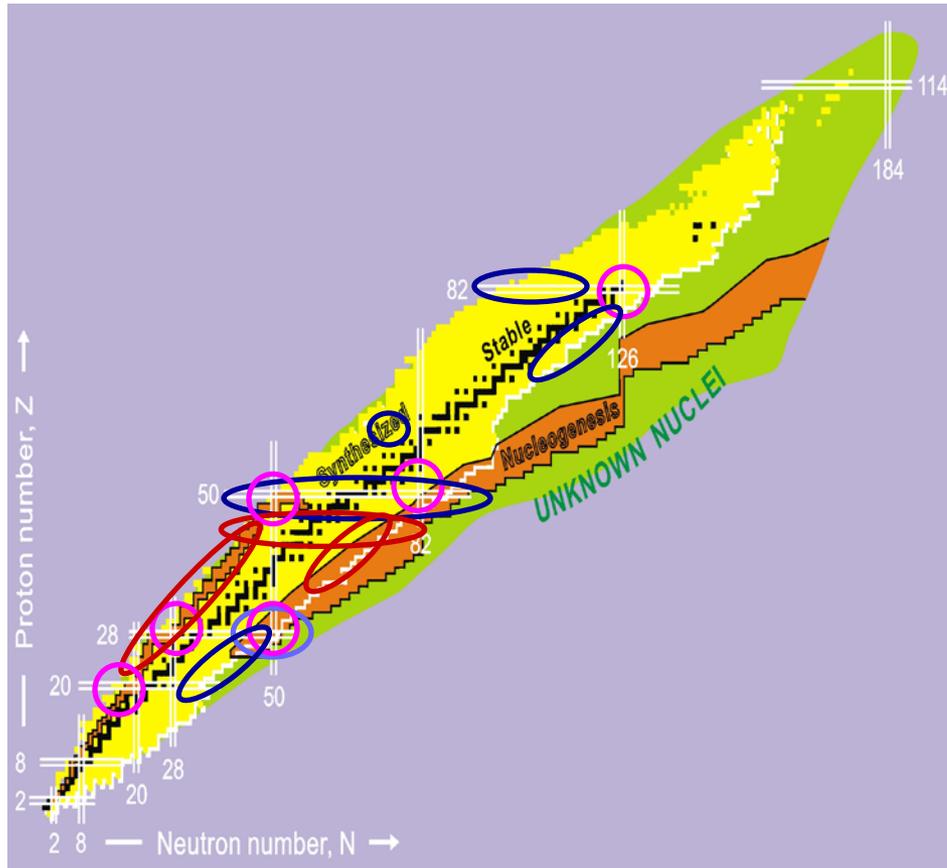


Status and perspectives of the PRESPEC campaigns

J. Gerl
GSI

June 29, 2011
EGAN11 Workshop
Padova, Italy

Nuclear Spectroscopy employing RIBs at GSI



Nuclear Shell structure

- $N \approx Z$
- $N \gg Z$

Nuclear shapes

- Quadrupole, Octupole, Triaxiality
- Shape transitions
- High K-isomers

Collective modes

- $N \gg Z$: GDR soft mode

Nuclear Symmetries

- mirror-isospin, pn-pair correlation

Nuclear astrophysics

- r, rp process

Coulomb excitation, Fragmentation and Decay studies using Rare Isotope Beams and high-resolution γ Spectroscopy

History...



