SLOW CONTROL ANALYSIS
LEVEL METERS, TEMPERATURE

Laura Zambelli - LAPP/CNRS

Wednesday, February 26th

Goals & Sensors

At any time, know :

- Where is the CRP wrt to liquid
- gas temperature at a given height above liquid

And :

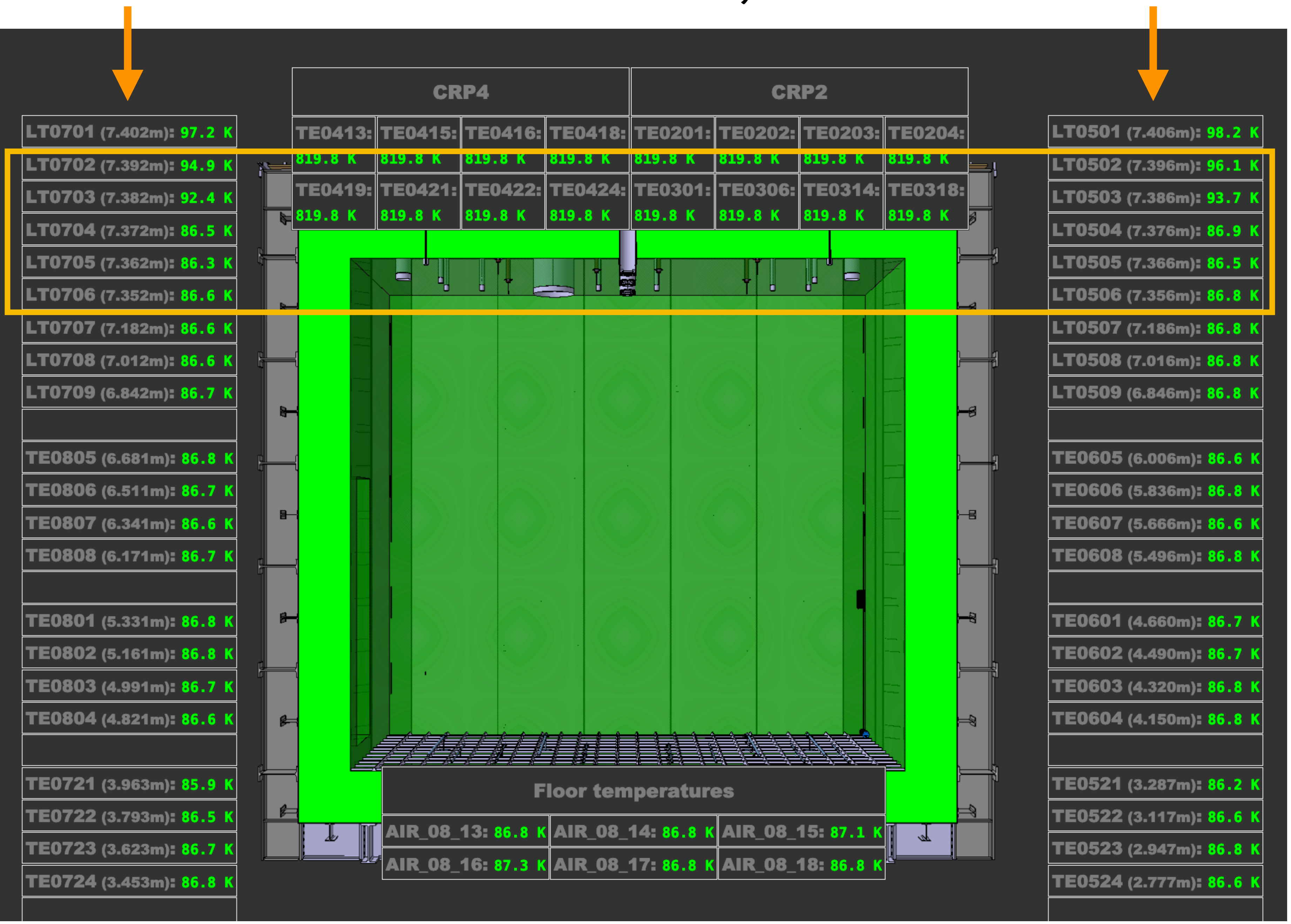
- Is CRP deformed ? How much ? Time dependent ?

- 16 level meters
  -> 14 installed along the CRP [We know precisely where they are]
  -> 2 on the membrane [we don't know exactly where they are]
  -> They have been calibrated, their responses are not linear with liquid height

- 42 temperature probes on the wall
  -> 21 on each side, from ~top to ~bottom
  -> spacing and distance from floor known *at the time of their installation*
  ... might have changed with argon weight and cold

