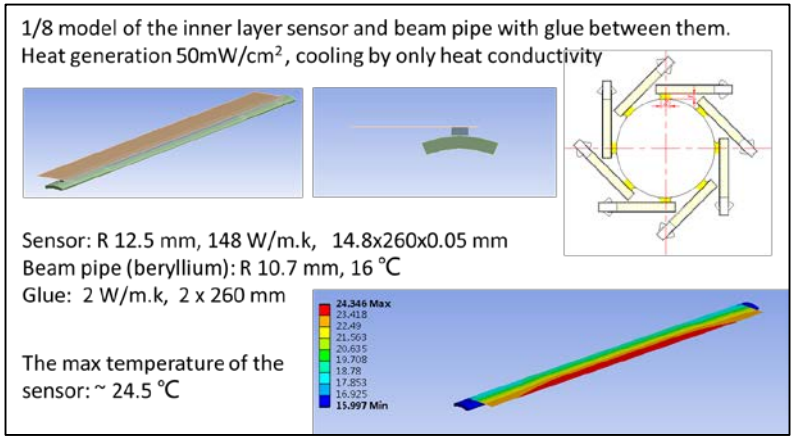
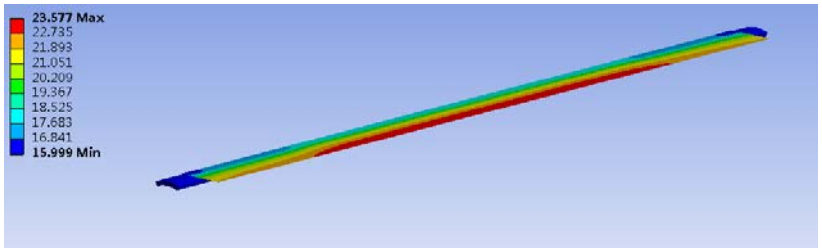
1. Vertex

Optimize the inner layer cooling scheme (*adjust the gap and glue coverage*), new thermal analysis :

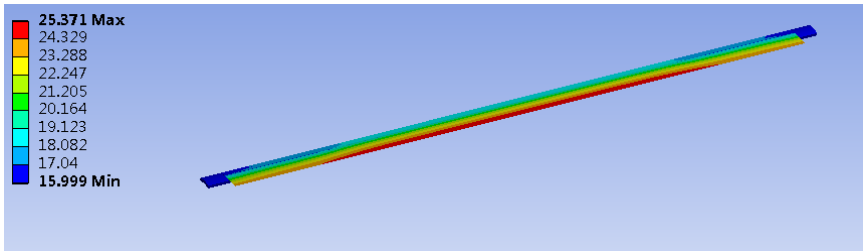
- Sensor: R 11.7 mm, 148 W/m.k, 14.8x260x0.05 mm
- Beam pipe (beryllium): R 10.7 mm, 16 ℃
- Glue: 2 W/m.k, 1.5 / 1 x 260 mm



50mW/cm2 uniform distributed:
The max temperature : 23.6℃ / 24.9 ℃



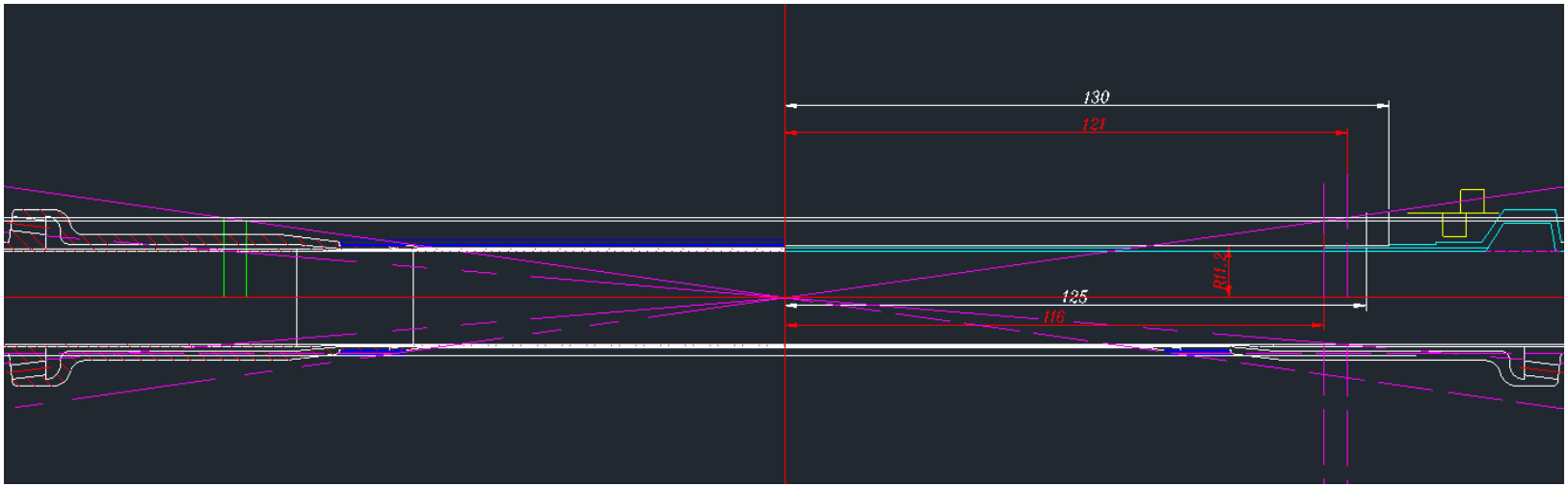
12.8mm wide area shares 8/13 of the total heat, and the left 5/13 shared by 2mm wide area:
The max temperature : 25.4℃ / 26.7 ℃



