Gas System for CYGNO-04

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About the impact of the gas system on detector and physics

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- The currently operating gas system was already designed for CYGNO-04

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  - in principle, largely over-dimensioned for LIME
  - in reality, we have already operated it for some periods with the maximum flows (20 l/h fresh flow and 100 l/h recirculation), and normal operations for LIME (5 l/h fresh and 20 l/h recirculation) are at 50% of the nominal CYGNO-04 flow
- The reason for operating LIME with relatively high flows is the concentration of contaminants (due to leaks)
  - total leaks in LIME + pipelines + gas system is now ~ 7 sccm
  - back-of-the-envelope calculations (with some reasonable assumptions) indicate that we need < 1 sccm leak to keep O(1 kevent/year) Radon background from the gas

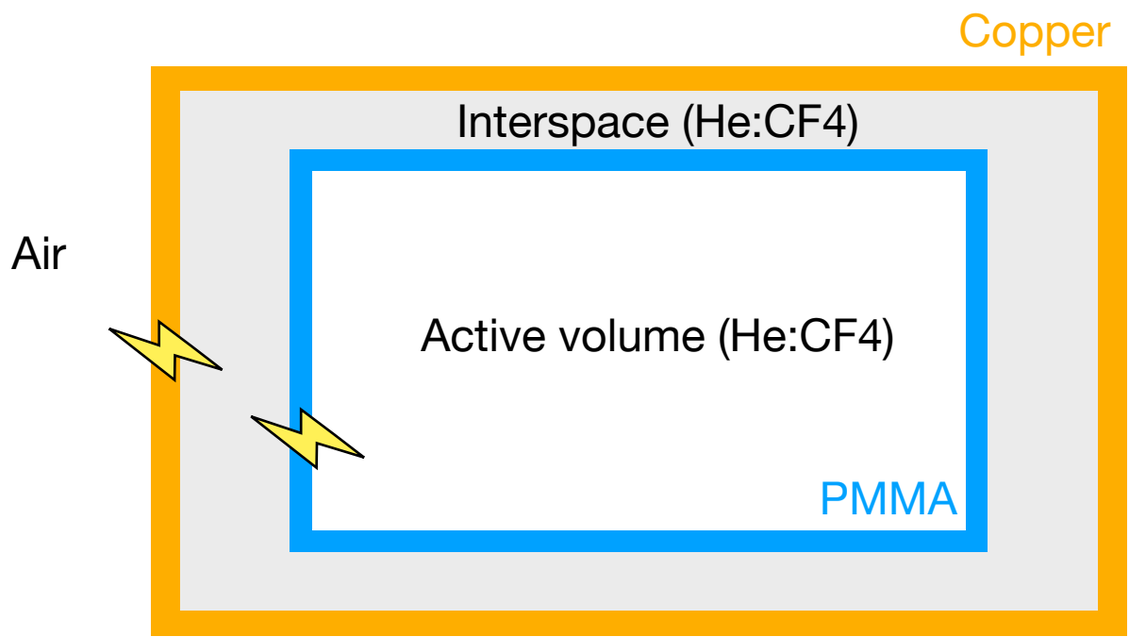
CYGNO-04 and leaks (I)

- The detector structure will be, by construction, tighter than the LIME one (better sealings)

- Thanks to the presence of an interspace between the active volume and the external atmosphere:

  - leaks through the PMMA vessel expose the active volume to a gas that is already much cleaner than air

  - air going through leaks in the Copper vessel needs to go through two vessels to reach the active volume



CYGNO-04 and leaks (I)

- Residual leaks could be present in the pipelines and inside the gas system
  - further campaigns of leak search and tests of critical elements (e.g. recirculation pump) are recommended at the end of the LIME run
  - If necessary, some components could be replaced with assistance from AirLiquide

Gas system and CYGNO-04 mechanics

Flowing scheme

- In CYGNO-04, we want He:CF4 in both active volume and interspace
- Differential pressure through the PMMA vessel should be ideally zero
- Some strict limit (< mbar?) apply for the differential pressure through the Copper vessel
- Can we flow active volume and interspace with two different gas lines?

