M A R T A

Monoblock Approach for a Refrigeration Technical Application

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Created in cooperation with CERN EP-DT , CUT, CEBEA & PONAR

Presenter: Tomasz Olchawski

outline

- Who are we?
- What is needed?
- What has been done?
- What is new in MARTA?
- How MARTA performs?
- What can we deliver?
- Summary & future plans

who are we?

HYDROAUTOMATYKA

Project MARTA – CUT, CEBEA and PONAR have created a consortium called **Konsorcjum PCP** in order to facilitate their relationship with CERN, in particular for realization of the MARTA project.

The objective of the MARTA project was to redesign the TRACI system in order to reduce the production costs and offer this technology for a broader field of use.

who are we?

multi-profile school of higher education and research in the fields of basic sciences, engineering technologies, and architecture, has expertise in the domains of Technical Physics, Mathematics, Computer Science and Information Technology, Materials Science and Mechanical Engineering, as well as Chemical, Civil, Electrical, and Environmental Engineering technologies. The Cracow University of Technology is an Associate Member of the ATLAS collaboration.

manufacturing company specialized in cooling technology for food industry, particularly in production of refrigerating equipment used for storage and direct selling of food;

largest Polish producer of oil hydraulics elements and systems, offering a full range of services from design, production, maintenance and repairs – up to complete, final products. Many applications of hydraulic systems contain an advanced cooling systems and a complex high pressure liquid distribution systems.

Prefabricator of control cabinets & complete machine wiring, software, visualisation and start-up, former member od PONAR Group, now as PONARs subcontractor

what is needed?

Closed loop and oil-free cooling system based on CO_2 evaporation which would guarantee:

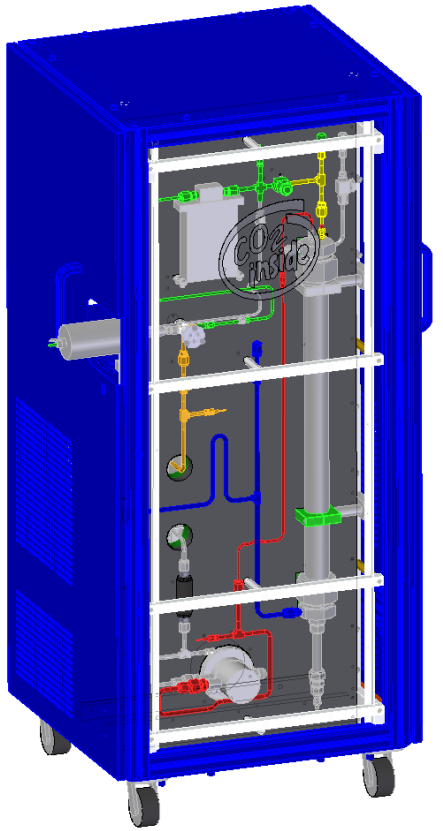
- Stable operation in requested temperature
- Precise control of the parameters
- Wide range of operation temperatures (-30 °C to +20°C)
- Repeatability

<u>Currently there is no product in the market that answers those needs</u>

what has been done (TRACI)?

TRACI - Transportable Refrigeration Apparatus for CO_2 Investigation

- Based on 2 phase accumulator CO2 loop (2PACL)
- Intellectual Property ownership: CERN + Nikhef
- Few prototypes available in some laboratories (not production units)
- Complicated piping, numerous fittings
- Cooling capacity: ~100W @ -30 °C



what is new in MARTA?

