Status of LEM production and tests

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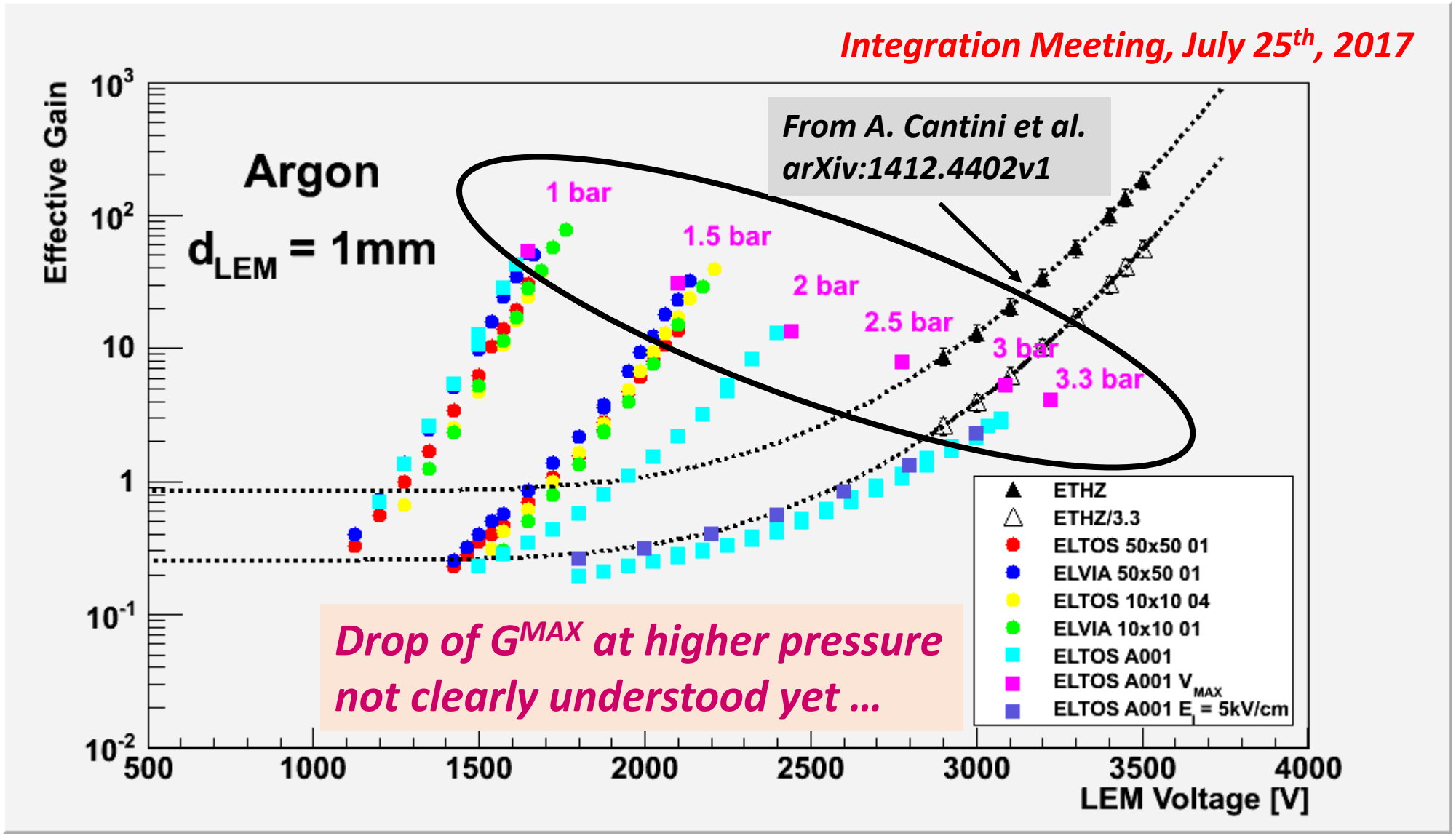
Status of LEM production

