



LHCb COOLING MEETING
10 November 2016



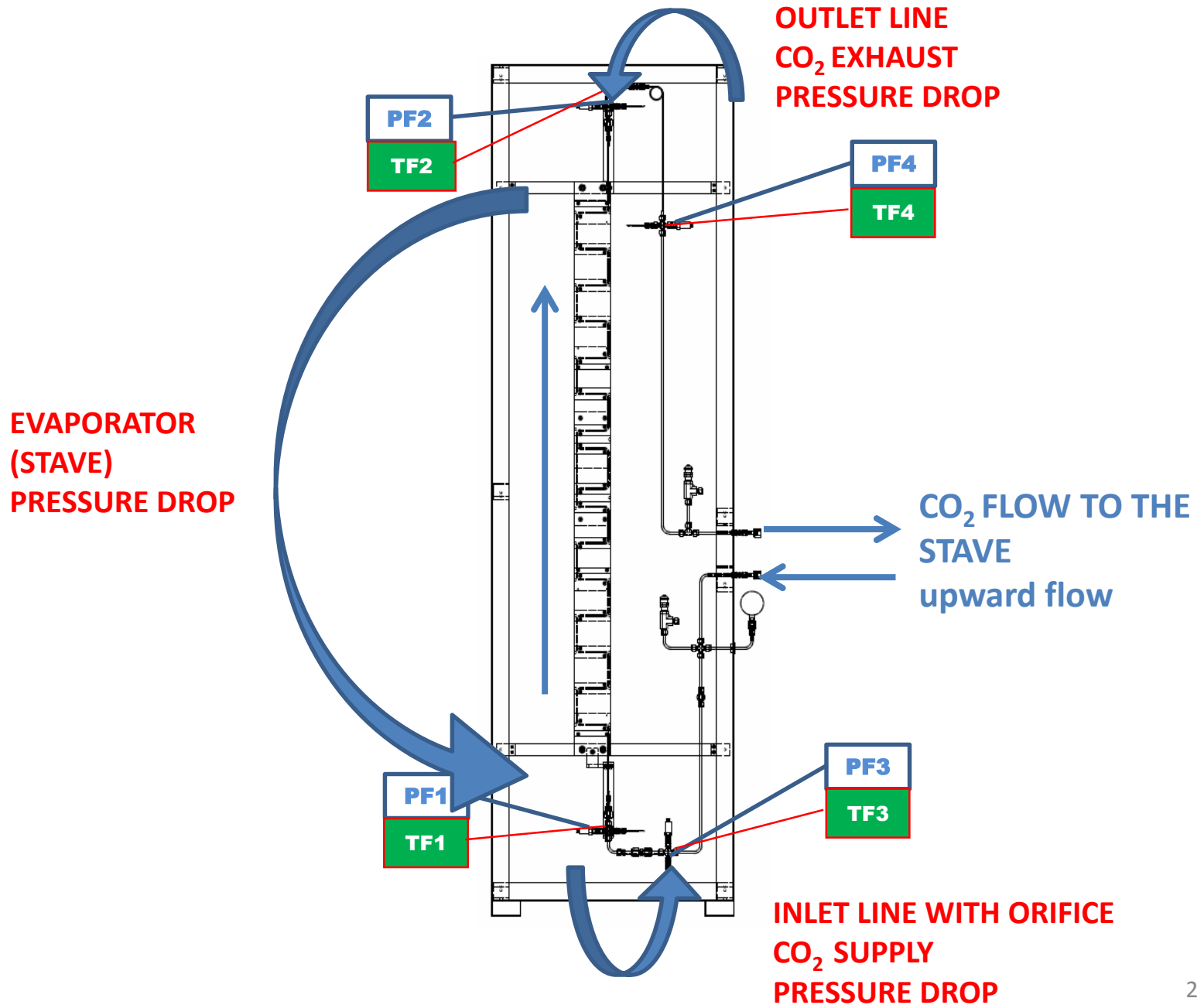
Istituto Nazionale
di Fisica Nucleare
Sezione di Milano

**Feedback on transfer line sizing and
flow calculations for UT**

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INFN Milano

For the Milano UT Group

CO₂ MEASUREMENT POINTS



MEASURED PRESSURE DROP CONTRIBUTIONS

CENTRAL STAVE "C"

MOUNTED RESTRICTOR: SWAGELOK ORIFICE 0,01 INCH = 0,25 mm I.D.

