

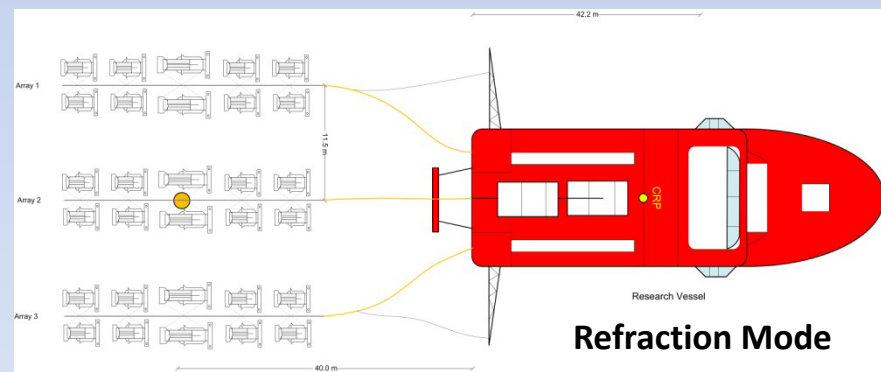
Reflexion Mode

Flip-flop mode also available

Maximum current source volume (5200 cu.in.):

- 1 Array of 2 strings with 5 positions (Gun Plates):
 - Each string (cu.in.): $520 - (380+380) - 520 - (250+250) - (150+150) = 2600$ cu. in.
 - Many multiple alternatives with our gun types and volume reducers combinations. Examples:
 - ✓ Each string (cu.in.): $520 - (380+380) - (250+250) - (150+150) - (150+150) = 2380$ cu. in.
 - ✓ Each string (cu.in.): $(380+380) - 520 - (200+200) - (110+110) - (70+70) = 2040$ cu. in.

Max. Shooting rate with our air generation		
Distance (m)	Survey Speed (Knots)	Max. Source capacity (cu.in)
12.5	4.5	1550
25	4.5	3100
37.5	4.5	4500
50	4.5	6200
Common refraction shooting rate (with one 900 cfm compressor) every 60, 90 or 120 seconds		



Refraction Mode

Maximum potential source volume (9180 cu.in.) :

- 1 Array of 3 strings with 5 positions (Gun Plates). Example:
 - Each string (cu.in.): $520 - (380+380) - (250+250) - (380+380) - 520 = 3060$ cu. in.

Maximum UTM current source volume (6000 cu.in.) :

- 1 Array of 3 strings with 5 positions (Gun Plates):
 - Each string (cu.in.): $520 - 380 - (250+250) - (150+150) - (150+150) = 2000$ cu. in.

Remarks: all SERCEL® GGUN-II type



- **Air Gun** : GGUN-II
- **Manufacturer:** SERCEL®
- Powerful, reliable, compact and a high degree of repeatability
- Wide range of volumes: 520, 380, 250 and 150 cu.in. chambers
- Clean, consistent time break pulse easy to process
- Deployed and retrieved without being pressurized at all
- Pressures up to 3.000 psi
- No internal lubrication required

- [150 cu.in.](#): 55 kg (597x292x287 mm)
- [250 cu.in.](#): 65 kg (597x292x287 mm)
- [380 cu.in.](#): 85 kg (640x292x287 mm)
- [520 cu.in.](#): 90 kg (640x292x287 mm)

- **Air Gun** : 1500LL y 1900LL
- **Manufacturer** : BOLT®
- Large volume chambers. Excellent low frequency generation
- Largest peak to peak amplitude on the market
- “Long Life”. High efficiency and robustness
- 1900LL Chambers: 10 - 380 cu.in.
- 1500LL Chambers: 40 - 2000 cu.in.
- Max. Working pressure: 3000 p.s.i.
- Far field 20% more efficient as a cluster, for the same volume
- Big peak to bubble ratio

- [40 cu.in.](#): 55 kg (265x290x280 mm)
- [95 cu.in.](#): 65 kg (275x290x290 mm)
- [255 cu.in.](#): 96 kg (500x330x350 mm)
- [500 cu.in.](#): 112 kg (700x400x370 mm)
- [1000 cu.in.](#): 144 kg (1080x380x370 mm)

GGUN-II Bodies	Current stock
520 cu.in. Volume	4
380 cu.in. Volume	5
250 cu.in. Volume	7
150 cu.in. Volume	16
Volume reductions for 150 cu.in. Body	Currently available
45 cu.in.	4
70 cu.in.	4
90 cu.in.	4
100 cu.in.	4
110 cu.in.	2
Volume reductions for 250 cu.in. Body	Currently available
200 cu.in.	2

