OFEG-TEC 2010 Kiel

4th Ocean Facilities Exchange Group
Technical meeting - 1st & 2nd December 2010

Synthetic rope and its impact on coring

CABTEX cruise

R/V *Pourquoi pas ?*
from 11th to 23rd June 2010

Synthetic rope and its impact on coring

CABTEX's objectives

- To define the behaviour of the rope,
- To test the ending of the rope,
- To improve the quality of core recovery,
- To dive deeper with penetrometer Penfeld,
- and some more technical aspects.

Synthetic rope and its impact on coring

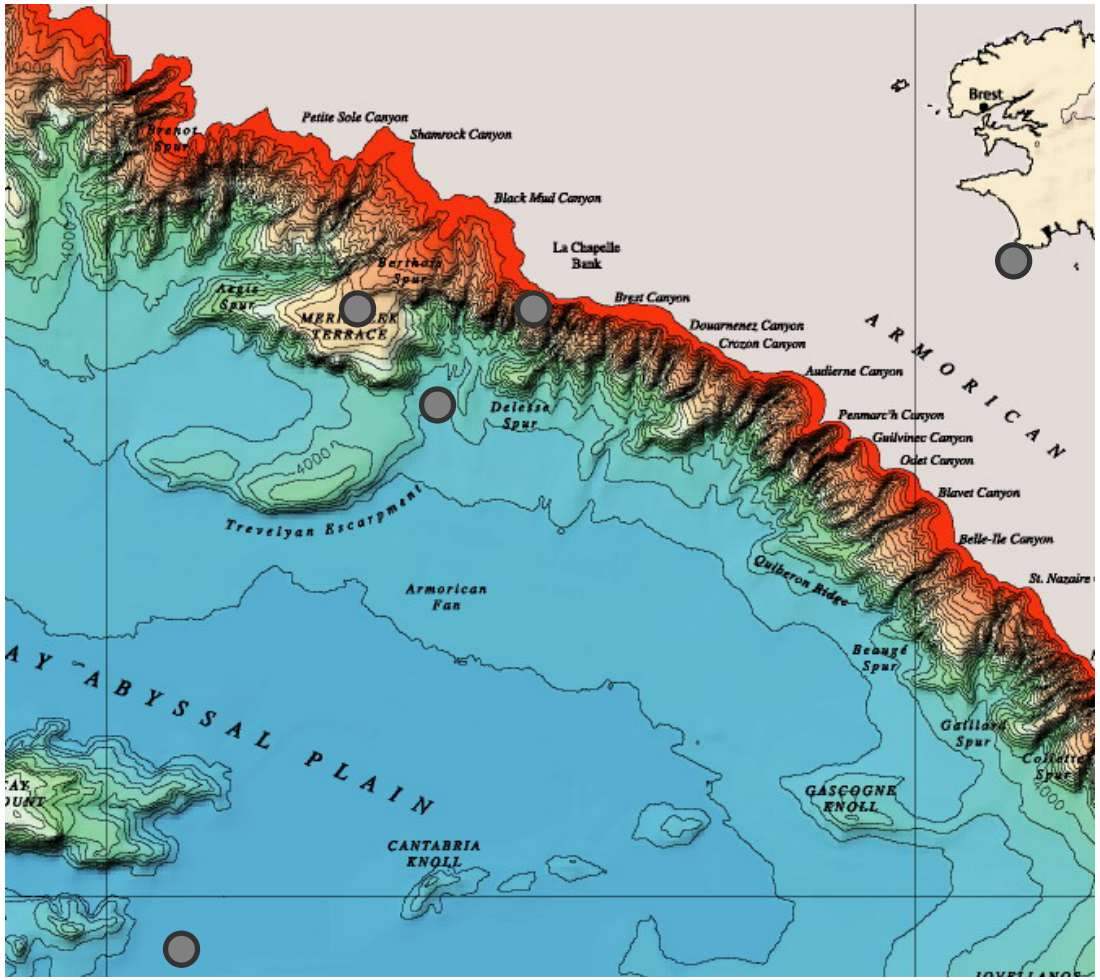
CABTEX at a glance

- Leg 1 – Technical tests (5000m),
- Leg 2 – 4 workspots (2200m, 4500m, 1000m, 100m) ,
- And on each spot :
  - ✓ Sub-bottom profiler,
  - ✓ Penetrometer Penfeld (CPT or Vp sensor),
  - ✓ Coring 30m, 24m, 12m or less ….

