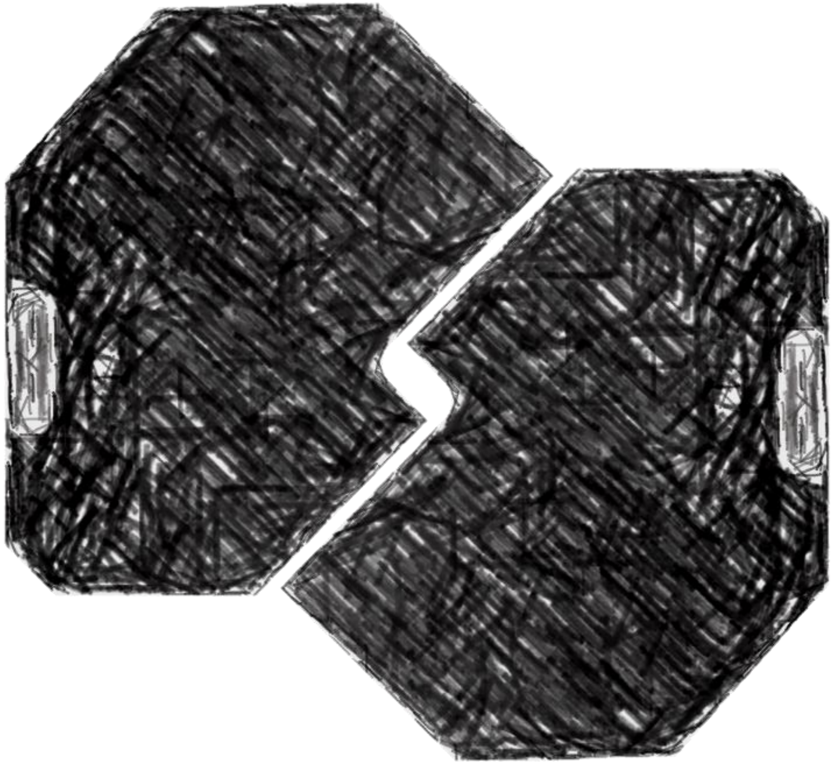
LHCb CO2 cooling meeting
Updates from VELO

Wiktor Byczynski on behalf of VELO team

Outline

- Detector Flow and ΔP
- $\Delta T(CO_2$ - silicon$)$
- Temperature sensors
- Installation and commissioning schedule



Detector Flow and ΔP

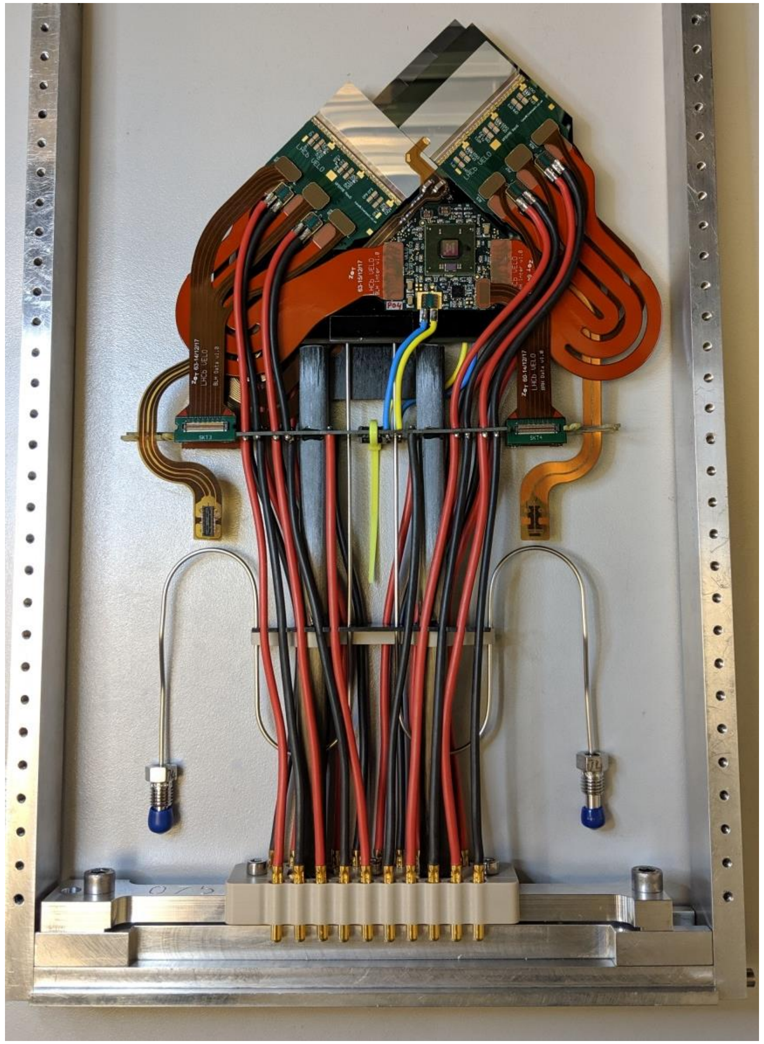
Slide: 04

Slide: 05

Property	Value	Units	Comments	
General				
Cooling system				
Maximum cooling power	2.08	kW	at the VELO	√
Fluid	CO_2			√
Typical/Maximum total flow	21.6/32.4	g/sec	through both VELO sides including the flow through the bypass to keep the distribution lines cold	√
Typical ΔP (manifold to manifold)	6-16	Bar	at the VELO (TBC – measurements ongoing)	√
Typical/maximum flow per module	0.4/0.6	g/sec		√
Fluid filtration	Yes		particles above 10 μm are collected by filters at strategic places	√
Fluid purity			standard CERN CO_2 purity level	√
Continues operation	Yes			√
Redundant/backup system	Yes		temporary share with UT Cooling System	UT purity status

LHCb VELO Detector Cooling Requirements

Module Power



MOD_75

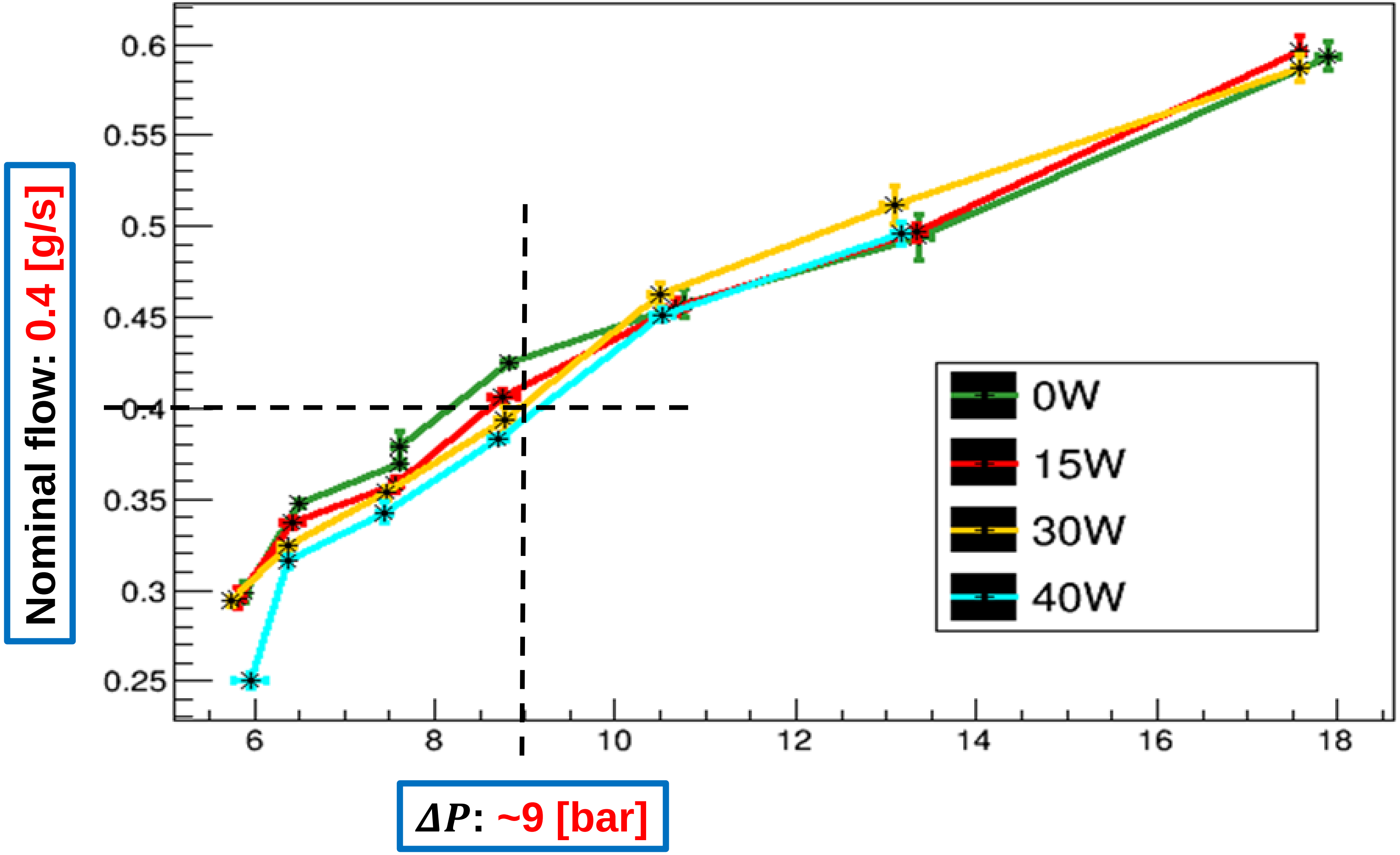
Step	Total power in module		
	Module Power	Power in GBTx / GBLD	Tile Power
0a	0,00	0,00	0,00
0b	3,26	3,26	0,00
1	12,26	3,23	2,26
2	16,96	3,23	3,43
4	22,51	3,20	4,83
5(240,240,on on)	25,82	3,20	5,66

Edgar Lemos Cid

Normal Operation Module Power (calculated) : 22.51 [W]
Expected power on sensors due to radiation damage 1[W] per each

