

Report on the AGATA experiment number 25.13

Particle–Gamma Correlations for the $^7\text{Be} + ^{208}\text{Pb}$ System at Near-Barrier Energies

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Scientific Motivation & The ^7Be Case

With this experiment, we are interested in studying **reaction dynamics induced by light weakly-bound Radioactive Ion Beams (RIBs)** at energies around the Coulomb barrier.

Historically, these measurements were aimed at understanding the fusion cross-section behaviour, and experimental work has shown that the weak binding of these projectiles mainly increases the total reaction probability rather than fusion itself.

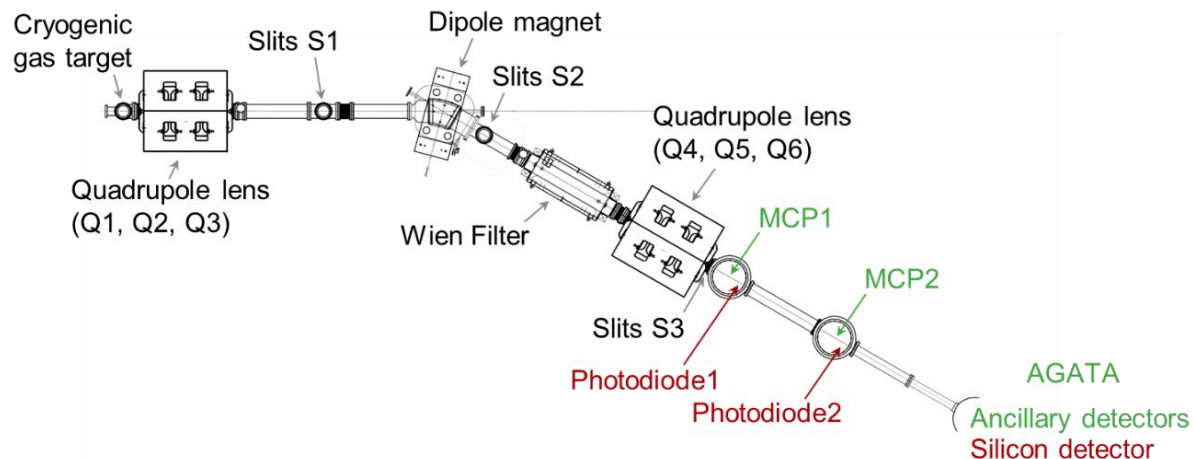
To untangle the underlying mechanisms, coincidence measurements are essential. Therefore, we investigated **^7Be -induced reactions** at near-barrier energies. ^7Be serves as an ideal system **to study the interplay between breakup and transfer mechanisms** due to its unique characteristics:

- ✓ **Low binding energy:** Lightest particle-stable beryllium isotope with a low breakup threshold ($S_\alpha = 1.586 \text{ MeV}$).
- ✓ **Pronounced cluster structure:** Clear $^3\text{He} + ^4\text{He}$ configuration.
- ✓ **Favorable fragments:** Both constituent clusters are highly stable with comparable masses, making the reaction channels easier to observe.

Experimental Setup: EXOTIC & SAURON

EXOTIC

The ^7Be radioactive ion beam produced at the EXOTIC facility. **EXOTIC can produce light, weakly-bound Radioactive Ion Beams (RIBs) using the in-flight technique.**

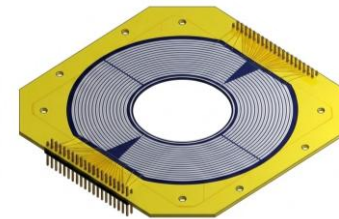


SAURON

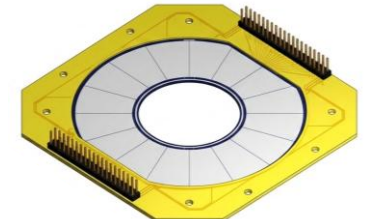
SAURON is a ring-shaped Double-Sided Silicon Strip Detector (DSSSD) that enables Pulse Shape Analysis (PSA) for particle identification.

