

Design parameter of Dual Phase Field Cage and comparison of components with the SP FC

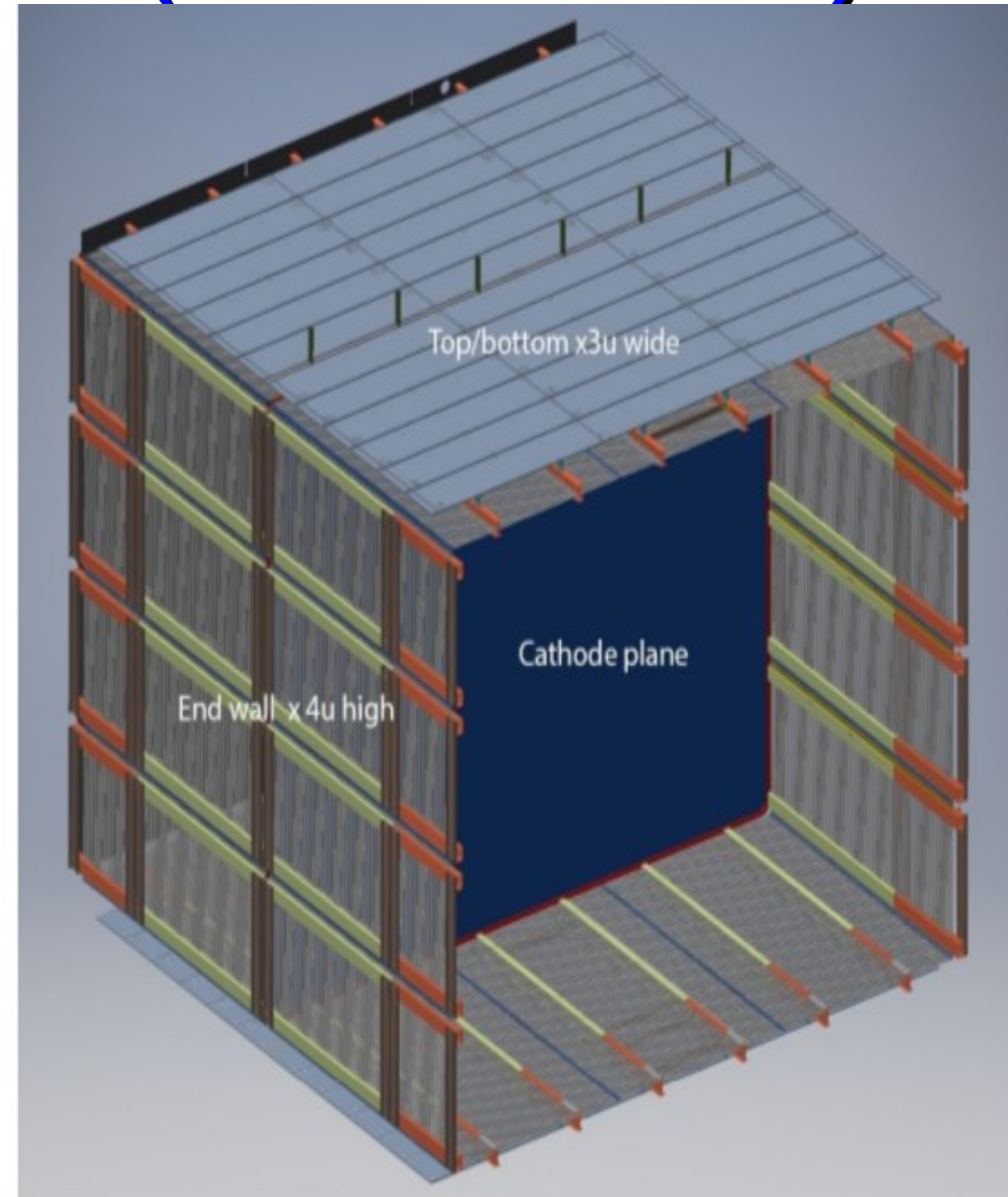
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Motivation

- Detail information about the Single phase and Dual Phase Field cage.
- Share the design parameter as much as possible between SP and DP so that they can be reflected in design finalization.
- Design common structure (design) of FC both for SP and DP.
- Finalize design parameter along with the electrical components for DP FC design.

