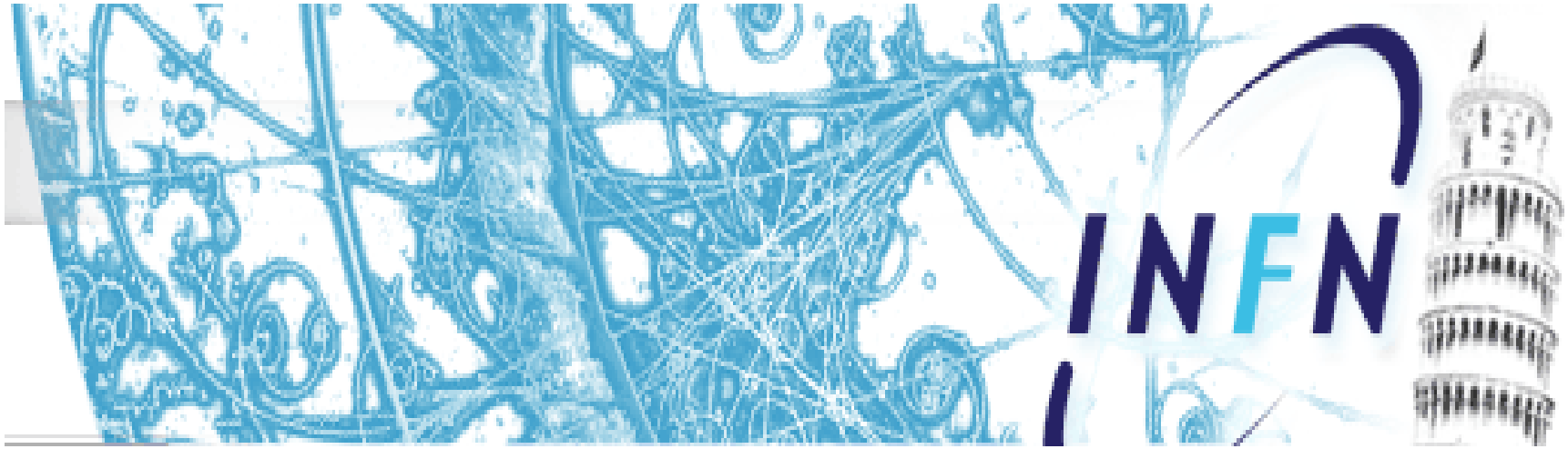
A guided tour of the construction facilities at the INFN-Pisa

F. Bosi
High-Technology workshop
INFN-Pisa



Wien – 25-26 April 2013

Outline

- The high-technology workshop (7 technicians + 1 Eng.) provides engineering and technological support to the experimental activities of the research groups of the INFN Section in Pisa.

Main technical activities:

- Development of Solid-State detector: Clean Room(s):
  - Space available for module construction
  - Metrology: manual/automatic CMMs
  - Mechanical/electrical micro-mounting
  - Microbonding
- R&D on cooling: Thermo-Fluid-Dynamic Lab.
  - Thermo-hydraulic test on micro-channels
  - Thermo graphic analysis
  - Climatic chambers
  - In progress set-up for evaporative cooling
- Design of mechanical support: Structural test Lab.
  - Dynamometer for material characterization
  - Vibrational analysis

Mechanical Engineering Support

Manpower: 1Engineer + 1 designer

Sw available :

- CAD 2D: Autocad 2013
- CAD 3D : Inventor Professional 2013
- FEA sw : ANSYS 2013
- FEA CFD: CFD design 2013
- Industrial solid models database : CADENAS Part Solution

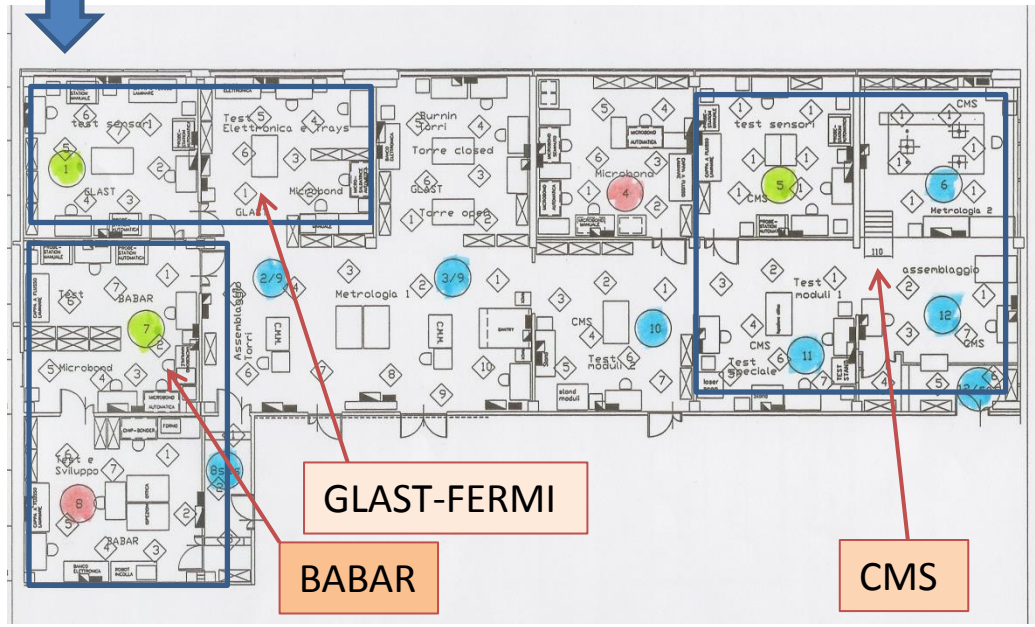
The technical staff matured their expertise in the module construction of the BaBar SVT, the Fermi-Glast LAT, CMS TIB-TID, passing through every steps of the construction of these trackers.

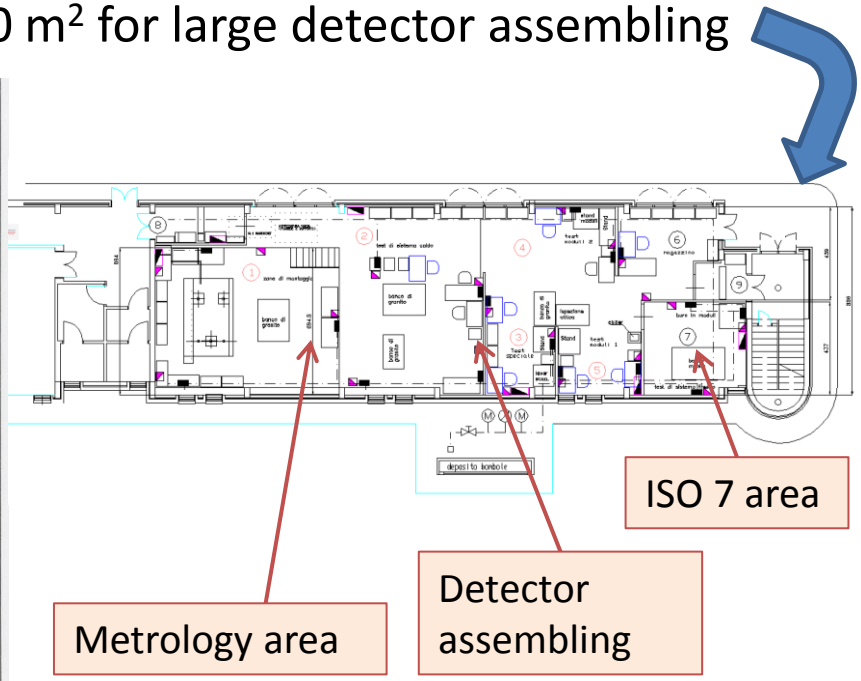
Clean Rooms

- Historically, in Pisa 3 groups working on Silicon: BaBar/Glast-Fermi/CMS
- Two rooms (for each group) dedicated to the electrical characterization of the detectors, with their own instrumentation (probe-stations&Semicon.Analyzer).
- During the construction phase, the acting group uses the central common space facilities.

