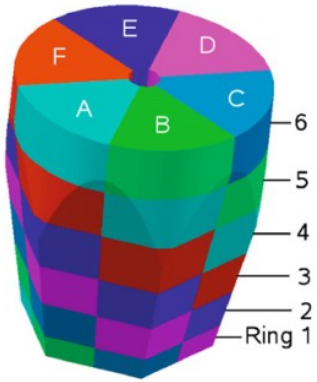
AGATA: Precision Spectroscopy of Exotic Nuclei

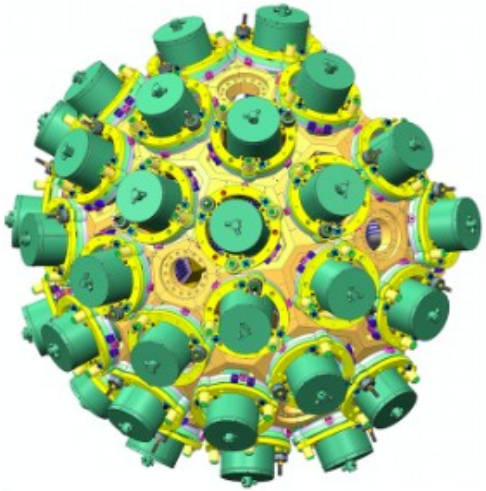
GANIL spiral2
laboratoire commun CEA/DRF CNRS/IN2P3

INFN Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Legnaro

SPES Project

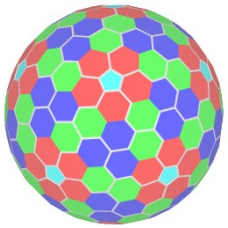
FAIR
Facility for Antiproton and Ion Research in Europe GmbH





AGATA

Daresbury Laboratory, University of Liverpool,
University of West of Scotland
University of York



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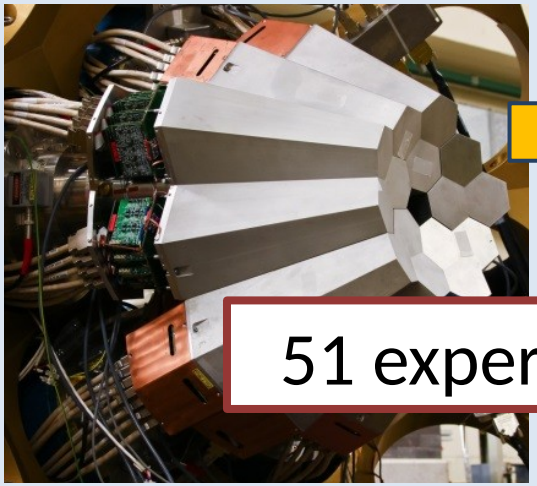
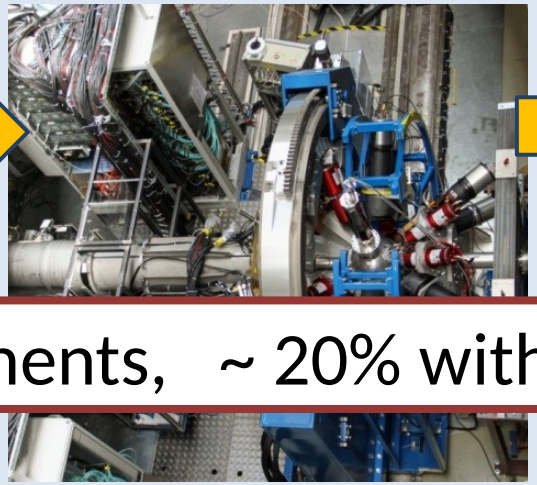
Progress of the AGATA array

2010-2012
Legnaro, Italy
Intense stable beams
15 detectors



AGATA Demonstrator + PRISMA

2012-2014
GSI, Germany
Fast fragmentation beams
25 detectors



AGATA at GSI

2014- present
GANIL, France
ISOL and stable beams
approaching 1π (45)

AGATA at GANIL

51 experiments, ~ 20% with a UK lead

> AGATA 1π already available
> Current MoU (end 2020) for 1/3 of full array – almost there.

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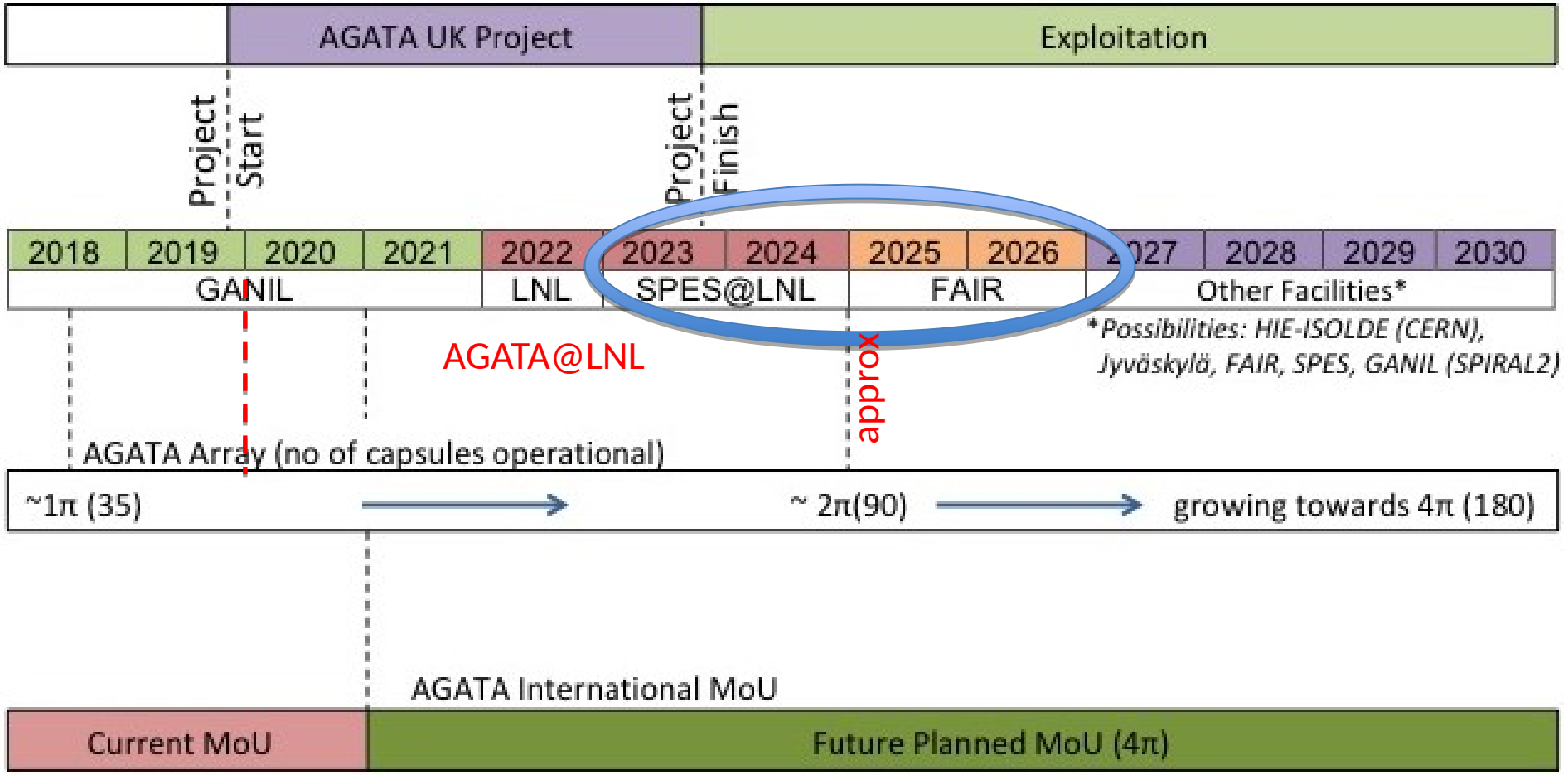
AGATA deployment



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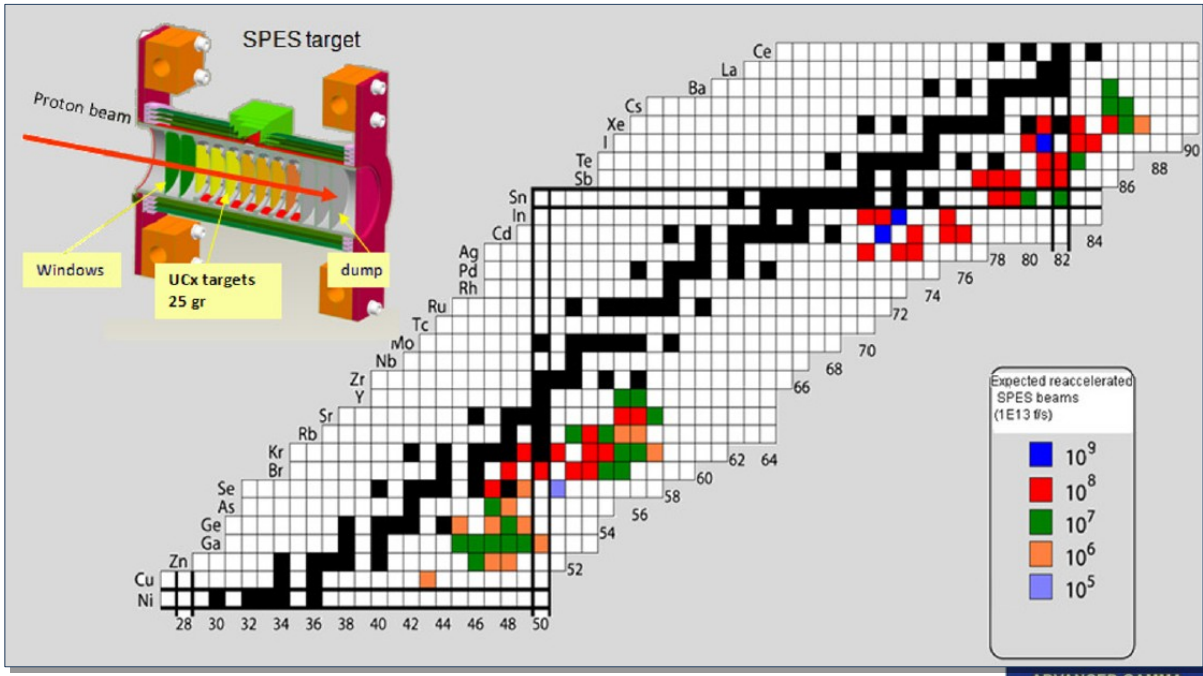
AGATA@SPES: 2023-2025

