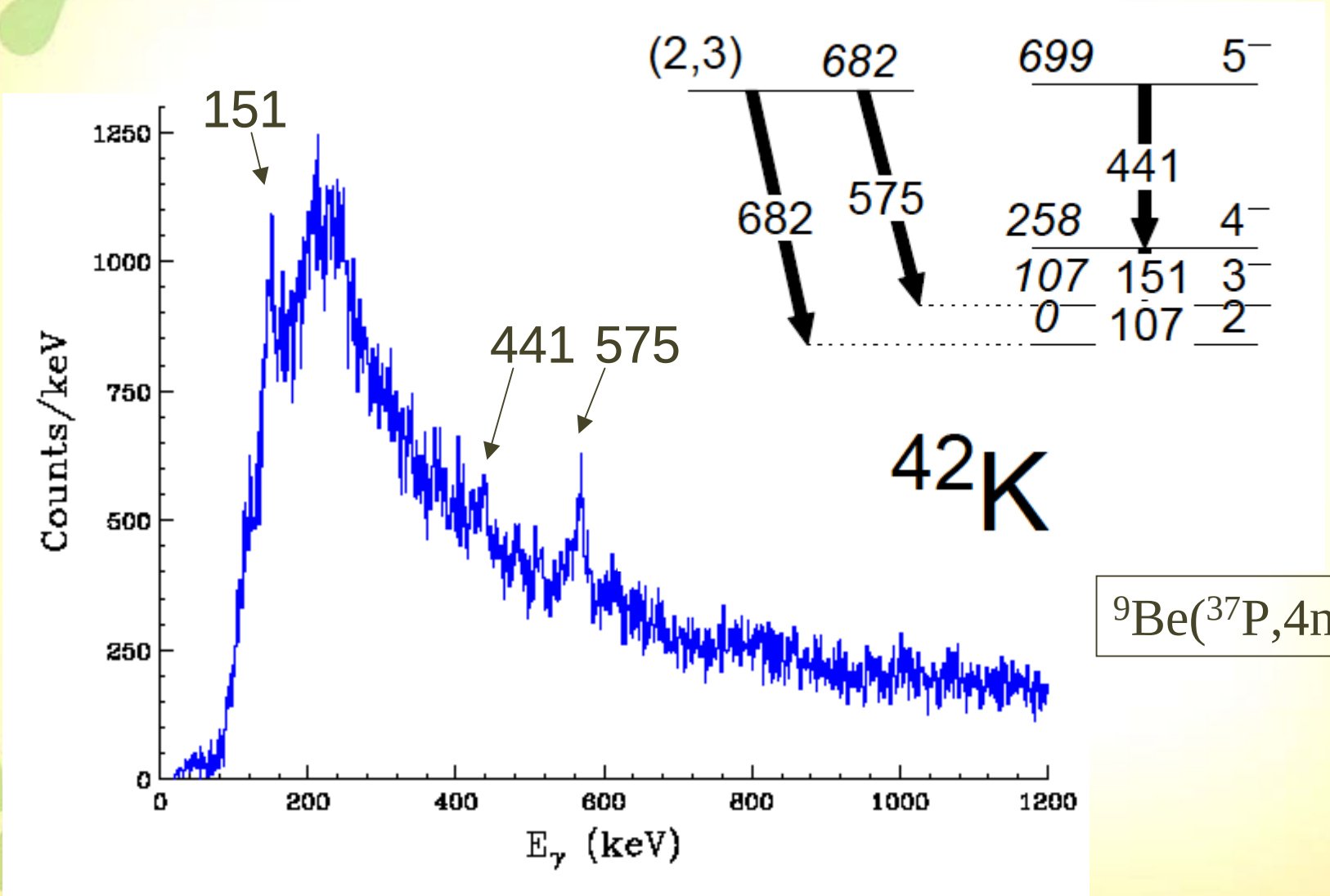




Characteristics

- Large cross section
  ～ 500mb
- Neutron rich beam
  → xn channel dominant
  → clean
- Δ Ebeam → ±2MeV/A

