

# Acoustic positioning: First results

S. Viola  
Rome, 21/06/2013

## NEMO Phase II -SMO Acoustic positioning system

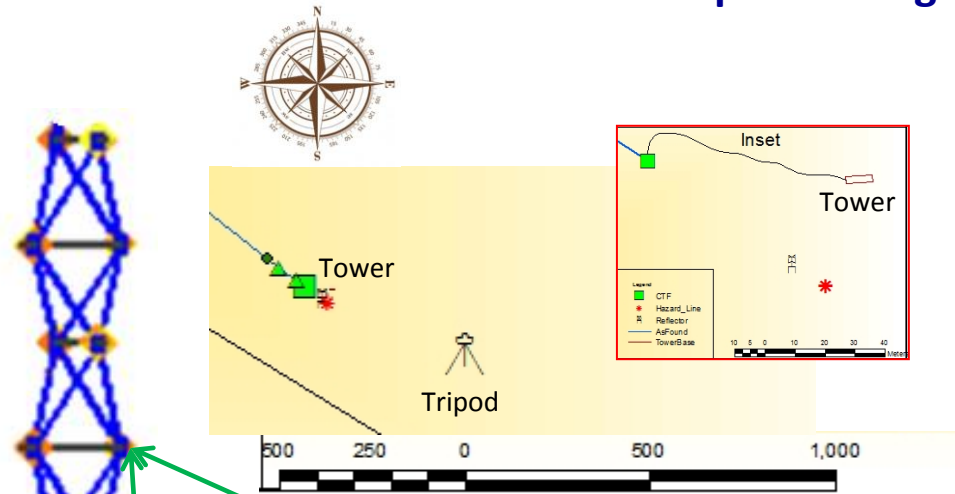
### FACTS:

- Standard ACSA-LBL calibration procedure:  
Measure distance between LBL-beacons with ROV and ACSA-calibration tool (1 cm)  
**Calibration tool is lost**
- Standard ACSA-LBL calibration monitoring:  
Acoustically measure distance between LBL and tower base (monitoring station): ToE  
**Monitoring station is broken**
- LBL: 1 Beacon deployed after tower unfurling, 400 m SE wrt tower

**We will not have target (accurate!!!) positioning**

# NEMO Phase II -SMO

## Acoustic positioning system

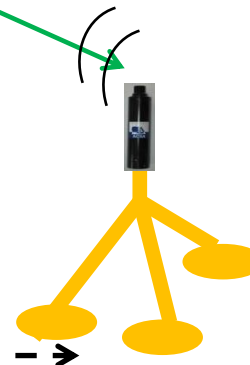


Point Name	WGS-84		UTM 33N		Depth	Heading
	Latitude	Longitude	Northing	Easting		
CableFound	N 36° 18' 49.46"	E 015° 57' 15.04"	4019169.87	585657.16	3451.4	N/A
Connectors	N 36° 18' 21.14"	E 015° 57' 51.41"	4018306.52	586572.77	3460.1	N/A
StrainRelief	N 36° 17' 50.73"	E 015° 58' 38.17"	4017381.22	587748.43	3461.3	N/A
CableSplice	N 36° 17' 49.94"	E 015° 58' 39.56"	4017357.11	587783.21	3461.3	N/A
CableSplice1	N 36° 17' 48.80"	E 015° 58' 41.40"	4017322.32	587829.5	3461.2	N/A
CTF	N 36° 17' 48.34"	E 015° 58' 42.25"	4017308.51	587850.81	3462.1	N/A
TowerBase	N 36° 17' 48.12"	E 015° 58' 45.06"	4017302.54	587920.93	3461.4	266.1°
Tripod	N 36° 17' 42.41"	E 015° 59' 00.00"	4017130.28	588285.42	3461.3	N/A
Reflector	N 36° 17' 47.22"	E 015° 58' 44.16"	4017274.53	587896.68	3462.1	N/A
Hazard_Line	N 36° 17' 46.97"	E 015° 58' 44.61"	4017266.96	587910.14	3461.8	N/A

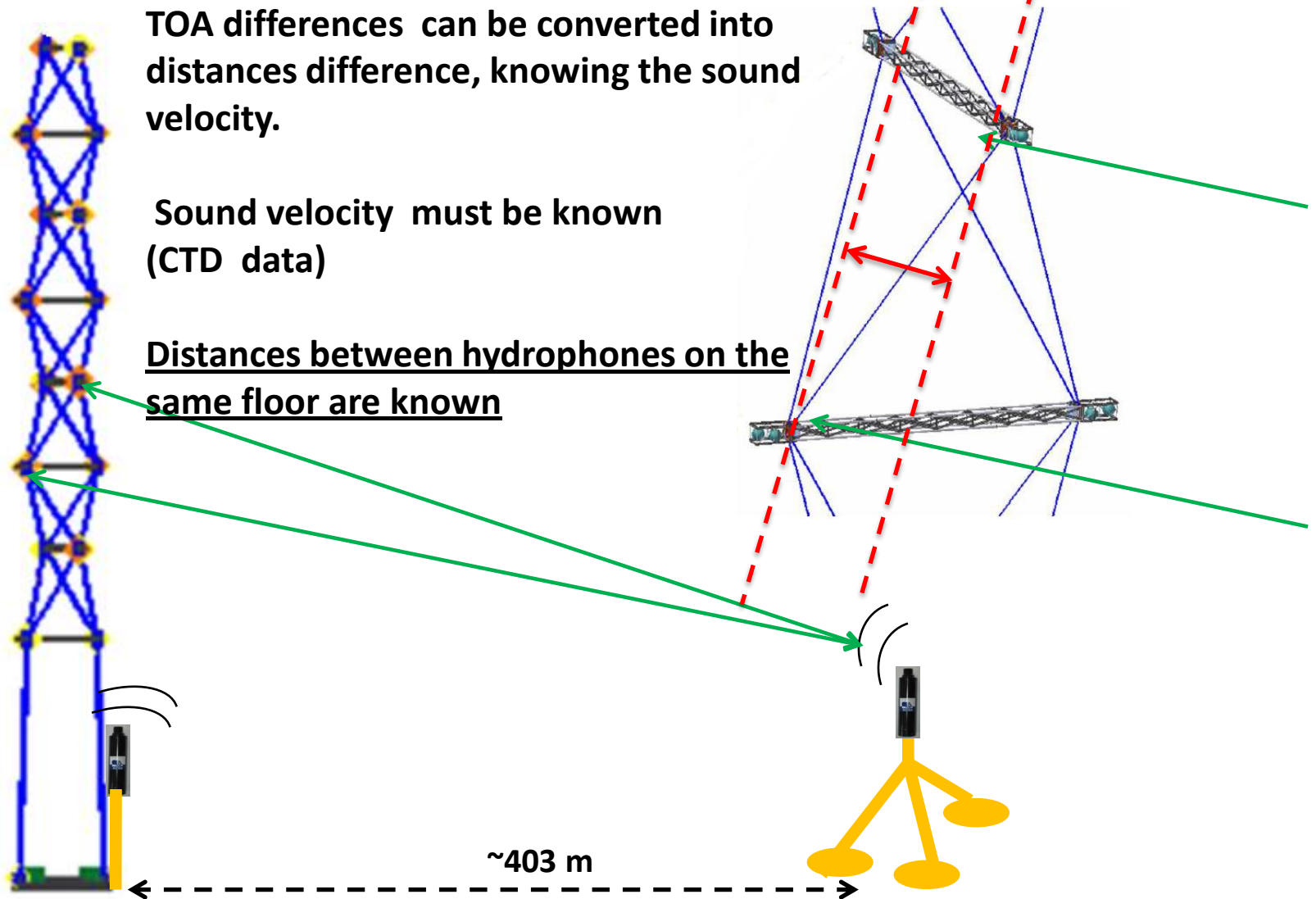
**Autonomous beacon**  
(not time synchronised with the apparatus)

AsFound Range / Azimuth Table		
Description	Range	Azimuth
CTF - Tower	70.4	94.9°
Tower - Hazard_Line	37.2	106.0°
Tower - Tripod	403.1	115.3°
Tower - Reflector	35.6	218.2°
AsFound CTF - RPL CTF	528.6	148.9°

