HYBRID COSMIC RAY DETECTOR

Detector: R&D and Performance

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OUTLINE

- INTRODUCTION
- DESIGN & CONSTRUCTION
- CHARACTERIZATION
  - *Counts as function of voltage supplied*
  - *Counts as function of gas differential pressure*

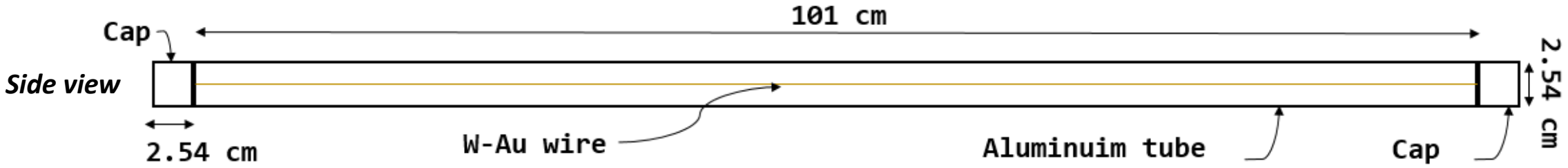
  - ***Ionization***
  - ***Cherenkov light***
- COSMIC RAYS FLUX MEASUREMENTS
- CONCLUSIONS

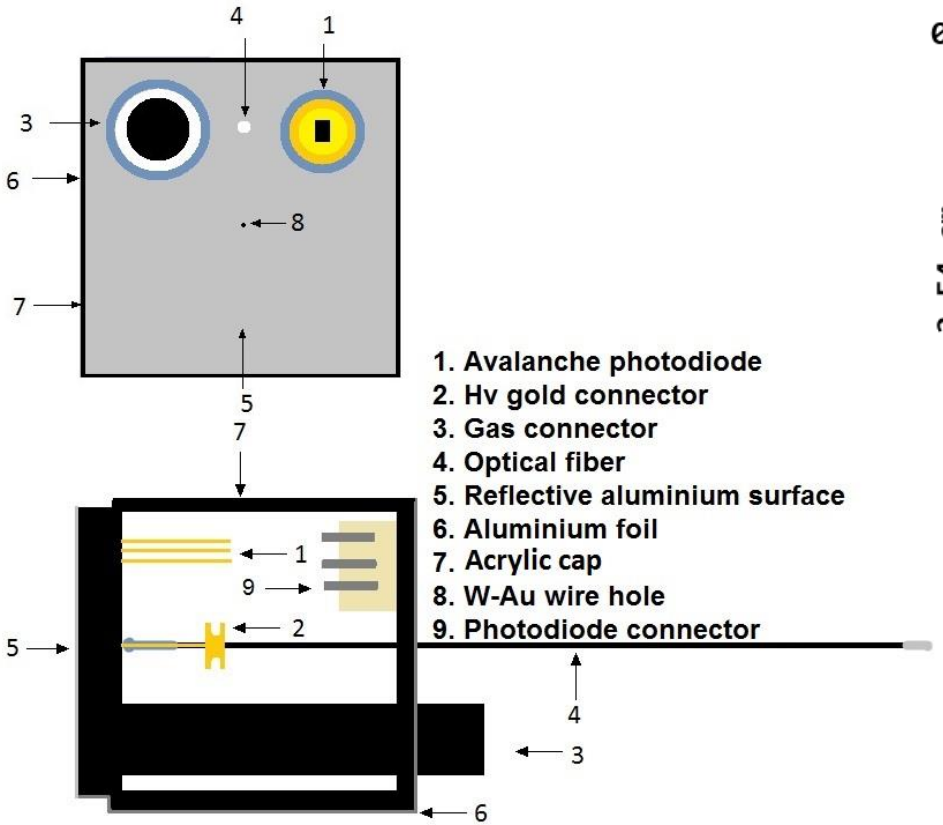
INTRODUCTION

- Here is a four channels ***Hybrid Cosmic Ray Detector*** that combines **Cherenkov light** and **Ionization** detection operating simultaneously in a gaseous medium of **90%Ar + 10% CH_4**, for teaching and research purposes.

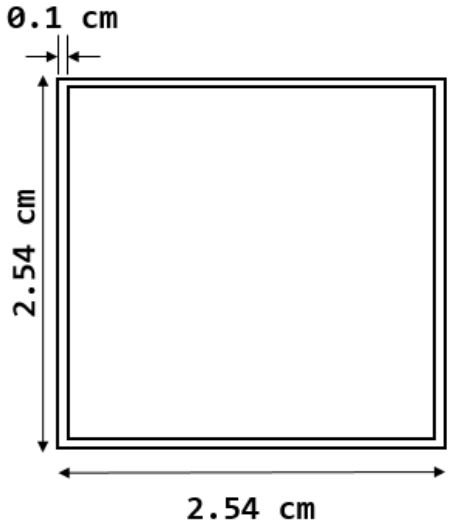
- It is a basic cell to build a larger Hybrid Cosmic Ray Detector.