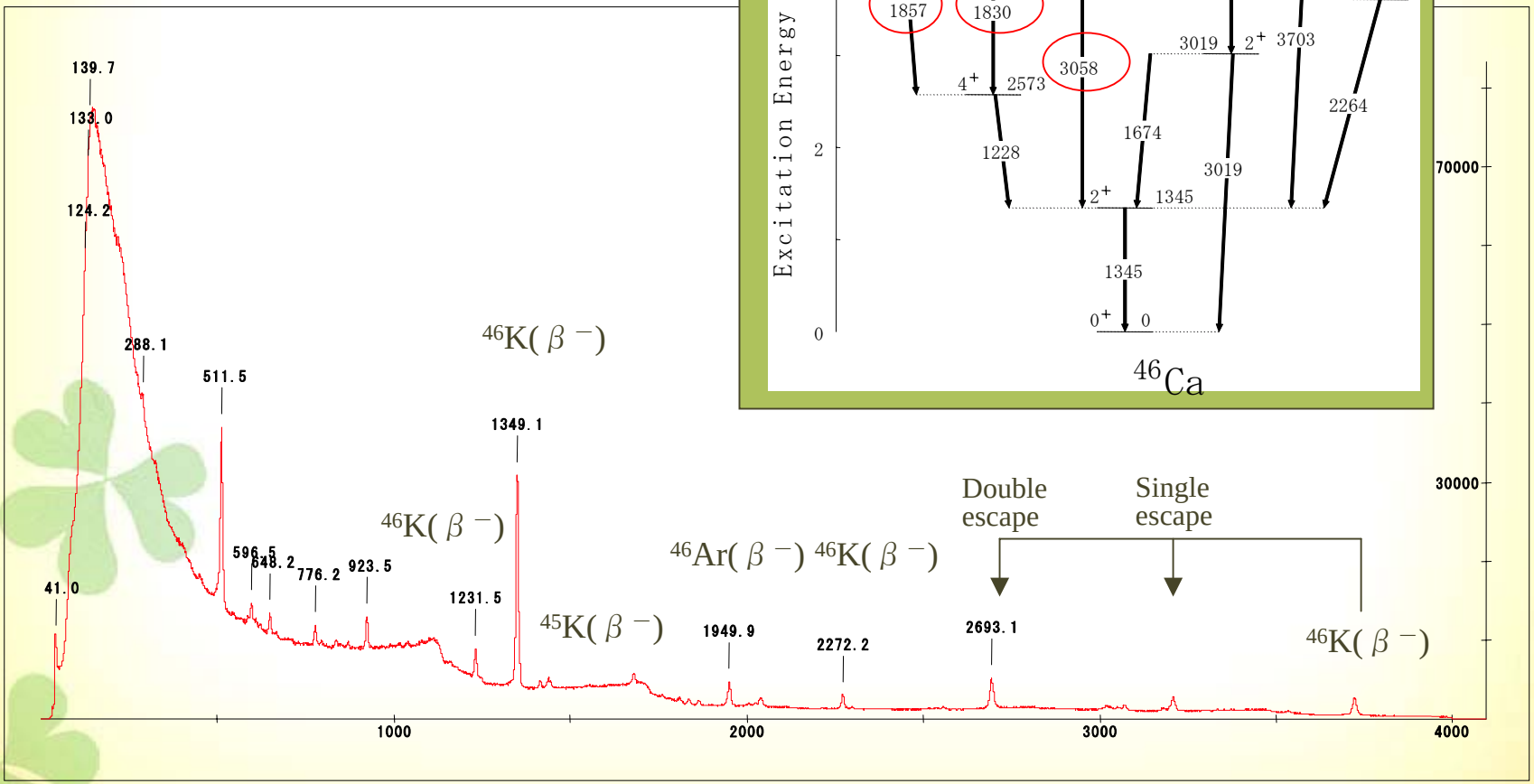
Gamma-ray spectrum (Preliminary)



