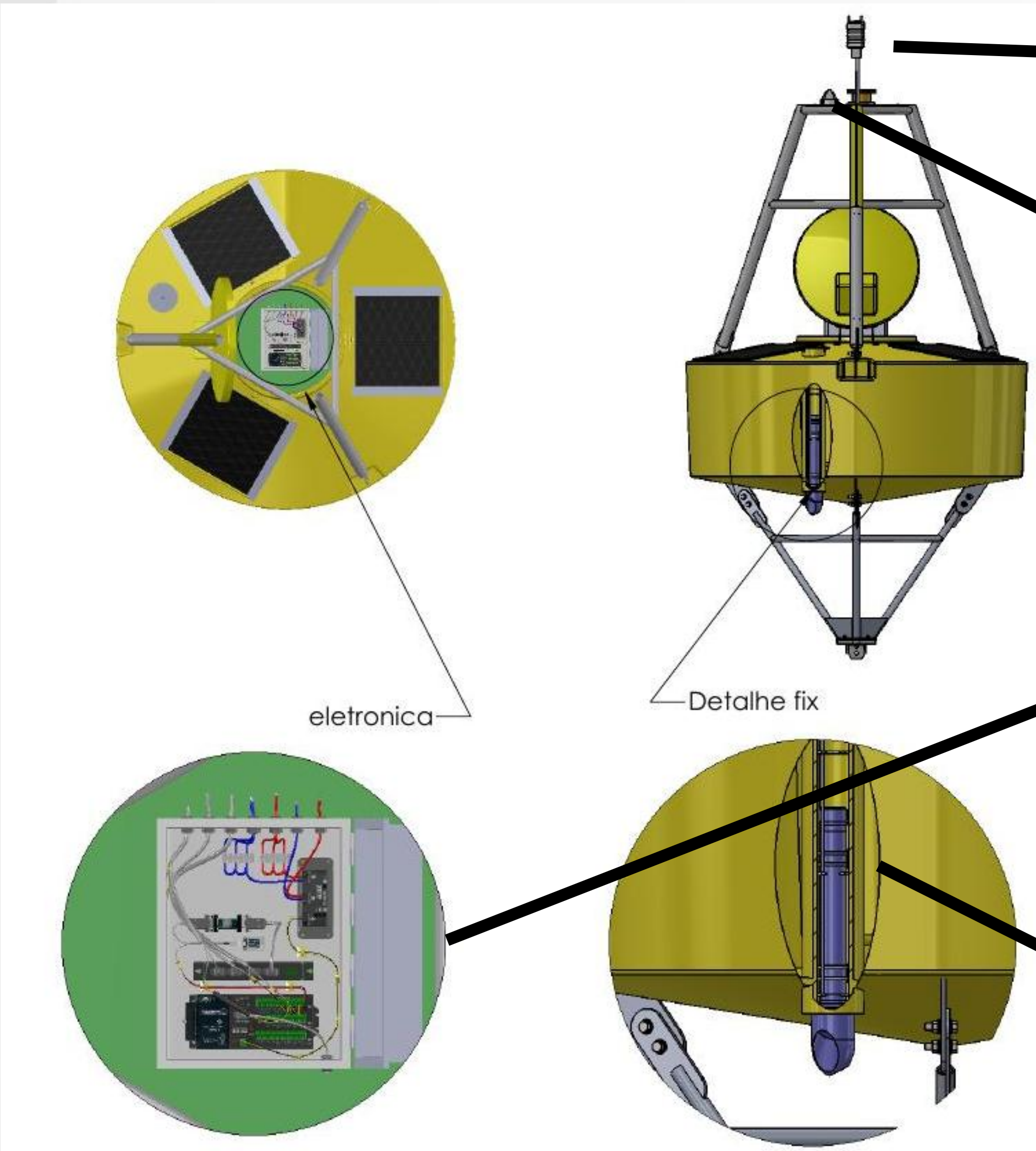
BUOY ELECTRONICS

CODE PROJECT

BMOP PROJECT

CODE PROJECT



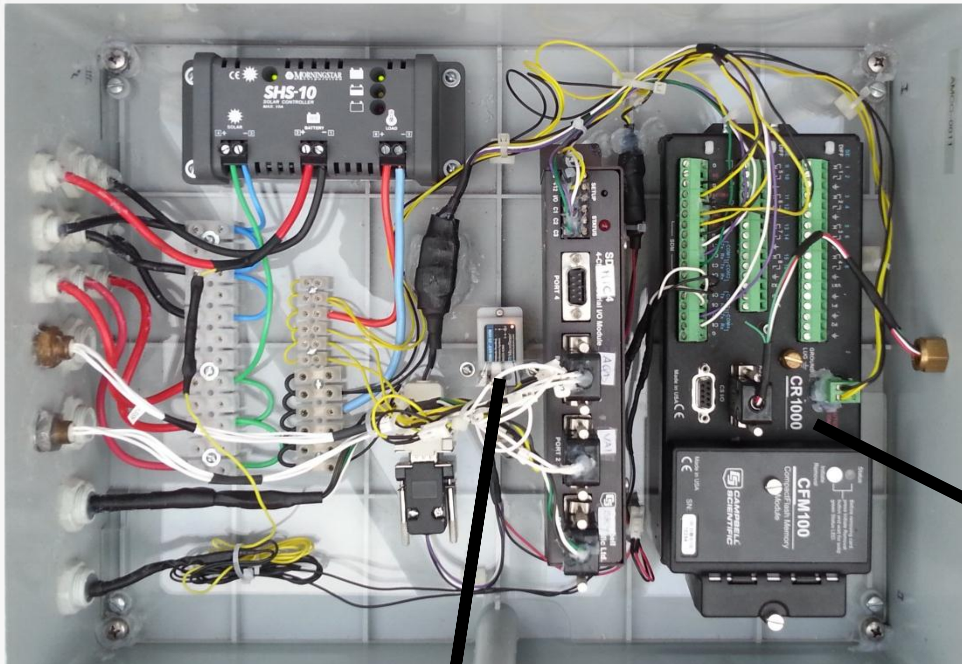
METEO STATION VAISALA WXT 520

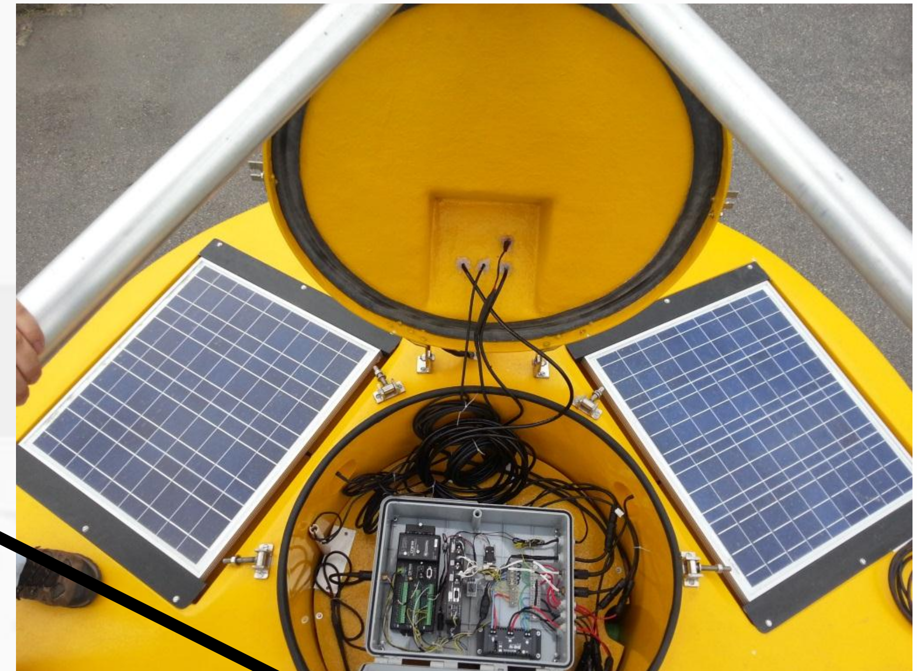
HOURLY DATA TRANSMISSION (Skywave IDP 690);

