ATHENA - Module Construction 1998-2000

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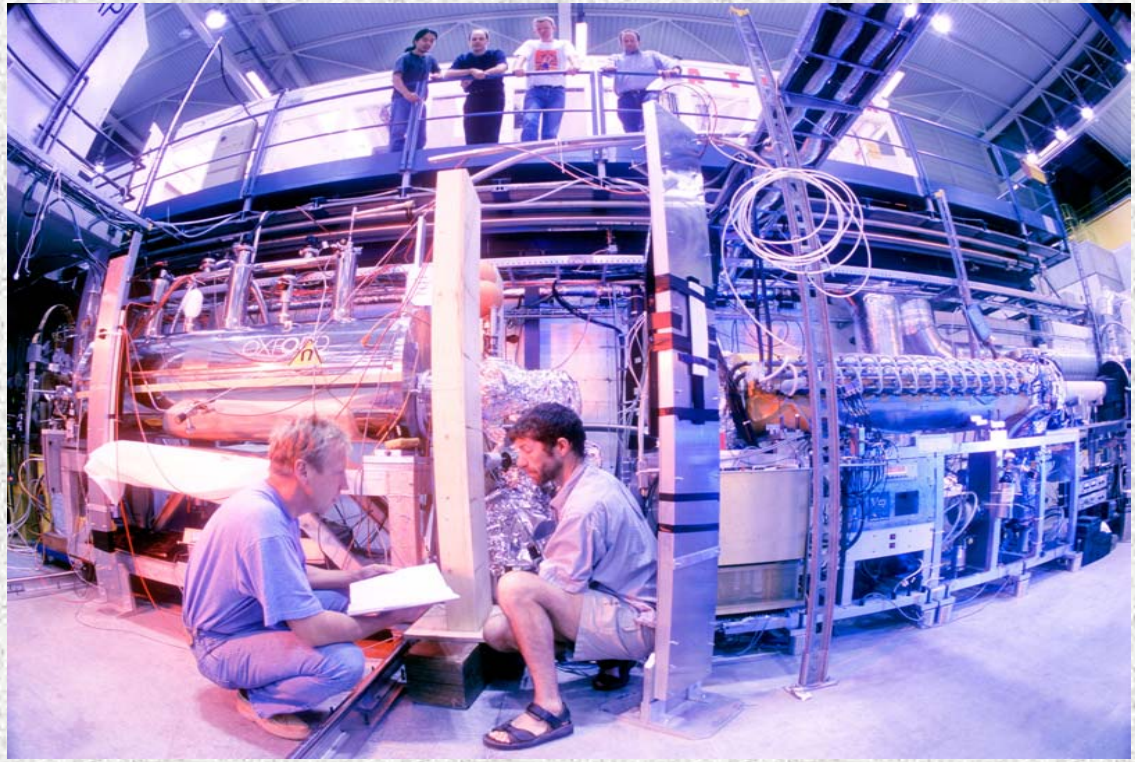


* now at CERN

ATHENA Silicon Vertex Detector

- Cylindrical symmetry
- Outer diameter: 139.7 mm
- Inner diameter: 75 mm
- Length: 241.1 mm
- Precision: +/- 15 μm

