Isospin Symmetry Structure of GT and M1 States in A=54 Nuclei

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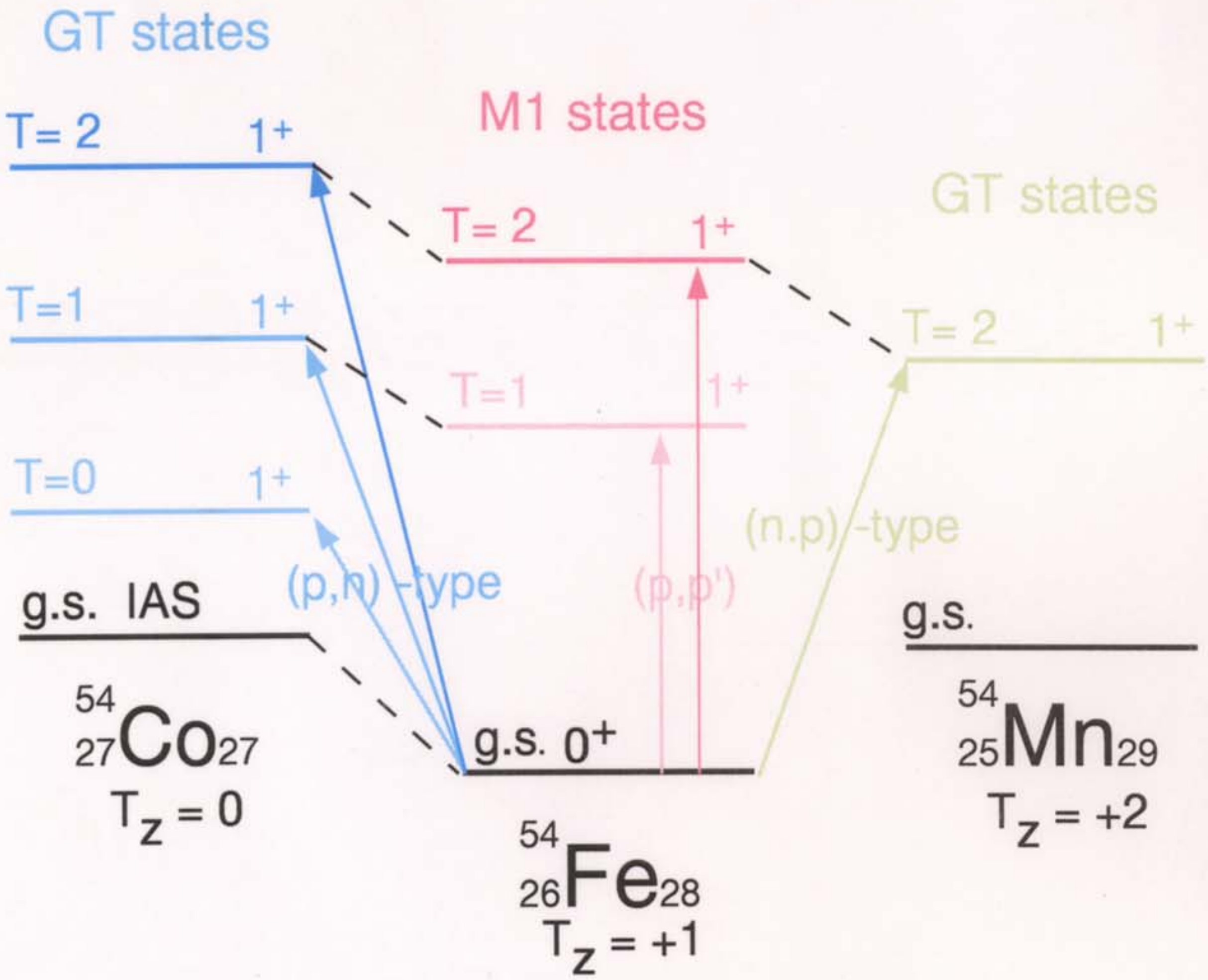
◎ Isospin Symmetry Structure in A=54 Nuclei

$\theta_{lab} = 0^\circ$, Incident energy > 100MeV/u

$\sigma\ \tau$ ($\Delta L=0, \Delta S=1, \Delta T=1$) : Dominant



$^{54}Fe(^3He,t)^{54}Co$ $^{54}Fe(p,p')^{54}Fe$
[(p,n) type]

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Observe isospin symmetry

GT states in ^{54}Co spectrum
M1 states in ^{54}Fe spectrum
] Comparison

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Identify isospin number T of GT and M1 states

◎ Identification of Isospin Quantum Number "T"

- Incident energy > 100MeV/u (2 step transition :small)
- $\theta_{lab} = 0^\circ$

