Mechanical design of the vertex detector prototype

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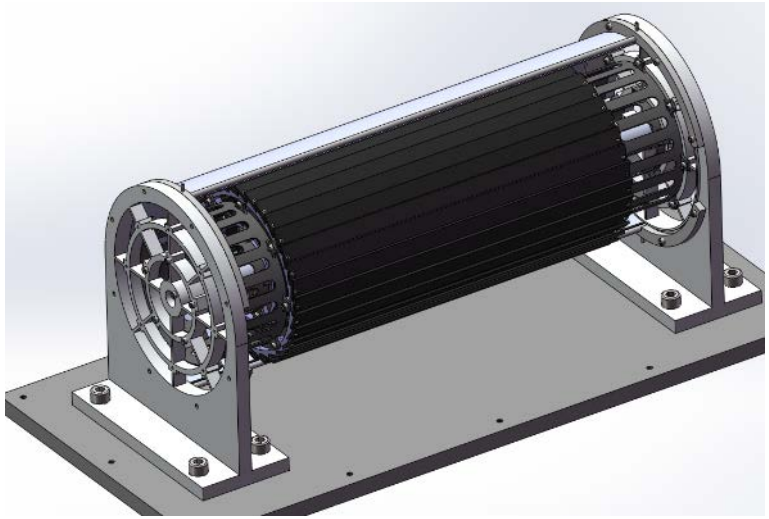
2022/4/13

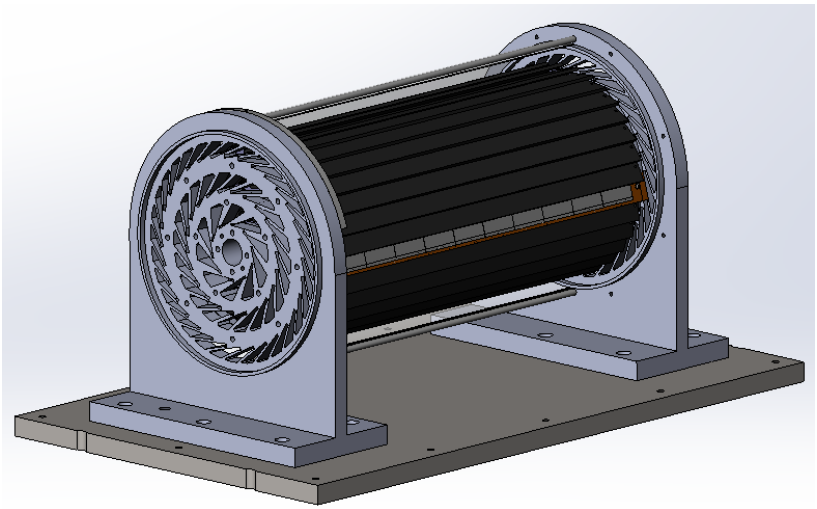
Mechanical design of the VTX prototype

The mechanical structure of the VTX prototype has been changed compared with the previous design after iterations with electronic (flex and sensor) design.

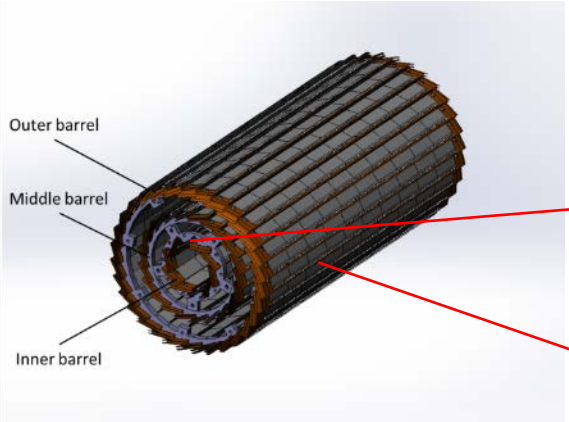
Previous structure



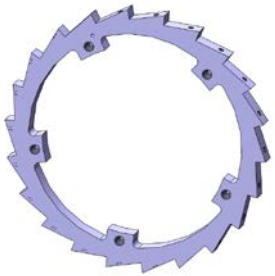
The updated structure



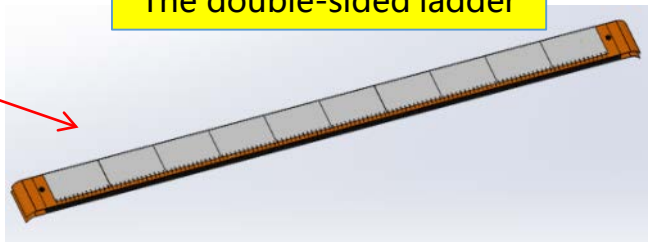
Main components of the VTX prototype



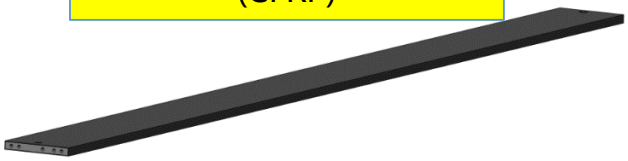
Side ring

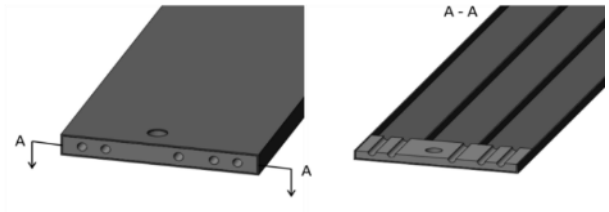


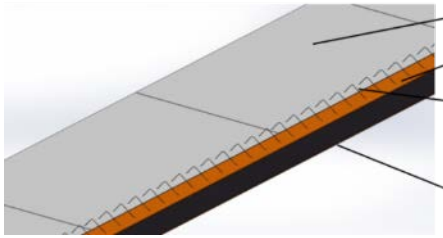
The double-sided ladder

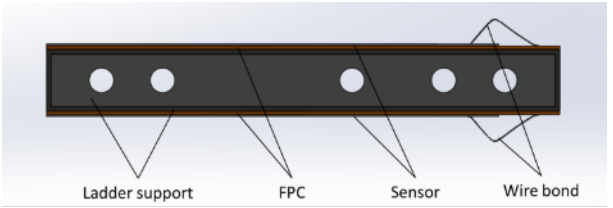


Ladder support structure (CFRP)