$^{9}Be(^{37}P,4n)^{42}K$

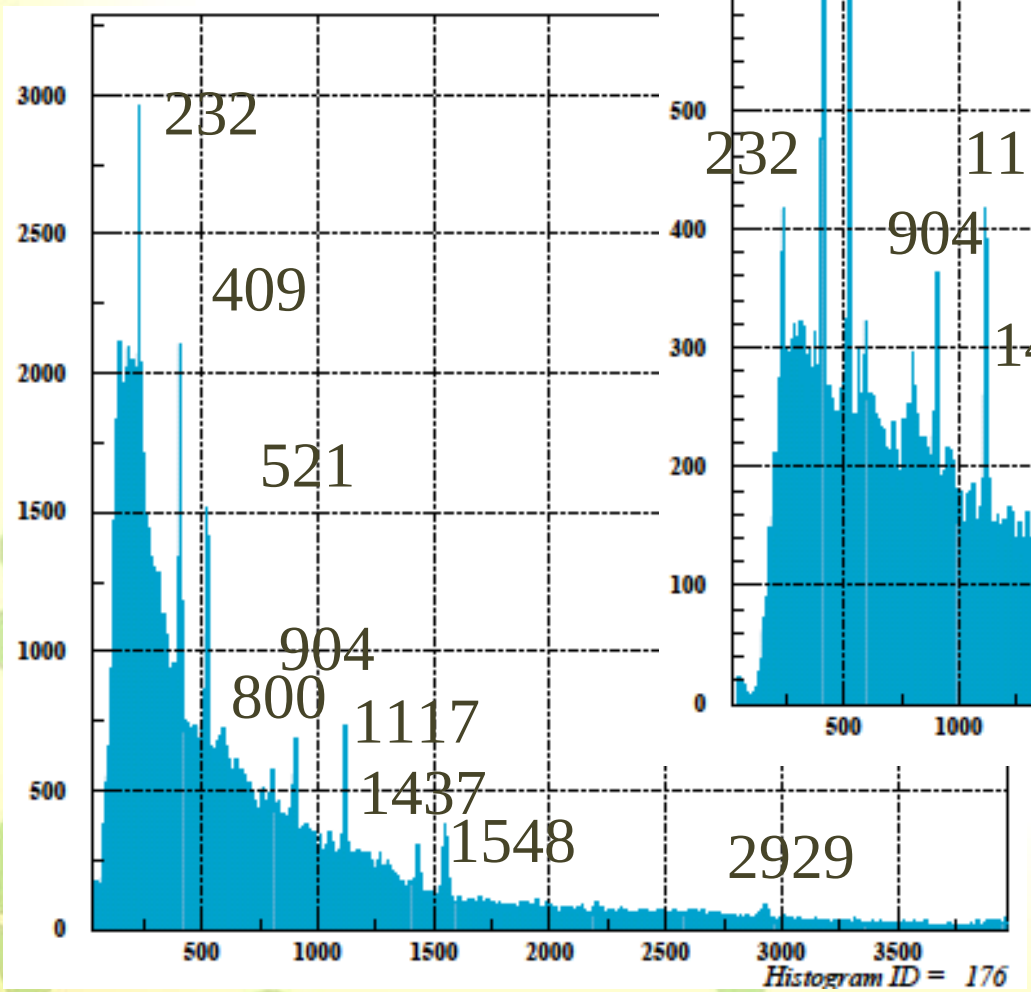
E_γ spectrum before Doppler correction

