Summary of 3x1x1 operation and studies

On behalf of the CIEMAT, IFAE and LAPP groups

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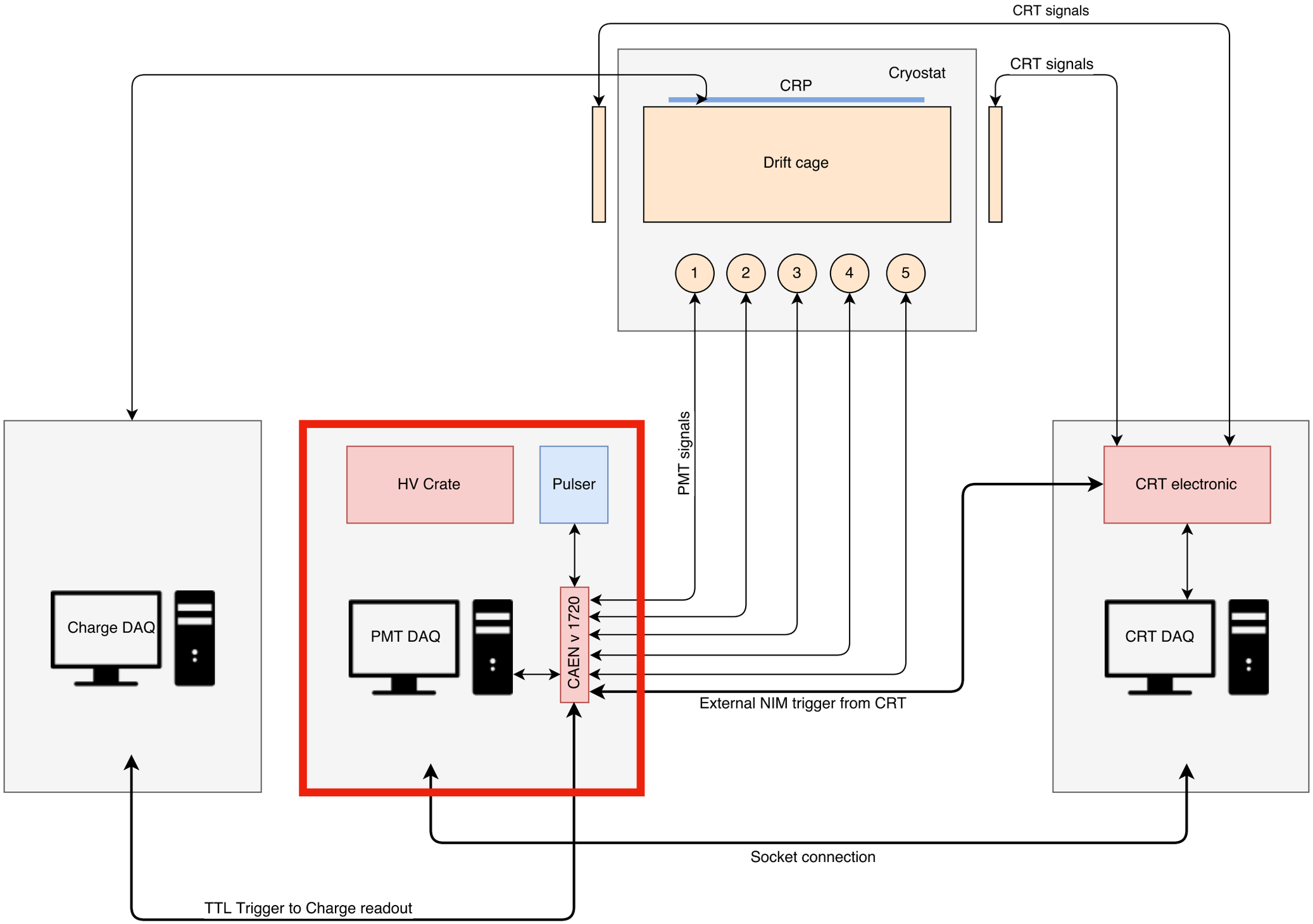
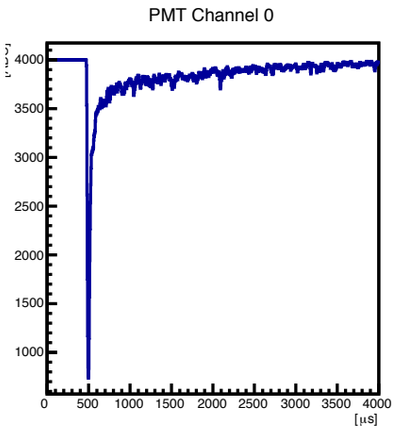
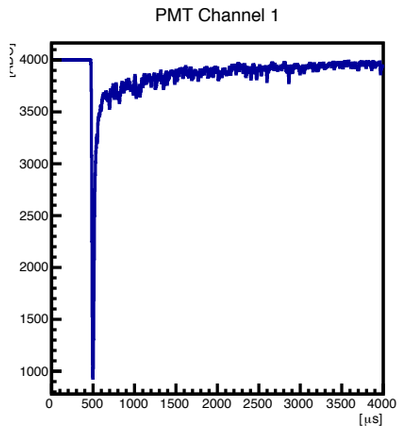
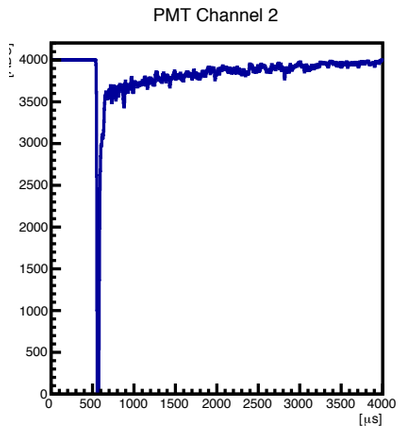
PMT-centric readout schematic

