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NextGenerationEU
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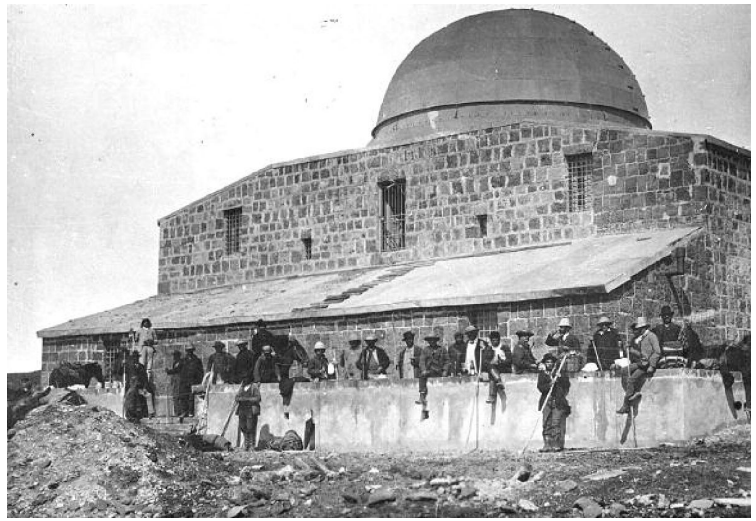
Italiadomani
PIANO NAZIONALE DI RIPRESA E RESILIENZA
ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA