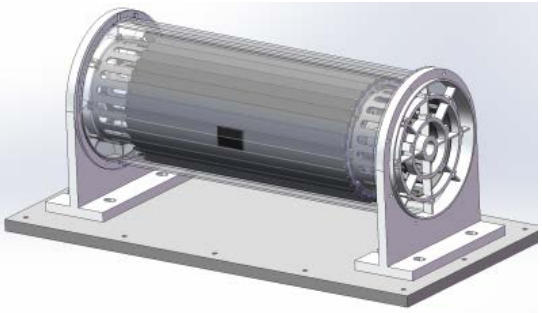




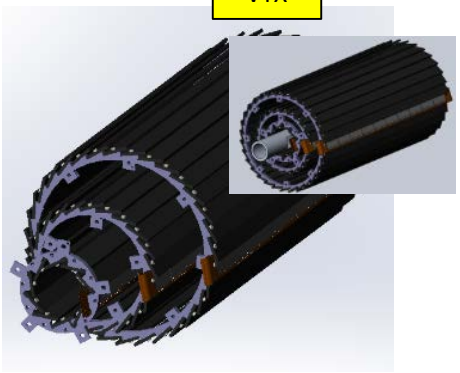


The previous structure and tooling

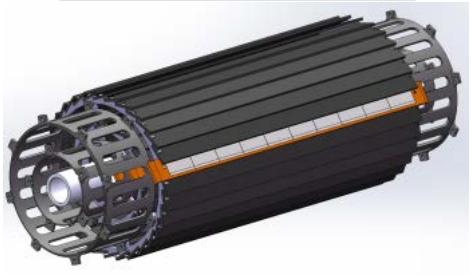
The assembly of VTX and support



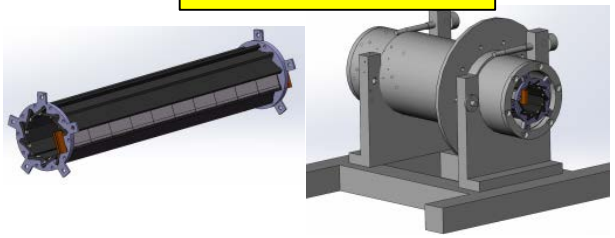
VTX



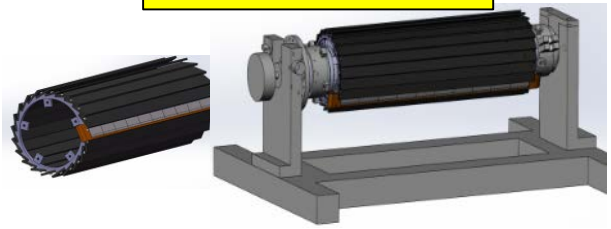
VTX + connecting flange



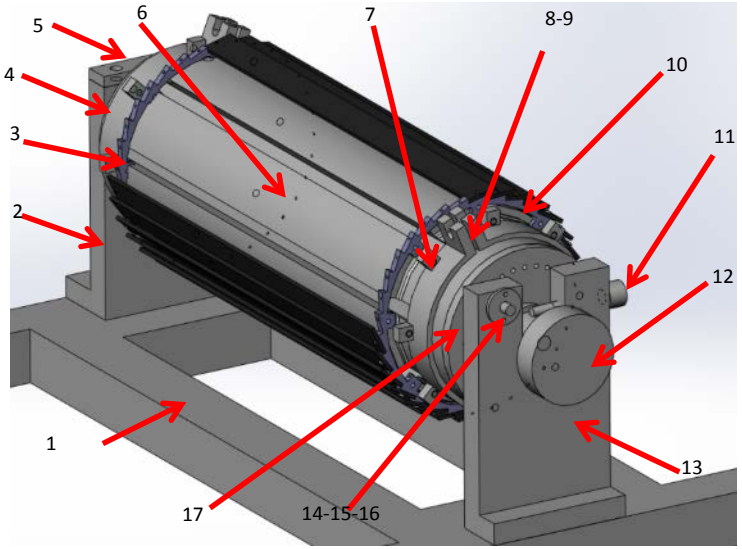
Inner barrel and tooling



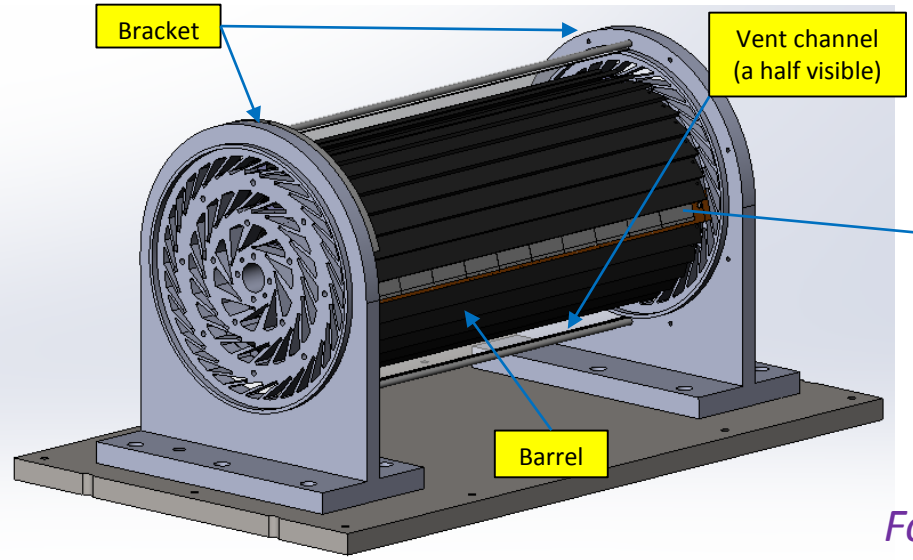
Middle barrel and tooling

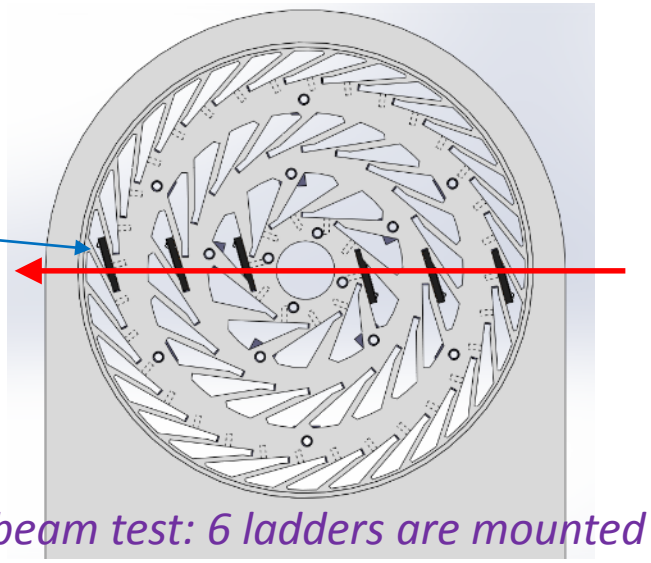


Outer barrel tooling



