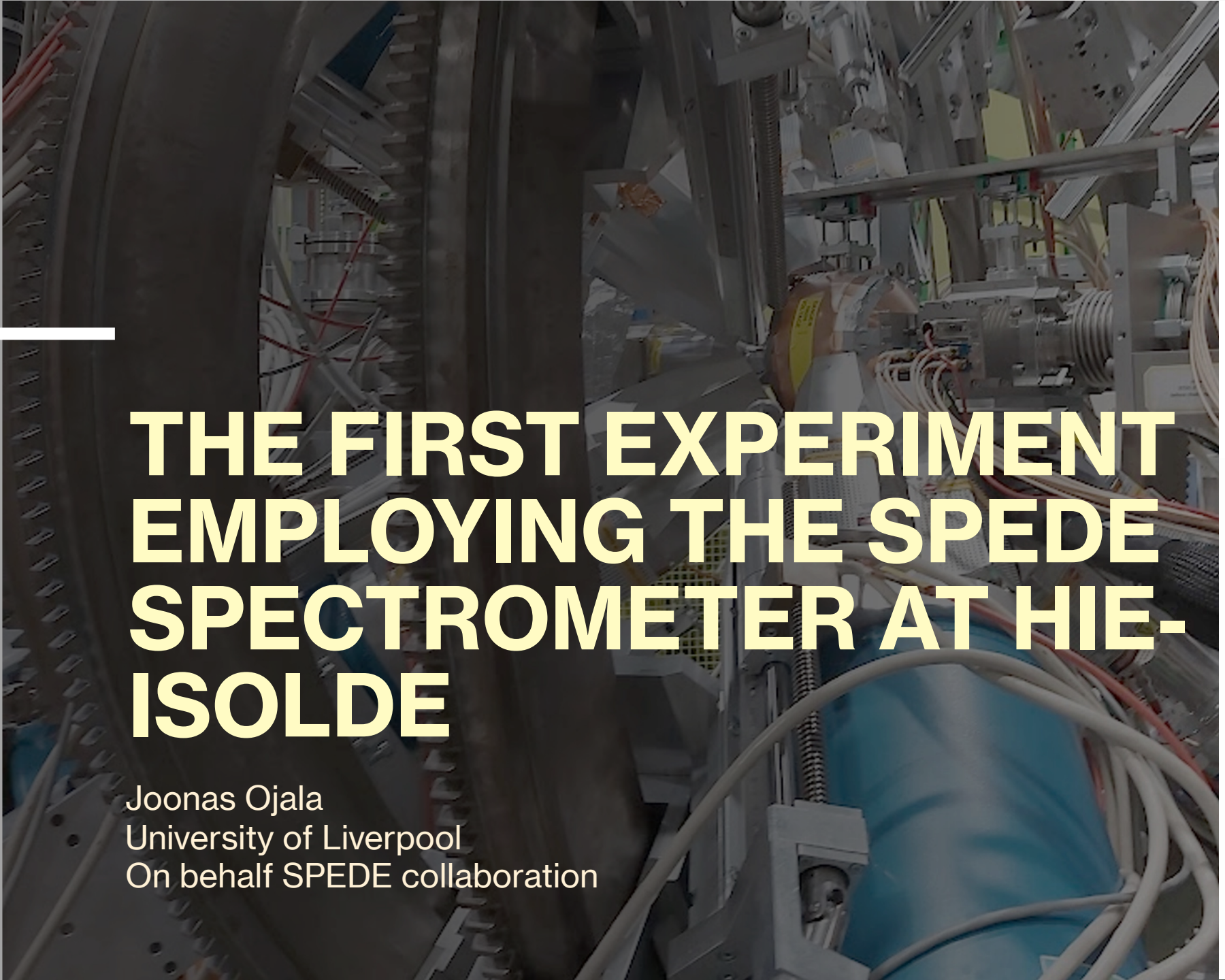


THE FIRST EXPERIMENT EMPLOYING THE SPEDE SPECTROMETER AT HIE-ISOLDE

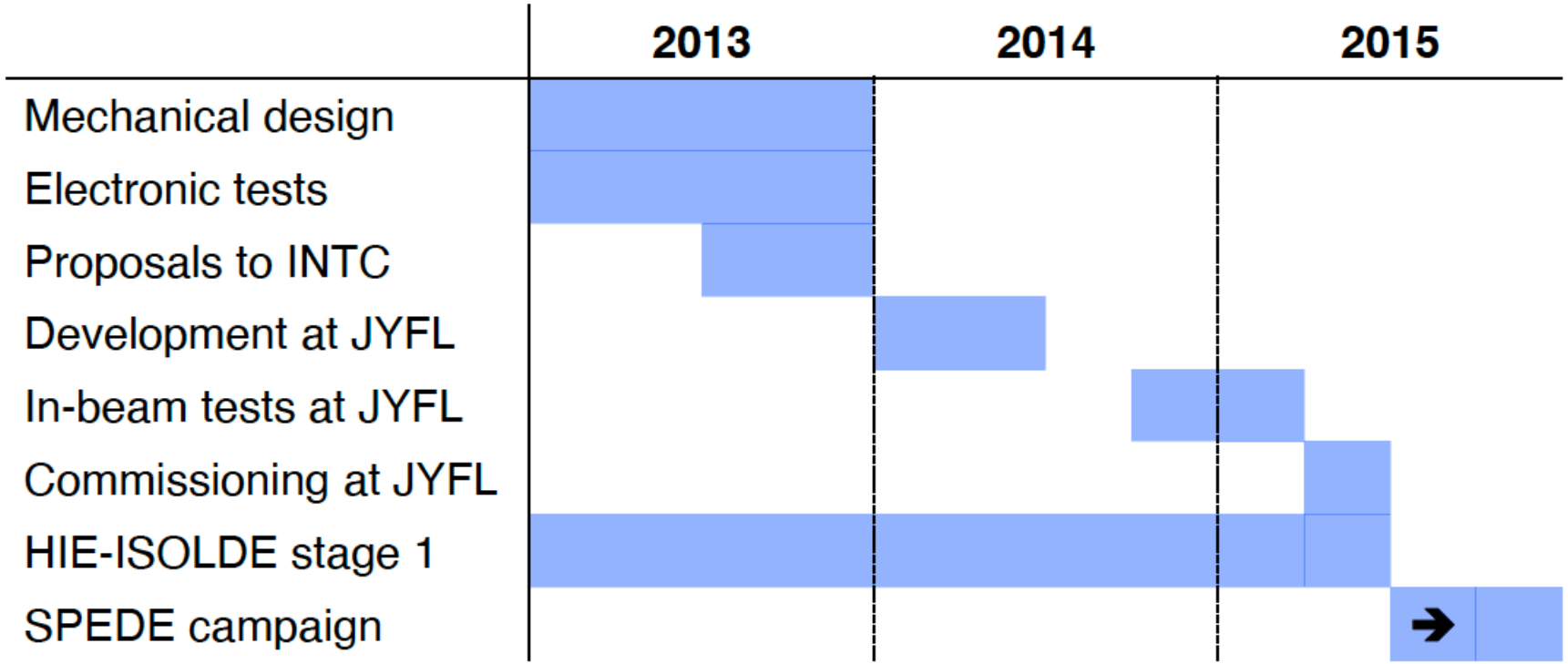
Joonas Ojala
University of Liverpool
On behalf SPEDE collaboration

SPECTROMETER
ELECTRON
DETECTION

MINI BALL

Brief history of the SPEDE spectrometer

Project time line



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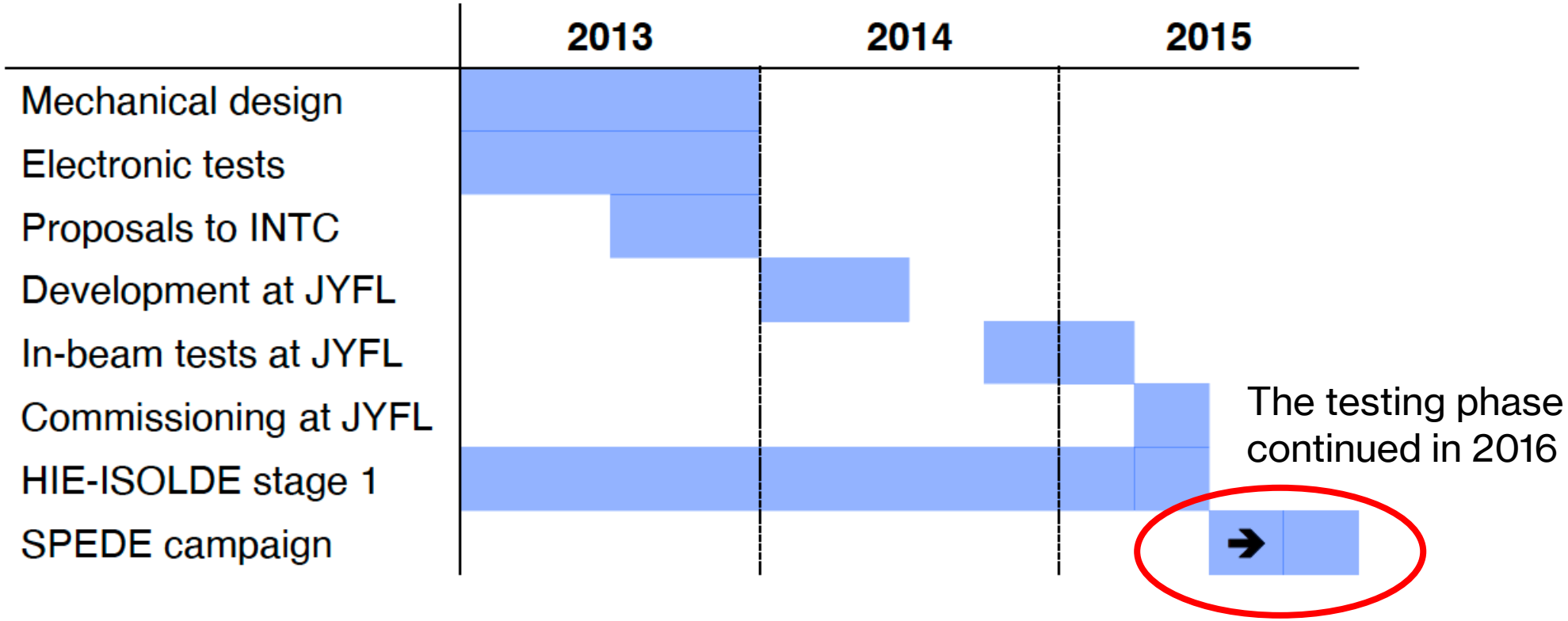