To be discussed

Due to the limited available space on the beam pipe, we tried to adjust the inner layer ladder:

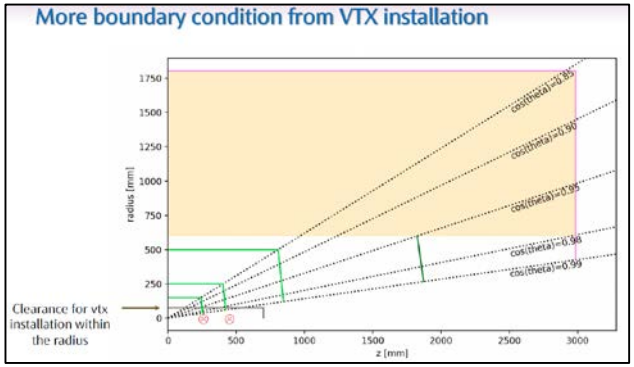
- Move the inner layer detector closer to beam pipe R 11.2mm (0.5mm gap)
- Given the ladder directly glued onto the beam pipe (the support machined on the beam pipe)
- Optimize ladders number (7vs 8, to be further discussed and confirmed).

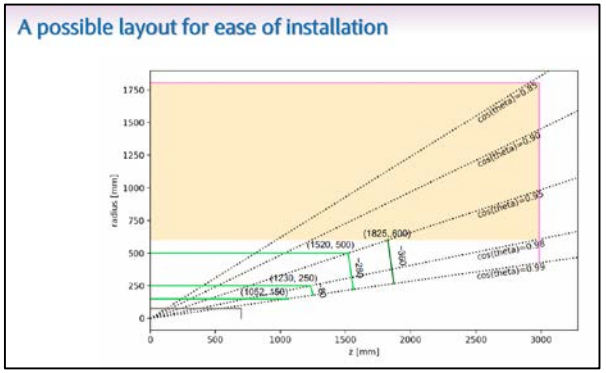


For the section with R11.2, the minimum length required by the VTX is 125mm, which is still longer and can't fit to the beam pipe .

