LAr Filling

and

Commissioning of Cryogenics

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GERDA Collaboration Meeting at LNGS
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Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali del Gran Sasso

GERDA Project

Procedure for Filling the GERDA Cryostat with Liquid Argon

Process Procedure Number	GERDA-PROC-2009-0x REV.0.1
Last Revision Date:	4 September 2009
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Last Revised by:	
Reviewed by:	.....
	.....
	.....
	Marco Balata (GLIMOS) .....

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General conditions for cool down & filling *

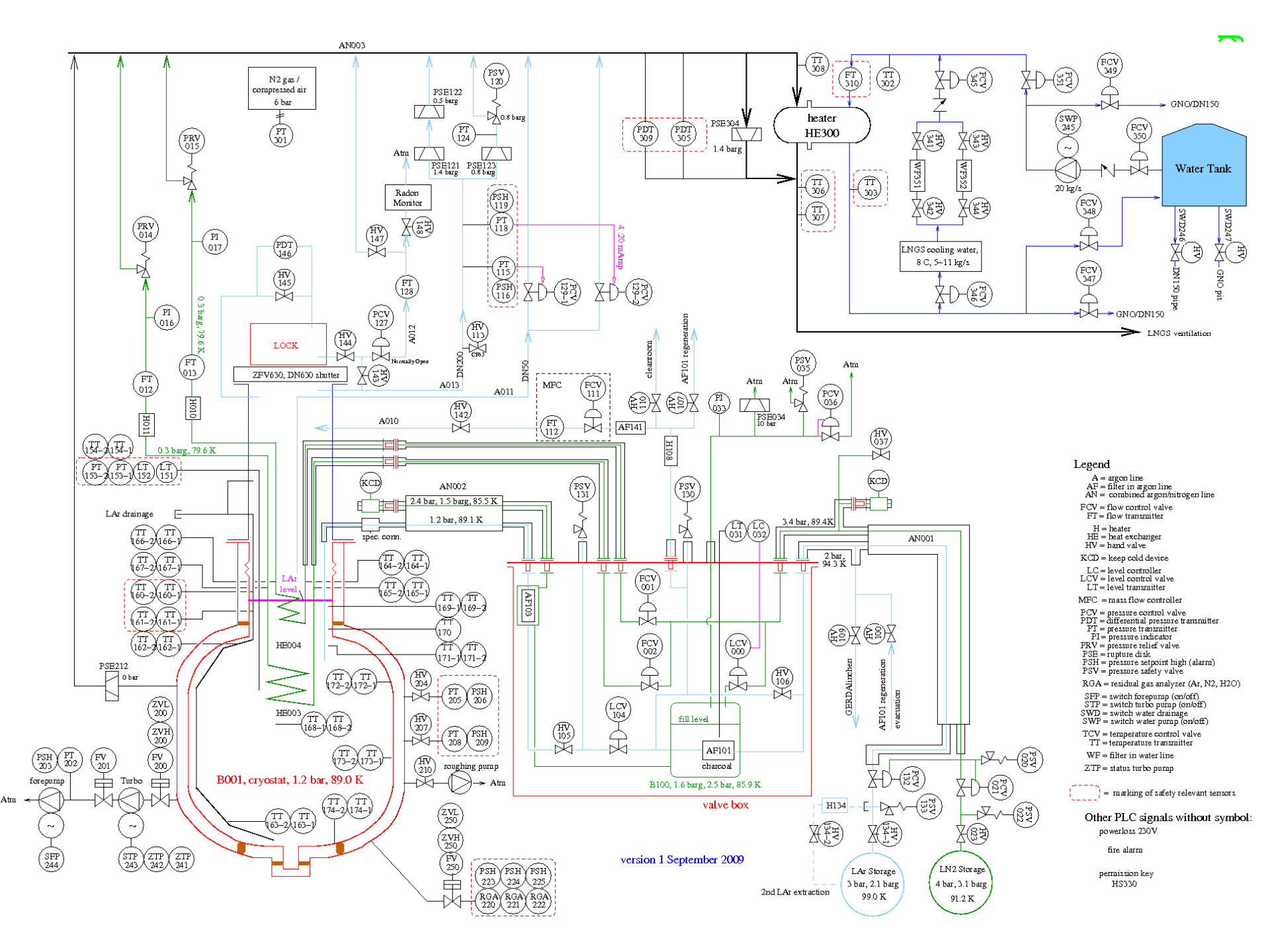
procedure acknowledged

infrastructure functioning
(water,ventilation, safety hardware,…

time schedule acknowledged

safety plan available (before fill of water tank)

* already done in hall A with liquid nitrogen – now easier by using available cryogenic infrastructure – see PID!


