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14-18 Settembre 2020

DESPEC phase-0 campaign at GSI

Experimental study of proton-rich nuclei in the ^{100}Sn region

14th-18th September 2020

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Outline

- Introduction: Case study
- Experimental details
- Analysis techniques
- Preliminary results
- Conclusions and outlook

Collaboration

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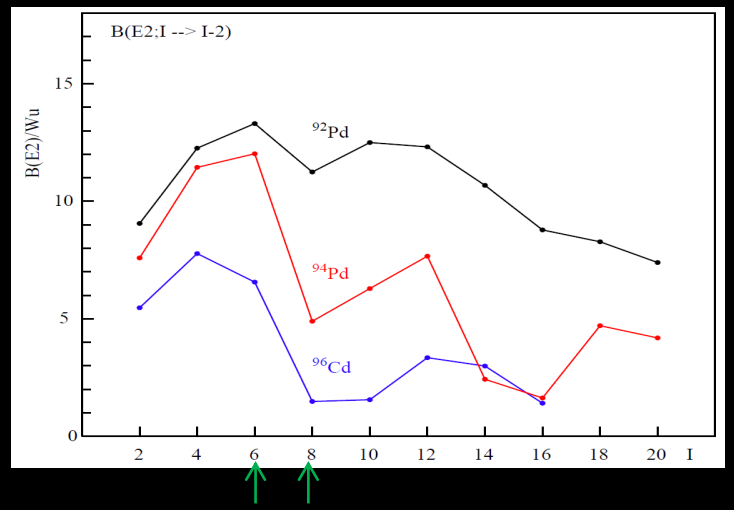
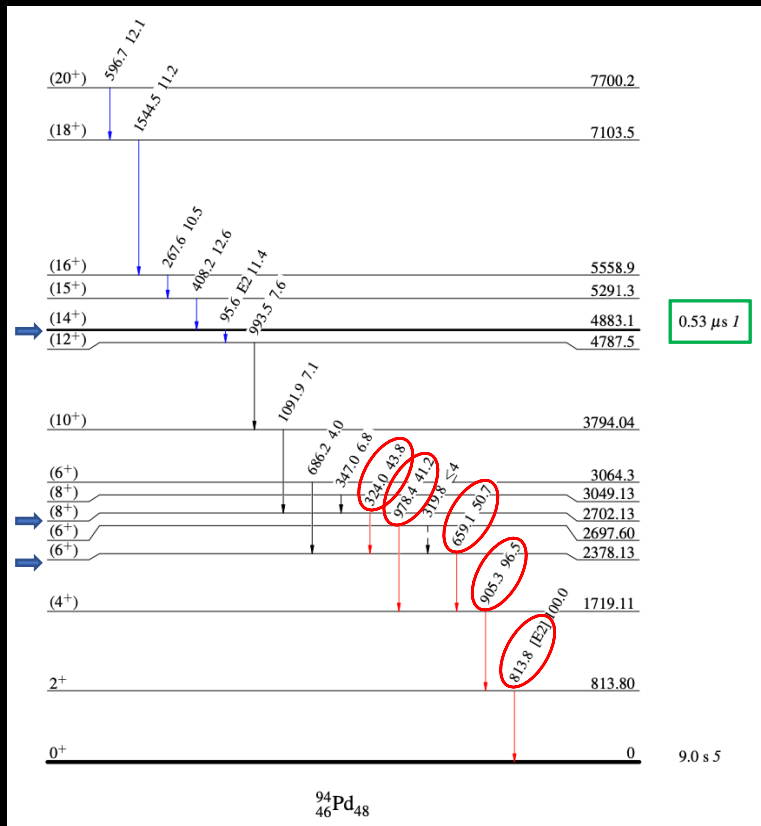
Case study: seniority isomers in ^{94}Pd



The experiment was focused on the proton rich nuclei along the N=Z line between A=90 and A=100:

- **Seniority isomers study in ^{94}Pd**
- **Proton emission in ^{89}Rh and ^{93}Ag**



M. La Commara et al., Nucl. Phys. A, 708 (2002) 167-180

Strong **drop in the B(E2) value** in the 8+ → 6+ transition between ^{92}Pd and ^{96}Cd

- Verification of **Shell Model calculations** for the most proton rich Pd isotopes

^{94}Pd provides a stringent test for the various models :

- Measurement of lifetimes of the known **6+, 8+ states** below the **14+ isomer**

Case study: Search for proton emission in ^{89}Rh and ^{93}Ag

The astrophysical rp-process is active in **Type I X-ray bursts**, thermonuclear runaways on the surface of neutron stars in close binary systems.

