# The microMegas construction project for the ATLAS New Small Wheel

D.Sampsonidis, C.Petridou, P.Charalampous, S.Kompogiannis and C.Lampoudis

Aristotle University of Thessaloniki

I.Gkialas
University of the Aegean

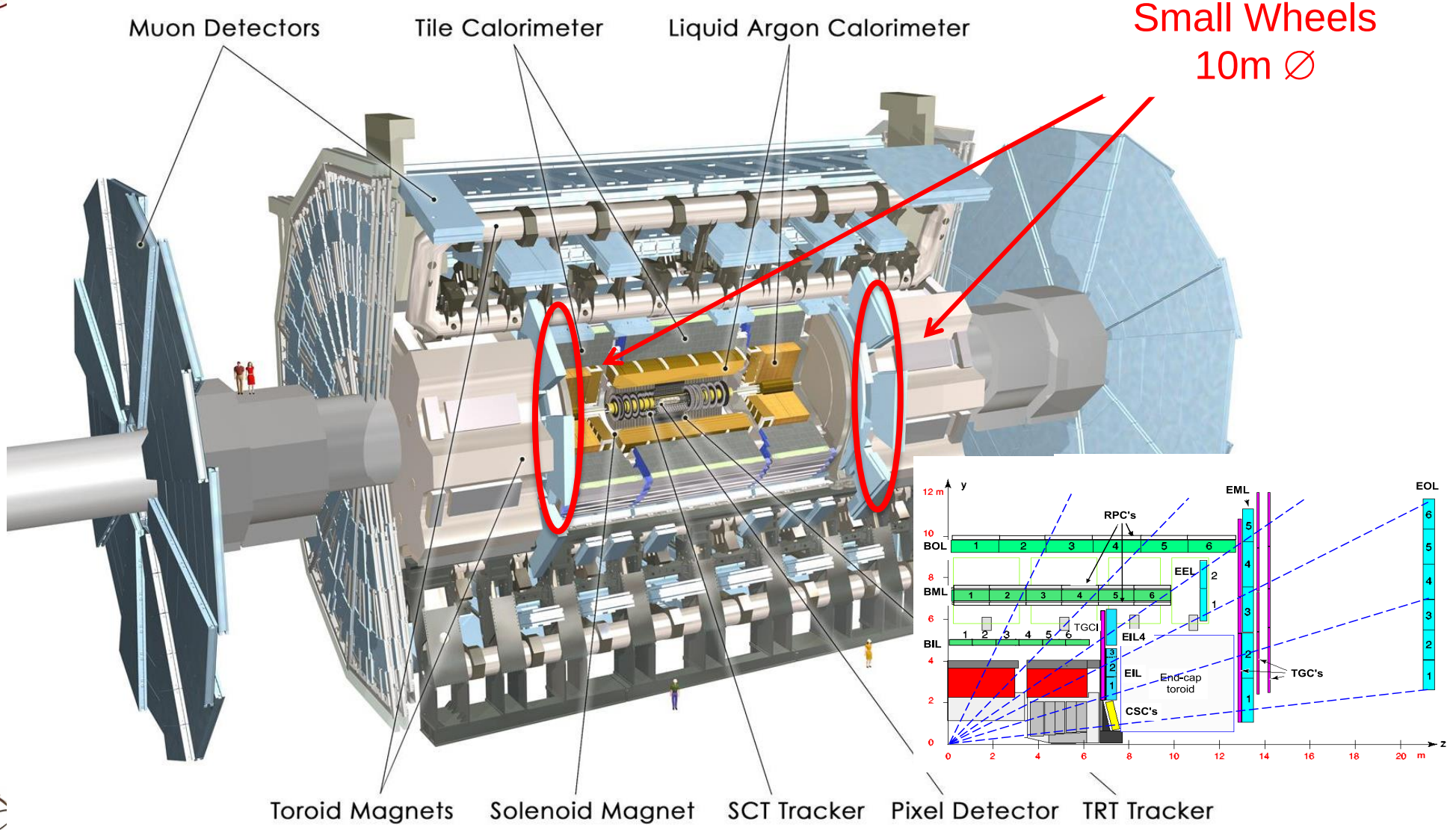
HEP 2015 – Conference on Recent Developments in High Energy Physics and Cosmology
15 – 18 April, Athens – Greece

European Union
European Social Fund
OPERATIONAL PROGRAMME EDUCATION AND LIFELONG LEARNING
investing in knowledge society
MINISTRY OF EDUCATION, LIFELONG LEARNING AND RELIGIOUS AFFAIRS
MANAGING AUTHORITY
NSRF 2007-2013
programme for development
EUROPEAN SOCIAL FUND
Co- financed by Greece and the European Union

# Contents

- ATLAS NSW project
- microMegas: objectives and construction
- Work share (construction sites)
- AUTh site readiness
  - tooling (clean room)
  - procedures (QA-QC)
- The zebra connectors
- Concluding remarks

# Where?


Muon Detectors
Tile Calorimeter
Liquid Argon Calorimeter
Small Wheels
10m ∅
Toroid Magnets
Solenoid Magnet
SCT Tracker
Pixel Detector
TRT Tracker
RPC's
BOL
BML
BIL
EML
EOL
EEL
TGCI
EIL4
EIL
End-cap toroid
CSC's
TGC's

# Why?

**Tracking:**

- Current tracking detectors are marginal for the Phase-1 upgrade, unusable after Phase-2.
- In Phase-2 expected hit rate >5 MHz/ MDT tube
- MDT single tube and reconstruction efficiency drop at rate >300 kHz/tube

**Trigger:**

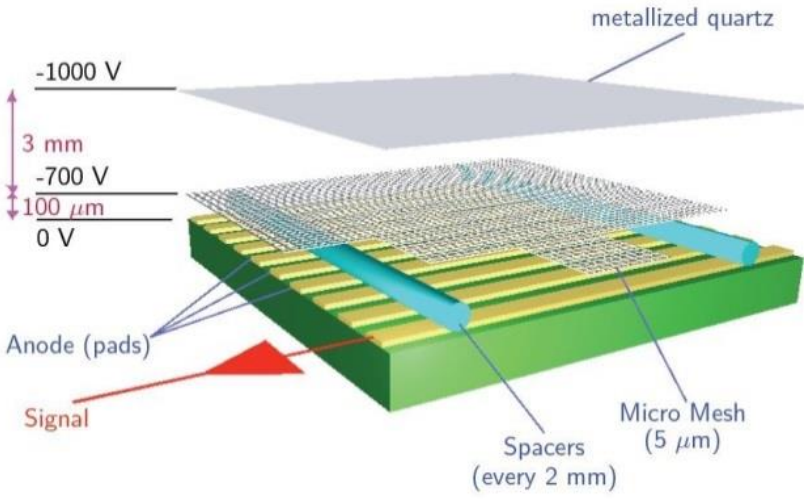
- L1 muon trigger rate in the End-cap dominated by fakes (>90%) 8-9 times larger than in Barrel
- At $3x10^{34}$ L1Mu20 ~60 kHz (bandwidth available ~15kHz) → prescale the trigger of factor 4 **loose 75%** of 'good' trigger; increasing the threshold does not help (still 30 kHz at 40 GeV)