Overview of SP-FC (Proto-DUNE)

- The single phase Proto-DUNE consists of 6 CPA's, 6 Top and 6 Bottom Field Cages (FC) and 8 Endwall FC consisting of 4 stacked assemblies on each side.
- The Cathode Plane Array (CPA) will each support the weight of half of the top and bottom FC with the other half being carried by the APAs.
- The EndWall FC will be hung independently from the ceiling supports.



Field cage at Stony Brook

- Stony Brook is developing the Top and Bottom field cage module for single phase (mainly the mechanical part).
- We had a detail discussion about the mechanical design, mechanical and electrical parameters of the Single phase FC.
- We have also discussed about what we can share about the design and parameter with the single phase.
- Visited the Stony Brook lab where they have build the one module of Top FC and collected all the necessary information for the design.

Field cage at Stony Brook

★ Field cage along with grounding plane.

Grounding plane :
For dual phase it is not necessary.

Field cage profile :
Made up with stainless steel.
Length : 2.3 m
Width : 46 mm.
Distance between two profile (center to center) : 60 mm.



Main I-beam

- ★ There are 2 main I beam in each module.
- ★ Length of main I beam is 3.6 m(Top and bottom).
- ★ Height of I beam is 6 inch.
- ★ Material used for I beam:
Fibre-reinforced plastic(FRP)



Cross-I beam

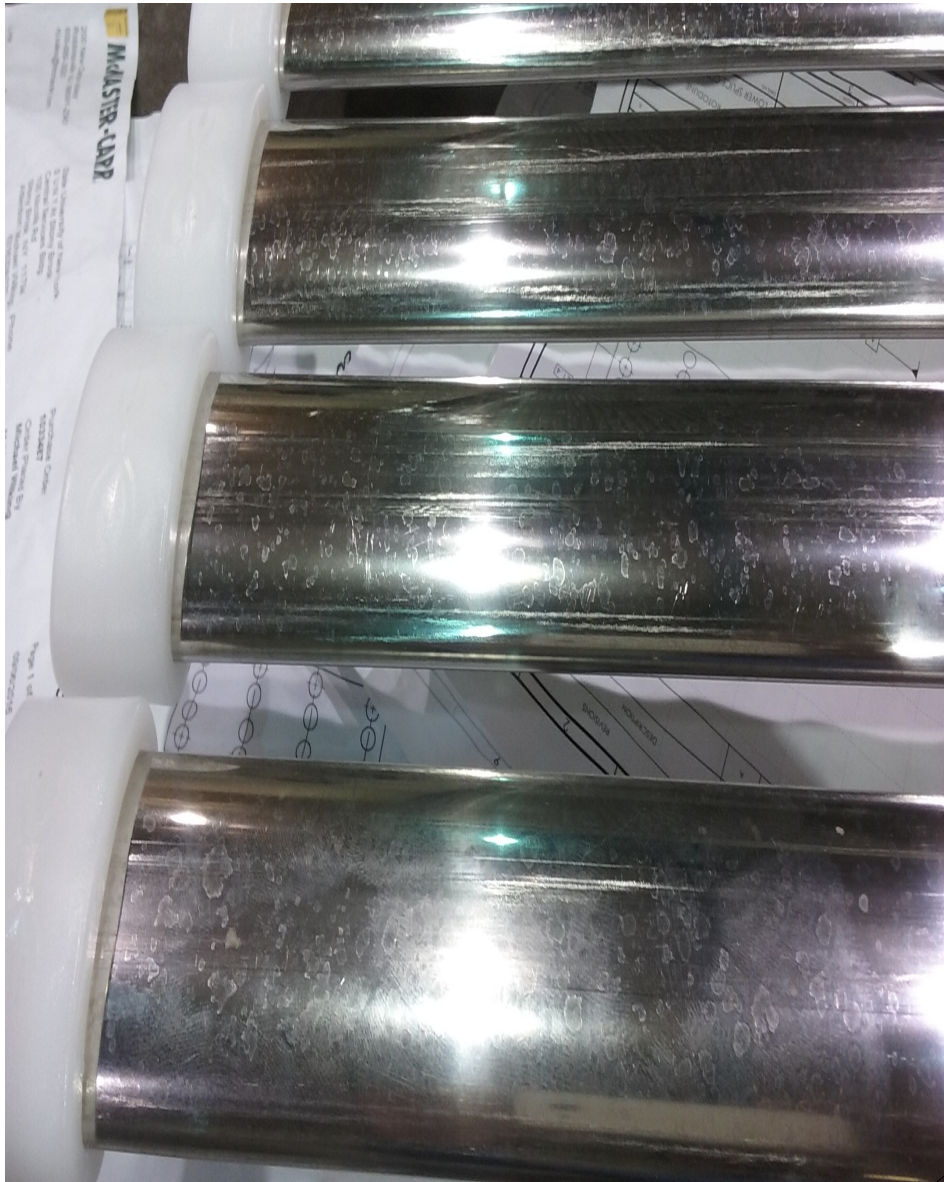
- ★ Number of cross-I beam used in each profile is 4
- ★ Material used for cross-I beam is FRP.
- ★ Connection with main I beam



