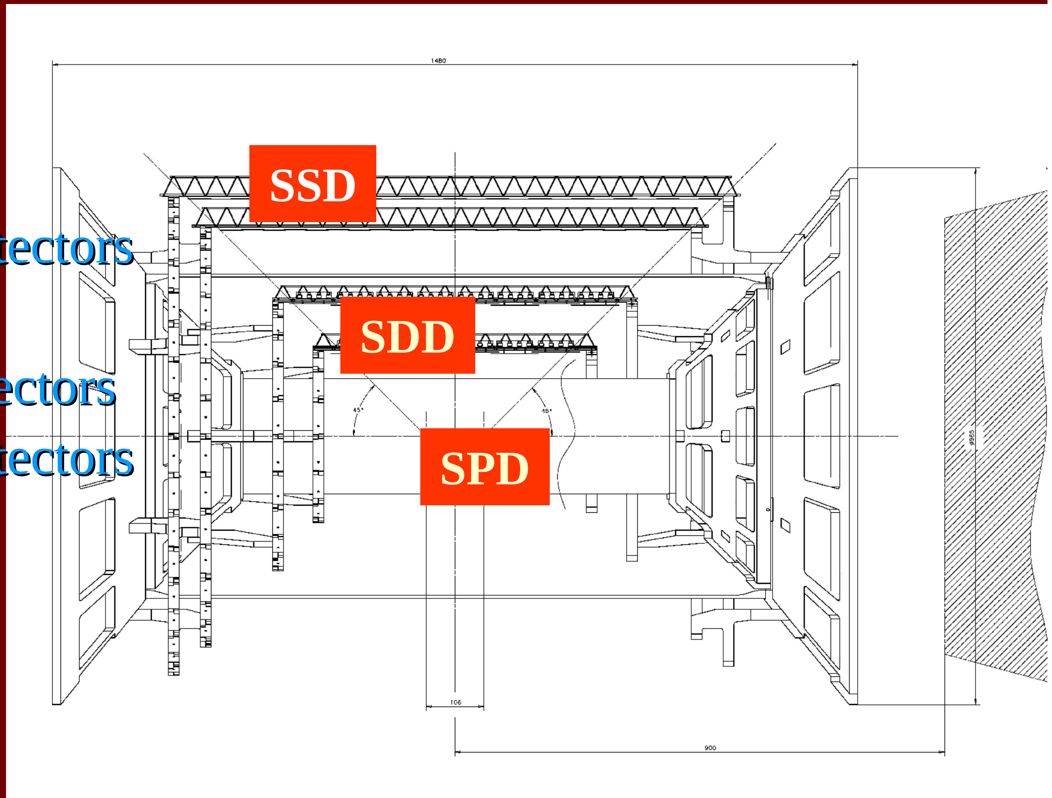
COMPOSITE MATERIALS FOR SUPPORT STRUCTURE: EXPERIENCE WITH ALICE's INNER TRACKING SYSTEM

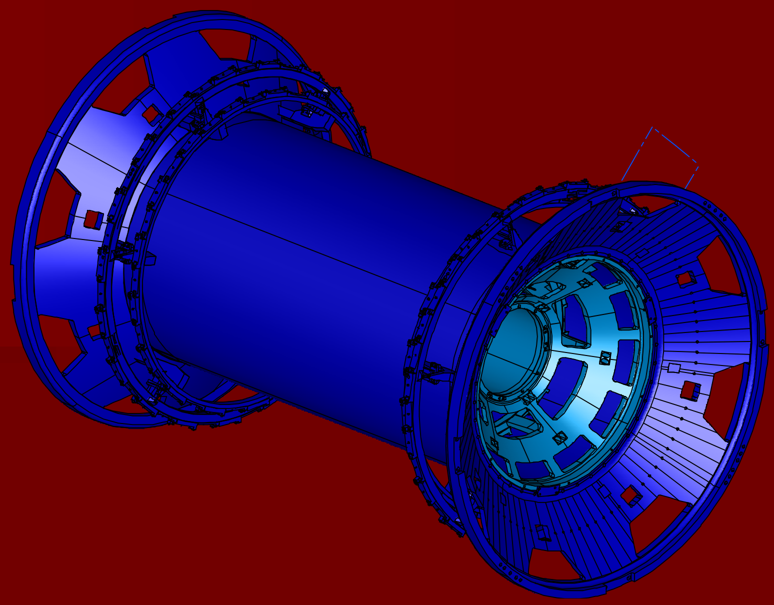
S.COLI, G.GIRAUDO, P.MEREU

I.N.F.N. TORINO

- 6 layers of silicon detectors.
- 3 different technologies:
  - Pixels.
  - Drift.
  - Strips.
- 3 sub-system.
  - SPD – 240 ladders, 240 detectors (not shown)
  - SDD – 36 ladders, 260 detectors
  - SSD – 72 ladders, 1698 detectors



The *ITS* support structure is a "*matrioska*" doll made by 2 similar, but independent sub-systems.



Each sub-system consist of:

- 2 cones
- 1 cylinder
- 4 supporting rings (for ladders)
- 12 connecting arms (for rings)

MAIN CHARACTERISTICS

- STIFFNESS
- GOOD LADDERS POSITIONING (<50 μm)
- HYGRO-THERMAL STABILITY
- SAVE MATERIAL BUDGET
- ACCURATE POSITIONING IN THE WORLD (i.e. TPC)