TRACI PRESSURE SET-POINT = 17 bar_A

SATURATION TEMP = -23°C

HEATER POWER = 75 W (nominal)

CALCULATED X out = 32 %

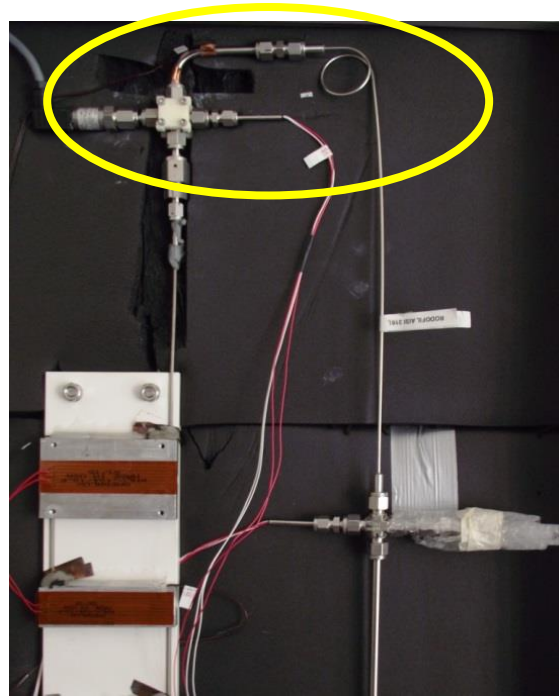
MASS FLOW-RATE = 0,84 g/s

PRESSURE DROP	bar
INLET LINE WITH ORIFICE	2,875
EVAPORATOR (STAVE)	0,314
OUTLET LINE	0,034

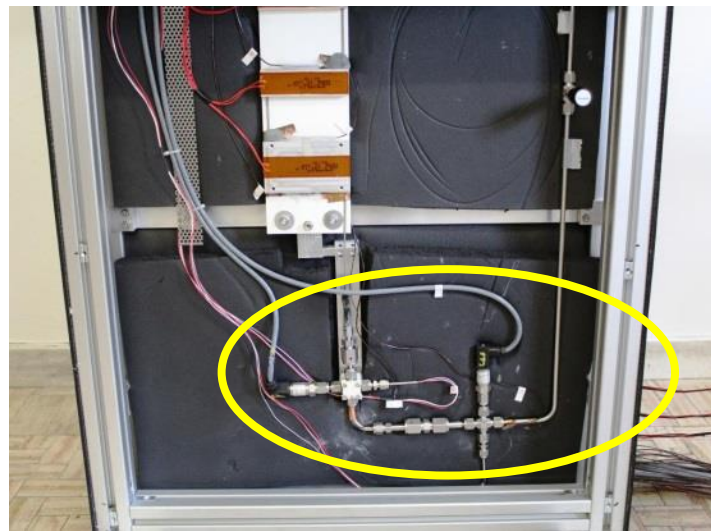


RATIO ~ 1:10

RATIO ~ 1:10



**OUTLET CONNECTION:
I.D. 2 mm PIPE COILED 1 LOOP**



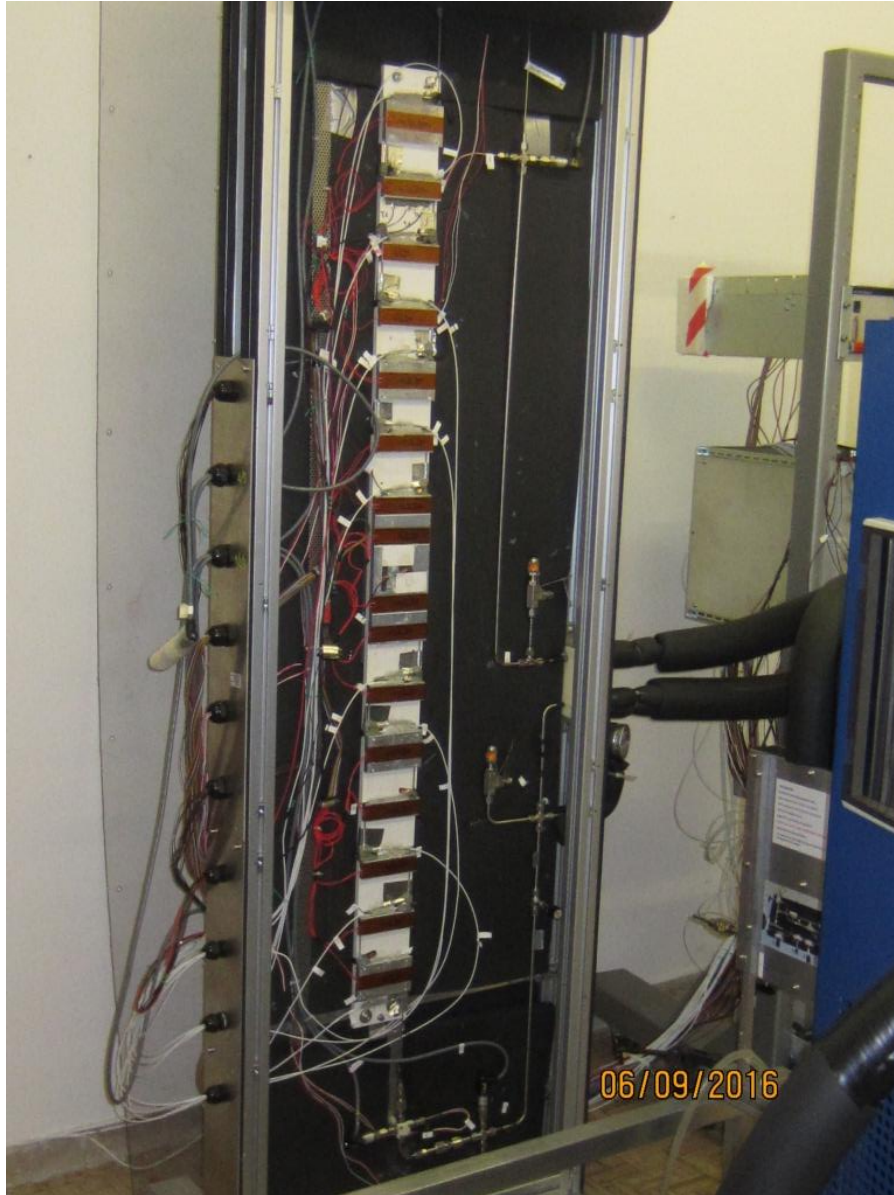
**INLET CONNECTION:
SWAGELOK ORIFICE
0,01 INCH = 0,25 mm I.D.**

