TCS Trigger Concept

As presented in the PAC48 proposal, PAC presentation,
answers to the committee questions,
discussions with Bogdan, Alexandre…

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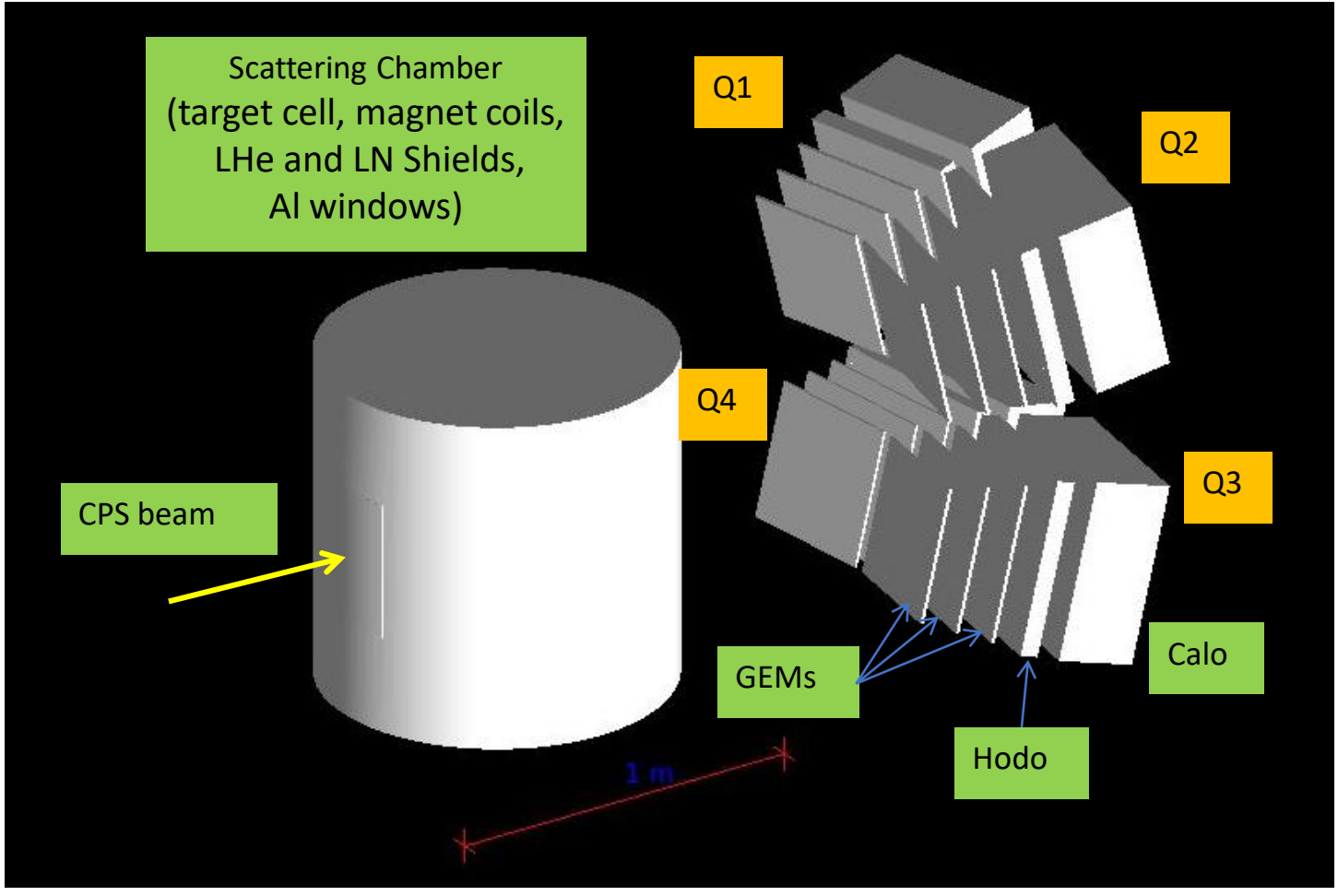
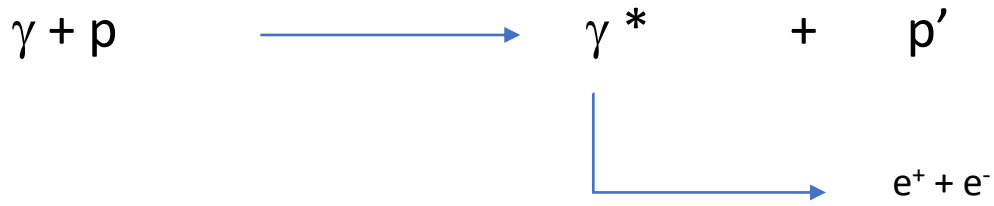
Proposed TCS setup

