Update on WG4

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Outline

- Progress on polyimide cooling
- Progress on silicon microchannels
- Progress on 3D drawing
- Progress on stave R&D

Polyimide MCHS Status Report

Status

Numerical Simulation

1) Thermo fluid dynamic in simplified configuration	1a) Single phase Water 1b) Single phase C_6F_{14} @ different heat load Q and ΔT_{max}	
2) Mechanical	2a)Stress – strain behavior @ different loads	

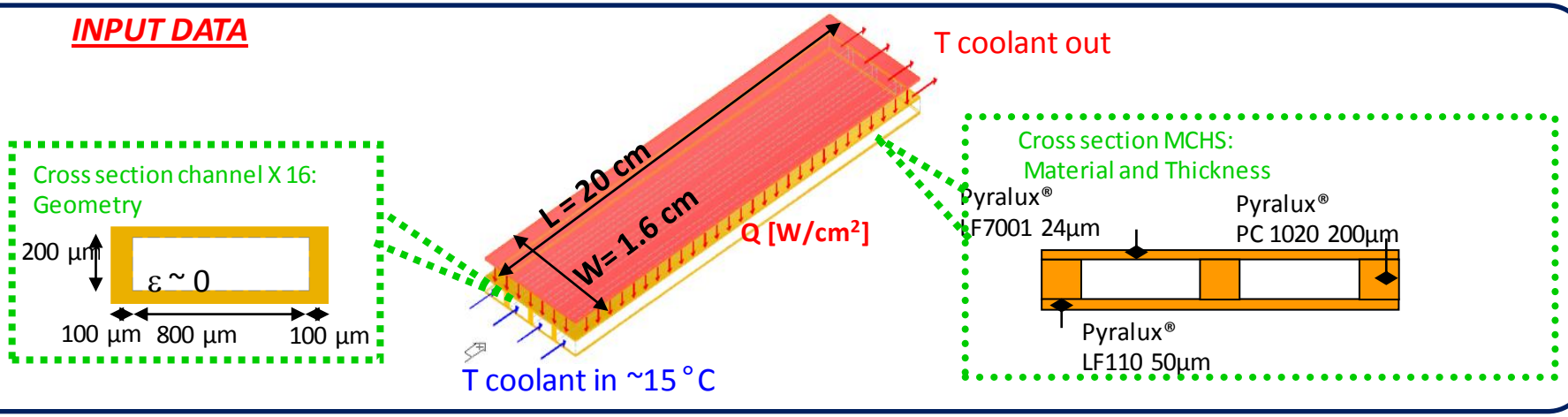
Test

1)Prototypes production	1) 1.6X 20 cm 16 channels 800X 200 μm^2 (by Rui de Oliveira)	
2)Mechanical	2a)Leak and compatibility test (Bari) 2b)Mechanical resistance (Bari) 2c)Strain– stress behavior (Bari)	
3)Geometrical	3)surface roughness measurement by atomic force microscope (Bari)	
4)Thermo fluid dynamic	4) MCHS cooling performance	4a) C_6F_{14} (Cern) 4b) Water (Bari)

Cosimo Pastore – Irene Sgura

Thermo-fluid Dynamic Simulation: Results

INPUT DATA



Coolant	Heat source [W/cm²]	TOUT Coolant out [°C]	TMIN Heated Surface [°C]	TMAX Heated Surface [°C]	Flow Rate Channel [l/h]	Flow Rate Stave [l/h]	Distrib. ΔP [bar]
H_2O	0,5	18.1	16.7	20.6	0.28	4.6	0,35
	0,4	17.5	16.2	19.4	0.28	4.6	0,35
	0,3	16.9	15.9	18.2	0.28	4.6	0,35
	0,3	18.2	15.9	19.7	0.2	2.8	0,2
C_6F_{14}	0,5	18.2	17.2	26	0.7	11.2	0,6
	0,3	17	16	21.6	0.7	11.2	0,6

