DAQ & GAGG Development (Pulse Shape Analysis)

Takayuki YANO (Kyoto University)

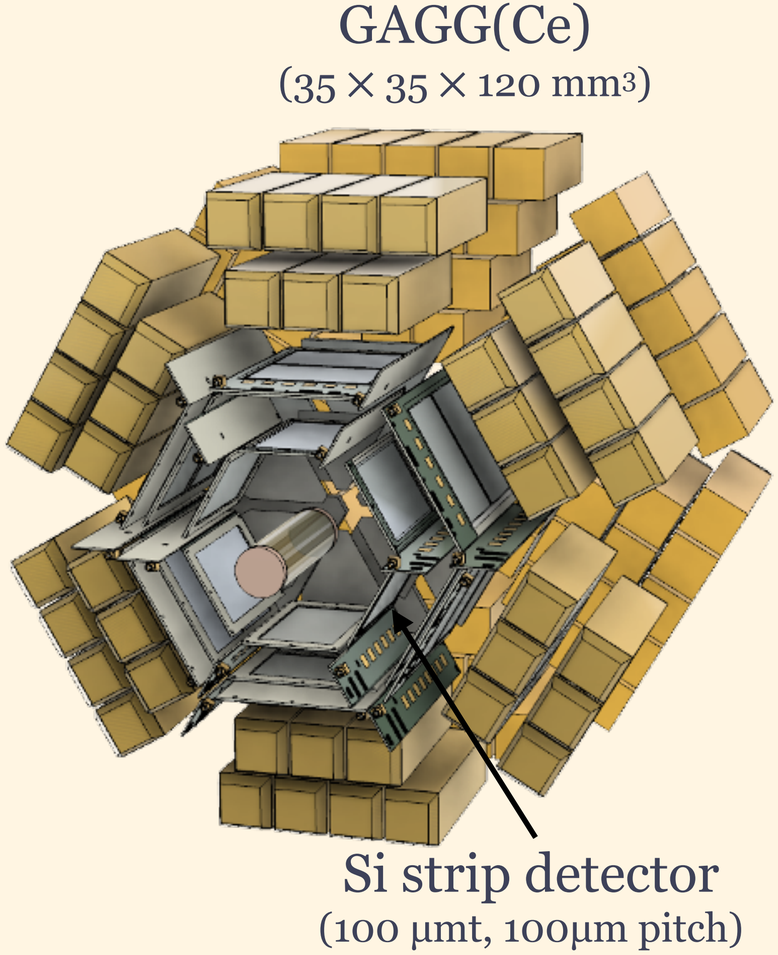
TOGAXSI Roadmap Workshop (Feb. 10, 2025)

Contents

- DAQ
  - Development of TOGAXSI DAQ
  - Upgrade of SAMURAI DAQ
- The new PID method by pulse shape analysis

Development of TOGAXSI DAQ

- TOGAXSI consists of Si strip detectors (SSD) & GAGG(Ce) calorimeters.
- DAQ for the SSDs has been already developed and used in some experiments.
- DAQ for the GAGG(Ce) array is currently under development, but it will be finished soon.



TOGAXSI GAGG DAQ

- CAEN VX2740B waveform digitizer with DPP_PHA firmware and Babirl based DAQ software are used.
- 3 digitizers will be used for TOGAXSI demonstrator.
- Basic functions were already tested and the test using beam will be performed in SAMURAI DAQ MS.

Upgrade of SAMURAI DAQ

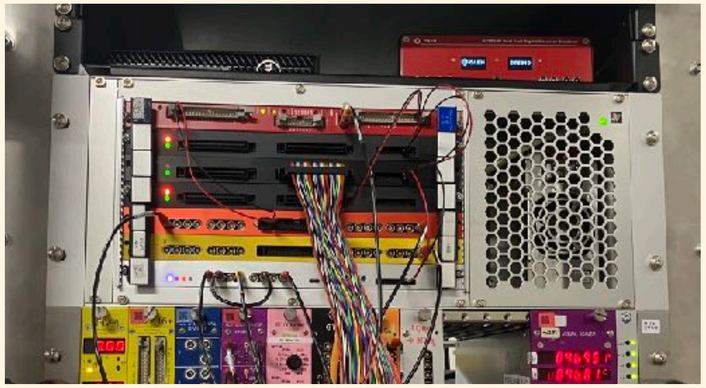
Higher Trigger Rate

- Acceptable trigger rate of the current SAMURAI DAQ is limited mainly because AMSC AMT-TDC , which are used for DCs are slow (~300 μs).

