

The **Institute of Marine Engineering (Istituto di Ingegneria del Mare, INM)** is a public research institute of the National Research Council (CNR) of Italy.

INM mission is pursued within the following **research areas**:

- Models, technologies and innovative design systems for marine/maritime sector
- **Marine vehicles**
- Marine robotics
- Marine renewable energy
- Environmental acoustics, **underwater acoustics**, and geo-acoustics
- Acoustic characterization of materials, structures, and environments
- Development and **applications of instrumentation (sensors, actuators, transducers)**
- Logistics and transport in maritime environment
- Marine vehicles energy management onboard and in port/coastal areas

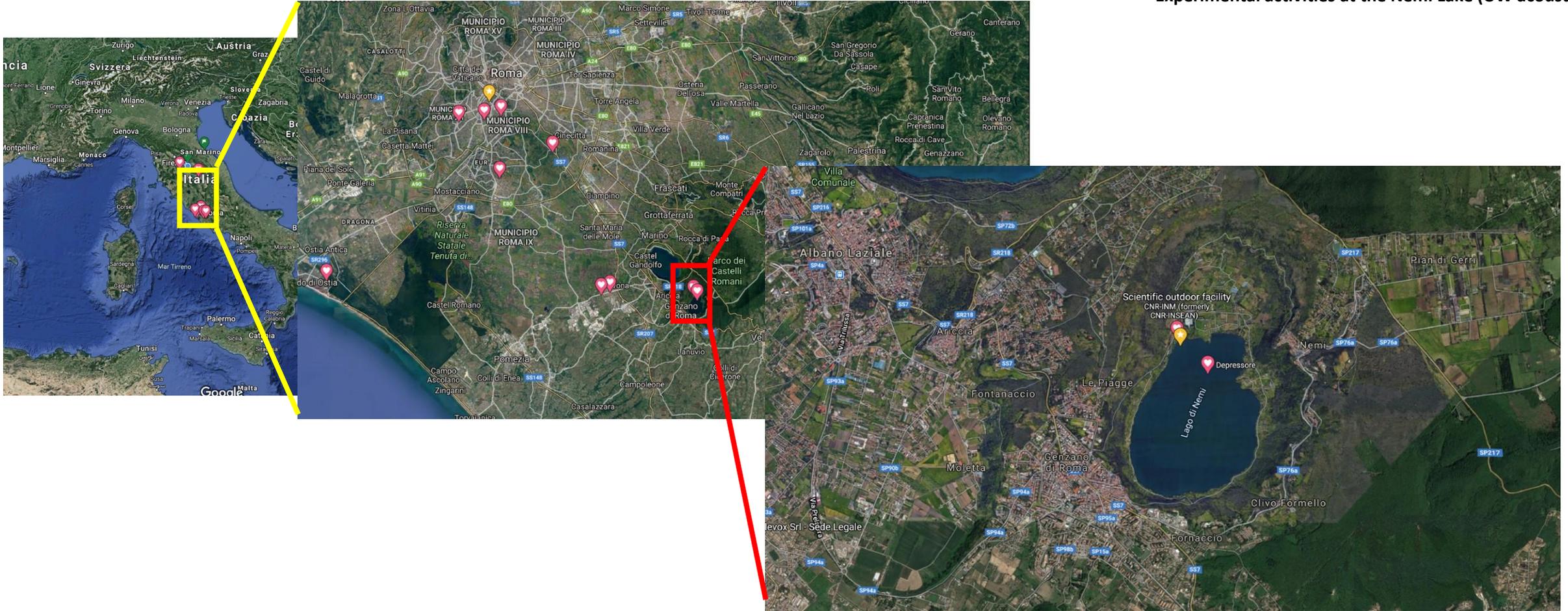
INM Headquarters are located in **Rome**. The Institute includes **Genova**, **Palermo**, and **Rome Tor Vergata (ARTOV)** branch offices. INM staff counts more than 180 people including research scientists and engineers, technicians, postdocs, students, and administrative personnel.

- **The CNR-INM Institute scientific topics**
- **The Outdoor Facility**
- **Experimental activities at the Nemi Lake (Manoeuvrability)**
- **Experimental activities at the Nemi Lake (UW acoustic)**



The CNR-INM's outdoor facility on the volcanic lake of NEMI

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- **Since 1937** is the Outdoor Maneuvering Basin at INSEAN
- Database of more than 5000 test carried out on more than **50 ship models manned**
- **From 1960** is part of the **ITTC's** (International Towing Tank Conference) catalog of facilities



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Type of tests:
Metod. sperimentale:
Sep-up of the methodology:
Activities carried out:

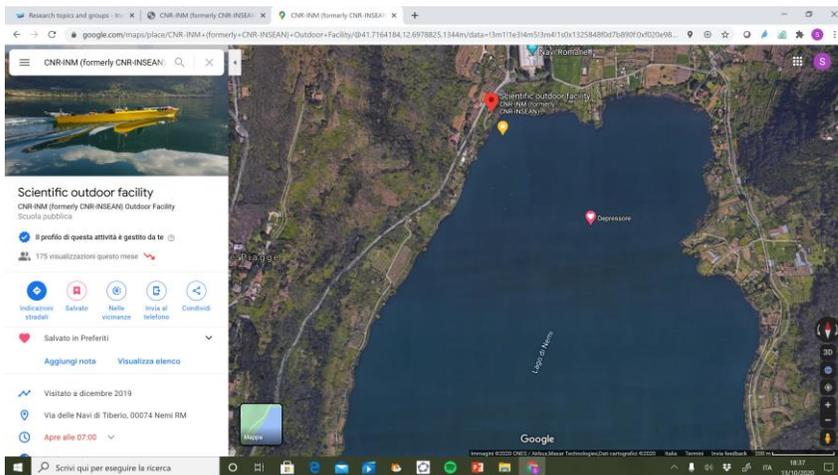
R&D:
Database:
What we verify [∇ , V , Δ , $(r-a)$, $d\delta/dt$]
What we measure (standard)

Manoeuvrability/Controllability (IMO/ANEP)
Free running self-propelled **unmanned surface ship's models**
1998
new ships, existing ships of the Italian Navy and other Navies
PNRM (Prossima, Prossima II), EDA (FLOWIS)
More than 10000 test carried out with unmanned ship's models
Rudder's effectiveness/efficiency (size, shape, position, etc.)
DGPS (x_g , y_g , speed), gyro (ψ , $d\psi/dt$), IMU (6 DOF), n_r , T_r , Q_r , n_l , T_l , Q_l , Q_δ

Constrains on the size of the model and on the tests conditions

Max dimension of the ship's model	10m
Δ_{max}	1500 Kg
Speed max.	10 m/s
Speed min.	0.05 m/s

Any restriction on the duration in time of the single test (irrespective of the speed of the test)
Any waiting time between consecutive tests (irrespective of the speed of the test)



The CNR-INM Outdoor Facility at the Lake of Nemi



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UW Noise measurements

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Data collected at the outdoor basin

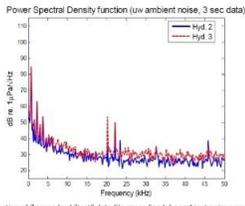


Figure 1. PSD function of 3 seconds of "test" data file recording lake ambient noise around 10:46 AM.

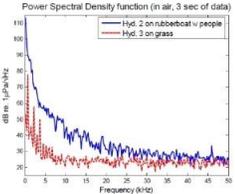
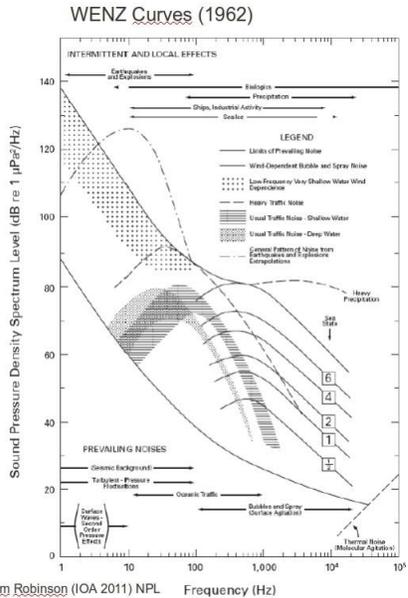
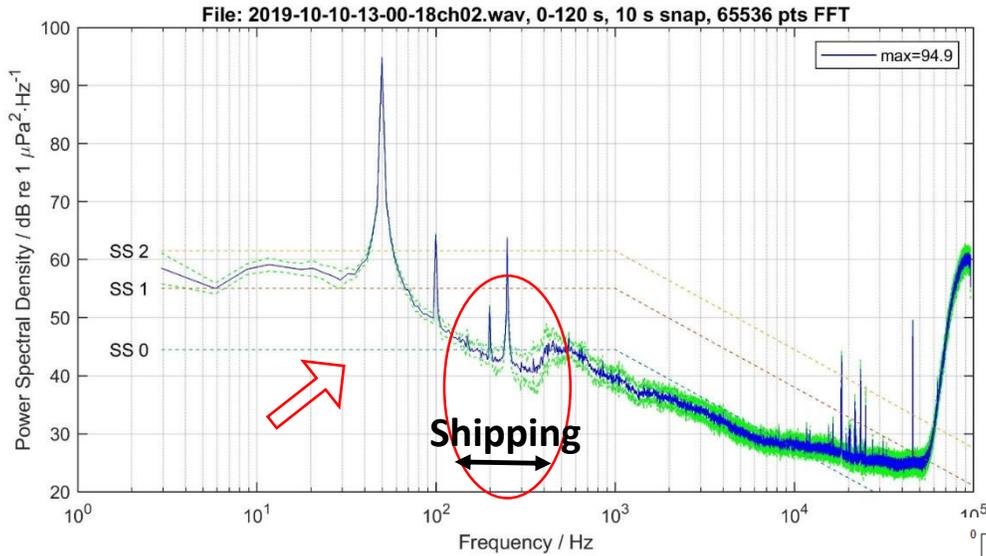


Figure 2. PSD function of 3 seconds of "12:33:09_001" data file recording ambient noise in air.



From Robinson (IOA 2011) NPL



1m < depth < 11m → ΔT ≅ 13°C

