

Status of LEM production and tests @ 3.3 bar

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Status of LEM production and tests

- First 2 LEMs (A001 & A002) from pre-series produced by ELTOS were received in Saclay on June 28th.
- Visit at ELTOS (Production Review) on July 6th.
- HV tests in argon up to 3.3 bar in progress.
- Spacers and nuts made in PEEK for LEM + ANODE assembly ordered. Delivery expected early September.

LEM Production Review at ELTOS (July 6th)

- Several QA/QC aspects discussed:
 - Selection of base material (Panasonic) for LEMs.
 - Thickness measurements (FR4 and copper).
⇒ *Guarantee the LEM thickness uniformity to better than +/- 0.04 mm*
 - Control samples for multiple microsections (Cu + gold thickness after etching and rim size measurement).
 - LEM dimension

LEM Production Review at ELTOS (July 6th)

- Technical specifications :

- Modified to cope with the fact that Panasonic delivers base material with FR4 and Cu thicknesses on average slightly smaller (20-30µm) than nominal.
- Final LEM dimension will not exceed 499.5 mm x 499.5 mm.

Parameter	Tolerance (contract)	Tolerance proposal
Dielectric thickness	1 mm +0/-0.04 mm	1.0 mm +/-0.05 mm
Average total thickness	1.21 mm +0/-0.04 mm	1.2 mm +/-0.06 mm
Dimensions	499.5 mm x 499.5 mm +0/-0.2 mm	499.5 mm x 499.5 mm +0/-0.3 mm
Final thickness	1.15 mm +/- 0.04 mm	1.1 mm +0.02/-0.05 mm
Holes diameter	0.5 mm +0.01/-0 mm	0.5 mm -0.01/+0 mm

ELTOS production planning

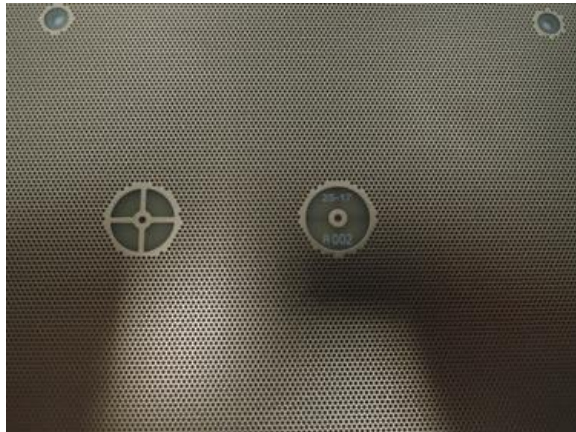
- First 6 LEMs delivered by end of July (confirmed by ELTOS today).
- 18 LEMs delivered by end of August.
- 12 LEMs delivered by mid-September.
- Remaining LEMs to be scheduled.

⇒ Total of 76 LEMS to be delivered to Saclay

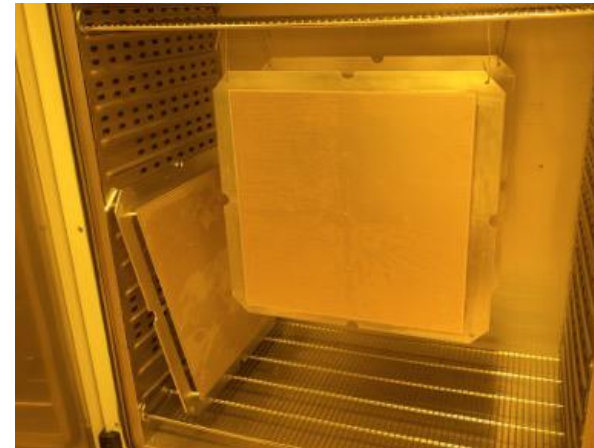
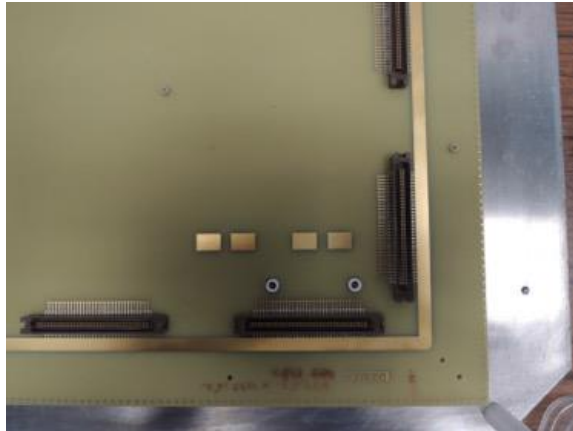
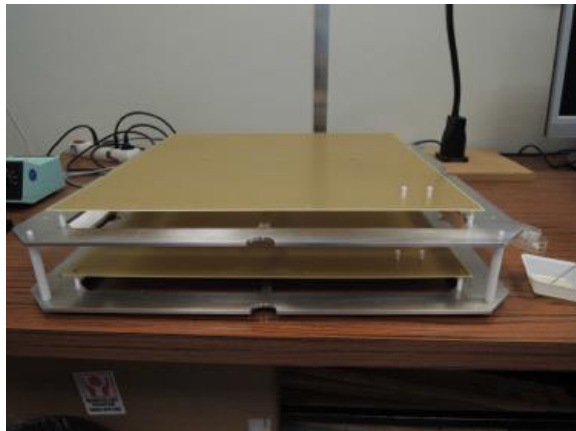
LEM preparation and cleaning of A001 and A002

