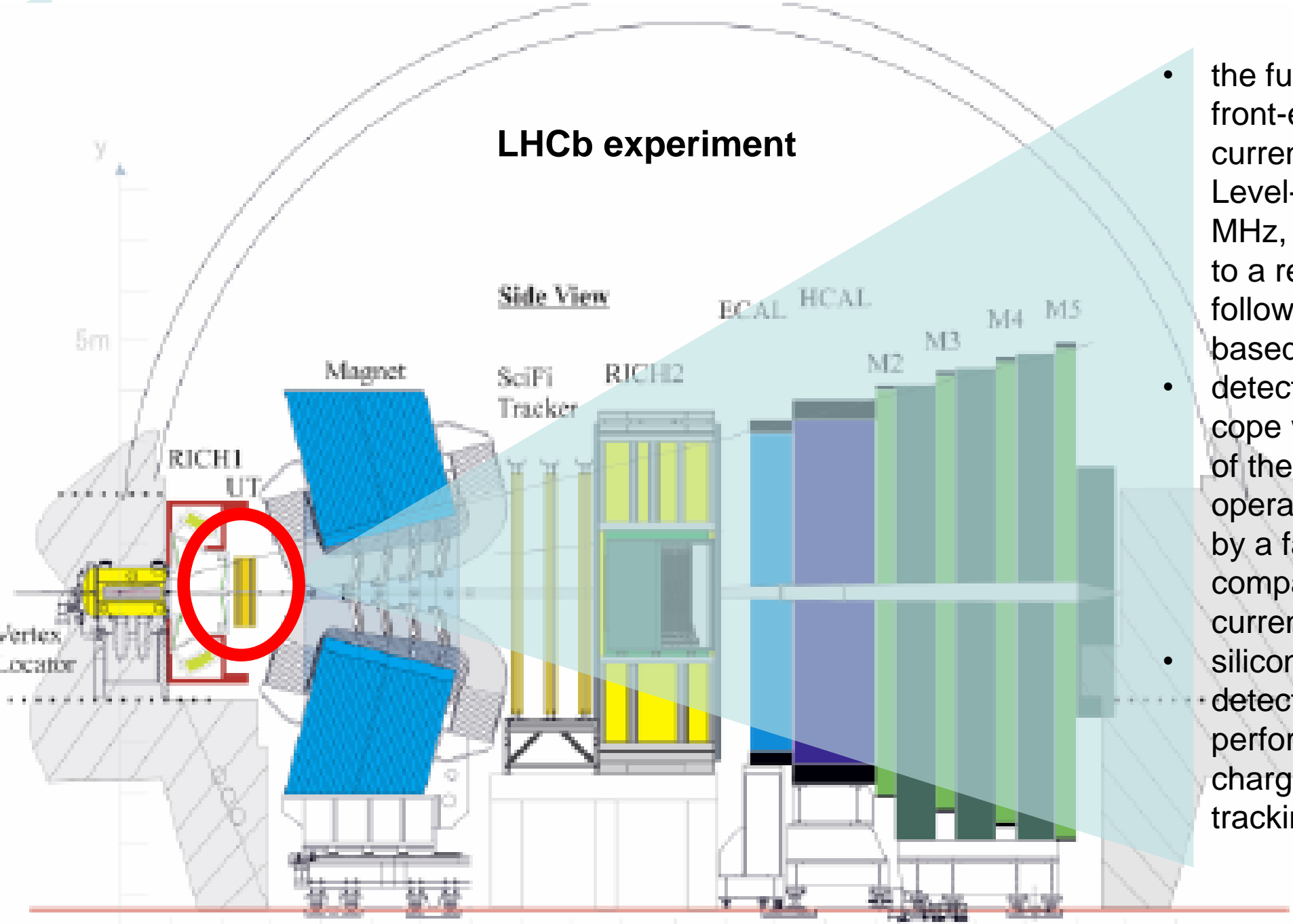
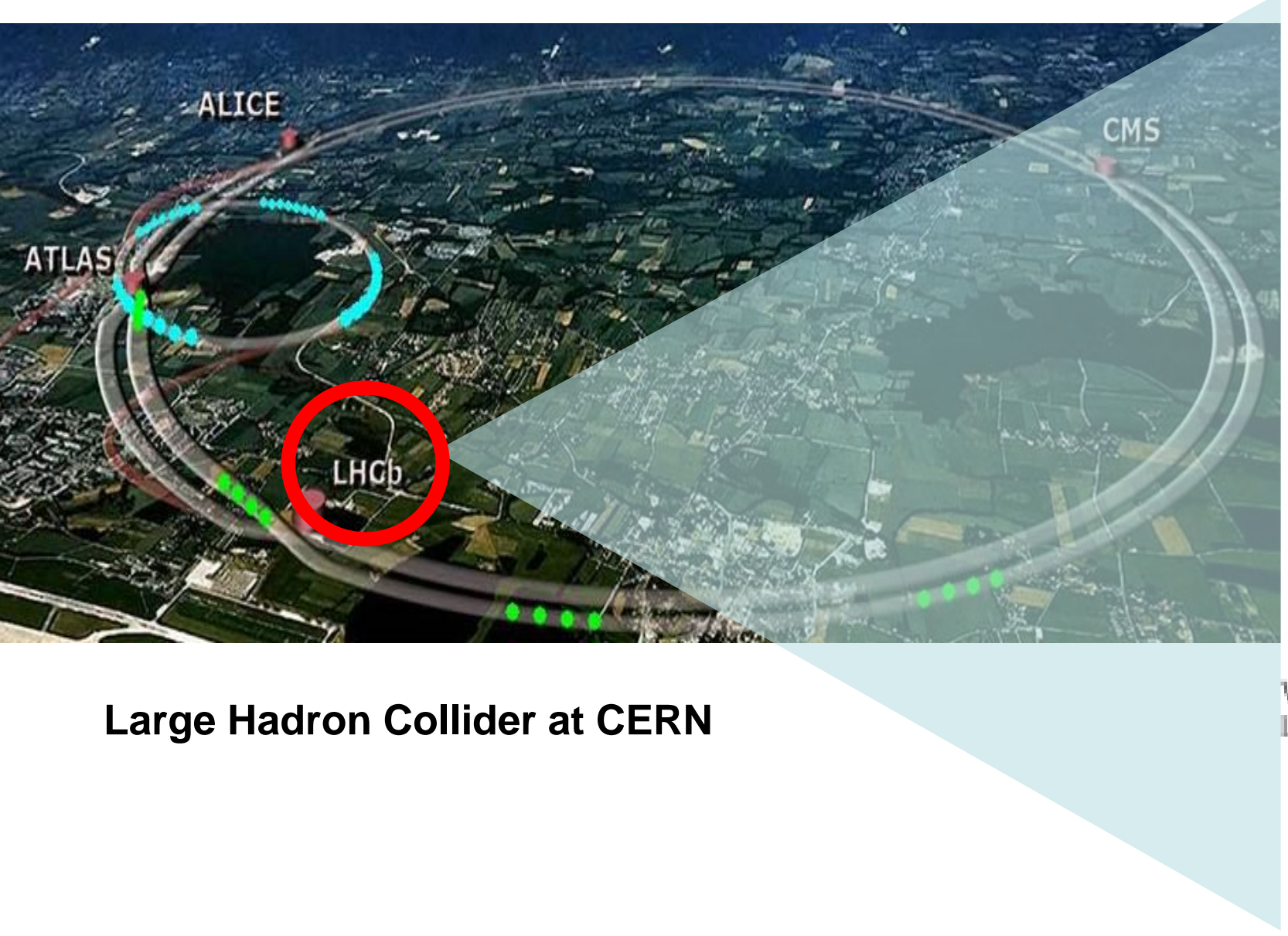