~403 m

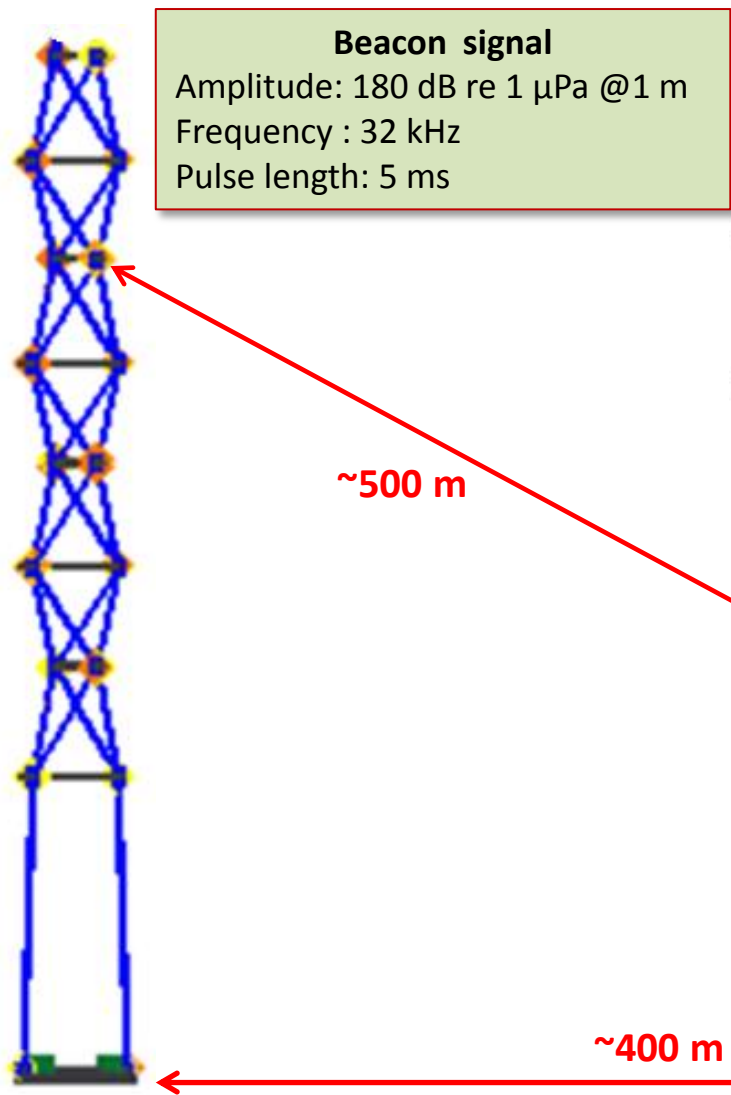


# NEMO Phase II -SMO Acoustic positioning system

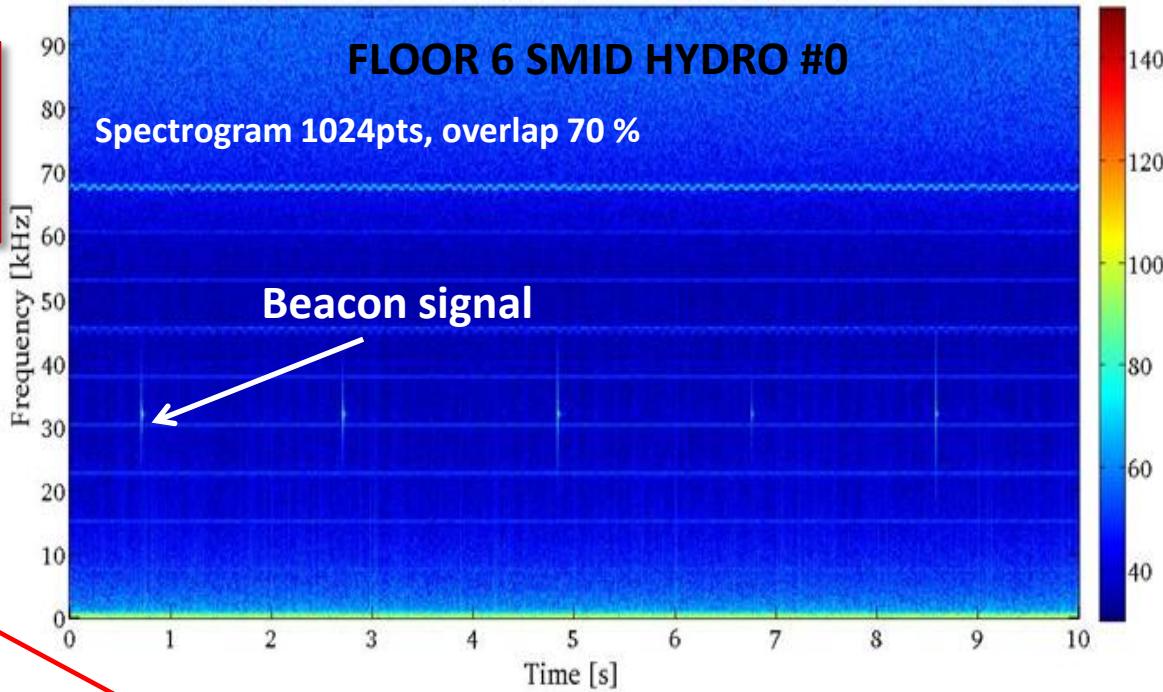


# NEMO Phase II -SMO

## Acoustic detection: status

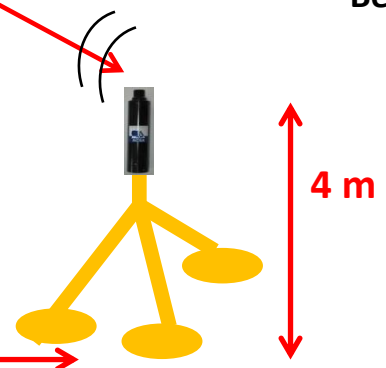


**Beacon signal**  
 Amplitude: 180 dB re 1  $\mu$ Pa @1 m  
 Frequency : 32 kHz  
 Pulse length: 5 ms



**Beacon 2 Time Spectral Spread Code**

Pulse 1	0.000 s
Pulse 2	1.891 s
Pulse 3	3.886 s
Pulse 4	6.011 s
Pulse 5	7.928 s
Pulse 6	9.754 s
Rate	11.684 s



