Cryostat Cryogenic Infrastructure

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Outline
- history
- status of contact with DeMaCo
- interface to clean room
- heater
- summary

History of design of cryogenic infrastructure

2005: first version of Piping and Instrumentation Diagram from Air Liquide for safety study, also design from Cryogenmash available

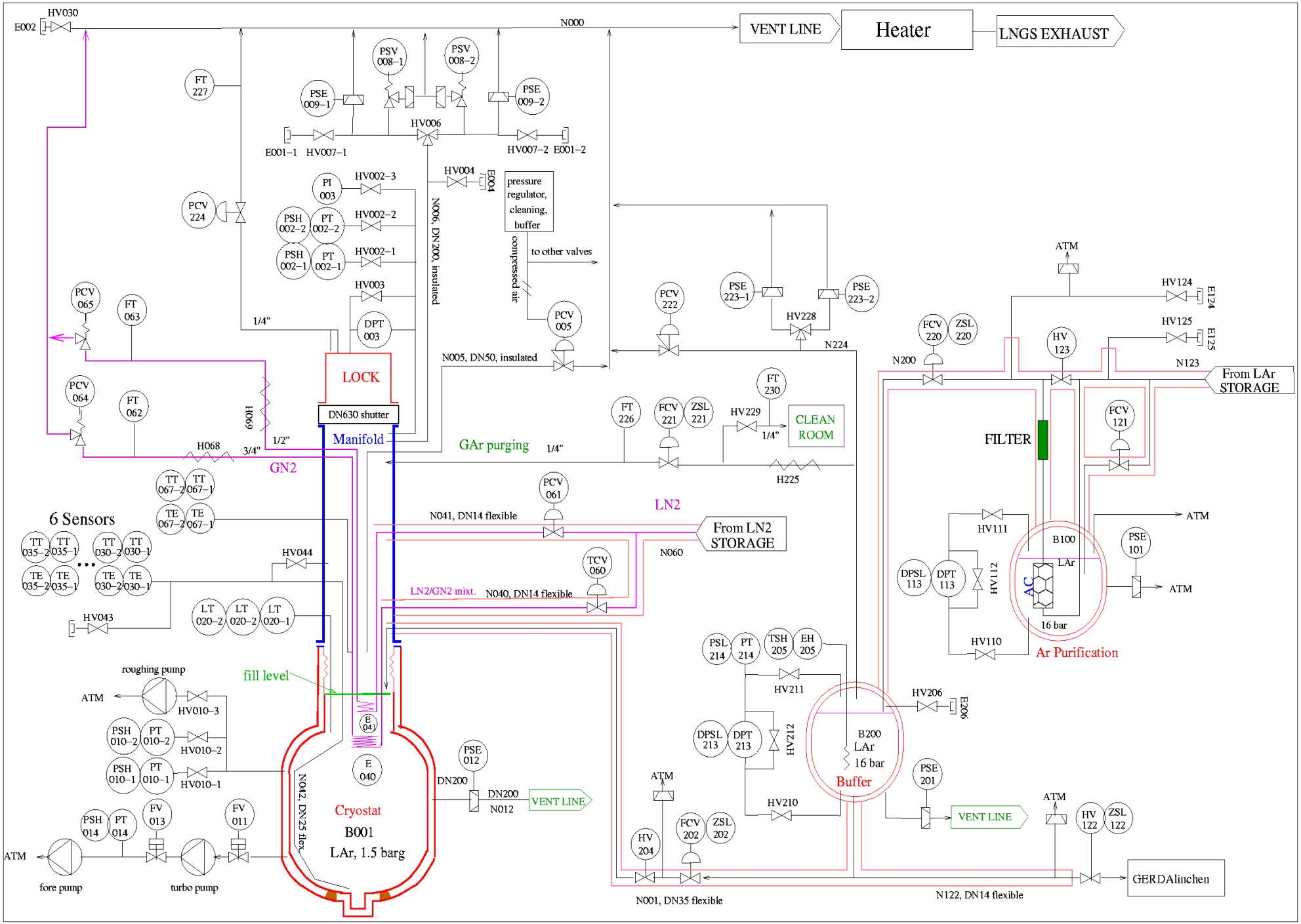
2007: input from Haberstroh/Uni Dresden, Perinic/CERN, Neumann/FZK

Jan-March 2008: European tender,
only 1 offer from SIMIC,
factor 2 higher than our budget and estimate from Perinic
--> tender cancelled

