Doing muon tomography on volcanoes

Technical issues

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Some constraints

Telescopes must support environmental conditions

* heavy rain (10 m/year)
* strong winds (more than 170 km/h recorded on La Soufrière)
* night/day temperature variations of about 40°C (e.g. Guadeloupe)
* seasonal temperature variations of about 60°C (e.g. Etna)
* relative humidity near 90%
* lightning (one telescope seriously damaged on Etna)
* designed for rope-access techniques and helicopter hauling
* designed for easy installation (2 people are sufficient)
* shocks during transportation (20 g peak acceleration recorded)

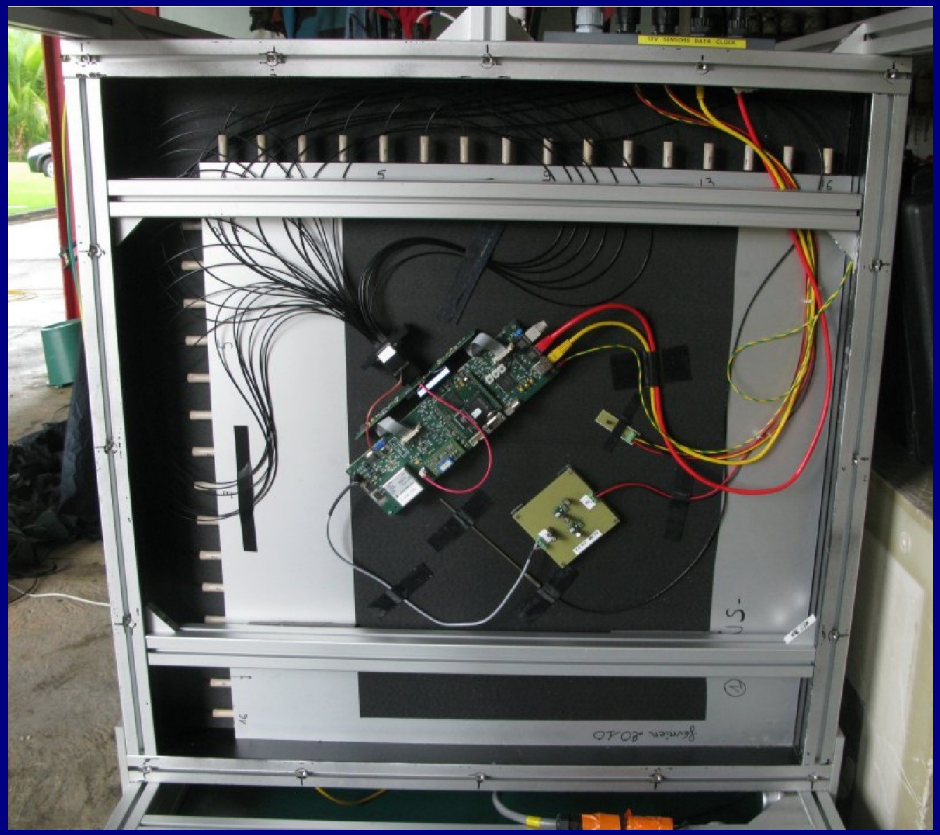
Telescopes must be standalone

* power consumption less than 40W (800W of photovoltaic panels installed on La Soufrière because of cloudy conditions. Wind generators are also used)
* sensors enabling remote control (reboot – switch off during black out)
* sensors for data pre-processing: atmospheric pressure, inclinometers
* telescope must comply with strict safety constraints for both workers and public (e.g. national park of Guadeloupe)

