Cryogenic Infrastructure

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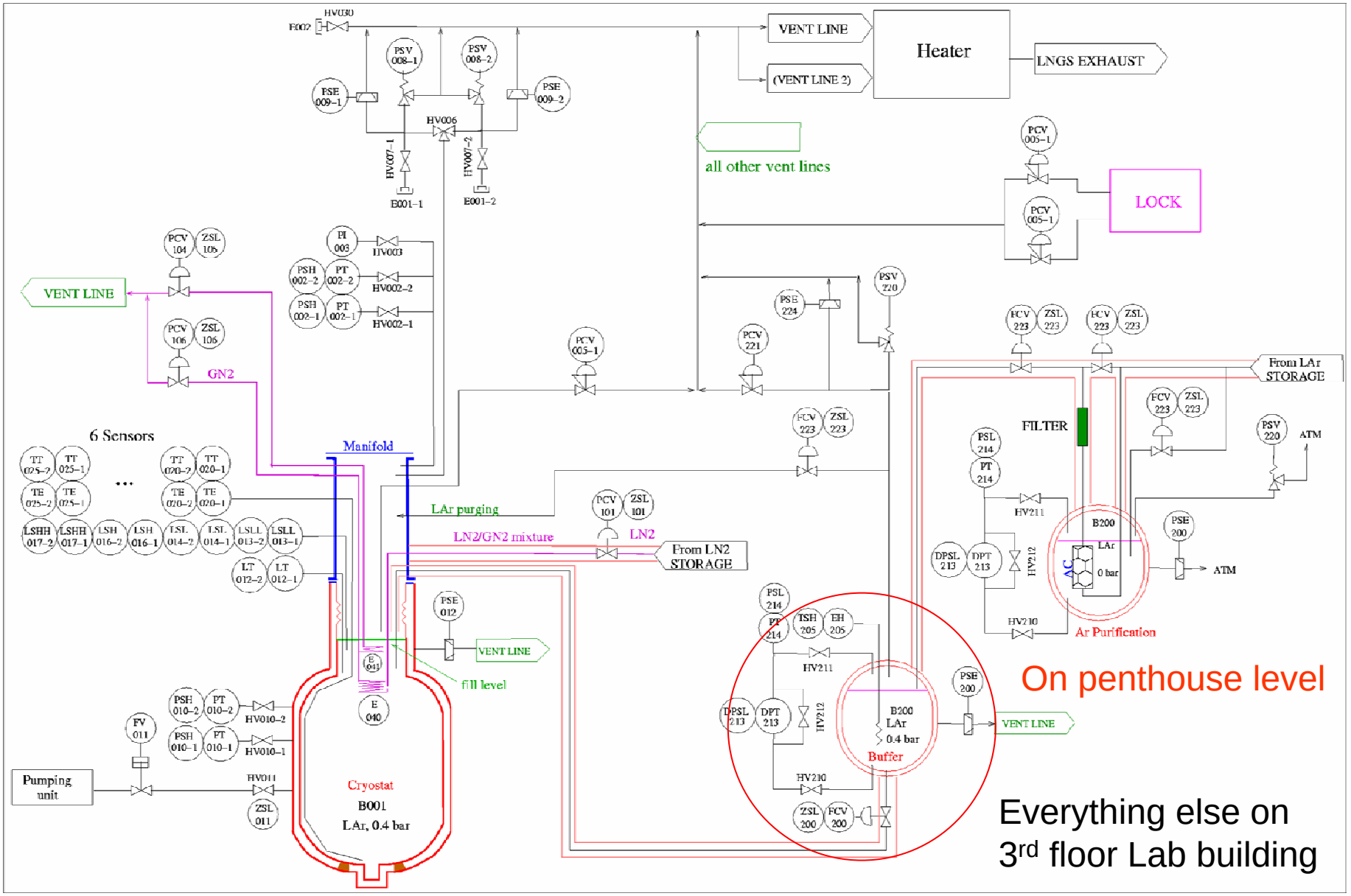
Outline

