

Mechanical design of the VTXD prototype

Jinyu Fu

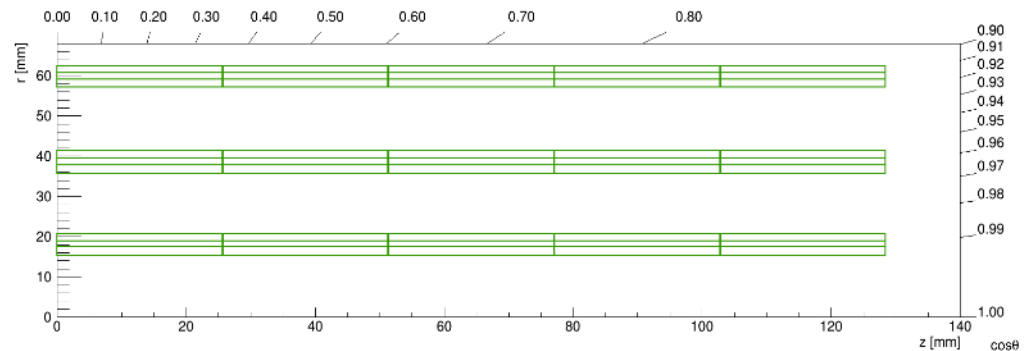
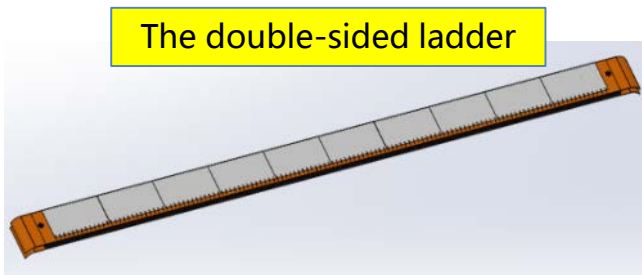
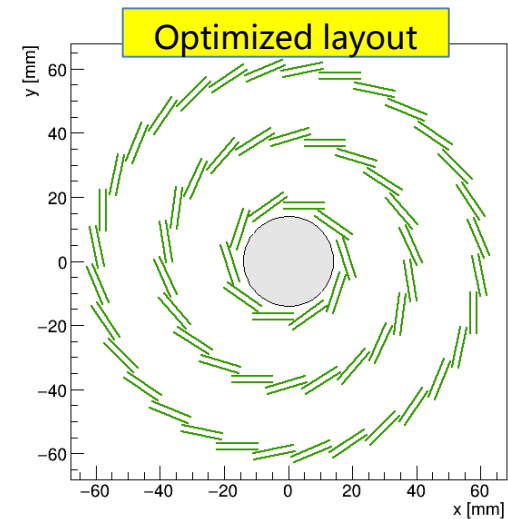
2023-4-1

The 2022 CEPC MDI workshop

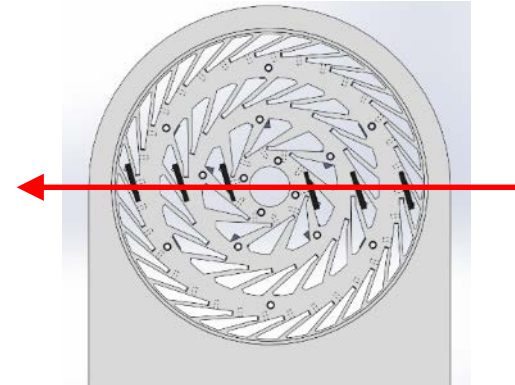
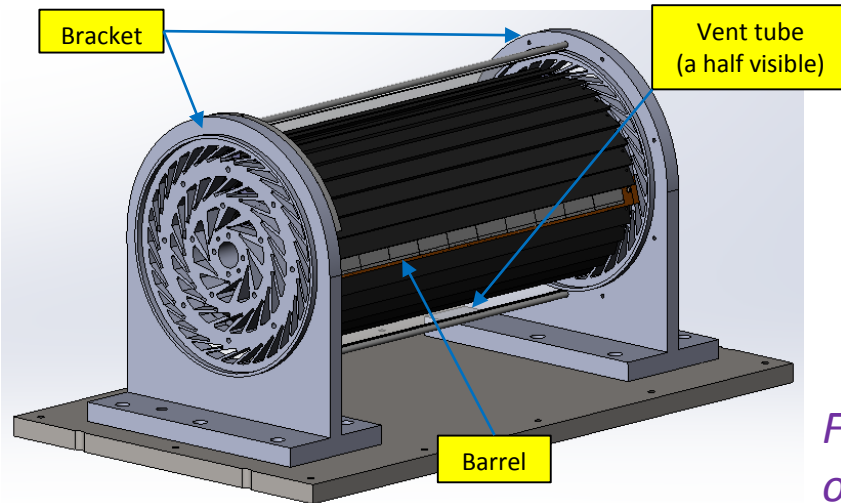
The CEPC VTXD layout

Design parameters of the optimized CEPC vertex detector

	R (mm)	z (mm)	Number of ladders	Number of chips
Layer 1	16	125.0	10	200
Layer 2	18	125.0		
Layer 3	37	125.0	22	440
Layer 4	39	125.0		
Layer 5	58	125.0	32	640
Layer 6	60	125.0		



Mechanical design of the VTXD prototype

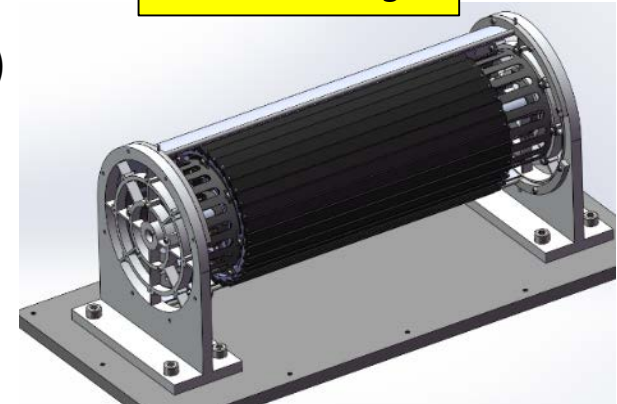


For beam test: 6 ladders are mounted on one line (others are bare ladder support).