Detection matrices are made with scintillator strips furnished by FermiLab

Matrices count 16 x 16 pixels of 5 x 5 cm^2

Rugged design



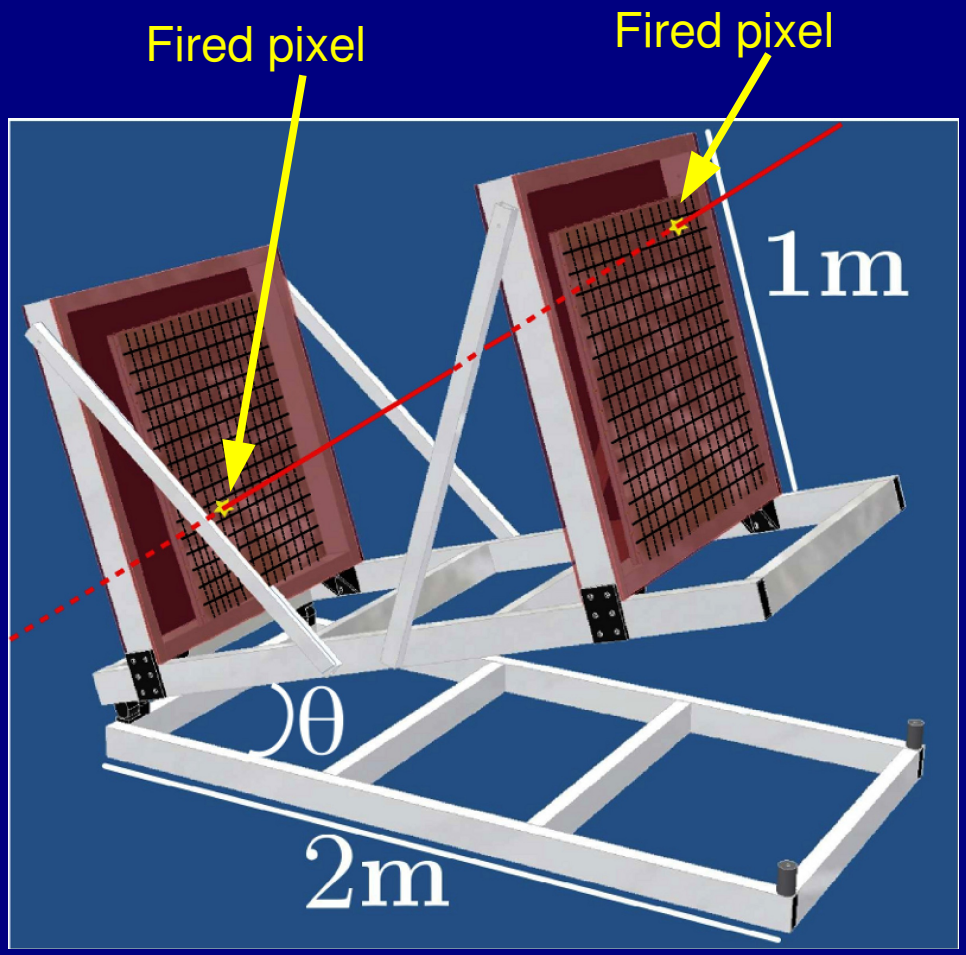
General design

