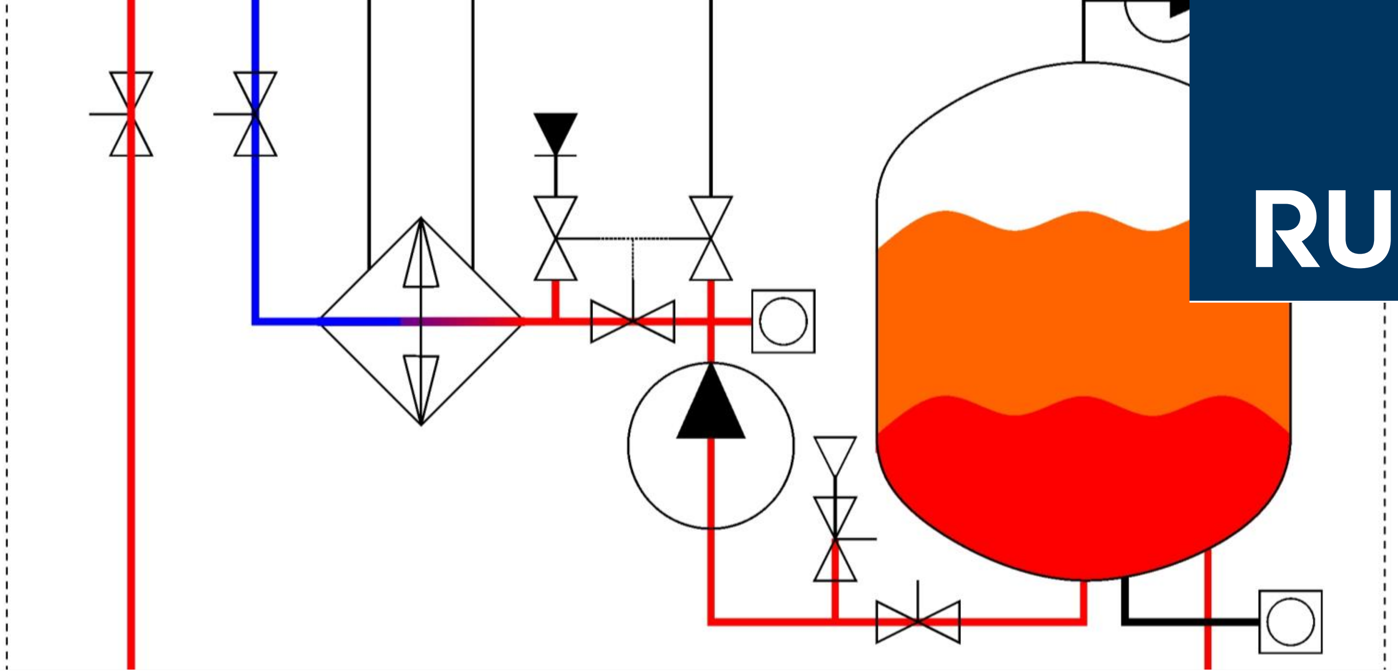

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A LEAKLESS COOLING SYSTEM

For the complete PANDA Target-EMC

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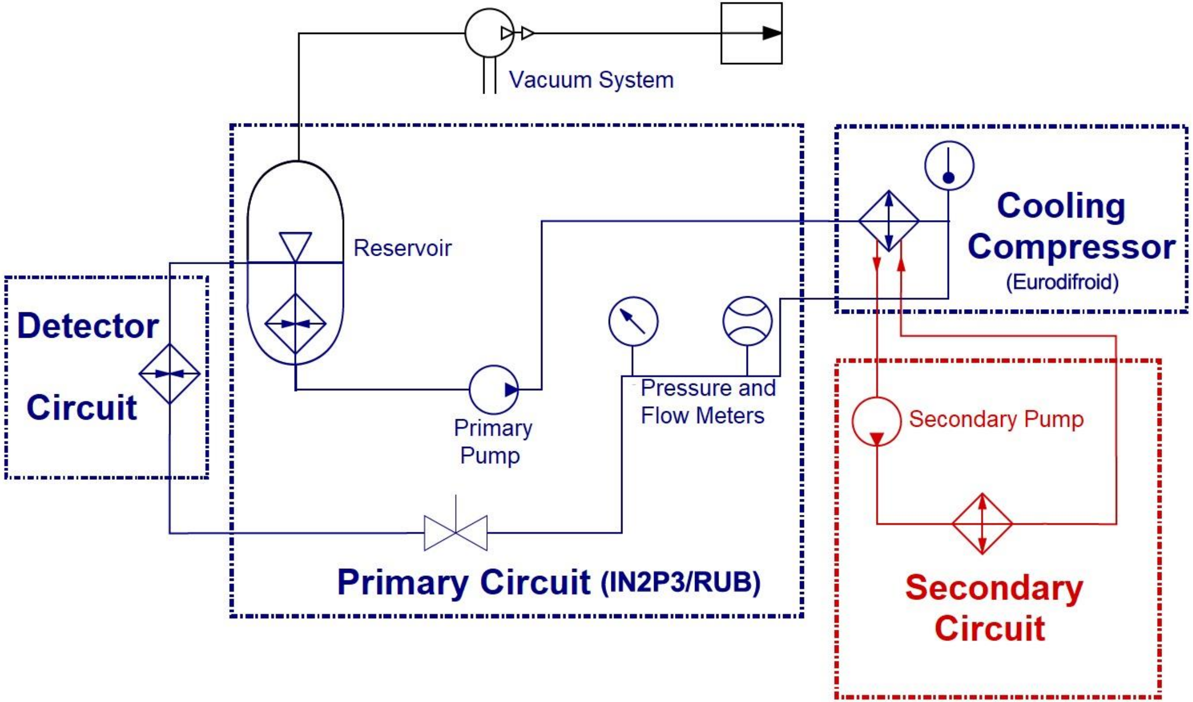
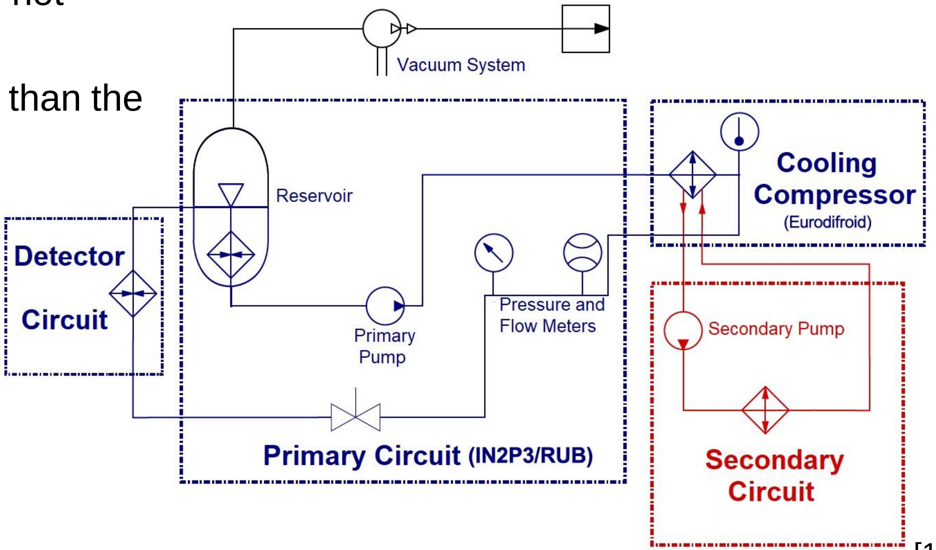
Prototype setup for endcap and first slice:



[1]

Problems with the prototype setup:

- Not intended to fit to the whole detector, only for testing forward endcap and one barrel slice.
- Operation as an underpressure pressure system not possible without malfunctions.
- Setup in a big box, consumes much more space than the components itself.
- Reservoir much too small.
- No built-in safety systems.