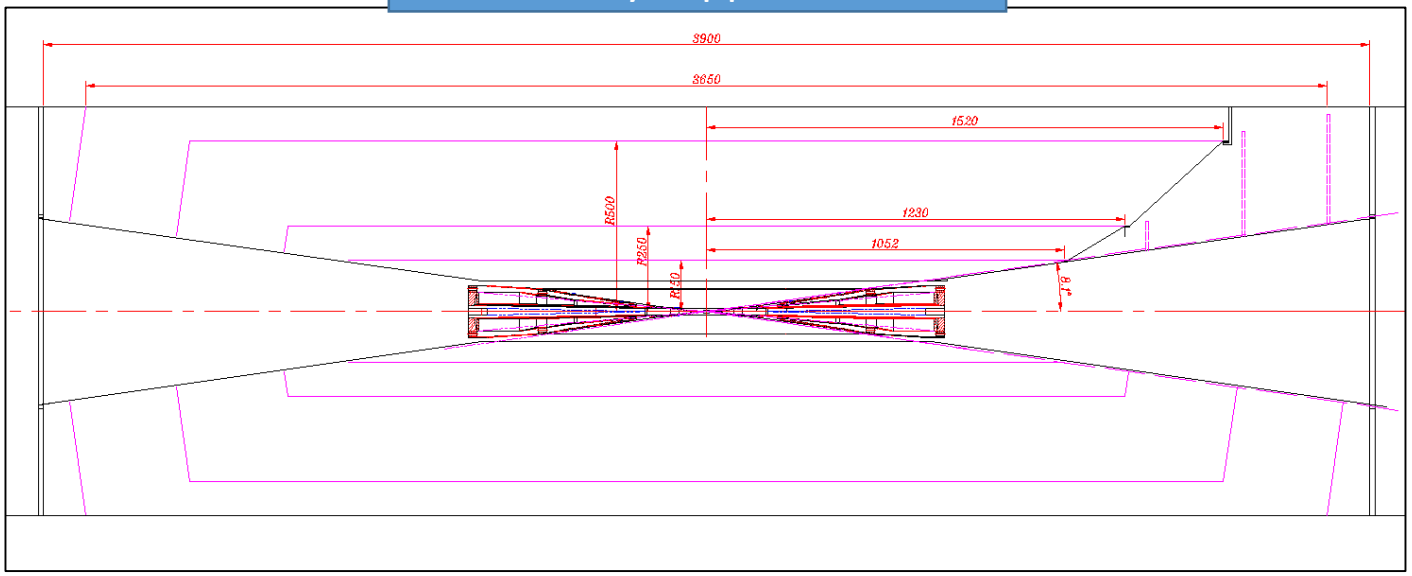
So, the general ideas for next?