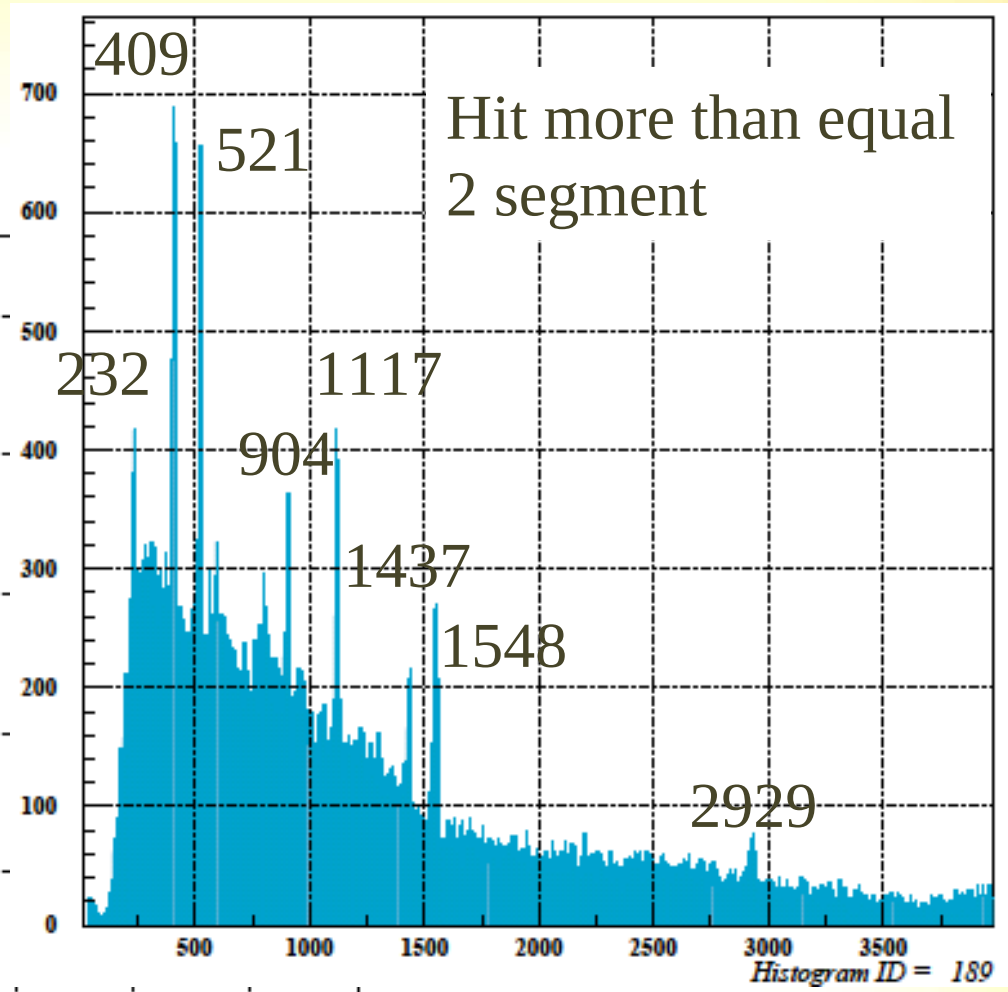
Preliminary



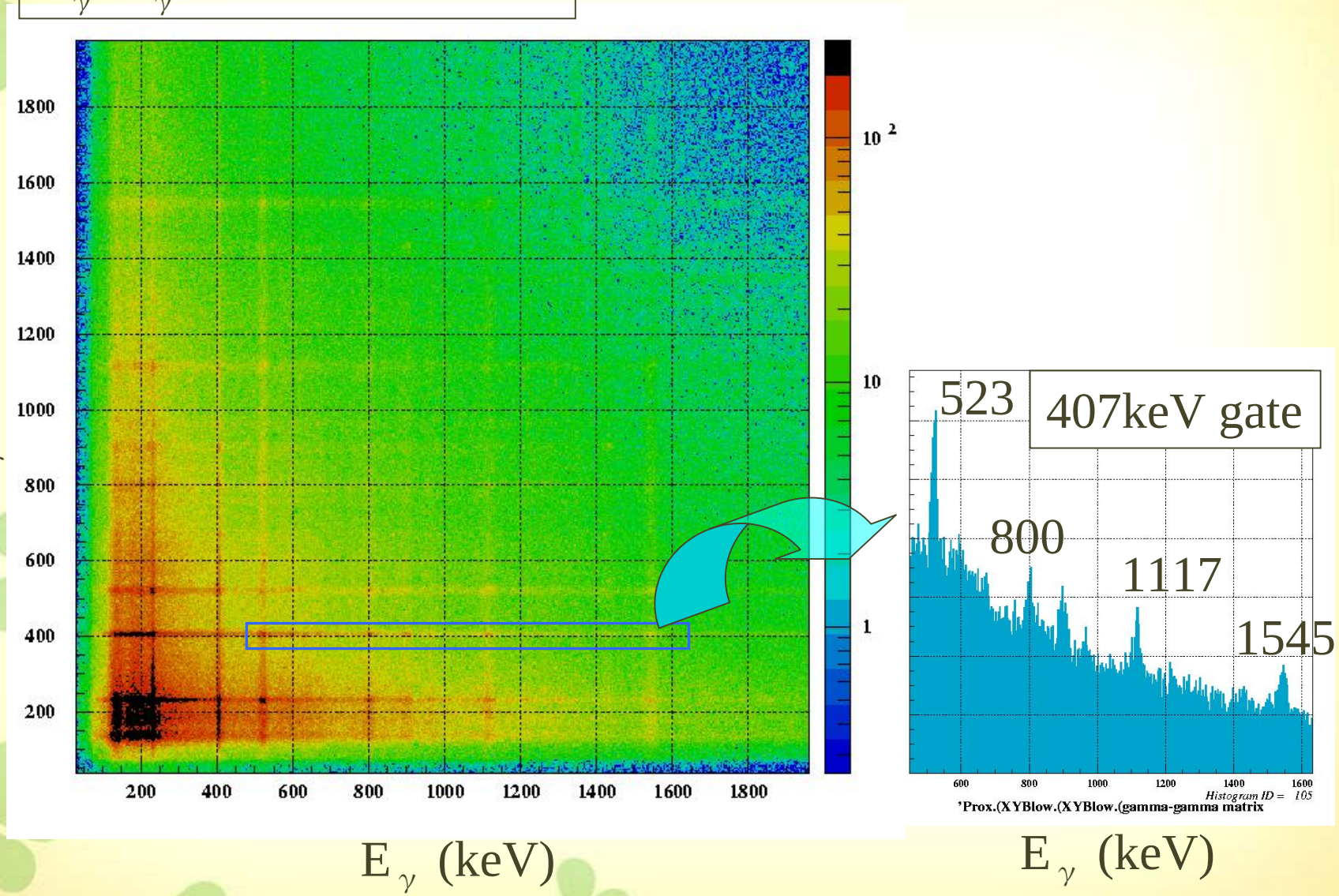
E_γ (keV)

