UNIVERSITÀ DEGLI STUDI FIRENZE

ARROWS
ARCHAEOLOGICAL ROBOT SYSTEMS FOR THE WORLD'S SEAS

MDM LAB

The ARROWS Project: Underwater Robotic Systems for Archaeology

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MDM Lab – Laboratory of Mechatronics and Dynamic Modelling

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DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

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INTER-UNIVERSITY CENTER ON

INTEGRATED SYSTEMS FOR MARINE ENVIRONMENT

ISME
Integrated System for Marine Environment

GENOVA Headquarter | *PISA* | *LECCE* | *CASSINO* | *ANCONA* | *FLORENCE*

- ***Established in 1999***
- ***> 30 researchers***
- ***Shared infrastructures , labs, equipements***

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ISME Expertise & Applications

Robotics

- Underwater manipulation systems
- Guidance and control of AUV's and ROV's
- Distributed coordination and control of AUV's team
- Mission planning and control

Underwater acoustics

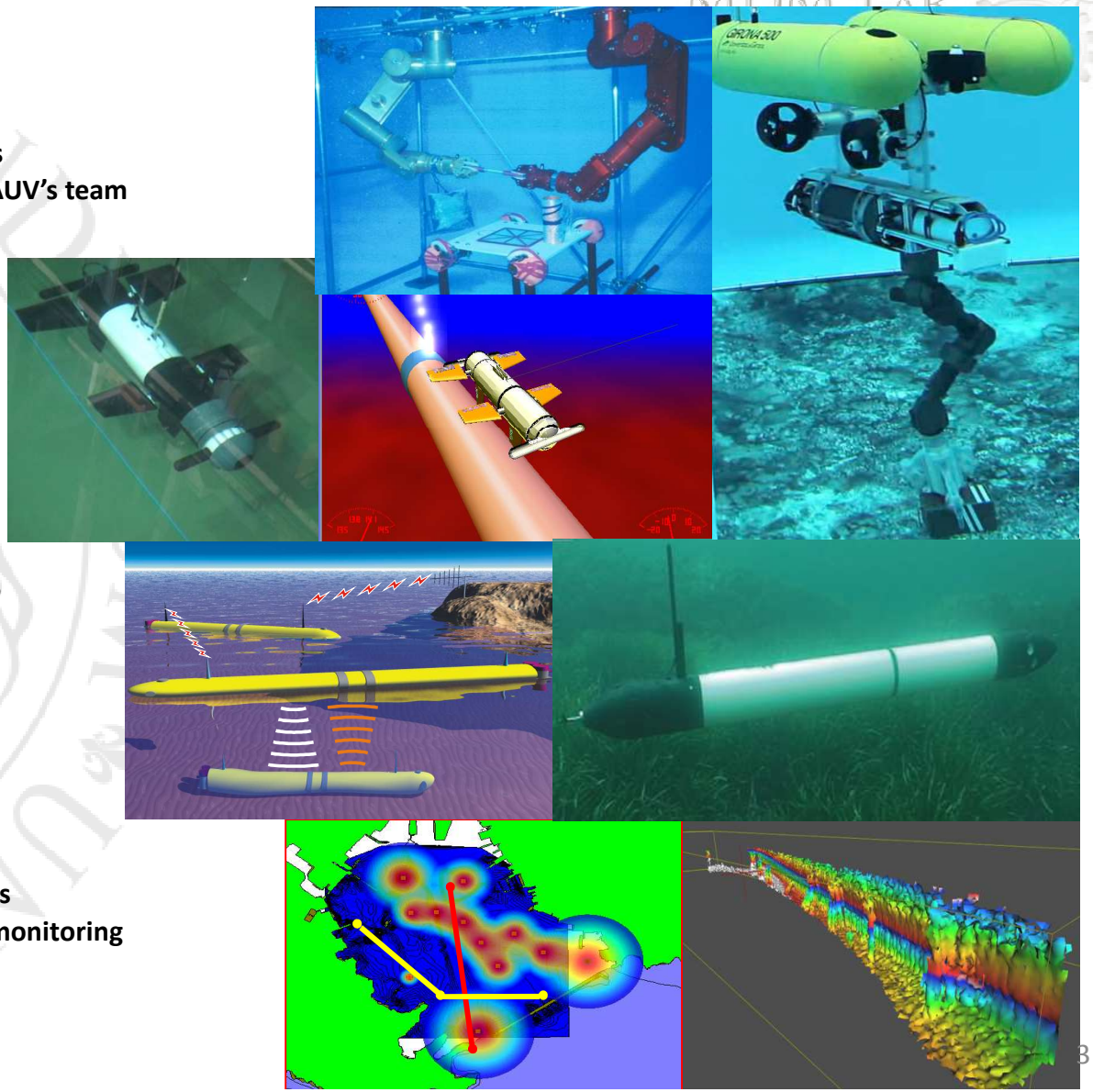
- Acoustic localization
- Acoustic communications
- Underwater optical communications,
- Acoustic Imaging and Tomography
- Seafloor acoustics
- Sonar systems