WORK IN PROGRESS:

**MEASUREMENTS ON THE LATERAL
STAVES TYPE A/B**

BACK-UP SLIDES

CO2 COOLING TEST



**Mounting in progress
inlet and outlet connections**

**S.S. pipe I.D. 2 mm/O.D. 2.5
mm with welded joints**

Coiled "1 coil"

**inlet RESTRICTION orifice
mounted on the bottom
(0,25 mm to start)**

**central "C" stave
then "A" and "B" stave**

Cooling connections



S.S. PIPE
2 mm I.D. / 2,5 mm O.D.

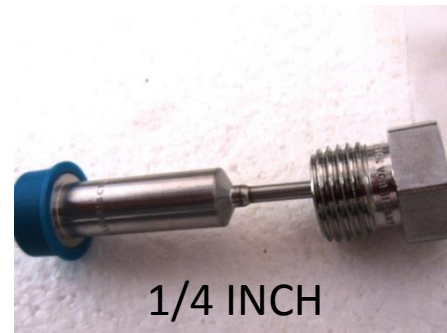
BENDE «1 COIL»

VCR SWAGELOK CONNECTORS
LASER WELDED:

CONNECTION STAVE SIDE



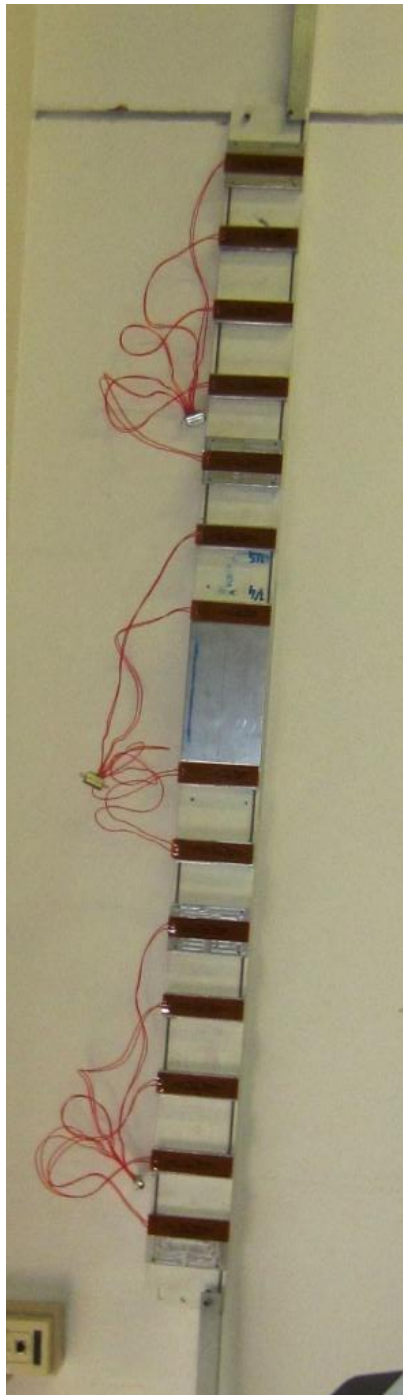
CONNECTION MANIFOLD SIDE



COILING TOOL



STAVE «A/B» TYPE

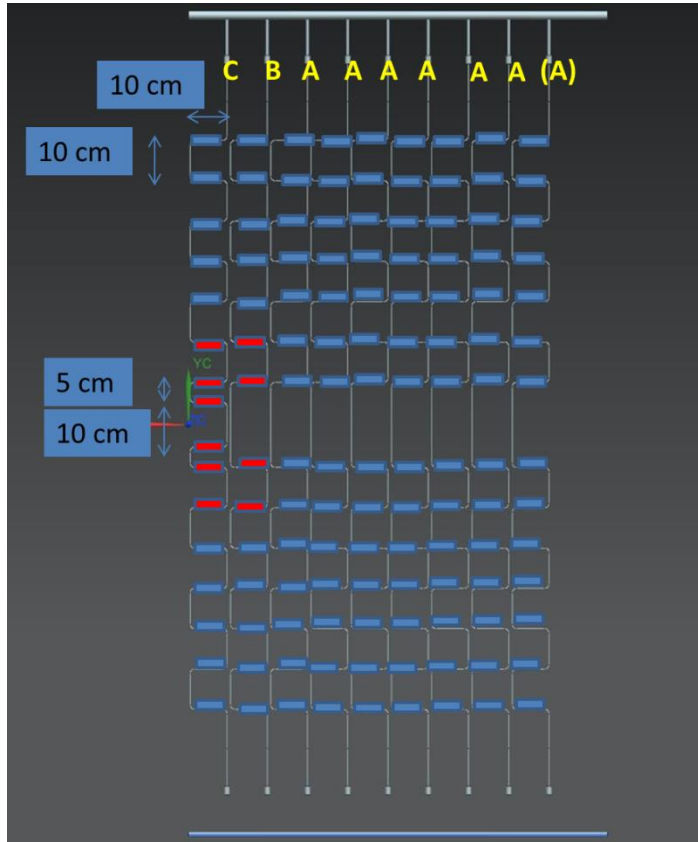


DUMMY STAVE

**WITH HEATERES MOUNTED AND
CABLED**

**READY FOR TEST AFTER TEMPERATURE
SENSOR WILL BE ATTACHED ALONG THE
STAVE COOLING PIPE**

POWER DISTRIBUTION



ASICs distribution on a “half-plane”

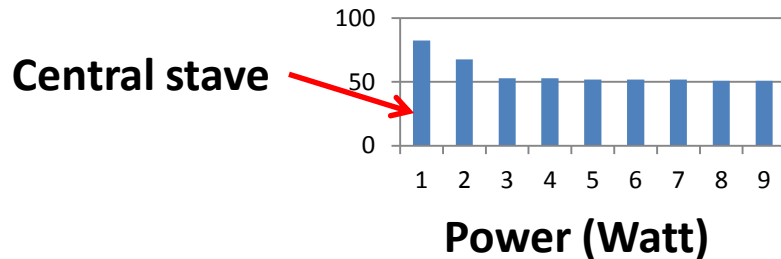
Differences between the evaporators

pipe in the central stave:

- 6% longer
- 4 more 90° bends

thermal load:

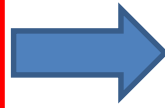
- Lateral stave 50 W
- central stave 75 W (50% more)



