Cubism - Braque’s Bottle and Fishes, Paris c.1910-12

ArgonCube 2x2 Cryogenics summary

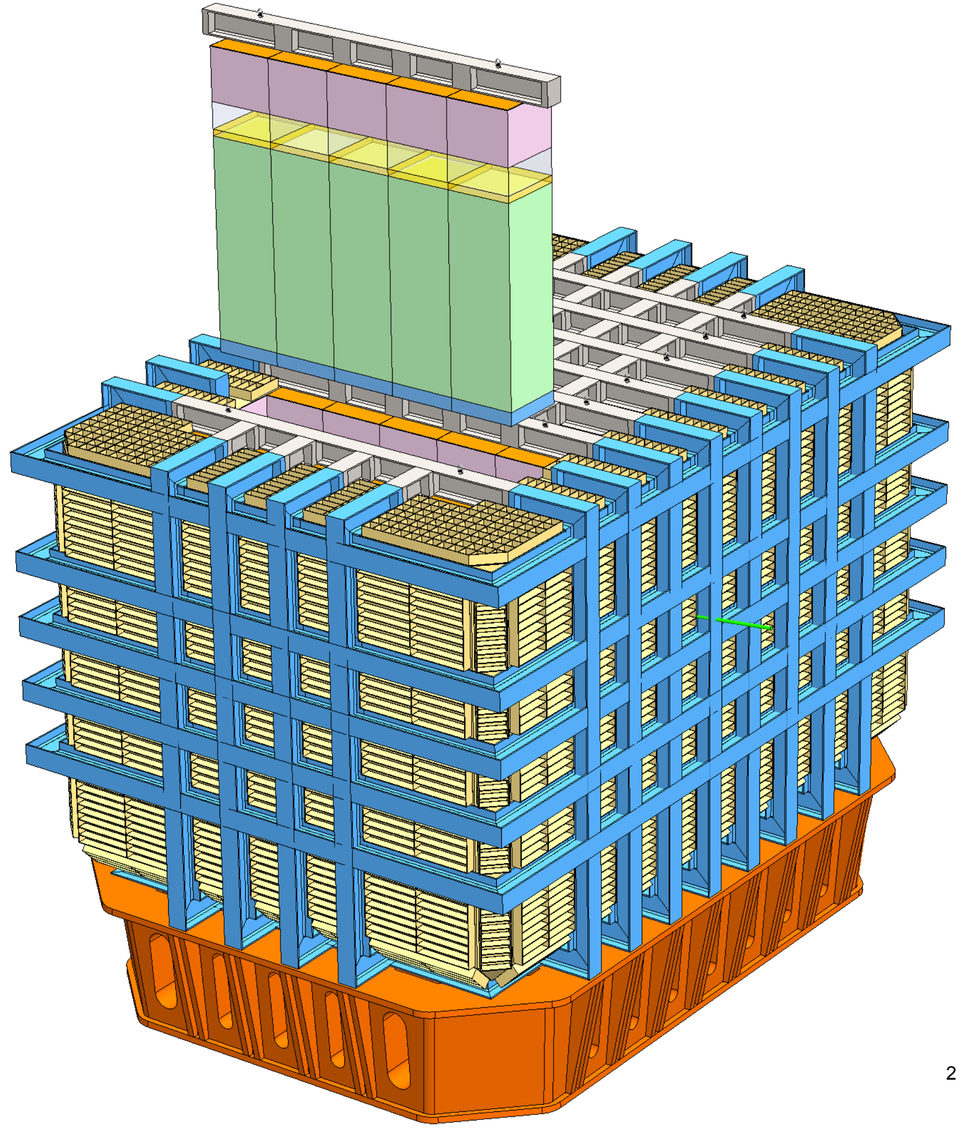
Cryogenics meeting
Dec 16th 2019
James Sinclair, LHEP

Some perspective

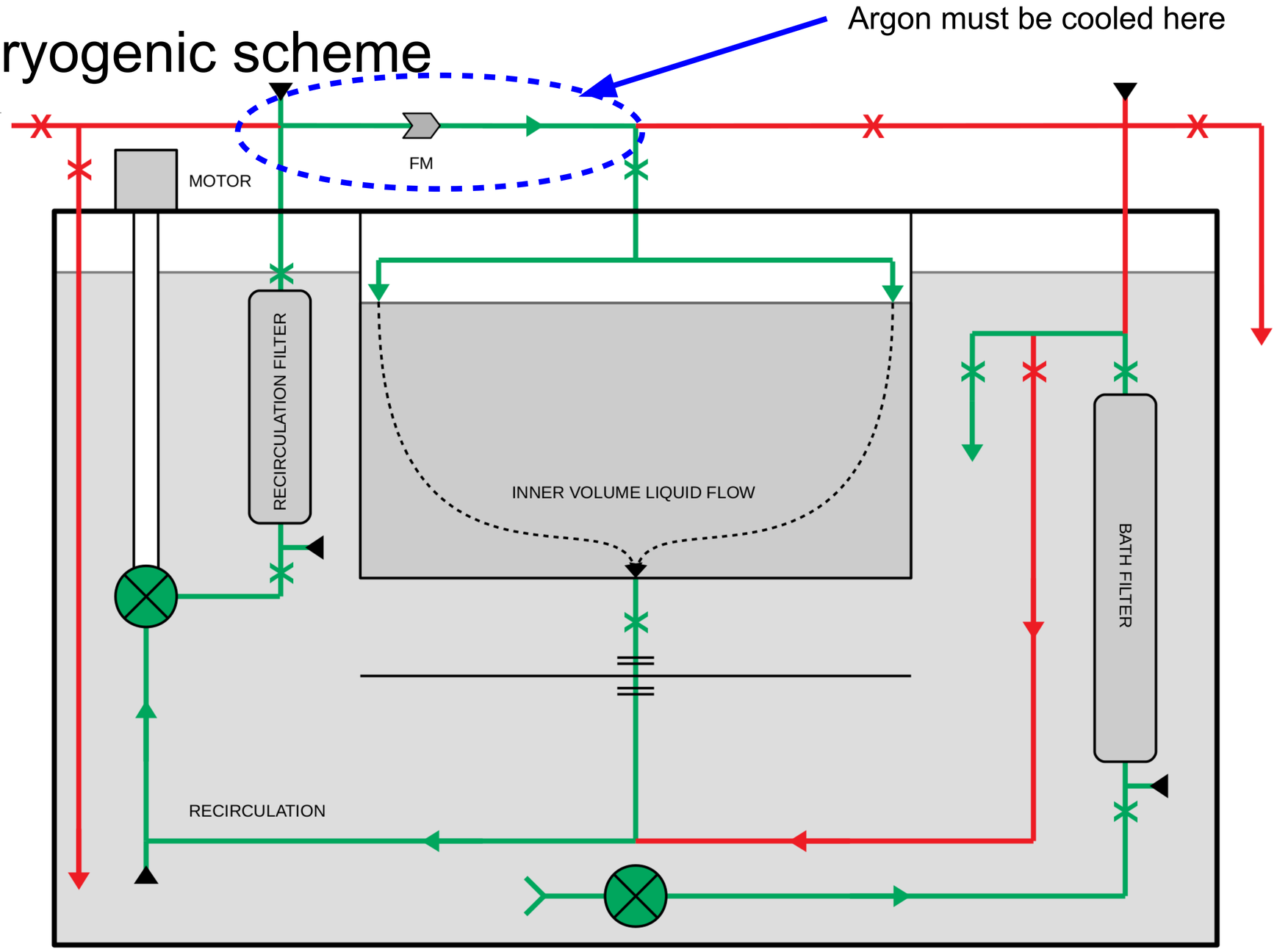
In the ND modules will be grouped in rows of five. Supported by a single cross beam.

