The shape of ^{70}Se from Coulex

Peter Butler (University of Liverpool)

REX-MINIBALL collaboration

Introduction

Evidence for spherical & prolate shape co-existence in ^{72}Se by Hamilton et al (1974)

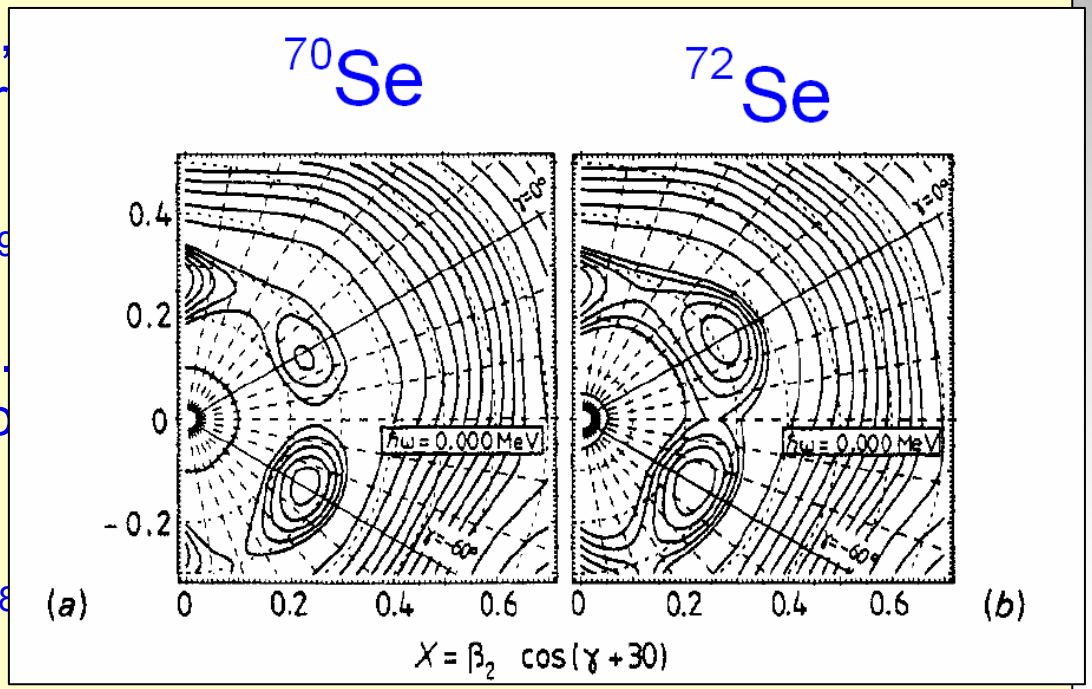
Theoretical predictions of well deformed s.p. oblate shapes ($\gamma = 60^0$) in this mass region by Aberg & Leander (1979), oblate deformation near N~Z~32-36 by Nazarewicz et al. (1985)

General feature of HO potential, predict oblate g.s. in this mass r

Evidence for oblate shape for g

WS calculations (Mylaeus et al. ^{70}Se, coexisting with excited pro configuration at I = 8 (1989)