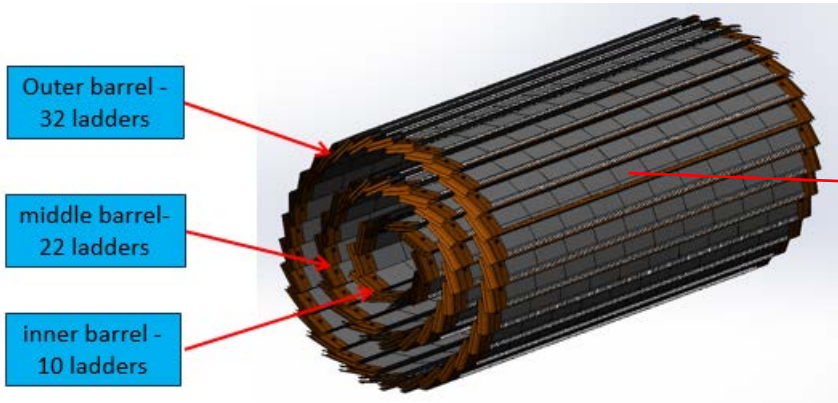
Compared with previous design:

- No connecting flanges (shorten flex)
- New bracket (solve the key issue - flex routing)
- Ladders of the innermost barrel are also mounted from outside of the side rings.
- Ladder size (slightly adjusted)
- New tooling required

Previous design

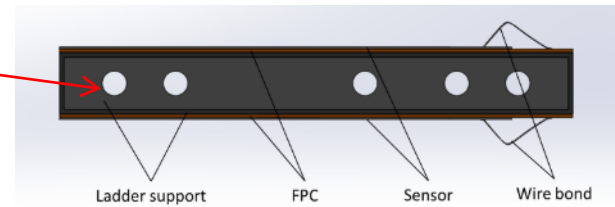
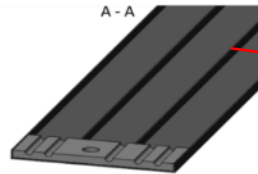
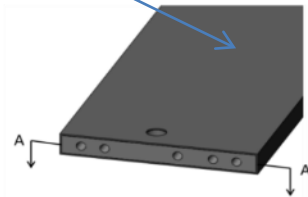
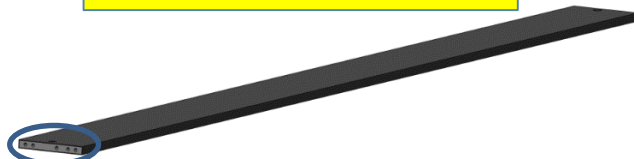
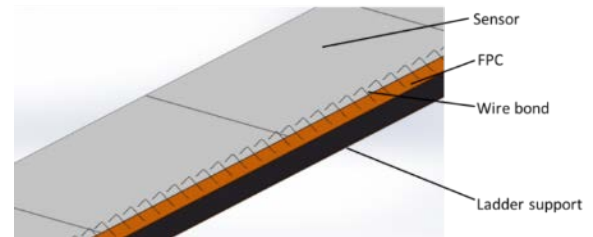
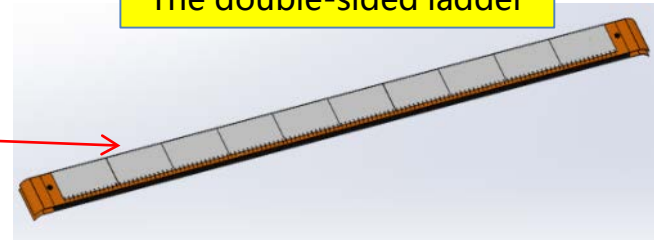


VTXD barrel



Ladder support structure (CFRP)

