Construction of a test stand for the tracker and assembly and component testing for calorimeter calibration in the “Muon g-2”

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Final Report

22 September 2016

Outline

1th PART with Brendan Casey:

- Working in Lab3 into a clean room on a tracking detector;
- Testing the channels of HV modules;
- About the tracker in the “Muon g-2” experiment;
- Data analysis on Cosmic Rays;

2th PART with Carlo Ferrari:

- About the calorimeter calibration;
- Optic chain: laser, diffusers, bundle, panel;
- Diffusers testing;
- Assembly;

- Conclusions.

HV system

C.A.E.N mod SY127

C.A.E.N mod A333

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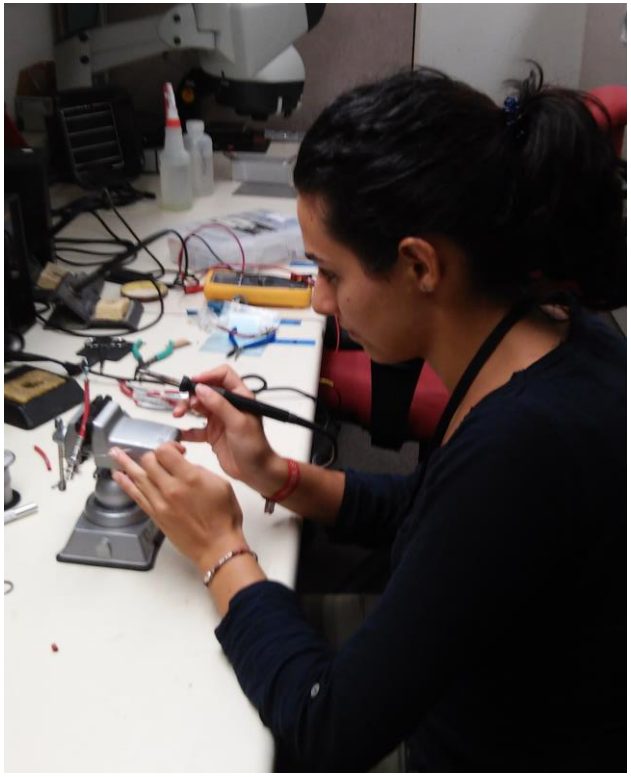
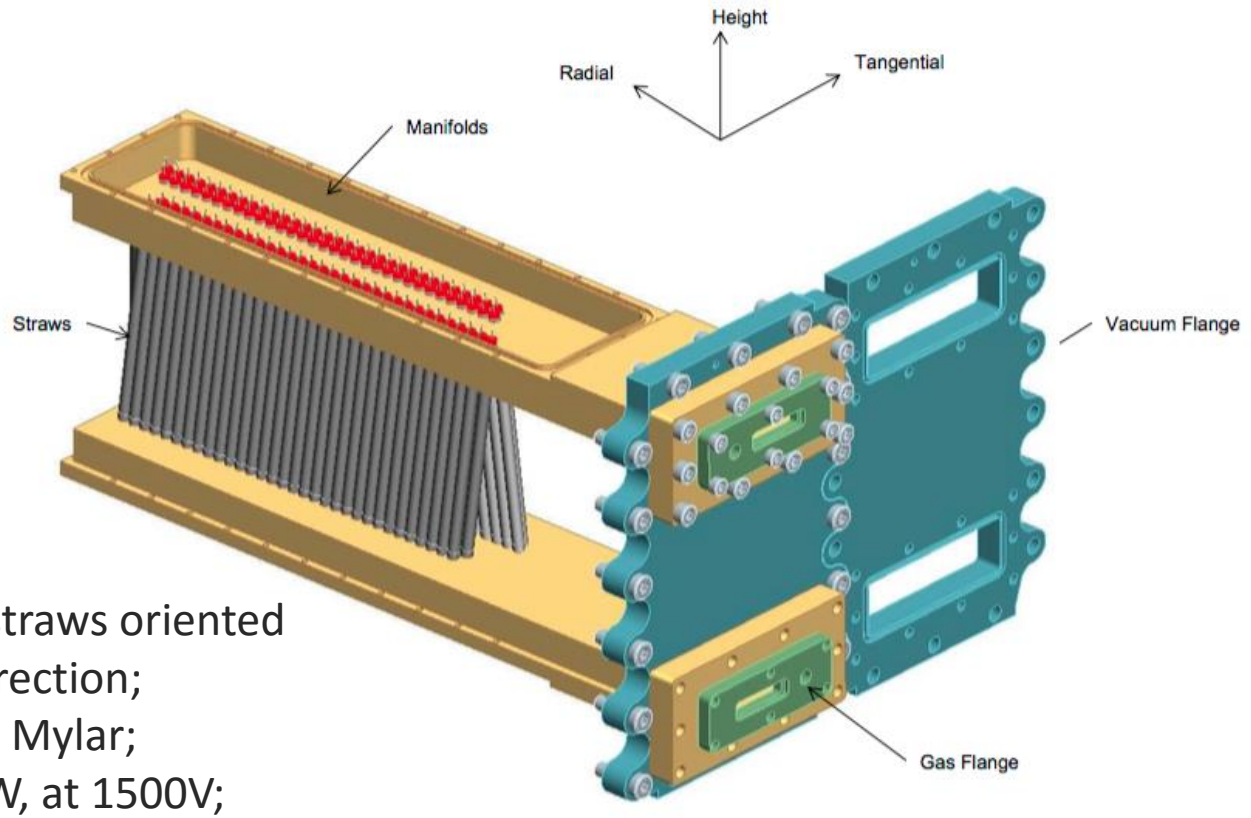
HV testing

- I designed some loads with a resistor of 20 MΩ, for 1mA and 2kV;
- I built them and tested with a smoke-test;
- I tested all of HV channels.