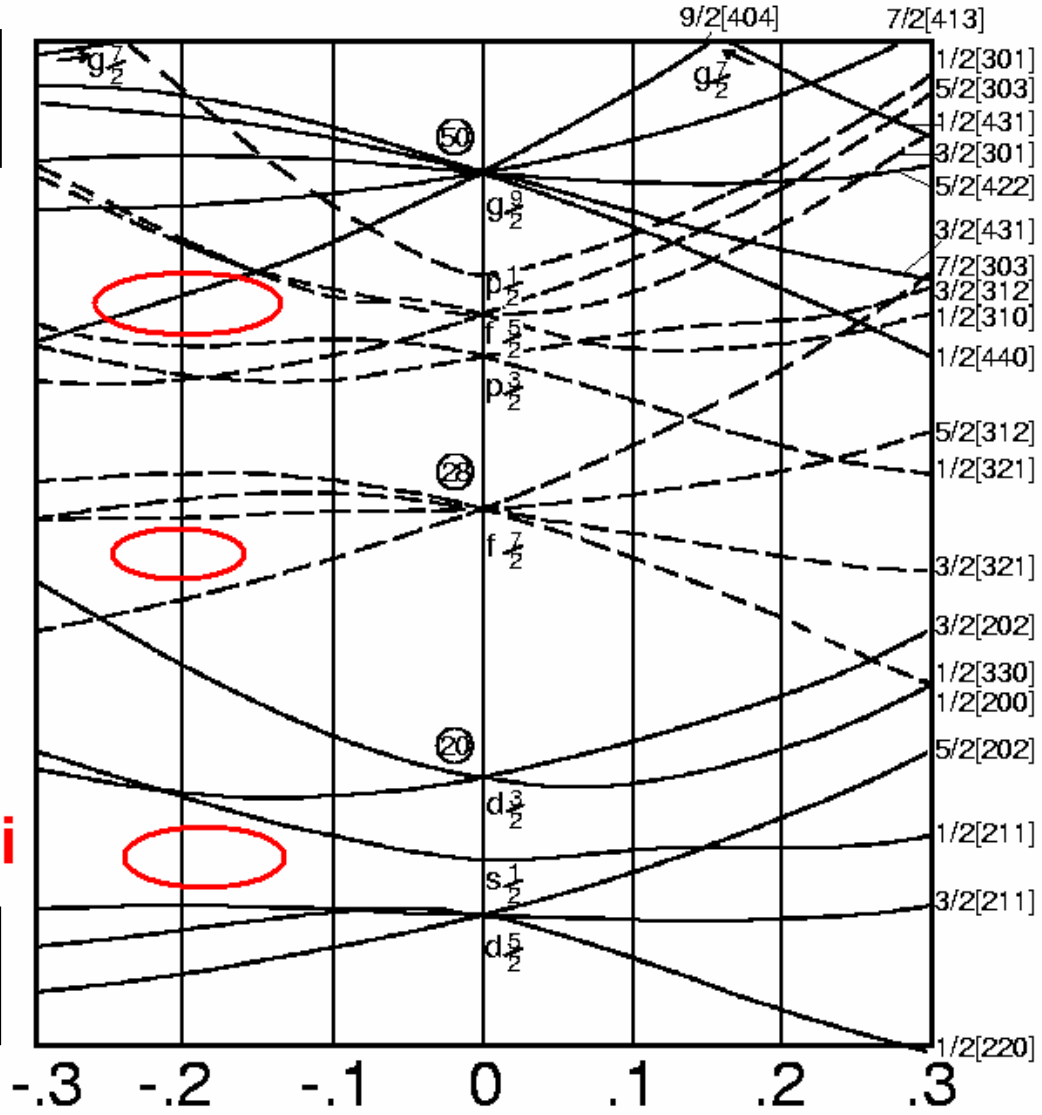
Evidence for oblate rotation in ^{68}



Deja Vu

A. Goergen
^{74,76}Kr

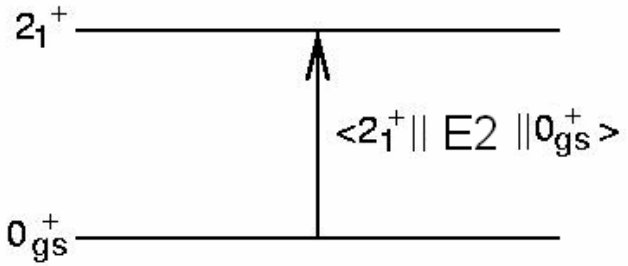
$^{72}_{36}$Kr
$^{68}_{34}$Se
$^{22}_{22}$Ti
$^{28}_{14}$Si



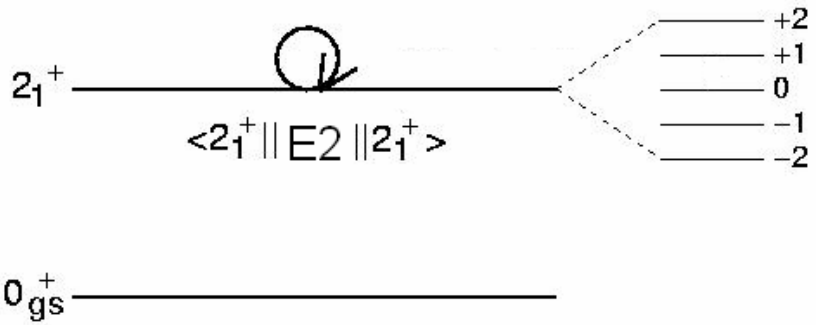
O. Hausser
PRL 23(1969)

