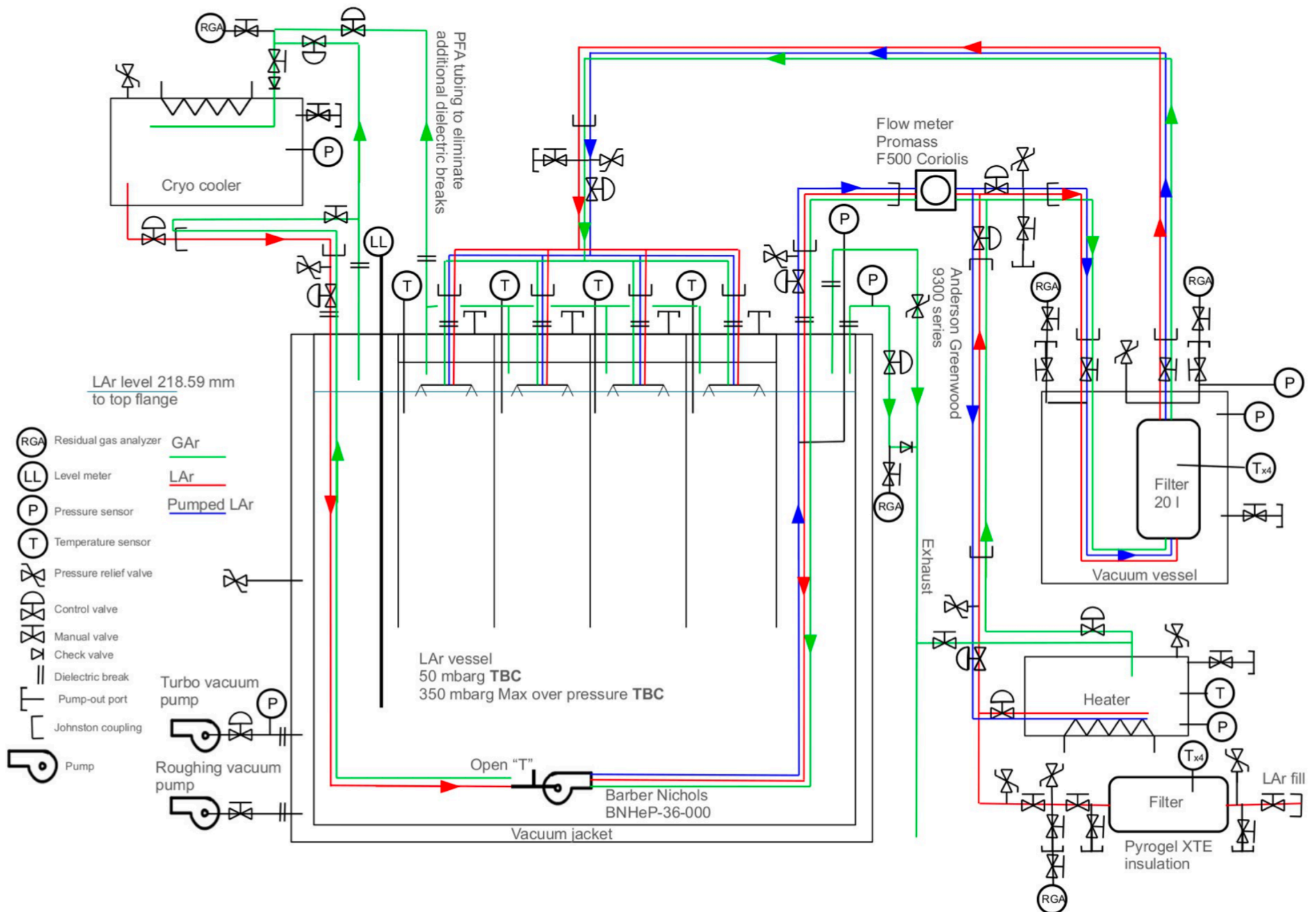


UPDATE ON CRYOGENIC SYSTEM DESIGN FOR ARGONCUBE 2X2



JUL 12, 2021

DAVIDE PORZIO
LHEP - UNIVERSITY OF BERN



Cryo Cooler

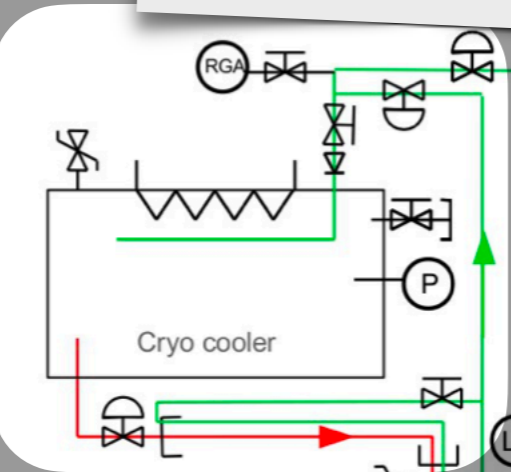
MAIN COMPONENTS

Flow Meter

Recirculation Filter in Vacuum Vessel

Heater

Cryostat + Modules



PFA tubing to eliminate additional dielectric breaks

LAr level 218.59 mm to top flange

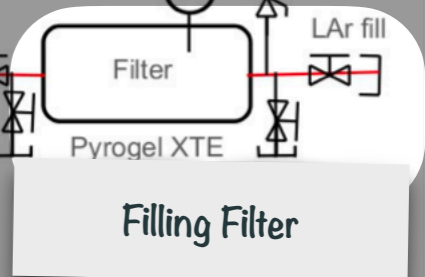
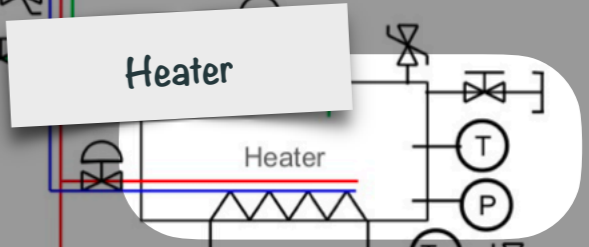
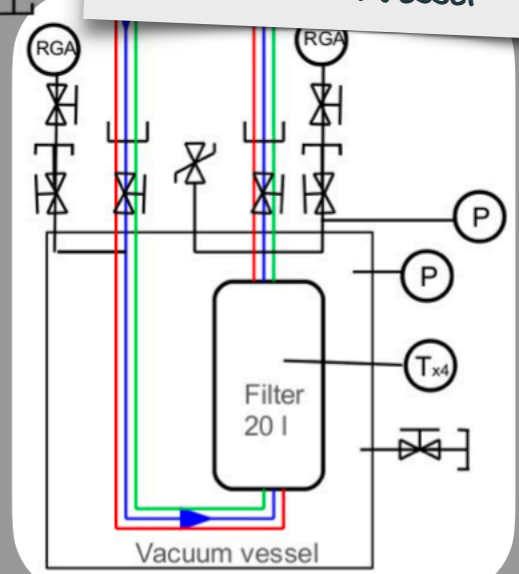
- RGA Residual gas analyzer
- LL Level meter
- P Pressure sensor
- T Temperature sensor
- Pressure relief valve
- Control valve
- Manual valve
- Check valve
- Johnston coupling
- Pump

Pumps

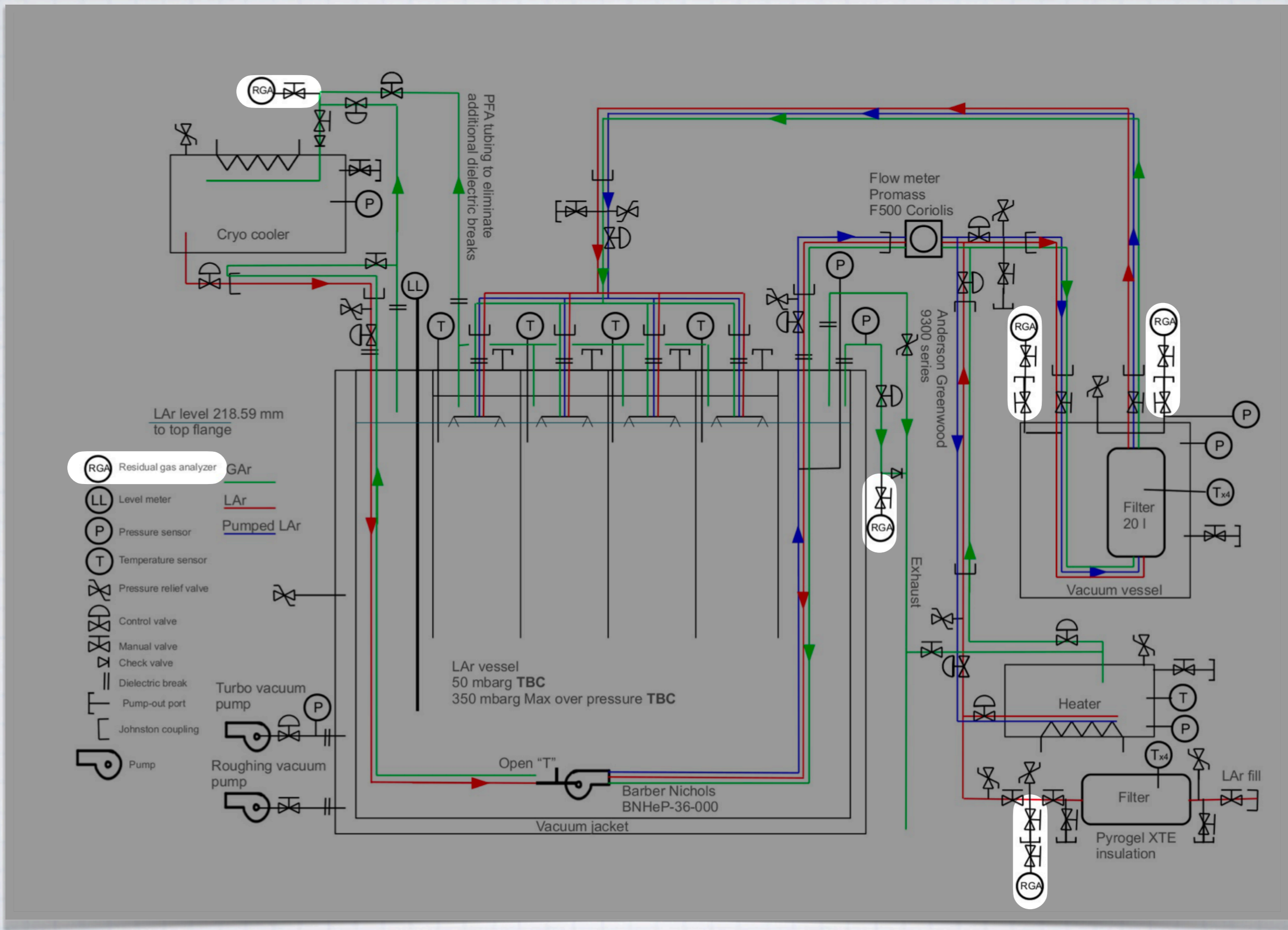
Roughing vacuum pump

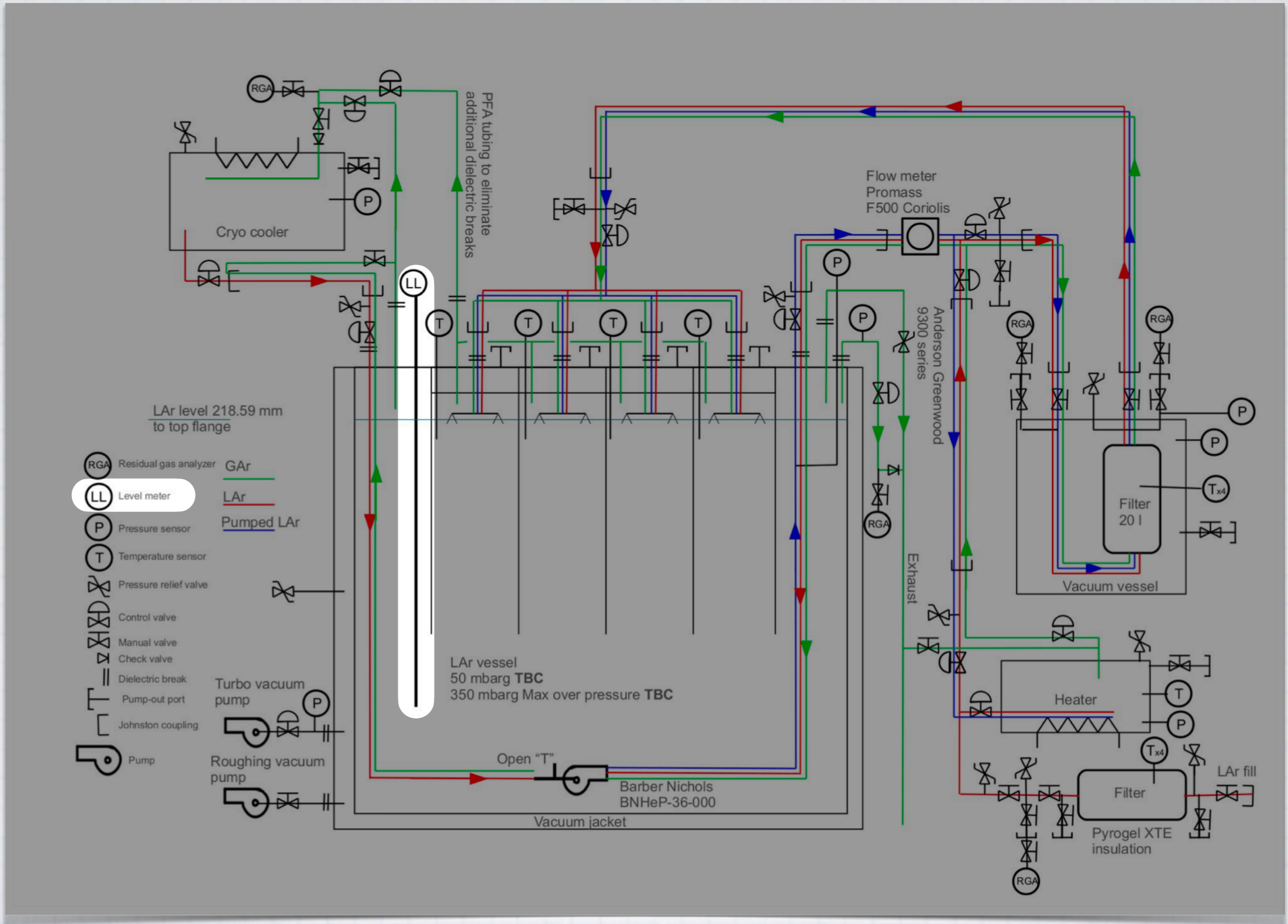
LAr vessel
50 mbarg TBC
350 mbarg Max over pressure TBC