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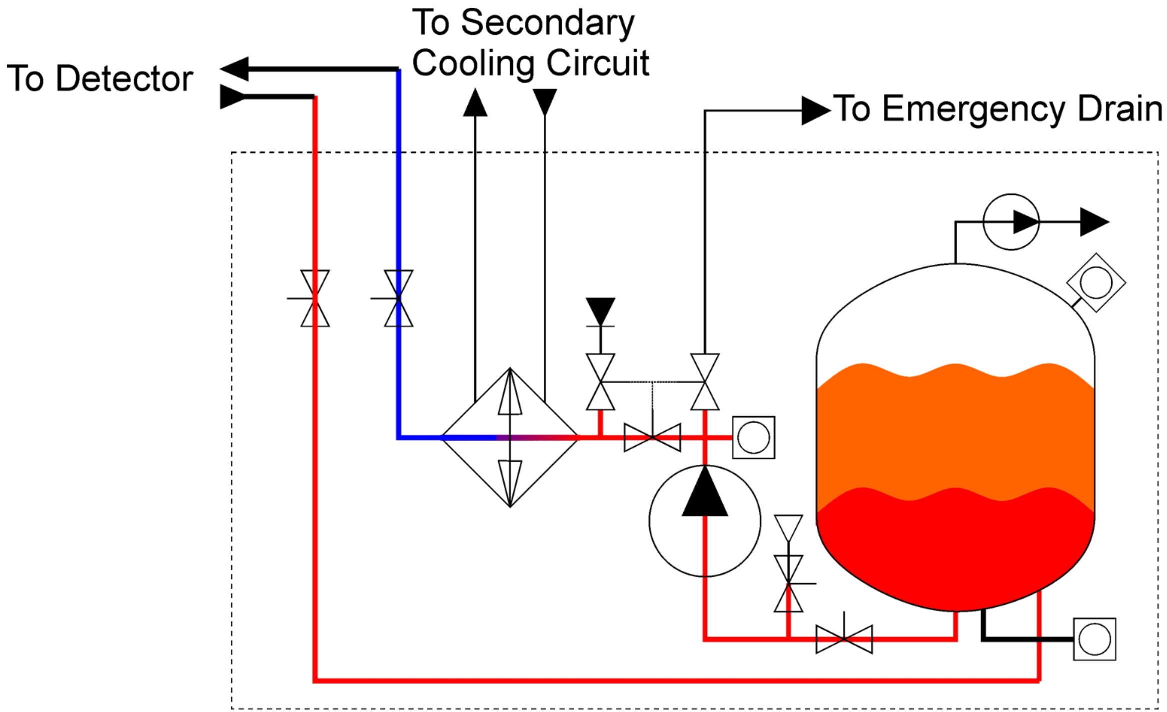
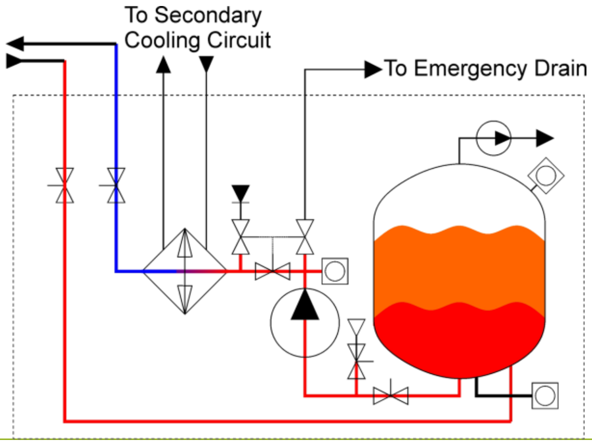
Concept for a new system for the whole target EMC



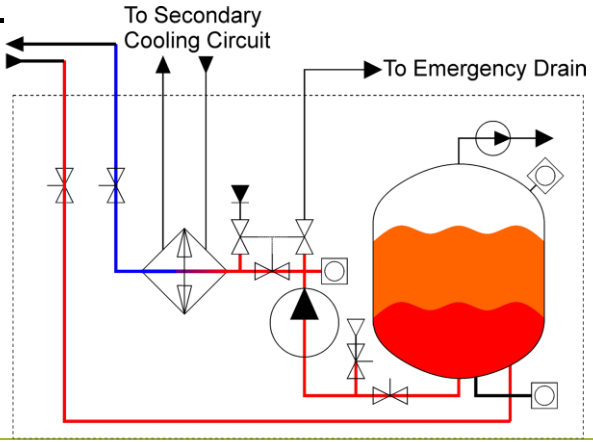
Advantages of the new system

- Designed from the start for all cooling requirements of the complete detector: estimated fluid volume ≈ 750 l, estimated total flow ≈ 300 l/min.
- The focus was on measuring and controlling, so sensors and valves were chosen to be automatable.
- Bigger reservoir, now also intended for storing the cooling liquid.
- Valves provide fast controllability.
- Multiple safety features for easier maintainability in the event of an incident.



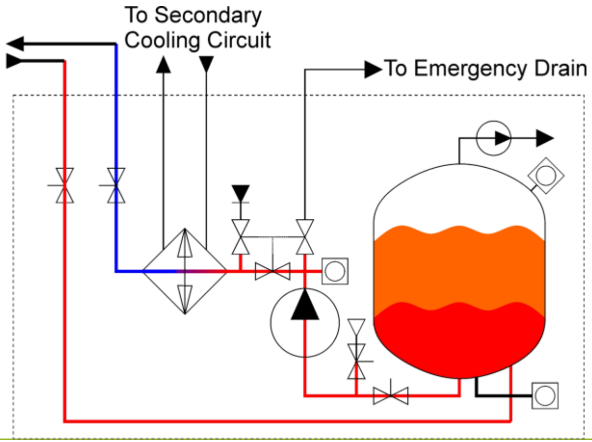
Advances in security and reliability

- Leakage safety precautions:
  - Leaks can be detected either by pressure drop in the reservoir or by differences in the pump running cycle.
  - if a leak occurs, the vacuum in the circuit draws in air and lets no liquid drop out.
  - Reduction of gas in the liquid after entering the reservoir by rising. → cooling is temporarily ensured in the event of small leaks.
- Emergency safety precautions, also useable for maintenance:
  - The whole cooling liquid can flow back to the reservoir by gravitation and/or vacuum.
  - The reservoir/cooling circuit can be drained to an external emergency storage vessel using main pump pressure.