(June 28th - 30th)

*Soldering HV pins +
glueing MACOR insulation*

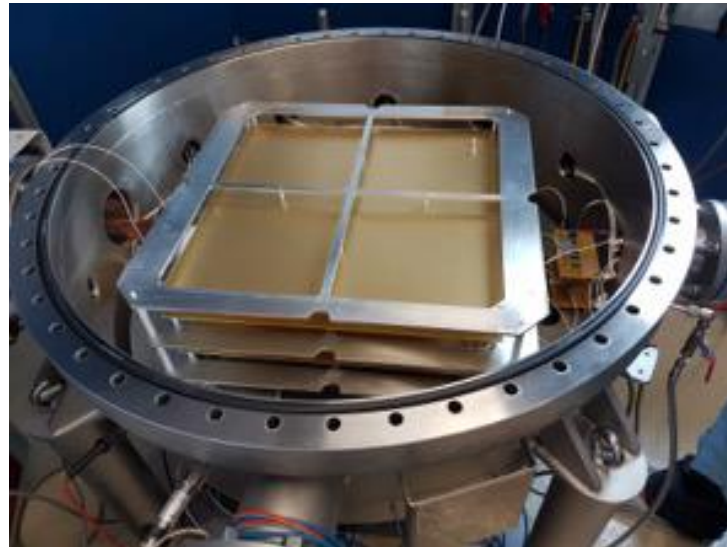
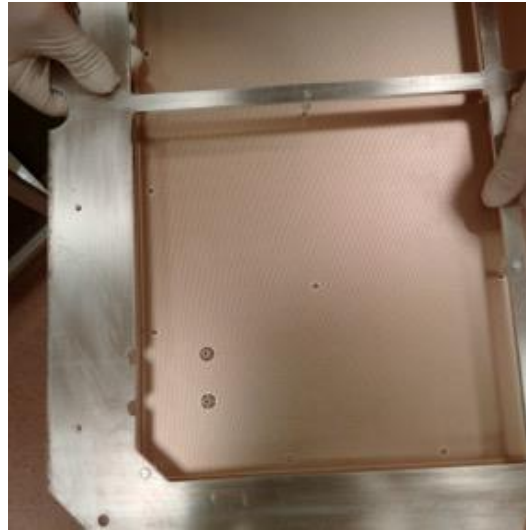
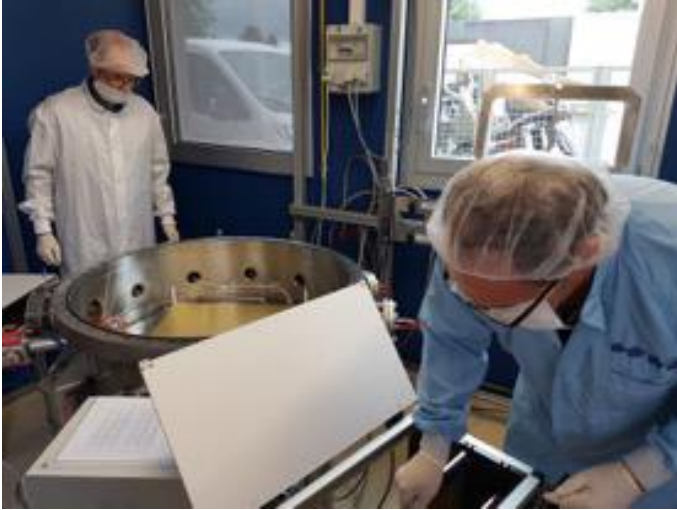


