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Preliminary look at the energy response of ALICE ITS3 babyMOSS to a mixed Ion beam

Roberto Baccomi, Paolo Camerini, Giacomo Contin, Tommaso Fagotto, Laura Gonella, Giovanni Vecil, Anna Villani*

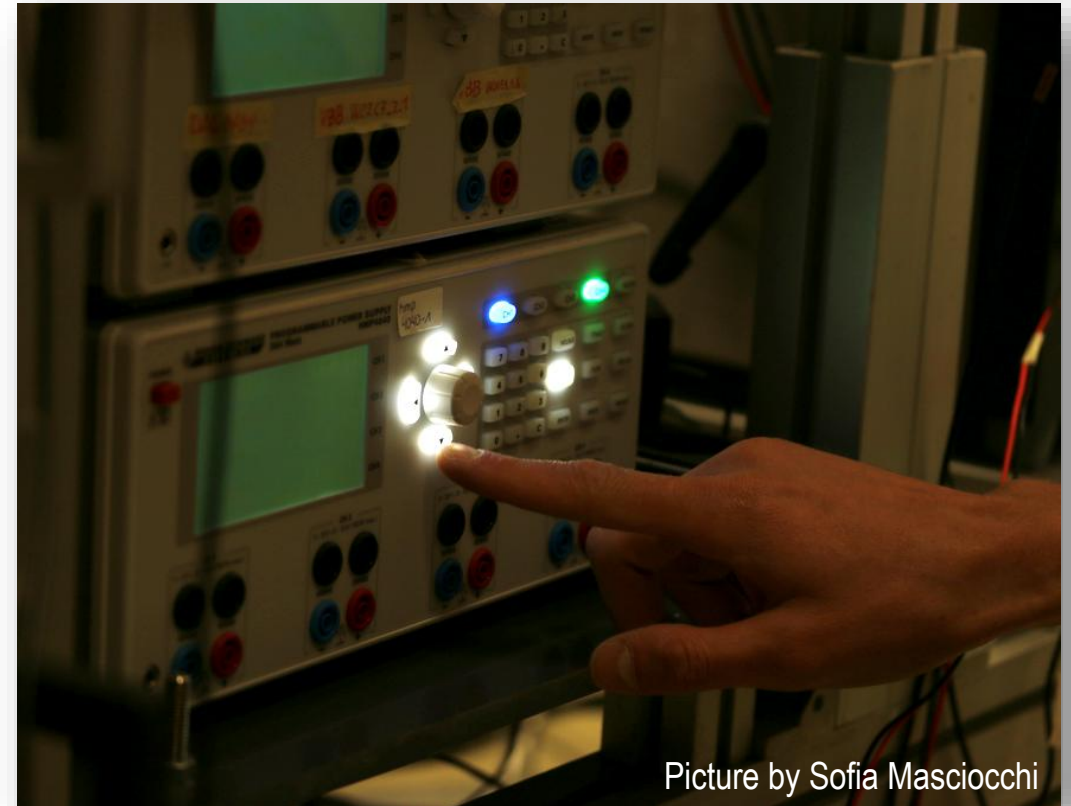
10-11 September 2025, Trieste, Italy,
ELMA Workshop on Energy loss
measurements with MAPS



Ministry of Foreign Affairs
and International Cooperation

Picture by Sofia Masciocchi

- The ELMA project
- The ELMA setup at GSI
- TOF and energy loss measurements
- Measurements with ALICE ITS3 MAPS prototypes
- Conclusions



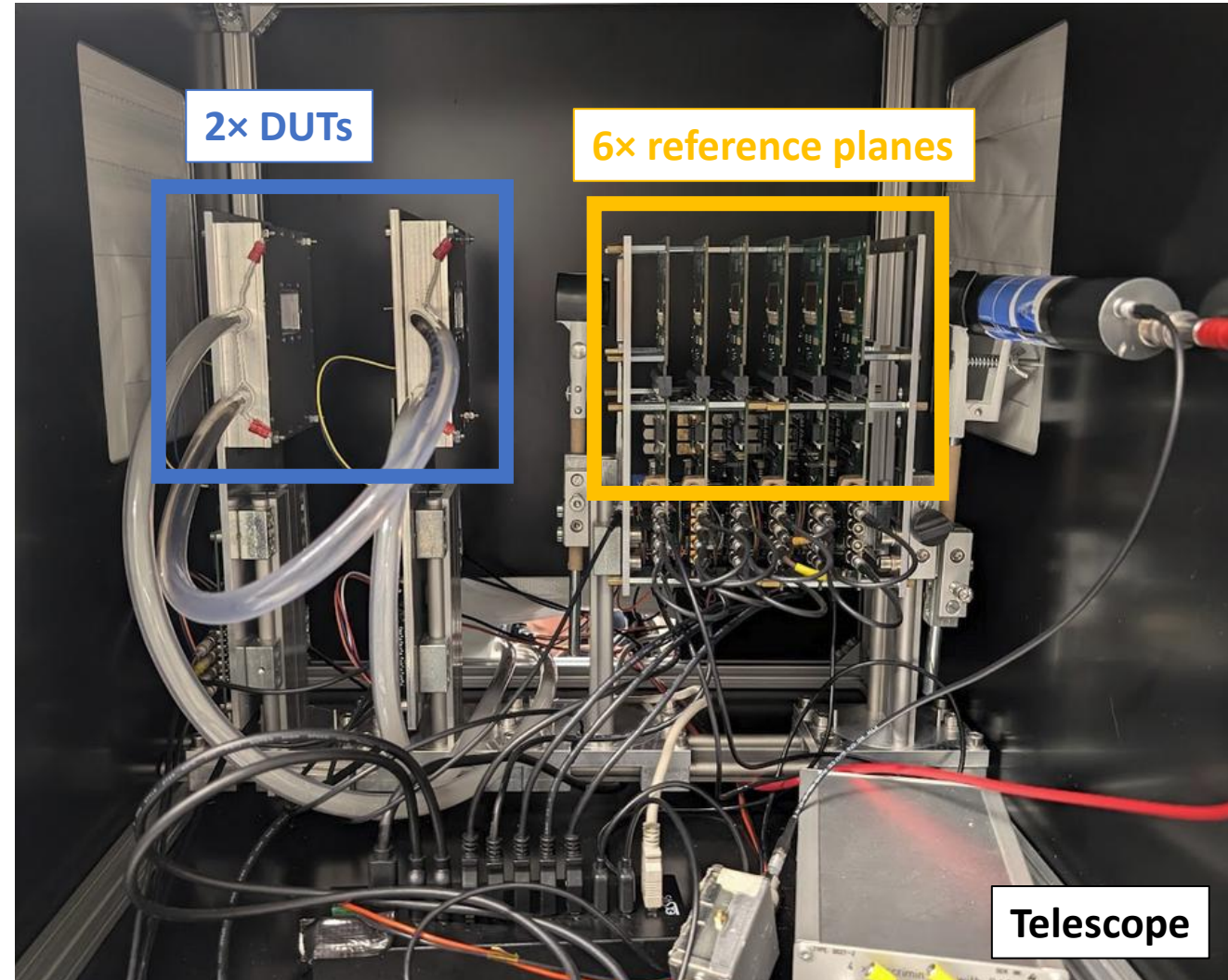
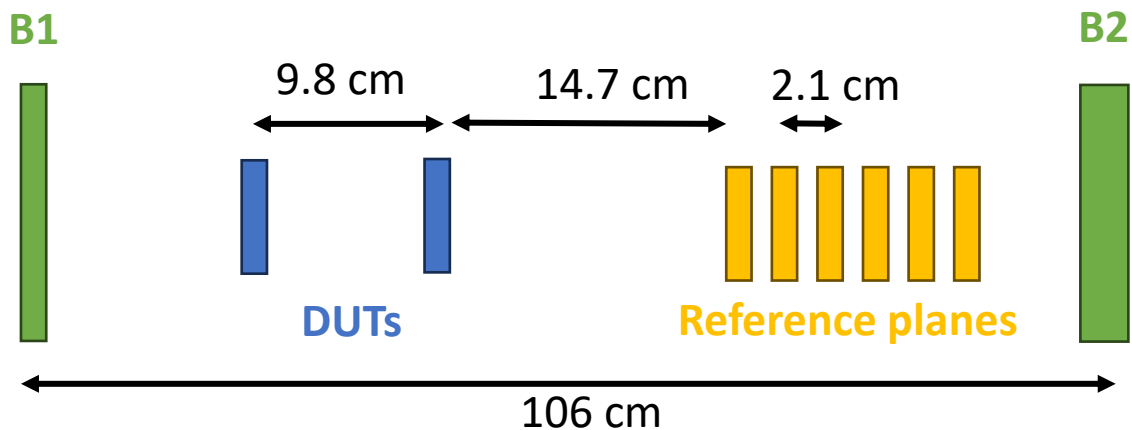
- Joint project between Italy and Germany, funded by **MAECI**, the Italian “Ministry of Foreign Affairs and International Cooperation”
- Goal: Monolithic Active Pixel Sensors (**MAPS**) technology exploitation for **energy loss** measurements and **particle identification**
- Beam test at the **GSI-FAIR** Heavy Ion Synchrotron SIS18 irradiation facilities with **heavy-ion beam** to:
 - Study of MAPS sensor **response to highly ionizing particles**
 - Evaluate the **contribution of charged nuclear fragments** emitted during hadron therapy **to the delivered dose** on biological tissues