Selective Production of Exotic Species

SPES exotic beams for science

- SPES is a new ISOL radioactive-beam facility under development at LNL, Italy
- Protons from new cyclotron incident on uranium carbide targets
- Reacceleration up to **10 MeV/A** using ALPI superconducting linac
- Development in phases: 2021 to 2023

- **Unique** aspect of SPES: high intensity primary proton beam
- Protons will induce 10^{13} fissions/s
- For example: ^{94}Rb - 10^{9} pps; ^{132}Sn - 10^{8} pps; ^{142}Xe - 10^{6} pps
- **High-intensity radioactive beams**

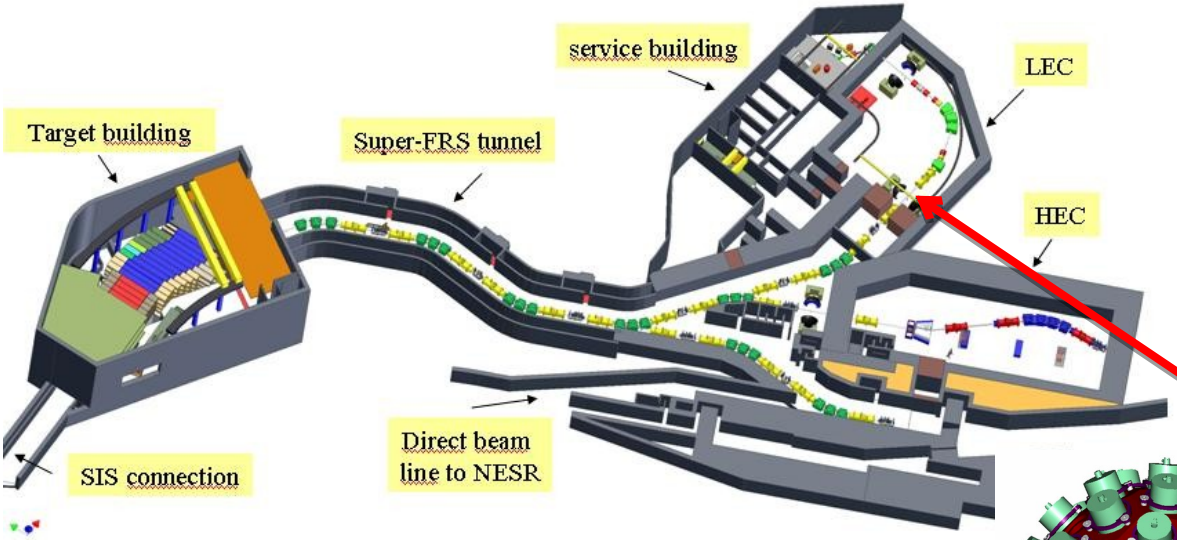


Techniques (e.g.):

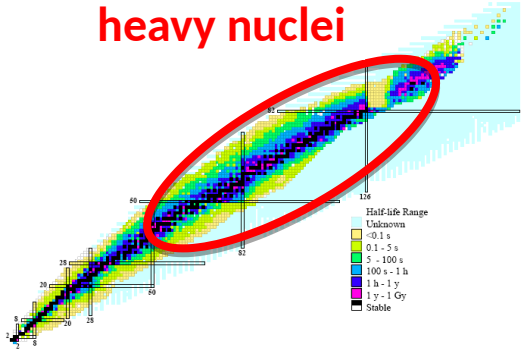
- Nucleon transfer
- Deep-inelastic reactions
- Low-energy Coulomb excitation
- Fusion evaporation

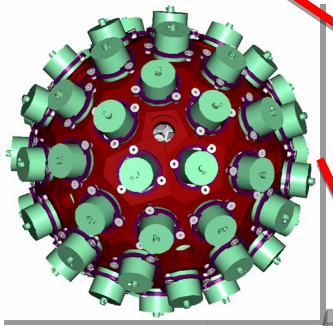
AGATA@FAIR: > 2025

High-resolution γ-ray **spec**troscopy (**HISPEC**) following reactions induced by radioactive ion beams at relativistic energies

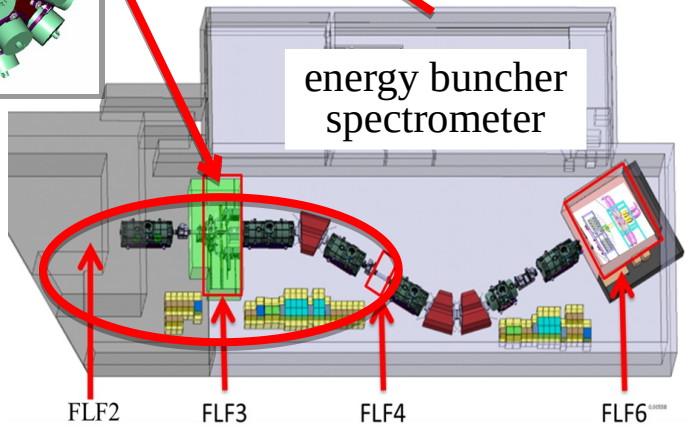


Unique place to study heavy nuclei





- **High-intensity exotic beams: p-rich and n-rich**
- High-energy **100-300 MeV/A** (**β~0.5**)
- Isomeric beams & high-Z beams



Techniques (e.g.):

- **Fragmentation**
- **Knockout**
- **High-energy Coulomb excitation**

AGATA Project Objectives

..are to contribute at the highest level to the current and planned phases of AGATA through

(a) Contribution to AGATA equipment, including detectors (MoU);
(b) pushing the development of AGATA towards the new science opportunities by exploiting the **UK's leading technical and scientific capabilities.**

Specific aims:

- **(WP1)** Contribute detectors, including working with ORTEC to develop second supplier;
- **(WP2)**: Lead the complex mechanical design and construction required for AGATA at new facilities;
- **(WP3):** Contribute at a high level to the development of AGATA electronics, and to lead initial developments for the future phase of the AGATA electronics system;
- **(WP4):** Lead crucial developments on pulse-shape analysis and tracking - the techniques that underpin the entire gamma-ray tracking concept;
- **(WP5):** Lead performance and experiment-design simulations to enable the maximum scientific output.

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AGATA Project Grant

Nov 2017: SOI Submitted
May 2018: Programme Evaluation submission **May 2018**, more info **August 2017**
Nov 2018: Invitation to make PPRP bid
Feb 2019: Submitted Proposal
April 2019: PPRP Meeting
May 2019: Visiting Panel
June 2019: Science Board – good (high level) feedback, but no decision
Dec 2019: Science Board – "tensioning" with ACPA

Final Bid £4.9M (of which £2.0M capital)

Key points:

- Bid meets our commitment under the current MoU (to contribute to 60-detector array)
- Case aimed at SPES and FAIR with a case for a 90-detector array (its growing)

Institutions (involved in Project): York (Bentley, Paschalis, Petri), **Daresbury** (Simpson, Labiche, Lazarus…), **Liverpool** (Harkness-Brennan, Boston A, Nolan, Boston H,…), **UWS** (Smith)

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AGATA Interim Funding

- Delay to funding decision due to short delay to ACPA
- Good feedback from Science Board
- UK Commitments to AGATA project – especially for Legnaro phase (2022)

STFC asked us to bid for "interim funding" – Ocober 2019 - April 2020

First 6 months of project work (173k)

- Mechanics for Legnaro
- PSA developments for Legnaro Phase
- Simulation package for AGATA-PRISMA

Capital contribution (£540k)

- Prototype AGATA capsule ORTEC (new Supplier) – 50% from Liverpool
- Two AGATA capsules from Mirion
- **Enough for 1 full triple cluster – delivery mid 2020**

£713k awarded, October 2019-March 2020.

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Questions

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TRACKING ARRAY

UK: a driving force for AGATA

Strategic Leadership *past* and **present**

- **AGATA Steering Committee**: **Chair** *Nolan 2009-2011* and **Vice-chair** **Simpson** 2018-2020 **Chair** **Simpson** 2021-2022), Members **Bentley** and **Simpson**
- **AGATA Collaboration Council: Chair** and spokesperson: *Simpson* 2010-2014
- **AGATA Management Board**: Project Manager and Chair: *Simpson* 2002-2010. Member 2011-present **A.Boston**

Scientific Leadership *past* and **present**

- **Spokesperson** for Legnaro Campaign: *S.Freeman (Manchester)*
- **Co-Spokesperson** for PRESPEC/GSI Campaign (using AGATA) *Bentley*
- **Spokesperson** for current GANIL Campaign: **Zs.Podolyak (Surrey)**
- **Chair** International Steering Committee for PRESPEC@GSI/FAIR *P.Regan (Surrey)*

Technical Leadership…

- **See over…**

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AGATA tasks and working groups

Project Manager, Resource Manager, Technical Coordinator

Working Groups Leaders, ASC Spokesperson ACC Spokesperson,
Local Campaign Managers, LNL, GSI and GANIL

AGATA Working Groups	AGATA TASKS				
AMB Chairman Project Manager	Detector Module	Detector & Cryostat	Detector Acceptance and testing	R & D on gamma Detectors & Applications	
	Front-end and Back-end Electronics	Pre-Amplifier and Digitizer	Global Trigger and Synchronization	Pre-processing	Slow Control & Front-End Monitoring
	Data Processing	Software: Data Flow, Services, GRID backup	Comp. Det. Elec. and DAQ Integration	Hardware: Local Infrastructure and Network	Data Analysis & TRACKING	Data distribution and re-processing
	PSA & Characterization	PSA Algorithm Development	Detector Characterisation PSA Data Base		
Resource Manager	Infrastructure. Comp. Det.	Detector array Infrastructure	Complementary Detectors	Mechanical Infrastructure	Comp. Det Mechanical Integration
	Performance and Simulation	AGATA Performance	AGATA Experimental Commissioning	AGATA Physics & exp. Simulation	
	Technical Coordinator	Compatibility EMC, Interfacing	Specification Control	Quality Control	Documentation & Security Issues

