The PreSPEC–AGATA Campaign:
Research Combined with FAIR Developments

D. Rudolph

Lund University

On behalf of the PreSPEC-AGATA Collaboration

The PreSPEC-AGATA Campaign

- What is it – about?
- Historical & political comments
- Commissioning 2012
- Experiments 2012
- Experiments 2013 **?**
- Summary & Outlook

HISPEC Physics Goals

Nuclear Structure, Astrophysics and Reactions

by means of **high-resolution γ-ray spectroscopy**

- Relativistic Coulomb excitation (Au, Pb targets)
- Secondary fragmentation (H_2, Be targets)

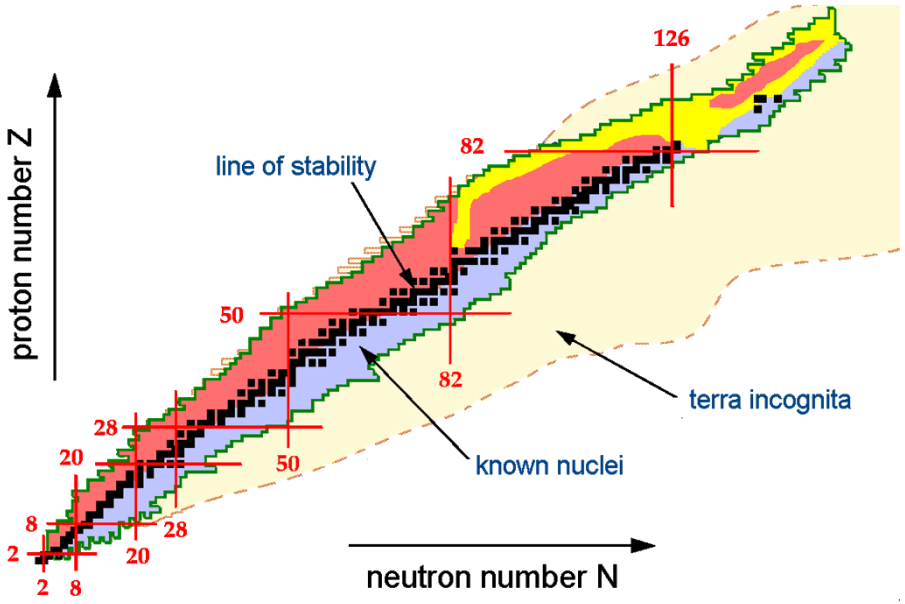
at typically 100-200 MeV/u

…

towards the outskirts of the nuclear landscape

…

and eventually inside the NUSTAR LEB cave!



PreSPEC-AGATA Set-up = Early Implementation of HISPEC

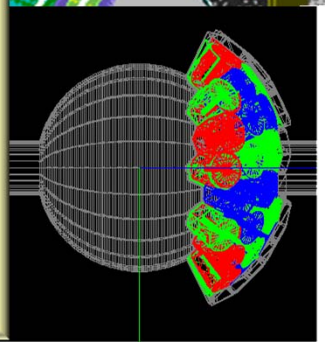
relativistic radioactive heavy-ions
from the GSI Fragment Separator
Up to 1GeV/A ^{238}U, 50% v/c

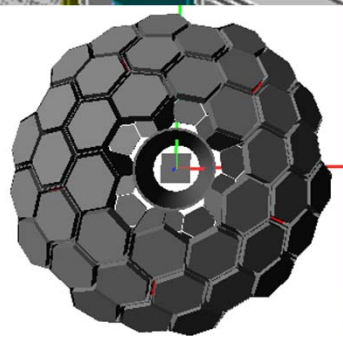
PreSPEC

FRS-detector suite yields
A and *Z* of incoming beam
and provides *x,y* tracking

HECTOR+
Large BaF_2 and $LaBr_3$ detectors
for high-energy γ rays

Advanced Gamma-ray
Tracking Array (AGATA)
up to 5 x 2+10 x 3 = 40
segmented HP Ge-crystals
d ~ 20 cm
$\varepsilon_{Ph} \approx 17\%$
$\Delta E \approx 0.4\%$





Lund-Cologne-York
Calorimeter (LYCCA)
A and *Z* particle-ID after
secondary target by means of
- x,y tracking
- Δ*E*-*E* (Si-CsI)
- Time-of-flight (plastic)

HISPEC-DESPEC Timeline

2004-2005: RISING In-Beam

EUROBALL Cluster, HECTOR, plus small Si-CsI array

2006-2009: RISING Stopped Beam

EUROBALL Cluster (plus active S

2010-2011: PreSPEC In-Beam phase 1

EUROBALL Cluster, HECTOR plus LYCCA-0

Physics: Next two talks!

2012-2013 ? PreSPEC In-Beam phase 2 (= HISPEC-0)

AGATA, H

2014-2016: PreSPEC

According to the original FAIR schedule we should be doing these latest this year!

2019- ? FAIR

Facility for Antiproton and Ion Research in Europe GmbH

(commissioning) experiments

PreSPEC-AGATA Timeline

2010: **Contract between AGATA & GSI: ≥ 12 weeks beamtime!**

Discussion of 36 Letters of Intent (LoI) (Istanbul meeting)

In-beam PreSPEC experiments with EB Cluster + LYCCA-0

2011: In-beam PreSPEC experiments with EB Cluster + LYCCA-0

Plunger and LH_2, commissioning experiments

Internal

GSI G-PA

GSI offers (can offer, cf. BMBF!?)
only some 3 weeks in 2013!

2012: PreSPEC

September: perforative commissioning

October-November: 5 out of 8 experiments, 3 weeks backlog

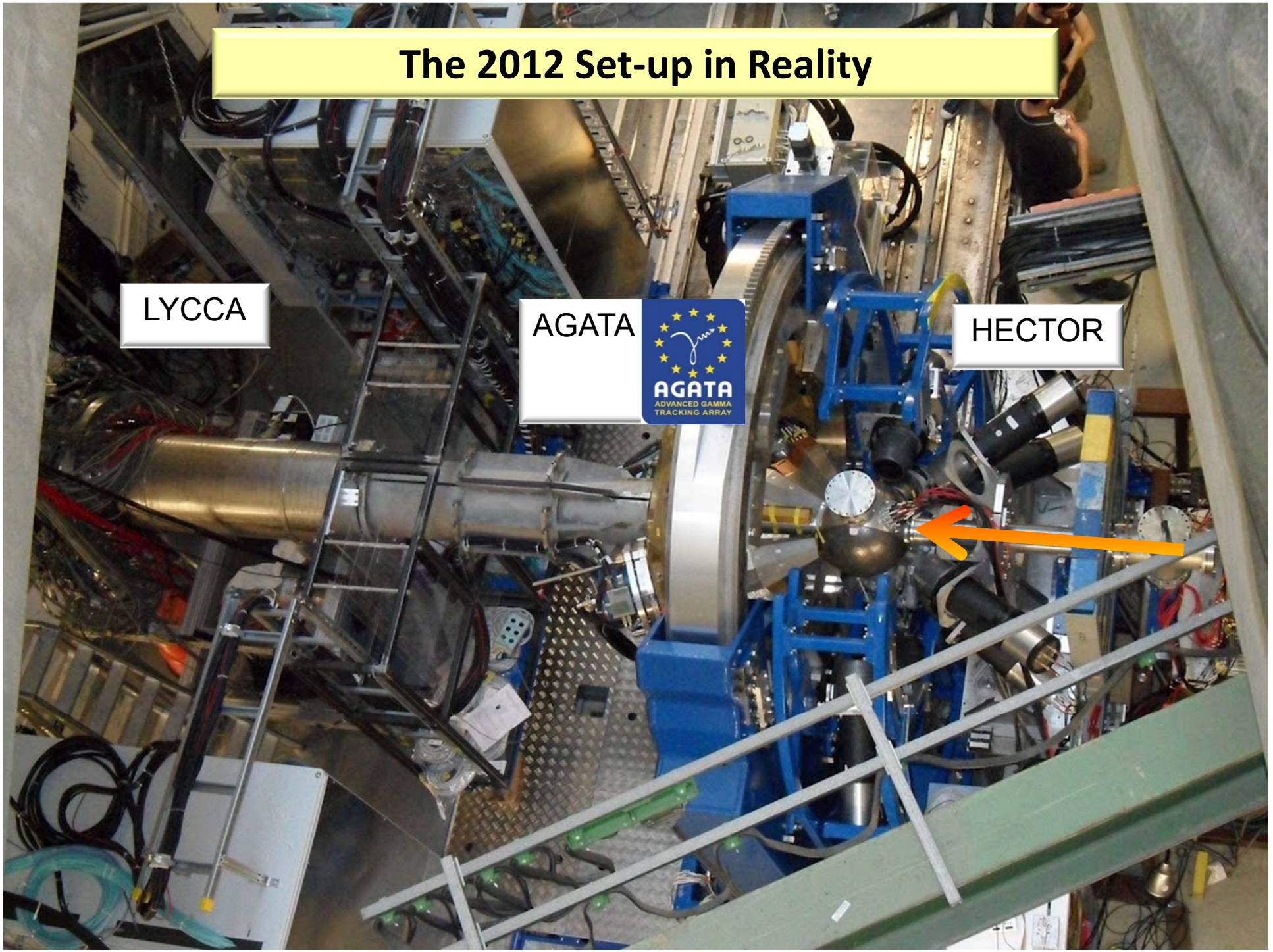
December: Discuss (revised and new) LOIs for the 2nd round