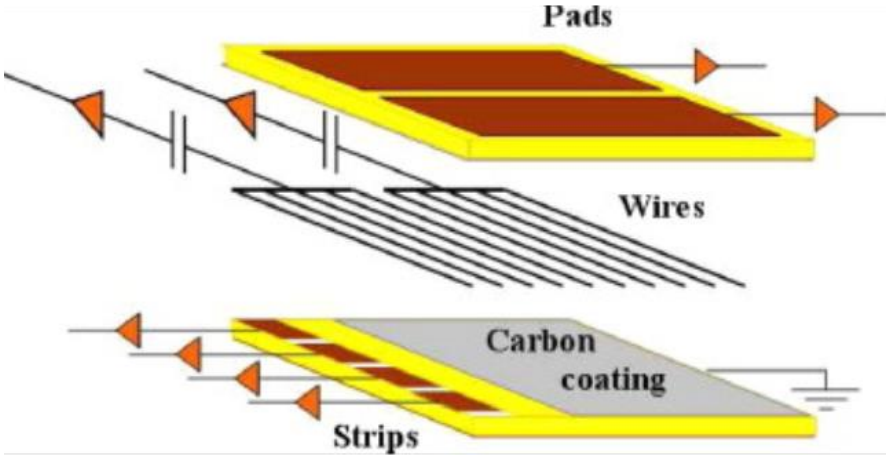
**New Small Wheel is needed with tracking and triggering capabilities**

# New Small Wheel: microMegas

**micro-Me**sh **Gas**eous detectors (microMegas) as primary precision tracker

- spatial resolution < 100 μm independent of track incidence angle
- good track separation due to small 0.5 mm readout granularity (strips)
- excellent high rate capability due to small gas amplification region and small space charge effects

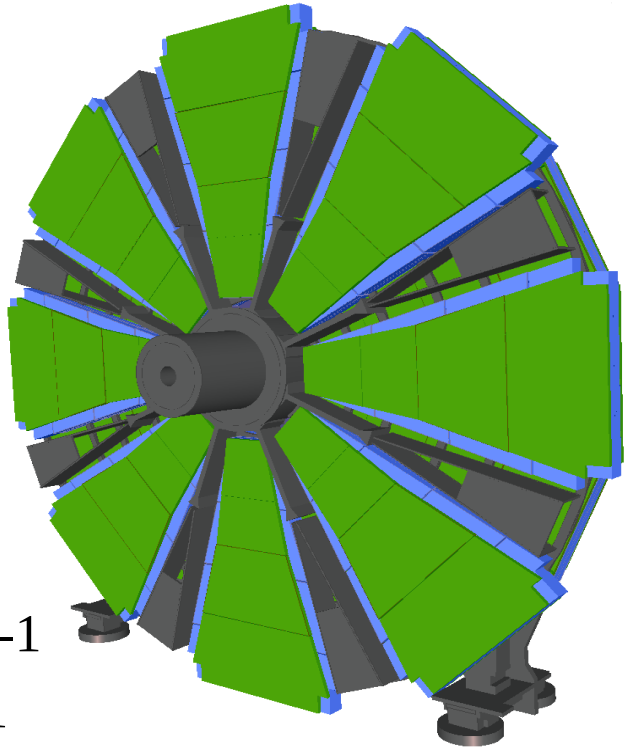


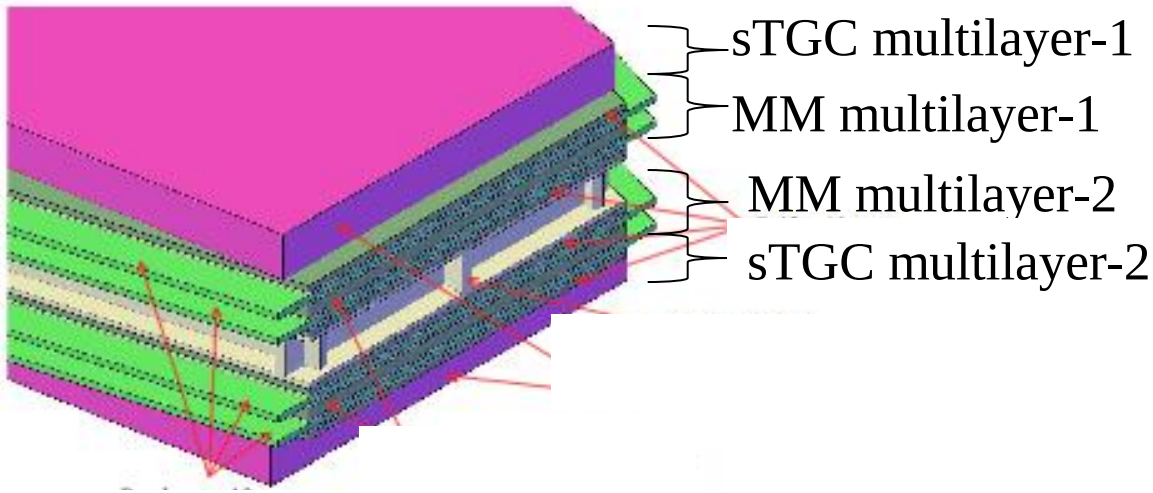




(a) a

# New Small Wheel

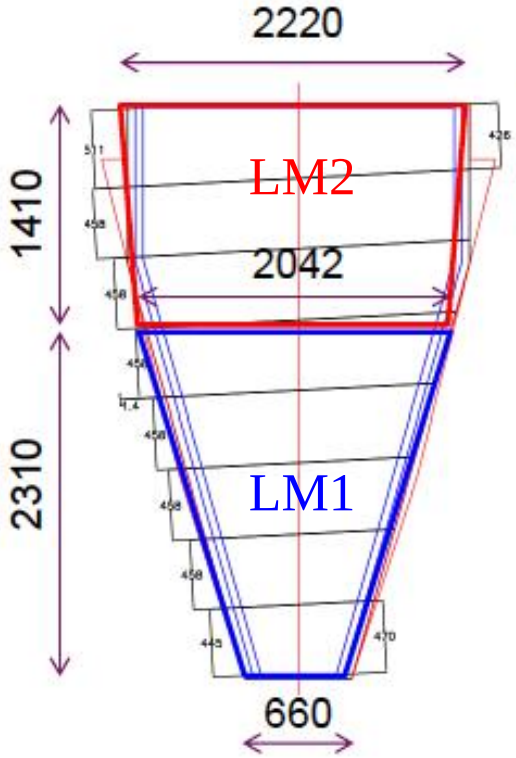
- 16 Sectors per wheel
  - 8 large
  - 8 small
- 2 multilayers per sector
- Each multilayer:
  - 4 sTGC planes
    primary detector for trigger
  - 4 microMegas planes
    primary detector for tracking

