MURAVES muography project

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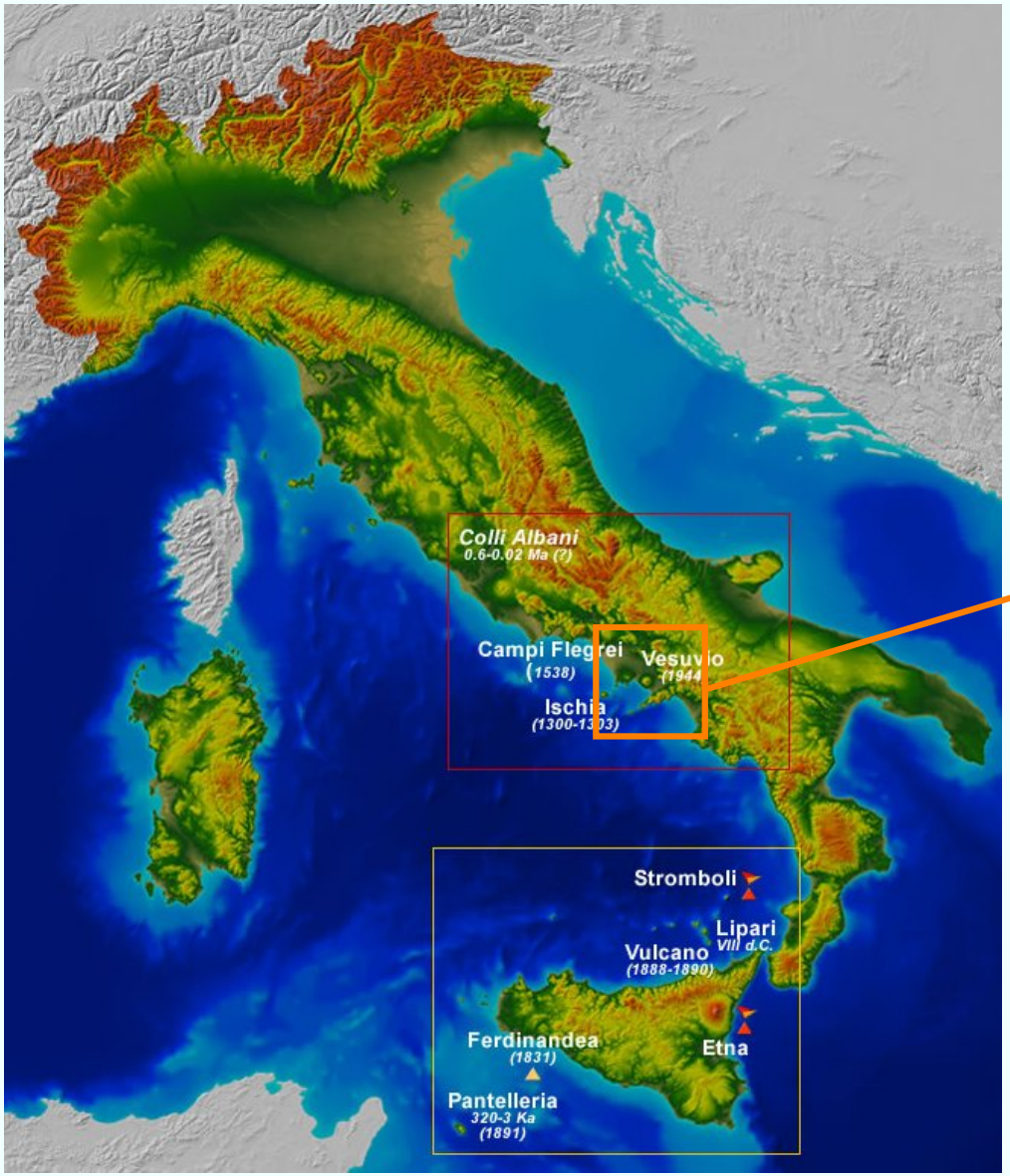
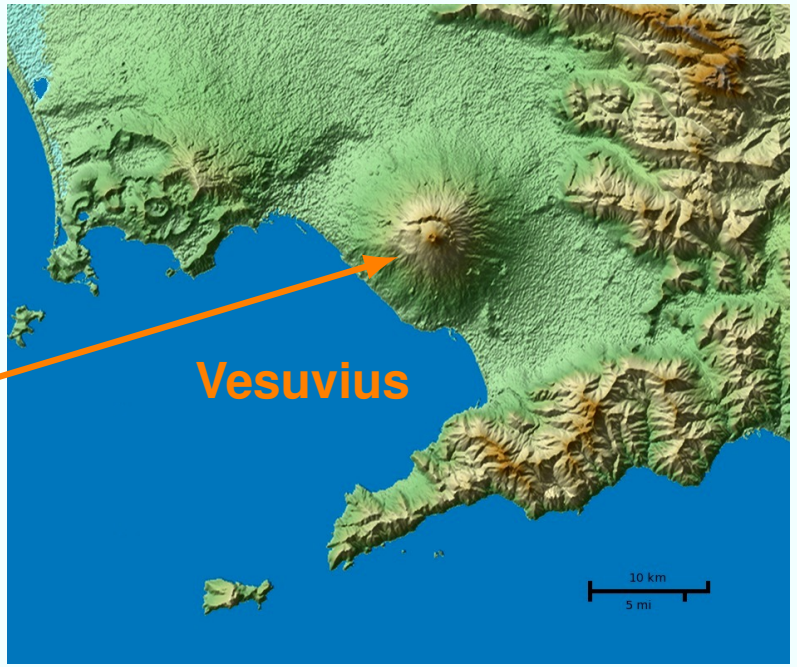
Tokyo, 7 November 2016

Summary

Active volcanoes in Italy (10)

