Requirements and Limitations for the Main Electro-Optical Cable

- Energy Power Requirement
- Data Transmission Requirement
- Distribution Network
- Batimetric Study
- Cable Deployment
- Cable Protection
- Maintenance
- On Shore Requirement
- Submarine Cable Trends

Energy Power Requirement

Telescope Electrical Power Budget

Estimated power for the km^3 is 50 kW included the Associated Science nodes

Transmission Requirement

Telescope Data Rate

Architecture of the telescope data transmission system

Number of Fibers in the Backbone Cable

Fibers Limit

- Before DWDM Unreapetered Submarine Cable (No Electrical Power):Big Amount of Fibers
- DWDM Advent Limited Fibers Amount Also in Unreapetered Submarine Cable
- Reapetered Submarine Cable (Electrical Power Transmission) Limit to 40 Fibers (Alcatel OALC 7-20 mm)
- High Numbers of fibers Limitations also due to Connection and Jointing systems

ICPC Recommendation

ICPC is the International Cable Protection Committee that gives recommendations to the Cable producers and Cable owners

ICPC Recommendation No. 2, Issue: 9. Date: 20 March 2006

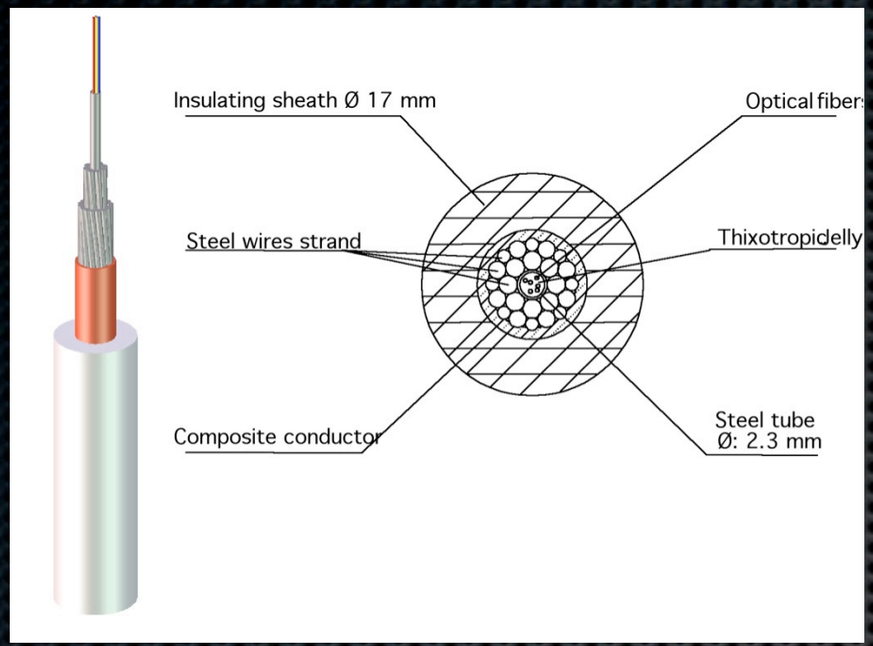
Recommended Routing and Reporting Criteria for Cables in Proximity to Others

- Parallel cables:

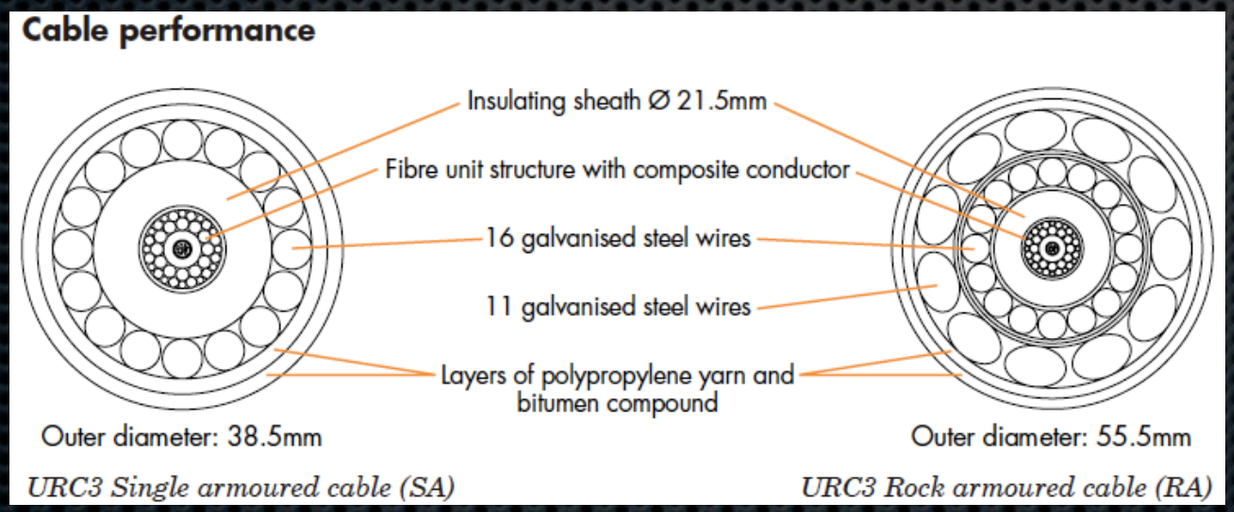
  Where cables parallel one another, the distance between them shall be maintained at 3 times depth of water where possible or 9 km, whichever is the lesser. However, with the use of modern navigational equipment and lay/repair practices, these distances could be reduced to 2 times depth of water and 6 km spacing, whichever is the lesser, after consultation and agreement by all affected parties.