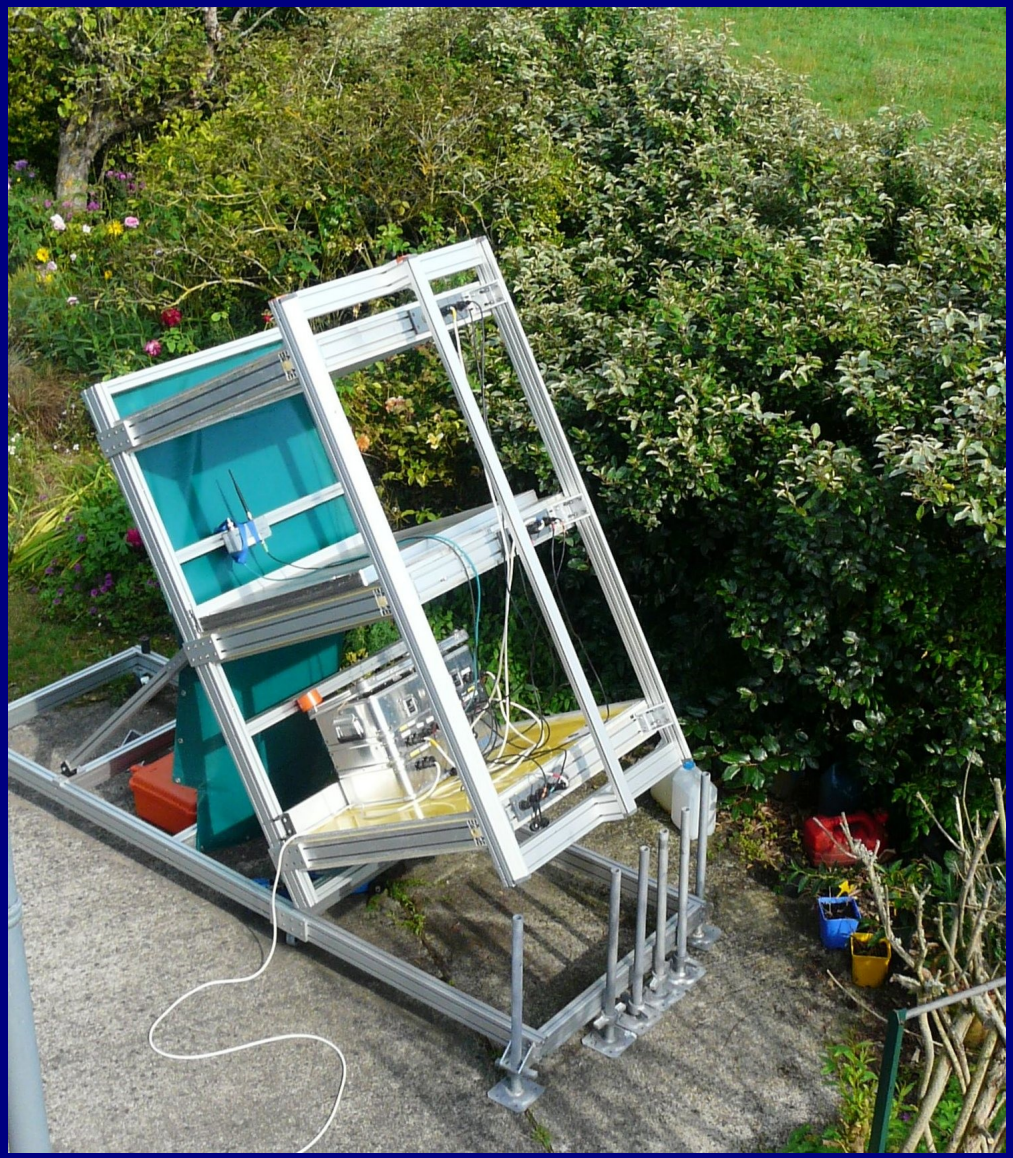
Modular: all items less than 50 kg

2, 3 or more matrices

Iron shielding

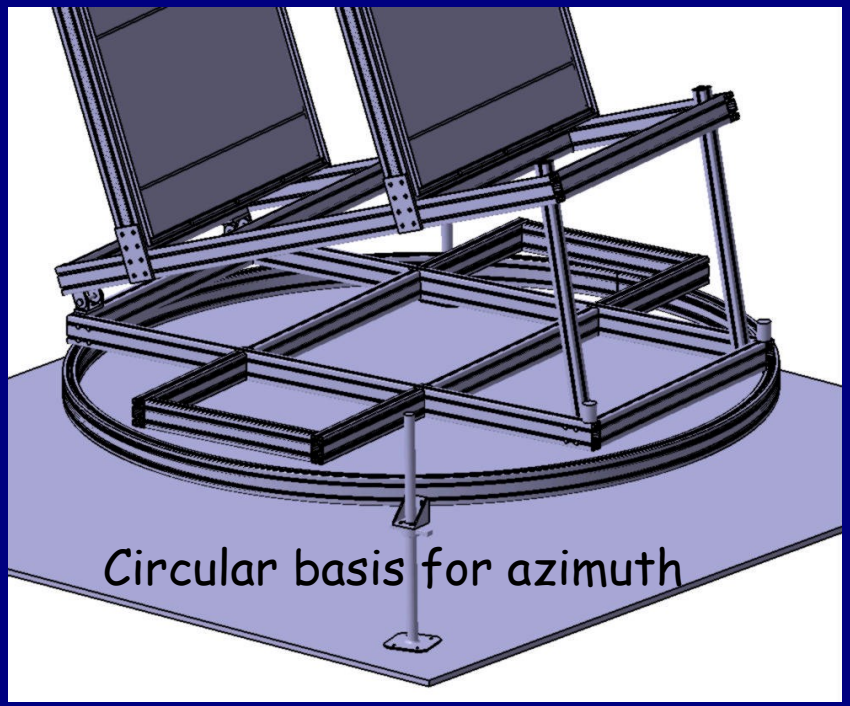
Options: cylinder for easy inclination and circular basis