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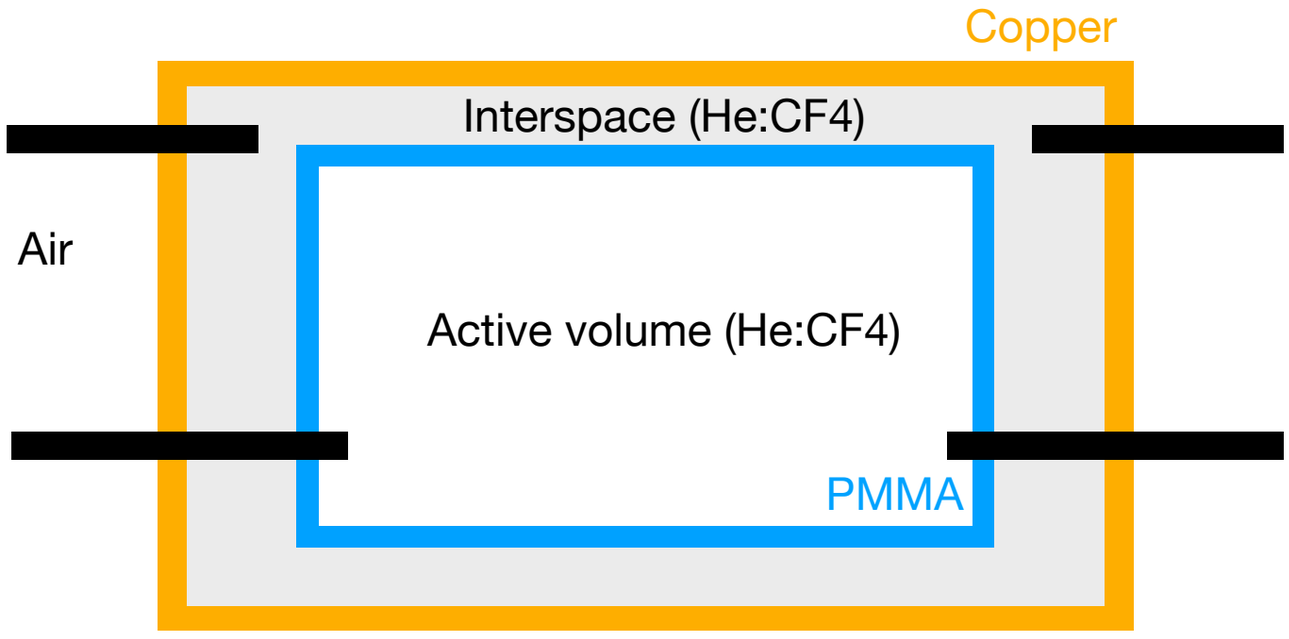
  - Heavy upgrade of the gas system needed (additional flowmeters, additional sensors, additional pressure control systems)