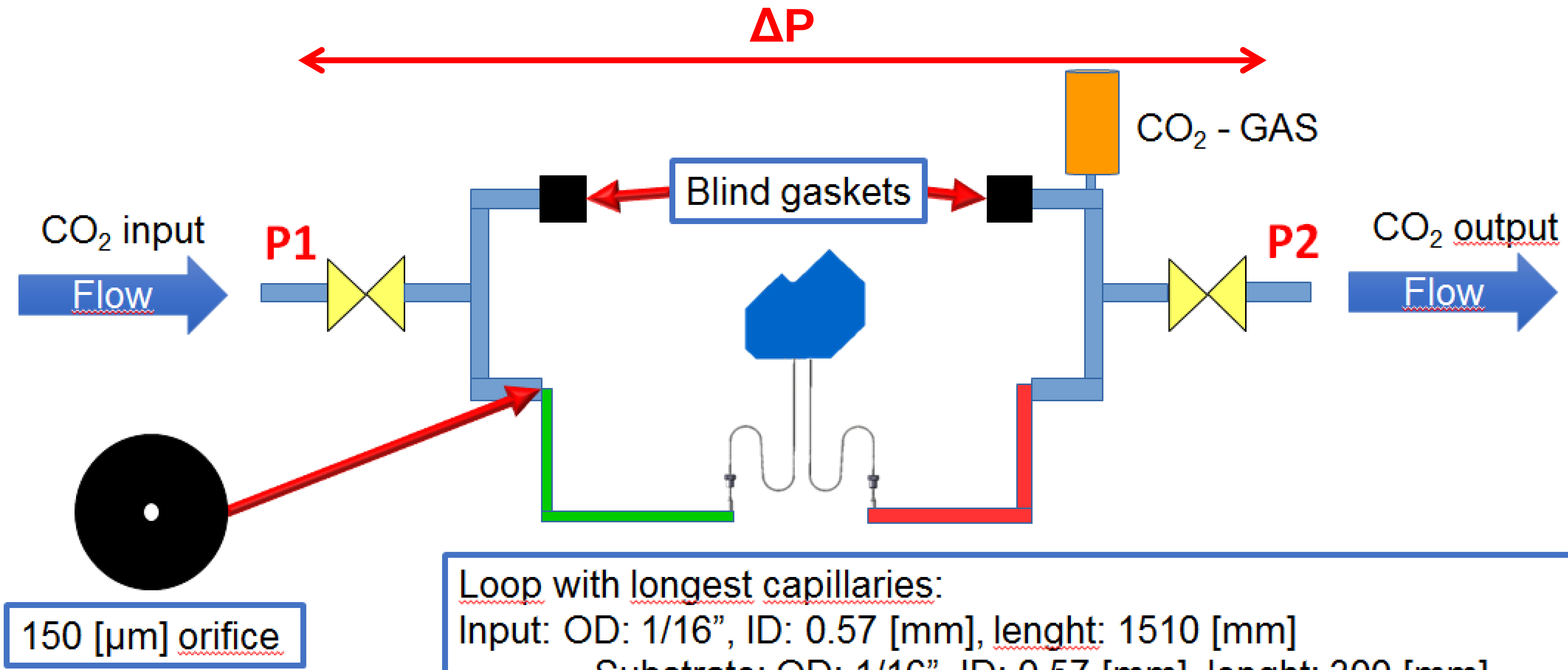
Expected Module Power: ~ 27 [W]

Detector Flow and ΔP



- **Measurements (CERN 2018)**
- **Realistic Mock-up (Details slide 06)**

Detector Flow and ΔP

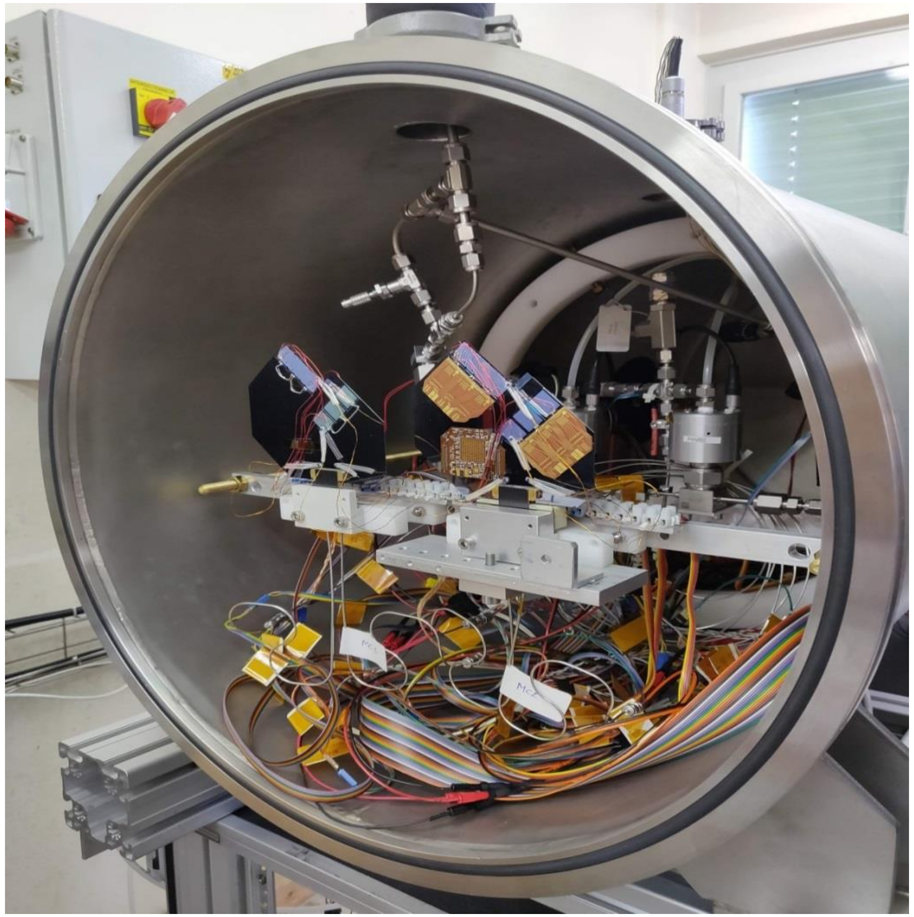


Loop with longest capillaries:
Input: OD: 1/16", ID: 0.57 [mm], lenght: 1510 [mm]
Substrate: OD: 1/16", ID: 0.57 [mm], lenght: 300 [mm]

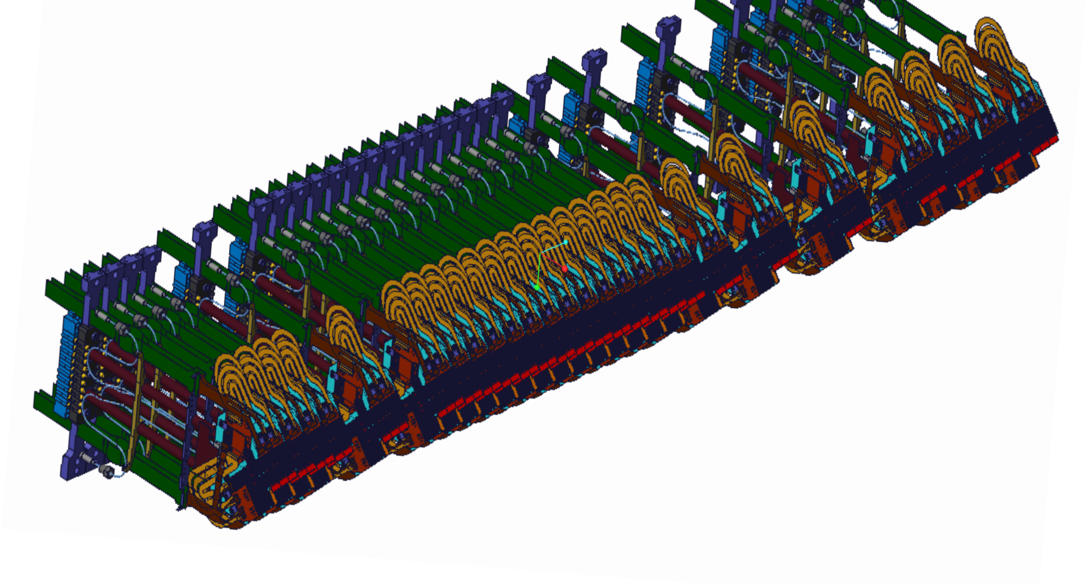
Output: OD: 1/16", ID: 1.2 [mm], lenght 1639 [mm]
Substrate: OD: 1/16", ID: 0.87[mm], lenght: 300 [mm]

Detector Flow and ΔP – open questions

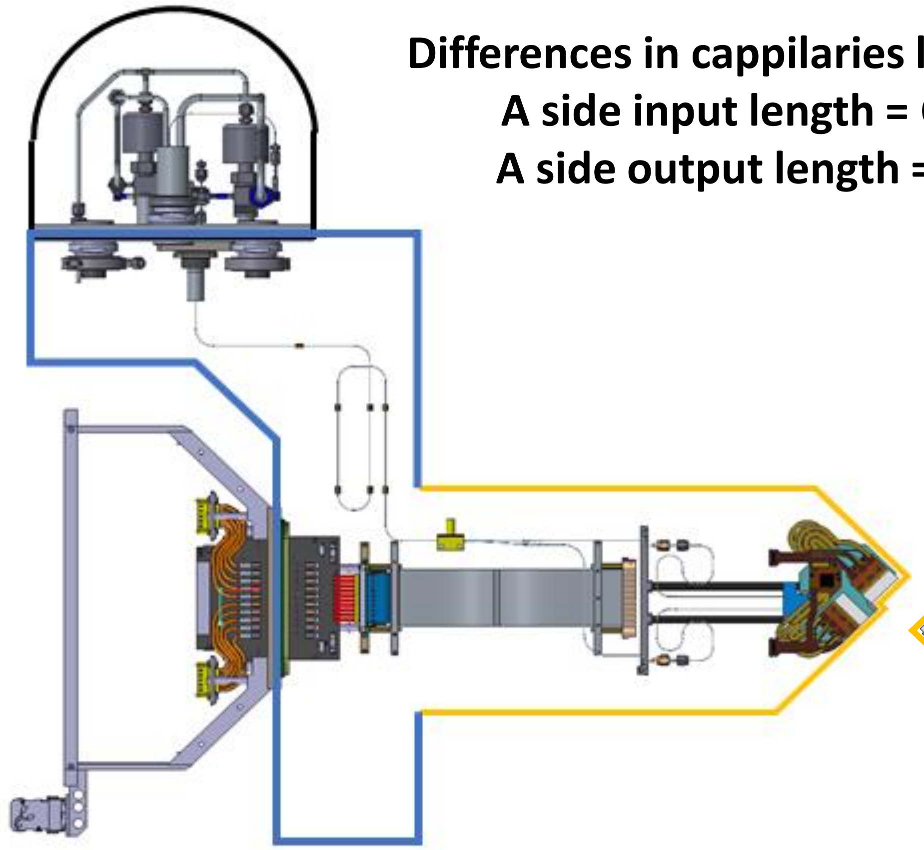
Operating 2 cooling substrates in parallel measured at CERN in 2018



