bverlaat@nikhef.nl

Introduction to the development of a multipurpose CO_2 cooler at the Nikhef/CERN CO_2 collaboration.

Bart Verlaat
(Nikhef/CERN)

4 February 2011

bverlaat@nikhef.nl

The CERN/Nikhef 1kW Multipurpose CO_2 Cooling Plant

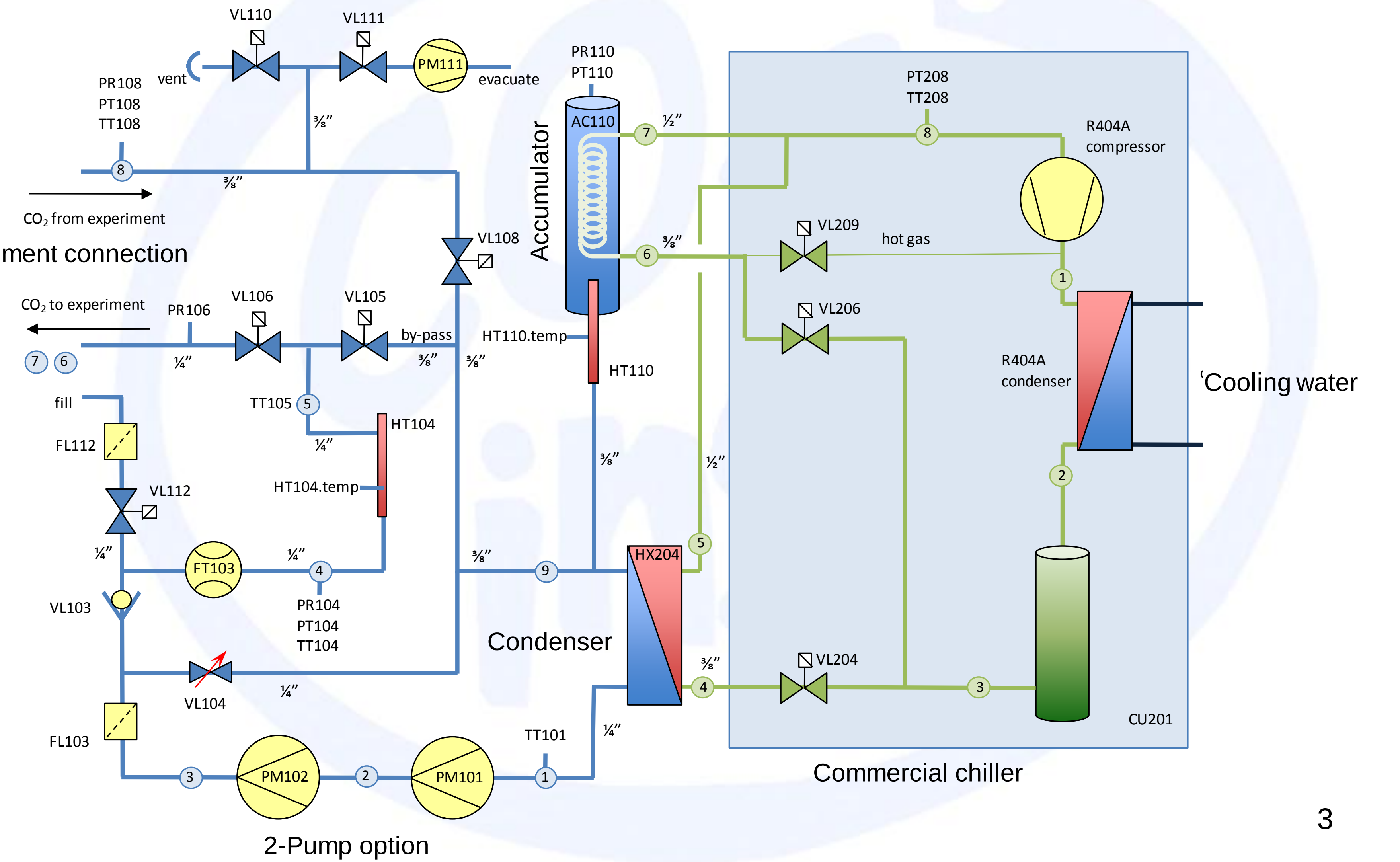
- CERN-DT together with Nikhef is developing a multipurpose CO_2 cooler based on the 2PACL principle designed for the LHCb-Velo and AMS-Tracker cooling.