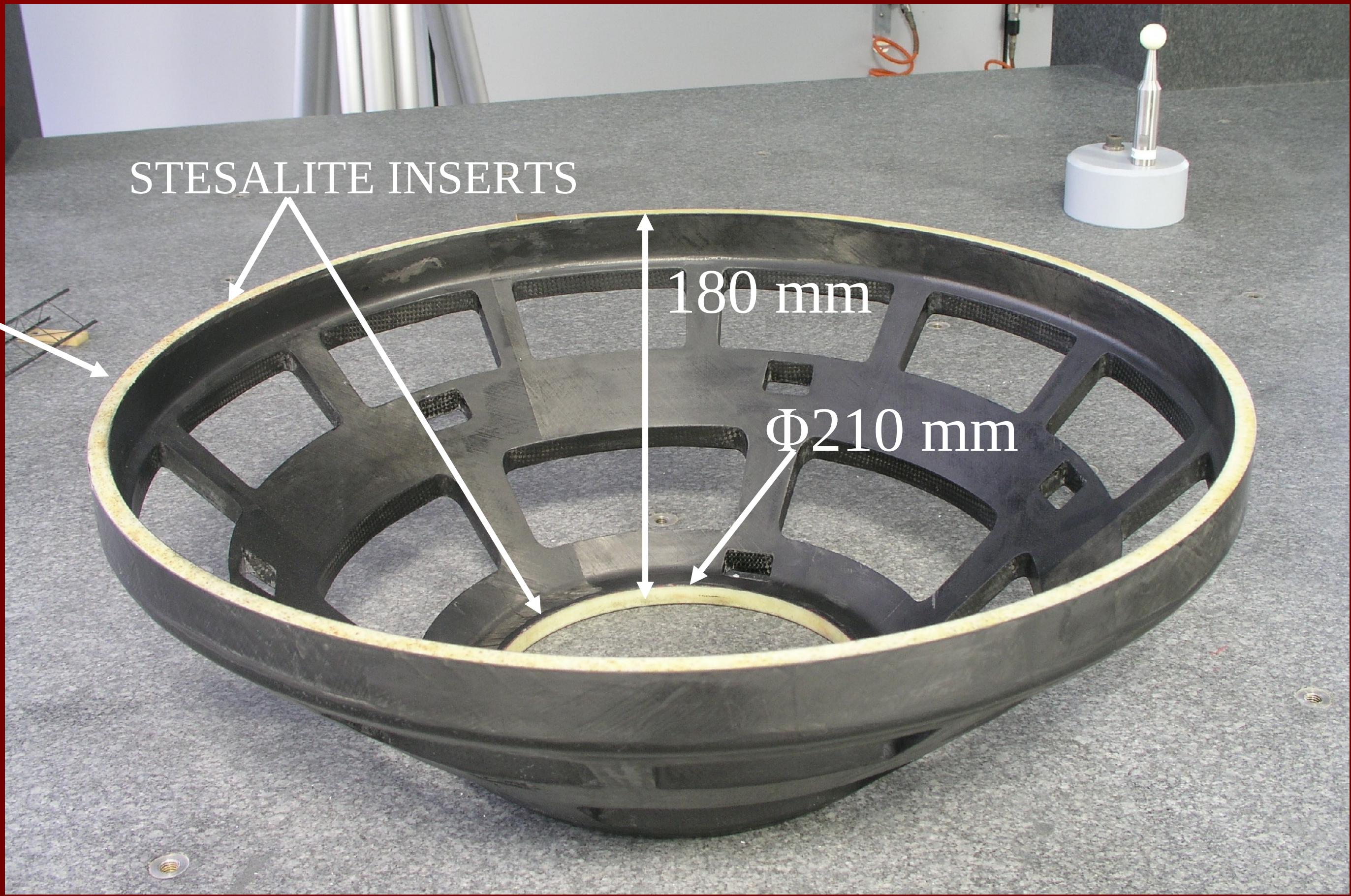
All *ITS's* structural parts are sandwich structure made by M55J/EU334 and Rohacell 51-IG, except the SSD's cylinder, made by HM80/EU334

	TENSILE MODULUS (GPa)	**STRENGTH (MPa)**	**DENSITY (kg/dm^3)**	**X_0 (mm)**
M55J/EU334*	270	2100	1,9÷2,1	~300
HM80/EU334*	470	1900	1,9÷2,1	~300
ROHACELL 51-IG	0,036	1,9	0,052	~6.665