2013: **Spring: Internal pre-selection and evaluation 2nd round**

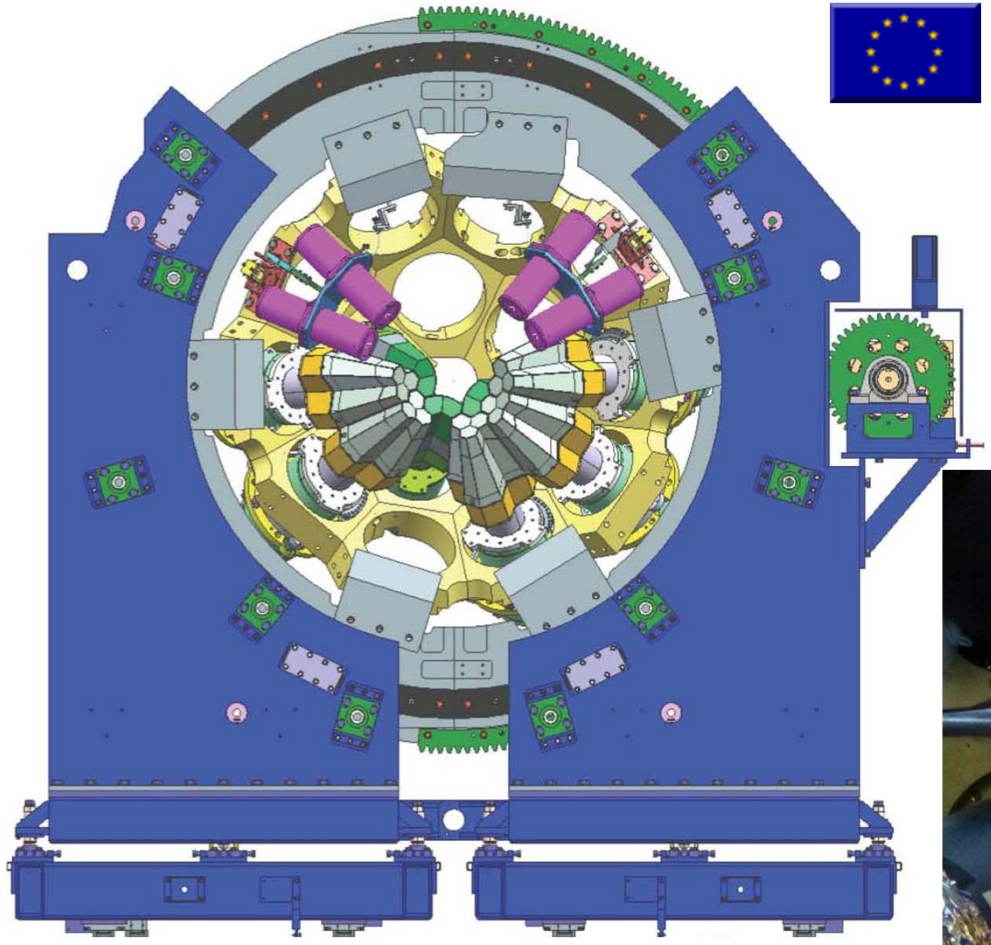
Fall: Backlog and new experiments, **about 8-9 remaining weeks**

2012 Commissioning

The 2012 Set-up in Reality



AGATA at PreSPEC 2012



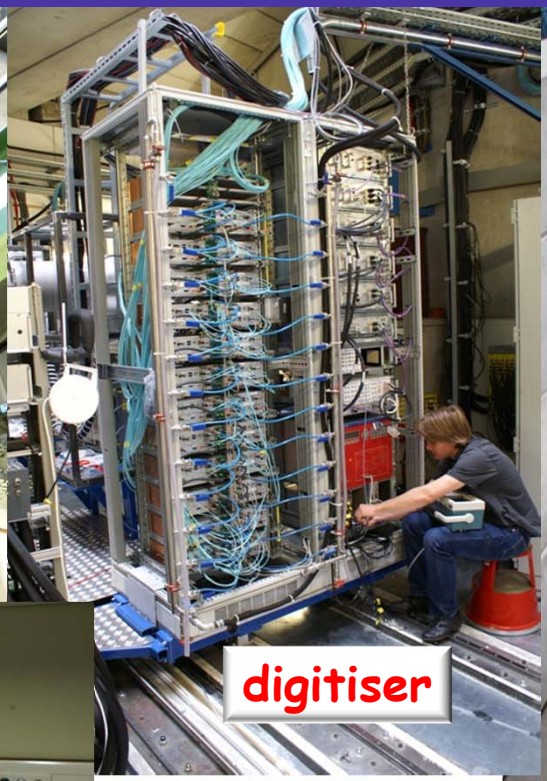
19 AGATA crystals (out of 25)
(with 37 high-resolution Ge channels each)

AGATA holding structure

New HISPEC target chamber

Plamen Boutachkov

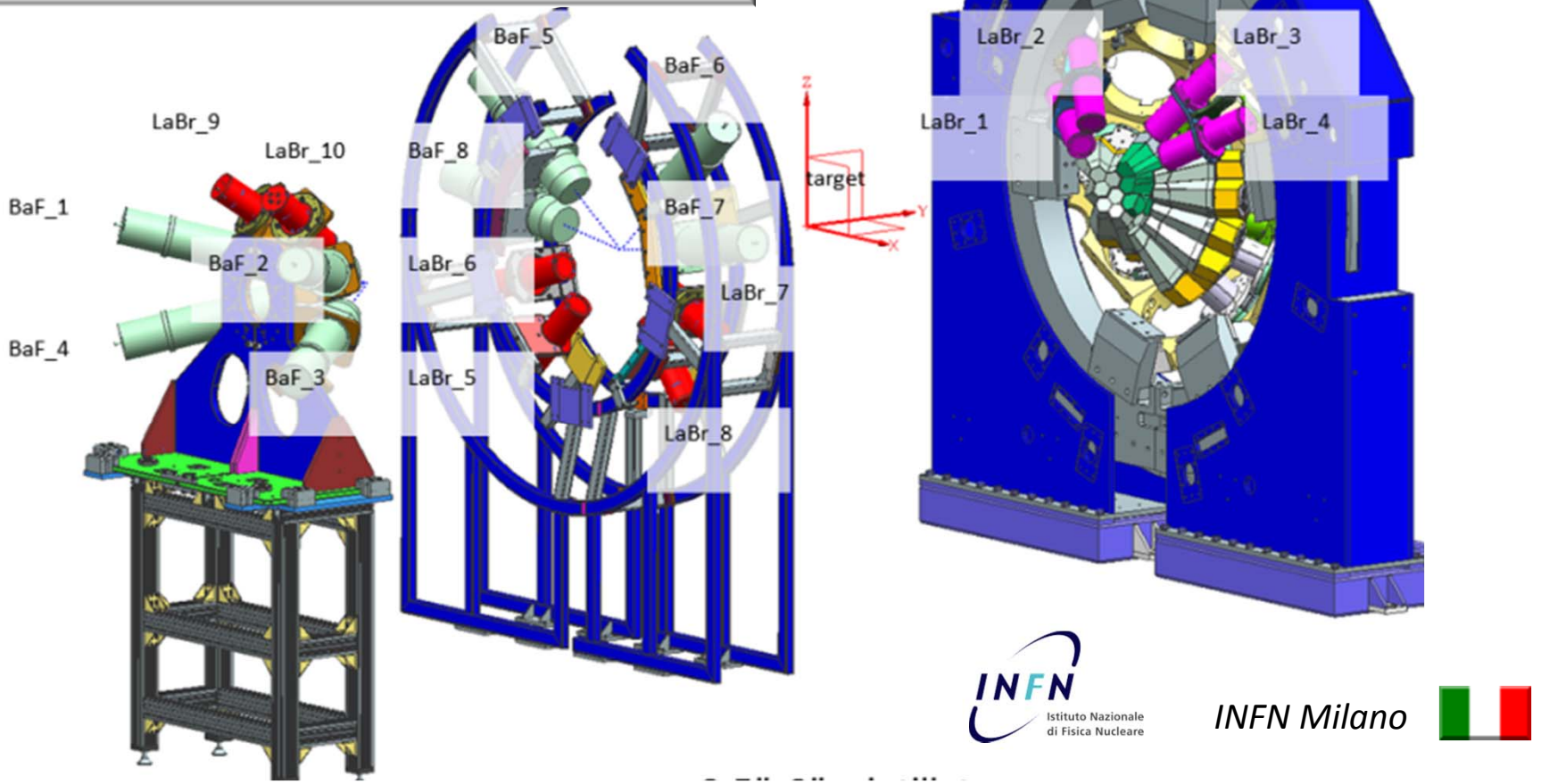
AGATA at PreSPEC 2012



Damian Ralet
Stephane Pietri

HECTOR+ at PreSPEC 2012

8 large-volume BaF_2 and
10 large volume $LaBr_3$ scintillators
at various angles …



