investigation, mechanical design and construction

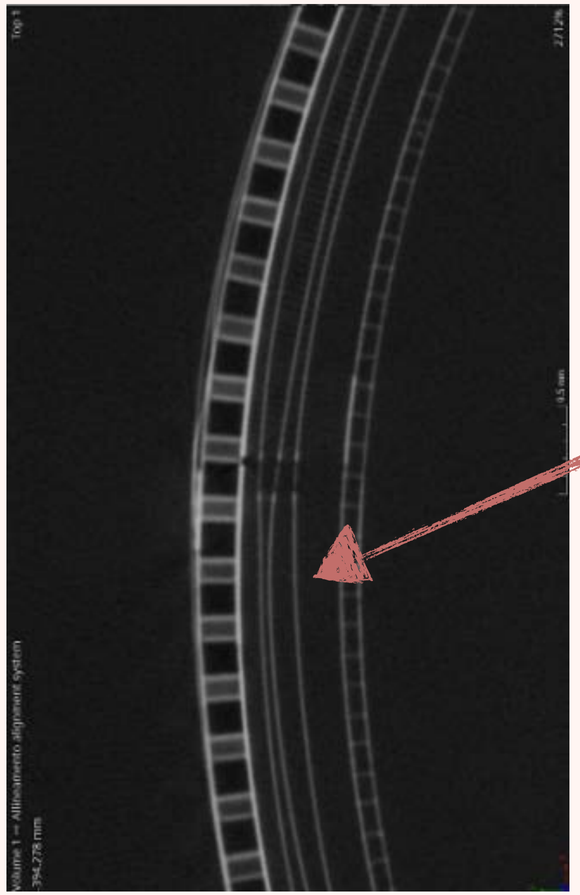
LAYER 3

WORKFLOW

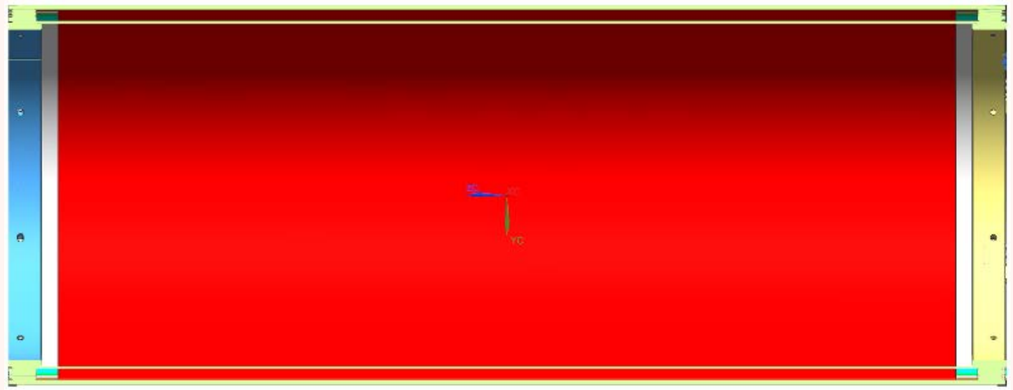
- electrical tests —> done (Jan. - Mar. 2021)
- imaging diagnostic
  - visual inspection of Layer 3 radiographies and CT scan —> done (Apr. - May)
  - virtual model comparison w.r.t. technical design —> in progress
  - CT scan on KLOE-2 CGEM detector —> done (May - Jun.)
- Static FEM simulations (L1, L2 and L3) —> done (Jun. - Aug.)
- FEM simulation validation by means of experimental “drop test” —> planned (this week)
- Mechanical test of spacing grid effectiveness —> to be addressed (end of Sep. - Oct.)
- New 3D model of layer 3 design (Nov.)
- Executive drawings (Dec. 2021)