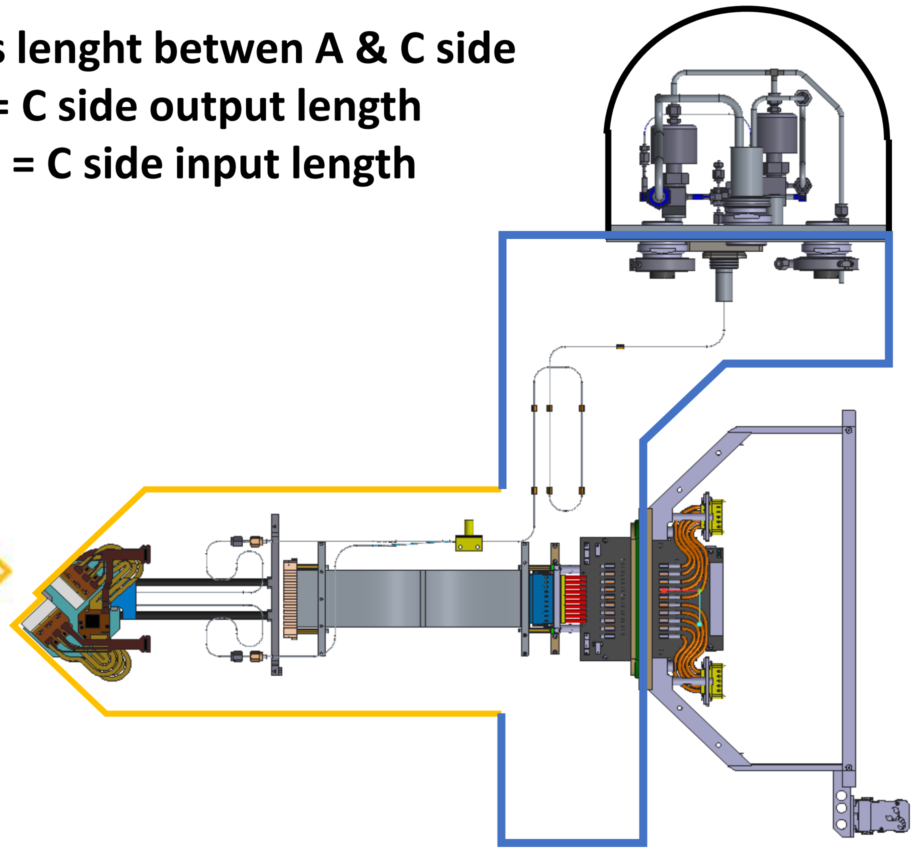
Operation of 26 cooling substrates in parallel in final system not measured. Size of the orifice has to be checked and if necessary optimize. In case of smaller orifice size expected **extra DP**



Detector Flow and ΔP – open questions

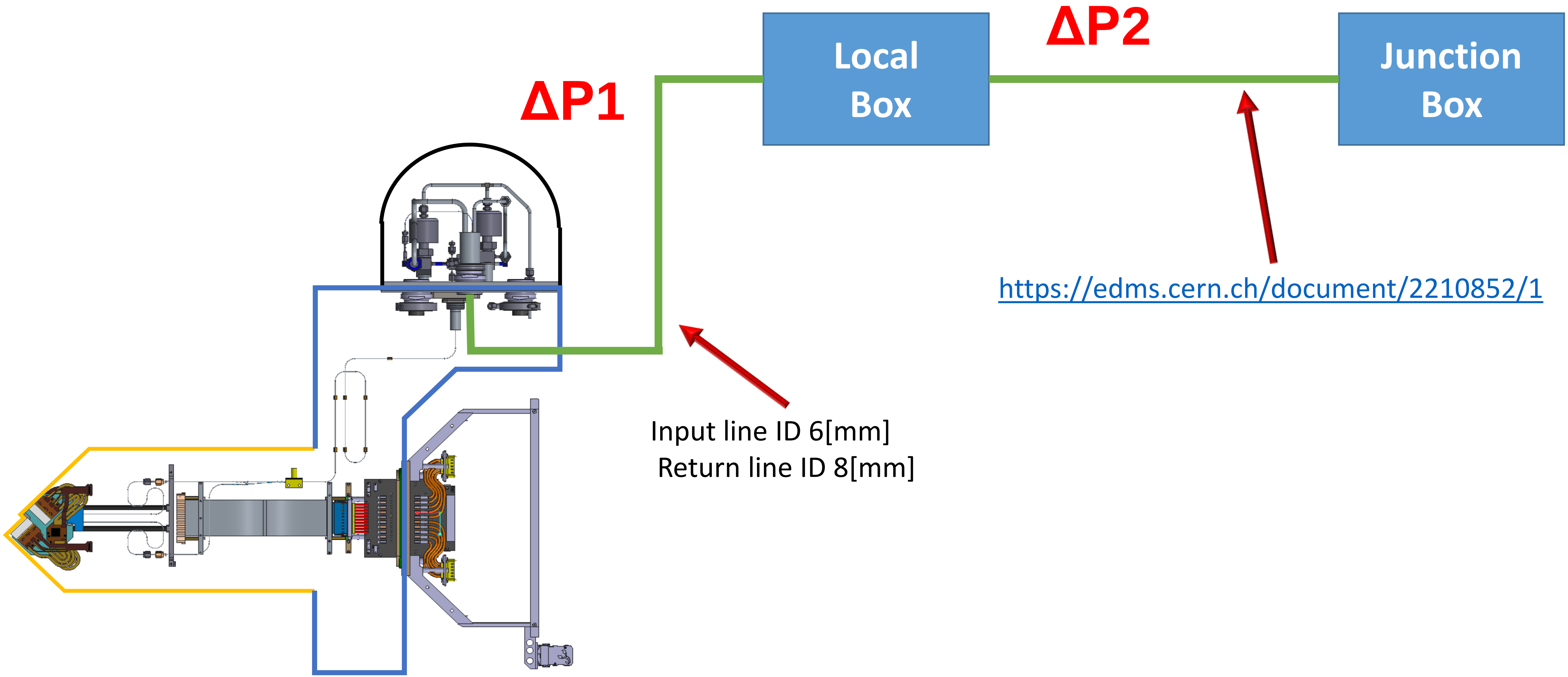


Differences in cappilaries lenght betwen A & C side
A side input length = C side output length
A side output length = C side input length



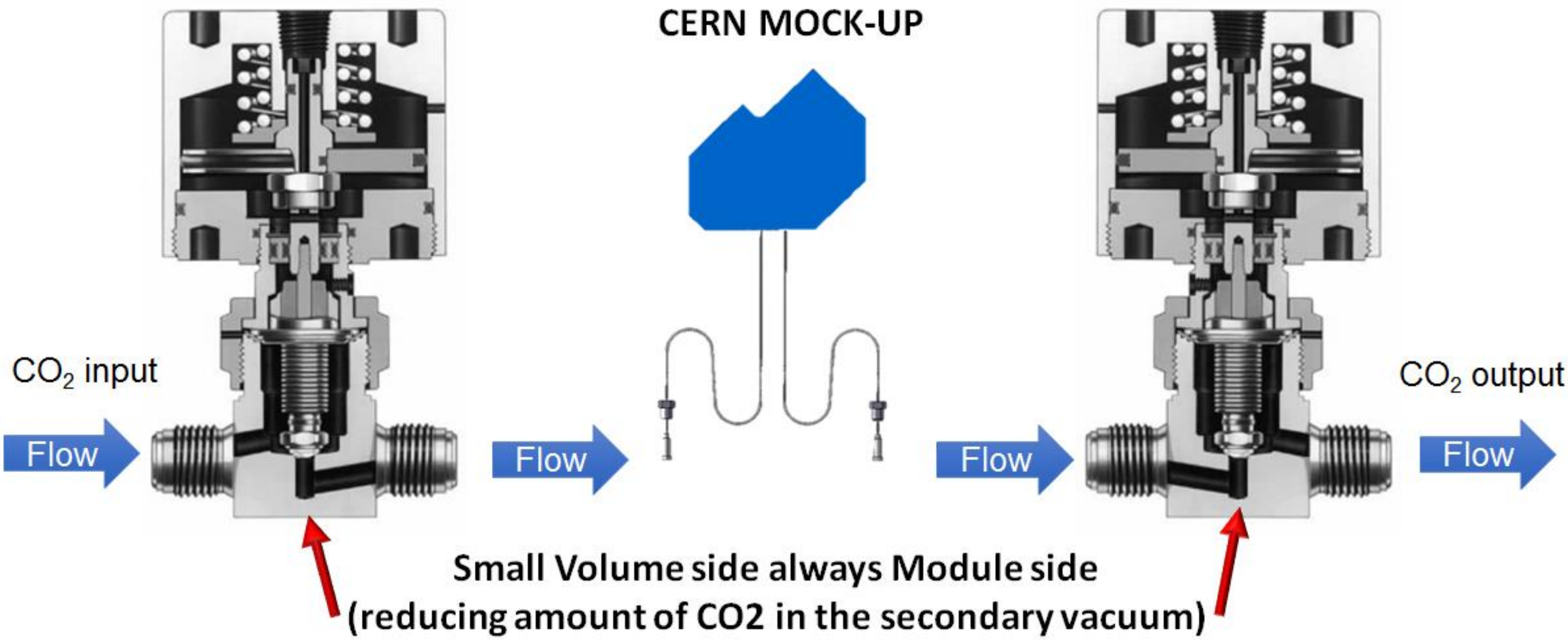
ΔP1 = ΔP2
?

