economie FOD Economie, K.M.O., Middenstand en Energie	**Kwaliteit en Veiligheid** **Kwaliteit en Innovatie** **Continentaal Plat**

Vergelijking tussen de EM3002D multibeam echosounder aan boord van Belgica en Ter Streep

Comparison between the EM3002D multibeam echosounders on the Belgica and Ter Streep

Documentinformatie en geschiedenis

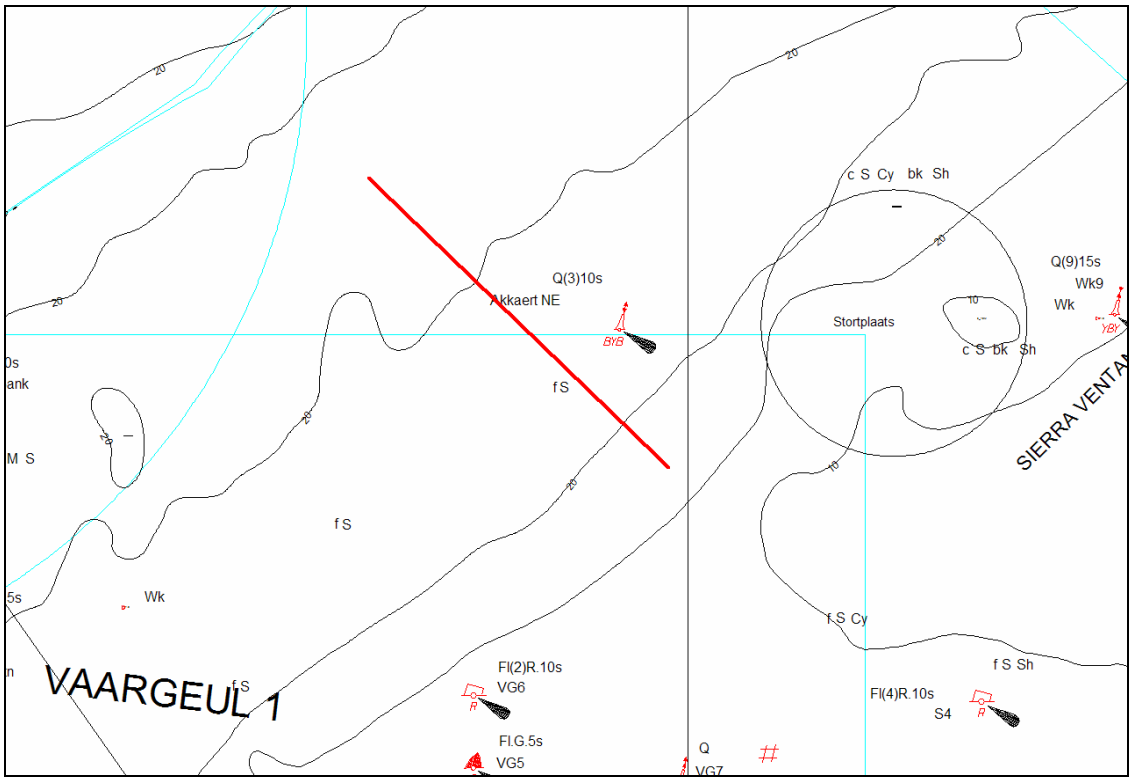
Auteur(s)	**Marc Roche, Koen Degrendele en Kris Vanparys**			
Bestandsnaam	**Test TerStreep Belgica.doc**			
Versie	**Datum**	**Opmerkingen**	**Verificatie**	**Goedkeuring**
A	**30/11/2009**			

1. Test survey Ter Streep – Belgica

Thursday October 22nd, 2009

Location: Akkaertbank

Coordinates:



Geographical WGS84	UTM zone 31N
2° 56.8963’ 51° 28.2004’	496407 5702095
2° 59.8134’ 51° 26.4471’	499784 5698844

1.1. Belgica EM3002D installation and runtime parameters

```
** Start/stop datagram **
Line name:          0000_20091022_084257
Start Time:         20091022  084257

Original Survey name:                (SID=) AB_test_0928

Main Head Serial:                    (SMH=) 593

Versions:
    BeamFormer:                      (BSV=) 2.0.0 080912
    Processing Unit:                 (PSV=) 2.0.5 090223
    Sonar Head1 Sw:                  (TSV=) 2.0.9 060126
```

```
    Sonar Head2 Sw:                 (RSV=) 2.0.9 060126
    Datagram Format:                (DSV=) 3.0.7 040104

Waterlevel Downward Position:       (WLZ=) -3.24

Waterlevel Downward Position:       (WLZ=) -3.240000
    Downward position:              (S1Z=) 0.98
    Forward position:               (S1X=) -5.82
    Starboard position:             (S1Y=) -2.29
    Heading offset:                 (S1H=) 359.56
    Roll Offset:                    (S1R=) 33.67
    Pitch offset:                   (S1P=) 1.48
    Sonar Head 1 Gain Offset:       (GO1=) -1.50

    Downward position:              (S2Z=) 0.95
    Forward position:               (S2X=) -5.82
    Starboard position:             (S2Y=) 2.32
    Heading offset:                 (S2H=) 2.01
    Roll Offset:                    (S2R=) -34.94
    Pitch offset:                   (S2P=) 1.51
    Sonar Head 2 Gain Offset:       (GO2=) 0.00

Installation parameters for Positioning System no.1
    Downward positioning:           (P1Z=) -23.02
    Forward positioning:            (P1X=) -10.81
    Starboard positioning:          (P1Y=) 0.40
    Time Delay:                     (P1D=) 0.000
    Time Tag,(0=int,1=Pos):         (P1T=) 0
    Datum:                          (P1G=) WGS84

Installation parameters for Positioning System no.2
    Downward positioning:           (P2Z=) 0.00
    Forward positioning:            (P2X=) 0.00
    Starboard positioning:          (P2Y=) 0.00
    Time Delay:                     (P2D=) 0.000
    Time Tag,(0=int,1=Pos):         (P2T=) 0
    Datum:                          (P2G=) WGS84

Installation parameters for Positioning System no.3
    Downward positioning:           (P3Z=) 0.00
    Forward positioning:            (P3X=) 0.00
    Starboard positioning:          (P3Y=) 0.00
    Time Tag,(0=int,1=Pos):         (P3T=) 0
    Datum:                          (P3G=) WGS84
Active Positioning System (0-2):    (APS=) 0

Installation parameters for Motion Sensor.
    Roll Reference Plane:           (MRP=) RP
    Roll offset:                    (MSR=) 0.00
    Pitch offset:                   (MSP=) 0.00
    Heading offset:                 (MSG=) 0.00
    Downward Position:              (MSZ=) 0.00
    Forward Position:               (MSX=) 0.00
    Forward Position:               (MSY=) 0.00
    Time Delay (ms):                (MSD=) 0

Gyrocompass heading offset (deg):   (GCG=) 0.00

Depth Sensor Parameters:
    Time delay:                     (DSD=) 0
    Heave use:                      (DSH=) NI
```

SVP: 15000m/s fixed

1.2. Ter Streep EM3002D installation and runtime parameters

```
** Start/stop datagram **
Line name:          0000_20091022_085622
Start Time:         20091022  085622

Original Survey name:              (SID=) Vergelijk_BEL
Comment:                           (COM=) vergelijking Belgica en TS
op NE Akkaert

Main Head Serial:                  (SMH=) 436

Versions:
    BeamFormer:                    (BSV=) 2.0.0 080912
    Processing Unit:               (PSV=) 2.0.3 081114
    Sonar Head1 Sw:                (TSV=) 2.0.9 060126
    Sonar Head2 Sw:                (RSV=) 2.0.9 060126
    Datagram Format:               (DSV=) 3.0.7 040104

Waterlevel Downward Position:      (WLZ=) 0.00

Waterlevel Downward Position:      (WLZ=) 0.000000
    Downward position:             (S1Z=) 3.58
    Forward position:              (S1X=) -0.01
    Starboard position:            (S1Y=) -1.05
    Heading offset:                (S1H=) 359.81
    Roll Offset:                   (S1R=) 40.15
    Pitch offset:                  (S1P=) -1.00
    Sonar Head 1 Gain Offset:      (GO1=) 0.00

    Downward position:             (S2Z=) 3.59
    Forward position:              (S2X=) -0.01
    Starboard position:            (S2Y=) -0.53
    Heading offset:                (S2H=) 359.30
    Roll Offset:                   (S2R=) -39.72
    Pitch offset:                  (S2P=) -0.62
    Sonar Head 2 Gain Offset:      (GO2=) 0.00

Installation parameters for Positioning System no.1
    Downward positioning:          (P1Z=) -19.66
    Forward positioning:           (P1X=) -15.32
    Starboard positioning:         (P1Y=) -0.23
    Time Delay:                    (P1D=) 0.000
    Time Tag,(0=int,1=Pos):        (P1T=) 0
    Datum:                         (P1G=) WGS84

Installation parameters for Positioning System no.2
    Downward positioning:          (P2Z=) 0.00
    Forward positioning:           (P2X=) 0.00
    Starboard positioning:         (P2Y=) 0.00
    Time Delay:                    (P2D=) 0.000
    Time Tag,(0=int,1=Pos):        (P2T=) 0

Installation parameters for Positioning System no.3
    Downward positioning:          (P3Z=) 0.00
    Forward positioning:           (P3X=) 0.00
    Starboard positioning:         (P3Y=) 0.00
```

```
    Time Tag,(0=int,1=Pos):         (P3T=) 0
Active Positioning System (0-2):    (APS=) 0

Installation parameters for Motion Sensor.
    Roll Reference Plane:           (MRP=) RP
    Roll offset:                    (MSR=) 0.00
    Pitch offset:                   (MSP=) 0.00
    Heading offset:                 (MSG=) 0.00
    Downward Position:              (MSZ=) 0.00
    Forward Position:               (MSX=) 0.00
    Forward Position:               (MSY=) 0.00
    Time Delay (ms):                (MSD=) 25

Gyrocompass heading offset (deg):   (GCG=) 0.00

Depth Sensor Parameters:
    Time delay:                     (DSD=) 0
    Heave use:                      (DSH=) NI
```

Runtime parameters copied from Belgica

```
openingshoek BB Port 75-20.
openingshoek SB Starboard 20-75.
coverage : 400m aan beide zijden
Hidensity

offsets
Heading BB : 0.182
Heading SB : -0.699
Roll BB : 40.15
Roll SB : -39.726
Pitch BB : -0.997
Pitch SB : -0.622
Laterncy 25ms
latency Heave : -0.015s

Beamwidth : normal
Max 40 pings per seconde
pitch stabilisation enabled
C : 1500m/s vast
Spike filter : medium
range gate : normal
angle from nadir : 7
absortion coefficient : 67.34 (gegevens van mensen van de Belgica)
Puls length : 200
geen TVG
0 en 0 voor de andere instellingen
```