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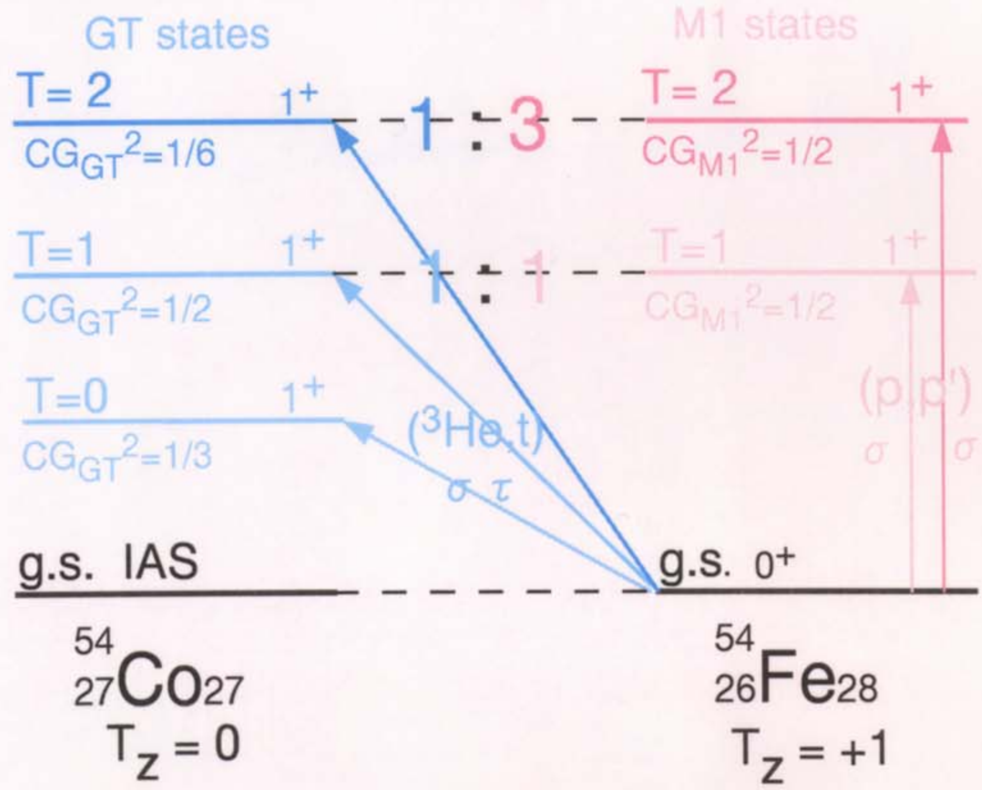
$\sigma\tau$ Dominant

<u>Proportionality</u>

$$\left(\frac{d\sigma}{d\Omega}\right)_{GT} \propto B(GT) \propto CG_{GT}^2 \left|\langle f \mid \sigma\tau \mid i\rangle\right|^2$$

$$\left(\frac{d\sigma}{d\Omega}\right)_{\sigma} \propto B(\sigma) \propto CG_{M1}^2 \left|\langle f \mid \sigma\tau \mid i\rangle\right|^2$$

CG: Clebsh Gordan coefficients for isospin number T



It is necessary to make a "level-by-level" comparison between analogous GT and M1 states.

(The interval between excited states are small (several ten keV))

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High resolution experiment needed