1998

2000

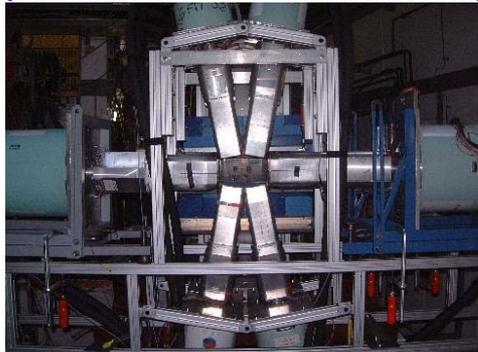
2002

2004

2006

2008

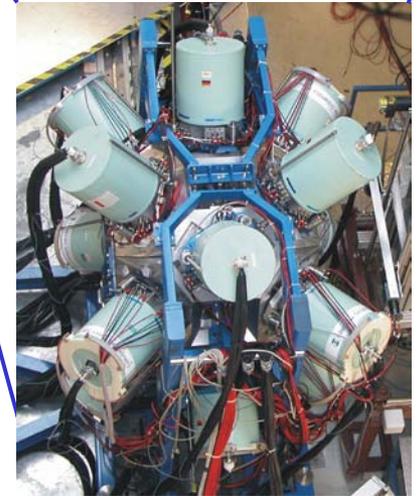
VEGA
Isomer campaign



RISING
Fast campaign



RISING
Stopped campaign



g-RISING



Fragment Identification, Implantation and Spectroscopy

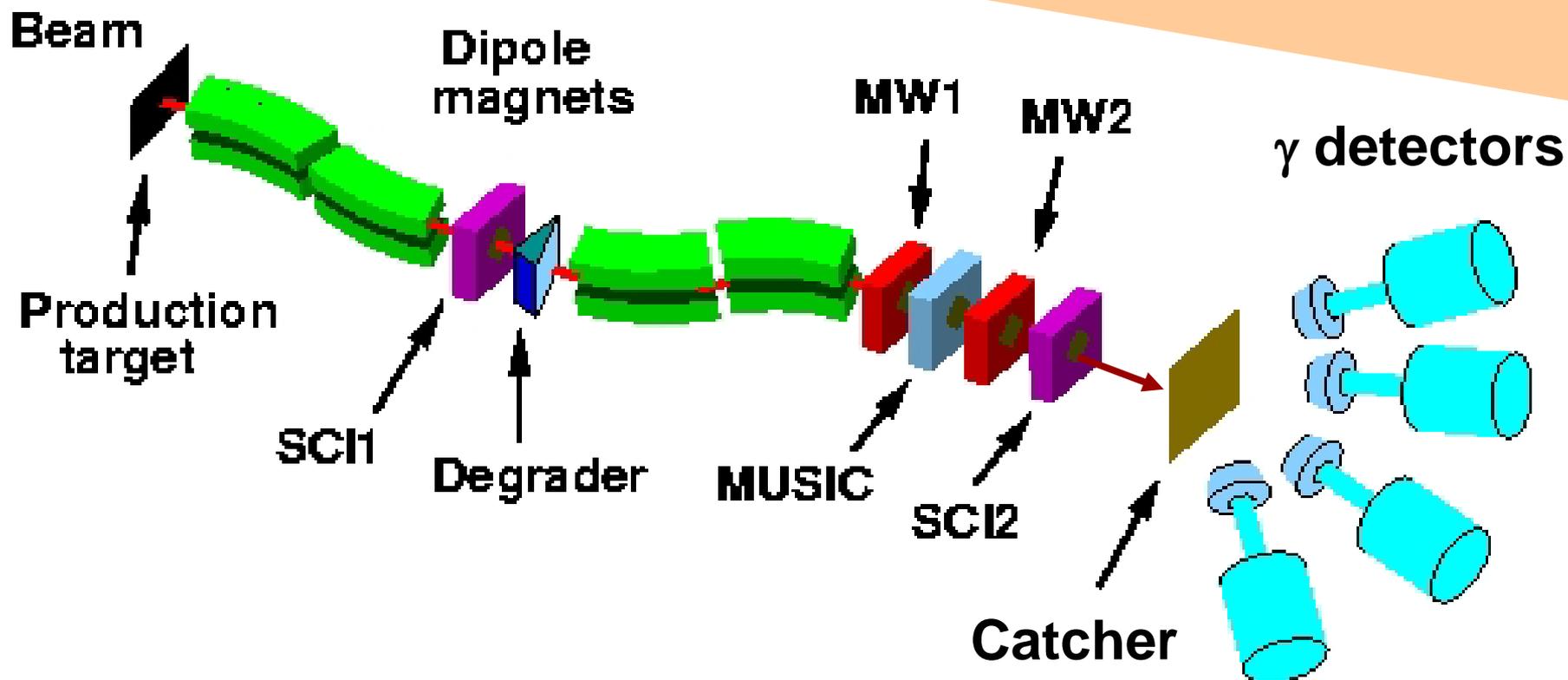
production

selection

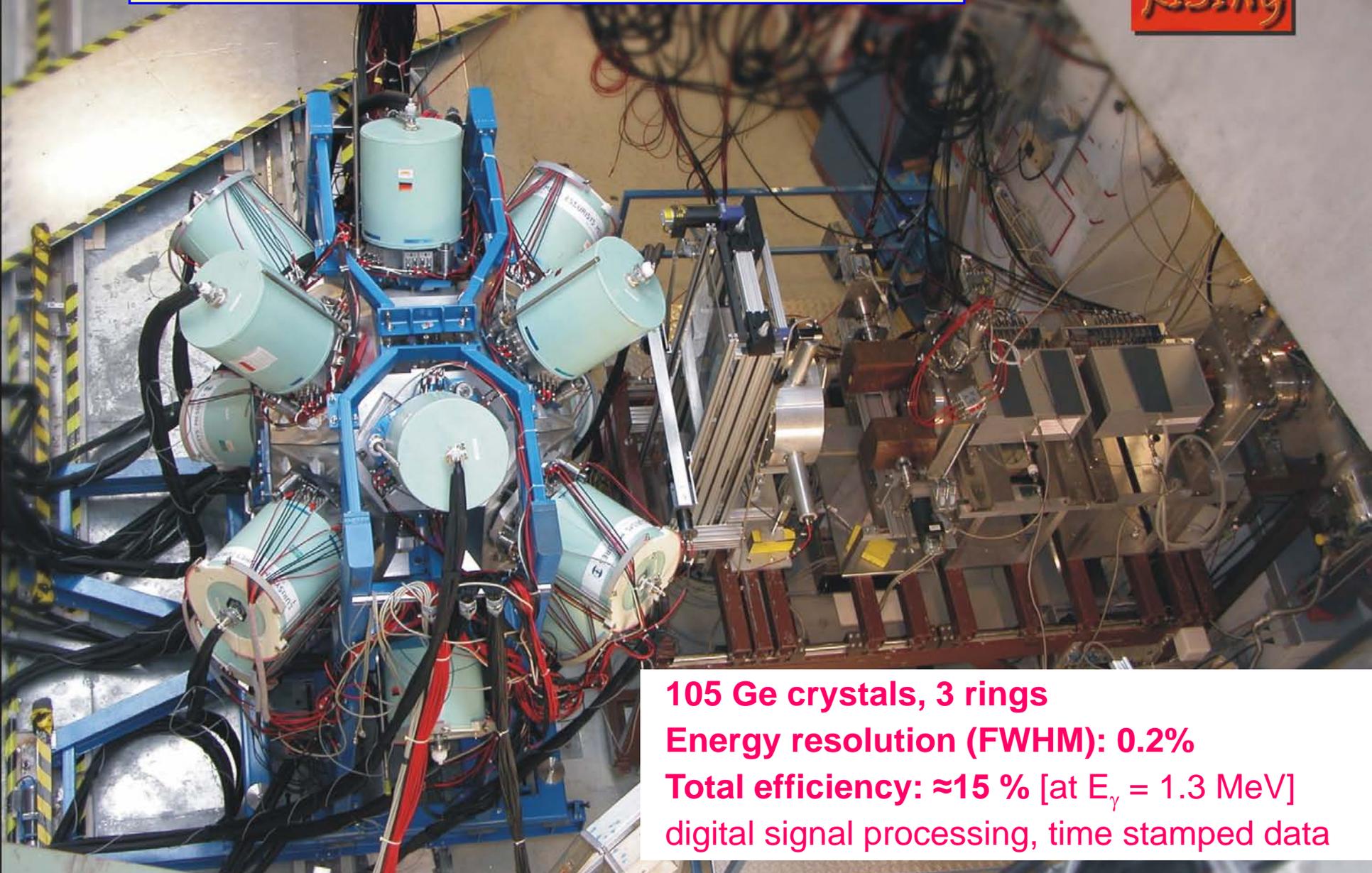
identification

spectroscopy

implantation

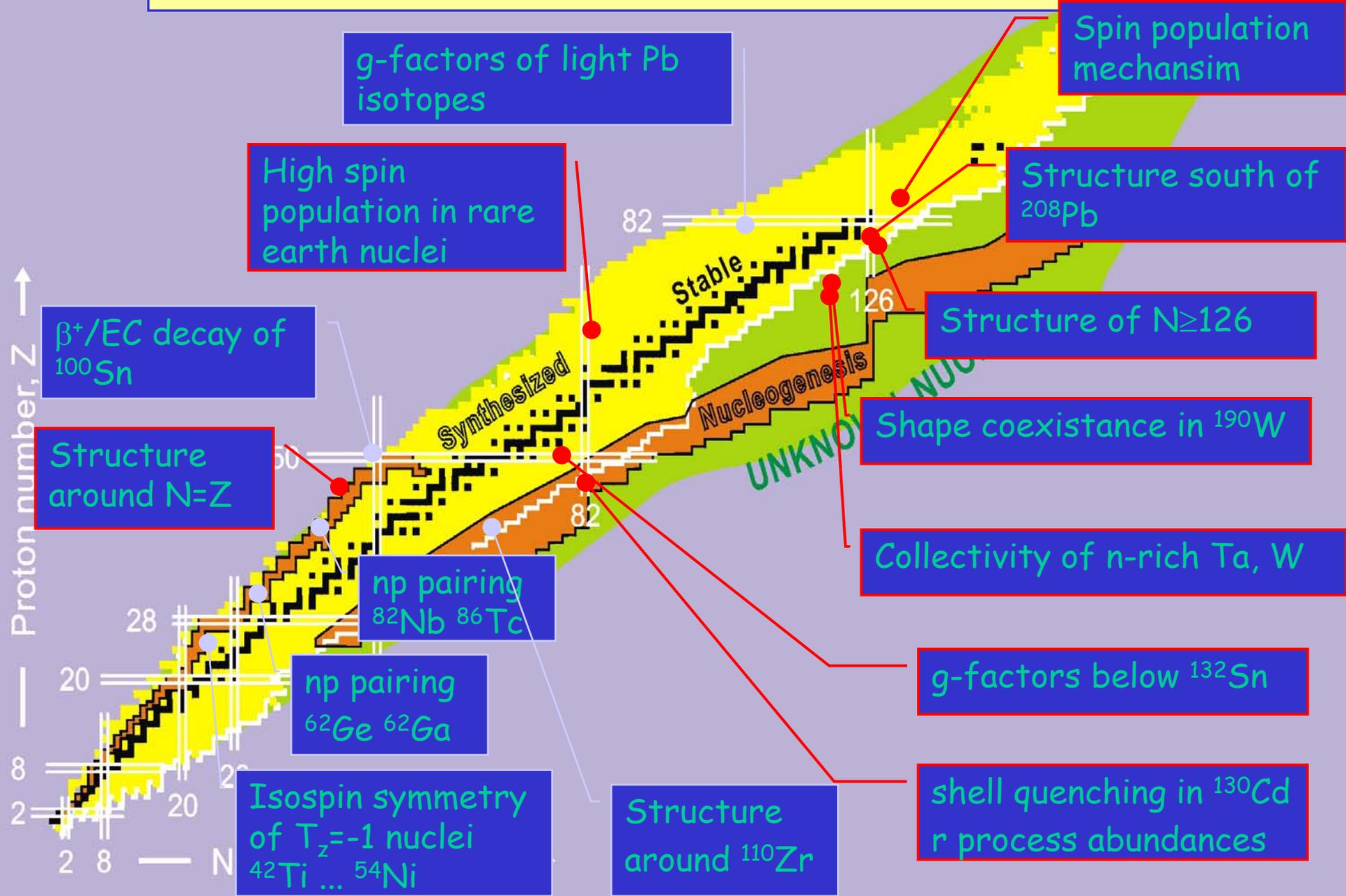


RISING Stopped Beam set-up



105 Ge crystals, 3 rings
Energy resolution (FWHM): 0.2%
Total efficiency: $\approx 15\%$ [at $E_\gamma = 1.3$ MeV]
digital signal processing, time stamped data

RISING: Stopped beam - physics focus



Fragment Identification, Reaction and Spectroscopy

production

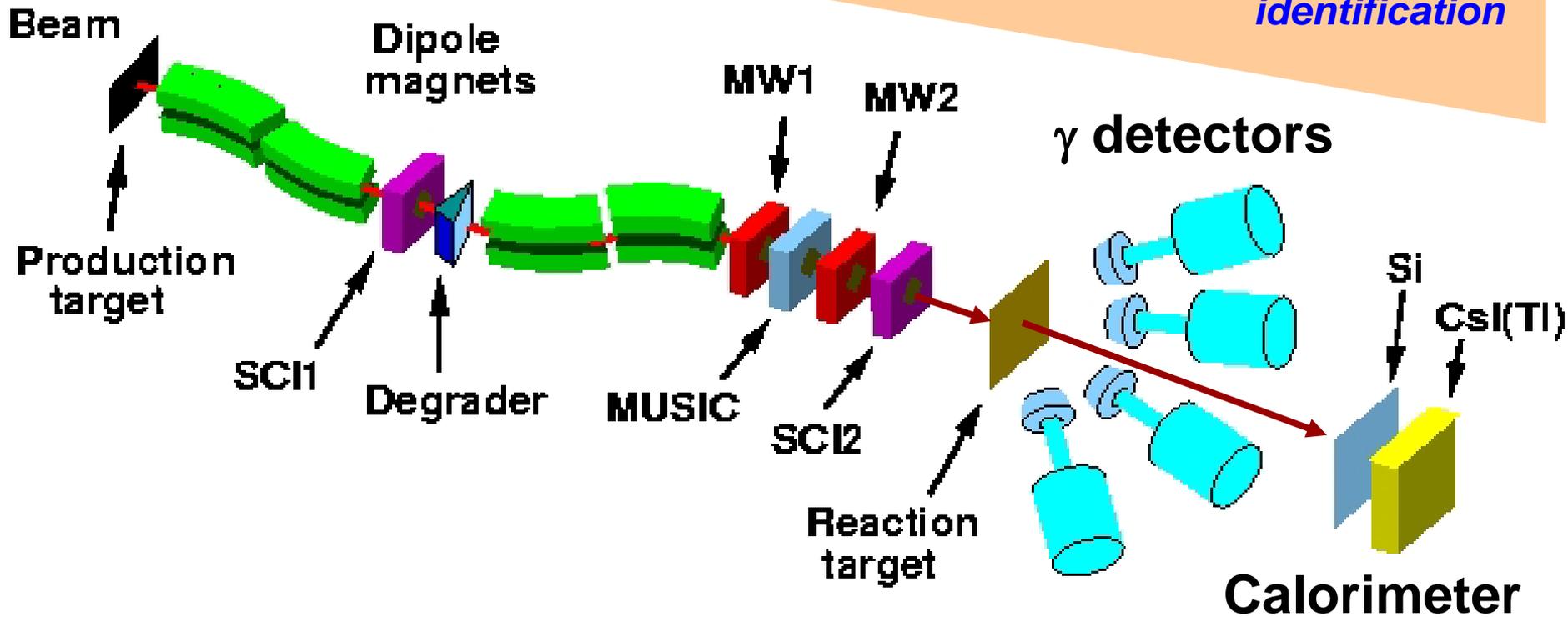
selection

identification

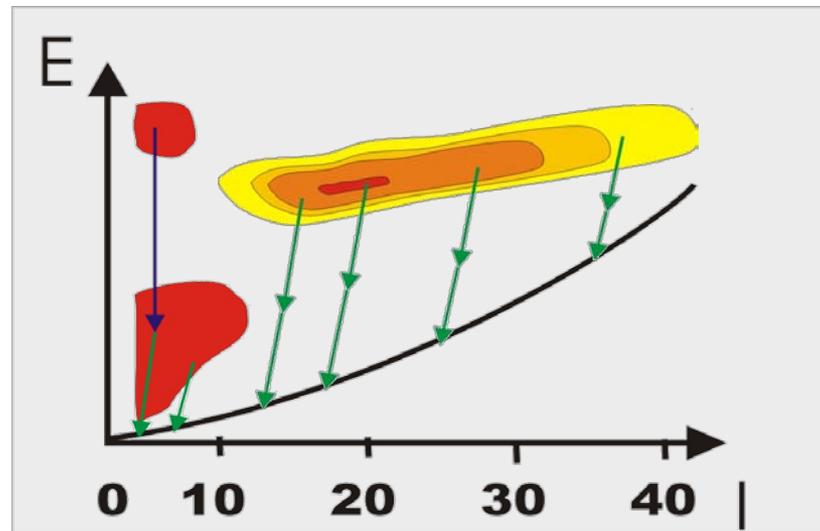
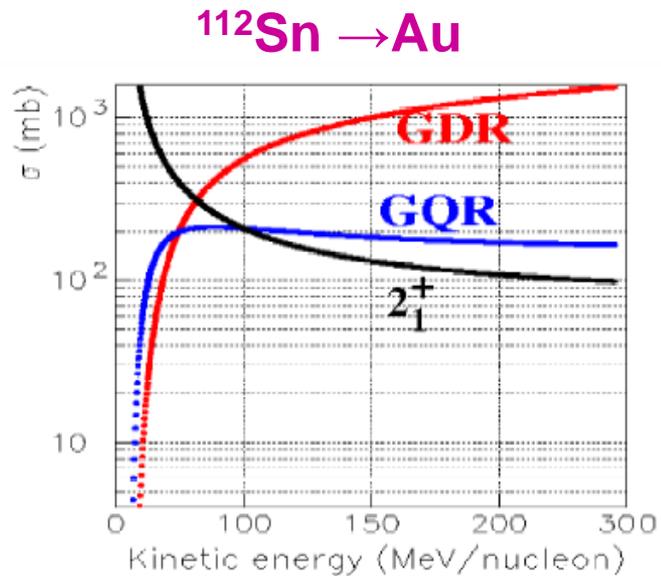
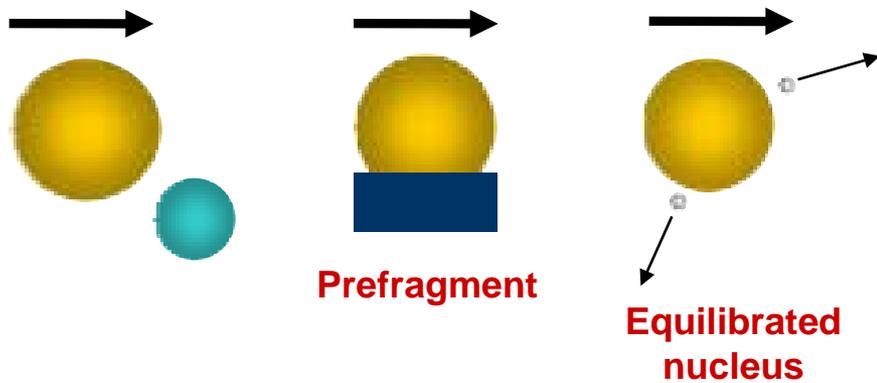
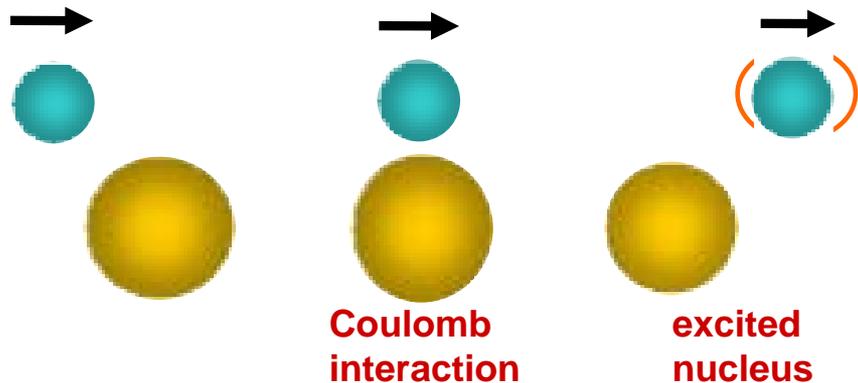
reaction