1.3. Belgica EM3002D tracks

0000_20091022_084257_Belgica.all
0001_20091022_092128_Belgica.all (50 m to the west)
0002_20091022_095854_Belgica.all (50 m to the east)
0003_20091022_103510_Belgica.all (control line)

List of all lines:

Line prefix, heading[deg], length[m], number of pings, average depth[m], average swath[m],

average speed[m/s], duration(h:m:s), First and last position

Line_prefix	hdt	len	no	dep	swath	spd	duration	firstLat	firstLong	lastLat	lastLong
0000_20091022_084257	127.90	4938	10422	20.54	124.34	3.91	00:21:35	N51°26'24.89"	E2°59'47.83"	N51°28'12.71"	E2°56'52.44"
0001_20091022_092128	325.08	4970	10705	20.61	125.38	3.82	00:22:15	N51°28'13.70"	E2°56'47.25"	N51°26'25.45"	E2°59'47.25"
0002_20091022_095854	123.82	4888	9830	20.90	127.11	4.03	00:20:43	N51°26'27.24"	E2°59'50.71"	N51°28'13.51"	E2°56'55.06"
0003_20091022_103510	50.45	765	1315	26.50	165.36	3.69	00:03:30	N51°27'57.43"	E2°56'43.28"	N51°28'14.60"	E2°57'03.63"

The total survey:

AB_test_0928 consists of 4 lines.
Max depth 29.94 meter, Min depth 13.11 meter, Average depth 20.00
Total number of positions are 8174.00
Total number of valid depths are 15737993.00
Total time of logging 01:08:04 (h:m:s)

1.4. Ter Streep EM3002D tracks

0000_20091022_085622_TerSTreep.all
0001_20091022_093202_TerSTreep.all (50 m to the west)
0002_20091022_100750_TerSTreep.all (50 m to the east)

1.5. Belgica EM3002D postprocessing parameters

Used draught: 3.24m
Measured draught 19/10: 3.236m – draught 23/10: 3.100
Correct draught: 3.13m
Applied correction: app. 0.10m

Tide: TS-B-0928_LAT.tide

1.6. Ter Streep EM3002D postprocessing parameters

Used draught: 0m
Applied correction: 0.37m

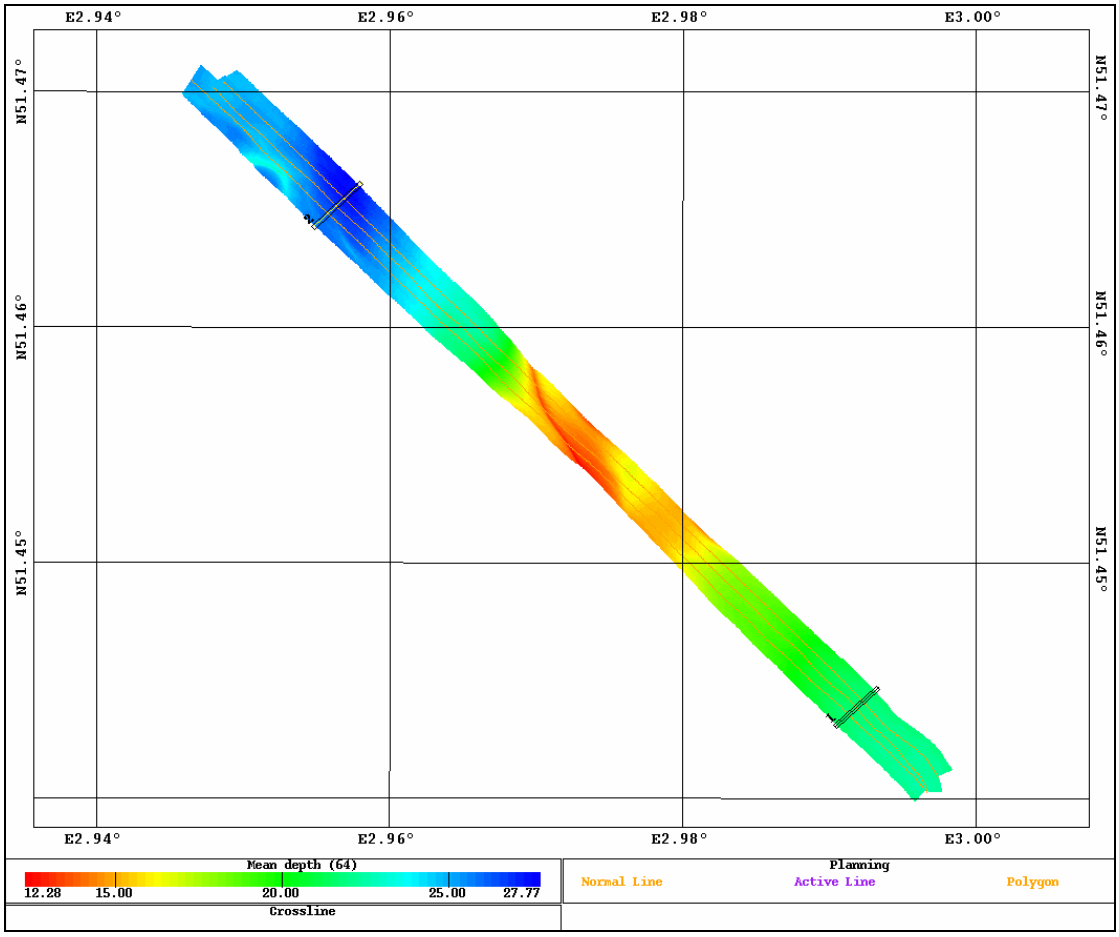
Tide: AB0928_TS_LAT.tide

2. Results

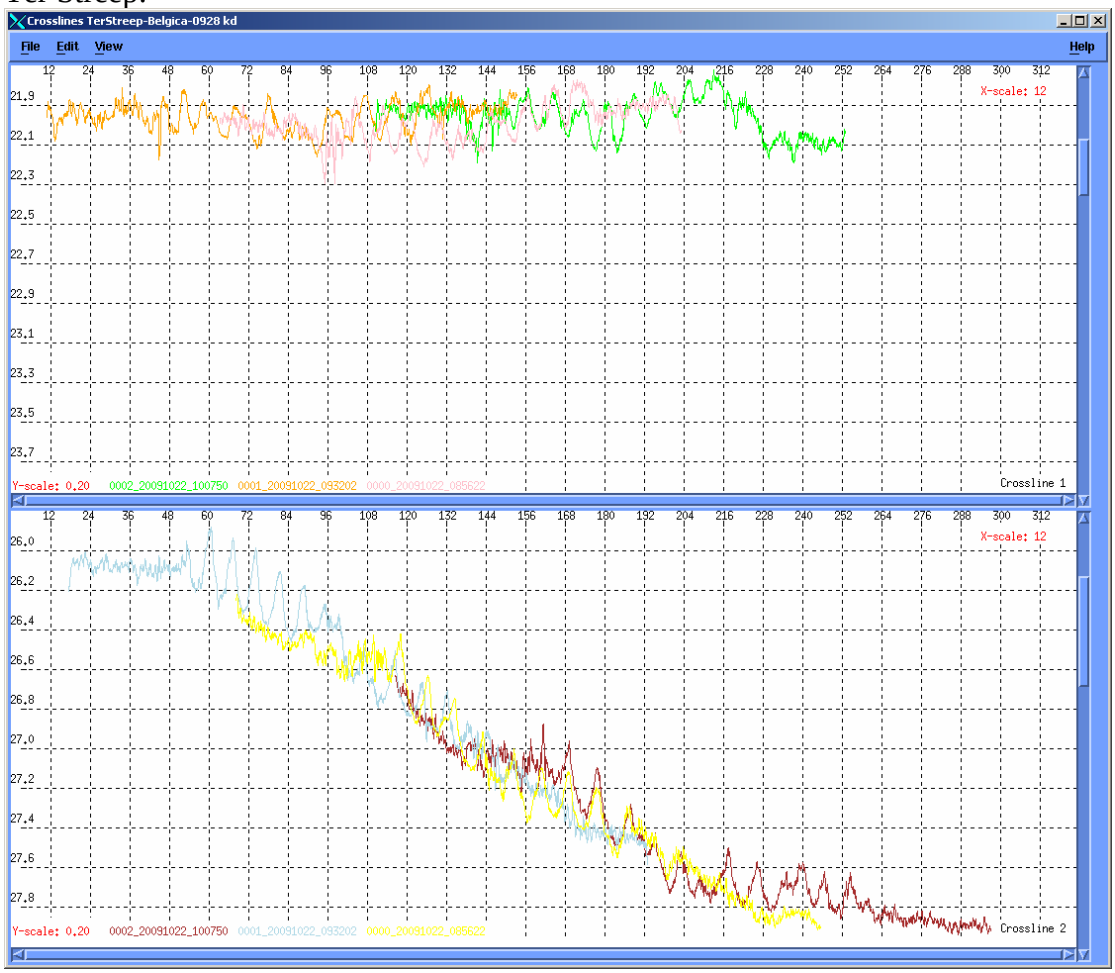
2.1. Bathymetry

Post-processing with Cfloor software (project Test TerStreep Belgica)

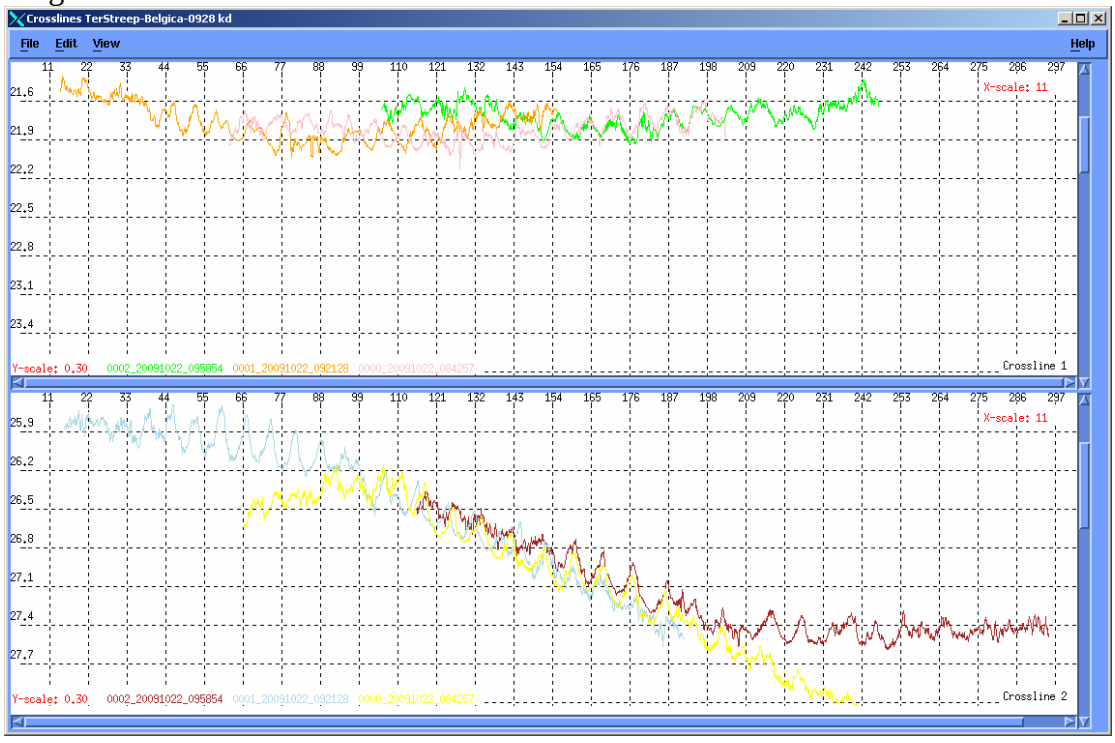
2.1.1. Crosslines (Neptune software):



