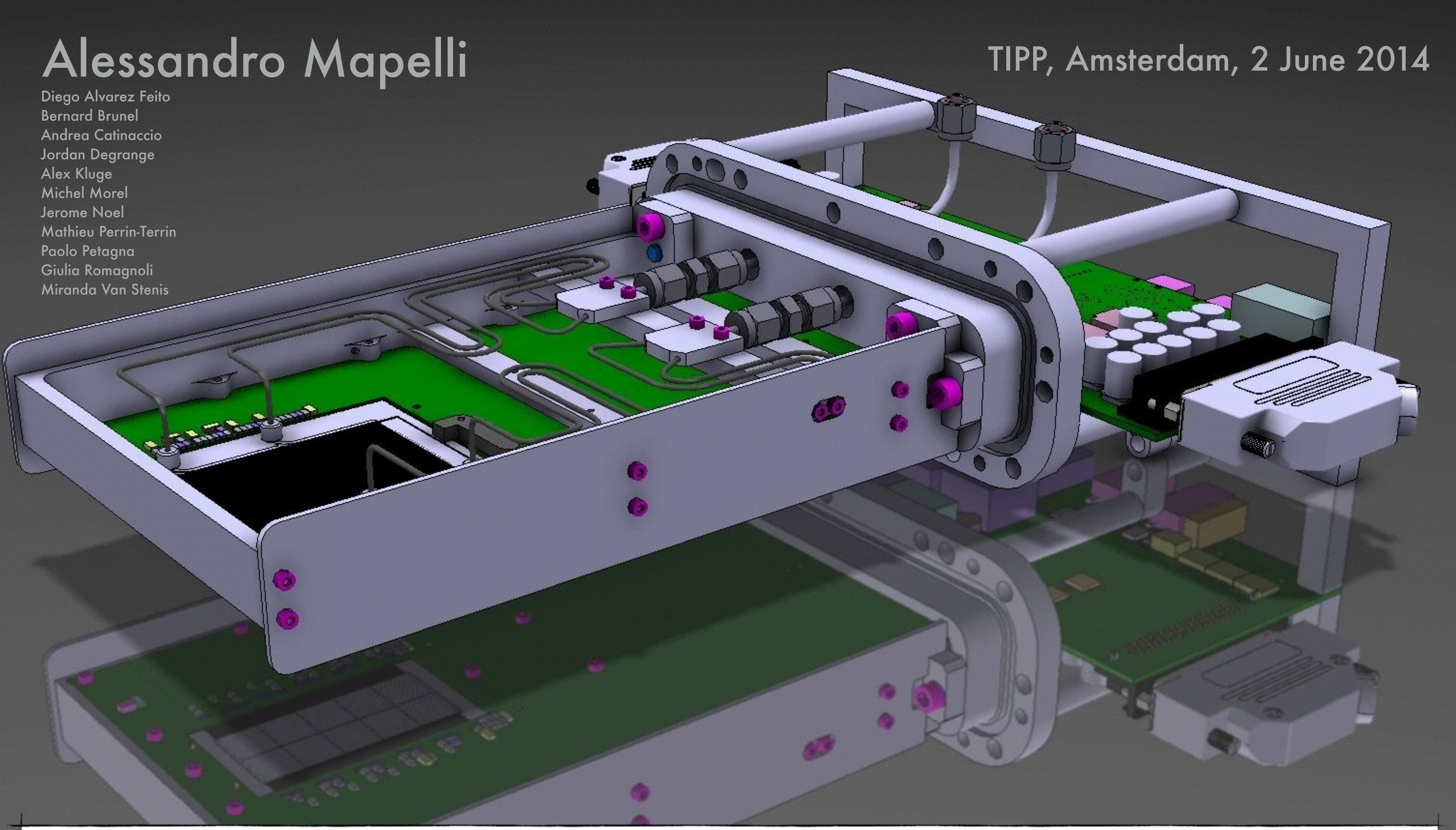
Alessandro Mapelli

Diego Alvarez Feito
Bernard Brunel
Andrea Catinaccio
Jordan Degrange
Alex Kluge
Michel Morel
Jerome Noel
Mathieu Perrin-Terrin
Paolo Petagna
Giulia Romagnoli
Miranda Van Stenis

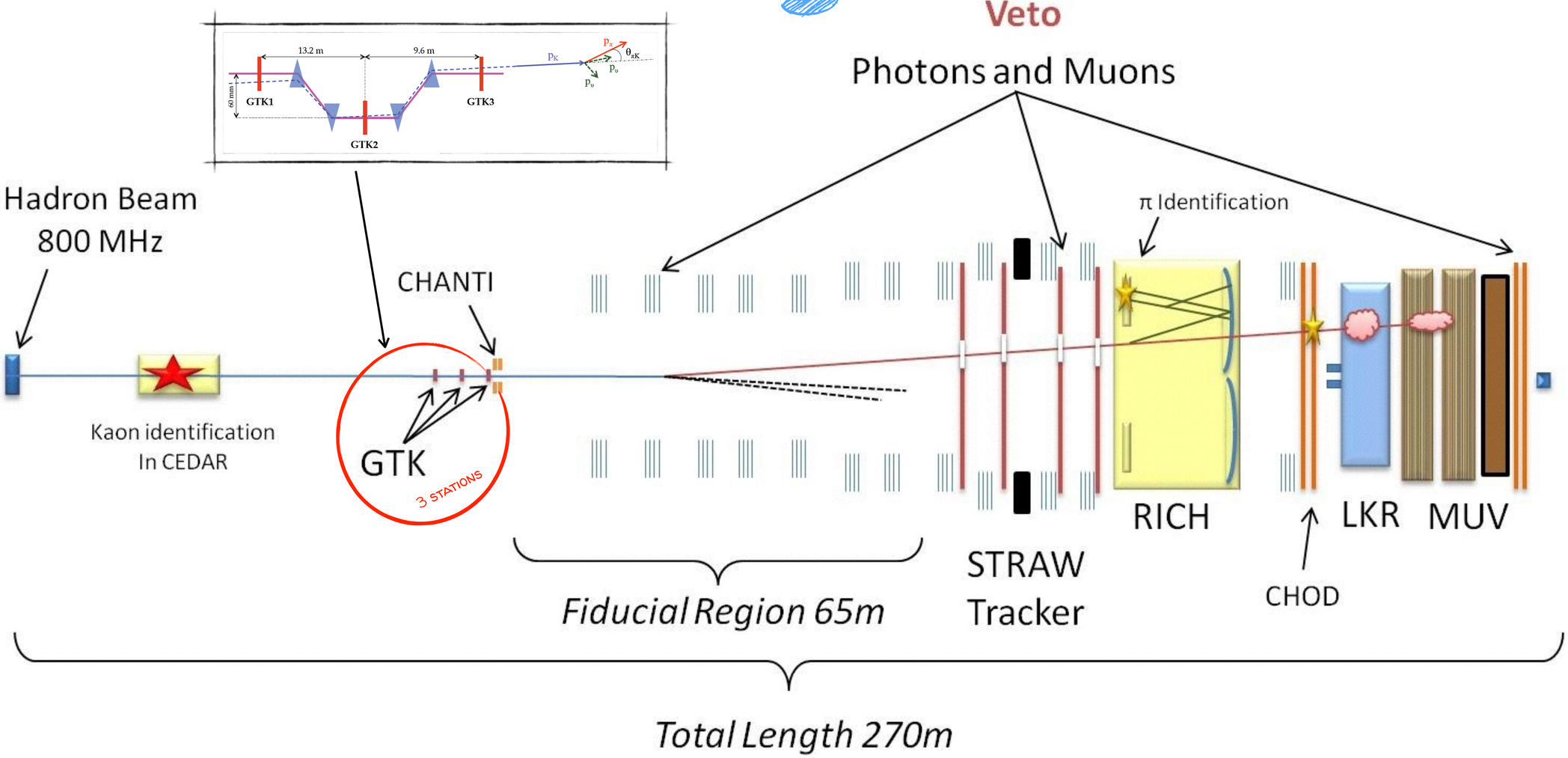
TIPP, Amsterdam, 2 June 2014



the thermo-mechanical integration of the NA62 GigaTracKer

TIPP '14 International Conference on Technology and Instrumentation in Particle Physics
2 – 6 June 2014 / Amsterdam, The Netherlands
"Instrumentation as enabler of Science"