Vesuvius has the highest risk





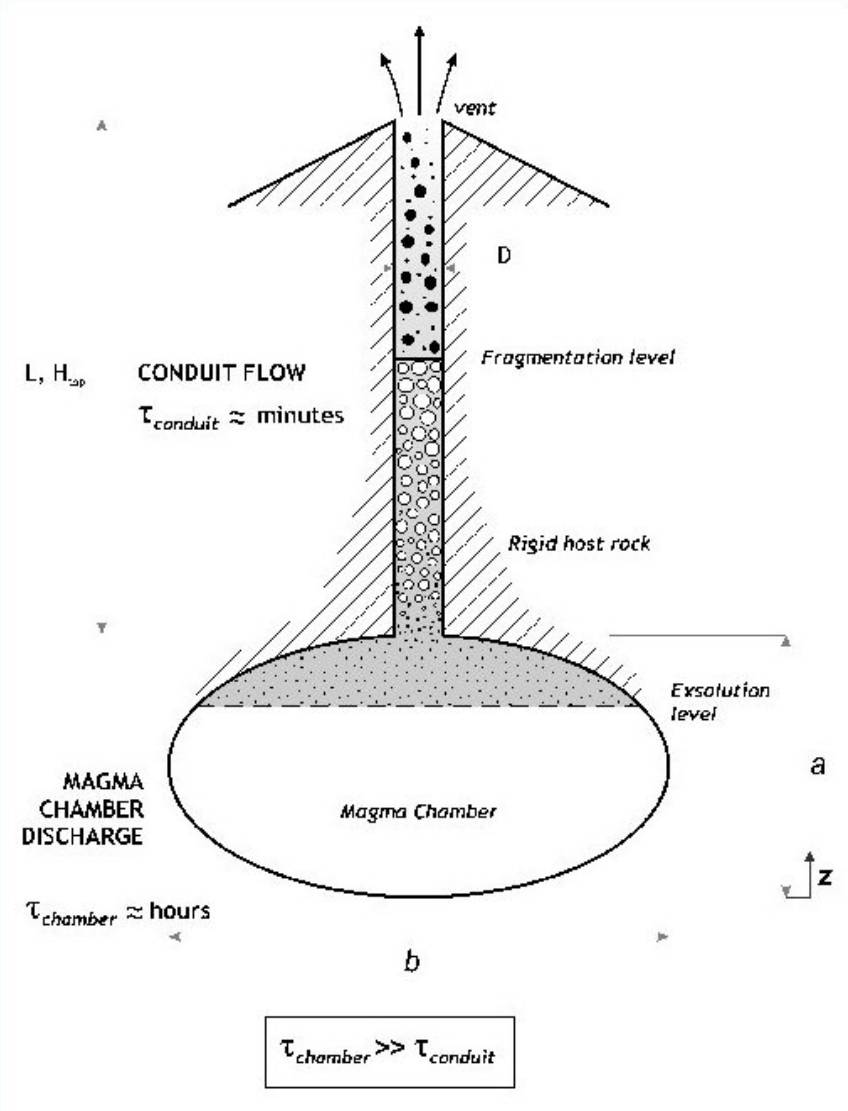
- **Last eruption occurred in 1944**
- **Now the conduit is closed**
- **Monitored 24/24**

Vesuvius has the highest risk

About 600,000 people live in the “Red Zone” of Vesuvius

Vesuvius today

Simplified scheme of a volcano



(from Martí et al., 2000)

The eruption dynamics depends on:

- Gas content
- Chemical composition and temperature of magma (viscosity)
- **Dimension and shape of the conduit**

The vent is circular

The interior of volcanic conduits (dykes)

