Name of research institute or organization:

## Institute of Geological Sciences, University of Bern
## Laboratory for High Energy Physics, University of Bern

Title of project:

Development and scientific application of nuclear emulsion particle detectors to geological problems in 3D

Project leader and team:

Proffs. Fritz Schlunegger and Antonio Ereditato, project leaders
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Project description:

This is an interdisciplinary project between the fields of *Earth Sciences (geology and geomorphology)* and *Physics* (*particle physics methodologies)* where we aim at imaging the base of an Alpine glacier in 3D with nuclear emulsion particle detectors exposed to the cosmic muon flux. This methodology offers a powerful tool to map surfaces that separate media with strong density contrasts (bedrock and the overlying glacier). Modern nuclear emulsion detectors provide an unbeatable position and angular resolution in the measurement of the muon track (< 1μm and a few mrad, respectively). We apply this technique to map the base of the Eiger glacier located in the Central European Alps, where the railway tunnel of the Jungfrau railway provides a unique situation for measuring the base of this glacier in 3D. We have framed the tasks of our project in two distinct objectives, where the scopes are to (i) develop the theoretical background for merging the data from various observation points to derive the 3D density map of the object under investigation, and to (ii) apply the advanced method thereby imaging the bedrock topography underlying the Eiger glacier.

The first objective represents the backbone of this project and includes: (1) the development of 3D inversion algorithms for the analysis of the retrieved images, (2) the optimization of emulsion scanning automated microscopes and the implementation of the software for image handling using state-of-the-art computing solutions, and (3) the design and construction of full scale advanced emulsion muon detectors.

The second objective involves: (1) the reconstruction of a 3D geologic/morphologic model of the Eiger area by combining published geological maps with digital elevation models and measurements of the bedrock fabric along the Jungfrau tunnel, (2) installation of the detectors at two sites within the Jungfrau tunnel, where they will be oriented to view the base of the Eiger glacier on the opposite side of the mountain belt, and (3) the reading out of the data and the reconstruction of the bedrock surface beneath the Eiger glacier in 3D. The data will be used to reveal how glaciers, paired with frost cracking processes, have shaped one of the most spectacular mountain ranges in the European Alps. In addition, this will be the first time that this imaging technique is applied to a geological problem in 3D.

We have started our project at the beginning of October 2015 and installed the first detector with emulsion films at the Eismeer station. A second detector will be installed in the middle of January 2016 between the Eismeer and Jungfraujoch terminal stations.

Key words:
Nuclear emulsion particle detectors, bedrock topography, image analysis, glacial erosion

Collaborating partners/networks:
To be established with colleagues from Nagoya University, Japan

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