*Cleaning + drying
+ polymerization*



HV tests in HP chamber

4 LEMs installed on June 30th



25/07/2017

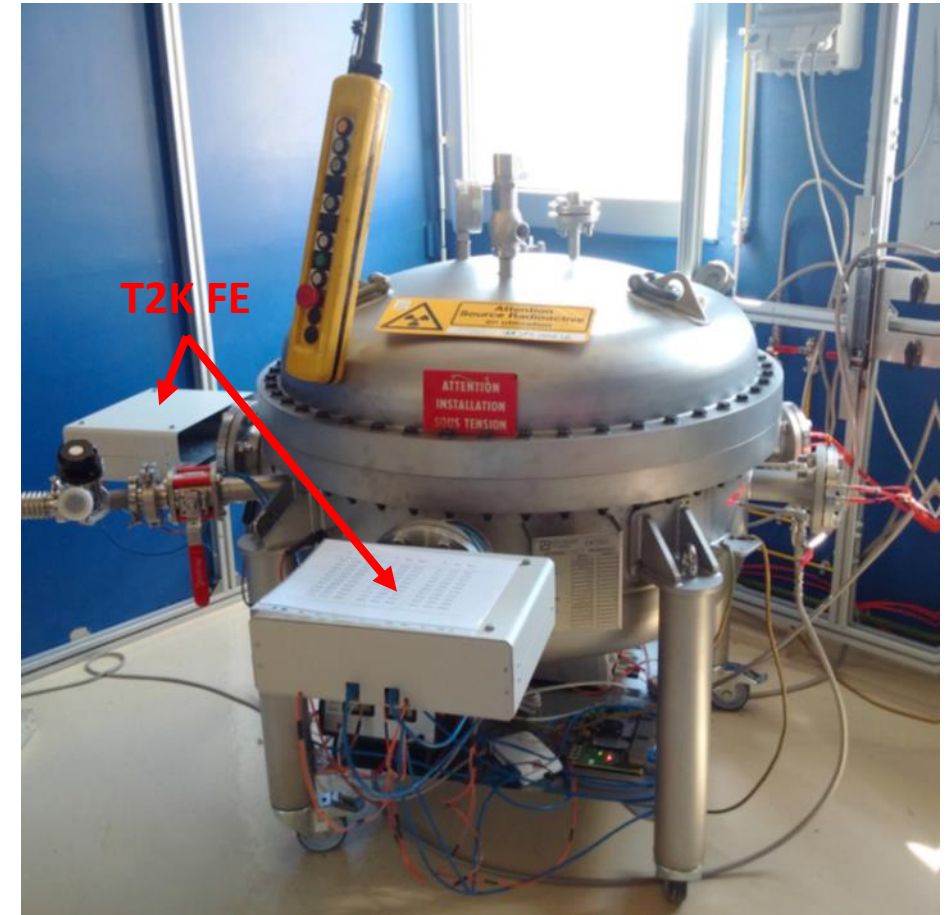
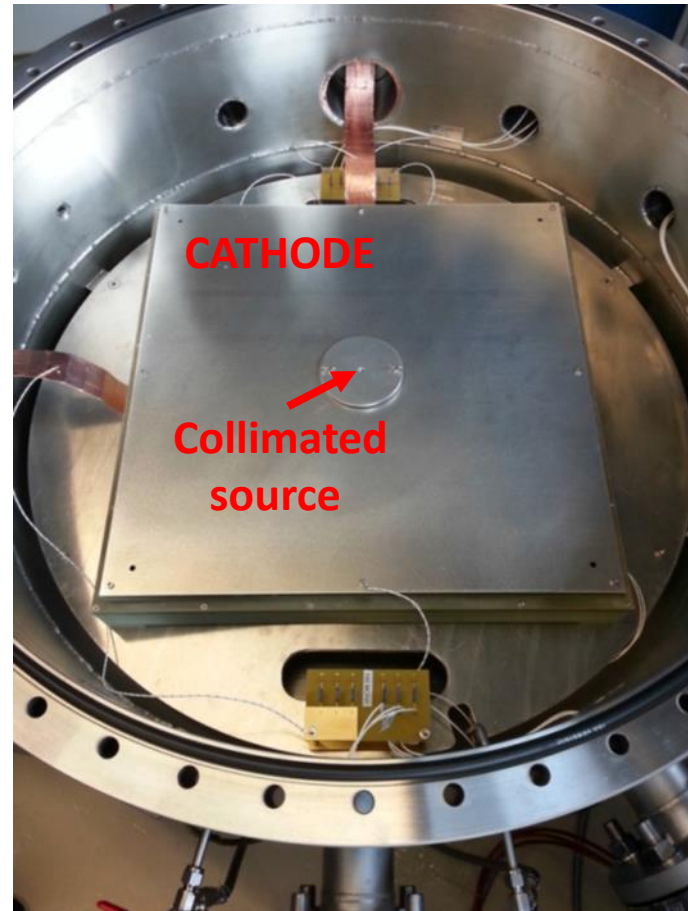
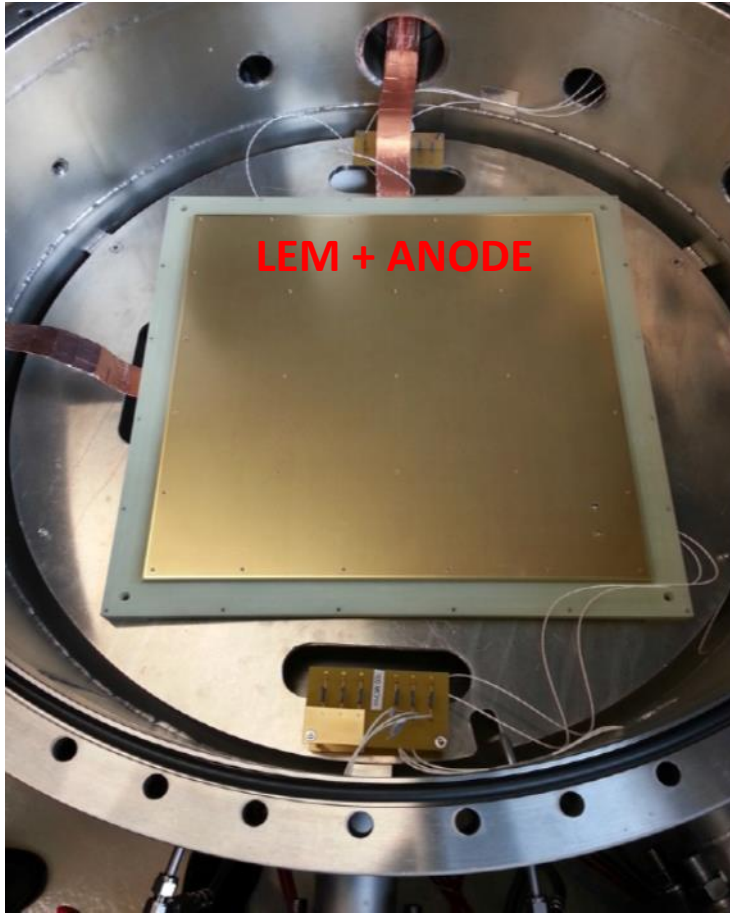
protoDUNE-DP Integration Meeting