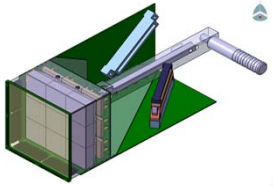
INFN Istituto Nazionale di Fisica Nucleare

INFN Milano

LYCCA-1 at PreSPEC 2012

Lund-York-Cologne CAlorimeter

Lund University · The University of York · University of Cologne



16 *ΔE-E* modules

1 target DSSSD

3 plastic multi-PMT ToF

1240 detector channels

FAIR PAC NUSTAR
FAIR TAC HISPEC/DESPEC

Technical Report, V1.2, June 2008

LYCCA — the Lund-York-Cologne CAlorimeter

Identification of reaction products in HISPEC-DESPEC@NuSTAR

D. Rudolph[1], C. Fahlander[1], P. Golubev[1], R. Hoischen[1,2], V. Avdeichikov[1], M.A. Bentley[3], S.P. Fox[3], J. Gerl[2], Ch. Görgen[4], M. Górska[2], G. Pascovici[4], P. Reiter[4], H. Schaffner[2], M.J. Taylor[3], S. Thiel[4], and H.J. Wollersheim[2]

[1] *Department of Physics, Lund University, S-22100 Lund, Sweden*
[2] *Gesellschaft für Schwerionenforschung mbH, D-64291 Darmstadt, Germany*
[3] *Department of Physics, University of York, York, YO10 5DD, United Kingdom*
[4] *Institut für Kernphysik, Universität zu Köln, D-50937 Köln, Germany*

FAIR TDR approved 2008

Used in PreSPEC since 2010

Constantly upgraded towards HISPEC-FAIR

FAIR in-kind

P. Golubev *et al.*, submitted to NIM A

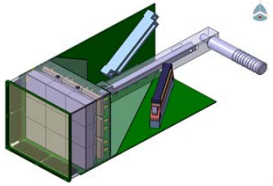
LYCCA-1 at PreSPEC 2012

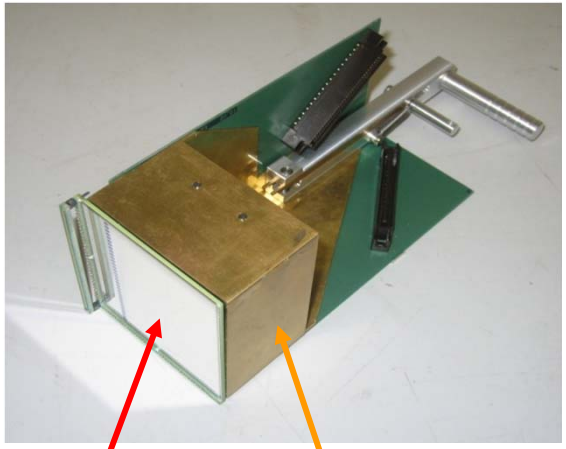
Lund-York-Cologne CAlorimeter

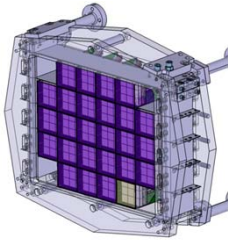
Lund University · The University of York · University of Cologne