- To accept higher trigger rate, we will install FIT & MPV (developed by Baba-san).

- The readout time will be improved.
  (t~300μs → t~15μs)

AMSC AMT TDC
77% for 1 kHz trigger



FIT + MPV
87% for 10 kHz trigger

Upgrade of SAMURAI DAQ

Delayed Gating Operation of QDC

- TOGAXSI triggers are slow because generated by GAGG(Ce) calorimeters.
- The current SAMURAI DAQ cannot wait the slow trigger (> 500 ns) because of QDC.
- We plan to utilize the delayed gating operation of Mesytec MQDC to accept the slow trigger.

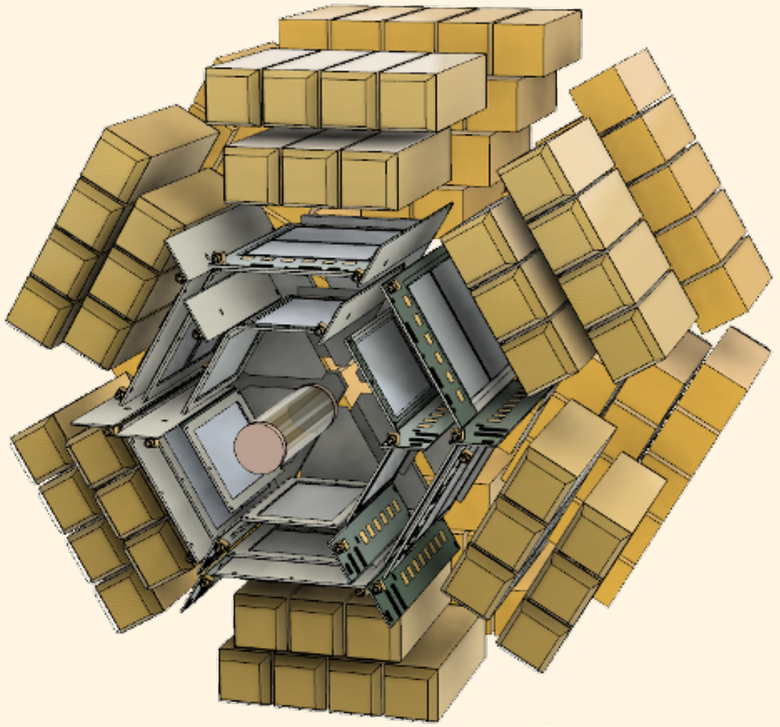
PID by Pulse Shape Analysis of GAGG(Ce)

- Particle identification (PID) is important for (*p*,*pX*) experiment.
- Si strip detectors which used for TOGAXSI are so thin that Δ*E* in Si detectors is small.

➡ PID by Δ*E*-*E* is difficult at high energy region.

