STATUS & PLANS for the CO_2 cooling system

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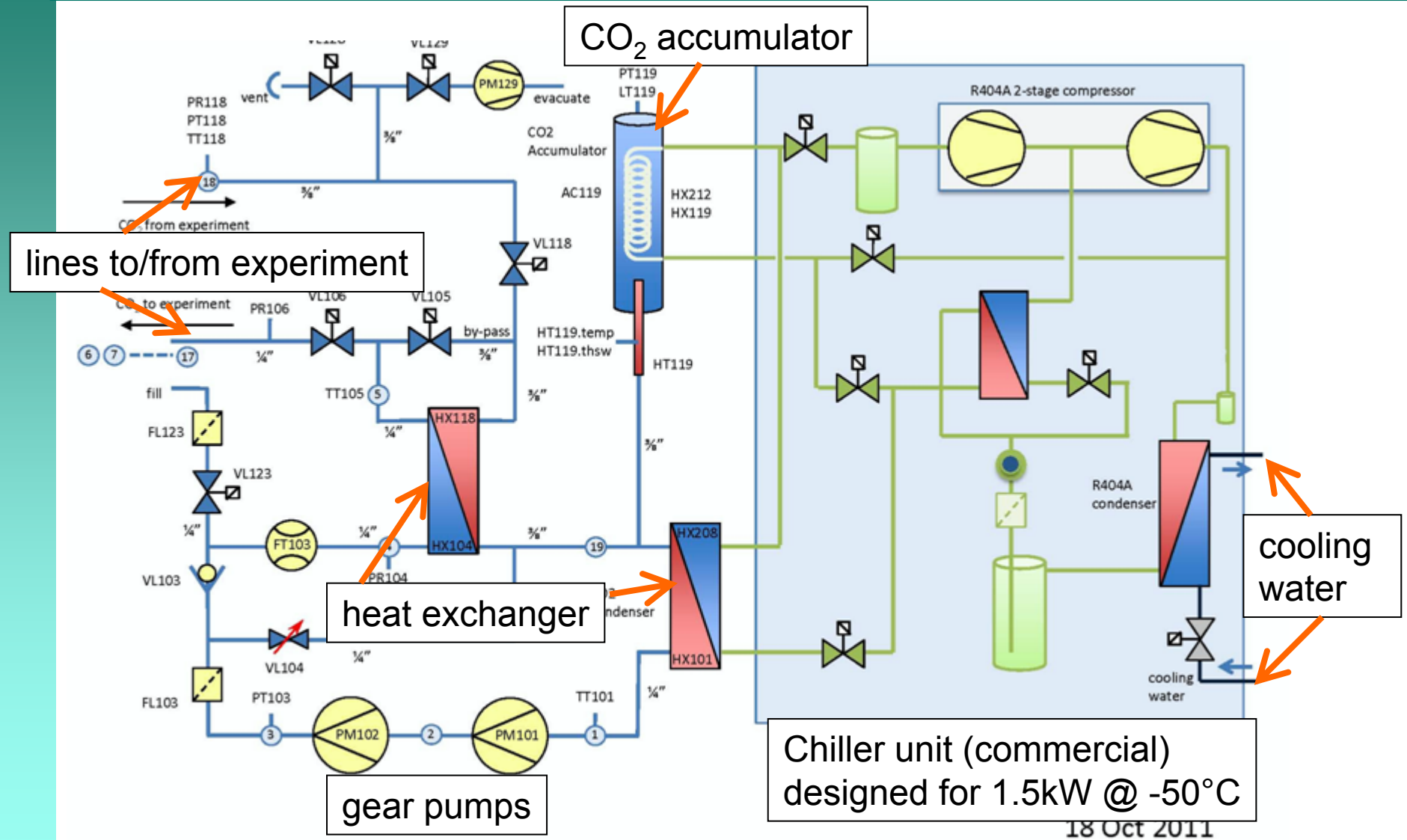
Outline

- Status and Plans of MARCO*
- Schedule for IBBelle
- Isolation of CO_2 lines

(*Multipurpose Apparatus for Research on CO)

