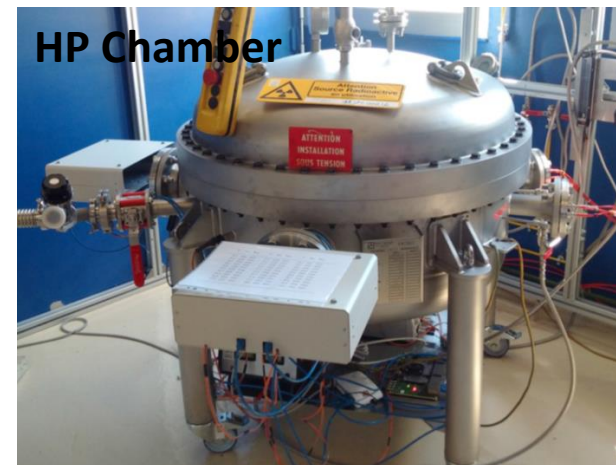
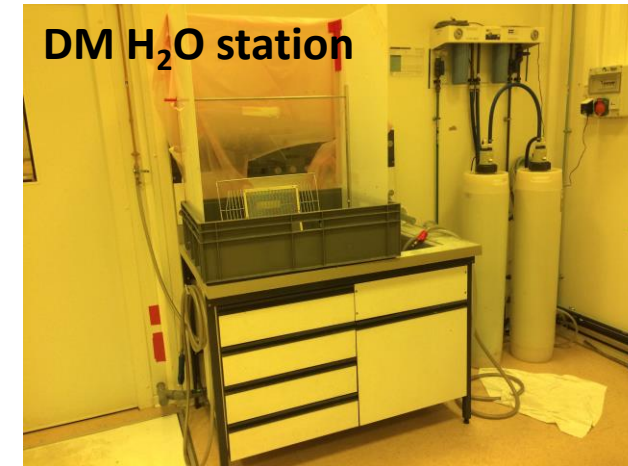


# LEM Production and Tests @ Saclay

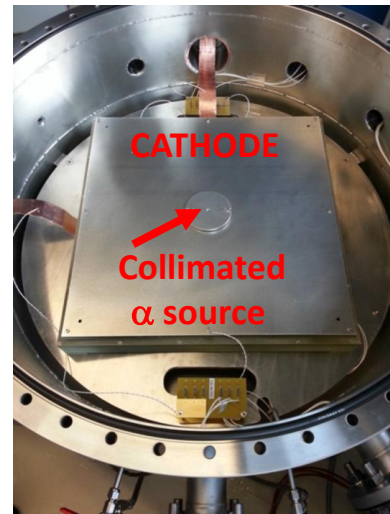
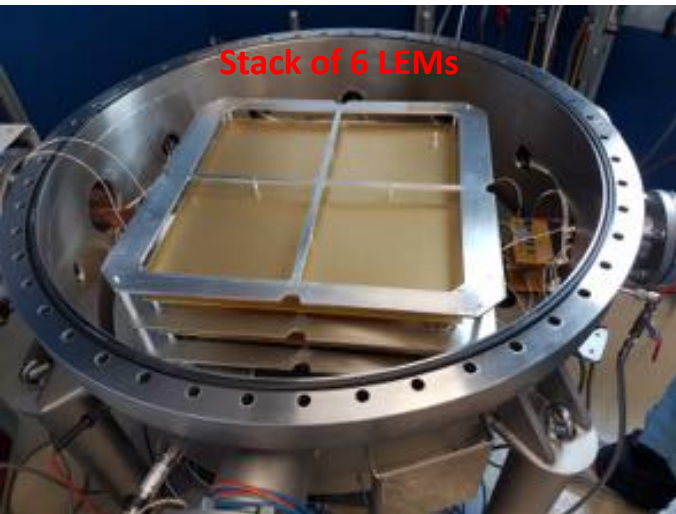
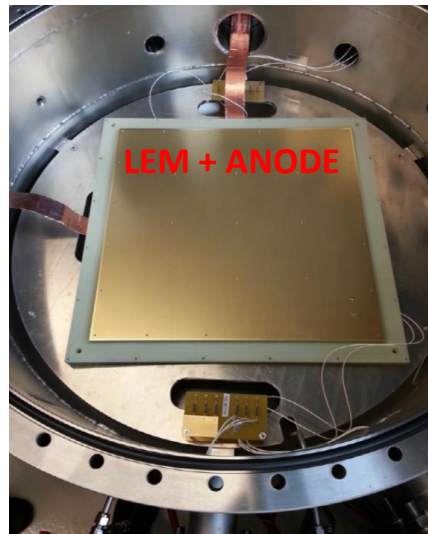
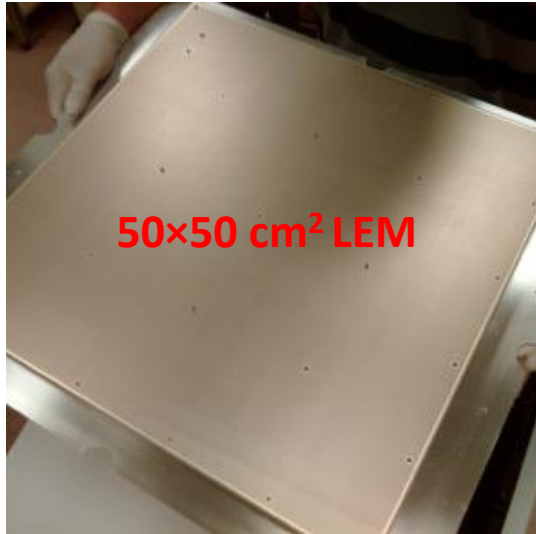
S. Bolognesi, Ph. Cotte, A. Delbart, S. Emery, M. Karolak, E. Mazzucato,  
Y. Pénichot, Y. Piret, G. Vasseur, M. Zito  
CEA Saclay, Irfu