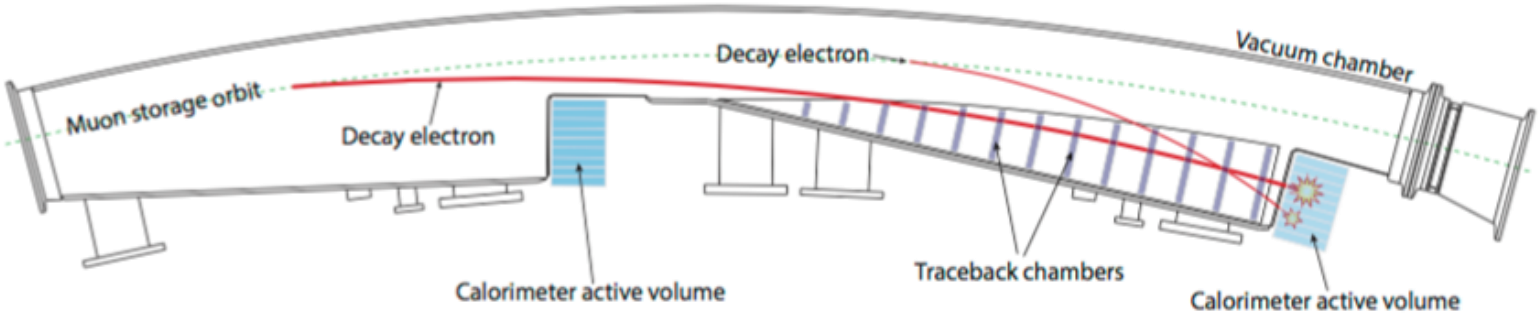
Tracking Detector

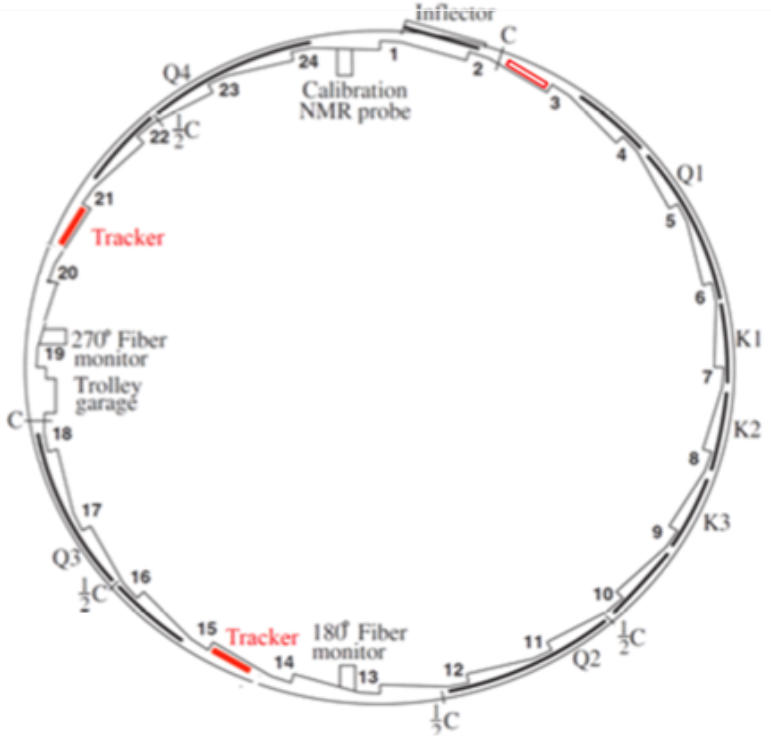
The primary physics goal of the tracking detectors is to measure the muon beam profile at multiple locations around the ring as a function of time throughout the muon fill.



- Two couples of layers of straws oriented ±7.5° from the vertical direction;
- straws (5mmx10cm) of Al Mylar;
- Sense wire of Au-plated W, at 1500V;
- Ar:Et in the tubes at 1 Atm and vacuum in the chamber.

Position into the ring





$$\pi^+ \rightarrow \mu^+ + \nu,$$

$$\mu^+ \rightarrow e^+ + 2\nu.$$

- 4 quadrupoles;
- 24 calorimeters PbF2+SiPM;
- 3 tracker stations;
- 8 trackers for each site;
- 32 straws per layer.

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Configuration system

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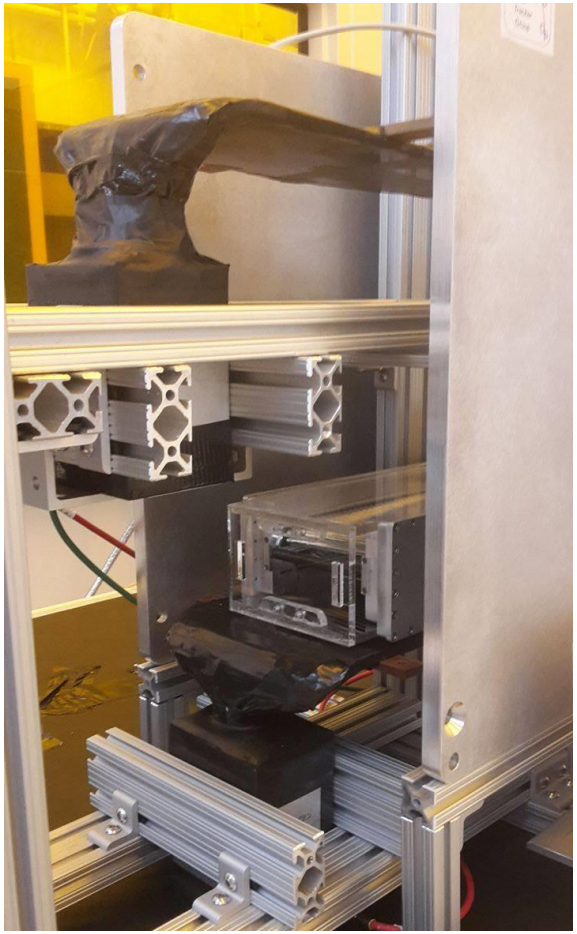
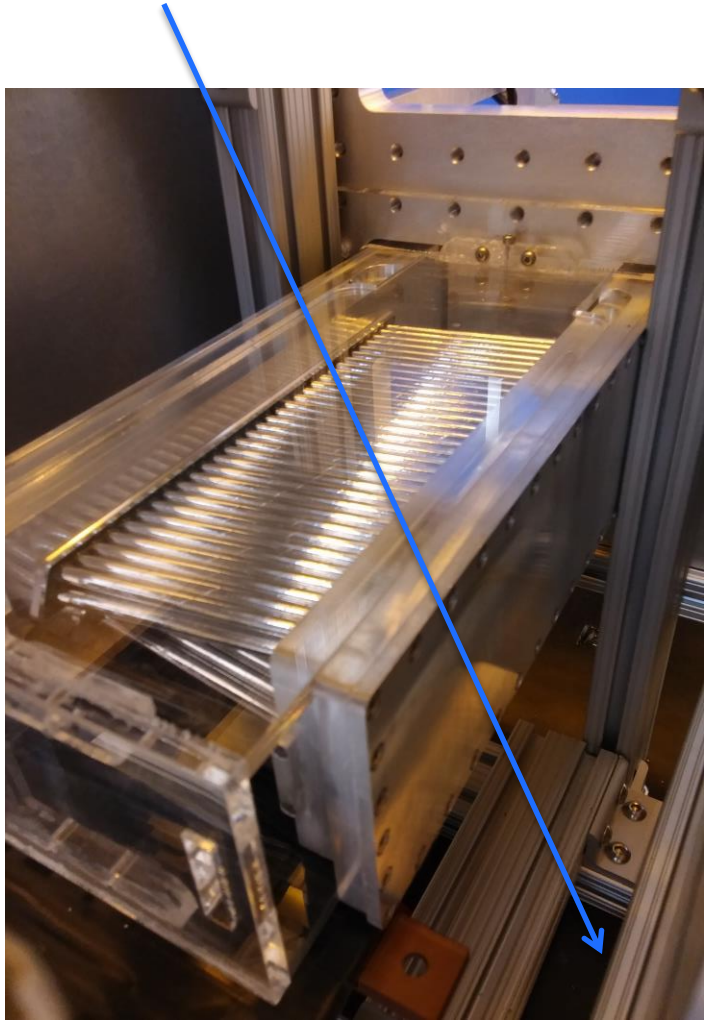
Detector testing



