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STATUS OF 6X6X6 m³ LEM PRODUCTION AND QA/QC PREPARATION FOR ANODE PROCUREMENT BY CEA/IRFU

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WA105 TCn vidyo meeting, january 19th 2018

LEM design	% Active area	LEM borders		Screw holes		HV connections	
		FR4	copper guard ring	FR4 ring Φ	copper guard ring Φ	FR4 ring Φ	copper guard ring Φ
CFR-34	96.2	2 mm	2 mm	4.2 mm	6 mm	10 mm	12 mm
CFR-35	85.8	10 mm	5 mm	10 mm	20 mm	10 mm	20 mm
CFR-36	92.1	2 mm	5 mm	10 mm	20 mm	10 mm	20 mm

CFR-34 design
(42 LEM produced)
96% active area

40+2 LEMs produced
Qualified w/o anode at 3200 V
(10 mn w/o spark)
But unstable operation at > 3200 V with anode

CFR-35 conservative design
85% active area

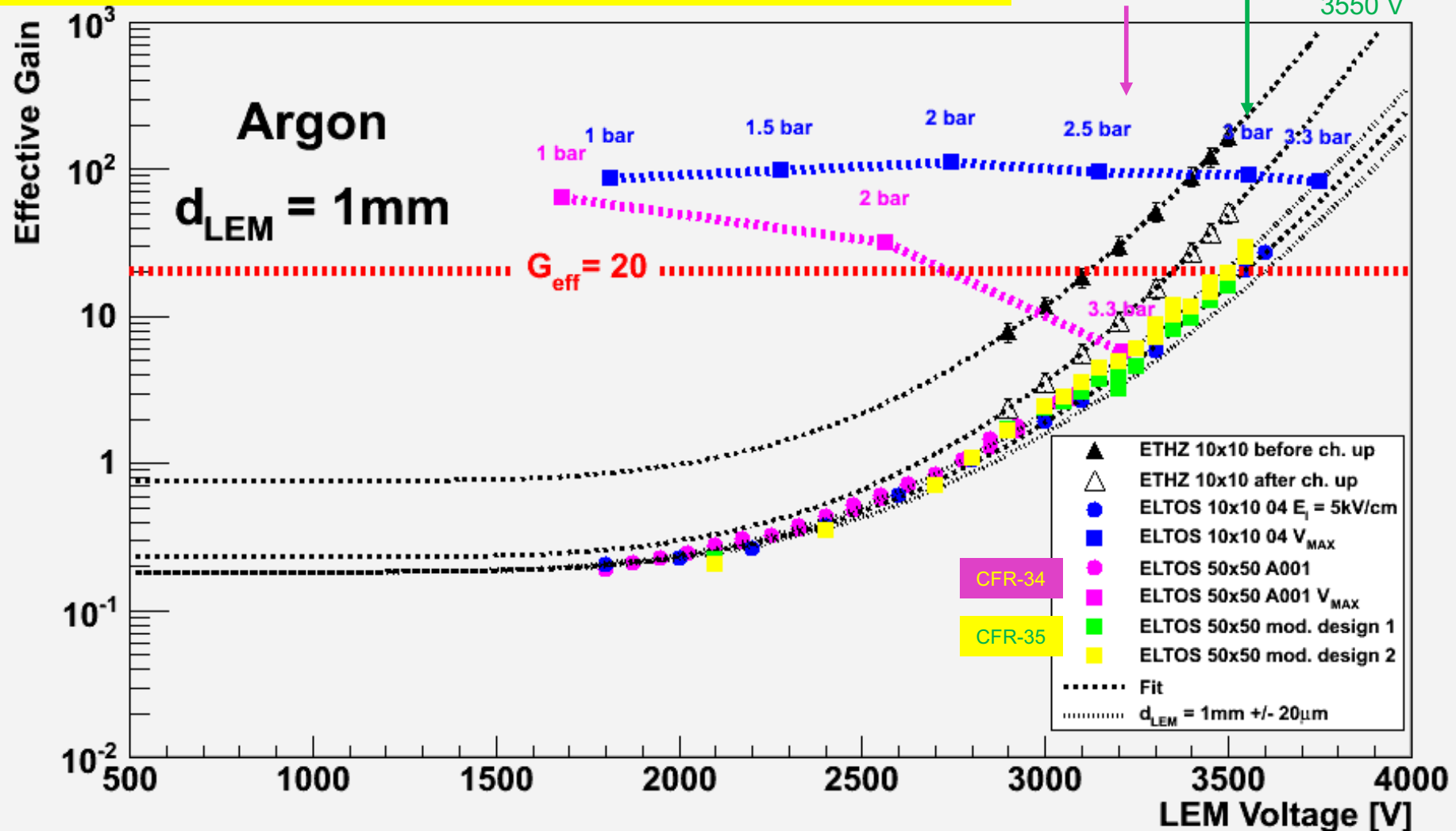
On-going production of 36 LEMs
Increased margin for stable operation at 3200-3400 V