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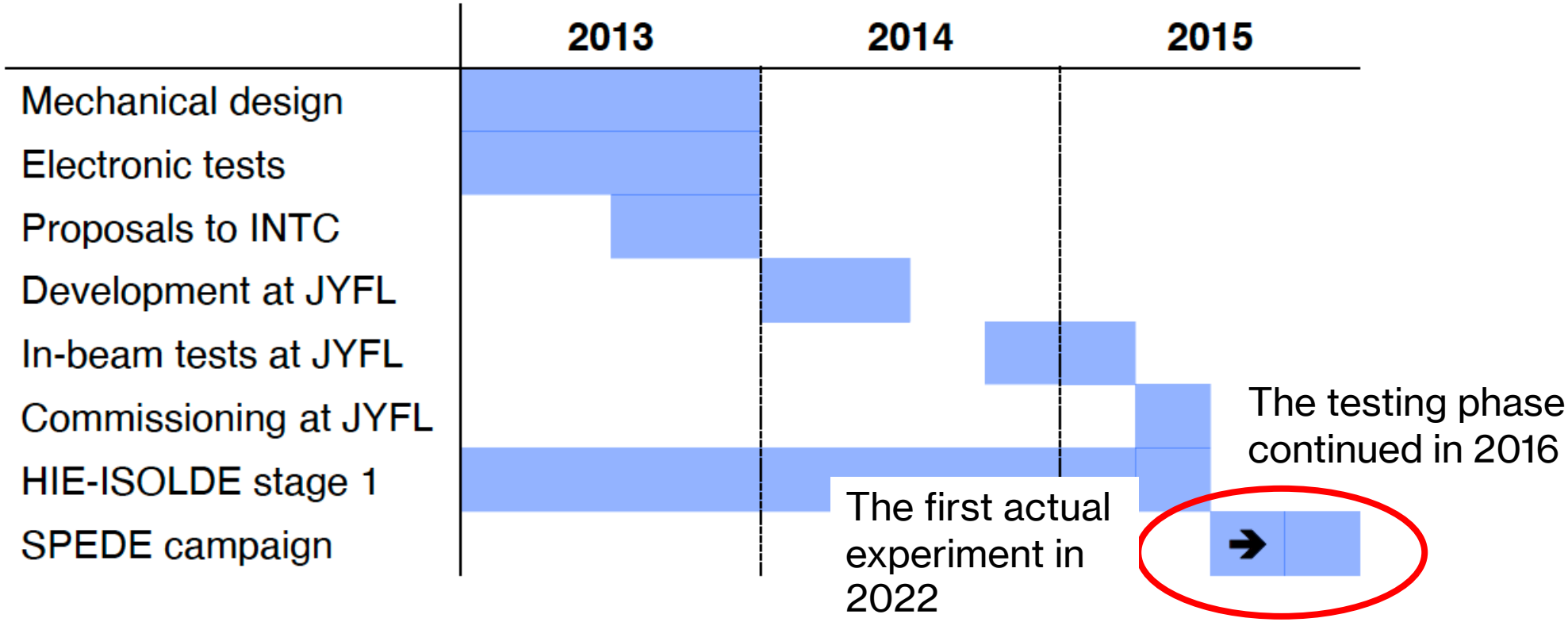
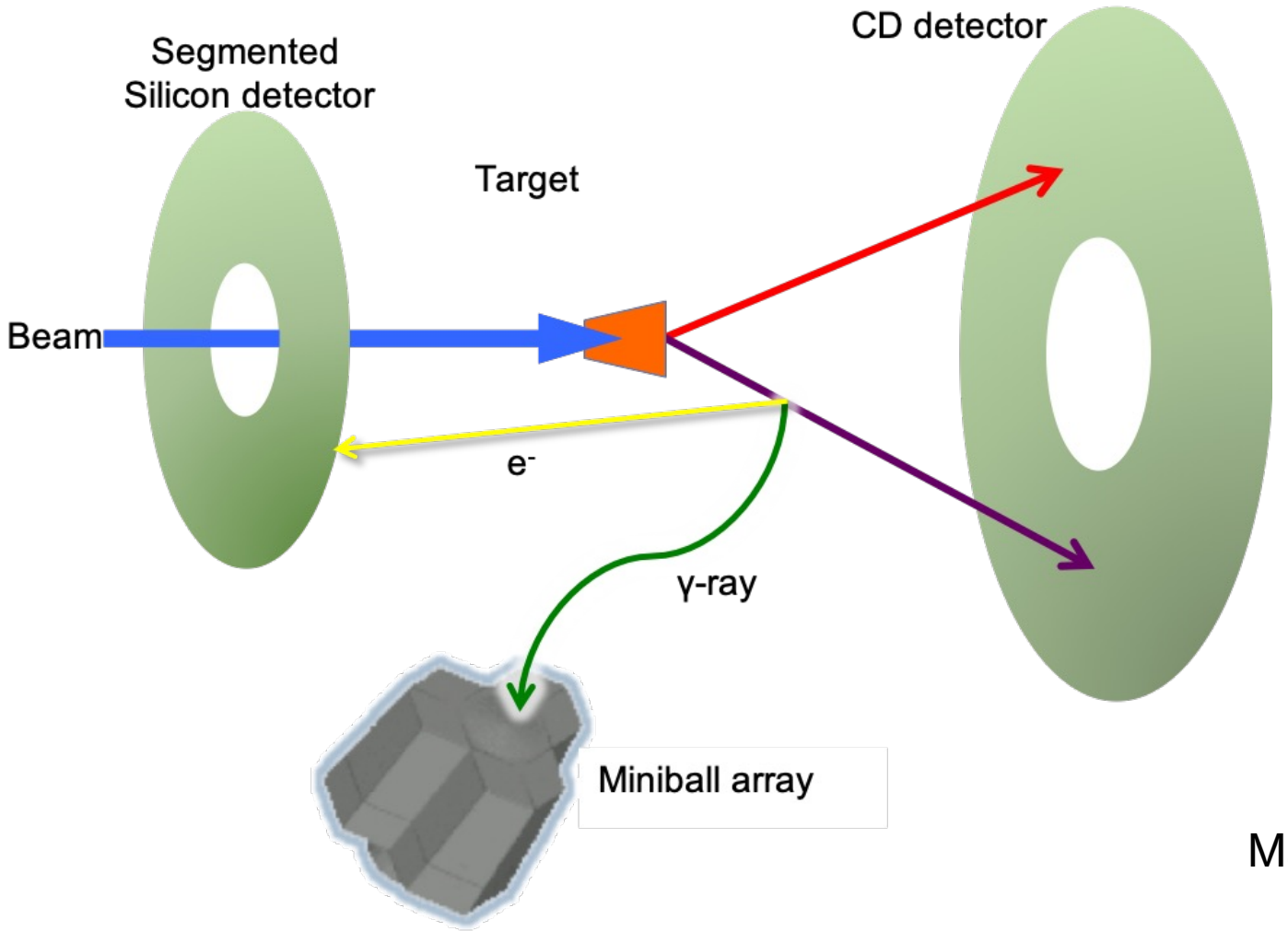