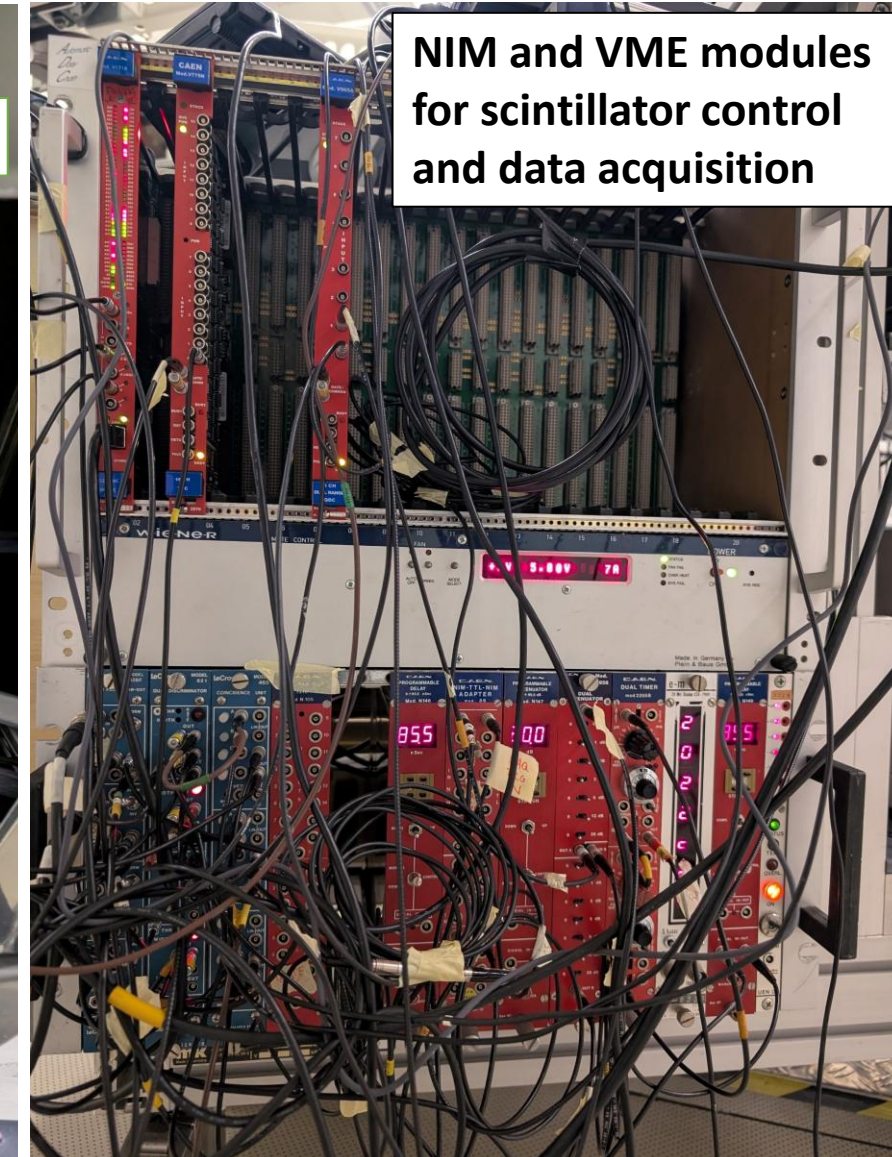
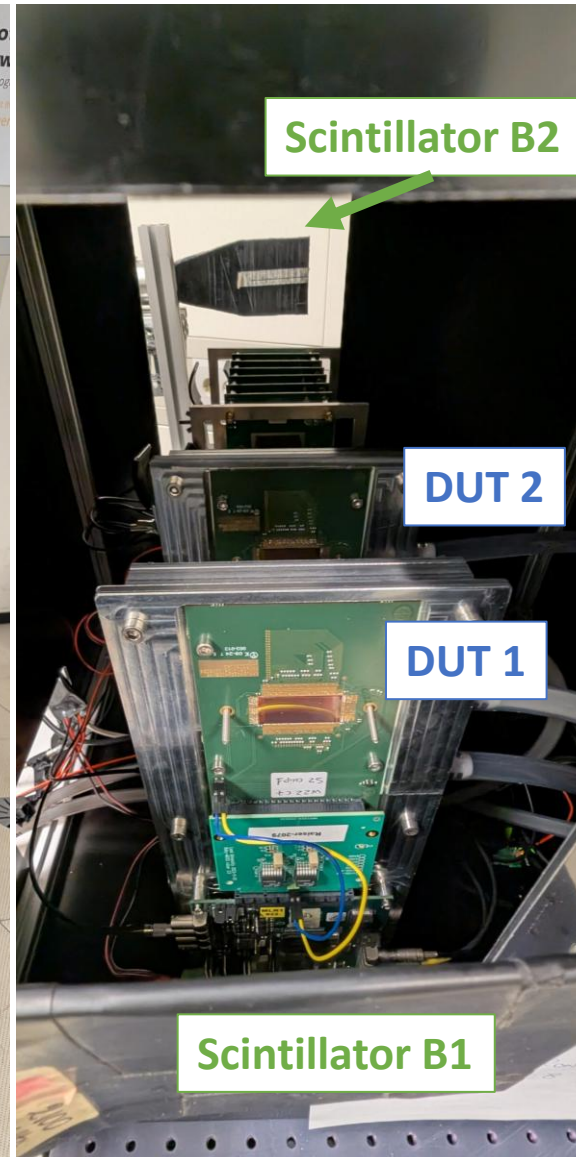
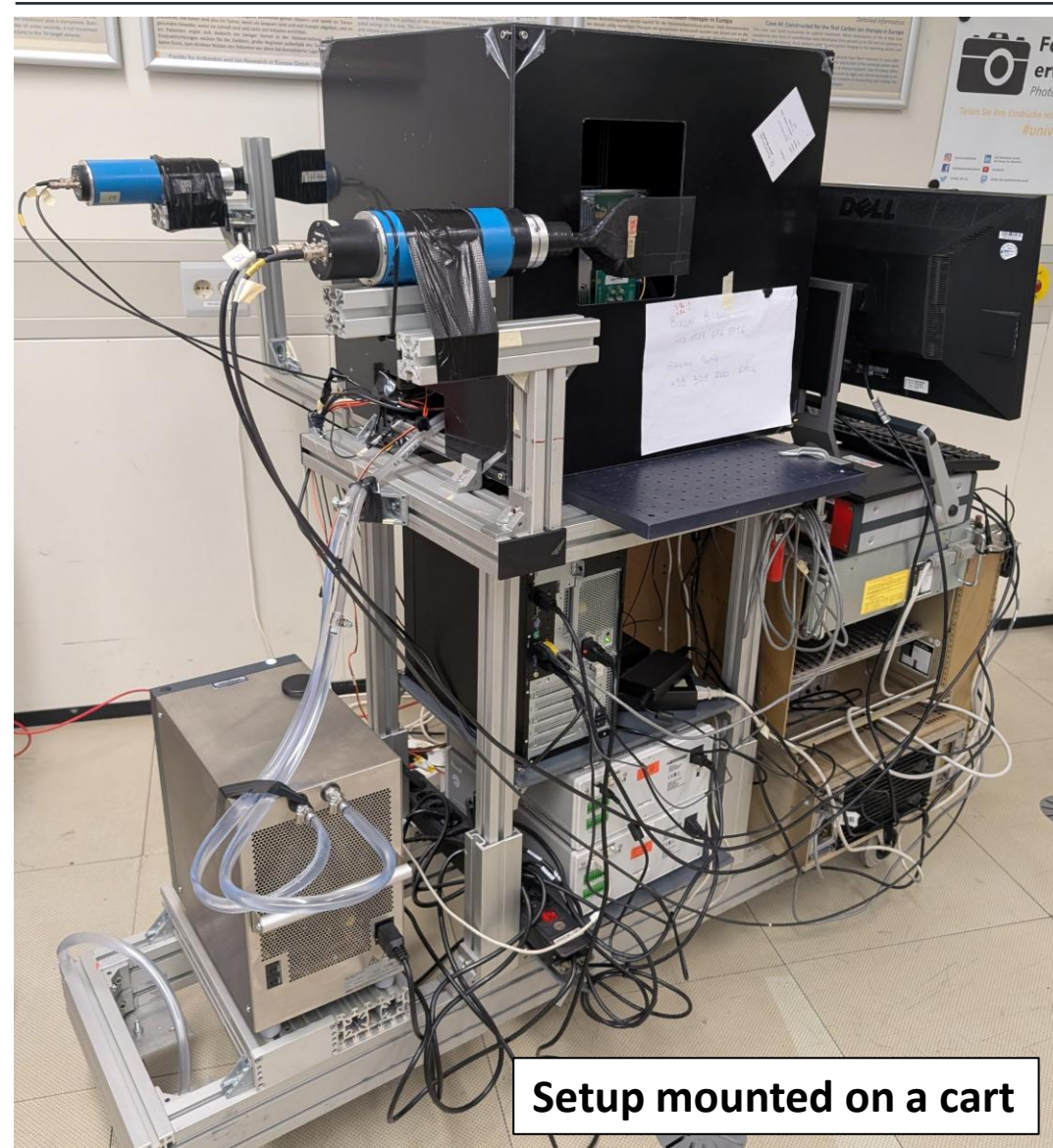
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- Telescope of 8 MAPS sensors:
 - Six **reference planes** for tracking
 - Two **DUTs** with Time-over-Threshold (ToT) measurement
- Two scintillators (**B1**, **B2**) for Time-Of-Flight (TOF) and energy-loss measurements
- ~ 2h data taking with mixed ion beam at GSI with 225 MeV/amu