Its segmentation consists of:

- Front (p-side): 4 quadrants $\times$ 16 rings (64 strips)
- Back (n-side): 16 radial sectors (pads)

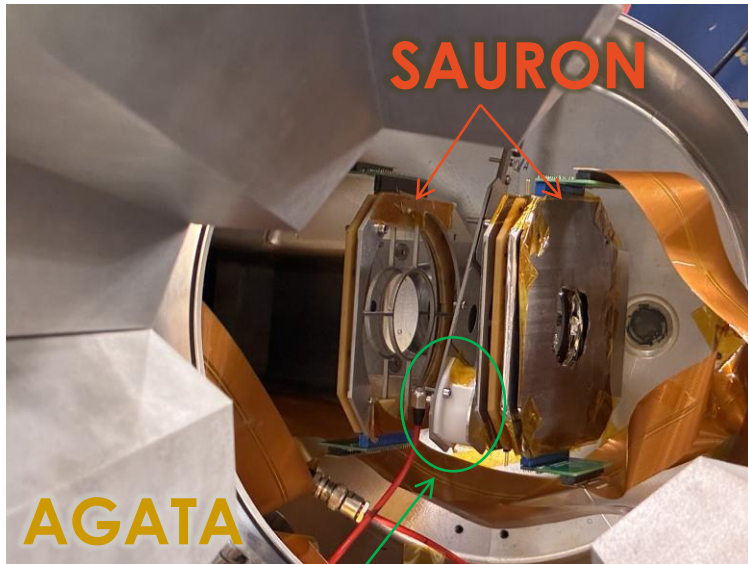


SAURON Front (64 strips)



SAURON Back (16 pads)

Experimental Setup (EXOTIC + SAURON + AGATA)

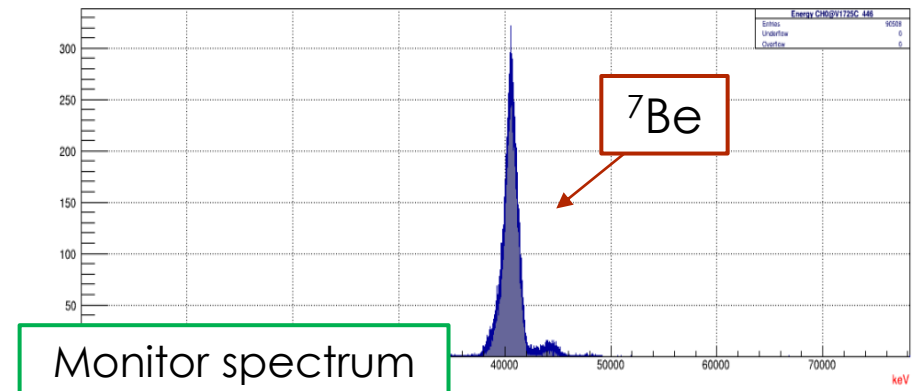


Silicon «monitor»

Surface barrier Si detector mounted on the target ladder to monitor the beam delivered

EXPERIMENTAL DETAILS:

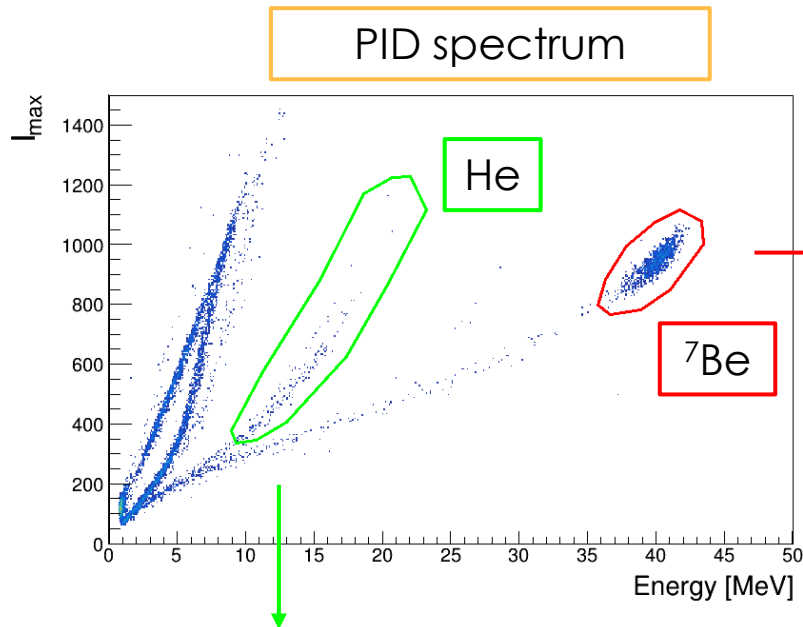
- **Target:** ^{208}Pb 2 mg/cm² on ^{12}C backing
- **Primary beam:** $^7\text{Li}^{+3}$ at 48 MeV ($3 \cdot 10^{11}$ pps)
- **RIB:** $^7\text{Be}^{+4}$ at 40.5 MeV ($1.6 \cdot 10^5$ pps)
→ Reaction: $p(^7\text{Li}, ^7\text{Be})n$



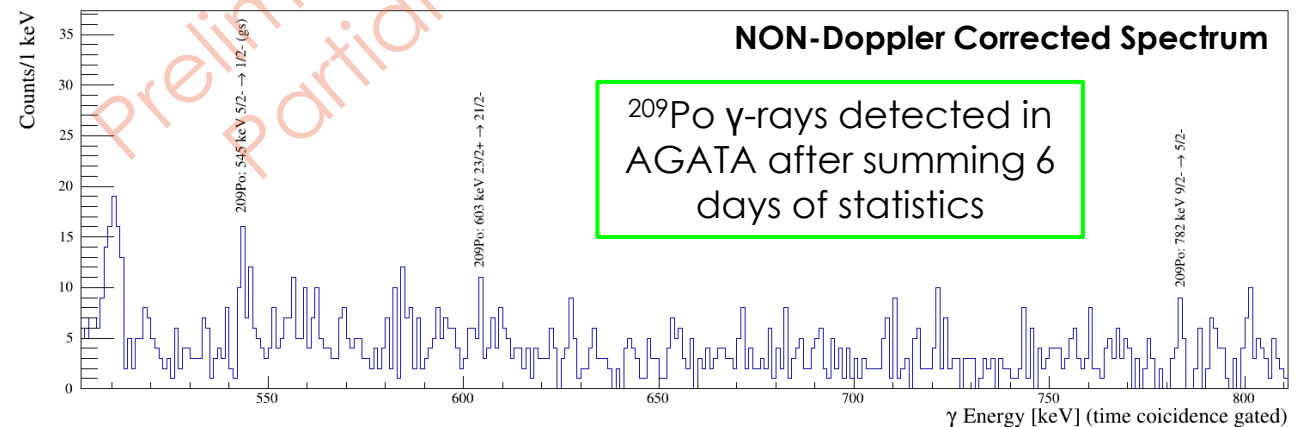
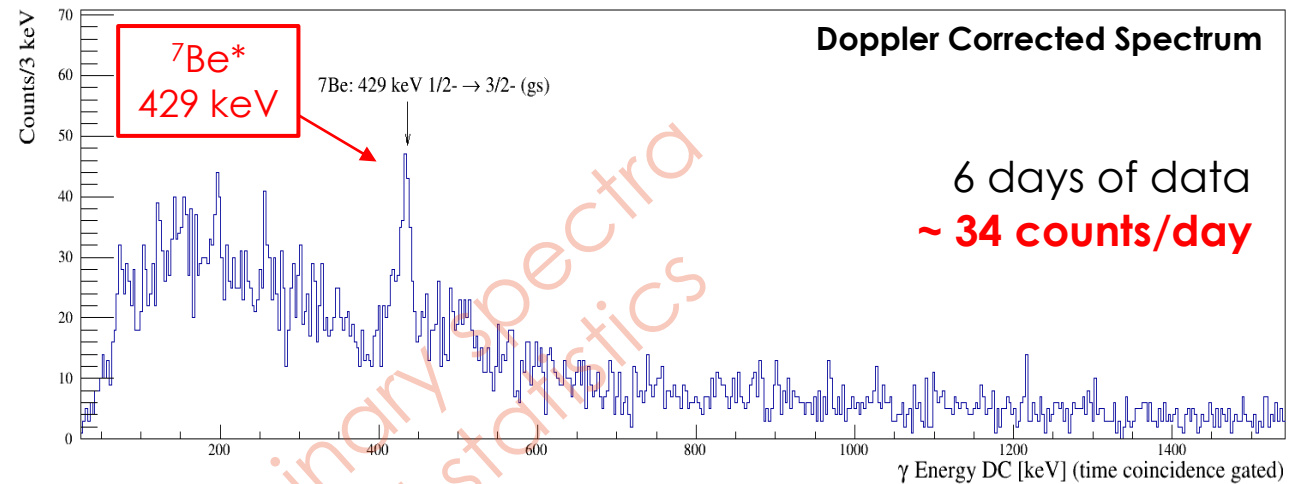
Spokepersons:

- Marco Mazzocco – Università degli studi di Padova, INFN sezione di Padova
- GaoLong Zhang – Beihang University, Beijing
- GuangXin Zhang – Sun Yat-sen University, Guangdong
- Sara Pigliapoco – Università degli studi di Padova, INFN sezione di Padova

Online spectra

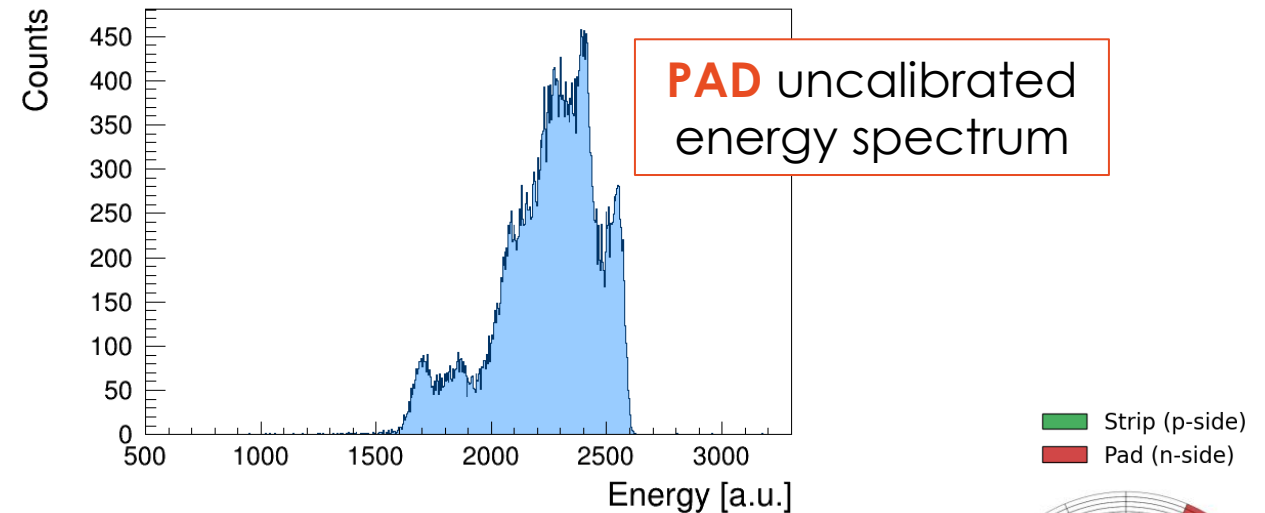
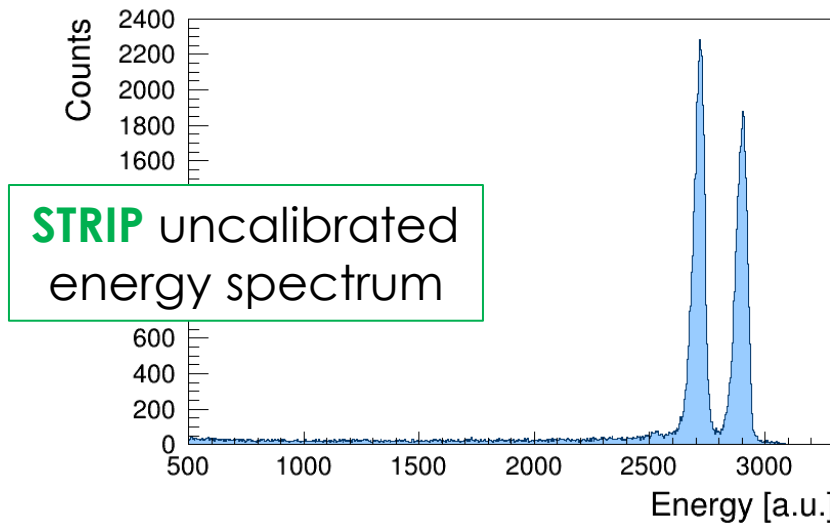


