



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

## Cryo Meeting





# ArgonCube Core Design Principle

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Modules are to be cold-swappable. 2x2 is being designed thus.

Regardless of not intending to extract modules at Fermilab.

This is non-negotiable.

# Cryo (liquid) Scheme for 2x2

Module recirculation:

Pump mounted at cryostat top flange used to extract argon from base of module, through filter and return to top of module.

Bath recirculation:

Pump in sump constantly recirculating bath through cold filters. Can also be used to drain bath and/or refill module. With appropriate valves closed the lines can be used for piston purge.

All cold lines are flexible steel pipe.

Piston purge possible via drain lines.

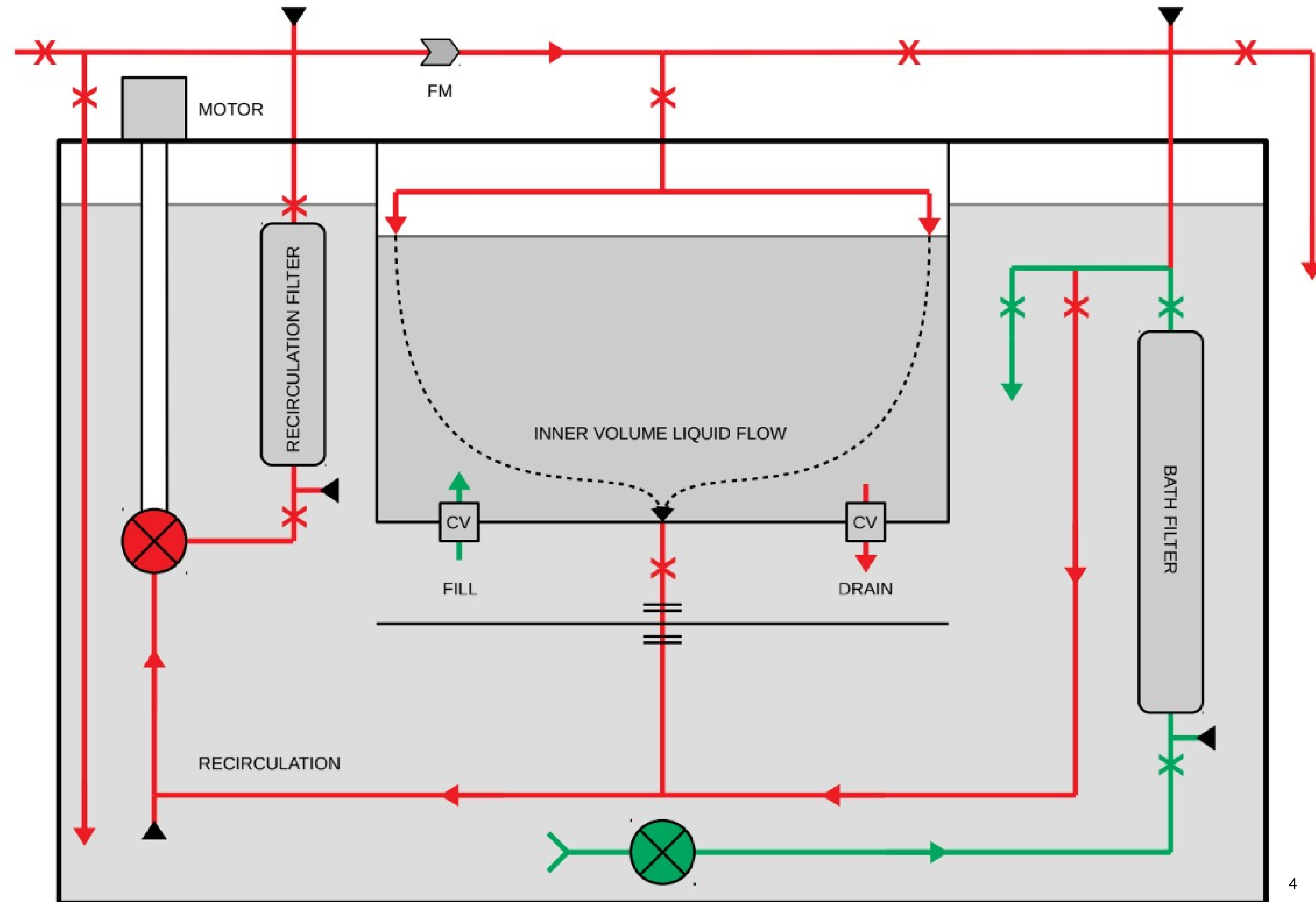
The diagram illustrates the cryogenic liquid management system for a 2x2 cryostat. It features a central rectangular module with a large internal liquid reservoir. Above the module, a horizontal line with a pump (represented by a circle with an 'X') and a flow meter (FM) facilitates module recirculation. This line connects to a vertical pipe on the left that leads down into the module's base, passing through a 'RECIRCULATION FILTER' before returning to the top. The internal reservoir is shown with a dashed line indicating 'INNER VOLUME LIQUID FLOW'. It has two control valves (CV) at its base: one labeled 'FILL' with an upward arrow and another labeled 'DRAIN' with a downward arrow. Below the module, a sump contains a pump and a 'BATH FILTER'. A line labeled 'RECIRCULATION' connects the sump pump to the base of the module. Another line from the sump pump leads to the right side of the module, passing through the 'BATH FILTER' and returning to the top. Various valves (marked with 'X') are distributed throughout the system to control flow and isolation.