2.ITK



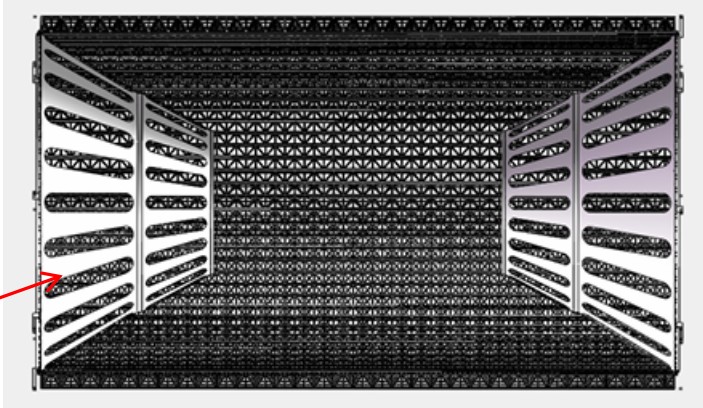


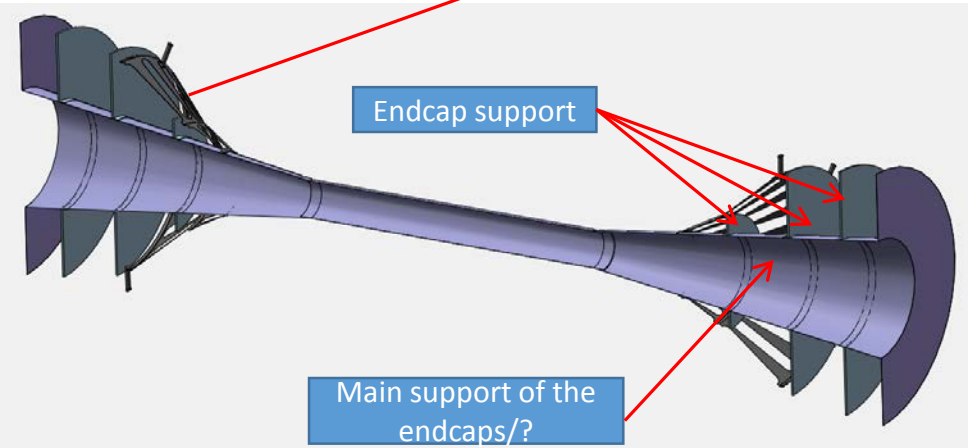
Preliminary support scheme



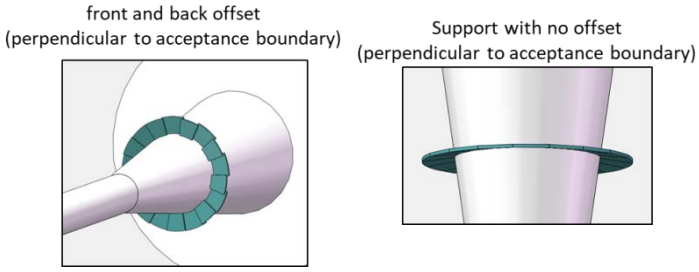
Preliminary mechanical support scheme

Local support:
Barrels stave - truss structure
Endcaps - flat ring





More to study

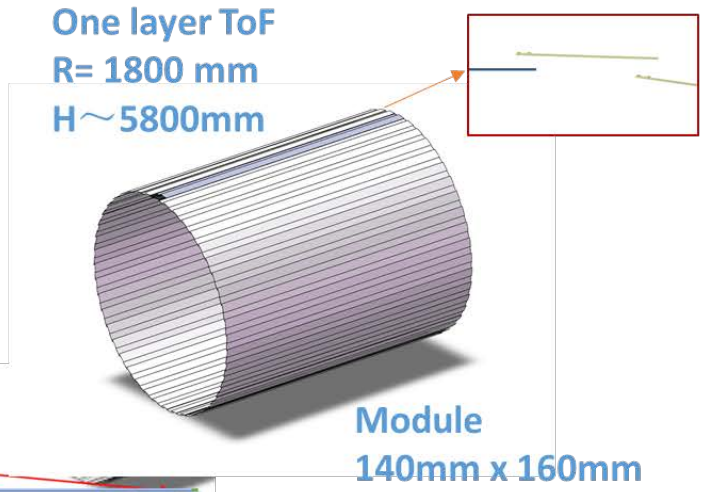


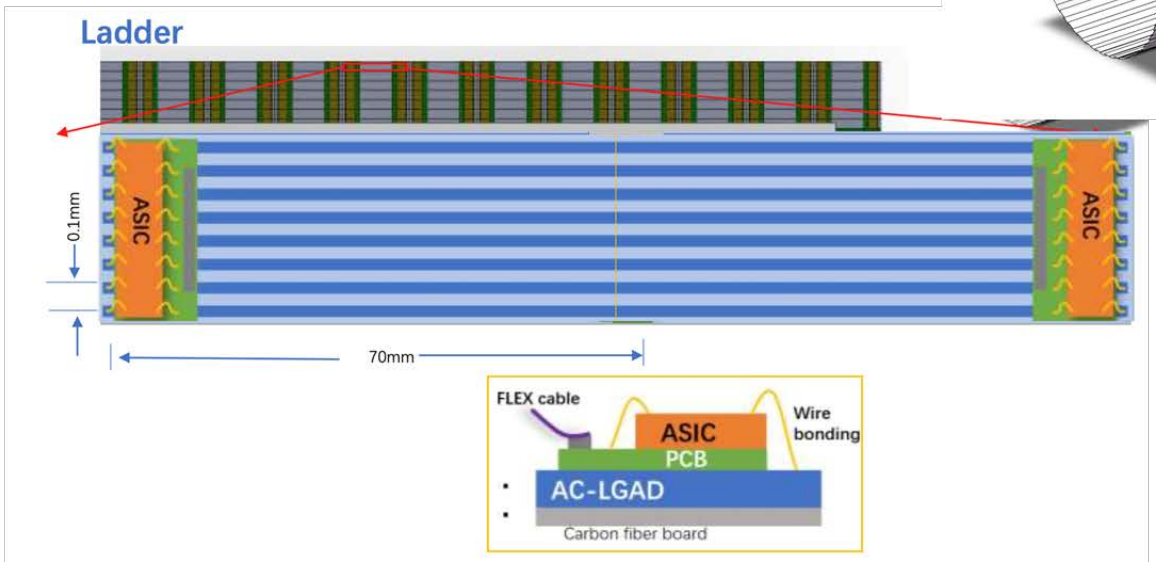
detector temperature ?

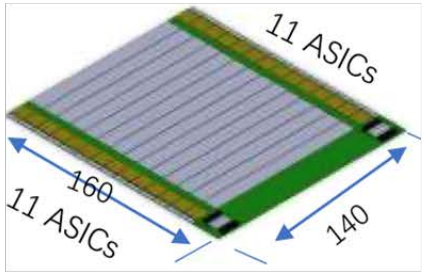
3.OTK

Arrangement of the ToF with strip LGAD： Barrel

- **One layer: 3780 modules**
  - 90 ladders，45 ladders each side,
  - ✓ 42 modules/ladder，
  - ✓ 22 ASIC/module，128 Channel/ASIC