Ter Streep:

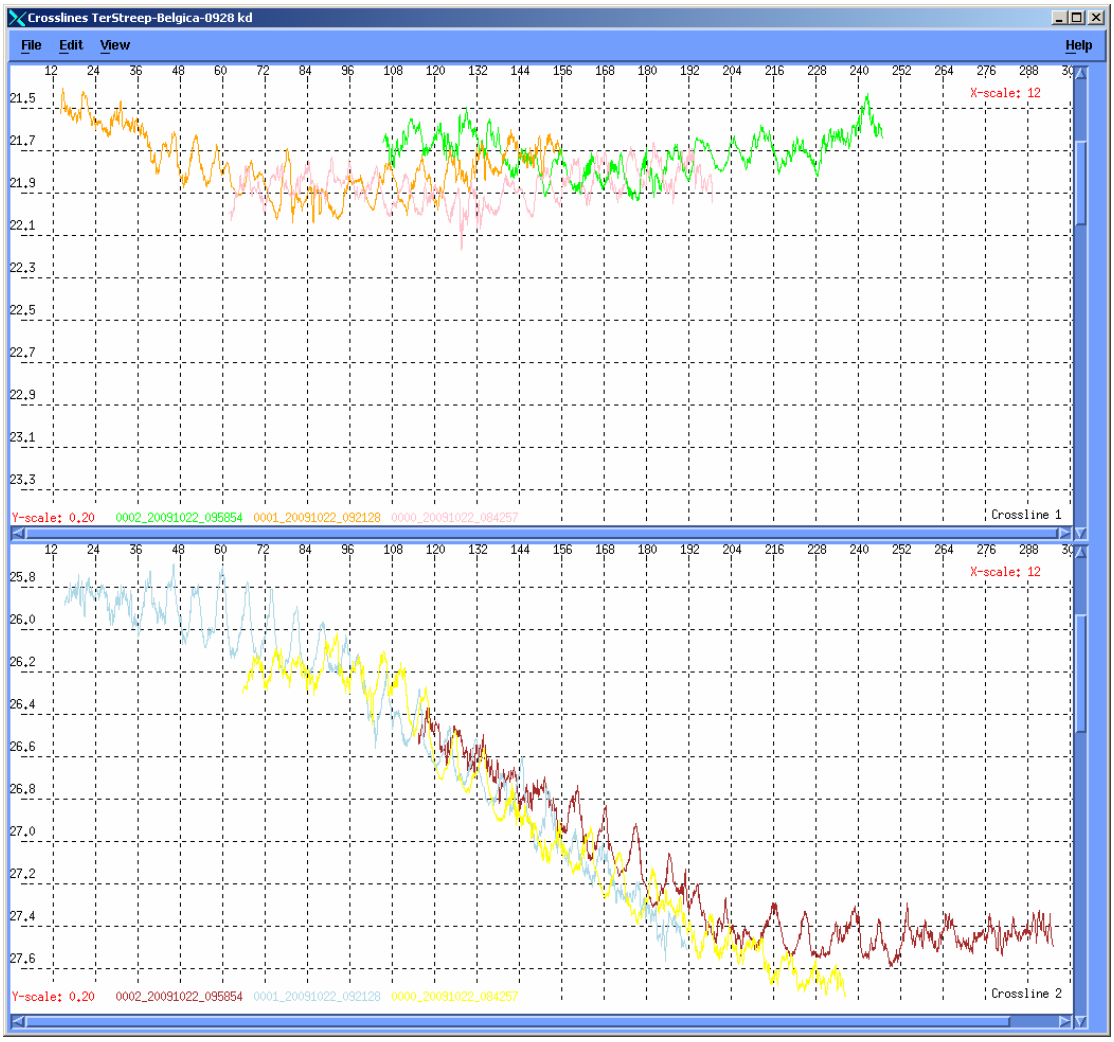


Belgica:

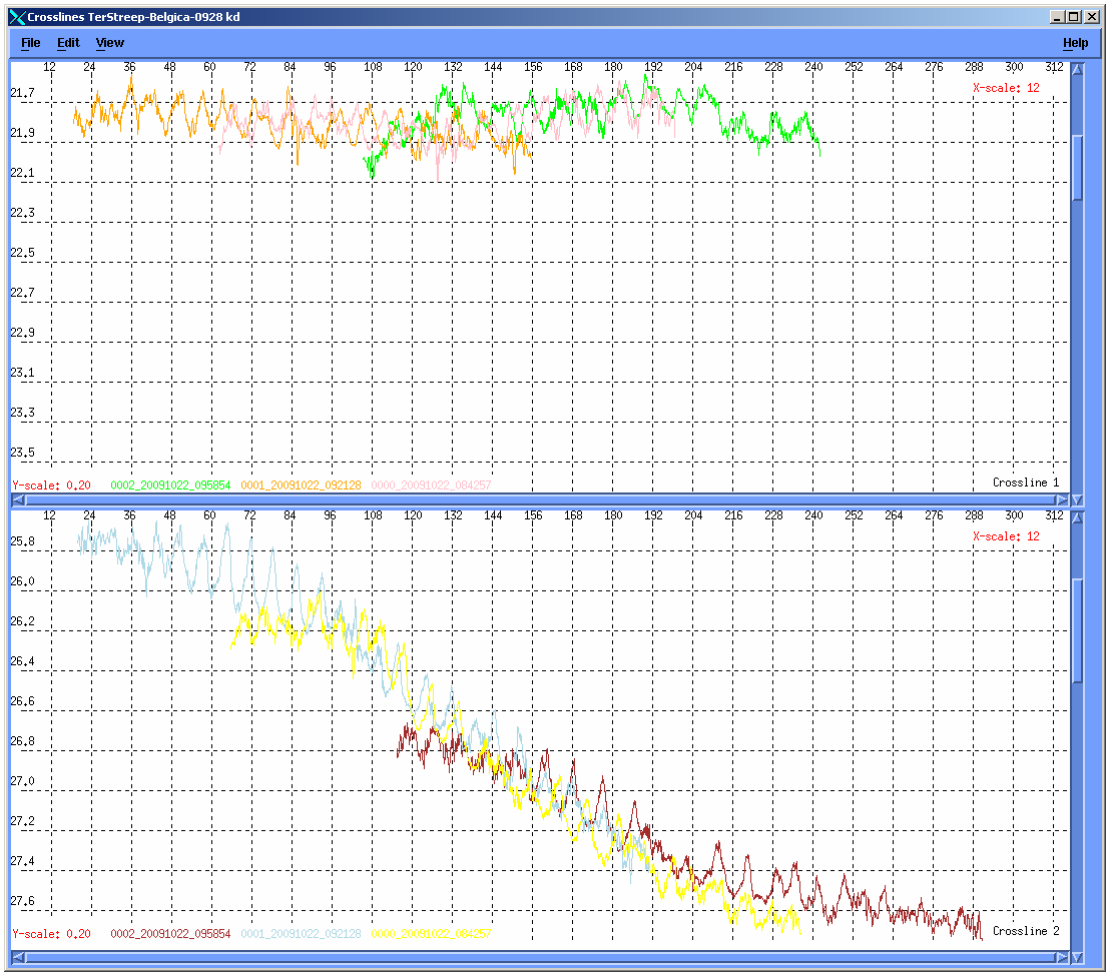


Evaluation of crosslines:

The Belgica EM3002D appears to have a problem with the outer beams: a smile\sad face - due to sound velocity?
This problem is not apparent in the Ter Streep data.
Recalculated Belgica line 0 (in yellow) with svp=1500m/s (was 1498m/s – oops):