The updated VTX prototype

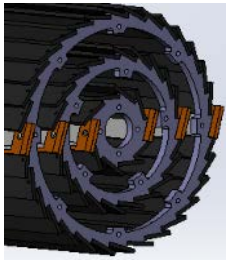




For beam test: 6 ladders are mounted on one line (others are bare ladder support).

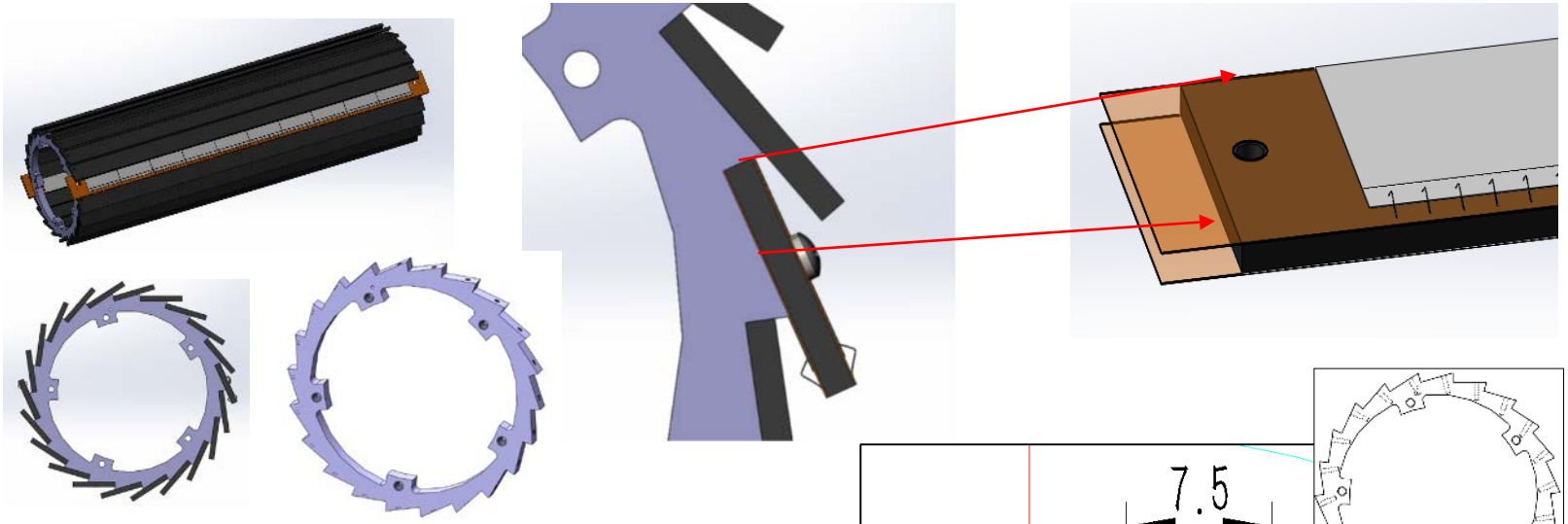
Differences compared with previous structure:

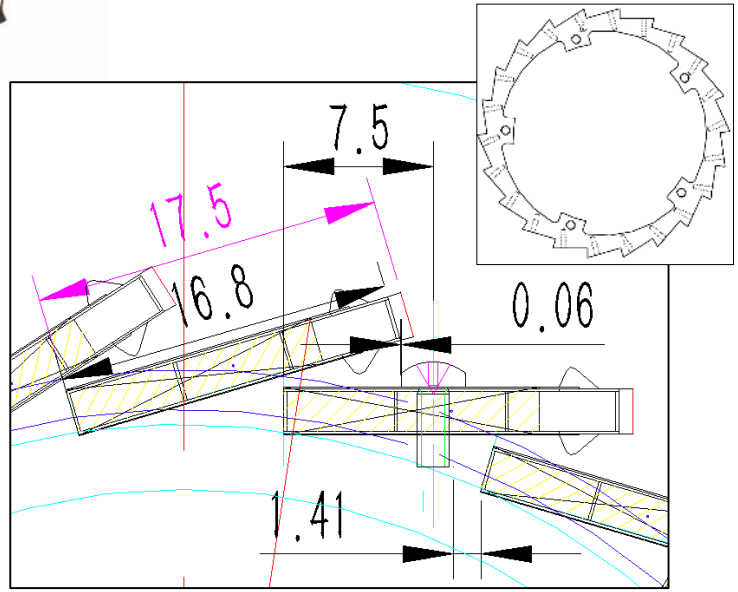
- No connecting flanges.
- For the innermost barrel, the ladders are also mounted from outside of the side rings.
- The flex for all ladders can pass through the brackets along the axial direction at both ends of the VTX almost without twist.