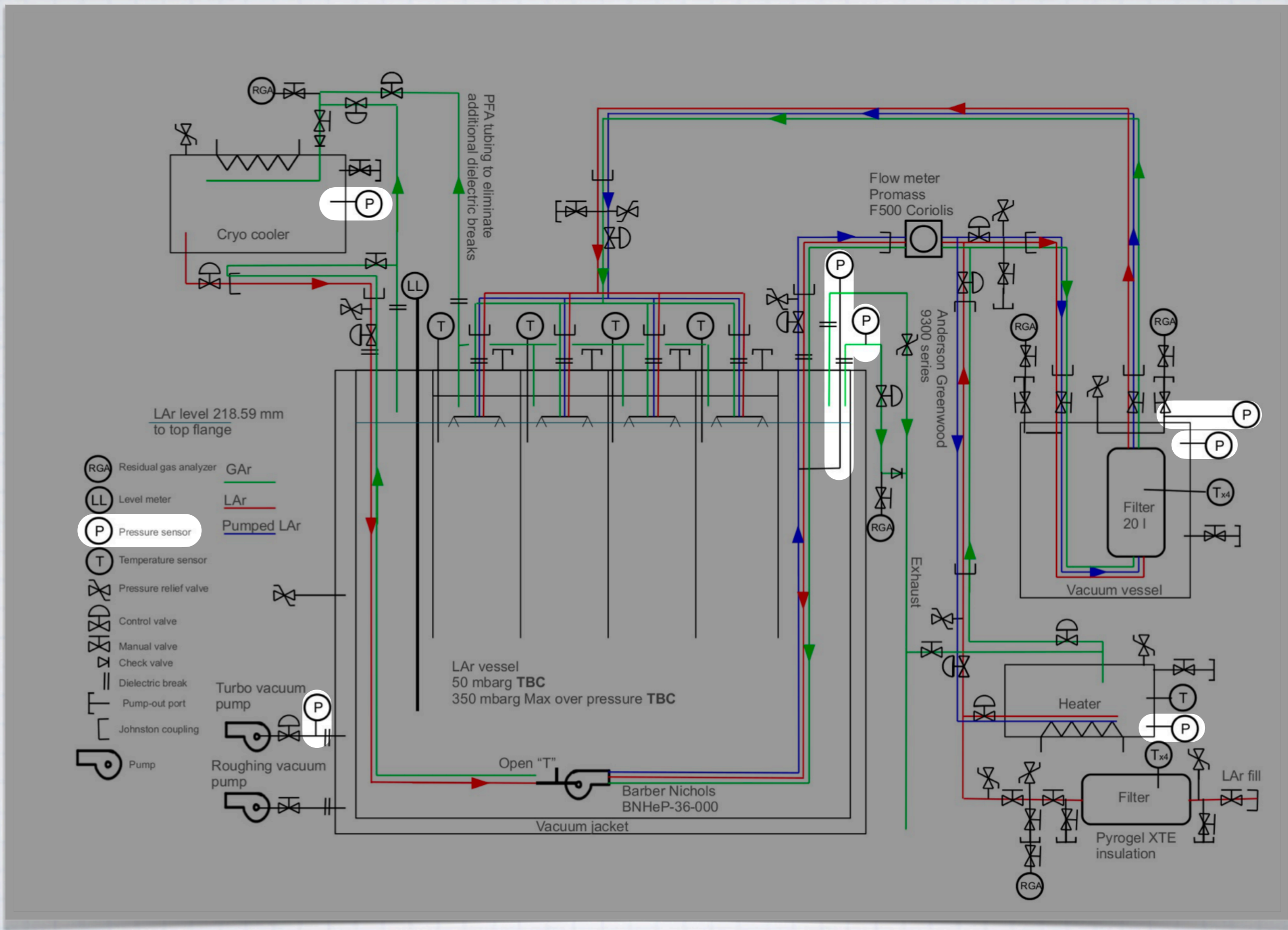
Barber Nichols BNHeP-36-000

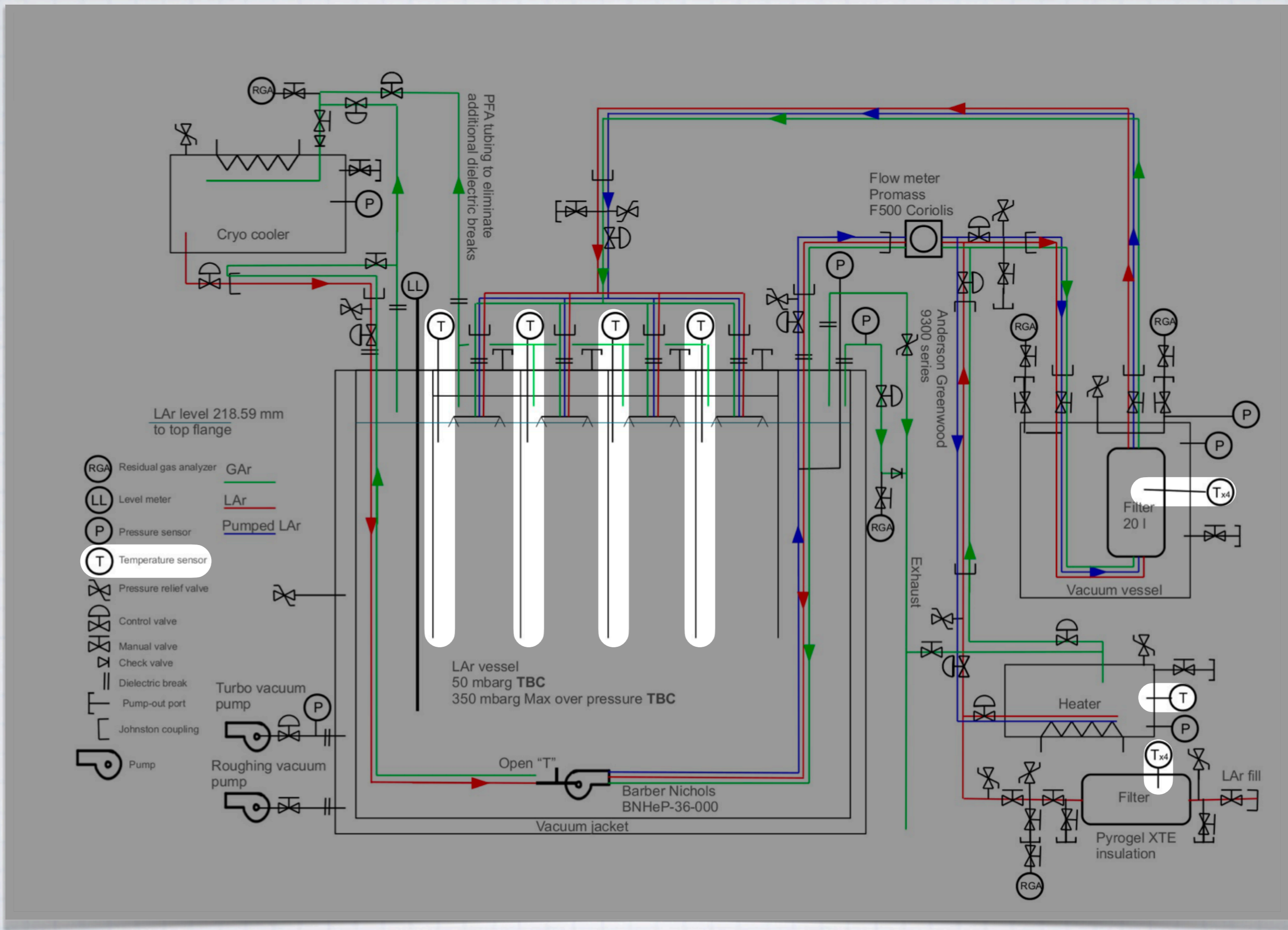


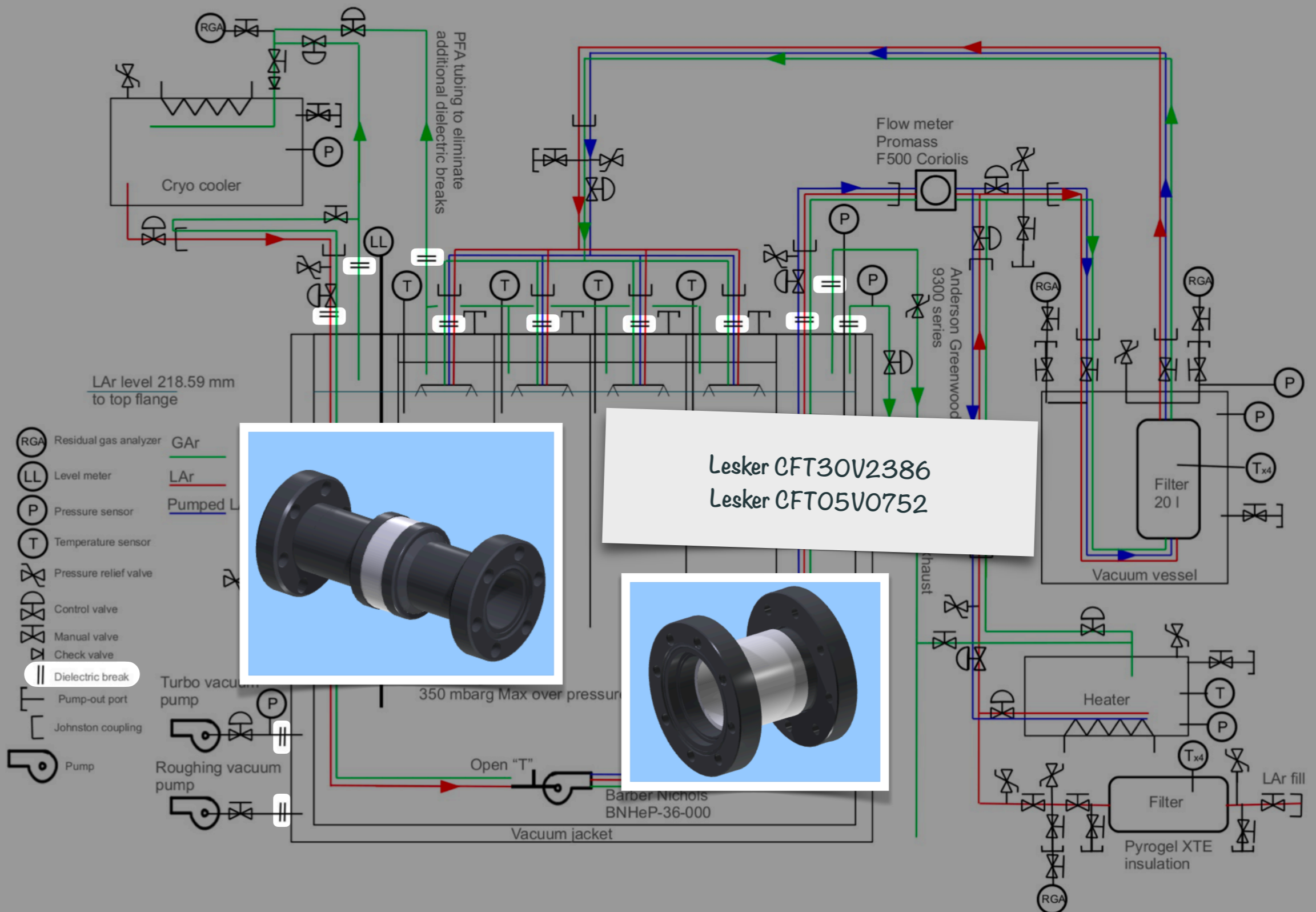
Filling Filter









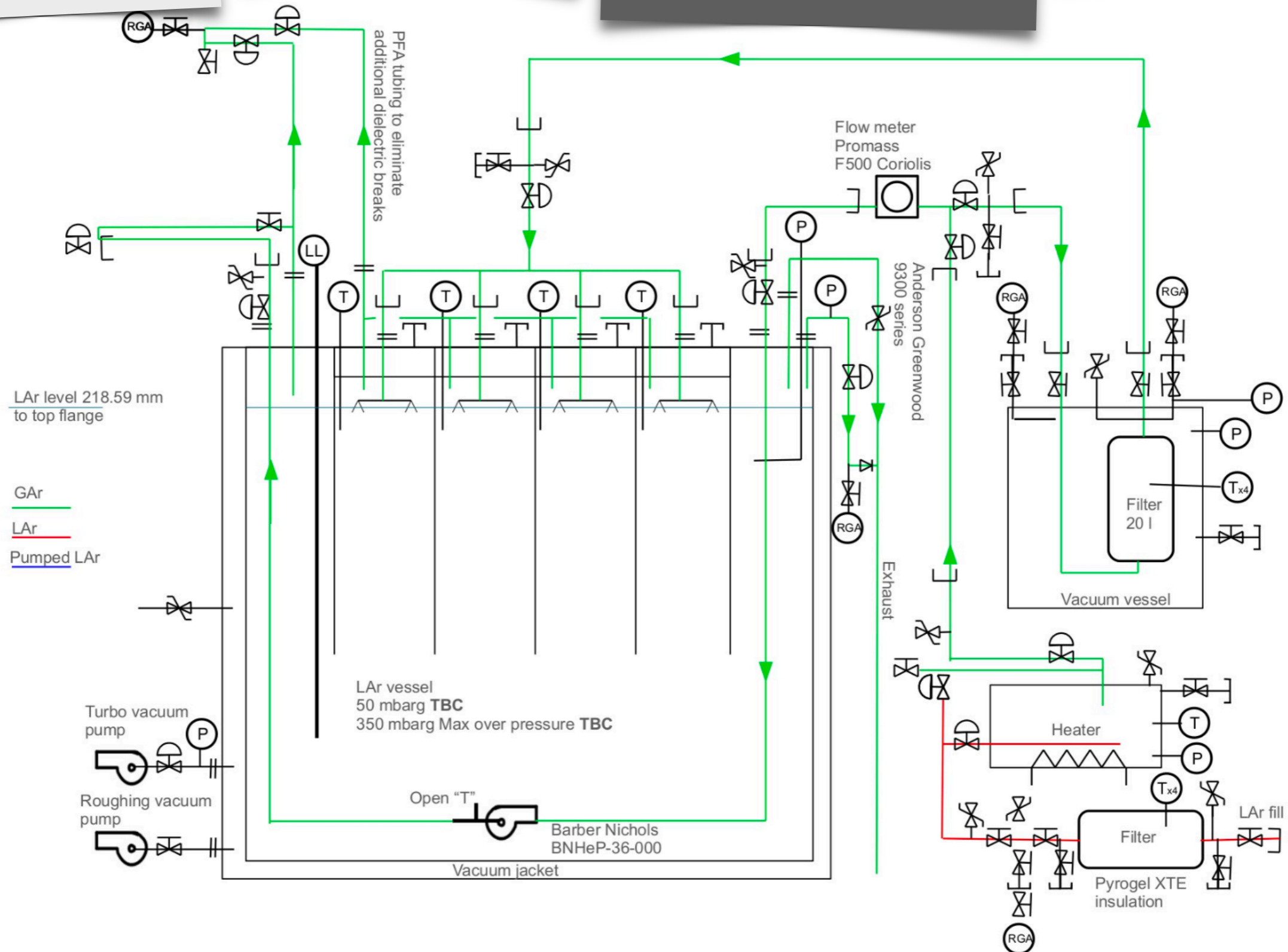


PISTON PURGE

FILLING

NORMAL OPERATION

DRAINING

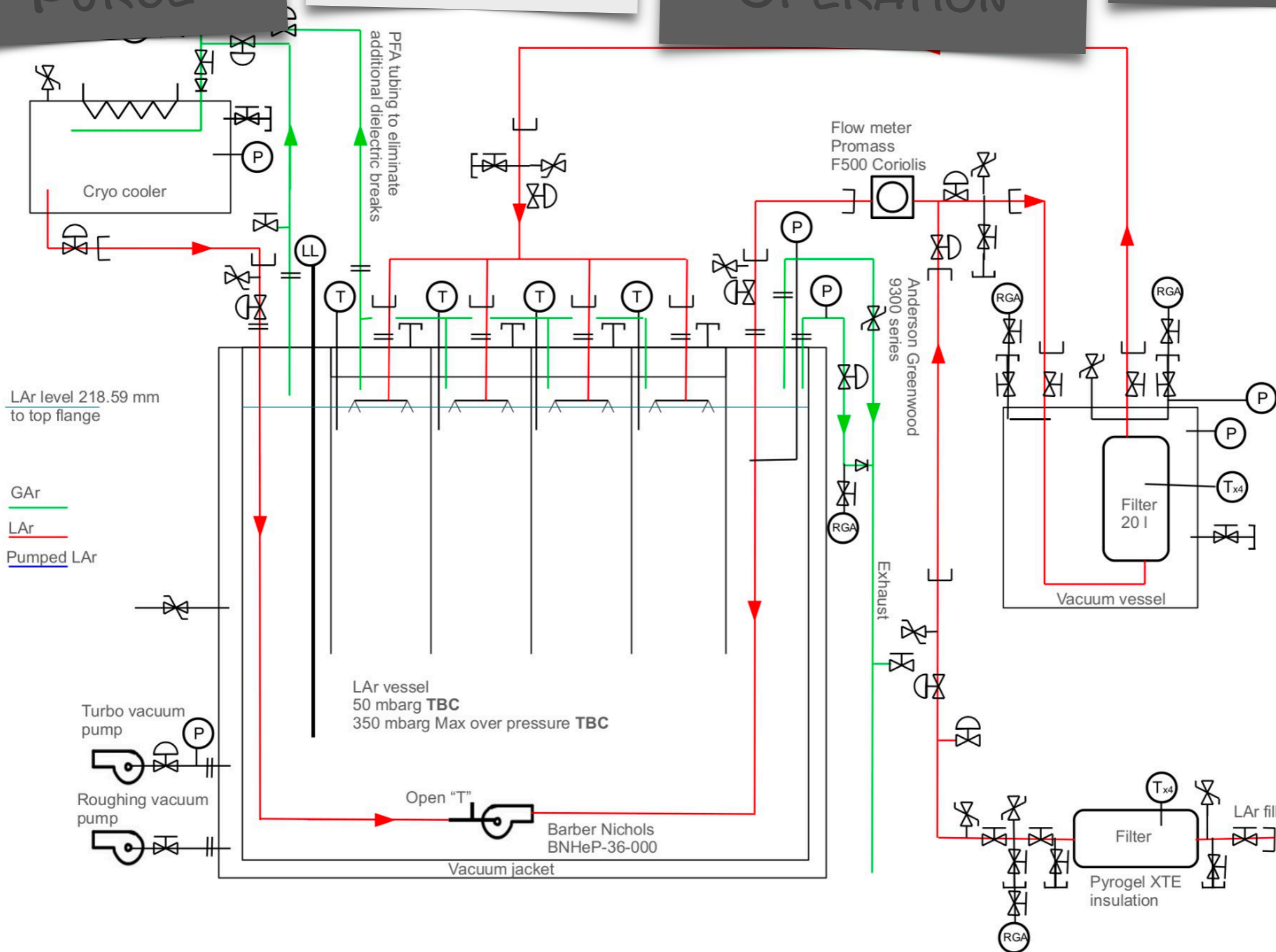


PISTON PURGE

FILLING

NORMAL OPERATION

DRAINING

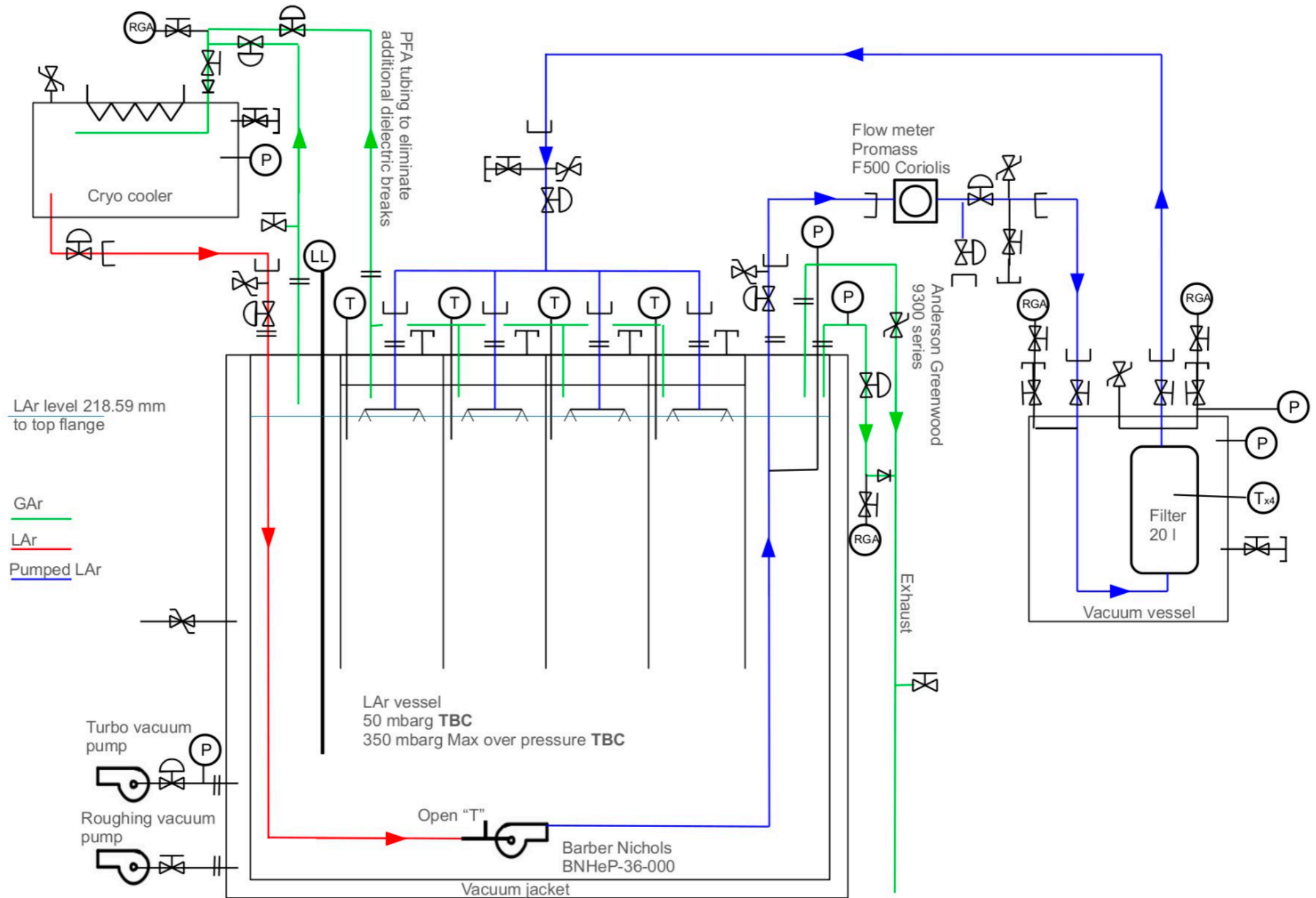


PISTON PURGE

FILLING

NORMAL OPERATION

DRAINING

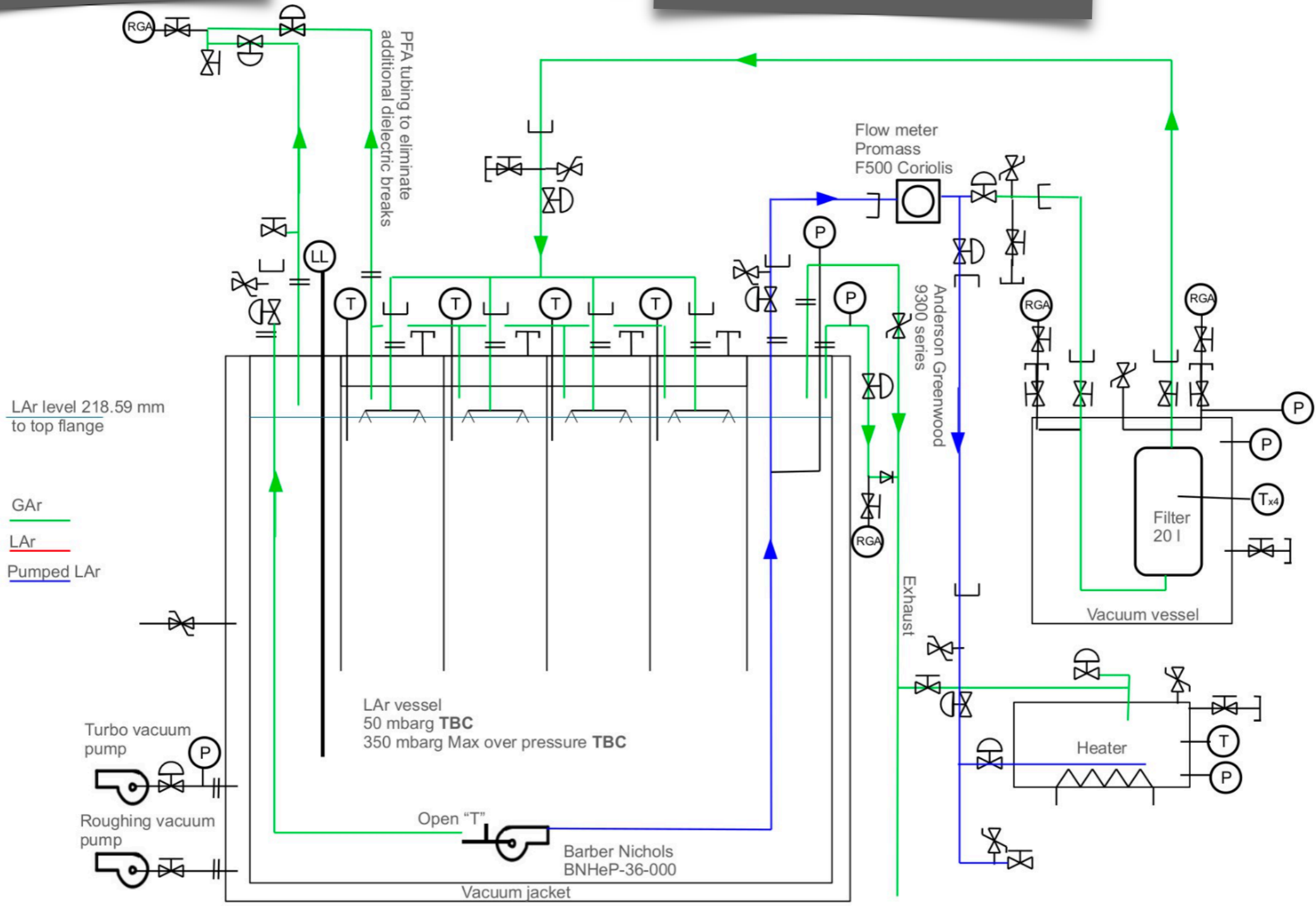


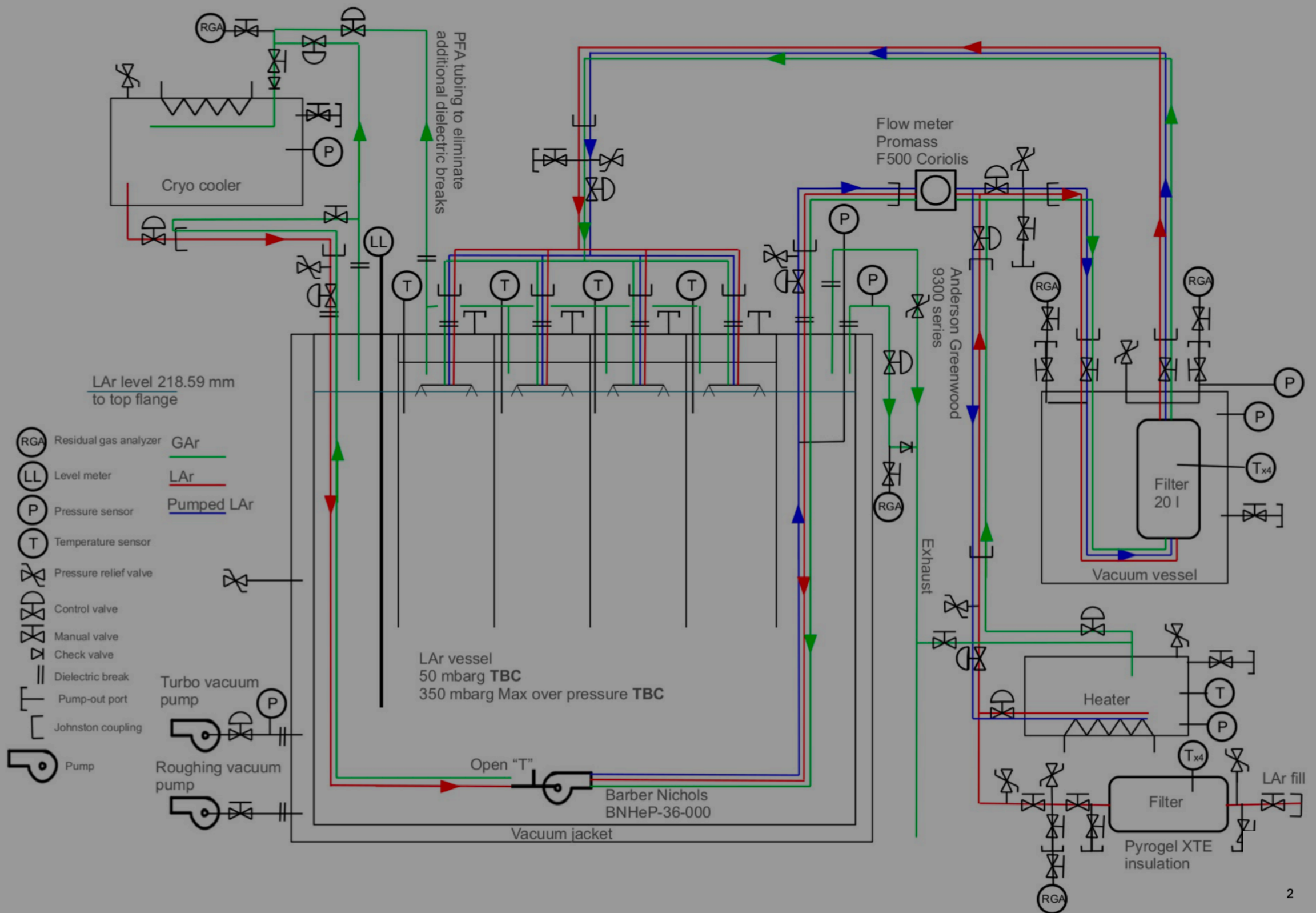
PISTON PURGE

