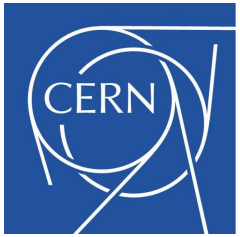

Commissioning and testing of a prototype detector for ultra long-lived particles

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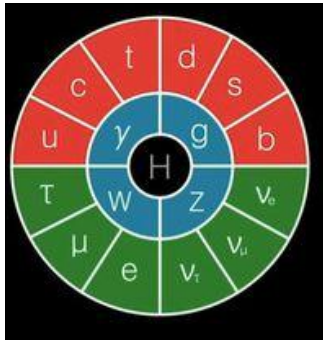
Roberto Guida (CERN)

Student Session
August 7th, 2018

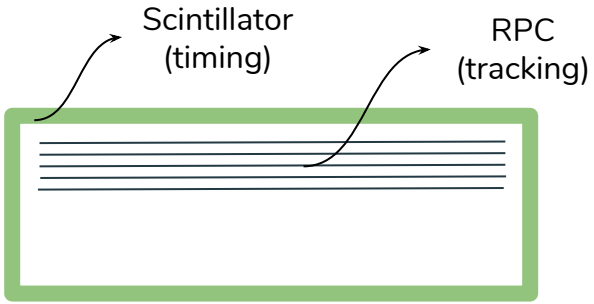
Motivation



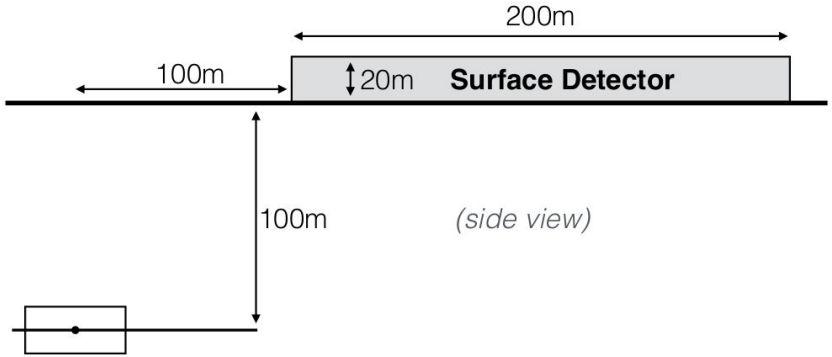
The Standard Model (SM) of particle physics…

- ➔ Completed by the 2012 discovery of a 125 GeV Higgs boson;
- ➔ Consistent with almost all the phenomena observed at colliders;
- ➔ There are still some unsolved problems;
  - ◆ Dark matter, neutrinos masses, hierarchy, matter-antimatter asymmetry
- ➔ Beyond the Standard Model (BSM) physics;
  - ◆ many models suggest the existence of **long-lived particles** with a macroscopic decay length that decay into SM particles (leptons and/or jets)
- ➔ **Neutral long-lived particles**;
  - ◆ Current studies at LHC are limited by detector size and large backgrounds
- ➔ **MATHUSLA** experiment
  - ◆ No LHC background
  - ◆ Allows to improve the sensitivity for much longer lifetimes

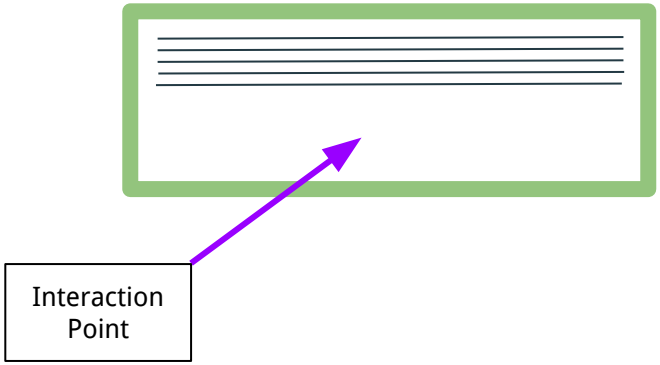
MATHUSLA (MAssive Timing Hodoscope for Ultra Stable neutraL pArticles)

