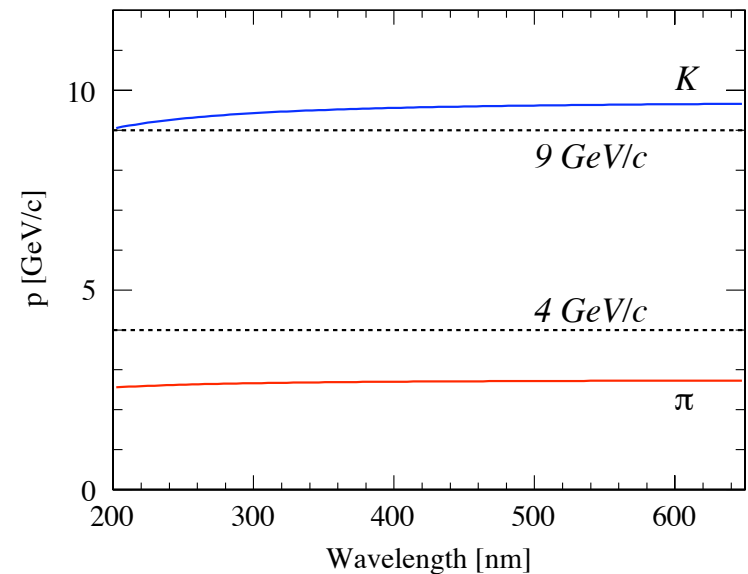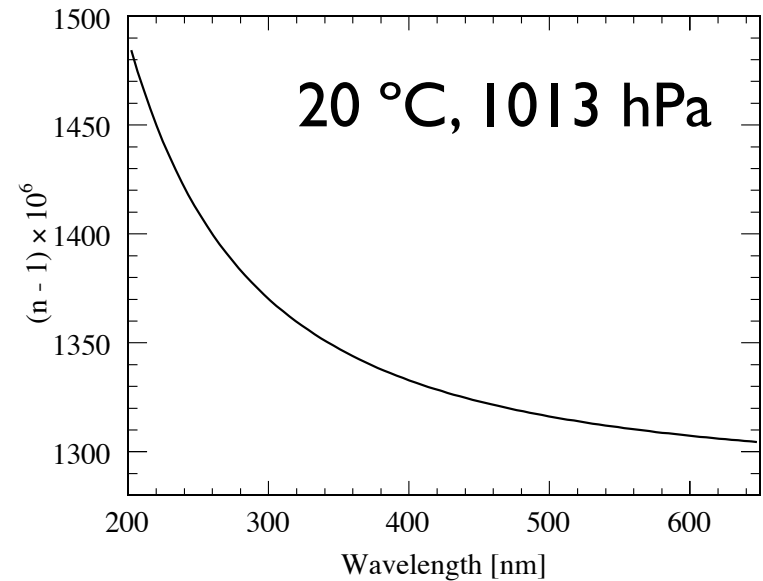# The heavy gas system

Sosuke Horikawa, University of Zurich
with Jacky Rochet, Olav Ullaland and Vitali Polyakov