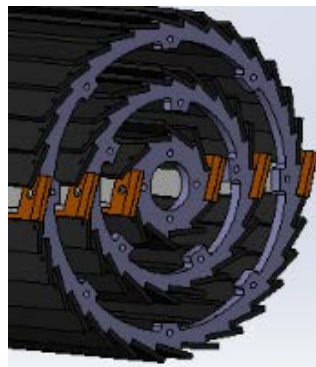
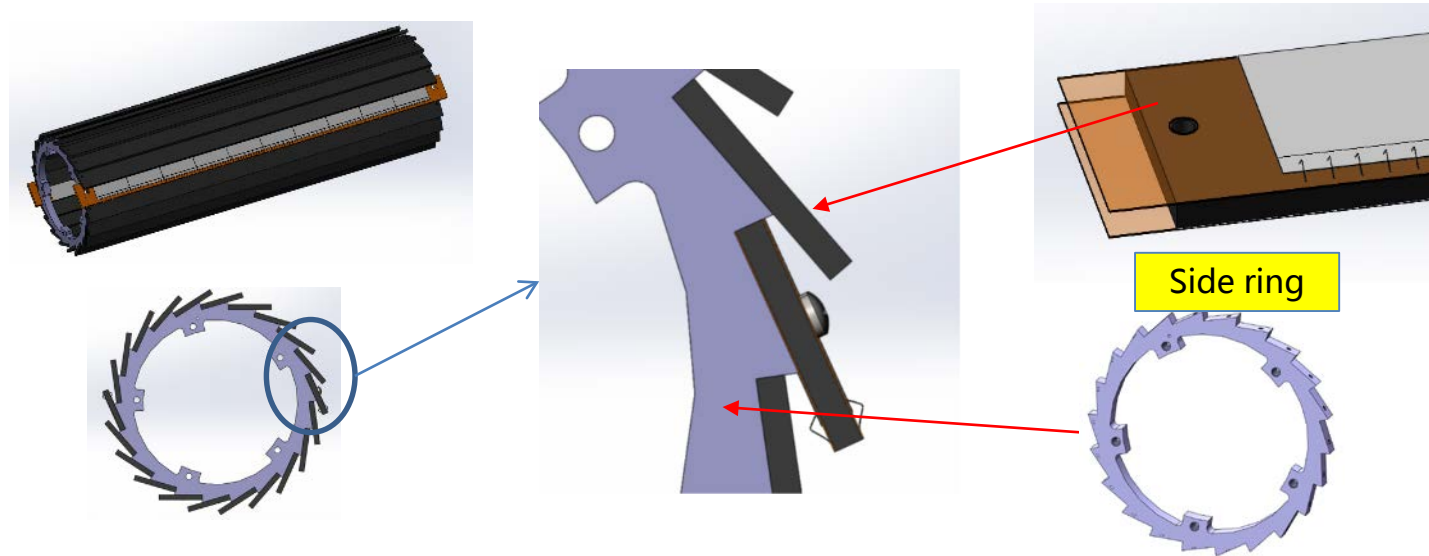
The double-sided ladder



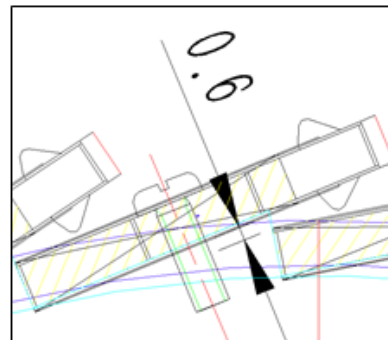
Material [⊖]	Thickness (μm) [⊖]	Radiation length [⊖] X_0 [⊖]
CFRP support [⊖]	145 [⊖]	0.051% [⊖]

Ladder fixation on barrel

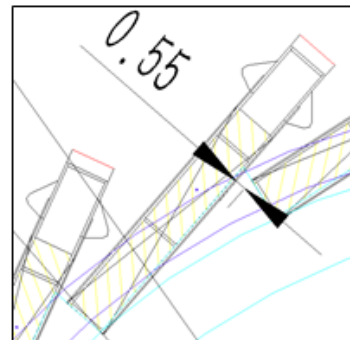
sides constraint/alignment + screw tighten



