

## Gaseous detectors Task 13.4.7 : **MPGD detectors to industry**

Preparation for large series production: standard production protocols of optimized MPPGD components to ease technology dissemination

(project leader : Fabien Jeanneau)

**MS84 (M36) PROTOCOLS AND SPECIFICATIONS FOR MPPGD PRODUCTION AND QUALITY CONTROL**

## Gaseous detectors Task 13.4.2 **Resistive anode Micromegas**

Preparation for large series production: procedures and tools for large series resistive micromegas anodes

(project leader : Stephan Aune)

**These two tasks are very interrelated.**

*Thanks to D. Attié, S. Aune, A. Delbart, E.Dumas, F.Jeanneau, M. Kebbiri, E. Mazzucato, M. Mur*

Initial motivation in 2014-2015 : Production of large Micromegas detectors for NSW (ATLAS muon chambers)

CERN workshop, though upgraded –for prototyping– in AIDA, is not sufficient to produce the 1200 m<sup>2</sup> of chambers needed for ATLAS New Small Wheel.

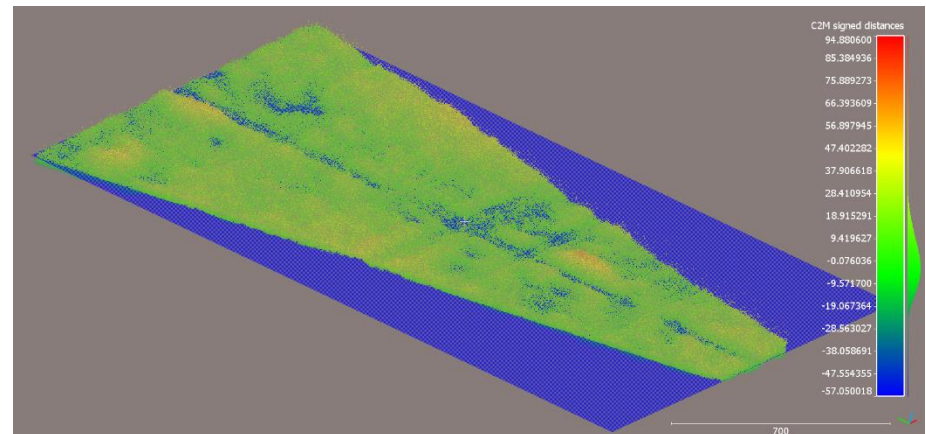
QC/QA of base elements from ELTOS and ELVIA done at CERN (bdg 188, see report in second annual meeting)

Assembly of the chambers in 4 labs in Germany, France and Italy.



Granite table for planéité measument

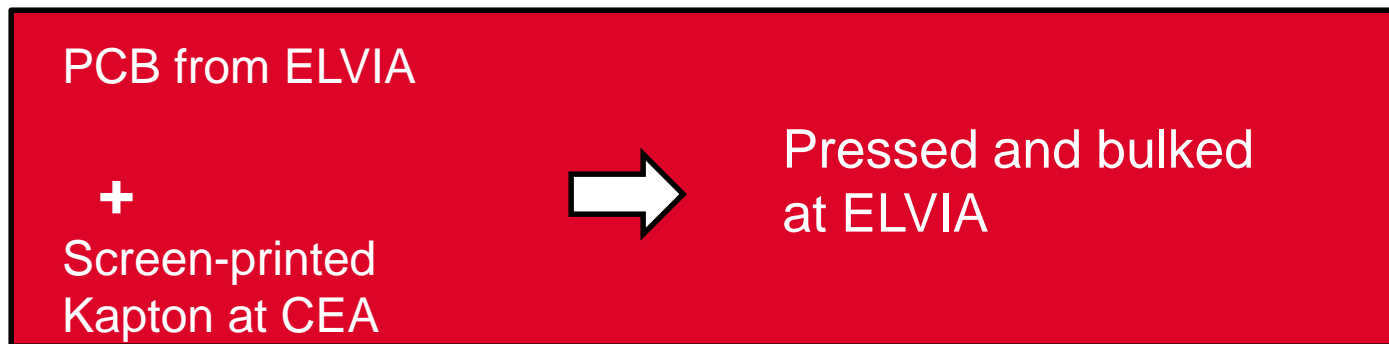
z within 1 $\mu$



500x500 mm<sup>2</sup> resistive Micromegas produced for muon densitography (for Security, Cultural Heritage, and industrial applications). Screen-printing at a pitch of 500 μm on kapton now used at CEA to improve the resolution by charge sharing.