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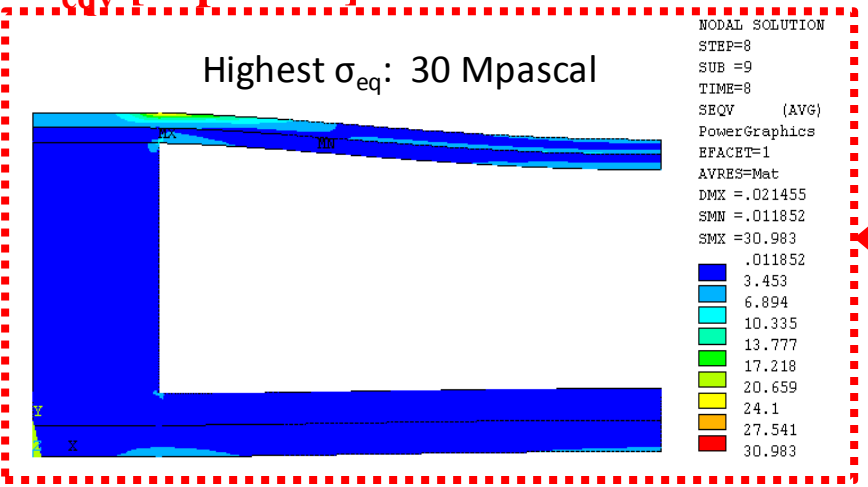
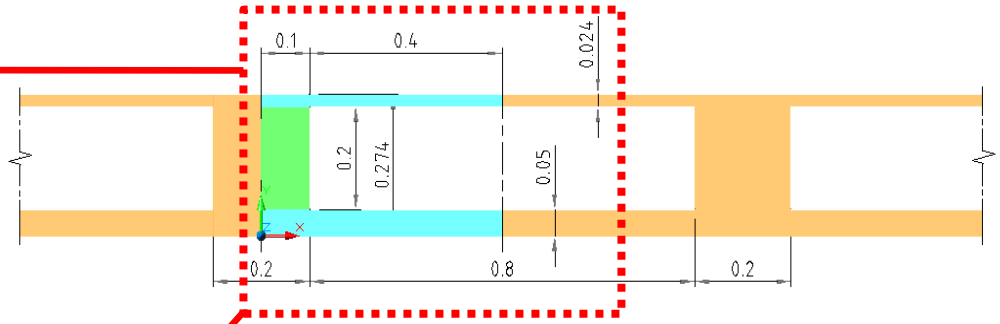
Mechanical Simulation Results @ load -0.4 bar

σ_{eqv} [Mpascal]

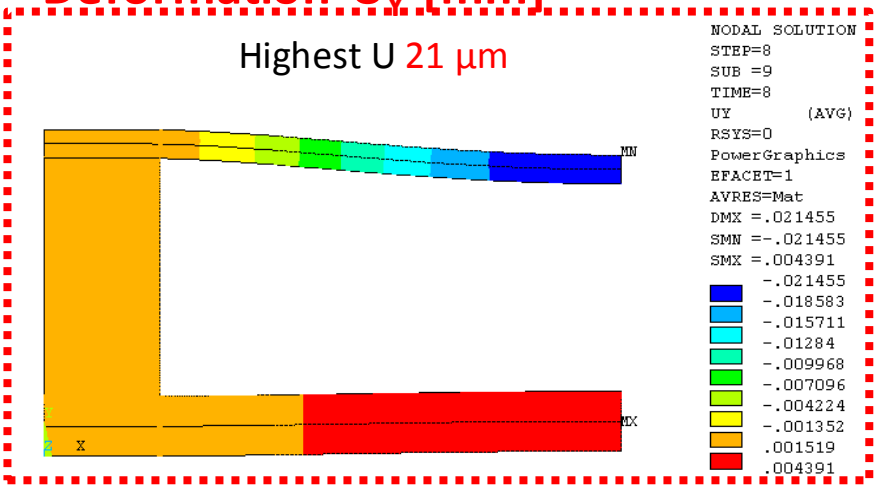
Highest σ_{eq}: 30 Mpascal



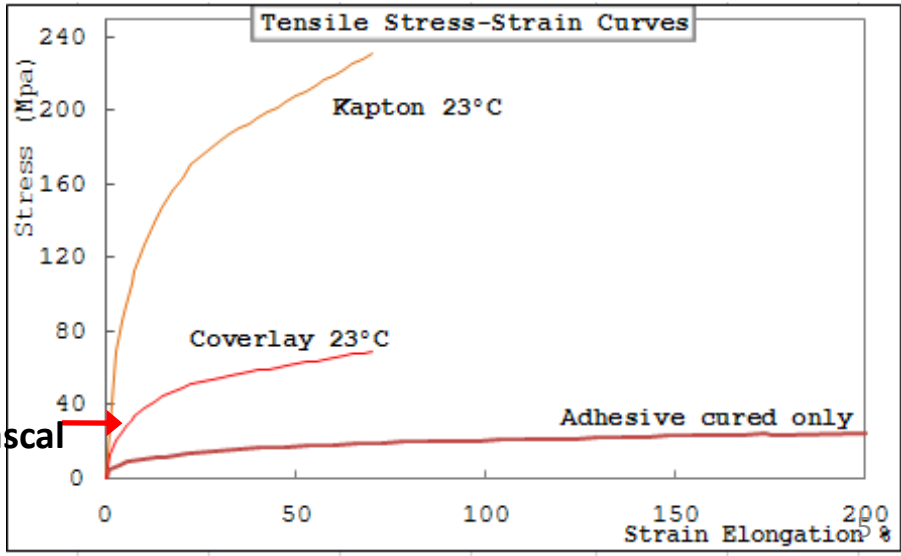


Deformation U_y [mm]

