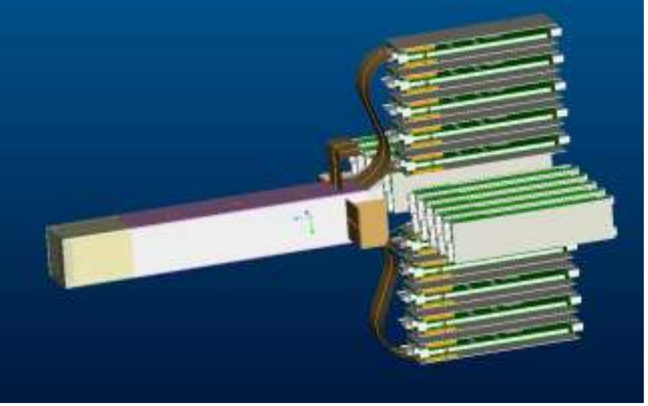


First experiments with HISPEC/DESPEC

Alison Bruce
University of Brighton

International Conference on Science and Technology for FAIR in Europe 2014

Worms, Germany, October 17, 2014

Finland France Germany India Poland Romania Russia Slovenia Sweden UK

NUclear STructure Astrophysics and Reactions

What are the limits for existence of nuclei?

Where are the proton and neutron drip lines situated?

Where does the nuclear chart end?

How does the nuclear force depend on varying proton-to-neutron ratios?

What is the isospin dependence of the spin-orbit force?

How does shell structure change far away from stability?

How to explain collective phenomena from individual motion?

What are the phases, relevant degrees of freedom, and symmetries of the nuclear many-body system?

How are complex nuclei built from their basic constituents?

What is the effective nucleon-nucleon interaction?

How does QCD constrain its parameters?

Which are the nuclei relevant for astrophysical processes and what are their properties?

What is the origin of the heavy elements?

NUSTAR the project

Super-FRS	RIB production, identification and high-resolution spectroscopy
DESPEC/ HISPEC	γ-, β-, α-, p-, n-decay spectroscopy in-beam γ-spectroscopy at low and intermediate energy
ILIMA	masses and lifetimes of nuclei in ground and isomeric states
LASPEC	laser spectroscopy
MATS	in-trap mass measurements and decay studies
R^3B	kinematically complete reactions at high beam energy
SHE	Synthesis and investigation of SHE
ELISE	elastic, inelastic, and quasi-free e^{-}A scattering
EXL	light-ion scattering reactions in inverse kinematics

The Approach

Complementary measurements leading to consistent answers

The Collaboration

> 800 scientists

> 180 institutes

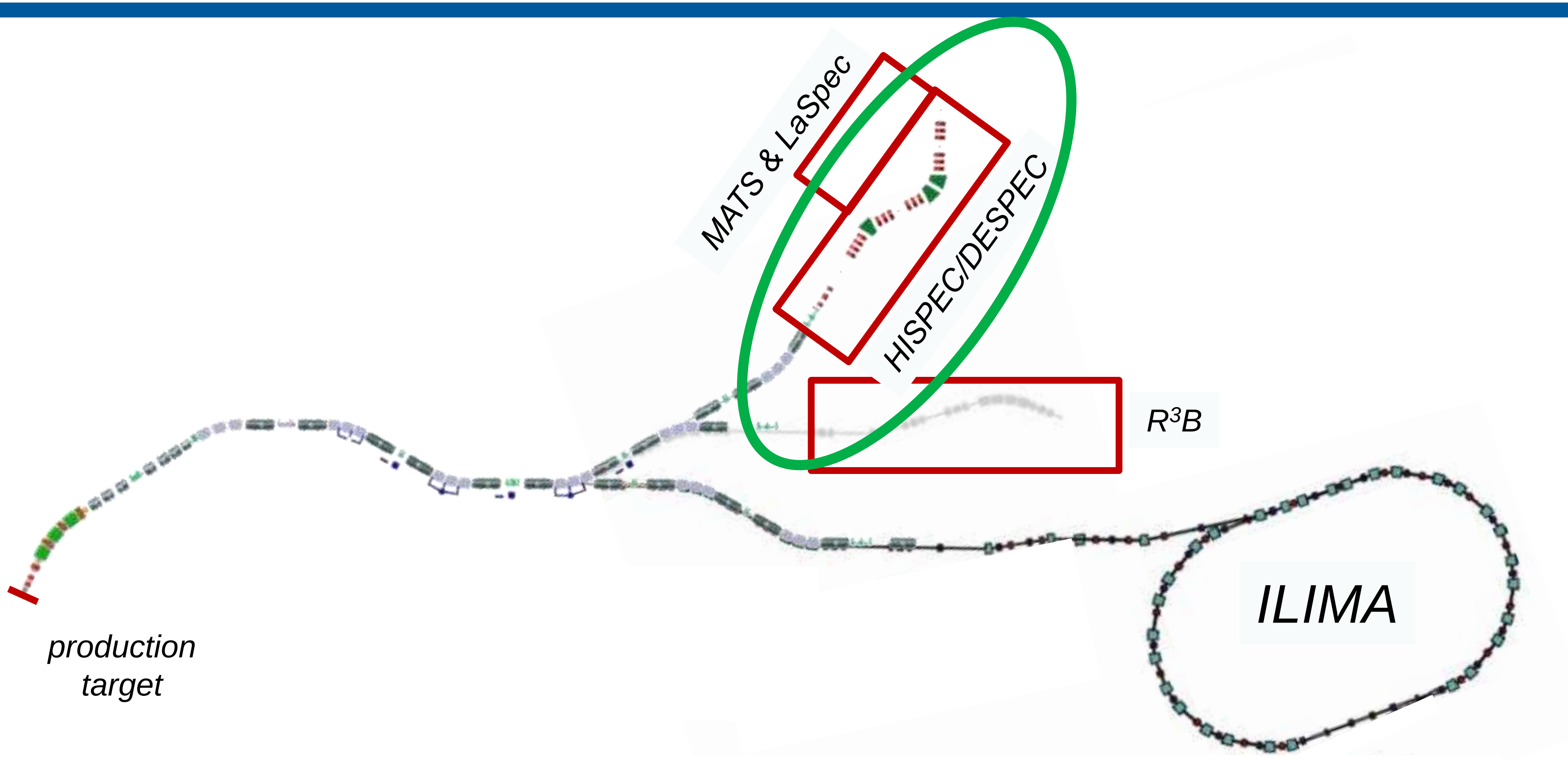
38 countries

The Investment

82 M€ Super-FRS

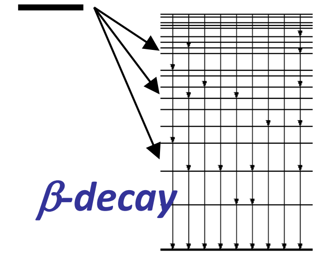
73 M€ Experiments

NUSTAR experimental areas

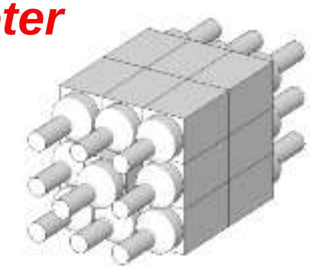


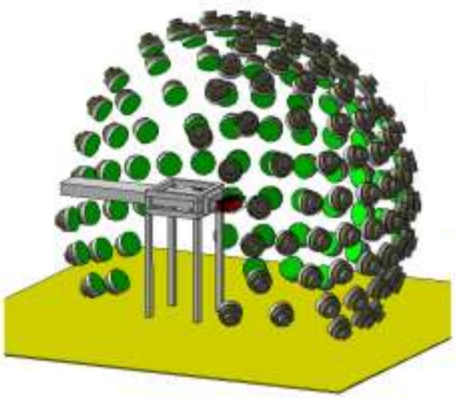
DESPEC: DEcay SPECtroscopy

β,n,γ-decay of exotic (neutron-rich) nuclei…..

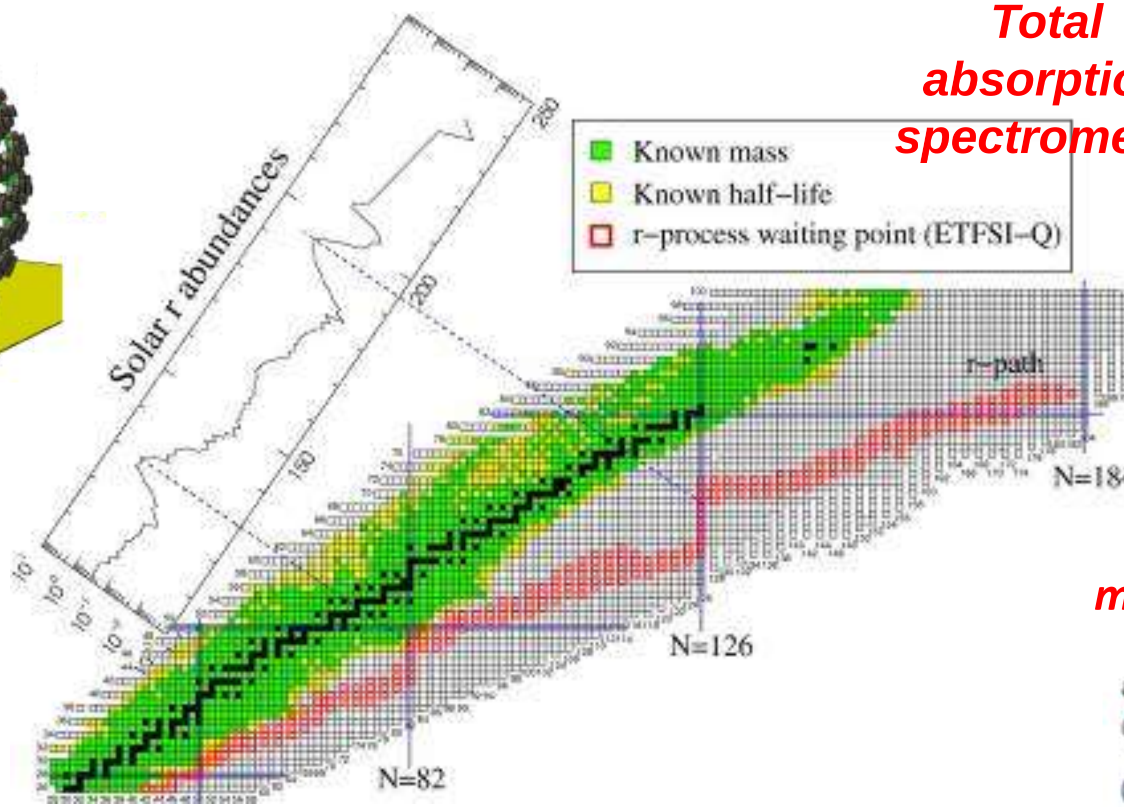


Total absorption spectrometer

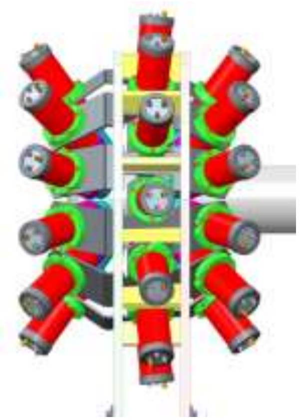




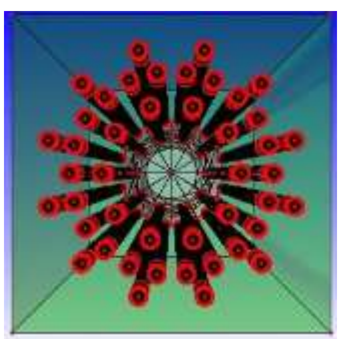
Neutron spectrometer MONSTER



***γ*-ray time measurements**

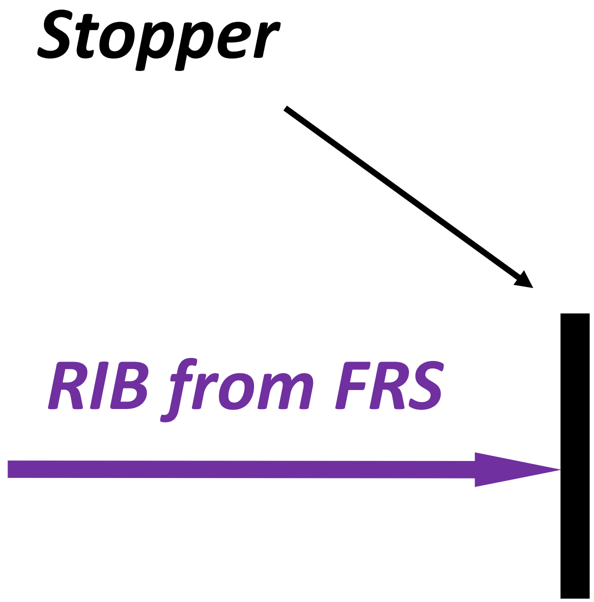


β–delayed neutron detector

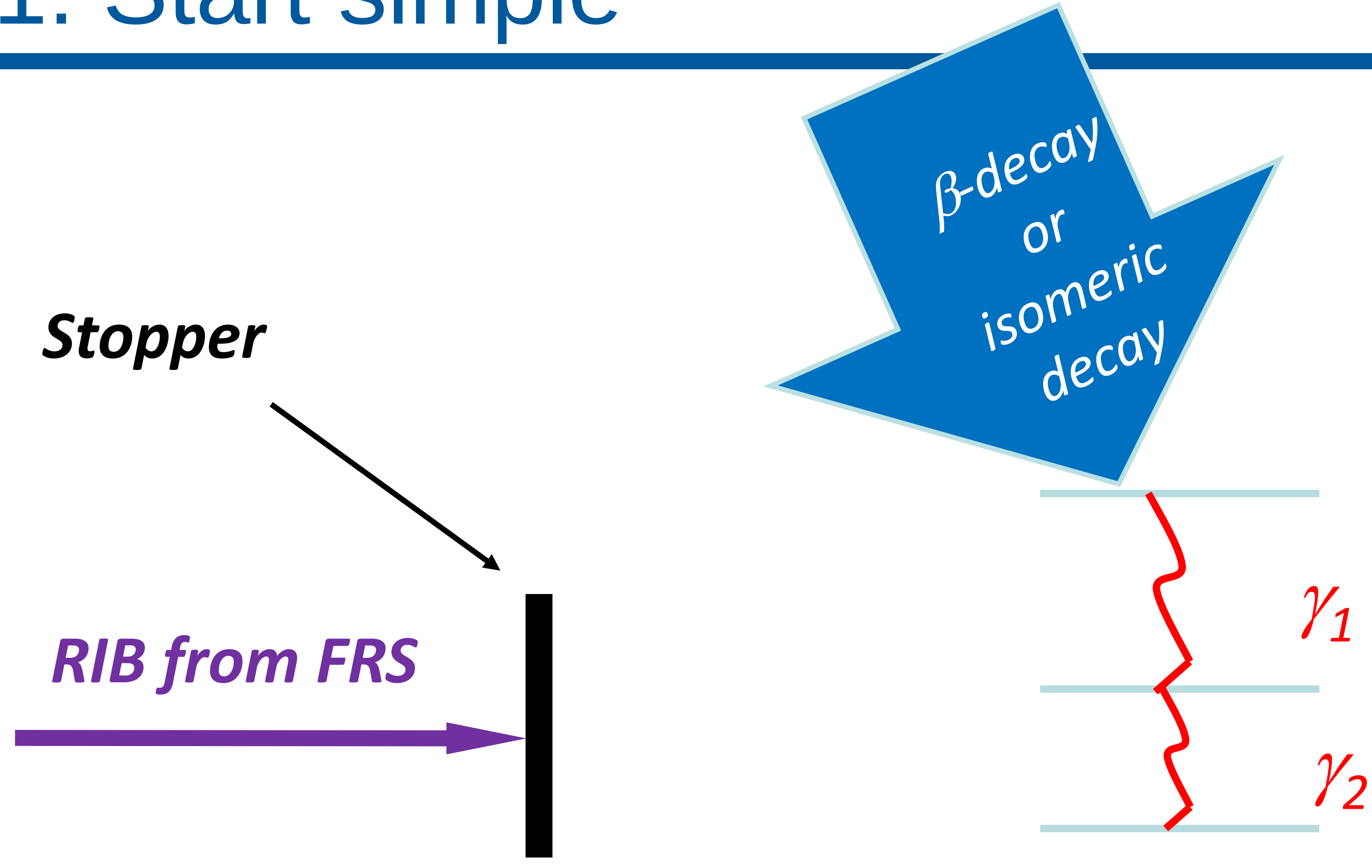


High resolution γ-ray energy measurements

Day 1: Start simple

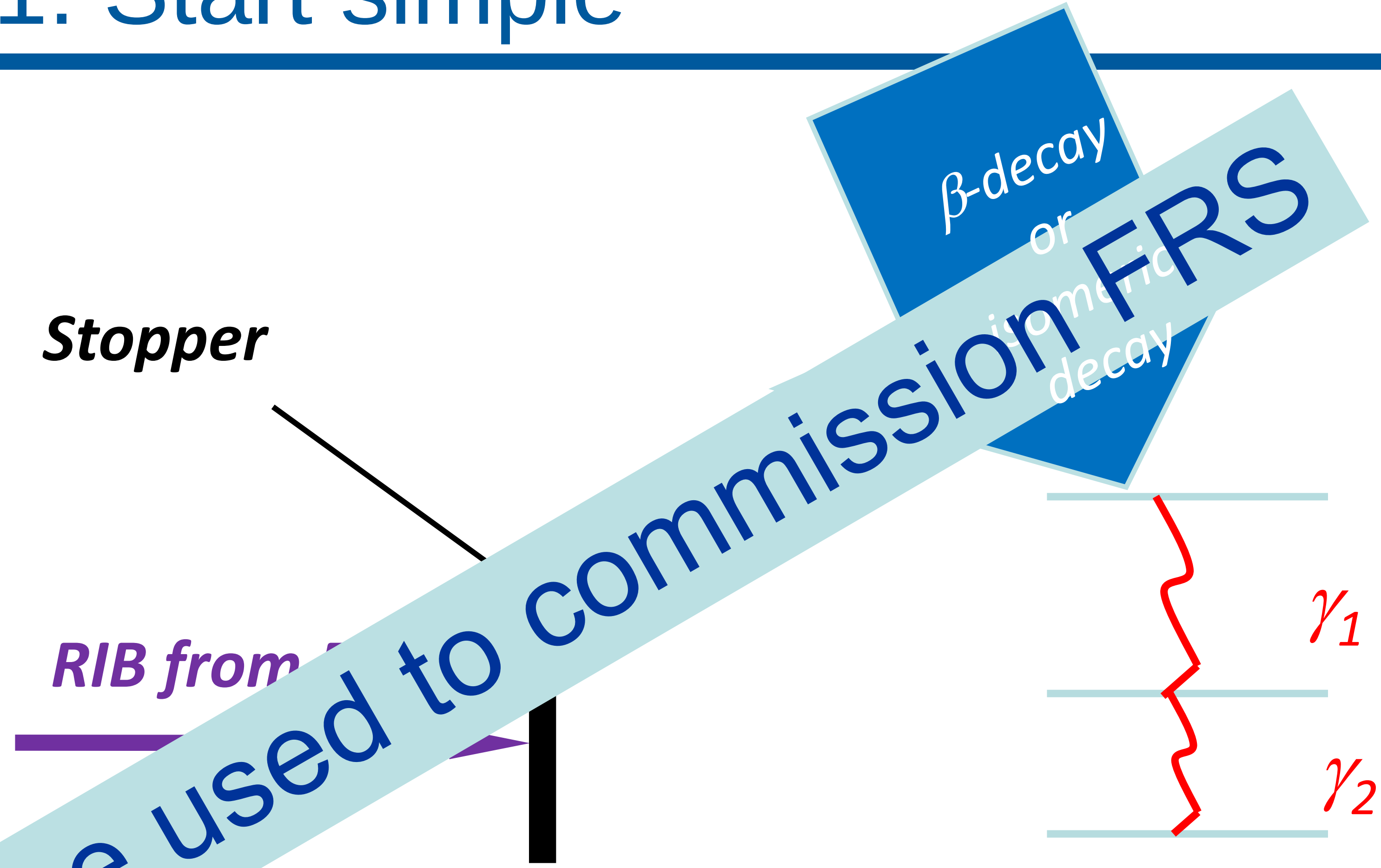


Day 1: Start simple



Get first information on lifetimes, decay modes, Q-values and scheme of excited levels