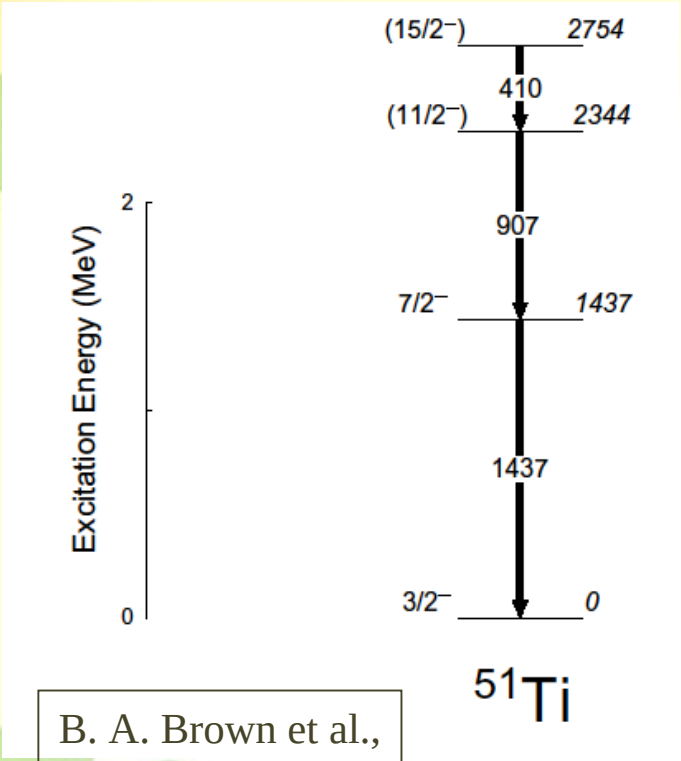
Gamma ray spectra



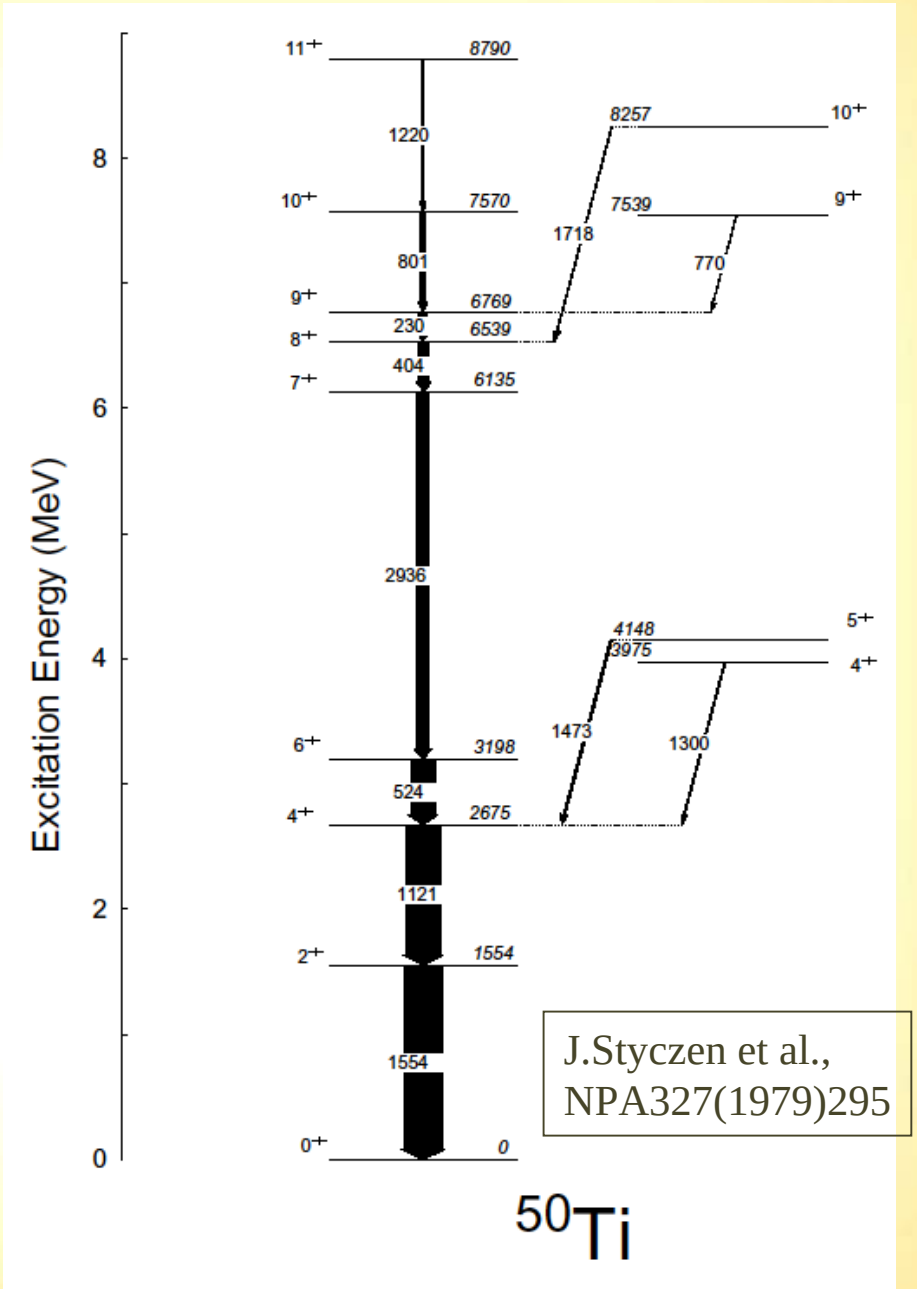


E_γ-E_γ correration matrix



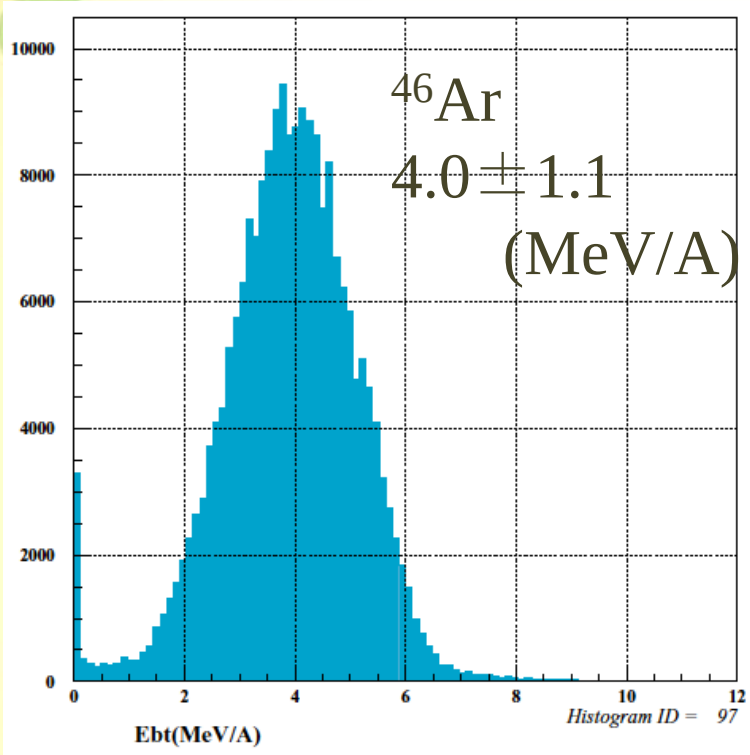


