Thoughts on electronics requirement for GRETA for fast beam + spectrometer experiments

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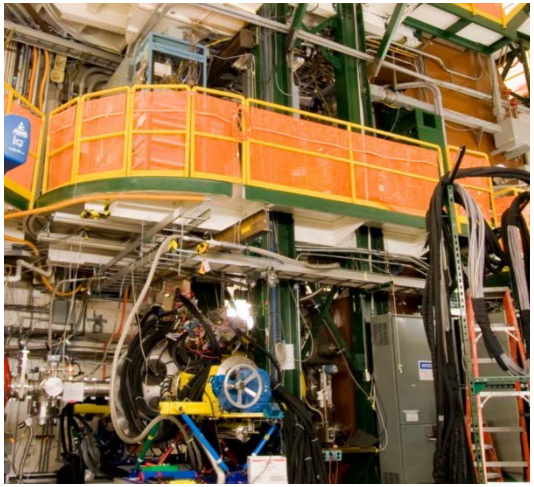
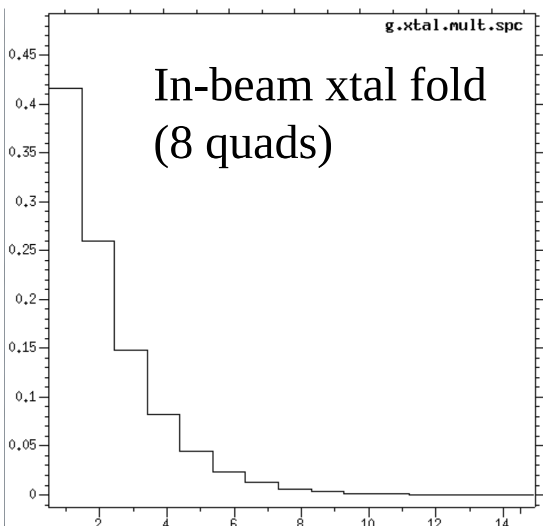
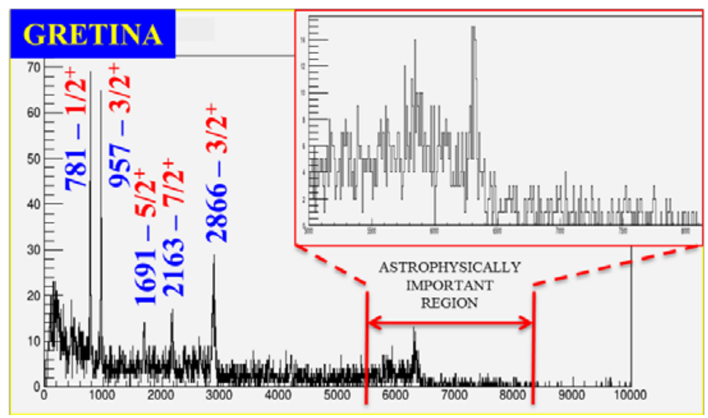
State of the art: S800+GRETINA



- Ran in S800-GRETINA coincidence mode, i.e. fast γ trigger sent to S800 trigger logic and trigger live sent back to GRETINA.
  (gamma coincidence needed to reduce trigger rate in S800 system **)**
  (GRETINA listened to S800 trigger needed to reduce GRETINA rate **)**
- Maximum trigger rate used ~3kHz (with ~60-70% time live)
- S800 focal plane detector limit: 10kHz
- Average crystal fold 2-3
- GRETINA threshold ~50keV
- Gammas up to 8MeV (after Doppler correction, v/c~0.4)





GRETA: 4kHz decomposition per xtal → 120 xtal 480kHz
Assume average fold ~4 → 100-150kHz GRETA event rate.
For spectrometers with trigger rates of 100kHz or less we would be just fine, but…..