HV Tests

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

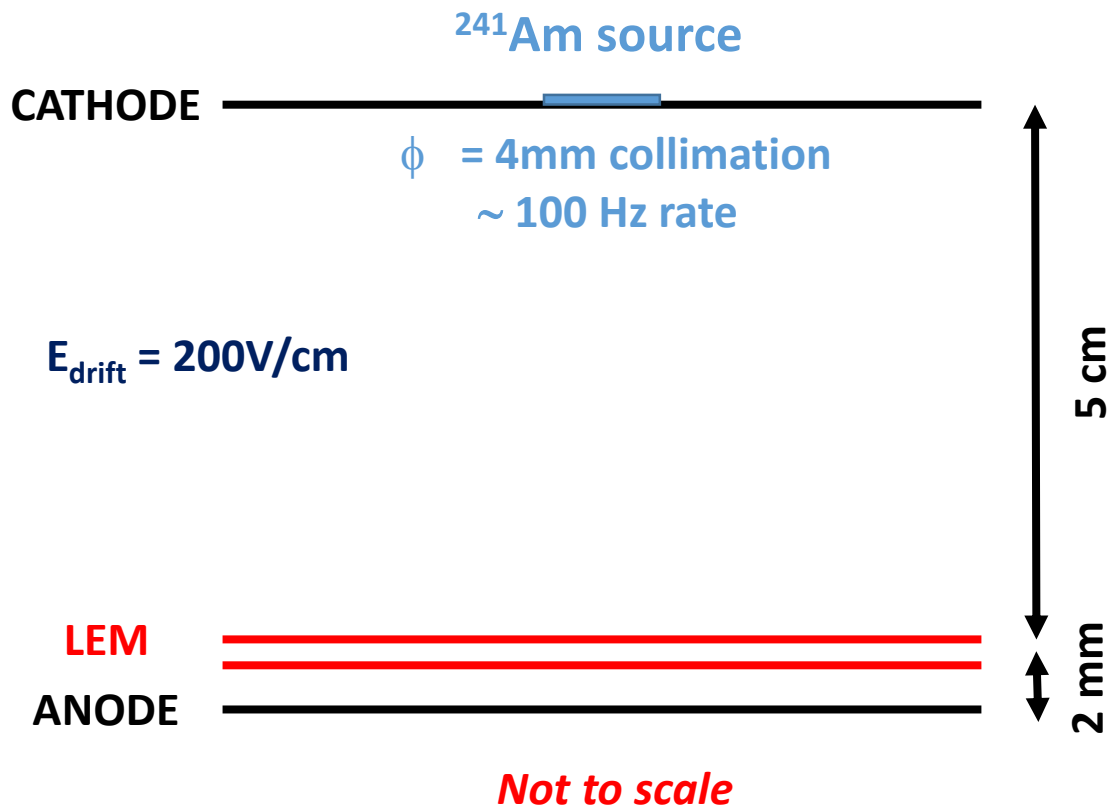
LEM	Dry air @1 bar	Argon @1 bar	Argon @1.5 bar	Argon @3.3 bar
LEM 10x10 #07	5160V / 0nA	1880V / 0nA	2300V / 0nA	3760V / 0nA 3740V / 0nA
LEM 50x50 #01	4680V / 0nA	1470V / 0nA	1800V / 0nA	2450V / 0nA 2600V / 0nA
LEM 50x50 A001	4680V / 0nA	1400V / 0nA	1750V / 0nA	2600V / 0nA 2550V / 0nA
LEM 50x50 A002	4600V / 25nA	1450V / ?nA		2400V / 7nA 2650V / 0nA