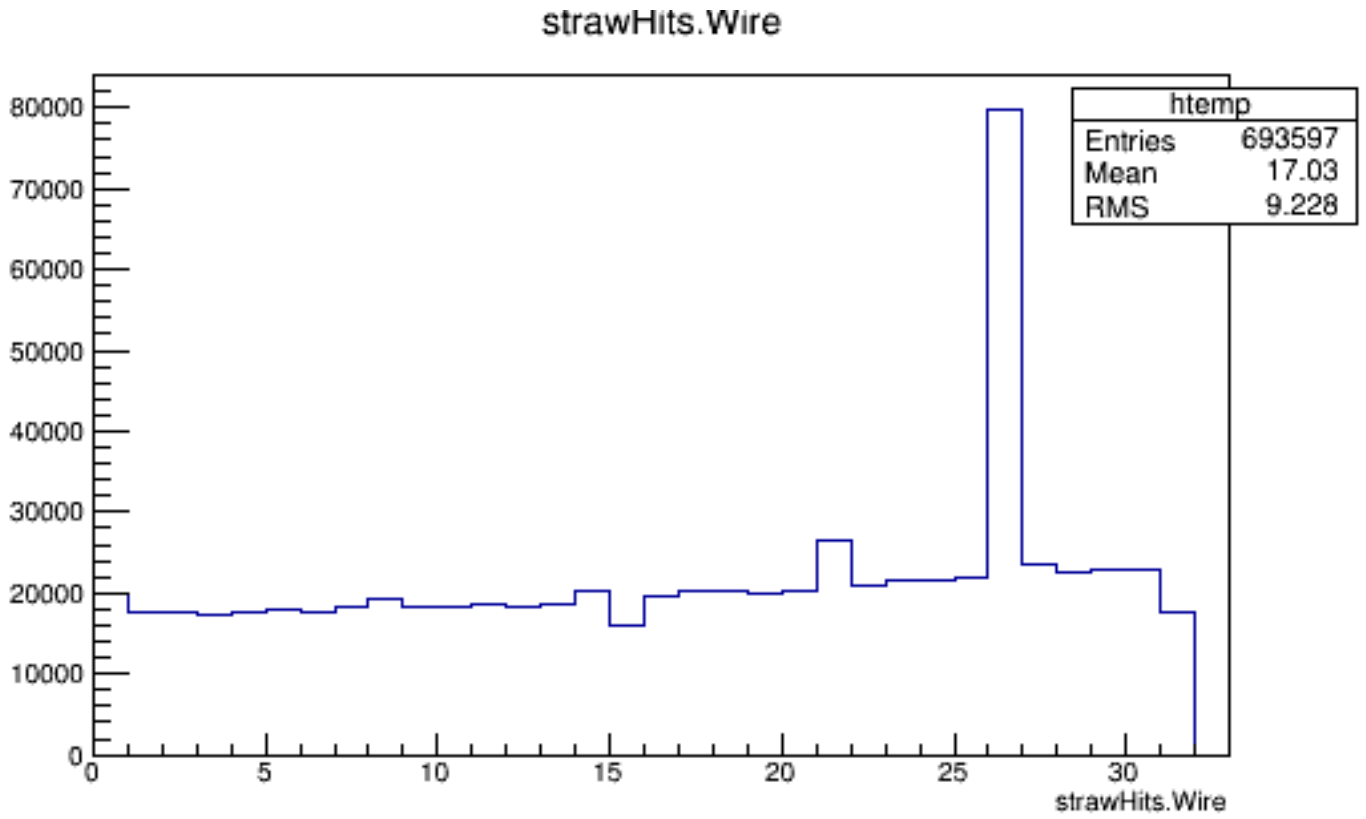
Scintillators for testing the MWPC with cosmic rays

Tracker is placed on horizontal direction



Data analysis (1)

From the total number of entries of wires ➡ Spike of noise at the 26th wire of the layer nº 1



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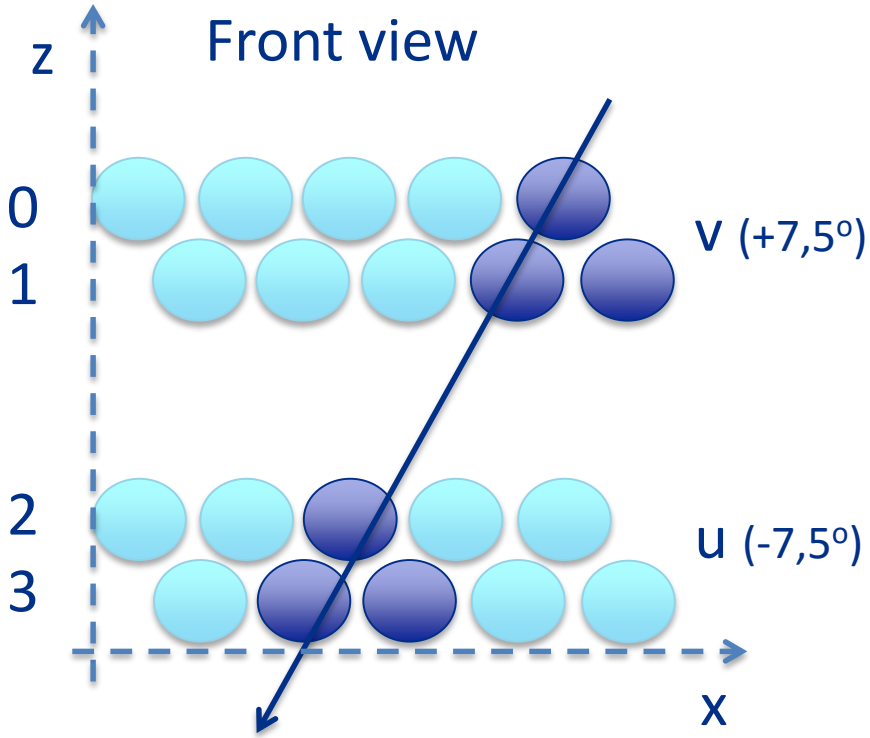
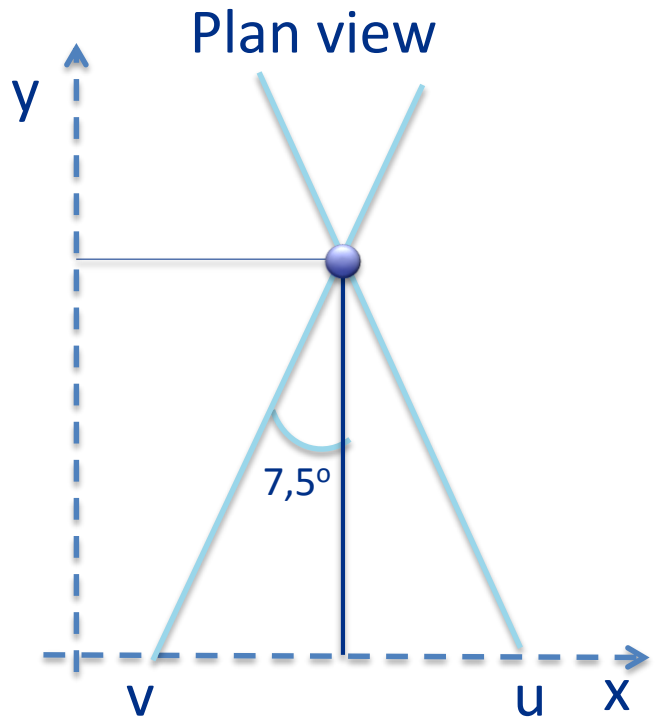
Data analysis (2)