# CEA-IRFU tasks in WA105

- CEA-IRFU responsible for the procurement of 1/2 of the 144 LEMs + anodes for the 6×6×6 + their validation.
- Irfu has contributed to the current LEM design, LAS assembly and to detector simulation.
- All the infrastructures necessary for the preparation and tests of the LEMs available at Saclay (cleaning, baking, polymerization, metrology, etc...).
- A High Pressure chamber has been built in order to perform LEM tests in argon at same gas density as in DLAr conditions (P ~3.3 bar at room temperature).
- LEM production started last July and is progressing well (contract with ELTOS for 78 LEMs). All LEMs for 1<sup>st</sup> CRP (36) expected to be available by mid-October.

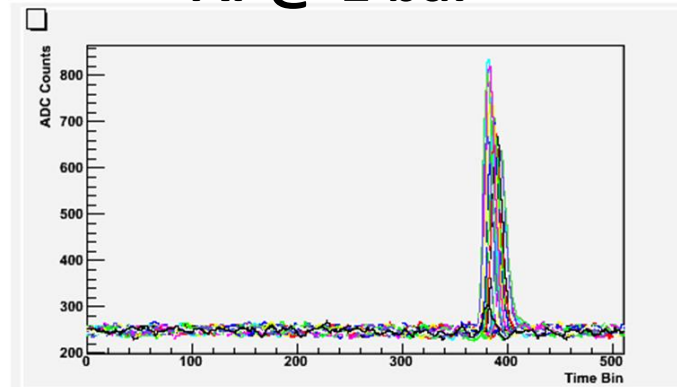


# HV Tests and Gain measurements

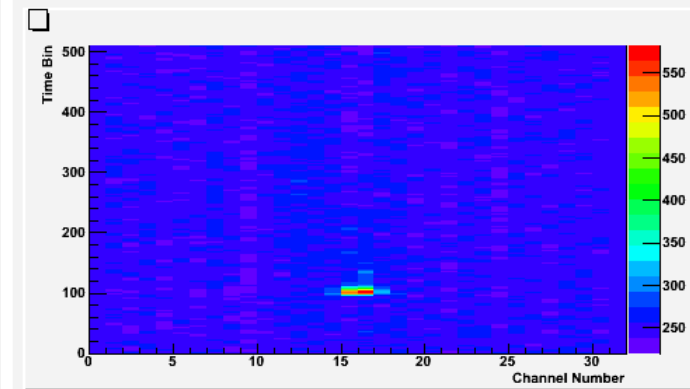
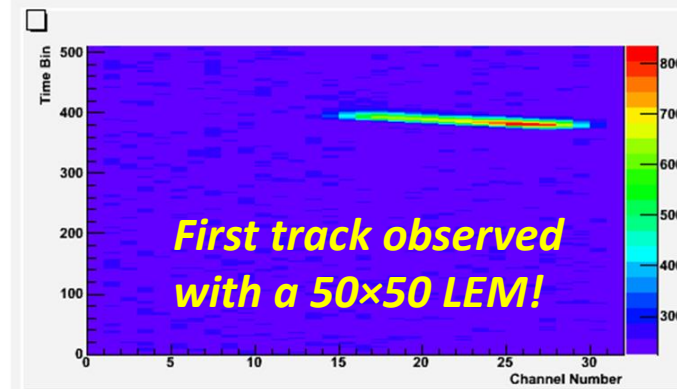
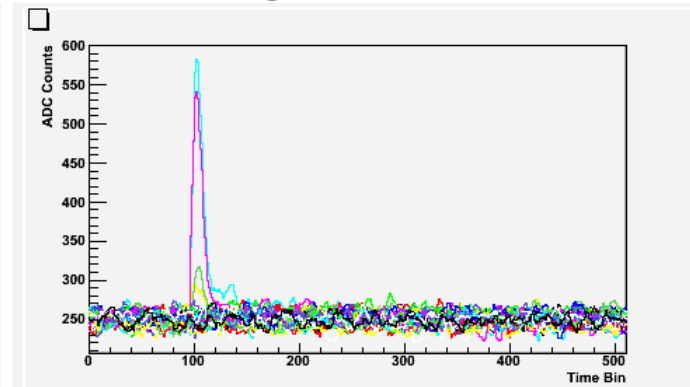