DESIGN & CONSTRUCTION

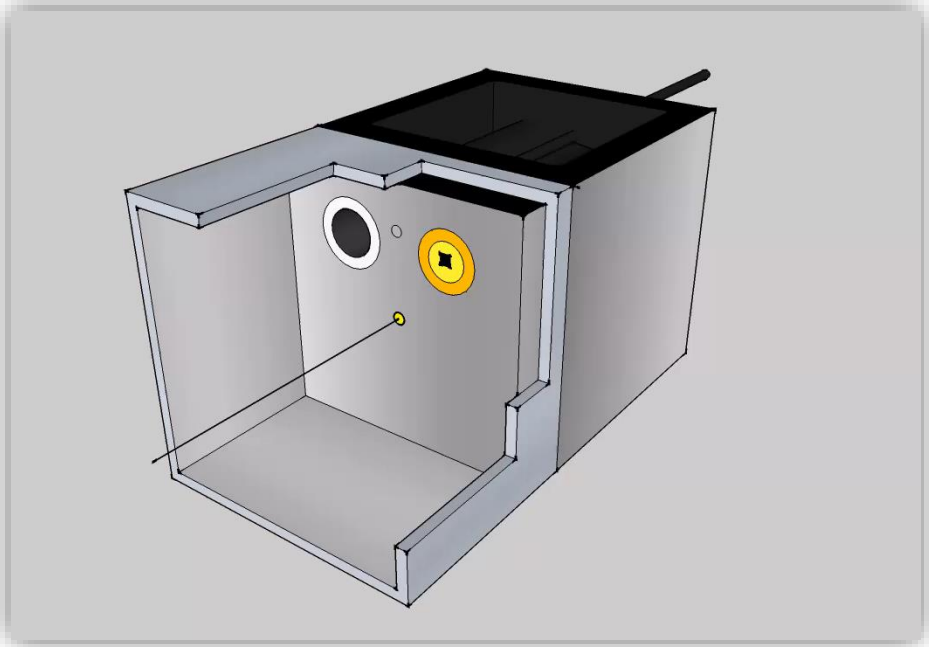




Cap design front and bottom view

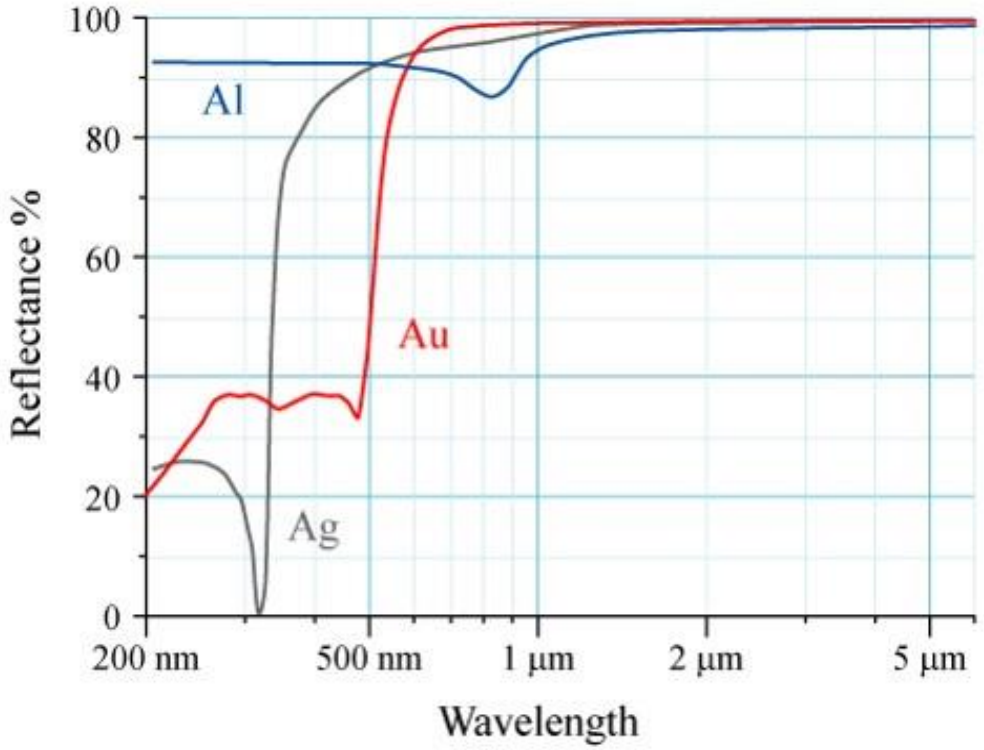


Cross section Aluminium tube view

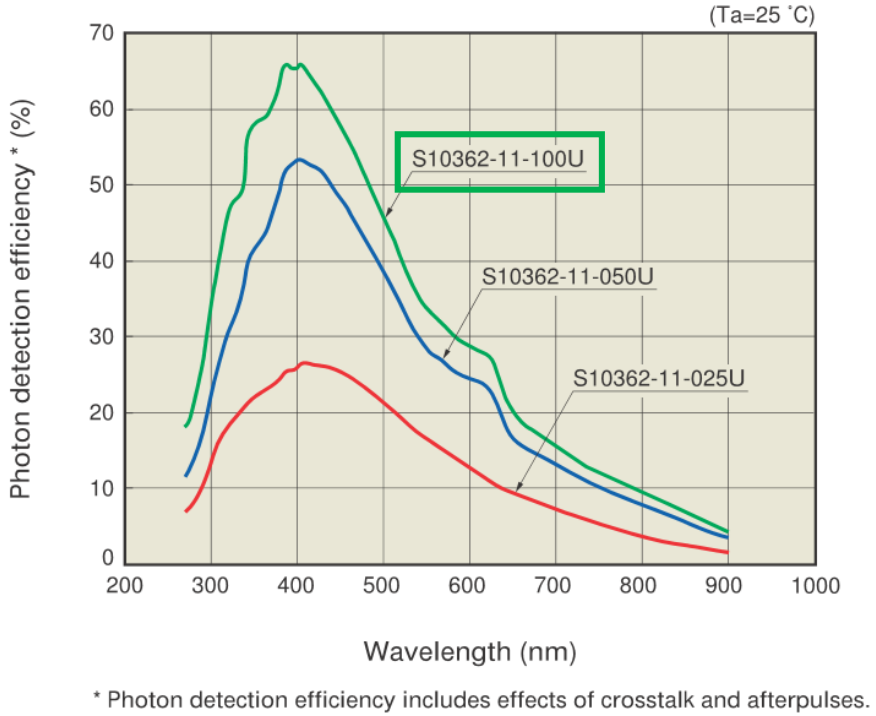


Cap detail into the Aluminium tube

DESIGN & CONSTRUCTION



a) Aluminium's reflectance [1].



b) Photon detection efficiency vs wavelength for S10362-11-100U photodiode [2].

[1] M. Bass, E. W. Van Stryland, D. R. Williams, and W. L. Wolfe, Handbook of optics, vol. 2. McGraw-Hill New York, 2001. U.S.

[2] Hamamatsu, "Mppc multi-pixel photon counter s10362-11-100u datasheet." http://www.datasheetlib.com/datasheet/707356/s1036211-100uhamamatsu−photonics.html,Jan2008.