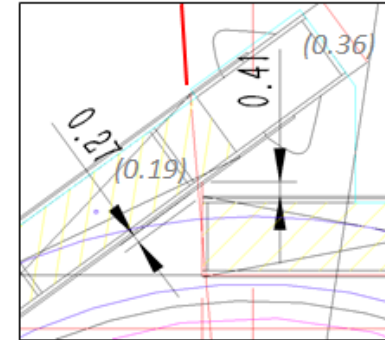
Outer barrel



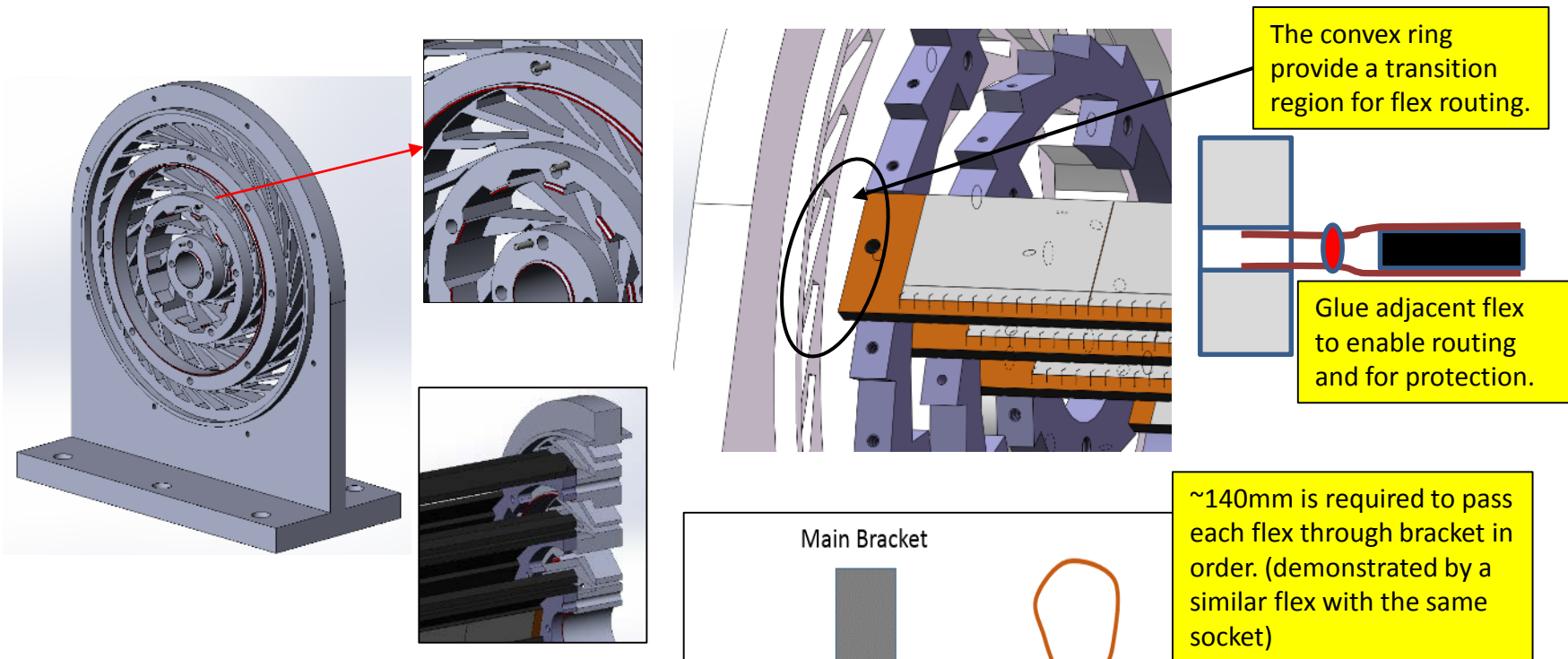
Middle barrel



Inner barrel

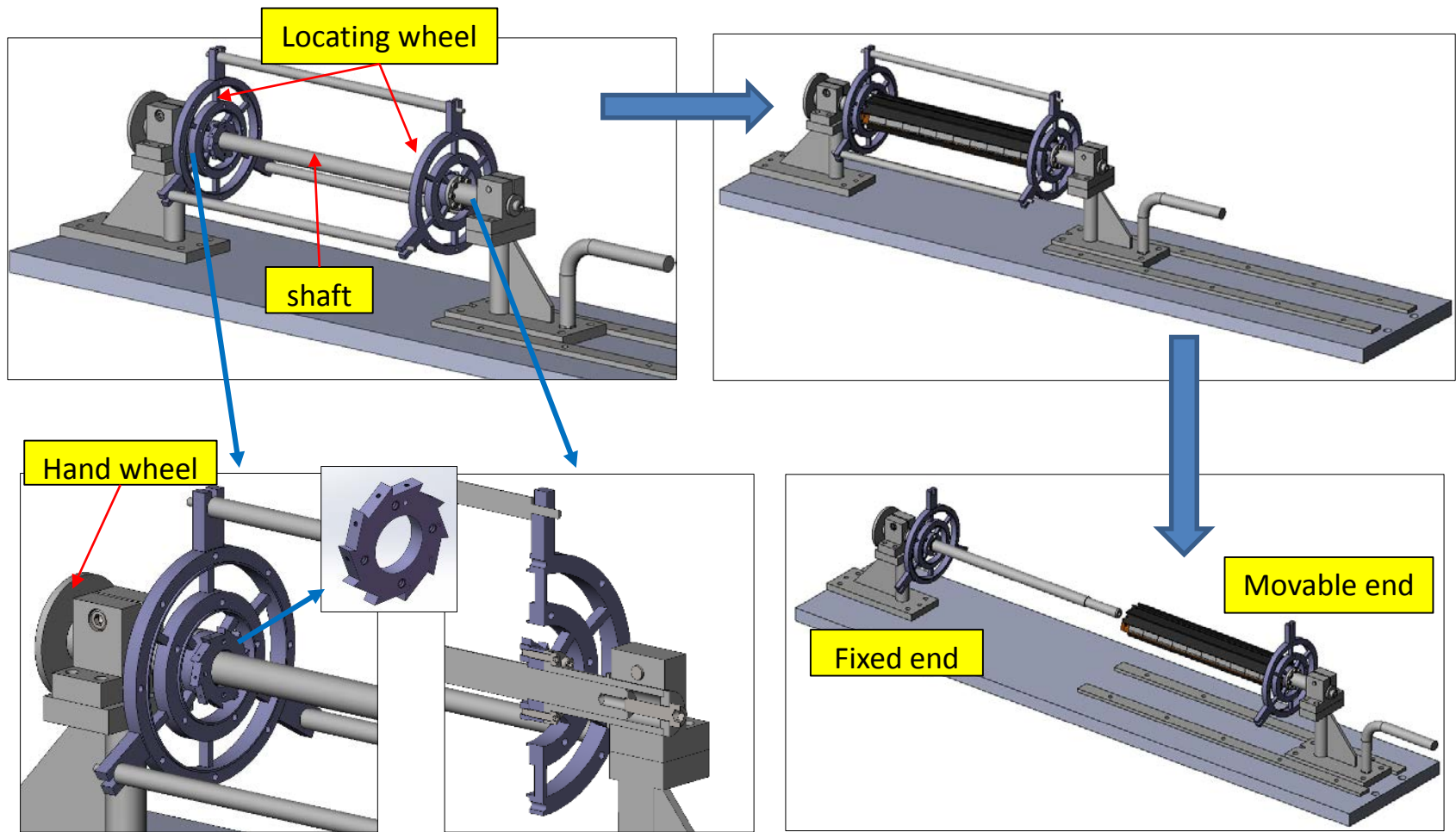


Barrels fixation on the brackets

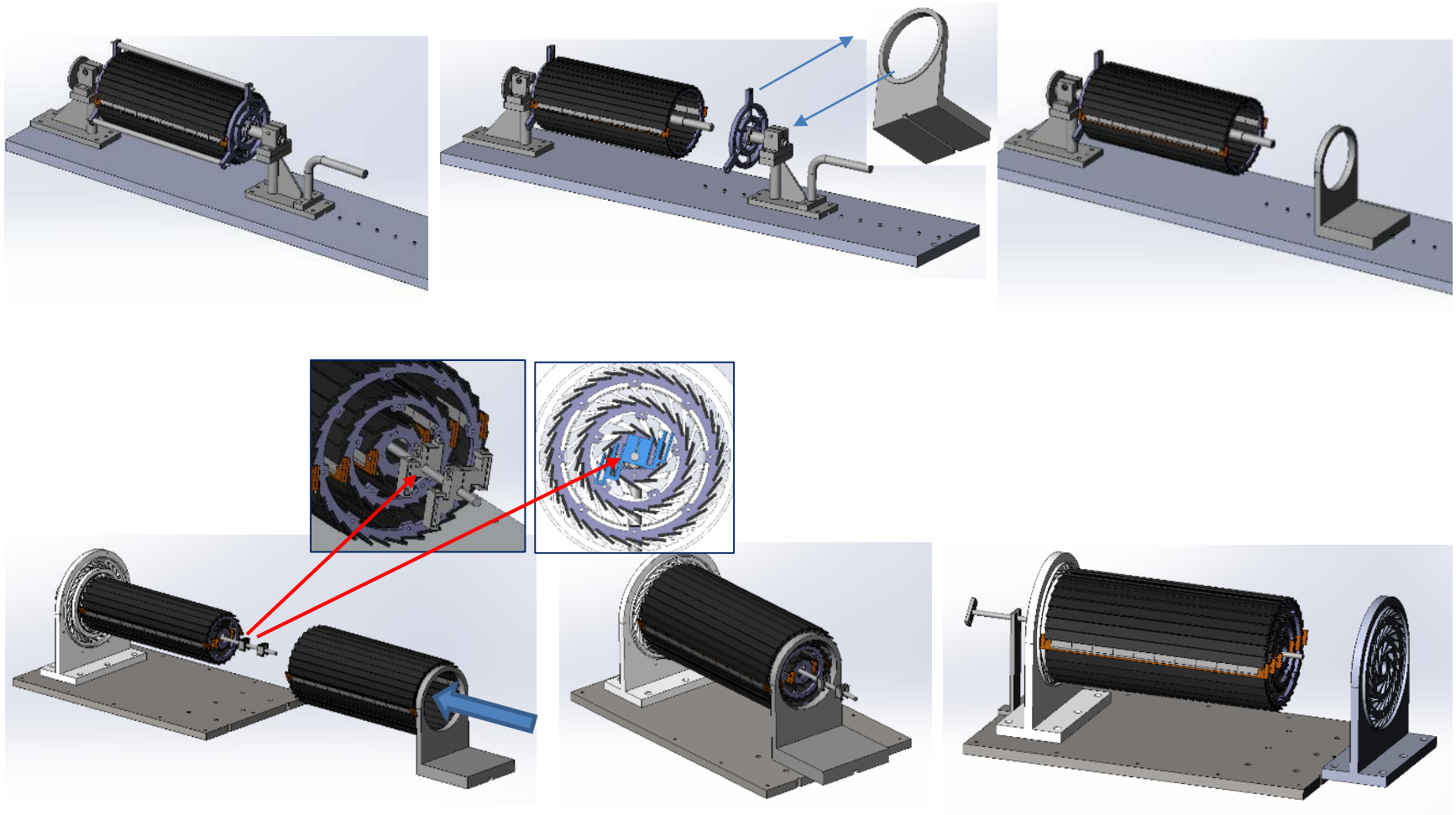


Barrels (side ring) are located on the main bracket by: ring + pin