One of the reaction of interests is the transfer reaction of ${}^3\text{He}$ (from the break-up of ${}^7\text{Be}$ into ${}^4\text{He}$ and ${}^3\text{He}$) to ${}^{208}\text{Pb}$ producing ${}^{211}\text{Po}$ that evaporates $2n$ leaving ${}^{209}\text{Po}$



Ongoing Analysis: SAURON characterization

Uncalibrated double- α (^{241}Am - ^{244}Cm) energy spectra

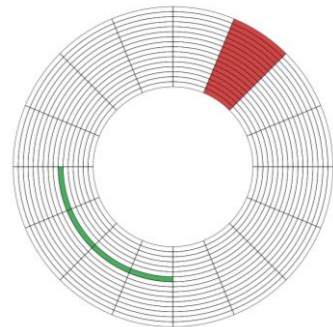


The discrepancy in the spectra comes from the **radiation damage due to elastic scattering**, which dominates the background in **previous experiments involving SAURON**

→ **Non-uniform radiation damage profile:**

- **Strips:** narrow polar-angle coverage
 - nearly uniform irradiation and damage
 - NO position-dependent calibration

- **Pads:** full polar-angle coverage
 - strong irradiation gradient
 - position-dependent calibration required



Ongoing Analysis: SAURON characterization

Position-dependent energy calibration for the **pads**:

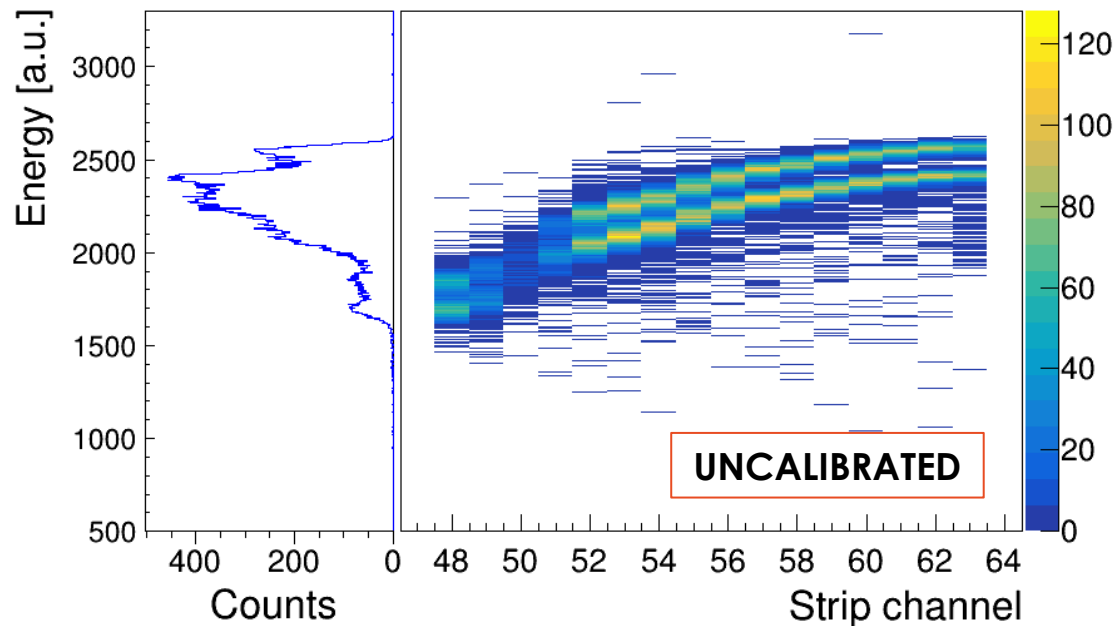


Fig 2.1: **Uncalibrated** energy spectrum of **pad 9**
SAURON Forward as a function of the strip
detected in coincidence