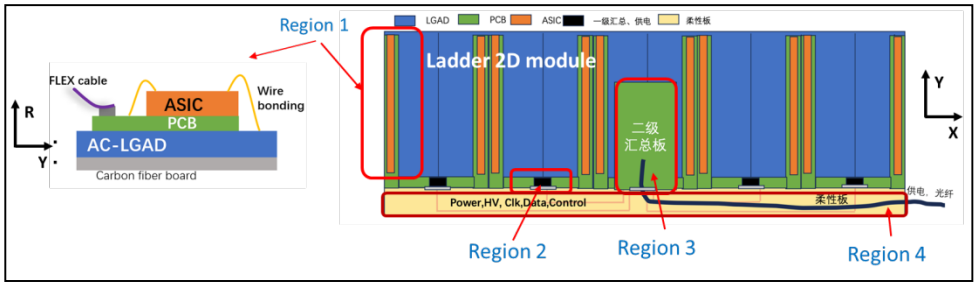


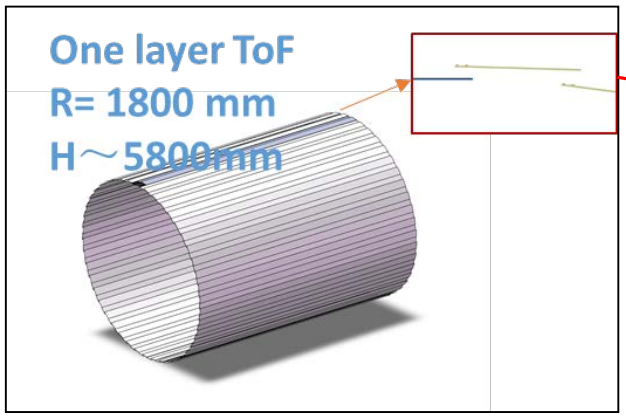
Preliminary barrel scheme

- Ladder: 160 x 5800（nominal） mm
- 90 ladder overlapped deployed

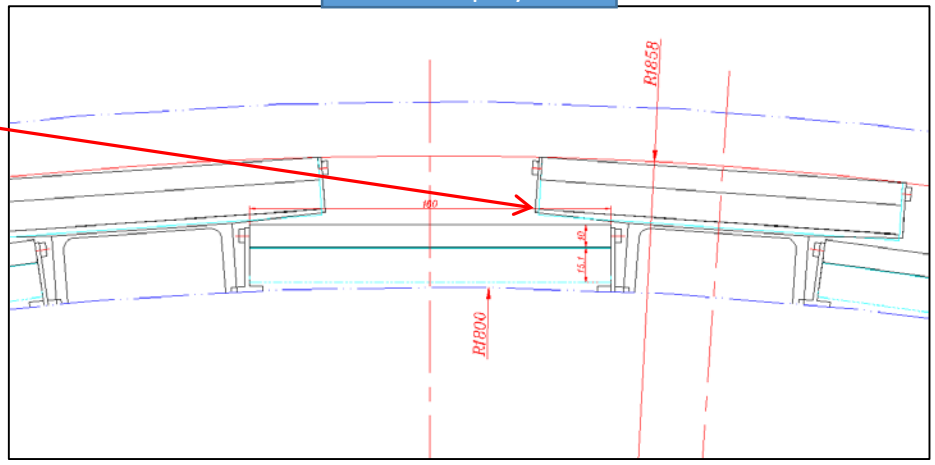
Detail thicknesses of different regions

- The thickness of the region 1：4.6mm
  - ✓ PCB：1.6 mm
  - ✓ ASIC：3 mm
- The thickness of the region 2:
  - ✓ 一级汇总供电：3 mm
  - ✓ PCB：1.6 mm
- The thickness of the region 3：**14.6 mm**
  - ✓ 电源模块：6 mm
  - ✓ 光电复合电缆：5mm
  - ✓ 弯折走线空间：2mm
  - ✓ PCB：1.6 mm
- The thickness of the region 4：6 mm
  - ✓ 柔性板厚度：1 mm
  - ✓ 二级汇总电缆：5 mm（高低压供电，光纤）