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# Cryo (liquid) Scheme for 2x2

On module insertion:

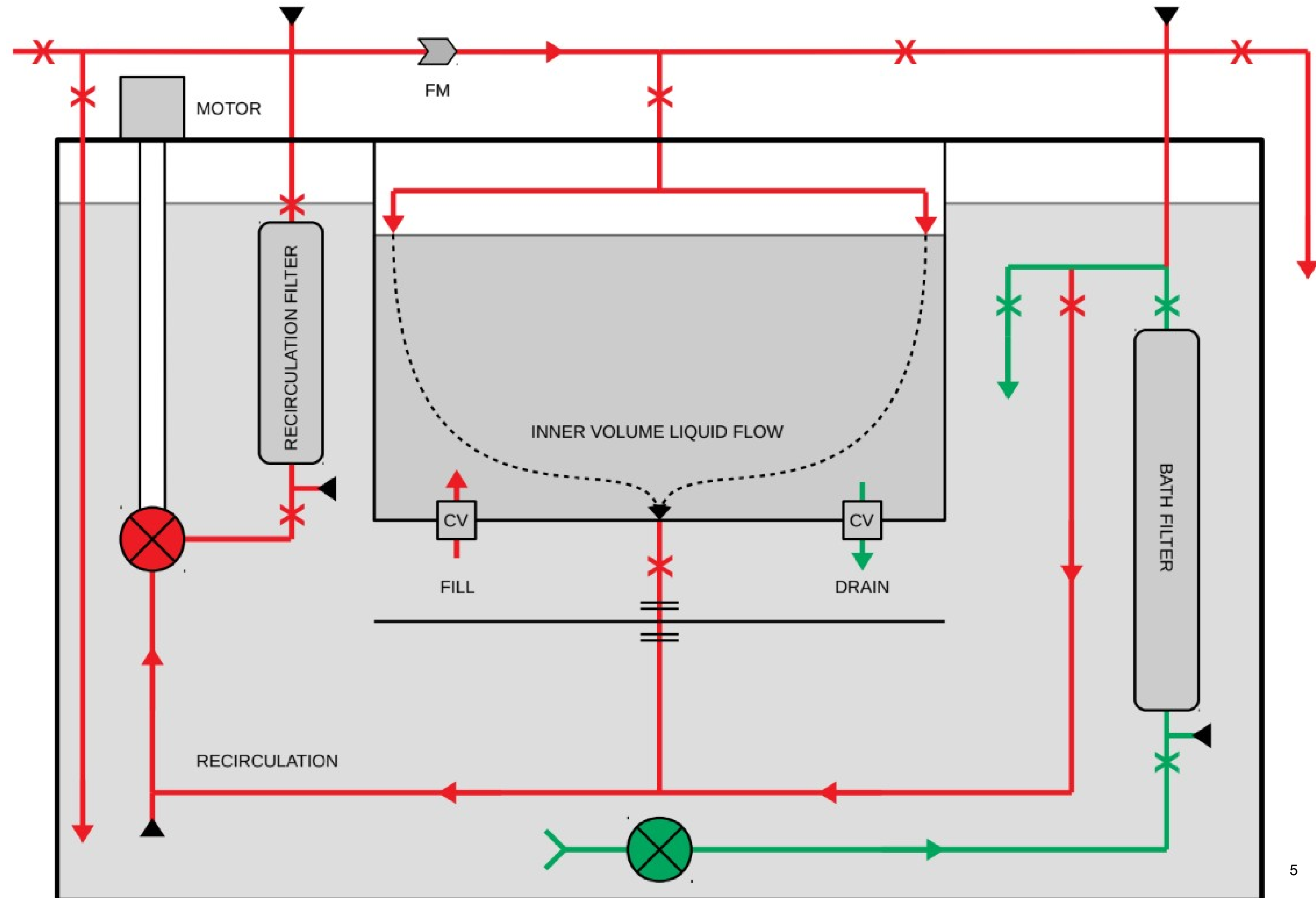
- The bath is continually purified.
- A valve at the base of the module is opened to fill with LAr.



# Cryo (liquid) Scheme for 2x2

On module extraction:

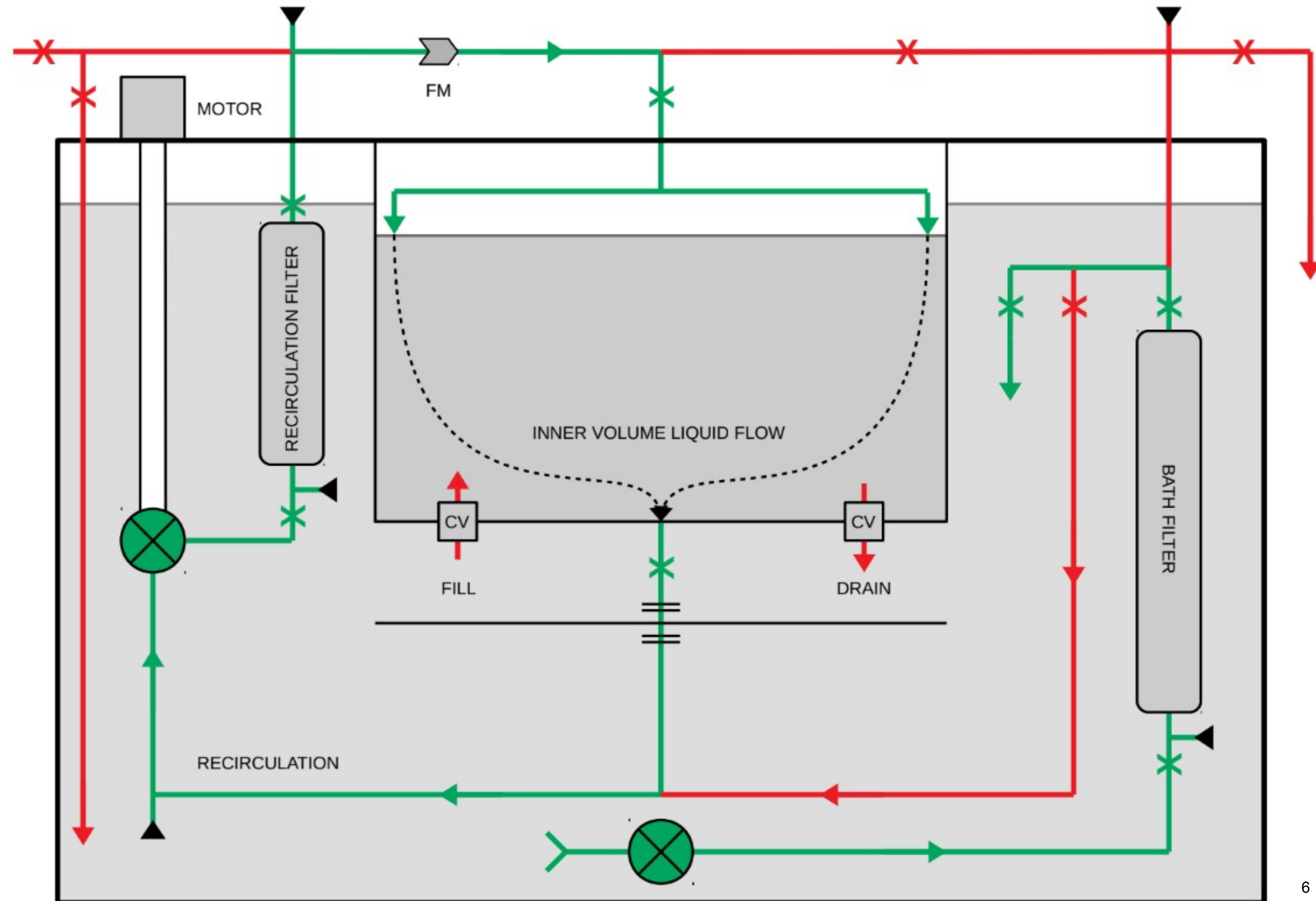
- The bath is continually purified.
- A valve at the base of the module is opened to drain of LAr.



# Cryo (liquid) Scheme for 2x2

Normal operation:

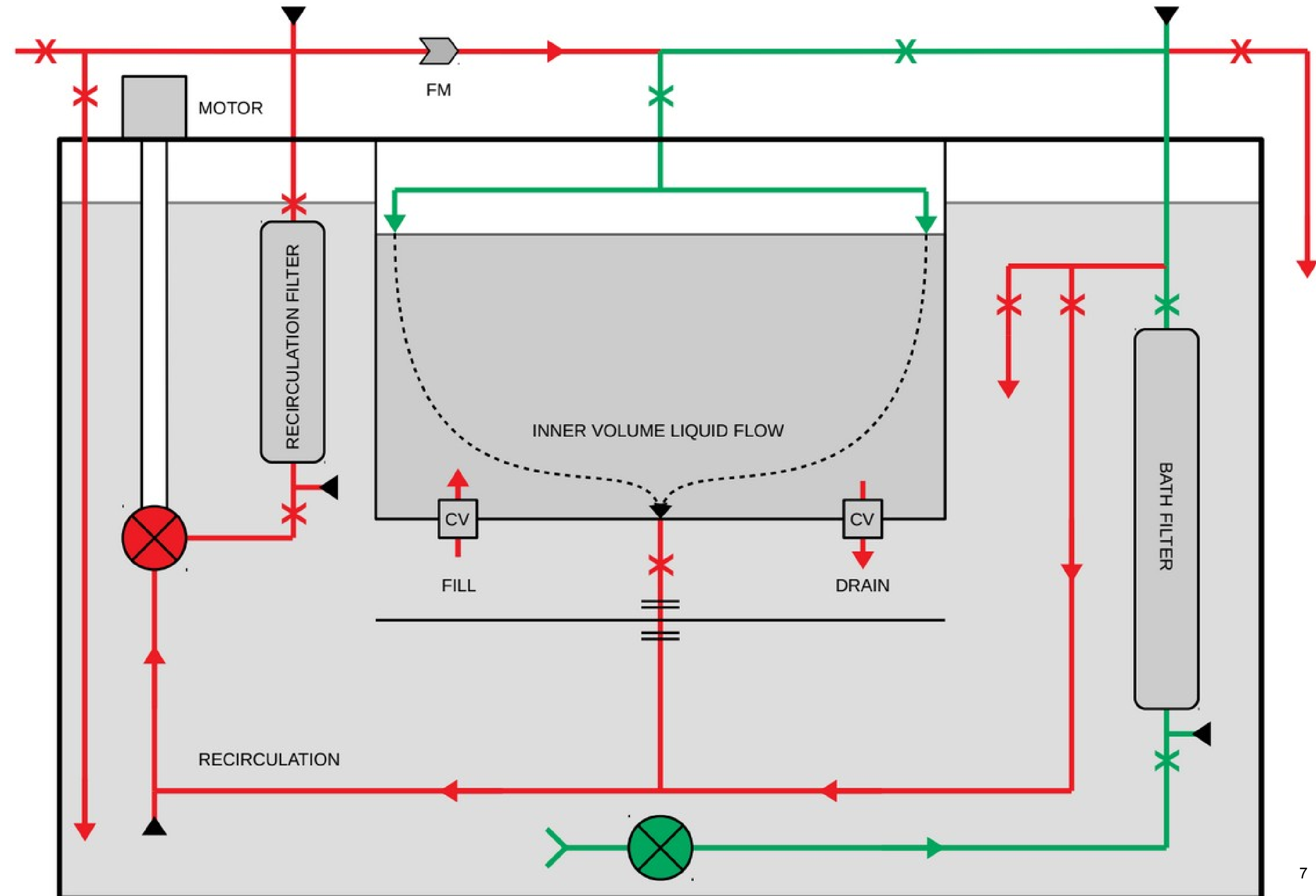
- The bath is continually purified.
- LAr is extracted from the base of the module, then pumped through a filter back into the top of the module.