Detector Flow and ΔP – open questions

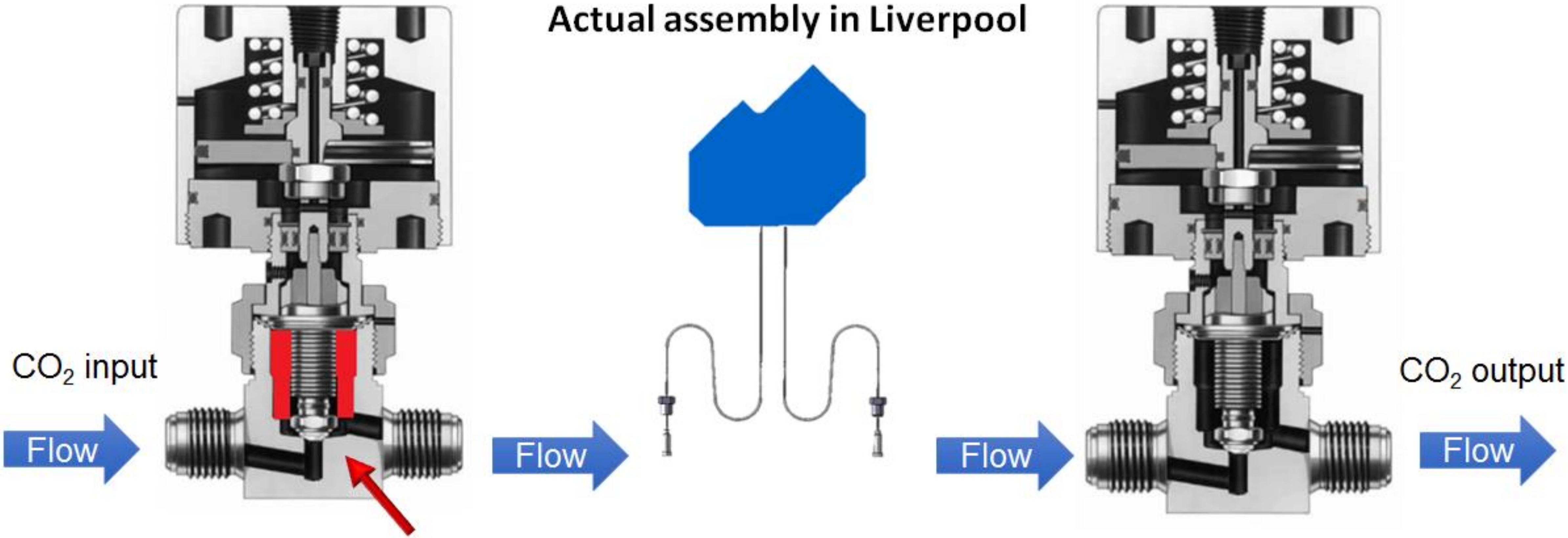


https://edms.cern.ch/document/2210852/1

Detector Flow and ΔP – open questions



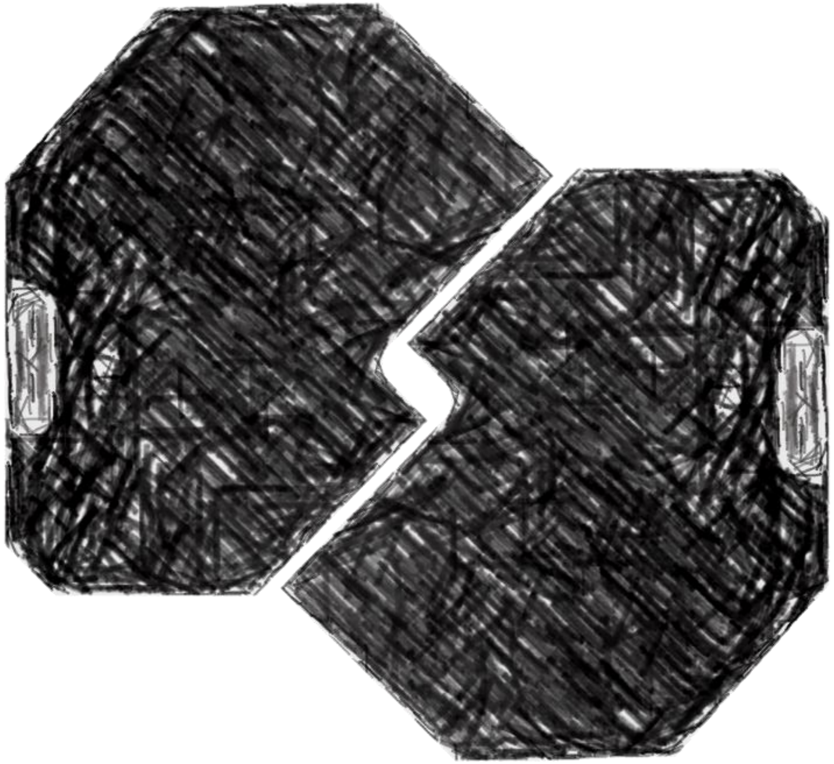
Detector Flow and ΔP – open questions



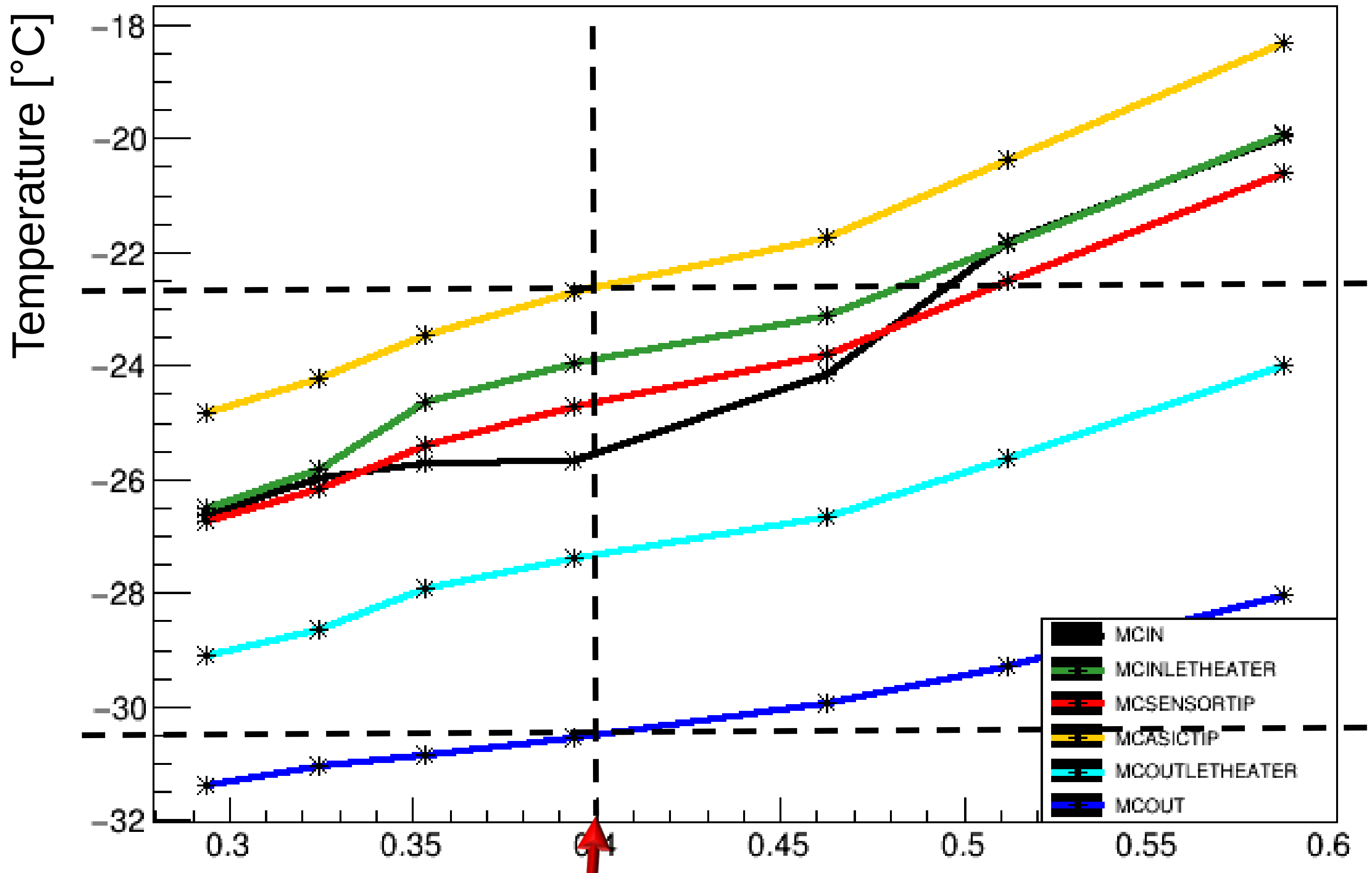
- Input valve assembled with respect to Swagelok Flow direction requirement
- To reduce amount of CO2 in secondary vacuum necessary to reduce volume of the valve
- Reducing insertion under design – TBC if will introduce **extra DP**

Outline

- Detector Flow and ΔP
- $\Delta T(CO_2$ - silicon)
- Temperature sensors
- Installation and commissioning schedule



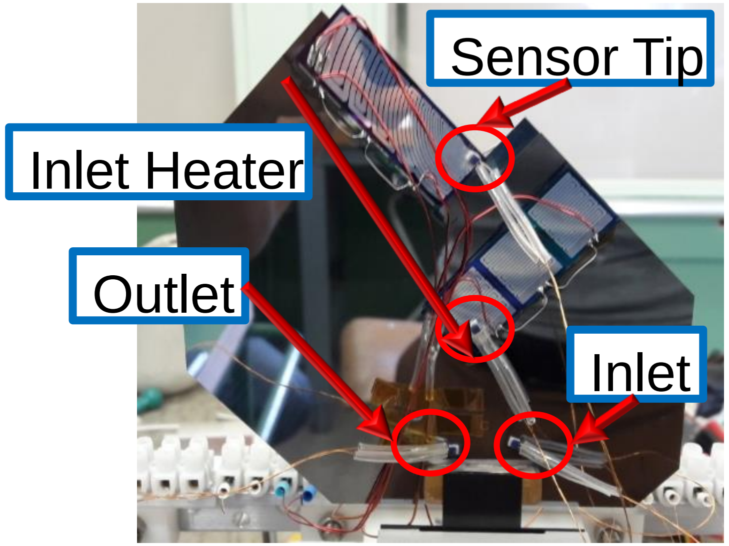
ΔT(CO_2 - silicon) – CERN 2018

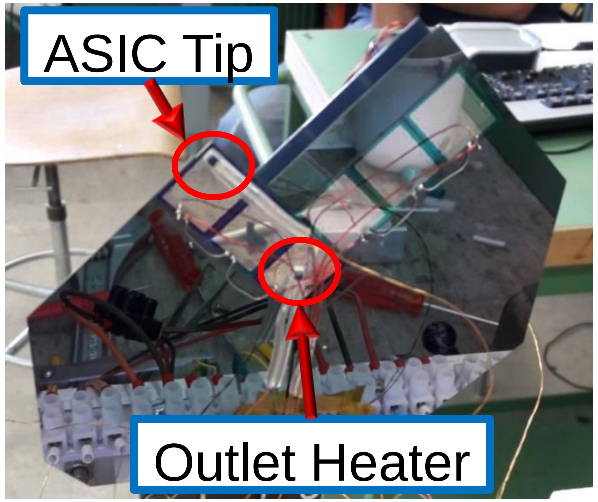


Nominal flow: **0.4 [g/s],** Power 30 [W]