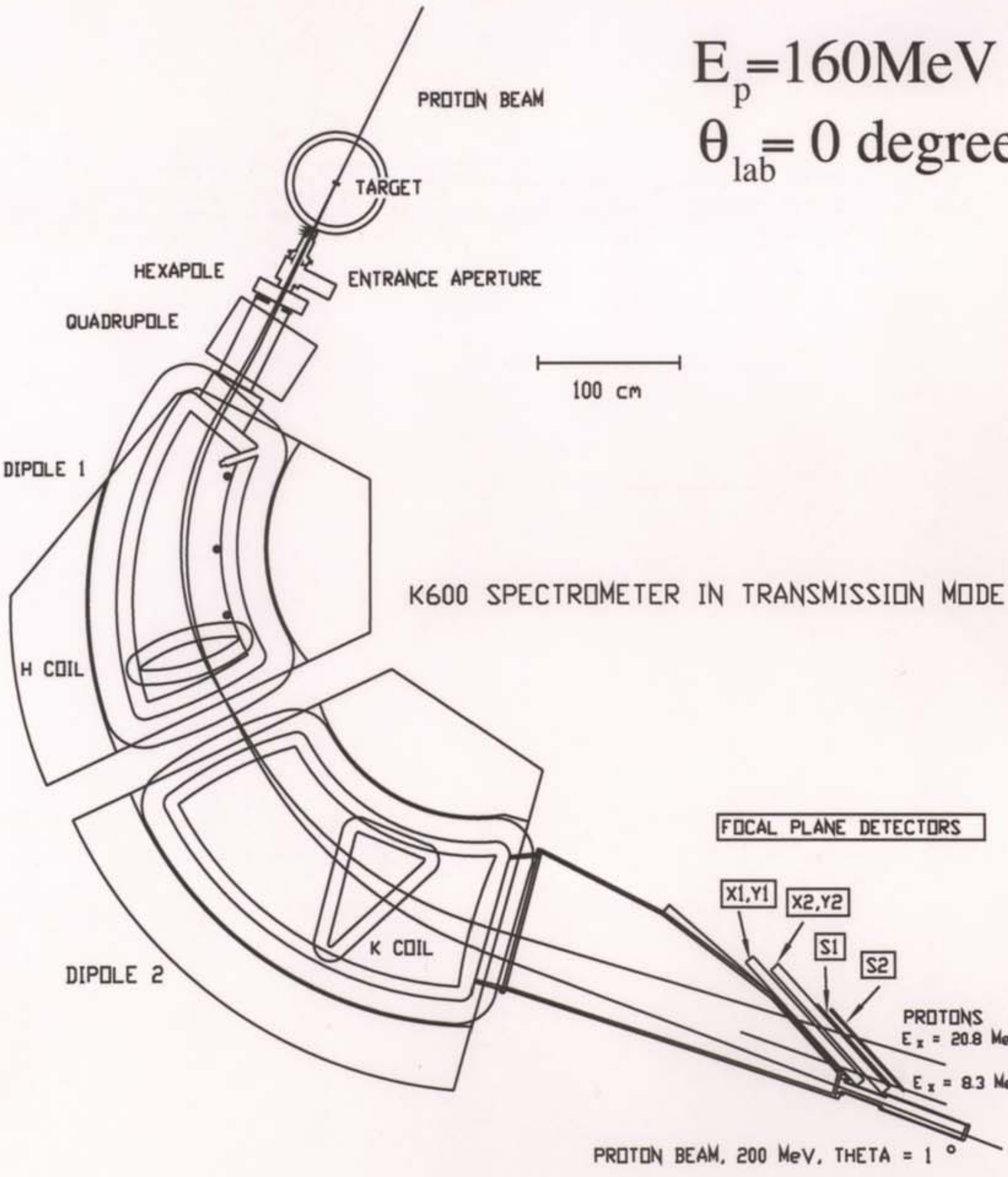
➡ Dispersion matching techniques

$^{54}Fe(p,p')^{54}Fe$

Magnetic spectrometer K600 at IUCF

$E_p = 160 MeV$

$\theta_{lab} = 0$ degree



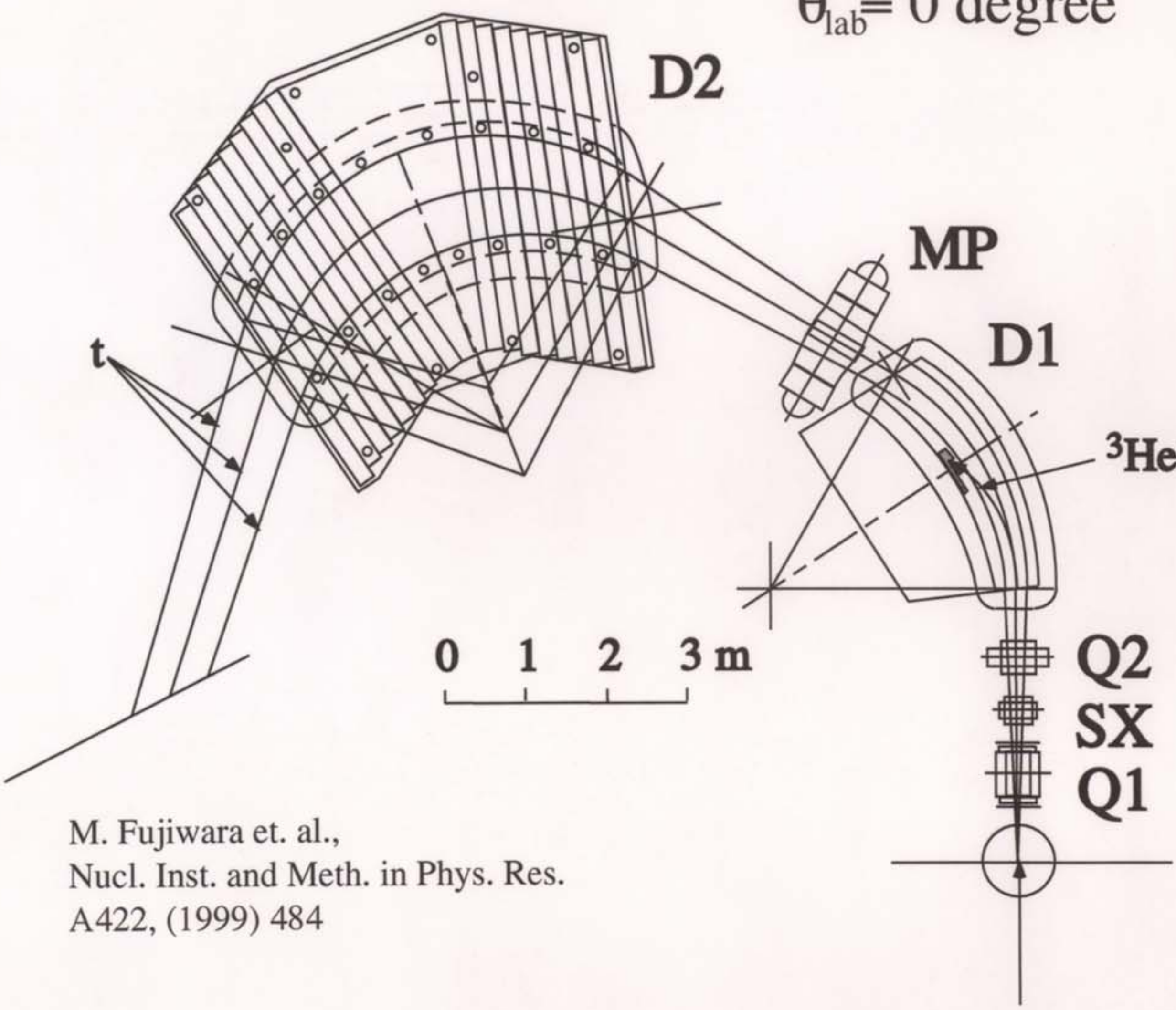
C.C Foster and G.P.A Berg,
IUCF Sci. and Tech. Report 1988-1989, p.193.

