The Construction of a Drift Chamber Prototype

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Abstract

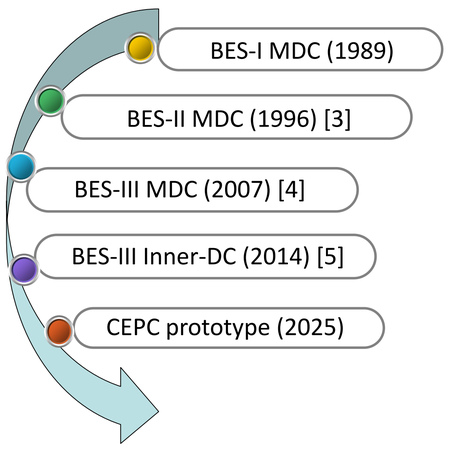
A drift-chamber-based design has been chosen and done as a possible alternative to the TPC, in order to contribute its PID performance in the CEPC reference detector's design[1].

Thanks to the nice collaboration with the ITA group[2], after the study of the simulation and the preliminary test, one short multilayer drift chamber prototype has been developed to study and optimize the resolution of dN/dx.

This work would like to report the construction of this short-multilayer drift chamber prototype including the key components and the construction standard during this work, as well as the experimentally measured results including wire-tension and leak current.

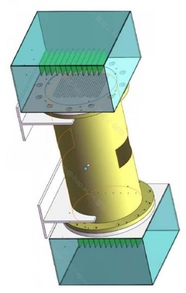
Introduction

IHEP Drift Chamber:



The design of the prototype

- Use of cluster counting for particle identification
- A cylinder + two end plates
- Length :~60cm
- 12 layers
- 10 cells/ layer
- 120 cells in total
- Cell size :18 mm x 18 mm
- Ratio of field wires to sense wires :3:1
- Sense wire :20 μm Au - plated tungsten
- Field wire :70 μm Aluminum



Construction

Prefers adopting the used skills of IHEP as much as possible:

1. Feed-through for the wire anchoring system;
2. Fully hand wiring, instead of the robot [6];
3. High standard of the precision mechanically(±25μm);
4. Wire feeding at almost closed cylindrical chamber ,
   a big challenge to operate, keep clean and quiet (instead of endplates with few rods gaining open operation space)[7];
5. Trained a new hand wiring team;
6. Reestablish the connection to the industries;
7. … .

Major components

Feed through

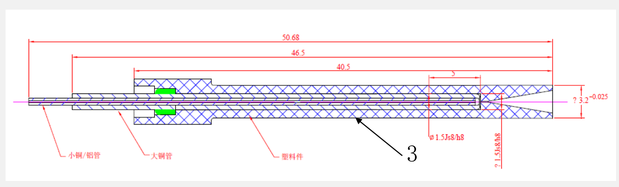
Feed through:

It consists of three parts coaxially: inner-tube(1), outer-tube(2), and plastic tube(3).

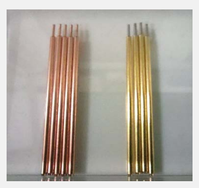
1: Anchoring-Positioning various wires in the chamber.

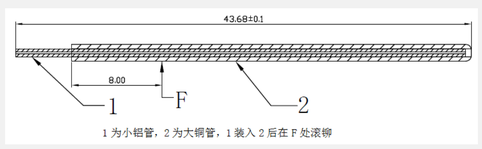
2: Import/export-Cabling with high voltage and output signals.

3: Ensure insulation(LCP-A310).



The design copies the BESIII's. Accuracy control within ±0.025 mm (diameter, coaxiality…）.

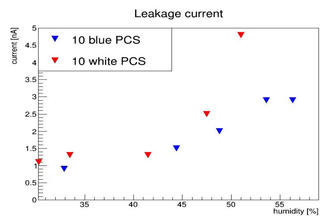




The connection between the inner/outer tube is achieved by using a special rolling riveting process（F）on the outer-tube, no adhesive.