Flow [g/s]

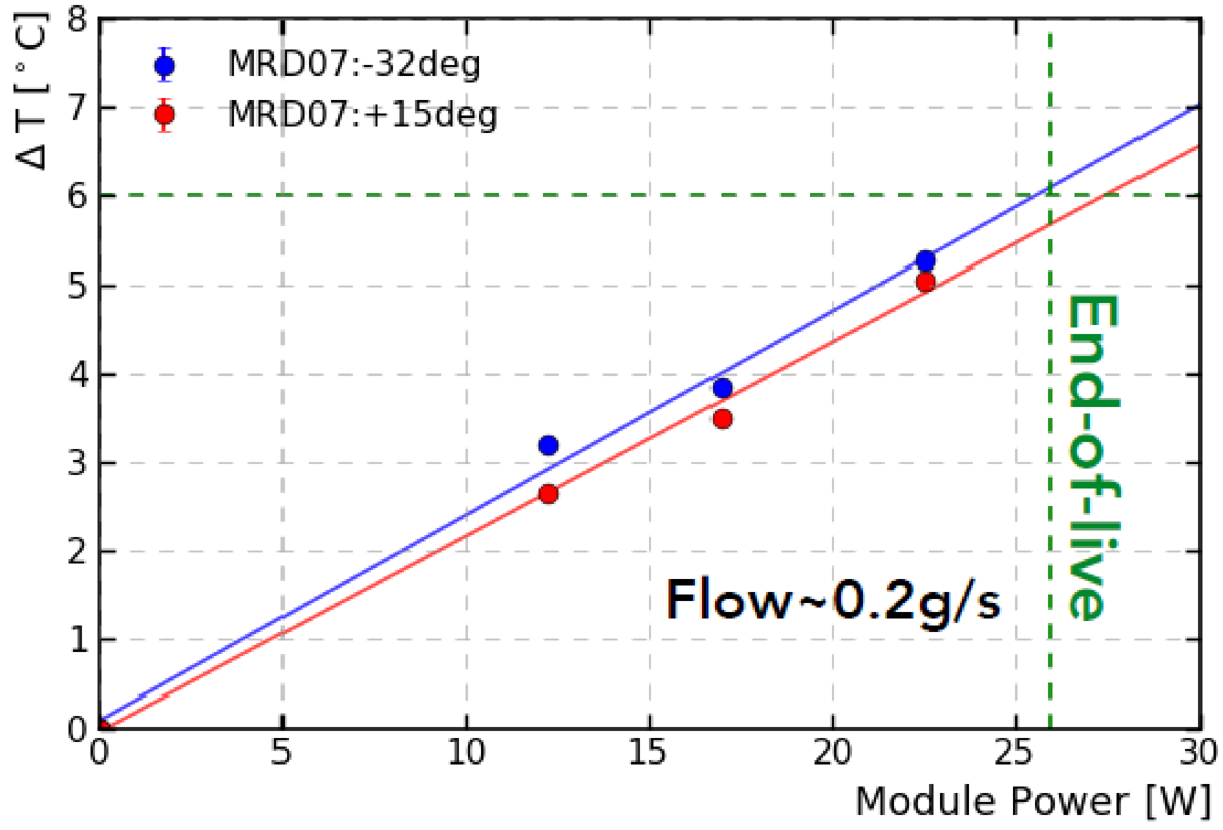
ΔT =~8 [°C]





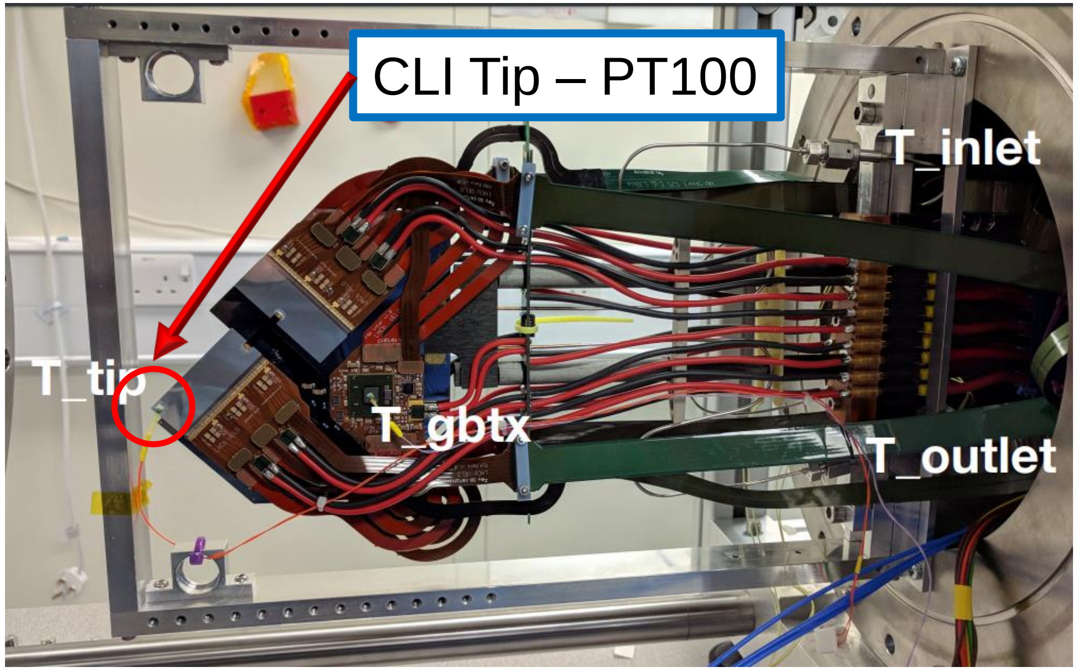
$\Delta T(CO_2$ - silicon) – 2019

MRD07 at CERN



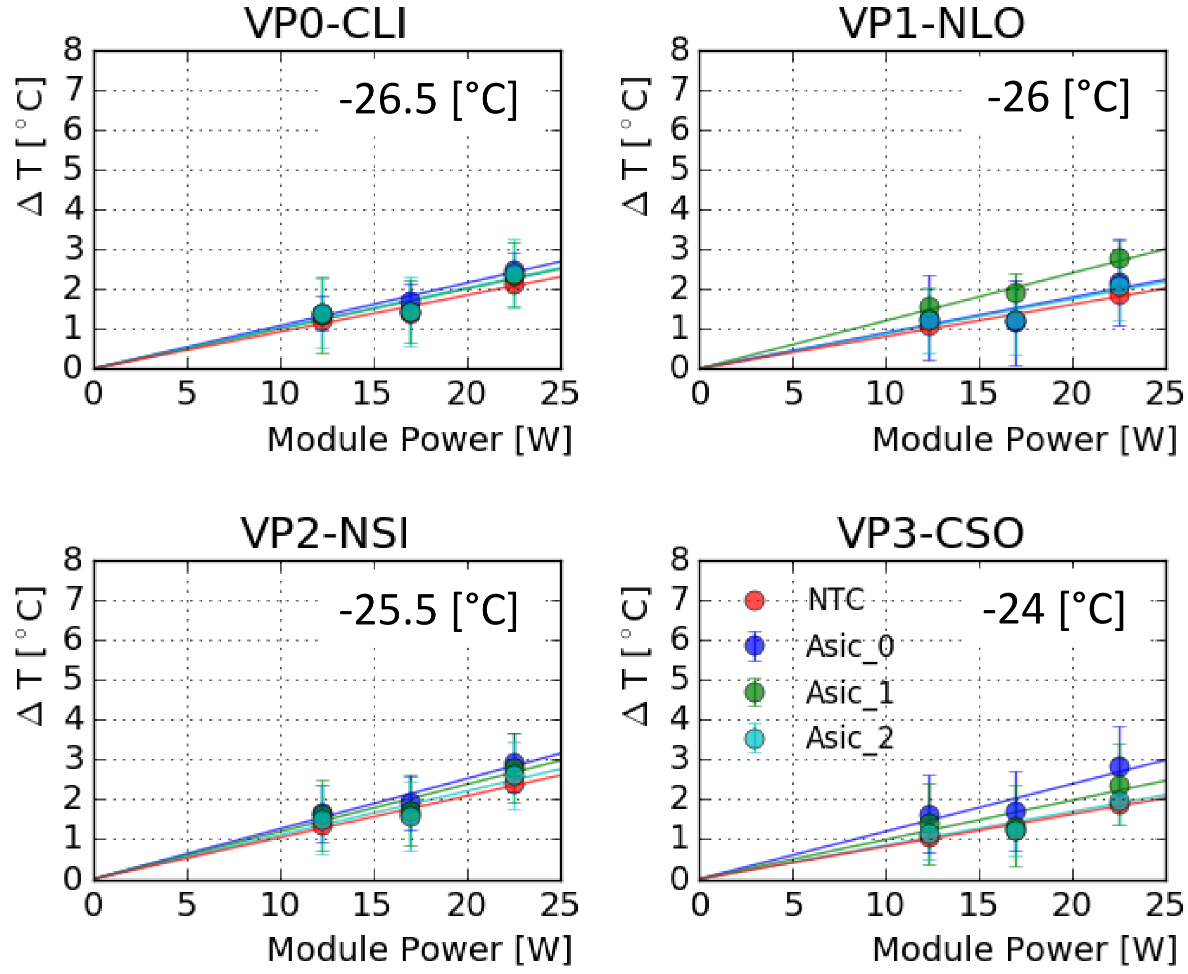
-32deg: reference temp NTC on hybrid: -24.2 [°C]
+15deg: reference temp NTC on hybrid: 17.7 [°C]