CO₂ evaporative cooling system for the LHCb UT Detector

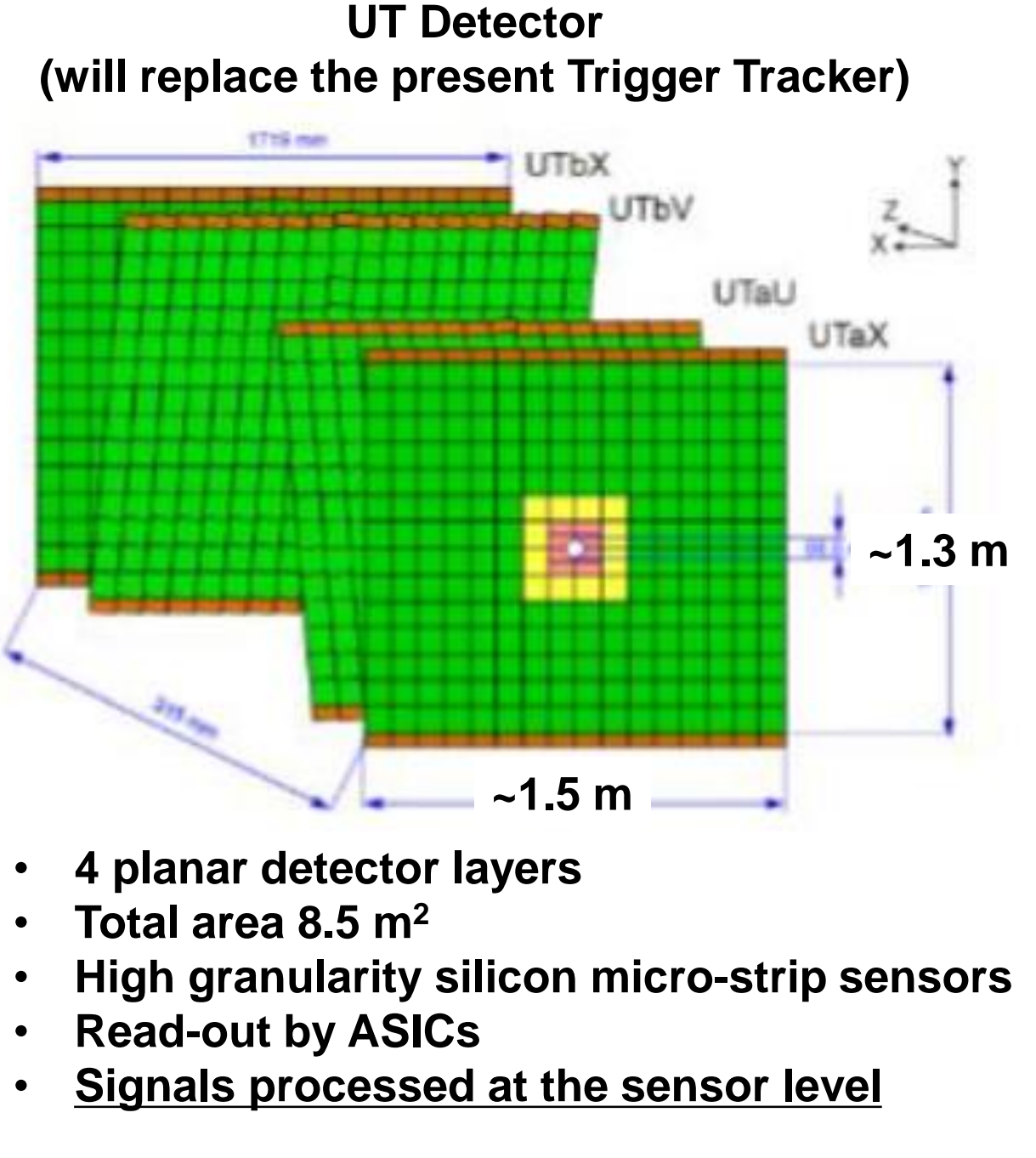
Ing. Simone Coelli - INFN Milano
on behalf of the LHCb UT Collaboration

e-mail:
simone.coelli@mi.infn.it

The LHCb experiment at the Large Hadron Collider uses a silicon strip detector for the Upstream Tracker (UT), part of its tracking system



