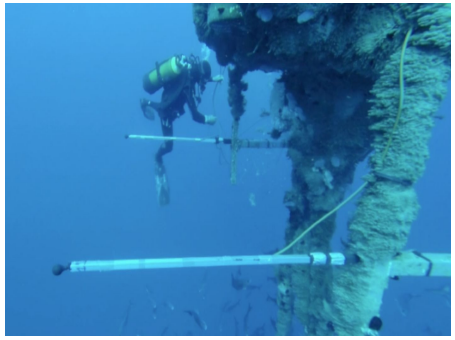
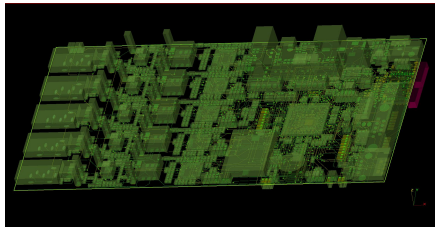
http://sabiod.org/EADM

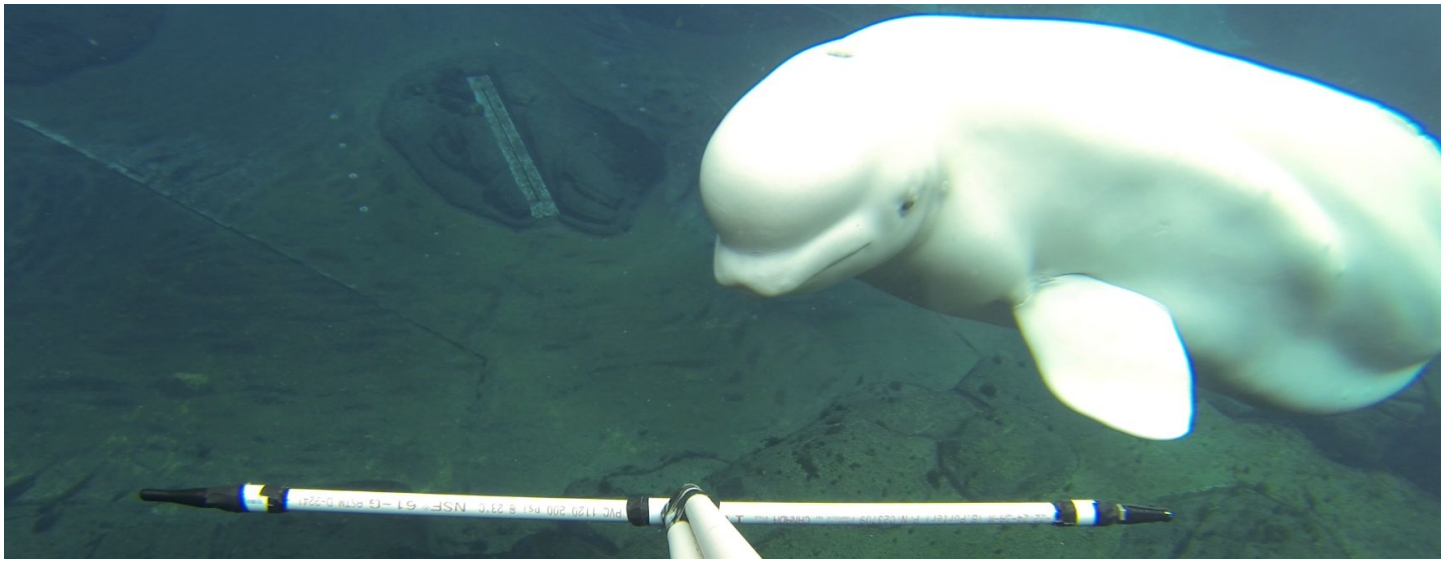
Scaled Bioacoustics for Biodiversity Surveys
- Volume, Velocity, Variability -

Glotin Hervé[5] with Gies V.[1], Giraudet P., Ricard J., Roger V., Barchasz V.[1], Chamroukhi F., Paris S., Razik J., Patris J.,Trone M.[2], Malige F.[2], Cosentino P., Pando L.[3], Bucur P.[3], Sellier G.[4]

LSIS CNRS, Univ. Toulon, Dyni team, glotin@univ-tln.fr







[1] SMIoT, [2] Brila STICAMSUD, [3] Explorama Lodge, [4] National Park Port-Cros, [5] Inst. Univ. France, Dyni LSIS & EADM

Russian-French Workshop on Big Data Applications – National Research University & French Ambassy – Moscow – 2/12/2016

MaDICS

Masses de Données, Informations et Connaissances en Sciences
Big Data, Data Science

Masses de données scientifiques

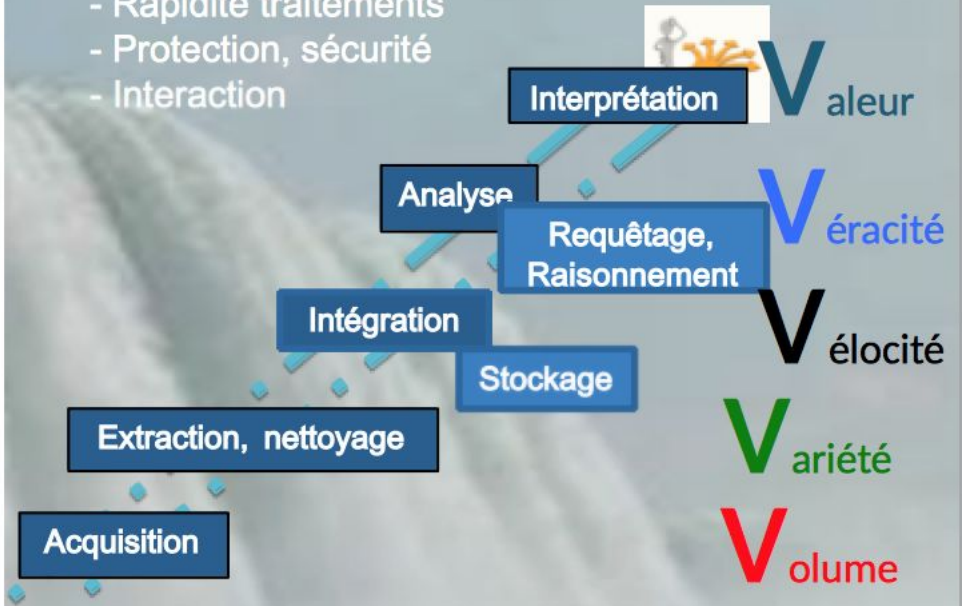
provenant d'instruments, de simulations numériques, de multiple dispositifs de collecte de données …

Changement de paradigme de traitement

- approche traditionnelle : les besoins métiers guident la conception de la solution
- approche par les données : les sources de données guident la découverte

Défis transverses

- Passage à l'échelle
- Rapidité traitements
- Protection, sécurité
- Interaction



repenser les outils algorithmiques et mathématiques

An interdisciplinary approach, data scientists for scaled acoustic monitoring :

Multisensors / IoT : on earth or in ocean,
Long Term : from milliseconds to year levels,
High Velocity : from Hz to megaHz...

Innovate Hardwares and Softwares for Big Data Acoustic Acquisition.

Learning acoustic **representation.**

Unsupervised and large scale classification.

Run **international challenges, new Hackathon**.

Distribute open solution for **citizen sciences**.

Industrial application : DCNS, OSEAN, NORTEK MED, SERMICRO (smart phone)
Creation of a technological plateform : Scientific Microsystem Internet of Things (SMIOT)
http://sabiod.org/SMIoT

Bioacoustics, an interdisciplinary research topics

1) CrowdSourcing (Android, net)

2) High Resolution (Electronic, transmission)

3) Long term acquisition (Autonomy)

4) Development of scaled representations (Scattering / Signal processing)

5) Unsupervised annotation (Infinity class clustering)

6) Bioacoustic classification (Large class / Deep learning)

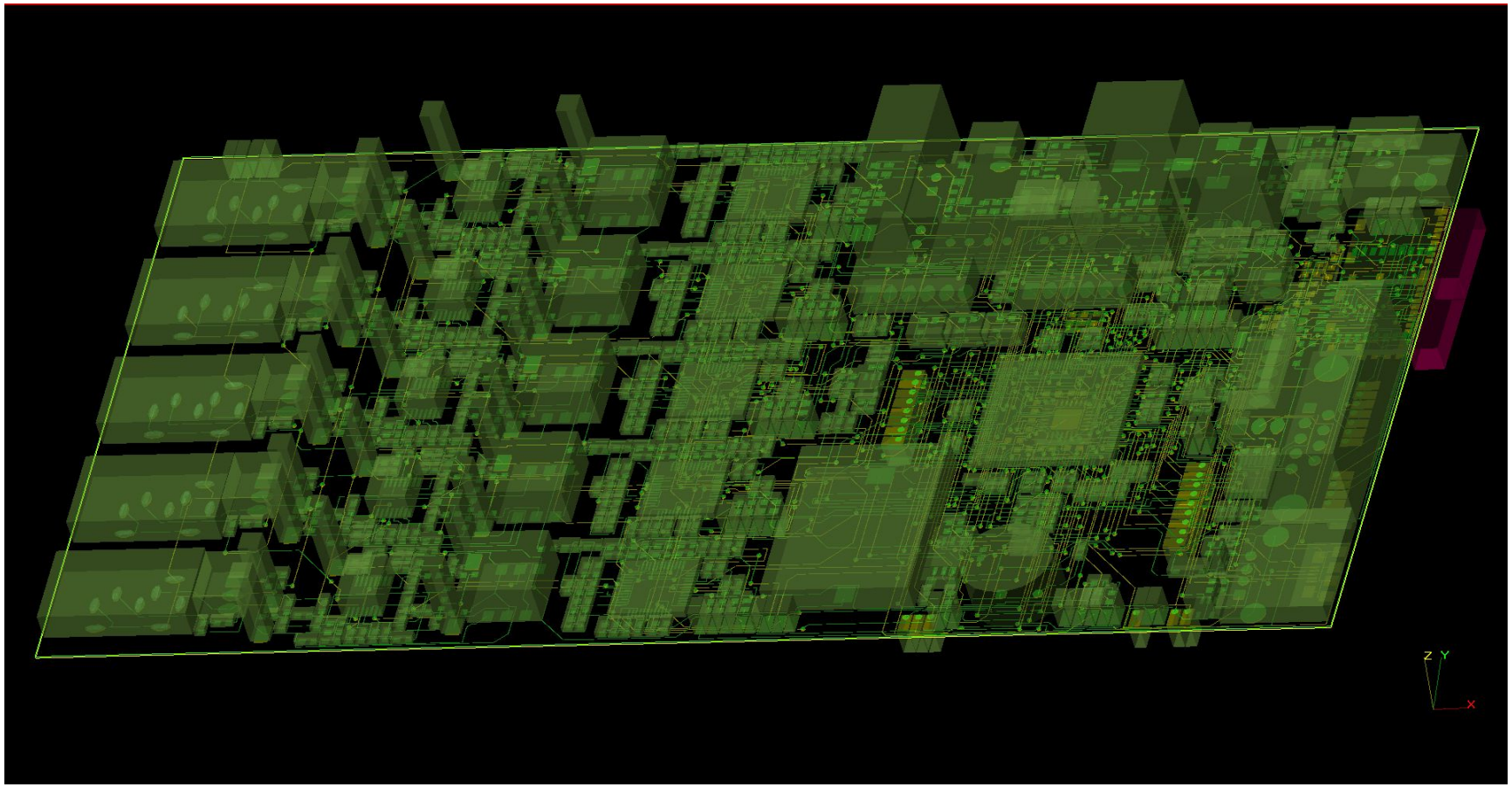
7) Identification (neuro-physiology, acoustics)

8) Biodiversity indexing

9) Anthropic noise impact / Climat impact

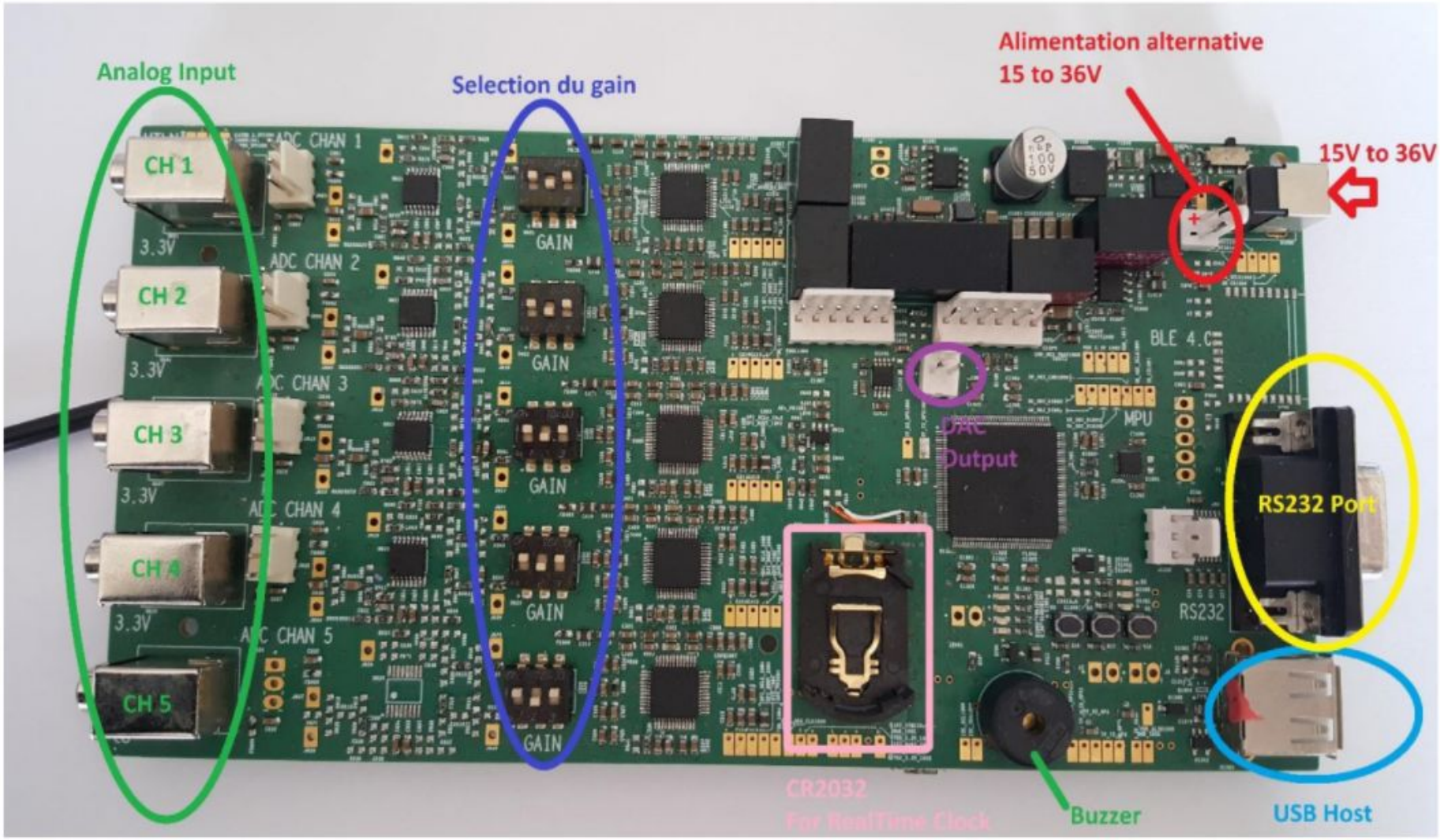
JASON = the HIGH VELOCITY multisensors DAQ

