The Silicon Drift Detectors for the ALICE Experiment

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The ALICE Experiment

- Heavy ion collisions @ ~ 5.5 TeV per nucleon to study very-high-temperature properties of hadronic matter
- Quark-gluon plasma (quark deconfinement) is expected to be formed
ALICE Detector
The Inner Tracking System

Tracking and identification of low momentum particles

• Particle identification via $dE/dx$ measurement
• Improvement of the TPC momentum and angle measurements

Primary and secondary vertices determination

• Reconstruction of charm and hyperon decays
ITS Structure

Si Pixel Detectors
- $r = 3.9, 7.6$ cm $\rightarrow 0.2$ m$^2$
- 9.8 Mchannels
- $r\phi$ resolution 12 $\mu$m
- $z$ resolution 100 $\mu$m

Si Drift Detectors (SDD)
- $r = 14.9, 23.8$ cm $\rightarrow 1.3$ m$^2$
- 133 Kchannels
- $r\phi$ resolution 35 $\mu$m
- $z$ resolution 23 $\mu$m

Si Strip Detectors
- $r = 38.5, 43.6$ cm $\rightarrow 4.9$ m$^2$
- 2.6 Mchannels
- $r\phi$ resolution 15 $\mu$m
- $z$ resolution 730 $\mu$m
SDD Layers

- Anodes along $z$
- Drift along $r\phi$
- 22 x 8 detectors in the outer layer
- 6 x 14 detectors in the inner layer
Detector operation

[Diagram showing detector operation with labels for hole bias current, hole dark current, bias HV divider, drift cathodes, Collection Anodes, holes, electrons, and ionizing particle.]

- POTENCIAL (V)

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ALICE SDD’s

- Silicon wafer: 300 mm thick, NTD, 3 KW.cm
- 7.5x7 mm² active area
- Drift: built-in 290-cathode voltage divider; 35 mm max drift length
- 2x 256 anodes with 294 mm pitch
- 2x 3 lines of 33 MOS charge injectors to correct for Si temperature sensitivity ($v_{\text{drift}} \propto T^{-2.4}$)
Resolution

Beam test results for the resolution along the **drift axis** and **anode axis** from 2002 data

- 667 V/cm
- 542 V/cm
- 417 V/cm
- 292 V/cm
Front-end

✓ PASCAL 64
  • 0.25 µm rad-tol CMOS technology
  • 64 3-gain preamp’s
  • 64 x 256 cells analog memory
  • 32 10-bit ADC’s
  • Parameter control via JTAG
  • LVDS low-noise pads

✓ AMBRA 4
  • 0.25 µm rad-tol CMOS technology
  • 4 x 16 Kbyte event buffer
  • Parameter control via JTAG
  • LVDS low-noise pads
Pascal Performance

Analog memory map

Baseline

Noise

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Pascal Performance 2

Linearity

ADC counts

1 MIP

Analog memory cell no.

Amplitude [ADC counts]

Charge [fC]

Charge [fC]

Average 31.42

RMS 0.12
Summary

✓ Final version of ALICE SDD is being tested and fulfils experiment resolution requirement
✓ Front end final prototypes also under test with satisfactory results
✓ Detector + front end + DAQ about to be beam-tested for the first time!