- The system will have the following thermal specifications:
  - Evaporative cooling temperature: -40ºC to +25ºC
  - Maximum cooling load: ~1kW

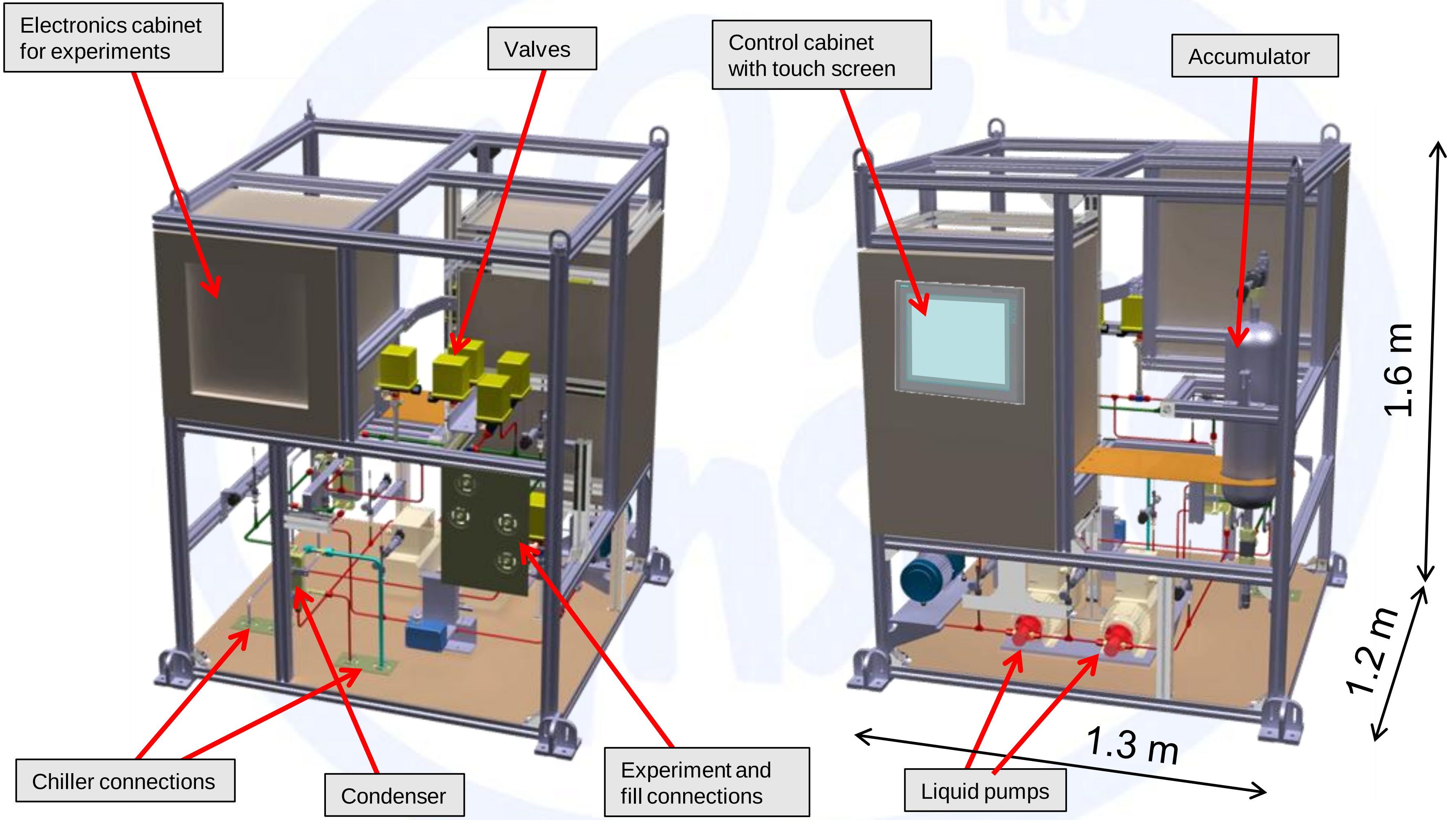
- The system is fully automatic and easy to operate. Basic CO_2 cooling knowledge required for the operator.
  - 3 user input variables:
    - Evaporative temperature
    - Mass flow
    - Enthalpy (sub cooling or vapor quality for user)
  - 4 operational states:
    - Connecting experiment
    - Disconnecting experiment
    - Cooling experiment
    - (re) filling CO_2
  - Control is done by a PLC and interfaced via an integrated touch screen. (Connection of PVSS is optional but not required)

- System is designed such that an upgrade to higher cooling powers is achievable with small modifications.
  - Larger vapor tubes (fits in 3d design)
  - Larger primary chiller (chiller is in separated compartment)
  - Different pump type

CERN / Nikhef
1kW Unit Schematics.