$^{54}Fe(^{3}He,t)^{54}Co$

Magnetic spectrometer Grand Raiden at RCNP

E_{He}=140MeV/u

θ_{lab}= 0 degree

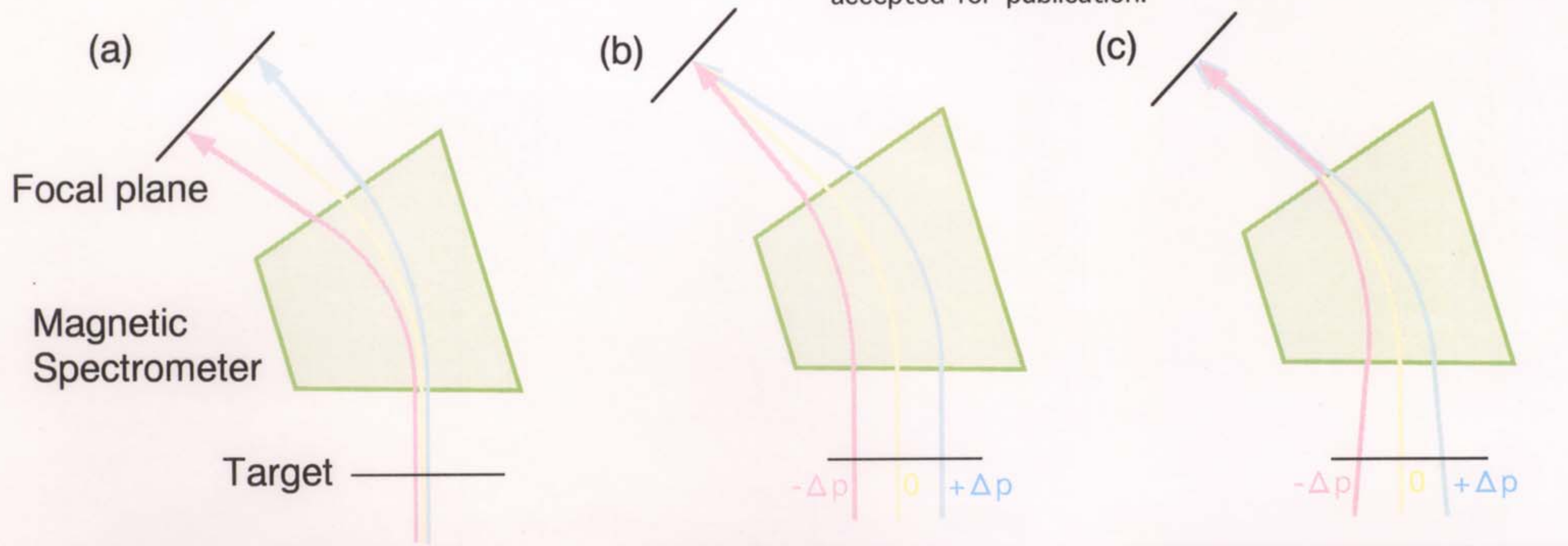


M. Fujiwara et. al.,
Nucl. Inst. and Meth. in Phys. Res.
A422, (1999) 484

◎ Dispersion matching technique

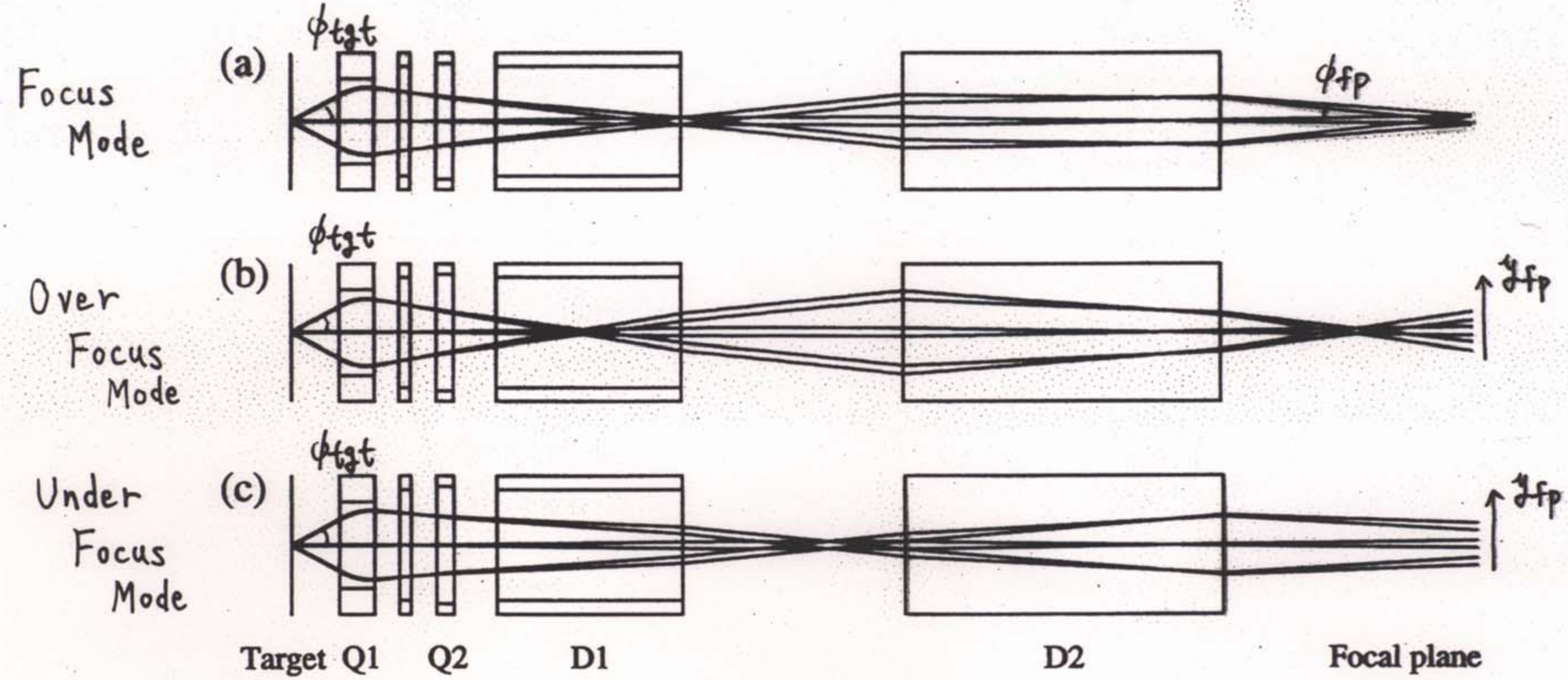
Y. Fujita et al., Nucl. Inst. and Meth. in Phys. Res. B 126 (1997) 274.