In Pisa area: 600 m^2 , divided in group-specific and common rooms

In S.Piero a Grado, 8 km far from Pisa, 250 m^2 for large detector assembling





These two Clean Rooms represent the largest INFN Clean Room Laboratories in Italy.

Clean Rooms

In every cleanroom work space area there are:

- Vacuum and air pressure facilities (8 atm).
- Dry air (dew point -40 °C)
- Thermo hygrometric condition are continuously monitored

Clean Room Cleaness Class: 100.000 - Class 10.000 (Federal Standard 209/E)

Temperature : 21 °C ± 1°C - Humidity : 50% ± 5%

In some little specific working areas (laminar flow cabinet) class 100 can be reached.

Contamination control measurements are systematically performed.

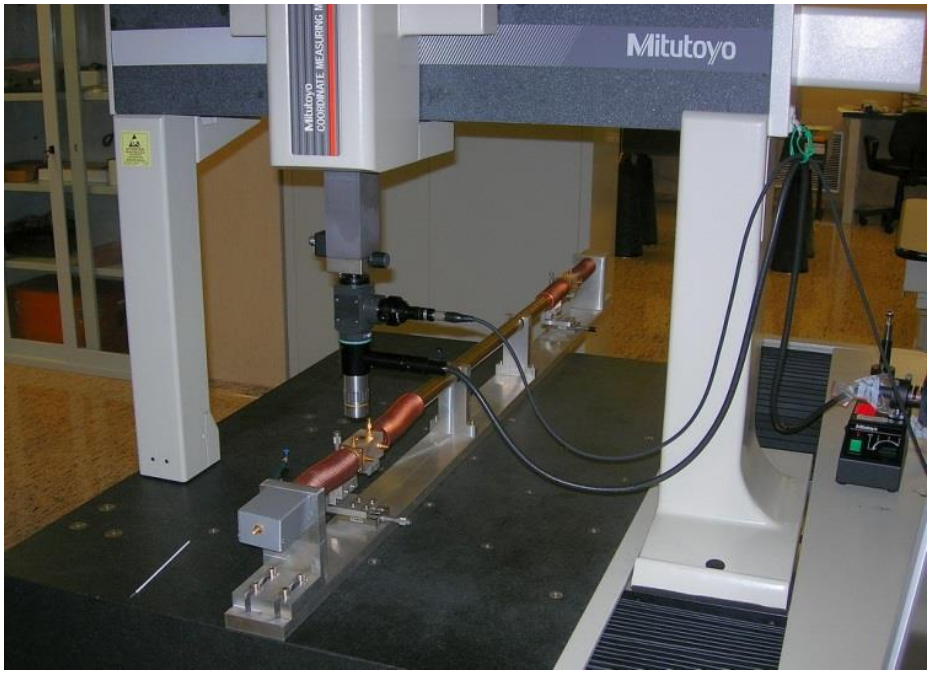
3D Metrology

Coordinate Measuring Machines (with and w/o probe contact):

- Mitutoyo F604 (measured volume 500x600x300 mm^3)
  Precision 3+4L/1000 um – resolution: 1 um – (semiautomatic)

- Mitutoyo BHN506 (500x600x300mm^3)
  Precision 3+4L/1000 um – res. 1 um

CNC controlled – PCDIMIS metrological sw



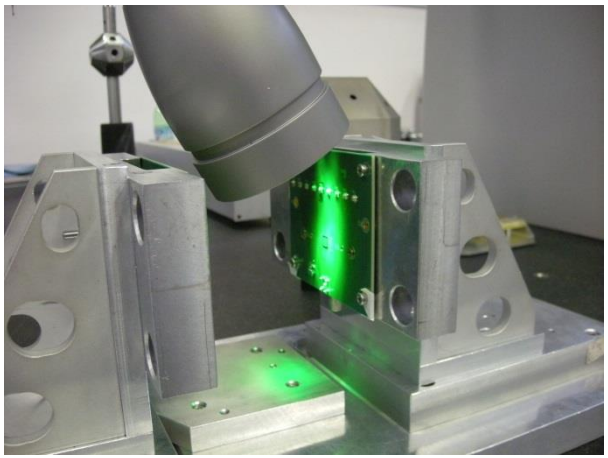
3D Metrology (with and w/o probe contact)

Coordinate Measuring Machines:

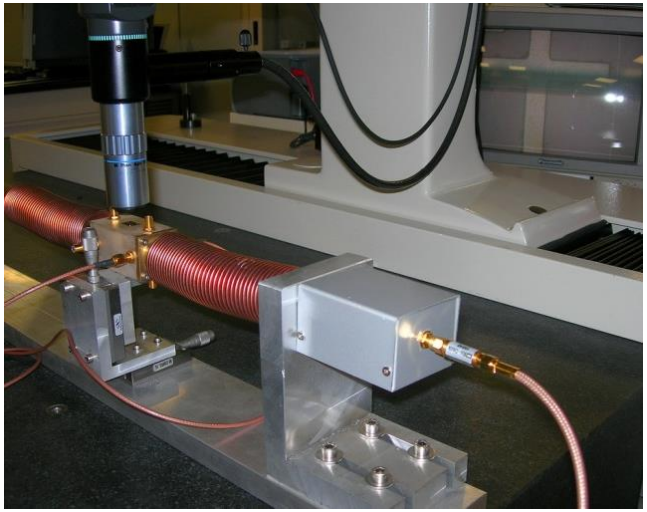
- DEA -Hexagon - Ghibli 26.15.14 (2600x1500x1350mm^3) (S.Piero Lab)
  Precision 4.5+4L/1000 um – res. 1 um
- DEA Hexagon – Global Image (1500x900x650mm^3)
  Precisione 1.7+3L/1000 um – res. 1 um