Each row will have an independent LAr recirculation system, and a common top vacuum-pocket flange.

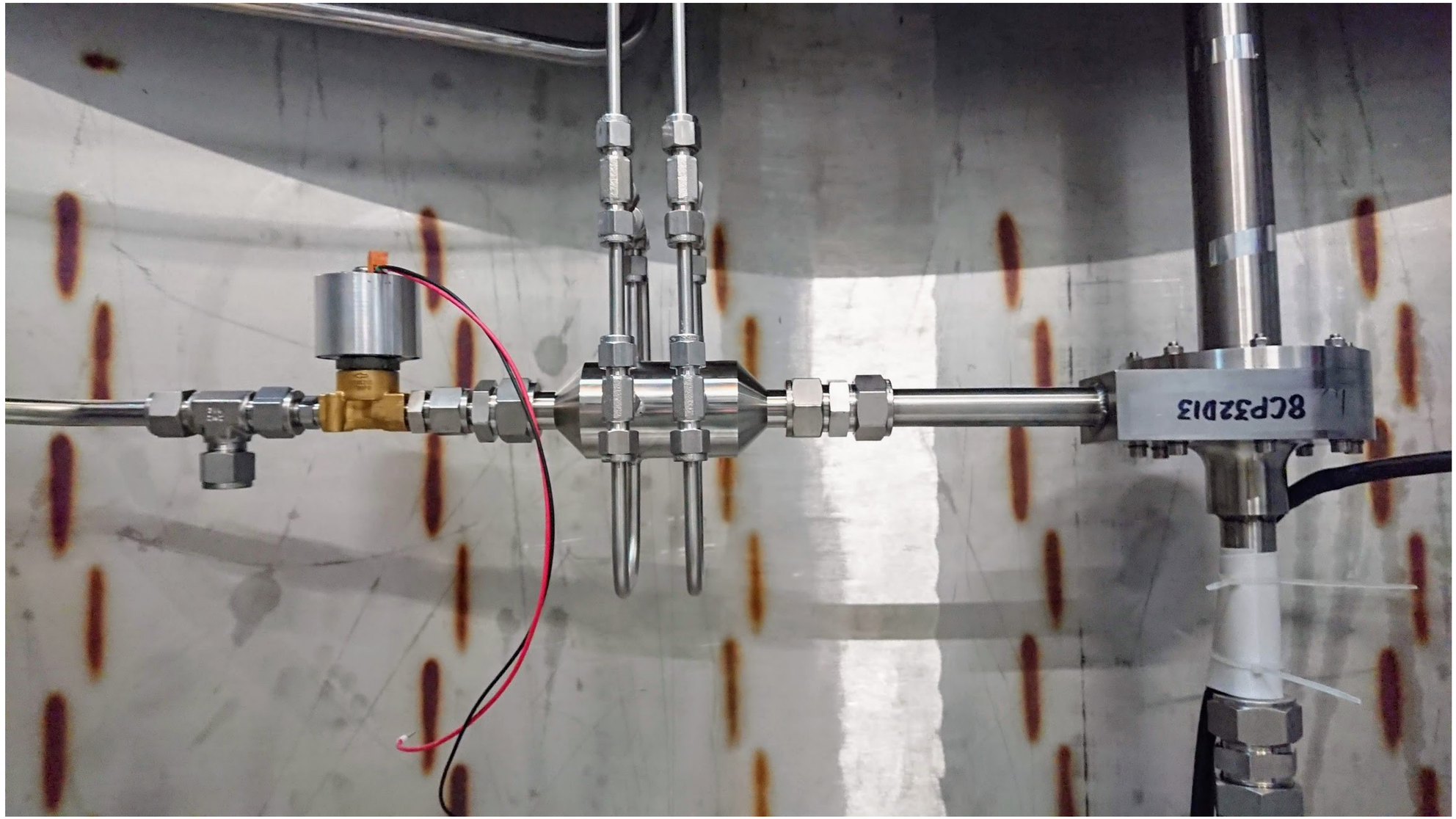
The recirculation system will be based on the findings of the 2x2.



The 2x2 cryogenic scheme



The scheme is reliant on cryogenic control valves



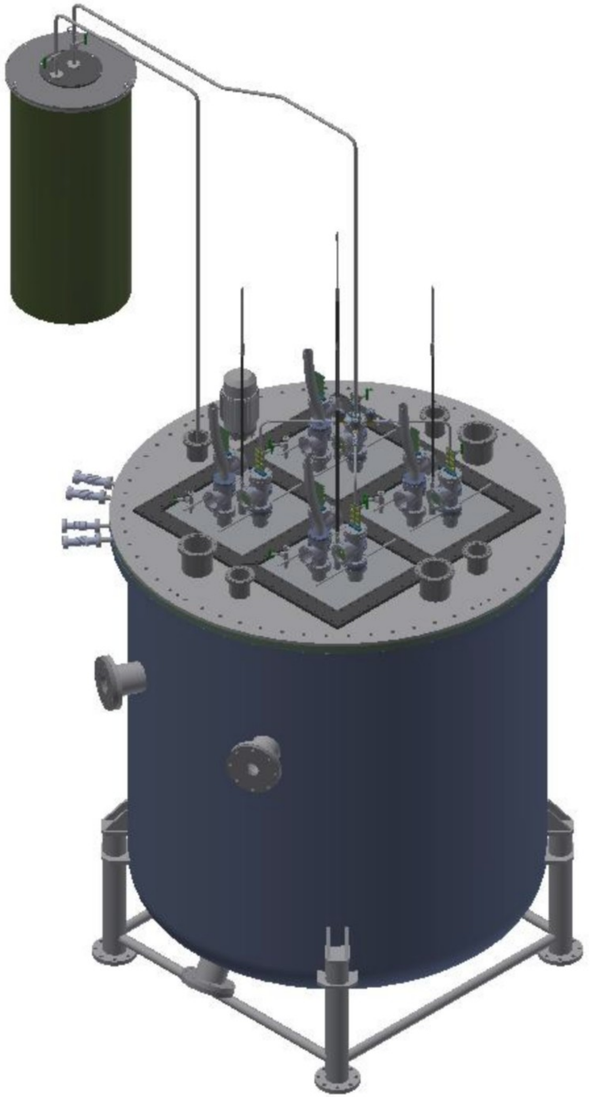
Many of the key components we installed an test in August

