

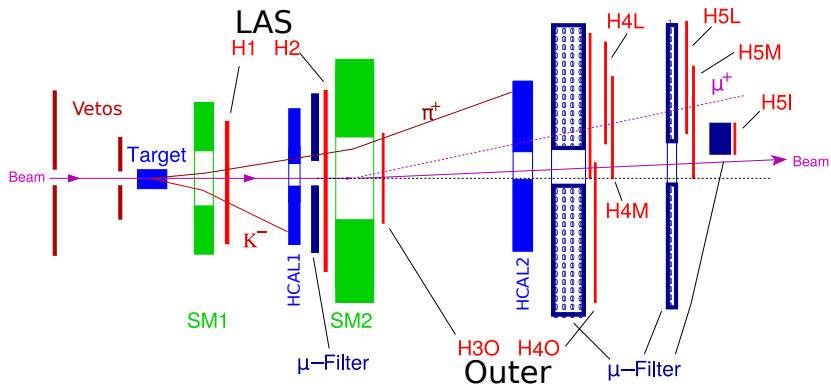
COMPASS Trigger Hardware Overview

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9. November 2017

- **Summary of current Trigger Hardware**
 - Muon Trigger System
 - Veto System
 - Trigger Electronic
 - Calorimeter System
 - Requirements on L0

COMPASS Trigger



Identification of muons via absorber.

Two independent trigger systems:

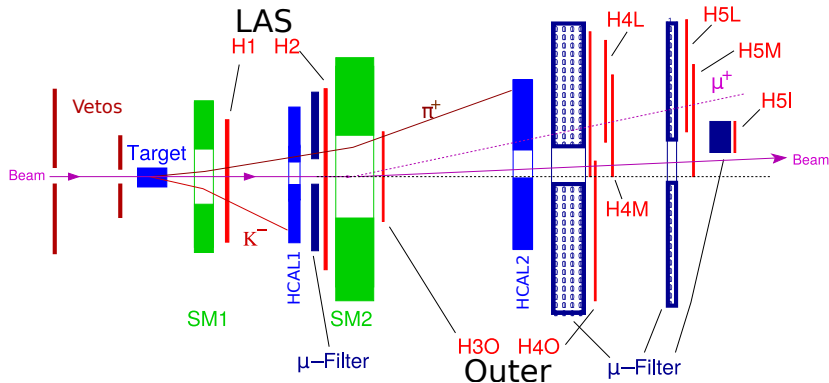
- Muon Trigger (Target Pointing / Energy Loss)
- Calorimeter Trigger (Energy threshold)

+ Veto System

COMPASS Trigger



COMPASS Trigger



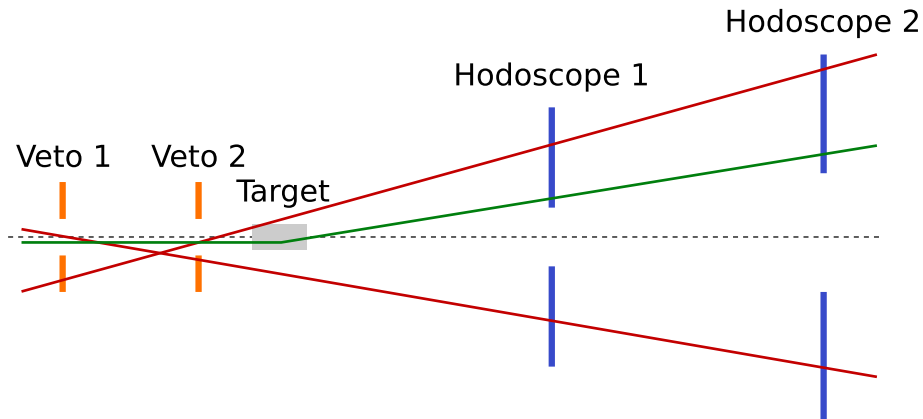
Identification of muons via absorber.

