Pulse shape analysis for GASPARD: ^{3}He-^{4}He separation using time information

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OUTLINE

Scope

Method (filter + observables)

Results at 340-V bias

Results at 350-V bias

Conclusions

SCOPE

Situation

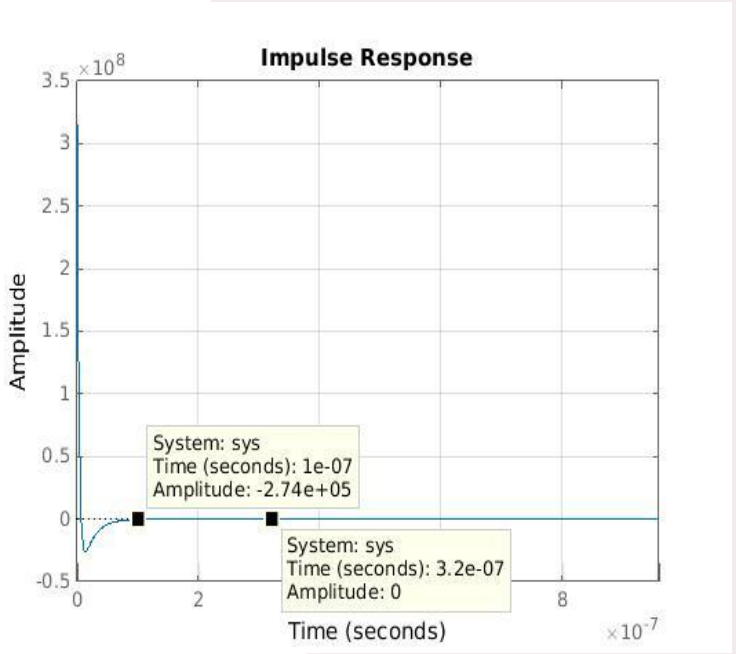
- The I_max vs Q_max plot is not sufficient for the particle identification:
  - Lowest energies
  - biases above the depletion voltage
- Ageing → may have to bias above the depletion voltage
- Best method for $^{3}He/^{4}He$ separation: relies on the digitization with a high dynamic range (PSENOB = ADC + noise + sampling rate)
- Cost/feasibility: additional channel vs present high-dynamic range channels?

Proposed method

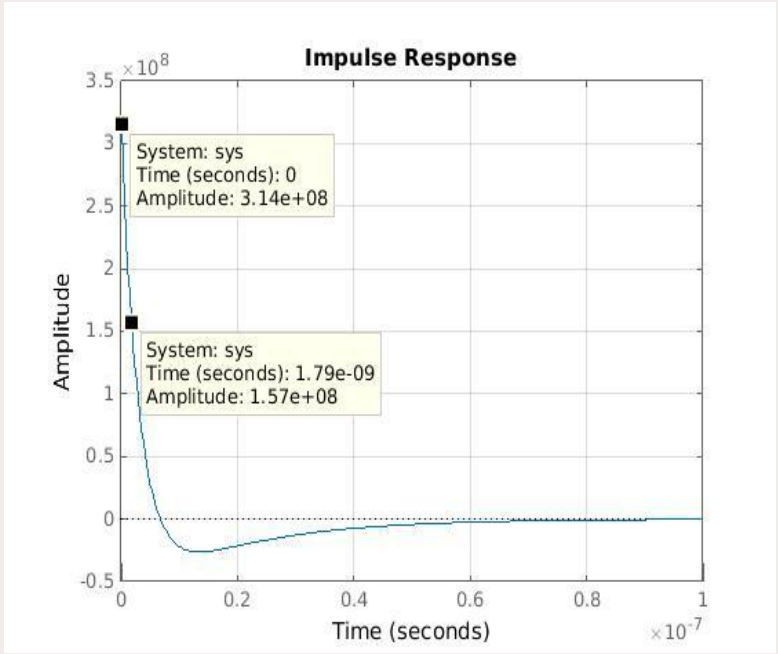
- Analysis of the 2013 data (BB13 + PACI + WaveCatcher), based on the 6-month work of a master's student (N. Bouida)
- Reaction: 24-MeV deuteron beam on Mylar target: expect at 40 deg. 12 and 16 MeV ^{3}He, 10 and 13.5 MeV tritons
- Time reference = beam sync. signal / poor time resolution (1 ns)
- Simulation of time measurements using an **analog filter** implementable in an ASIC

