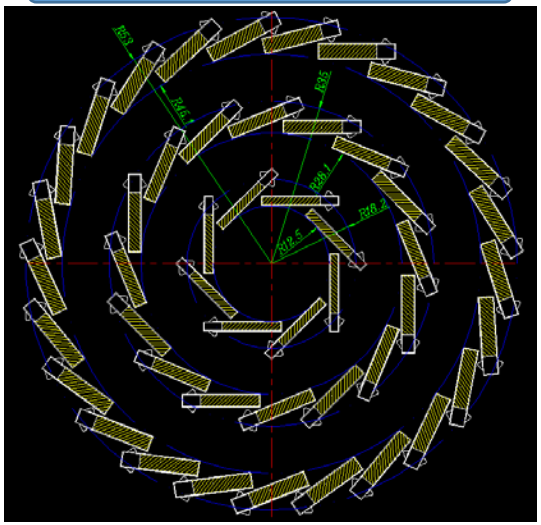
Layout - long barrel

The VTX - section view

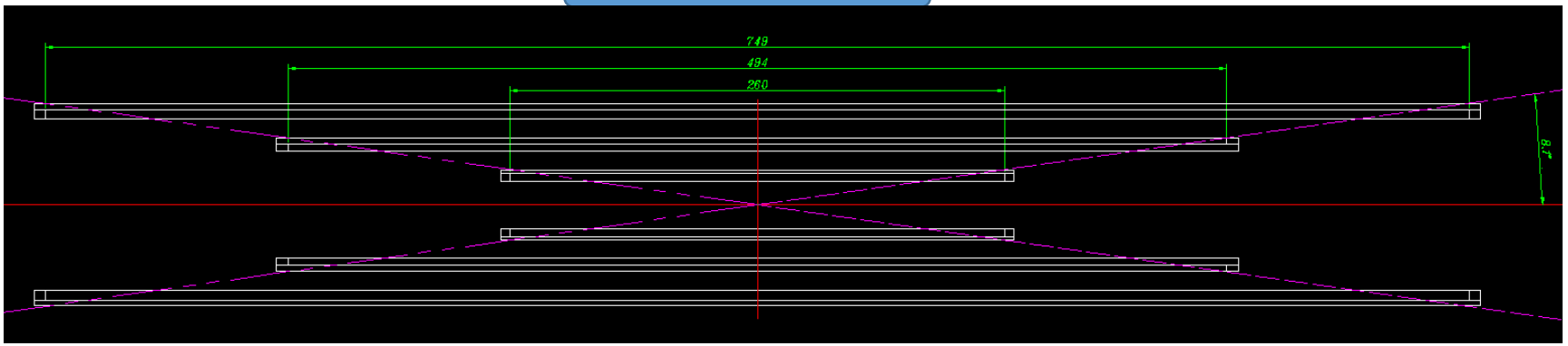


Three different sizes of ladders(section size and length) for barrels.

Ladder support size

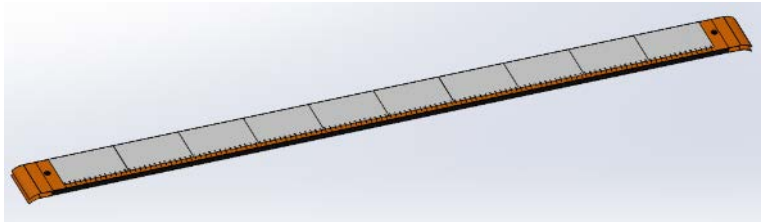
layer	Size .mm (W x H x L mm)
inner	17.4x1.7x260
middle	17.4x2.5x486
outer	17.4x3.2 x749

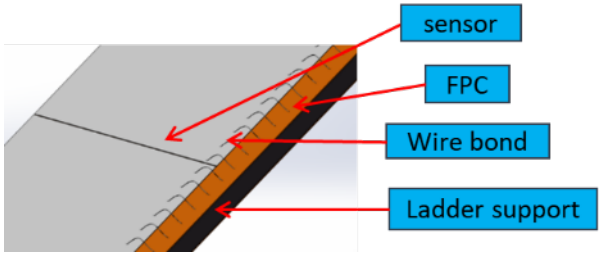
The VTX - side view



Ladder and ladder support

Ladder components are similar to most2 prototype

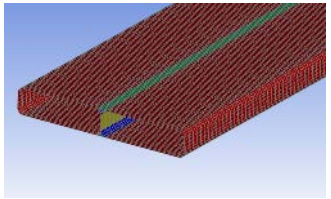


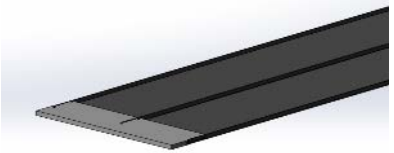


The max length of the ladder support is ~750 mm, about 3 times of that we made for the prototype.

