SYREDOMY : an underwater wireless pop-up system for deep and remote data recovery

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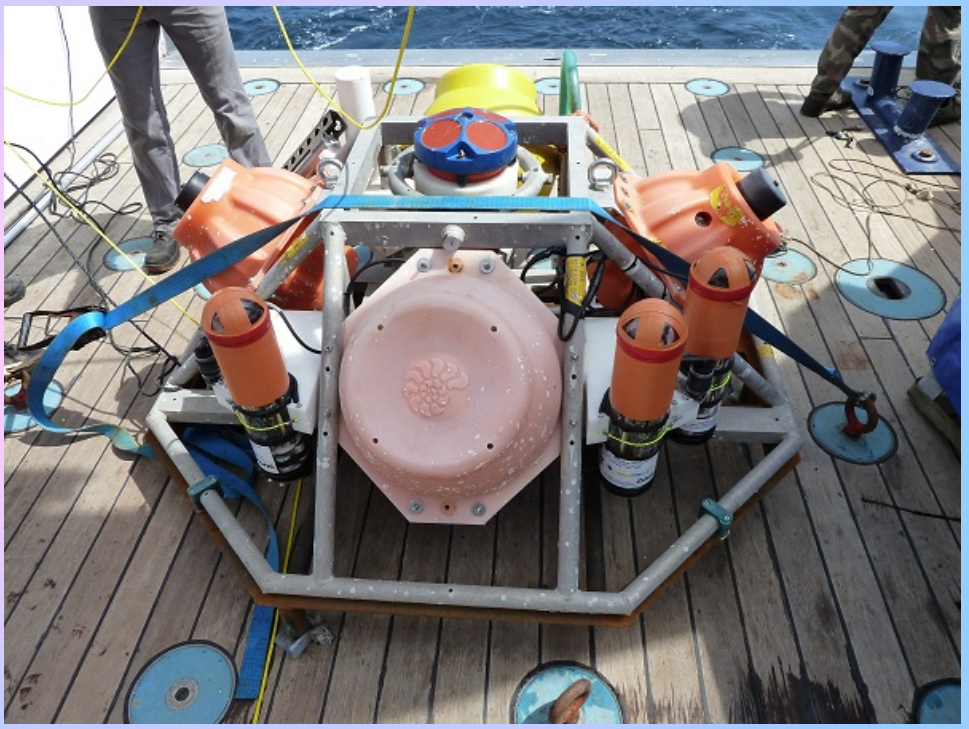
Two applications : CPIES and CIAM

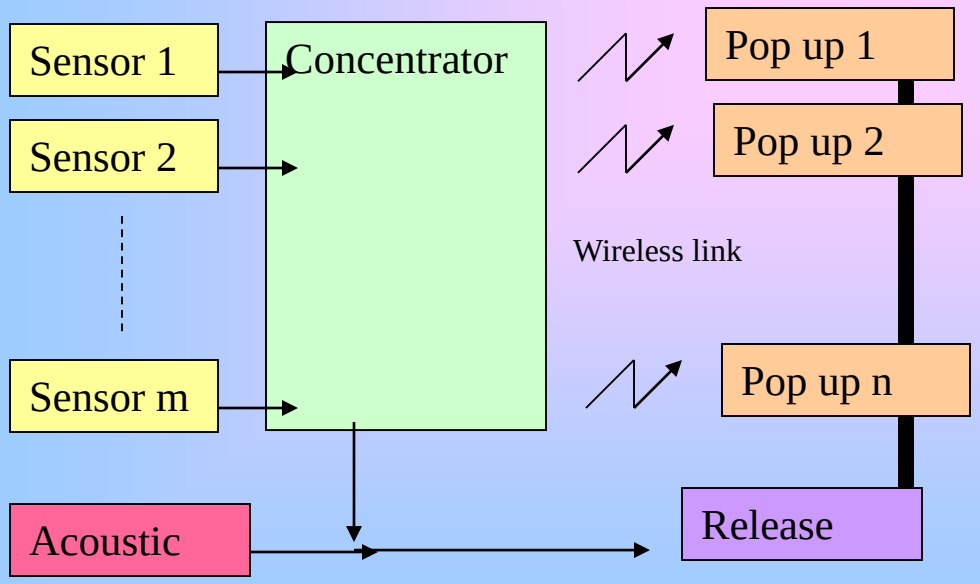


SYREDOMY Aims

1. Data recovery on shore from ongoing deployments
2. Status of immersed instruments
3. Start data validation as soon as received
4. Extend duration of deployment according to instruments status
5. Partial recovery of data in case of instruments damages

SYREDOMY : Principles

1. Every sensor/instrument collects and stores data whixh are sent to concentrator
2. At predefined rendezvous, the concentrator transmits data to pop-up messengers over an underwater wireless link
3. Pop-up messengers are released either on a predefined date or acoustic command from a surface (opportunity) ship
4. Once at surface, data are transmitted to shore via a satellite link (Iridium)



Some numbers and constraints

Instrument Type	Storage Capacity (Mb)	Transmission cost (k€)
CPIES	32	22
ADCP	1000	700
CTD (SBE37)	8	6

Transmission cost

Pop up buyoancy → Limits on embedded weight → Limits on embedded energy → Limits on data flow to shore