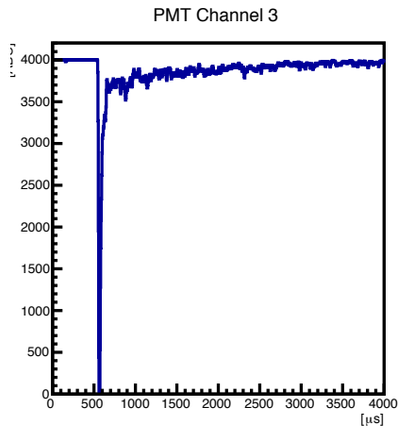


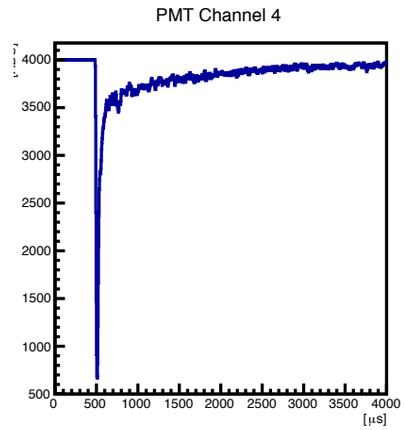
Online Monitoring

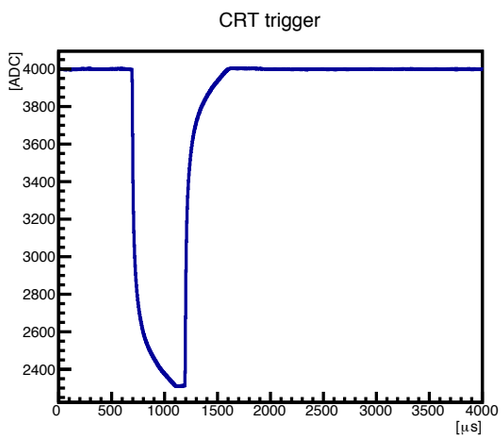


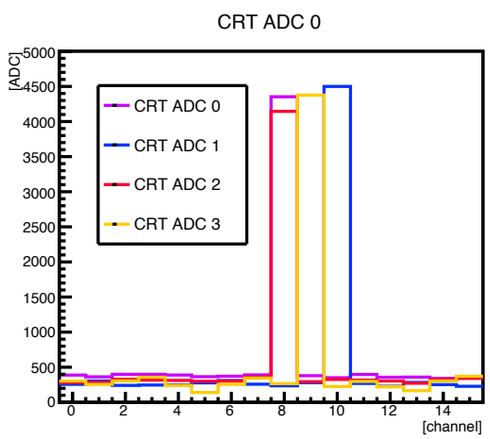


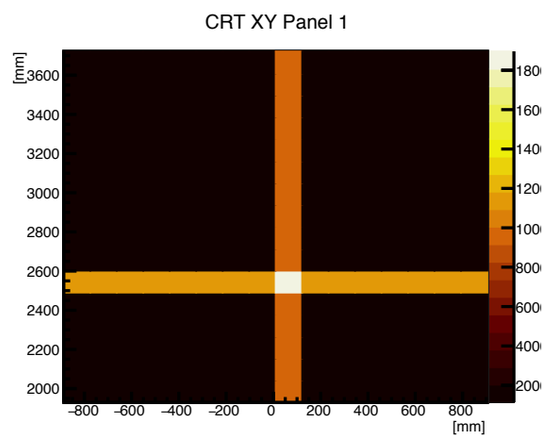


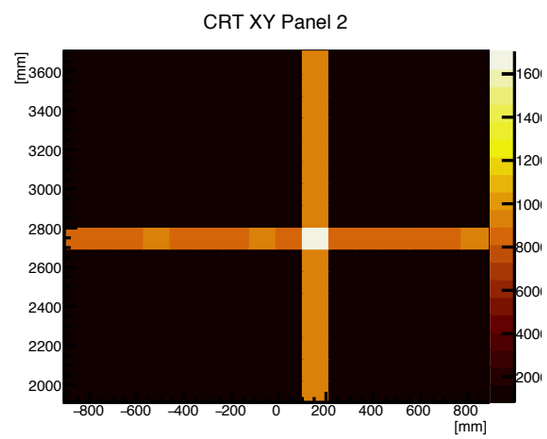


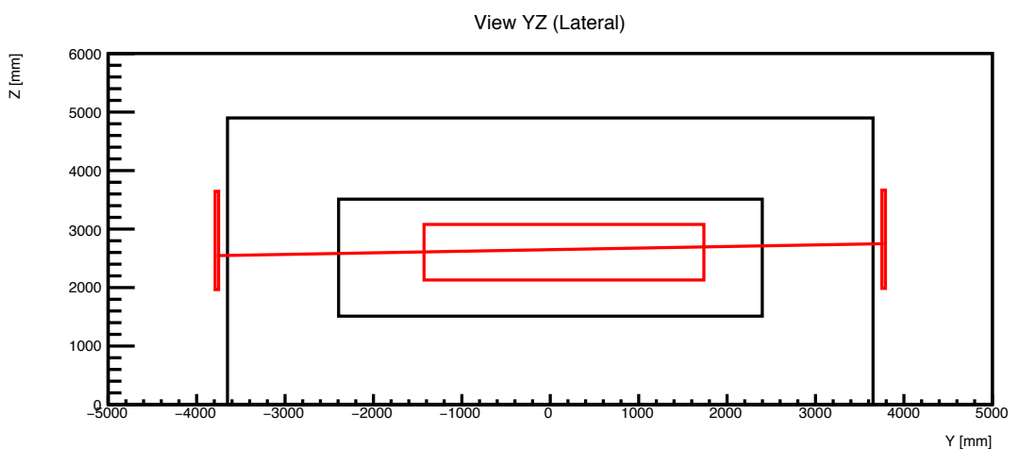


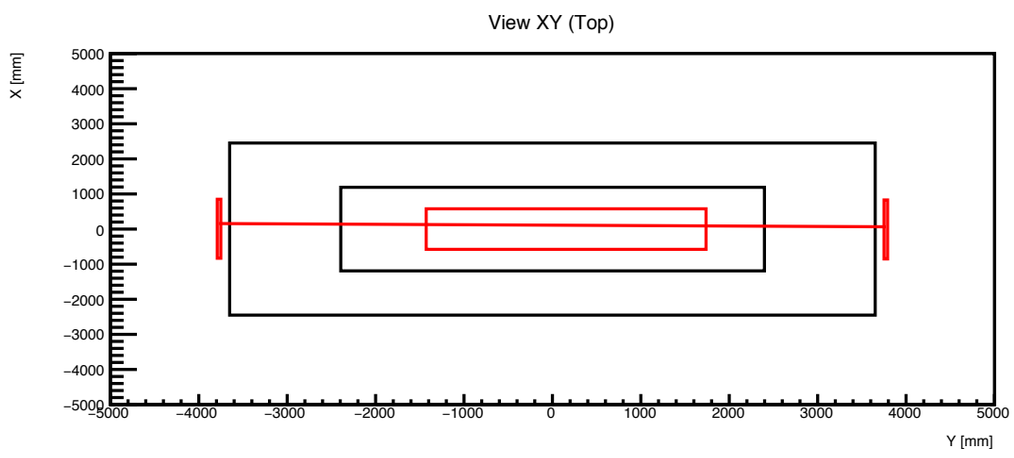






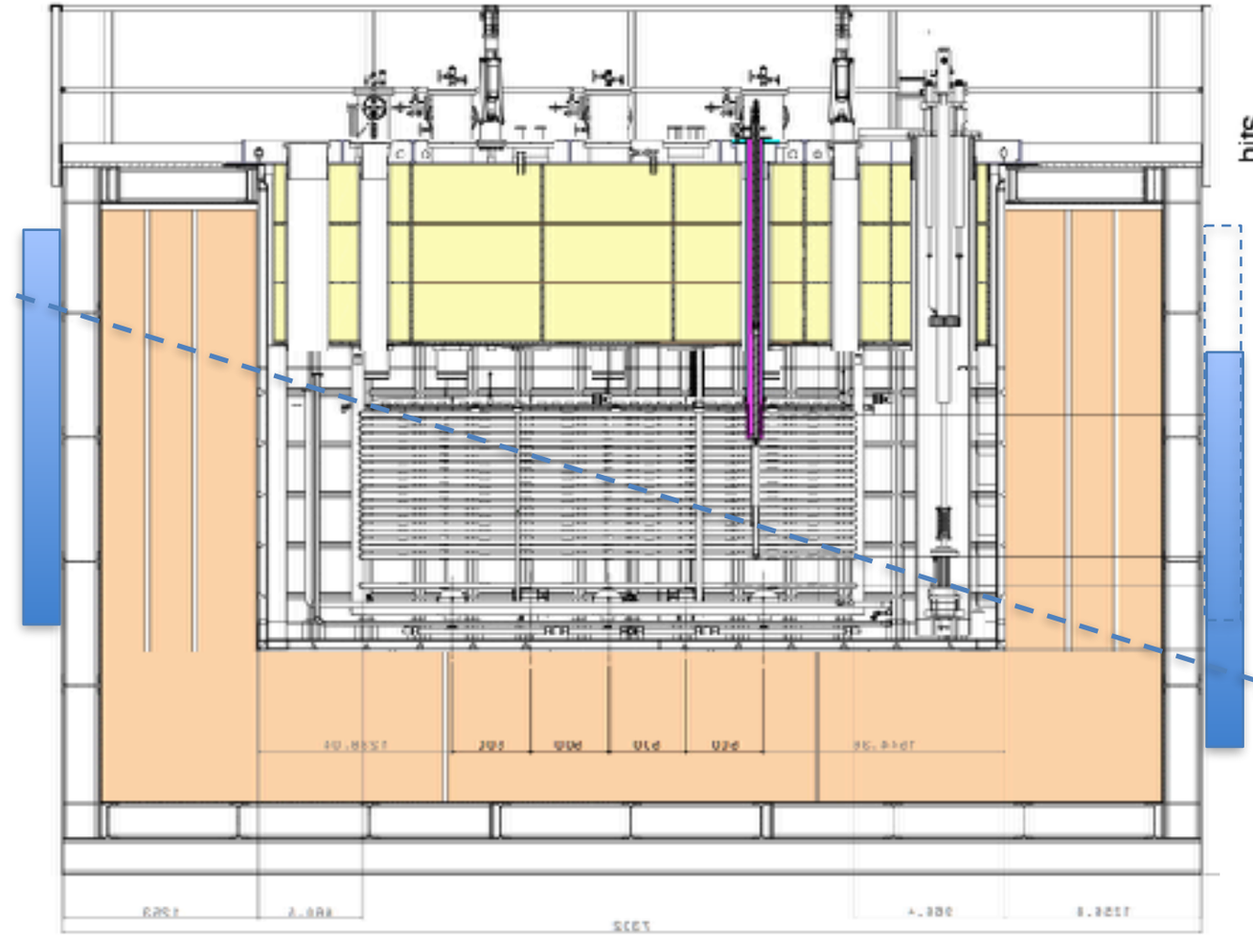


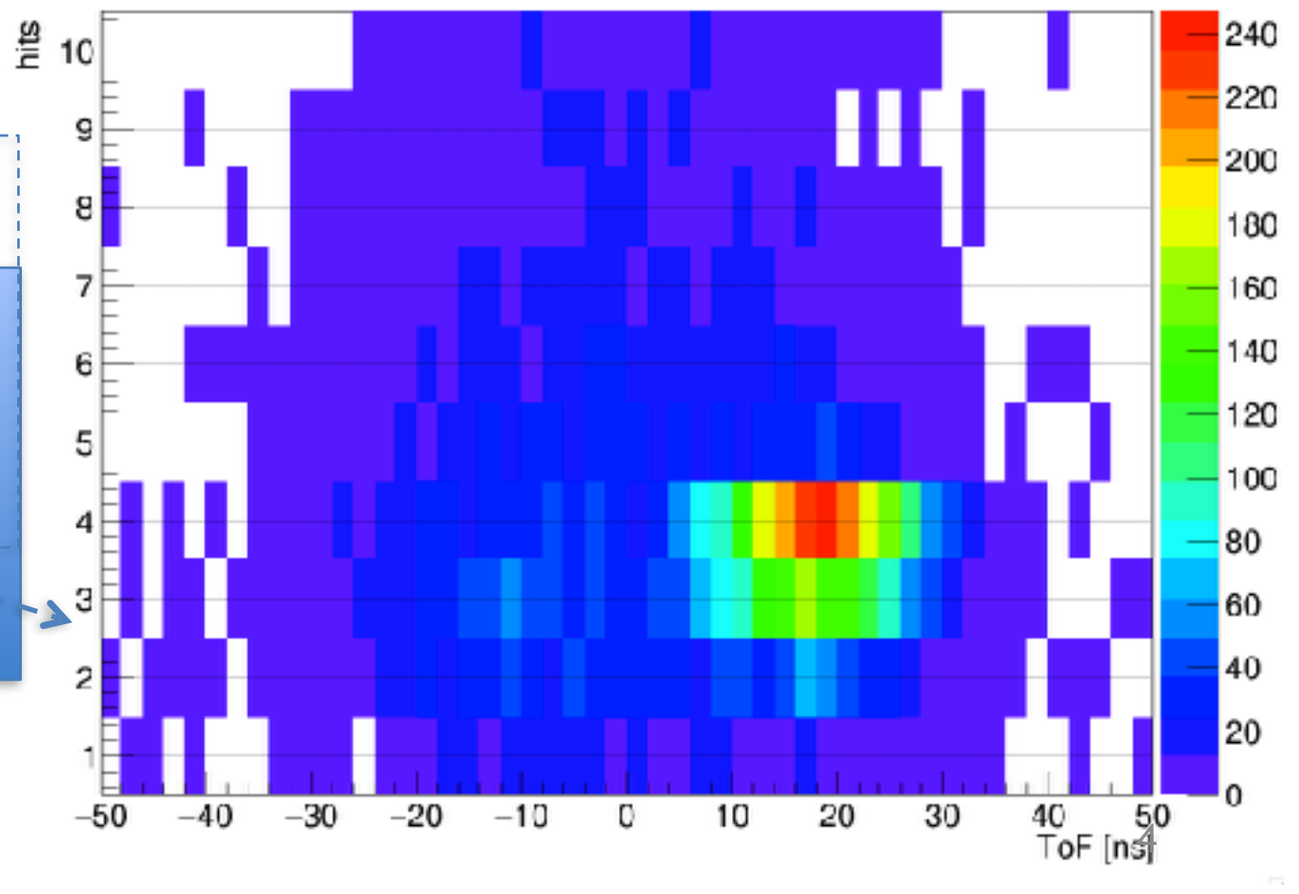




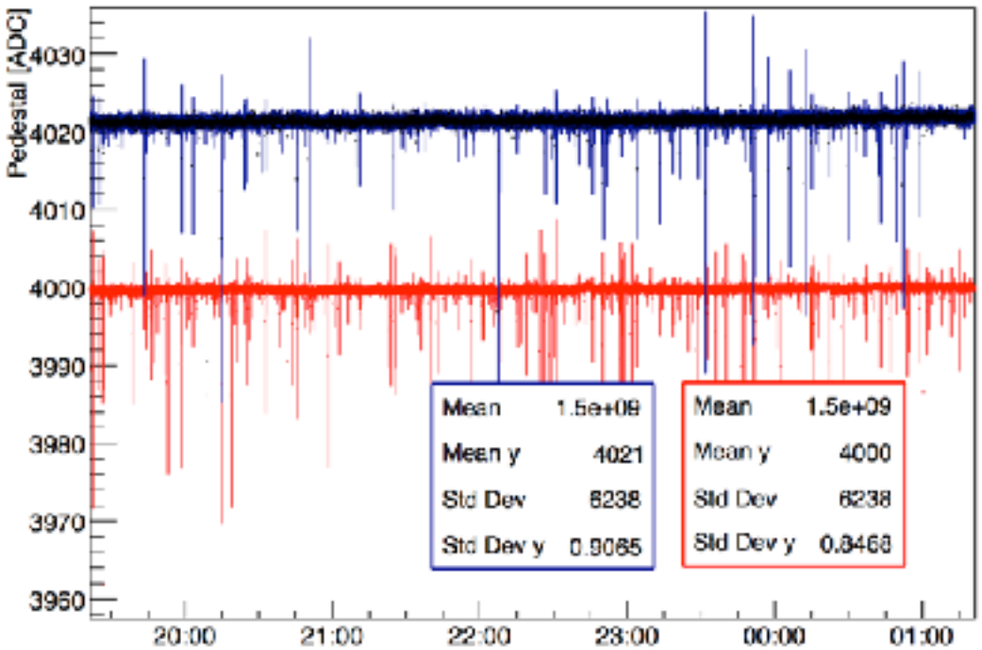
Cosmic Ray Trigger

- Single muons are selected by requiring one hit per panel on the 4 CRT panels.
- This selects events where the ToF is compatible with a traversing particle