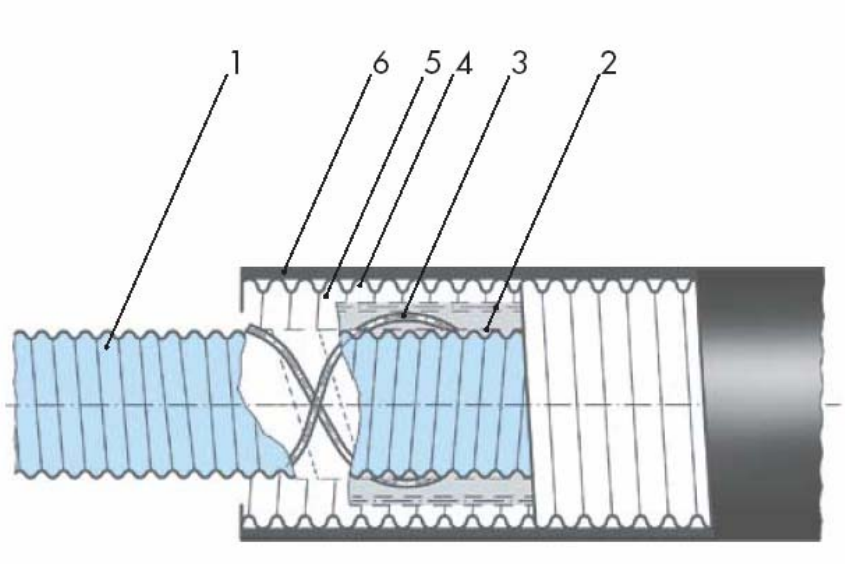
- Update on PID
- Pipes and Connections
- Valve specifications
- Active cooling
- Radon trap
- Heater
- Level sensors
- Summary