The doable new sections design of such long CFRP ladder support (compared and confirmed):

- material selection - M40 CFRP (ultra thin)
- 4 to 5 layers of plies with the maximum thickness of 0.15 mm
- optimized ply angles design both for the rigidity and the doable fabrication process





FEA of the CFRP ladder support -updated

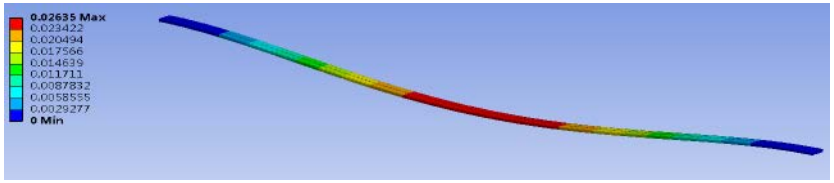
Increase the layers of Al to 6 for the middle and outer ladder, updated the FEA.

layer	Size .mm (W x H x L mm)	Thickness .mm (equivalent)	Max def .mm (Fully loaded)	Max def. mm (Self weight)
inner	17.4x1.7x260	0.167	0.019	0.006
middle	17.4x2.5x494	0.179	~~0.084~~ 0.096	~~0.026~~ 0.028
outer	17.4x3.2 x749	0.185	~~0.346~~ 0.354	0.107

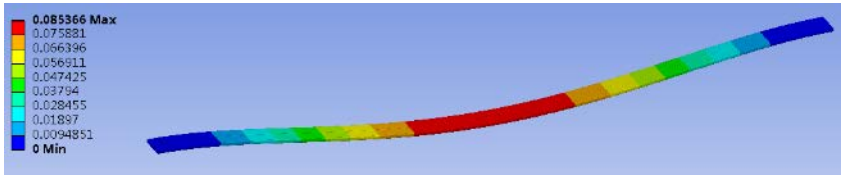
All ladder support resulted with very low IRF (the max is <0.02) under full load. (IRF>1 failure)