Temperature probes

TP are located on both sides of the cryostat



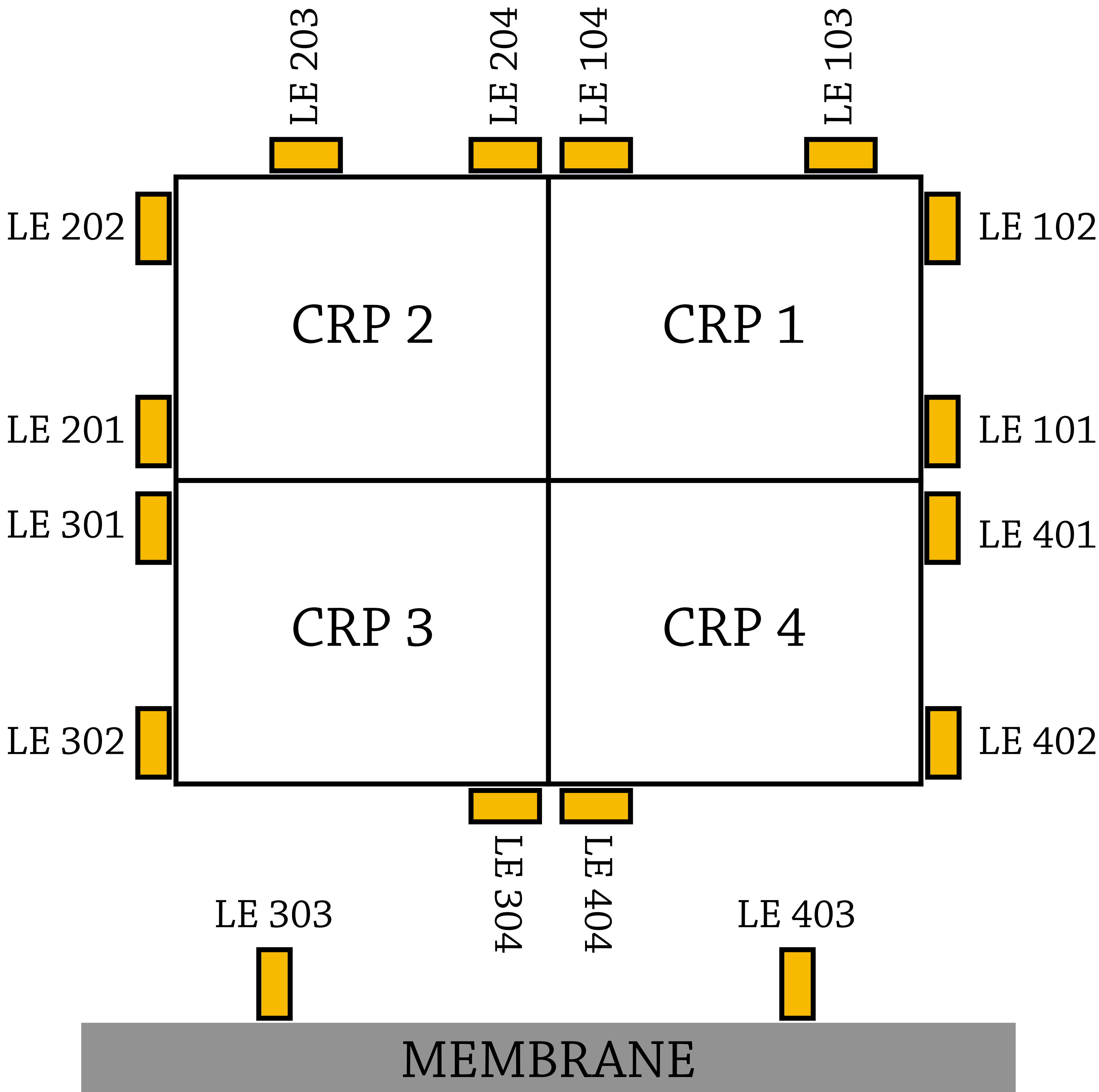
Liquid argon is around here

Spacing between TP:
- on one side : 10 mm
- alternating : 4/6 mm

are these values still correct ?
was it correct even in air ?

Not sure how they have been calibrated (almost 1 K spread in liquid (?))

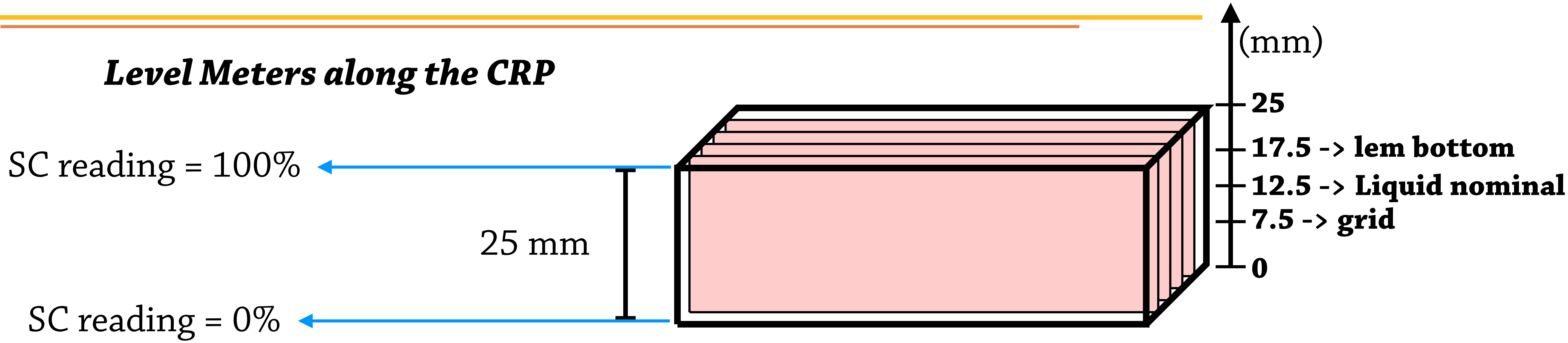
Level Meters



(not to scale)

Level Meters - from SC to mm

Level Meters along the CRP



f = LM reading in fraction
R = range in mm
B = Max Input value from LM
A = Nominal maximum Input value from LM

A	Offset		R	B	
27648	-0,1		34,9744	33474,96	LM1-1
27648	-0,1		28,6963	30158,13	LM1-2
27648	-0,1		30,7162	30555,97	LM1-3
27648	-0,1		33,0287	34868,4	LM1-4
27648	-0,65		36,2492	37531,23	LM2-1
27648	-0,65		28,547	29118,71	LM2-2
27648	-0,65		32,6131	31684,65	LM2-3
27648	-0,65		34,6869	35285,12	LM2-4
27648	-1,1		34,1597	36048,46	LM3-1
27648	-1,1		34,2441	31345,08	LM3-2
27648	-1,1		28,1901	40852,49	LM3-4
27648	-1,8		35,3715	32519,39	LM4-1
27648	-1,8		27,7575	27603,99	LM4-2
27648	-1,8		33,7586	41798,84	LM4-4

