Polarization of Post-Accelerated Beams at ISOLDE and TDRIV Experiments at Tandem-ALTO

TDRIV Experiments at Tandem-ALTO

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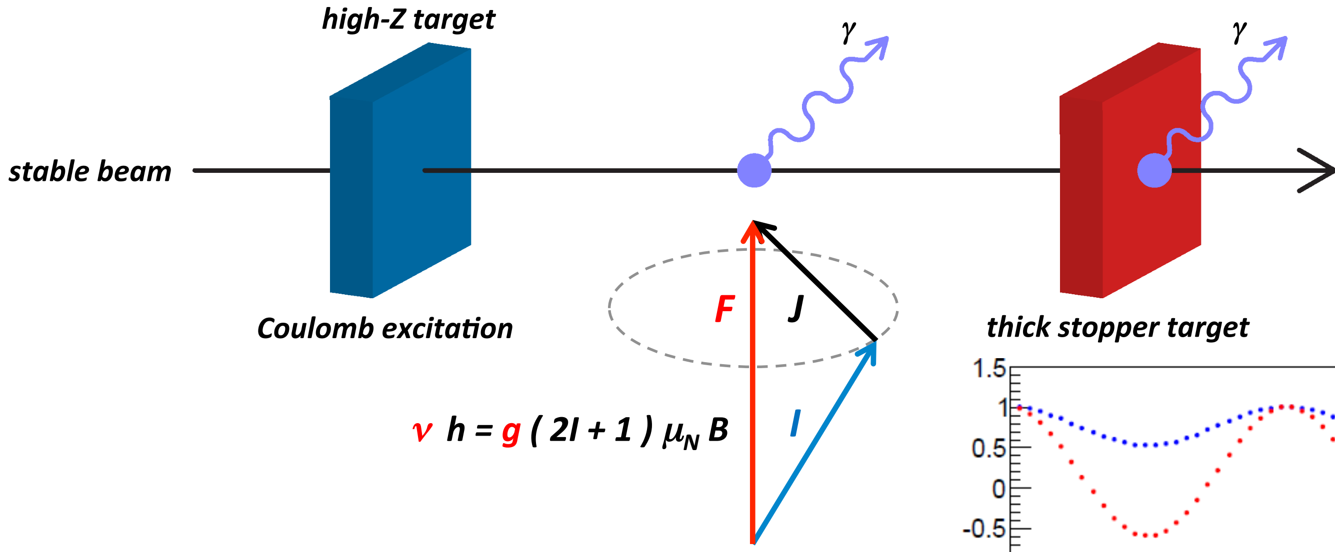
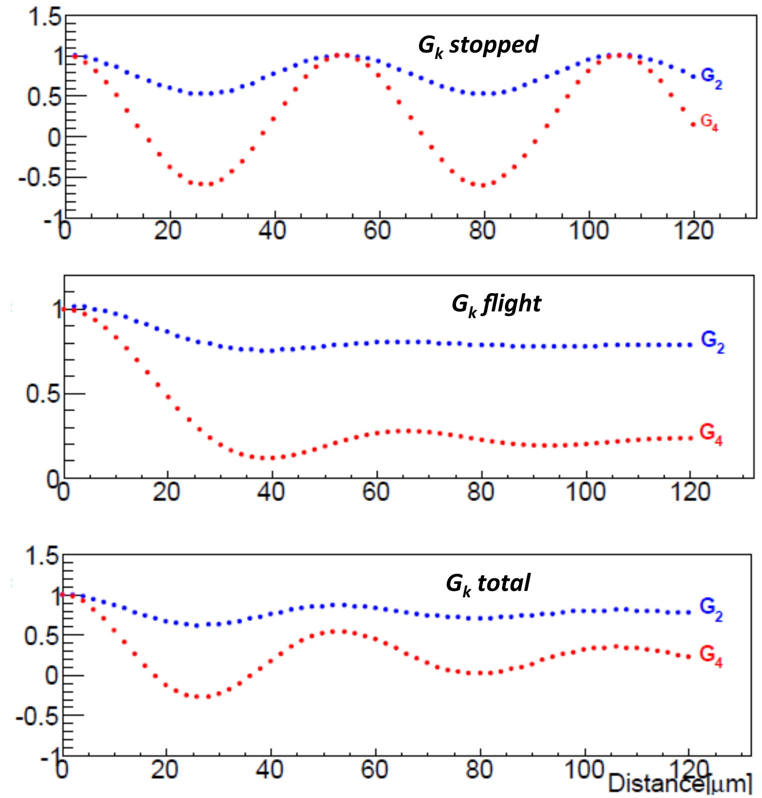
Time-Differential Recoil-in-Vacuum (Plunger) Method on Stable Beams