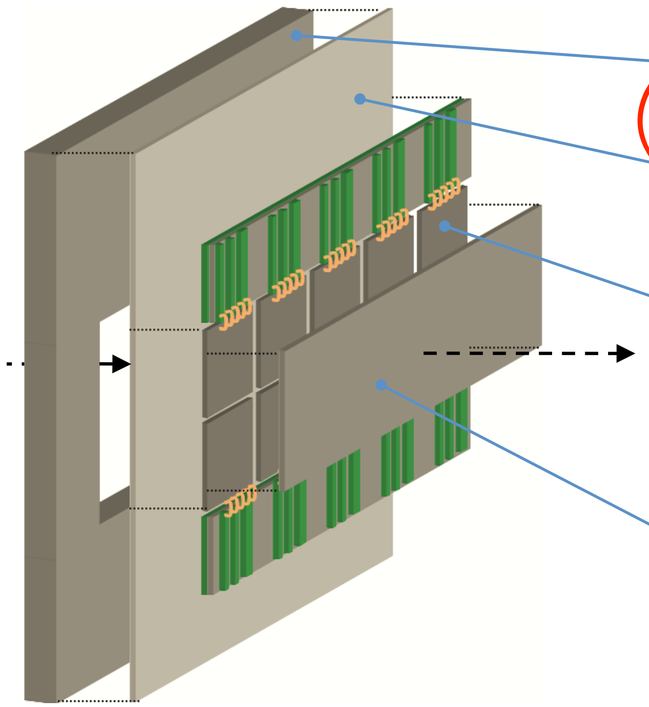
the NA62 GigaTracKer



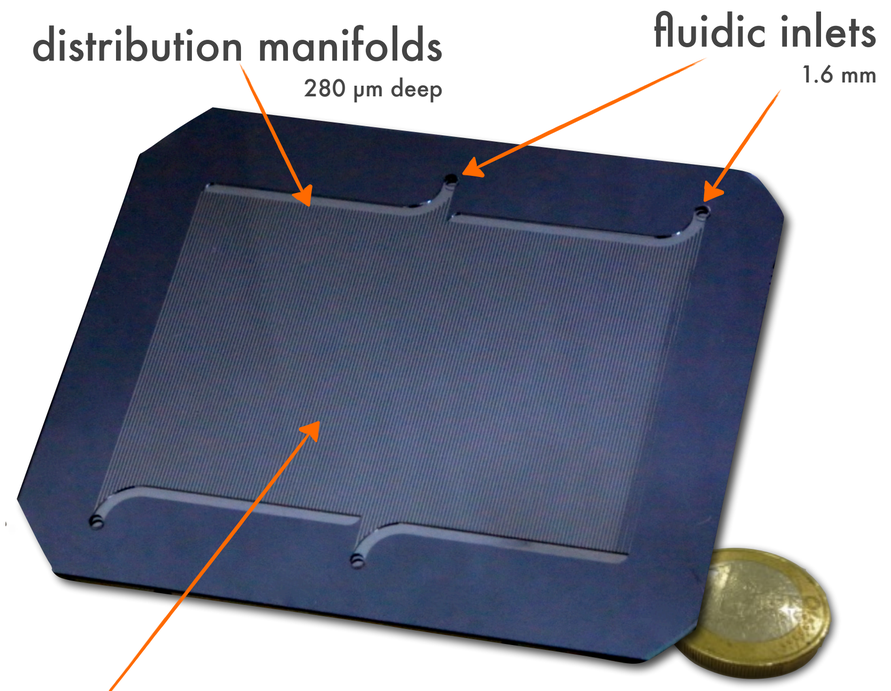
- NA62 aims at investigating extremely rare kaon decays in the North Area of the CERN SPS.
- The 3 GigaTracKer stations will provide information on each particle trajectory, momentum, and timing within 200 ps.

cooling of the NA62 GTK

- Each GTK station is made of one hybrid silicon pixel detector (29.3 mm x 63.1 mm with 18000 pixels 300 μm x 300 μm) flip-chip bonded to 10 ASIC front-end chips TDCPix.
- Each station also includes a support structure, a cooling system and electrical and optical connections.
- The GTK pixel detectors will be the first HEP detectors to be cooled with silicon microchannels.
- Liquid C_6F_{14} will circulate at -20°C in a 130 μm thick silicon plate with embedded microchannels (200 μm x 70 μm) to dissipate the heat produced by the electronics (power dissipation 40W).

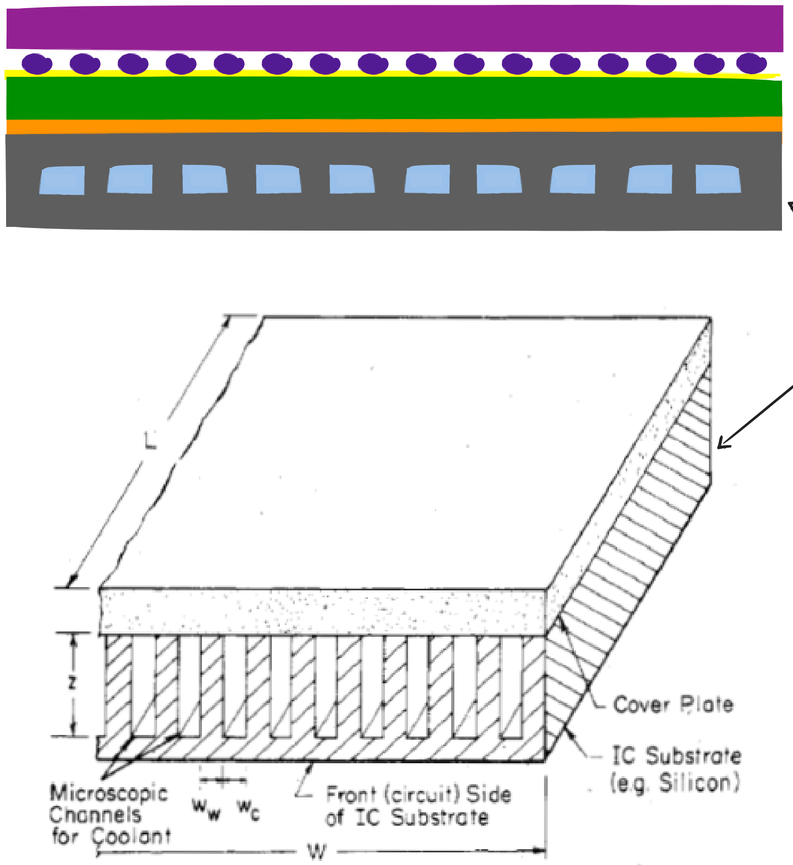


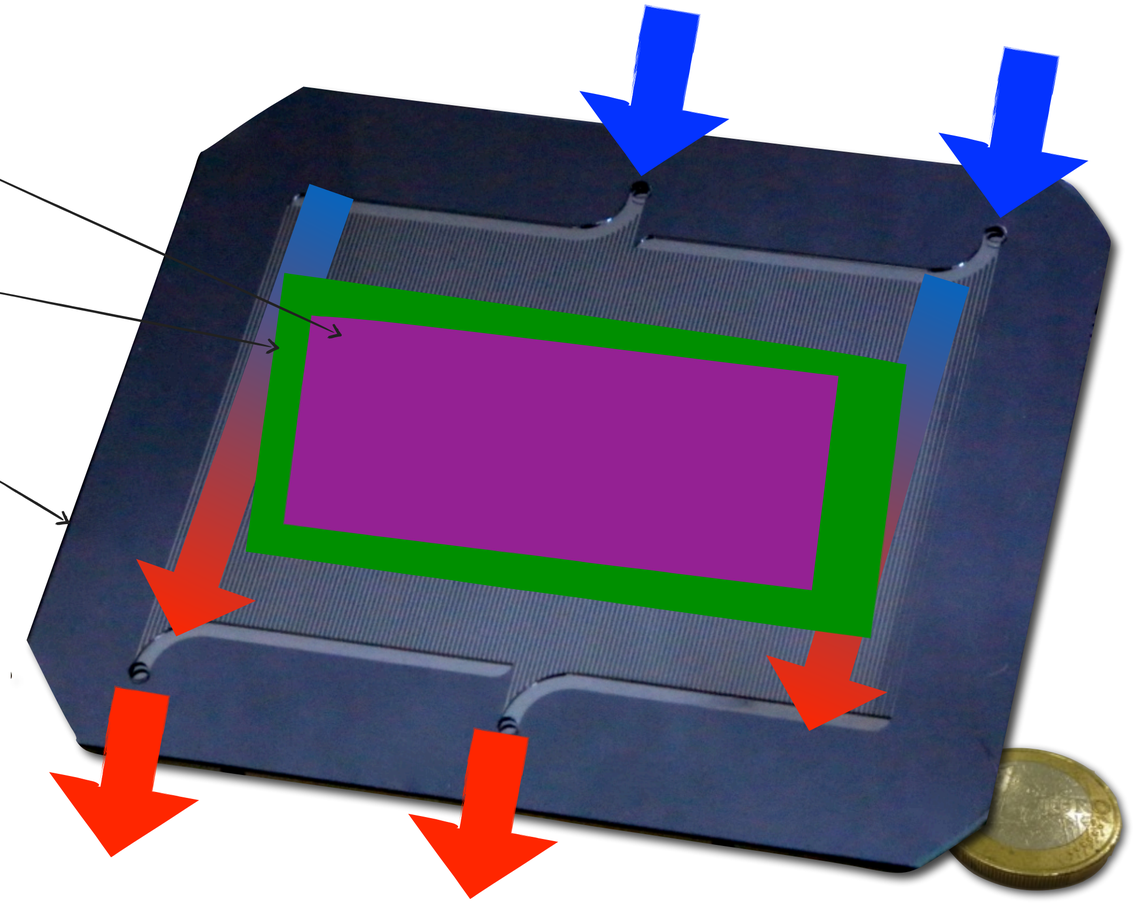
single GTK station



silicon microchannel cooling

- No CTE mismatch
- Low material budget
- Active/distributed cooling
- Integration potential