FILLING

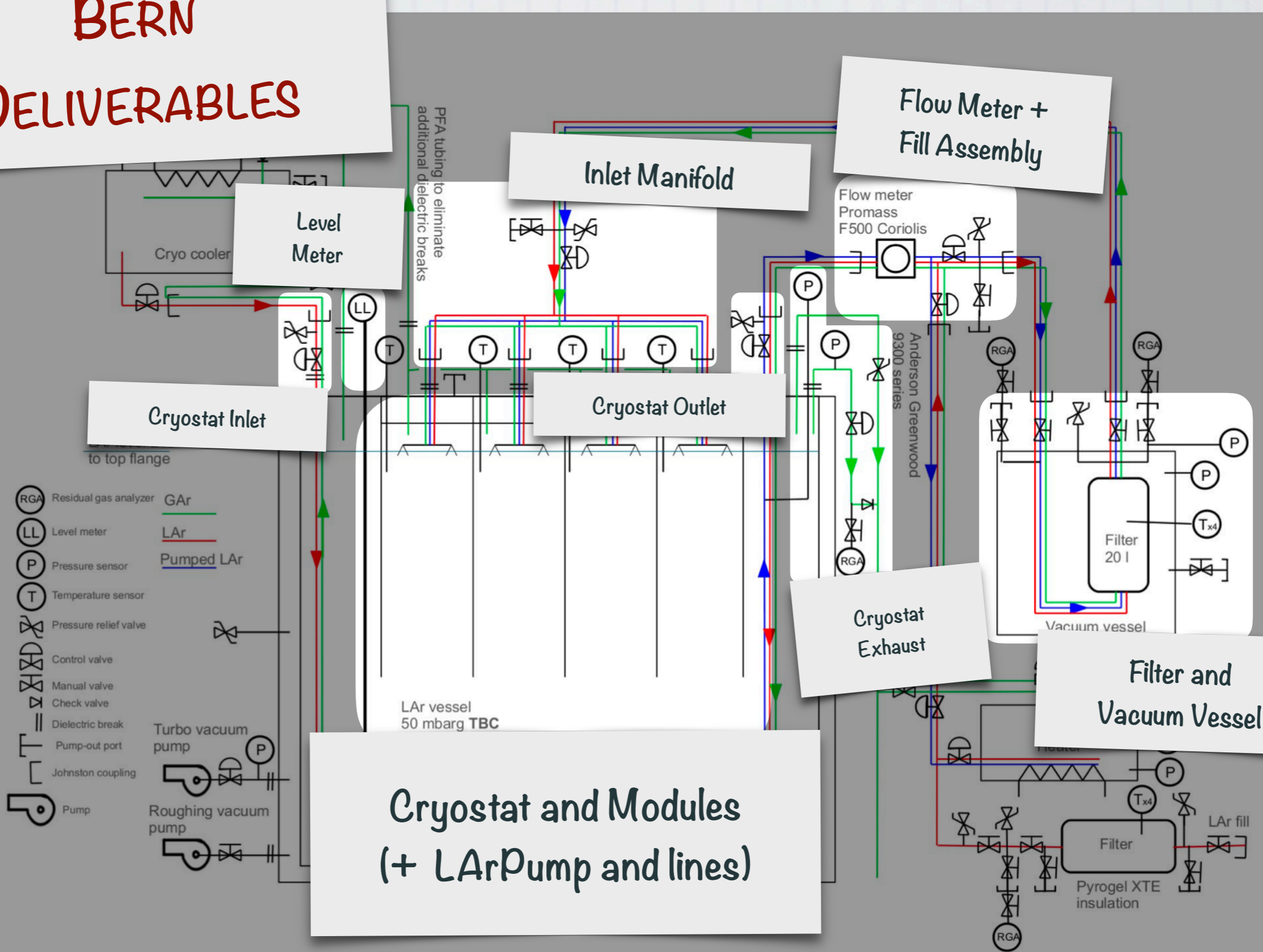
NORMAL OPERATION

DRAINING





BERN DELIVERABLES



Level Meter

Inlet Manifold

Flow Meter + Fill Assembly

Cryostat Inlet

Cryostat Outlet

Cryostat Exhaust

Filter and Vacuum Vessel

Cryostat and Modules (+ LAr Pump and lines)

- (RGA) Residual gas analyzer GAr
- (LL) Level meter LAr
- (P) Pressure sensor Pumped LAr
- (T) Temperature sensor
- Pressure relief valve
- Control valve
- Manual valve
- Check valve
- Dielectric break
- Pump-out port
- Johnston coupling
- Pump
- Turbo vacuum pump
- Roughing vacuum pump