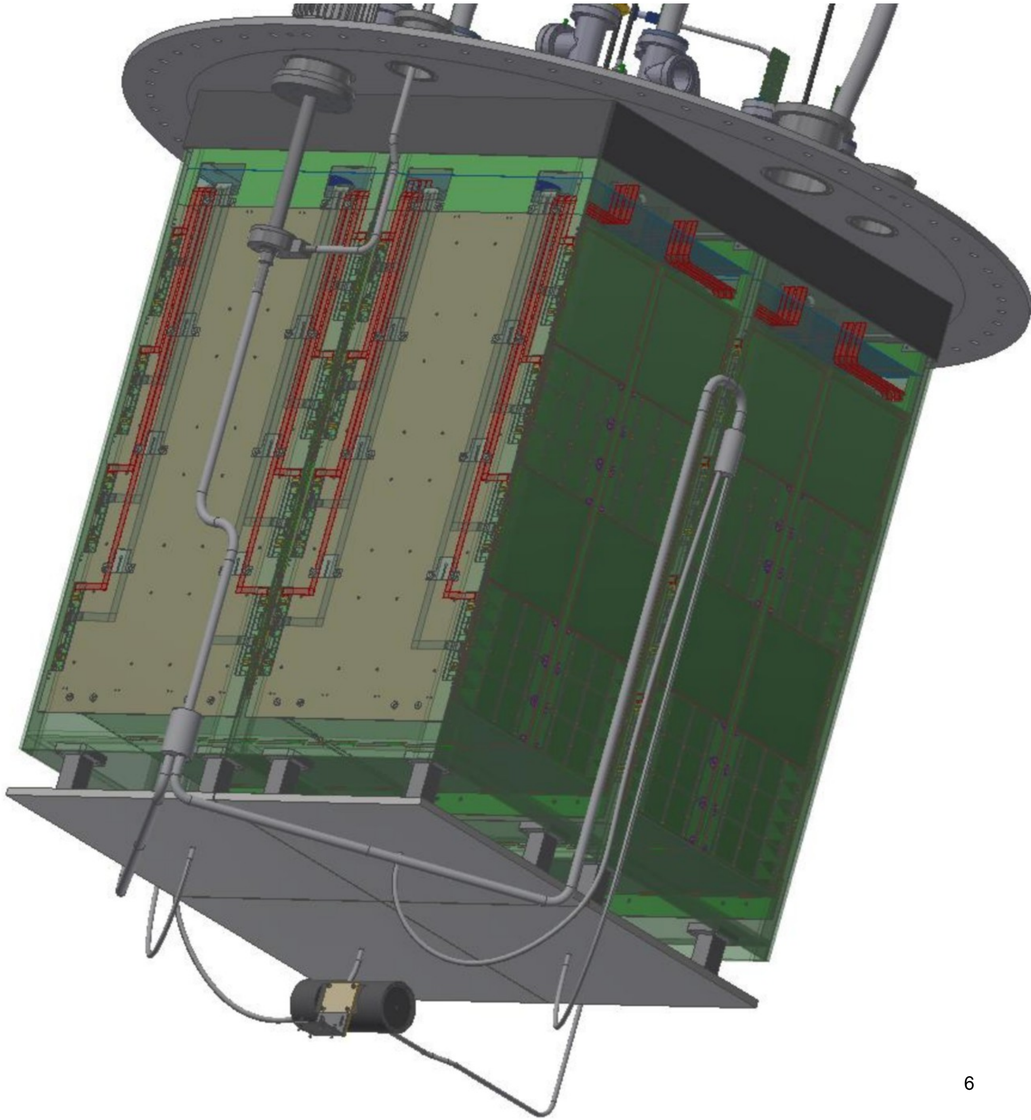
Now we must implement the full system

An external actively cooled oxygen trap and particle filter.

Internal lines and expansion chambers to minimise risk of cavitation.

Vacuum insulated external lines and feedthroughs.





Internal lines

Barber Nichols visited in September to advise on pump setup and servicing.

They also explained how best to route and connect the internal lines to minimise cavitation.

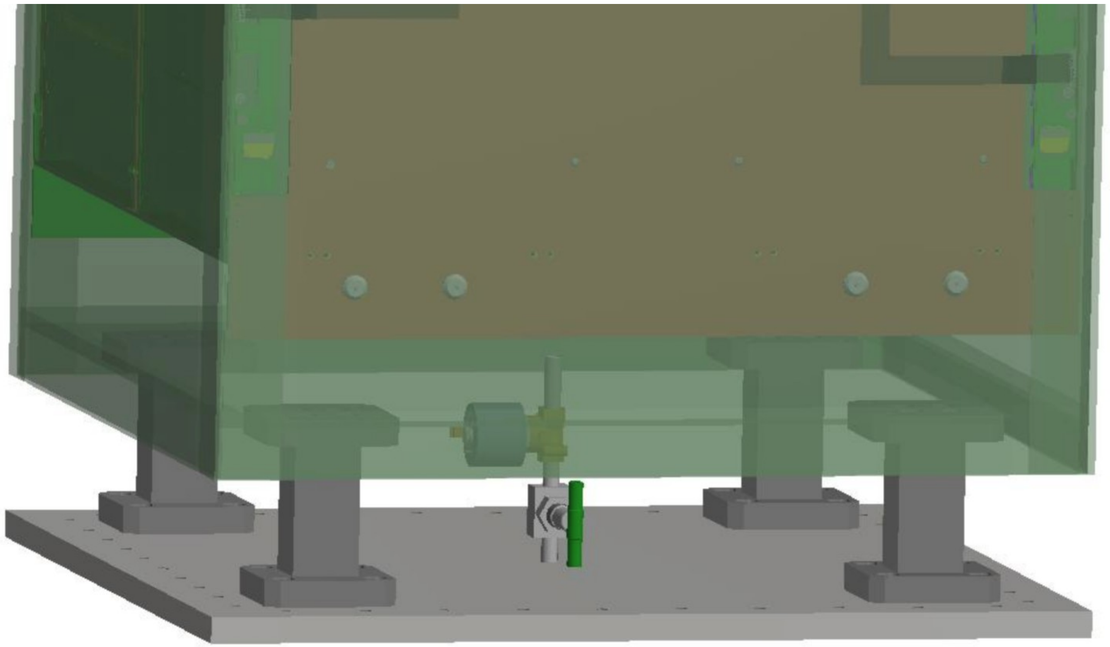
The pump is in place, however shaft bearings must be replaced.