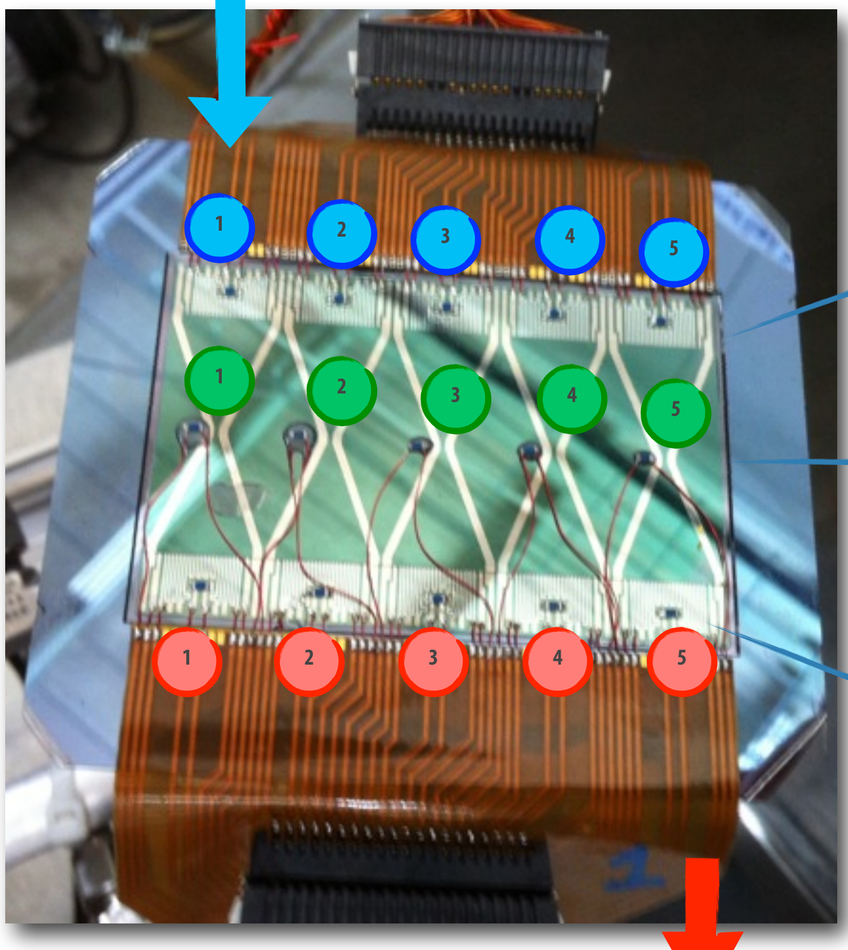




D.B. Tuckerman and R.F.W. Pease, IEEE Elec. Dev. Letters, Vol. 2, 5, 1981

experimental validation of silicon microchannel cooling for the GTK

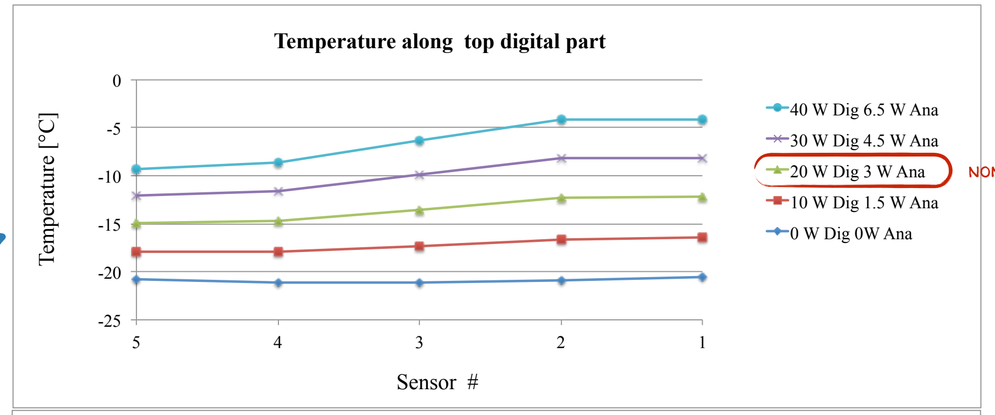
C_6F_{14} IN at -21°C
mass flow 8 g/s

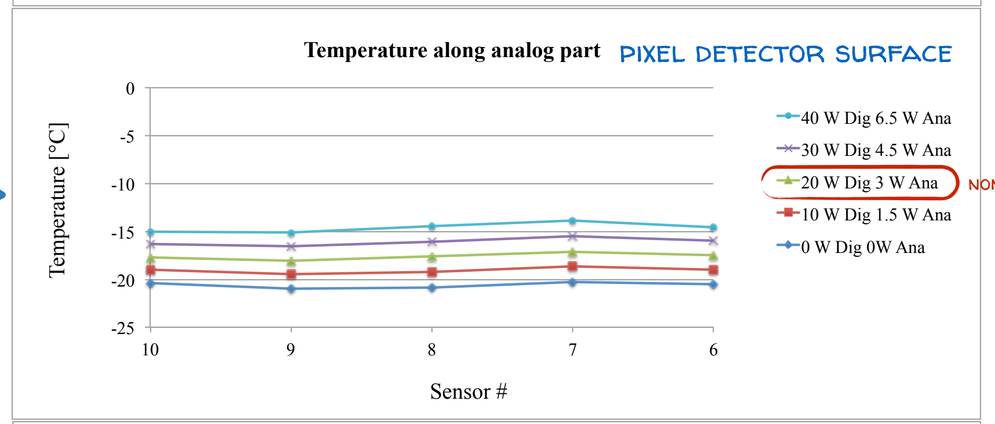


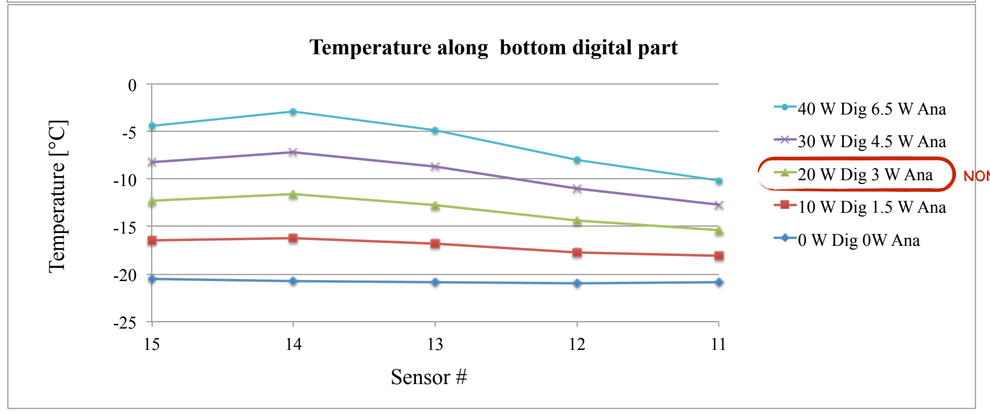
Digital
2.5 W/cm²

Analog
0.4 W/cm²

Digital
2.5 W/cm²







Microchannels meet the specifications at nominal conditions.

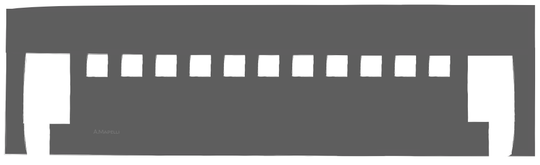
- max Δt_{sensor} 1 °C
- max Δ_{tchip} 3 °C
- max $\Delta_{tmodule}$< 5 °C

microfabrication of the cooling plates

Si wafer

Plasma etching of channels & manifolds

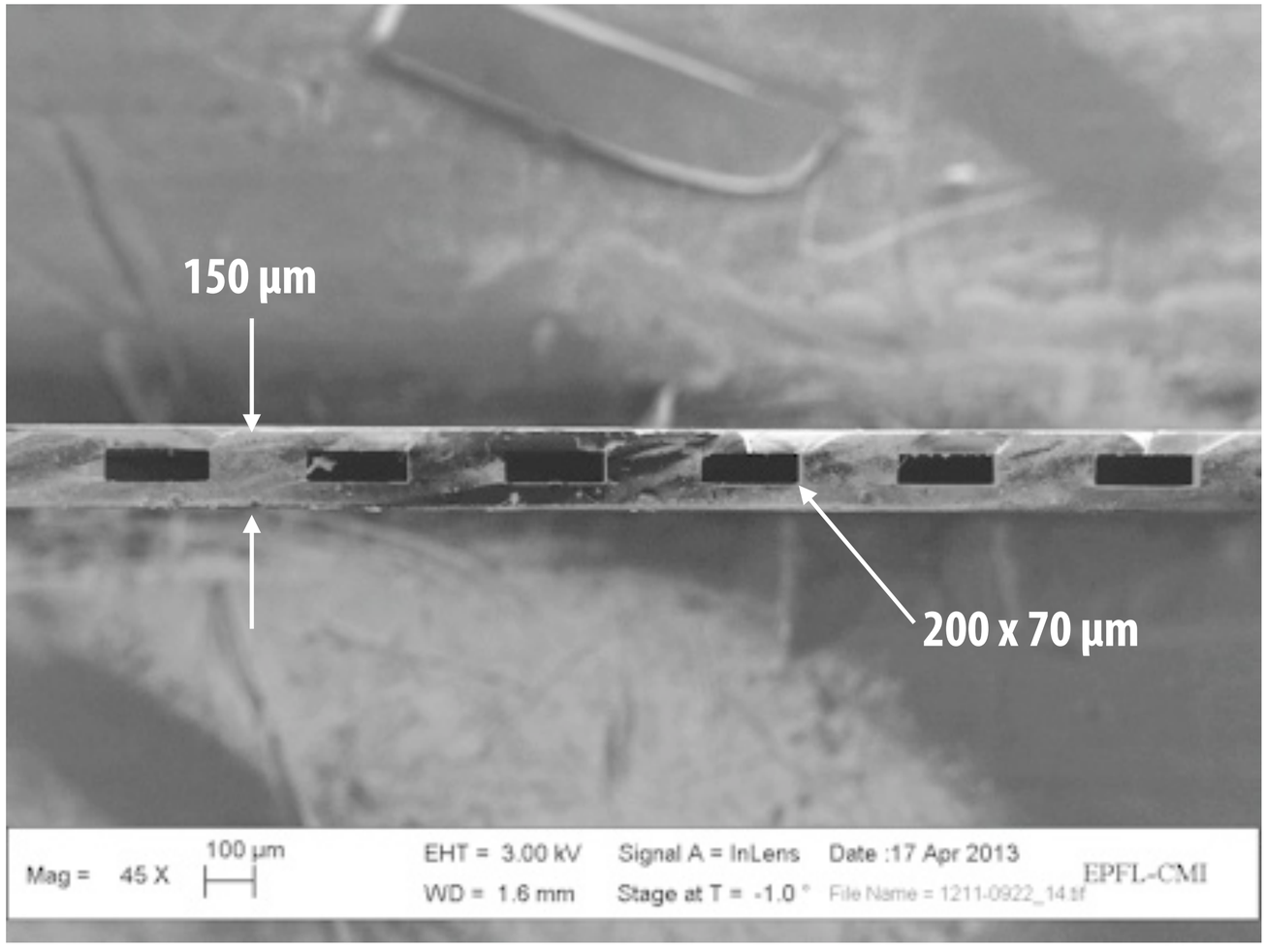
Bonding of Si cover



Plasma etching of fluidic inlets

Wet etching of acceptance

Metallization around Inlets



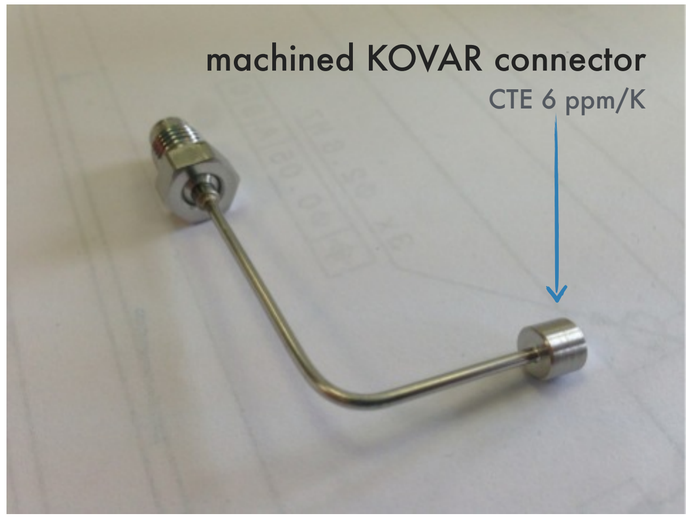
- Design by CERN PH-DT
- Prototypes fabricated by PH-DT at EPFL-CMi on 4" wafers
- Pre-production series by IceMOS on 6" wafers
- First series under fabrication at CEA-Leti on 8" wafers