Protons are fused successively to generate nuclei in the vicinity of ^{100}Sn,

⟶ **gamma-α reactions** ⟶ **α-unbound nuclei**

Waiting points:

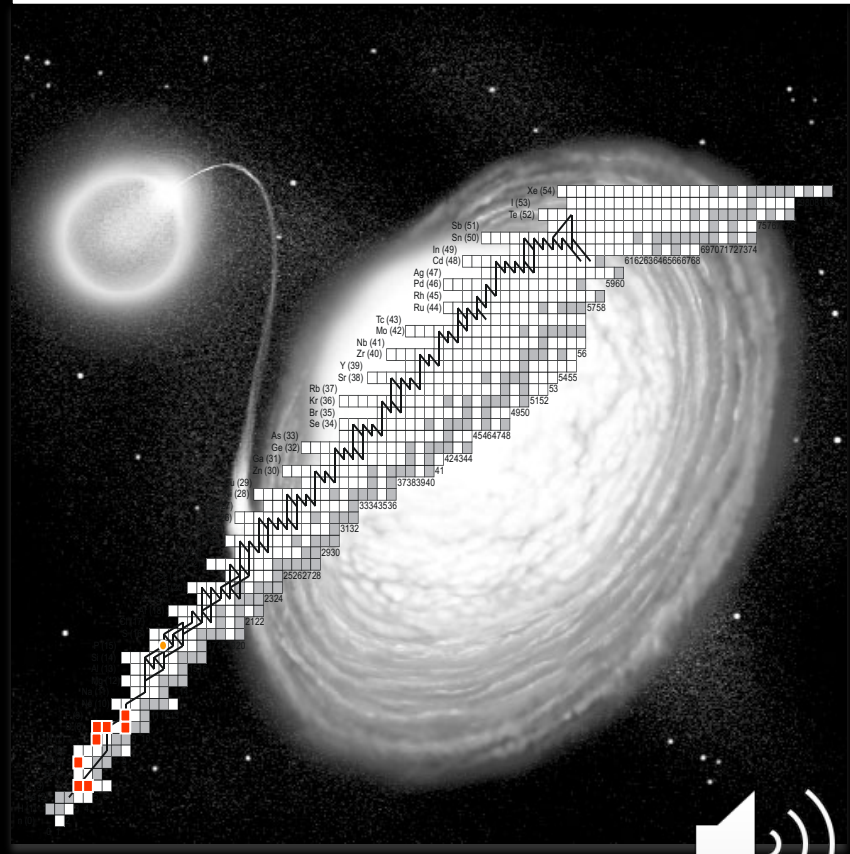
⟶ Enhancement of mass abundance of the considered isotope