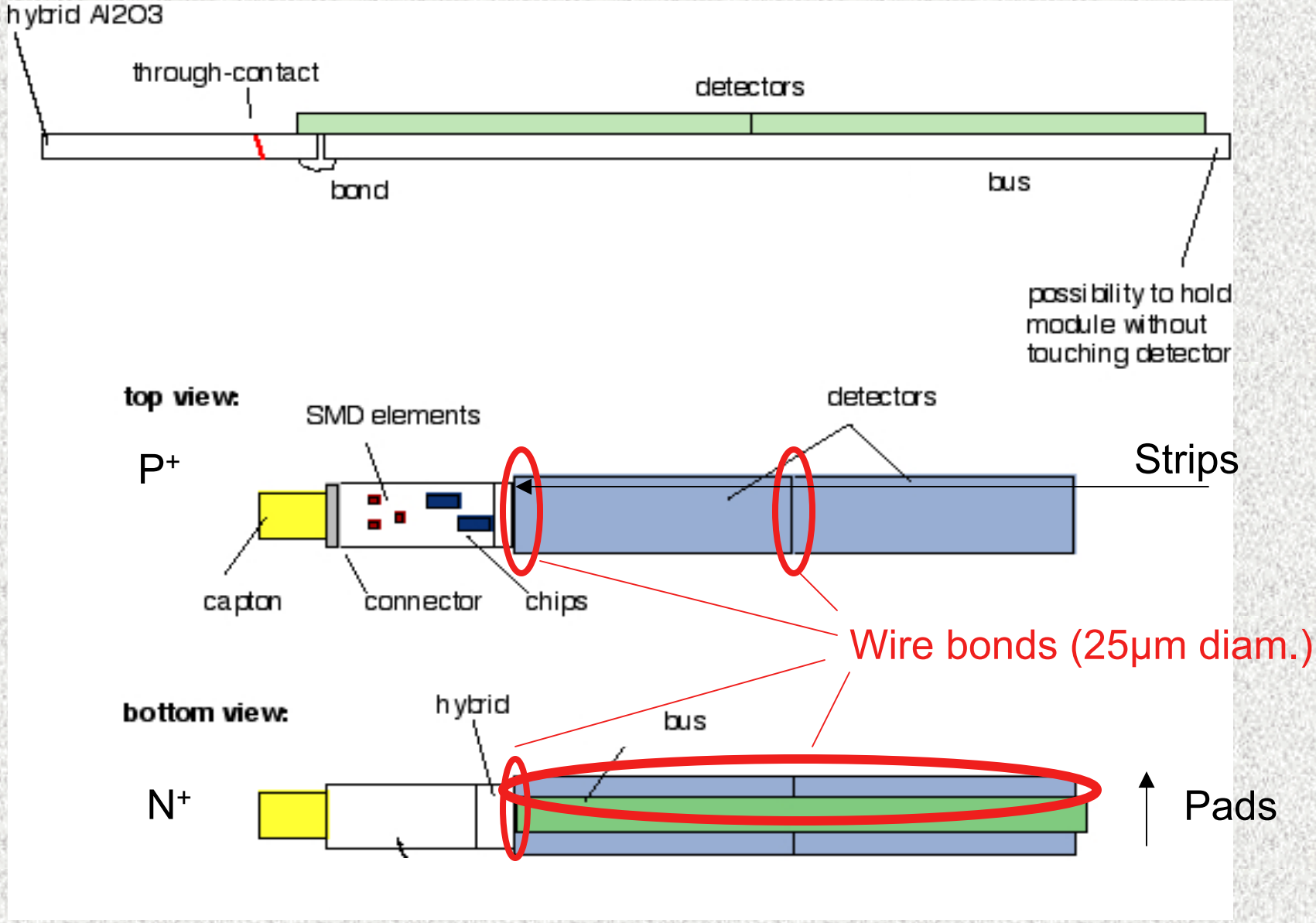
- **Temperature: 90-140K**
- **Vacuum: 10^{-8} mbar**
- **3 T magnetic field**

- 16-fold symmetry

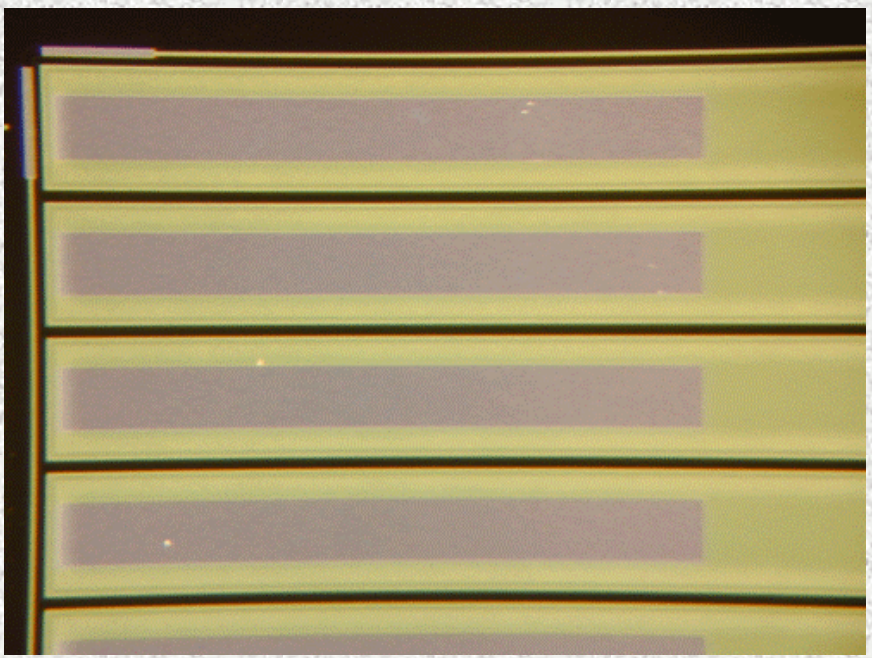
- 2 layers Si strip-detectors
- 192 CsI crystals with Si photodiodes