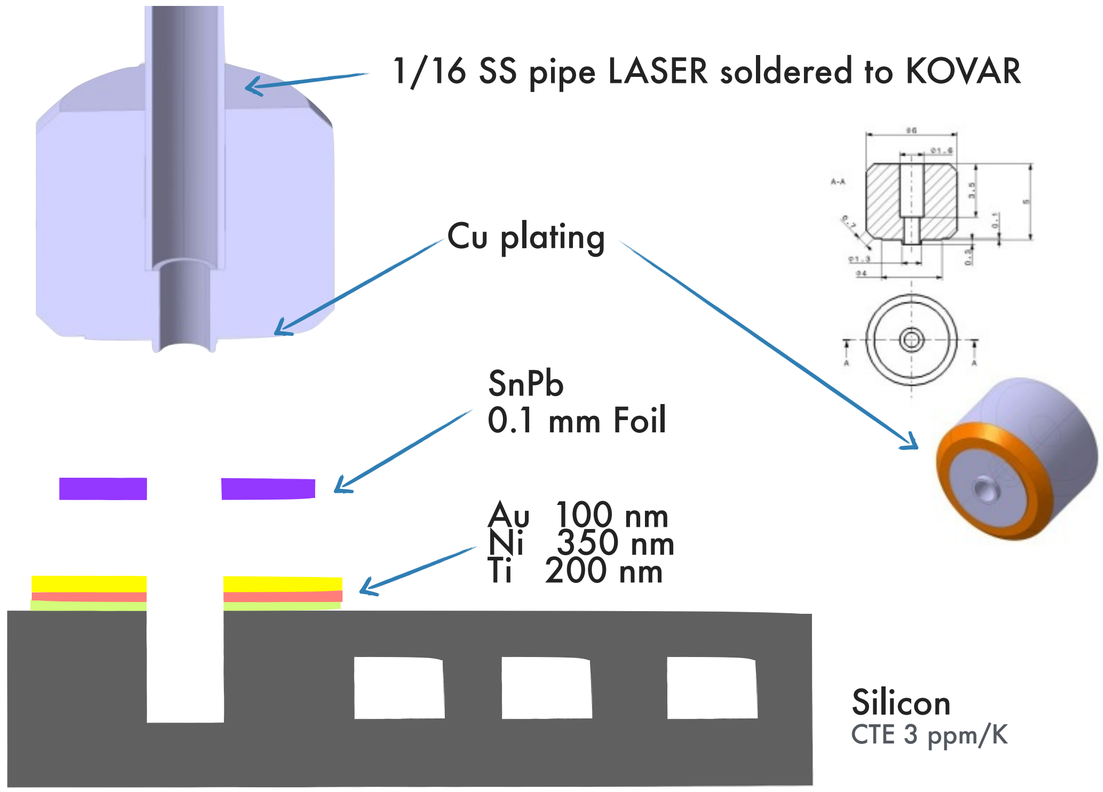
HOW
DO WE CONNECT
MICROCHANNELS TO THE
COOLING PLANT ??

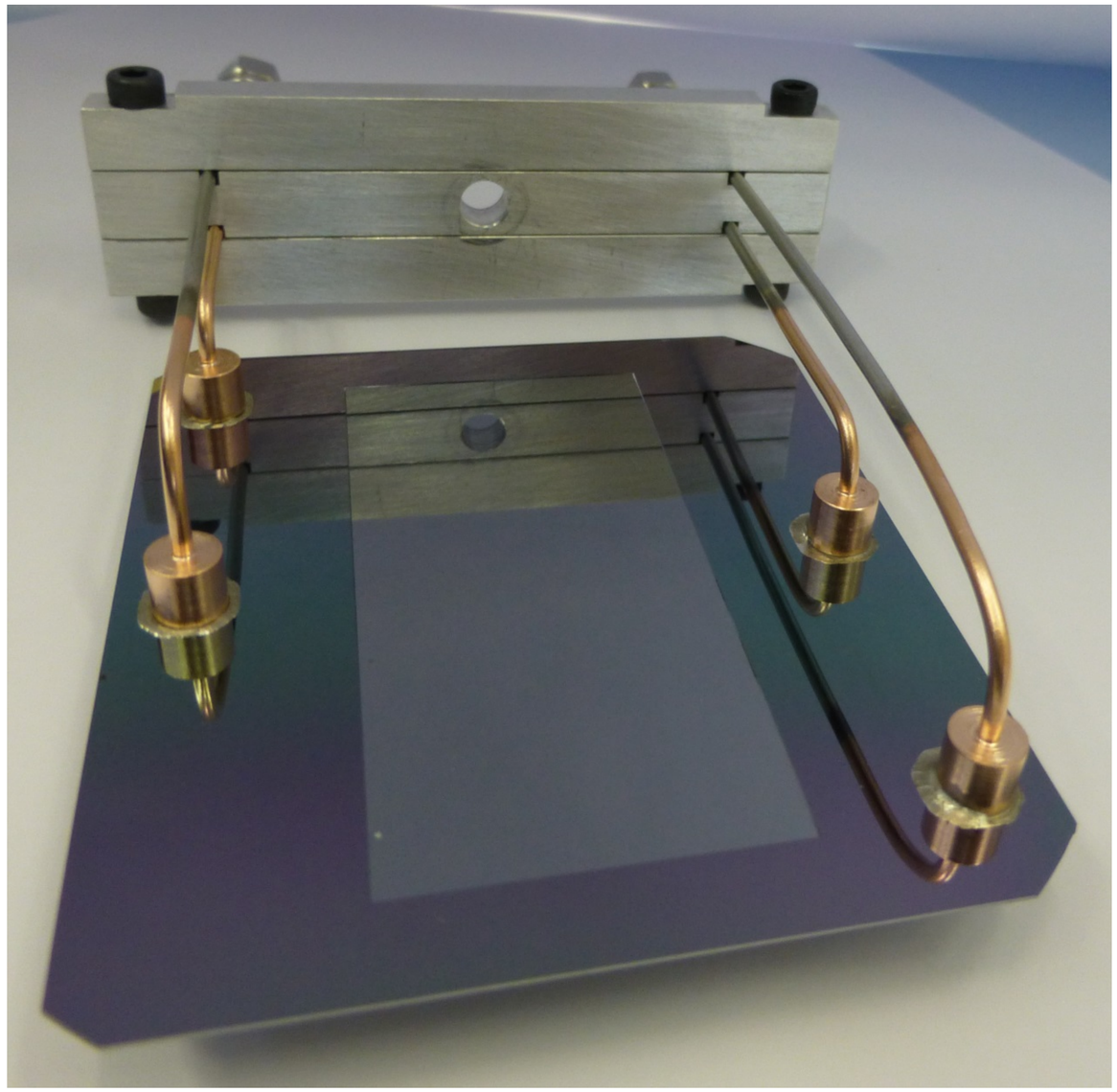
SOLDER
KOVAR CONNECTORS
TO SILICON !!