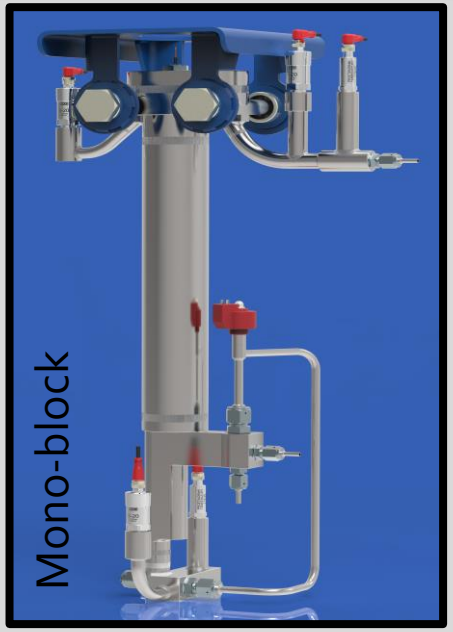
TRACI

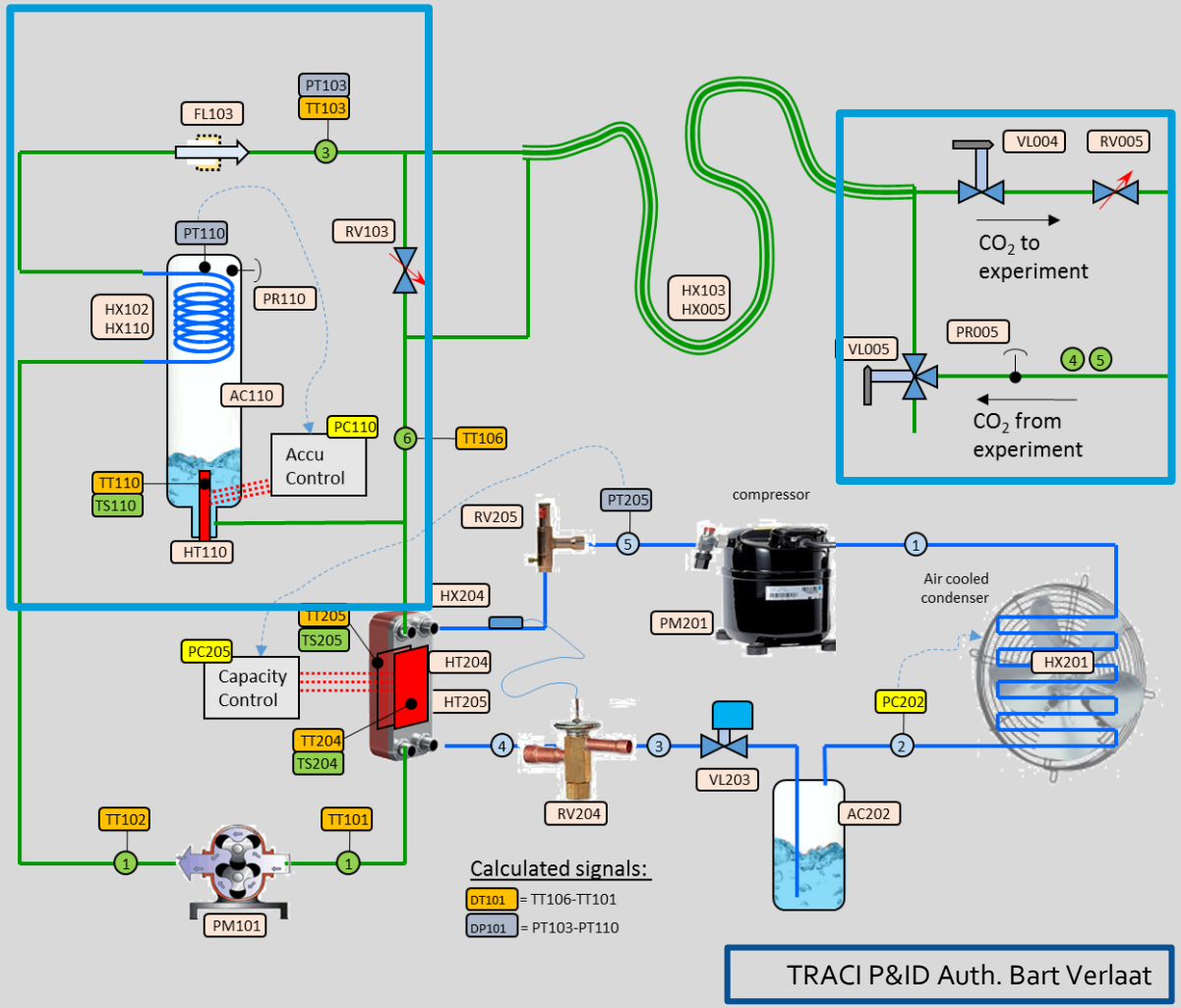
Dimensions: 1631 x 726 x 494

- Mono-block concept
- Smaller size
- Compact structure
- Top-mounted heater prevents condensation
- Cut-off valves installed
- Advanced software
- Various user-defined options available

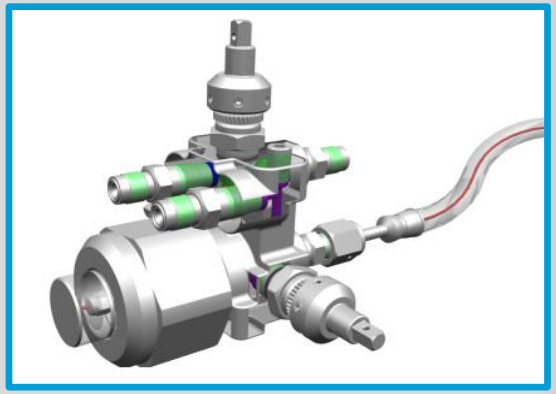
Dimensions: 1370 x 780 x 700 [h x w x d]

what is new in MARTA?