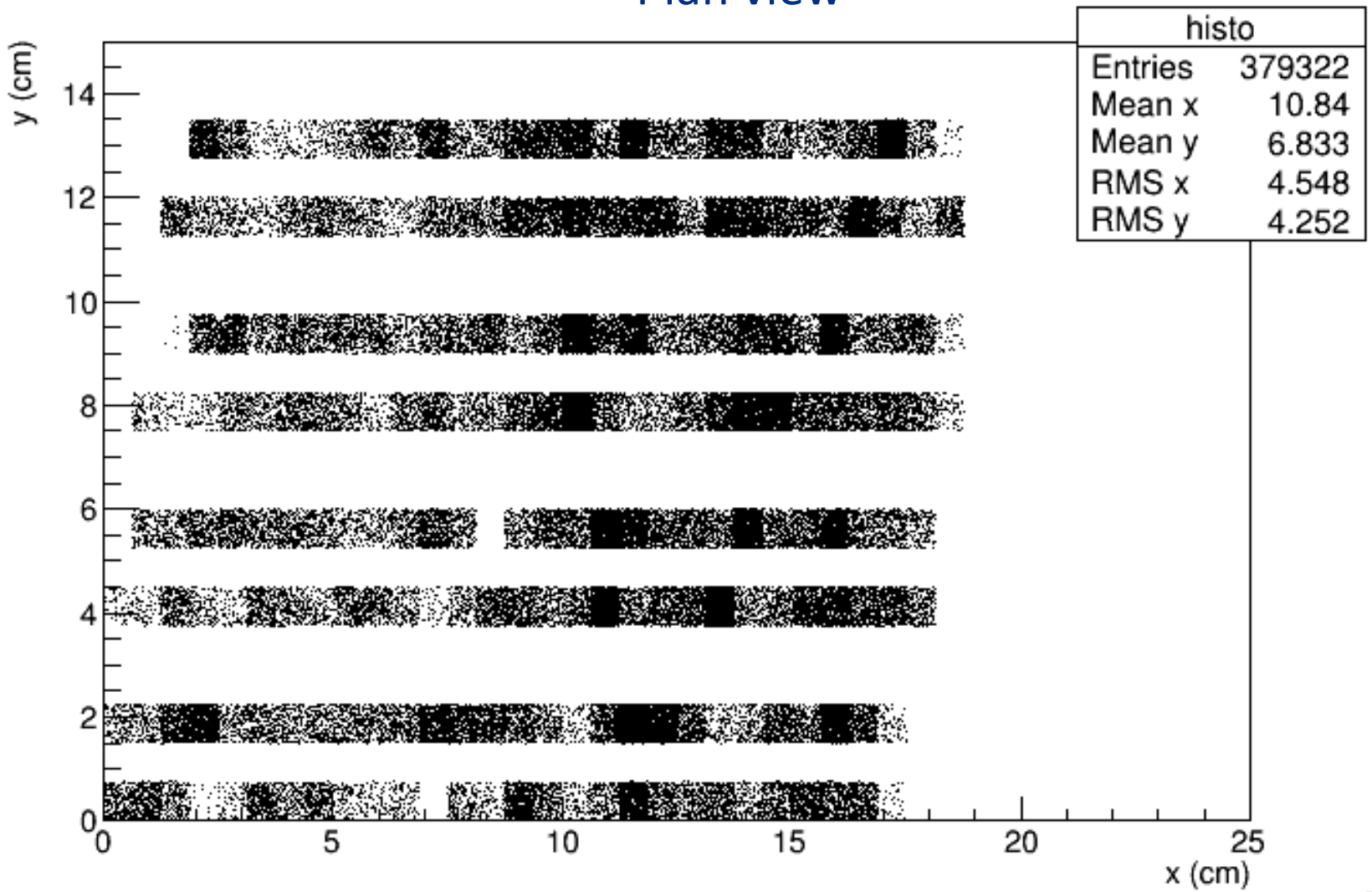
- I wrote a root code to select only the near wires of different layers;
- I did the difference in time between the selected wires to found the coincidence;
- I looked for the cross points of the wires that were hitting;
- Data's path: /gm2/data/t1042-straws/lab3-teststand/Lab3TreeDump_00294_00297_00298.root