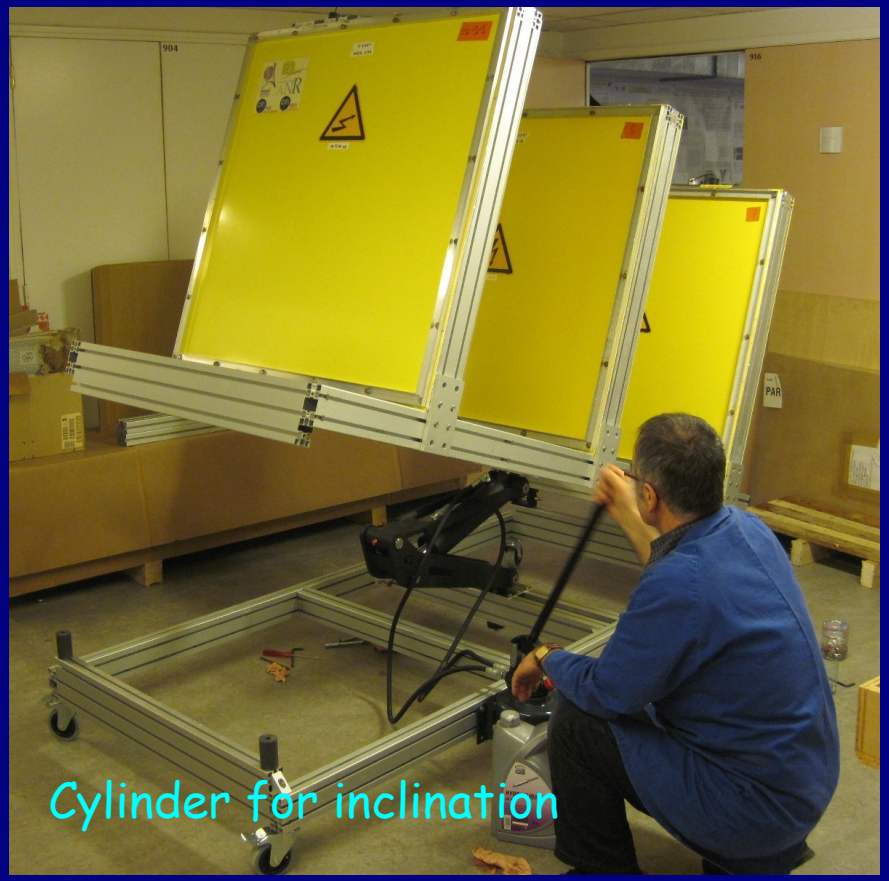


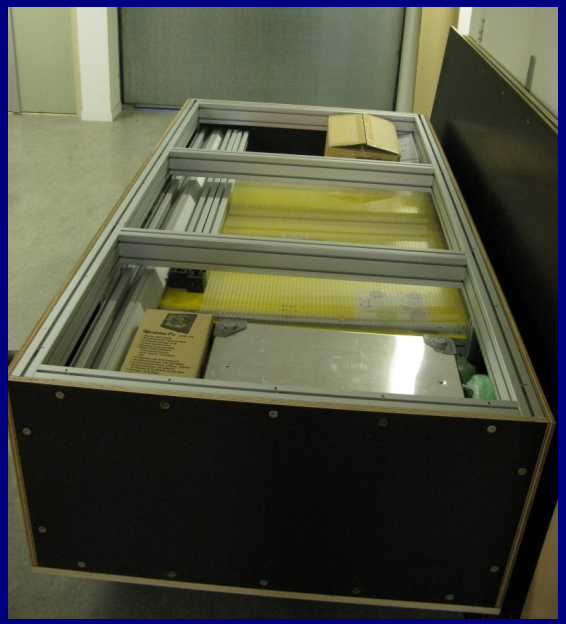


One of the 4 telescopes in a 3-matrices + shielding configuration during acceptance calibration experiment

Mechanical options