CFR-36 « alternative » design
92% active area

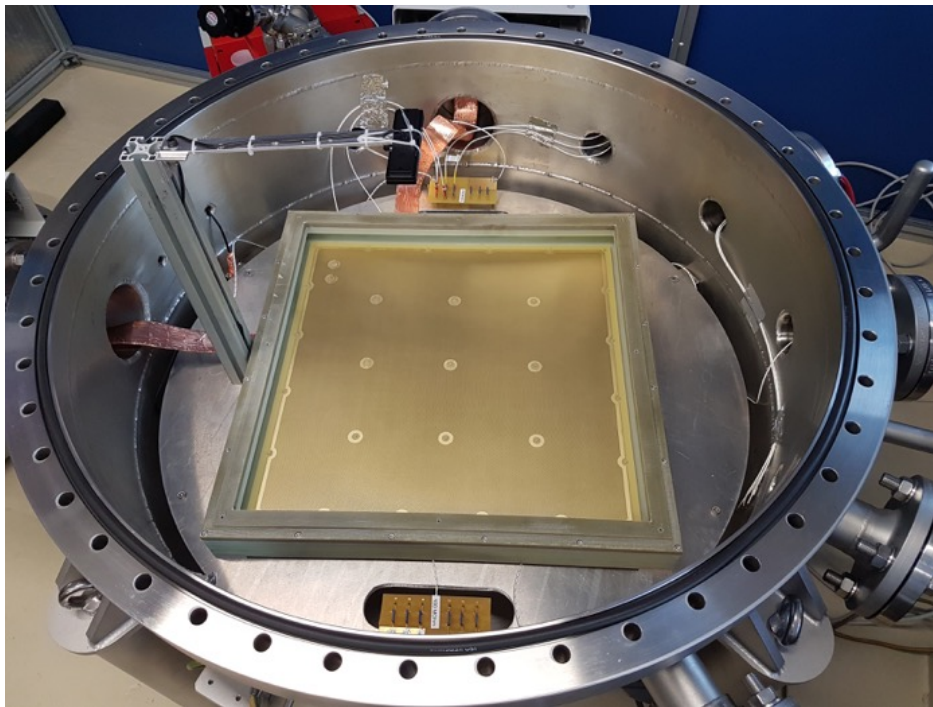
2 prototypes will be delivered next week at Saclay
Same stability as CFR-35 ?