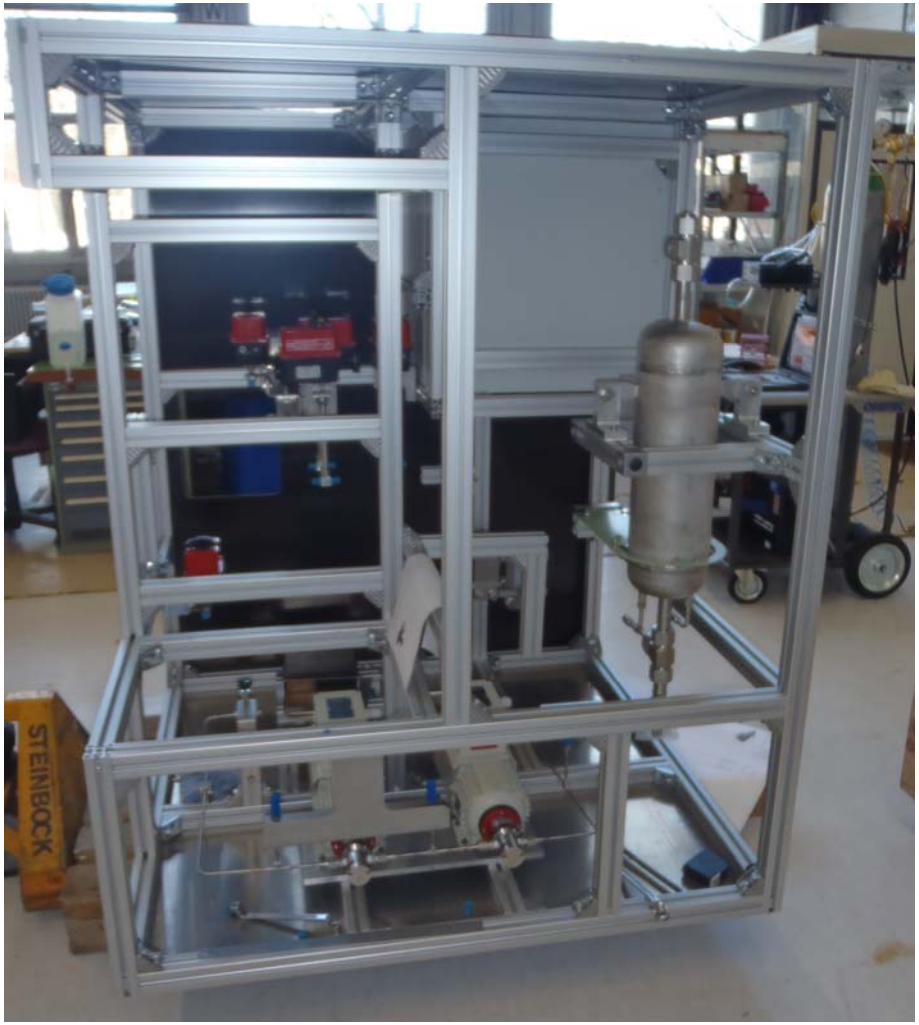
MARCO


CO_2 accumulator
lines to/from experiment
heat exchanger
cooling water
gear pumps
Chiller unit (commercial)
designed for 1.5kW @ -50°C
R404A 2-stage compressor
R404A condenser
CO2 Accumulator
PT119
LT119
AC119
HX212
HX119
HT119
HT119.temp
HT119.thsw
PM129
vent
evacuate
PR118
PT118
TT118
VL118
VL106
VL105
PR106
by-pass
TT105
fill
FL123
VL123
FT103
HX118
HX104
PR104
HX208
HX101
VL103
VL104
FL103
PT103
TT101
PM102
PM101
cooling water
18 Oct 2011