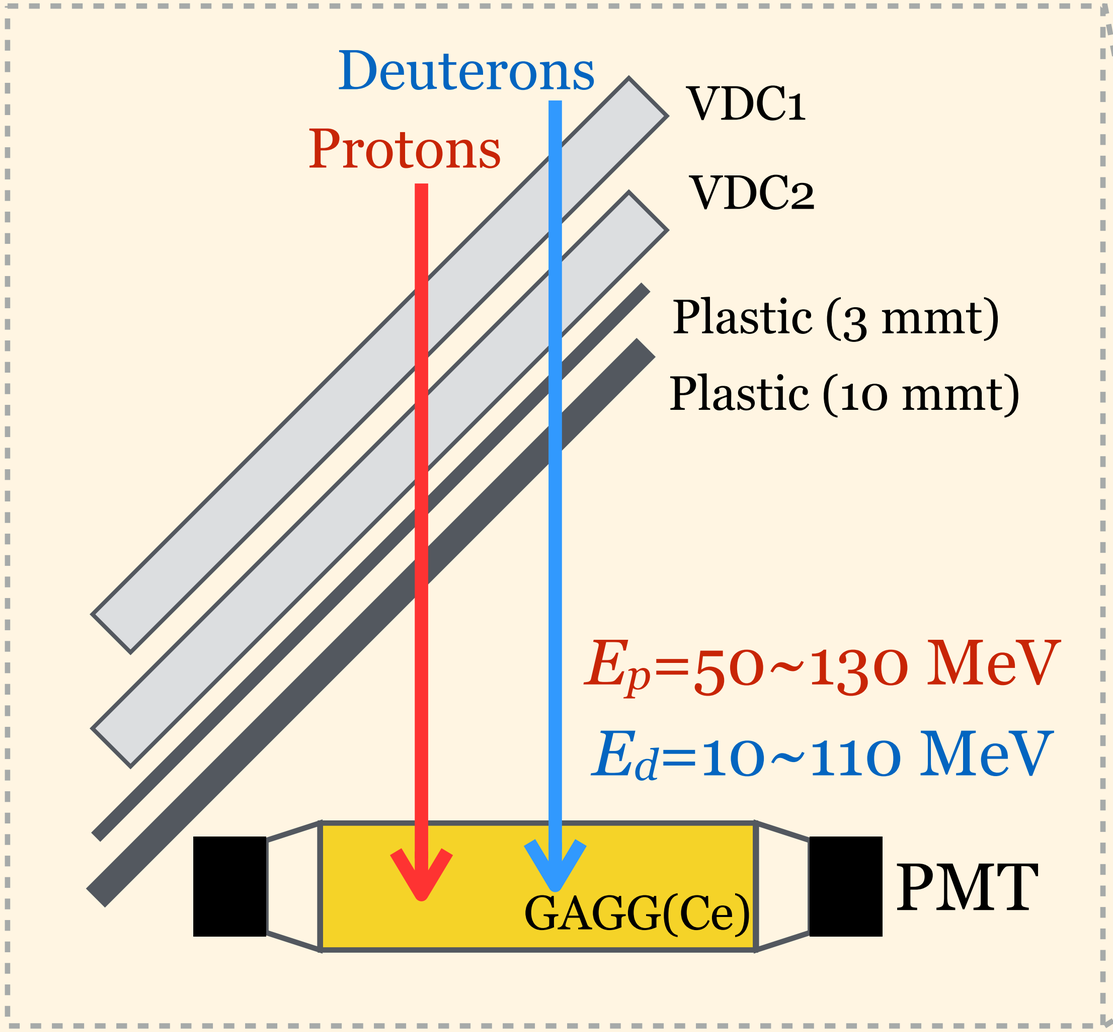
PID by Pulse Shape Analysis with GAGG(Ce)

GAGG(Ce)
(35 × 35 × 120 mm^3)