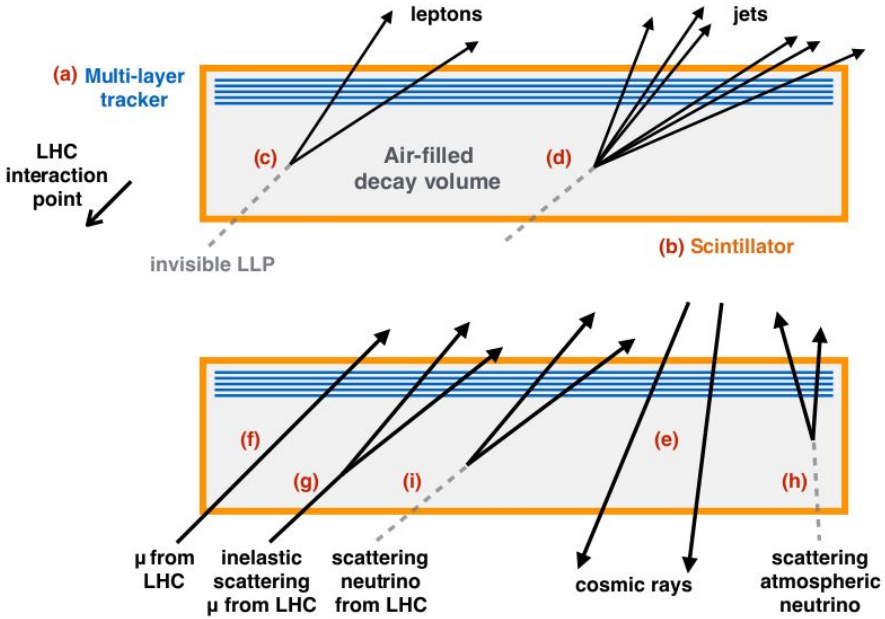


- The detector consists of an air-filled-decay volume, surrounded by 1 cm thick plastic **scintillator** and a multilayer of a **Resistive Plate Chamber** (RPC);
- Proposal 2018: 200 x 200 x 20 m^3;
- Located on the surface above and somewhat displaced from ATLAS or CMS interaction point.

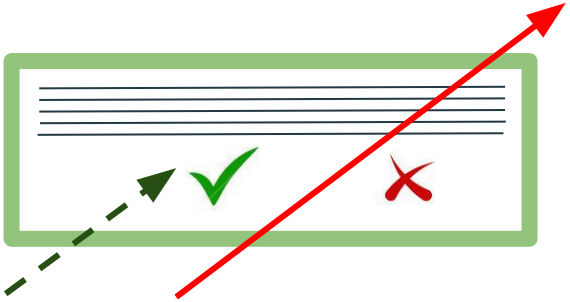


Geometry requirement:





Scintillator veto:

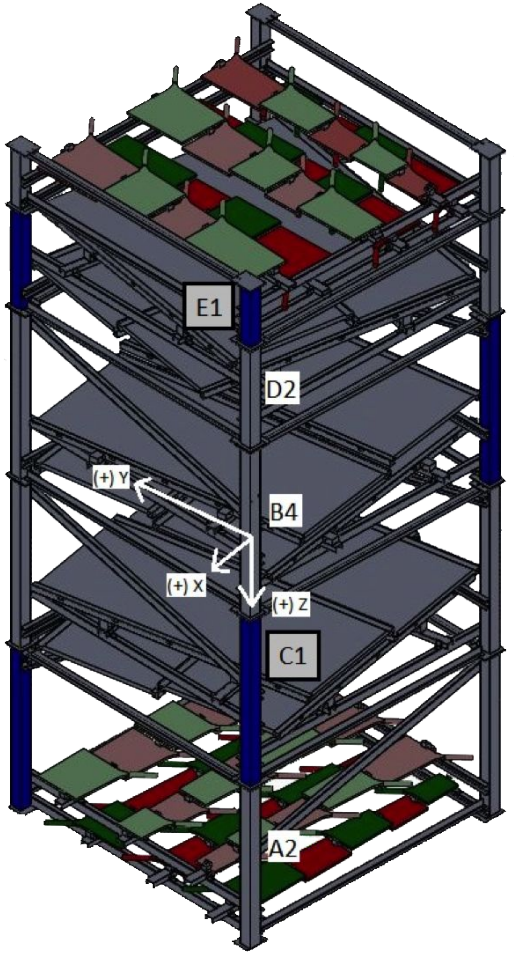


arXiv 1606.06298

MATHUSLA Test Stand

- MC simulations need data with LHC colliding protons and also when the beam is off;
- Test stand assembled last October thanks to the big help of CMS and ATLAS;
- 6.5 x 2.5 x 2.5 m^3;
- Main purpose: provide empirical information on potential **backgrounds** coming from the **LHC** as well as from **cosmic rays**.

- Cheap and fast test stand
  - RPC: from Argo-YBJ experiment (University of Tor Vergata, Italy);
  - Scintillators: from Tevatron DØ experiment (Fermilab)



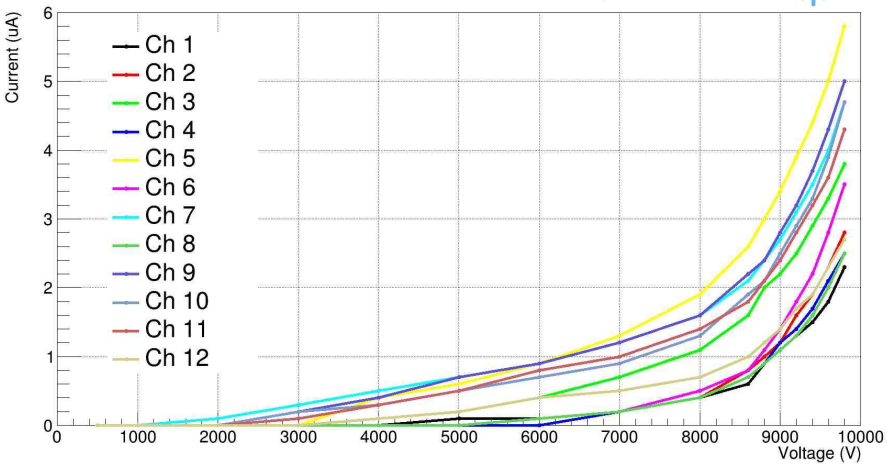
Gas performance in RPC **depends on the environmental conditions**

GasGain = GasGain(T,p)

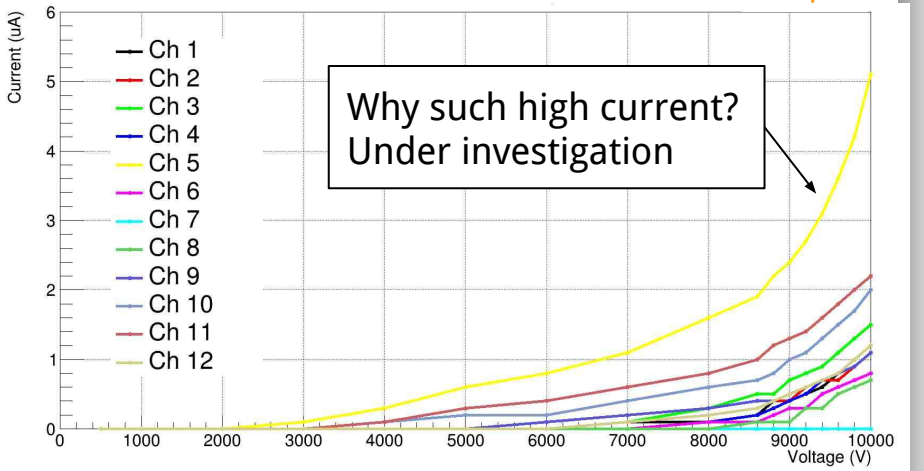
Different gas mixture, temperature and pressure

