

# Volcan UAV Project



Dipartimento di Ingegneria Elettrica, Elettronica e dei Sistemi  
Università degli Studi di Catania

## VOLCAN UAV

Istituto Nazionale di Geofisica e Vulcanologia



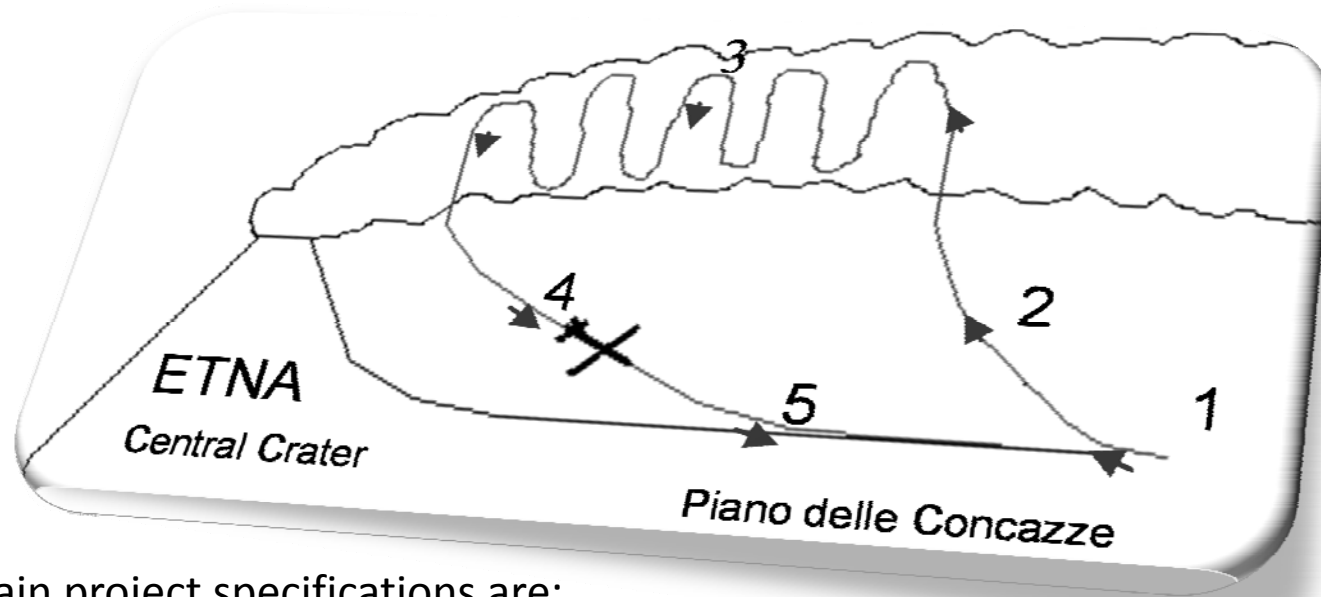
OTe Systems  
Catania



- Volcan, an autonomous volcanic gas sampling Unmanned Aerial Vehicle
- outbreak of a crisis: identification of causes and effects, rescue coordination, first aid
  - volcanic area surveillance and monitoring
  - volcanic gas sampling and analysis

## Volcan UAV Project

### - Typical mission



The main project specifications are:

- Autonomy of about 30 minutes
- Payload of about 5 kg
- Minimum cruise speed of about 40 km/h
- Maximum altitude 4000 m
- Working range 3 km
- Local and remote data log of the measures
- Autonomous navigation system (except for take-off and landing)
- Path planning through Way Points
- Real-time visualization on a user-friendly GUI

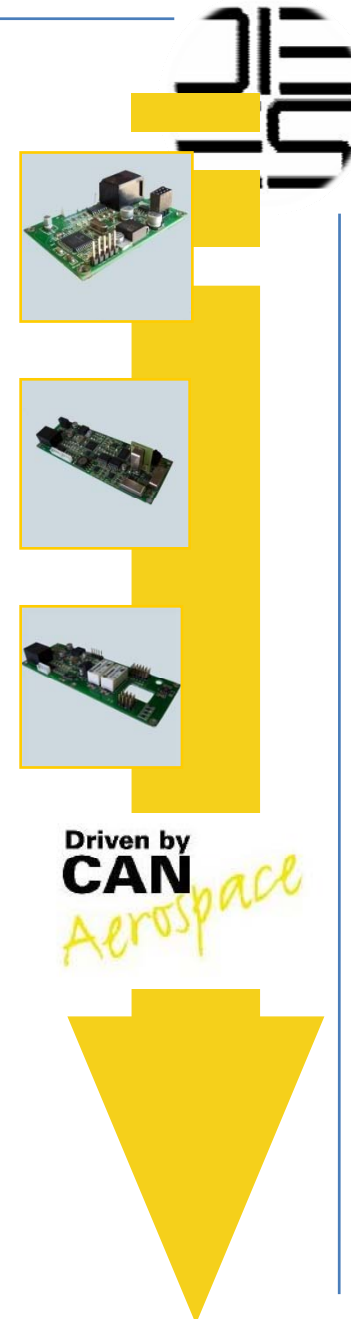
# Volcan UAV Project

## - Avionic modules

Volcan UAV is equipped with a set of avionic modules that allow to configure the plane in every state of the flight and make UAV capable of autonomous flight and payload control.