$\gamma + p \rightarrow \gamma^* (e^+ + e^-) + p'$



- Detect e^+, e^-, recoil p' in coincidence
- Detectors arranged in 4 quarters, oriented to target
- Triple-GEMs for e^+, e^-, p tracking
- Hodoscopes for recoil proton detection/PID
- $PbWO_4$ calorimeters for e^+, e^- detection/PID

Trigger concept



Trigger level 1

1. Request 2 strongest clusters in the calorimeters, in the opposite quadrants, with energy > 1 GeV each, with combined energy > 5 GeV
2. Request energy depositions in 2 hodoscope blocks, correlated in time and location with the calorimeter clusters.

Trigger level 2

1. Request 2 coincident clusters in the calorimeters (e+, e-)
2. Request a hit in scintillators (recoil proton) correlated in time with the calorimeter clusters, and corresponding 2 hits out of 3 in GEM-s.

Trigger details
(not presented to PAC)

- Each of four quadrants will provide in pipeline (2-3 micro seconds delay) parameters per cluster
  - Location, time, and energy of two strongest clusters in the calorimeter,
  - Energy deposition in the scintillator block correlated in time and location
- VTP (VXS trigger processor) will use the combined energy (> 5 GeV) for the trigger level 1
  - Search for proton signals in the scintillator hodoscope correlated in time to e+/e-
  - Initiate readout of GEM DAQ
- Preliminary proton tracking using GEM information in VMM3 (modern GEM chamber chip, an implementation under development for the SOLID preRD)

Calorimeter cluster trigger

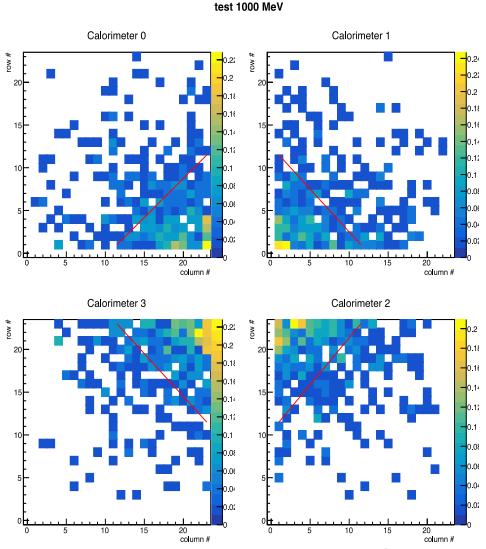
- Compute all 4x4 sums, one sum above threshold
- Request “seed” energy > 1 GeV, 2 quadrant combined energy > 5 GeV