Signal Processing and data acquisition

- Distributed data acquisition
- Geographical information systems
- Decision support systems
- Classification and data fusion

Applications:

- Surface and underwater security systems
- Distributed underwater environmental monitoring
- Underwater archaeology
- Underwater infrastructures inspection
- Sea surface remote sensing



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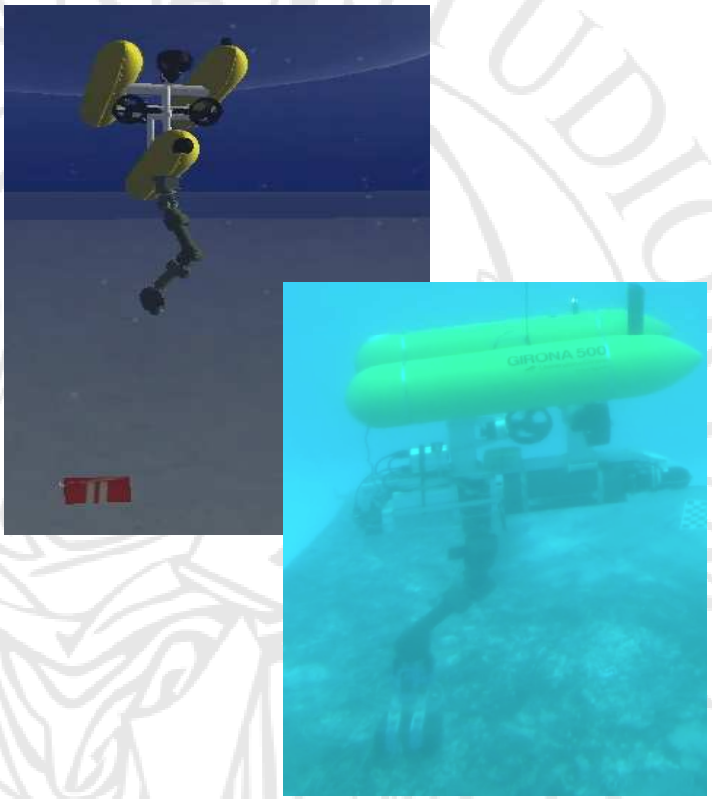
EU-FP6		
VENUS	***V**irtual **E**xploratio**N** of **U**nderwater **S**ites*	*Strep 06 – 09*
EPOCH	***E**xcellence in **P**rocessing **O**pen **C**ultural **H**eritage*	*NoE 04–08*
ARCHEOMED	*Patrimoine Culturel Maritime de la Mediterranee*	*Interreg 07–08*

EU-FP7		
UAN	***U**nderwater **A**coustic **N**etwork*	*Strep 08 – 11*
CO3AUVs	***C**ooperative **C**ognitive **C**ontrol of **AUVs***	*Strep 09 – 12*
TRIDENT	*Marine Robots and Dexterous Manipulation for Enabling Autonomous Underwater Multipurpose Intervention Missions*	*Strep 11 – 13*

Current and Recent National & Technology Transfer Projects		
CS3IM	AUV Team for Naval Asymmetric Threads Detection	DLTM 12 – 15
RIMA	UW Adaptive Sampling via AUV Cooperative Teams	DLTM 12 – 15
WAVE	*Wave Driven Autonomous* *Vehicle for Marine Exploration*	Italian Navy 13 – 15
-	Integrated Low-cost UW Communication and Localization Systems	FAS-DLTM 11 – 13
MARIS	Cooperative Marine Robots for Interventions	MIUR-PRIN 13 – 15
SUONO	Safe Underwater Operations iN Oceans	MIUR-Smart Cities 13-16