1500LL Bolt Bodies	Current stock
1000 cu.in.	2
500 cu.in.	2
330 cu.in.	1
265 cu.in.	1
255 cu.in.	1
175 cu.in.	1
165 cu.in.	1
1900LL Bolt Bodies	Current stock
140 cu.in.	1
95 cu.in.	1
85 cu.in.	1
55 cu.in.	2
40 cu.in.	2



High air pressure Compressors

- **Compressor:** 25/138-207E
- **Manufacturer:** LMF®
 - **Number of stages:** 4
 - **Compressed medium:** air
 - **Inlet pressure:** 1,013 bara = 14,65 psia
 - **Inlet temperature max.:** 45°C = 113°F
 - **FAD 1 (at inlet conditions):** 25 m³/min = 900 cfm
 - **Discharge pressure 1:** 138 bar = 2000 psig
 - **Discharge pressure 2:** 207 bar = 3000 psig
 - **Nominal speed of main drive (screw):** 1000 rpm
 - **Nominal speed of piston compressor:** max. 1000 rpm
 - **Power consumption:** 400 kW
 - **Operating voltage:** 3 x 660 V / 440 V
 - **Control voltage:** 230 V AC / 24 V DC
 - **Frequency:** 50 Hz (cps)
 - **Length:** 5540 mm
 - **Width:** 2440 mm
 - **Height:** 2140 mm
 - **Weight (wet/dry):** 18000 kg / 16900 kg



Indoor Sarmiento's
LMF® compressor



Outdoor Sarmiento's
LMF® compressor

The engine parts are stored into a high-cube 20 feet container. The frequency variator and electronic devices are mounthen inside a stardard 10 feet container.

Dimensions and weight - compressor unit without container

Multichannel Streamer

- **Manufacturer:** SERCEL®
- **Model:** Sentinel® SSAS
- **Hydrophones per group:** 8
 - **Sensitivity:** -193 dB re 1 V/μPa ± 1,5 dB (22,4 V/bar) @ 20°C
 - **Group capacitance:** 260 nF@ 20°C
 - **Group sensitivity (electronics included):** 19.7 V/bar @ 20°C
 - **Recording:** 3-200 Hz @ G1600 700 nV RMS, @ G400 200 nV RMS
 - **Distortion:** -105 dB
 - **Gain Accuracy:** < 0.1%
 - **Phase Accuracy:** 20 μs
- **Field Digitalization Unit:** FDU 2F one for two channels, A/D conversion
- **Groups per section:** 12
- **Typical group spacing:** 12.5 m.
- **Nominal section length:** 150 m.
- **Max. Active Section CSIC:** 6000 m. (40 sections, 480 channels)
- **Total length CSIC:** 6275 m.
- **Dimensions:**
 - **Streamer diameter:** 59.5 mm
 - **Jacket:** Polyurethane, 3.5 mm wall
 - **Operating temperature:** -10° to +40°C
 - **Maximum operating depth:** 30 m
 - **Maximum survival depth:** 250 m
 - **Filled section weight in air:** 419 kg ± 10 kg
 - **Operating tension:** 58 Kn
 - **Maximum Retrieval Tension:** < 26 kN



Multichannel Streamer Winch

- **Manufacturer:** IBERCISA®
- **Model:** Sarmiento
- **Features:**
 - **Inner Diameter:** 1600 mm
 - **Outer Diameter:** 1975 mm
 - **Streamer length capacity:** 3450 meters
 - **Max. Power:** 49000 Nm
 - **Hydraulic pressure and flow:** 180 bar ; 80 l/min.
 - **Hydraulic motor:** HAGGUNDS CA100-S