# Acoustic positioning MATLAB Code

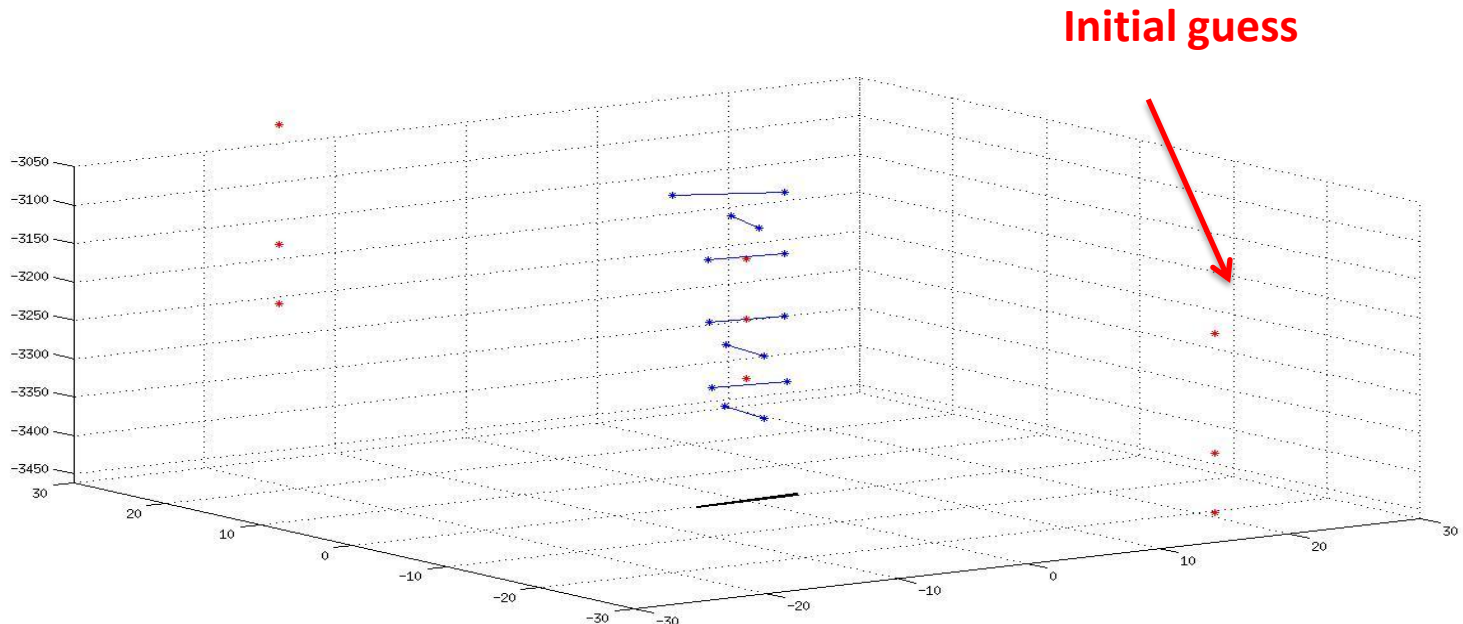
## Input

- Beacons positions
- TOAs
- (Depth Floor 1, Depth Floor 7 )
- Distances between hydrophones in the same floor
- Sound velocity (CTDs data)

**The code finds iteratively a root (zero) of a system of nonlinear equations.**

Initial guess:

- Expected depth (from CTDs data)

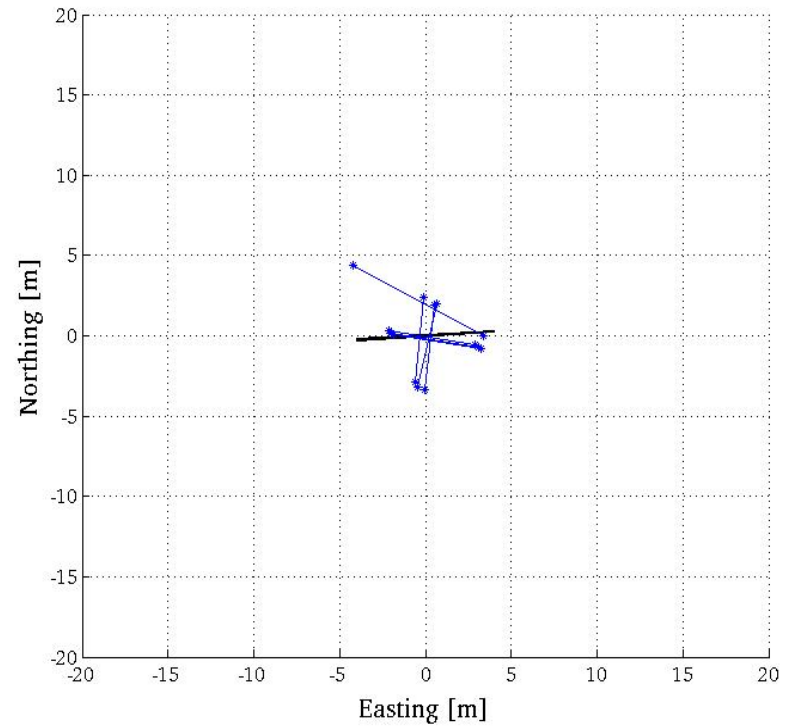
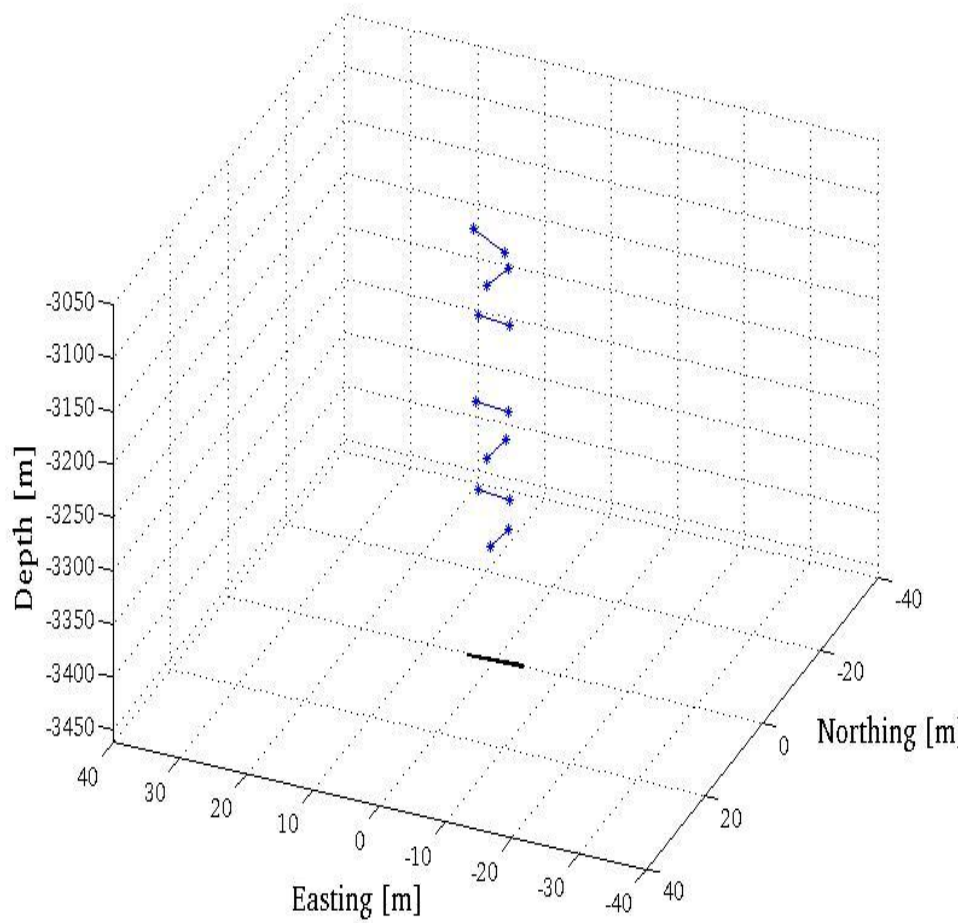