LAYER 3 DAMAGE

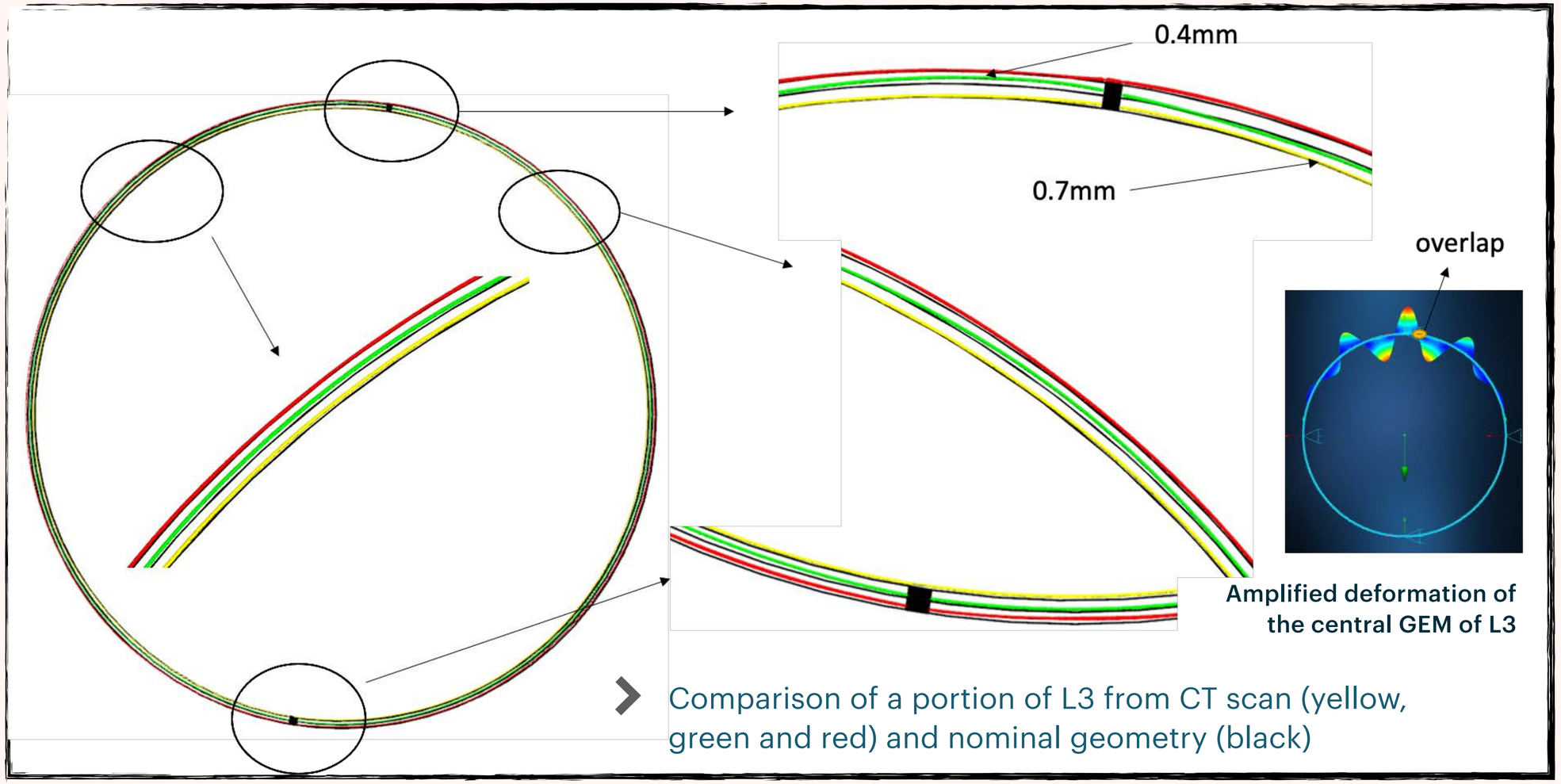
Images from L3 CT scan



- L3 is composed of two coaxial cylinders connected at the edges by permaglass rings
- The Carbon Fiber structure has no damage and it’s at nominal geometry
- The deformations appear only on the GEM foils

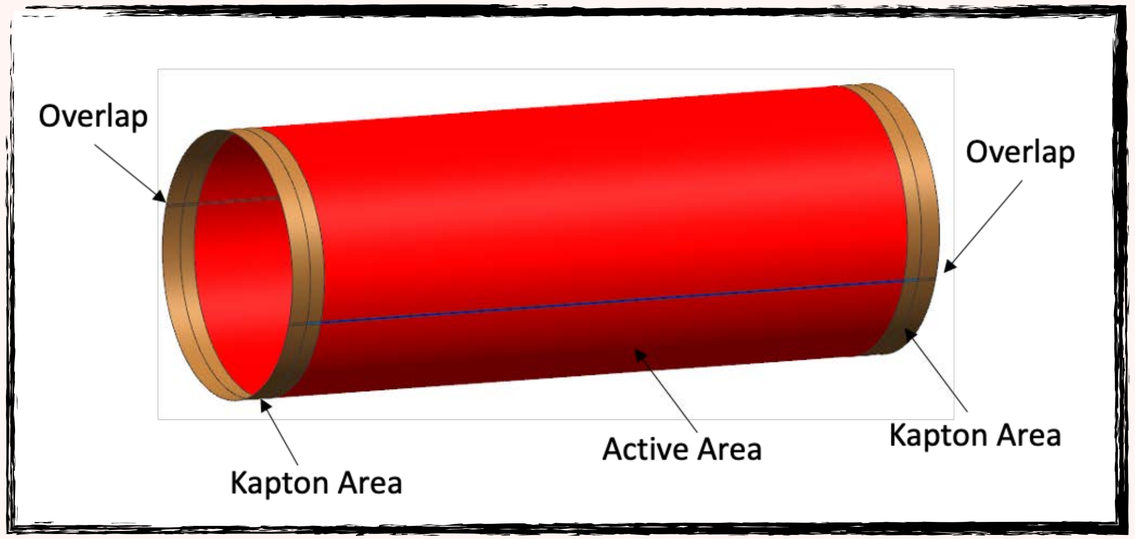


DISPLACEMENT FORM NOMINAL GEOMETRY



Comparison of a portion of L3 from CT scan (yellow, green and red) and nominal geometry (black)