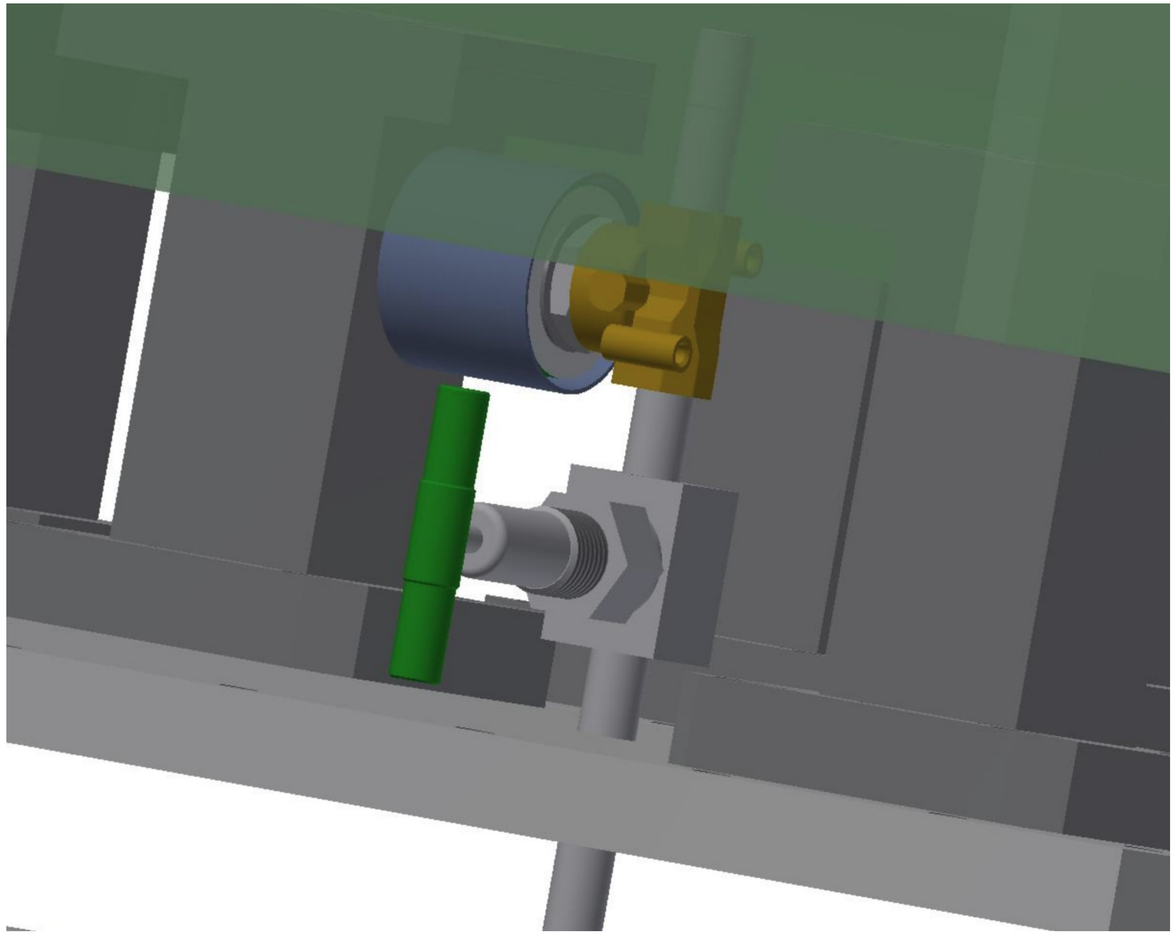
Flex lines are in hand. Fixed pipework must me manufactured.

Module LAr outlet

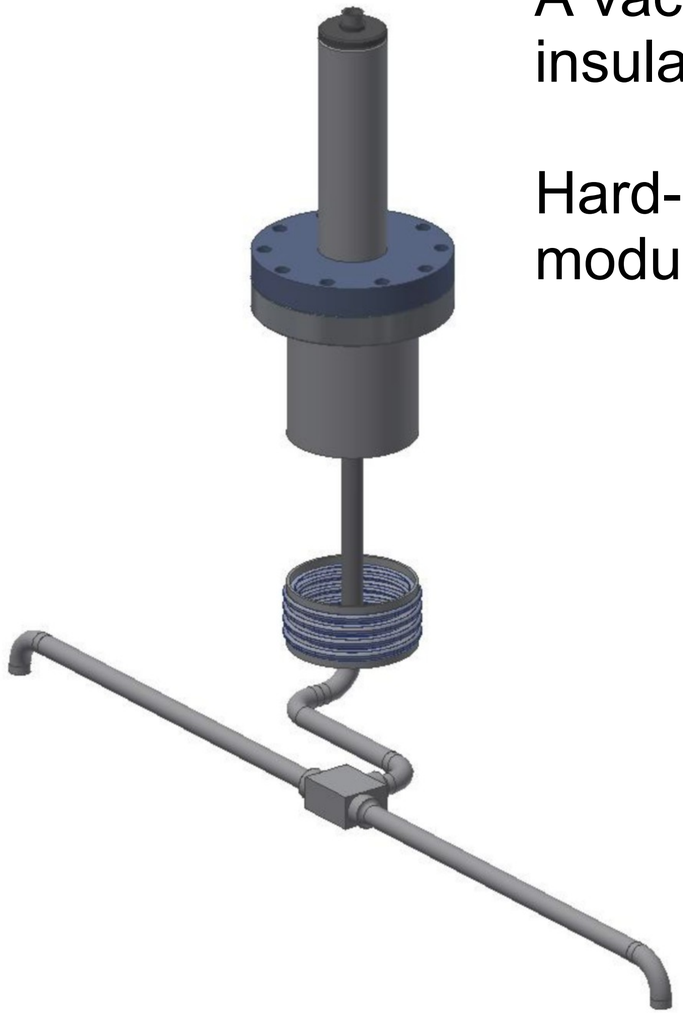
A solenoid valve will control the flow of LAr out of the base of the module.

There is an additional hard-metal valve to seal the line on module extraction.