Synthetic rope and its impact on coring

The team and the workspots

- 37 people :
- 12 scientists,
- 13 operators,
- 9 engineers,
- 3 observers.



Synthetic rope and its impact on coring

The synthetic rope

- BEXCO (www.bexco.be)
- HMPE – Dyneema SK75
- 12 strands - 8266 m
- Ø $29^{\pm 3\%}$ mm - Ø $29^{\pm 0.9}$ mm
- Working area 478 mm^2
- Linear weight 0.467 kg/m
- Density 0.975 kg/m^3
- Maximum Working Temperature 65°C

Synthetic rope and its impact on coring

Minimum Breaking Load

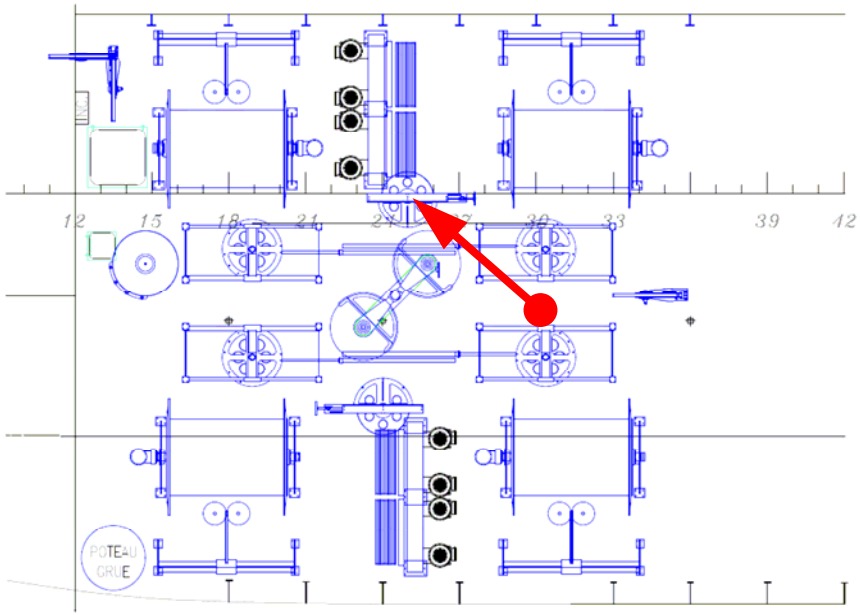
- unspliced rope 711 kN
- theoretical spliced rope 653 kN
- Bexco spliced rope 543-634 kN
- bosun spliced rope 510 kN

⇒ safety factor of 3.4 (510kN/SWL)