WP 6
Coordinator
Stefano Branca

Implementation of the Pizzi Deneri Volcano Observatory

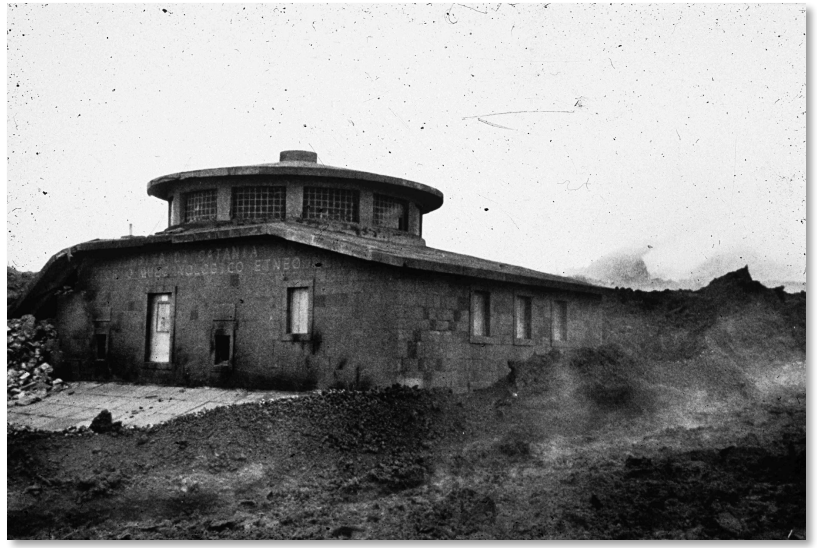
Assigned Budget: 2.5 M€

History of the observatories at Etna



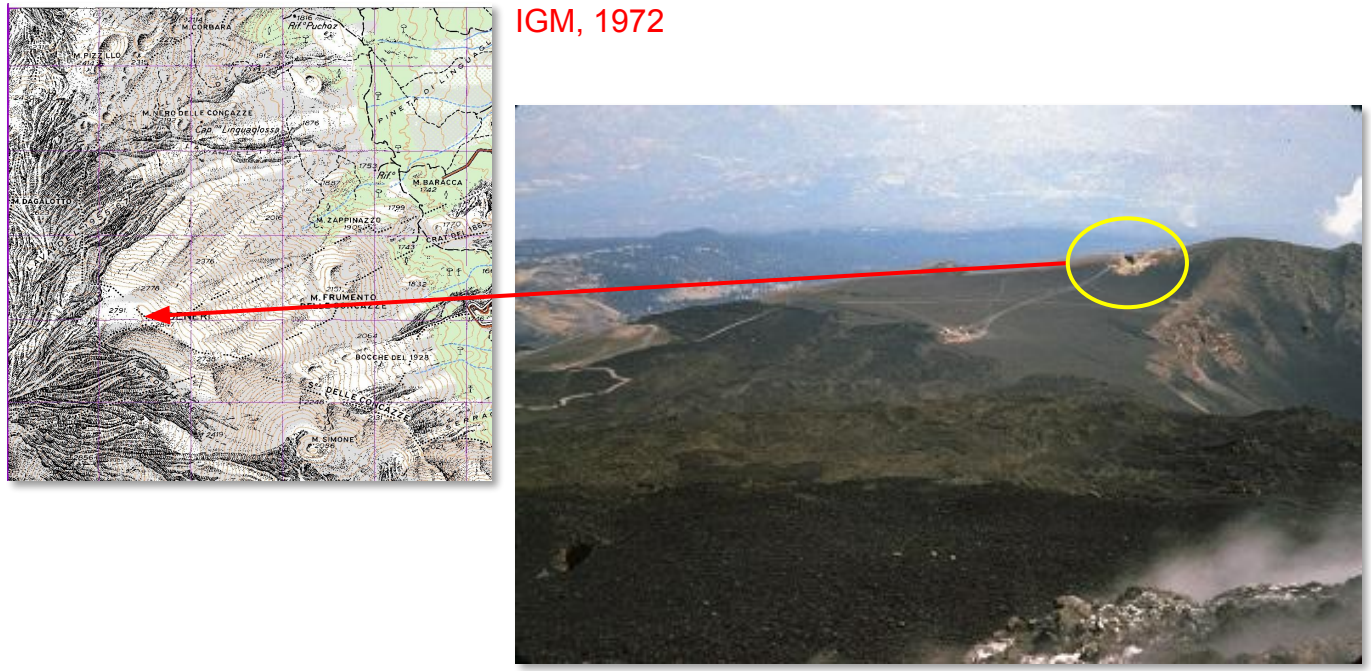
September 18, 1880. The Etnean Observatory during the 13th Congress of the C.A.I.

February 24, 1947. The Etnean Observatory after the end of the restoration work begun in 1939 which led to the dismantling of the old dome and the construction of the meteoric tower.



1971 eruption. The destruction of the historic Etnean Observatory of the University of Catania

During his career, **Gaetano Ponte** (1876-1955) made a considerable commitment to the recovery and rebirth of the Etnean Observatory, which was part of the Royal Astrophysical and Geodynamic Observatory of Catania, managing to have it annexed in **1926** to the chair of Volcanology of the homonymous institute of the University of Catania.