- the full read-out of the front-end electronics, currently limited by a Level-0 trigger to 1 MHz, will be changed to a readout at 40 MHz followed by a software based event selection detector designed to cope with an increase of the nominal operational luminosity by a factor 5 compared to the current detector
- silicon strip tracker detector with improved performance in charged particle tracking and triggering



Detector thermal design and cooling system tasks:

- extract the thermal power dissipated by read-out chips
- keep ASIC max temperature < 40 °C
- prevent thermal runaway in presence of radiation damage

=> keep the sensor temperature T max < - 5 °C

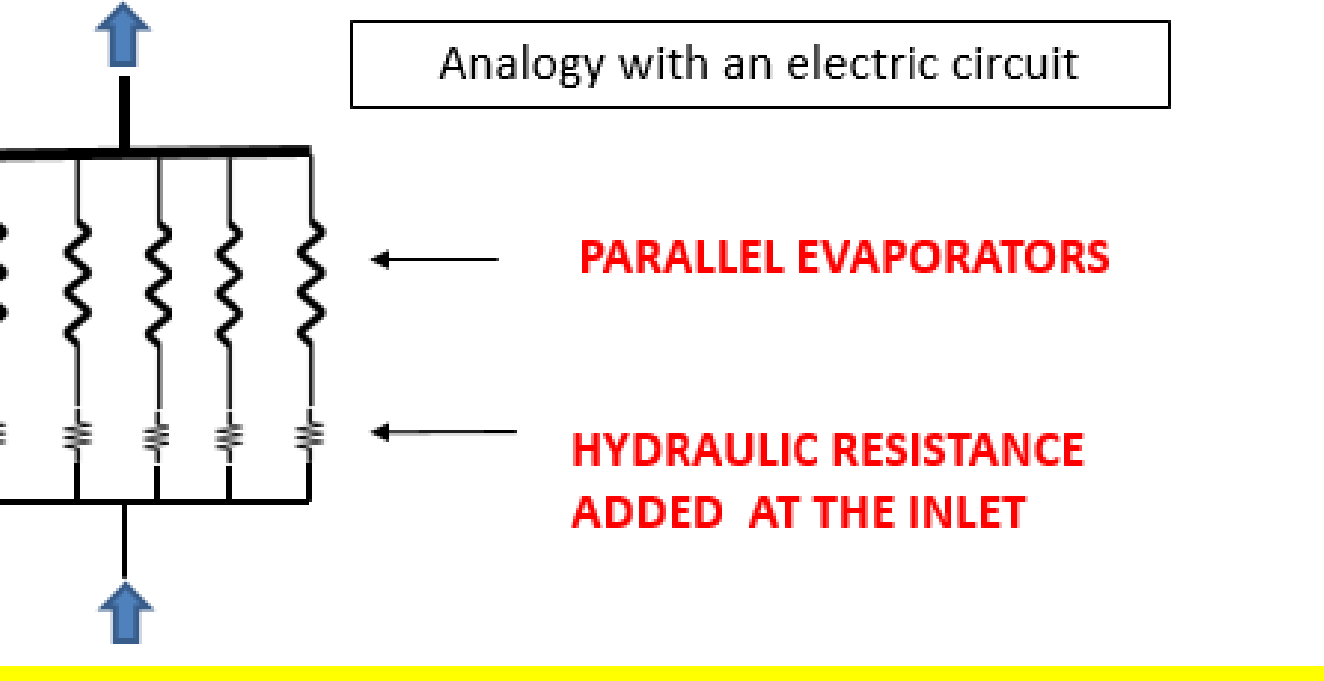
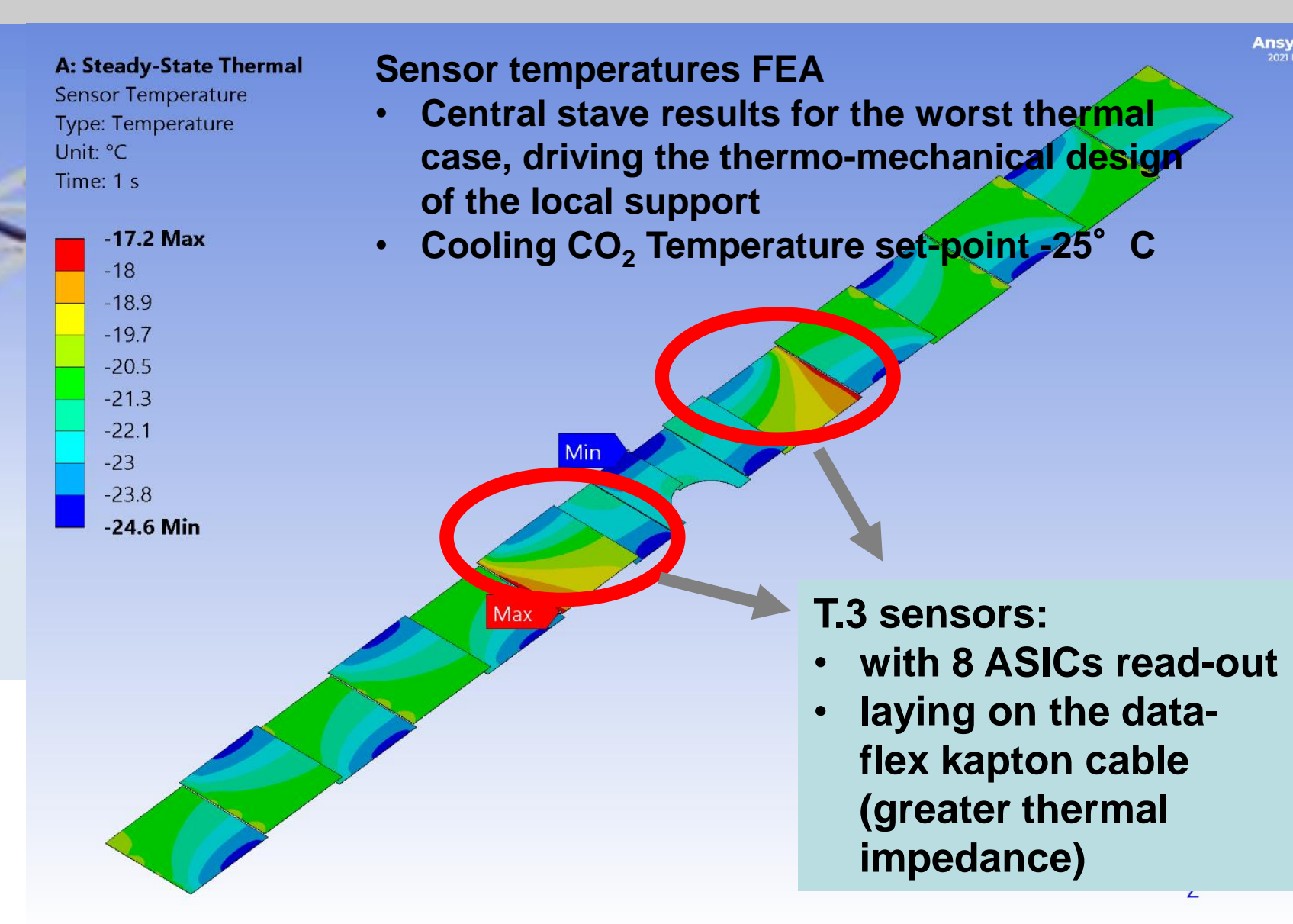
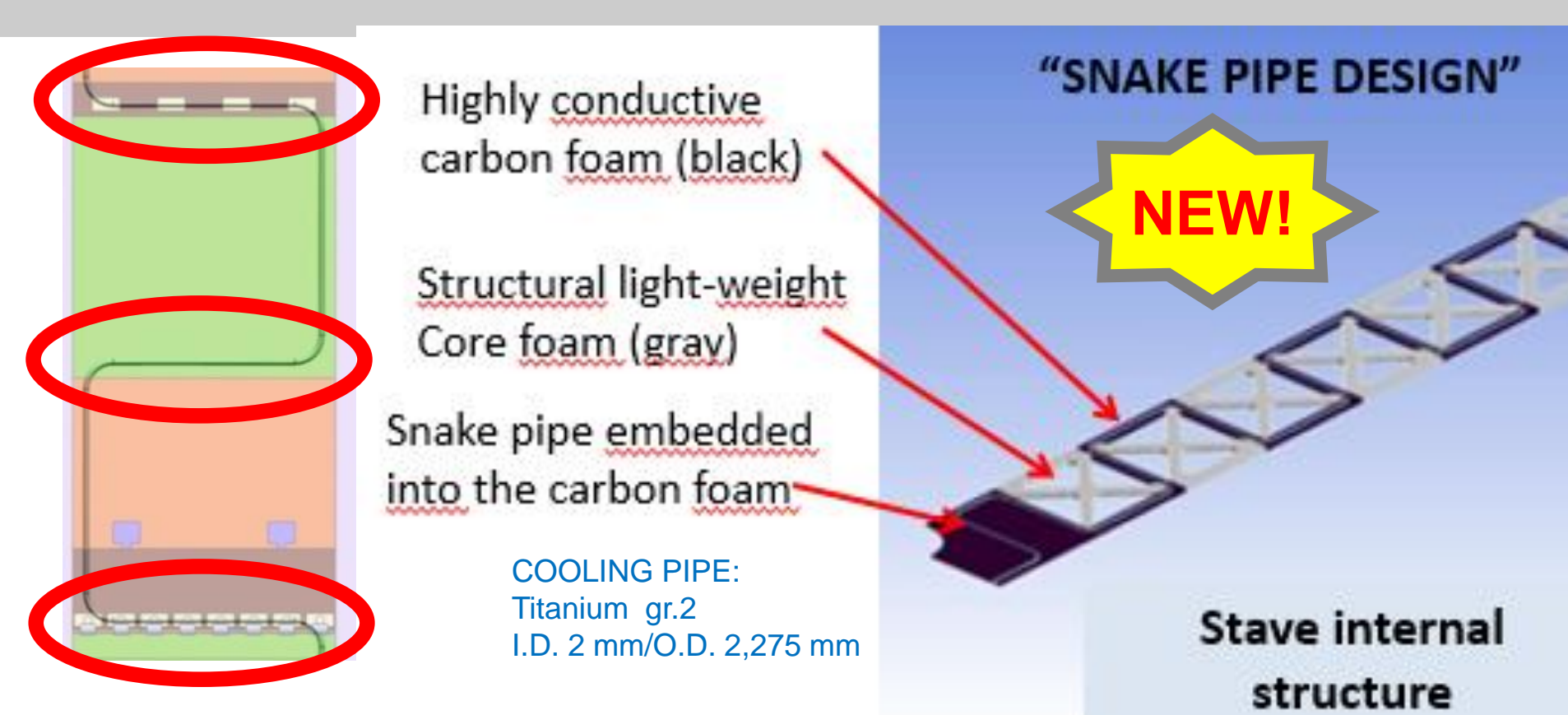
- minimize the temperature difference over the silicon sensors