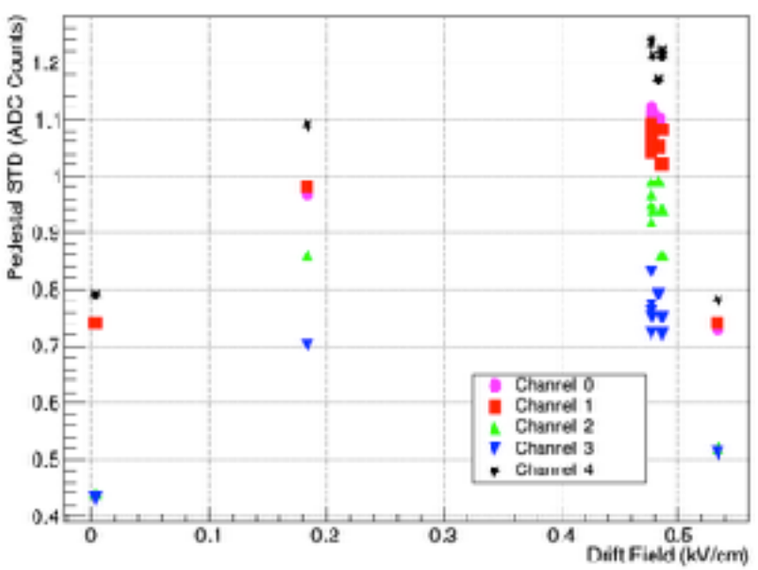


Operation Stability

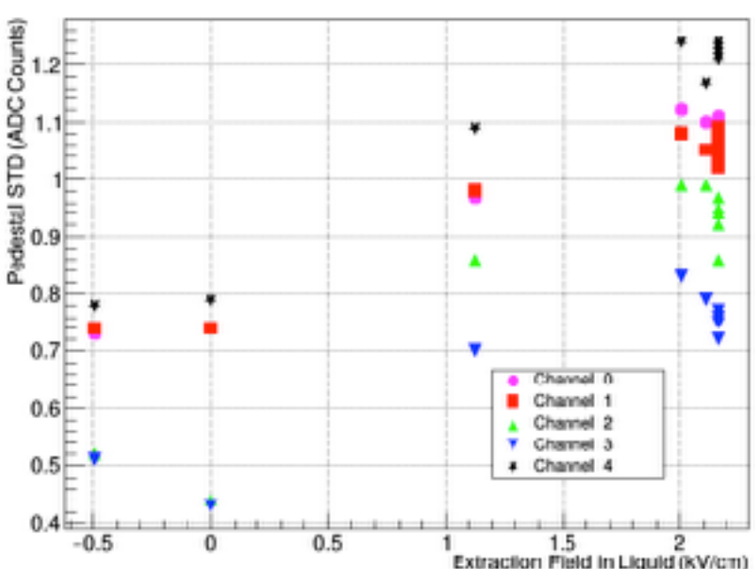


- Baseline variation is below 1 ADC count during entire data taking and for different operation conditions
- Pedestal widths remain below ≈ 1 ADC count even under high amplification fields