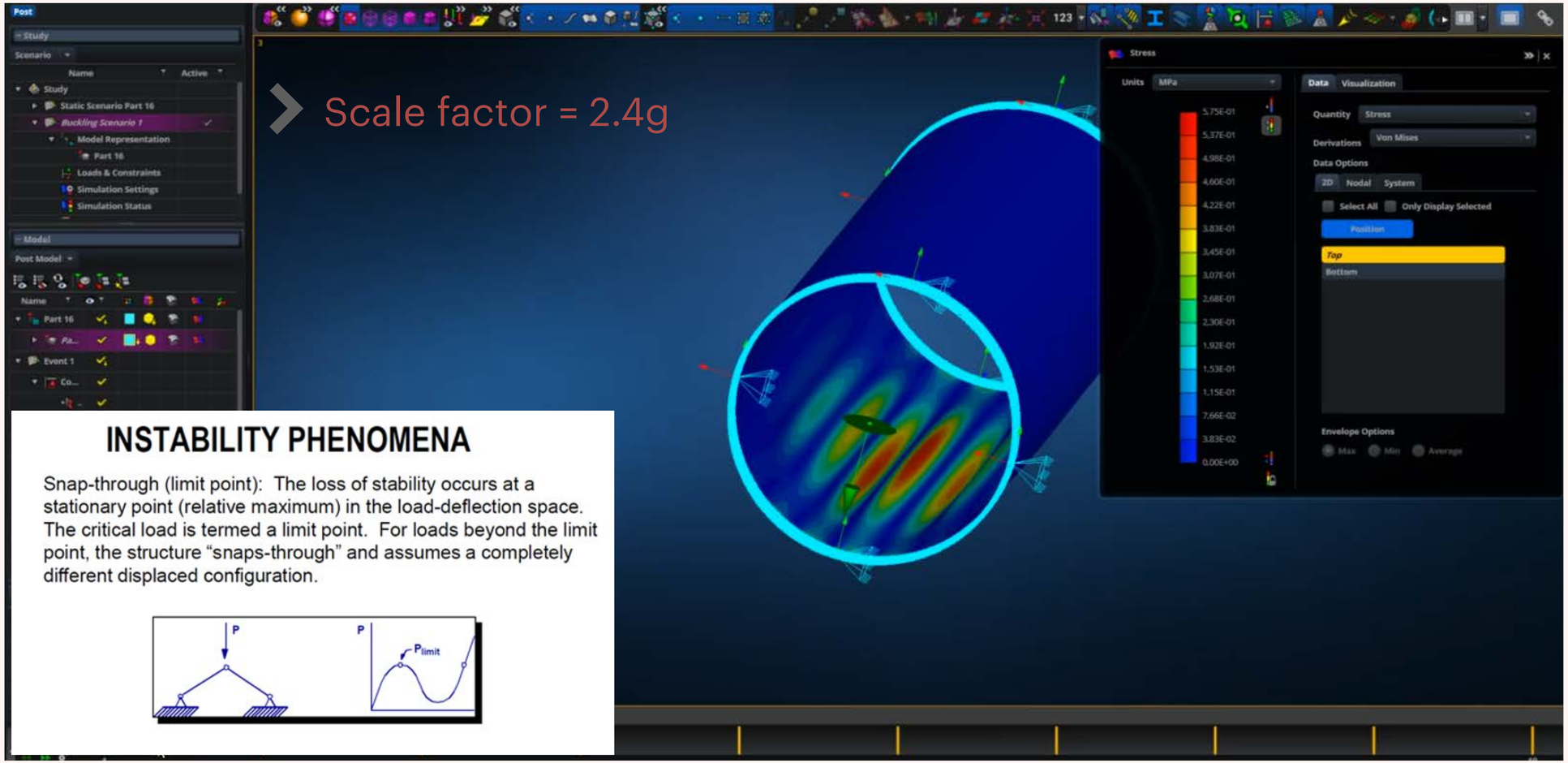
STATIC GEM MODEL



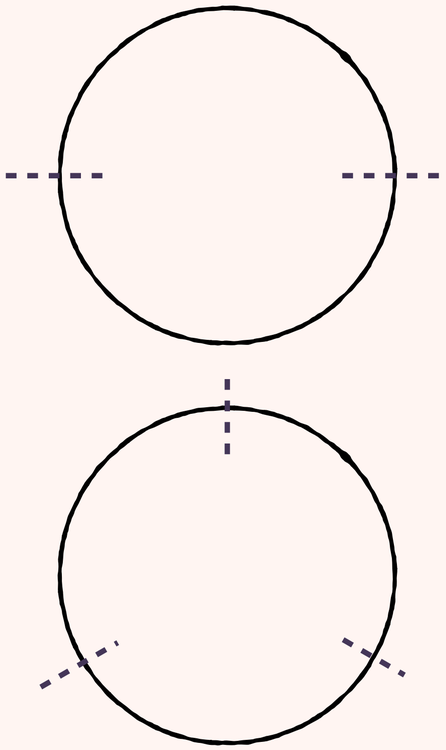
- The CGEM is described as a cylinder
  - diameter 364 mm
  - total length 940 mm
  - active area length 847 mm
- The active area is modeled using parameter extracted from mechanical tests and published at LNF-09/12(IR)
- The glue is neglected

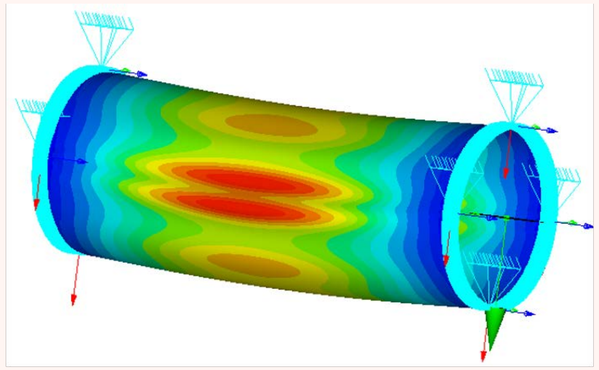
Component	Mass [Kg]	Thikness [μm]	Equivalent density[kg/m3]	Linear El. Modulus [GPa]	Poisson Coefficient
Active Area GEM-3	0,1273	50 (K) + 10 (Cu)	2291	4,8	0,335
Kapton Area GEM-3	7,2*10-3	50 (K)	1420	3,1	0,34

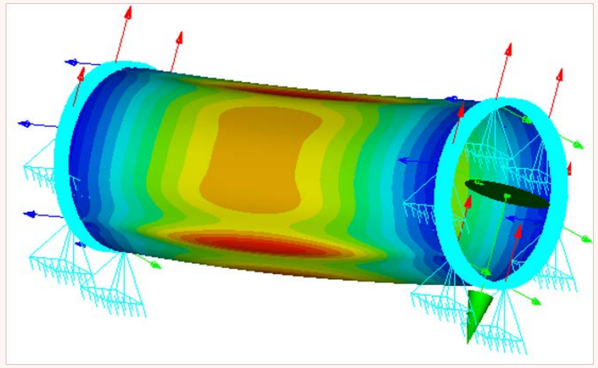
BUCKLING ANALYSIS: L3-GEM3



BUCKLING ANALYSIS: 2 VS 3 OVERLAPS



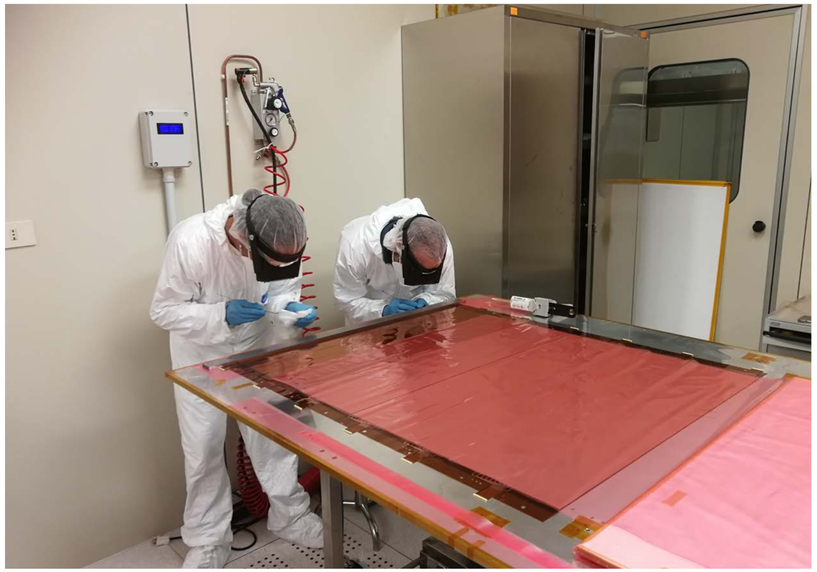


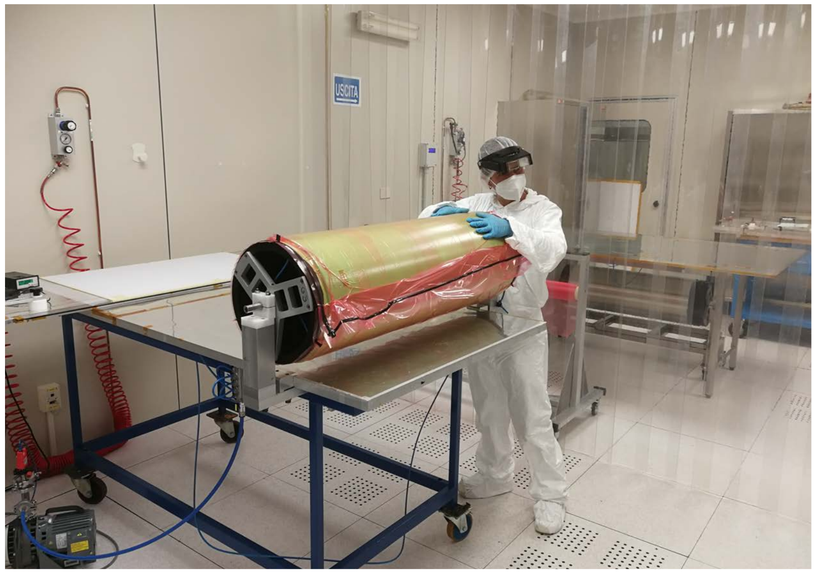


- Each GEM electrode is made of 2 GEM foils glued together
- The overlaps between foils are one of the most delicate part of the detector
  - The glueing must be performed by hand, very precisely
  - No sign of deterioration of the gluing found so far
- The overlaps carry most of the transverse tension within the GEM foils
  - Defects are sometime associated with overlaps
- Increasing the number of overlaps from 2 to 3 does not improve the static limit of the structure