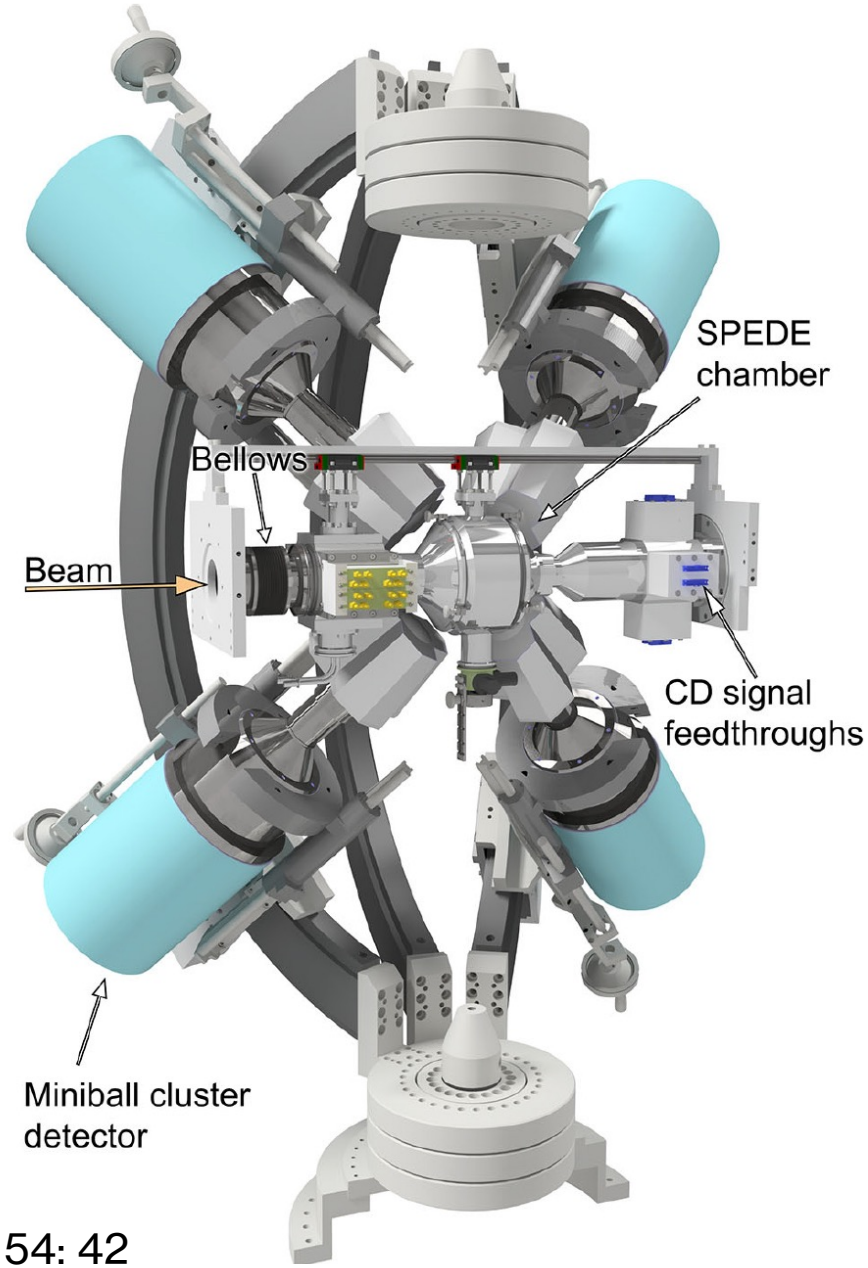
The SPEDE concept



Made by J. Pakarinen

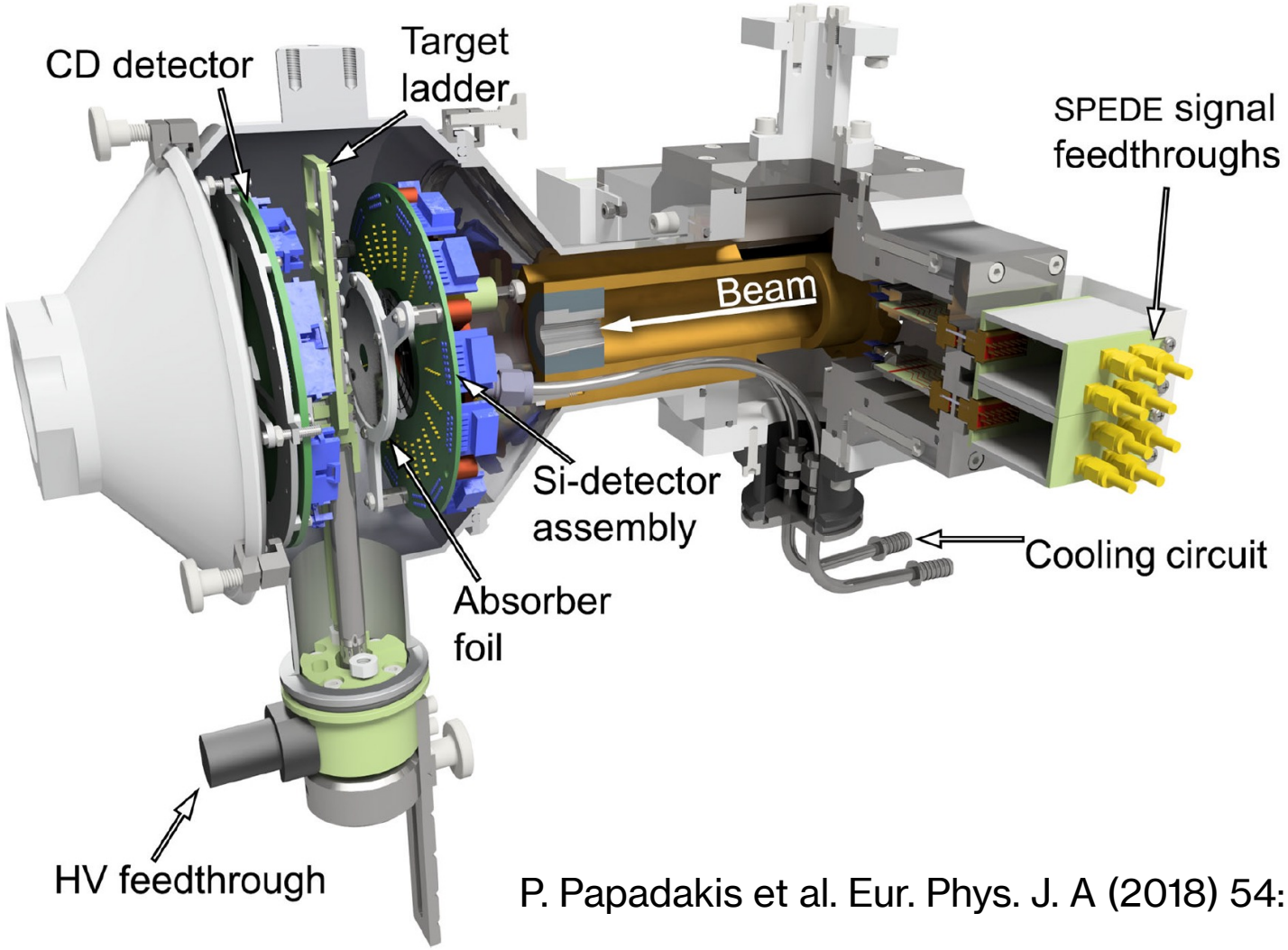
The SPEDE spectrometer

- Conversion electron spectrometer
- Used in conjunction with the MINIBALL germanium array and CD detector
- Allows simultaneous γ-ray and conversion electron spectroscopy using radioactive beam
- Target chamber designed for the SPEDE spectrometer



P. Papadakis et al. Eur. Phys. J. A (2018) 54: 42

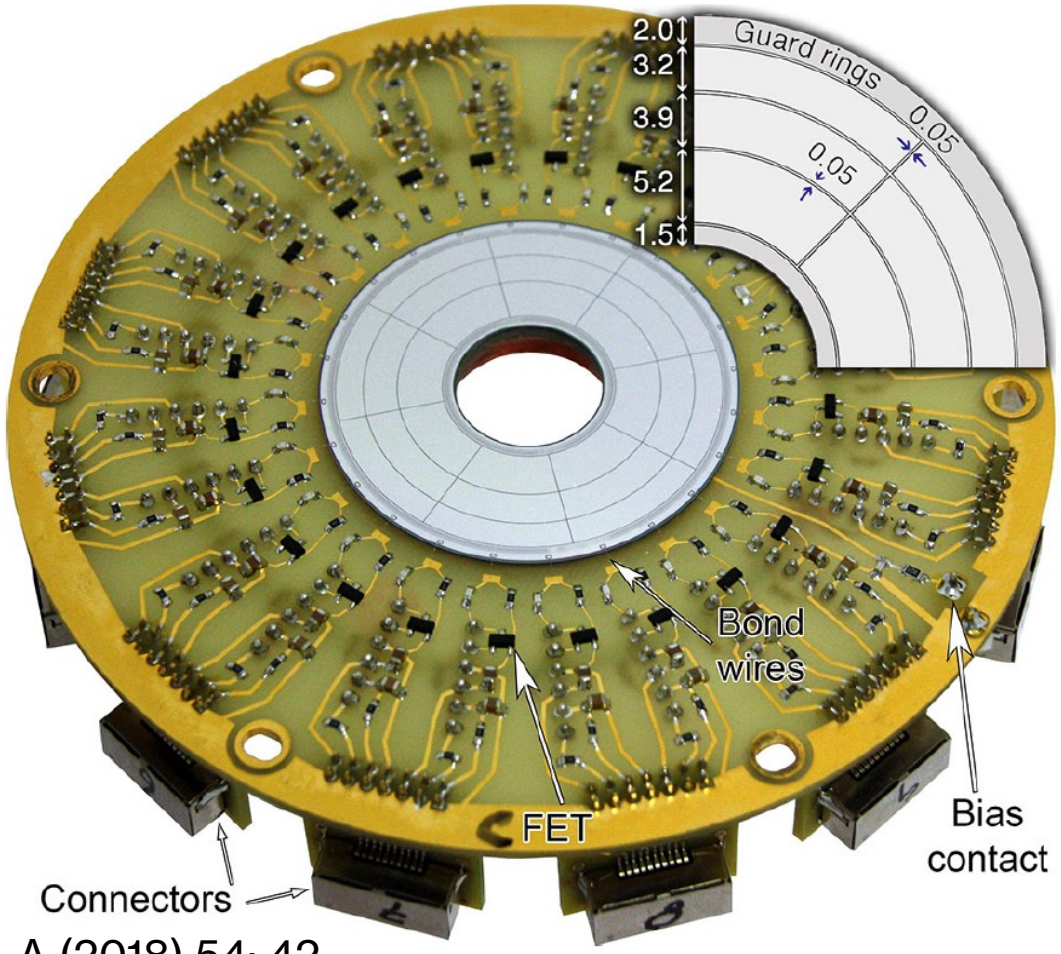
The SPEDE spectrometer



P. Papadakis et al. Eur. Phys. J. A (2018) 54: 42

The SPEDE silicon detector

- 24 pixels
- Silicon design is decided based on the simulations
- Thickness 500 μm
- AMPTEK A250F/NF used as preamplifiers
- Silicon is cooled down with ethanol near -5 ℃ temperature
- A typical bias voltage is +90 V



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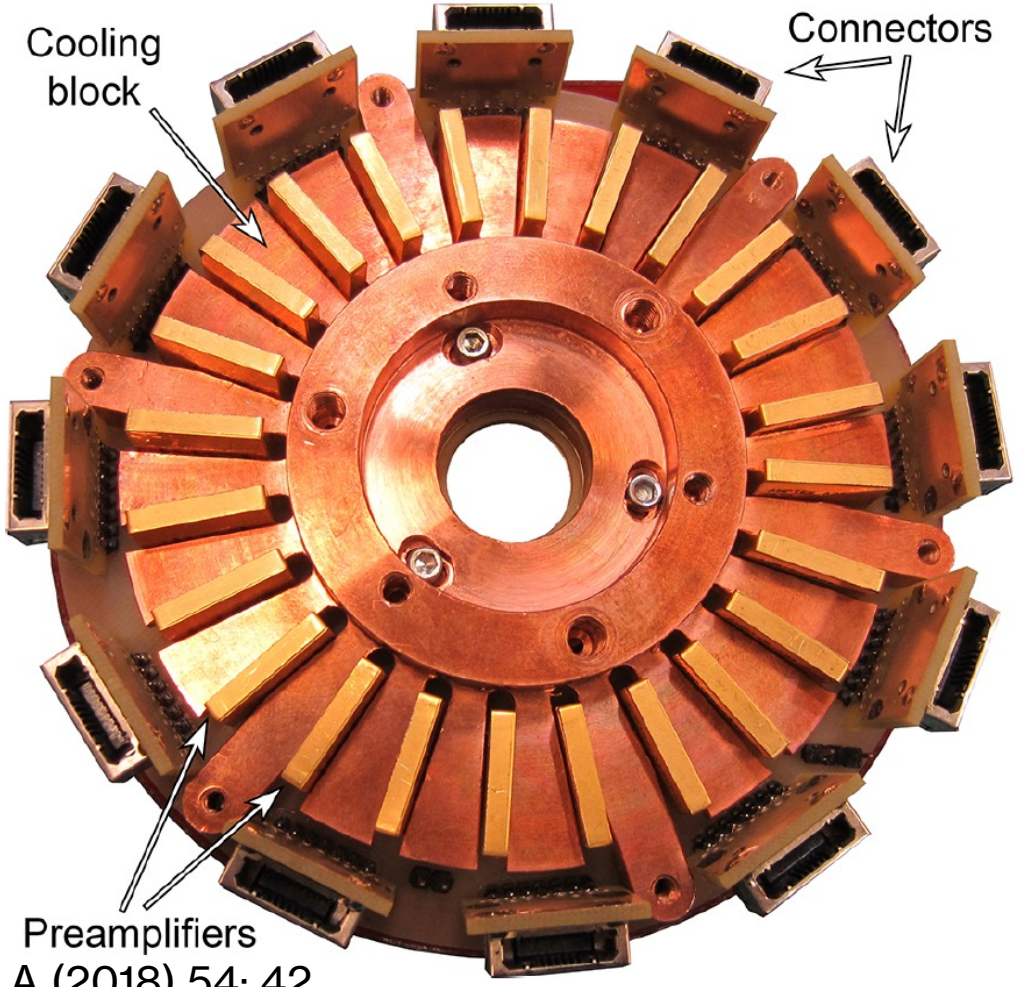