Ladder fixation on barrel

Edge constraint/alignment + screw tighten

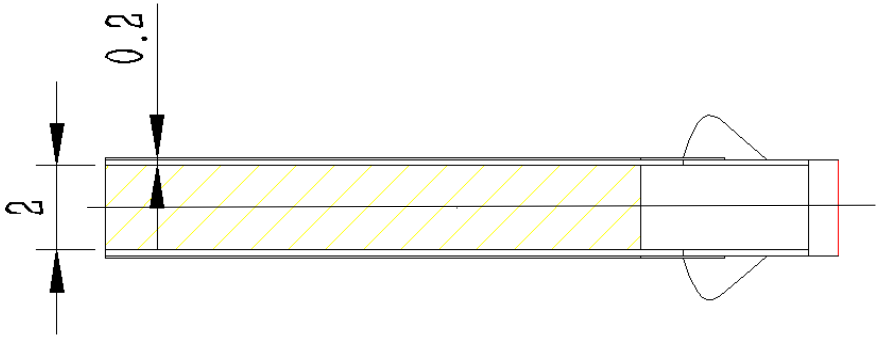




For the *middle barrel*, if all ladders are 17.5 mm wide:

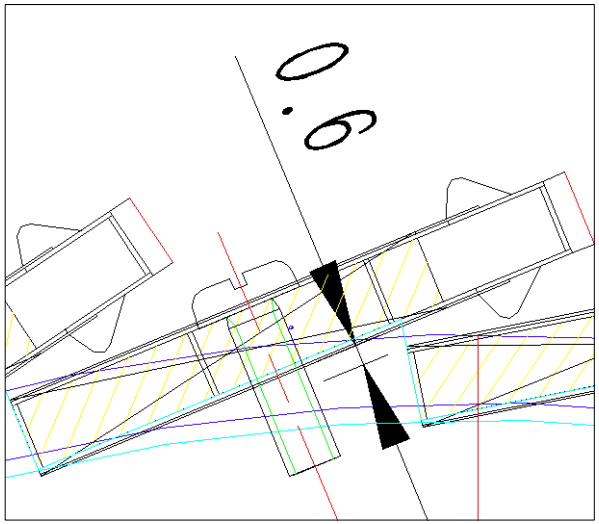
- mounted in order
- leave the last one not installed

Gaps between adjacent overlapped ladders

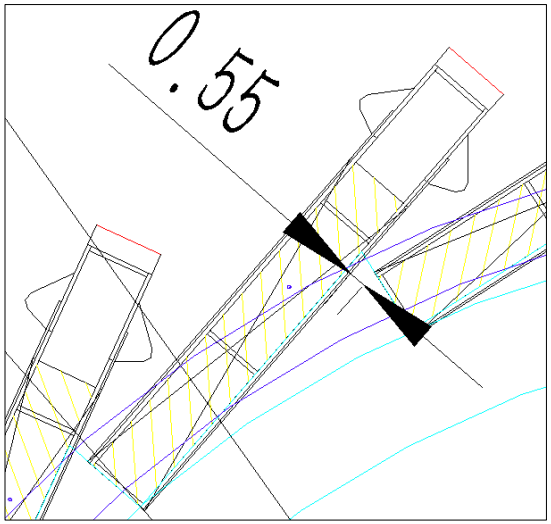


0.02+0.11+0.02+0.05 *(0.1)*=0.2 *(0.25)*

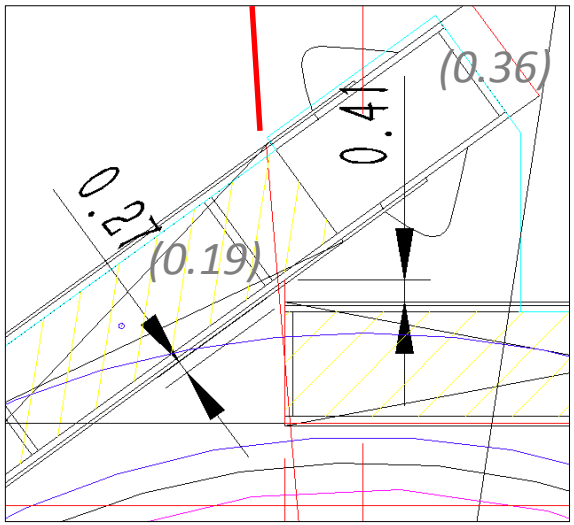
Outer barrel



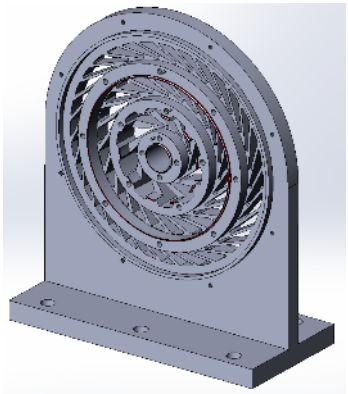
Middle barrel



Inner barrel



Structure details related to ladder and flex



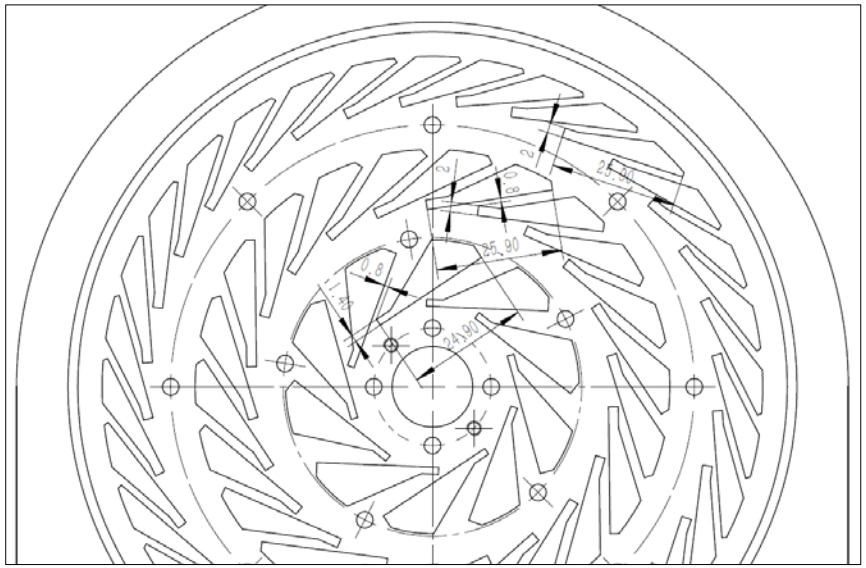
Flex end with socket

Socket: 21.5 mm(L) x 3 mm (w)x 1.5 mm (t)

Thickness of the Flex + metal pad under the socket(T):

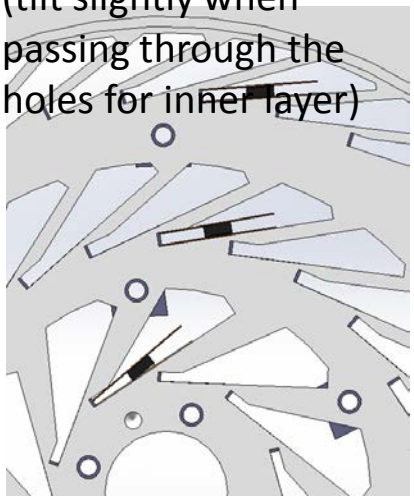
0.2 mm (*Max up to 0.3 is feasible*)