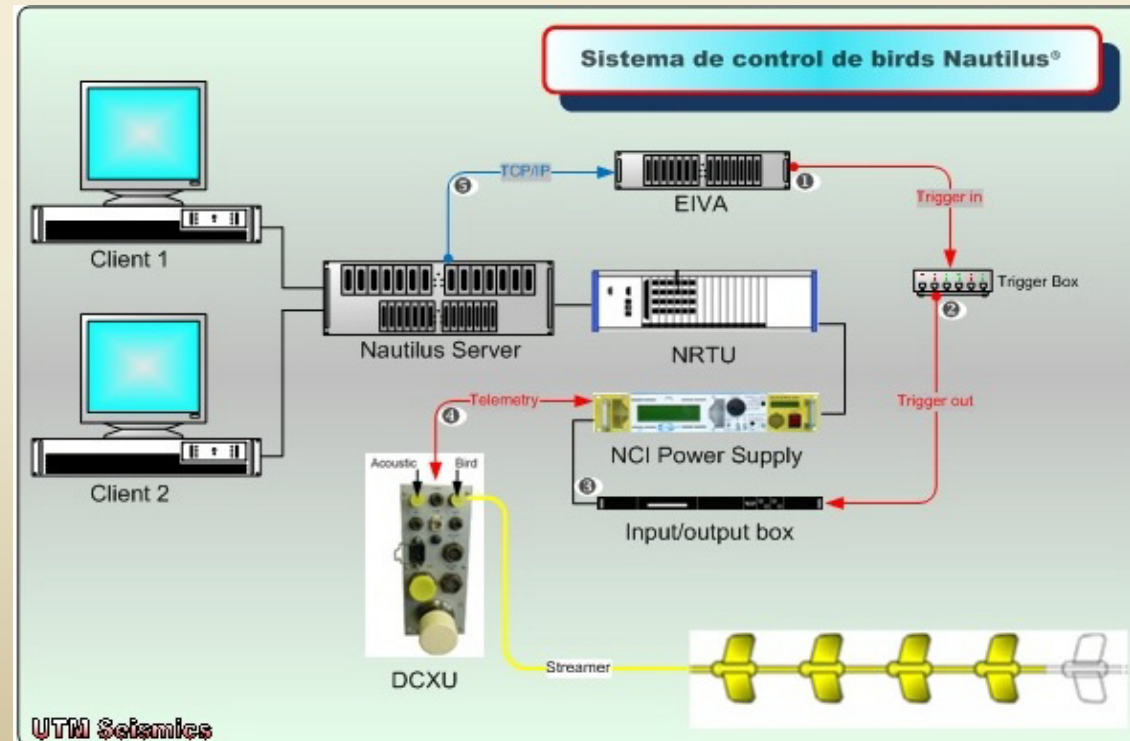
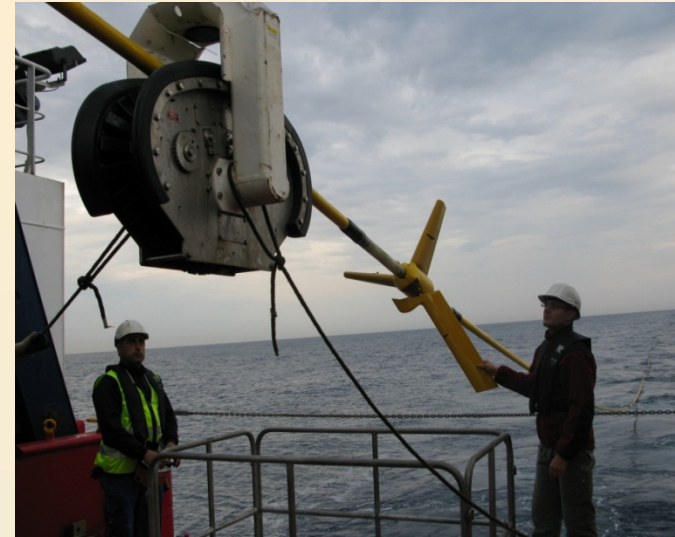
Compass-Retrievers

- **Manufacturer:** OYO GEOSPACE®
- **Model:** HSRD-500
- Combines a marine streamer heading sensor with a streamer recovery device
- Wireless communication via acoustic coils (nested within the streamer)
- All mission critical components sealed from seawater
- Replaceable Ion-Lithium batteries and recharge kits allows actuated units to be refurbished anywhere
- Externally visible flashing LED assures integrity of batteries and firing circuit
- Magnetic switch to deactivate this mechanism to avoid an accidental release
- Battery dual system for compass and retriever
- Resisting seawater corrosion
- Retriever: Automatic trigger system activated when the streamer sinks to a depth of approximately 48 meters or pressure of 70 psi.