AN003
N2 gas / compressed air 6 bar
PT 301
PRV 015
PRV 014
PI 017
PI 016
FT 013
FT 012
0.3 barg, 79.6 K
H10H
H11H
PSE122 0.5 barg
PSV 120
0.8 barg
FT 124
Atm
PSE121 1.4 barg
PSE123 0.8 barg
Radon Monitor
HV 147
HV 148
PSH 119
PT 118
PT 115
PSH 116
4-20 mAmp
FCV 127-1
FCV 127-2
FT 128
A012
PCV 127
Normally Open
HV 145
PDT 146
LOCK
ZFV630, DN630 shutter
HV 144
HV 143
HV 113
cre3
DN200
DN50
A013
A011
MPC
FCV 111
FT 112
A010
HV 142
cleanroom
AF101 regeneration
AF141
AV 110
AV 107
PI 033
PSE034 10 bar
Atm
PSV 035
PCV 036
HV 037
KCD
AN002
2.4 bar, 1.5 barg, 85.5 K
1.2 bar, 89.1 K
spec. corn.
PSV 131
PSV 130
H10R
LAr drainage
LAr level
HE004
HE003
PSE212 0 bar
ZVL 200
ZVH 200
FV 200
PSH 203
PT 202
FV 201
forepump
Turbo
Atm
SFP 244
STP 243
ZTP 242
ZTP 241
B001, cryostat, 1.2 bar, 89.0 K
HV 204
PT 205
PSH 206
HV 207
PT 208
PSH 209
HV 210
roughing pump
Atm
ZVL 250
ZVH 250
FV 250
PSH 223
PSH 224
PSH 225
RGA 220
RGA 221
RGA 222
AF103
FCV 001
FCV 002
LCV 000
HV 106
LCV 104
HV 105
fill level
AF101
charcoal
B100, 1.6 barg, 2.5 bar, 85.9 K
valve box
LT 031
LC 032
3.4 bar, 89.4K
2 bar, 94.3 K
AN001
HV 101
HV 100
GERDAlinechen
AF101 regeneration
evacuation
H134
HV 134-2
HV 134-1
PCV 132
PSV 133
PCV 021
PSV 020
PSV 022
HV 023
2nd LAr extraction
LAr Storage 3 bar, 2.1 barg 99.0 K
LN2 Storage 4 bar, 3.1 barg 91.2 K
PDT 309
PDT 305
PSE304 1.4 barg
heater HE300
TT 308
FT 310
TT 302
TT 306
TT 307
TT 303
HV 341
HV 343
WP351
WP352
HV 342
HV 344
LNGS cooling water, 8 C, 5–11 kg/s
FCV 345
FCV 346
FCV 351
FCV 349
GNO/DN150
SWP 245
20 kg/s
FCV 350
Water Tank
FCV 348
FCV 347
SWD246
SWD247
DN150 pipe
GNO pit
GNO/DN150
LNGS ventilation
version 1 September 2009
Legend
A = argon line
AF = filter in argon line
AN = combined argon/nitrogen line
FCV = flow control valve
FT = flow transmitter
H = heater
HE = heat exchanger
HV = hand valve
KCD = keep cold device
LC = level controller
LCV = level control valve
LT = level transmitter
MFC = mass flow controller
PCV = pressure control valve
PDT = differential pressure transmitter
PT = pressure transmitter
PI = pressure indicator
PRV = pressure relief valve
PSE = rupture disk
PSH = pressure setpoint high (alarm)
PSV = pressure safety valve
RGA = residual gas analyzer (Ar, N2, H2O)
SFP = switch forepump (on/off)
STP = switch turbo pump (on/off)
SWD = switch water drainage
SWP = switch water pump (on/off)
TCV = temperature control valve
TT = temperature transmitter
WF = filter in water line
ZTP = status turbo pump
= marking of safety relevant sensors
Other PLC signals without symbol:
powerloss 230V
fire alarm
permission key HS330