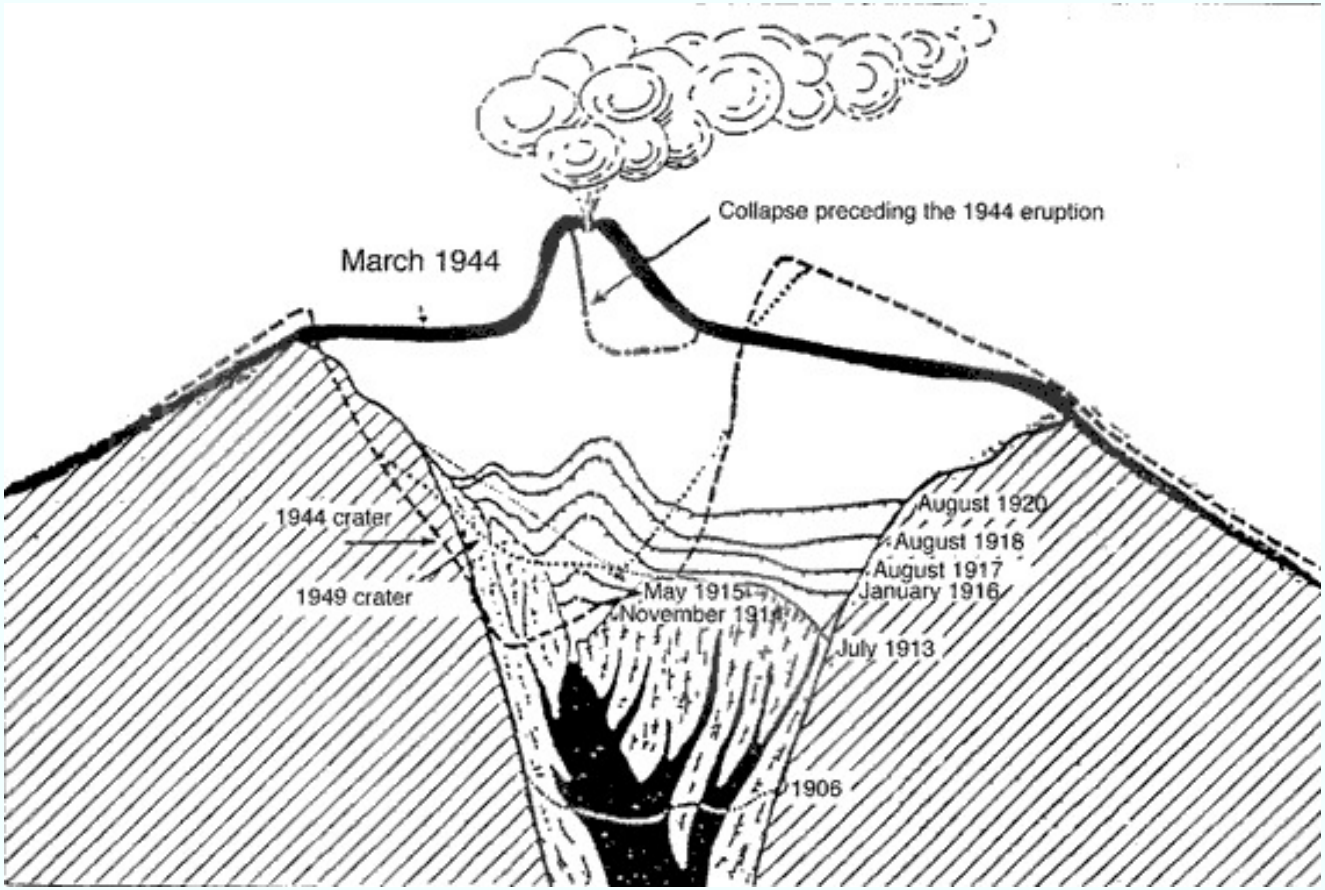
Emerged dyke at Crater Lake

Emerged dyke at Etna

Need: reveal the internal structure of Vesuvius

Past knowledge from direct observations

The Vesuvius crater between 1906 and 1944



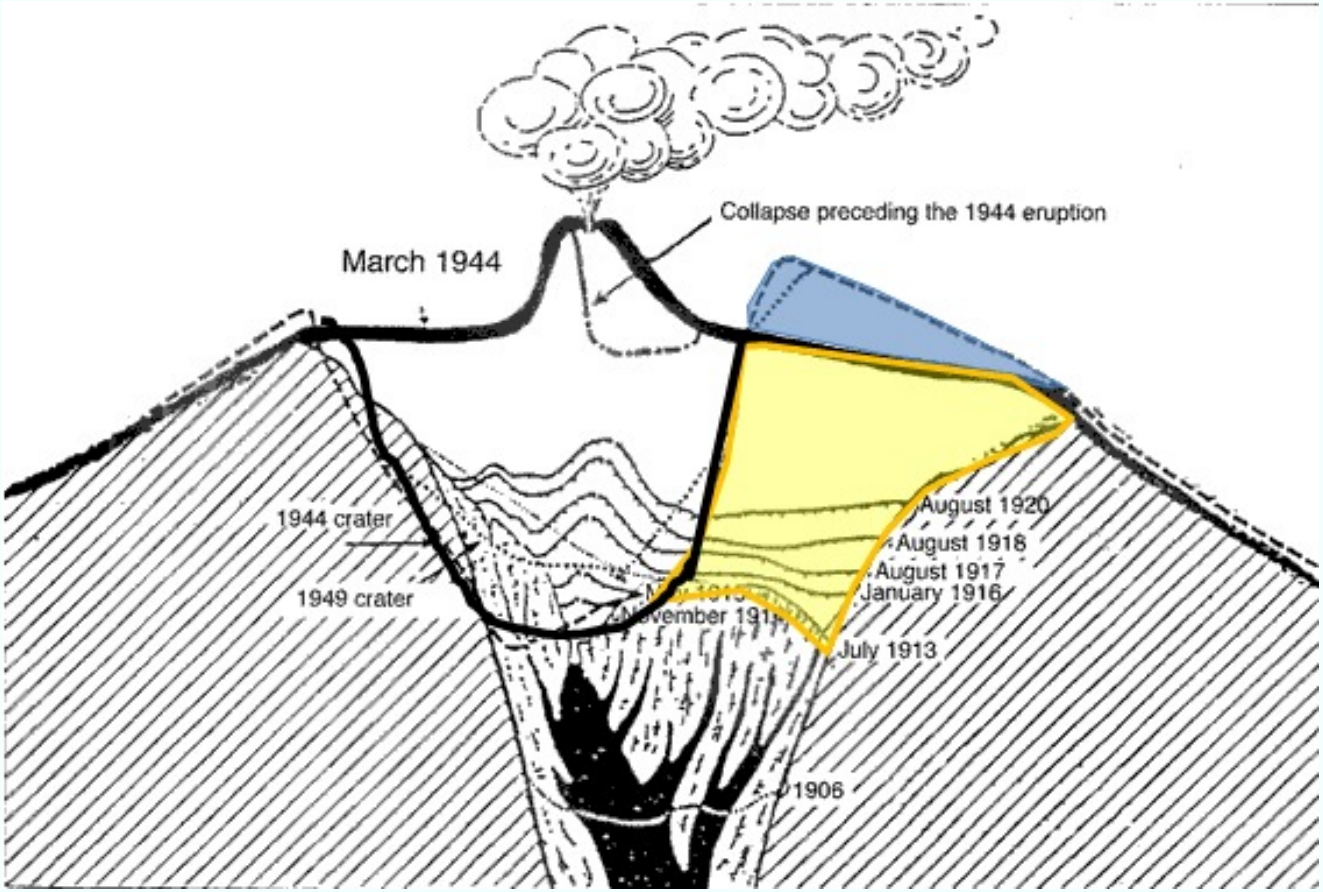
(from Imbò, 1949)

Vesuvius crater in 1944

Need: reveal the internal structure of Vesuvius

Past knowledge from direct observations

The Vesuvius crater between 1906 and 1944



(from Imbò, 1949)

Vesuvius crater in 1944

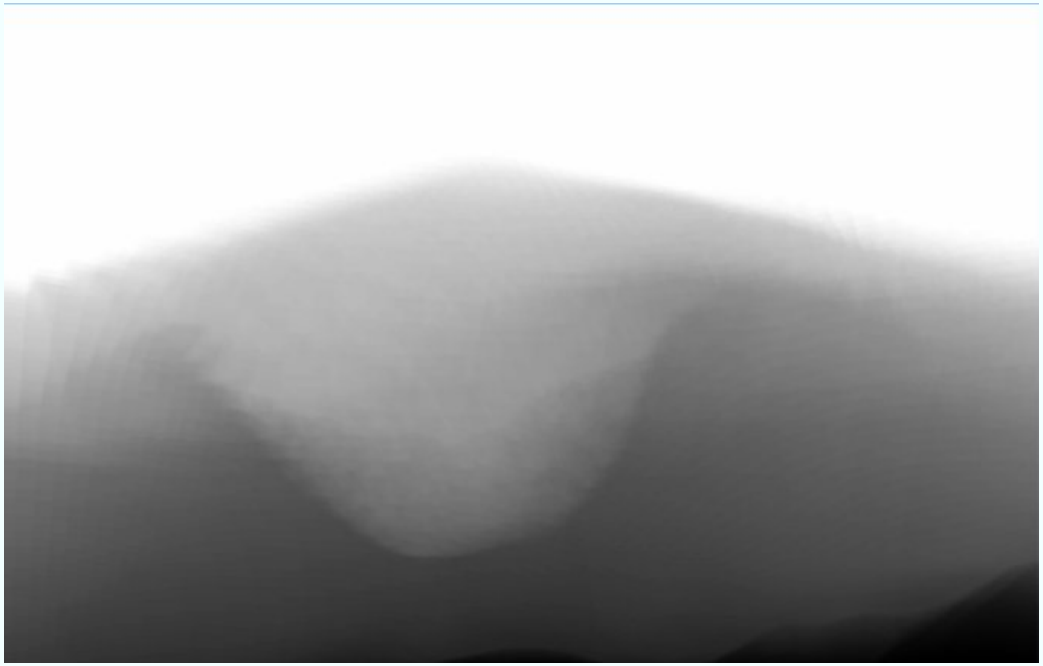
Vesuvius crater today

First experiments of muon radiography at Vesuvius

The MU-RAY project (2009)

Detector location (MU-RAY)

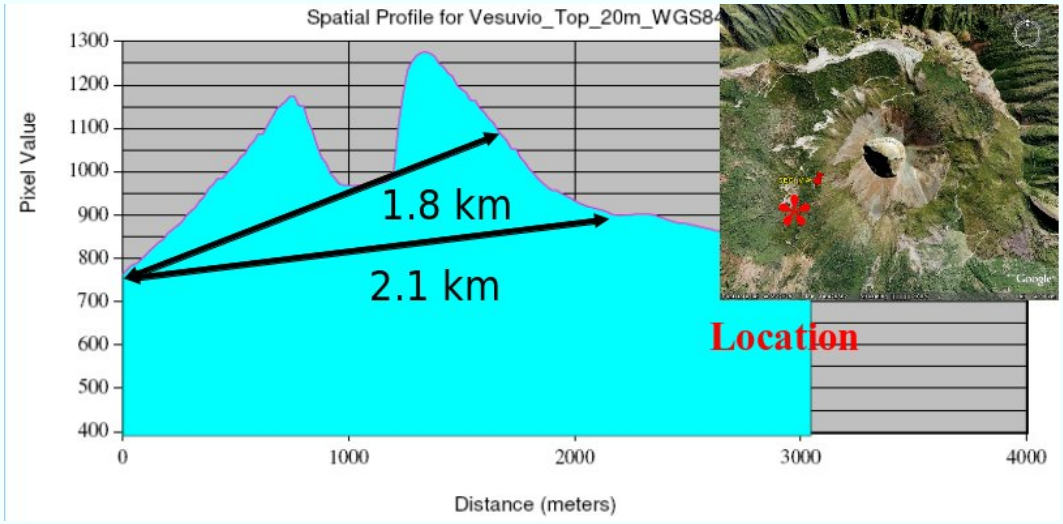
Map of the thickness



(from Macedonio and Martini, 2010)