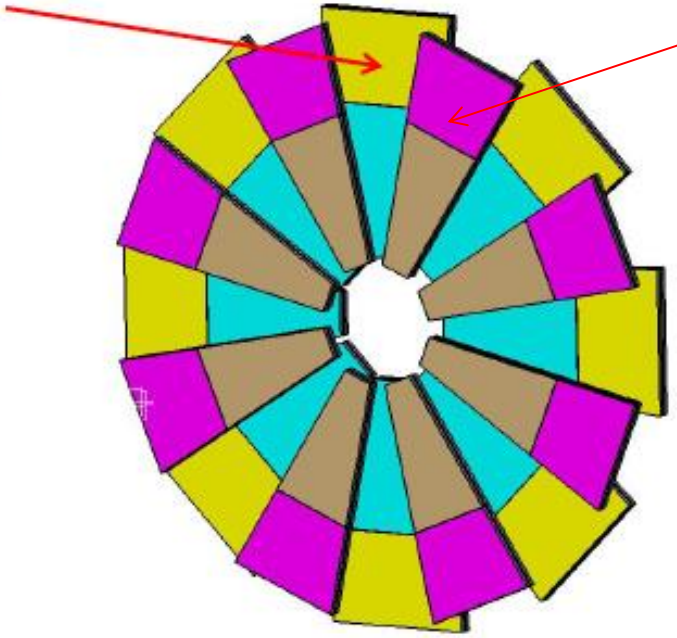




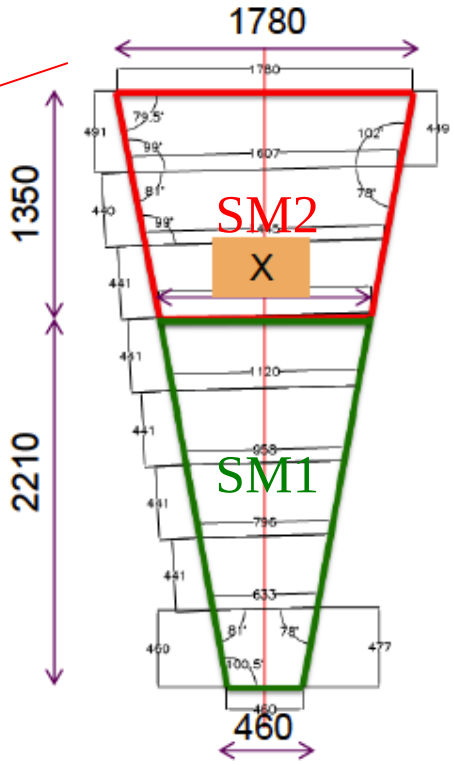
# mM Radial Segmentation

Large sector



Small sector




4 mM types (differ in size)

SM1, SM2, LM1, LM2

# microMegas construction

**microMega modules production to be done in different production sites according to type:**

**SM1: Italy, INFN consortium – Pavia, Rome 1 + 3, Frascati, Lecce, Cosenza, Napoli**

**SM2: Germany (Wurzburg, LMU Munich, Freiburg, Mainz)**

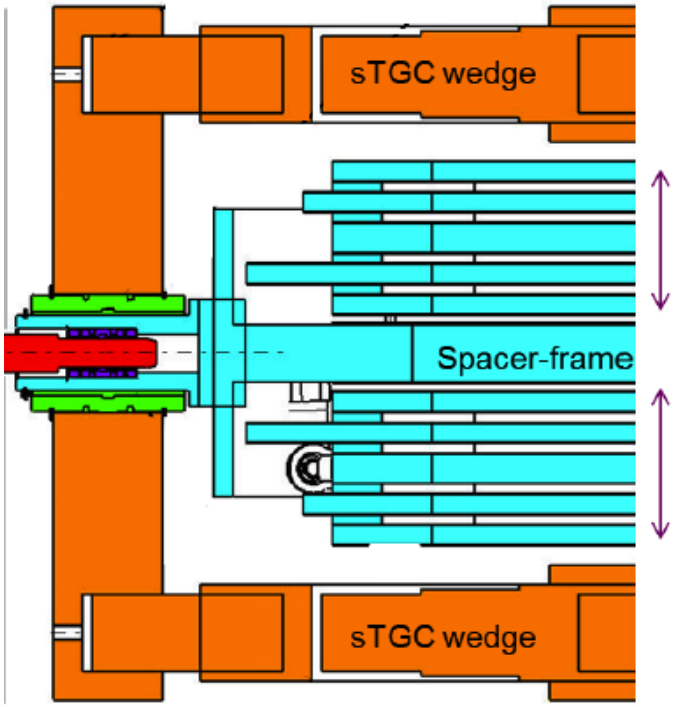
**LM1: Saclay**

**LM2: Thessaloniki (drift panels, assembly) + Dubna (readout panels, assembly)**

## Engineering challenges

Large Size detectors with planarity of the single plane and the alignment of different layers below 80 μm and mechanichal precision of 30 μm along the precision coordinate as required by the desired spatial resolution.

# mM Quadruplet




**A single mM module (quadruplet) consists of**

5 panels of two PCB skins on a honeycomb structure,
2 readout panels (twin),
3 drift panels (2 external, 1 internal)
4 meshes stretched on frames
Mechanical frames, gas circulation system etc.