# Cryo (liquid) Scheme for 2x2

Refilling the module:

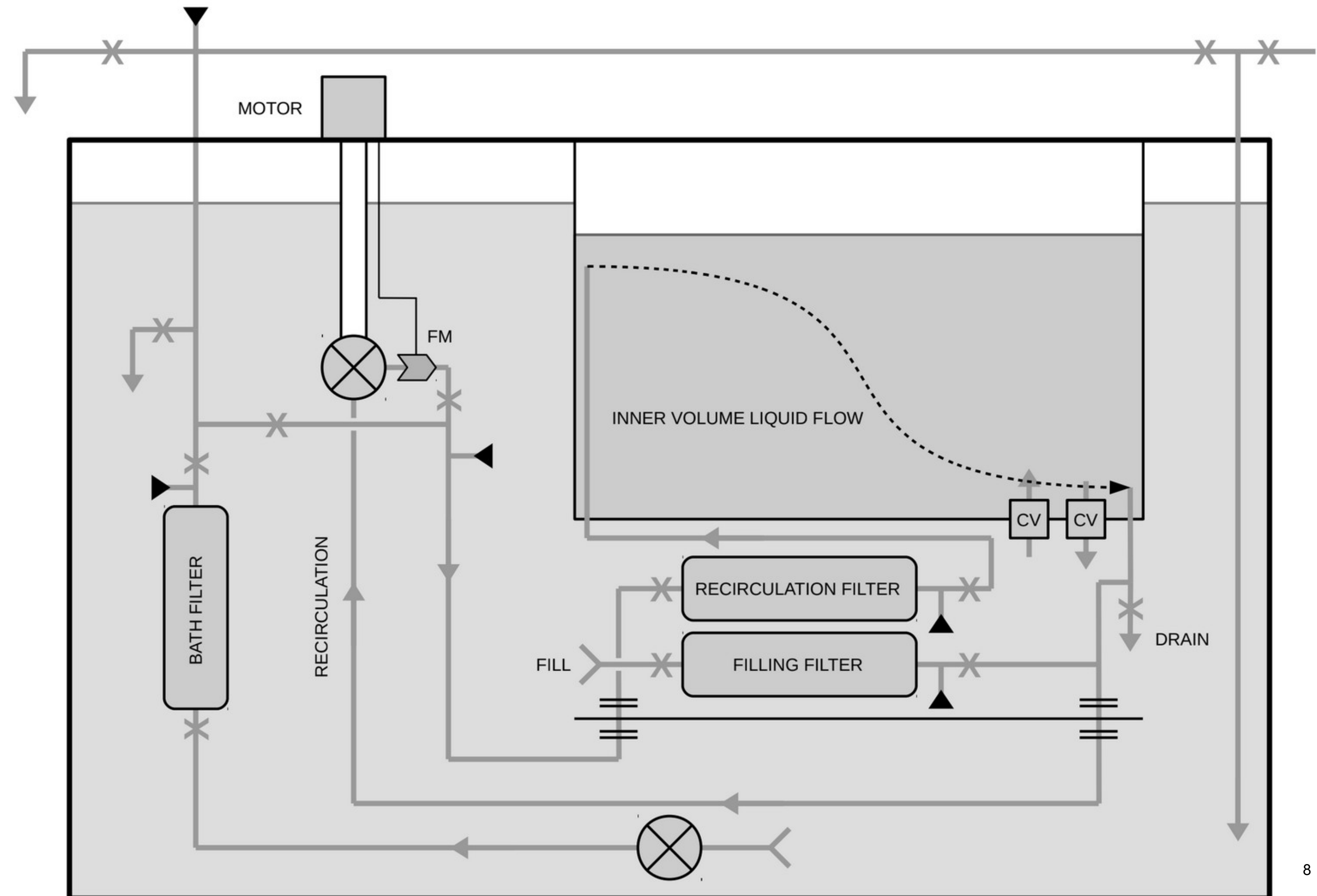
-- Bath purification system is redirected into the module.



# Cryo (liquid) Scheme for Next R&D Test in Bern

Adapting pre-existing components to demonstrate:

- Flexible steel lines below the dummy flange.
- Module recirculation with external (to module) pump
- Bath filtration, and module filling from bath system.

