



LMAIR : an innovative network of instrumented platforms for marine and underwater technologies

L@bISEN Yncréa Ouest

Pierre-Jean Bouvet, Philippe Forjonel, Yves Auffret



Outline

- Context
- Technical description
- Example of applications
- Conclusion

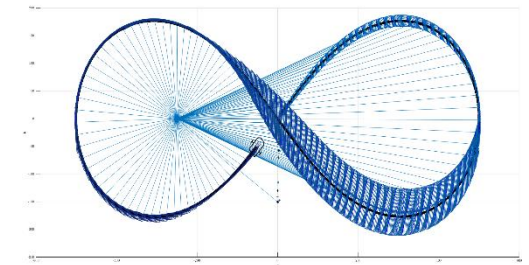
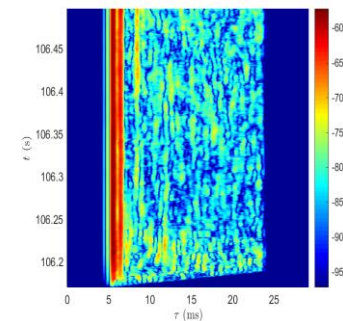
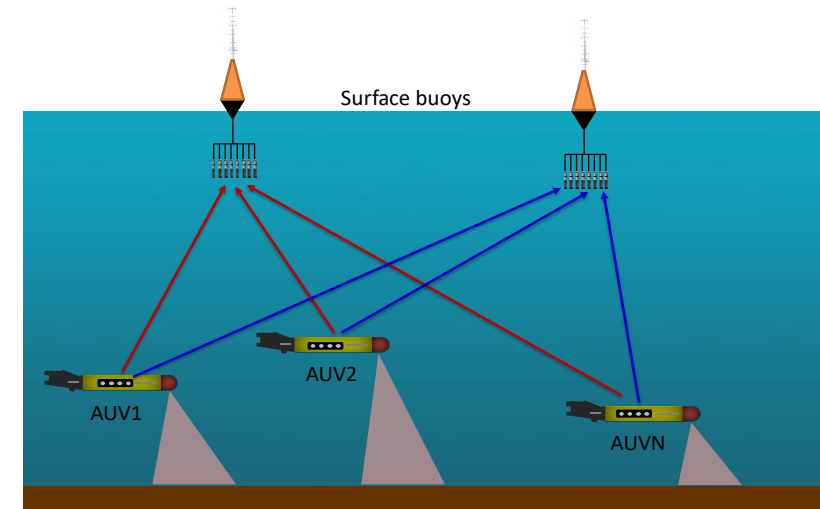


Context



L@bISEN Yncréa Ouest

- Research axis : Smart and Autonomous system
- 5 research teams
 - Energy & Electromechanical systems
 - Light Scatter learning
 - Vision data analysis
 - Knowledge learning and information modelling
 - **Embedded systems, acoustic and communications**
 - Underwater (acoustic) communications
 - Channel sounding
 - Underwater positioning
 - System on Programmable chip



Sea experiments issues

- **Financial cost**
 - Experimental means and assets are relatively expensive
 - missions are often reduced to couple of days
- **Weather constraints**
 - At sea mission may be cancelled / postponed
 - Experiments results are linked to given weather conditions
- **At sea facilities constraints**
 - Boat / crew availability
- **Ecologic cost**



The LMAIR project

- “Maritime laboratory for acoustics and imaging of the roadstead of Brest”
 - At sea laboratory available remotely 365/7/24 via a web interface using VPN for a secure connection
 - Real time acoustic/video monitoring and sea trials in real conditions while overriding sea experiments constraints
- Funded within the frame of the state-region (CPER) project IROMI
 - European Regional Development Fund (ERDF)
 - Brittany region
 - Finistere department
 - Brest city



The LMAIR project

■ Project management

- Coordination : ISEN Brest Yncréa Ouest / L@bISEN
- Partners : Sea Test Base (Celadon), Lab-STICC, IRENAV, UBS, ENIB

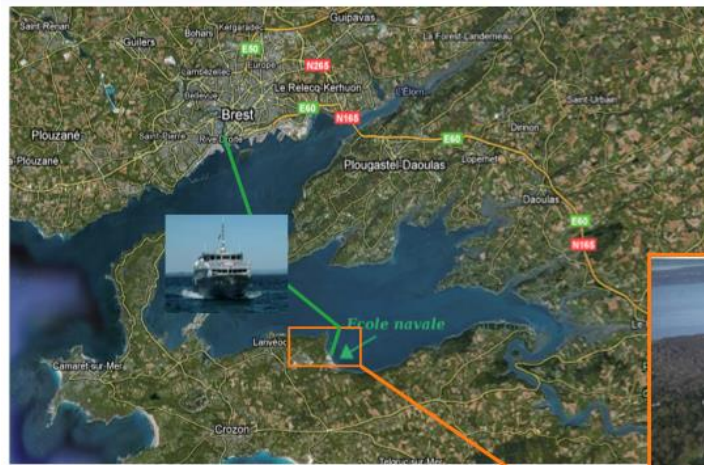
■ Calendar

- 2015-2016 : Electronic development of Sea Test base pontoon
- 2017 : System study
- S1 2018 : Call for tenders' creation and launch
- S2 2018 : Selection of RTSYS company's tender
- May 2019 : Prototype delivery on Sea Test Base pontoon
- Nov 2019 : 1st platform delivery and launch
- Jun 2020 : 2nd and 3rd platform delivery and launch