Highest U 21 µm

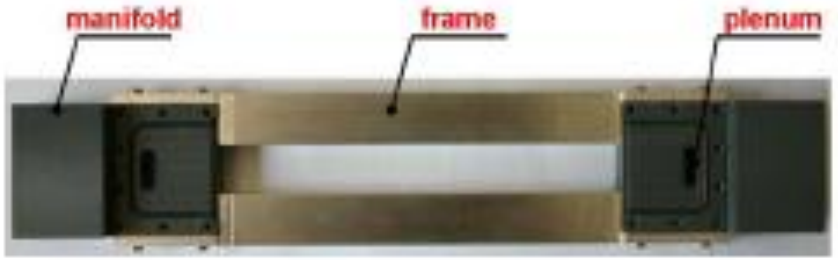


30 Mpascal



Mechanical Test: leak and water compatibility

Polyimide MCHS Top view.

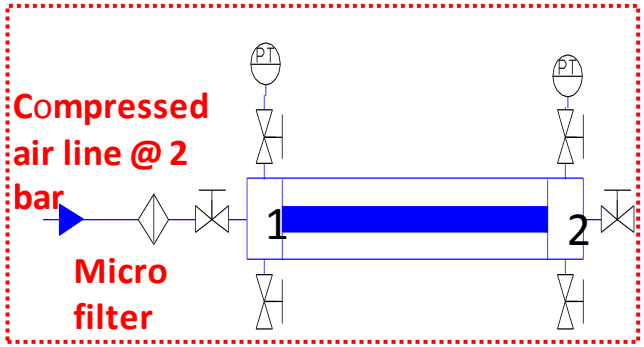


MCHS support frame fabricated for tests.
The first frame in stainless steel is now ready.

The **compatibility test** consisted in pressurizing the MCHS with compressed air at 2 bar, and submerged in water at 22C for days.

The **first test** spotted an incorrect polymerization of the MCHS during the fabrication process, causing a leak with the ungluing of the cover.

Having changed the polymerization's parameters, **NEW prototypes have been produced:** after 45 days the prototype is continuing to show an excellent behavior.