The whole telescope
may fit in a single crate

On the field

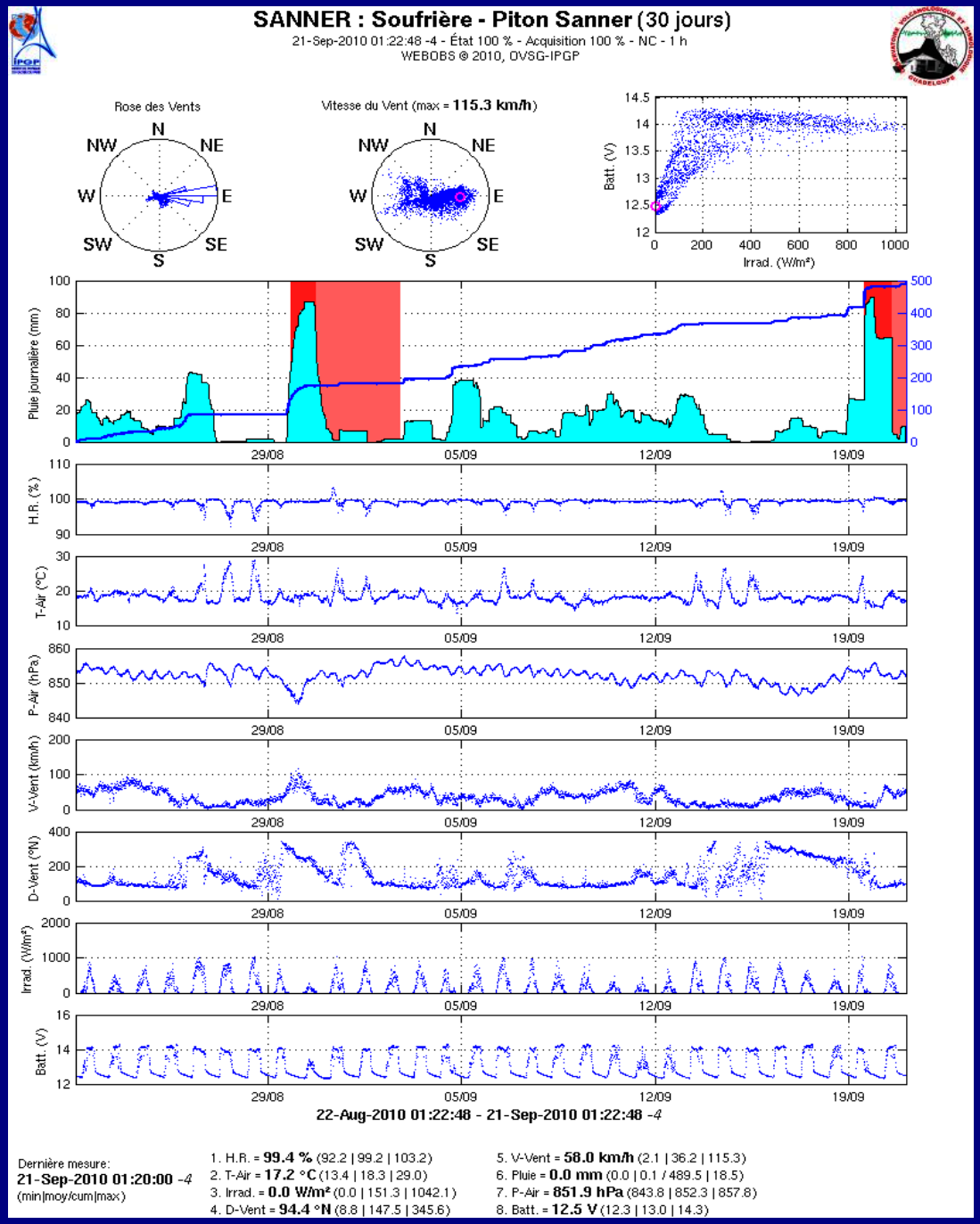
Telescope must be rugged enough to support rain during long stanby before helicoptere removal