# NEMO Phase II -SMO

## Acoustic positioning system

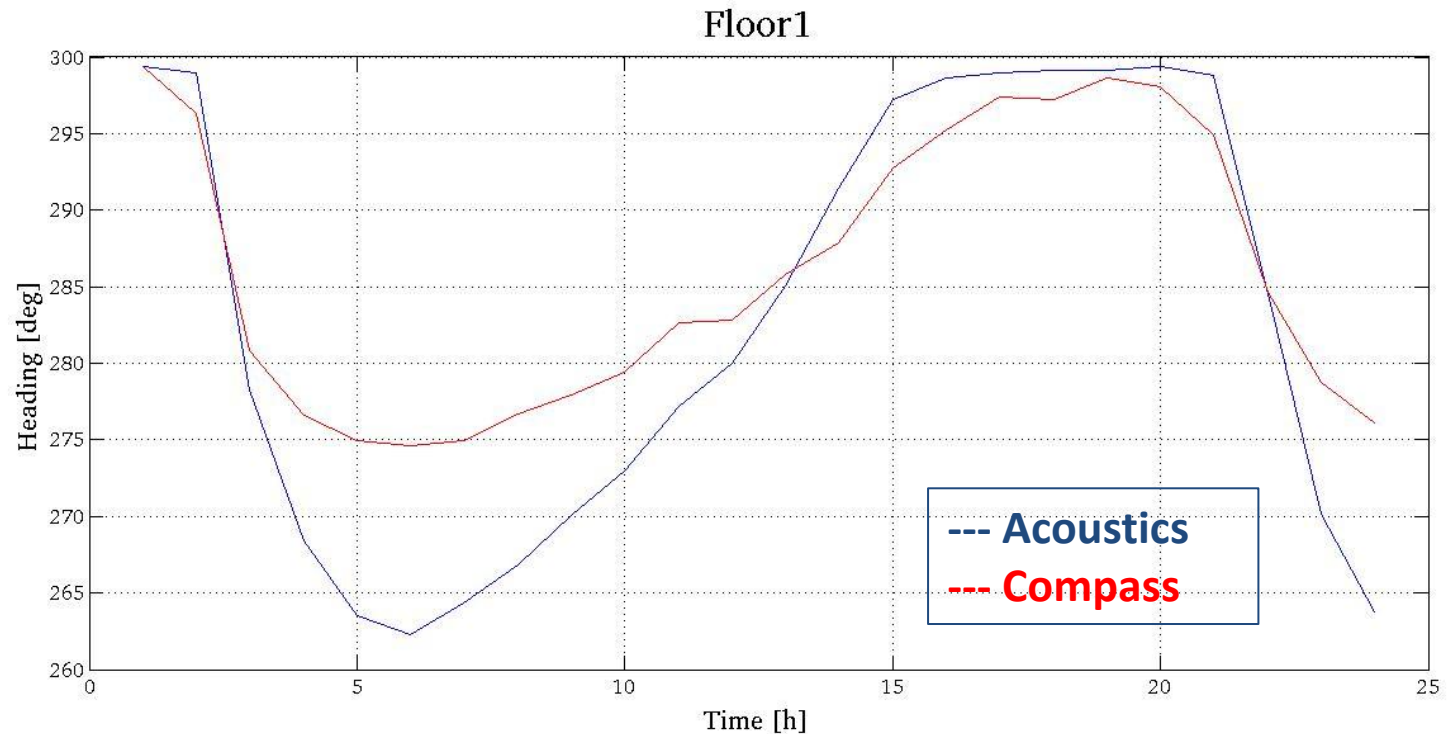
07/05/2013  
00:00 UTC



# Heading measurements

26/05/2013

00:00 UTC – 23:59 UTC



Acoustics: 1 pt/hour (median)

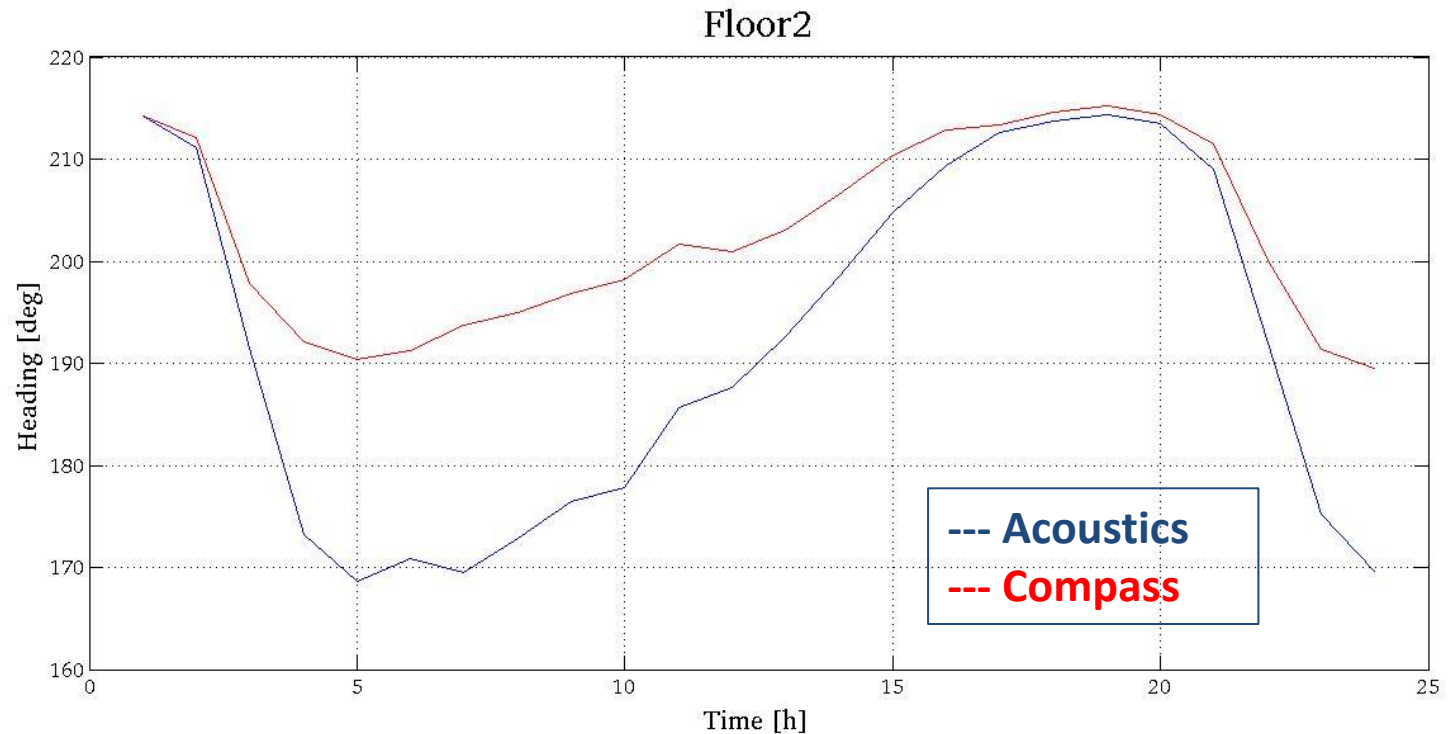
Compass: downsampled data (1 pt/hour)



# Heading measurements

26/05/2013

00:00 UTC – 23:59 UTC



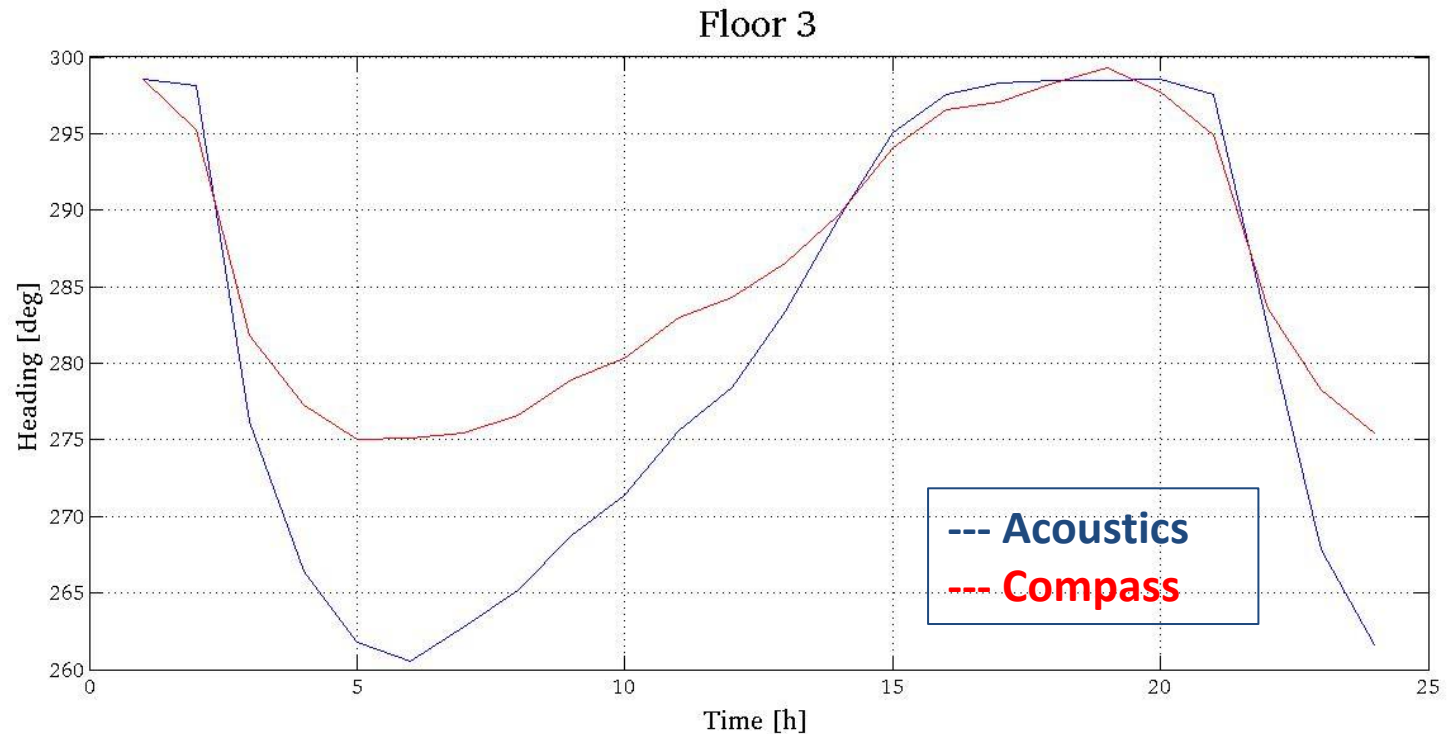
Acoustics: 1 pt/hour (median)

