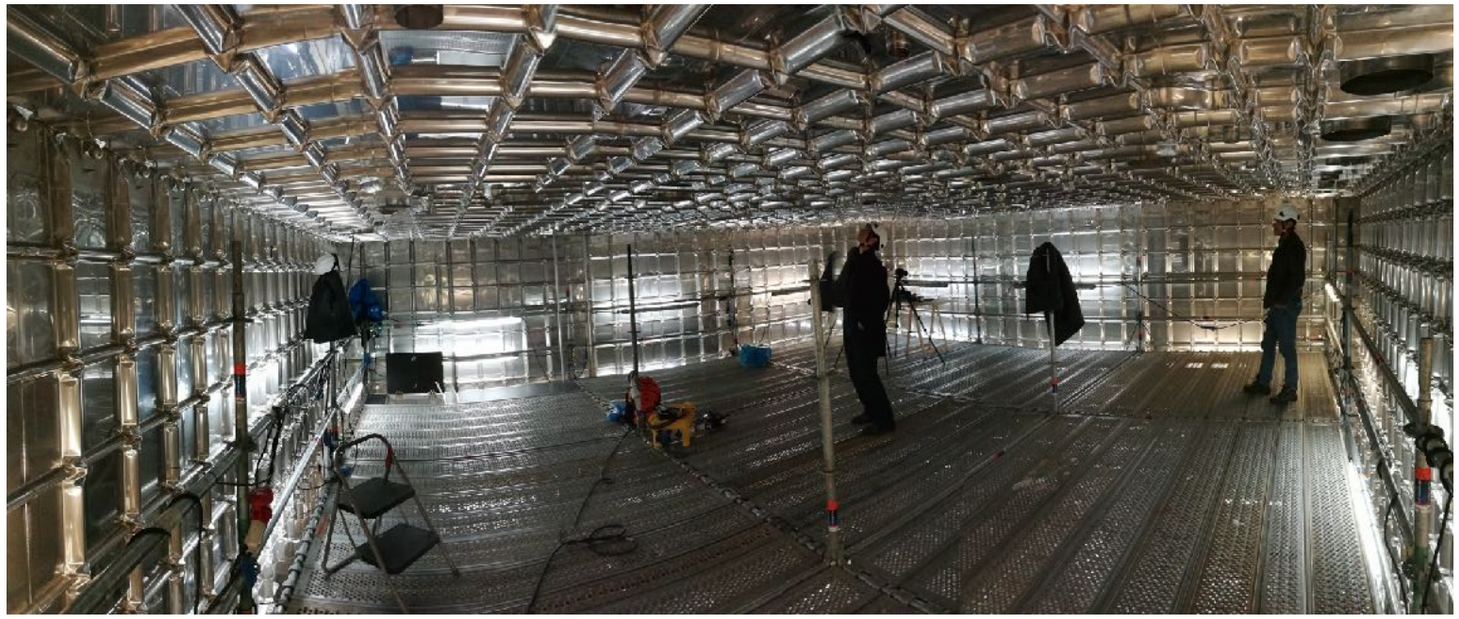
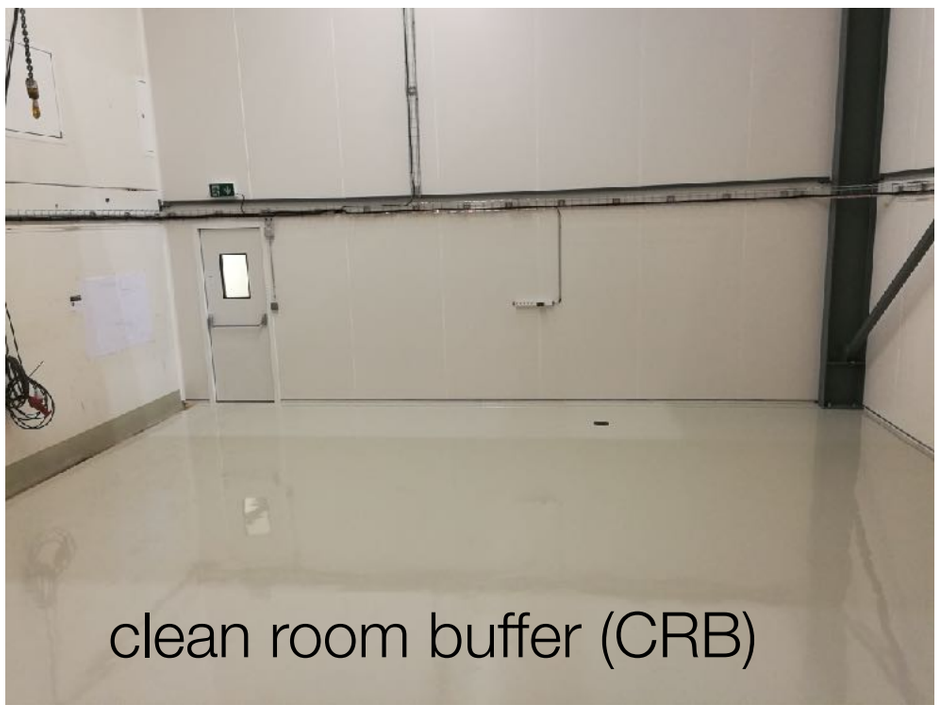
ProtoDUNE-DP and 3x1x1 Update

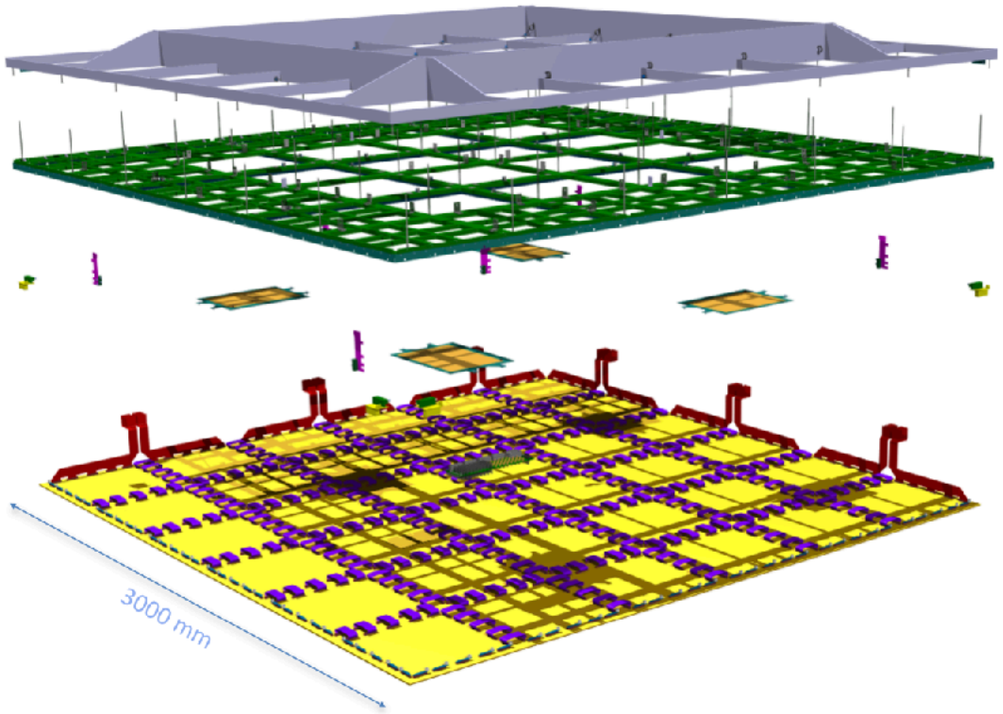
Status of cryostat



- Membrane completed Sept 21st
- Next internal piping and temporary floor
- Cryostat final cleaning week of November 13th



CRP#1 mechanical frame



Invar Frame

G10 Frame + Extracti
Grid

Instrumentation

Detection plane
LEM and Anode
assembly

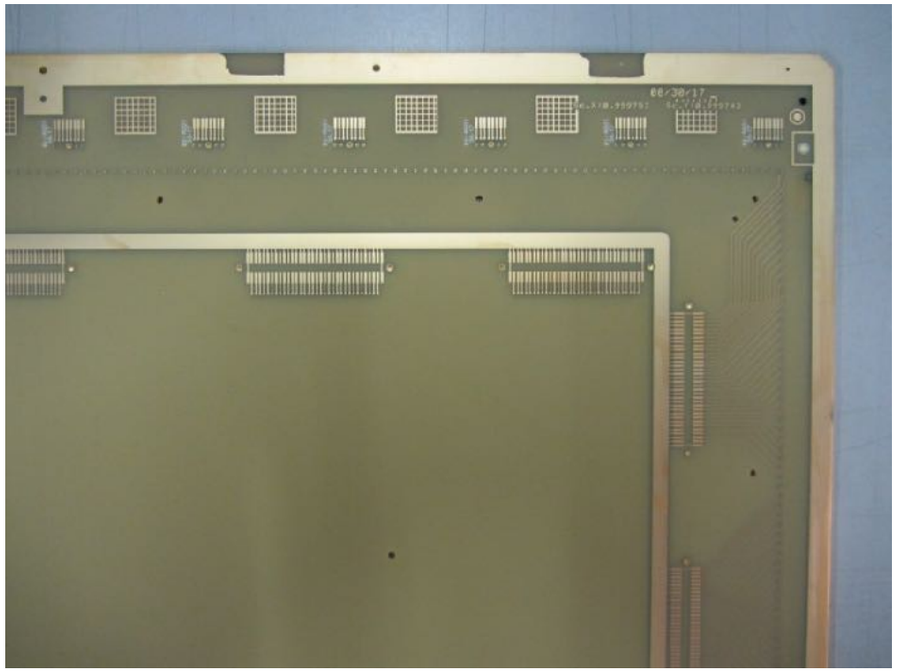
First Invar frame:

- full size engineering model checked and approved at firm on 29/09/17
- Cutting, assembly and welding procedures OK
- Quality, tolerances and properties were all within specs

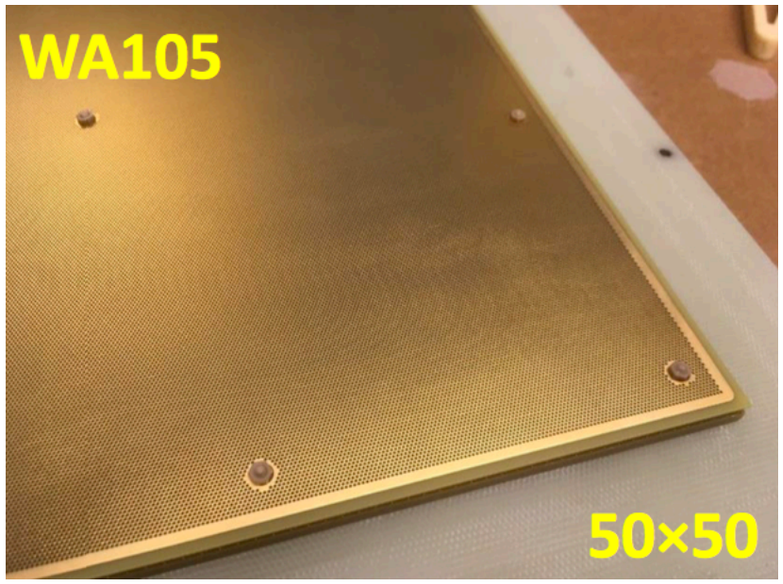
G10 frames arrive next week

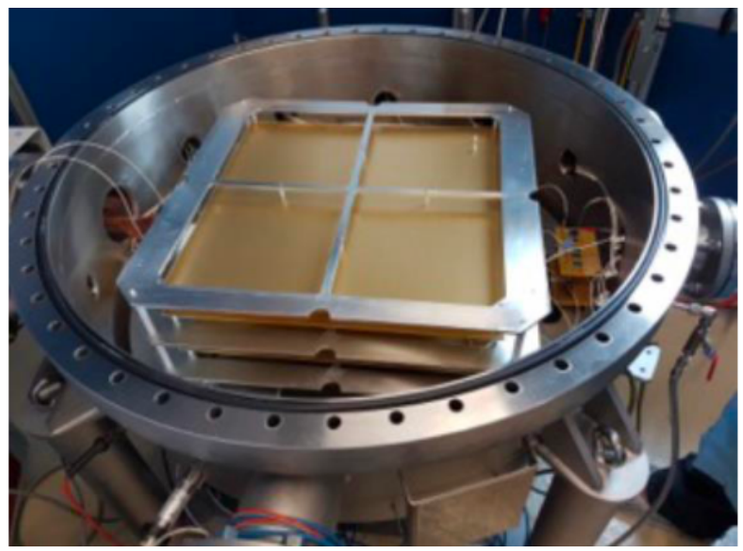
CRP #1 : Anode, LEM

1st prototype anode received and tested.
First batch of 5 shipped

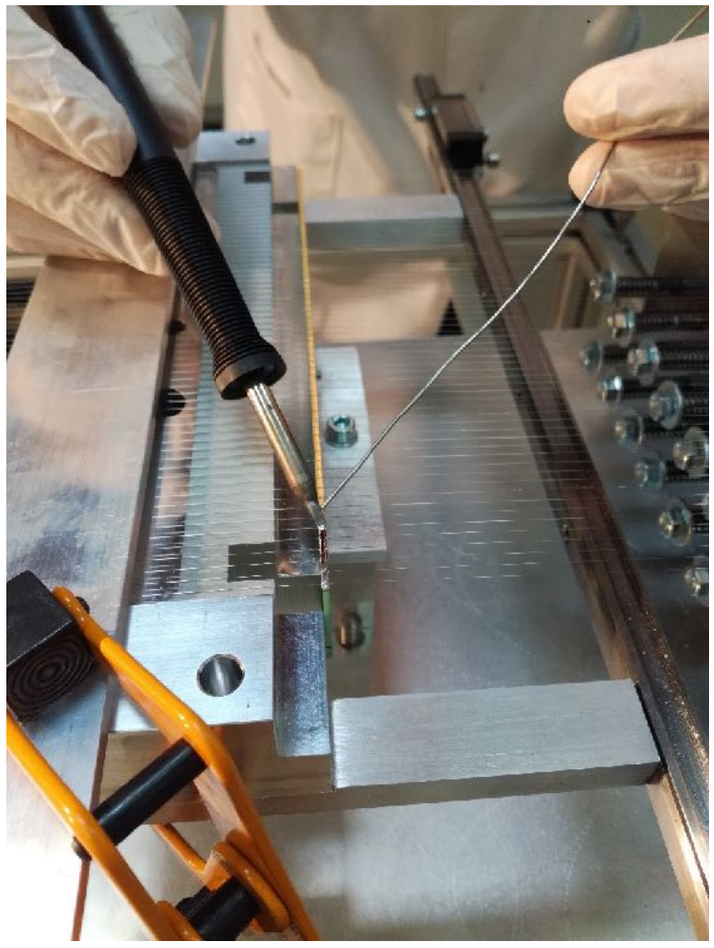


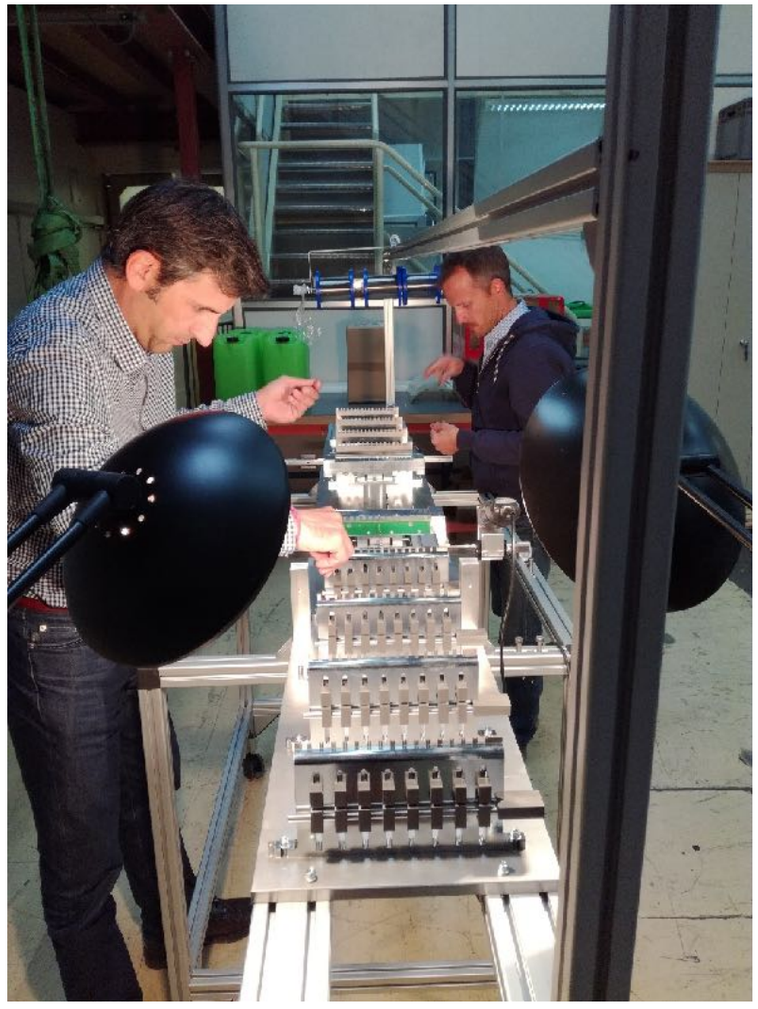
Received 32 LEMS, 25 certified so far
cleaning+ QA ongoing in Saclay