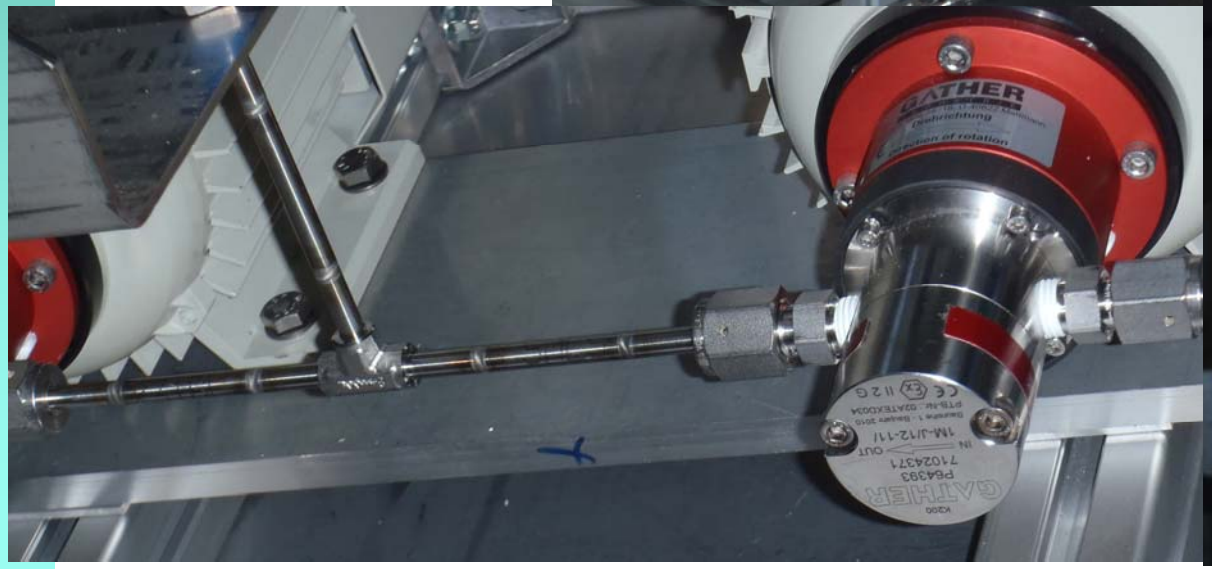
MARCO @ MPI

- MARCO arrived on 22/12/2011
- work on the piping started on January 26th
- still some problems with the mechanical drawings
- pressure test with TÜV in Munich

  (operation pressure 110 bar)