Compass: downsampled data (1 pt/hour)

# Heading measurements

26/05/2013

00:00 UTC – 23:59 UTC



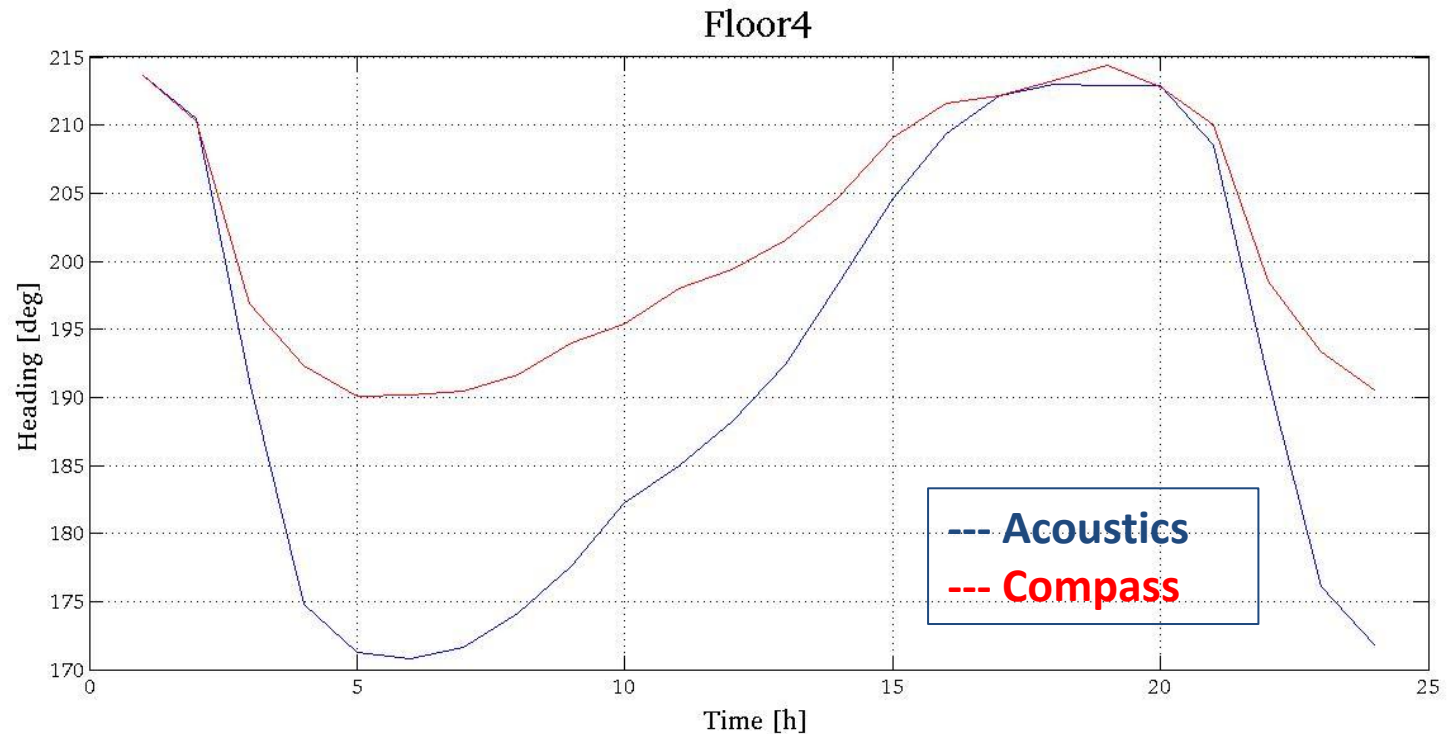
Acoustics: 1 pt/hour (median)

Compass: downsampled data (1 pt/hour)

# Heading measurements

26/05/2013

00:00 UTC – 23:59 UTC



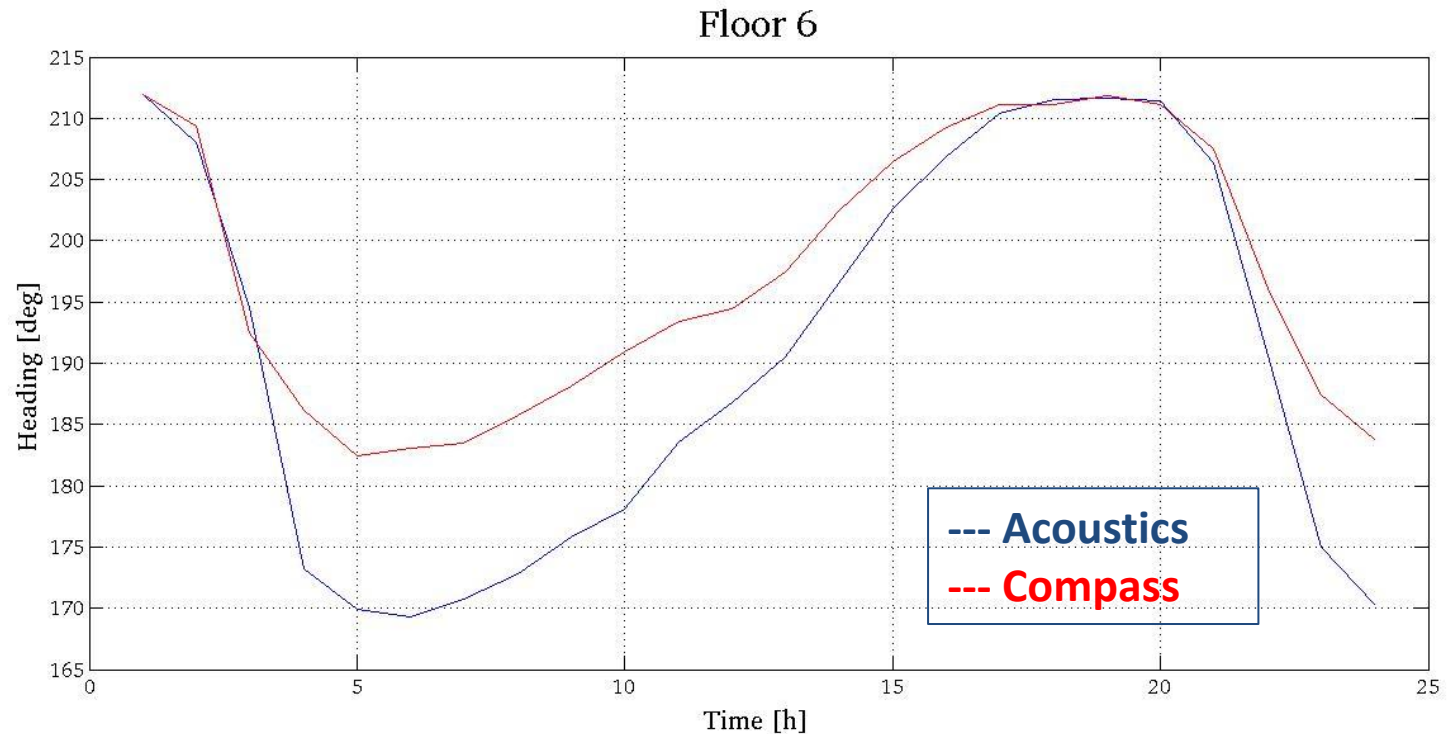
Acoustics: 1 pt/hour (median)

Compass: downsampled data (1 pt/hour)