DROP TEST

- FEM buckling analysis showed a limit point of ~2.4g for the layer 3 GEM geometry
- Depending on the surface, such an acceleration can be reached even with small impacts
- Simulation needs to be validated against data
- A “drop test” will be conducted later this week at LNF with a mockup of a layer 3 GEM cylinder
- The mockup has been assembled from spare GEMs and 3D-printed flanges (see next slide)
- One side of the mockup will be constrained onto a table; while the other side will be dropped from different heights
- Up to five accelerometers will be attached to the supporting structure and to the GEM foil to measure the deceleration due to the impact



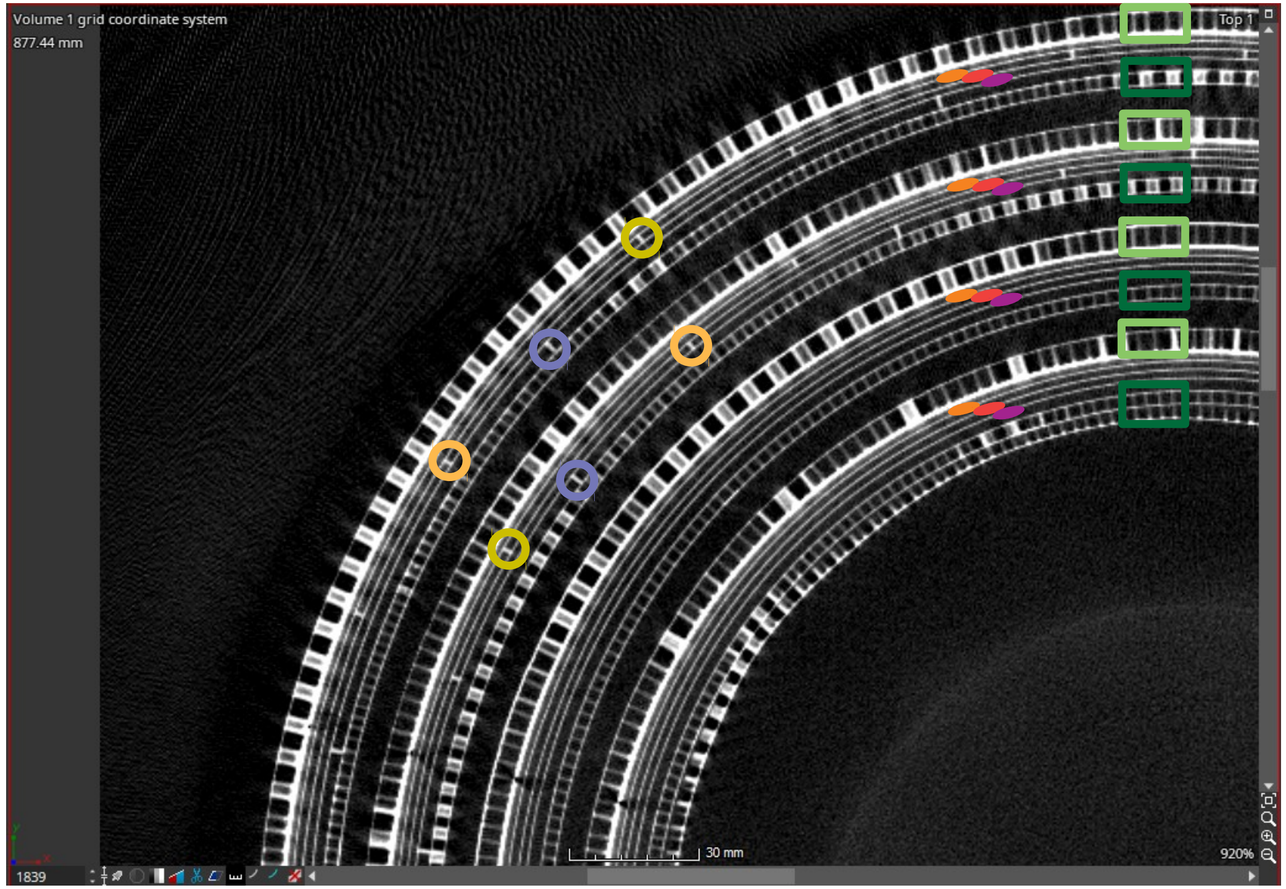

USOITA

Support Grid
10x10cm^2
T2
T1
Drift

GEM Foils
GEM3
GEM2
GEM1

Carbon Fiber
Mechanical Structure
External [Anode]
Internal [Cathode]

