Progress with NP04 Cool Down

Filippo Resnati (CERN)

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Timeline

- Cryostat pressure-tested on the 9th of July.
- Cryogenics completed for operation around mid of July.
- Operation started with purging the cryostat with warm GAr to remove air.
- Gentle cooling of the internal cryostat and the detector began on the 1st of August.
- First liquid argon injected on the 3rd of August.
- Cooling injecting liquid argon began on the 6th of August.
- Actual filling began on the 8th of August.
- Since 13th of August 2x 20 ton/day of LAr go into the cryostat.
- As of the evening of August 22nd about 2.3 m (230 ton) of LAr are in the cryostat.

Purging

Piston effect worked nicely: air quickly removed at the benign.

Constant monitors of the N_2, O_2 and H_2O contaminations.

H_2O was the main concerns: during purging, H_2O contamination stabilises around 100 ppm (about 70 g). Contamination is difficult to reduce because the sources (like cables and FR4) are inside the cryostat.

Improvement by purging simply takes too long.

Purging

Not possible to warm up the cryostat and the detector to favour the outgassing. Change approach: cool down to reduce the outgassing.

Cooling only with the sprayers resulted in ice forming on the sprayers (70 g H_2O on small and very cold surfaces).

Cooling

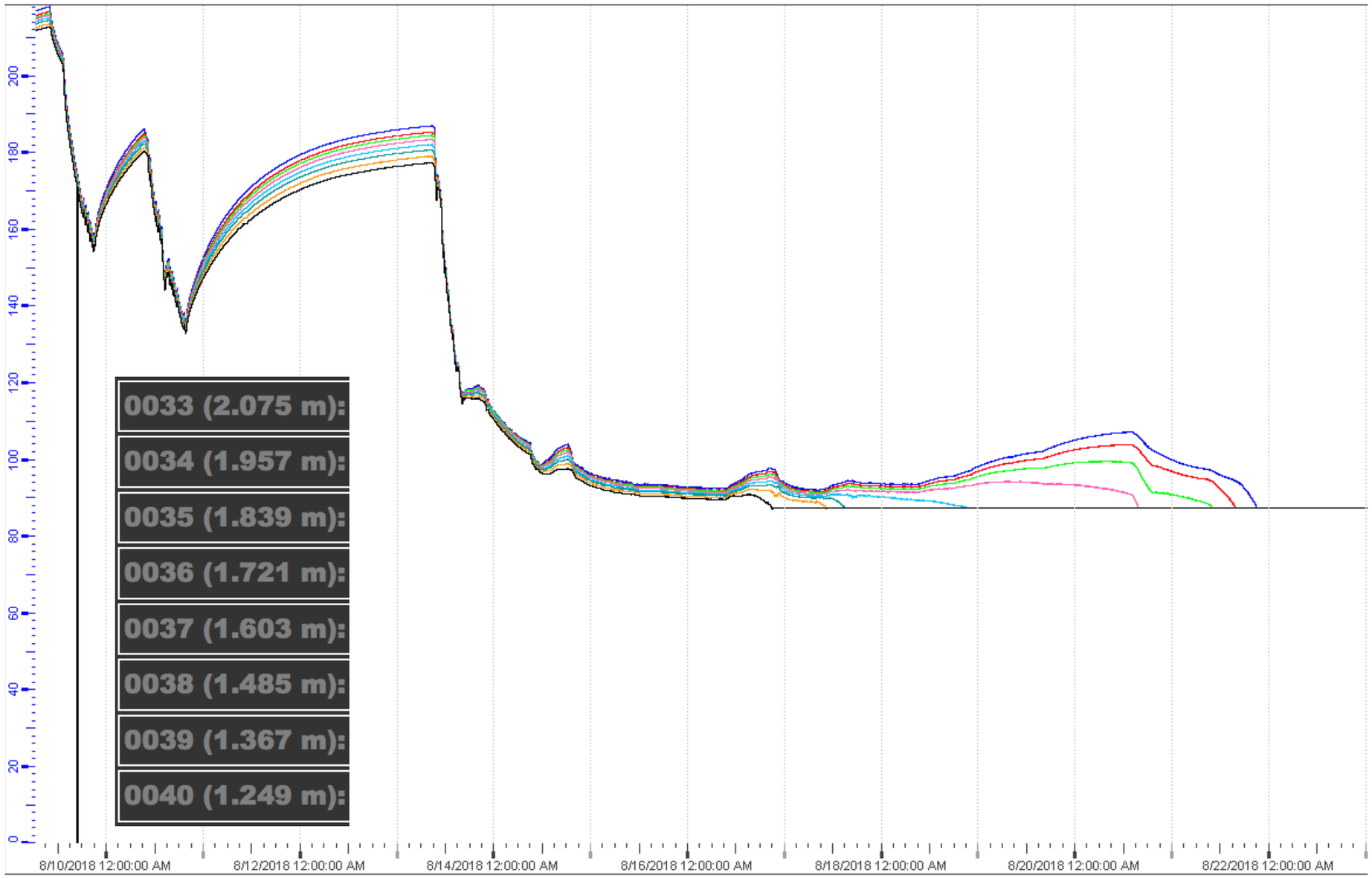
Cooling (not only with sprayers) a larger surface at the same time. Observation: sprayers need higher pressure difference to deliver the nominal argon flow.