H. Fujita et al., Nucl. Inst. and Meth. in Phys.Res. A, accepted for publication.



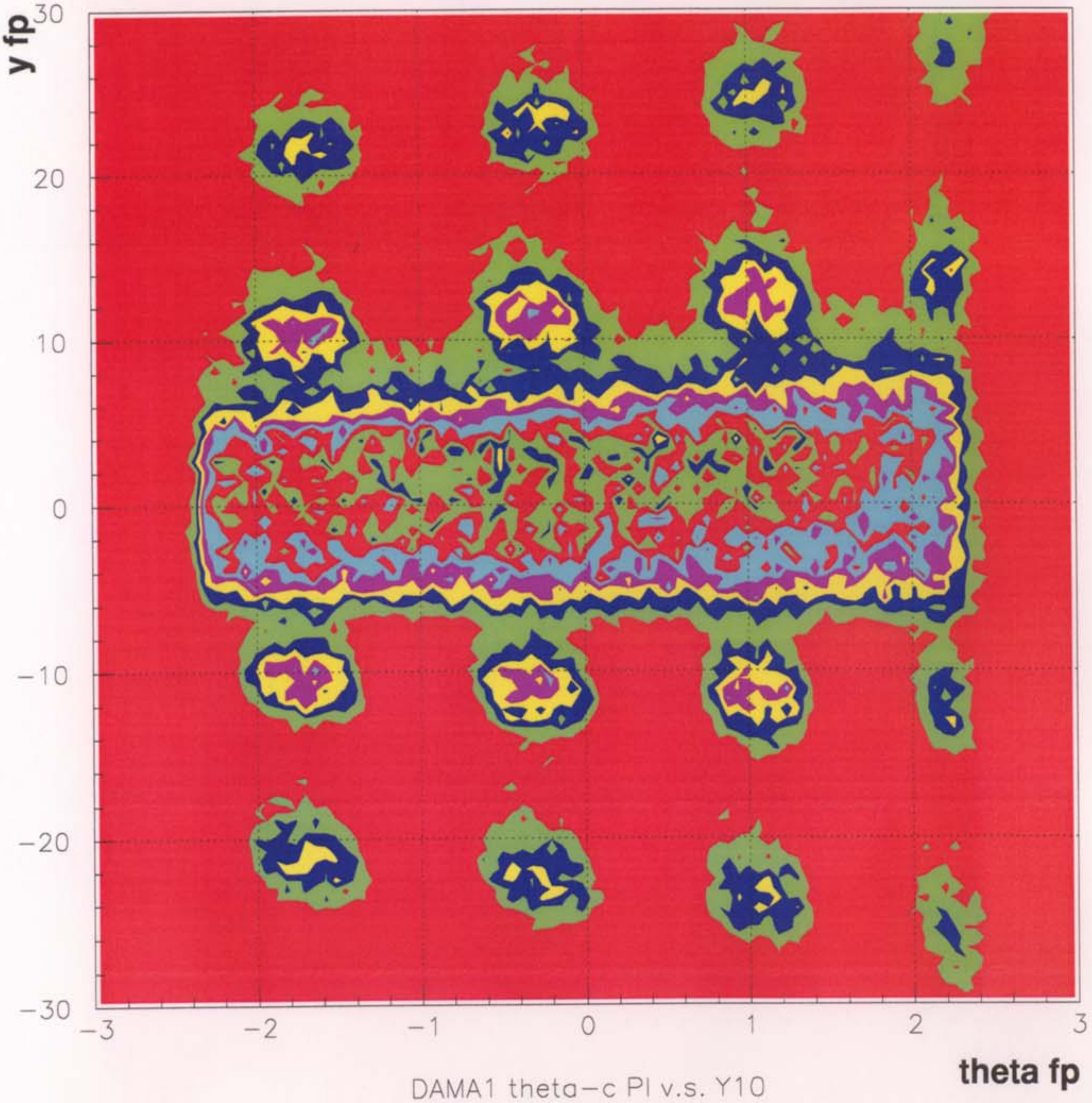
Achromatic beam transportation	*Lateral dispersion matching*	*Angular dispersion matching*
$\Delta E \sim 200$keV for 140MeV/u ^{3}He beam	$\Delta E \sim 35$keV Horiz. angle resolution $\Delta\theta_{sc} > 15$mrad	$\Delta\theta_{sc} \sim 5$mrad