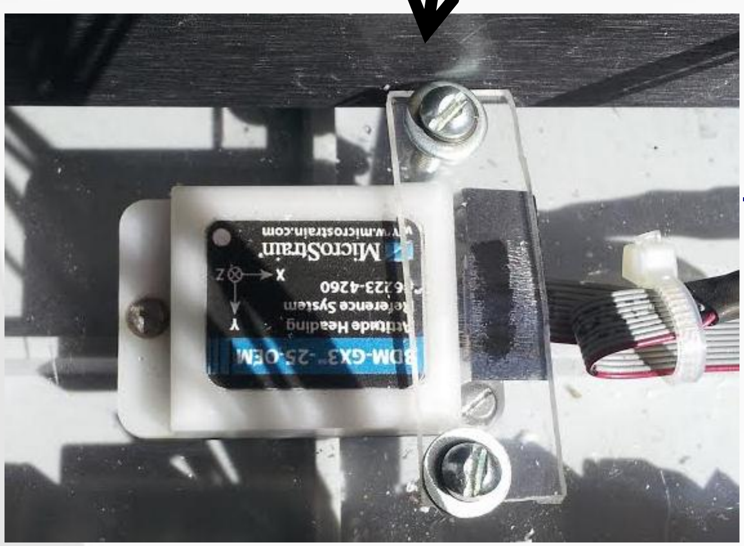
ELECTRONICS AND DIRECTIONAL WAVE SENSOR

CURRENT PROFILER NORTEK AQUADOPP 400 Khz

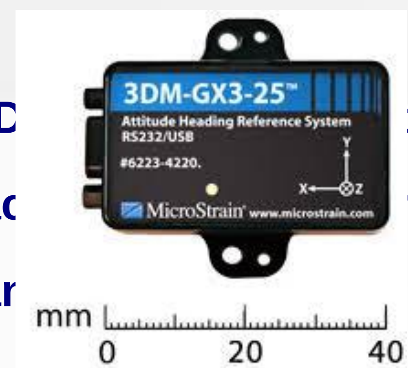
CODE'S electronics







- OEM 3D … rain:
  - 3 ac … o stab)
  - 3 ar
  - 3 magnetometers

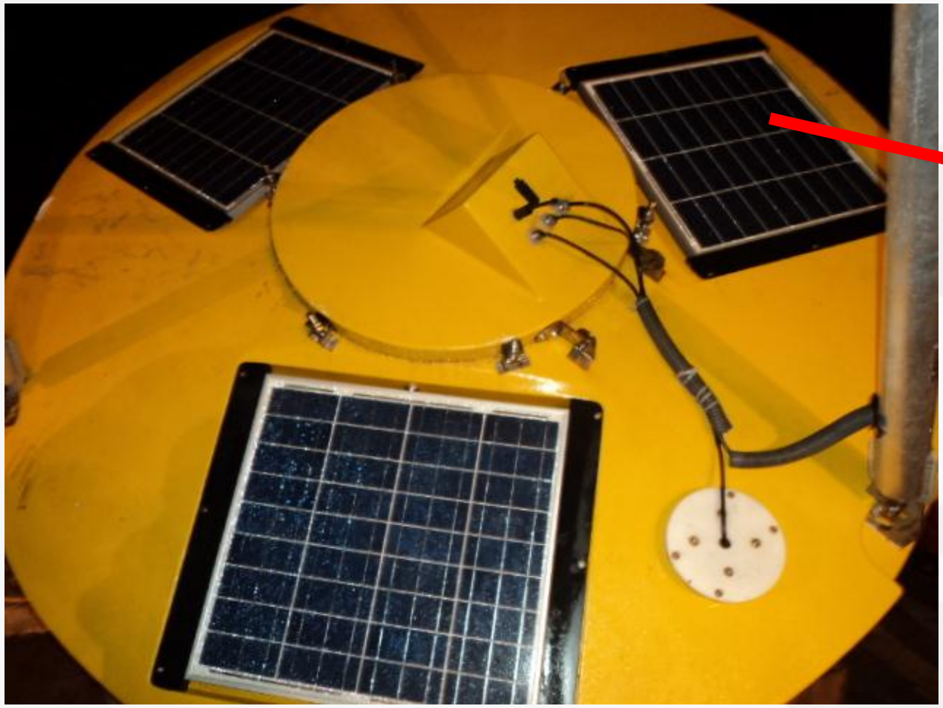


REPLACEMENT OEM BY A REGULAR SENSOR

CODE'S electronics

ENERGY SYSTEM

ENERGY SUPPLY FOR 30 DAYS WITHOUT SUN



3 SOLAR PANELS (45 W)

4 BATTERIES 110 A

SOLAR CHARGE CONTROL

BMOP PROJECT

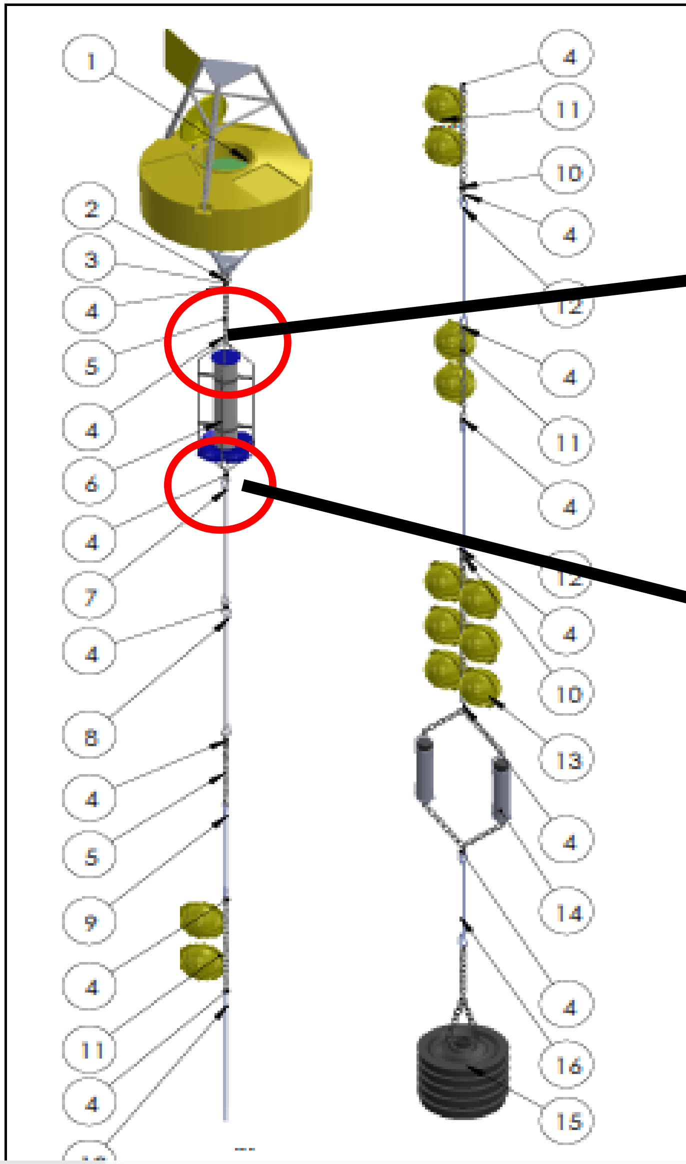
METEO STATION VAISALA WXT 520

HOURLY DATA TRANSMISSION
(Skywave IDP 690);

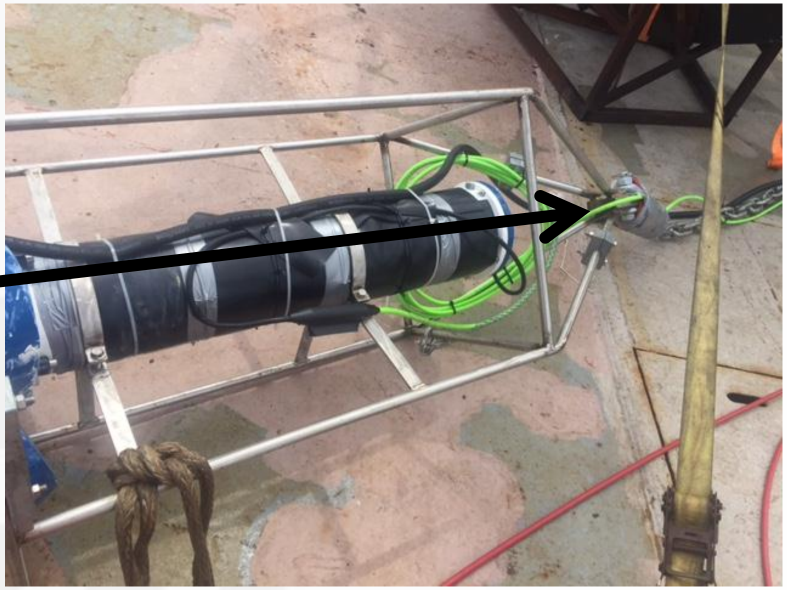
ELECTRONICS AND DIRECTIONAL
WAVE SENSOR

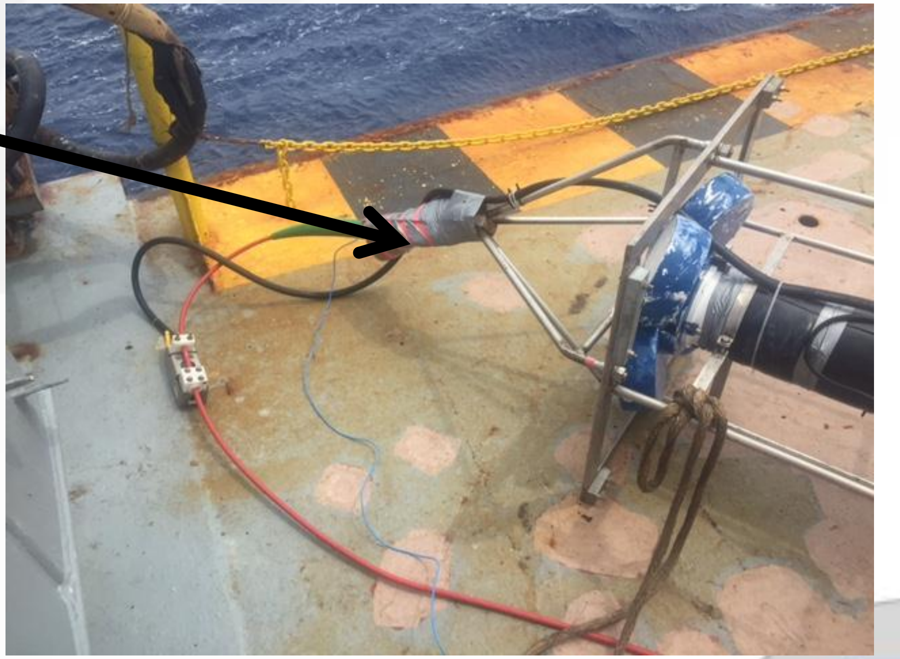
- INSTRUMENTED MOORING LINE:
- ADCP 75 Khz (REAL TIME),
- 10 TEMPERATURE SENSORS SBE 39 (REAL TIME DATA) USING INDUCTIVE MODEM SYSTEM,
- Wifi COMUNICATION (activated by satellite to save energy)
- BUOY CAM
- TRIAXYS AND SEAVIEW WAVE SENSOR

