Proceedings of BTS 2025

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● 1 INTRODUCTION

The summer school networking event took place during the "Breaking the Surface (BtS)" workshop, from November 9th to 15th in Limassol, Cyprus, and 194 people participated. The BTS is the international interdisciplinary workshop on robotics and maritime innovations that has been held for 17 years and serves as a meeting point for experts and students involved in marine robotics application areas. This year's BTS has been organized by the Cyprus Marine and Maritime Institute (CMMI) in collaboration with the Faculty of Electrical and Computer Engineering of the University of Zagreb (UNIZG-FER) and Centre of Excellence MARBLE and served as a venue for strengthening links with potential end-users. The program was divided into four tracks (marine robotics, maritime biology, marine oceanography, and marine archaeology), and included 16 in-depth lectures, 1 company presentation, 7 tutorials, 8 demos, presentations of three centres of excellence (CMMI (Cyprus), CoE MARBLE (Croatia) and INESCTEC OCEAN (Portugal), 2 company presentations, and the detection of underwater acoustic signals challenge.

This deliverable describes the BtS 2025 organization, including the work program. The deliverable is accompanied with abstracts and presentations of the program presenters.

Dates: 9th – 15th November 2025
Location: Limassol, Cyprus
Website: https://bts.fer.hr/

● 2 ABOUT BREAKING THE SURFACE

Breaking the Surface - BtS workshop has been organized by UNIZG-FER (LABUST research group) for 17 years. Following the success of previous BTS workshops UNIZG-FER hosted the BTS 2025 from 9th to 15th November 2024, in Limassol, Croatia. During the years, BtS served as a meeting place of experts and students of marine robotics and the marine robotics application areas such as marine biology, marine archaeology, marine security, oceanography, marine geology, and oceanology. This is the world's first successful, multi-year field training programme that combines academic topics in marine robotics and robotics application areas and hands-on working experience in the sea, doing remote sensing and sampling for various ocean sciences. The program is organized in the form of plenary talks, hands-on tutorials and demonstrations of marine technologies, e.g. marine robotics (MAROB), marine biology (MARBIO), maritime, nautical and ship archaeology (MARCH), oceanography (MAROCEAN), competitions for students, and company presentations.

BTS 2025 IN NUMBERS:

20 COUNTRIES   **194 ATTENDEES**   **16 LECTURES**   **8 TUTORIALS**

7 DEMOS   **3 PRESENTATIONS OF CENTRES OF EXCELLENCE**   **2 COMPANY PRESENTATIONS**

● 3 BTS ORGANIZATION STRUCTURE

3.1. Committee Chairs

Prof. Zoran Vukić, PhD
Honorary General Chair

Prof. Nikola Mišković, PhD
General Chair

Ioannis Kyriakides, PhD
General Co-Chair

Prof. Roee Diamant, PhD
Programme Chair

3.2. Programme Committee

Ioannis Kyriakides
CMMI

Cyprus

Asgeir Sorensen
NTNU

Norway

Massimo Caccia
Italian National Research Council (CNR)

Italy

Fausto Ferreira
UNIZG FER

Croatia

Bill Kirkwood
Monterey Bay Aquarium Research Institute (MBARI)

USA

Nuno Cruz
FEUP/INESC TEC

Portugal

Bridget Buxton
University of Rhode Island

USA

Gil Gambash
University of Haifa

Israel

Irena Radić Rossi
University of Zadar

Croatia

Jeff Neasham
Newcastle University, School of Engineering

UK

● 4 PROGRAMME

The BTS programme consisted of:

- lectures where the latest scientific research and results are presented,
- field demonstrations that showcase the latest technology achievements made by research groups and companies,
- tutorials that offer hands-on experience working with complex and modern underwater systems,
- company presentations with insight from company professionals about their company and company products,
- student competitions that serve as a platform for applying the knowledge acquired from BTS lectures and tutorials to address real-world challenges in marine robotics and blue economy.
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Fig. 1. BTS Opening session

Fig. 2. Group photo of BTS 2025 participants

4.1 BTS Agenda

The daily lecture programme follows below with the list of talks and speakers and links to the abstracts, biographies and presentations of the lectures. The program is also available on the [BTS 2025 website](#).