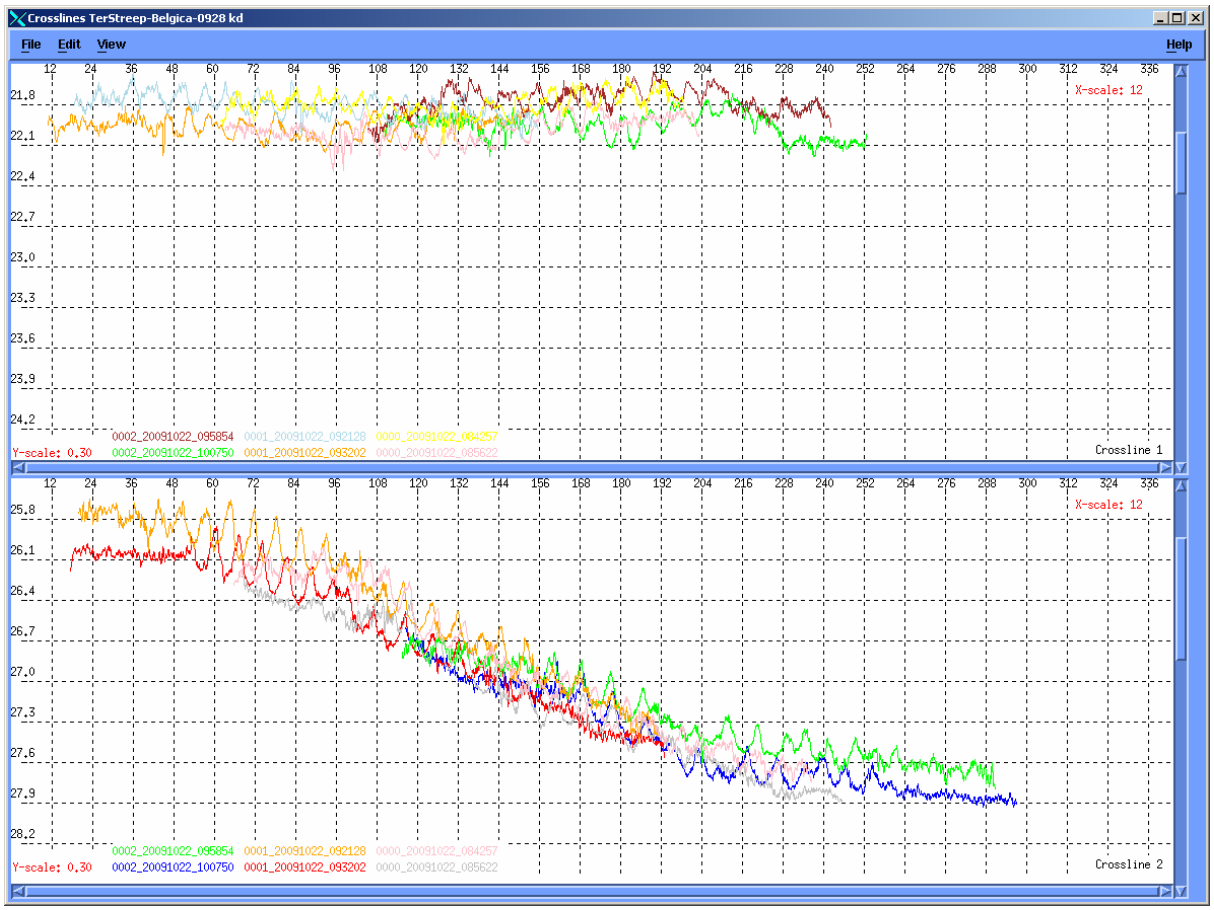


Line 0 in crossline 2 (yellow) looks better but other lines in crossline 1 still show a sound velocity problem. Line 1 and 2 are recalculated with svp=1500m/s (although this profile was selected on board:



Looks much better for crossline 1, the effect seems less positive for crossline 2.
The used sound speed values in SIS are not those from the selected profile (1500 m/s).
→ *Check runtime parameters on board Belgica.*

Comparison between both vessels:



(The three crosslines on the first line of the legend are the Belgica ones.)

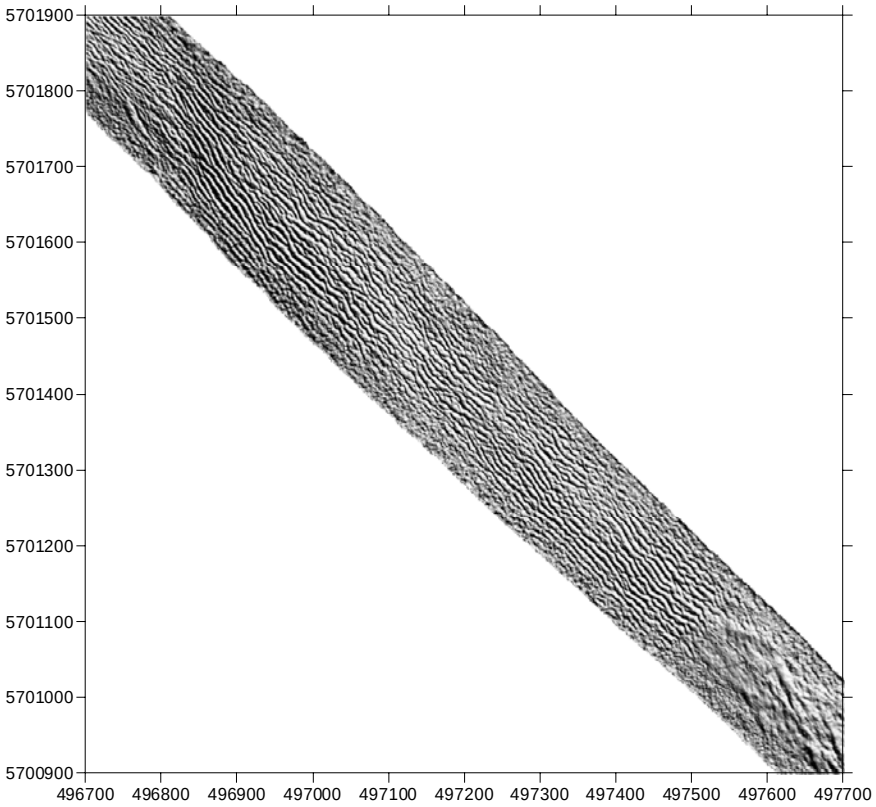
A systematic and constant difference in depth between both multibeams is observed (the Belgica profiles are app. 20cm less deep).

The outer beams of the Ter Streep show less relief: due to phase ramp problem?

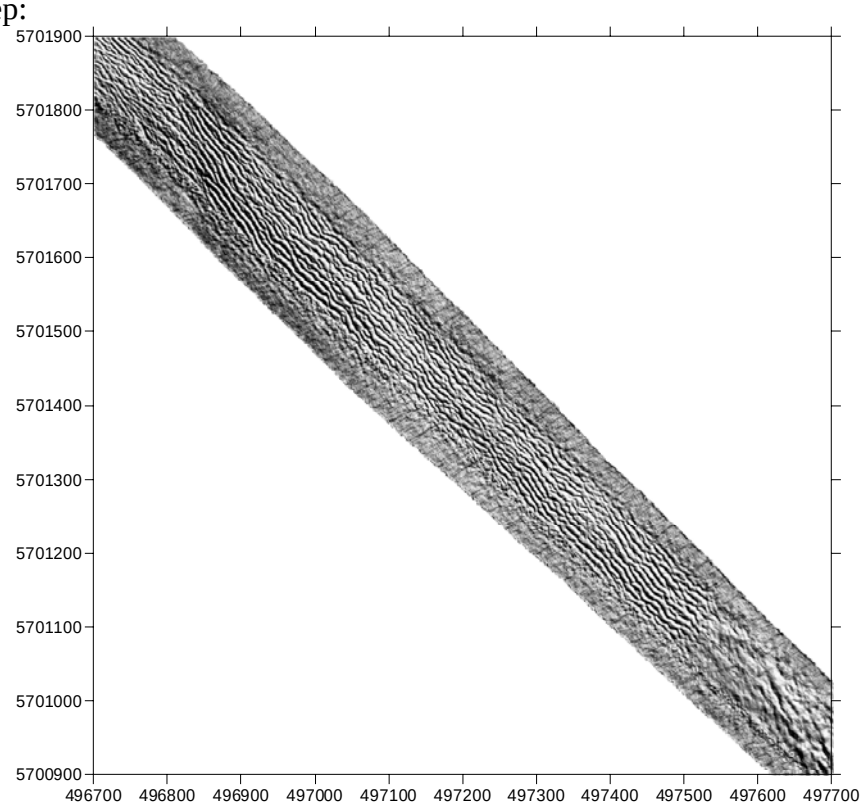
2.1.2. Quality of bathymetry: detail of northern part of line 2:

Detail of line 2 with sun shading NE:

Belgica:

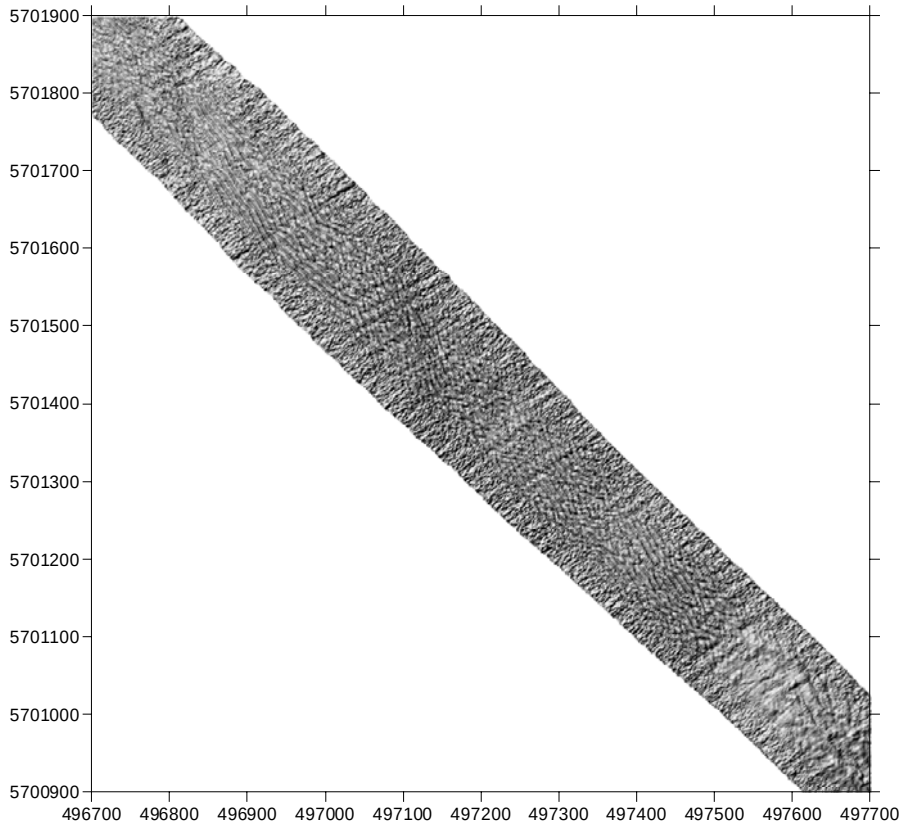


Ter Streep:

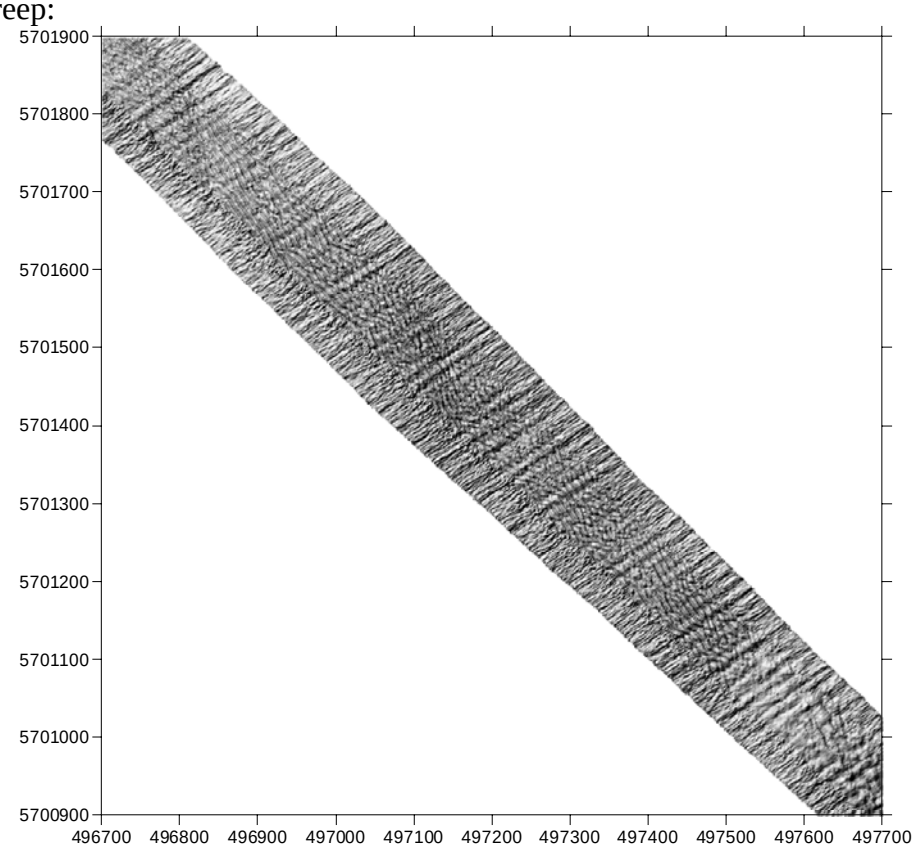


Detail of line 2 with sun shading NW:

Belgica:



Ter Streep:

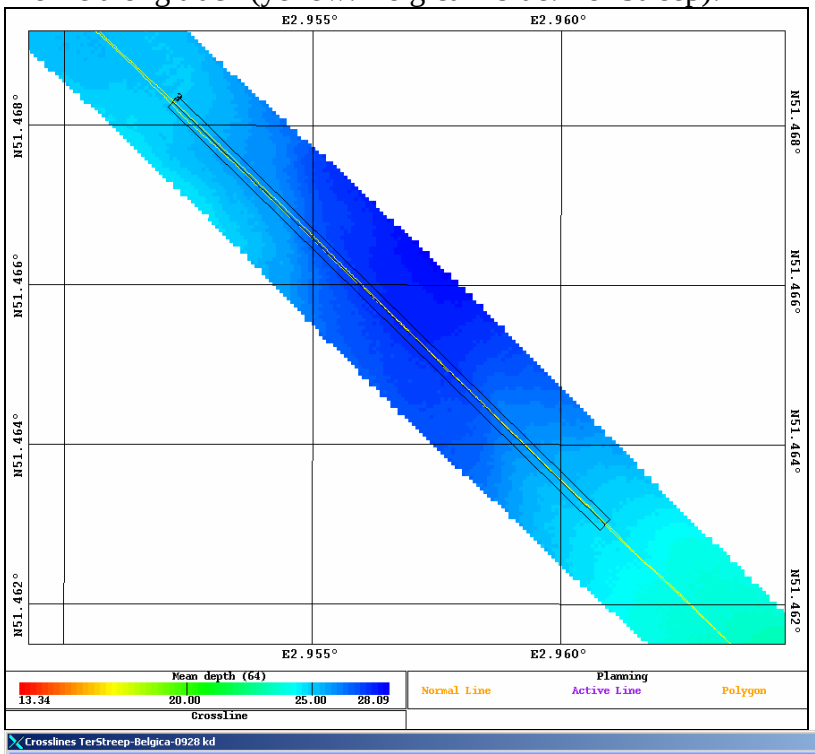


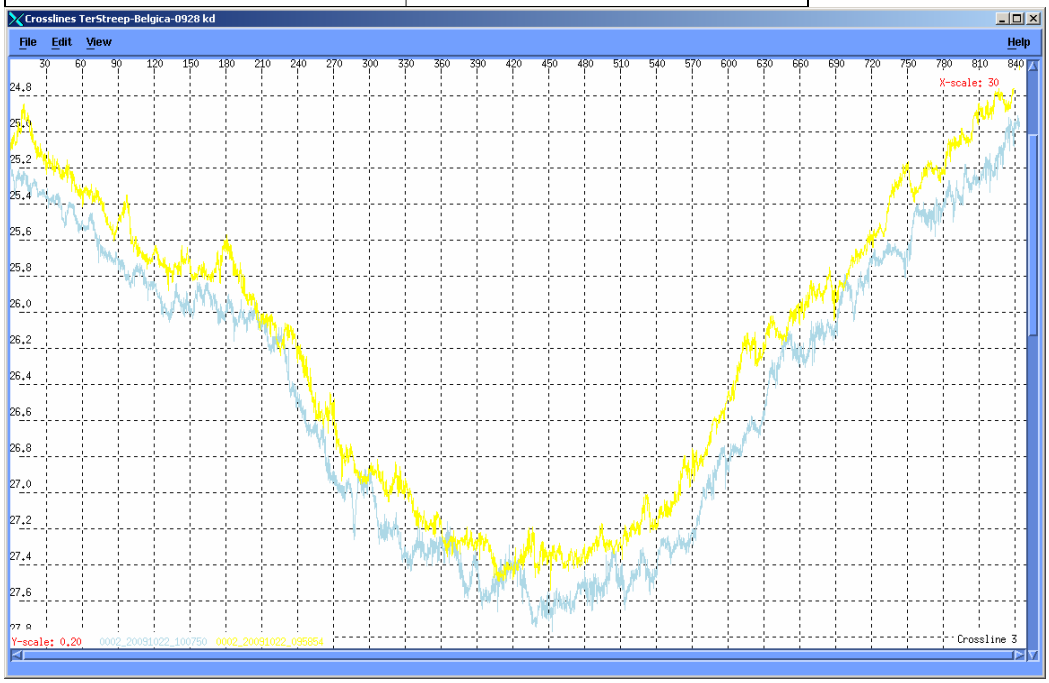
Evaluation of detailed bathymetry:

The phase ramp problem is very apparent in the Ter Streep data: no morphology is visible in outer beams.

A small heave or fault heave artifact is visible in the Belgica data, this artifact is very clear in Ter Streep data.

Profile along track (yellow: Belgica – blue: Ter Streep):





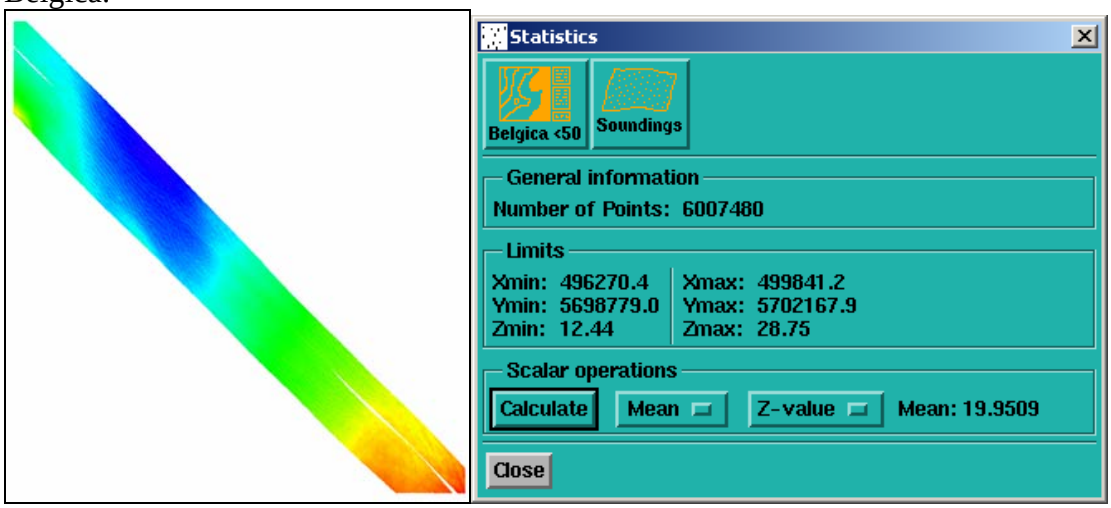
Amplitude of the artifact: app. 10 to 20cm on the Ter Streep data.

2.1.3. Quantitative comparison:

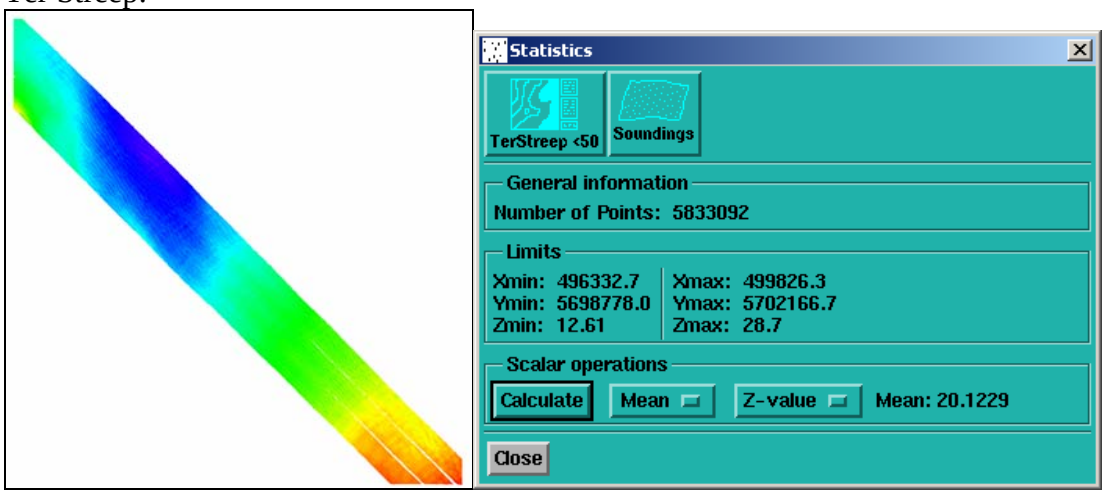
To eliminate the impact of the phase ramp problem all beams outside 50° are eliminated.