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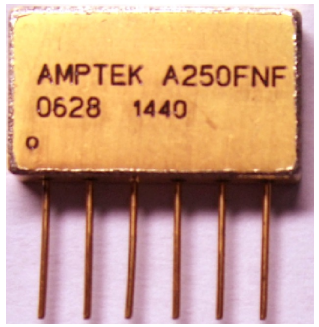
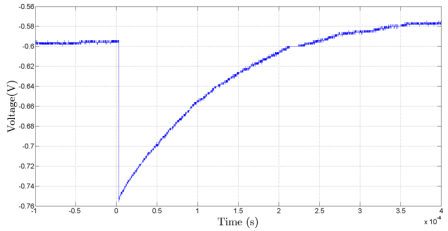
Electronics

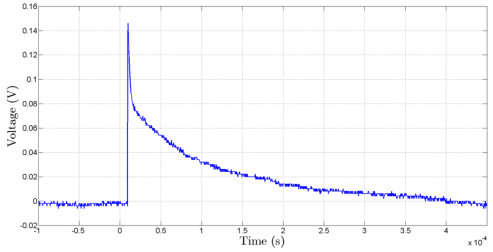
- Preamp power, Mesytec MNV-4
- Gain-offset (GO) unit
- Differential to single ended (DOS) cards
- FEBEX: DAQ cards
- Bias voltage supply (+90V), Mesytec MHV-4, for the detector
- HV supply, ISEG SHR, for a target ladder





SPEDE preamp

GO Box

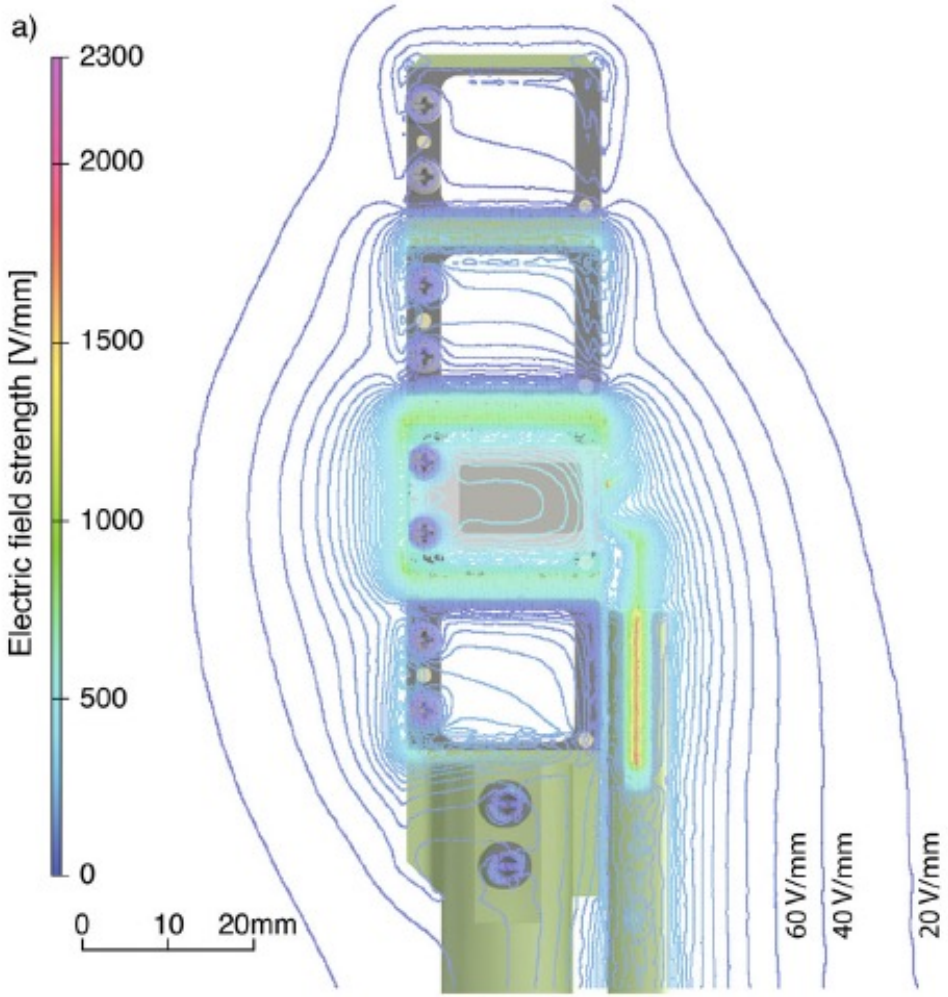


DOS-Cards

FEBEX

Suppressing delta electrons

- It is essential to suppress low-energy delta electrons
- 5000 V high voltage is applied to the target ladder
- The absorber foil (12 μm mylar coated with 0.5 μm aluminium) prevents low-energy electrons and scattered particles from hitting the detector



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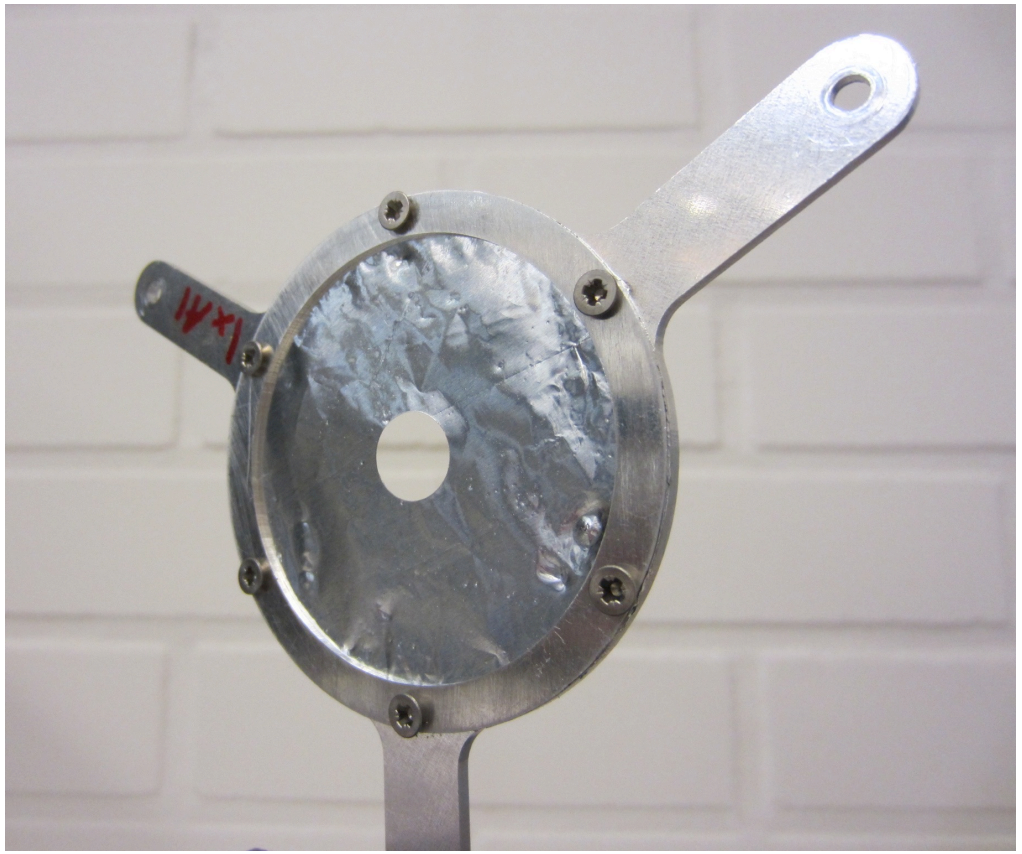