New generation fp detectors

Marco Cortesi's summary from LECM 2017 talk:

Summary

New Developments:

-) MPGD-based Detector
- CRDC with THGEM as pre-amplification stage
- DC/TPC with "Hybrid" MPGD (THGEM, THGEM+Micromegas, others)
  → Resistive (spark-protected) MPDG structure for high dynamic range

-) Fast & easy implementation, low cost
-) Sub-mm resolution
-) Limited counting rate capability (a few tens kHz)
-) Large dynamic range (resistive)
-) Poor Energy Resolution

-) New PPAC readout
- Delay-line PPAC
- Resistive Cathode PPAC (RC-PPAC)

-) Well established technology
-) Low cost
-) Counting rate capability
- Delay-line PPAC → Up to a few hundreds kHz
- RC-PPAC → limited (a few tens kHz)

-) Sub-mm position resolution
-) Poor Energy Resolution

-) Electroluminescence-based detector
- Optical Parallel Plate Avalanche Counter
- Optical Chamber

-) New technology, ongoing R&D
-) High cost
-) High rate capability (>1 MHz)
-) Moderate position resolution (~1 mm)
-) Large dynamic range
-) High Energy Resolution (OC -> a few % @1 MeV)

Focal plane systems capable of MHz !!!

Ideas for GRETA trigger conditions

Objective is to reduce gamma trigger rate (<150kHz what GRETA can handle)
'problematic' gammas are from REC and x-ray (target, high-Z projectile)

2-Level Trigger: one level for GRETA gamma trigger, other (lower) level for channel conversion in case of GRETA trigger was issued

Upper-Level Discriminator: Signal amplitude exceeding a certain height are disqualified for contributing to GRETA trigger (avoiding trigger on high-energy 'particle' events)

Detector-Location Dependent Multiplicity Trigger: Like 2-fold event in forward detectors OR 1-fold in the backward detectors issues a trigger

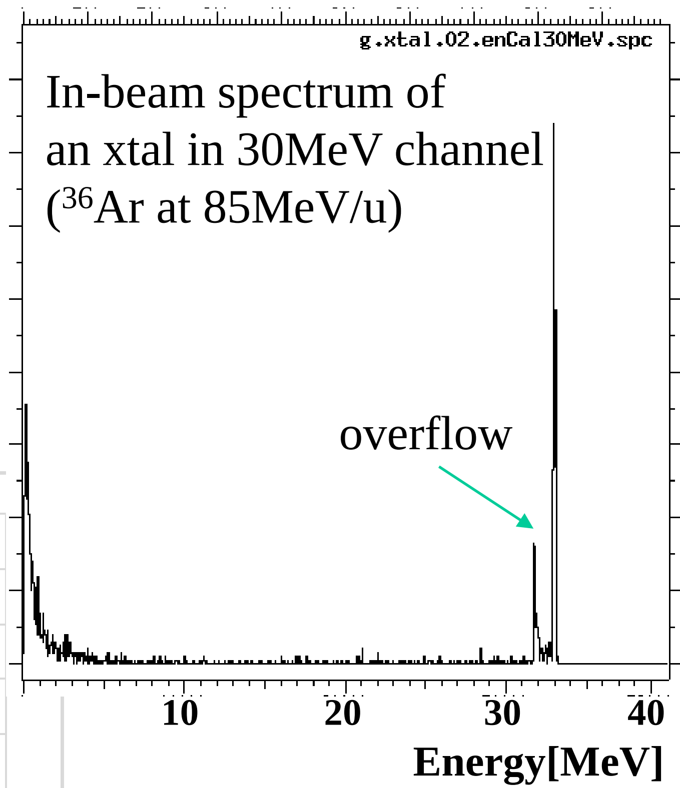
Energy-Sum Trigger: Obtain energy from a fast filter, add all energies (maybe even allow a fixed scale factor for Doppler-shift correction), and allow trigger threshold on result.
[Ge risetime ~600ns, so it takes at least 0.5-1us after 'fast' trigger to obtain an amplitude/energy information from signal]