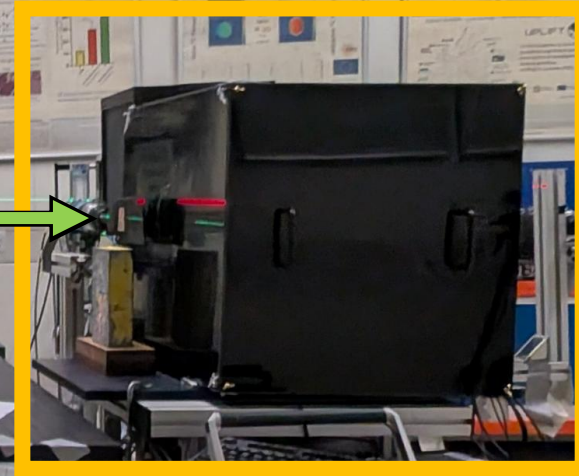


Setup



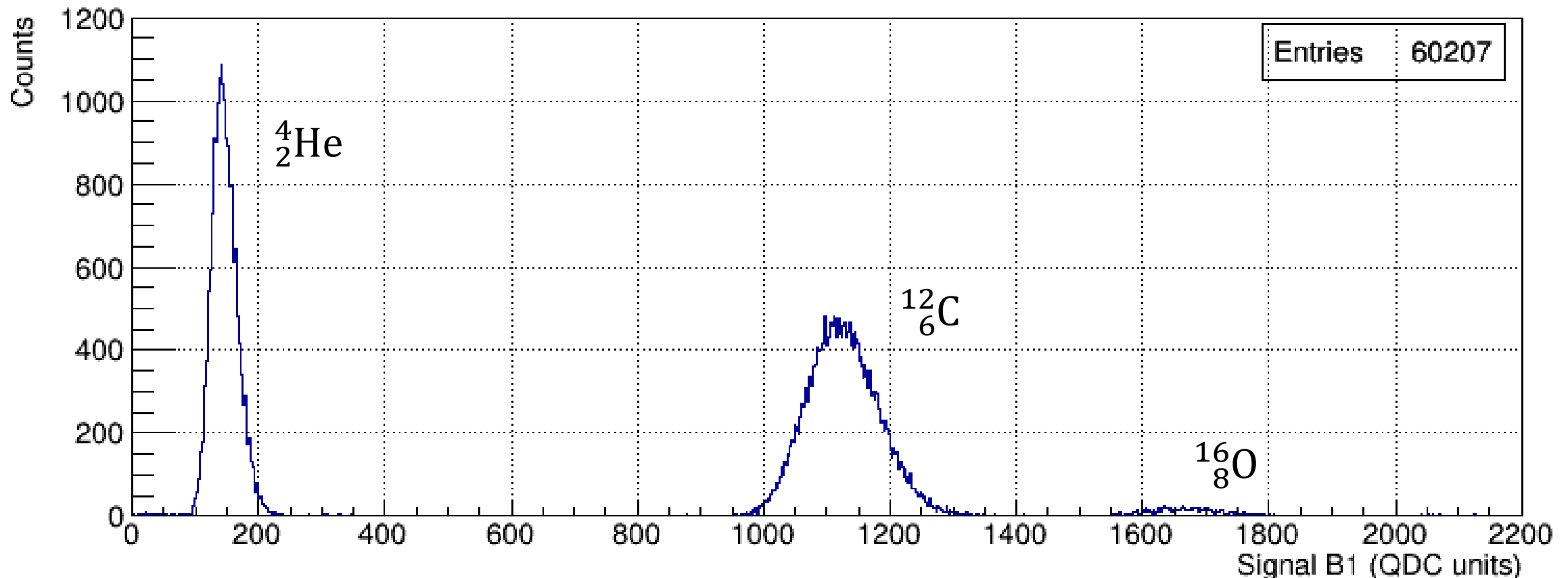
Telescope

Beam



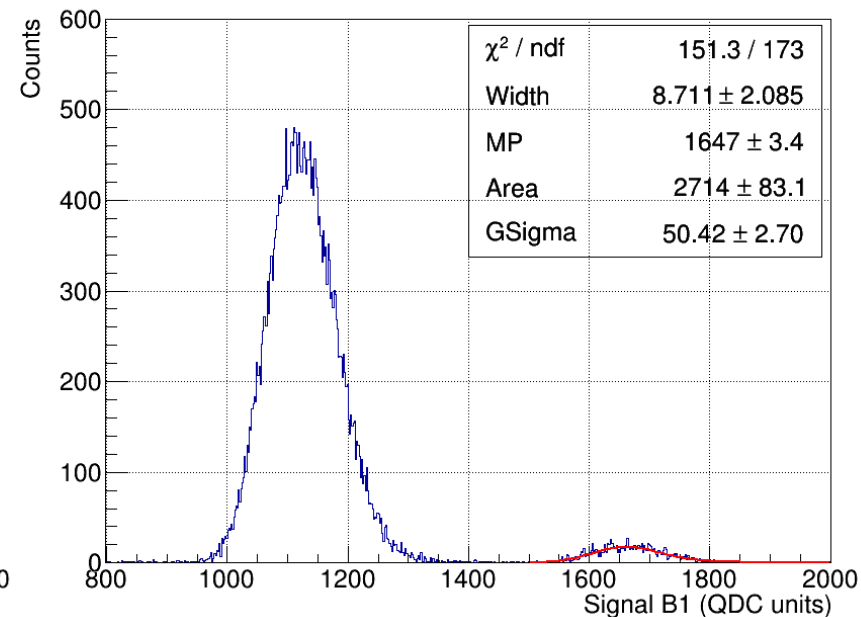
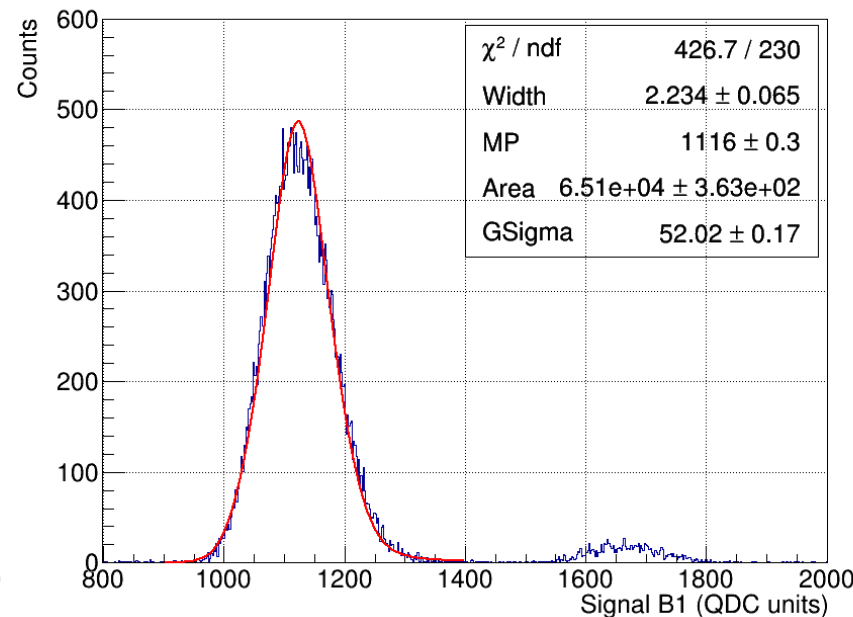
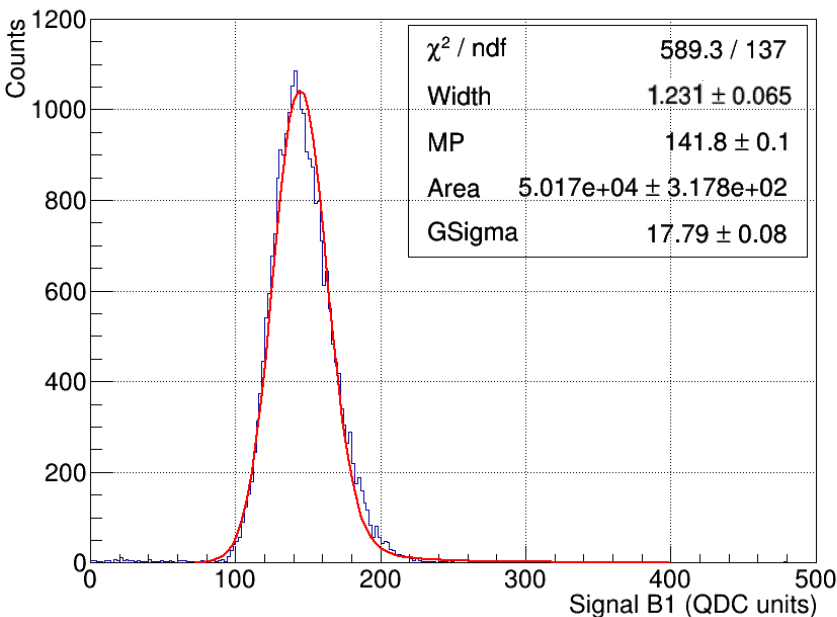
Beam spectrum with scintillators

- Expected a mixed ion beam of $\sim 50\%$ $^{12}_6\text{C}$, $\sim 45\%$ ^4_2He , $\sim 5\%$ $^{16}_8\text{O}$
- 3 peaks in the scintillator spectra identified

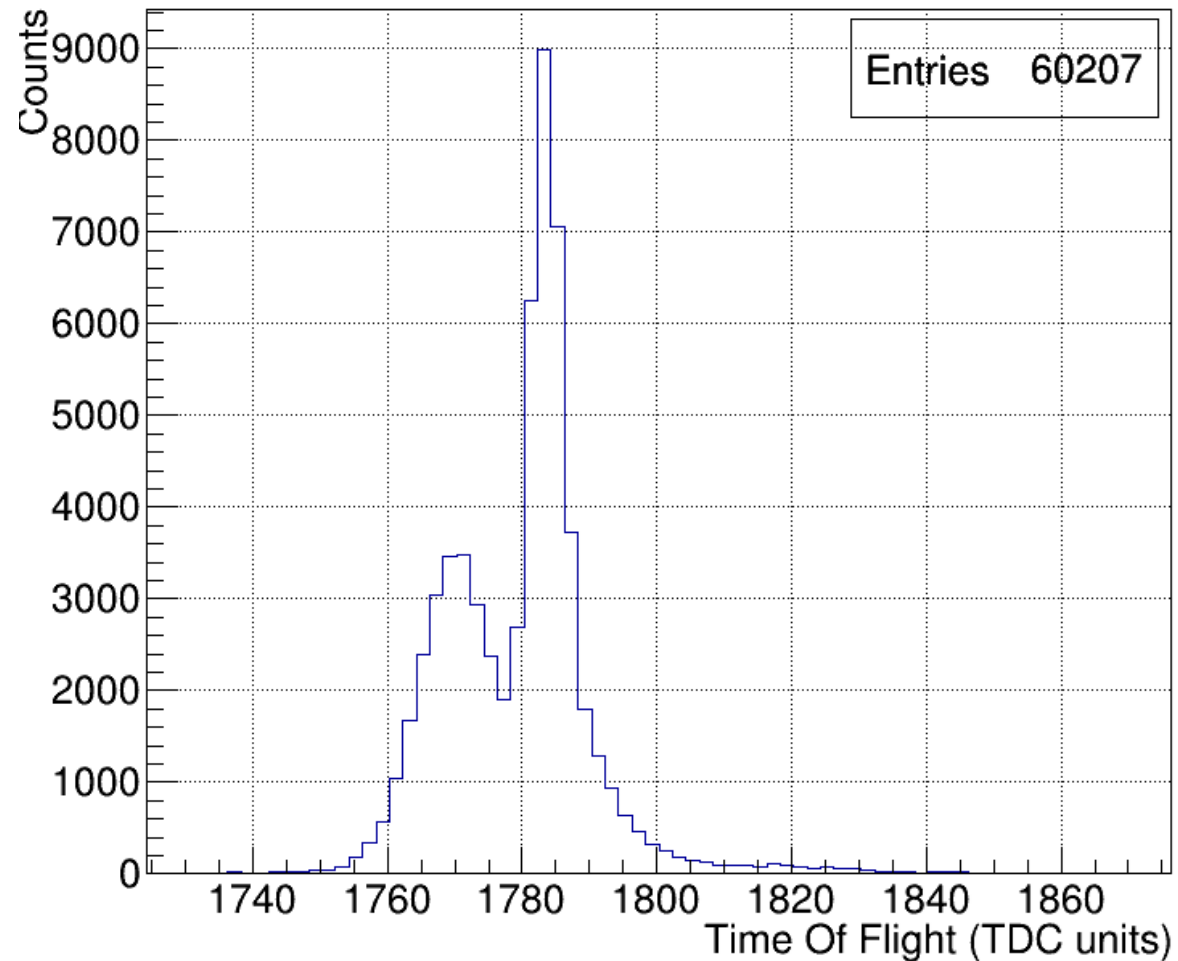


Beam characteristics

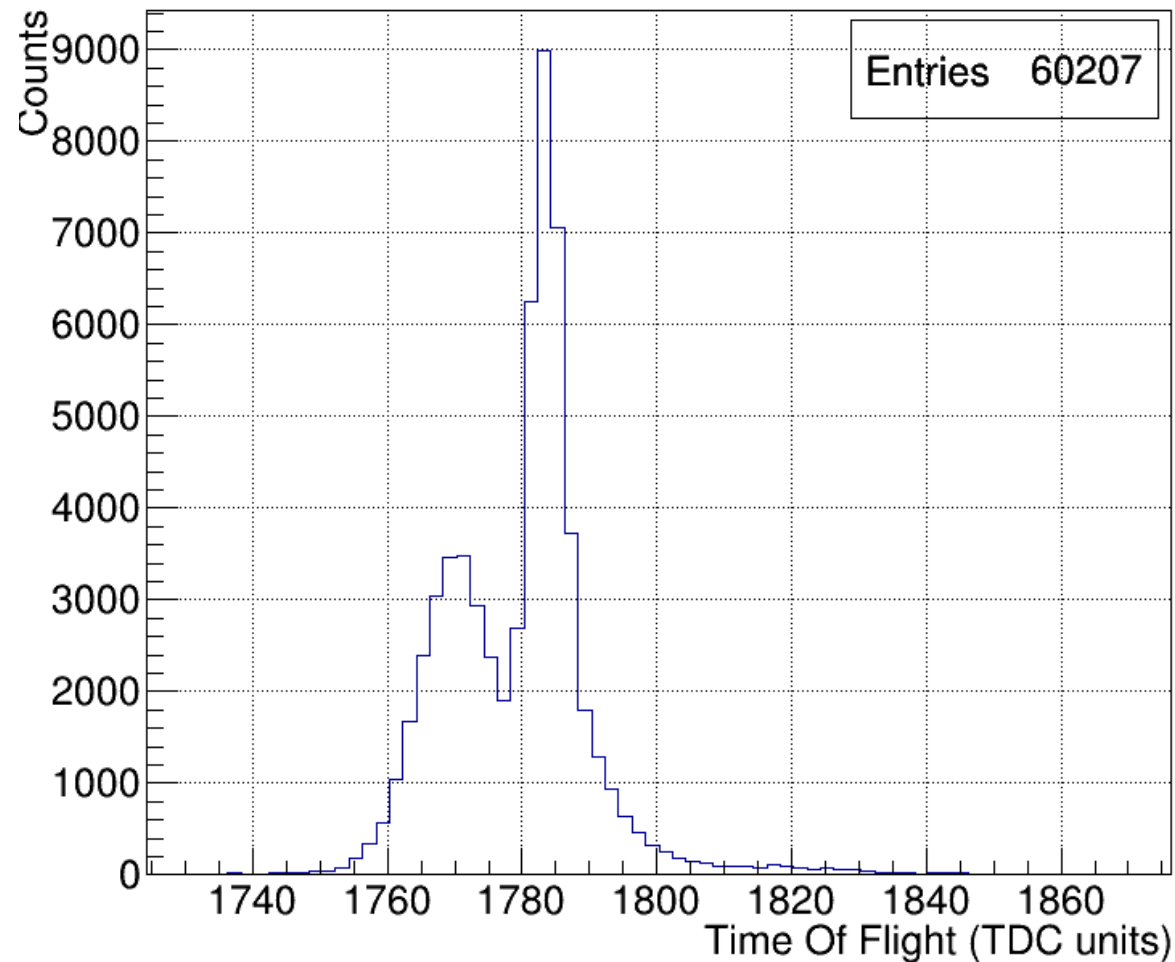
- Mixed ion beam of $\sim 50\%$ $^{12}_6\text{C}$, $\sim 45\%$ ^4_2He , $\sim 5\%$ $^{16}_8\text{O}$ expected
- Measured composition: 55.2% $^{12}_6\text{C}$, 42.5% ^4_2He , 2.3% $^{16}_8\text{O}$
- Measured $^{16}_8\text{O}$ MP value 30% lower than expected \rightarrow possible quenching
- Fit with Landau function to characterize the beam