## Bulking at CERN and Industry

In 2016-2017, 40 large bulk Micromegas have been built: 20 at CERN and 20 at ELVIA. Steady improvement of ELVIA quality.



In 2018, 40 more resistive bulks will be produced at ELVIA, 20 with screen printing and 20 with DLC. Small issues on pressing dispersion (depending on the position in the pile-up?)

## Many applications

- Homeland security
- Scan pyramids and other ancient graves
- Muo-graphy of stones
- Control of concrete buildings
- Mining
- ...



But still a market has to be found to make industrial production cost-effective

LEMS / THGEMs ARE MPGDs USING PCB DRILLING TECHNOLOGY : HOLES ARE DRILLED IN A FR4 PANEL BETWEEN 2 COPPER LAYERS.

THE MOST DELICATE FEATURE IS A RIM AROUND EACH HOLE, WHICH HAS TO BE WIDE ENOUGH TO PREVENT DISCHARGE TRIGGERING, AND NARROW ENOUGH NOT TO AFFECT TOO MUCH THE AMPLIFICATION FIELD IN THE HOLE.

A CAREFUL SANDING DOWN IS NECESSARY TO TRIM ANY POINT TRIGGERING DISCHARGES

80 50x50 cm<sup>2</sup> LEMs are to be produced for the demonstrator for DUvE (neutrino long baseline experiment) and tested at Saclay under pressure

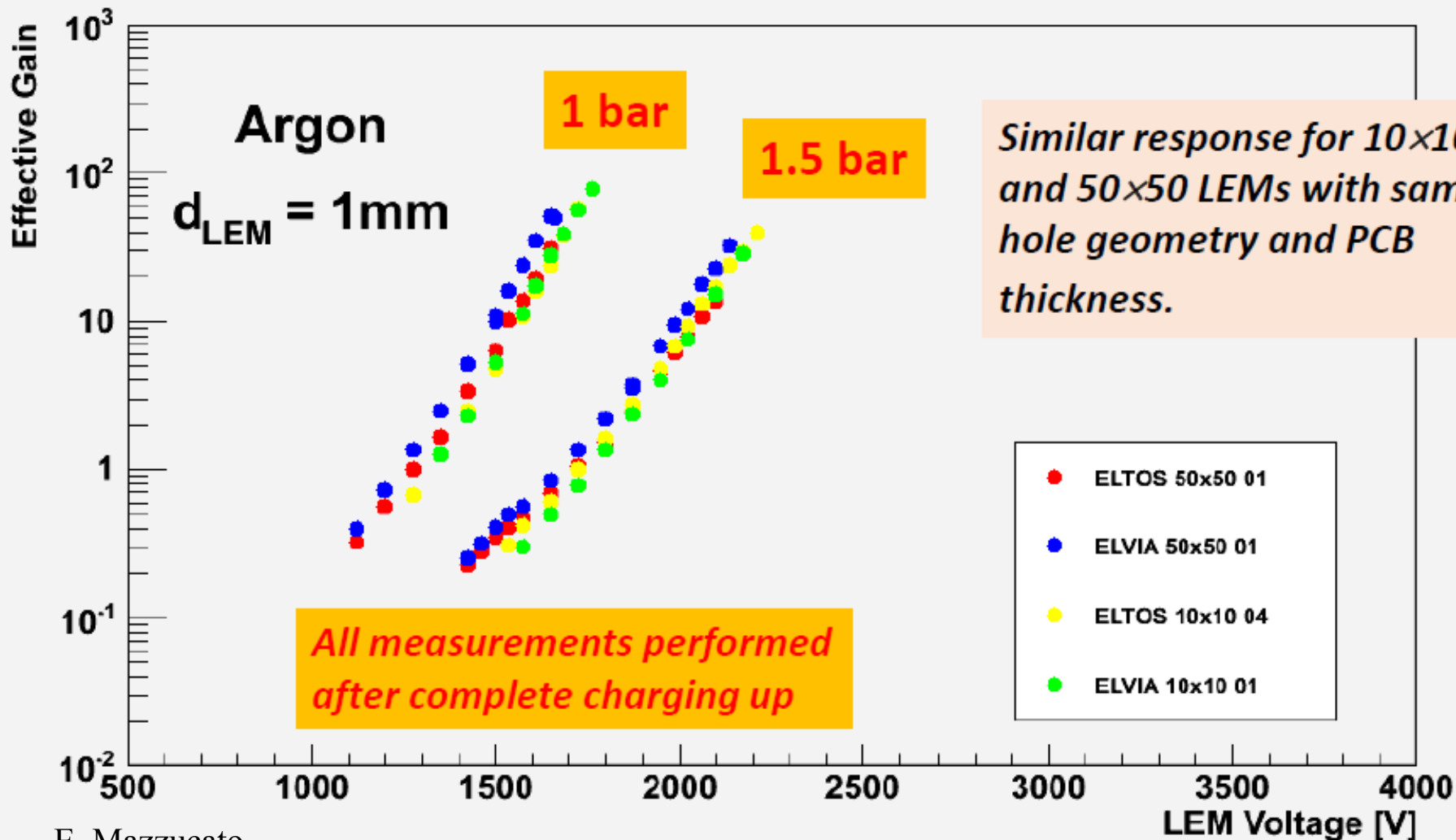
CEA/ Irfu is in charge of procurement and validation of half of the 144 LEMs necessary for the 6x6x6 m<sup>3</sup> prototype of Dune. All the infrastructures necessary for the preparation and tests are available at Saclay (cleaning, baking, polymerization, metrology, etc...)