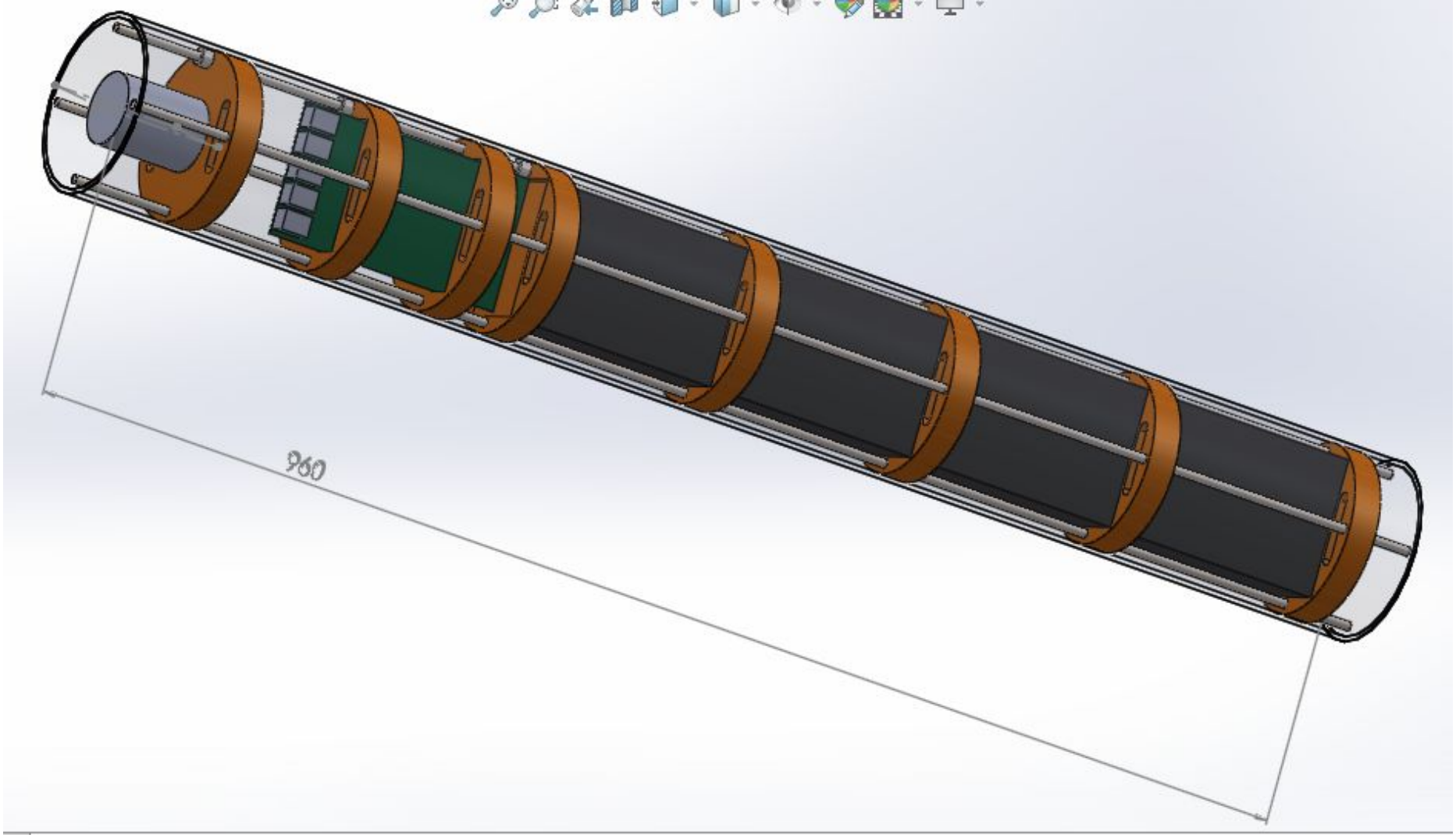
JASON HYPERSOUND DAQ : 5 x 1 mHz x 16 bits x low power
= High Velocity + long autonomy



JASON DAQ

THE JASON DAQ





JASON with its long life battery (3 months stereo ultrasonic recordings)

Marenmo
JASON
system

JASON EXPORTED IN SOUTH AMERICA AND ANTARCTICA

High Definition = information
JASON, expe 2016 Glotin et al.

Data sheet JASON

STEREO, or 5 channels, up to 2mHz SR 16 bits

Gains : 1, 4, 16, 64.
Recording on USB, SSD formatted in FAT32

Consommation in slipping mode : < 100 microA

Consommation in recording 5 chan. at max velocity and hydro alim : 2 W,
near 1 W in medium velocity, less with low power hydro and in stereo.

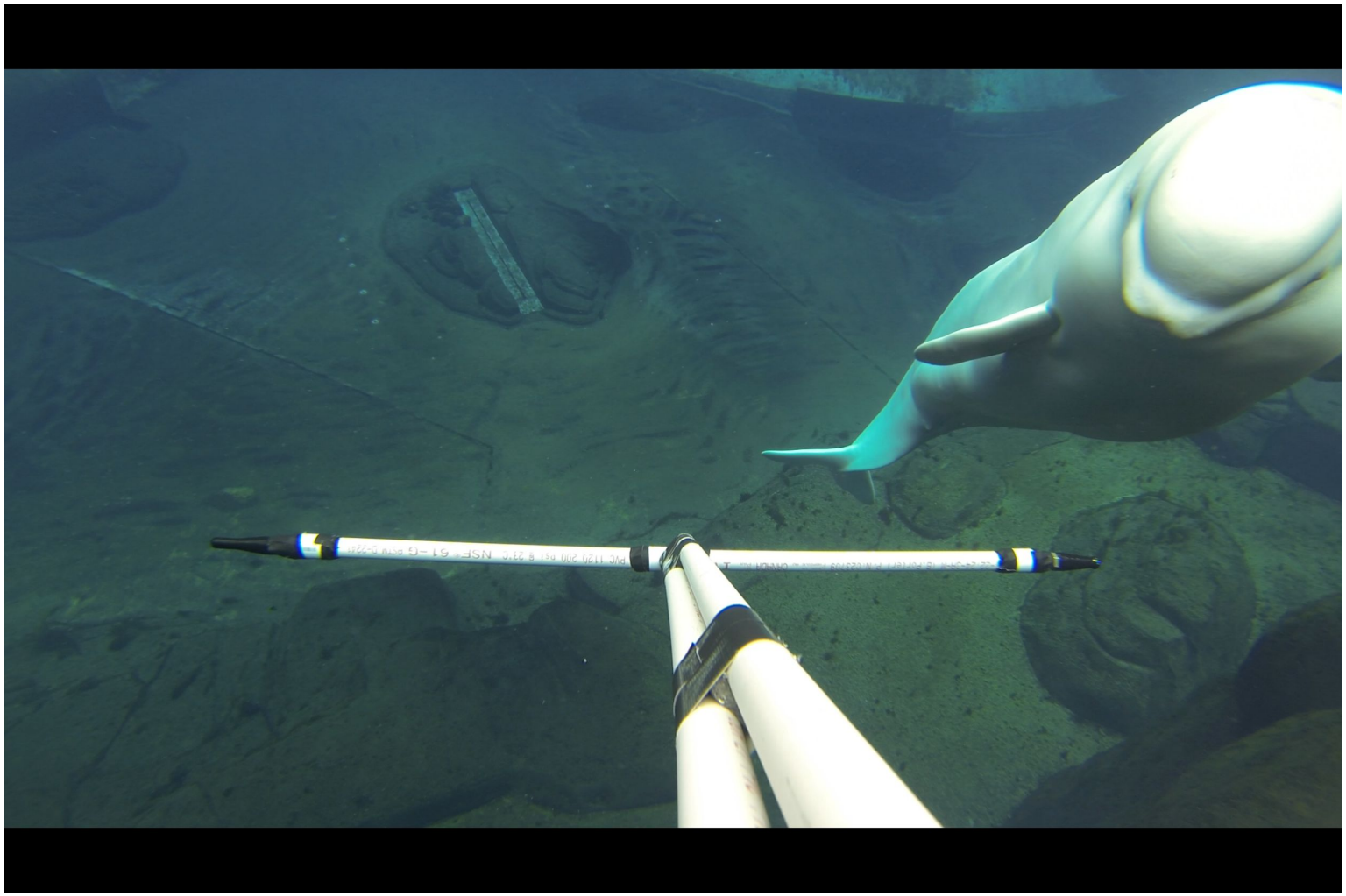
Voltage input : 6V to 36V

Autonomy in sleeping mode : 2 years
Autonomy 2 min recording / 13 min sleeping : 49 days with 24V 14Ah Pb batt.

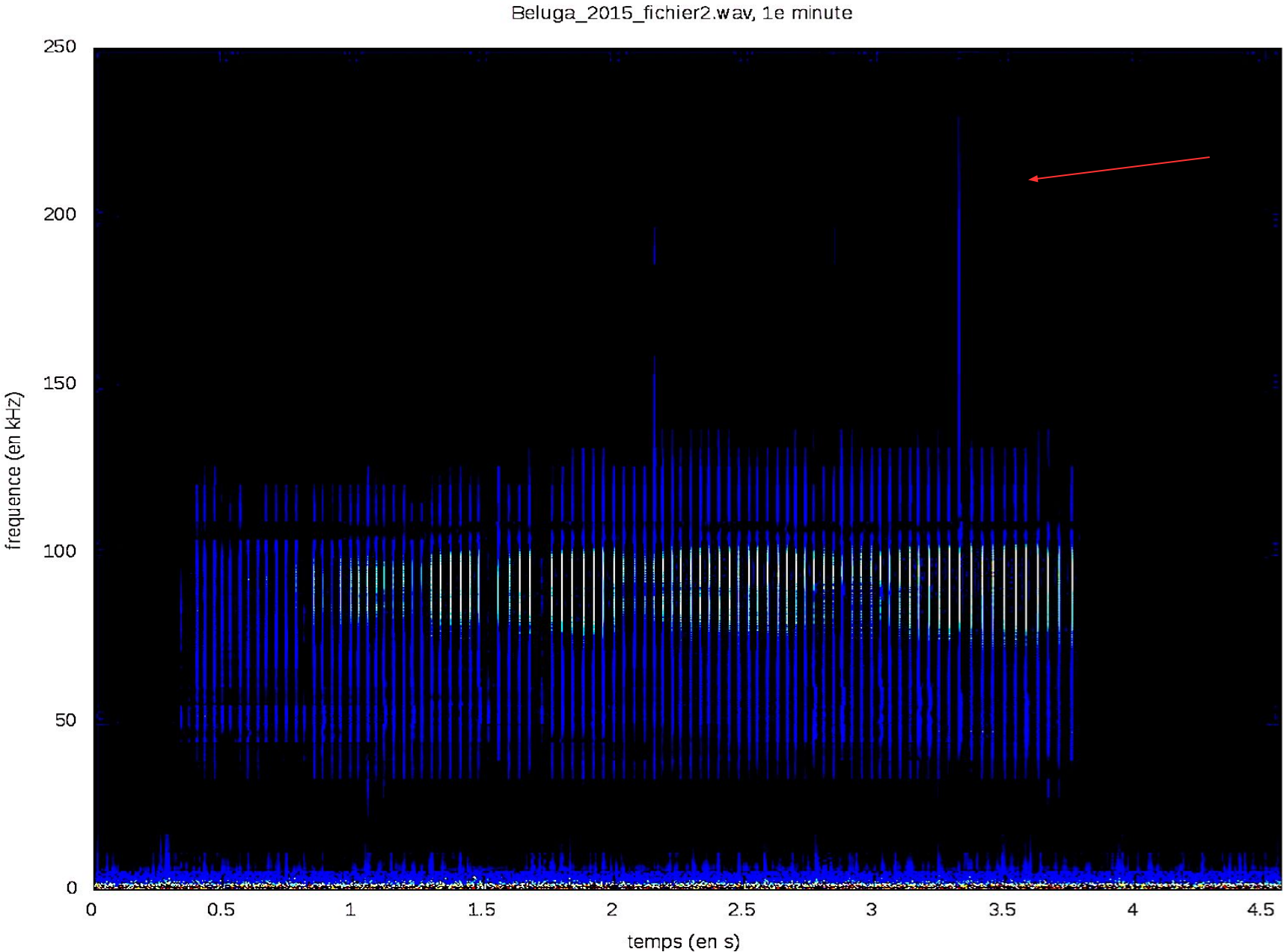
cost around 1500 euros

SMIOT : Valentin GIES, Philippe Arlotto, Hervé Glotin
vgies@hotmail.fr, arlotto@univ-tln.fr, glotin@univ-tln.fr
tel :06 28 35 76 85

Example of high resolution recording UTLN / Vancouver 2015
Projet : Survey of Arctic Beluga Population



Acoustic sample of Beluga (500 kHz SR, 16 bits) recorded by UTLN in 2015 showing high frequency emissions (more than noticed in the bibliography...)



High velocity
Inia g. in Amazonia

Trone Glotin et al. 2016, and ASA 2015,
http://www.bbc.com/earth/story/20160426-why-one-species-of-dolphin-has-turned-pink

7 hydrophones array recordings @ 1 mHz samp. rate JASON DAQ
→ 1 Tb of complex trains of clics of Inia and/or Sotalia
→ new knowledges on Amazon River Dolphins

Arrays set up (Aug. 2016)