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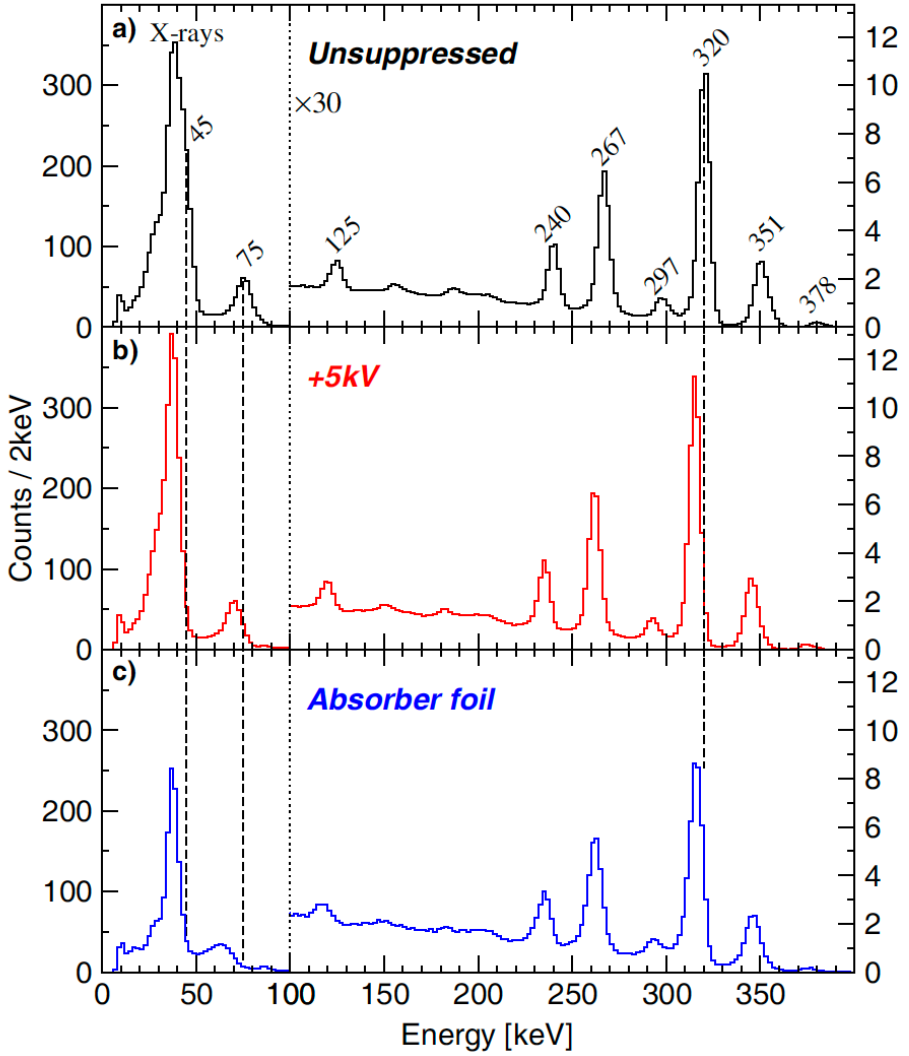
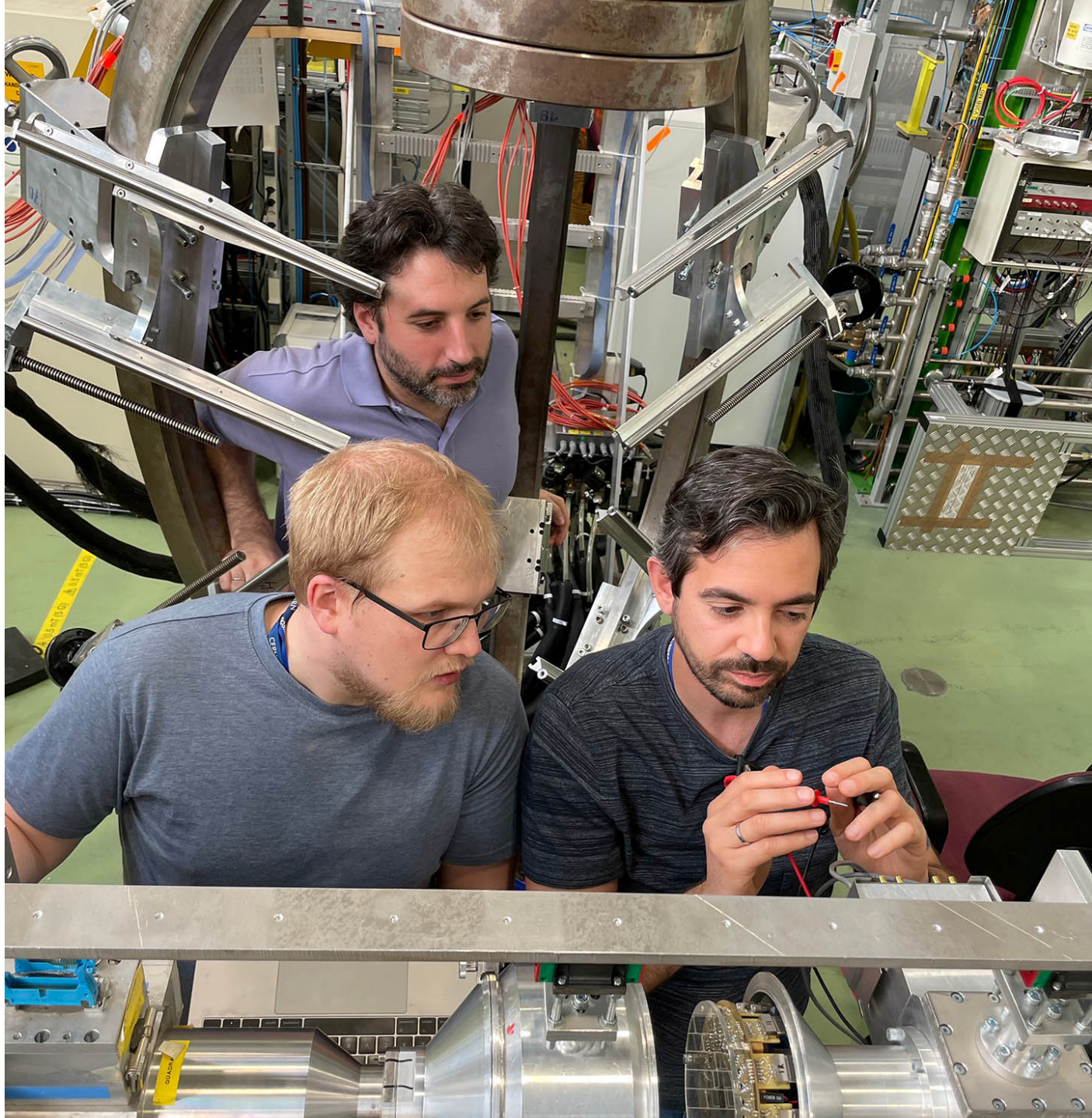


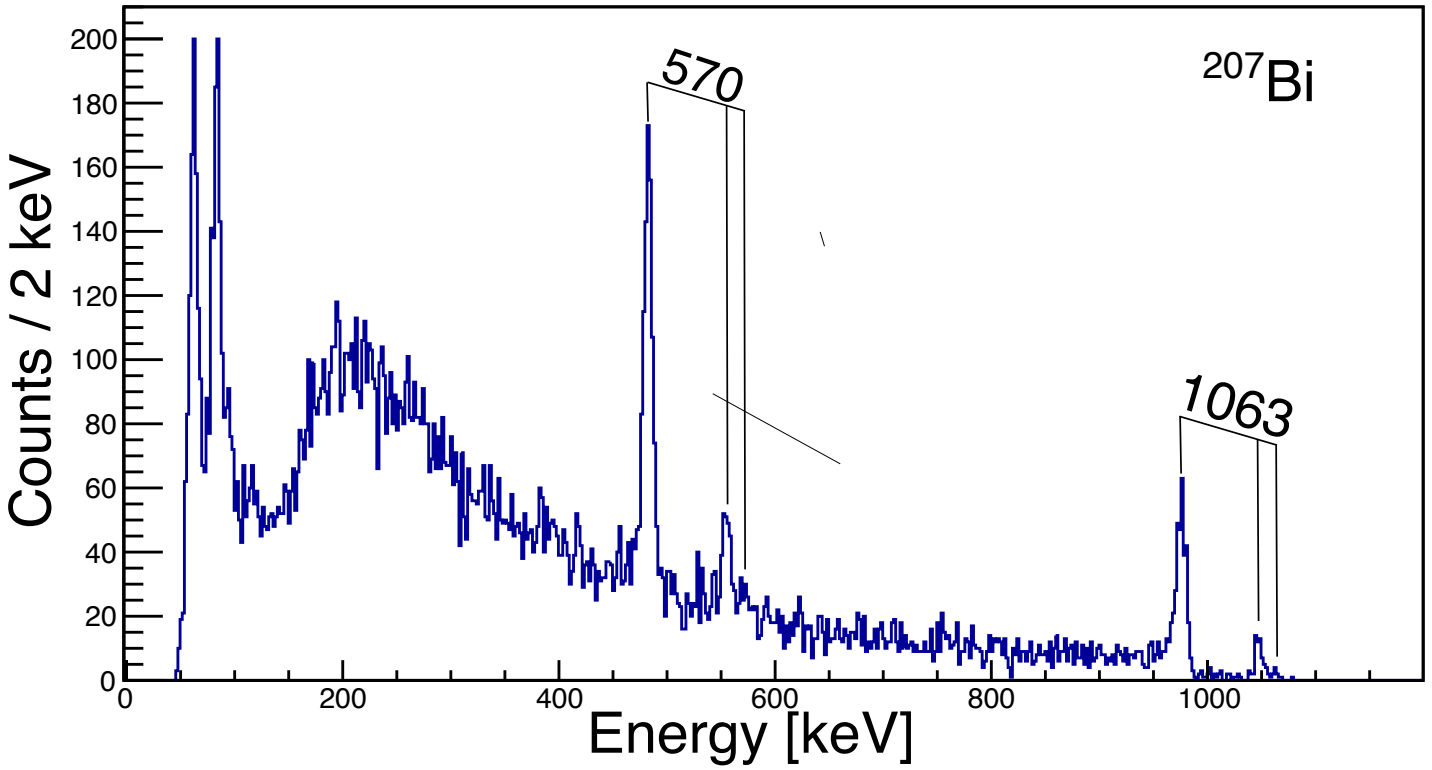
SPEDE Installation summer 2022

- Installation started May 2022
- Setting up electronics/devices (HV, Preamps, DOS-Cards, Julabo)
- Alignment of the target chamber
- Prepare the MINIBALL array
- New DAQ @MINIBALL



SPEDE Installation summer 2022

- FWHM @ 482 keV : ~8 keV (MCA)
- FWHM @ 482 keV : ~10 keV (DAQ)
- Due to preamp signal shape, the resolution depends on the DAQ
- Efficiency @ 482 keV : ~4%
- There is a clear need for a ^{133}Ba electron source for efficiency below 400 keV!