KOVAR connectors

common development with LHCb

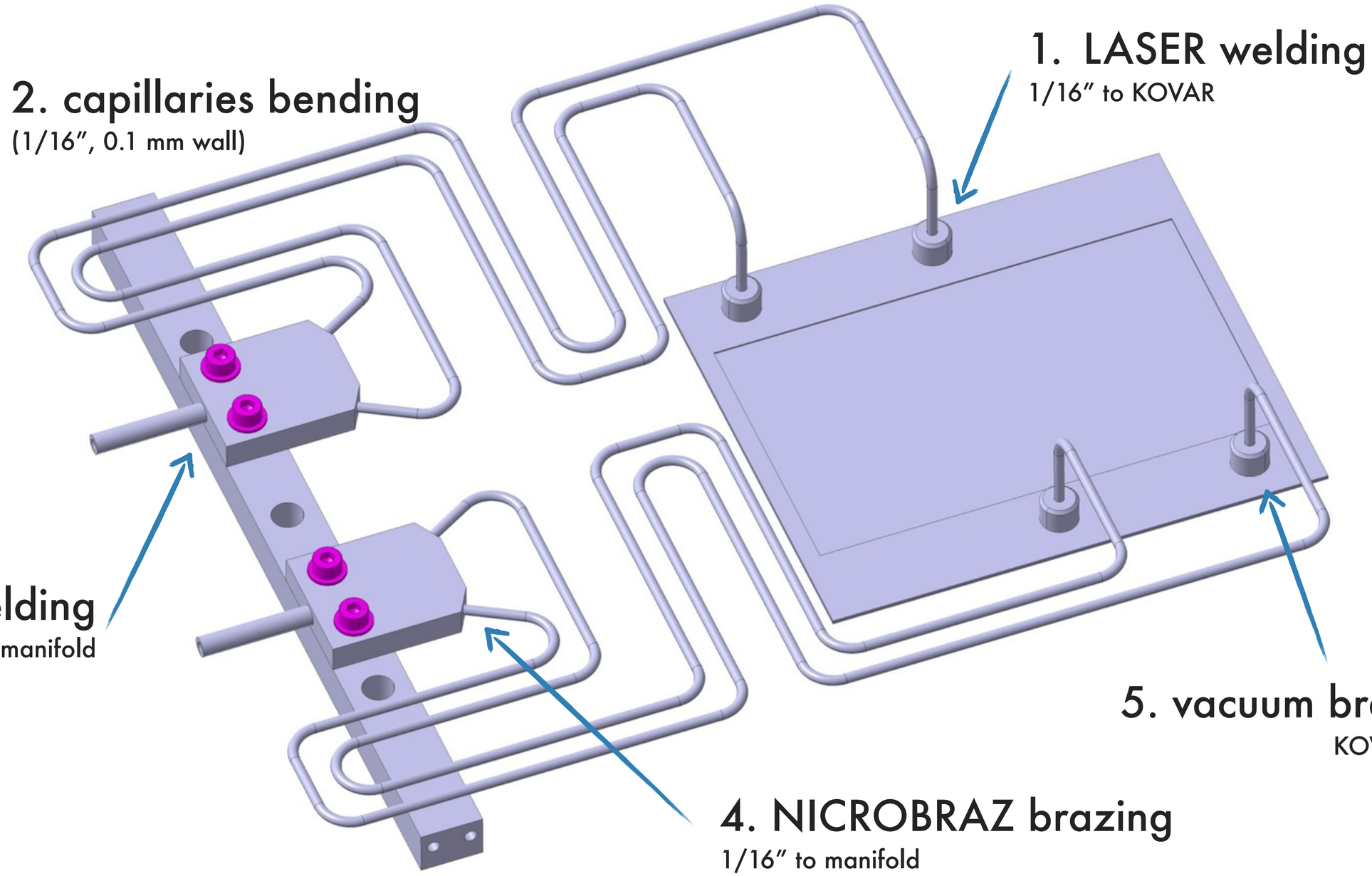




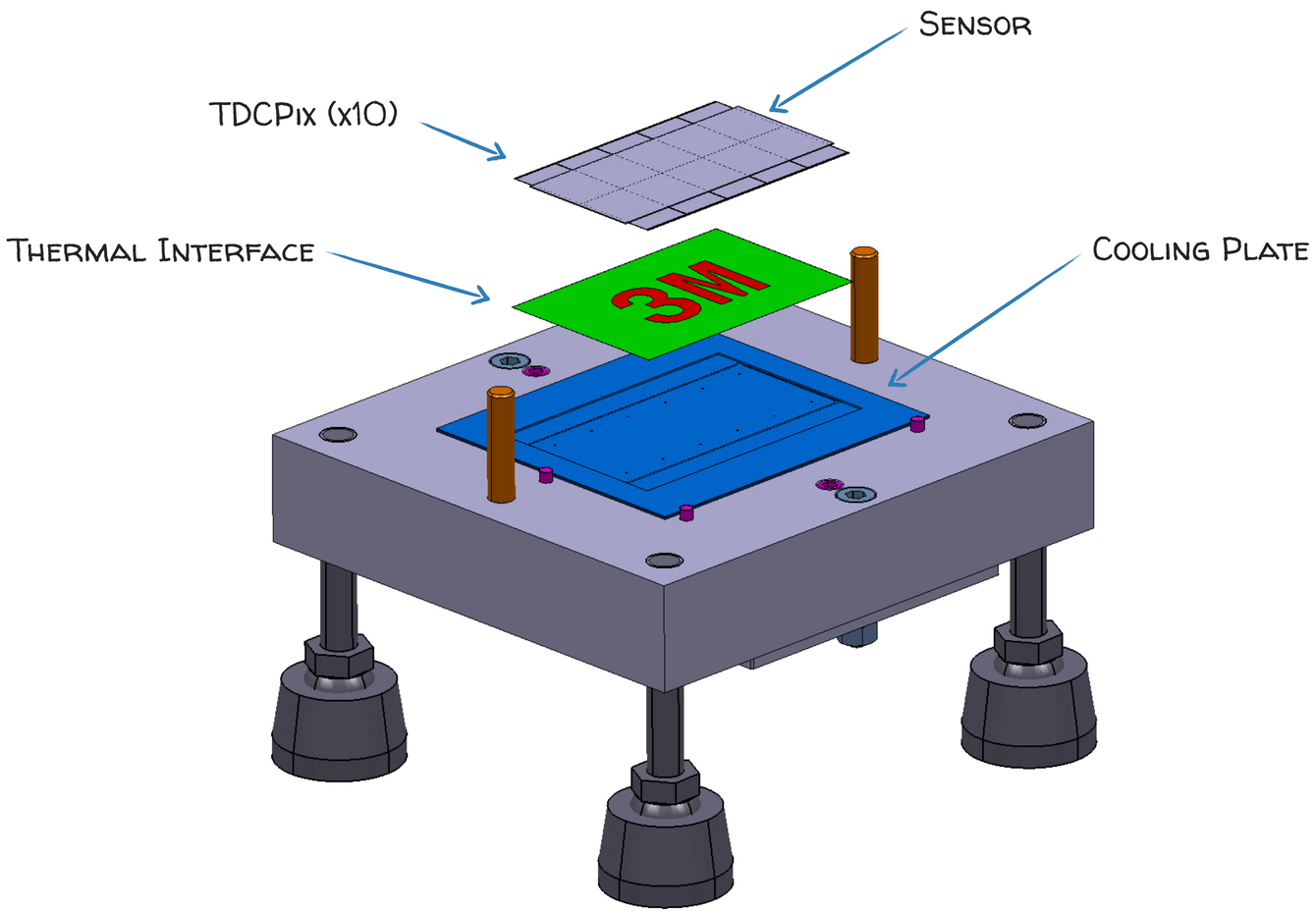


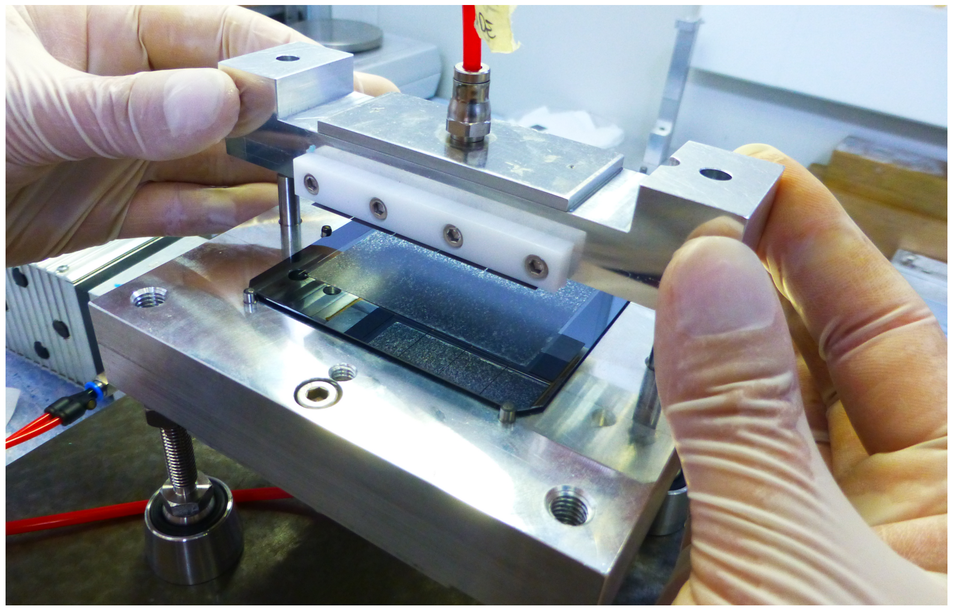
connecting capillaries to silicon

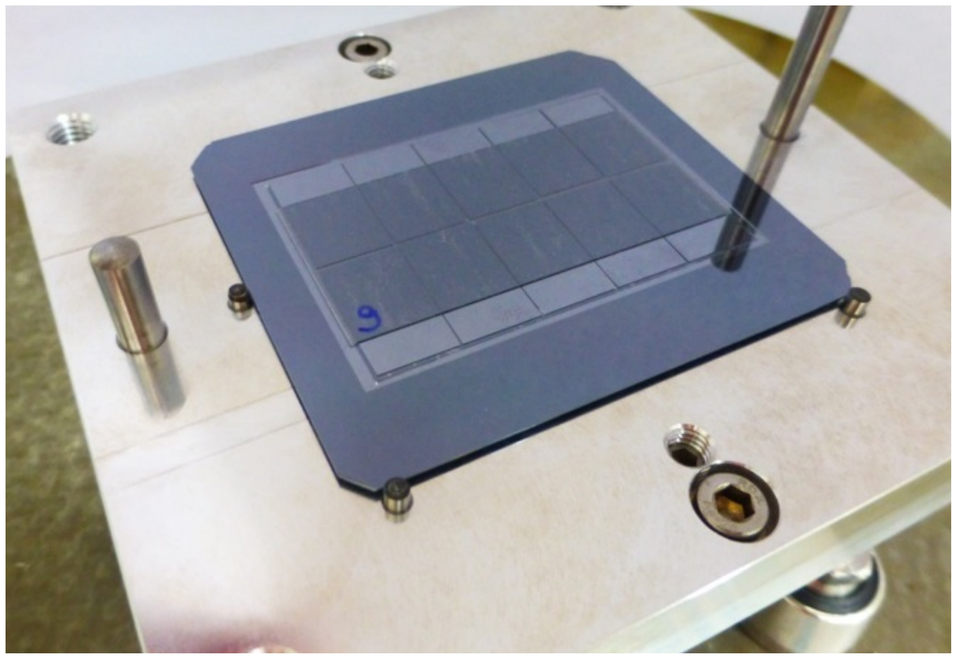
in collaboration with CERN-EN-MME



glueing GTK on the cooling plate

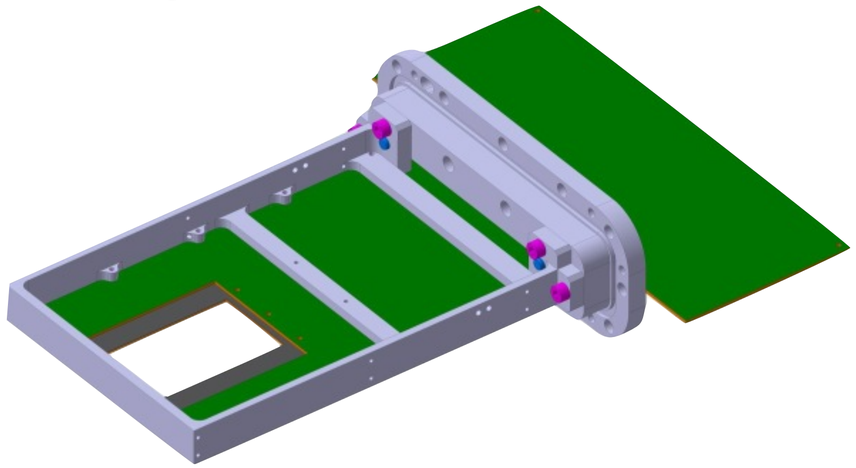


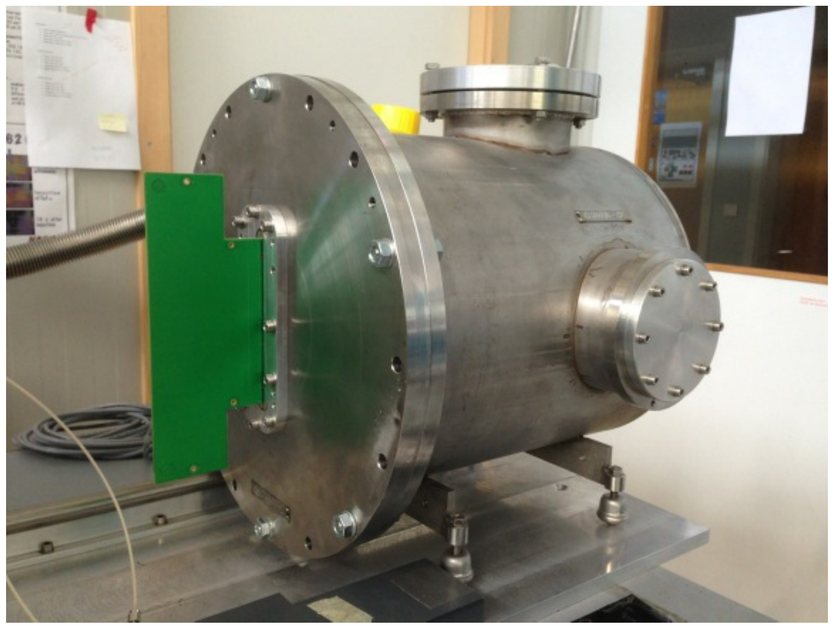