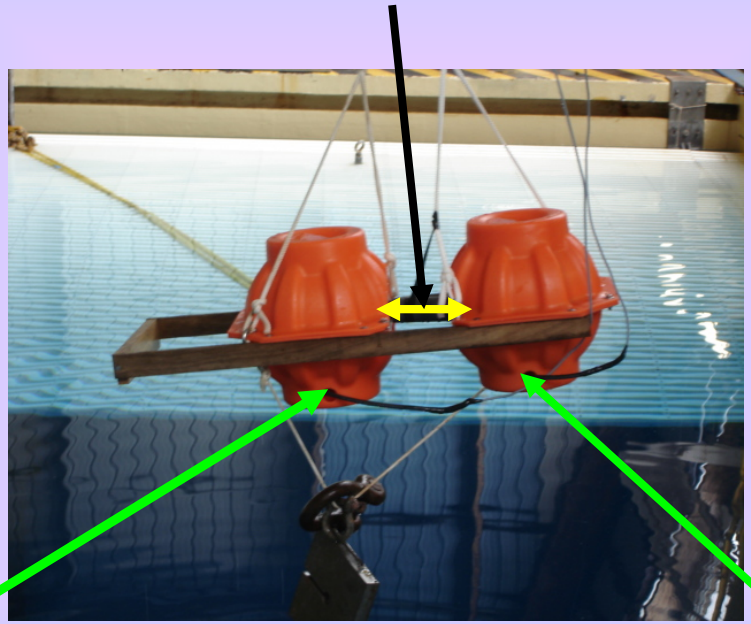
Compromise and strategy to define

Underwater wireless link : some options

	Advantages	Disadvantages
Acoustics	•High transfert ranges •Moderate to high data flow •1 emitter – many receivers	•Cumbersome devices •High energy •High cost
Optics (IR)	•Small devices •Low consumption •Low cost	•Small transfert ranges •Mechanical alignment •Moderate data rate •Emitter and receiver at all nodes
Magnetic induction	•Small devices •Low consumption •Low cost	•Small transfert ranges •Moderate data flow •Emitter and receiver at all nodes
Microwaves (Zigbee, Bluetooth, Wifi)	•Small devices •Low consumption •Low cost • Very high data rates •1 emitter – many receivers	•Very small transfert ranges

IFREMER pool tests to evaluate the microwave transfer (Zigbee)

2 spheres immersed at 1,5 m below the surface : evaluate the transfer distance



RS 232 link

RS 232 link

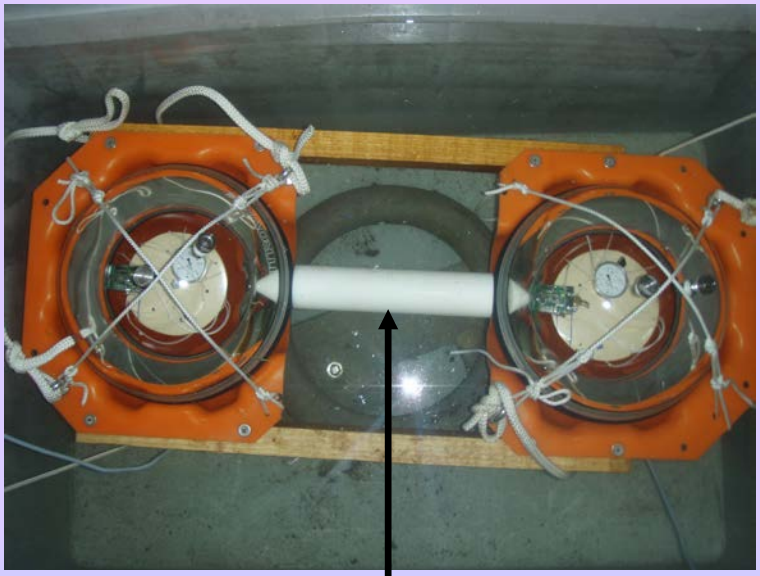
PC #1

Transfer character by character

PC #2

Maximum distance → 3 cm

To increase the range beetween the spheres, we must push away the water, which due to its conductivity, strongly attenuates the electromagnetic waves



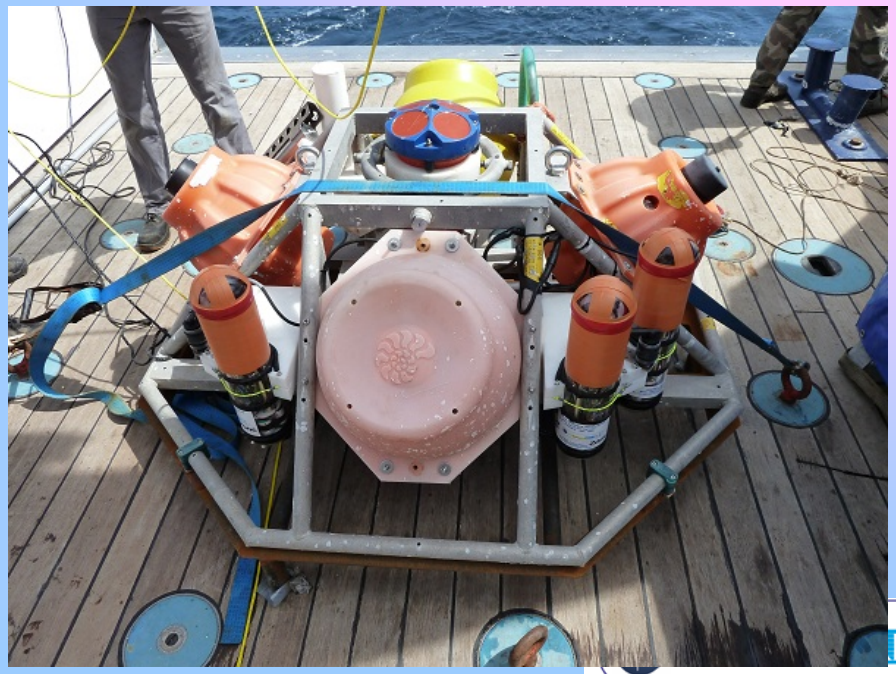
Use of a PVC piece diameter 60 mm, length 300 mm