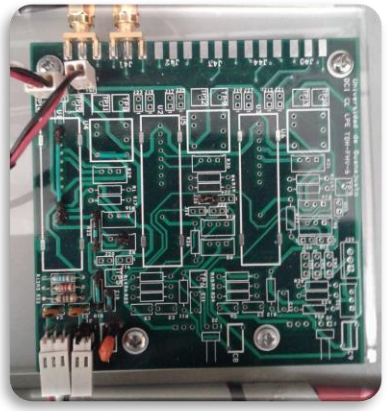
DESIGN & CONSTRUCTION

Assembling

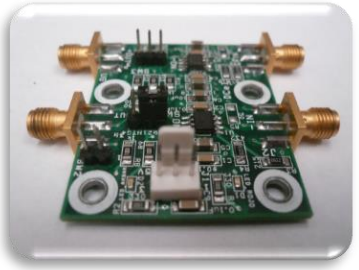
Tube Inside polished to mirror

Hybrid cosmic ray detector assembled

Electronic boards and Data Acquisition System



Read-out electronic boards

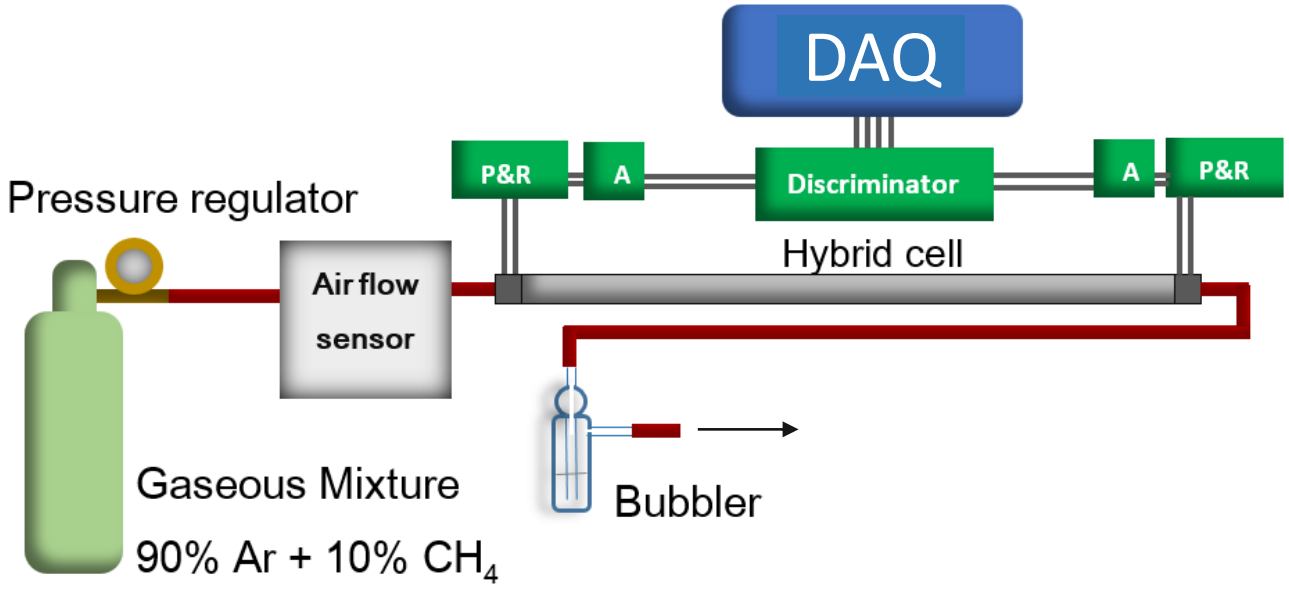


Discrimination, amplification and Gas-sensor electronic boards

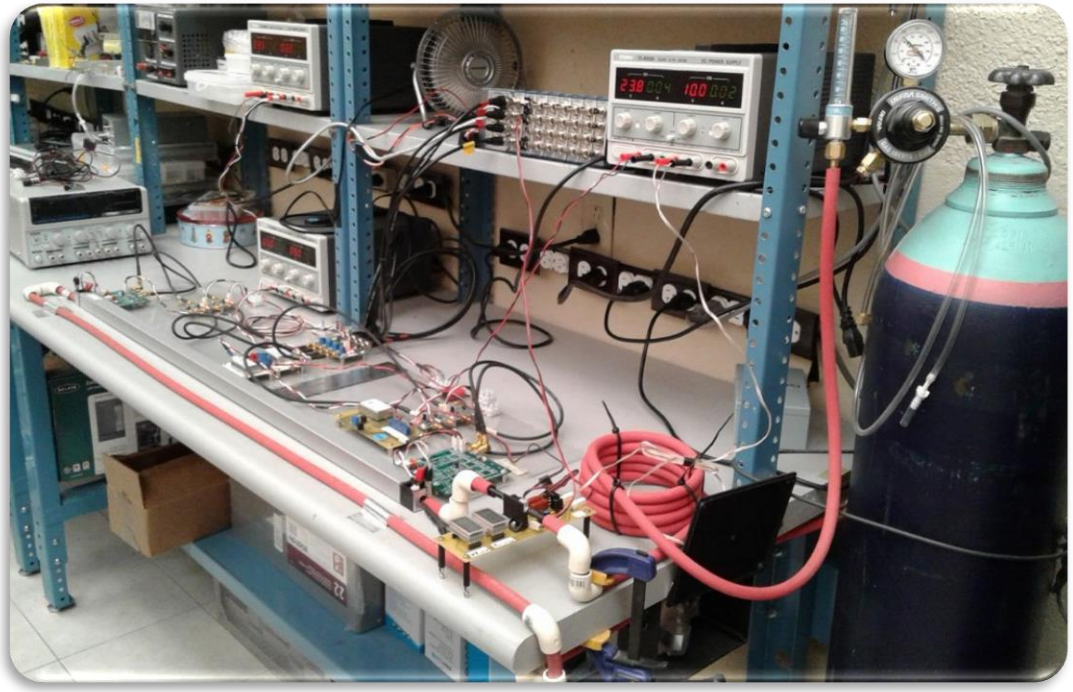
Data acquisition system CompactRIO by NI 40 MHz

DESIGN & CONSTRUCTION

Experimental System



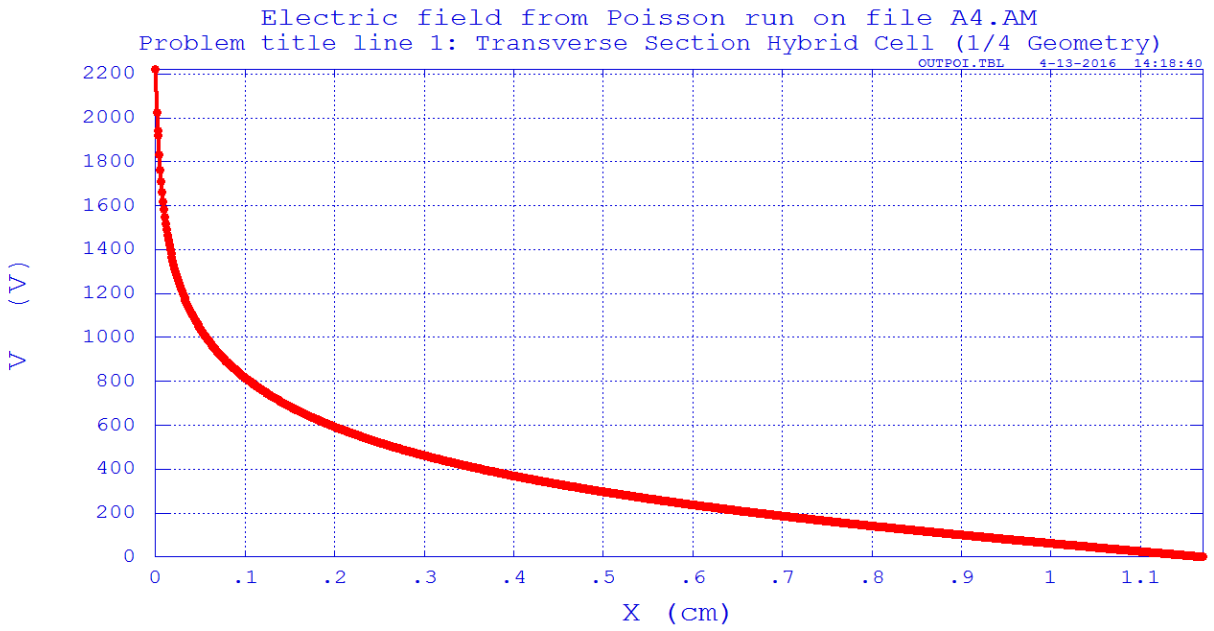
Experimental system connection diagram.