@3200 V: CFR-34 barely maintains HV (few minutes)
 + Anode CFR-35 #1 was operated during 24h with 30 sparks

CFR-34 max HV 3200 V
 CFR-35 max HV 3550 V



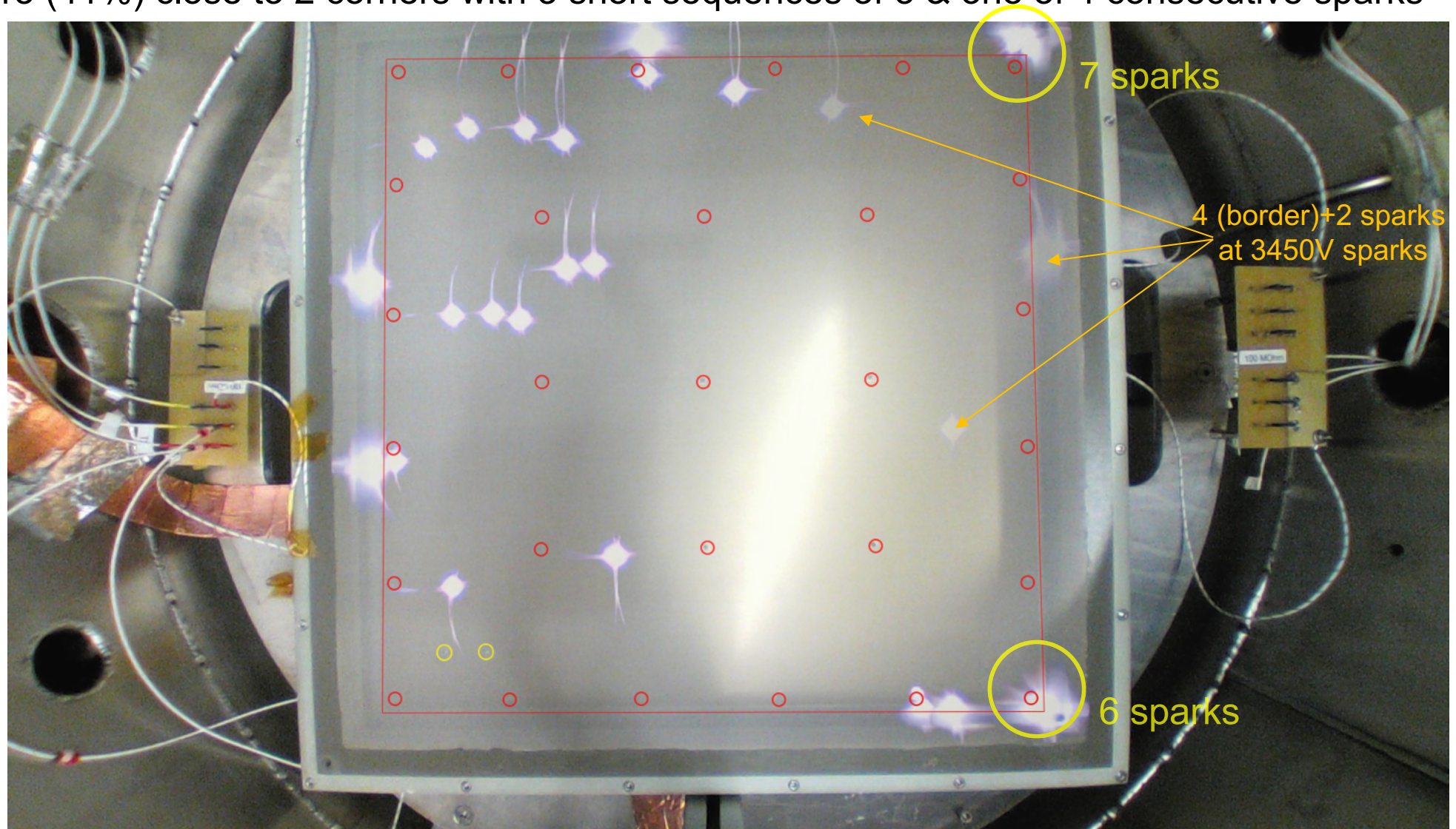
- The wide angle webcam is operational. The **two pre-series LEMs CFR-34 A001 & A002 + anode + drift electric field** were operated at $\Delta V > 3200V$ with a continuous video recording of sparks. Analysis was done by a “manual” (tedious !) scan of the camera recordings with the help of the time stamps taken from the LEM current monitoring Labview files.
- The freeware Video Surveillance software ContaCam is currently tested to detect and selectively record the sparking events and ease the data analysis.