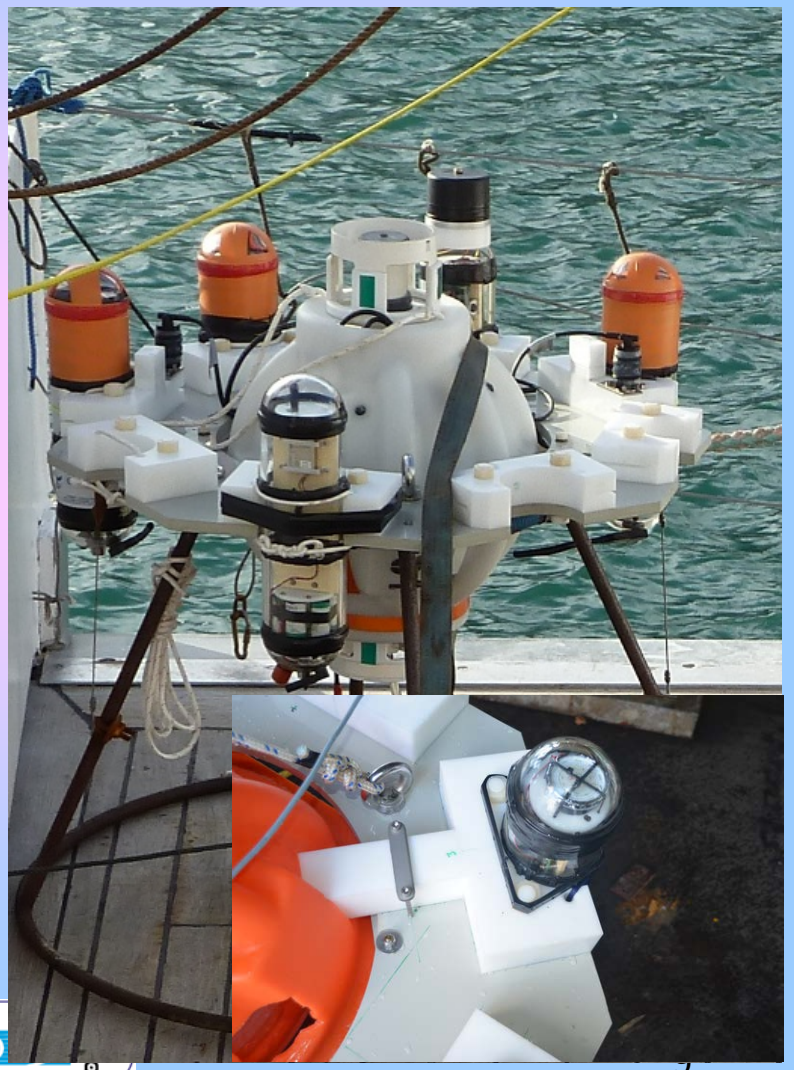
First prototypes

Concentrator and messengers in Nautilus glass tubes

White support is PEHD :

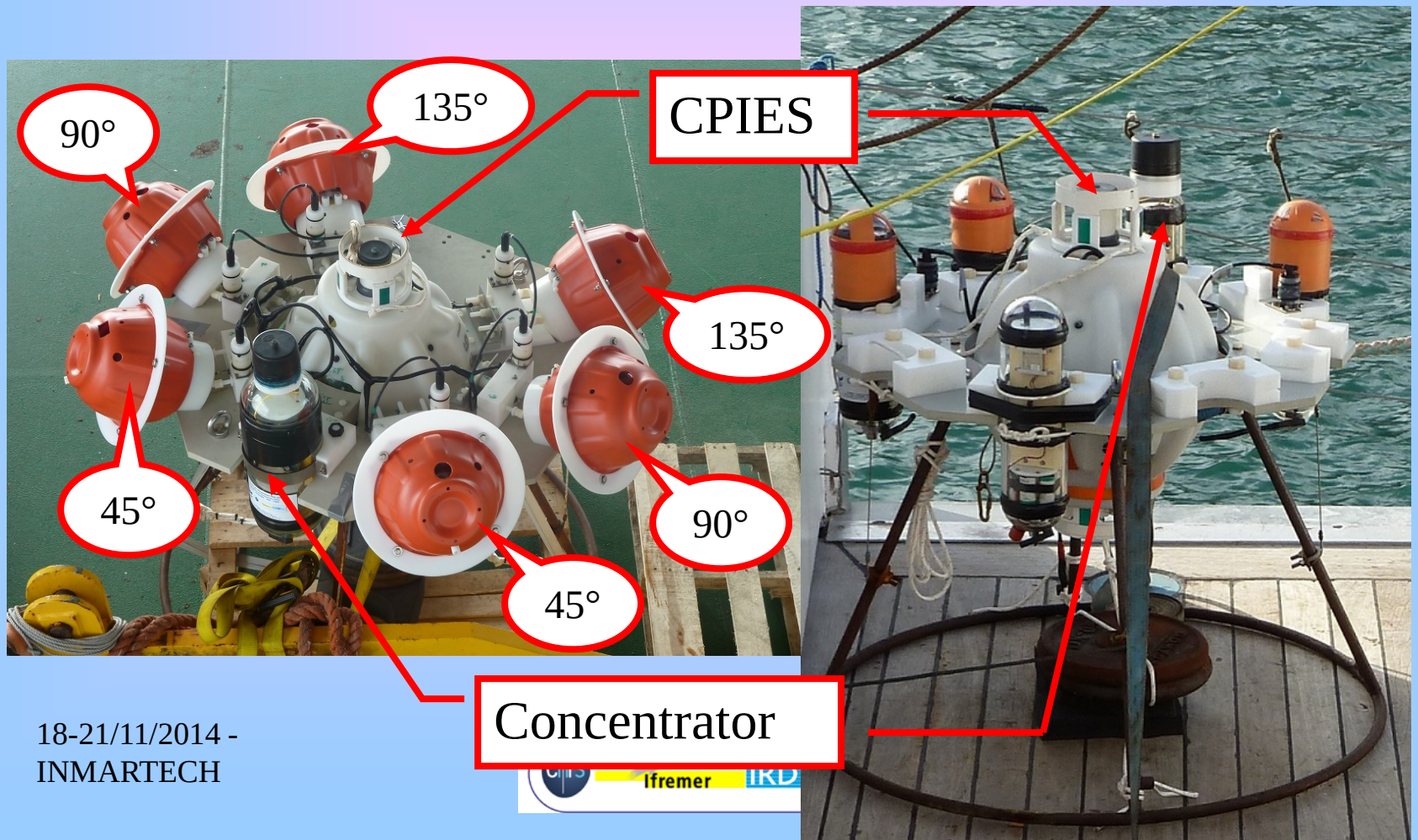
- Mechanical suuport for messengers
- « waveguide » for microwave propagation



