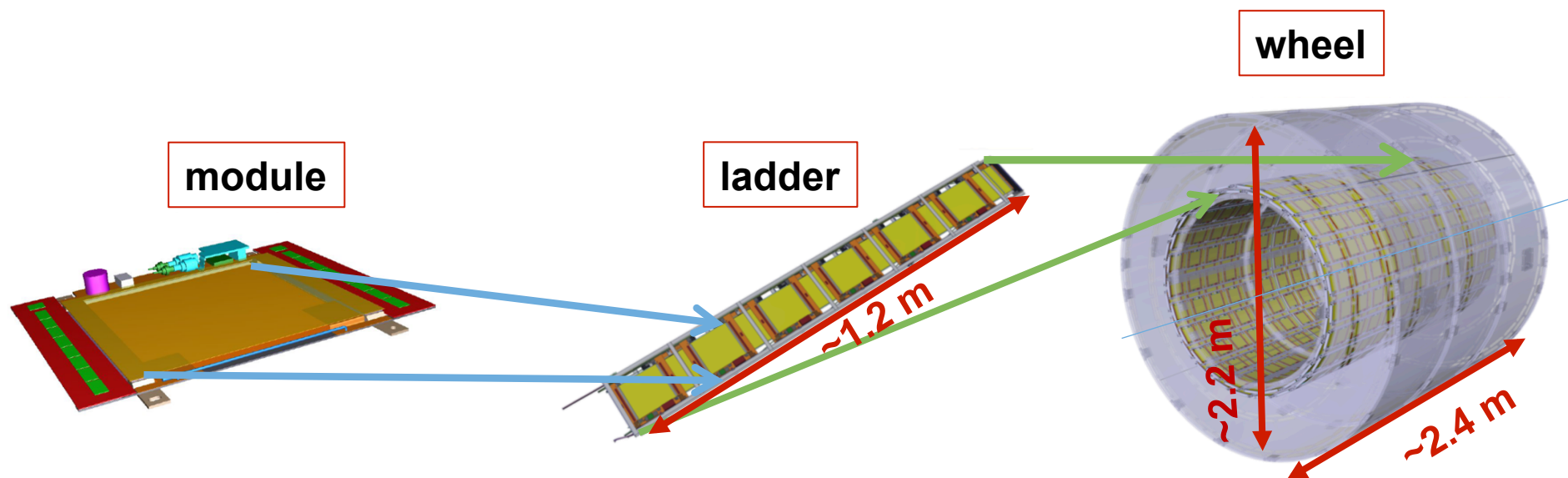




# **IPHC contributions to TB2S Mechanic**

**On Behalf of CMS-IPHC**



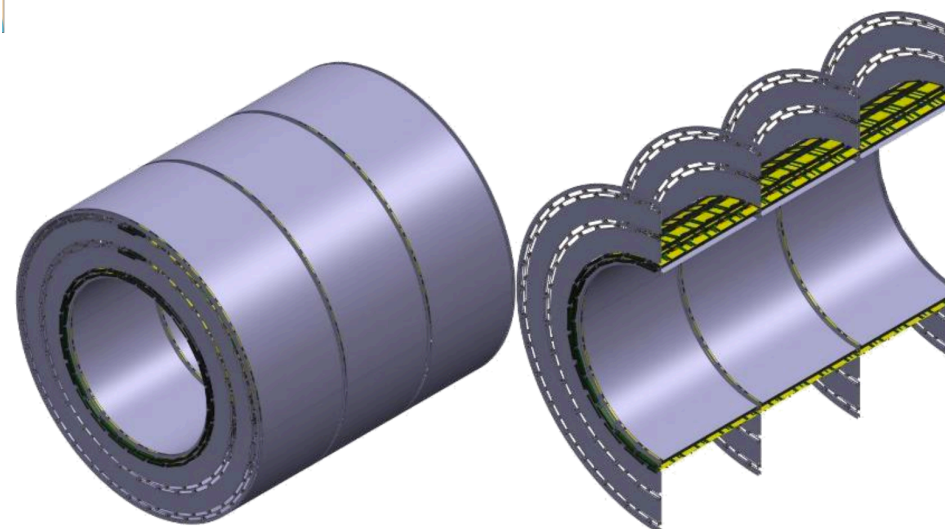
- **4464 2S modules** => Produced in India and Fermilab,
- **372 ladders** (12 modules per ladder) produced in Pakistan
- **TB2S wheel, made of carbon fibers** : 4 disks and 3 cylinders. Inheriting a lot from current TOB.