Both the machine are CNC controlled – PCDIMIS metrological sw

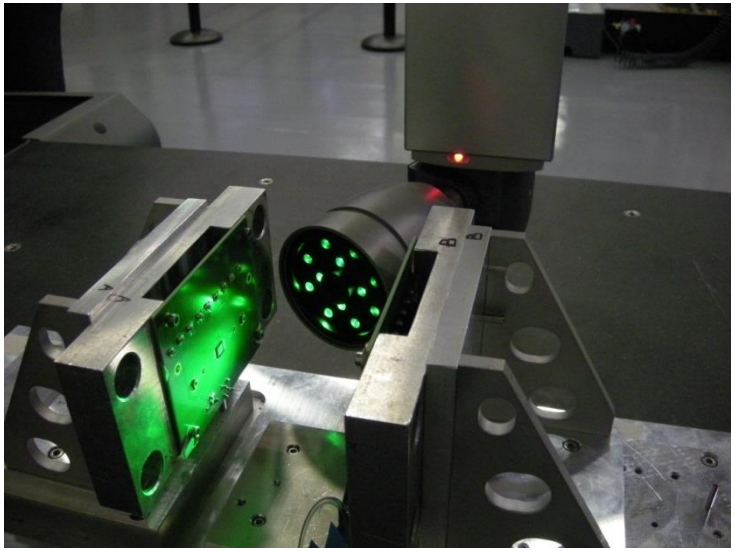
3D CMMs



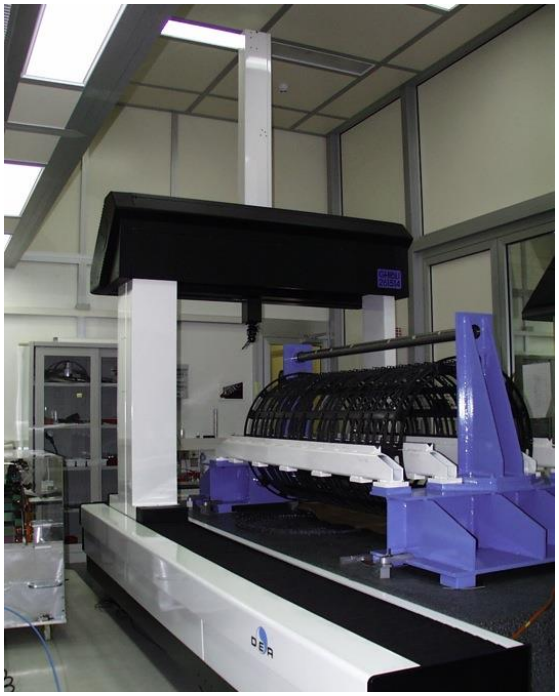
Special laser directional head without contact



Standard vertical optical head without contact



One technician dedicated to metrology.



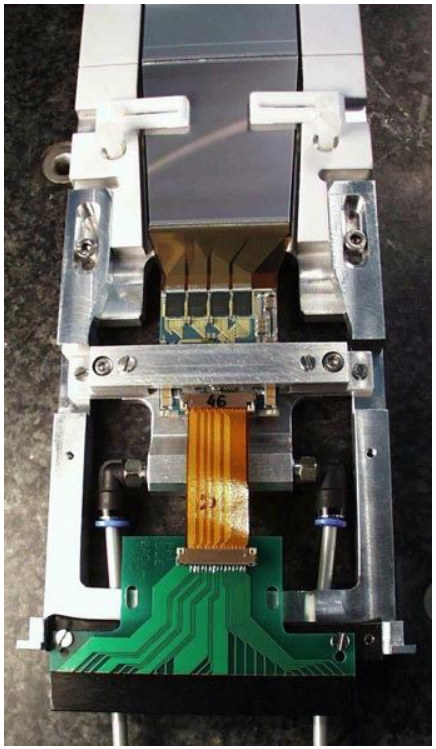
CMS support tracker structure under measurement on Ghibli 3D CMM (S.Piero Lab)

Mechanical Micromounting

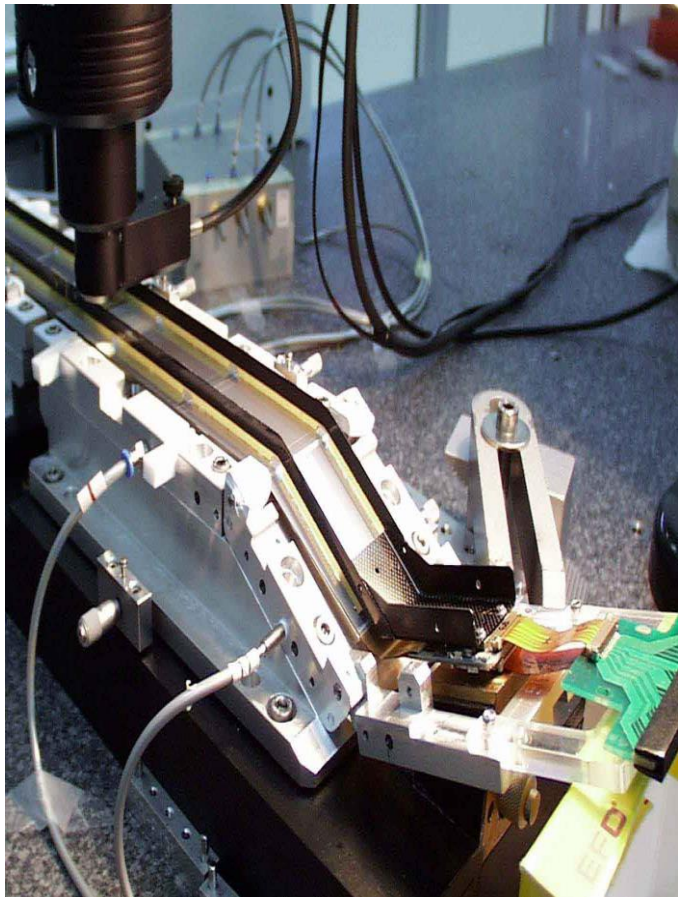
Silicon sensors positioning under CMM for assembling module production