Synthetic rope and its impact on coring

Overview of the winch room

- 4 storage drums; 10 kN of back tension
- 2 capstans; 150 kN SWL



Synthetic rope and its impact on coring

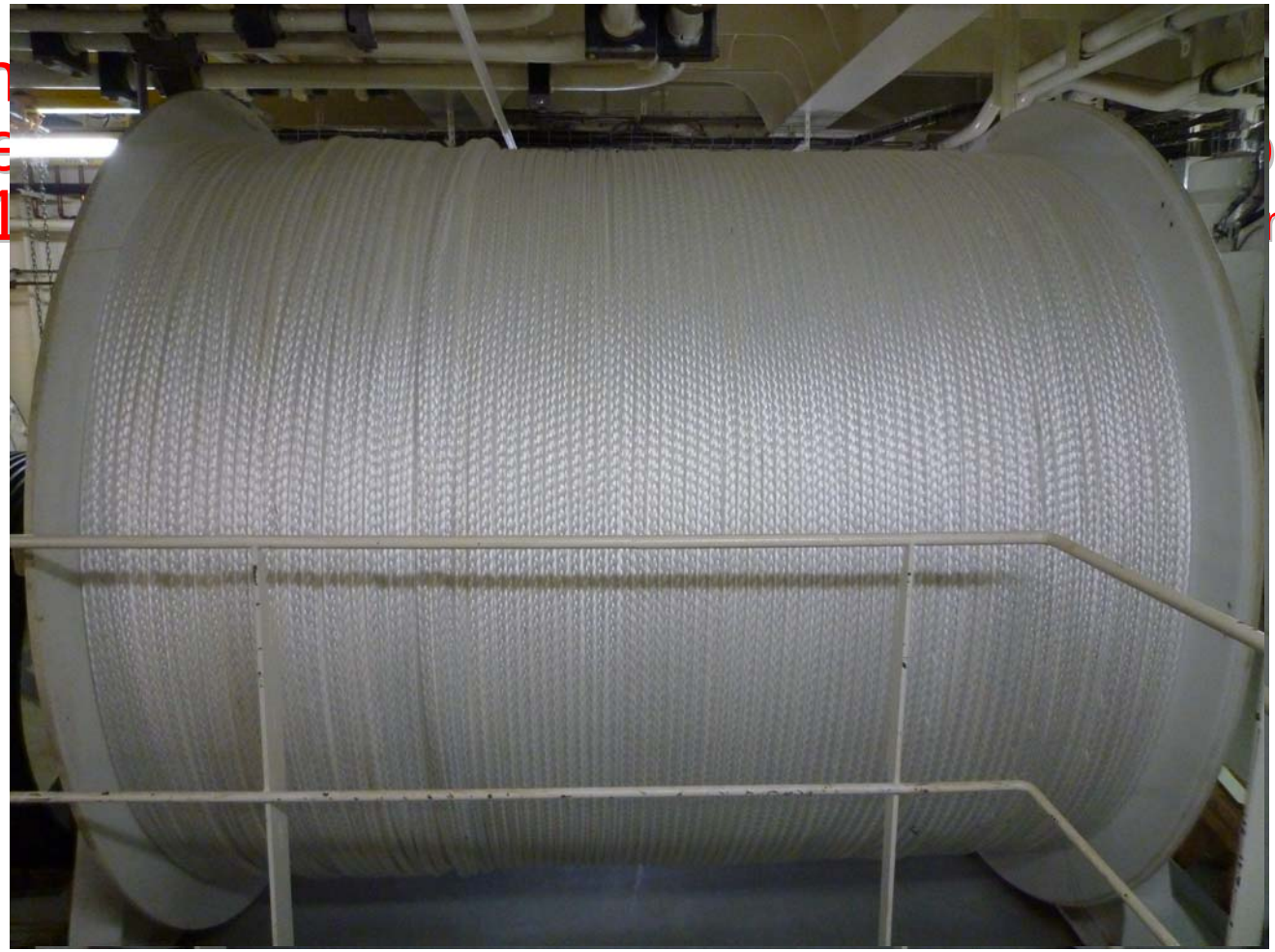
How to spool a synthetic rope ?

- the rope is not truly round !
- it tends to mould itself to the available space
- the rope shape is 27x29mm and 26x30mm in grooved and flat surfaces respectively
- the dimension used to calculate the spooling profile of a fiber rope must be consistent with the largest diameter, rather than average diameter

Synthetic rope and its impact on coring

Spooling of the rope

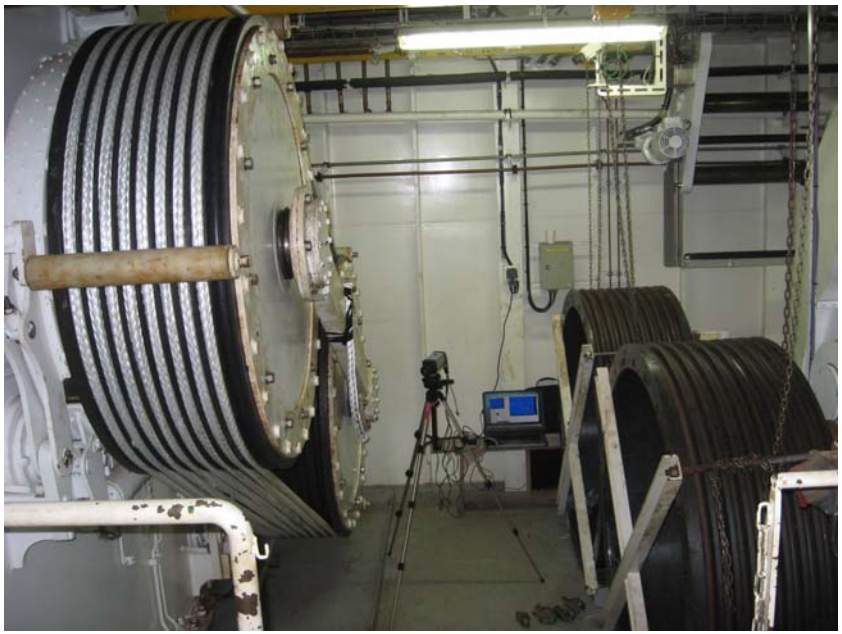
⇒ Th as
be
31 m).