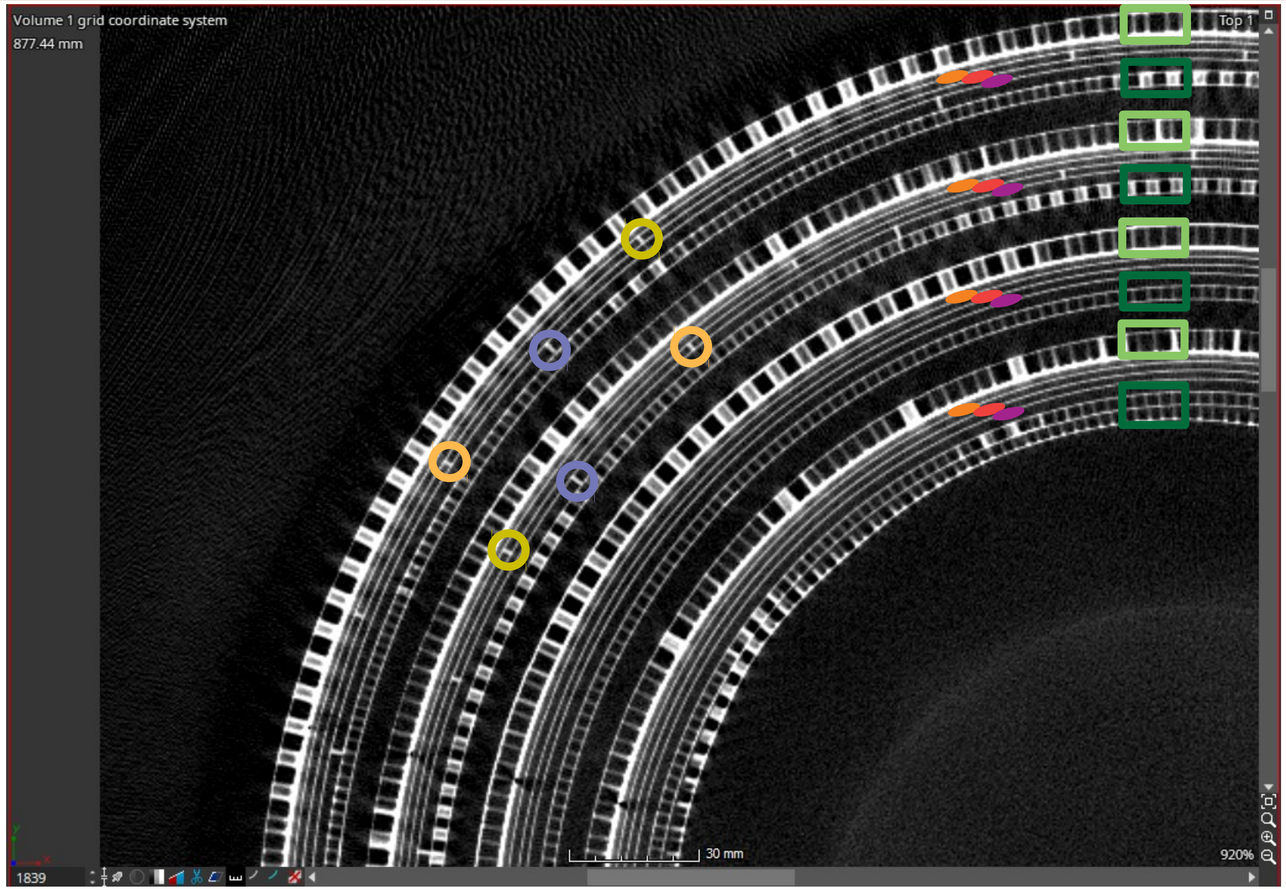
CT Scan to Kloe-2
CGEM detector



L4 ---- 20.5
L3 ---- 18.0
16.1 → CGEM-IT L3
L2 ---- 15.5
L1 ---- 13.0
12.1 → CGEM-IT L2
7.6 → CGEM-IT L1

Inner radius
[cm]

CT SCAN TO KLOE-2 CGEM DETECTOR



L4 ---- 20.5

L3 ---- 18.0

16.1 → CGEM-IT L3

L2 ---- 15.5

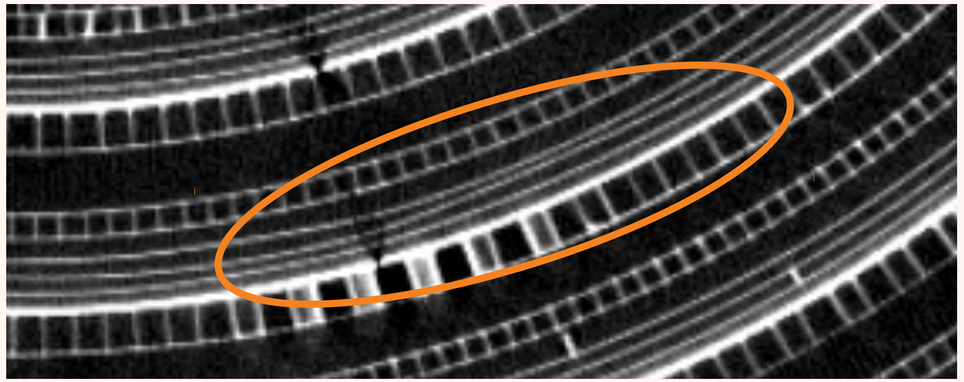
L1 ---- 13.0 → OK no grid

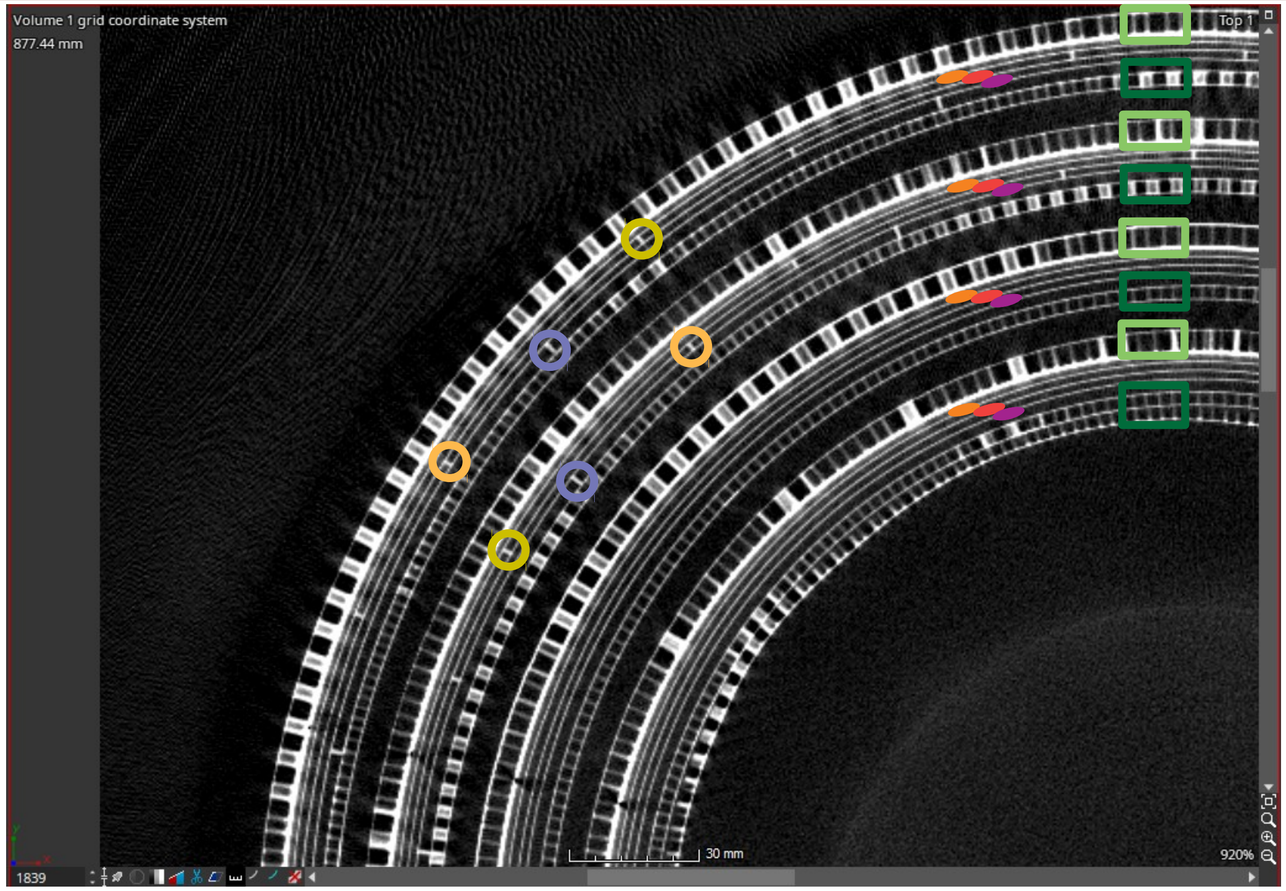
12.1 → CGEM-IT L2

7.6 → CGEM-IT L1

Inner radius [cm]