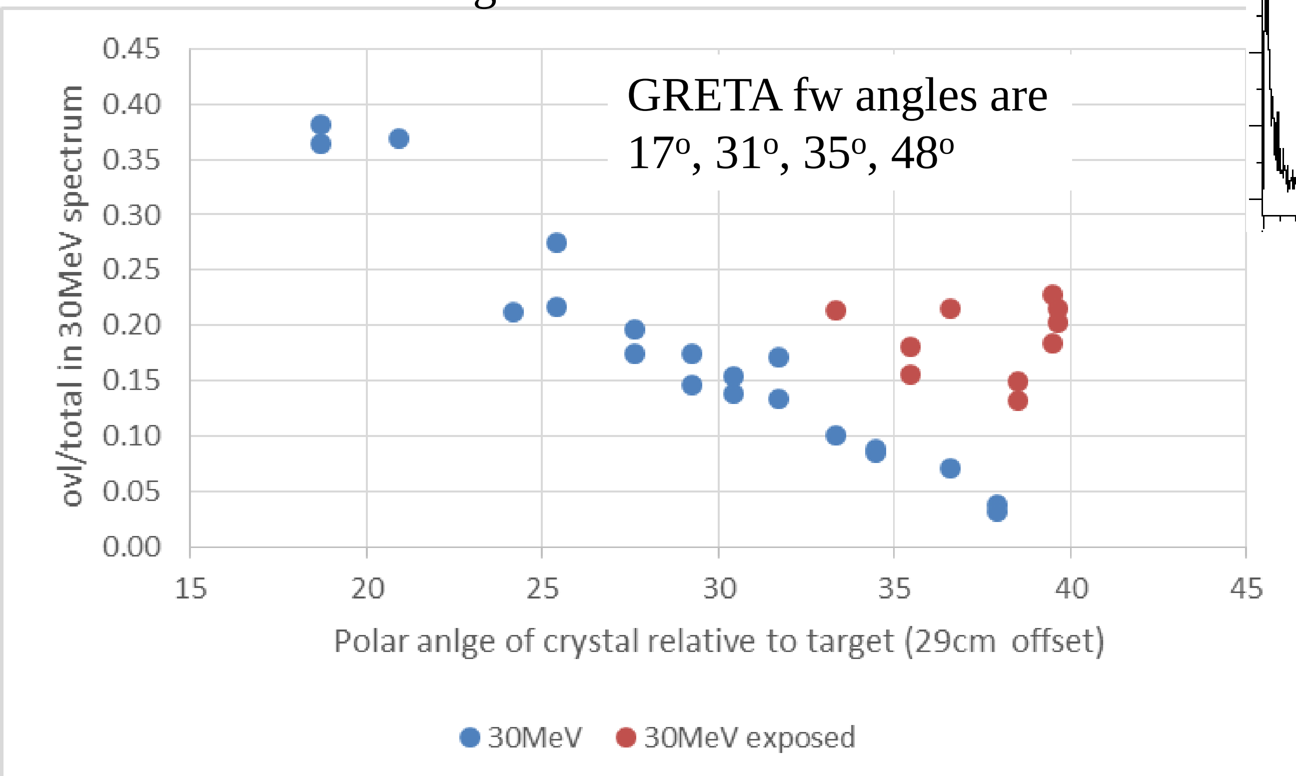
* Allow combinations of those trigger conditions.
* GRETA provides event-by-event which trigger conditions were met ('trigger register')

High-energy events

In fast-beam experiments we see a large fraction of overflow events in the 30MeV channel for forward detectors. The majority appears to be ‘particle-like’ as the most events happen in the front layer.