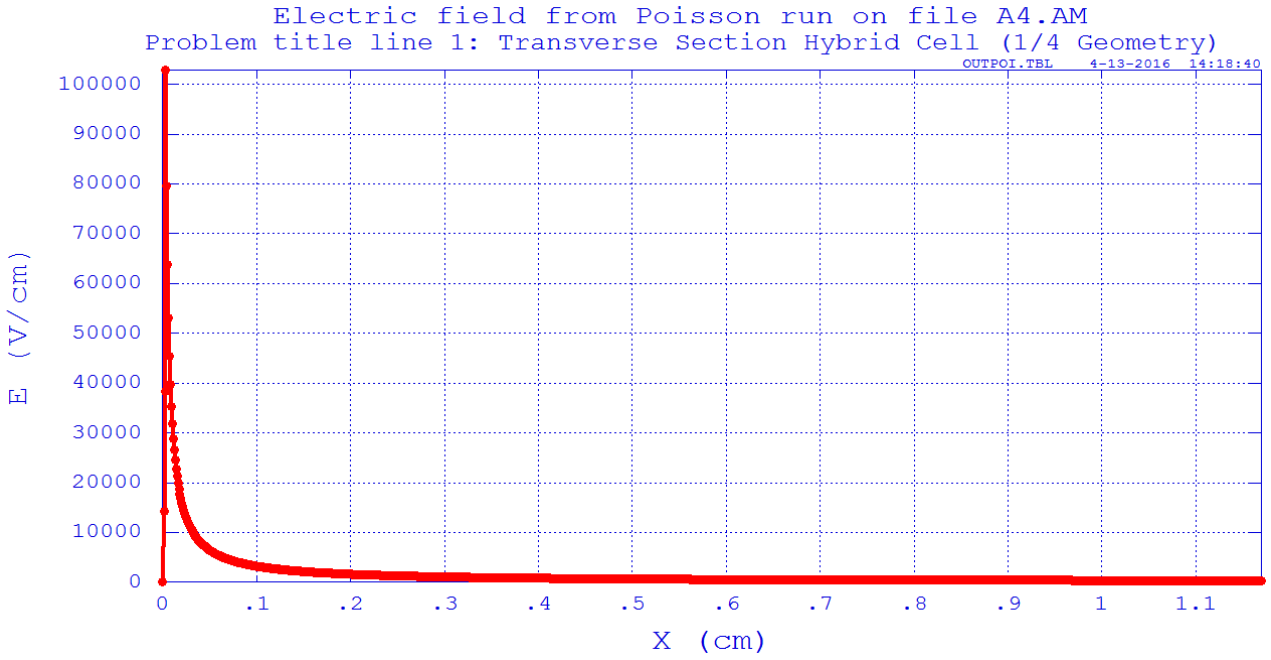


Experimental system at Laboratorio de Partículas Elementales of the División de Ciencias e Ingenierías , León, Mexico.

DESIGN & CONSTRUCTION

Electric field simulation by Poisson Superfish [3]

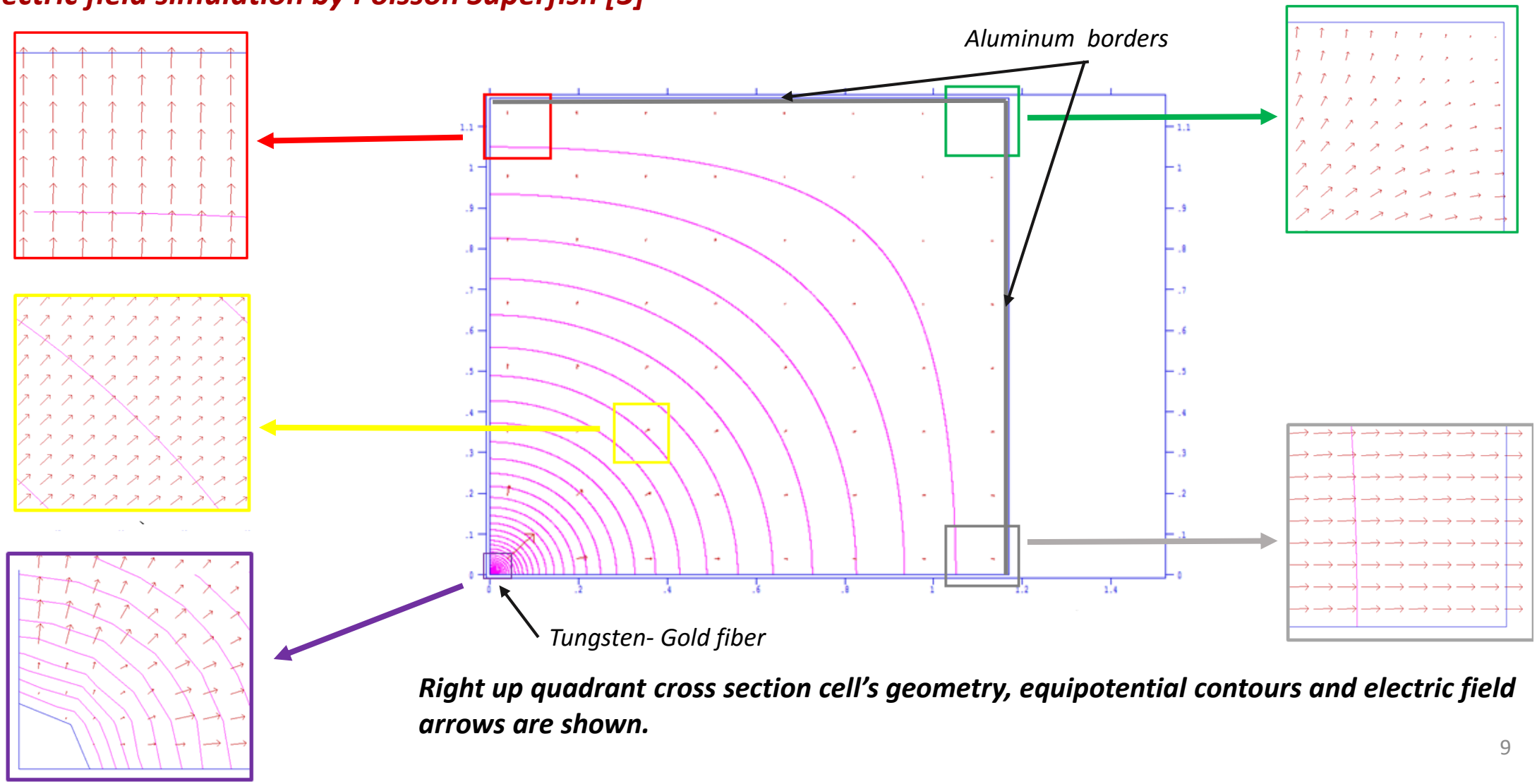




[3] M. Menzel and H. K. Stokes, “Users guide for the poisson/superfish group of codes,” tech. rep., Los Alamos National Lab., NM (United States), 1987.