Ladder deployment

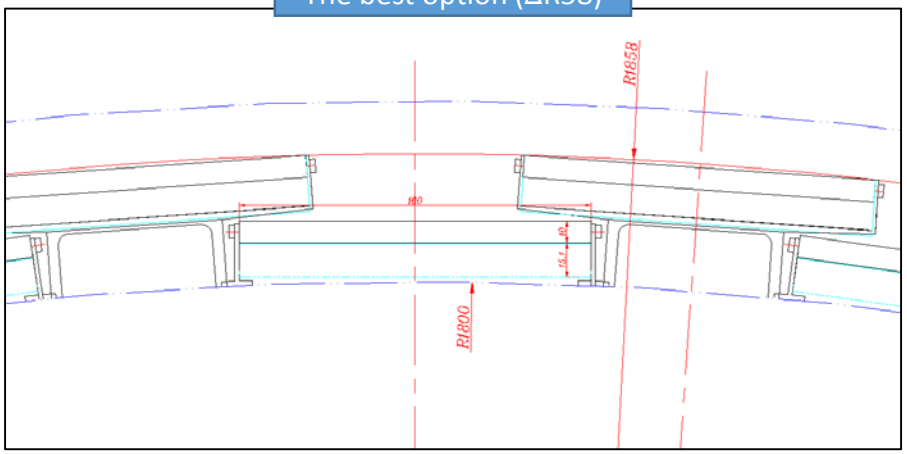


Ladder deployment

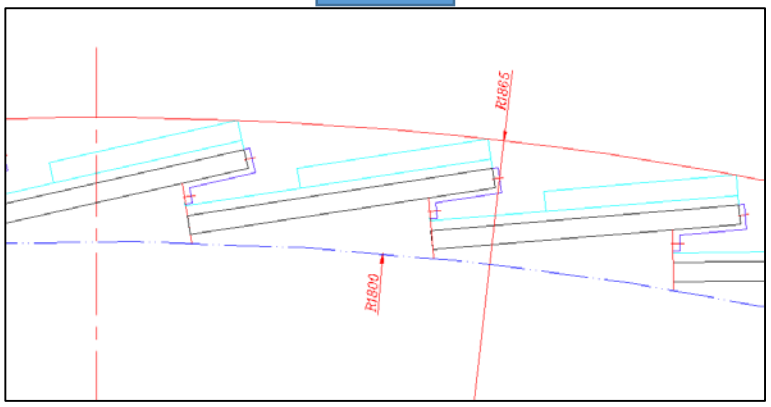
3 ladder deployment
The best option:

- With minimum space required in R direction ΔR=58
- Sensor towards IP

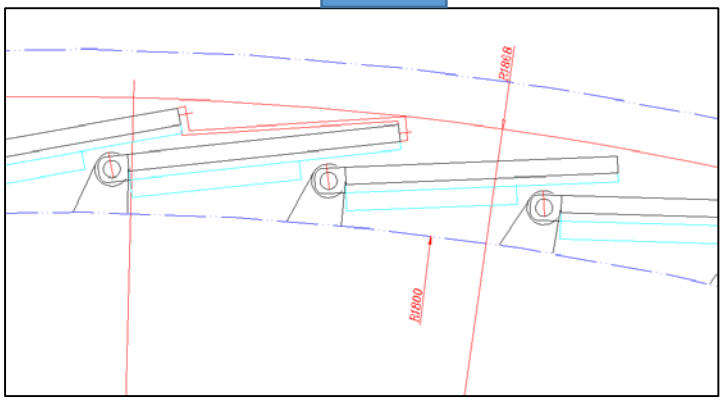
The best option (ΔR58)