- **Assembly of the TB2S wheel** : largest structure of the new tracker, made in carbon,
- **Coordinating the production** (made by industries) of **aluminium and plastic assembly elements**
- **Design and production of (potentially Titanium) pieces** for TB2S stands (support the weight of the entire tracker).

TOB



TB2S

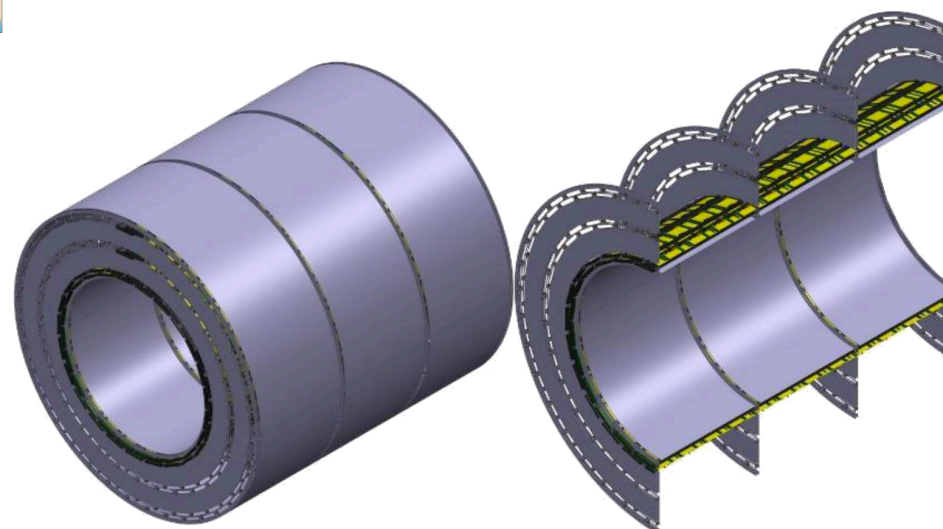


- looks more like a barrel than a wheel
- very close geometry to TOB, but 3 layers instead of 6
- recent changes reducing by 2.5cm the outer radius and 1cm the inner radius. To allow space for the timing detector and more space for cables for the inner tracker

