

# ICES TC 2016 REPORT

## Report of the ICES Training Course on “Principles and Methods of Broadband/Wideband Technologies: Application to fisheries acoustics”

8–13 December 2016, Bergen, Norway

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**ICES**  
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## 1 Summary

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The training course on “Principles and Methods of Broadband/Wideband Technologies: Application to fisheries acoustics” was held on board a Norwegian vessel, RV G. O. Sars, from 8 to 13 December 2016. The participants were on board on 7 December in Bergen, Norway and got off the vessel either in the evening on 13 December or 14 December. The number of participants was 20 from 13 countries, representing 20 organizations. There were also 5 instructors and 3 technical and logistic assistants.

With the rapid advances in technologies, broadband acoustic systems such as Simrad EK80 echosounder and EdgeTech towed and vertically deployable systems have become commercially available. The potential advantages of these systems over the currently widely used narrow-band, multi-frequency systems in target detection, acoustic characterization and classification of marine targets such as fish and zooplankton have made them increasingly popular and accepted within the fisheries acoustic community at a pace much quicker than expected.

To help colleagues to efficiently and accurately conduct surveys and researches in fisheries acoustics using these newly developed broadband acoustic systems, we proposed this training course to be held onboard a research vessel. The overall objective of this course was to provide participants the knowledge and skill of interpreting and processing acoustic broadband/wideband data with confidence, and to be well prepared for moving broadband/wideband technology forward into routine acoustic research and survey applications in fisheries science.



## 2 Course Descriptions

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### 2.1 Contents

The course covered both the theoretical background and how to apply the theory to actual fisheries acoustics through case studies and exercises with synthetic, previously recorded, and real time data collected during the training course.

A number of Simrad EK80 echosounder systems, including systems mounted on the ship drop keel, on TSprobe (a vertically deployable system that can be deployed up to 500 m depth), and WBAT (an autonomous EK80 recording system), were calibrated and operated during the class. Every participant had a chance to independently conduct the operation to gain hands-on knowledge and experiences.

### 2.2 Objectives

The overall objective of this course was to provide participants the knowledge and skill of interpreting and processing acoustic broadband/wideband data with confidence, and to be well prepared for moving broadband/wideband technology forward into routine acoustic research and survey applications in fisheries science.

By the end of the course, the participants could:

Understand the fundamental differences between narrow-band and broadband acoustic systems;

Interpret broadband/wideband echograms correctly;

Understand the spatial and temporal characteristics of the broadband/wideband systems;

Understand the techniques of spectral analysis such as pulse compression processing;

Process broadband/wideband raw and pulse-compressed (complex) data.

### 2.3 Level

The training course was an advanced course in fisheries acoustics. The participants were assumed to have moderate (college level) knowledge in algebra, calculus, and experience with narrow-band echosounders, such as Simrad EK60. In addition, programming ability (Matlab, R, etc.) was required.

### 3 Course programme

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Due to the room-space limitation on the vessel, the participants were divided into two groups. The two groups were taught essentially the same course contents but dealing with a slight different echosounder systems (different frequencies). Two groups had different course and dining schedules as listed provided in Table 1.

Every evening, there was a two-hour discussion session. During this discussion session, some questions, problems, and suggestions for the next day(s) were raised, answered, solved, or recorded. Some of the questions did suggest future projects. All instructors were available during this time.

The host of the training course was Ego Ona (Institute of marine Science - IMR, Bergen, Norway), who was the Chief Scientist or Project Leader on this G. O. Sars cruise. The IMR provided many necessary organizational and logistical supports.

#### 3.1 Training Schedule (detailed schedules are provided in Annex 2):

##### **Pre Training Course (7 Dec):**

Check in on Board R/V G.O. Sars.

