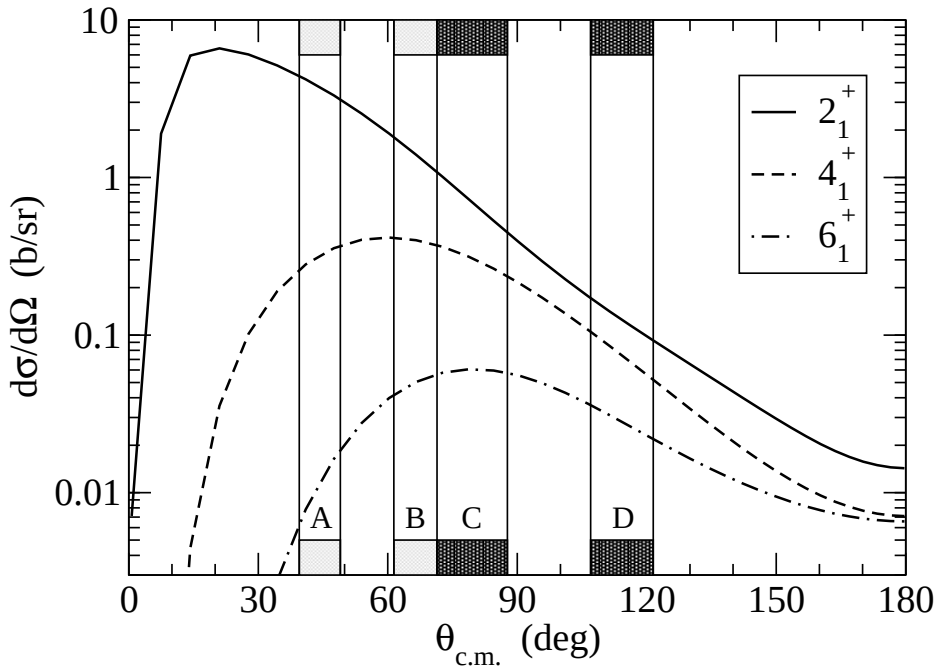
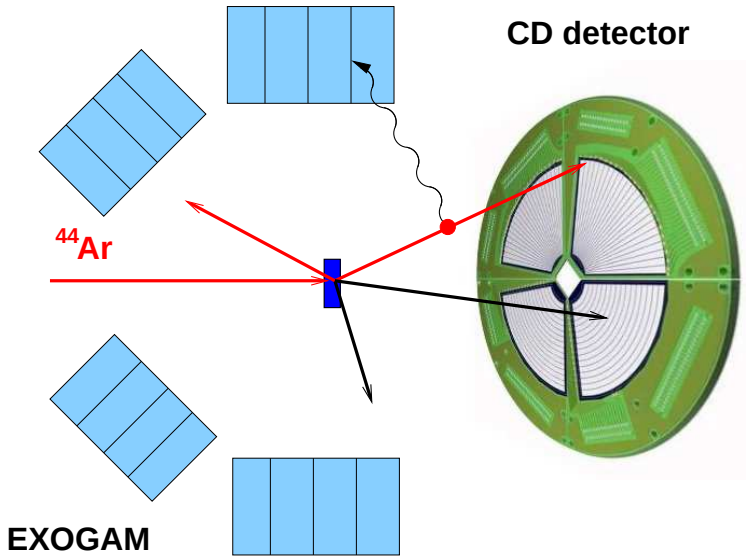
Stable beam experiments

- usually multi-step excitation and complicated level schemes
- for deformed nuclei it may be useful to couple all matrix elements inside each rotational band
- beam intensities of the order of 10^9pps: particle detectors at backward angles
- lifetime of several states known: no need for other kind of normalisation
- statistics enough for particle-gamma angular correlations