*UNIDIRECTIONAL

THE SDD CONE

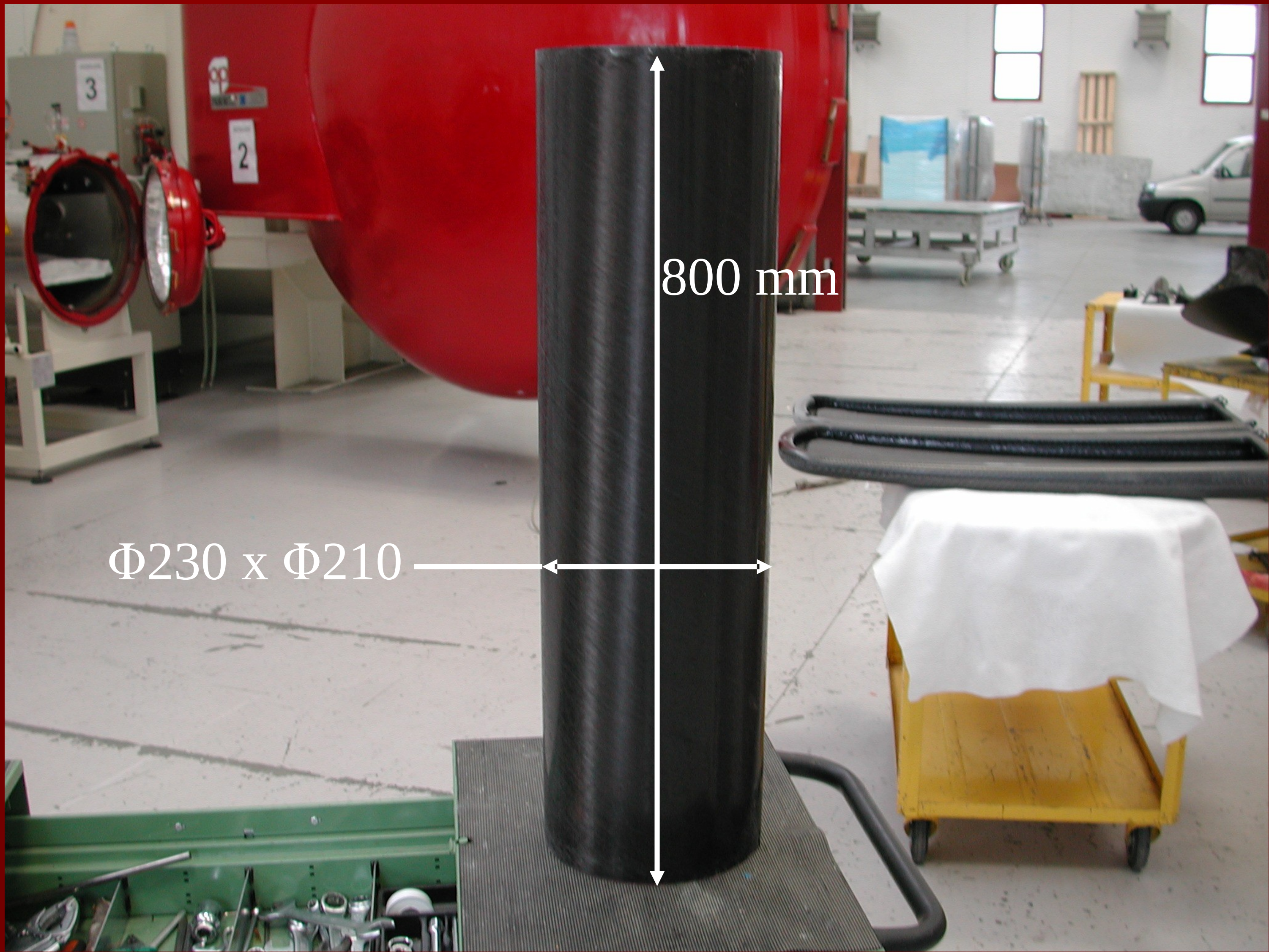
Φ600 mm



THE SDD CONE MANUFACTURING

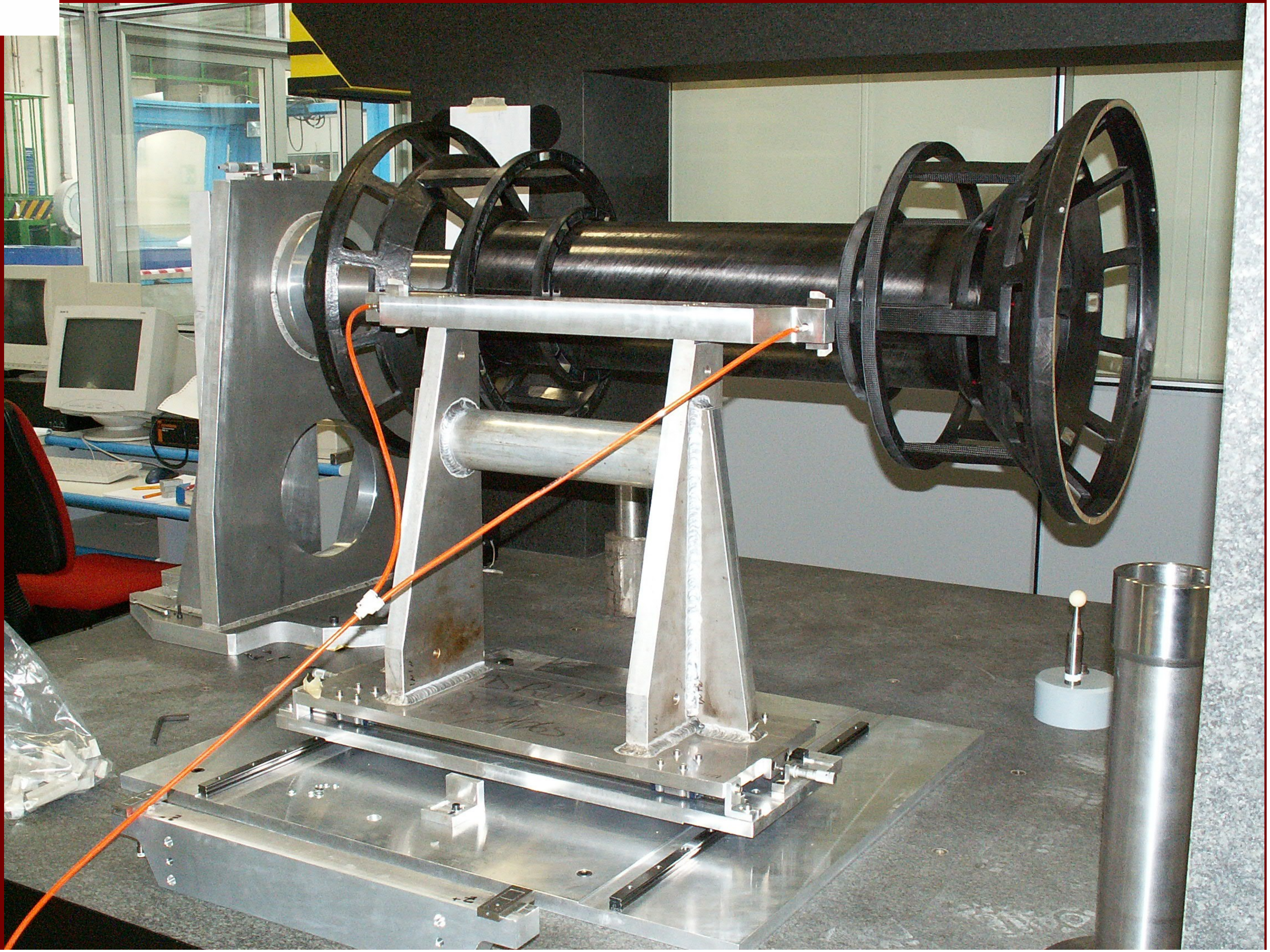
- ✓ 4+4 PLIES M55J/EU334-100
- ✓ STESALITE HEADS
- ✓ CORE - ROHACELL 51-IG – 10mm
- ✓ 2.1 kg

THE SDD CYLINDER



THE SDD CYLINDER MANUFACTURING

- ✓ 3+3 PLIES M55J/EU334-100
- ✓ STESALITE HEADS
- ✓ CORE - ROHACELL 51-IG – 10mm
- ✓ 1.5 kg



THE SSD CYLINDER

THE SSD CYLINDER IS THE MAIN *ITS* STRUCTURAL ELEMENT.
IT HAS BEEN STUDIED AS SINGLE PART CONSTRAINED IN CANTILEVER MODE, STRESSED BY 1000N ON THE FREE END.

