Outdoor Systems, performance and upgrade

Luis Lopes

MARTA Collaboration, LouMu Collaboration, Lip Detector Laboratory
Outline

• MARTA Eng. Array at Auger Site
  • Astrophysics

• LouMu
  • A project that combines particle physics and geophysics in order to map large geologic structures, using the Muon Tomography. Physics results already presented by Raul on Wensday

• Sealed RPC
  • Important approach concerning the limitations using HFCs in the near future

• Conclusions and future work
MARTA @ Auger site, prototype station

Harsh conditions
MARTA @ Auger site, prototype station

Due to pandemic chambers were off and out of gas from January 2020 until April 2022.

4 RPCs

4 double gap RPCs with 1.2x1.5 m² active area underneath the tank. Deployed in November 2019, restarted in April 2022. After gas flowing for some days chambers were turn on.

Gas bottle and distribution under ground to mitigate temperature effects. Probably we need to work on better solution due to condensation and tube material. We found some liquid inside the tubes, not clear what it is.!! Most probably water.
After 2.5 years seems to be all ok. Very high flow, not needed, misconfigured during installation!!
Humidity inside the aluminum boxes is too high… Need some experts @ site to check the reasons.
• Four plane telescope
  • double 1 mm gap and 1 m² sensitive area, MARTA like construction.
  • Pure R134a, recover and compressed for recycling.
  • prepared to be easily move to different places
  • Around 1 kg gas consumption per week.
  • HV automatic adjustment to keep gain and efficiency stable over time
    • constant monitoring of temperature, absolute pressure, RH and gas flow
  • Very stable performance over time
  @ lab
  • 64 channels Maroc front end in each chamber
  • Central unit, custom made trigger unit based on Xilinx Spartan-6 FPGA
LouMu @ Lousal mine

130 meters long plastic tubes

Telescope

Gas bottle

130 meters long plastic tubes
LouMu @ Lousal mine
LouMu @ Lousal mine

@ the Lab

@ the Mine
LouMu @ Lousal mine

Graphs showing data trends over time for various parameters:
- Current (nA)
- Temperature (°C)
- RH (%)
- Flow rate (cc/min)

@ the Lab
@ the Mine
Sealed Chamber

Double 1 mm gap, ~1m² sensitive area, 95% C₂H₂F₄ + 5% SF₆
Sealed Chamber

Sealing of gaps and HV electrode paint

Leave 15 mm without paint to minimize leakage current and current flow over full glass paths, no paint in the spacer area.
Sealed Chamber

Argon permanent discharge. Very good gap uniformity. Able to extract correct glass bulk resistivity.

For better gap cleaning we should keep Argon discharge for at least one month… No time so only 10 days….
Sealed Chamber

- From Argon to C2H2F4 + SF6
- Chamber sealed

Temperature (°C)
- 20 to 25
- 09-Aug-2022 to 26-Sep-2022

Relative Humidity (RH) (%)
- 40 to 80
- 09-Aug-2022 to 26-Sep-2022

Pressure (mbar)
- 980 to 1020
- 09-Aug-2022 to 26-Sep-2022

HV (V/gap)
- 0 to 10000
- 09-Aug-2022 to 26-Sep-2022

Current (nA)
- 0 to 10000
- 09-Aug-2022 to 26-Sep-2022

Time (day/month)
Sealed Chamber

HV scan, without and with $^{60}$Co

Considerable DC leakage current
- Spacers, inside gaps?
- Surface, outside gaps?

Gas gain
Sealed Chamber

Easily we can see that current follows the room RH more than any other variable!! Good! Bad from leakage current but, important confirmation of gaps sealing procedure.
Sealed Chamber

30 persons inside the room

Humidity reduced via Argon atmosphere

This can only come from leaks between the HV electrodes, through glass and epoxy surfaces!! We will work on it in the next prototypes, that are already in the oven..
Sealed Chamber

CONSTANT $^{60}$Co contribution

“pure” gas mixture inside gaps
Conclusions and near future

• MARTA
  • Need to work on improvement of gas system distribution.
  • Urgent to finalize DAQ to have constant data taking, which is of major importance for detector/system improvement.

• LouMu
  • Gas delivery lines need new material to limit moisture pollution of the gas.
  • All system very stable and producing good physics results

• Sealed Chamber
  • First 1 m² prototype, pop on some challenges with respect to leakage currents influenced by room RH. Need to work on stable solution.
  • Double gap sealing process seems to be correctly done.
  • Apart from DC leakage currents chamber operate stable over 1.5 months, test ongoing.
  • New prototypes already in production.
  • Full characterization of the detectors also in the line.
  • Important after getting a stable and reproducible chamber. Study the effect of temperature excursions (minimum 10-15 °C) on the chamber mechanical robustness and sealing
  • Most important, how long the chambers are able to operate smooth.