Cool down

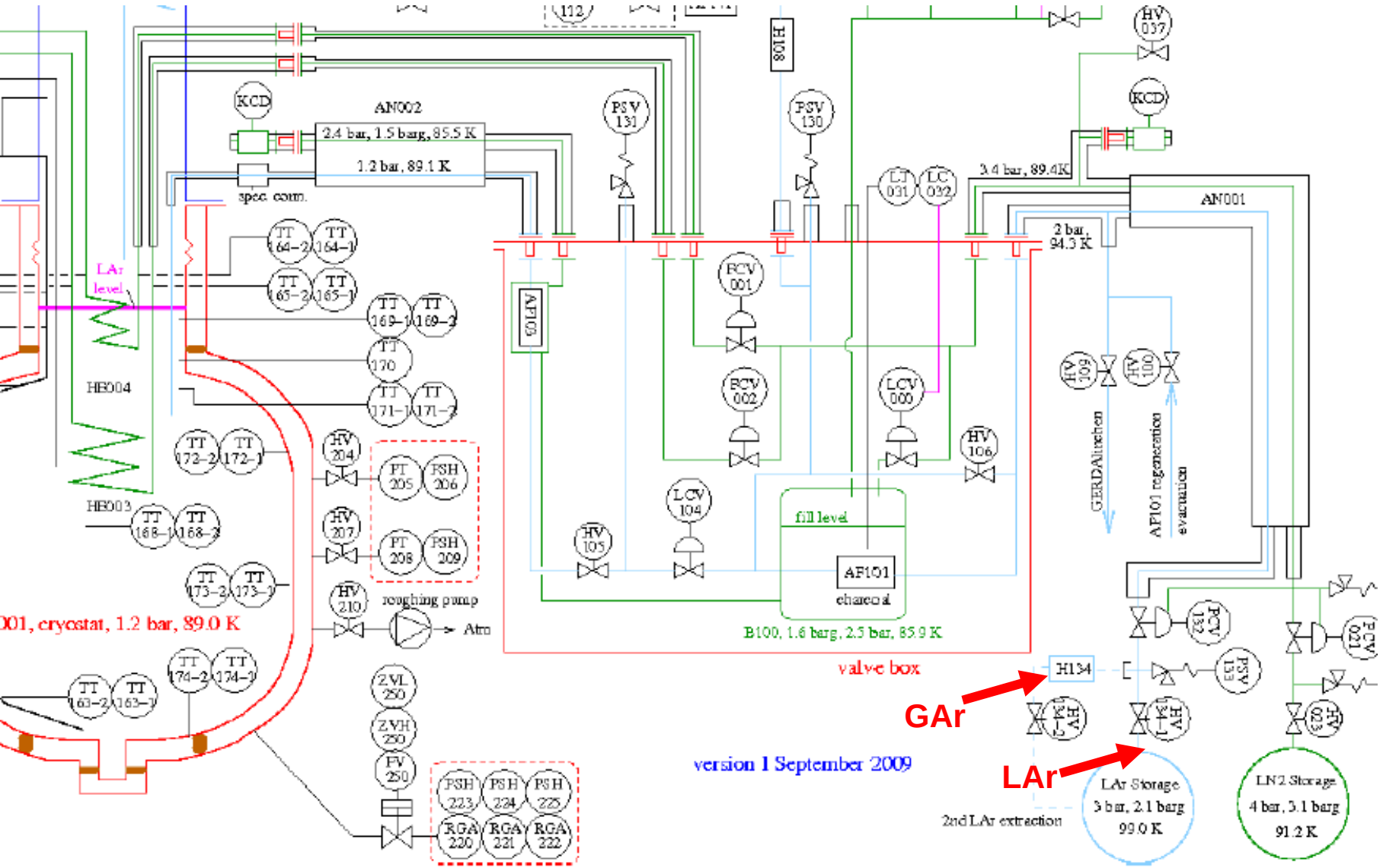
LAr to be taken from storage tank (6.3m^3) – needed (7+x) m^3

starting conditions

- no water in water tank
- isolation vacuum <10^{-3} mbar
- safety valve of isolation vacuum unlocked
- all other valves in defined status