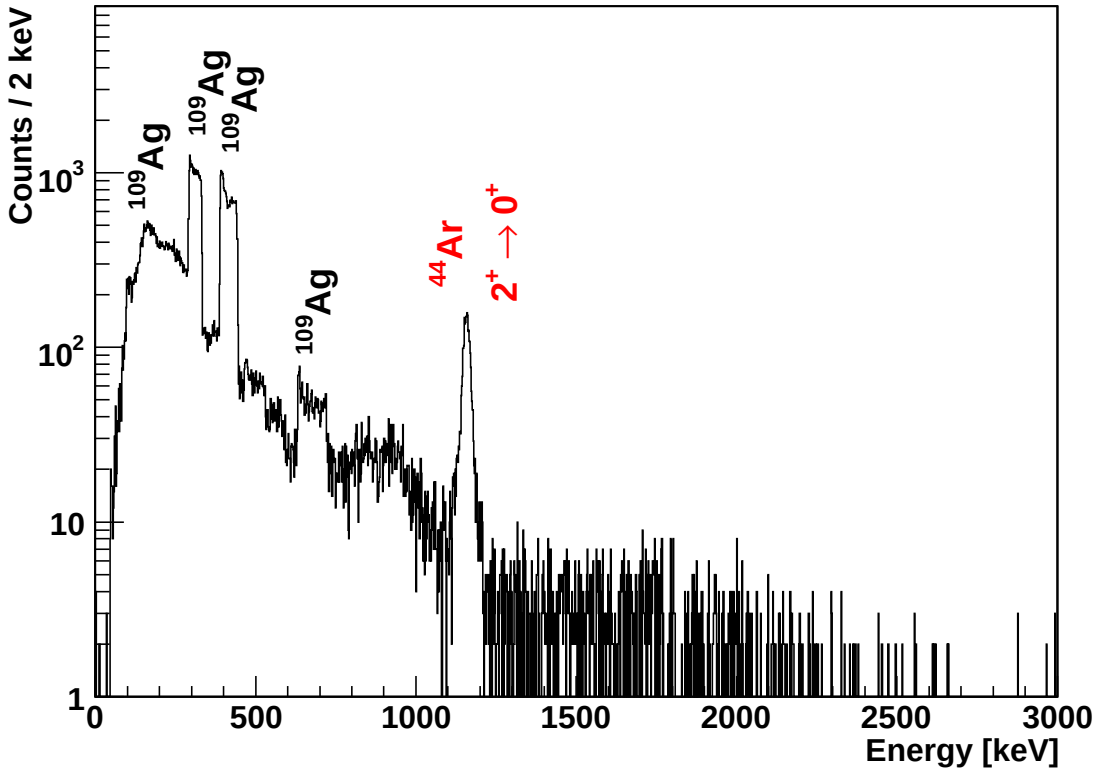
Exotic beam experiments

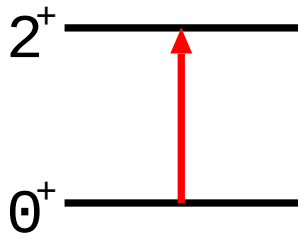
- usually one- or two-step excitation; level schemes not well known
- beam intensities rather low: particle detectors at forward angles to maximise the statistics
- normalisation to target excitation
- low statistics, sometimes only one gamma line observed
- relative normalisation of different ranges of scattering angles based on Rutherford scattering or target excitation



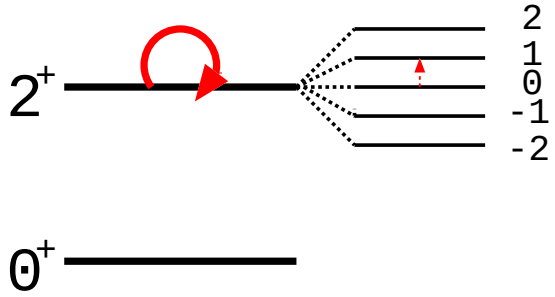
B(E2)'s in radioactive nuclei measured with Coulex

- usually only $2^+ \rightarrow 0^+$ transition visible
- normalisation to target excitation needed





$\langle 2^+ || E2 || 0^+ \rangle^2$
$\sim$ B(E2; $2^+ \rightarrow 0^+$)

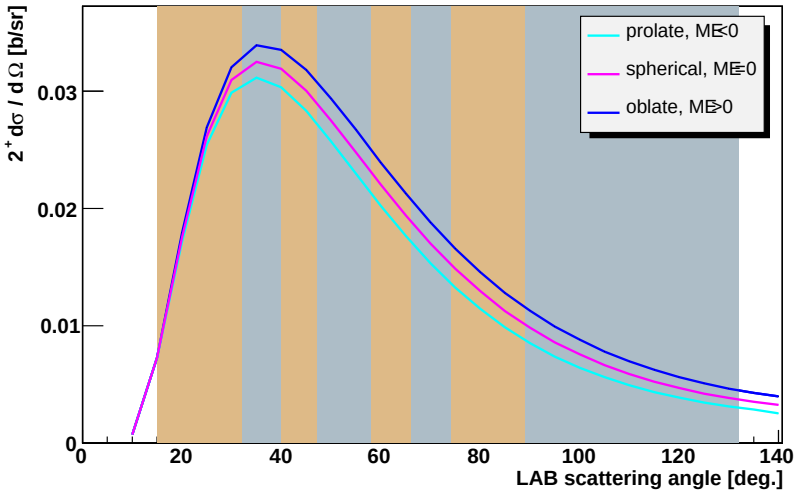


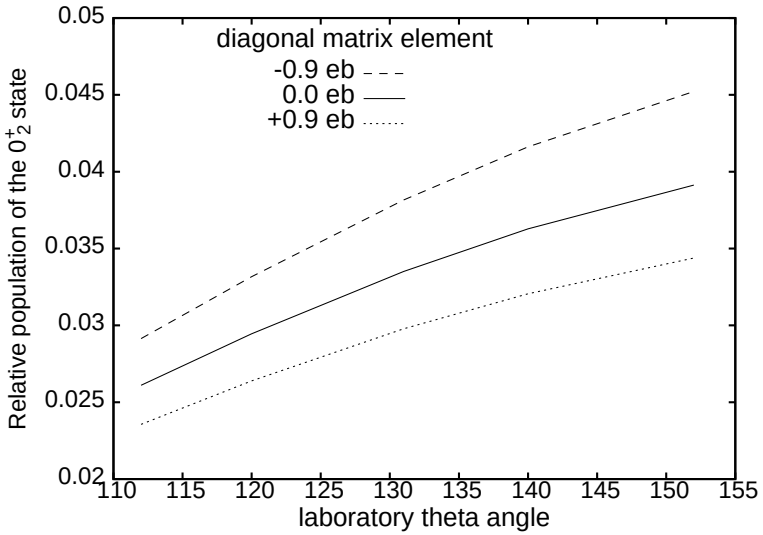
$\langle 2^+ || E2 || 2^+ \rangle \sim Q_0$

- Coulex cross-section depends both on the B(E2;$2_1^+ \rightarrow 0^+$) and the quadrupole moment!