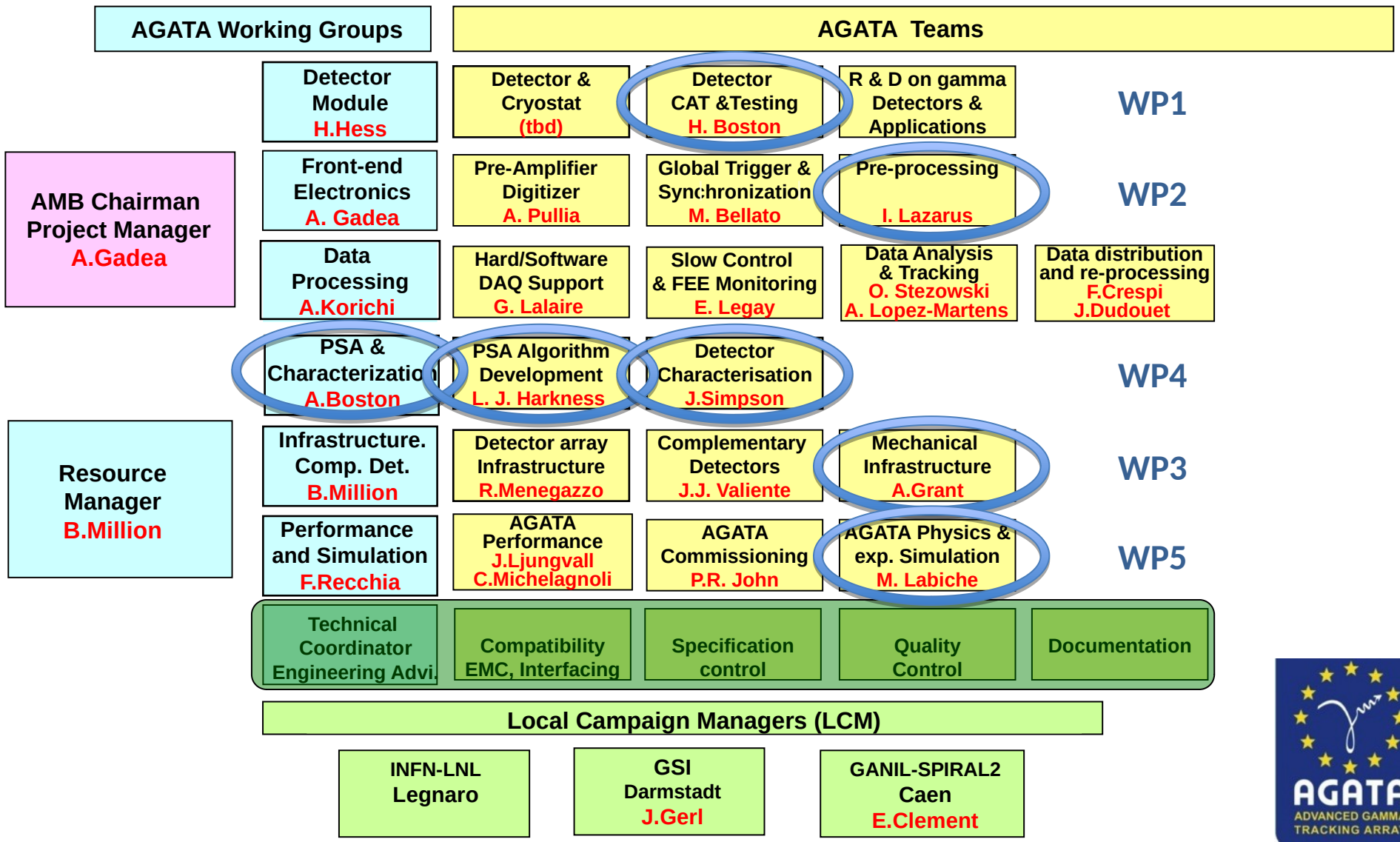
Local Campaign Managers (LCM)

INFN-LNL Legnaro	GSI Darmstadt	GANIL-SPIRAL2 Caen

UK: a driving force for AGATA

A. Gadea (Project Manager)

A. Boston, B. Million, A. Korichi, F. Recchia, H.Hess, P. Reiter (ASC) and W.Korten (ACC).
J. Gerl (LCM-GSI), E. Clement (LCM-GANIL)



Work package 1 - Detectors

1. Capital purchase: **5 AGATA asymmetric encapsulated detectors** (York and UWS)
2. Capital purchase: **ORTEC prototype** asymmetric encapsulated detector (Liverpool) - new company in market (**first order)**
3. **Customer Acceptance Testing** (CAT) of detectors (Liverpool)
4. **Cryostats, mechanical structure and electronics** (York, UWS)

Work Package 1 Summary (Cost to STFC)	2019/20	2020/21	2021/22	2022/23	2023/24	Total
Staff	5,372	14,890	21,316	23,602	11,801	**76,980**
Estates/Indirect/Overheads	3,858	7,716	9,716	11,716	5,858	**38,864**
Equipment	247,802	39,835	1,170,041	257,938	0	**1,715,616**
Travel	560	2,120	3,680	3,120	1,560	**11,040**
Other DIC	0	5,440	0	0	0	**5,440**
Total	**257,591**	**70,000**	**1,204,753**	**296,376**	**19,219**	**1,847,941**

Staff:

- **A.Boston (5%)** – WP leader, liaison with companies, prototype develpment
- **H.Boston (5%)** – CAT lead
- **Bentley (2.5%)** local procurement
- **Smith (2.5%)** local procurement
- **Judson (3.7%)** characterisation
- **Technician (22.5%)** CAT

Leadership related to project:

- **A.Boston –** Leads many developments with industrial partners in Ge technology
- **H.Boston** – CAT lead for AGATA project
- **Liverpool** – industrial applications of Ge technology

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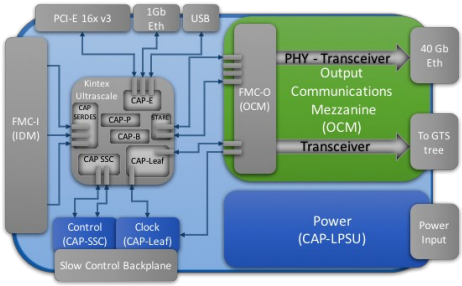
Work package 2 - Electronics

1. Development of tools for monitoring/visualization of signals (VHDL firmware, software and GUI) – provides crucial diagnostics
2. Development of energy processing algorithm to improve performance
3. Scoping of future work for next phase of electronics – uses UK expertise in cold ASICs and positions UK for future lead.



Work Package 2 Summary (Cost to STFC)		2019/20		2020/21		2021/22		2022/23		2023/24		Total
Staff		0		10,288		53,750		99,812		51,404		215,253
Estates/Indirect/Overheads		0		7,613		39,775		73,861		38,039		159,287
Equipment		2,500		10,000		10,000		10,000		2,500		35,000
Travel		3,150		6,300		6,300		14,300		3,150		33,200
Other DIC		0		0		0		0		0		0
Total		**5,650**		**34,201**		**109,824**		**197,972**		**95,092**		**442,740**

Staff:

- **Lazarus (10%)**– WP leader, technical oversight *(partly Cross Comm (CC))*
- **Kogimtzis (50%)** – Electronics Design *(partly CC)*
- **Pucknell (50%)** – Software design engineer *(partly CC)*
- **Technician (17.5%)** – prototyping build and test

Leadership related to project:

- **I. Lazarus –** AGATA WG leader,
- **Daresbury** – Leading role in AGATA Phase 1 electronics and software

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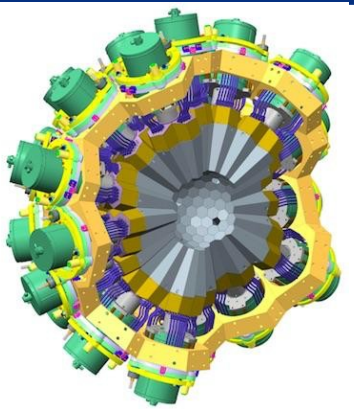
Work package 3 - Mechanics

1. Design, procurement, assembly and commissioning of a 90-detector frame for Legnaro/SPES
2. Design of a system capable of holding 180 detectors (2 x the 90 detector structure) at FAIR
3. Design and delivery of new detector mounting mechanics (SPES and FAIR)
4. Overall mechanical engineering management for the AGATA project



Work Package 3 Summary (Cost to STFC)		2019/20		2020/21		2021/22		2022/23		2023/24		Total
Staff		21,483		83,904		74,266		47,677		23,237		250,567
Estates/Indirect/Overheads		15,897		62,089		54,957		35,281		17,195		185,420
Equipment		0		183,760		0		0		40,540		224,300
Travel		5,000		10,000		10,000		5,000		5,000		35,000
Other DIC		0		0		0		0		0		0
Total		**42,380**		**339,753**		**139,223**		**87,958**		**85,972**		**695,287**

Staff:

- **Grant (16.2%)**– WP Leader, technical oversight *(partly CC)*
- **Burrows (75%)** – Mechanical Design *(partly CC)*
- **Electrical Tech (17.5%)** – technical support
- **Mech Tech (13%)** – technical support
- **ETC Tech (7.5%)** – technical support

Leadership related to project:

- **A. Grant –** AGATA WG leader,
- **UK** – delivered all mechanical design work for AGATA
- **UK** – designed and built most large-scale gamma-ray arrays in Europe

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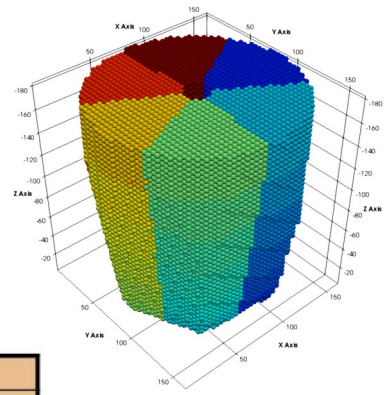
Work package 4 – Pulse-shape analysis

1. Data set for multiple interactions in a segment to improve tracking
2. Optimisation of grid-search algorithm for larger array
3. Implementation of a multiple-interaction algorithm in collaboration with GRETA
4. Characterisation of the ORTEC prototype
5. Experimental validation of novel self-calibration method.