PFA tubing to eliminate additional dielectric breaks

Flow meter Promass F500 Coriolis

Anderson Greenwood 9300 series

Filter 20 l

Vacuum vessel

LAr vessel 50 mbarg TBC

Filter

Pyrogel XTE insulation

LAr fill

- **Inlet manifold**
- Rigid vacuum-jacketed manifold that distributes the filtered supply to the four modules.

FROM FILTER

Inlet 1" ID Johnston female coupling

Shut off valve for port

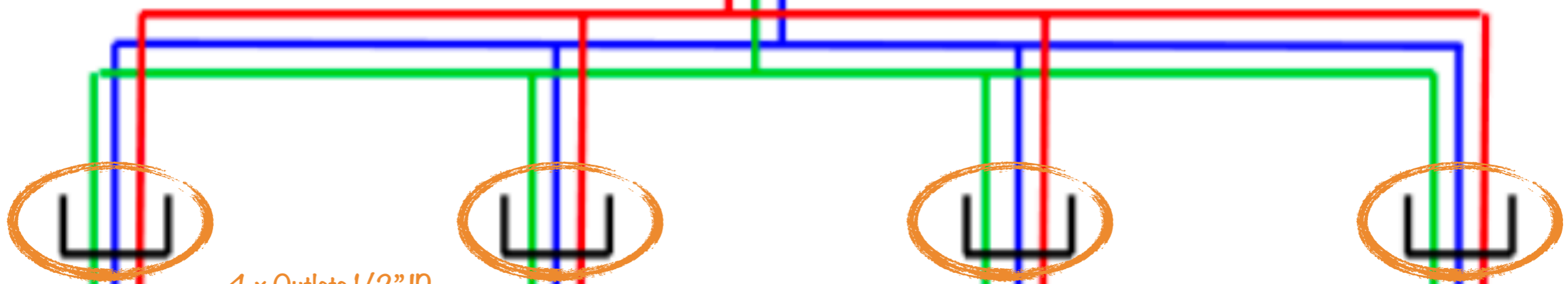
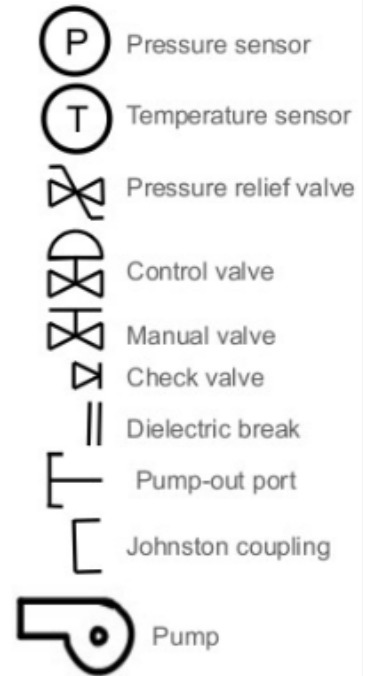
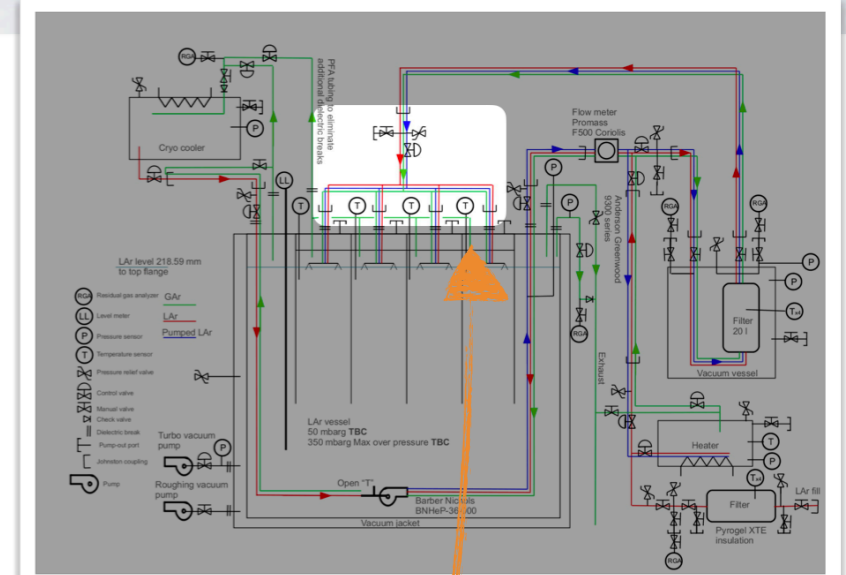
Pump-out port for line purge