- 8960 read-out channels

Double Sided Silicon Strip Detector Modules

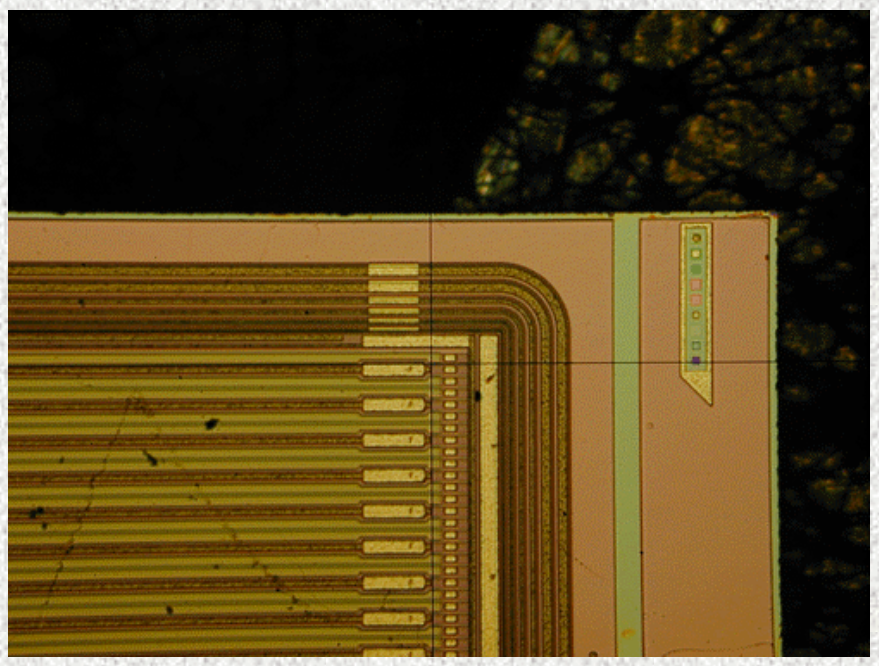


Bonding Pads



n^+ pads:
1mm wide
1248μm pitch
Bond pads: 500 μm x 1mm