Day 1: 9th November		
Time	**Presentation title**	**Speakers**
16:30 - 18:00	Registration	
18:00 - 19:30	Welcome reception	Nikola Mišković, General Chair (UNIZG-FER/CoE MARBLE)

Day 2: 10th November		
Time	**Presentation title**	**Speakers**
09:00 - 09:15	Opening session	Nikola Mišković, General Chair (UNIZG-FER/CoE MARBLE)
		Roee Diamant, Programme Chair (University of Haifa)
		Marina Loizidou, Local Organising Chair (CMMI)
09:15 - 10:00	Smart buoy developments and technologies applied in Cyprus ([presentation](#))	Nikolas Flourentzou/Lefteris Economou, SignalGeneriX Ltd, Cyprus
10:00 - 10:45	Enabling Intelligent Multi-Modular Structures for Ocean Energy Harvesting ([presentation](#))	Dong Trong Nguyen, NTNU, Norway
10:45 - 11:15	Coffee break	
11:15 - 12:00	From Arctic Expeditions to Coastal Labs: Robotic Infrastructure for Marine Monitoring ([presentation](#))	Martin Ludvigsen, NTNU, Norway
12:00 - 12:25	Automated detection of sperm whale clicks under interference from noise transient ([abstract](#))	Meisam Jahanshahi Zeitouni, UNIZG-FER
12:25 – 12:50	Monitoring the Mobility of Sea Turtles in Video Footage ([abstract](#))	Marko Barišić, UNIZG-FER
12:50 - 14:00	Lunch break	
14:00 – 15:30	**DEMOS DAY 1**	
15:30 – 16:15	**Tutorial 1 INTRO**: Underwater Noise Maps – a demonstration of the HARMONI-SN webtool and tutorial of practical acoustic measurements ([abstract](#))	Mark Shipton, University of Haifa
16:15 - 17:00	Detection of underwater acoustic signals **CHALLENGE** – introduction	Roee Diamant, University of Haifa
17:00 - 17:15	Short break	
17:15 – 19:15	Detection of underwater acoustic signals **CHALLENGE** hands-on / **Tutorial 1** hands-on	Roee Diamant (University of Haifa) / Mark Shipton (University of Haifa)

Day 3: 11th November		
Time	Presentation title	Speakers
09:00 - 09:45	Towards Autonomous Robotic Organizations (presentation)	Asgeir J. Sørensen, NTNU, Norway
09:45 - 10:30	Between Tradition and Innovation: Breaking the Surface in Underwater Cultural Heritage Management in Cyprus (presentation)	Anna Demetriou Patsalidou, CMMI, Cyprus
10:30 - 11:00	Coffee break	
11:00 - 11:45	Geophysical challenges in mapping ancient harbor systems: preliminary insights from the SHIPs project (presentation)	Michael Lazar, University of Haifa
11:45 - 12:30	Adaptive networking for underwater acoustic systems (presentation)	Paul Daniel Mitchell, University of York, UK
12:30 - 13:45	Lunch break	
13:45 - 15:15	**DEMOS** DAY 2 / **CHALLENGE** DAY 1	
15:15 - 16:00	Tutorial 4 INTRO: Marine Policy and Co-Management in Marine Protected Areas – Through Serious Play (abstract)	Barbara Čolić, Hrvoje Čižmek, Marine Explorers Society – 20000 Leagues, Croatia
16:00 - 16:45	Tutorial 3 INTRO: Subsea Object Recovery with a ROV in the MARUS Simulator (abstract)	Natko Kraševac, UNIZG-FER, Croatia
16:45 - 17:00	Short break	
17:00-19:00	Tutorial 3 HANDS-ON / Tutorial 4 HANDS-ON	Natko Kraševac / Barbara Čolić, Hrvoje Čižmek