Geometrical Characterization Test: Roughness measurement

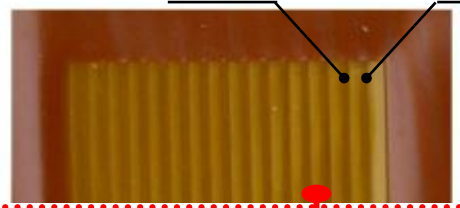
Top view

16 channels 800 x 200 µm²

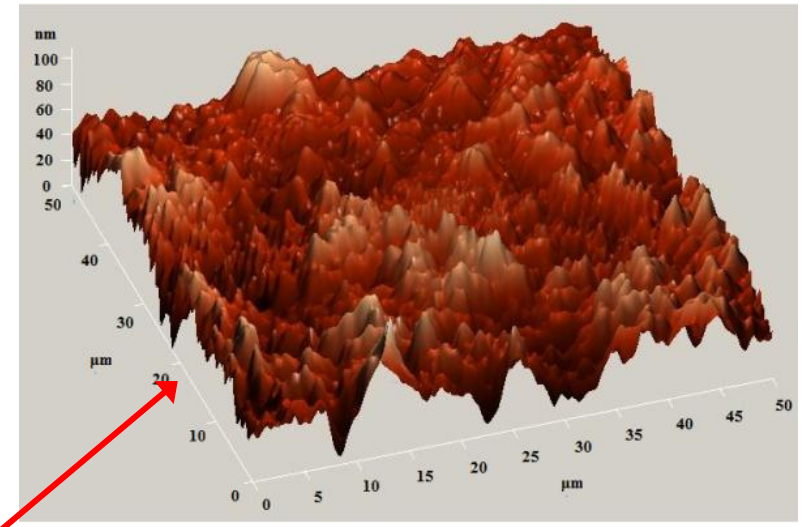
Local micrograph

wall

channel



50 x 50 µm² surface

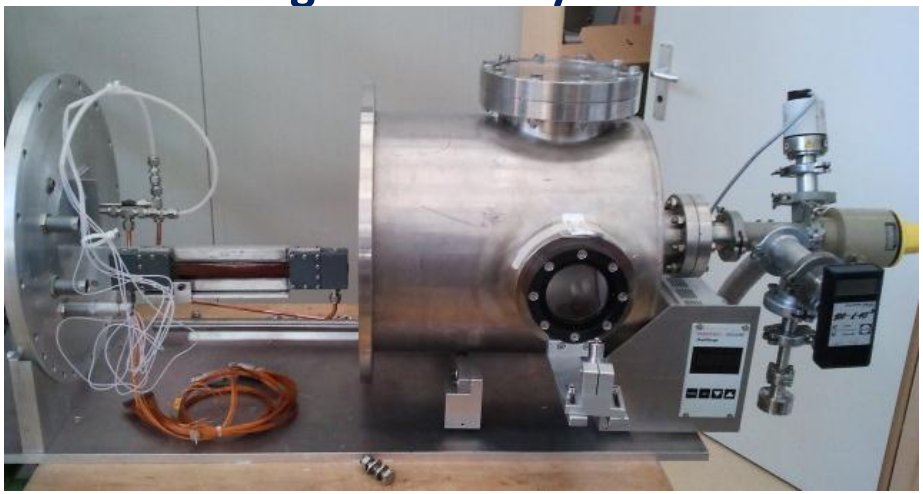


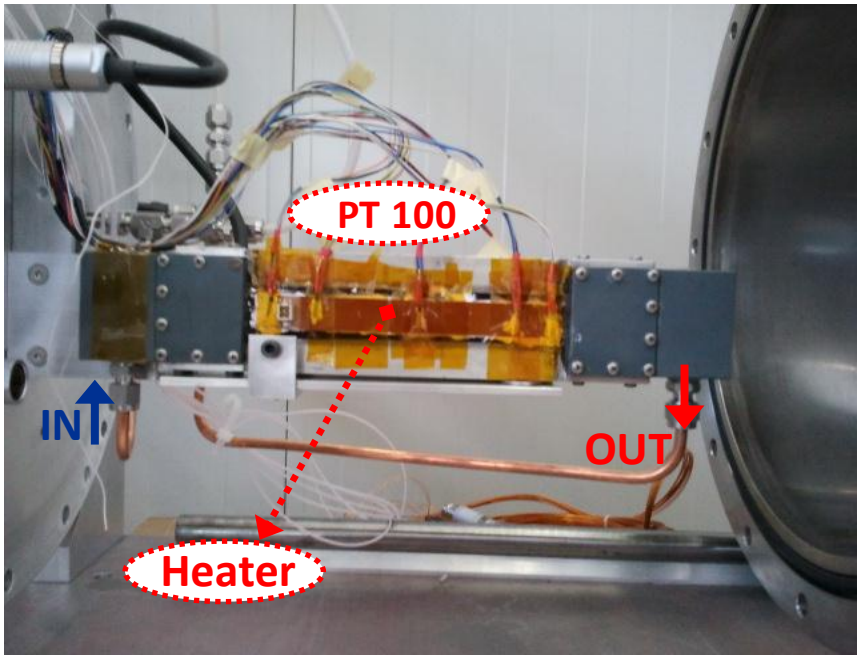
The 3D reconstructed roughness

The statistical average roughness is 12.44 nm. The effect of cross sectional reduction due to the protruding roughness IS NEGLIGIBLE

Thermo fluid dynamic test with C_6F_{14}

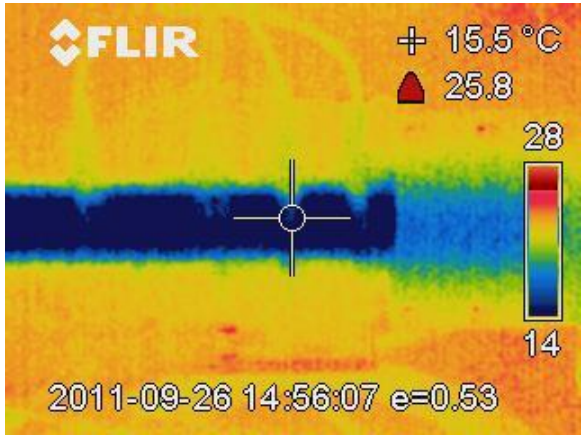
Part of the set up for the thermo-fluid dynamic tests: installation in Cern PH-DP Cooling Lab at 168/ R –F005.





