The tracking system of the IDEA detector concept for a future e+e- collider

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The IDEA detector concept for future e+e- colliders proposes a tracking system composed by a Si based inner system, an ultra-low mass Drift Chamber central system with Particle Identification capabilities and a Si based outer layer surrounding the drift chamber. The designed tracking system allows to fulfill the high momentum and angular resolutions requirements for the whole momentum range, particularly for low momenta, thanks to the extremely low material budget. Moreover, the use of the Cluster Counting technique allows for particle identification (PID) resolution below 3%, a factor two better than the resolution attainable with traditional dE/dx techniques. Details about the construction of the drift chamber, including both the adaptation of new materials for the field wires and new techniques for soldering the wires, the development of an improved layout of the drift cells, and the choice of the gas mixture will be described. The expected tracking system performance together with the Improved PID obtained with the cluster counting technique will be reported.

**Requirement**

- Extremely high luminosities: large statistics (high statistical precision) - control of systematics (@10^7 level)
- Large beam crossing angle (30mrad)
- very complex MDI emittance blow-up with detector solenoid field (< 2T)
- Physics event rates up to 100 kHz (at Z pole)
- strong requirements on sub-detectors and DAQ systems
- bunch spacing down to 20 ns (at Z pole)
- "continuous" beams (no power pulser)
- More physics challenges at Z pole:
  - luminosity measurement at 10^3 - luminometer acceptance = 1.2 µm
  - definition at <10^-5 - detector hermeticity (no cracks)
  - stability detector acceptance of momentum measurement - stability of magnetic field wrt E_{beam} (10^-3)
  - h/c/g jets separation - flavor physics (and rare processes)
  - particle identification (preserving hermeticity) - flavor physics (and rare processes)

**IDEA tracking system**

- Central tracking device:
  - drift chamber
- Silicon detectors for precision measurements
  - vertex region
  - silicon wrapper
- Thin solenoid with 2T field (according to MDI limits)
- Dual readout calorimeter
- Pre-shower detector - implemented by a pre-shower detector
- Moon chambers in the solenoid return yoke
- Requirements for the IDEA DCH can meet these goals:
  - Gas containment – wire support functions separation:
    - allows to reduce material
  - Feed-through-less wiring:
    - allows to increase chamber granularity and field/sense wire ratio to reduce multiple scattering and total tension on end plates due to wires by using thinner wires
  - Faster construction (per number of wires):
    - a semiautomatic wiring robot allows to speedup the wiring time and to build the large DCH in a reasonable time and with a high mechanical accuracy

**VTX + Wrapper (Si)**

- High precision impact parameter reconstruction with low mass vertex detector
  - at least 20 mm granularity
  - thickness < 0.3% of radiation length
  - < 20 mW/cm² to minimize services
- Supplemented by coarse/faster silicon detectors in front of the drift chamber
- Depleted Monolithic Active Pixels sensors
  - not necessarily the same technologies for both:
    - different requirements
  - present technologies are very promising
- R&D on different approaches (ARCADIA, ATLASPIX3)

- CMOS DMAPS Platform
  - started in INFN project, collaborations with Switzerland and China
  - Project within AIDAInnova WP5
  - Fully depleted monolithic sensor
  - Foudery 110 nm CMOS process

- Pixels:
  - sensor and back-side processing already tested on silicon
  - 25 X 25 mm² size
  - Area 50% analog – 50% digital
  - Small collection electrode (20% of pixel area)
  - versions with ALPIDE and BULKDRIVEN front-ends

- Functionalities:
  - momentum resolution
  - extend tracking coverage in the forward/backward region by providing an additional point to particle with few measurements in the drift chamber
  - precise and stable razer for acceptance definition
  - Covered area ~90 m²
  - Suitable technologies:
    - microstrips (2 layers)
    - double sided microstrip
    - DMAPS -> single layer, high resolution on both coordinates, maybe simpler integration

- Local supports needs original solutions for the internal tracker (lightweight) and the wrapper (long-term stability)
- Just a couple of examples:
  - ALICE: like staves, but built with subtractive technology
  - Staves with ATLASPIX3 modules as option for the STAR Wrapper
- Different cooling options available
  - pipes material: Ti, steel, carbon, microchannel
  - CO2 or water cooling
  - alternative cooling of edge supports for the vertex (a la Belle II)