Two independent trigger systems:

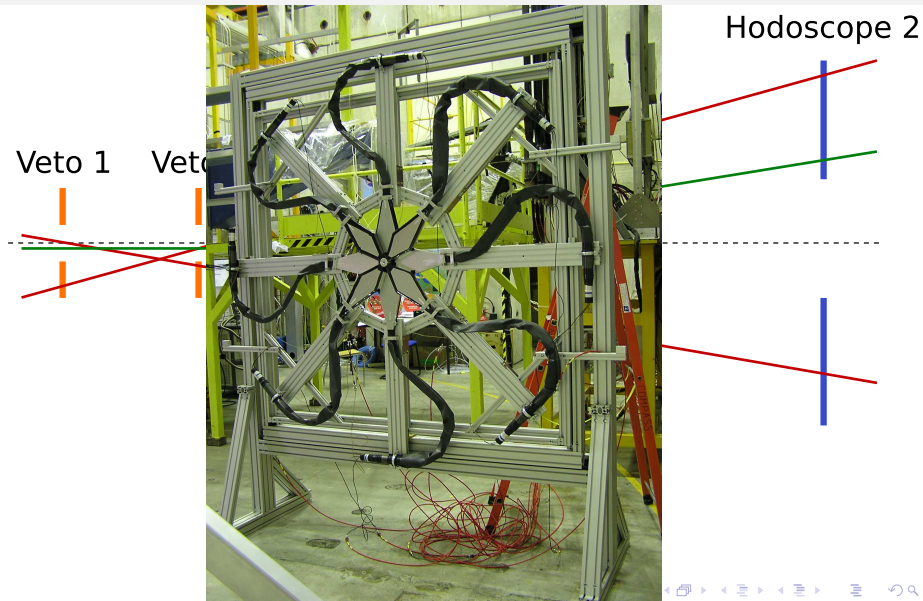
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Veto System

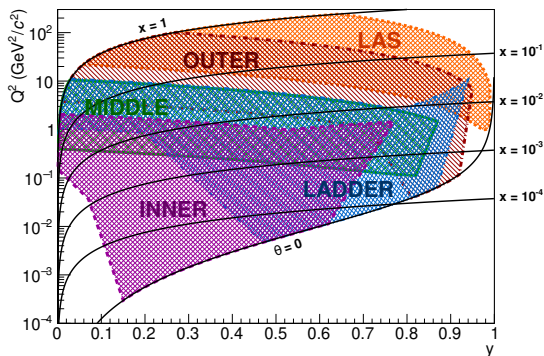


Veto System



Trigger Subsystems

4 different trigger subsystems with different acceptance.

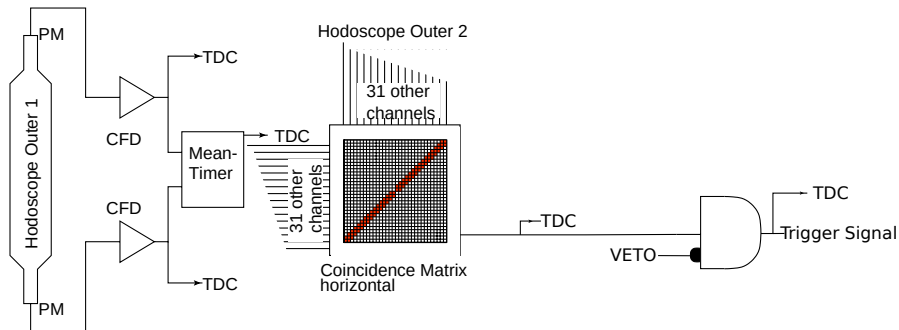


No INNER since 2012.

+ calibration trigger (BeamT, Halo, Random)

- Middle (HM04/05Y/X)
 - 8 Hodoscopes with 144 Slabs
- Ladder (HL04/05X)
 - 2 Hodoscopes with 64 Slabs
- Outer (HO03/4Y)
 - 2 Hodoscope with 50Slabs
- LAS (HG01/2Y)
 - 2 Hodoscopes with 96Slabs
- Inner (HI04/05)
 - 2 Hodoscopes with 128Slabs

Trigger Detail



Trigger Matrix Detail (Bonn-Matrix)