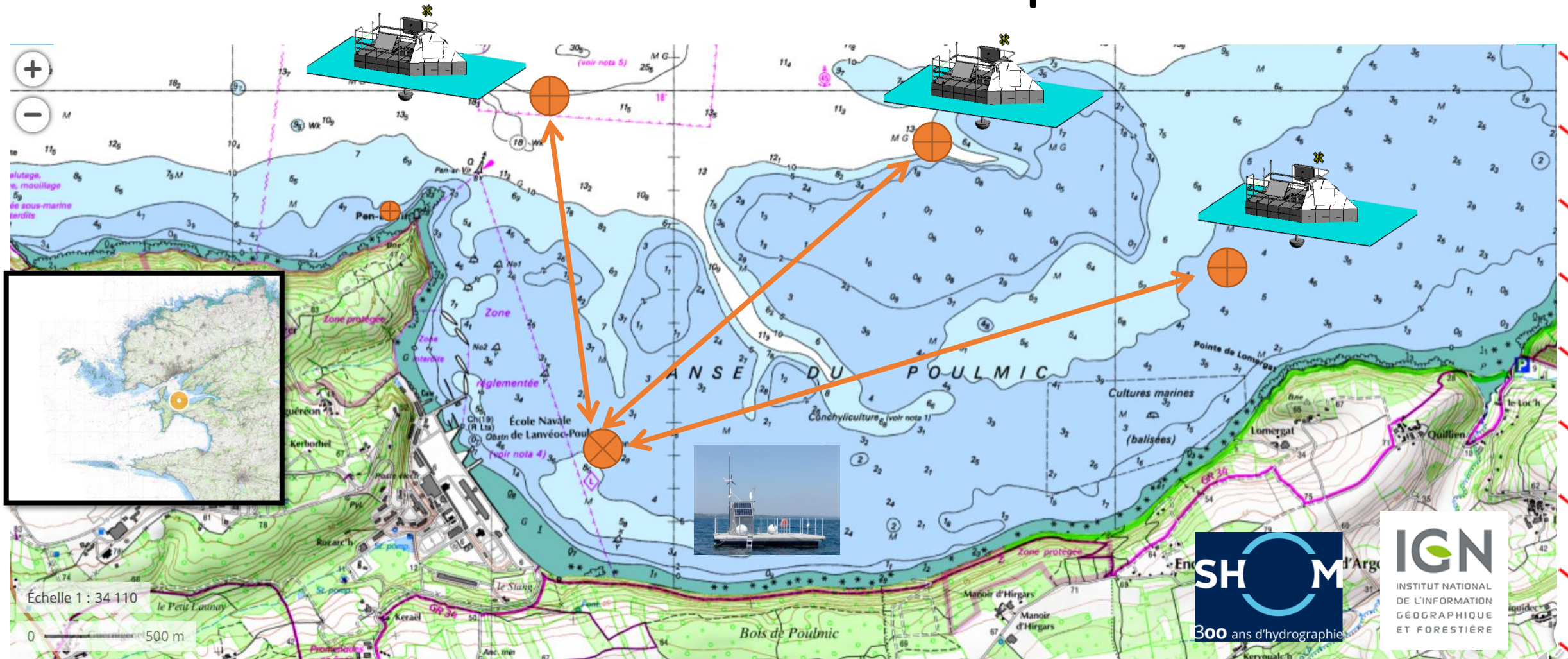
RTSYS



Location : Sea Test Base



Network of instrumented platforms



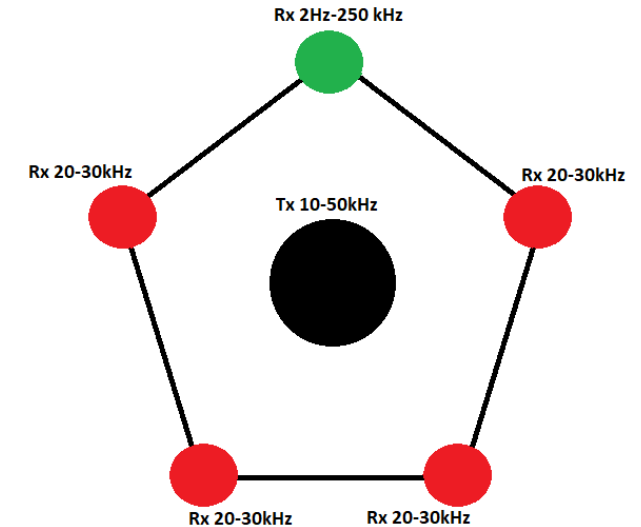
Technical description



Technical specifications

■ 3 relocatable platforms

- Energy self-sufficient (production/storage)
- 4 hydrophones HTI96-MIN (20 - 30 kHz)
- 1 hydrophone HTI99-HF (2 Hz - 250 kHz)
- 1 acoustic source Neptune D26BB (10 - 50 kHz)
- Acquisition & generation of underwater acoustic signals
- Weather station AIRMAR 120WX
- Camera 360° Axis P3707-PE
- Communication module (WiFi / 4G)