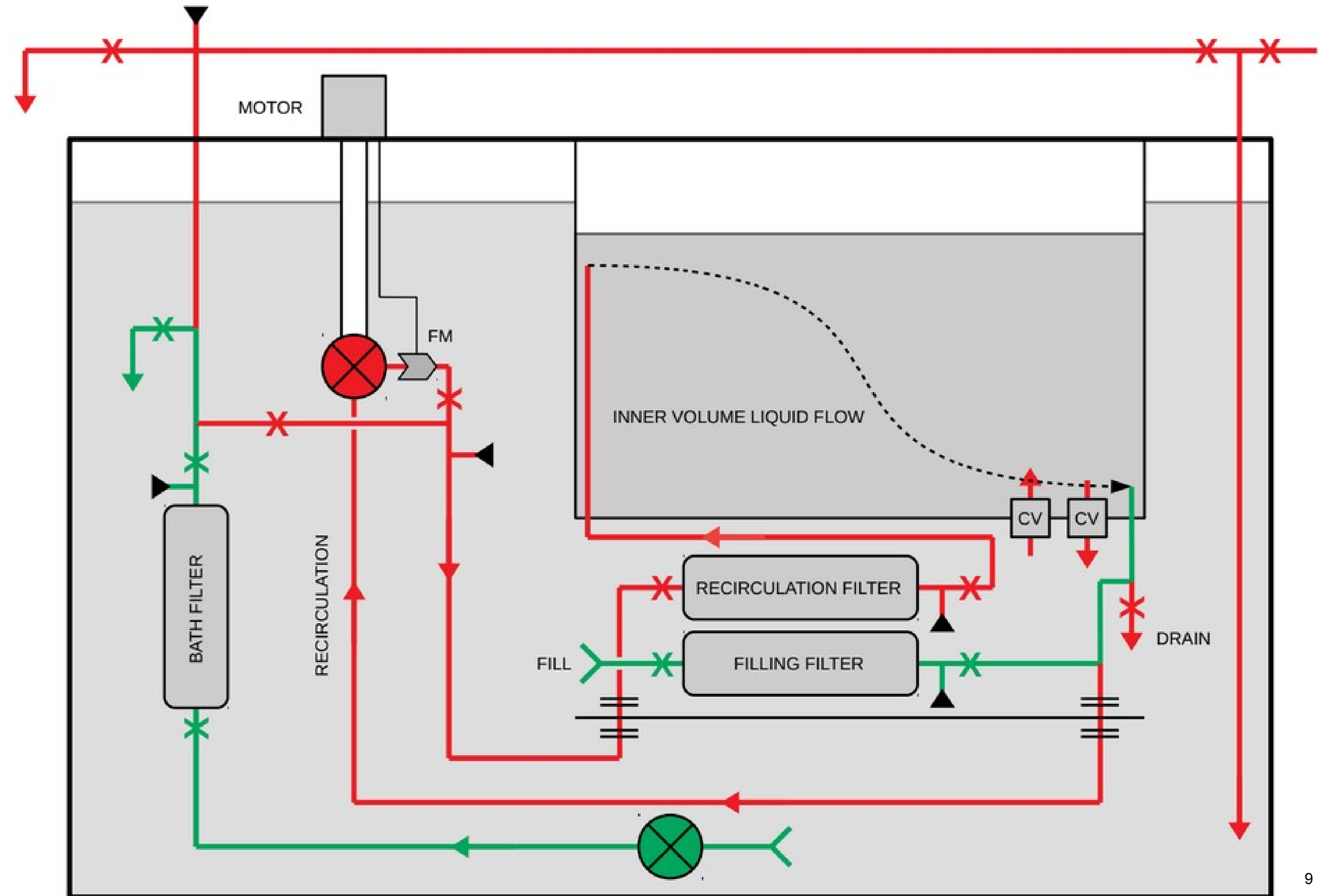




# Cryo (liquid) Scheme for Next R&D Test in Bern

On module insertion:

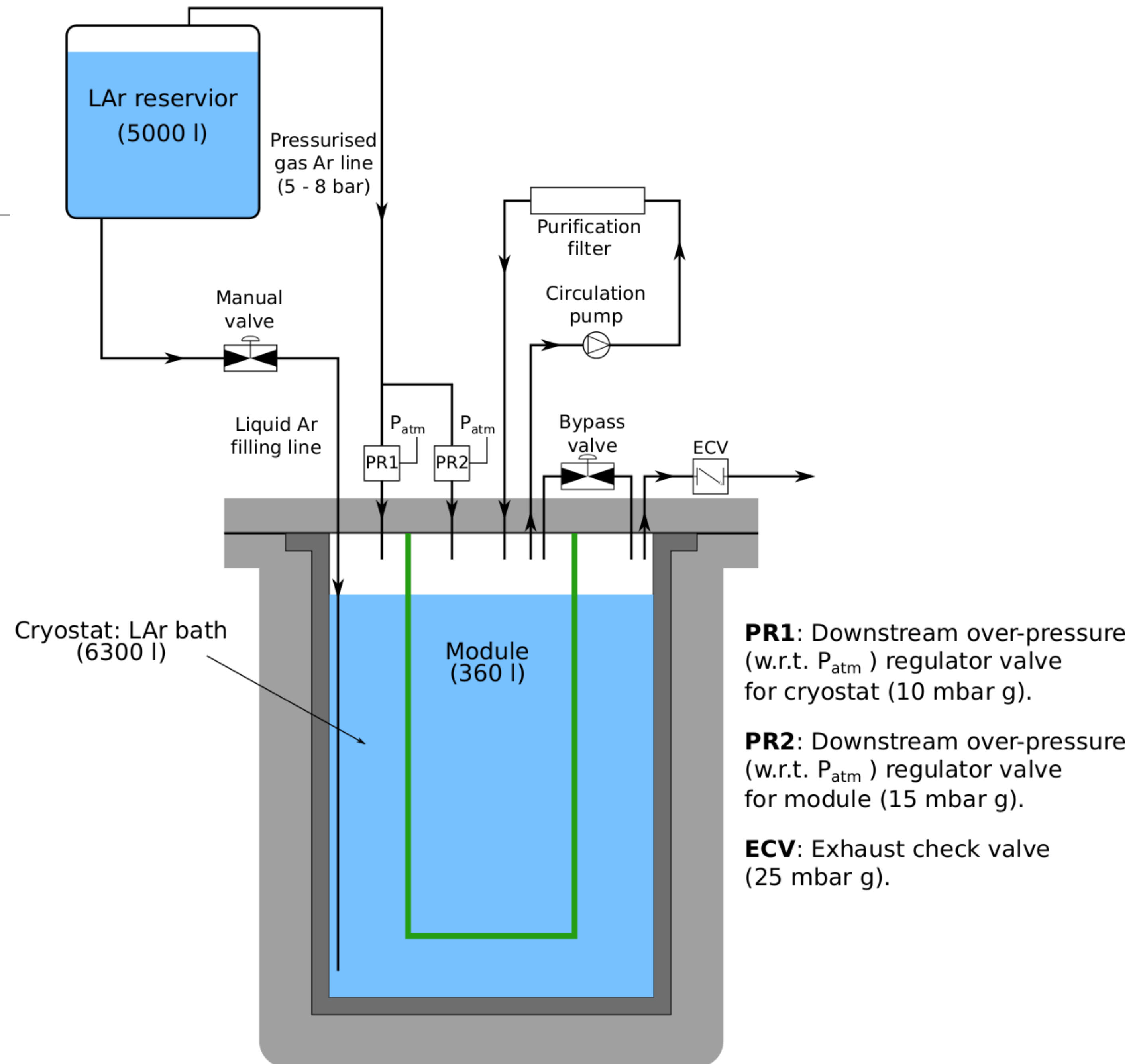
- The bath is continually purified.
- module is filled via a filter at the base.