16 November 2006, DIRAC Meeting at CERN

Radiator gas - C_4F_{10}

- Perfluorobutane, C_4F_{10}

- Non-flammable, Non-toxic

- Boiling point –2 °C at 1 bar

- Refractive index

  - 1.0013-1.0015 at 200-650 nm

- Purchased - August 2006

  - 2 x 15 kg for 4 years run

    - Including

      - Loss estimation

      - Safety factor x 2

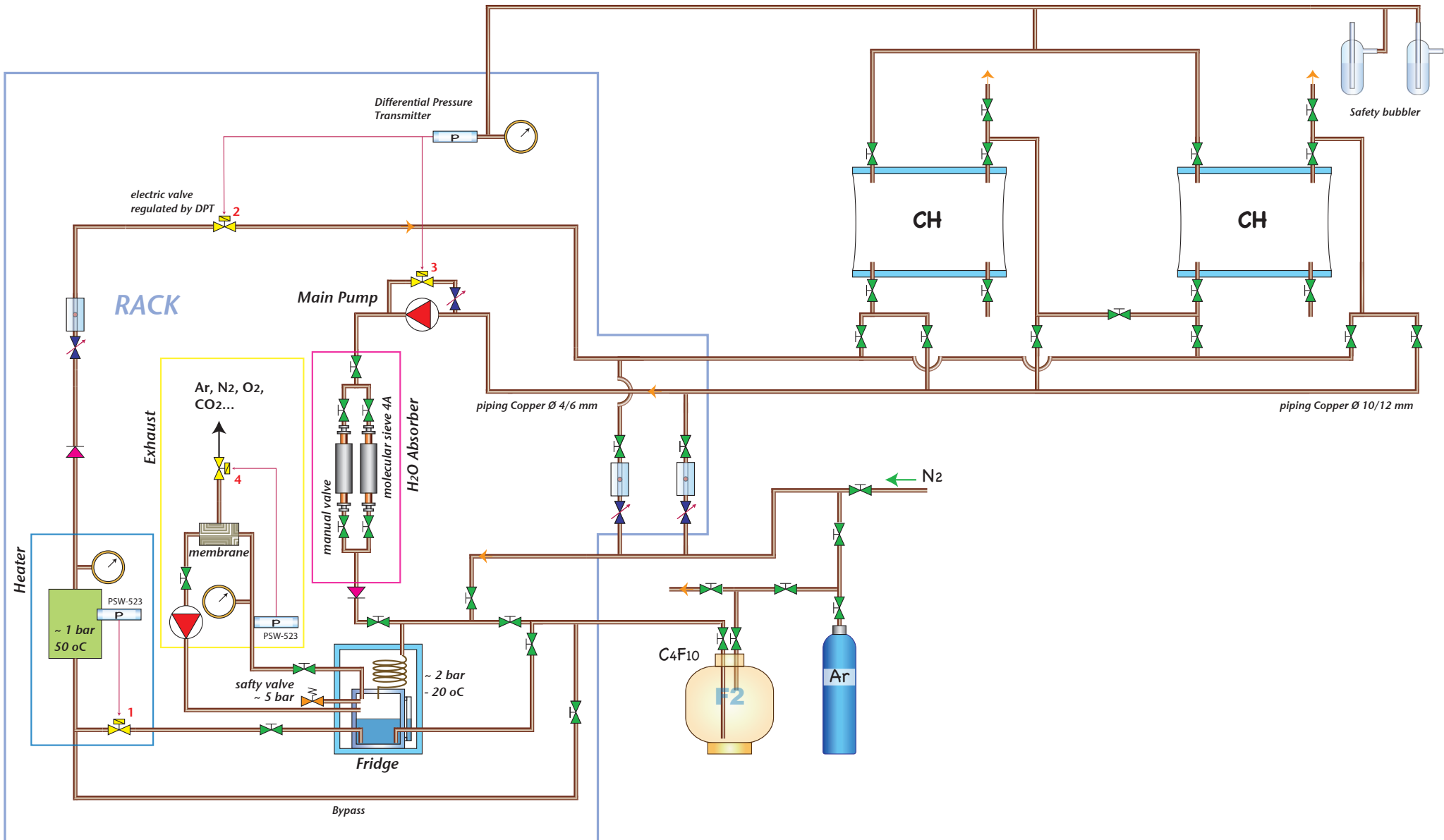 - From F2 Chemicals Ltd. (UK)

  - 7,832 CHF - expensive!

20 °C, 1013 hPa

(n – 1) × 10^6

Wavelength [nm]

K

9 GeV/c

4 GeV/c

π

p [GeV/c]

Wavelength [nm]

Radiator gas recirculation system

- To fill up the detector with C_4F_{10} without a significant loss of the gas

  ➡ Recirculation cycle, with separation of the Ar/N_2 and C_4F_{10}

- To maintain the purity of the radiator gas

  ➡ Recirculation through the water absorber and the separation unit

- To collect the gas back to the reservoir after the run (or whenever needed)