=> Delta T < 10 °C

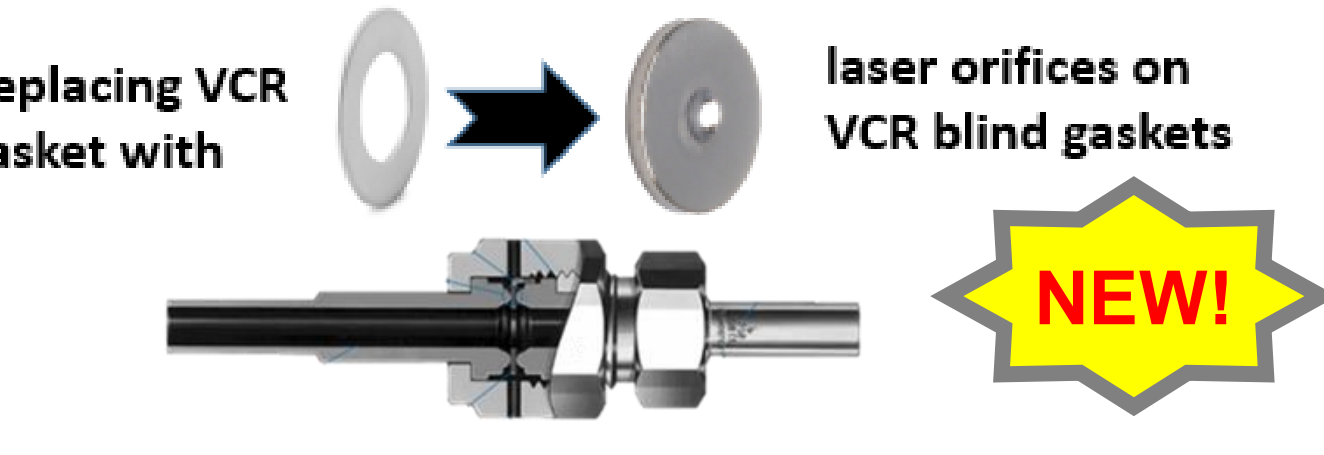
=> Design exploiting a cooling system based on CO₂ evaporation

Detector total power:
4192 ASICs ~ 0,8 W/each
+ cables + sensors + heat pick-up
=> ~ 4 kW power to be extracted