**$^{241}\text{Am}$   $\alpha$  tracks**

Ar @ 1 bar

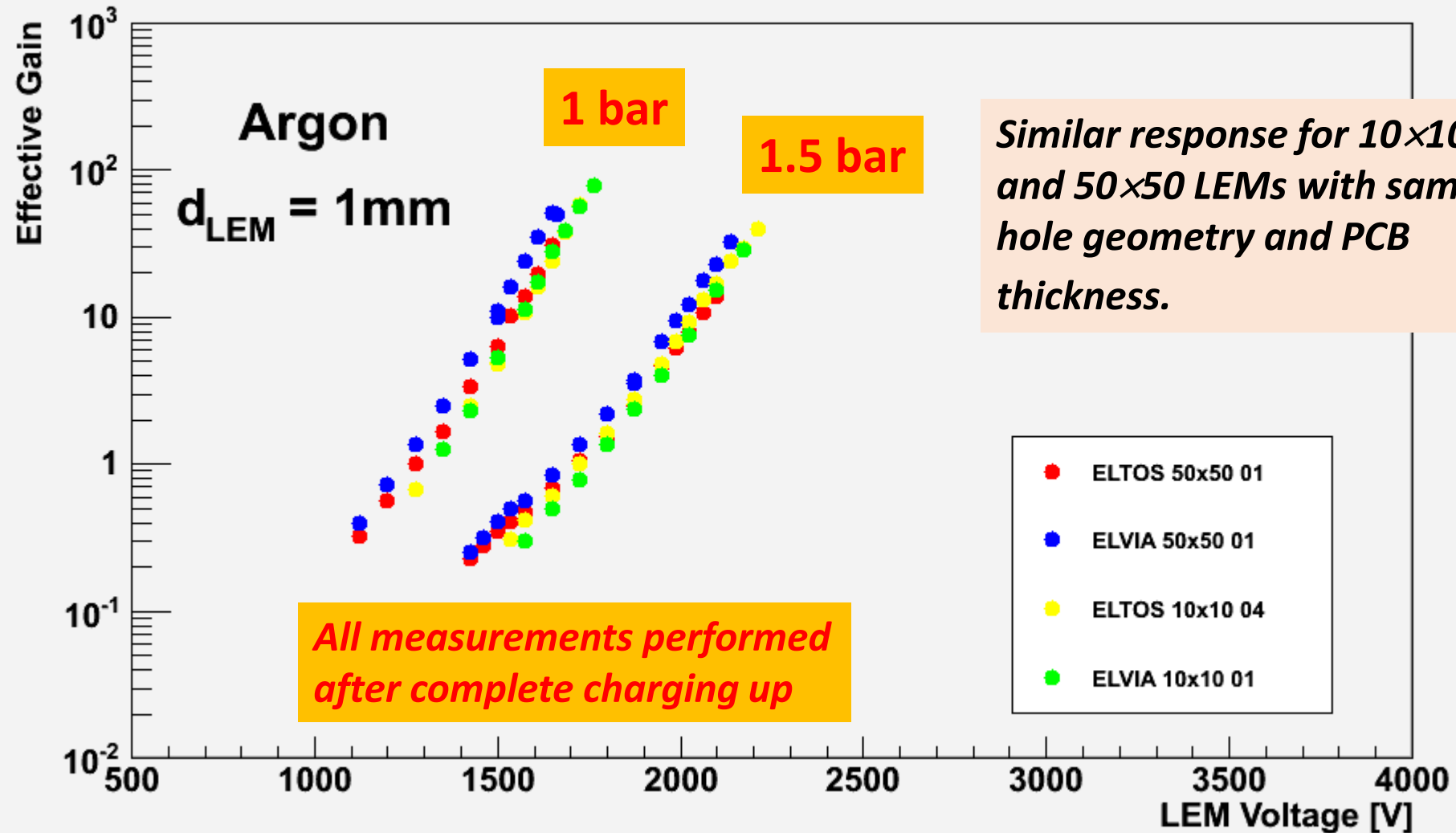