Birds or streamer depth control devices

- **Manufacturer:** SERCEL®
- **Model:** Nautilus
- Streamer levelling & streamer steering in a single device
- Single in-line canister for all functions: levelling, steering, acoustics, telemetry
- In-line acoustic transceivers
- Powered by the streamer with internal rechargeable battery for operation during streamer maintenance
- Redundant telemetry and power
- Acoustics based on a patented modulation and time derivation scheme allowing standard deviation to be determined for each range measured
- Flexible on-board controller:
 - Self-contained Graphical User Interface for full control of acoustic network and depth and steering controllers
 - Fully integrated with all Sercel on-board products such as SeaPro Nav, Seal, eSQC-Pro, etc.
 - Open interface for integration with any navigation system



Tail Buoy + RGPS

- **Manufacturer:** PARTNERPLAST®
- **Model:** 800
- System components:

GPS Remote module:

- Receive the DC power from the Tail buoy or the streamer.
- Receive the GPS satellite signals from the internal satellite antenna/receiver and pass the data to the internal UHF transceiver or streamer or both.
- Receive synchronizing and command signals from, and transmit GPS data and status data to, the Master Radio Module on the Recording Vessel via the internal
- UHF radio transceiver and its external antenna or streamer or both simultaneously directly to the Buoylink PC
- The wire transmission is limited to approximately 6km with 2400baud

Master radio module:

- Transmit, via the radio telemetry link, synchronizing/timing and command signals to all the remote units in the network using radio.
- Receive, via the radio telemetry link, GPS and status data from all the remote units
- Accept programming information from the control PC to change the parameters of the radio transceiver in this module.

Master GPS interface unit:

- Provide DC power to the Master Radio Module
- Provide an interface for the remote unit data between the Master Radio Module and the control PC

PC with EX-SEAMAP® Buoylink

- Control the radio telemetry and RS485 networks of remote modules
- Collect GPS data, process and display this GPS data to give a range and bearing from the Master to each unit, and distribute the data to other users



Side boomer for towed equipment

- **Manufacturer** : FERRI®
- **Modelo**: Sarmiento

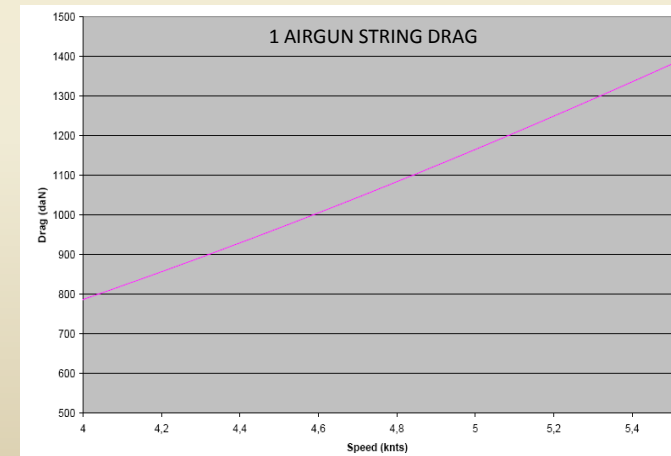
Bi-lateral side boomer system provides moving laterally stern towed equipment.

Essential for simultaneous works with equipment or stern cables, to prevent hook, resulting in shutdown periods.

Is a safe and effective method to appart different deployed devices. In a multichannel seismic scenario, several km of streamer is deployed by centreline, therefore it is necessary to use a side boomer to separate the source strings from the streamer.

Precise specifications are needed to hold a high tension. It is necessary to move an array of 10 guns equipped with float so the side bar must support more than 900 kg and a high friction force. It has been modelled the resistance force of an array of guns with similar characteristics to ours vs. sounding rate.

The results are shown on the graph beside.



**Some issues with a portable
system on a multipurpose vessel**

Installing a large seismic system in a multipurpose vessel

- Heavy load of the entire seismic system required structural reinforcement of the ship working deck.

PESO MÁXIMO DEL ESCENARIO DE SISMICA CON MAYOR CAPACIDAD			
EQUIPO	CANTIDAD	PESO UNITARIO (Tonnes)	PESO (Tonnes)
Compresor LMF	2	25	50
Variador de frecuencia + Electronica Compresor LMF	2	9	18
Estructura de sísmica Sercel	1	16	16
Twin winch umbilicales Sercel	1	10	10
Winch Ibercisa + 3000 m Streamer Sercel	2	28.5	57
Container almacén/taller UTM	1	5	5
Container adquisición sísmica UTM	1	3	3
TOTAL			159

Installing a large seismic system in a multipurpose vessel

- Cooling of 2 large compressors had not been originally planned for all scenarios during ship building and in hot weather has produced some issues.**
- The 2 compressors produced some harmonics that interfered with ship 3 generators. It has required some work to fix.**