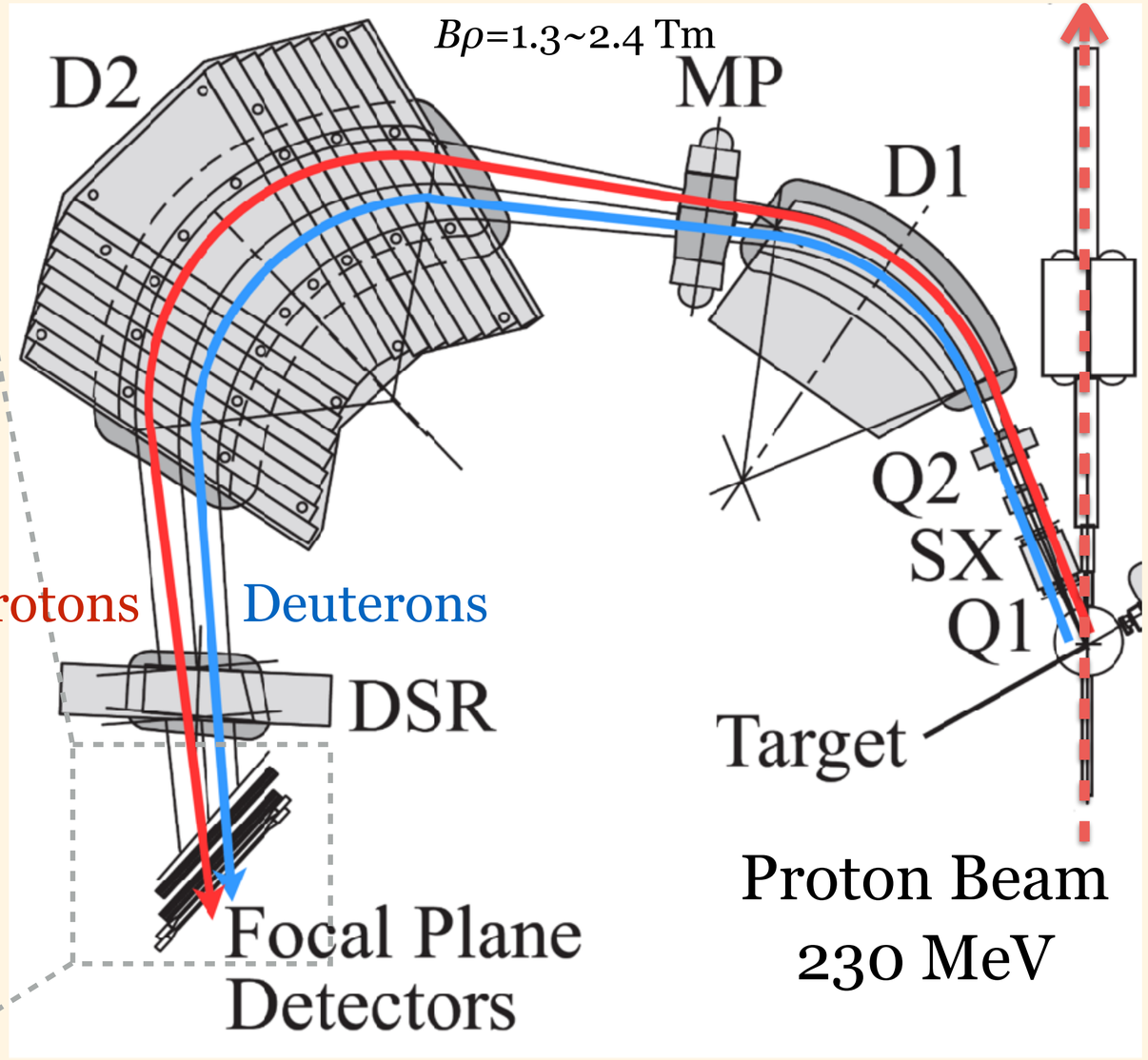


Si strip detector
(100 μmt, 100μm pitch)