Ar @ 3.3 bar

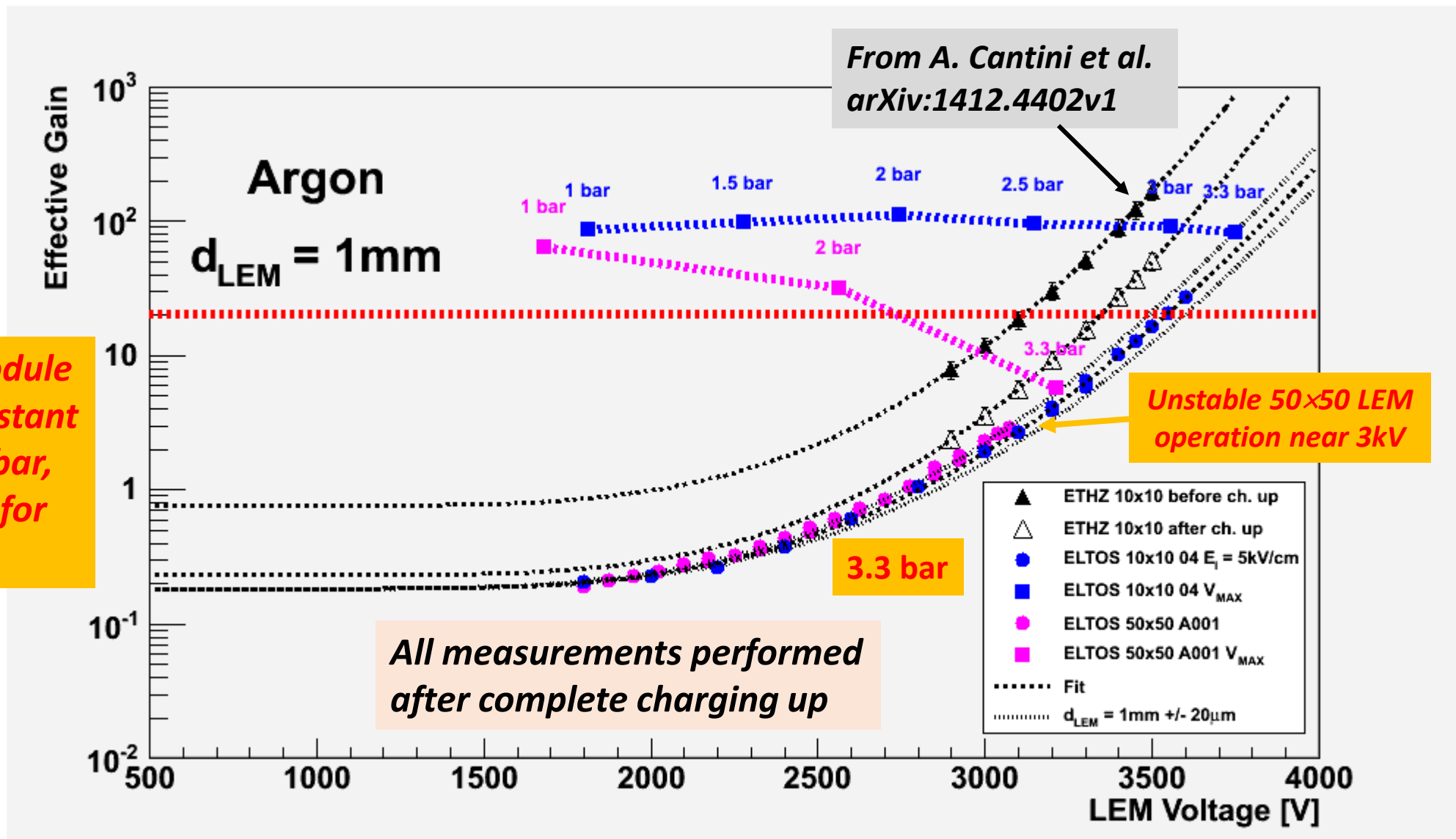


# Gain measurements

(Spring 2017)