BMOP'S electronics



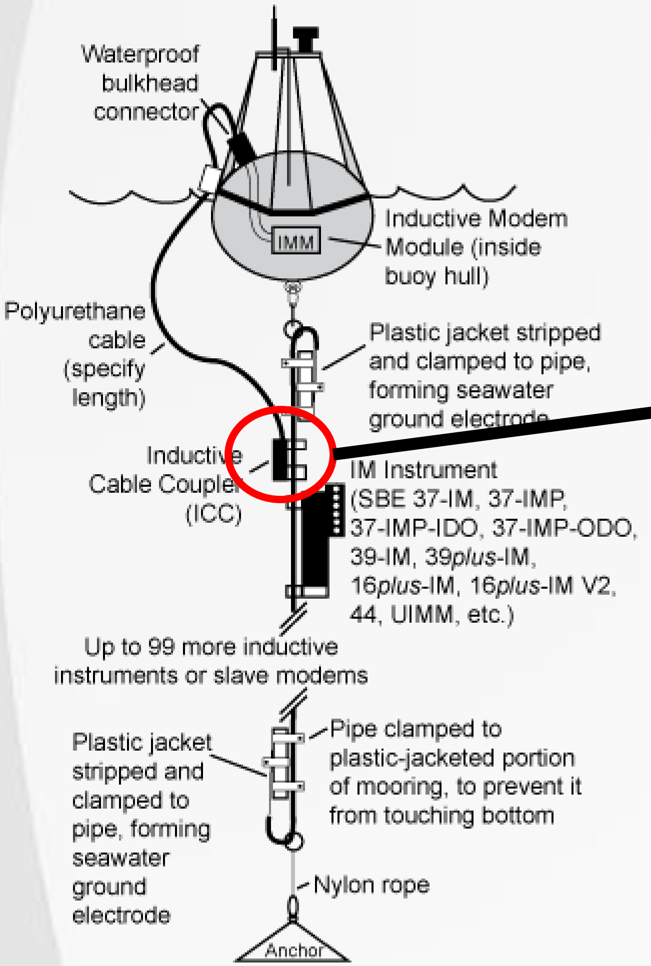
Nº DO ITEM	Nº DA PEÇA	QTD.
1	BMO	1
2	Manilha 1 pol	1
3	Anelão	1
4	Manilha 3-4 pol	20
5	Corrente 5 metros	2
6	Gaiola ADCP Long Ranger	1
7	Cabo de aço 150 metros	1
8	Cabo de aço 350 metros	1
9	Cabo poliester 200 m	1
10	Destorcedor	3
11	Conjunto Par Bola Benthos Alinhadas	3
12	Cabo poliester 500 m	[illegible]
13	3 pares bola Benthos (2 pares a cada 1.5m de corrente)	1
14	Conjunto liberadores acusticos	1
15	Poita 2 Ton	1
16	Cabo nylon 25 metros (20mm)	1
17	1,5 metros de corrente	1