Experiment



Grand Raiden



Analysis & Results

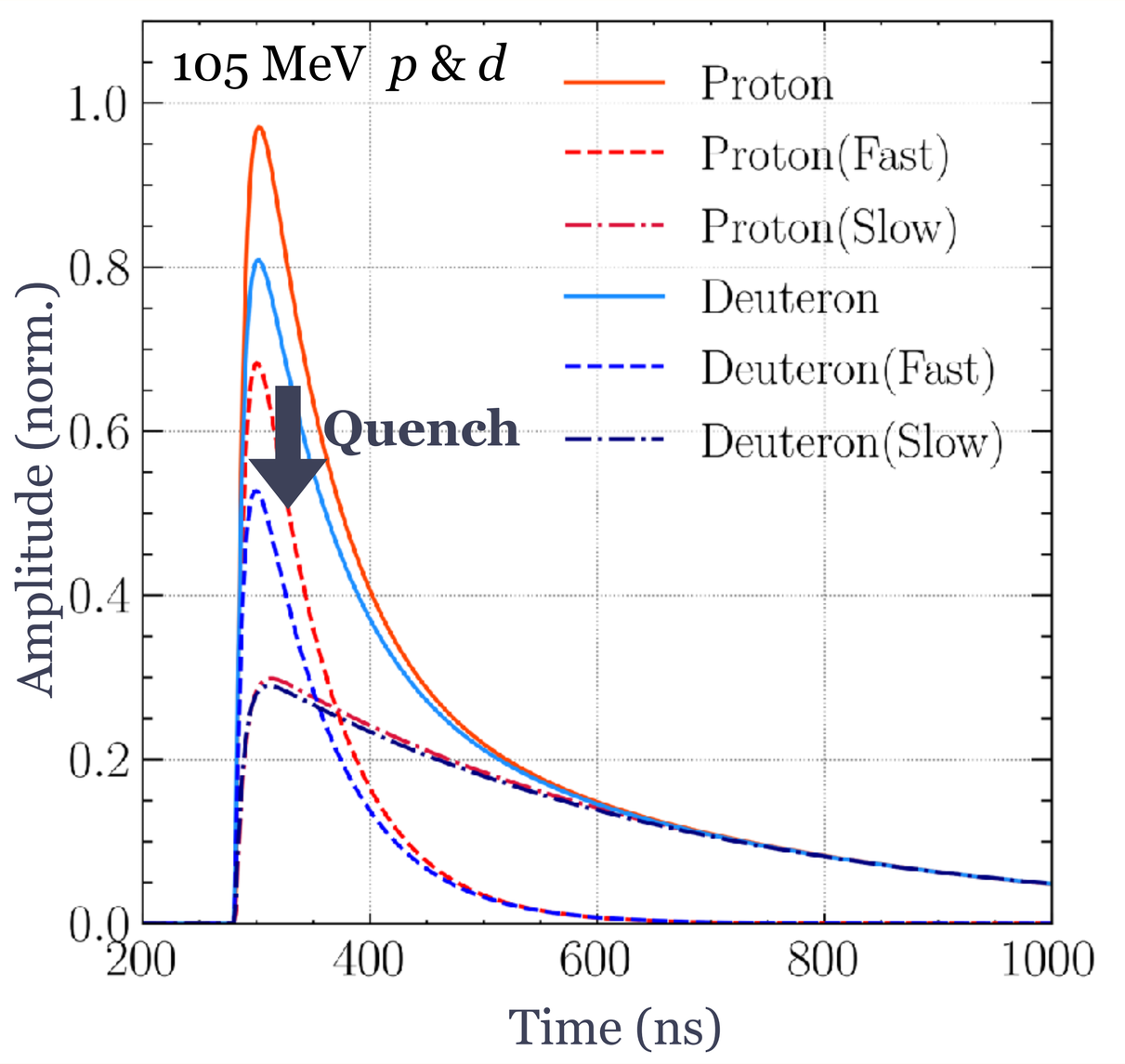
Pulse Shape Analysis

- Compare the pulse shapes of p & d of the same energy.

Component	Quenching Effect
Fast	Large
Slow	Small

➡ Pulse shapes depend on dE/dx .