Piping & Instrumentation Design

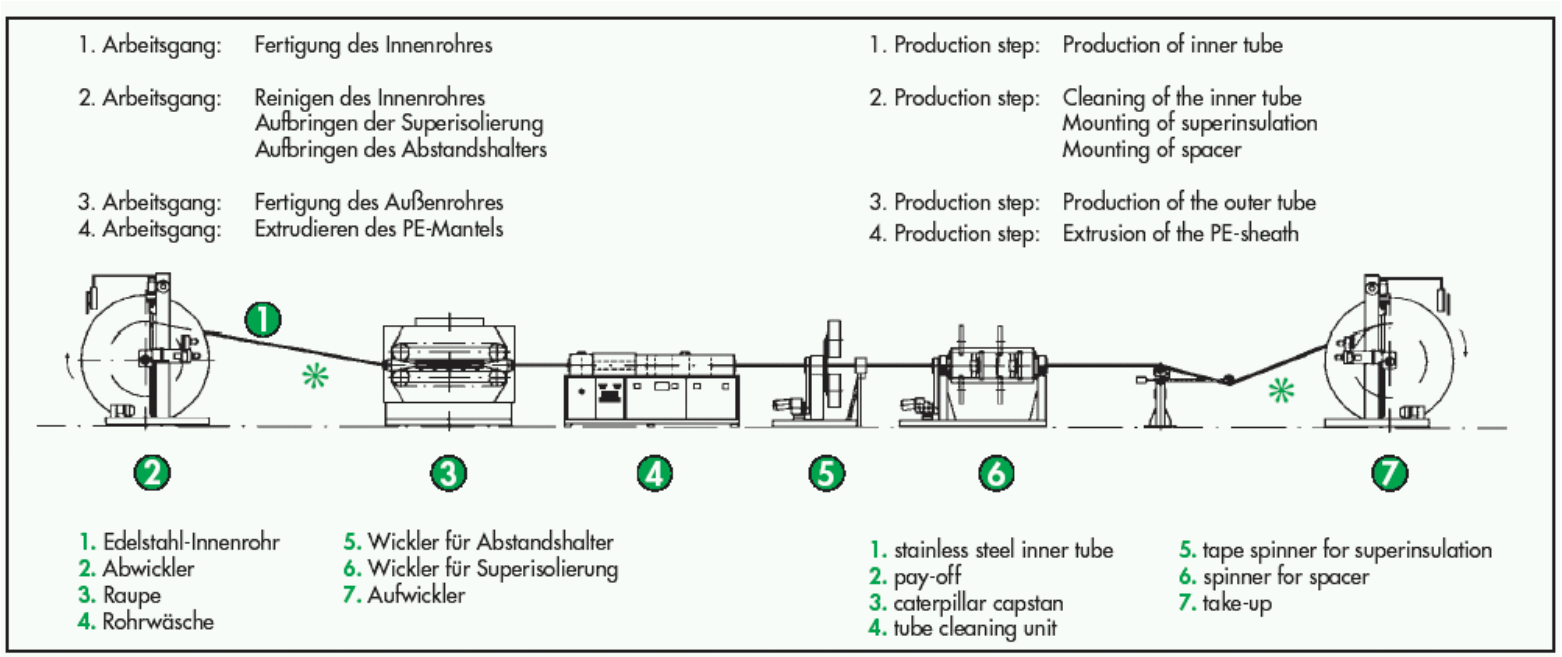


Pipes and Connections

Basic idea: use “flexible” superinsulated pipes for all LAr & LN2 transfer lines



Example: for 1 m^3/h need ID=30, OD=58 pipe,
Δp=0.3 bar for 40 m length,
bending radius = 500 mm
connections: customer specific,
e.g. Johnston coupling



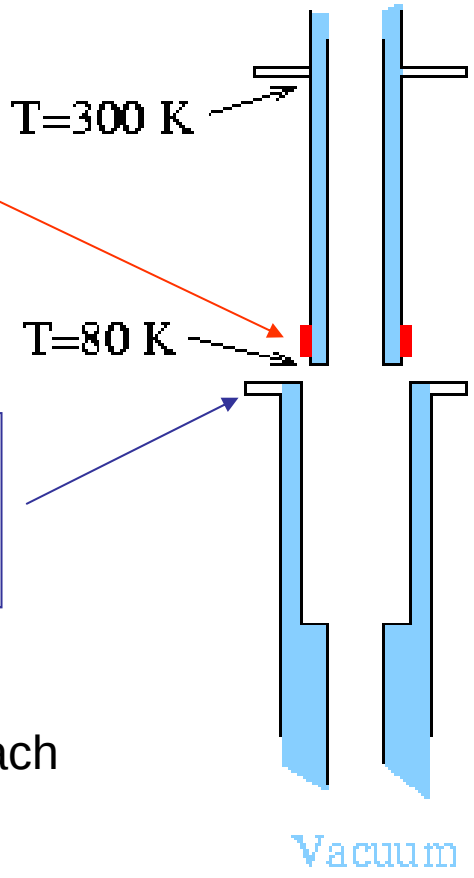
Production: sheet is cleaned before welding,
no grease for forming at the inside,
no cleaning at the inside needed

Connections at end of pipe:
Safety valve,
Vacuum pumping port
Gauge measurement port

price is similar to
non-flexible pipe with
flexible sections,
easier installation at LNGS