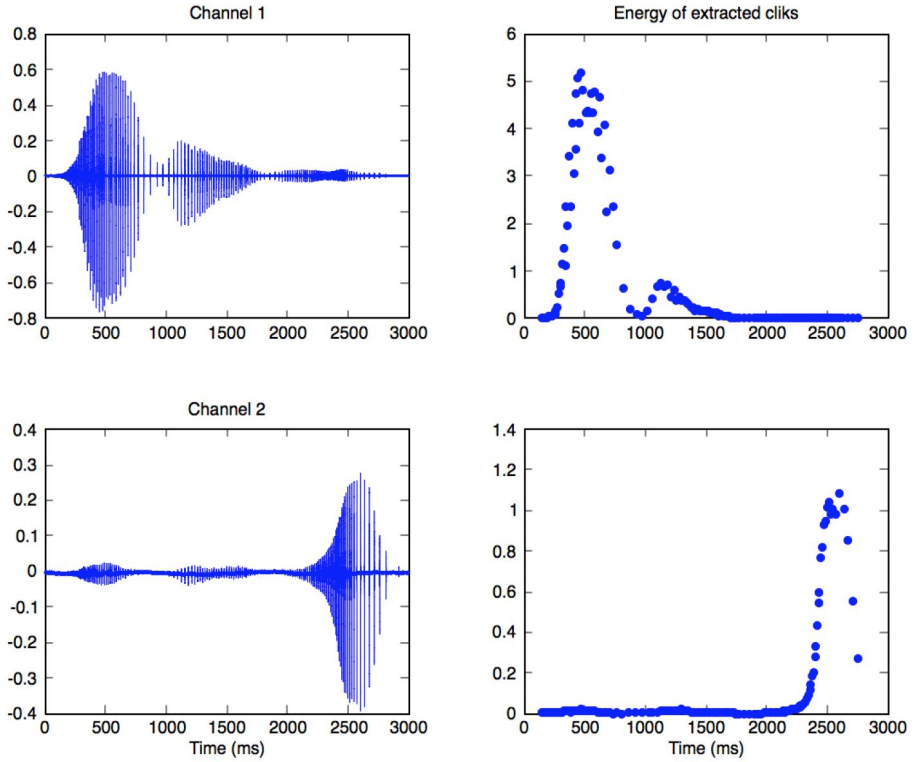
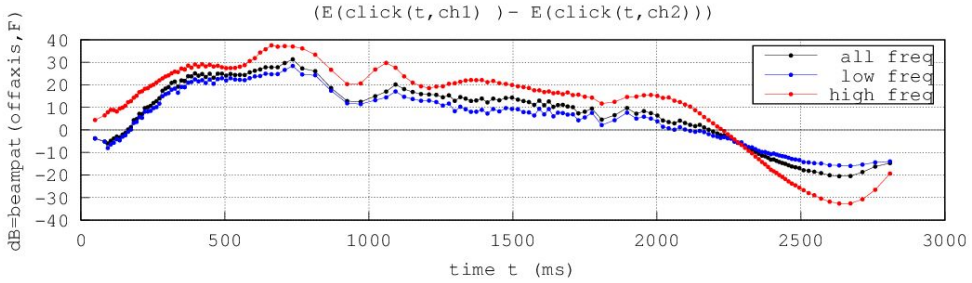
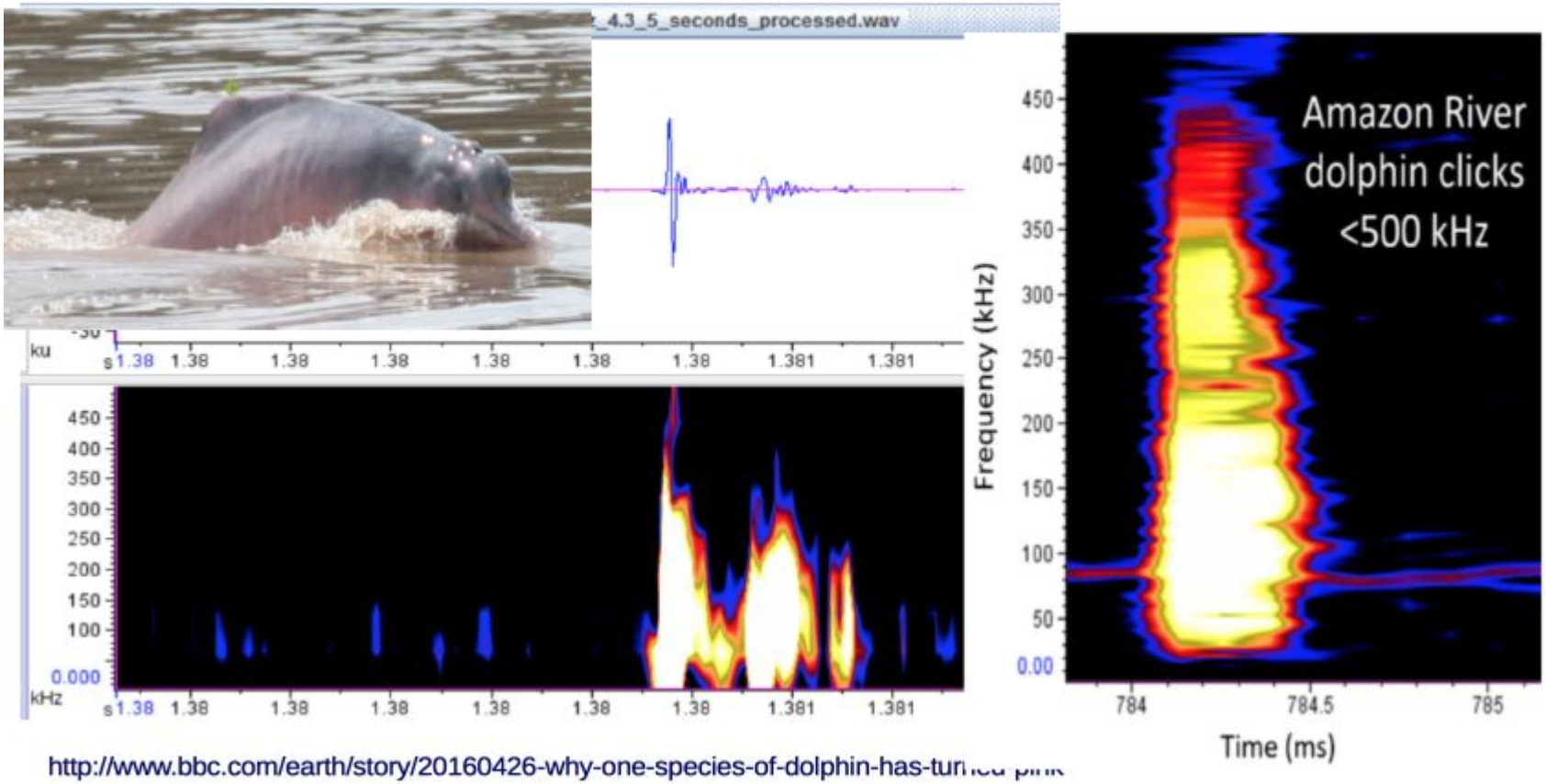


Figure 1 : (left) wave forms of the 2 C305, orthogonal, recording a single animal (chan 1 & 2 of JASONV1), and their corresponding energy (sum of squared samples, window of...). The wave forms show nice rotation effect in 2 seconds, this is not due to the move of the Inia in space, but due to fast rotation of its on axis (rostrum). We have more evidences of this in figure 2.



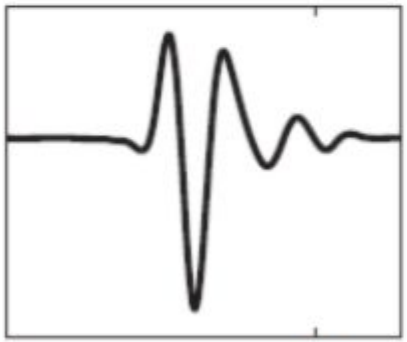
Jason reveals ultra high frequency *Inia g.* biosonar...

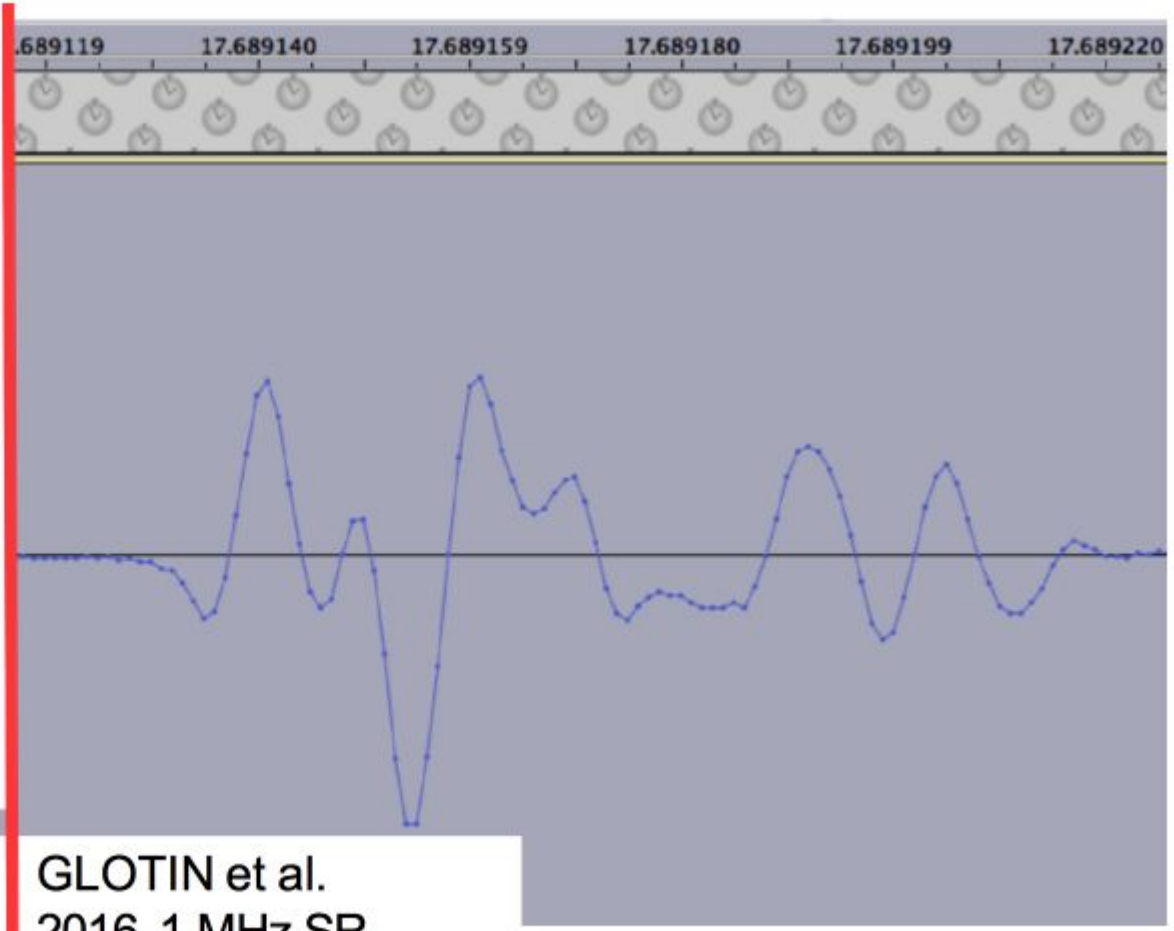


http://www.bbc.com/earth/story/20160426-why-one-species-of-dolphin-has-turned-pink