Over pressure valve for line relief

Control valve

TO CRYOSTAT

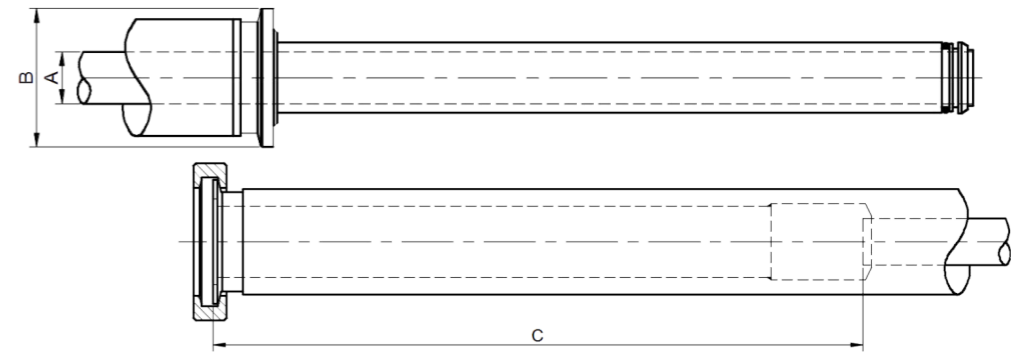
4 x Outlets 1/2" ID Johnston male coupling



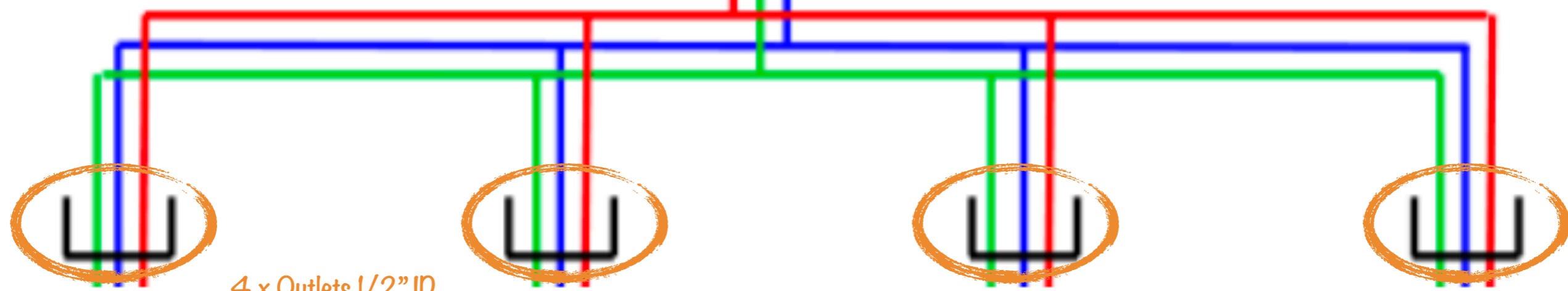
- **Johnston couplings**
- Stainless steel couplings used to connect vacuum insulated piping and vacuum insulated flexible spools.



Inlet 1" ID Johnston female coupling



- DESIGN SPECIFICATIONS**
- According Pressure Equipment Directive (PED)
 - Applicable for AD2000, EN13480 or ASME B31.3
 - Suitable for N₂, O₂, Ar, LNG, H₂, He, CO₂
 - Suitable for ambient temperatures till -35°C
 - Static vacuum with Multi-Layer Insulation
 - O-ring seal leakage <math> < 1 \times 10^{-8}</math> mbarl/sec

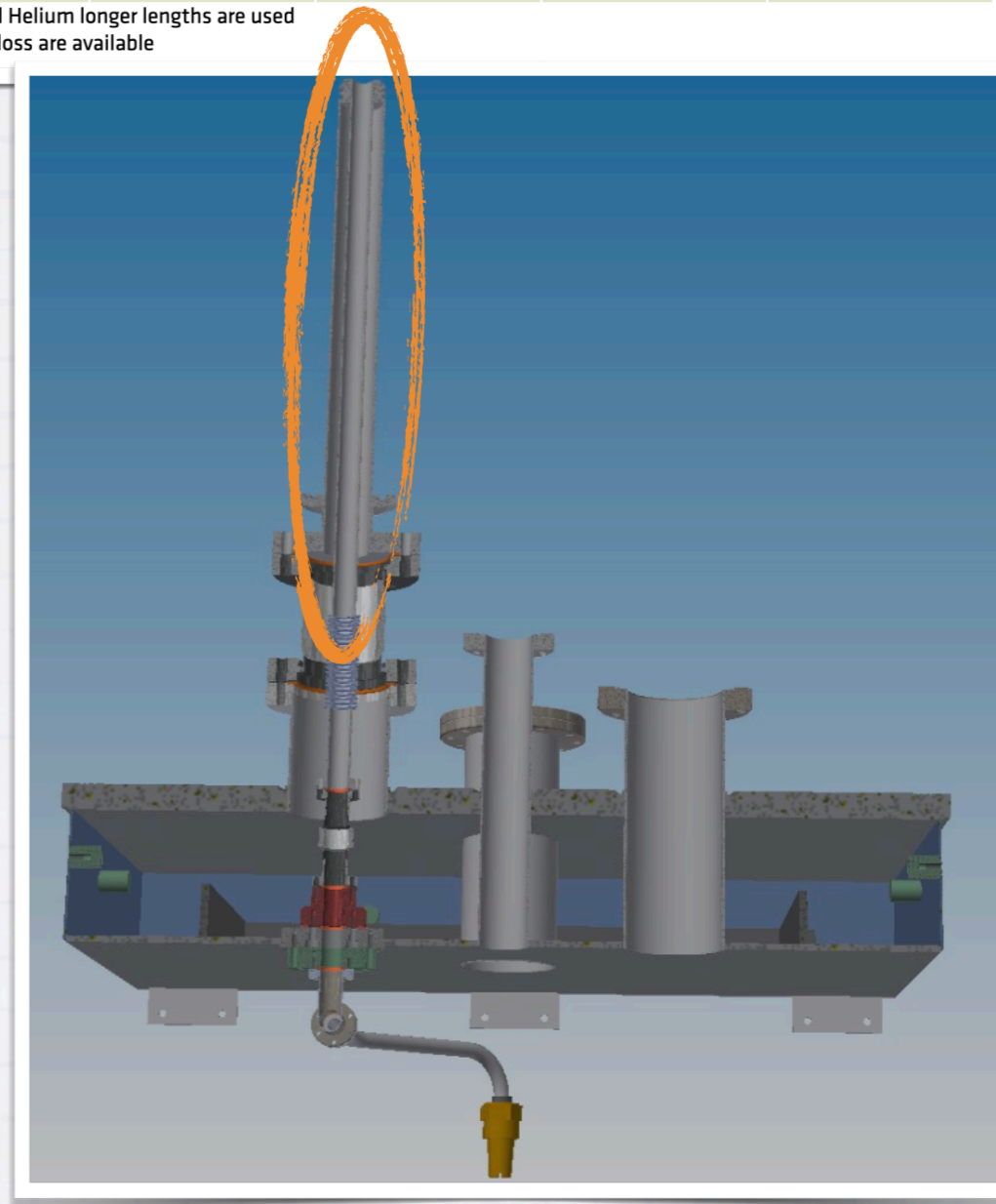
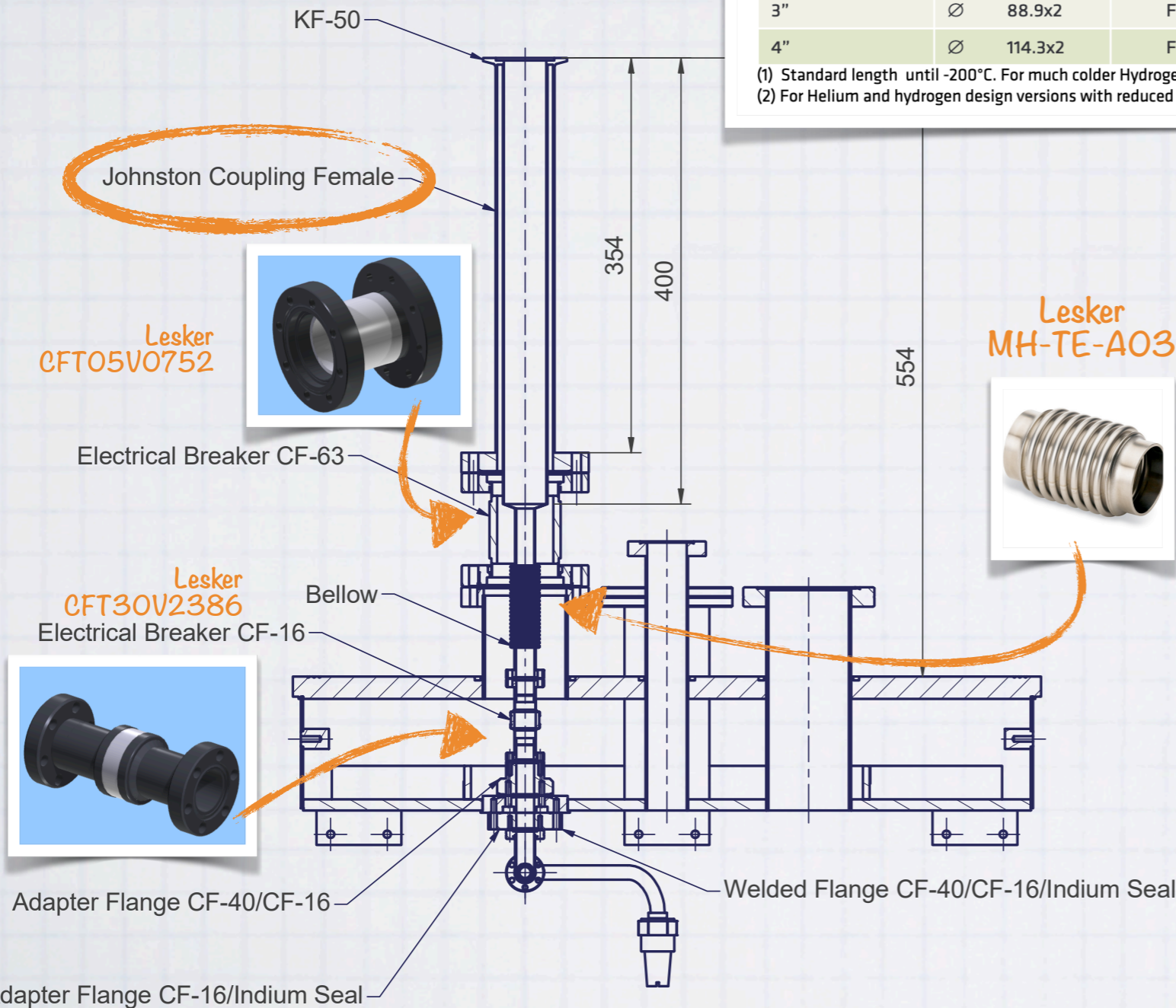


4 x Outlets 1/2" ID Johnston male coupling

- **Johnston couplings**
- Stainless steel couplings used to connect vacuum insulated piping and vacuum insulated flexible spools.