FILTER

- Digital simulation (ARMA implementation of an IIR)
- Baseline: CR-RC fast shaper used by Omega (PARISROC chip)
- Coefficient calculated with Matlab
- Calculation with a home-made software

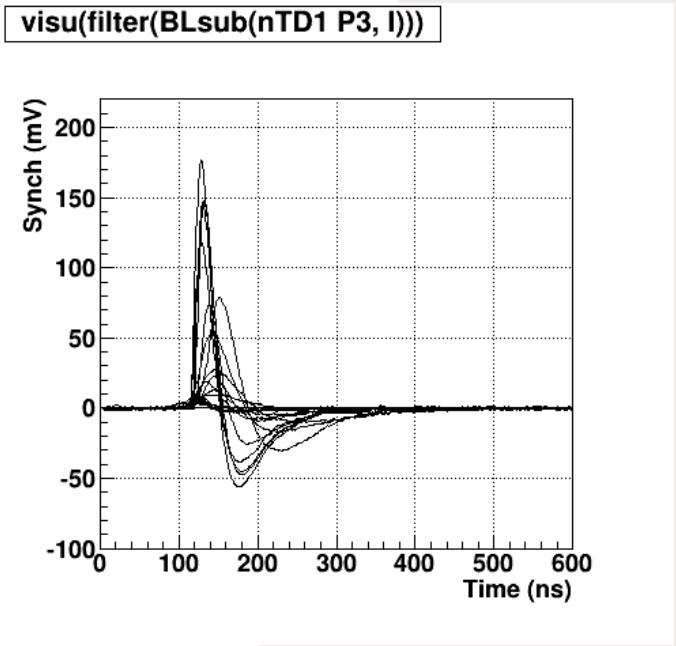


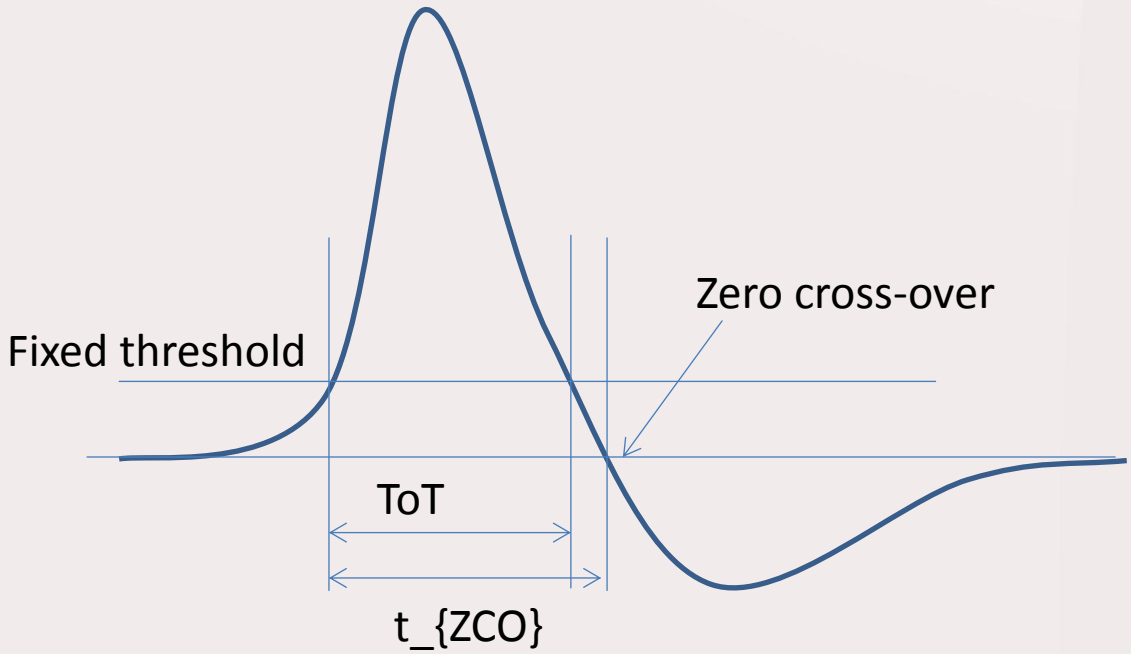
10 µs



100 ns

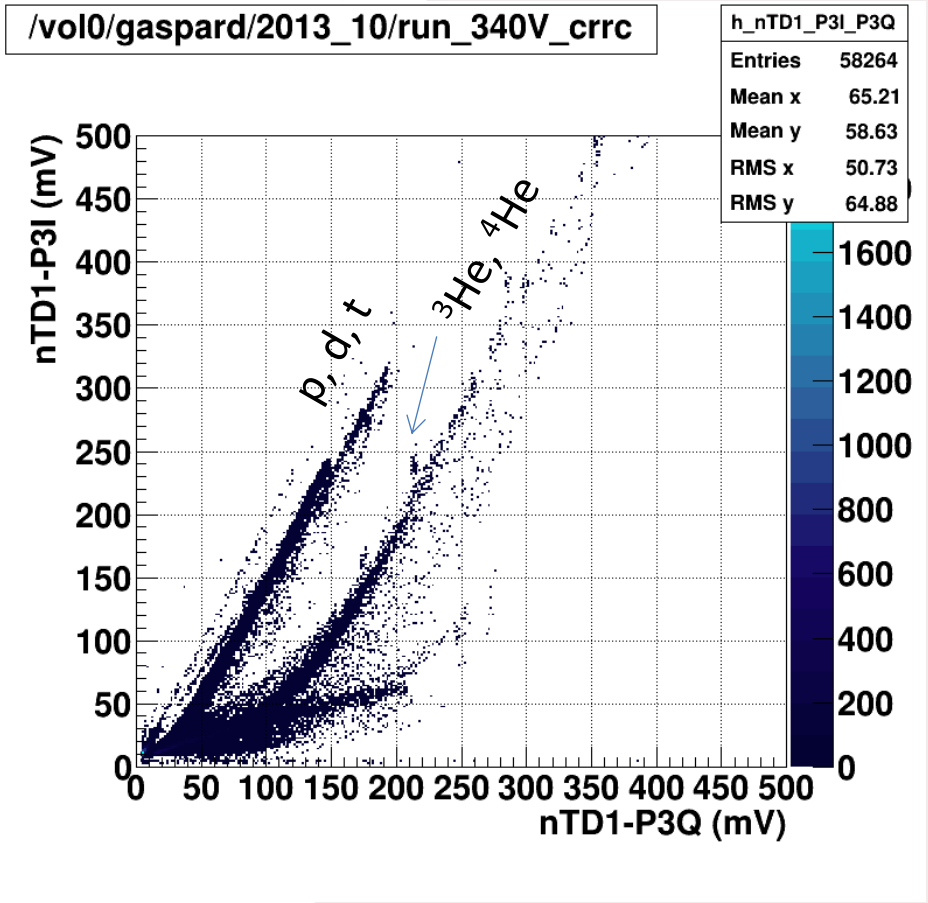
METHODS

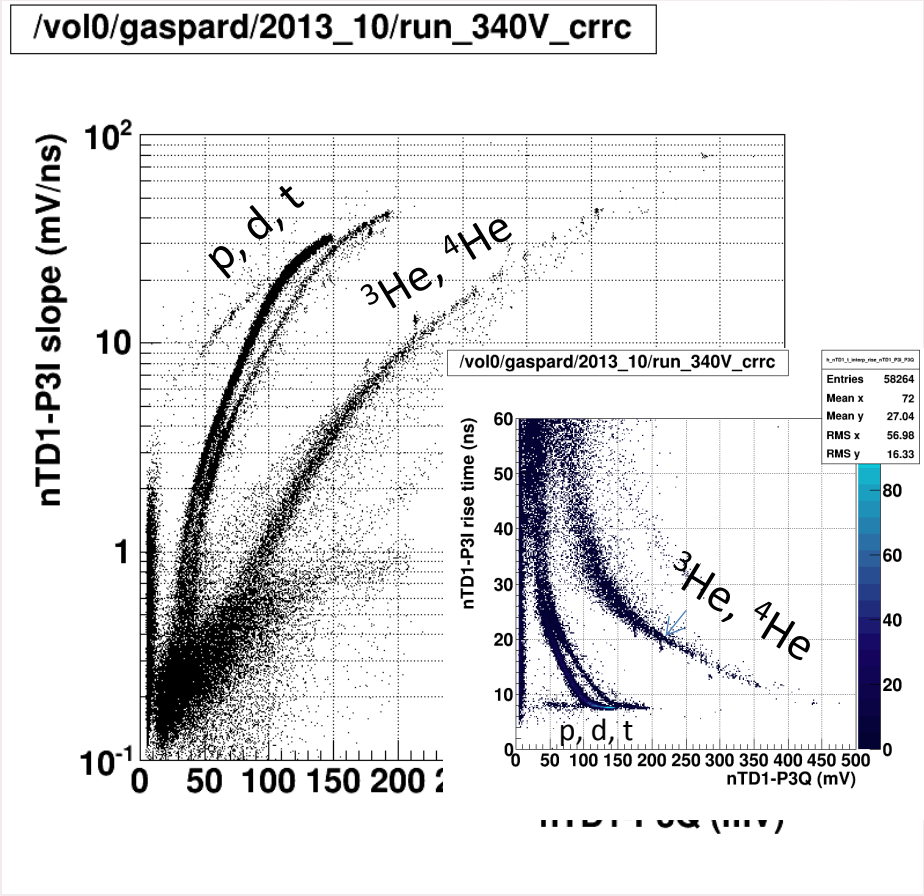




- ToT = Time over threshold (fixed threshold)
- ZCO = time at zero cross over – time at leading edge (fixed low threshold). In principle lower jitter if the filter is well tuned (greater slope)
- Since I focus on method to be implemented on an ASIC, I don't show times obtained by constant fraction discriminator simulation
- **Event selection**: suppression of punch-through by threshold, noise, partial inter strip suppression