Day 4: 12th NOVEMBER		
Time	Presentation title	Speakers
09:00 - 09:45	Robotics: Research Overview (presentation)	Ivan Stenius, KTH, Sweden
09:45 - 10:30	Amphibious Data: Sensing and Robotics Where Land Meets Water (presentation)	Maarja Kruusmaa, University of Technology (TalTech), Estonia
10:30 - 11:00	Coffee break	
11:00 - 11:45	Sustainability Robotics – Lifelike robots for Environmental Sensing (presentation)	Mirko Kovac, EMPA/EPFL, Switzerland
11:45 - 12:30	From Passion to Action: Building Opportunities in Marine Conservation (presentation)	Carlo Cerrano, Polytechnic University of Marche, Italy
12:30 - 13:45	Lunch break	

13:45 - 14:30	Tutorial 5 INTRO: Microplastics Detection (abstract)	Giannis Loizides, Maria-Christina Constantinou, AKTI, Cyprus
14:30 - 15:30	Tutorial 5 HANDS-ON	Giannis Loizides, Maria-Christina Constantinou, AKTI, Cyprus
15:30 - 16:30	**DEMOS** DAY 3 / **CHALLENGE** DAY 2	
16:30 - 16:45	Short break	
16:45 - 17:30	Tutorial 2 INTRO: The Need for Speed! Enjoying the Thrill of Autonomous Guidance	Marco Bibuli, CNR INM, Italy
17:30 - 18:30	Tutorial 2 HANDS-ON	Marco Bibuli, CNR INM, Italy

Day 5: 13th November		
Time	**Presentation title**	**Speakers**
09:00 - 09:15	INTRODUCTION – Centres of Excellence	CoE MARBLE, CMMI, INESCTEC OCEAN
09:15 - 09:30	CMMI - INTRODUCTION	Ioannis Kyriakides, CMMI, Cyprus
09:30 - 09:45	INESCTEC OCEAN - INTRODUCTION	Diana Viegas, INESCTEC OCEAN, Portugal
09:45 - 10:00	CoE MARBLE - INTRODUCTION	Nikola Mišković, CoE MARBLE, Croatia
10:00 - 11:00	Panel discussion	Representatives of the Centres of Excellence
11:00 - 11:30	Coffee break	
11:30 - 12:00	Company presentation: NORTEK AS	Kristian Sem, Cristobal Molina, NORTEK AS
12:00 - 13:15	Lunch break	
13:15 - 14:30	**DEMOS** DAY 4 / **CHALLENGE** DAY 3	
14:30 - 15:30	Centre of Excellence - CMMI	Ioannis Kyriakides, CMMI, Cyprus
15:30 - 16:30	Centre of Excellence - CoE MARBLE	Nikola Mišković, CoE MARBLE, Croatia
16:30-16:45	Short break	
16:45 - 17:45	Centre of Excellence – INESCTEC OCEAN	Diana Viegas, Marta Barbas, INESTEC OCEAN, Portugal

Day 6: 14th November		
Time	**Presentation title**	**Speakers**
09:00 - 09:45	Unfolding the Marine Protected Areas in the Republic of Cyprus (presentation)	Maria Christou, Ministry of Agriculture, Rural Development and the Environment of the Republic of Cyprus
09:45 - 10:30	Understanding and monitoring the effects of stressors on shallow water habitats (presentation)	Louis Hadjioannou, CMMI, Cyprus
10:30 - 11:00	Coffee break	