16 *ΔE-E* modules
1 target DSSSD
3 plastic multi-PMT ToF

1240 detector channels



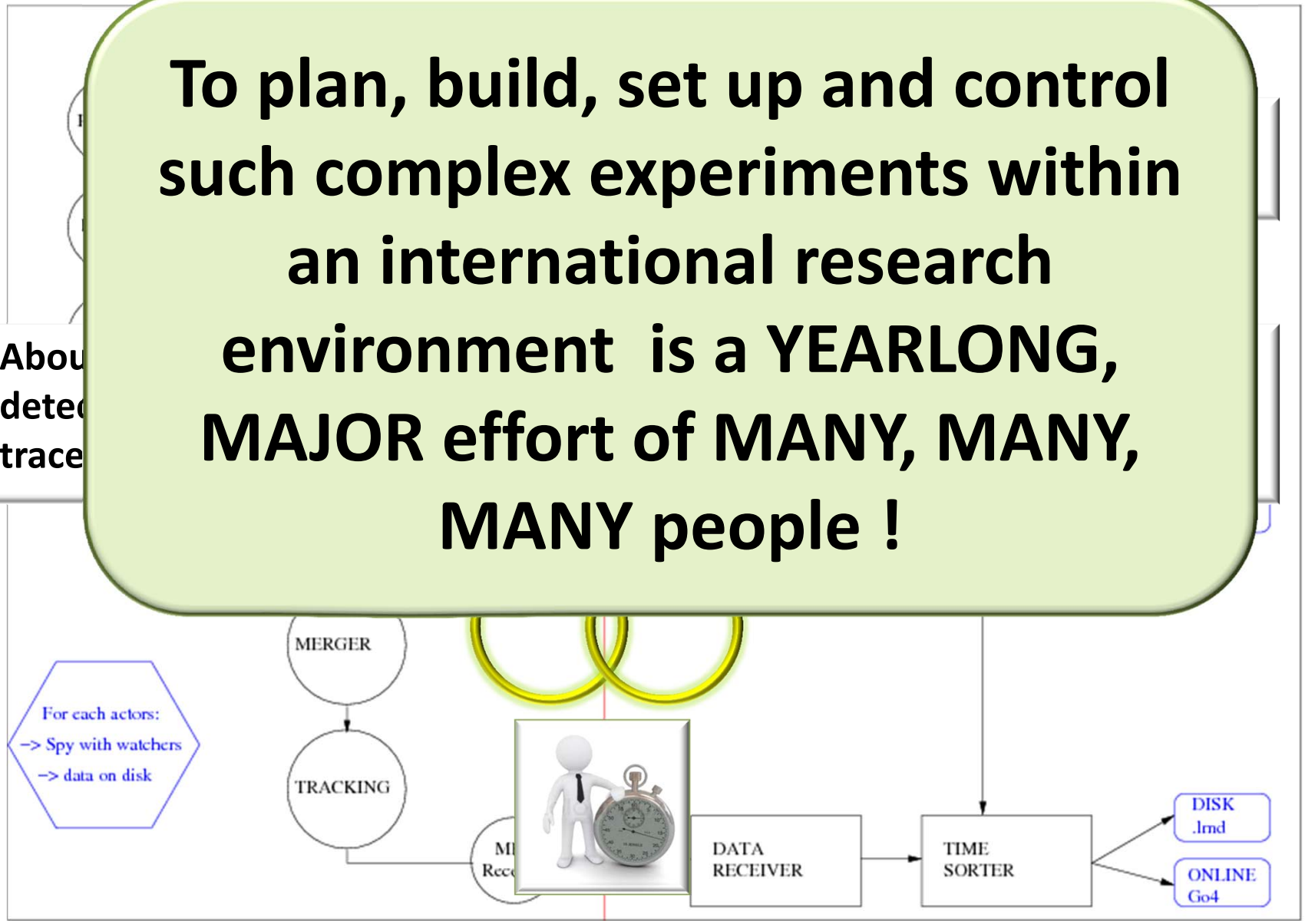




Pavel Golubev *et al.*

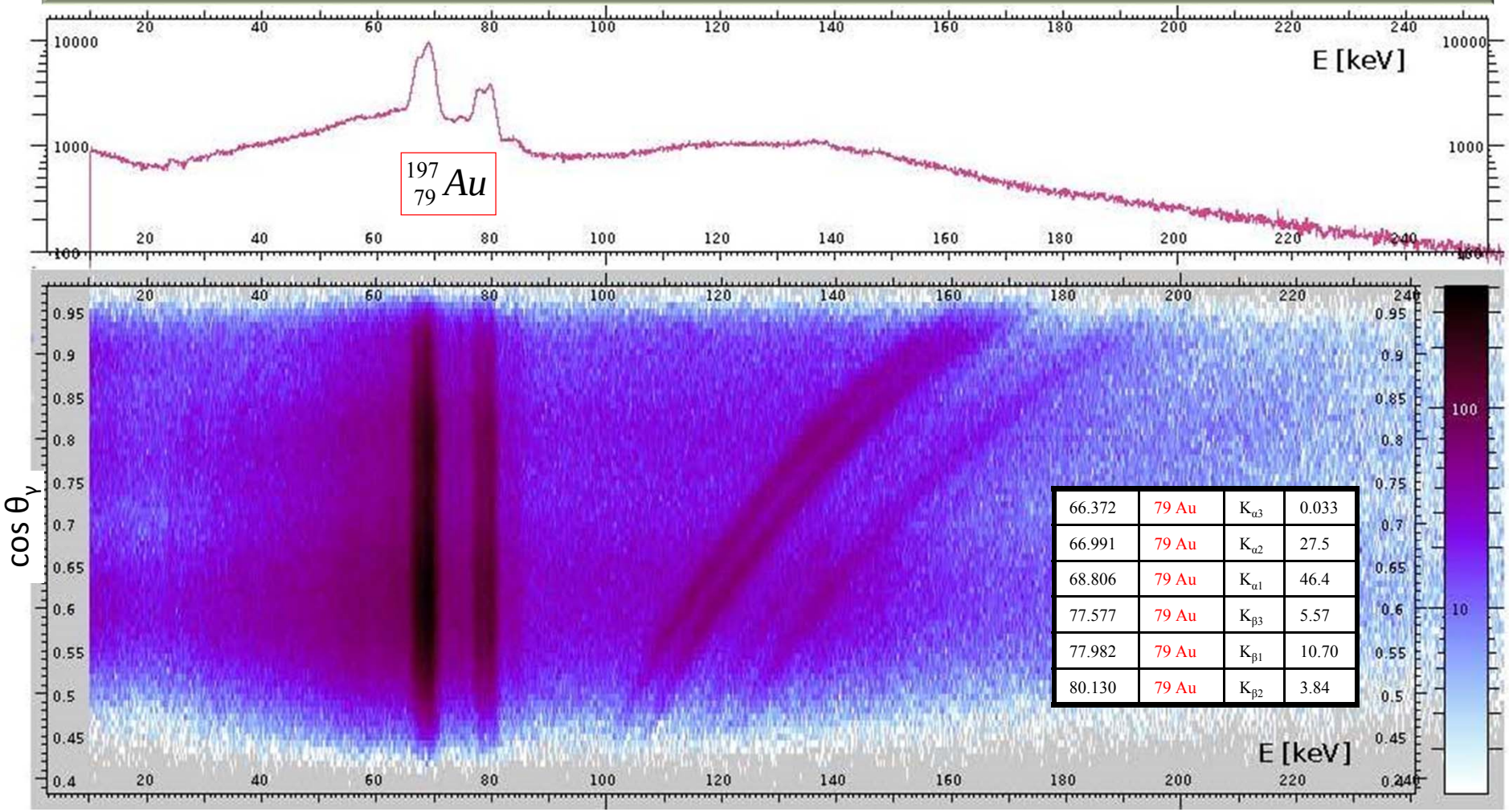
EDAQ PreSPEC-AGATA 2012

To plan, build, set up and control such complex experiments within an international research environment is a YEARLONG, MAJOR effort of MANY, MANY, MANY people !



Particle-AGATA Correlations

Scattering of 183 AMeV ^{238}U on a 0.4g/cm^2 Au target foil: no Doppler correction



Michael Reese

http://ie.lbl.gov/atomic/x2.pdf

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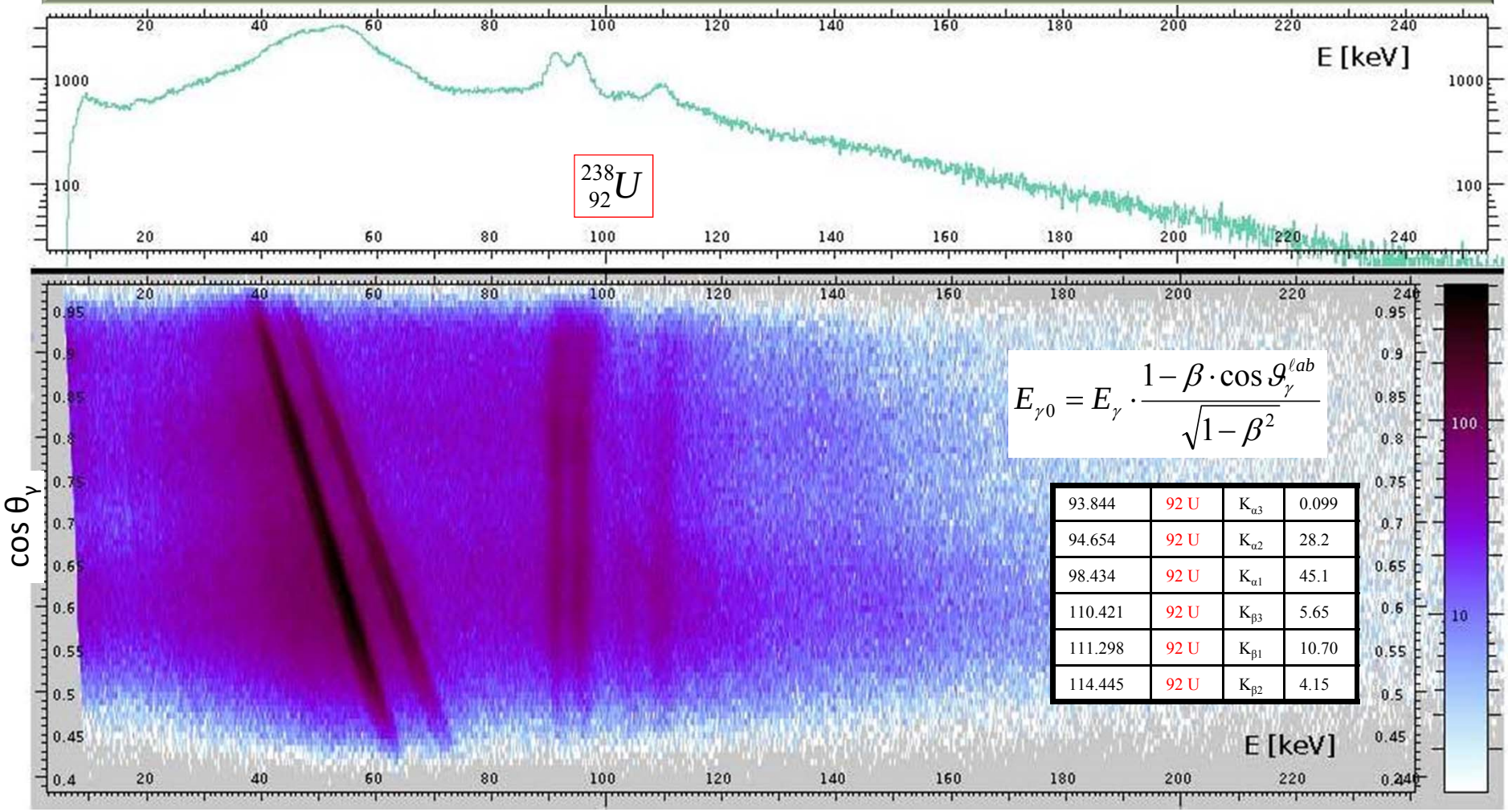
Scattering of 183 AMeV ^{238}U on a 0.4g/cm^2 Au target foil: Doppler corrected



$$E_{\gamma 0} = E_\gamma \cdot \frac{1-\beta\cdot\cos\vartheta_\gamma^{\ell ab}}{\sqrt{1-\beta^2}}$$

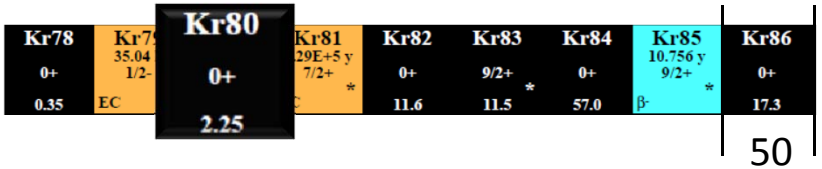
93.844	92 U	$K_{\alpha 3}$	0.099
94.654	92 U	$K_{\alpha 2}$	28.2
98.434	92 U	$K_{\alpha 1}$	45.1
110.421	92 U	$K_{\beta 3}$	5.65
111.298	92 U	$K_{\beta 1}$	10.70
114.445	92 U	$K_{\beta 2}$	4.15