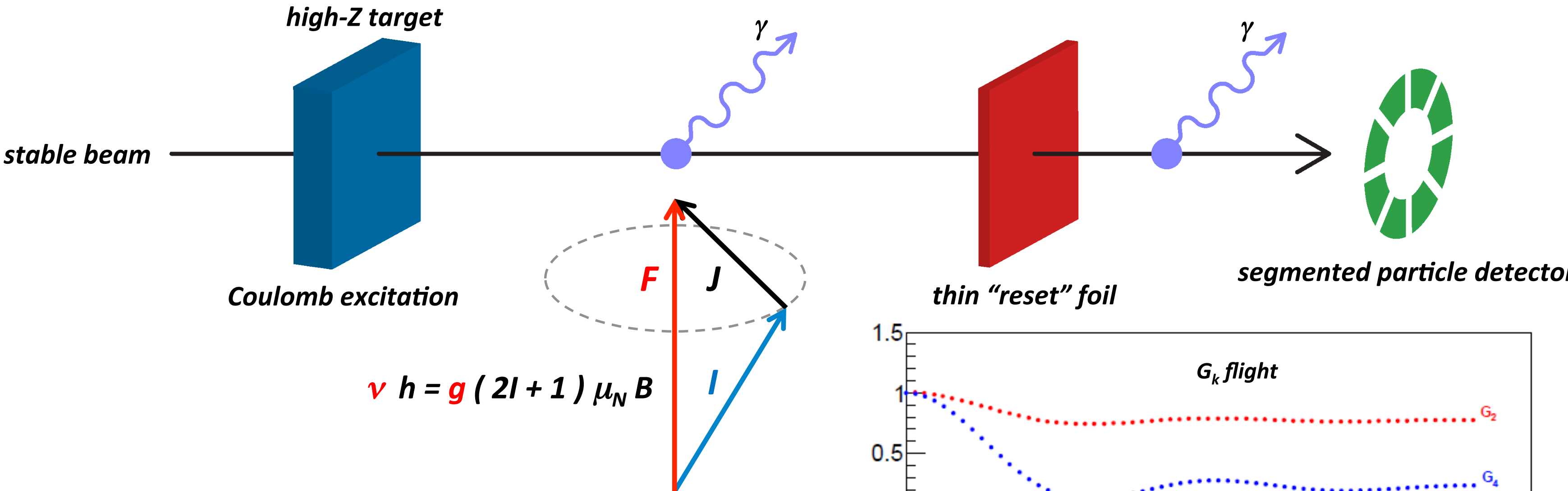
$\nu\ h = g\ (2I + 1)\ \mu_N\ B$



The time-dependent particle-γ angular correlation:

$$W = 1 + a_2\, G_2(t)\, P_2(\cos\theta) + a_4\, G_4(t)\, P_4(\cos\theta)$$

Time-Differential Recoil-in-Vacuum (Plunger) Method on Radioactive Beams



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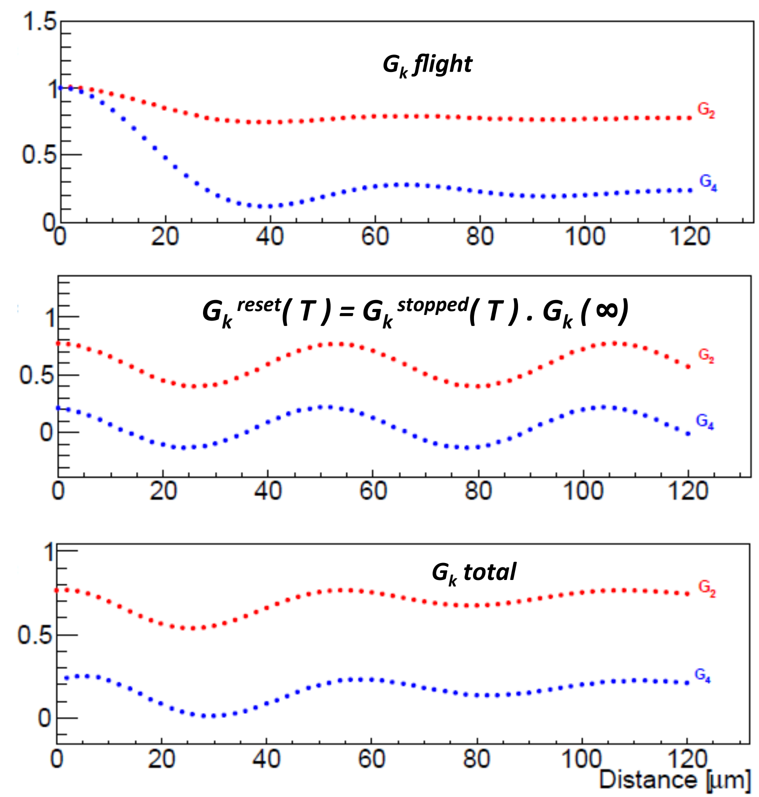

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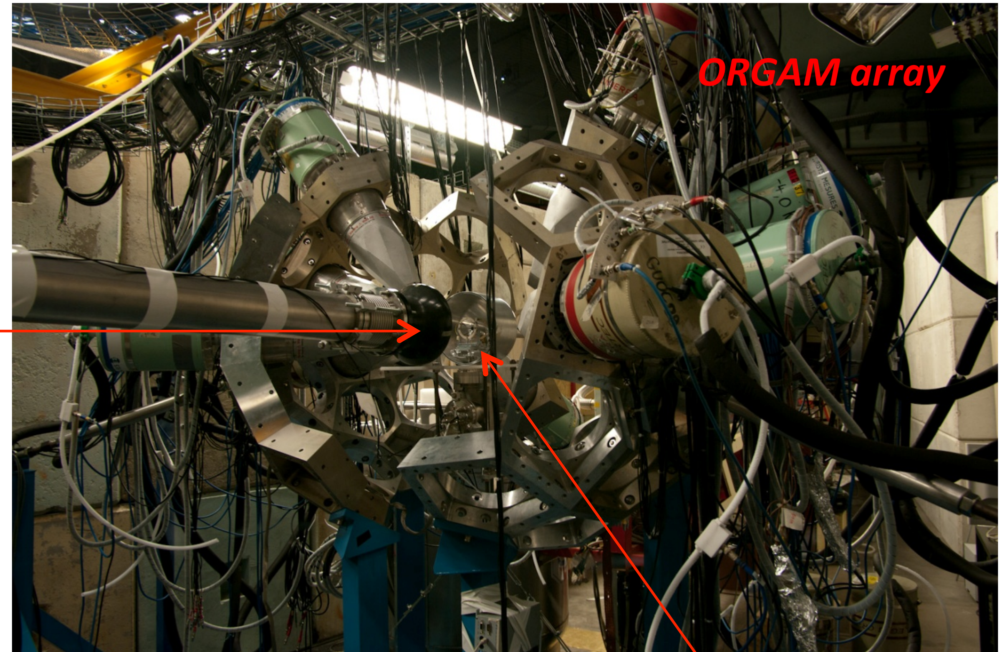
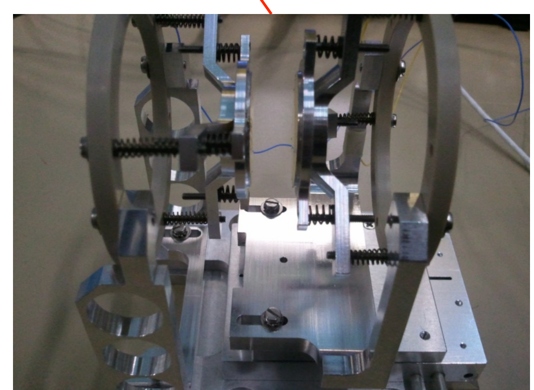
Stuchbery, Mantica, and Wilson
Phys. Rev. C, 71, 047302 (2005)

