Measurement of the muon flux in the bunker

of Monte Soratte with the CRC detector

What is CRC?

The Cosmic Ray Cube (CRC) is a portable tracking device conceived for outreach activities allowing a direct scientific experience for secondary school students.

- □ 48 channels
- 4x1x24 cm³ scintillating bars with TiO₂ reflector
- □ WLS fibres Y-11 coupled to SiPMs
- LEDs placed on SiPMs for real-time visualisation of cosmic rays
- its operation requires only the standard electrical power



Measurements

- In the bunker of Monte Soratte, ~50 km north of Rome - candidate site to host the Ptolemy experiment.
- Integrated data taking time of about 2 months during Covid-19 lockdown.
- Technical rotating support to scan in azimuth and zenith bins of $\Delta \phi = 15^{\circ}$ and $\Delta \theta = 15^{\circ}$:
- measure differential muon flux in the whole upper hemisphere.

Event selection

3D trajectory of muon crossing CRC reconstructed from 2D projections.

- ▷ each of the 4 planes of a lateral view with \ge 1 turned on LED
- ▹ if 2 LEDs are turned on in a plane, they must be contiguous
- > χ^2 < 1.5 from linear regression
- ▶ all previous conditions must be valid for both *x* and *y* views

Efficiency measured in 9x9 bins of 10° width with ~ 10° cosmic muons. Efficiency of a single plane is $\epsilon_{plane} \sim 93\%$.





Cosmic Ray Live" app for smartphones enables the connection of several CRCs around the world!

Analysis & Results

Differential muon flux

 $\Phi_{\mu} = \frac{R}{\omega \cdot S \cdot A \cdot \epsilon}$

The Φ_{μ} scan highlights the details of the mountain above the bunker

providing a map of the rock thickness that surrounds the detector.

A the Soratte hypogeum Φ_{μ} is more than O(10²) lower than on surface:

 $\Phi_{\mu} = 0.3 \text{ m}^{-2} \text{s}^{-1} \text{sr}^{-1}$

- R = cosmic muon rate
- ω = solid angle defined in a bin $\Delta \theta_x \Delta \theta_y$
- S = surface of a CRC plane







compatible with the requirements of astroparticle physics experiments requiring a low cosmic ray induced background. We plan to add the Soratte bunker to the educational CRC network at the disposal of high school students.



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