

# Cherenkov detectors for muography applications with the MIMA tracker

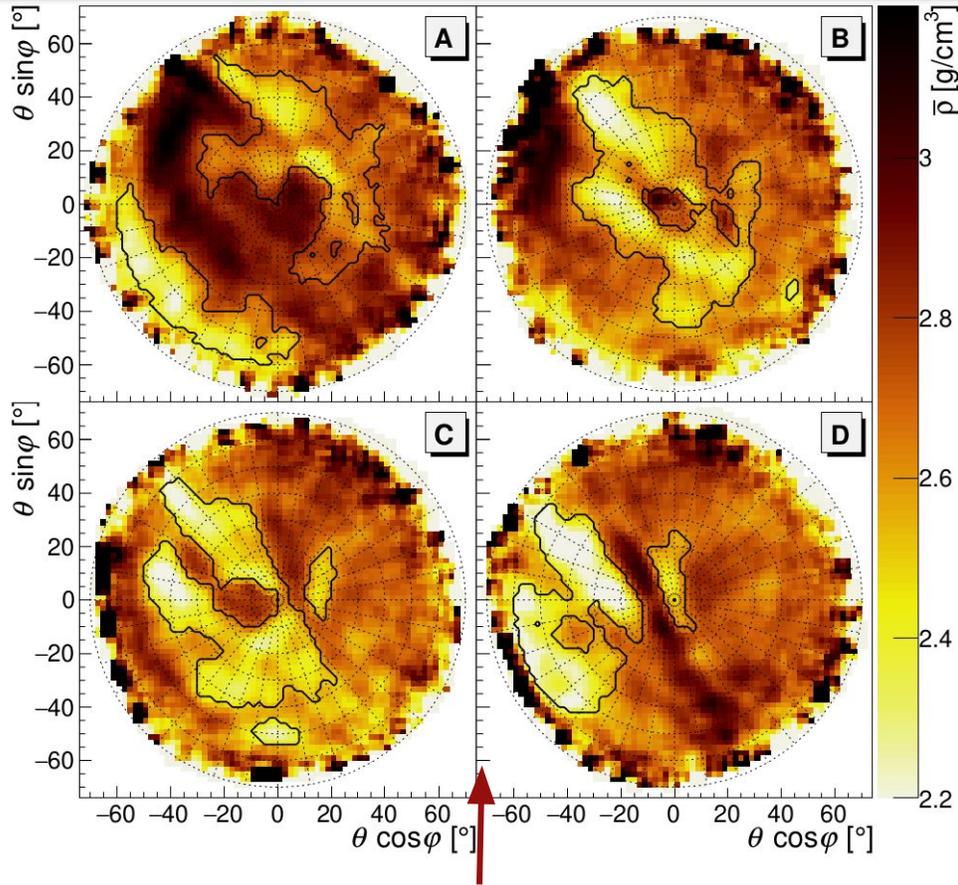
First MODE Workshop on Differentiable Programming

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On behalf of the MIMA Collaboration