All Cableship companies take into account the above recommendation

Operating Cables in Neutrino Experiments



NEMO Phase 2 Cable: Alcatel OALC 4 - 17 mm Type 31
Fibers Number 20



Antares Cable: Alcatel URC 21.5 mm
Fibers Number 48

NEMO System Lay Out

Shore Station

PFE

Total Lenght 100 km

20 Fiber Optics
ITU-T G655

Single Conductor

CTA

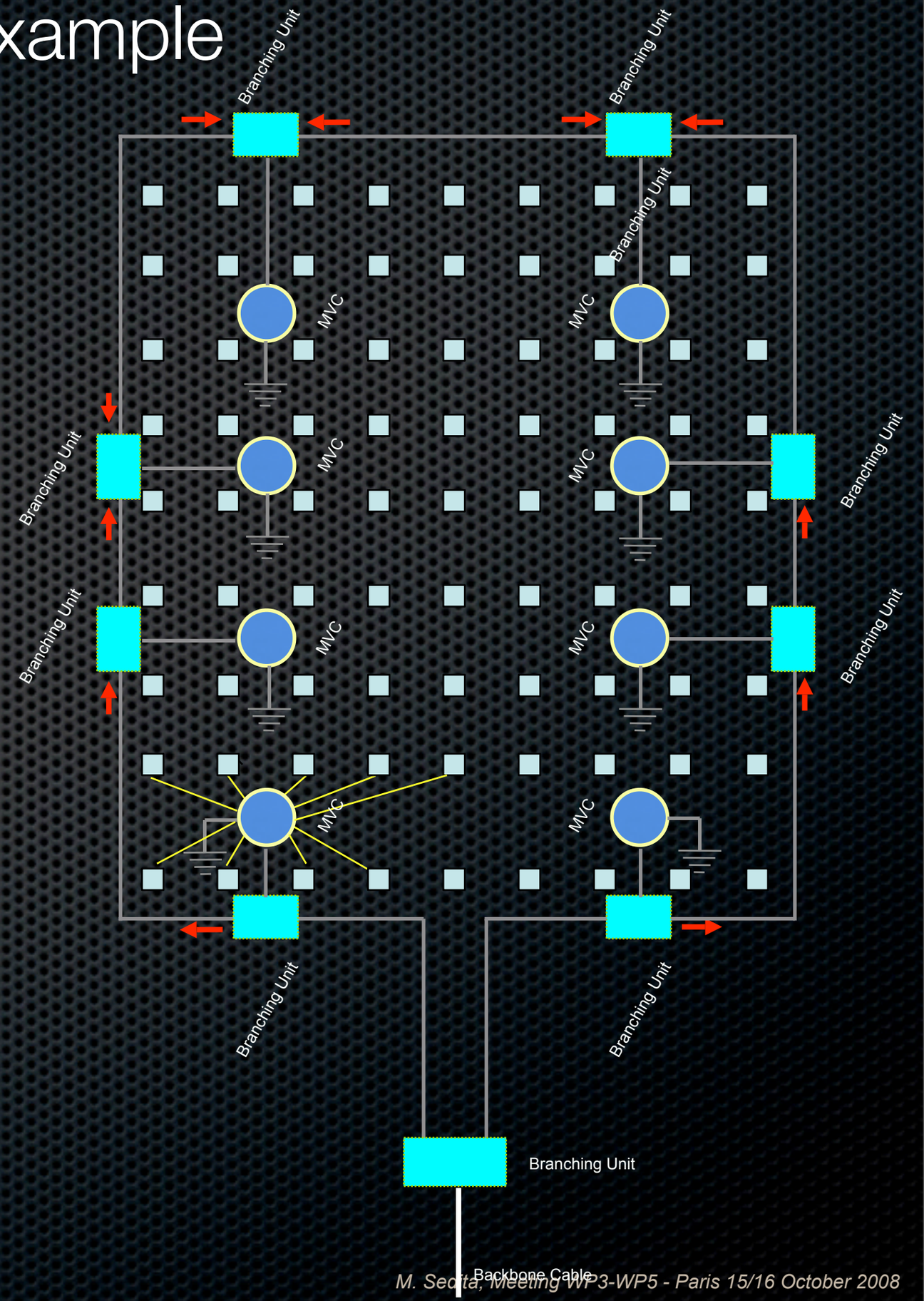
DC/DC

3.500 m
Depth

Alcatel OALC - 4
17 mm Type 30

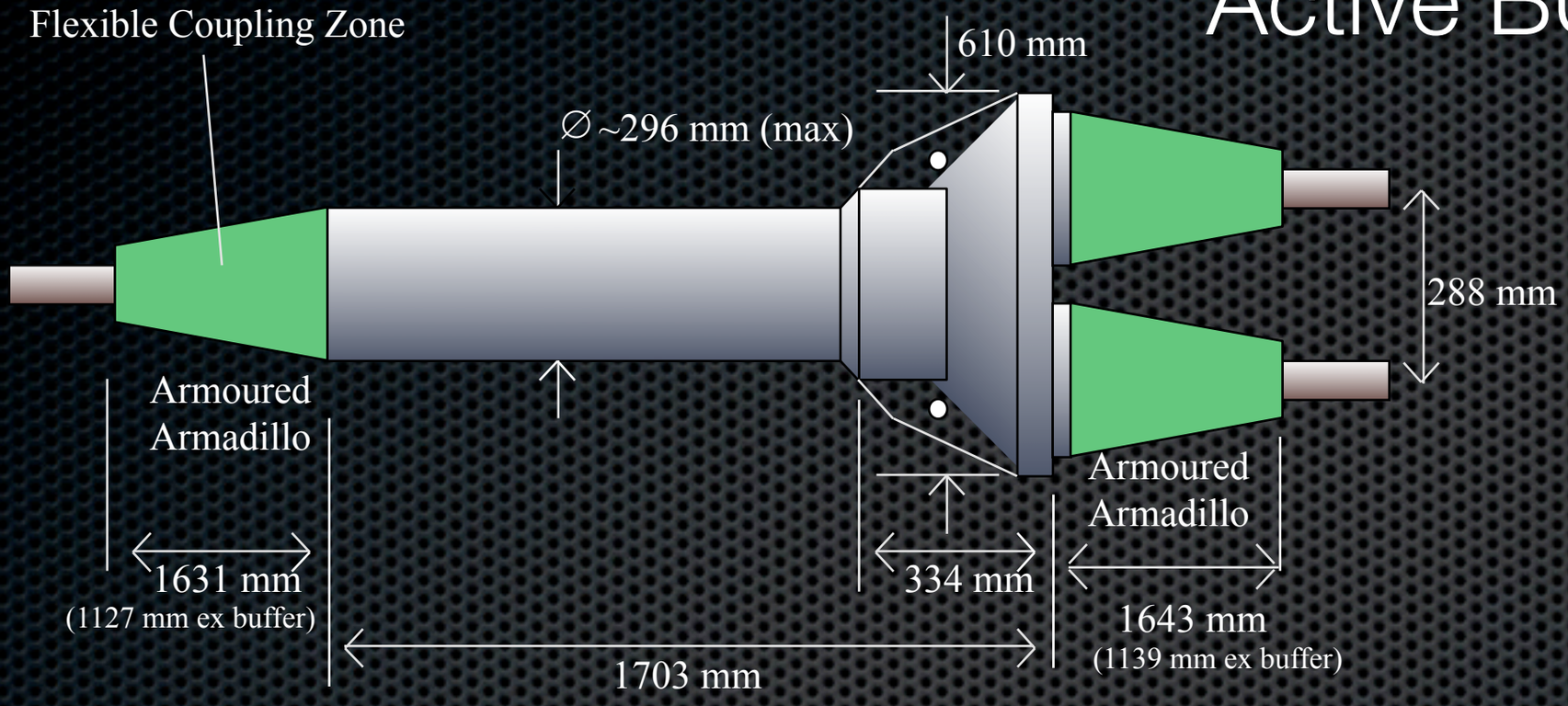
Network Distribution an Example

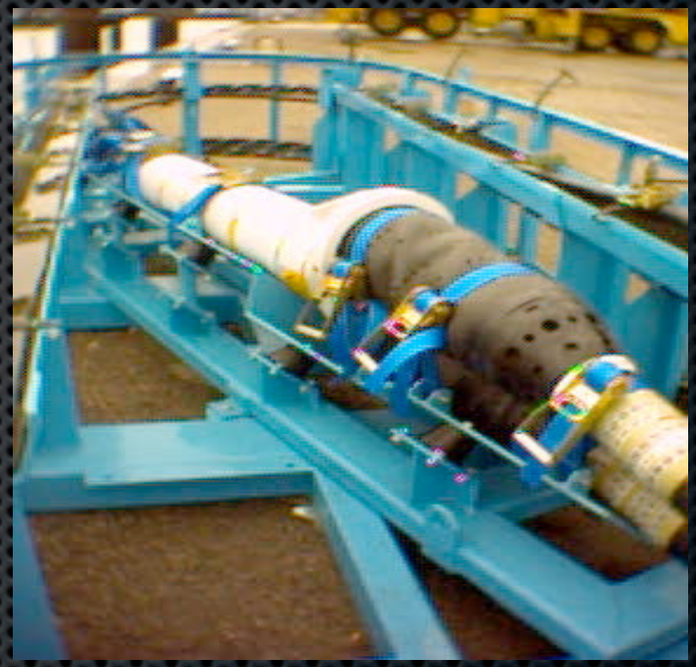
- 10 KV DC transport required due to network size and distance from shore
- Parallel mode is the only way to have large amounts of power at each BU (10 KW)
- DC/DC conversion is mandatory (MV Converter)
- Not a constant current linear network but a DC power grid!