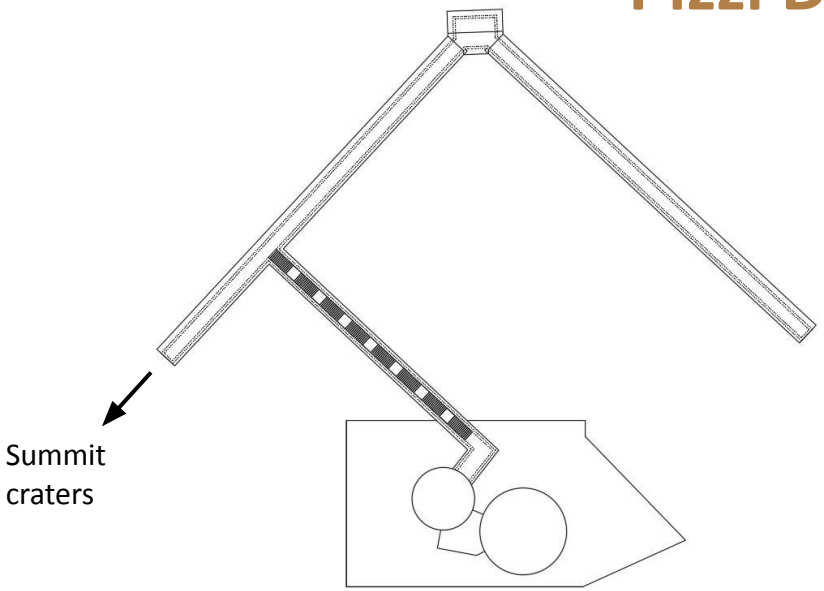
IGM, 1972

It was of Letterio Villari (1940-2021) the idea of building a volcano observatory on the summit area of Mt. Etna. The project became true **1977**, when Villari was appointed director of the Istituto Internazionale di Vulcanologia (CNR) of Catania

Pizzi Deneri Observatory in summer 1978. Photo by L. Villari

The observatory was built in summer 1977 at 2818 m elevation on the northern flank of the volcano on the morphologic high of Pizzi Deneri, corresponding to the rim of the Ellittico caldera. The site was selected to prevent the observatory from the hazard of lava flow invasion.

Pizzi Deneri Volcano Observatory (PDVO)



The structure consists in two contiguous polycentric domes, built in reinforced concrete, with elliptical sections. The domes were made using the so-called *Binishell* technique (name of the inventor, *Arch. Dante Bini*). The diameter of the domes are of 12 and 9 metres. Actually, given the small number of existing Binishell structures, PDVO can be considered as a world architectural heritage.

The overall structure of the observatory includes two 80 m custom tunnels, which were properly projected to host very high precision instrumentation.

Continuous, real-time high precision (>10^{-6} rad) *laser tiltmeter* measurements close to the volcano summit area (2 km).

Instrumentation	Description
Late '70 - '80	
Tiltmeter	**First surface installation method**
Geodetic benchmark for **EDM** (Electroptical Distance Measurements)	From a small column on the window of the room below the dome, **geodetic measurements**, with a small network of reflectors installed in permanent benchmarks at 3000 m a.s.l. on the NE flank of the volcano (Valle del Leone), were carried out
Late '80: from geodetic benchmarks to **GPS** measurements	GNSS data from the station area analysed in real-time and with high-frequency (1Hz)
Seismic station	The observatory hosts also BroadBand sensors and accelerometer and infrasound sensors
1990	
Long arm tiltmeter	Installation of **the 80 m long-arm tiltmeter (fluid mercury)** with laser reader in the tunnels
Tungsten wire strainmeter	Installation of one **strainmeter with tungsten wire**
Gravimetric measurements	Since 1994, gravimetric measurements (continuous measurements with a spring gravimenter and since 2020 with an absoulte gravimeter, absolute measurements with a ballistic gravimeter, reference for the discrete measurements carried out during fieldwork)
2000s	
2 laser interferometers	2012-2014: Installation of **2 laser interferometers** in the tunnels (Vulcamed project AP2.2.2)
Tiltmeter	2012-2014: Installation of **1 tiltmeter** at 30 m depth (Vulcamed project AP1.1.2)
Dilatometer	2014: Installation of **1 dilatometer** in a 150 m depth borehole
Seismic Array	2018 - 2019: Experiment with **array of optic fibre** and **rotational seismometers**

State of the art … and need of an urgent and radical restoration of the infrastructure

Due to the extreme site in which the observatory lies (e.g. very low temperatures, high wind speeds, exposure to huge amount of volcanic gases and volcanic ash) and although the numerous operations to solve the structural problems in the short-medium term, the actual status of the observatory needs new and strategic actions.