work on piping has started

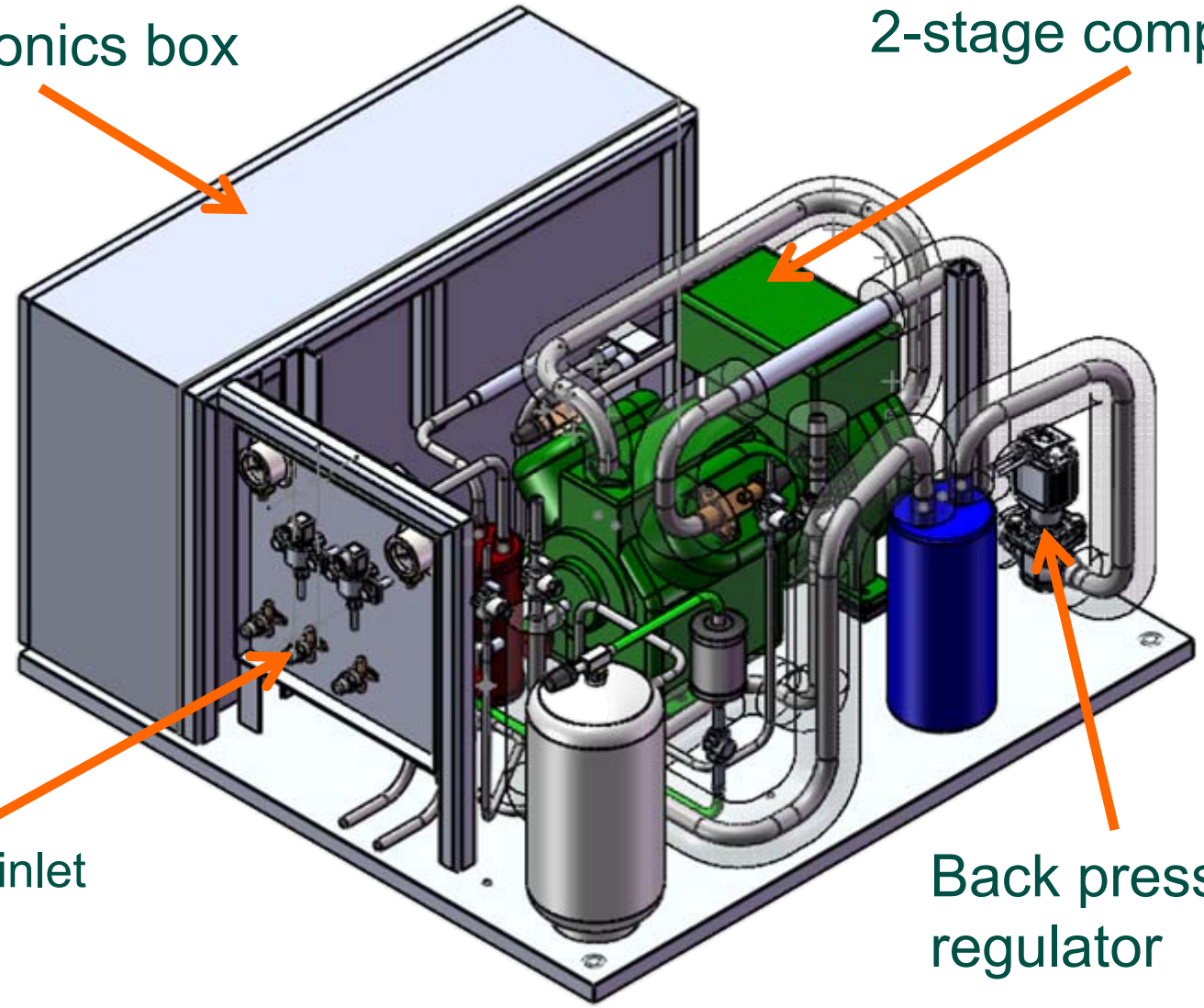


MARCO: status of mechanics/piping

- fixation of the flow meter needs to be redesigned (limiting point):
  - to protect the electronics against the cold, the support of the electronics box needs to be changed
  - to not loose the guarantee this will be done by Rheonic directly
  - should take about 3 weeks and will cost ~ 1kEUR

Piping and pressure tests done by end of the month

The Chiller Unit

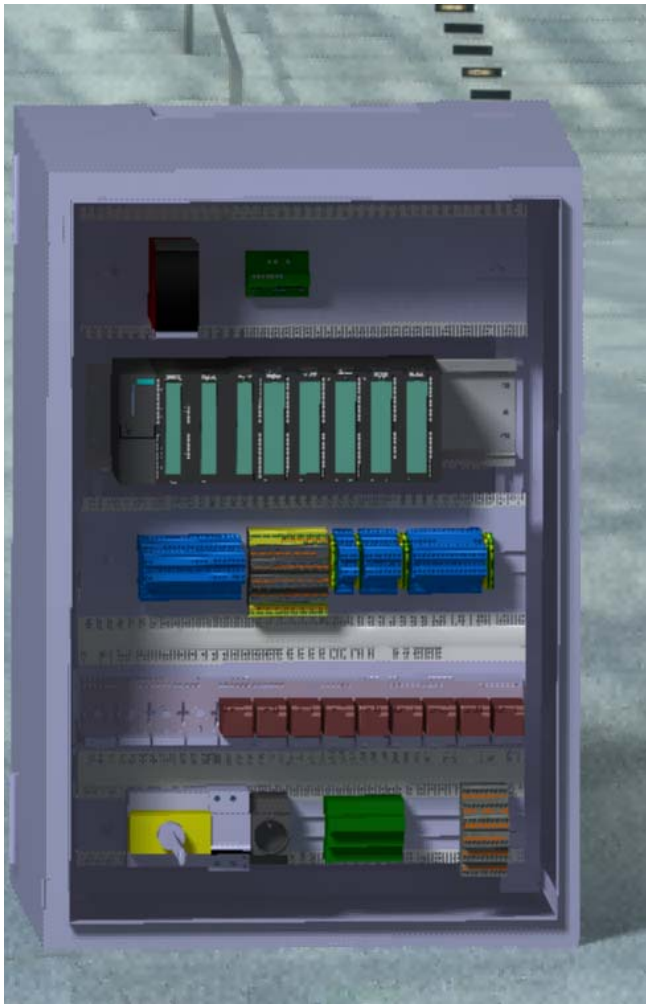


Status of Chiller Unit

- Chiller unit will be build by outside company
- order is issued from CERN
- design of Chiller completed
  - full design verification and compatibility check with mechanical drawings for MARCO done!
  - order for construction went out Friday
  - delivery @CERN expected end of February
- Chiller will be tested and verified @ CERN
- Integration of Chiller and MARCO
  - will be done @ MPI
  - planned for second half of March