Project examples:

Floating Manipulation

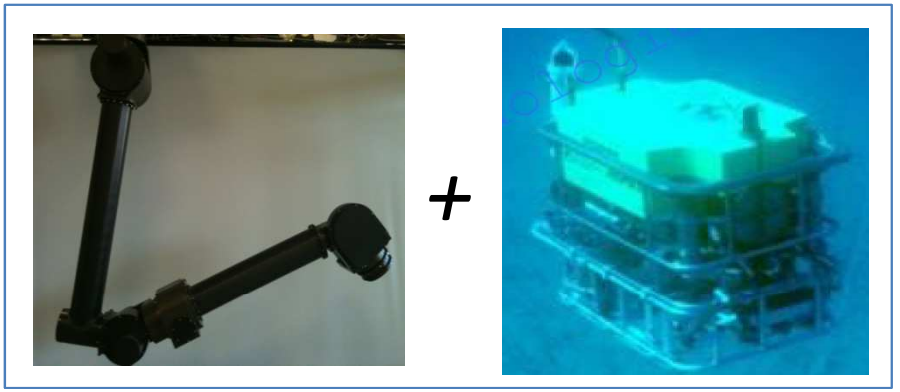


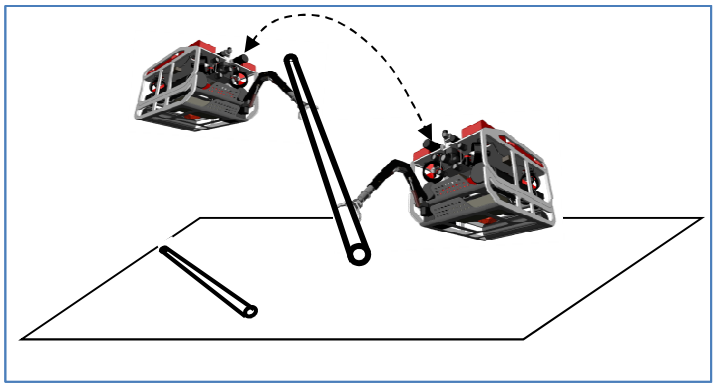
EU- TRIDENT Project 2010 – 2013

- *ISME-GE*
- *GRAALTECH*

Cooperative Floating Manipulation

ISME – GE *CNR-ISSIA – GE*



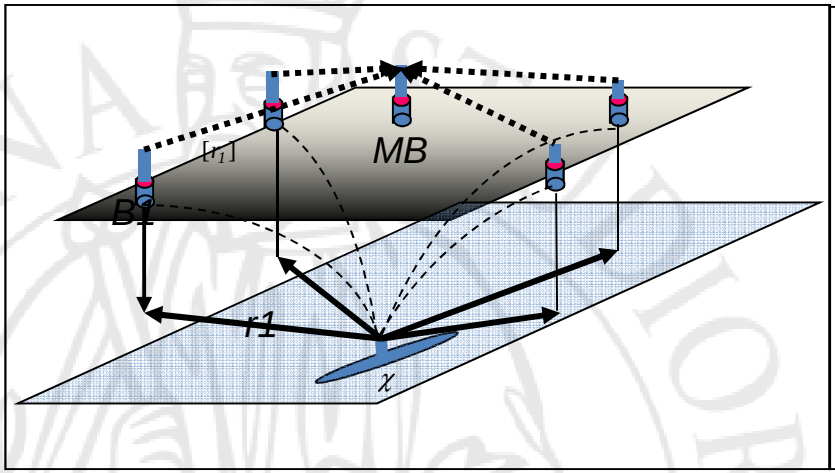


MIUR - MARIS Project 2013 – 2015

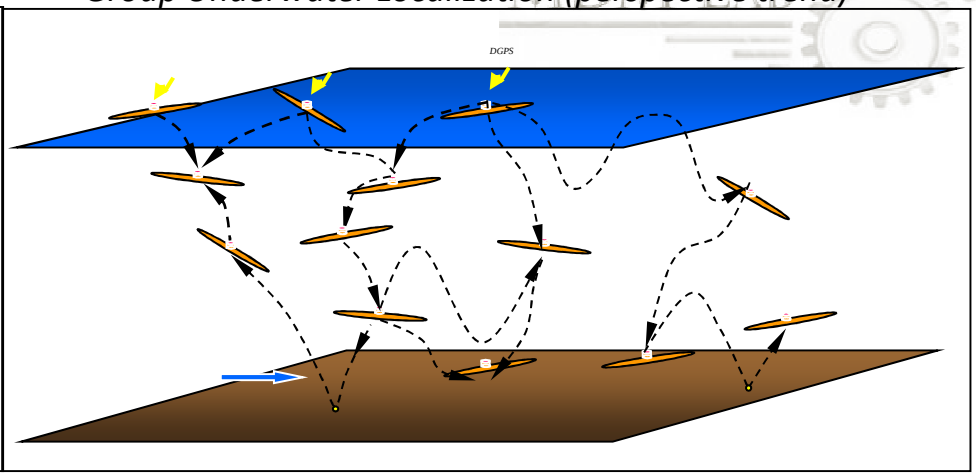