The difference to the BESIII design: Add release forth(F) from 70g to 200g.(Resist~5.8m wire)

- The connection to the domestic industries has been reestablished.
- New feed throughs have been tested in a module.
- Tests of the conductivity(1&2), insulation(2&3), dimensions, gas tight(2&3), release force(1&2), have shown the new process could satisfy the requirements.
- The crimping shows no wire broken or tension lost happened for more than six months.
- Total 5k feed throughs have been produced and delivered.

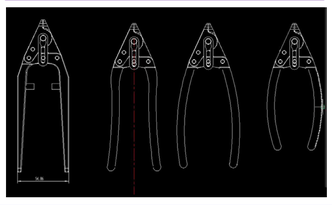


A good insulated performance.

Crimping

- The wire is fixed inside the feed-through by a special crimping.
- After inner-tube of feed through is crimped, the crimp parameter should be a relatively fixed value which had been optimized as the best performance of the wires.
- The localizational tool (Cleo design) has been adjusted to fulfil the task.

The crimp parameter:
Thickness:0.46mm
Width:0.85mm
Length:1.8mm



Wire

Wires:

- Luma Tungsten AU-plated:20μm
- CFW Al5056: 70 μm
- CFW Al5056 NI AU-plated: 80μm

$$T(c) = \lambda L^2/(8S_{ag})$$

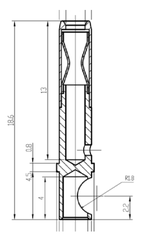
λ : Linear density
S_{ag} : Wire deflection
L :Wire length

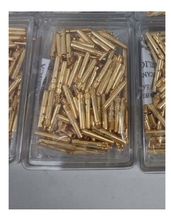
Parameters as 5.8 meter（Preliminary）

S/F	Diameter（μm）	Linear Density (10^{-5}g/cm）	Length（m）	Sag（μm）	Wire tension (Sag=450μm）（g）	Wire Break（g）
F	110	32.67	5.8	450	305	350-355
F	80	17.88	5.8	450	167	190-195
F	70	10.33	5.8	450	96	104-106
S	20	6	5.8	450	56	67-70

Connector

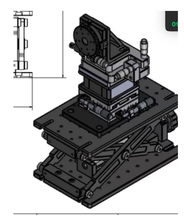
- The connector is used with the feed through for cabling.
- Total 3k connectors have been produced and delivered.





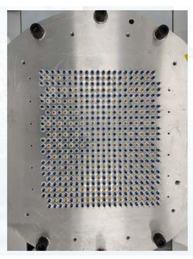
Wire Feeder

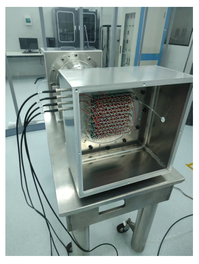
The wire has been fed vertically with two six-dimension tools in a no-visualized condition.

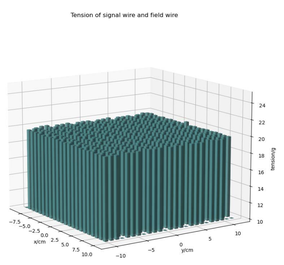


Status

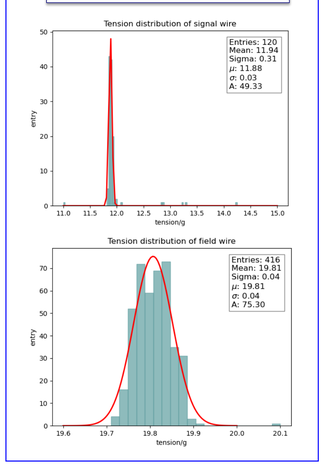
1. Finished wiring, accuracy on the position of the wires < 50 μm (Mechanically).
2. Sense wire tension :11.94±0.31g, Sag :25μ m
   Field wire tension :19.91±0.04g, Sag :25μ m
   - Wire tension distribution shows a good uniformity of the wire tension.
   - Leak current<1 nA







Wire tension



3. Finished the prototype construction, gas tightening, cabling and HV training.
4. Measurements with cosmic-ray (at IHEP)
   -> channel equalization, module calibration and system performances…

See Wenyu PAN's talk

Acknowledgments

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