Low energy Coulex

transitional matrix element

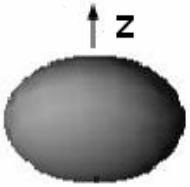


diagonal matrix element



negative $<2_1^+ || E2 || 2_1^+>$ => prolate shape

positive $<2_1^+ || E2 || 2_1^+>$ => oblate shape



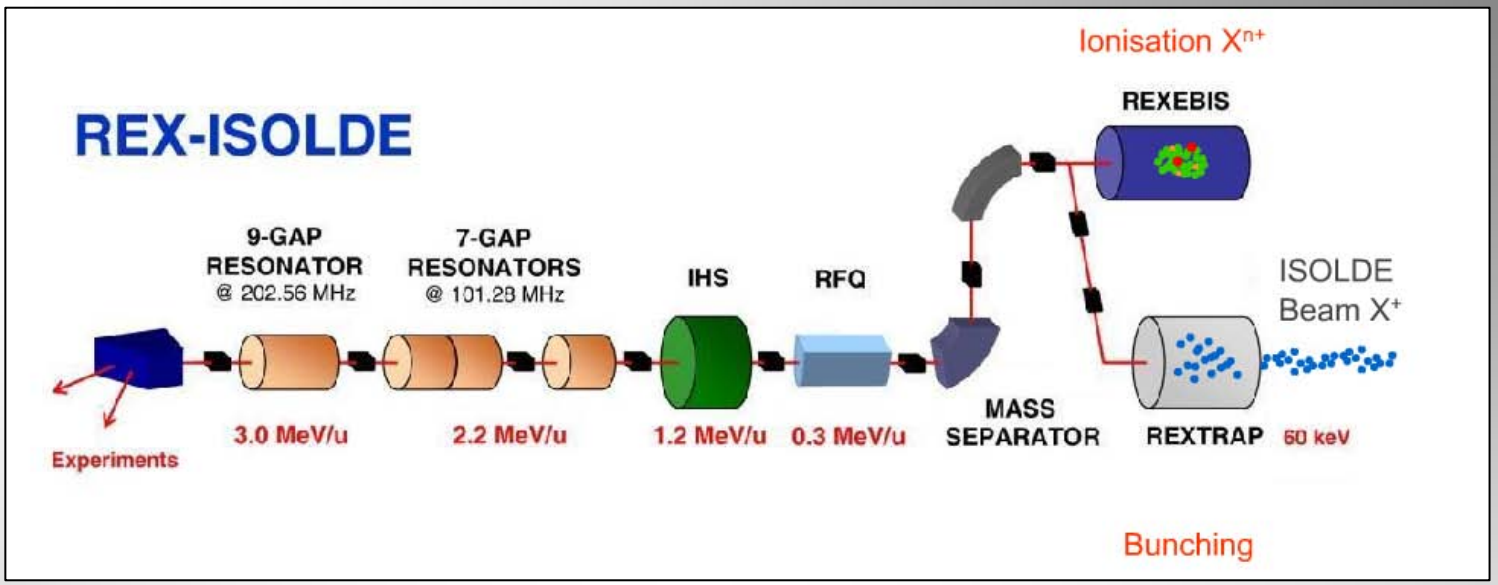
Reorientation effect

$$P_{2+} \propto \langle 0||E2||2^+\rangle^2 \cdot [1 - \langle 2^+||E2'||2^+\rangle f(\xi)]$$

$$\text{where } \xi \sim \Delta E/(E_{beam})^{3/2}$$

In our experiment P_{2+} changes by nearly factor of 2 if $\langle 2^+||E2'||2^+\rangle$ changes sign