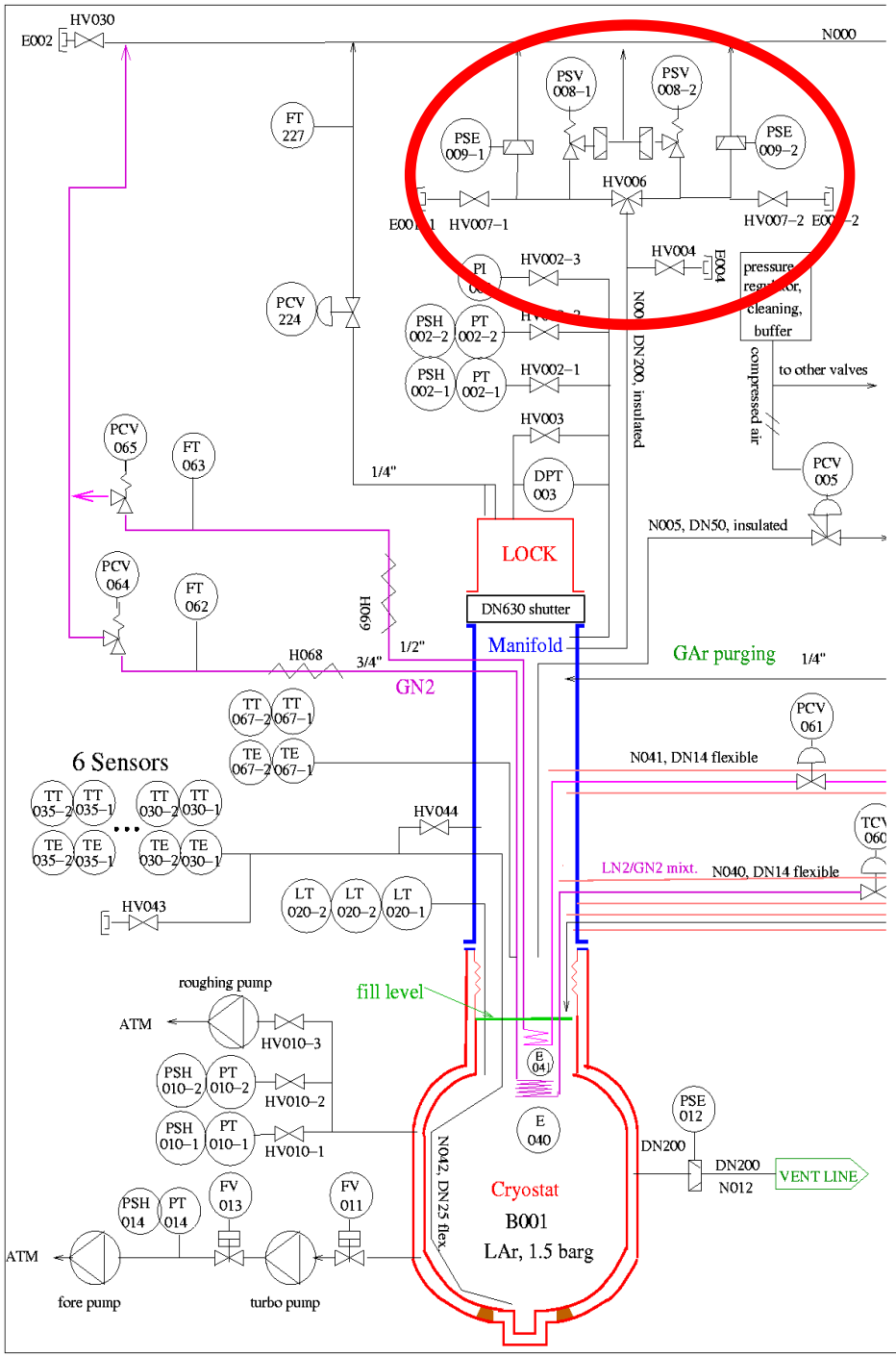
negotiations with Air Liquide (too expensive),
Krytem (too busy),
DeMaCo successful discussions, design contract
heater, PLC programming from different companies

end	June:	basic design: PID finalized, parts can be ordered
		design of exact routing & fixation of pipes needed by local people!
middle	August:	detailed design, machine shop drawing of parts built by DeMaCo
end	September:	finish procurement (3 months),
		installation of large diameter pipes before clean room construction
end	October:	finish production
end	December:	finish installation at LNGS

PID of tender



Modification safety devices



Legal requirements:
- 1 passive safety device,
  safety valve or rupture disk
- for maintanence under production
  need change-over valve & 2nd device

at CERN: 2 redundant devices

--> design shown in PID

Problems:
1) safety valves have He leak rate
   of 10^{-4} mbar*l/sec
2) HV006 made out of cast steel
   will emanate many mBq ^{222}Rn
   (small test vavle 2-7 mBq)