FEM

- MATERIAL BUDGET
- TYPE OF STRUCTURE (i.e. SHELL/SANDWICH)
- STACKING SEQUENCE
- DEFLECTION UNDER STATIC LOAD

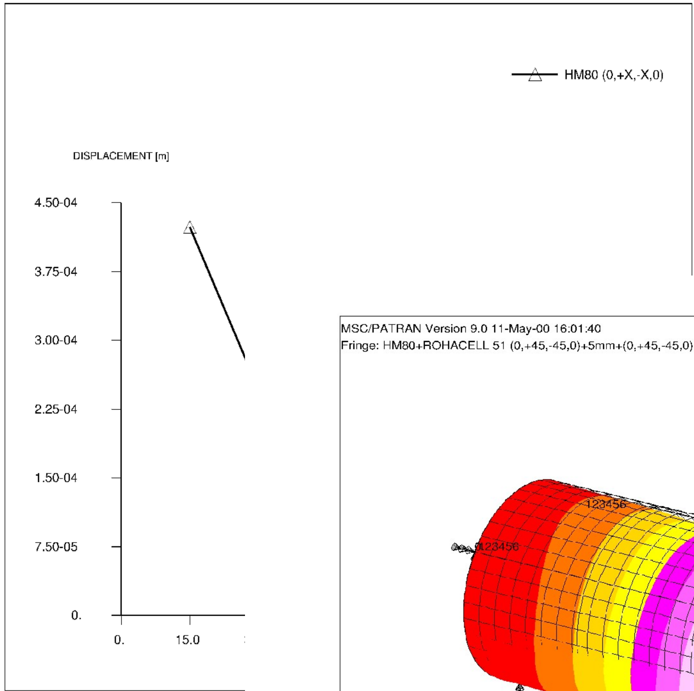
THE SSD CYLINDER

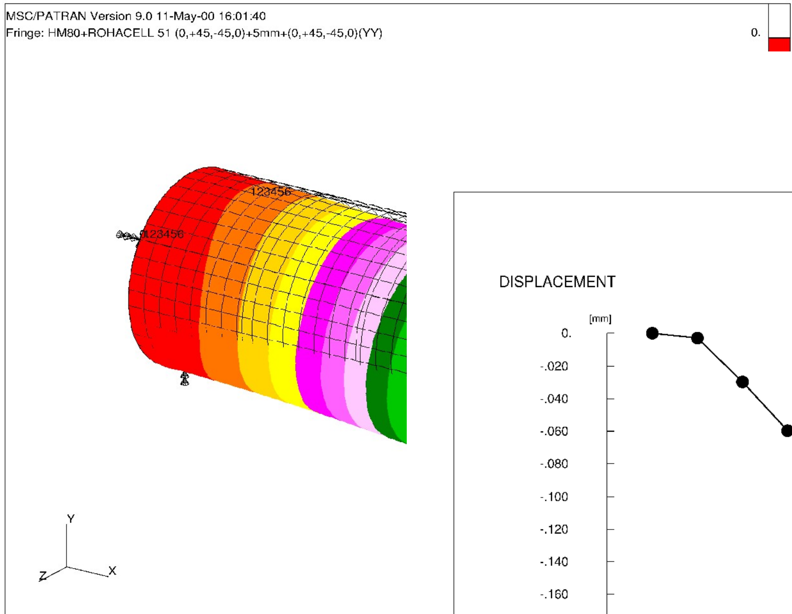
ρ_{min}=600mm

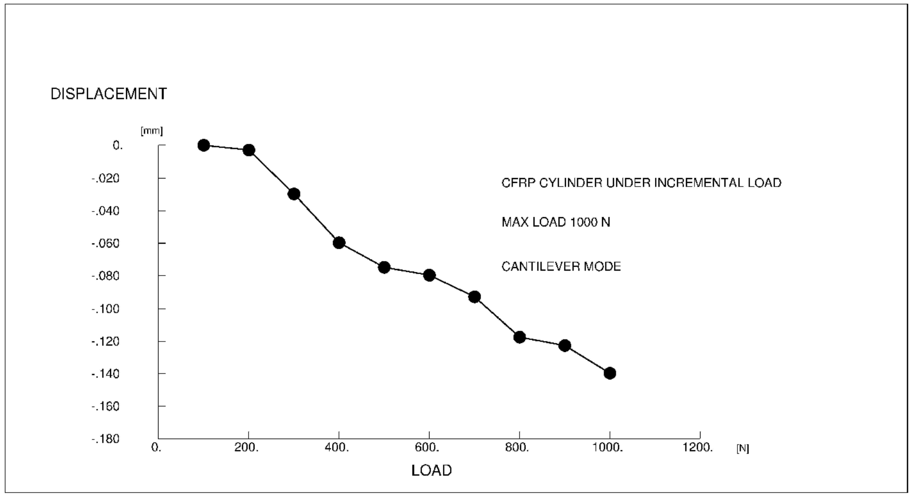
$$\tan\alpha = \sqrt{\frac{\rho\ min}{\quad} - 1} = 1$$

HM80 → 470 Gpa

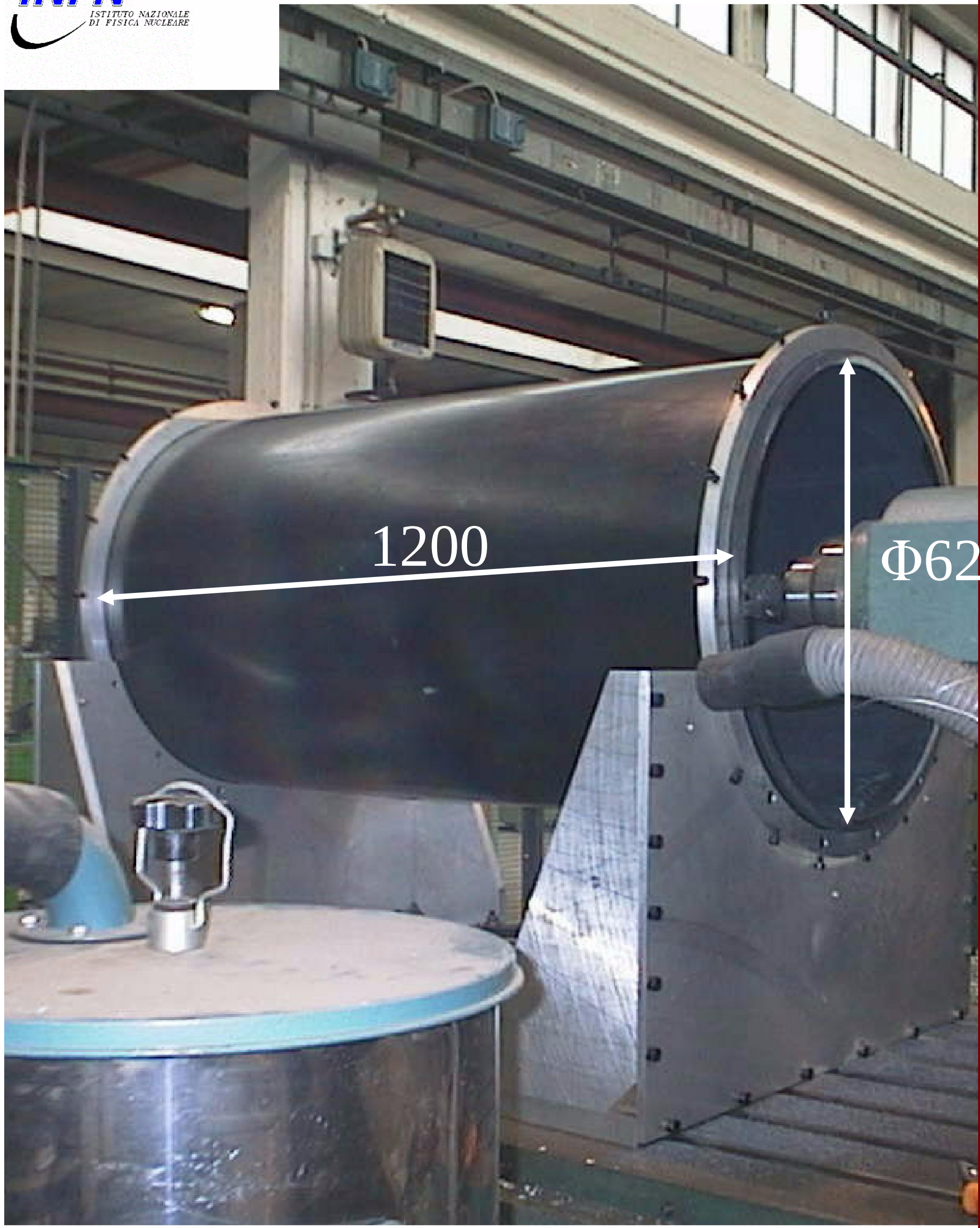
(0°,45°,-45°,0);(ROHACELL);(0°,45°,-45°,0)