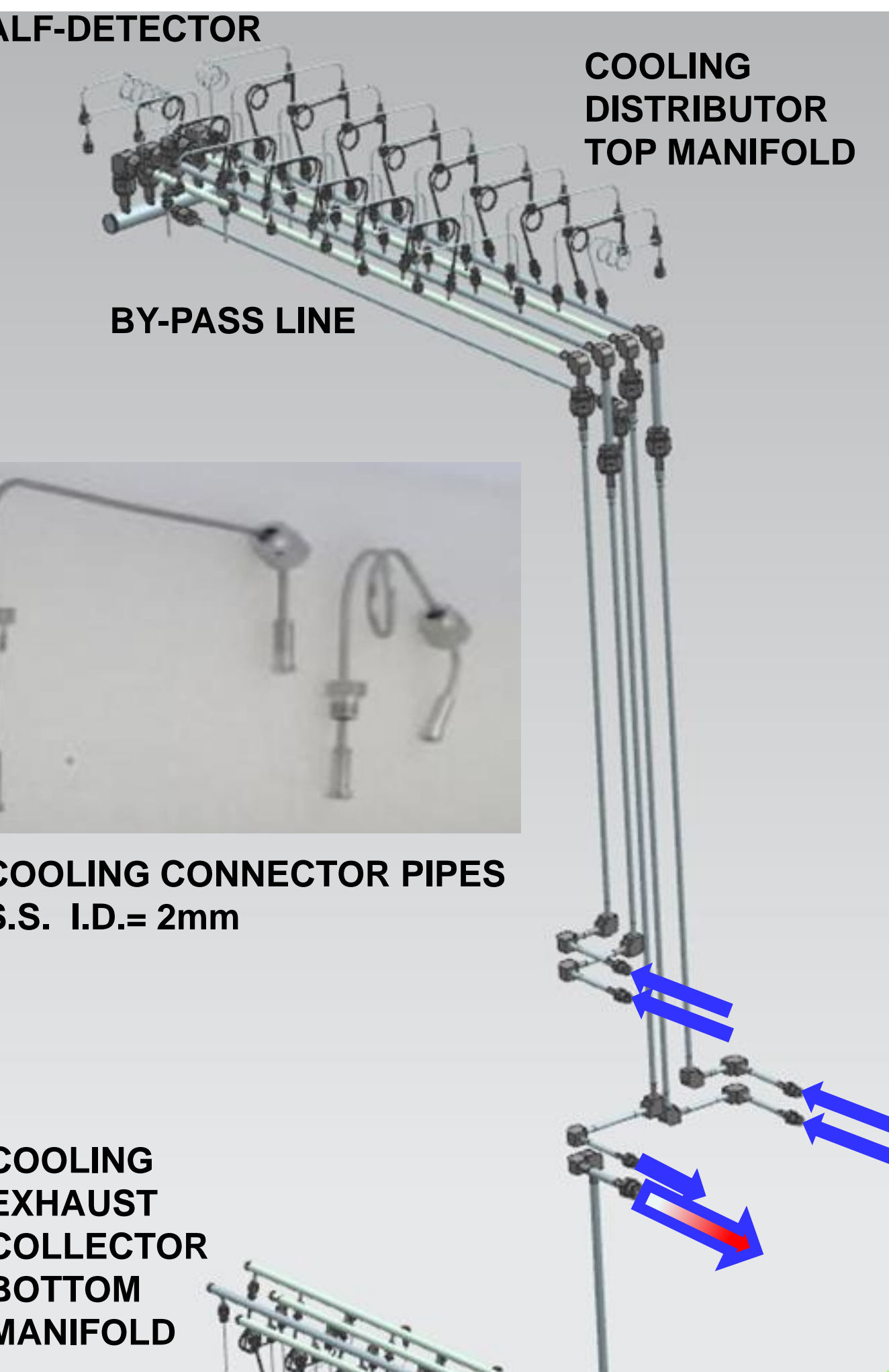
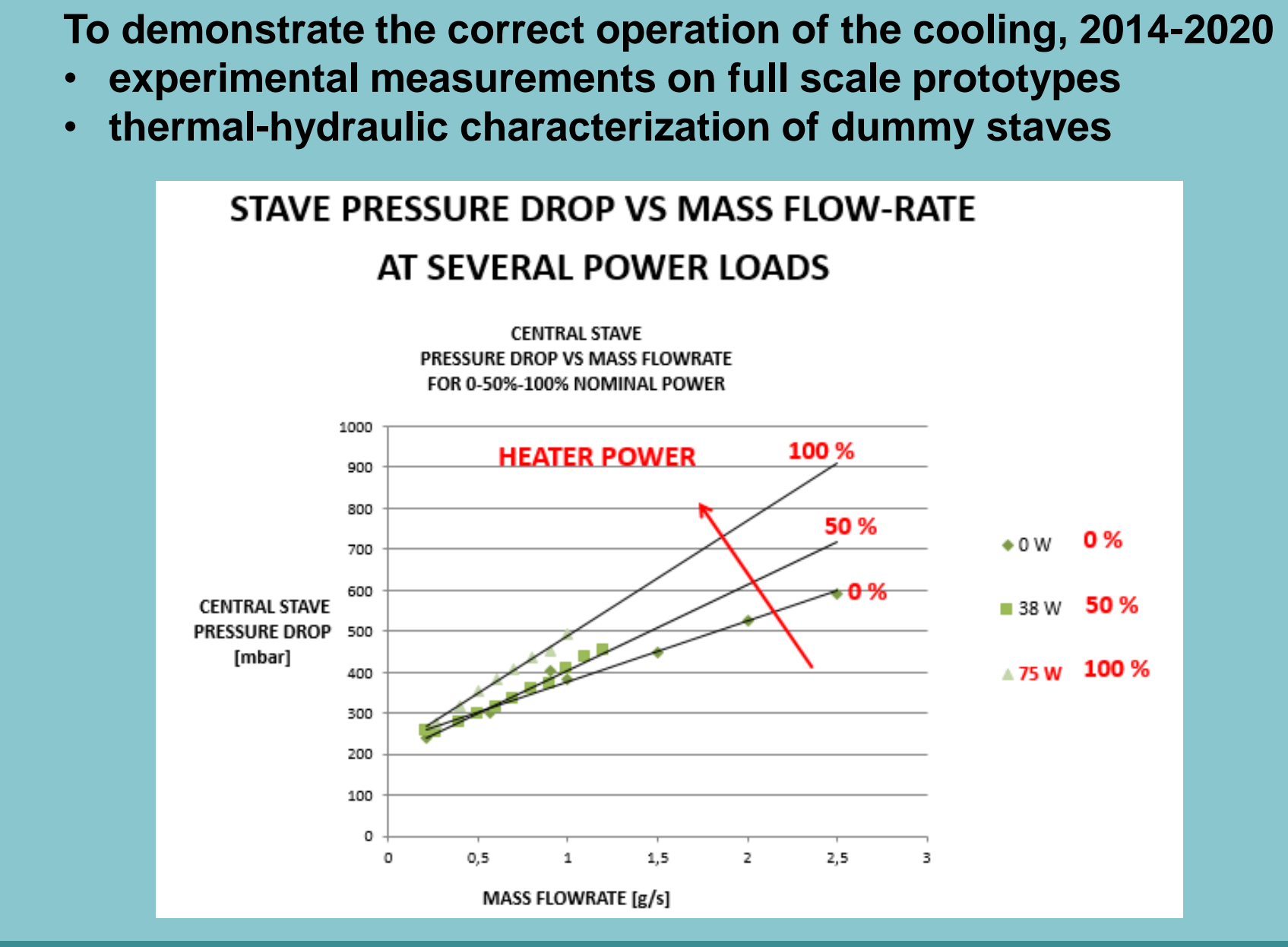
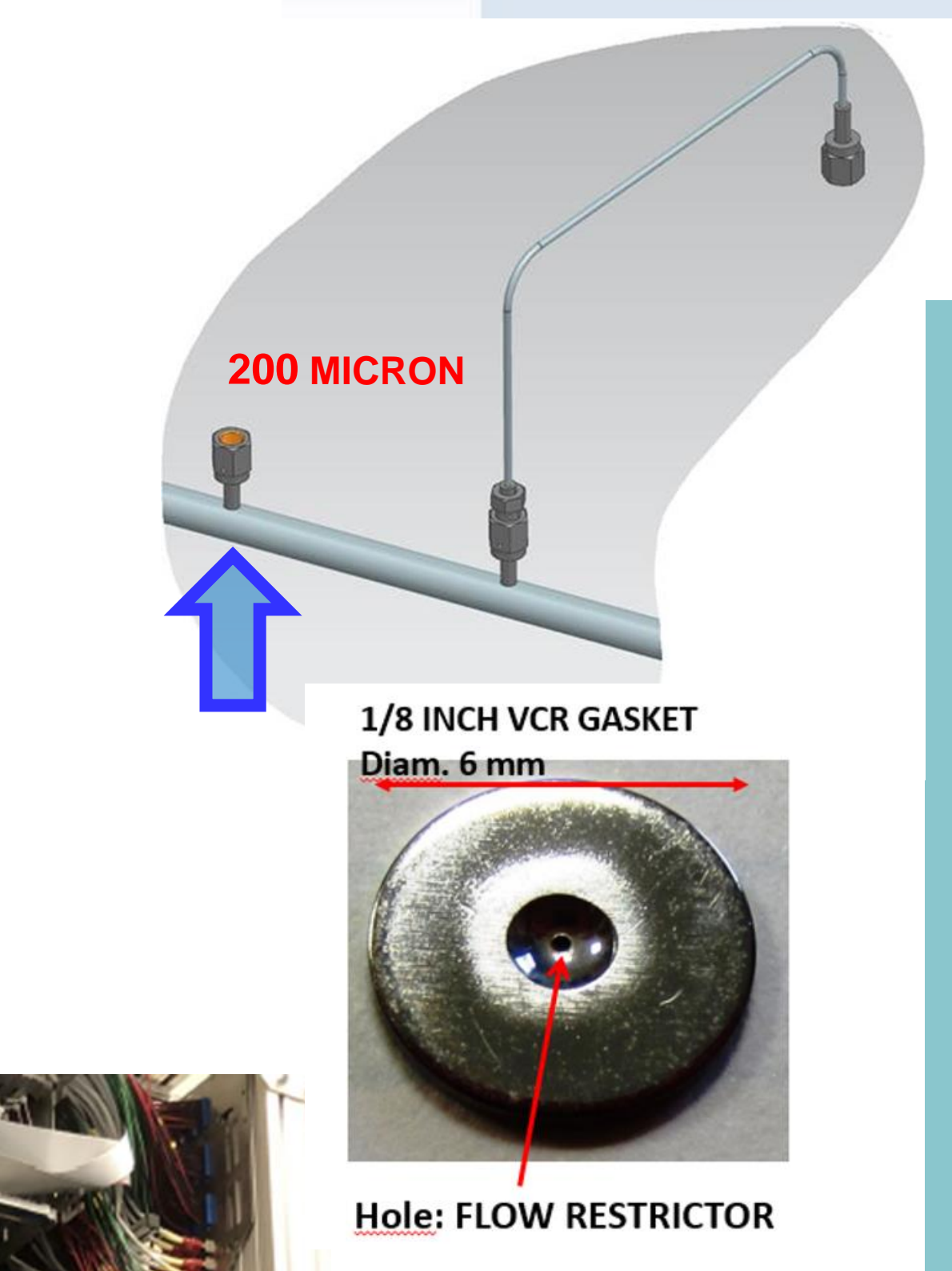
- Sensor modules are mounted on:
- lightweight carbon fiber mechanical structure
 - embedding a SNAKE SHAPED EVAPORATOR cooling pipe
 - passing underneath the read-out ASICs (thermal power sources to be cooled down)