- So far 21 LEMs received from ELTOS :
  - 8 received this week, in preparation (HV pins, MACOR tubes, cleaning, polymerization).
  - 2 from pre-series tested succesfully.
  - 7 tested in dry air (up to 4.5kV) and argon @3.3 bar (up to 3.2kV) and accepted.
  - 4 did not pass the air and/or argon tests. LEMs cleaned again and being tested now.
  - N.B. None of the produced LEMs was discarded after the cleaning step.
- 12 more LEMs to be shipped by ELTOS next week.
- More to come in the following weeks. Hope to have enough accepted LEMs for the 1st CRP by mid-October.
- Test speed is typically 6 per week as 2-3 days of pumping are necessary to remove water from the FR4 material.

Spacers for LAS assembly

- Sample of 50/4.5k spacers (PEEK) checked: all ok.
- Average D = 2.07mm with SD = 0.03mm.
- Nuts should arrive soon.

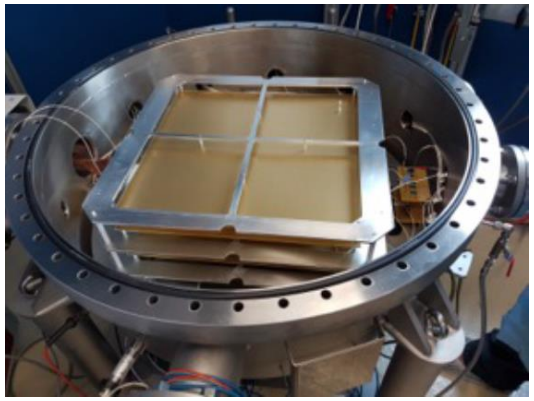
Gain measurements up to 3.3 bar



HV limitations observed @ 3.3 bar

Actions taken since end of July :

- Improve electrical insulation on HV PCB boards and connections.
- Reduce source activity by × 16 (use ϕ = 1mm collimation) to cope with much denser charge density @ 3.3 bar (ch. up time ~24h).
- Check gain curve for a 10×10 LEM.

