



TETRA TECH

# Cosmic rays in the mining industry

## Muon tomography

Cosmic rays are high-energy particles originating from space. When they reach our planet and interact with Earth's atmosphere, they generate particles known as muons.

Muons are heavy, high-energy particles that can penetrate and pass through any structures on Earth, such as mountains, rock formations, and dams. This property allows applications like muon tomography (or muography), which can be used to investigate the interior of geotechnical structures.

Muon tomography works similarly to X-ray imaging, but instead of using radiation, it employs a natural source of muons, allowing indirect measurement of the density of large objects and inference of other parameters.



## Our differentiation

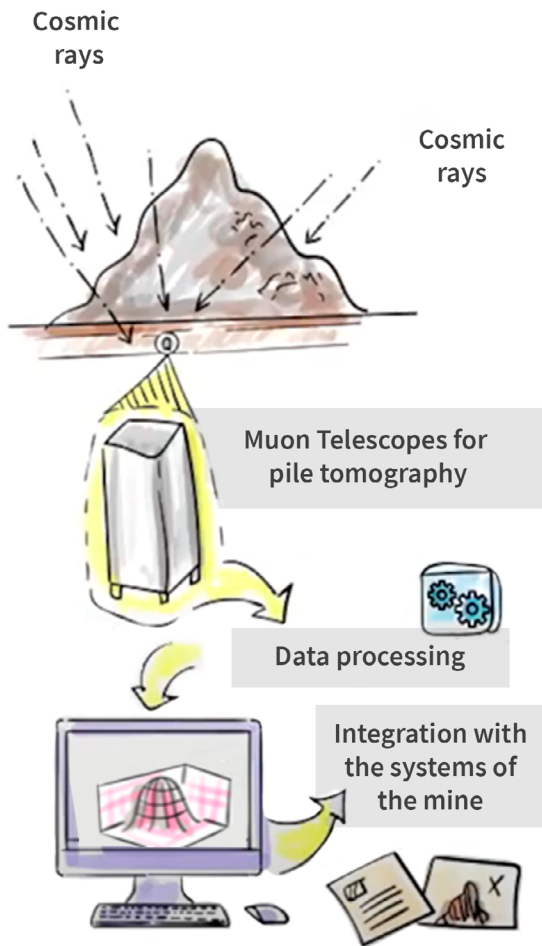
Tetra Tech is a global leader in science and technology, forging partnerships with companies aligned with our vision. In collaboration with **konker**, an expert in **muon tomography**, we conduct data acquisition and processing. Our differentiation lies in the **integration and interpretation** of data to provide customized solutions and well-founded decisions for **geotechnical challenges**.

## Solution

Muon tomography is a powerful and promising non-invasive technology that allows spatial visualization and inference of density variations in different materials.

It operates with one or more muon detectors (telescopes) positioned to monitor the region of interest. The detectors have the following characteristics:

- The systems are autonomous, self-calibrated, and can be configured remotely;
- They work with embedded artificial intelligence;
- They allow the creation of 3D models and monitoring dashboards;
- The systems are robust and offer excellent cost-benefit.



## Applications

Muon tomography can be applied to the mining industry considering different objectives from exploration to operation. Among others, some applications are:

- Temporal monitoring of density changes in the rock and its correlation with the fracturing and media deformation;
- Detection of geological structures and isolated ore bodies;
- Identification of voids and/or density changes in regions of pits, piles and tailings dams;
- Density measurement inside thickeners, minimizing machine downtime.