Cross points 2D

Plan view



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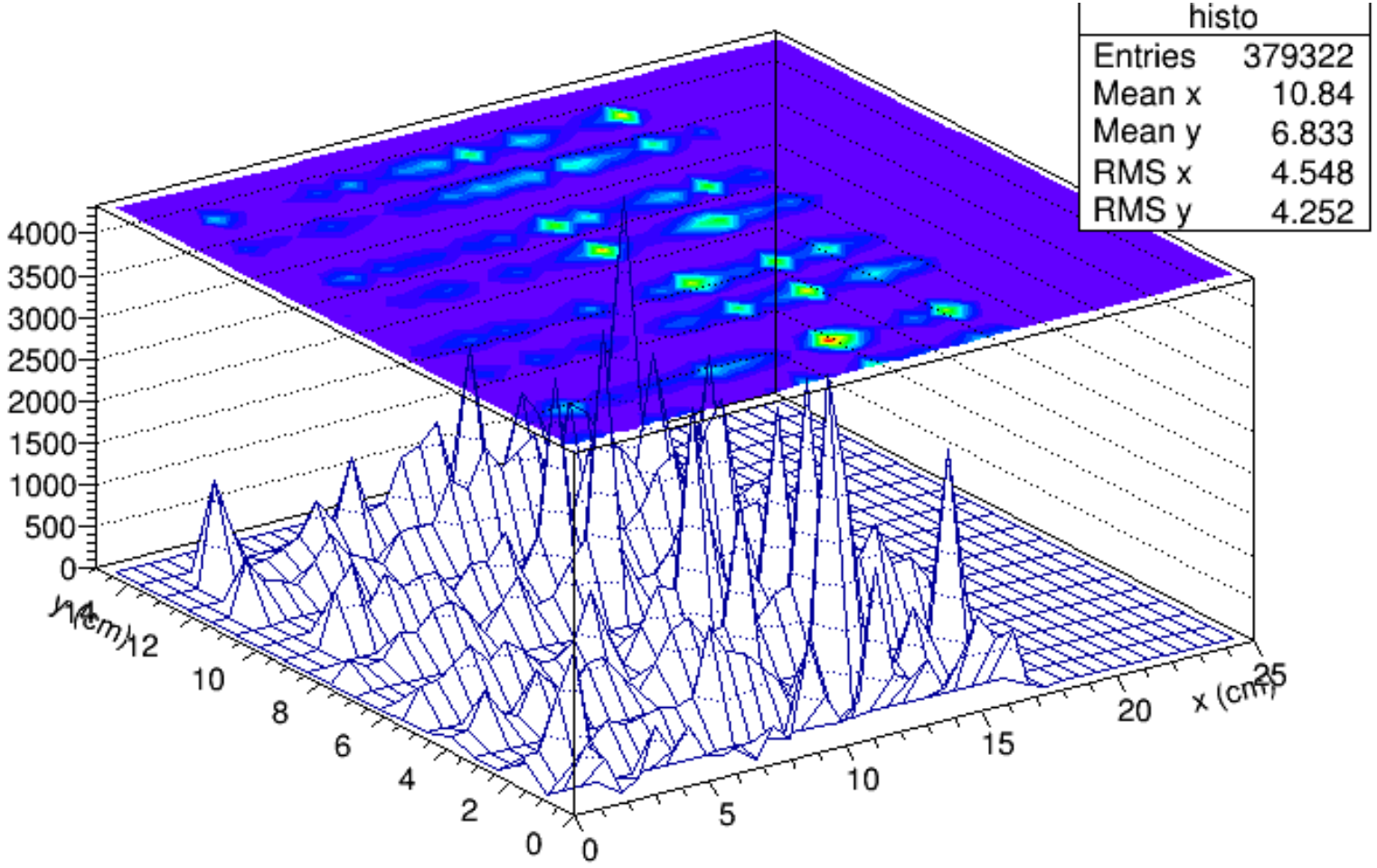
Cross points 3D



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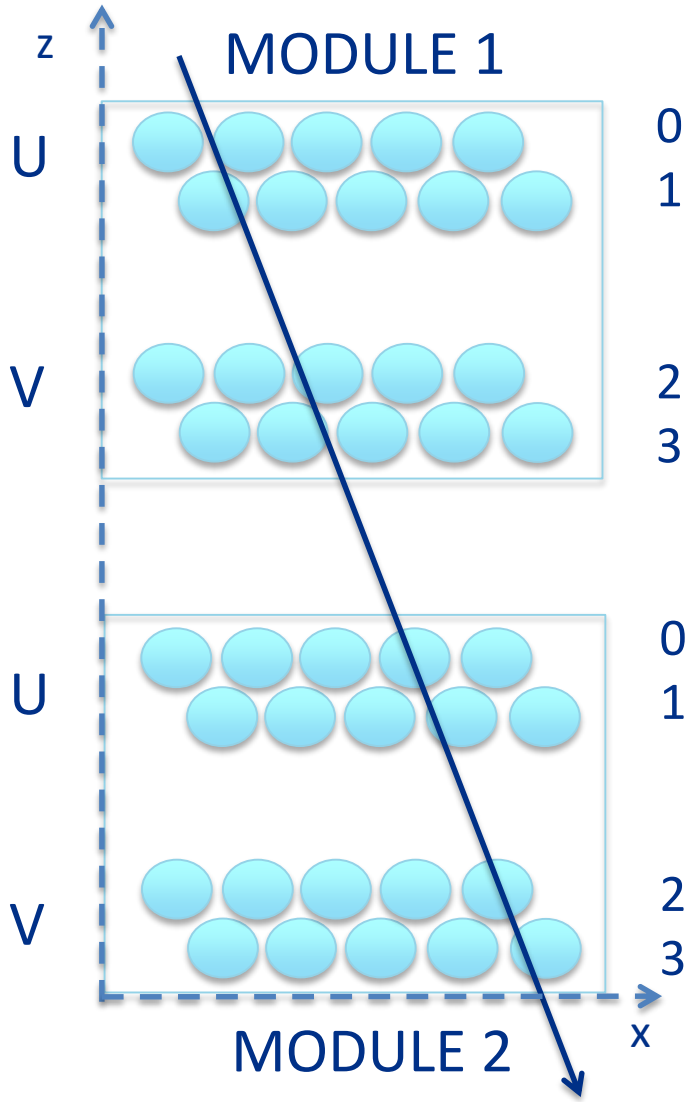
Analysis with two modules

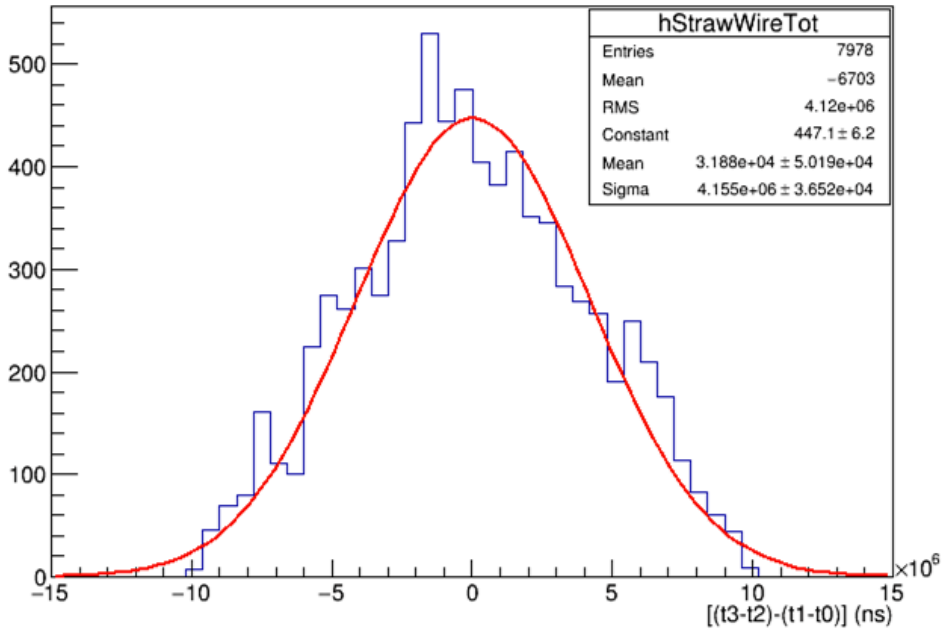


For two modules I did the difference between the hit times to match tracks in the U layer with tracks in the V layer (coincidence). I looked for two cross points, one for module and now I can found the particle path like as a line between two points.