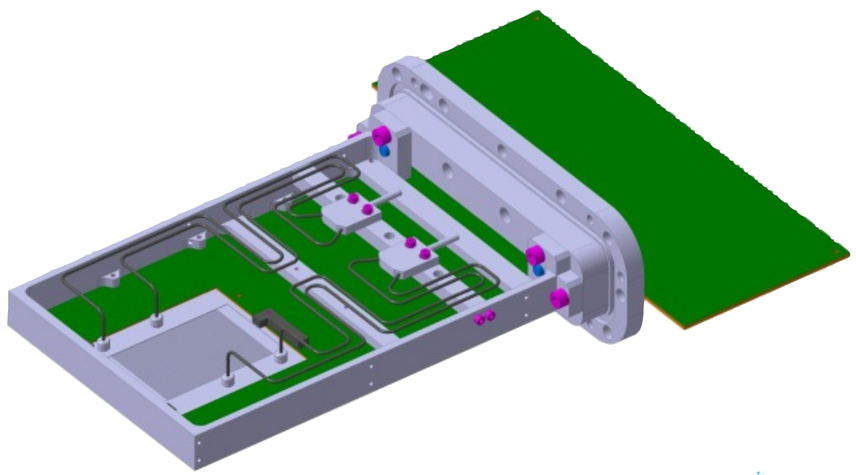
the read-out board

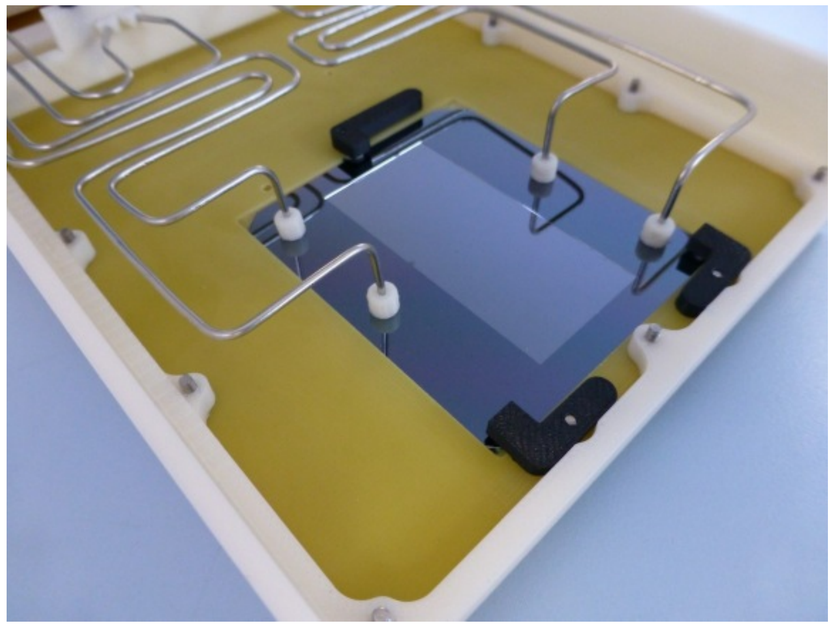
Glueing of vacuum flange to the read-out board “à la TOTEM” to guarantee leak tightness.





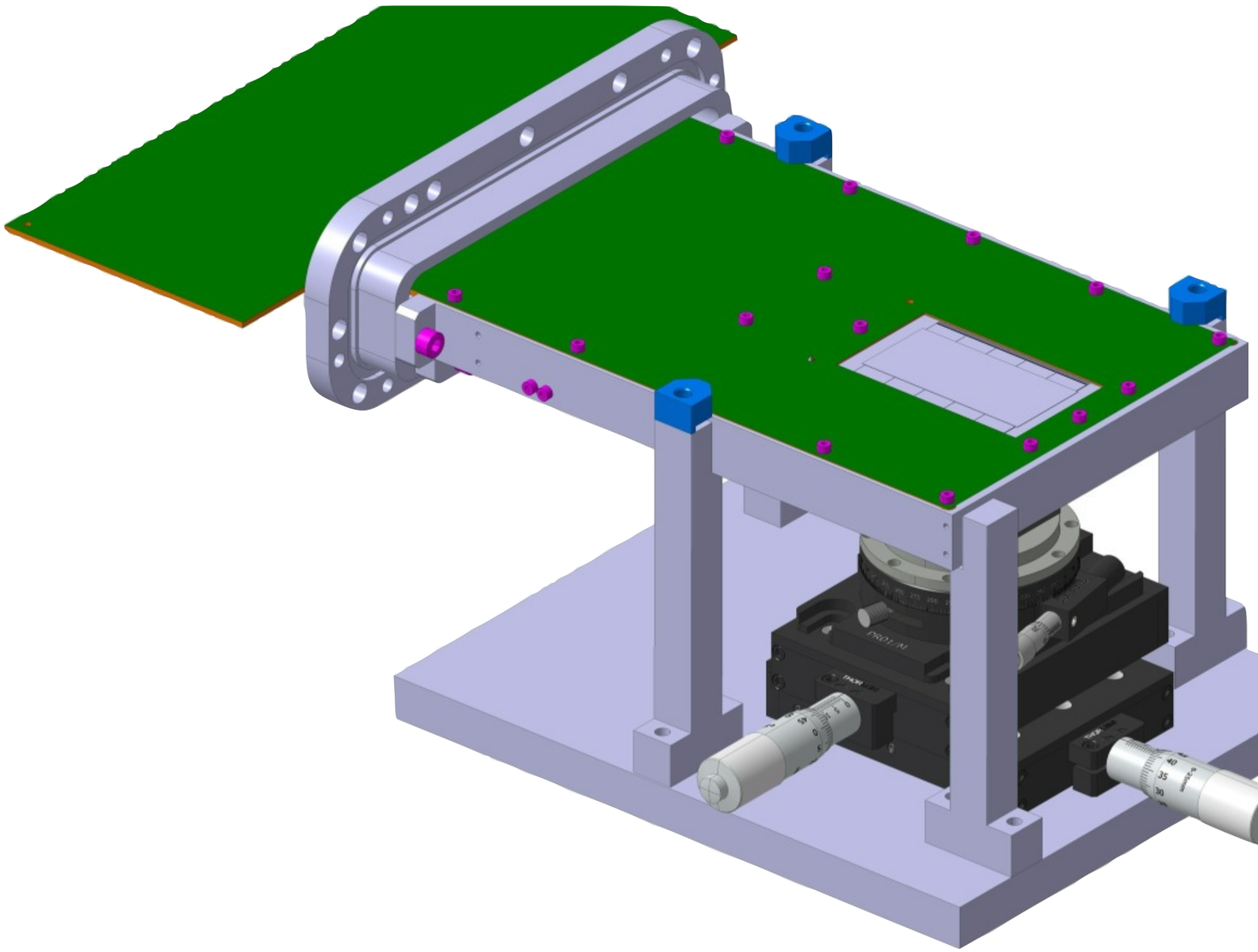
To minimise mechanical stress on the silicon cooling plate:
- it is held on 3 points to the read-out board,
- the tubes are bent for 3 degrees of freedom.