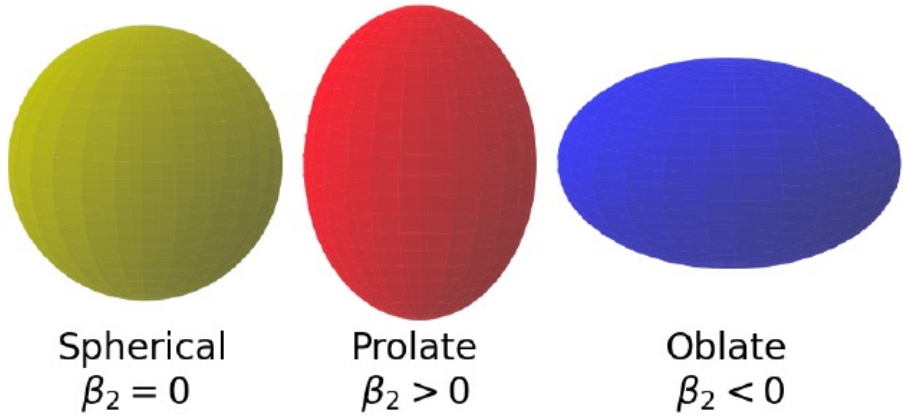


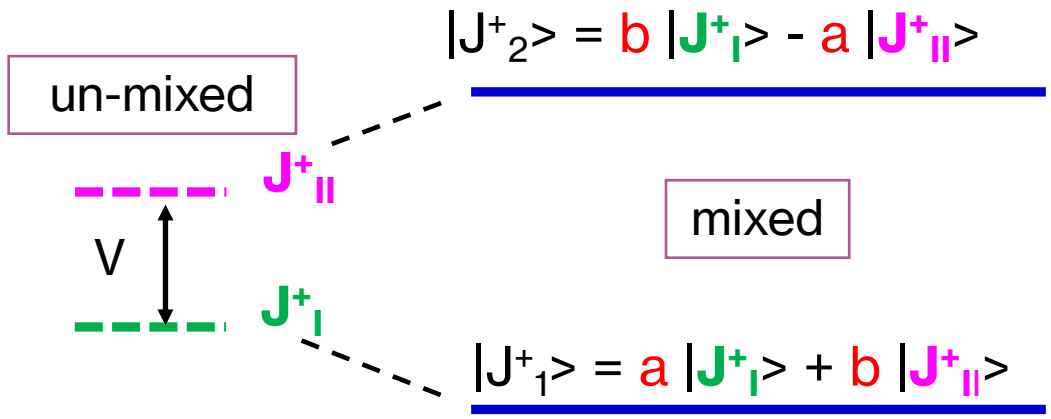
Why conversion electron spectroscopy?

- Allows to be sensitive to E0 transitions which mainly proceed via internal conversion
- The mixing of E0, M1 and E2 transitions in the $I \rightarrow I$ interband transitions
- The Coulex experiment makes it possible to populate the non-yrast structure with different mechanisms-> Cleaner electron spectrum for non-yrast structures than via fusion evaporation reactions
- The structural information of the nucleus can be obtained with the transitions strengths $\rho(E0)$

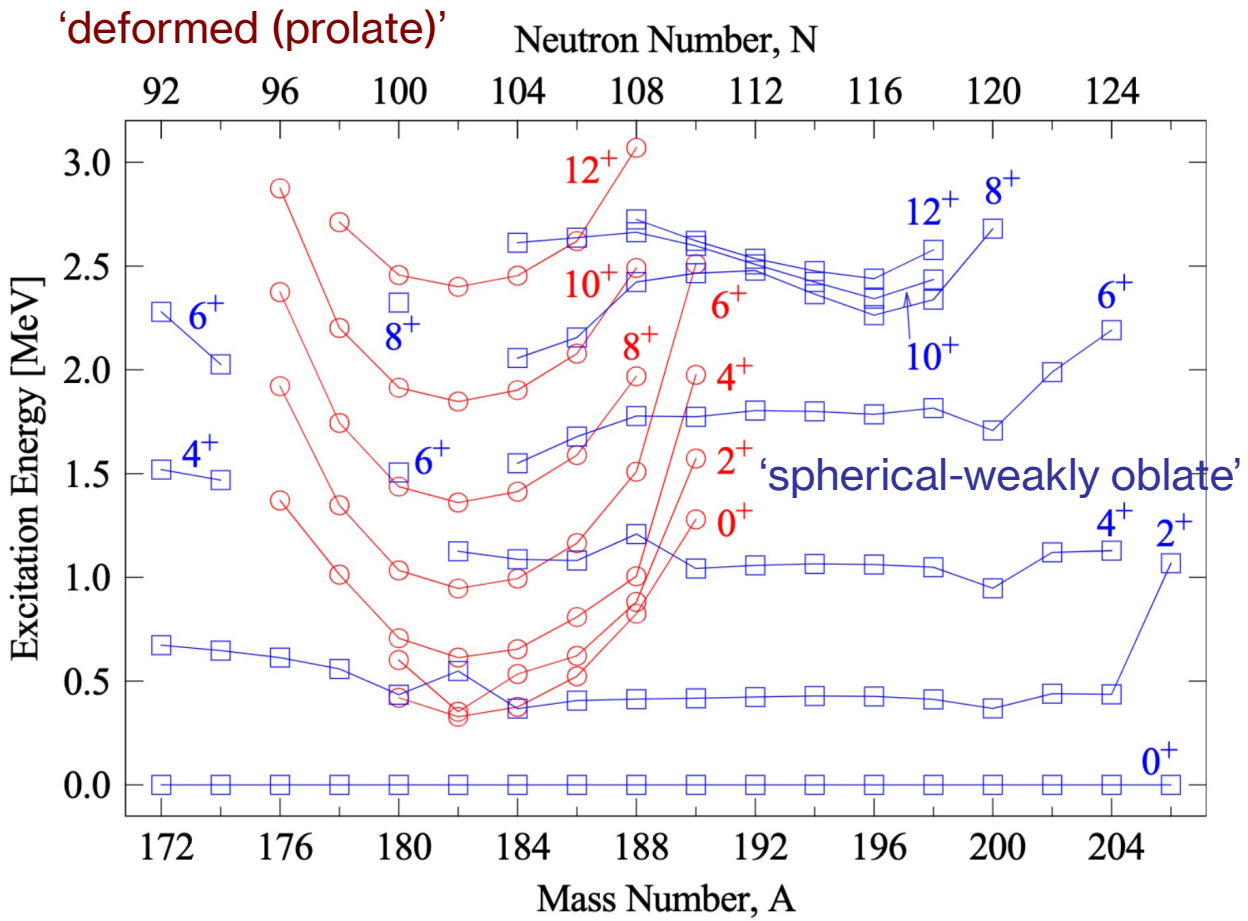
Shape mixing

- To obtain transition strength, one needs to know a lifetime of state and intensity of $E0$ transition
- $|\rho(E0)|^2 = \frac{1}{\tau(E0)\Omega(Z,E)}$
- A large $\rho(E0)$ transition strength value would indicate large mixing between different states
- Two-level mixing:
  - $\rho(E0)^2 = \frac{3}{4\pi}a^2b^2(\beta_1^2 - \beta_2^2)^2$
  - a, b are the mixing amplitudes
  - β is the deformation parameter





