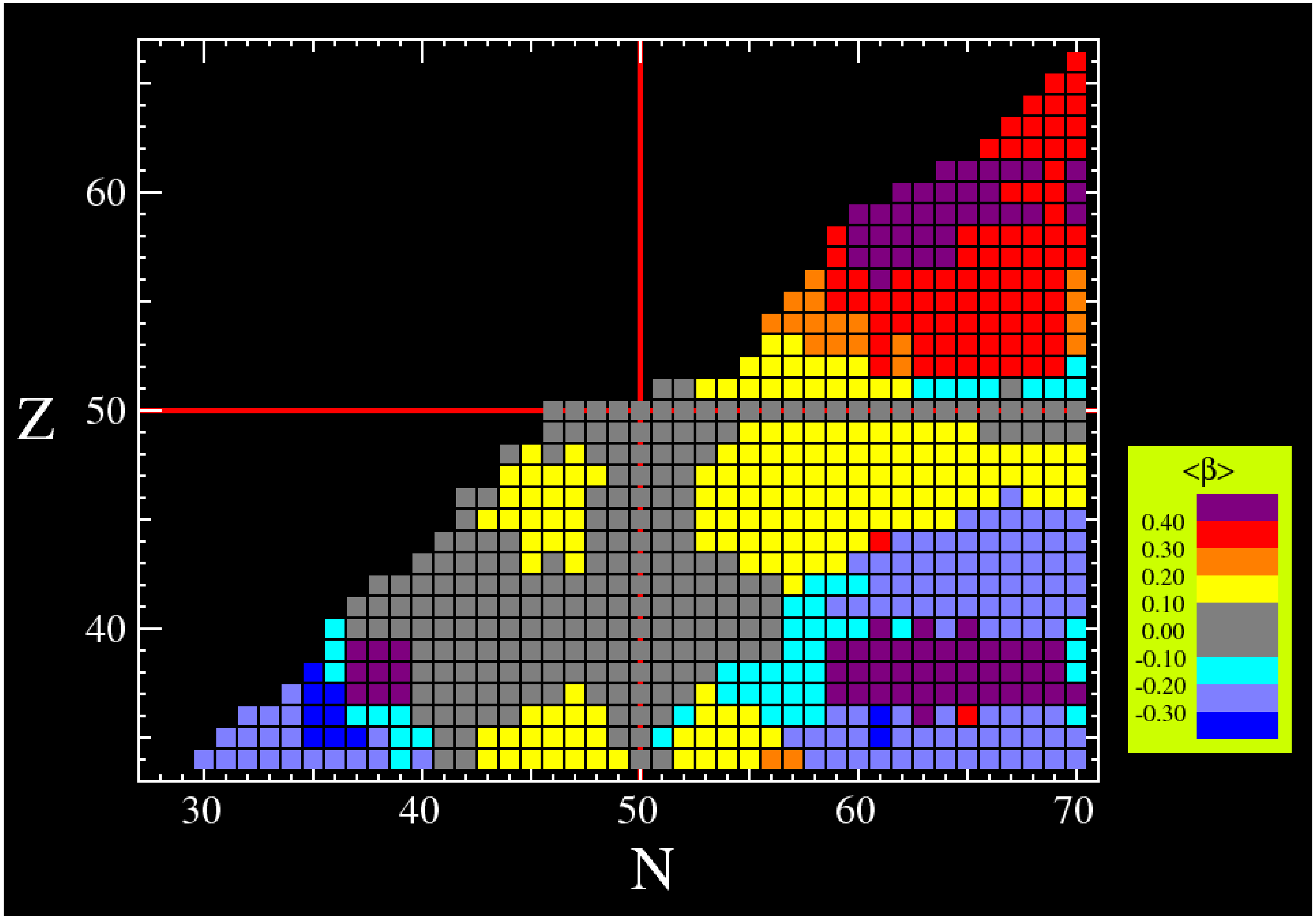
Quadrupole moments of isomeric states @S3

G. Georgiev et al.	*CSNSM, Orsay, France*
M. Hass et al.	*The Weizmann Institute, Rehovot, Israel*
D.L. Balabanski et al.	*ELI-NP/IFIN, Bucharest, Romania*
G. de France et al.	*GANIL, Caen, France*
A.E. Stuchbery et al.	*ANU, Canberra, Australia*
D.Yordanov et al.	*IPN, Orsay, France*
Y. Hirayama et al.	*KEK, Japan*
T. Nilsson et al.	*Chalmers University, Göteborg, Sweden*

Nuclear quadrupole deformation in the N~Z region



CEA/DAM

- **Spherical shapes in the vicinity of N~50; Z~50**
- **Shape coexistence in the Se/Kr/Sr region**

Sign of quadrupole moment - how?