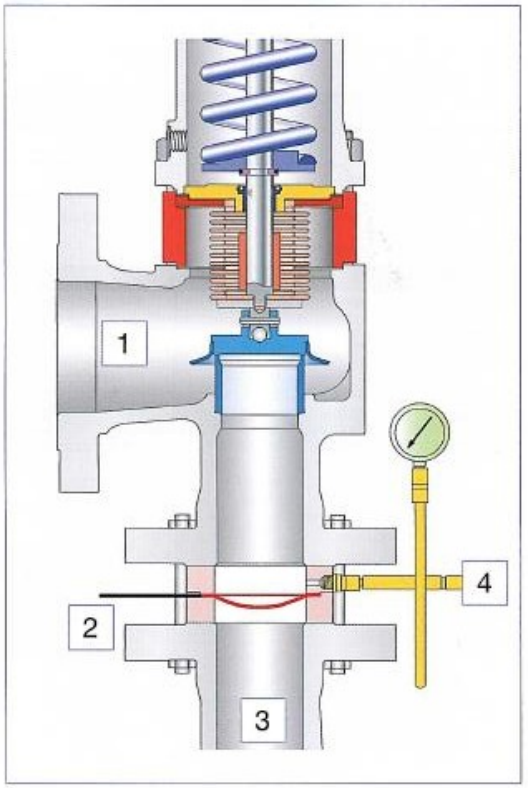
Solution: need gas tight rupture disk
in front of HV006 & safety valve

Example: combination rupture disk / safety valve from Leser

Best Availability LESER

How to Order Kombination Sicherheitsventil – Berstscheibe

Sicherheitsventile mit vorgeschalteter KUB-Berstscheibe



1 Sicherheitsventil

2 IG-KUB-Zweiteilhalter

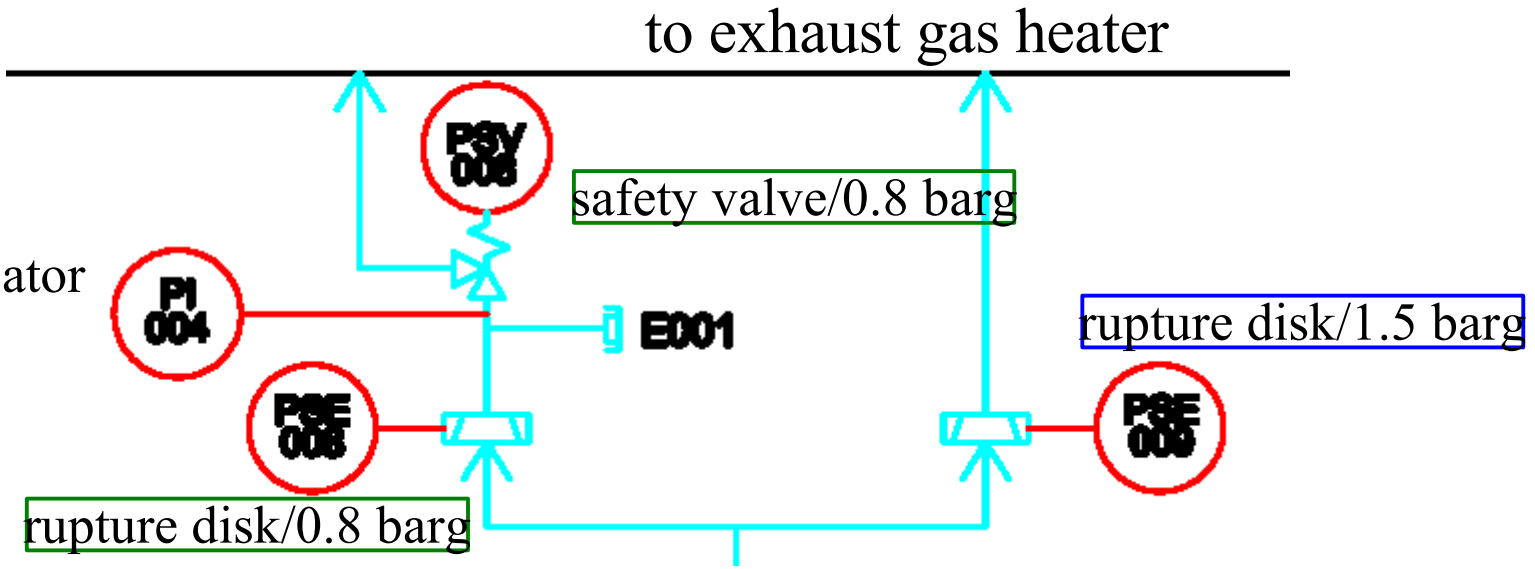
3 BT-KUB-Berstscheibe

4 Zwischenraumüberwachung und Manometer

Used for example when
- toxic process medium
- polymerizing medium
- corrosive process medium