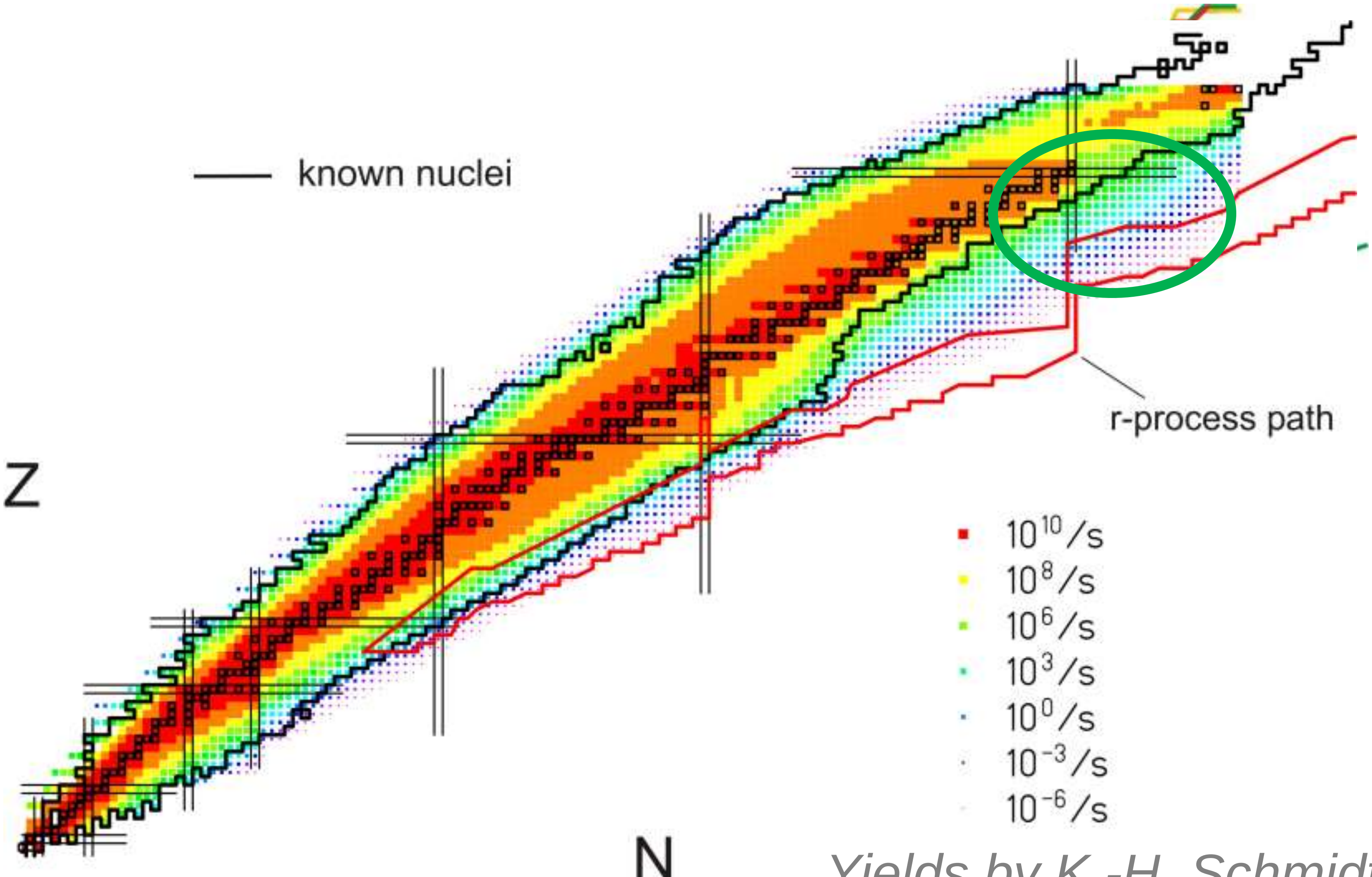
Day 1: Start simple



Can be used to commission FRS

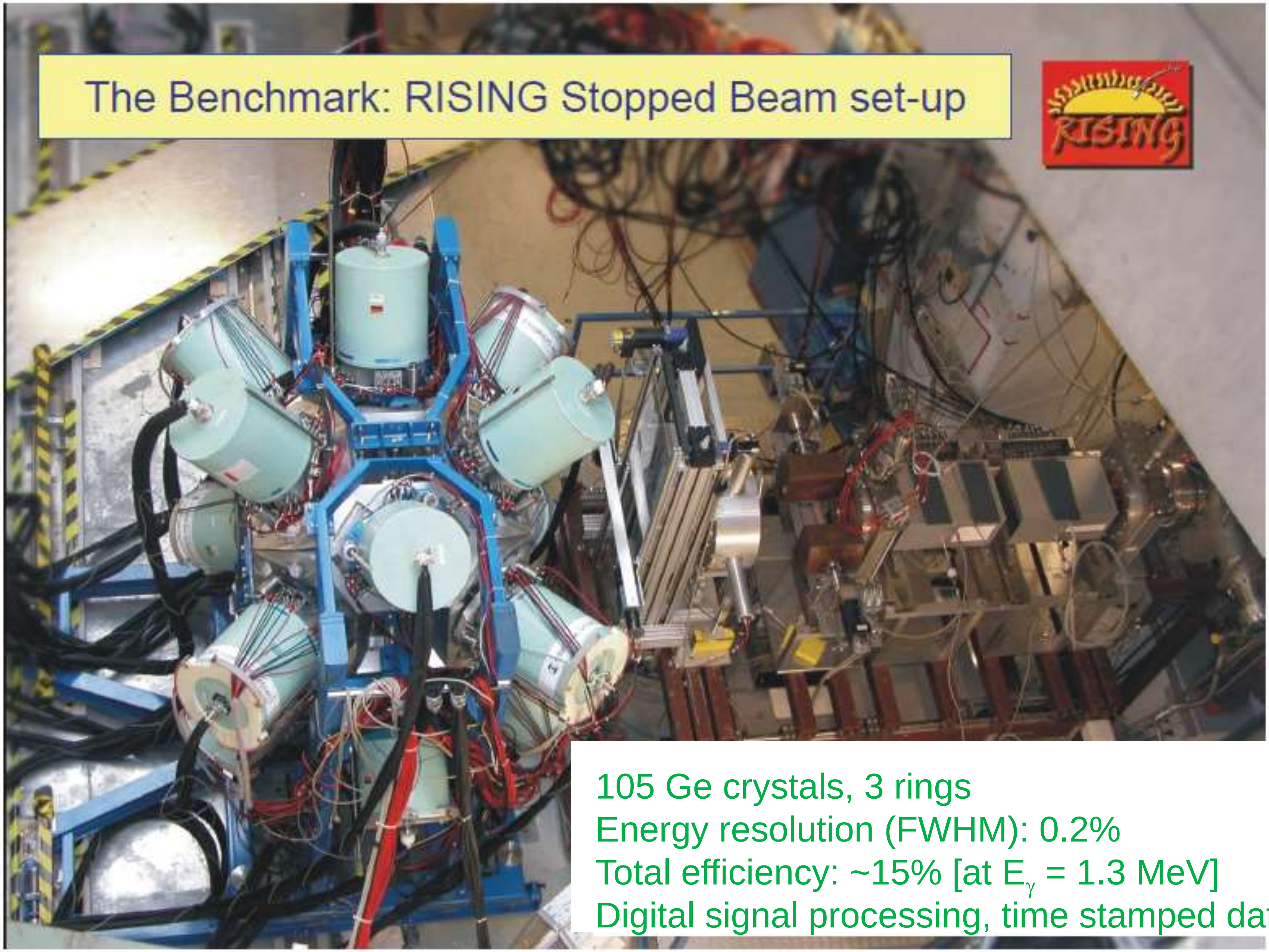
st information on lifetimes, decay modes, Q-values and scheme of excited levels

Day 1 experiments, n-rich Pb



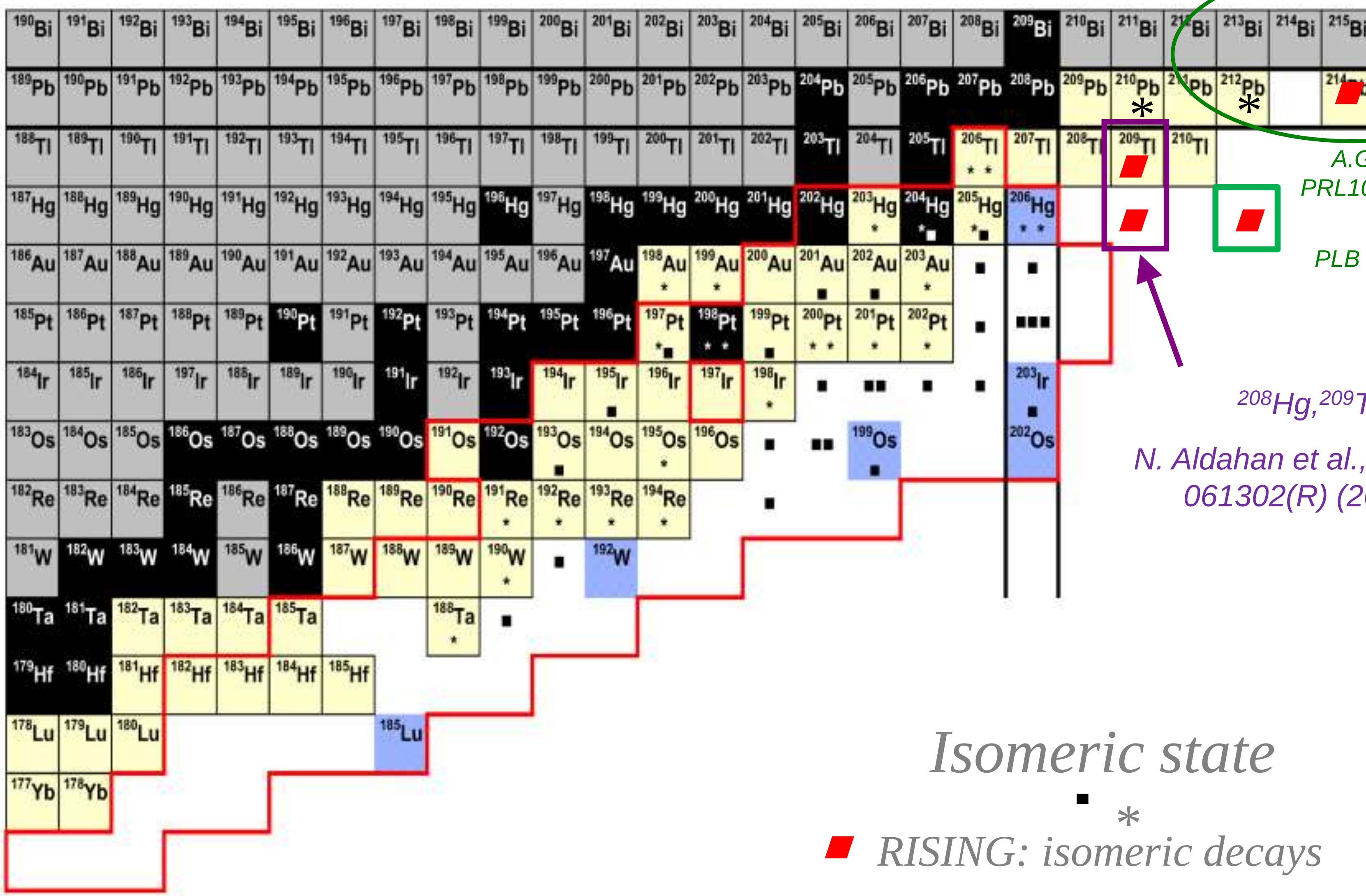
Yields by K.-H. Schmidt

The Benchmark: RISING Stopped Beam set-up



105 Ge crystals, 3 rings
Energy resolution (FWHM): 0.2%
Total efficiency: ~15% [at E_{γ} = 1.3 MeV]
Digital signal processing, time stamped data

Previous work (part of the RISING campaign)



A.Gottardo et al. PRL109(2012)162502

^{210}Hg: PLB 725 (2013)292

^{208}Hg, ^{209}Tl

N. Aldahan et al., PRC80, 061302(R) (2009).

Isomeric state

*

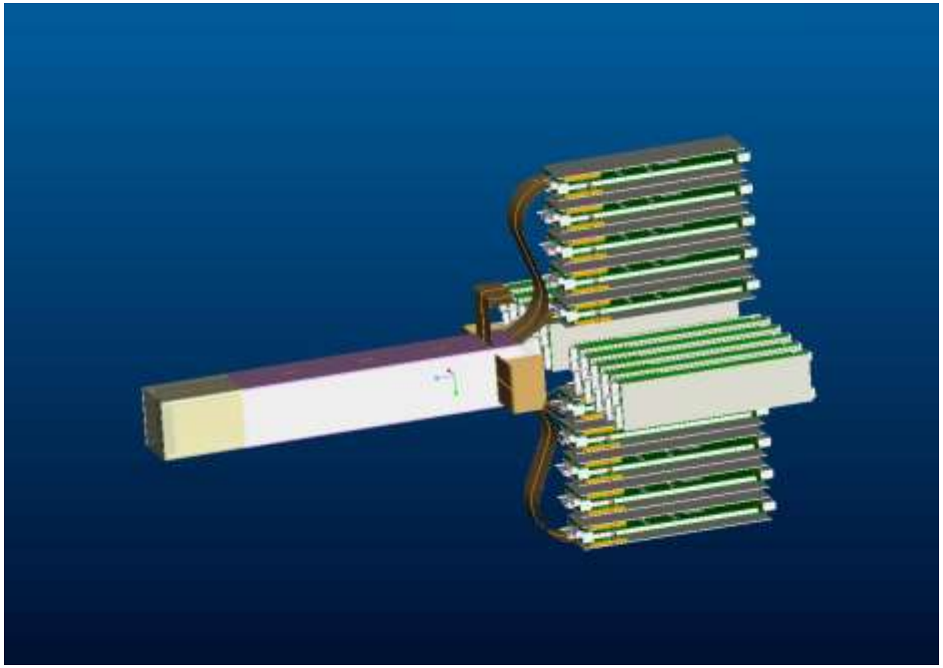
RISING: isomeric decays

S. Steer et al., Phys. Rev. C 84 (2011) 044313

Active stopper..AIDA

Advanced Implantation Detector Array

- *Uses 12 x 8cm x 8cm DSSSD*



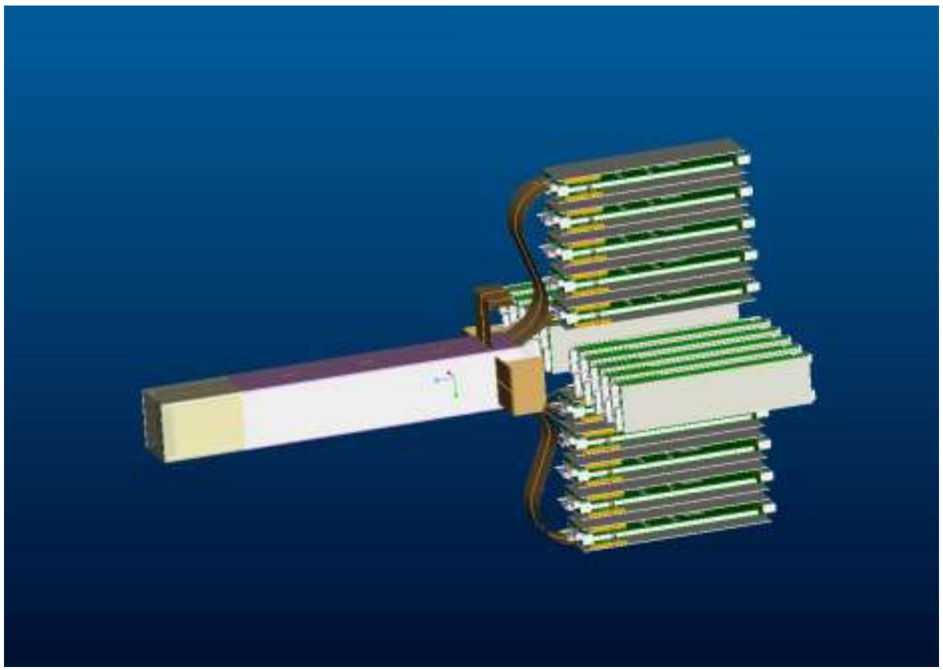
- *Measures position of implant*
- *Fast overload recovery (~μs}*
- *Time stamping*