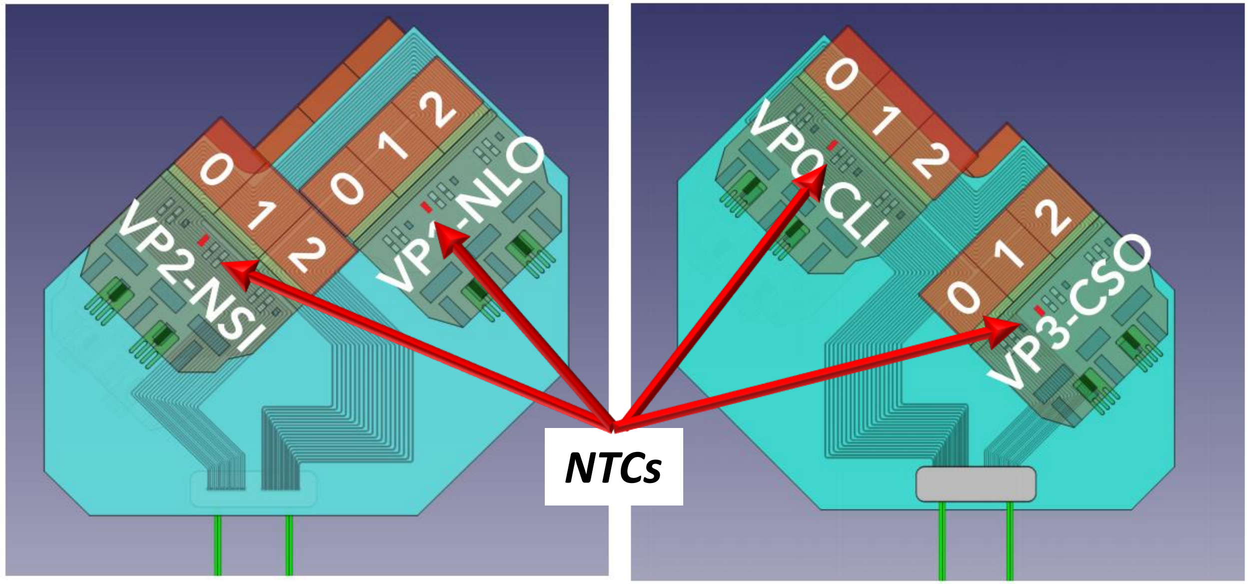
MRD05 at Manchester



ΔT(CO_2 - silicon) – Band gap 2019 ASICs temp

CERN, MRD07, Flow = 0.2 [g/s], Tacc -32 [°C]



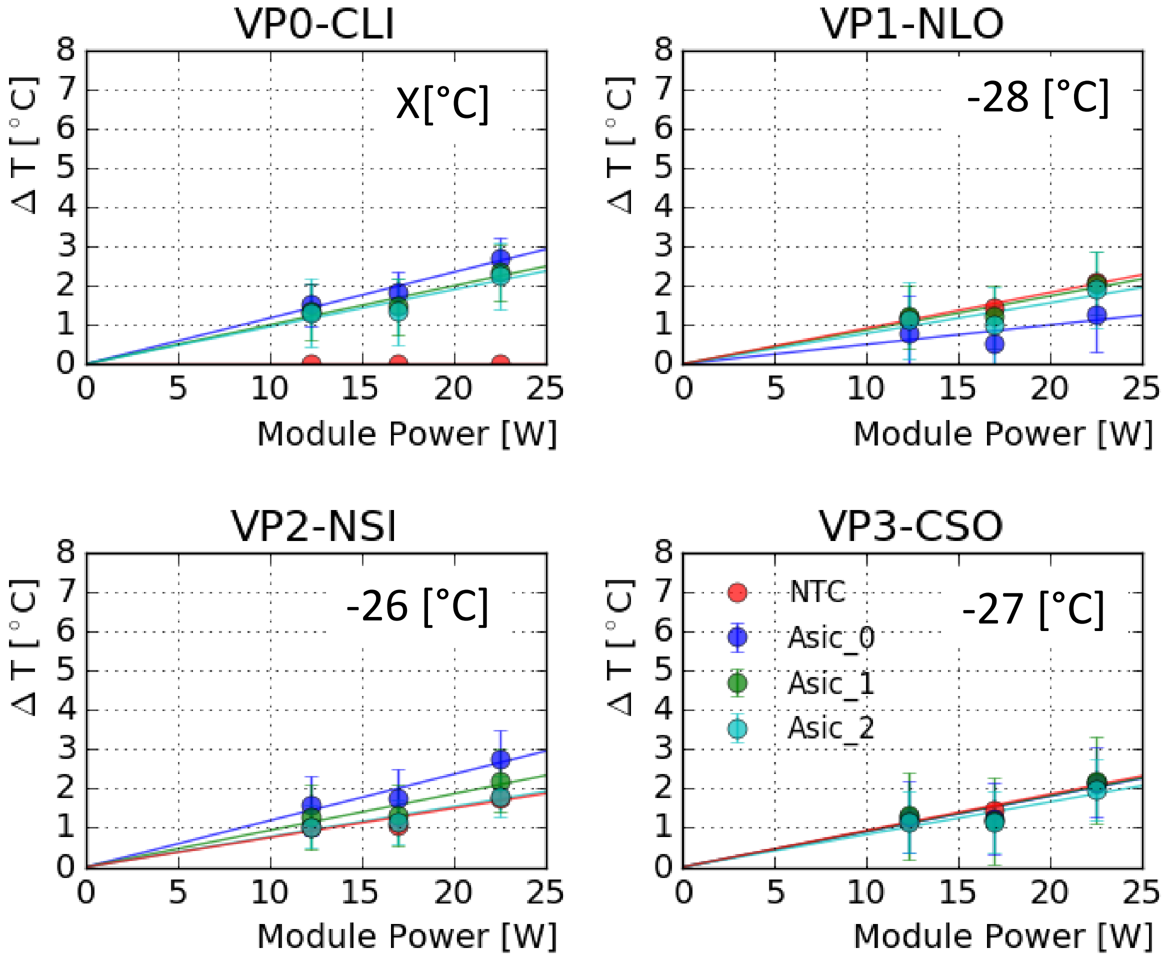


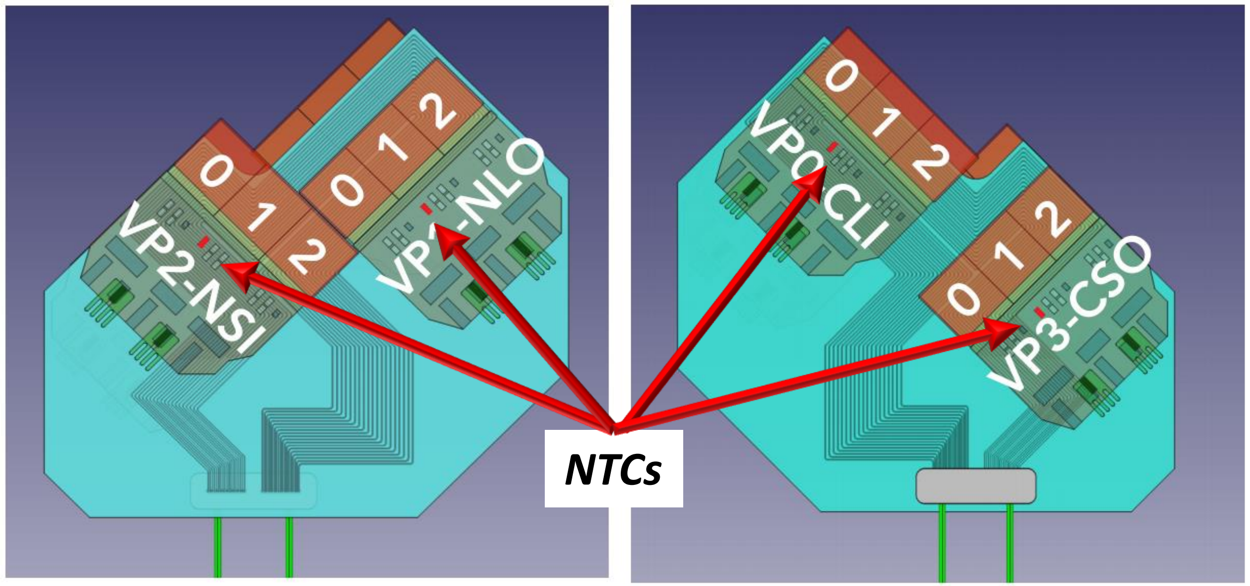
- **Use absolute temperature registered per each Asic and NTC for the power scenarios**
- **Made a linear fit of the temperature versus module power**
- **Normalise the point to the fit result**
- **Extrapolate to (0,0)**
- **Register temperature values for at least 1 min and take the mean and std value over 1 min**

Claudia Bertella

ΔT(CO_2 - silicon) – Band gap 2019 ASICs temp

Nikhef, MRD07, Flow = 0.4 [g/s], Tacc -35 [°C]



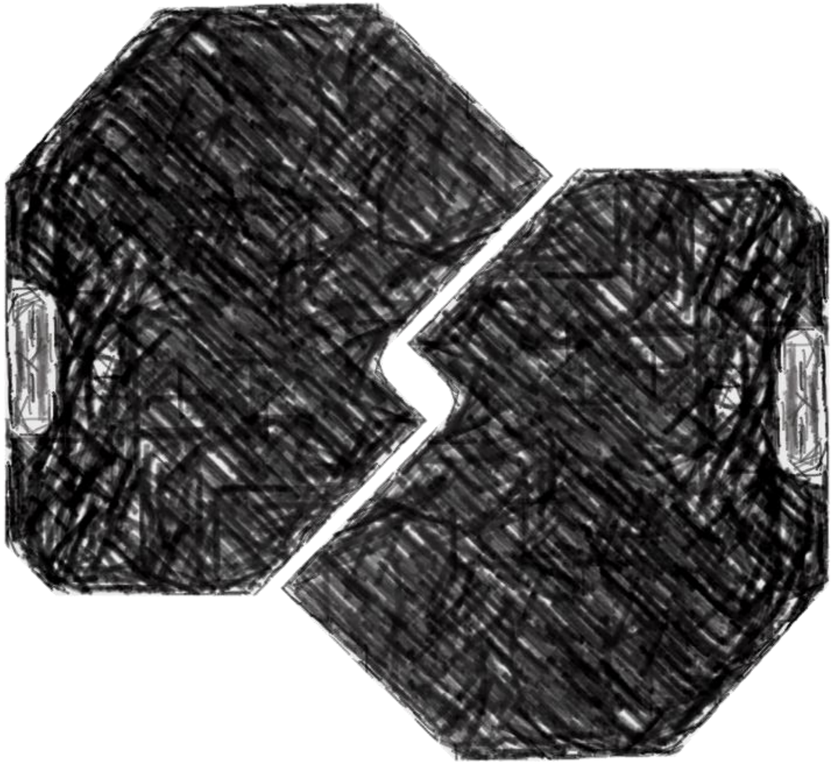


- **Use absolute temperature registered per each Asic and NTC for the power scenarios**
- **Made a linear fit of the temperature versus module power**
- **Normalise the point to the fit result**
- **Extrapolate to (0,0)**
- **Register temperature values for at least 1 min and take the mean and std value over 1 min**