Production



Mass 70 swamped by As, Ga, … select $^{70}Se^{12}C^{16}O \Rightarrow$ mass 98

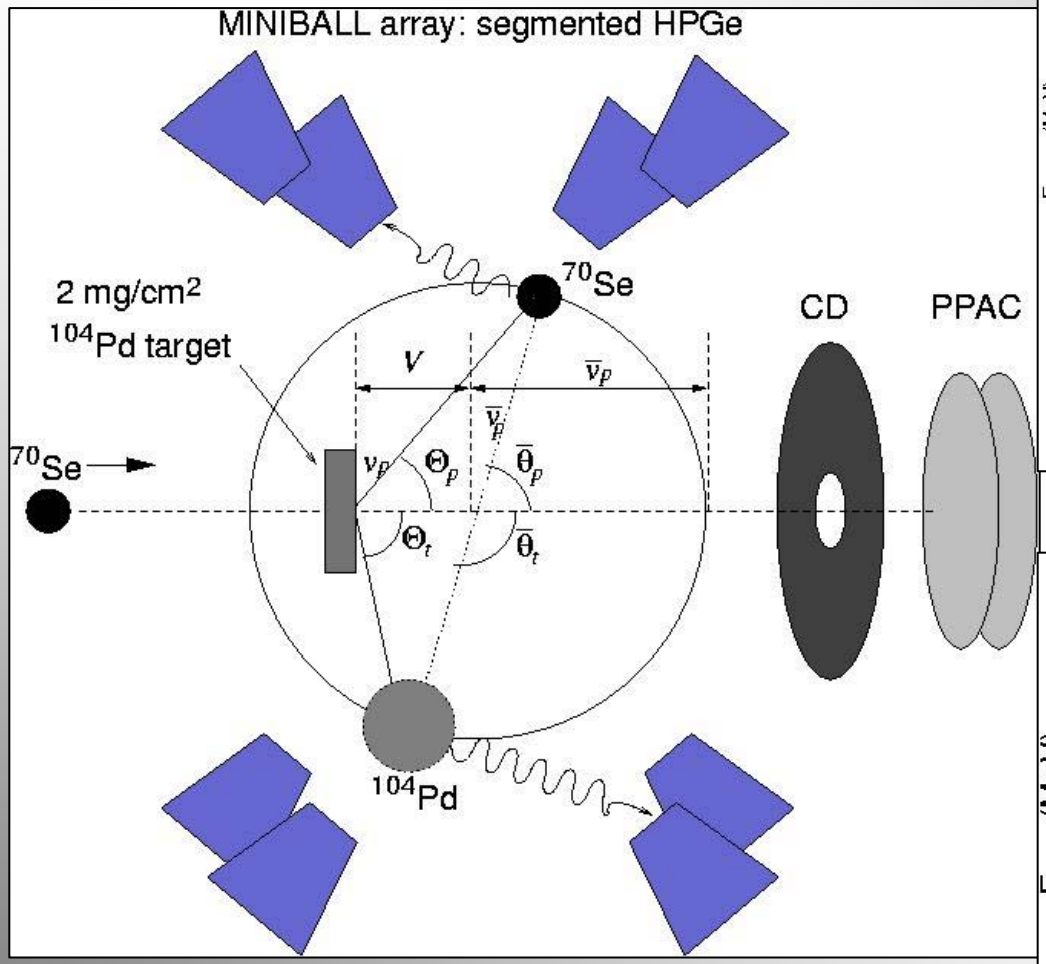
Break up $^{70}SeCO$ inside EBIS, and charge breed to $q = 19^{+}$

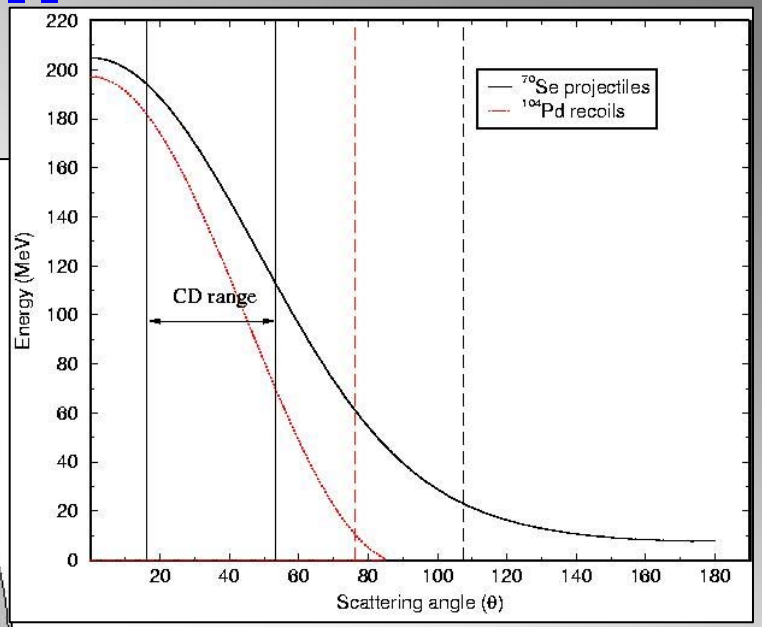
Mass select $A/q \sim 3.68$

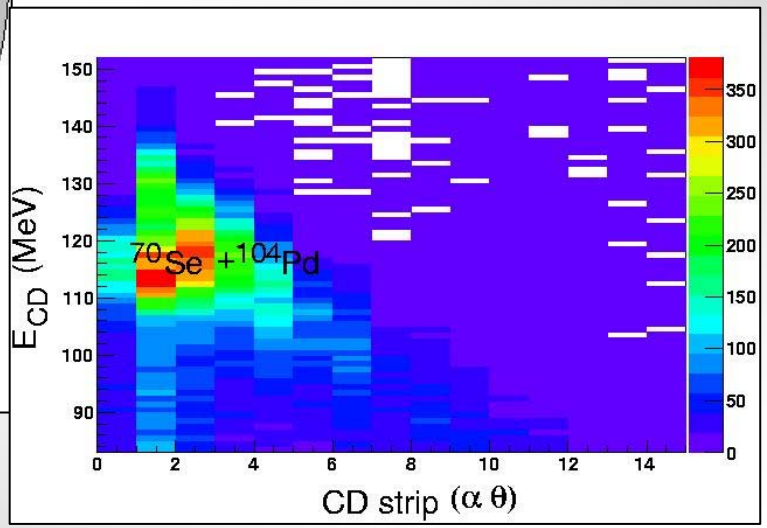
REX-ISOLDE $\Rightarrow \varepsilon \sim 2.4\% \Rightarrow I_b(^{70}Se) \sim 1.4 \times 10^4$ delivered to MB target