## mM Quadruplet

4 microMegas planes
primary detector for tracking

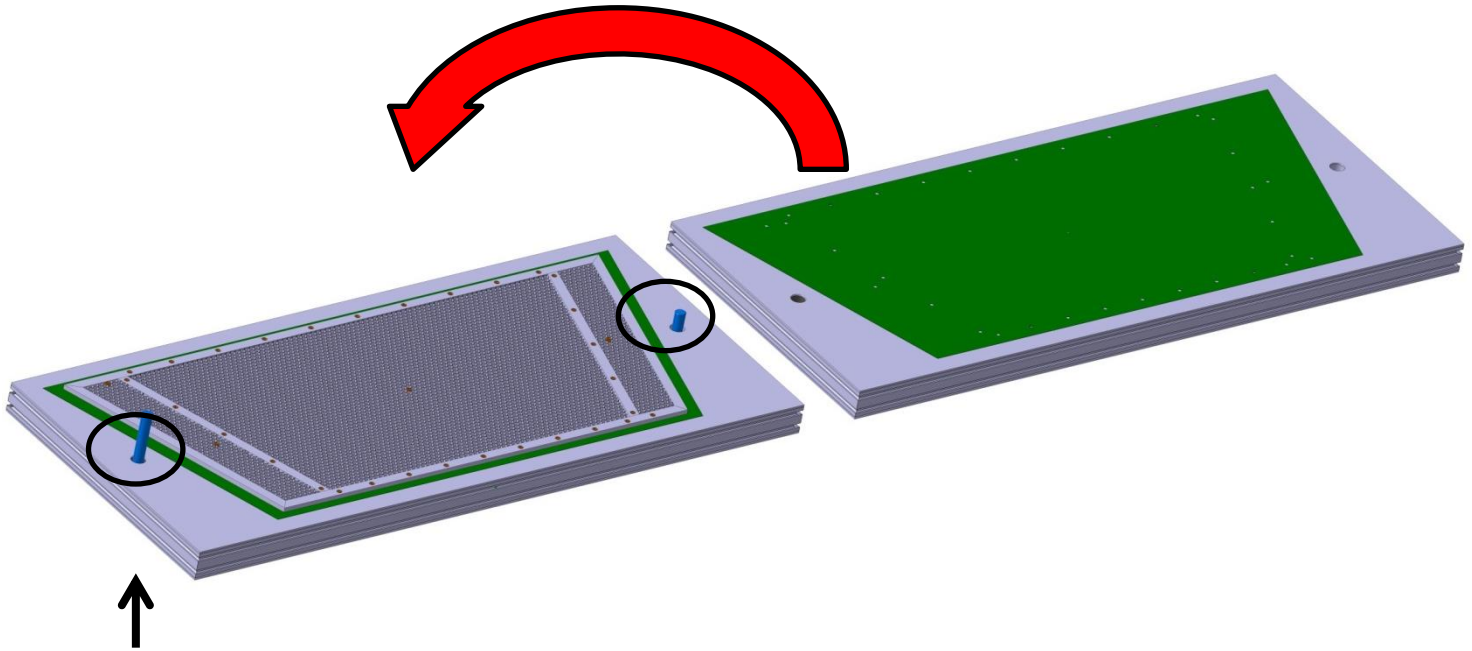
# Panel Construction

**Vacuum Table method** (proposed by CERN)

A sandwich of two soft skins glued on a stiff plane <u>without mechanical constraints.</u>

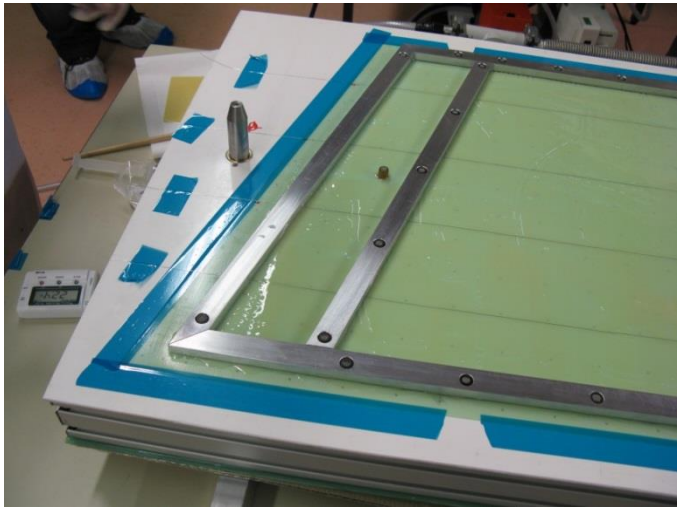
A sandwich consists of:

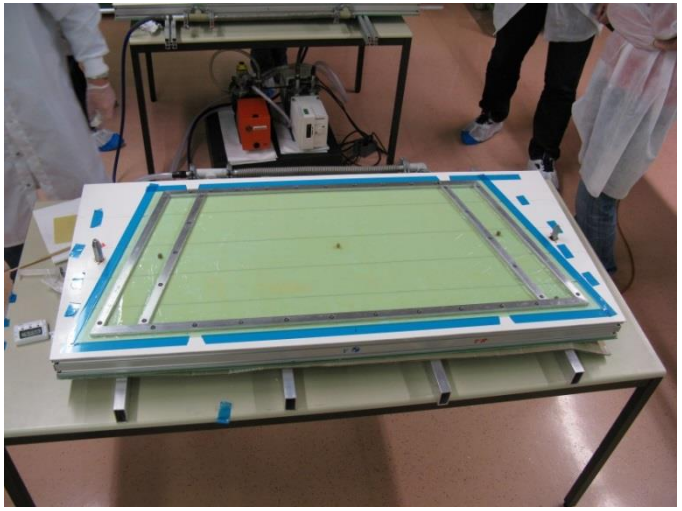
- One PCB (glass fibre skin, 0.5mm)
- Aluminium honeycomb surrounded with an aluminium frame
- Second PCB (0.5mm)