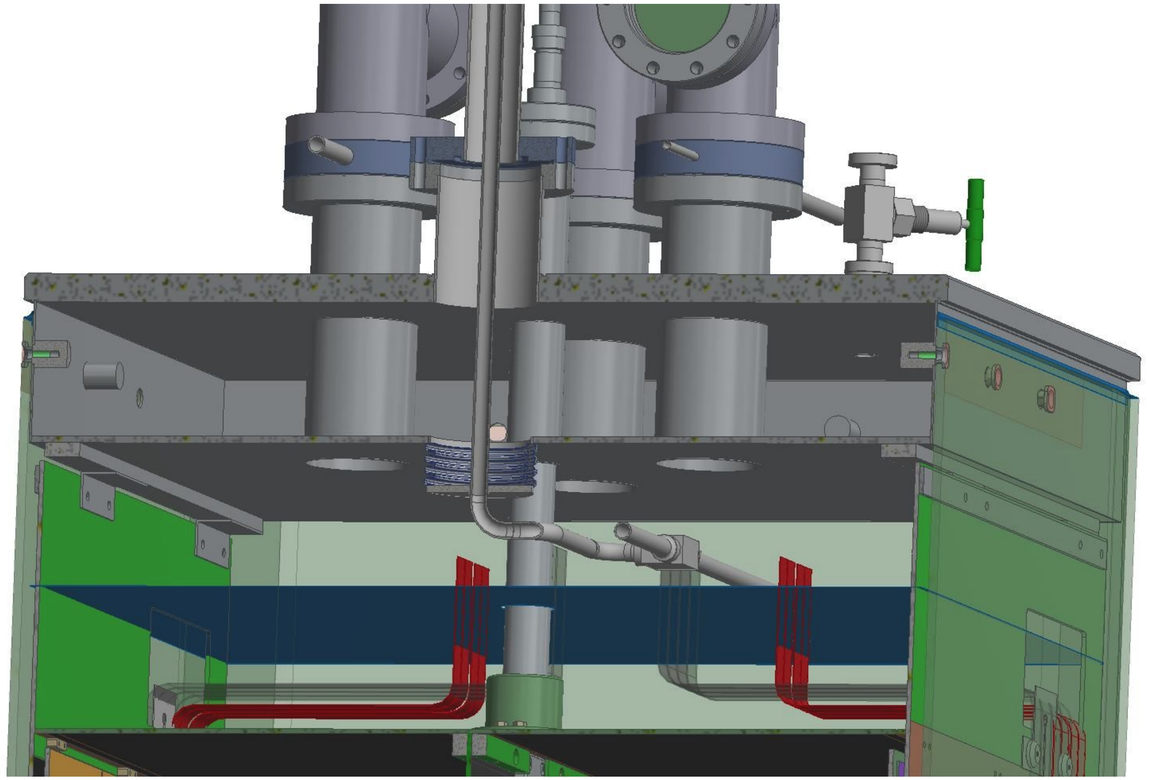


Module LAr inlet



A vacuum feedthrough (Knut's design) extends the vacuum pocket to insulate the connection. LAr is then directed toward the anode planes.

Hard-metal and solenoid valves are used on upstream to isolate the module and line



External filter

Active cooling of the external filter is desirable.

LN2 at 2.25 bar will provide 85 K. (Could be cooled with LAr at FNAL, or held at vacuum)

We have a spare LHe cryostat:

External dimensions 1.35 x 0.65 m

Internal dimensions 1.23 m x 0.25 m

Manufacturer (Cryogenic Ltd) says the vessel will be ok at 2.25 bar.

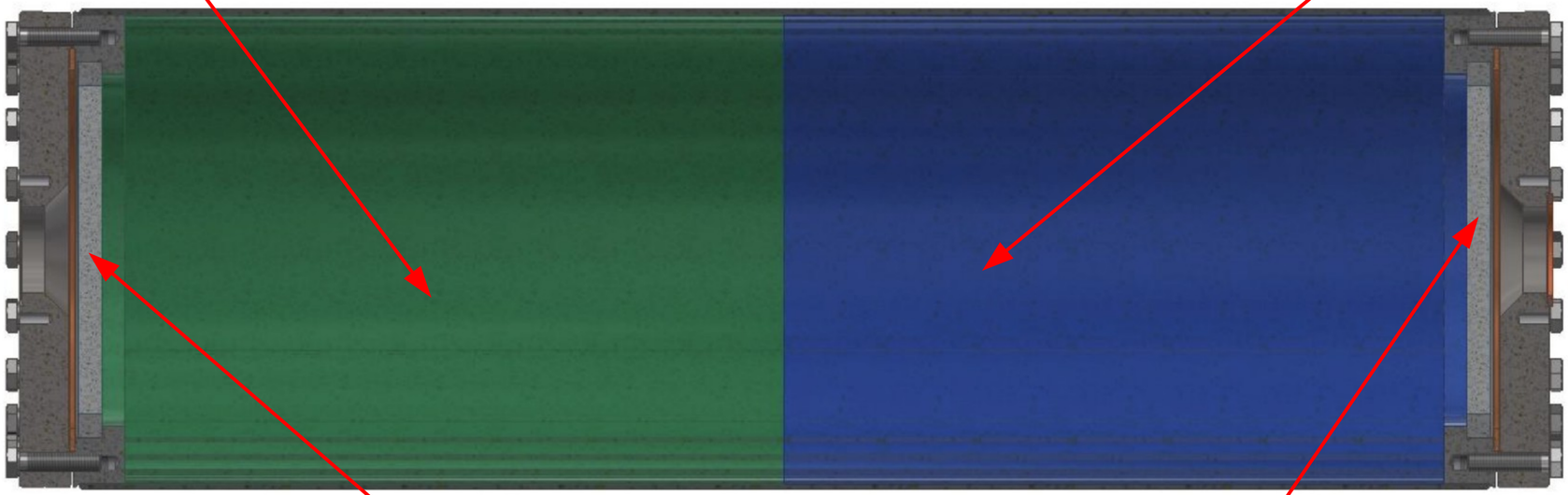
Pressure tested to 3.5 bar

Oxygen trap

Filter material from Research Catalysts is all in hand

~10 l getter (Q-5 Copper Catalyst)

~10 l molecular sieve (RCI-DRI 4A Mol-Sieve)

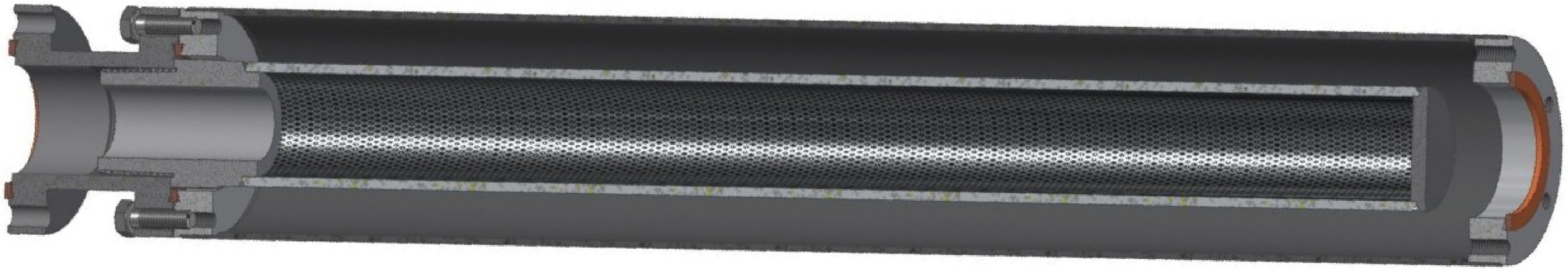


160 mm diameter 200 µm sintered stainless diffuser from GKN

Thanks Kathrine for the filter material and Mike for sintered metal.

Particulate filter

To minimise dp we use a stainless cartridge particulate filter, as in SBND and uBooNE.



400 mm cartridge 1’’ internal diameter 5 μm sintered stainless cartridge from GKN.

Sintered metal components will arrive the third week of January.