# LEM tests : 50×50 -vs- 10×10

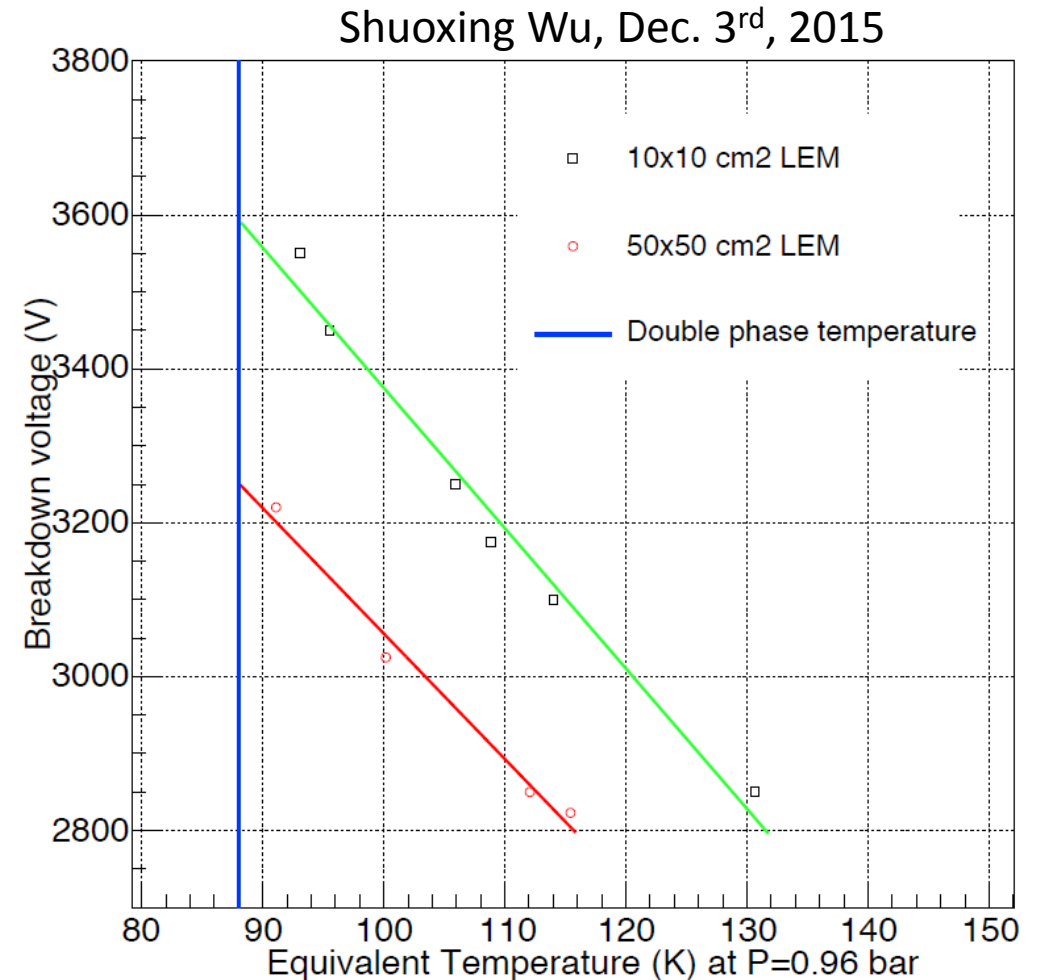


Unlike the 10×10 module which exhibits ~constant max. gain up to 3.3 bar, there is a clear drop for the 50×50 one.



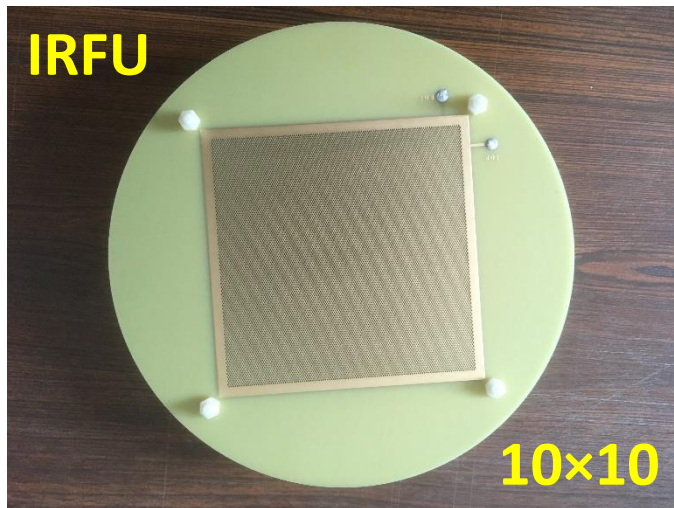
# LEM tests : 50×50 -vs- 10×10

- Similar difference between 10×10 and 50×50 LEMs observed in **cold** test at CERN almost 2 years ago.
- **Important to test with the 3×1×1 which  $V_{LEM}$  can be reached. Extraction from LAr not needed.**
- For  $G_{eff} = 20$   $V_{LEM} > 3.1\text{kV}$  (before ch. up) and  $V_{LEM} > 3.35\text{kV}$  (after ch. up).
- So far,  $G_{eff} \sim 5$  with the 3×1×1 @ 2.8kV (before ch. up).