Results of the middle layer ladder support

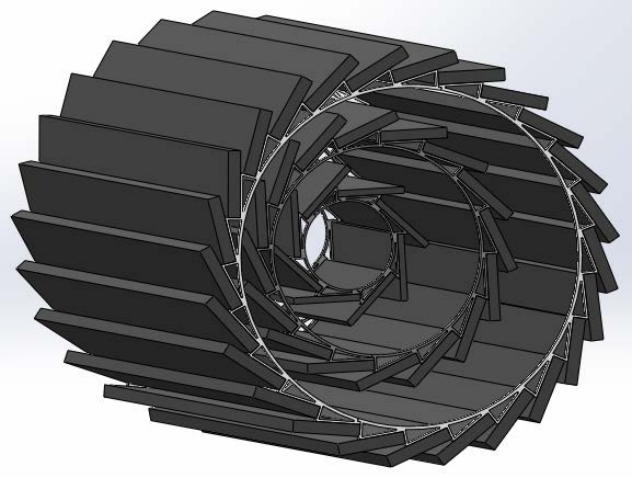
Def - self weight： 0.026mm



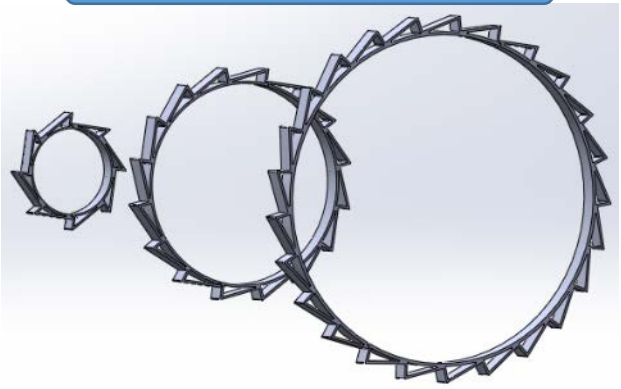
Def - fully loaded： 0.084mm

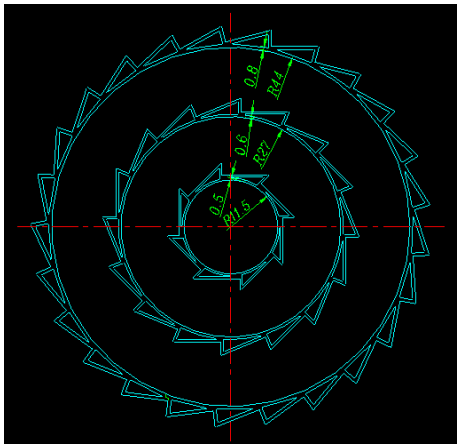


VTX assembly



Support rings / Al alloy

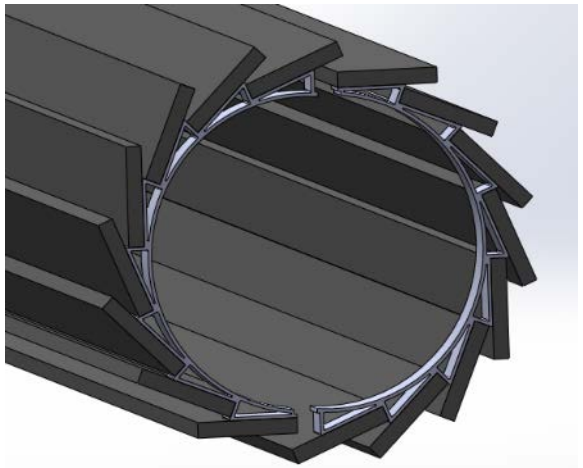




Ladder can be glued / bolted to the support ring. Gluing will save space to make the ratchet teeth hollow, which helps ventilation, currently we prefer this method.

Two methods to assemble the VTX:

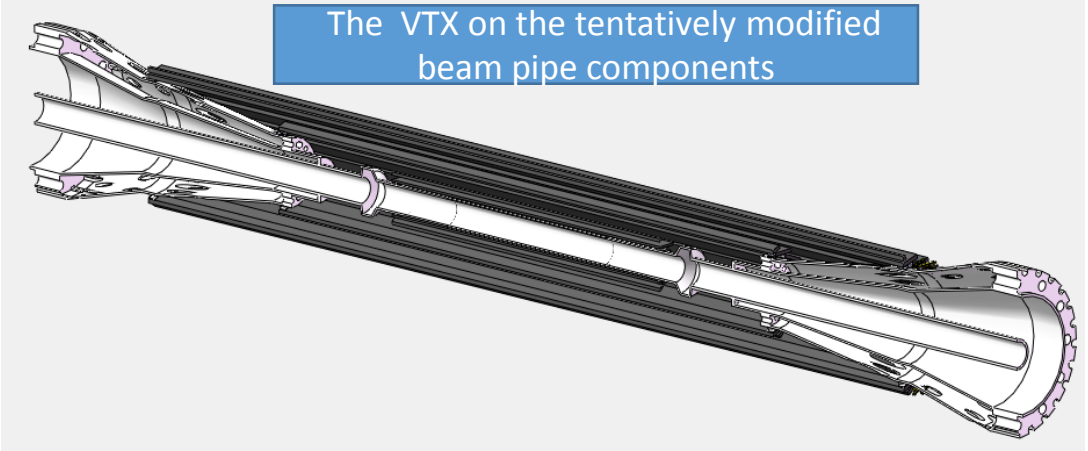
- Assemble the barrel in advance (consisting of two halves), then install the barrel on the beam pipe.
- Install (*or machined*) the support rings on beam pipe in advance, then directly install the ladders (preferred for inner most layer).