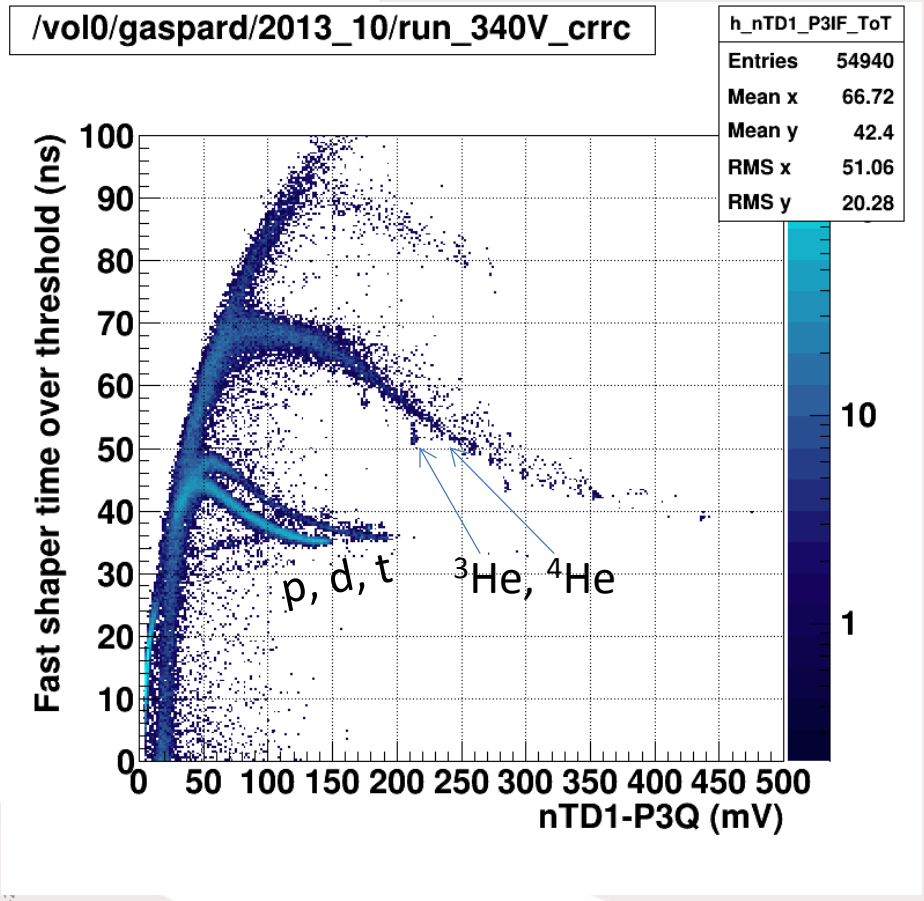
DATA – 340 V



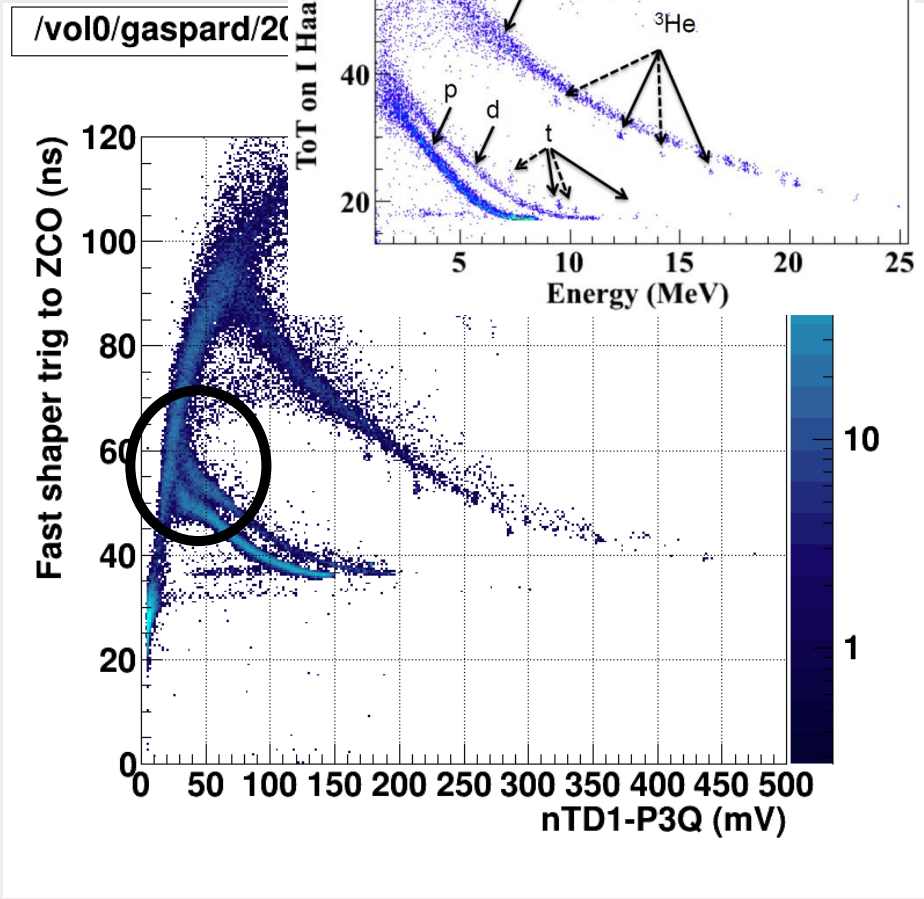


- Concatenation of several runs to increase the statistics
- **Slope** of the leading-edge current signal by interpolation, as a reference → possibility for the analysis / calculation costs (note the log scale)
- At low level: dominated by noise / could be improved by low-pass filtering (not performed here)

MAIN RESULTS – 340 V



Time over threshold



Trigger to Zero cross-over
Dominated by the trigger resolution (?)

CONCLUSIONS / QUESTIONS

For the implementation of the electronics

- Number of channels needed: probably two fast shapers needed to cover the whole dynamic range (depending on the slope)
- Need a good trigger

Application to the data analysis

- Compare the slope calculation and the time measurement on the filtered signals?
- Depending on the calculation time performance, use in the « real time » processing (during the acquisition)
- Slope calculation: could be improved at low level (since the greatest rise times are expected at the lowest amplitudes) / high calculation time