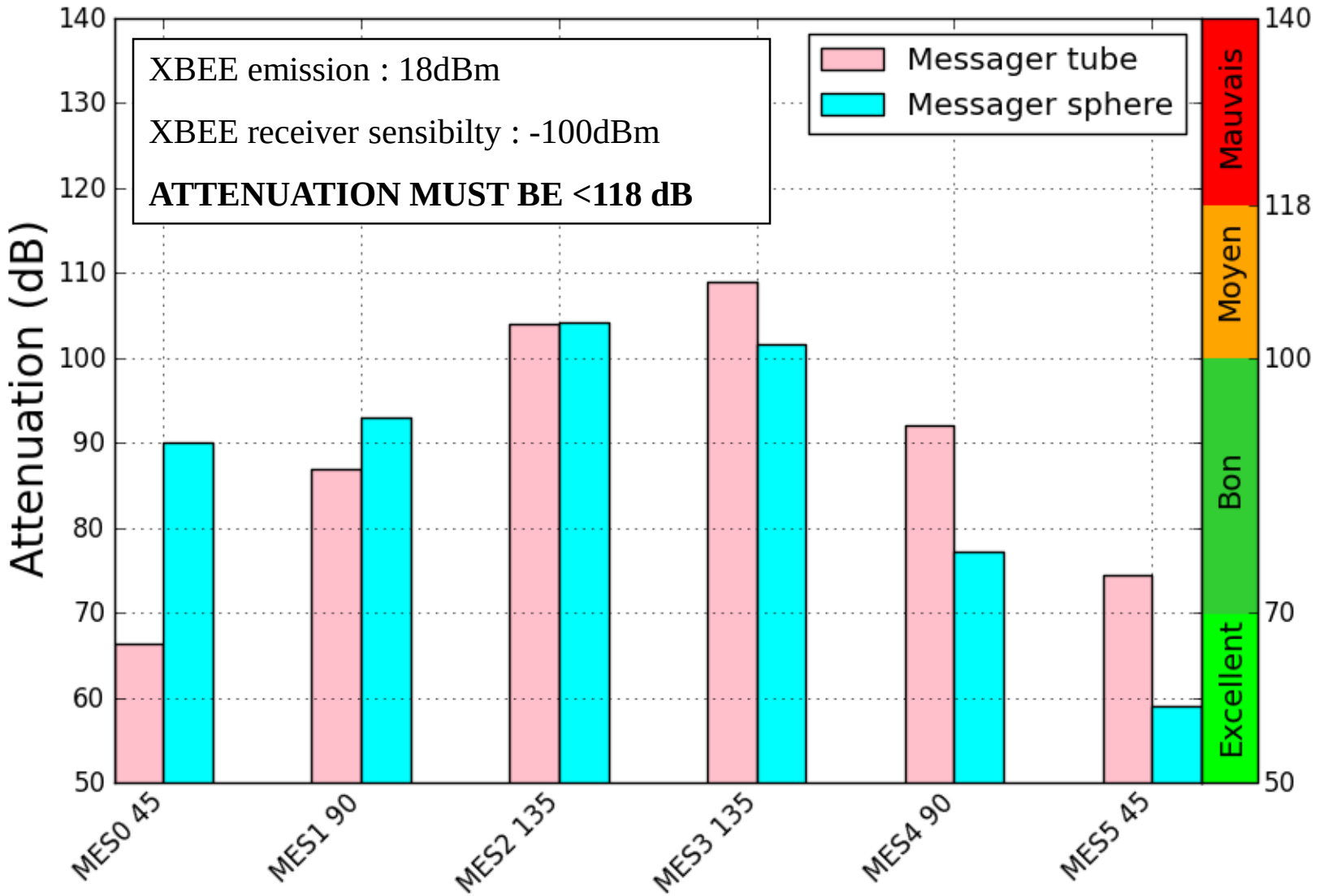


CPIES Version

- Messengers in Nautilus glass spheres or tubes
- Sphere is cheaper than tube (-1200€)
- 6 messengers ditributed as 2 at 45°, 2 at 90°, 2 at 135° relatively to concentrator



Attenuation measured beetween concentrator and messengers



ALEES – SYREDOMY-XBEE boards

ALEES board (Advanced Low Energy Electronic System)