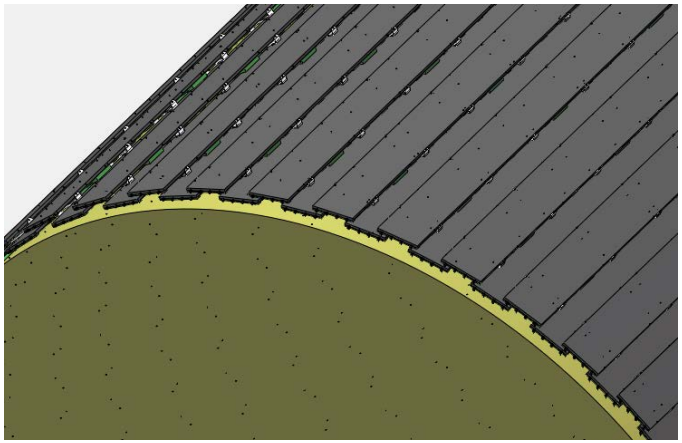
ΔR65

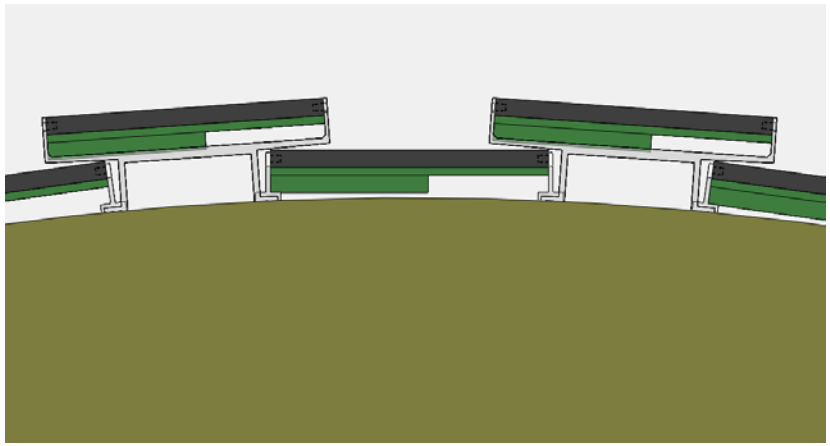


ΔR68

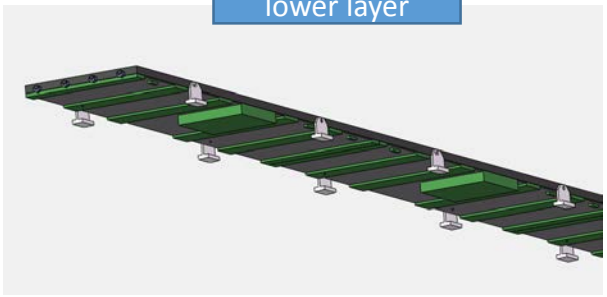


3D illustration of the barrel

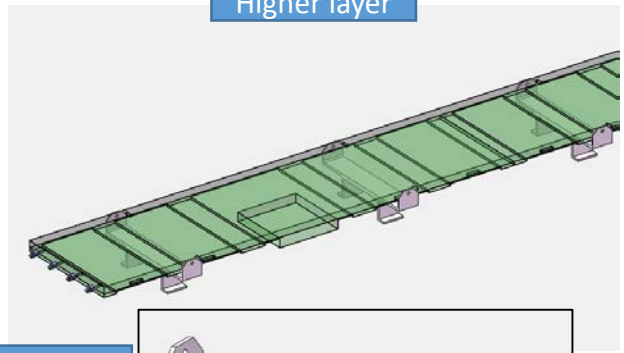


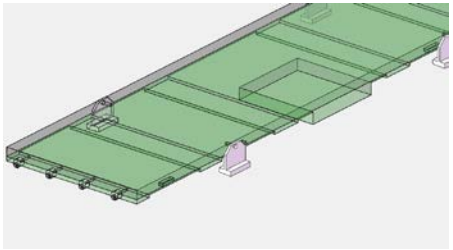


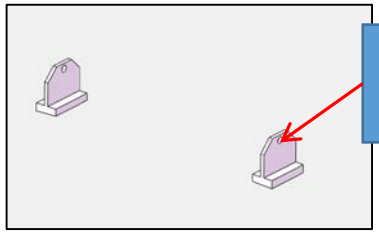
lower layer



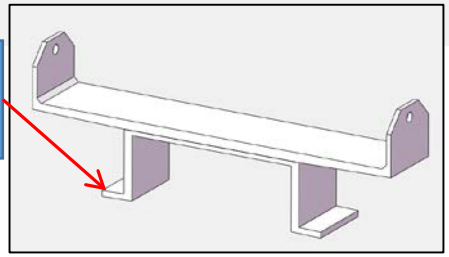
Higher layer







Ladder support (glued to TPC outer surface)



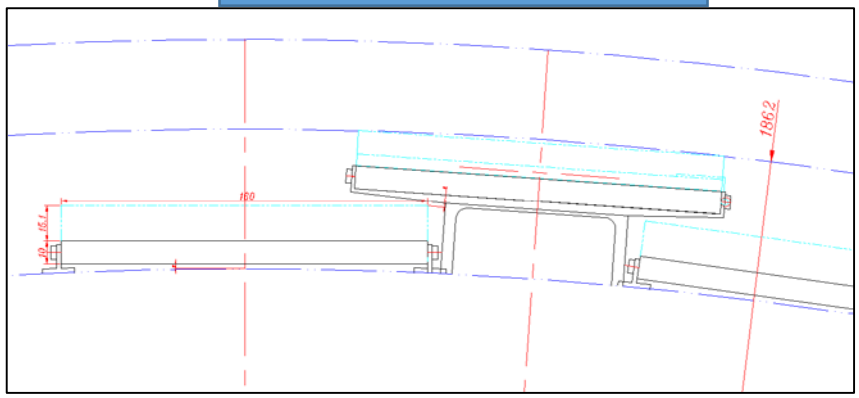
2x6=12

The latest optional scheme

Considering the heat generation mostly come from asics, given that we also need to deploy pipes outside the ladder support for more effective cooling of the asics.