Time	Activity	Presenter
11:00 - 11:45	Company presentation: FueLink: Where Digitalization Meets Decarbonization in Marine Fuel Procurement (abstract)	Konstantin Bronetskiy, FueLink, Cyprus
11:45 - 12:30	How deep we can understand biology without biology (presentation)	Sandi Orlić, Ruder Boskovic Institute, Croatia
12:30 - 13:45	Lunch break	
13:45 - 14:30	CHALLENGE presentations	challenge teams
14:30 - 15:15	Tutorial 7 INTRO: The Climarest Marine Restoration Digital Toolbox: An Online Decision-Support Platform (abstract)	Hassan Elkholy (NTNU), Lara Veylit (SINTEF), Antonio Vasilijevic (NTNU), Norway
15:15-16:00	TUTORIAL 8 INTRO: Rapid Integration Loop via Simulation: Underwater Docking (abstract)	Gabriele Kasparaviciute, Ambjørn Waldum, NTNU, Norway
16:00-16:15	Short break	
16:15- 18:15	Tutorial 7 HANDS-ON / Tutorial 8 HANDS ON	Hassan Elkholy (NTNU), Lara Veylit (SINTEF), Antonio Vasilijevic (NTNU), Norway / Gabriele Kasparaviciute, Ambjørn Waldum, NTNU, Norway
19:30 - 20:00	Closing ceremony	
20:00 - 21:00	Gala dinner	

Day 7: 15th November	
Time	**Activity**
09:00 - 17:00	Field trip

● 5 Competitions for students and young researchers

5.1 Detection of Underwater Acoustic Signals Challenge

The detection of underwater signal is a key enabling technique for any active and passive underwater acoustic sensor applications. Technologies such as SONAR imaging, acoustic communication, depth detectors, and signal identification, all use as a backbone detection capability. Underwater acoustic detection is different from the established radio frequency techniques. Due to the fast-changing sea environment, approaches based on noise estimation face mismatches between the assume noise model and its actual distribution. Further, the significant multipath that arrives closely in time produces negative and positive superposition, which makes it hard to identify the first arrival. And the time-varying-frequency-selective characteristics of the acoustic channel makes it challenging to loc onto the received signal. A simple binary detection is needed to distinguish between noise and signal. Since the distance to the emitter is also

of interest, we target not only the detection rate and the false alarm rate, but also the time of detection. In the applications considered, either a template of the signal is known, or neither the structure of the detected signal nor its statistics are known (e.g., duration, carrier frequency, bandwidth, etc.).

In this challenge, the focus was on learning techniques for detection of both known and unknown signal templates. The challenge tested the participants' skills in signal detection, time-delay estimation, and noise-robust decoding under realistic marine acoustic conditions.

The participants were divided into groups and introduced to the operation of acoustic recording hardware. During the conference, the groups performed the challenge task using a provided boat in three available slots and presented their results in a summary event on Friday, November 14th.

The challenge included two tasks: 1) Offline detection of signal of known structure, and 2) Offline detection of signal of unknown structure. Both signals were transmitted within a time window of 30min. In the known signal case, the groups were required to provide the time of detection for all detection events. At least 5 transmissions were performed from a second boat at varying source levels. In the unknown signal case, a pinger emitted an acoustic tone at an unknown frequency. Each pinger had a unique ID encoded in the specific interval pattern between its consecutive pings. The teams were required to decode the pinger's ID by determining the time intervals between the detected acoustic pulses.

Fig. 3. Localisation challenge introductory session and challenge description

The Competition

- 4 groups signed up for the competition
- Sea tests: Nov 12th and 13th

Figure 4. The competition

Results – Aggregate

Challenge 1

		True Positives	False Positives	Average Difference
3rd	Group 1	10	0	0,048112
4th	Group 2	6	0	0,001023
1st	Group 3	10	0	0,04439
2nd	Group 4	9	0,5	0,001122

Challenge 2

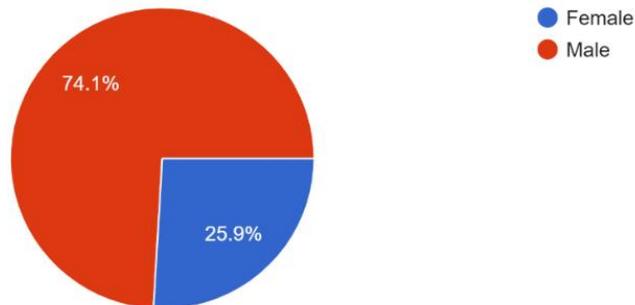|	Freq (KHz)	Period (ms)
	35	930
Group 1 Result	36,5	925
Group 1 Difference	1,50	5,00
Group 2 Result	35	920
Group 2 Difference	0,00	10,00
Group 3 Result	34,987	930,5
Group 3 Difference	0,01	0,50
Group 4 Result	35	929,86
Group 4 Difference	0,00	0,14