High-Frequency Pulse Waveform

Boto

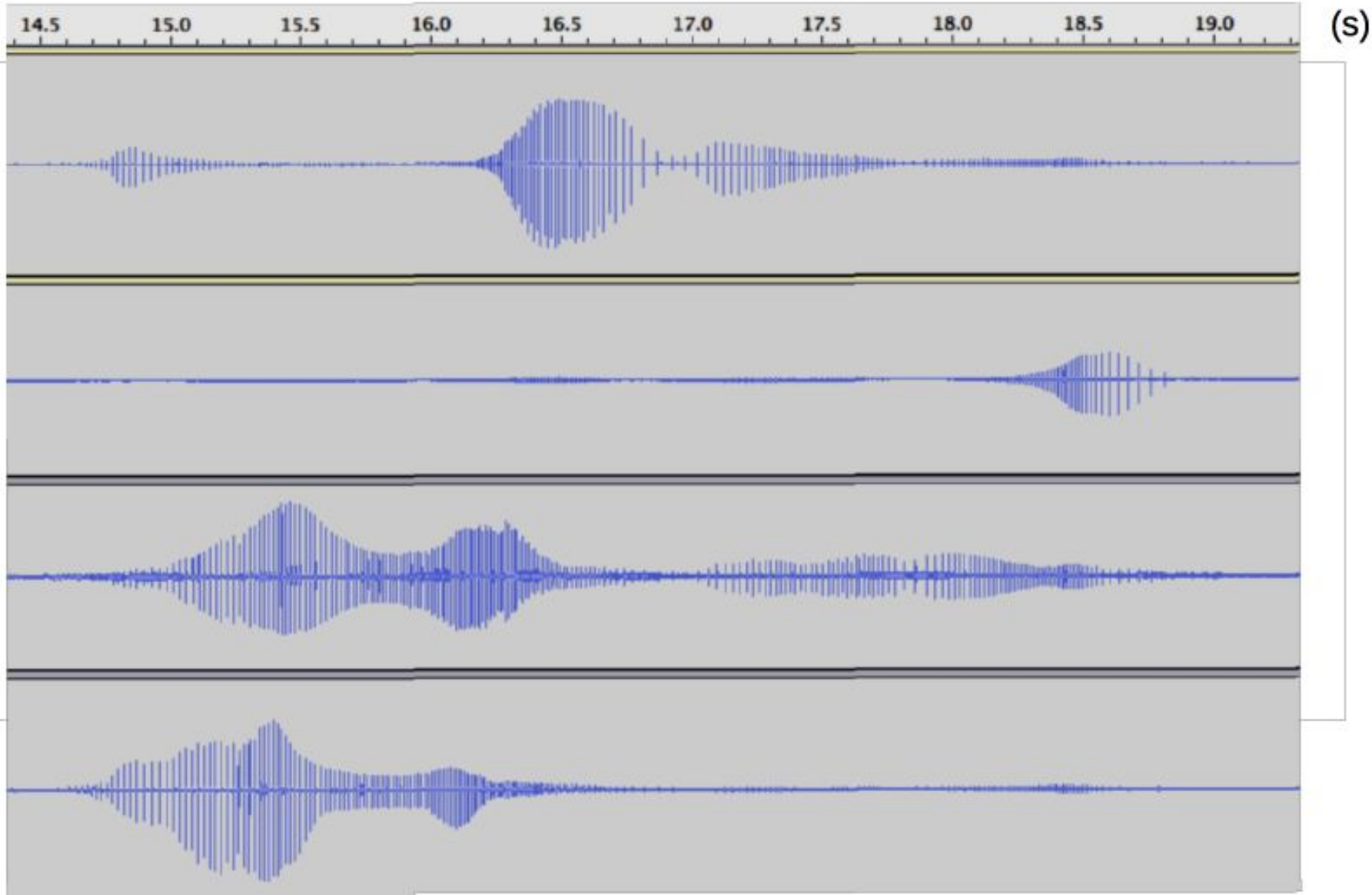




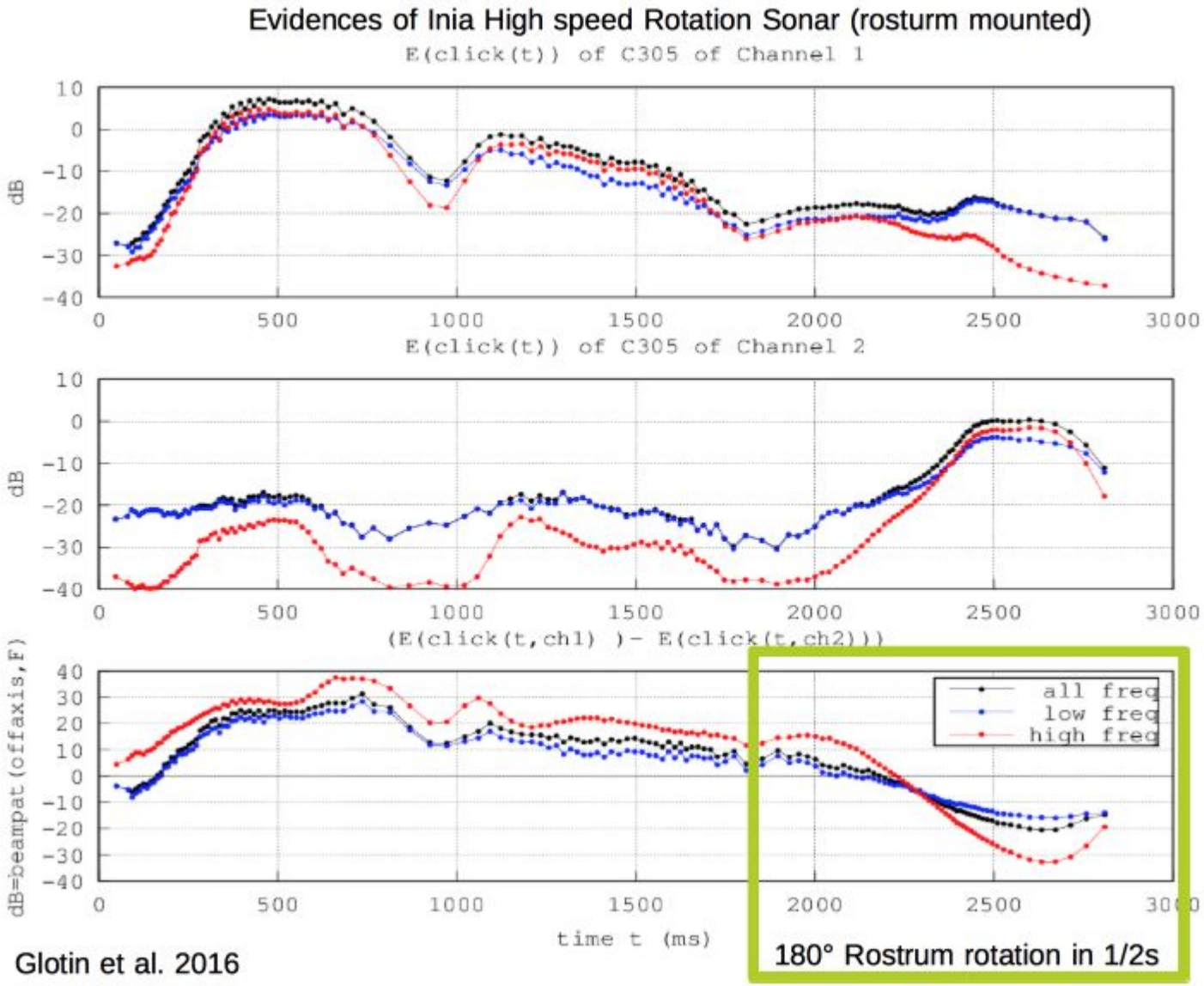
Ladegaard et al.
2015 500 kHz SR

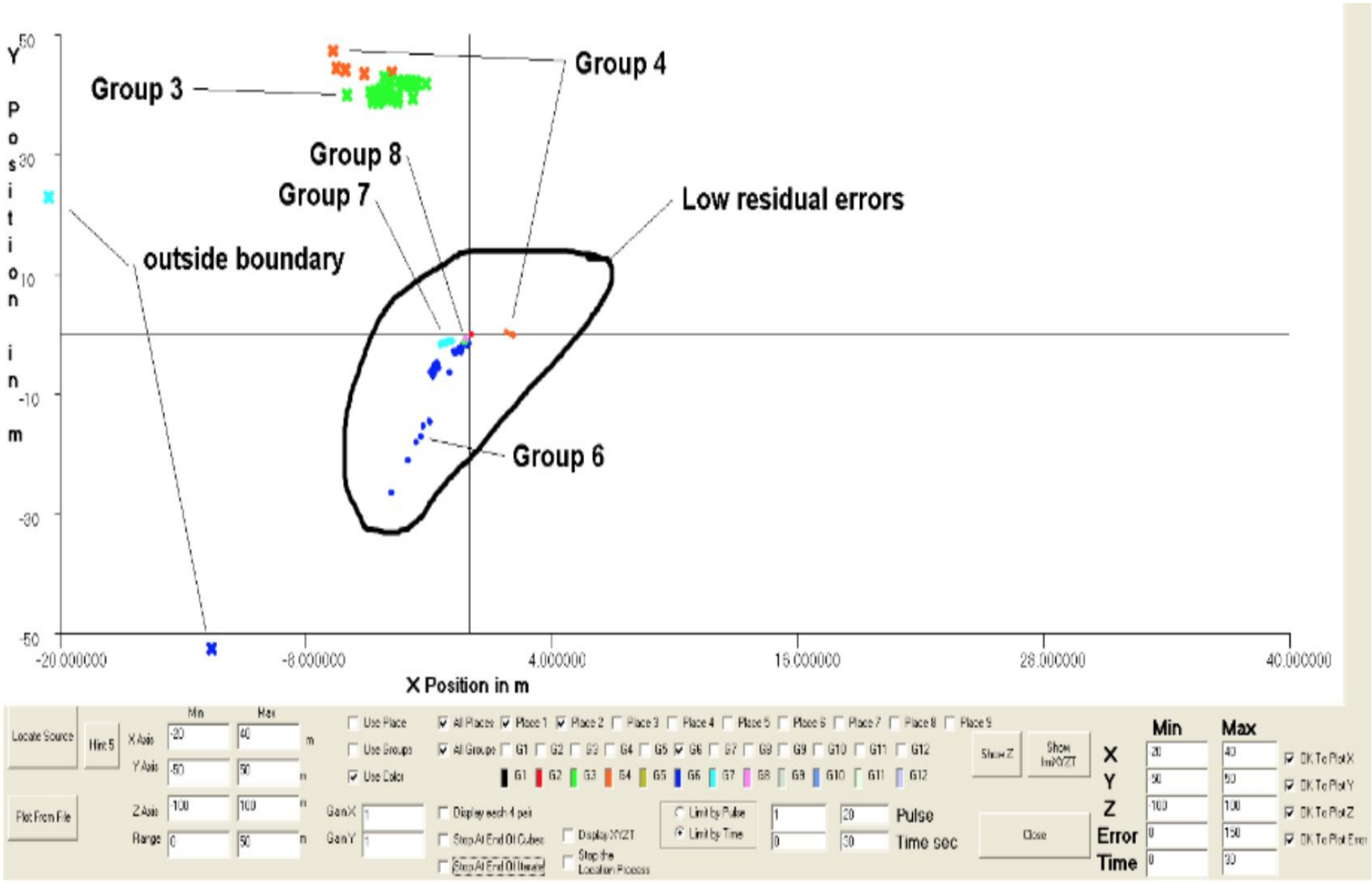
GLOTIN et al.
2016 1 MHz SR

The 4 JASON Channels at 1mHz SR : evidences of the beam pattern

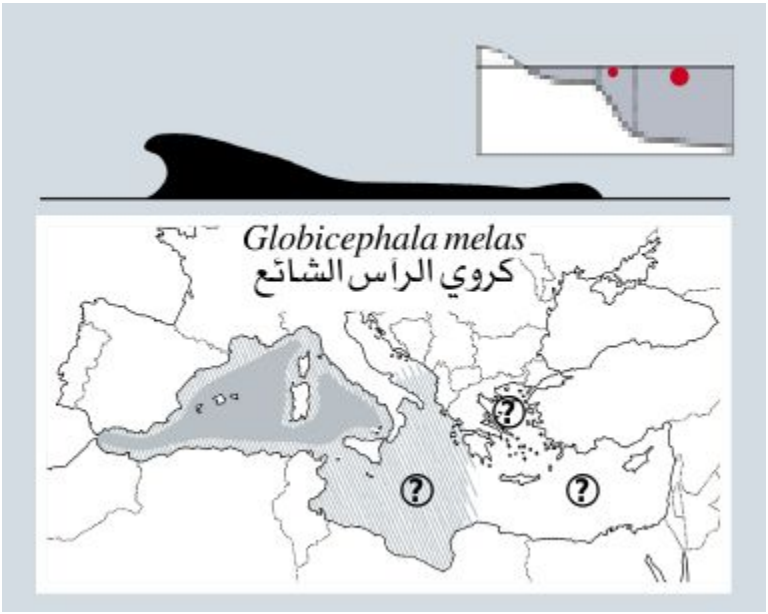


INIA field ethoacoustic research and Beam pattern analysis
Glotin et al 2016-2017



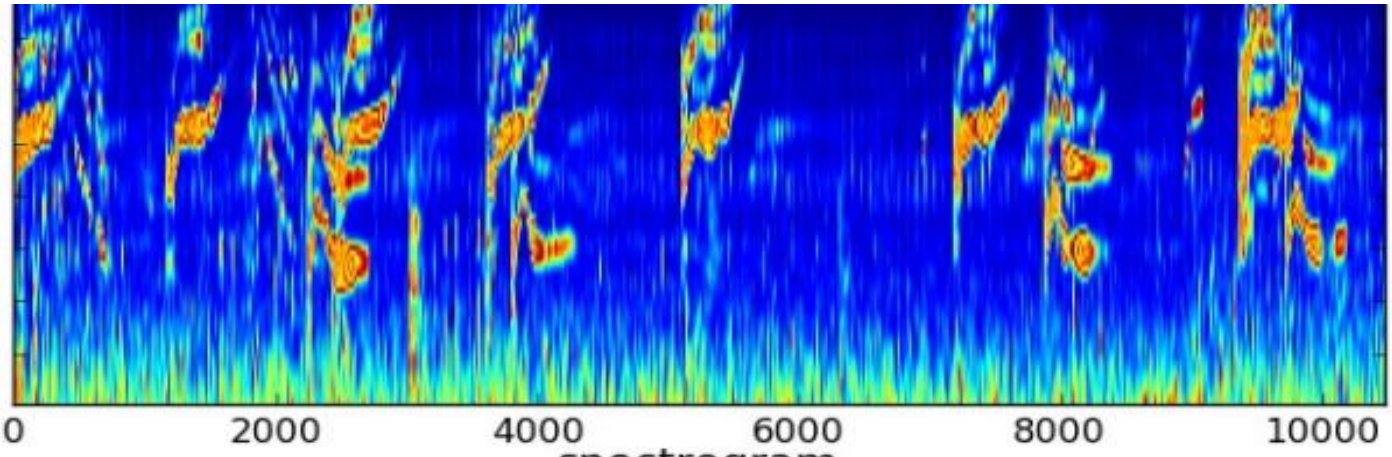

Group 3
Group 4
Group 8
Group 7
Low residual errors
outside boundary
Group 6
Y Position in m
X Position in m
50
30
10
-10
-30
-50
-20.000000
-8.000000
4.000000
15.000000
28.000000
40.000000
Locate Source
Hm 5
Plot From File
X Axis
Y Axis
Z Axis
Range
Min
Max
Use Place
Use Groups
Use Color
All Places
Place 1
Place 2
Place 3
Place 4
Place 5
Place 6
Place 7
Place 8
Place 9
All Groups
G1
G2
G3
G4
G5
G6
G7
G8
G9
G10
G11
G12
Show Z
Show ImXYZT
Gain X
Gain Y
Display each 4 pair
Stop At End Of Cube
Stop At End Of Image
Display XYZT
Stop the Location Process
Limit by Pulse
Limit by Time
Pulse
Time sec
Close
X
Y
Z
Error
Time
Min
Max
OK To Plot X
OK To Plot Y
OK To Plot Z
OK To Plot Error

Variability : Unsupervised representation of voices application to Long-Finned Pilot Whale *Globicephala melas*

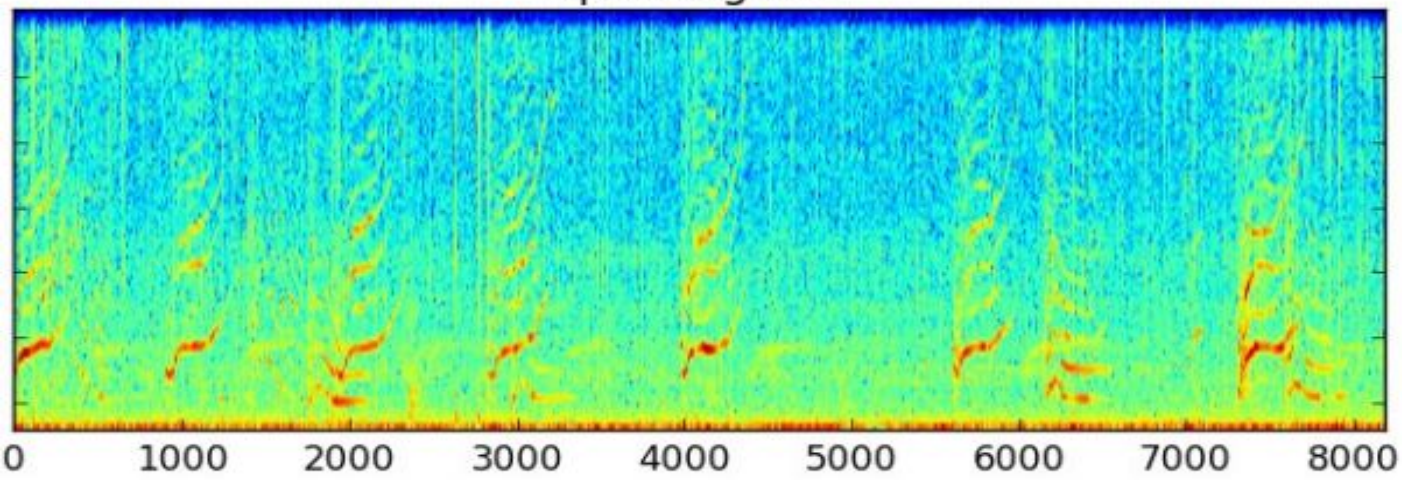


FAST advanced Decomposition : Chirplet
CIGAL toolkit
(here applied on *Globi. m.*)

Proposed Chirplet



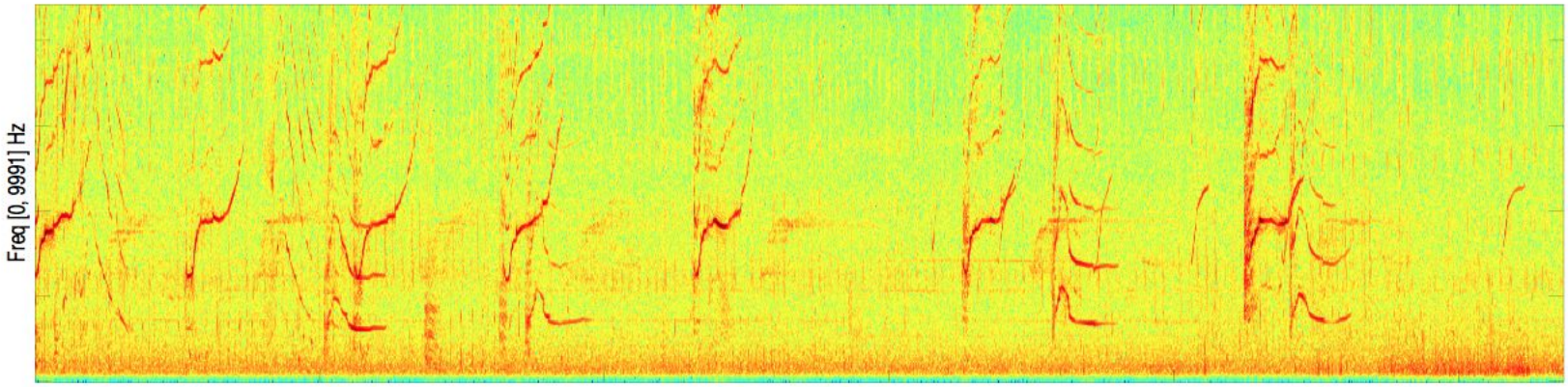
Usual FFT

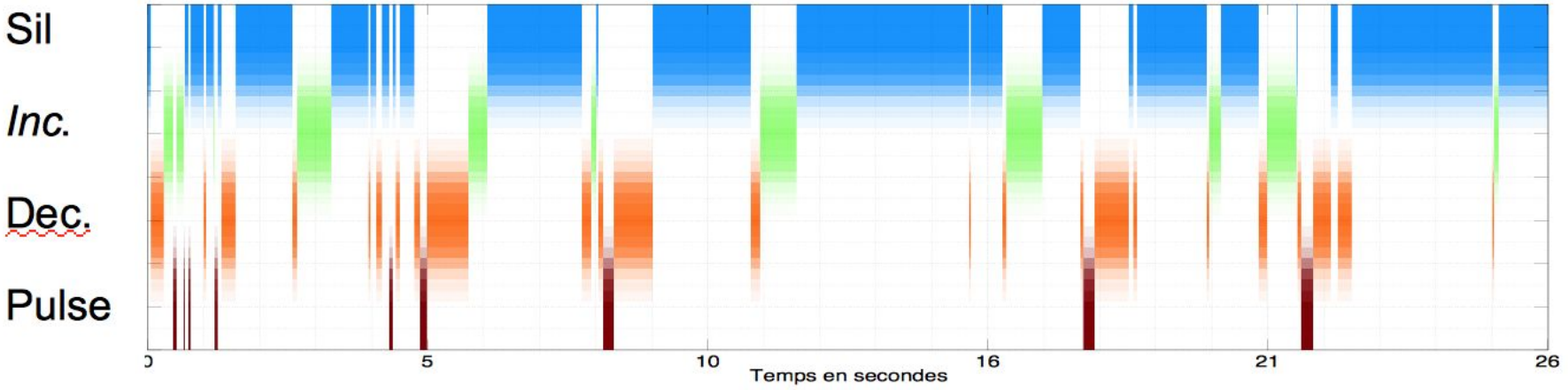


Time in bins (96 kHz SR, 24 bits, C55, Toulon 2014)