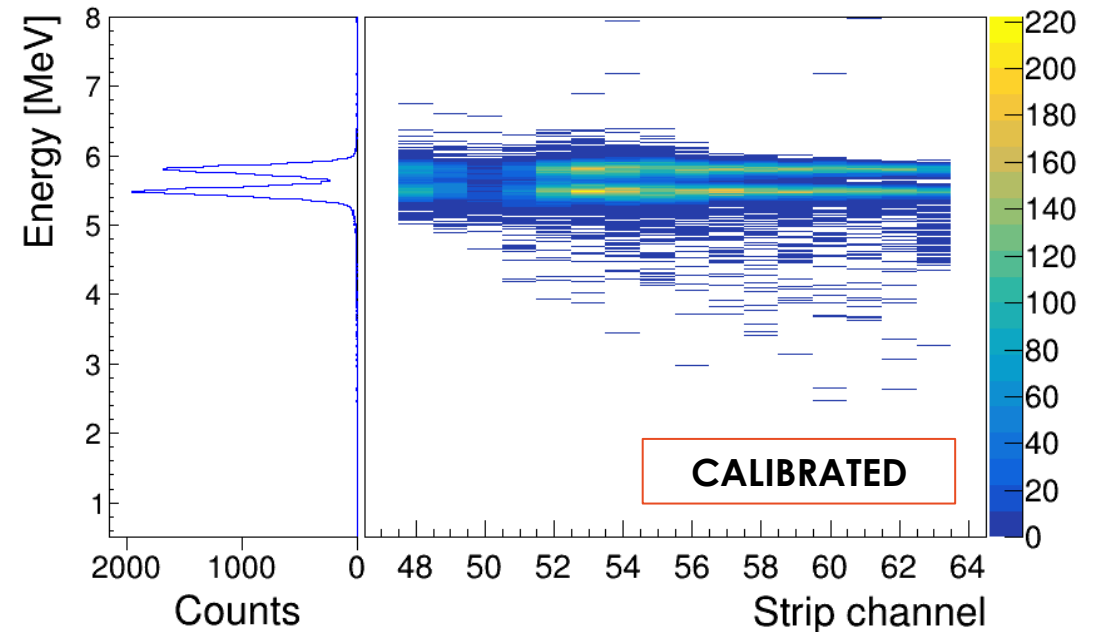
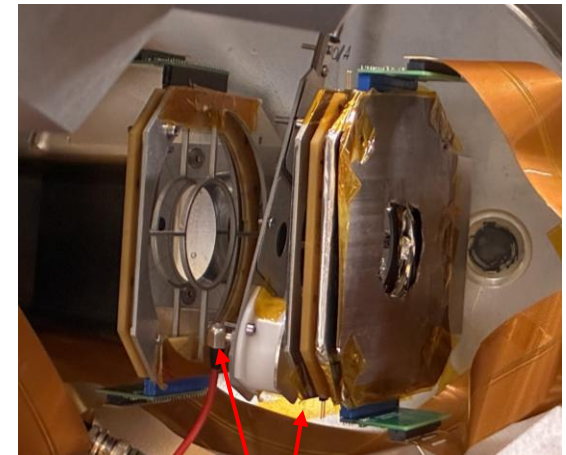
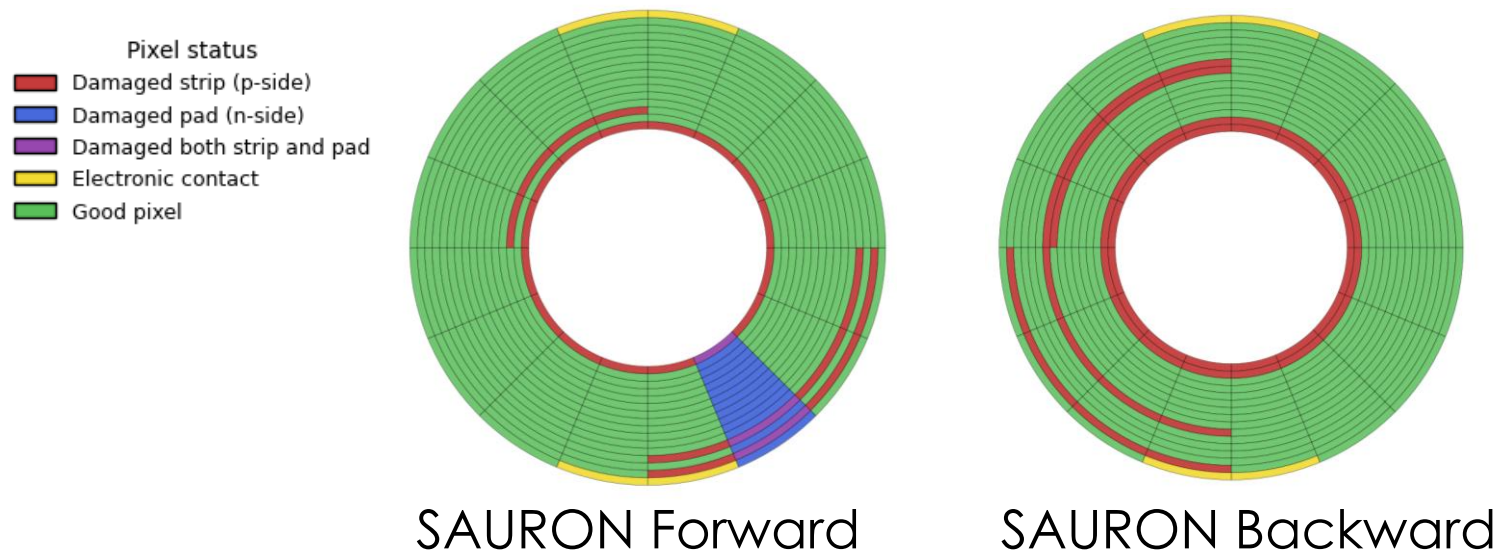


Fig 2.2: **Calibrated** energy spectrum of **pad 9**
SAURON Forward as a function of the strip
detected in coincidence

Ongoing Analysis: SAURON characterization

Maps showing the **working pixels** for both SAURON detectors identified during these initial stages of analysis



PROTECTIVE GUARD

The **inner rings** of the detectors were **shadowed by the protective guard** mounted in front of the detectors, to protect them from getting damaged while moving the target ladder

Going Forward

SAURON analysis:

- **Apply calibration** to the experimental data
 - Calibration points from the α -source are $\sim 5 \text{ MeV}$, while the experiment energy range is up to **40 MeV**
- **Analyze $^7\text{Be} + ^{208}\text{Pb}$ elastic scattering**
 - Identify ^7Be from the PID matrices
 - Verify the calibration using simulations
 - Eventually refine the calibration
- **Investigate radiation-damage effects** on the elastic scattering $^7\text{Be} + ^{208}\text{Pb}$

Thank you for the attention!

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