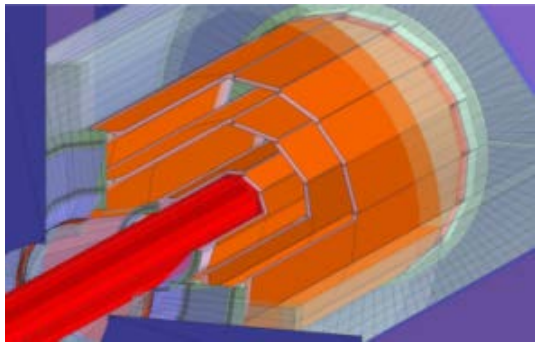
Status of the mechanical design of silicon VTX prototype

Jinyu Fu / IHEP

2021-4-22

Vertex Layout in Preliminary Design

	R (mm)	$\lvert z \rvert$ (mm)	Current z in total
Layer 1	16	62.5	130.6 mm
Layer 2	18	62.5	
Layer 3	37	125.0	263.1 mm
Layer 4	39	125.0	
Layer 5	58	125.0	263.1 mm
Layer 6	60	125.0	



6 layer of sensors (3 double-sided layers of barrels)

* **Material budget**: 0.15% X/X_0 for each single sensor layer.

* **Single point resolution**: currently in CDR range from 2.8-6 μm, eventually we aim for only one type of pixel sensor with single point resolution of 3-5 μm.

* **Power dissipation:**

Final goal: ≤ 50 mW/cm2. (air cooling)

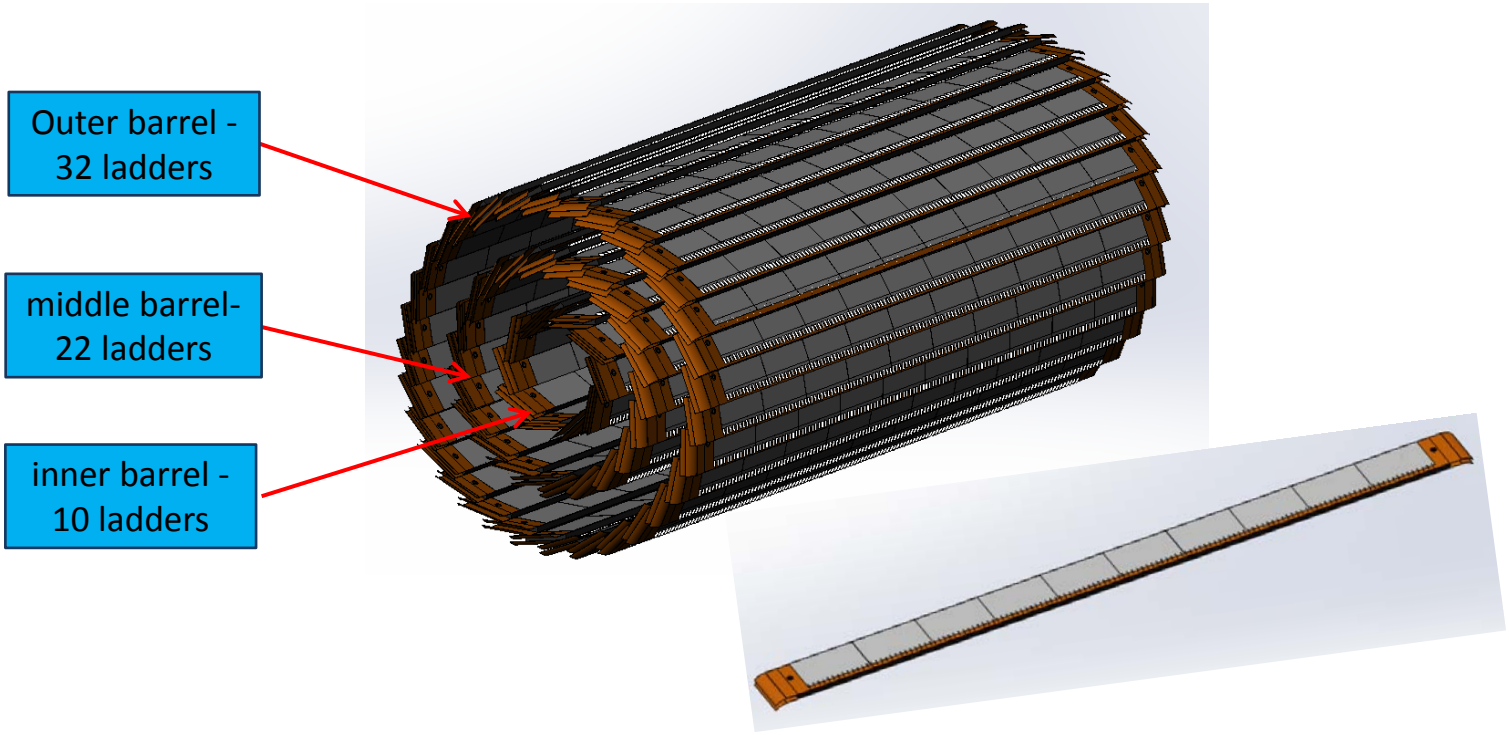
Current (estimation of the full size chip): triggerless mode ≤ 150 mW/cm2 .