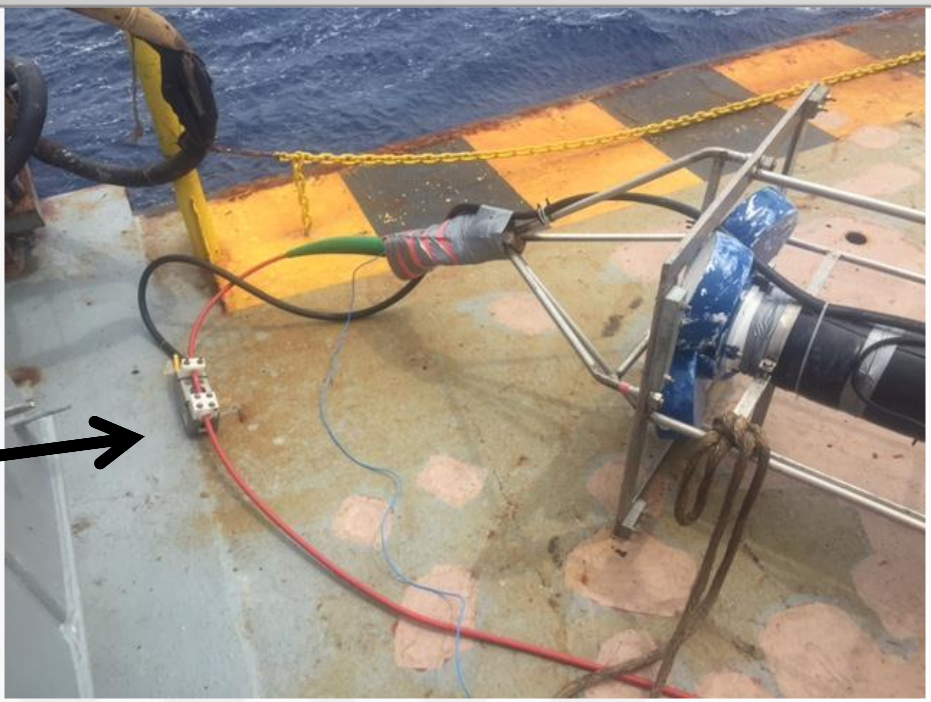




BMOP'S electronics: IM SYSTEM

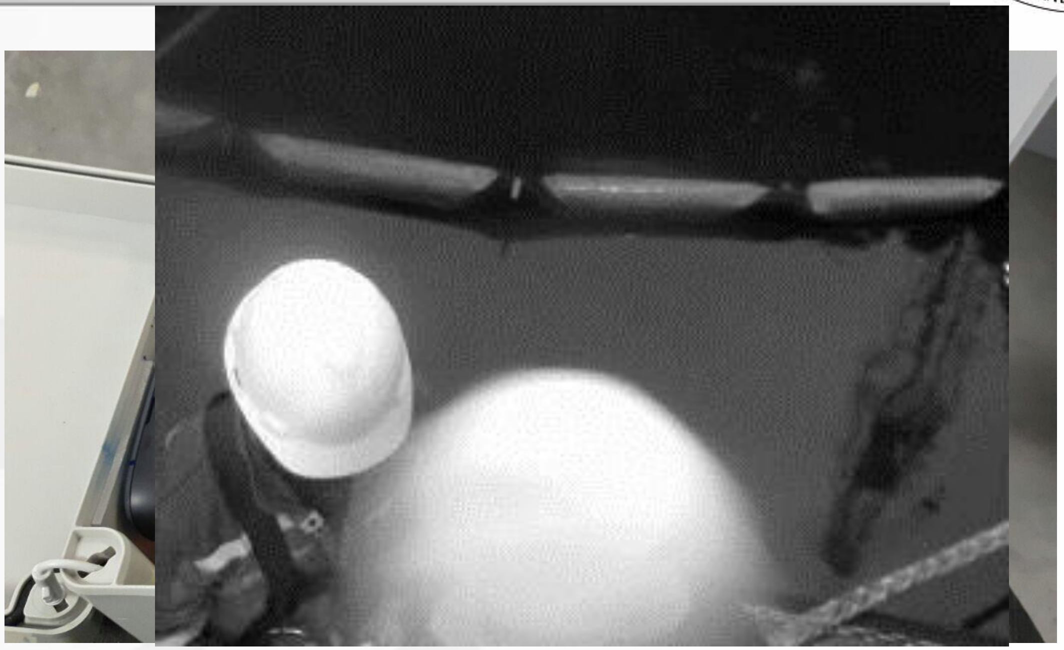
SBE INDUCTIVE MODEM SYSTEM



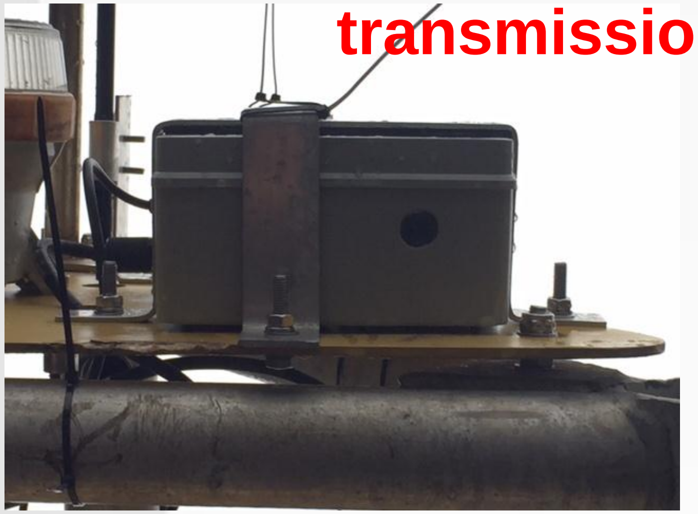


10 TEMPERATURE/PRESSURE SENSORS SBE 39

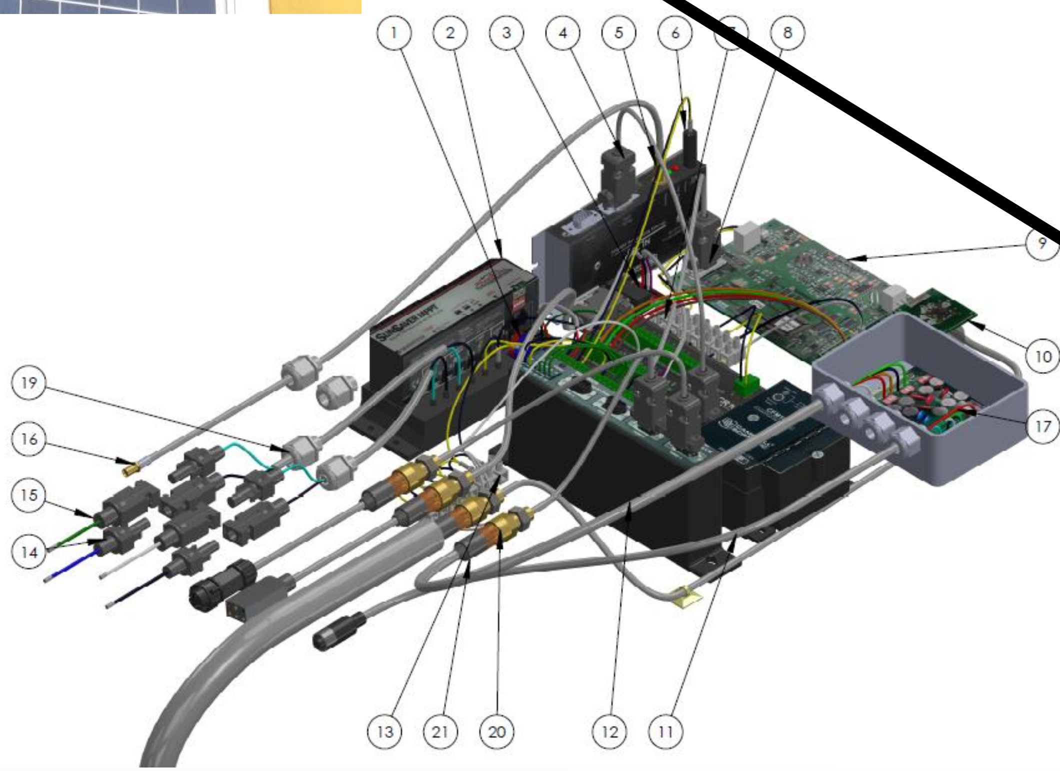
BMOP'S electronics: BuoyCam



Second skywave for photo transmission

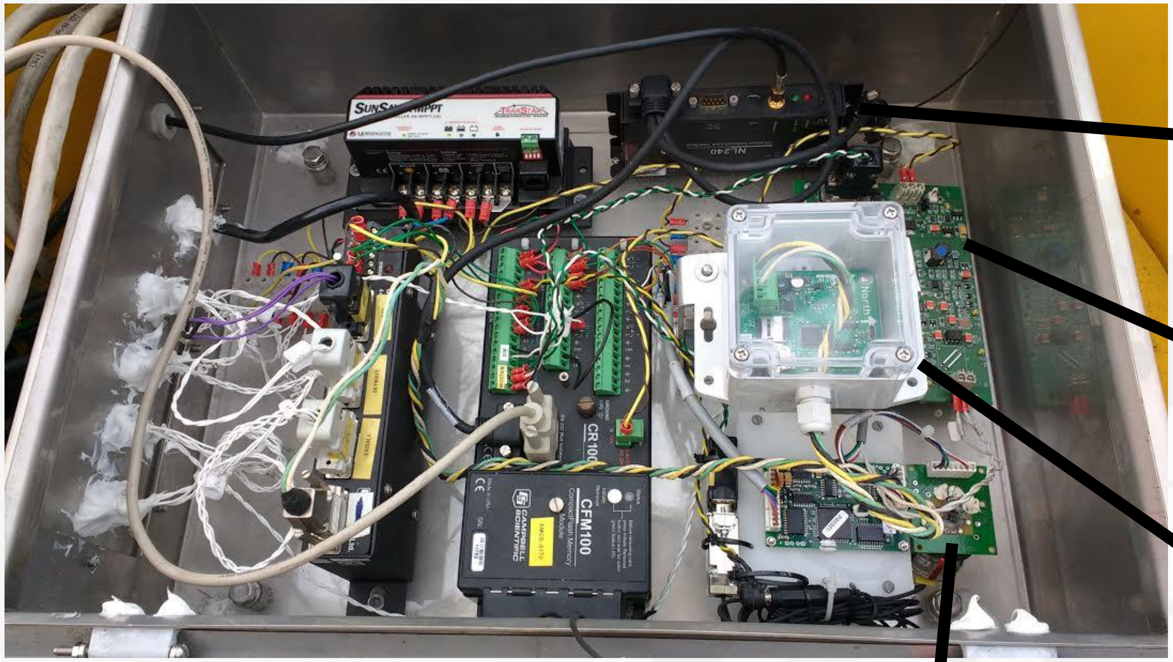


BMOP’S electronics



Microstrain AHRS 3DM-GX4-25

BMOP'S electronics



Wifi Campbell NL240 modem

SBE SBE SIM board (comunication with ICC)

SeaView Wave sensor (testing)

Compass KVH 100

DIRECTIONAL WAVE UNIT

WHY DEVELOP IT?

NDBC's Digital Directional Wave Module

Chung-Chu Teng, Richard Bouchard, Rodney Riley
NOAA National Data Buoy Center
Stennis Space Center, Mississippi 39529, U.S.A.

Theodore Mettlach, Richard Dinoso, Joel Chaffin
Science Applications International Corporation
NOAA National Data Buoy Center
Stennis Space Center, Mississippi 39529, U.S.A.

Enhancements to NDBC's Digital Directional Wave Module

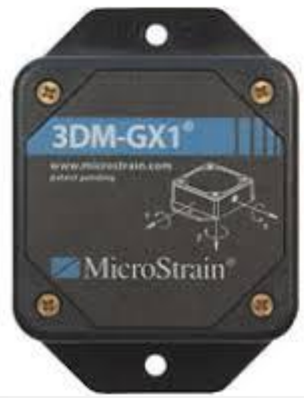
Rodney Riley[1], Chung-Chu Teng[1,2], Richard Bouchard[1], Richard Dinoso[3] and Theodore Mettlach[3]

[1]NOAA National Data Buoy Center
Stennis Space Center, Mississippi 39529, U.S.A.

[2]Present affiliation: NOAA Center for Operational Oceanographic Products and Services
1305 East-West Highway
Silver Spring, Maryland 20910-3281, U.S.A.

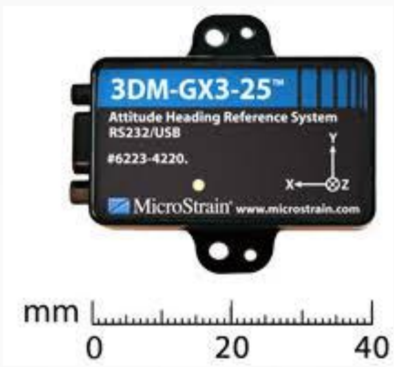
[3]Science Applications International Corporation
NOAA National Data Buoy Center Technical Services Contract
Stennis Space Center, Mississippi 39529, U.S.A.

NOAA /NDBC : Microstrain 3DM - GX1 (discontinued)



USED IN BMOP DIRCTIONAL WAVESENSOR (different communication protocol and uses Kalman filtering for reduce low frequency noise)

SENSORS USED IN CODE PROJECT (discontinued)



(also discontinued)

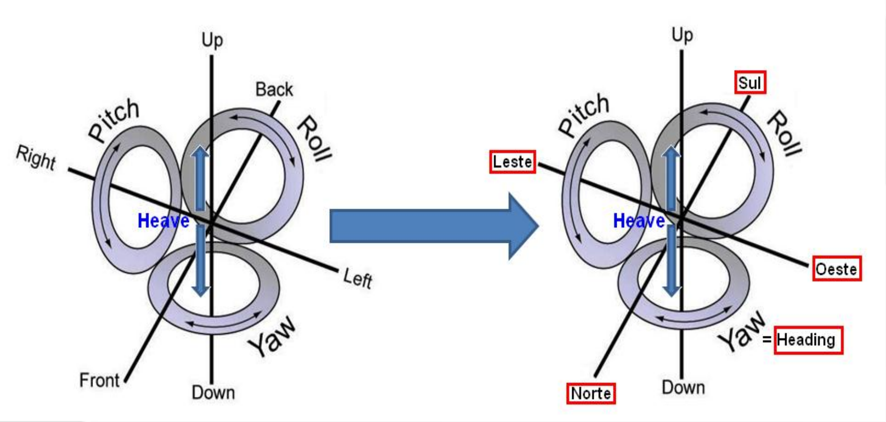
DIRECTIONAL WAVE UNIT

DIRECTIONAL WAVE UNIT
PROCESSING

NDBC Technical Document 96-01

Nondirectional and Directional Wave Data Analysis Procedures

Stennis Space Center
January 1996



INPUT DATA

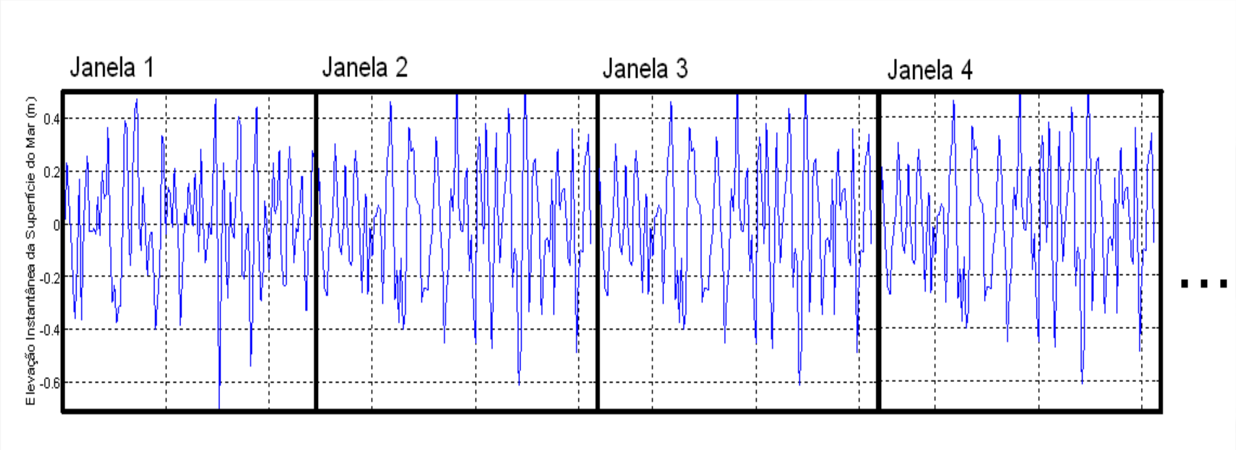
TRUE VERTICAL ACCELERATION (**gyro stab**) — pitch (incli EW) — roll (Incli NS)