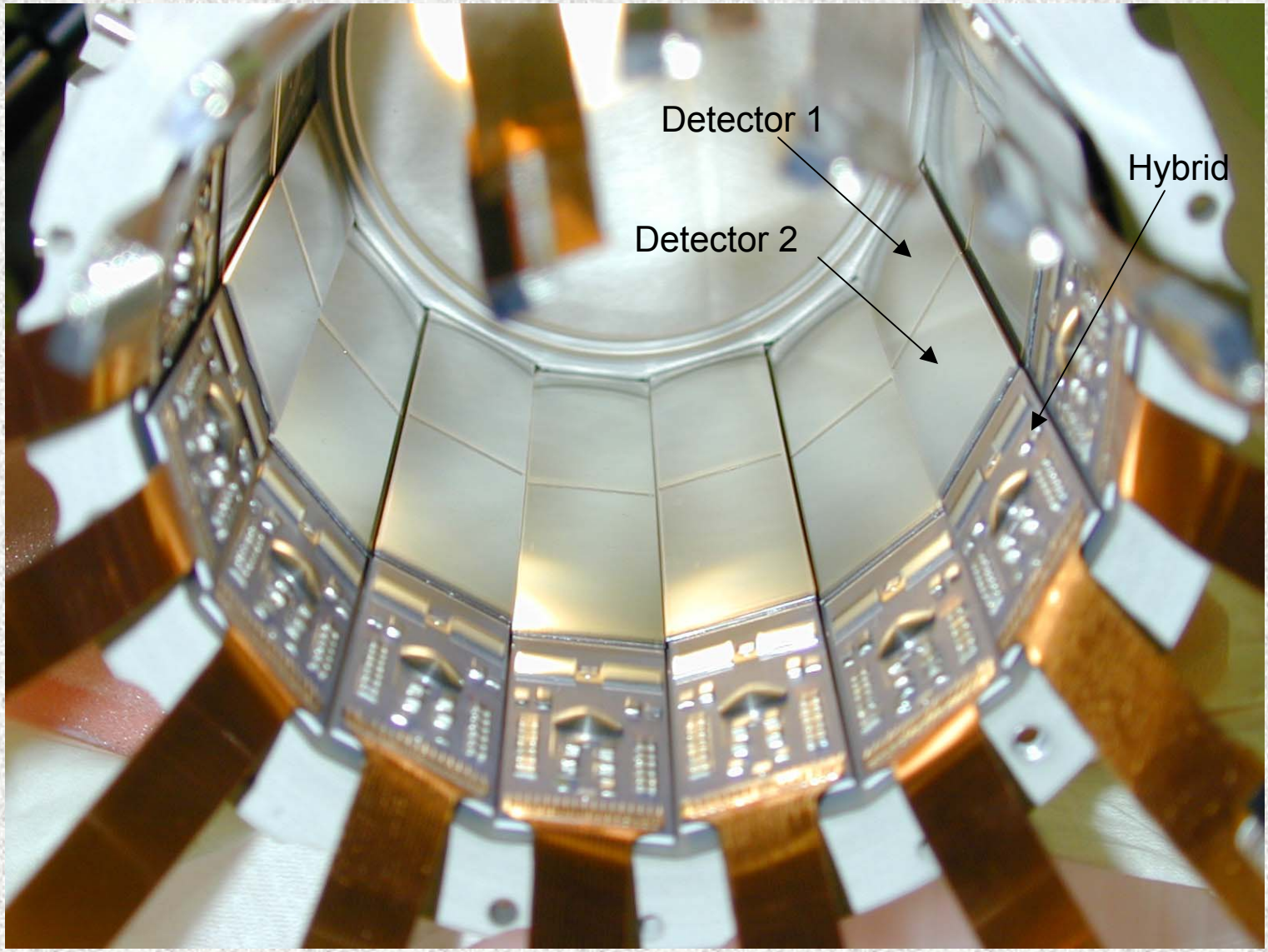
Bus was glued to this side



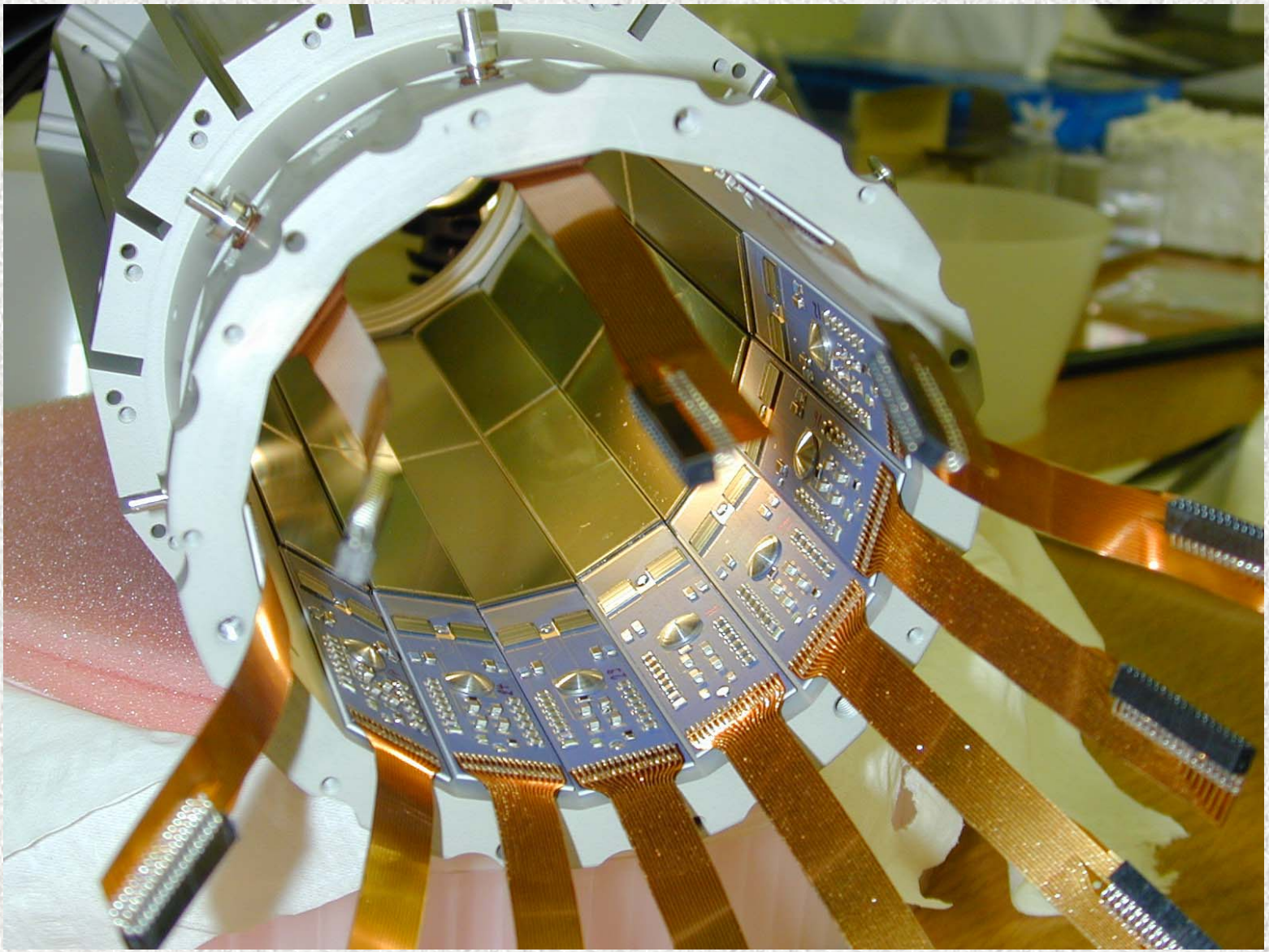
P+ side:
Bond pad: 60 μm x 200 μm
140 μm r.o. pitch (2 intermediate strips)

Bonding tested on sensors - ok!