Synthetic rope and its impact on coring

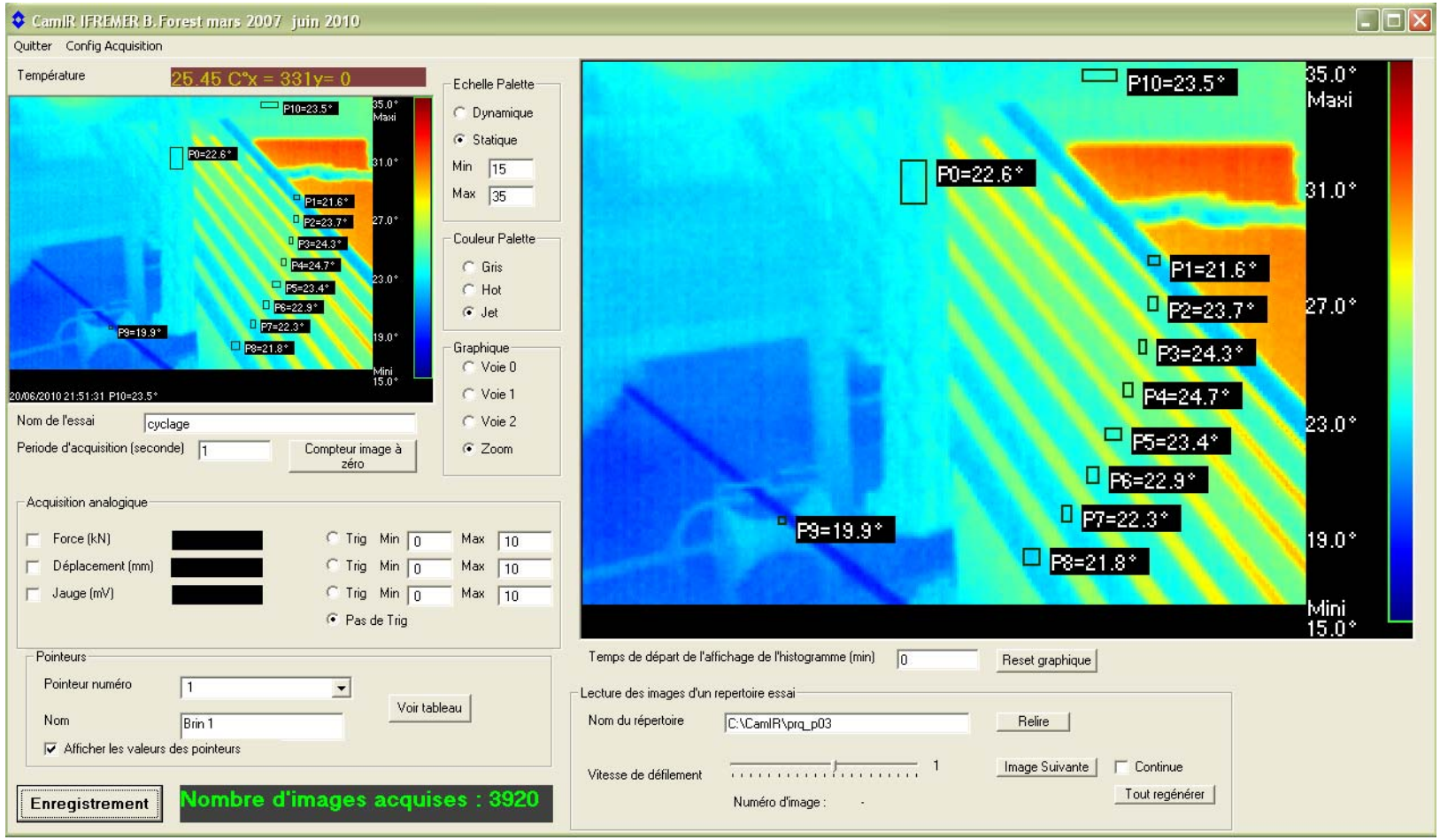
Heating of the rope

- Thermal camera filmed continuously,
- 11 spots were under observation,



Synthetic rope and its impact on coring

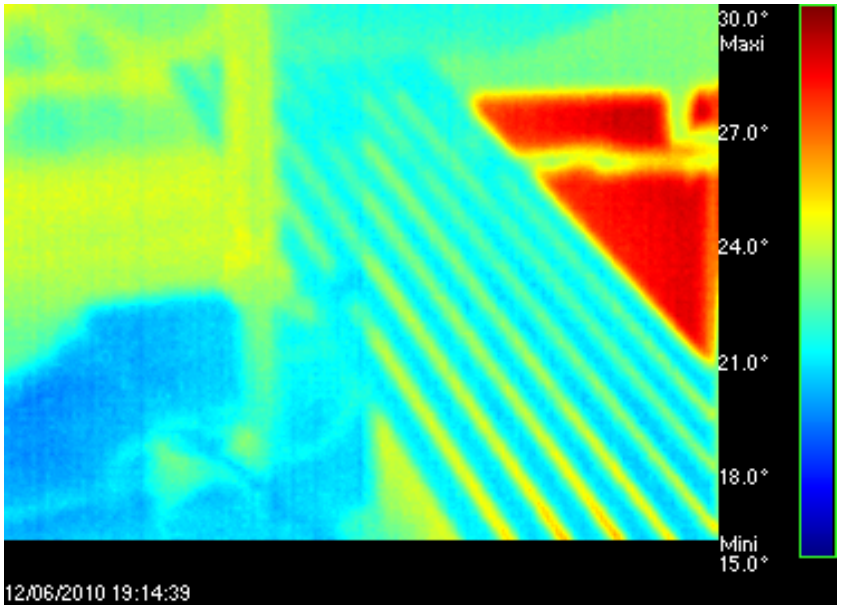