# Heading measurements

26/05/2013

00:00 UTC – 23:59 UTC



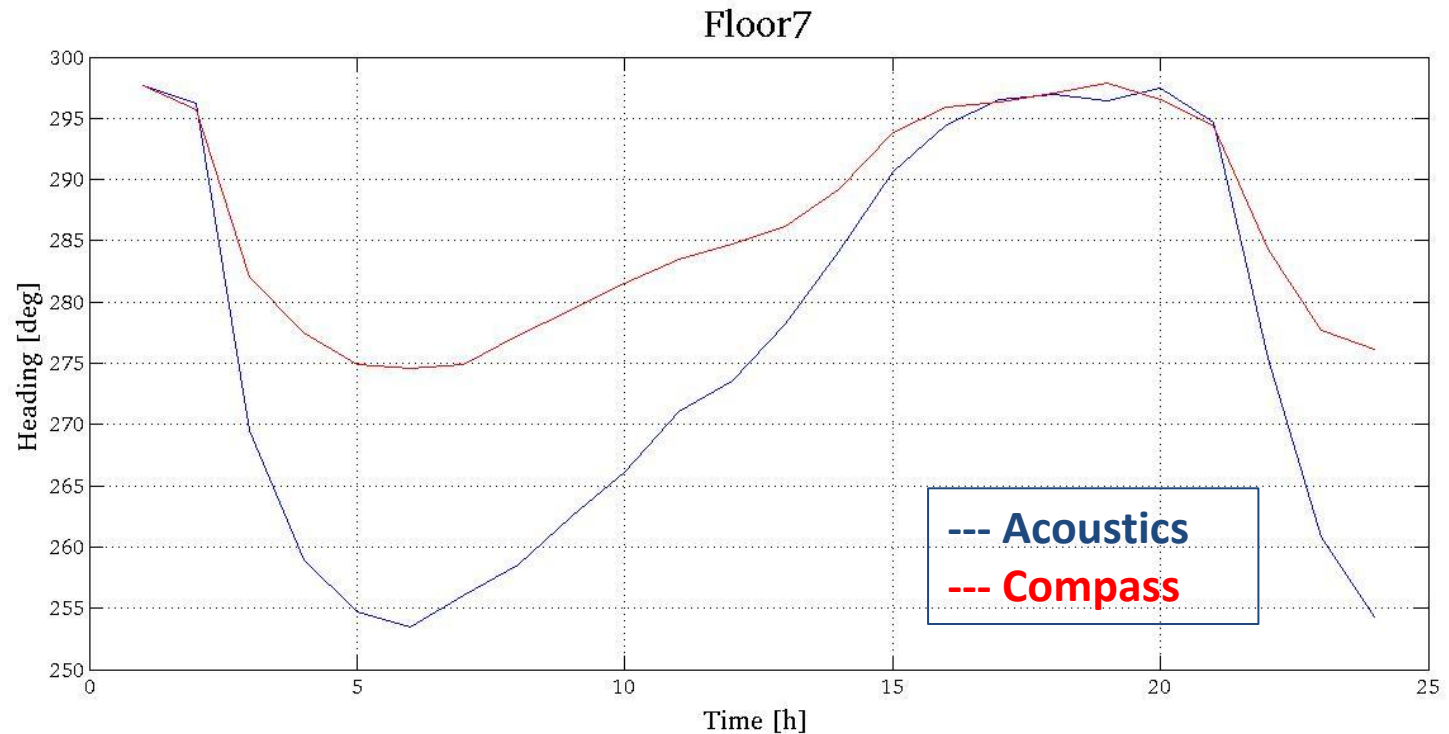
Acoustics: 1 pt/hour (median)

Compass: downsampled data (1 pt/hour)