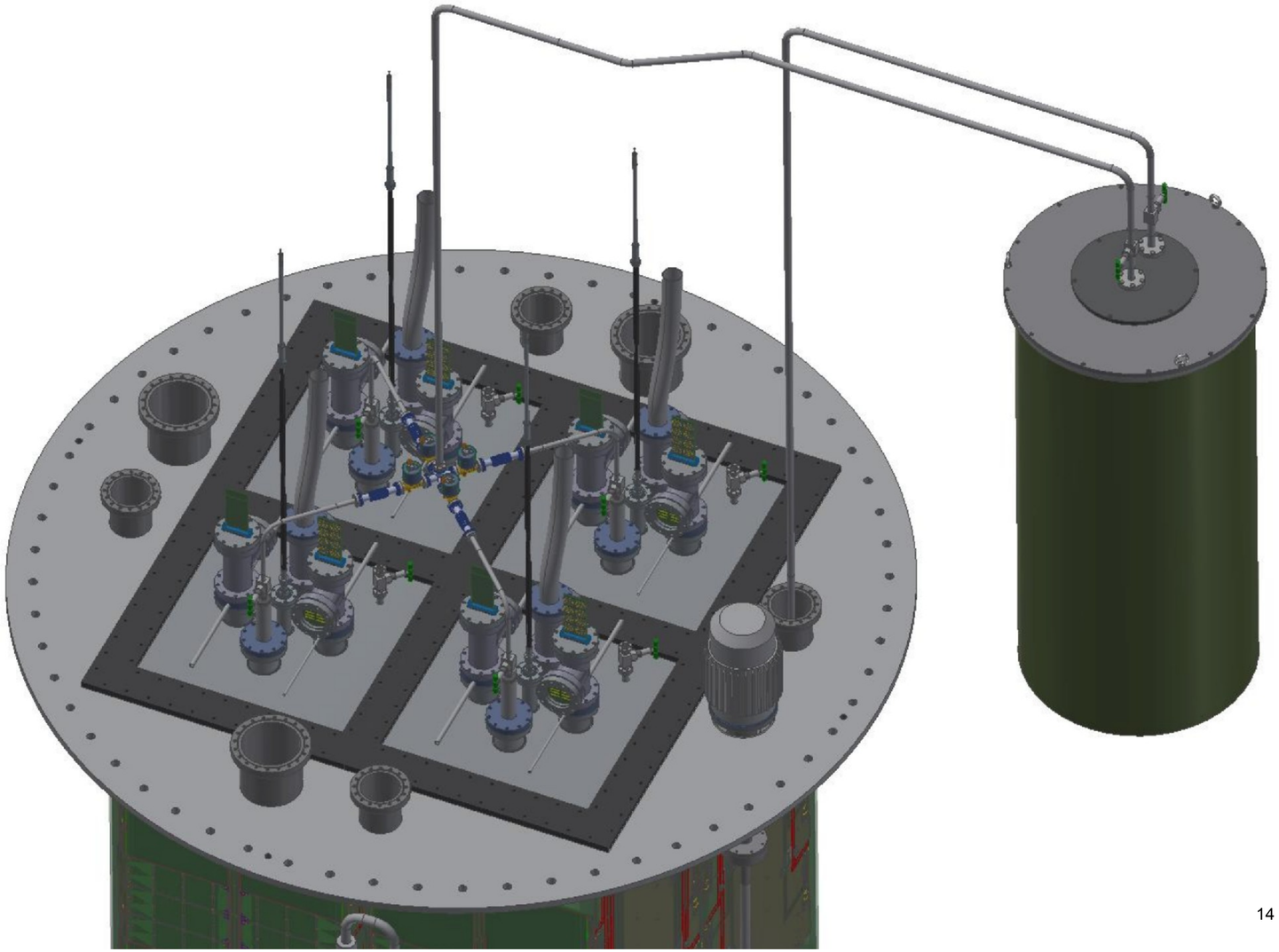
External lines

We still have to procure the vacuum insulated lines.

It is desirable to minimise length, but...

The layout of the Bern lab dictates the filters must be positioned above the detector.

It would be ideal if these lines could be reused at FNAL. We should test with same length/resistance.



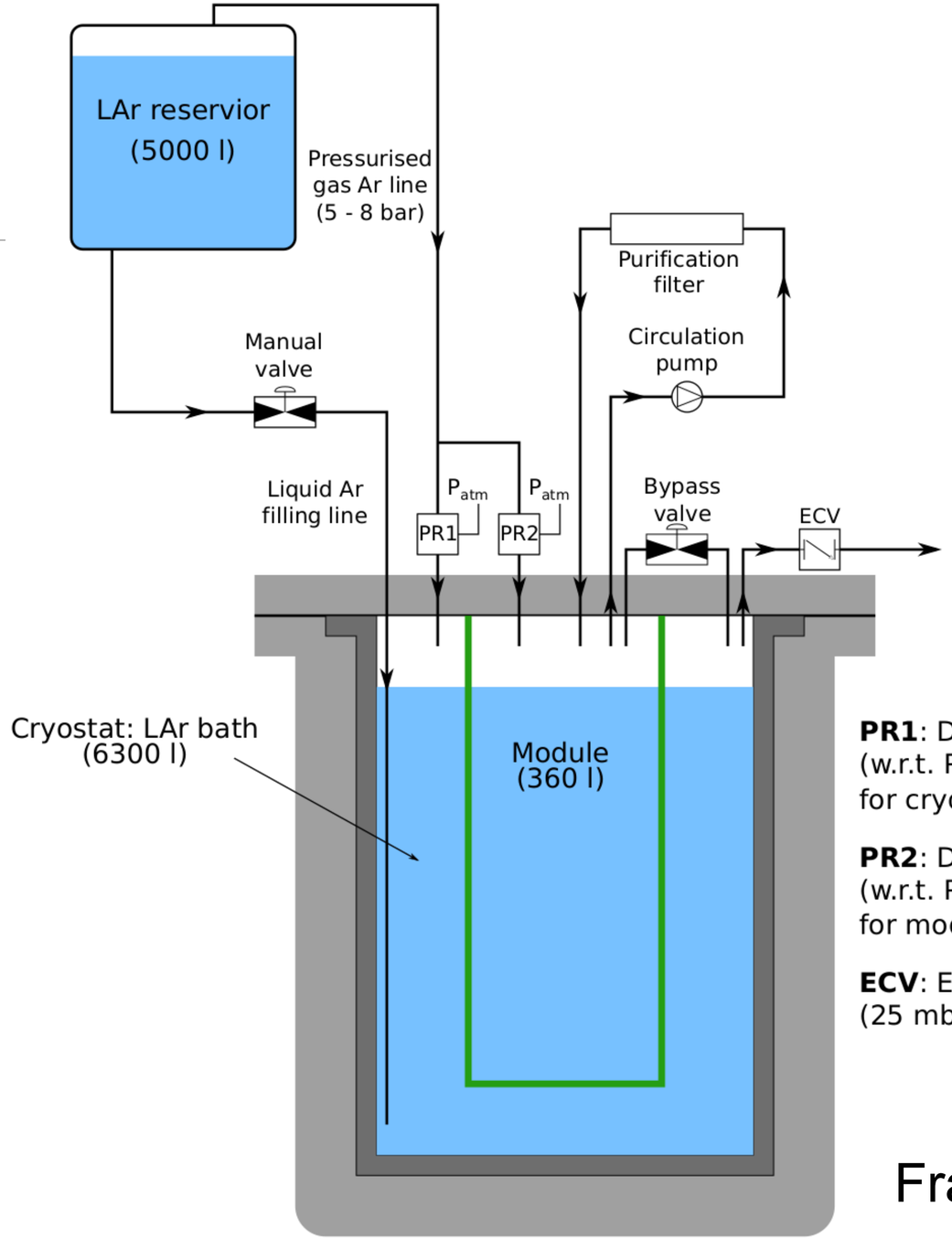
Gas System

There are four gas connections to the top flange:

Gas purification inlet and outlet 2 x 1/2’’ lines

Fast repressurisation (shown to maintain 5 mbar) 1 x 1/2’’ line

Over pressure relief 1 x 2’’ line



PR1: Downstream over-pressure (w.r.t. P_{atm}) regulator valve for cryostat (10 mbar g).

PR2: Downstream over-pressure (w.r.t. P_{atm}) regulator valve for module (15 mbar g).

ECV: Exhaust check valve (25 mbar g).

Francesco

Gas System

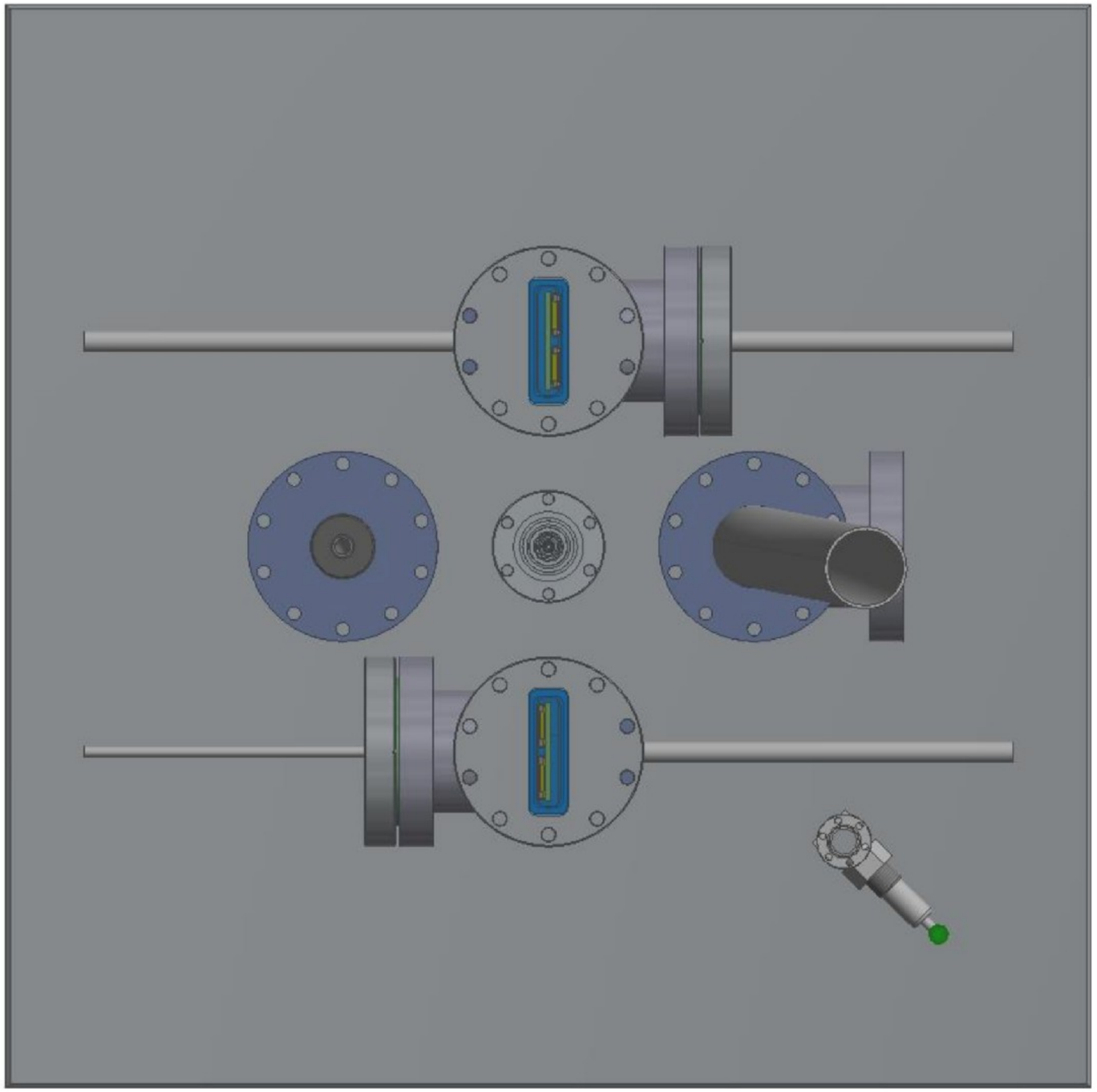
There are five gas connections to the top flange:

Gas purification inlet and outlet 2 x 1/2’’ lines

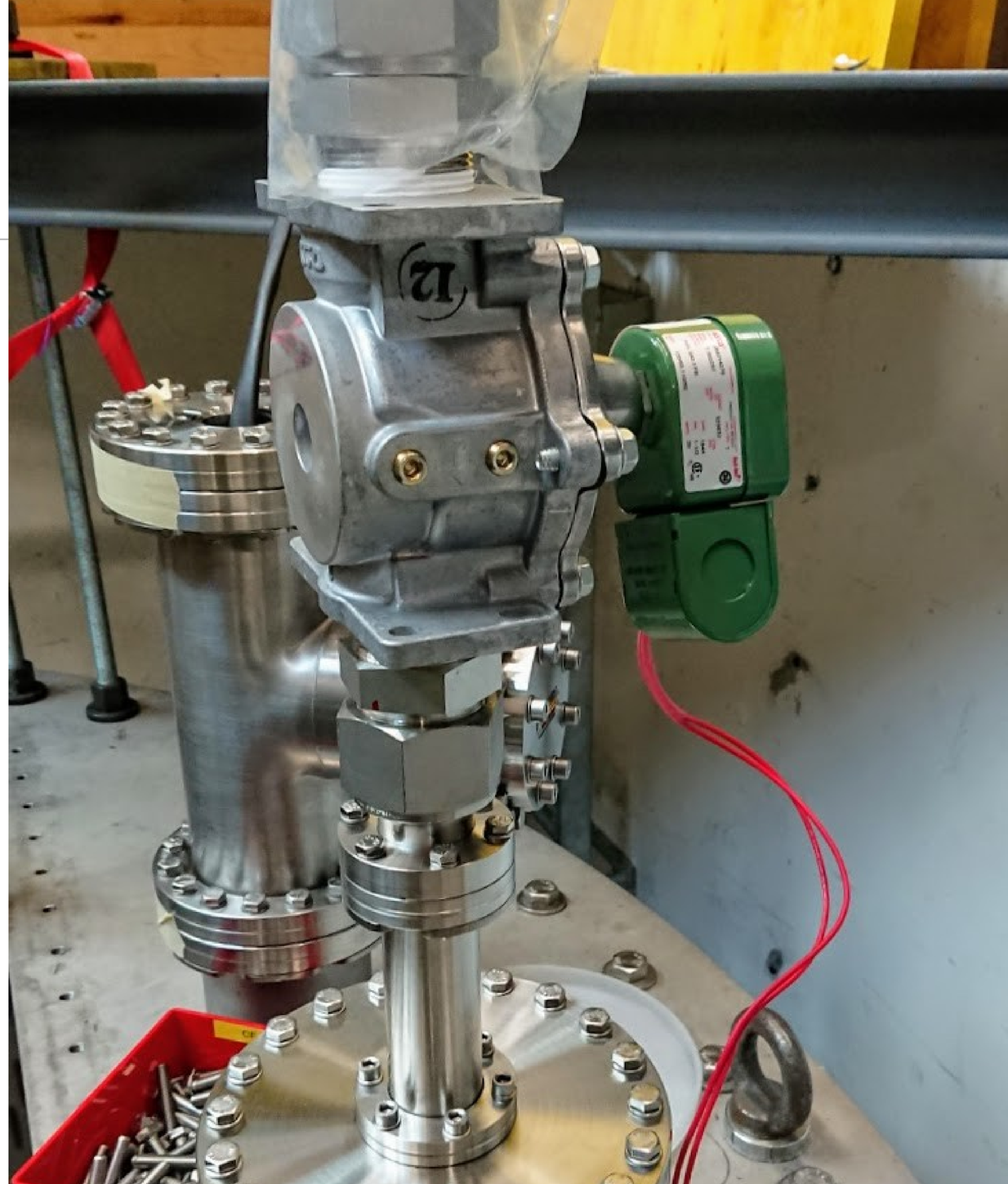
Fast repressurisation (shown to maintain 5 mbar) 1 x 1/2’’ line

Over pressure relief 1 x 2’’ line

Pressure sensor 1 x 1/4’’ line




Glycam | LEDs | SiPMs

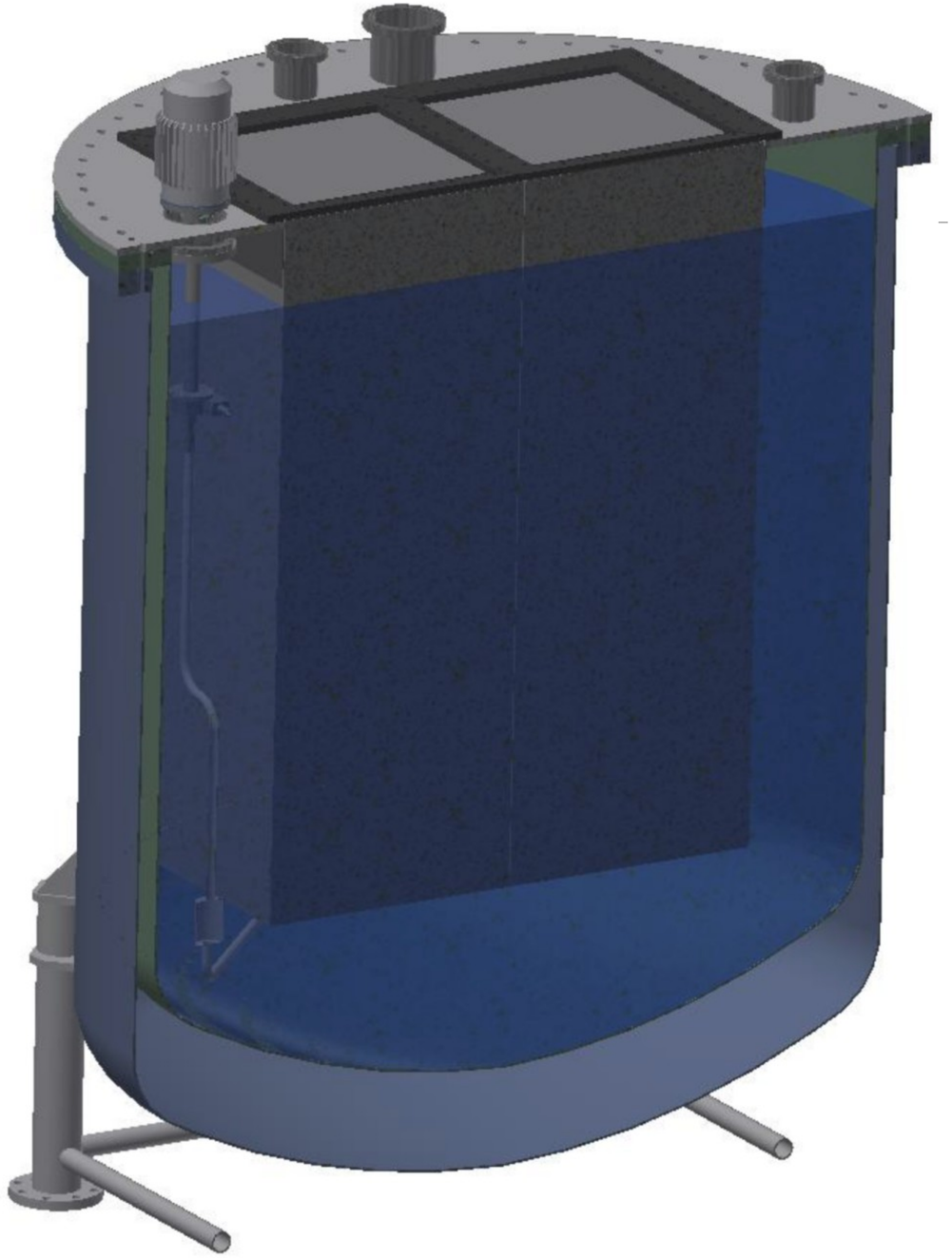


A Comment on Ullage

Total volume of cryostat = 6.4 m^3

To achieve 10% ullage (5.8 m^3 LAr) LAr level is 0.2 m below top flange.

Strong desire to keep it at 0.2 m to maximize pump head. Pump impeller at 0.43 m below flange, 0.23 m below liquid.



A Comment on Ullage

0.2 m LAr level corresponds to 0.1 m below vacuum pocket in module.

Conservatively 7% ullage.

Volume of submerged material and gas volume in feedthroughs will increase ullage.