THE SSD CYLINDER

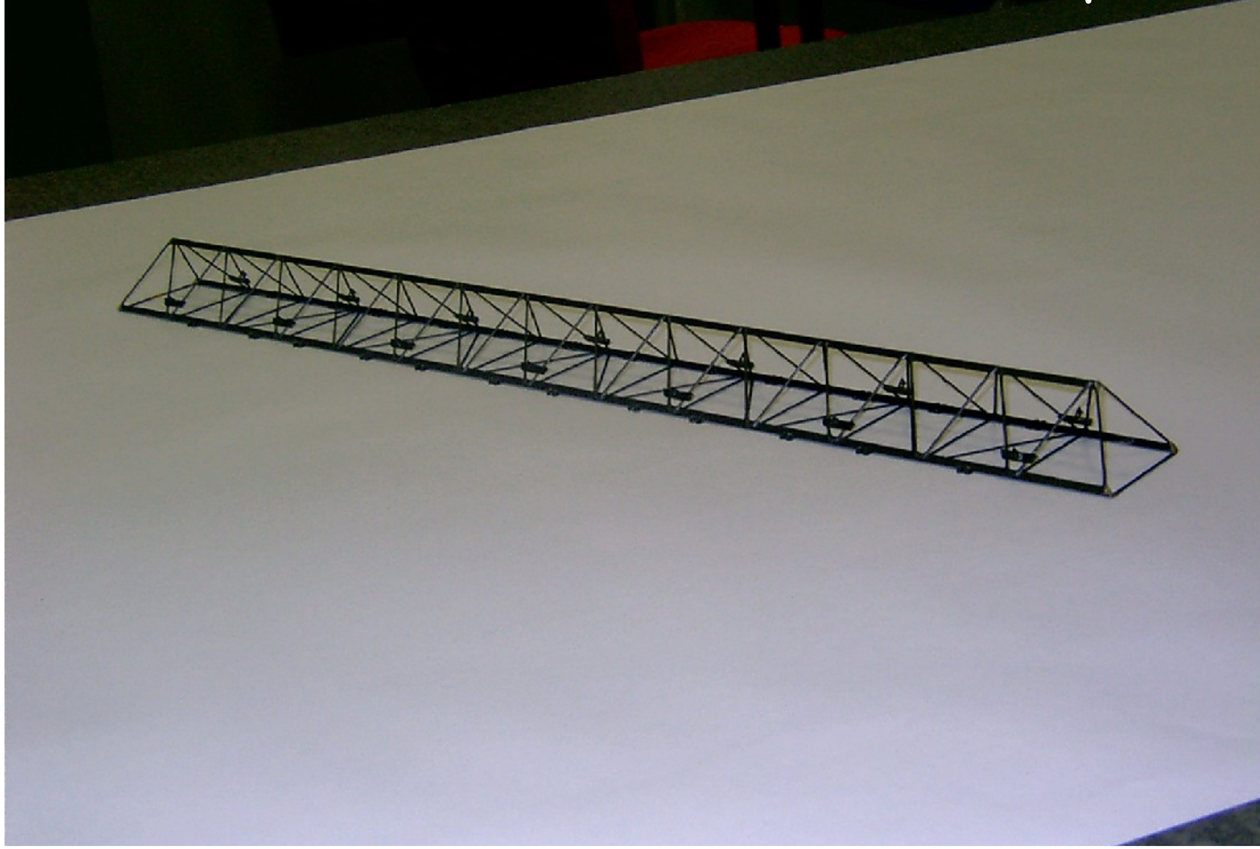


Φ620 x Φ610

4+4 PLIES => 1,2 mm
ROHACELL => 5 mm
0,5% X_0
WEIGHT = 10 kg

THE LADDERS

- *MONOLITHIC* SPACE FRAME
- ONE POLIMERIZATION CYCLE
- SUPPORT FOR DETECTORS, FRONT-END ELECTRONICS & COOLING ARTERIES
- DIMENSIONAL STABILITY ~10μm