- *ISME-GE-PI-LE-CAS*
- *CNR-ISSIA- GE*

Project examples: *Acoustic networked AUV Teams (UW Localization)*

Centralized Underwater Localization



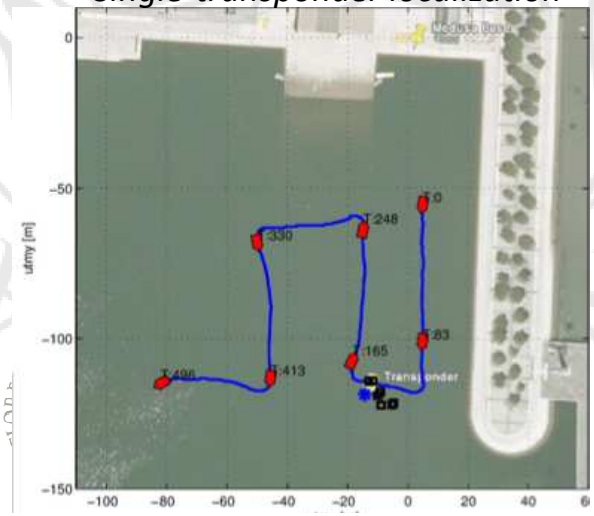
Group Underwater Localization (perspective trend)



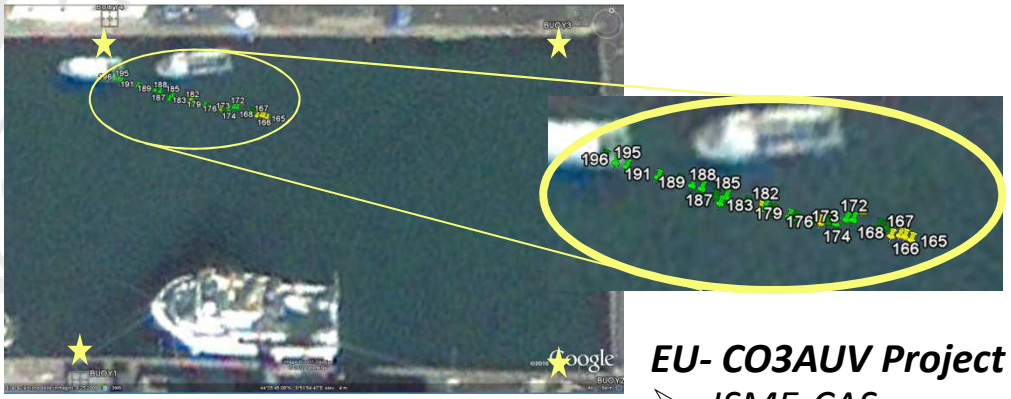
Employment of Real-time Ray-tracers for complying with acoustic propagation nonlinearities