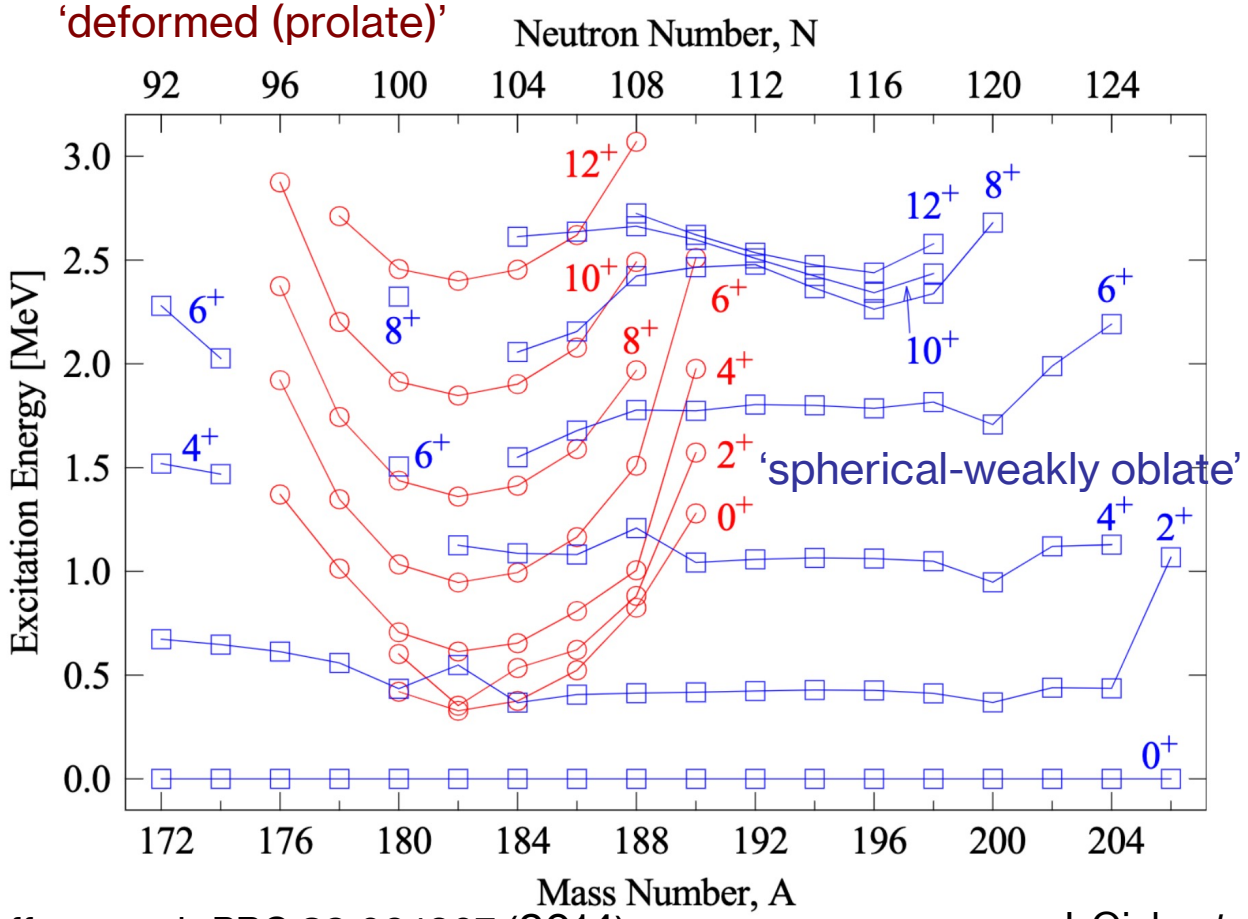
Shape coexistence in the Hg region



L. P. Gaffney, et al., PRC **89** 024307 (2014)

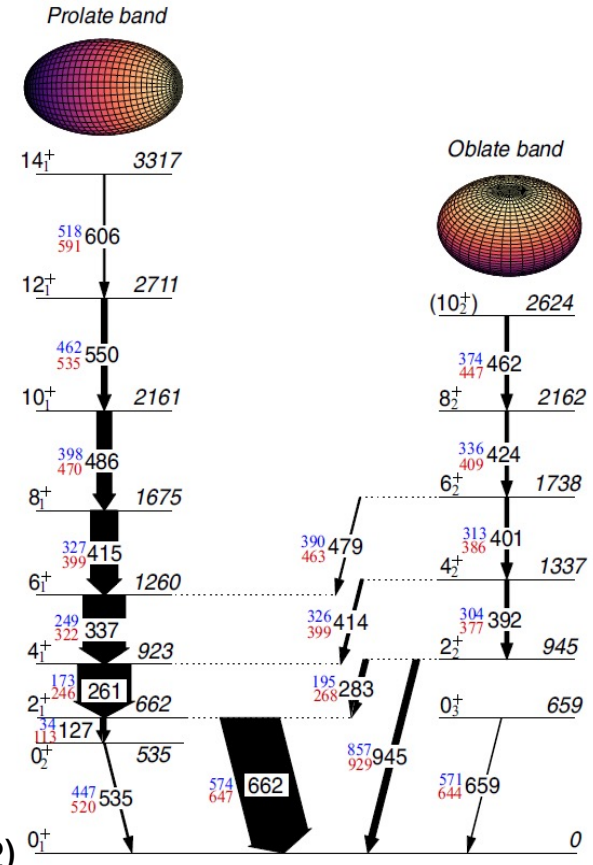
Shape coexistence in the Hg region

‘deformed (prolate)’



L. P. Gaffney, et al., PRC **89** 024307 (2014)

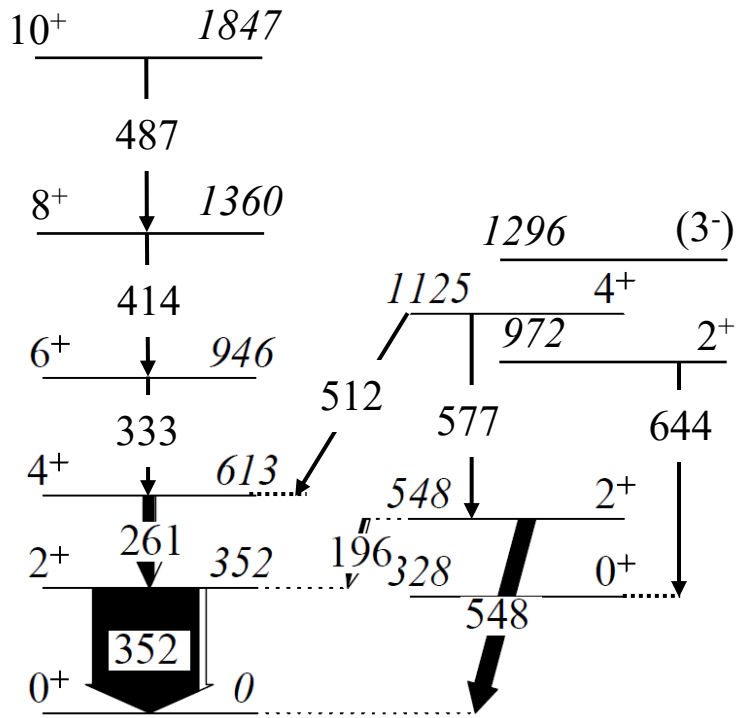
Example:
Combined γ-ray and conversion electron spectroscopy of ^{186}Pb



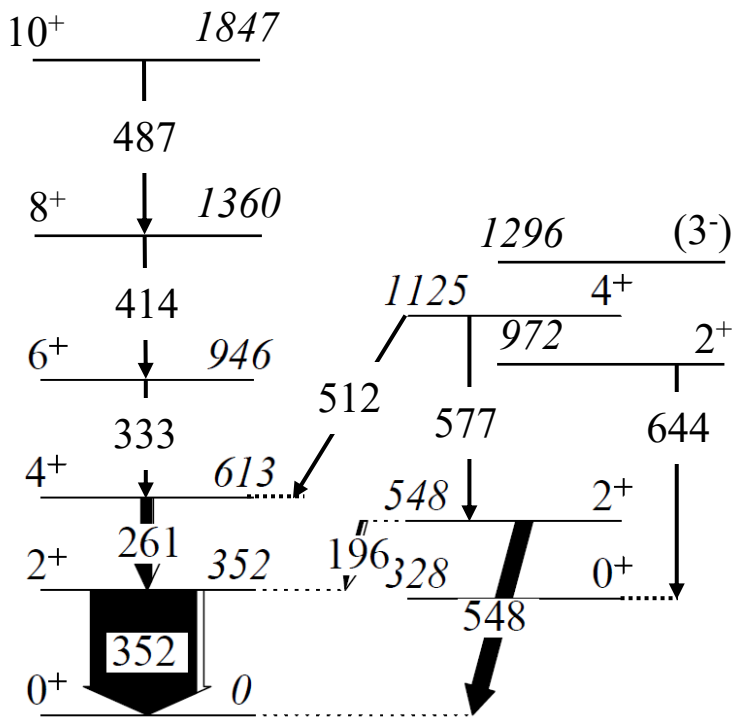
J. Ojala *et al.*, Nature Com. Phys 5 (2022)

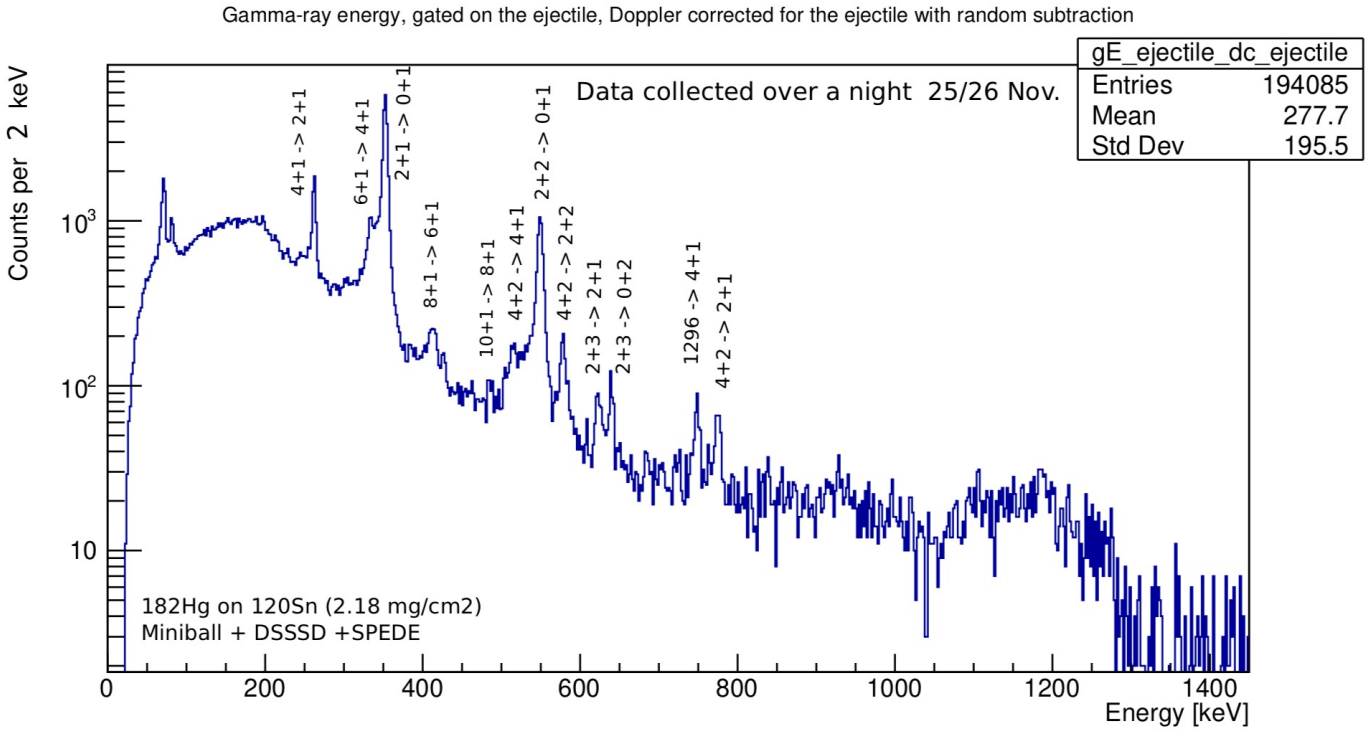
IS563: ^{182}Hg Coulex experiment

- Beam:^{182}Hg beam,
- Target:^{120}Sn
- The first radioactive ion beam experiment with SPEDE!!
- Objective: Reduce errors of diagonal matrix elements of 2^+ states to level where negative, zero and positive quadrupole moments can be distinguish
- SPEDE can be used to assess the intensity of E0 $2^+ \rightarrow 2^+$ transition