CT SCAN TO KLOE-2 CGEM DETECTOR





L4 ---------- 20.5

L3 ---------- 18.0

16.1 → CGEM-IT L3

L2 ---------- 15.5 → some buckling

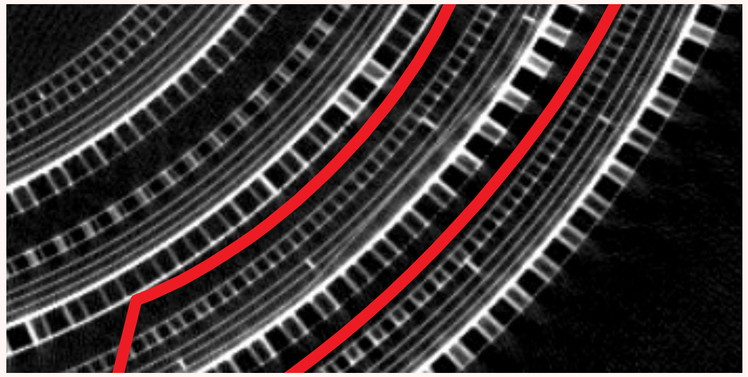
L1 ---------- 13.0

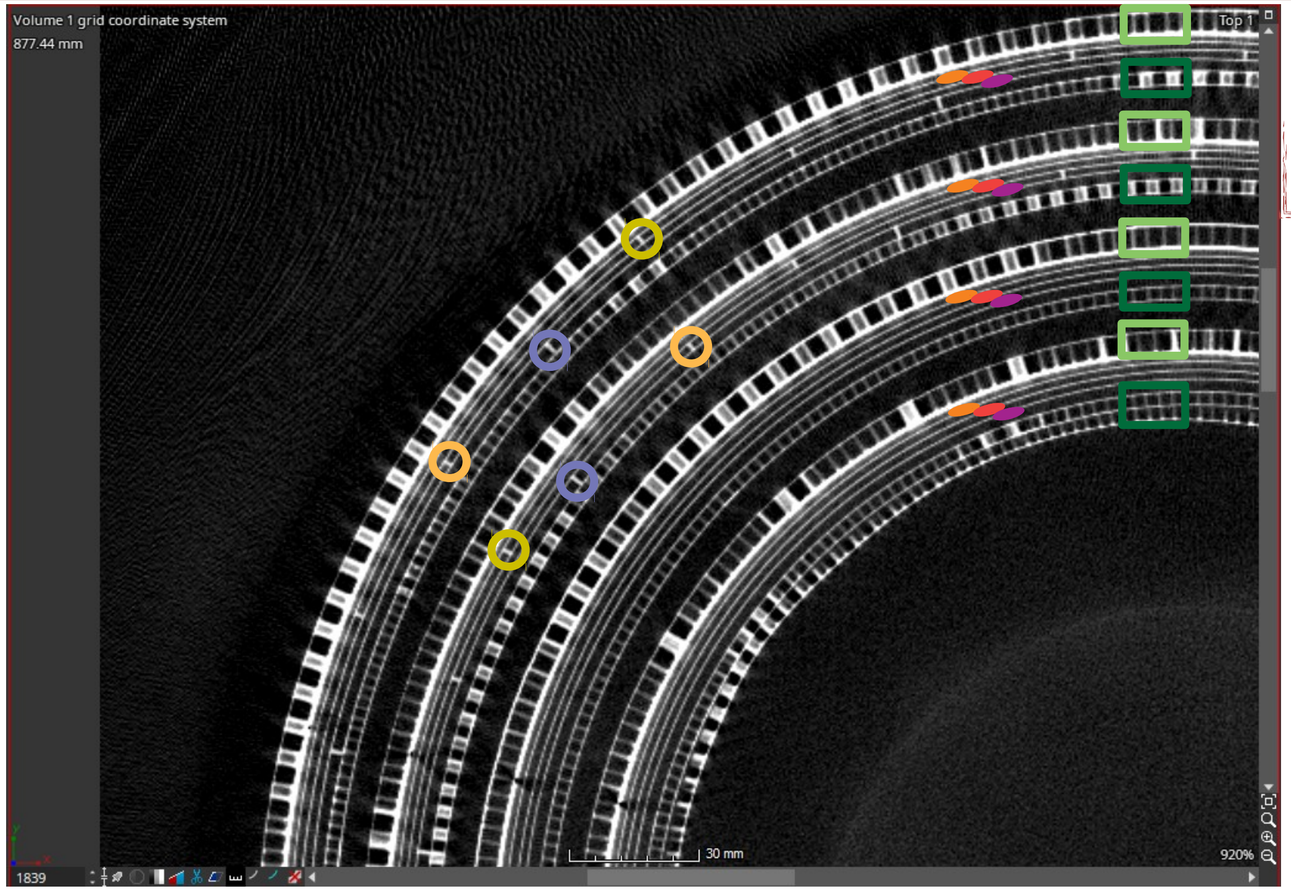
12.1 → CGEM-IT L2

7.6 → CGEM-IT L1

Inner radius [cm]