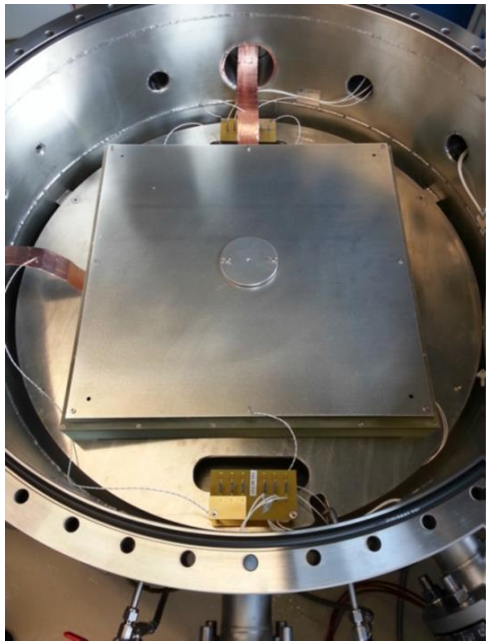


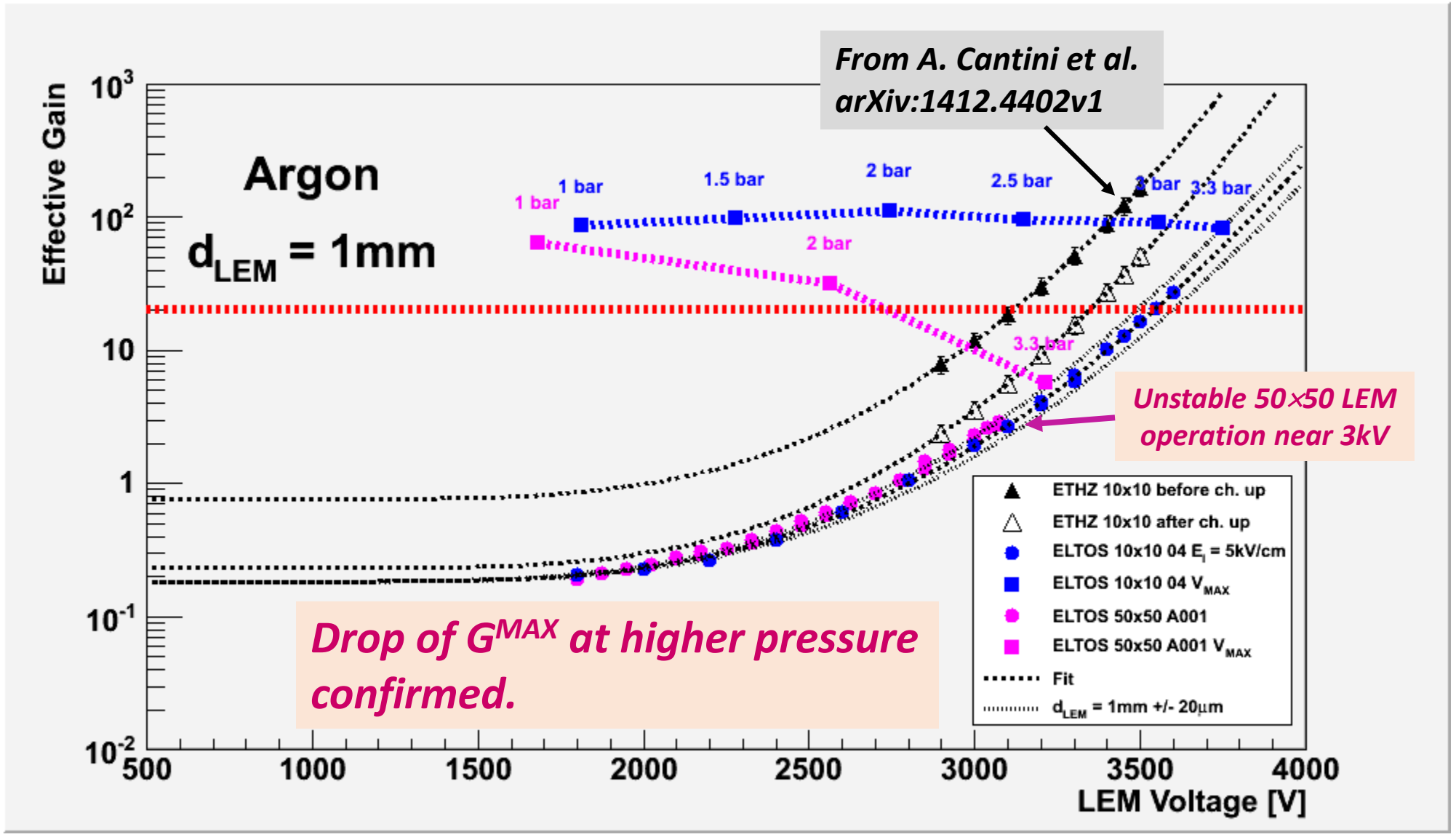
HV Tests (w/o ANODE)

Filling HP chamber with air / argon after pumping down to ~10^{-4} mbar

	First Test (July 2017)		2nd test after improving electrical insulation (Aug. 2017)	
LEM	**Dry air @1 bar**	**Argon @3.3 bar**	**Dry air @1 bar**	**Argon @3.3 bar**
LEM 10x10 #07	5160V / 0nA	3760V / 0nA	5050V / 0nA	3740V / 0nA
LEM 50x50 #01	4680V / 0nA	2600V / 0nA	4820V / 0nA	3530V / 0nA
LEM 50x50 A001	4680V / 0nA	2600V / 0nA	4790V / 0nA	3510V / 0nA
LEM 50x50 A002	4600V /25nA	2650V / 0nA	4850V / 0nA	3560V / 0nA