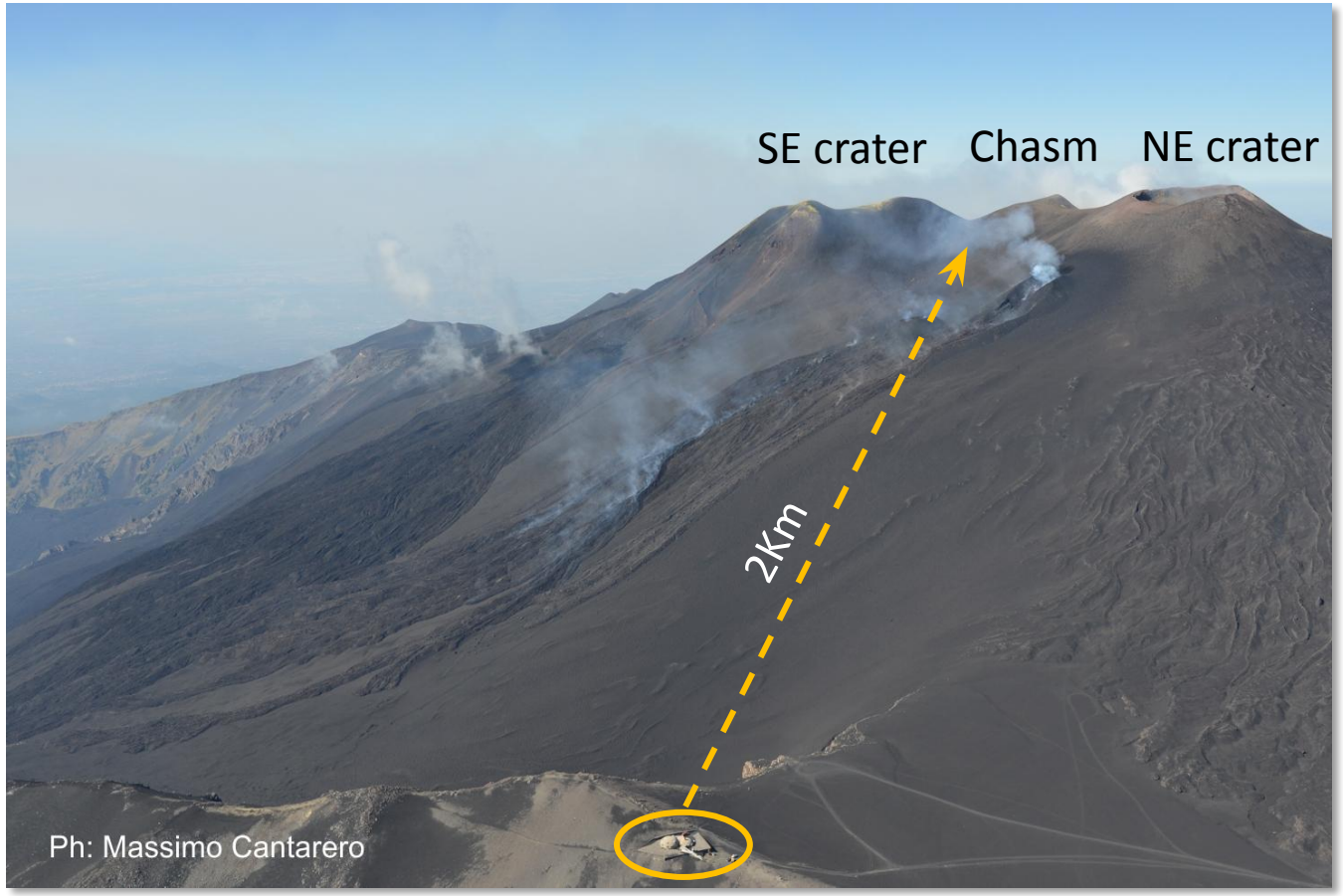




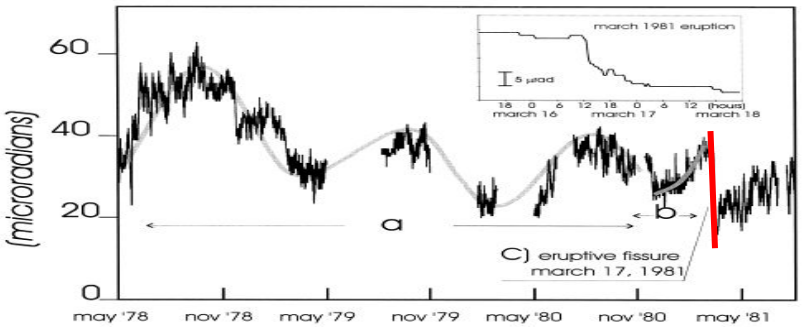


State of the art … and need of an urgent and radical restoration of the infrastructure