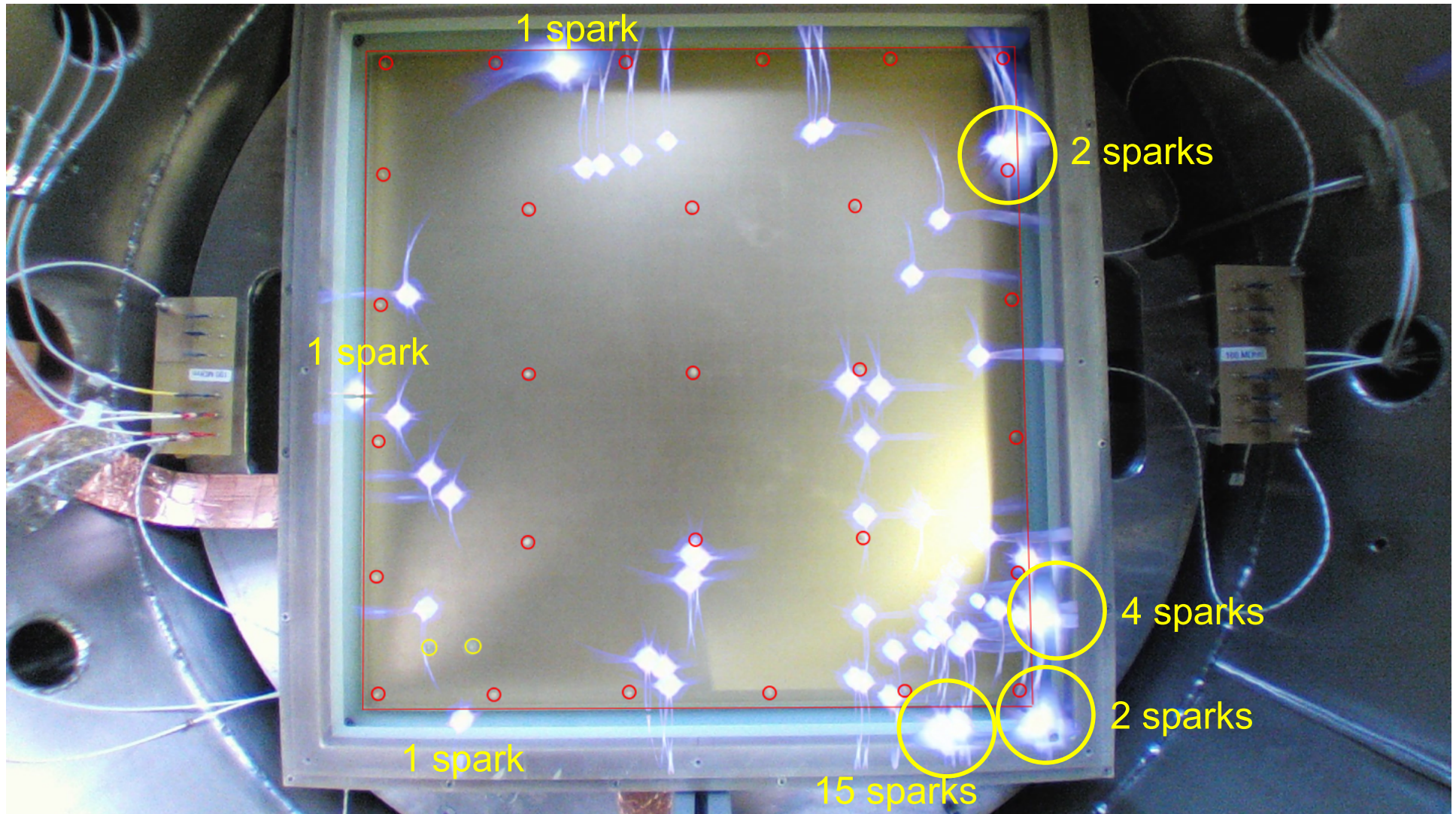
- Sparks are more **often observed close to the borders and corners** and not particularly in the vicinity of the LEM-Anode spacers, nor HV connections.
- Sparks occurring close to corners and borders often trigger **sequences of sparks** every 10-30 seconds during up to 2-3 minutes in the vicinity of the original spark, sometimes leading to the trip of the powersupply (set to do so if the LEM current is above $2 \mu s$ for 50s). This **does not happen for sparks localized away from borders**.