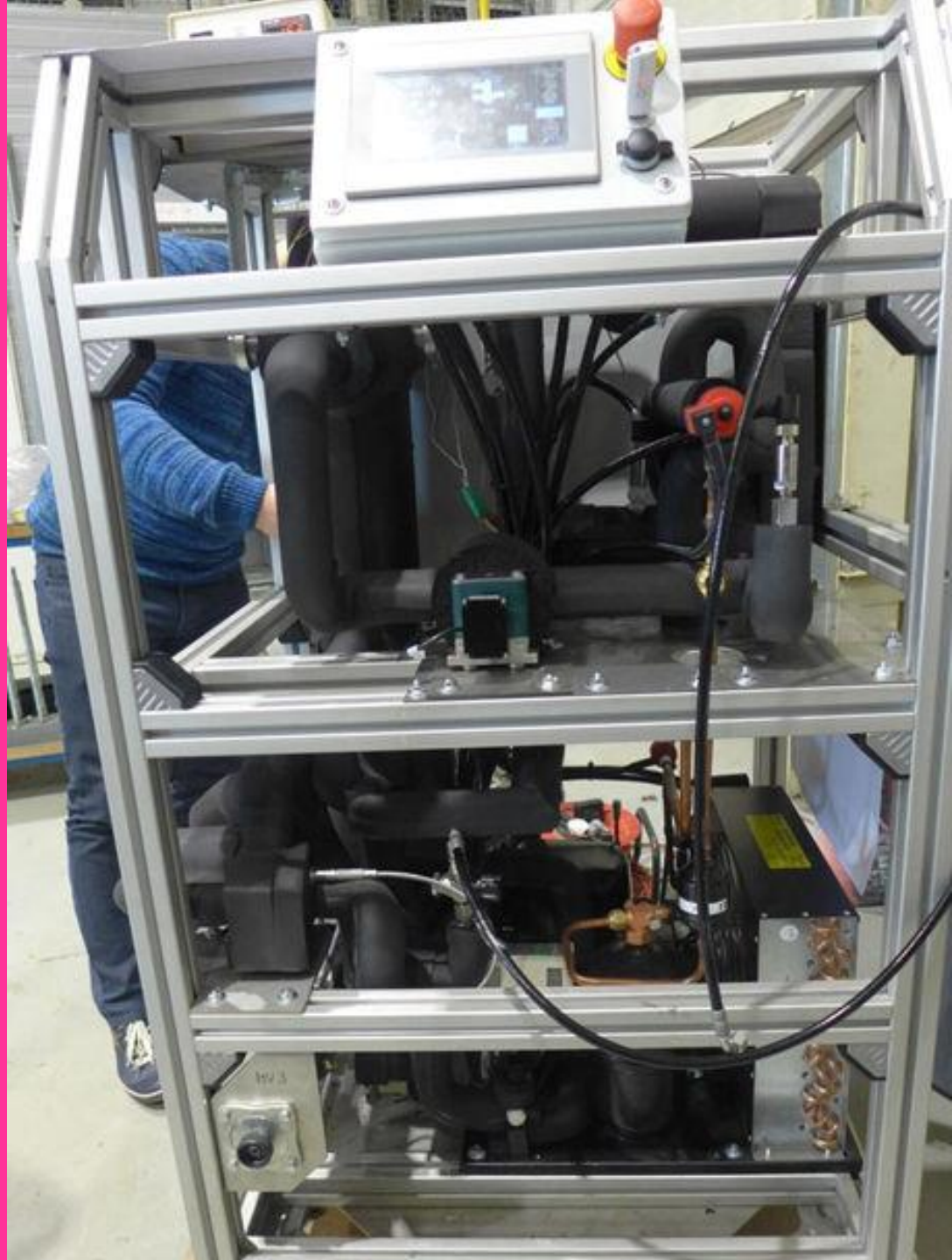


Local box



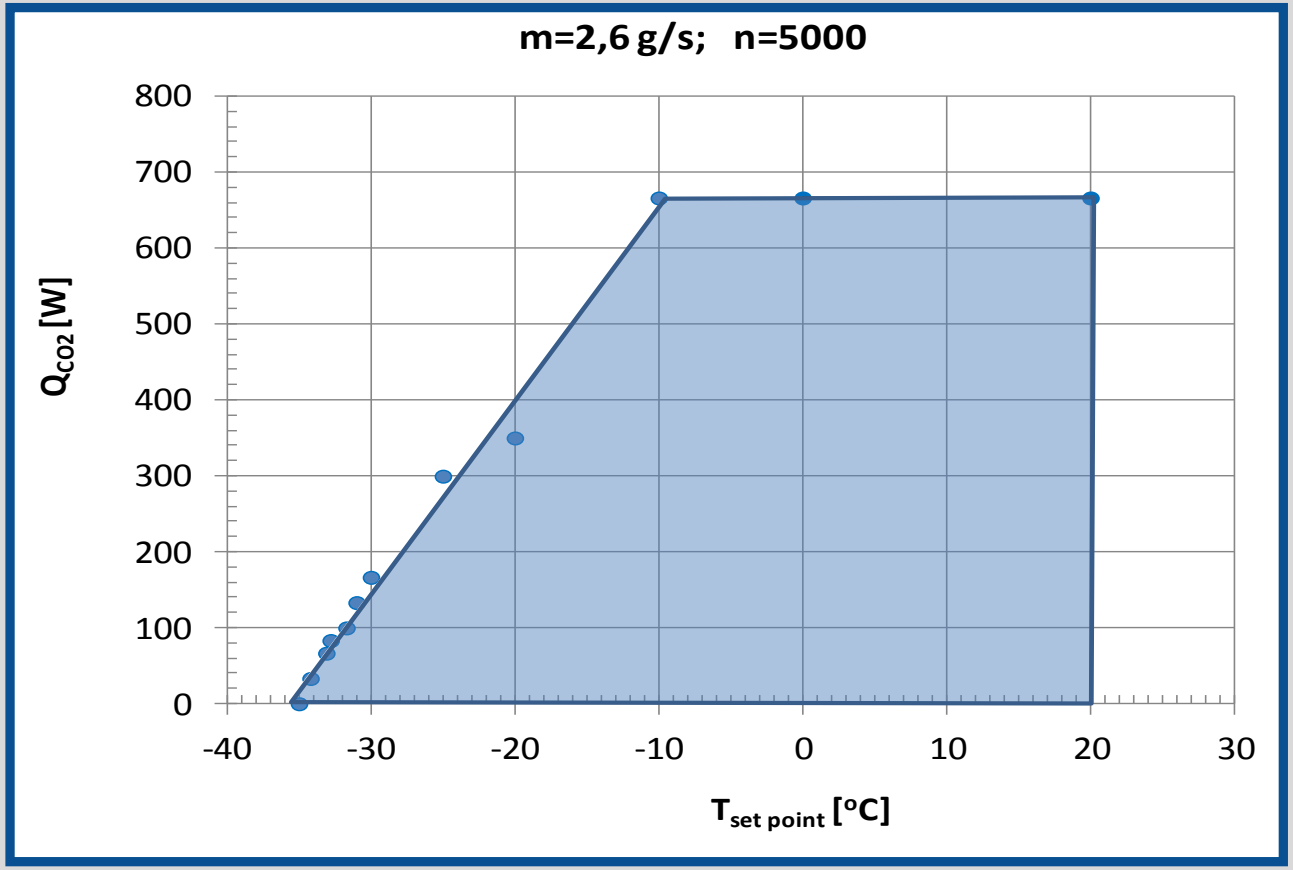
Mono-block innovation is based on over 50 years of PONARs experience in hydraulics

COMMISIONING



how MARTA performs?