Time-Differential Recoil-in-Vacuum (Plunger) Method on Radioactive Beams

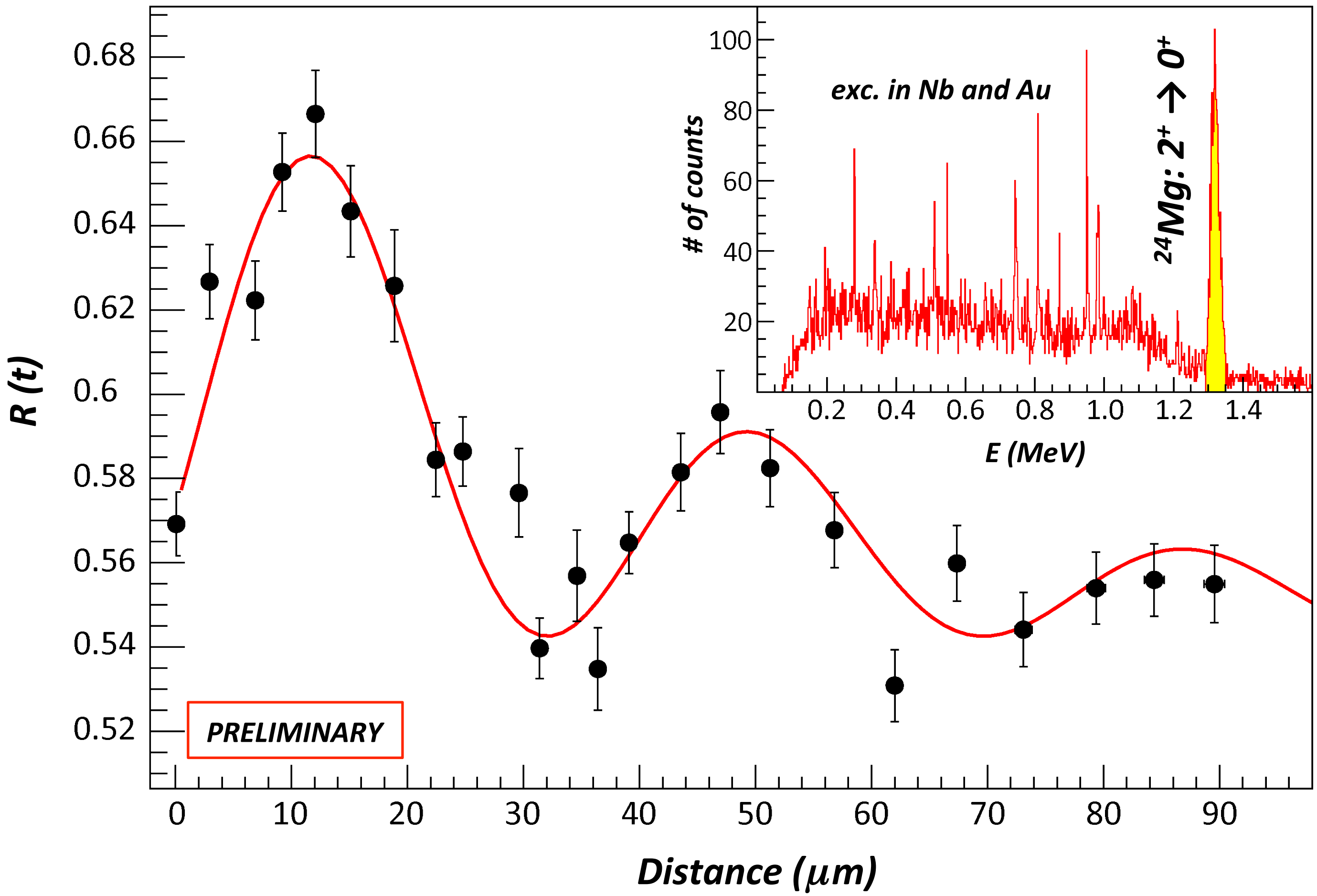




Beam: *^{24}Mg @ 120 MeV, 0.3 pnA*
Target: *2.4 mg/cm^2 ^{93}Nb*
Reset Foils: *1.7 mg/cm^2 ^{197}Au, 1.8 mg/cm^2 ^{9}Be*