Total length of flex: (~140)+272.9+(~140) = 553 mm (related to the length of the metal pad)



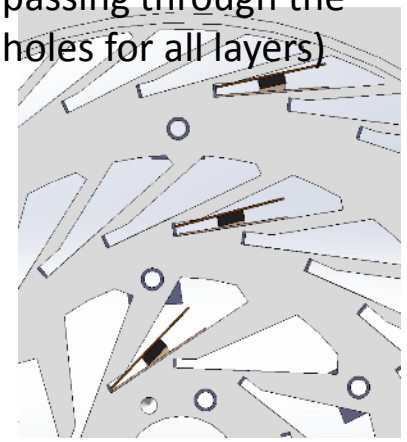
T=0.2

height required 1.9 mm (tilt slightly when passing through the holes for inner layer)



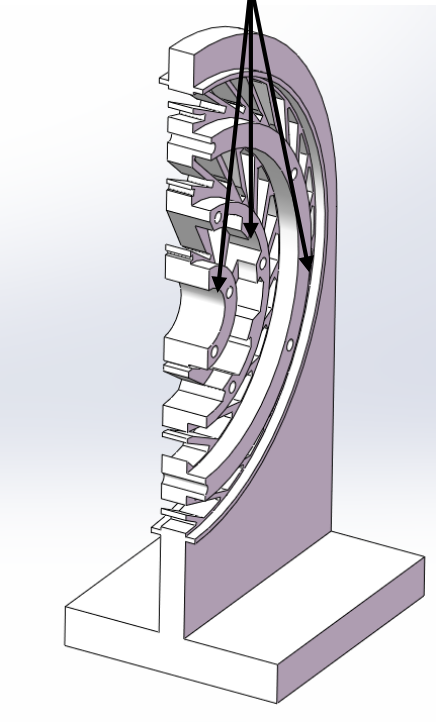
T=0.3

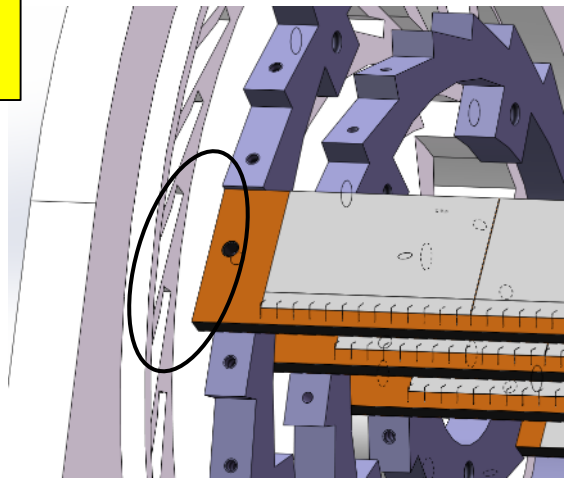
height required 2.1 mm (tilt slightly when passing through the holes for all layers)

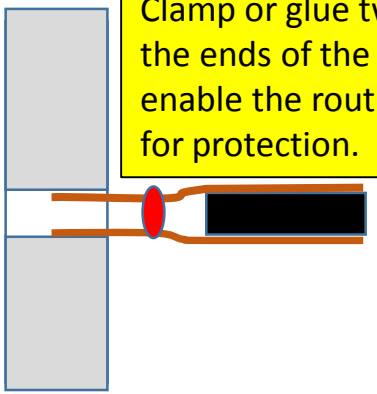


Structure details related to ladder and flex

These rings provide a transition region for flex routing.