Tooling design for VTXD assembly

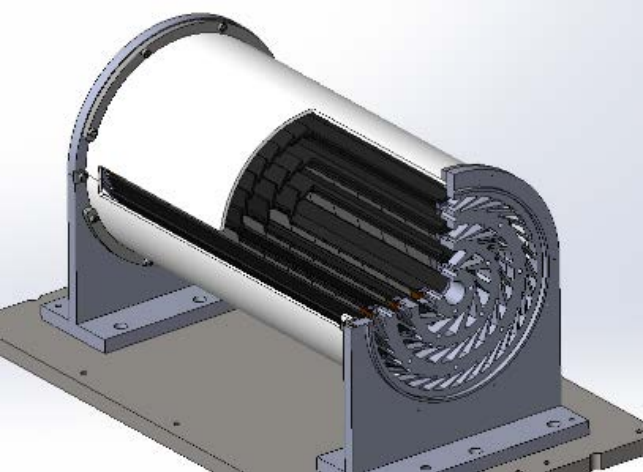


Tooling design for VTXD assembly

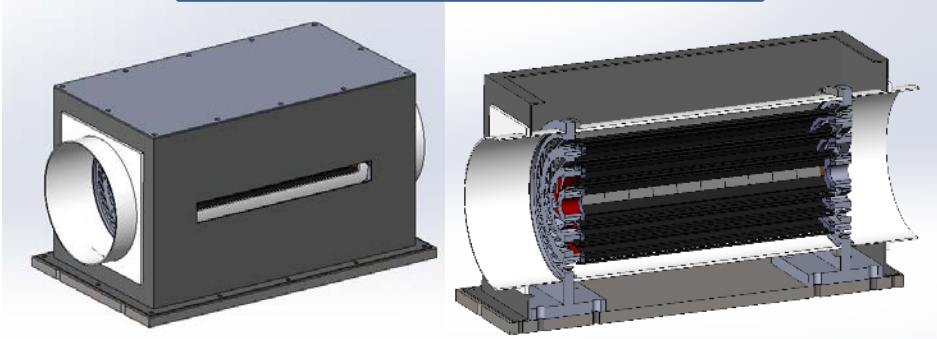


General structure of the VTXD prototype

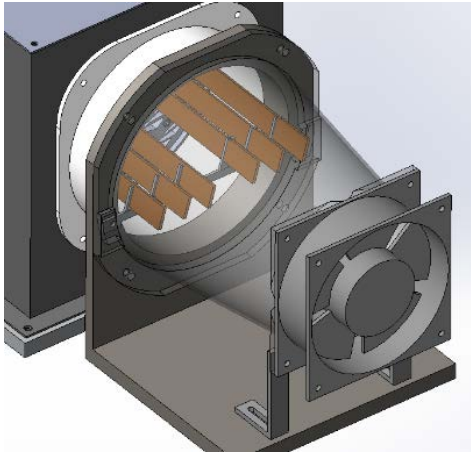
VTXD assembly



VTXD box (vent, protection, vibration-isolated)