Thermo fluido dynamic tests were carried out with C_6F_{14} as cooling liquid using both a thermal grease and a thermal glue between the microchannels and the heater (R= 12 Ω) .

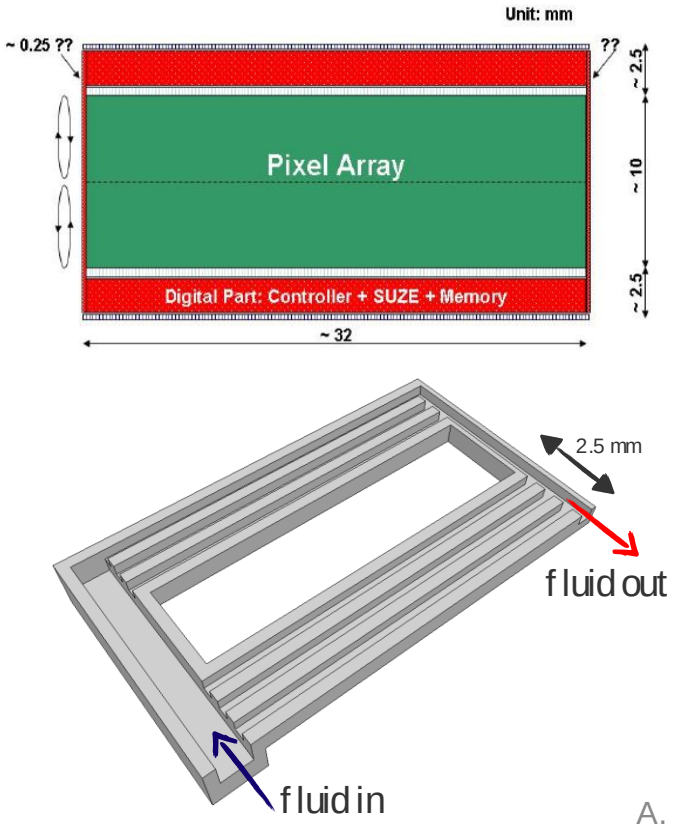
Data analysis is ongoing.

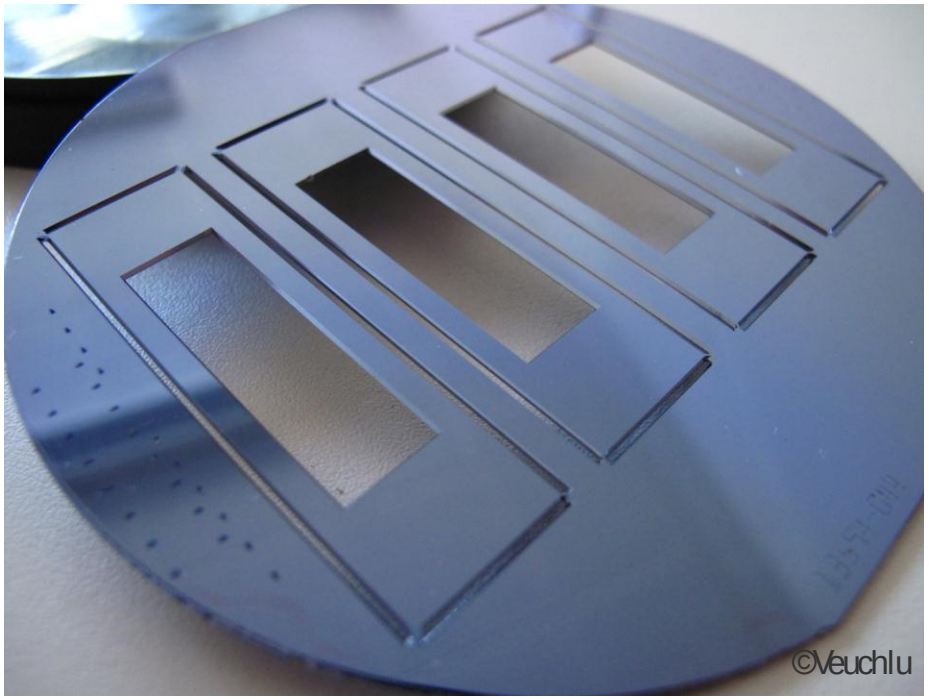


Thermo camera picture with C_6F_{14} @15 °C re-circulating through the microchannels

Silicon cooling frames

- First prototypes of micro-structured full silicon cooling frame have been successfully produced in 4” wafers.
- Holes for fluidic connections not yet etched.