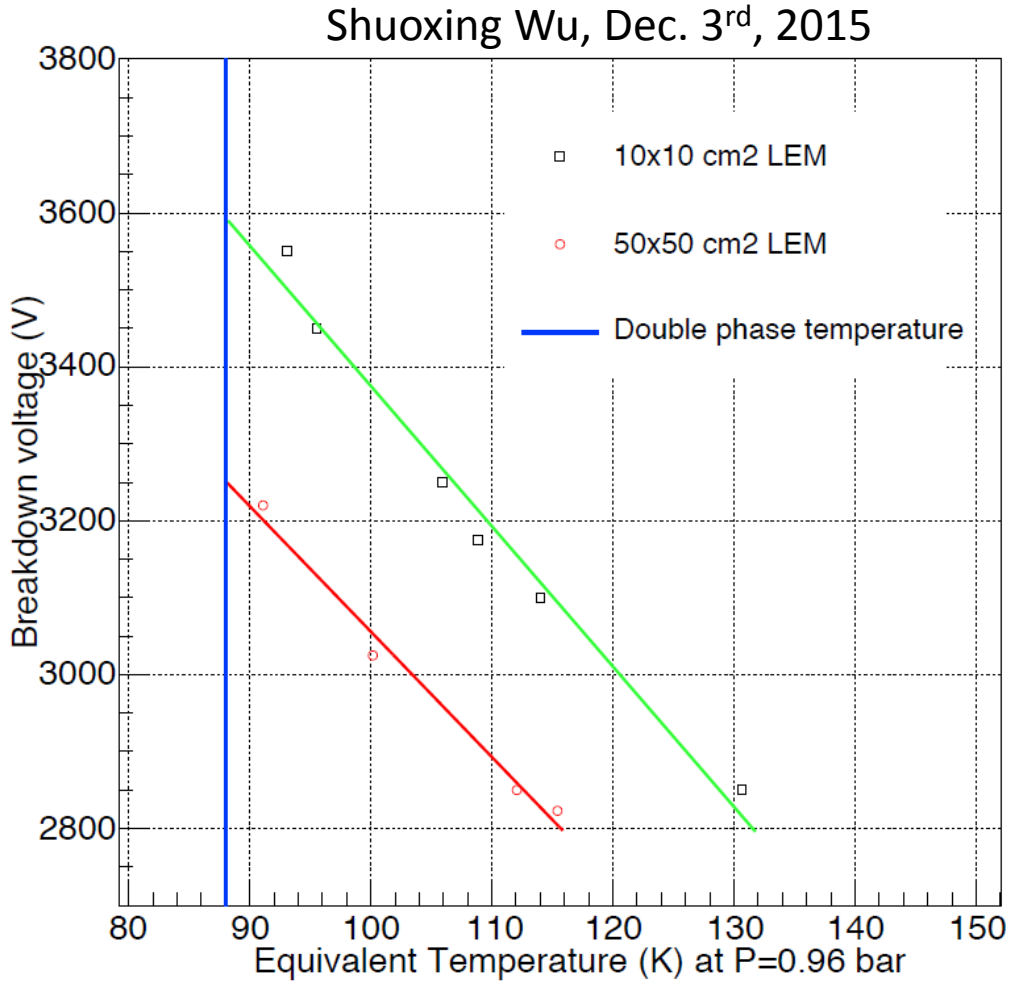
LEM tests : 50×50 -vs- 10×10





LEM tests : 50×50 -vs- 10×10

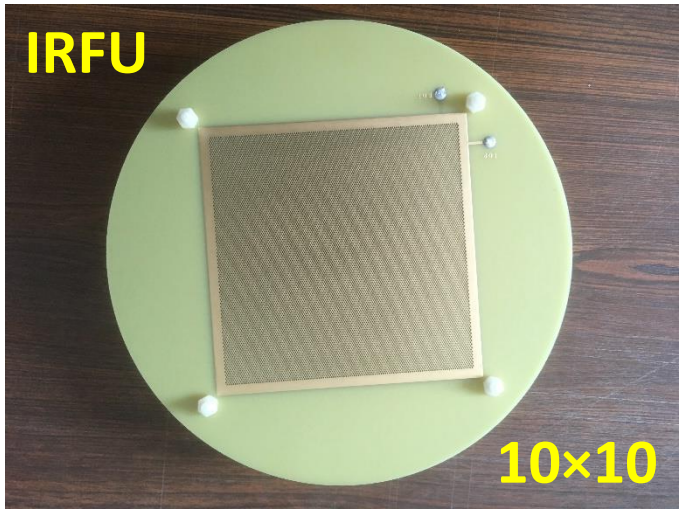
- Similar difference between 10×10 and 50× 50 LEMs observed in cold test at CERN almost 2 years ago.
- Important to test with the 3×1×1 which V_{LEM} can be reached. Extraction grid not needed.
- For G_{eff} = 20 V_{LEM} > 3.1kV (before ch. up) and V_{LEM} > 3.35kV (after ch. up).
- So far, G_{eff} ~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