✓ Exclude 1/8 “hot” blocks close to beam pipe → ~23% reduction of useful events

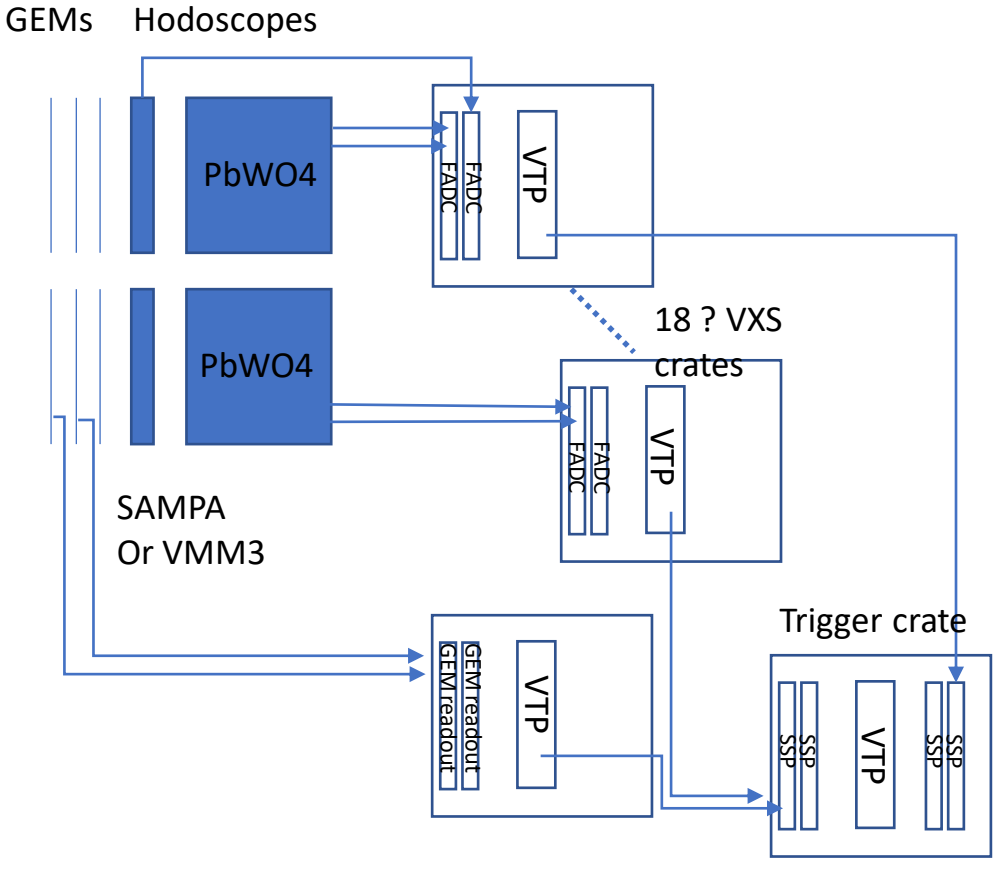
✓ ~3 MHZ integral hit rate in each quadrant, reasonable for trigger formation

✓ 38 kHZ background trigger rate → 10 – 20 ns time window, reasonable for trigger formation

✓ At least 90% efficiency for TCS events (estimate with no background)



Scheme of DAQ



4 x 23x23 crystals and scintillators
= 2116 x 2 = 4,232 fADC

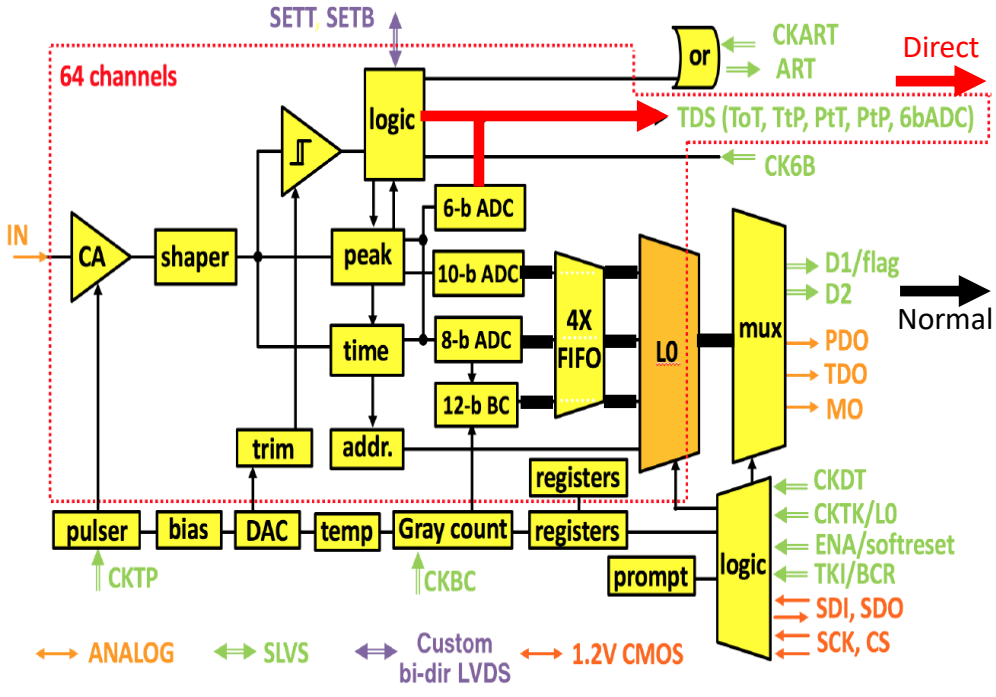
4 x (5 layers of GEM chambers 50 cm x 50 cm)
= 16 x 2 x 500/0.4 = 50,000 MVV3