Miniball

^{104}Pd(^{70}Se,^{70}Se) @ 2.94 MeV/u

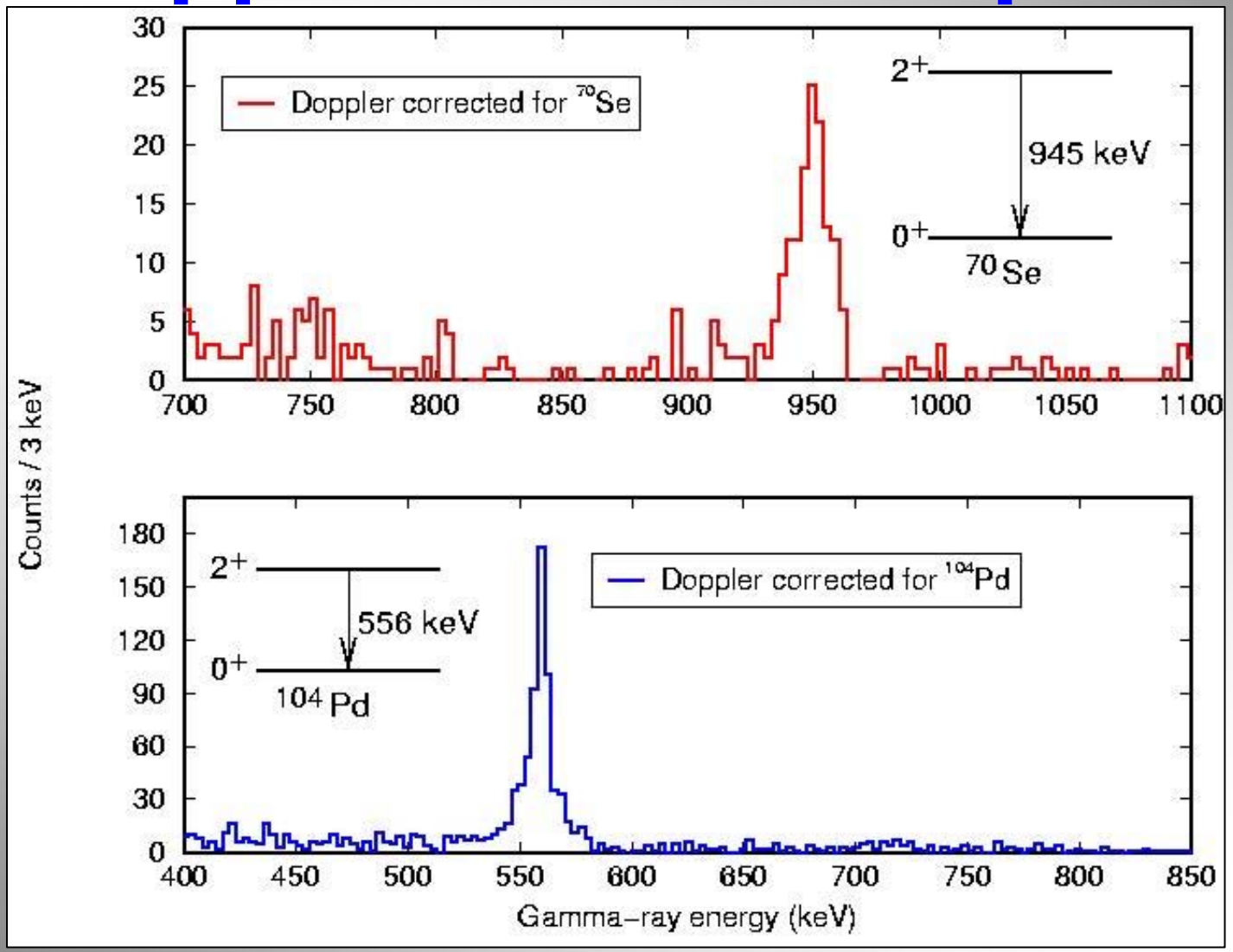






"normal kinematics"