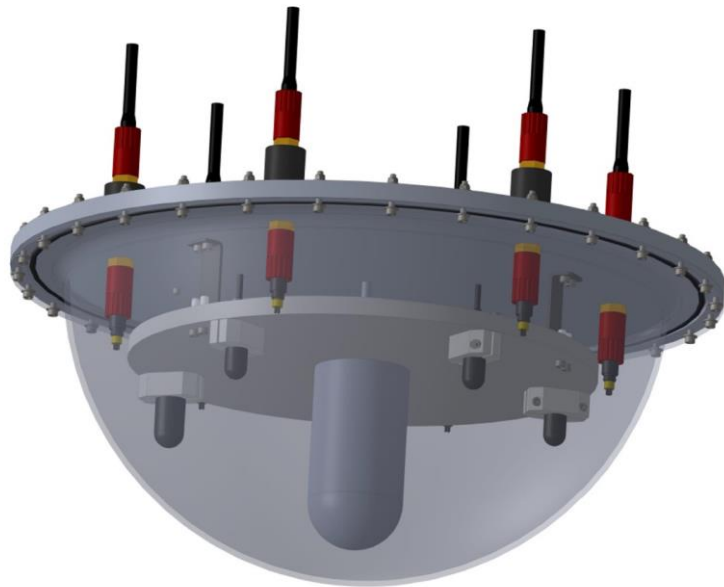


■ Instrumentation on Sea Test Base pontoon : same as platform

■ High data rate internet connection (real time data transfer)



Electronic



Acoustic dome



Main system

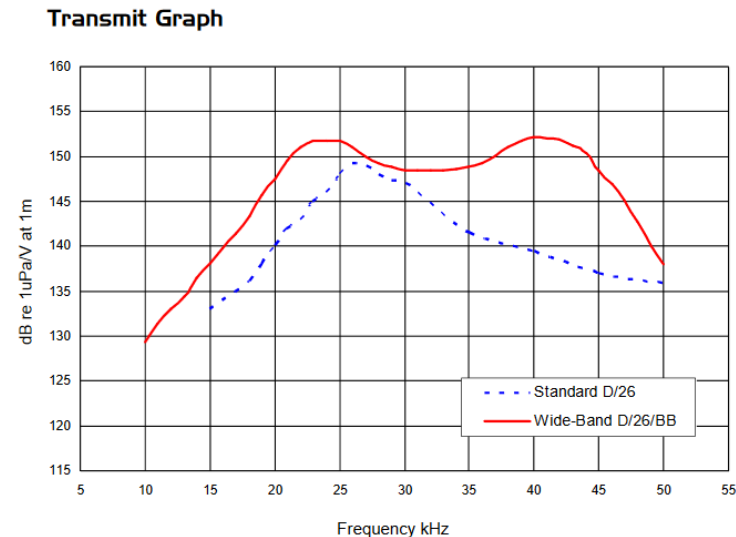


Acoustic performance

Transmission

■ Neptune Sonar D26BB

- $S_v = 153$ dB max
- $SL = S_v + 33$ dB = 186 dB max



Reception

■ Sensitivity HTI-96-min

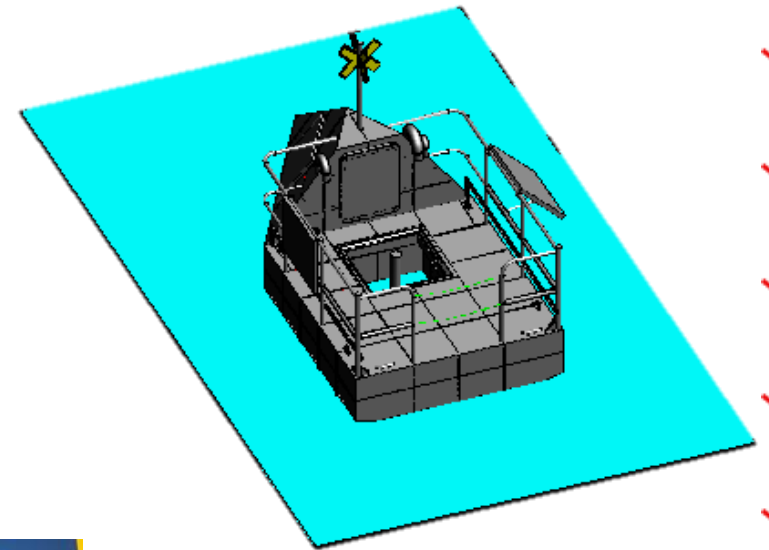
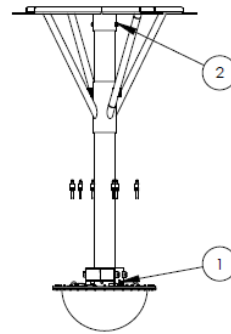
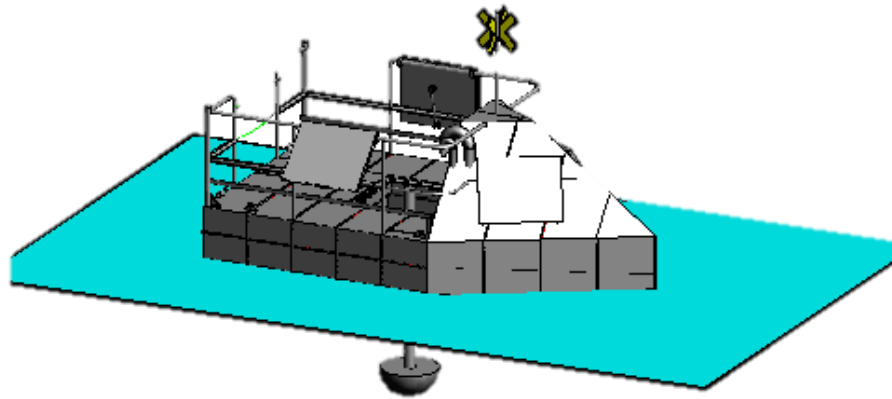
- 165 dB re: 1V/µPa (562 V/bar)
- Bandwidth from 2 Hz up to 30 kHz