Work Package 4 Summary (Cost to STFC)		2019/20		2020/21		2021/22		2022/23		2023/24		Total
Staff		5,081		86,989		93,504		80,394		11,944		277,912
Estates/Indirect/Overheads		12,173		77,683		78,350		79,016		12,840		260,061
Equipment		0		0		0		0		0		0
Travel		1,560		8,120		11,120		11,120		2,560		34,480
Other DIC		1,600		1,440		0		0		0		3,040
Total		**20,414**		**174,232**		**182,973**		**170,530**		**27,344**		**575,493**

Staff:

- **Harkness-Brennan (10%)**– WP Leader, tech oversight, PDRA/PhD supervision
- **Boston (2.5%)** – PDRA/PhD supervision
- **Nolan (5%, zero cost)** – work with Liv PDRA
- **Petri (5%, 2.5% cost), Paschalis (5%)** – oversee work on self-calibration
- **Liverpool PDRA (75%)** – Tasks 1-3
- **York PDRA** (25%) – Task 5
- **PhD student** – Task 4
- **Technician (22.5%)** – mech. support

Leadership related to project:

- **Harkness-Brennan –** AGATA WG leader
- **Boston –** AGATA WG leader
- **Nolan** – former Chair AGATA Steering Committee
- **UK** – leads PSA activities in AGATA
- **Petri, Paschalis** – led self-calibration R&D

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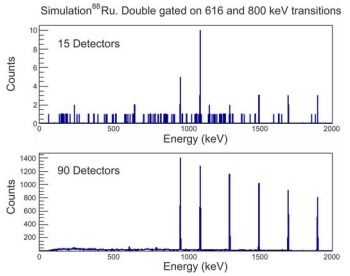
Work package 5 – Expt design & performance

1. AGATA simulation code: improve PSA in simulation with data
2. AGATA simulation code: integrate beam-optics event generator for fragmentation beams
3. AGATA simulation code: develop gamma-ray polarisation model
4. Connect AGATA and PRISMA codes for LNL/SPES
5. Connect AGATA and LYCCA/S-FRS/Spectrometer codes for HISPEC (FAIR)
6. Array performance tests and experiment design tasks (SPES & FAIR)



Work Package 5 Summary (Cost to STFC)		2019/20		2020/21		2021/22		2022/23		2023/24		Total
Staff		18,212		55,665		56,714		78,700		39,765		249,056
Estates/Indirect/Overheads		31,211		63,165		63,744		64,340		32,478		254,938
Equipment		0		0		0		0		0		0
Travel		1,760		7,520		5,520		5,520		3,760		24,080
Other DIC		800		1,440		0		0		0		2,240
Total		**51,983**		**127,790**		**125,978**		**148,560**		**76,003**		**530,314**

Staff:

- **Bentley (10%)** – WP Leader, PDRA supervision, scientific oversight, contribute to tasks 5 and 6.
- **Labiche (40%)** – technical oversight of all tasks, work with PDRA
- **Petri (5%, 2.5% cost), Paschalis (5%)** – support to PDRA on physics simulations and liaise with GRETA team
- **York PDRA (62.5%)** – all tasks.

Leadership related to project:

- **Labiche –** AGATA WG leader, UK simulation specialist
- **Bentley –** AGATA Campaign leader (GSI), UK-HISPEC lead, LYCCA simulation leader
- **Petri, Paschalis** – led self-calibration R&D, worked on gamma-ray tracking for AGATA and GRETINA

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Work package 6 – Project Management

1. Oversight of all tasks and tracking progress
2. Maintain project plan, adjusting tasks and timelines
3. Financial tracking and planning
4. Risk management
5. Oversight Committee liaison
6. Liaise with internation project at all levels

Work Package 5 Summary (Cost to STFC)	2019/20	2020/21	2021/22	2022/23	2023/24	Total
Staff	18,212	55,665	56,714	78,700	39,765	249,056
Estates/Indirect/Overheads	31,211	63,165	63,744	64,340	32,478	254,938
Equipment	0	0	0	0	0	0
Travel	1,760	7,520	5,520	5,520	3,760	24,080
Other DIC	800	1,440	0	0	0	2,240
Total	**51,983**	**127,790**	**125,978**	**148,560**	**76,003**	**530,314**

Staff:

- **Bentley (10%)** – WP Leader, PI for project, PI for York, WP5 Management
- **A.Boston (5%)** – PI for Liverpool, WP1 Management
- **Simpson (15%) -** PI for Daresbury, WP3 Management, ASC Chair/Vice-Chair
- **Project manager (20%)**
- **Harkness Brennan (2.5%)** – WP4 Management
- **Smith (2.5%)** – PI for UWS

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Q7: AGATA White Book

studied by Coulomb excitation or clus

measurements, respectively.

Higher-order nuclear defor

Spectroscopic Studies for Nuclear Astrophysics

Reactions involving radioactive nuclei play a key role in nuclear astrophysics, particularly in explosive scenarios such as X-ray bursts, novae and supernovae. Unfortunately, many of the reactions of interest cannot be measured directly owing to the low intensities of radioactive beams or lack of radioactive targets. An important indirect approach is, therefore, to employ transfer reactions, such as (d,p), to populate the key astrophysical resonances in order to obtain information on their most

rons are (almost) identical particles, though it is known that isospin ore significant way by the weak ion, the isospin formalism, number T, remains an

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Isospin Symmetry Studie

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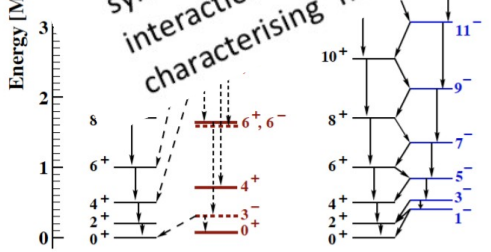

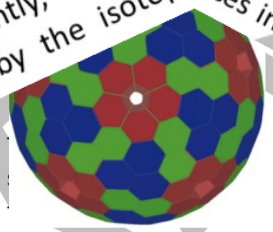

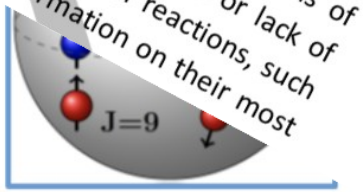

Signatures for
T= 0 pairing

Duchêne, A. Gadea, M. Gorska, P. Gree
iter, J. Simpson, J.J. Valiente-Dobon, M

M. Bentley, G. Benzoni, D. Beaumel, J. Cederkall, M. Ciemala, F.C.L. Crespi, J.
D.T. Doherty, B. Fernandez-Dominguez, B. Fornal, L.P. Gaffney, K. Gladnishki,
A. Lopez-Martens, A. Maj, D. Mengoni, A. Nannini, D.Napoli, A. Obertelli, J. Pa
Z. Podolyak, G. Rainovski, R. Raabe, F. Recchia, A. Tumino, O. Wieland, K. Wi

(List to be completed)

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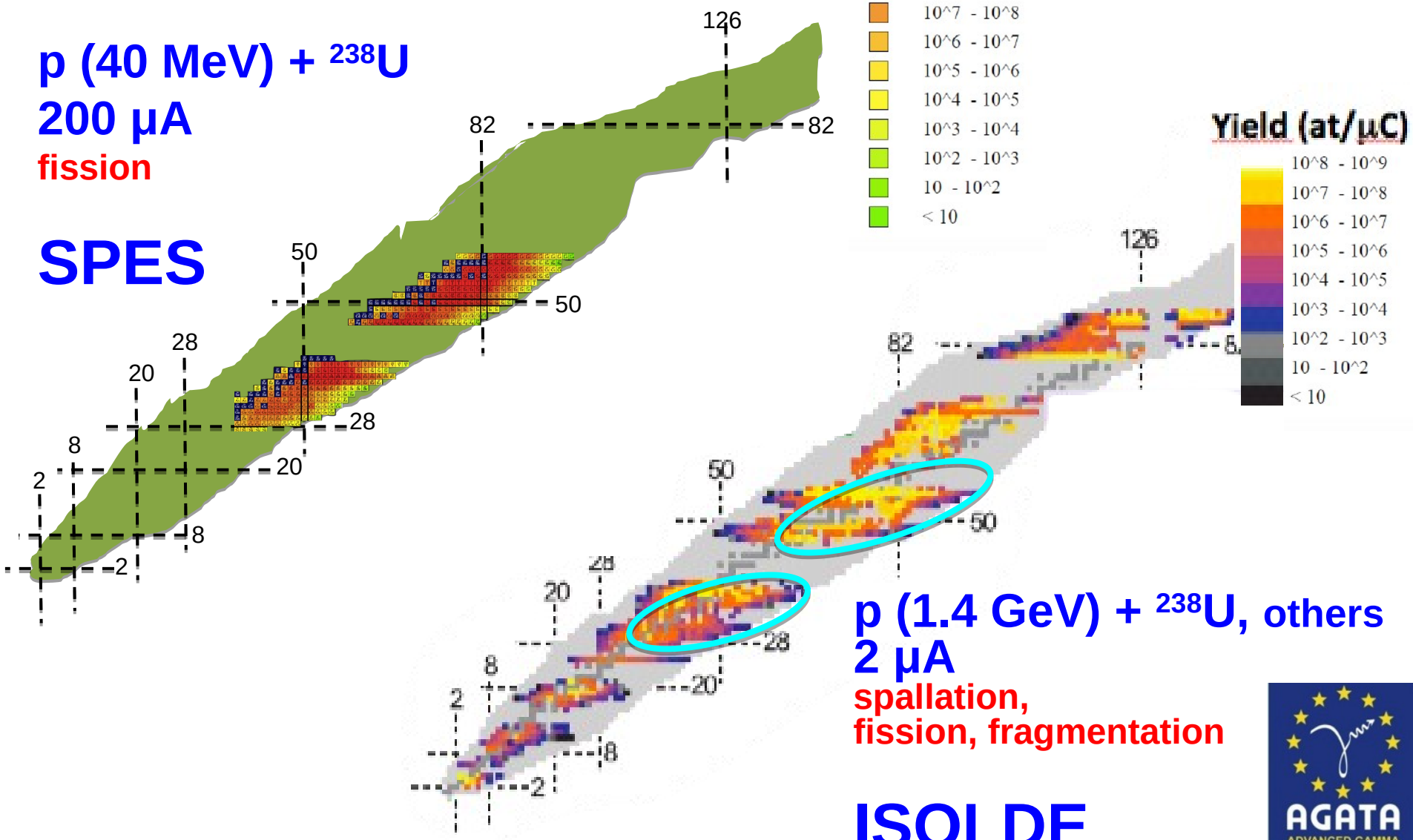
TRACKING ARRAY