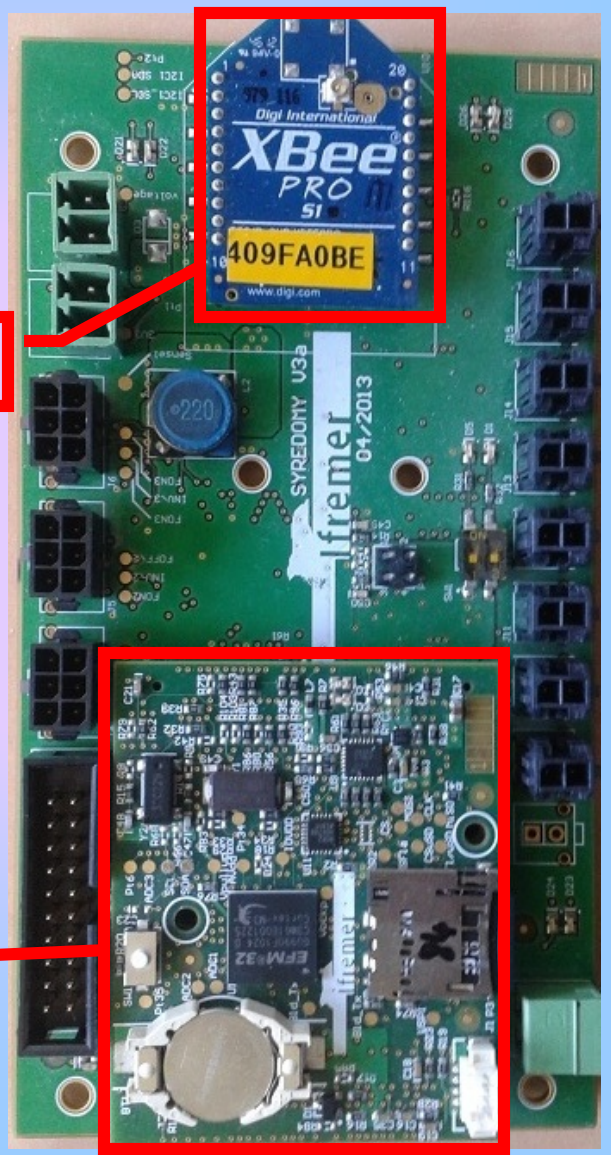
- developped by IFREMER REM/RDT/I2M
- Microcontrôleur Energy Micro EFM32
- Active lowpower mode : <2 µA / 3V
- Active mode at 48 Mhz : 10 mA / 3V
- IDE : Eclipse, GCC compiler, JLINK JTAG debugger
- Size 45x55 mm

SYREDOMY application board

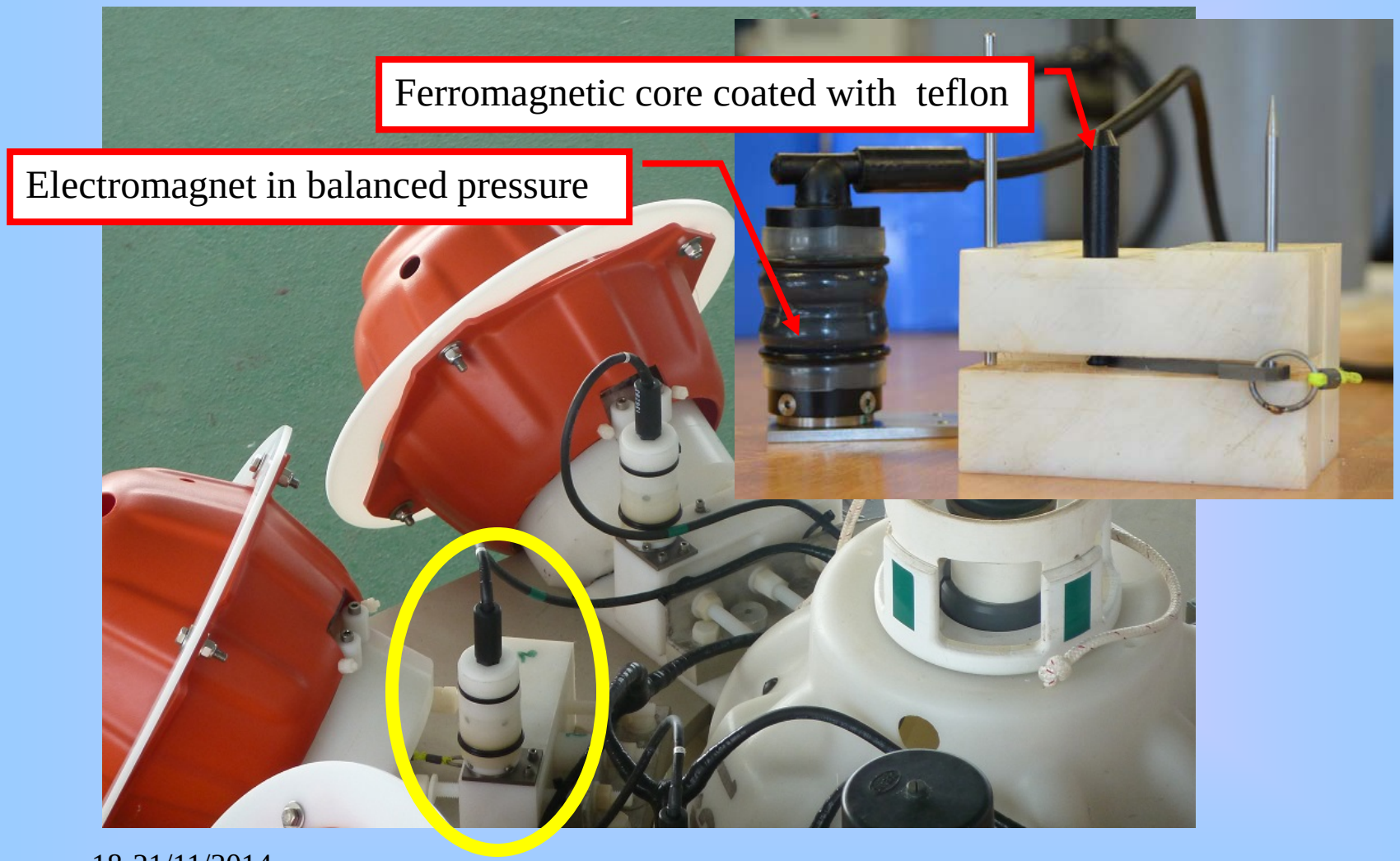
- receive ALEES and XBEE module
- RS232 level adapters
- Voltage regulator
- Power switchs