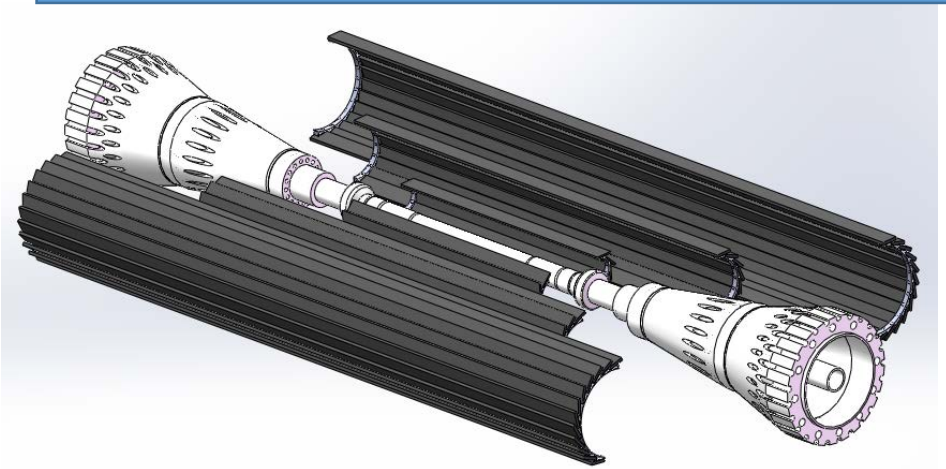
VTX installation on the beam pipe

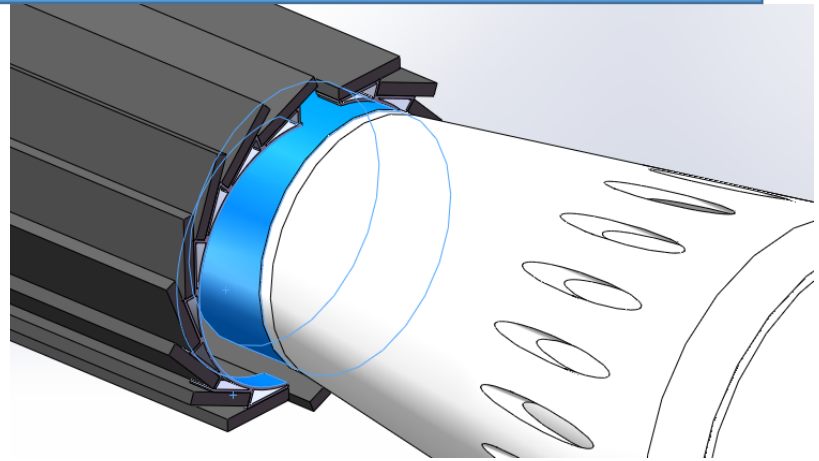
The support ring can be either glued/bolted to or pre machined on the beam pipe related parts. (for the inner most layer bolted connection is too difficult)

The VTX on the tentatively modified beam pipe components



The option that pre-assembled halves of barrels mounted onto the beam pipe (dedicated tooling required)

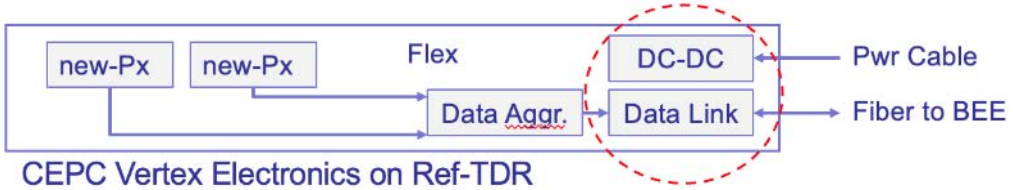




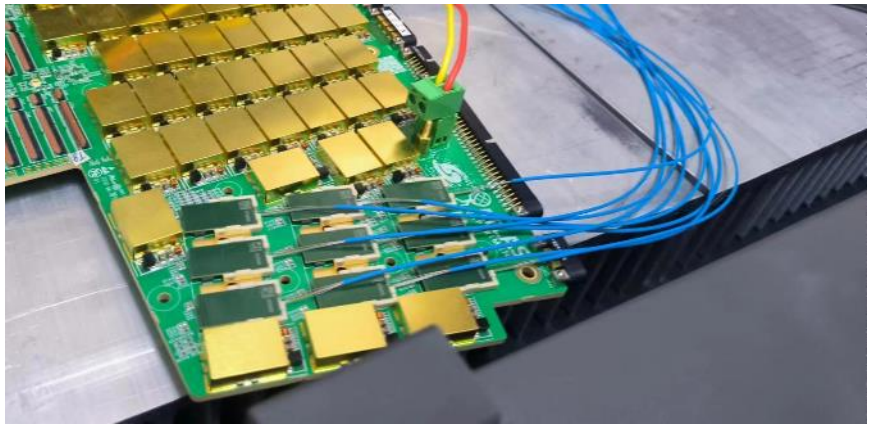
- More consideration - different constraint on two ends?