Status of Electrical Installation

- Electrical Installation will be done @ CERN
- the electrical diagrams of MARCO are ready
- planning of the control cabinet is done
- mechanical installation in progress
- order of electrical components completed, 95% already delivered



MARCO: Schedule & Plans

- mechanical installation of MARCO and Chiller will be finished end of March
- electrical assembly will start in 2 weeks
  - participation of MPI engineer forseen
- PLC/PVSS programming needs ~ 1 month
  - participation from DEPFET expert desired
- commissioning will be done at CERN

- Operation of fully equipped and commissioned MARCO @ MPI foreseen this summer!!

Plans for IBBelle II

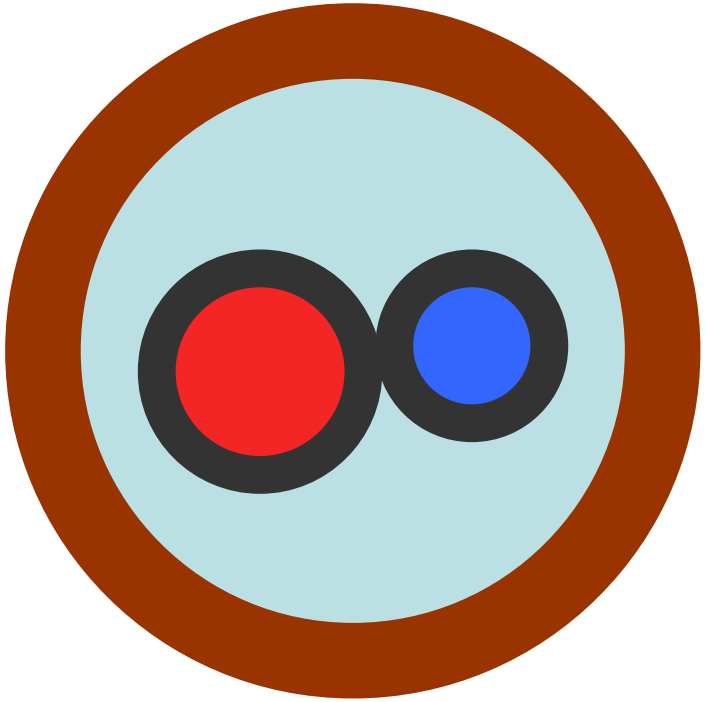
- IBBelle II planned as simple scale-up from 1kW to 2kW cooling power
  - only basic changes with respect to MARCO:
    - different pumps (long term operation)
    - reduce complexity (test sensors)
    - thicker pipes for larger power
- mechanical design will start after first commissioning phase of MARCO
- expect IBBelle II to be built by end of 2012

Isolation of the CO2 lines

- MARCO will be some 25-30m away from the experiment
- need to isolate the transmission lines
- expect to loose about 50% of cooling power in transmission lines (experience from LHCb)
- current isolation scheme is as follows:
  - first ~15m with foam (armatec or like)
  - about 3m with vacuum isolation
  - last 1m – 1.5m in cold dry volume, no isolation on the pipes

