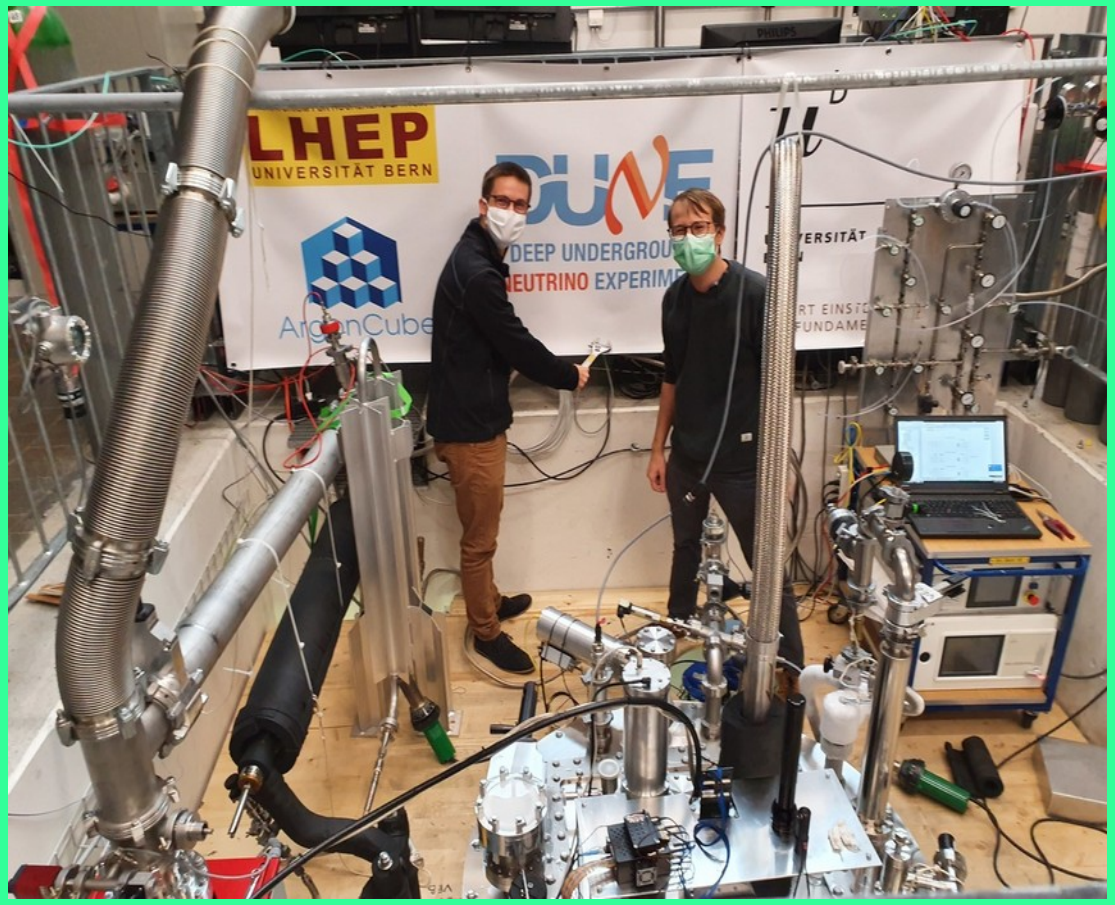
LABORATORIUM FÜR HOCHENERGIEPHYSIK
LHEP
UNIVERSITÄT BERN

ArgonCube

SingleModule test run overview
December 4th, 2020



Test objectives:

1. Test 2x2 module structure in cryogenic environment with HV at the cathode. (first test of the resistive field shell in large scale LAr TPC)

2. Confirm ability of the system to reach target LAr purity

3. Test of 100-chip pixel plane in 63x64x120 cm 2x2 TPC module

4. Validate and quantify charge-light matching between ArCLight/LCM and LARPIX data.

5. Confirm LCM triggering capability

6. Characterise ArCLight/LCM PDE, coordinate and time resolution

Test timeline
(starting from the Cryostat Sealed)