BaBar Si module production

Si module assembly production

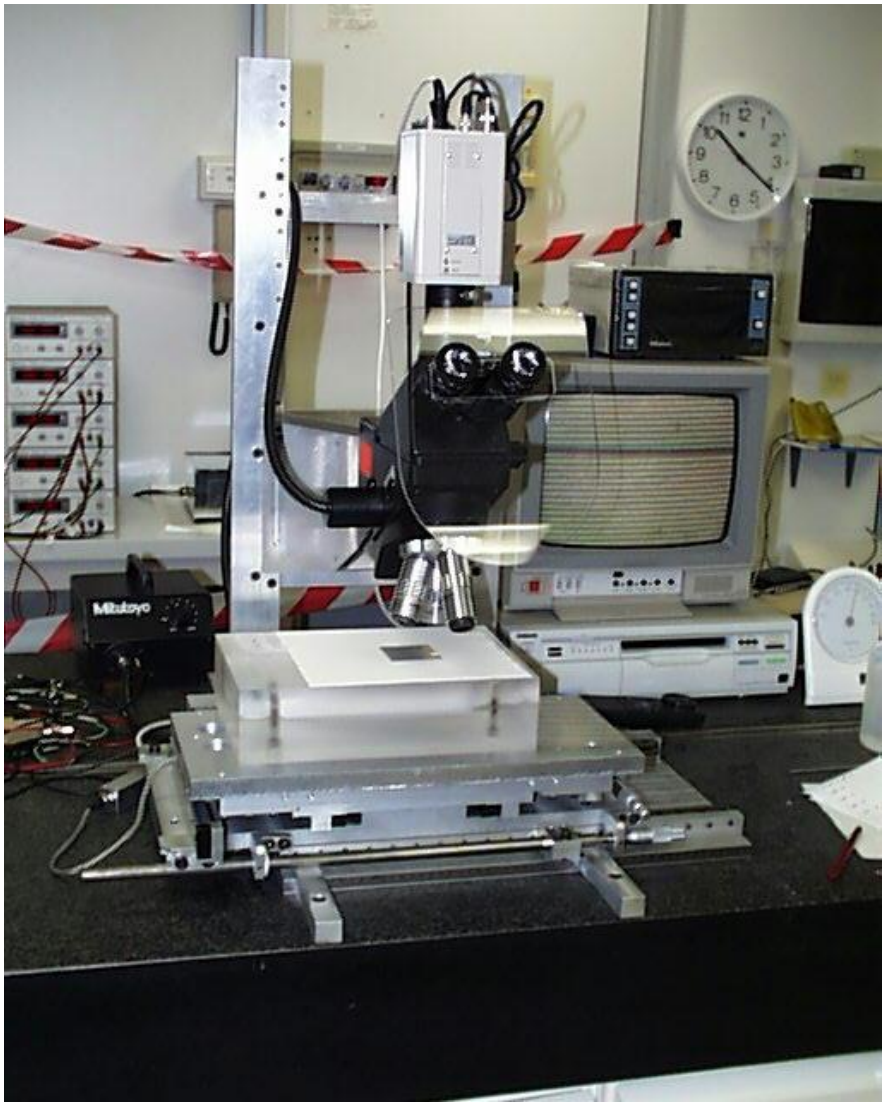


Wedge module before bending



Arch module bent

Other Lab facilities



Optical inspection bench

FLIP CHIP Bonder KARL
SUSS FCM 505

Gluing Machines

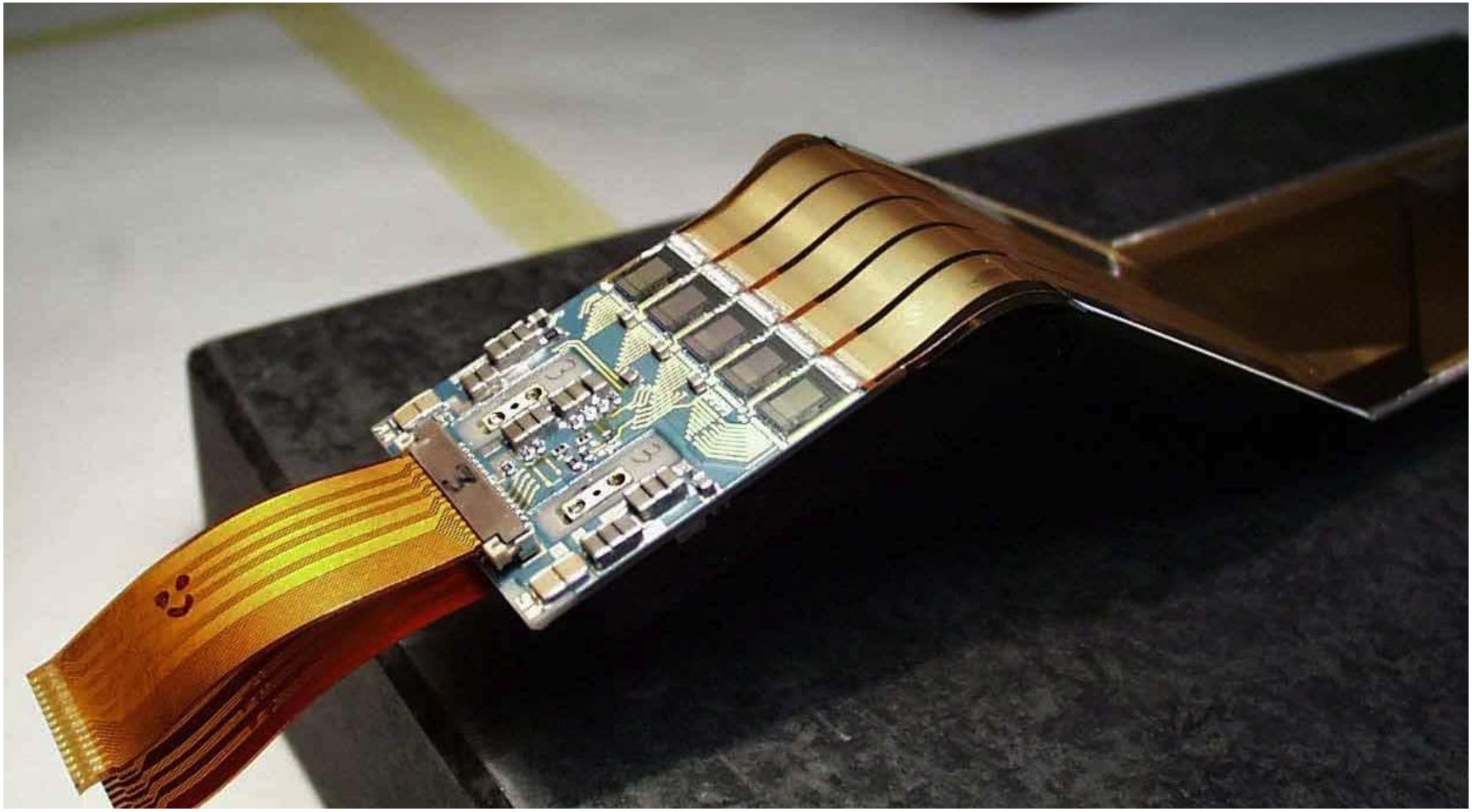
I&J Fisnar 750 gluing robot dispensing

Used for the fanout gluing operations of BaBar Si modules

Die-attach machine Cammax DB 600

Used at cern for the hybrid Die mounting of Totem Si module (adhesive tape)

FE-Chip loading



Precise positioning of FE chip on ceramic substrates (BaBar).
Ovens for conductive glue curing. Possible reworking.

Microbonding

Manual/semi/automatic deep access bonding machine

Used wire Al 25.4 um - diameter

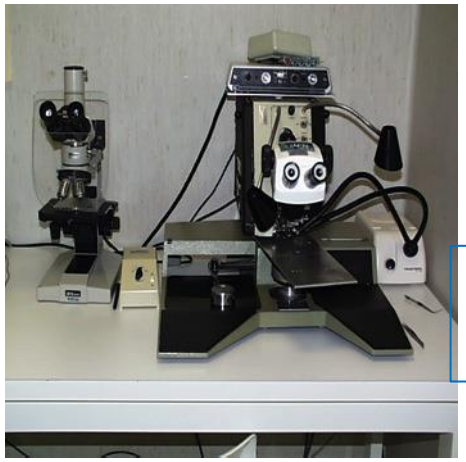
One technician dedicated to u-bonding

(+one if needed during production)

K&S 8090 – (CMS)

HUGES 470 deep-access automatic (BaBar)

K&S 1470 deep-access semiautomatic



Manual machine K&S 1470

Pull-test machine DAGE 4000

Thermal Environment test

Humidity & temperature test chambers for thermal cycles on (large) detector assembly