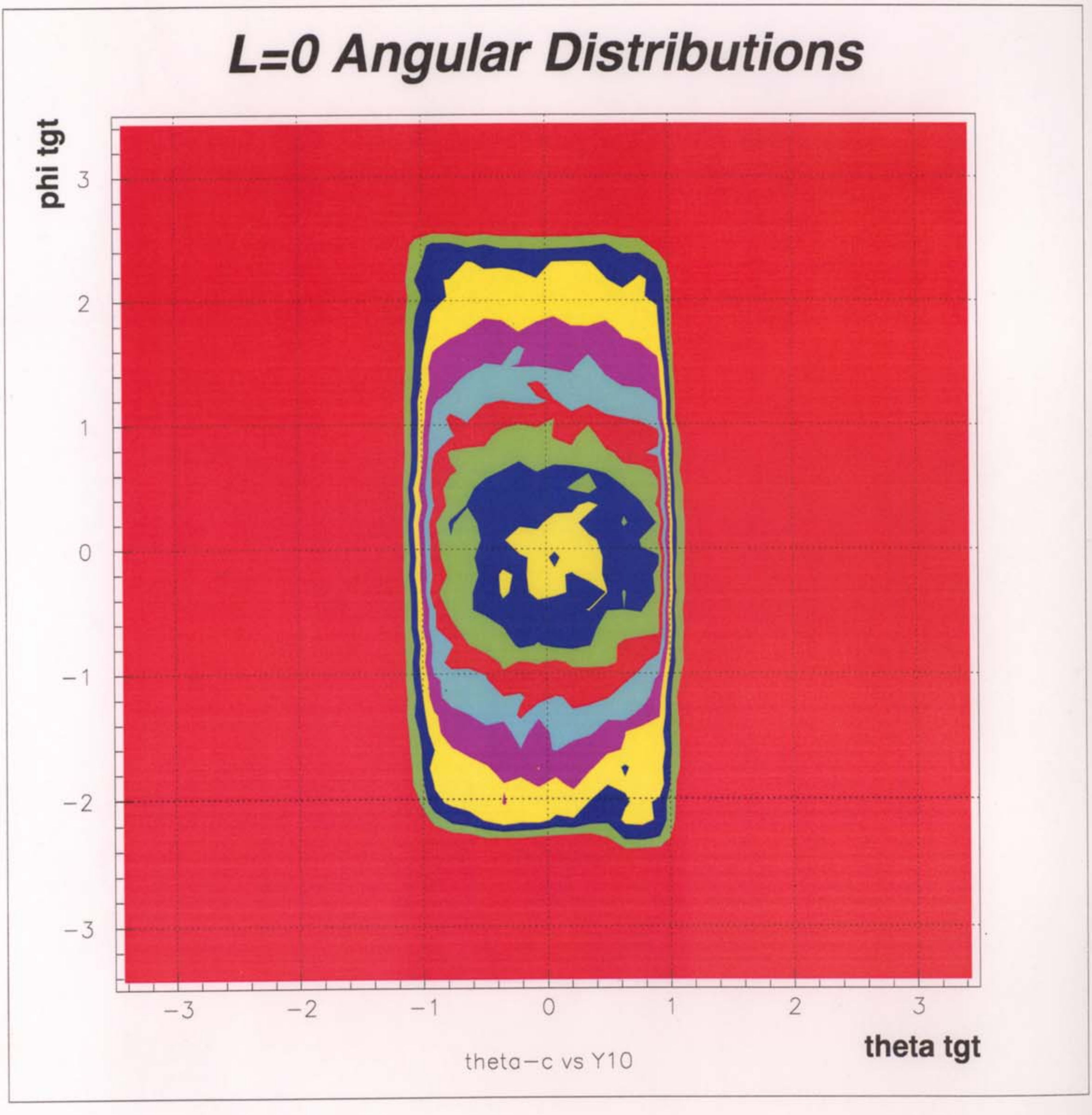
Vertical Scattering Angle Measurement from the Vertical Position in the Focal Plane