CRP#1 infrastructure and tooling



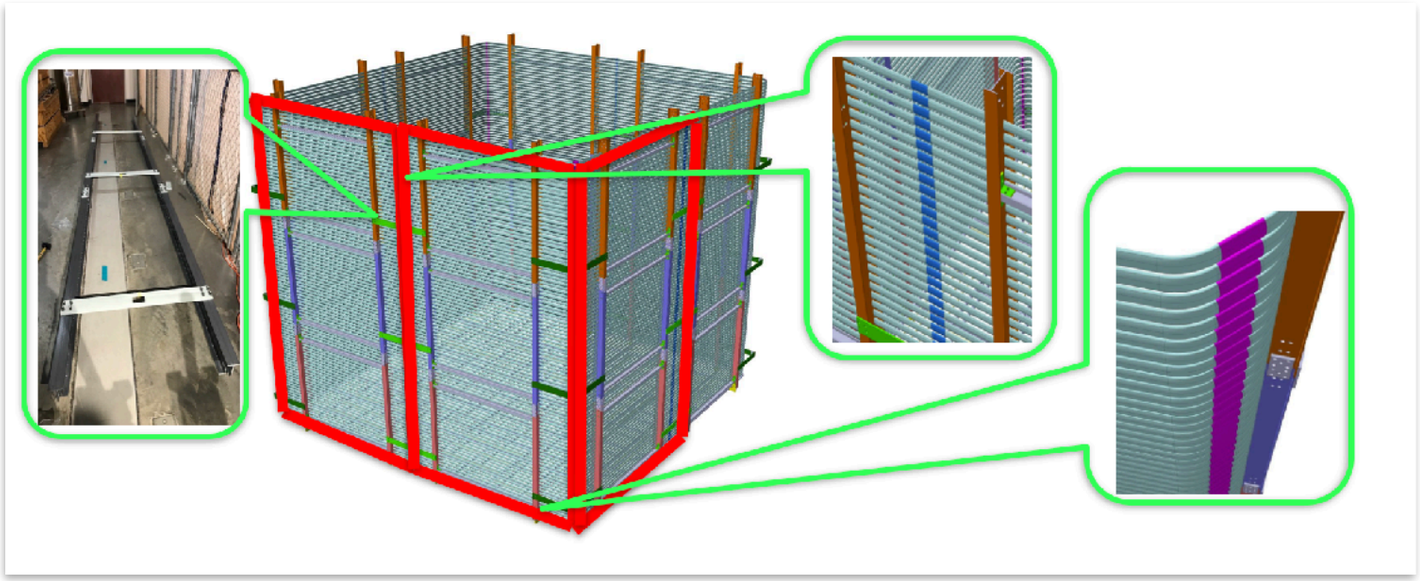


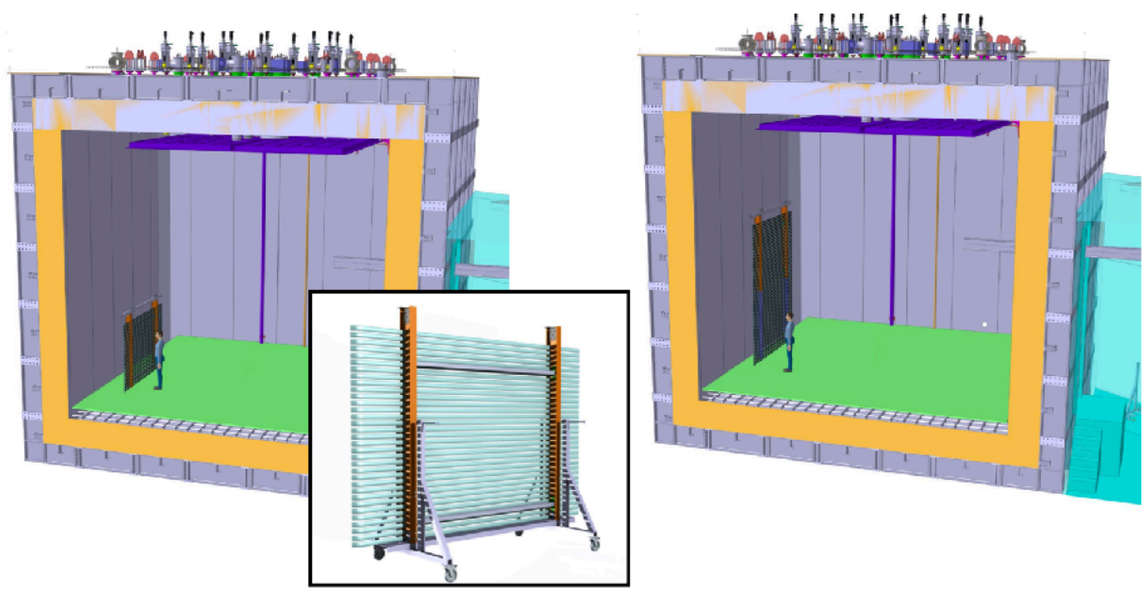
Clean room 185 is ~ready. Wire tensioning system has been tested will be shipped to clean room mid-October.

Drift cage

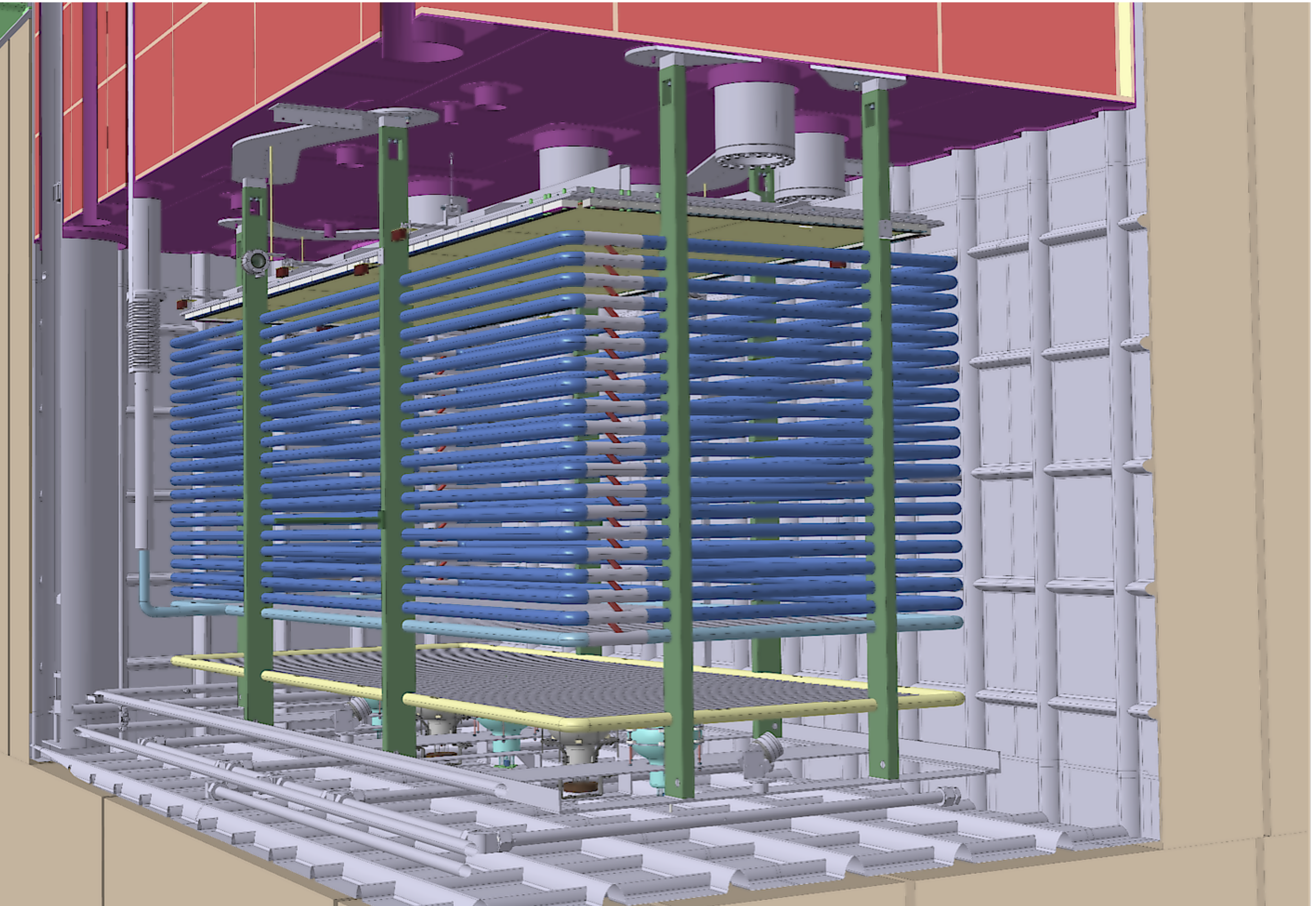
Installation of 1/3rd of the drift cage before the end of the year

- Large amount of work in the past months at UTA for trial assembly of submodules, QA/QC etc.
- Assembly starting November 20th. All parts to arrive before then
- Manpower, infrastructure, tools being organised (CERN, UTA).