Experimental results

Single-transponder localization



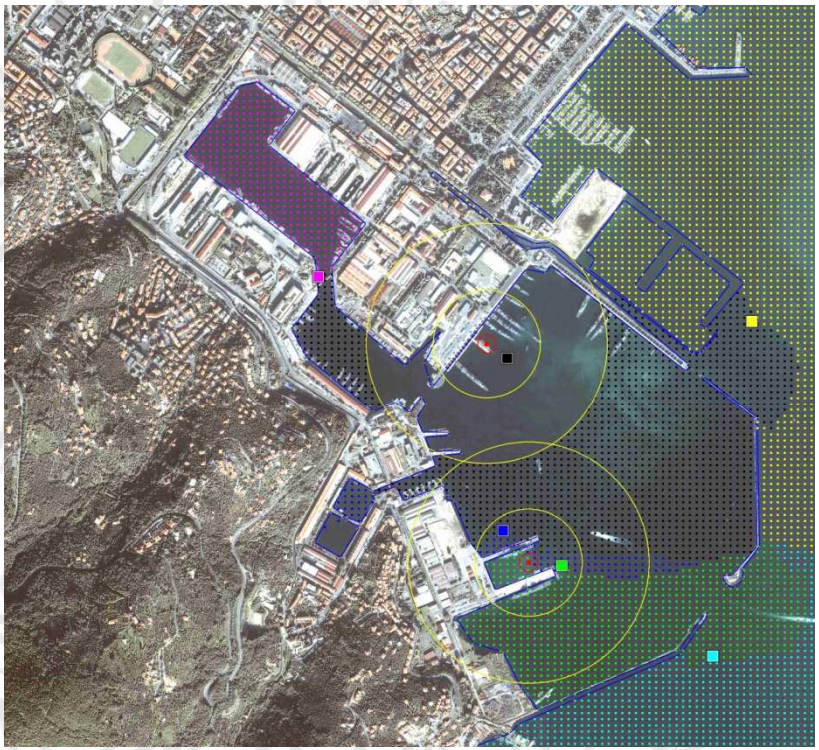
Centralized multi-transponder localization



EU- CO3AUV Project (2009-2011)

- *ISME-CAS*
- *GRAALTECH*

Networked ASV Teams
(UW optimal interceptor allocation)



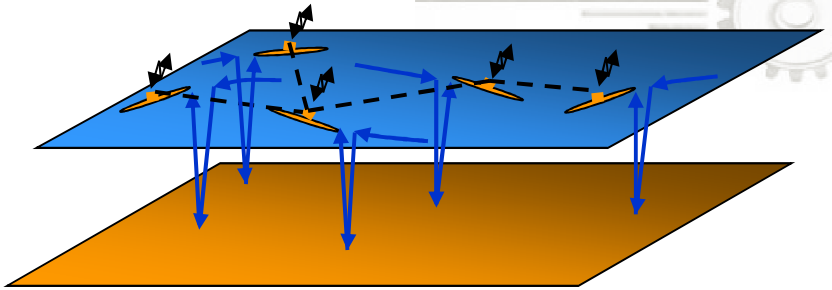
EU- CO3AUV Project (2009-2011)

- *ISME-GE*

SIIT-AUTOMATION Phase 1 Project

- *ISME-GE*
- *SELEX-SI*

Networked ASV Teams (Adaptive Sampling)



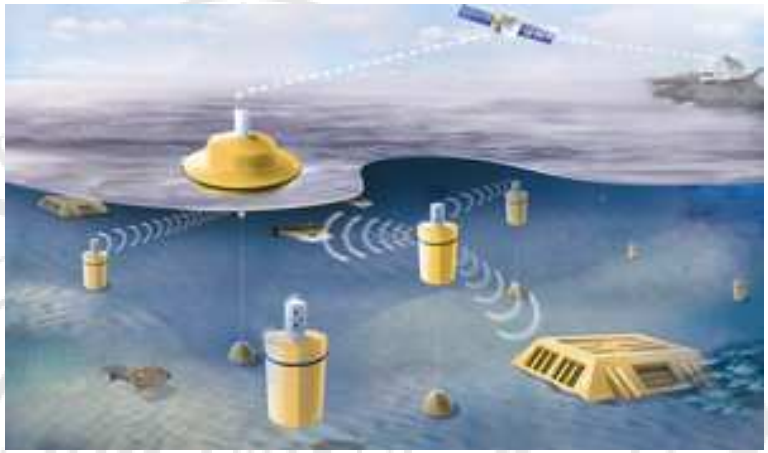
- *Dynamic Programming Based Approach*
- *Dynamic Voronoi Partition Based Approach*

EU- CO3AUV Project (2009-2011)