Reorientation effect

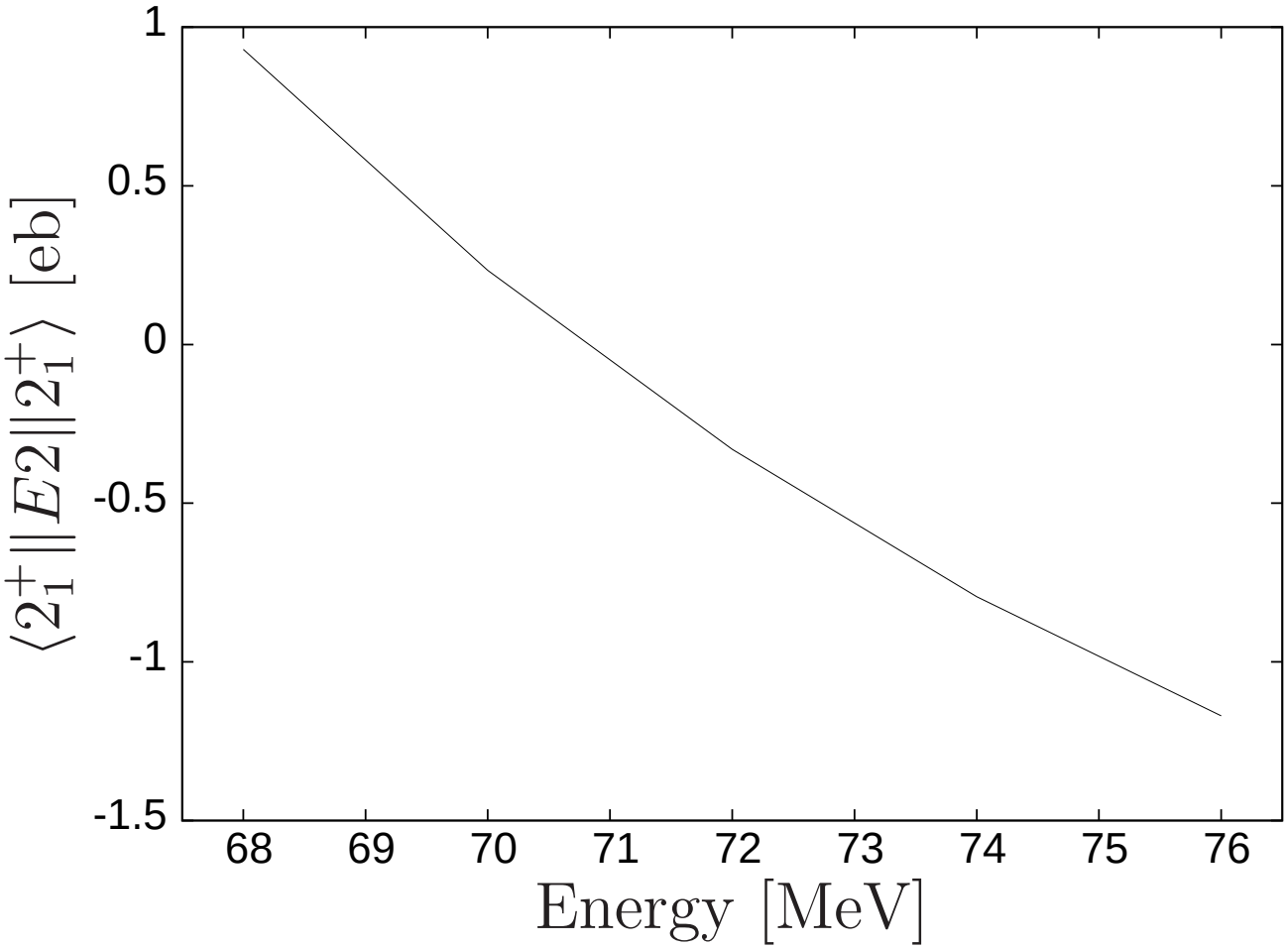
- influence of the quadrupole moment of the excited state on its excitation cross-section
- dependence on scattering angle and beam energy
- BE CAREFUL – influence of double-step excitation of higher states may have the same effect!



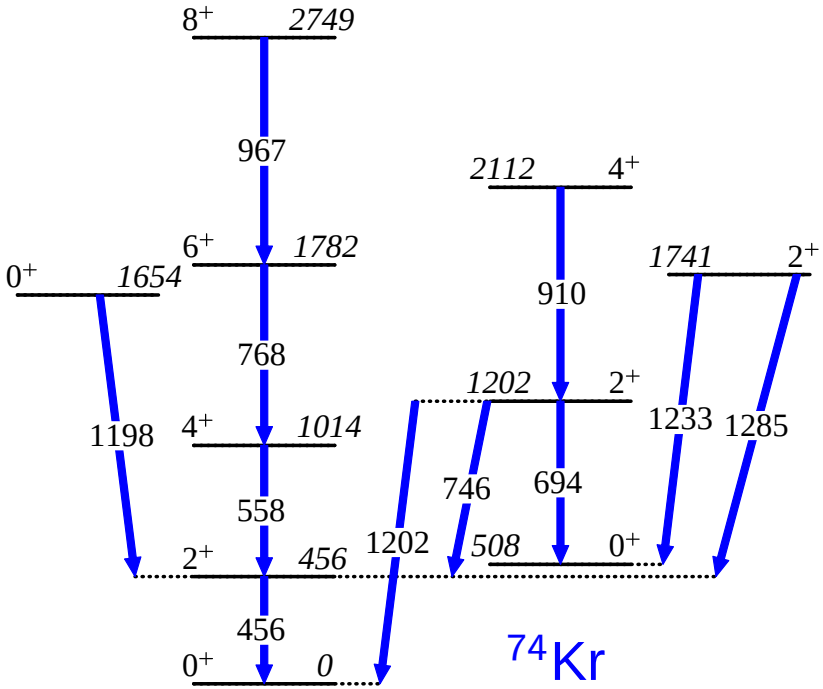


What happens if we don't know the exact beam energy?

- bad things of course!