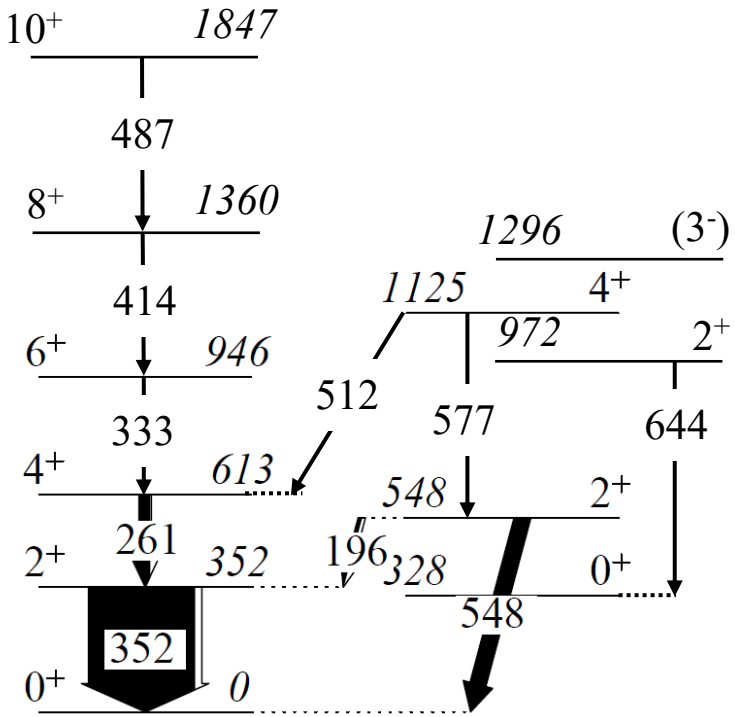
IS563: ^{182}Hg Coulex experiment

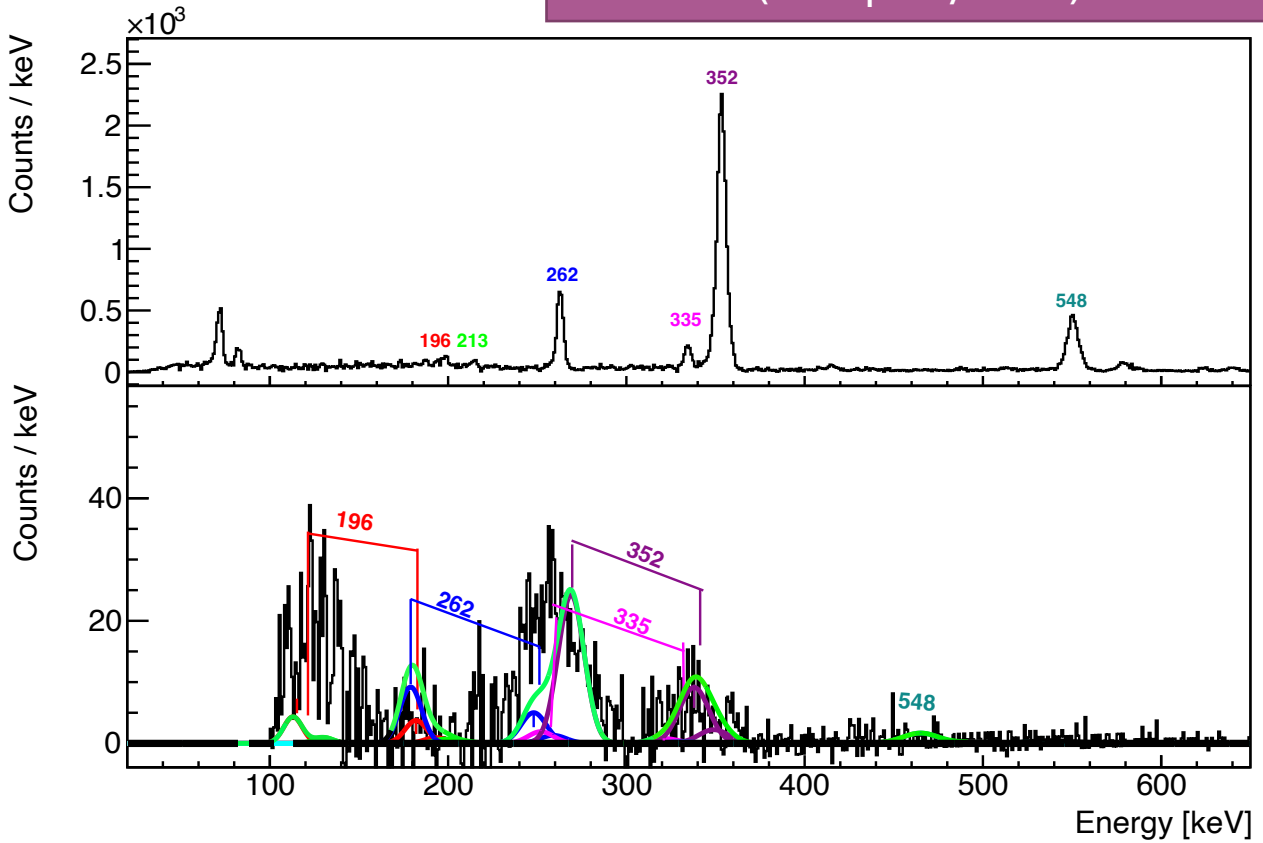




IS563: ^{182}Hg Coulex experiment

Subset of overall data
Analysis by Adrian Montes Plaza
(Liverpool/JYFL)





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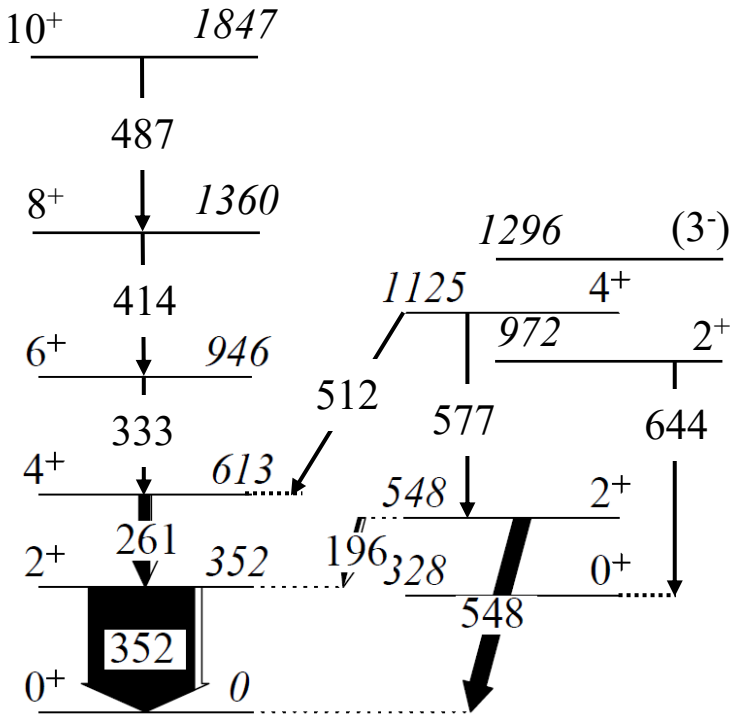

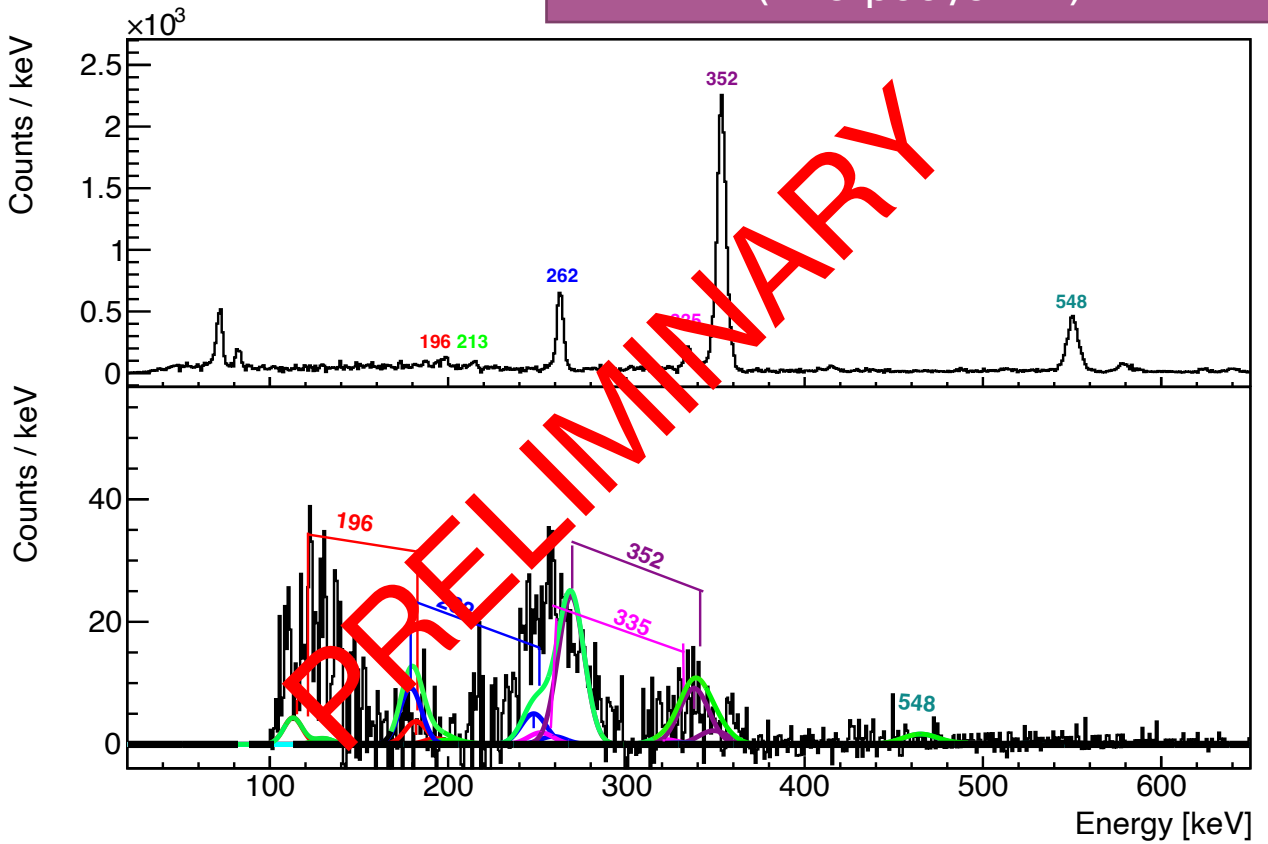

SUMMARY

- SPEDE was used for the first time at HIE-ISOLDE
- Further analysis for ^{182}Hg is needed
- The upcoming experiment ^{184}Hg and ^{185}Hg with new DAQ firmware!

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UNIVERSITY OF JYVÄSKYLÄ

ISOLDE

UNIVERSITY OF LIVERPOOL

SUOMEN AKATEMIA

KU LEUVEN

SEVENTH FRAMEWORK PROGRAMME

TECHNISCHE UNIVERSITÄT DARMSTADT

University of Cologne

UKRI Science and Technology Facilities Council