ISOL Production Schemes



p (40 MeV) + ^{238}U
200 μA
fission

SPES

p (1.4 GeV) + ^{238}U, others
2 μA
spallation,
fission, fragmentation

ISOLDE

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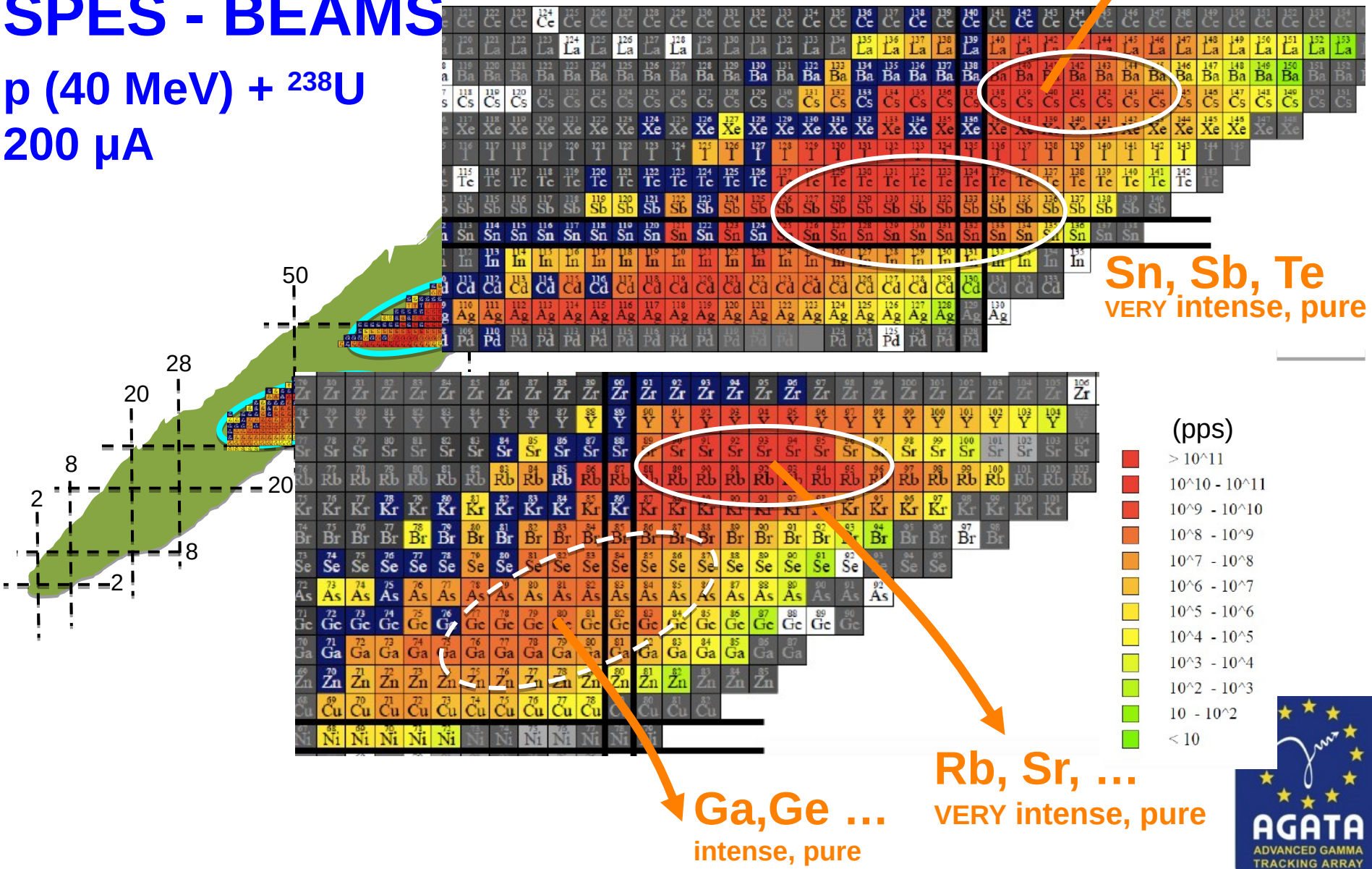
ISOL Production Schemes

SPES - BEAMS

p (40 MeV) + ^{238}U
200 µA



(AGATA@) SPES vs (GRETA@) FRIB

Eight examples where SPES yields win over those from FRIB…

Beam	*Z*	*N*	*SPES intensity (p.p.s.)*	*FRIB intensity (p.p.s.)*	*Factor*
^{100}Rb	37	63	8.99×10^3	1.00×10^1	900
^{94}Sr	38	56	2.54×10^8	2.16×10^6	120
^{118}Ag	47	71	1.03×10^8	1.43×10^6	70
^{132}Sn	50	82	3.11×10^7	1.92×10^5	160
^{140}Te	52	88	5.51×10^3	2.12×10^1	260
^{138}Xe	54	84	2.02×10^8	1.66×10^6	120
^{146}Cs	55	91	8.90×10^4	2.37×10^2	400
^{140}Ba	56	84	1.21×10^9	1.70×10^6	700

… with typical improvement factors of several hundred.

A number of experiments that cannot be carried out with FRIB + GRETA (on a reasonable timescale) can be carried out with SPES + AGATA

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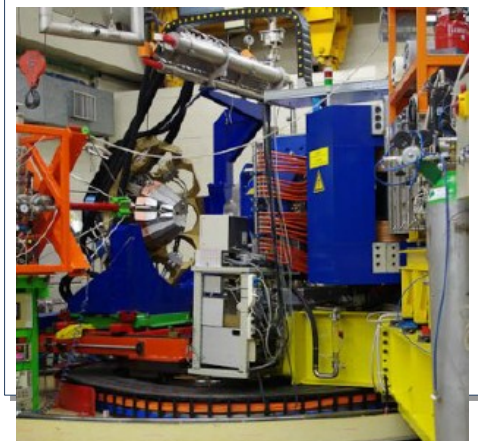
Unique opportunities with SPES and AGATA

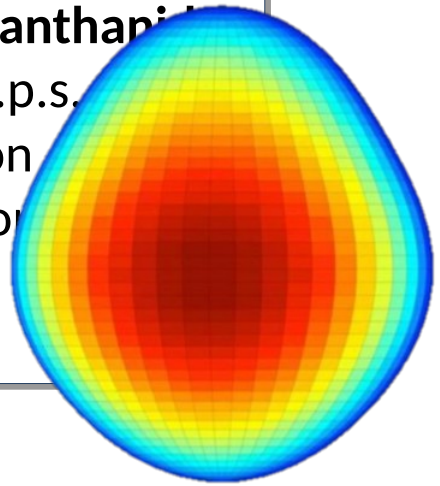


Shell evolution near doubly magic ^{132}Sn

- e.g. ^{132}Sn SPES beam intensity: 10^7 p.p.s.
- Excited states and single particle energies using deep-inelastic reactions with AGATA + PRISMA
- Spectroscopic factors studied using light-ion transfer with AGATA + MUGAST

Reflection asymmetry in neutron-rich lanthani

- e.g. ^{144}Xe SPES beam intensity: 10^5 p.p.s.
- Radioactive beam Coulomb excitation
- AGATA coupled to SPIDER (Si detecto
- Measurement of B(E3) values
- A range of experiments possible…



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Uniqueness of FAIR

FAIR will be a worldwide unique facility to deliver high-intensity radioactive ion beams covering the entire chart of nuclides with high energies up to 1500 MeV/u.

FAIR will therefore be **the world-leading facility** for experiments that require or take advantage of:

- highest energy/velocity of the RIBs (beyond 0.5 GeV/u)
- radioactive beams of all elements up to U
- isotopically pure secondary beams
- electron-free beams (fully stripped ions) up to the heaviest elements
- isomeric beams (down to ns lifetimes)