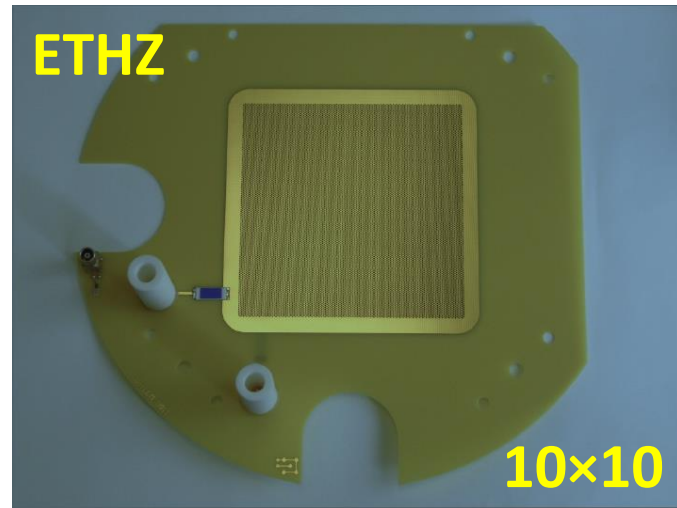


# LEM design : 50×50 -vs- 10×10

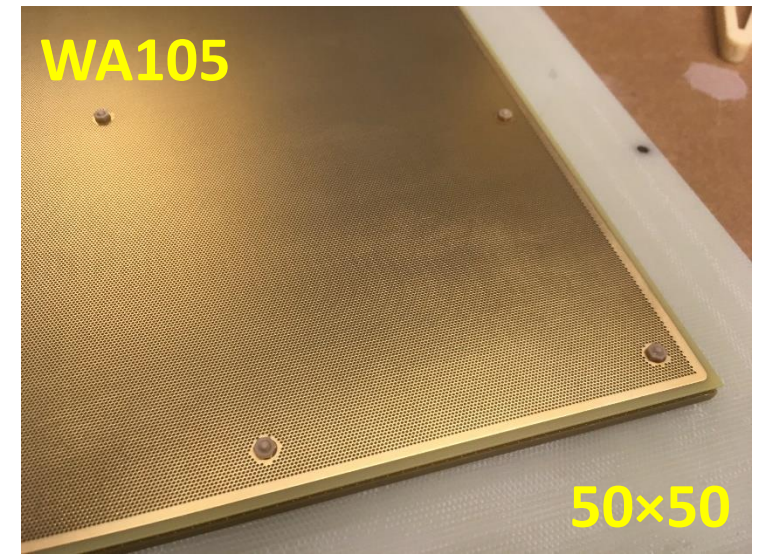
- Although hole geometry and PCB thickness is the same, the 10×10 LEM designs (ETHZ or IRFU) differ from the 50×50 one : no screw hole, no HV connector in active region but large area insulating material surrounding the LEM edges.
- Difference in LEM maximum voltage may not be due uniquely to size effects.