Main Cable Distribution Elements

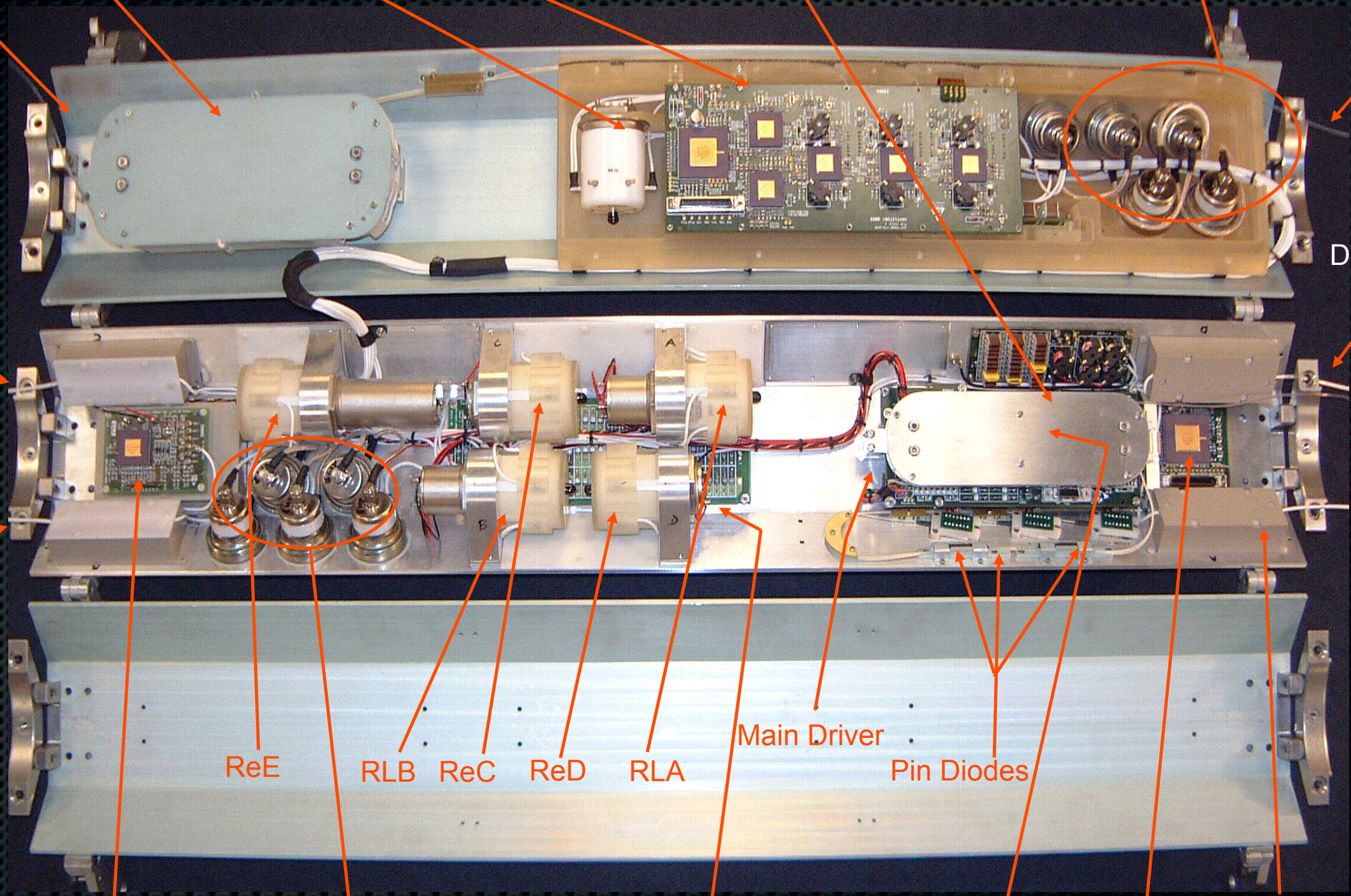
Active BU



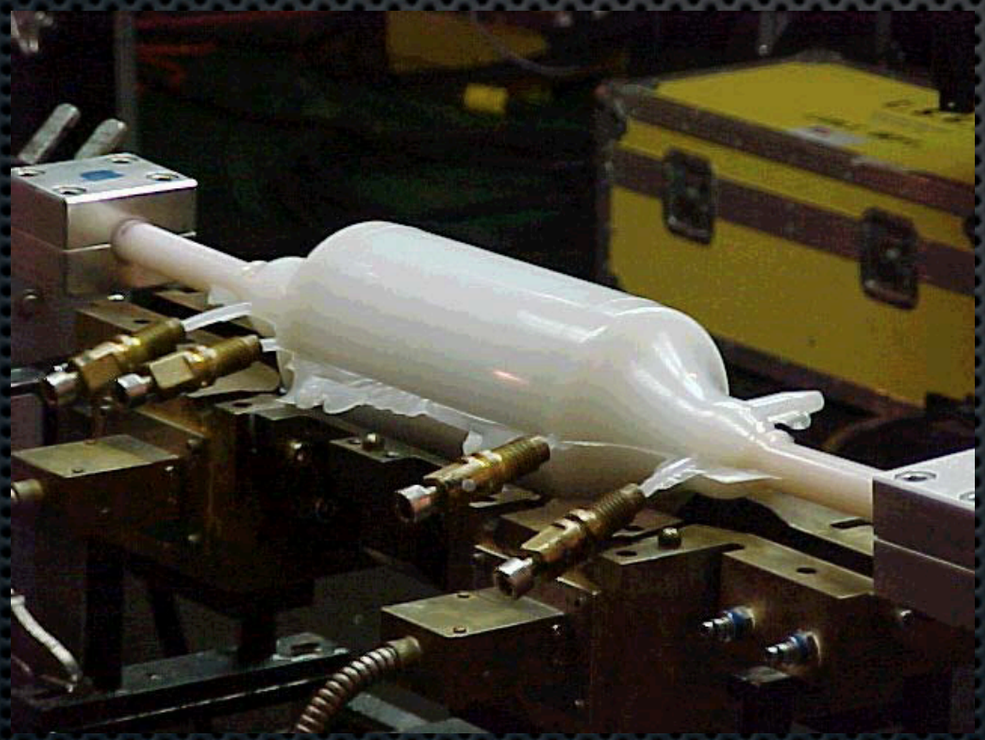


NEMO Cable Termination Assembly

Active Branching Unit



The Universal Joint

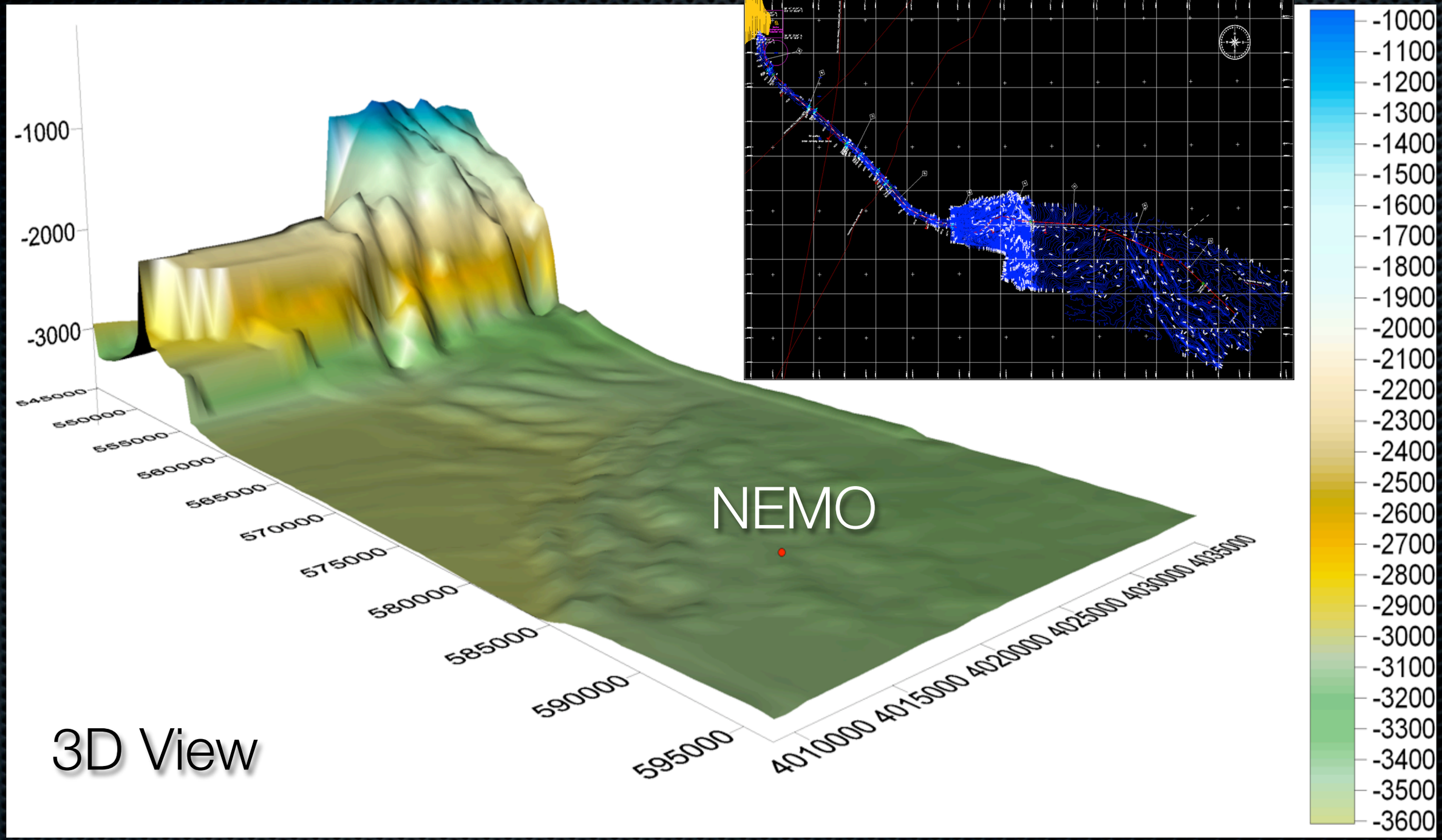


The Universal Joint (UJ) is well established as a core industry technology for submarine telecommunications cables having its roots in the first optical cables systems which has evolved as optical cable technology has developed and grown.