- Next step is the study of spark localization with CFR-35 and CFR-36.

32 sparks : 7 (22%) close to borders, 12 (37%) randomly spread on the LEM active area
13 (41%) close to 2 corners with 3 short sequences of 3 & one of 4 consecutive sparks



67 sparks : 24 (36%) close to borders (with 15 in bottom right), 41 (61%) randomly spread on the LEM active area (with 20 in bottom right) and 2 (3%) in bottom right corner





LEM PRODUCTION STATUS



- 42 CFR-34 design LEMS were delivered (2 pre-series LEMs included).
- 37+2 passed the QA/QC tests in synthetic air and 5.7 Argon @ 3.3 bar absolute pressure.
- ELTOS has 38 raw Panasonic FR4 R-1566W sheets for the remaining 36 LEM production of CEA contract and ordered a new batch of 68 panels expected for delivery end of January.
- Production was resumed for 36 CFR-35 design LEMs to be delivered by end of February. Batch #8 (LEM A005-A050) will be delivered next week.
- ELTOS sent his quotation to CERN for a production of 36 more LEMs. Conditions are the same as the ones of CEA contract with a production rate of 6 LEMs per week.
- The HP vessel could be filled with up to 9 LEMs with a modification of the LEMs assembly. We will receive next week the mechanical parts to test this new setup.