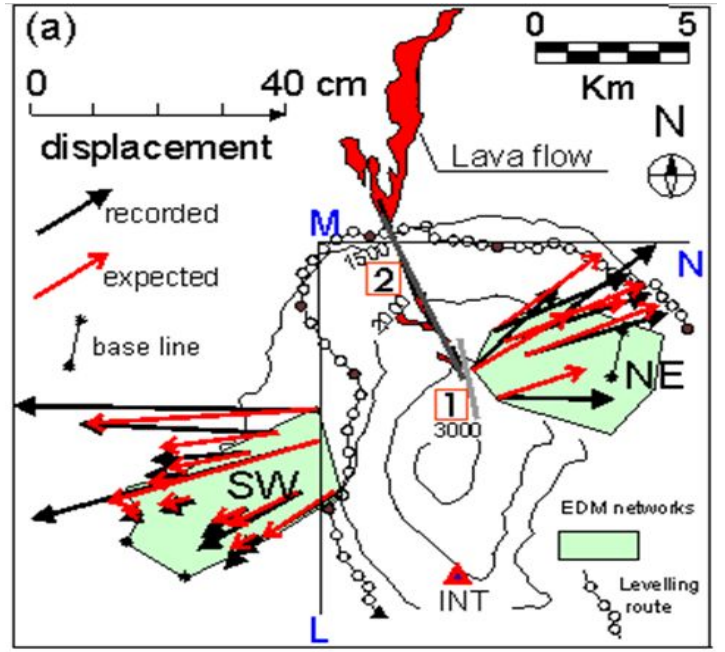
Indeed **the strong motivation for restoring** the Pizzi Deneri observatory lies in the **great potentiality of such infrastructure** that for its strategic position (~2 km distant from the summit craters) can be considered a **unique natural laboratory** for carrying out **monitoring** and **surveillance** activities as well as proximal **field experiments** and **physical access** and **dissemiantion** activities.

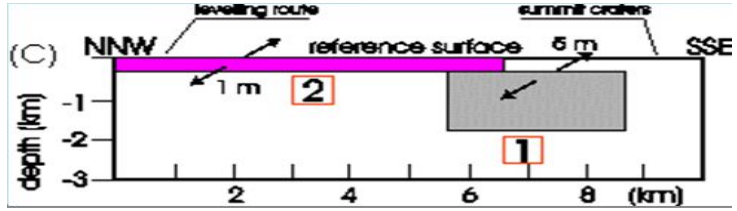


Example of the use of the observatory instrumentation to monitor an eruptive phase: the 1981 eruption (Randazzo)



Pizzi Deneri tiltmeter time series





Bonaccorso et al. 1999. PEPI

Physical access to Piano Romani from 2016 to 2021

(ENVRIPlus project - envriplus.eu & EUROVOLC project - eurovolc.eu)