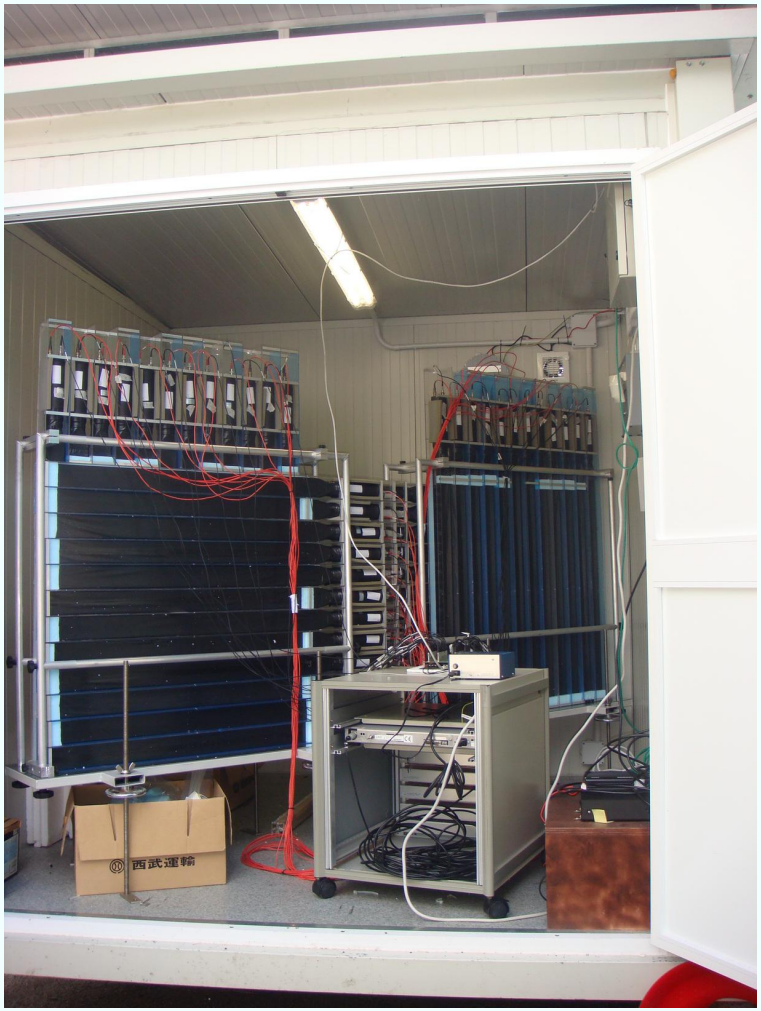
The MU-RAY project

- Japanese detector (from H.Tanaka) tested at Vesuvius
- Two parallel planes (distance 1.2m)
- Each plane has 12 plastic scintillators (100x7x3cm), coupled with photomultipliers (52mm diameter)