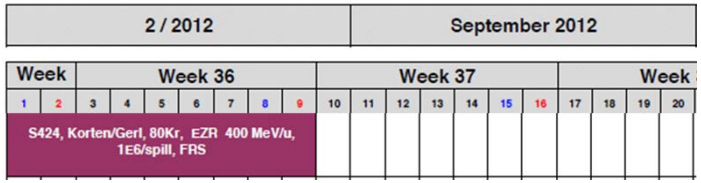
Michael Reese

http://ie.lbl.gov/atomic/x2.pdf

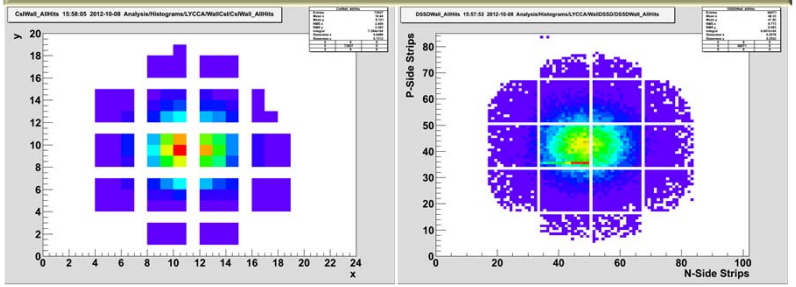
Performance Commissioning

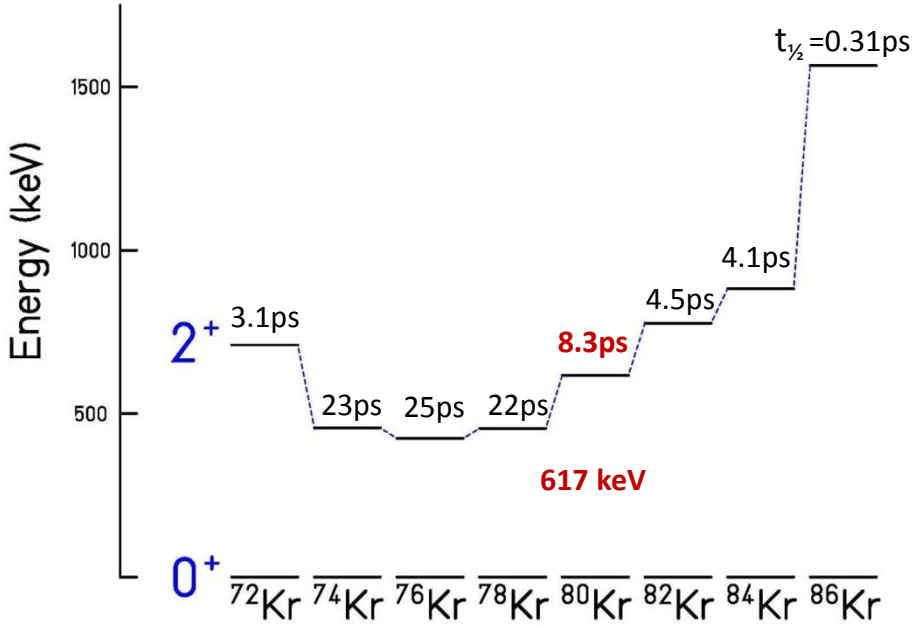
Coulomb excitation of ^{80}Kr





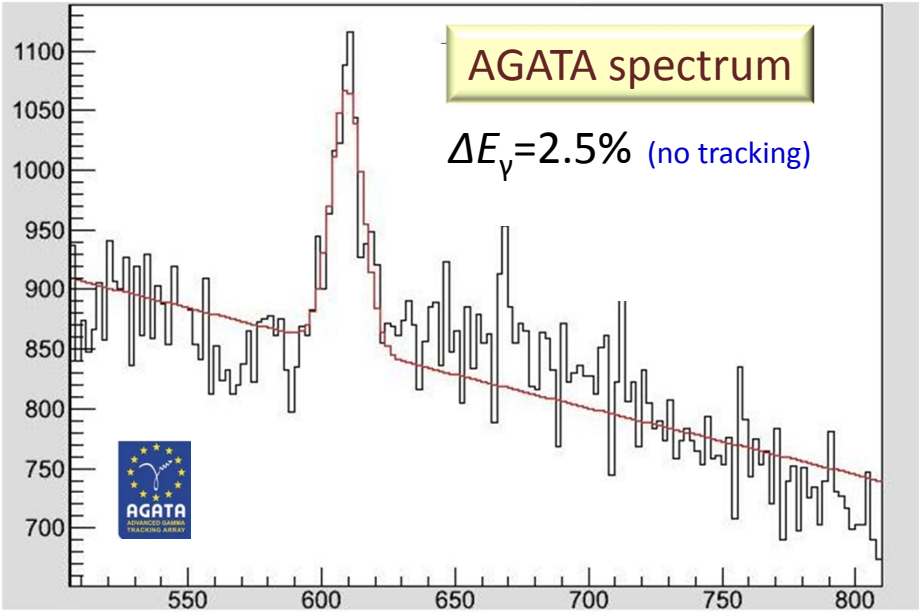
LYCCA CsI and DSSSD-Wall hitpattern





AGATA spectrum

ΔE_γ=2.5% (no tracking)



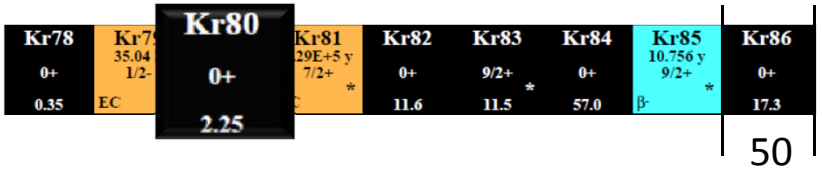
exp. conditions:
target DSSSD, LYCCA, AGATA time

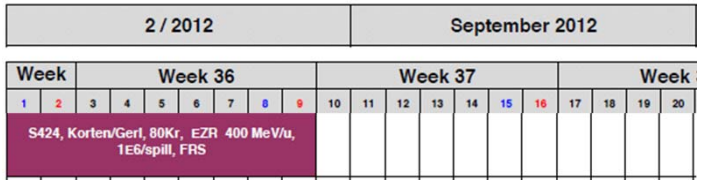
E_γ [keV]

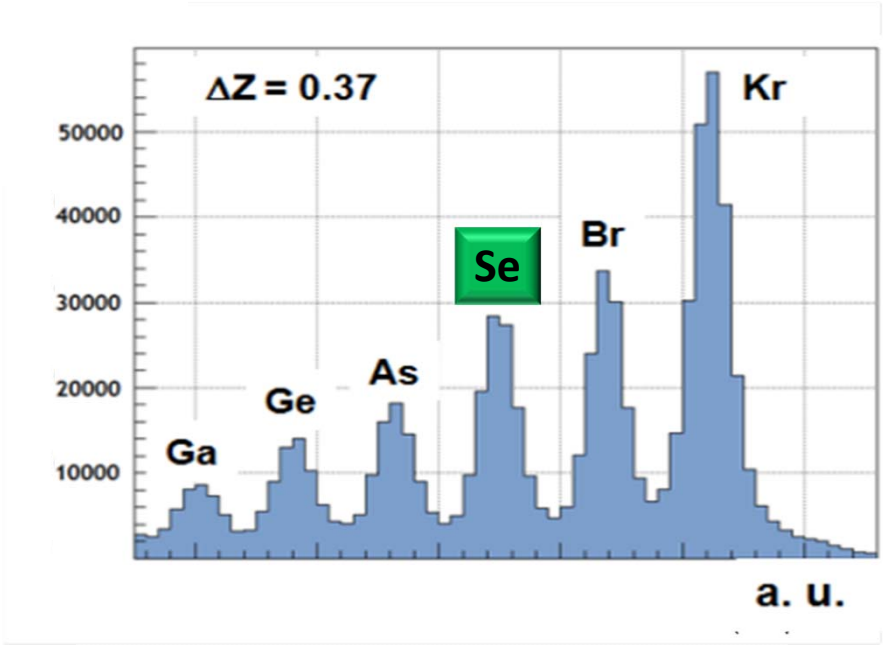
Edana Merchan, Namita Goel

Performance Commissioning

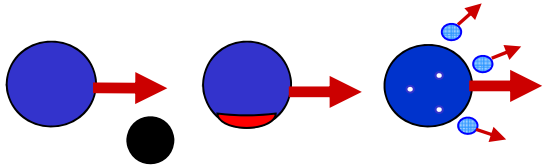
"Secondary" fragmentation of ^{80}Kr



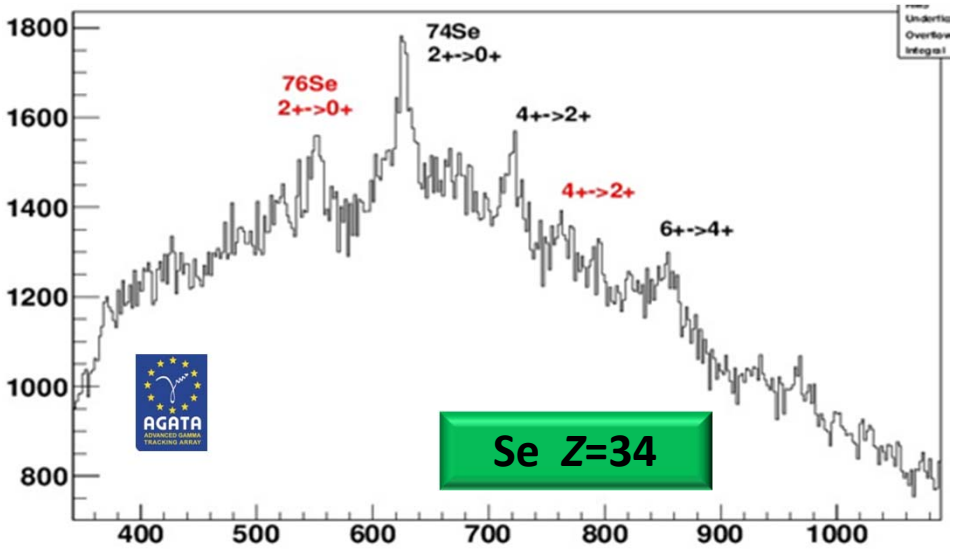




P. Singh, GSI AnnRep 2012



AGATA spectrum



exp. conditions:
target DSSSD, LYCCA, AGATA time

Edana Merchan, Namita Goel

2012 Experiments

Approved 2012 Proposals









S424: Korten/Gerl (4 days, 9/2012)

Performance commissioning (PreSPEC-AGATA- LYCCA)

S429: Rudolph / Podolyák / Gerl (6 days, 10/2012)

Quadrantic evolution of collectivity around ^{208}Pb

S430: Wieland / Gorská (5/7 days, 10/2012)