MECHANICAL

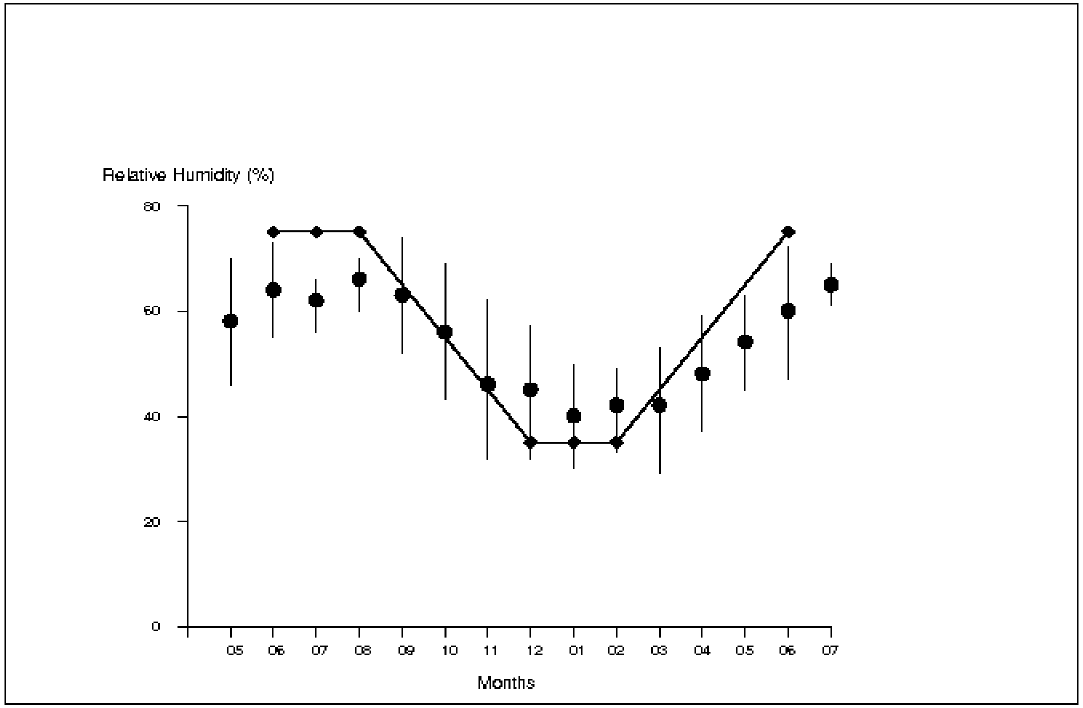
- **POSITION ACCURACY**
- **STIFFNESS**
- **STABILITY**
- **LOW-MASS**

$$\left.\right\} \quad E \cdot X_o >> 0$$

ENVIRONMENT

- **RADIATION RESISTANT**
- **LOW CTE**
- **LOW CME**
- **LOW MOISTURE ABSORPTION**

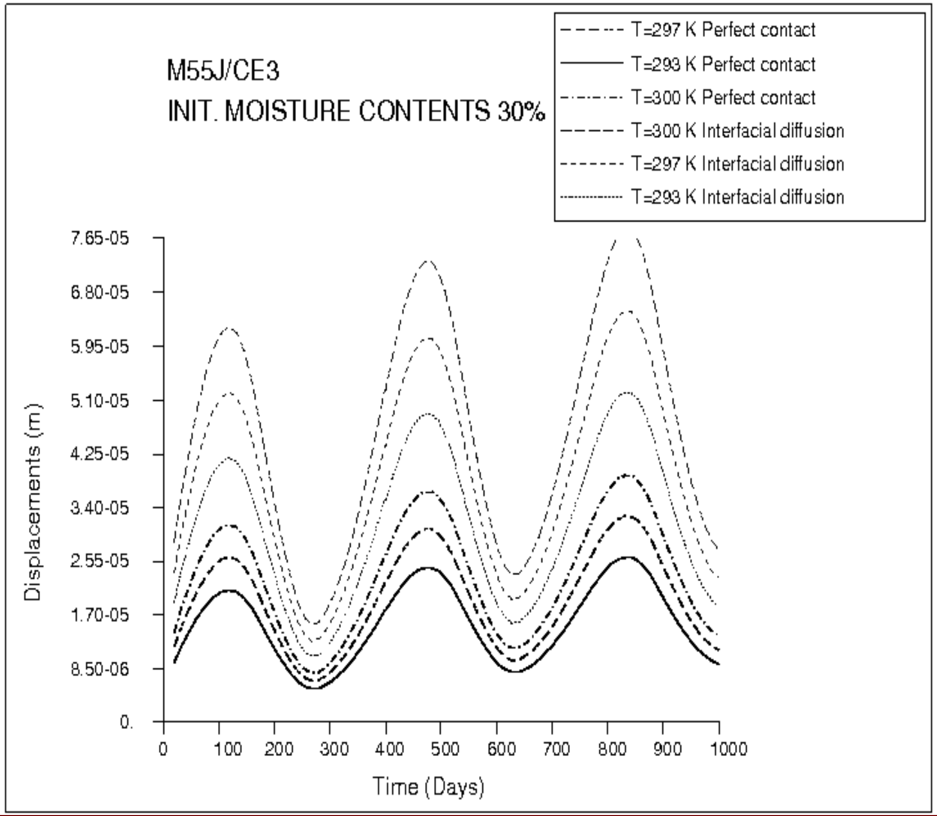
SIMULATION OF THE BEHAVIOUR WITH TRANSIENT ANALYSIS USING HYGRO-THERMAL ANALOGY

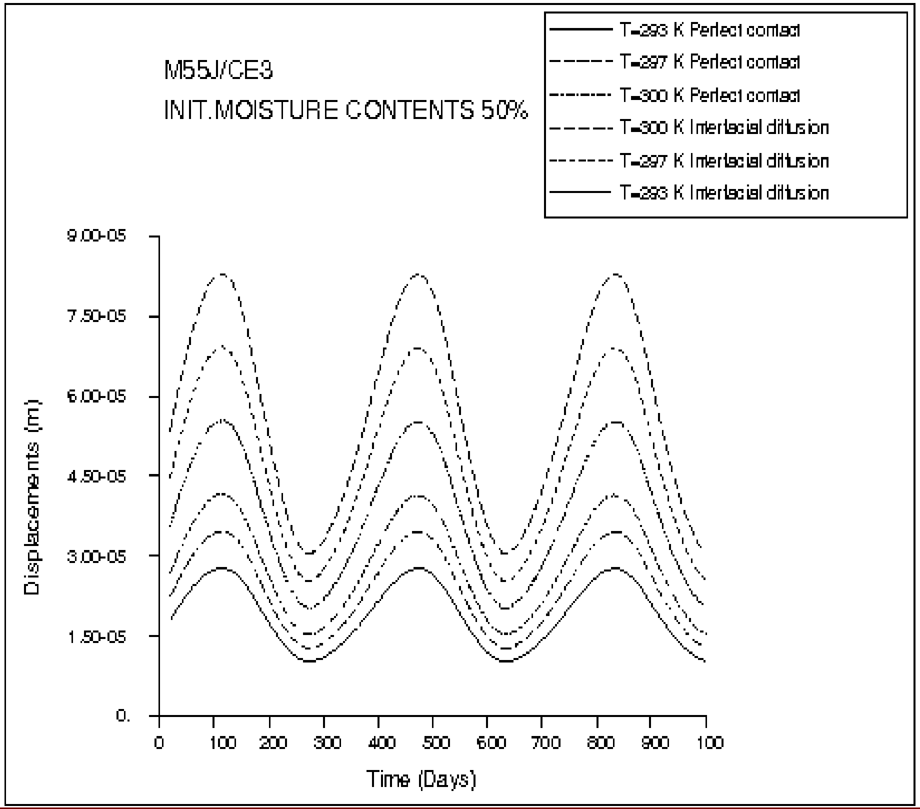


RH → 35% - 75%