13 HPGe
8-fold segmented annular detector

Time-Differential Recoil-in-Vacuum (Plunger) Method on Radioactive Beams



analysis by A. Kusoglu

Polarization of Post-Accelerated Beams at ISOLDE

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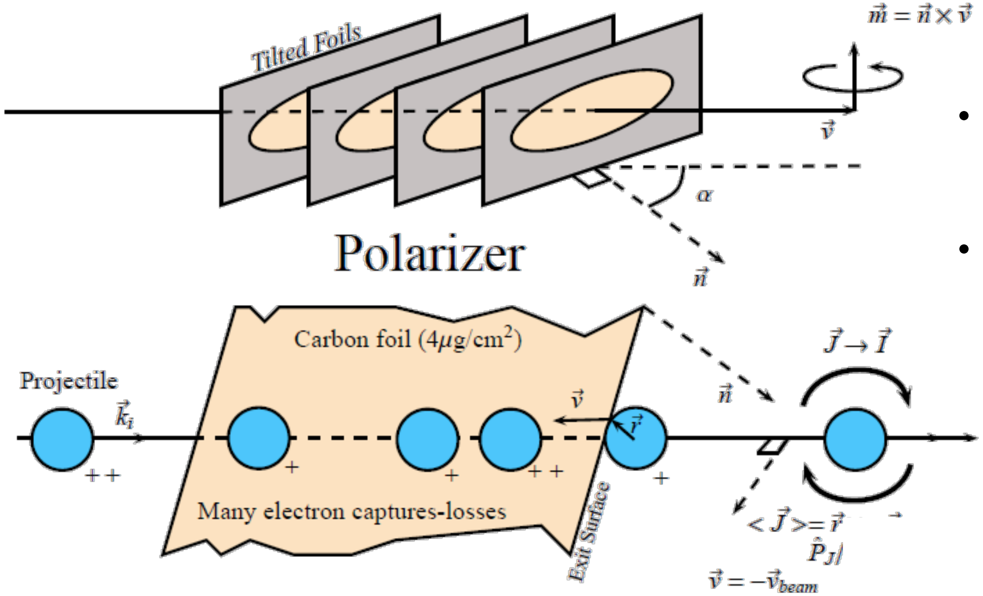
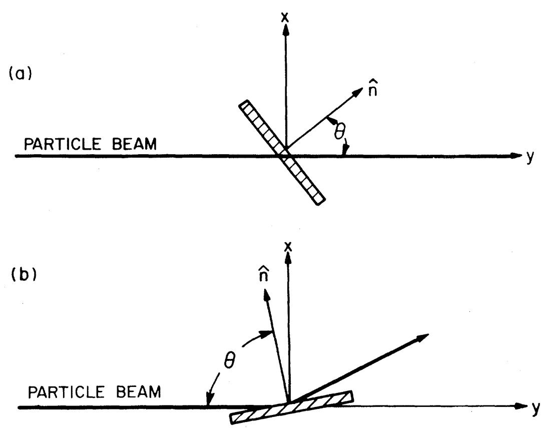
ANU, Canberra, Australia

Y. Hirayama, N. Imai

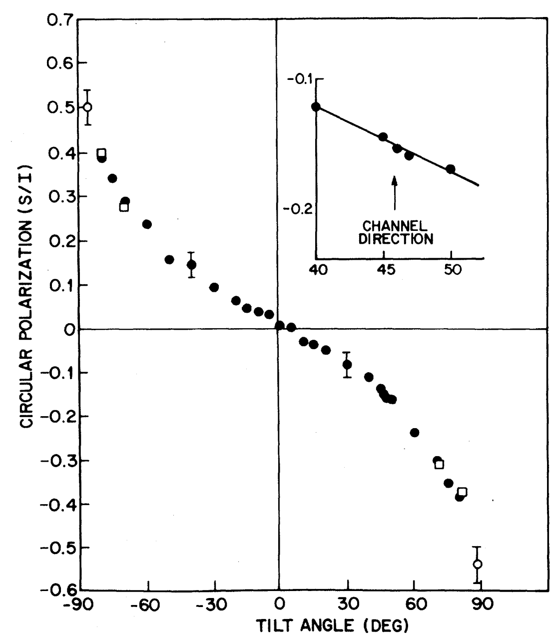
KEK, Japan

Electron Polarization



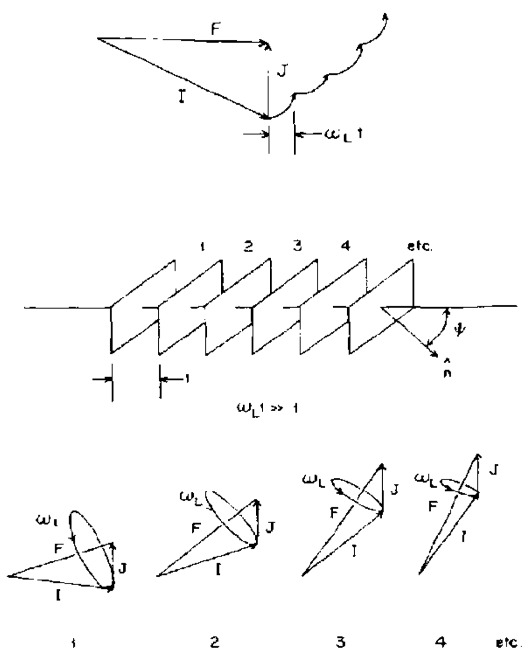


- *The polarization is identified as a result of the ion-surface interactions (no bulk-effects influences)*
- *Smooth behaviour of the polarization, independently on the geometry (transmission or reflection)*

