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Particle Detectors for the Most Energetic Particles

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2 Equipment

3 Results

4 Conclusions

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MARTA - Pierre Auger Observatory

MARTA

Muon Array with RPCs for Tagging Air Showers



Figure 1: Cherenkov water tanks for cosmic rays detection

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RPC - Resistive Plate Chamber

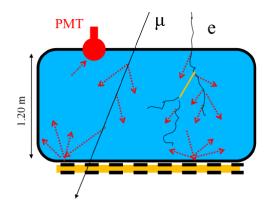


Figure 2: RPC schematic

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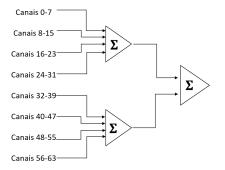
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Circuit Board



Figure 3: Used Circuit Board



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Figure 4: Summation Circuit Schematic

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Schematic

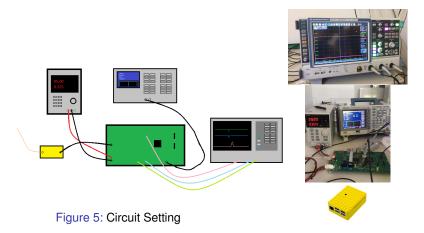


Figure 6: Oscilloscope, Power Supply, Signal Generator and Raspberry Pi

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Signal at the OpAmp



Figure 7: Signal at TP27 with 32 channels on with 64 gain with noise

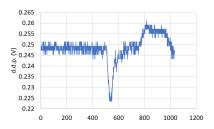


Figure 8: Signal at TP27 with 32 channels on with 128 gain without noise



Figure 9: TP27 - Output of the Third occ

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Initial Testing

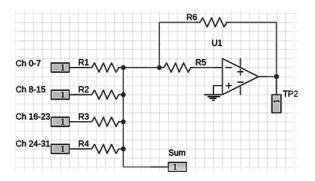


Figure 10: Summation Amplifier Circuit

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→ E → < E</p>

Voltage Measurements - First OpAmp

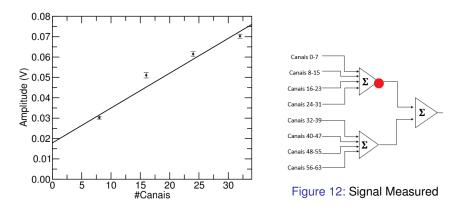


Figure 11: Fit of a linear curve over the voltage of the Summation for a gain of 32

→ E → < E</p>

Conclusions

Voltage Measurements - Second OpAmp

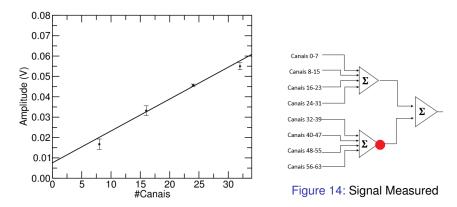


Figure 13: Fit of a linear curve over the voltage of the Summation for a gain of 32

Voltage Measurements - Third OpAmp

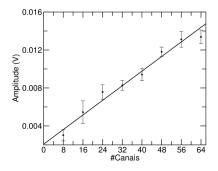


Figure 15: Fit of a linear curve over the voltage of the total Summation for a gain of 32

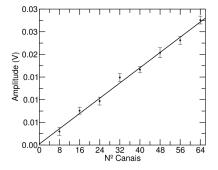


Figure 16: Fit of a linear curve over the voltage of the total Summation for a gain of 64

→ E → < E</p>

Voltage Measurements - Third OpAmp

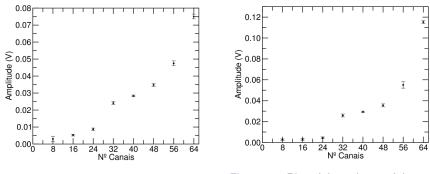


Figure 17: Plot of the voltage of the total Summation for a gain of 128

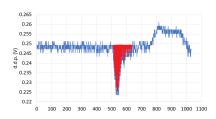
Figure 18: Plot of the voltage of the total Summation for a gain of 256

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Particle Detector

Charge Measurements



q = C.V

Figure 19: Integral of the Slope Curve to Calculate the Charge

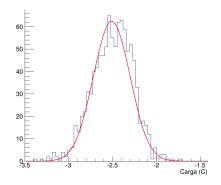
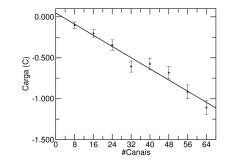
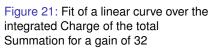


Figure 20: Normal Distribution of the Integrated Charge over 1000 measurements with 48 channels enabled

Charge Measurements





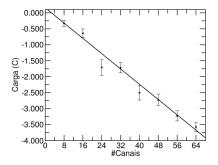


Figure 22: Fit of a linear curve over the integrated Charge of the total Summation for a gain of 64

→ E → < E</p>

0.000

-1.000

-2.000

-3.000

-4.000

-5.000 -6.000

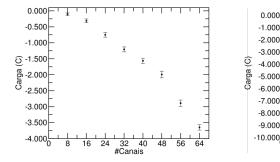
-7.000

-8.000

-9.000

8

Charge Measurements



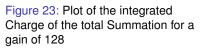


Figure 24: Plot of the integrated Charge of the total Summation for a gain of 256

24 32 40

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★ E → < E</p>

48 56 64

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Conclusions

The output of the OpAmps didn't behave as previously expected:

- It was expected a symmetry of results on the output signal of the OpAmp 1 and OpAmp 2.
- It was also expected a small gain on the summed signal (Summing Amplifier)

Measuring Problems

There was a significant amount of noise on the measured signal, possibly due to signal reflections, and pickup noise.

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Impact on The Project

We helped improving the first part of the circuit board: the group decided to move the summation part to a side board.

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Questions ?

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