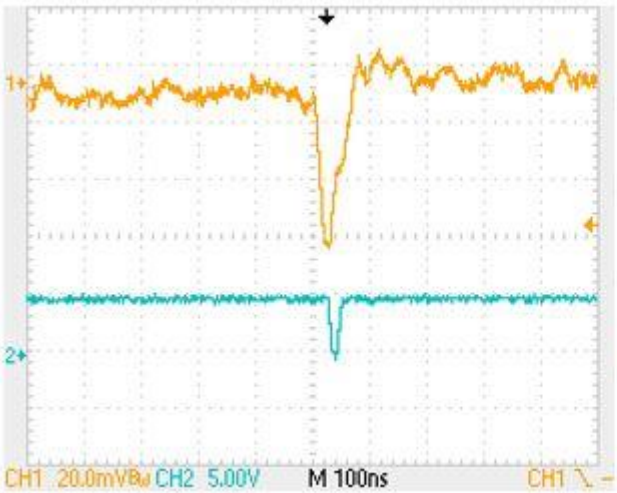
DESIGN & CONSTRUCTION

Electric field simulation by Poisson Superfish [3]



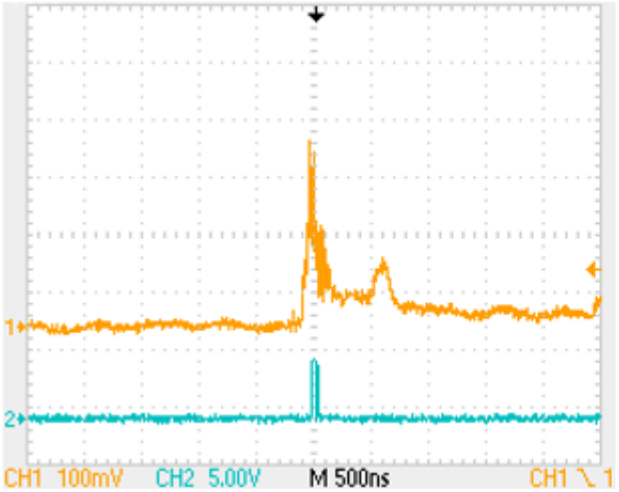
Right up quadrant cross section cell's geometry, equipotential contours and electric field arrows are shown.

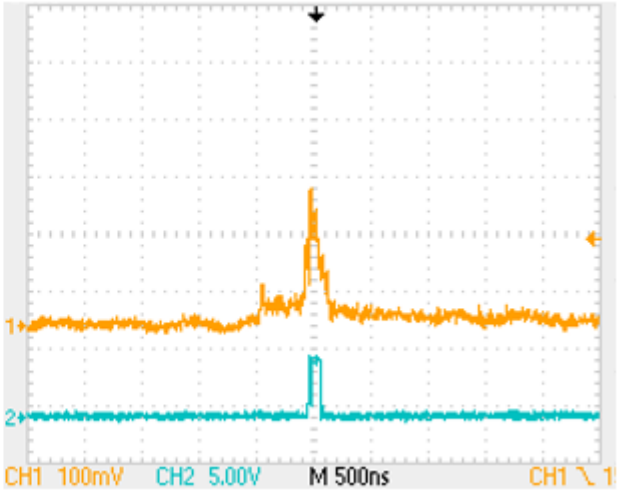
CHARACTERIZATION



OUTPUT SIGNALS

Cherenkov channels output signals
60 mV amplitude and duration of 50 ns.

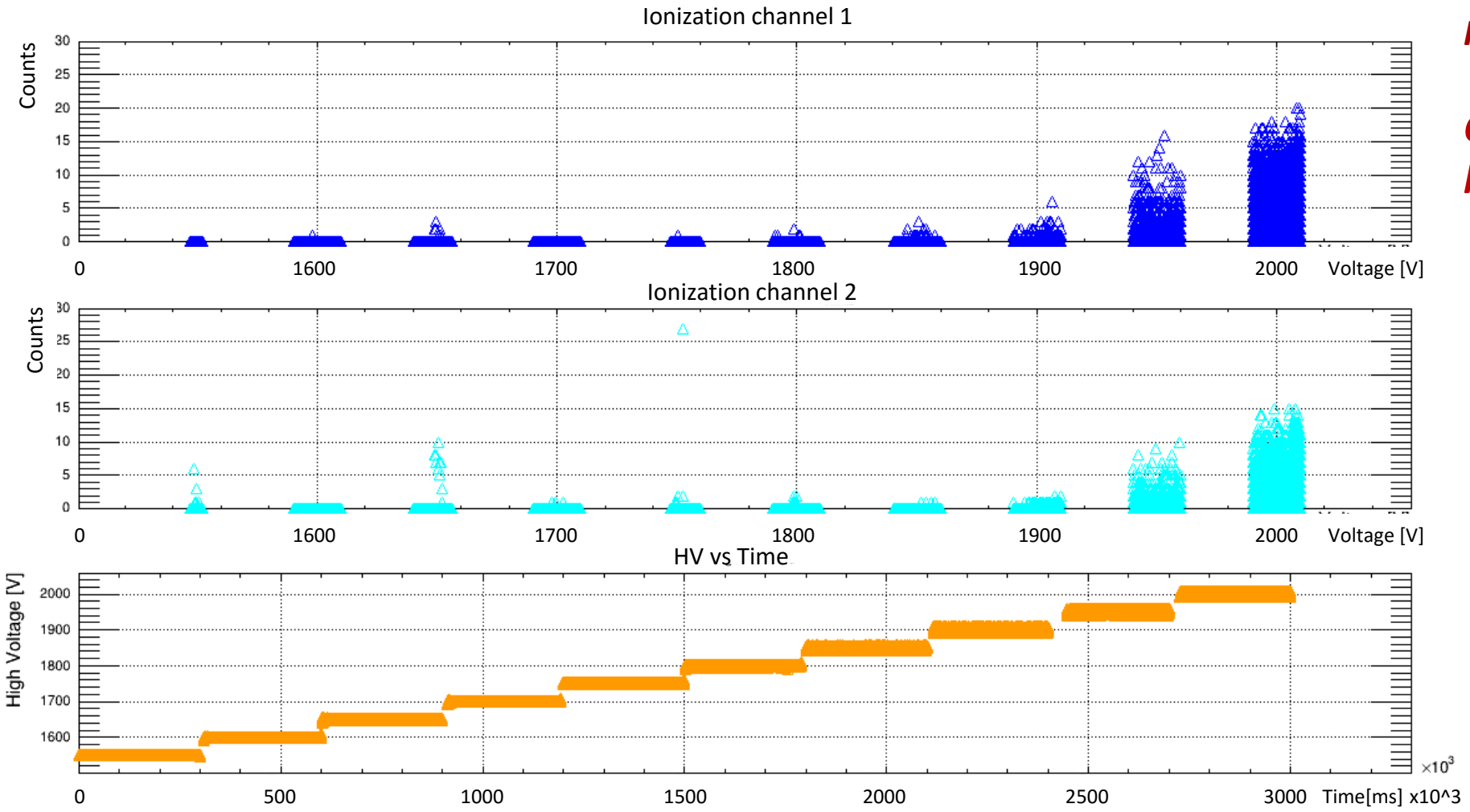




Ionization channels output signals
250 mv - 300 mV amplitude and duration of 100 ns

In blue a digital discriminator output pulse
of 5 volts amplitude .