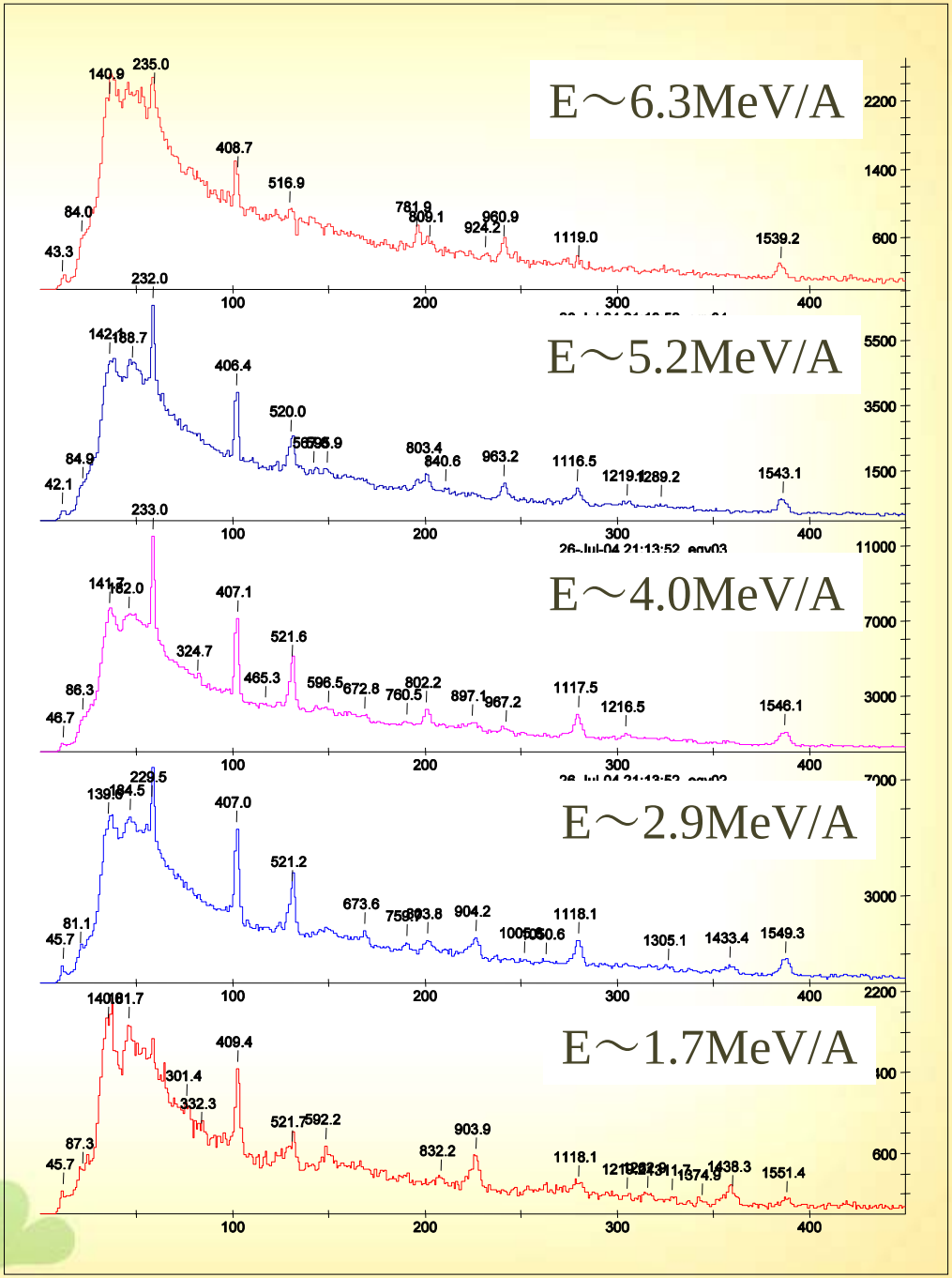
B. A. Brown et al.,
PRC(1976)1016



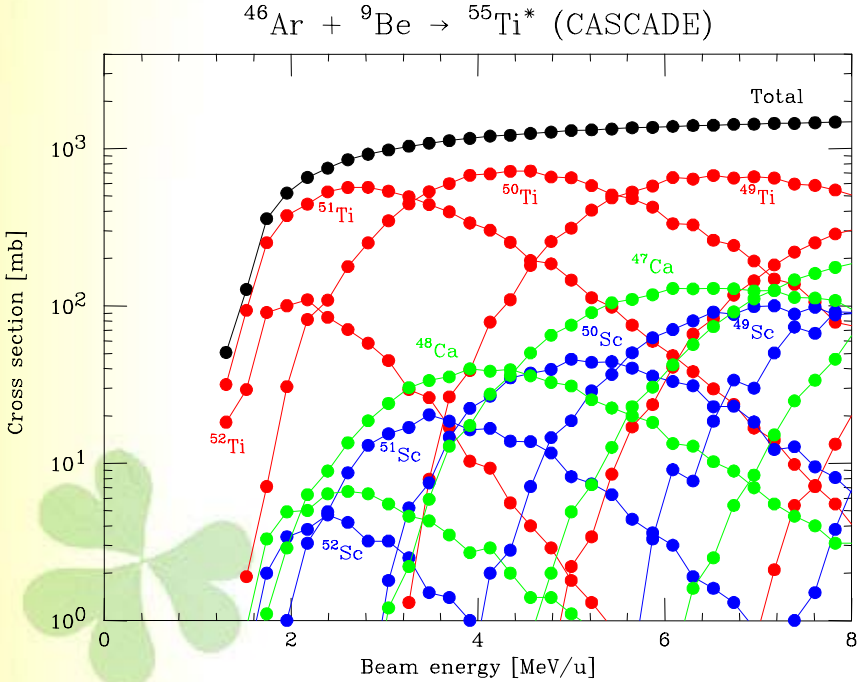
J.Styczen et al.,
NPA327(1979)295

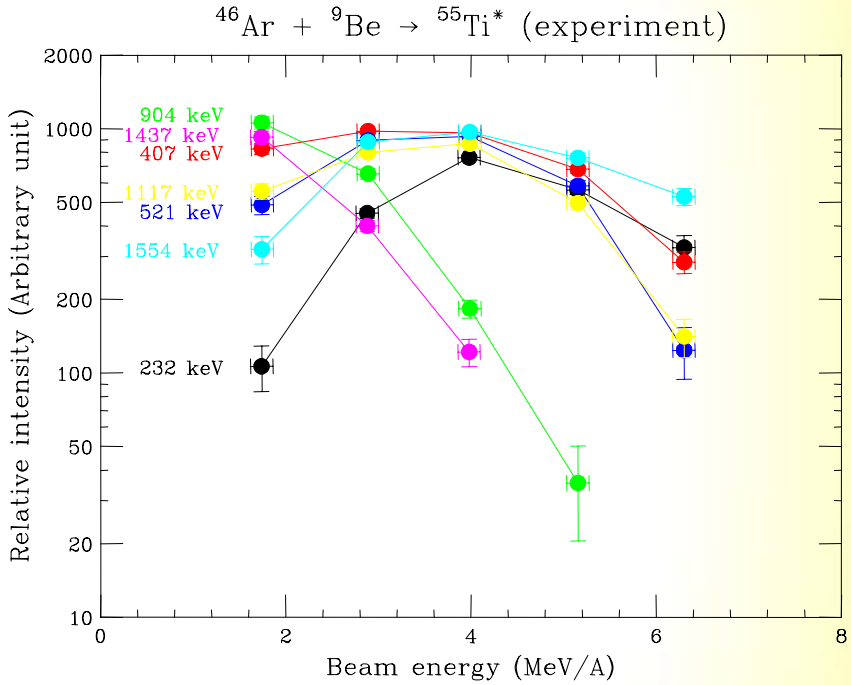
Excitaion function





Excitation function





preliminary

Summary

Development of low-energy 2ndary beam

^{37}P beam: Intensity = 1×10^5cps at F3

Purity = almost 100%

Energy = 3.9 ± 2 MeV/A

^{46}Ar beam: Intensity = 3.2×10^5cps at F3

Purity = ^{46}Ar 90%

Energy = 4.0 ± 1.1 MeV/A

Gamma-rays due to 2ndary reactions

^{42}K, ^{50}Ti (up to 11+), ^{51}Ti (up to (15/2-))

Excitation function