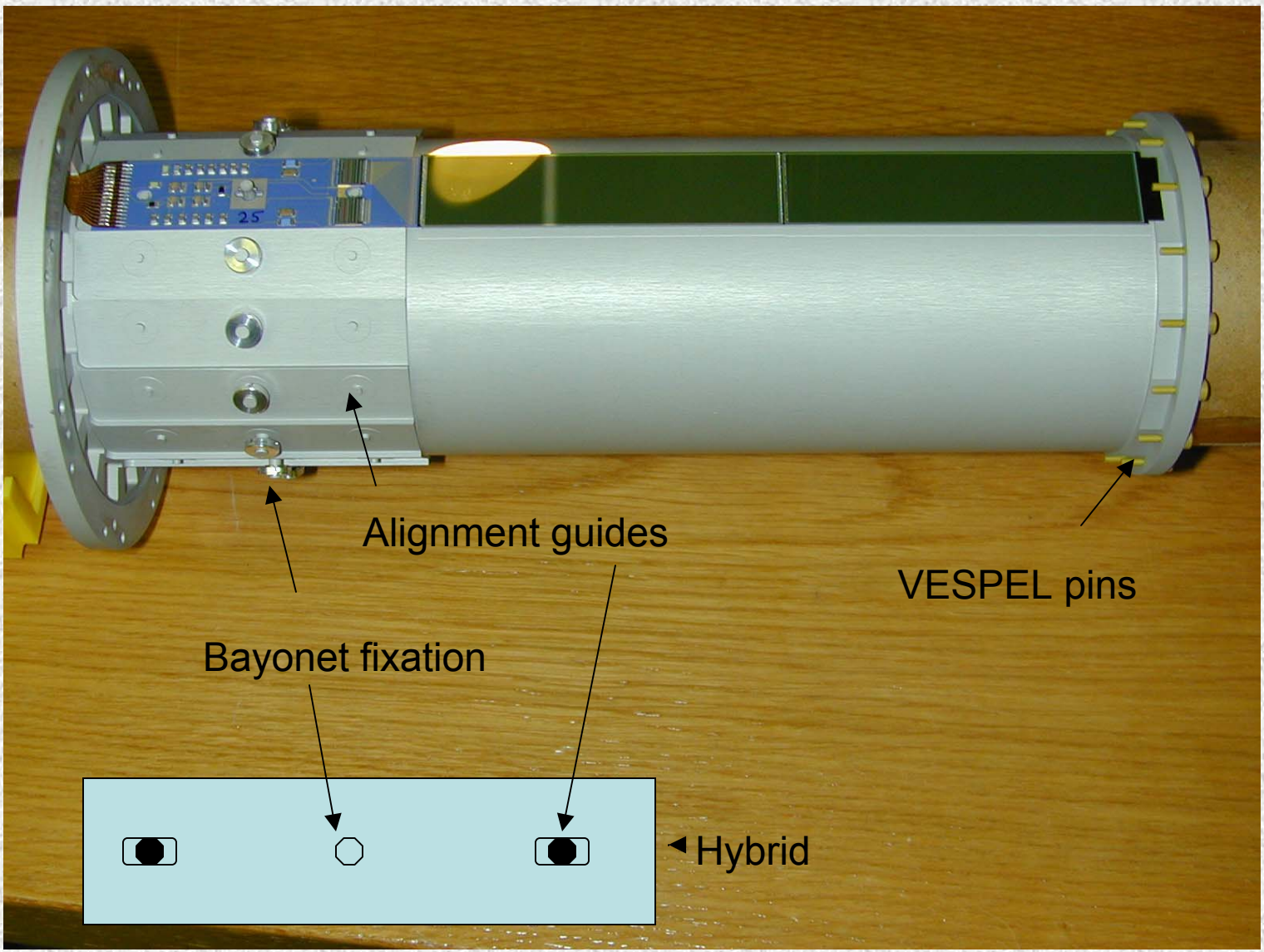
Outer layer - 16 modules



Outer layer mounted with bayonet fixation and spring compensator on Al support



Inner layer support
Modules mounted in wind-mill configuration (0.9 mm over-lapp)