Gain measurements with ^{241}Am source



Setup for gain measurements with an α source

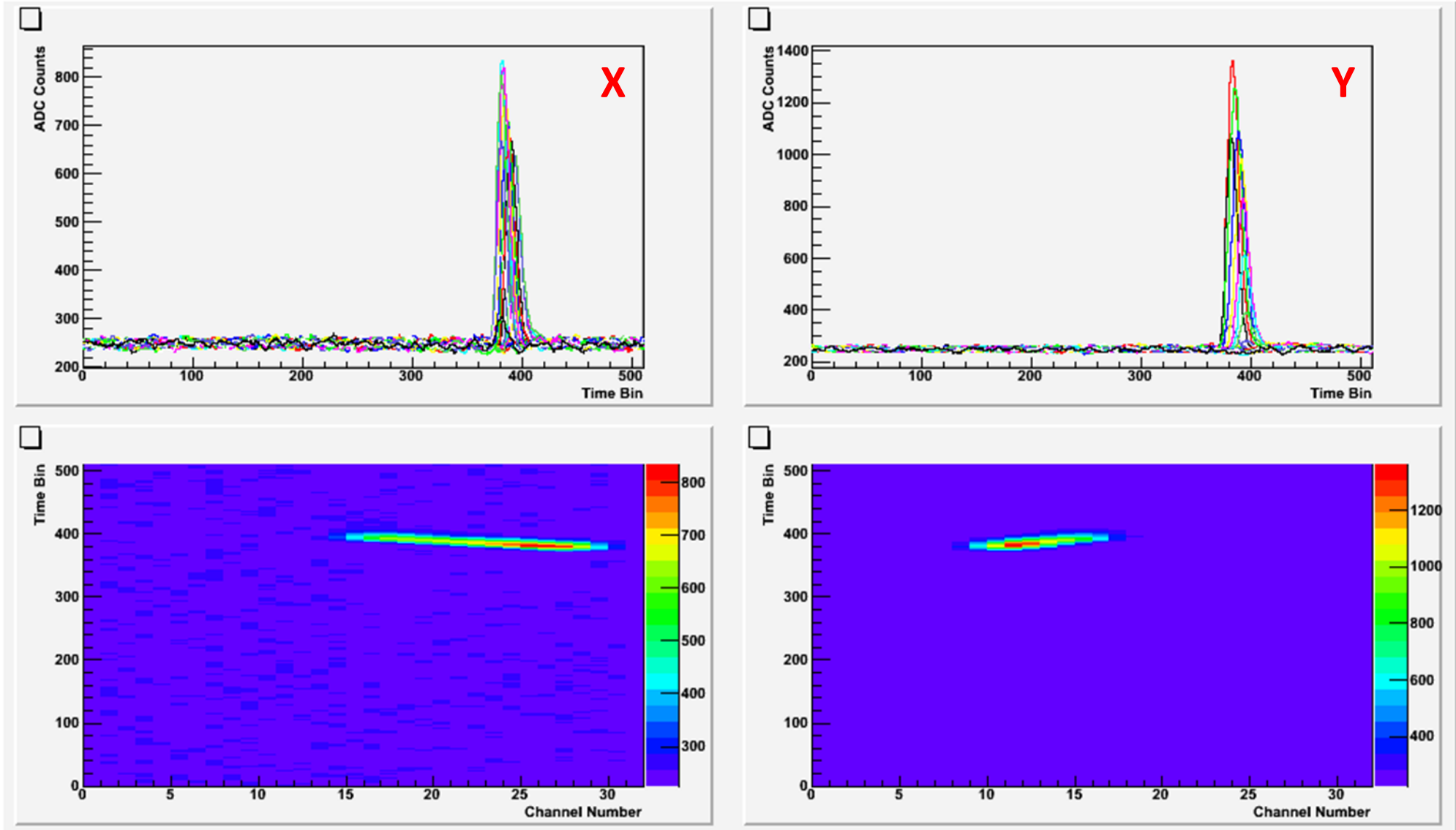
$E_\alpha = 5.5 \text{ MeV}$ $L = \sim 4.5 \text{ cm tracks @1 bar}$



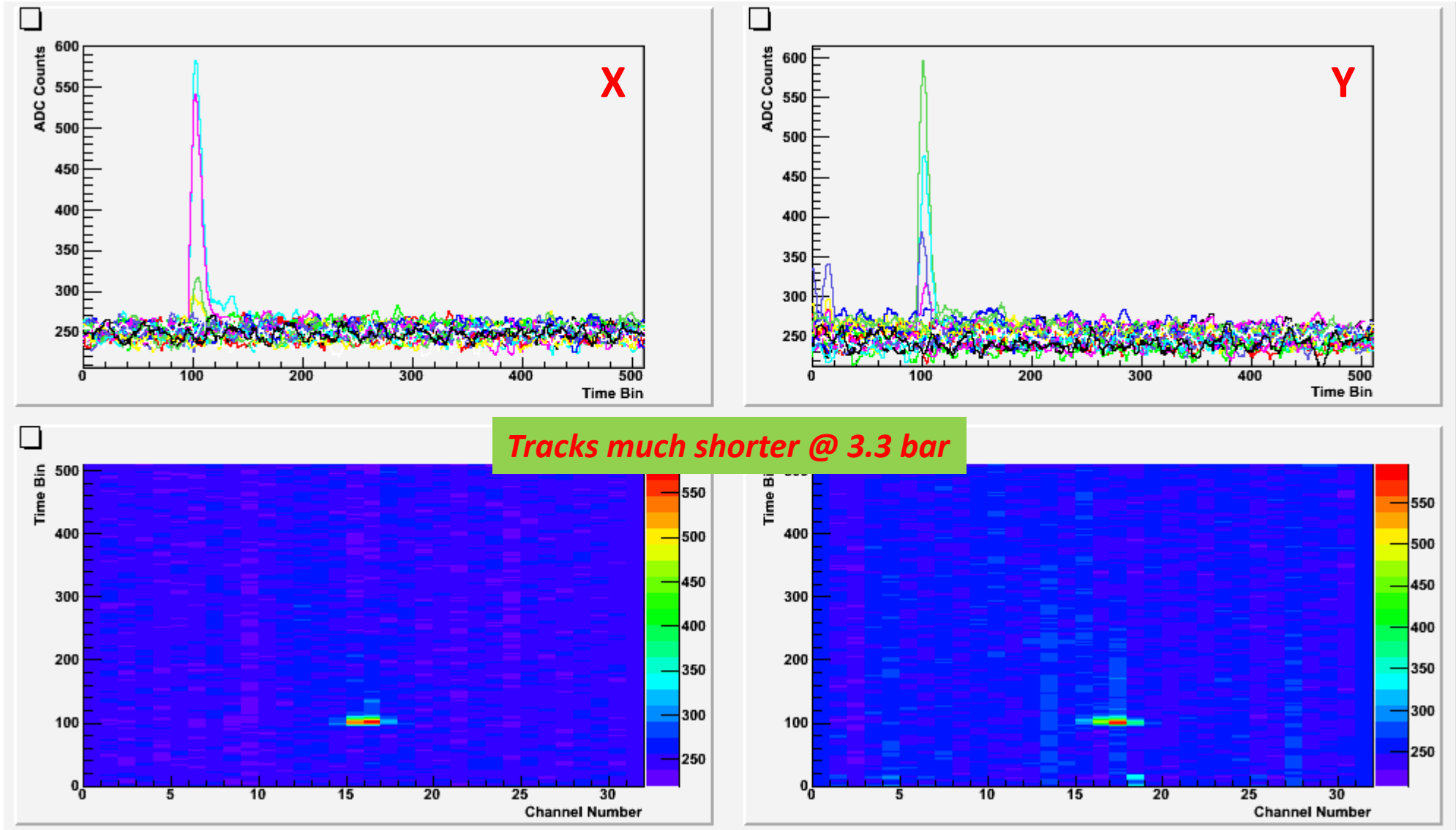
- FE : T2K ASIC AFTER + FEMINOS R/O + TCM :
 - 12 bit ADC
 - 120fC - 600fC full range range
 - 1.9 μsec peeking time
 - 511 time bins R/O @ 6.66 MHz (150ns)
 - 32 channel R/O per view (X,Y)
 - E noise : $\sim 0.2\text{-}0.4\text{fC}$
 - Measurement range : $\sim 2 - 1600\text{fC / view}$
- Ar (5.7) purity : $> 99.9999\%$
- $< 10^{-4}$ mbar pumping before Ar filling
- ~ 60 ppm of impurities after 30h of operation
- Charging up time : 2-3h @ 1bar and $G^{\text{eff}} \sim 10$