Cables routing

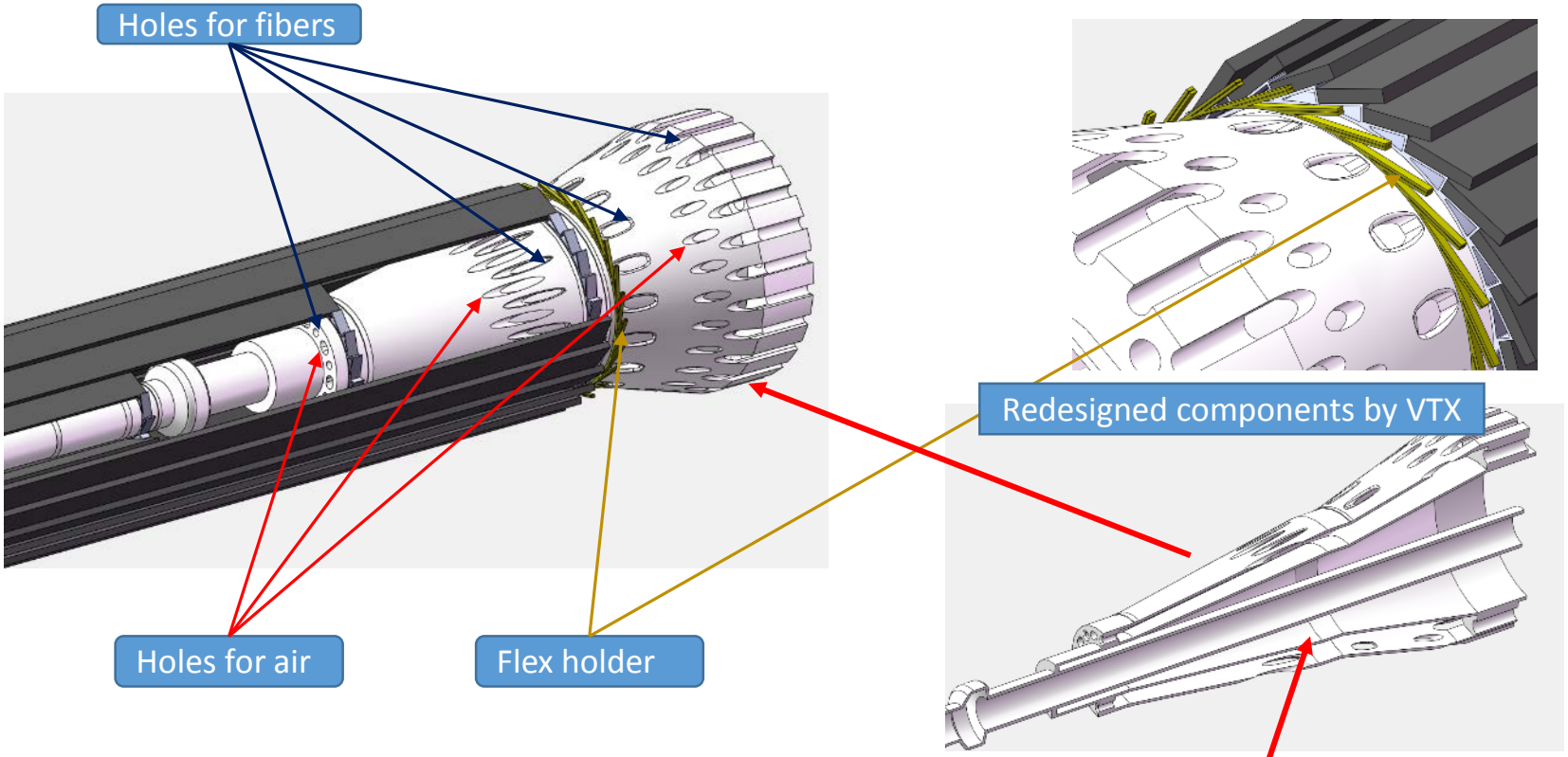
- Optoelectronics module is proposed.
  - Radiation hardness of Optoelectronics module
  - Optical fiber and power cable goes out from cabling space below
  - Next step: need dimension of Optoelectronics module and fit them into engineering design



Example from CERN vtrX



Air channels and cables routing



According to the current plan, assuming the flex will be switched to fiber where beyond and near the end of the ladder.

Cooling simulation of the VTX - long barrel

Power dissipation: 50 mW/cm2
Total heat generation of the VTX: 421 W
Inlet air temperature 5 ℃
In current simulation beam pipe temperature not considered
…**more setup will be simulated**

Layer of barrel	Chip coverage (mm)	Number of ladders	Heat generation- of barrels(W)	Simulation results the Max temp (Celsius)
inner	14.8x260	8	27	82
middle	14.8x494	16	117	34.5
outer	14.8 x749	25	277	37.2

- Based on a rough calculation, given 15 degrees Celsius rise, the estimated air flow rate is 1.49 m3/min. *In the sectional area of the barrels the average speed about 2.3 m/s.*
- In the simulation, transfer the flow rate to 12 inlet pipes with ID-8mm, the air speed is 41 m/s (it can be reduced by increasing the inlets)
- Cooling setup with a lower flow rate was also tried but resulted with much higher temperature then this case.