# Muon Tomography @Florence - A few highlights

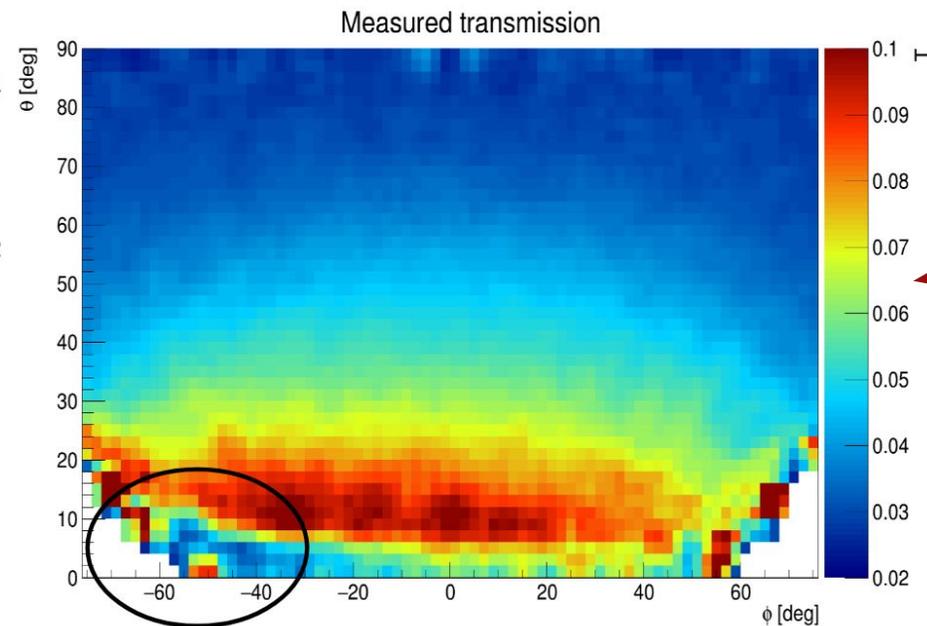
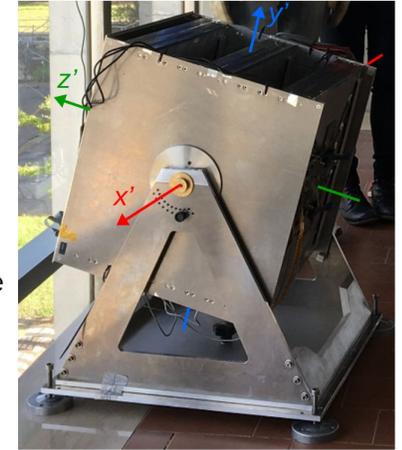
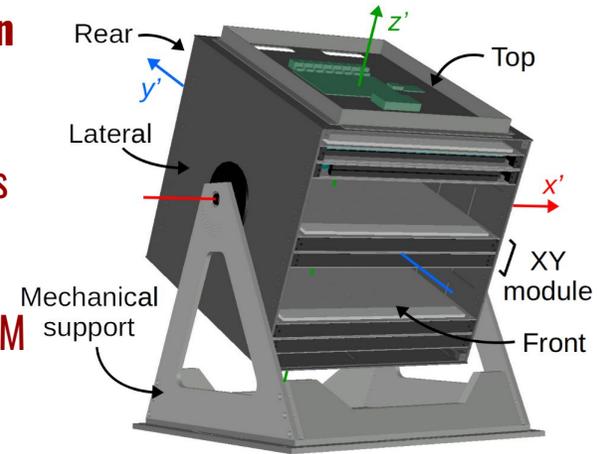


**Measurements at the Temperino Mine**  
Low opacity clusters identified using 3 measurements from different points of view

[Universe2019.5, 34; doi:10.3390/universe5010034](https://doi.org/10.3390/universe5010034)

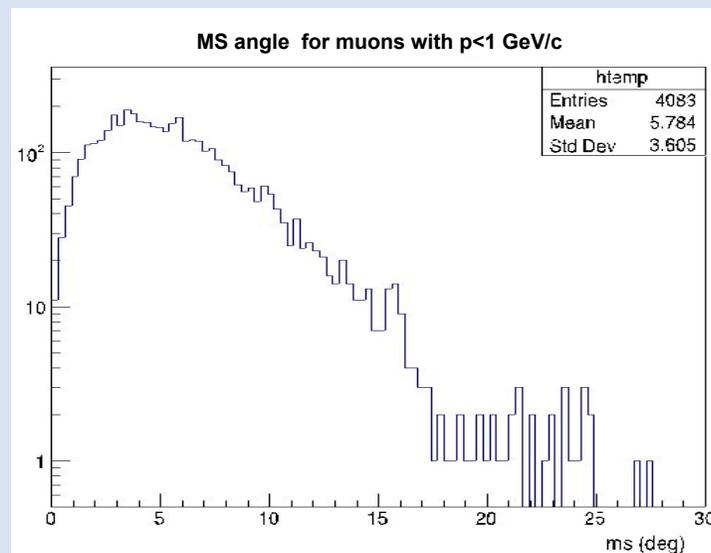
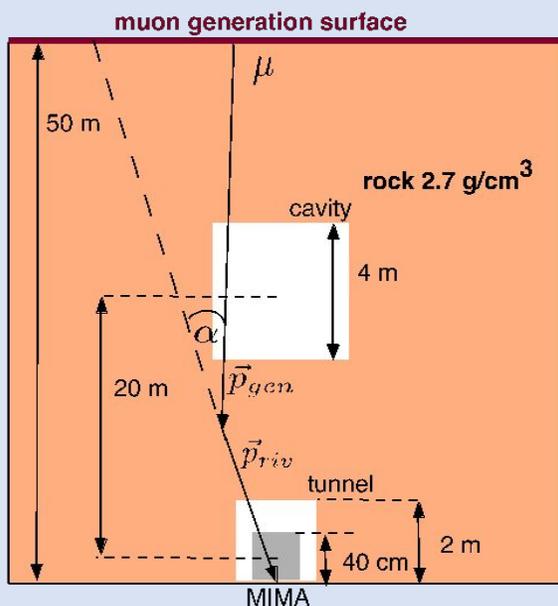
**MIMA detector (Muon Imaging for Mining and Archaeology)**  
3 muon tracking planes (x-y) realized with segmented plastic scintillator bars and SiPM