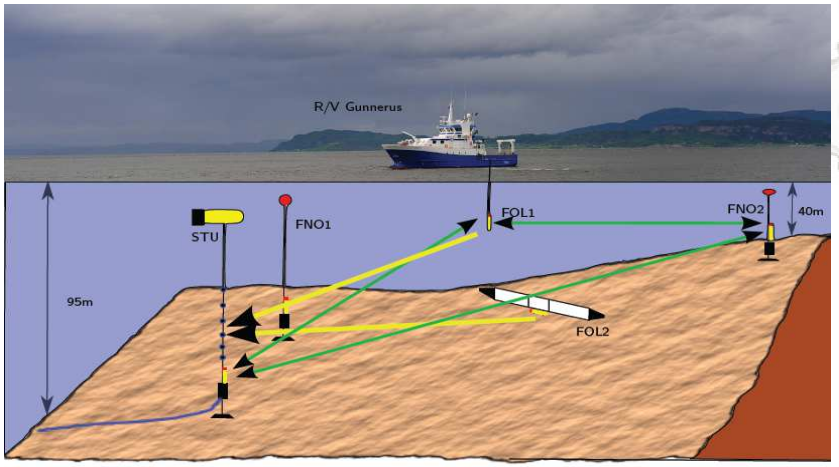
- *ISME-PI-GE-CAS*

IND. 2015 SlimCONTROL Project (2009-2012)

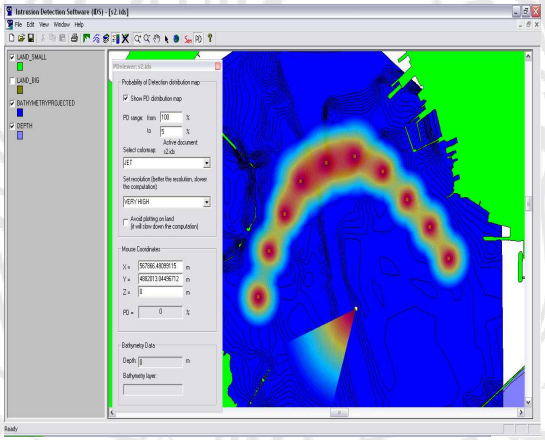
- *SELEX_ELSAG*
- *ISME-GE*
- *SIELCO S.r.l*
- *GRAALTECH S.r.l.*



Fixed topology UW Acoustic Network



Addition of mobile units for adaptability to varying Acoustic transmission properties



SIELCO

Integrating protection or environmental sensors within UW Acoustic networks

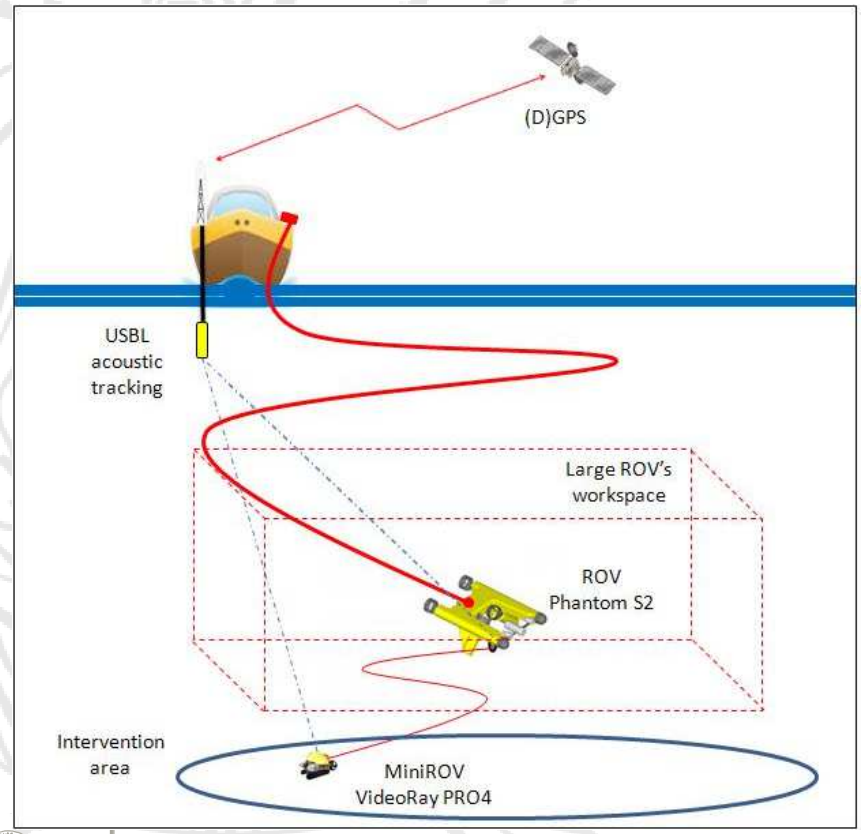
EU- UAN Project (2009-2011)