##### **Day 1 (8 Dec):**

Morning: Check-in and sea safety training for both groups

Afternoon: Overview of the training class and the EK80 hardware and software with participants are divided into 2 groups

##### **Day 2 (9 Dec):**

Both groups: Theory I and ship board calibration of the EK80 systems - I

##### **Day 3 (10 Dec):**

Both groups: Theory II and ship board calibration of the EK80 systems - II

##### **Day 4 (11 Dec):**

Both groups: Theory III and IV, and acoustic and biological data collection (focused on fish & zooplankton aggregations).

##### **Day 5 (12 Dec):**

Both Groups: TS-Probe/WBAT data collection & EK80 data processing. TS-Probe focused on collecting TS of individual or resolved fish and zooplankton.

##### **Day 6: (13 Dec):**

Both Groups: More Data Processing Issues & Course conclusion

Vessel was dock at the pier in the afternoon/evening, participants could choose to stay on board the vessel or at the local hotels. For those who stayed on the vessel were required to be back to the vessel no later than 11:00 pm local time.

##### **Day 7 (14 Dec):**

Get off the vessel.

## 4 Accomplishments

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- 1) Theory on broadband technologies
  - a) Background on narrow band and broadband signal
  - b) Understanding the temporal, spatial, and spectral aspects of the complex broadband signal
- 2) Overview of the specifications and data flow of commercially available and most commonly used broadband systems – Simrad EK80
- 3) Knowledge on EK80 system operation and hands-on experiences
  - a) System configurations
  - b) Calibration procedures
  - c) Data collection and preliminary processing
- 4) Data Processing
  - a) Calibration quantities as a function of frequency
  - b)  $TS(f)$  of tracked individual targets
  - c)  $Sv(f)$  of a scattering layer

## 5 Recommendations

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Some useful comments and recommendations from the course evaluation questionnaire (see Annex 3).

- 1) Provide course material prior to the course – it was the first time ever such course was taught. There were some uncertainties about the contents of the course, which were not determined prior to the course. After this first course, we have gained experience and will be able to provide the course material ahead of the course if there will be another course in the future.
- 2) Provide a “big picture”, or overview on each course subject – this suggestion will be reflected in the next training course if there will be another one.
- 3) Theory should be more connected with the application (real EK80 data) and fewer equations– hopefully during the next course, more field data application can be integrated into the theory.

## 6 Acknowledgements

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We would like to thank Institute of Marine Research and the University of Bergen for their generous support of the Training Course by 8 days of ship time onboard the RV G. O. Sars. It allowed the course participants to have hands-on operation on the newly developed broadband echo sounders for real field applications and established an unprecedented format of the ICES training course.

## Annex 1: List of participants

NAME	COUNTRY	EMAIL	
<b><u>Instructors:</u></b>			
Dezhang Chu	USA	dezhang.chu@noaa.gov	
Lars N. Andersen	Norway	lars.nonboe.andersen@simrad.com	
Egil Ona	Norway	egil.ona@imr.no	
Rolf Korneliussen	Norway	rolf.korneliussen@imr.no	
Gavin J. Macaulay	Norway	gavin.macaulay@imr.no	
<b><u>Course Participants:</u></b>			<b>Assigned Group</b>
Matthias Schaber	Germany	matthias.schaber@ti.bund.de	1
Marian Peña	Spain	marian.pena@ba.ieo.es	2
Sascha Fässler	Netherlands	sascha.fassler@wur.nl	1
Jeroen van der Kooij	UK	jeroen.vanderkooij@cefasc.co.uk	2
Kevin Boswell	USA	kevin.boswell@fiu.edu	1
David Demer	USA	david.demer@noaa.gov	2
Tim Ryan	Australia	tim.ryan@csiro.au	1
Julius Parulek	Norway	juliusp@metas.no	2
Laurent BERGER	France	laurent.berger@ifremer.fr	1
Geoff Matt	Australia	geoff.matt@echoview.com	2
Christopher Bassett	United States	chris.bassett@noaa.gov	1
Yoann Ladroit	New Zealand	yoann.ladroit@niwa.co.nz	2
Jaroslava Frouzova	Czech Republic	jarkafrouzova@gmail.com	1
Andrew Brierley	UK	asb4@st-andrews.ac.uk	2
Lucio Calise	Spain	lucio.calise@zunibal.com	1
Teresa Silva	Iceland	teresa@hafro.is	2
Guillermo Boyra	Spain	gboyra@azti.es	1
Adrian madirolas	Argentina	adrian@inidep.edu.ar	2
Anne Lebourges-Dhaussy	France	anne.lebourges.dhaussy@ird.fr	1
Giovanni Canducci	Italy	giovanni.canducci@an.ismar.cnr.it	2