Pygmy Dipole Resonance in ^{64}Fe and the properties of neutron skin

S426: Pietralla / Rainovski / Gerl (1/8 days, 2013)

Relativistic *M*1-Coulomb excitation of ^{85}Br

S433: G days, 10/2012)

p in ^{52}Fe

S431: E days, 11/2012)

S428: P days, 11/2012)

Shape evolution in neutron-rich Zr

S427: Sahin / de Angelis (5 days, 2013)

Study of the Tz=-1 nucleus ^{70}Kr (isospin symmetry A=70)

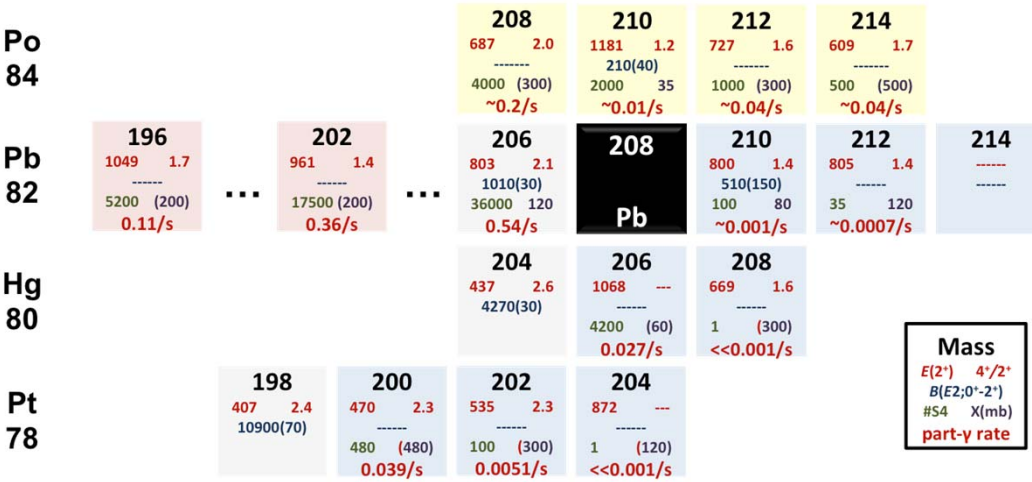
S434: Recchia / Bentley (5 days, 2013)

Transition rates and mirror energy differences in isobaric multiplets

Backlog: about 3 weeks!

S429
Quadrantic Evolution of Collectivity Around ^{208}Pb

$B(E2;0^+\rightarrow 2^+)$ transition strengths in the vicinity of ^{208}Pb | D. Rudolph, Z. Podolyak, J. Gerl *et al.*

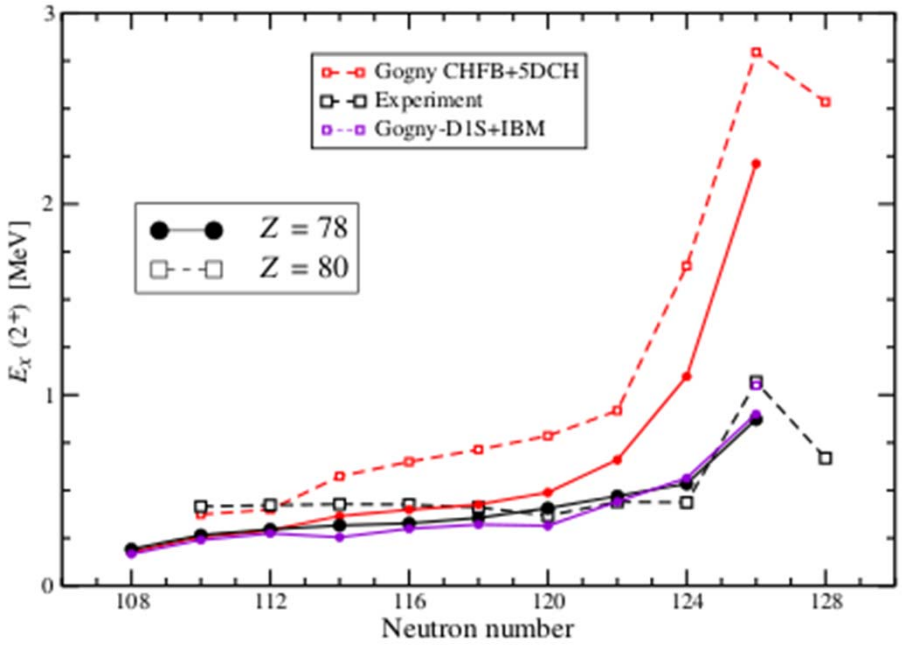


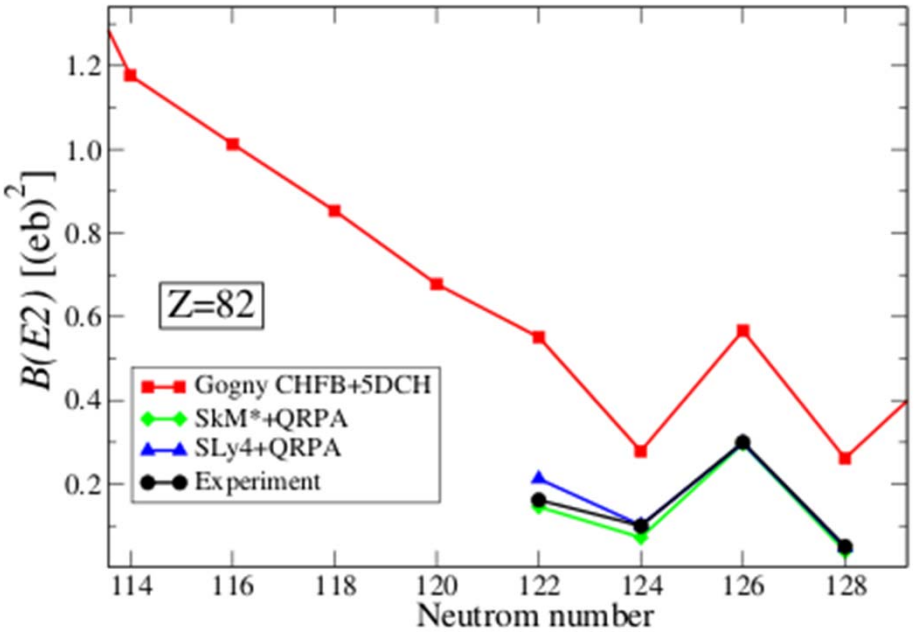
Lack of experimental information!

Staged programme:

Z=82 and *N*=126 isomers: RISING Stopped
$^{198\text{-}206}$Pb, ^{206}Hg and ^{200,202}Pt: ^{208}Pb beam GSI
$^{208\text{-}214}$Po, ^{210}Pb: ^{238}U beam GSI

^{204}Pt, ^{208}Hg, ^{21X}Pb : ^{238}U beam HISPEC-FAIR





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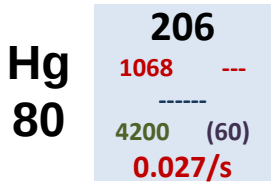

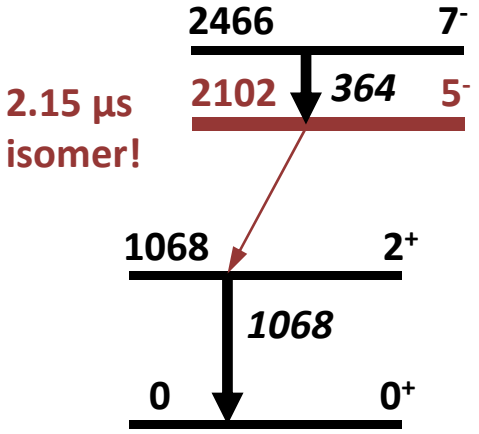

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$^{208\text{-}214}$Po, ^{210}Pb: ^{238}U beam GSI