New non supervised Hierarchica Dirichlet Process Segmentation (Bartcus et al. 2015 / Roger et al 2016)

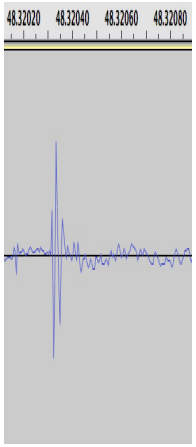
Globi. m. => behavior

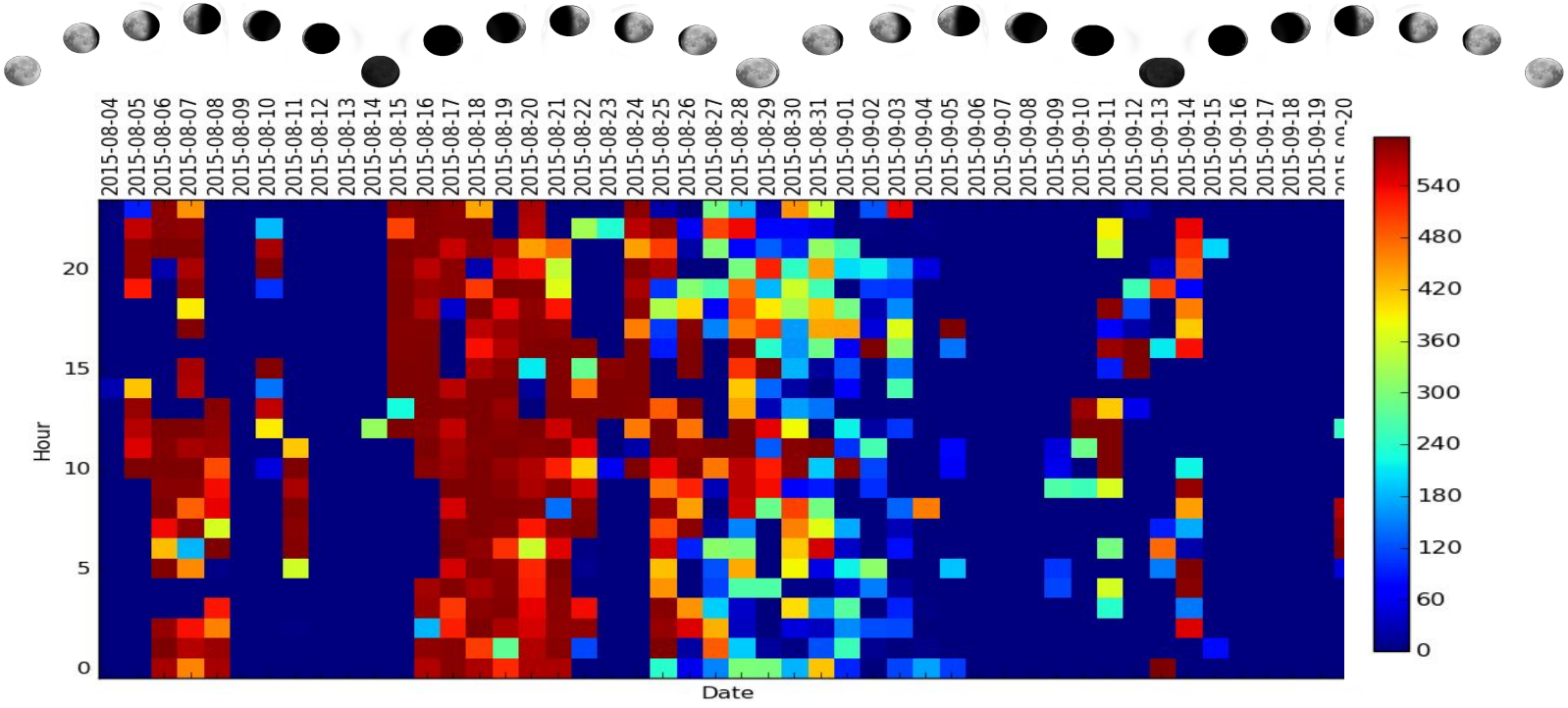




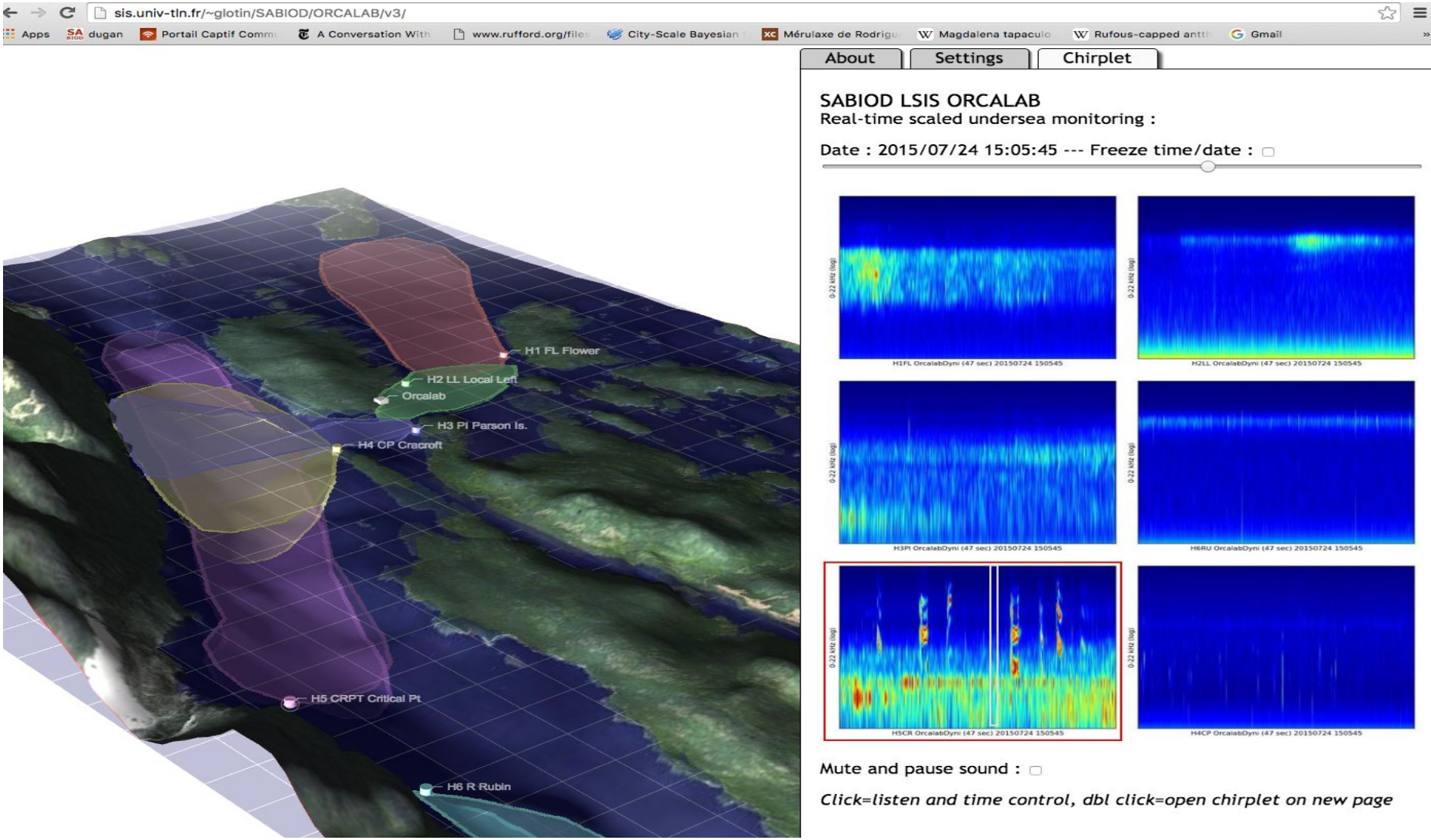
==> Our system clusters in 3 sound units the songs of the cetaceans => data mining...

Application to Narwhal Survey, in Baffin Bay



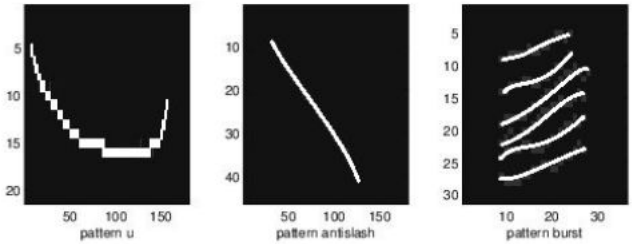


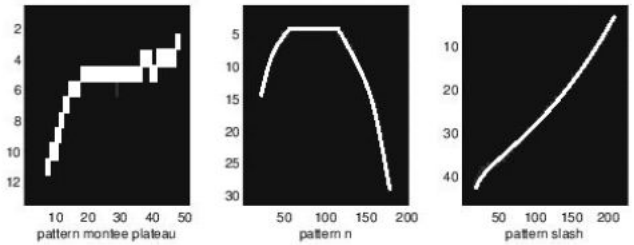
Online survey of Orca population in West Canada (Chirplet and 2d tracking system)

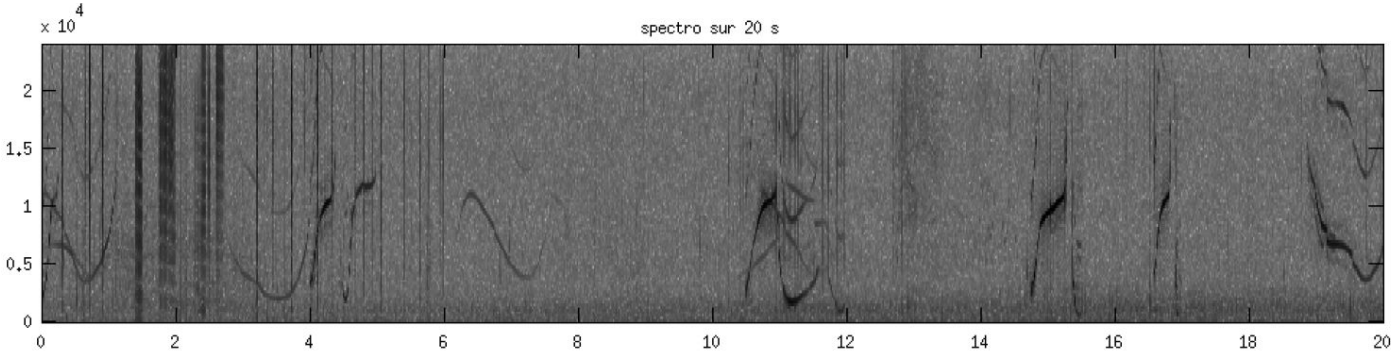


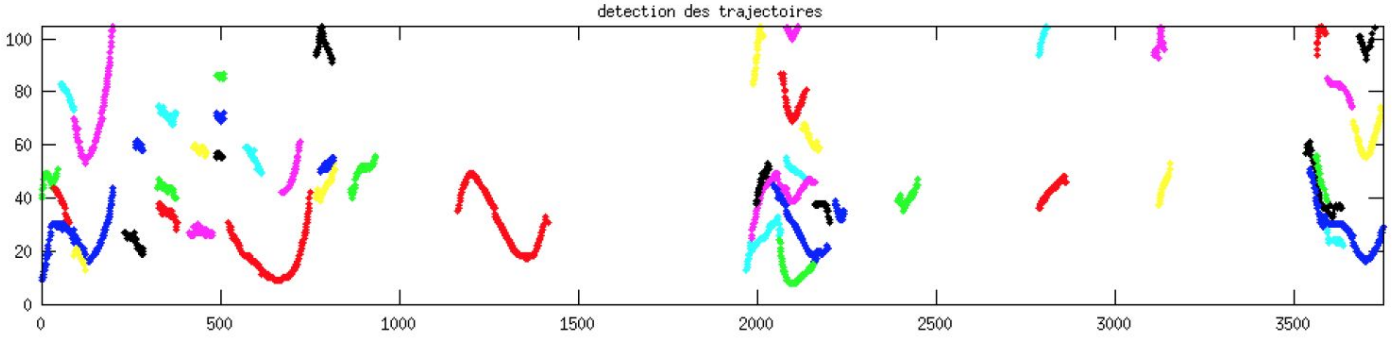
http://sabiod.org/EADM/orca

Dolphin's alphabet ?