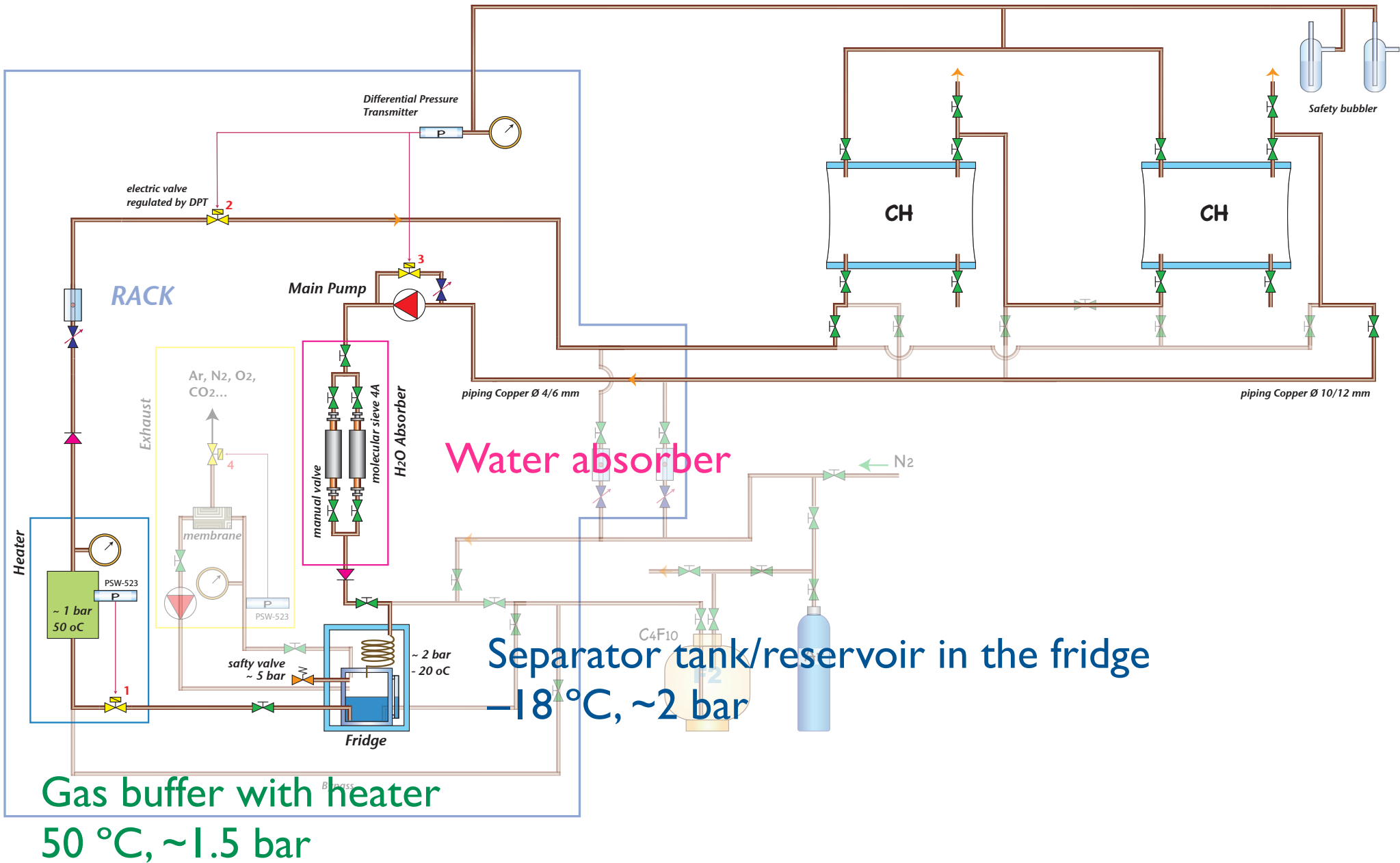- To automatically regulate the pressure inside the detector vessel in ±5 mbar range

Radiator gas recirculation system

- Separation unit
  - Gas-liquid separator tank in the fridge (−18 °C, ~2 bar)
    - Separate Ar/N_2 and C_4F_{10} by means of clearly different boiling points
  - Membrane module
    - Selectively vent Ar/N_2 to the air by means of smaller kinetic diameter of the molecules
- Water absorber
  - Molecular sieve (4 A)
- Ar/N_2 supply

Full scheme

Differential Pressure
Transmitter

electric valve
regulated by DPT

RACK

Main Pump

Ar, N2, O2,
CO2...