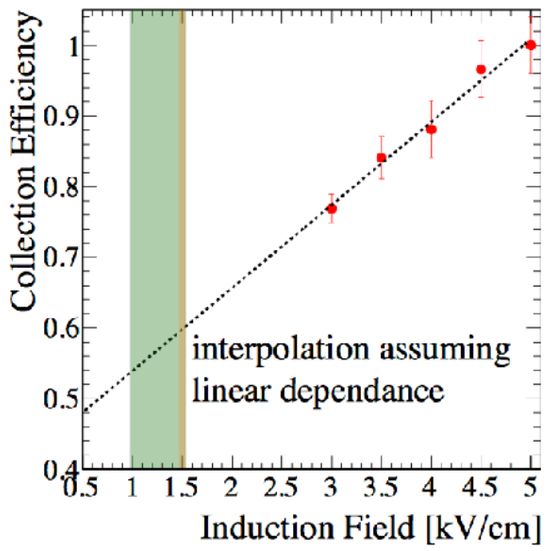


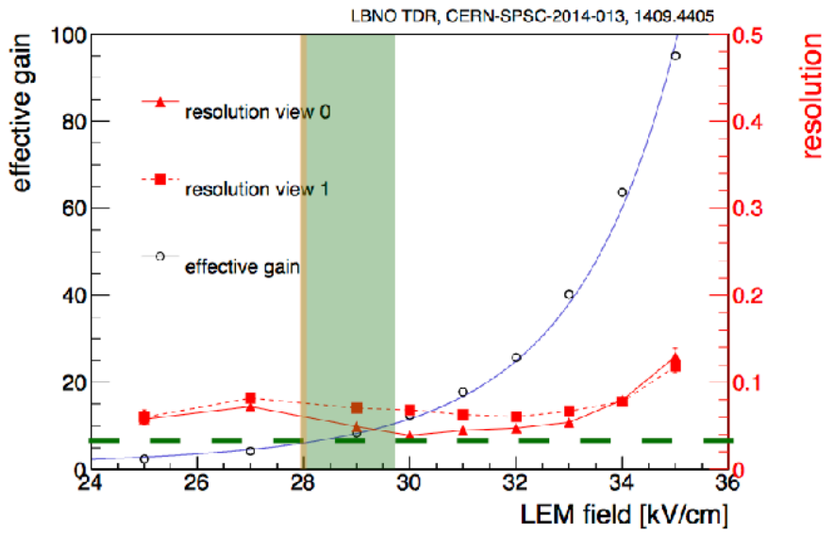
3x1x1status

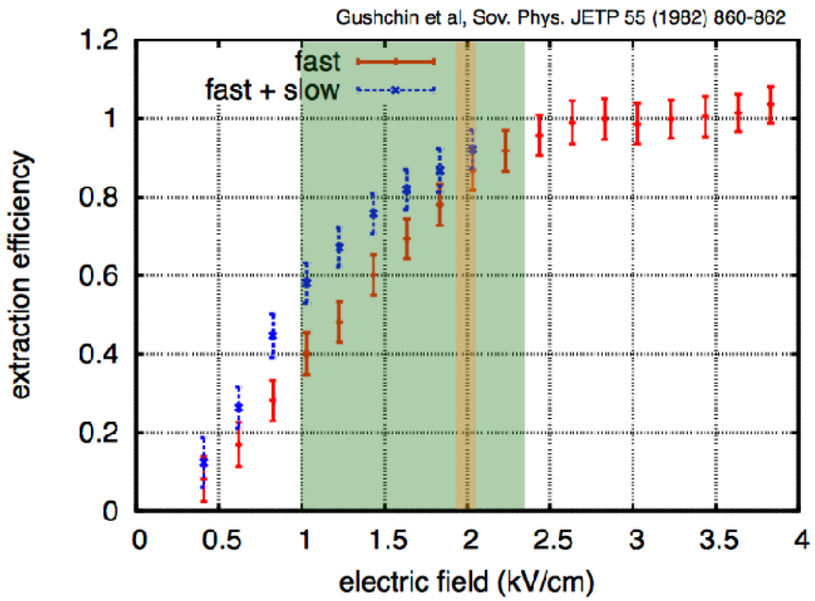


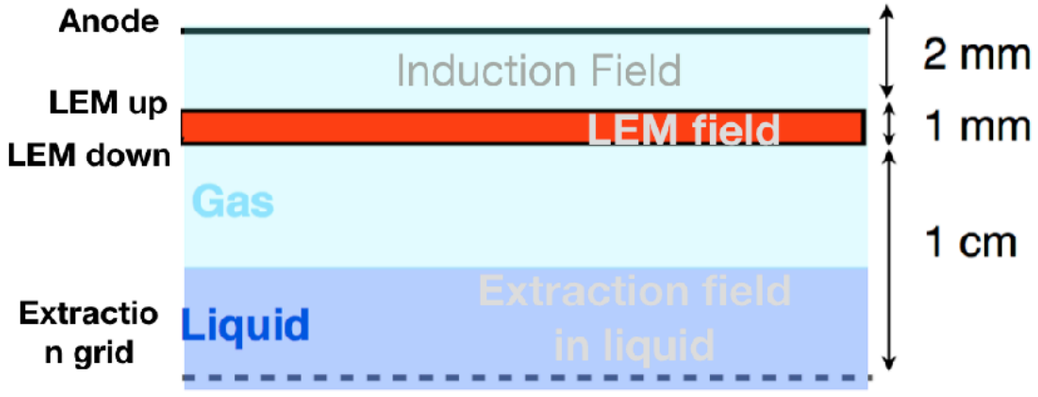
3x1x1 status - CRP HV configuration achieved

In green the field values scanned so far.
In orange the field values at most stable conditions.









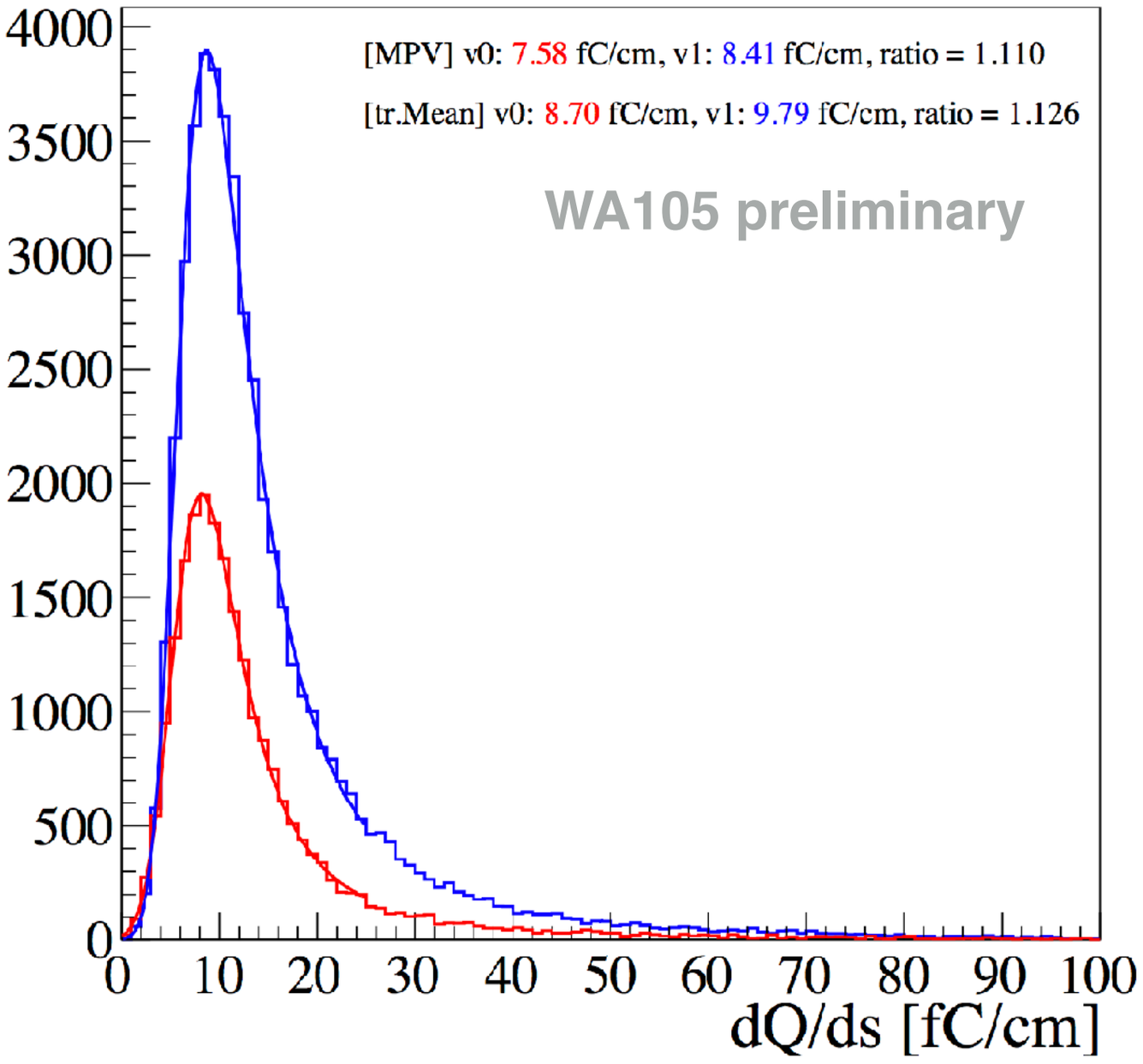
$$G_{eff} = \varepsilon_{extraction} \times G_{LEM} \times \varepsilon_{induction}$$

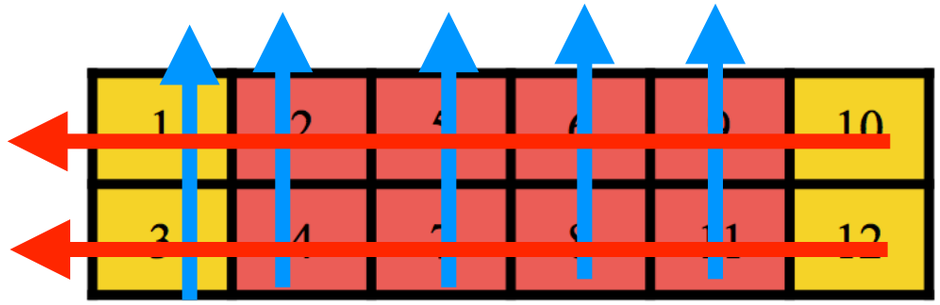
we measure per view: 0.5 0.9 5 0.5 10 fC/cm