N.B. Gain measurements performed after charging up and usually with $E_{\text{LEM}} / E_I = 6$.

Argon @ 1 bar

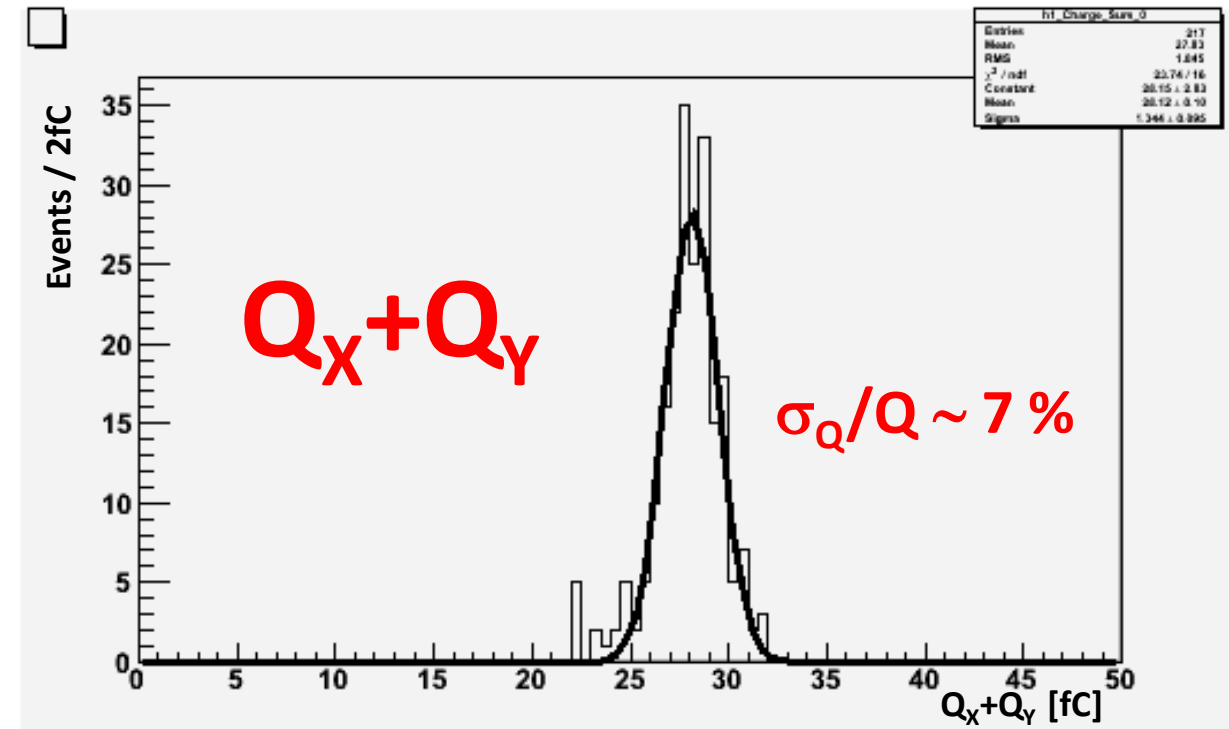
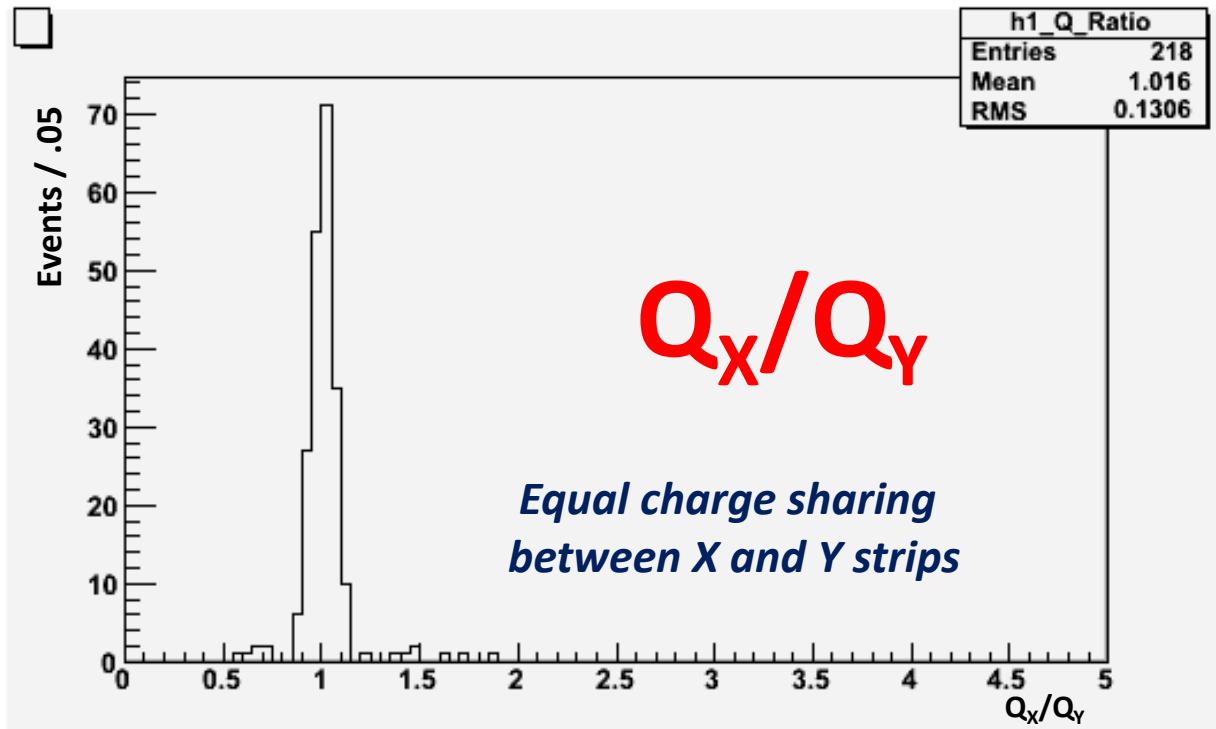