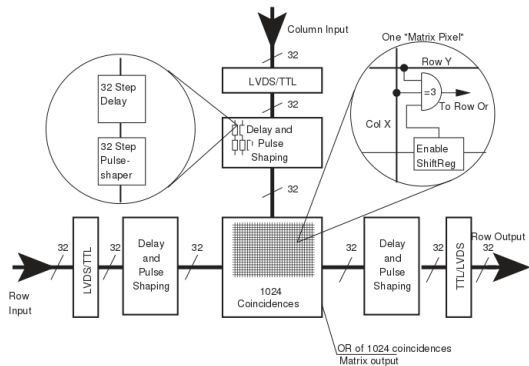
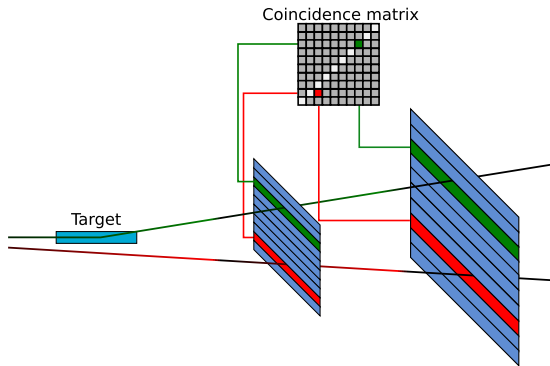


Fig. 13. Schematics of the matrix board.

- 2x 32 inputs
(row/column)
- 1024 coincidence units
- Input delay
32 steps each 250 ps
- Pulse shaping
Typical coincidence window ≈ 2 ns
- Row output
not used at the moment
- Matrix output
Or of 1024 coincidence pixels

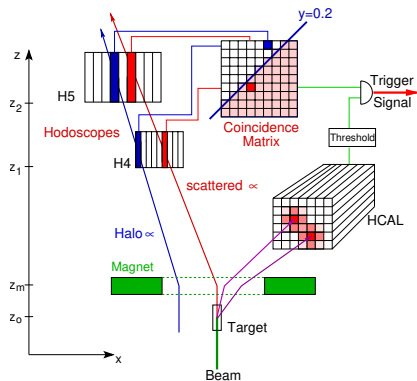
Vertical Target Pointing

Measure in the non bending plane.



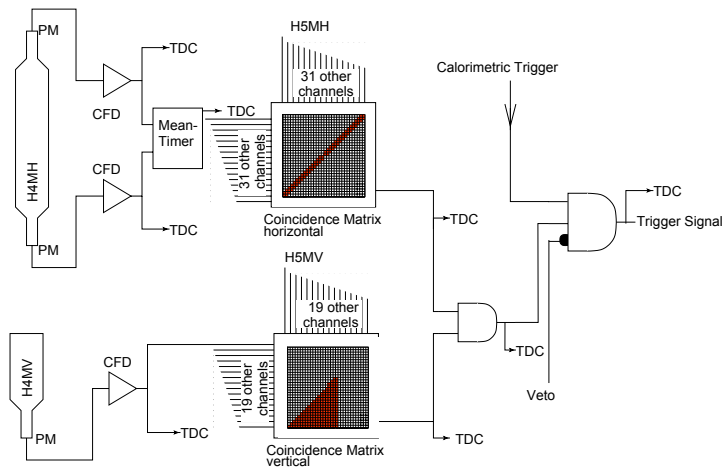
Diagonal pattern for: Middle (horizontal), Outer, LAST
Pattern width and slab width depends on target position!

Measure in the bending plane.



Triangle pattern for: Inner (semi-inclusive), Middle (vertical), Ladder

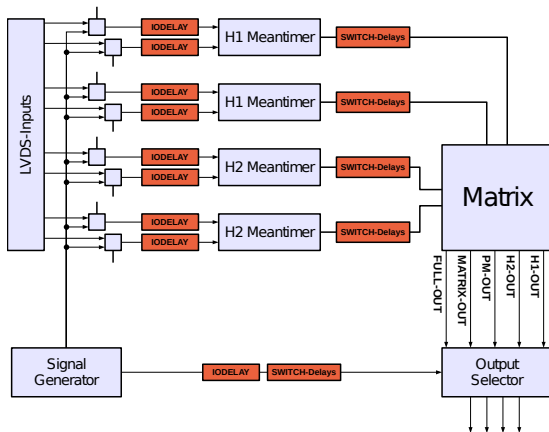
Combinations of Triggers



Combination of Triggers through NIM modules.