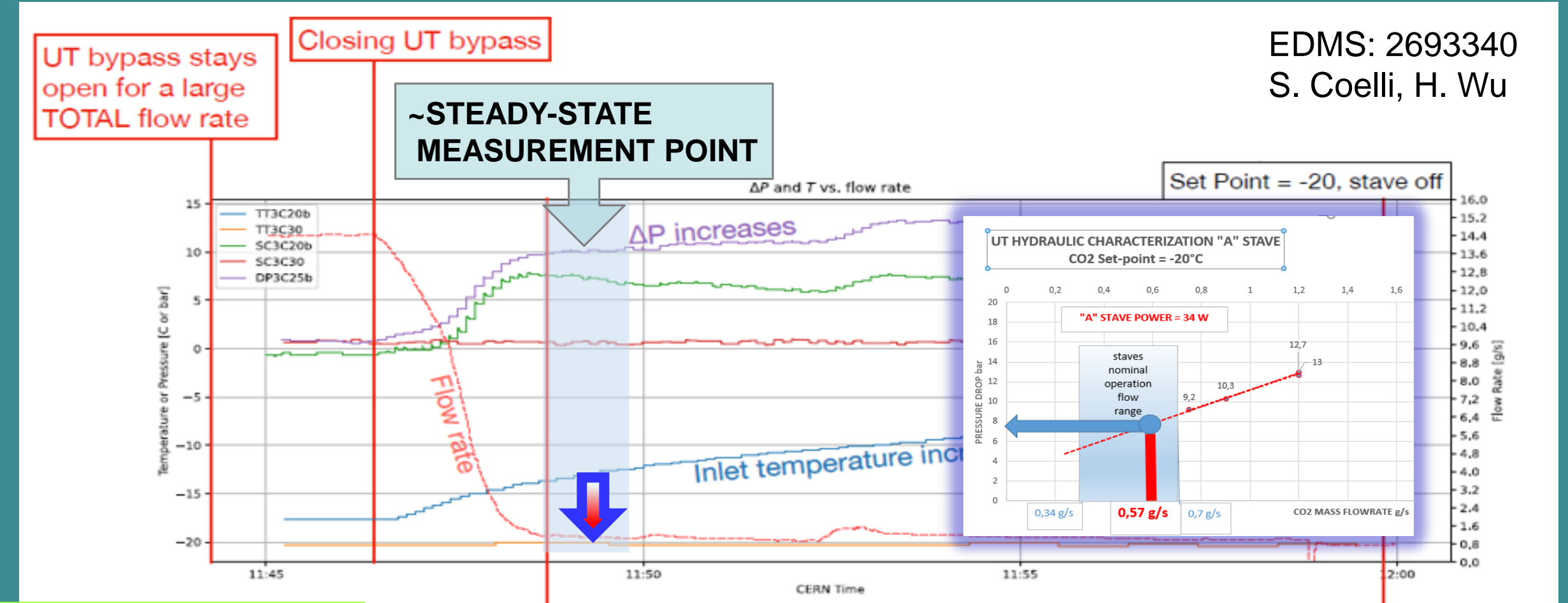
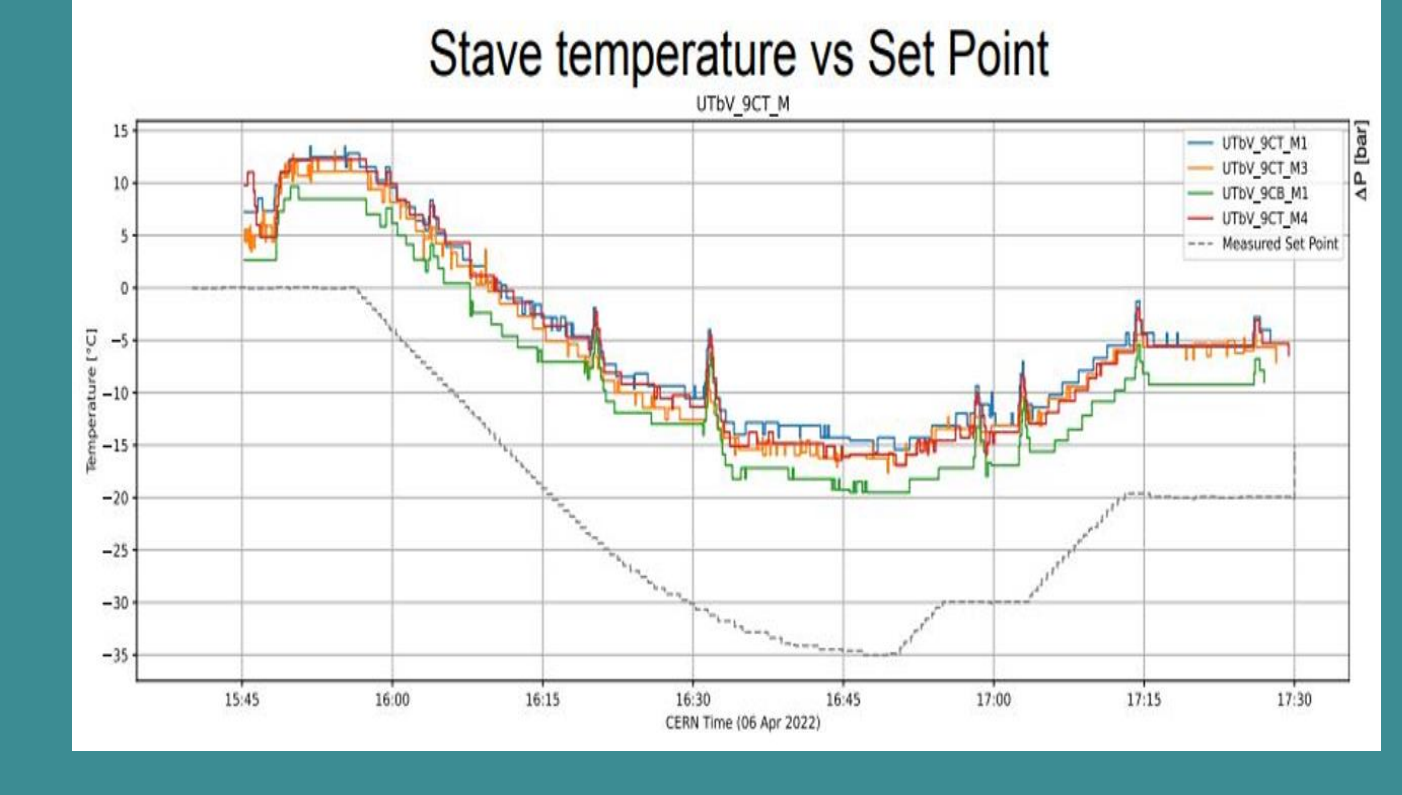
COOLING DISTRIBUTION SYSTEM WITH FLOW RESTRICTORS INSTALLED AT THE EVAPORATOR INLET: 200 MICRON CALIBRATED ORIFICES



- FLOW RESTRICTORS**
- Less used in present tracker detectors
 - A gasket (VCR) can become a restrictor
 - Small diameter orifice => risk of clogging
- IMANDATORY:**
- To use proper filtering elements
 - To use a pure fluid (no moisture)
 - Take care of the cleanness of the plant lines
 - Vacuum the lines before filling



- COMMISSIONING MEASUREMENTS, MAY 2022**
- LUKASZ cooling unit
 - «A» TYPE lateral stave installed
 - Characterization from +15/ -35° C set-point
 - Stability studies



WORK IN PROGRESS: DETECTOR INTEGRATION & SYSTEM COMMISSIONING

- UT cooling system is working within expected parameters range.
- Thermo-hydraulic behaviour is under control.
- Commissioning in progress. Further test is planned with multiple staves.

EDMS: 2693340
S. Coelli, H. Wu