## Annex 2: Detailed course schedule

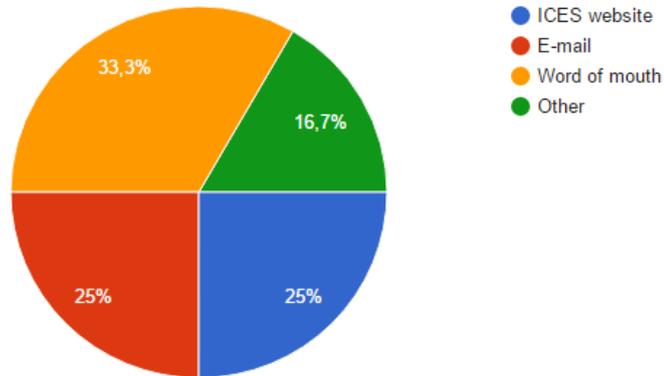
ICES Training Course Schedule				
<b>Course Title:</b>	Principles and Methods of Broadband/Wideband Technologies: Application to fisheries acoustics			
<b>Time:</b>	8 - 13 Dec 2016			
<b>Location:</b>	On Board R/V G.O. Sars			
<b>Instructors:</b>	Dezhnag Chu (DC), Lars N. Andersen (LA), Egil Ona (EO), Rolf J. Korneliussen (RK), Gavin J. Macaulay (GM)			
<b>Meal Time on G.O. Sars:</b>	Breakfast: 7:30 - 8:00 am	Lunch: 11:30 am - 12:30 pm	Dinner: 5:30 - 6:30 pm	
<b>Coffee Break:</b>	two breaks in the morning and three breaks in the afternoon (10 - 15 min.)			
Date	Group 1		Group 2	
	Time	Event	Time	Event
7-Dec-16	9:00 - 17:00	Fishermen Doctor Certificate (contact Egil Ona) & check in on G.O. Sars		
12/8/2016 (Day 1)	9:00 - 10:30		Departure & safety training	
	10:30 - 10:45		Welcome (EG) - Auditorium	
	11:30-12:00	Lunch	12:00-12:30	Lunch
	13:30 - 15:20	Course Overview (RK)	13:30 - 15:20	EK80 hardware & software intro (LA)
	15:30 - 17:20	EK80 hardware & software intro (LA)	15:30 - 17:20	Course Overview (RK)
	17:30 - 18:30	Dinner	18:00 - 18:30	Dinner
	19:00 - 21:00	Questions /Discussions	19:00 - 21:00	Questions /Discussions
12/9/2016 (Day 2)	7:45 - 11: 15	Theory - I (DC)	8:00 - 11:30	Calibration -I (setup, data collection & data processing) (EO & GM)
	11:30 - 12:00	Lunch	12:00 - 12:30	Lunch
	13:30 - 17:00	Calibration -I (setup, data collection & data processing) (EO & GM)	13:30 - 17:00	Theory - I (DC)
	17:30 - 18:00	Dinner	18:00 - 18:30	Dinner
	19:00 - 21:00	Questions /Discussions	19:00 - 21:00	Questions /Discussions
12/10/2016 (Day 3)	8:00 - 11:30	Theory - II (DC)	7:45 - 11:15	Calibration II (setup, data collection & data processing) (EO & GM)
	12:00 - 12:30	Lunch	11:30 - 12:00	Lunch
	13:30- 17:00	Calibration II (setup, data collection & data processing) (EO & GM)	13:30 - 17:00	Theory - II (DC)
	18:00 - 18:30	Dinner	17:30 - 18:00	Dinner
	19:00 - 21:00	Questions /Discussions	19:00 - 21:00	Questions /Discussions
12/11/2016 (Day 4)	7:45 - 8:45	Theory - III (DC)	8:00 - 11:30	Ship EK80 data collection & trawlingfish/zooplanton sorting (biological data sampling) (EO & GM)
	9:00 - 11:15	Theory - IV (LA)		
	11:30 - 12:00	Lunch	12:00 - 12:30	Lunch
	12:45 - 17:15	Ship EK80 data collection & trawling fish/zooplanton sorting (biological data sampling) (EO & GM)	13:00 - 14:00	Cont. - Ship EK80 data collection & trawlingfish/zooplanton sorting (biological data sampling) (EO & GM)
			14:15 - 15:15	Theory - III (DC)
			15:30 - 17:45	Theory - IV (LA)
	17:30 - 18:00	Dinner	18:00 - 18:30	Dinner
19:00 - 21:00	Questions /Discussions	19:00 - 21:00	Questions /Discussions	