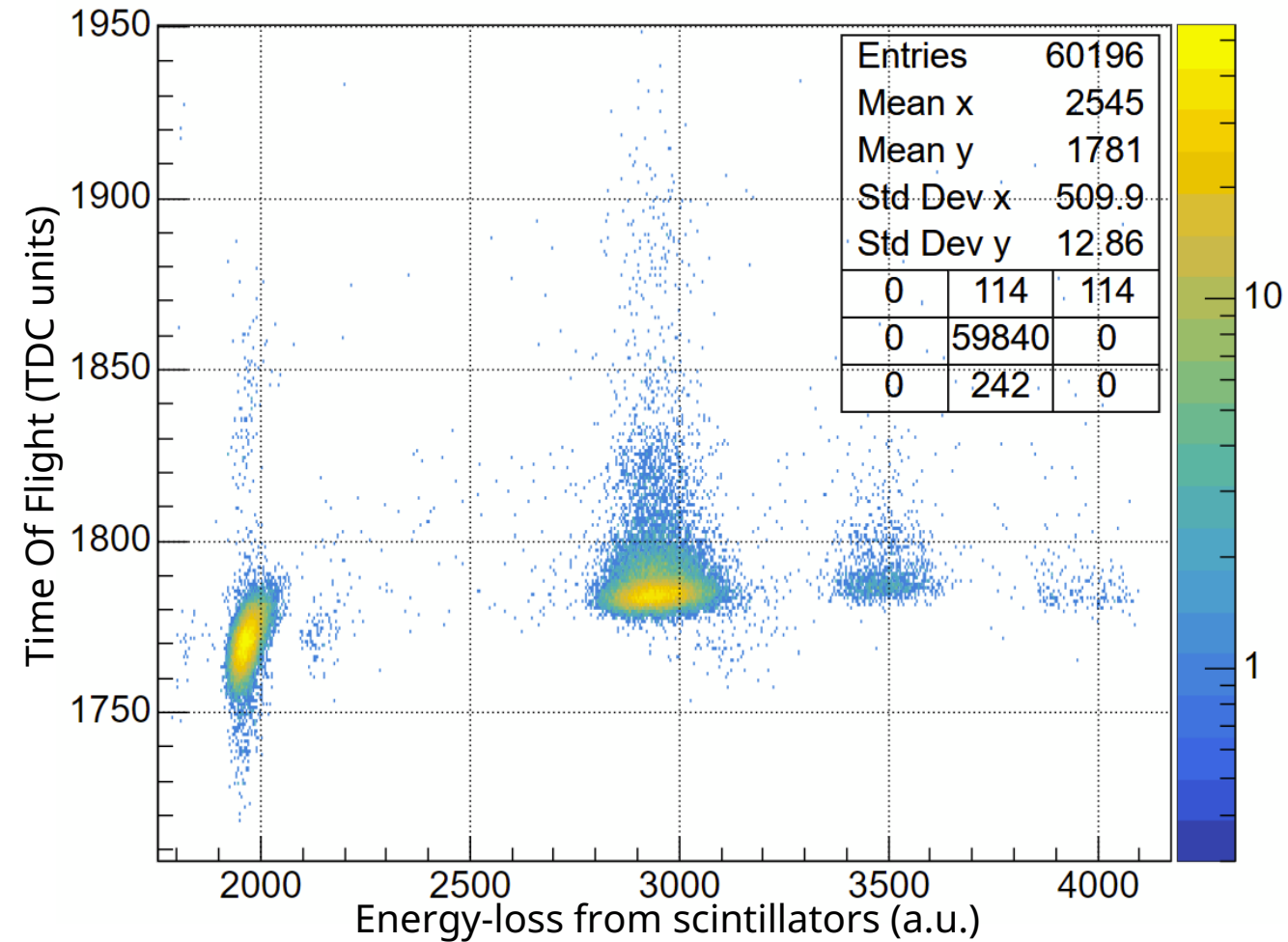
TOF measurements



TOF measurements

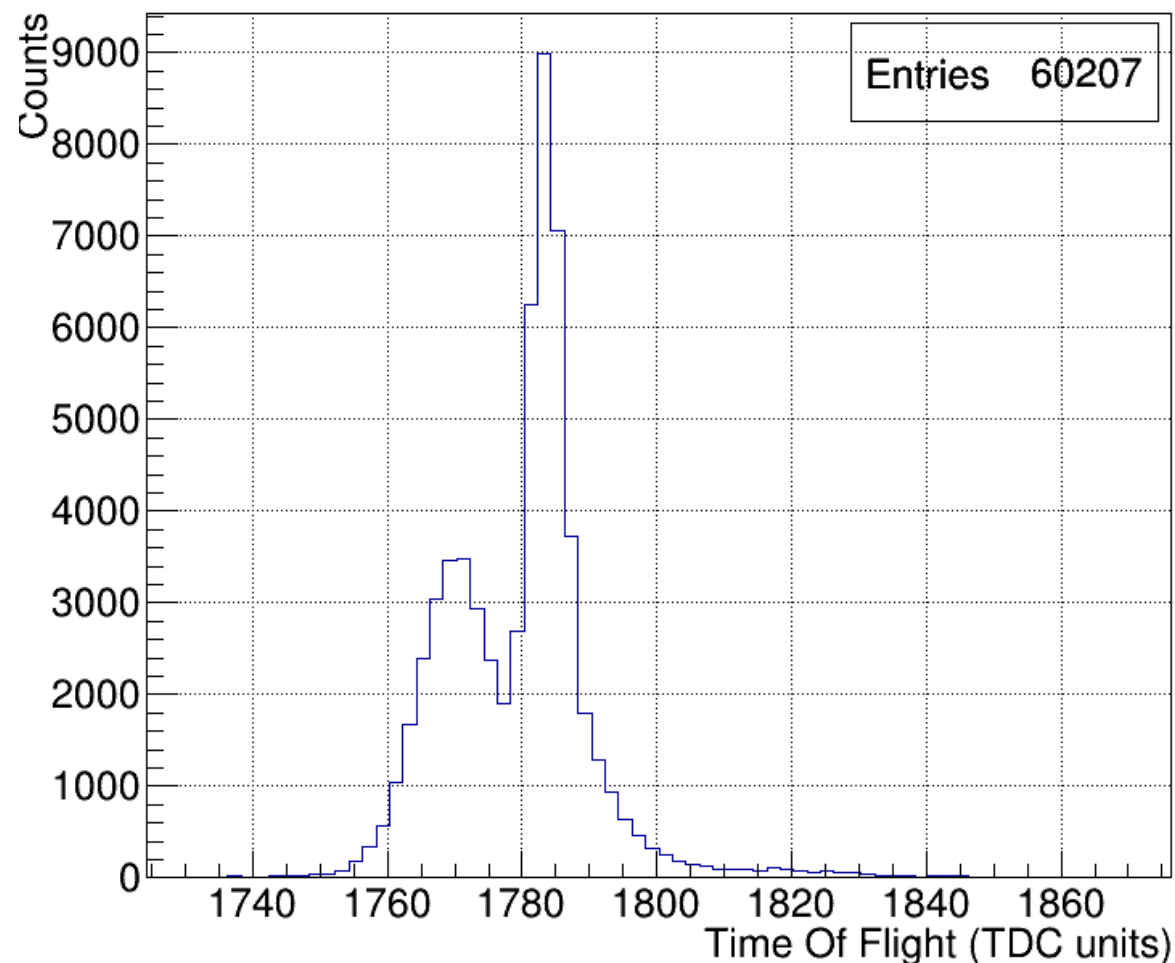


TOF vs energy loss
-> ion identification

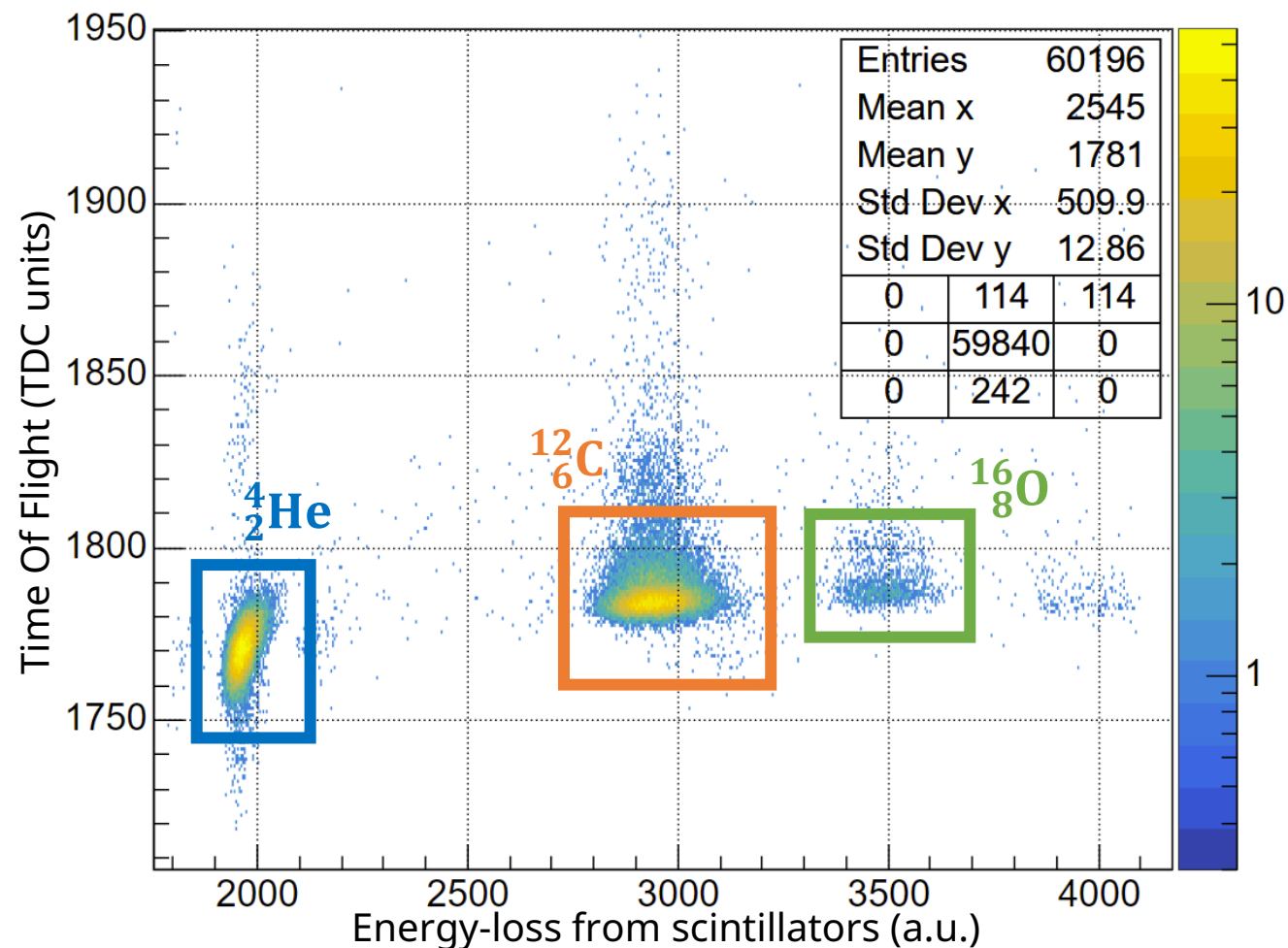


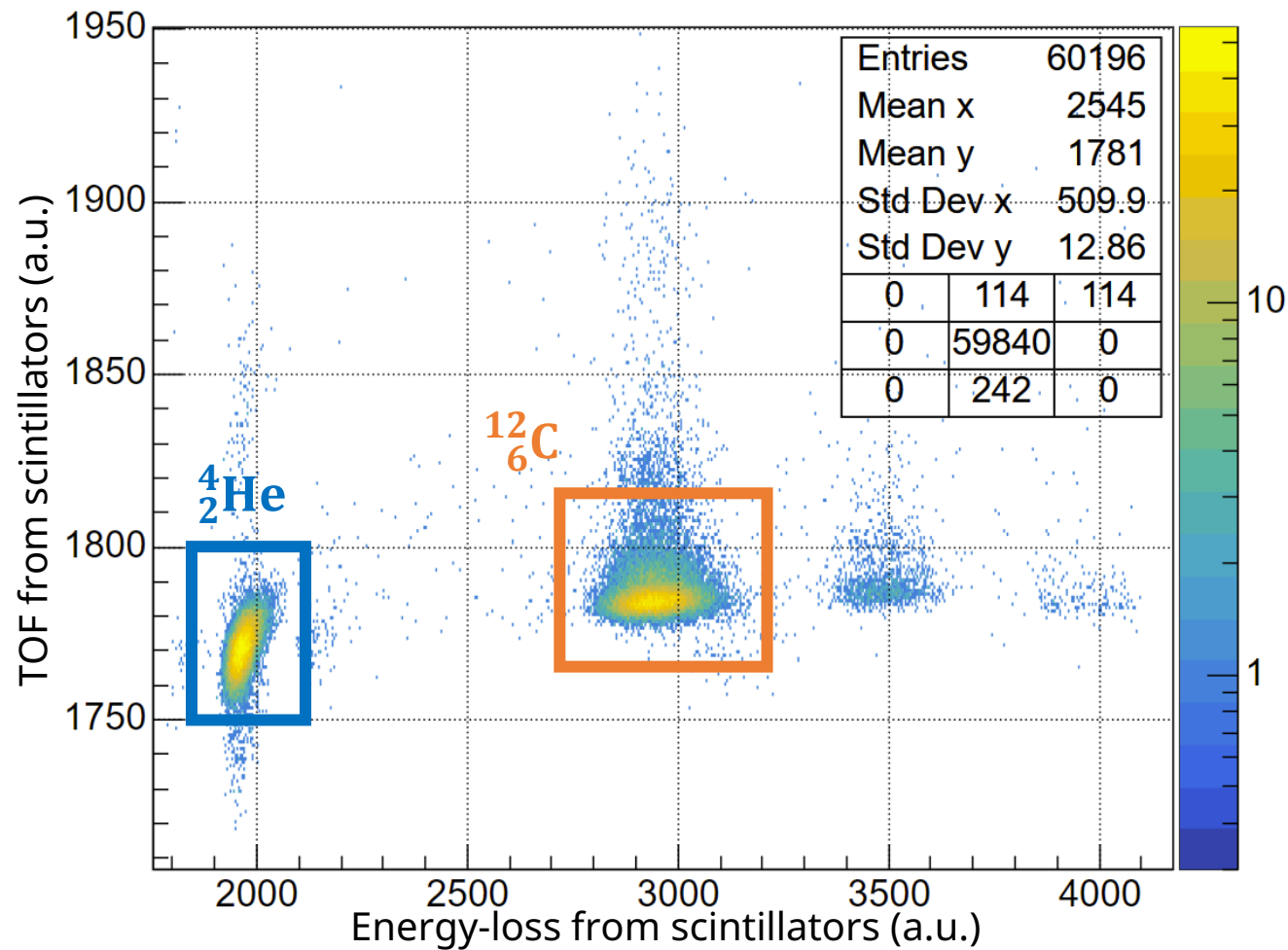
Time Of Flight measurements

TOF measurements