TOB



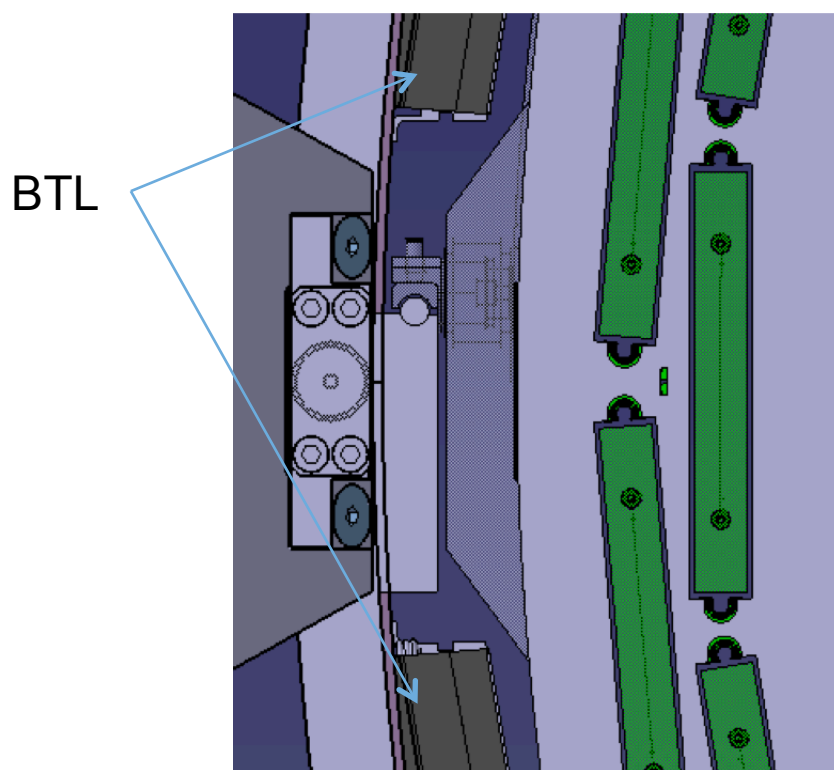
TB2S



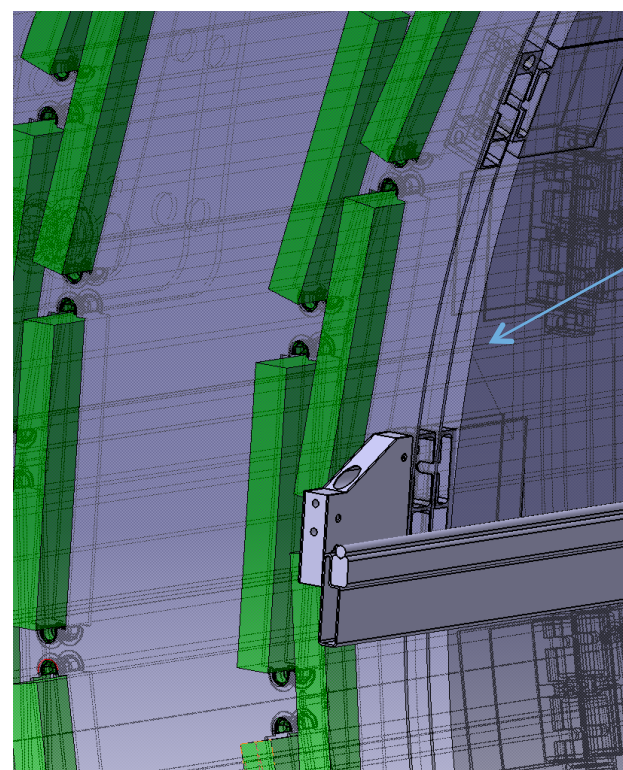


# Wheel geometry

- **recent changes reducing by 2.5cm the outer radius and 1cm the inner radius.** To allow space for the timing detector and more space for cables for the inner tracker



1 ladder less in last layer



More space for cables, there was enough margin



# Assembly of the TB2S wheel



- (Large) Carbon fibers elements of TB2S produced by industries, ordering supervised by CERN,
- These pieces will be received by IPHC, where the overall assembly will be made :
  - **Assembly of the disk** : 4 disks made of 2 carbon fibres disk each, with several brace (glued)
  - **Assembly of the tube** : 6 cylinders (screwed/glued aluminium connectors)
  - **Precise assembly done on a “precision” flat table**, assembly done “vertically”
- Process inspired from TOB assembly.
  - We can benefit from **CERN expertise** through close collaboration.
  - We will **recycle the flat table** used for the TOB assembly. Already at IPHC. Adaptation with different reference marks.
- **Constraints** :
  - Large structure => large assembly room need,
  - Temperature (+/-1 degree) and hygrometric controls,
  - Metrology control needed.