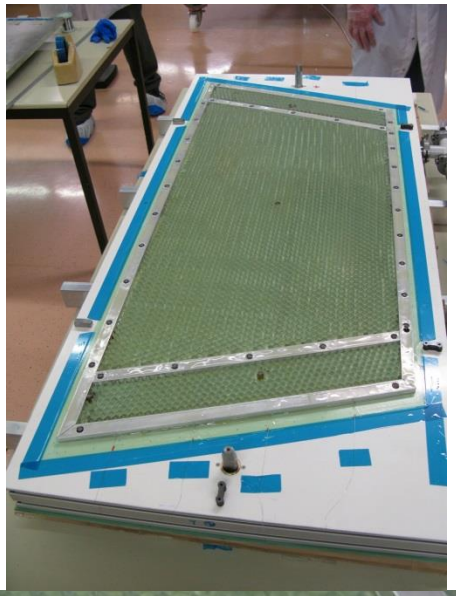


## Vacuum Table method at CERN

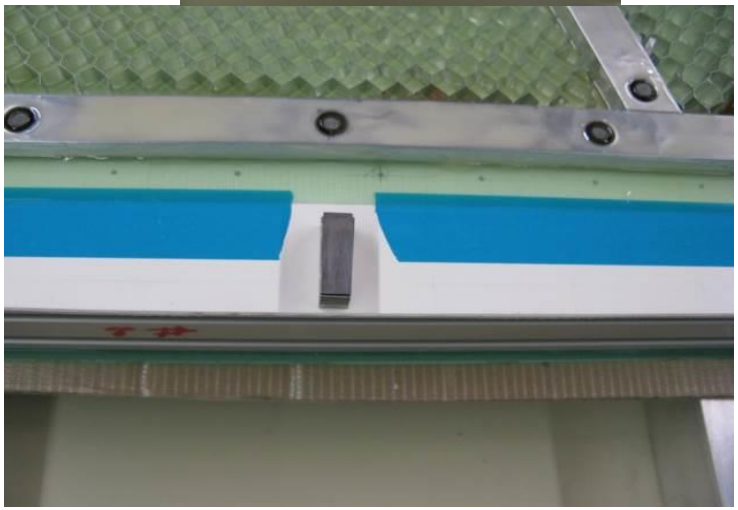
Aluminium frame installation



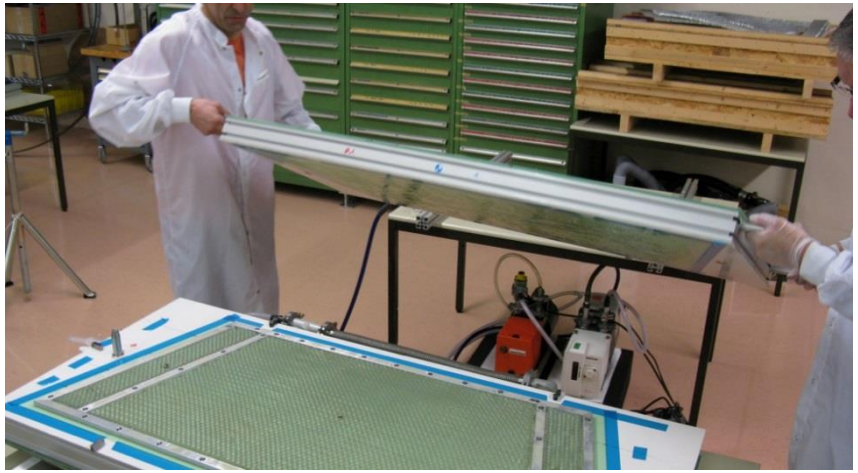


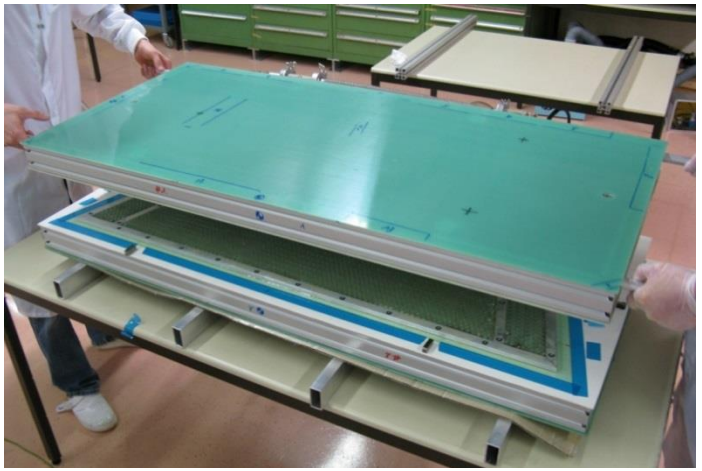


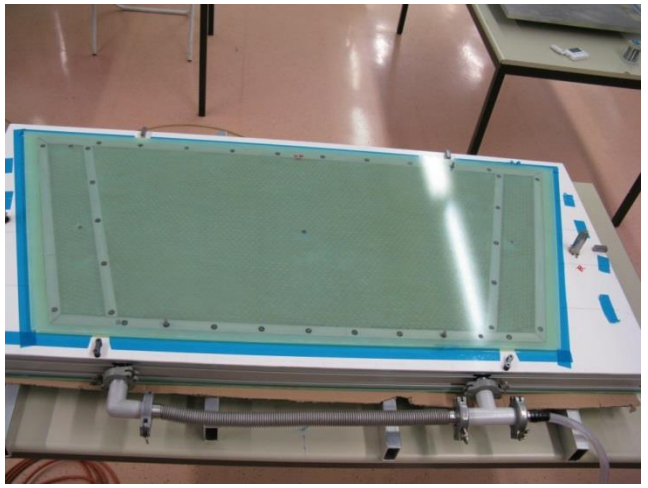
Honeycomb installation



# Panel Construction







Top side flatness: 160μm (max-min)

Bottom side flatness: 90μm (max-min)

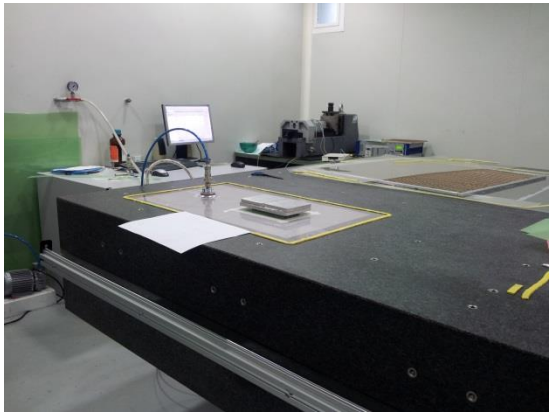
# AUTh site: status

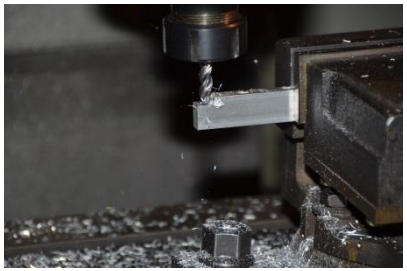
- Tooling for construction (drift panels)
- Tooling for QA/QC (drift panels)
- Logistics and Planning

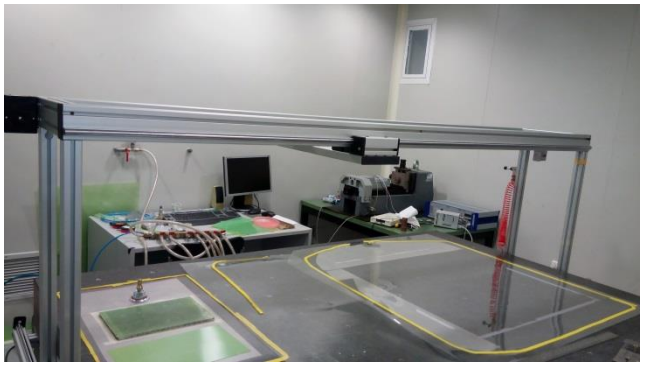
# Tooling: construction (drift panels)

## Prerequisites:

- granite table as reference (ready/on site)
- stiff-back sandwich (pending/CERN)
- vacuum pump(s) (ready/on site)
- custom made Al-profile setup (ready/on site)
- automated gluing system (ready/on site)
- mesh tension setup (ongoing/industry)
- machinery for processing and custom needs (ready/on site)