I did a couple of HV-I scans to check the RPC performance this Summer

November 2017

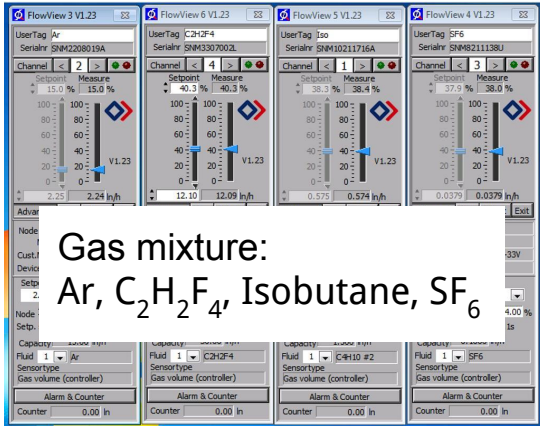


July 2018



JINST 8 T03002

Goal: constant gas performance → calibration!



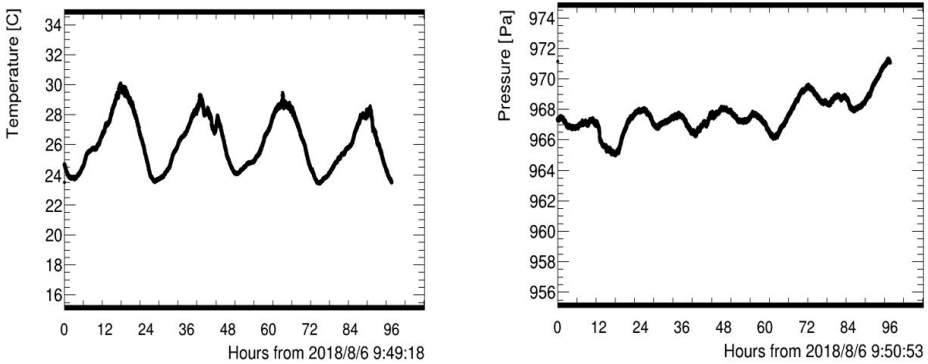
Gas mixture:
Ar, $C_2H_2F_4$, Isobutane, SF_6

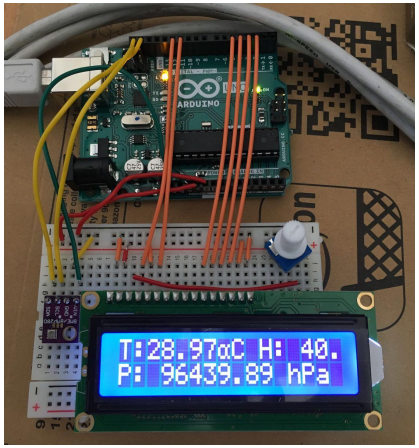
✓ Gas flow

I wrote a code that constantly tracks the gas mixture, and sends an email to the collaboration in case of any change.

✓ Temperature & pressure

I built an arduino system that constantly tracks the temperature and the pressure





❑ High voltage (on going)

I'm working on a code to automatically change the applied high voltage according to the environmental conditions

Conclusion

1. MATHUSLA experiment is a possibility to study ultra long-lived particles in BSM;
2. My project during the Summer School is a contribution to the commissioning of a test stand, that will be crucial for the design of the main detector:
    a. Monitored performance of the RPC
    b. Development of systems to monitor the gas flow and the environmental conditions

References

1. New Detectors to Explore the Lifetime Frontier - Chou J. *at al.* - arXiv 1606.06298, 2017
2. Ultra Long-Lived Particles with MATHUSLA - Cristiano Alpigiani - Proceedings of Science ALP2018, 2018
3. Operational features, monitoring and control for the RPCs in the ARGO-YBJ experiment - Camarri P - JINST 8 T03002