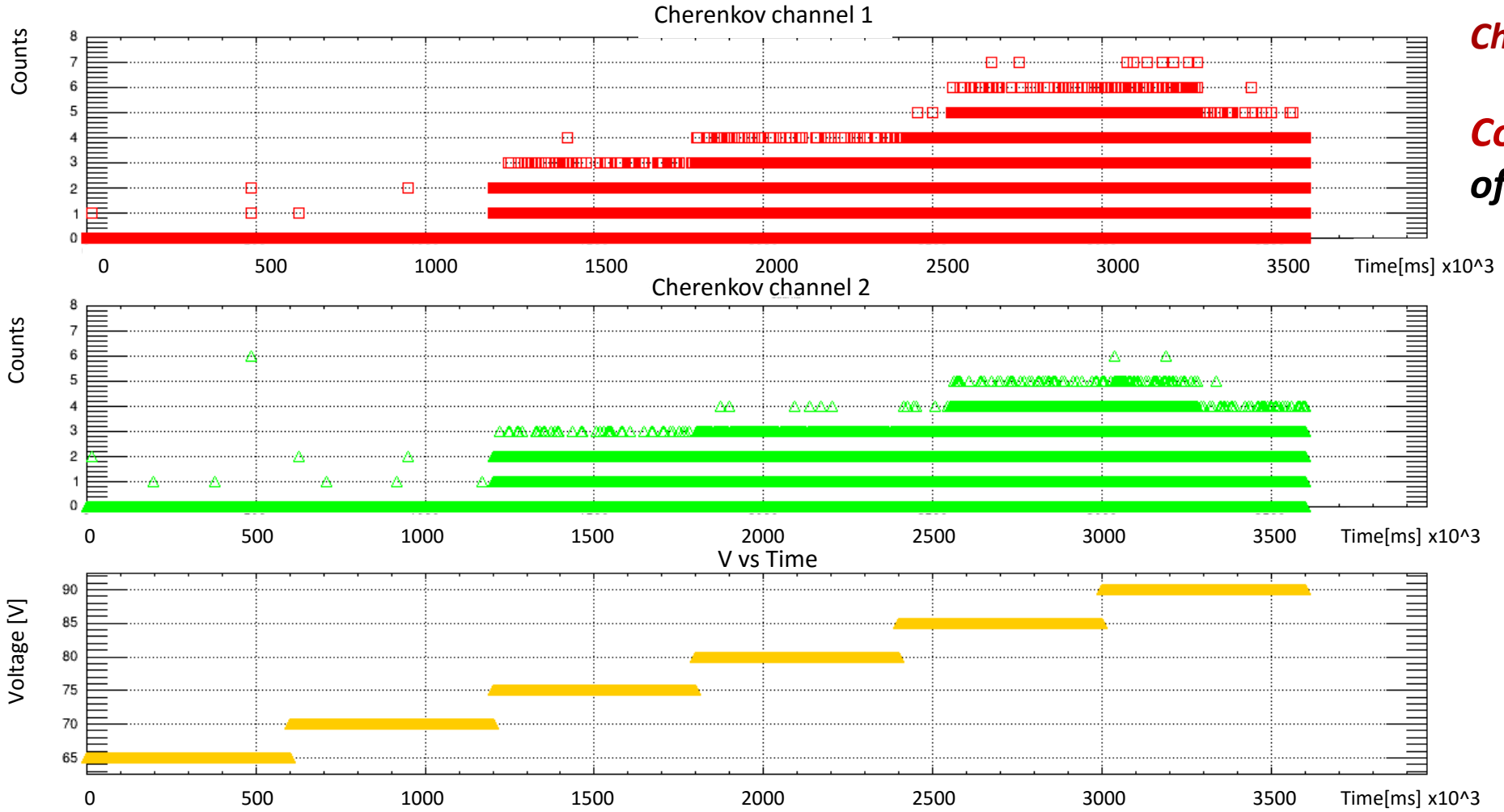
CHARACTERIZATION



Ionization channels

Counts as function of high voltage supplied

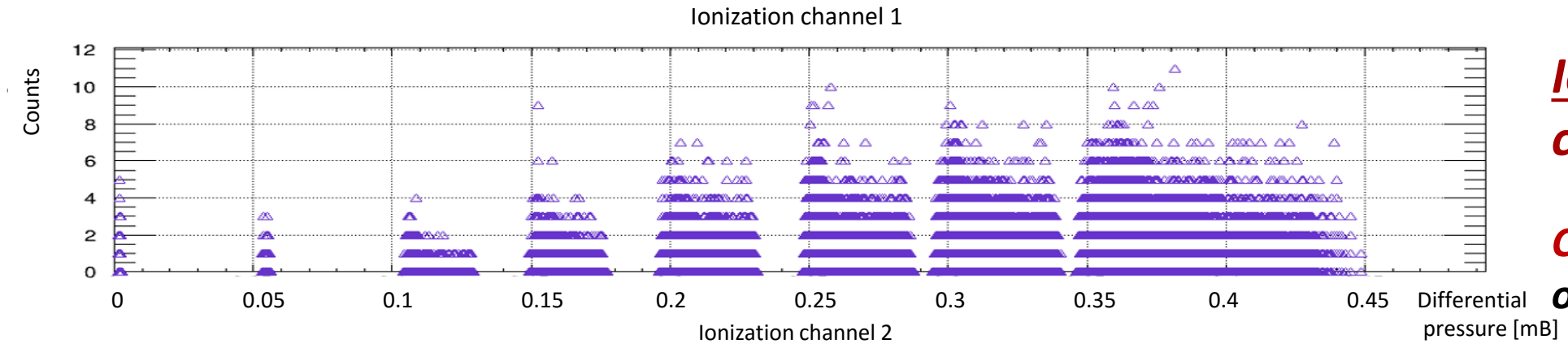
CHARACTERIZATION

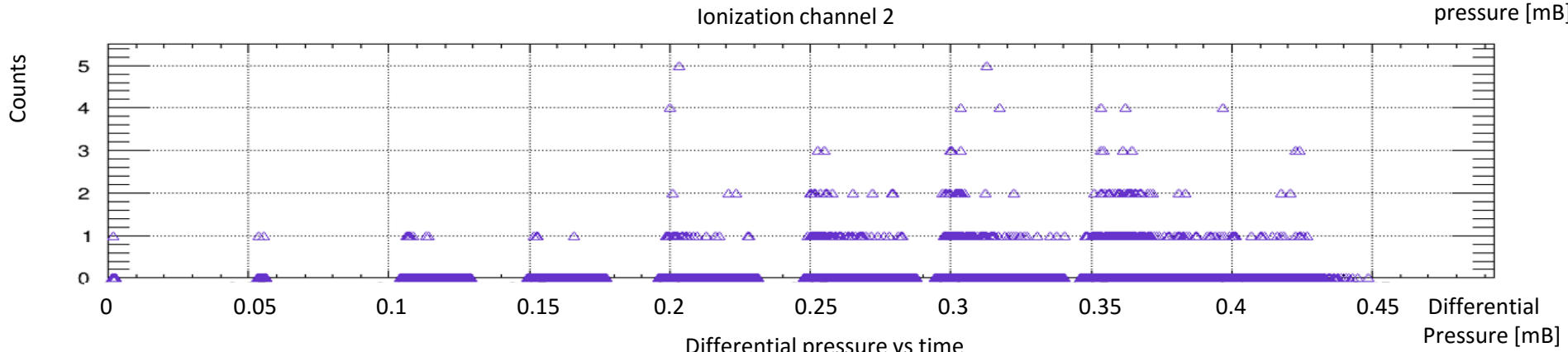


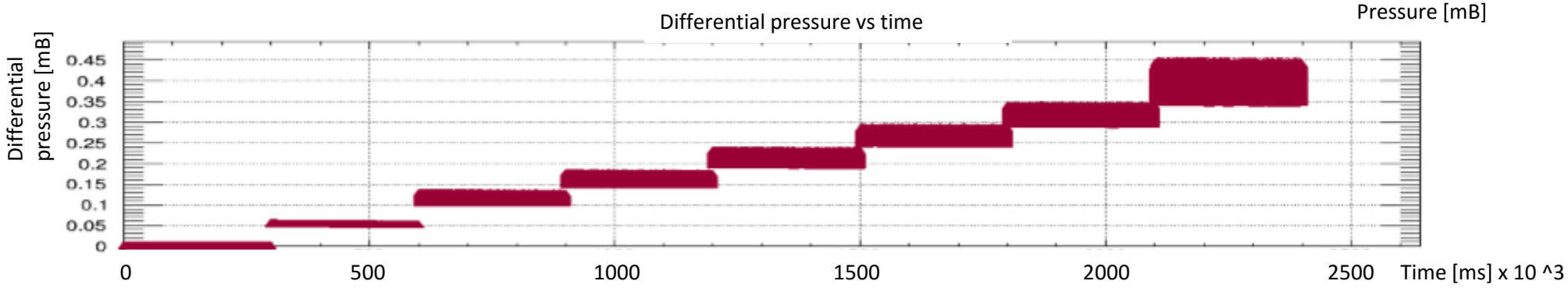
Cherenkov channels

Counts as function of voltage supplied

CHARACTERIZATION



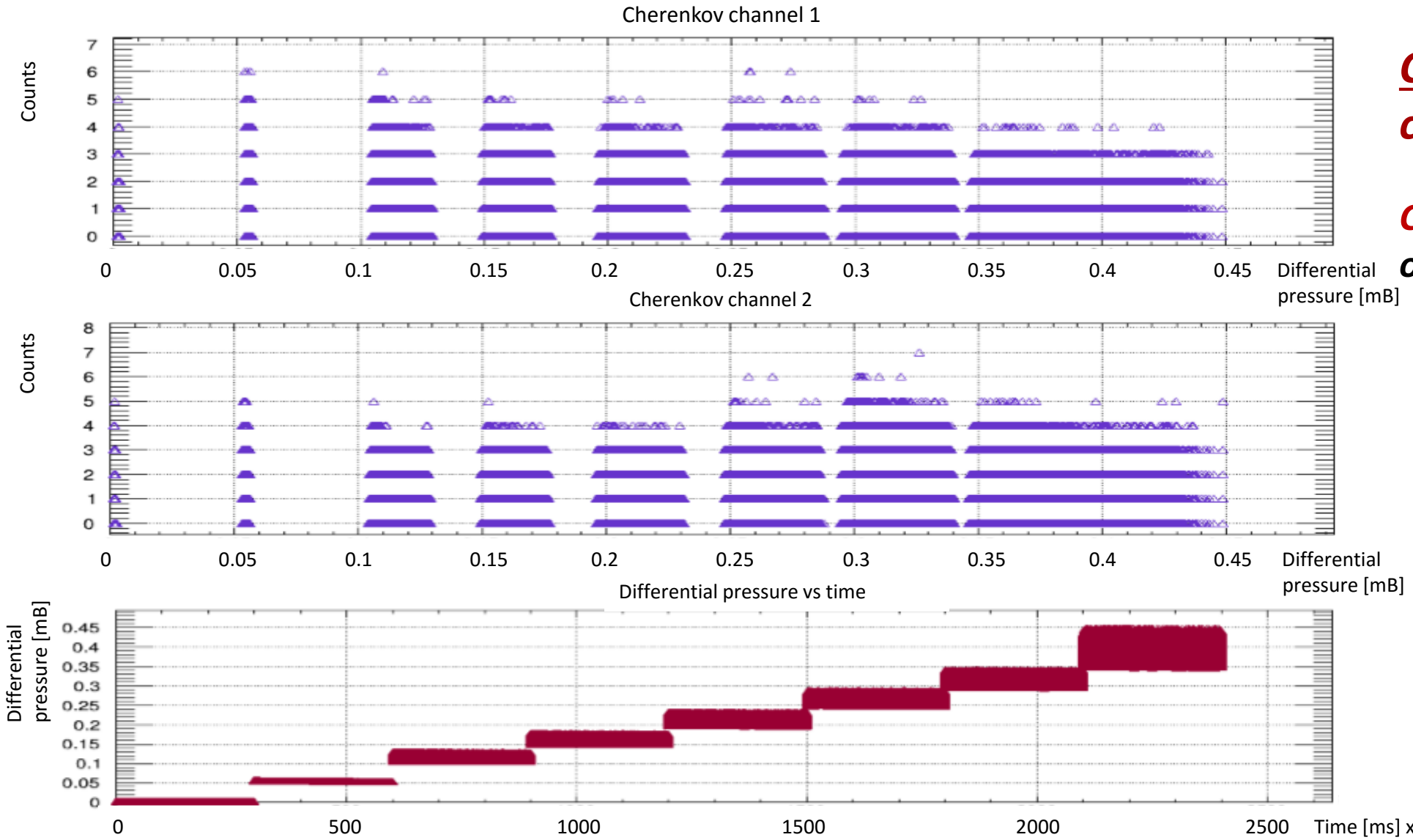




Ionization channels

Counts as function of gas pressure

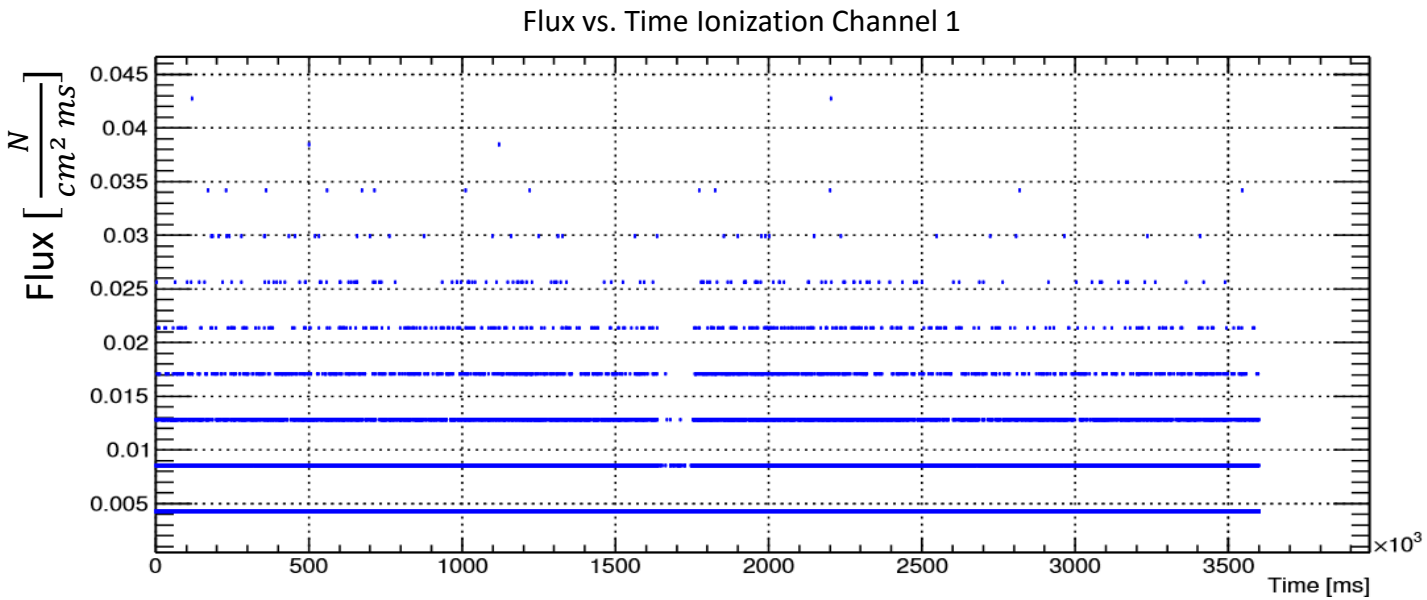
CHARACTERIZATION

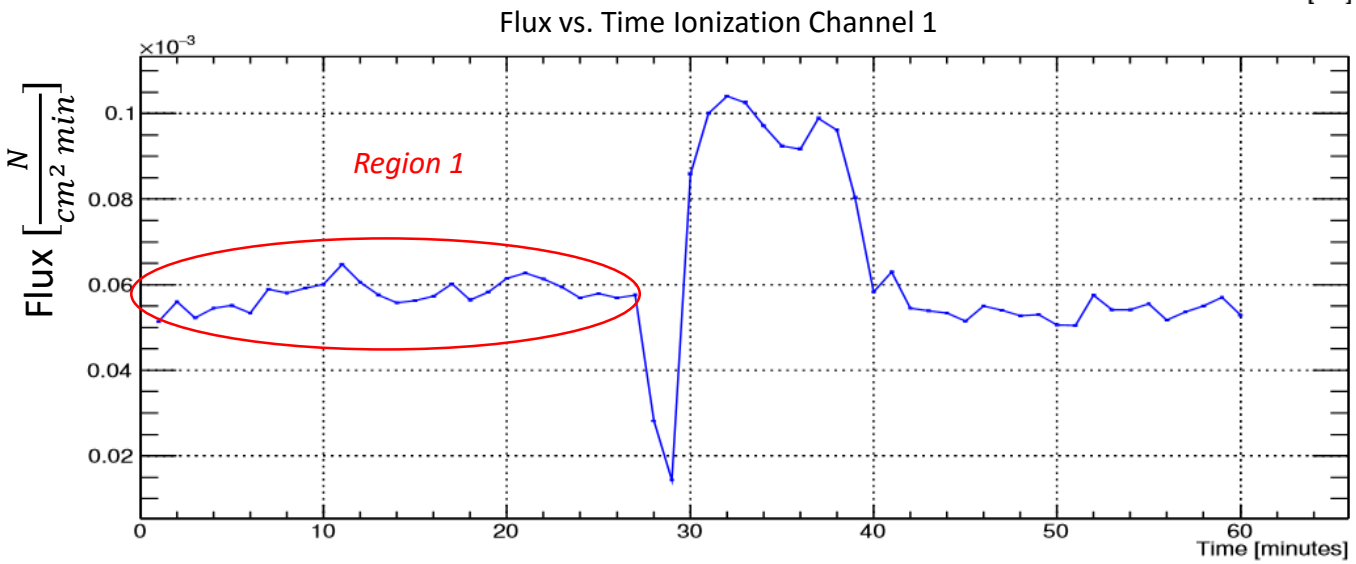


Cherenkov channels

Counts as function of gas pressure