■ Sensitivity HTI-99-UHF

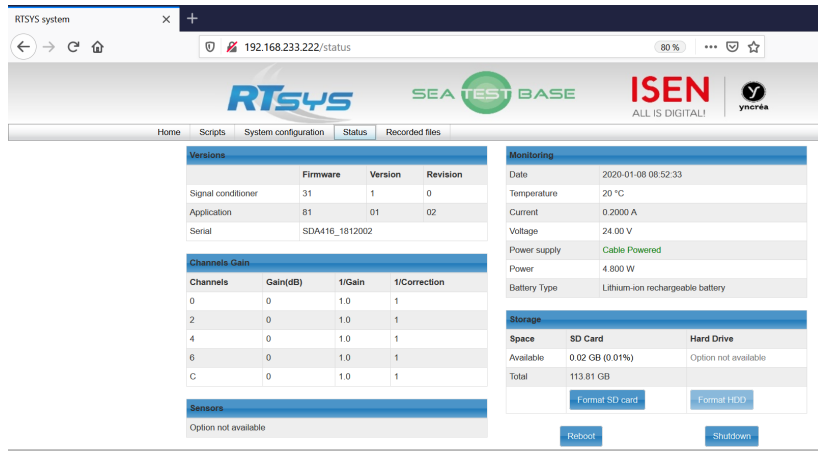
- 165 dB re: 1V/µPa (562 V/bar)
- Bandwidth from 2 Hz up to 250 kHz



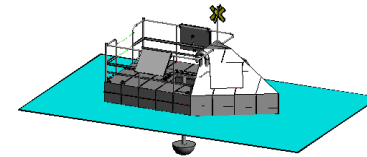
Relocatable platforms



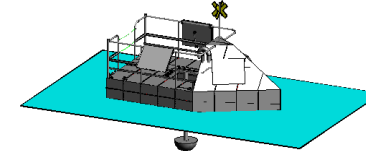
Virtual lab



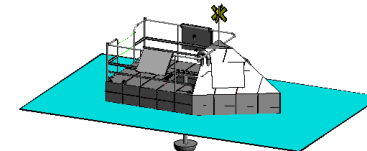
« Crozon »



« Ouessant »



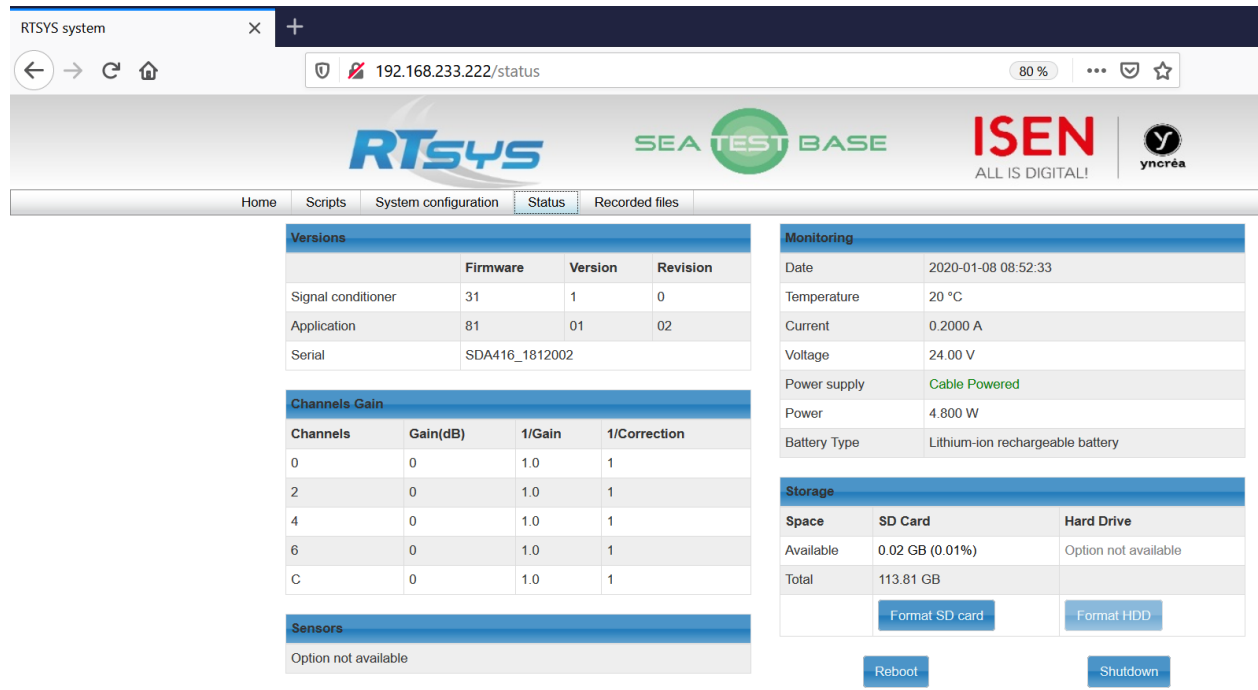
« Molène »