Low pressure evaporative cooling facility

A small cooling station for C_4F_{10} was refurbished:
by-pass installed after the pump

By-pass is required to tune the flow rate during the test section

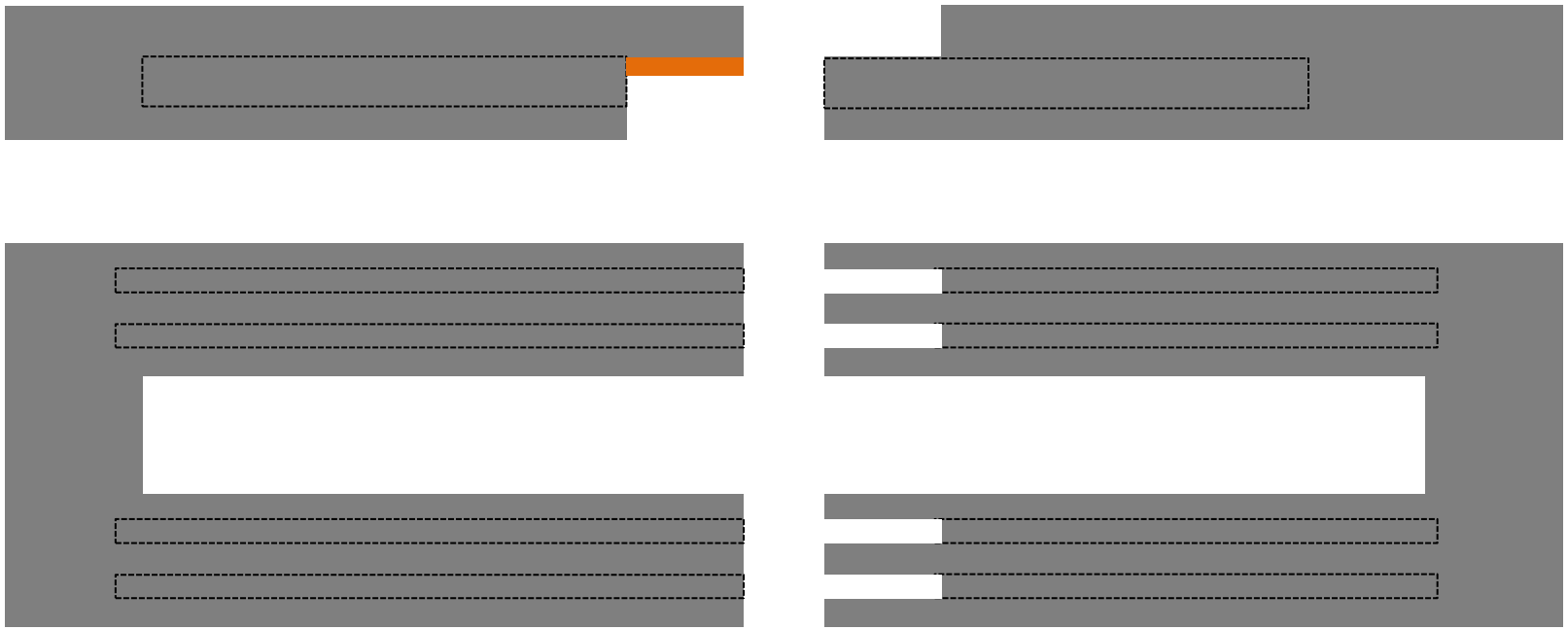
Magnetic drive gear pump specifications:

Model	Connection size	Max. capacity L/min	Max. discharge pressure MPa	Max. vacuum kPa	Liquid temp. range °C	Viscosity limit mPa•s	Motor	Mass kg
MDG-M2S6B220	1/8NPT	2.0/2.4	0.55	5.3	0 - 65	50	AC220 - 240V, 45/50W	3.6