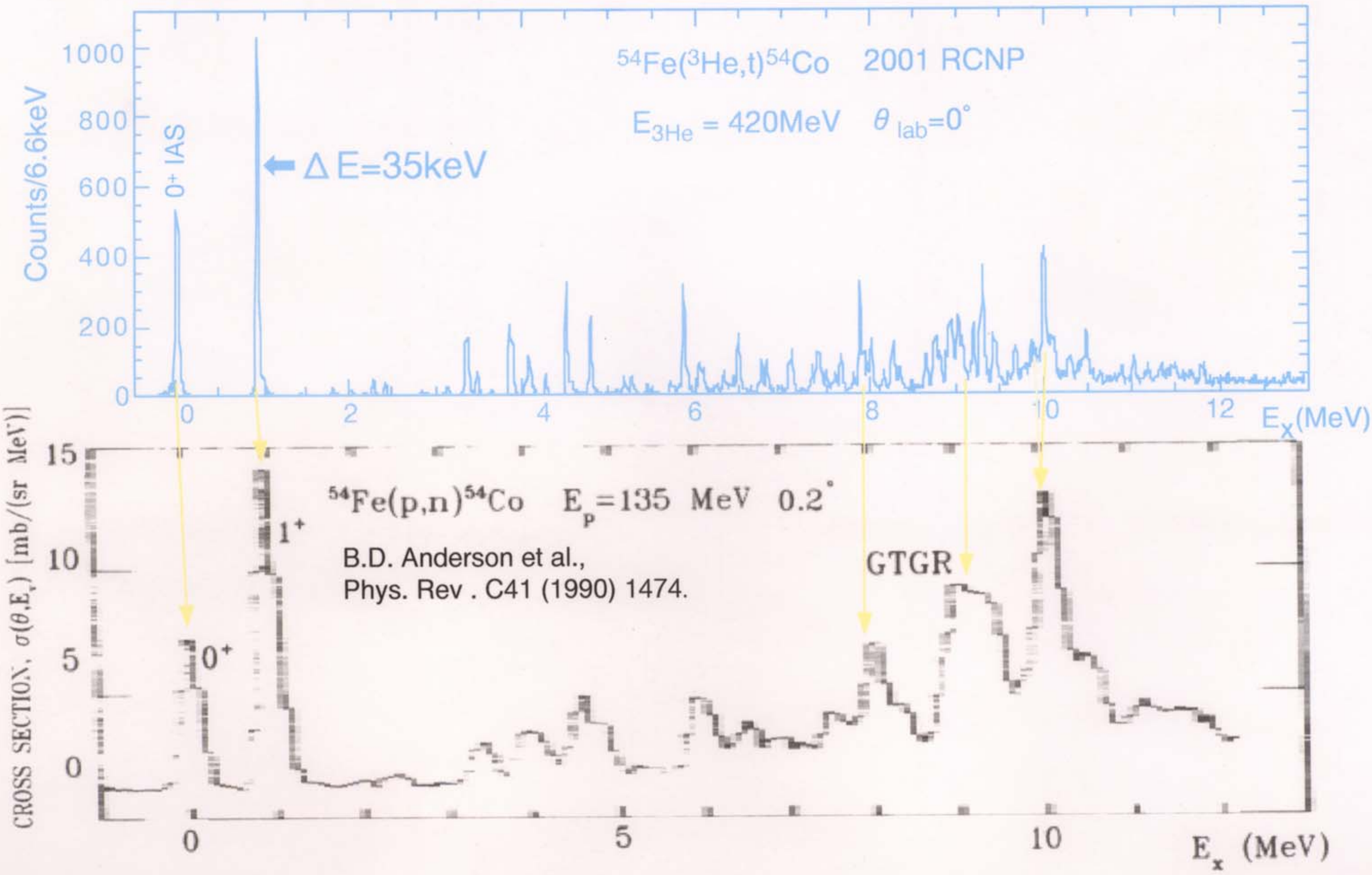
H. Fujita et al.,
Nucl. Instrum. Methods Phys. Res. A469 (2001) 55.