Heating of the rope

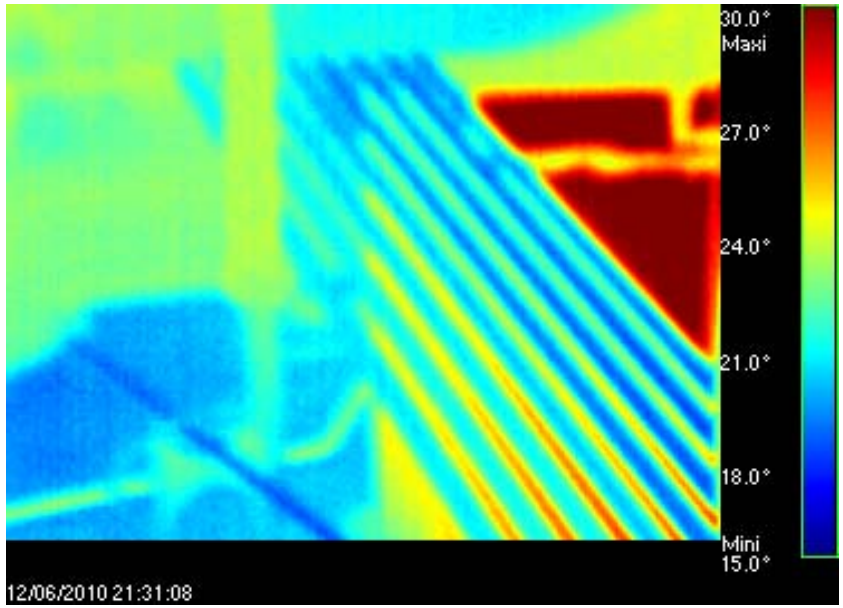


Synthetic rope and its impact on coring

Heating of the rope

- During lowering; the rope heats slowly on board
- During lifting; the rope is wound up at sea temperature