# Pressure Control

Module Liquid level can be maintained by monitoring level in the volume above TPC, and filling from bath purification system.

To cope with dynamic pressure changes, it is preferred not to move liquid directly between the bath and module. Instead, the pressure should be maintained using the gas phase.





# Cryogenic Control Valves

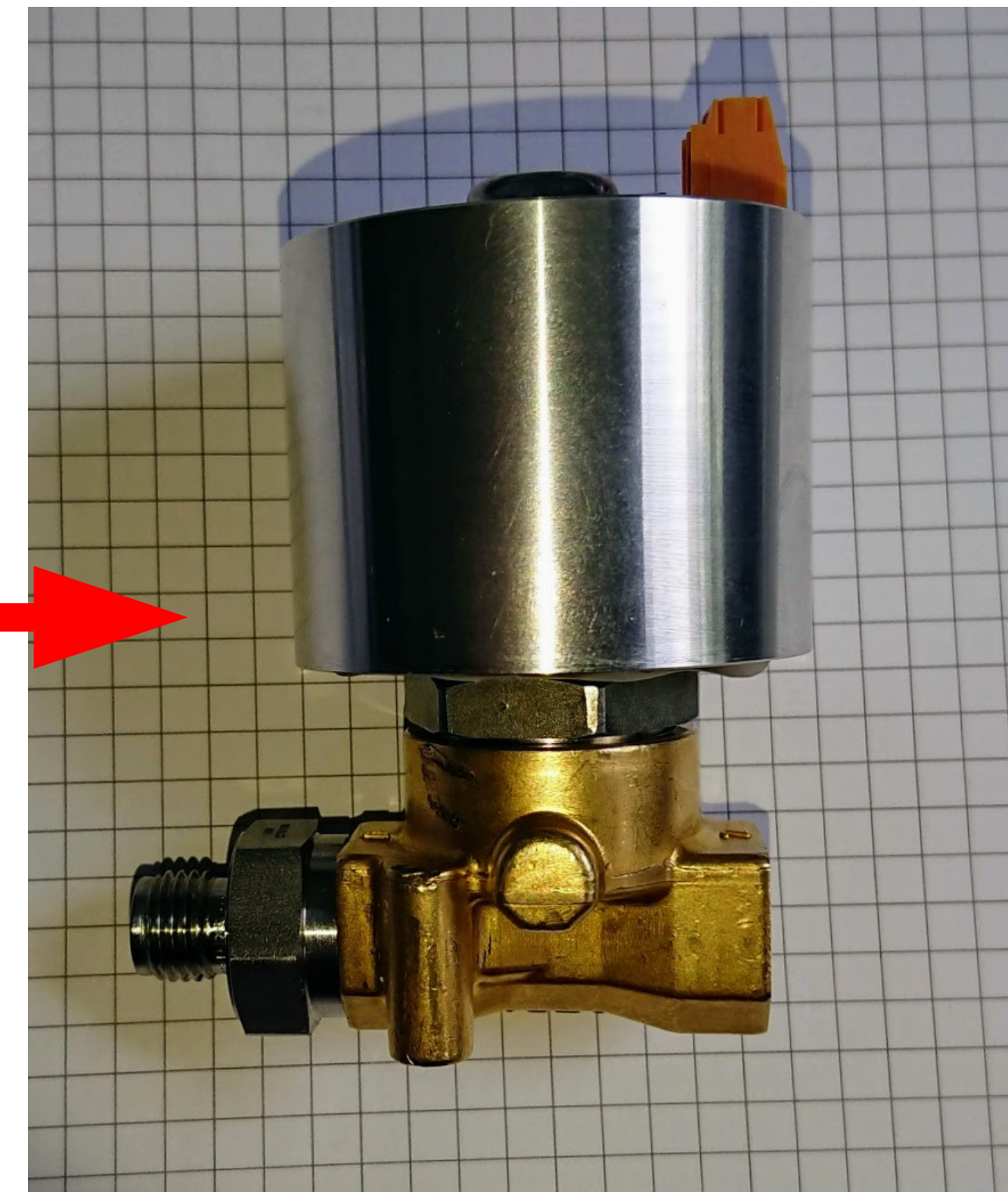
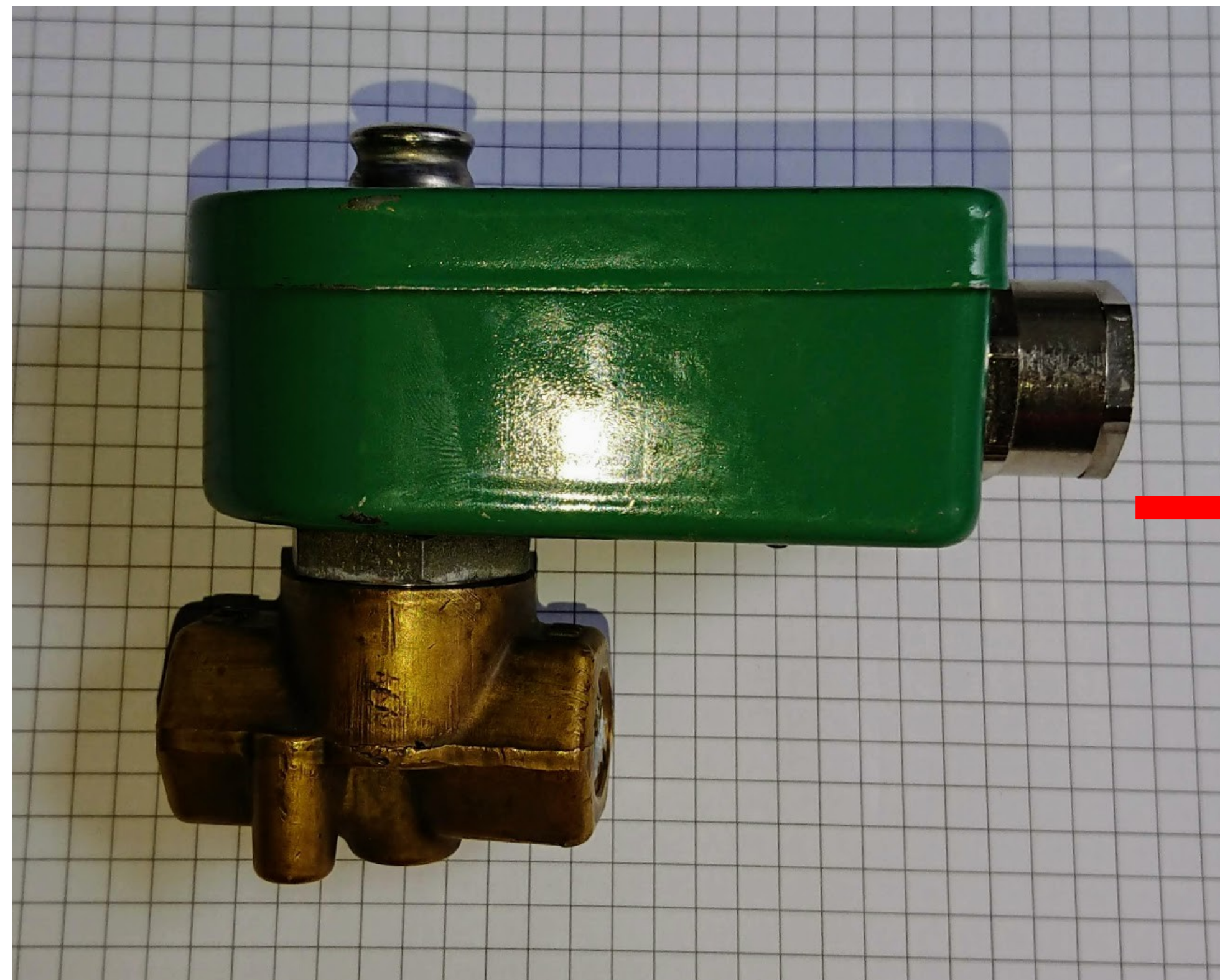
Cryogenic solenoid valves would mitigate the need for check valves.