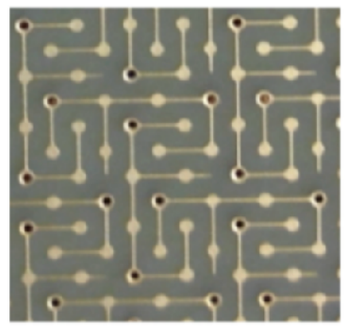
$$< \frac{dQ}{ds} >_{view_i} = F_{share}(view_i) \times \varepsilon_{extraction} \times G_{LEM} \times \varepsilon_{induction} \times < \frac{dQ}{ds} >_{MIP}$$

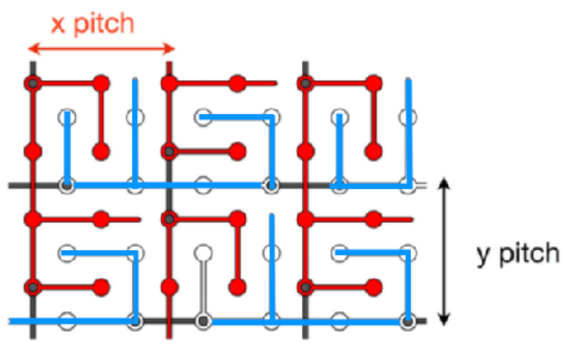
3x1x1- status

deposited charge measured on view 0 (3m strips) and view 1 (1 m strips)







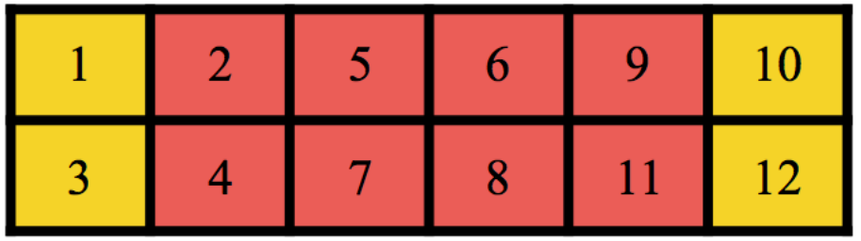


~50% sharing between views

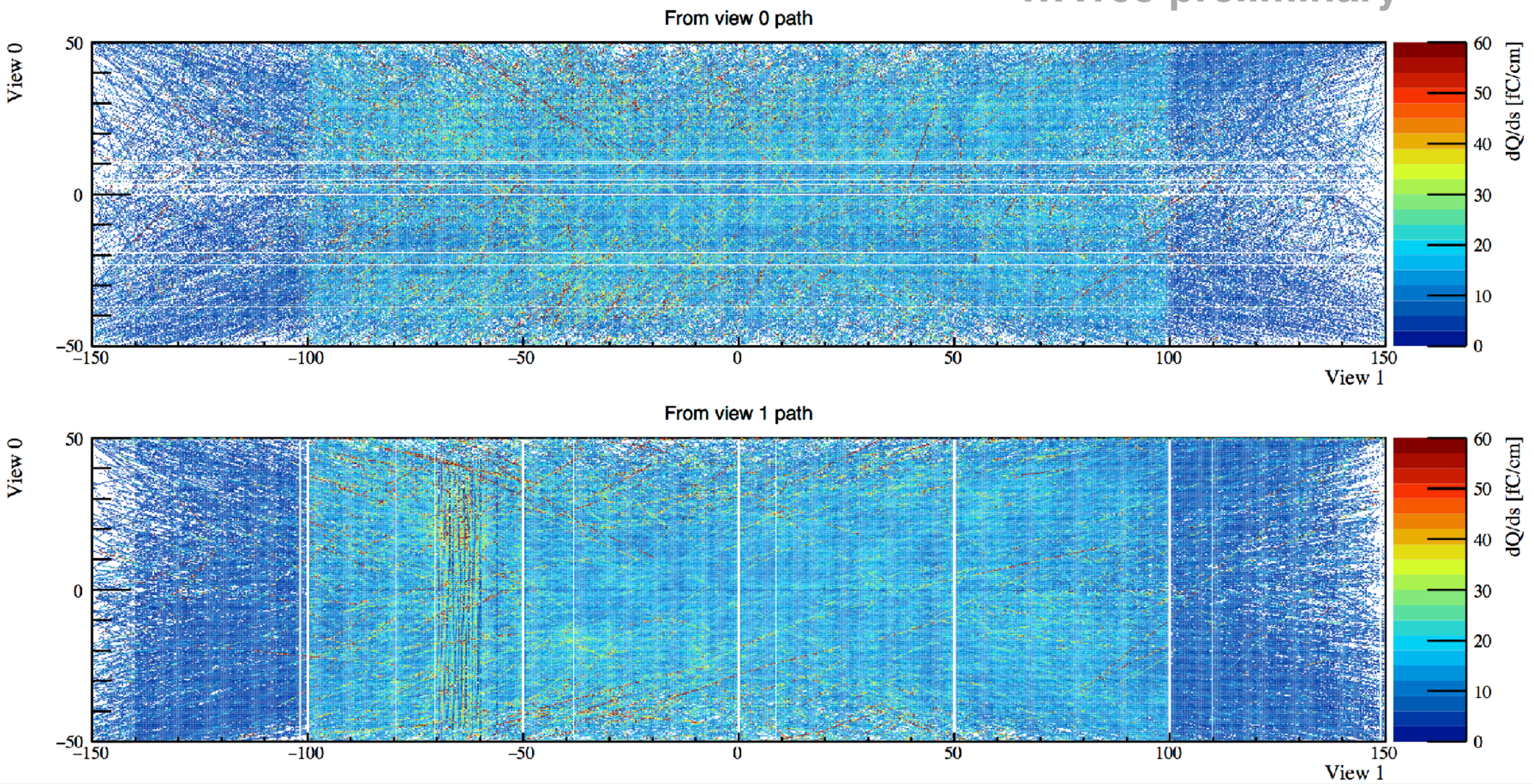
$$< \frac{dQ}{ds} >_{view_i} = F_{share}(view_i) \times \varepsilon_{extraction} \times G_{LEM} \times \varepsilon_{induction} \times < \frac{dQ}{ds} >_{MIP}$$

3x1x1- status

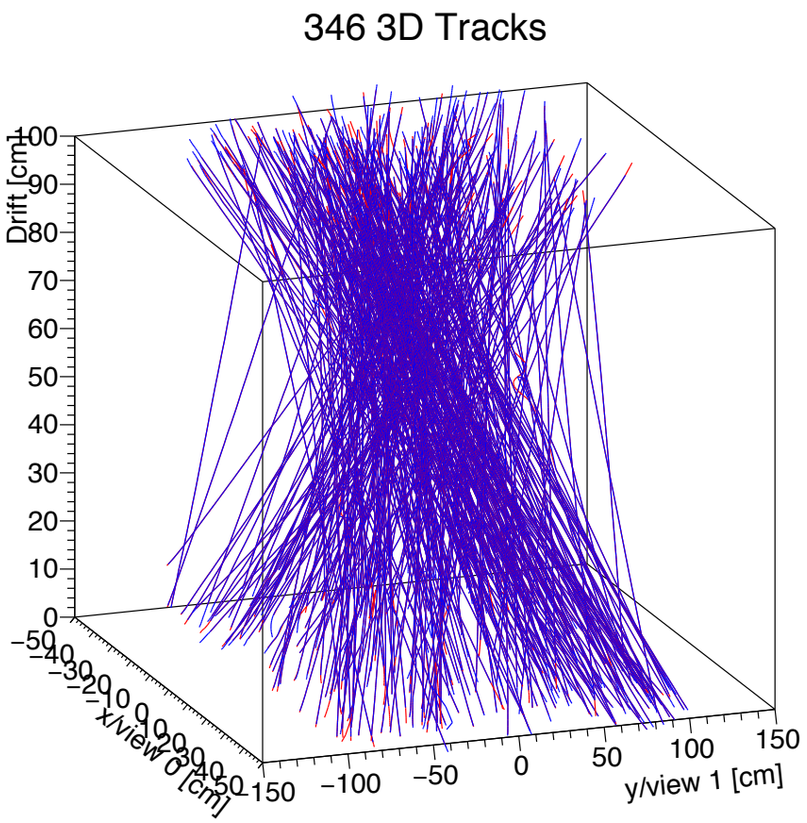
- All reconstructed 3D tracks with a length of 50 cm, starting at the anode or ending at the cathode
- Each entry is the mean of deposited charge for each channel.