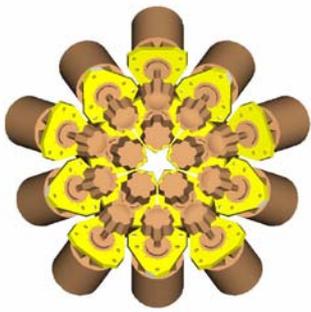
spectroscopy

identification

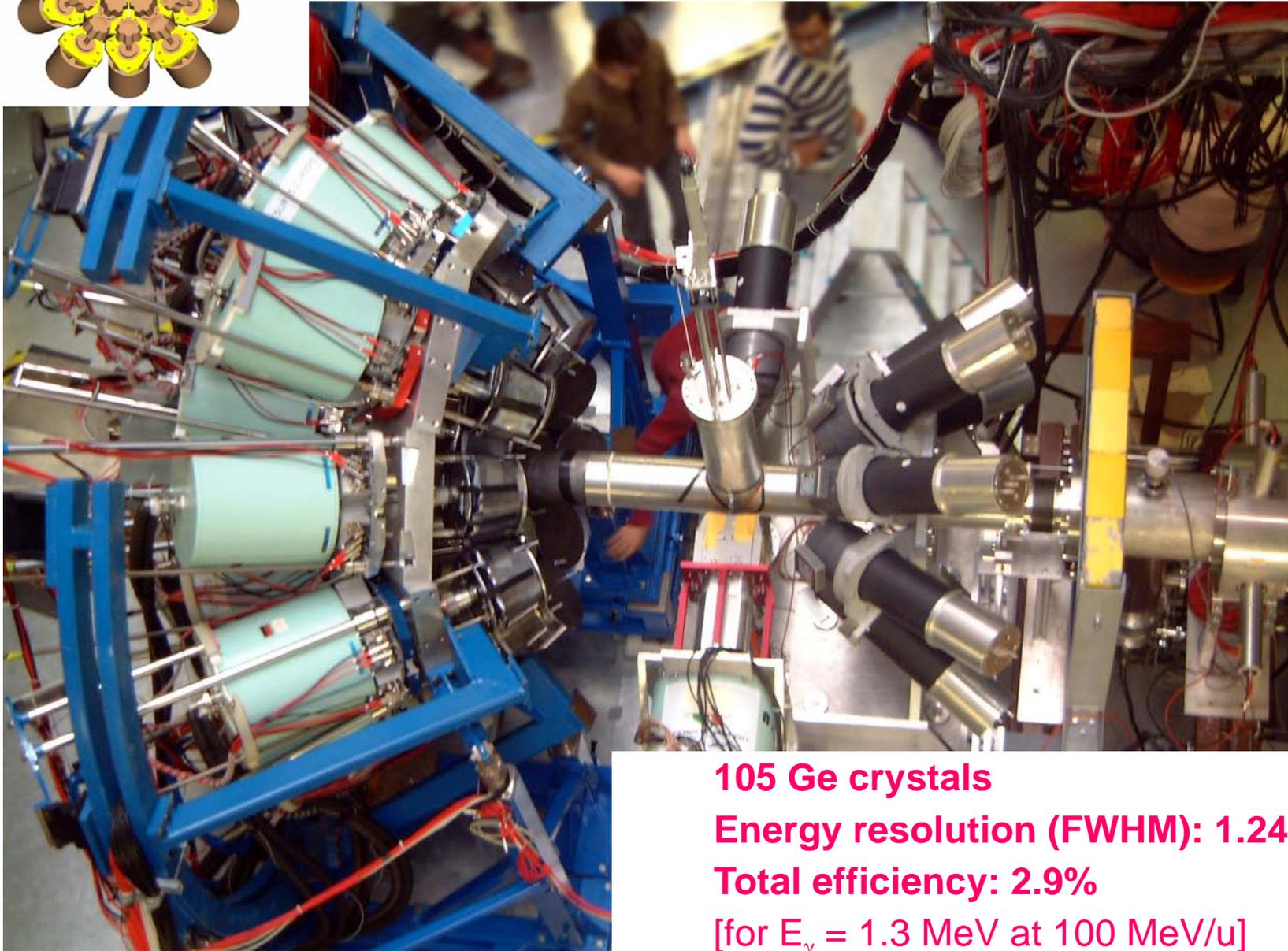


Relativistic Coulomb excitation / fragmentation





RISING In-flight set-up



105 Ge crystals

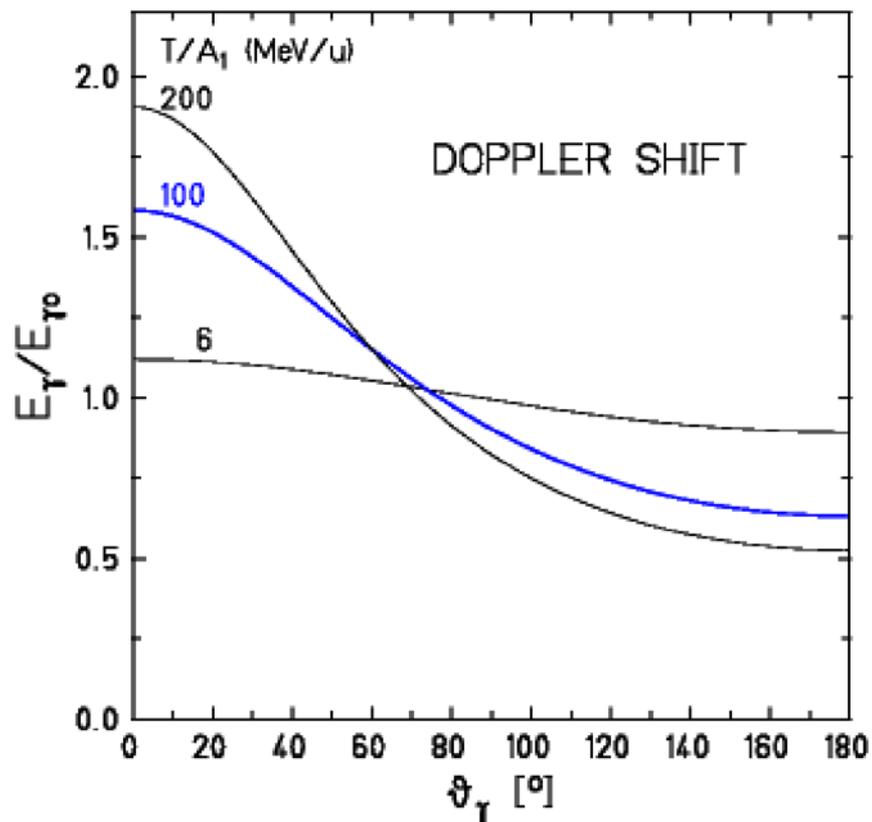
Energy resolution (FWHM): 1.24%

Total efficiency: 2.9%

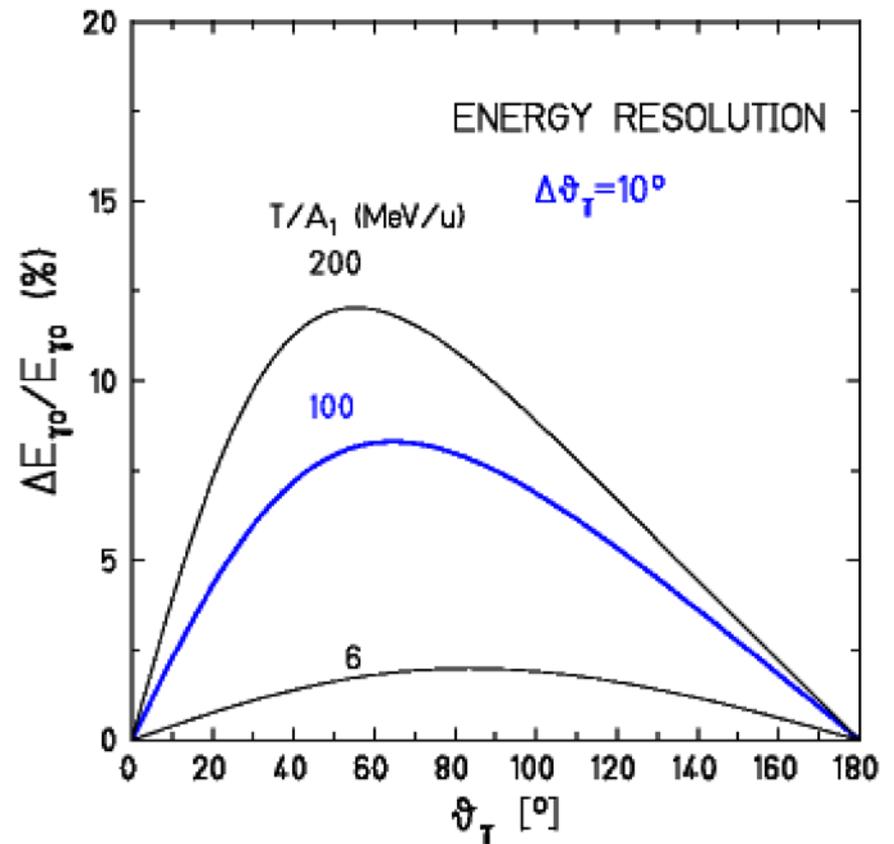
[for $E_\gamma = 1.3$ MeV at 100 MeV/u]

Doppler Effect

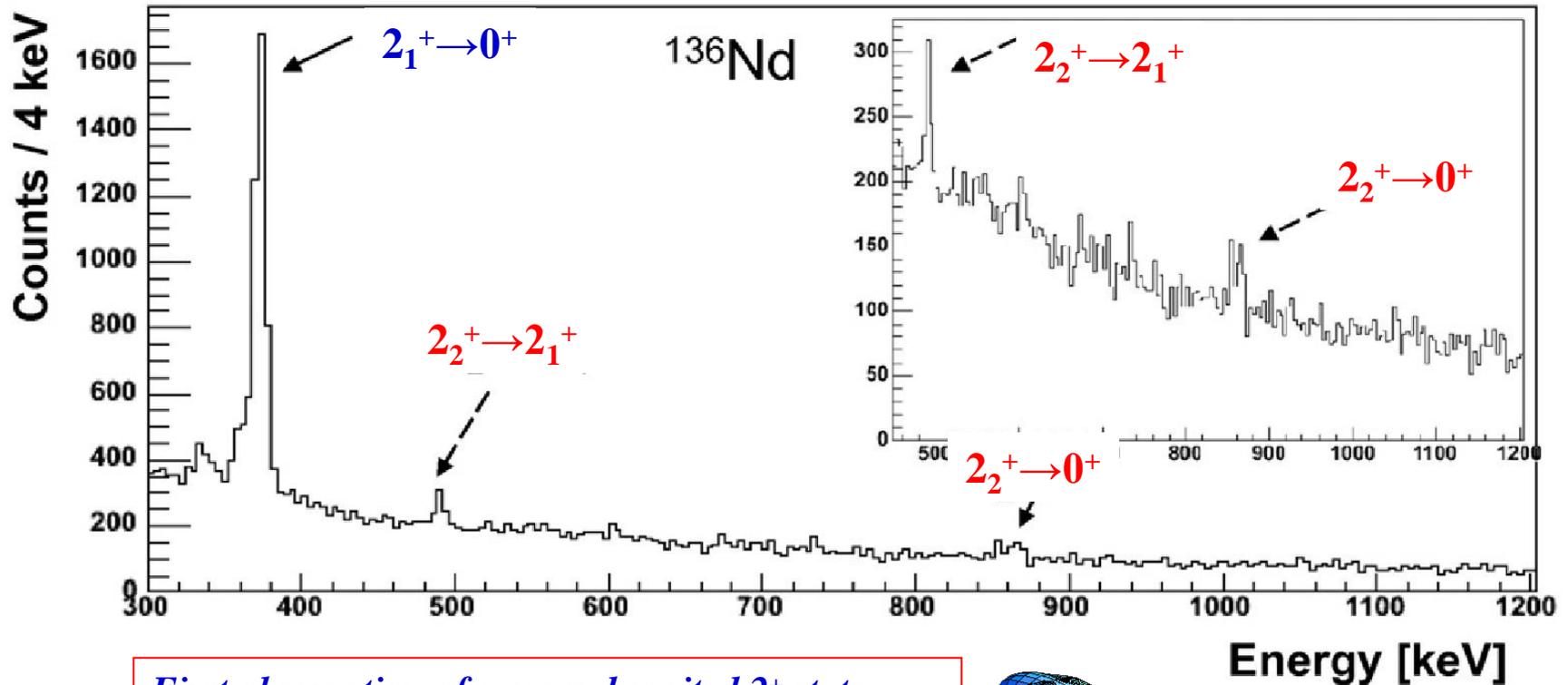
Doppler shift



Doppler broadening

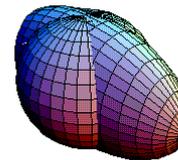


High-energy Coulomb excitation triaxiality in even-even nuclei (N=76)



First observation of a second excited 2^+ state populated in a Coulomb experiment at 100 AMeV using EUROBALL and MINIBALL Ge-detectors.

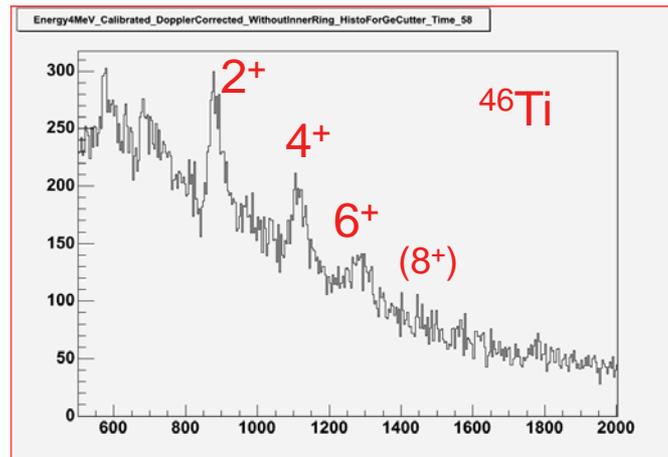
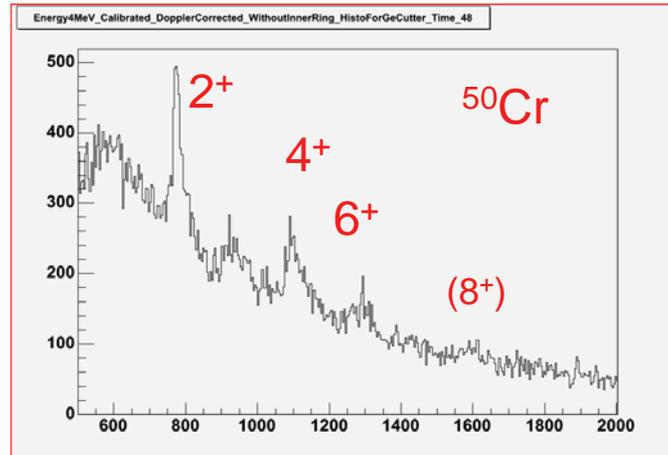
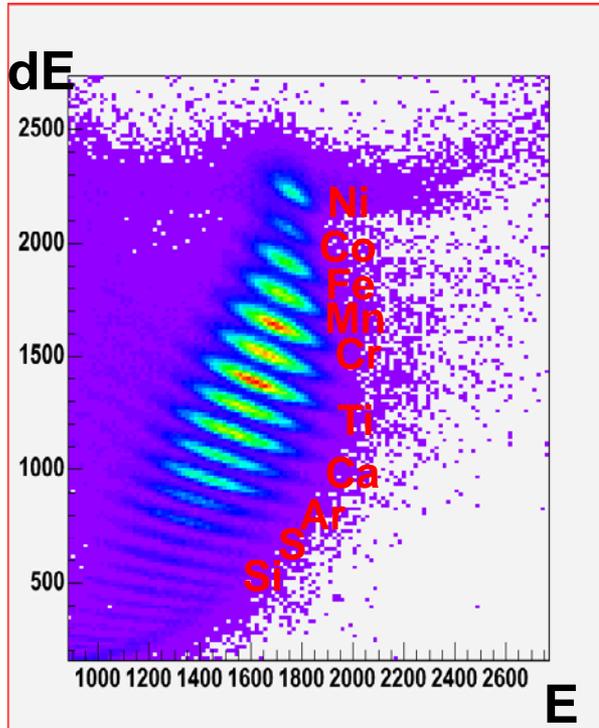
- shape symmetry
- collective strength



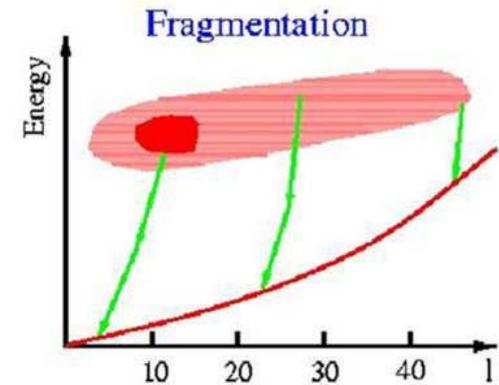
Secondary fragmentation of ^{55}Ni on ^9Be at 140 MeV/u

Mirror symmetry
at $N \approx Z$

Mike Bentley et al.