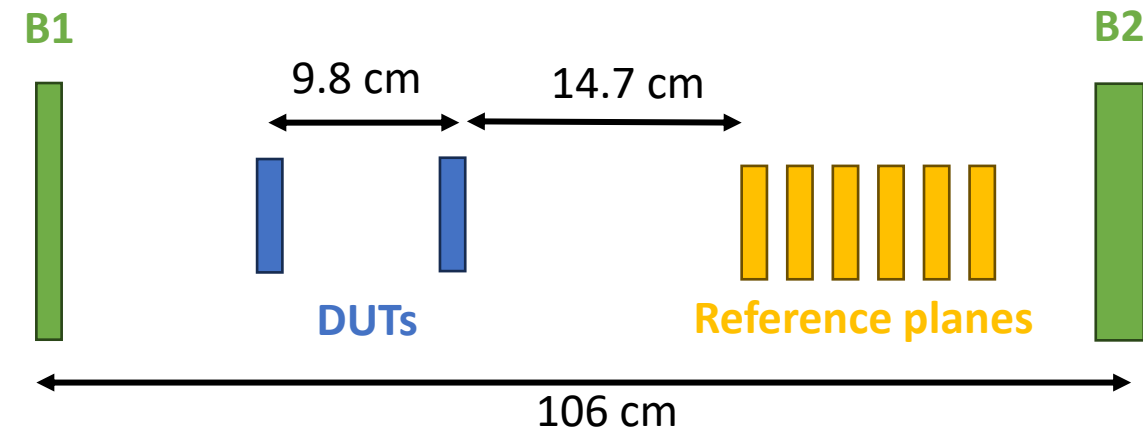


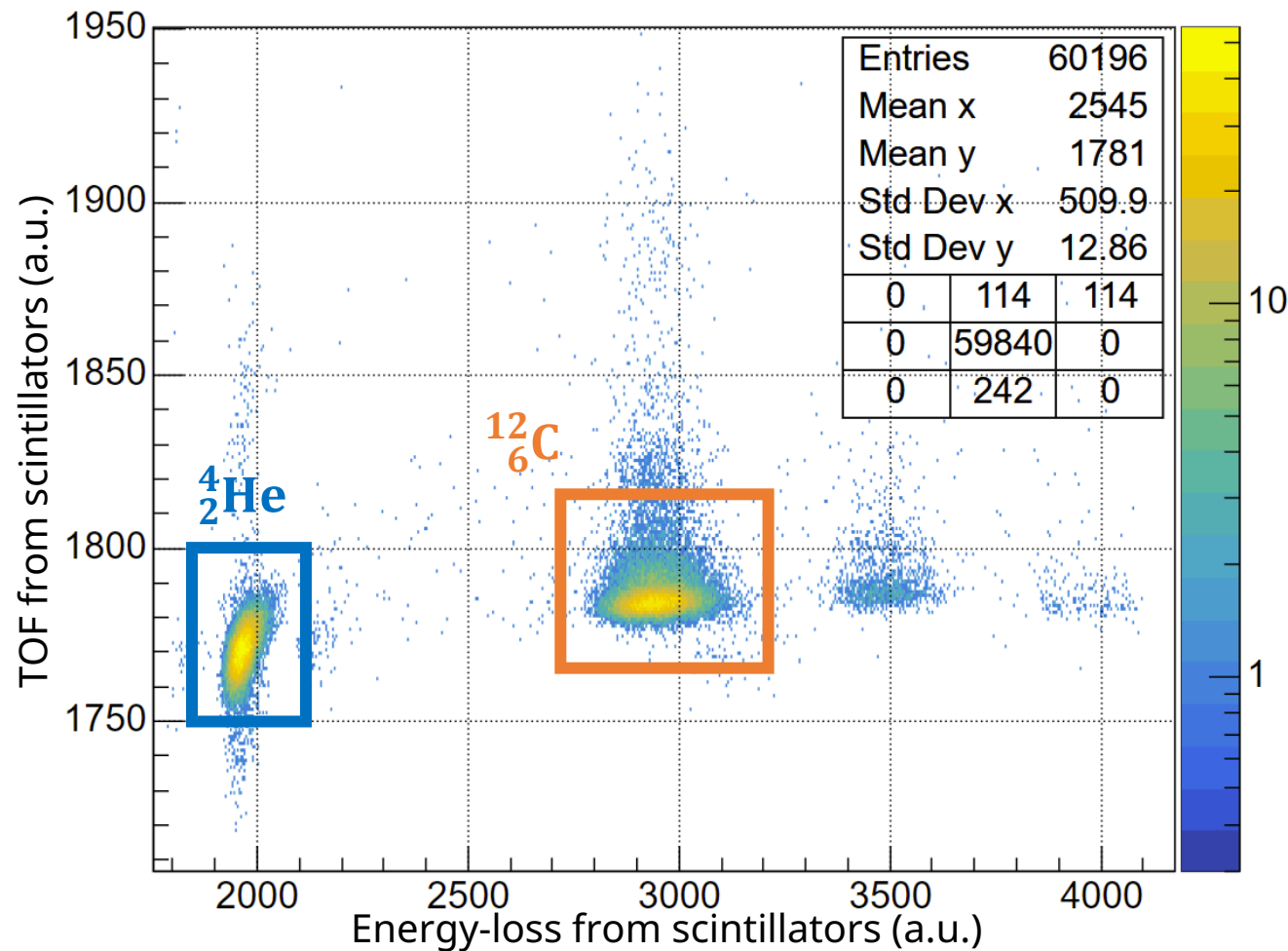
TOF vs energy loss
-> ion identification



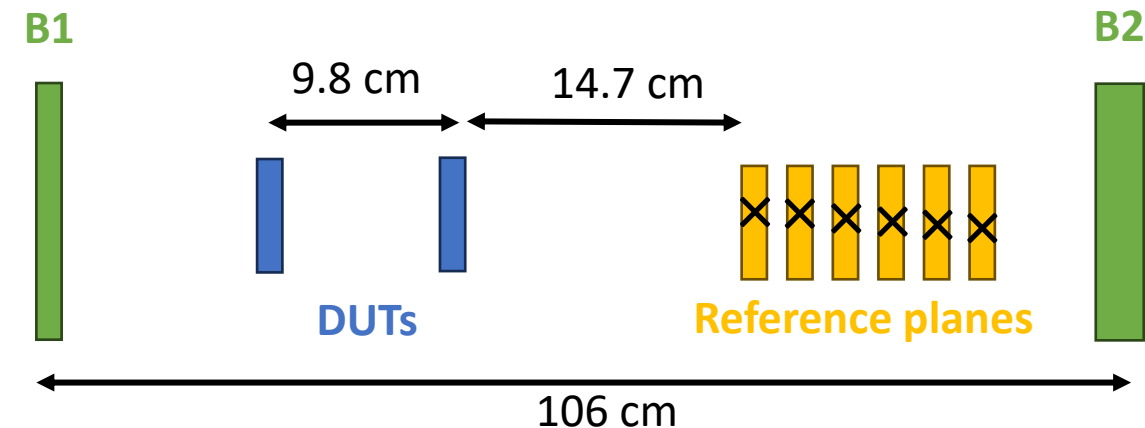


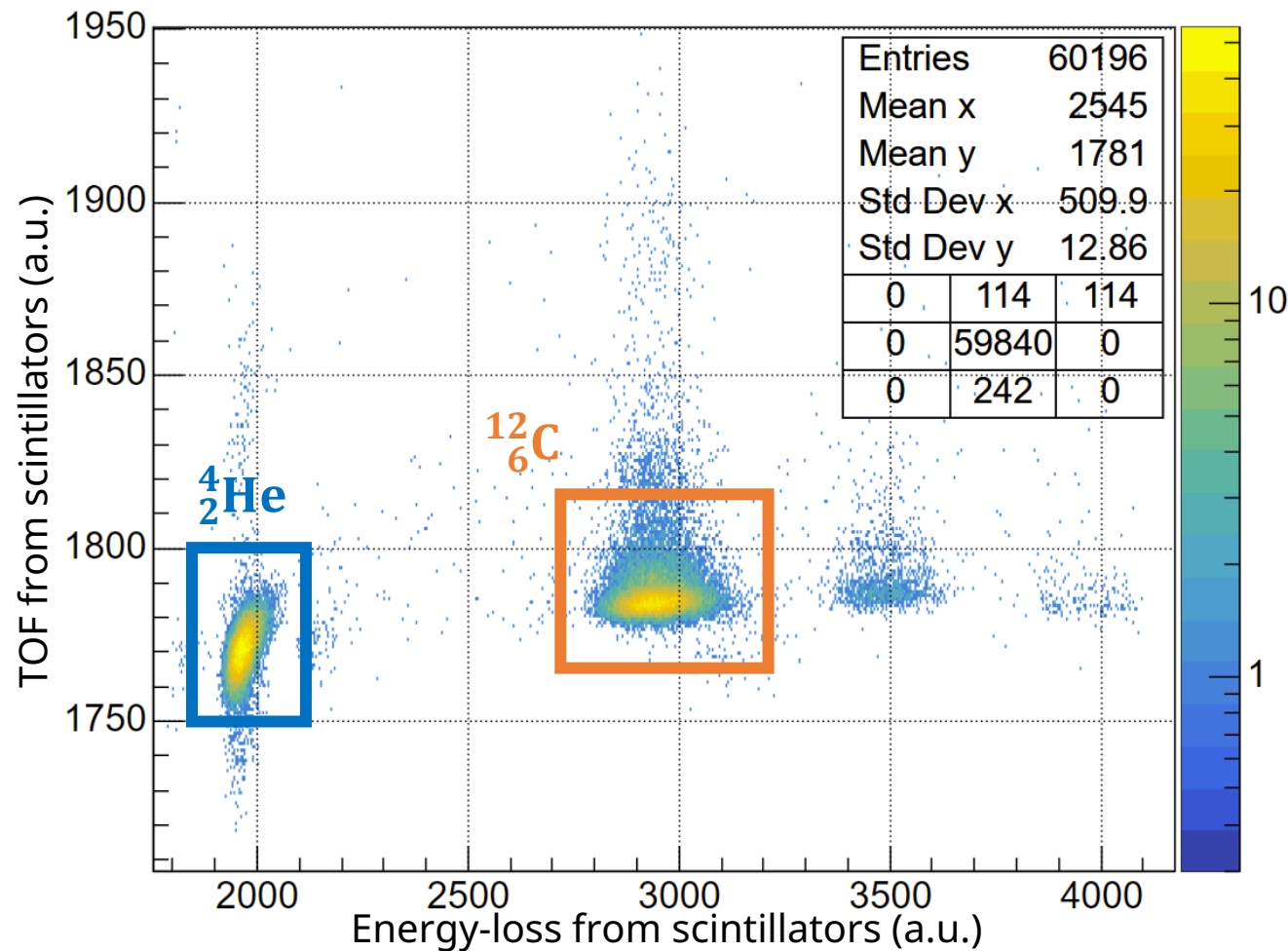
- Correlation between scintillator TOF and energy loss -> particle identification