DIGI XBEE module

- Range: up to 100 m
- Rfemission power: 58 mW (18 dBm) adjustable



Electromagnetic Release in balanced pressure



Integration in 10" Nautilus sphere (1)

IRIDIUM antenna

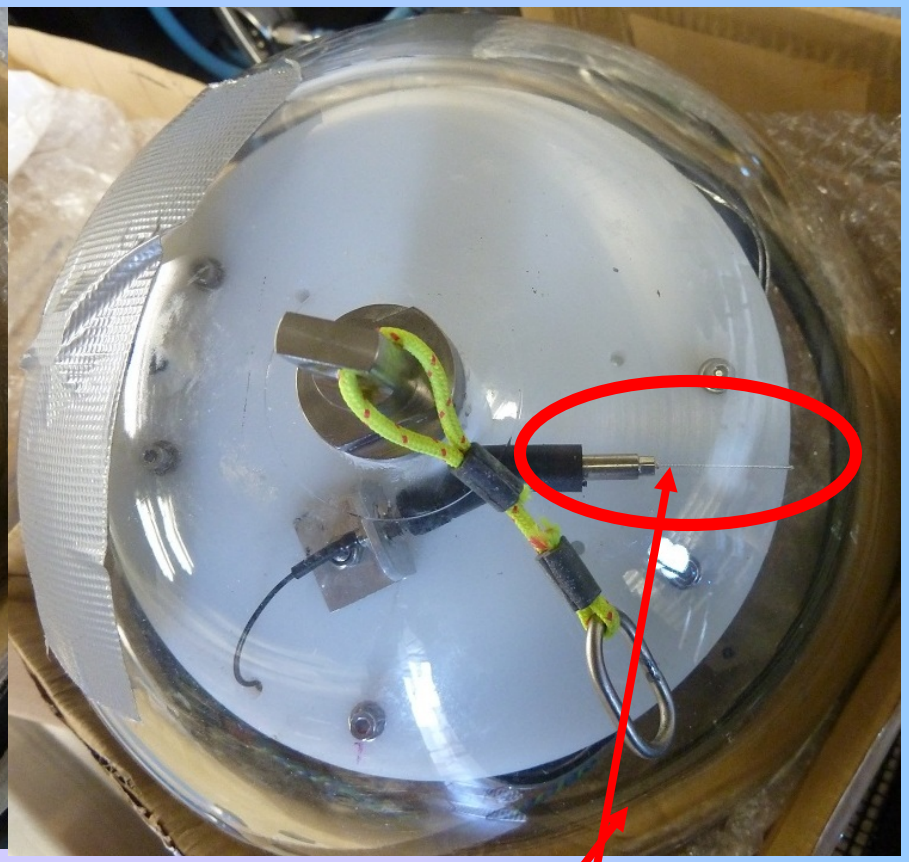
Reed relay (release detect)

SYREDOMY-ALEES-XBEE

Energy : 6 lithium Saft LSH20 primary batteries

7.2V/39Ah

Integration in 10" Nautilus sphere (2)