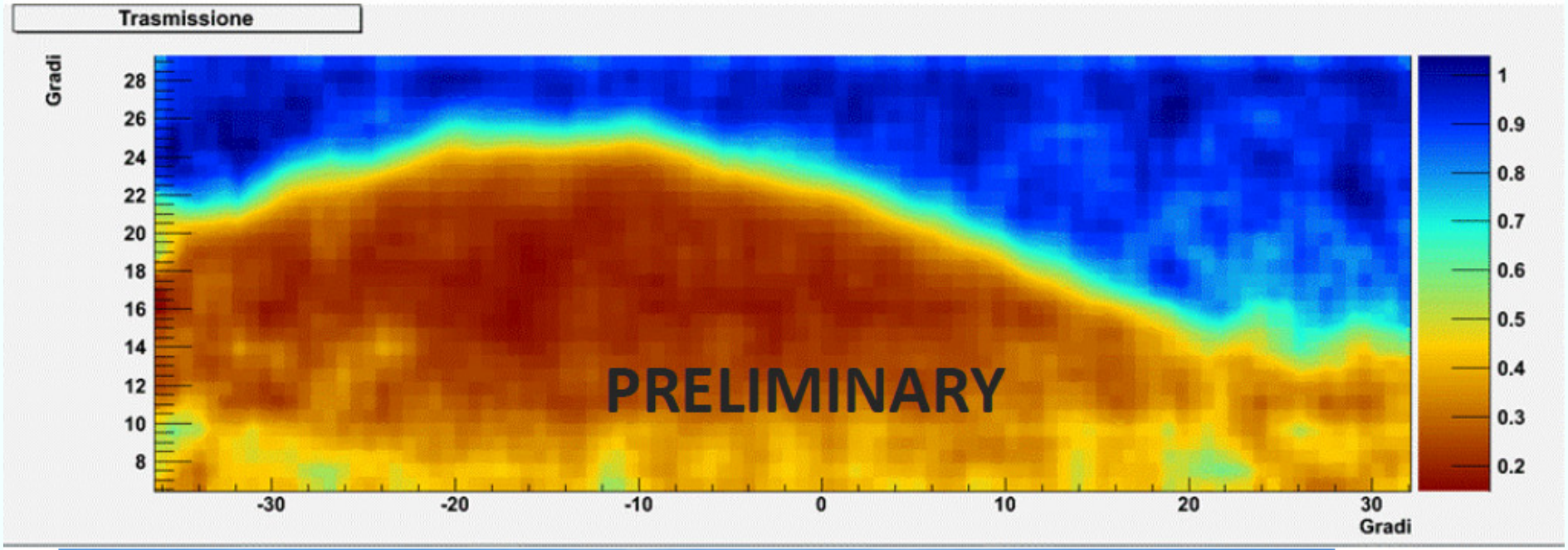


The MU-RAY experiment at Vesuvius

Mounting the Japanese detector, 2009-2010

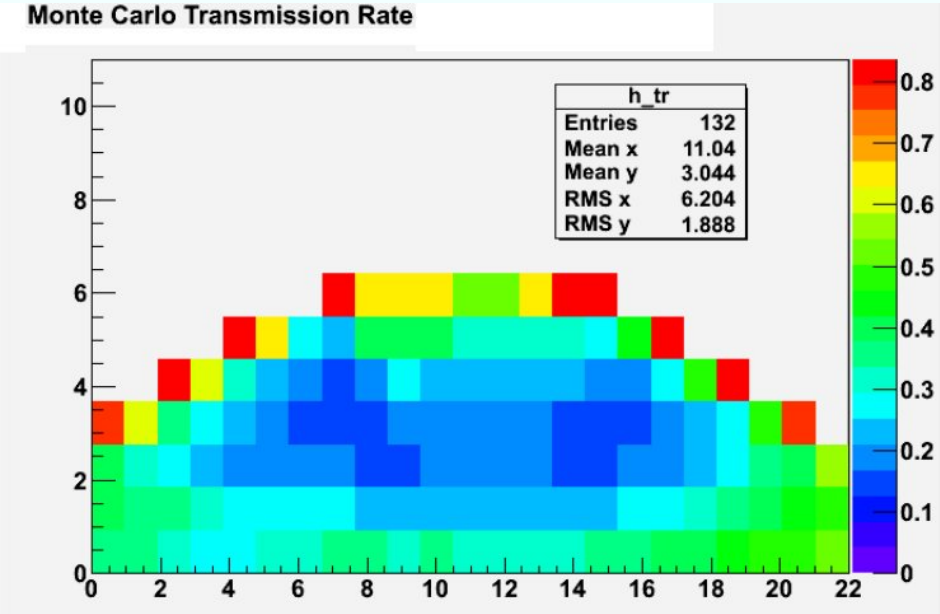


MU-RAY First results

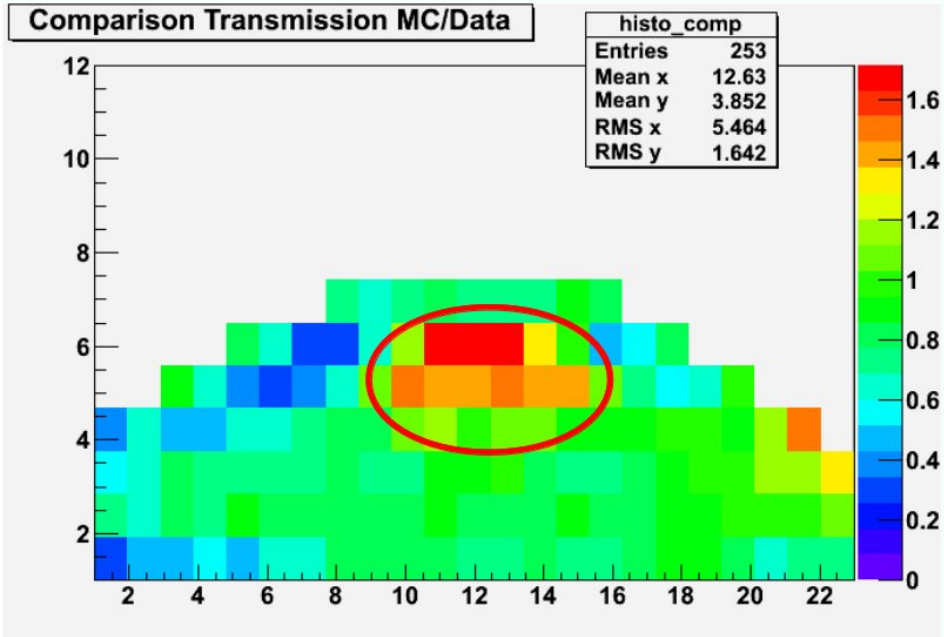


Comparison with Monte Carlo simulations

Monte Carlo Transmission rate



Comparison of Monte Carlo and data



The MURAVES Project

Muon radiography of Vesuvius

Objectives

- Build a **new telescope** for volcano radiography using cosmic muons with better resolution and background suppression than previous experiments
- Achieve an **integrated model of the Vesuvius' structure** based on muon radiography and geophysical investigations
- Develop a **model** for the integration of data from muon radiography, gravimetry, seismology and (possibly) geoelectrics

Muon radiography of Vesuvius

The MURAVES Project

Experience from previous projects

- MU-RAY Project (INFN, INGV, UNINA)
- MURAY2 Project (INFN, in collaboration with INGV)

MURAVES Project

- Funded by MIUR (Project “Premiale 2012”)
- **INGV** (host institution) + **INFN** (main partner)
- Budget 860 kEuro

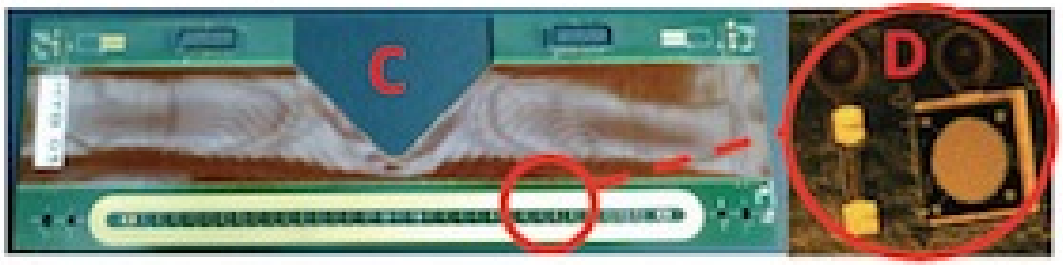
Project duration: **3 years**

- First year: Laboratory setup on Vesuvius, beginning of data acquisition
- Following years: Data acquisition and analysis