25/09/2017



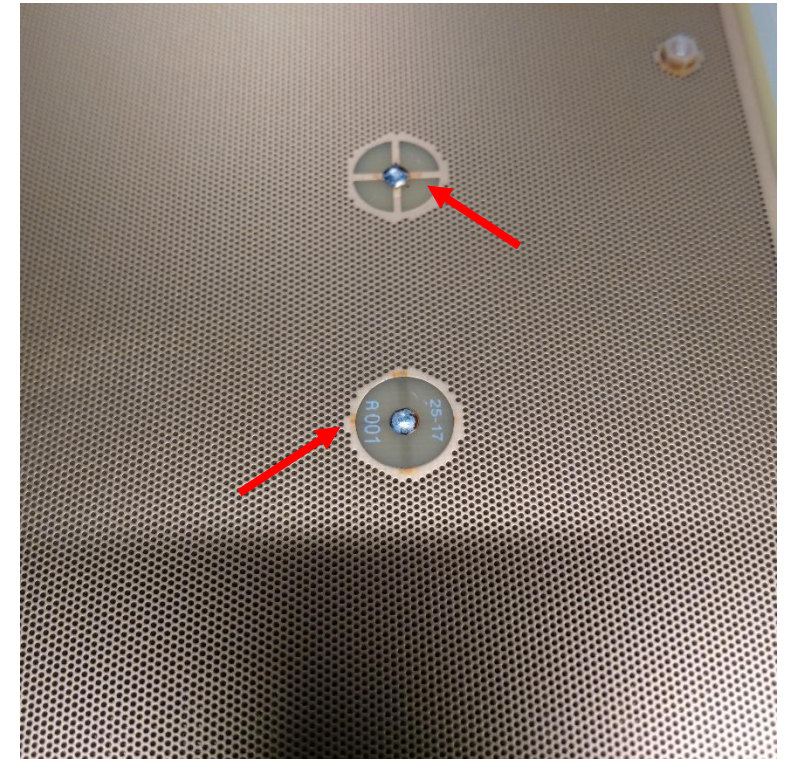
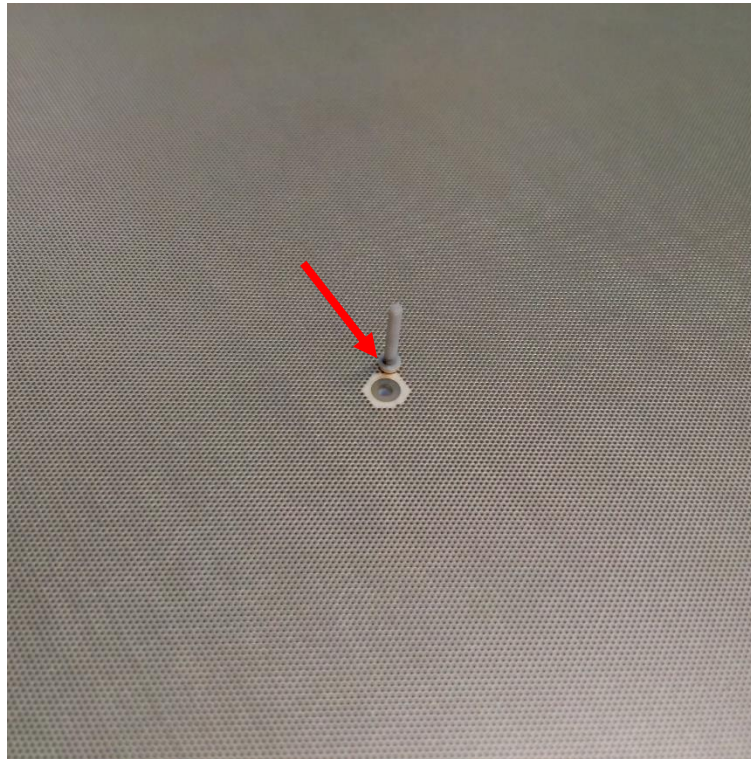
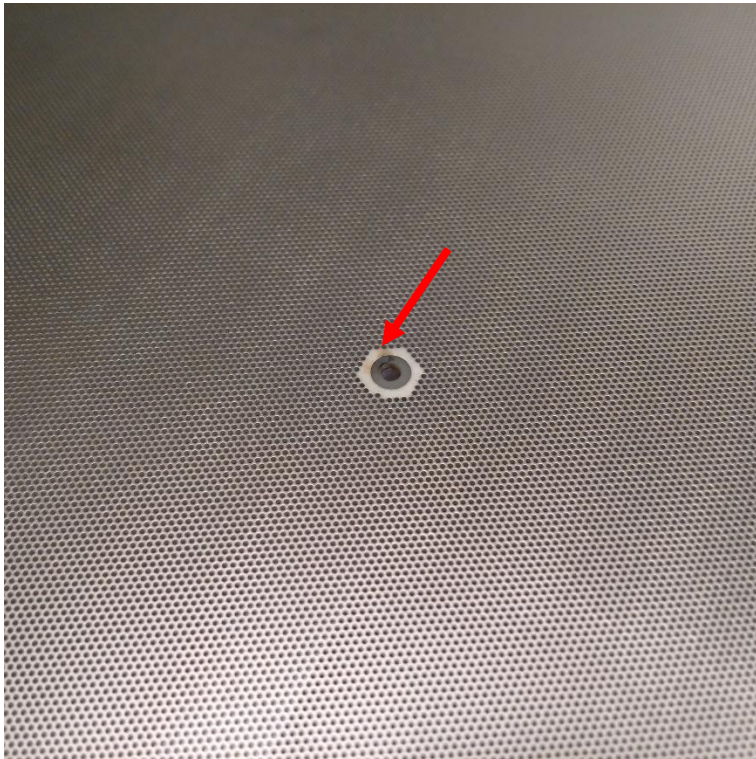
WA105 Review Meeting





# Dark spots observed after HV tests

*See Alain Delbart talk on Sept. 1<sup>st</sup>, 2017 at the protoDUNE-DP Integration Meeting*





# Proposal

- If the 3×1×1 prototype cannot demonstrate that the LEMs can operate in a stable mode with sufficient gain (initial WA105 goal was  $G_{\text{eff}} > 20$ ), we propose to pause the LEM production after the 1<sup>st</sup> CRP (36 LEMs) in order to address this issue (would obviously need to negotiate with ELTOS).
- A logical step to minimize changes in the LEM design would be to use larger clearance and guard rings (copper only without holes) around screw holes, LEM edges and perhaps also near HV connectors (simulation needed to check impact on track reconstruction).
- Other possibilities could also be considered but they would interfere with present CRP design : LEM segmentation, 2 LEMs in cascade (promising tests performed at Saclay with 10×10 LEMs in Ar(90%)/CO<sub>2</sub>(10%)).
- We cannot afford building the 6×6×6 that would not meet the WA105 requirements.