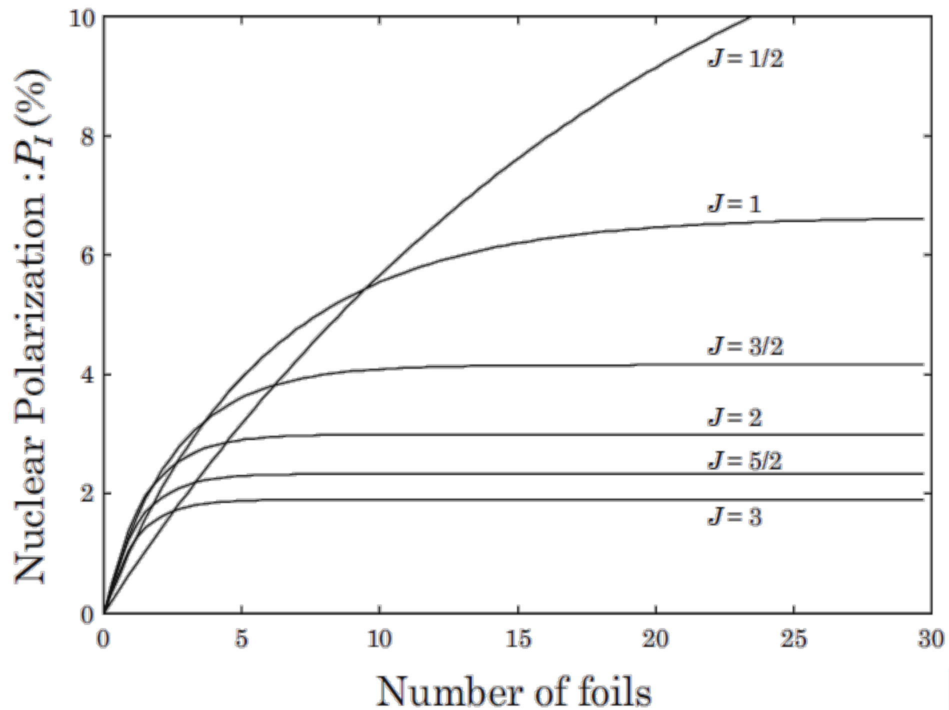


T. Tolk et al., PRL 47, 487 (1981)

Transfer to Nuclear Polarization

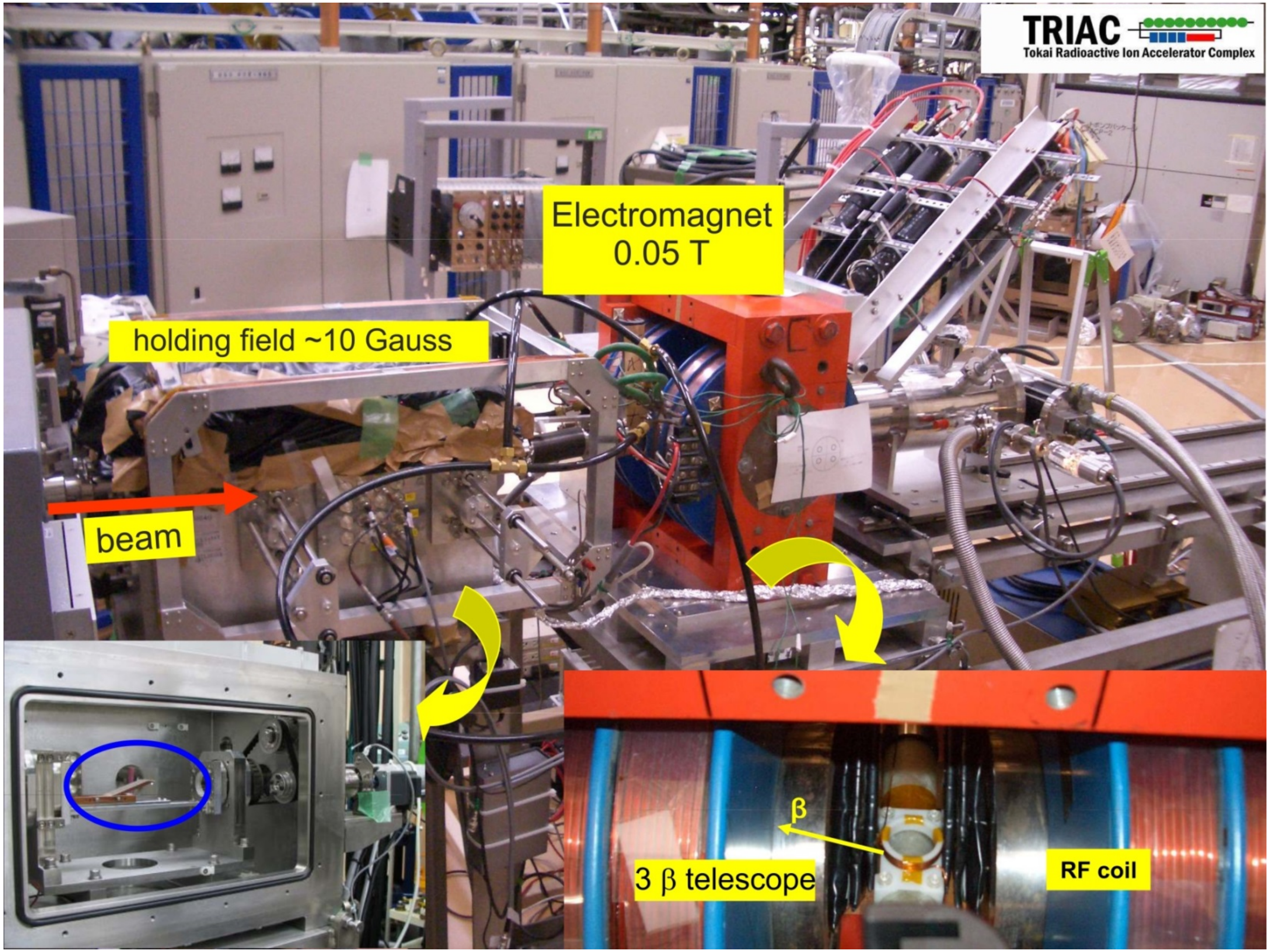


M. Hass et al., NPA 414, 316 (1984)



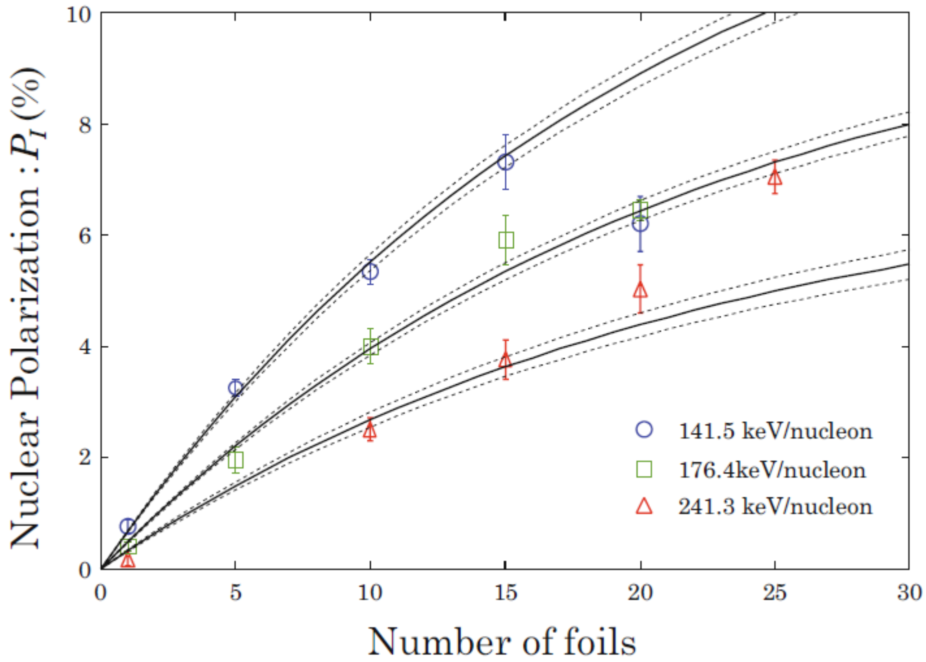
- *coupling of the electron (J) and the nuclear (I) spins*
- *"rotation regime" ($\omega t << 1$), PRL 38, 218 (1977)*
- *"polarization transfer regime" ($\omega t >> 1$)*
- *strong dependence on J and the number of foils*
- *faster saturation at higher J (fewer foils needed)*
- *higher polarization at lower J*