A. Delbart (CEA) / S. Mazzi (ELTOS)
last update date 15 December 2017 by S.Mazzi

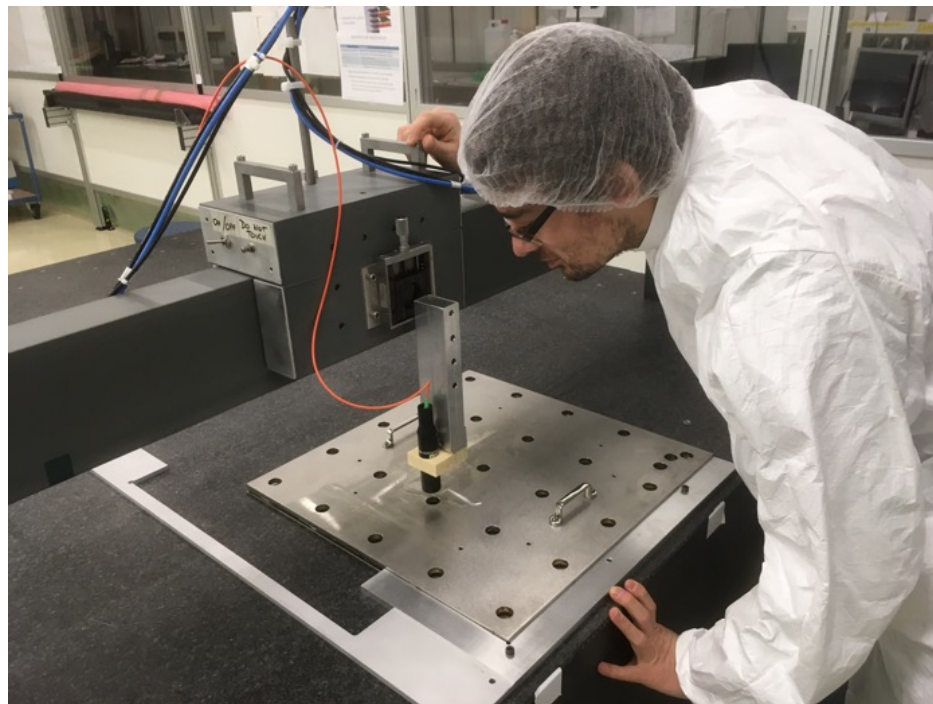
Batch#	LEM S/N	shipment to CEA	ELTOS QA/QC	QA/AC at saclay	delivered	qualified	QA/QC comments comments
0	A001-A002	23 June 2017	26 June 2017	passed (08/04/2017)	2	2	A002 needed 2 cleaning-drying-HV QC
1	A003-A008	02 August 2017	04 August 2017	6 LEMs OK	6	6	A003,A006 A008 needed second cleaning-drying-HV QC
2	A009-A014	scheduled 28 august	28 August 2017	6 LEMs OK	6	6	A009 repaired by ELTOS. Global "drop" of "visual" quality A011, A012 needed second cleaning-drying-HV QC
3	A015-A020	11 September 2017	5 LEMs 11/09/2017	5 LEMs OK	5	5	"visual quality" is good. A016 needed 2 HV QA/QC
4	A021-A026	11 September 2017	5 LEMs 11/09/17 & 1/11/17	4 LEMs OK	5	4	"visual quality" is good.
5	A027-A032	19 September 2017	6 LEMs on 19/09	6 LEMs OK	6	6	
6	A033-A038	19 September 2017	5 LEMs on 19/09	6 LEMs OK	6	6	A037 : a gold deposit on a border / A038 : a suspicious mark
7	A039-A044	07 November 2017	6 LEMs on 07/11	6 LEMs OK	6	4	

Production Paused. Resuming of the production decided on dec 14th 2017 with NEW gerber CFR-35 (LEM A018 & A025 will not be produced)

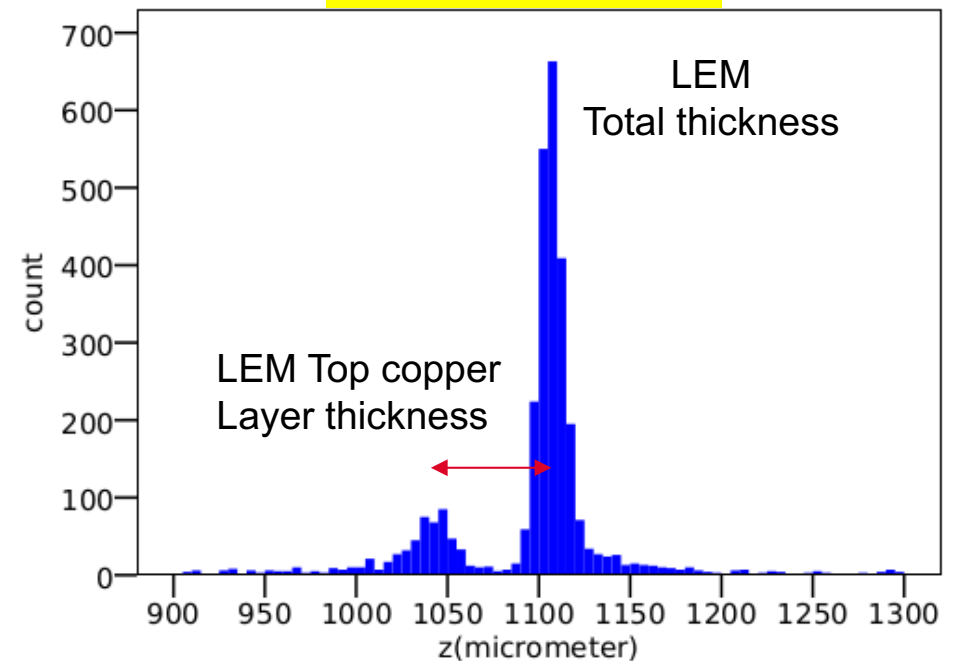
8	A045-A050	scheduled 15 January 2018	delay to January 22		6		
9	A051-A056	scheduled 22 January 2018			6		
10	A057-A068	scheduled 29 January 2018			12		
11	A069-A080	scheduled 05 February 2018			12		