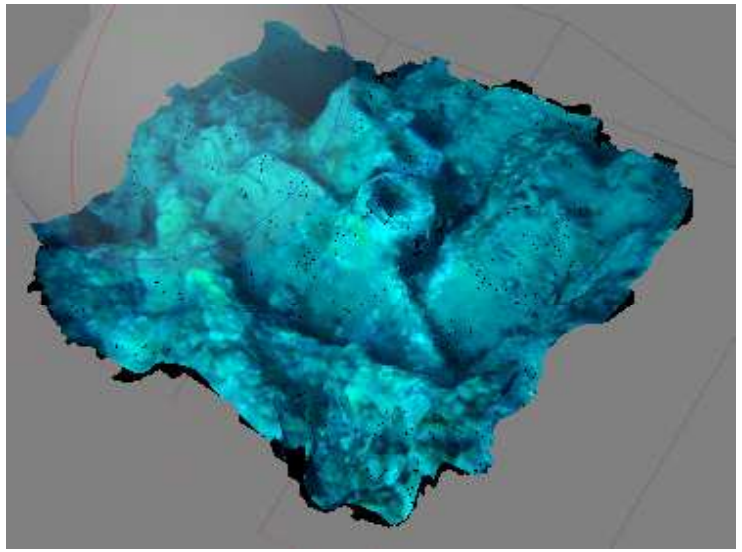
- *ISME-PI-GE*
- *SELEX-SI*
- *NURC*
- *GRAALTECH*

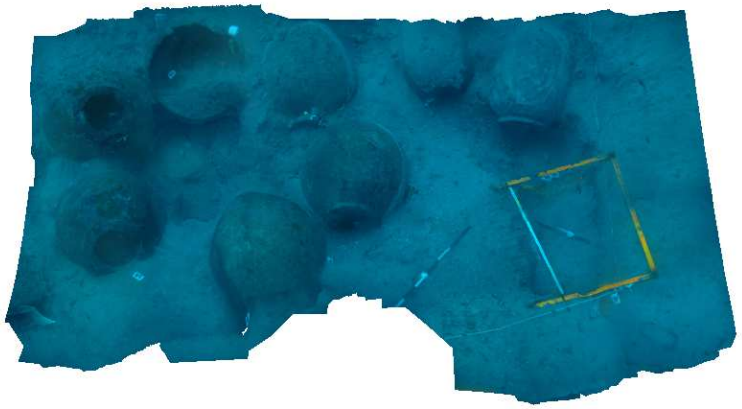
IND. 2015 SlimCONTROL Pr.jt (2009-2012)

- *SELEX_ELSAG*
- *ISME-GE*
- *SIELCO S.r.l*
- *GRAALTECH S.r.l.*

Project examples: *Cooperative Semi-autonomous ROV Systems for Archaeological Data Gatheringl*







EU- VENUS Project (2006-2009)

- *ISME-AN-PI*

SUONO

SAFE UNDERWATER OPERATIONS IN OCEANS

The roots of ARROWS…

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THESAURUS

Project duration 30 months

2011/03/01 – 2013/08/31

REGIONE TOSCANA

THESAURUS Goals

MDM LAB

- to develop/adapt methods and technologies devoted to ***detect***, ***explore***, ***classify***, and documenting underwater human artifacts of archaeological and/or ethno-anthropological interest
- the project tries to integrate robotics and ICT technologies with scientific methodologies which are typical of History and Archaeology

REGIONE TOSCANA

REPVBBLICA ITALIANA

FAS Fondo Aree Sottoutilizzate 2007-2013

- ***University of Pisa:*** Co-ordination, Ocean Engineering, Communications, Vehicle Cooperation, Acoustic Imaging
- ***University of Florence:*** Vehicle Design, Navigation, and Control, Computational Vision
- ***ISTI-CNR, Pisa:*** Data Collection and Integration
- ***Scuola Normale Superiore, Pisa:*** Investigation about Routes and Sites, Data Interpretation