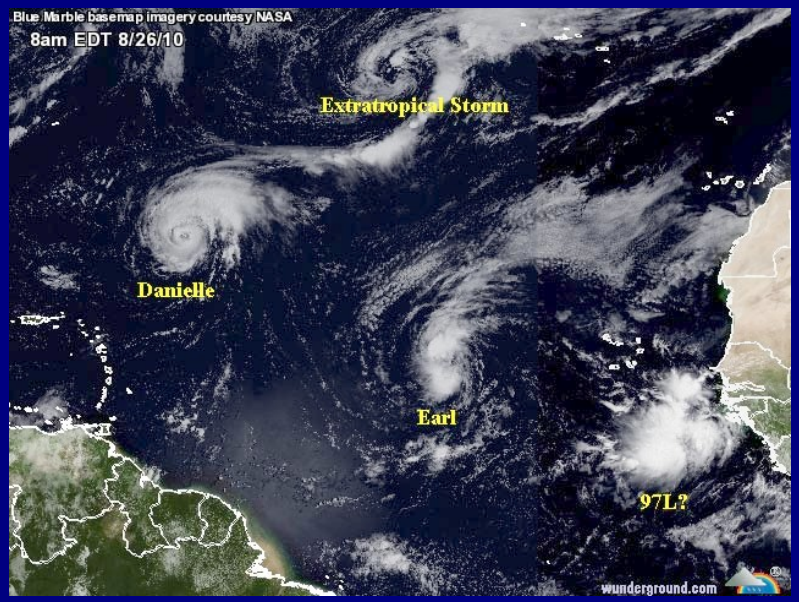
On the field

Heavy rain and strong winds

Cloudy weather

Steep slopes and small landslides

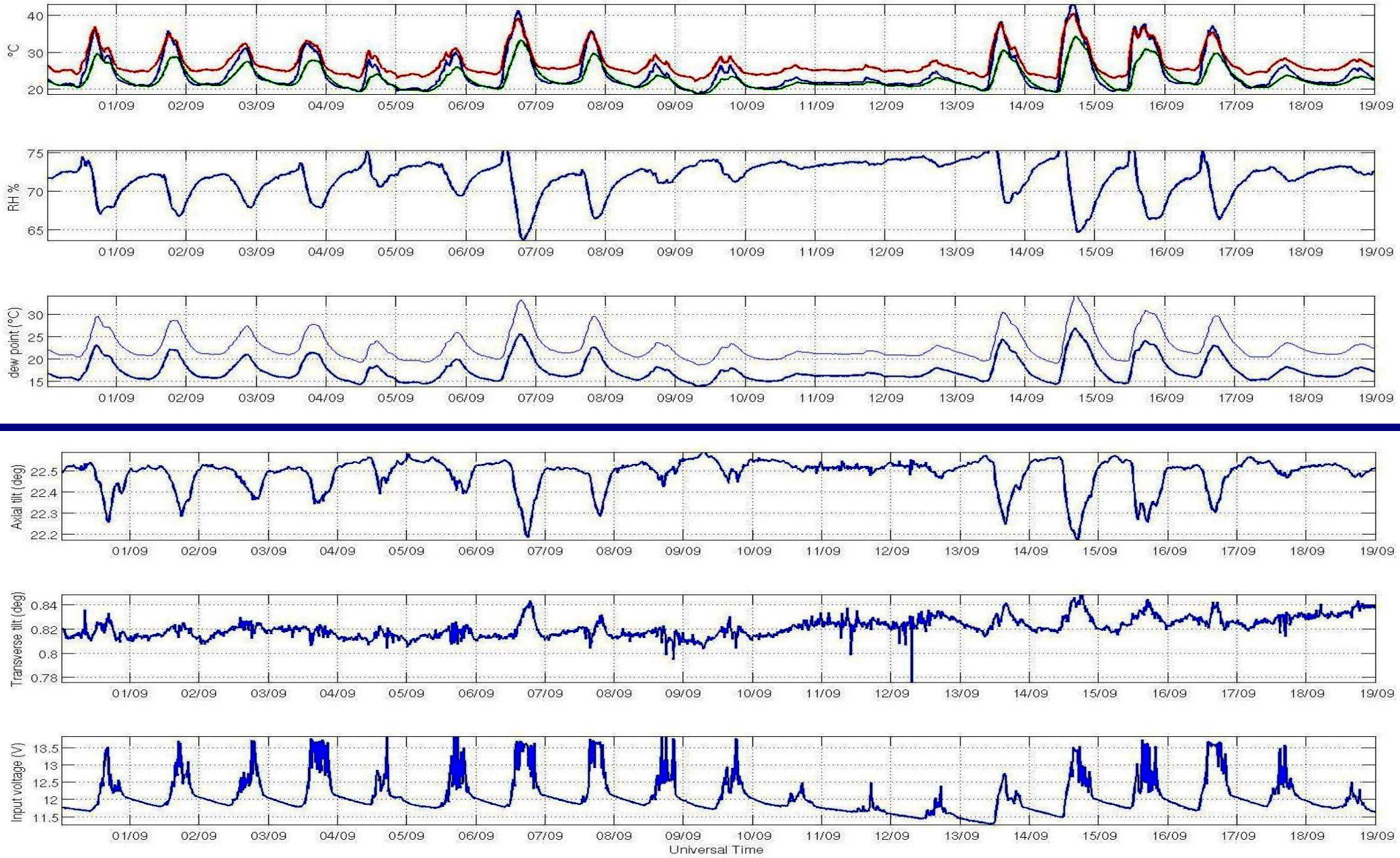




Remote control - Monitoring

Temperature – Humidity – Dew point – Voltage – Inclinometers

Power consumption – Switch off control



On-going projects

Mont Terri underground laboratory (3 years of measurements)

La Soufrière of Guadeloupe (2 years of data)

Mount Etna (first experiment summer 2010, next one summer 2012)

Soufrière Hills Montserrat (start experiment in Autumn)

Publications

Lesparre, N., D. Gibert, J. Marteau, F. Nicollin, O. Coutant & J.-C. Komorowski, Density Muon Radiography of La Soufrière of Guadeloupe: Comparison with Electrical Resistivity and Seismic Tomography, Geophysical Journal International, revised, 2012.

Lesparre, N., J. Marteau, Y. Déclais, D. Gibert, B. Carlus, F. Nicollin & B. Kergosien, Design and Operation of a Field Telescope for Cosmic Ray Geophysical Tomography, Geosci. Instrum. Method. Data Syst., in press, 2012.

Lesparre, N., D. Gibert & J. Marteau, Bayesian Dual Inversion of Experimental Telescope Acceptance and Integrated Flux for Geophysical Muon Tomography, Geophysical Journal International, Vol. 188, 490-497, 2012.

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