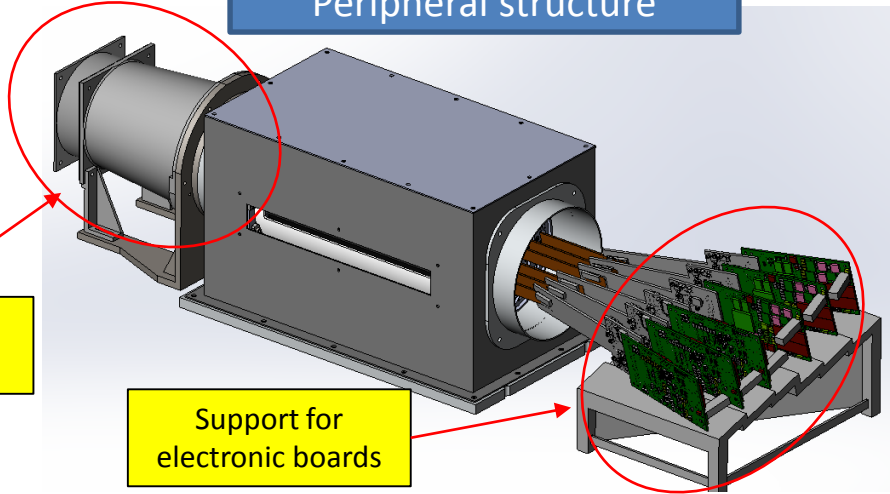


Peripheral structure



Cooling fan and duct

Support for electronic boards

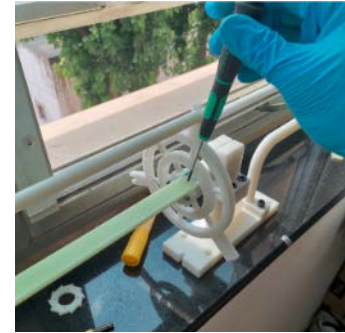


Mockup - barrel assembly

The mockups of the support structure and tooling were made.

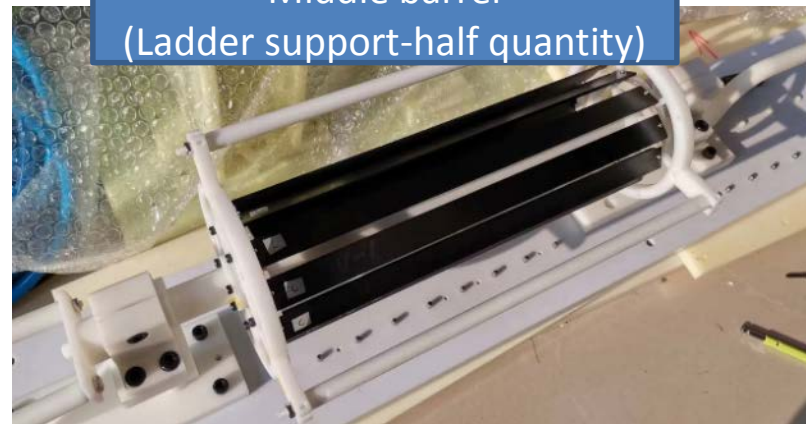
Trial assembly and installation verified:

- Operation space of ladder installation on the tooling
- Tooling assembly process
- Barrels assembly process



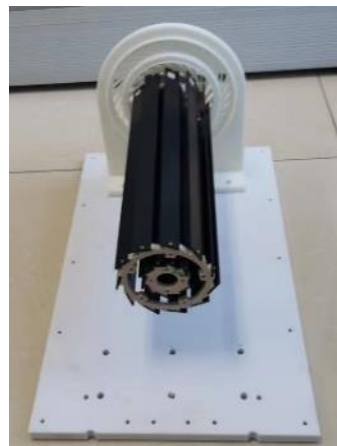
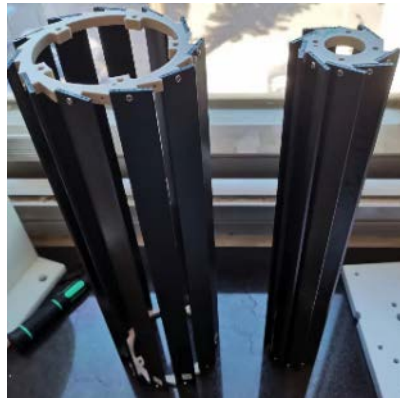
Middle barrel
(Ladder support-half quantity)

Inner barrel



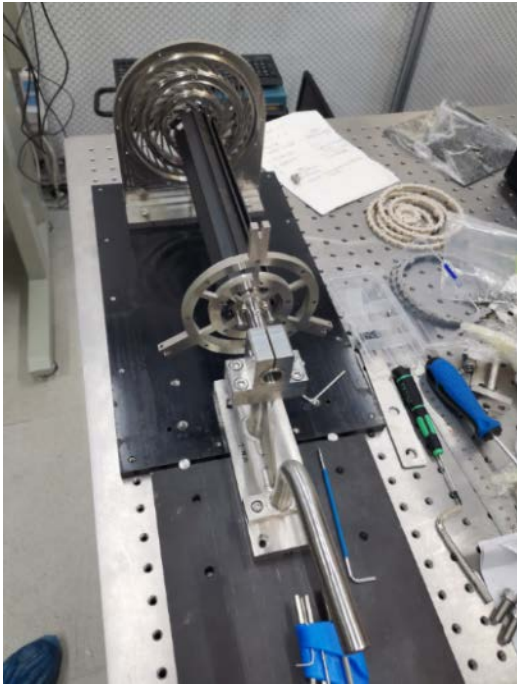
Mockup - Barrels on the main brackets

The installation of the barrels on the main support brackets were demonstrated.