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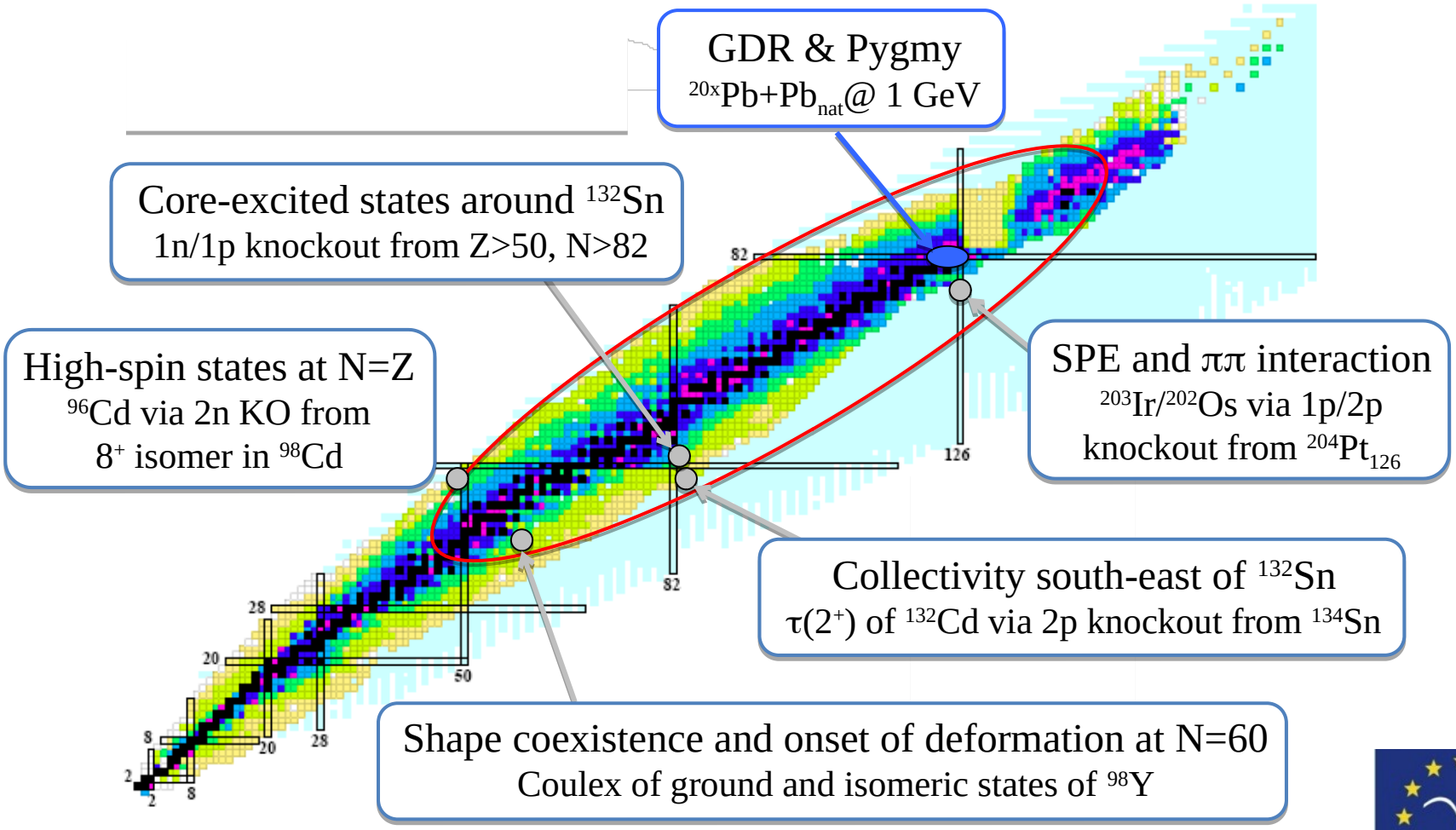
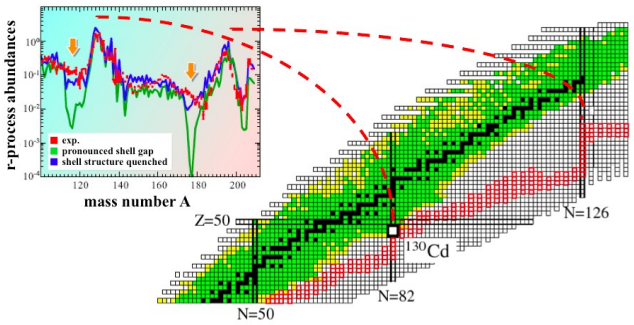
Highlight physics cases for AGATA@FAIR

From AGATA White Book



Unique opportunities with FAIR and AGATA



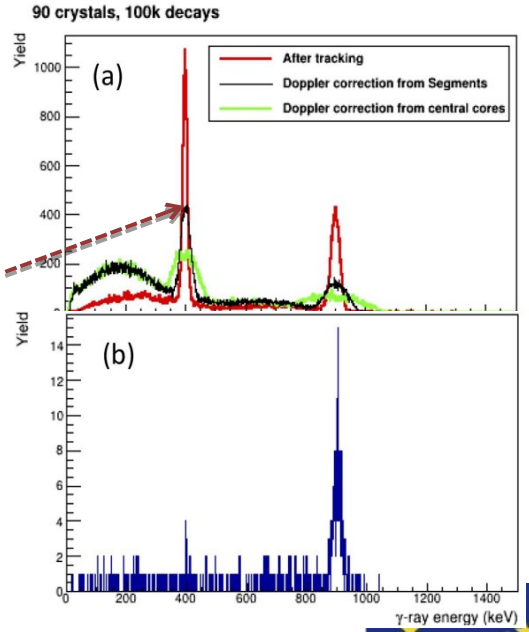
Spectroscopy of r-process nuclei around N=126

- Knockout from intense beam of ^{204}Pt
- Evolution of proton s.p. orbitals, r-process region
- **Uses unique FAIR capability** (heavy nuclei)

Spectroscopy of exotic Pb isotopes (e.g. ^{218}Pb)

- In-beam (p,2p) reactions using AGATA and MINOS
- Evolution of shell-structure far from stability
- **Uses unique FAIR capability** (heavy nuclei)
- Very high velocity (β~0.8) **only possible at FAIR**
- AGATA position tracking **crucial**

Position resolution essential



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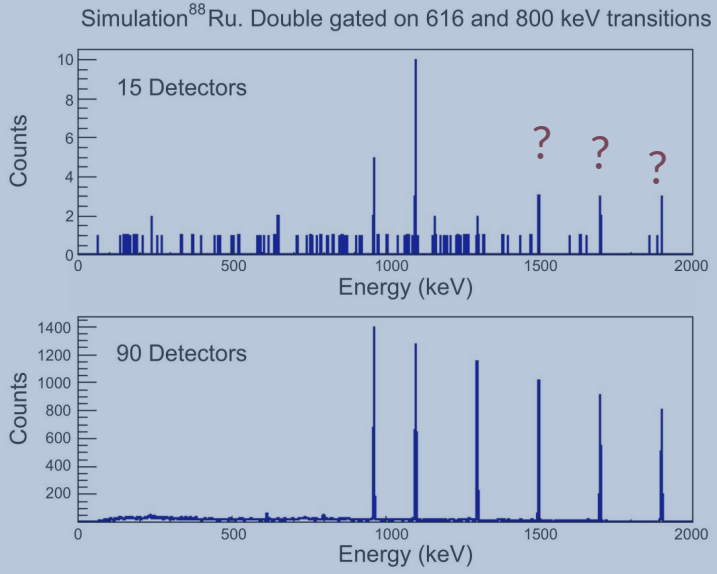
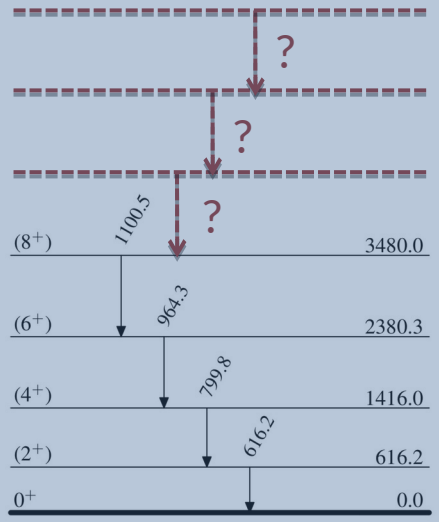
Simulations from 15 □ 90 detectors:





SPES-type example

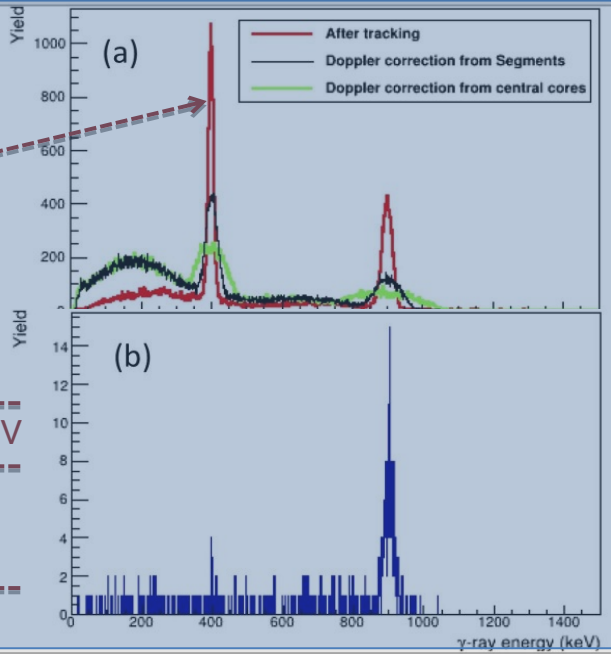
- Typical reaction, v/c ~ 5%
- Multiple coincident gammas
- “Statistical reaction”
- γ-γ, and γ-γ-γ analysis
- Factor ~200 better for γ-γ-γ

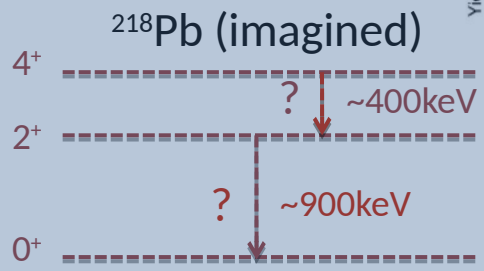
$^{88}_{44}Ru_{44}$ 90 crystals, 100k decays

FAIR-type example

- Typical reaction, v/c ~ 50%
- Huge Doppler effects
- “direct reaction”
- γ- and γ-γ analysis
- Factor ~30 better for γ-γ