Complete I beam structure



Profile in close look



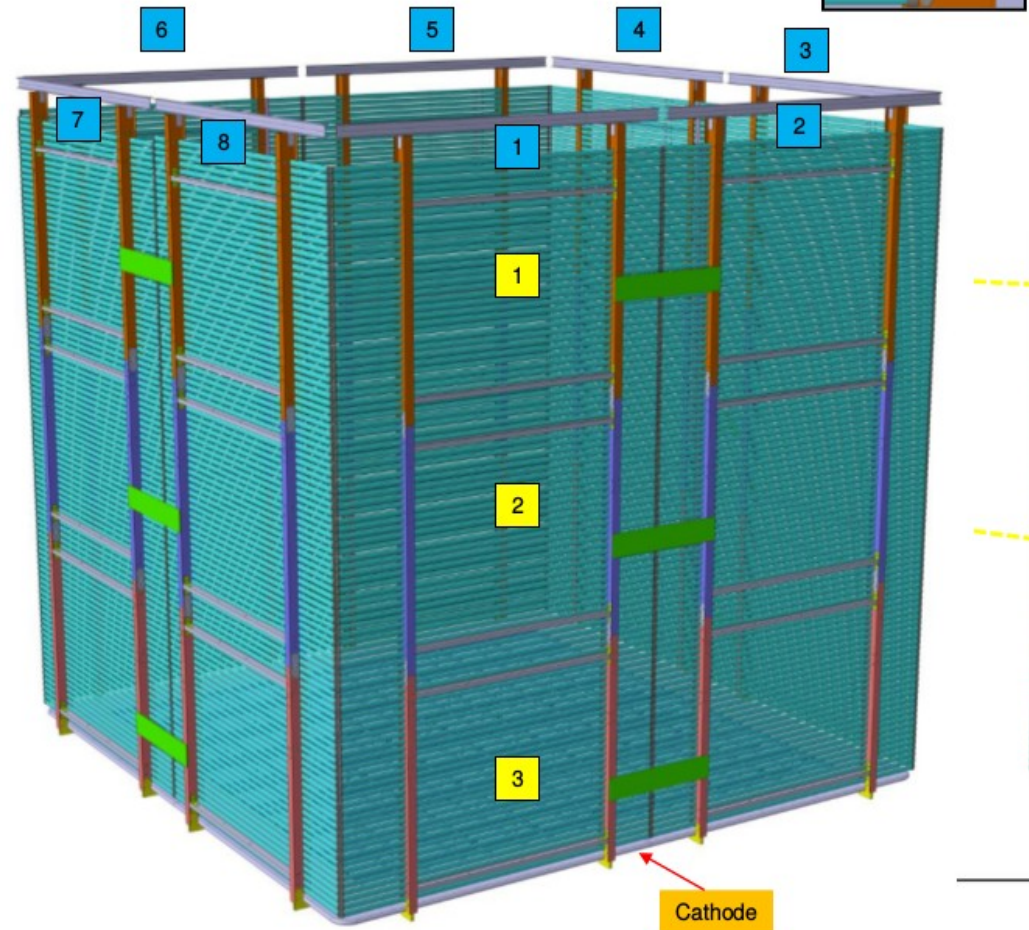
End Cap

Overview of DP-FC

(taken from A.Gendotti's talk)