[JINST 13 \(2018\) 11, P11001](https://doi.org/10.1088/1742-6596/11/1/P11001)



**Measurements at the Bilancino Dam**  
Preliminary muon transmission measurements to assess the risk of breakage inside the dam structure

**Geant4 simulation:** detector under 50 m of rock observing a cavity 20 m away

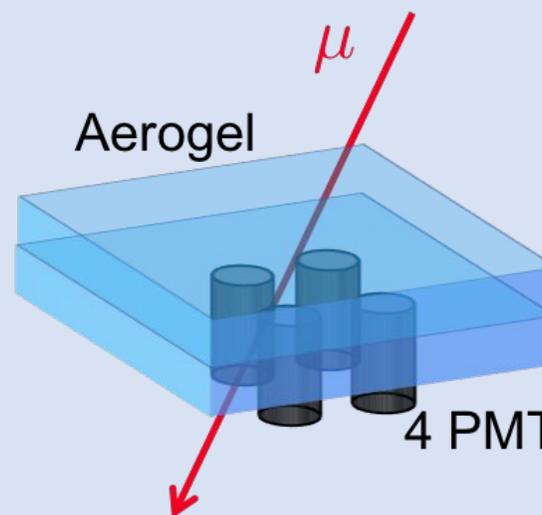


$\alpha$ : angle between the muon's initial and final direction

Below  $\sim 1 \text{ GeV/c}$  the average MS angle is of about 5 degrees, greater than the typical angular resolution of trackers used in muography (i.e.  $\sim 0.8$  degrees)

**Low Momentum Muon Discrimination System:** light and easily transportable

aerogel Cherenkov threshold detector



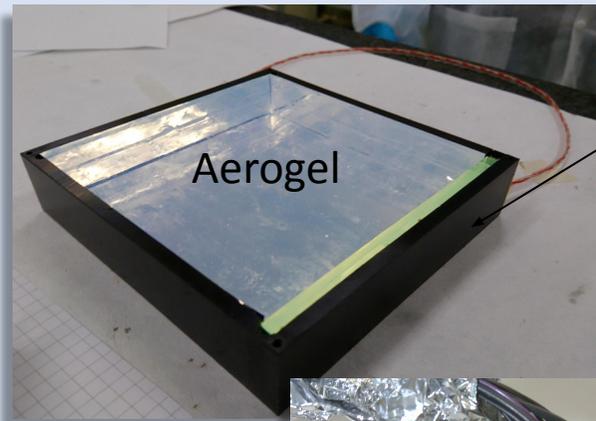
First test of a prototype:

- Two layers  $(11.5 \times 11.5 \times 0.9) \text{ cm}^3$  + 4 PMTs
- $n=1.03$ ,  $E_{thr} \sim 0.4 \text{ GeV}$ ,  $\beta_{thr} \sim 0.97$

The Cherenkov detector can be used together with the tracker to veto low momentum muons.