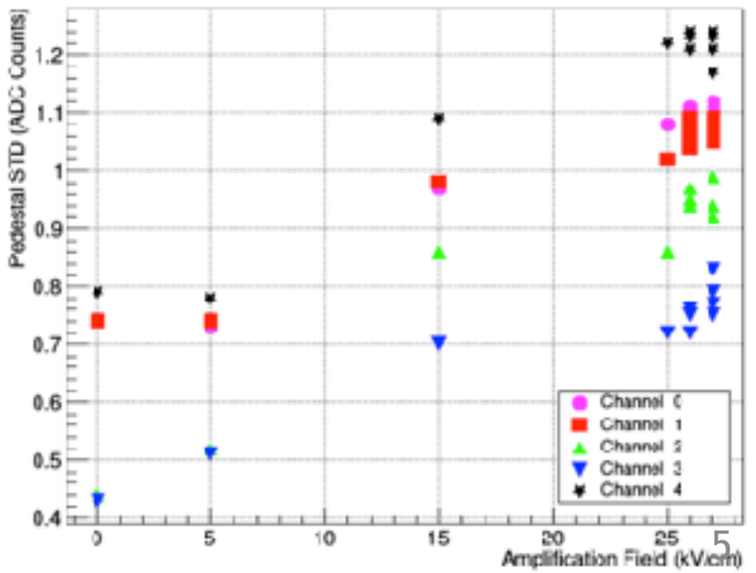
Varying Drift Field



Varying Extraction Field

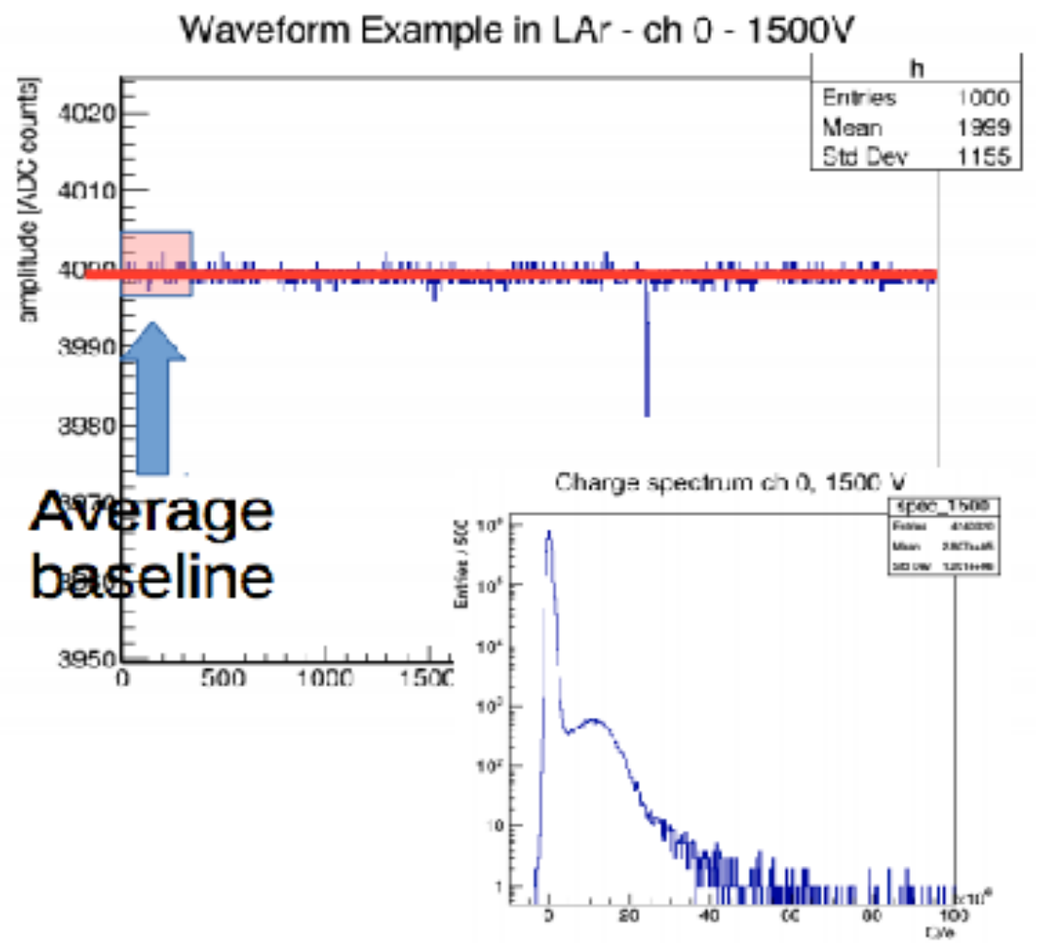


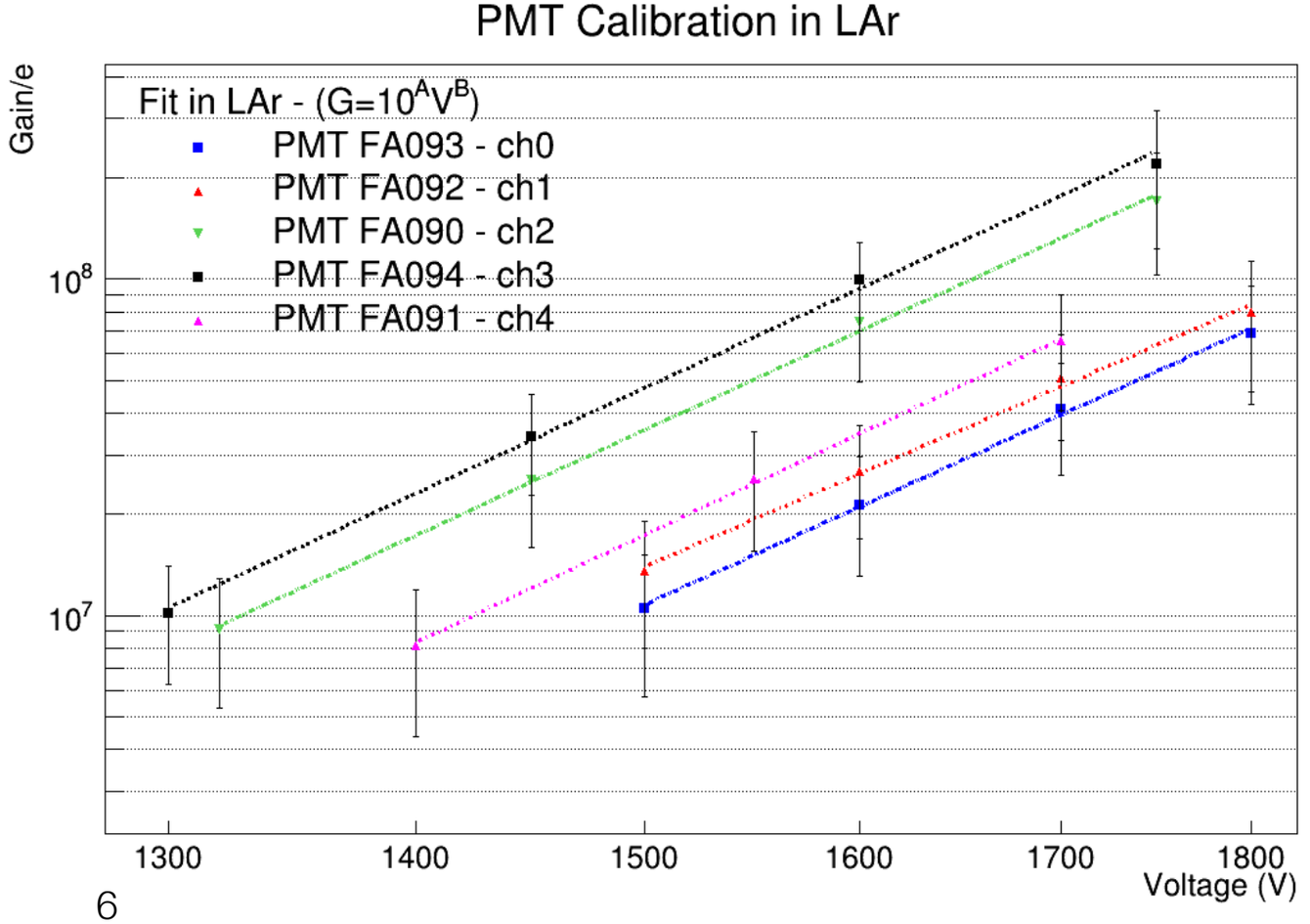
Varying Amplification Field



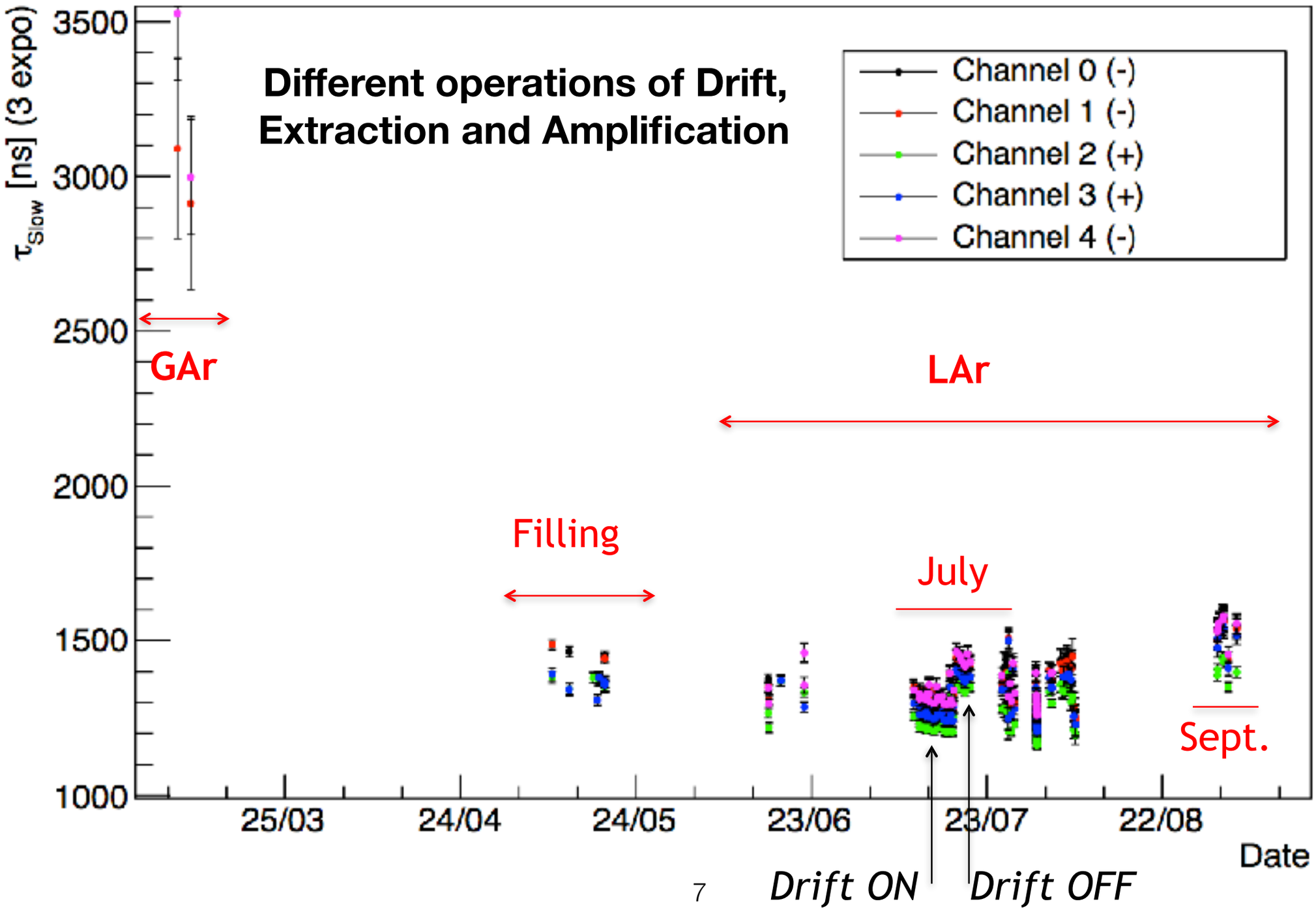
PMT SPE calibration

- 3x1x1 PMTs have not been calibrated in LAr prior installation
- No available PMT calibration system (as will be in the WA105 demo)
- Calibration performed reconstructing SPE ADC spectrum on data taken with random trigger