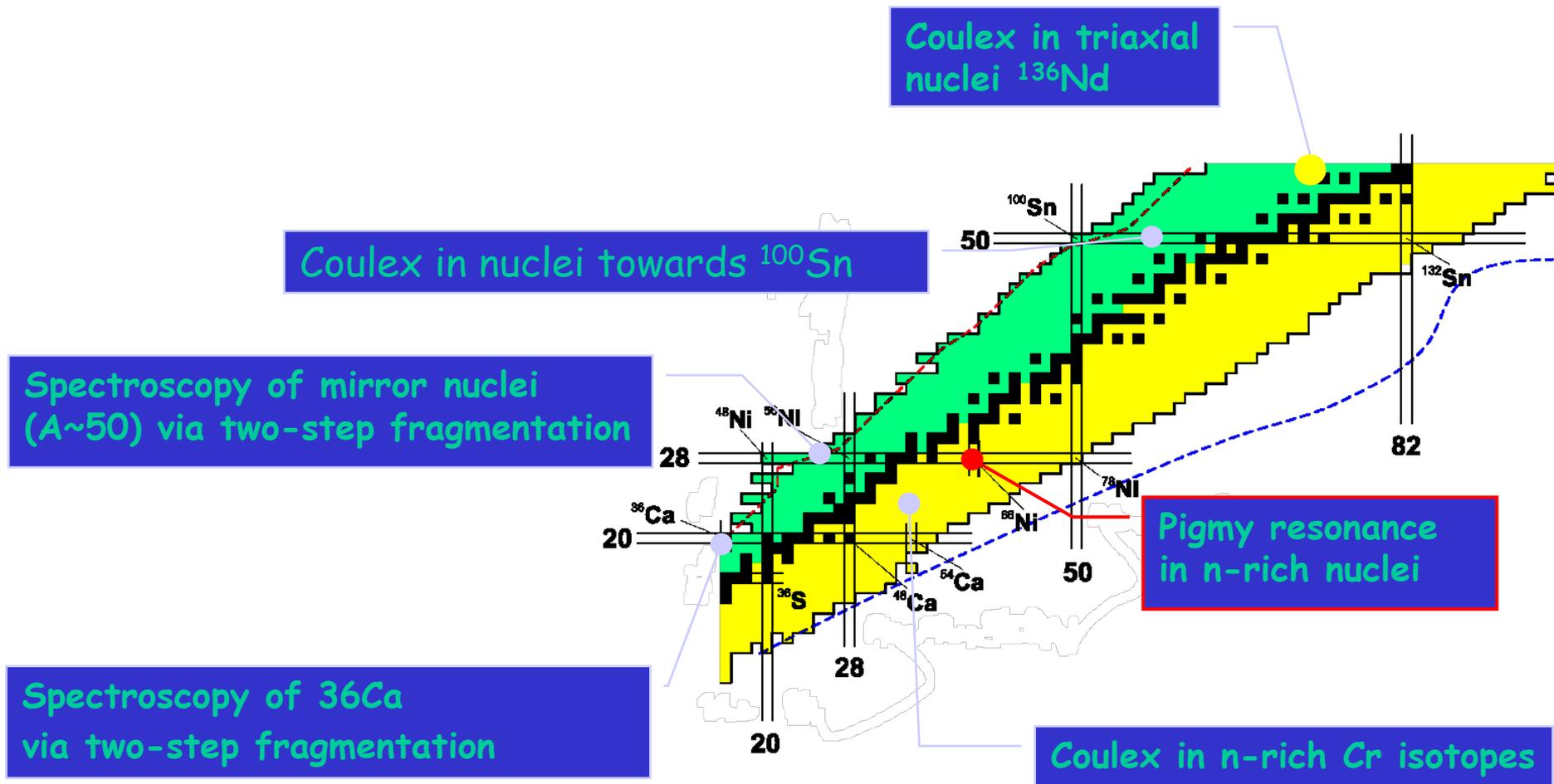


extract
lifetimes
from
lineshapes



First observation of higher spin states at relativistic energies

RISING: Fast beam - physics focus



From RISING to HISPEC/DESPEC

RISING stopped in September 2009

Want to continue successful spectroscopy programme

HISPEC/DESPEC starts after 2016

Need to commission and implement new instrumentation



Decay and **In-beam spectroscopy** programme at the FRS until HISPEC/DESPEC starts

Employing new instrumentation as it becomes available

Platform for coordinated test and commissioning of HISPEC/DESPEC components

Organisational framework of the spectroscopy community at GSI/FAIR

Planned Improvements

production
primary int.

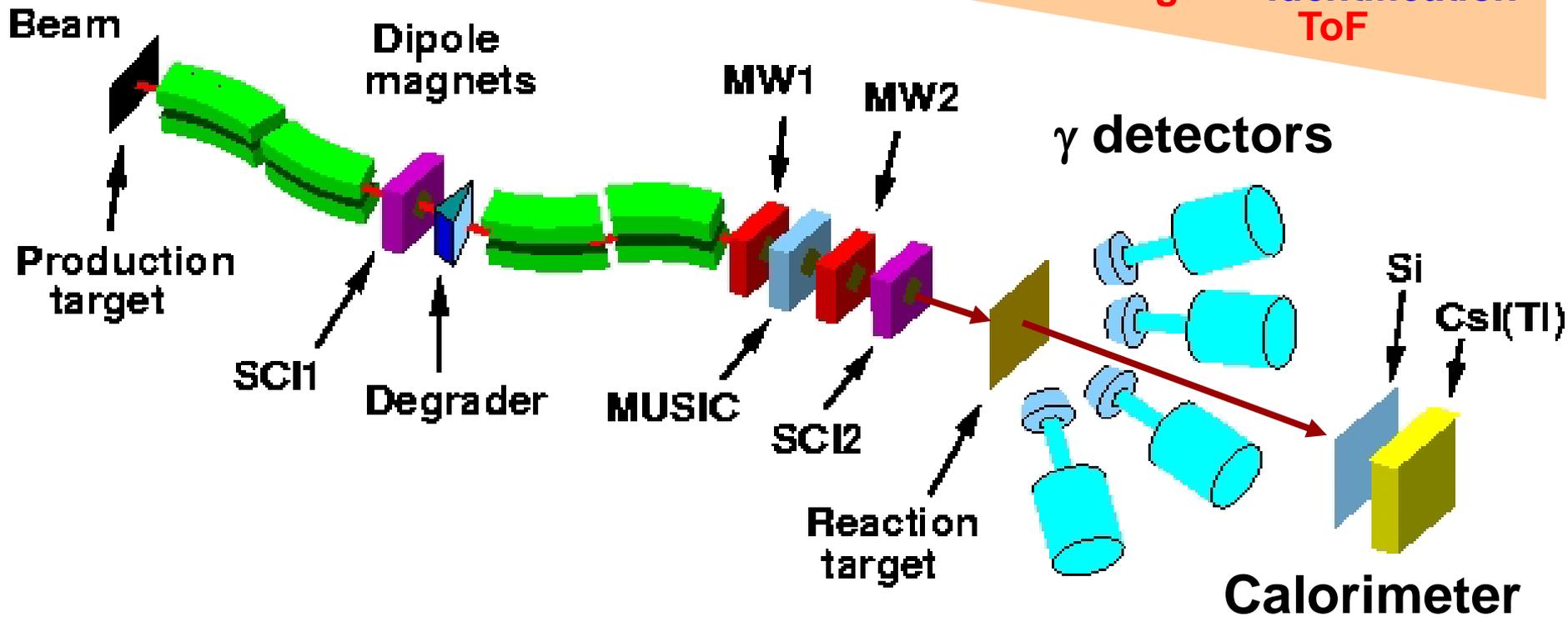
selection

identification
rate capability

implantation /
reaction
granularity /
active target

spectroscopy
 γ tracking

identification
ToF



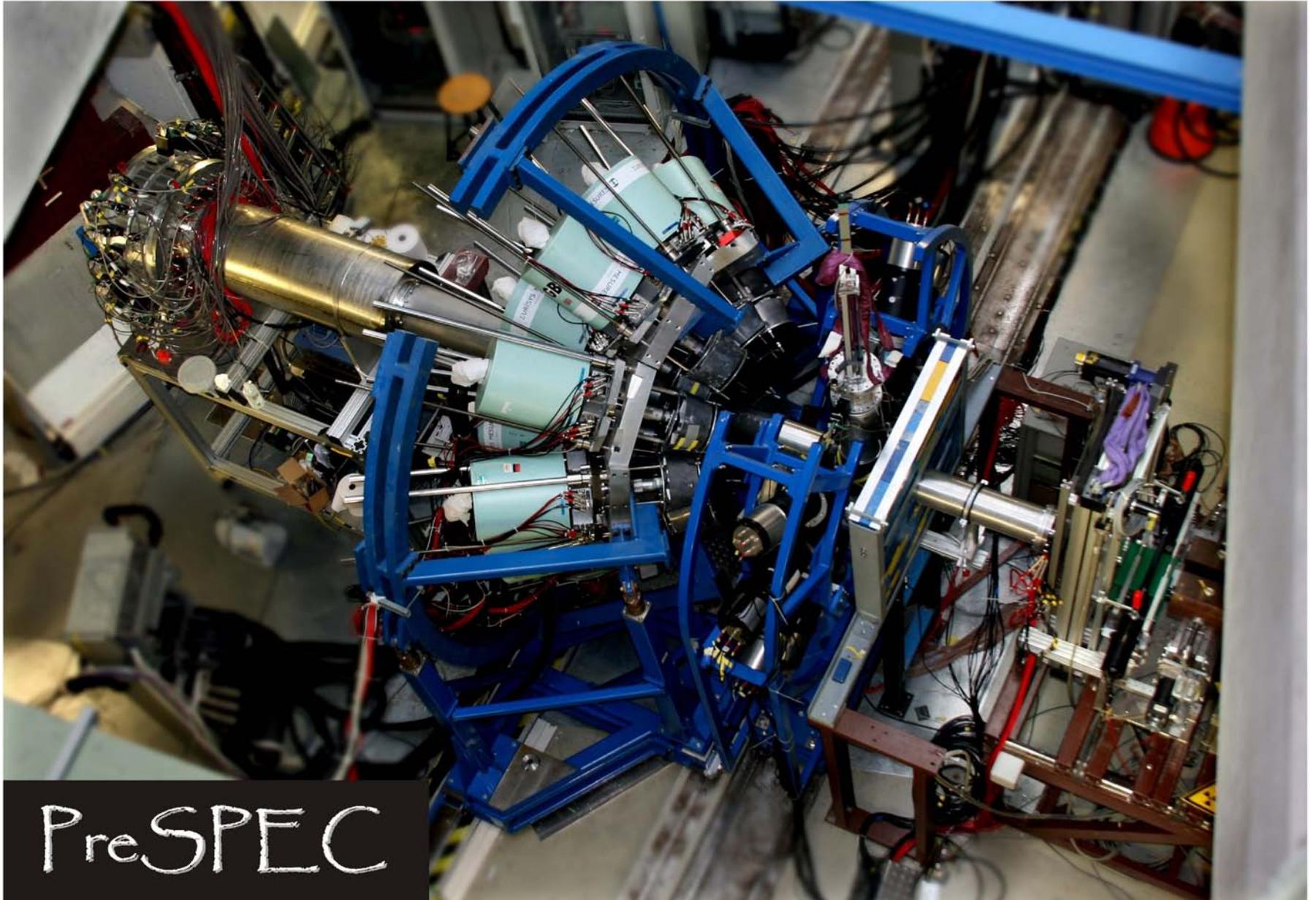
PRESPEC time plan

	Main beam time (weeks)	Parasitic beam time (weeks)
2010		PRESPEC
	PRESPEC fast beam campaign 2	LYCCA-0 Commissioning 2
2011	1	HISPEC/DESPEC test+commisioning 2
		AGATA - PRESPEC Preparation 2
2012		
	AGATA - PRESPEC fast beam campaign 8	2
2013	4	2
		PRESPEC decay campaign preparati 1
2014		
	PRESPEC stopped beam campaigns 5	2