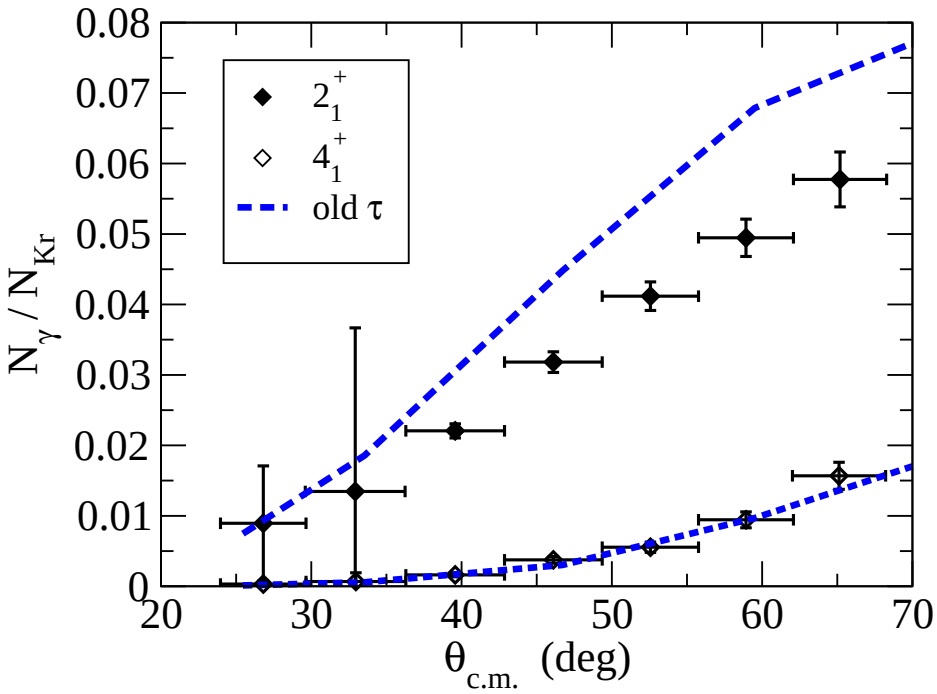


Coulomb excitation and lifetime measurements



- subdivision of data in several ranges of scattering angle
- spectroscopic data (lifetimes, branching and mixing ratios)
- least squares fit of ∼30 matrix elements (transitional and diagonal)

- results inconsistent with previously published lifetimes
- new RDM lifetime measurement:
  Köln Plunger & GASP
  ^{40}Ca (^{40}Ca,α2p) ^{74}Kr
  ^{40}Ca (^{40}Ca,4p) ^{76}Kr



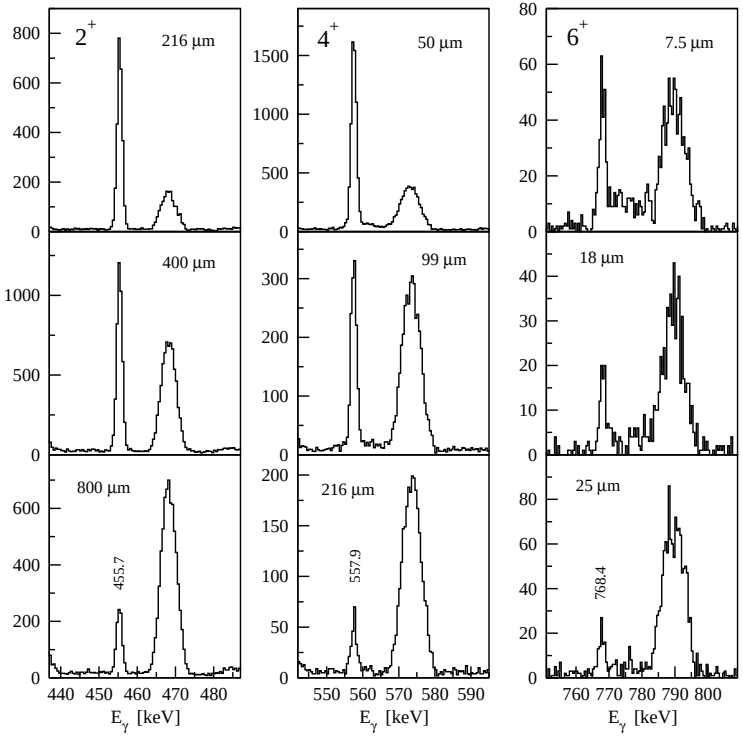
Lifetime measurement

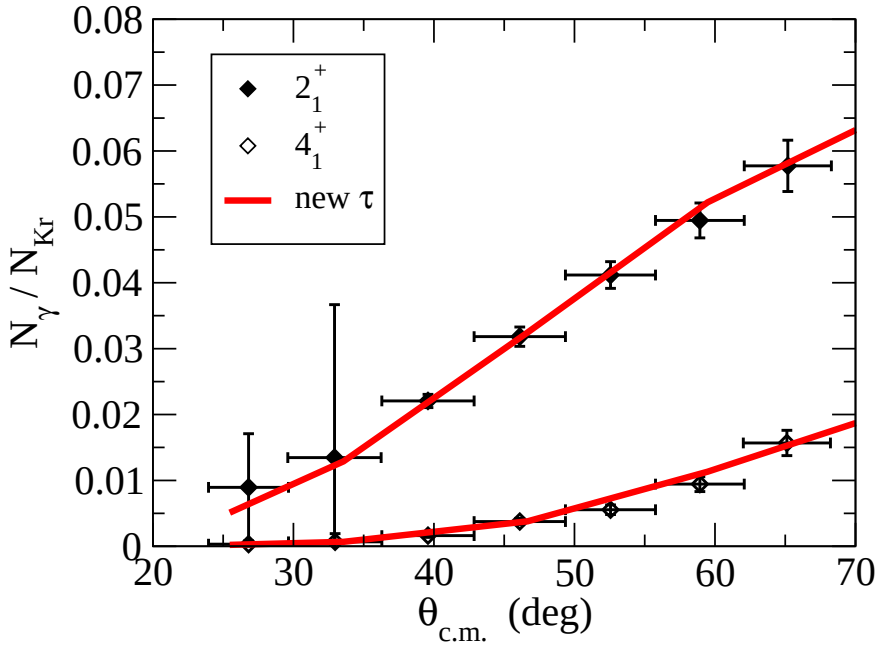
A. Görgen *et al.* EPJ A 26 153 (2005)