CT SCAN TO KLOE-2 CGEM DETECTOR





L4 ---------- 20.5

L3 ---------- 18.0 → accident during production

16.1 → CGEM-IT L3

L2 ---------- 15.5

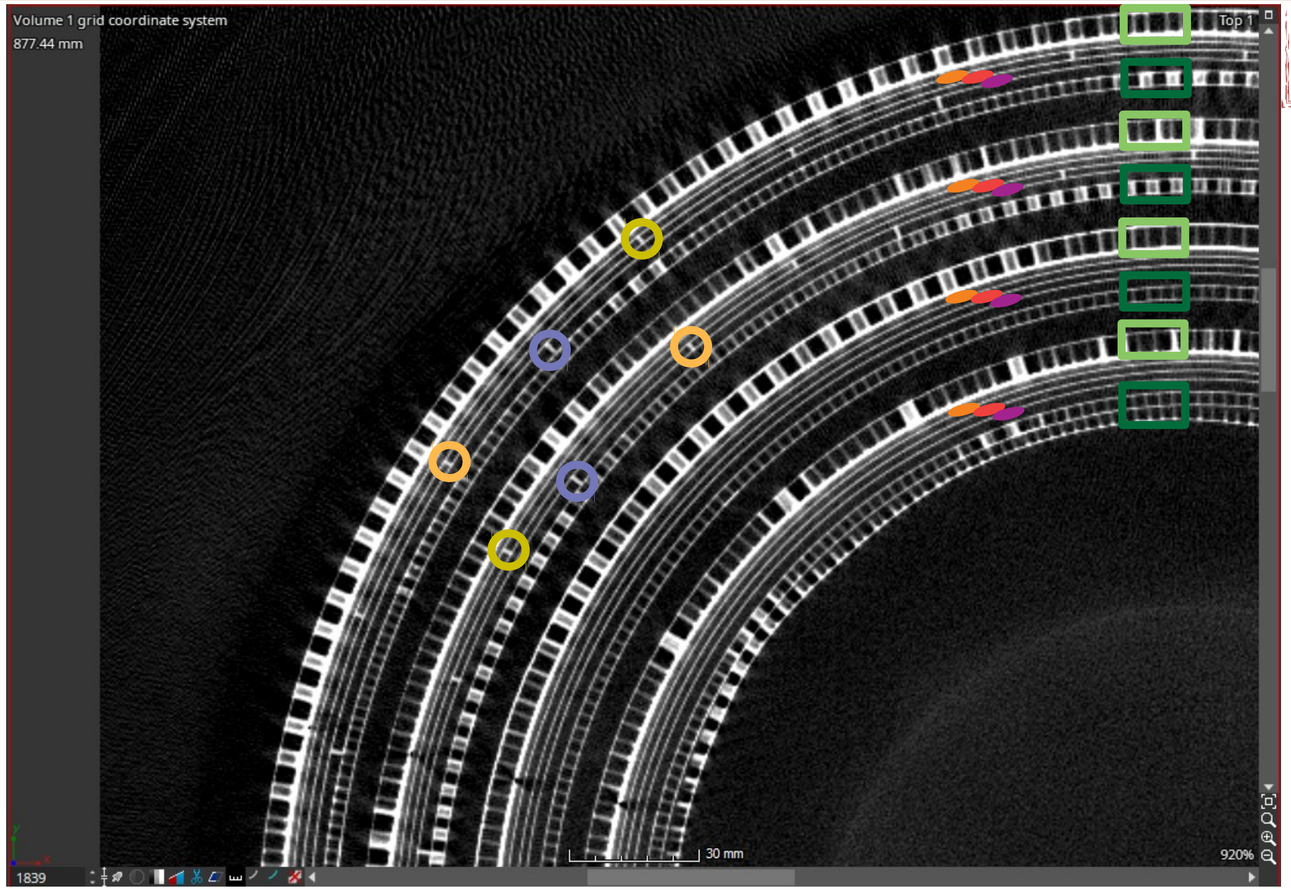
L1 ---------- 13.0

12.1 → CGEM-IT L2

7.6 → CGEM-IT L1

Inner radius [cm]

CT SCAN TO KLOE-2 CGEM DETECTOR



L4 ..... 20.5 → OK with grid

L3 ..... 18.0

16.1 → CGEM-IT L3

L2 ..... 15.5

L1 ..... 13.0

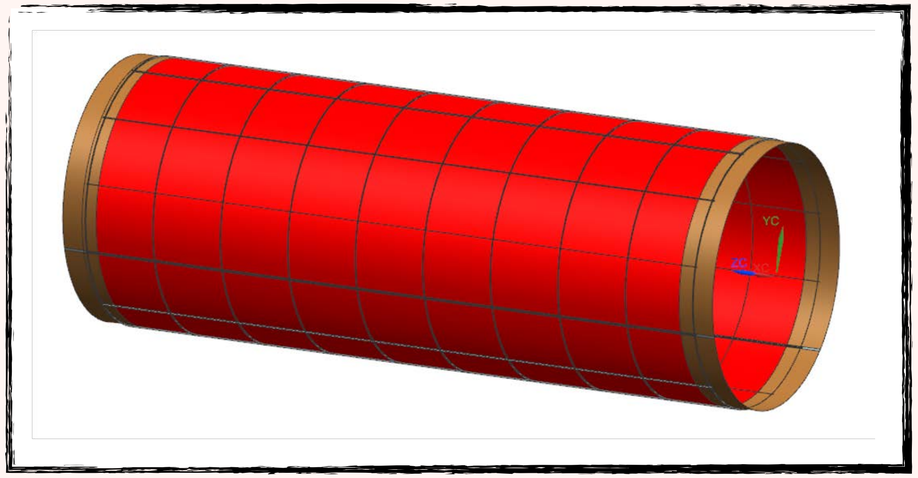
12.1 → CGEM-IT L2

7.6 → CGEM-IT L1

Inner radius [cm]

SPACING GRID

- KLOE-2 used a peek grid to keep the distance between the GEM foils on the outermost layers (L3 and L4)
- The grid have been shown to be effective in containing a large defects due to assembly accidents on KLOE-2 layer 3
- No buckling effects on KLOE-2 layer 4



- Dynamic simulation too complicated and would require some validation with data
- A mechanical test could be the best way to assess the its efficacy
  - Discussion in progress