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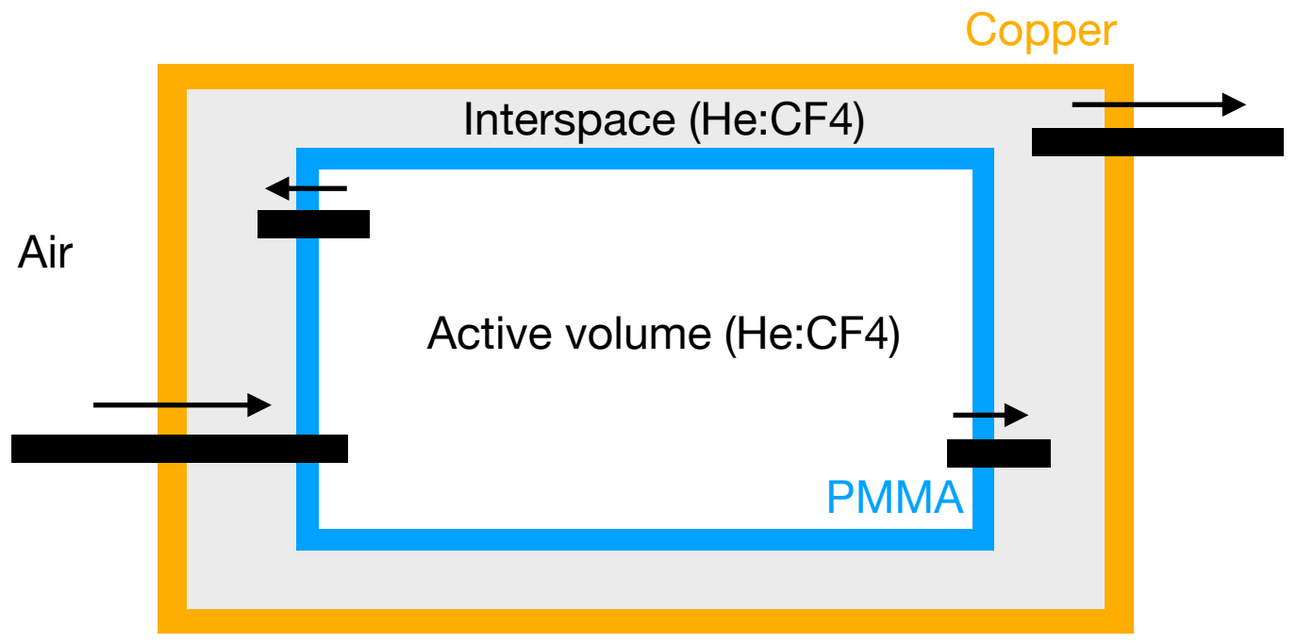
- Some strict limit (< mbar?) apply for the differential pressure through the Copper vessel
- Do we need to flow active volume and interspace with two different gas lines?
  - No, there is no real advantage (the gas in the interspace would be less clean than fresh gas, but still orders of magnitude cleaner than air)



Connection requirements

- To keep the differential pressure through the PMMA low, we need the connections to be low in impedance
- Still, we could desire a small pressure difference (a fraction of mbar)
  - “regulated” by number and length of pipes in between the two volumes