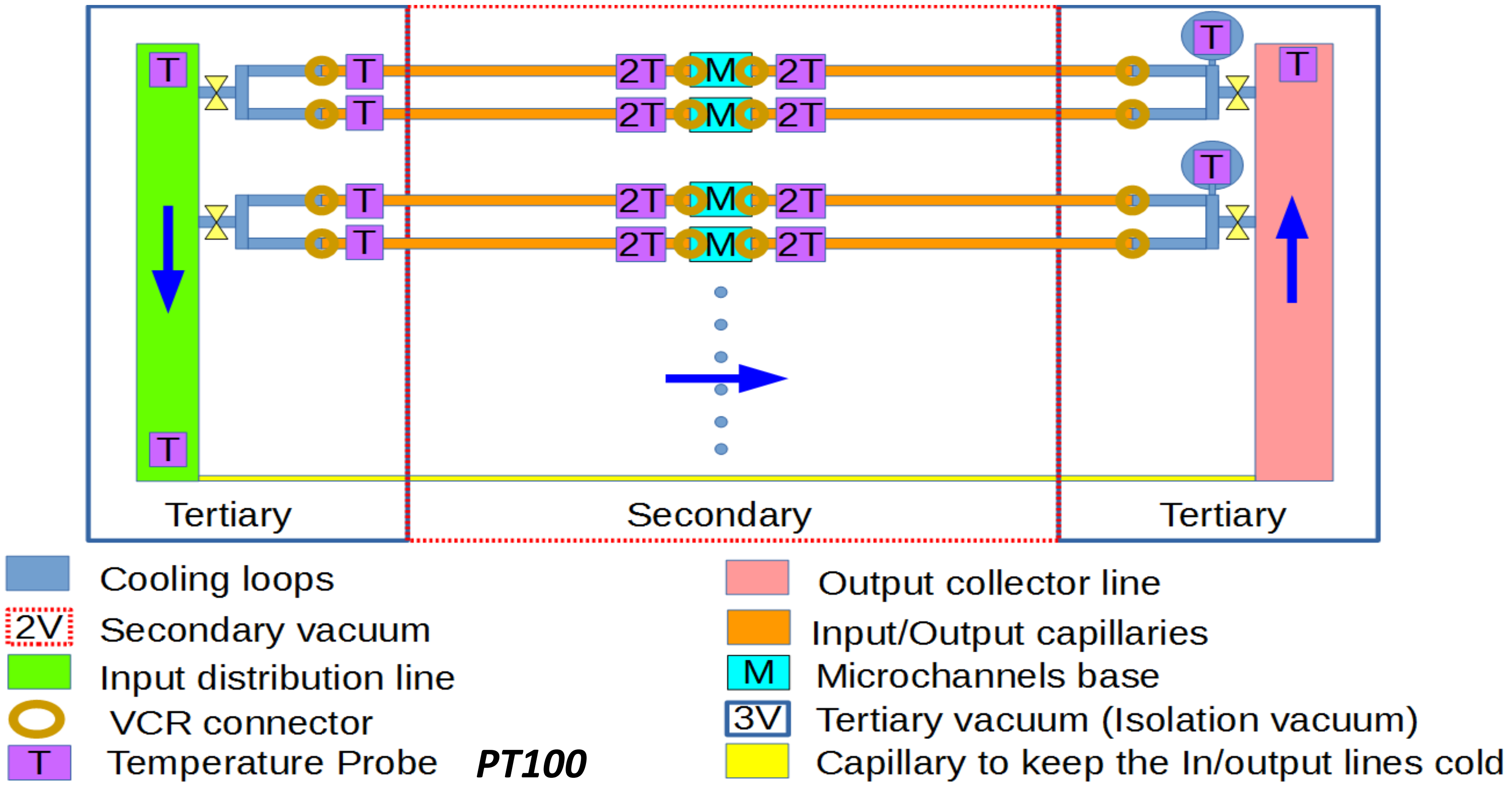
Krista De Roo

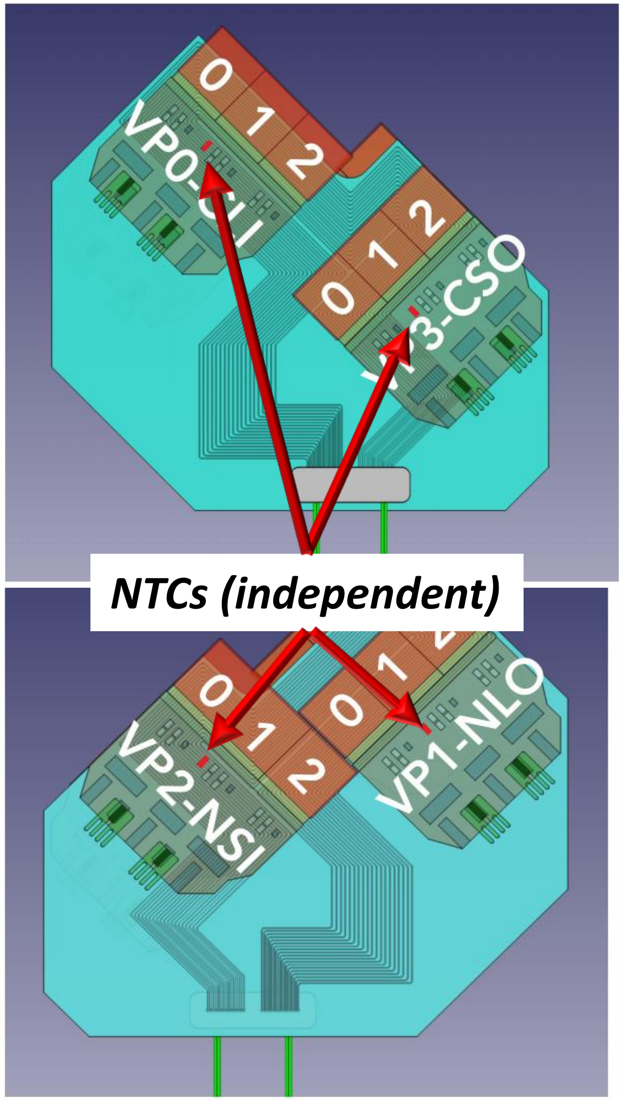
Outline

- Detector Flow and ΔP
- $\Delta T(CO_2$ - silicon)
- Temperature sensors
- Installation and commissioning schedule