A high-pressure chamber has been built to perform LEM tests in argon at the same gas density as in the experiment (3300 hPa at room temperature).

LEM production started in July 2017 (contract with ELTOS for 78 LEMs)



(Spring 2017)



E. Mazzucato

- On PCB (halogen-free FR4) for piggy-back readout
- On 50  $\mu\text{m}$  kapton : bulk Micromegas on HN kapton (done at Saclay)
- Attempts to screen-print thin layers of insulators.
- Study of insulator + resistive paste mixing for High-Resistivity pasts



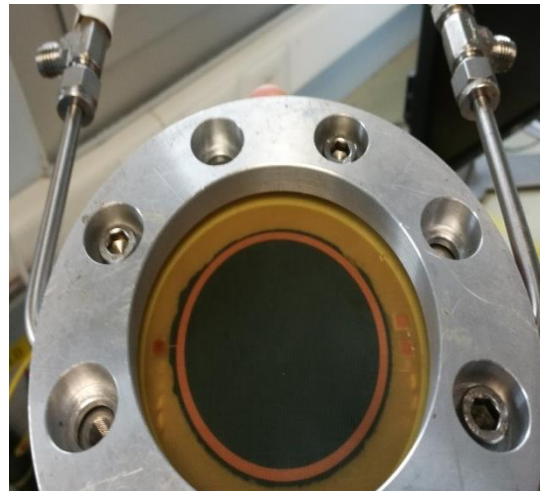
## CALISTE PROJECT

S. Aune, M. Kebbiri

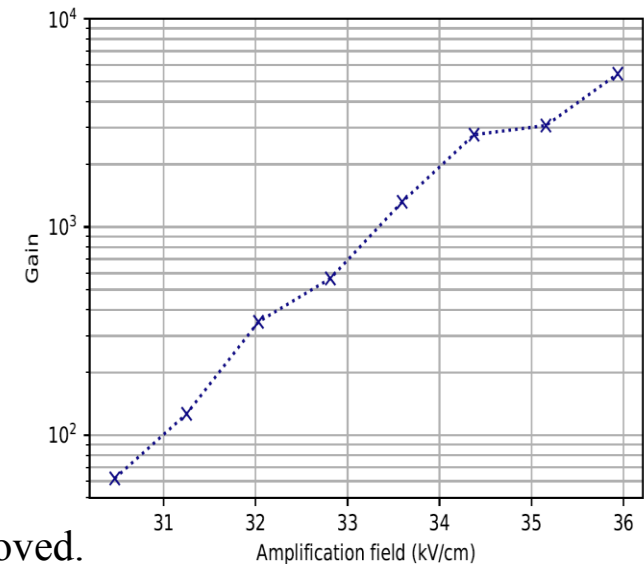
- RESISTIVE LAYER ON THIN FR4 IN PIGGYBACK MICROMEAS  
pixel readout not on collection PCB = easy exchange of resistive layer with same readout
- RESISTIVE SCREEN PRINTING ON 200MM, 400 MM, 800 MM -THICK PCB WITH SEVERAL RESISTIVITIES. (TEST ON-GOING)