Special requirements AD2000
- non-fragmenting rupture disk
- large cross section disk
- signal for rupture disk open
- pressure indicator in volume between disk & valve

Solution



Maintanence:

- not needed for rupture disk because:
  1) no fatigue since pressure constant,
  2) pressure low during normal operation (0.2 barg)
  3) no corrosion
- every 3-5 years for safety valve: rupture disk in front blocks radons
  --> no stop of operation

this solution was communicated to LNGS in an integration meeting

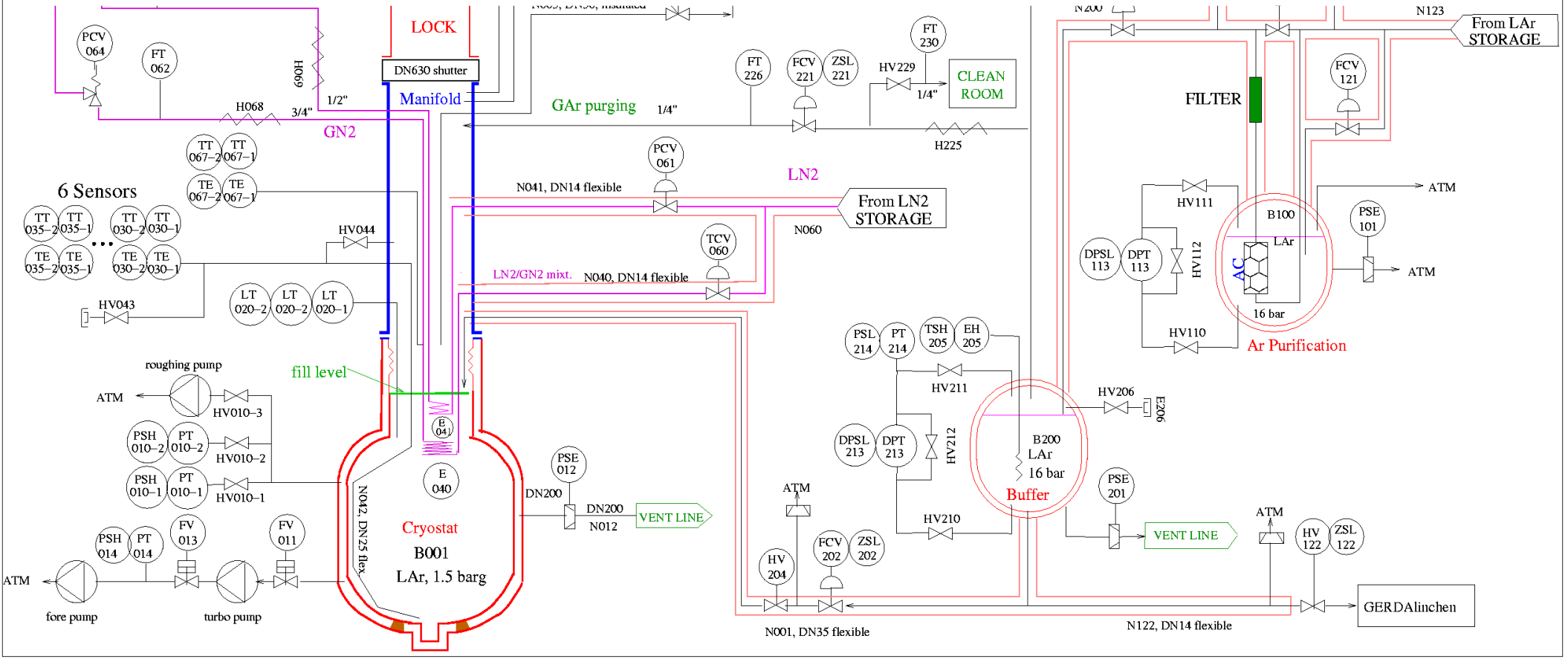
Refilling of LAr without flash gas

idea: Phase separator B200 at Level 9700, filling by “gravity”