Statistics for a selection of the survey (northern part -app. 6.000.000 points):

Belgica:



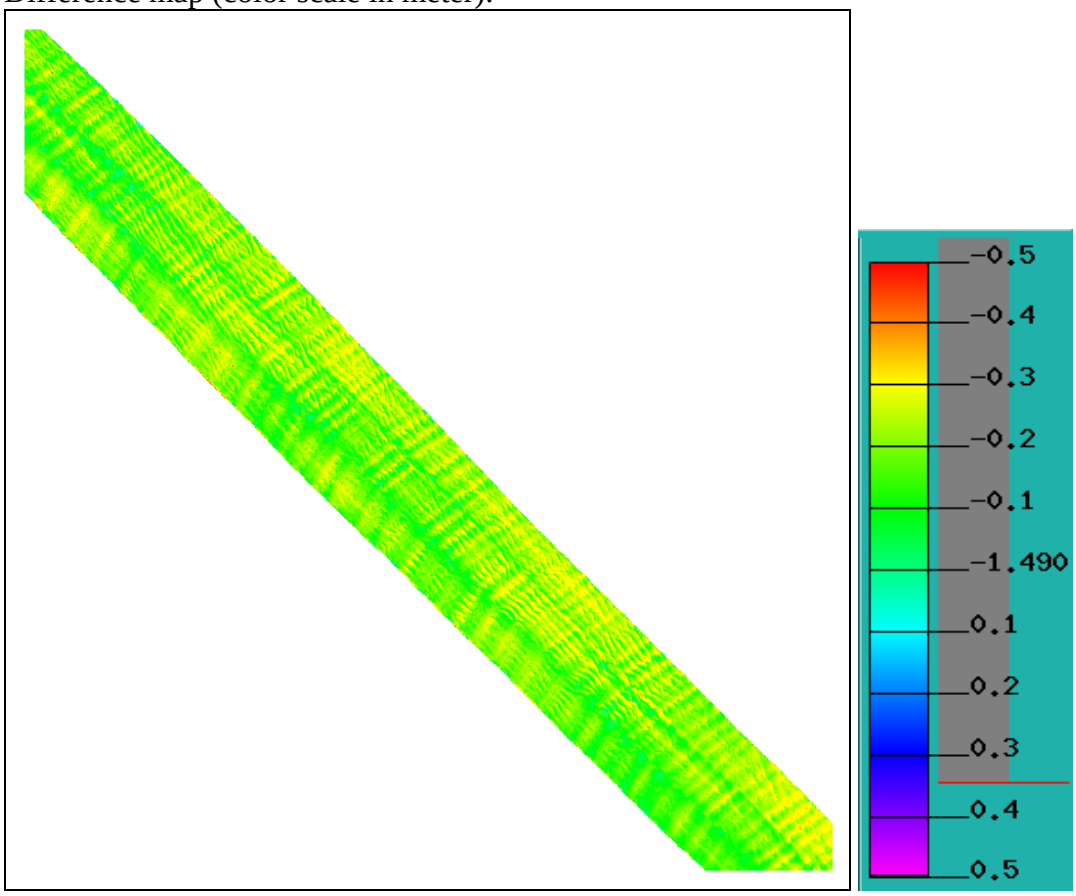
Ter Streep:



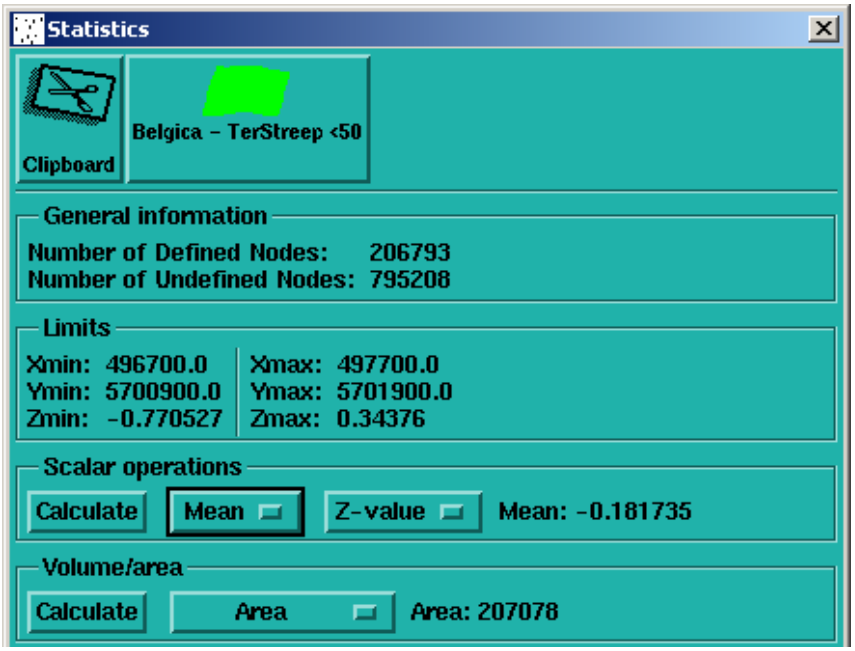
Mean difference: 20.12-19.95=0.17m

Based on this selection a 1mx1m grid was created for both data sets (using a simple inverse distance algorithm). The difference surface (Belgica – Ter Streep) between these 1x1m grids is calculated.

Difference map (color scale in meter):



Statistics of the difference surface:



Mean difference = 0.18m

Evaluation:

The strong across track artifact is clearly visible on the difference map.
The mean difference is very close to the value measured with the Belgica in the Vandamme sluis in Zeebrugge: average difference between Belgica depth measurement and theoretic floor of lock = 0.18m. This seems to indicate that the Belgica has a systematic draught error of app. 18cm and that the Ter Streep depths are correct.
The draught shift of the Belgica needs to be verified with a further calibration survey with the Belgica (the Demeysluis in Oostende is a good proposition from Kris) and a comparison with RTK calculated depths.

2.2. EM3002D Backscatter Strength data (BS)

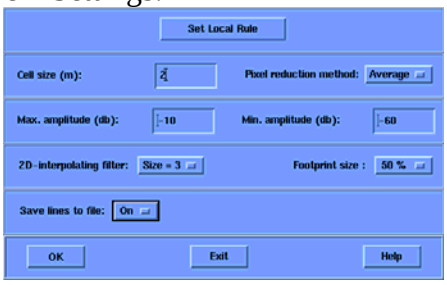
2.2.1. Processing of the 2 datasets:

Belgica	Ter Streep
0000_20091022_084257_Belgica.all	0000_20091022_085622_TerSTreep.all
0001_20091022_092128_Belgica.all	0001_20091022_093202_TerSTreep.all
0002_20091022_095854_Belgica.all	0002_20091022_100750_TerSTreep.all

BS grid = 2x2 m

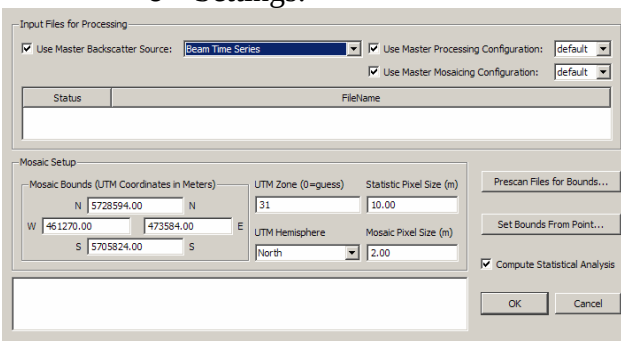
Use of 3 BS mosaicking softwares:

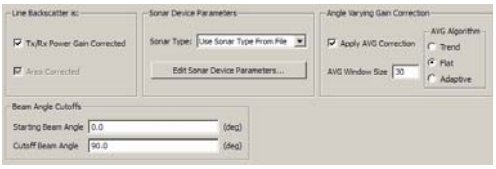
- Poseidon from Kongsberg:
  - Settings:



  - Followed by a 100 % histogram correction

- Geocoder from IVS
  - Settings:





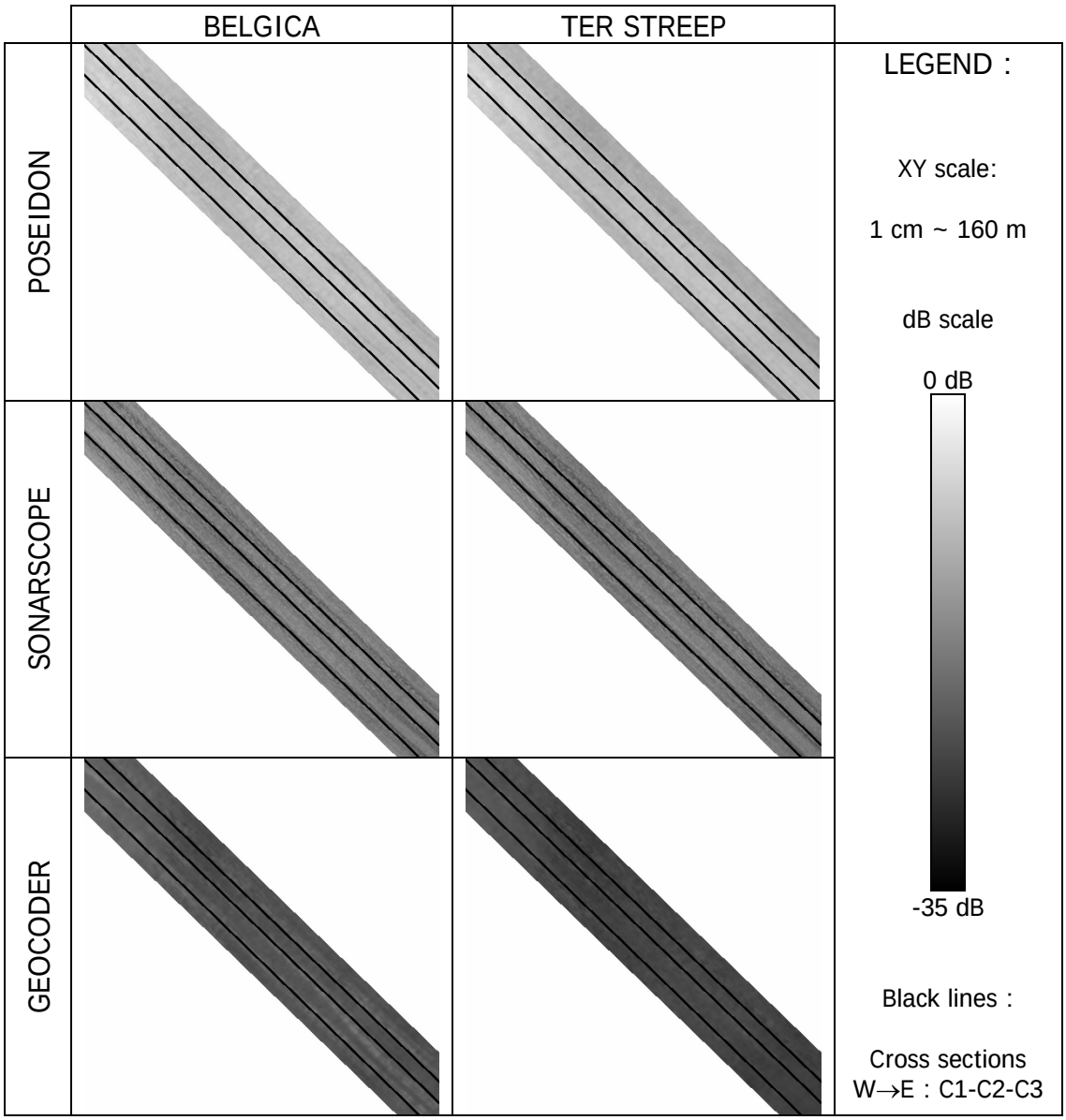
- SonarScope from Ifremer:
  - Processing done by Jean-Marie Augustin from Ifremer

2.2.2. Results:

Comparison of the mosaics:

- As demonstrated by the figure below, the mosaics computed by Poseidon, Sonarscope and Geocoder with the Belgica and the Ter Streep datasets are quite similar.