# Heading measurements

26/05/2013

00:00 UTC – 23:59 UTC

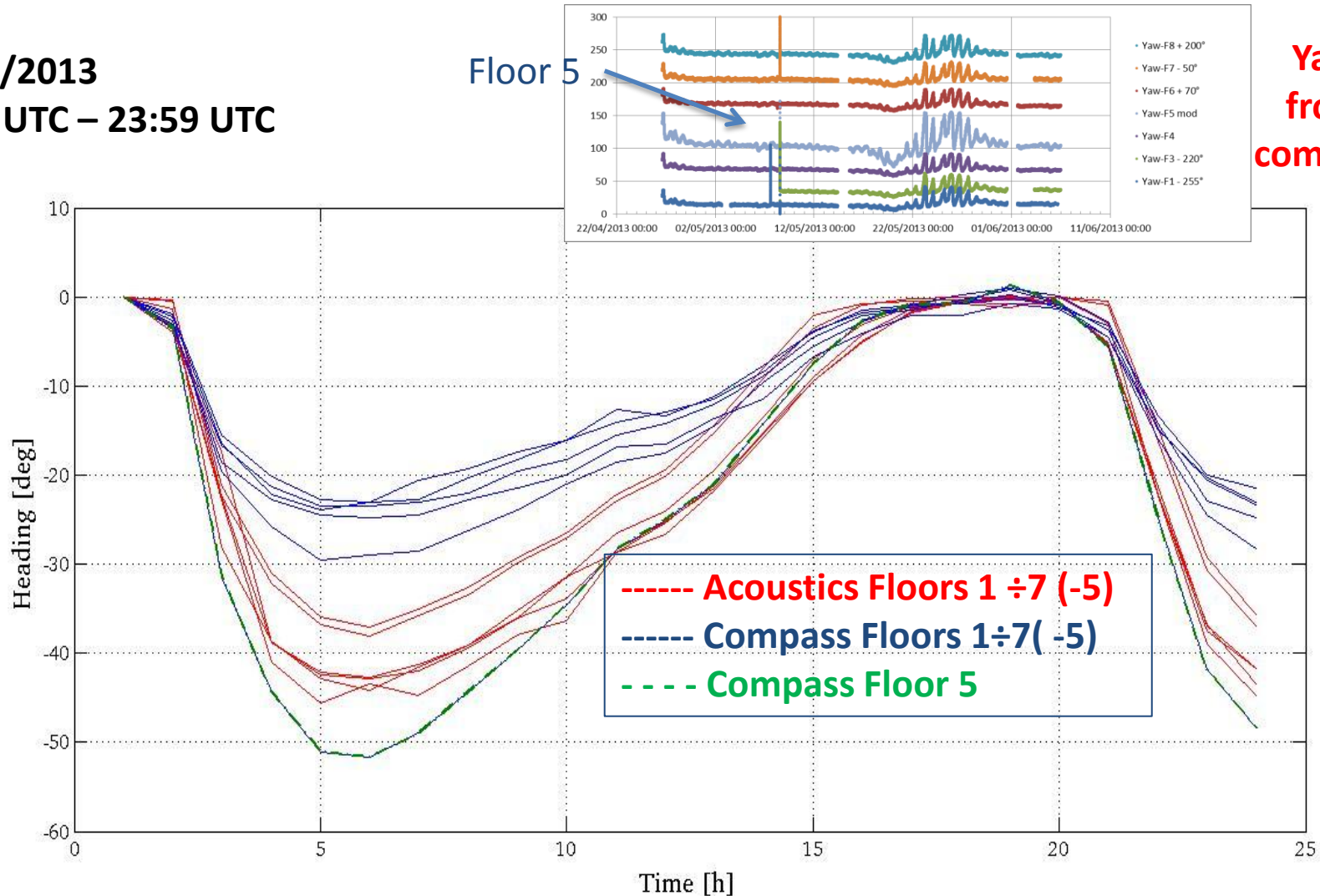


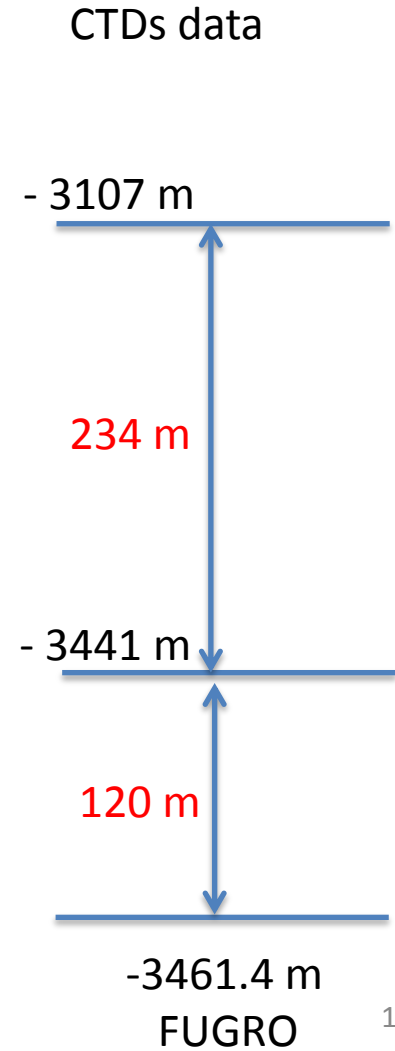
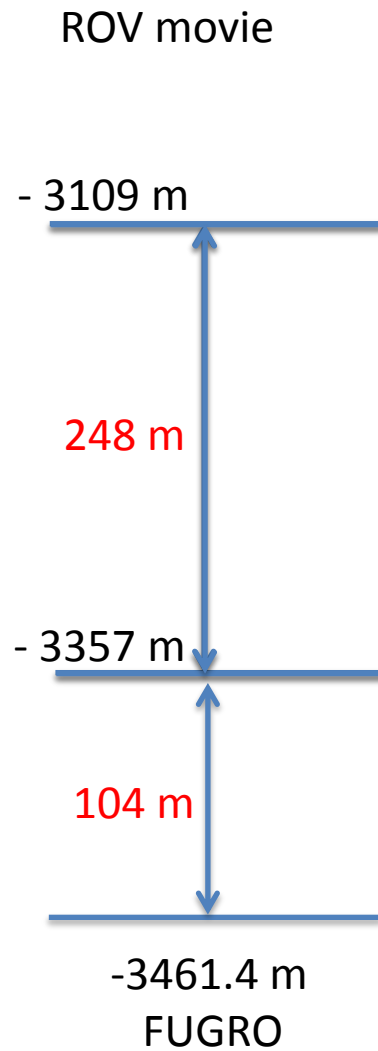
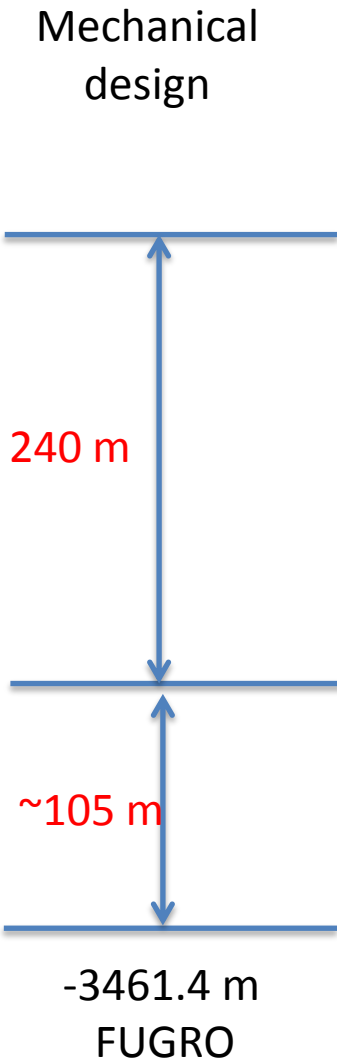
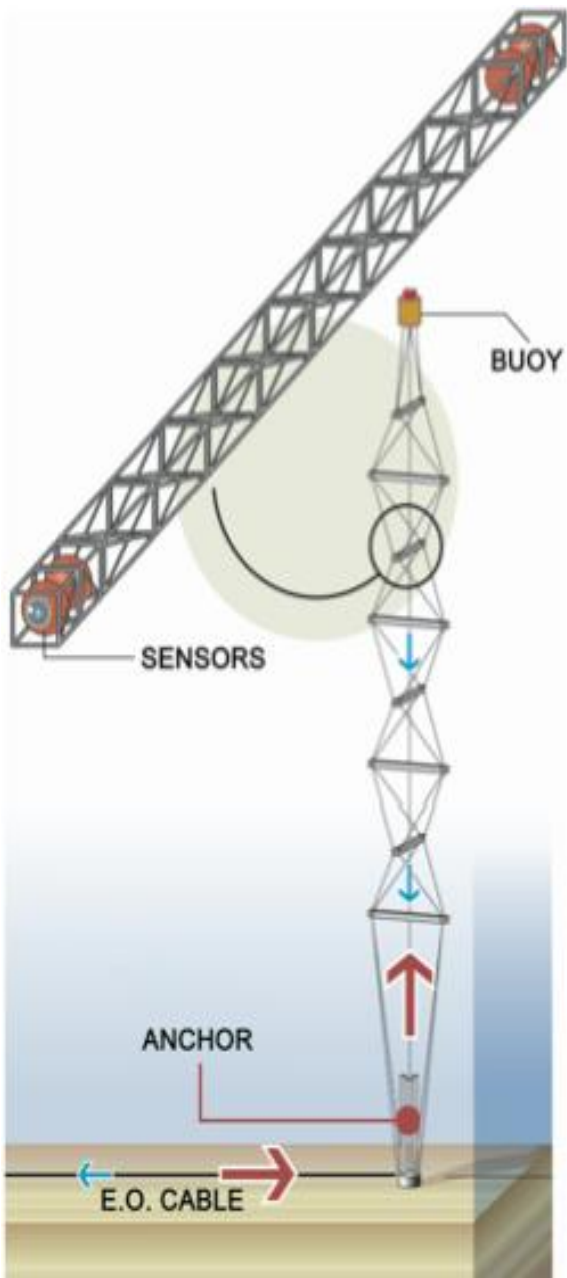
Acoustics: 1 pt/hour (median)

Compass: downsampled data (1 pt/hour)