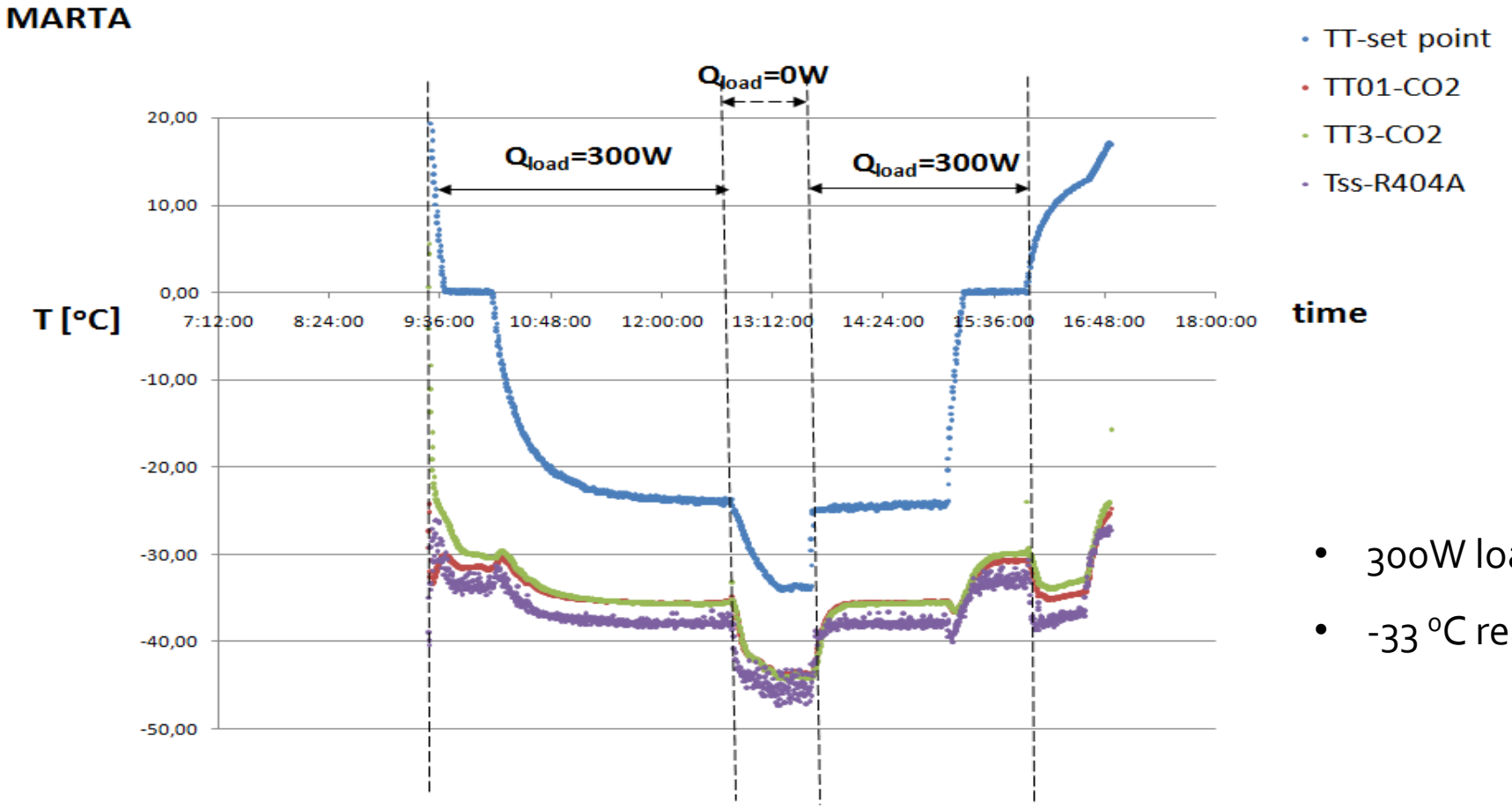
MARTA First prototype operating area (blue)



Cooling capacity @ -30°C: TRACI ~100W, MARTA