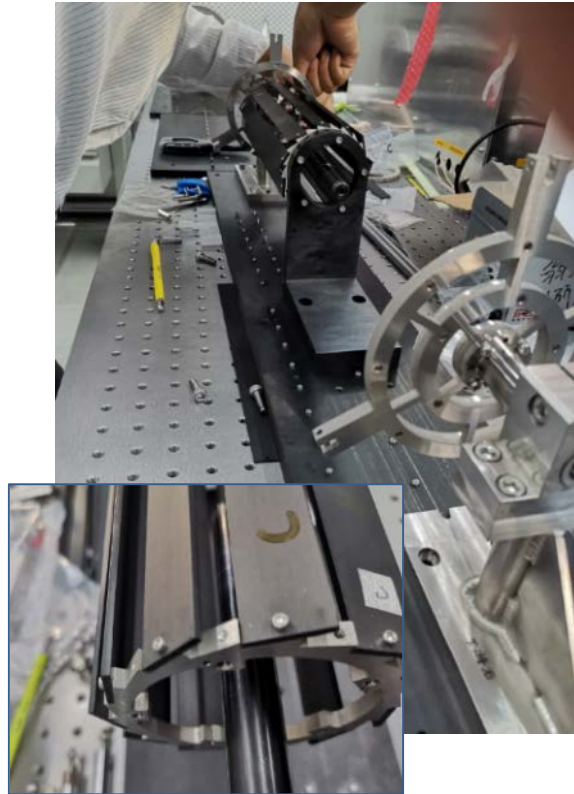


Prototype - barrels assembly

Inner barrel



Middle barrel
(half number of ladders)

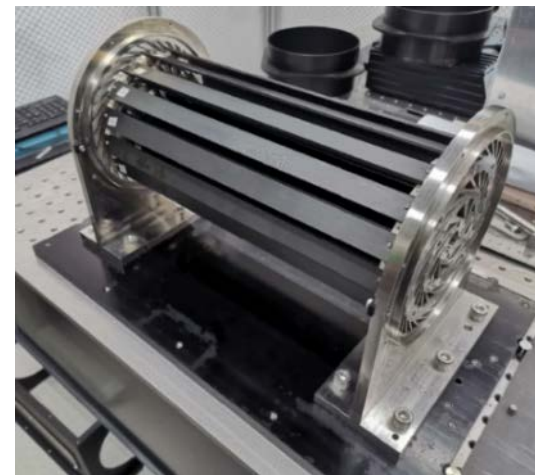


Outer barrel
(half number of ladders)



Prototype - barrels installation

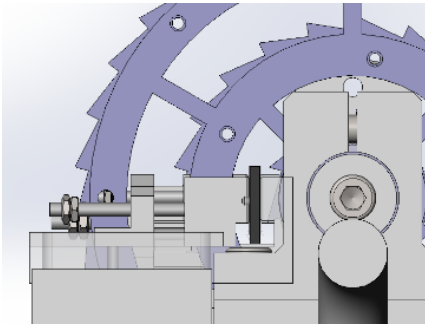
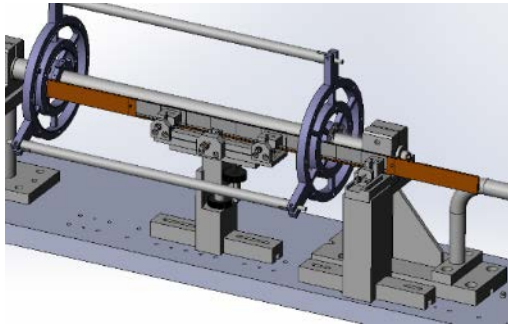
The installation of the real parts was very smooth, all three barrels can fit to the main bracket very well. (Half of the total ladders were mounted)



Tooling design for ladder loading

Two assemblies were designed for ladder installation on barrel.

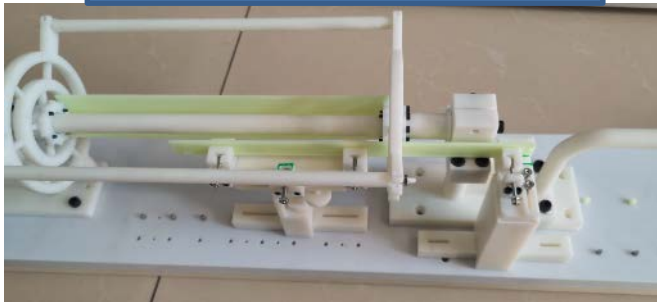
(Allow ladders to move in 3 axial directions and rotate along the longitudinal direction)



Parts of the mockups V1

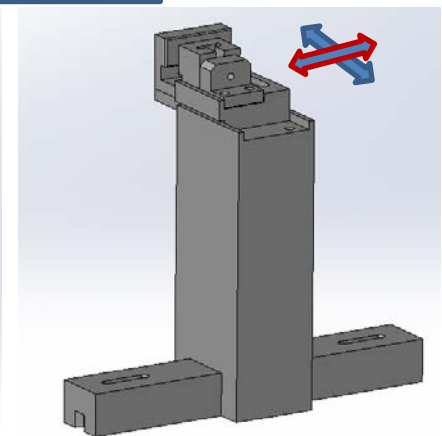
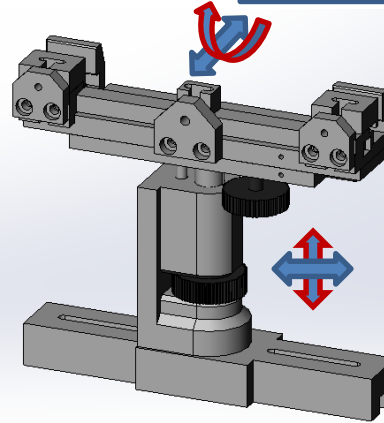


Trial use of the mockup V1



Two version, to make the ladder move more stable also with higher adjusting space, optimized the first version.