trigger mode ≤ 100 mW/cm2.

***Working temperature range:** 20-50 ℃ (best performance under 30 ℃)

General Structure of the Vertex Detector (VTX)

- 3 layers of barrels, diameters close to CDR
- Each barrel consist of numbers overlapped **ladders**.
- Detectors on both sides of the ladder.

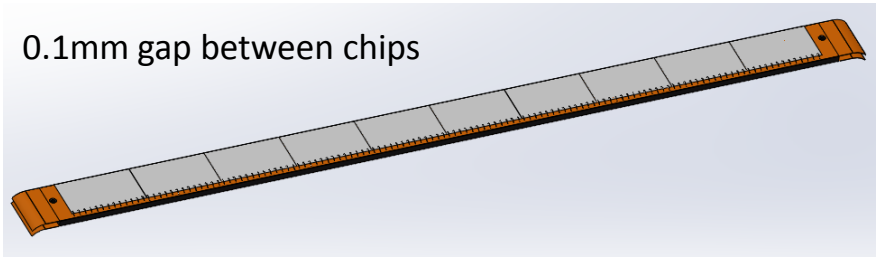


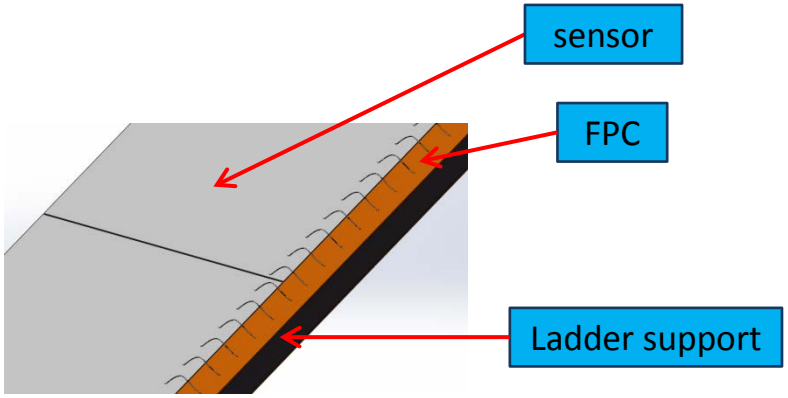
Ladder Design

Sensor chip : 14.8* x 25.6 x 0.05 mm (2* mm margin at one side for wire bonding)

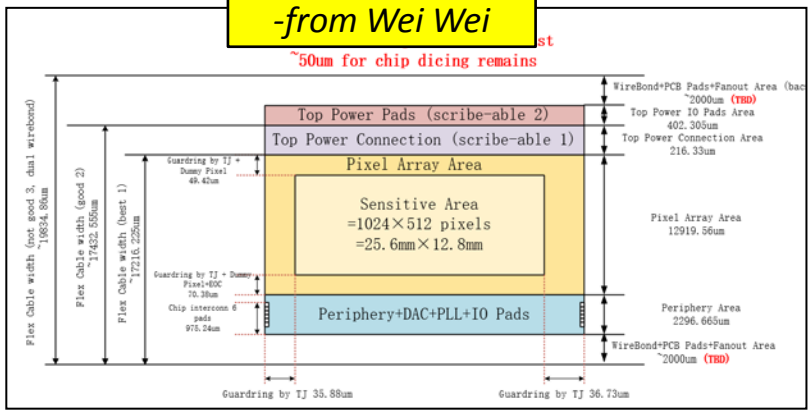
Ladder: support + sensors + FPCs, sensors and FPCs on doubled sided of the ladder.