CO₂ COOLING TEST

CO₂ BOILING IN

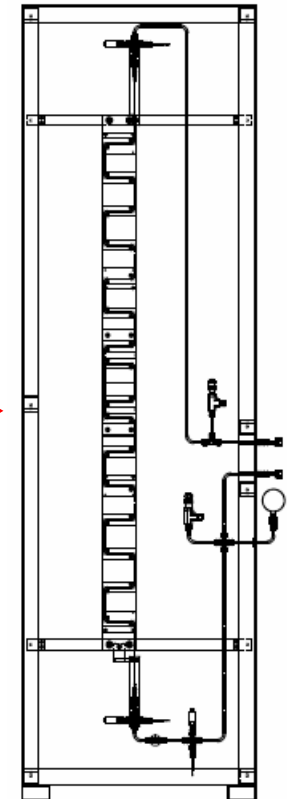
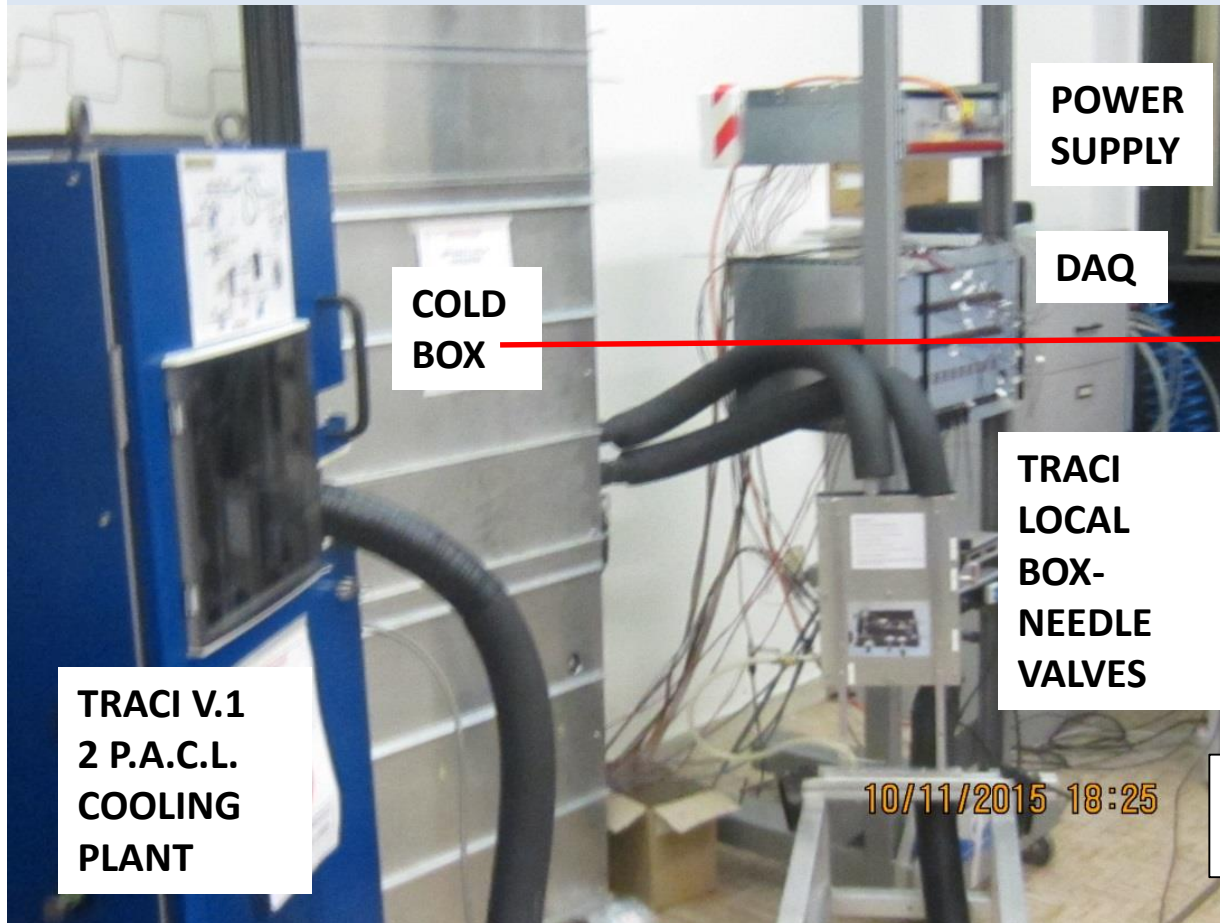
- VERTICAL
- «SNAKE» PIPE
- 2 mm I.D.