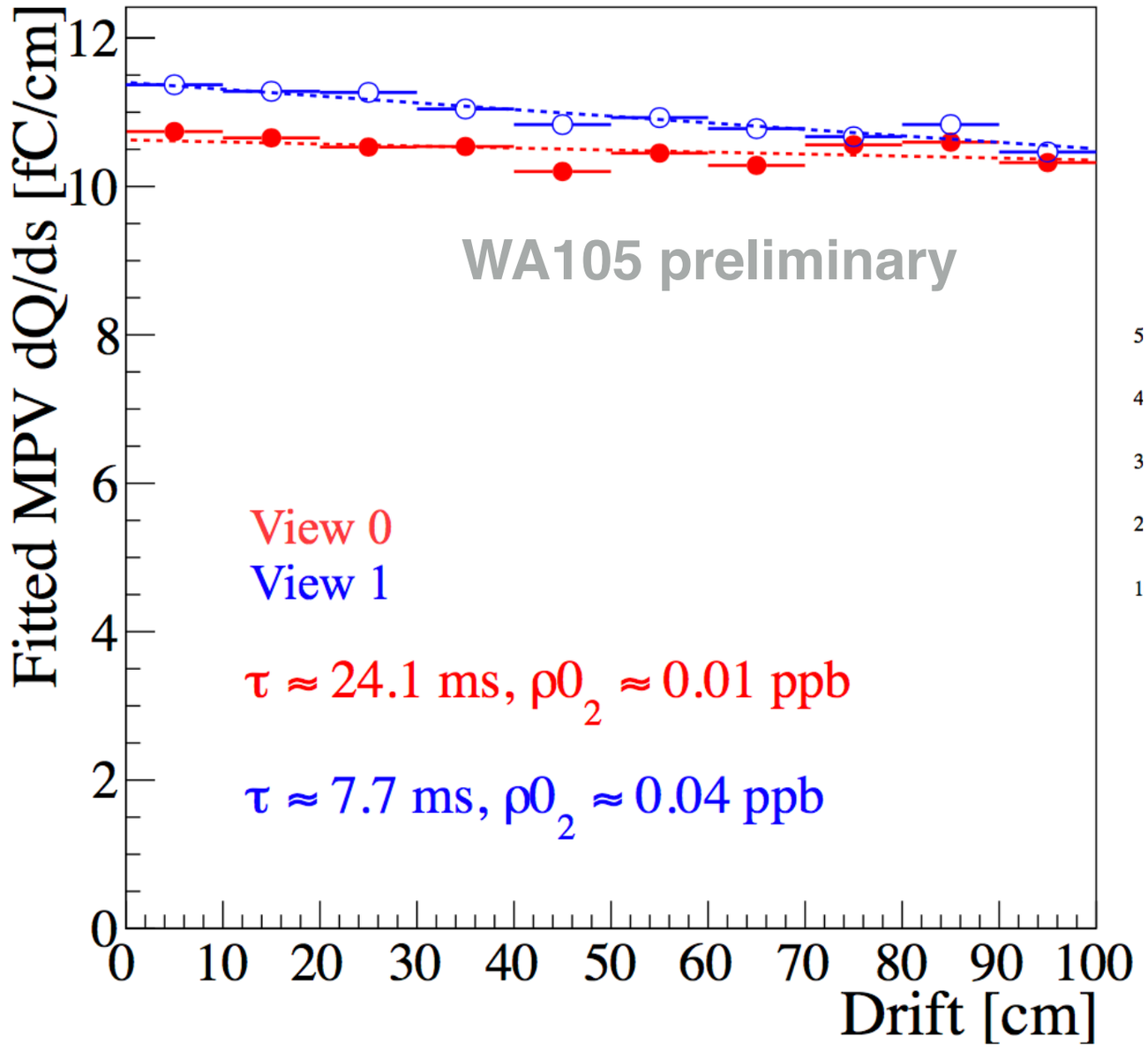
LEMs 1,3,10, 12 at lower field



3x1x1 status electron lifetime



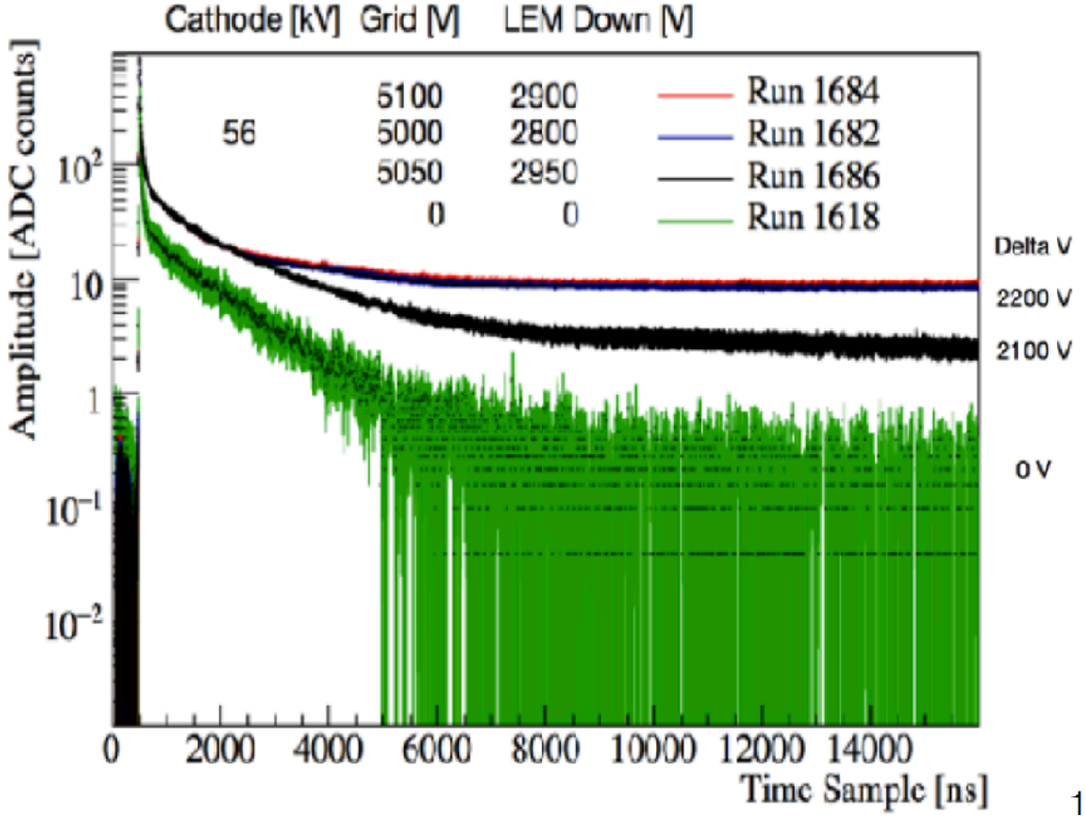
Hit charge as a function of the drift length

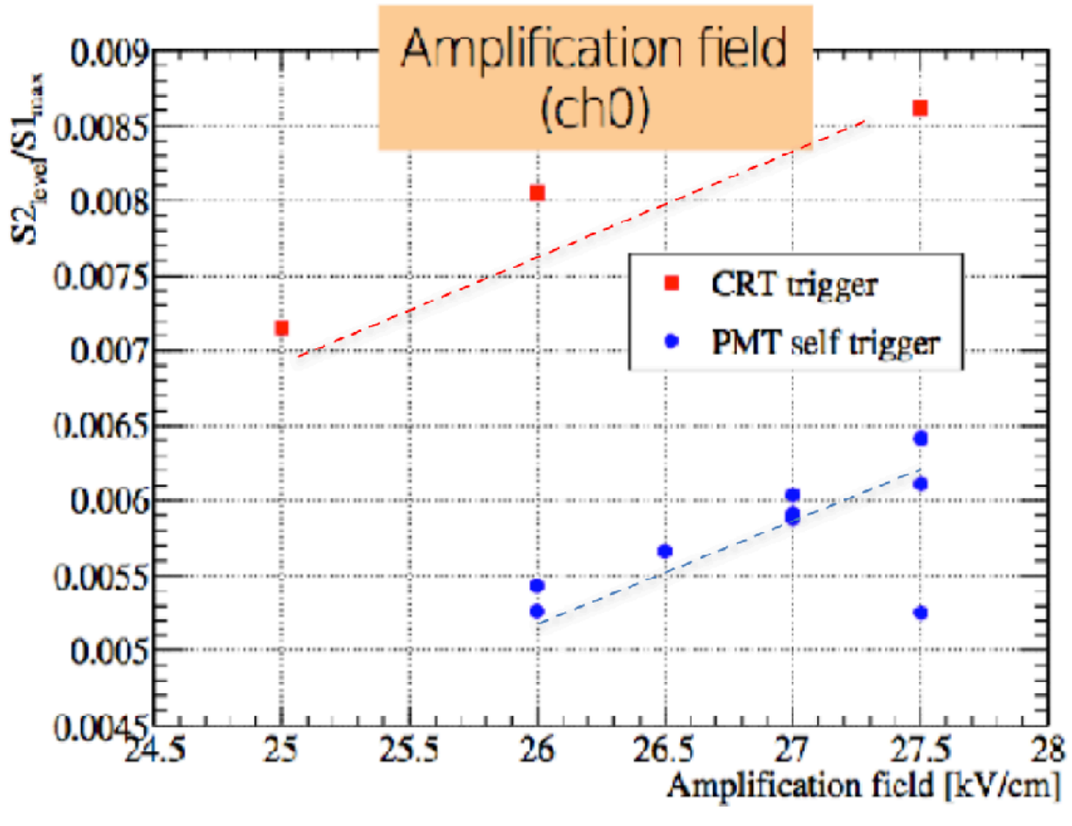


Light data

- Results from photon detectors
- PMT stability and gain measurement Scintillation time monitoring
  Scintillation time vs drift field
  Light charge vs drift field
- PMT trigger rate vs drift field
- S2/S1 light collection vs extraction/amplification fields
- S2 time extension vs drift field