Optimized design

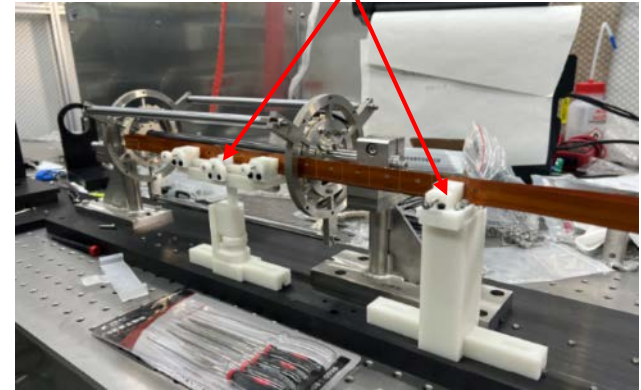


Tooling design for ladder loading

The formal jigs have been fabricated and tested with dummy ladder:

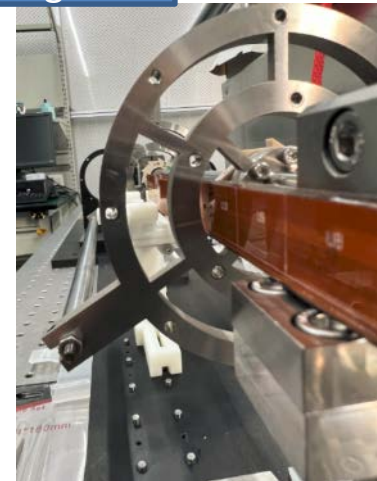
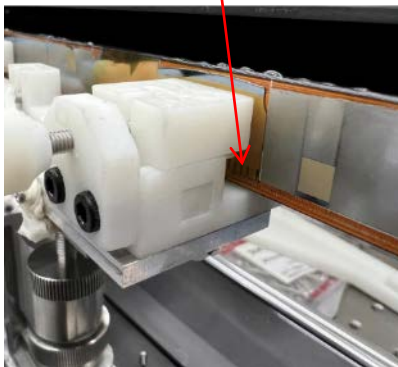
- the fixture and jig worked well
- the loading procedure is feasible.
- wire-boding is protected during ladder loading

Mockups V2

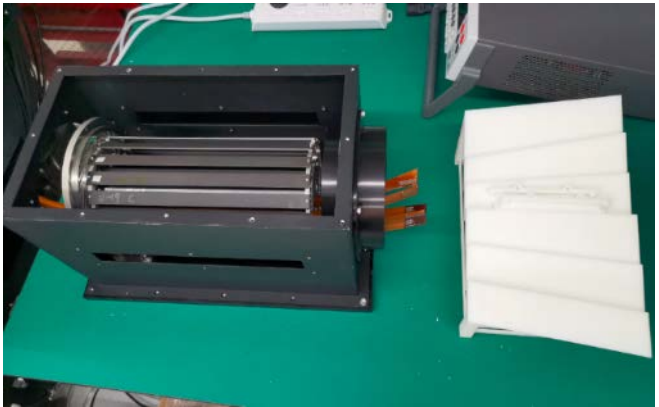
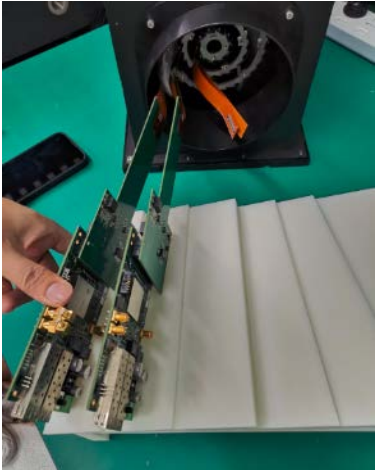
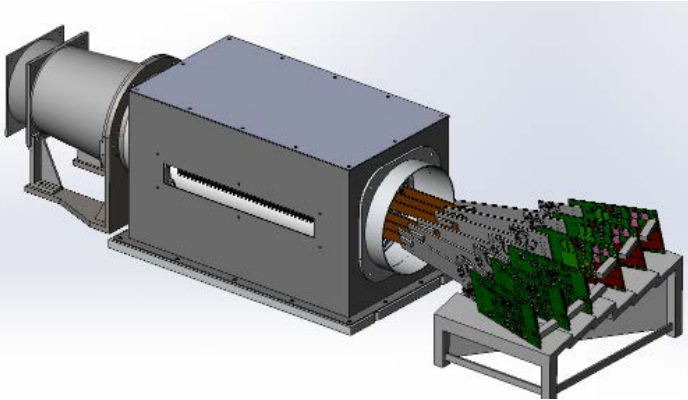


Formal parts - ladder loading test

Wire-bonding



Prototype - general



Summary

- The support structure of the VTXD prototype and necessary assembly tooling have been designed
- Mockups were made for some key parts to validate the design and verify related operation procedures
- Most parts of the general VTXD structure have been fabricated and assembled, only a few are being or will be assembled
- There are still some tests and research to be done

Thanks