⟶ Shaping of the composition of the rp-process ashes

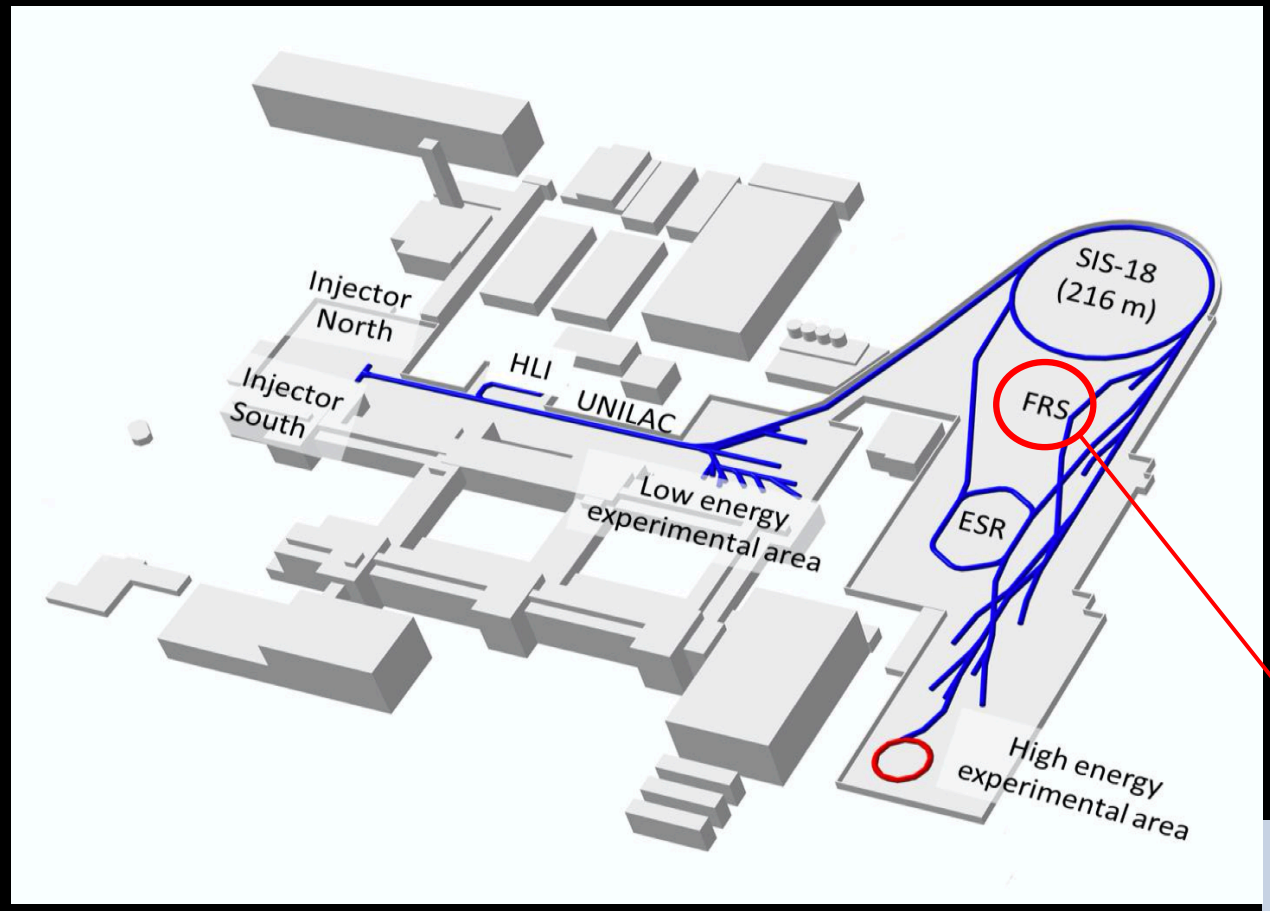
Predicting this composition reliably is important for the understanding of:

- **neutron-star crusts**
- **the origin of ^{92,94}Mo and ^{96,98}Ru**

H. Schatz et al., Phys Rev. Lett. 86, 3471 (2001)

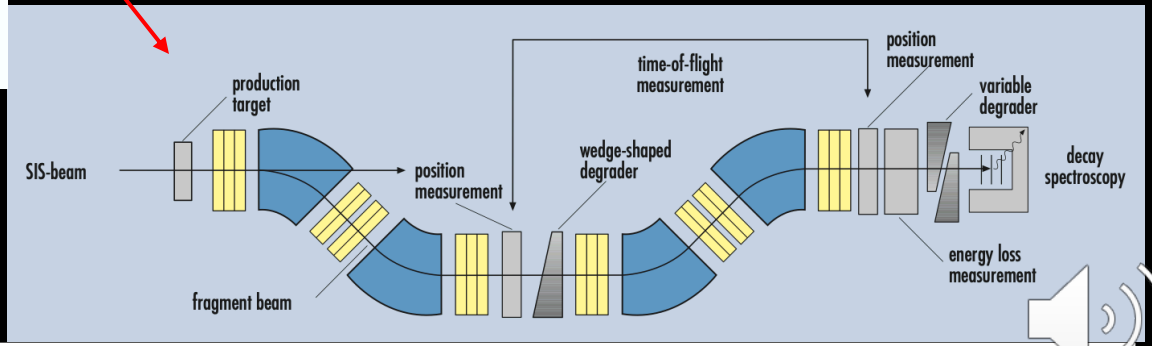


GSI facility and FRS

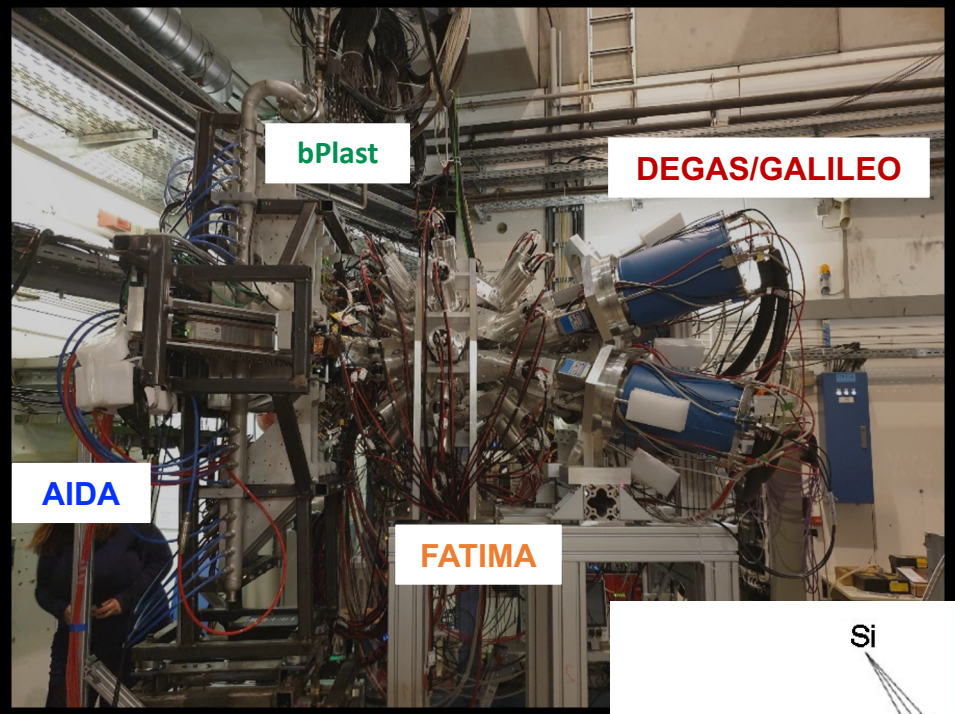


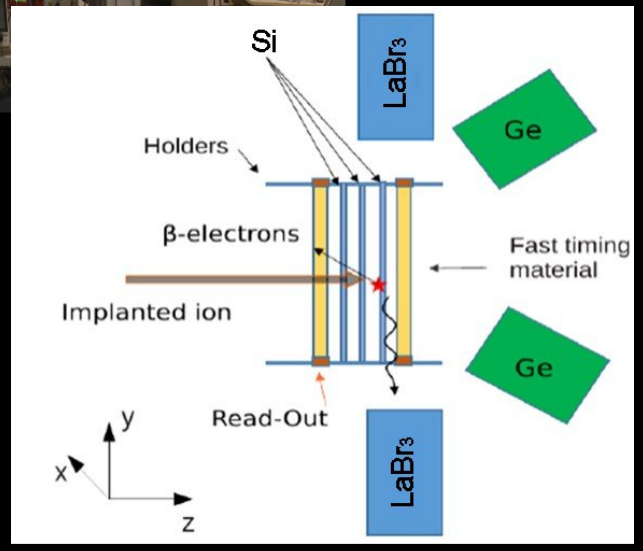
The nuclei of interest were produced using the fragmentation of a **^{124}Xe beam** at an energy of **850MeV/nucleon**.

- Acceleration of heavy ion beams with:
  - **UNILAC** (linear accelerator)
  - **SIS18** (synchrotron)
- Selection and transport using:
  - $\beta\rho - \Delta E - \beta\rho$ method
  - $ToF - \beta\rho - \Delta E$ method
- Identification via the measurement of:
  - The ratio of **mass number over ionic charge** A/Q
  - The **atomic number Z** or the **X position** in the final focal plane



FRS+DESPEC at GSI-FAIR: the β decay station





The setup is composed of:

- **AIDA**: a stack of three DSSSD detectors
  8x8 cm^2, 1 mm thick, 128x128 strips
- **bPlast**: fast plastic detector
  BC-400 scintillator material
- **DEGAS/GALILEO**: HPGe array for gamma detection
  arranged into 6 triple clusters
- **FATIMA**: array of 36 $LaBr_3$(Ce) of dimensions 1.5" diameter and 2" length