Exhaust

Heater

membrane

PSW-523

~ 1 bar
50 oC

manual valve

molecular sieve 4A

H2O Absorber

piping Copper Ø 4/6 mm

piping Copper Ø 10/12 mm

Safety bubbler

CH

CH

N2

safty valve
~ 5 bar

~ 2 bar
- 20 oC

Fridge

C4F10

F2

Ar

Bypass

PSW-523

Main recirculation line

Differential Pressure Transmitter

electric valve regulated by DPT

2

RACK

3

Main Pump

Exhaust

Ar, N2, O2, CO2...

membrane

PSW-523

4

manual valve

molecular sieve 4A

H2O Absorber

piping Copper Ø 4/6 mm

Water absorber

N2

piping Copper Ø 10/12 mm

Safety bubbler

CH

CH

Heater

PSW-523

~ 1 bar
50 oC

1

safty valve
~ 5 bar

~ 2 bar
- 20 oC

Fridge

C4F10

F2

Separator tank/reservoir in the fridge
−18 °C, ~2 bar

Bypass

Gas buffer with heater
50 °C, ~1.5 bar

Membrane filter

Composite hollow fibre membrane
Selectivity :Ar/N₂/C4F10 = 10/1/0.1

Flow Ar/N$_2$

Differential Pressure Transmitter

RACK

electric valve regulated by DPT **2**

Main Pump **3**

Ar, N$_2$, O$_2$, CO$_2$...