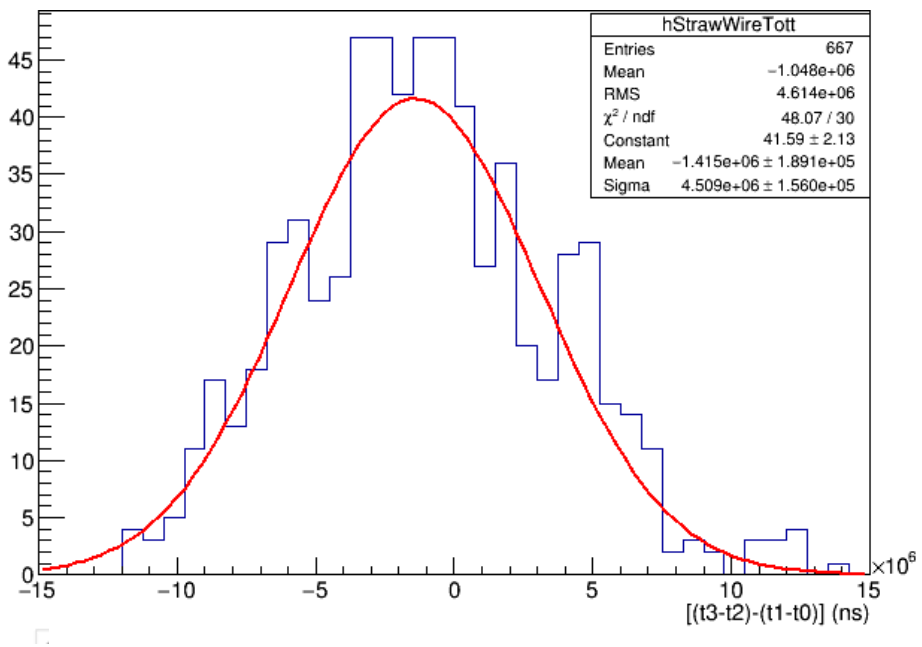
Difference of time

After selecting the wires, I did the difference between the hit time of the chosen wires for the module 1 and 2. The values around zero are for hits in the same time, in this way I select the coincidence between the layer U and V.

MODULE 1



MODULE 2



Data's path: /gm2/data/t1042-straws/lab3-teststand/Lab3TreeDumper_00695_00696_00697_00698_00699_00702_00706_00707_00708.root

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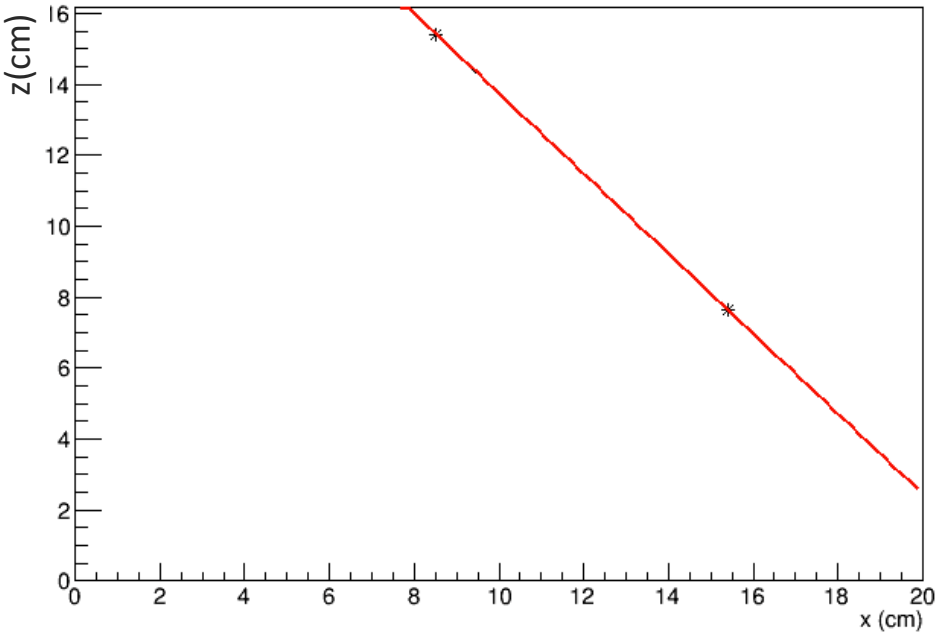
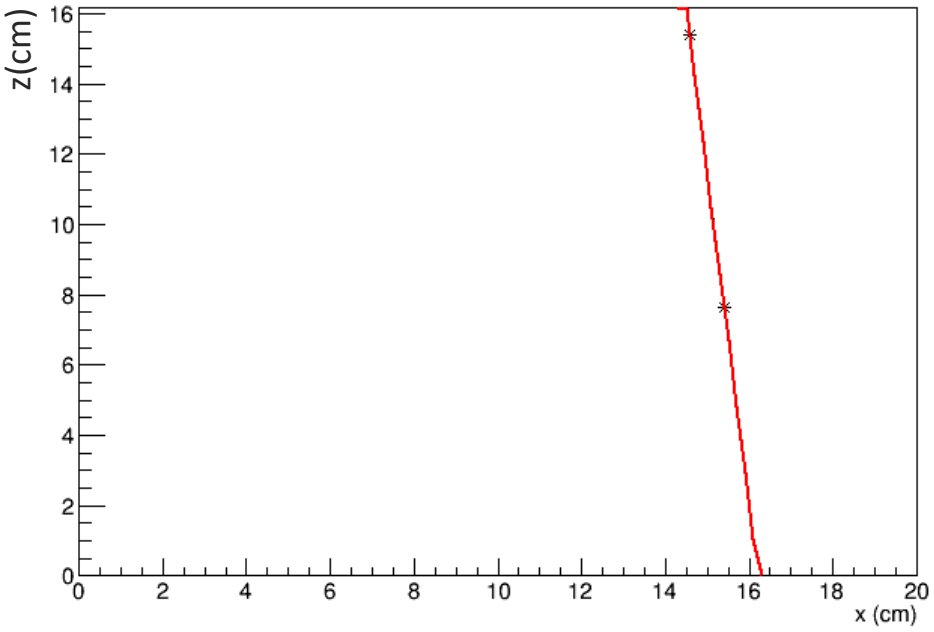
Path of a particles





These lines are some examples of a particles that through the two modules.