- TDPAD with quadrupole interaction

$$W(t) = 1 + \sum_{k_1,k_2,q} a^{q}_{k_1,k_2} \sqrt{2I+1} \rho^{q}_{k_1} F_{k_2} G^{qq}_{k_1,k_2}(t)$$ → the angular distribution

the perturbation factors:

$$G^{qq}_{k_1,k_2} = \begin{cases} \sum_n S^{k_1 k_2}_{nq} \cos(n\omega_0 t) & for\ k_1 + k_2 = even \\ -i \sum_n S^{k_1 k_2}_{nq} \sin(n\omega_0 t) & for\ k_1 + k_2 = odd \end{cases}$$

alignment (for $k_1 + k_2 = even$)

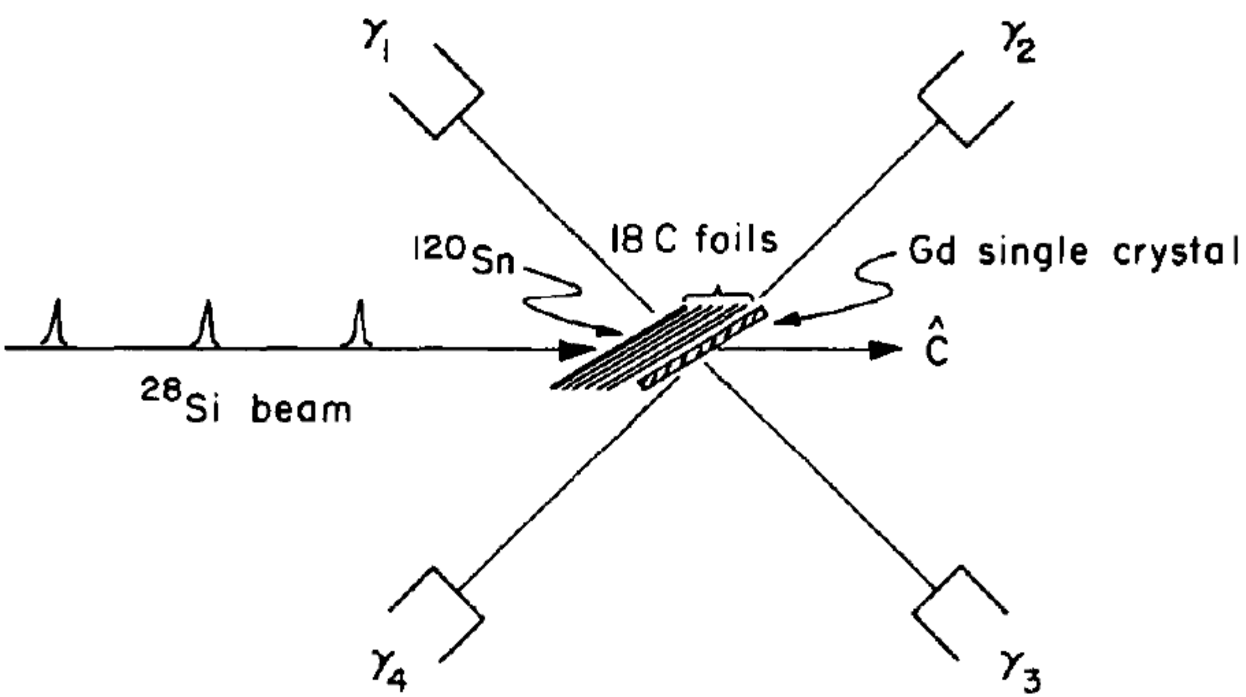
polarization (for $k_1 + k_2 = odd$)

With a polarized ensemble of nuclei one can obtain both the magnitude and the sign of the quadrupole moment