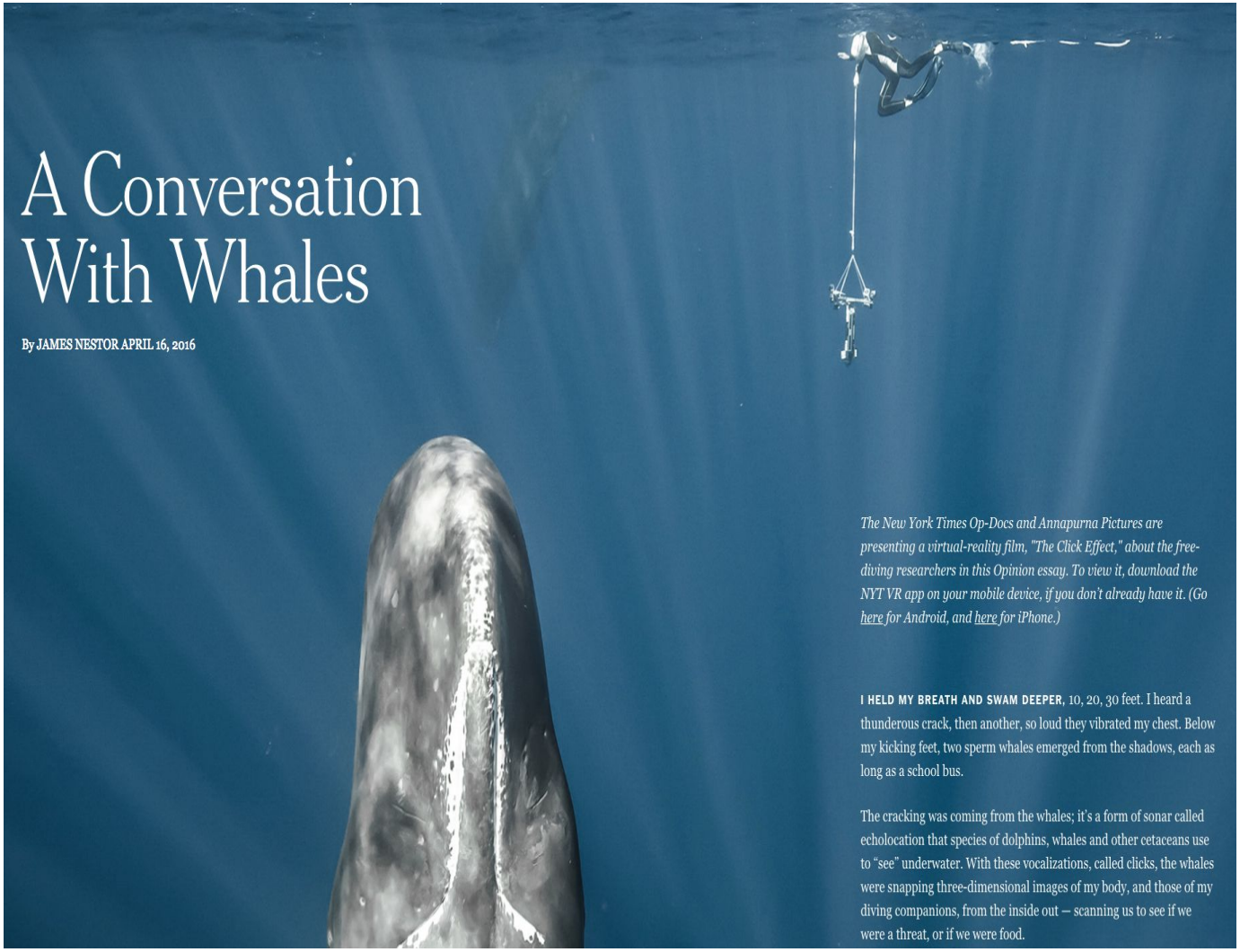








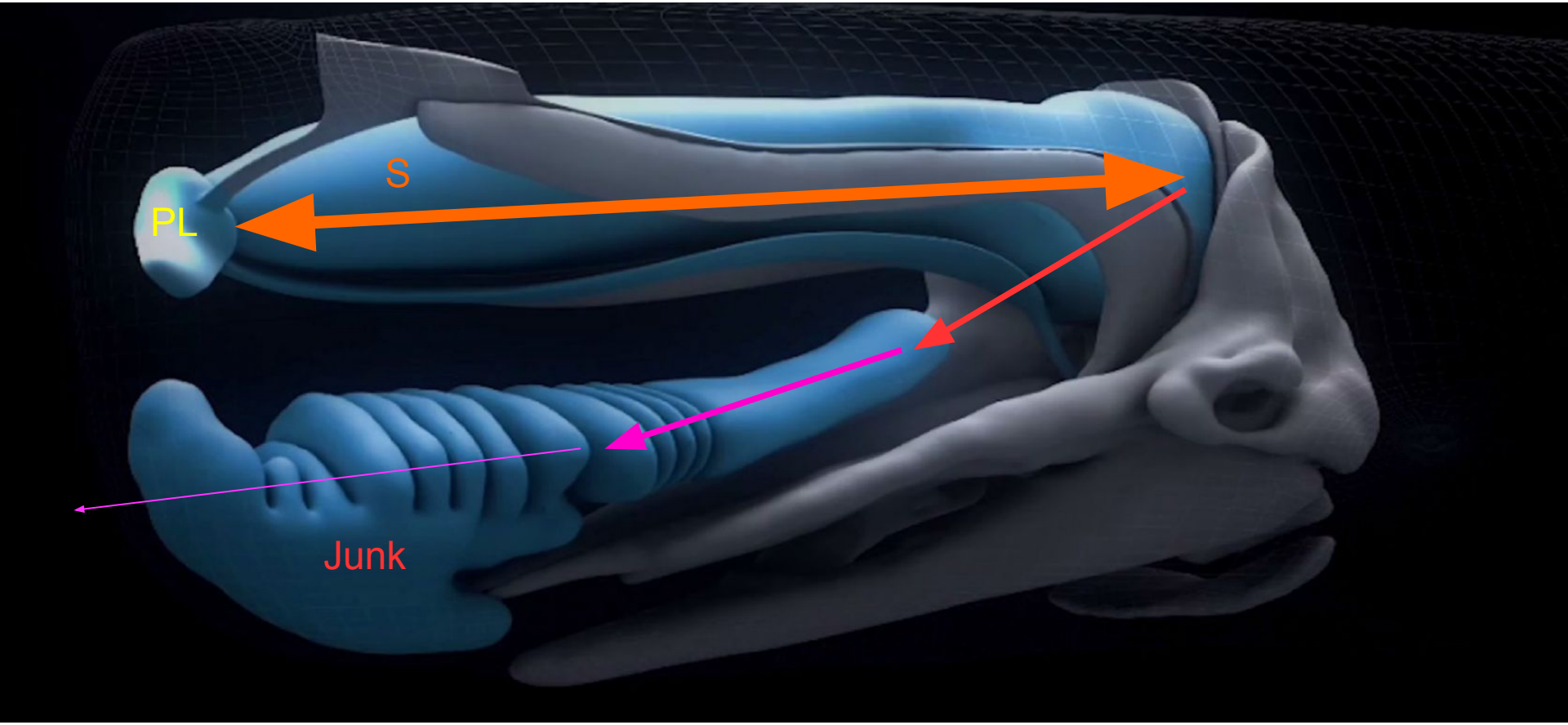
Physeter macrocephalus long series monitoring

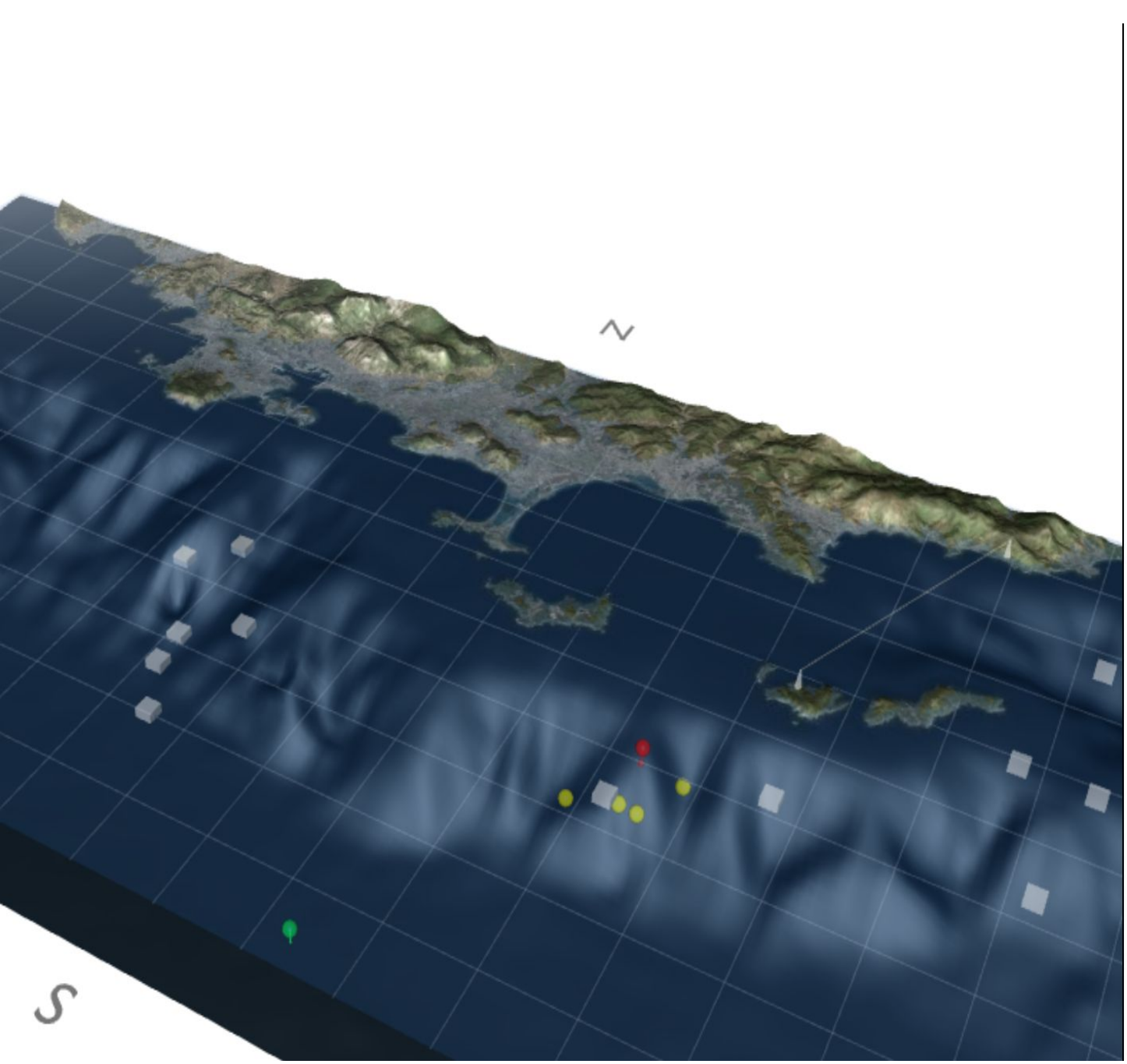


http://www.nytimes.com/interactive/2016/04/16/opinion/sunday/conversation-with-whales.html

01/11/2012

HPC FEM modelisation
Inside the most advanced sonar :
Origin of the multi-pulse structure
multi-intra head acoustic paths... Asch, Glotin 2016-2018





VAMOS (Université de Toulon, PNPC & PELAGOS)

Suivi bioacoustique d'odontocètes, différé & temps-réel

Légende :

- Boules jaunes: localisations 3D réelles de cachalot du 17.08.2015 (par Bombyx)
- Cubes blancs: localisations depuis bateaux (DECAV PELAGOS 2010-13)
- Boule rouge: BOMBYX
- Boules vertes: ANTARES
- Trait blanc: connexion WIFI 2Mo/s JASON (signal de Bombyx ou autre à terme)

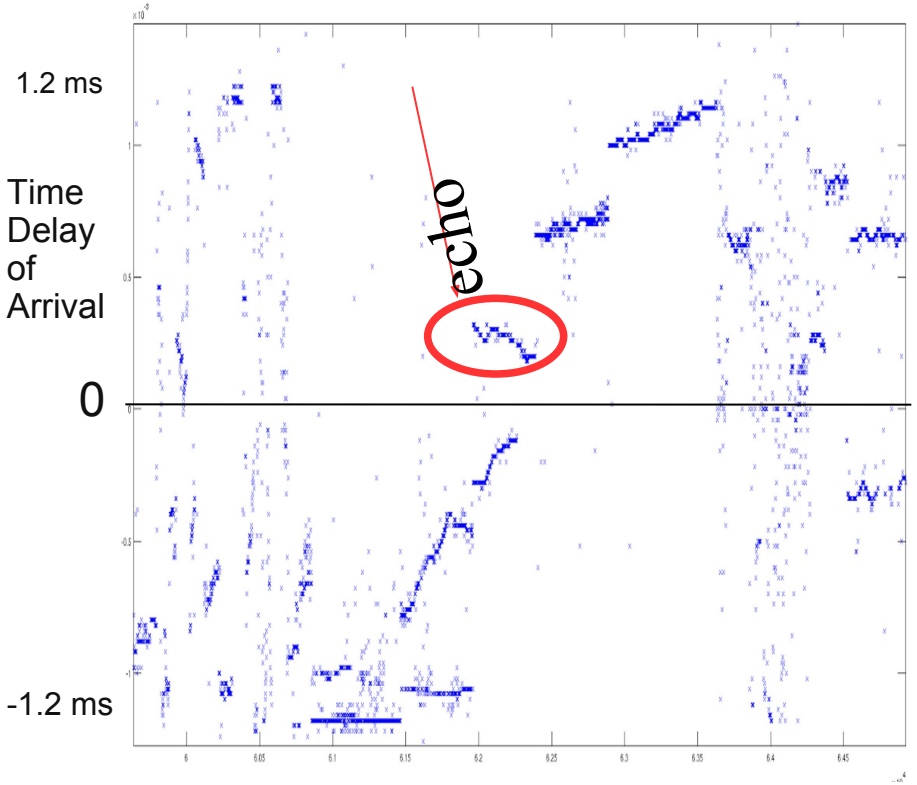
☑ grille (5km) ☑ surface de l'eau

Echelle verticale : x2

La vue peut-être orientée avec la souris (bouton & molette)

Double-clic sur un objet pour infos et centrage

BOMBYX VAMOS PELAGOS PNPC project 2015-2016
We followed the azimuth of hundred of Physeter macrocephalus during hours, over 2x3 months @ 2 * 50 kHz SR 24 bits
1 Tb processed in 20 days on HPC



Cachalots detections during 24h (5'/25')

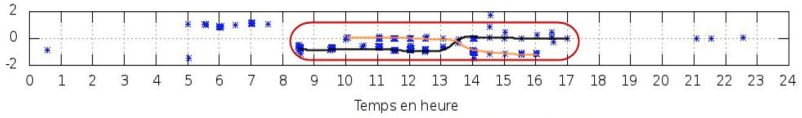
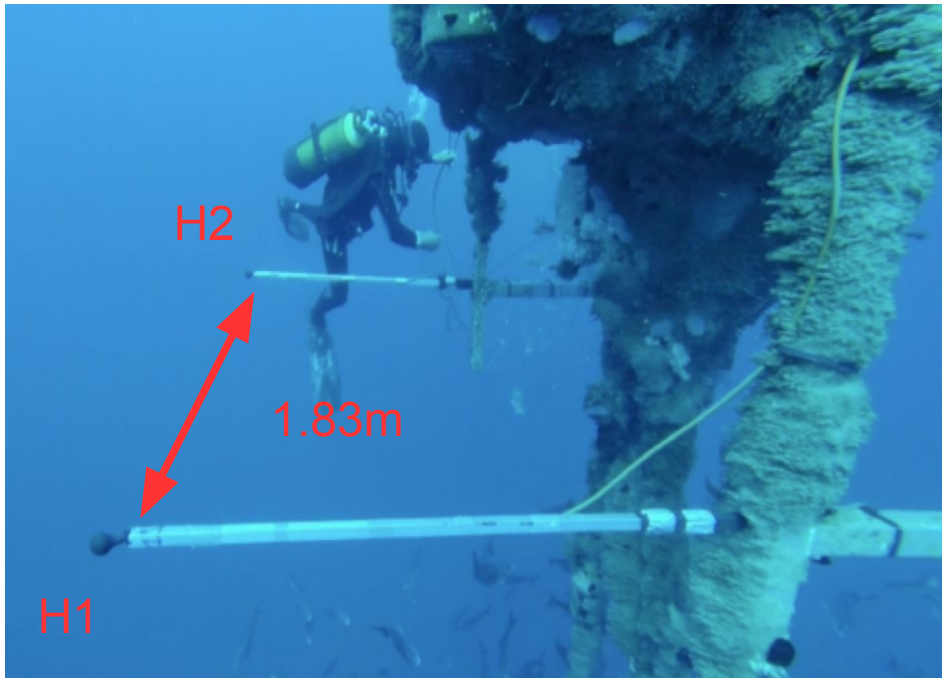
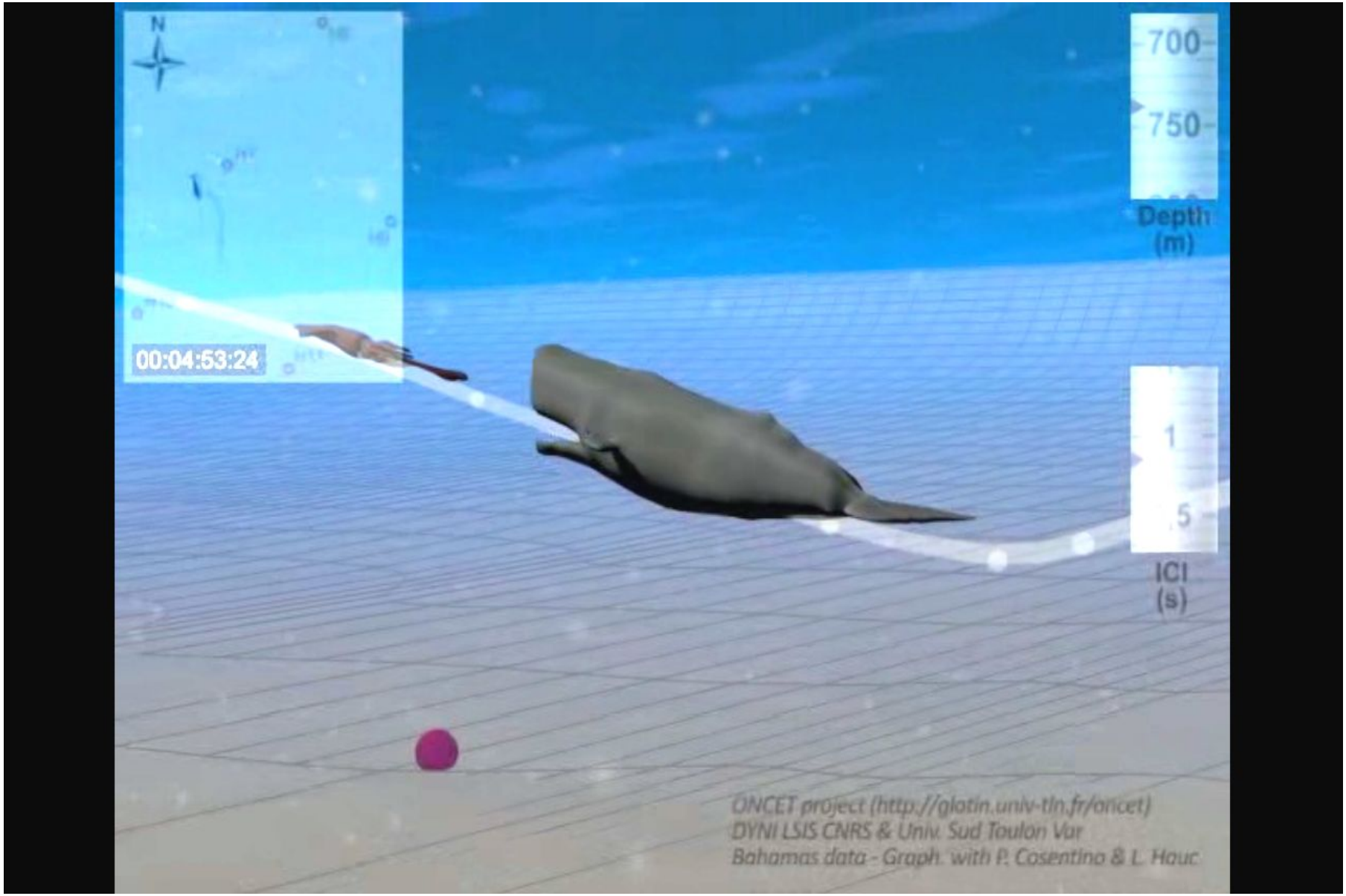