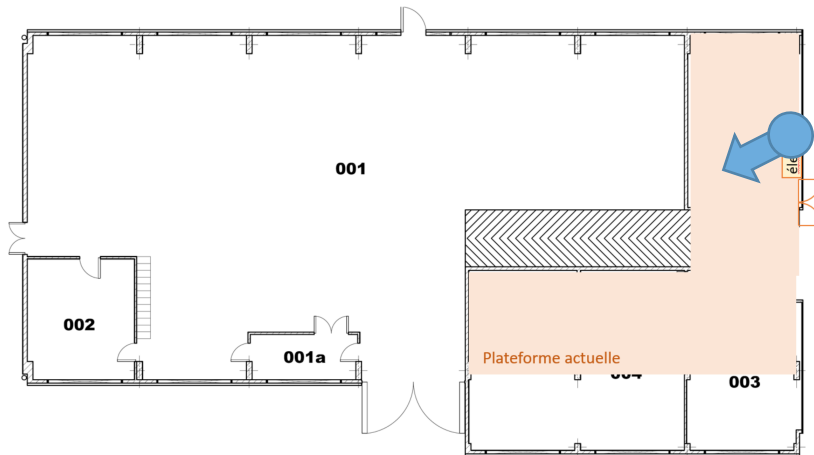


# Assembly room



Mezzanine in mechanics workshop (existing overhead crane)