advantage: - standard technique

disadvantages: - line from B200 to cryostat warm

- little space at Level 9700 mm
- cost for phase separator estimated at 25k-30k

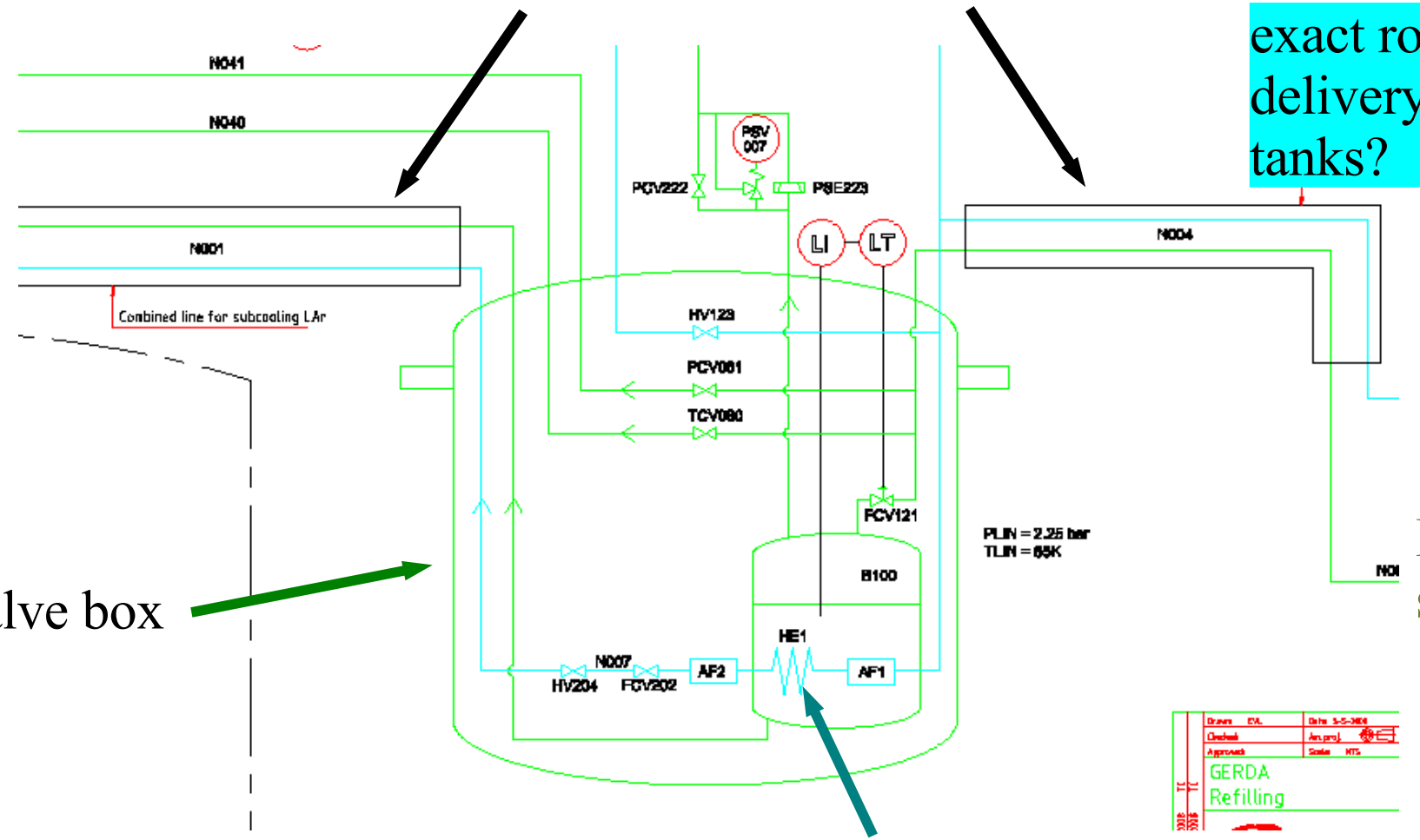


Solution: subcool LAr, keep pipe cold

LAr pipe and LN2 pipe in same vacuum jacket (cost ~ 2.5x single pipe)

exact routing?
delivery storage tanks?

