MUON TOMOGRAPHY

Muon Tomography

Every second of every day, we are bombarded with thousands of particles that pass through our bodies without us noticing. Many of these particles are muons, second-generation leptons that are produced by cosmic rays and reach Earth's surface at a rate of 1 per square centimeter per minute!

Cosmic rays (https://home.cern/about/physics/cosmic-rays-particles-outer-space) are a form of high-energy radiation that originate from outside our solar system. When they reach Earth, the rays collide with particles in the upper atmosphere to produce a "shower" of particles, including muons. Muons are heavier than electrons and don't get absorbed by materials as quickly as their less-massive relatives. They do not lose as much energy as they travel, allowing them to penetrate more deeply into materials than X-rays or other forms of radiation. Because of this, muons are excellent for probing unseeable objects.

Scientists today are finding ways to put these particles to use. One technique called Muon Scattering Tomography (https://en.wikipedia.org/wiki/Muon_tomography#Muon_scattering_tomography) (MST) uses cosmic ray muons to construct three-dimensional models of the densities of obstructed objects or volumes.

MST is based on multiple Coulomb scattering (https://en.wikipedia.org/wiki/Rutherford_scattering), a phenomenon in which muons are deflected and slow down when they interact with material with a high atomic number, or "high-Z". In multiple Coulomb scattering, particles are scattered due solely to the Coulomb force, the force that says opposite charges attract and like charges repel. As negatively-charged

muons pass through a volume, they interact with the negatively-charged electrons in the material and are deflected. Researchers can analyse their angles of deflection before and after passing through a volume to gather information about the mass they are inspecting.

Click the links below to read about different ways researchers are using muon tomography and CMS technology to safeguard our cities, preserve our environment, and protect human health.

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CERN

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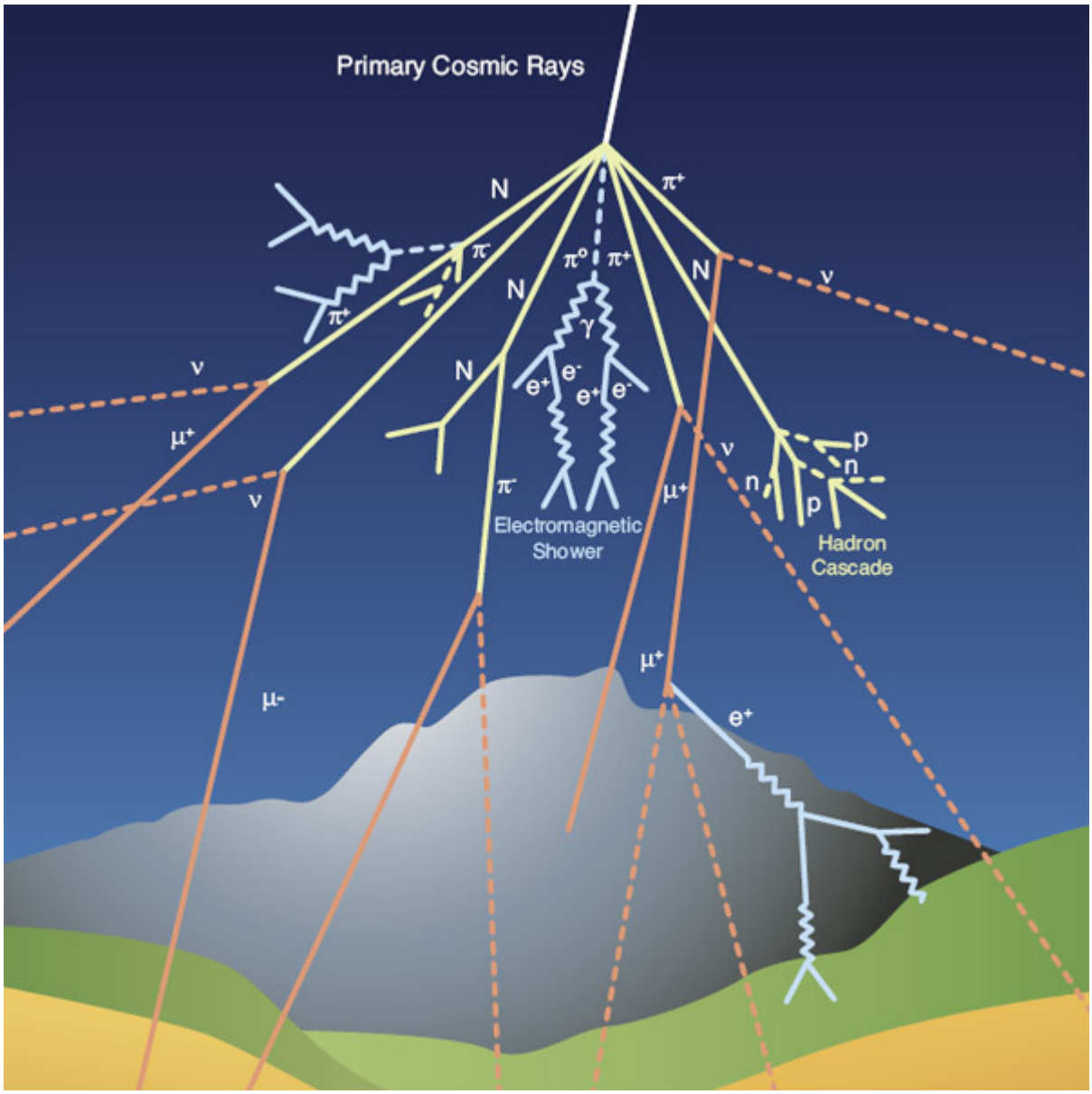

(//cds.cern.ch/images/CMS-PHO-GEN-2017-008-1)

A diagram of cosmic rays interacting with the atmosphere and producing secondary particles, including muons. (Image: CERN)

DETECTOR

How CMS works

- Bending Particles (/detector/bending-particles)
- Identifying Tracks (/detector/identifying-tracks)
- Measuring Energy (/detector/measuring-energy)
- Detecting Muons (/detector/detecting-muons)

Building the CMS Detector

- Civil Engineering (/detector/civil-engineering)
- Massive Underground Excavation (/detector/massive-underground-excavation)
- CMS Assembly (/detector/cms-assembly)
- Heavy Lowering (/detector/heavy-lowering)

Dealing with Data

- Triggering and Data Acquisition (/detector/triggering-and-data-acquisition)
- The Computing Grid (/detector/computing-grid)

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- Agriculture (/content/agriculture)
- Muon Tomography (/content/muon-tomography)

Security and Environmental Protection (/content/security-and-environmental-protection)

Homeland Security (/content/homeland-security)

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The CMS Experiment at CERN

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