TRACI-XL, the test cooling system for the CBM Silicon Tracking System*

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An evaporative bi-phase cooling system based on CO_2 has been chosen as the best option to extract the heat produced by the read-out electronics in the CBM Silicon Tracking System. In the framework of the EU-FP7 project CRISP, the system TRACI (Transportable Refrigeration Apparatus for CO_2 Investigation), developed at NIKHEF/CERN to provide support to the ATLAS and LHCb experiments, is being upgraded at GSI from 100 W to 1 kW cooling power. This system TRACI-XL will be used as a testing device for the CBM application.

I-2PACL concept applied to TRACI-XL

The I-2PACL principle (Integrated 2 Phase Accumulator Controlled Loop) was created as simplification of the 2PACL systems by using the CO_2 line to condensate the gas inside the accumulator instead of using a branched line derived from the condensing unit. Therefore the control is reduced to one cartridge heater controlled by PLC Siemens Simatic S7-1200. The size of the control unit is decreased and it allows a wider range of possible operating temperatures from -30° C up to room temperature.

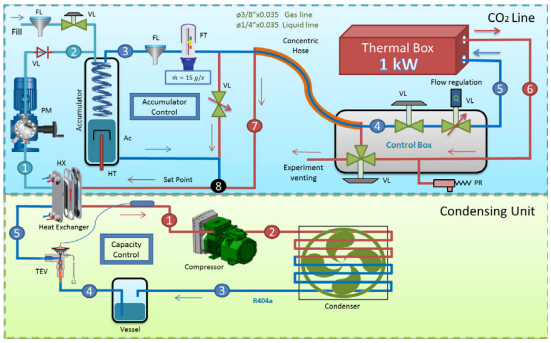


Figure 1: Process diagram of TRACI-XL.

This range is obtained due to the implementation of a condensing unit equipped with a Bitzer 2DC-3.F1Y Varispeed compressor and Swep heat exchanger with a system performance as follows:

- at 30 Hz; Q_0 = 0,55 kW, T_0 =-45° C, $T_{suction}$ = -30° C, T_c = +35° C, T_{sub} = 3 K, R404a.
- at 87 Hz; Q_0 = 1.59 kW, T_0 = -45° C, $T_{suction}$ = -30° C, T_c = +35° C, T_{sub} = 3 K, R404a.

System operation

A LEWA membrane pump with remote head design, as innovation to avoid the addition of residual heat in the coolant, transports sub-cooled CO_2 to the evaporator in the thermal box (1-2-3-4-5 in Fig. **??**). The CO_2 is heated up to the right evaporation temperature by a heat ex-change produced inside an inner hose with the returning CO_2 line (6-7). Due to the pulses generated by the metering pump the installation of a pulsation dampener is needed.

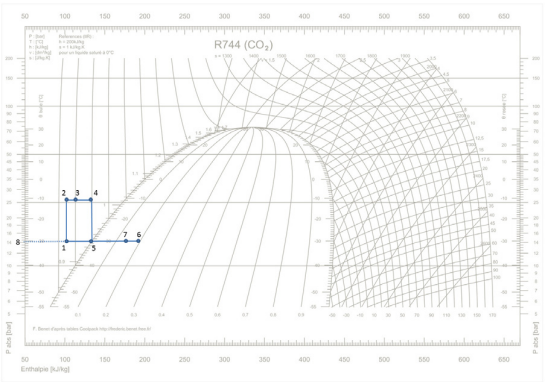
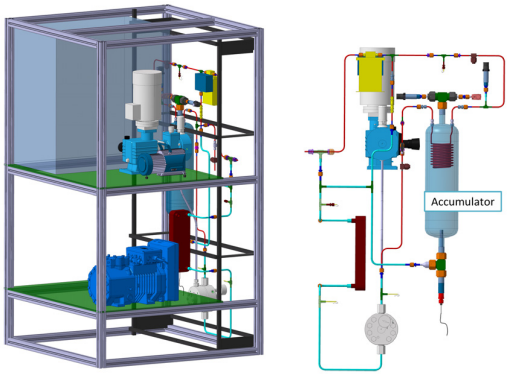


Figure 2: Cycle in Enthalpy-Pressure diagram for R744.



(a) Full model. (b) CO_2 Line.

Figure 3: CAD model with CO_2 line detail.

The heat generated in the read-out electronics is absorbed and extracted by the evaporator capillaries inside the thermal box (5-6). The return line (8-1) contains a bi-phase mixture which is liquefied by the condensing unit named previously below the operating temperature. By controlling the pressure inside an accumulator the evaporation temperature can be fixed. This vessel contains two-phase CO_2 in contact (see Fig. **??**).

References

[1] Verlaat, B., International Conference of Refrigeration 2007, Beijing, China, ICR07-B2-1565

* Supported by EU-FP7 CRISP.