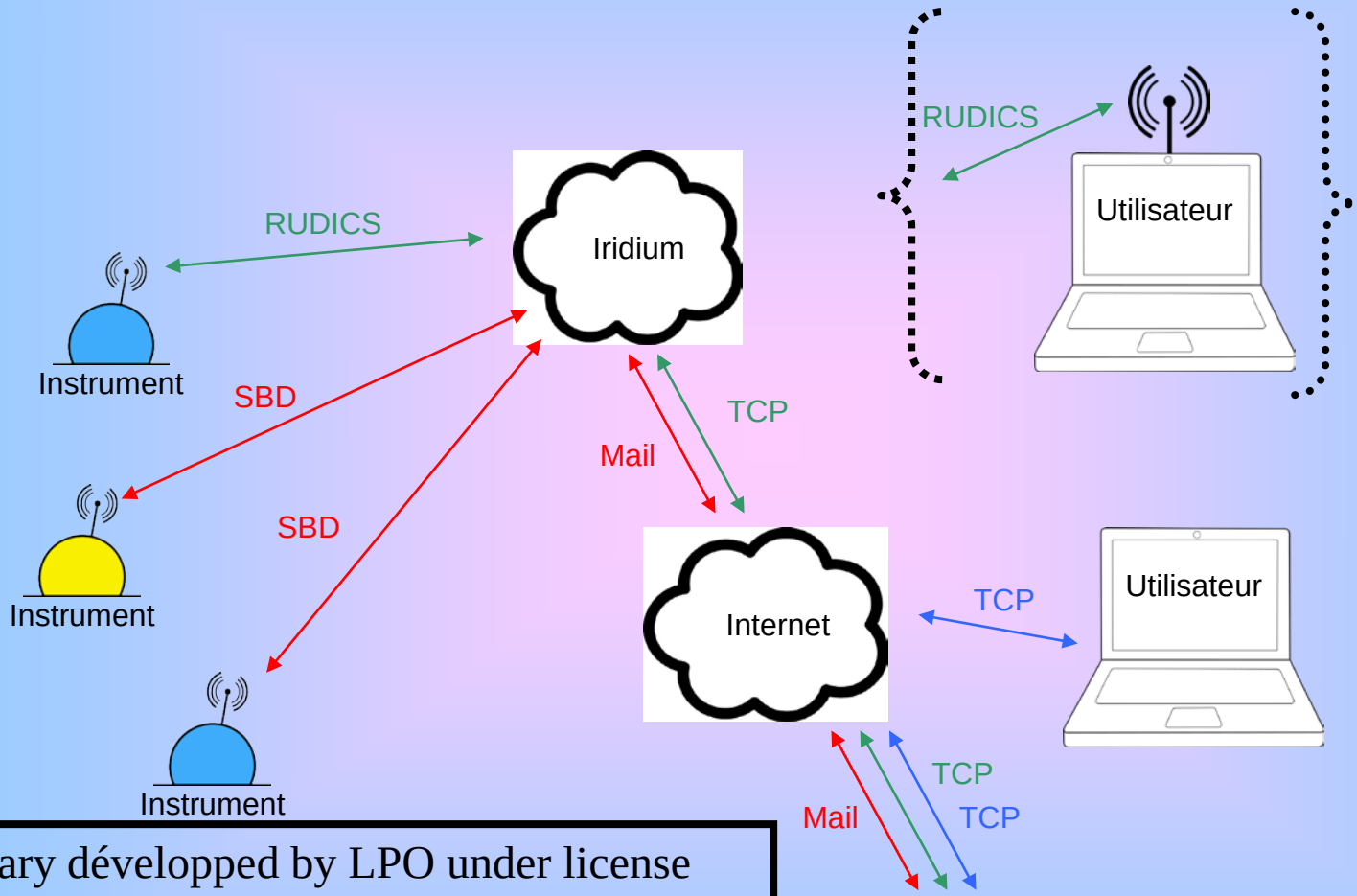
Vacuum port

Iridium modem9602

Hook to hold sphere on the frame

XBEE antenna

Transmission IRIDIUM : SSUIT (Simple and Secure Usage of Iridium Transmission)