LAST Matrix

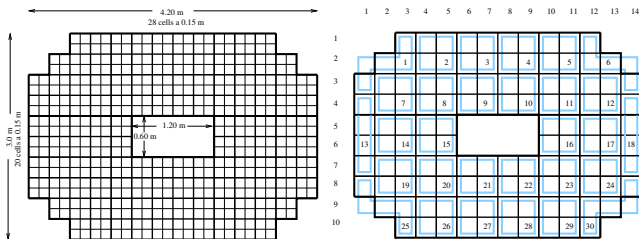
LAS Trigger new since 2010.



Matrix and meantimer based on FPGA (Gandalf) [external discriminators].

Calorimeter Trigger

Calorimeter Trigger build up from using two hadron calorimeters.

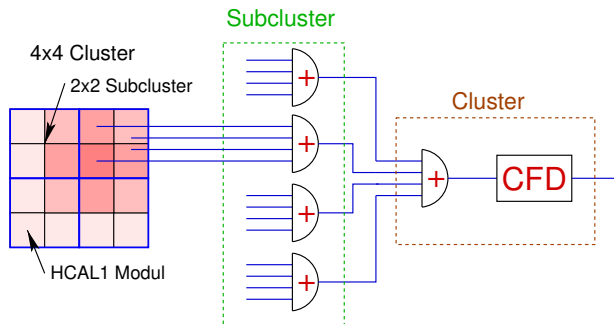


Triggering on energy threshold in 4x4 cell.

Cell size equals the transverse size of an hadron shower.

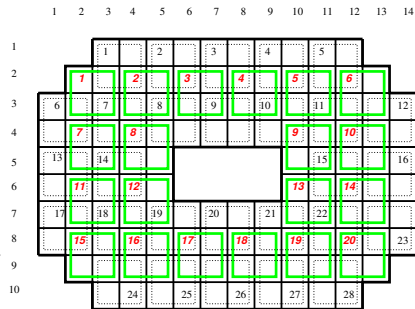
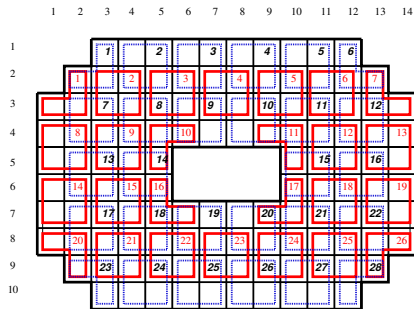
Independent trigger system to test the muon trigger.

Calorimeter Summation



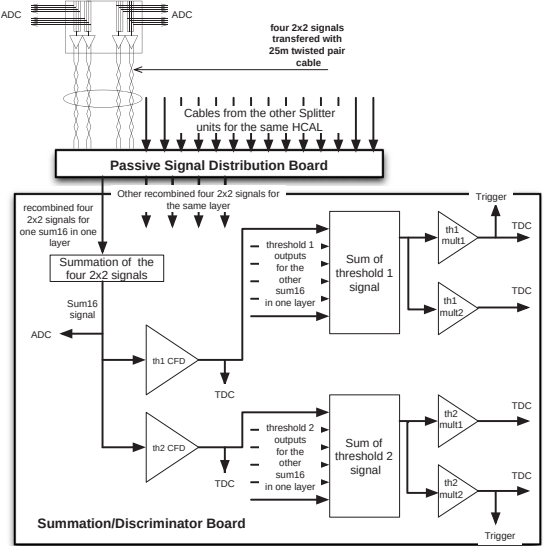
Calorimeter Trigger Cell Summation

Trigger cell coverage for HCAL1:

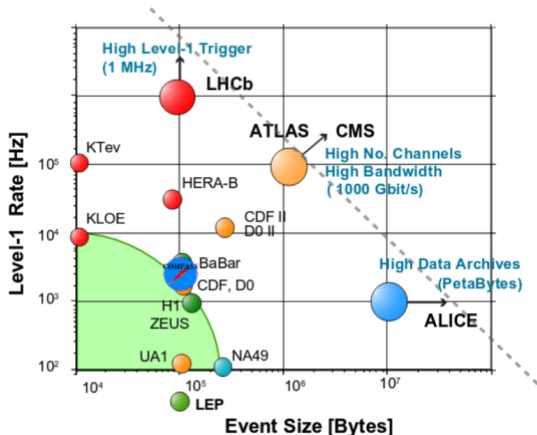


In total 208 4x4 cells for HCAL1 and 80 4x4 cells for HCAL2.