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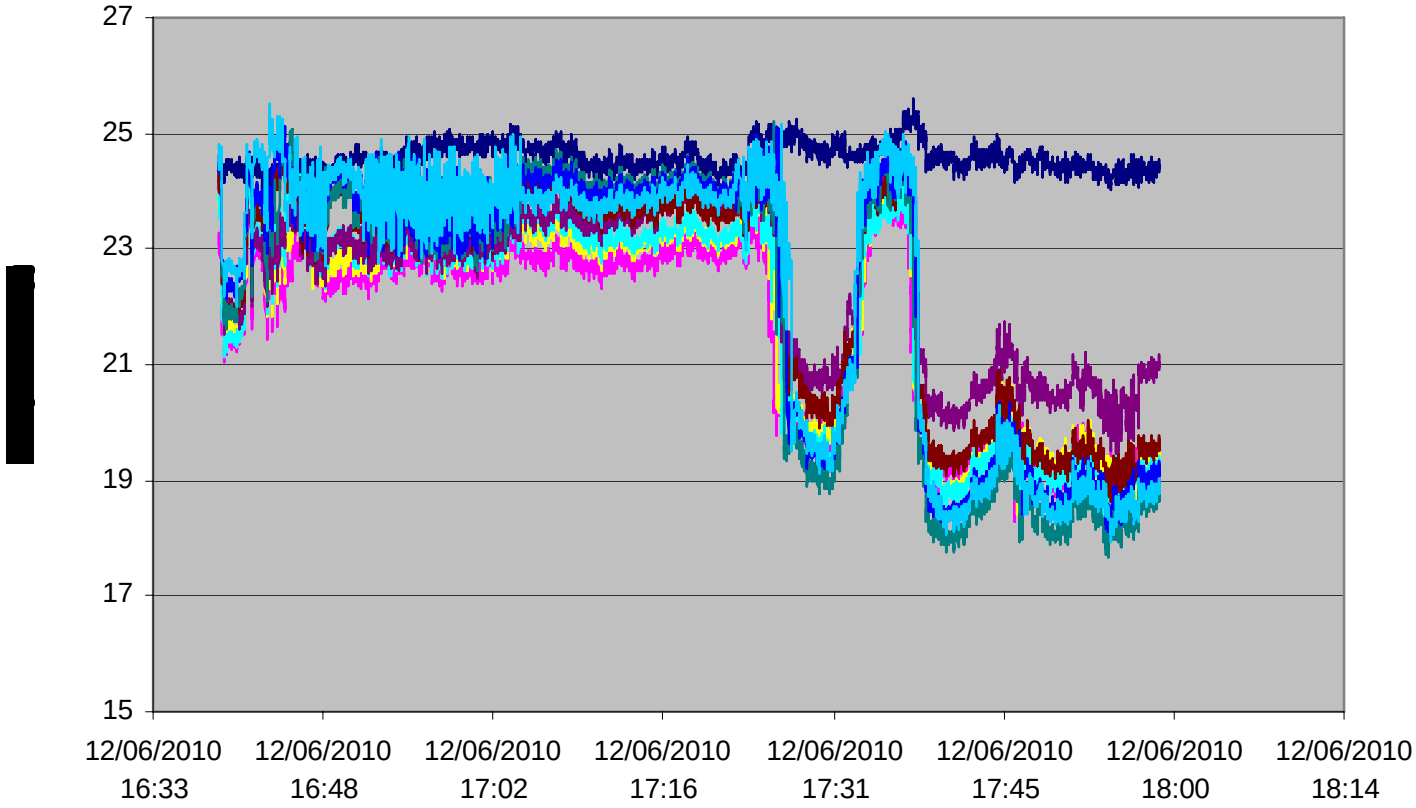
Heating of the rope