Physics program of PreSpec Fast Beam Campaign

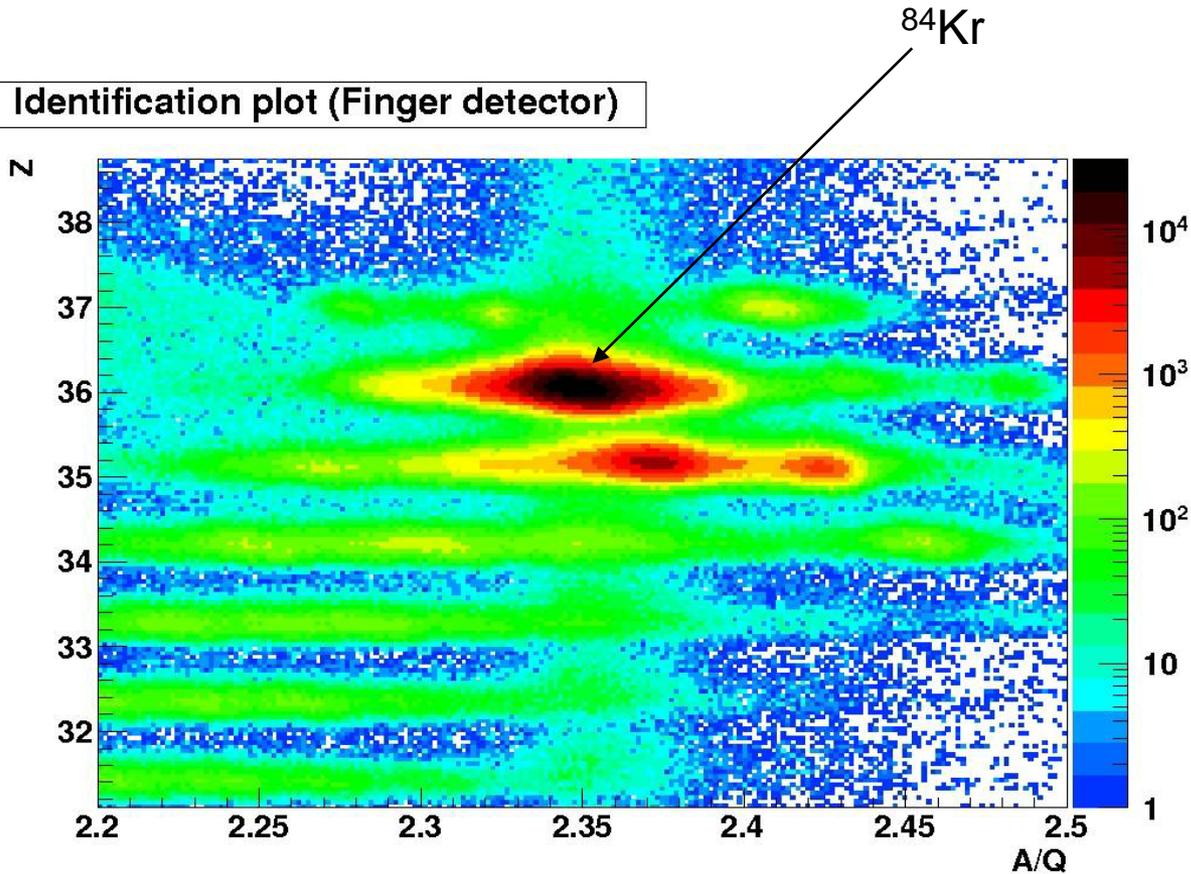
- **LYCCA/PRESPEC Commissioning**
- **3 Main Experiments**
 - 1) B(E2) value of the mixed symmetry 2^+ transition in ^{88}Kr
 - 2) B(E2) value of the 2^+ transition in ^{104}Sn
 - 3) Neutron-deficient sd-shell nuclei and mirror symmetry at the drip line
- **Test and Commissioning of HISPEC/DESPEC detectors**
 - Hydrogen target
 - Plunger
 - High-velocity transient fields
 - AGATA
 - ...

PRESPEC fast beam set-up



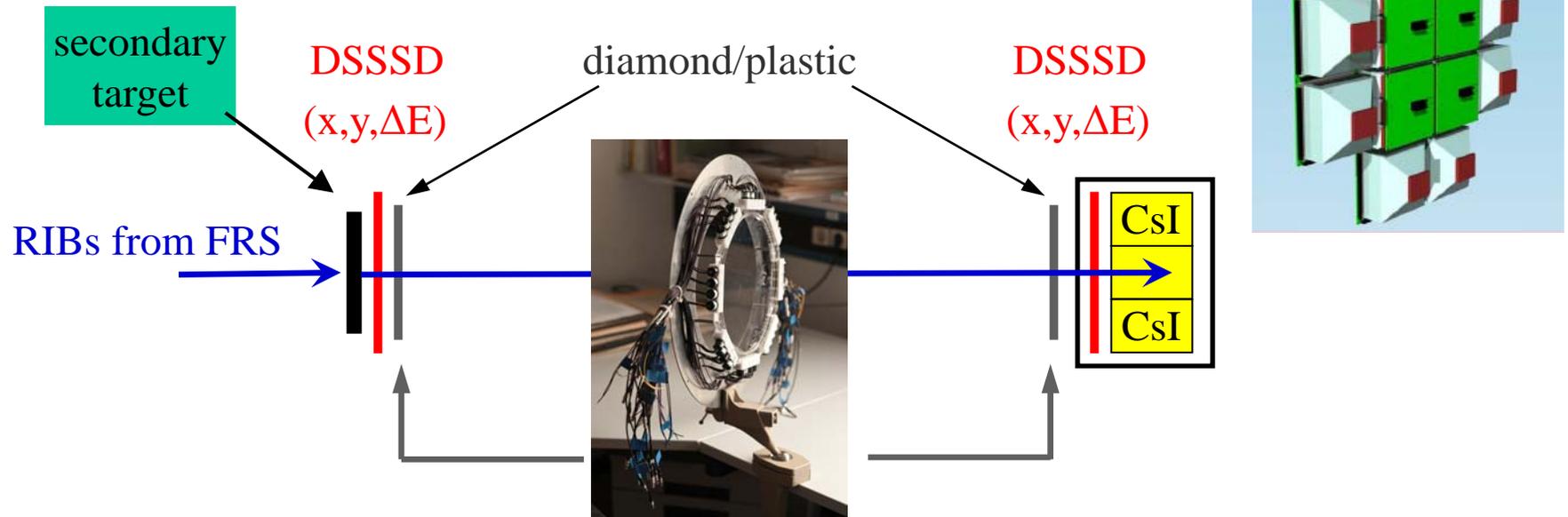
PreSPEC

Z – A/Q



Finger detector successfully commissioned
with rates up to 10^6 /s

Lund-York-Cologne CALorimeter (LYCCA)



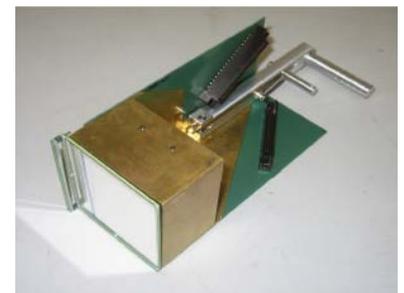
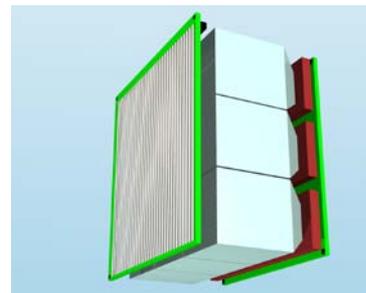
Fragment identification from ΔE , E and TOF

DSSSD's:

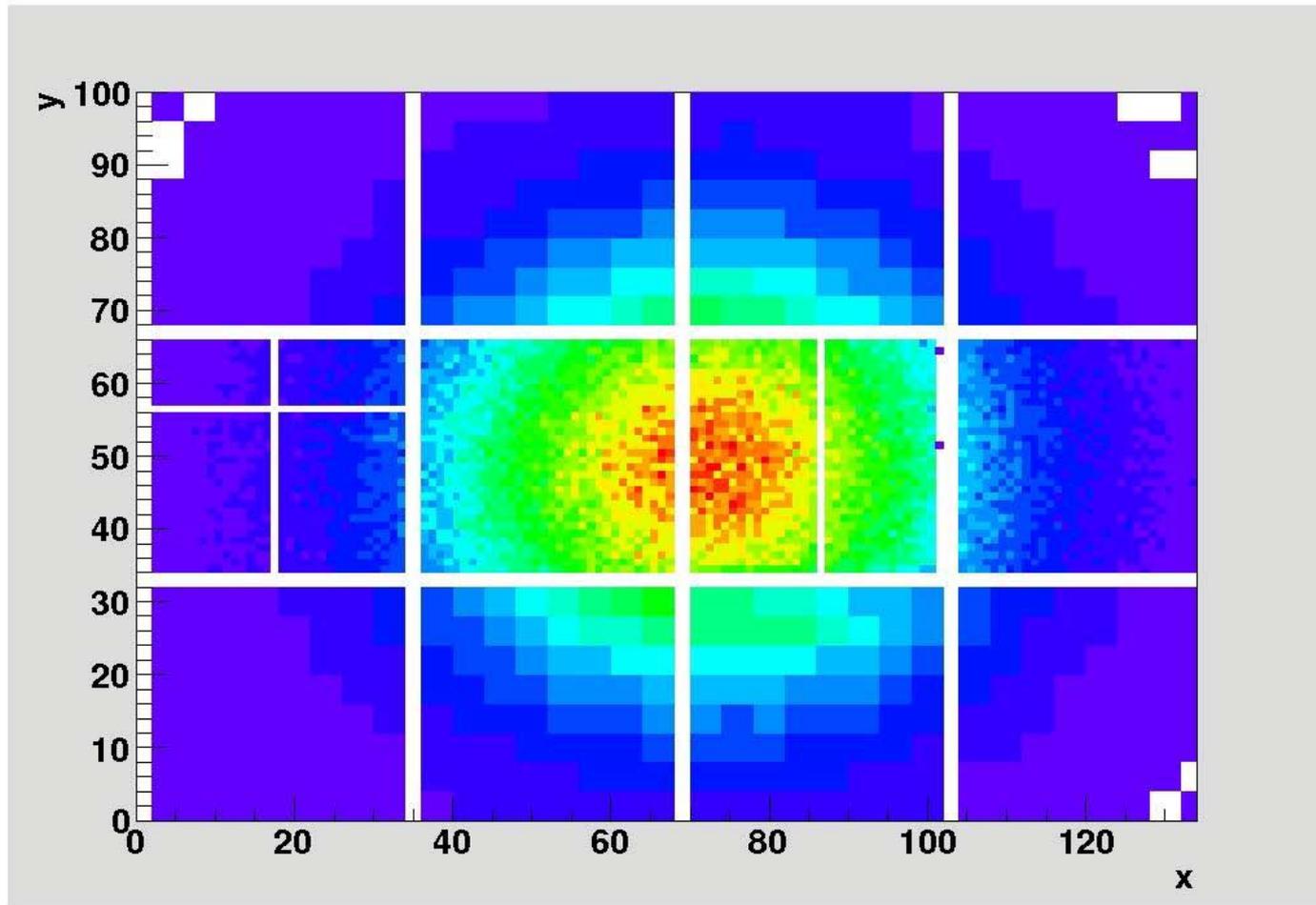
60·60·0.3 mm³, 32 x 32 strips

CsI's:

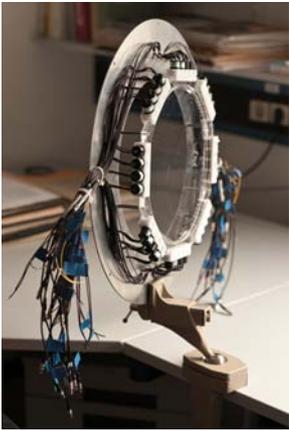
20·20·11 mm³, 3 x 3 x 3 array



LYCCA x - y

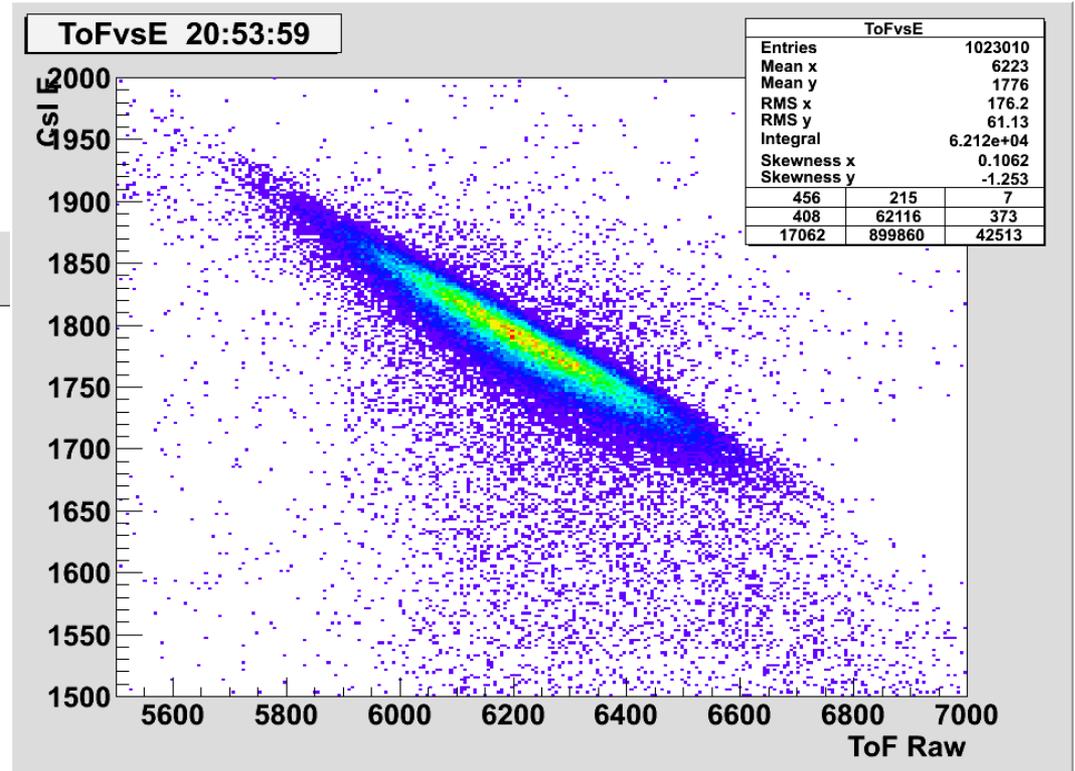
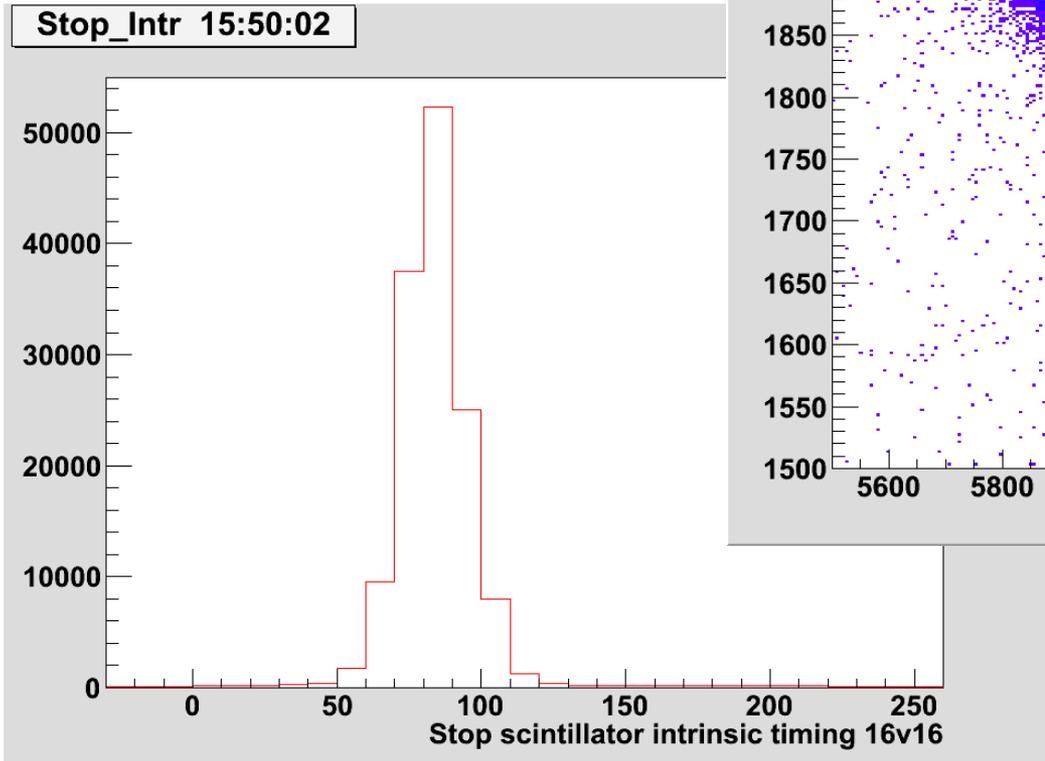


LYCCA successfully commissioned

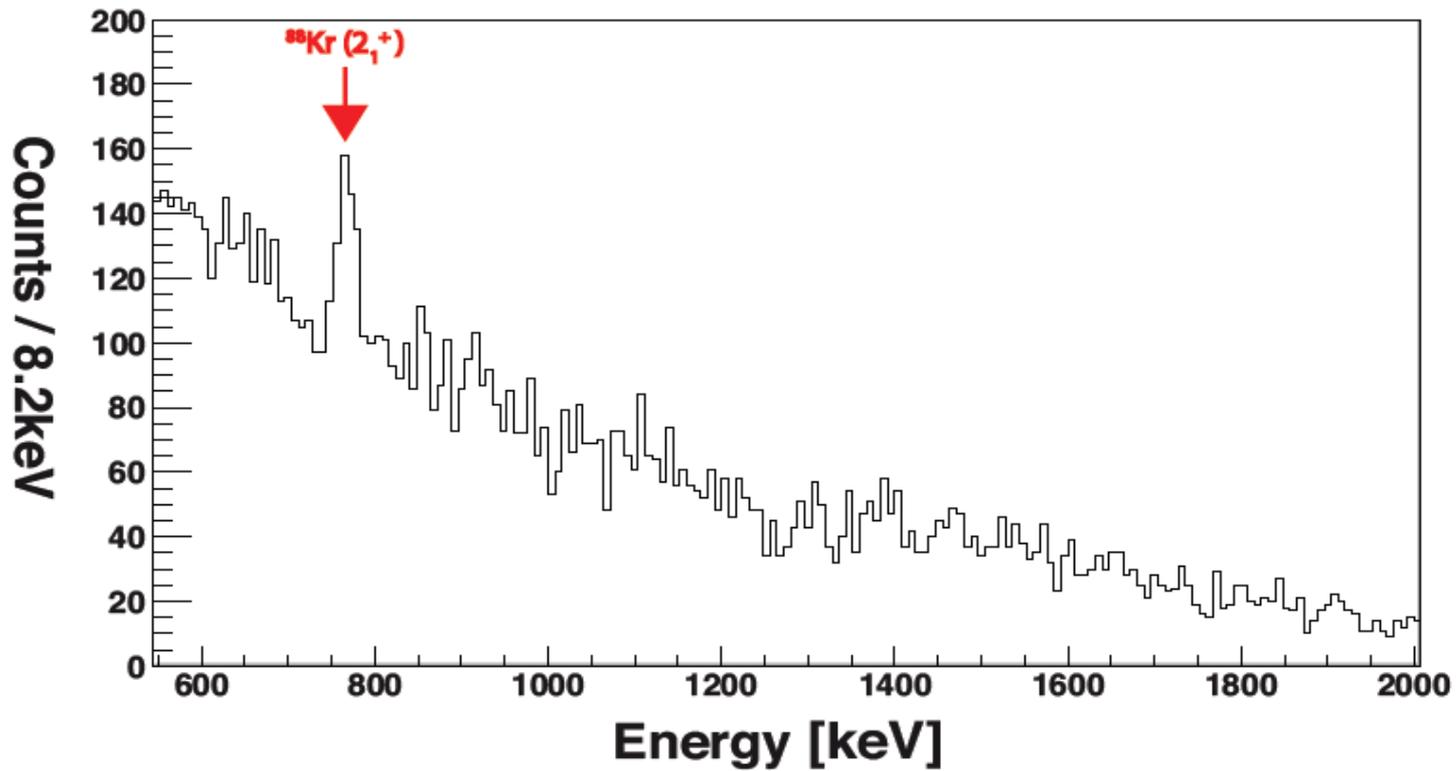


Preliminary TOF

12,5 ps intrinsic FWHM



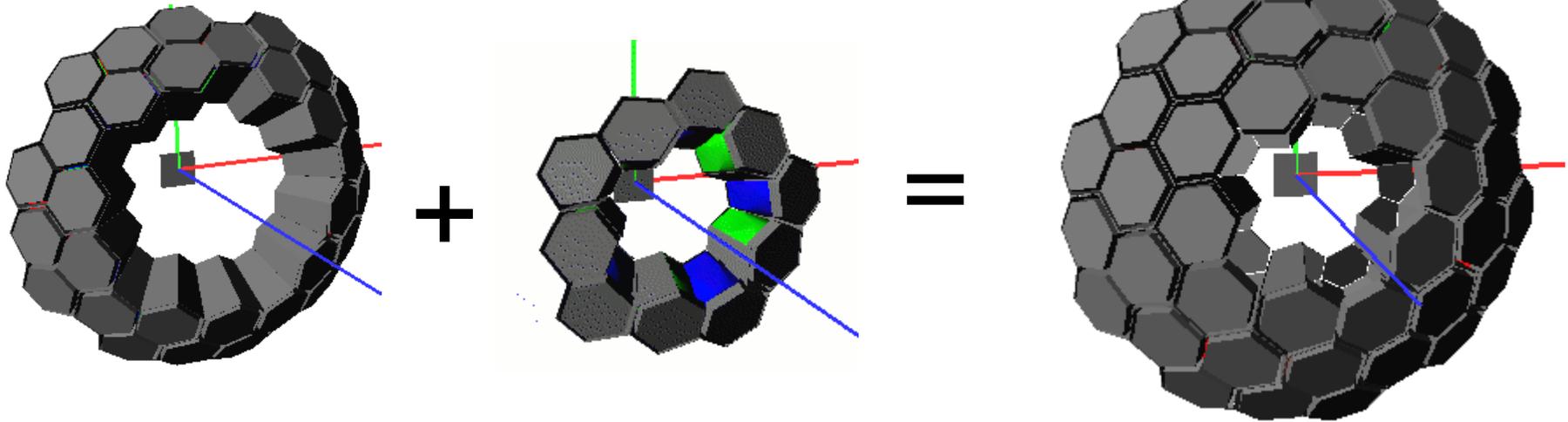
^{88}Kr Coulex



AGATA at GSI set-up

Challenge: FRS beam size!!!

AGATA S2 Geometry



10 triple Cluster

+

5 **double** Cluster

S2' Geometry:

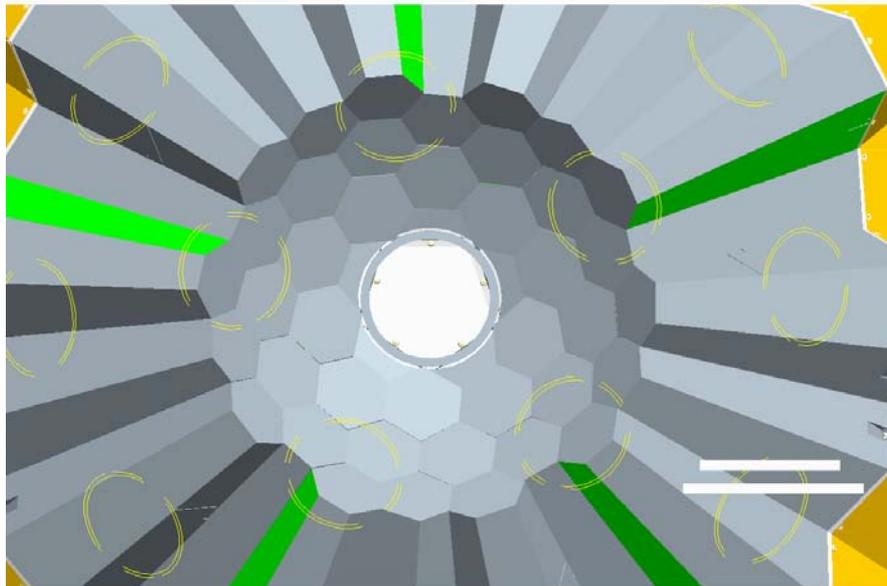
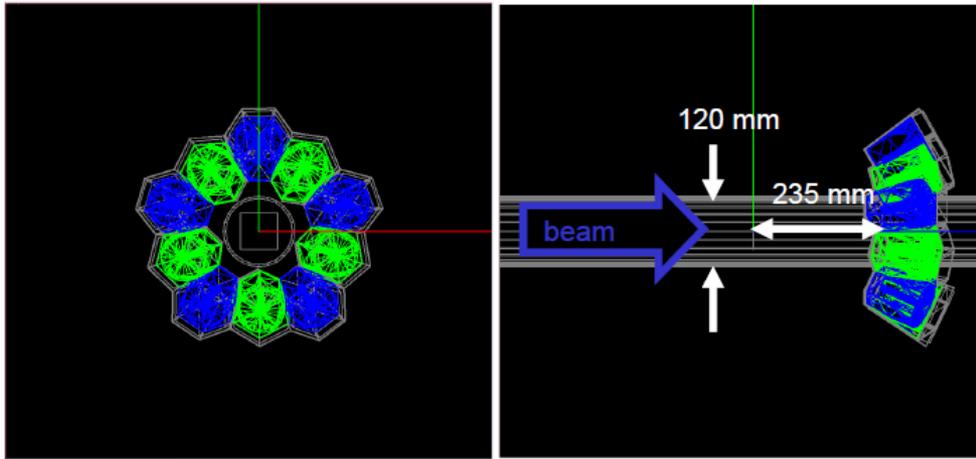
$P_{\text{ph}} \leq 17\%$; $\Delta E = 0.4\%$