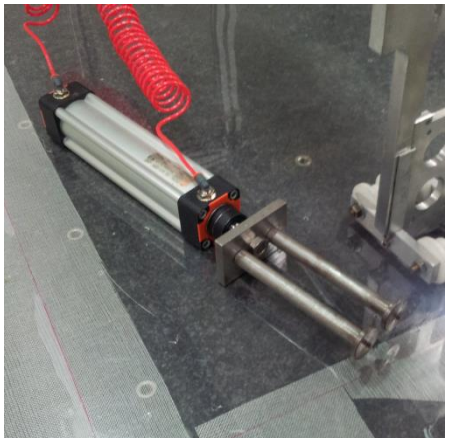


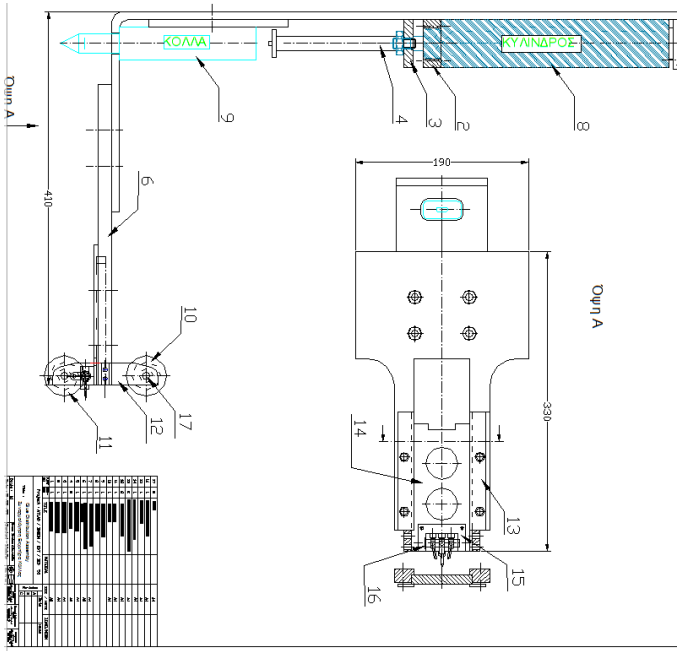


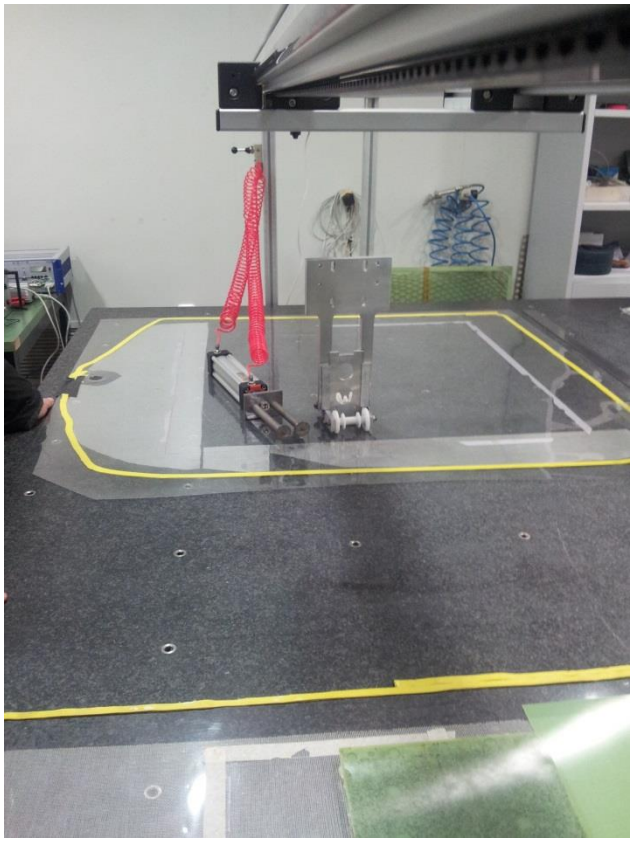


# Gluing setup

- Mounted on a variable length moving arm on the Al-profile frame.
- Automatically operated (start/stop, speed control).
- Need of new dispenser (ref. Pavia system).





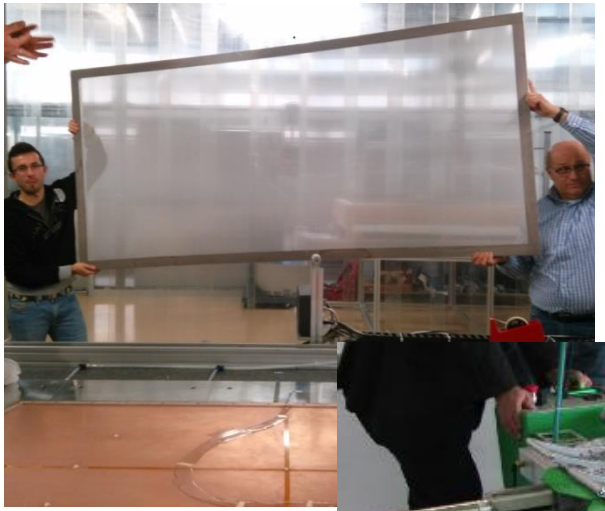



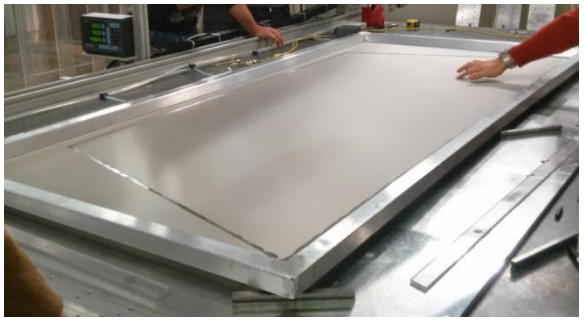
# Mesh stretching

- Mesh stretching to be done in industry or locally (construction site).
- Uniform stretching is required.
- Transfer frame to be used for final mounting but also for cleaning.