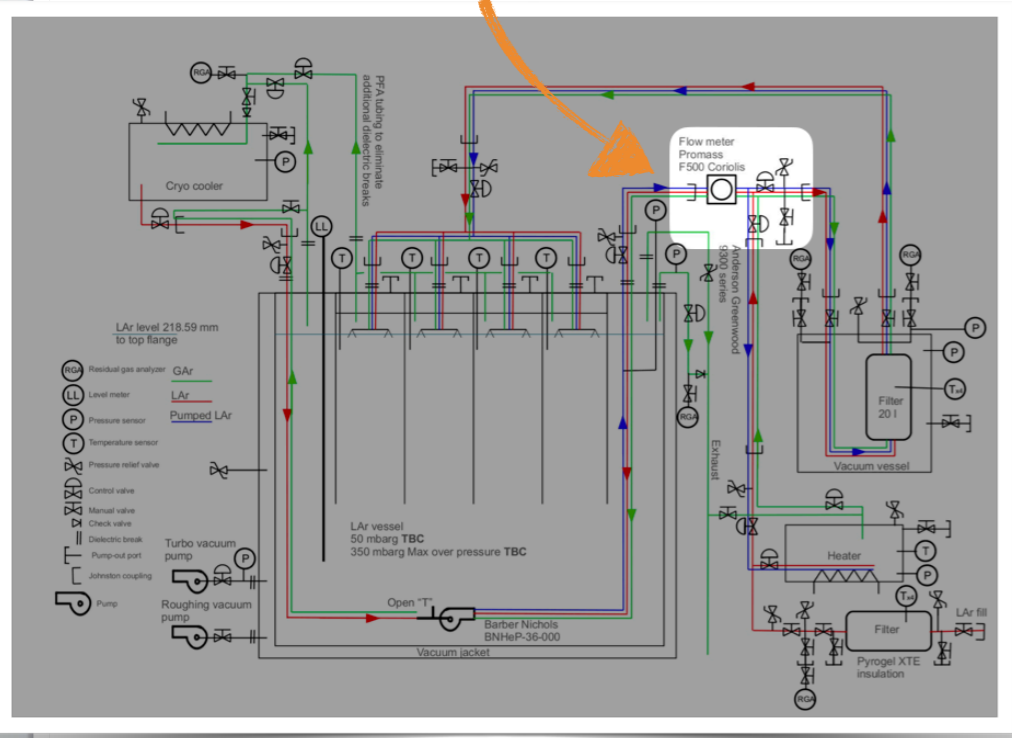
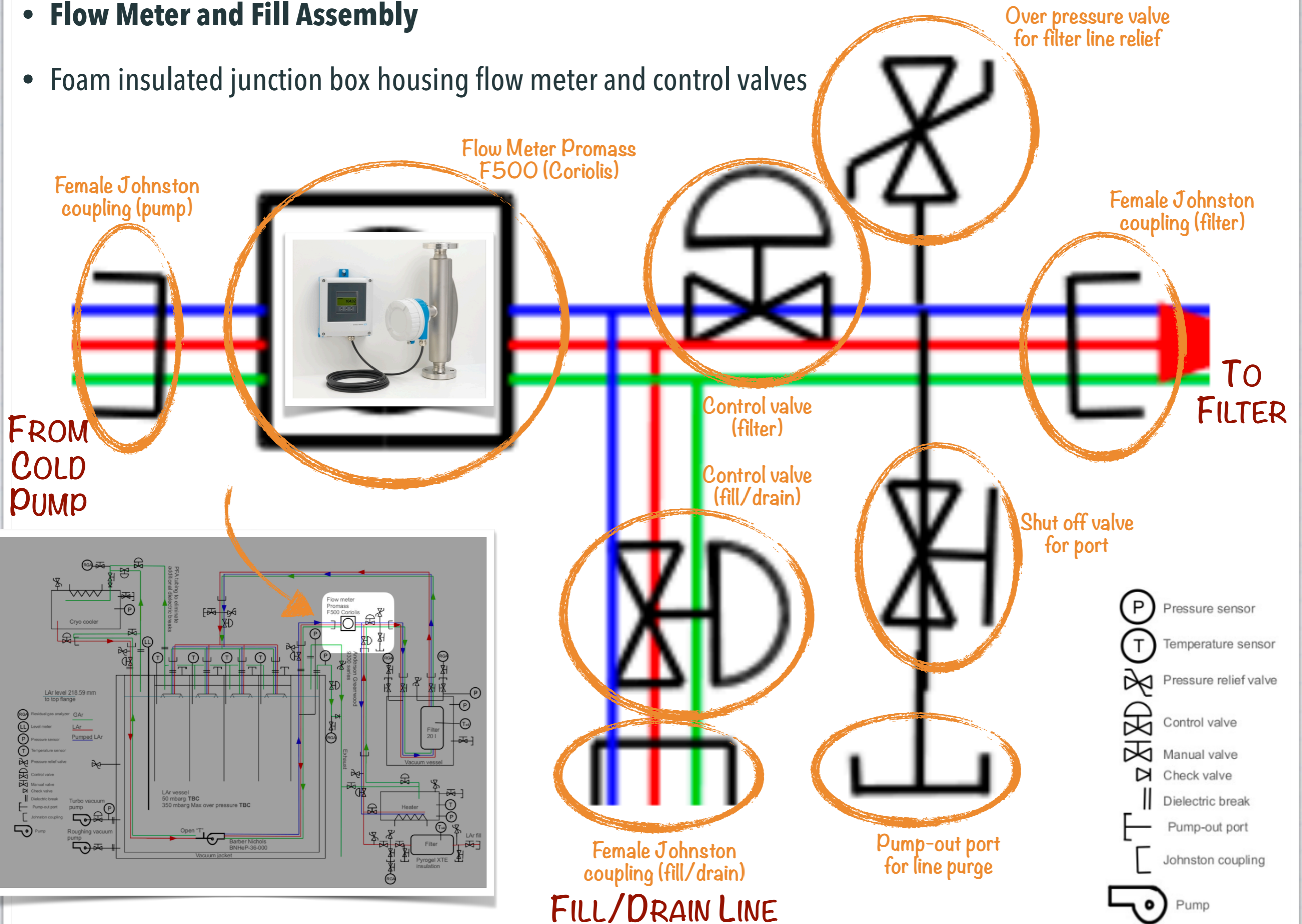
PIPE SIZE	PROCESS PIPE O.D. A - (mm)	FLANGE CONNECTION (Type)	FLANGE DIAMETER B - (mm)	COUPLING LENGTH C - (mm)	DESIGN PRESSURE (barg)	HEAT LOSS INDICATION (W)
DN10 Small	∅ 12x1	Threaded	50	225	25	2.0
DN10	∅ 12x1	KF50 Clamp	75	400	40	4.2
DN15	∅ 18x1	KF50 Clamp	75	400	40	4.2
DN25	∅ 28x1	KF50 Clamp	75	400	40	4.2
1/2"	∅ 33.7x1.6	Flanged	130	500	40	5.8
1"	∅ 48.3x1.6	Flanged	140	500	40	5.8
2"	∅ 58.3x1.6	Flanged	177	500	40	5.8
2 1/2"	∅ 76.1x2	Flanged	200	700	16	8.2
3"	∅ 88.9x2	Flanged	213	700	16	11.2
4"	∅ 114.3x2	Flanged	250	800	16	14

(1) Standard length until -200°C. For much colder Hydrogen and Helium longer lengths are used
 (2) For Helium and hydrogen design versions with reduced heat loss are available

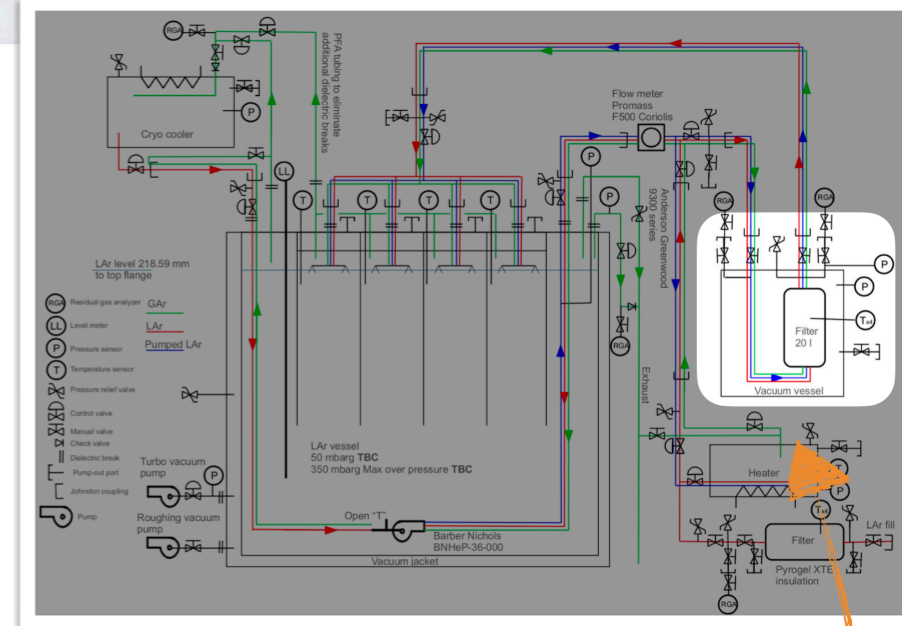
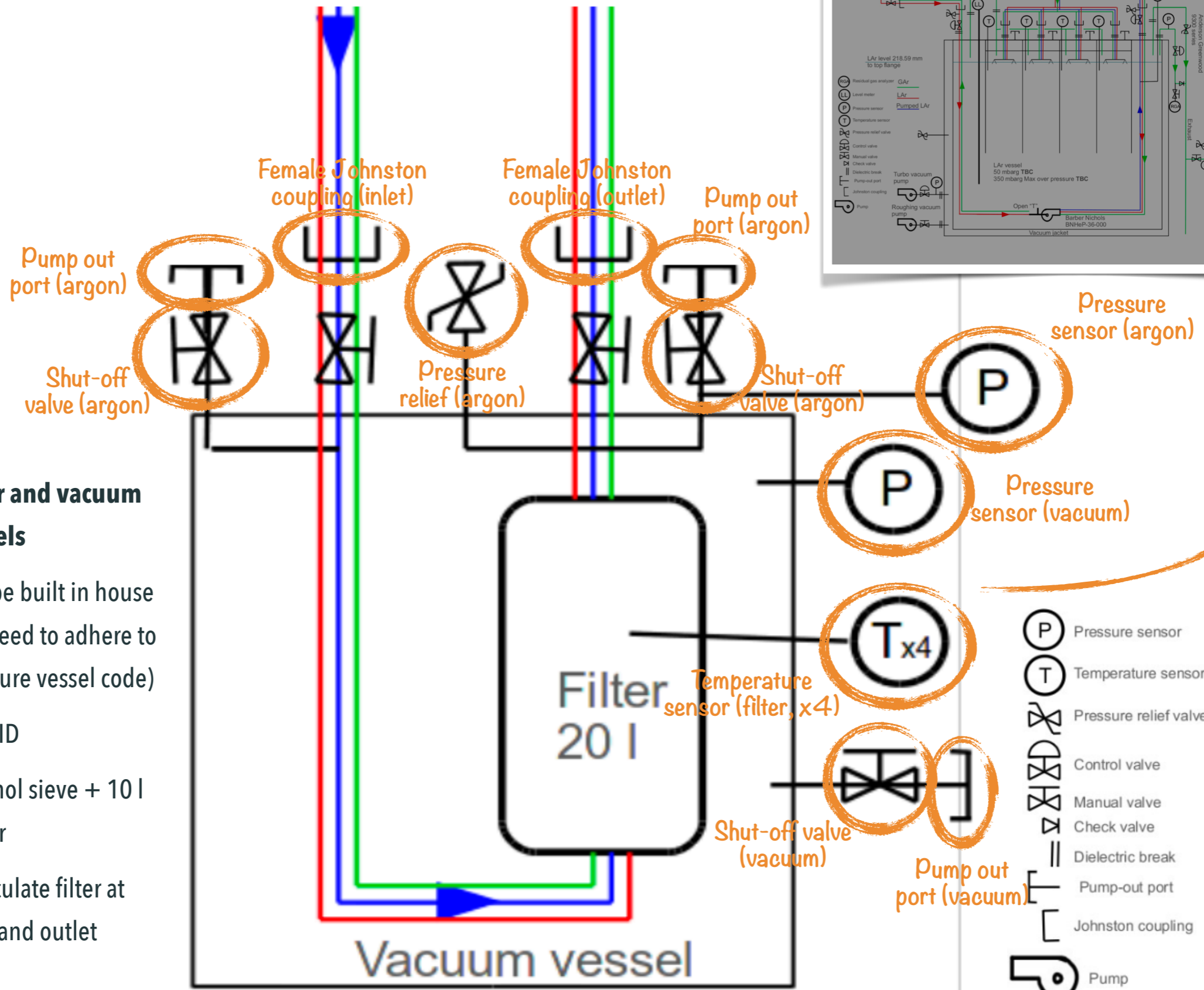


