

The Prompt Trigger of the Silicon Pixel Detector for the ALICE Experiment



Fig.1 - ALICE experiment at CERN

ALICE EXPERIMENT

- study strongly interacting matter in heavy ion collisions
- data taking also during p-p collisions
- 18 sub-detectors
- 0.5 T magnetic field

SILICON PIXEL DETECTOR

- 2 barrel layers at radii of 3.9 cm and 7.6 cm, respectively
- 120 half-staves consisting of
 - 2 silicon sensors (70.7 x 16.8 mm², 200 μm thick)
 - 10 pixel chips (8192 cells, 150 μm thick)
 - 1 Multi Chip Module
 - 1 Al-Kapton multilayer flexible cable (bus)
- ~1% X₀ per layer
- ~10⁷ readout channels
- pixels size: 425 x 50 μm²
- 12 μm point resolution in the bending plane

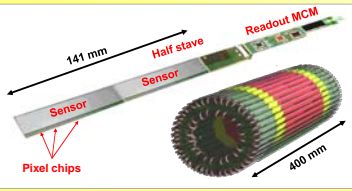


Fig.2 - SPD and Fast-Or signal

FAST-OR SIGNAL

- active on registration of at least 1 hit per pixel chip
- 1200 Fast-Or bits every 100 ns on data optical path in the full detector

PIXEL TRIGGER SYSTEM

- unique feature among the vertex detectors of the LHC experiments
- dedicated system to process Fast-Or bits prior to Central Trigger Processor
- contributes to the L0 (low latency) ALICE trigger
- maximum latency of 800 ns
- OPTIN BOARD
 - extracts 1200 Fast-Or bits from SPD data
- BRAIN BOARD
 - has 10 OPTIN boards connected as mezzanine cards
 - processes the bits with up to 10 different algorithms at the same time

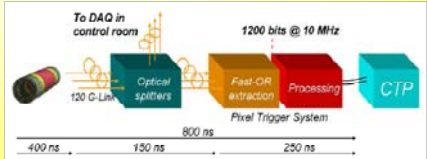


Fig.3 - Pixel Trigger hardware architecture



Fig.4 - Pixel Trigger crate

RESULTS

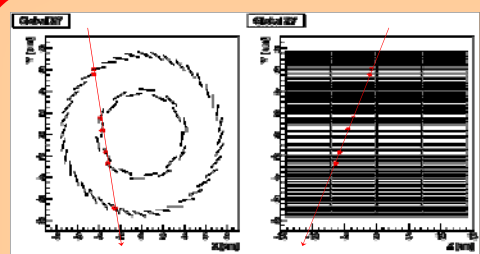


Fig.5 - Cosmic ray passing through the SPD (online display)

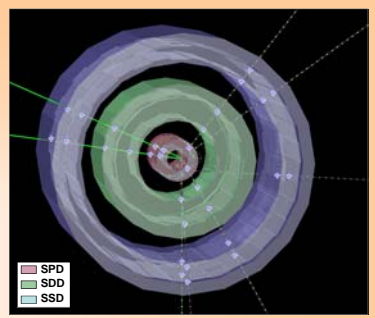


Fig.6 - First beam-induced event observed (11 Sep 2008)

DATA FROM COSMIC RAYS

- coincidence between top outer layer and bottom outer layer to detect cosmic muons through SPD (top)
- since May 2008 collected ~100k tracks with at least 3 points
 - 45000 tracks with 4 clusters
 - 35000 tracks with 3 clusters
- also used as trigger for other detectors (e.g. SDD, SSD, TPC)

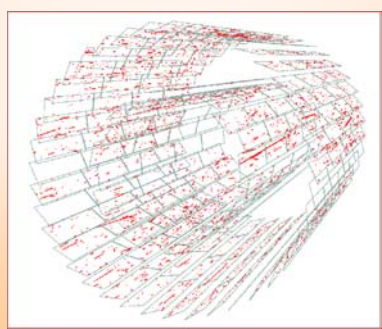


Fig.7 - Particle shower in the SPD during injection test (15 June 2008)

DATA FROM BEAM

- first "sign of life" from LHC observed from injection test in June 2008 (left)
- first beam-induced interaction observed in ALICE (processing algorithm based on multiplicity) in Sep. 2008 (top)

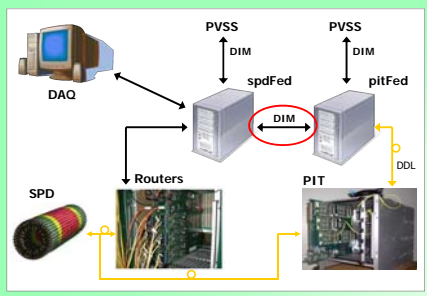


Fig.8 - Pixel Trigger integration

FAST-OR CALIBRATION

- Required for every of the 1200 pixel chips to
- maximize detection efficiency
 - minimize readout noise

AUTOMATIC PROCEDURE

- verify Fast-Or efficiency in different operating conditions
- compare
 - number of manual test pulses sent to SPD
 - Fast-Or counts read from Pixel Trigger
- operate on subset of 4 pixel DACs
- repeated after uniformity response tuning

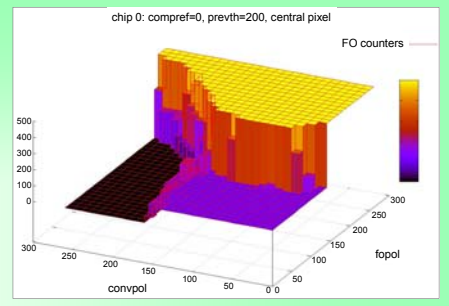


Fig.9 - Output of the Fast-Or automatic calibration

CALIBRATION STATUS

	Half-staves	Operating chips
Outer layer	72 / 80 (90%)	691 / 720 (96.0%)
Inner layer	33 / 40 (82.5%)	315 / 330 (95.5%)
TOTAL	105 / 120 (87.5%)	1002 / 1050 (95.4%)

Fig.10 - Status of the calibrated chips (as per October 2008)

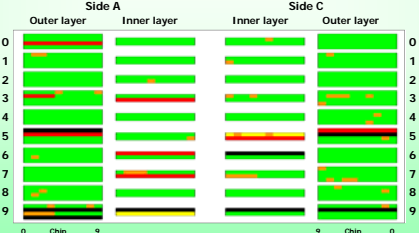


Fig.11 - SPD calibrated chips (as per October 2008)

FAST-OR COMMISSIONING

- baseline rate per chip: 1.4 hits/minute -> 0.023 Hz
- same rate as for readout -> no noise induced
- cosmic rate:
 - coincidence top- bottom outer layer: 0.08 - 0.20 Hz
 - in agreement with Monte Carlo simulations and measured flux in cavern
 - global OR rate: ~20 Hz