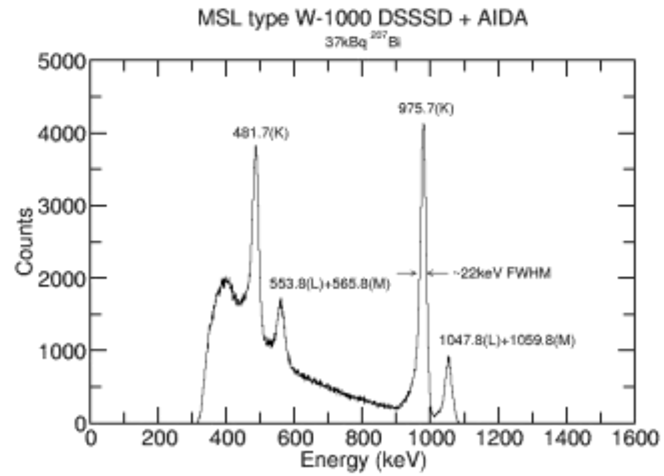
http://www2.ph.ed.ac.uk/~td/DSSD/

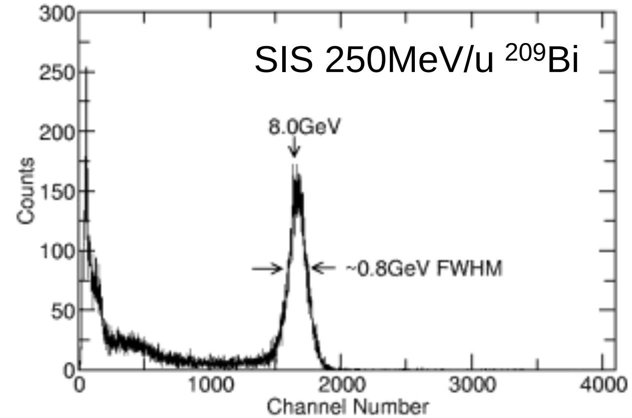
Active stopper..AIDA

Advanced Implantation Detector Array

- *Uses 12 x 8cm x 8cm DSSSD*







THE UNIVERSITY OF EDINBURGH

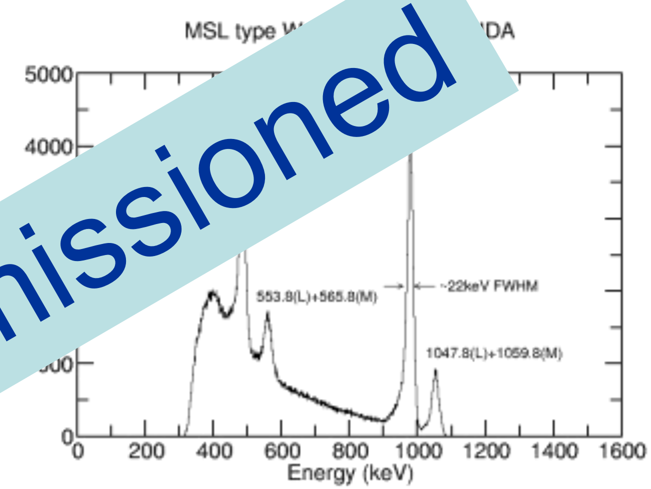
Science & Technology Facilities Council

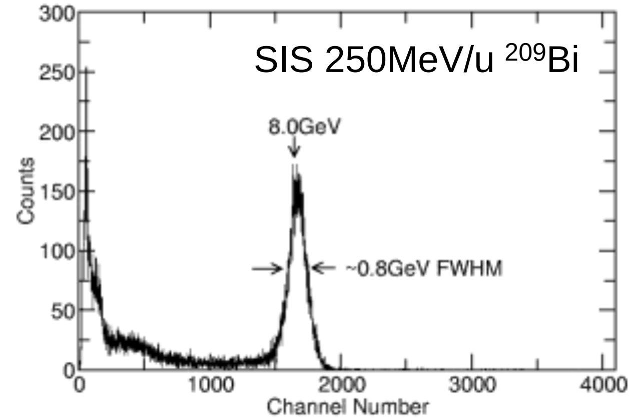
THE UNIVERSITY of LIVERPOOL

Active stopper..AIDA

Advanced Implantation Detector Array

- *Uses 12 x 8cm x 8cm DSSSD*



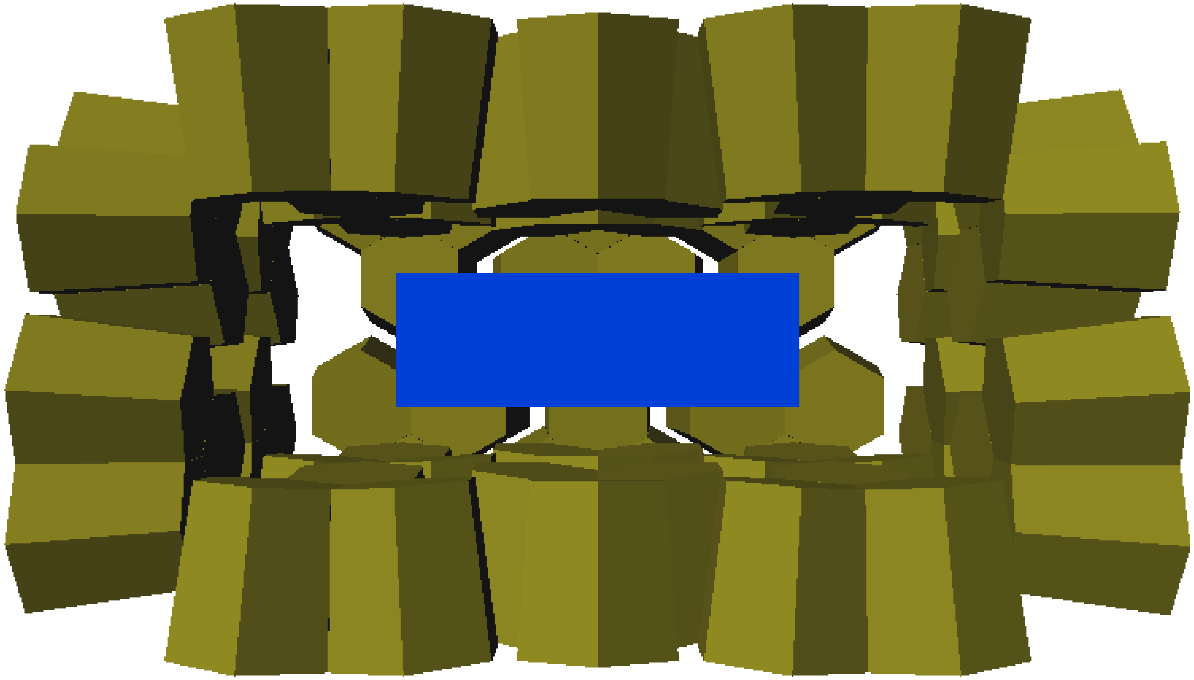


TDR approved, commissioned

Science & Technology Facilities Council

THE UNIVERSITY of LIVERPOOL

DEGAS: Next generation detector array

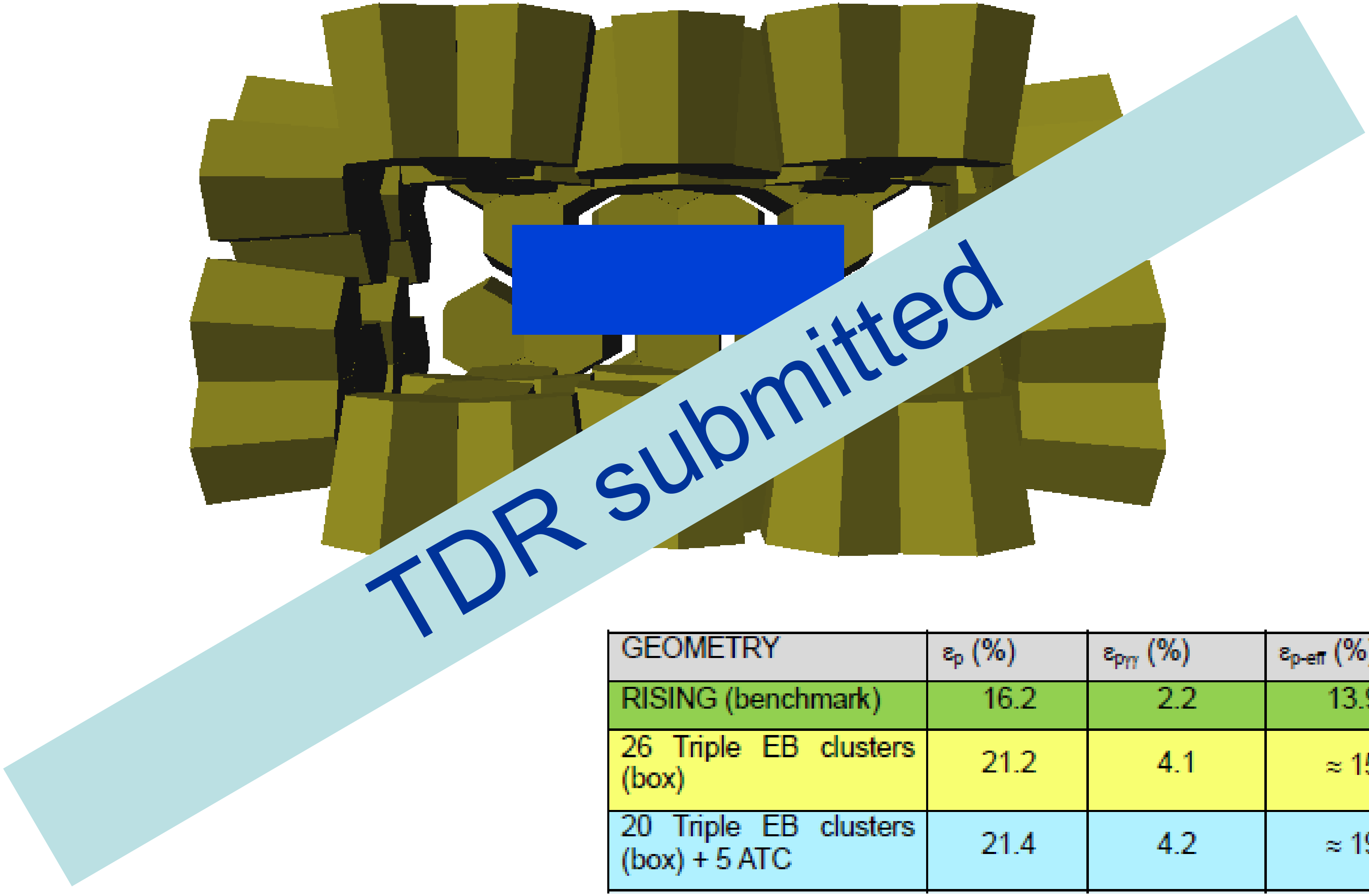


GEOMETRY	ε_p (%)	$\varepsilon_{p\gamma\gamma}$ (%)	$\varepsilon_{p\text{-eff}}$ (%)
RISING (benchmark)	16.2	2.2	13.9
26 Triple EB clusters (box)	21.2	4.1	≈ 15
20 Triple EB clusters (box) + 5 ATC	21.4	4.2	≈ 19

Phase 1

Phase 2

DEGAS: Next generation detector array



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26 Triple EB clusters (box)	21.2	4.1	≈ 15
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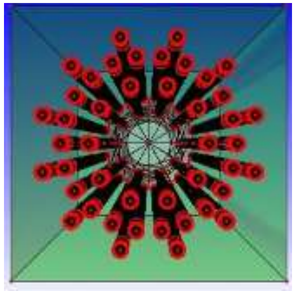
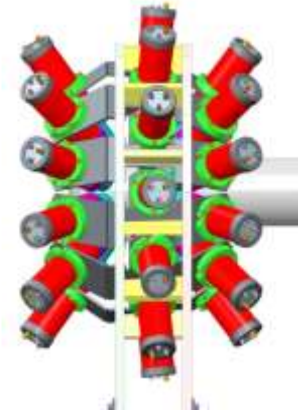
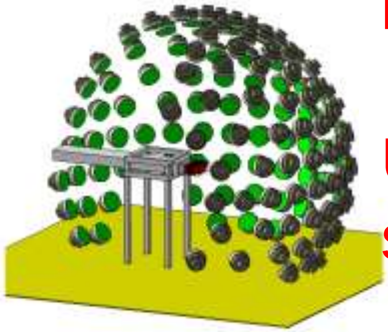
Second stage:



Use BELEN to measure beta-delayed neutron emission

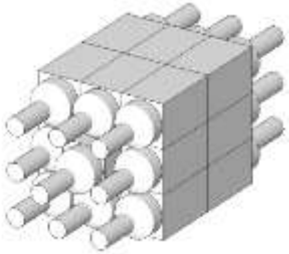


Use FATIMA to measure level lifetimes in the nanosecond regime

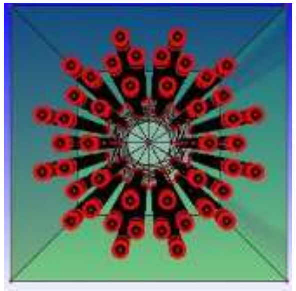


Use MONSTER to carry out neutron spectroscopy

Use DTAS to measure beta decay strengths

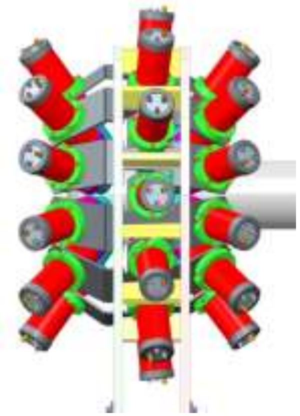


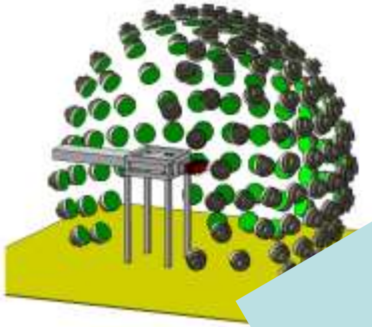
Second stage:



Use BELEN to measure beta-de ayed neutron emission

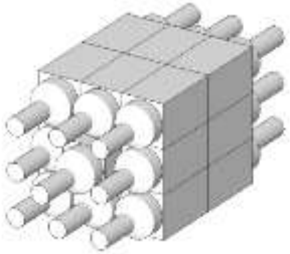
Use FATIMA to m ... lifetimes in the nanose ...





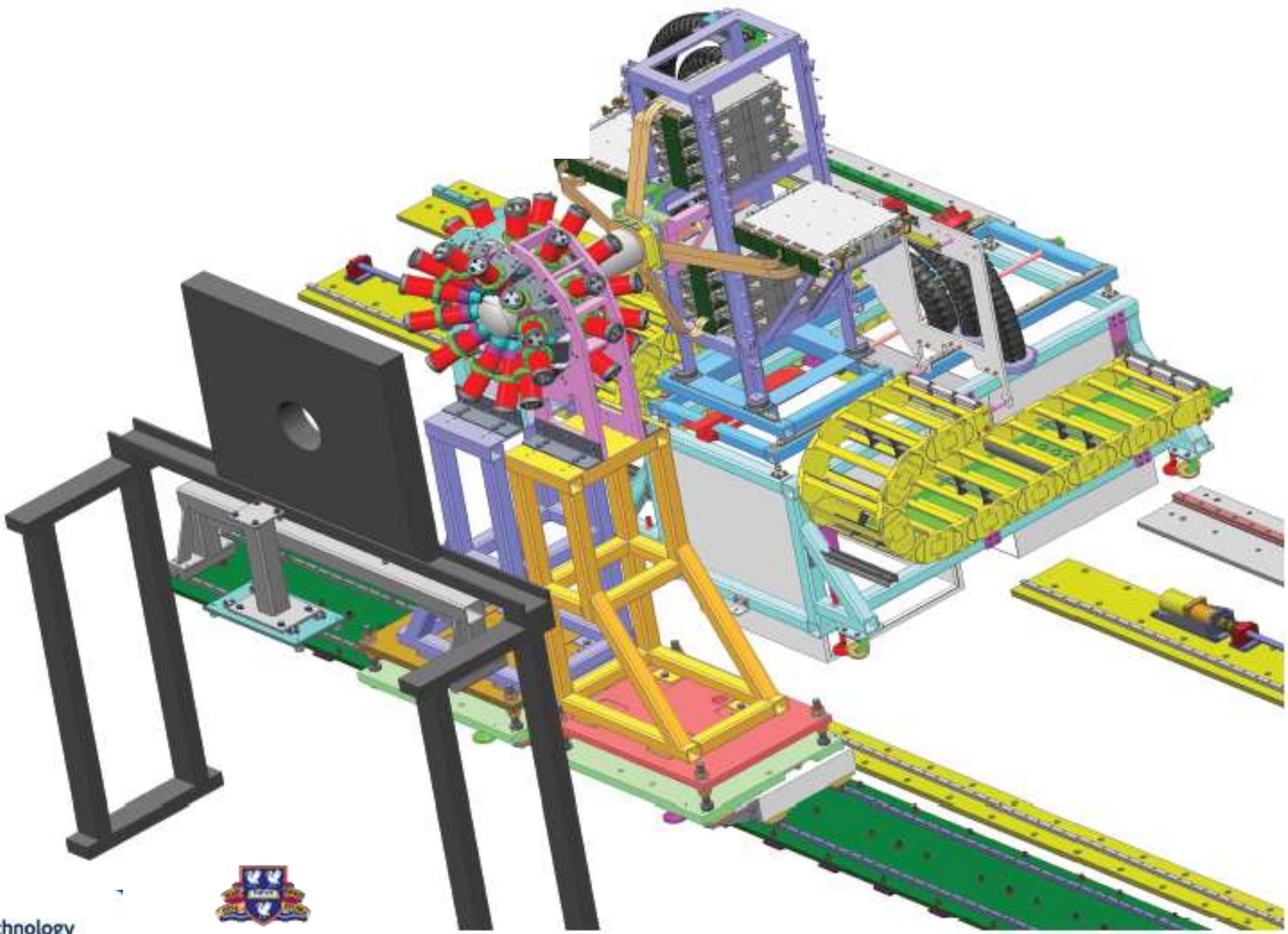
Use ... to carry out neutron ... py

... e DTAS to measure beta decay strengths



3 out of 4 TDR's approved
Commissioned and FAIR ready

Design of the array, mechanical support structure and integration



Science & Technology Facilities Council

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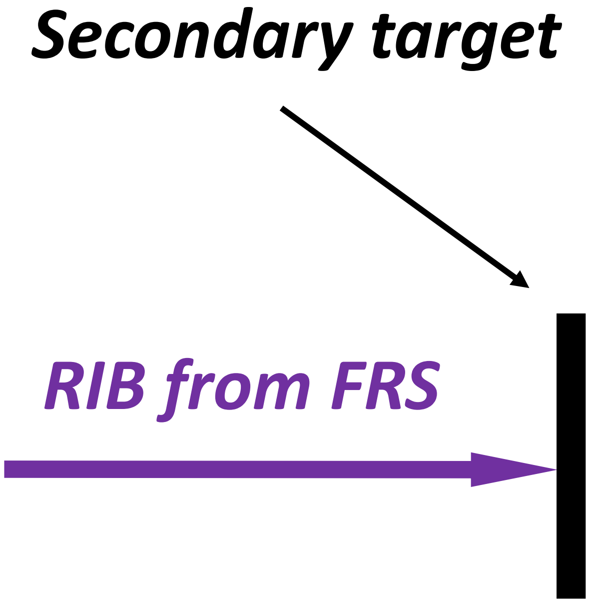
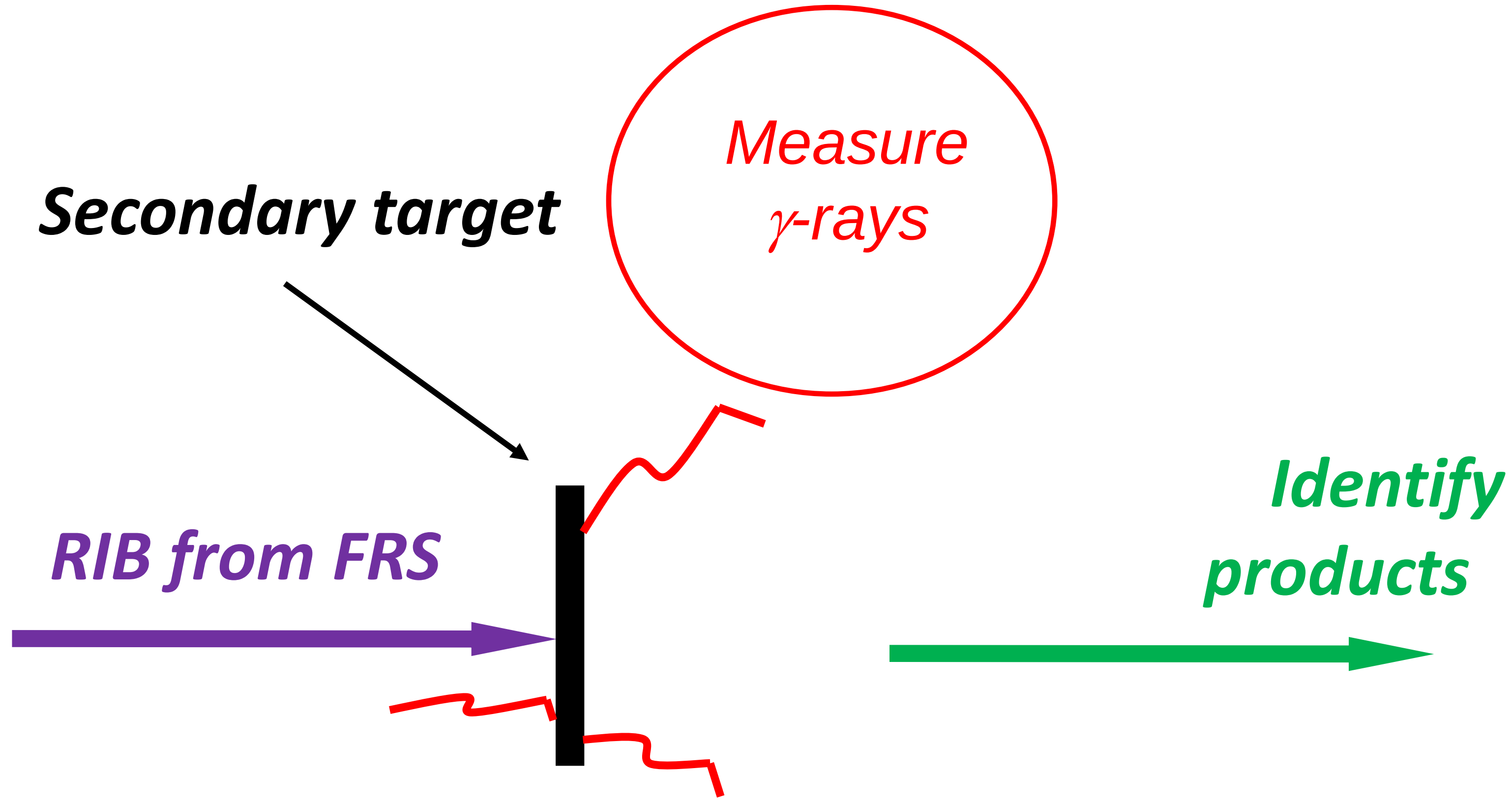
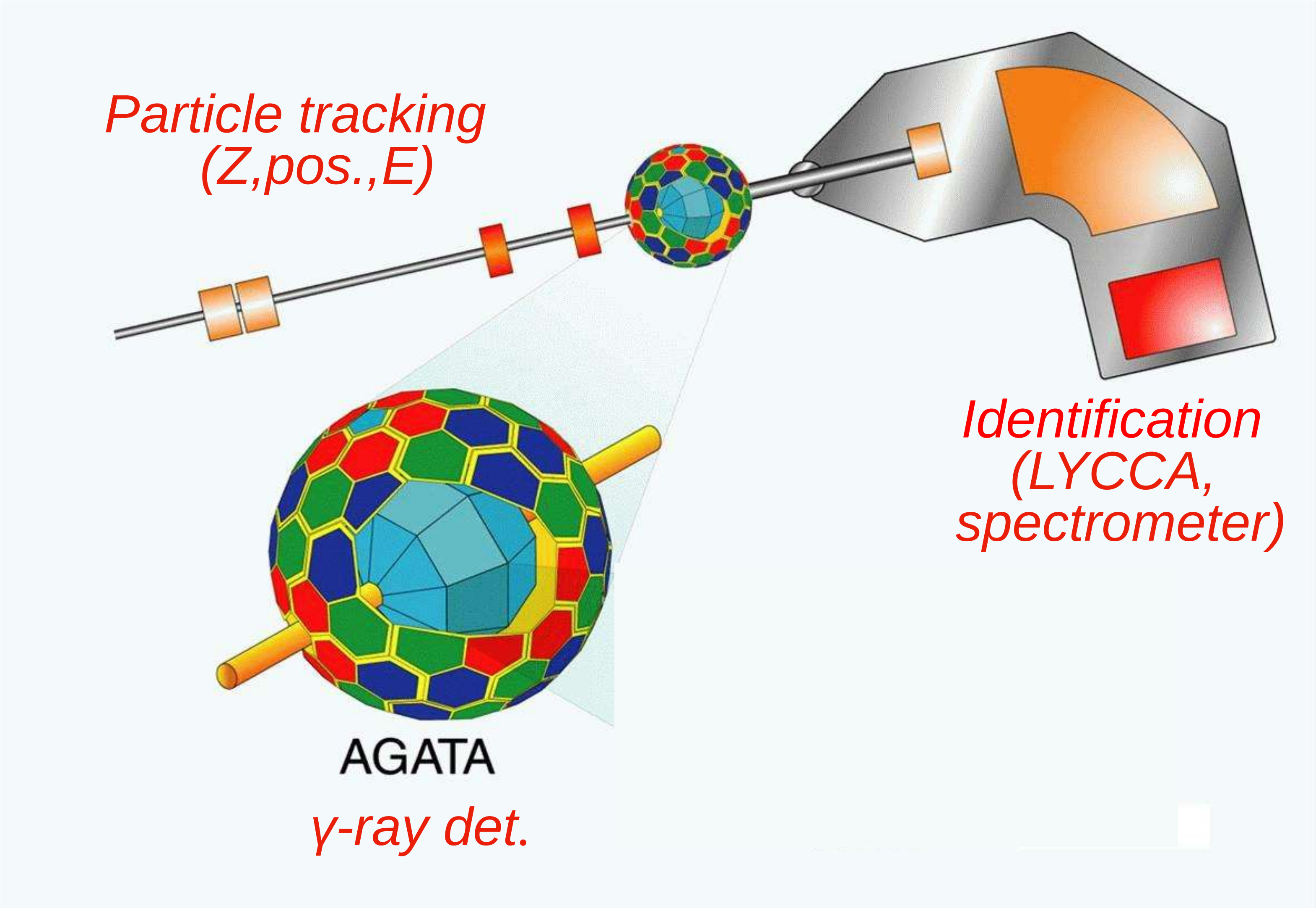
HISPEC: High-resolution in-flight spectroscopy