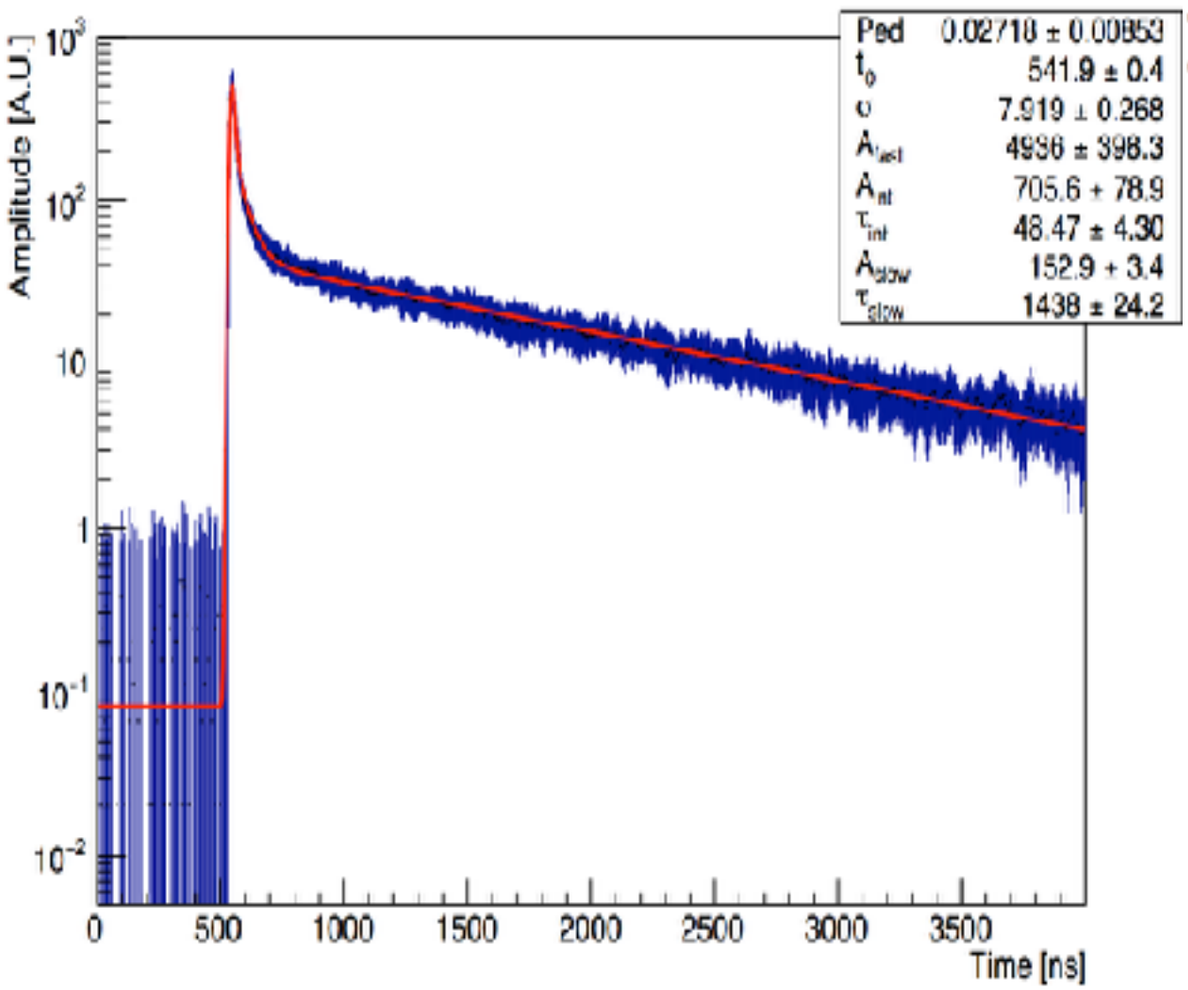


Scintillation slow component vs. Time

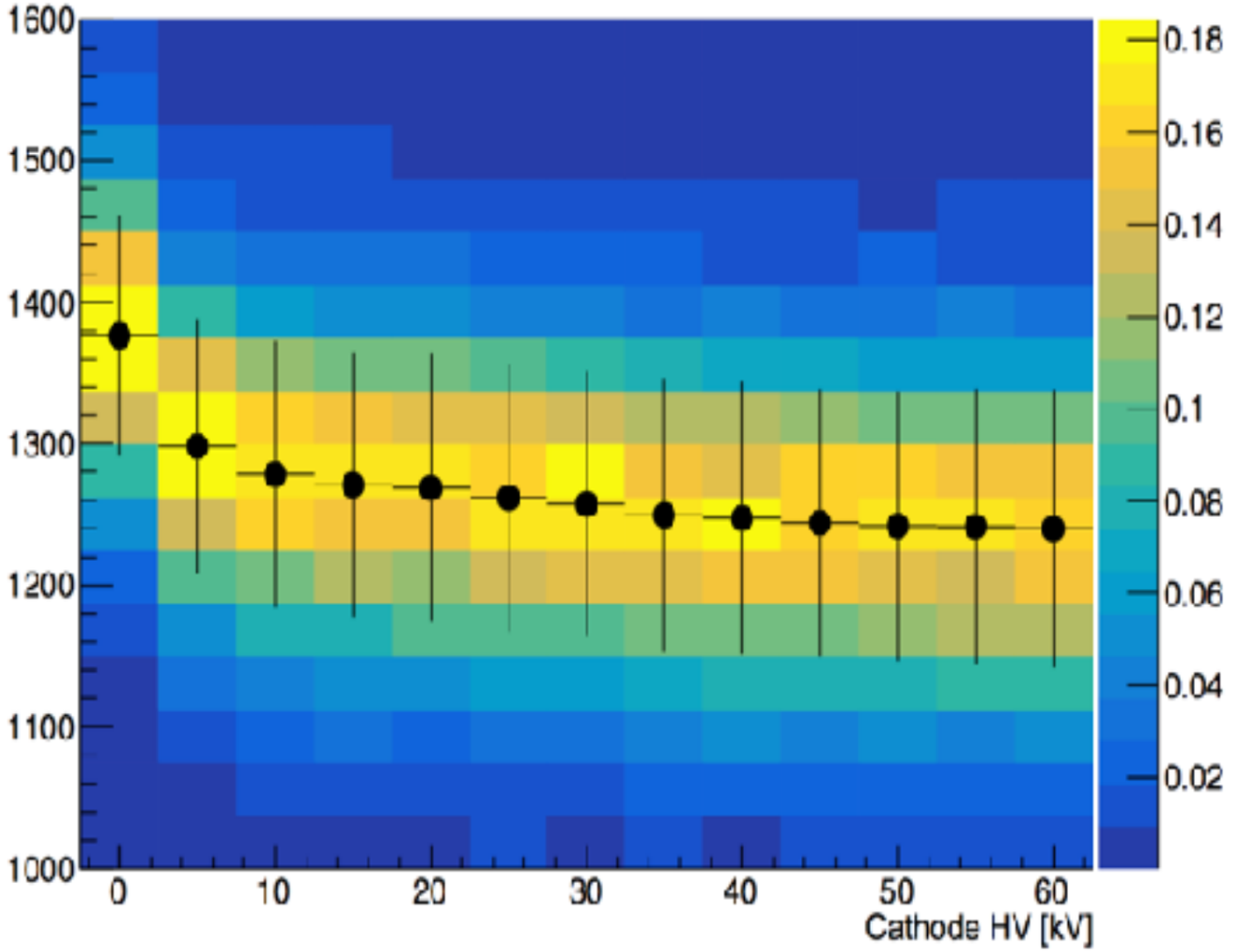


Scintillation Slow Component vs. drift field

Observed a decreasing scintillation time with increasing drift field



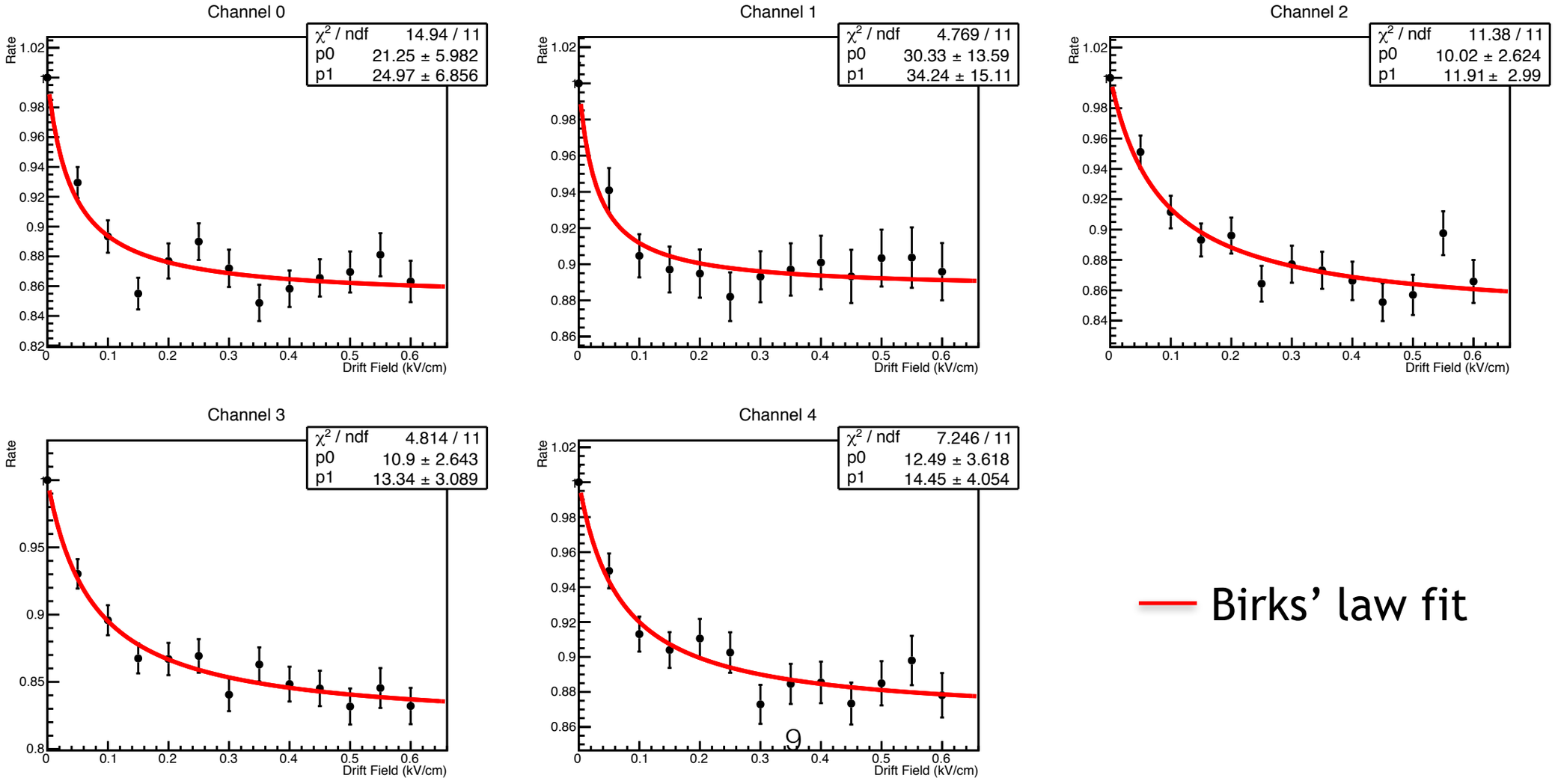
Average Waveform no field



Event-by-event τ_3 fit

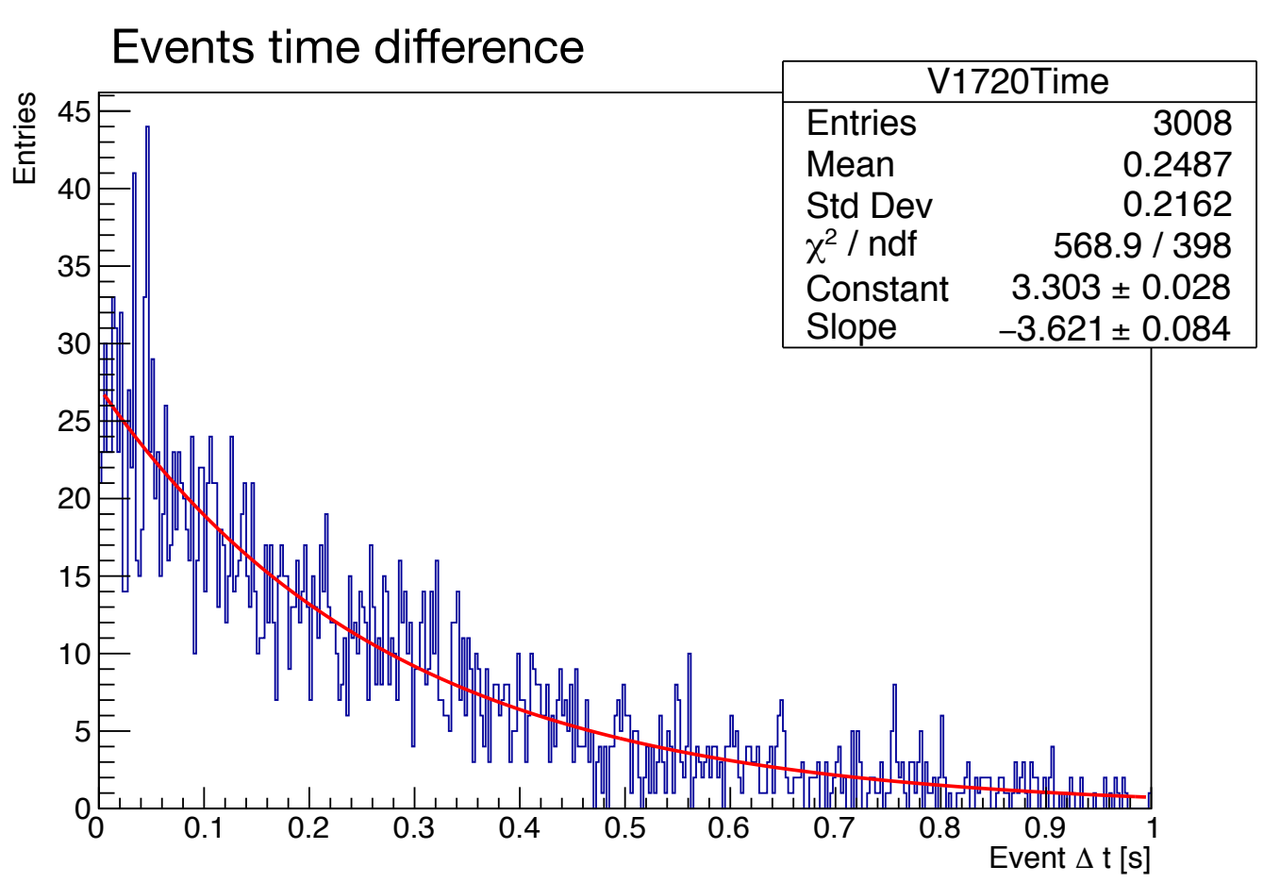
Light Yield vs. drift field

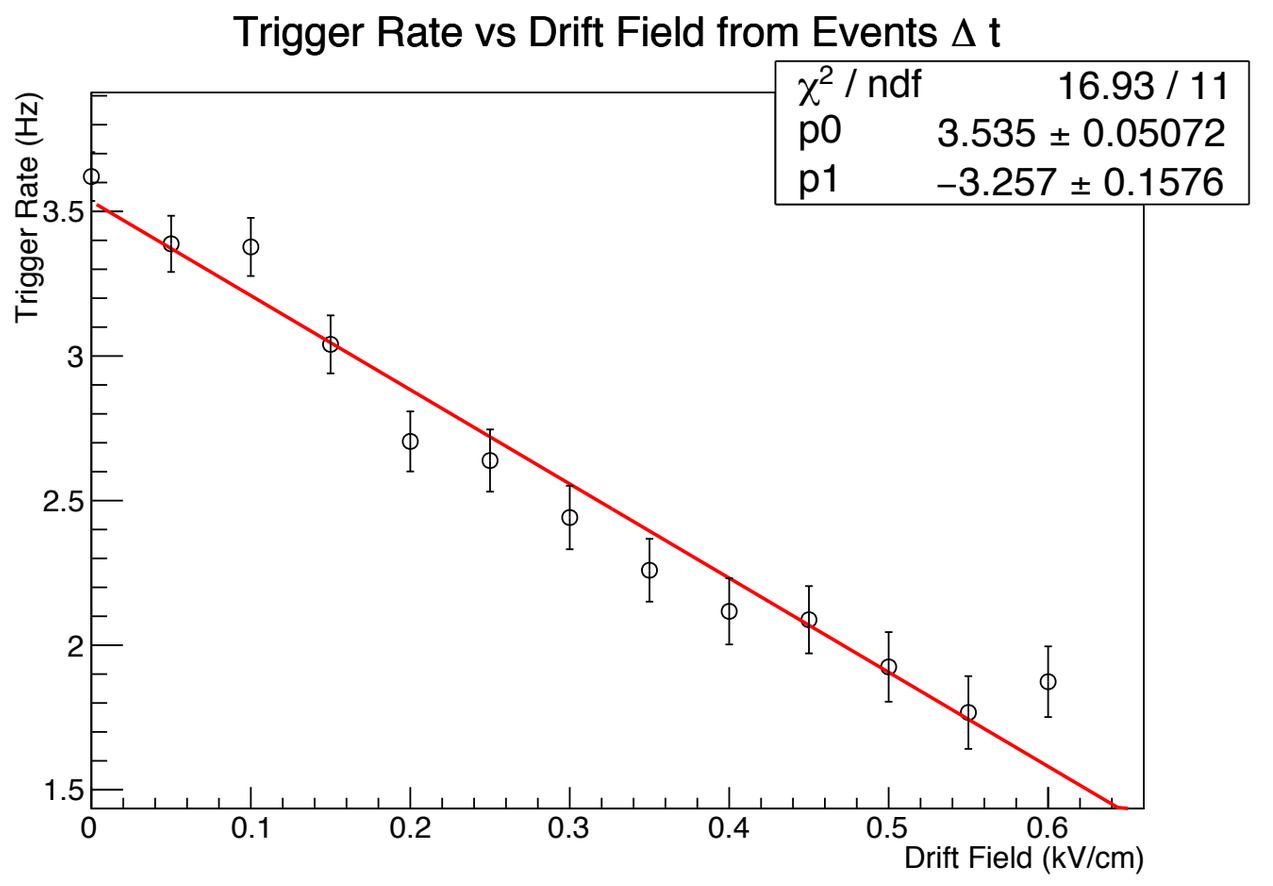
- Decrease of integrated light charge with increasing drift field
- Relative charge reduction shows a behaviour compatible with the expected attenuation of scintillation light from recombination



