Detector R&D ECFA Roadmap Discussion

TF1 Gaseous Detectors

Large volume Drift Chambers at e^+e^- Colliders

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Role of **large volume drift chambers** at **e^+e^- colliders**

- **All recent past [CESR (CLEO3), PEP2 (BaBar), KEKB (Belle), DAFNE (KLOE)] and current [VEPP4 (KEDR), VEPP2000 (CMD-3), BEPC2 (BES3), SuperKEKB (BelleII)] e^+e^- colliders** make use **exclusively** of **drift chambers** as tracking detectors
- **All proposed future e^+e^- colliders [FCC-ee, CEPC, SCTF, STCF]** include at least one of the central trackers constituted by **drift chambers**, except for **ILC** and **CLIC** (originally proposed for higher E_{cm} ranges, let's not forget **4th-Concept**)
- Alternatives to drift chambers exist (**TPC** and **Si trackers**), however
  - not a single concept is planning to use a TPC as tracker, except for **ILD at ILC** (mention **CEPC**)
  - proposed Si trackers (not for **SCTF** and **STCF**) exhibit
    - not superior performance in terms of resolutions ($\sigma/\sqrt{N}$ and multiple scattering dominated)
    - lack of particle identification capabilities
    - lack of redundancy for secondary vertices within the tracking volume
    - system complexity

A **drift chamber based tracking detector** represents a more than adequate solution for a general purpose detector at **future circular e^+e^- colliders** (FCC-ee, CEPC, SCTF, and even EIC). It is, therefore, of utmost relevance for the entire community not to waste the opportunity of supporting the necessary **R&D program** to turn the **INFN IDEA** drift chamber **proposed innovations** into a **tangible reality**.

R&D program for a **Cluster Counting Drift Chamber**

- **Studies on New Materials**
  - **new wires**: **metal coated Carbon monofilaments** in place of metallic field wires
    electrostatic stability for 1 cm drift cells and 4 m long wires requires tensions T_c
    - $T_c \geq 260$ N for 40μm Al field wires, **dangerously close to the 300 N elastic limit**
    - $T_c \geq 250$ N for 35μm C monofilament, elastic limit 830 N
  - **new polymeric fibers** (very valuable wherever a "transparent", shielded gas vessel is required)
    - **3-phases graphene-polymer nano-composite**
    - **conductive polymeric matrices** (PEDOT:PSS) with **graphene**-based fillers
    - to strongly reduce gas permeability (Helium)
    - to enhance electrical conductivity for electrostatic and radiofrequency shielding

    thus improving the chamber transparency without metallic layers contributing to multiple scattering
- **Front-end, DAQ and pre-processing electronics for cluster counting (PID)**
  - **FEE**: wideband (1 GHz) amplifier (25 dB) low mass, low power, low noise, multichannel (×8) **ASIC**
  - **digitizer**: 12 bit, 2 GSa/s
  - **multi-channel (16/32) pre-processing board**: **FPGA** for filtering, triggering and data reduction
- Construction of **full scale prototypes** to test the proposed innovative materials and of **reduced scale prototypes** to experimentally determine the **particle identification performance** in the relativistic rise region and for studies of **non-explosive, environmental-friendly gas mixtures**
- **Test beam facility**
  - Absolutely necessary a **test beam facility** with identified beams of ***e/μ/π/K/p*** in the range **1-50 GeV/c**