HISPEC: High-resolution in-flight spectroscopy



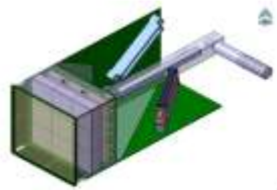
HISPEC: High-resolution In-flight SPECtroscopy

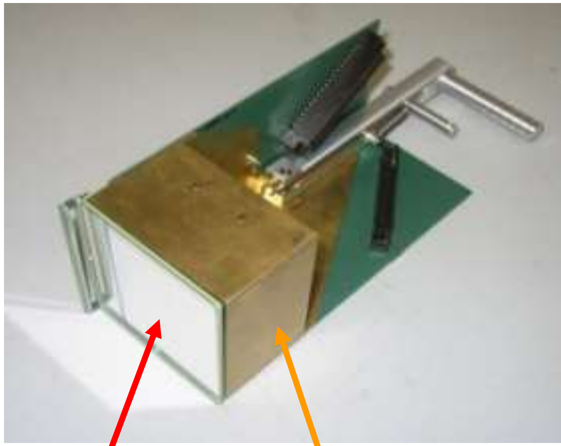


LYCCA: Lund York Cologne CAlorimeter

16 ΔE-E modules
1 target DSSSD
3 plastic multi-PMT Time-of-Flight

1240 detector channels



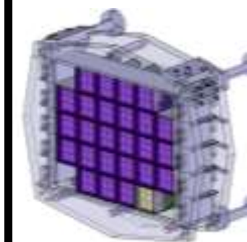


DSSSD CsI

RIB from FRS

plastic multi-PMT ToF:
Δt < 30 ps FWHM!
R. Hoischen et al., NIM A654, 354 (2011)

STOP plastic



secondary target

START plastic

(x, y) DSSSD

ΔZ/Z ~1%
ΔA/A ~1%

(E)

TOF

TOF1 ***TOF2***

(ΔE, x, y)

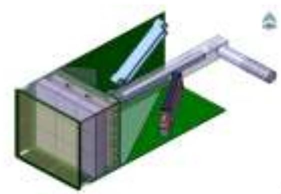
P. Golubev *et al*., Nucl. Instr. Meth. A723, 55 (2013)

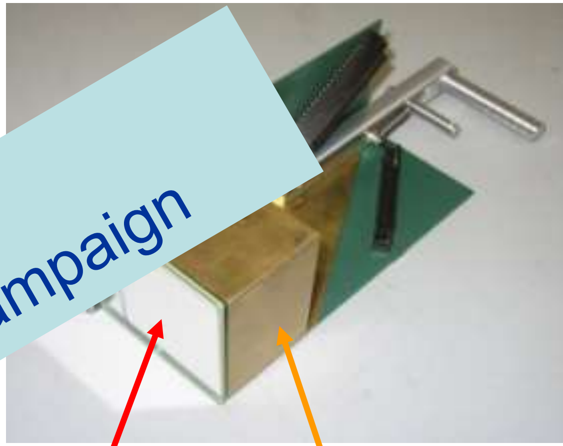
LYCCA: Lund York Cologne CAlorimeter

Lund University · The University of York · University of Cologne

16 ΔE-E modules
1 target DSSSD
3 plastic multi-PMT Time-of-Flig

1240 detector chan





…TDR approved
Commissioned and used in PRESPEC campaign

RIB from FRS

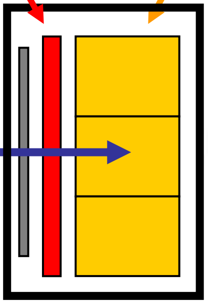
MT ToF:
ps FWHM!
n et al., NIM A654, 354 (2011)

secondary *target*

ΔZ/Z ~1%
ΔA/A ~1%

DSSSD CsI

STOP plastic



START

(x, y) DSSSD

(E)

(ΔE, x, y)

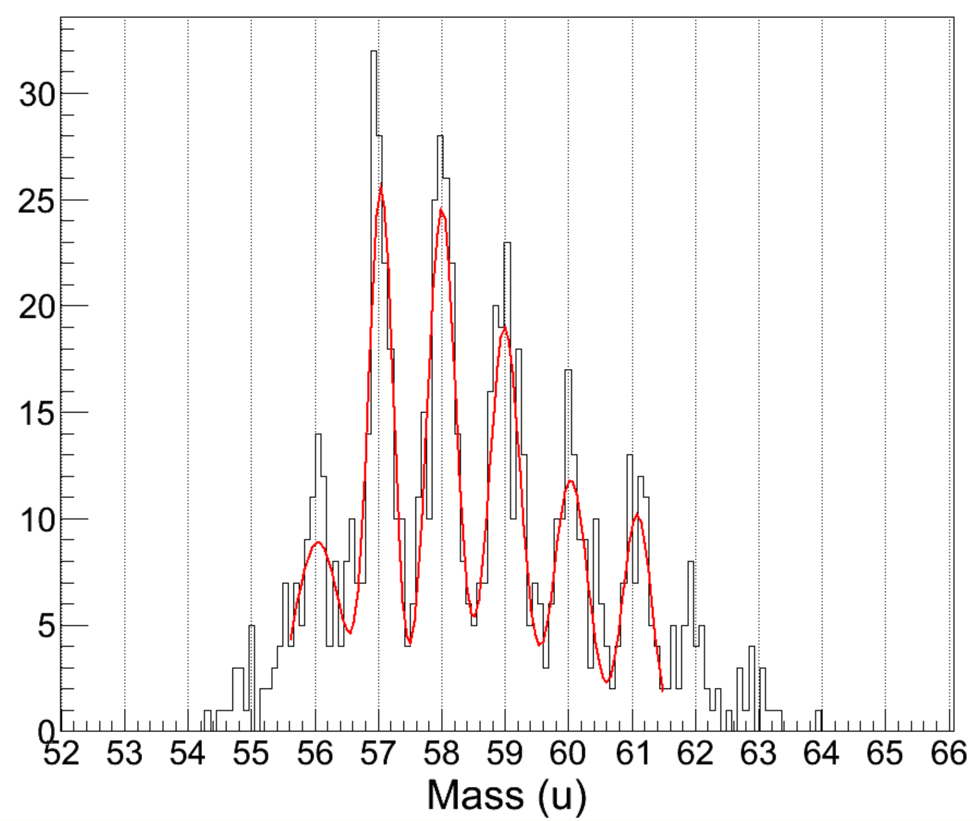
TOF

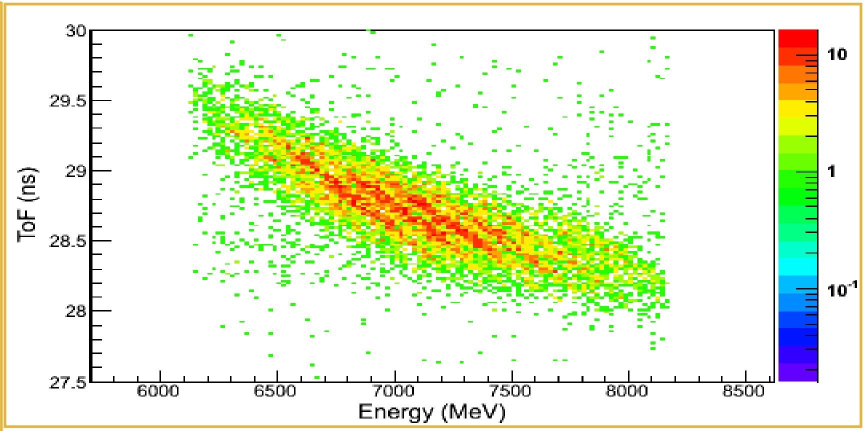
TOF1 *TOF2*

P. Golubev *et al*., Nucl. Instr. Meth. A723, 55 (2013)

LYCCA performance

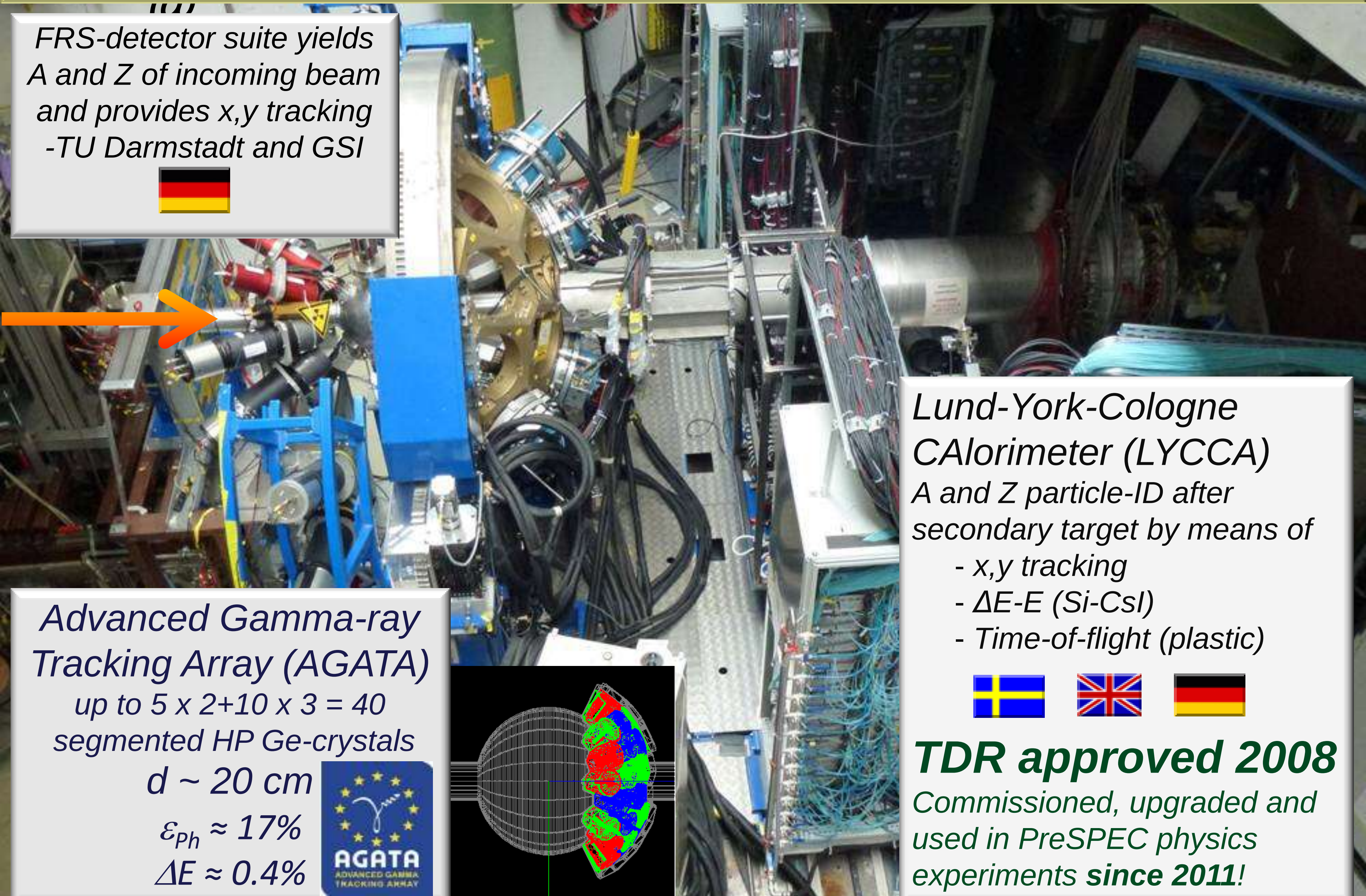
Fe fragments selected after secondary reactions on Fe beam





- *Mass res:* ***0.55 ± 0.02 u***
- *Timing res:* ***50.8 ± 2.4 ps***

PreSPEC-AGATA 2012-2014: Early Implementation of HISPEC



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

Advanced Gamma-ray Tracking Array (AGATA)

up to 5 x 2+10 x 3 = 40 segmented HP Ge-crystals

d ~ 20 cm

$\varepsilon_{Ph} \approx 17\%$

$\Delta E \approx 0.4\%$

AGATA ADVANCED GAMMA TRACKING ARRAY

Lund-York-Cologne CAlorimeter (LYCCA)

A and Z particle-ID after secondary target by means of

- *x,y tracking*
- *ΔE-E (Si-CsI)*
- *Time-of-flight (plastic)*

TDR approved 2008

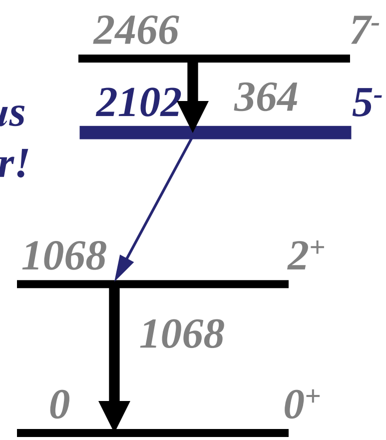
*Commissioned, upgraded and used in PreSPEC physics experiments **since 2011**!*

S429: $B(E2;0^+\rightarrow 2^+)$ transition strengths in the vicinity of ^{208}Pb

D.Rudolph, Z. Podolyak, J. Gerl et al.

206
Hg
80

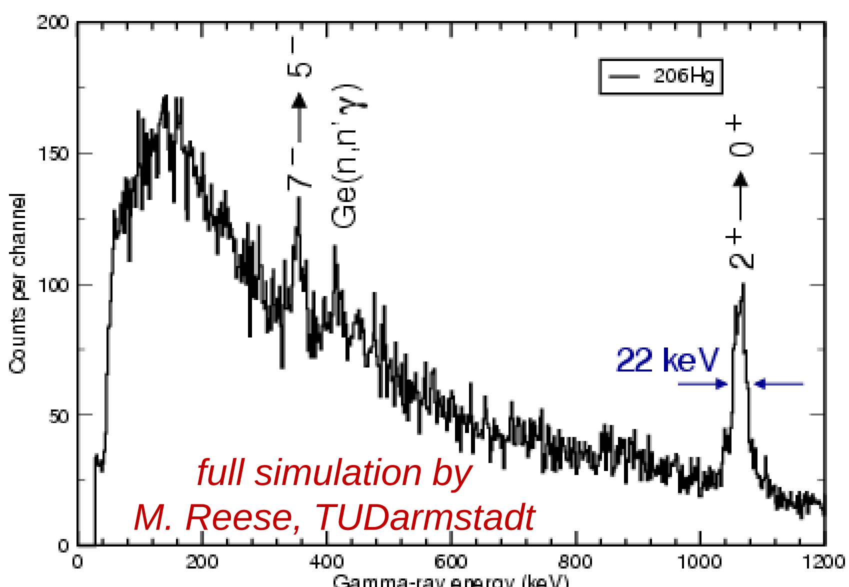
2.15 μs isomer!