1024 linhas

TRUE VERTICAL ACCELERATION	pitch (incli EW)	roll (Incli NS)
+0.420	-0.012	+0.073
+0.250	+0.014	+0.091
+0.310	+0.045	+0.053
+0.360	+0.070	+0.031
+0.370	+0.030	+0.054
+0.300	+0.018	+0.022
+0.080	+0.014	-0.003
-0.460	+0.049	+0.037
-1.040	+0.063	+0.076
-1.290	+0.072	+0.084
-1.350	+0.053	+0.118
-0.670	+0.018	+0.057
+0.230	-0.034	+0.085
1.100	-0.020	+0.003
1.450	+0.022	+0.028
1.470	+0.021	+0.013
1.210	+0.005	+0.010
+0.680	+0.008	+0.077
-0.220	+0.070	+0.072
-0.930	+0.069	+0.055
-1.300	+0.012	+0.075
-1.390	+0.040	+0.069
-1.300	+0.057	+0.089
-0.850	+0.022	+0.086
-0.190	-0.019	+0.069
+0.530	-0.014	+0.078
+0.960	+0.011	+0.011
1.110	+0.031	+0.024
1.250	+0.055	+0.052
1.290	+0.020	+0.011
1.020	-0.017	-0.008
+0.210	-0.025	+0.042

DIRECTIONAL WAVE UNIT

DIRECTIONAL WAVE UNIT PROCESSING



...

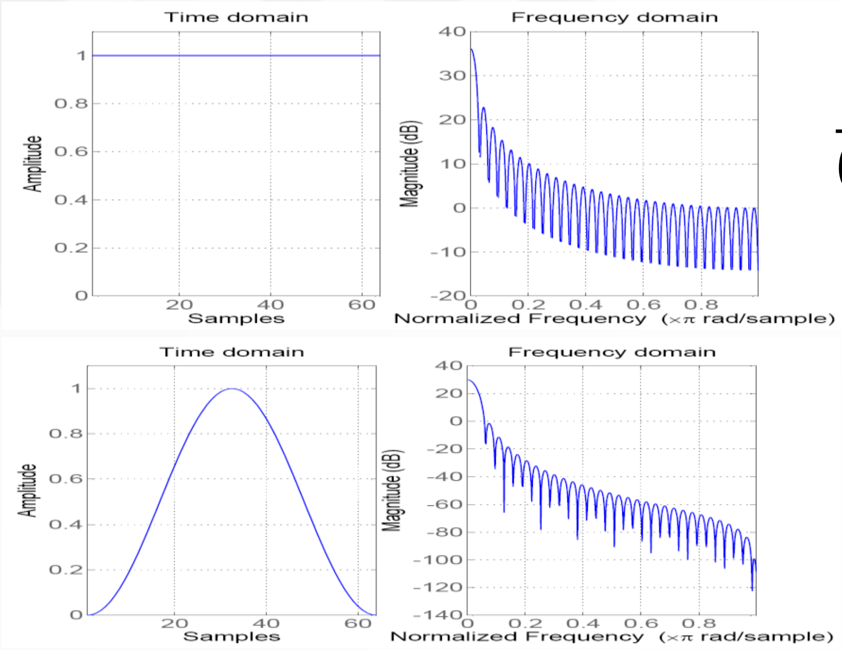
Hanning window

TRUE VERTICAL ACCELERATION (**gyro stab**)

$$A_1 = \frac{1}{k}\frac{Q_{12}(\omega)}{C_{11}(\omega)}$$

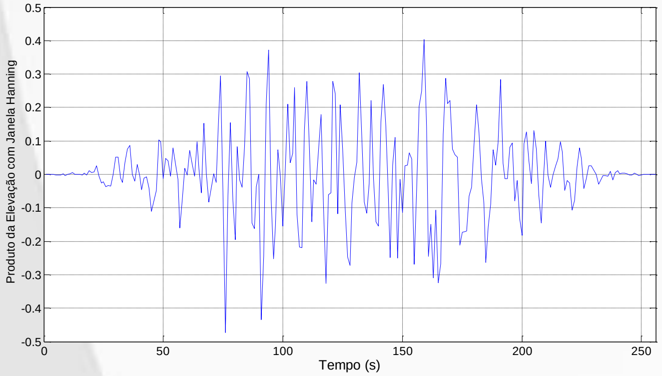
$$B_1 = \frac{1}{k}\frac{Q_{13}(\omega)}{C_{11}(\omega)}$$

First FFT - 0 a 128
Second FFT - 128 a 256
...
Total dof 8 FFTs with 128 points



$$\overline{\theta}_{\Delta f} = \tan^{-1}\left(\frac{Q_{13}}{Q_{12}}\right)$$

MEAN DIRECTION BASED IN QUADRATURE SPECTRUM



DIRECTIONAL WAVE UNIT

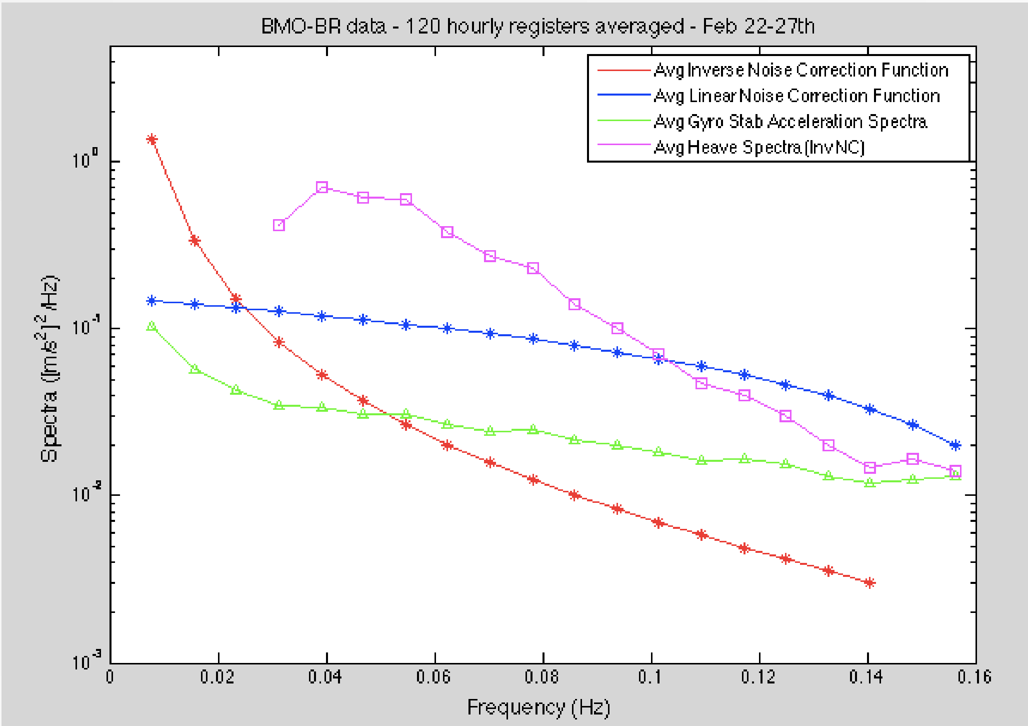
- mooring influence on data

- Noise Correction function:
  - subtractive
  - inverse
  - adjustable for mooring line / depth / buoy hull