cryostat



LAr storage

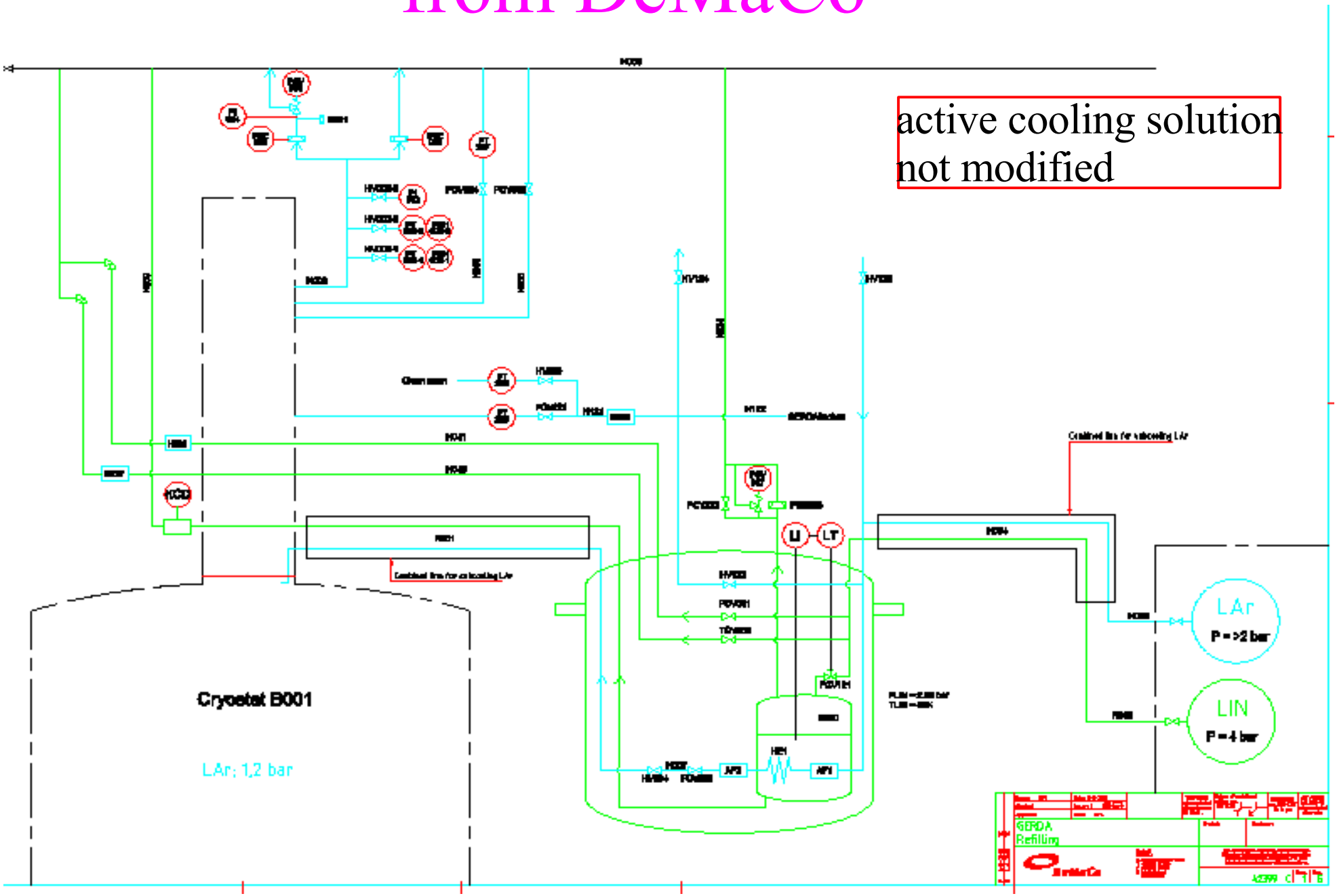
LN2 storage

valve box

B100 filled with LN2 at 85K & heat exchanger for 50 l/h LAr subcooling

No phase separator needed any longer, no equipment at level 9700 any longer, fewer valves (1 instead of 3 LAr control valves), fewer components