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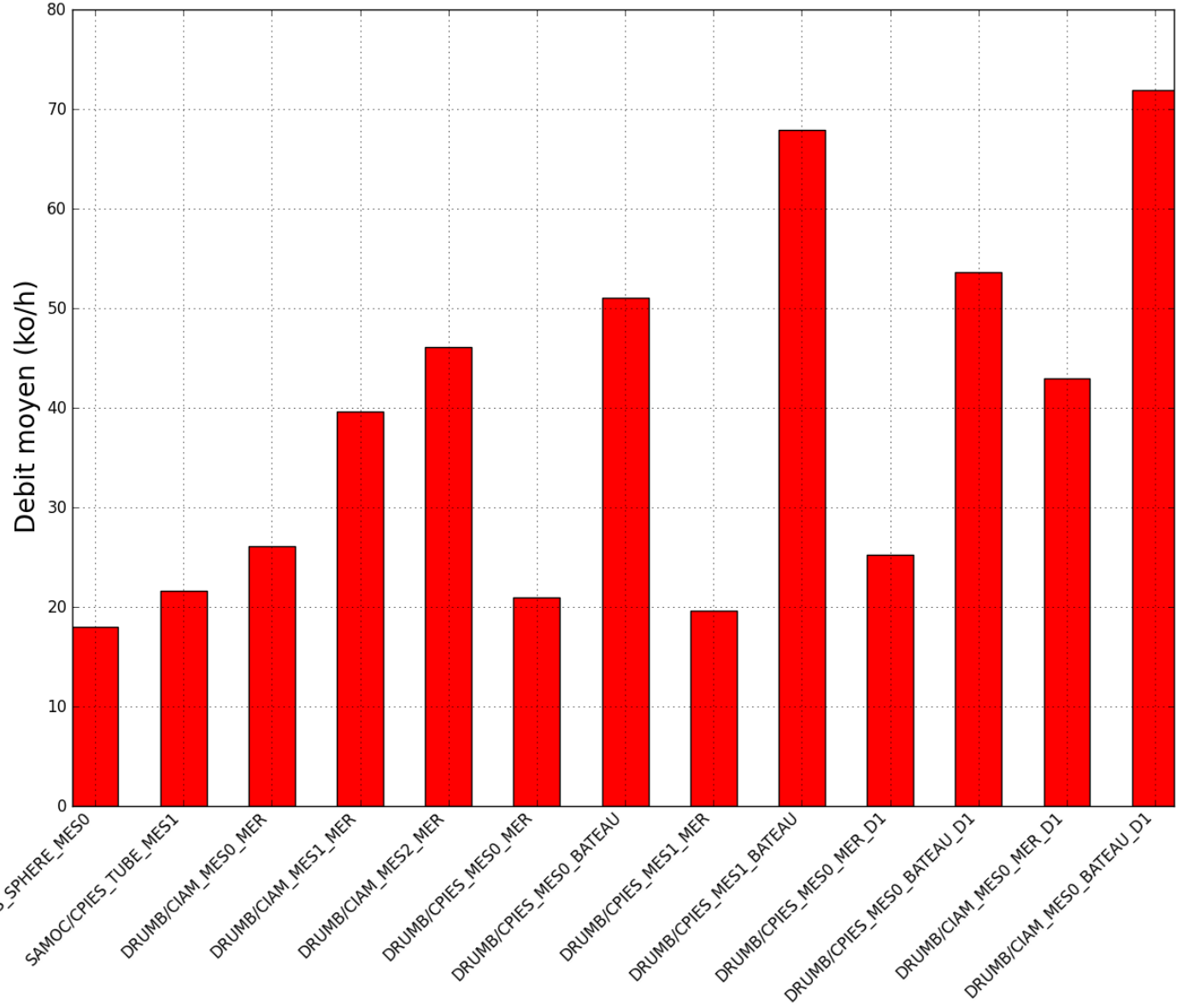
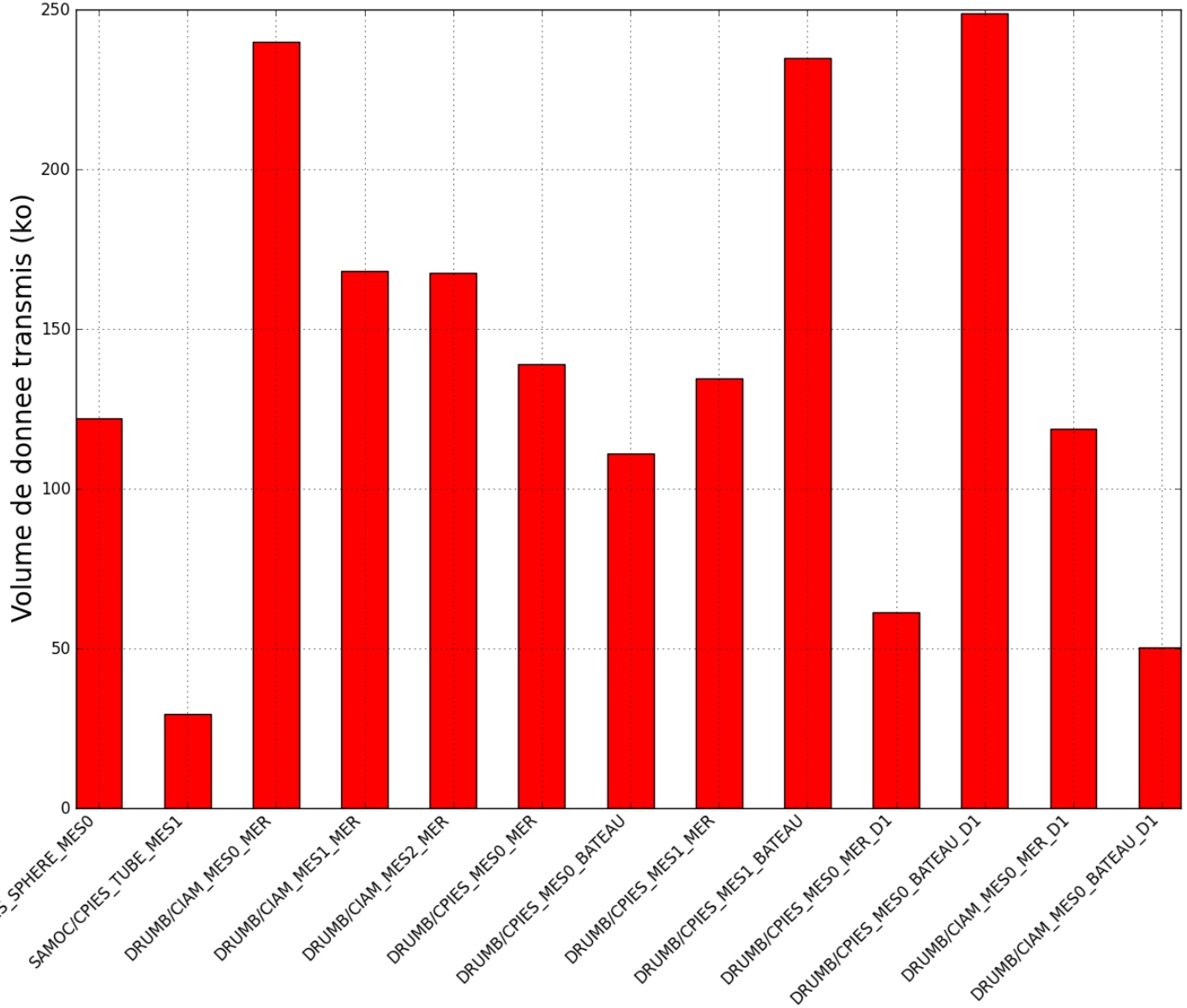
IRIDIUM :results

Iridium data rate : 18 to 70 kb/h



IRIDIUM :résultats

Total SBD transmitted volume : 1825 kb



SYREDOMY : timelines/résults

2010 :

- Start developping on Persistor CF2 board (concentrator+messenger)
- Validate overall feasability (in laboratory, pool…)

2011 :

- 1rst trial at sea for a week (~300 m depth)
- Validate underwater wireless XBEE link

2012 :

- Switch to ALEES board
- 2nd trial at sea for 5 months
- Validate concentrator on ALEES board
- Validate Iridium SBD (340 bytes) SSUIT.

2013 :

- Global system integration and validation
- 09/2013 : 1rst operationnal deployment (SAMOC program)

2014 :

- 06/01/2014 : 1rst messenger release -> Nominal functionning 100 % of data recovered from mid-Soth-Atalntic coming from 5000 m depth instrument récupération des données
- Since then : no more ?!
  - Hypothesis : trouble with electromagnetic release ➔ corrosion ➔ burnwire

Conclusion

• Wireless microwave link is feasible

• Iridium SBD transmission from small devices barely emerging is working

•Attractive system but…

• need to work on simle and robust release ➔ burnwire is a good candidate

Thanks for your attention