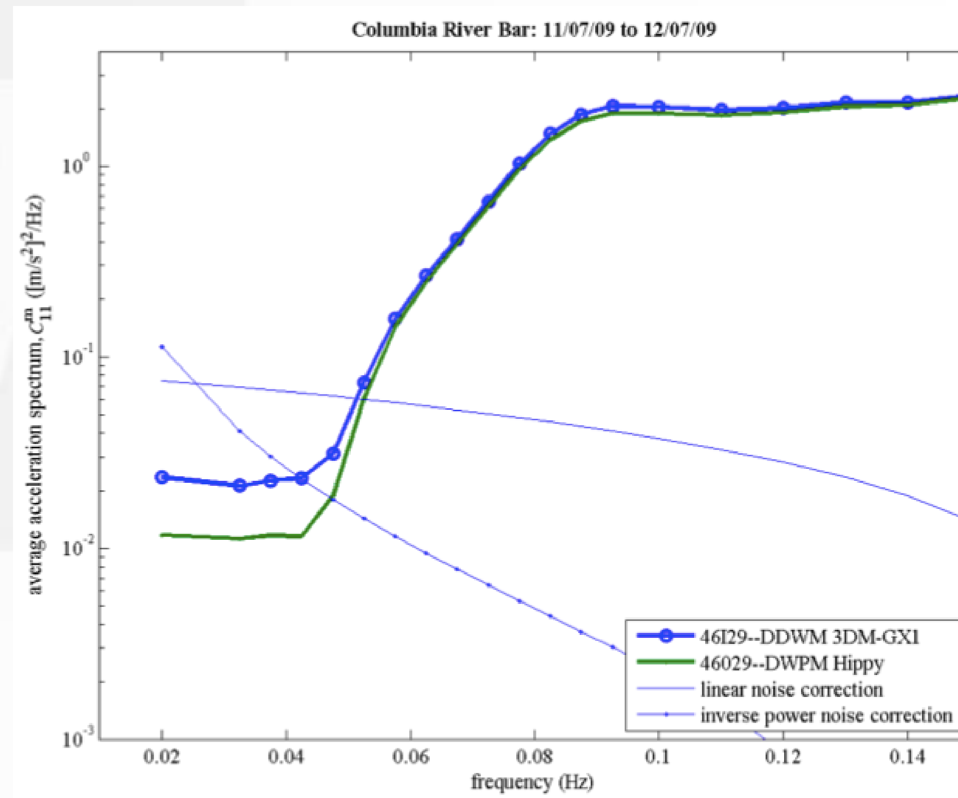
$$C_{11}(f) = \frac{C_{11}^{m}(f) - NC(f)}{\left(R^{hH}\right)^{2}(2\pi f)^{4}}$$

$$NC_{(inverse\ power)}(f) = a\left[\frac{C_{11}^{m}(b)}{f^{d}} - \frac{C_{11}^{m}(c)}{c^{d}}\right];\ f \leq c$$

DIRECTIONAL WAVE UNIT



- **Empirical noise correction created using BMO (CODE PROJECT) WAVE UNIT Data**



- **vertical accelerometer spectra low energy**
- **gyro stabilized accelerometers time series**

DIRECTIONAL WAVE UNIT

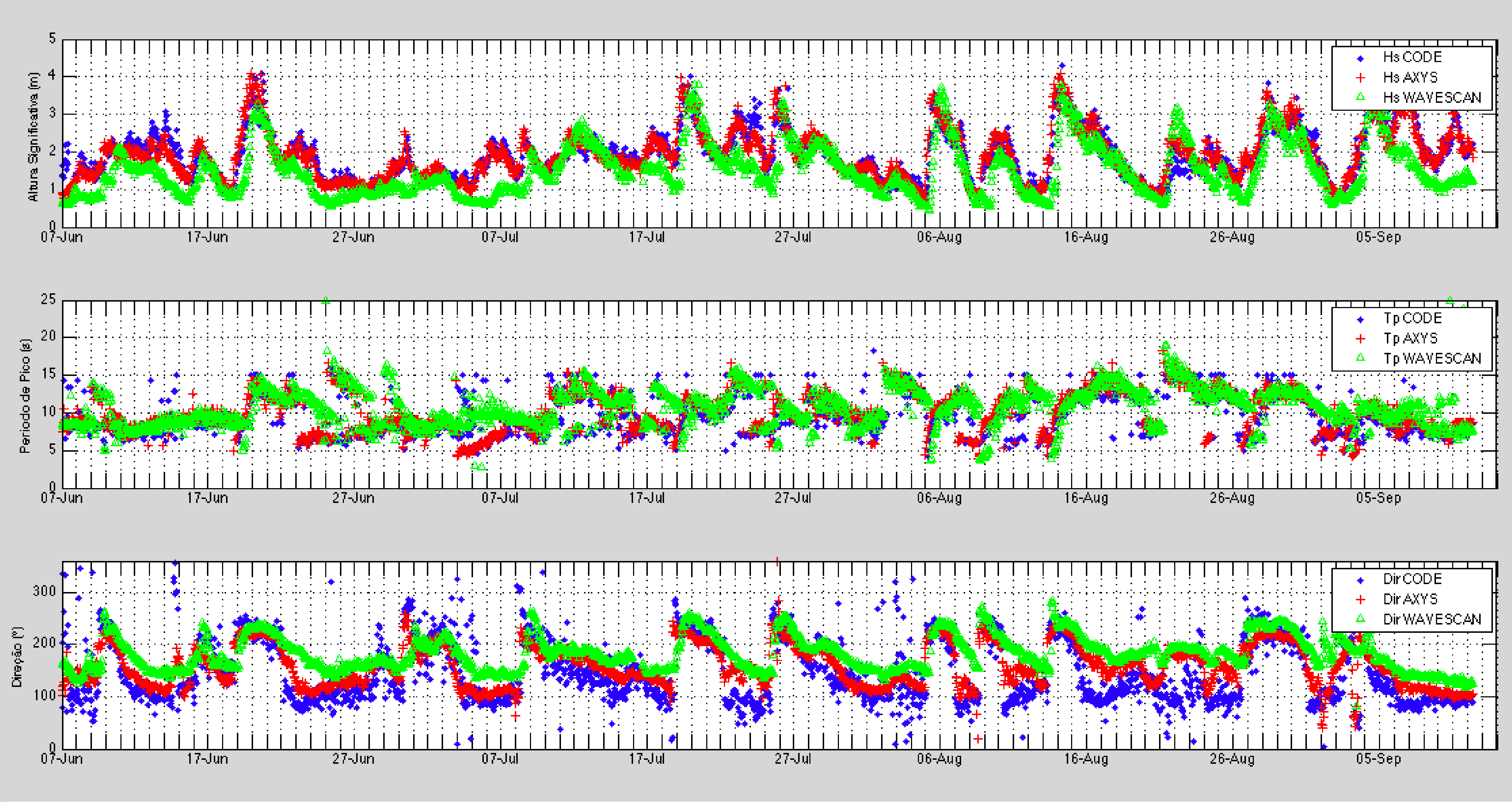
- Noise Correction function wasn’t enough. An empirical correction based in a referential/comercial wave unit module was necessary.

AN EMPIRICAL CORRECTION FUNCTION WAS CREATED AND PUT IN THE DATALOGGER'S ALGORITHM FOR CALCULATING AND SEND REAL TIME WAVE DATA

A miniTriaxys wave unit was installed inside the buoy payload

4 months collecting simultaneolsly data with Microstrain and Triaxys (CODE project)

DIRECTIONAL WAVE UNIT



Best results obtained in CODE project. The Wavescan buoy was located far from BMOBR02. Even so, the correlation was high. (using Microstrain 3DM-GX3)

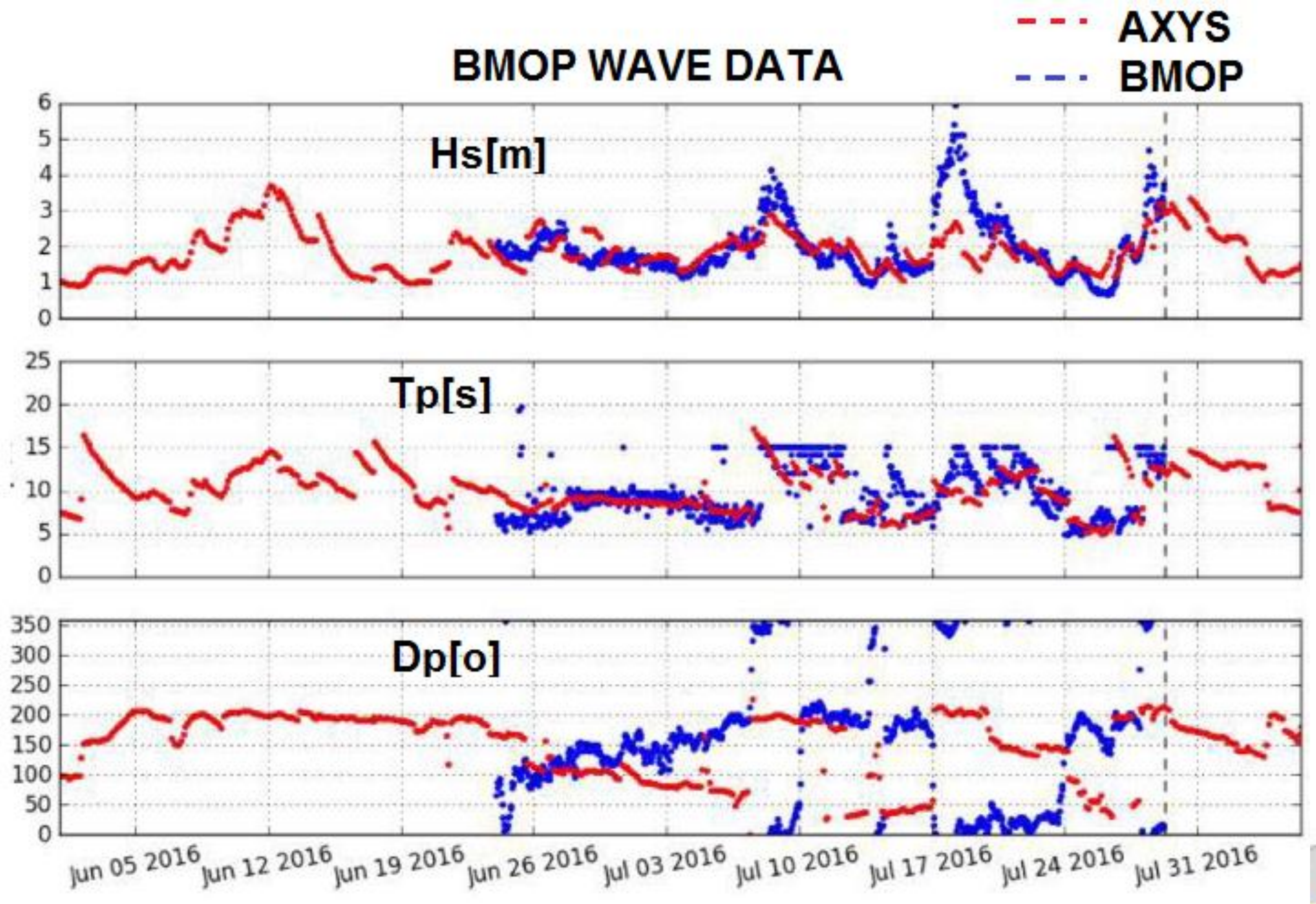
DIRECTIONAL WAVE UNIT

The same experiment was done in BMOP project. The 1D (Hs,Tp) data had a high correlation but not for directional data (Dp);