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Calorimeter calibration

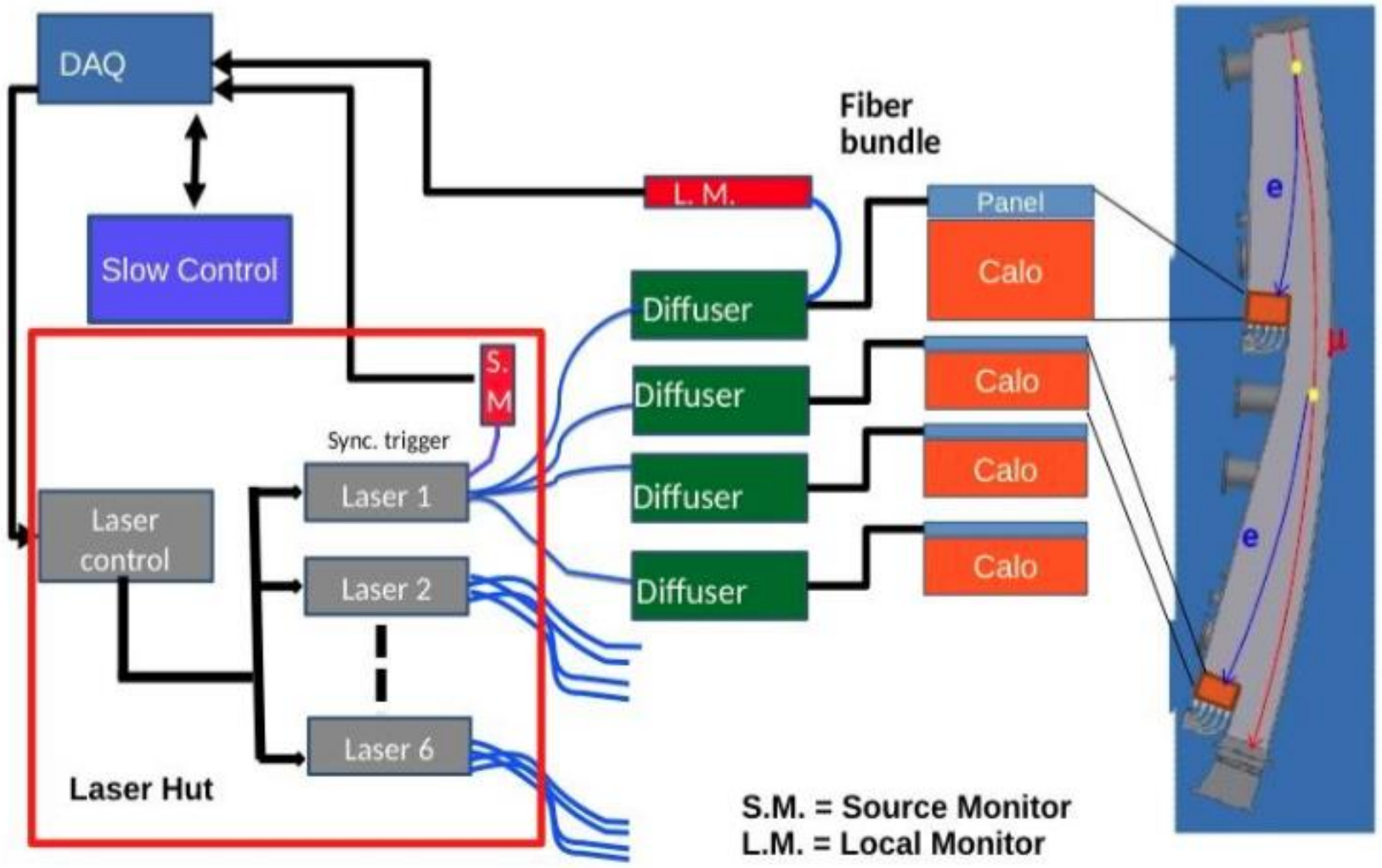
Time reference

The 24 calorimeters are not syncronized:
we send a laser pulse before the Muon fill to each photosensor (SiPM);

Energy calibration

The photon detection efficiency of the SiPM must be calibrated:
we send laser puls with different intensity;

Calorimeter calibration



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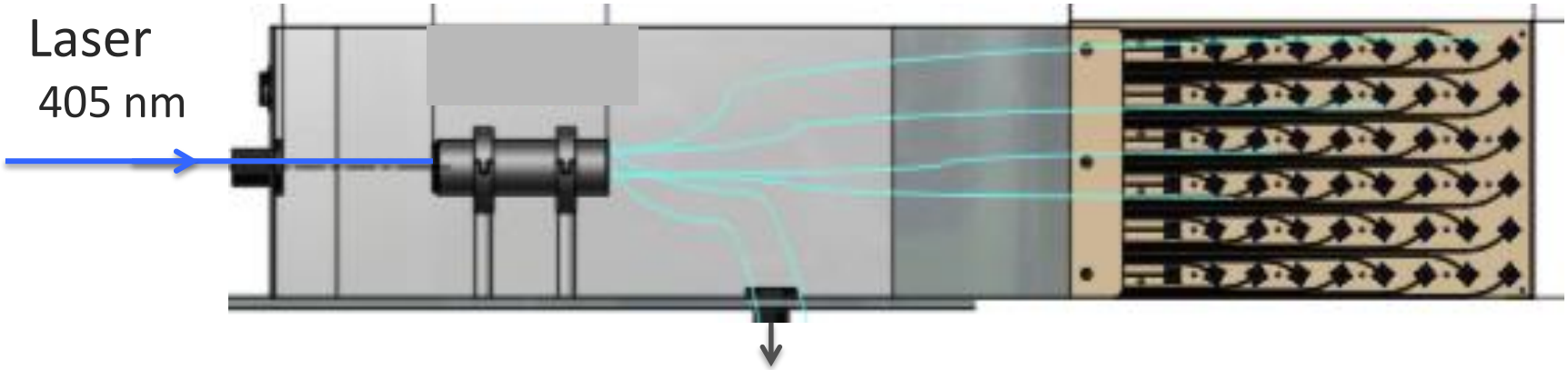
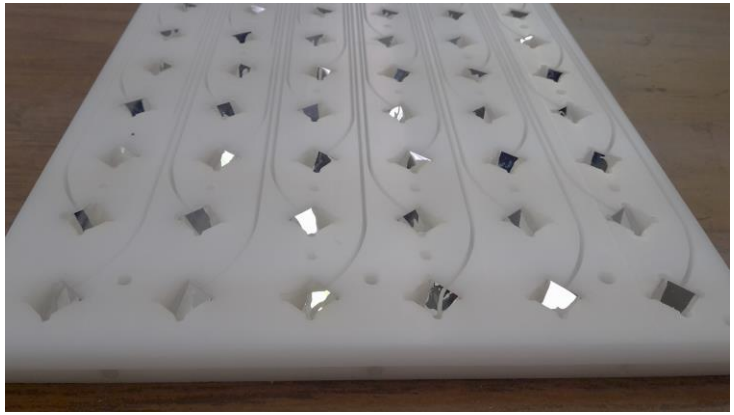
Optic chain



Fibers for the Local Monitor

Bundle fibers and Diffuser

Panel with 54 Prisms



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Diffuser testing (1)

