The PANDA MVD Strip Detector

Tommaso Quagli, Robert Schnell, Hans-Georg Zaunick
II. Physikalisches Institut, Justus-Liebig-Universität Gießen

The PANDA Detector
- PANDA (AntiProton ANnihilation at DArmstadt)
  - fixed target experiment
  - almost 4π acceptance
  - cooled Antiproton beam using
  - electron cooling
  - stochastic cooling
  - momentum from 1.5 up to 15 GeV·c⁻¹
  - peak luminosity of 2·10³² cm⁻²·s⁻¹
- detector divided into
  - Target Spectrometer
  - Forward Spectrometer
  - MVD (Micro Vertex Detector)
    - tracking detector for charged particles
    - silicon pixel and strip detectors
    - main tasks
    - vertex reconstruction for primary and secondary vertices
    - improvement of momentum resolution
    - additional input for global PID
    - requirements
      - trigger-less readout with high rate capability
      - good time resolution and low material budget

Sensors
- double-sided silicon strip detectors
  - CiS GmbH (Erfurt, Germany)
  - FZ Si, 4", (285 ± 10) μm
  - 2.3 ... 5.0 kΩcm, p-spray isolation
  - 8 guard rings, punch-through biasing
  - AC-coupling, 90° stereo angle
  - 65/50 μm pitch
- total single strip capacitances:
  - performed with probe-card
  - p-side (l=33.32 mm): (9.8 ± 0.2) pF
  - n-side (l=58.28 mm): (17.1 ± 0.4) pF

MVD Mechanical Design
- the MVD comprises 4 sub-structures
  - pixel barrels
  - pixel disks
  - strip barrels
  - strip disks
- requirements to materials
  - low radiation length
  - high thermal conductivity
  - mechanical stability
  - stable under high radiation levels
- CAD design, schematic cross section and prototype of the strip barrel stave
- materials chosen
  - barrel holding structure:
    - sandwich of carbon fibers (M55J) and Rohacell foam core
  - barrel staves:
    - sandwich of carbon fibers and carbon foam (POCCO HTC) with high thermal conductivity at place of electronics, Rohacell at sensor location
  - embedded cooling pipe beneath the front-end chips

Hybridization
- pitch-adapter based on flex-PCB
  - Manufacturer: GS Swiss PCB
  - 2-layer flex-PCB
  - dielectric thickness: 25 μm polyimide
  - laser drilling: 50 μm blind vias
  - smallest wire and spacing: 35 μm
  - copper thickness: 2x12 μm
  - surface chem. Ni/Au for bonding
  - pitch- adapters tested successfully
  - next step: assembly of flex-PCB front-end boards
  - 2-layer flex-PCB
  - 1 front-end chip connected to sensor via fan-out structure
  - goal: integration of pitch-adapter into readout-hybrid
  → one multi-layer flex-PCB at stave-level

Electronics
- front-end development
  - ASIC design at INFN, Torino
  - self-triggering
  - fully digital output
  - time-over-threshold (ToT) digitization using analog interpolators
  - precise time resolution

- Module Data Concentrator at stave level
  - ASIC design carried out at FH-SWF, Iserlohn
  - decoding of front-end data
  - mapping, clustering
  - slow control functions
  - interfacing DAQ via serial GBT E-links
  - Strip-DAQ-chain
  - use fast optical data links
  → utilize GBT (CERN)