PMT trigger rate vs drift field

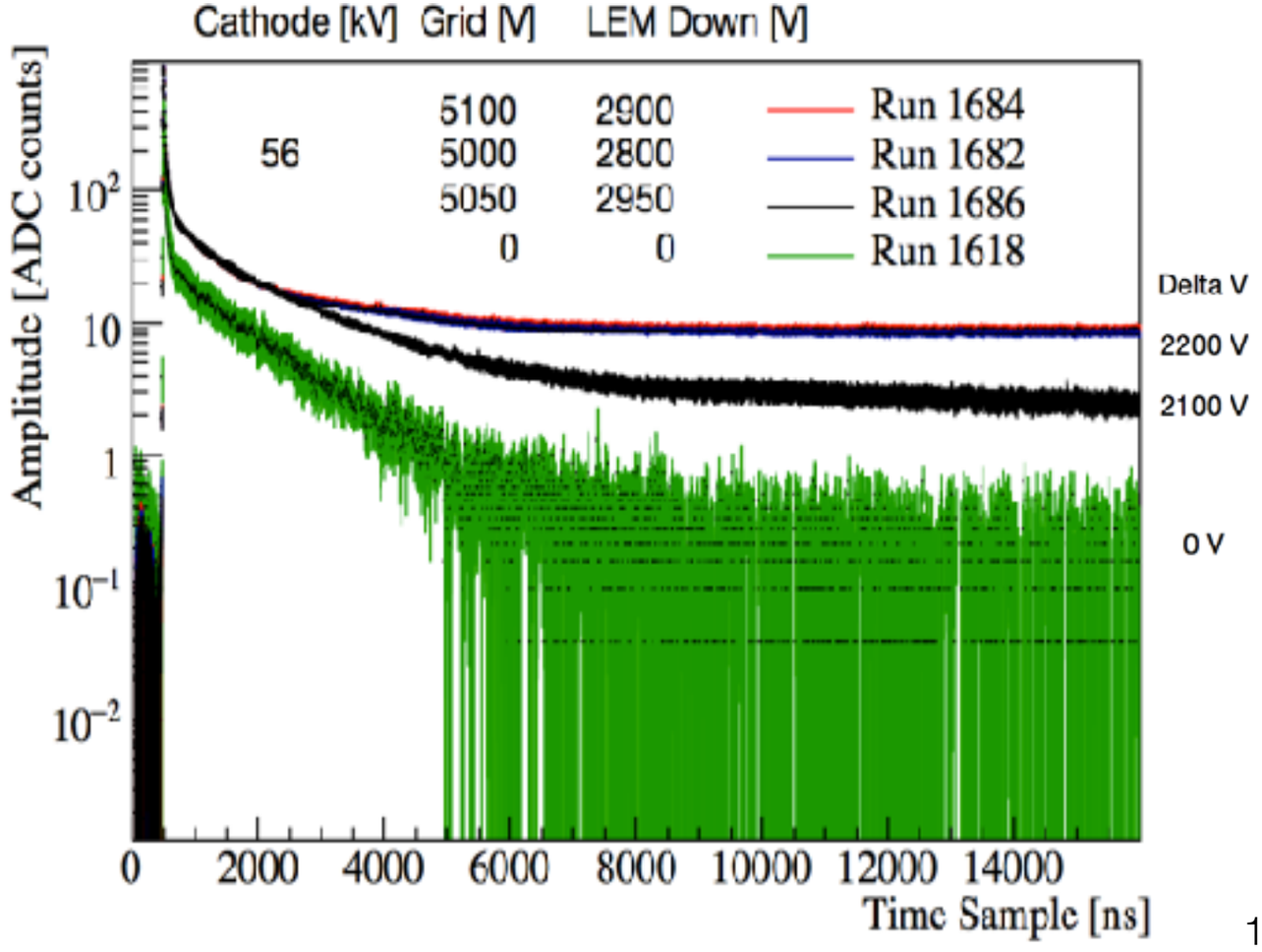
- Event trigger formed from majority of PMT with signal above threshold
- Decreasing light signal amplitude with increasing drift field corresponds also to a reduction of the trigger rate

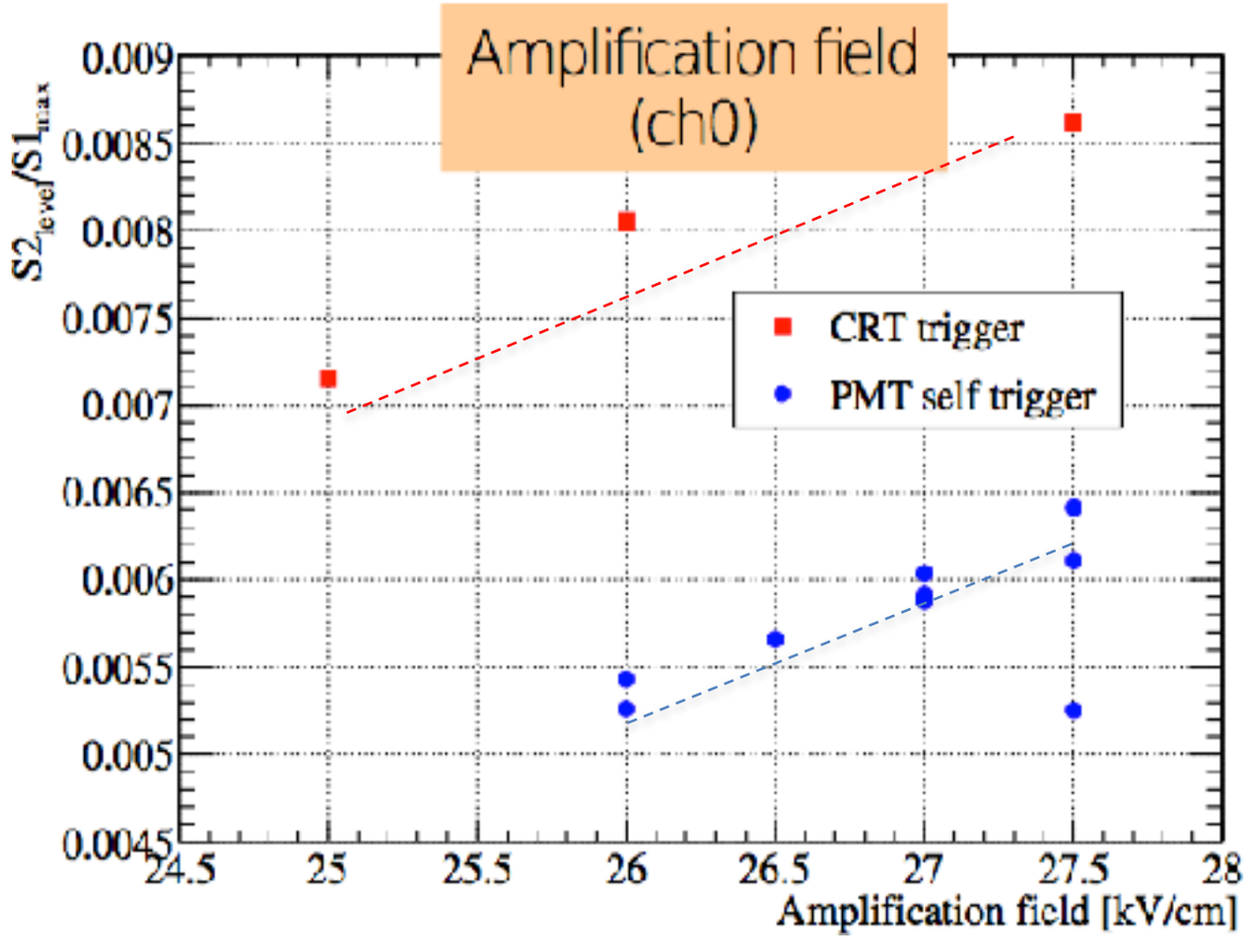




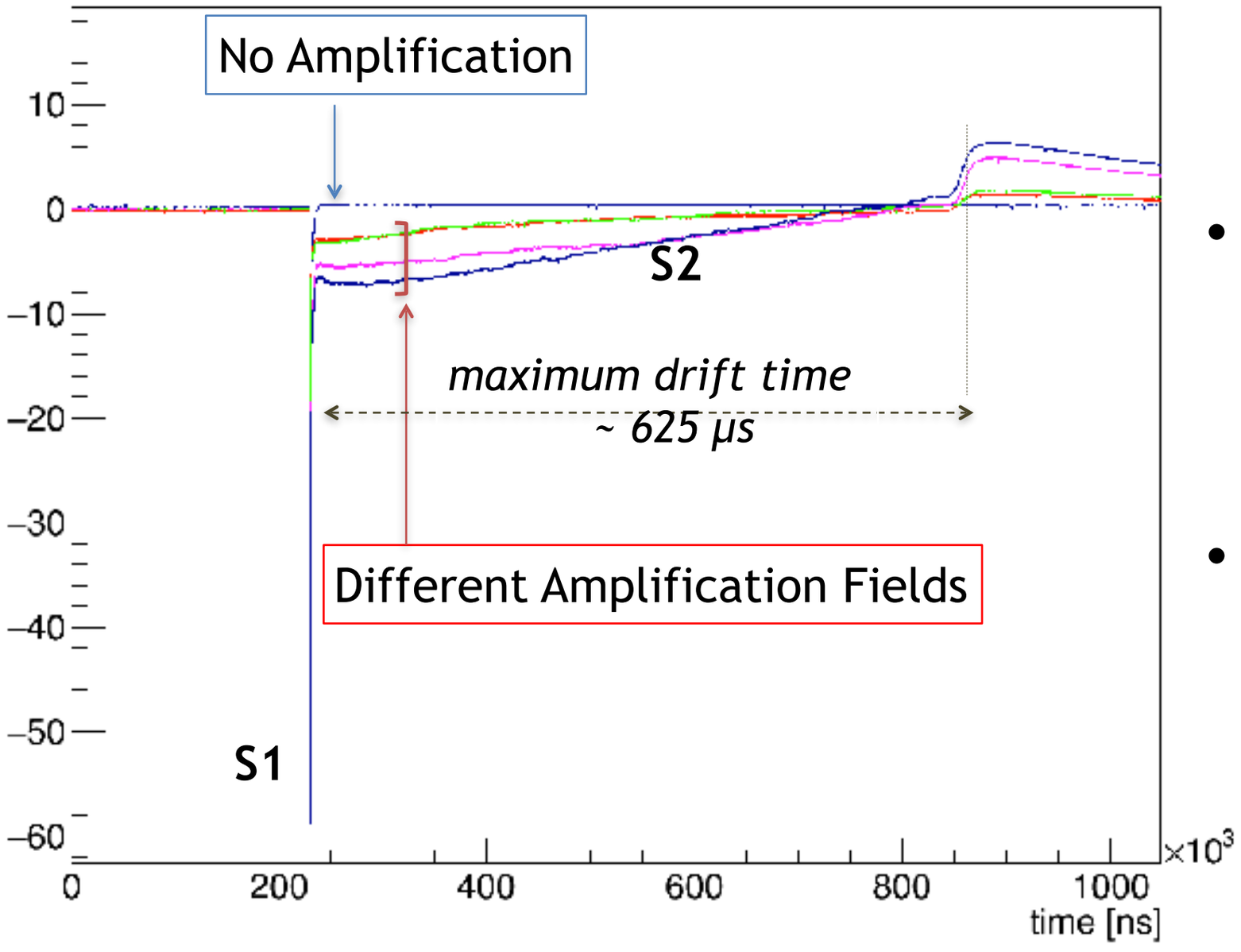
S2/S1 vs Amplification and Extraction Fields

- Measuring the ratio of S2 mean amplitude to S1 maximum amplitude
  - ✓ proportional to the Amplification Field
  - ✓ almost constant w.r.t. the Extraction Field