Johnston coupling

PTFE seal with internal spring for horizontal orientation of coupling

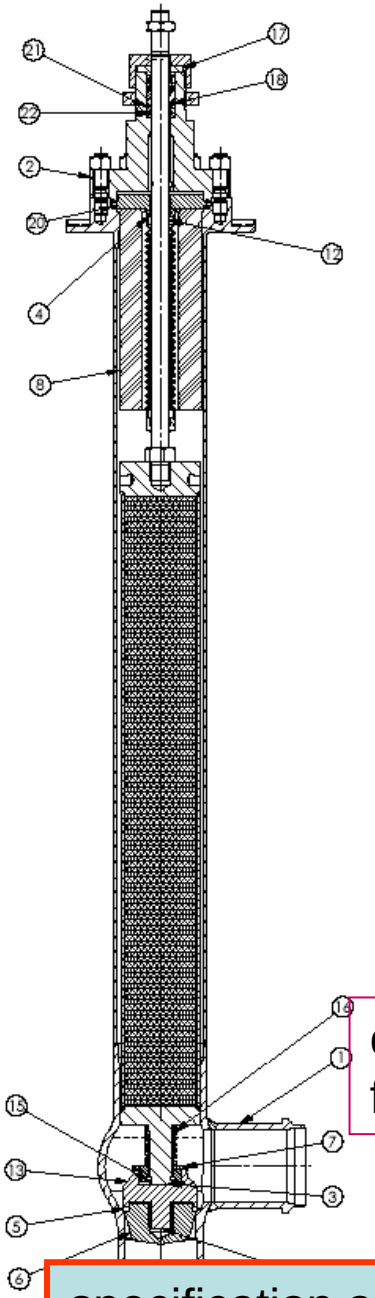


flange with metal seal, e.g. CF for Rn tightness

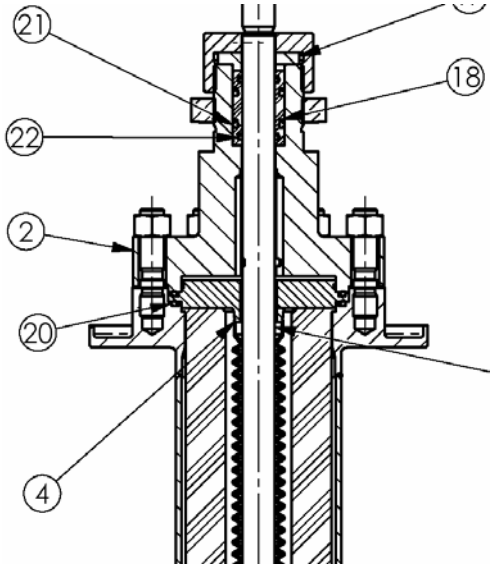
for horizontal orientation:
PTFE seal blocks LAr to reach the warm flange

galvanic decoupling possible at Johnston connection

Valve specification

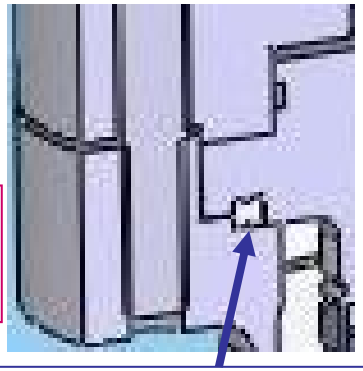


- for LN2 active cooling:
  no special requirements
- for LAr: metal seal to atmosphere
  (< 10^{-7} mbar*l /s)
  metal seat due to charcoal particles
  (< 10^{-5} mbar*l/s)
- for GAr: soft seat for tightness to atm.
  (< 10^{-7} mbar*l/s)
  metal seal to valve body
  (< 10^{-7} mbar*l/s)



need some equal percentage control valves
→ order same type everywhere

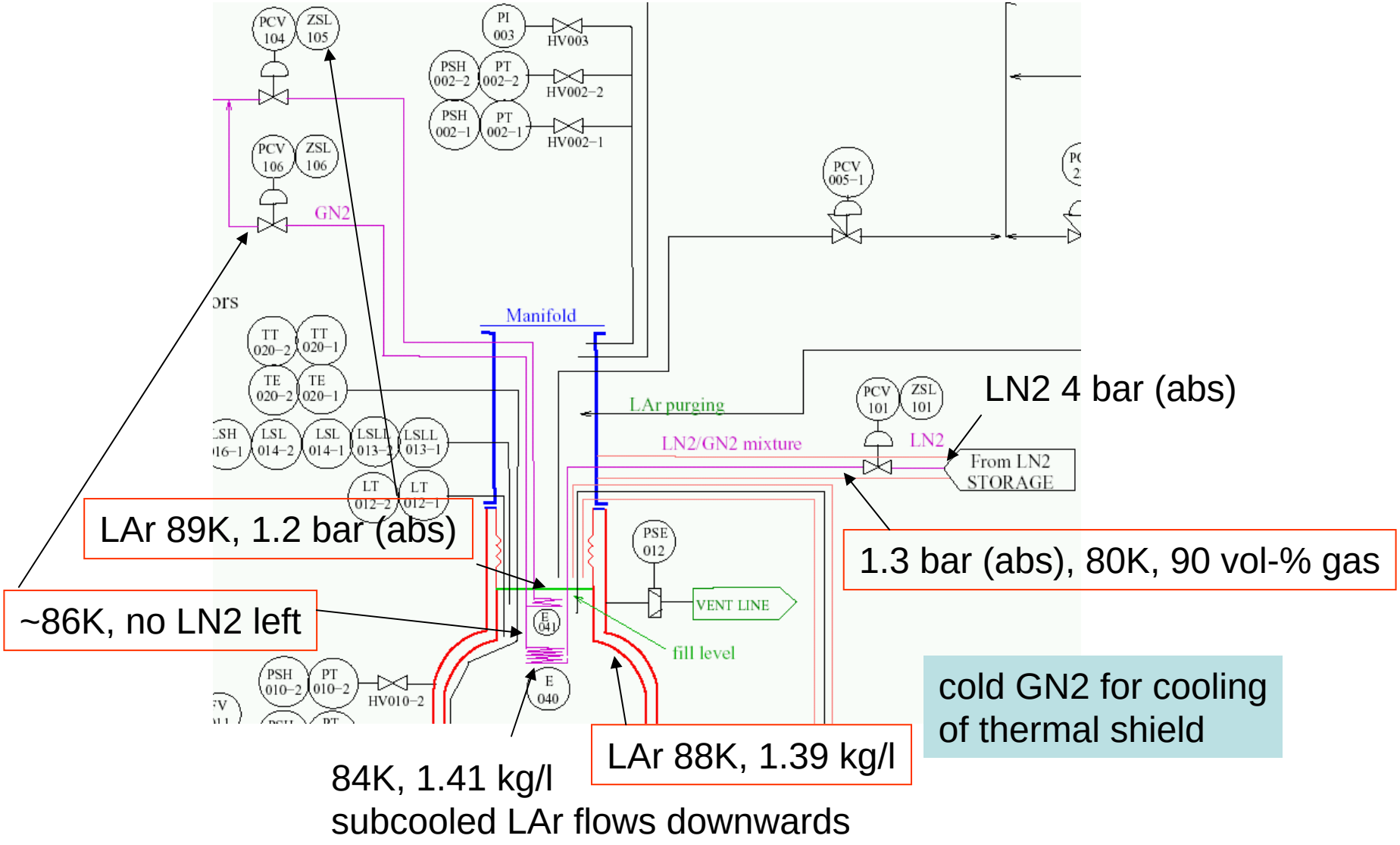
companies are very helpful, provide test valves for Rn diffusion measurement ...