D. Duchesneau 6/02/2020

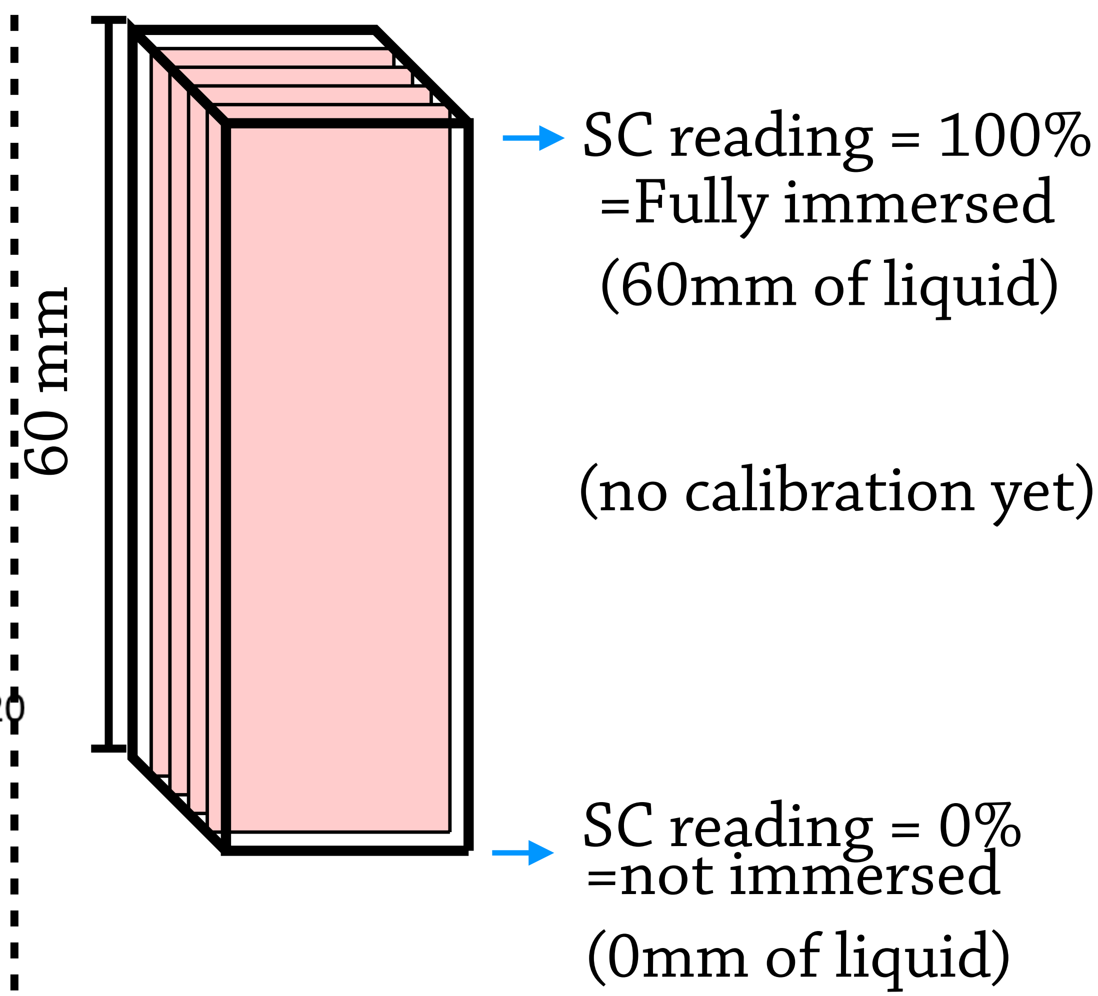
Level wrt to the top:

$$Level = R \times \left(1 - f \times \frac{A}{B}\right) - Offset$$

->Liquid height above grid :
h = 17.5 - *Level*

⚠ This calibration is valid in the nominal regime of the LM (i.e. liquid in between grid/lem)

Level Meters along the membrane



The plan

Few simple hypothesis considered:
- once in liquid the temperature is ≲ 87 K and becomes quite stable
- liquid argon level is flat
- LM and temperature probe positions do not change with time (after filling)

○ *gas temperature at a given height above liquid*
- since filling, the liquid argon have changed within the range of the membrane level meters
  ↳ can get the relative spacing of the two membrane LM
- look at temperature probe located nearby membrane LM and retrieve when they enter/exit liquid argon
  ↳ can get their relative spacing wrt to the membrane LM