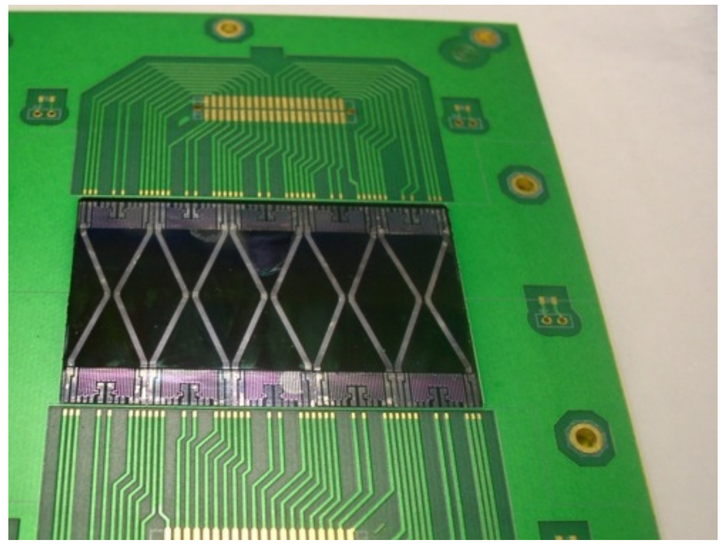


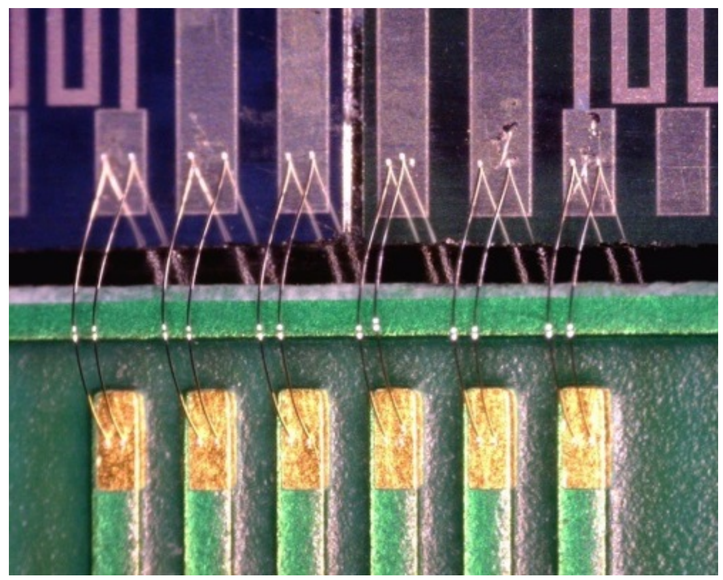


alignement of TDCPix and wire-bonding

talk by Matt NOY thursday at 17:10
The TDCPix ASIC: Tracking for the NA62 GigaTracker
session III.a FE & ASICs

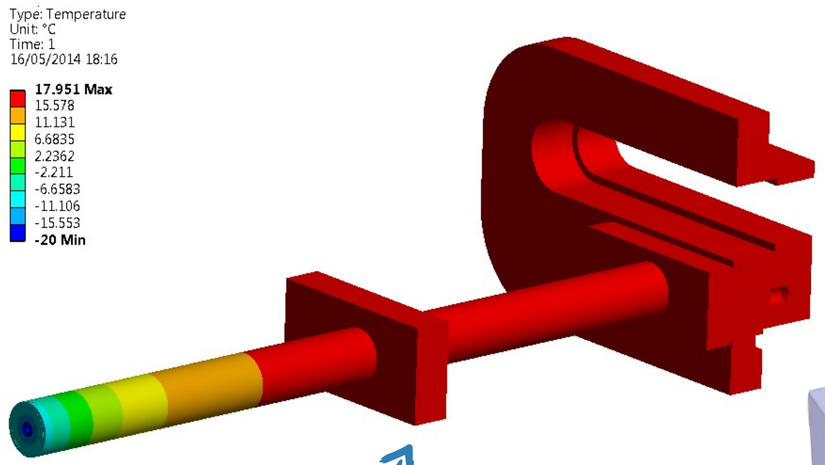






18000 wire bonds with a pitch of 73 µm
wire-bonding will be performed at CERN

vacuum insulation of cooling capillaries out of the vessel



Vacuum flange

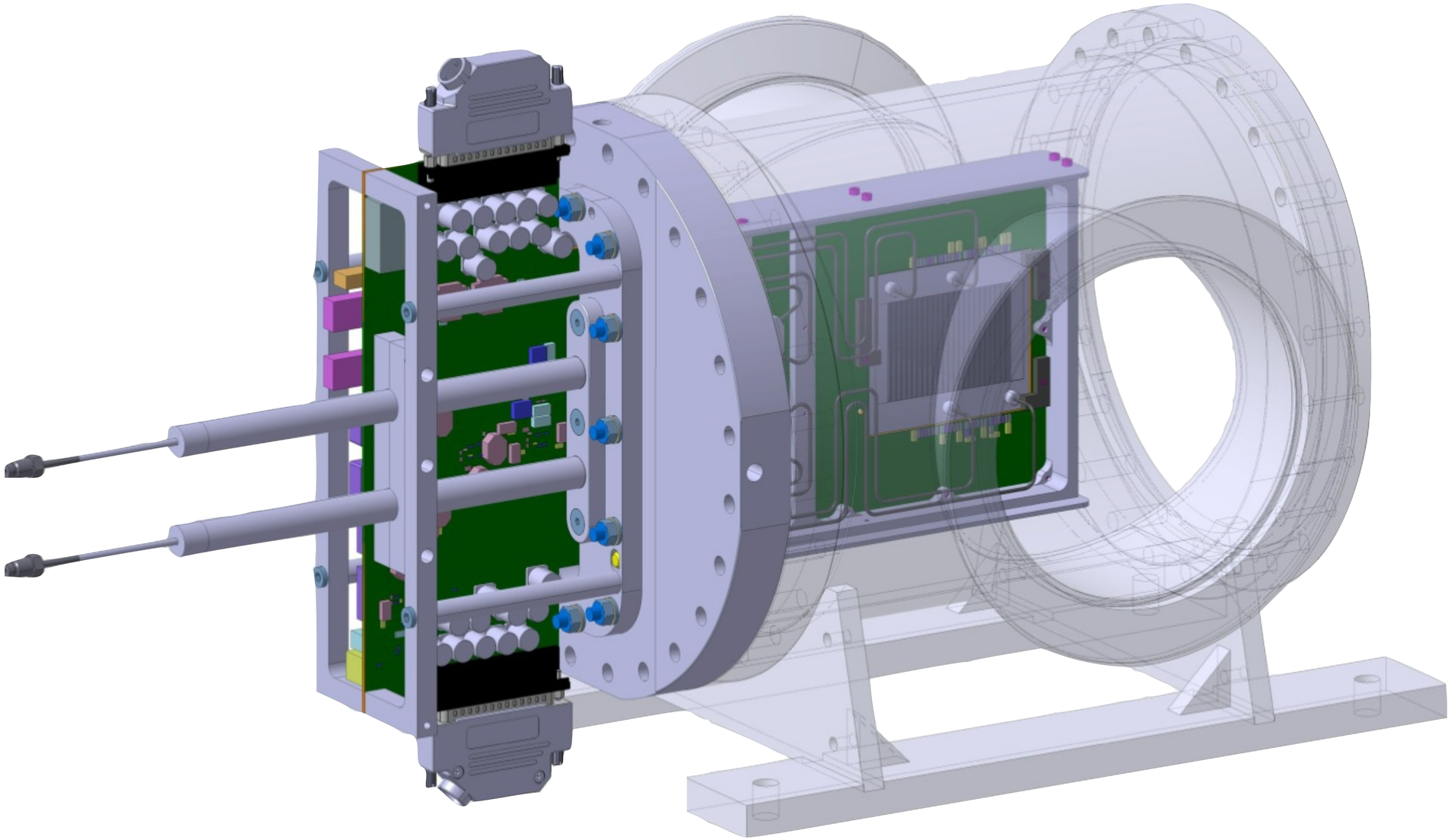
Al support

Vacuum tube

200 mm long
OD 16 mm
wall 1 mm

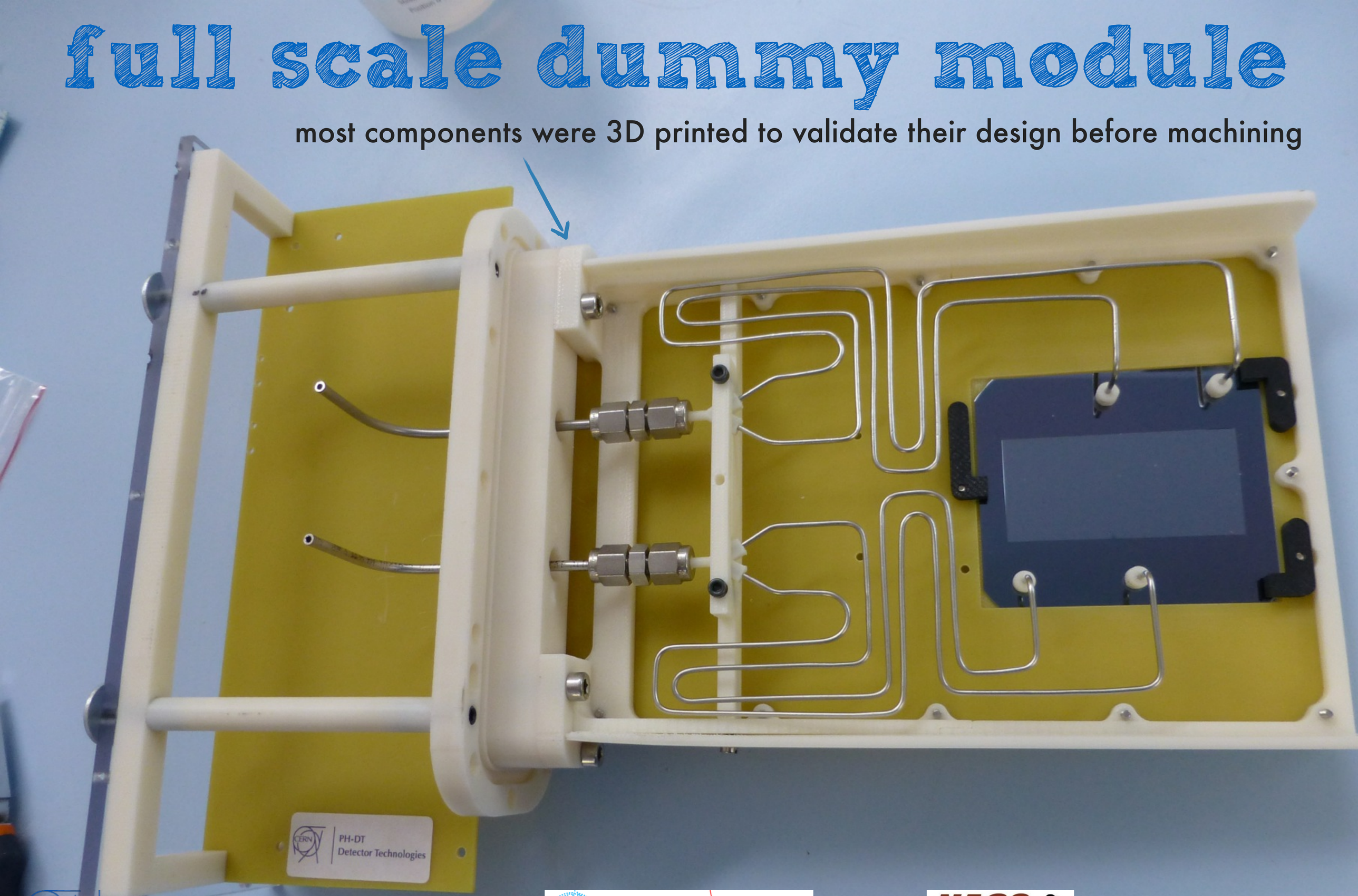
Condensation is predicted to occur in a region where it doesn't pose a threat to the electronics.