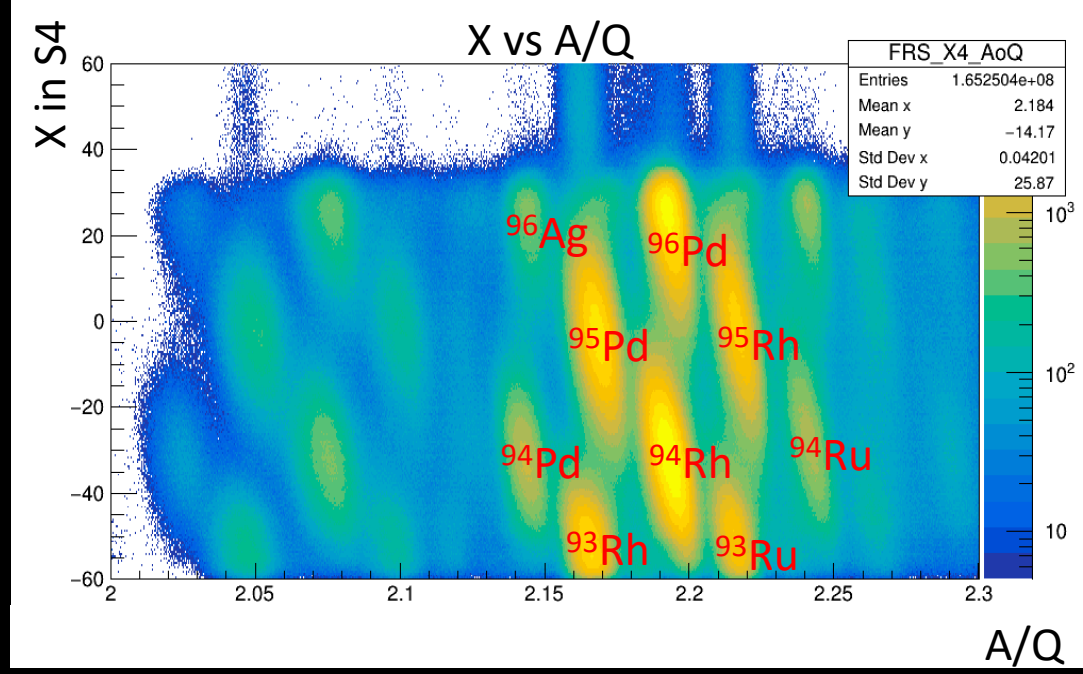
Ion → Isomers
Ion → β decay → γ rays

Identification of the ions of interest

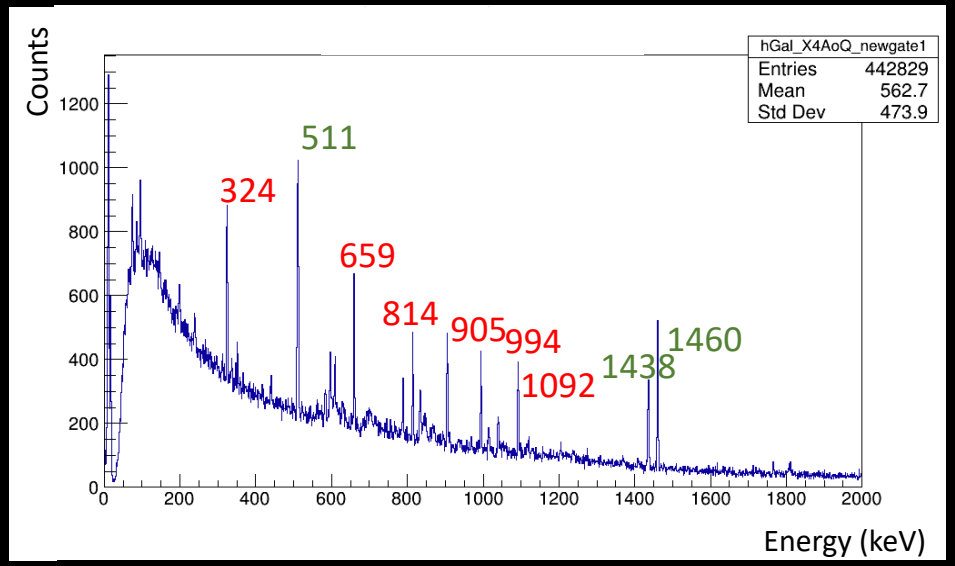
- ✓ Recontruction of the ions of interest via ID plots
- ✓ Identification of corresponding γ transitions in the HPGe energy spectra

Ongoing:

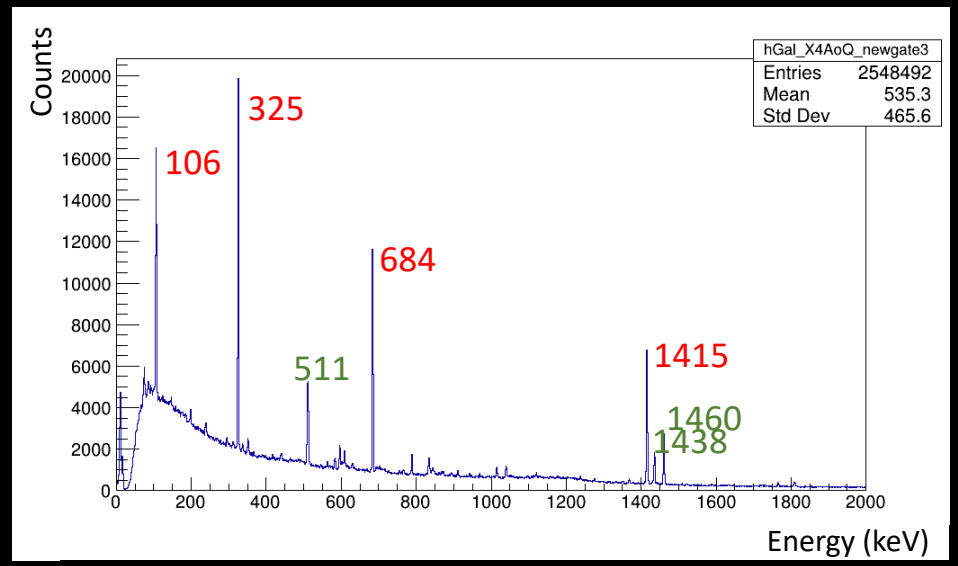
- Search for additional γ-ray transitions
- Level's lifetime measurements