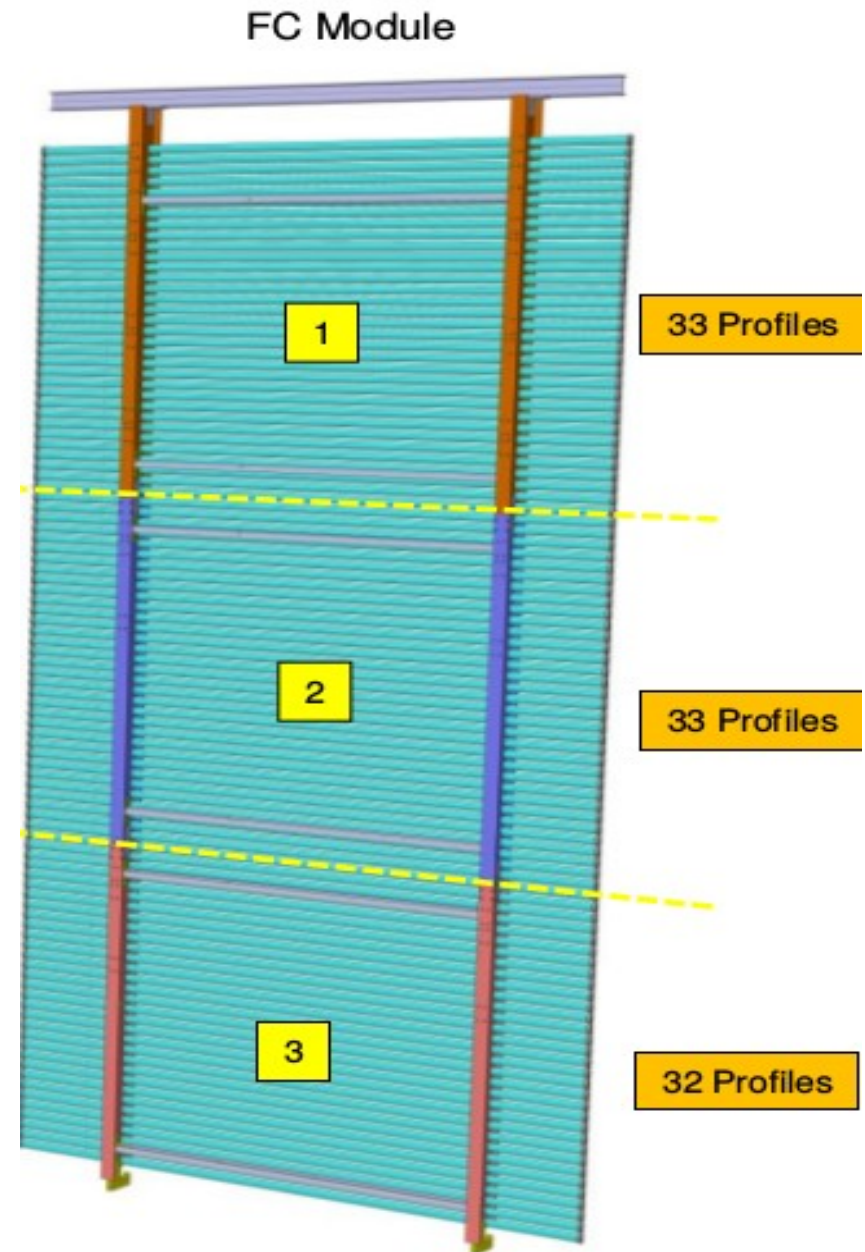
- Total 8 modules.
- 2 modules in each detector side.
- Size of each module is 6.238m x 3.017 m (155mm thickness)
- Each module is composed of 3 sub-modules.
- Each module has 98 profiles + cathode.