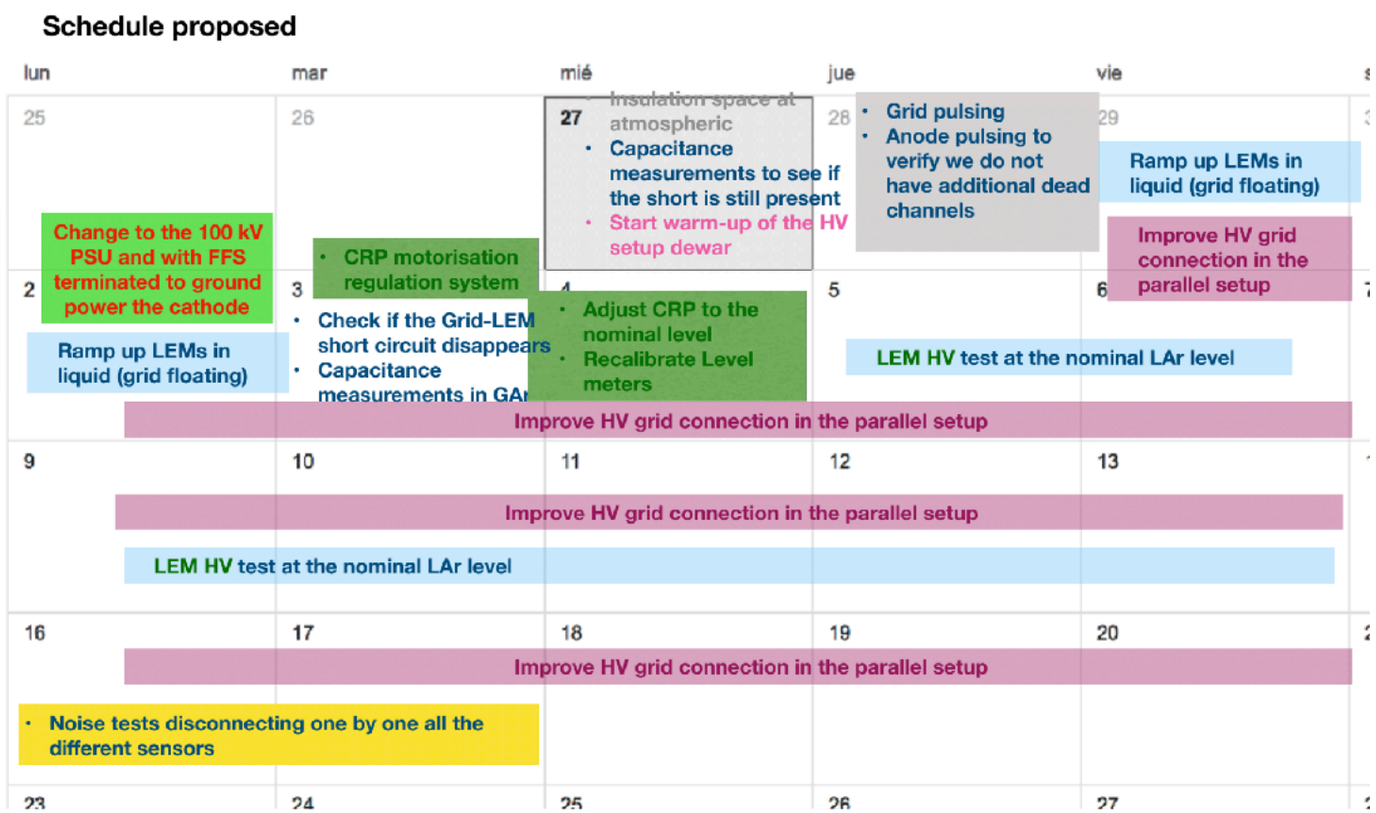
Example S2/S1 as a function of LEM amplification field





3x1x1status

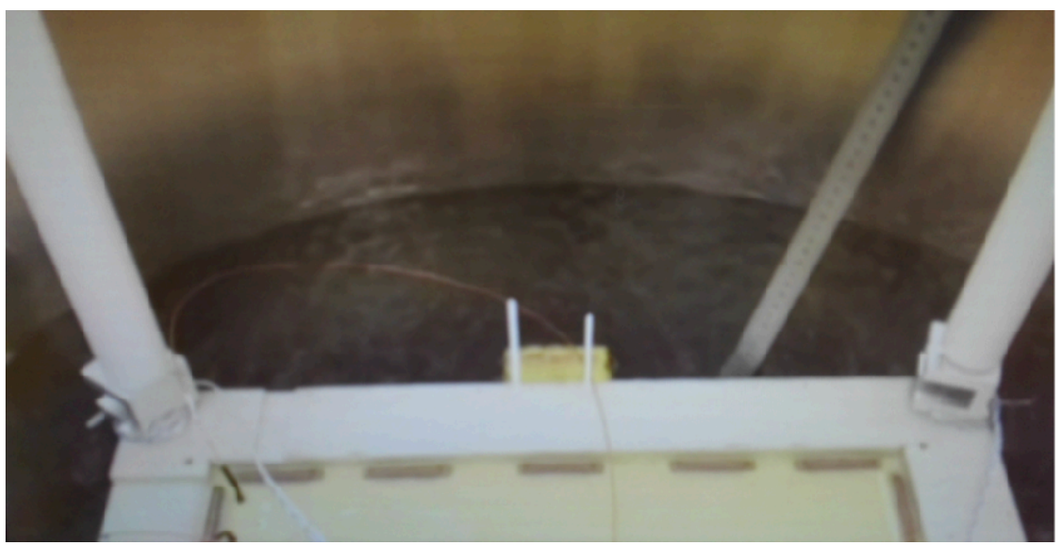
- During operations we have always stayed below the nominal operating voltages due to trips of the extraction grid. This issue is under investigation.

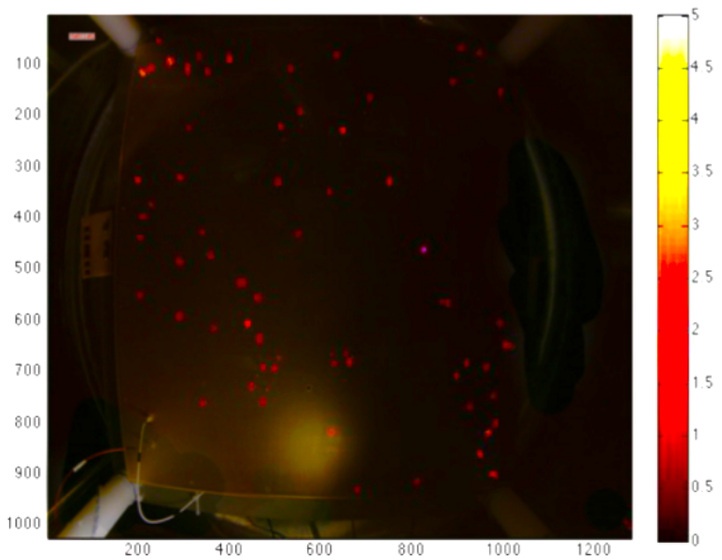


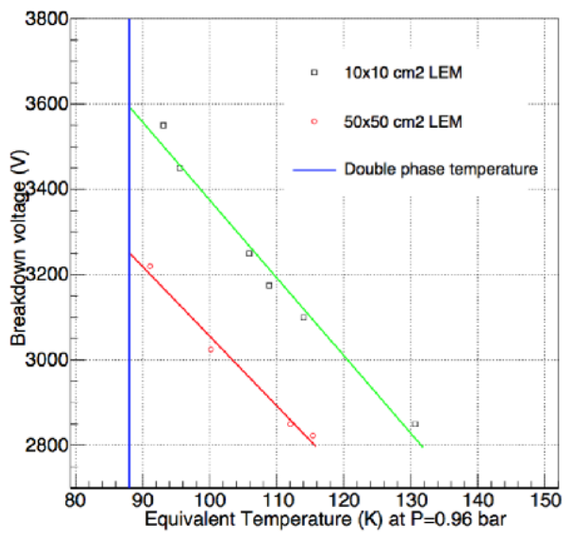
detailed day by day schedule for the remaining ~2 weeks of tests. Daily run meetings as of this week

3x1x1 LEMs

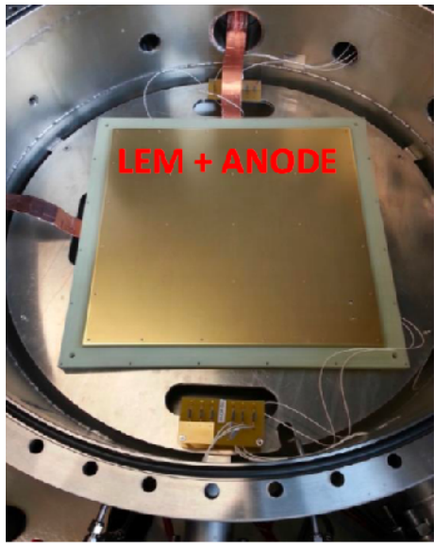
- single LEM+anode configuration HV tested in dual phase condition before 3x1x1 construction (Nov, 2015) in open dewar + camera. at P=0.989 bar, T=88 K and gas purity ~ 0.5 ppm.
- stable operation up to 31-32 kV/cm. Discharges are uniformly distributed.