Volume test
1000x1100x1000 mm^3
Temperature range:
-70°C - +180 °C

Environmental chamber
Angelantoni Challenge

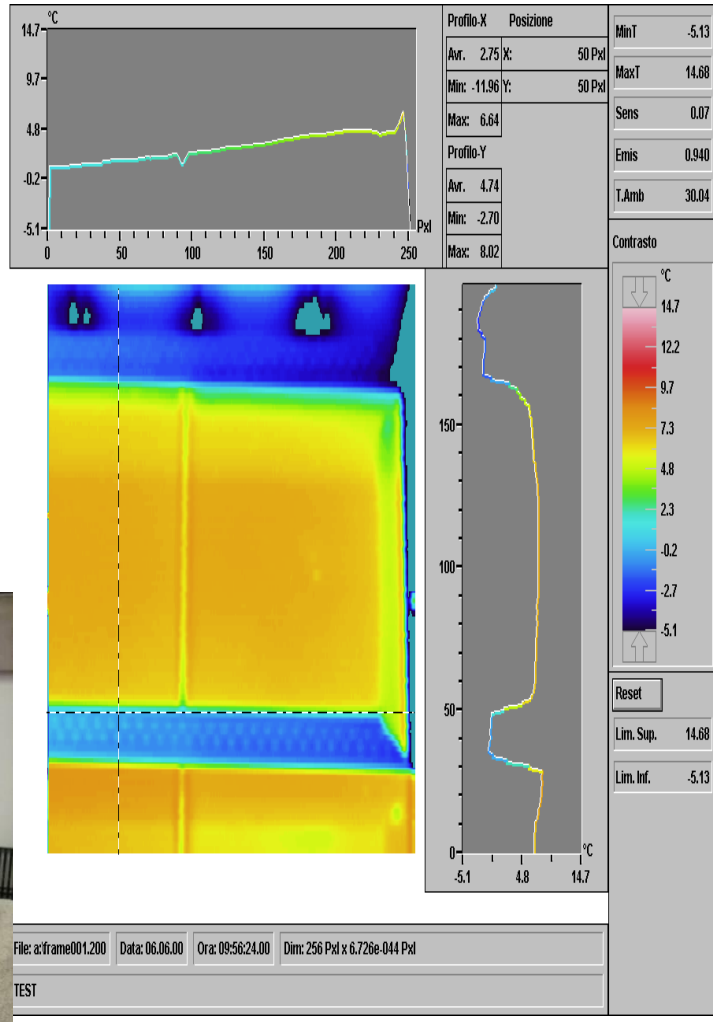
Volume test
3300x3500x2500 mm^3
Temperature range:
-30°C - +80 °C

Environmental chamber - S.Piero lab
Angelantoni WZH30-A1

Thermography

Temperature measurement by I.R. thermo-camera (AVIO TVS-2000Mk II long wawe)

- Resolution: 0.1 °C
- Temperature range: -40/+250 °C
- Experimental thermal analysis on prototypes of cooled read-out electronic for semiconductor detector



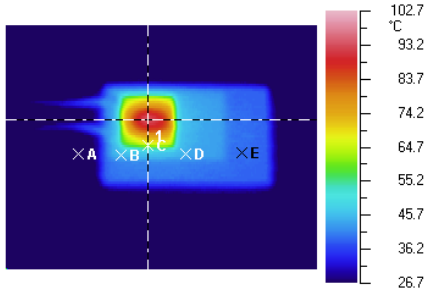
Thermography

GORATEC Technology

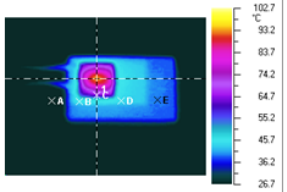
Location	*INFN sezione di Pisa*		
Operatore	**Mammini Paolo**	**tel. 050 2214228**	paolo.mammini@pi.infn.it
Equipment	TVS2000MK-II		

- La misura e' stata eseguita in ambiente climatizzato (clean room), laboratorio del servizio **Alte Tecnologie** dell' Istituto Nazionale di Fisica Nucleare di Pisa.
L'oggetto in esame e' stato collocato su un supporto a temperatura ambiente ricoperto da un panno ad emissivita' nota e riflessione nulla. L'oggetto in esame si presentava interamente ricoperto da un sottile strato di vernice acrilica di colore nero, questo ha consentito di impostare sulla termocamera il valore di emissivita' = 0,90.
L'oggetto e' stato alimentato fino al raggiungimento di 9,215 watt di potenza assorbita. La rilevazione termica e' stata eseguita quando la temperatura e' risultata costante.

Img. A

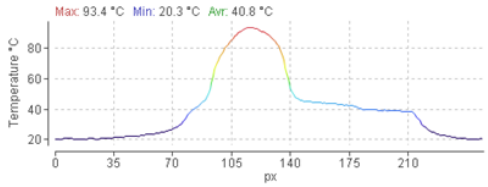


img. B



Point	T °C	Emis.	Ta °C
- A	22.6	0.90	21,2
- B	44.6	0.90	21,2
- C	61.0	0.90	21,2
- D	44.2	0.90	21,2
- E	39.1	0.90	21,2

Profilo orizzontale

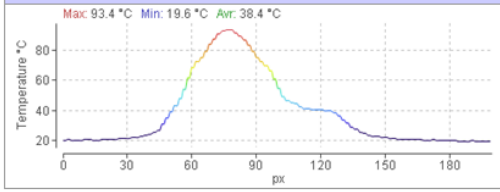


Ora/data:
15:55:48 11/26/2003

Condizioni di lavoro
Temp. ambiente 21,2 C.
Umidita' rel. 55%

Additional information
Sensibilita' strumento 0,04 C.