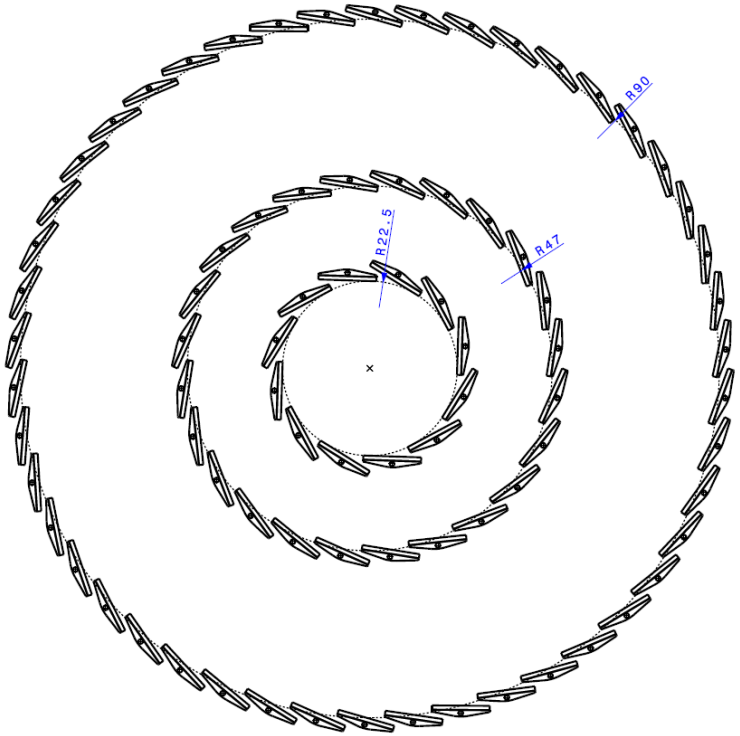
Towards half stave cooling…

- Long cooling frame from 12” silicon wafers
  - CEA-LETI
  - VTT ?
  - Other…?

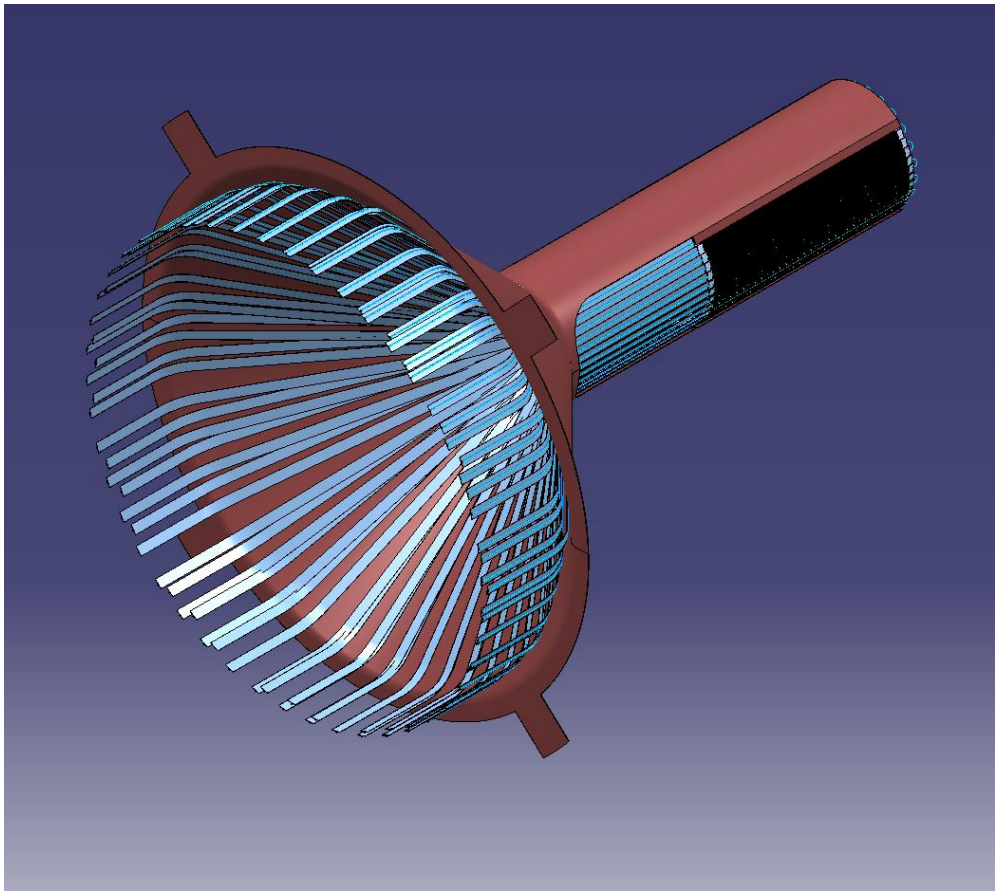
- Develop microfluidic interconnections between short frames from 4” or 6” wafers (benefiting from low pressure operation).