prototype ~170W

how MARTA performs?

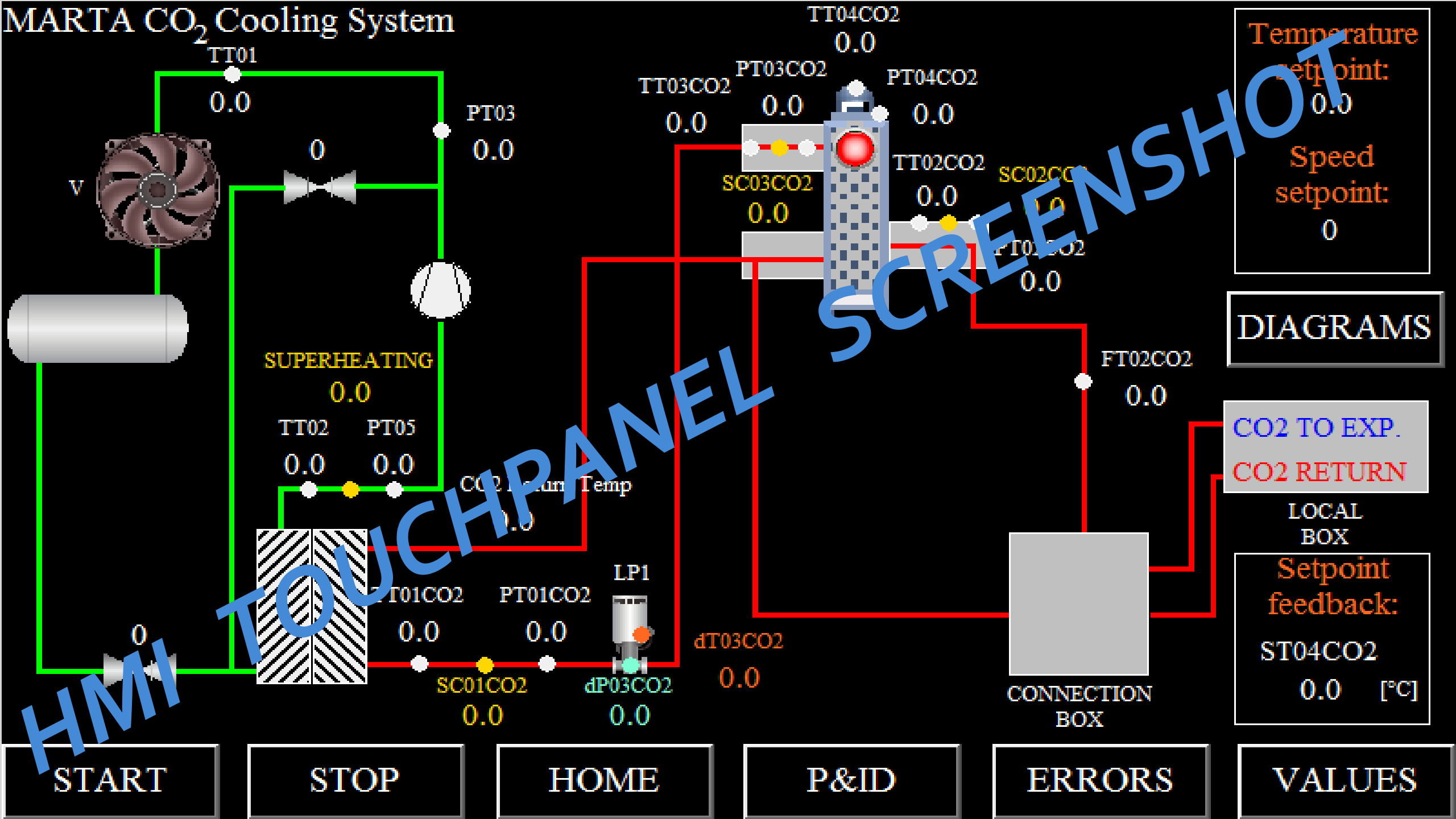
First prototype long-time performance test