Tilted Foils experiments from the 80's

In-beam TDPAD experiments

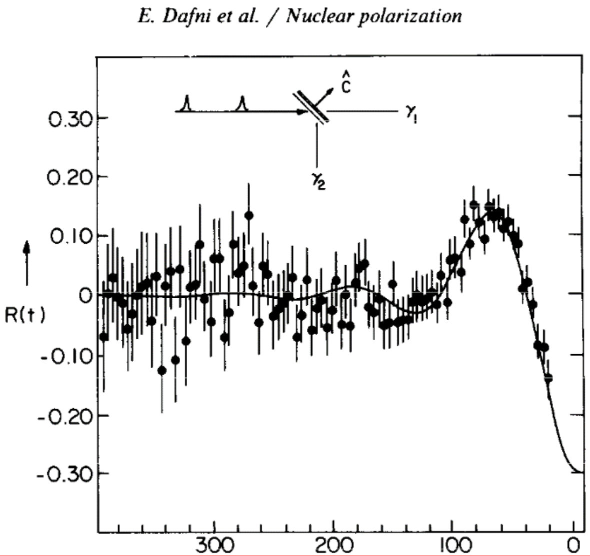
E. Dafni et al. / Nuclear polarization



- some 12 – 18 C foils (3-5 μg/cm^2) @ 60° wrt beam axis
- compact geometry - reaction channels
  → ~5 – 10% of the total reaction x-section

Q-TDPAD with polarized beams

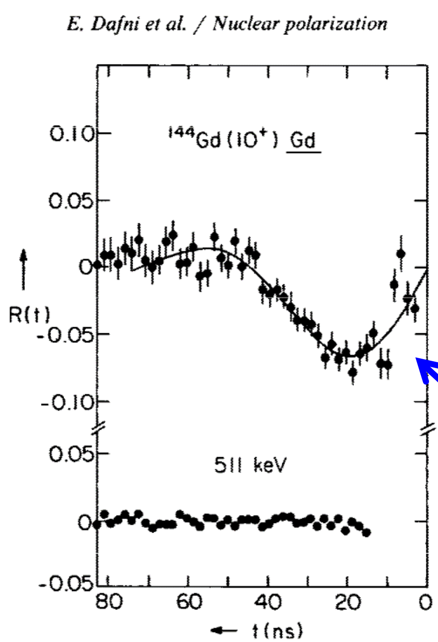
E. Dafni *et al.*, NPA 443, 135 (85)