The double sided Ladder (16.8 *x 272.9 mm) has 20 chips

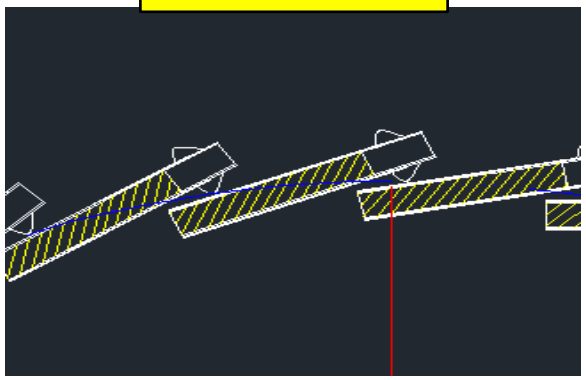




Chip size
-from Wei Wei



Overlapped area



Ladder Support (ladder-spt)

Different ladder support designs have been done and anylized.

Size: 272.9 x 16.8 x 2 mm (L x W x H).

Material: CFRP, surface thickness is 0.15 mm*, 3 layers , 0-90-0. *(as the result of analysis of the stacking design of the CFRP and optimization).*

Preferred design

The other optional design:

The same overall dimensions as the preferred design.

PMI foam strips (or fully stuffed) inside.

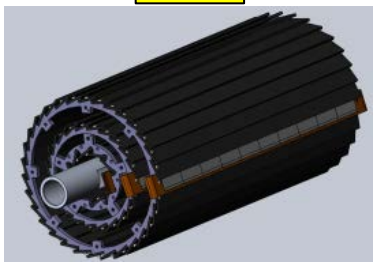
Optional scheme

The result of static analysis shows that the stiffness of the optional design is smaller than that of the preferred design under the same mass and load and the same boundary condition.

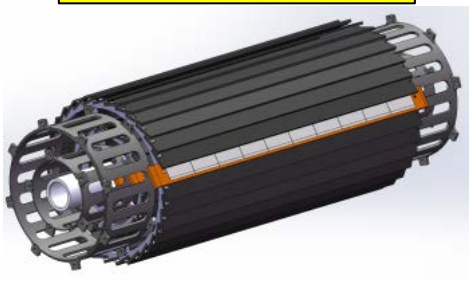
Design scheme	Mass (g)	Def. Self weight+ given load (μm)
√Preferred design	2.56	4.1
×Option	2.55	7.6

The Mechanical Support of VTX Prototype

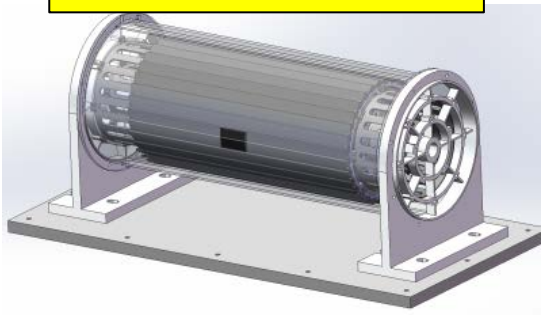
VTX



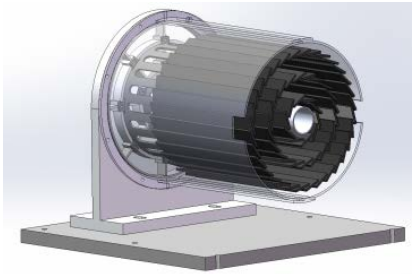
VTX + connecting flange



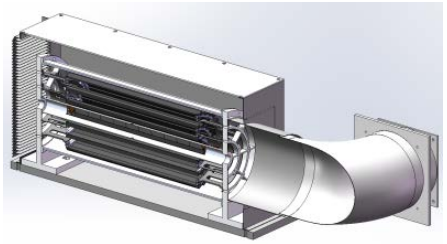
The assembly of VTX and support



- Optional materials and manufacturers were investigated.
- Fabrication of some trail parts (e.g. the side ring) which are tentatively made of composite will start.



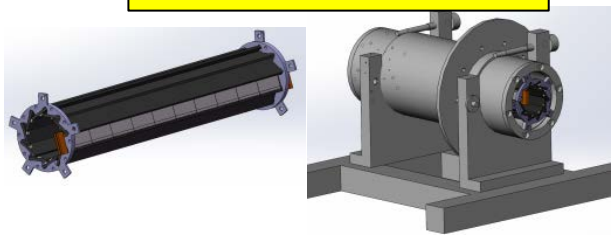
For the VTX prototype, the design of barrels with two halves assembled is also being considered.



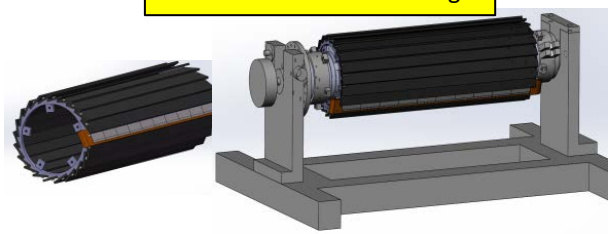
Tooling Design for Barrels Assembling

- 3 sets of tooling for barrel assembling.
- tooling and special tool for inner and middle barrels assembling.