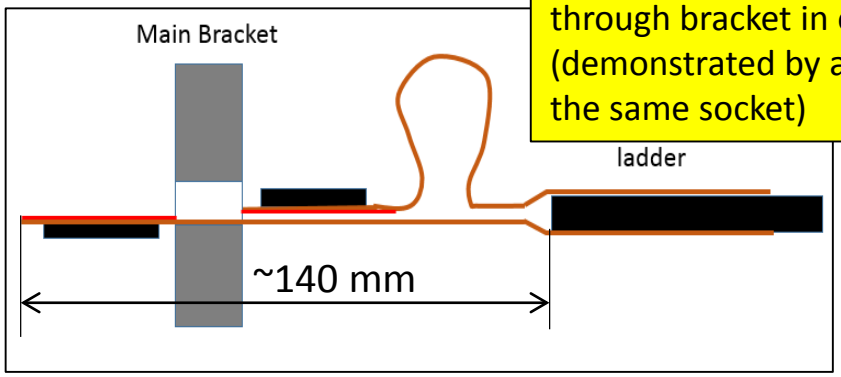




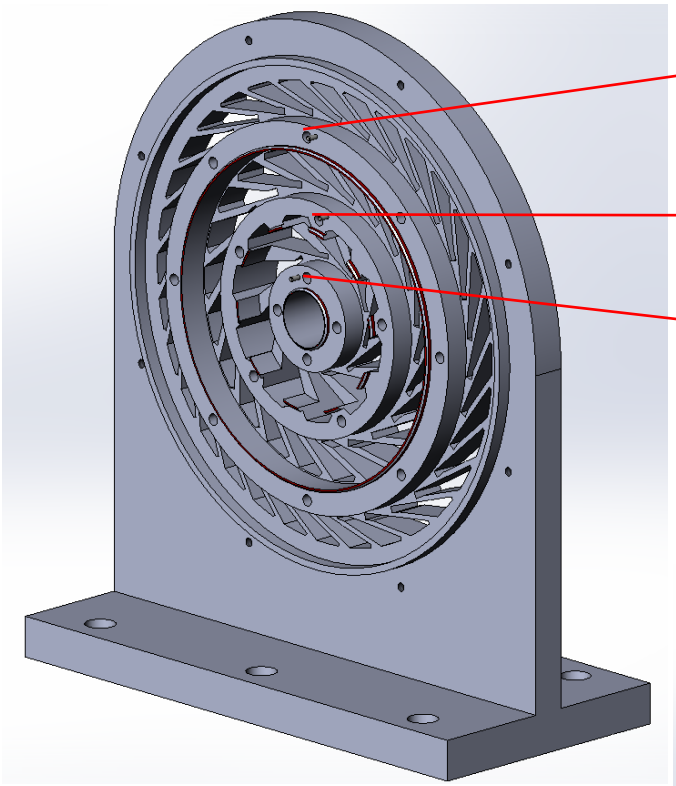


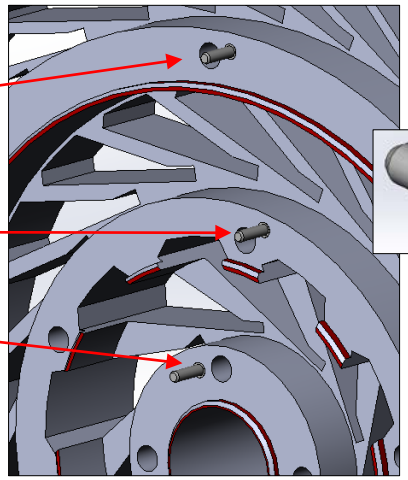
Clamp or glue two flex at the ends of the ladder to enable the routing and for protection.

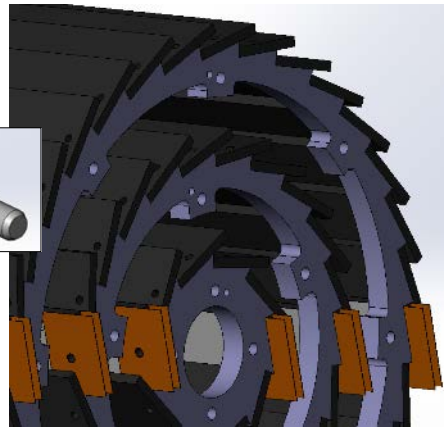
~140mm is required to pass each flex through bracket in order. (demonstrated by a similar flex with the same socket)