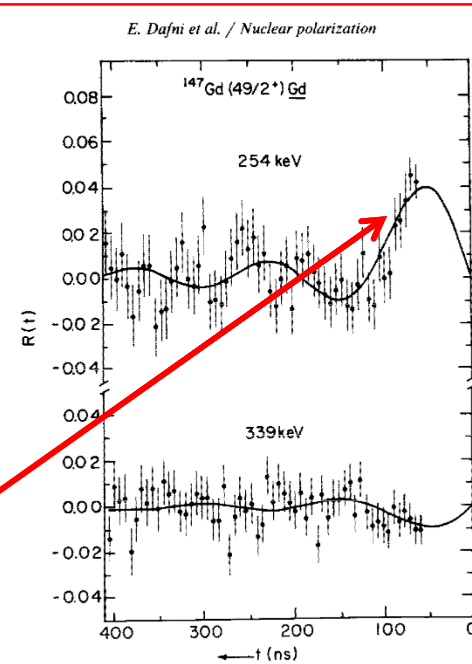


^{144}Gd(10$^+$) - alignment

R(t) = maximum at t=0

Polarization

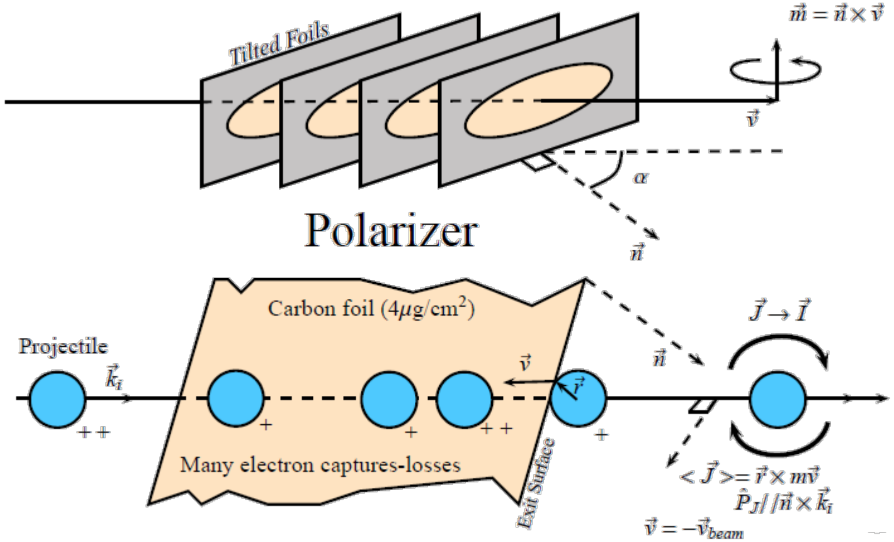


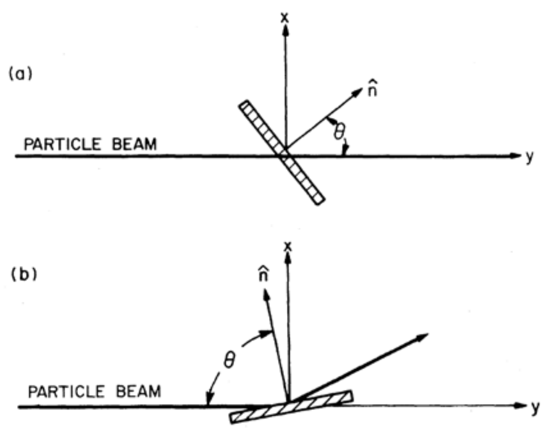


R(t) = 0 at t=0

direction - sign

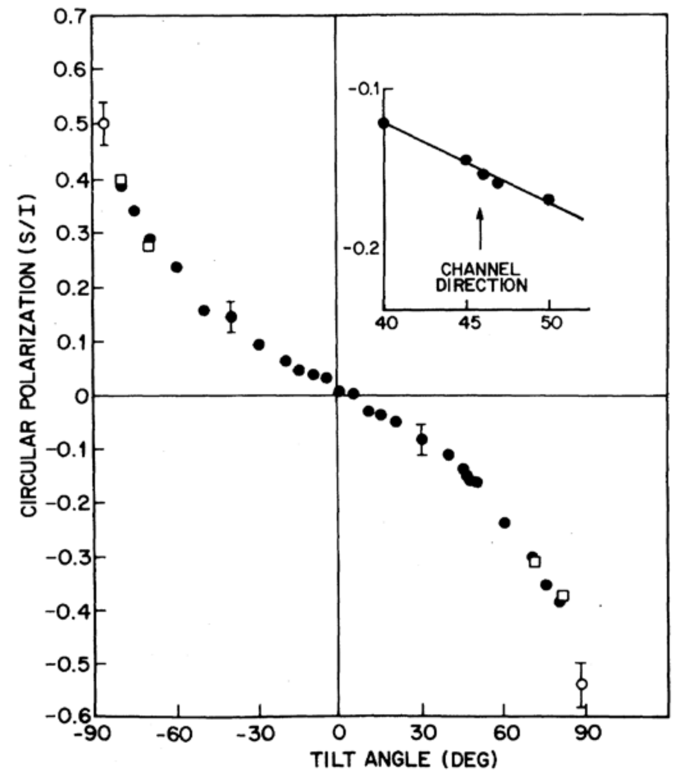
(Atomic) Spin polarization from Tilted foils





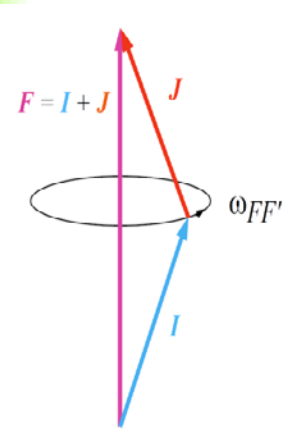
T. Tolk et al. PRL47, 487 (1981)

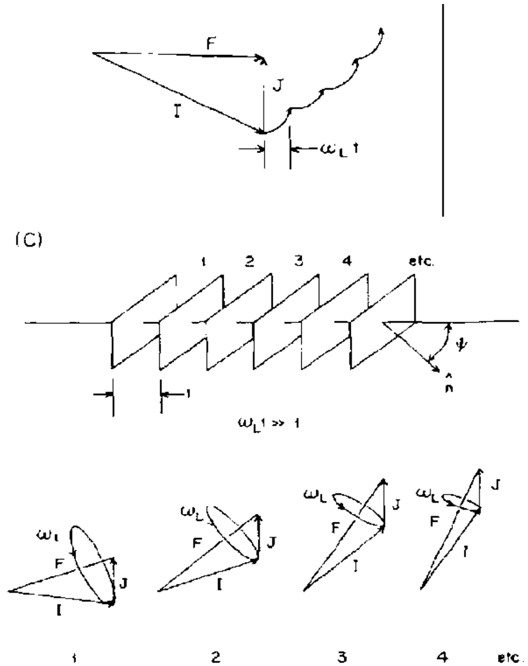
The polarization identified as a result of the ion-surface interactions (no bulk-effects influences)