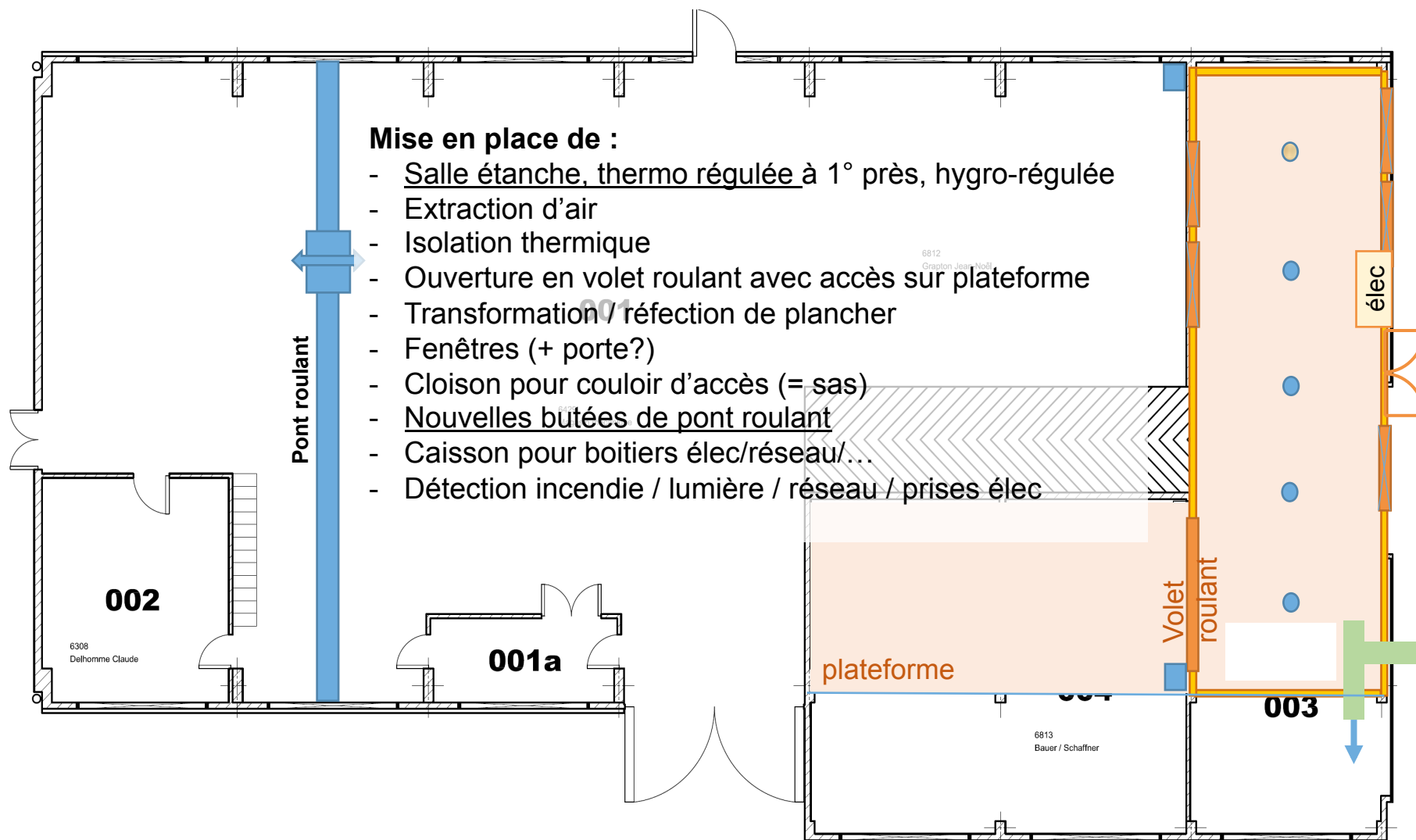
Point de vue







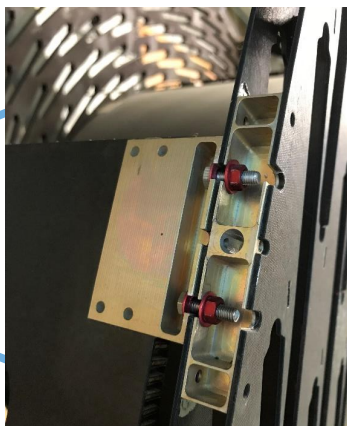
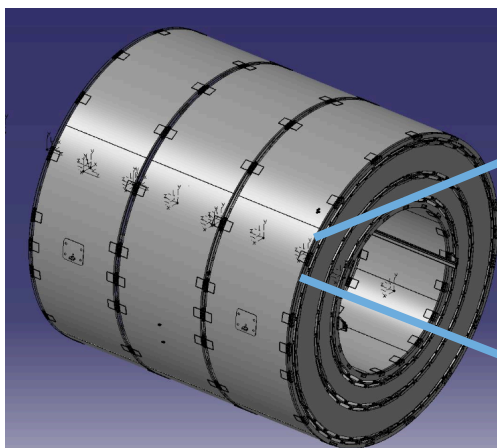
# Assembly room preparation



# Production of aluminium and plastic assembly elements

- Assembly pieces, to be produced by industries.
- Inserts in plastic for ladder holding and positioning each TB2S Ladder (1488 pieces).

Currently investigations for using 3D printing technology



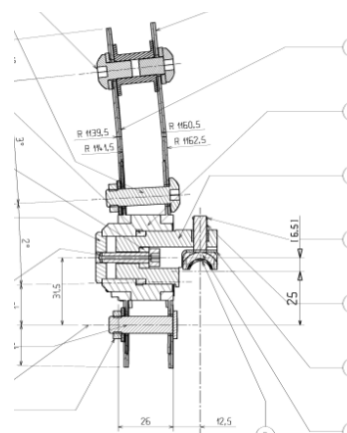
- Pieces in aluminium for disks and cylinders assembly (750 pieces)
- Too large production to be handled by IPHC.
- Production made by industries, IPHC in charge of coordination/follow-up.





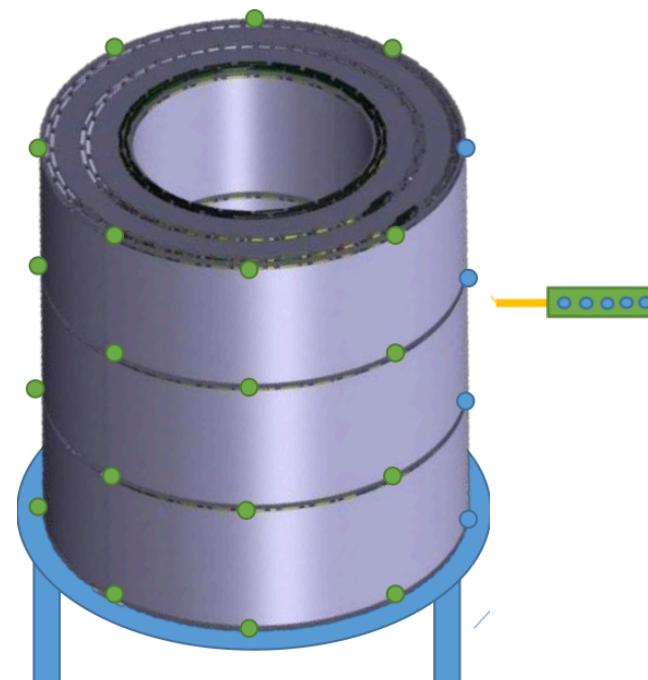
# Design and production of titanium pieces