THERMO-HYDRAULIC CHARACTERIZATION OF

- STAVE
- DETECTOR COMPONENTS PROPOSED FOR THE DESIGN

COOLING TEST SET-UP IN MILANO

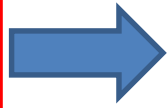


INSTRUMENTED DUMMY STAVE UNDER TEST

CO₂ COOLING TEST

CO₂ BOILING IN

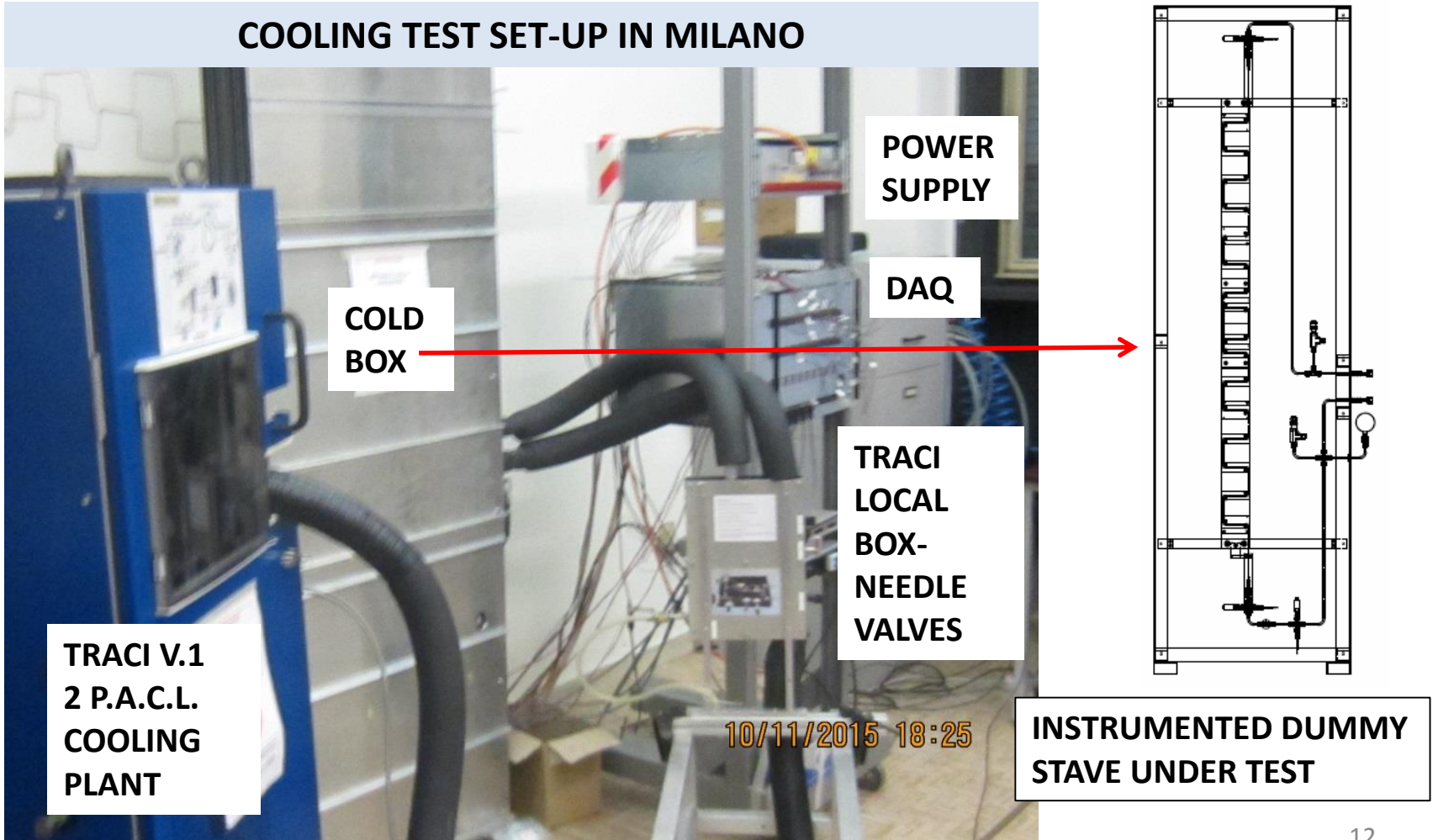
- VERTICAL
- «SNAKE» PIPE
- 2 mm I.D.