Current version PID (not complete) from DeMaCo



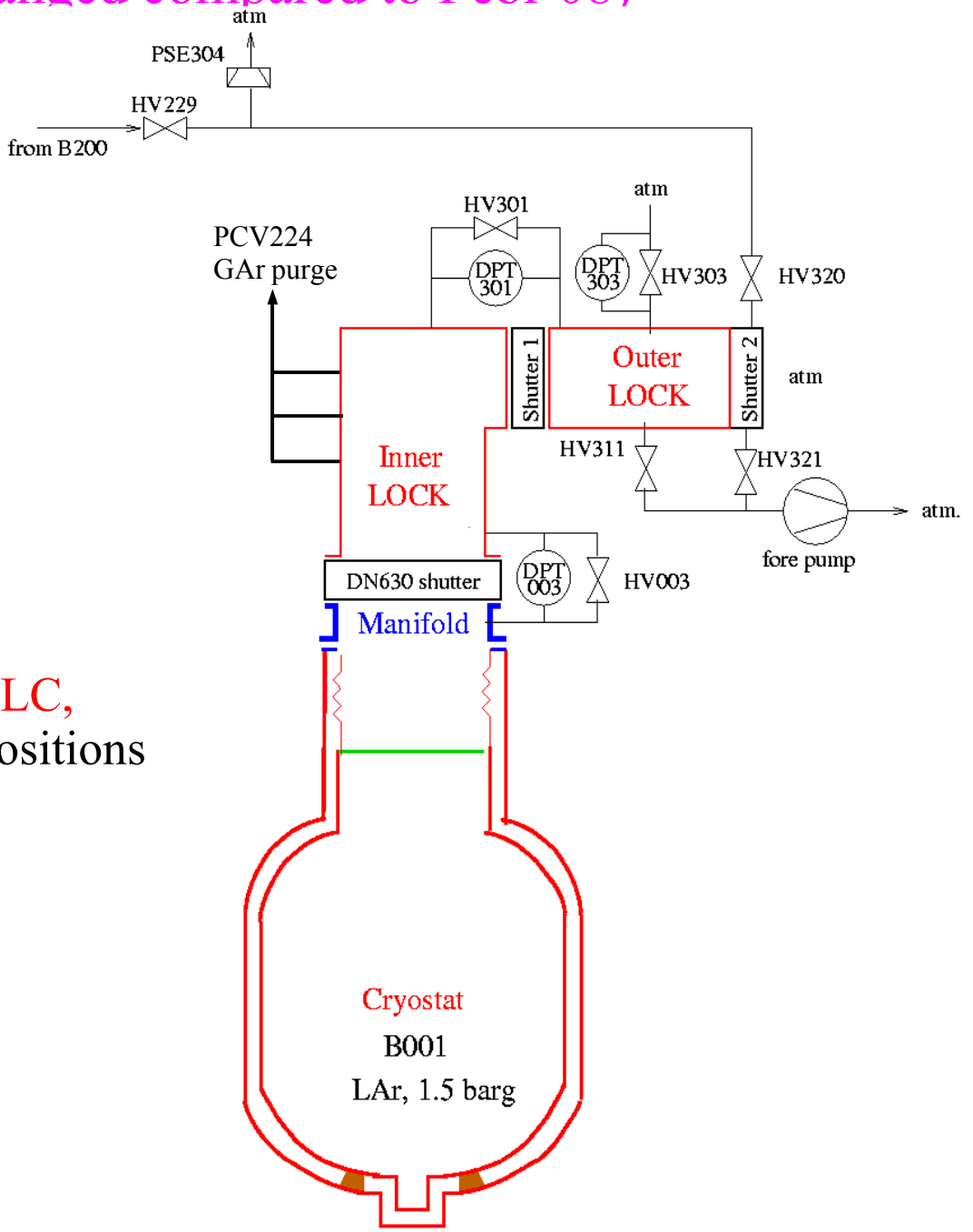
Interface to cleanroom infrastructure

(nothing changed compared to Febr 08)

Inner lock filled with GAr from cryostat (HV003)
--> no overpressure possible

Outer lock filled with GAr from Inner lock only (HV301)
--> no overpressure possible

Inherently safe operations,
no/little interference with cryostat PLC,
exchange of pressures and shutter positions between PLCs



Exhaust gas heater

vacuum loss of cryostat: ~1 kg/sec evaporation of LAr , probability 1E-2/year
hole in one cryostat wall: ~4.6 kg/sec evaporation of LAr provided additional passive insulation on inner & outer vessel is added, probability according to NIER < 1E-8/year