« Sein »



Virtual lab



RTSYS system

192.168.233.222/status

RTSYS SEA TEST BASE ISEN ALL IS DIGITAL! yncréa

Home Scripts System configuration Status Recorded files

Versions

	Firmware	Version	Revision
Signal conditioner	31	1	0
Application	81	01	02
Serial	SDA416_1812002		

Channels Gain

Channels	Gain(dB)	1/Gain	1/Correction
0	0	1.0	1
2	0	1.0	1
4	0	1.0	1
6	0	1.0	1
C	0	1.0	1

Sensors

Option not available

Monitoring

Date	2020-01-08 08:52:33		
Temperature	20 °C		
Current	0.2000 A		
Voltage	24.00 V		
Power supply	Cable Powered		
Power	4.800 W		
Battery Type	Lithium-ion rechargeable battery		

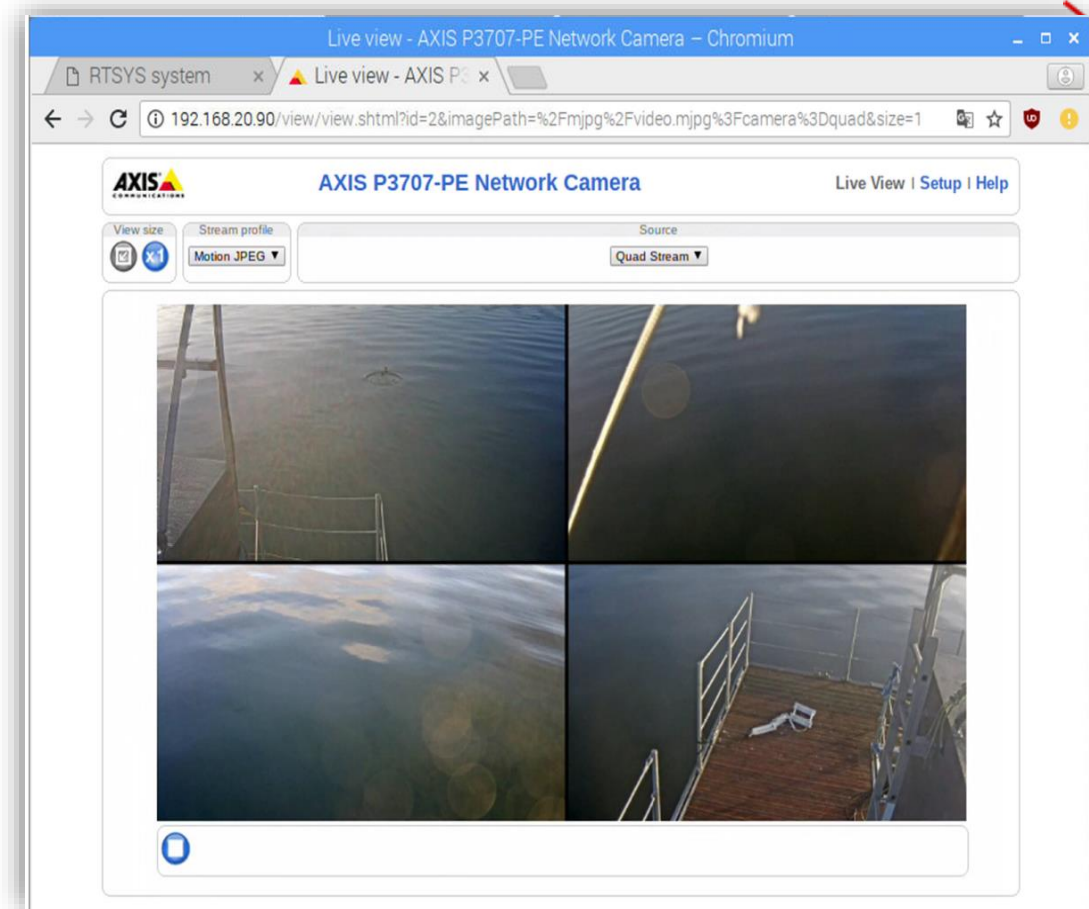
Storage

	SD Card	Hard Drive
Available	0.02 GB (0.01%)	Option not available
Total	113.81 GB	