Access period	Title of the project and acronym	PI	Pi Institution	Project funds
21/6 – 21/7/2016 **16 – 22/7/2017**	Etna Plume Lab - Radioactive Aerosols and other source parameters for better atmospheric Dispersion and Impact estimatiOns, (EPL-RADIO)	Pasquale SELLITTO	Ecole Normale Supérieure – Département des Géosciences, Paris	ENVRIPlus
18-21/6/2017	Ash fragmentation at Mount Etna and implications of different particle shape on ash dispersal in the atmosphere, (ETNASH).	Margherita POLACCI	The University of Manchester – School of Earth, Atmospheric and Environmental Sciences	ENVRIPlus
24-27/7/2018	Etna Plume Imaging and Chemical Composition (EPICC)	Emmanuel DEKEMPER	Royal Belgian Institute for Space Aeronomy (BIRA-IASB)	ENVRIPlus
21/-30/5/2018	Radon Analyses in Volcanic Emissions from Etna volcano: a tool to shed light on magmatic processes and environmental issues (RAVE@Etna)	Pierre-jean GAUTHIER	Laboratoire Magmas et Volcans, Clermond-Ferrant.	ENVRIPlus
24/6 – 21/7/2018	Design of a light multi-parameters station based of the GEOCUBE+ architecture (GEOCUBE+@Etna)	Pierre BRIOLE	Ecole Normale Supérieure – Département des Géosciences, Paris	ENVRIPlus
21-27/10/2018	Volcanic Airborne Gas Monitoring using the miniGAS and miniature Mass Spectrometer UAV based Systems (VAMOS-UAV)	Jorge Andres DIAZ	GASLAB, UCR, Costa Rica	ENVRIPlus
28/6 – 8/7/2019	Fiber optical cable: an Alternative method for Monitoring volcanic Events (FAME)	Philippe G.M. JOUSSET	GFZ German Research Centre for Geosciences	EUROVOLC
1-7/7/2019	VOlcanic emissions analysis through SeiSmic and Infrasound Advanced monitoring (VOSSIA)	Luciano A.M. ZUCCARELLO	University of Granada	EUROVOLC
1-7/7/2019	Etna Plume Lab – near-source estimations of Radiative EFfects of voLcanic aErosols for Climate and air quality sTudies (EPL-REFLECT)	Pasquale SELLITTO	Laboratoire Interuniversitaire des Systèmes Atmosphériques, Université de Paris-Est Créteil (LISA-UPEC)	EUROVOLC
18-26/7/2021	G-ET-SUMMIT	Peter VAJDA	Earth Science Institute, Slovak Academy of Sciences, Bratislava, Slovakia	EUROVOLC
18-27 /7/2021	VOSSIA 2	Luciano A.M. ZUCCARELLO	University of Granada	EUROVOLC

WP6 Description of action

The aim of enhance the strategic role of the Pizzi Deneri observatory can be translated in the following 3 actions/Tasks:

Task 1: Infrastructure upgrade (M. Cantarero)

Task 2*: Monitoring system upgrade (D. Reitano)*

Task 3*: Dissemination / Transnational access (L. Spampinato)*

GANTT CHART

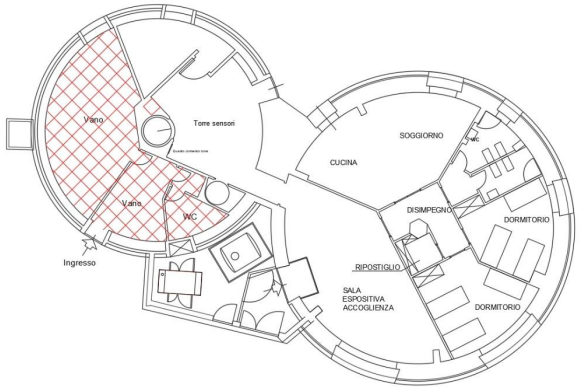
Note that the schedule of the activities might be subject to changes, given that the observatory can only be reached in the summertime due to the high altitude of the site and, thus to the extreme environmental conditions, and of course in the case of eruptive activity affecting that sector of the volcano.