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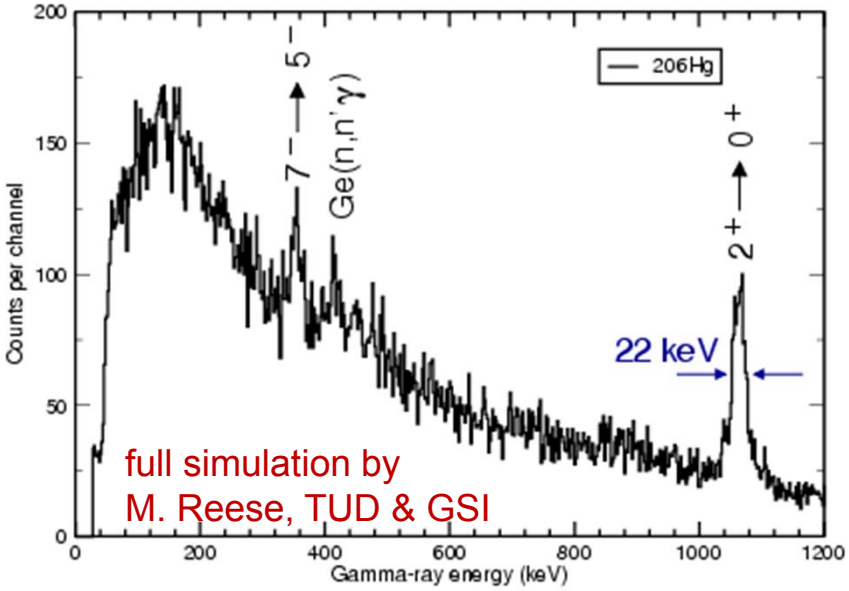
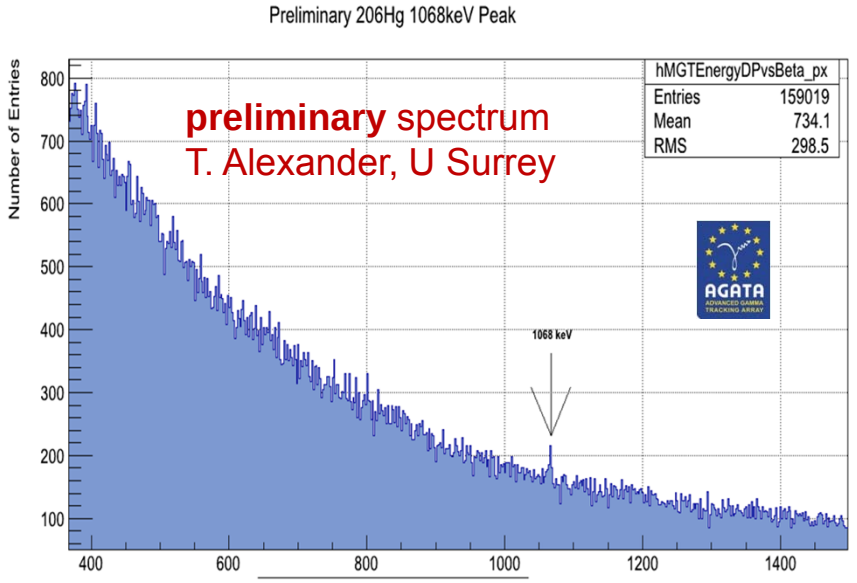
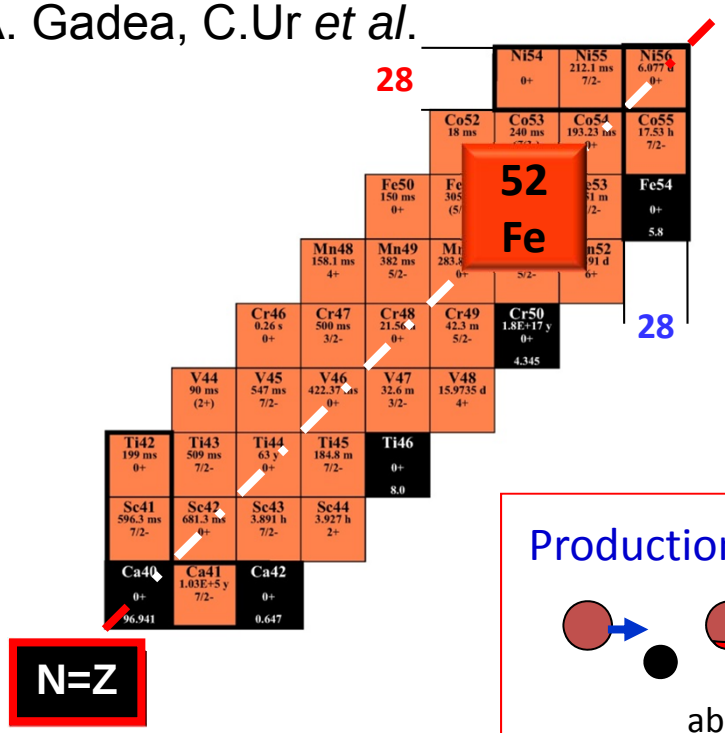


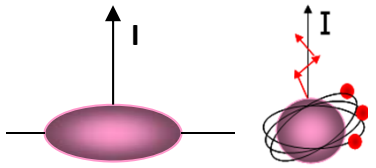


S433 Coulomb Excitation of the Band-terminating 12^+ Yrast Trap in ^{52}Fe

A. Gadea, C.Ur *et al.*



π and ν:
[312]5/2⁻ [303]7/2⁻



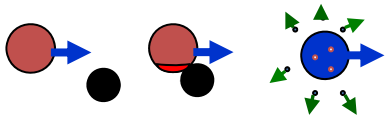
$\pi(f_{7/2})^{-2}$ x $\nu(f_{7/2})^{-2}$

$T_{1/2}$=45.9 s

^{52}Fe

10^+ 7381
12^+ 6957
8^+ 6360
8^+ 6493
6^+ 4872
K=6
2qp
6^+ 4325
4^+ 3585
2^+ 2760
K=2
γ-band
4^+ 2384
$t_{1/2}$=8 ps
2^+ 850
β≈0.23
0^+ 0
K=0

Production of isomeric beams:



abrasion ablation

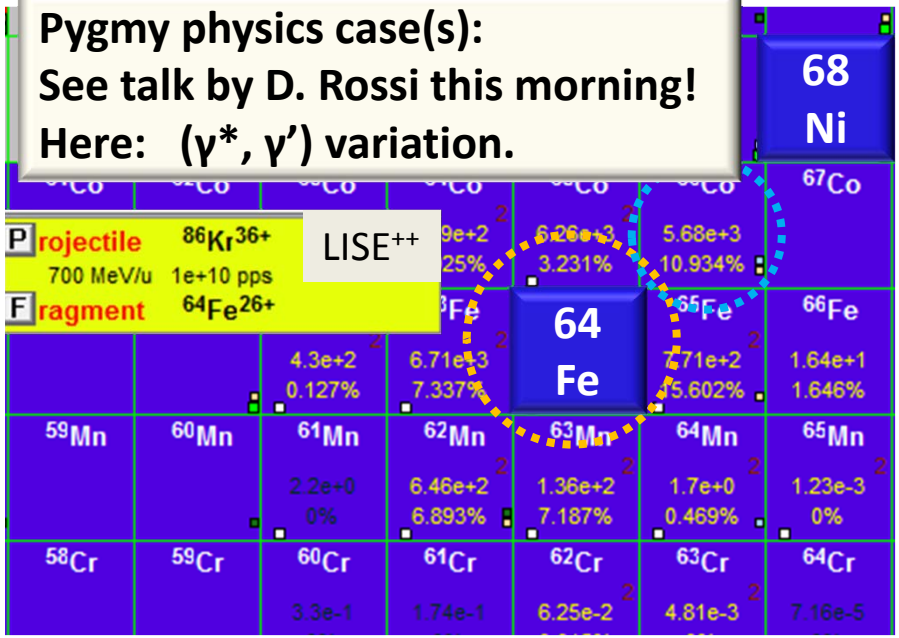
❖ in 20% of all cases the fragment is excited

A.Gadea *et al.*, Phys.Lett.B619, 88 (2005).

K.L. Yurkewicz *et al.*, Phys. Rev. C70, 034301 (2004).

S430
Fine Structure of the Pygmy Resonance in ^{64}Fe

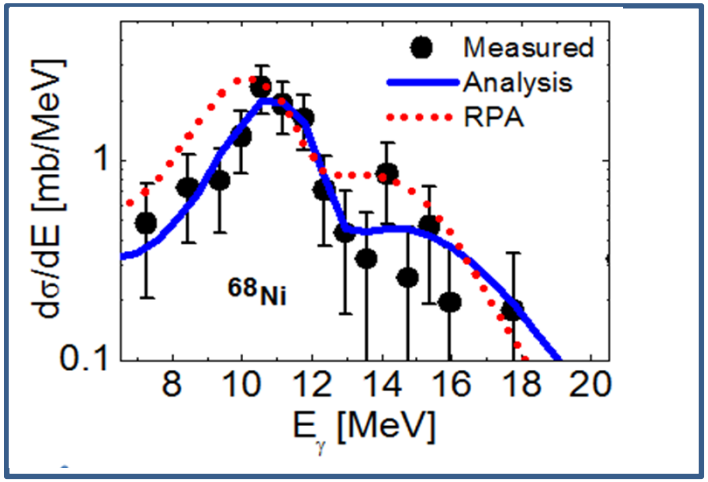
Pygmy physics case(s):
See talk by D. Rossi this morning!
Here: (γ*, γ') variation.