Calorimeter Trigger Electronic



L1 Trigger Rate vs. Event Size



Maximum allowed trigger rate determined by typical event size:

$$\text{DAQ Bandwidth} = \text{Maximum Trigger Rate} \times \text{Event Size}$$

L0 Trigger Rates

L0 Rate = Sum of Beam Trigger, Inner Veto and Halo.

Transversity 2010 250E11 pot on T6
Prescaler setup for run 89064

Trigger element	Short name	Division factor	In rate (1st spill)	Out rate (1st spill)
Inner Trigger	IT	1	30982	30982
Middle Trigger	MT	1	4674	4674
Ladder Trigger	LT	1	39609	39609
Outer Trigger	OT	1	27270	27270
Calorimeter Trigger	CT	1	76768	76768
Inner Veto	VI	40000	26679562	667
Halo Trigger (Veto Outer AND H4 outer)	Halo	10000	5909470	591
Beam Trigger	BT	99999	94118896	942
Middle Trigger Inclusive	MTincl	1	40095	40095
Large Angle Spectrometer Trigger	LAST	1	141169	141169
True Random	TRand	1	3567	3567
Noise Random	NRand	0	125396	0

≈ 13 MHz

DY 2015 120E11 pot on T6
Prescaler setup for run 263045

Trigger element	Short name	Division factor	In rate (1st spill)	Out rate (1st spill)
Dimoon Trigger (Middle and LAS)	MT+LAST	1	5090	5090
One moon Middle Trigger	MT	100	480297	4803
Dimoon Trigger (Outer and LAS)	OT+LAST	1	6683	6683
One moon Outer Trigger	OT	100	137393	1375
Calorimeter Trigger	CT	0	2412075	0
Inner Veto	VI	0	11447881	0
Halo Trigger (H2 AND H4Outer)	Halo	0	3059313	0
Beam Trigger	BT	35000	65339393	1868
Dimoon Trigger LAS	LAST 2mu	1	126869	126869
One moon Trigger LAS	LAST 1mu	500	859374	1720
True Random	TRand	1	7063	7063
Noise Random	NRand	0	1726931	0

≈ 16 MHz

DVCS 2017 150E11 pot on T6 mu+
500mm Be Target
Prescaler setup for run 279166

Trigger element	Short name	Division factor	In rate (1st spill)	Out rate (1st spill)
Tiger BT BKVeto	TigerDT0	0	10890437	0
Middle Trigger	MT	1	35639	35639
Ladder Trigger	LT	1	27255	27255
Outer Trigger	OT	1	30144	30144
Calorimeter Trigger	CT	10	20108	2011
Inner Veto	VI	10000	13312477	1332
Halo Trigger (H2 AND H4Outer)	Halo	500	2374088	4749
Beam Trigger	BT	8000	58737659	7343
ECALO trigger	ECALO	0	0	0
LAS Trigger	LAST	1	38785	38785
True Random	TRand	1	13331	13331
Noise Random	NRand	0	542656	0

≈ 15 MHz

Latency of current system max 3 μ s.

Summary of the current Trigger System:

- Muon Trigger:
based on target pointing / energy loss
760 channels for PMTs
276 channels for Meantimer
9 Matrix Boards (7 Bonn-Matrix / 2 FPGA)
- Veto System:
62 channels for PMTs
18 channels for Meantimer
- CALO System:
based on energy threshold in HCAL cells
208 4x4 Sums for two thresholds (HCAL1)
80 4x4 Sums for two thresholds (HCAL2)

In total: 1404 TDC channels in use with 9 matrix boards

Thank you for your attention!

Questions ?