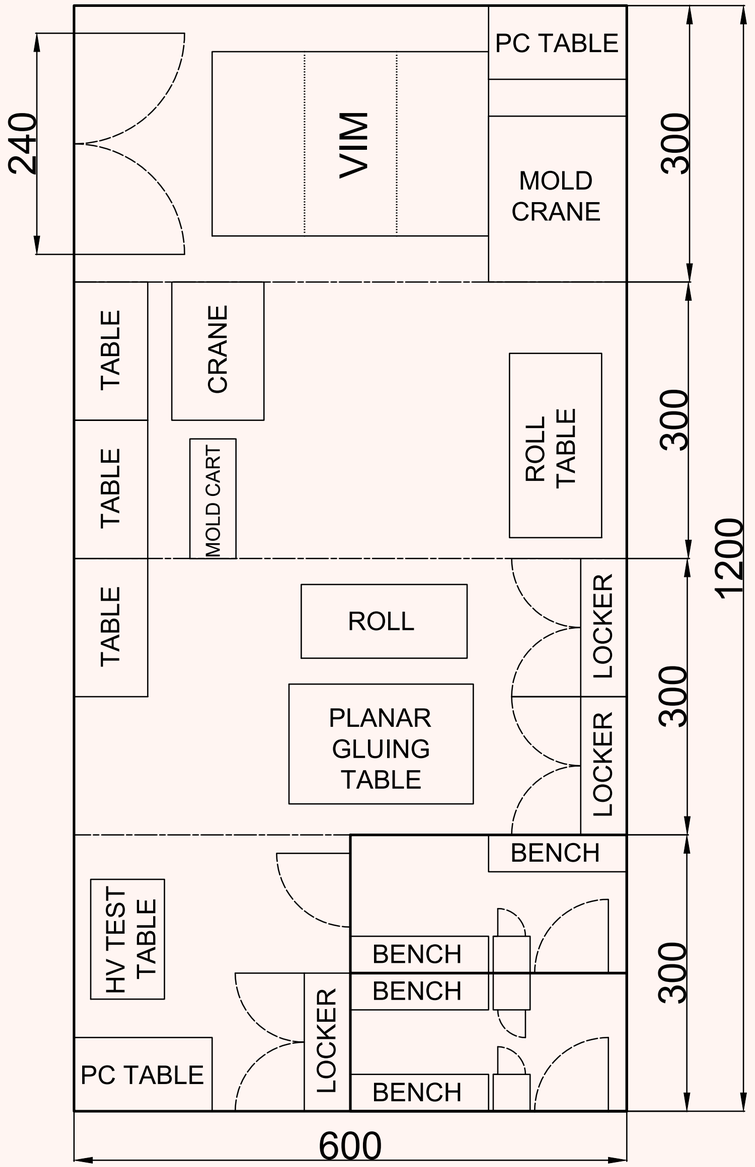
WHAT ABOUT L1 AND L2

- Preliminary buckling analysis on L1 and L2 showed higher limit points (about double for L2 and four times for L1)
- KLOE-2 CT scan seems to confirm that at small radius the design geometry is quite stable
- The two BESIII layers are working properly in Beijing (except when the humidity is very high)

Preparing for CGEM construction at IHEP

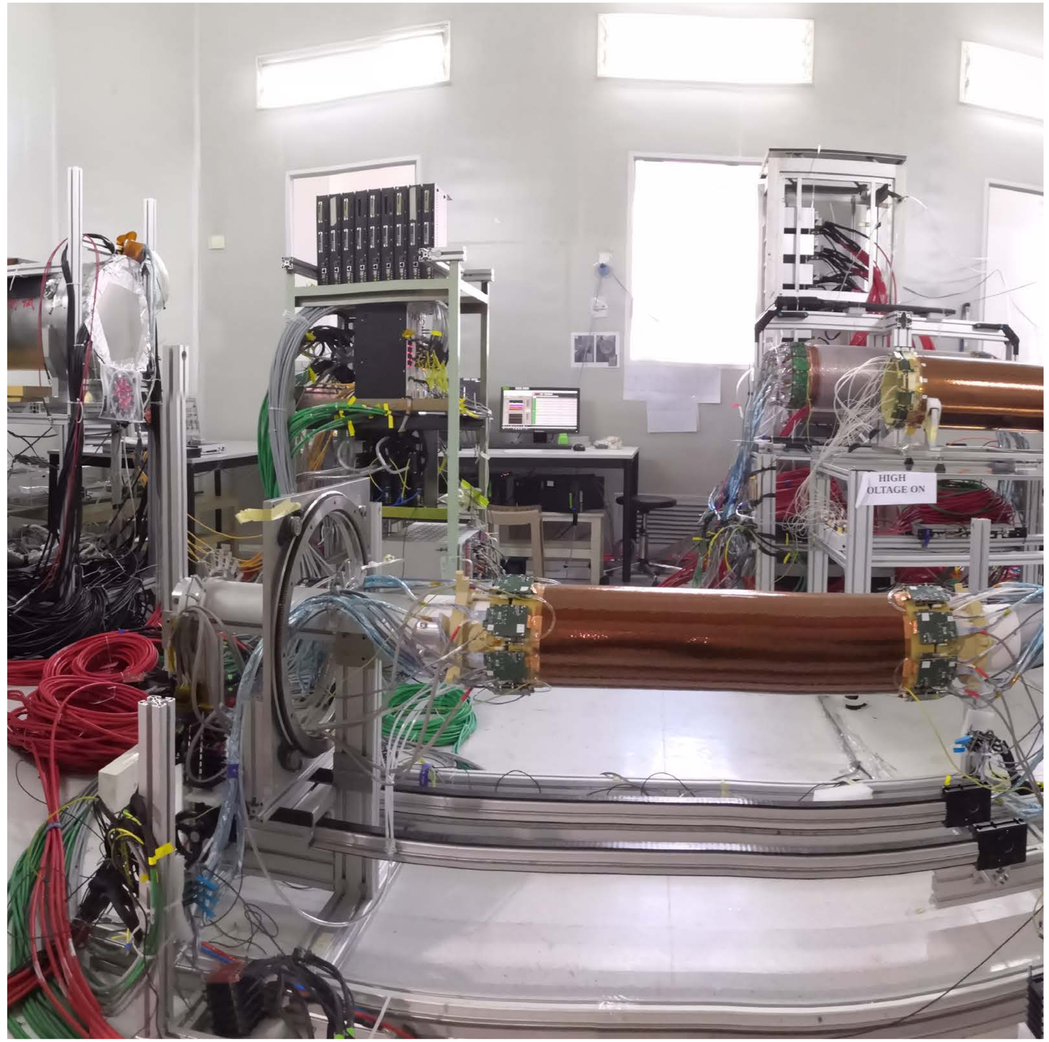
CLEAN ROOM REQUIREMENTS

- We are working to identify a place for the layer 3 construction @ IHEP with the help of Jianchun Wang, Qun Ouyang, Hai-Bo Li and Mingyi Dong
- About 72 m^2 are currently used for CGEM construction in the Frascati clean room
  - Test
  - Single electrodes gluing
  - Vertical Assembly
- The clean room is of Class 1000
- Non-standard height due to the vertical inserting machine —> 300 cm



UPGRADE THE CLEAN ROOM CURRENTLY USED FOR CGEM TEST

- Advantages
  - The ceiling is very high
  - We know the place very well
  - It’s available
- Disadvantages
  - Area is about 40 m^2 (vs 72 m^2 required) —> need to proceed in multiple steps: test, glue, assemble
  - Need to relocate the CGEM and MDC detectors
  - Need to be upgraded to Class 1000 —> big investment



Critical path

No task on the critical path —> due to the travel restrictions some activities must be monitored

- Layer 3 design to be completed by the end of 2021
- Logistics for construction at IHEP —> ~6 months
    - Setup clean room (discussion on that later)
    - Ship/build assembly infrastructures
- Assembly of the detector —> ~6 months
- L1 and L2 maintenance —> up to 12 months

the travel ban
is the main source
of uncertainty

THANKS!