After regeneration of the LAr purification cartridges, start gently filling of the cryostat and flow gas through the LAr.
GAr flow resulted too small, but the filling itself produced enough gas flow to cool the top of the cryostat.

Cooling from the top improves the temperature uniformity.
Stratification dominates while cooling from the bottom.

Cooling

History of GAr temperatures between 1.25 m and 2.07 m



Concerns for cooling and filling

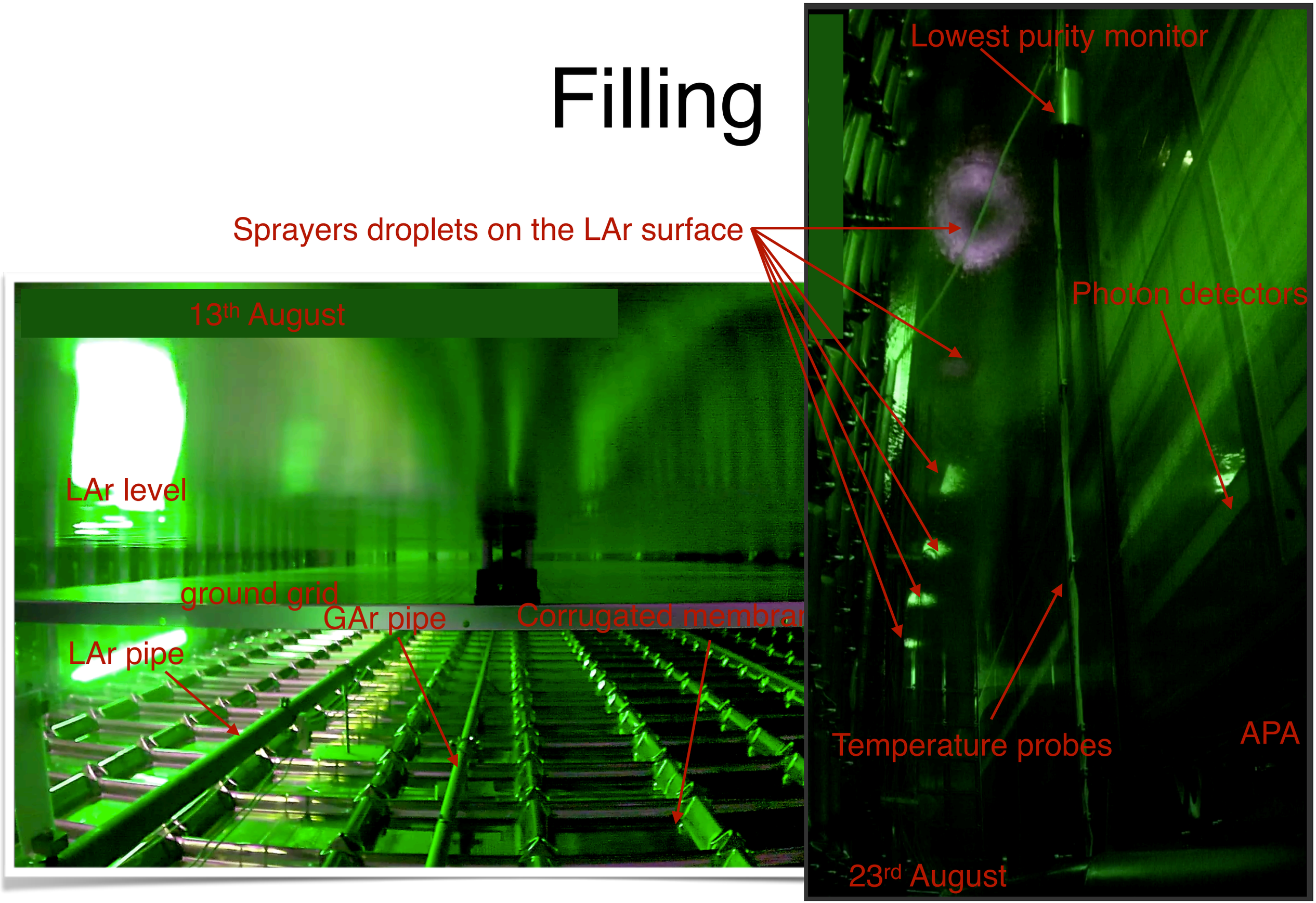
Speed of the cooling: at most at 40 K/h (APA requirement)