With these informations, we can have the gas temperature gradient

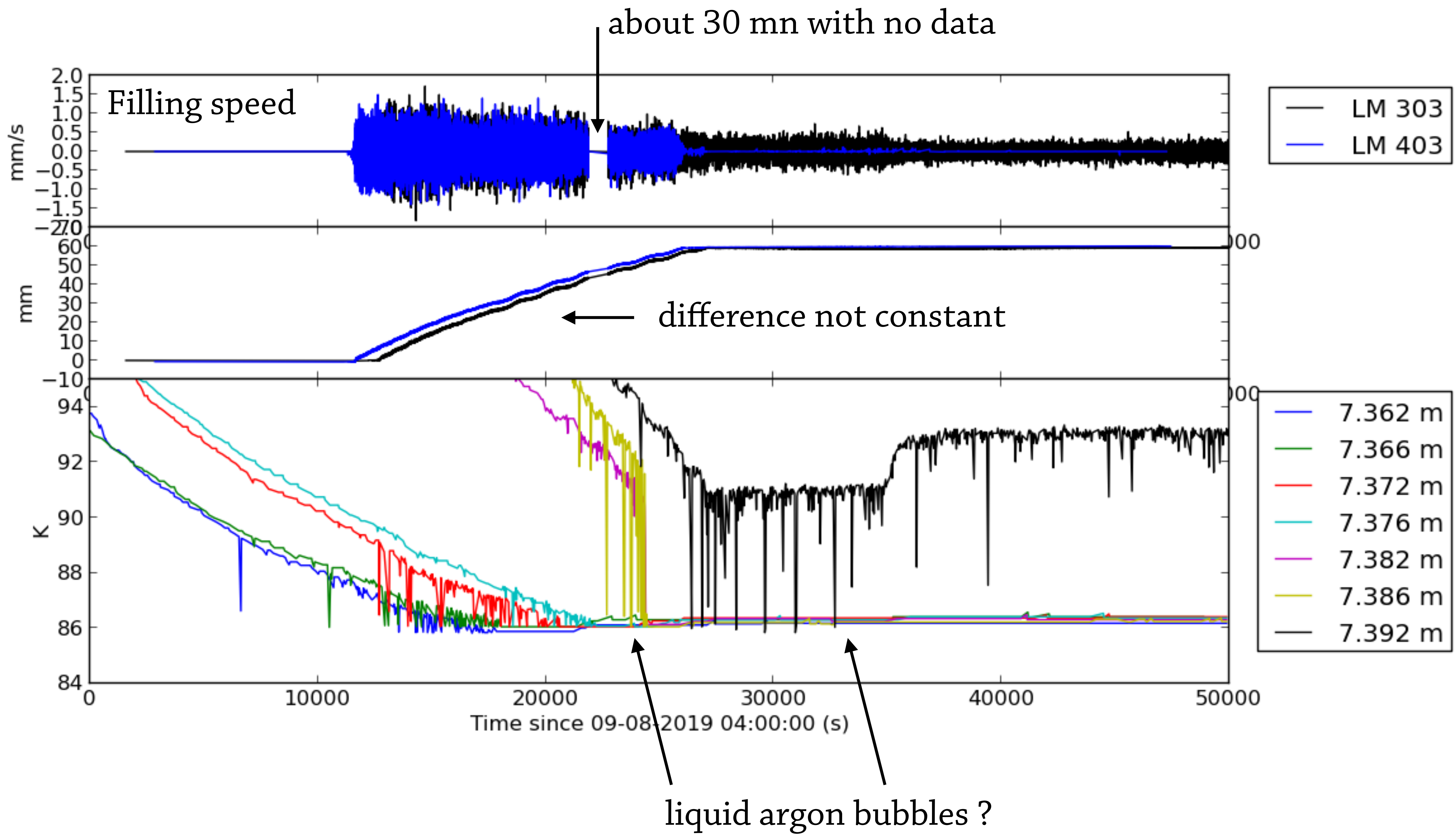
○ *Where is the CRP wrt to liquid*

○ *Is CRP deformed ? How much ? Time dependent ?*

Given the CRP-LM calibration, we can look at it, but :
- the CRPs may not be always parallel to the liquid surface, raw data can be biased

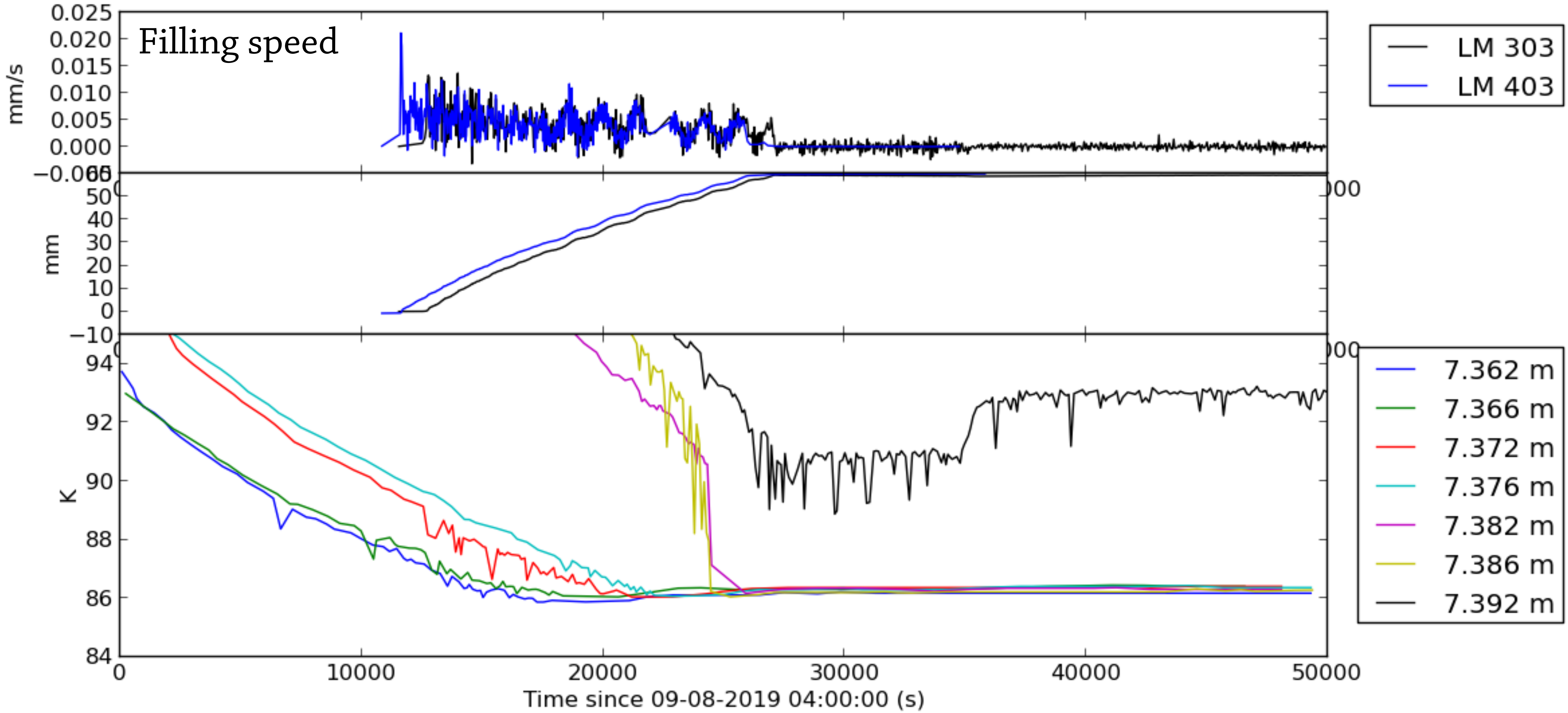
The reality - the day LAr arrived to LM

LM data sampling : ~1 point per second ; temperature probes : ~ 1 point per 30 s



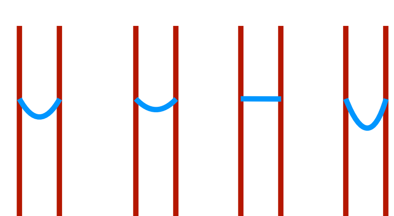
The reality - the day LAr arrived to LM

data points rebinned (by 30 for LM ; 3 for temperature probes)



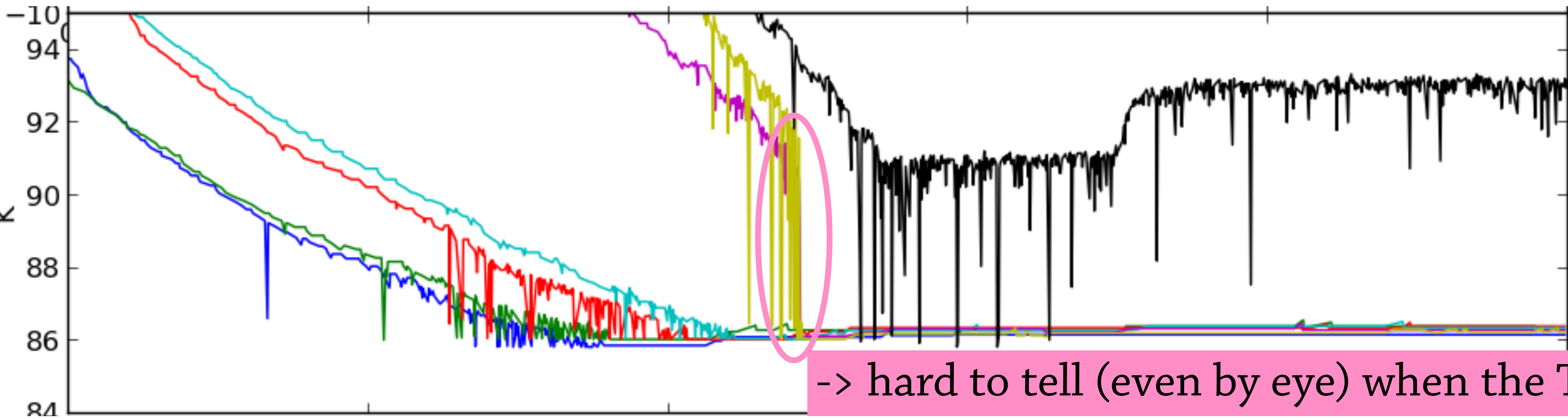
non-constant difference between LM could be explained by:

- non linearity of the electronics
- liquid capillarity between plates:



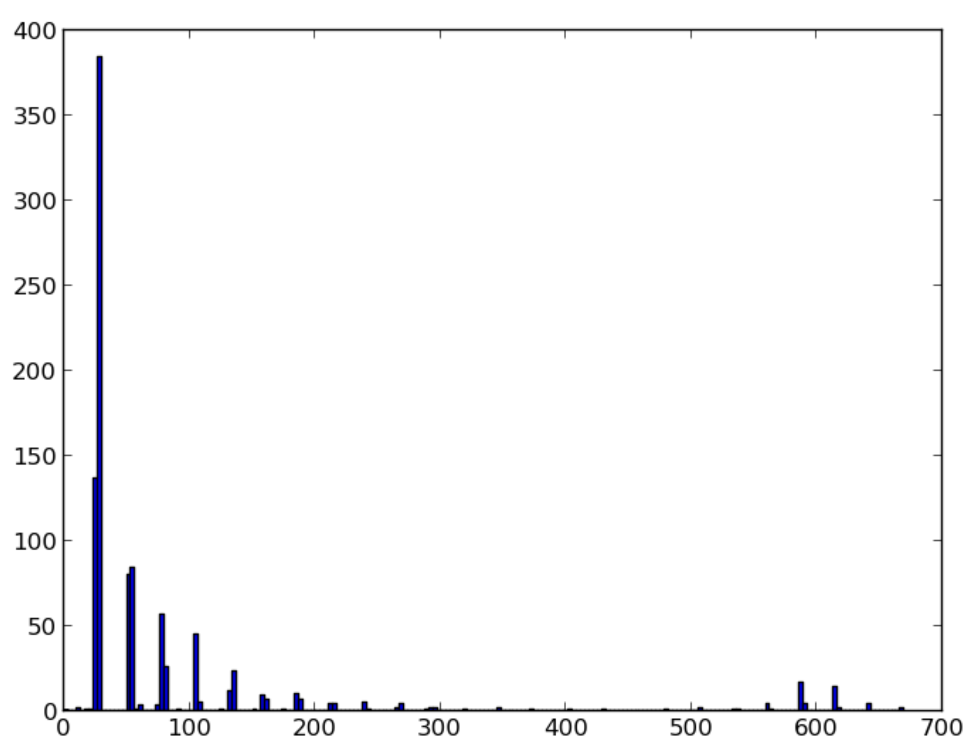
(see later)

Temperature probes



-> hard to tell (even by eye) when the TP gt into liquid

The key point is to build an algorithm that will extract when the sensors is in/out of liquid.



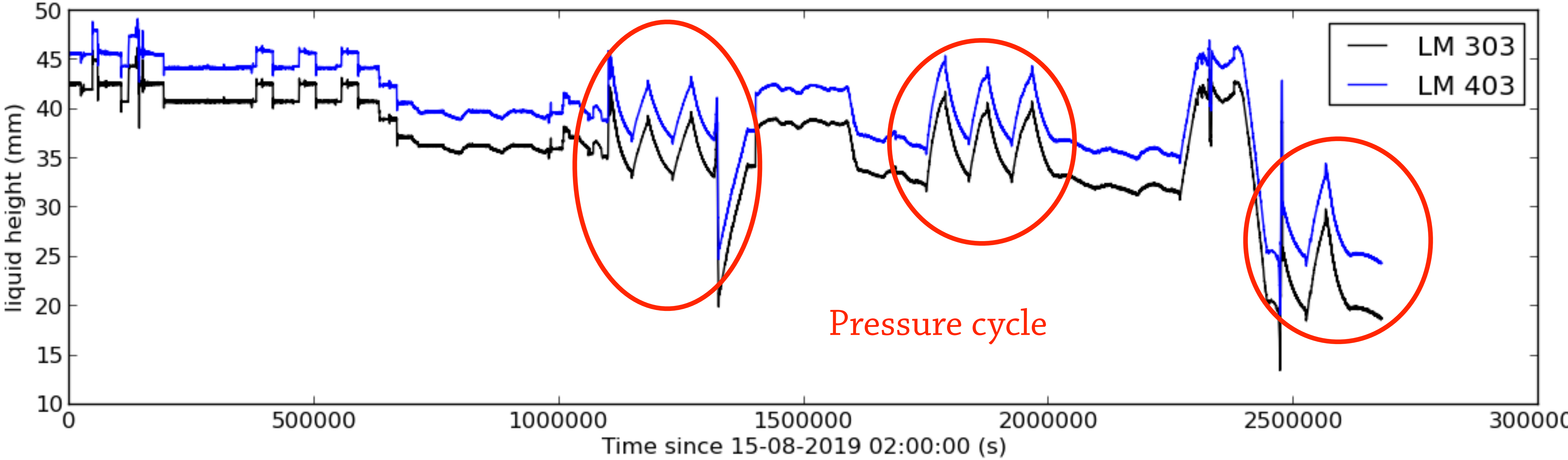
time between two consecutive points (s)