		old	new
^{76}Kr	2^+	35.3(10) ps	41.5(8) ps
	4^+	4.8(5) ps	3.87(9) ps

		old	new
^{74}Kr	2^+	28.8(57) ps	33.8(6) ps
	4^+	13.2(7) ps	5.2(2) ps

^{74}Kr, forward detectors (36°) gated from above





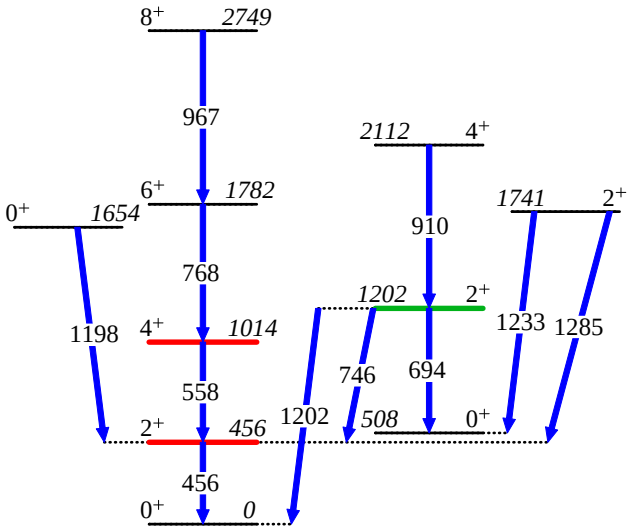
- new lifetimes in agreement with Coulex
- enhanced sensitivity for diagonal and intra-band transitional matrix elements

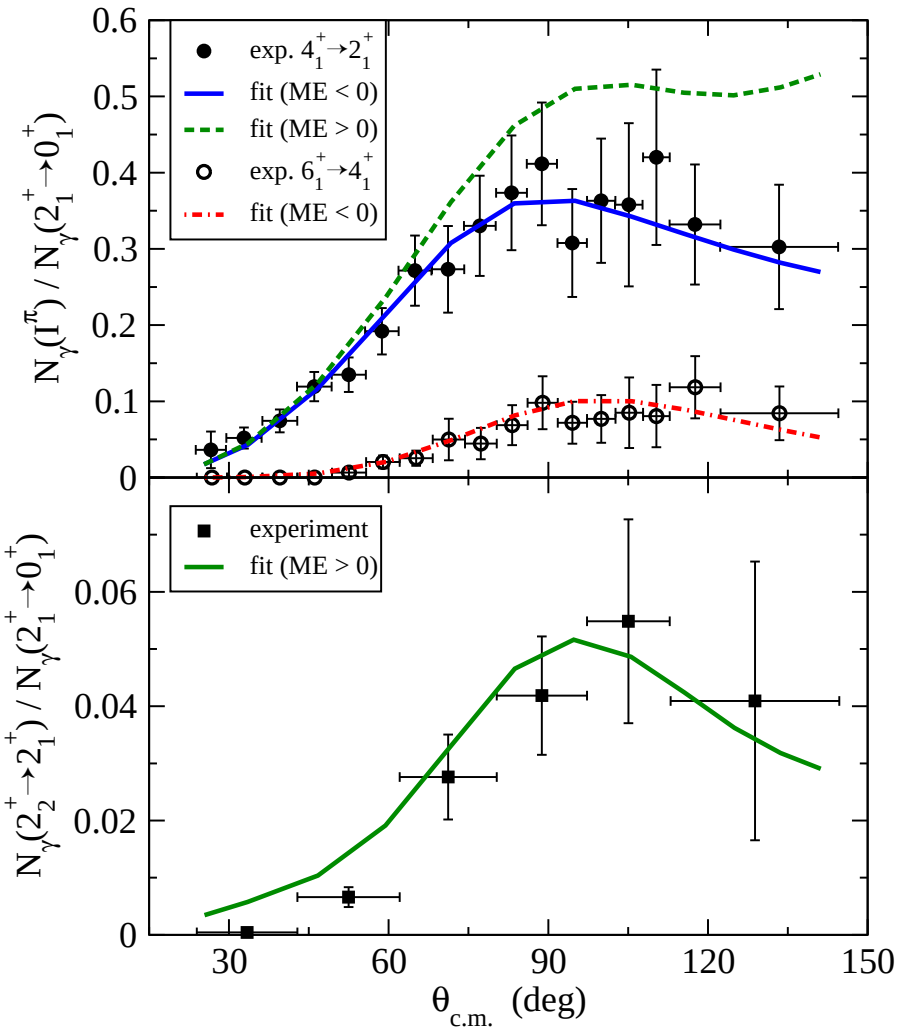
Results: shape coexistence in light Kr isotopes