Fig. 5. Final localisation results

● 6. SURVEY RESULTS FROM PARTICIPANTS ON SUMMER SCHOOL EXPERIENCE

Below we present the results of survey focused on the summer school experience, which offers a detailed overview of the participants' perceptions and feedback.
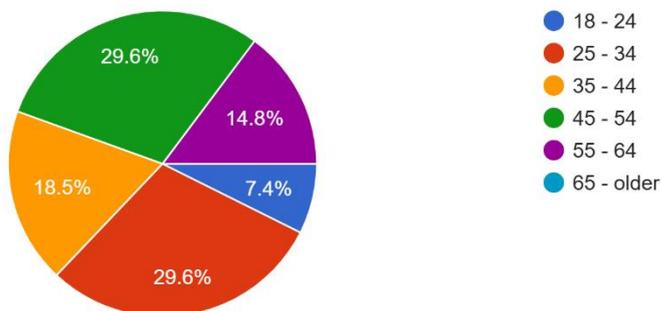
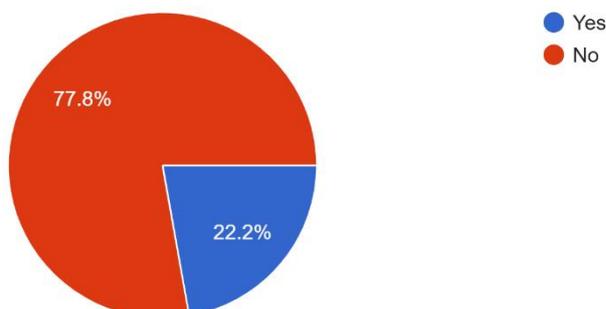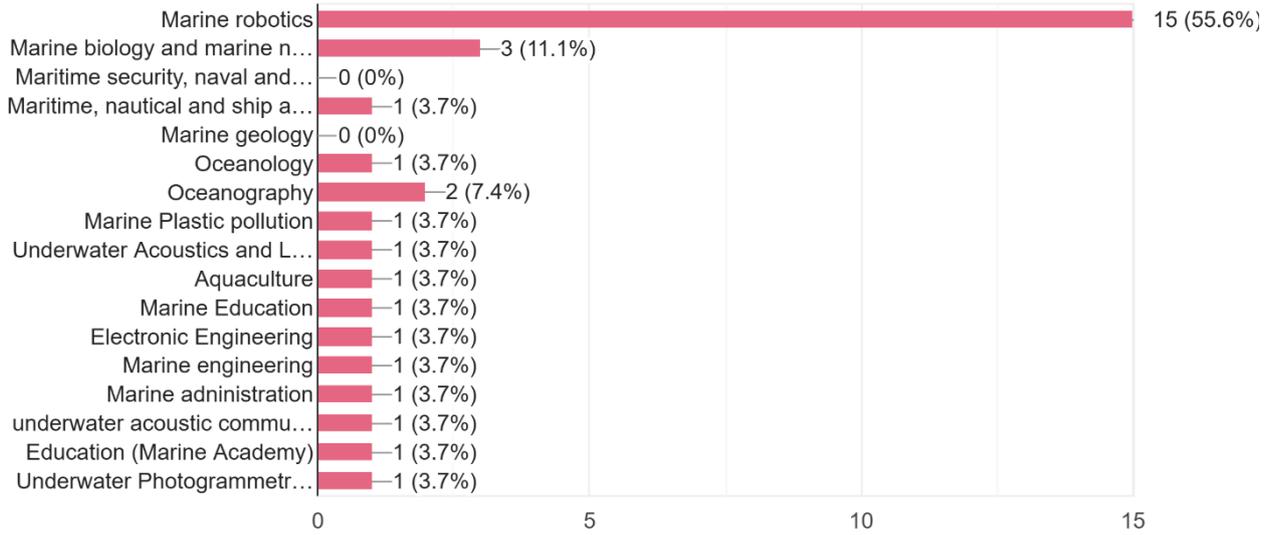What is your gender?
27 responses

