# GEOSTAR, SN-1, **ORION-GEOSTAR-3: Deep-sea multidisciplinary** observation systems managed from the sea surface

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- Since 1995, Istituto Nazionale di Geofisica e Vulcanologia (INGV) has been running a scientific and technological programme for the development and operation of deep-sea observation systems for geophysics, oceanography and environmental sciences.
- The programme has been initially funded by the European Commission (EC) within the 4th and 5th Framework Programme through the GEOSTAR and GEOSTAR-2 projects.
- Italian national funds from the National Programme for the Research in Antarctica and the National Group for the Defence against Earthquakes supports projects to derive other systems from the previous EC projects for specific applications.

### **INGV and the Projects on Seafloor Observatories**

 European Projects

 Co-ordinator:
 4 FP - GEOSTAR (1995-1998)

 5 FP - GEOSTAR 2 (1999-2001)

 - ORION-GEOSTAR 3 (2002-2005)

 Participant:
 5 FP - ASSEM (2002-2004)

 - ESONET (2003-2004)

National ProjectsCo-ordinator: SN-1 (2000-2003) in GNDT - National Group<br/>for the Defence against Earthquakes<br/>MABEL (2000-2003) PNRA - National<br/>Programme for Researches in Antarctica

### **Eight years of Projects**



### **The GEOSTAR concept**



### **GEOSTAR** system



### MODUS

## submarine vehicle for GEOSTAR deployment/recovery



### **GEOSTAR Communication Systems**





Surface buoy: near real-time acoustic and satellite link Messengers: floating data capsules



### **GEOSTAR** system

#### Bottom station

- Weight: 3000 kg in air (1500 kg in water)
- Dimensions: 3.5 m x 3.5 m x 2,9 m
- Power : 11 W
- HD capacity: 2.1 Gbyte x 2 (+ 48Mbyte on flash cards)
- Batteries: 2700 Ah, 24 V

### MODUS

- Weight: 1000 kg in air ( 800 kg in water)
- Dimensions: 2.37 m (Ø) x 1.8 m
- Power: 25 kW
- Thrusters: 2 vertical, 4 horizontal (700 kN each)

#### <u>Buoy</u>

- Weight: 3500 kg
- Dimensions: 5 m<sup>3</sup>

### **GEOSTAR** system

#### Acoustic Transmission System

- Power: 80 mA @ 24 V (Rec.), 3 A @ 24 V (Trans.)
- Max Rate: 2400 bps

#### Messengers:

- Expendable capacity: 64 kbyte
- Storage: capacity 40 Mbyte
- Height: 1,30 m

#### NRTCS

• Satellite sys. INMARSAT

### Rate: 2400 bps

Power: 20 W (Rec.), 40 W (Trans.)

• Radio Transmission: VHF

## Data Acquisition and Control System (DACS)

DACS manages the whole observatory and is based on

- 2 Data Acquisition Units (switch on/off, communication with sensors, generation of data structures, storage of data on HDs);
- 1 Mission and Power Control Unit (management of the communication with the sea surface, data storage on Messengers, activation of special devices for sensors and acquisition of the seismometer clock signal)

#### Unique time reference for all the sensors: seismometer clock

### **Logistics for seafloor observatories**



- Medium size vessel equipped with Aframe or crane;
- dGPS on board;
- Electro-optical cable (3 optic fibres + 2 conductors; 1800 kg/km in water) and winch (National funds to INGV)







### The sea-floor observatory missions

**GEOSTAR 1** (1995 - 1998)Adriatic Sea 1998 **Demo mission** 

**GEOSTAR 2** (1999-2001)Tyrrhenian Sea 2000-01 (20 days, 42 m w.d.) (7 months, 2000 m w.d.)

**SN-1** (2000-2003)Ionian Sea 2002-03 (7 months, 2105 m w.d.)







### **The sea-floor observatory missions**

**GEOSTAR 1** 



**GEOSTAR 2** 

@1988-1998 Microsoft e/o relativi fornitori. Tutti i diritti riservati.

**SN-1** 

The sea-floor observatory missionsGEOSTAR 1GEOSTAR 2SN-1(1995-1998)(1999-2001)(2000-2003)Adriatic Sea 1998Tyrrhenian Sea 2000-01Ionian Sea 2002-03(20 days, 42 m w.d.)(7 months, 2000 m w.d.)(7 months, 2105 m w.d.)

Seismometer

Scalar and vectorial magnetometers

ADCP

CTD

Transmissometer

S and V magnetometers ADCP and CTD Transmissometer Currentmeter Gravity meter Hydrophone Water sampler

Seismometer

Seismometer CTD Gravity meter Hydrophone Currentmeter

### **GEOSTAR 2 - Geophysical data**

#### **Gravity meter**



#### Hydrophone



#### **Magnetometers**



# **GEOSTAR 2**

**Oceanographic and geochemical data** 



### **SN-1: Submarine Network 1**





Based on GEOSTAR
concept (use of MODUS)
Acoustics for periodic
checks





### **NEMO pilot experiment**



EO Cable:

Catania, Eastern Sicily

LABORATORY





**UNDERWATER** 

**STATION** 





Length – 25 km
10 Optics Fiber ITU- T G-652 (6 used)
6 Electrical Conductors Φ 4 mm2 (4 used)

CONFIGURATION OF THE PILOT EXPERIMENT ARRAY



### **Underwater Laboratory: NEMO and SN-1**

#### **INFN Laboratory**



MABEL Project 2001-2002 Mission in Weddel Sea (INGV – AWI)

- •Site characterisation
- •Tests on chemical package
- •Vertical profiles with CTD





Basin tests with simulated polar conditions. HSVA (Hamburgische Schiffbau Versuch Anstalt)

VLV ?T Workshop "Technical Aspects of a Very Large Volume Neutrino Telescope in the Mediterranean Sea" October 5-8, 2003NIKHEF, Amsterdam

1.00

### **ORION-GEOSTAR 3 Ocean Research by Integrated Observatory Network**



6-8 month experiment NW of Marsilivolcanic seamount at3260 m w.d.

- Networking.
- GEOSTAR is the gateway station
- satellites with the most demanding sensors (seismometers)



### **ORION STRUCTURE**



### **MISSION AT MARSILI SEAMOUNT**



# COMPARISON BETWEEN FRAMES ORION Node 1 ORION Node 3 (GEOSTAR upgraded)



#### www.ingv.it/geostar

#### GEOSTAR and SN-1 movies available upon request

#### Main references:

Phys. Earth Plan.Int., 108, 175-183, 1998

EOS, 81, 5, 45 and 48, 2000

Developments in Marine Technology Series, 12, 268pp. Elsevier, 2002

Earth Planets Space, 55, 361–373, 2003