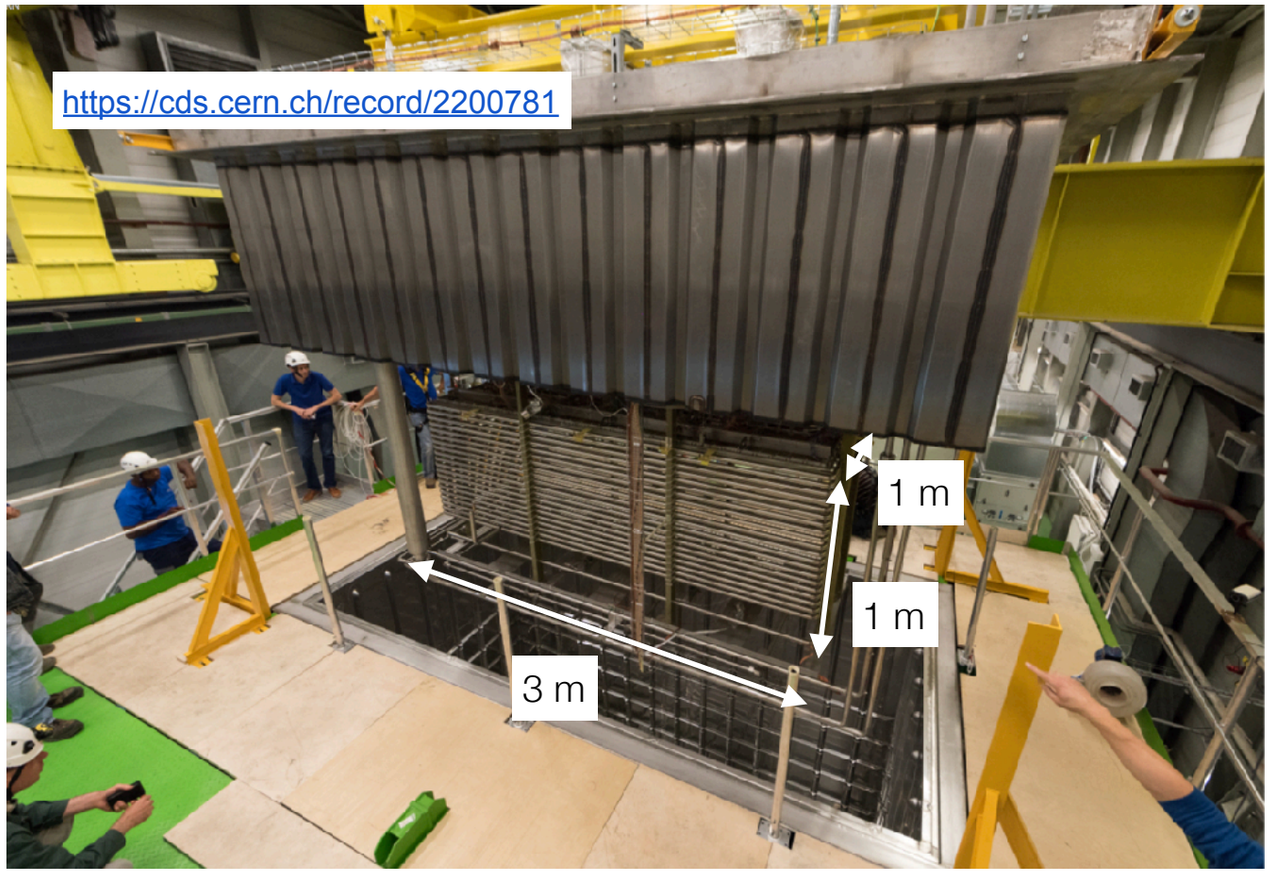


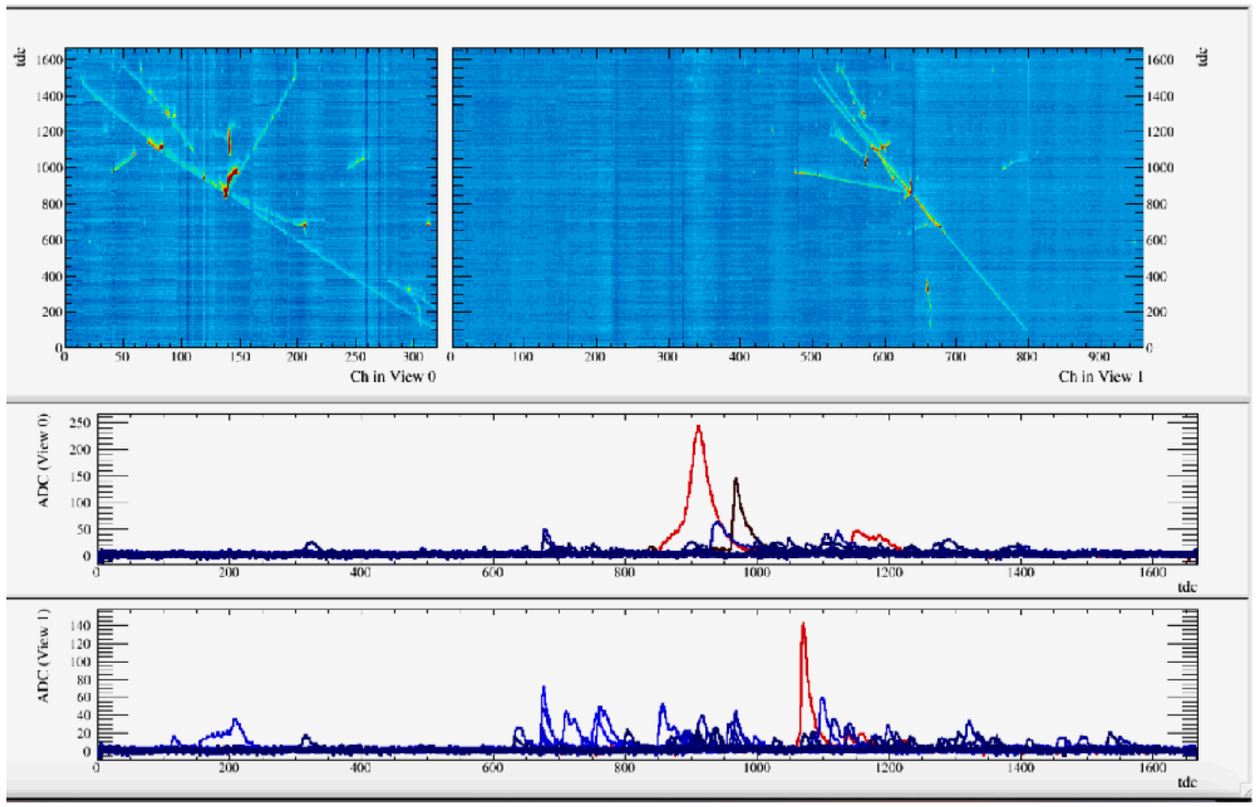
- single LEM+anode test ongoing in Saclay in GAr @ 3.3 bar (including new design of 50x50 cm2 LEM with larger clearances on the side)

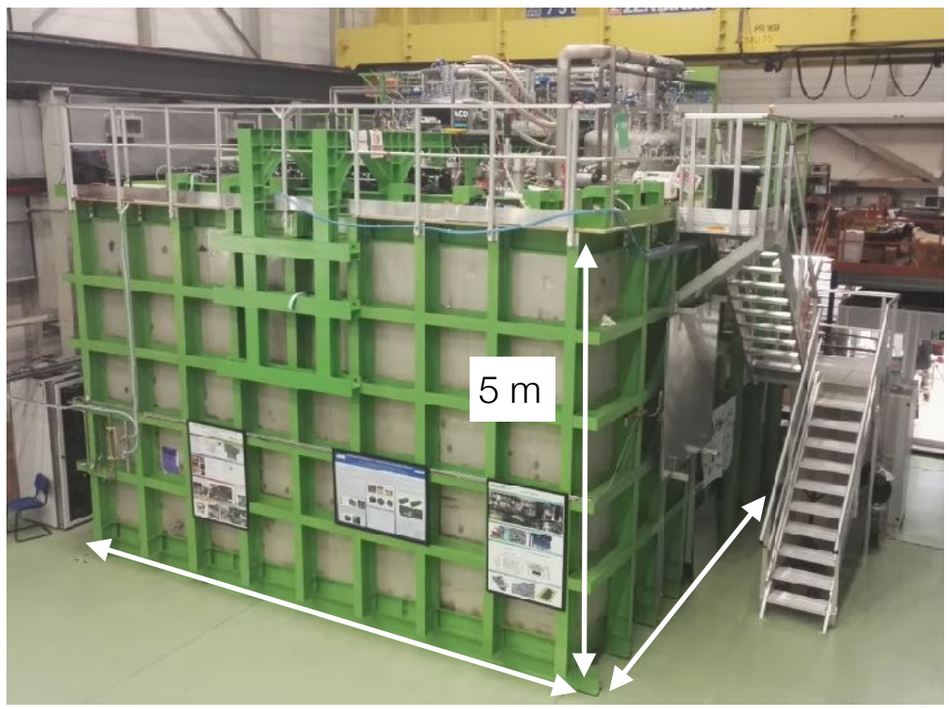


- Tiled LEM configuration to be tested in the 3x1x1

3x1x1 operation and data collected this summer







- This summer about 350 k cosmic events collected. Data of high quality clearly illustrates the state of the art imaging of the dual phase technology.
- Stable 500 V/cm drift field over one meter
- Excellent performance of immersed liquid pump and purity compatible with ms electron lifetime. First time achieved at CERN with membrane cryostat.
- LAr level stable at sub-mm scale.
- First time ever, extraction over 3m^2 area and LEM amplification demonstrated on the 50x50 cm2, which is the final design for DUNE
- Good S/N ratio on two collection views (3 meter and 1 meter strips) even without software noise removal algorithms.