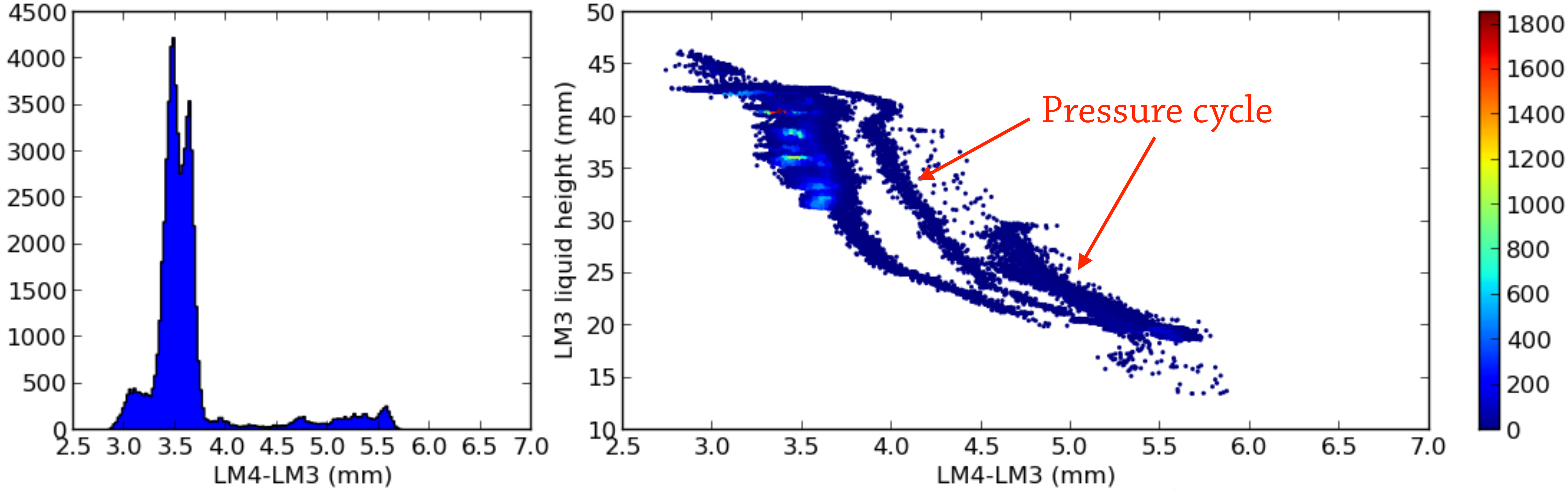
Looking at the Δt between two consecutive TP data points, it seems that the tp sensors values are checked every ~ 27 s and stored "if there is a significant change". If nothing happens after ~10mn the current value is stored.

This makes the algorithm a bit more complicated than originally thought
↳ under development