### Volcan UAV avionic modules:

- > *FCCS - Flight Control Computer System*  
performs flight control function providing Automatic Flight Control System (AFCS)
- > *ADAHRS - Air Data and Attitude Heading Reference System*  
combines tri-axial angular rates, tri-axial linear accelerations, tri-axial magnetic field measurements, air data and GPS to provide a complete 6DoF attitude and pose solution
- > *SACS - Servo Actuator Control System*  
interfaces to the R/C receiver to drive servo commands and supplies them electrical power deriving from the onboard batteries. Opto-isolated servo signals increase power supply noise immunity. Every SACS can control up to 8 servos or other peripherals and allows to activate manual override through a normal RC Radio command.
- > *GDLS - Ground Data Link System*  
provides the radio link between on board electronics devices and the ground station
- > *GCI - Ground Control Interface*  
is a ground control software which allows to set-up the mFCS adapting it to the specific UAV platform. GCI permits easy “click ‘n fly” operations, facilitating powerful mission planning, monitoring and in-flight adjustment on a notebook pc.





## Volcan UAV Project

### - Gas sampling UAV: why?

Measuring the composition of volcanic plumes allows the computation of volcanogenic fluxes for other volatiles by scaling to SO<sub>2</sub> concentration, and provides insights into volatile degassing mechanisms during magma ascent and eruption.

In situ air sampling poses several practical problems, mostly because of risks involved in sample collection and the consequent difficulty of maintaining a high frequency of sampling. In general, a few discrete measurements (e.g., a few short measurement surveys per month) can be carried out on volcanic craters, and one must accept that these discrete measurements are representative of the composition of the plume over the medium or long term, which is a rough assumption in the light of the fluctuating nature of plumes.

The “UAV-Volcano project” could satisfy the need of performing measurements within the plume and near eruptive vents, without particular risks for the operators. The vehicle would contain light IR-spectrometer for CO<sub>2</sub> measurements and electrochemical cells for SO<sub>2</sub> determinations.



Studied and realized for volcanic gas sampling, Volcan UAV represents an innovative solution for surveillance and monitoring in volcanic and industrial environments.



## Volcan UAV Project

### - Gas sampling UAVs: state of the art

The scientific literature is rich of civil applications of UAVs; they have been used for several applications concerning the measure of air pollution and weather variables. However just a few experiments for volcanic gas sampling exists in the literature.

- The first one was a 2002 project funded by NASA, a collaboration between the University of South Florida, Southwest Research Institute, and the University of Miami. An unmanned aerial vehicle was used to fly inside volcanic gas plumes and directly sample and analyze volcanic gases without the need for the human operators to visit volcano craters. Unfortunately at present, due to some failure in the preliminary tests, they have abandoned this design.
- In another experiment U.S. Geological Survey (USGS) in 2004 made a single 20 minutes test flight above Mount. St. Helens using the Silver Fox UAV. However no publication concerning the achieved results or other tests has been published.
- Also AEROSONDE together with JPL announced in 2003 a project on the adoption of UAV for monitoring volcanic plume, however no results have been presented.
- A group from the Scripps Institution of Oceanography managed to fly three autonomous UAVs in a coordinated way for studies of radiative forcing of clouds over the Maldives. The UAVs were flying at different altitudes below, within and above the cloud system. However, the UAVs were not equipped for the measurements of gases.

## Volcan UAV Project

### - Project phases



- ✓ Test of avionics
- ✓ Test of autonomous navigation system
- ✓ Test of launching system
- ✓ Test of different prototypes



*Done*

- Test of instrumentation
- High altitude test of airplanes
- Gas sampling missions

*In progress*



---

Volcan UAV Project  
- **Contacts**



*Prof. Giovanni Muscato*

Dipartimento di Ingegneria Elettrica Elettronica e dei Sistemi

Università degli Studi di CATANIA

viale A. Doria 6

95125 CATANIA Italy

TEL: +39-095-7382321 FAX: + 39-095-7387961

e-mail: [gmuscato@diees.unict.it](mailto:gmuscato@diees.unict.it)

Robotic page : <http://www.robotic.diees.unict.it>