Constraints: flash gas < 250 m^3/h,
low temperature gradients

mixing of gas and liquid

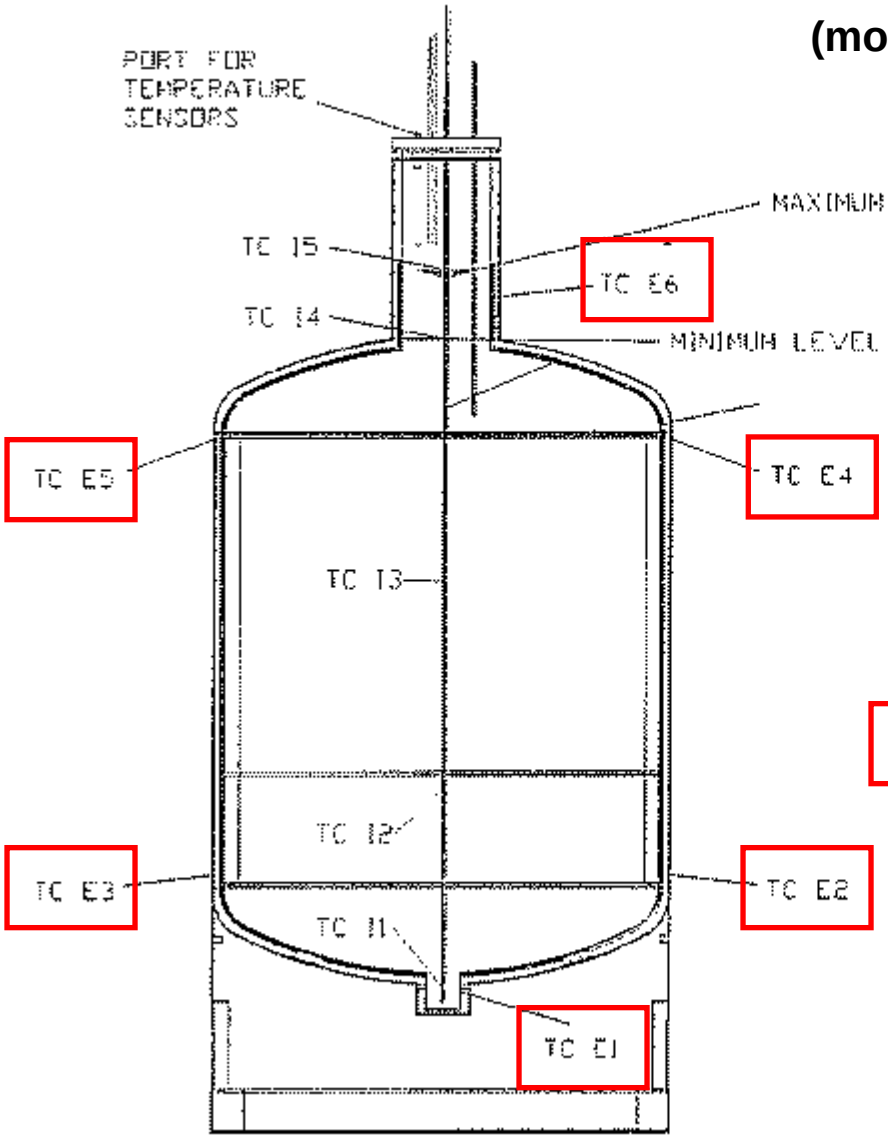


alternative:
use ~3m^3 LN2 storage tank with integrated heater; connect at HV109

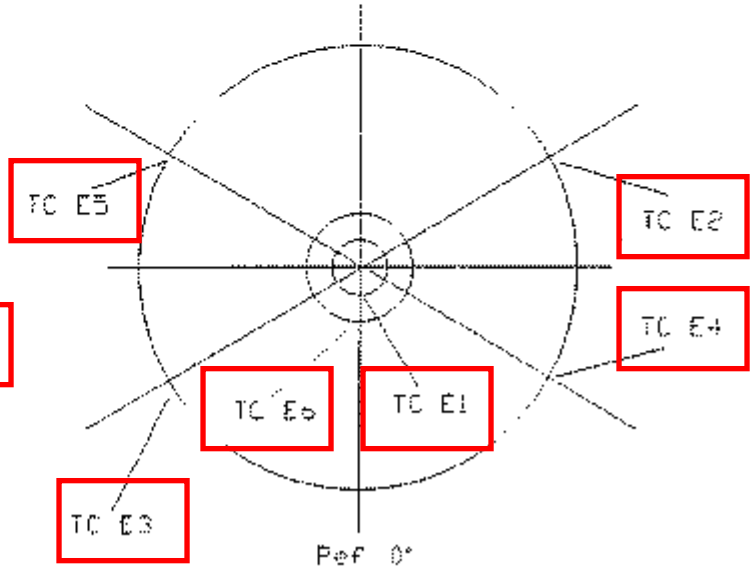
circular end of fill tube with many holes - avoid cold spots!

thermocouples TC E1 - E6

(mounted on outer surface of inner container)



temperature drop <20 deg/h
ΔTij < 50 deg (no cold spots!)



Cool down done if temperature readings are <100 K.

Slow process, we plan 1 week.

No constraints for TIR tunnel since LAr will be taken from storage tank.