special GERDA design with Cu ring and cutting edges

specification advanced, valve diameters calculated, tendering could start soon

Active cooling



Dimension heat exchanger:

- from boiling curve LN2: heat transfer coefficient ~300 W/(m^2 K)
- GN2/LN2 has temperature of 80 K at inlet heat exchanger
- LAr should be cooled to 84 K (above freezing point)

→ ~ 1m^2 area for heat exchanger is enough

Valve control in LN2 / GN2 circuit:

- at input to reduce pressure to 1.3 bar (abs) → 90 vol-% gas

-at output of 2nd heat exchanger controlled by pressure in cryostat
→ determines operating point of cryostat, 0.2 bar overpressure

- at output of 1st heat exchanger controlled by temperatures:
  GN2 at outlet
  LAr below heat exchanger
  LAr close to heat exchanger to avoid freezing of LAr
→ regulates cooling power of main heat exchanger

Challenge:

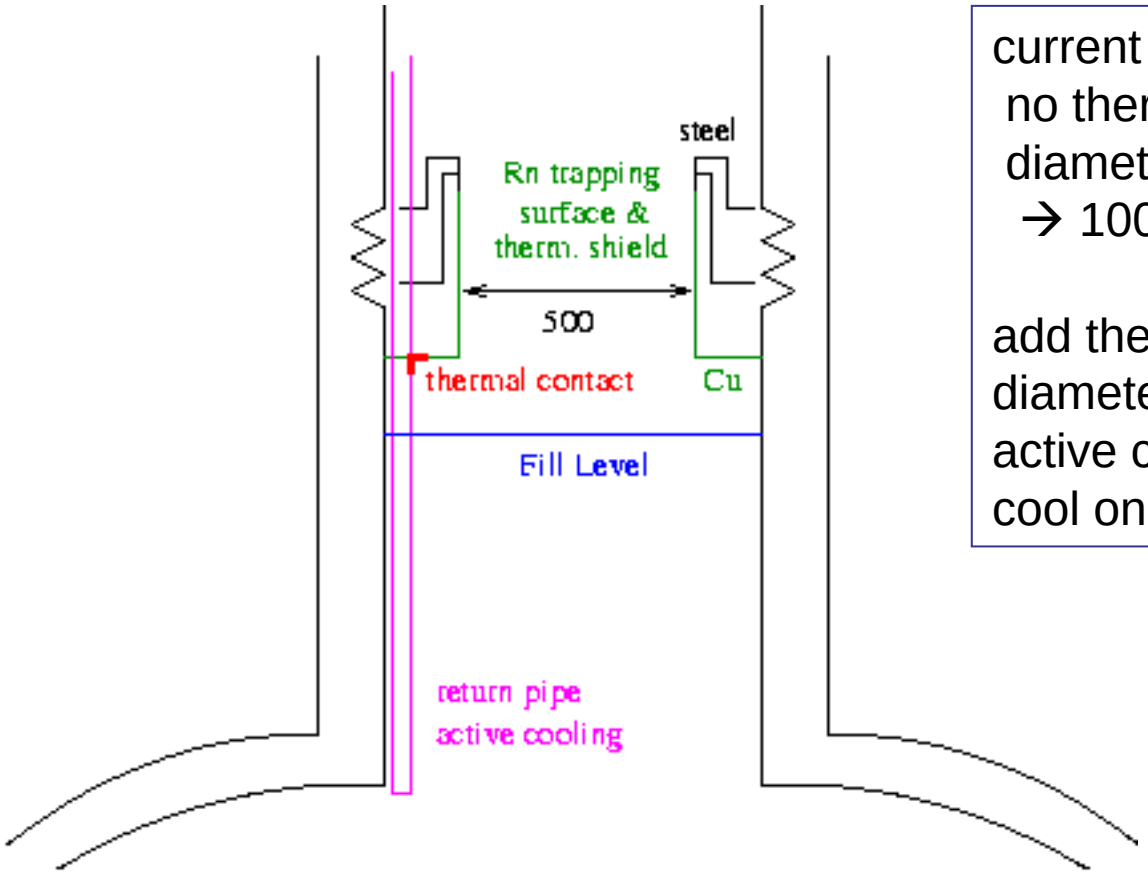
valves affect each other, need different time constants for PI(D) regulators