Format SD card Format HDD

Reboot Shutdown

Copyright RTSYS 2019



Live view - AXIS P3707-PE Network Camera - Chromium

RTSYS system Live view - AXIS P3707-PE Network Camera


192.168.20.90/view/view.shtml?id=2&imagePath=%2Fmjpg%2Fvideo.mjpg%3Fcamera%3Dquad&size=1

AXIS COMMUNICATIONS

AXIS P3707-PE Network Camera Live View | Setup | Help

View size Stream profile Source

Motion JPEG Quad Stream



Reboot Shutdown



Molène platform launch (Nov. 2019)



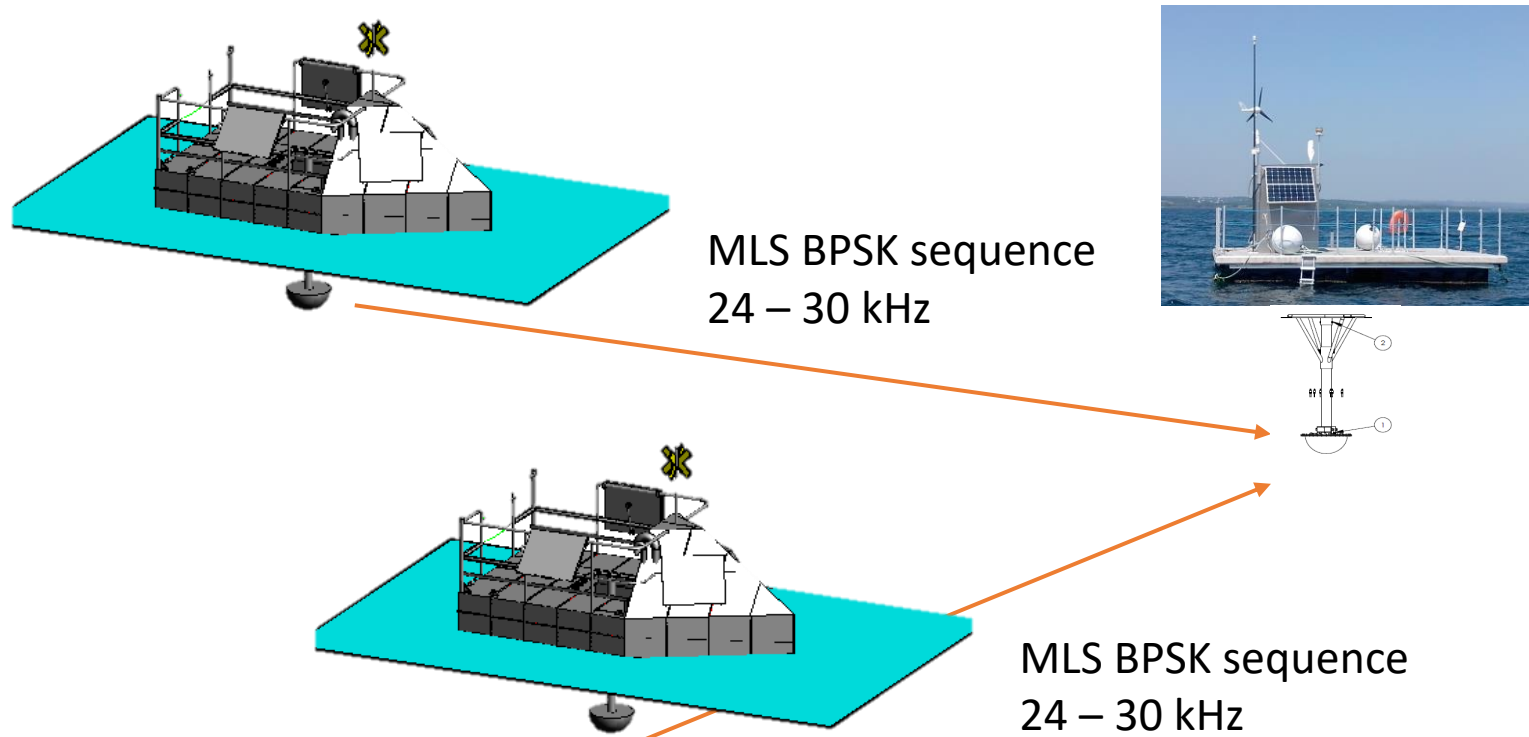
Sein and Ouessant platforms launch (Jun. 2020)