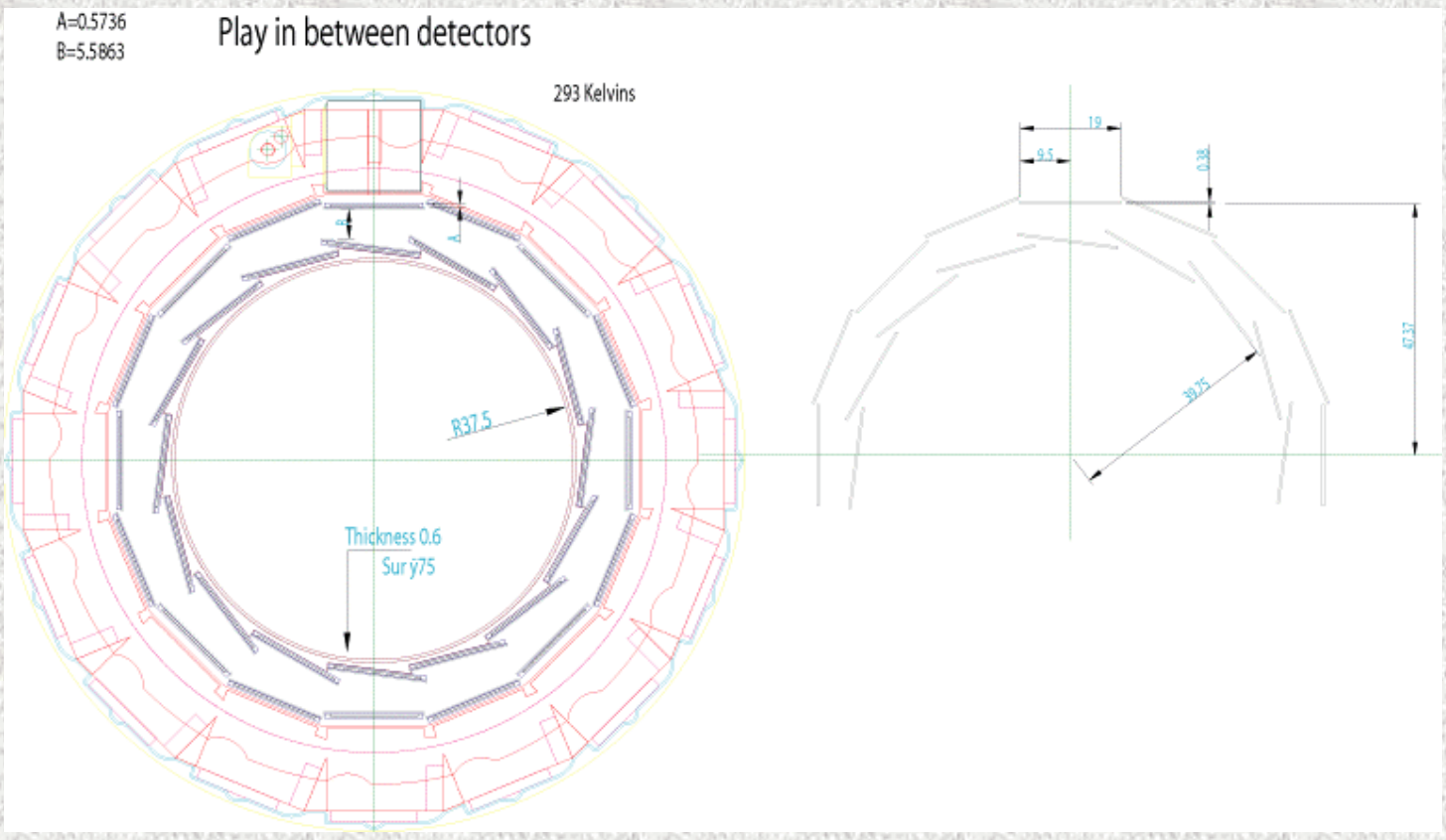
Constraints and Problems

- Double sided strip detectors
  - o handling
  - o connections on both sides required

- Special mounting jigs required for each assembly step+double sided bonding

- Temperature range: 90 K - 300 K
  - o mechanical stability (different TEC) - BUS!
  - o glue

- Two layers of double sided detectors with 5.5mm min. distance
  - o bonds
  - o mounting


A=0.5736
B=5.5863
Play in between detectors
293 Kelvins
R37.5
Thickness 0.6
Sur ÿ75
19
9.5
0.38
47.37
39.25

Gluing of the Bus

Glue: araldite W106 low temperature mixture (50:50)

Temperature cycling (300K-77K-300K)

- Reliable
- Regular
- Repeatable
- no glue on the bond pads!
- no air bubbles (vacuum!)