• **Flow Meter and Fill Assembly**

- Foam insulated junction box housing flow meter and control valves

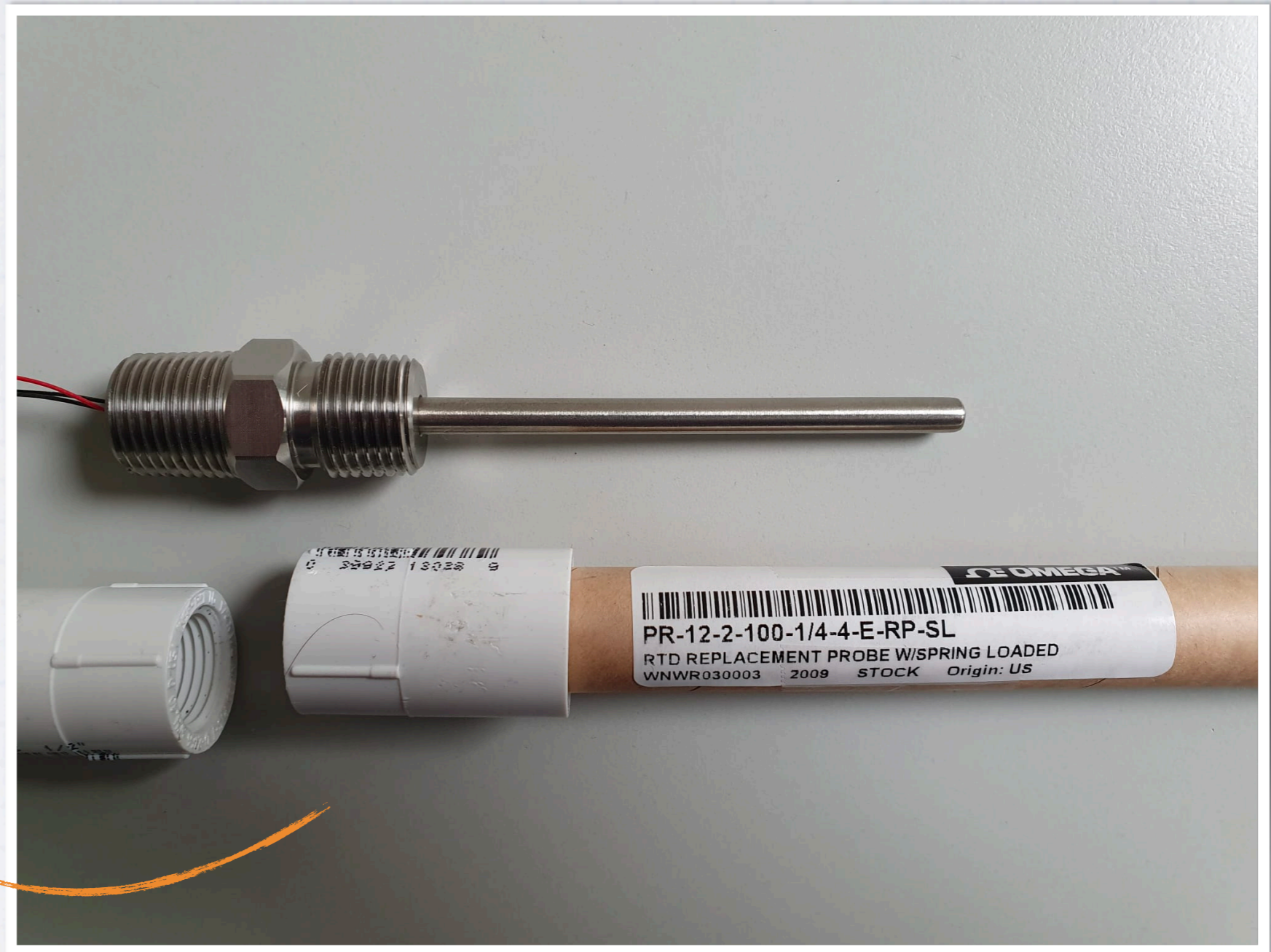
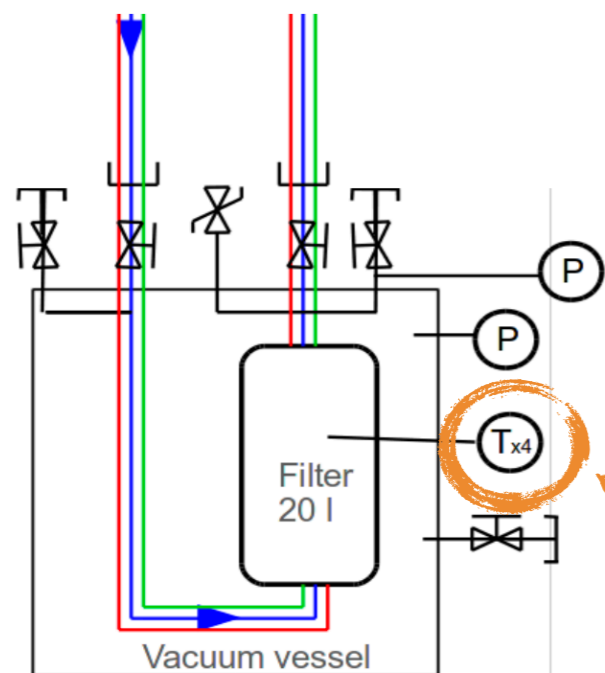


FROM PUMP/FILL LINE TO CRYOSTAT

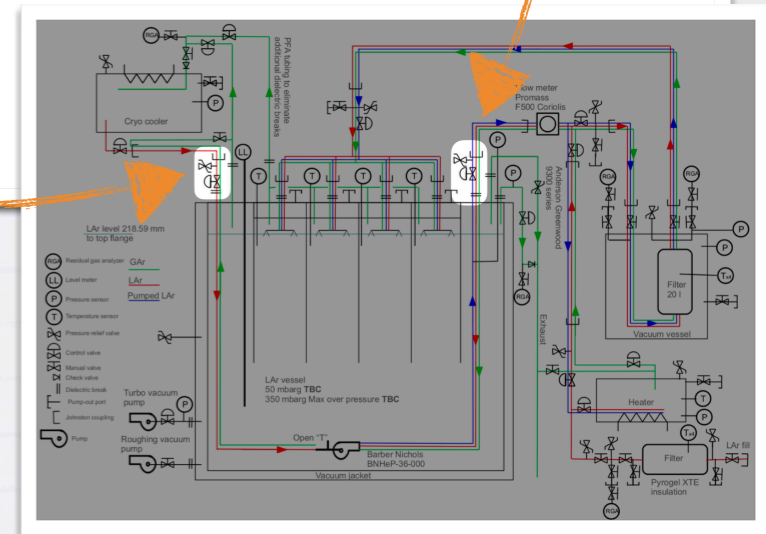
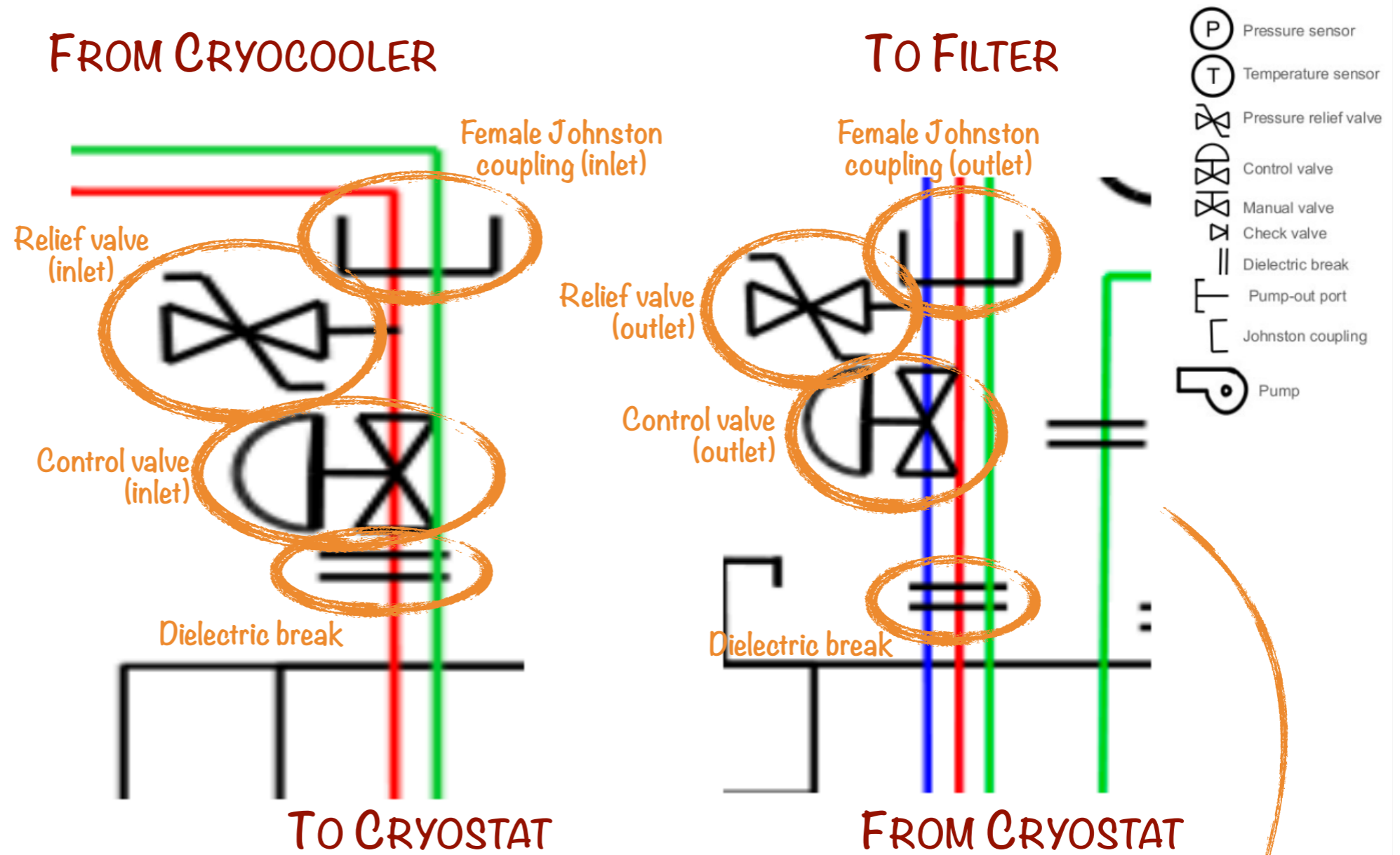


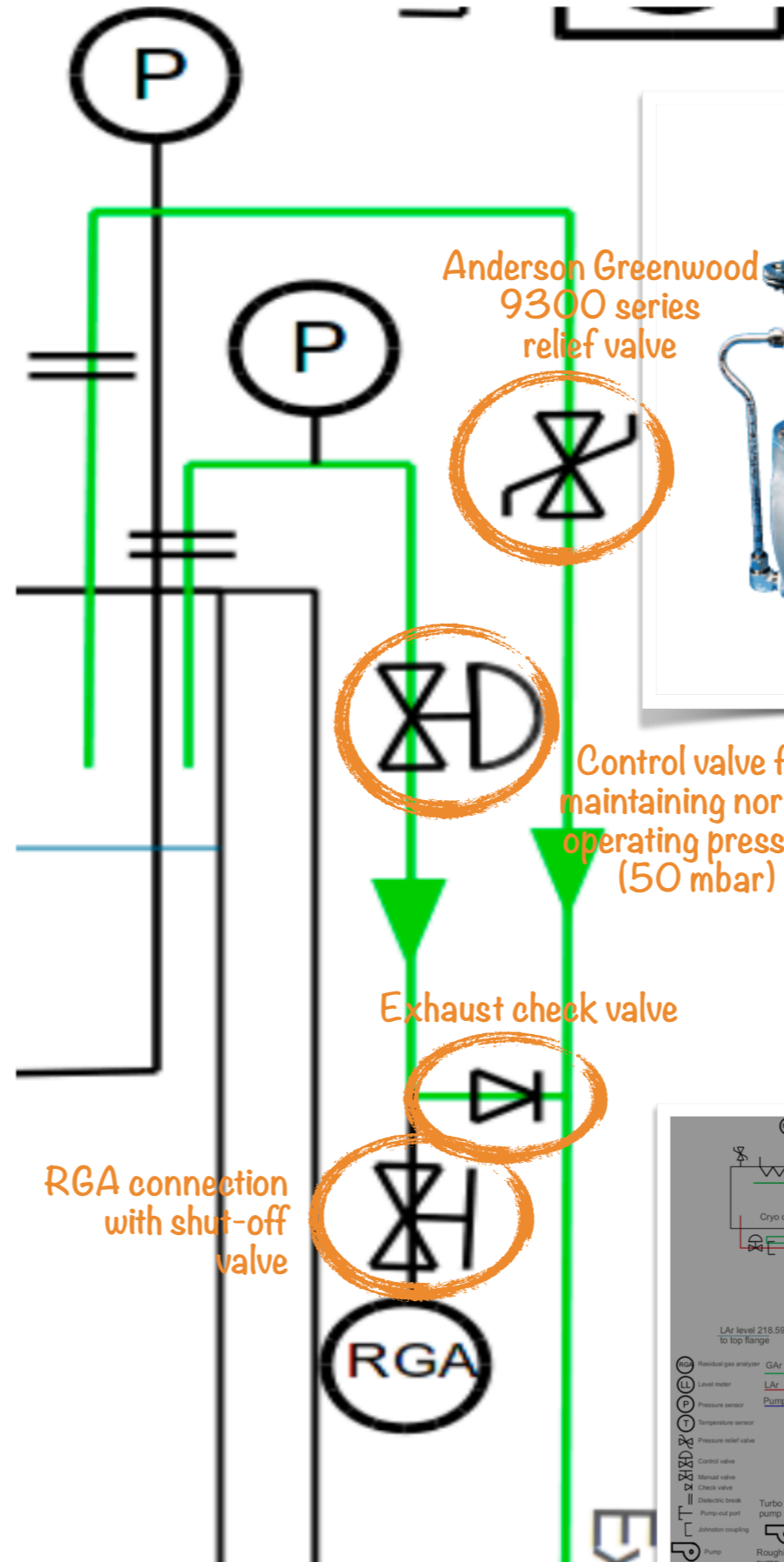
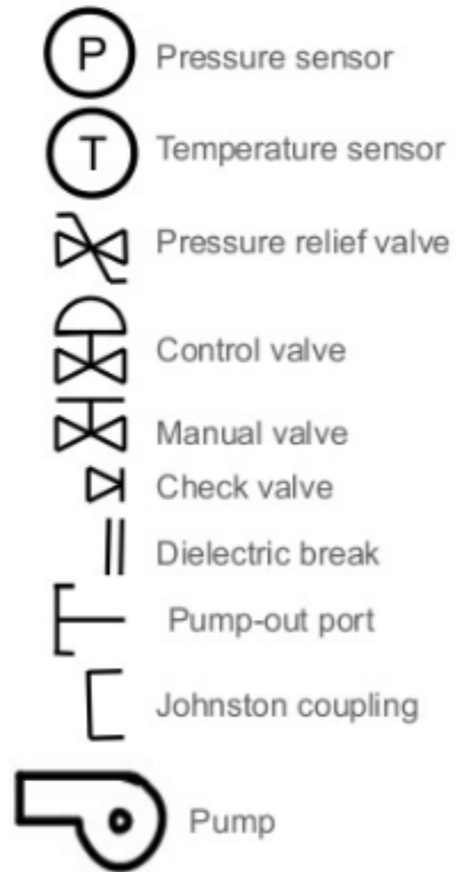
- **Filter and vacuum vessels**
- Can be built in house (no need to adhere to pressure vessel code)
- < 6" ID
- 10l mol sieve + 10 l getter
- Particulate filter at inlet and outlet