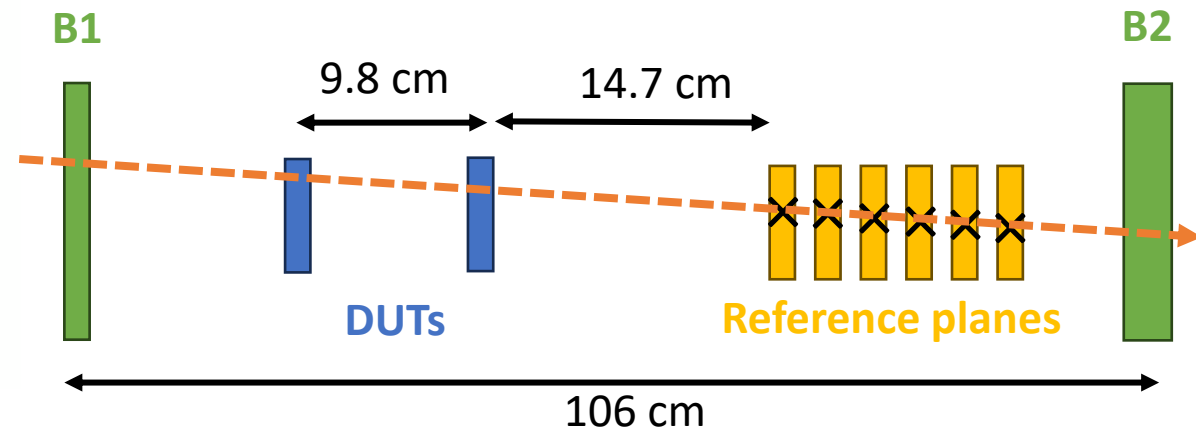


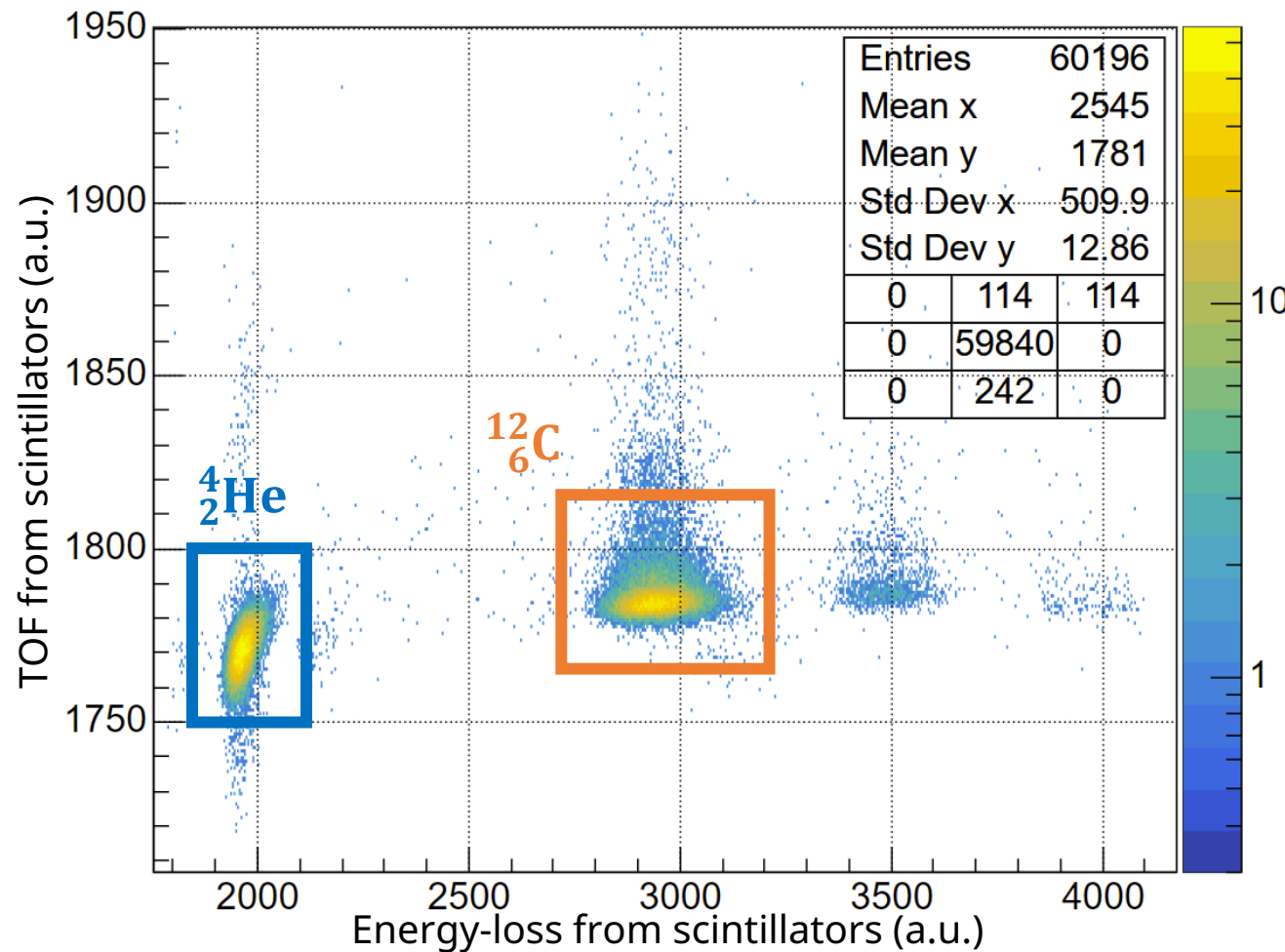
- Correlation between scintillator TOF and energy loss -> particle identification
- Tracking with reference planes using [Corryvreckan](#)