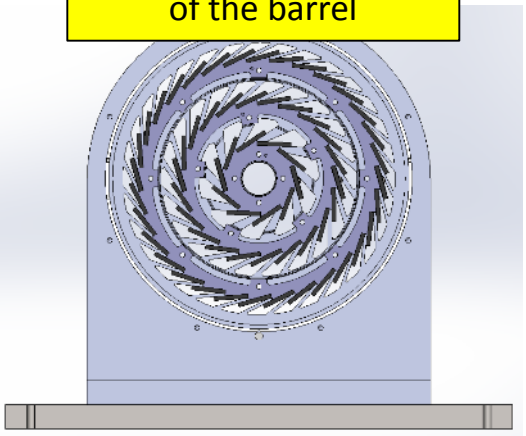
Barrels fixation on the brackets

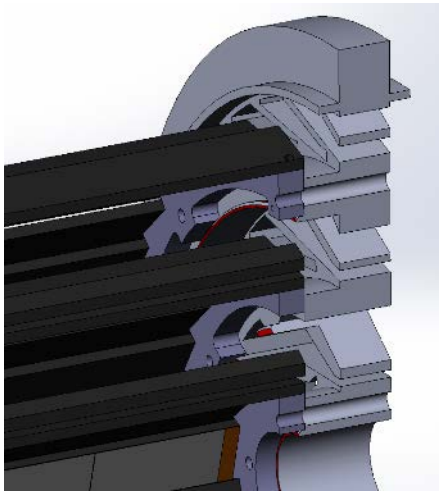






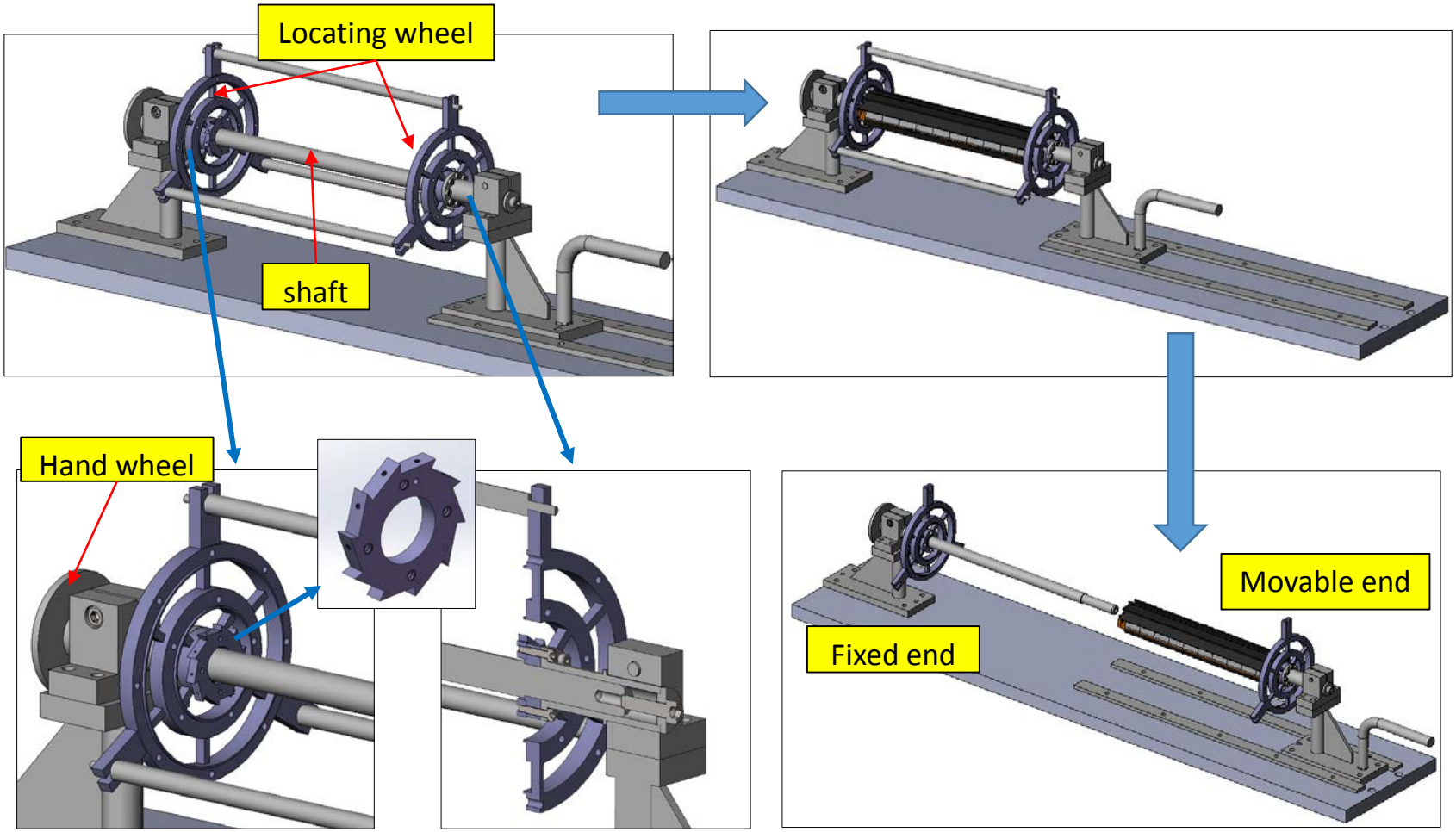
Cut view from middle of the barrel



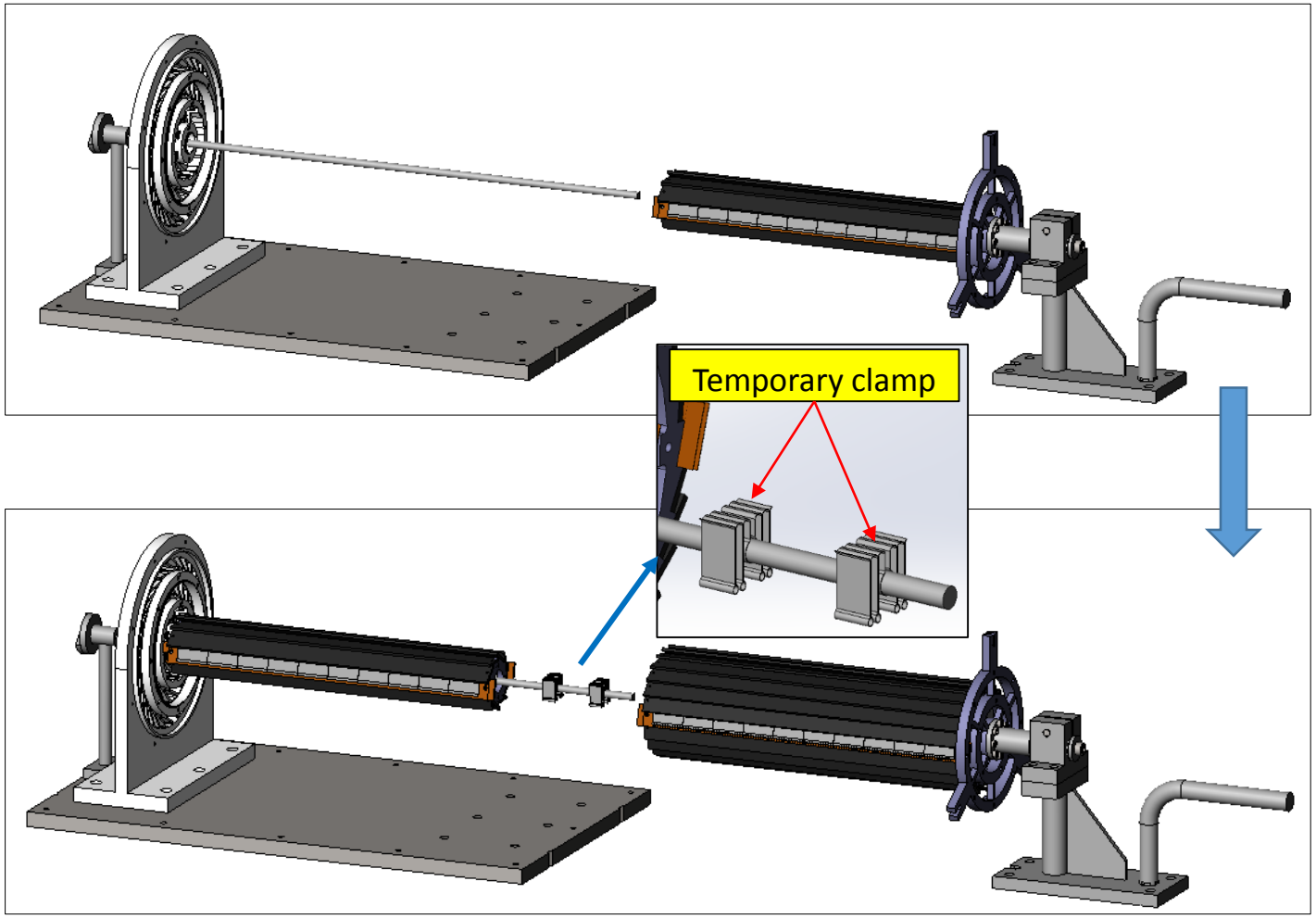


Barrels (side ring) are located on the main bracket by: ring + pin

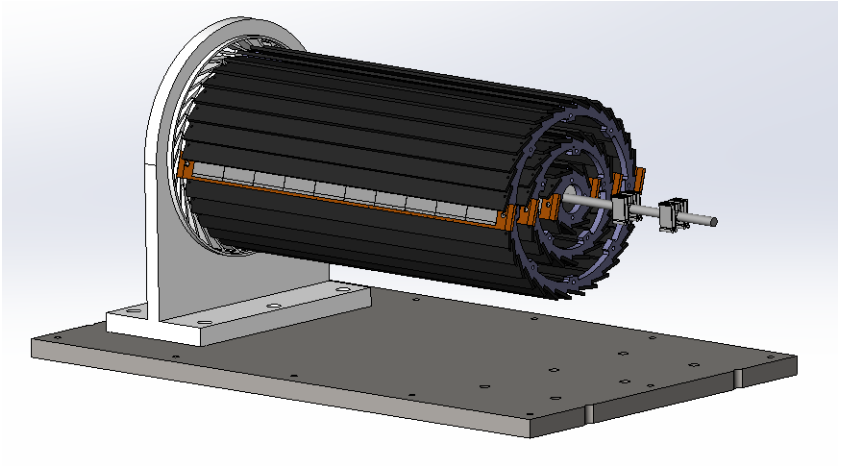
Tooling for barrels assembly

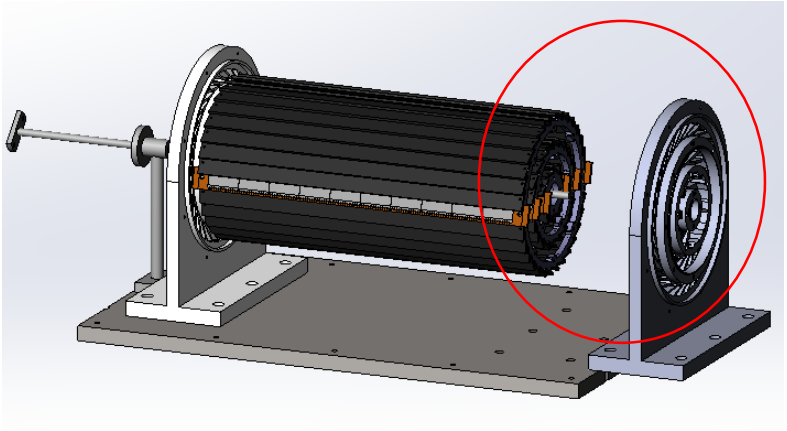


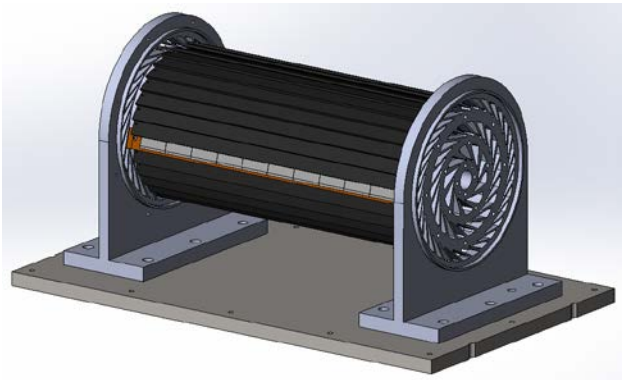
Barrel installation

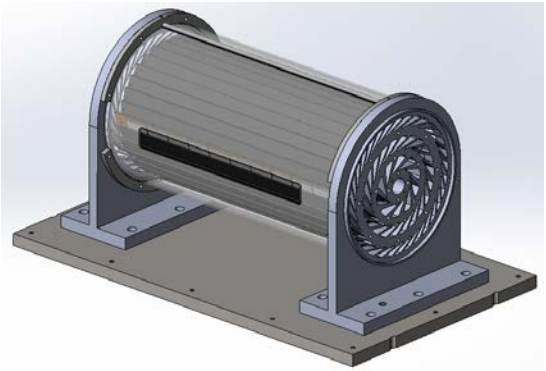


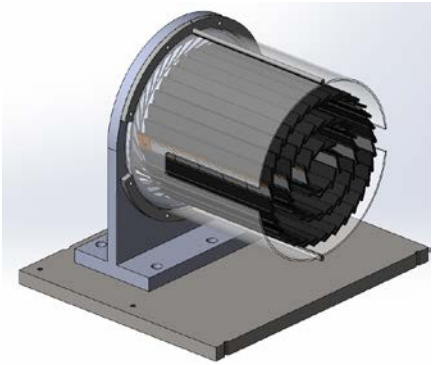
Barrels installation





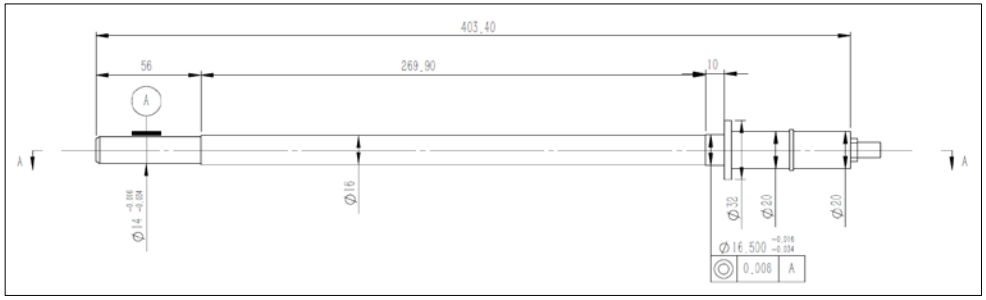






FEA for related components