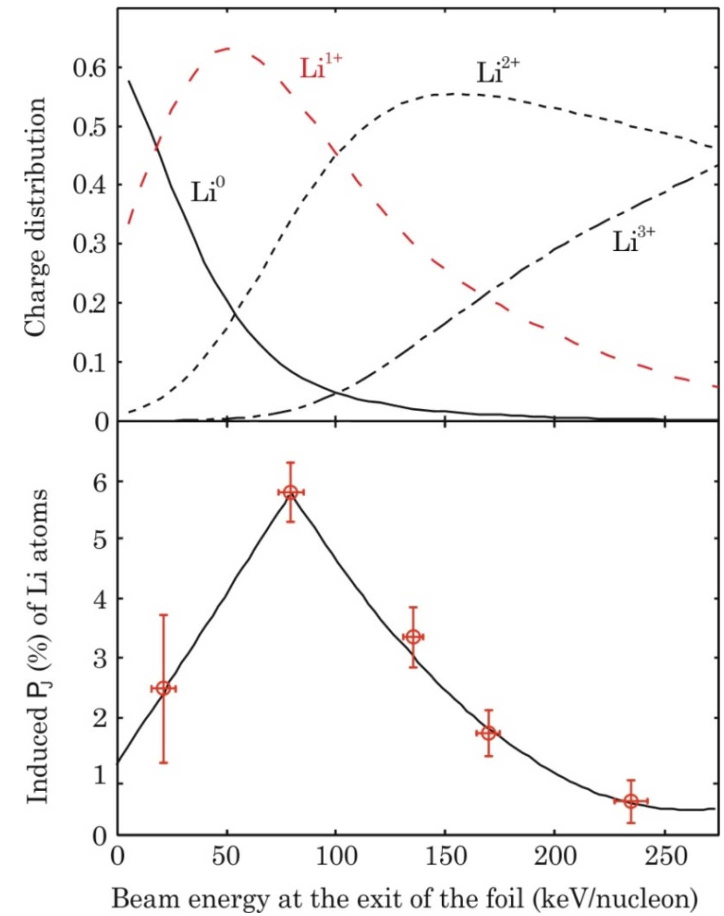
Former polarization measurements with ^{8}Li @ TRIAC