Profilo verticale

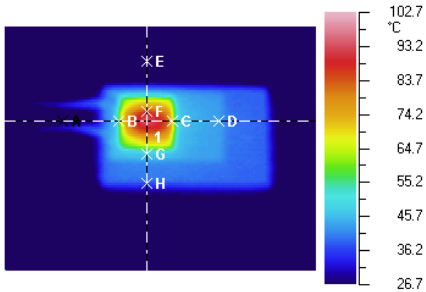


Potenza assorbita

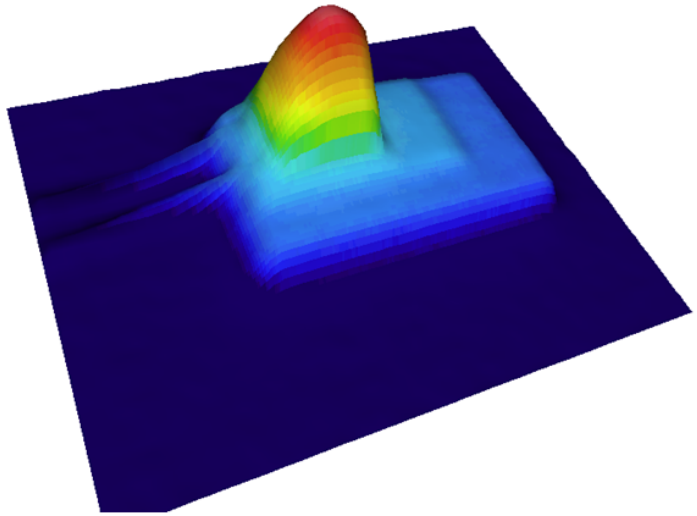
9,215 w

1

Minsk 12.10.2002
GORATEC Technology GmbH



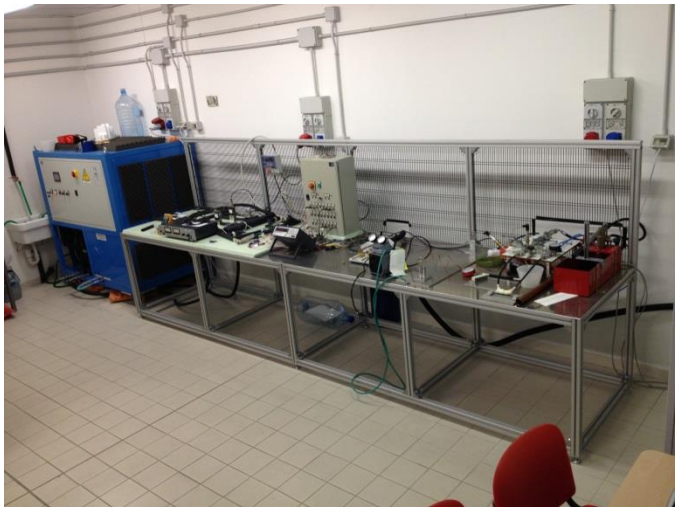
T.max.	93,4	**A**	22,6	**B**	57,2	**C**	67,5	**D**	42,6
T.min.	21,6	**E**	21,6	**F**	83,7	**G**	46,7	**H**	36,4



Thermo-Fluid-Dynamic Lab

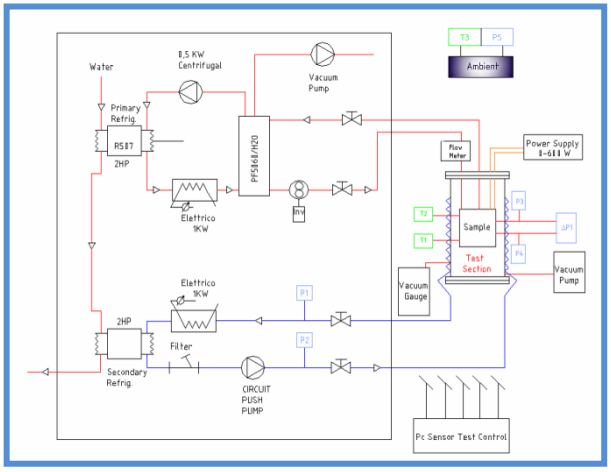
The lab is used for cooling tests and thermal characterization of low mass support structure based on micro-channel technology

- Test bench and chiller for forced convection of liquid monophase



The instrumentation allows to measure/store the values of temp/pressure/flow in the thermal exchange.

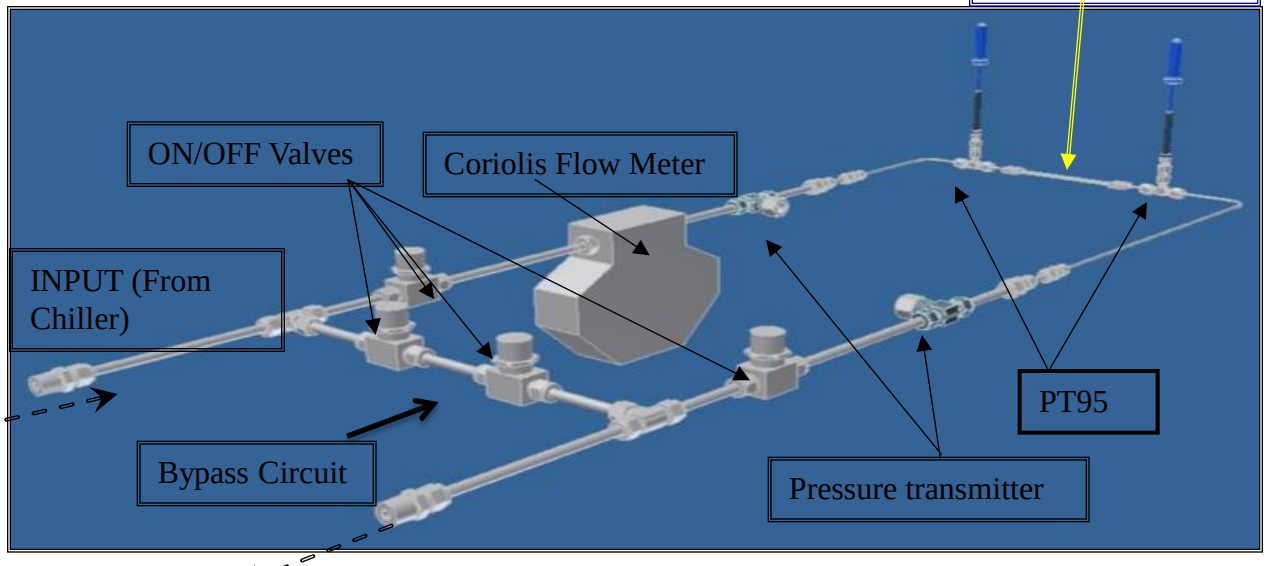
Scheme of the Test-bench hydraulic circuit



- DAQ HW system (N.24 probe for temperatures, pressure and flow).
- Chiller dimensioned for a cooling power > 1/2 kW primary and secondary cooling circuit

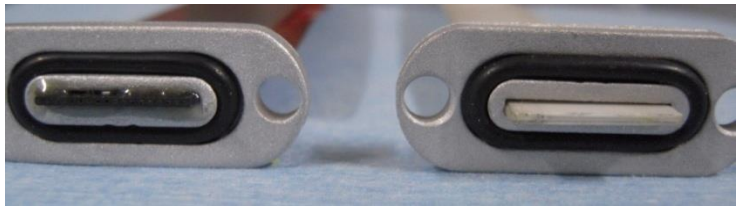
Test and set-up at TFD lab

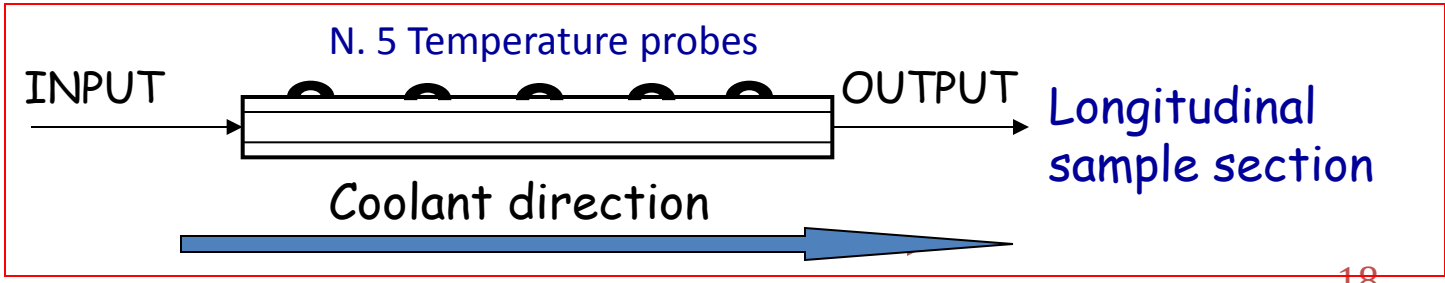
Cooling Circuit Schematic View:



DAQ System:

Test Section:



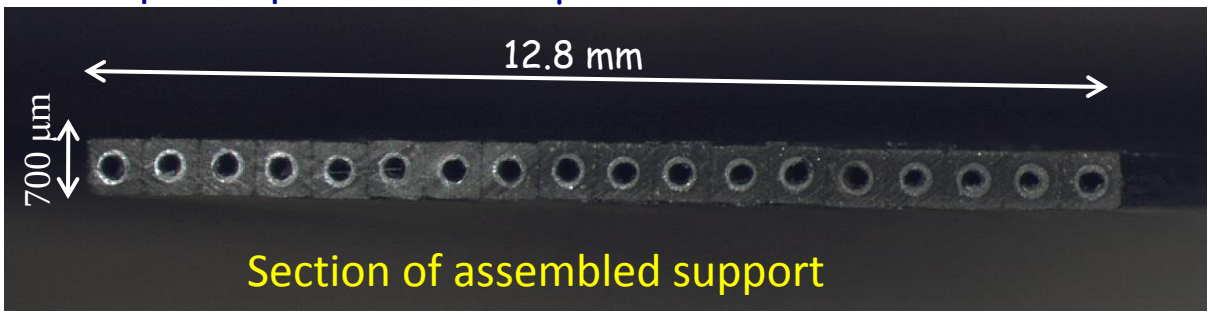


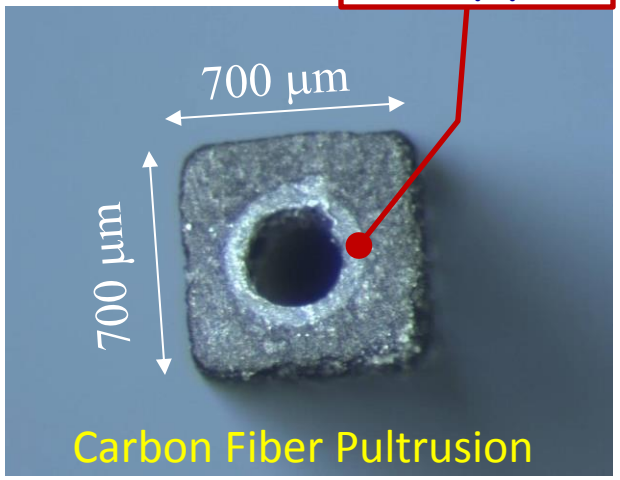
Module support

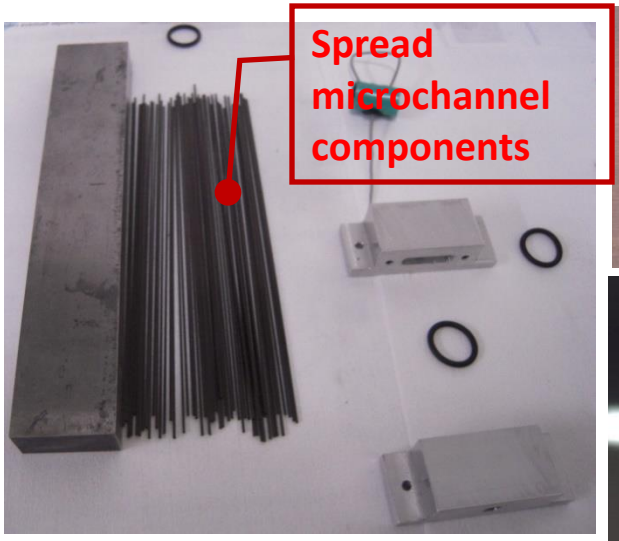
CFRP MICROCHANNEL MODULE

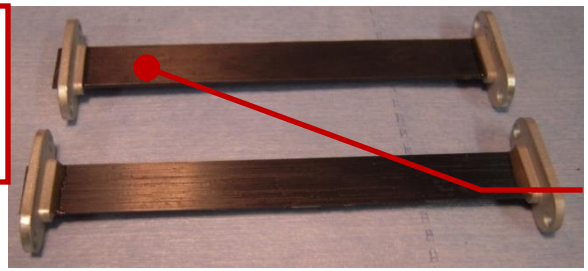
Obtained by pultrusion C.F. TohoTenax HTS 40 , adding and gluing in special masks, side by side, 18 single micro-tube.

The inner diameter of the peek micro-tube is 300 μm, the thickness of the square composite profile is 700 μm.

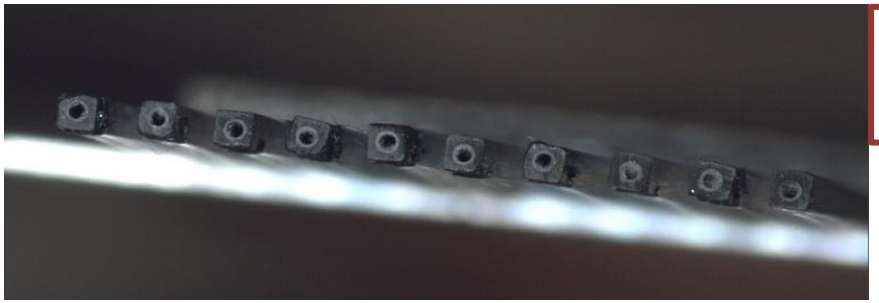








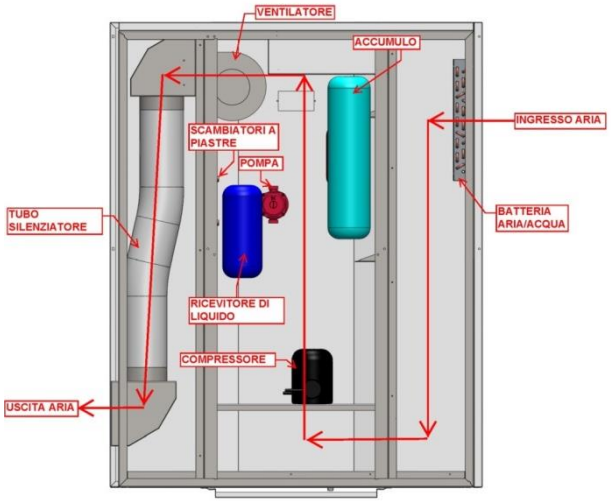
Support Module assembled

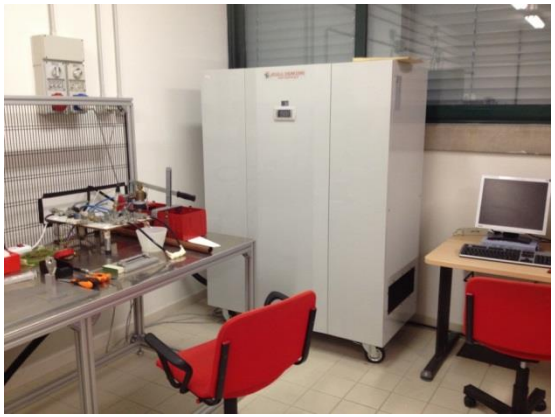


Net micro-channel module

Thermo-Fluid-Dynamic Lab.