Uniformity of the cooling: maximum temperature difference on the APA of 50 K.

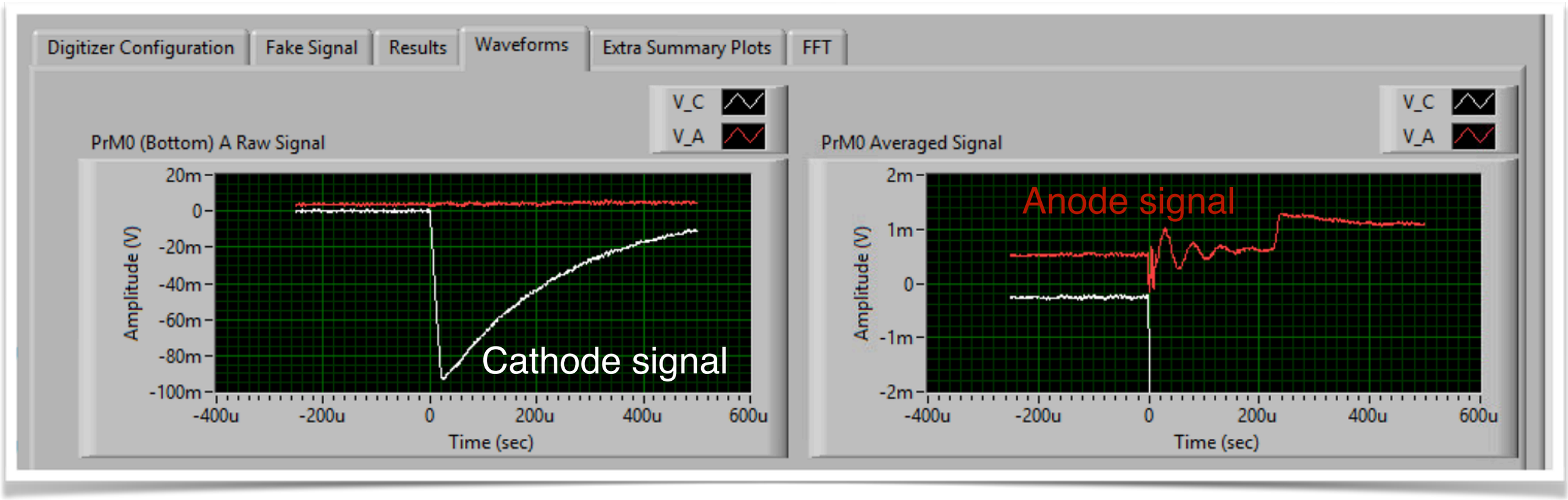
APA temperature is not measured at any point.
Conservatively, temperature of the gas considered instead.

When the LAr level touched the bottom of the APA, the temperature of the gas at the top of the APA was 138 K.

Filling


Sprayers droplets on the LAr surface
13th August
LAr level
ground grid
GAr pipe
Corrugated membran
LAr pipe
Lowest purity monitor
Photon detectors
Temperature probes
APA
23rd August

LAr Purity

As soon as the lowest purity monitor was immersed: ~40 us -> 7.5 ppb O_2^{eq}

Investigating the possibility to purify the LAr while not filling (during the weekend)