LAr fill

Filled from LAr tanker via storage tank – needed (64+x) m^3

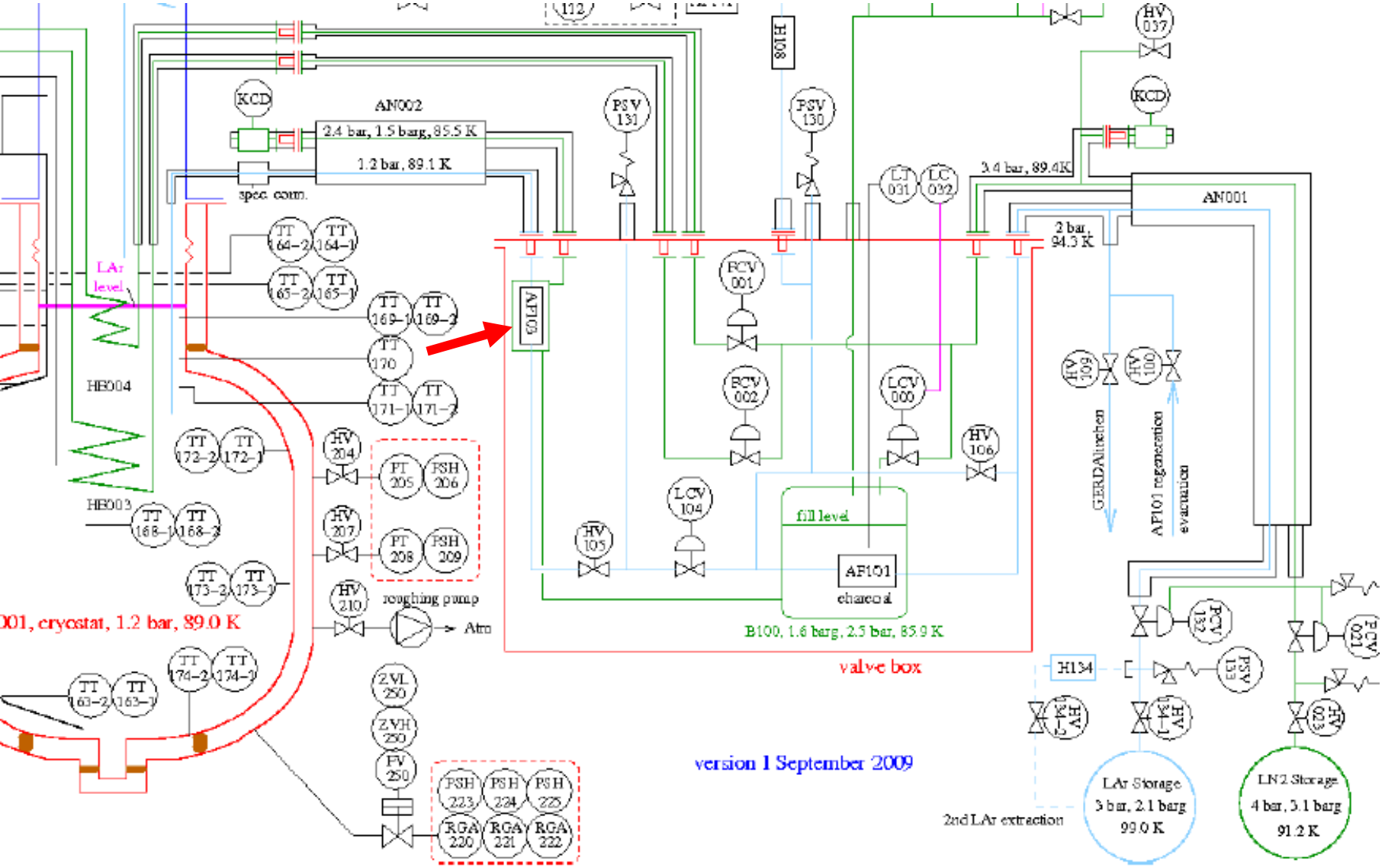
Starting conditions

- no water in water tank
- cryostat completely cool
- isolation vacuum $<10^{-5}$ mbar
- all relevant valves in defined status
- tanker‘s output connected to storage tank‘s fill line
- pressure in storage tank 2 barg

Constraints: during fill cryostat pressure must be <0.5 barg.

Fill level monitored by Pt100s in volume, by radar, swimmer, temperature and vapour pressure sensors in neck – can be also deduced from tanker‘s flow meter.

Filling can be fast, in principle.
However, fill rate might be limited by ultrafine filter AF103



Assuming fill rate of 1m^3/h, fill would take 64 hours.

Tanker with 20m^3 would block TIR tunnel for 20 hours.
Possible scenario:

tanker 1 starting fill on a Friday 4 pm
tanker 2 continues on Saturday noon
tanker 3(4) complete fill at the following weekend.

alternative 1:

fill during nights from 7 pm to 7 am

alternative 2:

fill from storage tank

Optimized plan will be available as soon as throughput of filter has been measured.

Commissioning of cryogenic infrastructure

The three major tasks*:

1) automatic refill of cryostat

2) final automatic regulation of pressure in cryostat

3) active cooling system (with DeMaCo participation)

* assuming that PLC and all individual components are working according to specs.

1) automatic refill of cryostat

calibrate all the various fill level sensors
in cryostat‘s neck

- radar
- swimmer
- Pt100s
- vapour pressure sensors (2 pcs)