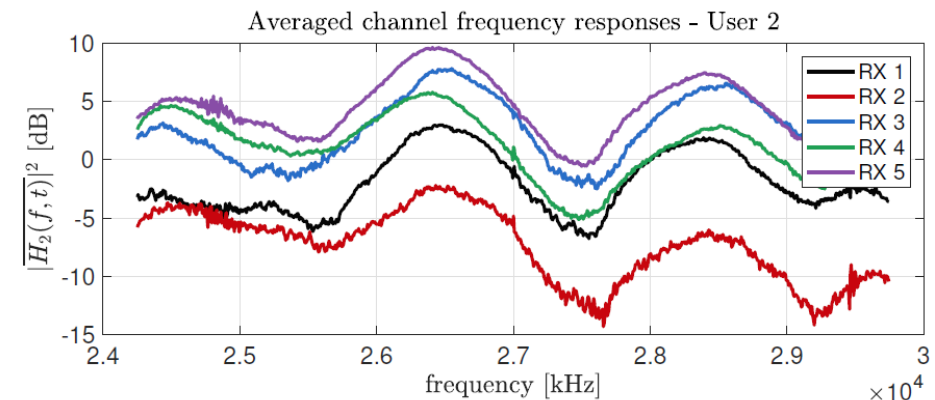
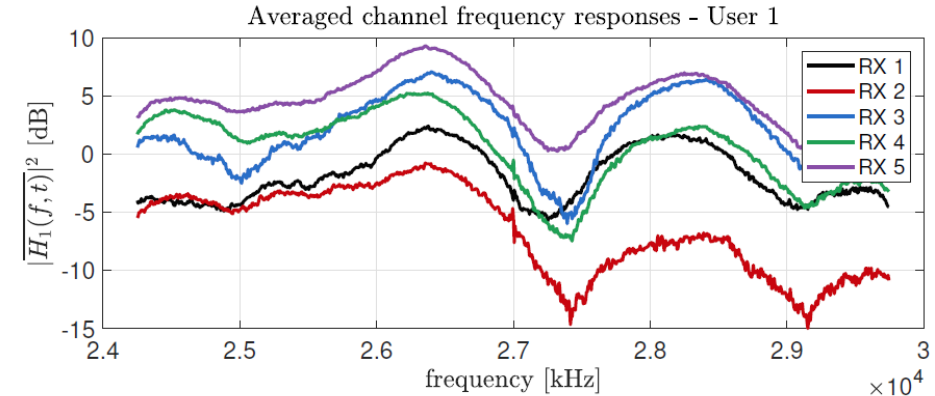
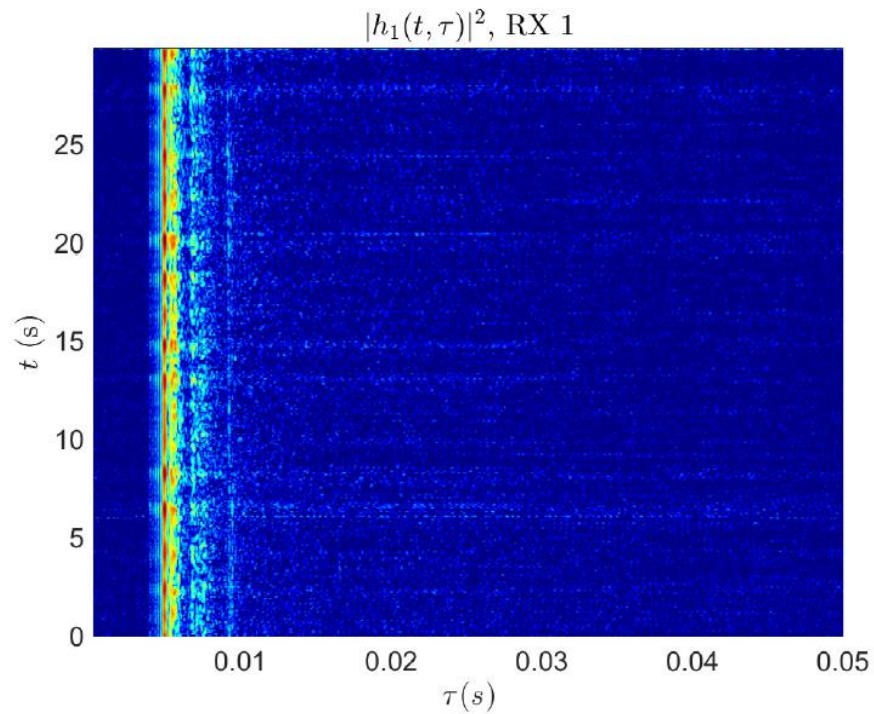
Example of applications



Underwater acoustic channel sounding



Underwater acoustic channel sounding



[1] A. Pottier, P.-J. Bouvet, and P. Forjonel, "Performance evaluation of Multi-User MIMO Underwater Acoustic Communications," presented at the 2021 Fifth Underwater Communications and Networking Conference (UComms), Aug. 2021.