^{94}Pd



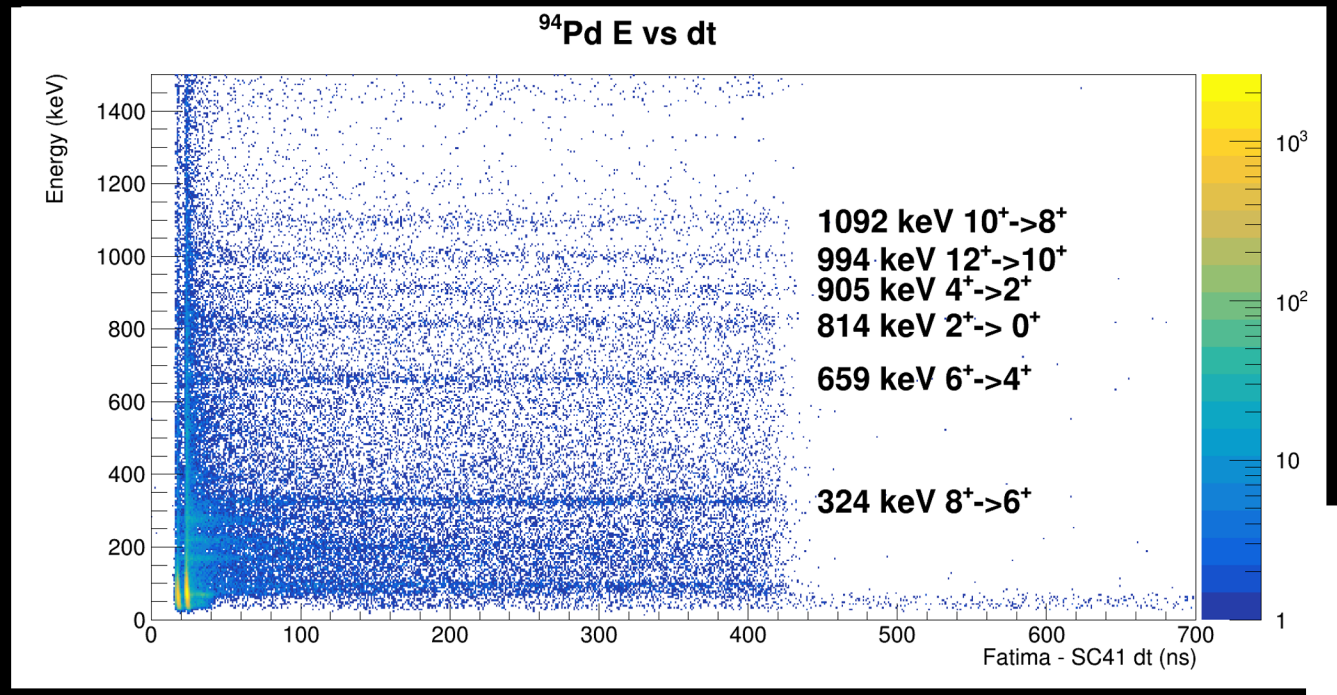
^{96}Pd



Transitions from the nucleus of interest

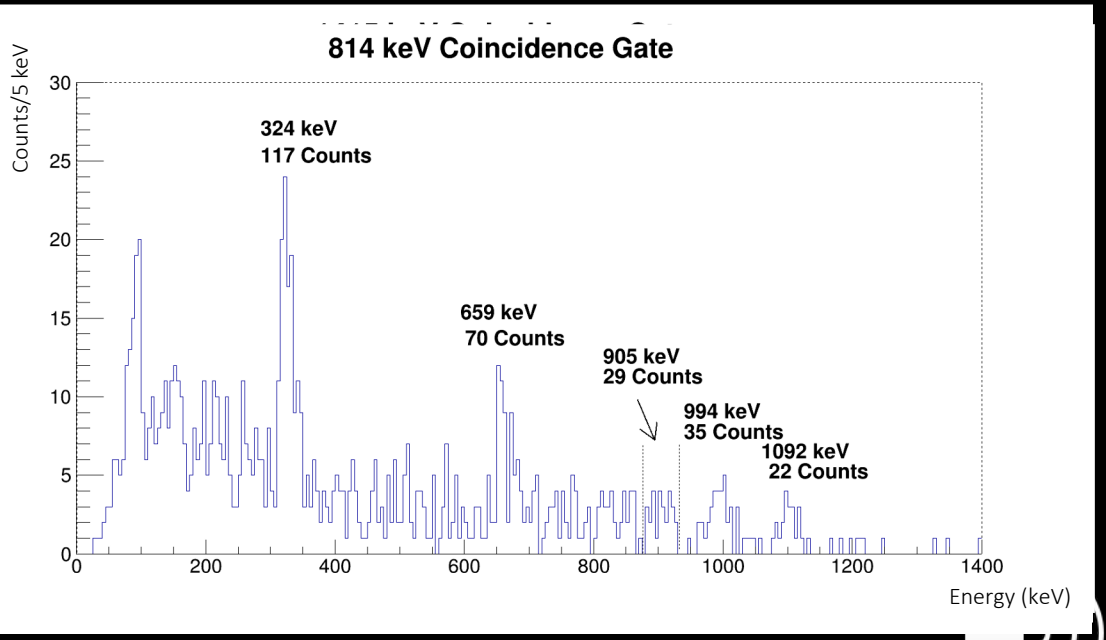
Background and FATIMA self activity

Isomers lifetime measurements: ^{96}Pd and ^{94}Pd



Reference case!

New input!