Argon @ 3.3 bar



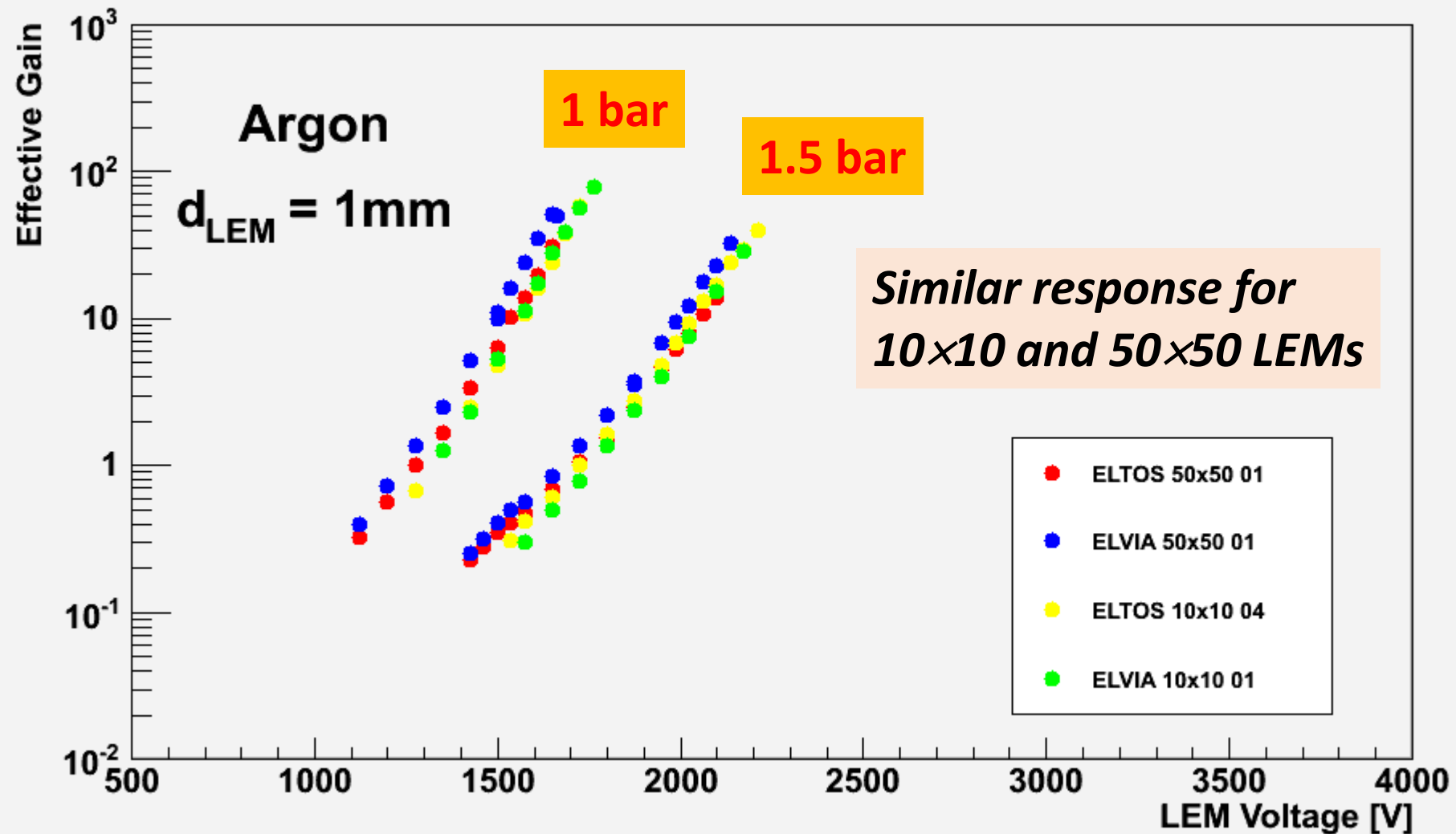
Test with ^{241}Am source @ 3.3 bar

$E_{\text{LEM}} = 30 \text{ kV/cm}$ and $E_i = 5 \text{ kV/cm}$

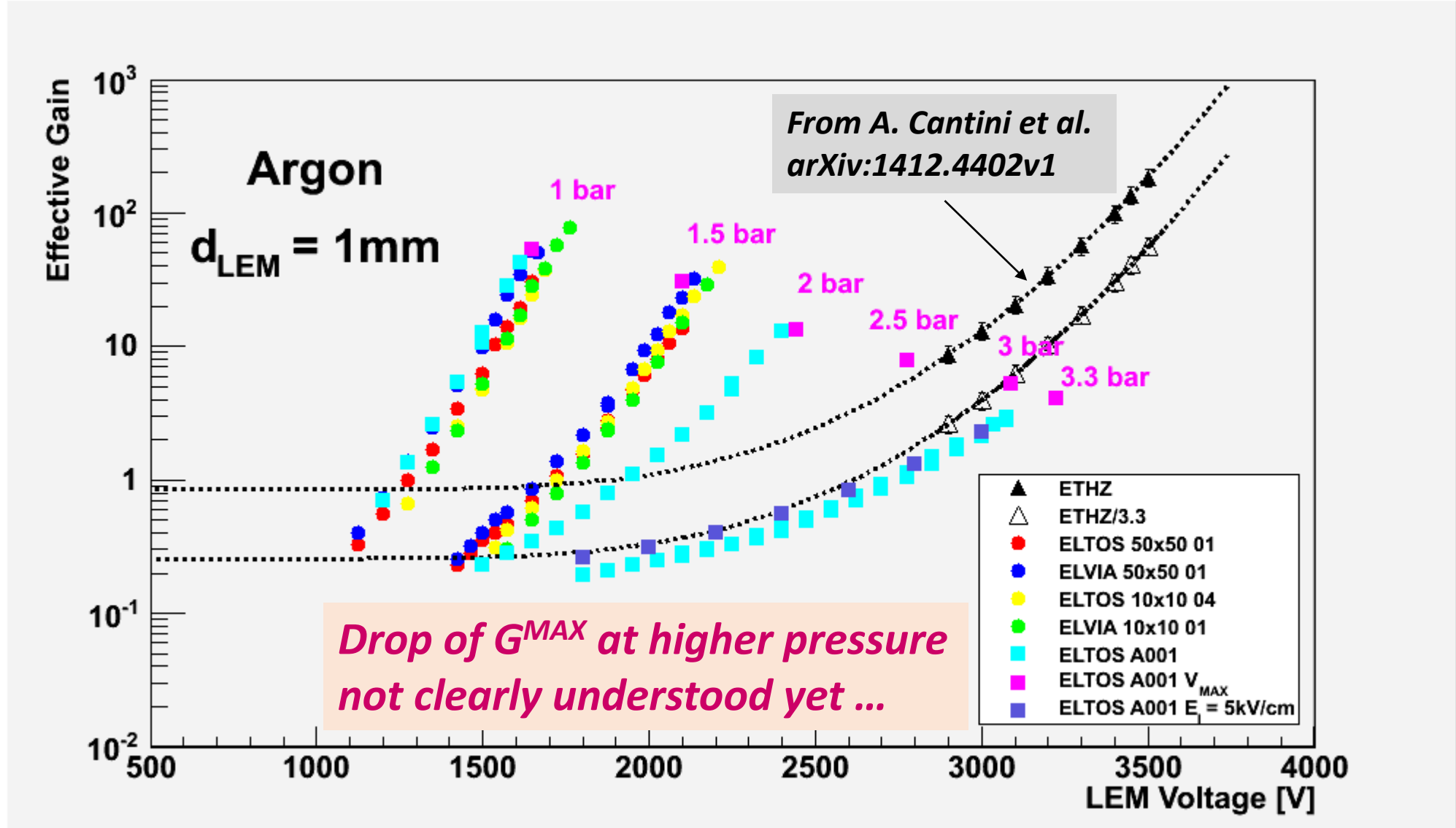


Gain measurements up to 1.5 bar

(Spring 2017)



Gain measurements up to 3.3 bar



HV limitations observed @ 3.3 bar

- Investigate if limitation is due to LEM or experimental conditions :
 - Make sure electrical insulation on HV PCB boards and connections are ok.
 - Reduce source activity by at least $\times 10$ (use $\phi = 1\text{mm}$ collimation) to cope with much denser charge density @ 3.3 bar (charging up time $\sim 24\text{h}$ then).
 - Measure gain curve for 10×10 LEM.

Summary

- LEM production for Saclay by ELTOS has started. Delivery of the first batch of 36 LEMs expected by mid-September.
- Tests of LEM in Ar at @ 3.3 bar in progress with and without source. First gain curve measurements of a 50×50 LEM performed...
- HV limitations at DLAr gas density being investigated.
- Important to check with the 311 which V_{LEM} can be reached.