^{76}Kr: 18 transitional + 5 diagonal ME
^{74}Kr: 14 transitional + 5 diagonal ME

$$\langle 2_1^+ \| E2 \| 2_1^+ \rangle = -\,0.70^{-0.33}_{-0.30}$$
$$\langle 4_1^+ \| E2 \| 4_1^+ \rangle = -\,1.02^{+0.59}_{-0.21}$$

$$\langle 2_2^+ \| E2 \| 2_2^+ \rangle = +\,0.33^{+0.28}_{-0.23}$$



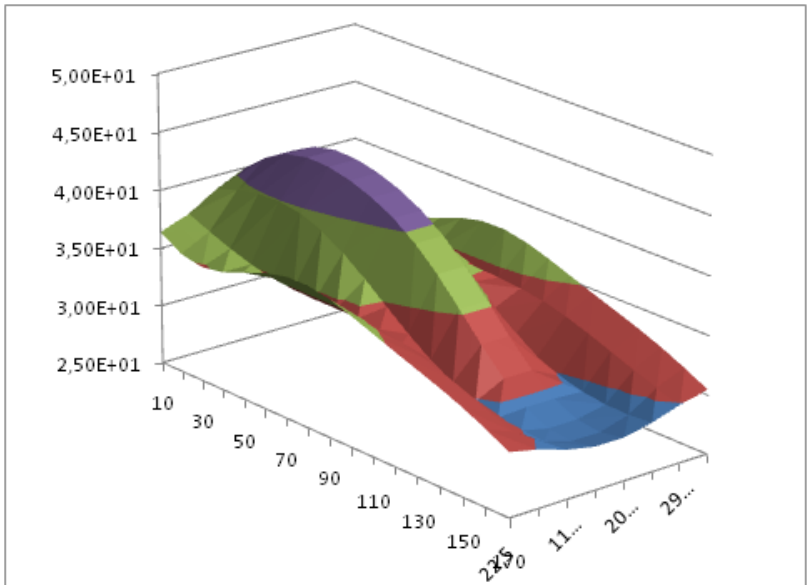


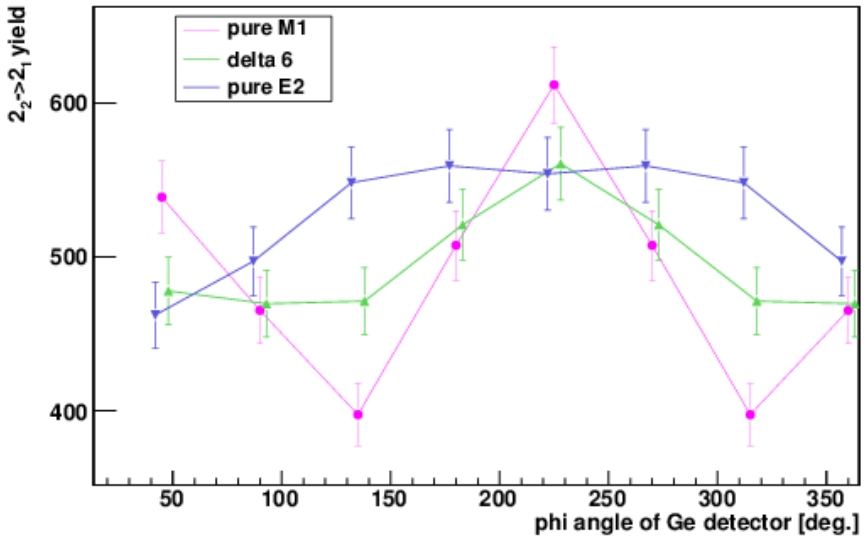
First measurement of diagonal E2 matrix elements using Coulex of radioactive beam

E. Clément *et al.* Phys. Rev. C75, 054313 (2007)

Gamma-particle angular correlations

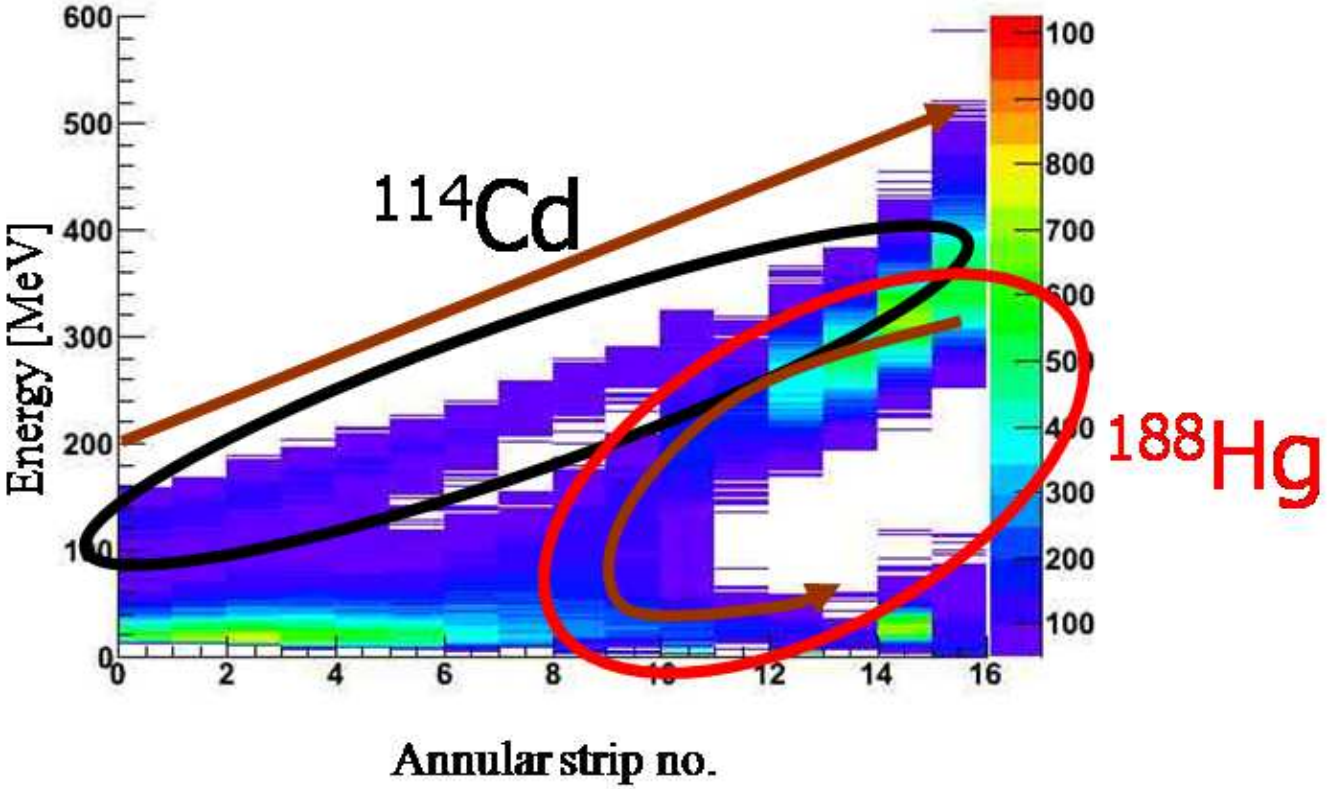
- feasible at several thousands of counts in a given gamma line
- determination of E2/M1 mixing ratios
- determination of spin of a decaying level
- distribution in phi usually more conclusive than in theta