C.R. FLUX MEASUREMENTS





Output Signal validation

$$Ion\ CH1 \cap Che\ CH1 \cap Che\ CH2$$

$$\Phi(t) = p_1 t + p_0$$

Fit parameters for region 1 by ROOT [4]

$$p_1 = 1.734^{-7} \pm 3.28^{-9}$$
$$p_0 = 5.525 \text{ x } 10^{-5} \pm 5.177\text{x}10^{-8}$$

$$\Phi(0 \rightarrow 29) \sim 15 \frac{N}{m^2\, minute}$$

[4]. R. Brun and F. Rademakers, "Root—an object oriented data analysis framework," Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, vol. 389, no. 1, pp. 81–86, 1997.

CONCLUSIONS

- We have developed a Hybrid Cosmic Ray Detector.
- A Hybrid Cosmic Ray Detector of two Cherenkov light and two ionization detection channels works properly.
- According to cosmic ray flux measurements as function of time by means the Hybrid Cosmic Ray Detector, the cosmic ray flux varies sharply and then tends to stabilize. It is not constant.

ACKNOWLEDGEMENTS

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- To Víctor Armengol, Carlos Méndez, Jonathan Sánchez, Juan Segura and Miguel Vázquez, students from Universidad Tecnológica de la Mixteca, who designed and implemented the polishing machine.

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