This was established early in the 20 years of the subsea optical fibre telecommunications industry and continues to incorporate the changes to cable technology to an ever changing customer base of system owners, maintenance providers and system suppliers.

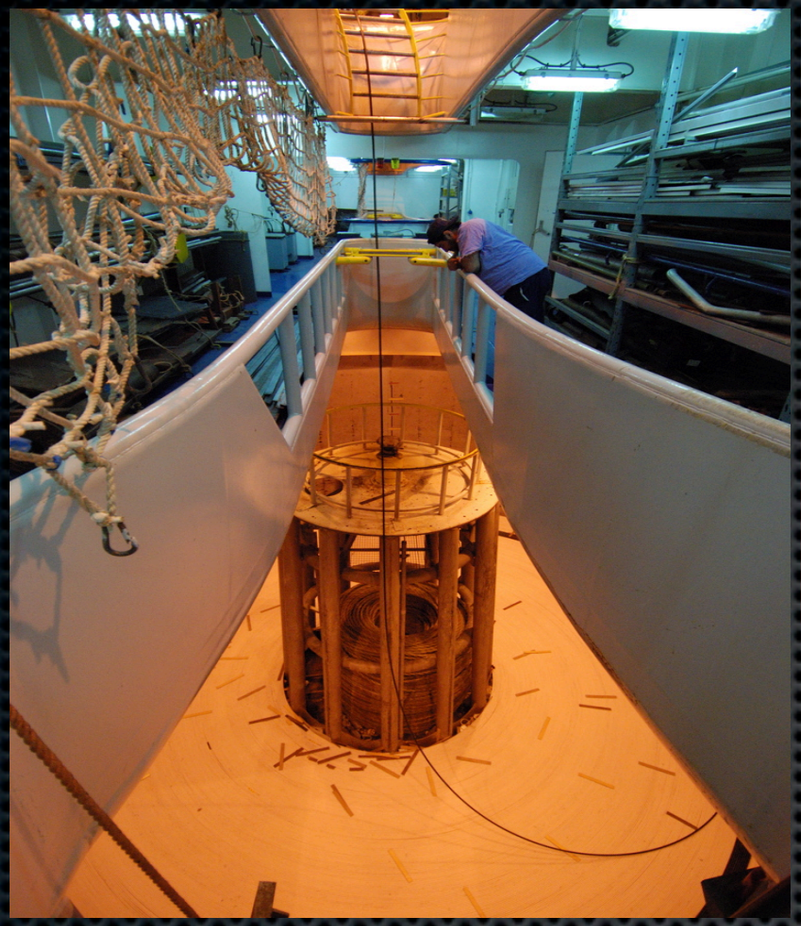
The Universal Joint permits to connect the commercially available submarine cables (max 40 fibers).

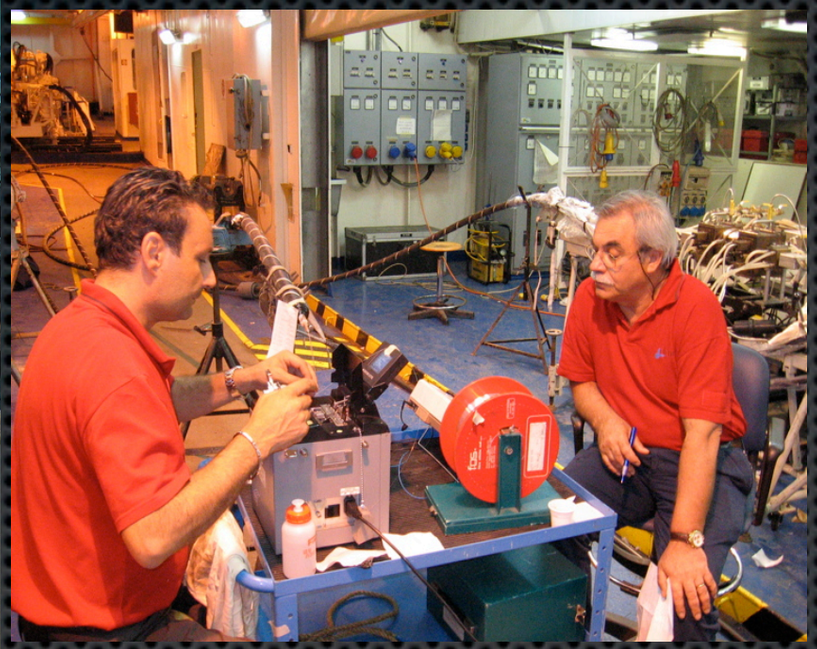
Bathymetry of the cable path and termination area in Capo Passero