Choose ISO: 100

⬇

Choose time exposure: 1/10s

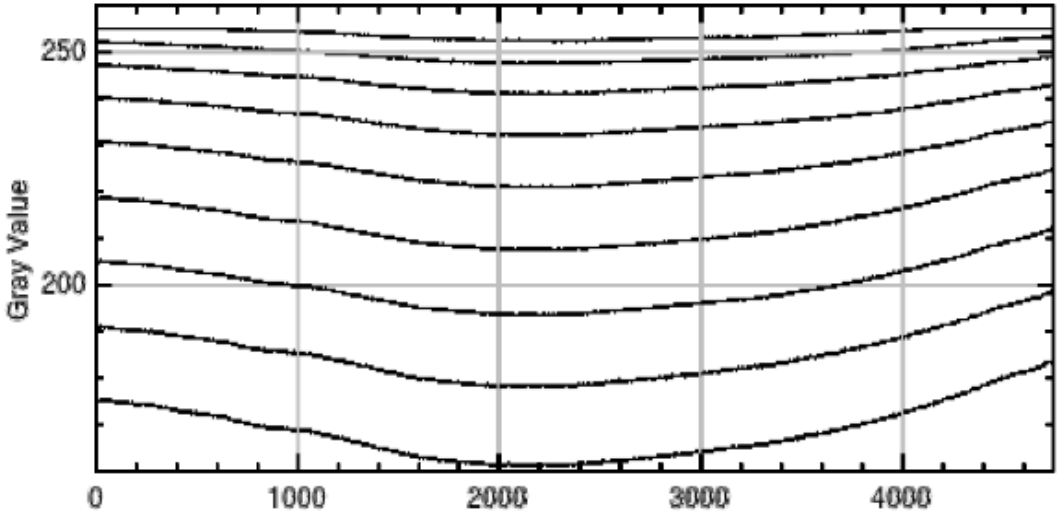
⬇

Test on 24 optic diffusers

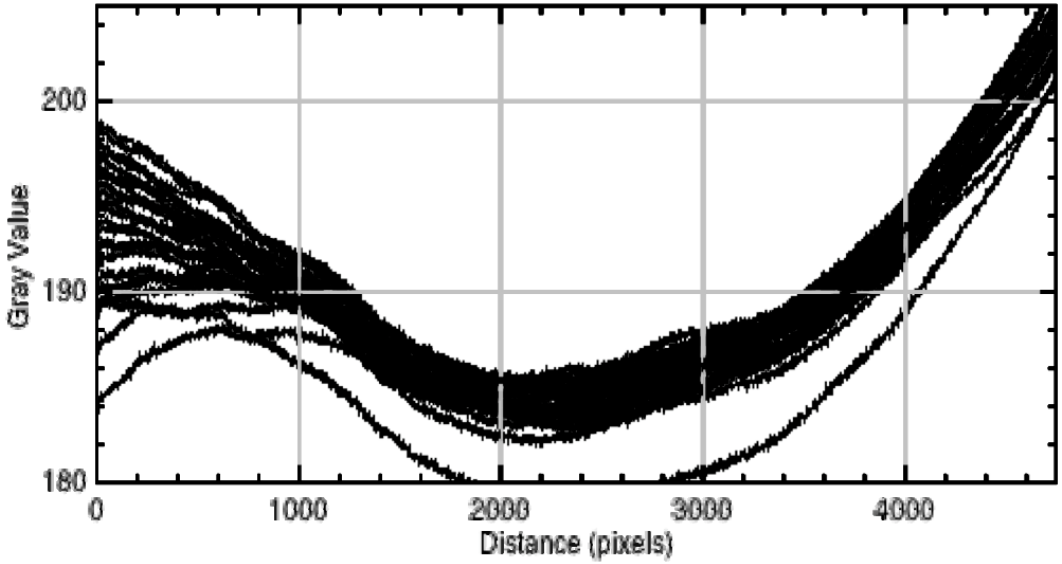
I used the program “Image J” to analyze the photos and the function “Plot Profile” to get the profile of a selected photo’s area.

ISO: light sensibility of the sensor;
Time exposure: indicates the width of the interval of time during which the shutter is open.

Diffuser testing (2)



ISO: 100
Increasing the exposure time 1/13s to 0”5s



ISO: 100
e.t.: 1/10s
curve for each diffuser

Bundle testing

Testing with a Power meter the power of the laser, alone and with a diffuser and bundle, for each fiber(60).

P_{laser}=2,82 mW;
P_{fiber}=4,5 uW;
E=10%.

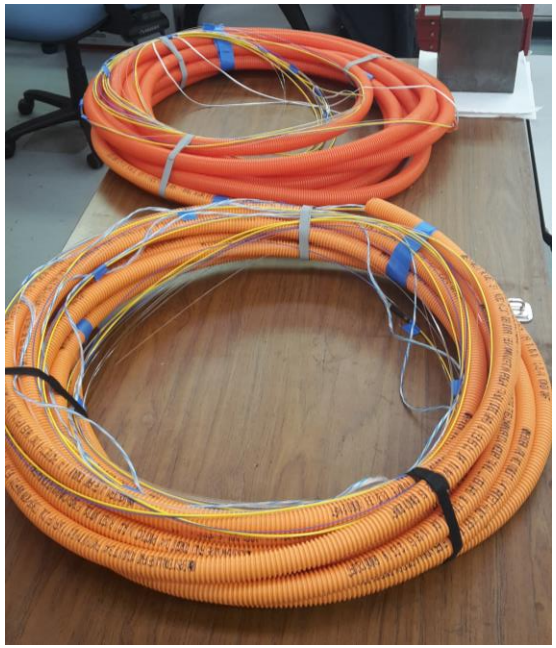
Polishing the fibers

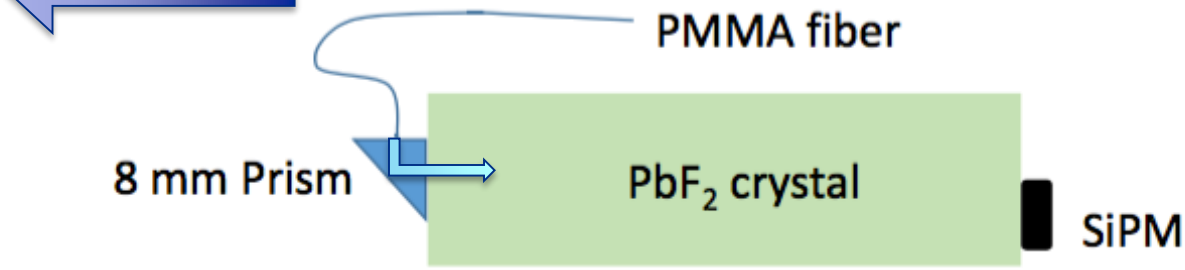
Four sand papers of:

- 5 um;
- 3 um;
- 1 um;
- 0,3 um.

To adapt the fiber with the laser wavelength of 400 nm

Final assembly





Laser and fibers for the local monitor inside the straw

Conclusions

During this internship at Fermilab I worked on “Muon g-2” experiment, with the help of Brendan and Carlo, about:

- Tracker detector in the clean room and testing HV modules;
- Analysis data on cosmic Rays to select the path of a particle that cross the detector;
- Testing and assembling the laser instruments to calorimeter calibration.

In two months I was part of a team of international physicists and I learned to collaborate with other people in a big experiment!

THANK YOU to give me this opportunity!