- Anode gerber files (CERN-1359) were validated in June 2017 for the order by ETHZ of 80 anodes to ELTOS. Technical specifications (gerber files, PCB stack, QA/QC) were fixed to cope with both ELTOS and ELVIA requirements. Q/C by the manufacturer are standard ones driven by the IPC A-600 2 (including A.O.I and electrical continuity measurements). Q/C of KEL soldering connections is done by WA105 thanks to the test bench provided by CEA/Irfu.
- We add two QC requests to the manufacturers :
 - measurement of the anode dimensions which should be $499.5 -0/+0.1$ mm : to prevent the cutting of active strips which are located at $60 \mu\text{m}$ from the borders and to cope with the mechanical tolerances of the anode integration on the CRP
 - measurement of the deflection of the anode in the center to be less than 1 mm
- We have the quotations (Anode + KEL connector soldering) of both ELVIA and ELTOS. Offers are within 10%. Delays are 30-41 working days (for 40 anodes).
- We will get the quotation from the OUESTRONIC (France) company next week.
- We plan to place an order for 40 anodes by the end of the month for a delivery by end of April. A second order of 40 LEMs will be placed mid March.

- Total LEM thickness is measured on the 4 corners of the LEM and on 2 metallographic sections by the LEM manufacturer. In order to check LEM thickness uniformity, we are tuning an optical test bench for the scan of 25 x 3 cm² locations over the LEM surface.
- LEM is flattened on an optical table with a stainless steel plate. The optical beam reflections through the LEM holes, on the LEM top copper surface and on the LEM top FR4 surface are used to derive the reference optical table surface elevation, the total LEM thickness and the LEM top copper layer thickness. First tests were done with a LEM prototype.