Modify the actuator of existing valves (**NOT THE VALVE MECHANISM**), to create a bi-stable cryogenic valve. Using a permanent magnet and solenoid.

Prototype has been shown good for 150k cycles in LN2.

12 valves produced. Capacity 10 in PLC, limited by I/O.

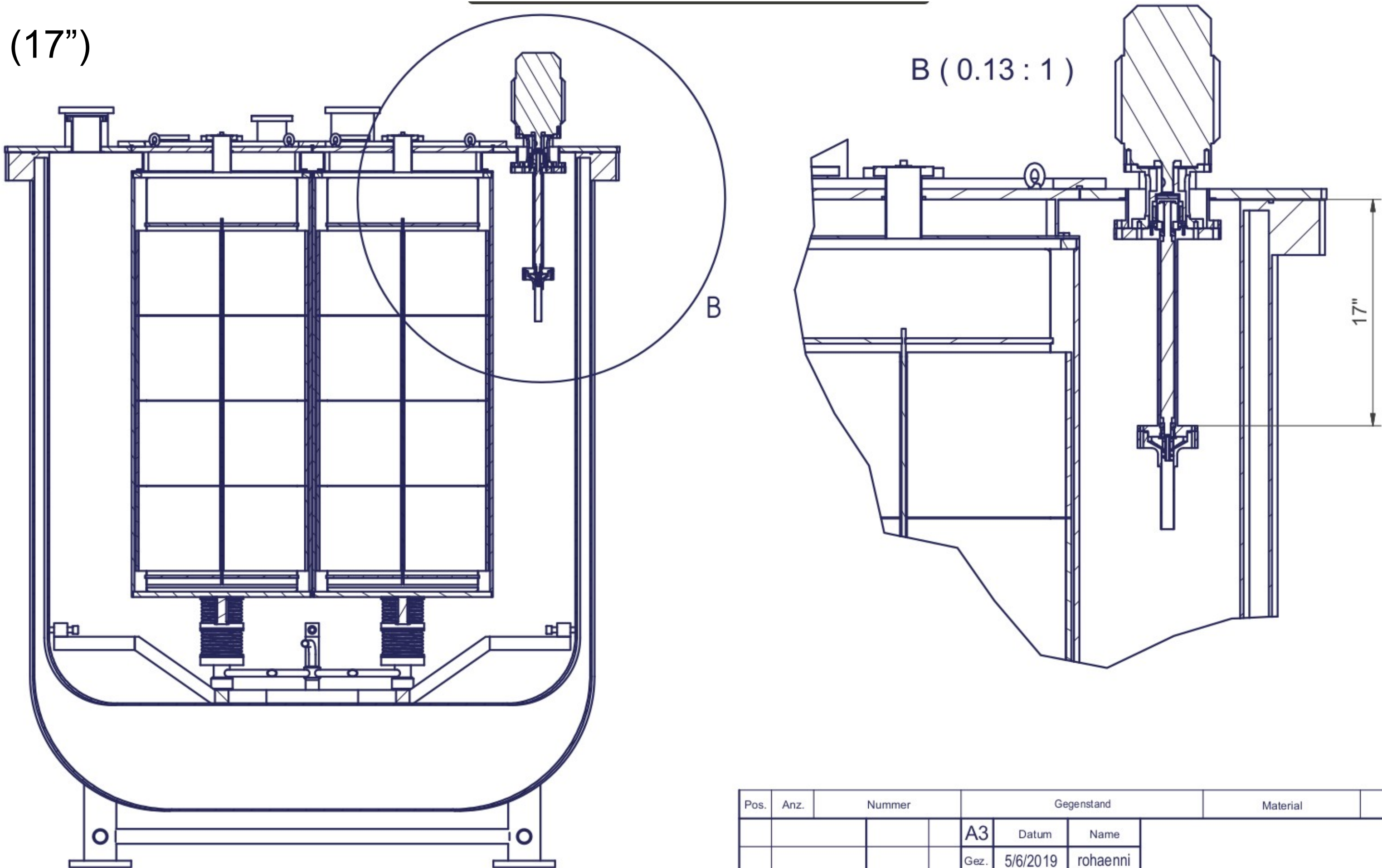
Currently, working on control modules for each valve.  
(Thanks to Trevor for advice on PCB design).