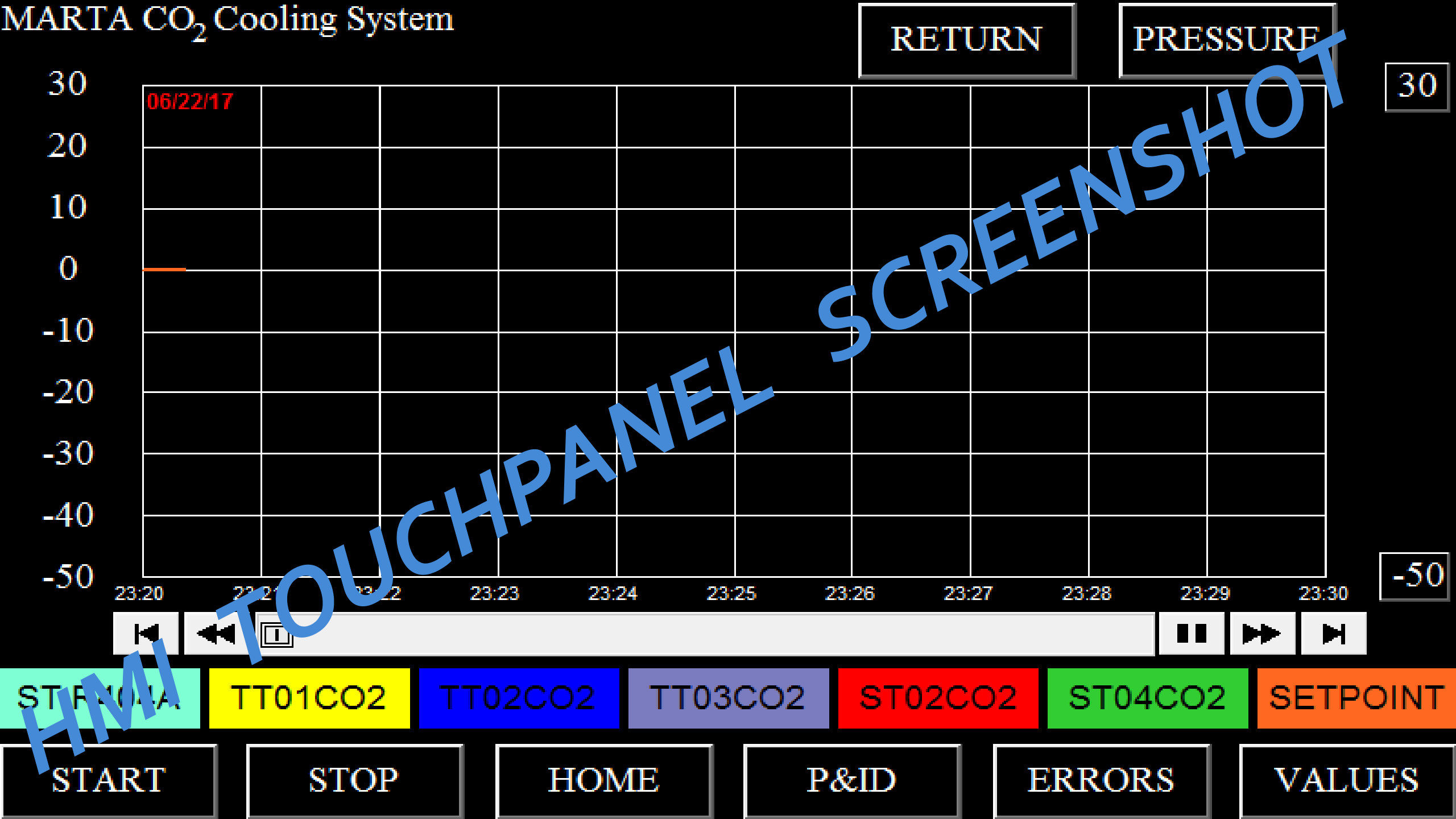


- 300W load aplied: ~ -24°C
- -33 °C reached without load

what can we deliver?