By courtesy of Y. Hirayama

TRIAC results

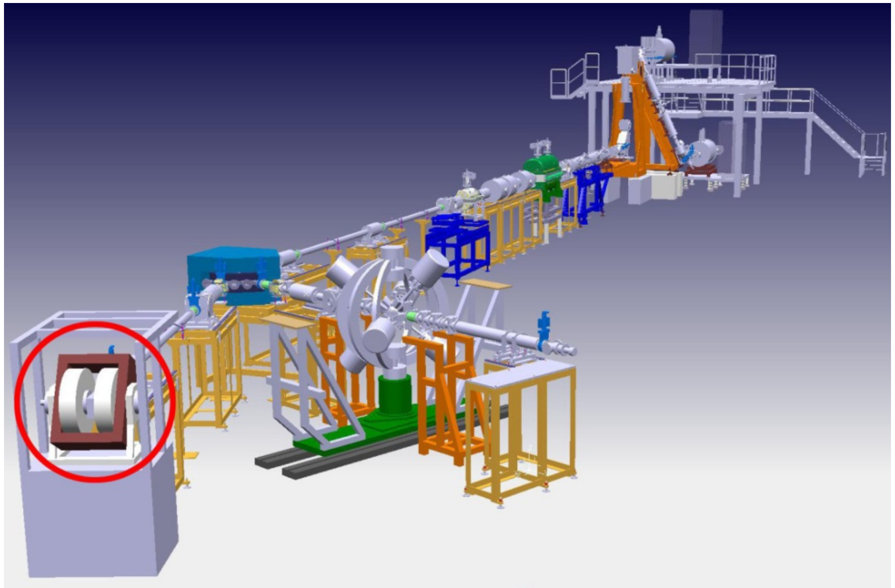


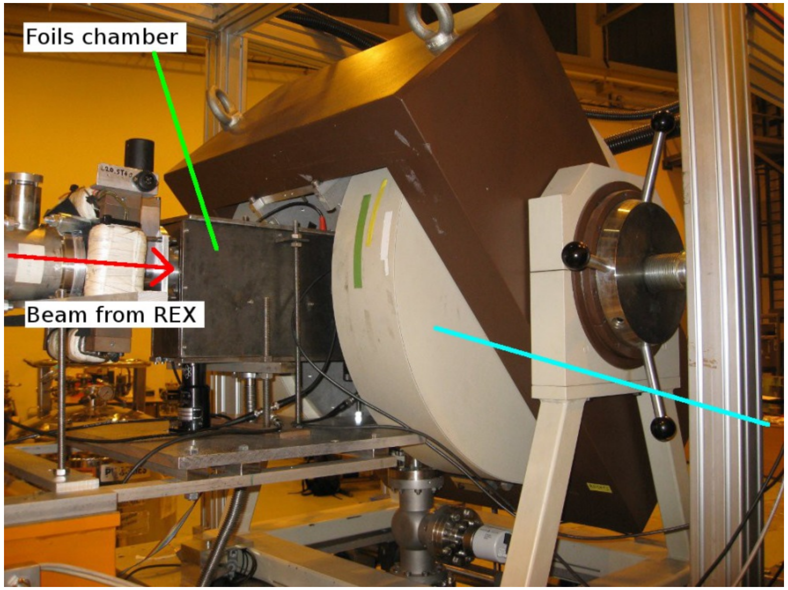


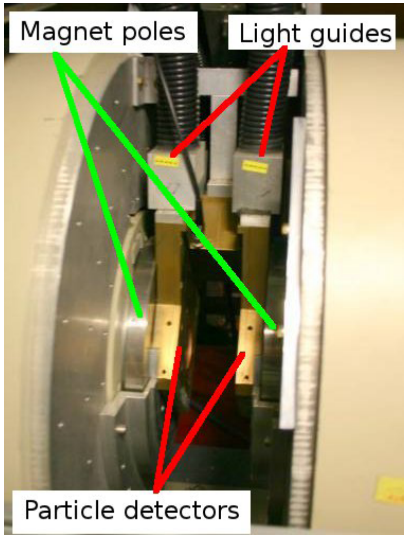
- *from the observed nuclear polarization → J=1/2*
- *$^8Li^0$ and $^8Li^{2+}$ are expected to contribute to the nuclear polarization*
- *$^8Li^{1+}$ - configurations with J=1, 2 … could contribute*
- *$^2P_{1/2}$ state - expected to be dominant*
  ($^8Li^0$: 2p ($^2P_{1/2}$) → 2s ($^2S_{1/2}$) t = 27 ns; $^8Li^{2+}$: 2p ($^2P_{1/2}$) →1s ($^2S_{1/2}$) t = 0.02 ns)
- *P_J = 2.92(8); 2.08(6); 1.40(7)% for 141.5; 176.4 and 241.3 keV beam energy*
- *difficulties to disentangle between energy and charge-state dependence*

Hirayama et al., Eur. Phys. J. A 48, 54 (2012)

The newly-built TF setup @ ISOLDE - CERN

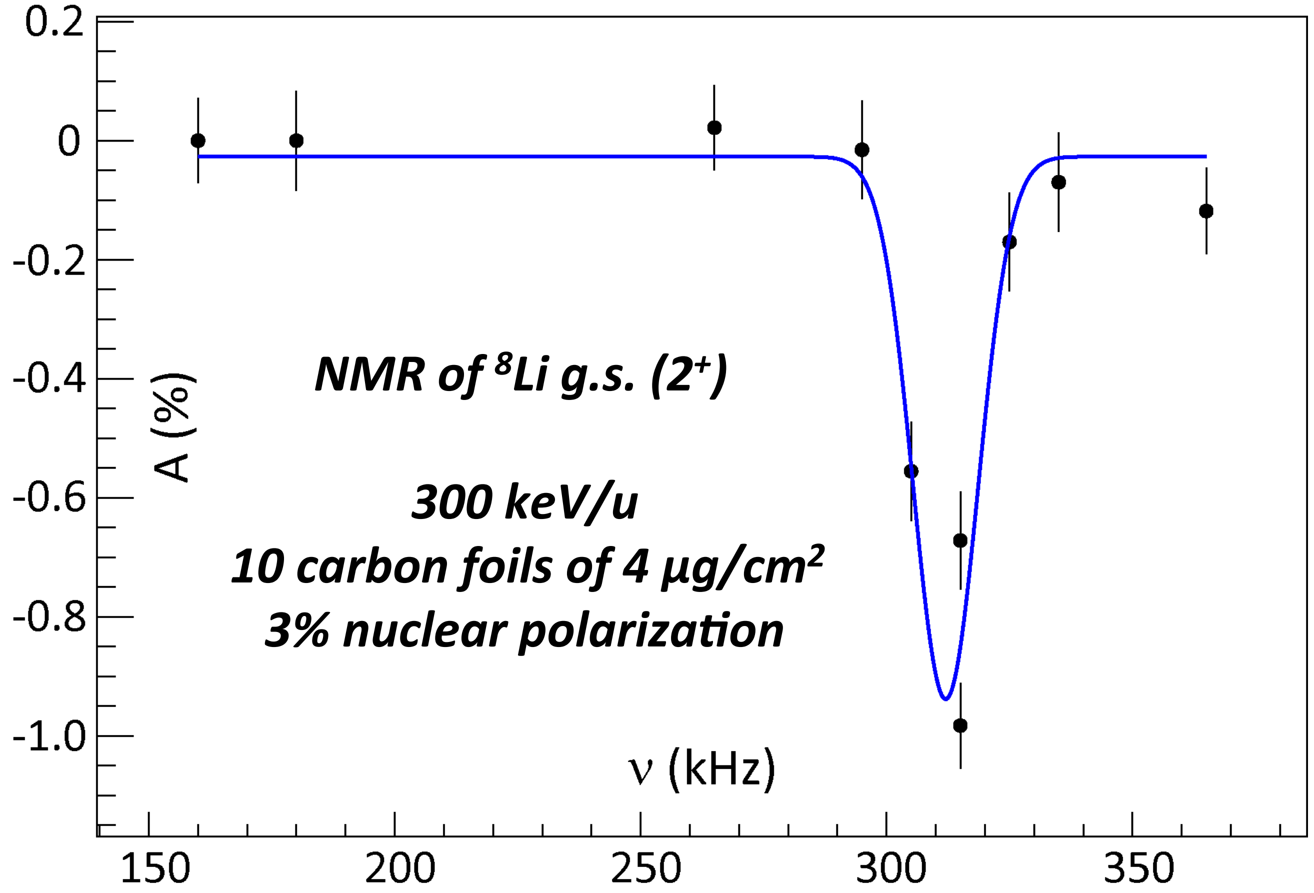






- *post-accelerated beams from REX-ISOLDE*
- *beam energies between 0.3-3.0 Mev/u*
- *beta-NMR determination of polarization*

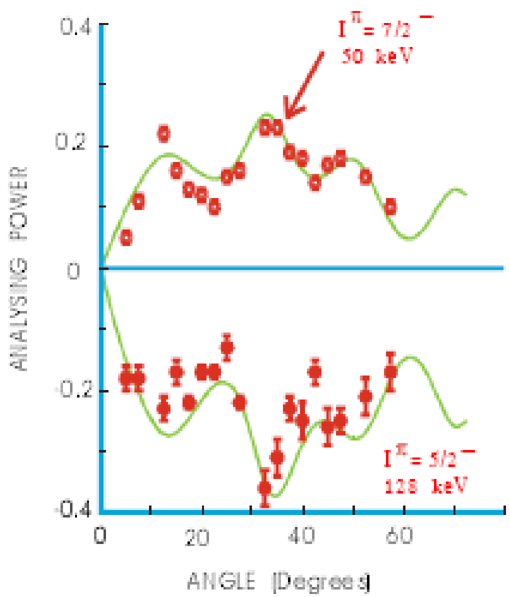
July 2012: First successful TF test at REX-ISOLDE