(sensitivity gain 30x RISING)

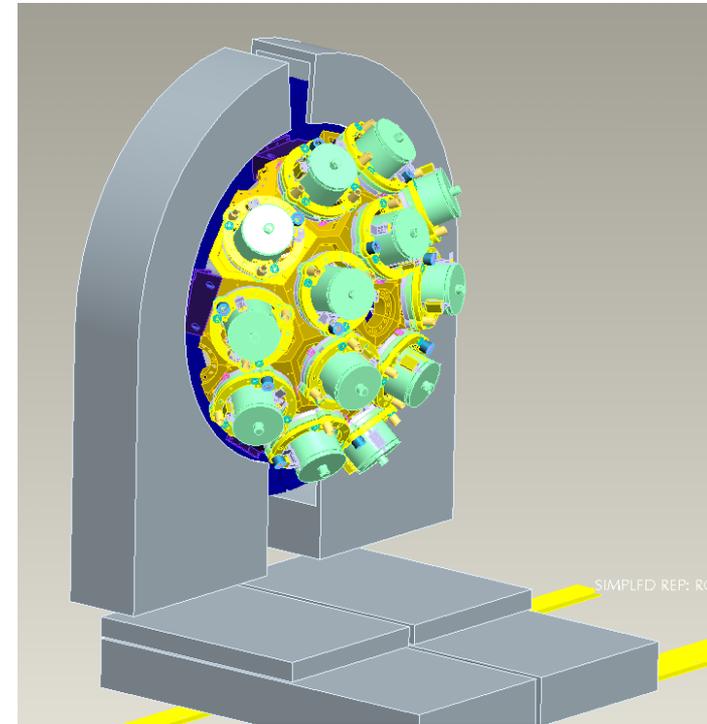
First designs of the AGATA@GSI geometry



Nominal Configuration (Target-Array 23.5cm)

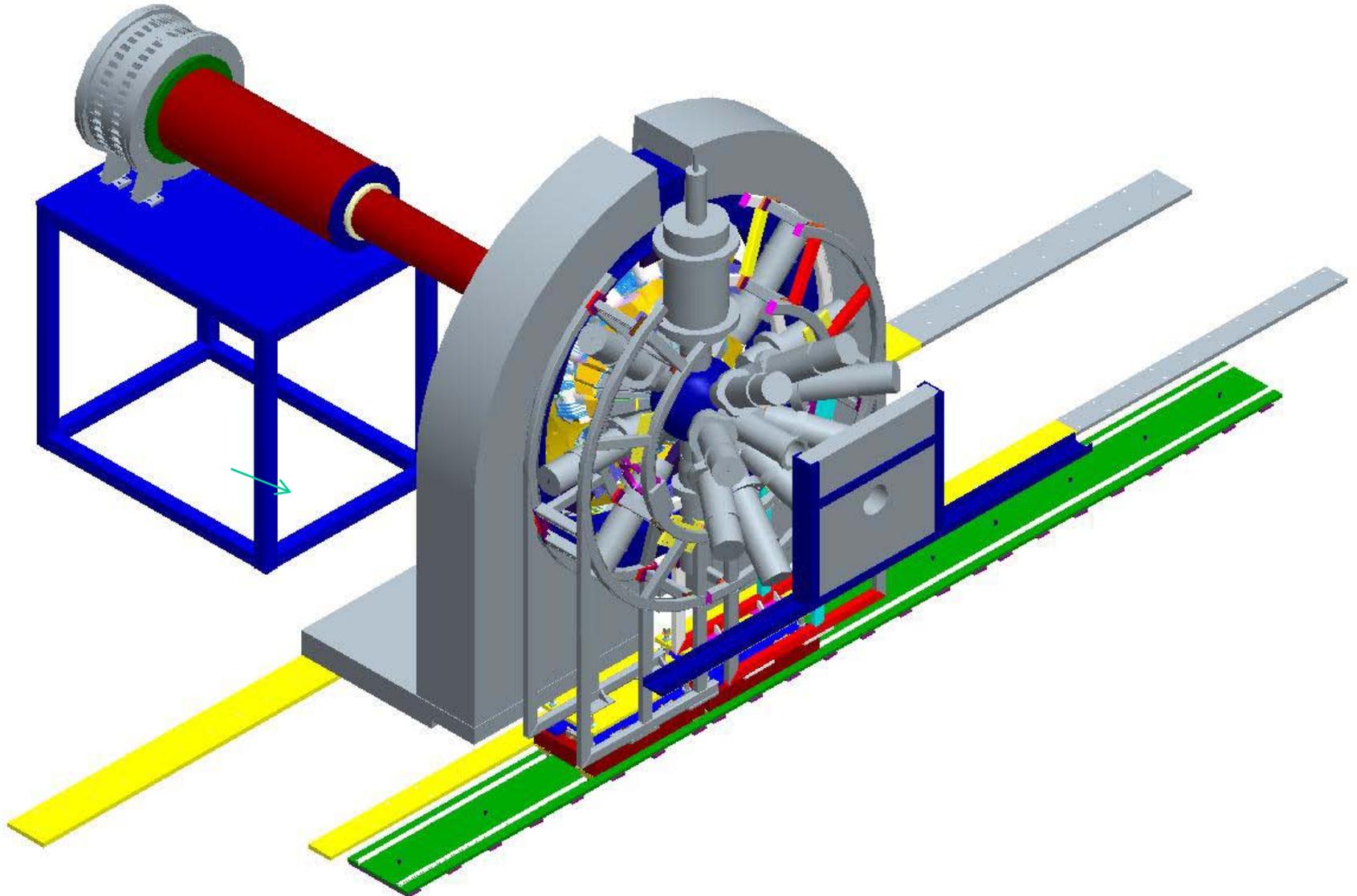


Beamline view (showing 125mm OD beamtube)



Courtesy
J. Strachan STFC Daresbury

Planned experimental set-up





- **34 Lol's received; 6 major themes identified**

- 1) Nuclear structure effects **near $N=Z$** :

The neutron-proton degree of freedom and the astrophysical rp-process

- 2) **Shell evolution** in light neutron-rich nuclei: $N=40$ and below

- 3) Nuclear structure studies **towards ^{78}Ni** and the evolution of the $N=50$ shell closure

- 4) **Shape evolution** and collective motion in nuclei far from stability

- 5) Nuclear structure studies **approaching ^{100}Sn** and the heaviest self-conjugate nuclei

- 6) Structure of nuclei in the astrophysically important region **near ^{132}Sn**

- **Many different experimental methods**

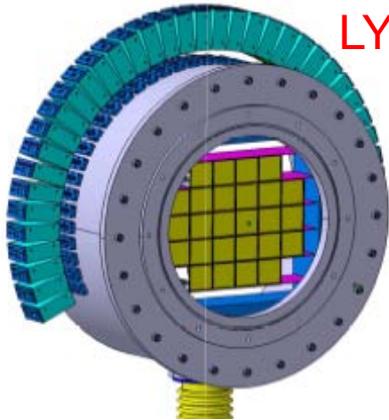
- e.m. excitation and knock-out together with lifetime measurements (RDM & DSAM)
- light ion induced reactions (p,p') , (p,d) , (p,xp)
- angular correlations, high-velocity transient fields, ...

Towards proposals for the AGATA-PreSpec campaign

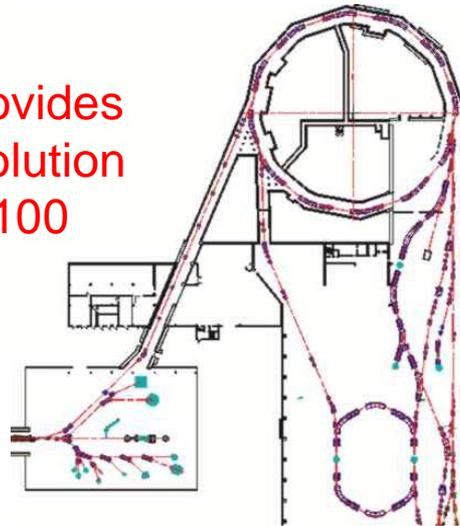
- **Technical pre evaluation of all Lols**
 - Local GSI group + coordinators
 - Feedback to all Lols
- **Working group meetings (September to November 2010)**
 - Priorities for each theme (physics, feasibility, urgency,...)
 - Complete FRS simulations (rates, beam profile, ...)
 - AGATA simulations (realistic w. background, RDM, DSAM,...)
- **Decision on priorities by end 2010**
 - First round submission in autumn 2011
 - Second round submission in autumn 2012

Fast Beam Campaign

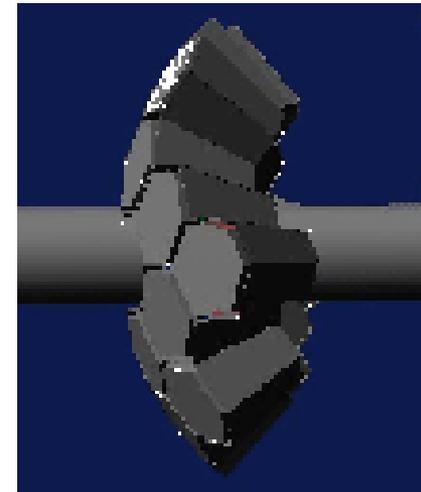
great perspectives....



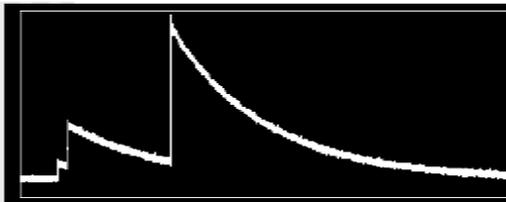
LYCCA-0 provides mass resolution up to $A \approx 100$



SIS/FRS intensities increase up to $\approx 10x$

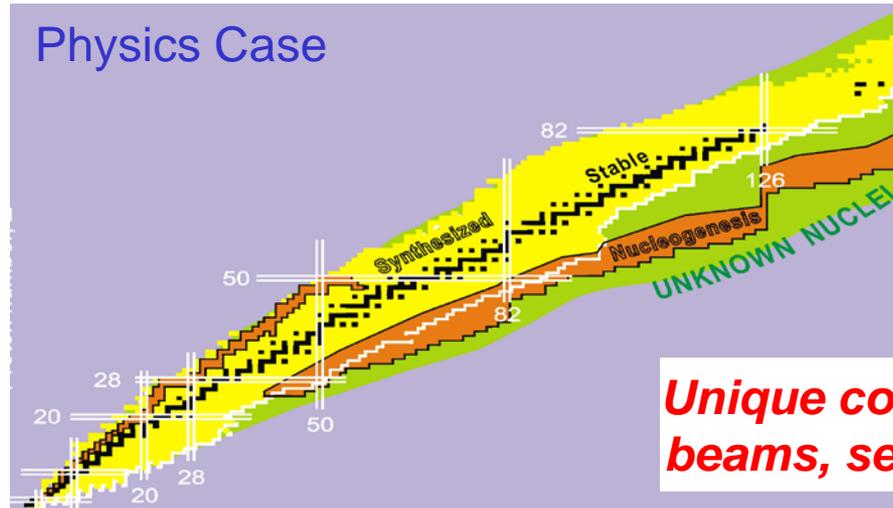


AGATA increases γ -sensitivity 10x ... 100x



Tracking det. and EDAQ upgrade increase max. rate and throughput 10x

Physics Case

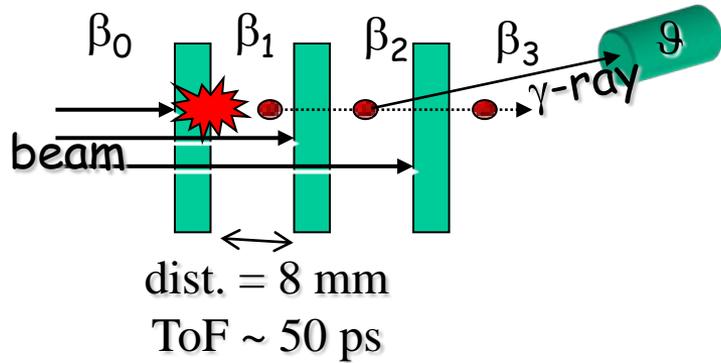


Very attractive and competitive spectroscopy themes

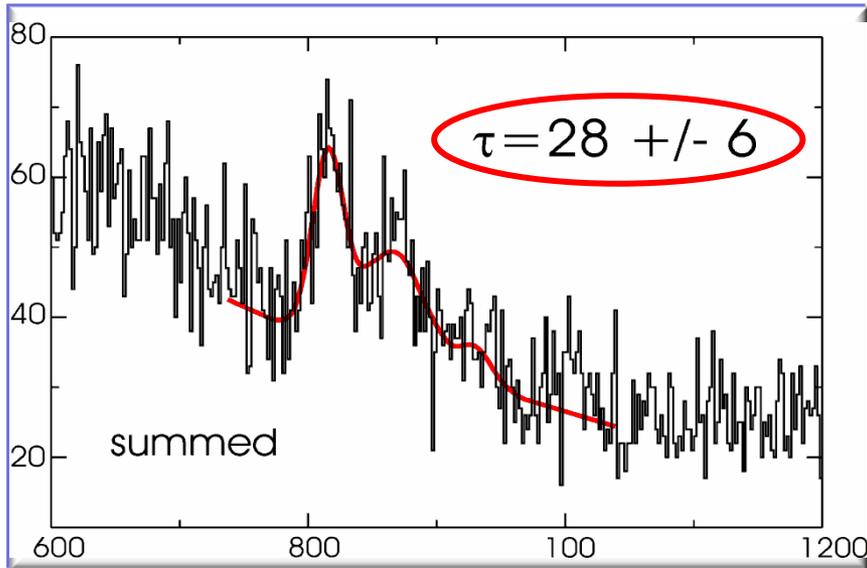
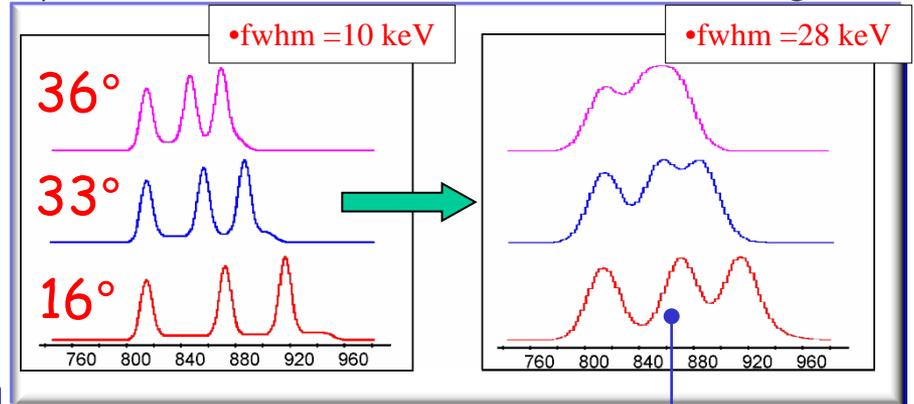
Unique combination of beams, set-up and people