insertion in the vacuum line

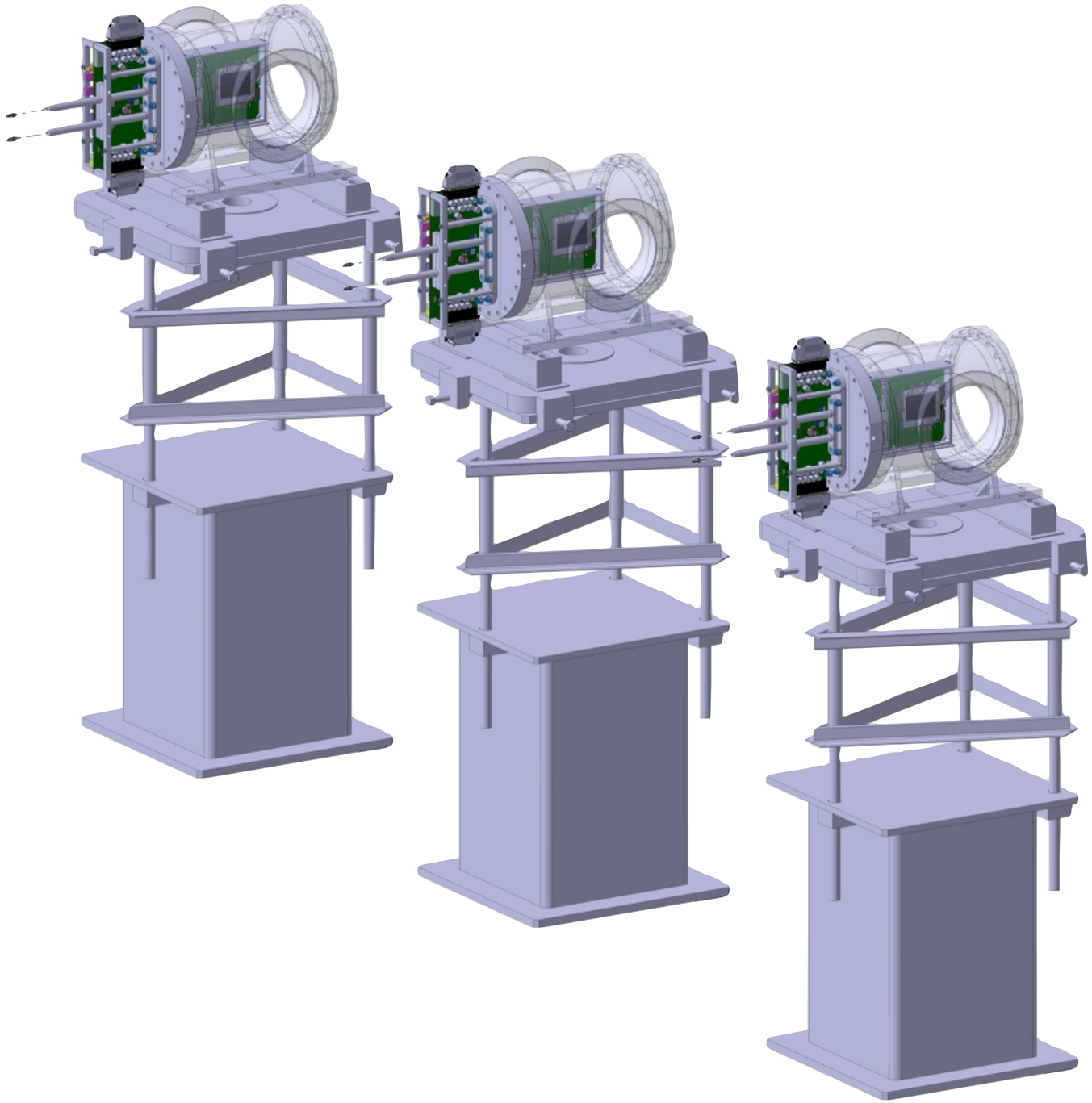
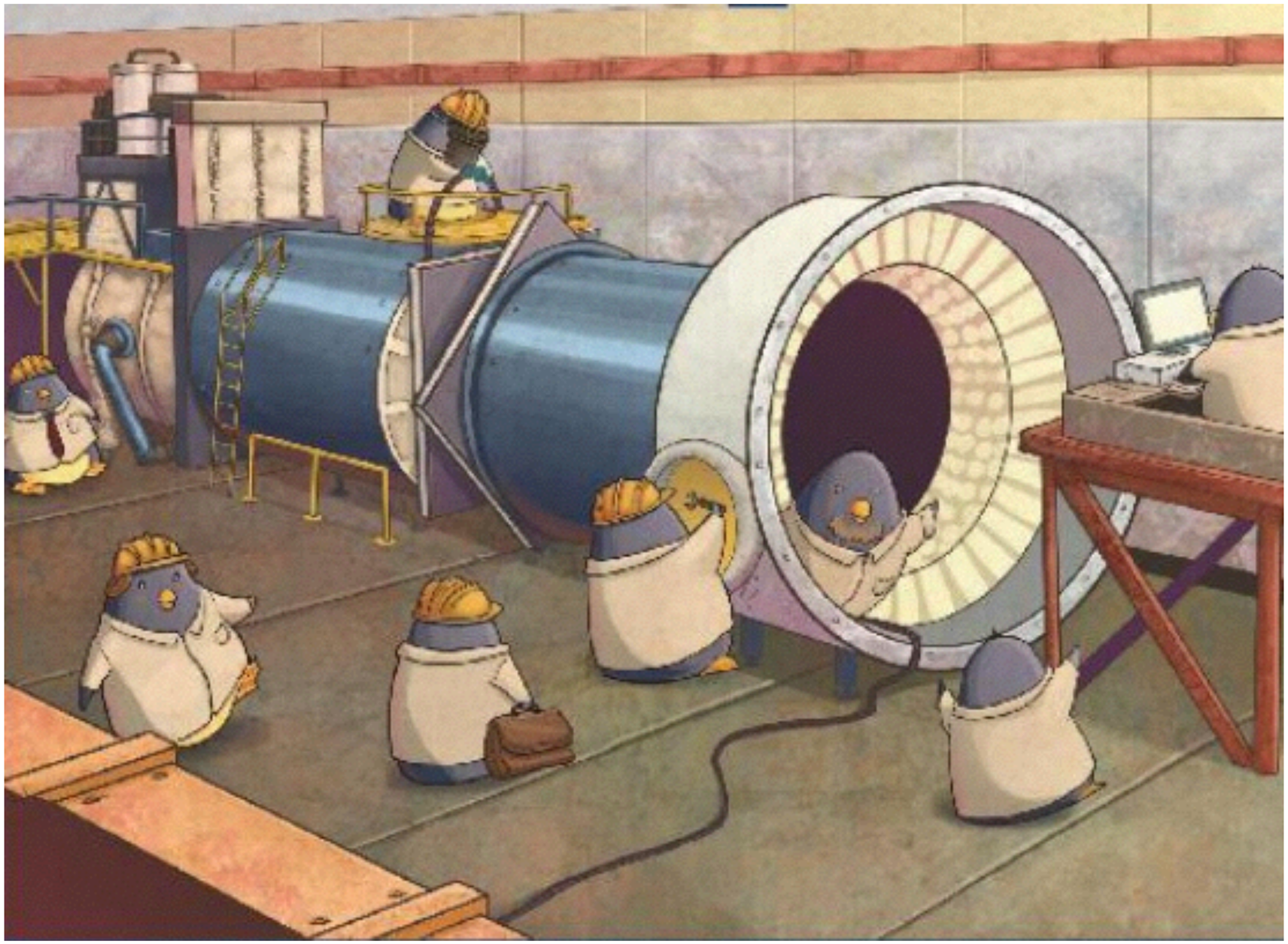


full scale dummy module

most components were 3D printed to validate their design before machining



installation of 3 modules in October 2014



- 3 GTK stations are being assembled.
- They will be installed in the SPS in October 2014 for the 1st Physics Test Run.
- The GTK detectors will be the first modules to be thermally managed with a silicon microfluidic on-detector cooling system in HEP.
- The modules will be replaced every year until LS2.