Position resolution essential





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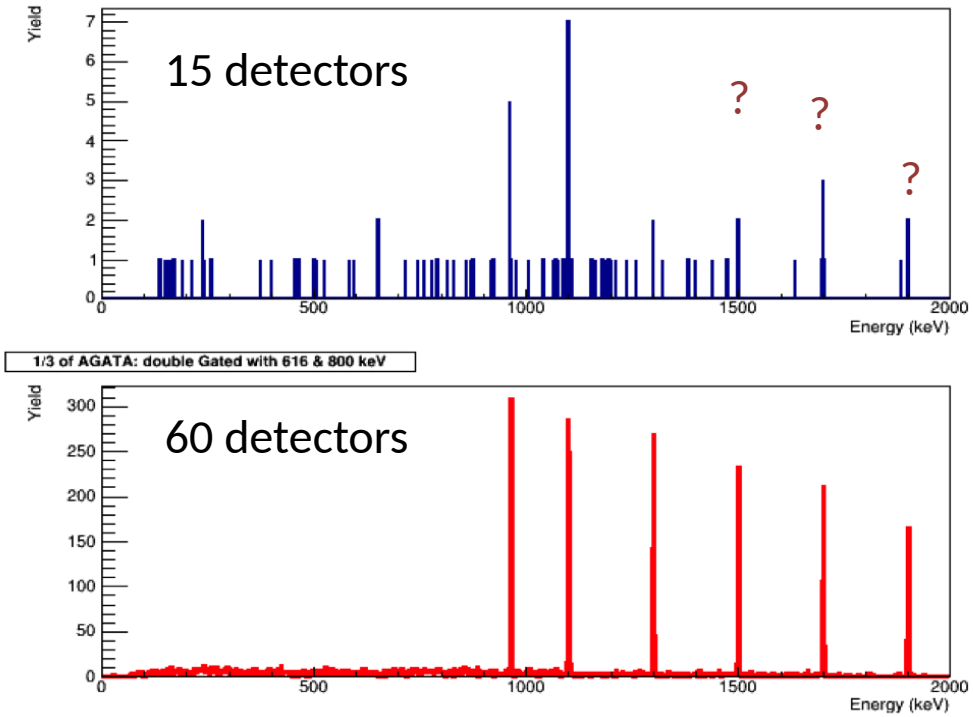
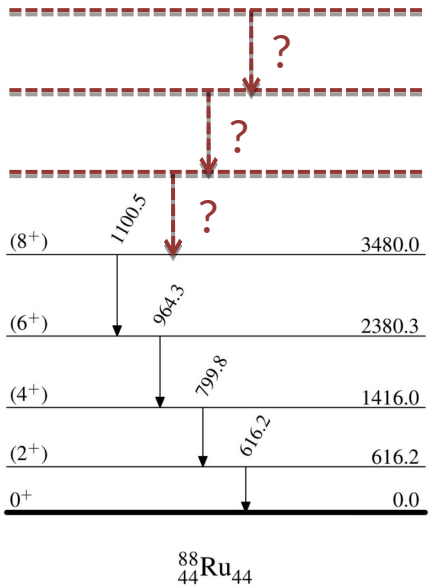
Q8: Improvements from 15 – 60 detectors





"SPES-type" example

- Typical reaction, v/c ~ 5%
- Multiple coincident gammas
- "Statistical reaction"
- γ-γ, and γ-γ-γ analysis
- **Factor ~200 better for γ-γ-γ analysis**

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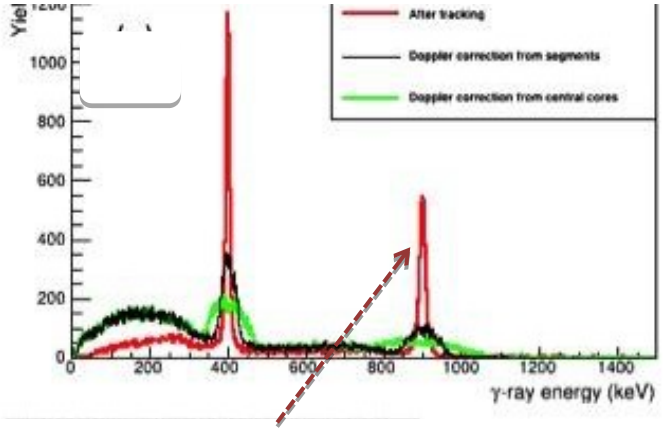
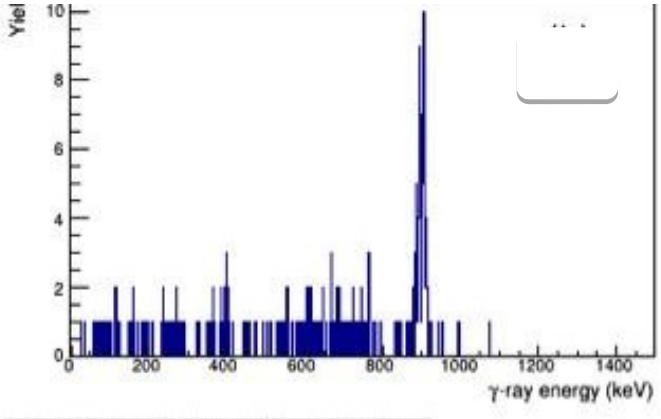
Q8: Improvements from 15 – 60 detectors

100k decays, 60 detectors



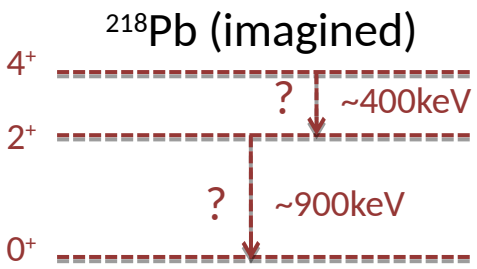
Position resolution essential

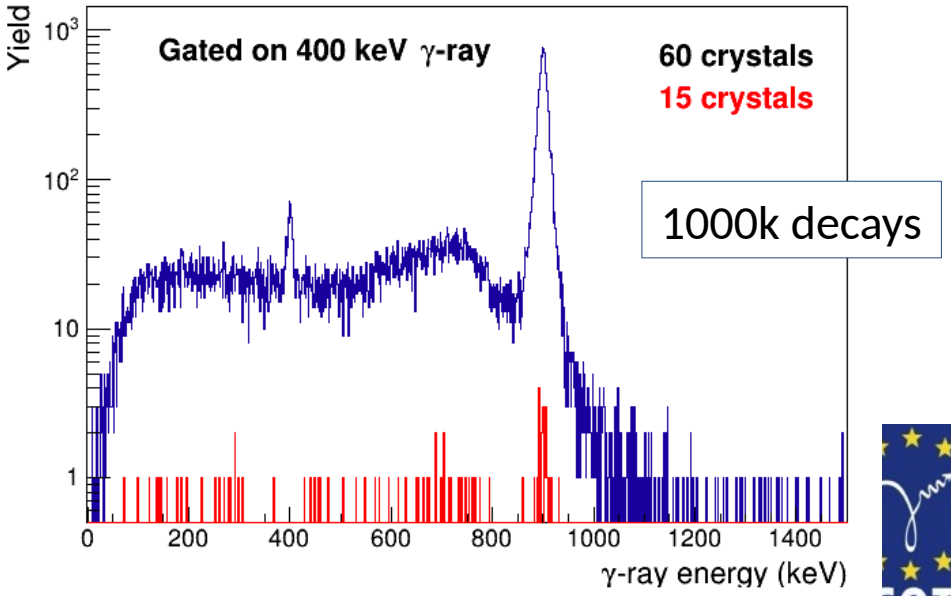
10k decays, 60 detectors (realistic event rate)



Spectrum “empty” for 15 detectors

- High v/c = 80%
- Huge Doppler effects
- **Factor ~300 better for γ-γ**





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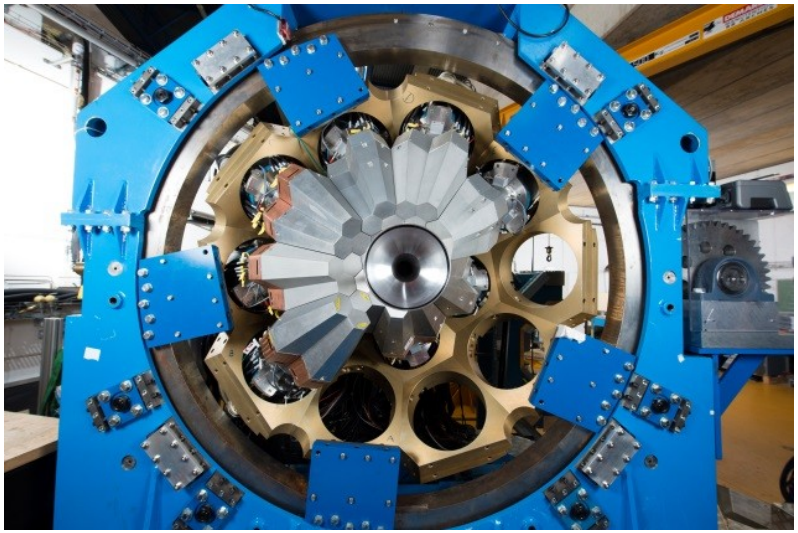
Societal Impact

Scientific Research Curiosity

Applications

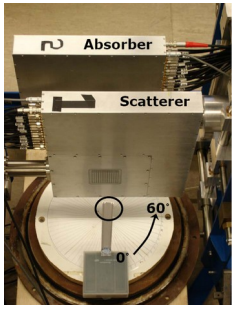


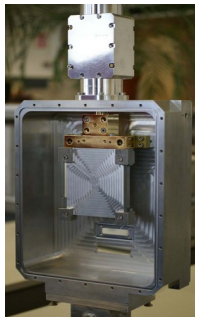
State of the art detectors

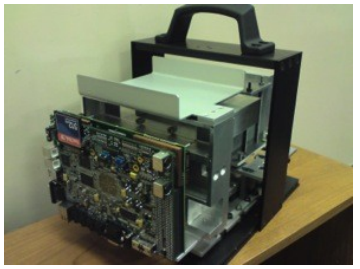
Societal Impact

Many applied projects funded by a variety of bodies, including, STFC/IPS/CLASP/PNPAS, Universities, EPSRC, TSB, MRC, NHS, NNL (NDA), AWE

e.g.







SMARTPET (Medical)

- Novel Small Animal PET system

PROSPECTUS (Medical)

- Novel SPECT imaging system.