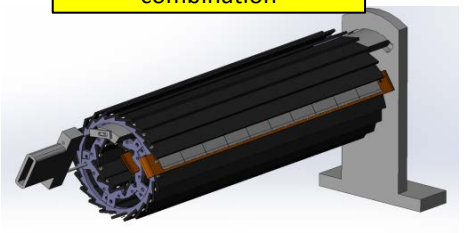
Inner barrel and tooling



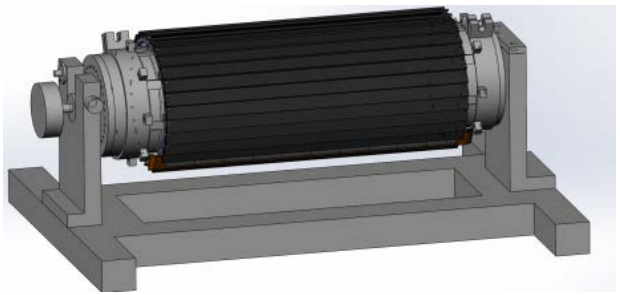
Middle barrel and tooling

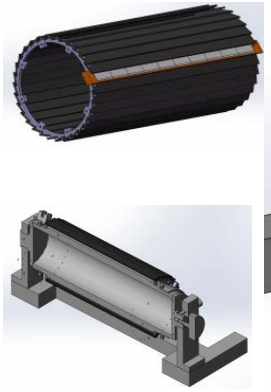


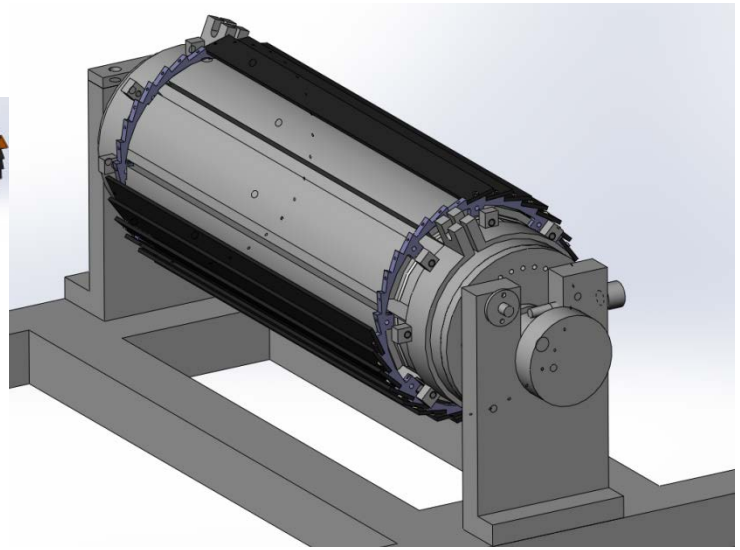
Inner and middle barrels combination



Outer barrel tooling

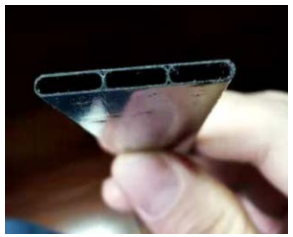


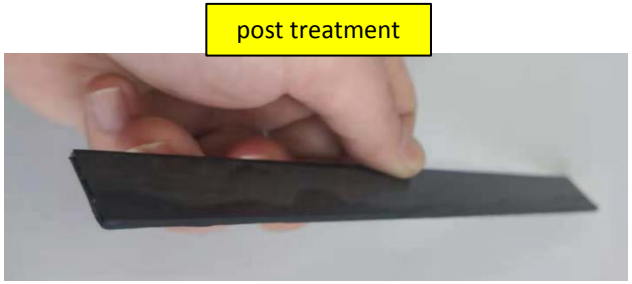




Ladder Support Prototype

The trail production of the ladder support prototype are being conducted for process validation:

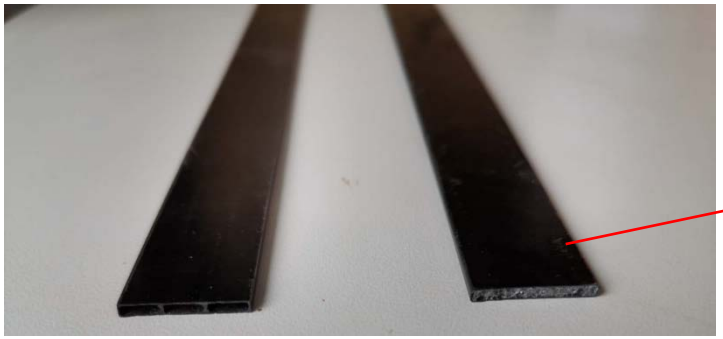


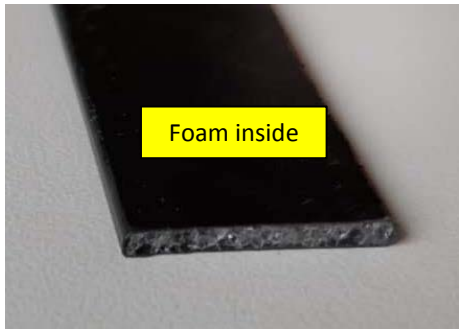


Section 16.8x2 mm, about 180 mm long (not full length）, thickness 0.12 mm.

The design has been validated to be feasible.

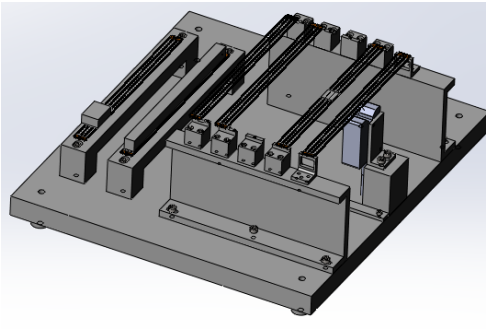
Besides, we also plan to produce samples of the optional scheme with foam inside for comparison and test. Also the trial fabrication for process validation has been done.



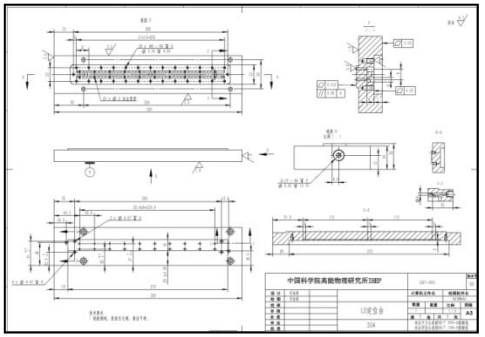


Design of Test Platforms

Most of the ladder prototype (and VTX) test related items have been considered.

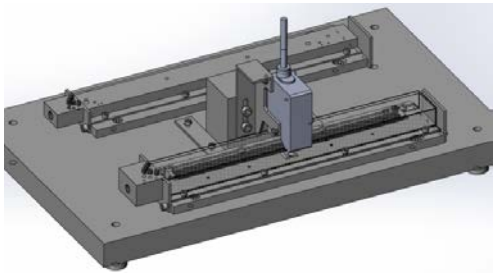


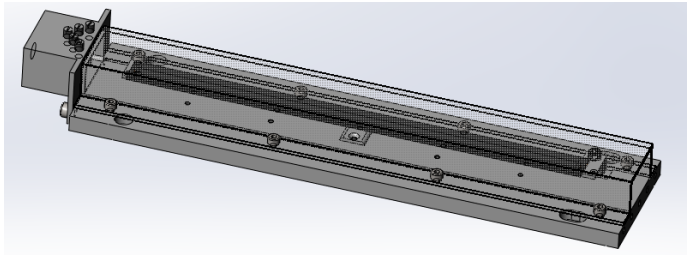
- Design of platforms and tooling for different test.
  - Static (different support and load cases)
  - Vibration and cooling + pressed air (different cases)
  - Vacuum test - for surface check of ladder support and ladder and procedure training (i.e. module fixation).

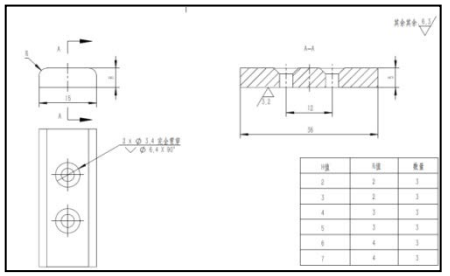


- Auxiliary tools and instruments for test have been investigated and purchased. To measure or control :

  Deformation, temperature, air speed, flow rate, etc.







Next

- Fabricate the Ladder support prototype. *The first batch of ladder support prototype will be available soon.*
- Test the bare ladder support .

  (Besides that, more test of the “ladder” with dummy flex and dummy sensor can also be done once they are ready)
- Finalize the design of overall support and tooling and finish the engineering drawings (Aug.).
- Fabricate all the mechanical support of the VTX prototype (Nov.).