- # FC Module
- # FC Sub-Module

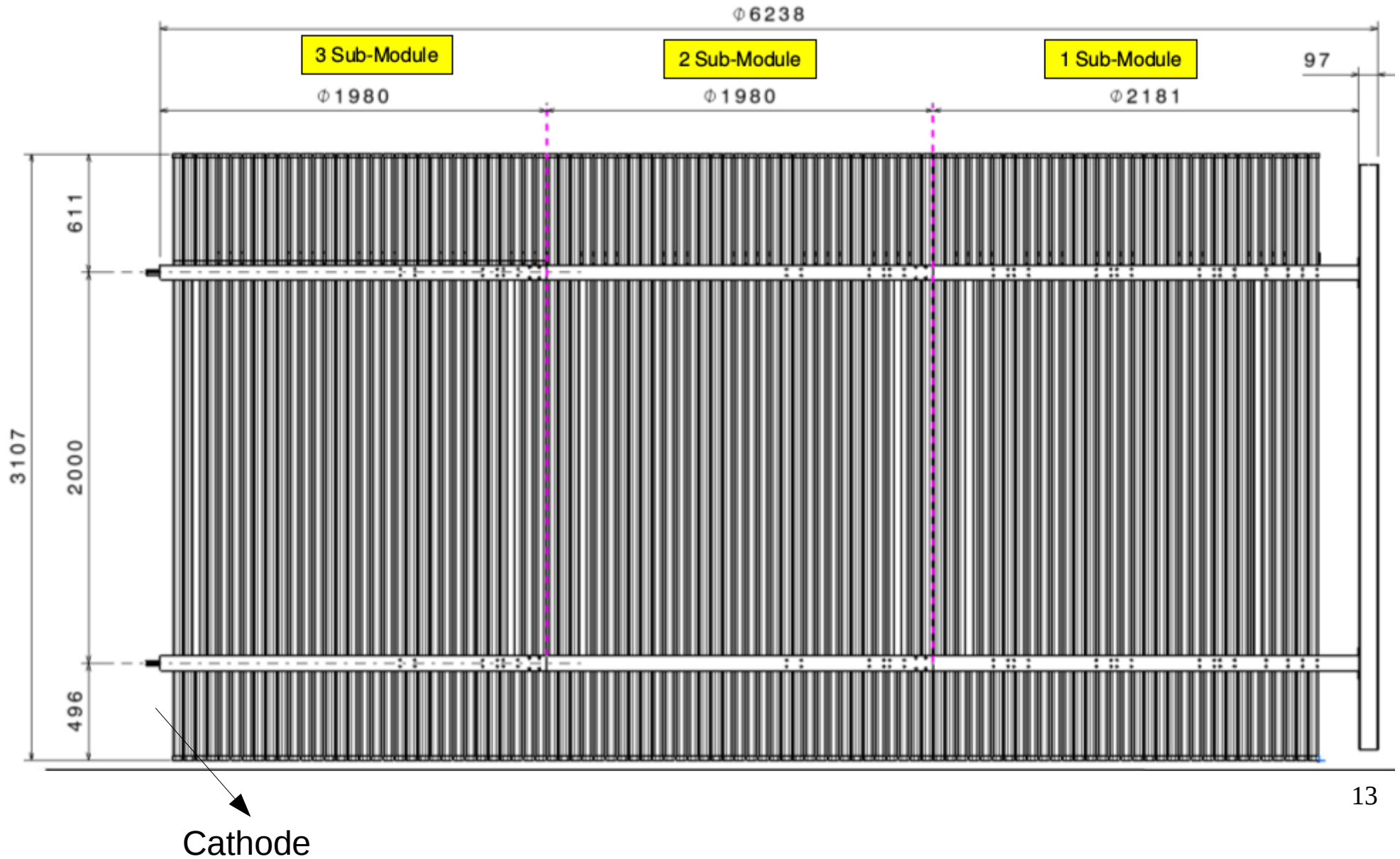


DP-FC overview

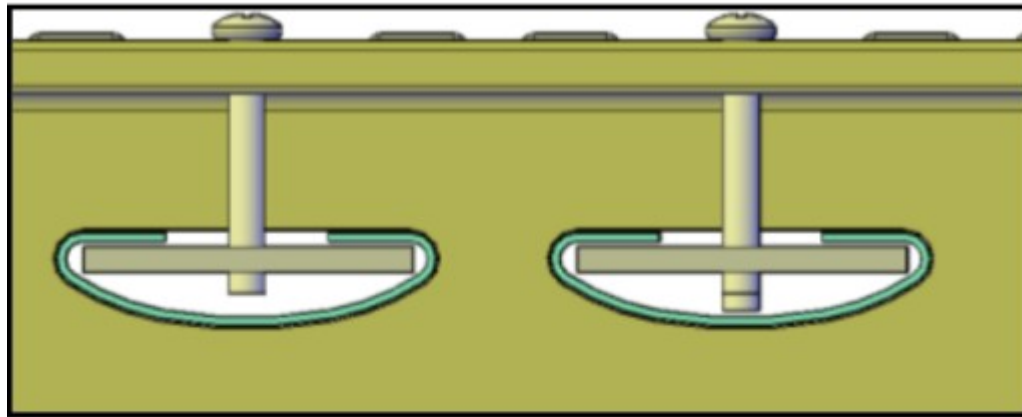
- Each Module has 98 profiles.
- Distance between each profile in a module is 60 mm.
- Distance between two modules is 3mm (Cap-Cap distance).
- Size of each profile is 3.017 m x 8 mm.



Each DP Module

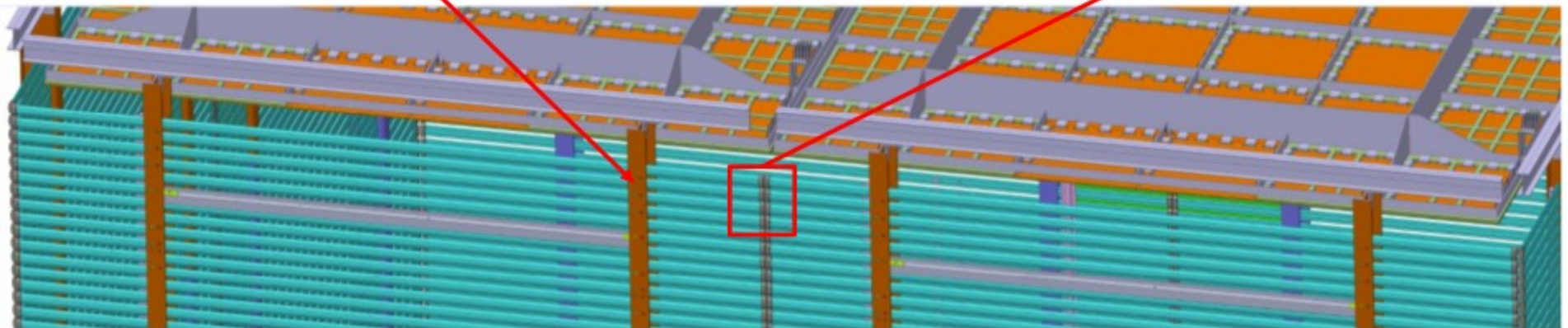
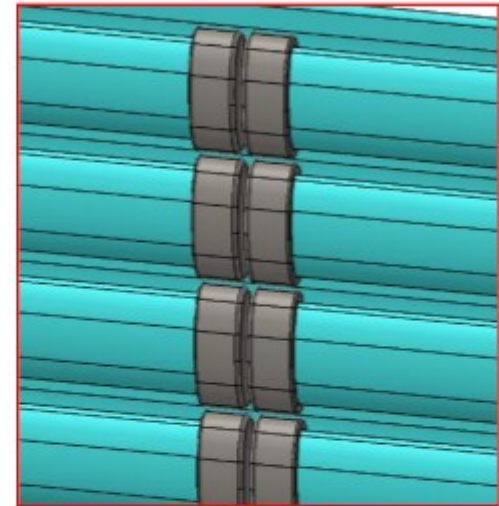


Gap between two modules



Profiles fixed in the center Beam of the modules

3mm distance between the PE Caps



Common parameters between SP and DP FC

- Discussion with Bo Yu and Michael Wilking about Single Phase FC, can share common design parameter between SP-FC and DP-FC.
- We have written down both mechanical and electrical parameter list for DP-FC along with the specification of SP.