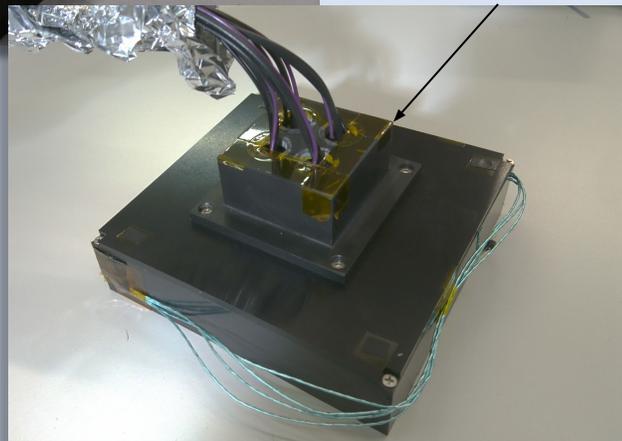
## Prototype of the Cherenkov detector

- Two layers (11.5x11.5x0.9)  $cm^3$  + 4 PMTs
- $n=1.03$ ,  $E_{thr} \sim 0.4$  GeV,  $\beta_{thr} \sim 0.97$

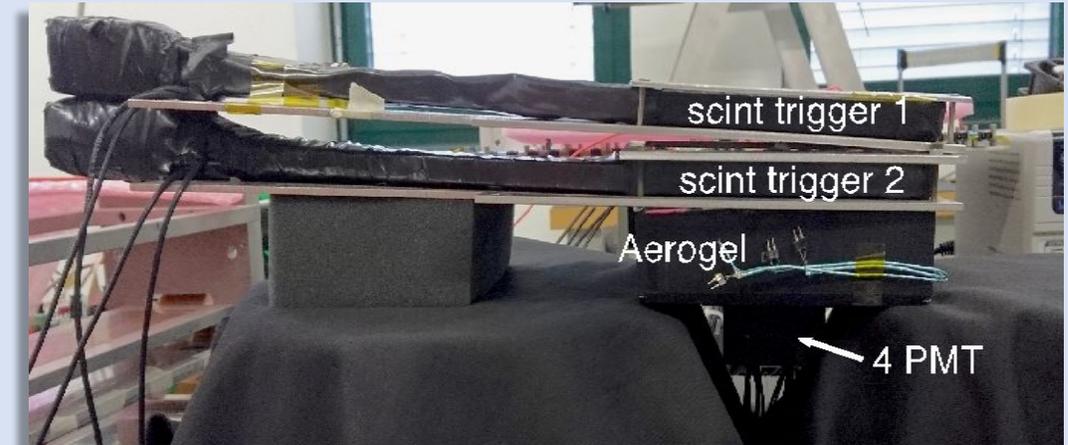


black PVC housing box

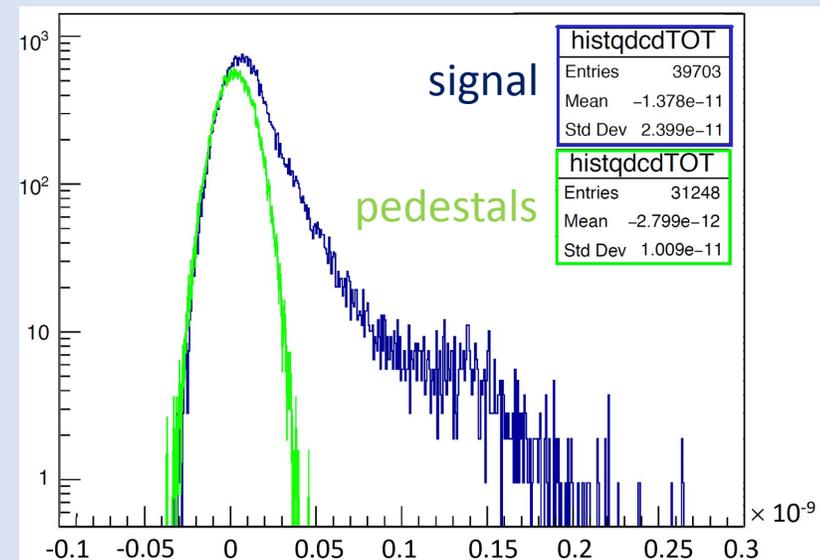
4 PMT R7400U-03 Hamamatsu



## Setup for preliminary tests on charge collection



Sum of the 4 PMT signals



- **Refractive index of the aerogel**
  - Lower  $n$  → higher energy threshold → better low momentum muon rejection
  - But higher cost of the aerogel
- **Thickness of the aerogel layer**
  - Thicker layer → larger signal
  - But potentially worse light collection efficiency of the PMT
- **Several other aspects could be optimized**
  - Size of the Cherenkov layers
  - Cherenkov detector position inside the tracker
  - PMT number and type
  - ...