Doppler corrected spectra



Normalisation

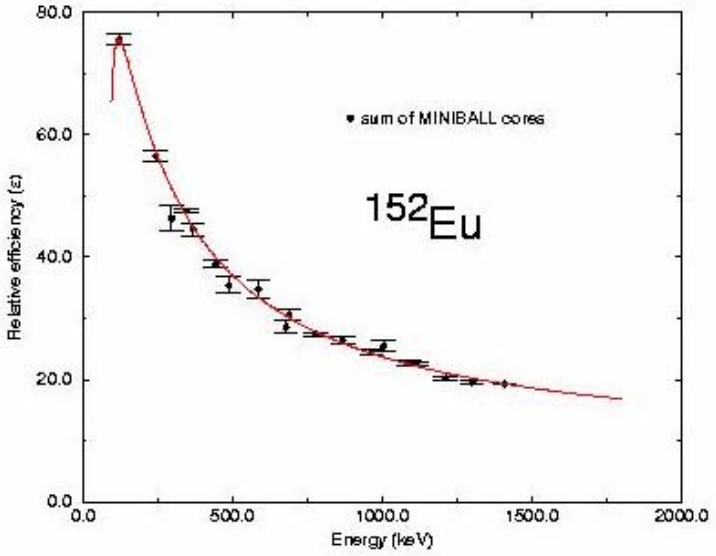
projectile excitation:

$$I_\gamma(^{70}\mathrm{Se}) = \sigma(^{70}\mathrm{Se})\,\varepsilon_p\,t\,I_b\,\varepsilon_\gamma(^{70}\mathrm{Se})$$

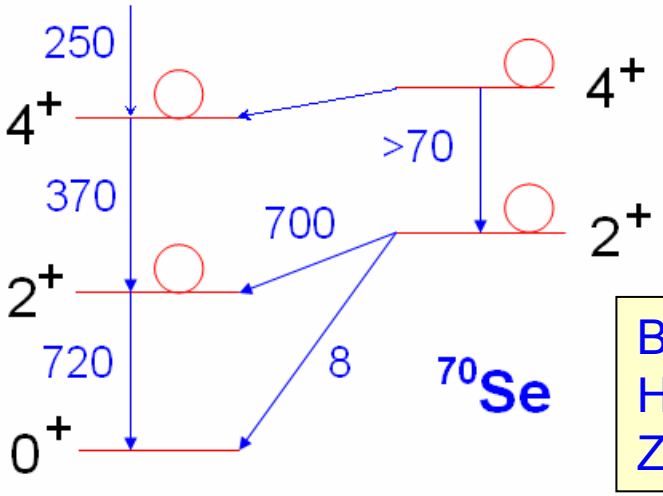
target excitation:

$$I_\gamma(^{104}\mathrm{Pd}) = \sigma(^{104}\mathrm{Pd})\,\varepsilon_p\,t\,I_b\,\varepsilon_\gamma(^{104}\mathrm{Pd})$$

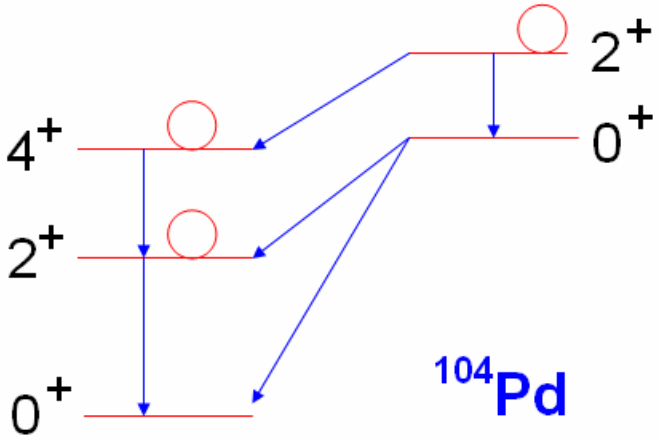
$$\sigma(^{70}\mathrm{Se}) = \sigma(^{104}\mathrm{Pd}) \cdot \frac{\varepsilon_\gamma(^{104}\mathrm{Pd})}{\varepsilon_\gamma(^{70}\mathrm{Se})} \cdot \frac{I_\gamma(^{70}\mathrm{Se})}{I_\gamma(^{104}\mathrm{Pd})}$$