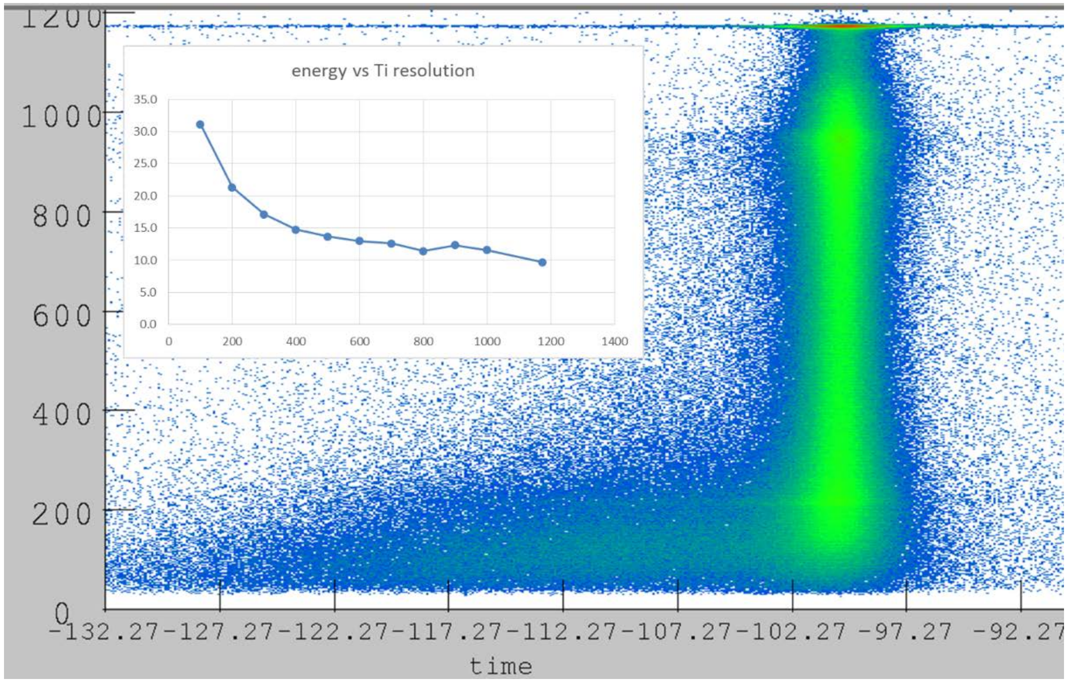
In forward detectors in GRETA we can expect that 20-40% of events are overflows (> 30MeV). Channel in overflow for about 40us on average.