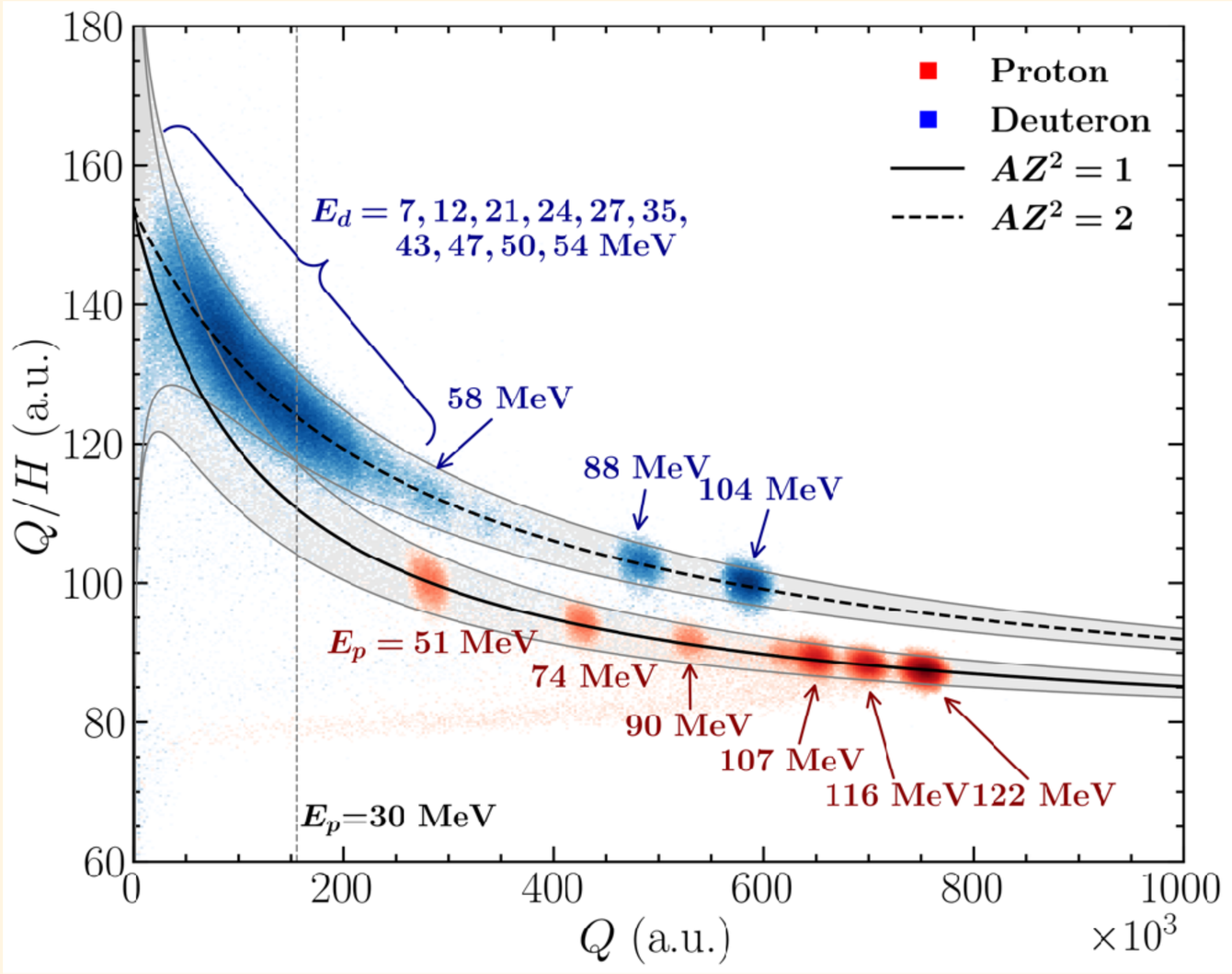
- Reduced the pulse shapes to Q & H.
  - Q : Integrated total charge
  - H : Pulse height



Analysis & Results

PID with Q/H vs Q

- PID parameters:
  - Q = Light output
  - Q/H ~ Decay time
- The loci are clearly separated in the Q/H vs Q correlation !!
- Response function depending on AZ^2 was successfully deduced.
- 2σ separation between p & d was achieved at E_p>30 MeV.