12/12/2016 (Day 5)	8:00 - 11:45	EK80 Data processing - I (RK & GM)	7:45 - 11:15	TS-Probe & WBAT data collection (EO & GM)
	12:00 - 12:30	Lunch	11:30 - 12:00	Lunch
	13:00 - 14:00	Cont - EK80 Data processing - II (RK & GM)	12:45 - 17:15	EK80 Data processing - I & II (RK & GM)
	14:15 - 17:45	TS-Probe & WBAT data collection		
	18:00 - 18:30	Dinner	17:30 - 18:00	Dinner
	19:00 - 21:00	Questions / Discussions	19:00 - 21:00	Questions / Discussions
12/13/2016 (Day 6)	8:00 - 9:00	More Data Processing Issues (GM)	8:00 - 9:00	More Data Processing Issues (RK)
	9:10 - 10:10		9:10 - 10:10	
	10:20 - 11:20	Lunch	10:20 - 11:20	Lunch
	11:30 - 12:00		12:00 - 12:30	
	16:00 - 16:30	Class Summary - Auditorim (DC)		
	16:30 - 16:45	Course Close (EO)		
	18:30 - 19:30	Dinner		
	23:00	Back to G.O. Sars if stay on the vessel		
14-Dec-16	Your own schedule			

### Annex 3: Results of course evaluation questionnaire

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How did you hear about this course? (12 réponses)



Comments (2 réponses)

Within the WGFAST ICES group study

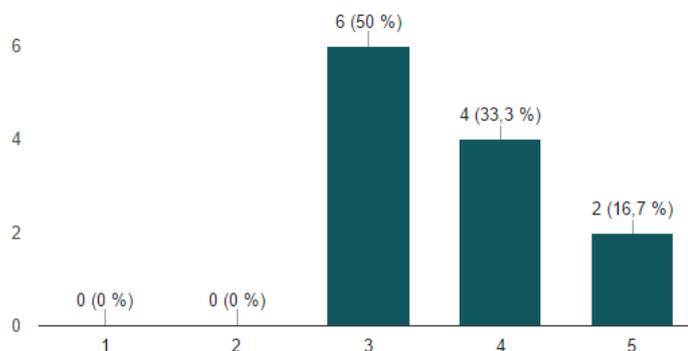
WGFAST

#### Course content

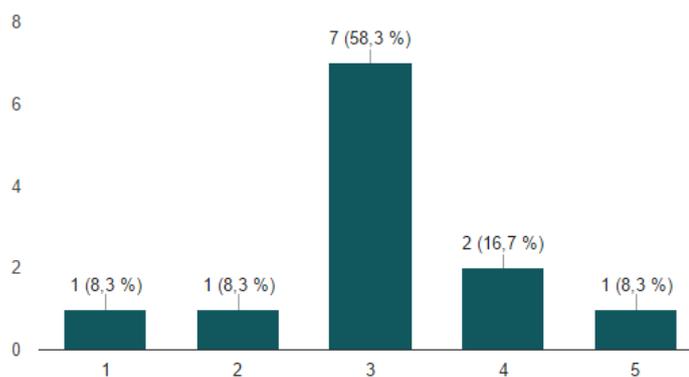
Did the Training course meet your expectations? (12 réponses)