- Female
- Male

74.1%

25.9%

What is your age group?
27 responses

- 18 - 24
- 25 - 34
- 35 - 44
- 45 - 54
- 55 - 64
- 65 - older

29.6%

14.8%

7.4%

18.5%

29.6%

Are you a student?
27 responses

- Yes
- No

77.8%

22.2%

What best describes your area of work?

27 responses

Area	Count (%)
Marine robotics	15 (55.6%)
Marine biology and marine n…	3 (11.1%)
Maritime security, naval and…	0 (0%)
Maritime, nautical and ship a…	1 (3.7%)
Marine geology	0 (0%)
Oceanology	1 (3.7%)
Oceanography	2 (7.4%)
Marine Plastic pollution	1 (3.7%)
Underwater Acoustics and L…	1 (3.7%)
Aquaculture	1 (3.7%)
Marine Education	1 (3.7%)
Electronic Engineering	1 (3.7%)
Marine engineering	1 (3.7%)
Marine adninistration	1 (3.7%)
underwater acoustic commu…	1 (3.7%)
Education (Marine Academy)	1 (3.7%)
Underwater Photogrammetr…	1 (3.7%)

You work in:

27 responses

- Academia — 77.8%
- Industry — 22.2%

You took part in BTS as a:

27 responses

- Lecturer — 22.2%
- Demonstration host — 11.1%
- Tutorial host — 14.8%
- Company representative
- Participant — 29.6%
- Student — 14.8%
- Accompanying person
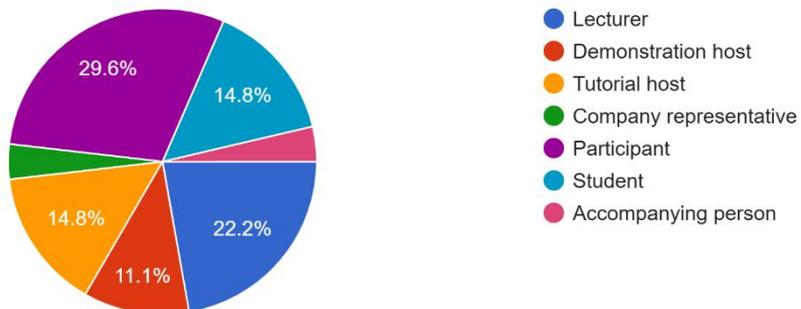
You learned about BTS through:

26 responses

Category	Value
Social media	0 (0%)
Web	3 (11.5%)
E-mail or newsletter	5 (19.2%)
Personal recommendation	22 (84.6%)
TV, newspaper or radio	0 (0%)
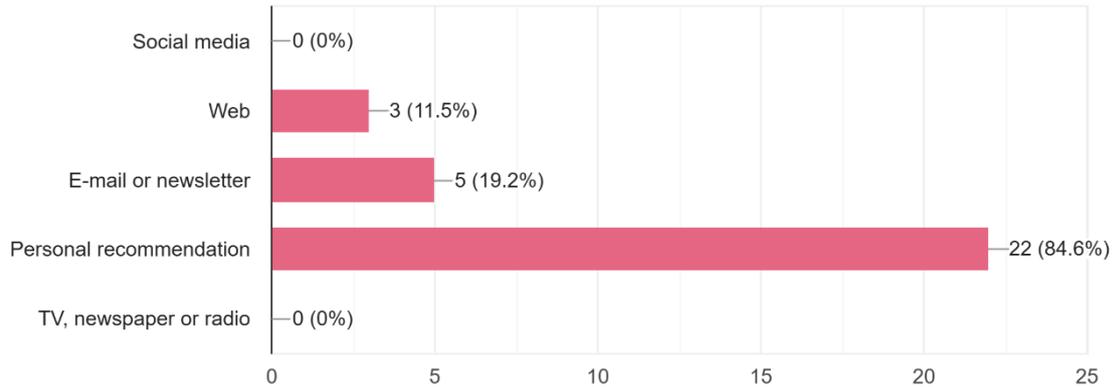
Why did you decide to participate in BTS 2025?