- **Temperature sensors, for filter material**
- RTD Probe PR-12-2-100-1/4-4-E-RP-SL by Omega



- **Cryostat liquid inlet/outlet**
- Connection for inlet from cryocooler and pump outlet, including internal lines
- Identical setup



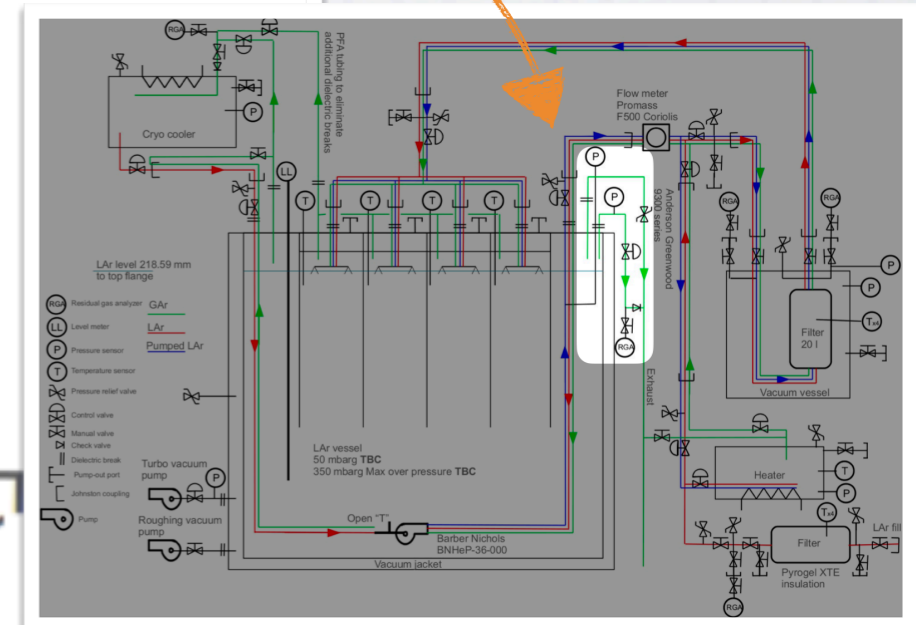


Control valve for maintaining normal operating pressure (50 mbar)

Exhaust check valve

RGA connection with shut-off valve

- **Cryostat exhaust**
- Exhaust lines for the cryostat and associated valves



- **Cryostat and Modules**
- 3 vacuum jacketed lines
 - Cryostat → Flow Meter
 - Flow Meter → Filter
 - Filter → Cryostat
- LAr Recirculation Pump and pipe work
- Level meter (Demaco)



Recirculation pump is a Barber Nichols BNHeP-36-000

SECTION A-A SCALE 1 : 1

INTERFACE DETAIL

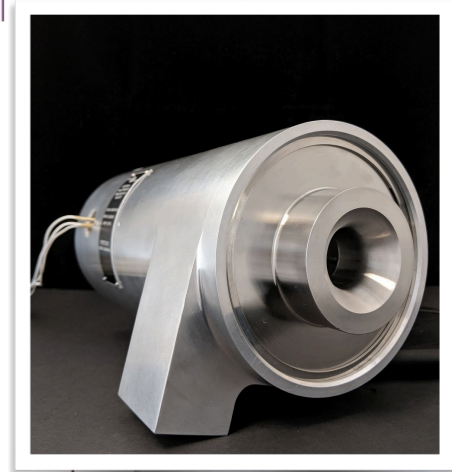
ISOMETRIC VIEW

NOTES:

- ASSEMBLE AND TEST PER BNTI - 1502.
- MEASURE FROM RING GROOVE OUTBOARD SURFACE (A) TO IMPELLER HOUSING LAND (B), THEN SUBTRACT SNAP RING THICKNESS AND 0.003 TO FIND FINAL IMPELLER HOUSING THICKNESS.
- MEASURE FROM RING GROOVE OUTBOARD SURFACE (B) TO MOTOR CAP LAND (C), THEN SUBTRACT SNAP RING THICKNESS AND 0.003 TO FIND FINAL MOTOR CAP THICKNESS.

REVISIONS		DATE	APPROVED
ZONE	LTR	DESCRIPTION	

UNLESS OTHERWISE SPECIFIED INTERPRET PER ASME Y14.5-1994 TOLERANCES ON DECIMALS: 1 PLACE 2 PLACE 3 PLACE MM ±.16 ±.08 ±.05 INCH ±.005 ±.005 ±.005 ANGULAR DIMENSIONS ±° SURFACE ROUGHNESS 3.2µm(125)	<p>THIRD ANGLE PROJECTION</p> <p>MATERIAL: SEE BILL OF MATERIAL</p> <p>HEAT TREATMENT: ----</p> <p>PROCESS: ----</p> <p>REMOVE BURRS ALL FILLLET RADI BREAK EDGES .02 MAX</p>	<p>APPROVED: B. PETERS 2/19/2019</p> <p>DATE: 2/19/2019</p> <p>DATE: 3/7/2019</p> <p>DATE: 3/7/2019</p> <p>DATE: 3/7/2019</p> <p>DATE: 3/7/2019</p> <p>DATE: 3/7/2019</p>	<p>Barber Nichols</p> <p>TITLE: HELIUM SUBMERSIBLE TRANSFER PUMP</p> <p>SIZE: D CODE IDENT NO: 57377 DRAWING NO: BNHEP-36-000</p> <p>SCALE: 1:2 WT ACT SHEET 1 OF 1</p>
---	---	---	--

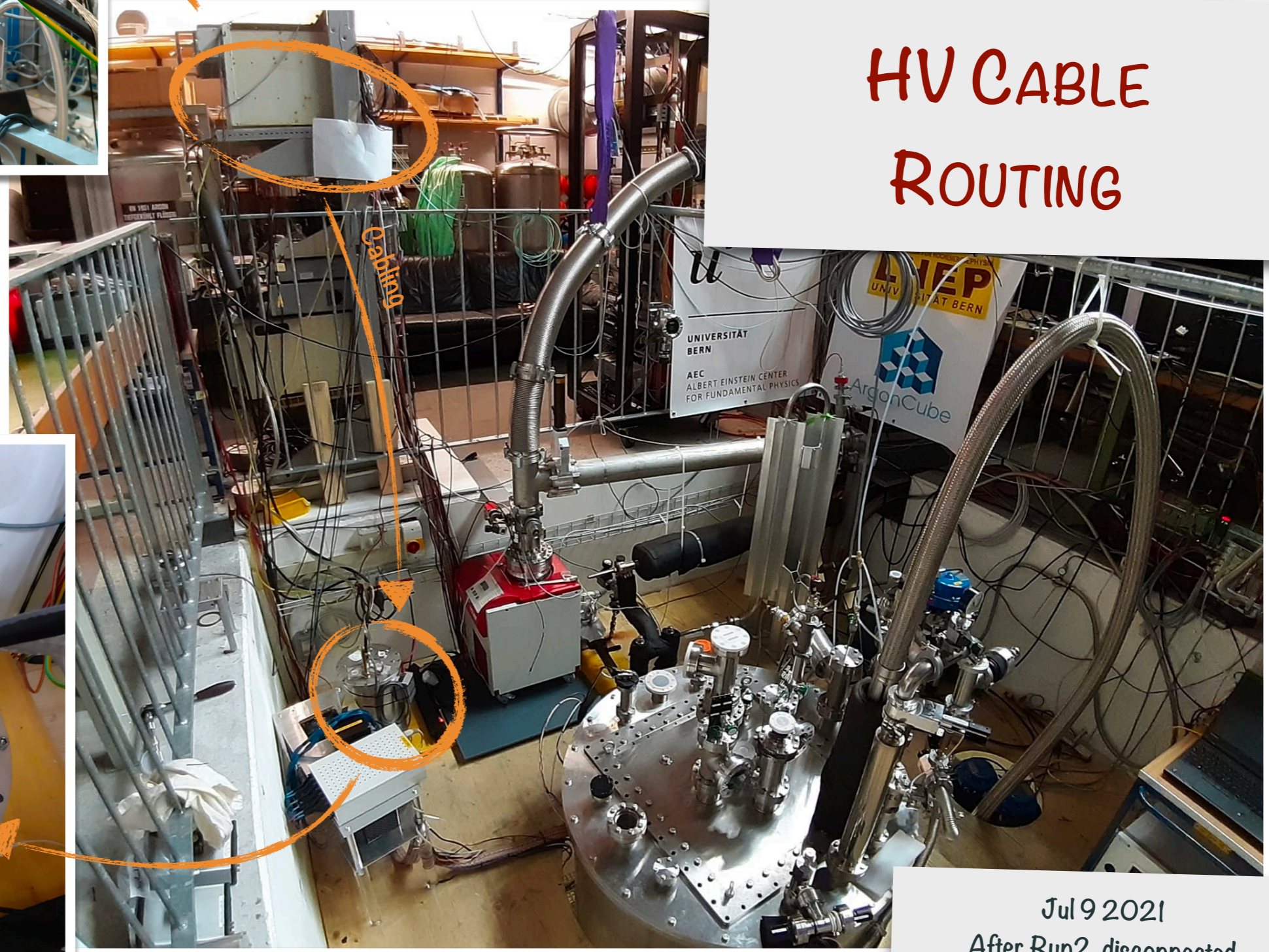


Power supply

- Power supply to filter box
- Along the rail, vertically

HV CABLE ROUTING

Filter box

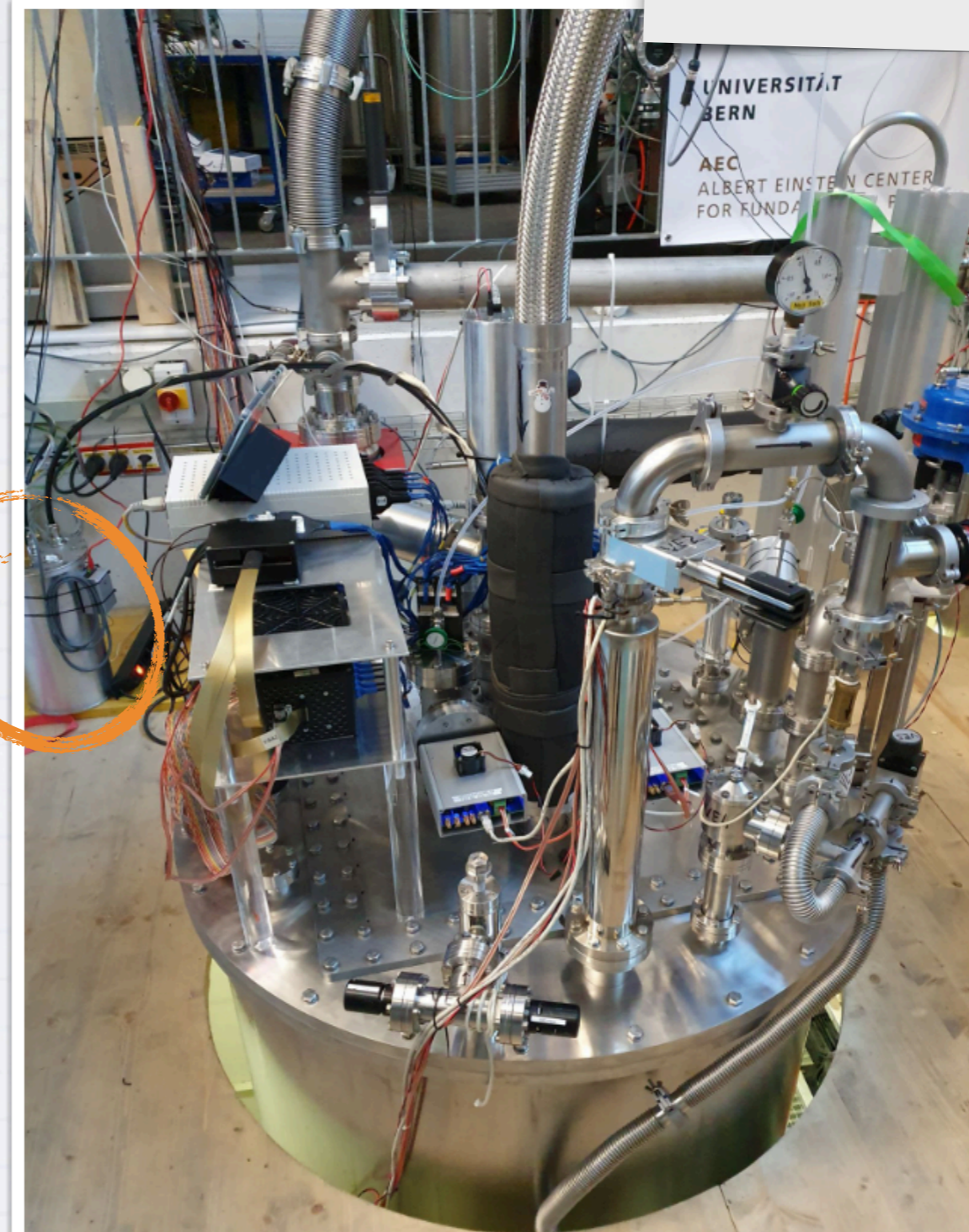


Jul 9 2021
After Run2, disconnected

- Module0 HV Cable: 1.9 m from the filter to the module
- Large bending radius



NOT bent



Module0 Run I

HV CABLE ROUTING