- Test bench in progress for CO2 facilities evaporative cooling
- Chiller for CO2 production installed



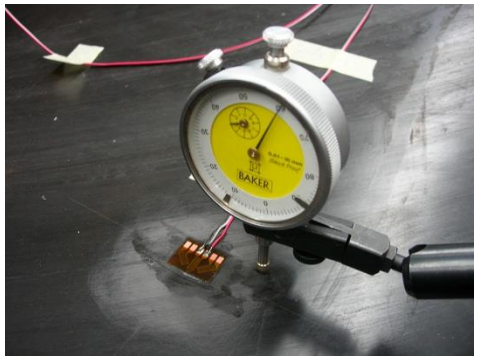


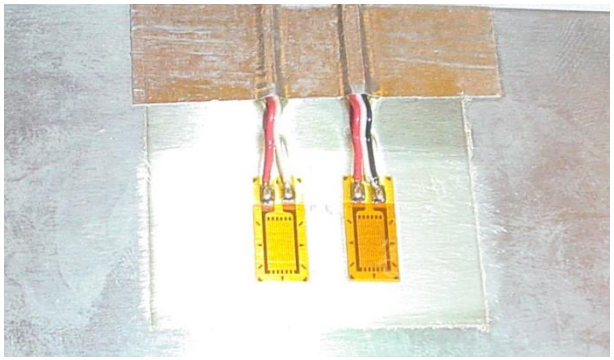
Inlet/outlet pipes
for test section

- CO2 Chiller: wide settable range of coolant temperature (-30 °C a +10 °C)
- System circuit control able to set cooling power in the range 16 W - 400 W (antifrost system)
- Coolant flow settable from 0.05 to 1 Kg/min

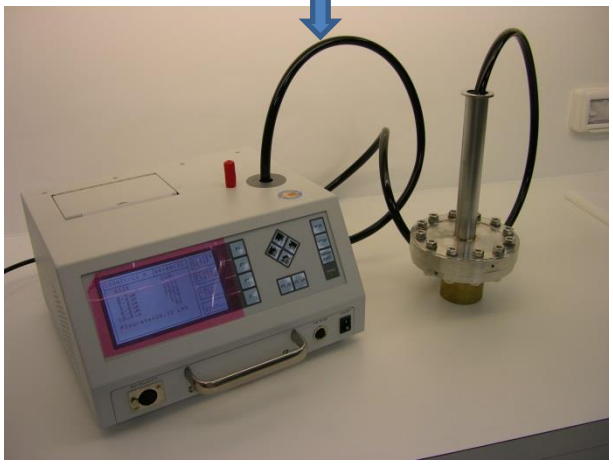
Other Lab facilities

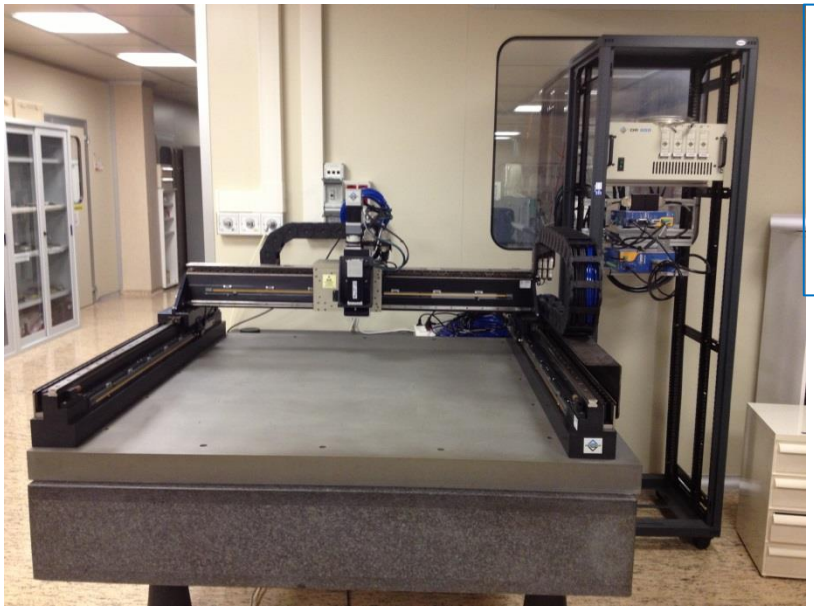
• Stress-Strain Analysis (Strain Gauge)
Scanner VISHAY with/5 channel
Portable tester VISHAY 1300 MM





•Contamination control measurement





Gantry system
Aerotech
Working area 1m^2
Precision $\pm$2 um

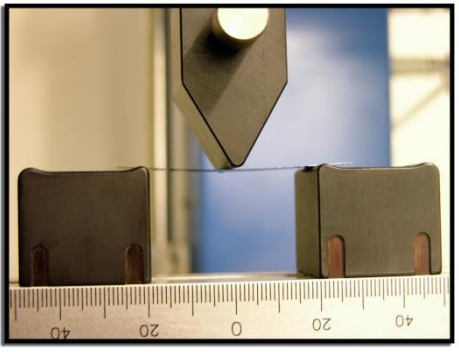
•MET ONE airborne particle counter
•0.3 micron sensitivity

Structural test Lab

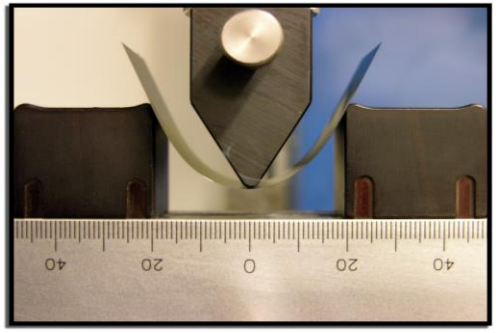
- Mechanical characterization

Materials Testing Machine Lloyd Instruments LR50KPlus

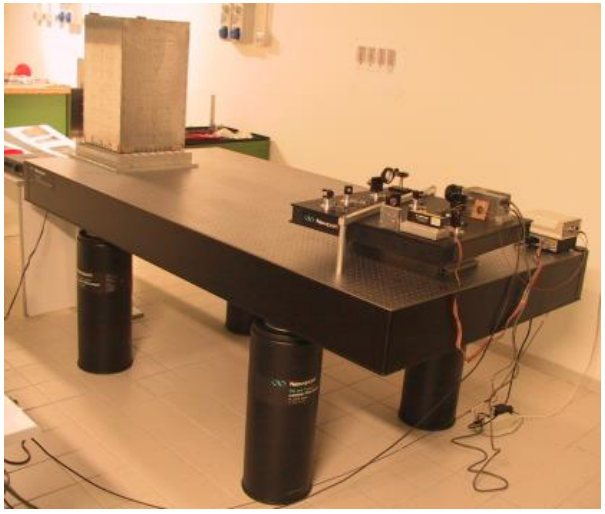
(test up to 50.000 Nw)



Si sample 50 um thick



•Vibrational Analisys
(Dynamic Shaker up to 10 Kg)



ESPI System (GLAST/FERMI)

Conclusion

The INFN-Pisa High Technology Workshop can rely on facilities and technical expertise in order to provide the support needed to contribute to the module construction of the BELLE II SVD.