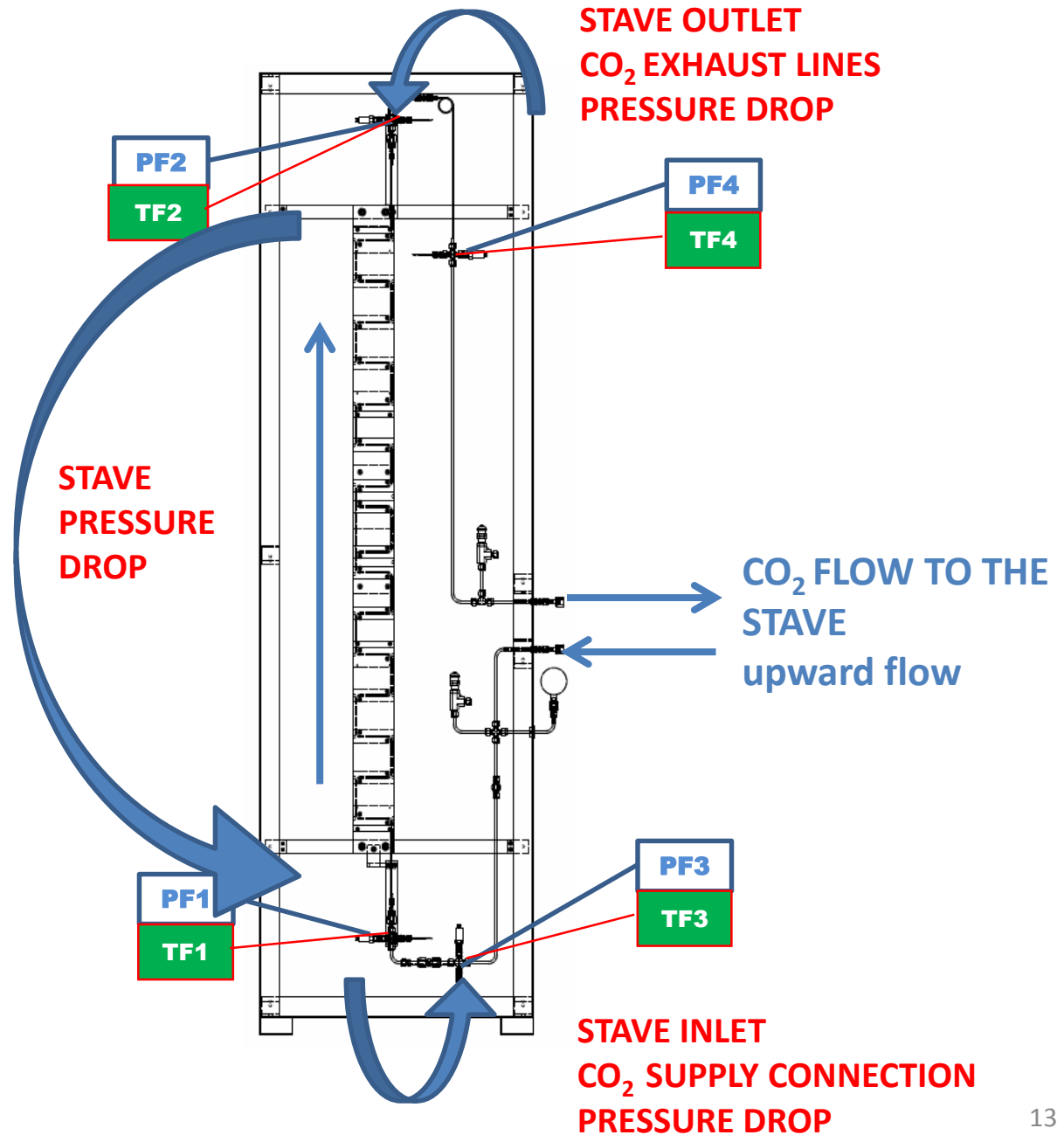
THERMO-HYDRAULIC CHARACTERIZATION OF

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CO₂ MEASUREMENT POINTS

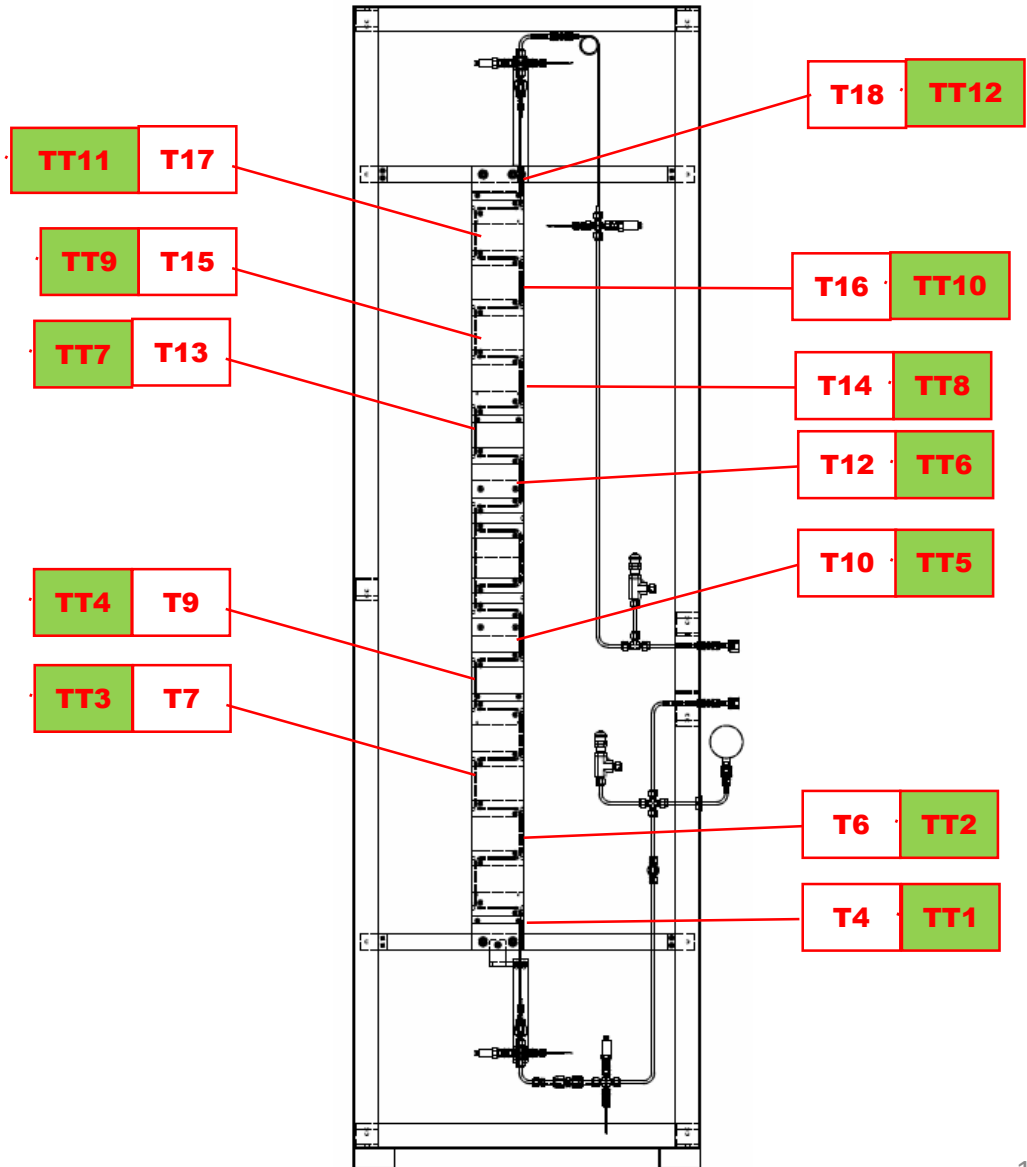


TEMPERATURE SENSORS ALONG THE COOLING CIRCUIT

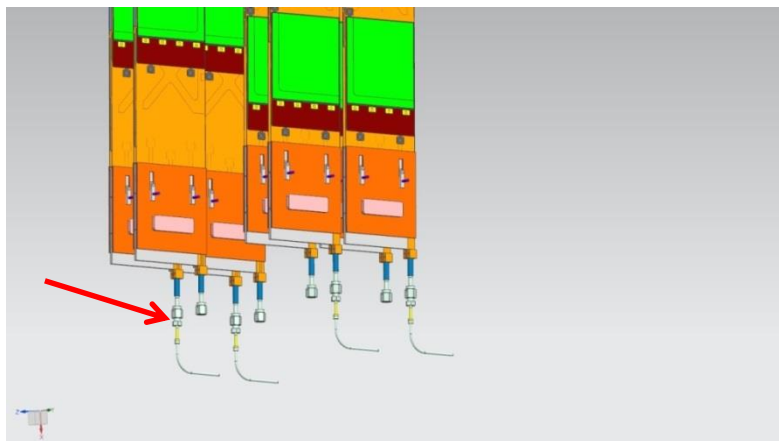
20 "T" type Thermo-couples
along the cooling pipe circuit

12 PT100-4wires

Glued on the external pipe wall using
thermal paste $K=5 \text{ W/mK}$



2. DISTRIBUTION IMPLEMENTING CALIBRATED ORIFICES



compact design:
flow restrictor incorporated in the inlet connection line

SWAGELOK flow restrictors

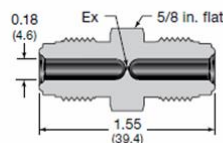
Flow Restrictors

This product can be used in liquid or gas delivery systems where repeatable flow reduction or limiting is required.