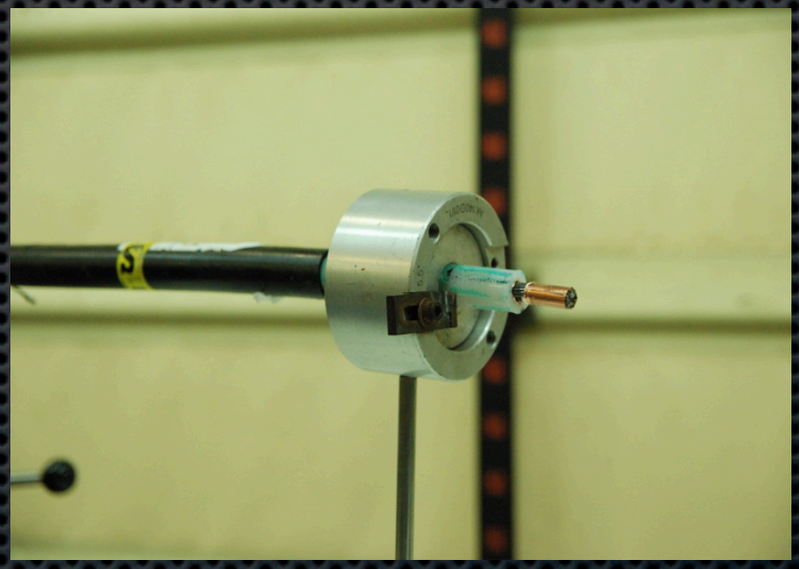


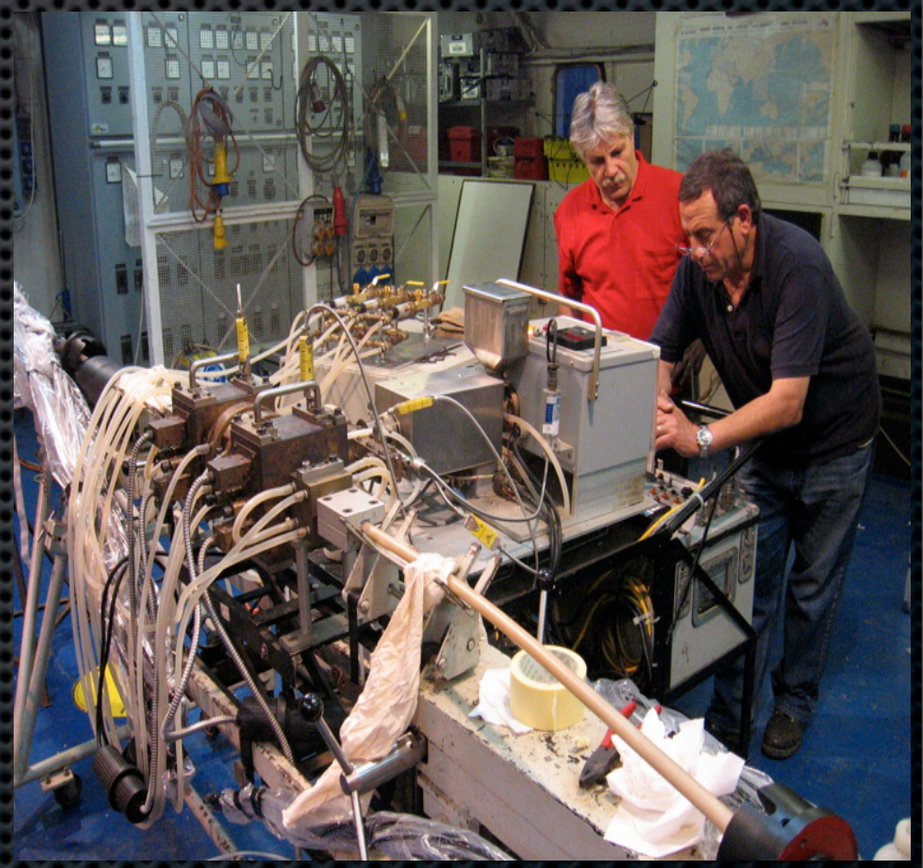
3D View

Cable Deployment of NEMO Cable



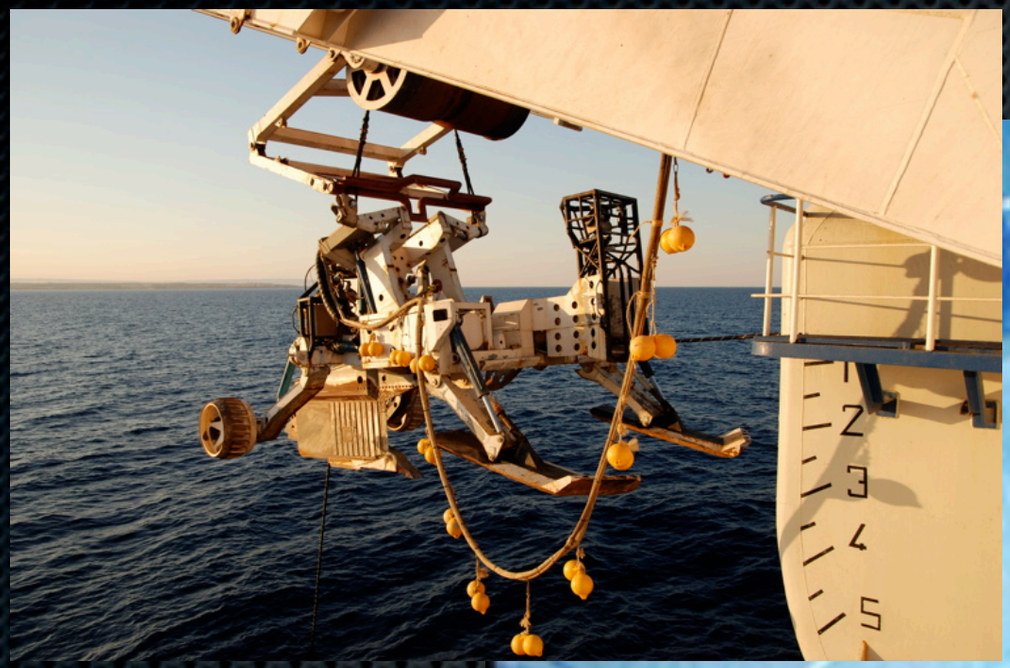


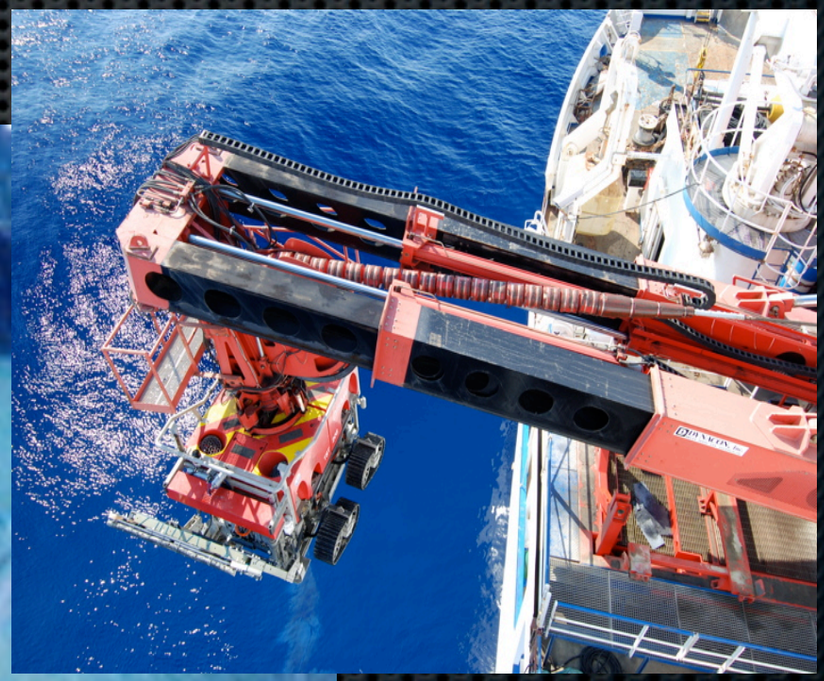




Cable Protection

The Buryal Activity on NEMO Site

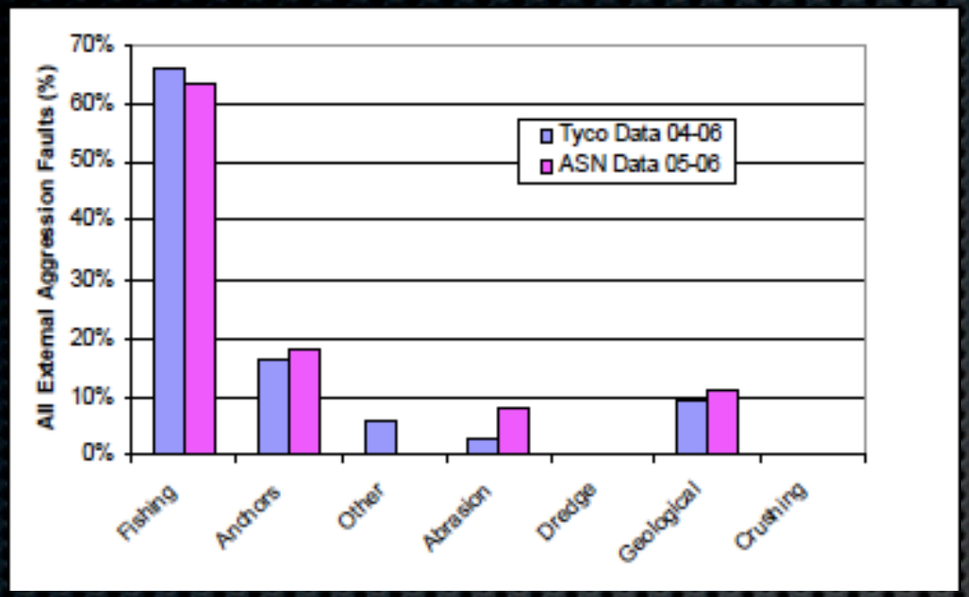




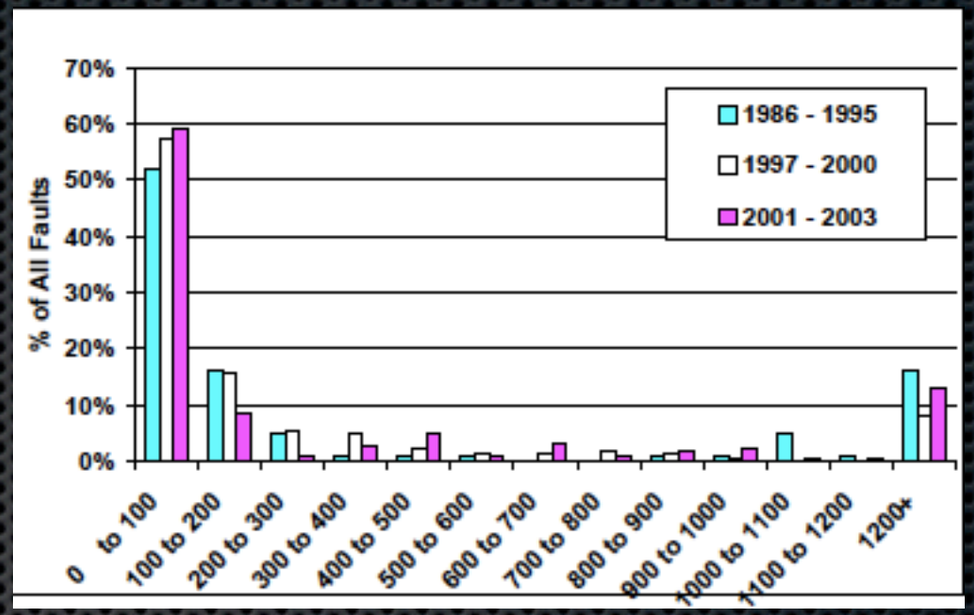
Soft Soil

Hard Soil

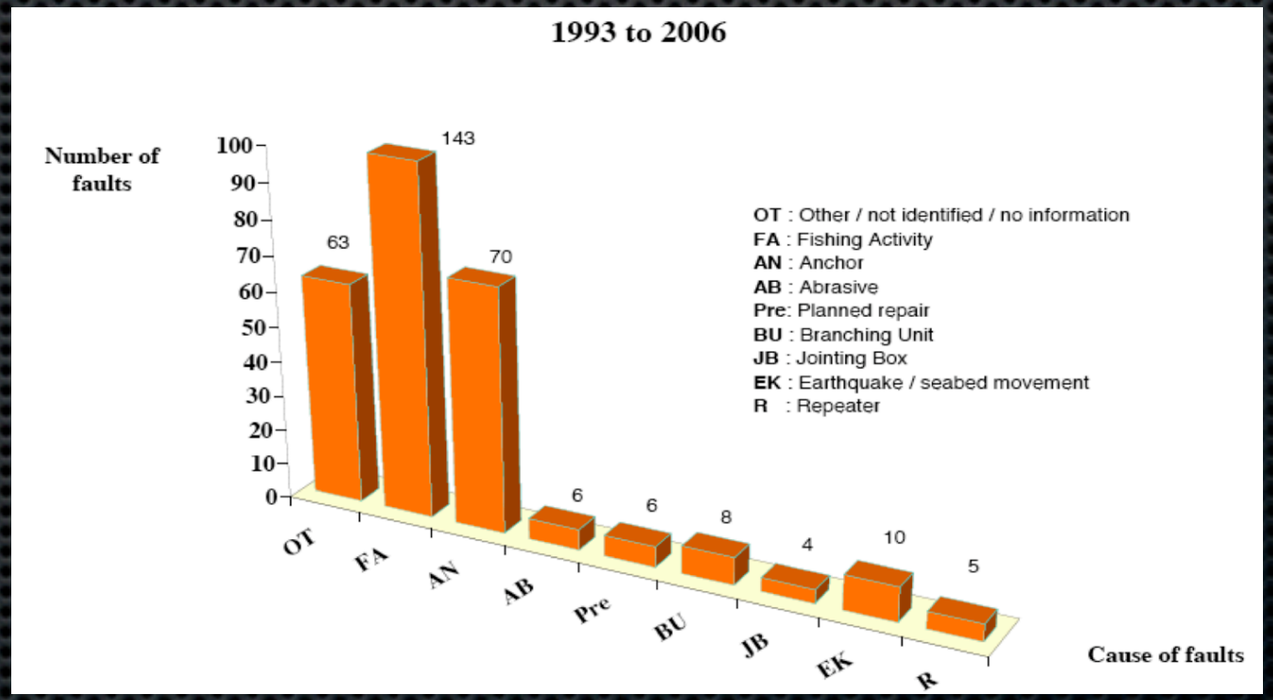
Submarine Cable Faults



External Aggression Faults for all Water Depths



Depth Distribution of all External Aggression Fiber Optic Faults



MECMA cables causes of faults

M. Sedita, Meeting WP3-WP5 - Paris 15/16 October 2008

Submarine Cable Damage

Effects of deep sea currents, abrasive abrasive ridge and rocky anchors

Cable Maintenance
The MECMA Consortium

The MECMA Cable Ship and ROV Running Costs

Year: 2008 and 2009 Cable Ship: Rene Descartes	Repair Operations In Base Port	On Passage	On Ground/ Cable work	Other Costs per Operation
Fuel Details				
i) Fuel (1)				
- Consumption	2 tonnes per day	34 tonnes per day	20 tonnes per day	
- Current price	Euro 495.8/ tonne	Euro 349.36 /tonne	Euro 349.36 /tonne	
Ii) Lube Oil (1)				
- Consumption	28 lts/day	150 lts/day	200 lts/day	
- Current price	Euro 1.24 /lt	Euro 1.24 /lt	Euro 1.24 /lt	
Costs	Euro per day	Euro per day	Euro per day	Euro per Operation
i) Fuel	992	11,878	6,987	
Ii) Lube Oil	35	186	248	
v) Port Charges (Applicable to ports not being the vessel base port)				Depending on the relevant port
vi) Cable Handling (Applicable to ports not being the vessel base port)				Depending on the depot
- Loading				
- Unloading				
- Port Due				
Ix) Miscellaneous Costs				
Includes but not limited to:				
Representative's on board				
Operational Communications				
Specialist Navigation Services				
Representatives Victualling, communication etc				
Shallow Draft Platforms and associated personnel etc				To be agreed with the Maintenance Authority when incurred
Tugs				
Guard Vessels				
Local taxes, duties				
Permits and seabed recovery costs				
Import duties and local customs				
Shore end operations additional costs				
Total (Fuel and Lube oil only)				