Figure 2 : Pistes de cachalots détectées entre le 07 et 15 juillet 2016
(délais entre l'hydrophone 1 (Est) et 2 (Ouest) en millisecondes, en fonction du temps en heure)



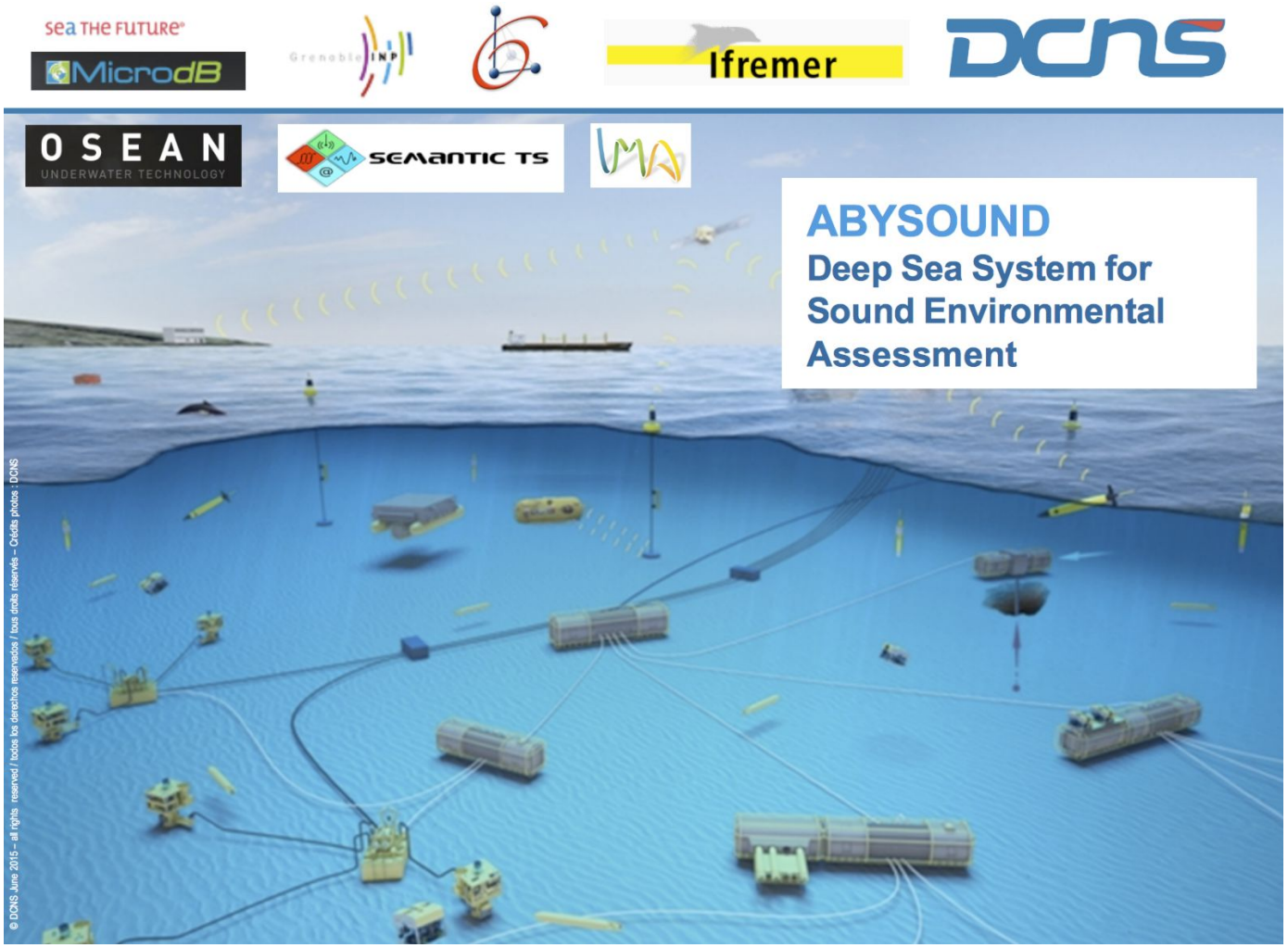
The two hydrophones of Bombyx



Real Time Whale tracking by passive acoustics
Glotin 2009, patented

http://sabiod.org

JASON USED IN FUI ABYSOUND WITH IFREMER AND DCNS



Long term classification

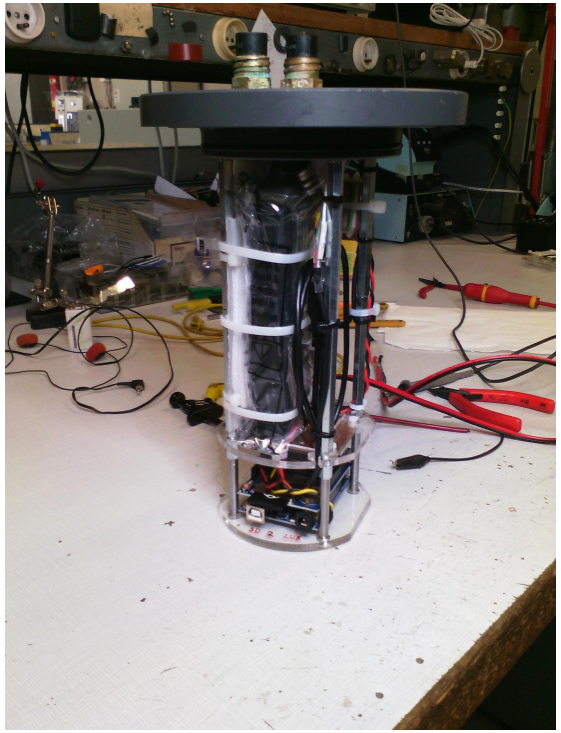
Dataset		**Method Three** *(HPC)*		**Method Two** *(Desktop Server)*		**Run Time Efficiency.**
Sample Rate	Total Hours (Size bytes)	Number of Cores	Runtime (HH:MM :SS)	Number of Cores	Runtime (HH:MM: SS)	
16 kHz	5,520 (592 GB)	48	12:46:40	4	162:00:00	**x13**
2 kHz	168 (11 GB)	48	00:29:10	4	04:53:00	**x10**
2 kHz	29,808 (380 GB)	48	03:57:08	4	36:00:00	**x9**

High Performance Computer Acoustic Data Accelerator: A New System for Exploring Marine Mammal Acoustics for Big Data Applications

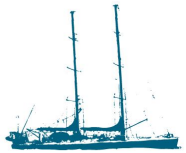
Peter Dugan, John Zollweg, Marian Popescu, Denise Risch, Herve Glotin, Yann LeCun, and Christopher Clark, Arxive 2015

Axe Information JASON on TARA PACIFIC 2016-2018 for soundscape and light JOINT monitoring of the Coral Reef http://glotin.univ-tln.fr/TARA

UTLN JASON tube 2.0



The road map of TARA PACIFIC CORAL REEF



tara EXPEDITIONS FOUNDATION

tara PACIFIC 2016 - 2018

The National Park of Port Cros may also use this system JASON DAQ,
Collaboration with Bonnelie and Arlotto, G2I, Axe Information UTLN
It will be placed in Magellan Detroit end of 2016.

Earth application examples:

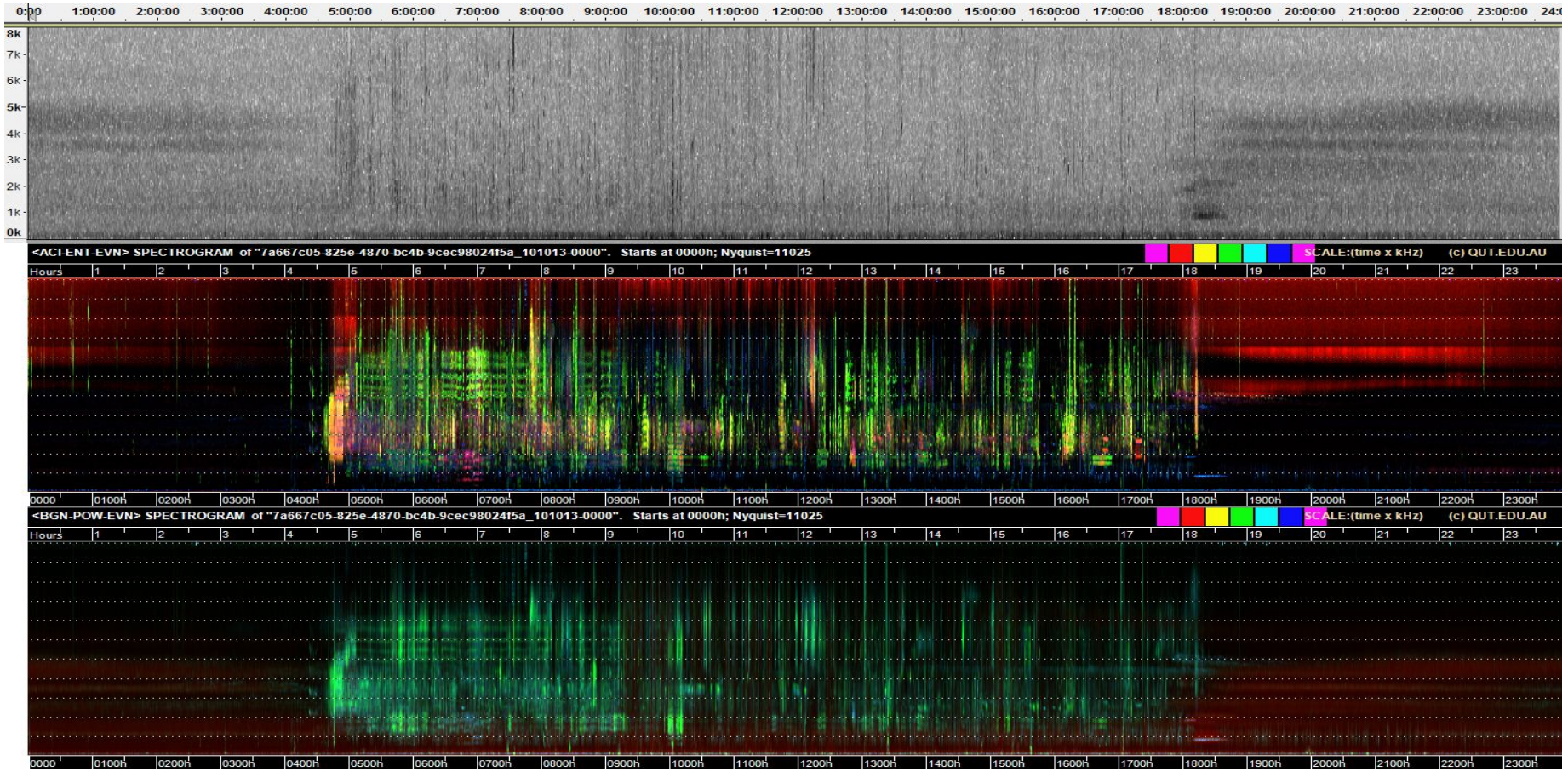
JASON

Joint Acoustic Survey for Online Biodiversity

cnrs

SABIOD MASTODONS Big Data

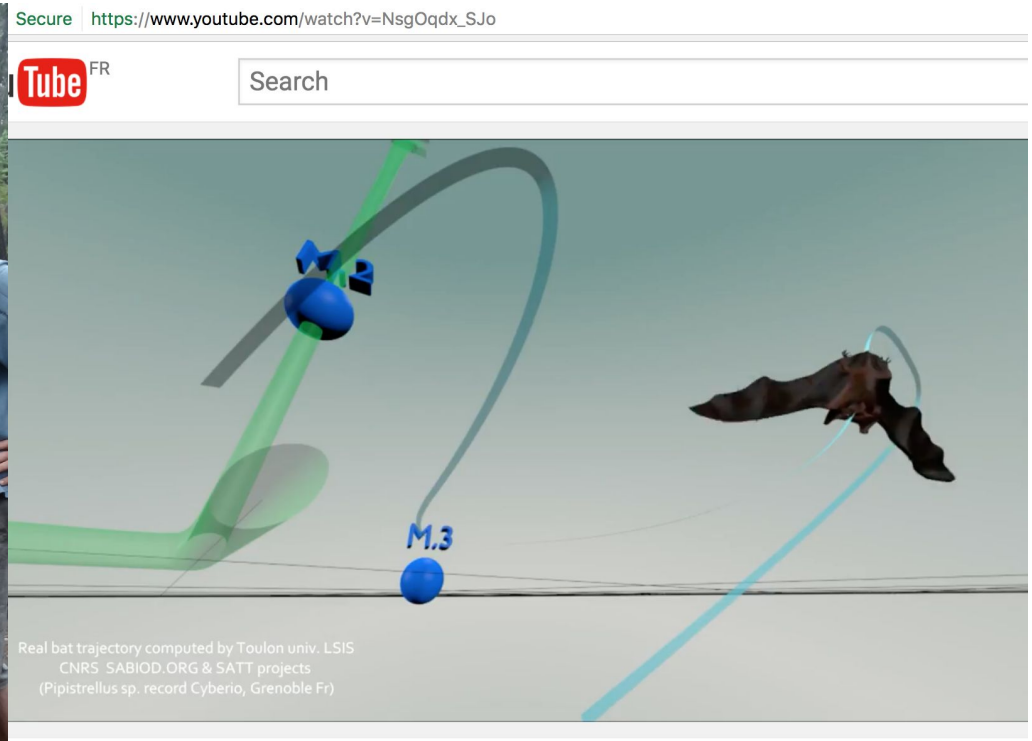
Long term representation of short events (Towsey)



These three images are spectrograms of the same 24-hour recording in bushland 30 km of Brisbane, Australia. The recording starts and ends at midnight, with midday in the centre of each image. Time scale resolution = 60s/pixel, frequency range for the top image = 0-8kHz and 0-11kH else. The top grey-scale spectrogram illustrates the "compression by averaging" performed by Audacity. The effect is to highlight only general background noise, such as the cicada chorus at 1820h and the insect chorus tracks at night. The middle false-colour spectrogram is obtained by assigning the acoustic indices ACI, ENT and EVN to RGB respectively. The morning chorus is obvious but more surprisingly, several bird species can also be identified because their brief calls nevertheless leave similar traces in consecutive minutes of spectrogram. The bottom false-colour spectrogram is obtained by assigning the acoustic indices BGN, POW and EVN to RGB respectively. Different indices provide different "views" into the soundscape. However in case of the lower spectrogram, two of the indices, POW and EVN are somewhat correlated and therefore less information is revealed in the false-colour rendering.