- One piece, compact design saves space
- Standard orifice sizes drilled through a 1/4 in. male VCR union
- No dead volume for clean operation
- Identification of orifice and heat code marked clearly on the body
- Electropolished, cleaned, and packaged in accordance with Swagelok *Ultrahigh-Purity Process Specification (SC-01)*, MS-06-61
- Working pressure 10 000 psig (689 bar)

Ordering Information and Dimensions



VCR components with fixed threads must remain stationary during normal installation. These fitting connections should be assembled only to glands with rotating female nuts.

Ex, in. (mm)	Ordering Number
0.010 (0.254)	6LV-4-VCR-6-DM-010P
0.012 (0.305)	6LV-4-VCR-6-DM-012P
0.015 (0.381)	6LV-4-VCR-6-DM-015P
0.017 (0.432)	6LV-4-VCR-6-DM-017P
0.020 (0.508)	6LV-4-VCR-6-DM-020P
0.023 (0.584)	6LV-4-VCR-6-DM-023P
0.025 (0.635)	6LV-4-VCR-6-DM-025P
0.026 (0.660)	6LV-4-VCR-6-DM-026P
0.027 (0.686)	6LV-4-VCR-6-DM-027P
0.030 (0.762)	6LV-4-VCR-6-DM-030P
0.035 (0.889)	6LV-4-VCR-6-DM-035P
0.040 (1.016)	6LV-4-VCR-6-DM-040P
0.045 (1.143)	6LV-4-VCR-6-DM-045P

Ex, in. (mm)	Ordering Number
0.050 (1.270)	6LV-4-VCR-6-DM-050P
0.055 (1.397)	6LV-4-VCR-6-DM-055P
0.060 (1.529)	6LV-4-VCR-6-DM-060P
0.065 (1.651)	6LV-4-VCR-6-DM-065P
0.070 (1.778)	6LV-4-VCR-6-DM-070P
0.075 (1.905)	6LV-4-VCR-6-DM-075P
0.080 (2.032)	6LV-4-VCR-6-DM-080P
0.085 (2.159)	6LV-4-VCR-6-DM-085P
0.090 (2.286)	6LV-4-VCR-6-DM-090P
0.093 (2.362)	6LV-4-VCR-6-DM-093P
0.095 (2.413)	6LV-4-VCR-6-DM-095P
0.100 (2.540)	6LV-4-VCR-6-DM-100P