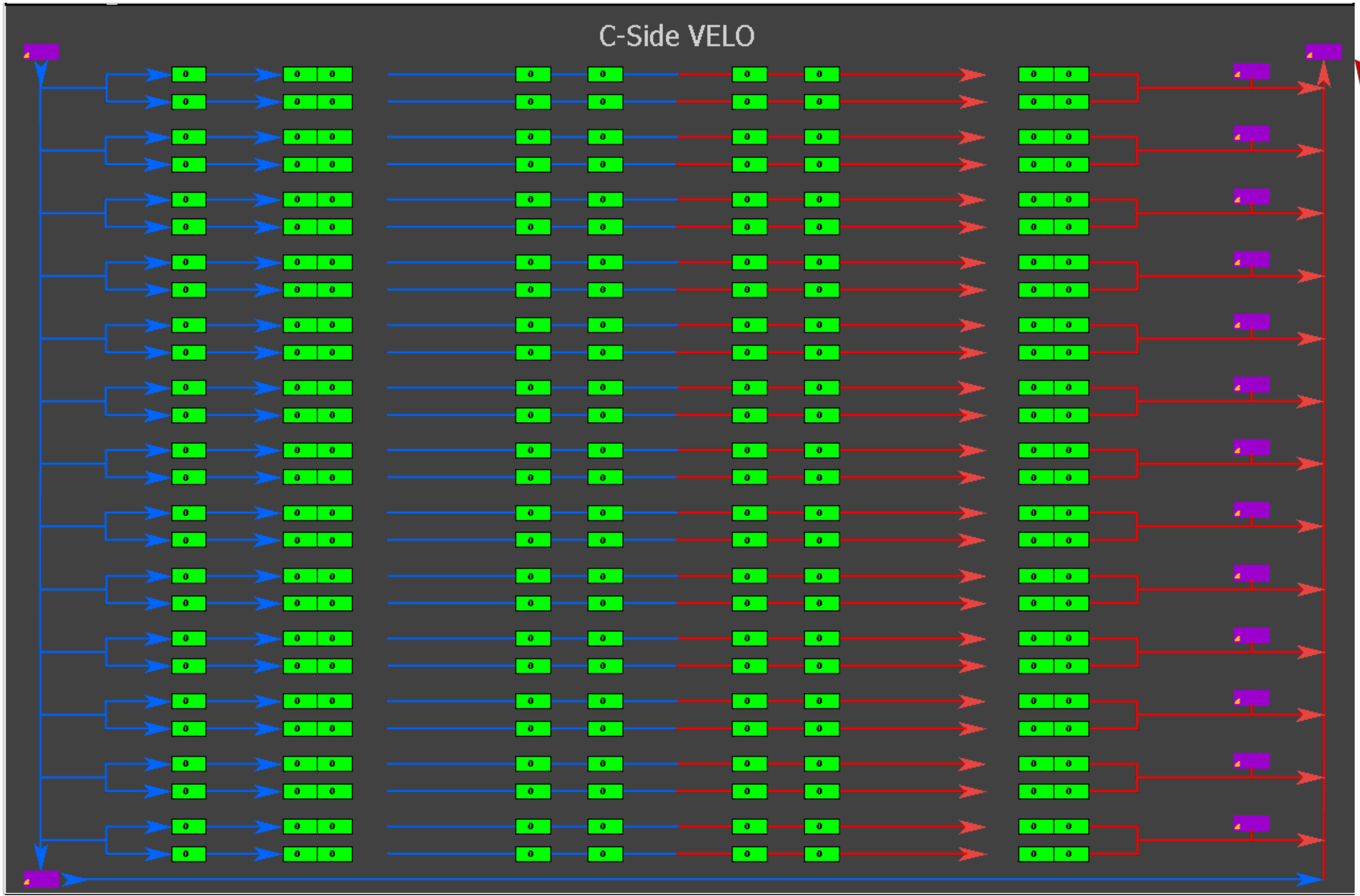


Temperature sensors



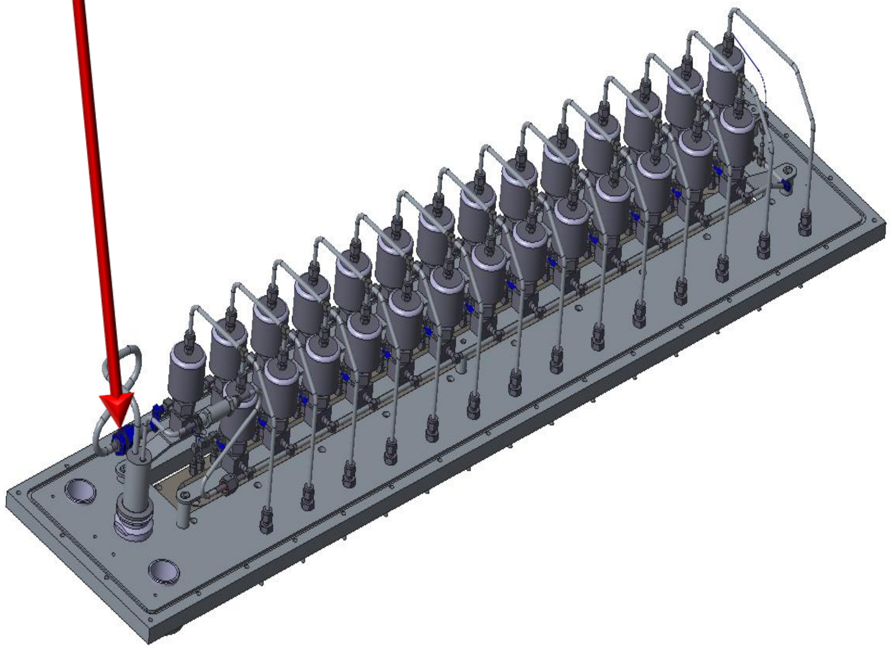


Temperature sensors



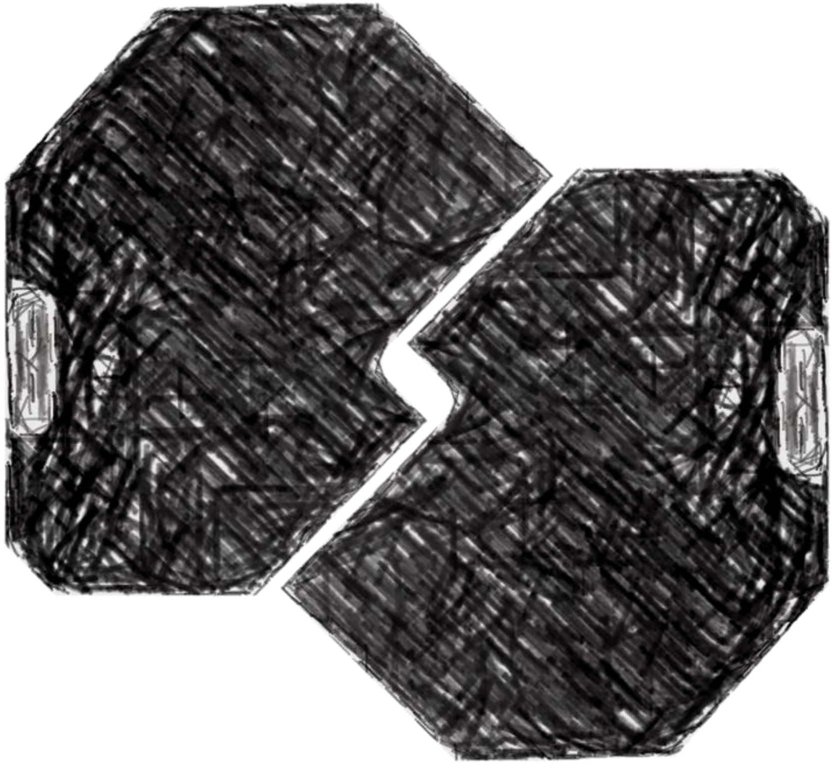
SCADA, Arkadiusz Homa

Detector output temperature
Always below -30 [°C]



Outline

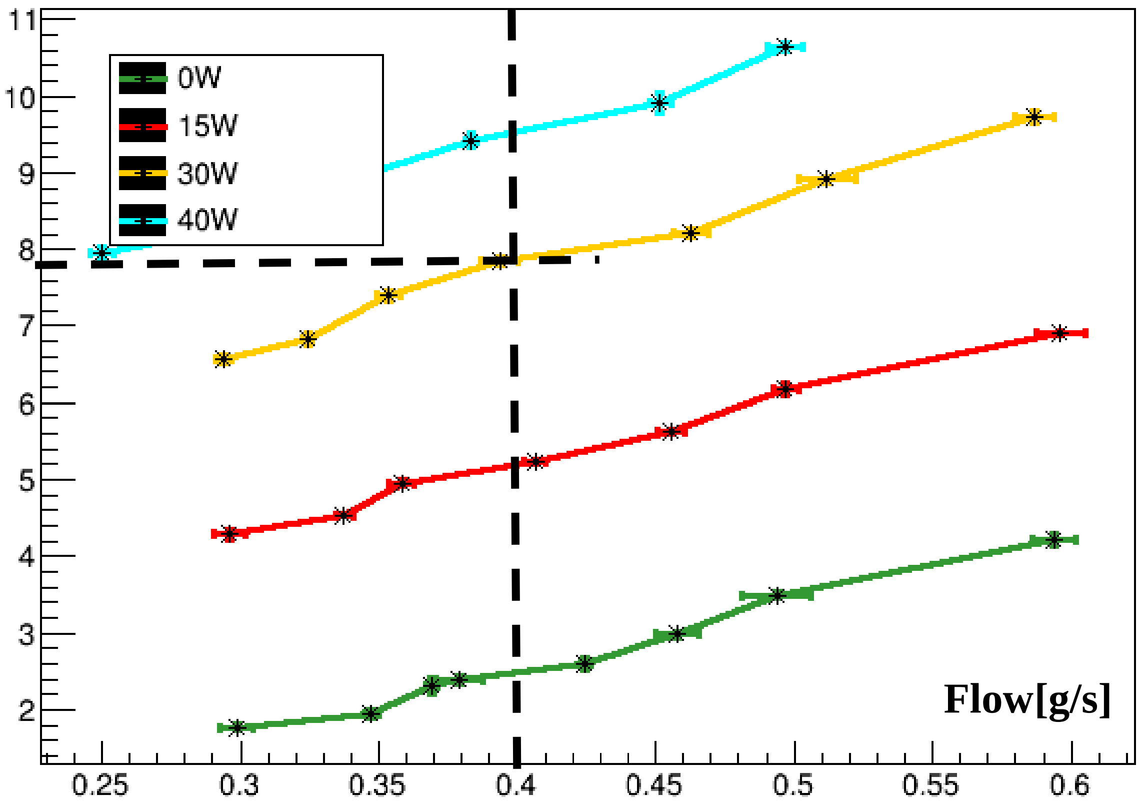
- Detector Flow and ΔP
- ΔT(CO_2 - silicon)
- Temperature sensors
- Installation and commissioning schedule
  - Liverpool status



Backup

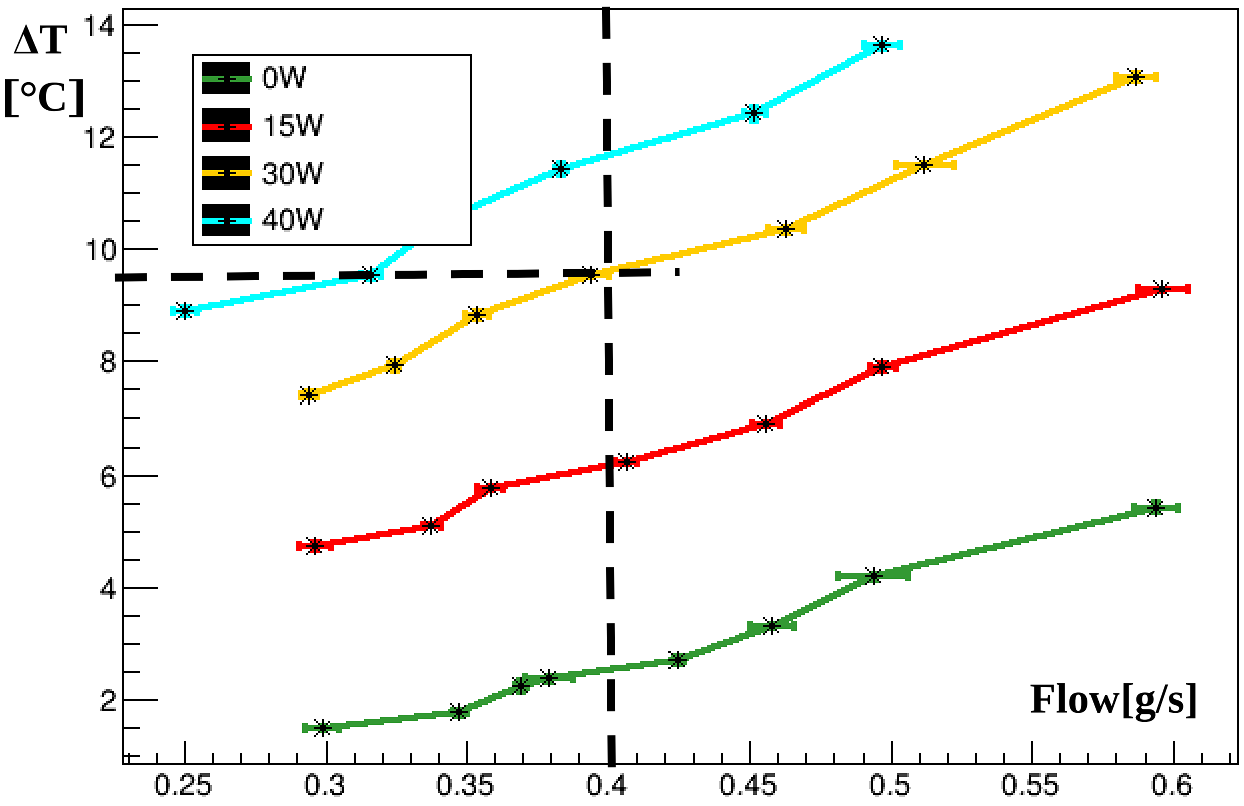
MC2 + Return Line ID 1.2 [mm]

ASIC Tip – MC Outlet (Flow)



ΔT = ~7.8[°C]

ASIC Tip – Detector Output (Flow)



ΔT = ~9.5[°C]

Capillary return line lost (for 0.4 [g/s]): 1.7 [°C]