O. Wieland, M. Kmiecik *et al.*

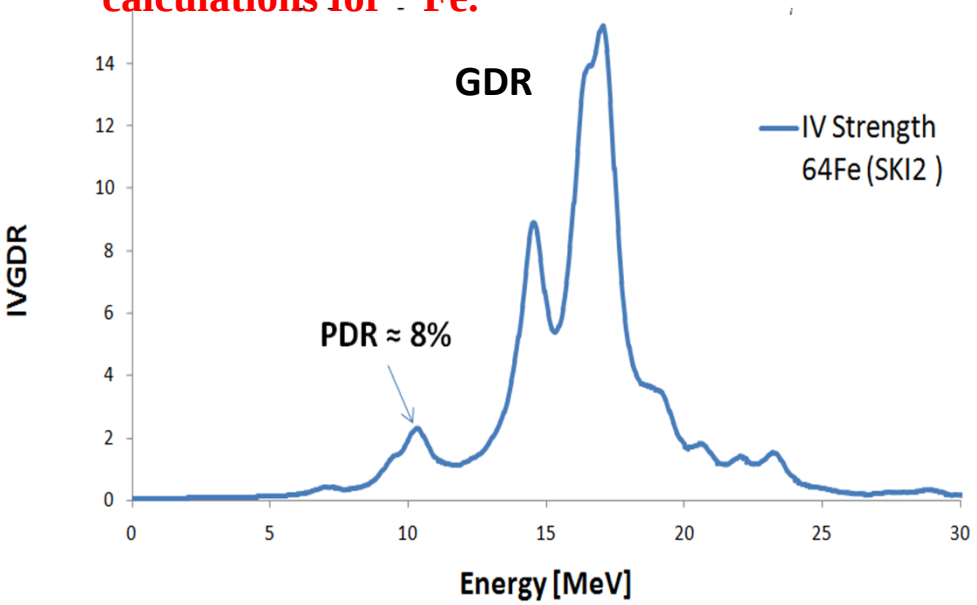
Properties of the **PDR in ^{64}Fe** and the **neutron skin**, following the line of the 2005 RISING experiment on ^{68}Ni

RISING



O.Wieland *et al.*, PRL 102, 092502 (2009)

RPA predictions:
SKL2, SLY5, …
calculations for ^{64}Fe.



2013 Experiments ?

Commissioning of a LH_2 target

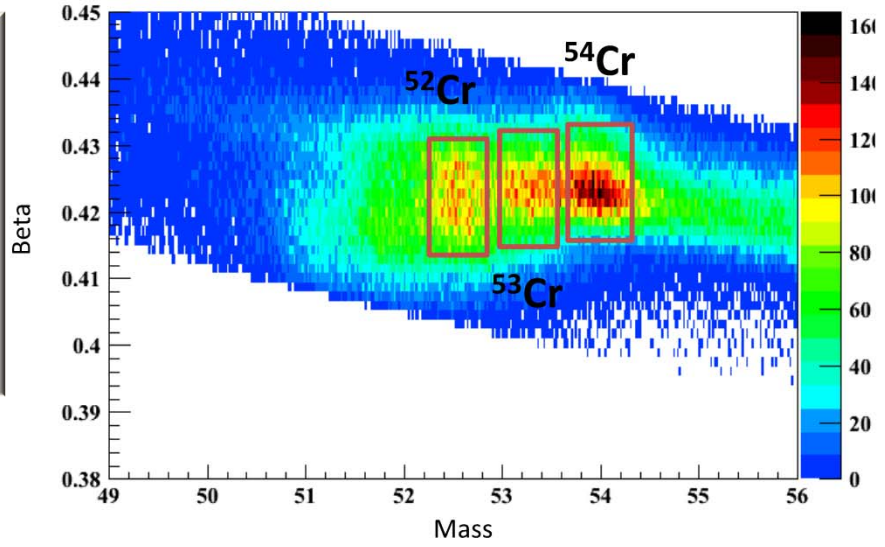
A. Obertelli, C. Louchart *et al*.

LH_2 target used during the test in May 2011:

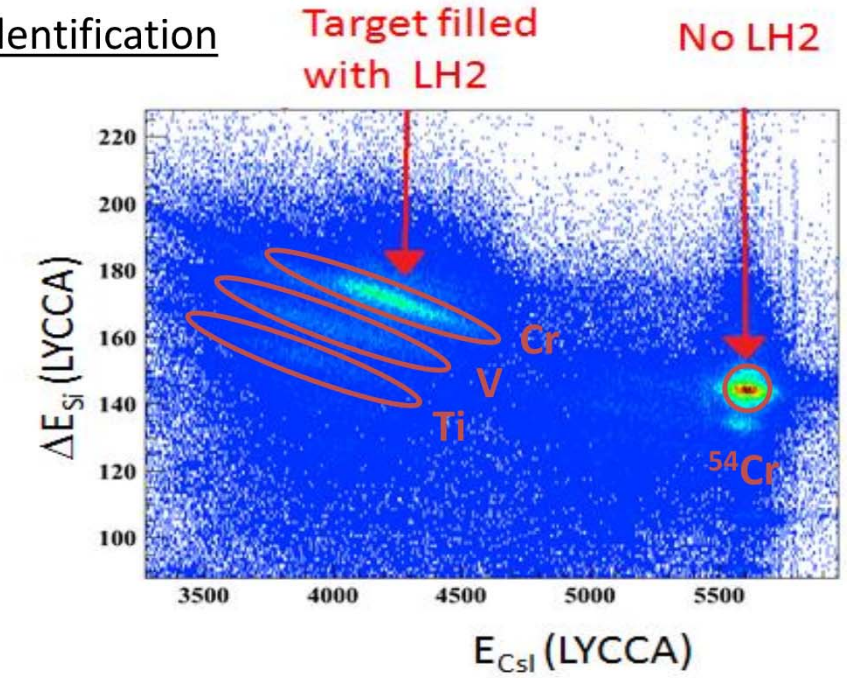
- **2 cm thickness**
- **7 cm diameter**

^{54}Cr at 150 MeV/u

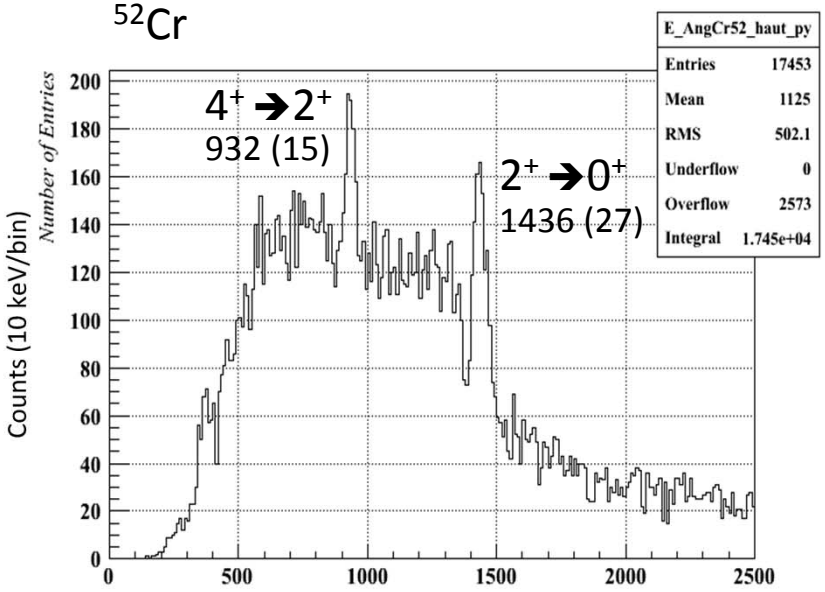
Mass identification of Cr isotopes



Z identification



^{52}Cr



PreSPEC-AGATA Timeline #2

2010: **Contract between AGATA & GSI: ≥ 12 weeks beamtime!**

…..

2012: **About 24 days out of 44 approved days realised in 2012**
about 3 weeks backlog, and about 40 more days "available"

October: Call for new and revised proposals incl. LH_2 opportunity

December: Presentation of 18 Letters of Intent (LoI)

2013: **January: 15 (in part joined) Pre-Proposals received, 78 days requested:**
6x Coulex, 3x fragmentation/DSAM, 5x p,p'-type LH_2, 1x Atomic

February-March: Technical evaluation / consistency check at GSI

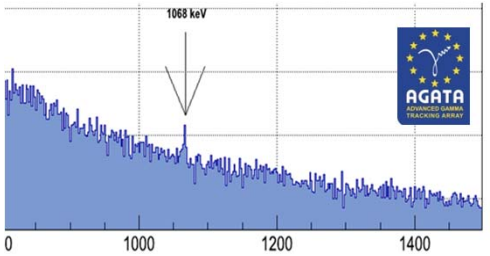
March: Feedback and internal assessme

April: Finalize and submit proposals

May: Assessment and evaluation by exte

pending due to unclear beam-time situation at GSI !!

Conclusions & Outlook



Core ingredients (and more!) of HISPEC successfully commissioned in phase with original FAIR timeline

PreSPEC-HISPEC-DESPEC equipment 'readily' available for Super-FRS commissioning … in 2019+

5 out of 8 approved PRESPEC-AGATA 2012 experiments conducted, at least 4 with anticipated physics results, NUSTAR meetings 2014/2015

3 remaining: new type of *M*1-Coulex and 2x isospin symmetry across *N*=*Z*

15 new/revised LoIs for PRESPEC-AGATA 2013 –
many with technically and technologically HISPEC relevant R&D ideas

LH_2 target (p,p'), (p,n), new plunger/DSAM-style lifetime techniques at relativistic energies isomer tagging, large area plastic position, implementation of NUSTAR electronics, etc. pp.

Backlog of 3 weeks from 2012 plus about 5-6 *contracted* weeks for new LoIs seemingly impossible to be scheduled in 2013.

Letter of protest from ASC, NUSTAR board (and other collaborations) to BMBF

Acknowledgements to … the GSI and AGATA teams
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