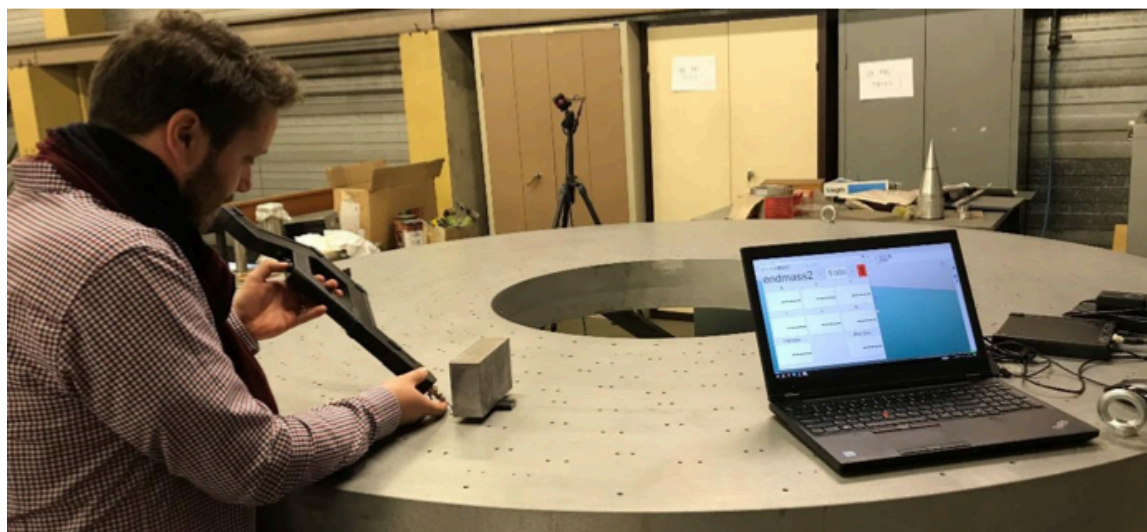
- TB2S is the largest structure of the tracker.
- It supports also the other parts of the tracker barrel (including the pixel) => **Stands of TB2S is something critical.**
- TB2S position on 2 trails, with 4 stands.
- "Head" of the stand should be able to rotate along 3 axes, to absorb mechanical tension,
- IPHC in charge of the re-design and the construction of these pieces.
- Study their feasibility in Titanium.
- **We might be ask to produce the stands of the other partitions too (internal train for inner tracker).**



## Starts in 2019 !

- Alignment checks at each steps of the mounting
- First mounting at IPHC, shipping to CERN in 3 parts, re-mounting at CERN
- Metrology in vertical position for mounting, tests in horizontal position on trails (without and with loads)
- Investigated/tested different solutions: hand scanner, measuring arm, scanning laser...
- Different cost, precision and user friendliness
- Wants to reach 0.1mm precision
- Current choice for a palming stick with a CCD camera for getting its position in 3D





- Tests of technics

- On the flat table: found that the inner part is 0.2mm higher than the outside
- On an old TOB ladder: test of an arm





# Manpower



- **Timeline:**

- Design of pieces, preparation of the room: 2019
- Procurement of raw material and components: 2020 - 2021
- Construction of the wheel: end 2021 - 2022

- **Institutional people involved:**

- 2 persons from STM (1 from BE, 1 from Workshop + the 2 responsables: Mark Krauth, Eddy Dangelser), 2 physicists (JL Agram, Jeremy Andrea).

- **Request:**

- **CDD** : 24 months of AI, 1 year for the production of titanium pieces, 1 year to participate to the construction.