17 Nov - 20 Nov evacuation of the detector, leak fixing, residual P=8.6e-5 mbar

20 Nov - 22 Nov purge with warm argon

22 Nov - 23 Nov purge with cold argon (mild rate cooldown)

23 Nov - 24 Nov cooldown

24 Nov - start of DAQ, calibrations

25 Nov HV @ 0.5 kV/cm

26 Nov HV @ 0.7 kV/cm

27 Nov HV @ 0.75 kV/cm

28 Nov HV @ 1.0 kV/cm

1 Dec - last data run, start emptying detector

3 Dec - Detector is at room T, 24-h shifts are finished.

HV- stability

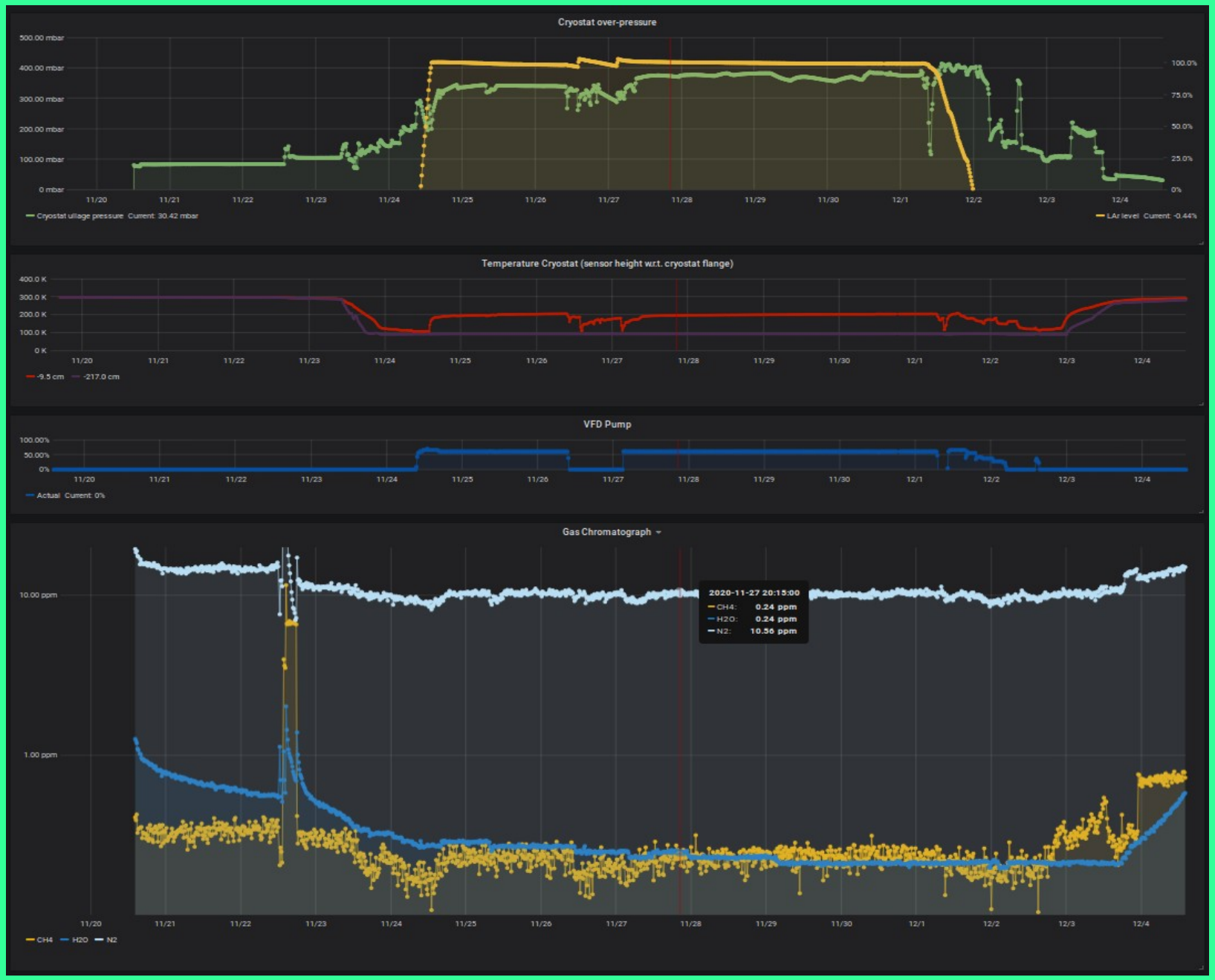
~ 48h at 0.5 kV/cm

~ 24h at 0.75 kV/cm

~ 24h at 1.0 kV/cm - several short (~5min) instabilities observed at the beginning (HV conditioning of the field shell?)