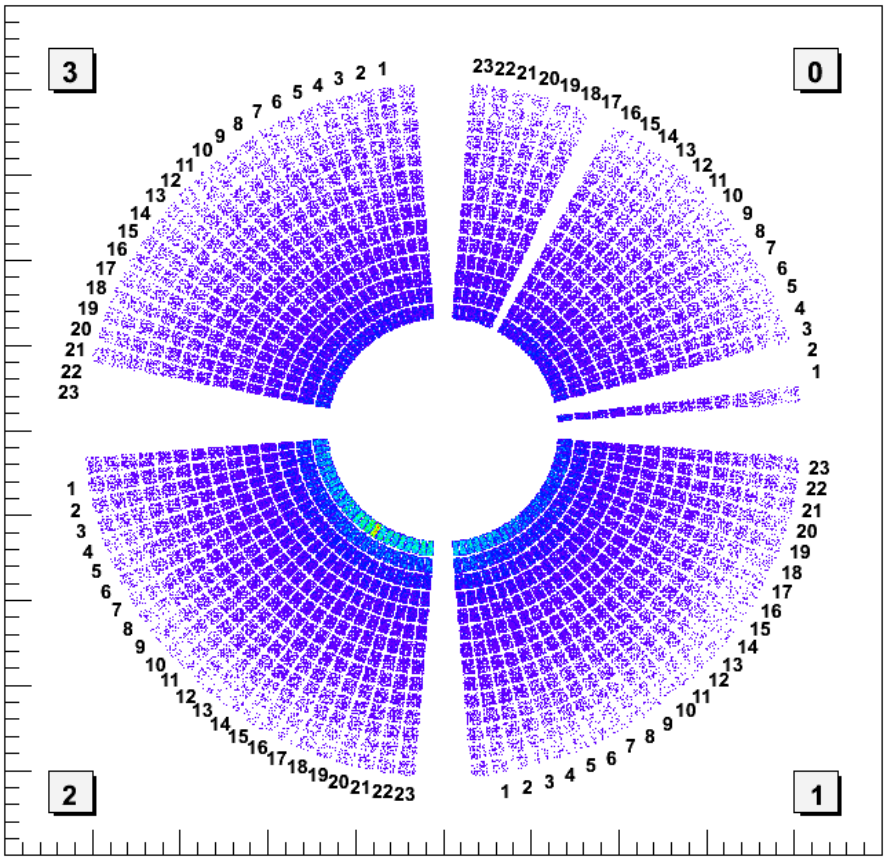


Inverse kinematics

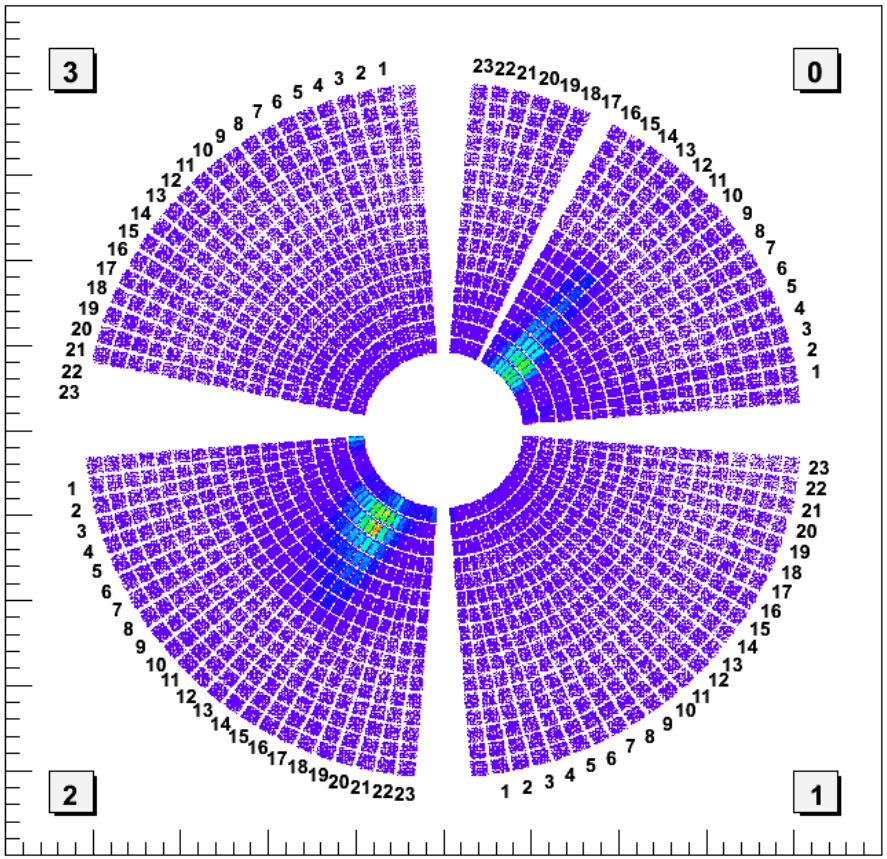
- two kinematic solutions: higher and lower CM angle
- OP,INTG: angular range covered by the particle detector MUST correspond to one solution only
- OP,INTI: this problem removed