Drift velocity from secondary light signals



- S2 trailing edge allow to measure the maximum drift time and drift velocity
- At 0.5 kV/cm expected maximum drift time is 625 μs

Checklist

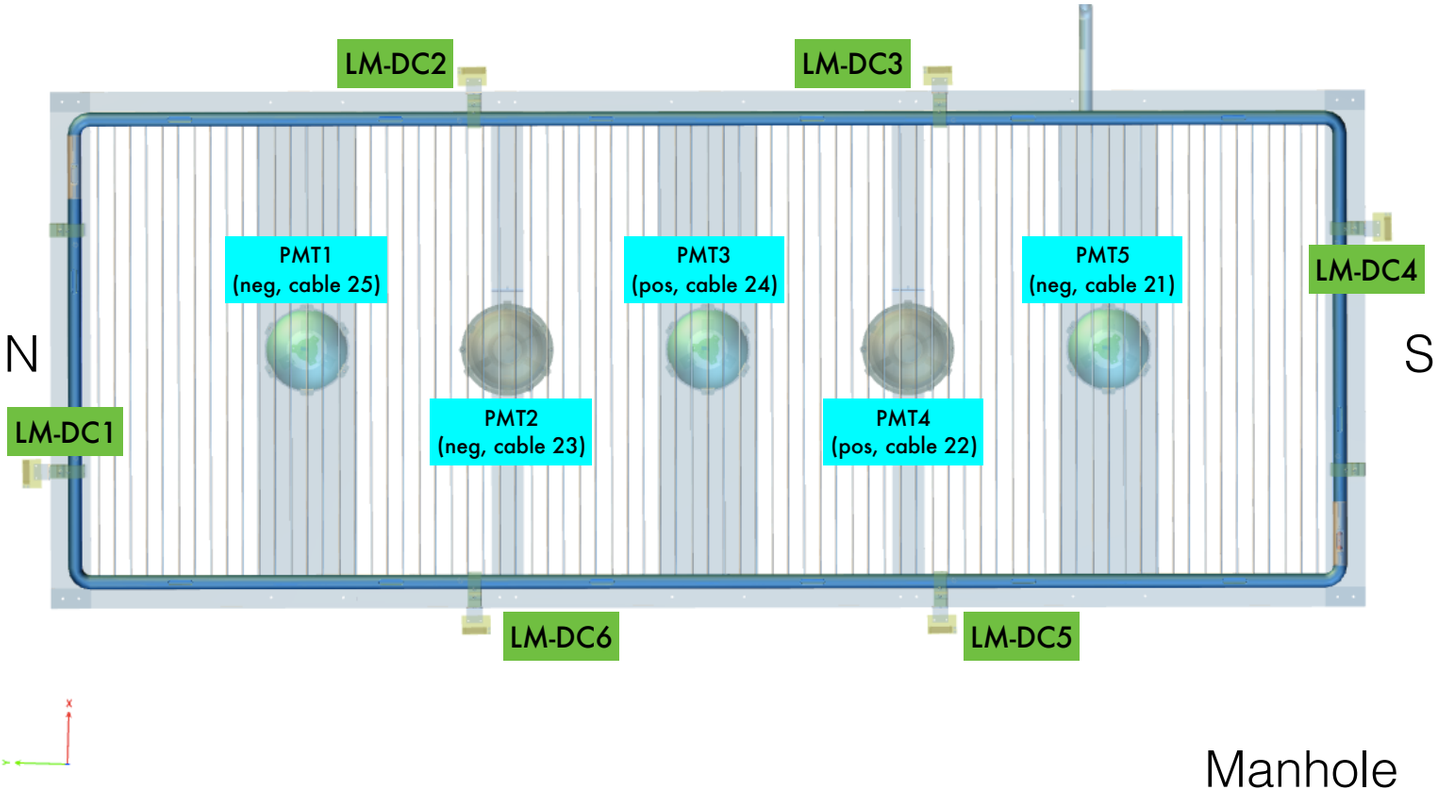
- PMT stability and gain measurement
- Scintillation time monitoring
- Scintillation time vs drift field
- Light charge vs drift field
- PMT trigger rate vs drift field
- S2/S1 light collection vs extraction/amplification fields
- S2 time extension vs drift field

Backups

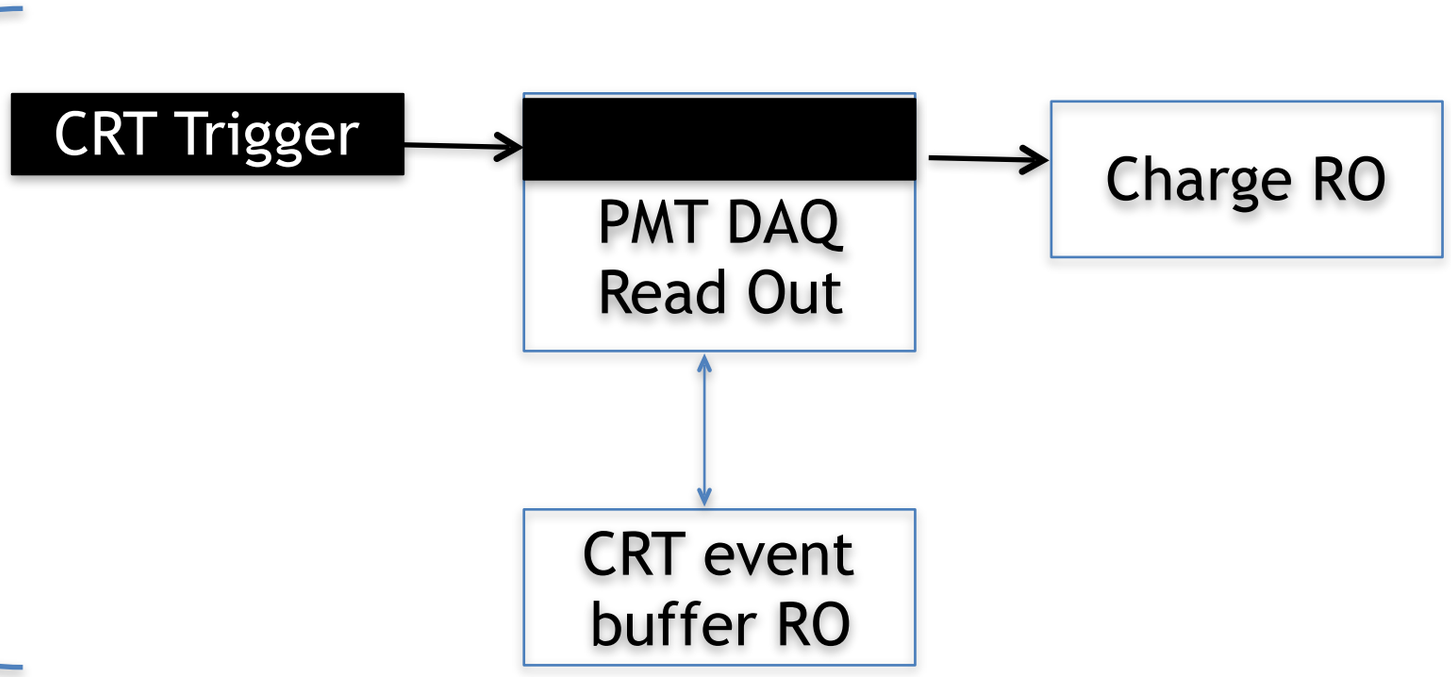
PMT setup

- 5 8” Hamamatsu PMT (R5912-02MOD)
- Different TPB coating and polarisation
- Installed below the cathode

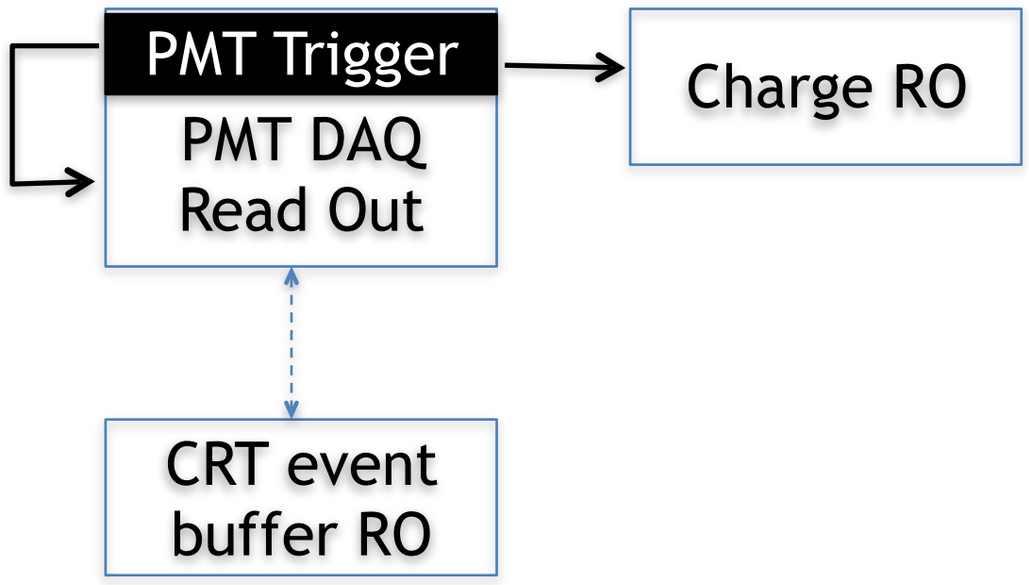
Name	PMT1	PMT2	PMT3	PMT4	PMT5
PMT #	FA0093	FA0092	FA0090	FA0094	FA0091
ADC channel	0	1	2	3	4
Pos/Neg	— (2 wires)	— (2 wires)	+ (1 wires)	+ (1 wires)	— (2 wires)
operating HV	-1200 V	-1200 V	+1150 V	+1150 V	-1200 V
HV cable #	25	23	24	22	21
Signal cable #	3	2	none	none	16
TPB	direct coating	plate	direct coating	plate	direct coating
Base	KEK	KEK	CIEMAT	CIEMAT	KEK



Trigger/DAQ Flow Schemes



CRT Based trigger
(or Pulser trigger e.g. for calibration studies)