Conclusion

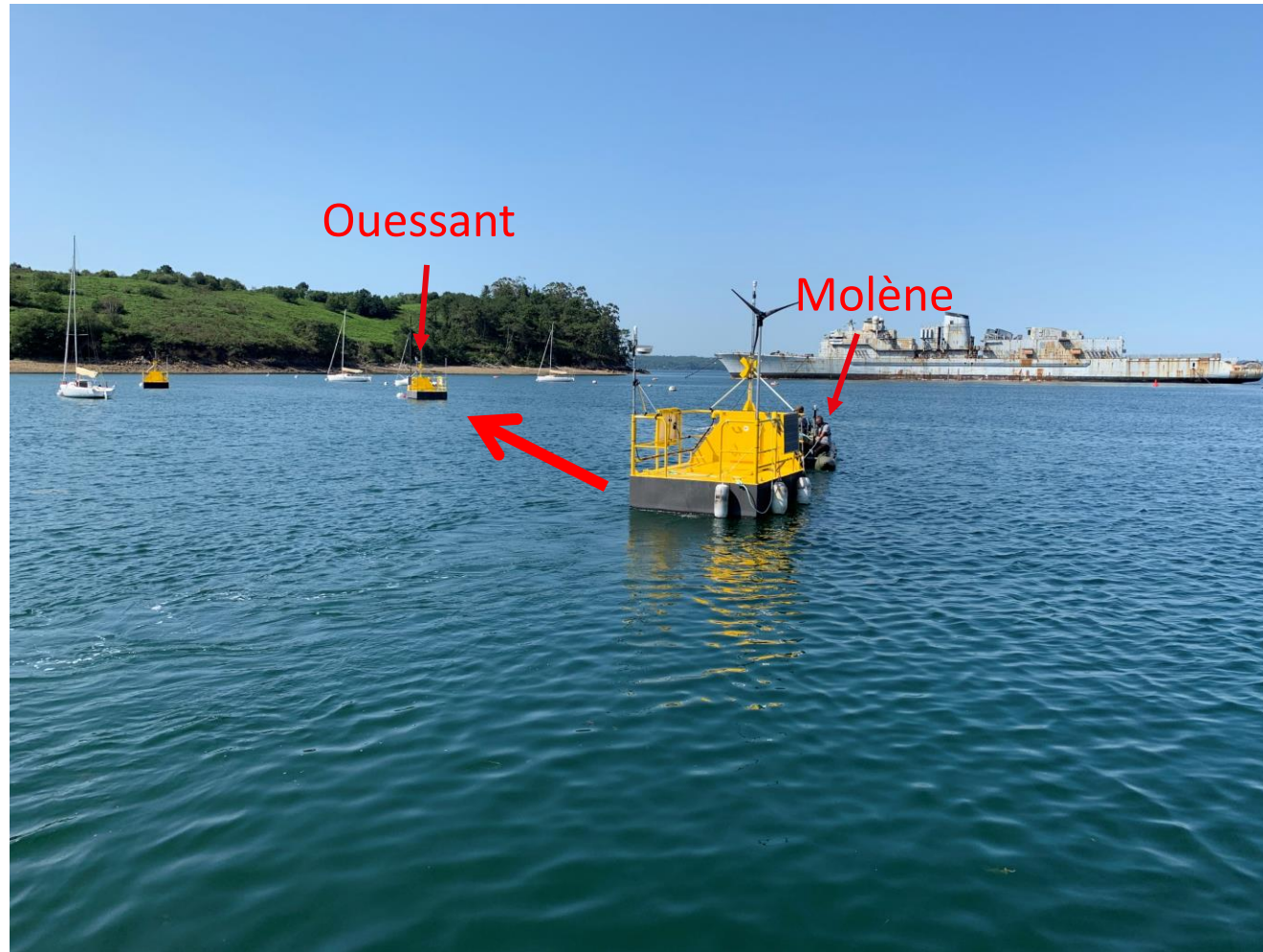


IROMI LMAIR

- A remotely operated laboratory for sea experiments of marine technologies
- Many research applications
 - Underwater acoustic channel sounding
 - F. Florin, F. Goaper and F. Effa, *“High Frequency Acoustic Channel Modeling and Experiment in Shallow Waters”*, Moqesm / Sea Tech week conference, Oct 2020
 - Underwater acoustic communication
 - Acoustic tomography
 - Acoustic positioning system
 - Passive acoustic monitoring
 - Acoustic and vision-based environment monitoring or maritime surveillance
 - Impact study of acoustic environment
 - ...



IROMI LMAIR : a real-time demonstration





Home

Scripts

System configuration

Status

Recorded files

Welcome!

Copyright RTSYS 2019

Demonstration

record_2020-10-13_14-57-30

Fichier Édition Sélectionner Affichage Transport Pistes Générer Effets Analyse Outils Aide

Clavier de raccourcis: I, Alt, Ctrl, Cmd, G, D, Q, R, S, T, U, V, W, X, Y, Z, [,], ^, _

Microphone Array (Realtek Audio) | 1 canal d'enregistrement | Speakers / Headphones (Realtek)

0,0 0,5 1,0 1,5 2,0 2,5 3,0 3,5 4,0 4,5 5,0

record_2020_01
Silencer Solo
0,10
0,05
0,00
-0,05
-0,10
Gauche, 78125Hz
32 bits flottant

record_2020_02
Silencer Solo
39k
30k
25k
20k
15k
10k
0k
Droit, 78125Hz
32 bits flottant

record_2020_03
Silencer Solo
0,10
0,05
0,00
-0,05
-0,10



IROMI LMAIR

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