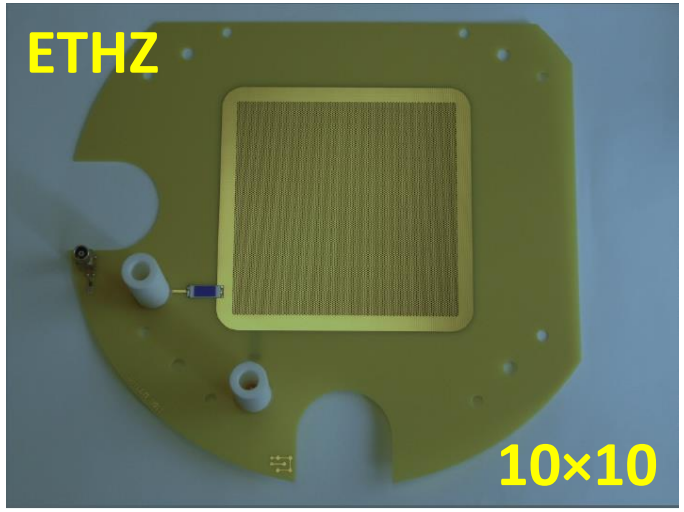


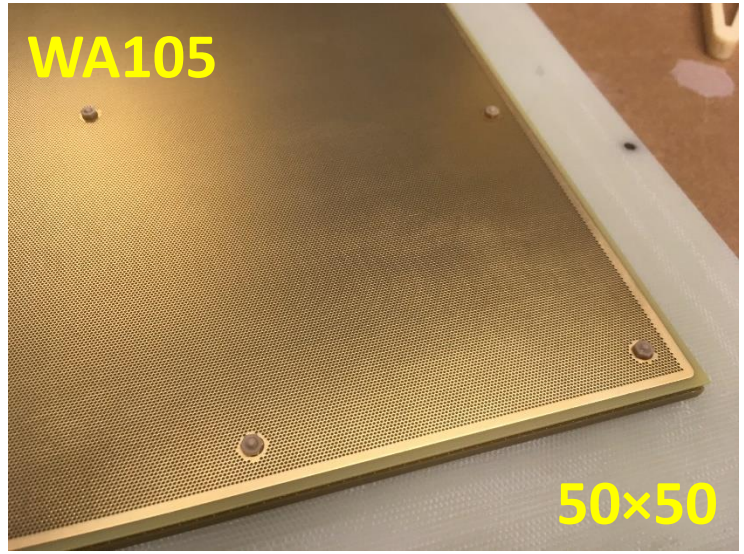
LEM design : 50×50 -vs- 10×10

- Although hole geometry and PCB thickness is the same, the 10×10 LEM designs 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 V_{LEM} max. voltage may not be due uniquely to size effects.