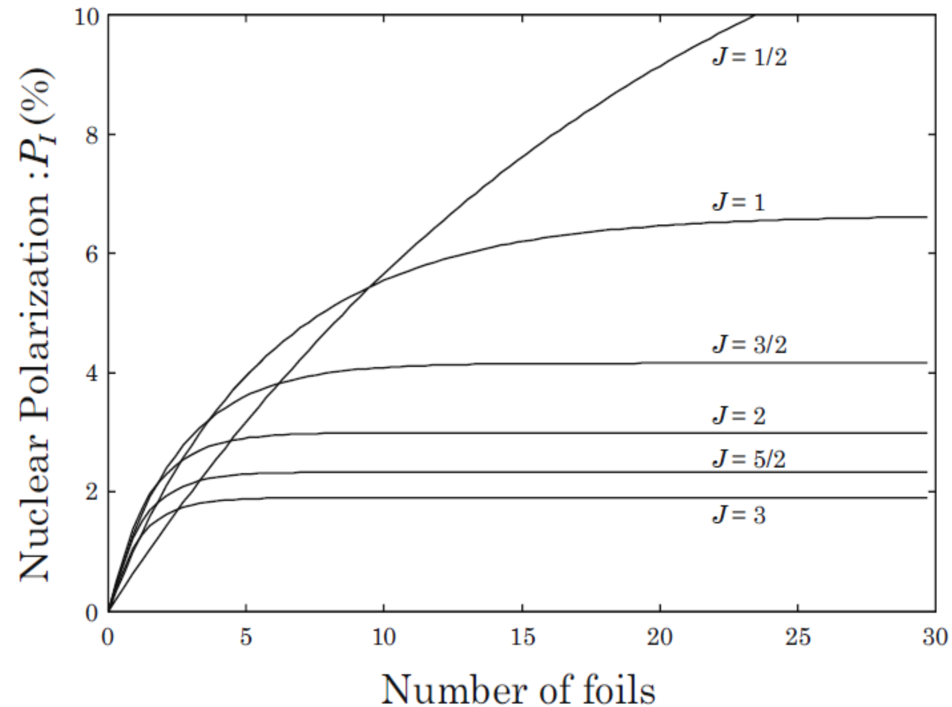
Large circular polarization observed ~50% for a specific optical transition

Transfer to nuclear polarization





M. Hass *et al.*, NPA 414, 316 (84)



- coupling of the electron (J) and the nuclear (I) spins
- interaction of total spin F with the magnetic field of the electrons (ω_L)

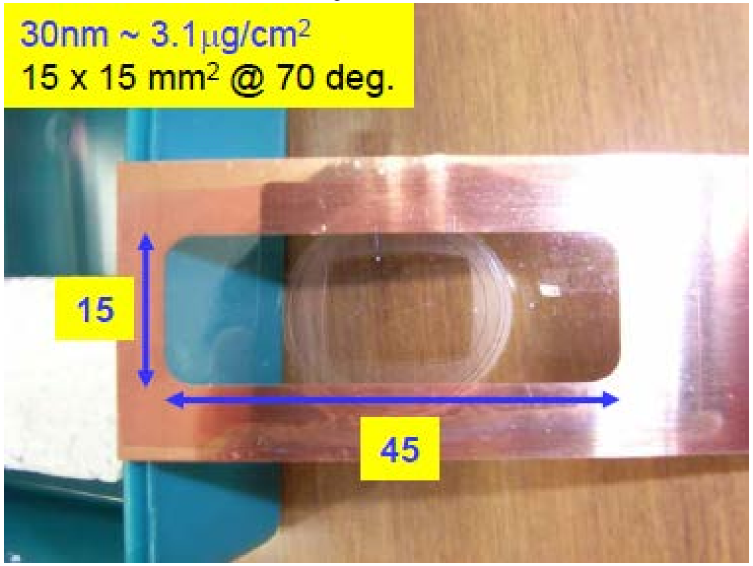
Strong dependence on the atomic spin J and the number of the foils:

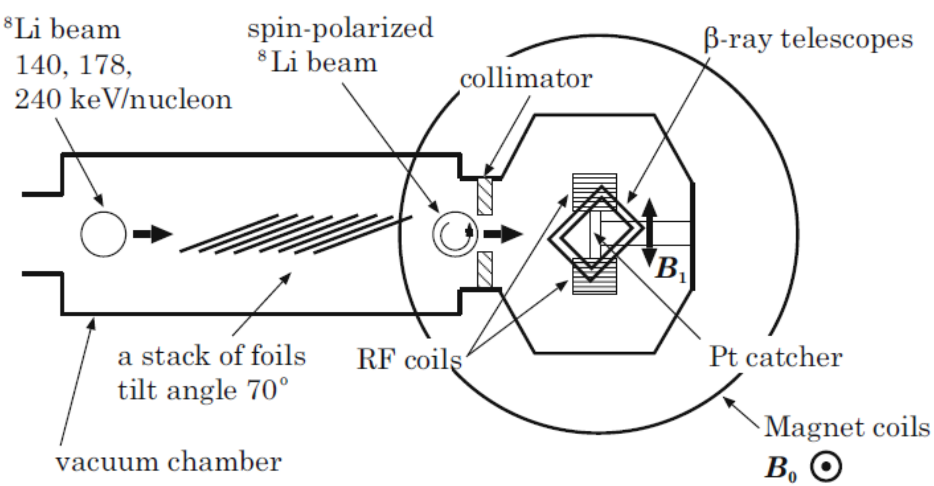
- higher nuclear polarization at lower J
- higher nuclear polarization at higher I
- $P_I > P_J$

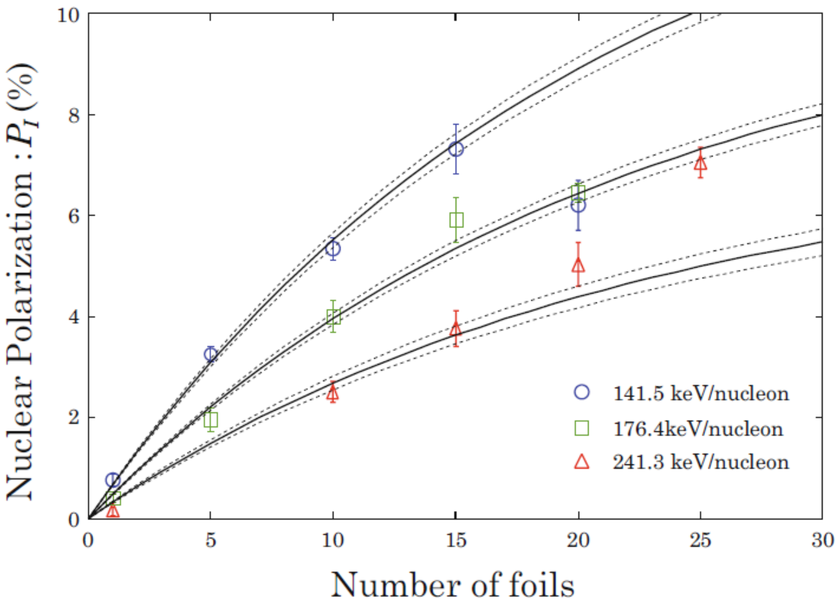
Systematic studies with post-accelerated ISOL beams @ TRIAC

Y. Hirayama *et al.*, Eur.Phys.J A48, 54 (2012)

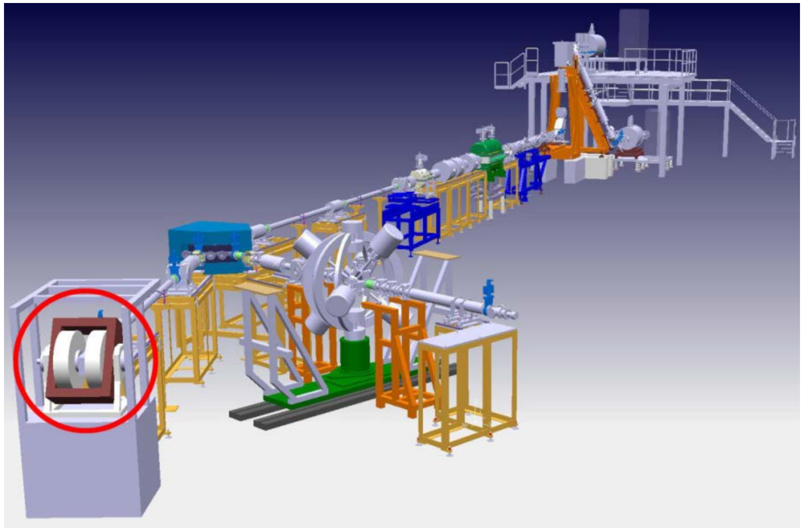
- ^{8}Li ($I^{\pi} = 2^{+}$) beam
- accelerated to few hundreds of keV/u
- thin carbon or polystyrene foils (1 – 20)
- up to 7.3 (5) % polarization observed
- A study as a function of the number of foils, beam energy, tilt angle …
- Considered contributions of different atomic states configuration to the nuclear polarization