....thank you

Lifetime measurement using RDDS



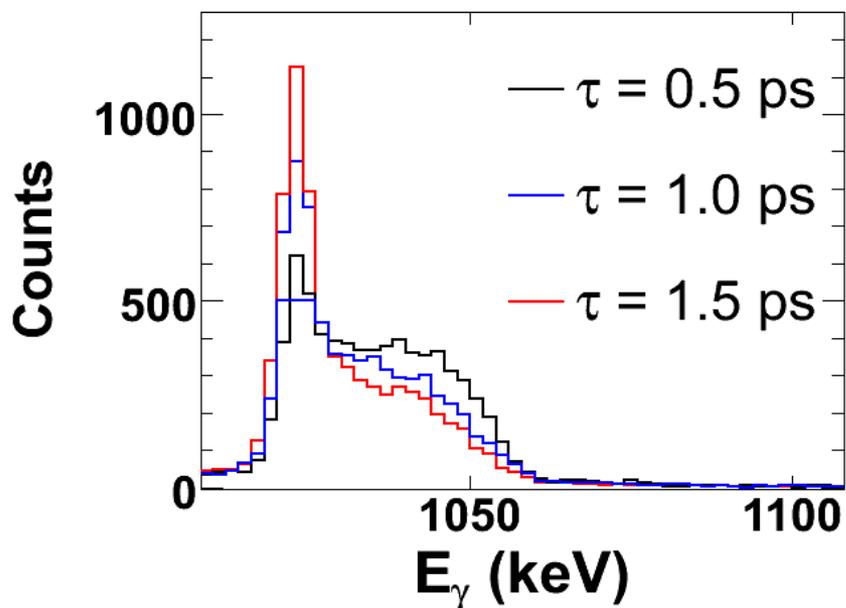
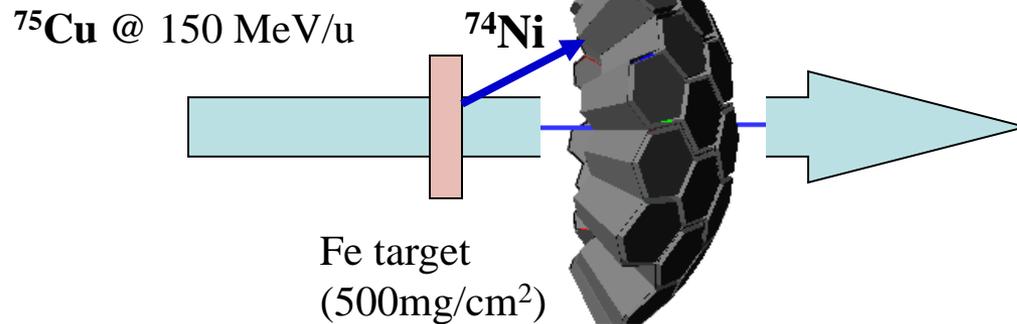
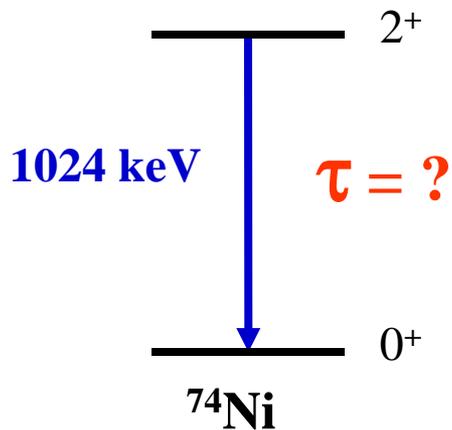
γ -lines seen at the different RISING angles



^{36}K angle intergrated spectrum

P.Bednarczyk et al., Acta Phys.Pol. B41, 505 (2010)

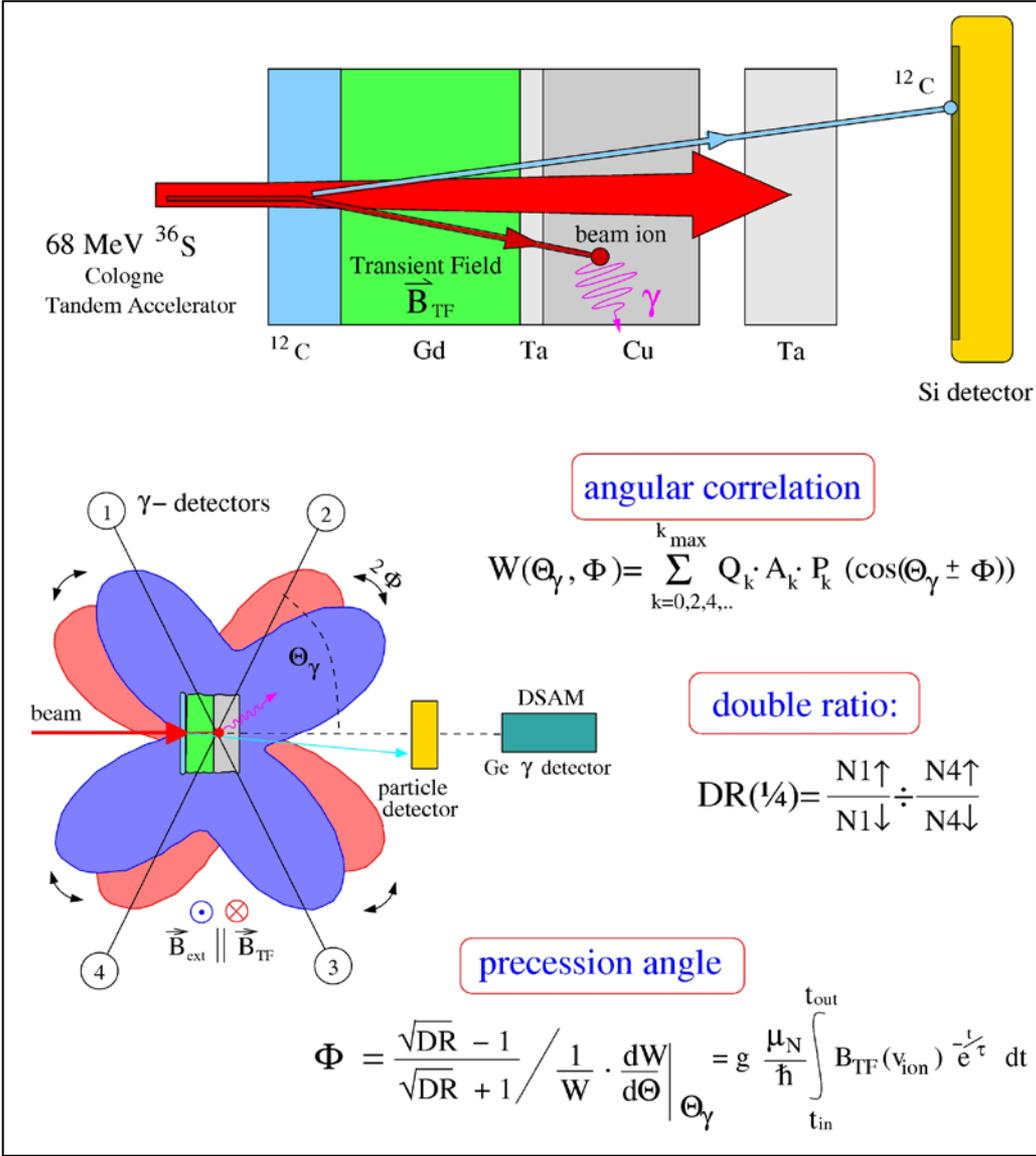
Line shape effect of first 2^+ state (DSAM)



5 doubles around 120mm dia beam pipe

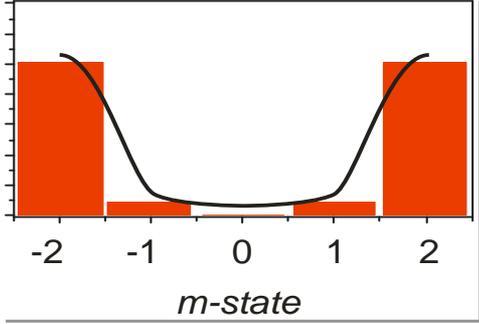


g-factor measurement with transient field technique

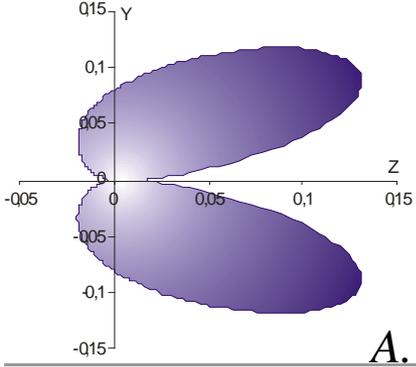


➤ EM interaction
 $2^+ \rightarrow 0^+, \beta=0$

prolate alignment



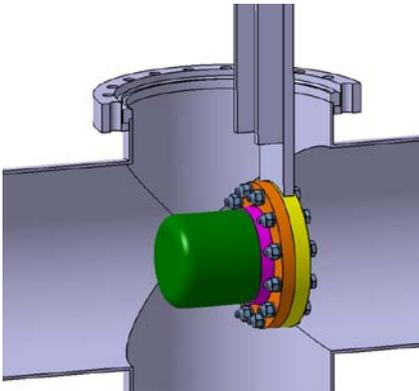
intensity distribution



Proton scattering (LH_2 target)



$d = 6 \text{ cm} \equiv 3 \cdot 10^{23} \text{ cm}^{-2}$
- no absorbing material
- dedicated to (p, p') and knockout



form factor measurement

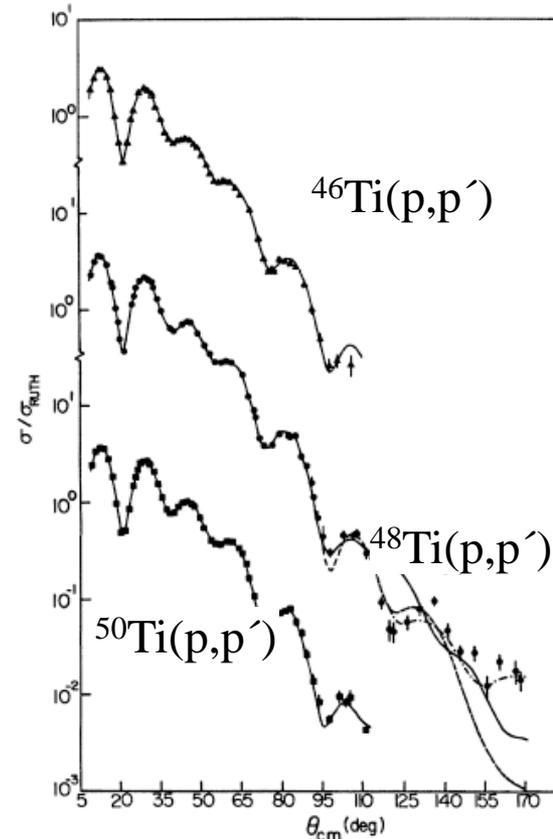


FIG. 1. 100 MeV $p+^{46,48,50}\text{Ti}$ elastic differential cross sections plotted as ratio to Rutherford. The solid lines are optical model fits to the 9° – 110° data using a WS form factor. The dashed line is obtained by fitting the 9° – 168° data of ^{48}Ti . The dotted-dashed line is obtained with a WS^2 potential.