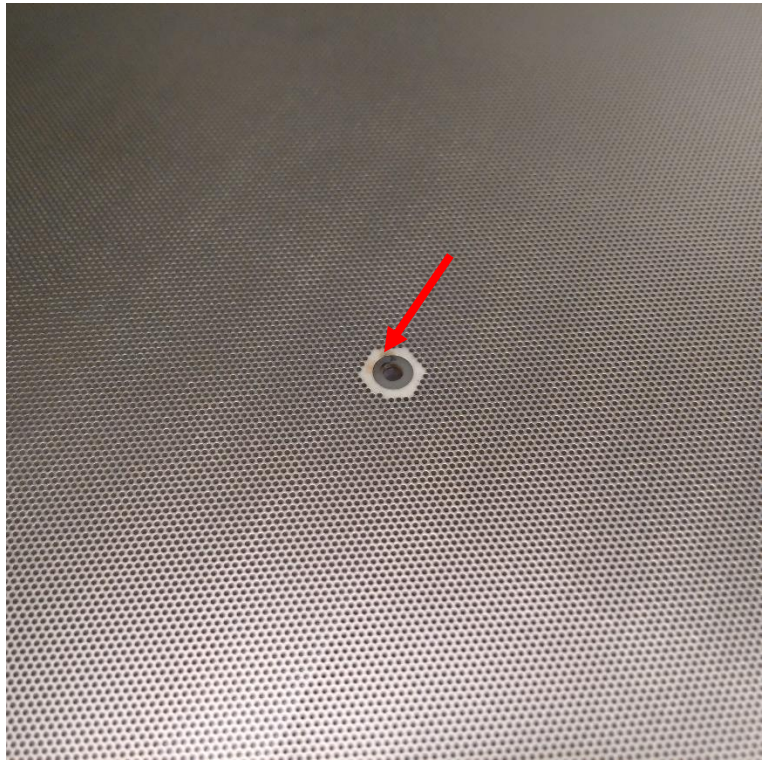


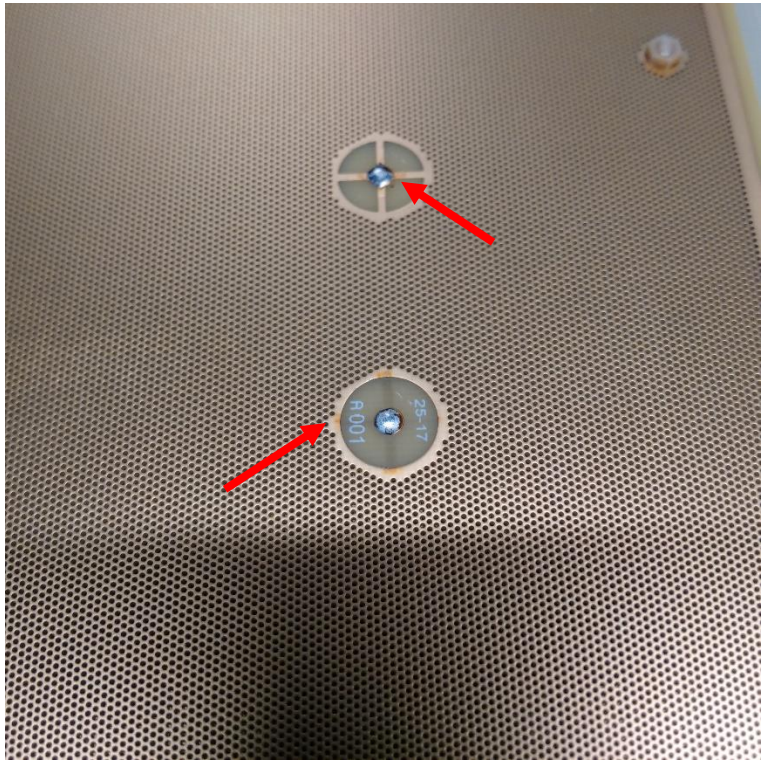




Dark spots observed after HV tests

See Alain Delbart talk on Sept. 1st, 2017





Proposal

- If it is demonstrated with the 3×1×1 prototype that LEMs cannot operate in a stable way with sufficient gain (initial WA105 goal was $G_{eff} > 20$), we propose to pause the LEM production after the 1st CRP (36 LEMs) in order to address this issue (would obviously need to negociate with ELTOS).
- A logical step to minimize changes in the LEM design would be to test larger dead space around screw holes, LEM edges and perhaps also near HV connectors (simulation needed to check impact on track reconstruction).
- This would clearly delay CRP construction by several months to allow for prototype construction and tests. We cannot afford building the 6×6×6 that would not meet the WA105 requirements.