# Module Recirculation Pump

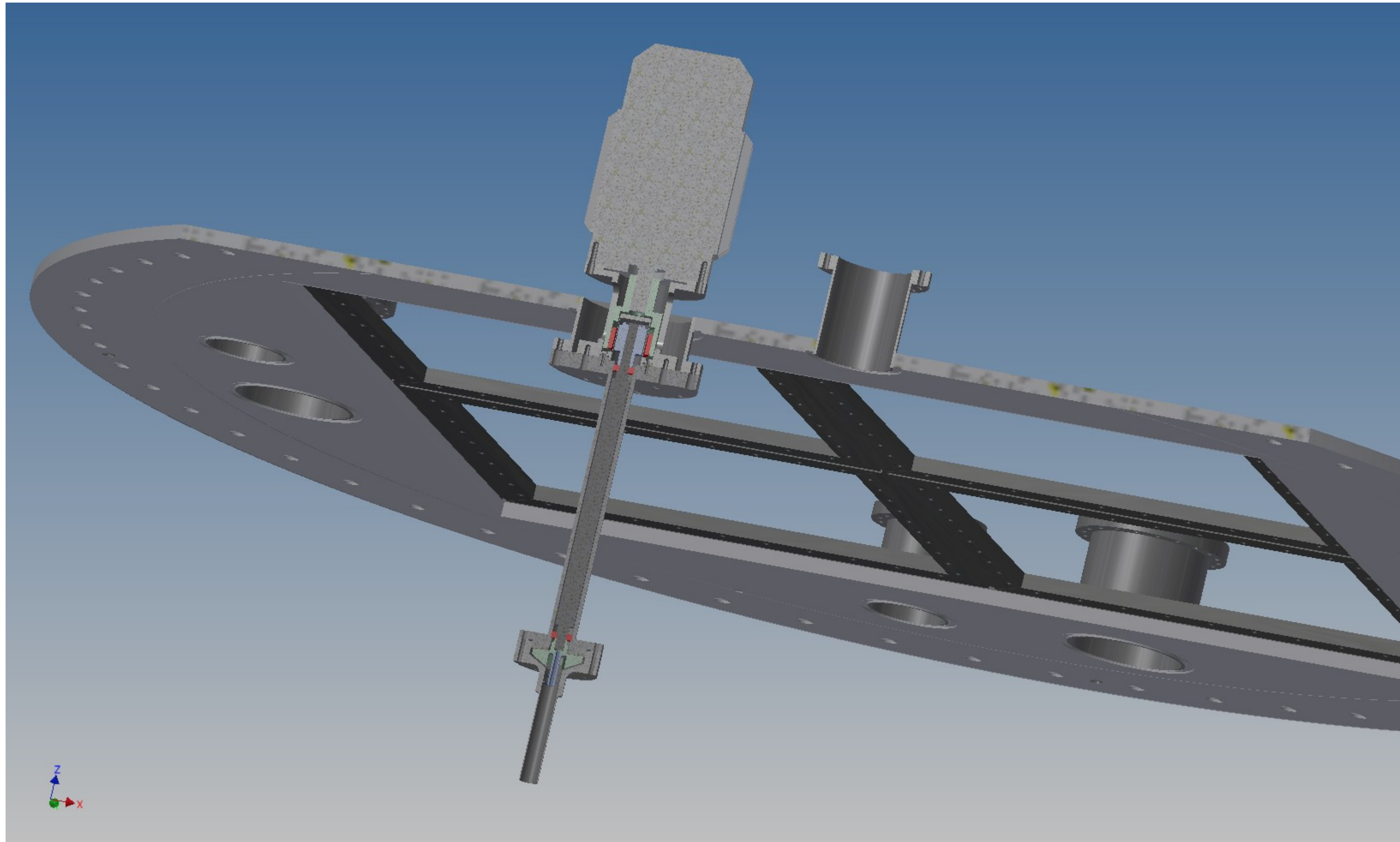
Impeller depth 432 mm (17")



Pos.	Anz.	Nummer		Gegenstand			Material	Bemerkungen							
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# Module Recirculation Pump

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# Module Recirculation Pump

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