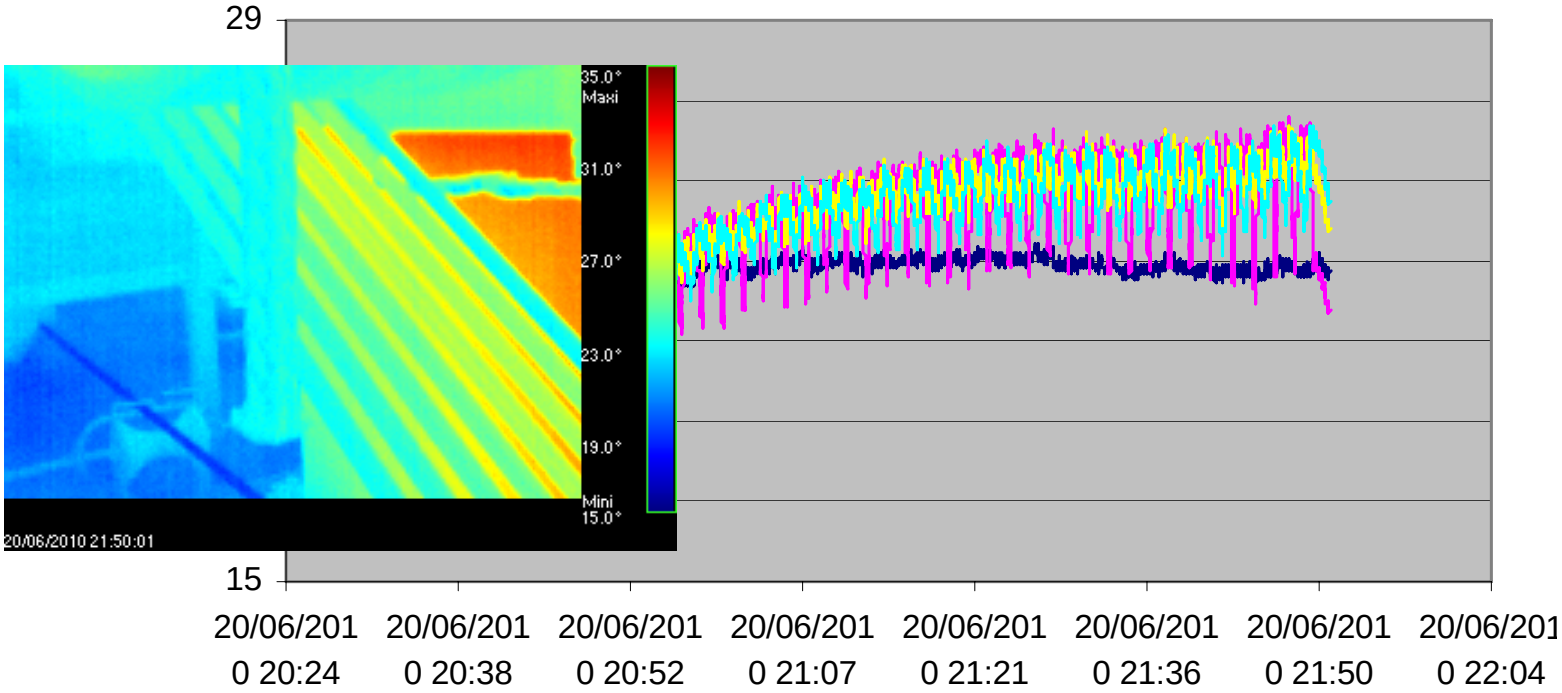
- What happens when the capstan stops …



Synthetic rope and its impact on coring

Heating of the rope

- We cycled the rope during 1 hour on 30m length
  - ✓ 1,0 m/s - 45 kN - +6° at worse