Events distribution in CD

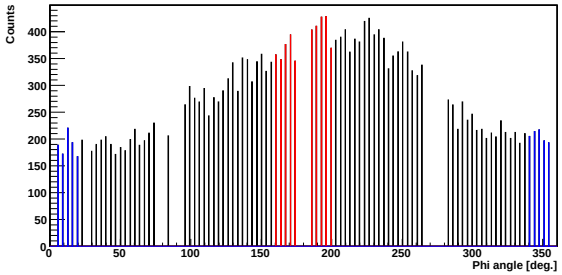


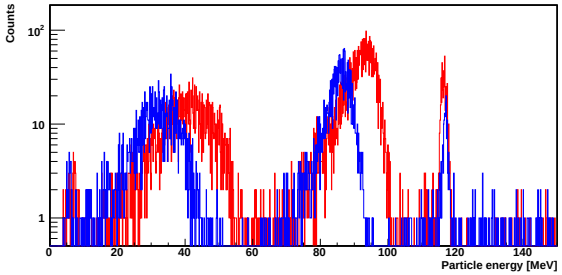
scattered beam

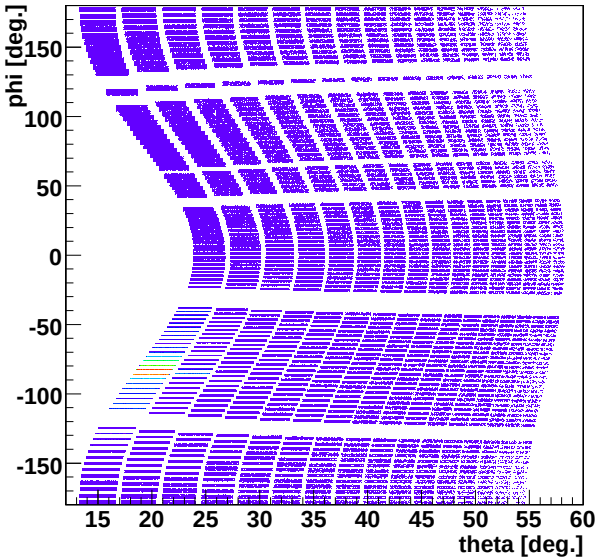


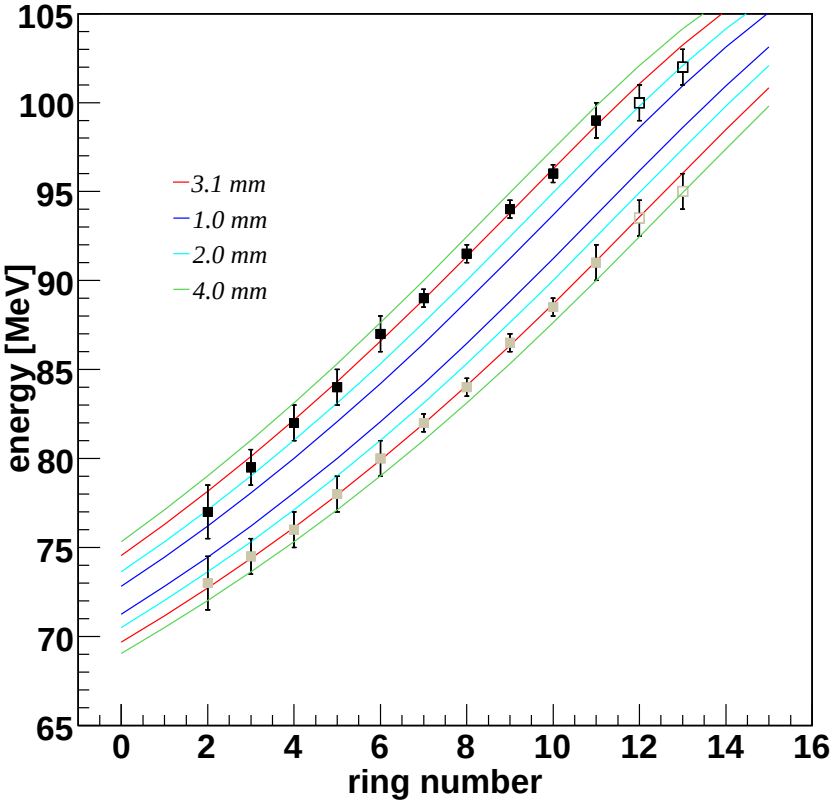
direct beam

Estimation of detector displacement









- estimation confirmed by Doppler correction
- complicated shape of the detector due to its displacement