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- ***Endorsement:*** Nucleo Operativo Subacqueo (N.O.S.), Soprintendenza per i Beni Archeologici della Toscana

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THESAURUS

Robot system made of AUVs for underwater archaeology

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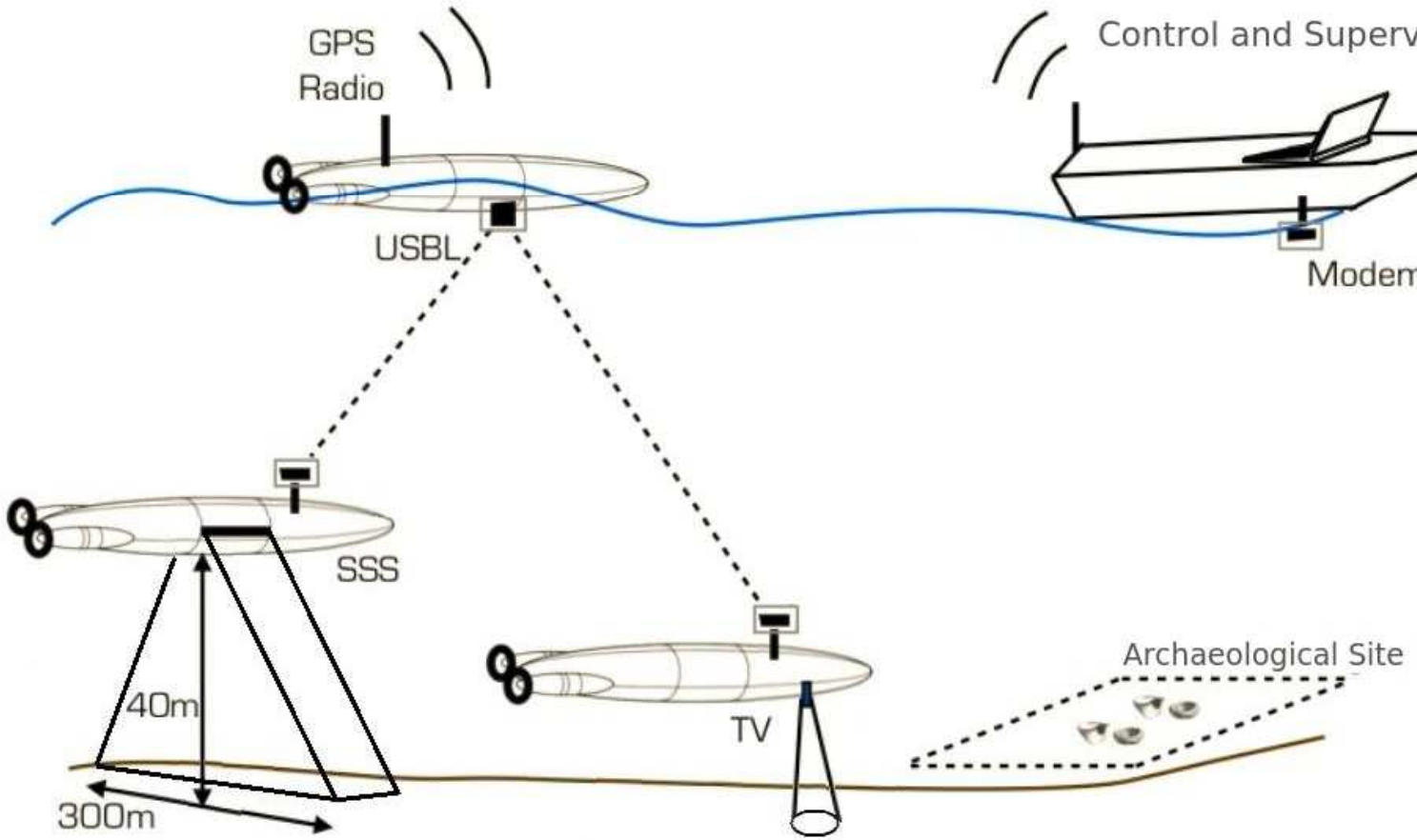

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Test site @Lake Roffia (San Miniato),
Length: 2km, Max depth: 15m

Tests with Typhoon 1,
February 2013

Foto: Vigili del Fuoco, Nucleo Sommozzatori Comando Provinciale di Livorno