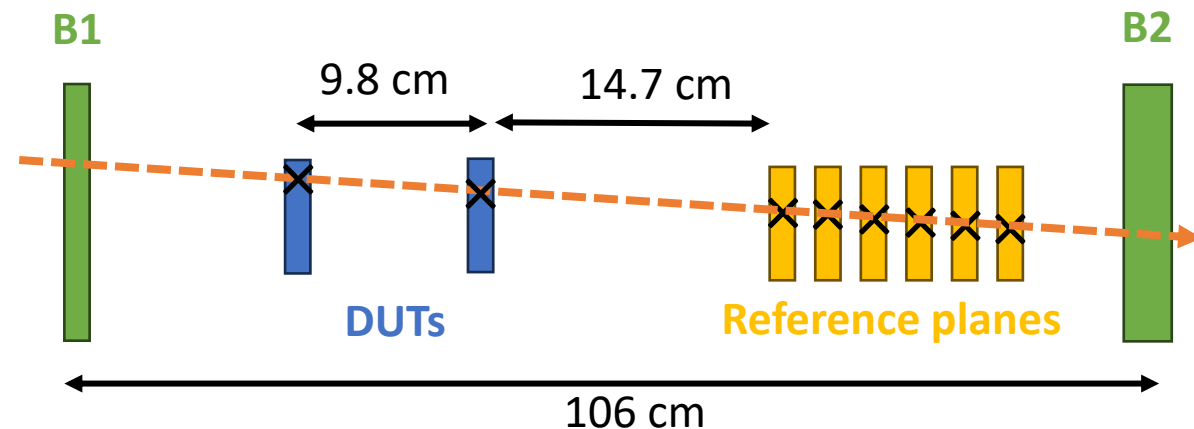


- Correlation between scintillator TOF and energy loss -> particle identification
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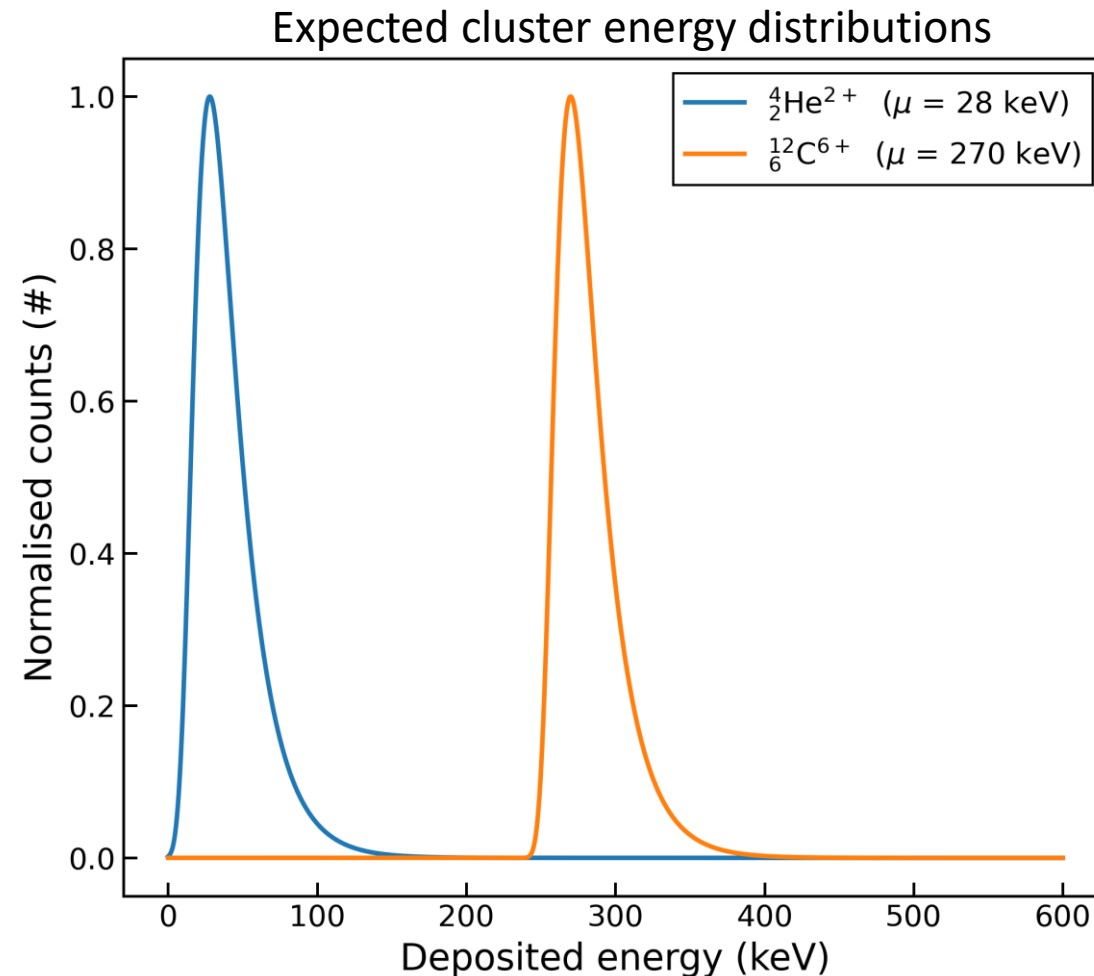
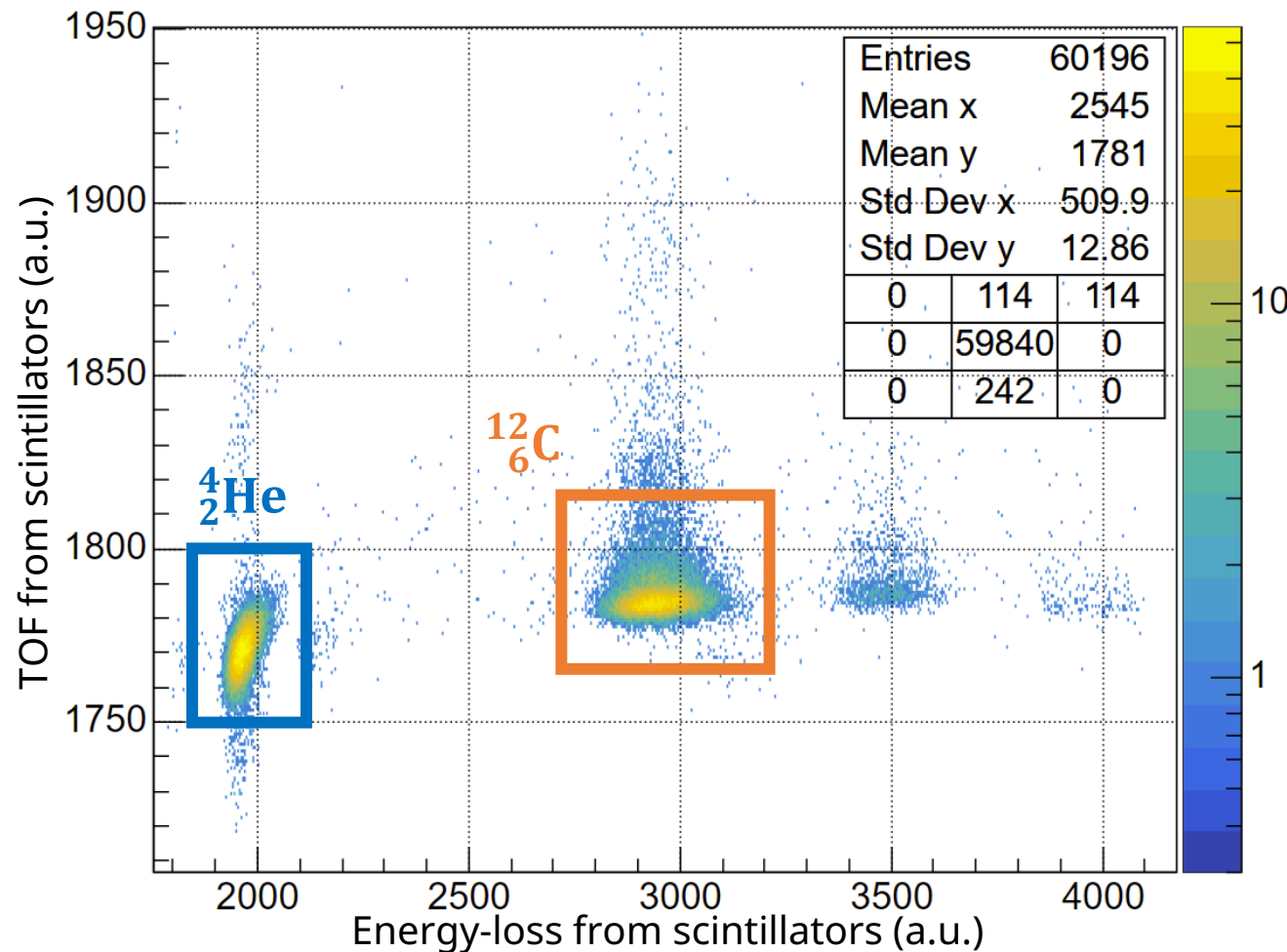


- Correlation between scintillator TOF and energy loss -> particle identification
- Tracking with reference planes using [Corryvreckan](#)
- Association of cluster on each DUT
- Study the DUT energy loss response to identified particle



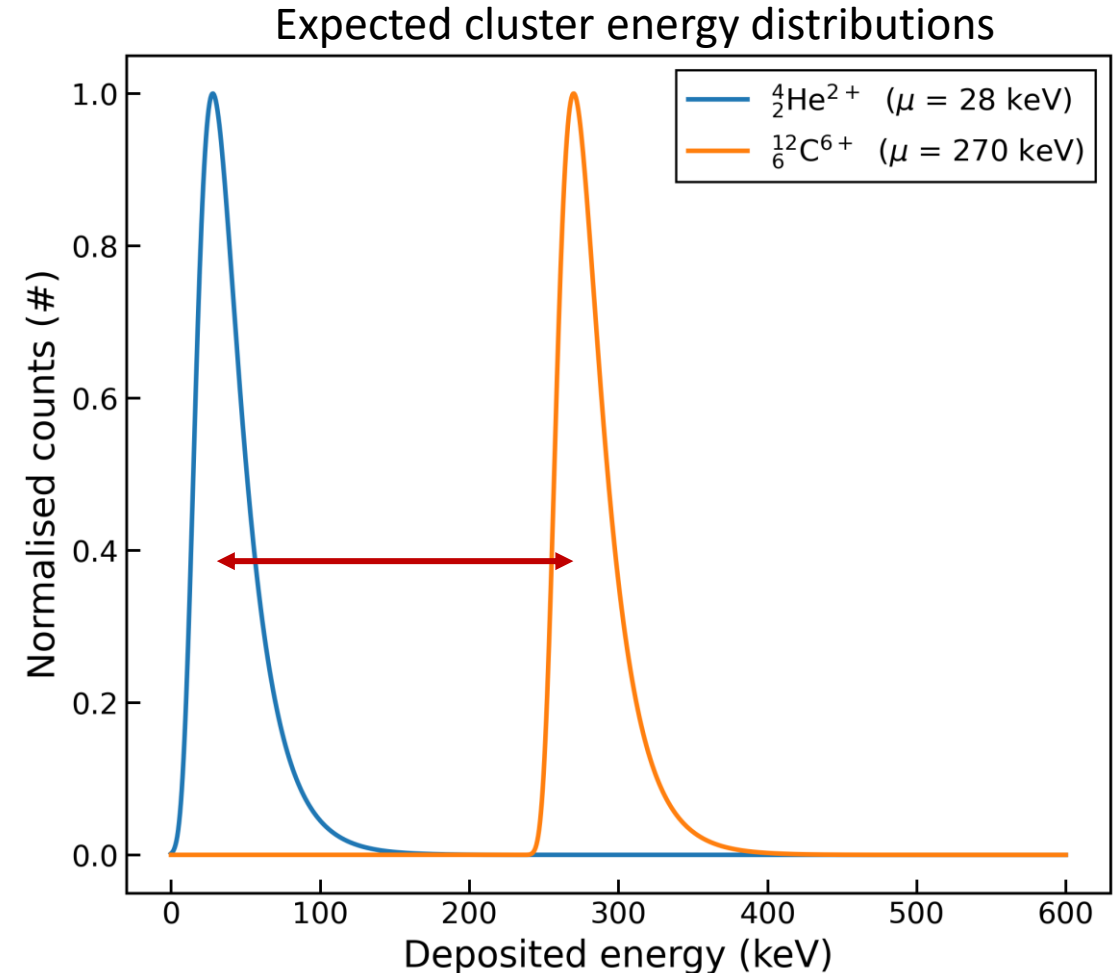
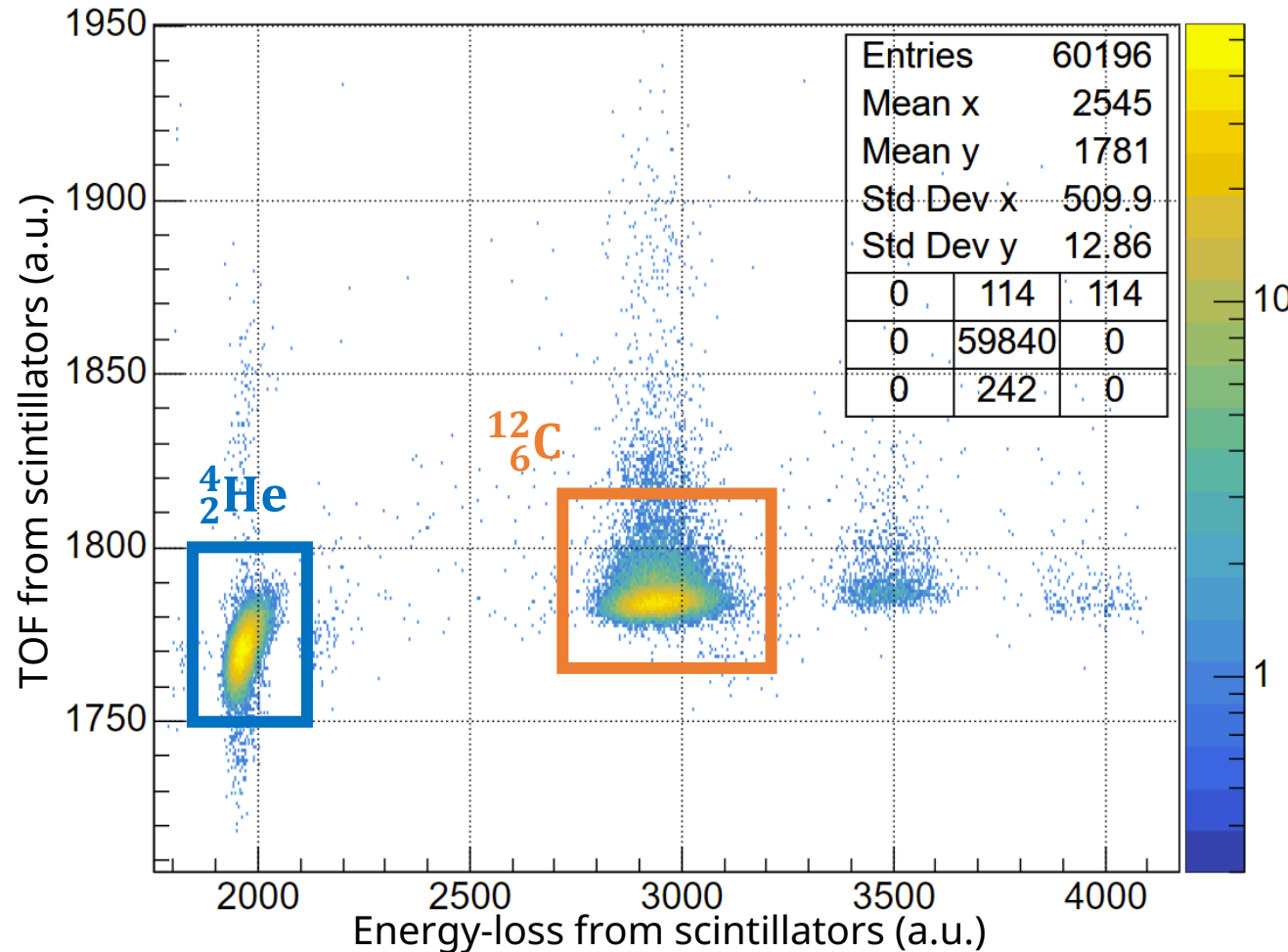
He and C selection

- He and C selection based on TOF and energy loss as measured by the scintillators
- Measurement of the total cluster energy registered on the DUT for the associated particles