dimensioning (almost) finished, test in our “prototype neck” foreseen

Radon trap & thermal shield

GAr purge flow to small to purge Rn coming out of cables,... → need Rn trap

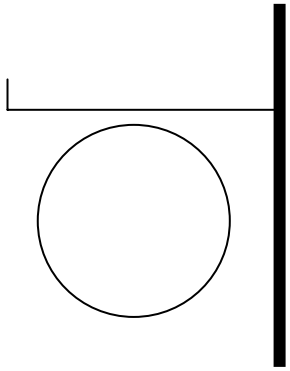
Sketch for a radon trap = cold surface



current prefered solution:
no thermal shields in the middle,
diameter ~ 500 is open
→ 100 Watt thermal loss

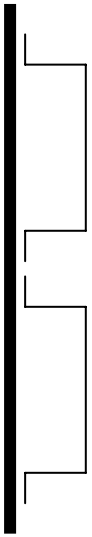
add thermal shield between
diameter 500 and 800,
active cooling for LAr should also
cool one layer of the shield

Exhaust gas heater options



DN 300 tube fixed to cable trays of Muon Veto
3 turns inside the water tank → 100 m^2 surface
(for heating 10000 m^3/h cold Argon gas to 5 ^oC)

prefabricated parts with flanges (water tight seal enough)



rectangular tube (140x500) on the OUTSIDE of the water tank,
6 turns → cover 100 m^2 outer surface

welded (or even screwed), some small leaks tolerable,
thin material (1 mm) should be enough (almost no overpressure),
no interference with muon veto, no (little) interference with schedule, no feedthrough in water tank roof

prices for the two solutions not yet investigated

Level sensors

For initial filling of cryostat: 6 Pt-100 sensors (1/m fill level), switched off later
in the neck: want two independent level measurements with ~10 cm resolution

WEKA Level measurement

- Pt-100 sensors at different height
  (problem due to active cooling (cold gas)?
  bad experience at test cryostat and Rn traps)

- hydrostatic pressure? NO, needs warm pipe
  in vacuum volume

- ultra sound? (reflectivity at LAr & sound speed
  variation with T)

- radar (100 MHz – 1.5 GHz, specified at 77 K,
  interference with Ge measurement?)

- capacitive? (interference with Ge?)

- swimmer and REED contacts a la WEKA?
  not specified but first tests show that it can work

Summary

- Progress has been made for the specification of entire cryo infrastructure (valves, pipes, ...),
  but slower than expected in Nov 06 (no tendering yet)
- still some open issues: rupture disk, level sensor,...
- many thanks to Mr Perinic (CERN),
  Mr Haberstroh (Dresden)
- possibly make a decision concerning
  the heater &
  galvanic decoupling between infrastructure & cryostat