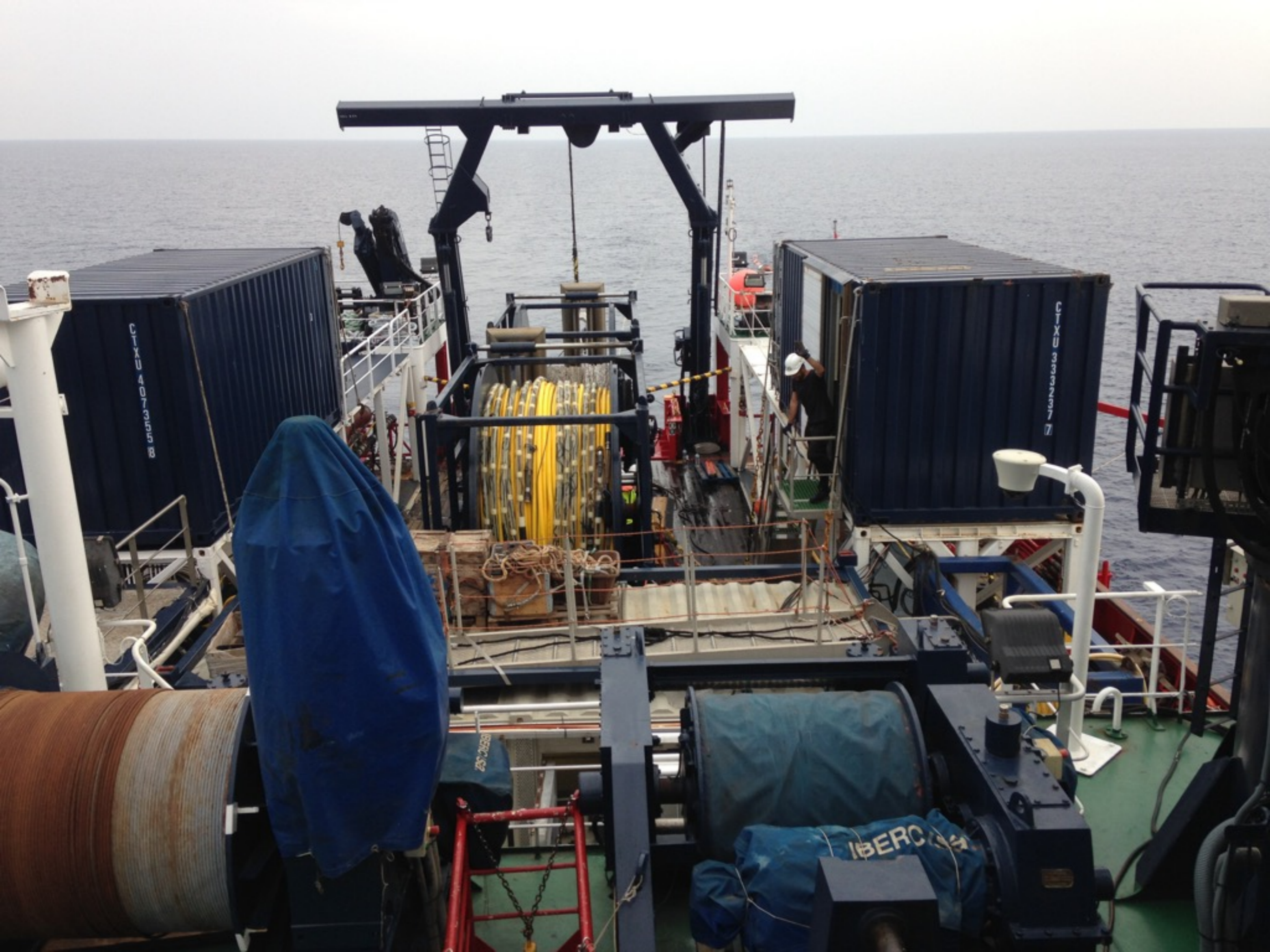
Gun Arrays Onboard Frame

- The frame to deploy and retrieve the gun arrays was originally designed by Sercel but did not work well because they had not had the need to make one for a multipurpose ship. Umbilicals etc.. were fine.
- The current frames for guns arrays were designed by UTM-CSIC and build at a shipyard in Vigo (Spain).









Guns and Streamer Open Issues

- G-II guns from Sercel can work to 3000 psi (200 bar) but it is not obvious how to operate them for large arrays where large guns in strings are relatively close. There are many break downs or components (pigtailed etc..) and we have mostly operated them at 2000 psi (140 bar) for regional seismic lines.**
- In Feb 2015 SERCEL communicated some previously unknown problem for the Sentinel streamer original design. The connector for birds and active sections (150 m long sections) need to be changed to a new system or the streamer can not be deployed longer than 4 km. Estimated cost about 300k €.**