Year: 2008 and 2009 Cable Ship: Teliri	Repair Operations In Base Port	On Passage	On Ground/ Cable work	Other Costs per Operation
Fuel Details				
i) Fuel (1)				
- Consumption	2.8 tonnes per day	20 tonnes per day	12 tonnes per day	
- Current price	Euro 490/ tonne	Euro 490 /tonne	Euro 490 /tonne	
Ii) Lube Oil (1)				
- Consumption	25 lts/day	200 lts/day	200 lts/day	
- Current price	Euro 1.30 /lt	Euro 1.30 /lt	Euro 1.30 /lt	
Costs	Euro per day	Euro per day	Euro per day	Euro per Operation
i) Fuel	1,372	9,800	5,880	
Ii) Lube Oil	33	260	260	
v) Port Charges (Applicable to ports not being the vessel base port)				Depending on the relevant port
vi) Cable Handling (Applicable to ports not being the vessel base port)				Depending on the depot
- Loading				
- Unloading				
- Port Due				
Ix) Miscellaneous Costs				
Includes but not limited to:				
Representative's on board				
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Tugs				
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Local taxes, duties				
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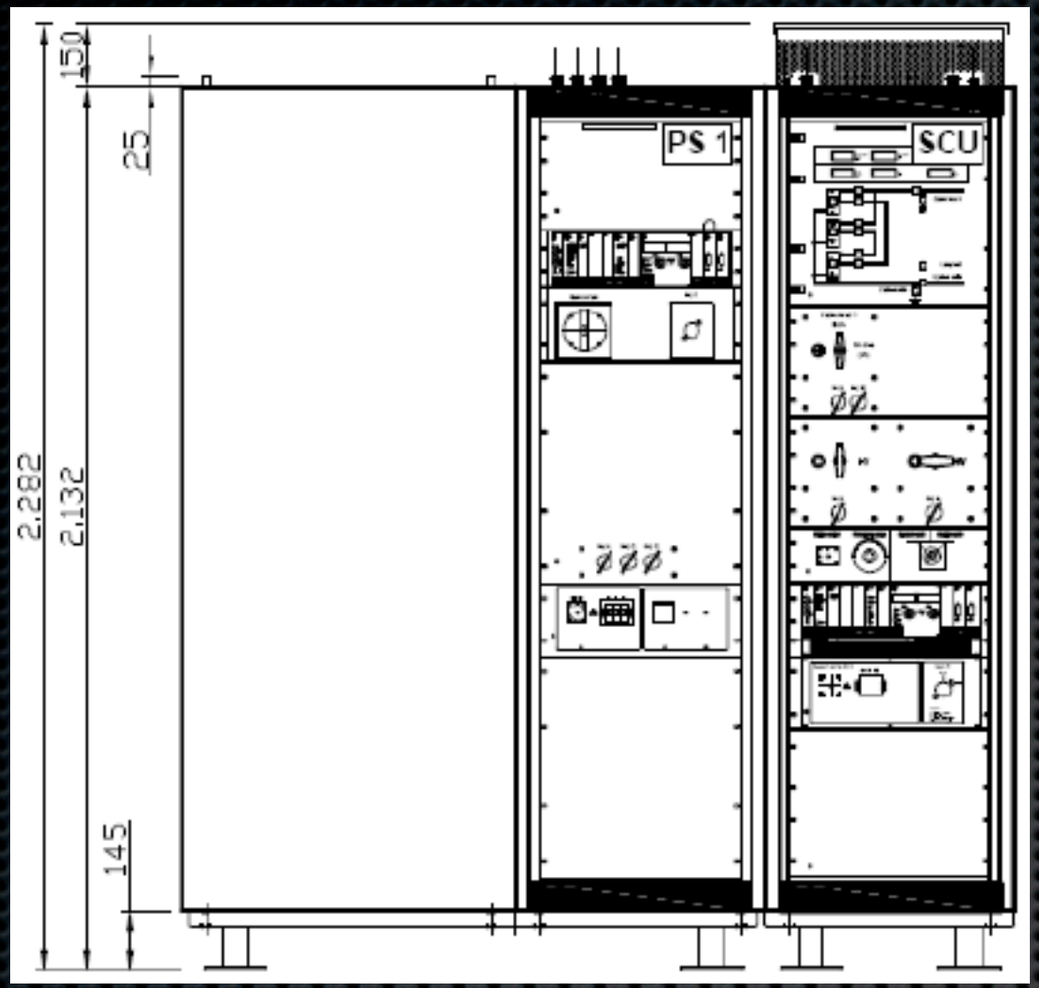
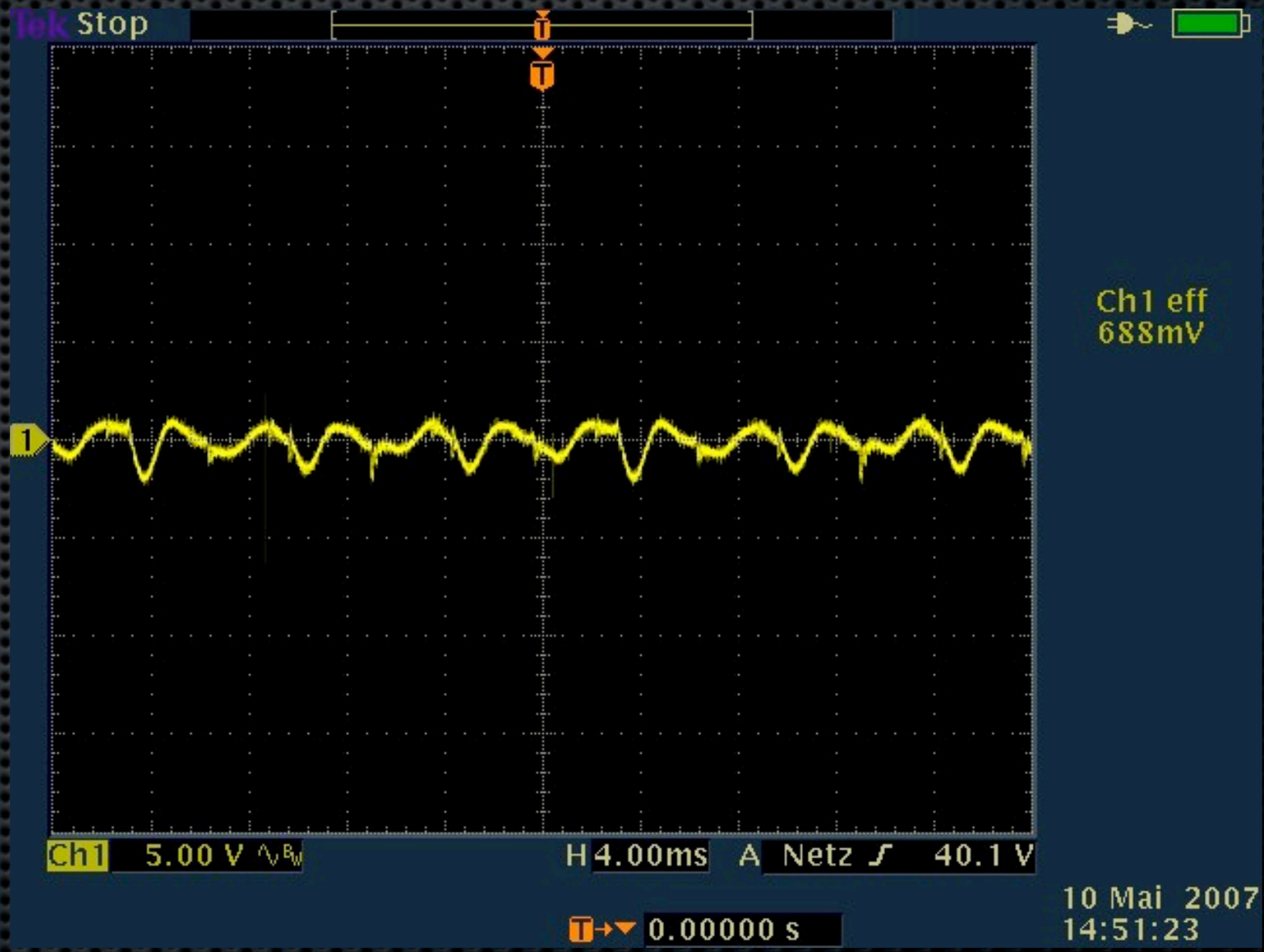
Import duties and local customs				
Shore end operations additional costs				
Total (Fuel and Lube oil only)				

NEMO On Shore System



Type Heinzinger PHN, programmable and regulated power supply.
Electrical data:
Output voltage: 0 … 10,000 V DC
Output current: 0 … 5 A
Output polarity: negative



Output_ripple_10kV

On Shore System

To Prevent Damage on PFE and to Backbone Cable an ON LINE UPS Motor Diesel Type 150 KWA Total Power