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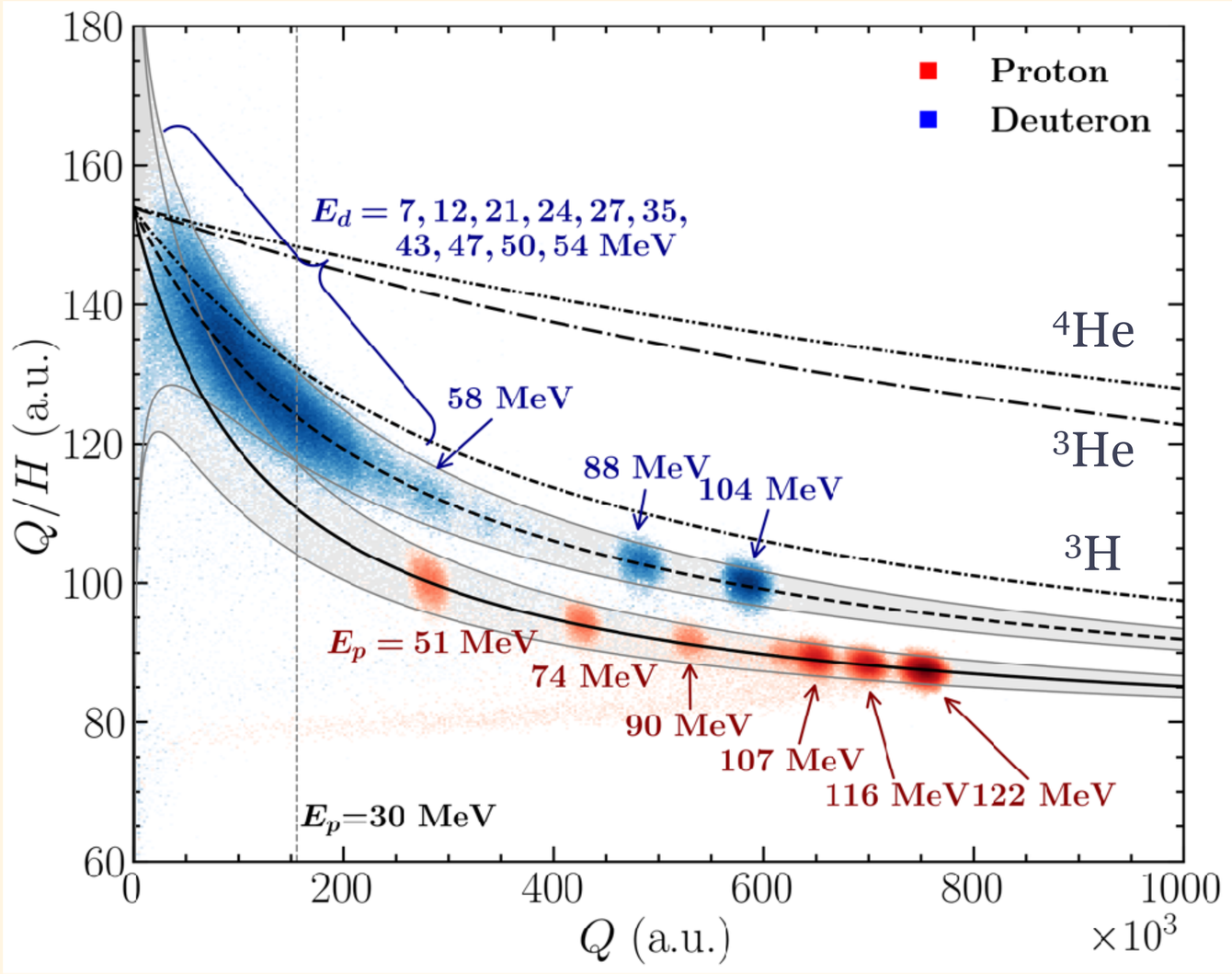
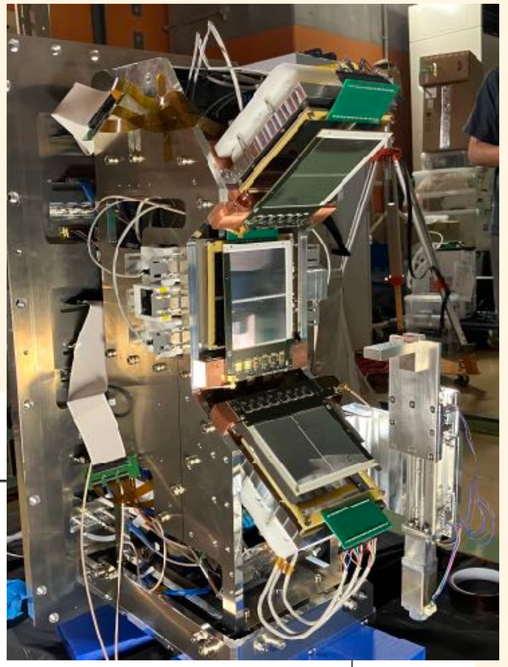


Recent Developments

Implementation of PID with Q/H vs Q in FPGA



- This new PID method is implemented in the firmware of MIRA (125 MS/s waveform digitizer). In this firmware, the waveform is processed by the FPGA and only the charge (Q) and pulse height (H) are recorded.

- MIRA with this new firmware was employed in the TRIP MESA experiment (Nov. 2024) and it looked working well.