Was the level of instruction appropriate? (12 réponses)



Was the length of the training course appropriate? (12 réponses)



Comments (4 réponses)

- Great ship, great people, great instructors
- I would like to have a little more theory/ orientated classes with more examples and more oriented to what we can do.
- theory was too much and given in a too 'dry' context (without examples) for the short time available
- There were aspects that were perfectly suited, and then others where more exercise could be helpful (i.e., data analysis and synthesis). Within the context of the 1 week course though, It was as thorough as one could have hoped for.

### What did you like best or find more useful about the training course?

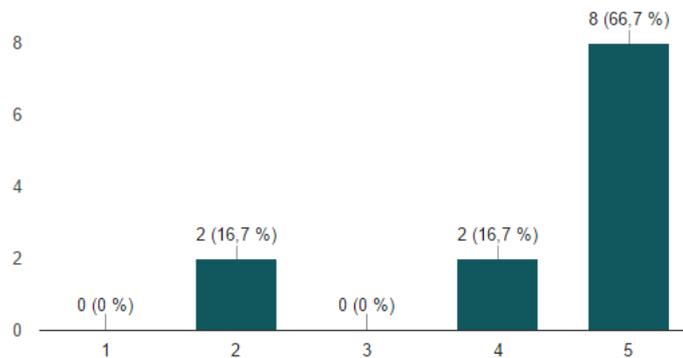
(11 réponses)

- Combination of the theory and the practice, continuous sharing of experiences with other participants and instructors.
- Interaction with others
- Practical
- Being on a vessel and be able to apply this technology in the field
- To be held on such a great vessel full time assisted by very excellent instructors.
- the practical applications
- To follow a training course directly in situ (on sea) in a great research vessel as G.O. Sars was extremely useful.
- Interaction with many experts. Being on board the vessel.
- I really enjoyed the practical application with the context of the theory. It would have been helpful to have exercises to put the theory into practice- perhaps that could be a group level activity. All in all it was a wonderful venue, and splitting into two groups allowed for effective communication and interactions. I would certainly attend again if allowed.
- The experience of onboard training, both on the theoretical and practical issues of broadband, increased the fruitfulness of the course exponentially.
- The ability to apply theory in practise onboard the RV and using autonomous gear

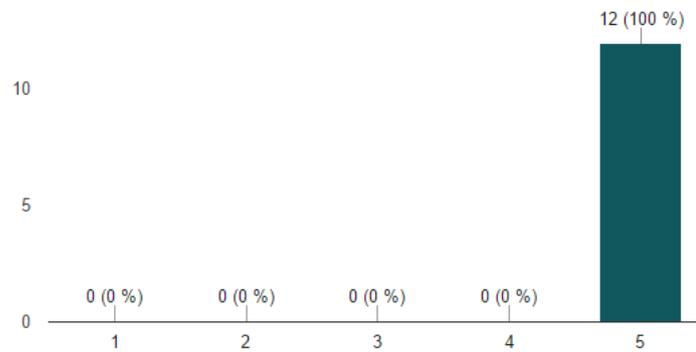
## Course Organization

Inscription to the training course and communication with organizers were efficient.