1. Under self-weight the end of the cantilevered shaft sinks : mm



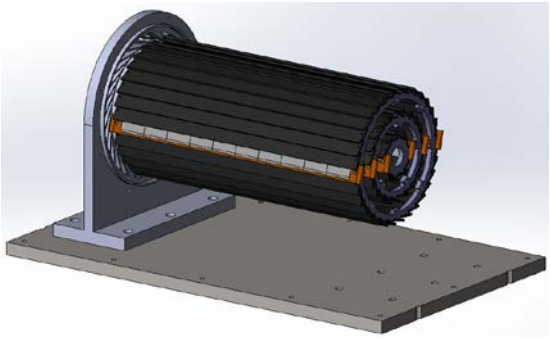
2. The cantilevered shaft with wheels and side-rings sinks: mm

3. The simply support shaft with wheels and side-rings sags: um

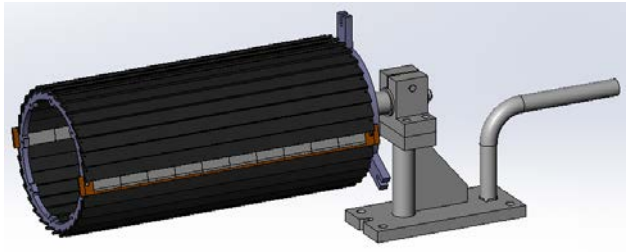
FEA for related components

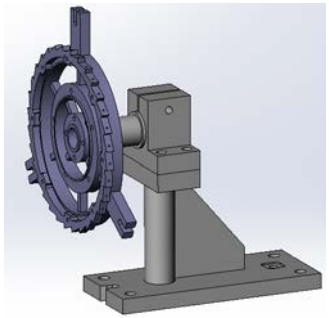
4. Three cantilevered barrels on the bracket sinks: (273/170) x 0.0= mm

Weight of barrels and moment applied to surfaces that contact the side-rings



5. The cantilevered *outer barrel* on tooling sinks： (273/120) x 0.0= mm





These results are basically acceptable for tooling manufacturing and prototype installation.

Summary