- the sensor located on the outside direction of the barrel
- more to be considered for pipe deployment

ΔR62(with no cooling pipes outside the ladder)



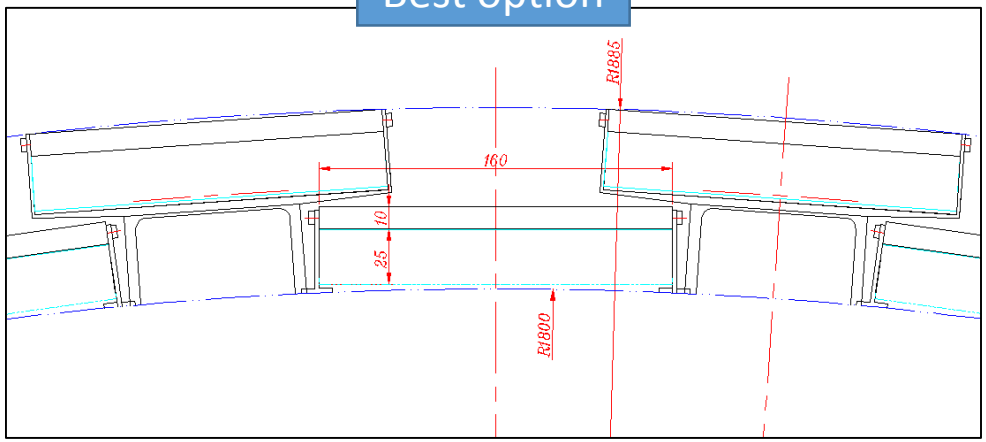
Cooling simulation for the TOF module will be carried out to evaluate the cooling pipe deployment.

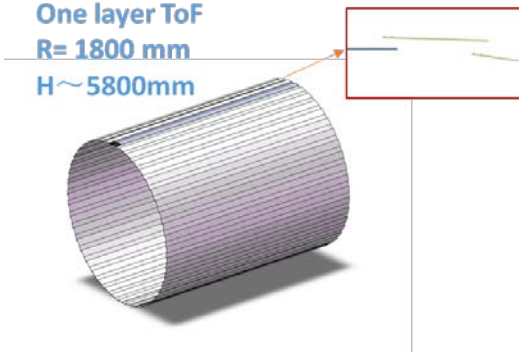
Backup

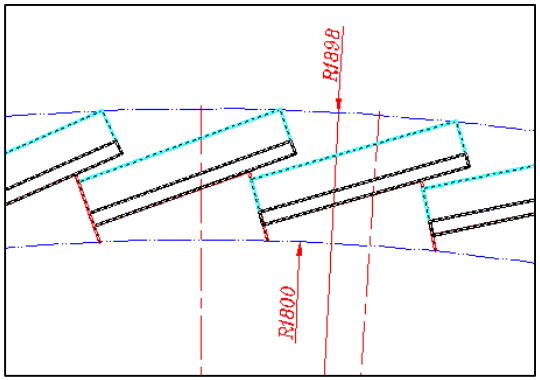
Space the LGAD requires

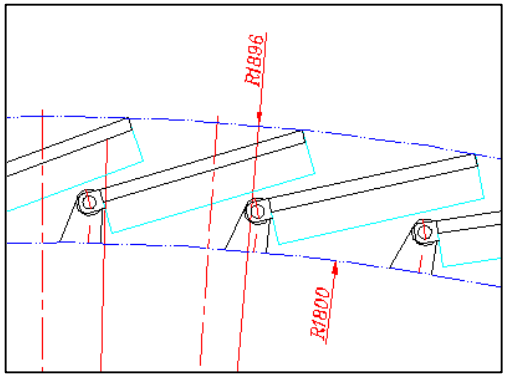
Barrel: compared different ladder deployments (same number), the minimum space required in radius direction is **85mm** (R1800~1885).
Ladder thickness: 35, 10mm for ladder support with cooling tubes embedded inside, 25mm for electronics.

Best option









Space the LGAD requires

Endcap: Detector area R400~1800 mm

In Z direction the space required for the endcap is **90 mm**.