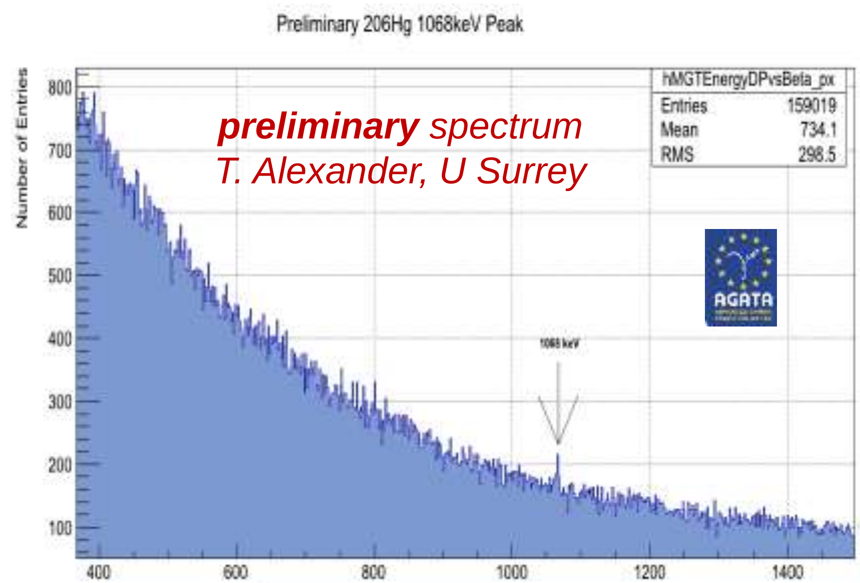


Staged programme:

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

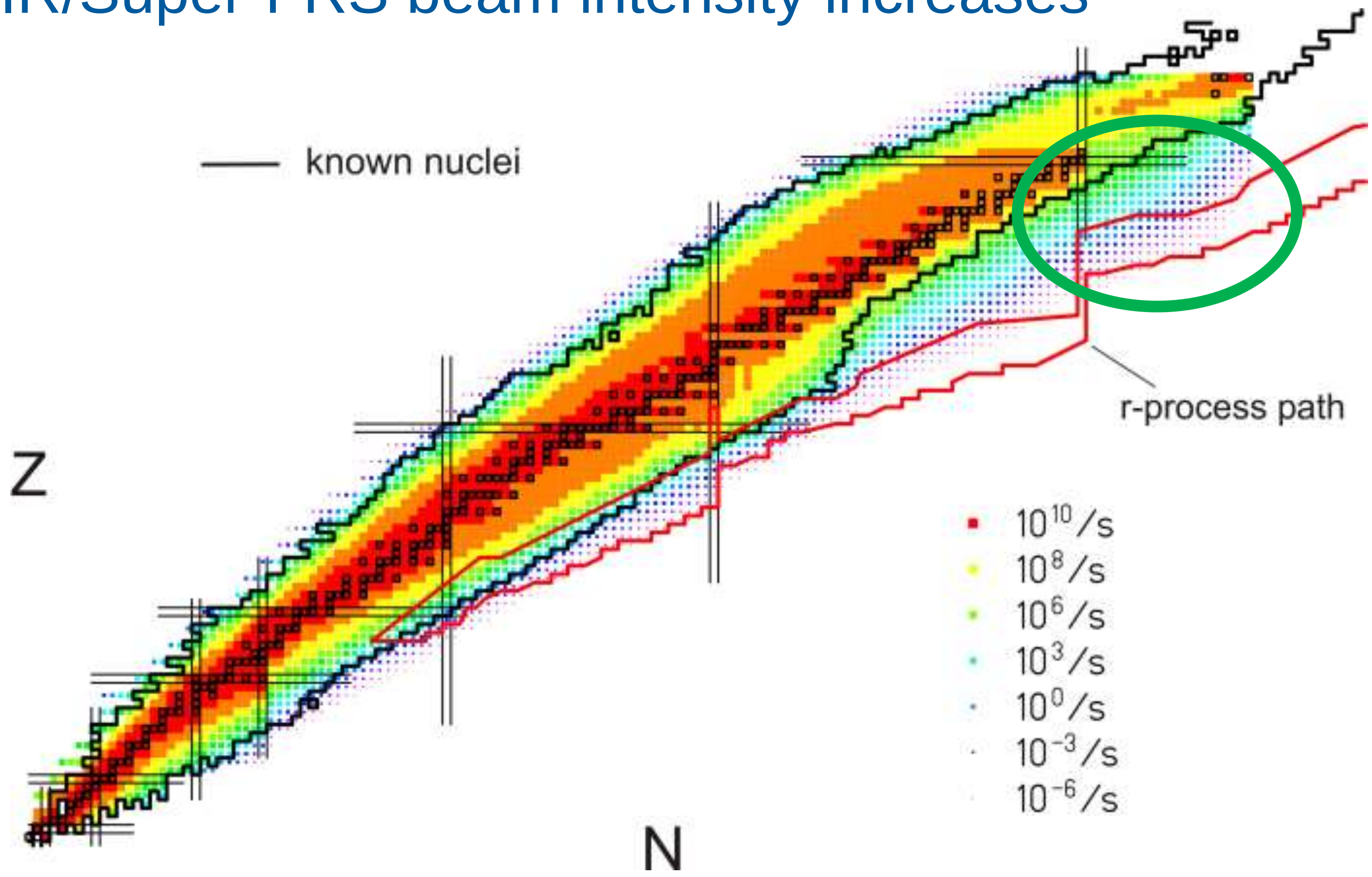
^{204}Pt, ^{208}Hg, ^{21X}Pb : **^{238}U beam HISPEC-FAIR**





Summary

- We will start by looking in the n-rich Pb region (which cannot be done at RIKEN nor FRIB). Evolutionary process as FAIR/Super-FRS beam intensity increases



The lead region is only one of many….

Home Page

Presentations
Programme (PDF)

Registration

Registered Participants

Accommodation Information

First Announcement (PDF)

Contact
Alison Bruce
Paddy Regan

University of Brighton

UNIVERSITY OF SURREY

Science & Technology Facilities Council

W3C XHTML 1.0 W3C CSS

Decay Physics Workshop
12th - 13th January 2011
University of Brighton

Talks from the Workshop

This version of the programme contains links to the presentations from the meeting, in PDF format.
There are also links to the original PowerPoint files where they exist.
These files are either in PowerPoint 97-2003 format (PPT) or Open XML format from PowerPoint 2007 or newer (PPTX).

The original programme can be downloaded here (PDF).

	Wednesday 12th January		
10:00	Alison	Bruce	Introduction, welcome and housekeeping
10:10	Jim	Al-Khalili	A model of one-proton emission from deformed nuclei (PPT)
10:25	Bertram	Blank	Decay of 73Sr to study unbound 73Rb in the framework of the rp process
10:40	Robert	Page	Proton emission from deformed rare earth nuclei (PPT)
10:55	Paul	Sapple	Proton emission from deformed rare earth nuclei: A possible AIDA physics campaign (PPT)
11:10	Andrey	Blazhev	Isomeric states in 98Cd and 98Ag (PPTX)
11:35	Dirk	Rudolph	Isomers and isospin symmetry aspects in the f7/2 shell
11:50	David	O'Donnell	High-spin states feeding seniority isomers in heaviest N=82 isotones (PPTX)
12:05	Adam	Garnsworthy	Present and Future Decay Spectroscopy at TRIUMF-ISAC
12:25	**Lunch**		
13:30	Zhong	Liu	Search for proton radioactivity in the trans-lead and sub-tin regions (PPT)
13:45	Rayner	Rodriguez-Guzman	Signatures of nuclear shape transitions with a microscopic perspective
14:00	Phil	Walker	Isomers and shape transitions in the n-rich A~190 region (PPT)
14:15	Andrea	Gottardo	New isomers in neutron-rich lead region (PPT)
			Discovery of highly excited long-lived isomers in neutron-rich hafnium and tantalum isotopes through direct mass measurements (PPT)

http://npg.dl.ac.uk/PRESPEC-11/Talks.html

Summary continued

- Our equipment……

AIDA built and commisioned at RIKEN

DEGAS builds on RISING and AGATA imaging

FATIMA_0 built and commisioned at RIKEN

BELEN built and commissioned at GSI,Jyvaskyla,RIKEN

DTAS built and commisioned at Jyvaskyla

LYCCA built and commissioned at GSI

AGATA demonstrator already tested at GSI

Summary continued

- Our equipment……

AIDA built and commisioned

DEGAS builds on RISIN

FATIMA_0 built an … N

BELEN built a … ,Jyvaskyla,RIKEN

DTAS bu … yvaskyla

LY … ned at GSI

… already tested at GSI

We are ready-already!

The latest HISPEC/DESPEC collaboration meeting

Valencia, September 2014

The latest HISPEC/DESPEC collaboration meeti

We are ready….raring to go!

Valencia, September 2014

TECHNISCHE
UNIVERSITÄT
DARMSTADT

HISPEC/DESPEC - foreseen instrumentation

HISPEC

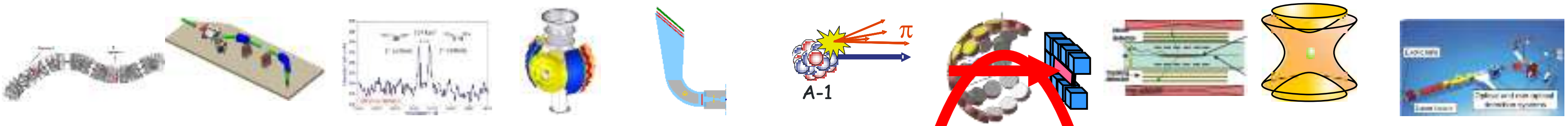
- LYCCA heavy-ion calorimeter with ToF capability
- AGATA gamma spectrometer
- HYDE light particle array
- NEDA Neutron Detector Array
- Plunger nuclear level lifetime measurements

DESPEC

- AIDA active implantation device
- DEGAS Ge Array gamma spectrometer
- FATIMA Fast TIMing Array
- BELEN neutron detection array
- DTAS Decay Total Absorption Spectrometer
- MONSTER neutron ToF array

Complementarity of NUSTAR experiments

Super-FRS *R3B* *ILIMA* *EXL* *ELISE* *AIC* *HISPEC/ DESPEC* *exo+ pbar* *MATS* *LASPEC*



	Super-FRS	R3B	ILIMA	EXL	ELISE	AIC	HISPEC/ DESPEC	exo+pbar	MATS	LASPEC
Masses			bare ions, mapping study				Q-values, isomers		dressed ions, highest precision	
Half-lives	ps…ns-range		bare ions, s…h				dressed ions, µs…s			
Matter radii	interaction x-sect	matter radii		matter densitiy distributions		matter radii from absorption		nuclear periphery		
Charge radii					charge density distribution					mean square radii
Single-particle structure	high resolution, angular momentum	complete kinematics, neutron detection		low momentum transfers			high-resolution spectroscopy			

HISPEC/DESPEC - foreseen instrumentation

HISPEC

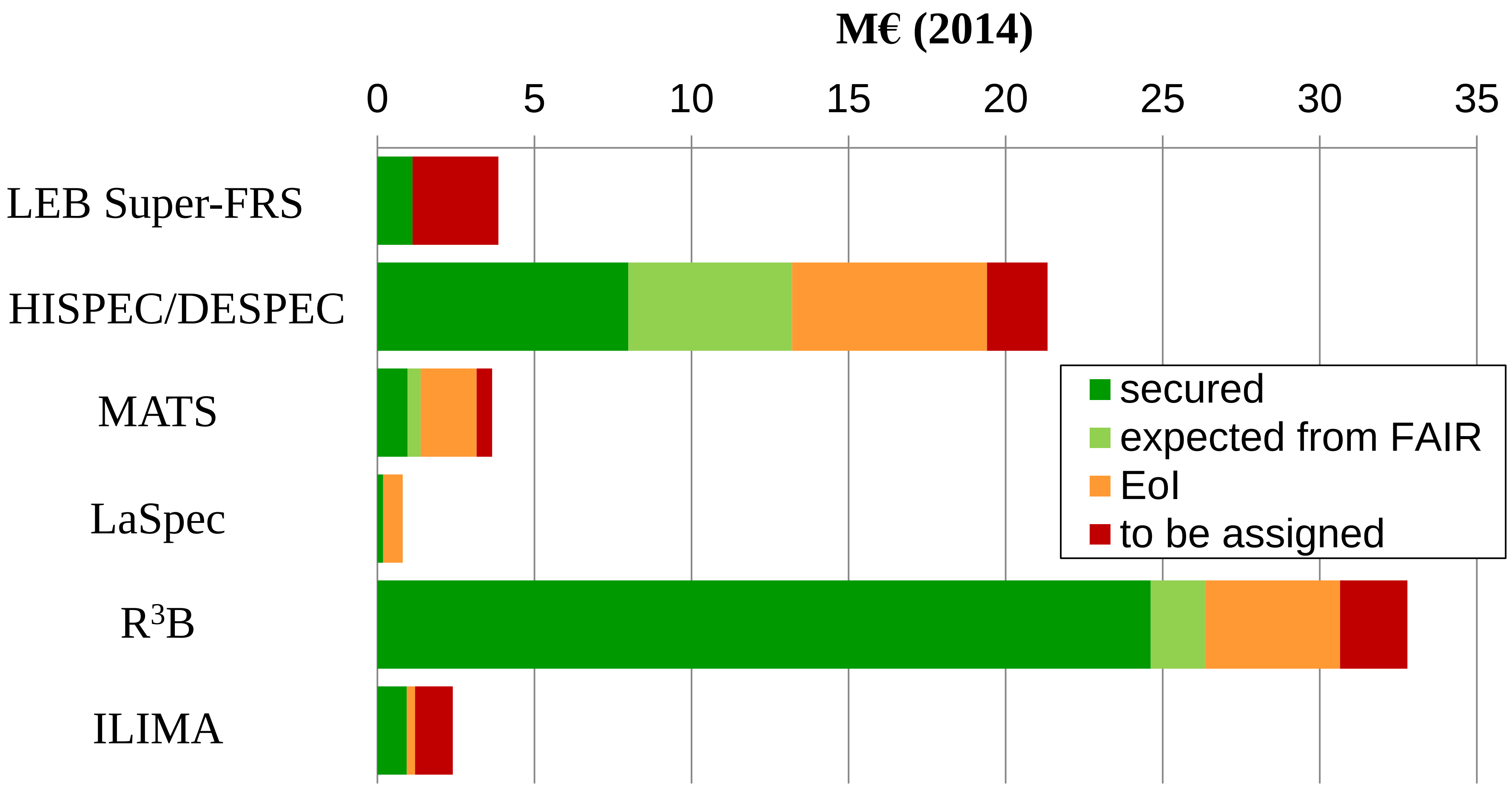
- LYCCA heavy-ion calorimeter with ToF capability
- AGATA gamma spectrometer
- HYDE light particle array
- NEDA Neutron Detector Array
- Plunger nuclear level lifetime measurements

DESPEC

- AIDA active implantation device
- DEGAS Ge Array gamma spectrometer
- FATIMA Fast TIMing Array
- BELEN neutron detection array
- DTAS Decay Total Absorption Spectrometer
- MONSTER neutron ToF array

Fast-timing array

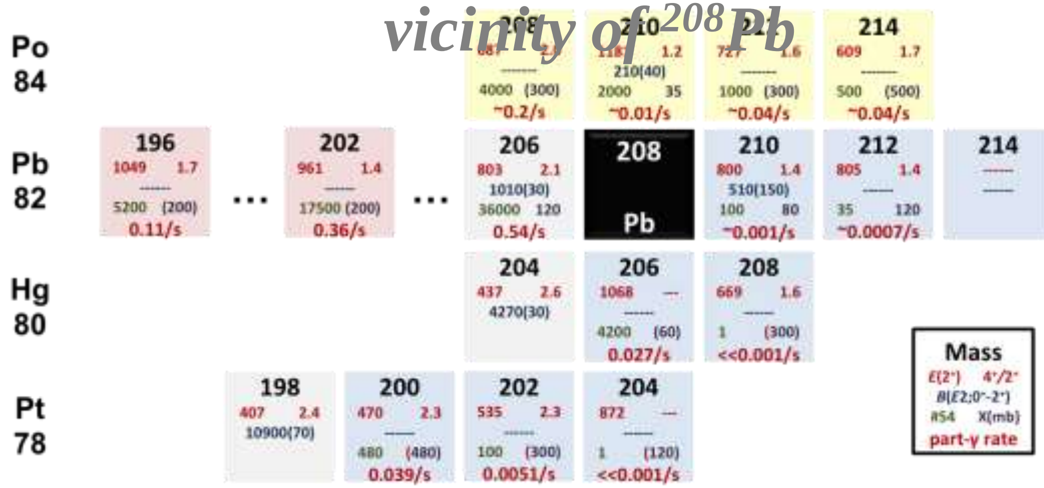
Status of NUSTAR experiment funding



S429
Quadrantic Evolution of Collectivity Around ^{208}Pb

$B(E2;0^+\rightarrow2^+)$ transition strengths in the vicinity of ^{208}Pb

...udolph, Z. Podolyak, J. Gerl ...



Lack of experimental information!

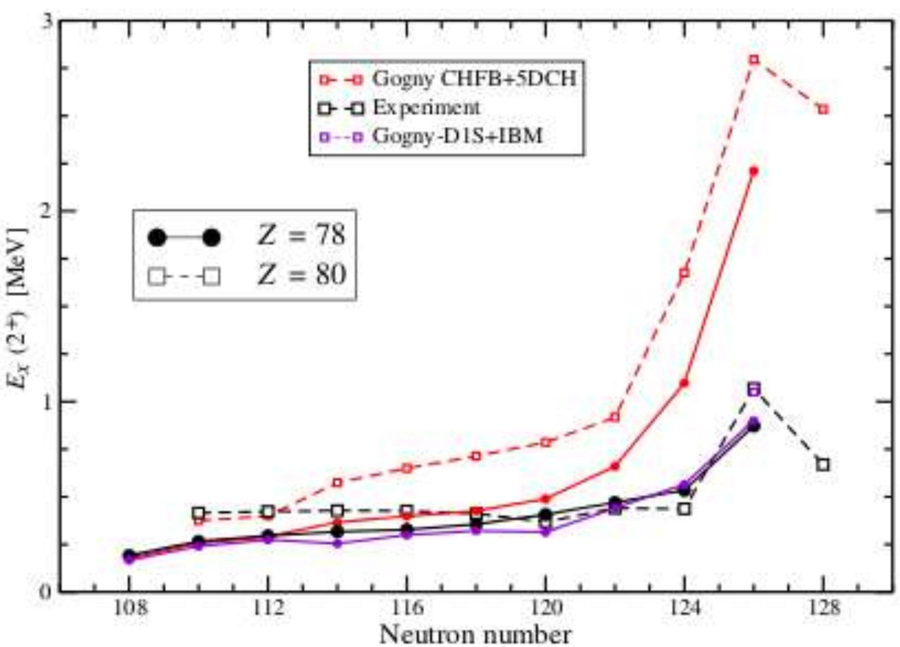
Staged programme:

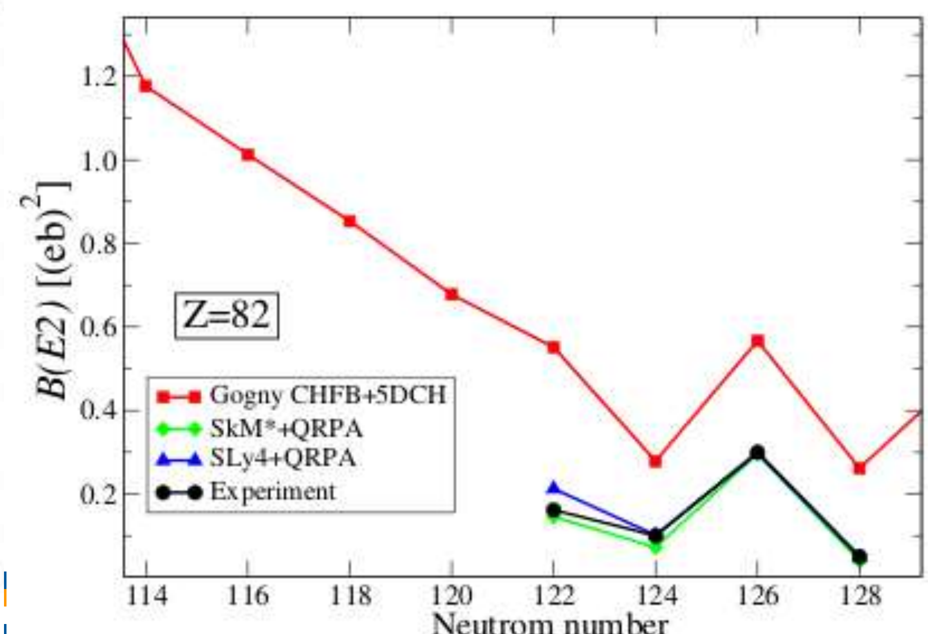
Z=82 and N=126 isomers: RISING Stopped

$^{198-206}$Pb, ^{206}Hg and ^{200,202}Pt: ^{208}Pb beam GSI

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

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





NUSTAR@FAIR

World-wide unique synchrotron-based RIB production for:

- High-energy Radioactive Beams (≤1.5 GeV/u)
  - Efficient production, separation, transmission and detection aided by Lorentz boost
  - Access to the heaviest nuclei without charge-state ambiguities
  - Large range of attainable reaction mechanisms
- Storage rings
  - Mass measurements and beam preparation/manipulation
  - Isomeric beams
  - Novel experimental tools (beyond MSV/with CRYRING, ESR and HESR)

Combined with:

- Wide range of state-of-the-art instrumentation – *not monolithic!*
  - Strong evolution from existing programs
  - Dynamic progress in terms of TDRs/construction/operation
  - Some NUSTAR FAIR experiments could already start in 2017/2018

Day-1 experiments (at FAIR-start)

Physics goals with exotic nuclei

- Limits of stability
- Evolution of shell structure far off stability
- Nuclear structure and new effects
- New modes of radioactivity, new modes of excitations