Difference between membrane LM

Membrane level meter data from 15/8 to 15/9

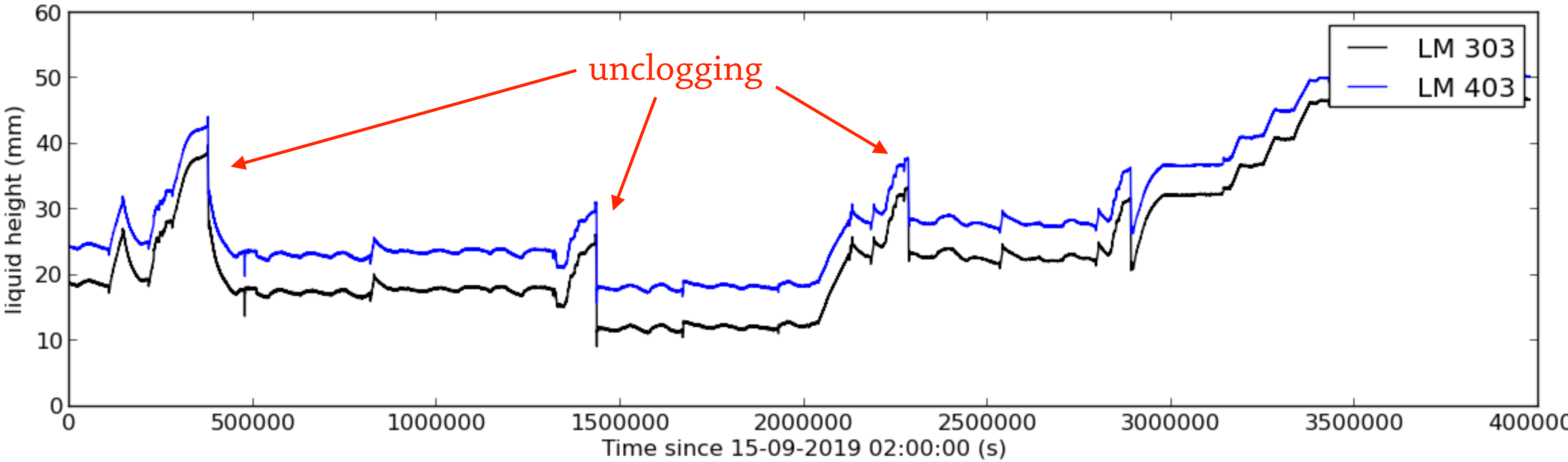


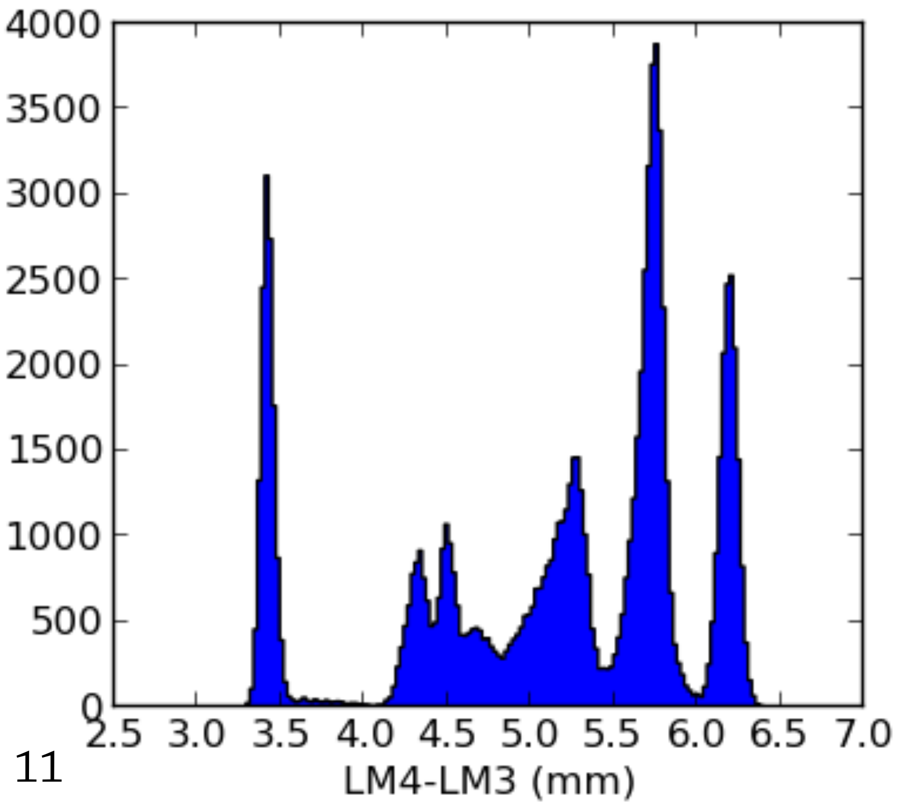


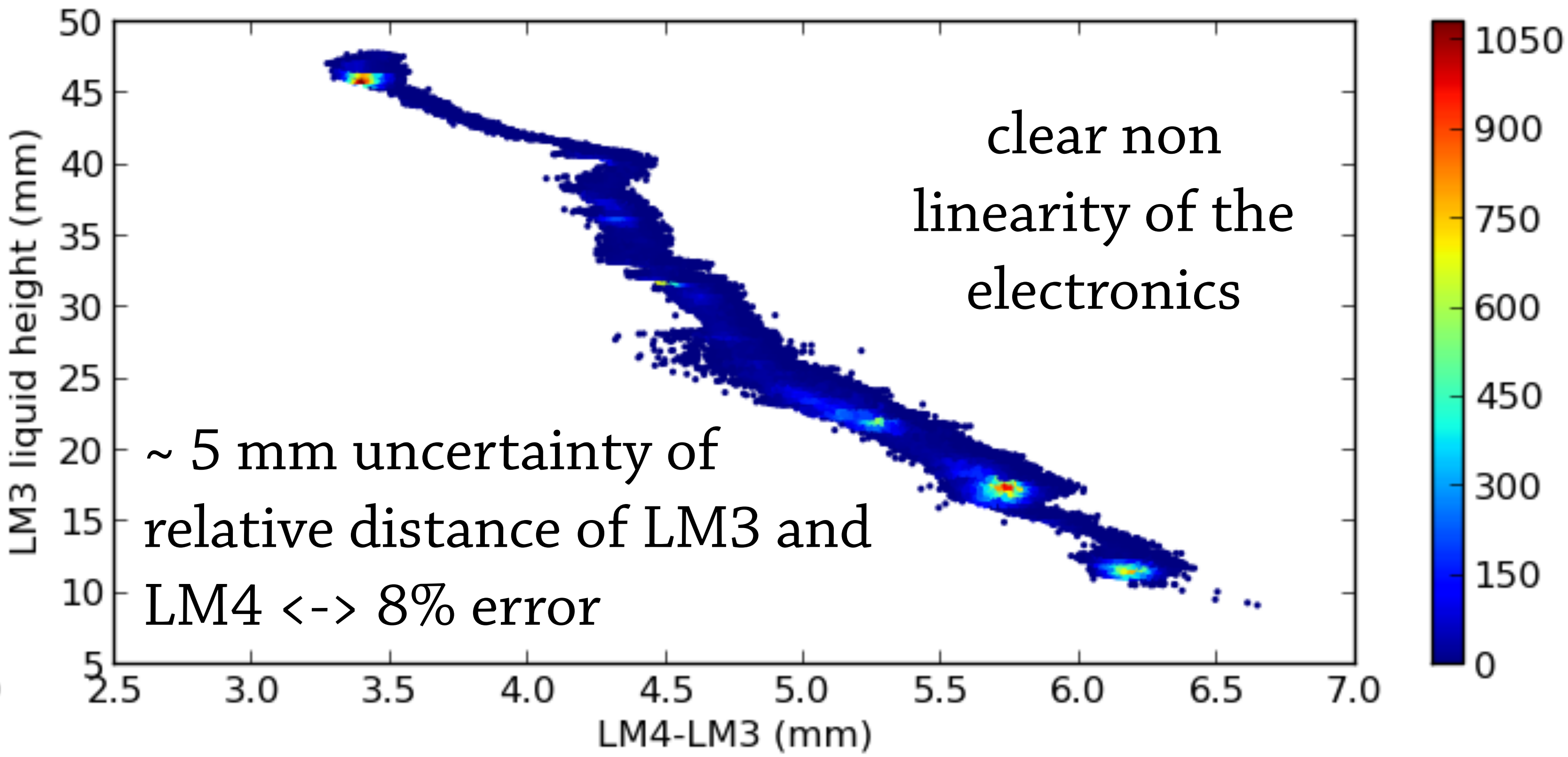
 —> The pressure cycle (rapid liquid level change + thermodynamics) makes things complicated