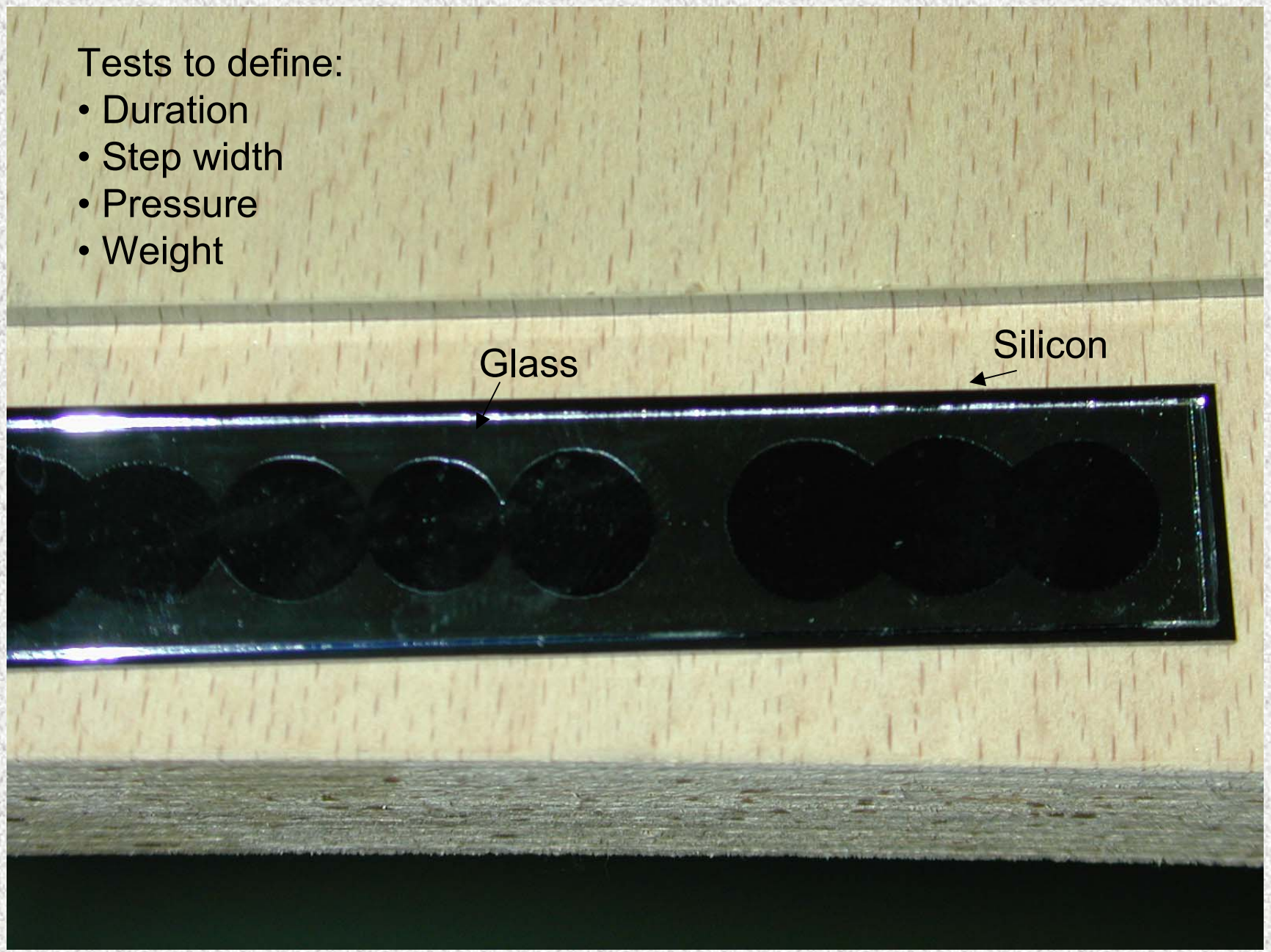
Commercial glue dispenser

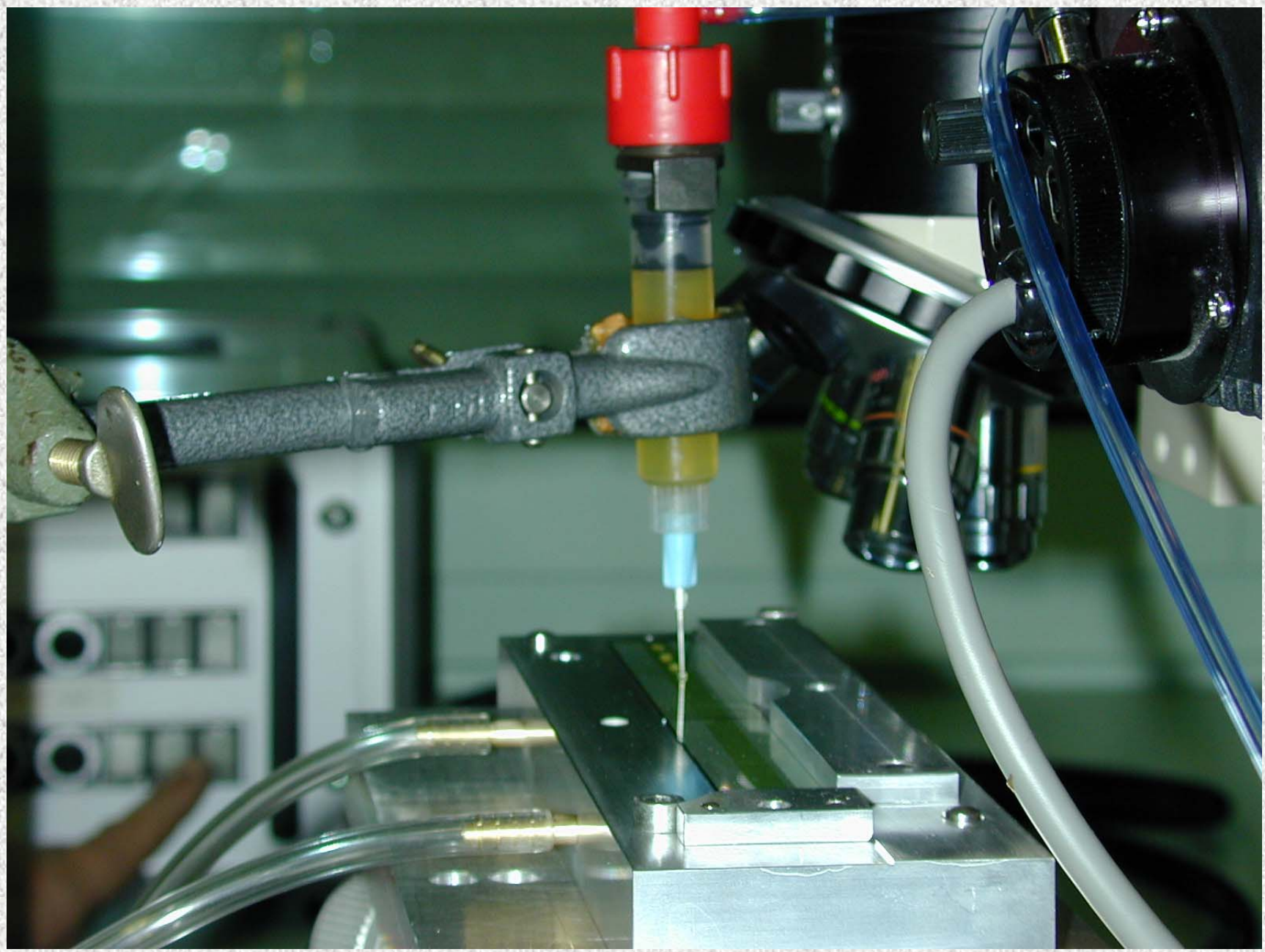
+

Alignment table with microscope

Tests to define:

- Duration
- Step width
- Pressure
- Weight





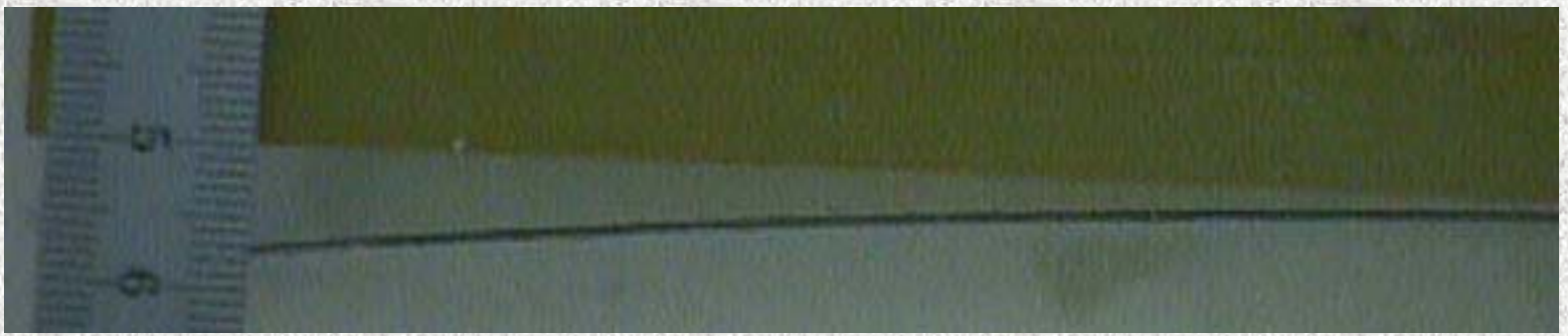
Finding the right carrier material for the bus

Production of prototypes:

Prototype 0: 160 mm Si + PCB hybrid + capton (V0)
Prototype 1: 162 mm Si + alumine hybrid + alumine bus (V1)
Prototype 2: 162 mm Si + alumine hybrid + glass (D263) bus (V1)
Prototype 3: 162 mm Si + alumine hybrid + alumine bus (V1)
Prototype 4: 162 mm Si + alumine hybrid + glass (AF45) bus (V1)
Prototype 5: 162 mm Si + alumine hybrid + carbon bus (V1)
Prototype 6: 162 mm Si + alumine hybrid + silicon bus (V1)

Tests with LN_2 in special low temperature test box with glass window

Alumine bus - prototype seen from the side at lN_2 temperature



Glass bus (D263) - prototype seen from the side at LN_2 temperature

Thermal expansion coefficients:

Capton	~30 ppm/K
Alumine	6.5-6.7 ppm/K
Glass D263	7.2 ppm/K
Glass AF 45	4.5 ppm/K
Carbon	2.1 ppm/K
Silicon	2.6-4.2 ppm/K

(~40μ deviation on full length)

Bus:

Produced on 200mm Si wafers (400μ)
Water-cooled laser-cutting
(PREJET AG, CH)

Bonding on the Bus

Bus provides connection between n+ pads and the hybrid (..pitch adapter..) and is also the support for the two sensors.

Layout:
40 µm wide lines
Bond pads: 50µm x 200µm
Pitch: 1248µm on n^+ side, 120µm on hybrid side

Base material: 8” wafers thinned to 400µm, coated with polyimide on both sides (~10µm)

Traces and pads: Chrom+Aluminium

…**bond test fails** - bonds do not stick (varied bonding parameters, plasma etching, bake out,…)

Add Ni-Ti-Au layers onto the bonding pads + plasma etching - Bonding OK

Summary

• The development and production for the ATHENA SVX took ~ 3 yrs.

• The limited space and the operation at LN2 temperature and in vacuum put serious constraints on the individual components and the assembly.

•A special mechanical support was designed with only one side fixed in order to absorb all the occurring forces during the temperature cycles (90-300 K).

• The help from R. de Oliveira made it possible to produce the silicon bus which provides mechanical support and the electrical contacts for the double sided silicon detectors (bonding!)

•The SVX has been operated successfully for 2 years with a new run period coming up now. In the meantime the detector was warmed up and cooled to ~90K several times.