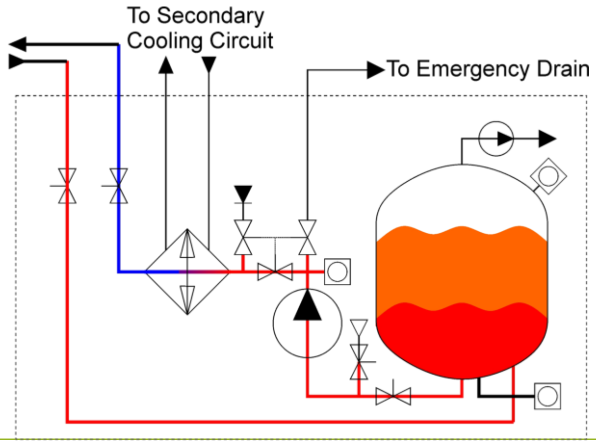
Component conciderations

- All metal parts should be made of stainless steel for corrosion reason.
- All parts, especially valves, pressure meters, etc, must be low-temperature and methanol proof.
- Valves, pipes and the reservoir should use flange instead of threaded connections, for maintenance reasons.
- It is suggested to isolate all liquid containing parts to avoid condensing air humidity and reduce thermal losses.
- All measuring devices should use the same interface standard.



Dimensioning

- Reservoir volume must be high enough to hold all liquid, also from pipes! Complete fluid volume, incl. piping ≈ 750 l → ≈ 1 m³ reservoir volume may fit.
- Pipes and valves must be wide enough for not creating relevant pressure losses. Estimated complete flow (for $\Delta T < 1$ K) ≈ 300 l/min → D = 80 mm will give < 1 mbar pressure loss in valve section.
- All valves should be fast switching to provide maximum security.
- Pressure sensors ranges should be as small as possible to allow small measuring errors, but on the other hand should be overpressure resistant.



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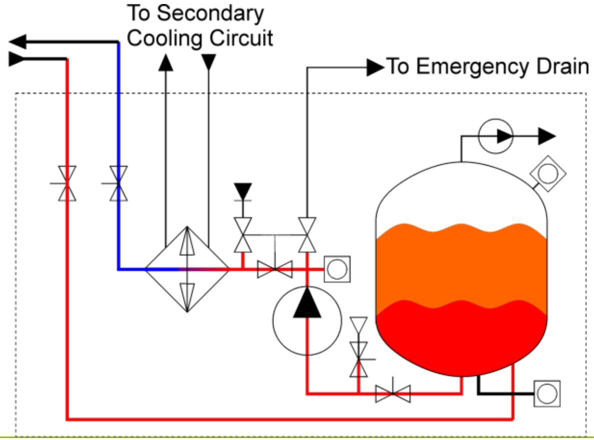
About valves

Since a valve position is held for long times, ball valves are preferred instead of magnet valves, which would always need controlling voltage and are higher priced.

Actuator: pneumatic or electric?

+ Pneumatic drives are cheaper, faster and available for lower ambient temperatures.
– Extra magnet valves and compressed air are needed to make it accessible to electronic controlling.
+ Electric drives are directly controllable and only need cables instead of pipes.
– Electric drives produce waste heat and consumes constant power.



Next steps

- Decisions will be made which parts will be the best ones.
- A stronger main pump and cooling compressor must be found.
- Parts will be ordered.
- While waiting: controlling software (for a µC) must be developed.
- It may be necessary to rework the vessel/reservoir (adding flanges etc.).
- Some parts may be manufactured in-house.
- Everything must be set up and be tested/calibrated.
- Writing a clear documentation and understandable manual.

➢ Mission complete!

Thank you for listening!

Are there any questions?

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[1]: T. Triffterer. „Entwicklung von Komponenten für das Detektorsteuersystem des PANDA-Kalorimeters und Studien zur Photoproduktion angeregter η-Mesonen mit dem CB/ELSA-Experiment“. Dissertation. Ruhr-Universität Bochum, 2016.