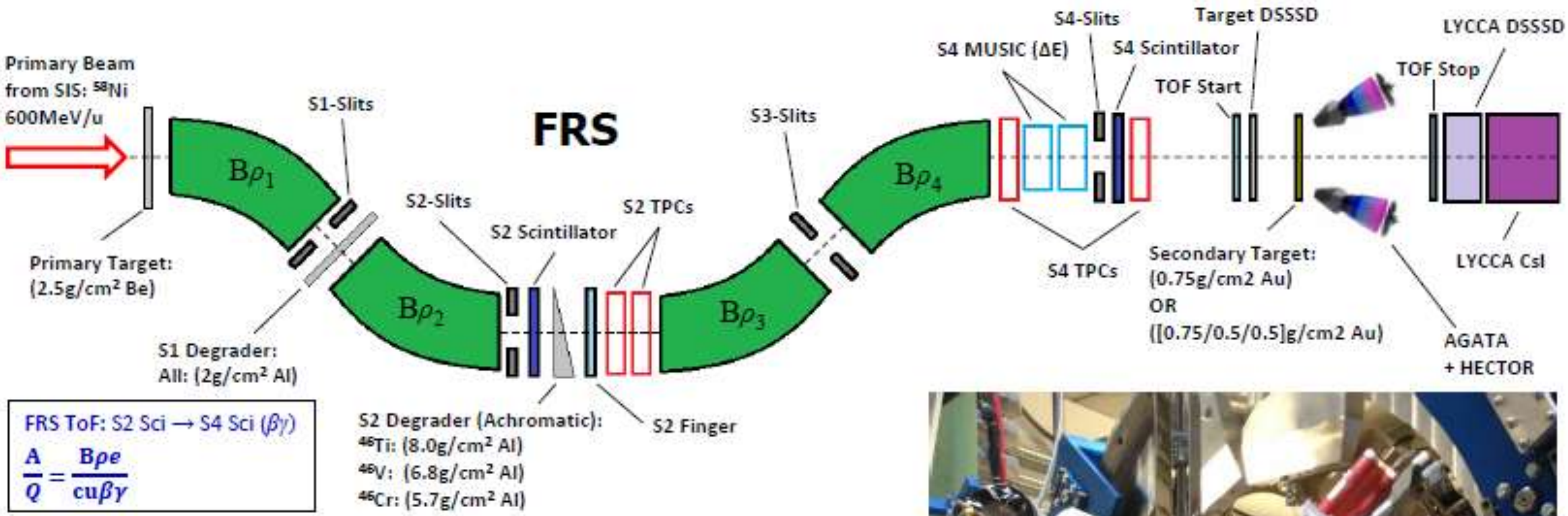
Approach

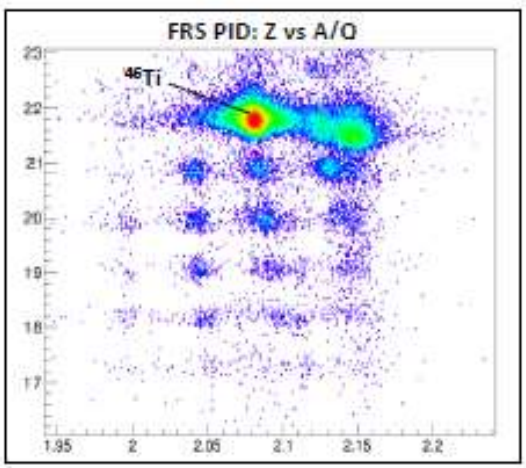
- Intense primary beams, fragmentation and fission of very heavy projectiles, reactions with relativistic radioactive beams
- NUSTAR sub-systems placed at Super-FRS focal planes, (incl. HEB, LEB, RB)

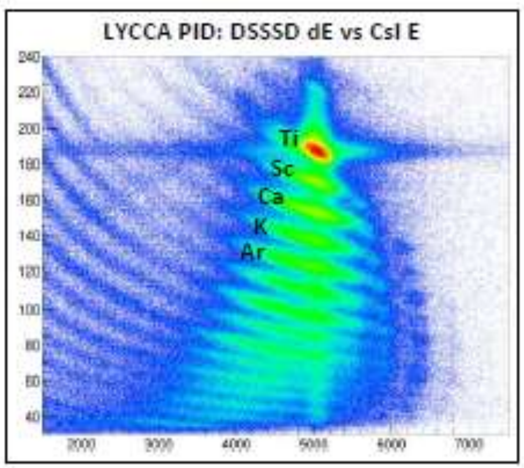
NUSTAR "day-1 experiment"

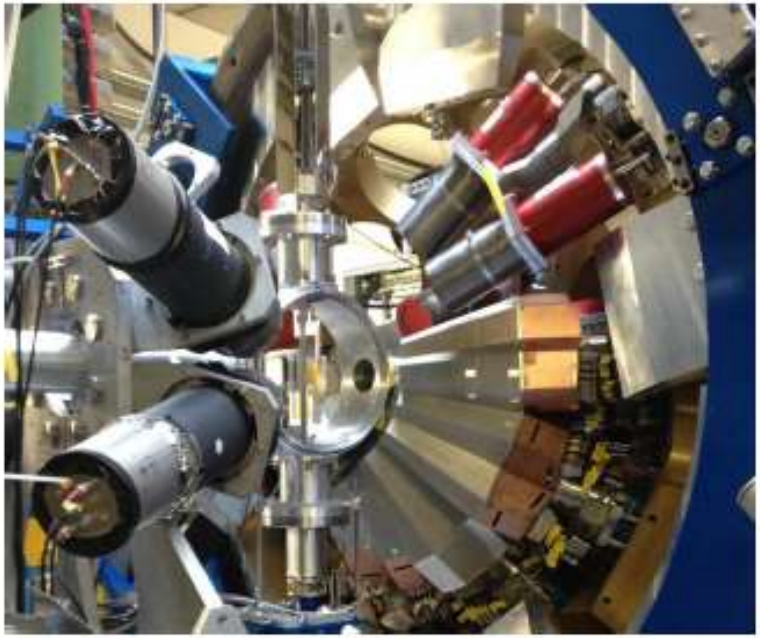
- New isotope search, neutron drip-line up to Ni
- Exotic atoms, exotic hypernuclei
- Gross properties (mass, $T_{1/2}$,...), spectroscopy of very heavy very n-rich isotopes from Sn to U, high-energy reactions (matter and charge radii) and quasi-free scattering (spectroscopic factors)

(From: S.Milne, University of York)









NUSTAR experiment-funding overview (MSV)

Experiment	Cost 2014	Secured* 2014	EoI 2014	To be assigned 2014
	[k€]	[k€]	[k€]	[k€]
LEB Super-FRS	3853	1118	0	2734
HISPEC/DESPEC	21337	13204	6204	1929
MATS	3654	1381	1780	493
LASPEC	809	181	627	0
R3B	32791	26351	4298	2142
ILIMA	2403	935	268	1200
Total NUSTAR MSV	**64846**	**43170**	**13177**	**8498**

(*partially expected from FAIR budget)

Status: June 4, 2014

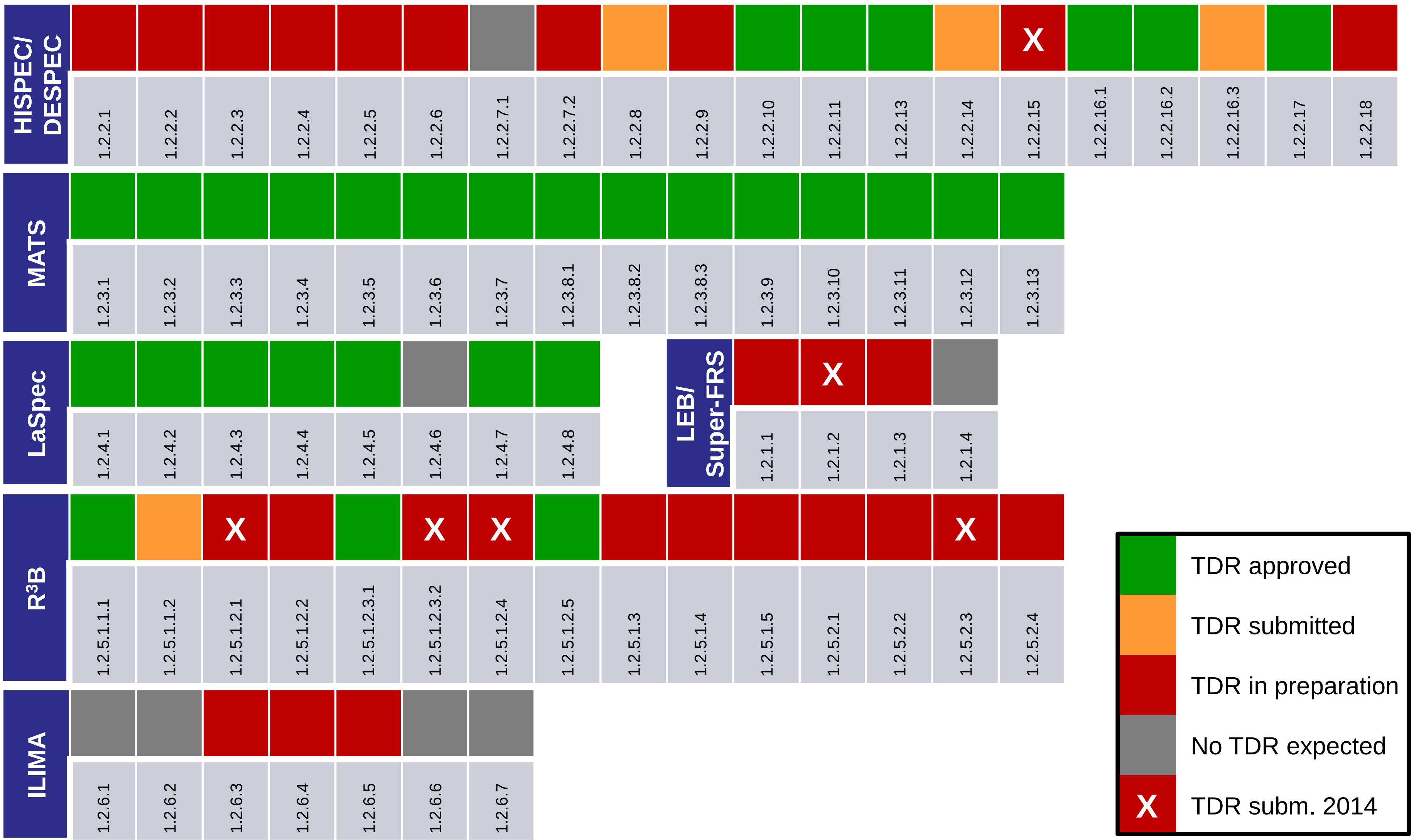
Status Technical Design Reports (35 TDRs)

- *Approved TDRs (10):*
  - *HISPEC/DESPEC (6) (LYCCA, Plunger, AIDA, BELEN, MONSTER,DTAS)*
  - *MATS + LaSpec (1) (all subsystems – except LD-RIS: no action)*
  - *R^3B (3) (Multiplet, NeuLAND, CALIFA-barrel)*

- *Submitted (4):*
  - *HISPEC/DESPEC (AGATA, DEGAS, NEDA)*
  - *R^3B (GLAD)*

TDRs expected (21) (submission profile – October 2014)				
2014	2015	2016	2017	2018
6	12	3	0	0

NUSTAR work packages (62 with TDR)



LASPEC

For the case of lead, the investigated isotope chain ($^{182\text{-}214}Pb$) could be extended into the neutron-rich region up to ^{220}Pb (production rates of ~1500/s, hence still 15 ions/sec at the LaSpec station at 1% efficiency of the catcher and cooler). In the lead region mostly neutron-deficient isotopes were studied so far, most recently using in-source resonance ionization spectroscopy at ISOLDEand it was in this mid-shell region of the nuclear chart where shape coexistence was first discovered. Extending these investigations further to neutron rich isotopes will be possible at FAIR. It is expected that measurements in the chains of Tl, Hg, Au, Pt and Ir can be extended typically 7 isotopes further from stability. In the case of gold the figure rises even to 10 new isotopes.

R3B fission barriers (Day 0)

The future FAIR facility is the ideal place for such studies, as its high beam energies of 1 GeV/nucleon allows to work with fully stripped heavy beams. Currently, similar experiments are difficult to perform at any other RIB facility, as such heavy beams can not be produced with sufficient intensity and purity (of charge states). Thus, already for day-0 experiments, new and exciting physics can be extracted. A possible first experiment is e.g. ^{215}Bi(p,2p)^{214}Pb. This would give first insight into the evolution of fission barriers "east" of ^{208}Pb, and will be a critical benchmark for modern mean field theory and the shell corrections, involved in such calculations.

R3B spectroscopy of 2+ states (Day 0)

The energies of the first excited 2^+ states in even-even nuclei are known to be a very sensitive indicator of changes in the structure of nuclei. At the same time, 2^+ energies can be measured rather easily once sufficient beam intensities of a few ions/s are available using inelastic excitation on light targets or nucleon removal reactions such as knockout or (p,pN).

Due to the high beam energies required to identify the nuclei before and after the target, first experiments will focus on semi-magic nuclei, where rather large 2^+ energies are expected, that can be well separated from possible backgrounds. The heaviest Pb isotope with known 2^+_1 energy is ^{214}Pb. For the Day-0 program in cave C at GSI the intensities are sufficient to study the proton removal reaction, either (p,2p) or knockout on Be or C targets, from ^{217}Bi and ^{219}Bi.

For Day-1 experiments these studies can be continued with ^{221}Bi and ^{223}Bi beams and for Day-2 with ^{225}Bi and ^{227}Bi beams. For the Day-0, Day-1, Day-2 program, nuclei with similar beam intensity can be studied along the N=126 isotonic chain. For the Sn region similar experiments can be carried out, if not already performed elsewhere.

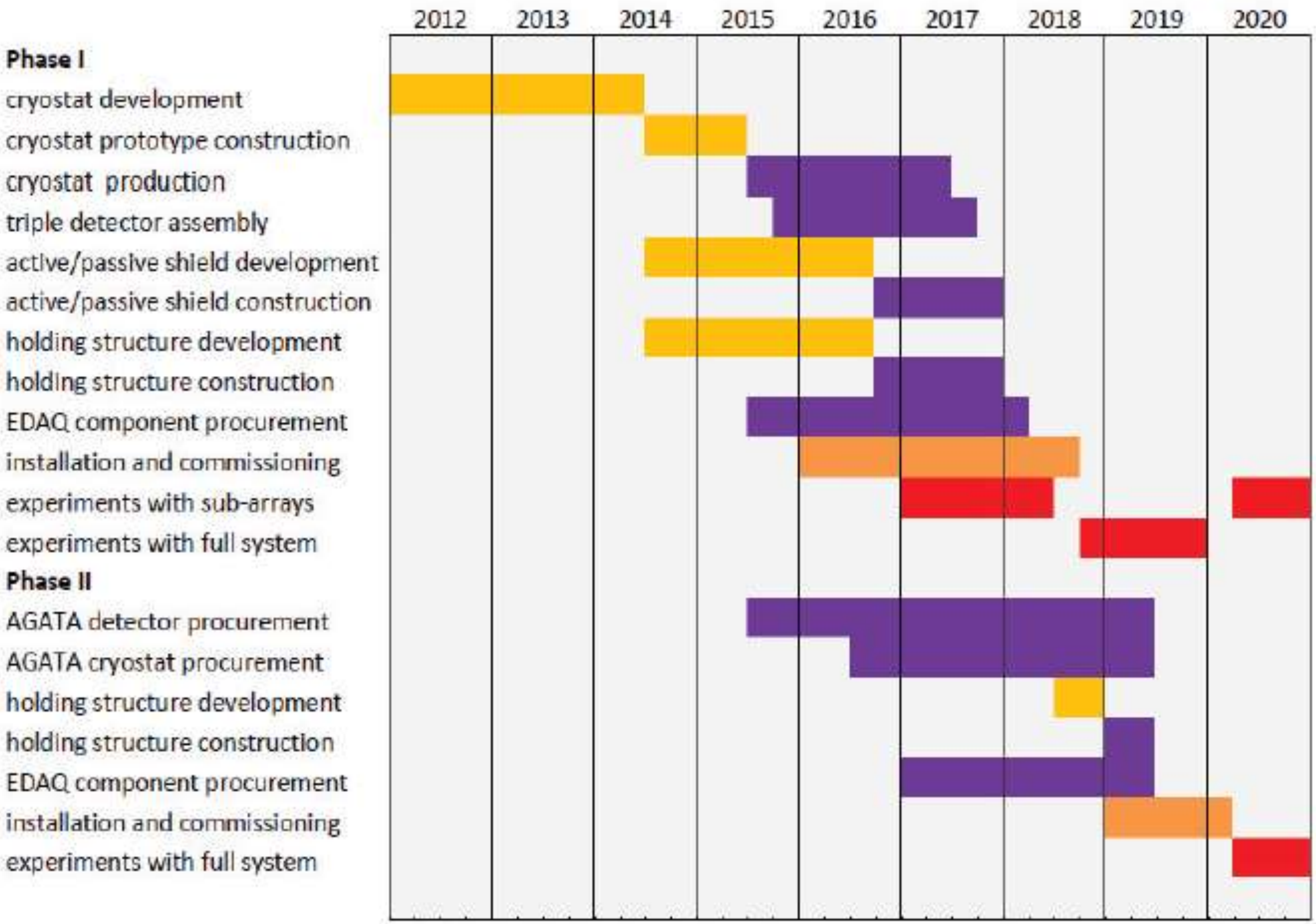
R3B (Day 1)

III-1) Dipole response of heavy neutron-rich beams
Day-1: $^{208-218}$Pb
Day-2: $^{220-224}$Pb (when design intensity is reached: 100/spill ^{222}Pb, 5/spill ^{224}Pb)

The dipole response of neutron-proton asymmetric nuclei is of great scientific interest for several reasons: 1) The dipole response of neutron-rich nuclei becomes softer and a partial decoupling of strength related to Giant Dipole vibrations and a soft mode related to less bound valence neutrons appears. The nature and characteristics of this soft dipole mode is debated and experimental data is scarce. A systematic appearance of this often called Pygmy resonance, i.e., its strength and resonance energy for different mass regions and as a function of neutron excess is highly mandatory. 2) The redistribution of strength, i.e., the softness of the dipole response depends on the density dependence of the symmetry energy. A robust observable quantifying this is the dipole polarizability, which will be extracted from the same measurement. Since the effect is large for heavy neutron-rich nuclei, the neutron-rich lead isotopes will provide key data to constrain the density dependence of the symmetry energy, in a density region complementary

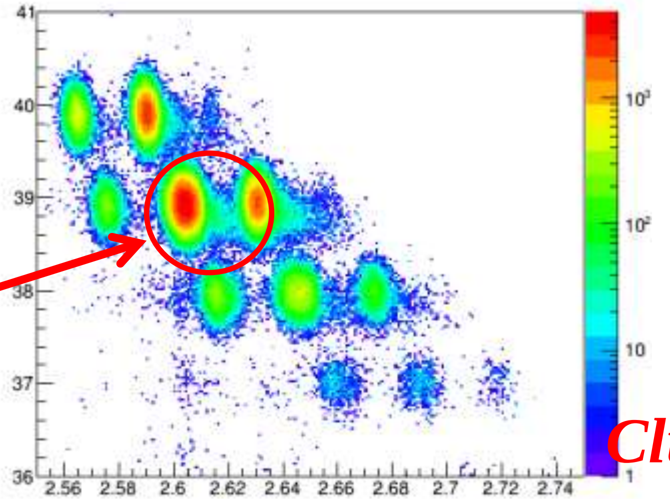
In a first step, we propose to measure the neutron-rich Pb isotopes up to mass 218, which should be possible already shortly after start-up of the facility with assumed intensities of about two orders of magnitude below design value. Later, when the design intensities will be reached, the dipole strength function, dipole polarizability and properties of giant and Pygmy resonances can be determined up to mass 224.