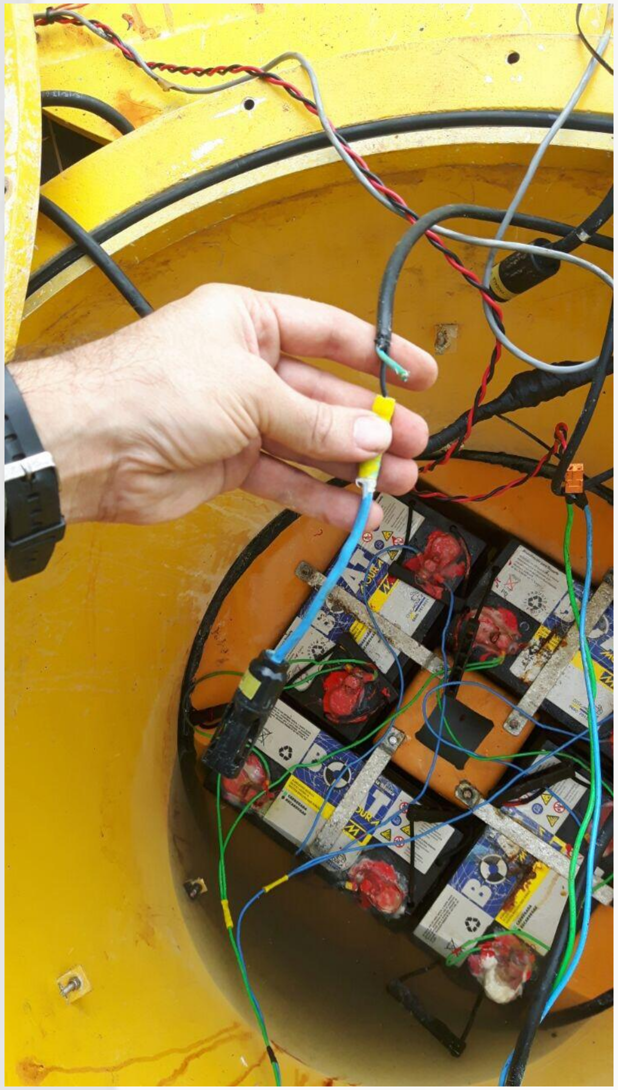
Why? Maybe because BMOP uses Microstrain 3DM-GX4 with a different protocol

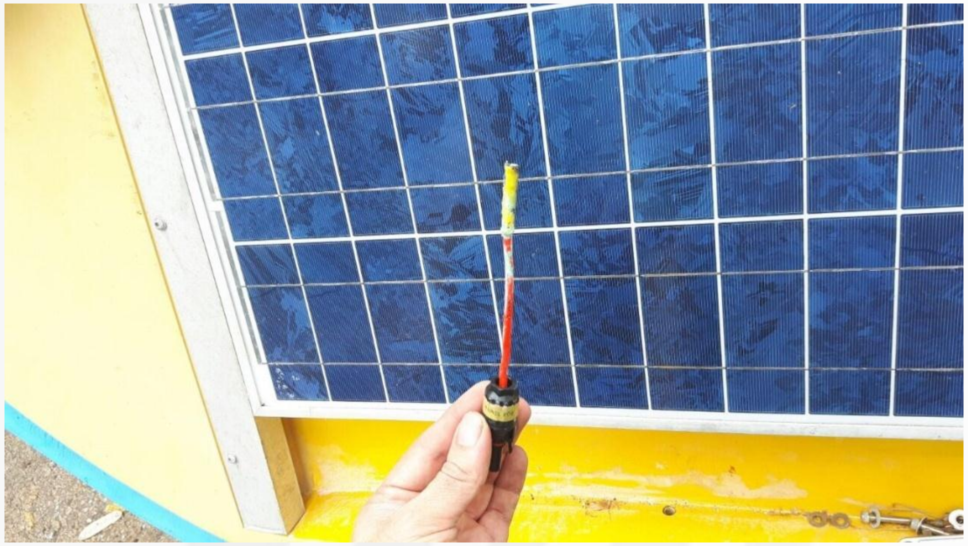
Maybe the influence of payload batteries in Microstrain gyro compass

Still under investigation !!!



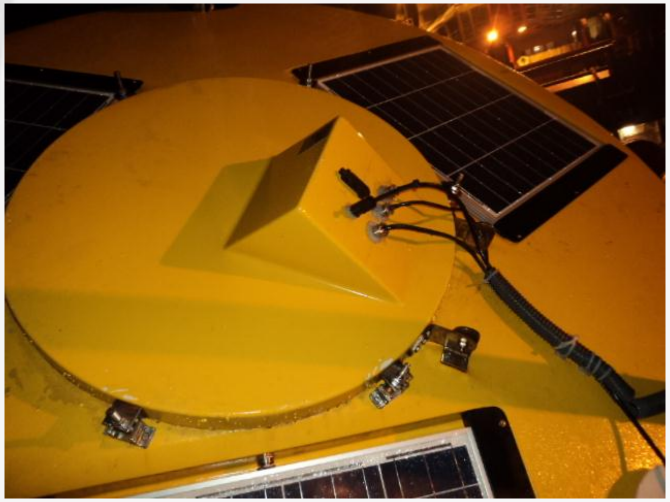
IMPROVEMENTS MADE DURING THE PROJECTS

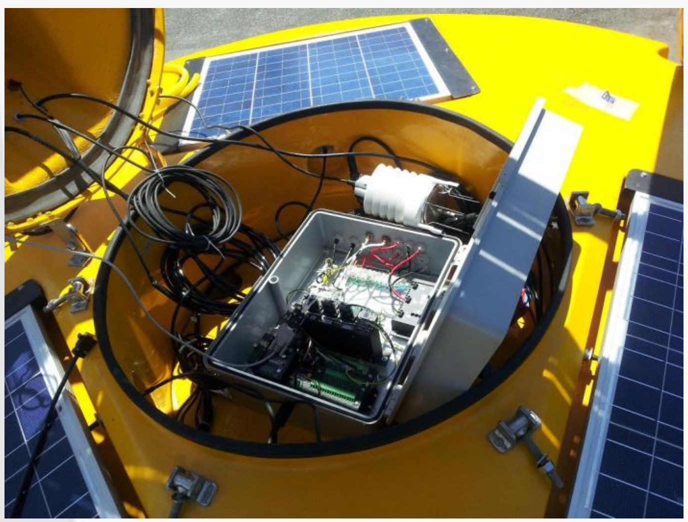


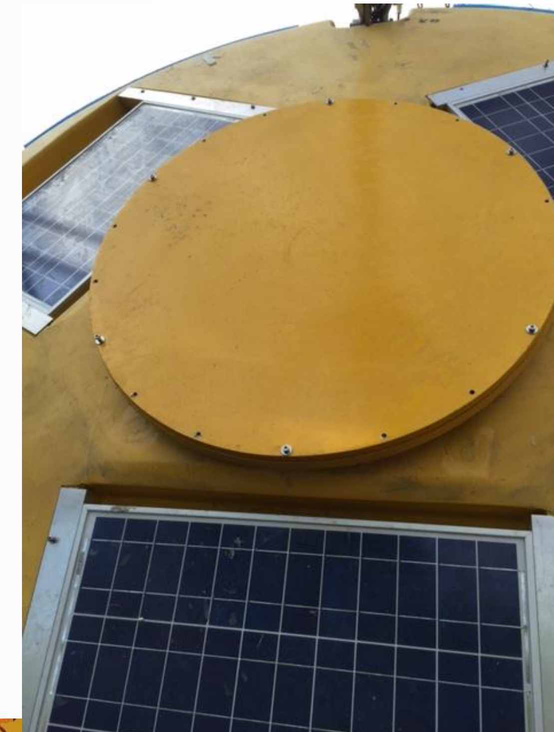


- Corrosion in battery terminals;
- Special care (protection) in this terminals by applying waterproofing resin