(12 réponses)

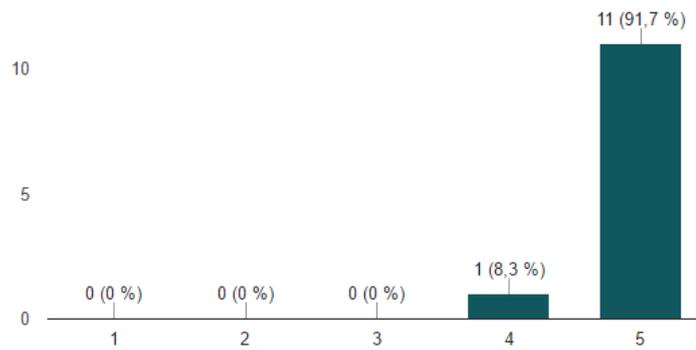


The training facilities were adequate and comfortable. (12 réponses)

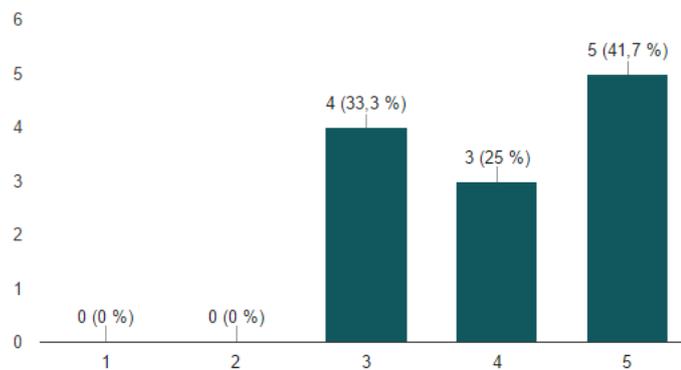


**Teaching and Learning Support**

The instructors were helpful, informative, and approachable. (12 réponses)

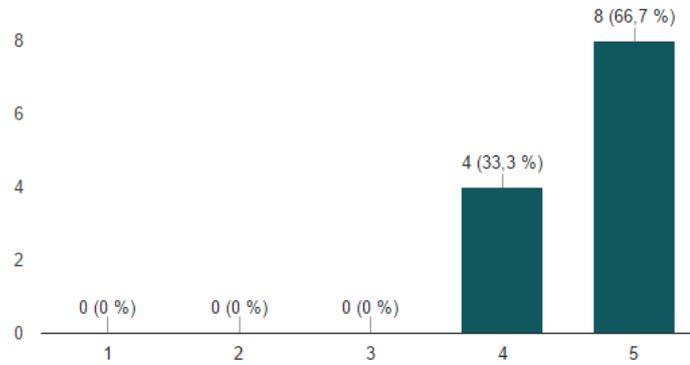


The working documents were presented in a way that facilitated learning. (12 réponses)

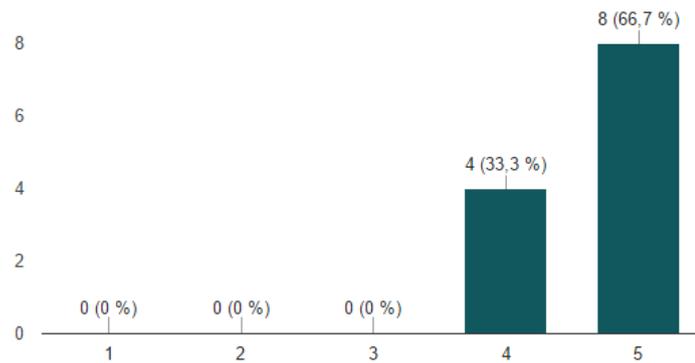


## Overall Evaluation

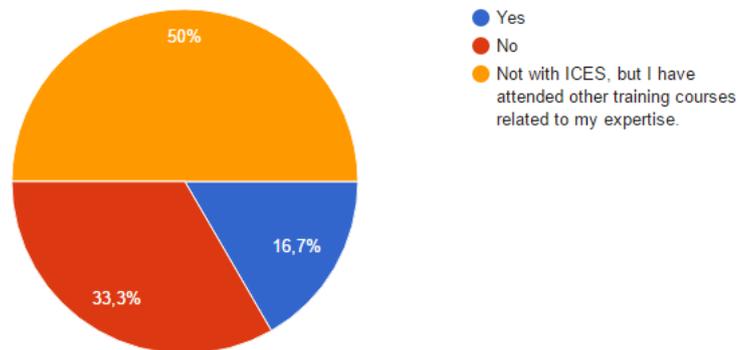
Overall, how would you rate this training course? (12 réponses)