**Need to consider: Cost, Logistics, Quality.**

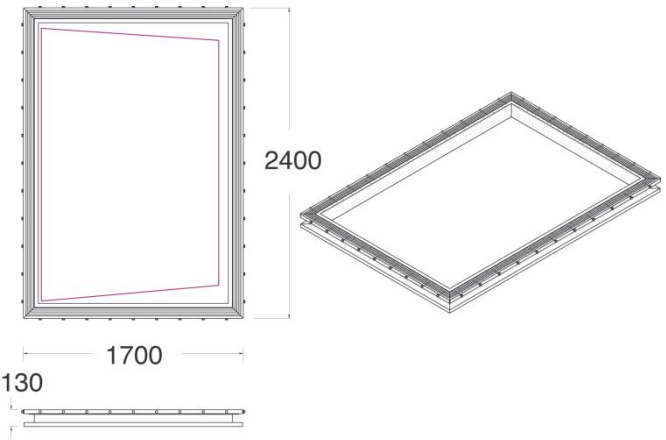
| | left 5 cm | mid-left 25 cm | center 45 cm | mid-right 65 cm | right 85 cm |
|---|---|---|---|---|---|
| 5 | 21.0 | 18.2 | 16.0 | 19.0 | 21.4 |
| 25 | 16.6 | 15.2 | 12.6 | 15.6 | 17.2 |
| 45 | 10.2 | 10.6 | 9.2 | 11.2 | 12.6 |
| 65 | 8.0 | 9.0 | 7.8 | 8.8 | 8.8 |
| 85 | 7.2 | 7.8 | 7.0 | 7.8 | 7.4 |
| 105 | 7.0 | 8.2 | 7.4 | 8.0 | 8.6 |
| 125 | 17.4 | 16.0 | 12.8 | 15.2 | 17.8 |
| | 6.0 | 15.0 | 24.0 | | |



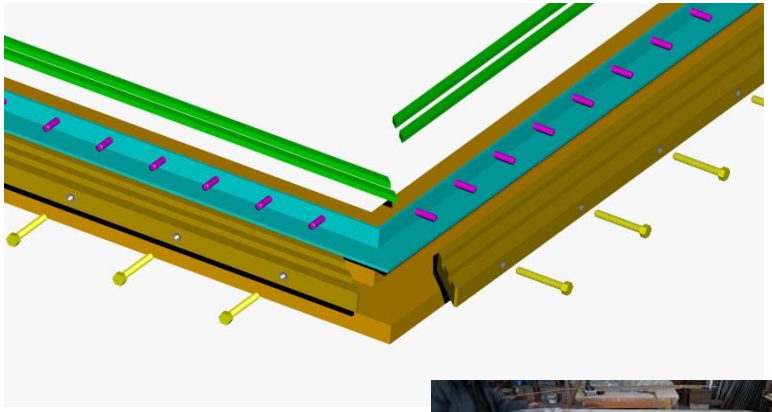


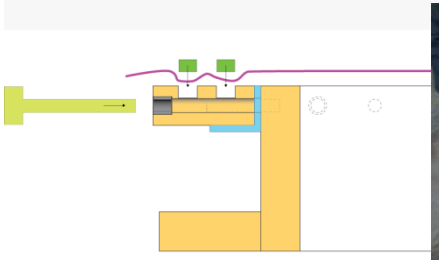
# Mesh stretching: AUTh

- Mesh stretching outsourced (company: YFOS).
- Custom made design with fine tuning option.
- Tests were performed with thicker wire mesh (!)
- Still need to verify tension uniformity/stability and finalize the design.





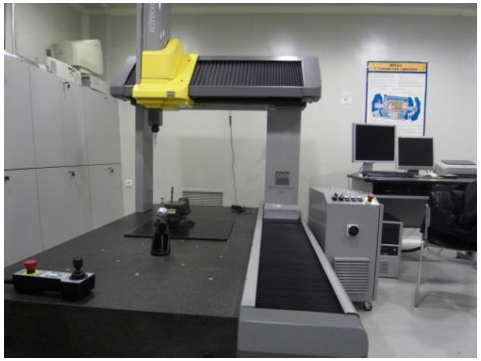




# Tooling: QA/QC (drift panels)

## Prerequisites:

- CMM, dial gauge (on site)
- tension meter (on site)
- Ar sniffer (on site)
- Ohm-meter, power supply etc. (on site)
- Rasniks (on site)
- Precision Ruler/Templates (pending)
- mesh cleaning device (pending)



# Remarks and Conclusions

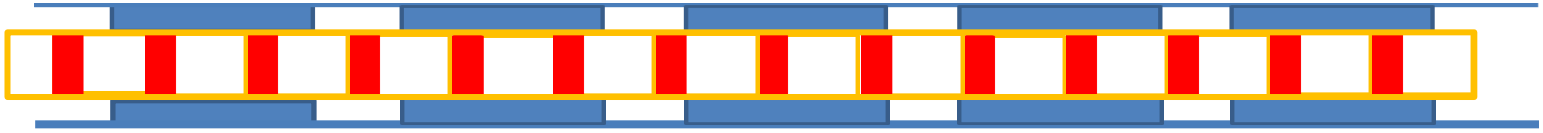
- Module – 0 construction: scheduled for June 2015
- AUTh group (2 physicists + 2 engineers) will join the CERN group for mod – 0 construction
- AUTh readiness:
  - tooling: >80%
  - know – how: prototypes + module – 0
  - AUTh – Dubna workflow and logistics: pending
- Transition to mass production

Ioannis GKIALAS
Univ. of the Aegean

# Studies on several types of zebra connectors

Principle: Instead of making direct contact between the leads

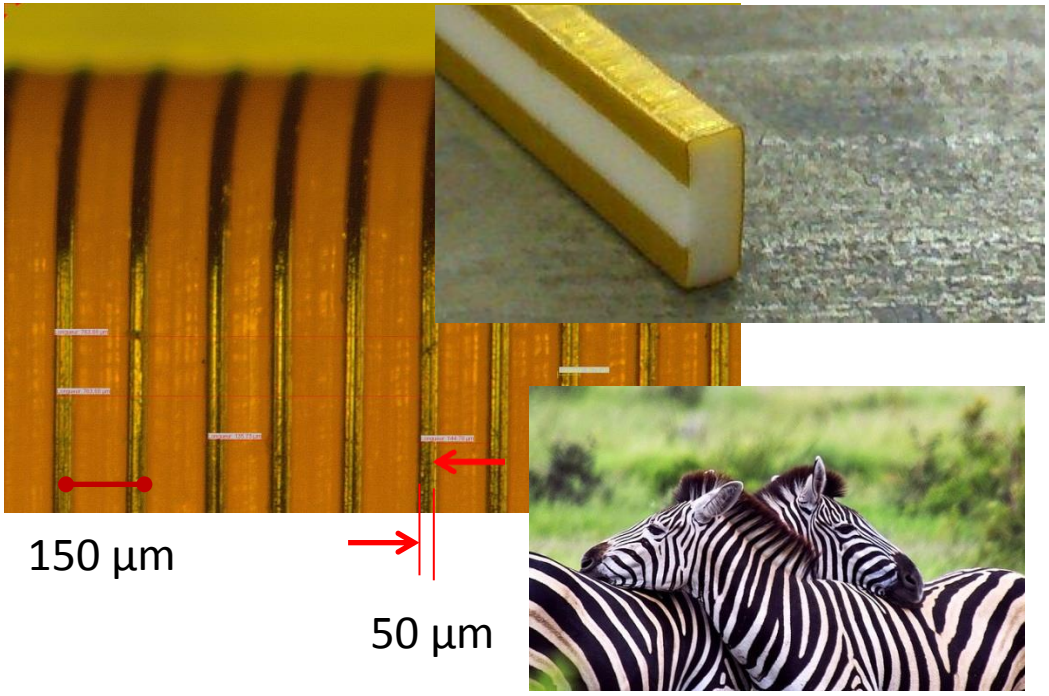
One can interject intermediate conductors (red color)