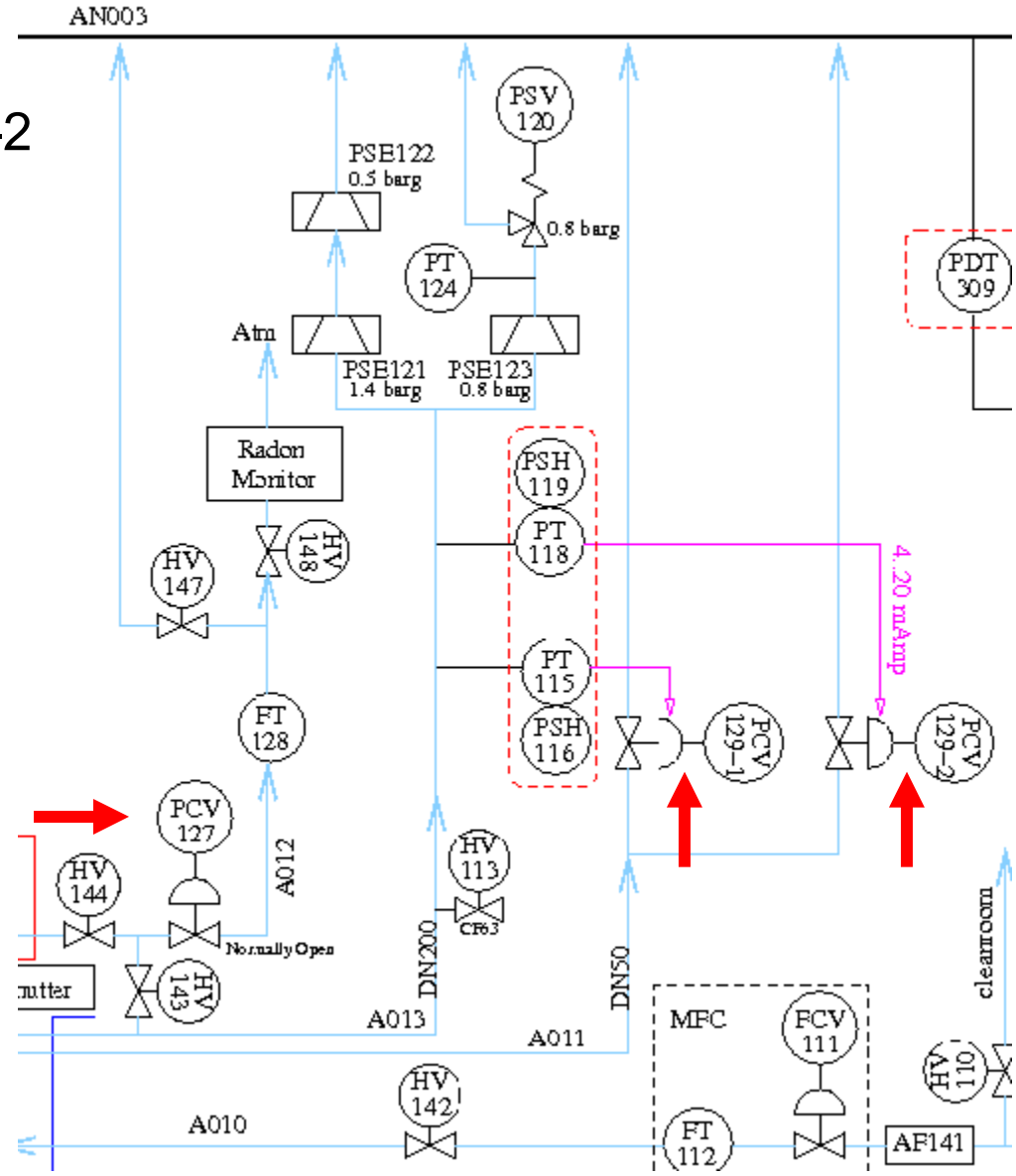
filling itself will be yes/no decision

2) final automatic regulation of pressure in cryostat

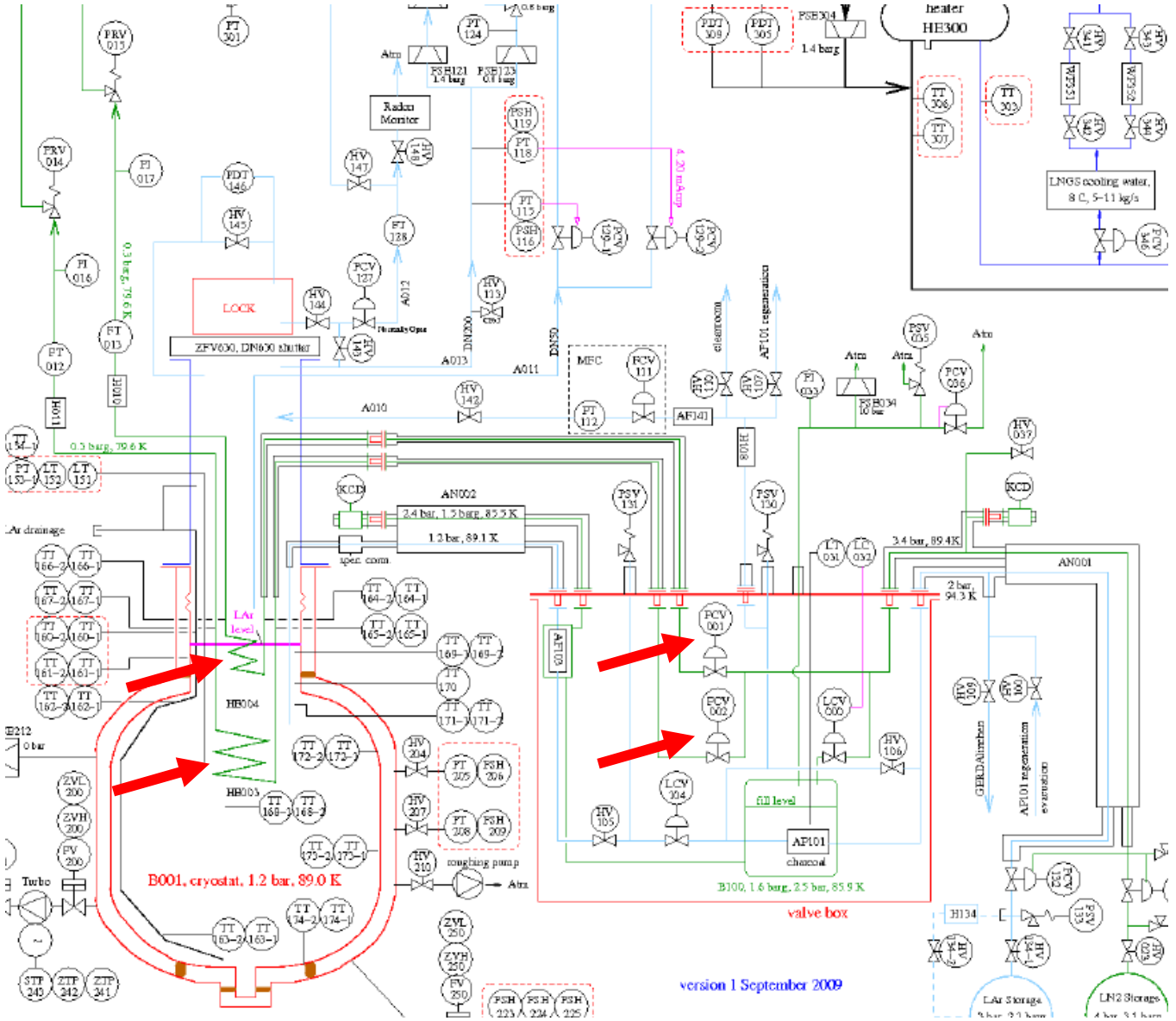
fine control PCV127
coarse control PCV129-1/-2
(redundant system)

tested already before fill
now more realistic test

set appropriate thresholds
tune PID parameters



3) active cooling system - complex, long time constants



find optimized PID parameters

Conclusion

GERDA cryostat practically ready for fill - waiting for OK from LNGS

► ad hoc meeting this Wednesday, 15:30

Time budgets:

cool down:	1 week
LAr fill:	2 weekends or 6-7 nights (best guess)
thermal equilibration	3 days

► ready for running

Cryo-commissioning after fill:

refill, pressure regulation, active cooling	1 month altogether – minimum.

Agenda of meeting on 30th September, 3:30 pm, Occhialini room:

1) Safety & control systems: status of works, mangement of system.

2) GERDA exhaust gas heater: commissioning, functionality, and water supply.

3) Connection between GERDA heater and LNGS ventilation plant:status.

4) Shift & personnel during cooling down operations? Shifters or on call persons during GERDA start up and data taking?

5) Safety procedures in case of seismic event: emptying of water tank automatically or only in case of pressure/temperature alarms.

6) GERDA – laboratory drainage water plant: test of the system, installation of an additional automatic valve to the available manual valve?

7) Integration of all safety plants (GERDA & LNGS) and procedures: test and commissioning before water filling.

8) Seismic analysis: integration of all parts in a single one.

9) Management of 40t crane in hall A.

the end