	Standard	Enhanced	Special Version
Cooling power	max. 200 W at -30°C, $t_{ambient}$ 22°C (300W at -25°C)	max. 300 W at -30°C, $t_{ambient}$ 22°C	max. 600 W at -30°C, $t_{ambient}$ 22°C
CO_2 mass flow rate	controlled 0-4 g/s	controlled 0-4 g/s	controlled 0-4 g/s
Maximum head pressure	6 bar	6 bar	6 bar
Mass Flow-meter	optional	optional	optional
Size [HxWxD] mm	1370x780x700	1370x780x700	TBD
Power Supply Standard	230 V/AC, 50 Hz	230 V/AC, 50 Hz	TBD
Other Power Supply standards	optional	optional	optional
Control system	PLC+HMI	PLC+HMI	PLC+HMI
Connectivity and Remote Access	optional	optional	optional
Desktop software	optional	optional	optional
Data Logging	standard	standard	standard
Analog Input and Output	optional	optional	optional
Digital input and Output	optional	optional	optional
CO_2 Transfer Line (standard 3m)	optional	optional	optional
Local Box	optional	optional	optional
Special functions	TBD	TBD	TBD


MARTA CO_2 Cooling System
TT01
0.0
PT03
0.0
0
V
SUPERHEATING
0.0
TT02
0.0
PT05
0.0
0
TT04CO2
0.0
TT03CO2
0.0
PT03CO2
0.0
PT04CO2
0.0
SC03CO2
0.0
TT02CO2
0.0
SC02CO2
0.0
PT02CO2
0.0
FT02CO2
0.0
LP1
PT01CO2
0.0
SC01CO2
0.0
dP03CO2
0.0
dT03CO2
0.0
Temperature setpoint:
0.0
Speed setpoint:
0
DIAGRAMS
CO2 TO EXP.
CO2 RETURN
LOCAL BOX
Setpoint feedback:
ST04CO2
0.0 [°C]
CONNECTION BOX
HMI TOUCHPANEL SCREENSHOT
START
STOP
HOME
P&ID
ERRORS
VALUES


MARTA CO_2 Cooling System
RETURN
PRESSURE
30
20
10
0
-10
-20
-30
-40
-50
06/22/17
30
-50
23:20
23:23
23:24
23:25
23:26
23:27
23:28
23:29
23:30
TT01CO2
TT02CO2
TT03CO2
ST02CO2
ST04CO2
SETPOINT
START
STOP
HOME
P&ID
ERRORS
VALUES
HMI TOUCHPANEL SCREENSHOT

what can we deliver?

MARTA Software information & standard features

- PLC based control system
- 7’ Touch screen
- USB port for data log
- PC Remote access in local network
- Pump rotation or output temperature control loops (optional flow control loop)
- Internal software locks preventing undesirable operation
- Main screens
  - Home (setpoints, main elements state)
  - P&ID (graphic view of control loop with main measurement shown)
  - Errors (malfunctions, alarms)
  - Values (measured and calculated)
  - Diagrams (online drawn charts)

what can we deliver?