TEMP. → 20 ^{O}C - 27 ^{O}C

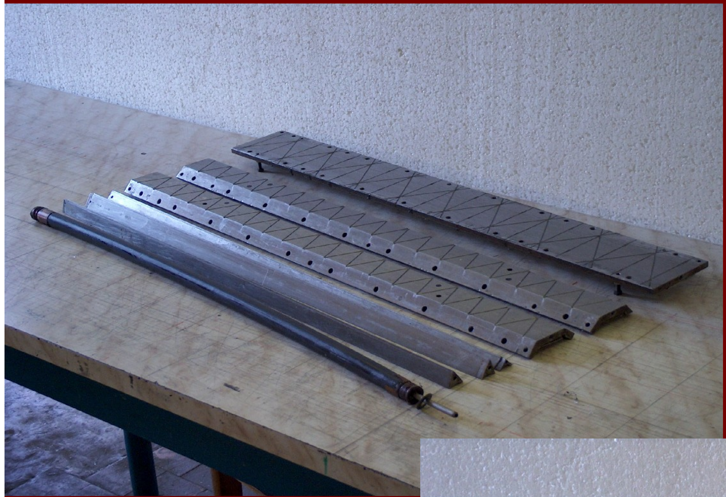
SIMULATION RESULTS

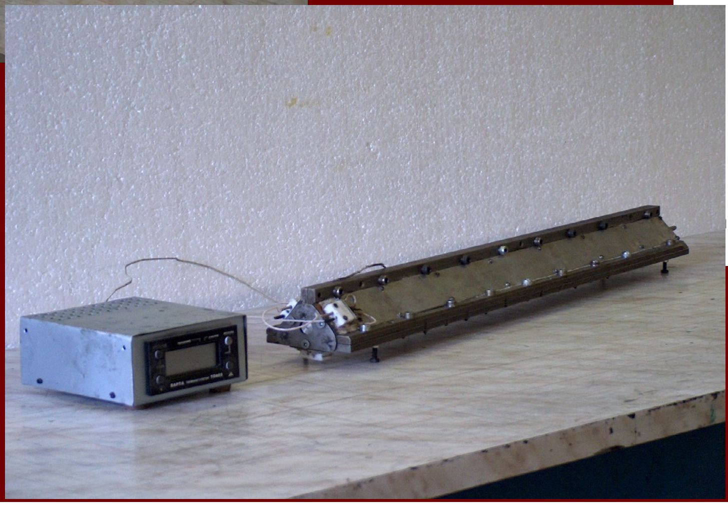


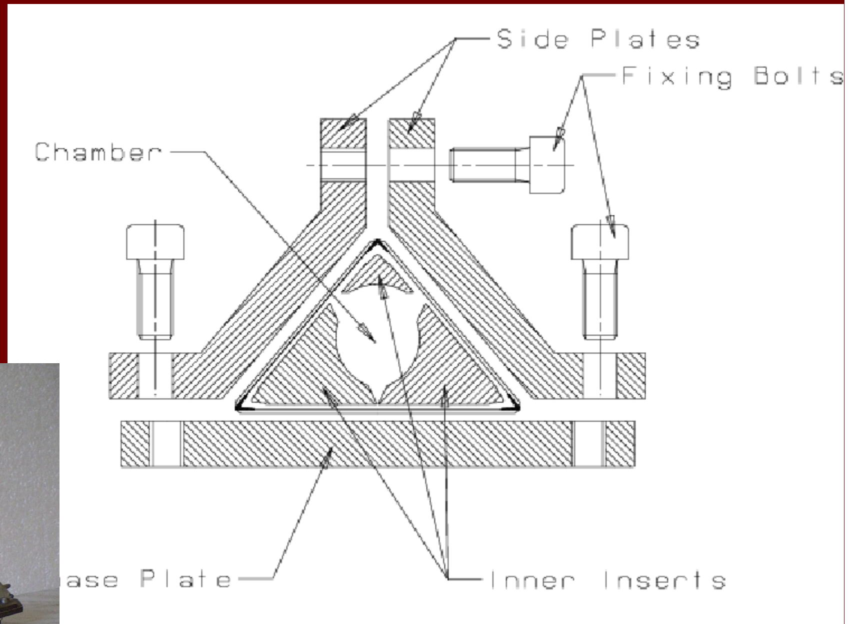


CENTRAL DESIGN BUREAU OF MACHINE BUILDING
STATE UNIVERSITY OF ST.PETERSBURG

- ONE CYCLE PROCESS
- PRECISION METAL MOLDS







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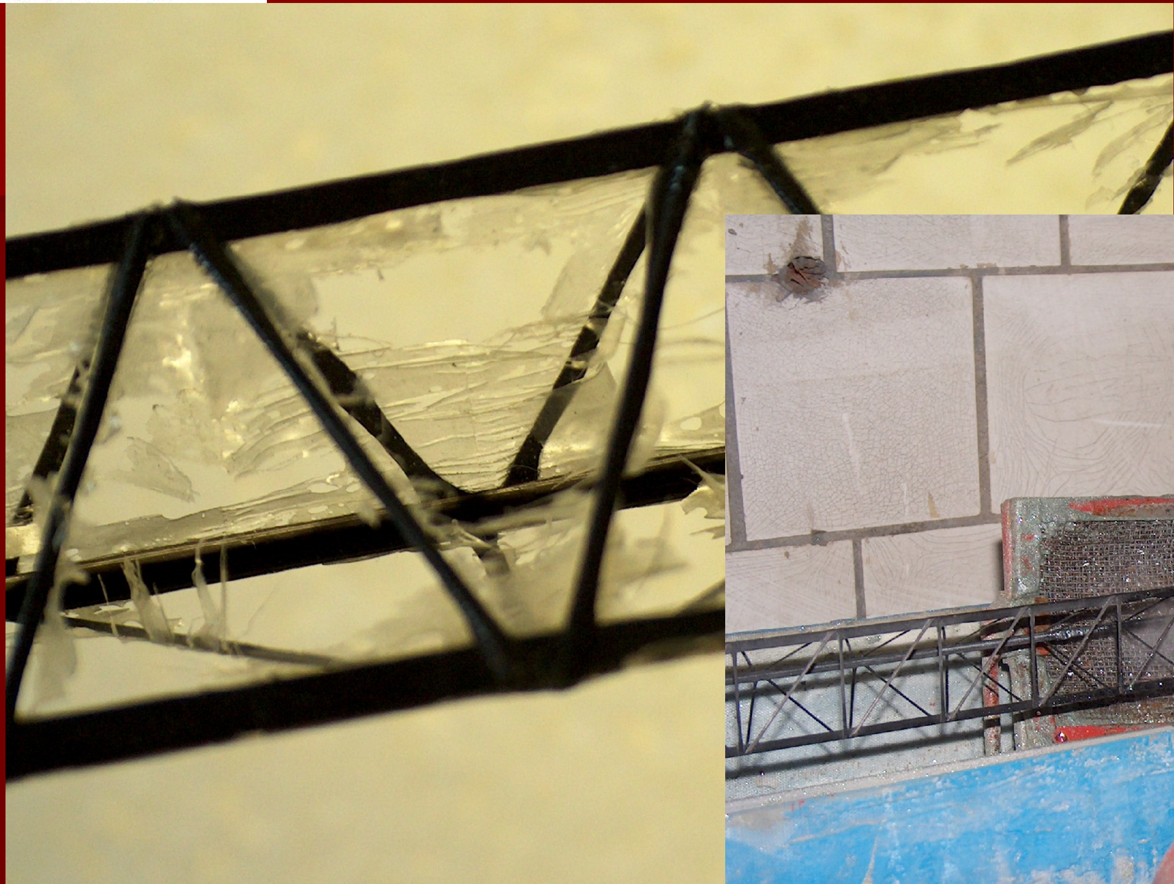
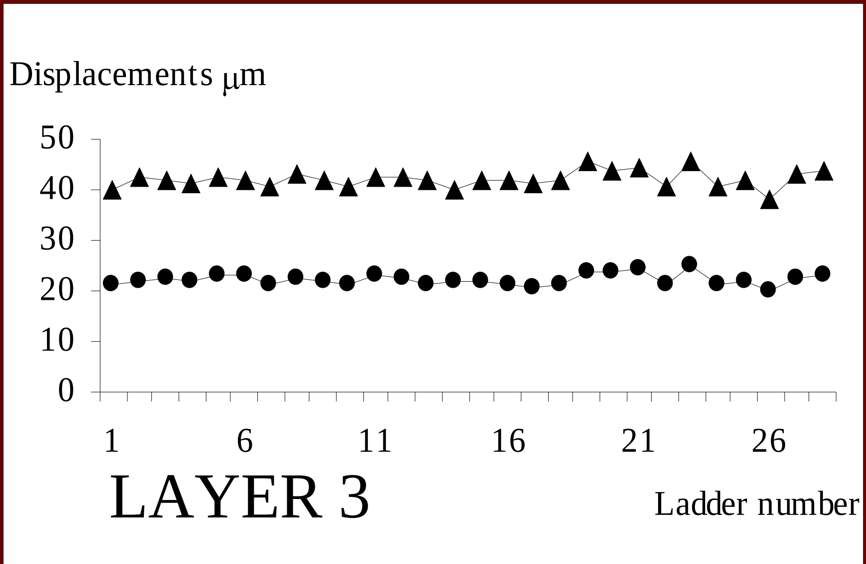
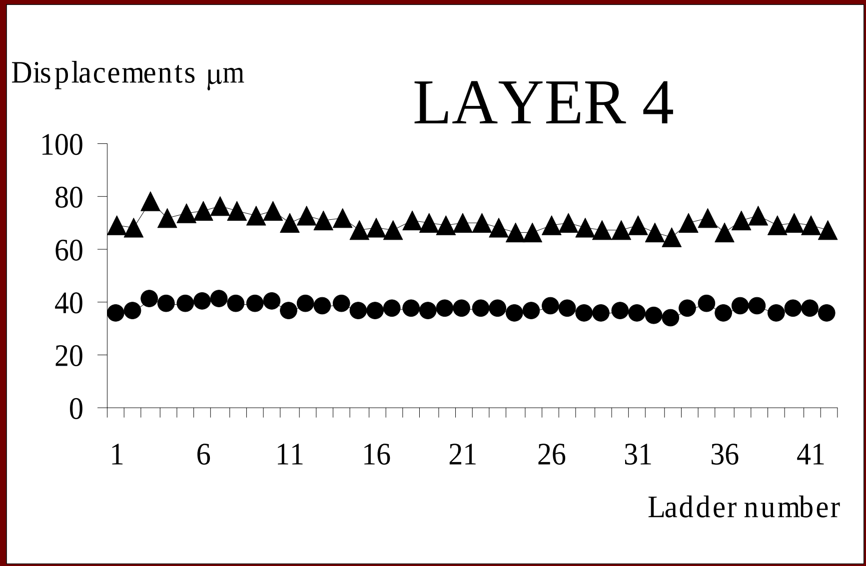
LADDERS MANUFACTURING



FINAL TESTS

- ❑ VISUAL INSPECTION
- ❑ SAGGING MEASURING
  - ✓ OPTICAL BENCH
  - ✓ INTERFEROMETER ACCURACY ±0,1 μm
  - ✓ APPLIED LOADS: 120g – 240g





CONCLUSION

THE STRUCTURAL ELEMENTS DESCRIBED COMPLY WITH THE MECHANICAL CONSTRAINTS IMPOSED BY THE ALICE EXPERIMENT

- MANUFACTURING PROCESS
  - *O.K.*
- SIMULATIONS
  - *LOCAL CONTROL OF TEMPERATURE AND HUMIDITY*
  - *SURFACE COATING*
- LOADS
  - *STABILITY → $\pm 10\mu m$*