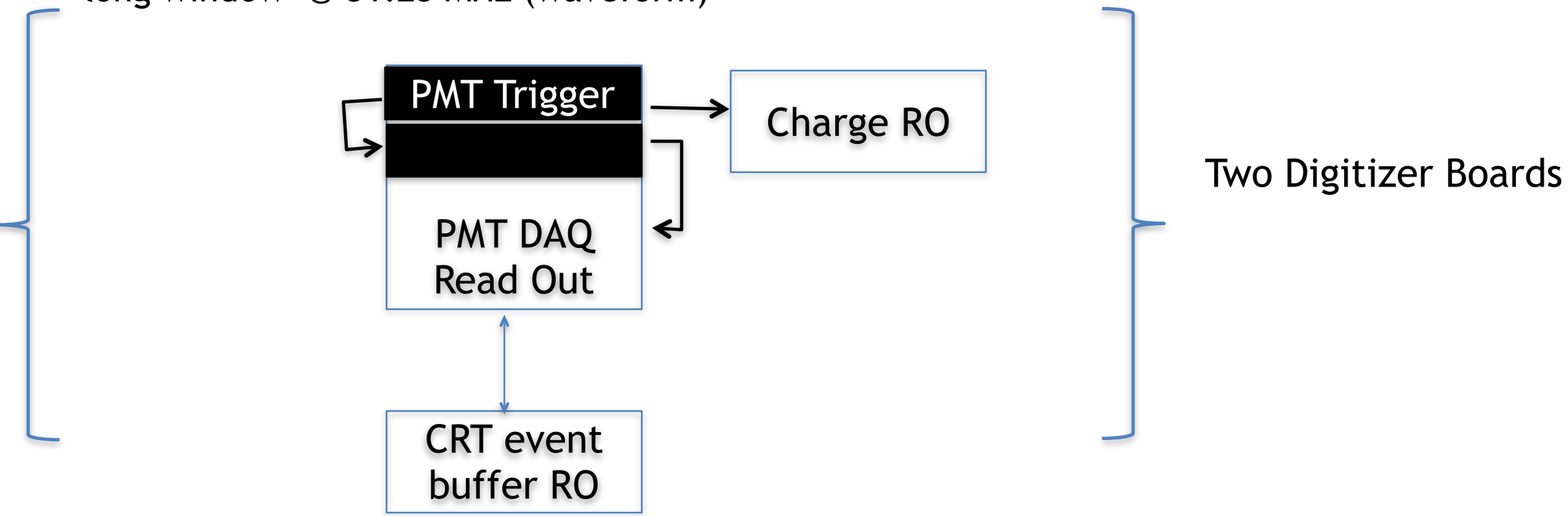


PMT Based trigger

Trigger/DAQ Flow Schemes

Long Digitization window (~1ms) needed for S1/S2 studies makes event size difficult to handle for the the Front End.
Investigated possibility to use two boards working at different frequency :

- short window @ 250 MHz (trigger)
- long window @ 31.25 MHz (waveform)



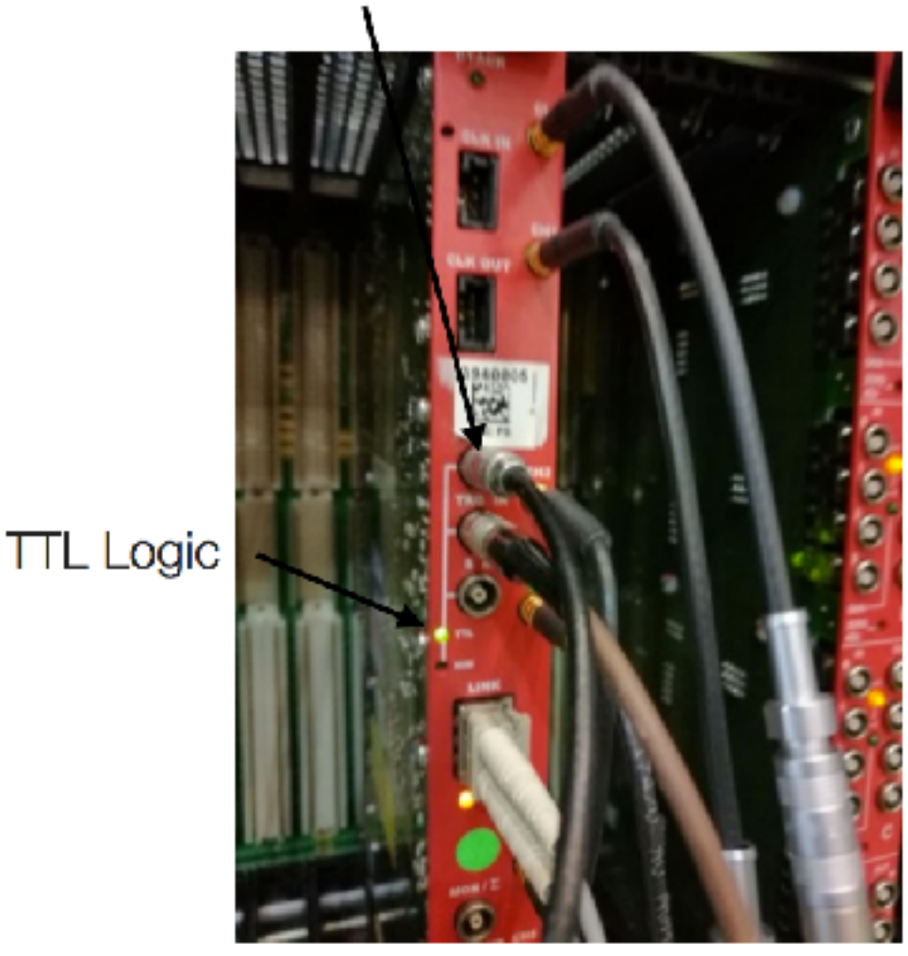
To change the v1720 board firmware to set a lower sampling frequency it is not really supported by the hardware.

Alternative Option Implemented:

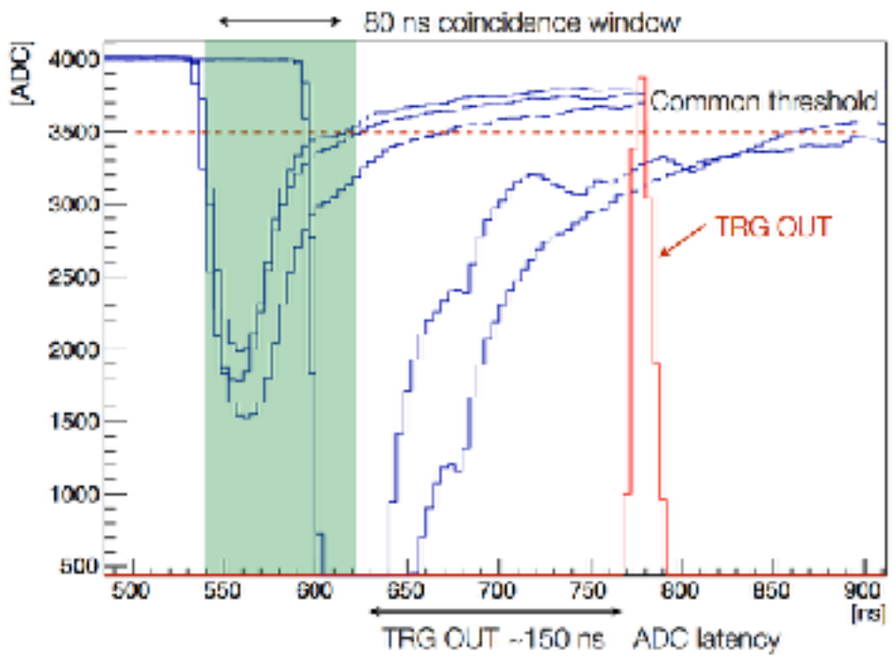
- Software downsampling: Digitization performed @ 250 MHz (4ns)
  While retrieving data from the Board adc data are downsampled before being written in the FE

PMT – Digitizer - Trigger Formation

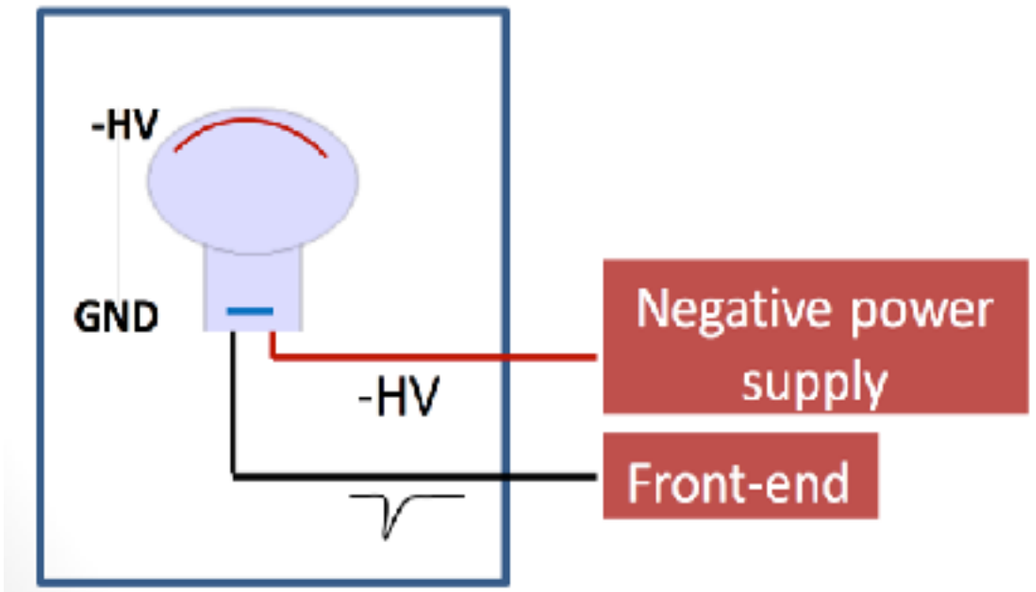
- TTL Trigger distributed to Charge Readout Computer
  - ✓ CRT Trigger
  - ✓ PMT Based Trigger
    - 5 PMTs over thr coincidence within given time window (80 ns).
    - Rate adjusted at @3 Hz (as requested form CRO)

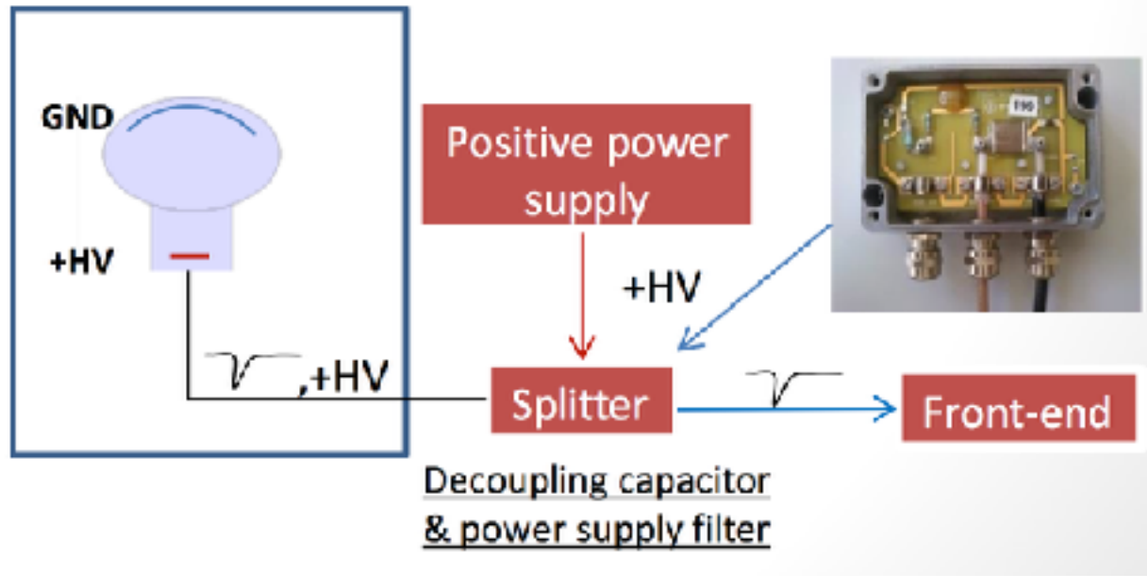


PMT ADC Board



PMTs Readout





PMT readout and digitisation

- The readout Board: CAEN V1720
  - 8 channels, 12 bit ADC, 250 MS/s, 2 V input range
  - Buffer memory 1.25 MS/ch (up to 5 ms time window)
  - External NIM trigger
  - Software configurable self-trigger logic
- The DAQ Software:
  - MIDAS: linux based DAQ developed by PSI & TRIUMF
  - Easy setup + web based interface for data taking
- Storage: 2TB local USB disk + 1TB storage on EOS