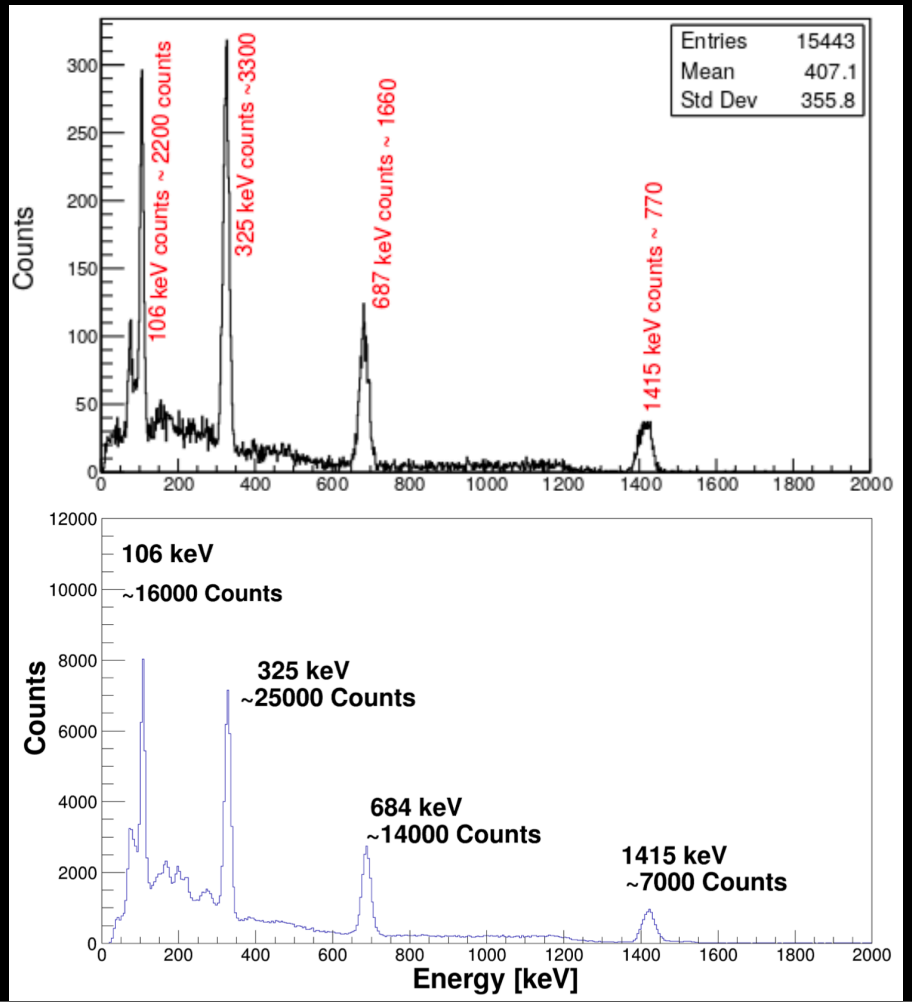


Courtesy of S. Jazrawi

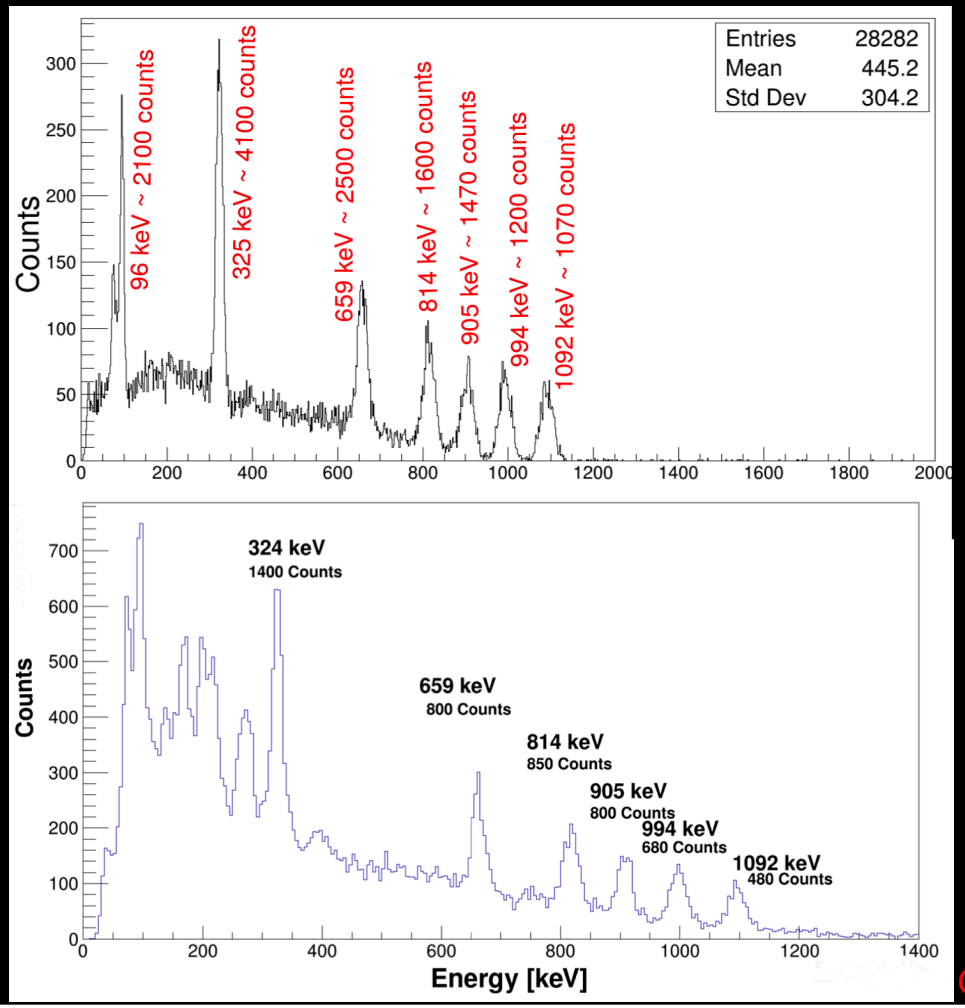
Comparison with simulations

The data were used to fine tune **GEANT4 simulations**:

^{96}Pd



^{94}Pd



Courtesy of [illegible]Ishii

Conclusions and outlook

Experimental study in the N=Z region between A=90 and A=100 to search for seniority isomers in ^{94}Pd and proton emitters in the vicinity of ^{100}Sn.

✓ Final commissioning of the **DESPEC setup** and **analysis techniques**

✓ Successful identification of the **ions of interest** and **isomers**

Further developments:

- Ongoing **lifetime studies** for isomers in ^{94}Pd
- The **β decay** of the species is under study

Thank you for your attention!