HV- stability and data rate

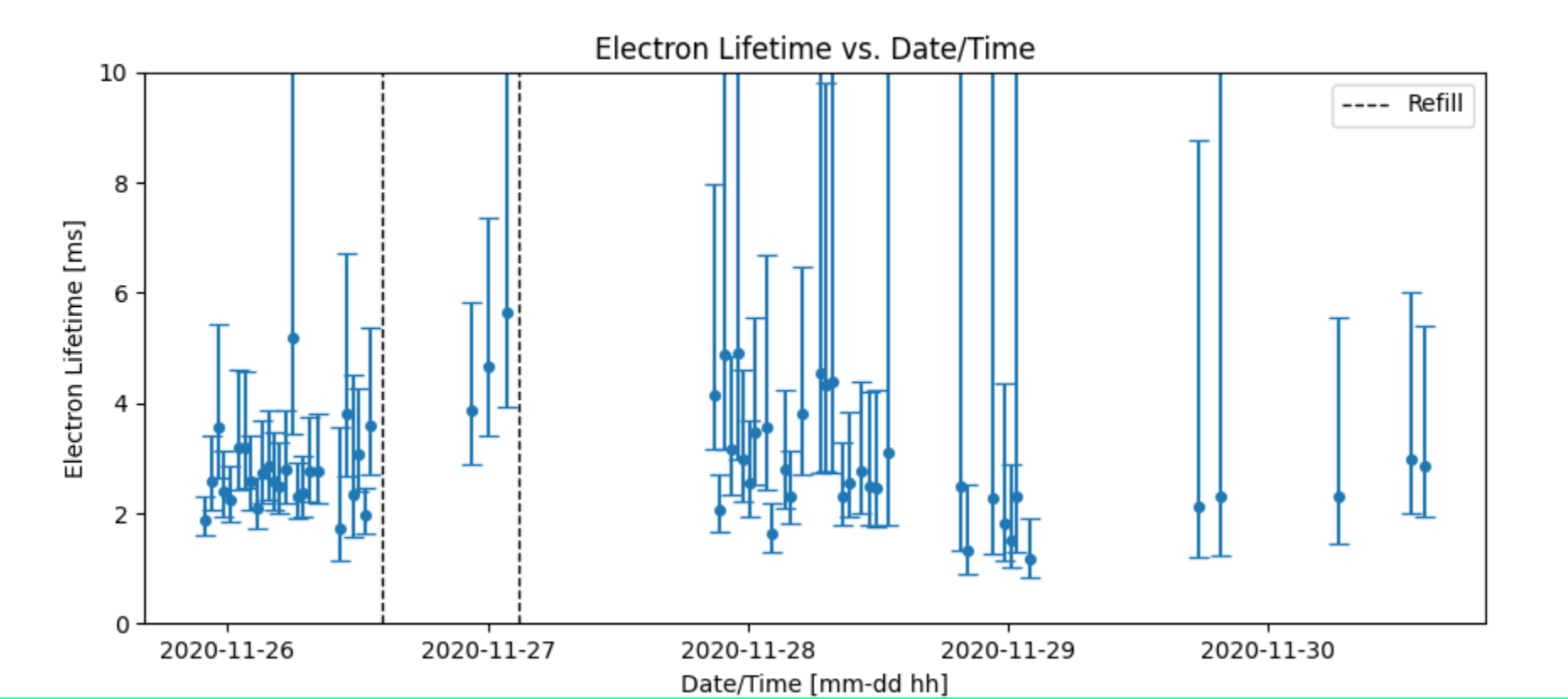
LAr purity


Cryostat over-pressure
500.00 mbar
400.00 mbar
300.00 mbar
200.00 mbar
100.00 mbar
0 mbar
100.0%
75.0%
50.0%
25.0%
0%
11/20
11/21
11/22
11/23
11/24
11/25
11/26
11/27
11/28
11/29
11/30
12/1
12/2
12/3
12/4
Cryostat ullage pressure Current: 30.42 mbar
LAr level Current: -0.44%
Temperature Cryostat (sensor height w.r.t. cryostat flange)
400.0 K
300.0 K
200.0 K
100.0 K
0 K
-9.5 cm
-217.0 cm
VFD Pump
100.00%
50.00%
0%
Actual Current: 0%
Gas Chromatograph
10.00 ppm
1.00 ppm
2020-11-27 20:15:00
CH4: 0.24 ppm
H2O: 0.24 ppm
N2: 10.56 ppm
CH4
H2O
N2

LAr purity

> 2 ms lifetime is achieved in both modes:

- Sealed detector at ~400 mbarg, continuous recirculation
- No recirculation, exhausting LAr at a rate of 65 slpm GAr (level loss ~0.5 cm/h)



LAr purity


Cryostat over-pressure
500.00 mbar
400.00 mbar
300.00 mbar
200.00 mbar
100.00 mbar
0 mbar
100.0%
75.0%
50.0%
25.0%
0%
11/20
11/21
11/22
11/23
11/24
11/25
11/26
11/27
11/28
11/29
11/30
12/1
12/2
12/3
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Cryostat ullage pressure Current: 30.42 mbar
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Temperature Cryostat (sensor height w.r.t. cryostat flange)
400.0 K
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0 K
-9.5 cm
-217.0 cm
VFD Pump
100.00%
50.00%
0%
Actual Current: 0%
Gas Chromatograph
10.00 ppm
1.00 ppm
2020-11-27 20:15:00
CH4: 0.24 ppm
H2O: 0.24 ppm
N2: 10.56 ppm
Electron Lifetime [ms]
2020-11-26
2020-11-27
2020-11-28
2020-11-29
2020-11-30
CH4
H2O
N2

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HV- Run Results and Lessons Learned

1. HV - stable up to 0.75 kV/cm, at 1 kV/cm stable after conditioning

2. Resistance of the field shell is slighly lower than expected (0.83 G/sq @ 1kV/cm)

3. Purity - 5 ms within reach, but pump must be running! Implications for DAQ, desirable to place pump outside of the detector cryostat.

4. Cryostat top flange freezing: need to redesign LAr inlet and screen below the flange

5. Cooling capabilities at limit (sealed at 400 mbarg) -> new pump and flow meter Higher flow will also ease thermal situation in hot spots near electronics

6. Drain circuit for LAr is desirable

7. Fermilab PLC with direct 4-20 mA interfaces to crytical sensors (LN2 levelmeter)

8. General network -> protected LAN (after event of DNS service loss for ~2 hours)

9. Allocate several TB of disk space for the next run.

We are looking forward to start assembly of the fully instrumented Module 0 (1?) !