The MURAVES telescope

INFN, INGV, Universities of Napoli and Florence

The detector is based on plastic scintillators

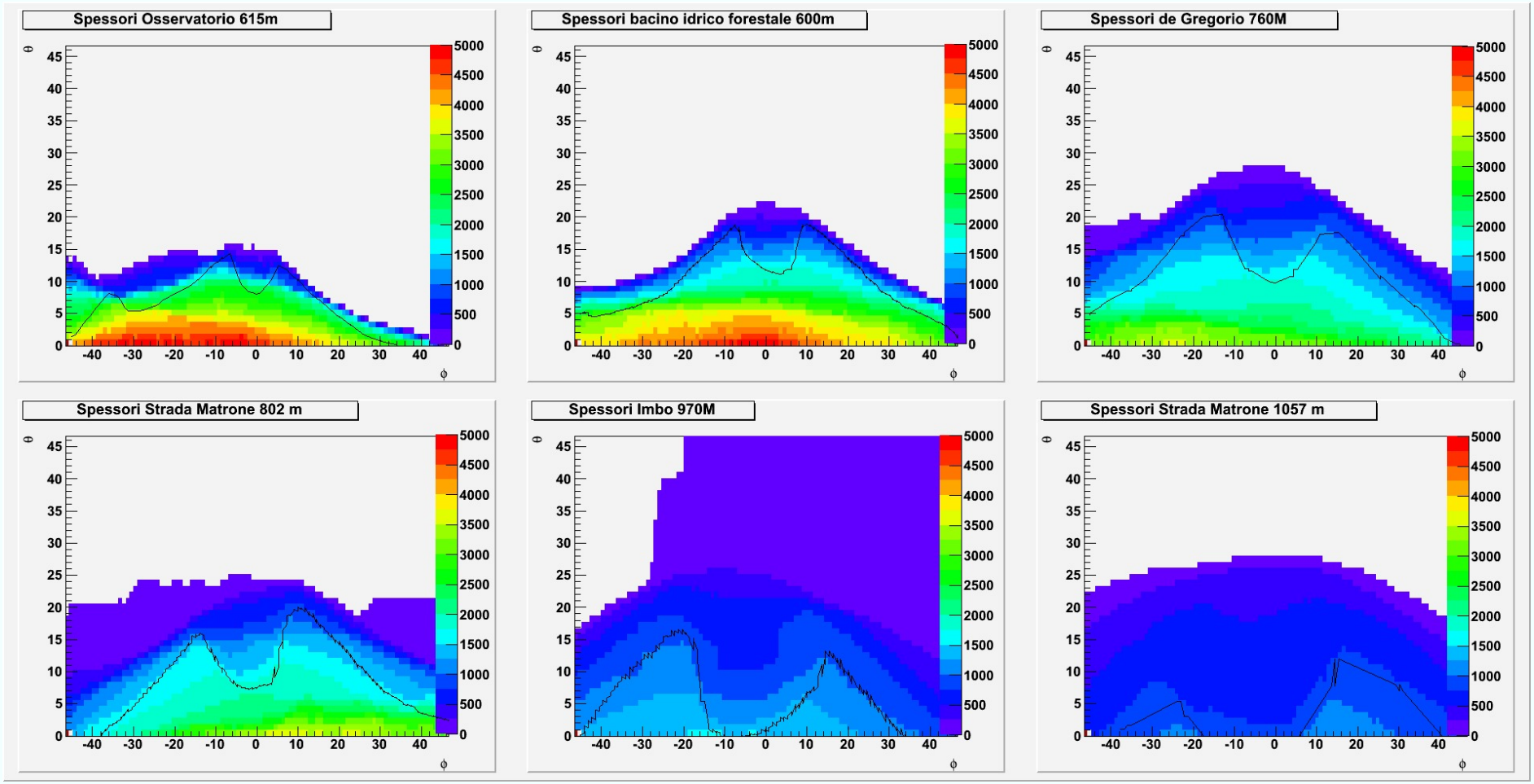


Investigated sites

Monte Carlo simulations and logistics

Rock thickness

Optimize: logistics, investigated depth, acquisition time



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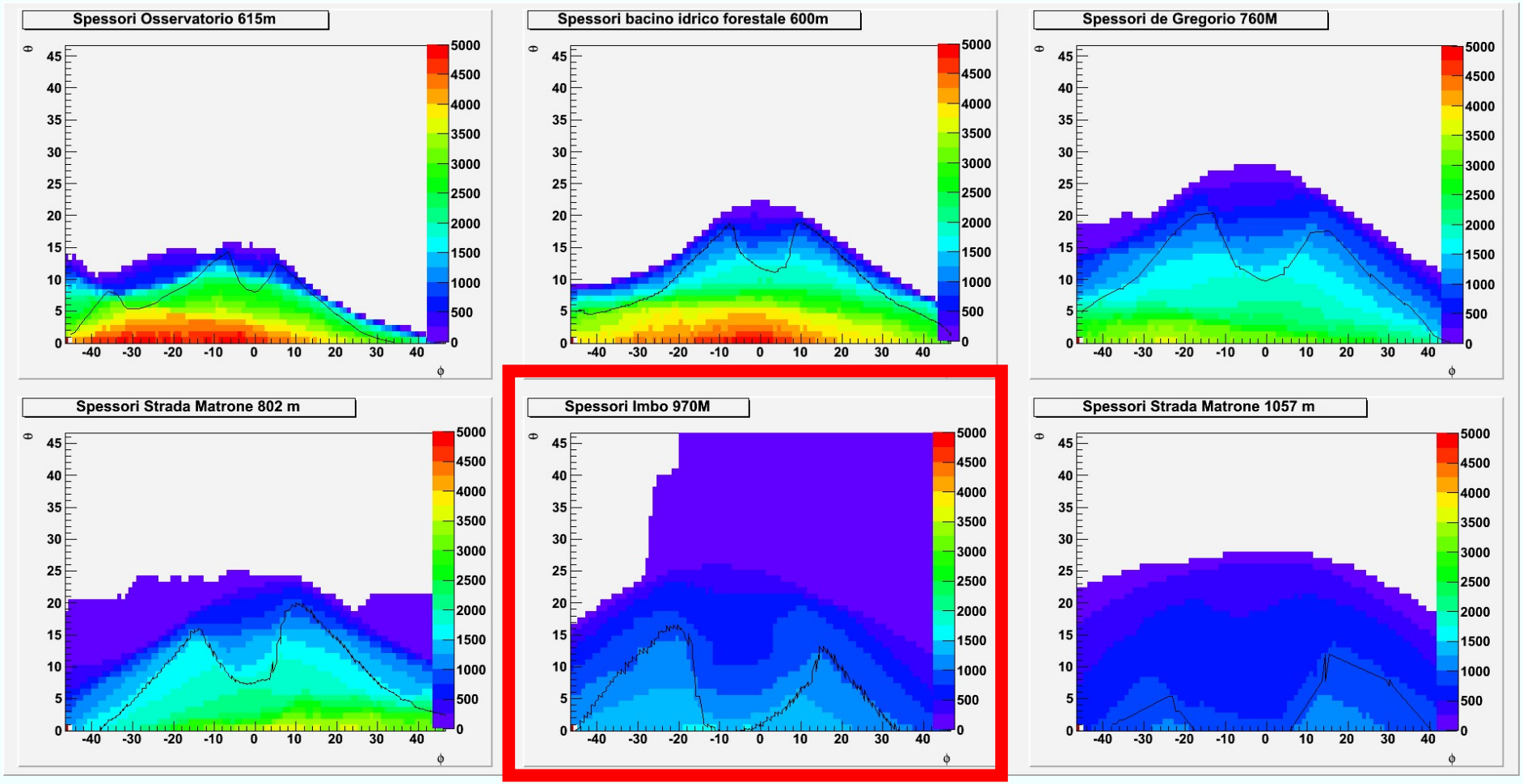
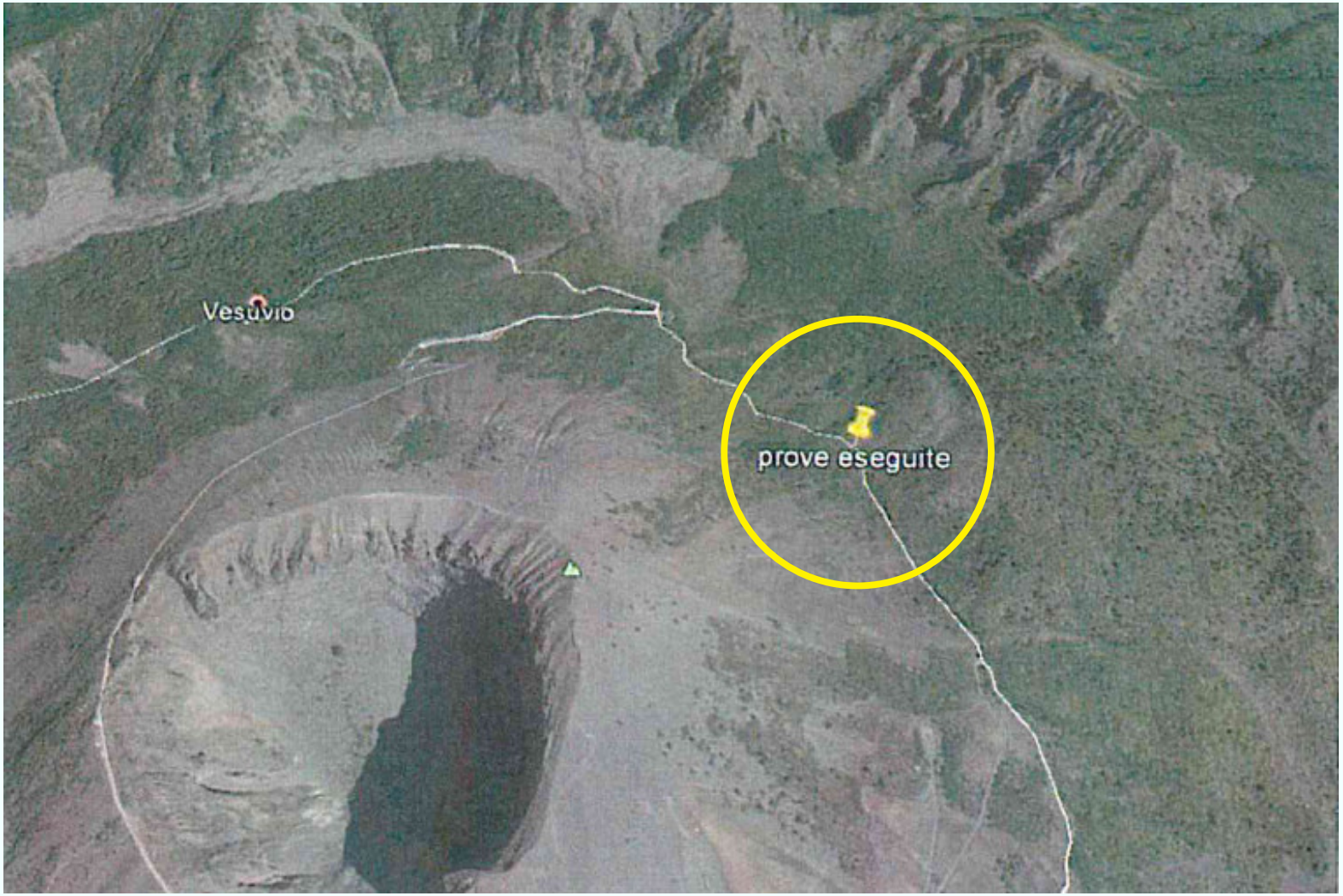