Exhaust

4

Heater

molecular sieve 4A

H$_2$O Absorber

manual valve

membrane

PSW-523

~ 1 bar
50 oC

P

PSW-523

1

safty valve
~ 5 bar

Fridge

~ 2 bar
- 20 oC

piping Copper Ø 4/6 mm

piping Copper Ø 10/12 mm

Safety bubbler

CH

CH

N$_2$

C$_4$F$_{10}$

F2

Ar

Bypass
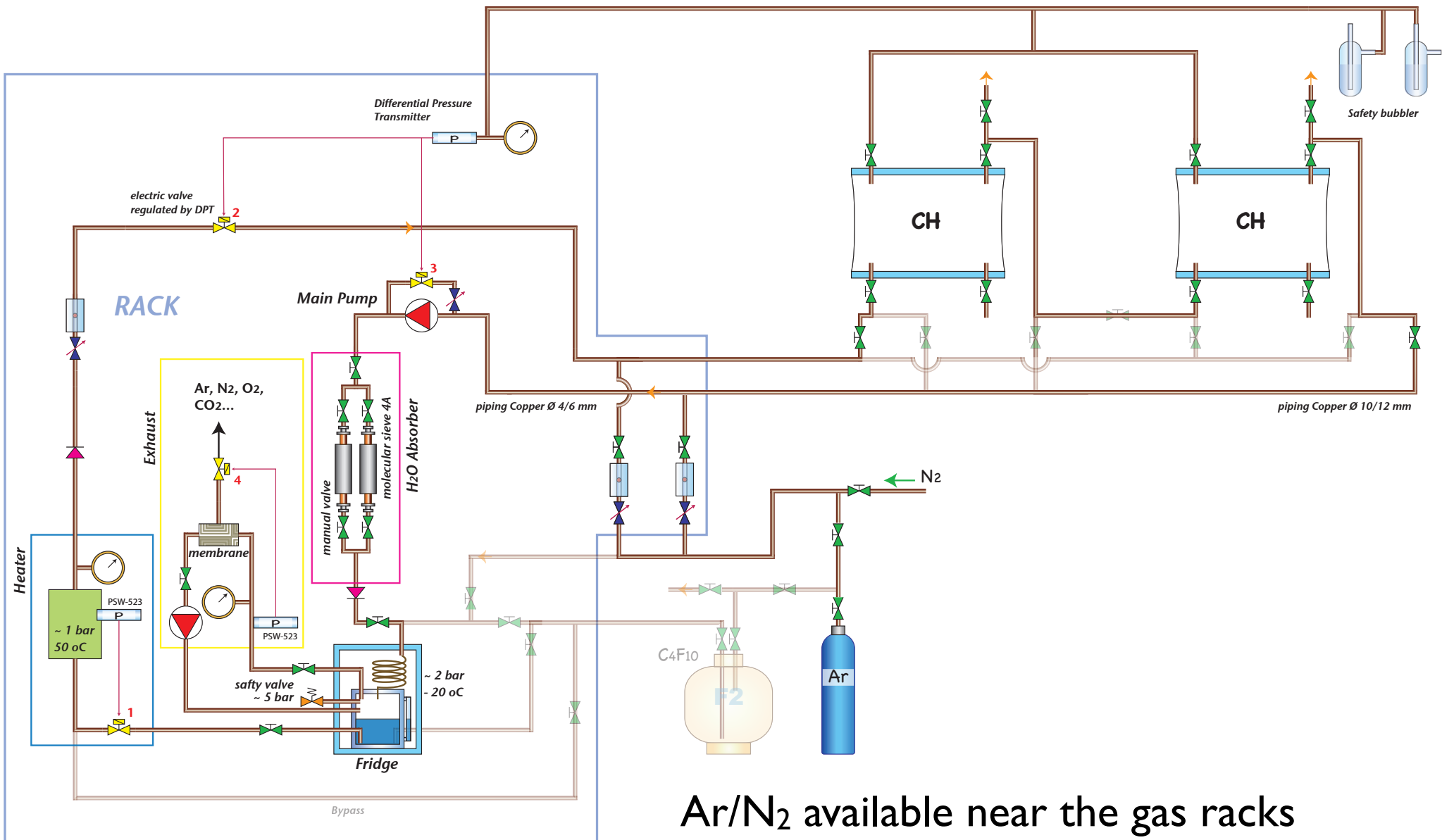
Ar/N$_2$ available near the gas racks

Under construction

August 2006

Where is the rack?