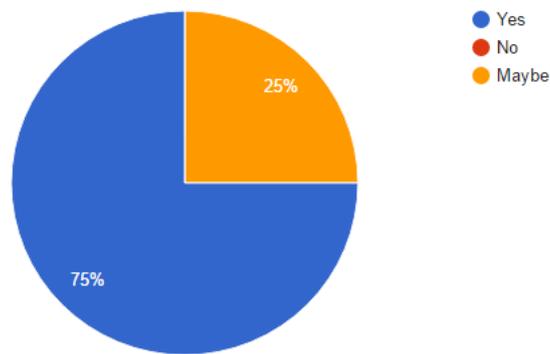
Overall, how would you rate the quality of the teaching? (12 réponses)



Have you taken any other ICES training courses? (12 réponses)



Would you be interested in another training course within ICES? (12 réponses)



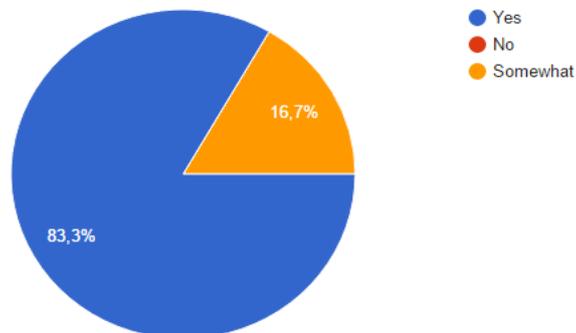
If yes, which topic would you be interested in? (9 réponses)

Underwater acoustics, fish ageing
Wideband data processing with Lss.
Remote sensing of the ocean
Fisheries Acoustic
Survey design
Underwater acoustics
EK80 data processing in matlab.
fisheries acoustics and acoustic methodologies
Underwater sound propagation; Fisheries acoustics and Acoustics ecology; Survey design for fish abundance estimation.

### Social Event

Do you feel that you have benefited from networking opportunities on the course?

(12 réponses)



## General comments on the Training Course

(7 réponses)

Practical implementation of wideband technology in a survey needs to be emphasized in the future

This was the best training course of my life, share such amazing technology side by side with experts on a vessel that was always at sea and in operation mode, was simply amazing.

The course overall was really good. The only negative aspect was the theory lessons, which were too far removed from practical applications. It would have been better to leave out some of the details (no need to give theoretical proof of some of the equations..) but then deal with the exercises during the class. For the short time available there was too much detail covered. So next time maybe concentrate on the essentials (signal types, decimation, pulse compression, fft) and then spend some more time on these with examples. There was no point in showing 100+ slides with equations given the spread of experience in the group...

Good course, excellent teacher and students, great to have a research vessel on the sea as location.

The level of the course was good and the teachers are experts in this field, but I think they lack teaching expertise. It was difficult to follow the theoretical classes. Some recommendations on readings before the course would have helped a lot. Data processing was done with a commercial software that it is not even the most used one (although it is the most advanced with EK90 right now). I think that some simple data processing with a free software such as R or matlab would have helped much more to understand the theoretical part. You can also show what the commercial softwares can do as a short demonstration. I think the course was good and I learned a lot but I expected a bit more.

This training course was a great experience. The course topics (both, the hands on and the theory lectures) as well the possibility of increasing the working links with colleagues and the learning from others working experiences, benefited a lot by being onboard of a sailing vessel. This turned the training course into a continuous 24 hs a day learning experience.

Generally speaking an excellent course; I particularly like the combined theory and practical approach. A couple of points for possible improvement: having the (correct) presentations available before the lecture in all cases would be very useful so that notes can refer to the slides and no effort is spent copying slides unnecessarily. Also some of the theory was too complex and I am not sure it was necessary for the purpose of the course; so I would suggest a reduction in algorithms and a focus on the key message (in words) instead.