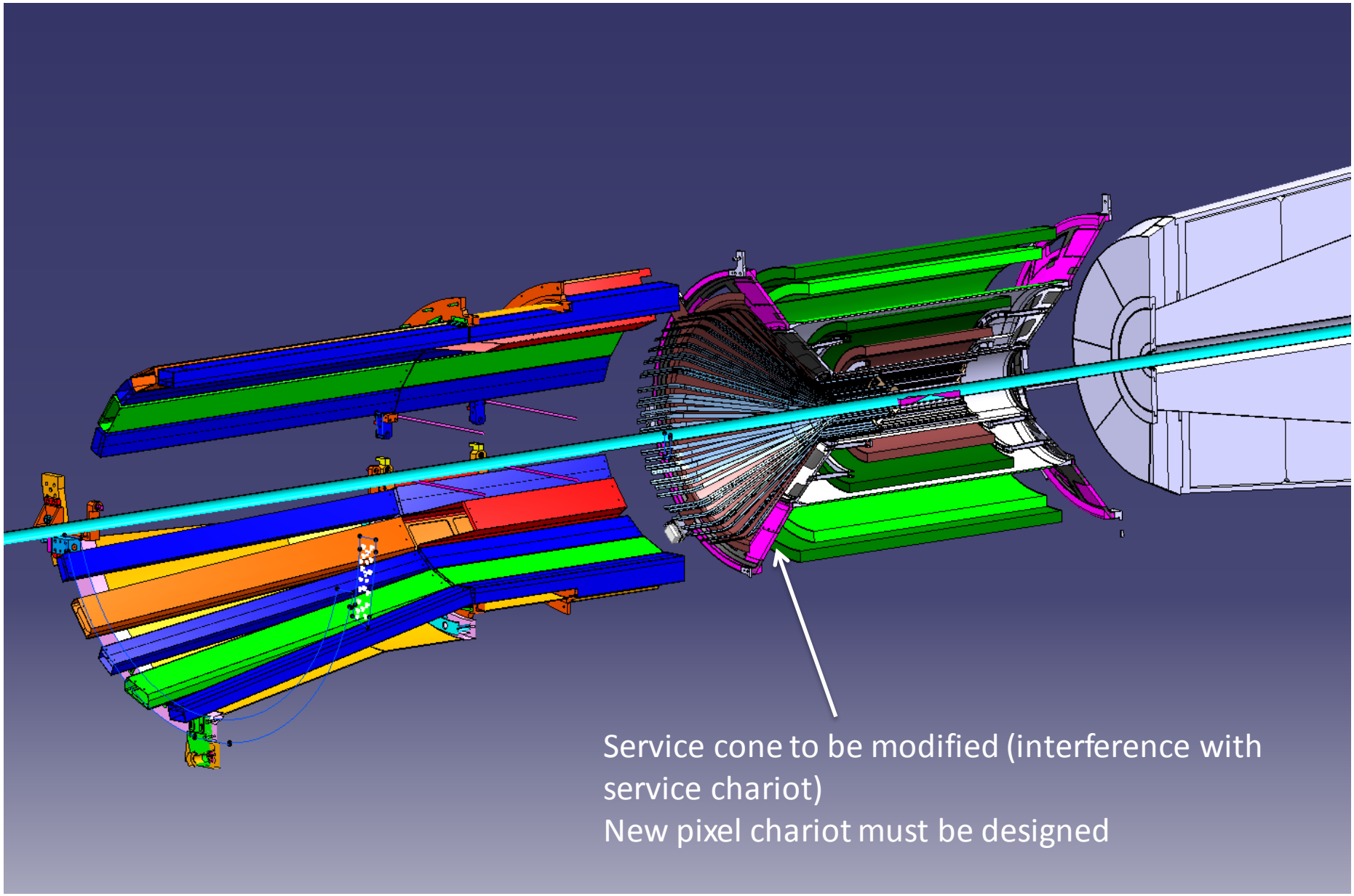
Progress on 3D drawings



Layer0 => 12 staves
Layer1 => 24 staves
Layer2 => 46 staves
➔82 staves



Option 1: new pixel detector in place



Staves R&D

- ✓ Peek tube 35ft OD/ID = 1,5874/1,397 mm
  From **IDEX health and science** (Swiss)
- ✓ Graphite (3X) 305mm X 305mm X 13mm
  From **GRAFTECH** **UCAR** (France)
- ✓ Carbon Foam K9 6” X 12” X 1”
  From **ALLCOMP** (US)

Cutting tool and mold under preparation

- ✗ Carbon Fiber (K13A)
  Expected around mid Nov