Measurement in the Focal Plane

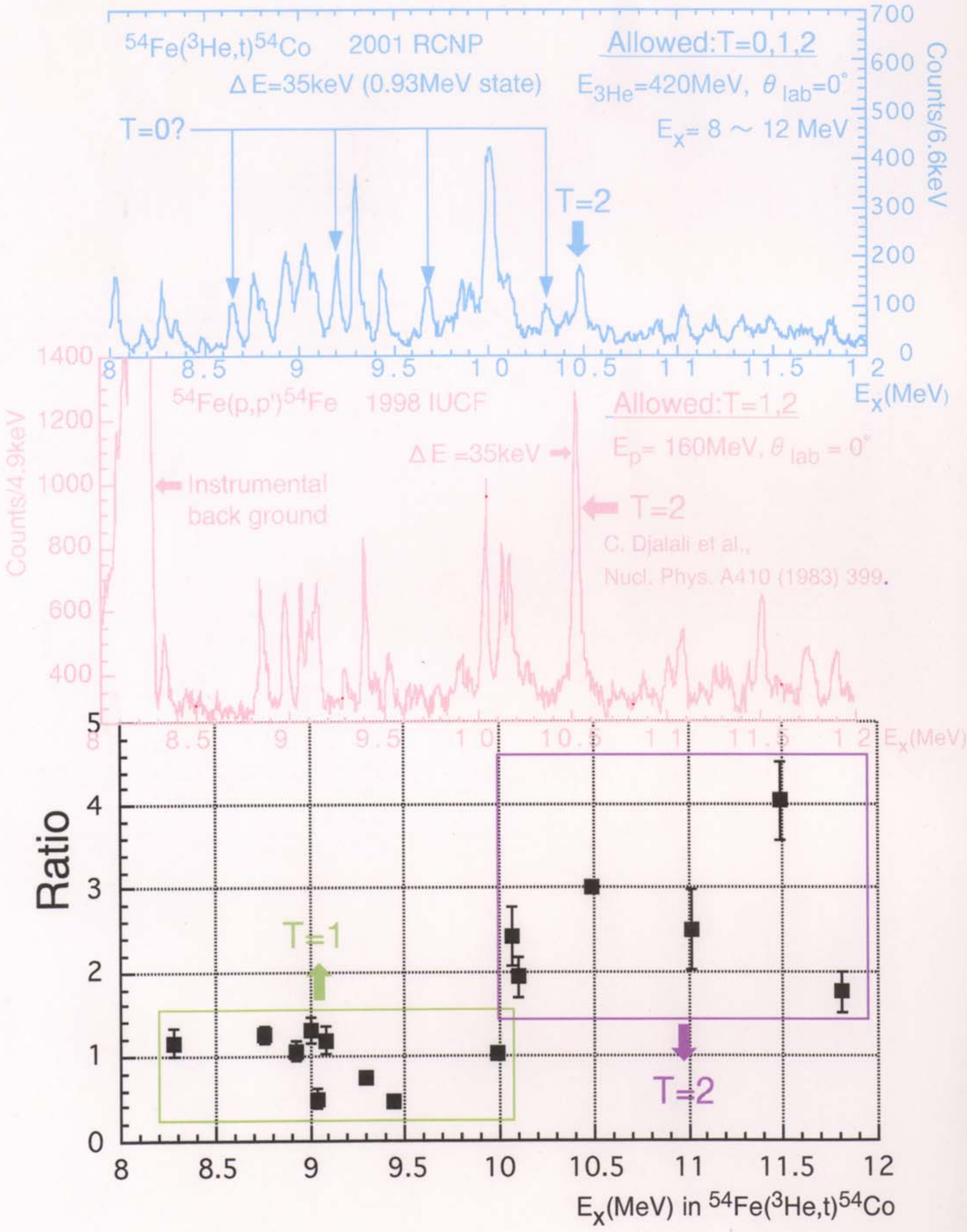



L=0 Angular Distributions
phi tgt
3
2
1
0
−1
−2
−3
−3
−2
−1
0
1
2
3
theta tgt
theta−c vs Y10

◎ An Improvement of the Resolution



◎ Ratio of Cross Sections for Analogous States



◎ Summary

Motivation

To observe isospin symmetry in A=54 nuclei and identify isospin number "T" by comparing GT and M1 states

Experiment

1. Applying "Dispersion matching techniques"

   High resolution was achieved

   ΔE=35keV ^{54}Fe(^{3}He,t)^{54}Co (0.93MeV state)

2. Applying "Angular dispersion matching techniques" and using over focus mode

   Good angle resolution achieved

   ΔL=0 angular distributions were clearly observed

Comparison

^{54}Fe(^{3}He,t)^{54}Co v.s. ^{54}Fe(p,p')^{54}Fe spectra : 8 -12MeV

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Candidates of T=0 states could be found

Analogous states could be seen

➡ Identification of "T" by the ratio

Candidates of T=1 states E_x= 8-10MeV

Candidates of T=2 states E_x= 10-12MeV