IMPERIAL

Muon tomography for non-invasive geotechnical investigations

Supervisory team: Dr Tiago Gaspar (Civil and Environmental Engineering), Dr. Nicholas Wardle (Physics)

Project description:

With increasingly evident impacts of climate change, there is a growing need to improve how unstable coastal cliffs are characterised and monitored. Along the south coast of the UK, cliff failures are occurring under unprecedented conditions. In many cases, understanding and managing these hazards is limited by the inability to safely observe the condition of highly unstable slopes over time.

Conventional geotechnical investigation methods rely on intrusive testing and embedded sensors, which can be unsafe or impractical at actively failing cliffs. As a result, internal changes associated with drying, cracking, or progressive damage often remain unobserved, particularly under extreme conditions where changes can develop gradually before culminating in sudden failure.

This PhD project spans geotechnical engineering and applied particle physics to explore the use of **muon tomography** as a non-invasive method for subsurface characterisation and long-term monitoring of unstable cliffs. Muons are naturally occurring atmospheric particles capable of passing through tens of metres of rock or soil. By measuring how muons are attenuated or scattered, it is possible to infer internal density variations and structural anomalies without drilling or embedded instrumentation.

The project will be developed in collaboration with **Geoptic**, an industry partner specialising in muon imaging systems, ensuring close alignment between fundamental research and real-world deployment.

Student activities

You will conduct lab experiments using muon detectors to study how different soil/rock samples influence measured responses. These experiments will examine sensitivity to material type, moisture, and internal structure and how changes can be detected over time. Building on the lab studies, you will use **multi-detector muon tracking and machine learning**, techniques routinely used in experimental particle physics, to explore how different materials and states can be distinguished beyond density, including sensitivity to atomic number and mineralogical traits. Lessons from the lab will be applied at an **unstable coastal cliff in southern England**, where you will test and refine these approaches in a real-world setting.

Student benefits

This studentship will offer **training across geotechnical engineering, particle physics, and data science**, providing hands-on experience with cutting-edge sensing technologies and field deployment. The student will develop skills in experimentation, machine learning, and interpretation of environmental data while collaborating with academic, industry, and public-sector partners.

In particular, the student will engage with project partner **Geoptic**, gaining insight into detector technology, instrumentation challenges, and practical implementation of muon imaging systems. The student will also interact with partners including the World Heritage Organisation and local council authorities, providing exposure to stakeholder engagement and applied hazard management.

Applicant requirements:

Academic background (essential)

- Applicants should hold, or be on track to achieve, a First Class or Upper Second Class (2:1) degree (or international equivalent) in Civil Engineering, Engineering Geology, Physics or a closely related discipline.

Technical background (desirable)

- Prior laboratory or experimental experience in geotechnical engineering, soil/rock testing, and/or particle physics related experimentation.

Skills and attributes (essential)

- Strong analytical and data processing ability and a clear interest in geomechanics, particle physics, and/or measurement techniques.
- Good written and verbal communication skills in English.

Scholarship:

The studentship will provide funding for up to 3.5 years, including:

- London weighted UKRI stipend (£23,195 per annum for 26/27)
- ***Full funding is available to Home students only (overseas applicants must not apply).***
- Research expenses associated with the project (£4,000 over the 3.5 years) for consumables, conference attendance, and travel associated with the research etc.

How to apply:
Applicants wishing to be considered for this opportunity should send the following application documents to Dr Tiago Gaspar (t.gaspar@imperial.ac.uk):

1. Cover letter, explaining their motivation and suitability by addressing the requirements
2. Current CV including degree result and, if possible, class ranking.
3. Undergraduate and/or postgraduate academic transcripts illustrating grades for each module undertaken

Deadline
The deadline for student applications is **Friday, 27 February 2026.**

Application via the Imperial College Registry is not necessary at this stage, and will follow after discussions with the supervisory team.