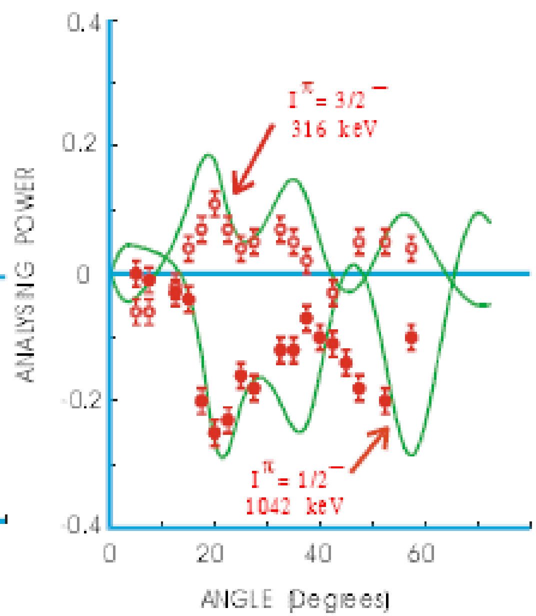


by courtesy of the TF collaboration (CERN-INTC-I-083)

Polarized beams - Why?

- ***Transfer reactions (analyzing power), j = l +/- 1/2***





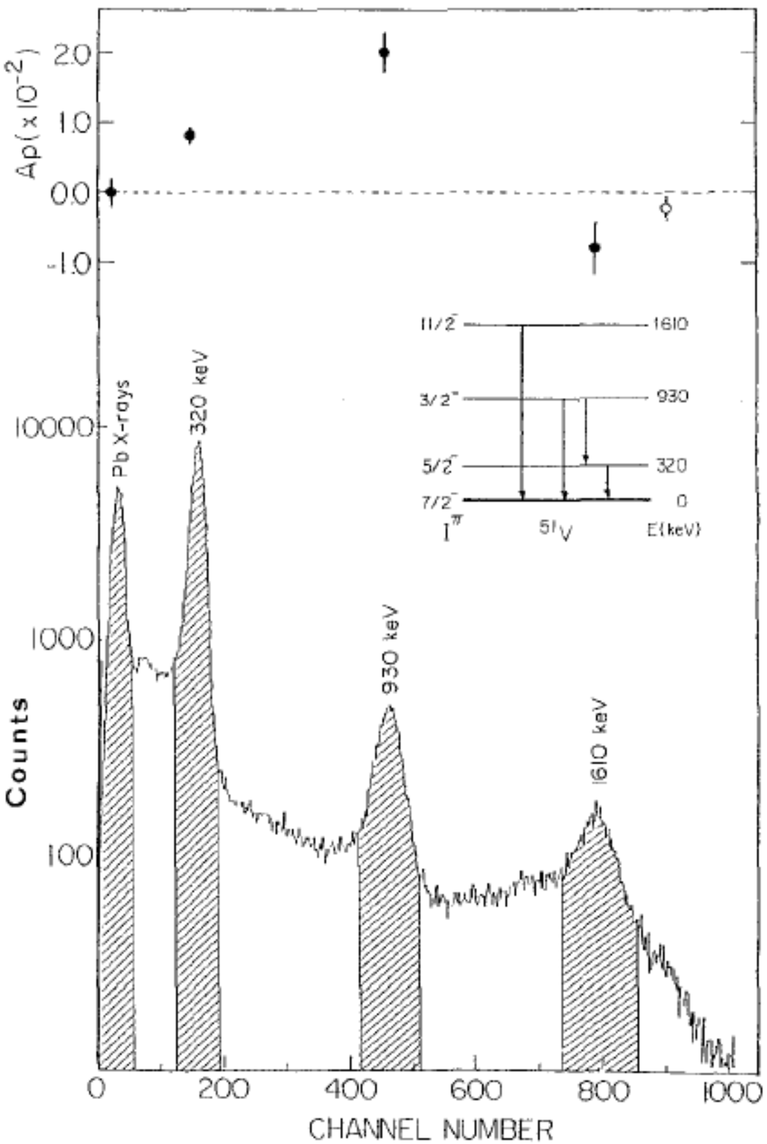
$$A_y = \frac{\left(\frac{d\sigma}{d\Omega}\right)\uparrow - \left(\frac{d\sigma}{d\Omega}\right)\downarrow}{\left(\frac{d\sigma}{d\Omega}\right)\uparrow p\downarrow + \left(\frac{d\sigma}{d\Omega}\right)\downarrow p\uparrow}$$

- ***Coulomb excitations - spin/parity; multipolarity assignments etc.***

Summary

- *TDRIV method commissioned in radioactive-beam geometry*
- *TF method commissioned for REX energies at ISOLDE-CERN*

Tilted foils measurements with stable beams



J. Bendahan *et al.*, ZPA 331, 343 (88)

Coulomb excitation of polarized nuclei

^{51}V@50 MeV
→ TF
→ ^{51}V (I^p = 7/2$^-$), 13$^+$ charge state
→ 195 MeV
→ Coulex on Pb

- ***^{51}V beam intensity ~ 1 pnA***
- ***left-right asymmetry***
- ***polarization observed:***
  - ***P_l = 1.2(2)% at b = 6.5% (2 MeV/u)***
  - ***P_l > 1.0(1) % at b = 4.6% (1 MeV/u)***
    - ***for 13$^+$***
  - ***P_l ~ 0 % at b = 4.6% (1 MeV/u)***
    - ***for 14$^+$***

\- ***A factor of >2 assumed for the depolarization due to the post-acceleration***