Inclusion of GEM in trigger will be developed

VTP : VXS Trigger Processor
SSP : Sub-System Processor

VMM3 chip

VMM3 block diagram



- ASIC for ATLAS New Small Wheel
- Radiation hard similar to APV25 : > 100 Mrad
- 64 channels
- Low noise over wide range of input capacitance (<1 pF to ~1 nF)
- Shaping times : **25 ns**, 50 ns, 100 ns, 200 ns
- Pulse amplitude proportional to charge at input
- Gains : 0.5, 1, 3, 4.5, 6, 9, 12, 16 mV/fC
- **6 bit ADC (25 ns conversion)** and **10 bit ADC (250 ns conversion)**, 8 bits TDC (1 ns resolution), 12 bits Beam Crossing time stamp
- 4 MHz of rate per channel thanks to multilevel FIFO
- Continuous or triggered readout on normal data path
- Latency up to 16 μs in triggered mode
- **Fast direct outputs (64 channels) for ATLAS trigger (6b ADC, ToT)**
- Normal data link up to 320 Mb/s

Backup slides

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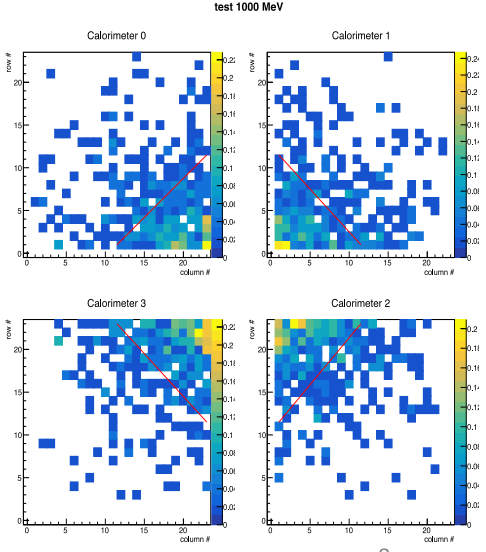
✓ Exclude 1/8 "hot" blocks close to beam pipe → ~23% reduction of useful events (E_{QUAD}^{+}>1GeV , E_{QUAD}^{-}>1GeV , $E_{QUAD}^{+}+E_{QUAD}^{-}$>5GeV)

✓ ~3 MHZ integral hit rate in each quadrant, reasonable for trigger formation (E_{MODULE}>1GeV, 1/8 "hot" blocks excluded)

✓ 38 kHZ background trigger rate, reasonable for trigger formation (E_{SEED}>1GeV, $E_{QUAD}^{+}+E_{QUAD}^{-}$>5GeV, rectangular quadrants)

✓ At least 90% efficiency for TCS events (E_{QUAD}^{+}>1GeV , E_{QUAD}^{-}>1GeV , $E_{QUAD}^{+}+E_{QUAD}^{-}$>5GeV , rectangular quadrants, estimate with no background)



Proton PID with GEMs