Difference between membrane LM

Membrane level meter data from 15/9 to 31/10

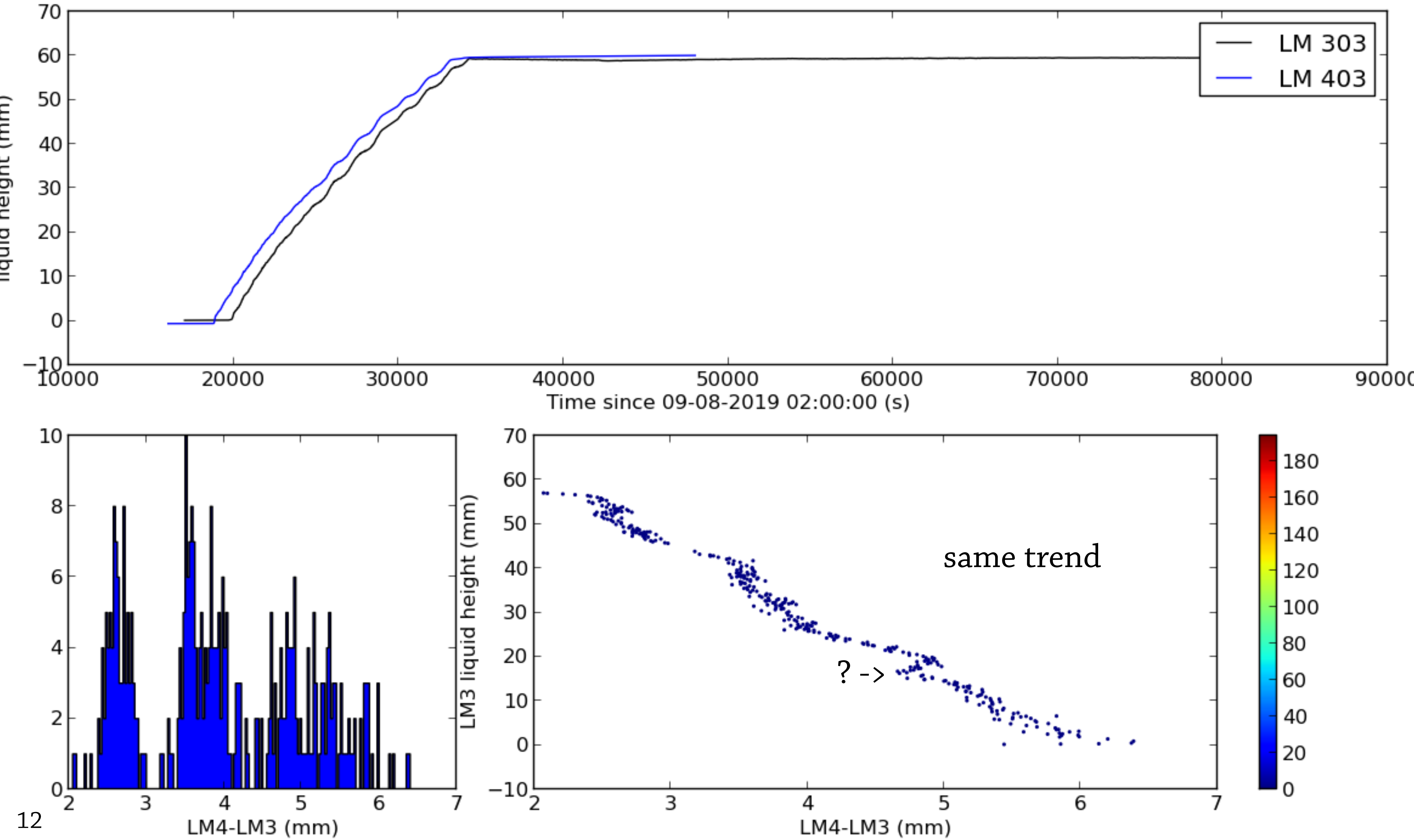






Difference between membrane LM

Filling day (9/8/19)



In conclusion & things to do

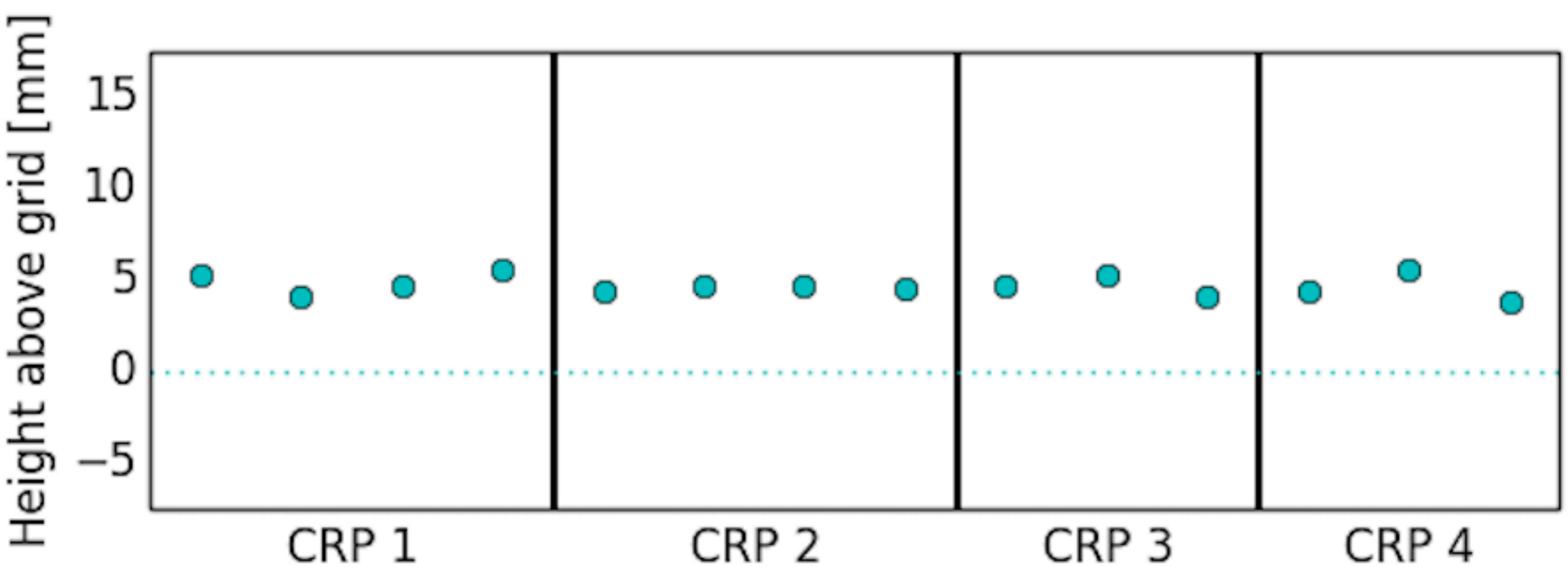
- Membrane LM

  Check with nov ~ now data if the non-linearity trend is still the same

- temperature sensors

  Extract times when sensors goes in/out of liquid ; get the corresponding LM3&4 values
  From Aug. to Nov. 2019, the liquid level changed a lot, we should be able to have several LM points per temp. sensors -> get an average value

- CRP deformation : example run 1415 (14/1/20)



There is a clear spread in the CRP-LM values.
It should be fairly easy to plot the relative difference vs time, given that :
- the electronics is also not linear
- the crp have not always be parallel to the liquid surface

In conclusion : it's more complicated than expected

Miscellaneous

- Are the timestamps given by the slow control in UTC or CET ?
- Is it the same timestamp as for the charge and light ?

I've put my version of slow control access code on dropbox here :
https://www.dropbox.com/s/5w7c4q7ewjqg7w2/slow_control_access.tar.gz?dl=0
-> works inside and outside of lxplus domain (two different access way)

• get the run offline informations and make a summary plot (but these two things will be on the offline database)
• run your own slow control analysis

• there is a list of the "name":ID correspondance I gathered (LEM voltage, current, nominal, over current ; cathode & ffs voltage & currents ; temperature sensors, internal pressure ; level meters ; outside temperature , pressure, humidity)