Bulk micromegas  
(resist. layer under the mesh)



In setup, from below, readout removed.  
(resistive layer visible through thin PCB)

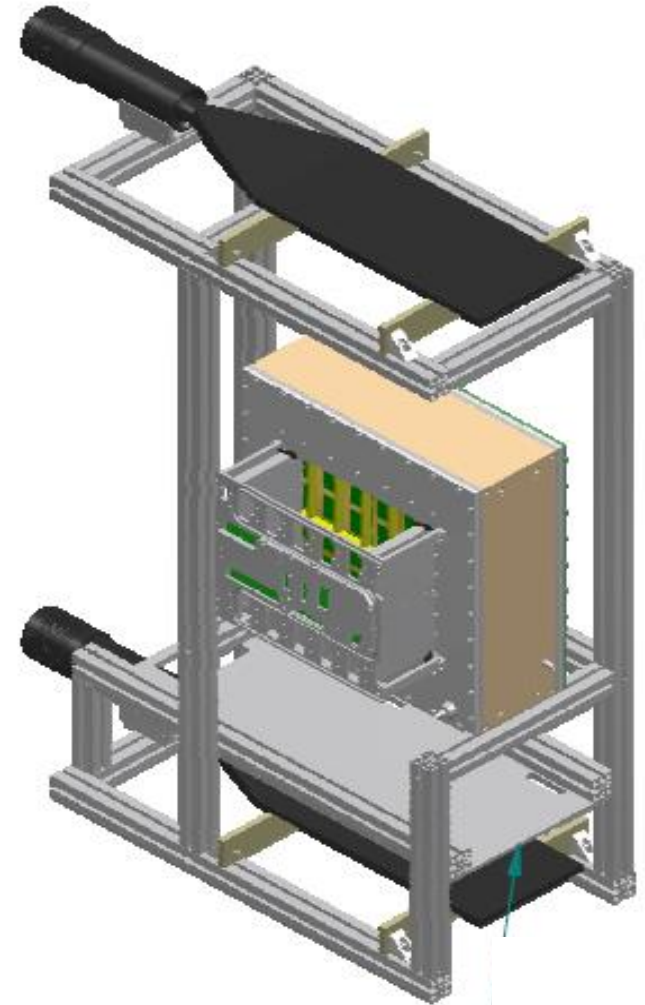


First gain curve

THE T2K UPGRADE PLAN IS TO ADD 2 NEW TPCs READ OUT WITH ENCAPSULATED-RESISTIVE-ANODE MICROMEGAS IN REVERSE GROUNDING SCHEME .

THIS ALLOWS IMPROVING THE RESOLUTION WHILE LOWERING THE COST AND CONSUMPTION.

A DLC DETECTOR HAS BEEN MADE (2.5 MOHM/SQ) AND A 400 KOHM/SQ IS ORDERED TO BE-SPUTTER COMPANY (VISIT IN 10 DAYS IN KYOTO)



VERY INTENSE ACTIVITY, IN FULL SYNERGY WITH SEVERAL ACTUAL PROJECTS

REMAINING ISSUES (SOLUTIONS IN PROGRESS)

- CLEAN CONDITIONS FOR PRODUCTION (IDEALLY CLEAN ROOMS WOULD BE NEEDED)
- PRESSURE DISPERSION AT THE PRESSING STAGE
- CONDITIONNING PROCEDURE ('BURNING') FOR RESISTIVE MICROMEGAS TO BE ELABORATED AND TRAINED
- THGEM/LEM PERFORMANCES CLOSE TO NOMINAL AT ELTOS AND ELVIA (COMMERCIAL ISSUES)

MILESTONE MS84 BEING WRITTEN

Budget Status :

Spent in P1 (1/5/2015 → 31/10/2016) : 25100 €

Spent in P2 (1/11/2016 → 30/4/2018) : 22500 €

Remains for WP13.4.2 and 13.4.7 for procurements 31200 €.

This can be enough for 2 more years, as a large part of the procurements is done (base material, resistive paste, tooling...)

A lot remains to be done, as new ideas come during the work:

- continue to work with ELTOS and ELVIA
- explore new structures (with resistive materials, insulators and conductors)
- Explore more DLC providers, go to lower resistivity, study aging and robustness

**ALL THIS CALLS FOR AN EXTENSION BY ONE YEAR. IT IS ESSENTIAL TO KEEP THE COMMUNITY TOGETHER**