Best compromise

Selected site for the MURAVES detector

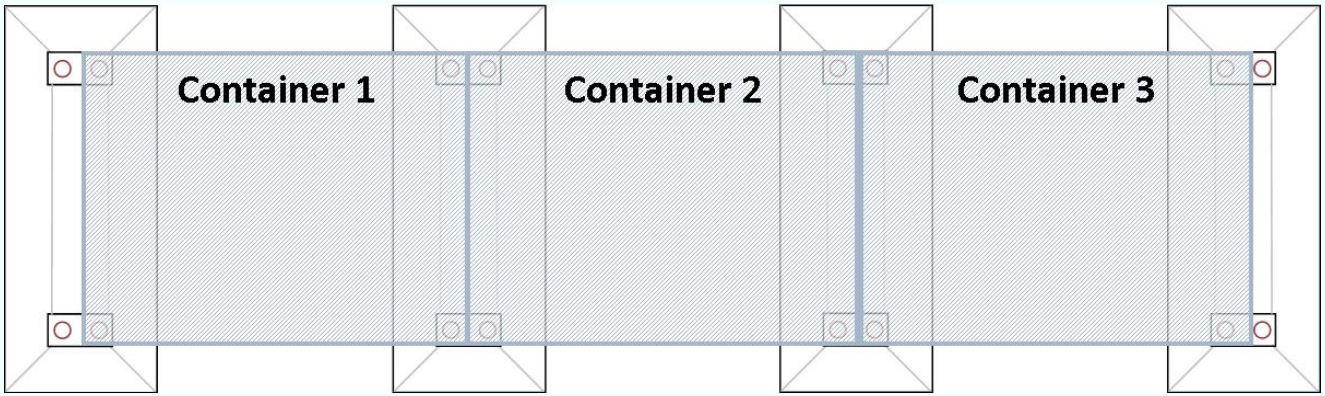


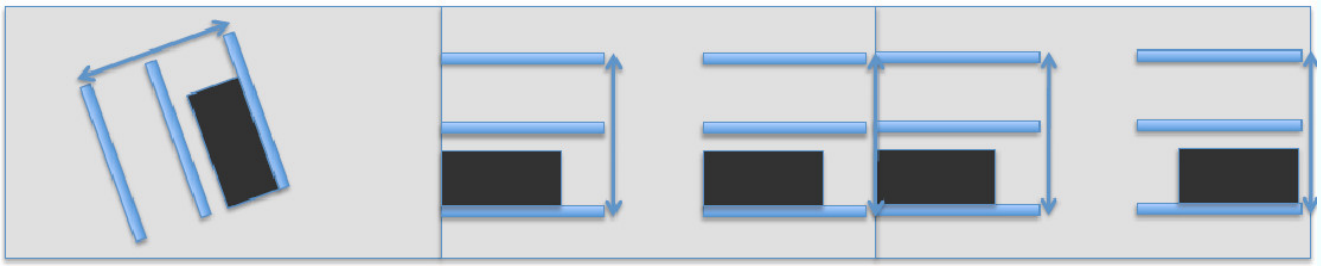
Position: E 14° 26' 02.35"; N 40° 49' 35.48" (962 m a.s.l.)