Optional MARTA features

- **Local box**

  manifold for quick connecting to experiment CO_2 loop

- **Connectivity & remote access**

  communication protocol data exchange and process control via web page

- **Desktop software**

  dedicated application for managing and analysing collected data

- **Signal by wire**

  Detector control system & safety system wired connection

- **Different power supply voltage**

- **Individually defined functionalities**

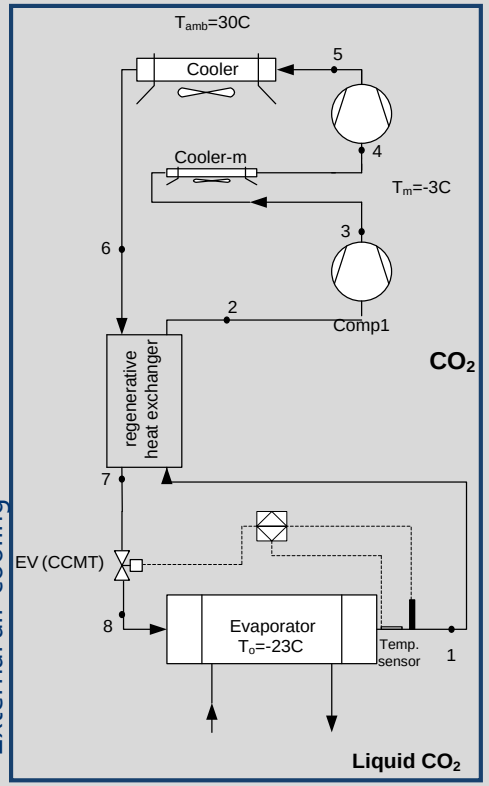
summary

- MARTA prototype using 2PACL has been build and tested
- Cooling capacity at -30°C : 170W
- Mono-block used in MARTA
  - Simplified piping and assembly
  - Allowed to reduce overall dimensions
  - Reduced possible leakages
  - Decreased total amount of CO_2 in the system
- MARTA Team is working on improving cooling capacity
- Consortium PCP is ready to start production

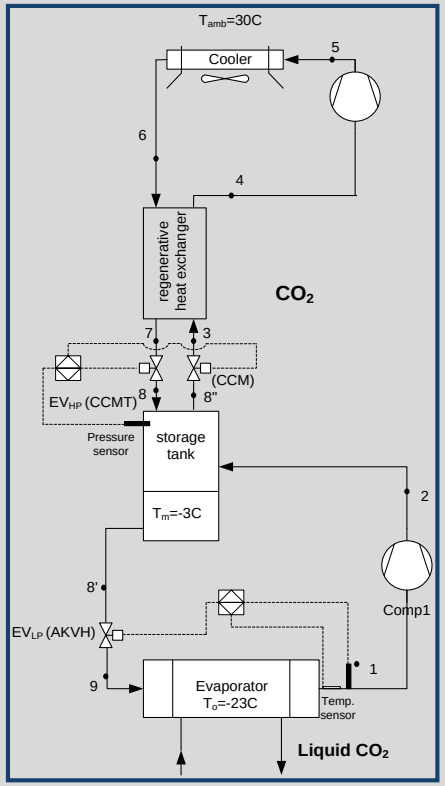
future plans

Second stage of MARTA project aims for replacing current R404A chiller with CO_2 chiller
Several versions of first CO_2 stage are discussed
Development of this phase depends on the community interest

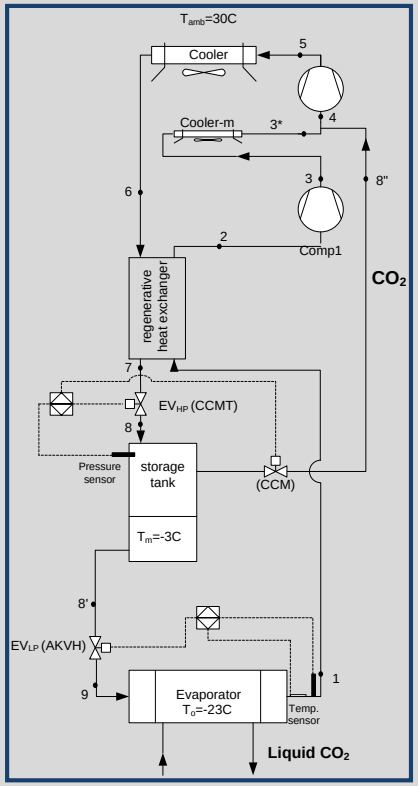
V1: Heat recovery, Inter-stage air-cooling, External air-cooling



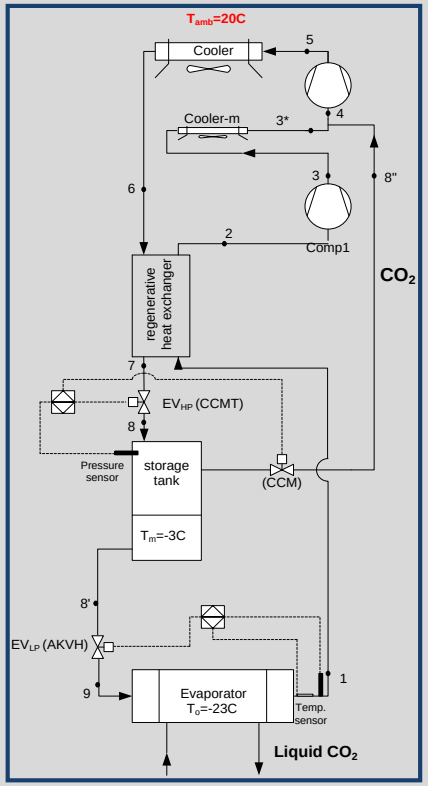
V2: Heat recovery, Inter-stage throttling with storage tank, External air-cooling



V3: V2 + Injection of liquid CO_2



V4: V3 + Evaporative cooling of condenser



THANK YOU FOR YOUR ATTENTION

http://icp.mech.pk.edu.pl/martaco2/

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