21 responses

I think it was the right place to increase the network of my company in the south of Europe.

Networking, state of the art

I've participated before.
Because i participated in the RAMI 2025 and it allowed me to win the ticket to BTS.

To represent the national authority for marine environment protection

I found it very interesting

It is a recognized event under the marine robotics area

Well know event with good networking possibilities

Networking and scientific content

Good words about the conference and nice location.

We recently completed a deep-sea project and are now seeking partners for new opportunities

Collaboration with the host organisation

It was a nice venue to expose a more technical audience to the services we created.

it's a good chance for us to connect with the world
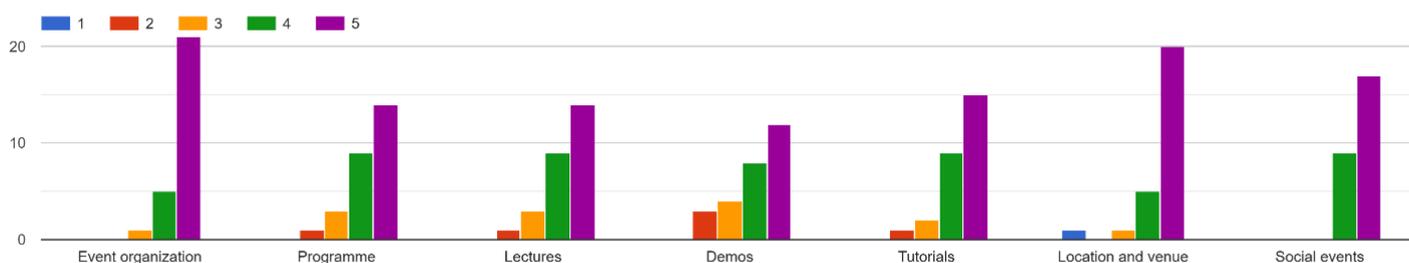
Project partner

SeaTecHUB member

Reputation of the event and it's scope including robotics in particular.

We are interested in marine robotics, for educational reasons

To know what is the SOTA in the field and get some knowledge

learn and interact with the community

How would you rate the following aspects of BTS (5 is the highest, 1 the lowest grade):

Would you like to point anything out about these particular aspects of BTS?

9 responses

No

Overall, very satisfied. The program was a bit caotic and unclear. Same with the meals timing and costs.

But the CMMI staff was very helpful, the content of the presentations was (most of the times) very interesting. The demo area was a bit far, but it worked more or less well

Demos were empty most of the time, more structured sessions would have helped. I eas expecting more technical lectures. Very good social events

I have suggested that the competition should be more practical what you can that next year there could a robotics competition where you will have some tasks which robots have to perform initially you can provide the task details to the team and ask them to implement it in the simulation and during the competition we would have the real competition that will allow more peoples will participate because it will help them to showcase their technology also it will built interest to the peoples who is coming for the conference

Very useful to have different sectors working together for protecting the marine environment using technological advances
Mix of all these toghether

I would like to see students contributing with something. Instead of papers, perhaps their DOI referenced code or data, or an innovation.

I think the event was extremely well organized with a very nice atmosphere!