- However, the dB levels change dramatically from one software to another.



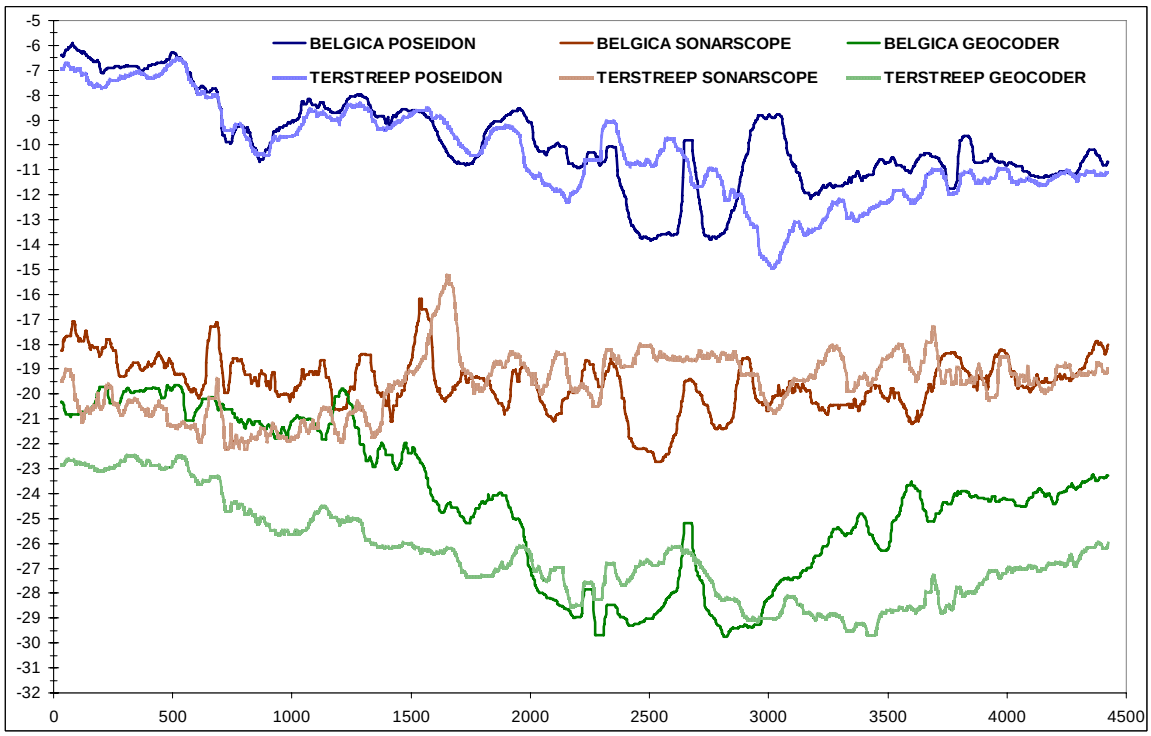
Statistics:

	CELLS	AREA (ha)	MIN (dB)	MAX (dB)	MEAN (dB)	MEDIAN (dB)	STD (dB)
BELGICA POSEIDON	200944	80.4	-25.6	-4.5	-10.8	-10.9	2.4
BELGICA SONARSCOPE	201104	80.4	-31.4	-11.6	-19.4	-19.5	2.4
BELGICA GEOCODER	200688	80.3	-33.3	-17.0	-24.9	-24.7	2.7
TERSTREEP POSEIDON	201136	80.5	-26.7	-4.1	-11.7	-11.5	2.8
TERSTREEP SONARSCOPE	201136	80.5	-31.0	-10.5	-20.2	-20.3	2.5
TERSTREEP GEOCODER	201136	80.5	-34.6	-20.8	-26.8	-26.9	2.1

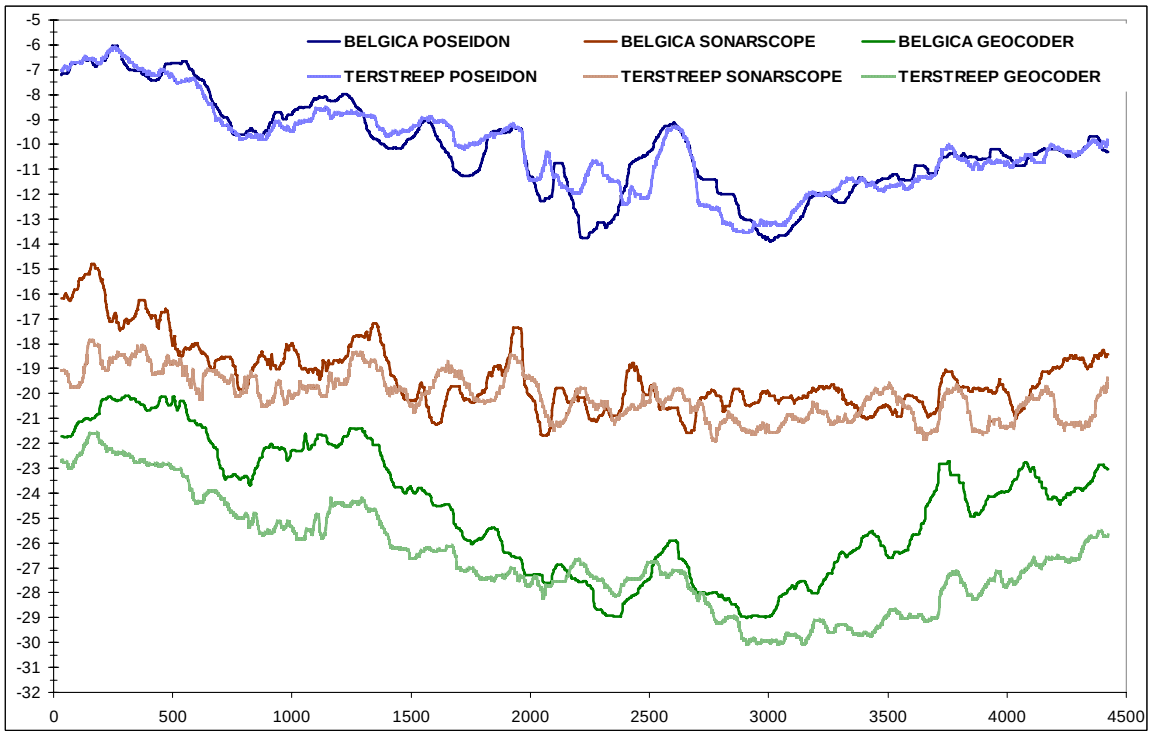
	Δ MEDIAN (dB)
BELGICA - TER STREEP POSEIDON	0.7
BELGICA - TER STREEP SONARSCOPE	0.7
BELGICA - TER STREEP GEOCODER	2.3

Cross sections:

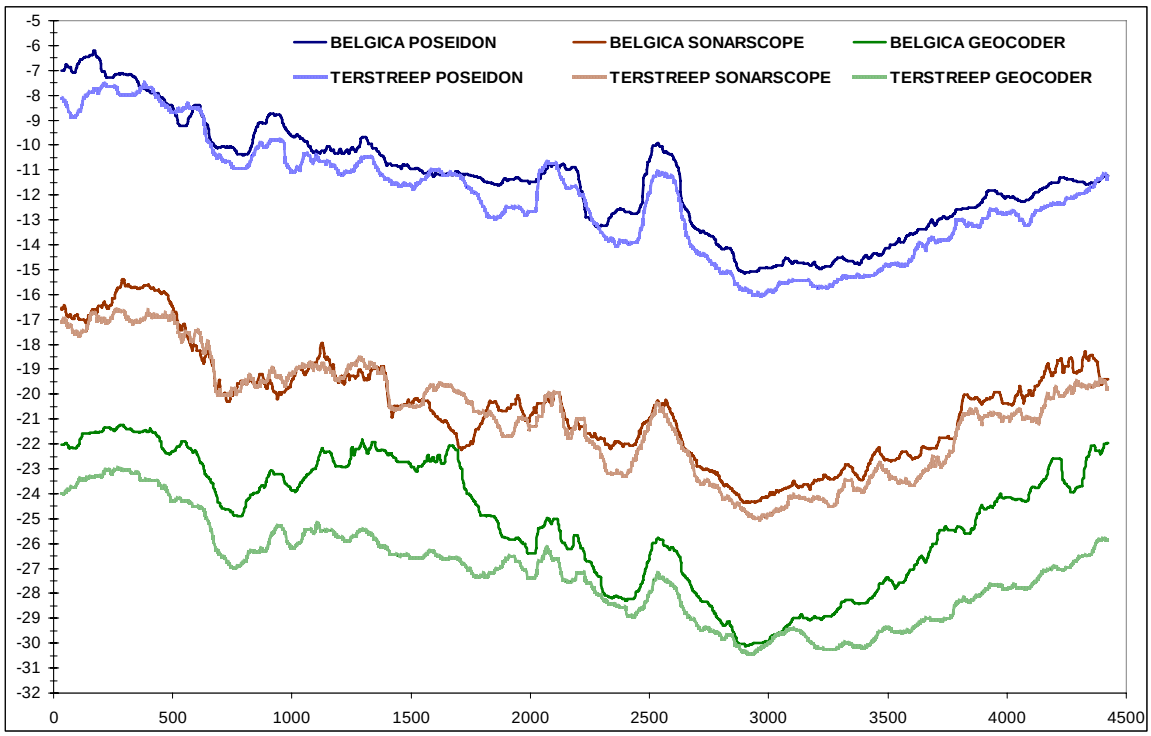
CROSS SECTION 1:



CROSS SECTION 2:



CROSS SECTION 3:



Comparison of the cross sections:

- As demonstrated by the 3 cross sections, the Belgica and the Ter Streep datasets BS values are quite similar.