TF β-NMR setup @ REX-ISOLDE



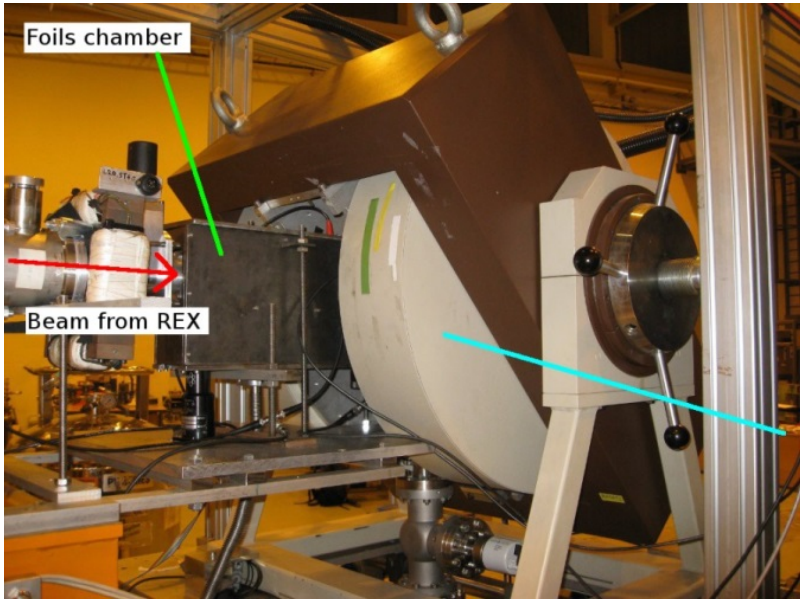
NMR of ^{8}Li g.s. (2^{+})