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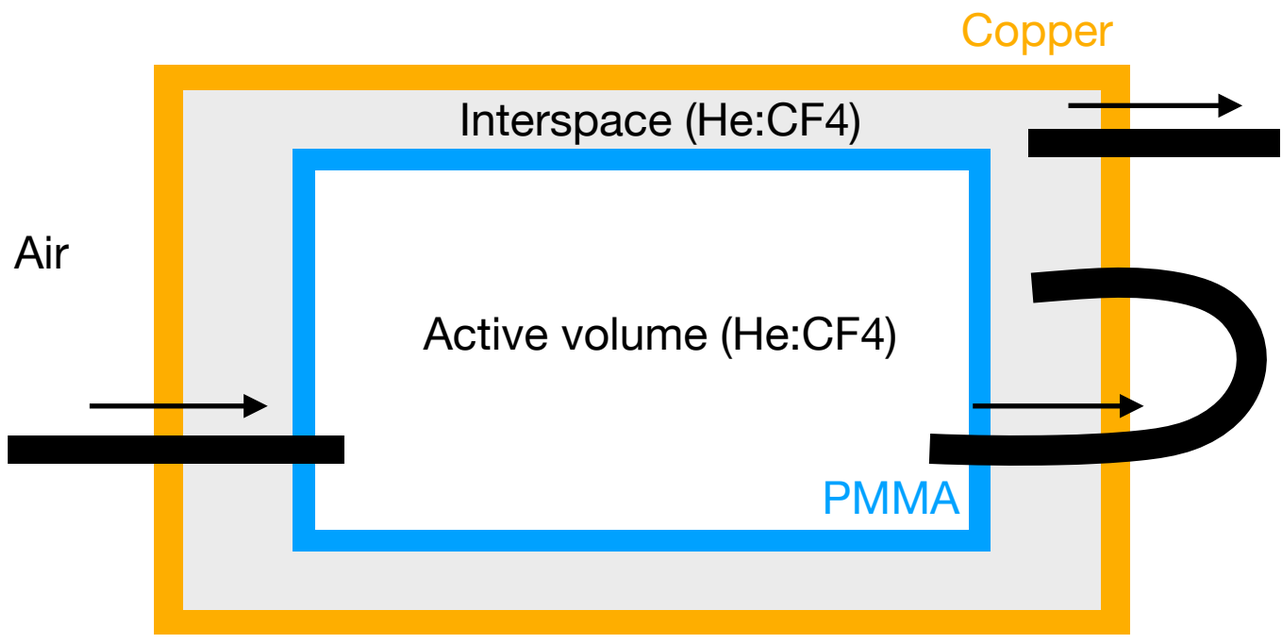
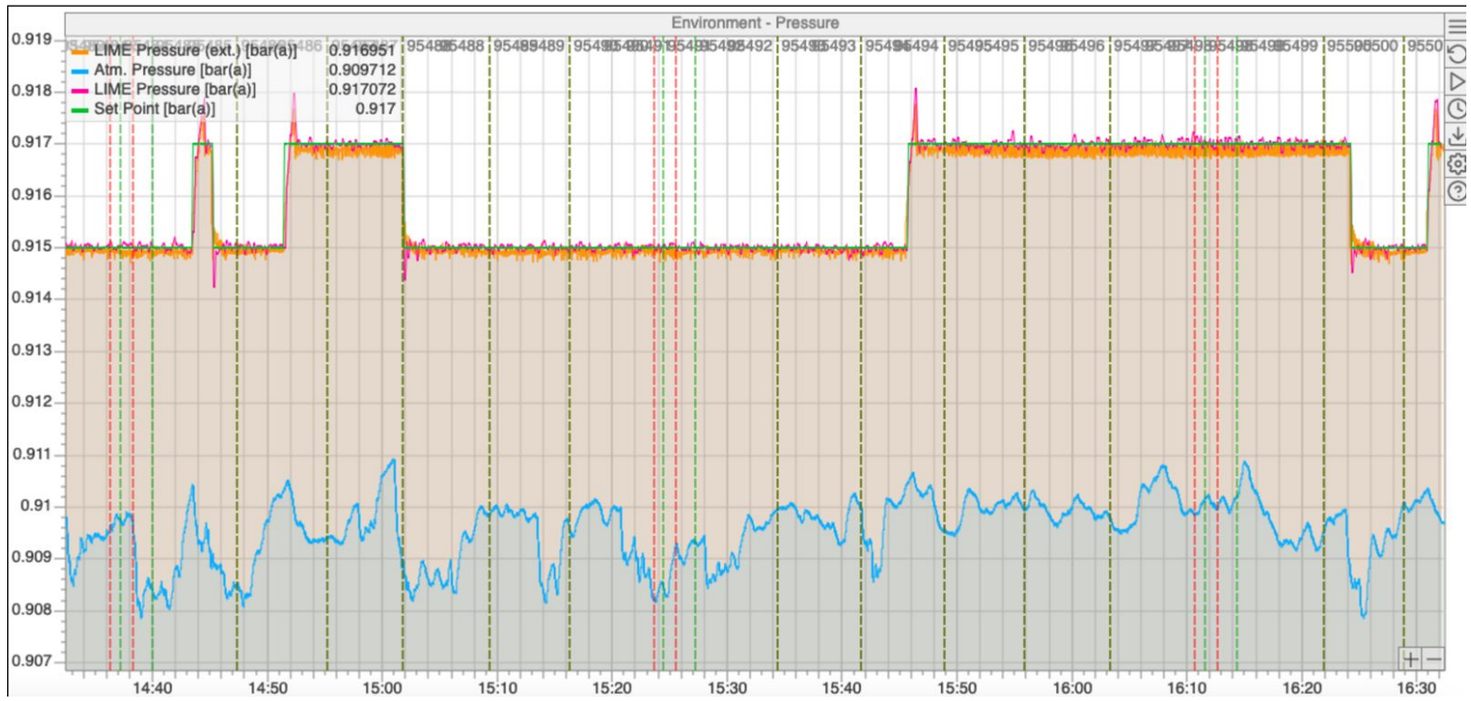
➡ one could even consider a pressure drop “tunable” on site



Pressure control

- At present, we control the **absolute pressure** inside LIME, but we regulate the set point so that the differential pressure against the atmosphere is always between +2 and +8 mbar.



  - To do that, a cross-calibration between sensors was performed, whose stability was never tested
  - Typical short-time fluctuations of the atmospheric pressure are ~ 3 mbar
- Without an upgrade of the system, pressure control within less than a few mbar has to be tested
  - To go below 1 mbar, we could need to switch to **differential pressure control** (change of sensors and firmware)