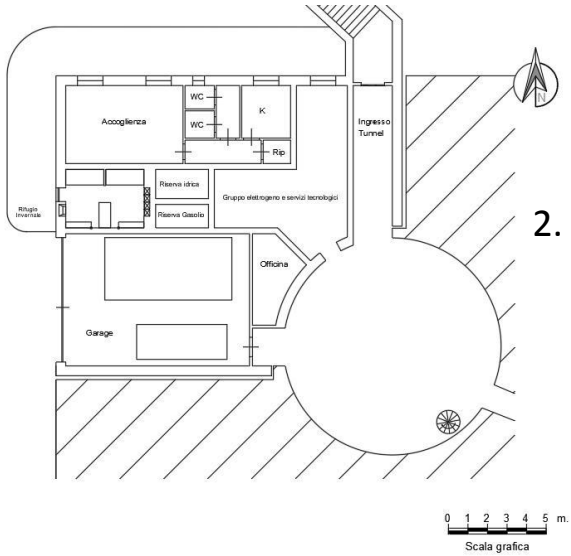
BUDGET AVAILABLE FOR THE ACTIVITIES

Task name	Description	Costs (in €)
1. Infrastructure Upgrade	- Civil works for the infrastructure restoration and installations: - Electrification from both network and renewable resources; - Arrangement for new scientific instrumentation; - Selection of materials of low maintenance and minimum environmental impact.	1.495.327,10
2. Scientific instrumentation and technological equipment, software licenses and patent	Multiparametric monitoring systems upgrade (e.g. FTIR, rotational seismic array, seismoacustic sensors, cameras, fiber optic sensors). Data transmission systems.	599.742,99
3. Promotion of the Pizzi Deneri Observatory for virtual and transnational access	Open science paradygm. Virtual and physical access to the infrastructure and instrumentation. Summer school and event organization.	42.056,10
Personnel on the project-24M	1 CTER, 1 Technologist	213.280,00