Plans for vacuum isolated pipes

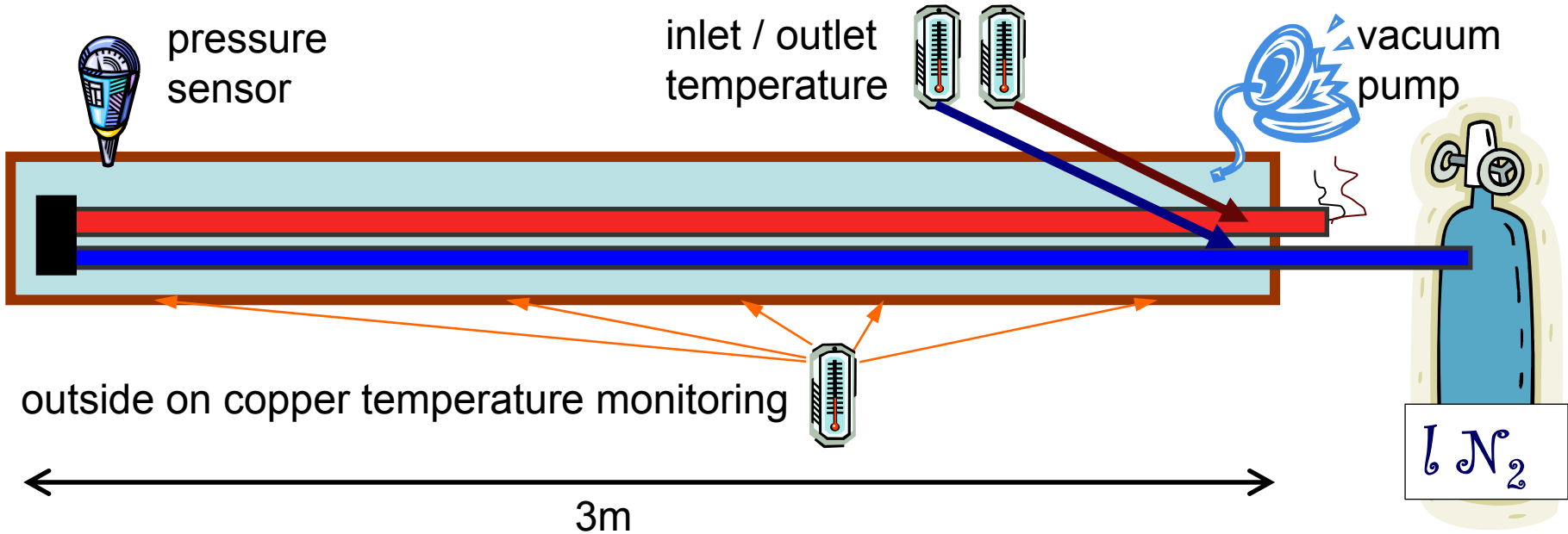
- CO_2 line:
  2 thin (3mm, 4mm outer radius) stainless steel pipes



- isolation:
  copper pipe with 12mm outer, 10mm inner radius evacuated to pre-vacuum (10^{-3}mbar)

Does this provide enough isolation to avoid condensation on the pipes?

Test of vacuum isolation @MPI



- simple test set-up to see effect of isolation
- geometry of copper and steel pipes as foreseen for Belle II
- using lN_2 as cool medium in steel pipes
- measurement of thermal resistivity

First results

- without isolation lN_2 evaporates in beginning of steel pipes
- with isolation liquid N_2 exits the pipes after 25min
- temperature of steel pipes: -180°C
- temperatures on copper pipe (in stable operation):
  13°C (end) 3-5°C(middle) 1°C(inlet)
  with about 22°C room temperature
- isolation effect works very well! ΔT(in/out)=180K
- rough estimation of the specific thermal conductivity in this setup: 2e-6 W/(K m)

Next steps

- effect of isolation reduced if steel pipes touch copper (in simple setup 1 contact in 3 meters)
- we expect to have ~10 contacts in 3 meters due to bends in the pipe
- study effect of contact in 2 ways:
  - measure temperature profile around 1 well defined contact point (effect of temperature regulation in copper)
  - bend pipes and measure outside temperature as a function of number of bends
- could a shrink hose around steel pipes help?

Other parameter: vacuum pressure

- Isolation also depends on vacuum quality
  - in principle 10^{-3} mbar should be sufficient
- will try to measure thermal resistivity as a function of vacuum pressure

Conclusion

- construction of MARCO well underway
  - interesting phase of PLC/PVSS programming and the commissioning to start soon
  - MARCO expected @MPI for test operations this summer!
- design & construction of IBBelle II to start soon
  - finished IBBelle II expected end of the year
- first test measurements of vacuum isolation successful
  - tests for touching pipes ongoing