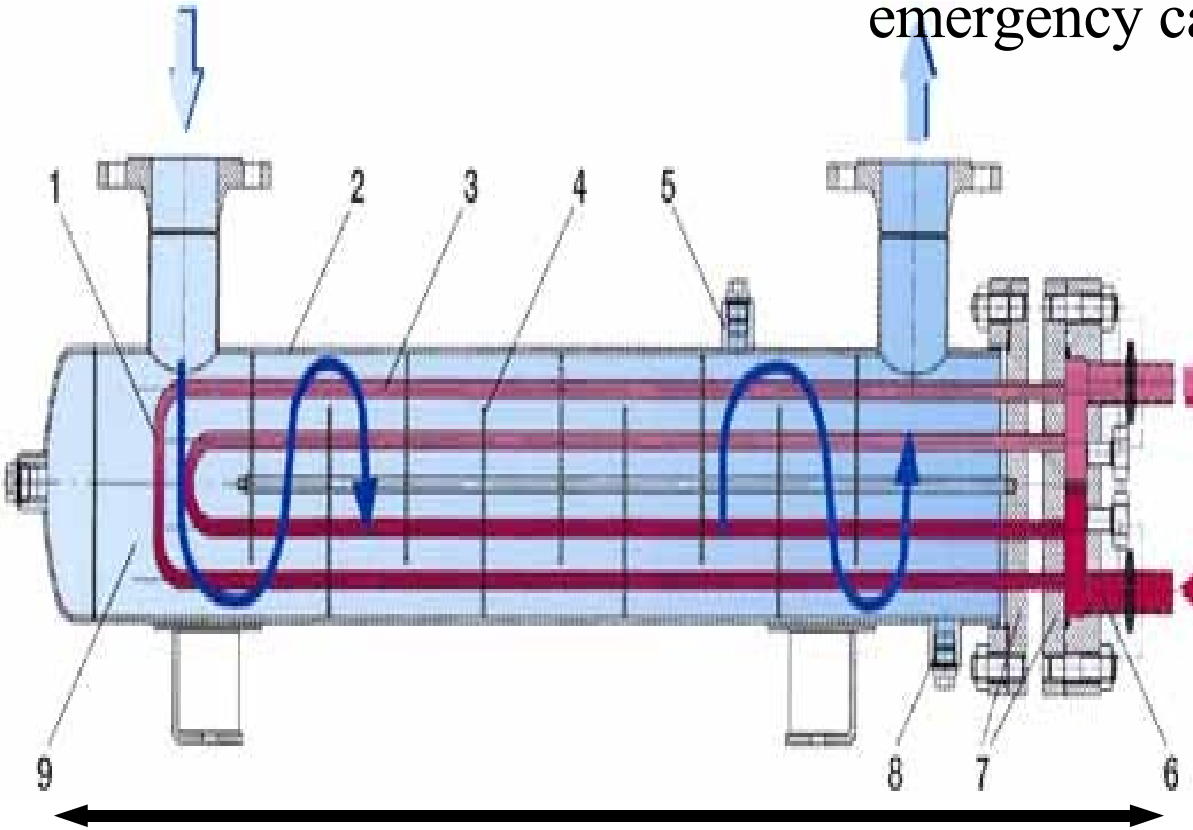
cold gas has to be heated before discharged to LNGS ventilation:
fans need minimum temperature -20 °C & ice formation inside pipe --> clogging

LNGS director defines: 1 kg/sec is enough & water-argon heat exchanger
BUT our precaution: heater should not fail at 4.6 kg/sec

Specifications for TEMA BEU heat exchanger

water in 14 °C,

water out 10 °C, 20 m^3/h
emergency case 40 m^3/h



700

GAr out +3 °C,
0.05 barg
power ~ 100 kW

GAr in -183 °C,
0.95 kg/s, 0.1 barg

850 kg
1.4571 stainless steel

3000

- solution discussed with LNGS in integration session,
- tender published last Friday, company selection end of June, delivery January 2009
- expect much reduced price compared to 500 kW heater

Details to be discussed for integration session:

HEATER:
where to get the water from for the heater,
- recirculation from water plant through heater?
- separate 20-40 m^3/h (permanent) pump, circulation or drainage?
- cooling water only if water tank empty
  (what is quality of cooling water, Fe ions? Ferroxyl test?)
- who takes care of piping of heater, design and installation?
  water + argon gas, inlet + outlet, include in GERDA building drawing
- where is cooling water coming from and where does it go?

what flanges of water tank are available and where?

how to bring the heater into the ground floor of GERDA building
(removable wall, lift/removal of stair case needed?)

UPS for water pumps

Cryogenics:

- DeMaCo will only provide cryogenic piping (most likely),
  other pipes + pressurized air for valve control provided by us
- design of fixation + installation of large diameter pipes before clean room
  floor is installed,
  these are
  a) DN200 from “rupture disk” vacuum at cryostat to heater
  b) DN200 from cryostat to safety devices at Level 6000 (hole in HEB700)
  c) DN50 from cryostat to pressure control valve at Level 6000
  d) DN50(100?) from turbo pump at cryostat to forepump at Level 6000
  notice: pipes need compensators and good fixations: 5 kN force at 1.5 barg
- cable trays
- is Armaflex ok as insulation material or rock wool?
- routing and fixation of transfer lines for LAr/LN2
- storage tanks, when do we get them? when is door removed?
- argon pipes to and from clean room (LAr, GAr)
- UPS for cryogenics
- LNGS safety network connection
- walls around cryogenic infrastructure + oxygen monitor ?

Summary

- DeMaCo has started with the cryogenic infrastructure design (& production)

- offer for PLC programming from ANAPUR available

- test stand in Heidelberg for active cooling ready (h=2.3 m, Ø = 0.8 m)
  avoid LAr evaporation losses by LN2 cooling

- tender for (“small”) heater started

- many details to be discussed in integration session, become urgent

Infrastructure should be available Jan/Feb 2009, no known show stopper