**THE ISSUE**

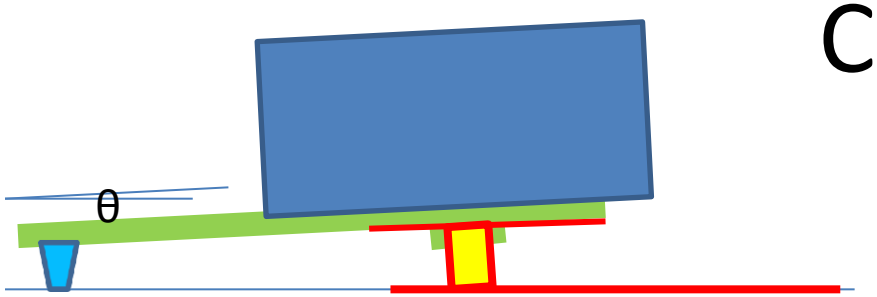
The Electronics board insertion method calls for sliding the board and pressing downwards at the same time.

This can create deformation in two dimensions and misalignment

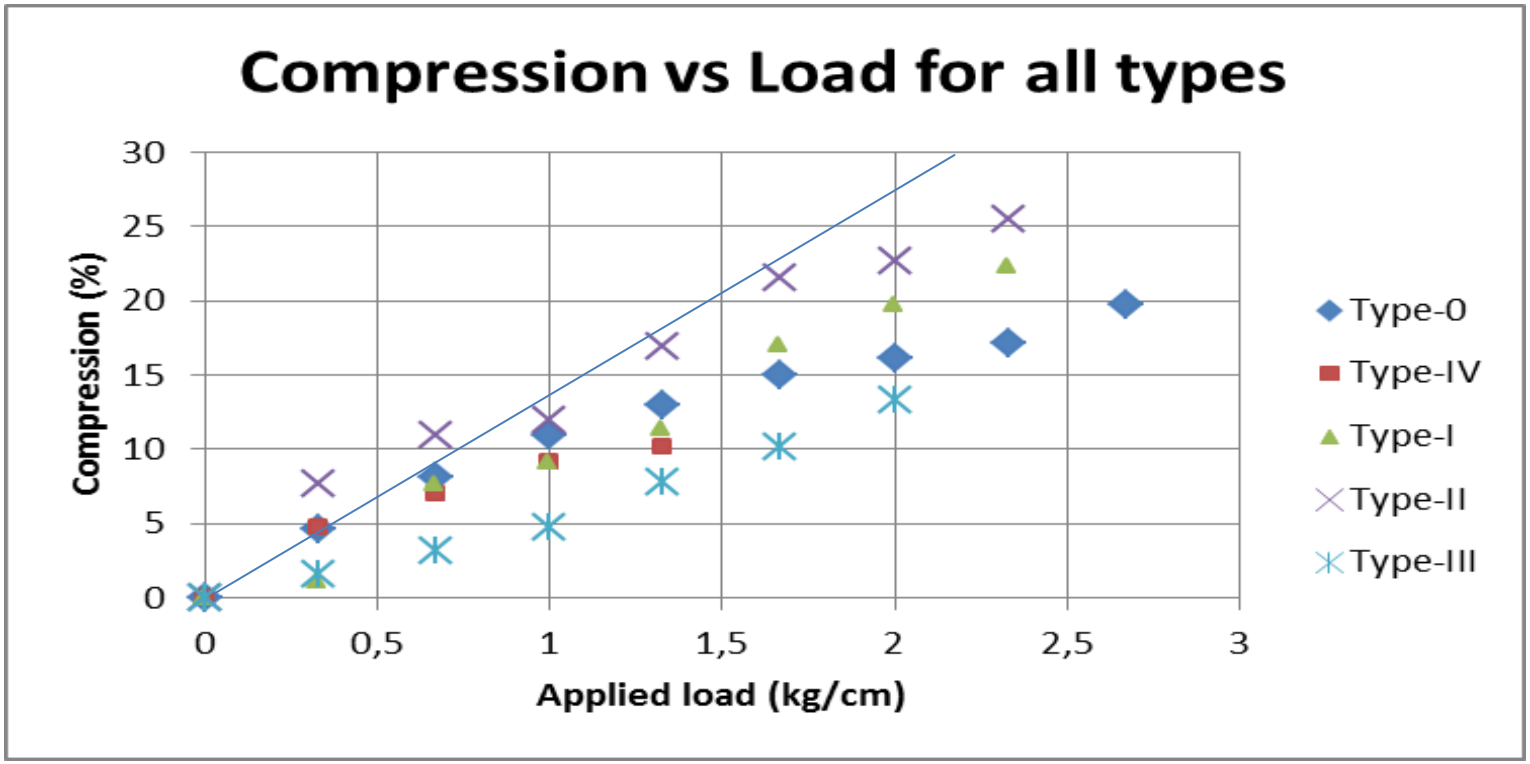


# Connectivity results

| Zebra Type | Compression (%) | | | | | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | 3.4 | 4.7 | 5.8 | 7.0 | 9.0 | 10.0 | 11.0 | 12.5 | |
| **0** | | Reliable and reproducible contact | | | | | | | |
| **I** | | | | | | | | | No contact or very large resistance |
| **II** | | | | | | | | | Many non-contacts and shorts (2 to 4 at a time) |
| **III** | Shorts | | Ok | | Ok | | | | Yellow Ok but not always. Width is about the size of the holder gap. No free space |
| **IV** Holder gap 2.45 mm | | | | | | | | | It takes a couple of times to get it right |




# Compression test results




- Core of silicon rubber, 50 Shore A hardness
- C-shaped Fujipoly (Type-0) 1.1 kg/cm for 15% compression (data sheet and calculation)

# Improvements of the Scheme

- Since the zebra idea is attractive not less because of its low cost, we want to use it provided we can improve its performance.

- **Main problems identified**
- Horizontal Positioning.
- Horizontal force during board positioning creates random distortions with unwanted and non-reproducible results.
- A method to apply the force vertically on zebra connector is desirable.
- Width of holder affects hardness and probably connectivity.

- **So, a new method of positioning** the frontend card is being implemented, to make better horizontal positioning, eliminate horizontal distortions and apply force on the zebra connector vertically only.
- **Use zebra of finer pitch** to allow for 3 conductors per strip

Thank you for your attention