The container

Characteristics

- Three aligned containers LC 15'
- Total internal: L=13.5 m, W=2.1 m, H=2.05 m
- Three doors on the long side
- Concrete basement (pre-built)



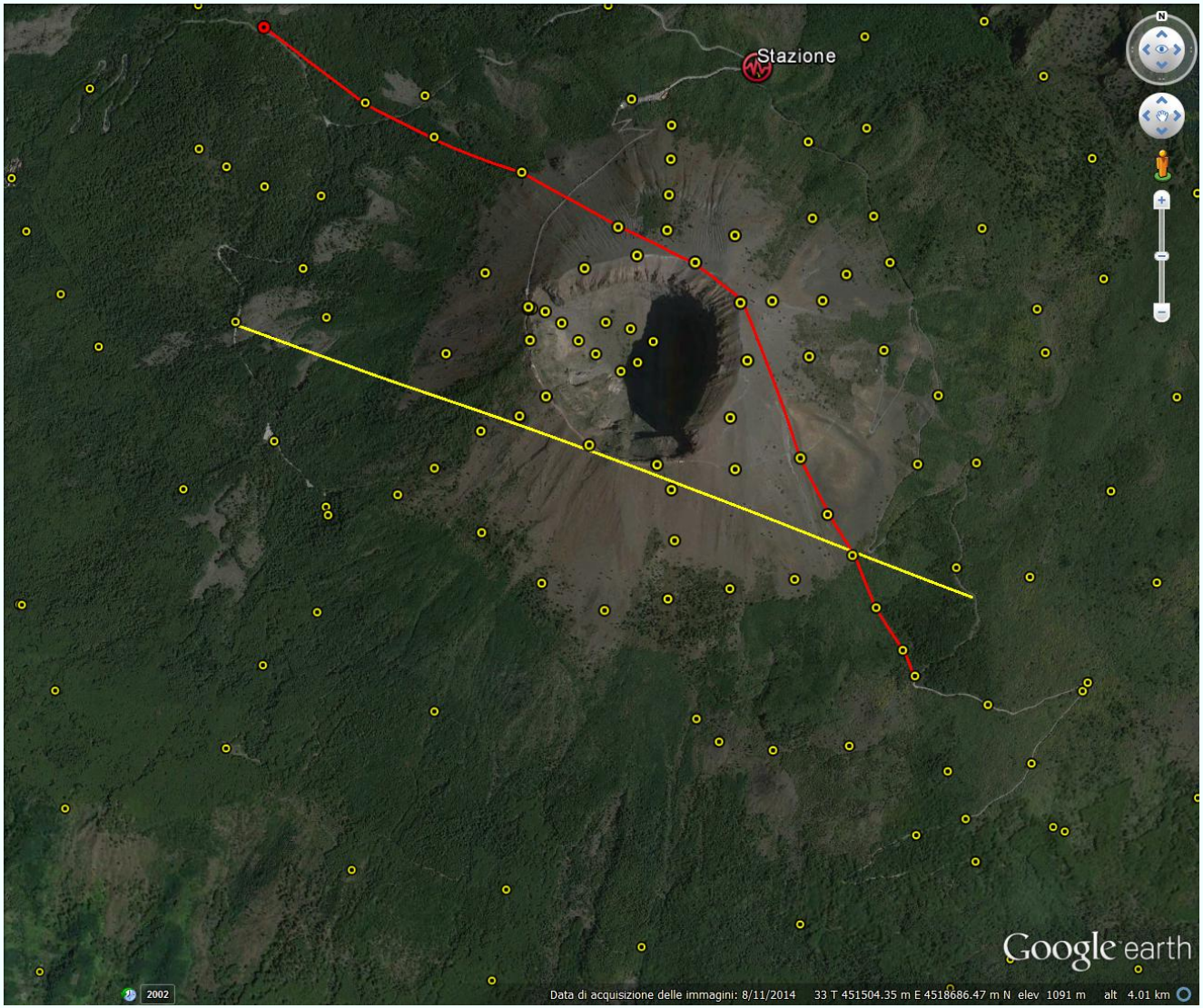


Lead from the OPERA experiment

Re-melt in bricks

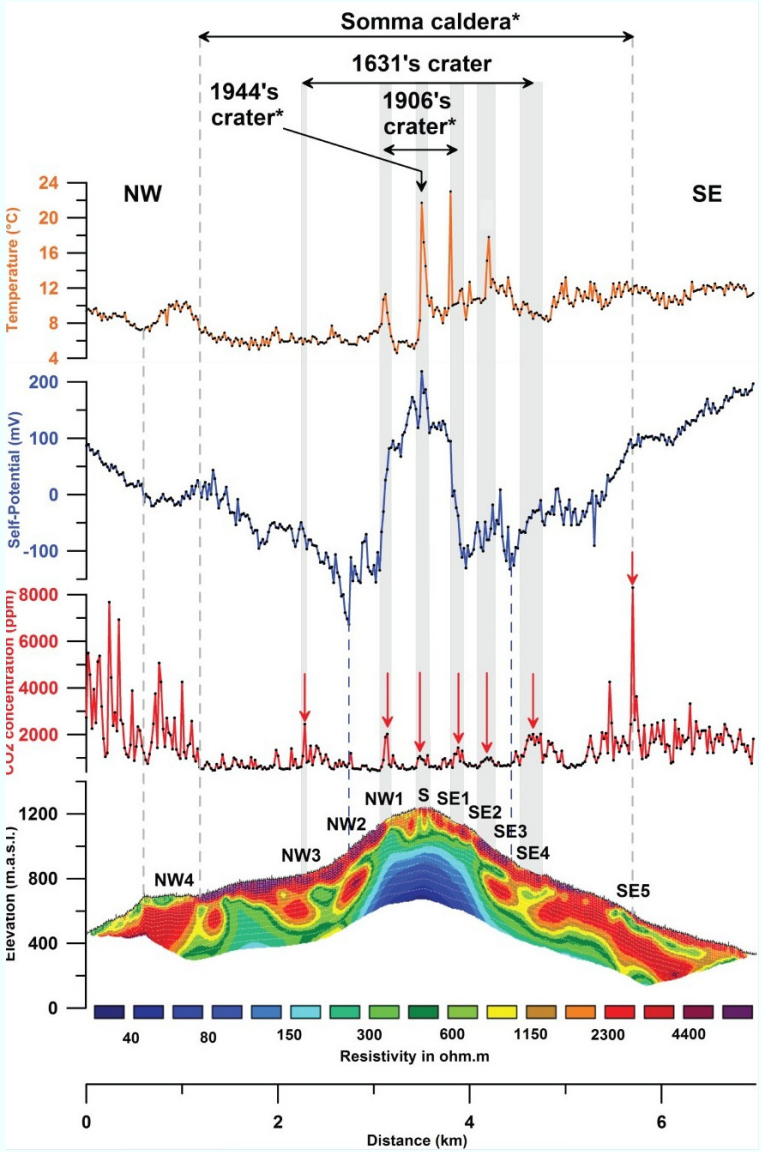
Geoelectric profiles

March 2015 (yellow line) + gravimetry (yellow dots)



Survey coordinated by Tullio Ricci and Anthony Finizola (2015)

Preliminary results from geoelectric inversion



Survey coordinated by Tullio Ricci and Anthony Finizola (2015)

Conclusion

MURAVES Project

- MURAVES has started in 2015 (INGV + INFN)
- Born from the MU-RAY/MURAY2 Projects, in cooperation with ERI (Japan)
- Cooperation with UC-Louvain (Belgium) in progress
- Cooperation with IN2P3 (France) in progress
- Expected start of data acquisition at Vesuvius: March 2017