PGRIS (Security, decommissioning)

- Hand-held radiation identification and location device

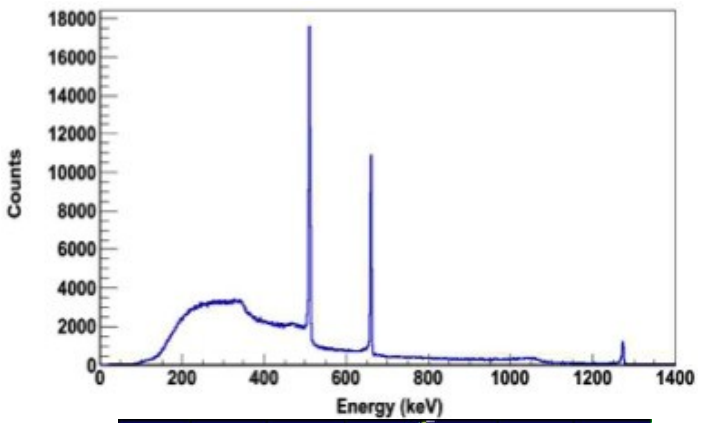
Gri+: Portable Gamma Imaging System (security, decommissioning, environment)

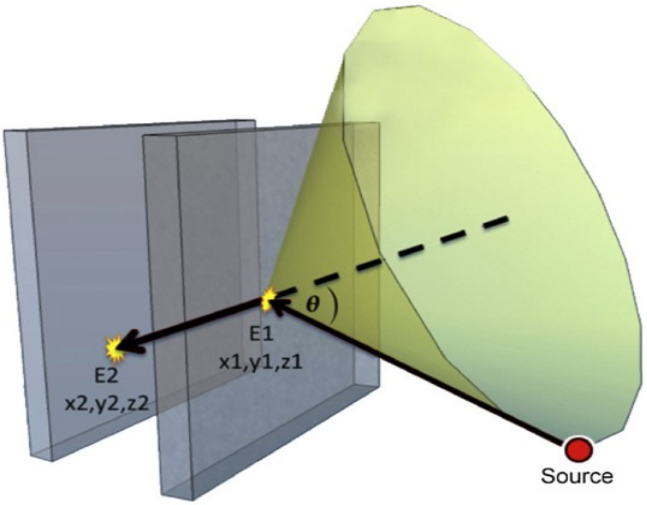
- 3D Gamma and Optical Stereoscopic Image Fusion

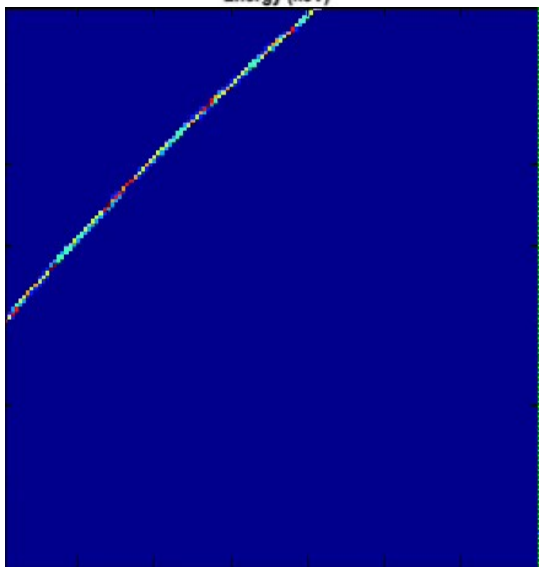
All projects are collaborations some with industrial partners. All involve contributions from other parts of STFC.

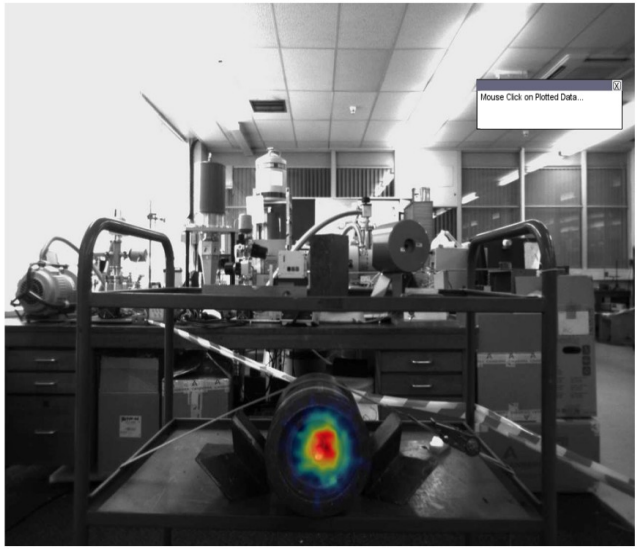
Case Study: A 3D integrated mobile γ-ray and vision system

- Gamma-ray interaction positions determined by PSA
- Kinematic reconstruction of gamma-ray paths
- Source of radiation located at max cone overlap
- In-situ nuclear decontamination field trials at Sellafield 2019









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From AGATA to portable imaging

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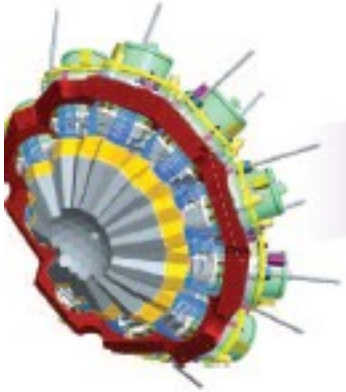
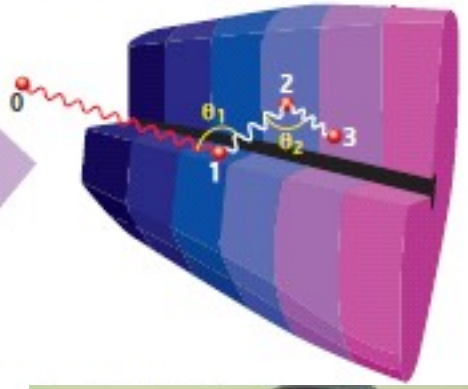
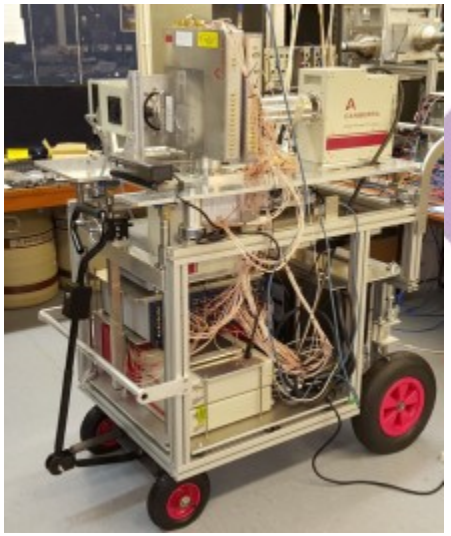
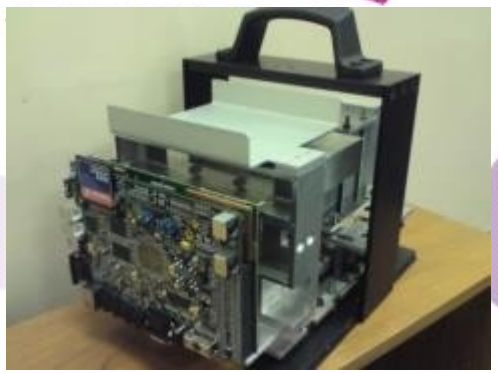
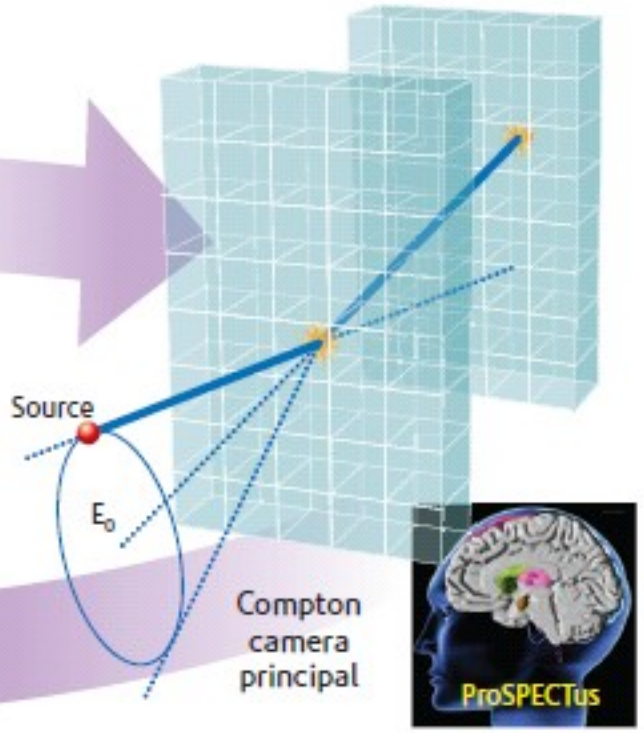


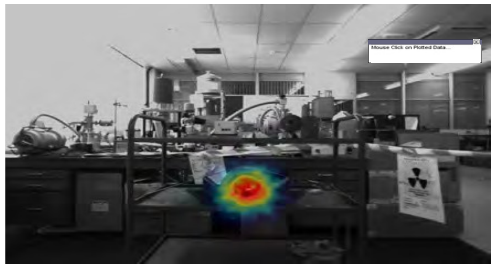
Gamma-ray tracking in an AGATA detector

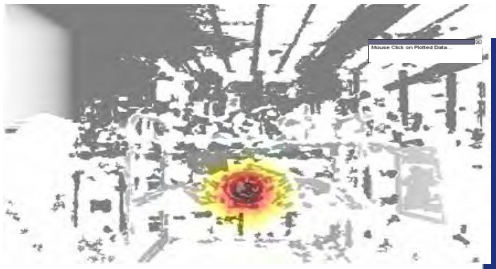












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AGATA MoU (-> end 2020)

- Agreement on the realisation, operation and management
- Sharing of costs and responsibilities
- Operation costs
- Current specific project **to 1/3 4π (60 detectors) by 2021**
- Aim for 4π by 2031
- Open collaboration
- Laboratories are science driven (PACs)
- Signed by STFC (G.Blair)

MoU ongoing, ~85 % achieved (detectors)
Capital contribution, ~85% achieved (UK shortfall)

- AGATA 4π: Project Definition: Preparation Ongoing (**informing this bid**)
- New MoU being planned for the 4π array

AGATA Collaboration see
http://npg.dl.ac.uk/agata_acc/index.html

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Q1: Impacts of AGATA

Metrics:

- 17 past PhD students
- 5 current PhD students
- 136 papers (83 technical, 53 science)
- 19 PDRAs worked on AGATA (/data)

- All these are tracked within the AGATA collaboration

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