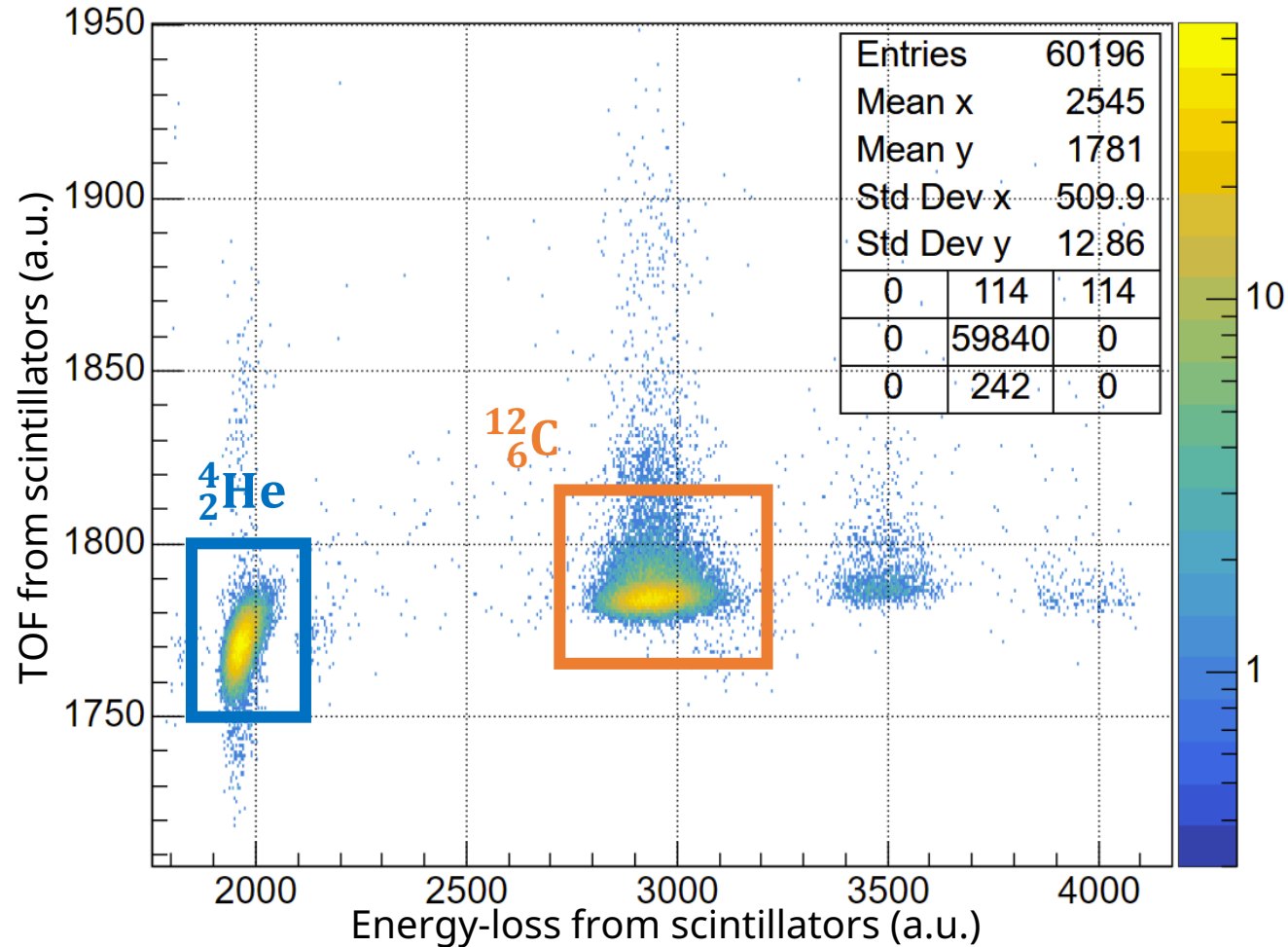


He and C selection

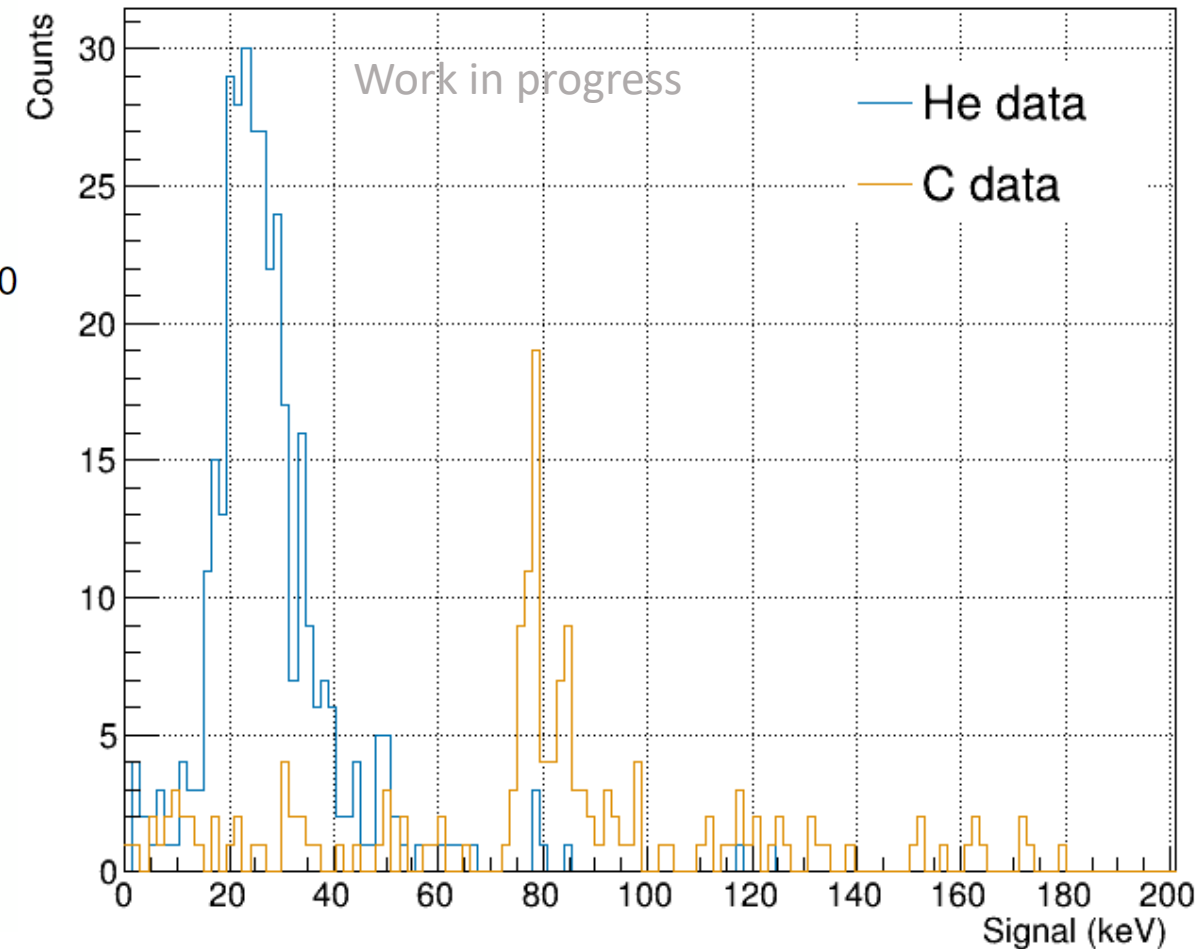
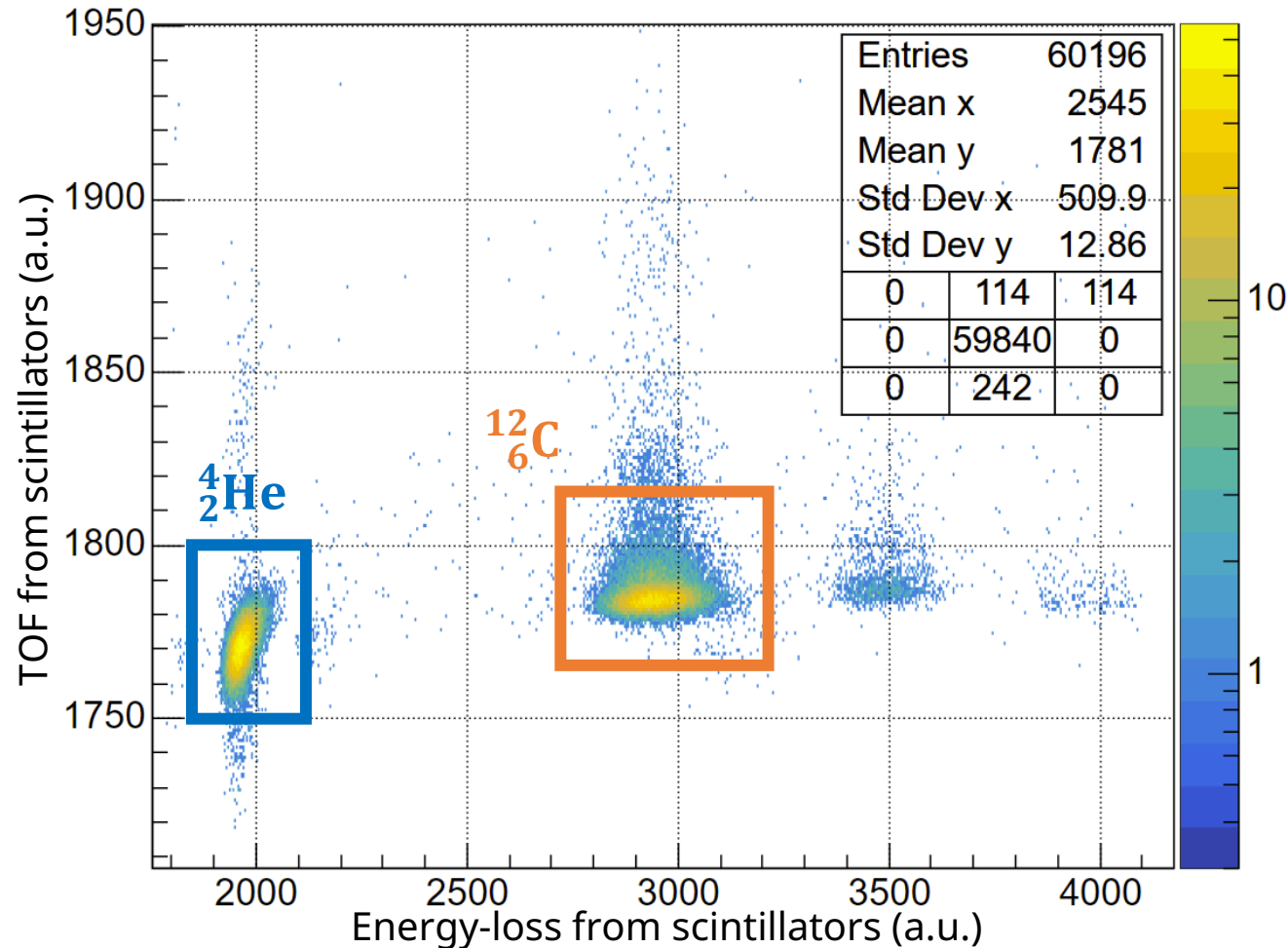
The analysis will aim at: - estimating the **separation power**
- evaluating the DUT response over a large energy range



- Work in progress results



- Work in progress results



- ELMA: Energy loss measurements with MAPS
- Measured energy loss by Helium and Carbon ions (225 MeV/amu) with the ALICE ITS3 prototype babyMOSS at GSI

Analysis ongoing, expected info on:

- Energy loss measurements capabilities of the babyMOSS
- Separation power between He and C ions
- Potential effects associated with high-energy release events:
 - Formation of large clusters
 - Response saturation
 - Charge collection inefficiencies

Thanks!

ELMA team:

Roberto Baccomi, Bogdan Blidaru, Paolo Camerini, Giacomo Contin,
Tommaso Fagotto, Laura Gonella, Simon Gross-Boelting, Simon Kieninger,
Silvia Masciocchi, Tobias Rudolf, Giovanni Vecil, Anna Villani

Picture by Sofia Masciocchi



Backup