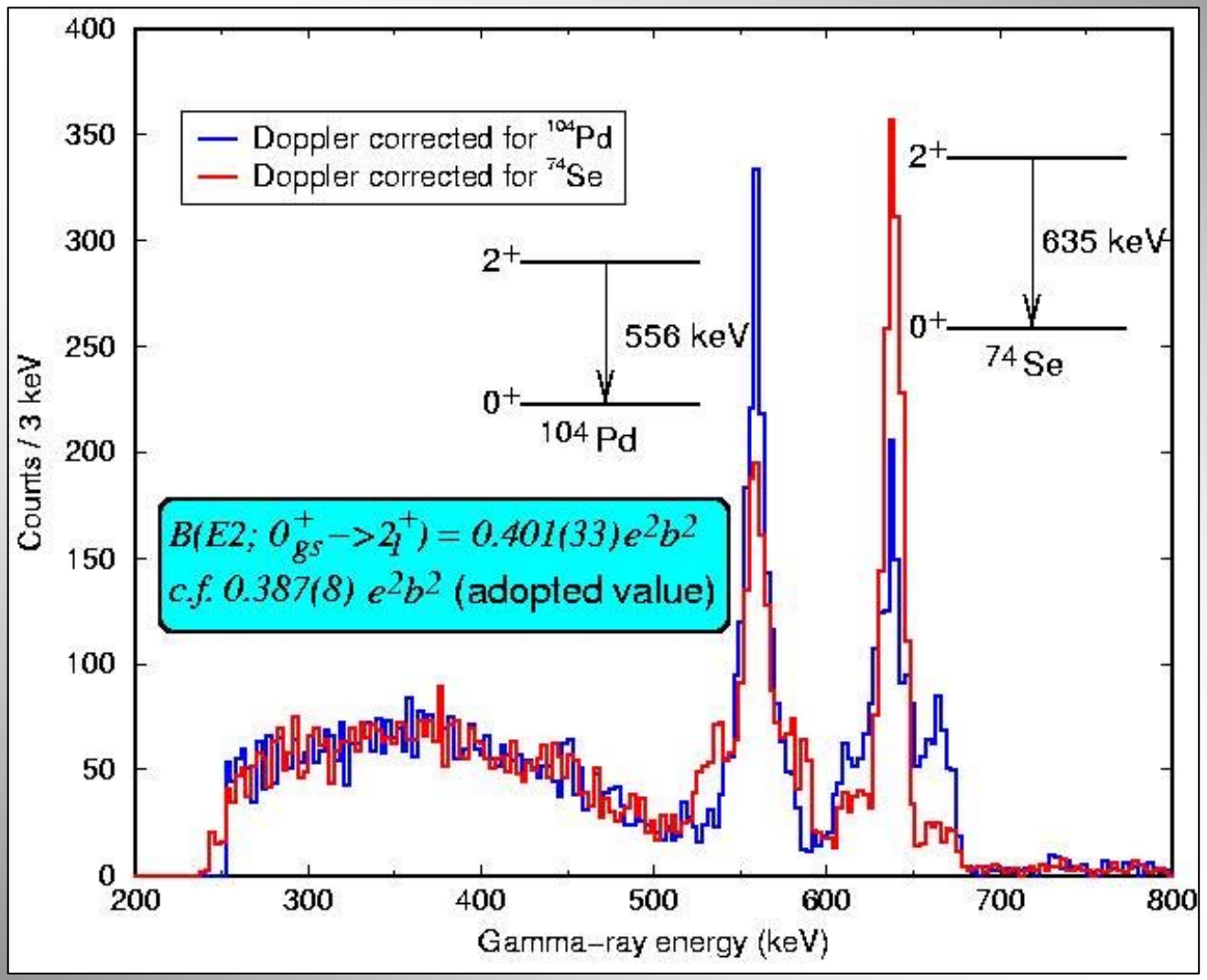
Matrix elements



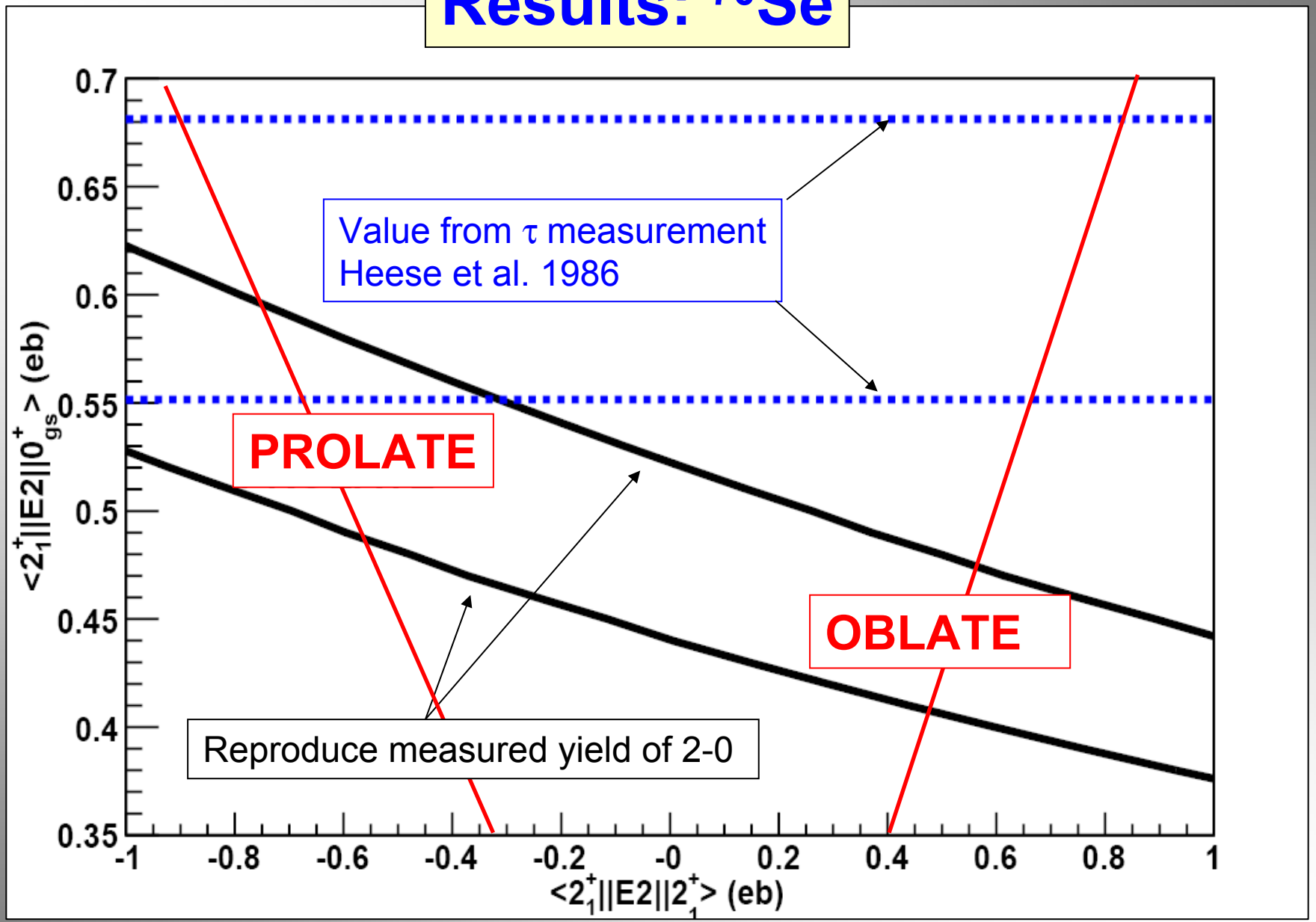
B(E2) values
Heese et al
Z.Phys.A (1986)45



Test beam: Coulomb excitation of ^{74}Se



Results: ^{70}Se



$\beta_2 \sim 0.3$

Summary

The measured diagonal E2 matrix element for the 2^+ state in ^{70}Se is consistent with a prolate shape

Next step: increase energy to 4.5 MeV/u: measure shape of 2^+_2

Collaboration

A.M. Hurst[1], *P.A. Butler*[1], *D.G. Jenkins*[2], F. Ames[6], C. Barton[2], A. Buerger[14], J. Cederkall[6,7], E. Clement[14], T. Czosnyka[8], T. Davinson[4], G. DeAngelis[15], P. Delahaye[6], J. Eberth[10], A. Ekstrom[7], S. Franchoo[6], G. Georgiev[6], A. Goergen[14], O. Ivanov[5], J. Iwanicki[8], G.D. Jones[1], P. Kent[2], U. Koster[6], M. Munch[12], E.S. Paul[1], M. Pantea[11], M. Petri[1], H. Scheit[9], T. Sieber[6], S. Siem[13], J.F. Smith[3], A. Steer[2], I. Stefanescu[5], C. Sunde[13], N. Syed[13], J. Van de Walle[5], R. Wadsworth[2], N. Warr[10], F. Wenander[6], D. Weisshaar[10], M. Zielinska[8].

[1]Department of Physics, University of **Liverpool**, UK
[2]Department of Physics, University of **York**, UK
[3]Department of Physics and Astronomy, University of **Manchester**, UK
[4]Department of Physics and Astronomy, University of **Edinburgh**, UK
[5]IKS, Catholic University of **Leuven**, Belgium
[6]PH Division, **CERN**, Geneva, Switzerland
[7]Department of Physics, University of **Lund**, Sweden
[8]Heavy Ion Laboratory, University of **Warsaw**, Poland
[9]MPI, University of **Heidelberg**, Germany
[10]IKP, University of **Cologne**, Germany
[11]IKP, **Darmstadt** Technical University, Germany
[12]Department of Physics, **Munich** Technical University, Germany
[13]Department of Physics, University of **Oslo**, Norway
[14]CEA, **Saclay**, France
[15] INFN-LNL **Legnaro**, Italy