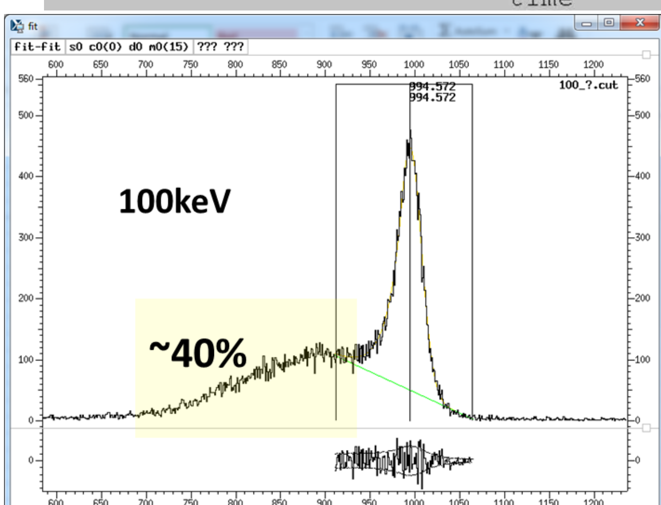


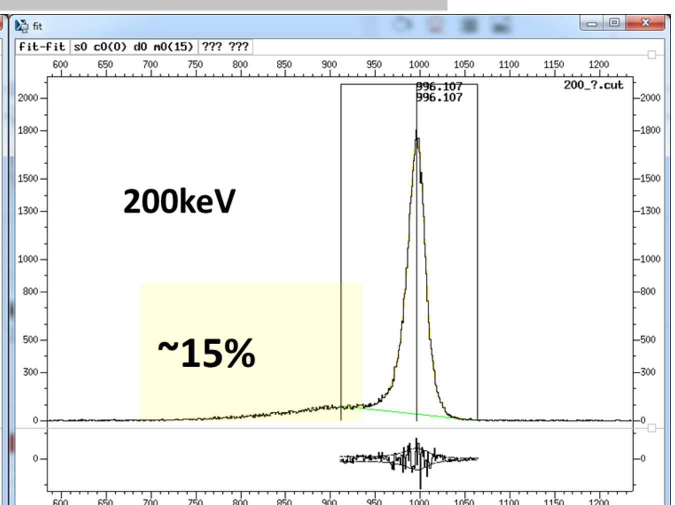
Timing

Ge-Ge timing for coincidence with 1.33MeV

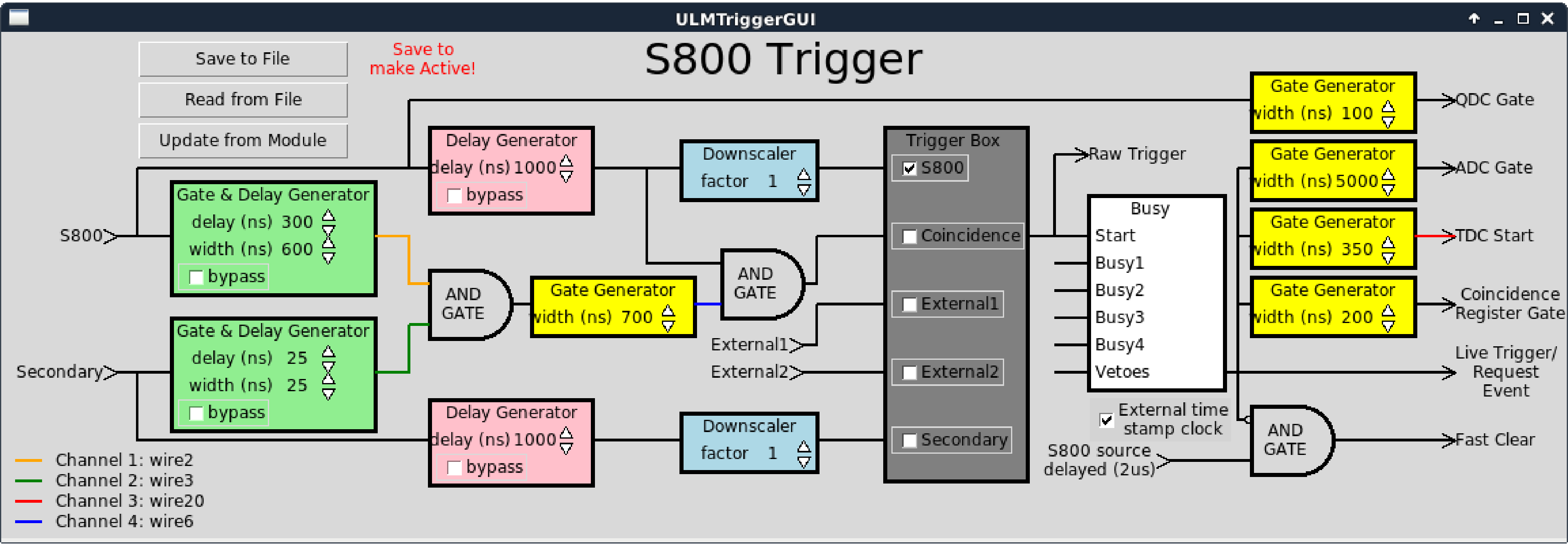


Current offline timing exhibits a wide 'timing' tail for low-energy events.





Typical S800-GRETINA trigger timing



Note that S800 branch includes the flight time from target to fp.