Time line for phase I & II

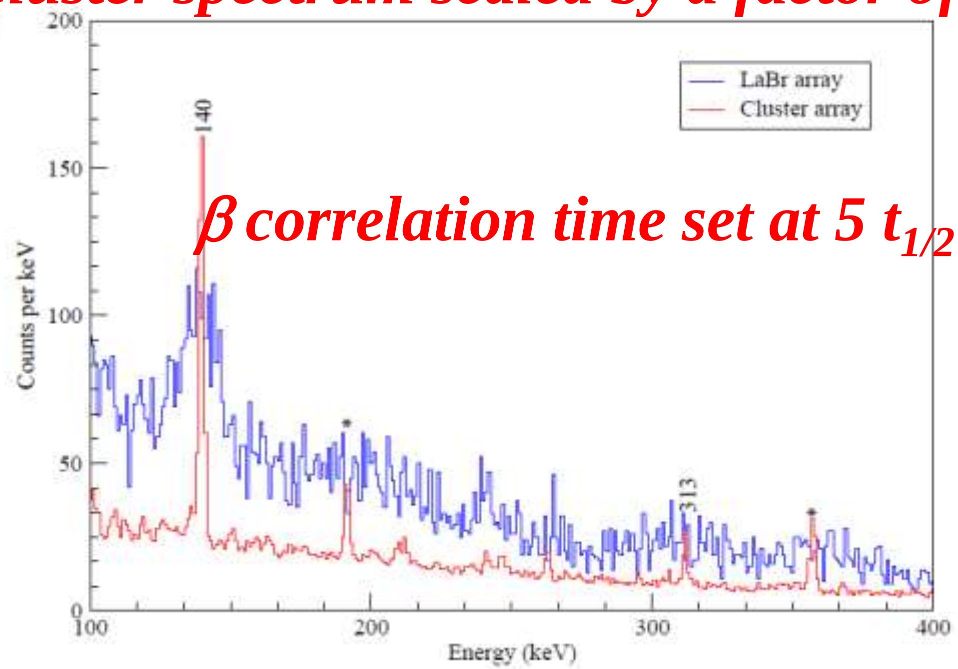


PID plot for ^{102}Y setting,
5×10^5 ^{102}Y implants in 2.5 hours

^{102}Y

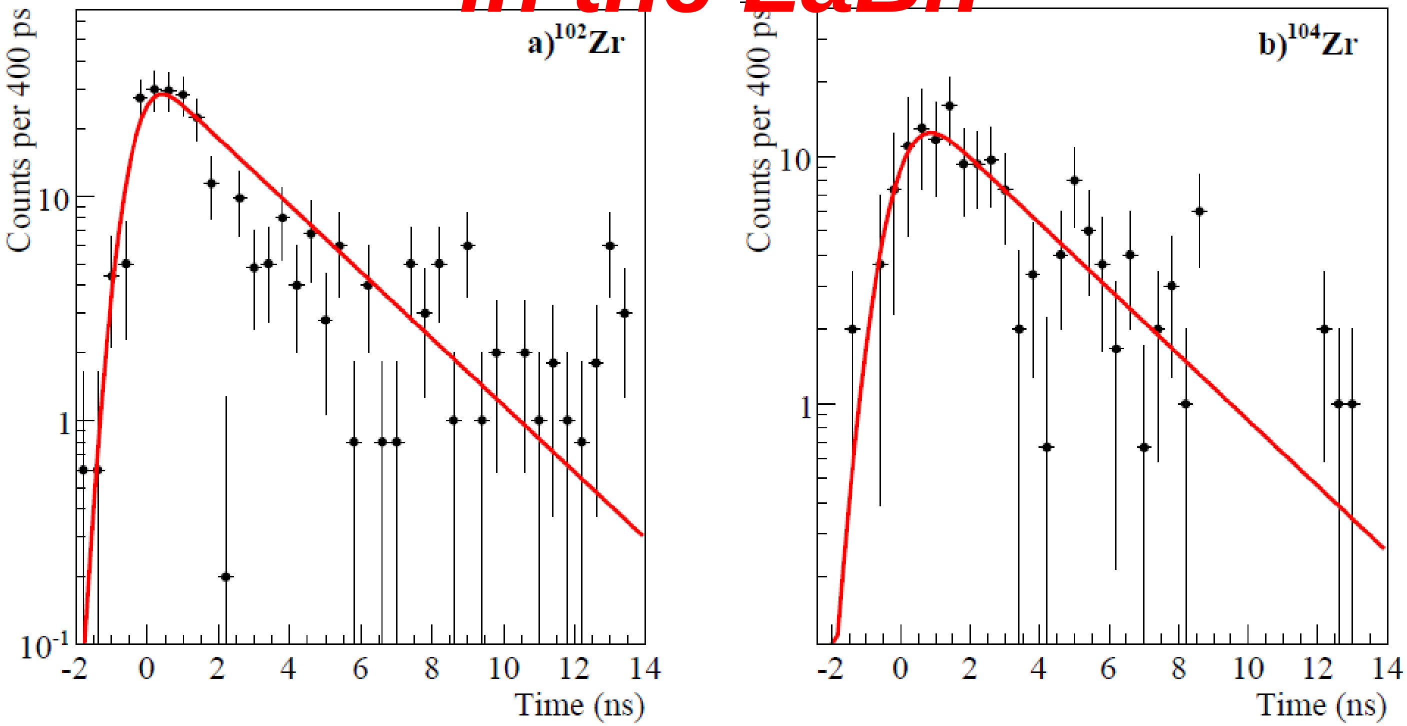


Cluster spectrum scaled by a factor of 0.0



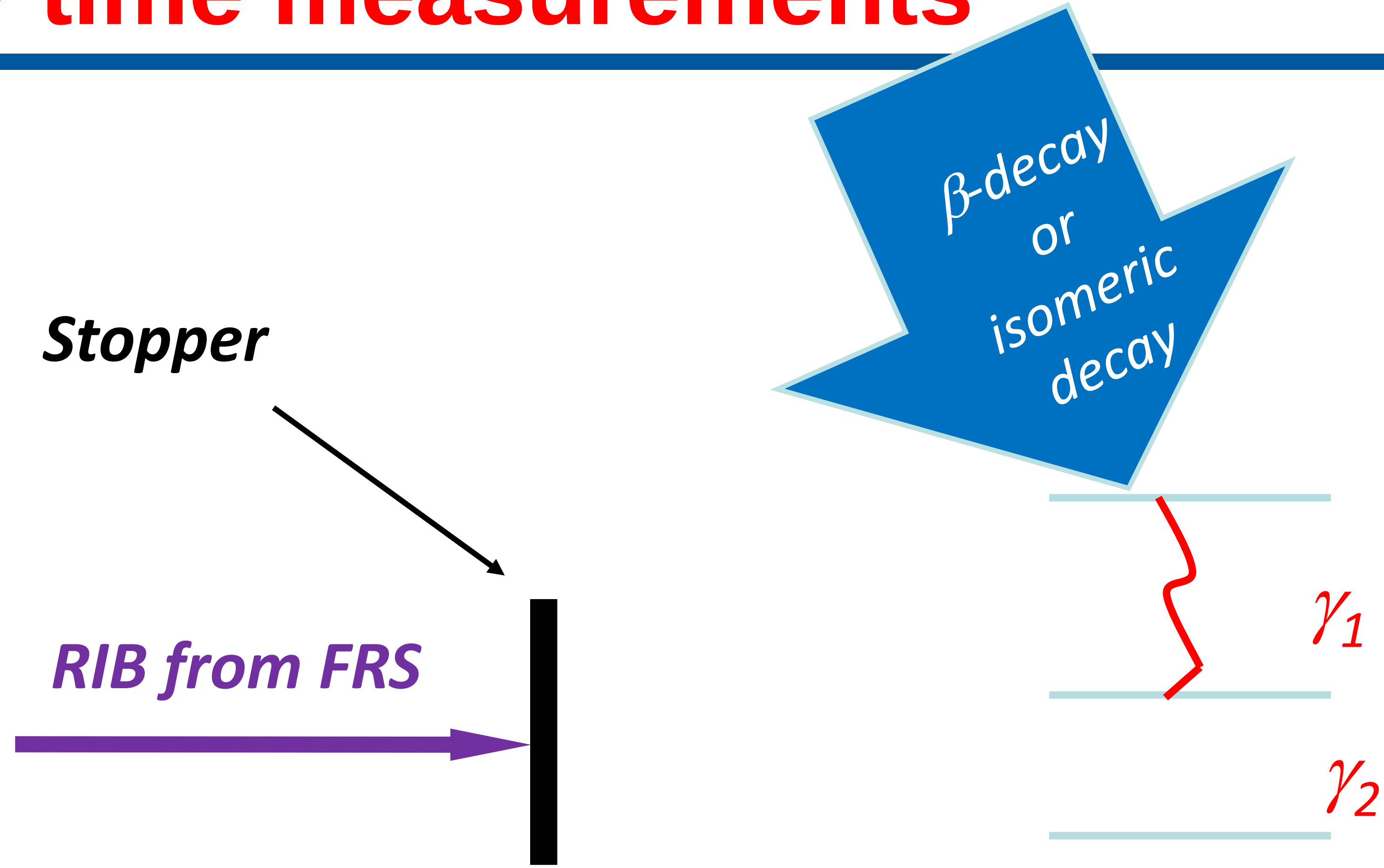
β correlation time set at 5 $t_{1/2}$

Time between the beta (measured in the plastic) and the gamma-ray in the LaBr.



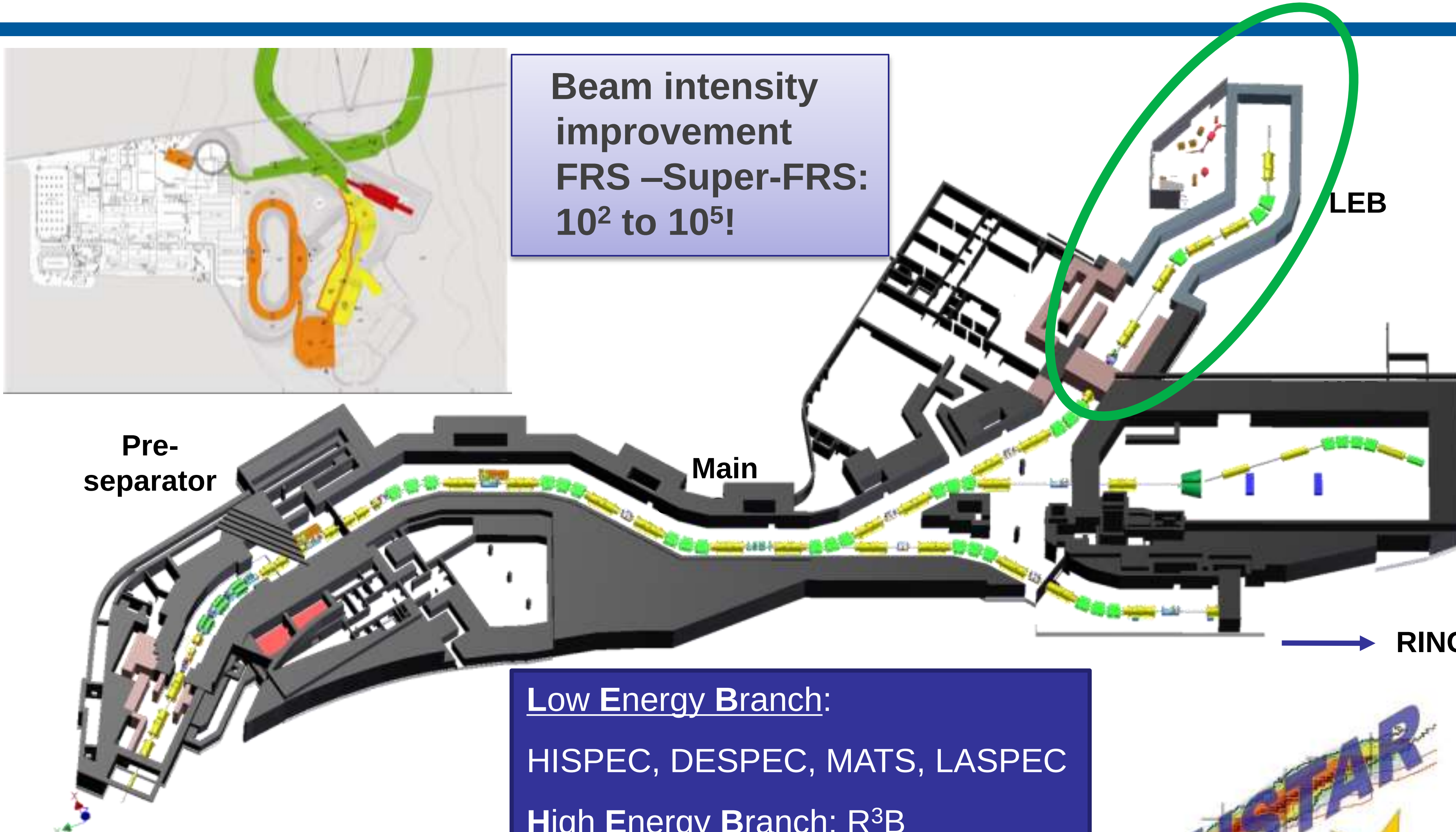
Measured $t_{1/2}$ = 2.0 (2) and 2.0 (3) ns, in agreement with literature values

γ-ray time measurements



NUSTAR - The Facility

Beam intensity improvement FRS –Super-FRS: 10^2 to 10^5!

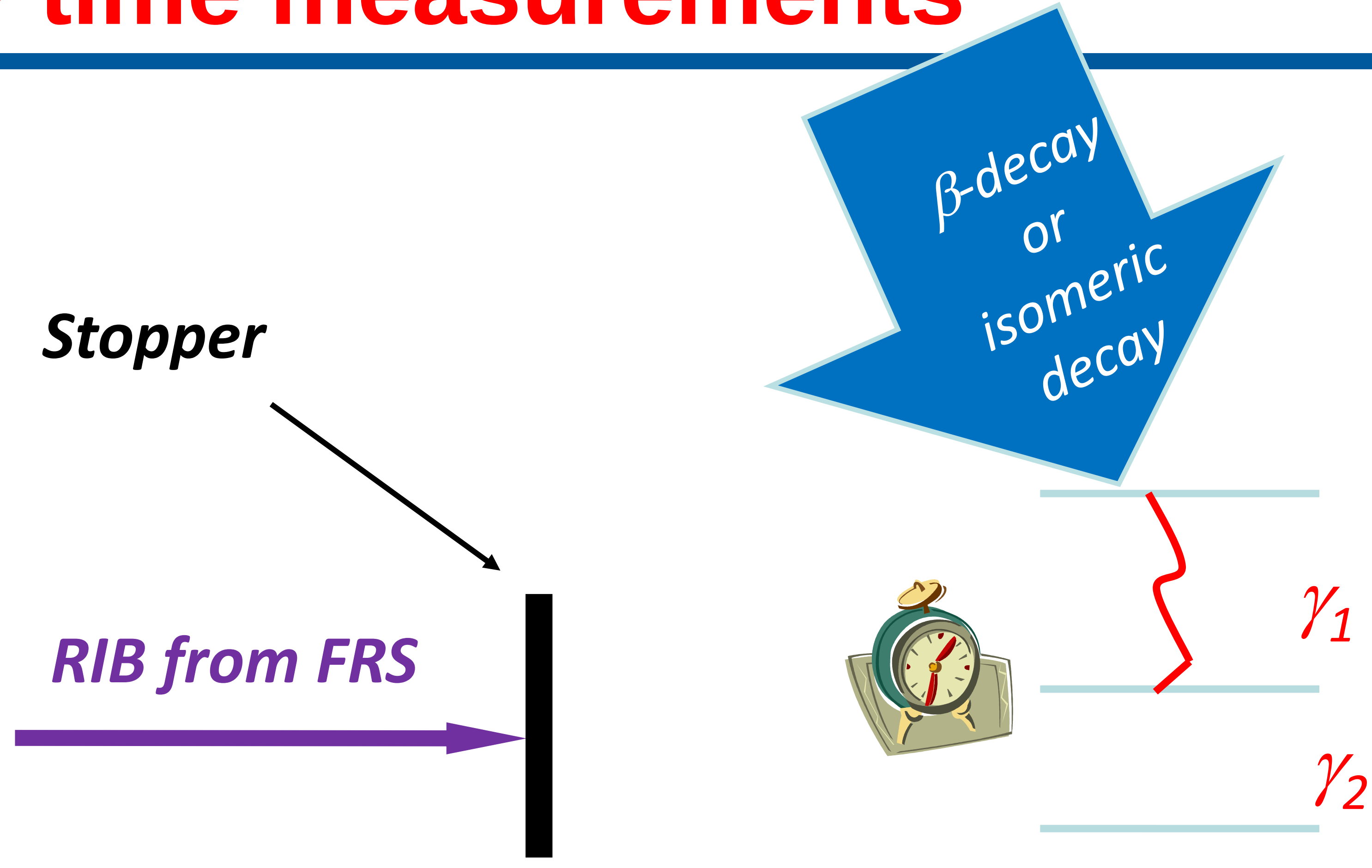


<u>L</u>ow <u>E</u>nergy <u>B</u>ranch: HISPEC, DESPEC, MATS, LASPEC

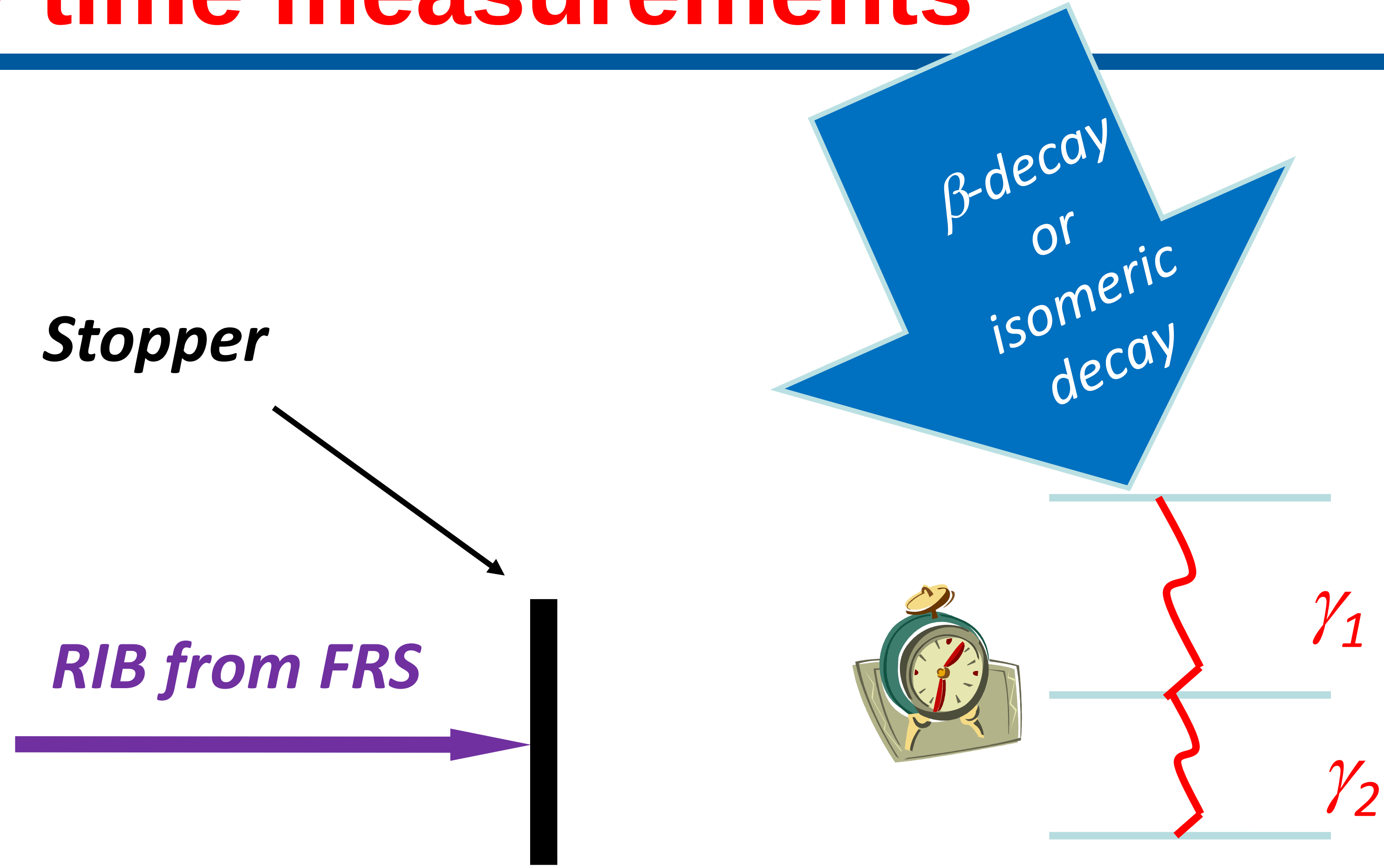
<u>H</u>igh <u>E</u>nergy <u>B</u>ranch: R^{3}B