IMPROVEMENTS MADE DURING THE PROJECTS

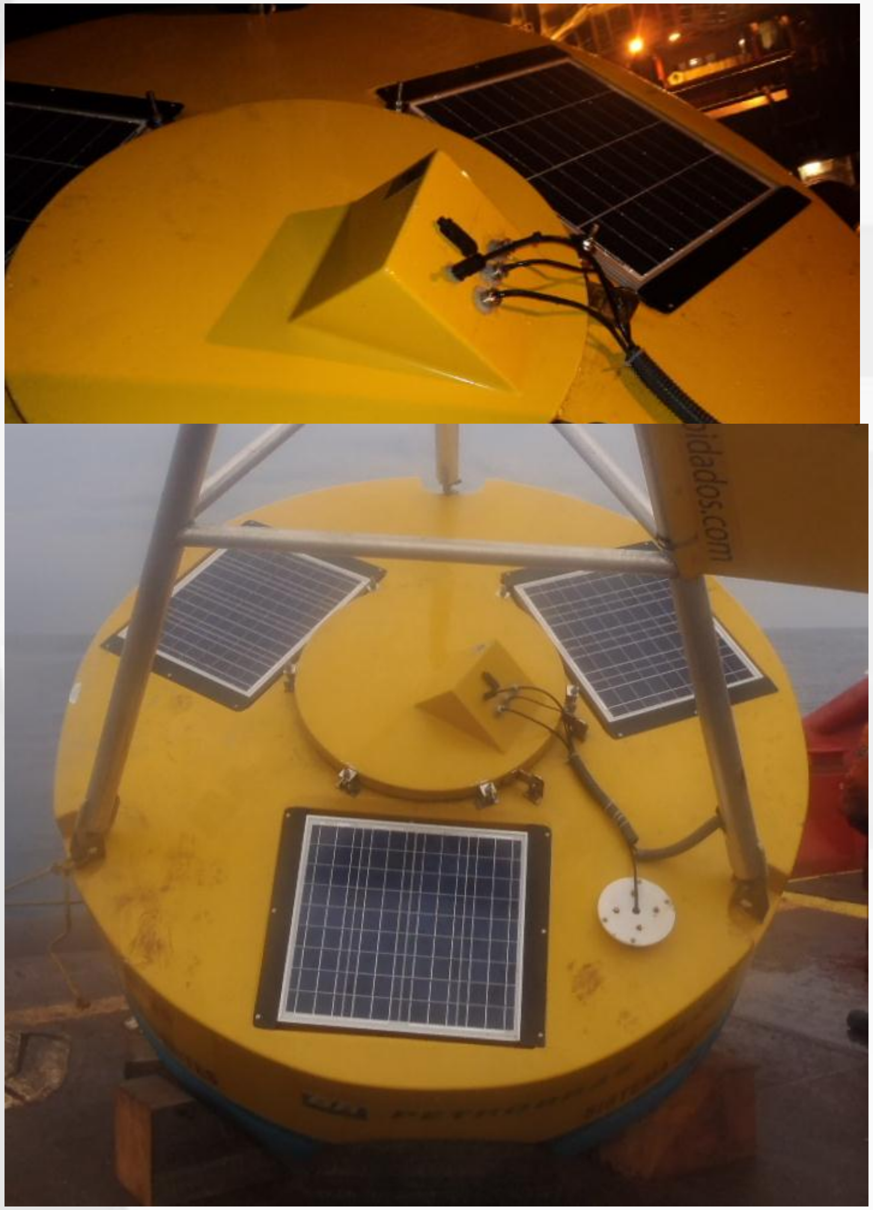






Payload cap changed for flange with o'ring to prevent salt water entering

IMPROVEMENTS MADE DURING THE PROJECTS

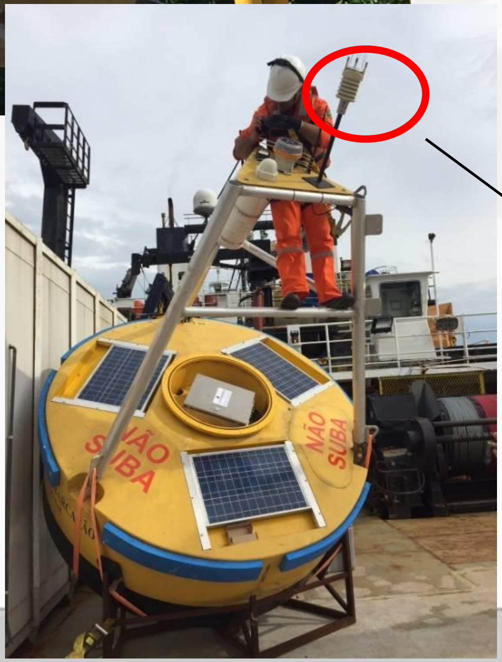


No exposed cables in buoy surface to prevent wire damage

hidden and protected cables

IMPROVEMENTS MADE DURING THE PROJECTS

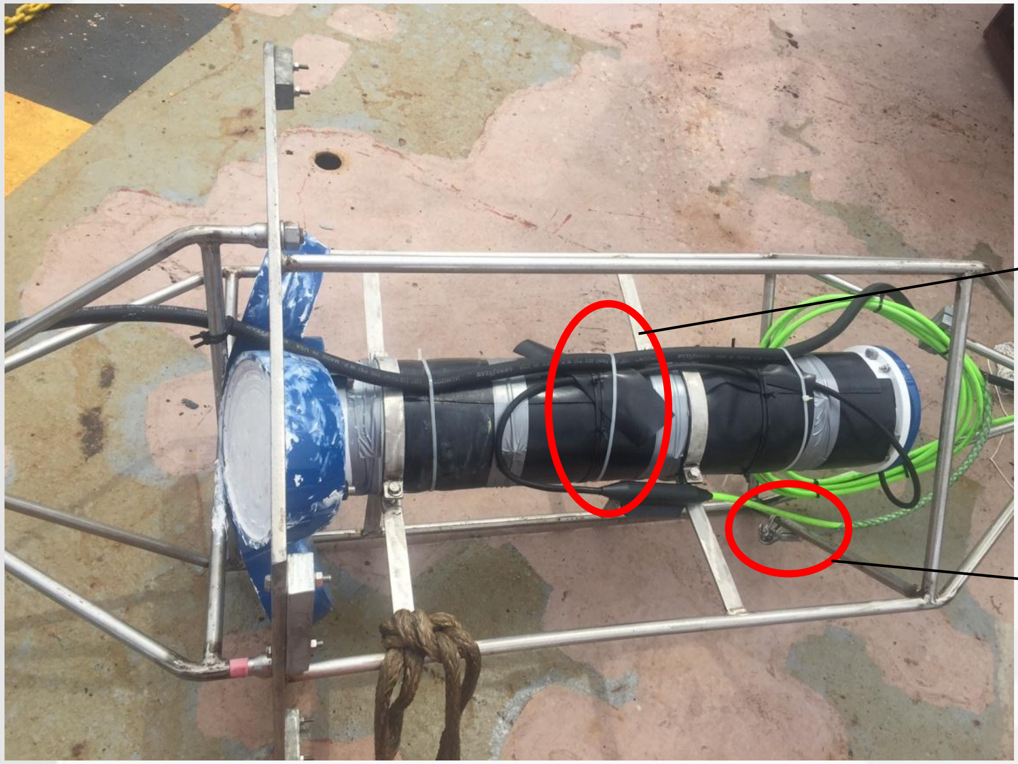
Wifi connection with buoy electronics for configuration during the cruise and after deployment for checking if the buoy is operational. Activated by satellite.



2 independent tracking systems for locate the buoy in case of the electronics death

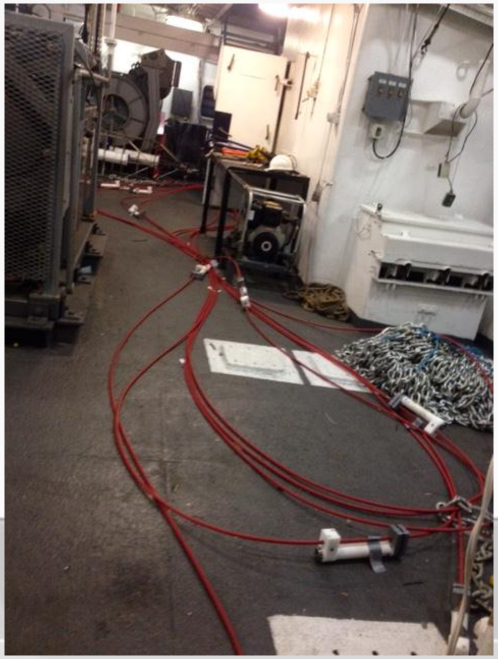
Take off the meteo station before buoy launching if possible

IMPROVEMENTS MADE DURING THE PROJECTS



do not use plastic clamp because it cut the communication cables with the buoy natural movement

chinese finger is used to prevent cable tension to be transferred to communication non-armored cable



Test the inductive modem transmission before the deployment.

Inspect the jacket cable. It can be damaged during the transportation

IMPROVEMENTS MADE DURING THE PROJECTS

Careful is necessary in passing ADCP's and IM's cables through the moonpool to prevent tension with the buoy spin.

Chenese finger attached to the armored cable

In case of communication cable cut, the electronics can't stop working. Also, the sensors must keep collecting and recording data internally even not sending real time data anymore.

Electronics must have a surge protection system.

Perspective of Phase 3

- Partnership with Navy for further development and operation;
- Compliance with GTS and BNDO data quality standards;
- Final Field Qualification (TRL-7)

Field Qualified	6	**System Installed** (Production system installed and tested)	Meets all the requirements of TRL 5; production unit (or full scale prototype) built and integrated into intended operating system; full interface and function test program performed in the intended (or closely simulated) environment and operated for less than three years; at TRL 6 new technology equipment might require additional support for the first 12 to 18 months	7
	7	**Field Proven** (Production system field proven)	Production unit integrated into the intended operating system, installed and operating for more than three years with acceptable reliability, demonstrating low risk of early life failures in the field	8, 9

Source: modified from API 17N Scale

OBRIGADO!

Thank you