Real time 3D bioacoustic tracking

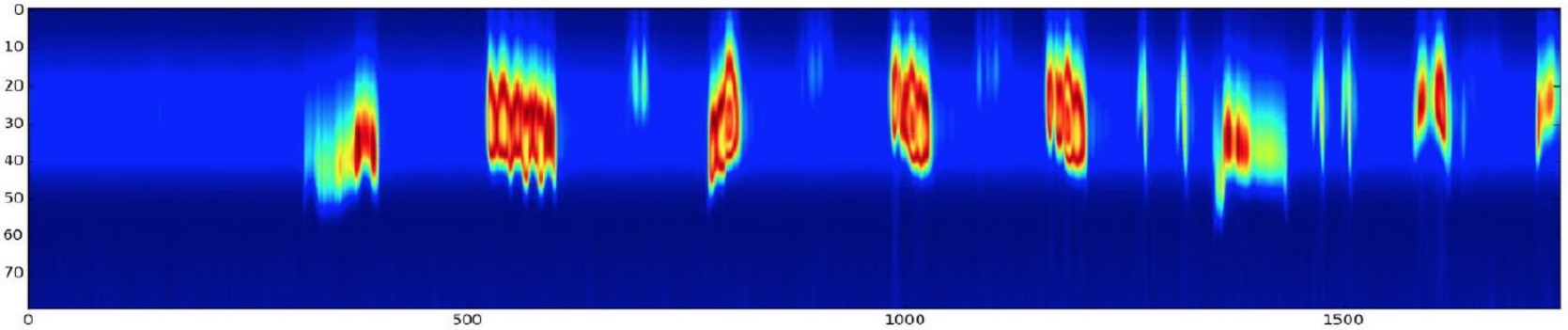
demo : https://www.youtube.com/watch?v=NsgOqdx_SJo



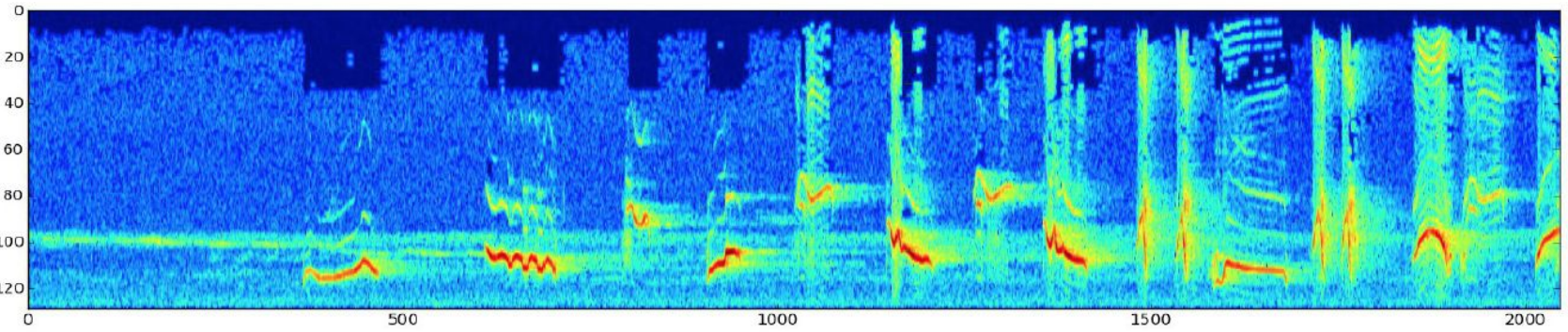
Real bat trajectory computed by Univ.Toulon, LSIS CNRS (enregistrement p7pkuhl micro 1)

Toulon runs advances in signal processing : Fast Chirplet Transform
for efficient bioacoustics representation
Glotin ICDM EADM 2015

chirp



FFT

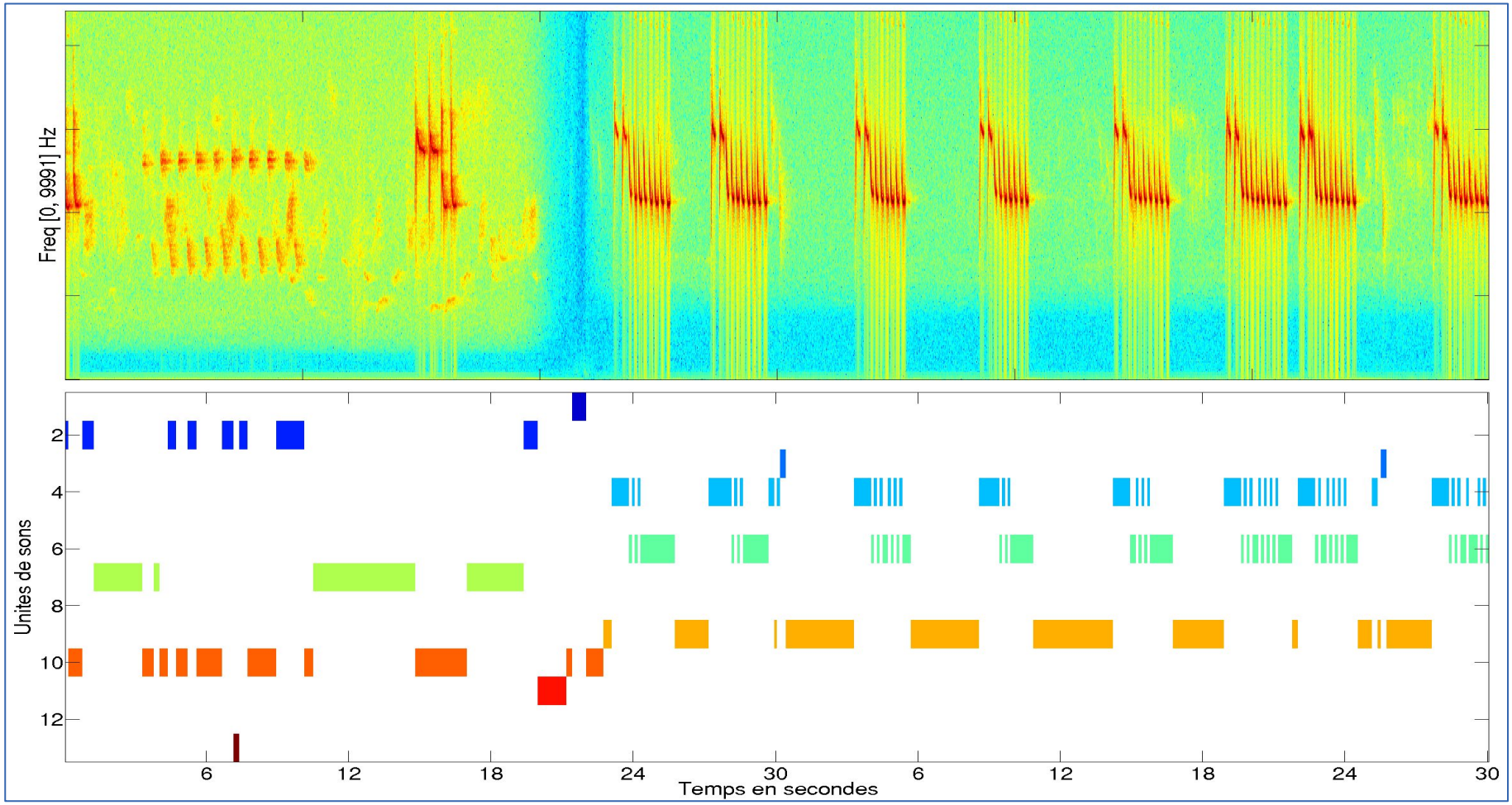


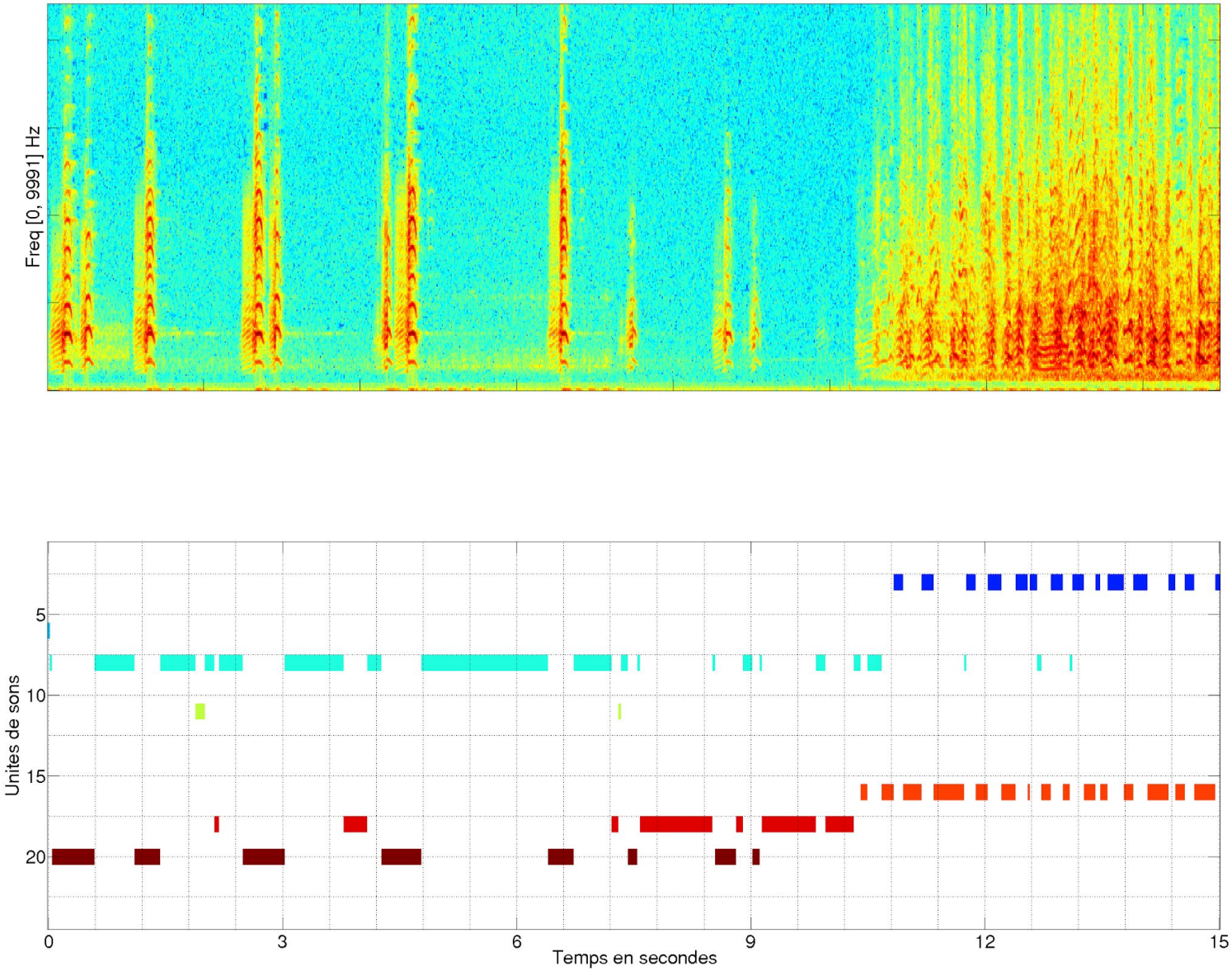
=> Co-org LIFE CLEF Challenge avec INRIA
Classification de 1500 Amazon Bird Species
http://www.imageclef.org/lifeclef/2017

Non Parametric Decomposition (HDP HMM Glotin et al 2016)

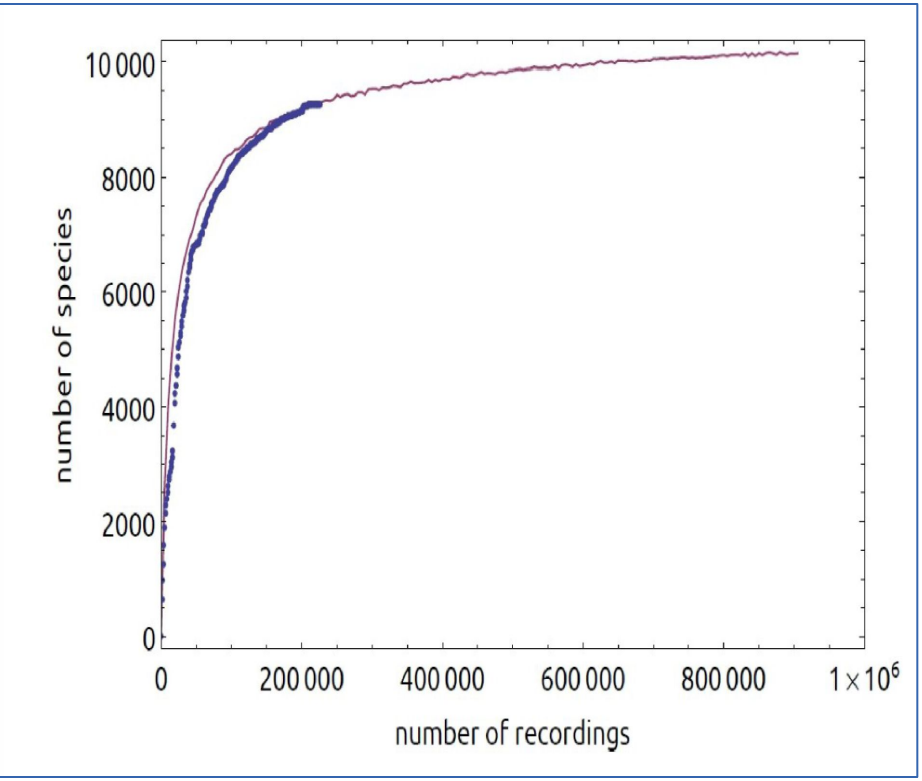
(cf démo at :

http://sabiod.univ-tln.fr/workspace/BIRD_35_MNHM_ICML4B_30ms/




Freq [0, 9991] Hz
Unites de sons
5
10
15
20
0
3
6
9
12
15
Temps en secondes

Large scale classification - Amazon Bird Challenge (LifeClef 2014,15,16,17...)
- Chernobyl Biodiversity Survey (2016, 17, 18)
- Fukushima Monitoring (2017-...)



Collection of bird species

Informations / challenges
http://sabiod.org/EADM

And other application : Drone survey by acoustics

National project ANR SGDSN...

ANTI DRONE - ANR SPID SYSTEM

http://www.univ-tln.fr/L-UTLN-developpe-un-detecteur-acoustique-pour-la-lutte-anti-drones.html

Synopsis of LSIS acoustic system

a) Estimation of (Az, El) by Time Delay of Arrival in 5 channels fixed antenna
b) Estimation of (Az', El') via Intensity Difference Level of 2 moving parabola
c) Automatic recognition of the source, risk evaluation, target ranking
d) Merge (a) and (b), rank Azimuths and Elevations
e) Enhance SNR of the target of 1st rank (Az*, El*) by pan tilt parabola
f) Goto (a)