Parameter list (mechanical)

	Parameter	SP	DP	note
1	Total size of Field Cage	7.2m x 6.9 m x 6m	6m x 6m x 6m	
2	Total Number of FC modules	6 Top, 6 Bottom, 8 in each endwall side (total 28)	8 Modules	
3	Number of Sub Module in each module		3	There is no as such submodule for SP
4	Size of each Module	Top and Bottom : 3.6m x 2.3 m Endwall module : 3.6 m x 1.5 m	6.238m x 3.017 m	Do not know thickness of single phase
5	Number of profiles in each module	58	98	
6	Distance between two modules	3mm	3mm	Cap- Cap distance
7	Distance between each profile in a module	60mm	60 mm	Same as SP
8	Number of main I beam in each module	2	2	Same as SP
9	Length of main I beam	3.6 m	6.238m	
10	Height of I beam	6 inch	6 inch	Height is not decided yet, but 6inch proposed for DP
11	Material used for I beam	FRP	FRP	Material for

				DP is not decided (FRP proposed)
11	Number of cross I beam in each module	4	4	Proposed same as SP
12	Material used for Cross I beam	FRP	FRP	Material for DP is not decided (FRP as proposed)
13	Length of each profile	Top and Bottom 2.3 m End wall 1.5 m	3.1 m	
14	Width of each profile	46mm	46mm	We proposed the same width as SP
15	Thickness of each profile	8mm	8mm	
16	Material used for profile	Stainless steel (default)	Aluminum or stainless steel	Aluminum or stainless steel

Parameter list (electrical)

	Parameter	SP	DP	Note
1	Number of resistive stages	8 in series		Inputs from LSU will be important
2	Number of resistors(parallel) in each stages	2	2	Proposed same as SP
3	Value of parallel resistance	1 GOhm	1.3GOhm	Inputs from LSU will be crucial
4	Number of varistor in each stage	3	3(Final number will depend on the model of varistor)	3 varistors are in series with each other and placed parallel with resistors.
5	Company of varistor	Panasonic	Panasonic (if varistor is used)	Inputs from LSU will help to make choice.
6	Size of Voltage divider Printed circuit board	520mm x 80 mm		Can be finalize once resistors are fixed
7	Material used for PCB	0.062 inch thick FR-4 laminate with 1 ounce		LSU might have different option

		weight copper cladding on top and bottom		
8	Number of mounting holes with the profile	9		Depends on the number of profile connection
9	Space between Mounting holes	60 mm	60 mm	Same as SP

Requirement list

	Parameter	Value for SP	units	Value for DP	notes
1	FC-maxcurrent : Limit of total bias current at 500V/cm	1	nA	1 nA	Same as SP
2	FC-maxvoltage : Maximum percentage of bias voltage corresponding to 500V/cm drift field	150	%	150%	Same as SP
3	FC resistance tolerance :	1	%	1	Same as SP
4	FC bar- separation: constant separation with respect to neighbors	1	mm	1	Same as SP
5	Frame flatness tolerance over full length.	3	mm	5	Same as SP
6	FC- straightness Maximum	5	mm	8	Same as

	sagitta for each profile				SP
7	FC- smoothness : FC profile shall have no surface defect with a depth exceeding the tolerance	100	microns	100	Same as SP
8	FC lifetime : The FC shall maintain its integrity for the specified lifetime.	1	years	1	Same as SP
9	FC- Qfactor : maximum allowable resistance over a bar length that can develop over the specified lifetime.	1	Ohm	1	Same as SP

Work at UTA

- We will be building a mechanical mock-up of a sub-module of size 2m x 3m at UTA.
- We will use aluminum profiles.
- We also possibly perform a cold test in a liquid nitrogen bath at U. of Wisconsin.

Timeline

- Come to an agreement about the design parameter after the discussion.
- Circulate the final version of the draft after implementing suggestions and comments within this weekend.
- Start simulation of FC with the design.
- First version of the design along with the simulation by the end of November.
- Time-line for UTA mechanical mock-up is within next month or so.
- I will be going to CERN on 3rd week of October to work on the design of FC.

Outlook

- We had an useful discussion about SP-FC design in detail at Stony Brook.
- We have visited FC lab at Stony Brook and collected all the necessary information for the design.
- We can implement common module structure, mechanical and electrical components of SP-FC in DP-FC.