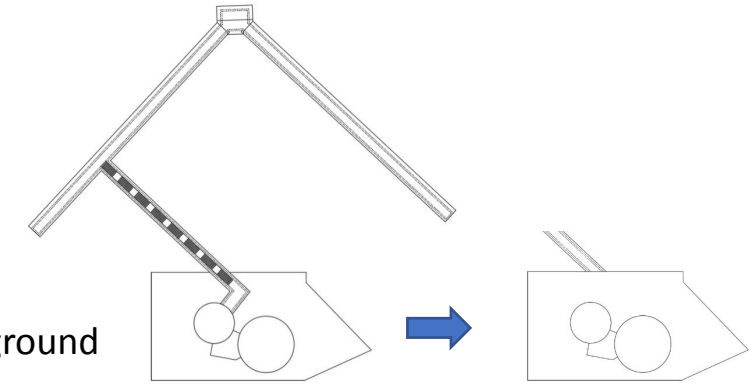
Task 1: Infrastructure Upgrade

1. Functional internal distribution

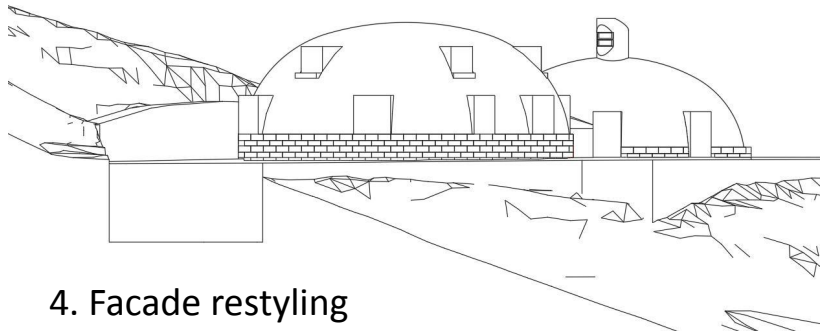




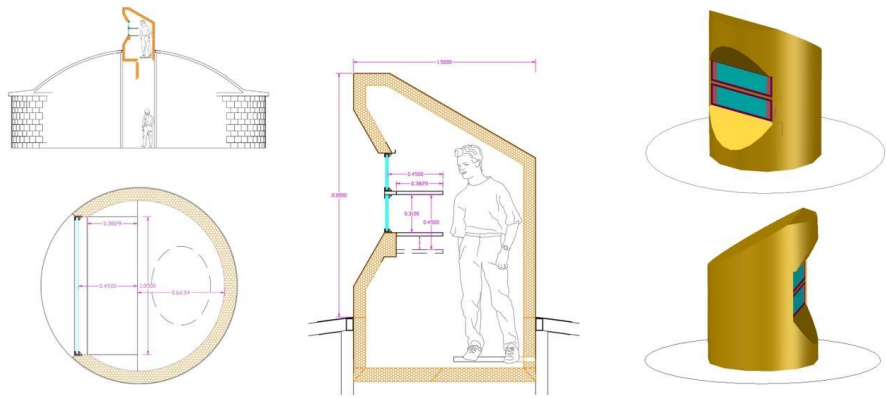
2. Refurbishment of service areas and smart shelters



3. Elimination of the staircase body above ground



4. Facade restyling



5. Construction of a monitoring tower

In summary, the project includes:

1) An external restyling that qualifies the importance of the Observatory and identifies it by characterizing it.
2) A functional recovery intervention necessary to:
   - protect the structures from the aggression of atmospheric agents
   - allow excellent thermal insulation, necessary to improve energy efficiency and reduce the environmental impact,
   - considerably reduce the need for maintenance interventions,
   - to restore a new and greater solidity to the entire building, which is necessary, given the 40 years since construction and the strong exposure.
3) An internal redistribution more functional to the specific purposes of the Observatory, in order to increase its usability.
4) The construction of a building structure, below the walkway of the square, which contains all the services useful for operation in all seasons: the winter shelter, the garage, the water and diesel tanks, the generators, the pumps heat, etc.
5) The use of renewable energy systems.
6) The construction of a monitoring tower for the installation of sensors to observe the crater areas of Etna.

Task 2: Scientific instrumentation and technological equipment, software licenses and patent

Equipment	Description
Laser Tilt	Tunnel upgrade made by **laser tilt** and **interferometers; borehole** equipment upgrade
Monitoring systems	Upgrade of monitoring volcanic and ash plume sensors (e.g. **cameras, radiometers, FTIR, weather data**);
GNSS network	GNSS network upgrade
Optical fiber / DAS	fiber optic cable for strain measurement (**DAS**);
Array	**rotational seismic sensors** / **seismo-acustic array**

Task 3: Promotion of the Pizzi Deneri Observatory for virtual & transnational access

Research infrastructures are crucial to promote research based on the paradygm of **the Open Science** and **Open Innovation**. In this contest, the Pizzi Deneri volcano **observatory has already been used for transnational access** activity in the frame of two EU projects **ENVRI PLUS** and **EUROVOLC**.

With **the aim of promoting the observatory as 'Natural Laboratory'** for volcanology, but not only, in the frame of the WP6 of the MEET project, **Task 3 (IUO 03) will**:

- **define the access rules** (procedures and politcies) **for both physical and virtual access** to the infrastructure and instrumentation;
- **define and classify the data** to be offered in virtual mode, **define the metadata and formats** in compliance with the activities foreseen in WP11;
- **organize one event for the promotion of the infrastructure** as pole of attraction to carry out research activities, transnational access, and networking of the research comunities.

As soon as the restoration will be completed, the observatory will be opened for **physical access in the frame** of the TNA activities of **the EU project Geo-INQUIRE**.

Working groups and Collaborations

Many colleagues from the Osservatorio Etneo will be involved in the WP6 activities; depending on their skills, they will be grouped in **3 Working Groups**, one for each of the 3 WP Tasks that will be coordinated by the 3 Task leaders i.e. M. Cantarero, D. Reitano, and L. Spampinato.

MOREOVER, a **scientific/technological collaboration** with the **Politecnico of Milan University** (PoliMi) has been proposed in order to benefit from PoliMi colleagues expertise in **high altitude architecture**.

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Dipartimento di Energia