Scan through one hole of 3 cm²

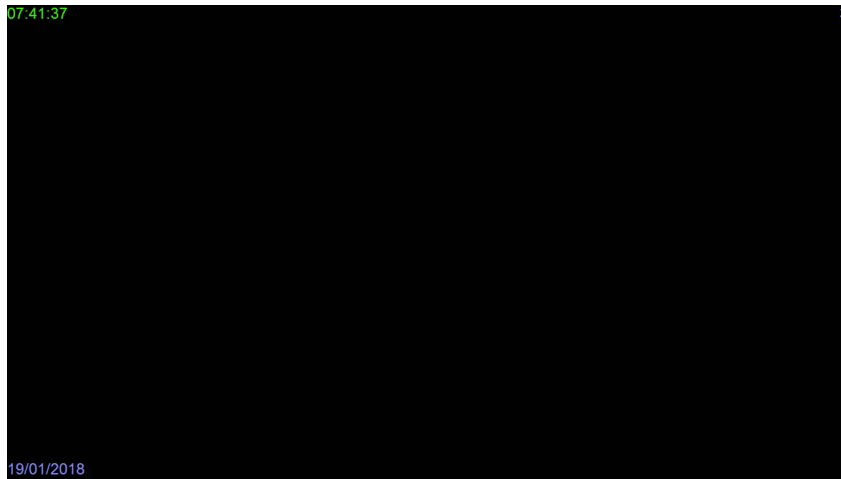


- LEM production at ELTOS was resumed for an expected delivery of 36 CFR-35 LEMs by the end of february. First batch A0045-A050 will be delivered next week.
- The HP vessel is equipped with a camera. Recording of the sparking locations in pure argon @ 3,3 bar for two CFR-34 LEMs operated at $\Delta V=3400-3500V$ was done. Sparks are more often observed close to the borders and corners.
- Localization of sparks on CFR-35 and CFR-36 prototypes will be done the next 2 weeks before the resuming of the QA/QC of the WA105 LEMs.
- The High-Pressure vessel used for QA/QC of the LEMs in Argon at 3.3 bar has room to qualify a tower of 9 LEMs in one run. This upgrade from 6 LEMs will be tested next week and should increase the QA/QC rate to 9 LEMs per week.
- We will select next week a PCB manufacturer to place an order for 40 anodes (+ KEL connector soldering) which should be delivered by the end of april.
- An optical test bench is under development for LEM thickness measurements and could be used to check the LEM thickness uniformity of the next produced LEMs.

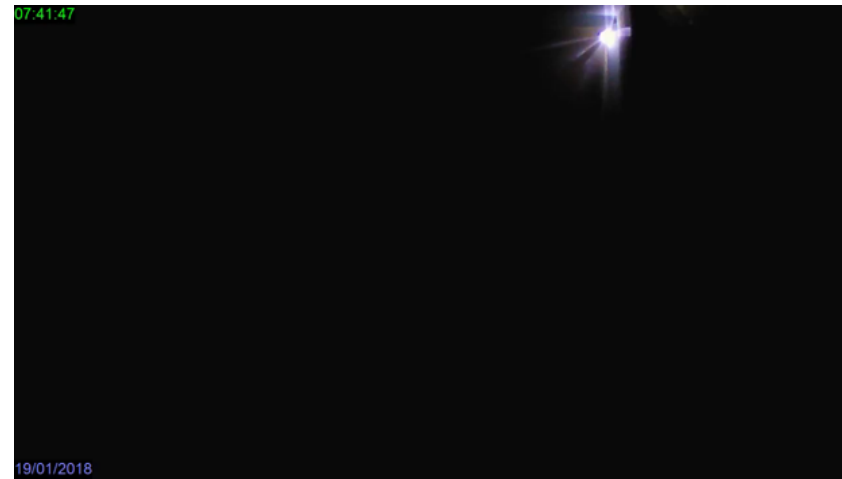
BACKUP : ON-GOING TEST WITH 55FE SOURCE

Detection of a spark with ContaCam recording software (A001+anode+cathode+55Fe)

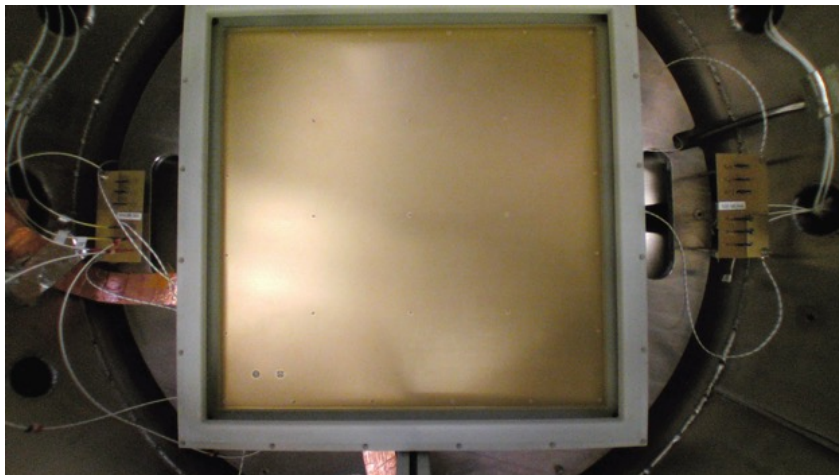
Automatic detection and recording of a spark



The detected spark



Reference position of the A001 LEM



Setup with cathode and 55Fe