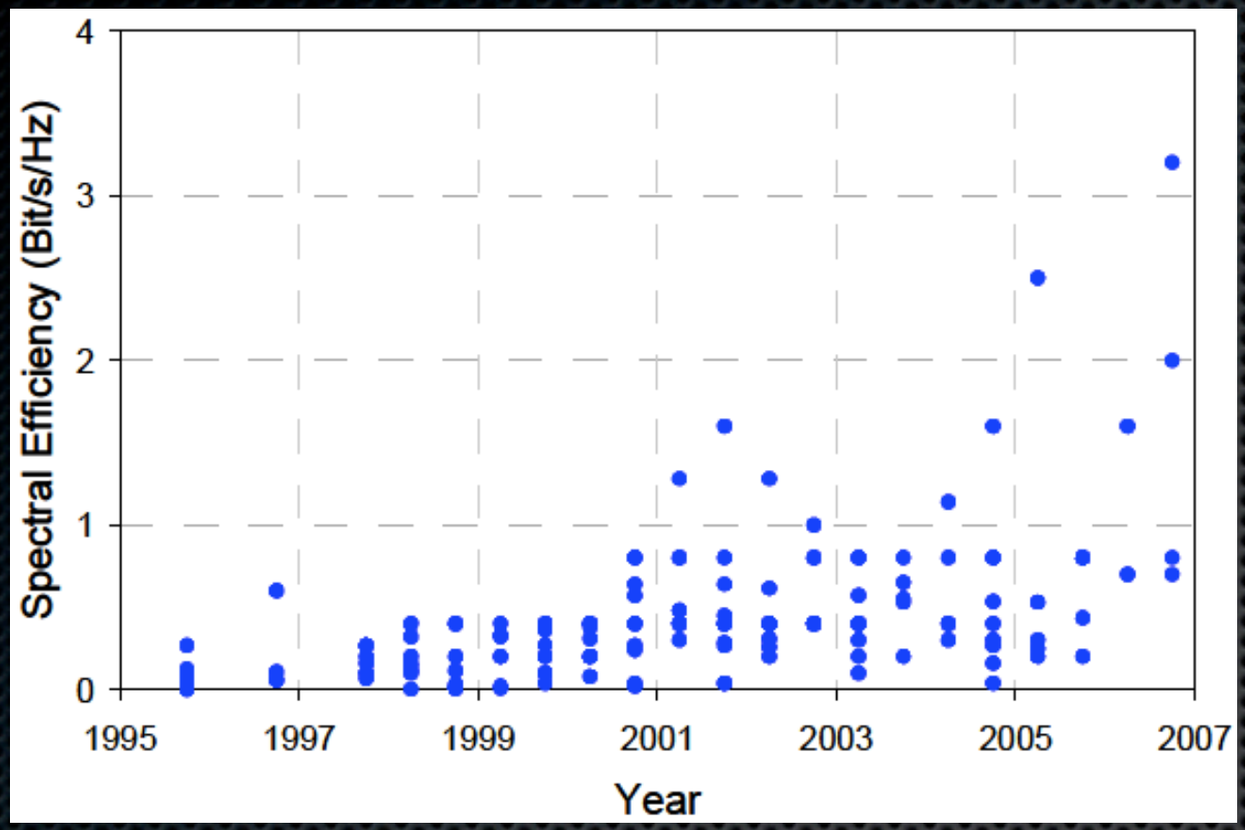
1. Diesel engine;
2. Electromagnetic brushless clutch;
3. A special brushless rotating machine, called a "stato-alternator", composed of:
   synchronous alternator
   kinetic energy accumulator with single excitation
4. A power cabinet containing the motorized breaker units and an inductance;
5. A control panel containing, a PLC, and the dedicated electronic circuit boards to control and monitor operations.

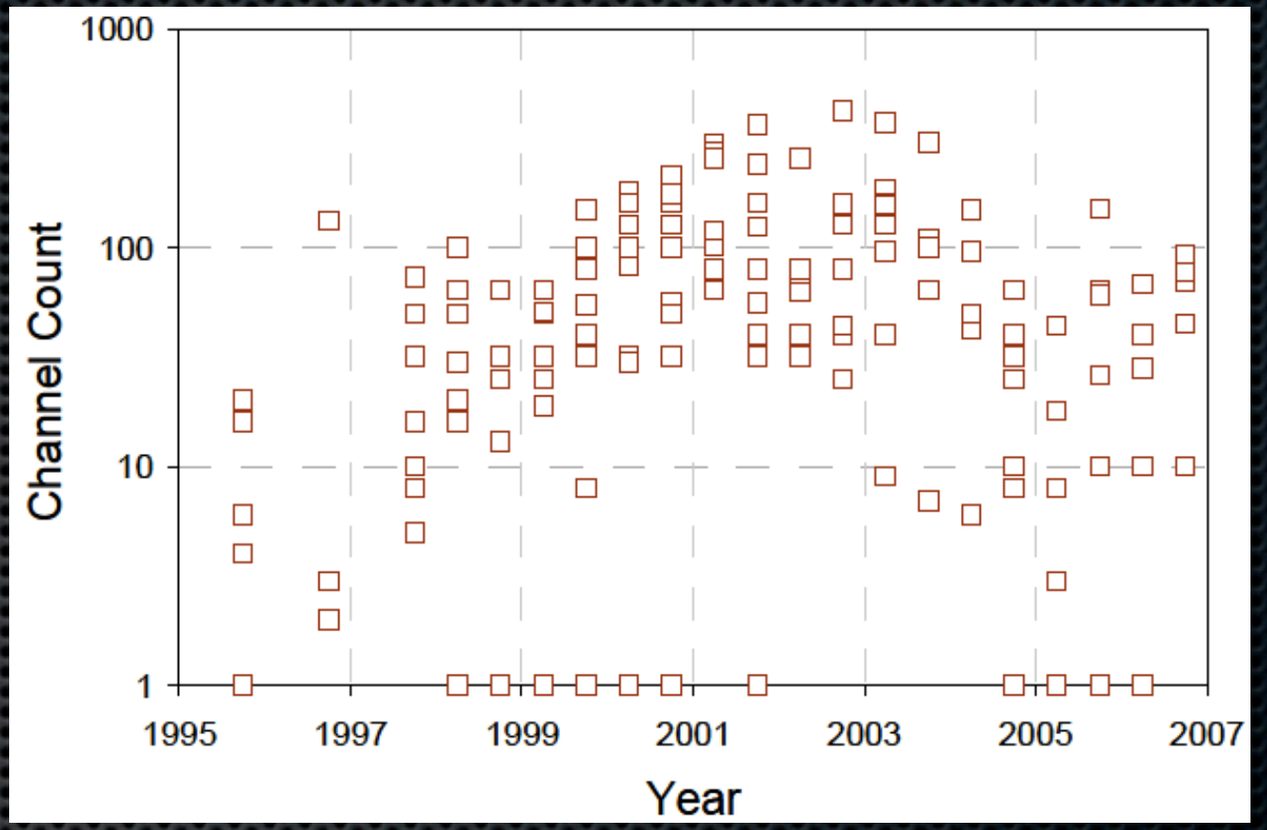
Submarine Cable Trends

Network Type	Distance (km)	Network Requirements	Key Fiber Attributes	Fiber Solution
Transoceanic	**9.000-13.000 (Trans-pacific)**	High Capacity (0.4-1 Tb/s)	Flat Span Dispersion, Large Aeff and Low PMD	Dispersion Managed fiber
Transoceanic	**6,500 (Trans-Atlantic)**	High Capacity (0.4-1 Tb/s)	Low dispersion slope, Large Aeff and Low PMD	Hybrid Solution (Large Aeff NZDSF followed by Low Slope NZDSF)
Intracontinental	**3,000-6,000**	Moderate Capacity	Low dispersion slope, Large Aeff and Low PMD	Hybrid Solution
Regional	**600-3,000**	Moderate – Low Capacity	Low dispersion slope or High Aeff	Large Aeff NZDSF *or* Low slope NZDSF
Unreapetered	**< 600**	Low Capacity	Low Attenuation or Large Aeff	Low Loss Fiber or Large Aeff Fiber

Network requirements for different network types and fiber attributes that can enable simpler and more cost effective network designs. NZDSF stands for non-zero dispersion shifted fiber.

Technology Trends





Spectral efficiency (a) and number of channels (b) reported at OFC and ECOC (major conference on optical communications) from 1996 until 2007.

They illustrate two undeniable trends – spectral efficiency is increasing while the number of channels used in “hero” experiment will stabilize to ≤100. Simple estimates show that spectral efficiency of ~3 bit/s/Hz for the ~30 nm band of Erbium amplifiers will result in >10 Tb/s total capacity per fiber.
That is about 10 times higher than the highest capacity commercial system deployed today.

Thank You