# Comparison between compasses data and acoustic measurements

26/05/2013  
00:00 UTC – 23:59 UTC



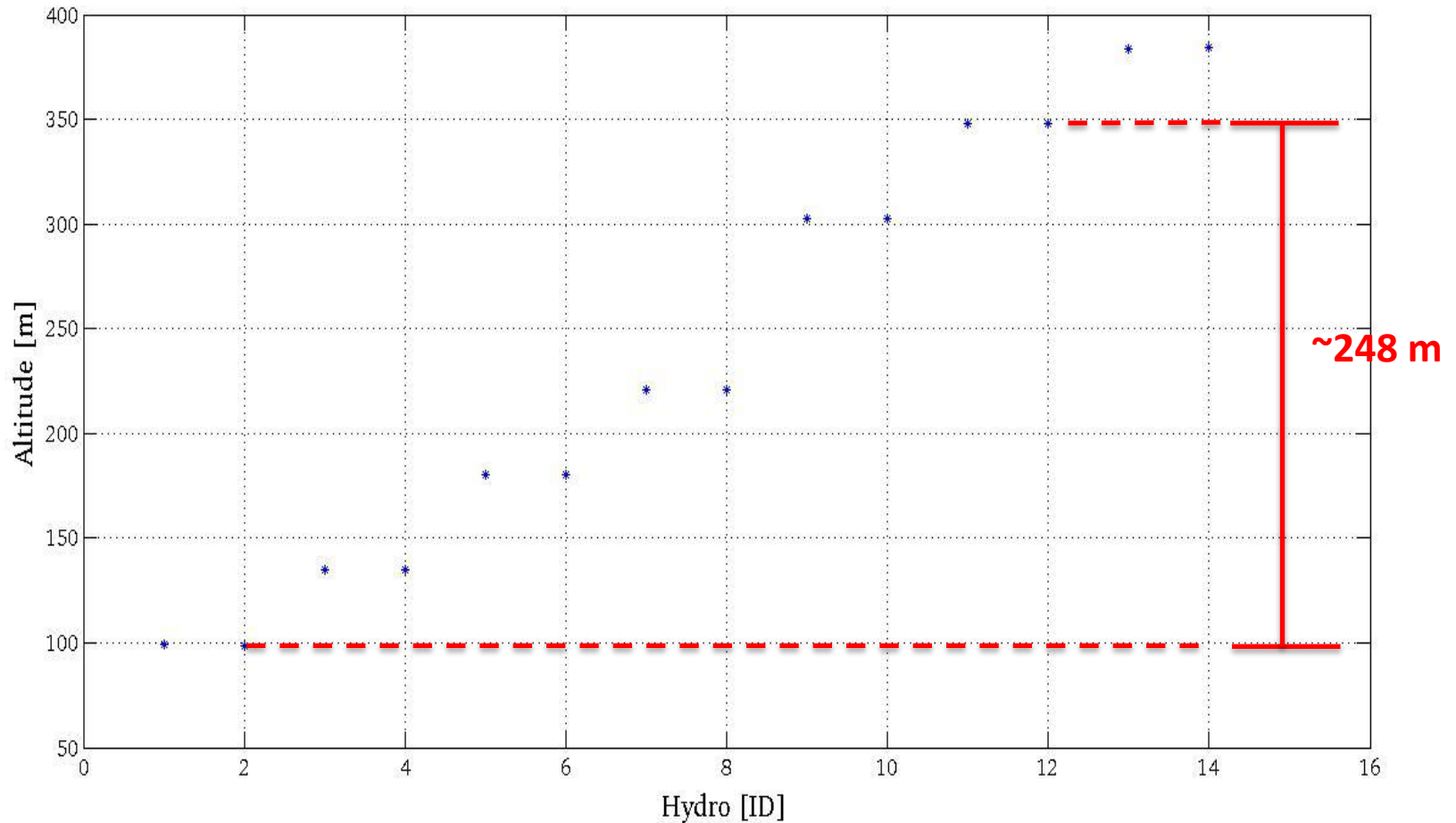




# Floors depth: acoustic measurements

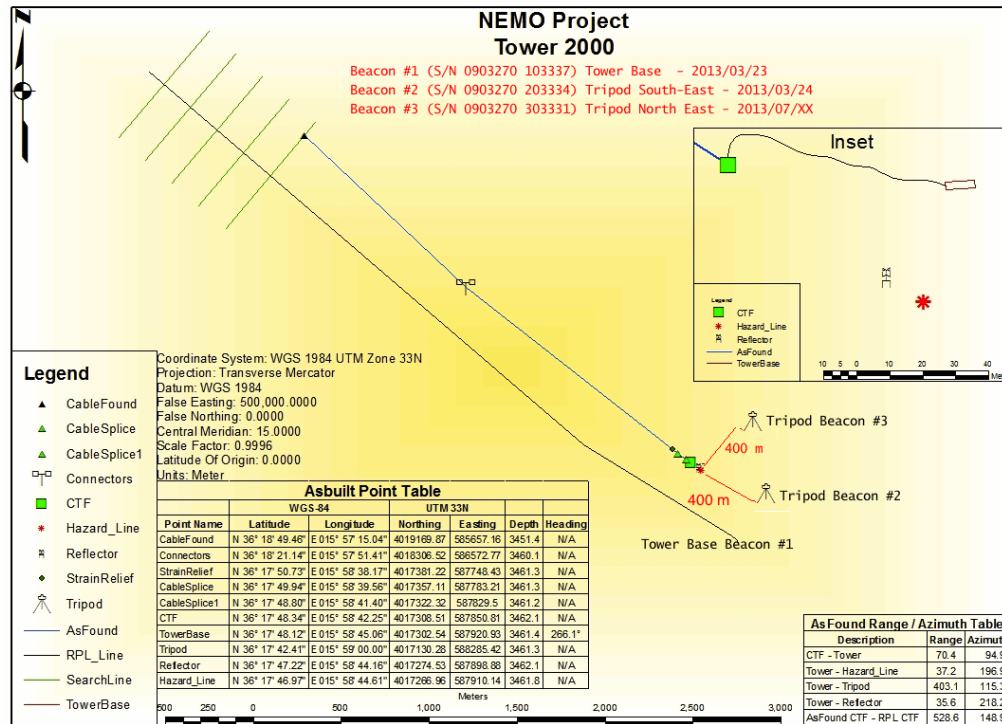
26/05/2013

05:00 UTC – 06:00 UTC



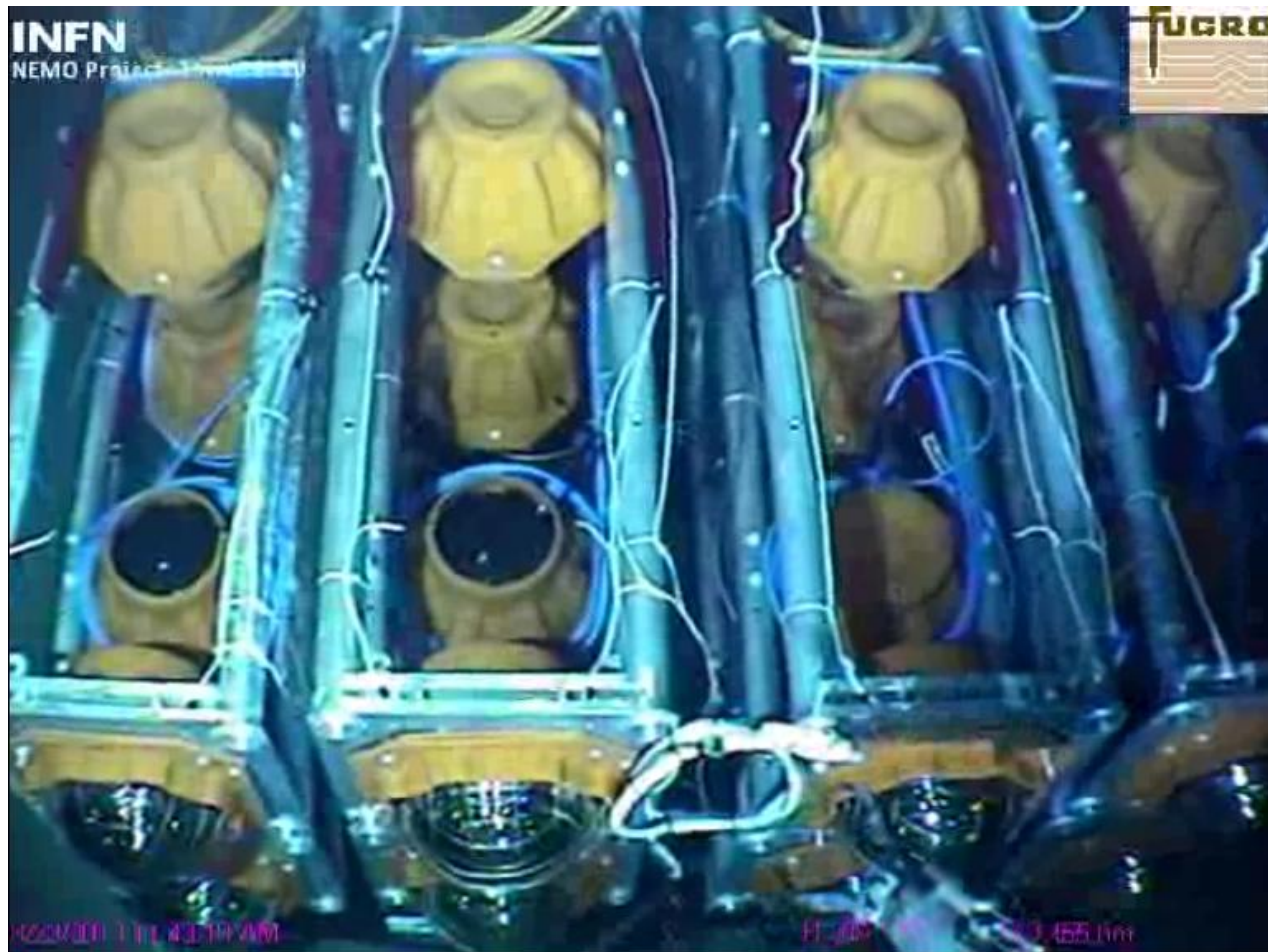
# Conclusions

- Cross-check results with available instrumentation must be examined in depth
- Tower base Spanish beacon (time synchronised with the apparatus) will allow to measure absolute distances between beacons and hydrophones → depth puzzle solution
- A further autonomous acoustic beacon will be deployed in July to improve positioning accuracy



# BACKUP

# Picture at $-3455$ m (ROV CTD data)



# Picture at $-3357.7$ m (ROV CTD data)



# Picture at $-3109.1$ m (ROV CTD data)