CO_2 Cooling unit mechanical design

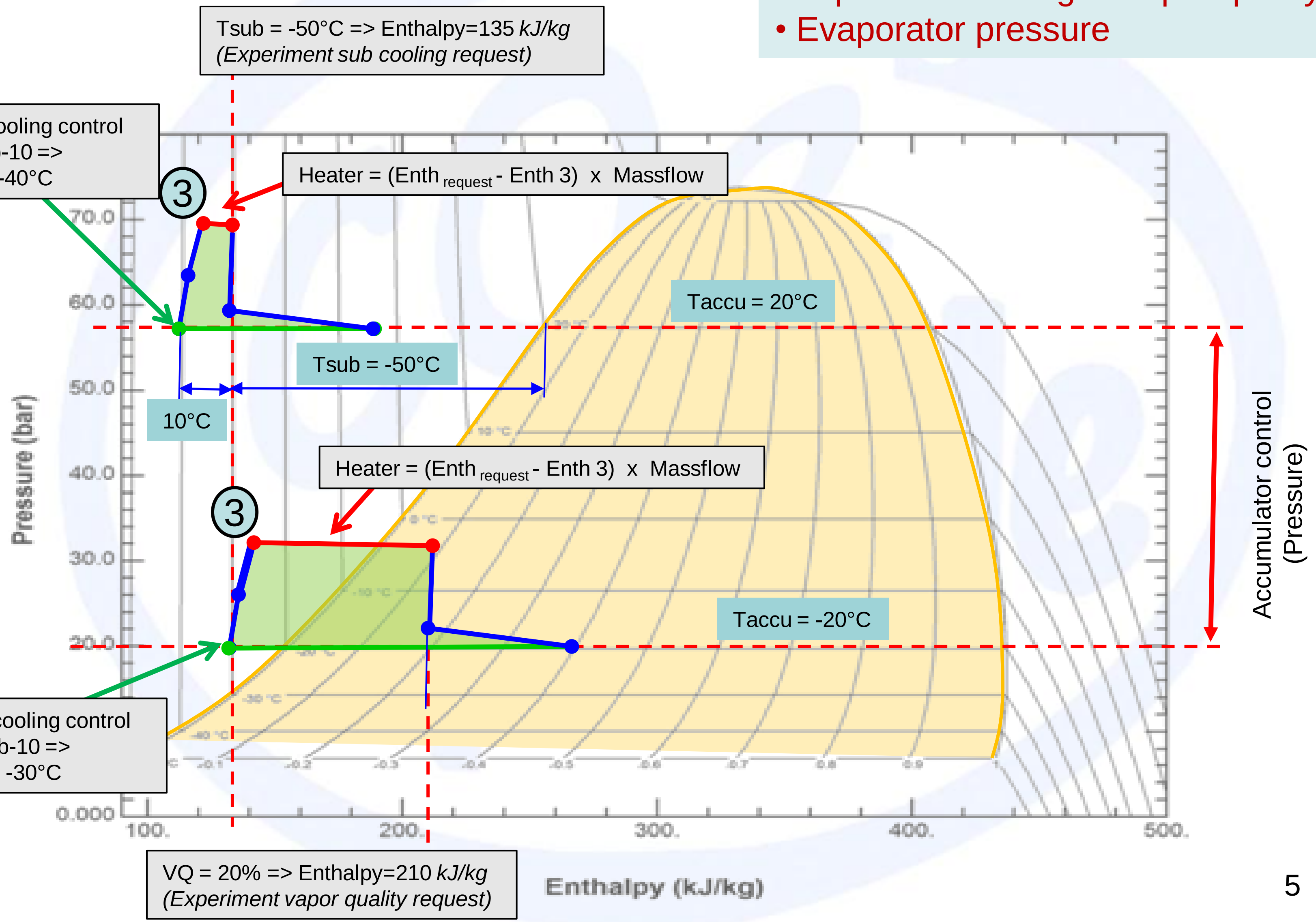


1.2x1.3x1.6

What can you control with the CO_2 cooler?

bverlaat@nikhef.nl

- Mass flow
- Liquid sub-cooling or vapor quality
- Evaporator pressure



bverlaat@nikhef.nl

Explanation the system in the PH-Diagram

3 variables can be set by the user:

1. Mass flow
   - PID control of the pump speed by mass flow meter (FT103).
2. Liquid sub-cooling or vapor quality.
   - The system can be used as single phase liquid system or 2-phase evaporative system. A positive request (0-100) is the percent vapor quality at the inlet of the experiment (Lower cycle). A negative request is the degrees of sub cooling measured from the accumulator saturation temperature (Upper cycle). Vapor quality and sub cool temperature are translated into enthalpy. A request of 0 is at the saturation line, like an internal heat exchanger.
   - The translated enthalpy request is achieved by the enthalpy heater (HT104) using the heater inlet pressure and temperature (PT104& TT104) together with the mass flow (FT103).
   - The pump inlet temperature is controlled by the chiller expansion valves and is 10ºC below the accumulator saturation plus the sub cool request if negative.
3. Experiment evaporator temperature
   - The evaporator temperature in the attached experiment is following the accumulator saturation temperature. The accumulator pressure (PT110) is controlled by the heater (HT110) and chiller expansion valve (VL206)

bverlaat@nikhef.nl

CO_2 cooler project status

- The project serves the purpose of providing standard CO_2 coolers to institutes who need CO_2 cooling for their detector research in the kilowatt range. A different program is set-up for a cooler in the 100 watt range.
- CO_2 cooler design can be the base for future cooling plants to be used in experiments.
- The project is as usual lacking manpower and resources for a fast development. Groups who like to invest in CO_2 cooling development are invited to join and take advantage of the 12 years of CO_2 cooling knowledge obtained in the Nikhef/CERN project group.
- If you are interested or need more information, please contact bverlaat@nikhef.nl