The Rack

Manual valves

Gas buffer ~10 liter

Freezer

C_4F_{10} bottle
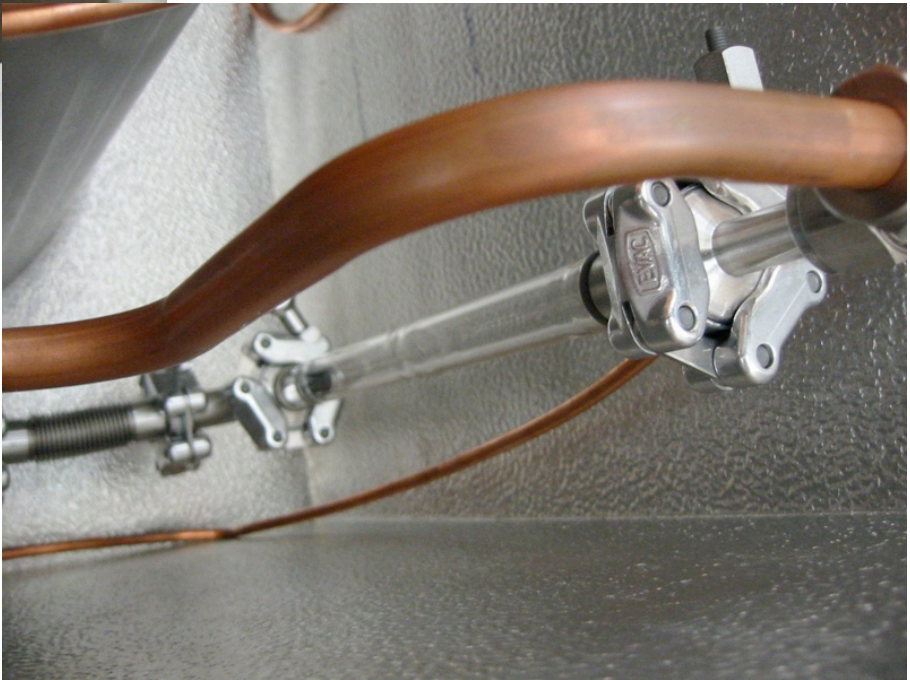15 kg
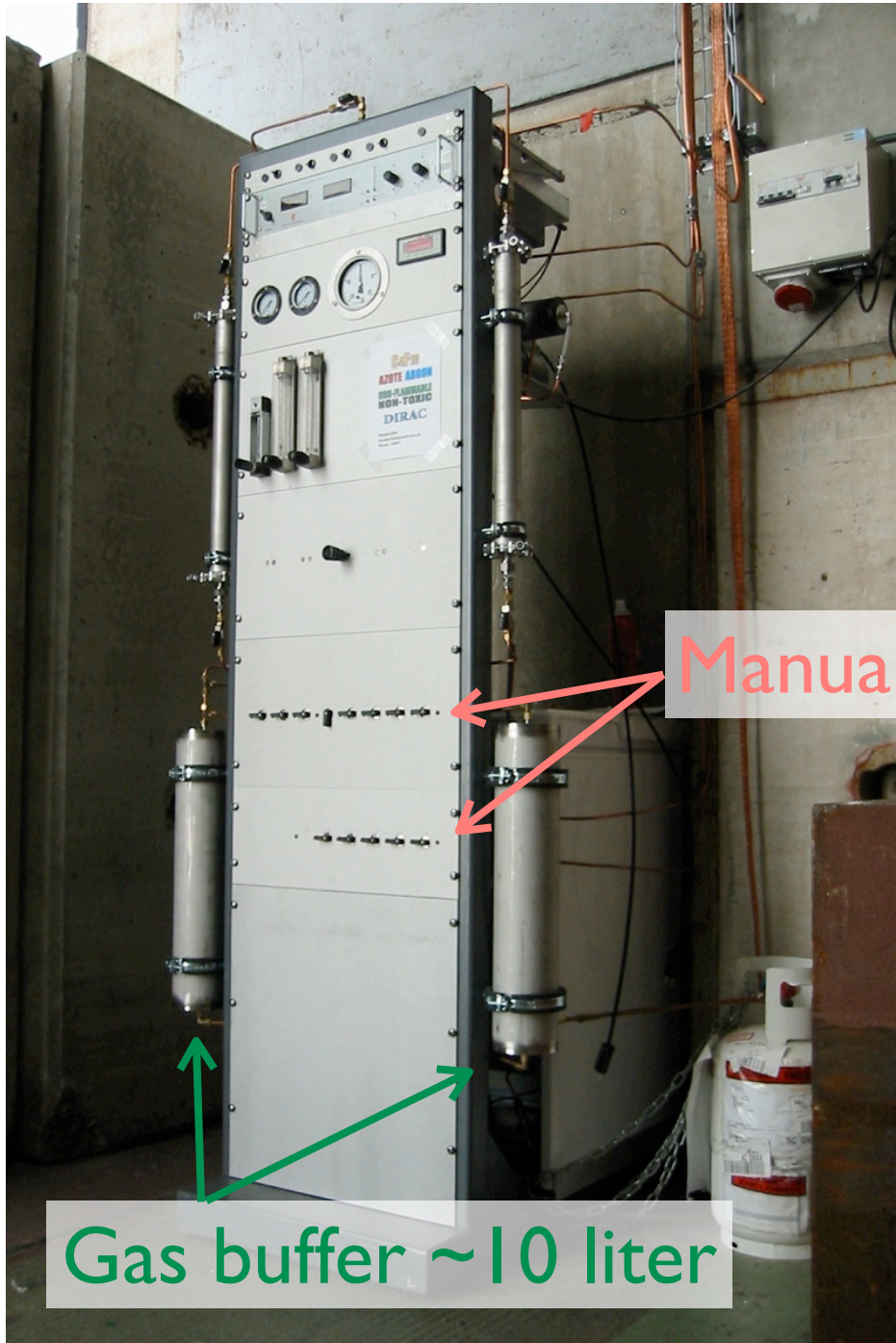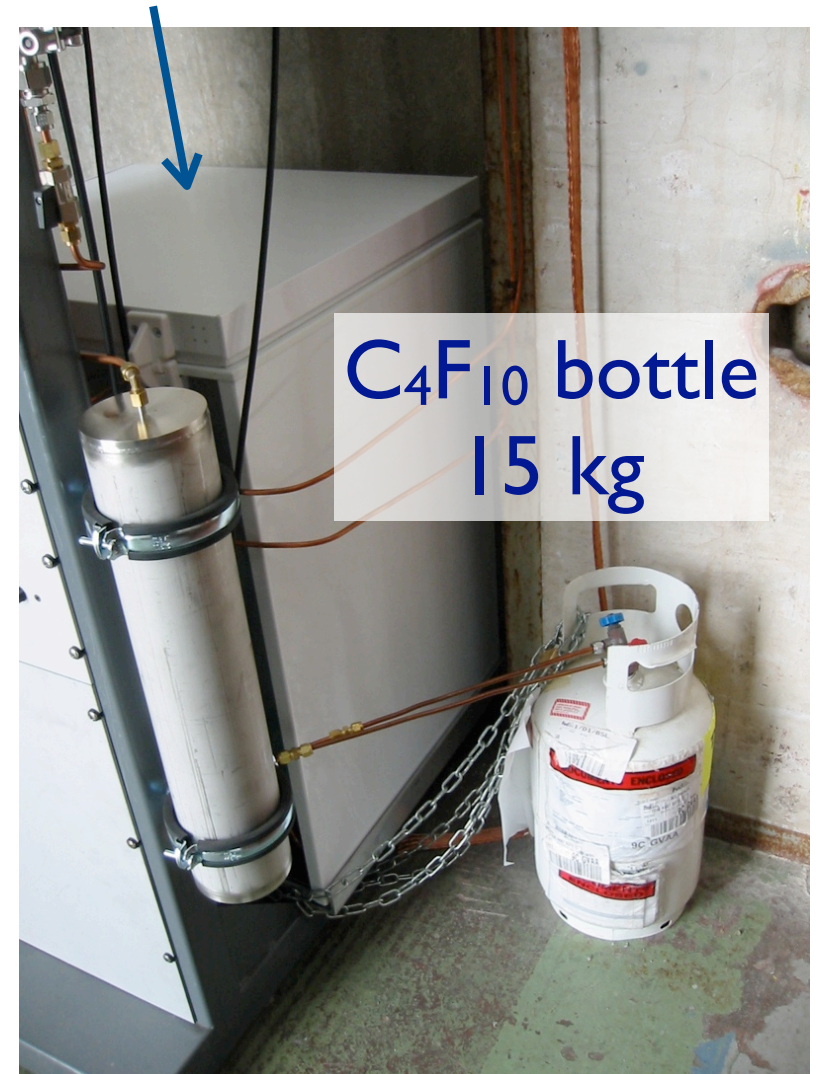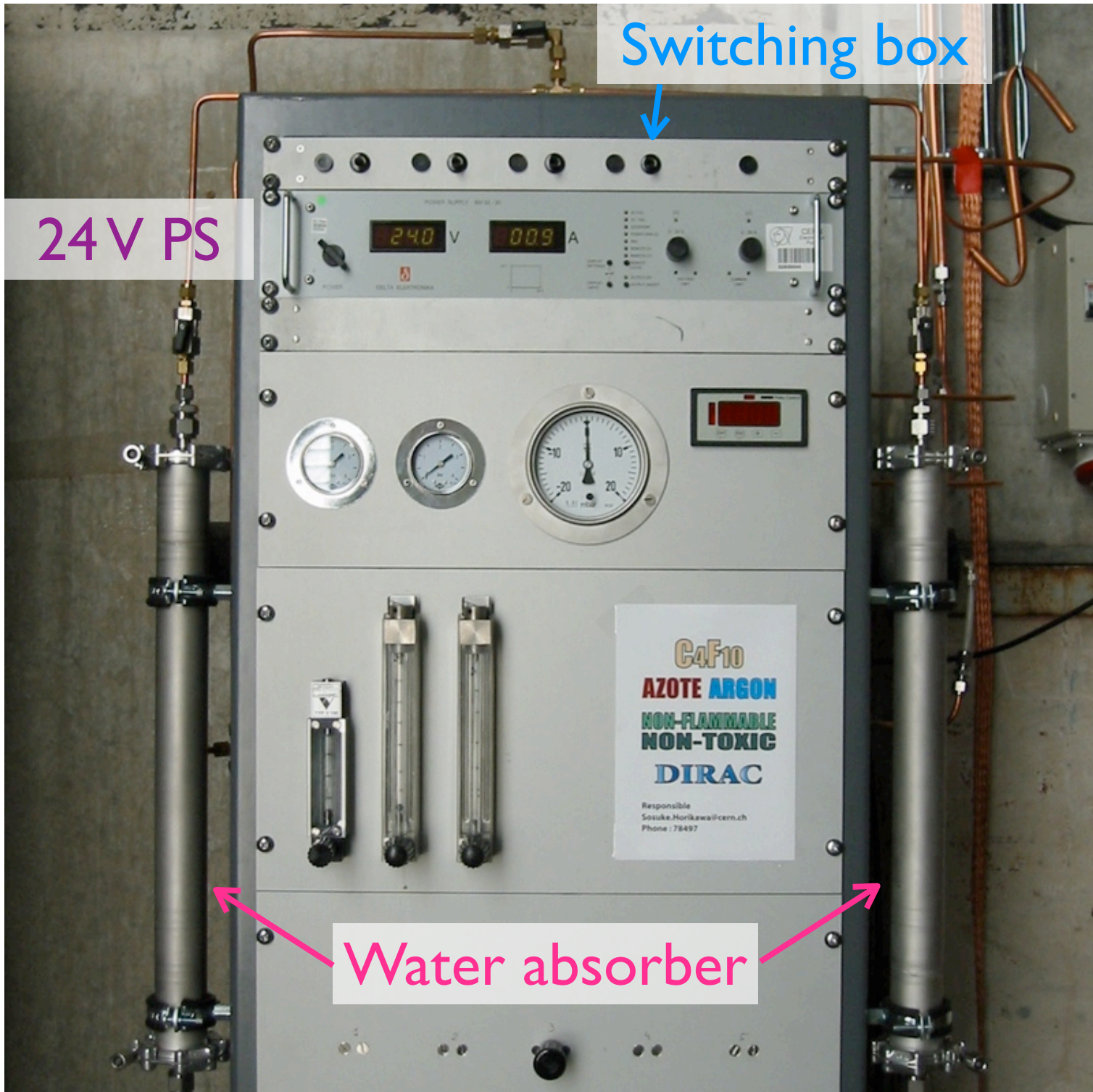
Piping

Back

Sensors

Wiring

In the Freezer

Heat exchanger coil

Glass tube

Gas/liquid separator tank / Reservoir ~30 liter

Near-detector panel

N$_2$ circulation test in the rack

- Output and input short-circuited

- Done in September and October

- Leak test : Major leaks fixed

  - Leak rate < 0.1 liter/h = 6 CHF/day

- Manual control : Works well

- Automatic pressure regulation :

  - Two pressure switches tested and working well

Plans (1)

- Final connection between the near-detector panel and the detector

  ➡ this evening after 17h

- Leak test of the whole system? Detector vessel??

- Test of the pressure sensor for the detector with N_2

- Recirculation test with N_2 for the full system

  ➡ by the end of the year

Plans (2)

- Filling with C_4F_{10}

  ➡ When?

- Estimation :

  - 2-3 days for the regeneration of the molecular sieves

  - 1 week for cleaning the system with N_2

  - 2-3 days for the filling

Conclusions

- Construction mostly done

- Test of the full system by the end of the year

- Can be ready for the run in one month