14

Overall, how...
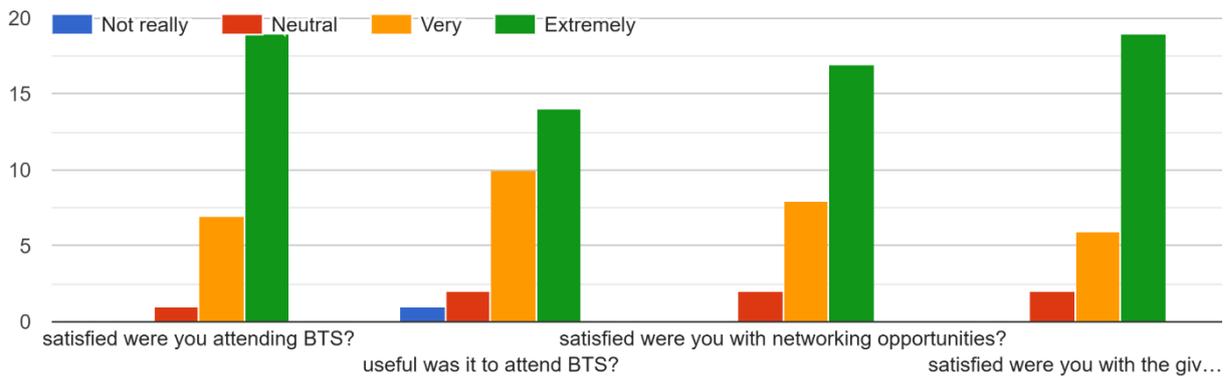
What was the most interesting lecture for you?

13 responses

Mirko Kovac
Michael Lazar
Overall the first day
The one from Martin Ludvigsen.
The one from the norway about robotics.
Understanding and monitoring the effects of stressors on shallow water habitats
Smart buoy
Sustainability Robotics – Lifelike robots for Environmental Sensing
Kovic and Stenius
I really was interested in the Marbles lectures as we have a similar program
From Arctic Expeditions to Coastal Labs: Robotic Infrastructure for Marine Monitoring

What was the most interesting and useful demonstration for you?

9 responses

Nortek
The Chinese wind boat.
Norway with the docking station
Toolbox for marine restoration
Glider
N/A
na
NORTEC

What topics would you recommend for lectures or tutorials next year?

10 responses

Understanding underwater navigation

More focus on the lack of automatic systems/methods and robots in many marine areas like

biology/archeology/chemistry/etc (how all underwater science needs more engineering). A round table would also be nice

More interactive sessions with exercises using programming

N.c.

AI foundation models for marine robotics

More technical but also high level talks on digital ocean twins

Photogrammetry

Marine litter observation and mitigation

Who would you like to see as a lecturer in next year's programme?

7 responses

Luis Pascoal - Luis Sebastiao (ITS Lisbon)
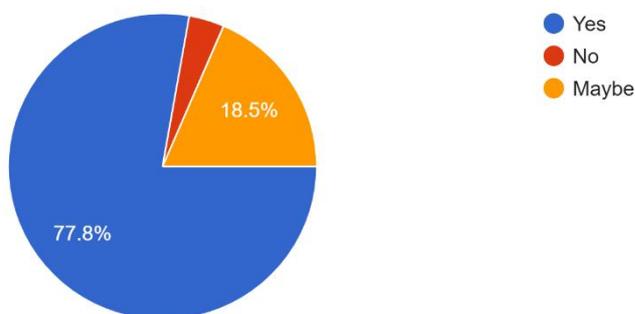John Leonard (MIT, US), Orlando Rodriguez (IST, PT), Jeffrey Neasham (NCL, UK)
Blair Thornton
Joao Sousa
Mirko Kovac
Dimitris Poursanidis

Would you like to attend BTS again?
27 responses

- Yes
- No
- Maybe

18.5%

77.8%

If **you have any additional suggestions or comments, feel free to add them here.**

4 responses

Thank you

In the programme would be nice to write the rooms where the lectures/tutorials are taking place for better coordination

More marine robotics companies attending and demonstrating

The fieldtrip maybe doing it with something related with the ocean