<u>Ring</u> Branch: EXL, ILIMA, ELISE

γ-ray time measurements

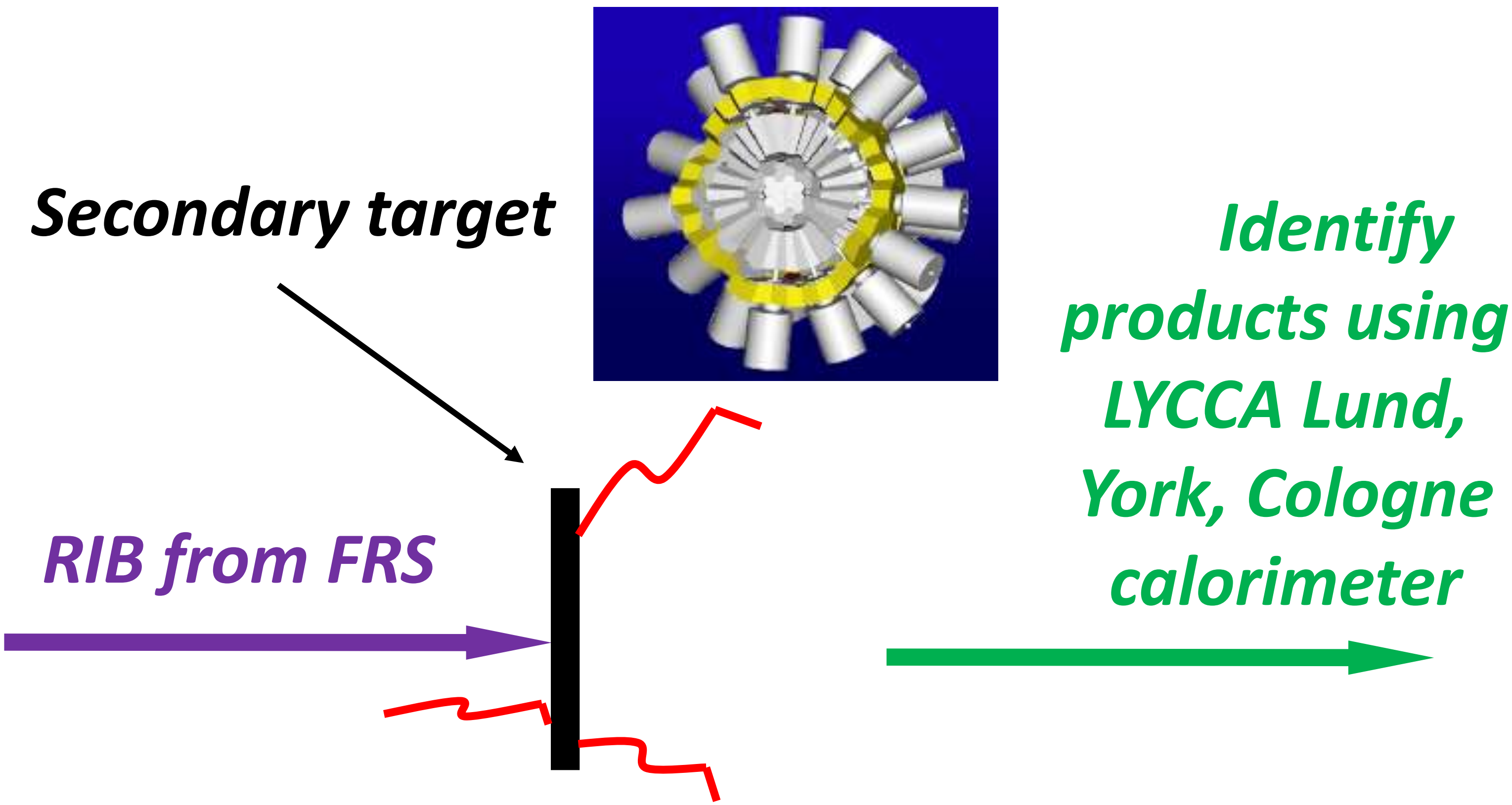


γ-ray time measurements

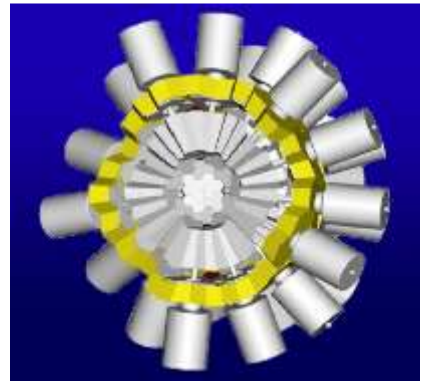


Precision tests of wavefunctions by measuring level lifetimes.

HISPEC: High-resolution in-flight spectroscopy

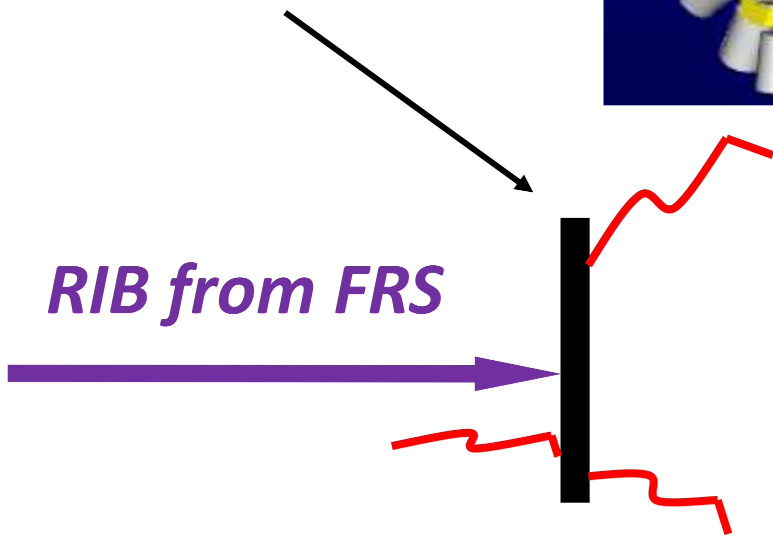


HISPEC: High-resolution in-flight spectroscopy



Secondary target

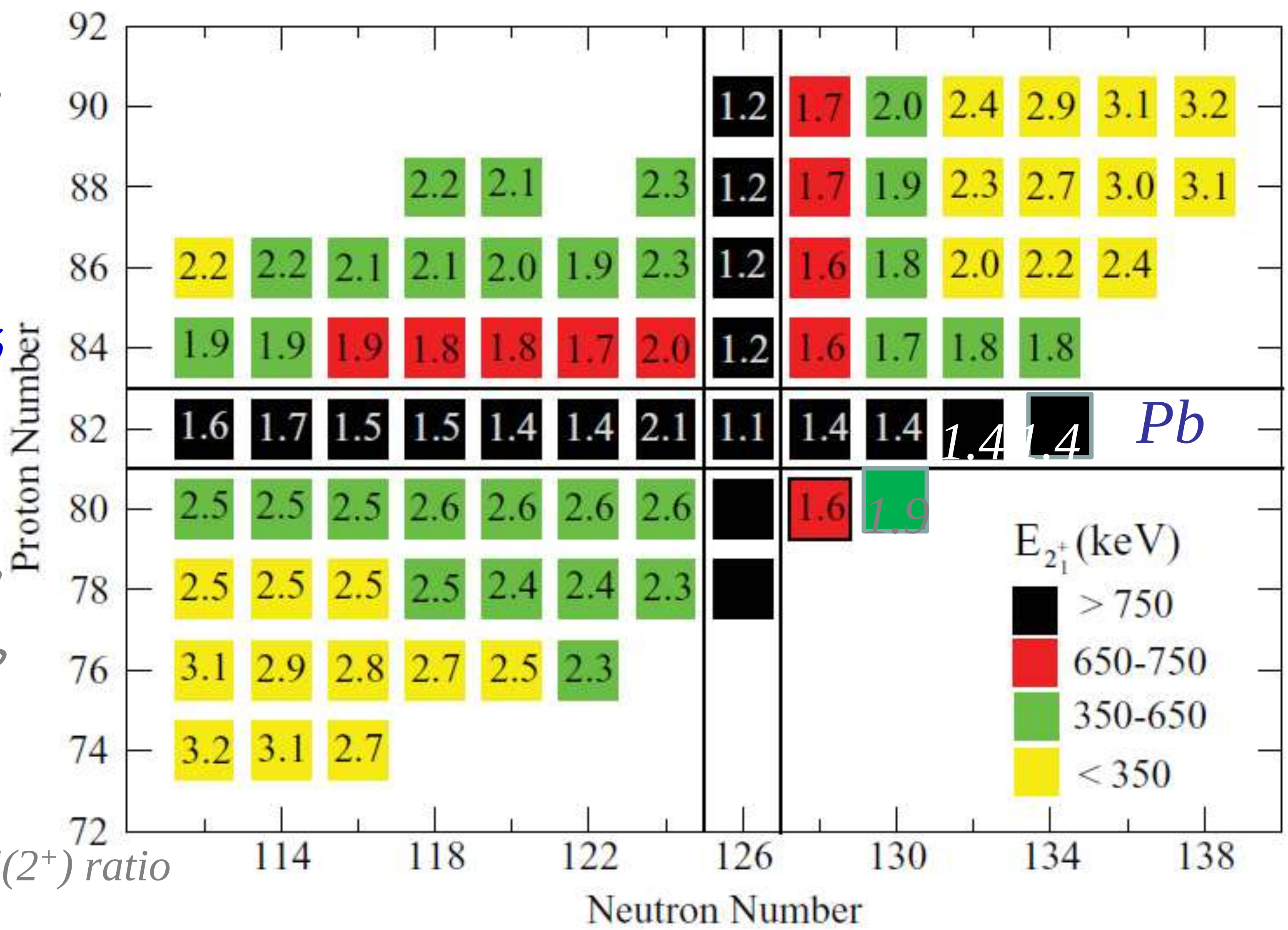
RIB from FRS



Identify products using LYCCA Lund, York, Cologne calorimeter

Core excited states in ^{208}Pb

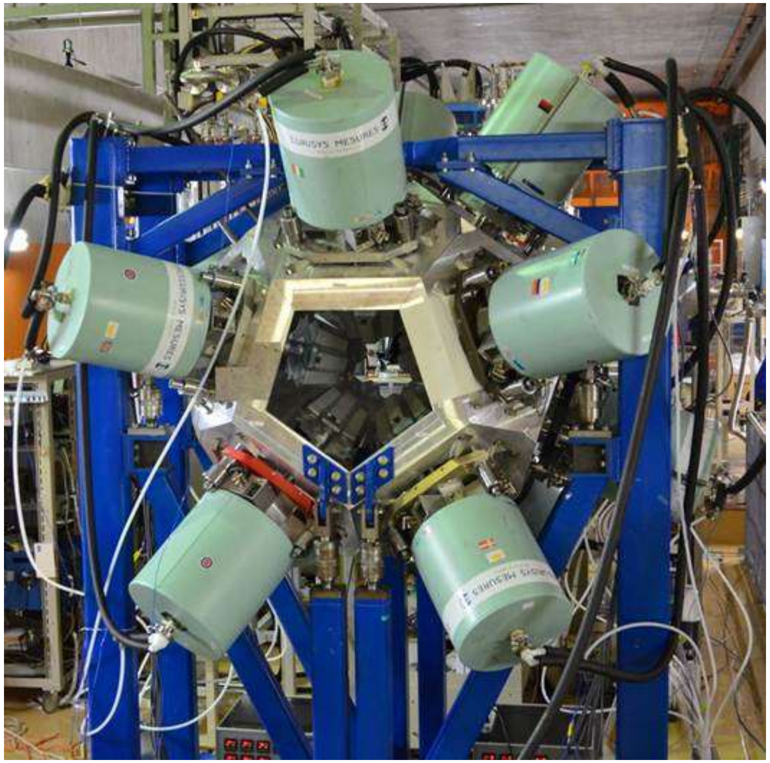
π	ν
f7/2	j15/2
i13/2	i11/2
h9/2	g9/2
Z=82	N=126
s1/2	p1/2
d3/2	f5/2
h11/2	p3/2
d5/2	i13/2



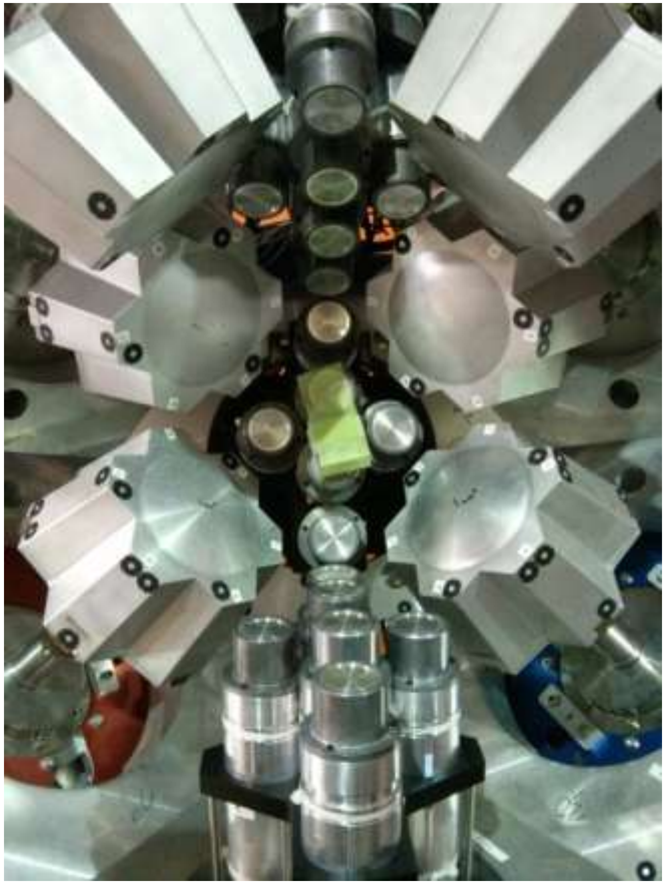
In box: $E(4^+)/E(2^+)$ ratio

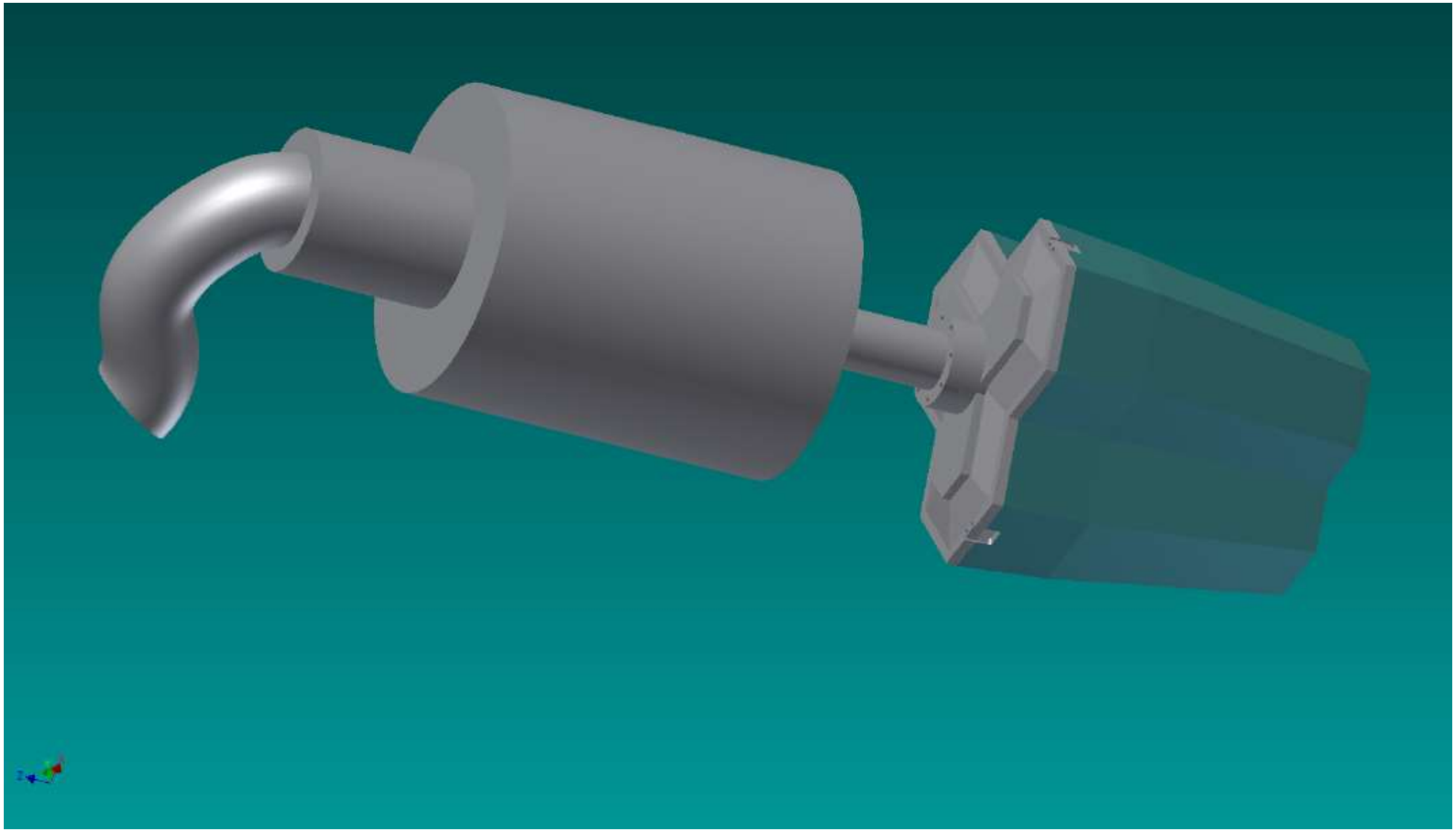
FAST TIMING measurements @ Riken

12 RISING clusters

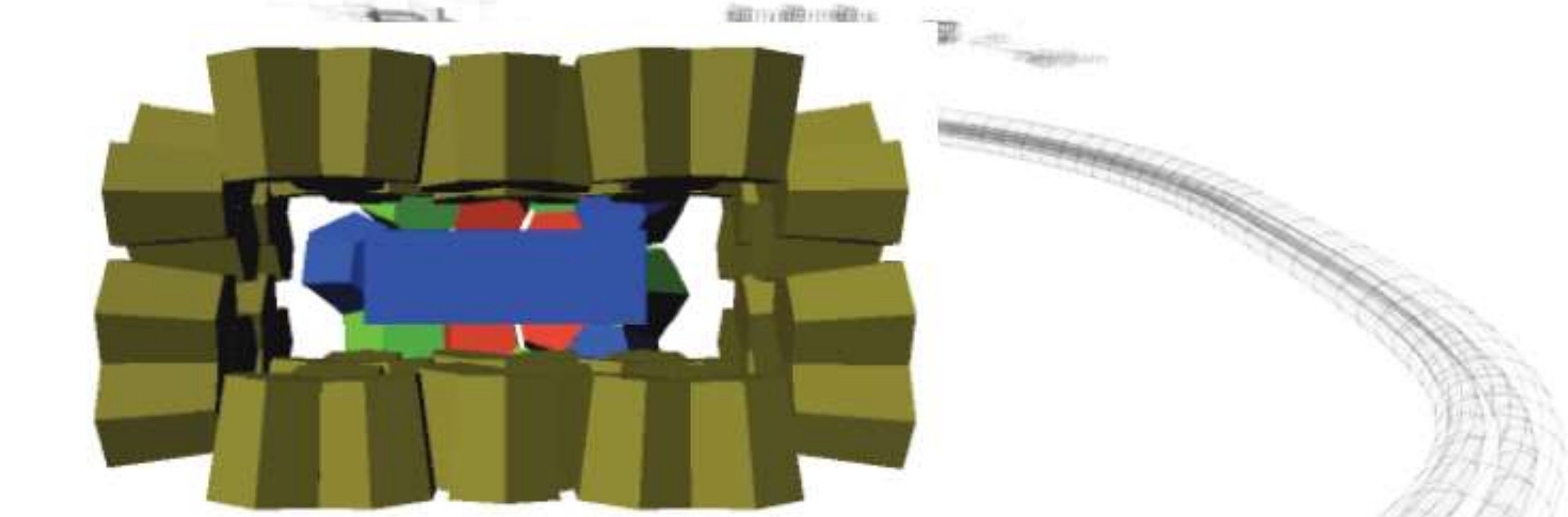


18 $LaBr_3$(Ce) detectors





Summary of Simulation of DEGAS



GEOMETRY	ε_p (%)	$\varepsilon_{p\gamma\gamma}$ (%)	$\varepsilon_{p\text{-eff}}$ (%)
RISING (benchmark)	16.2	2.2	13.9
26 Triple EB clusters (box)	21.2	4.1	≈15
20 Triple EB (box) + 5 ATC	21.4	4.2	≈19

Ref: M Doncel