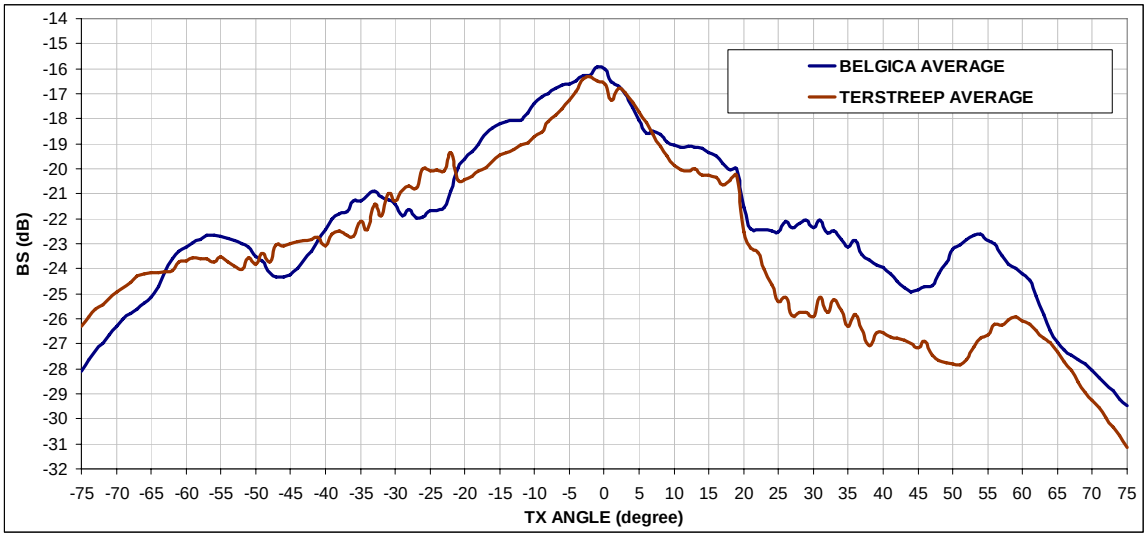
- However, the dB levels change dramatically from one software to another.

- Poseidon and SonarScope results are consistent: Belgica and Ter Streep curves are very similar.

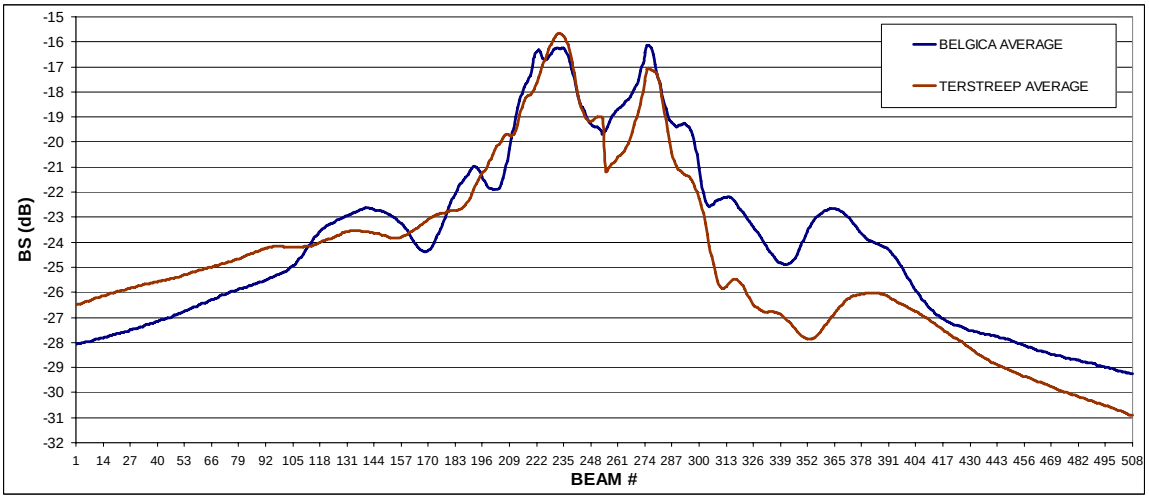
- Sections across the 2 mosaics computed with GeoCoder show a quite large difference between the Belgica and the Ter Streep BS datasets. That should be investigated more in detail.

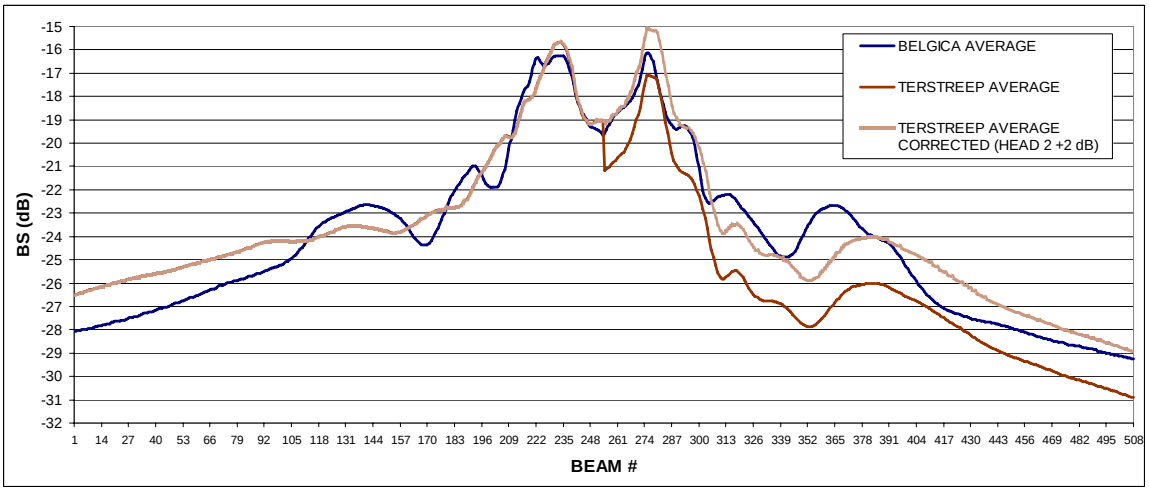
Calibration curves:

BS VERSUS TX ANGLE:

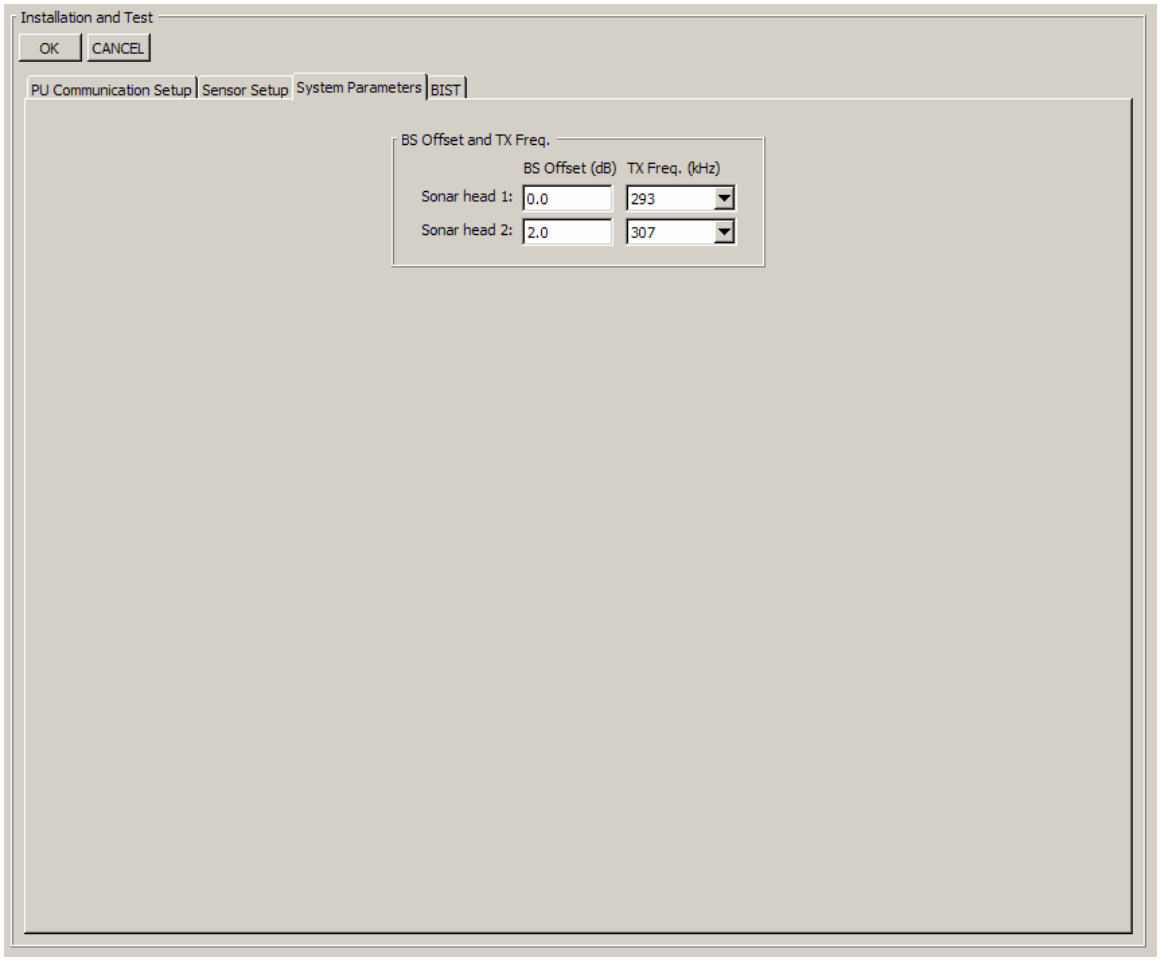


BS VERSUS BEAM #:





- An offset of 2 dB should be introduced for the Ter Streep Head 2. With this offset the 2 ships will have a very similar BS curve.


Installation and Test
OK
CANCEL
PU Communication Setup
Sensor Setup
System Parameters
BIST
BS Offset and TX Freq.
BS Offset (dB)
TX Freq. (kHz)
Sonar head 1:
0.0
293
Sonar head 2:
2.0
307

3. Conclusions

1. **Among the runtime parameters the absorption coefficient is especially important for the backscatter recordings. Since this parameter's primarily a function of water salinity and temperature it can vary considerable. A constant monitoring of both temperature and salinity is a minimum (in a mixed environment as the Schelde estuary knowledge of the evolution in time of the vertical profiles of both parameters is needed) to obtain comparable BS data.**
2. **Both the Ter Streep and Belgica data (less) show a across track artifact. This could be the sign of an inadequate heave correction. A recalibration or upgrade of motion sensor is a possible solution.**
3. **The phase ramp problem in the Ter Streep data is very clear and needs a solution from Kongsberg.**
4. **The almost constant depth difference between both transducers is most probably the impact of a problem with the Belgica draught correction. The same depth difference was measured during a survey with the Belgica in the Vandamme sluis. More calibration surveys with the Belgica are necessary.**
5. **The recorded backscatter data from both vessels is very similar. A compensation of 2dB for head two of Ter Streep would make both datasets interchangeable. An important issue is the choice of processing software. DB levels change dramatically from one software to another.**

Many thanks to the crews of the Belgica and Ter Streep for their valuable cooperation on this study.