Beam energy → 300 keV/u

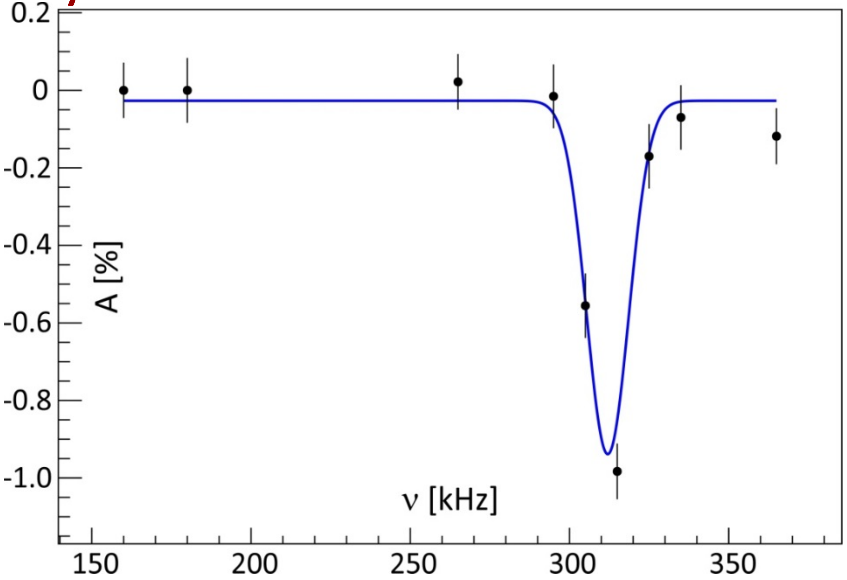
1 mylar foil (0.5 μm) – energy degrader

10 carbon foils of 4 μg/cm²

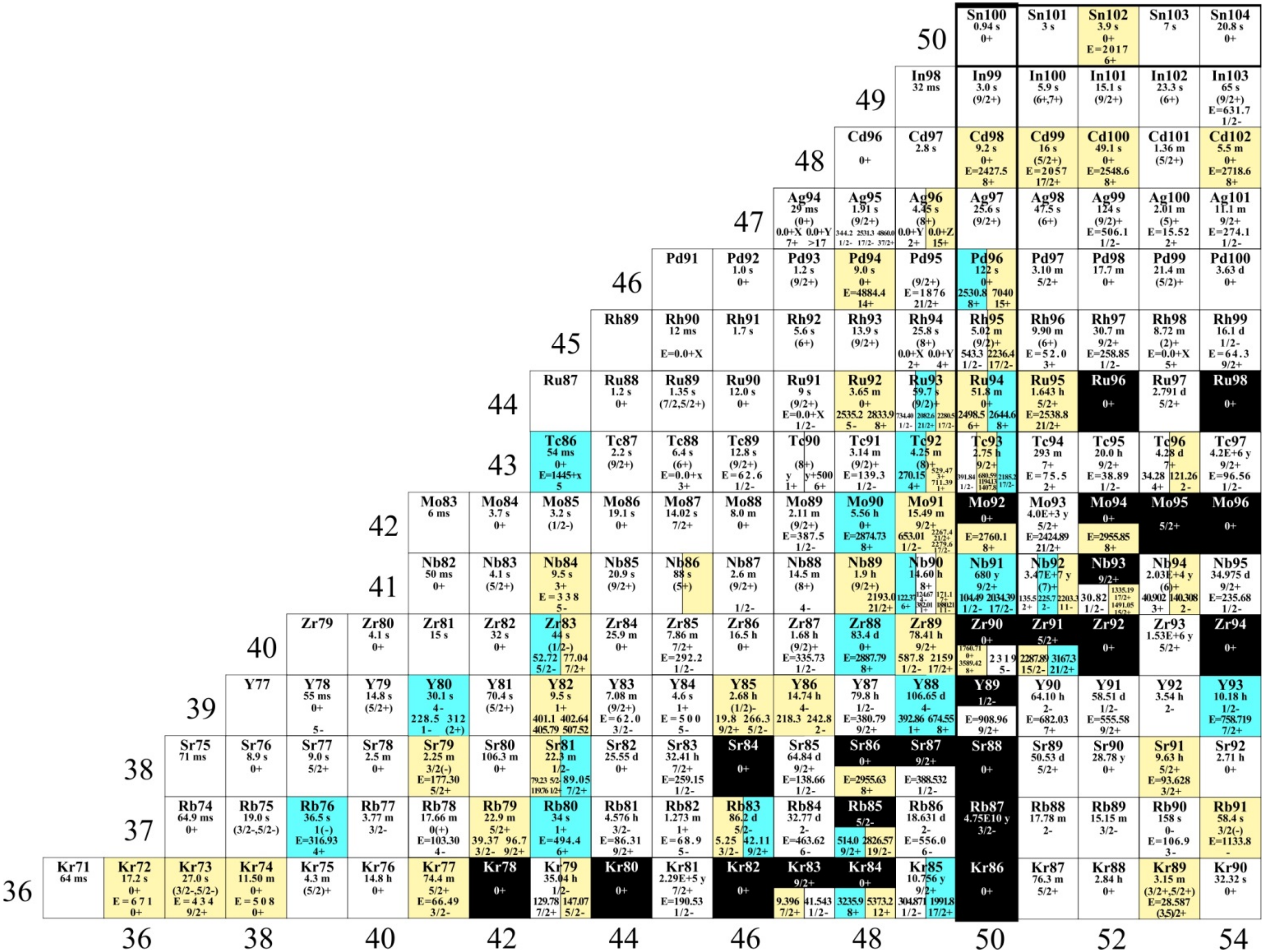
3.6(3) % nuclear polarization



July 2012: TF test at REX-ISOLDE



Isomeric states in the N~Z region accessible @ S3



Q-TDPAD measurements @ S^3

Requirements:

- Beam intensity – 10^3 pps or higher
- Beam purity ~ 10% at implantation point
- Time definition – beam pulsing (???) or implantation definition?
- γ-ray detectors at specific positions

Limitations:

- Beam spot size
  - 20 x 70 mm foils for 15 mm diameter
- Decay in flight
  - 50 – 100 ns/m flight path → $t_{1/2}$ ~1 μs or higher?

Thank you!