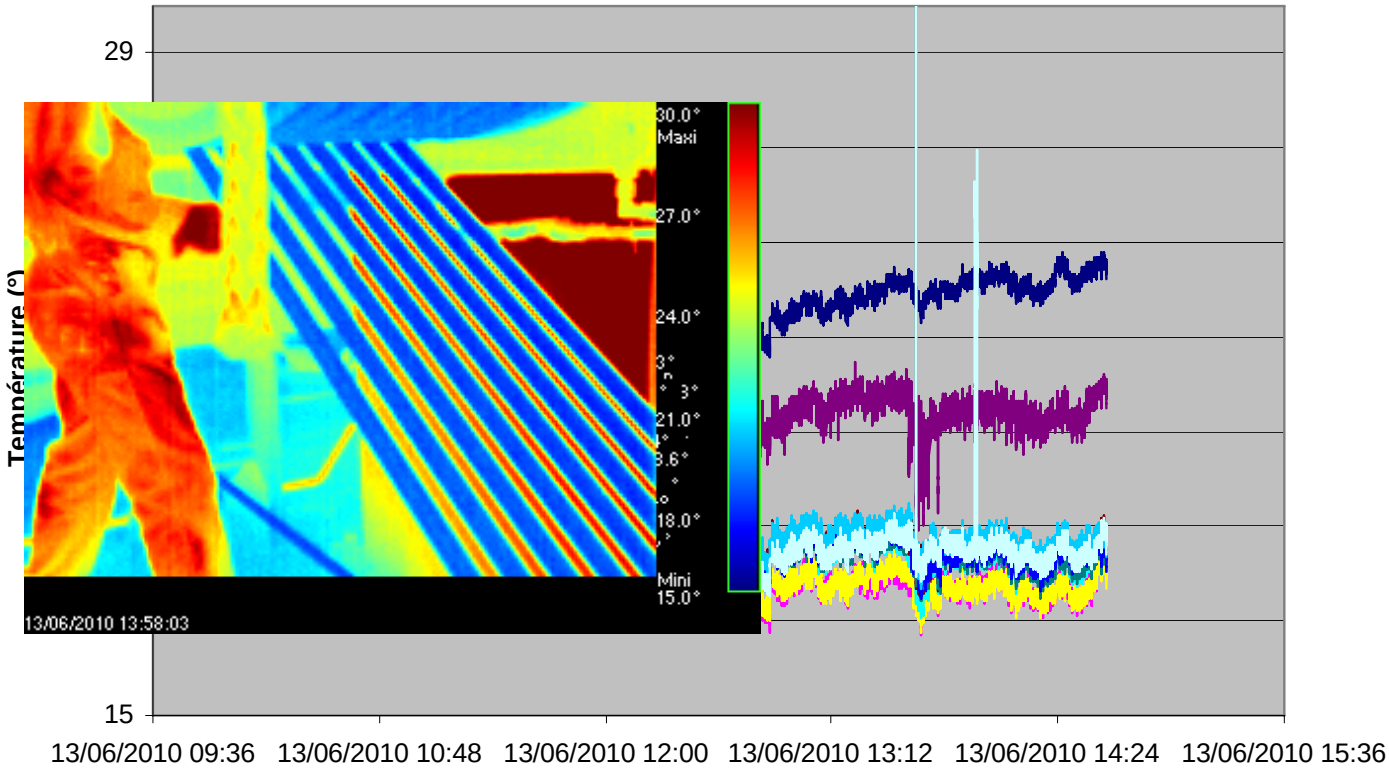


Synthetic rope and its impact on coring

Heating of the rope

- The more difficult was to prevent unusual measurements

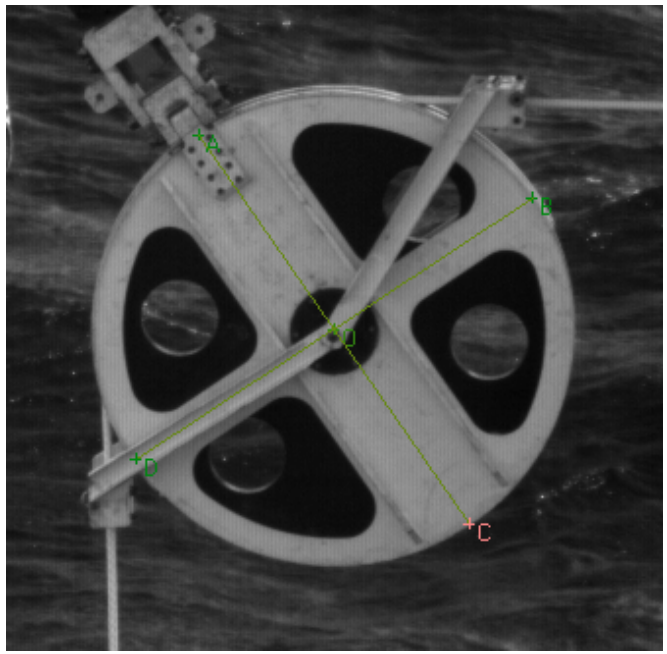
…



Synthetic rope and its impact on coring

Movement of the mobile sheave

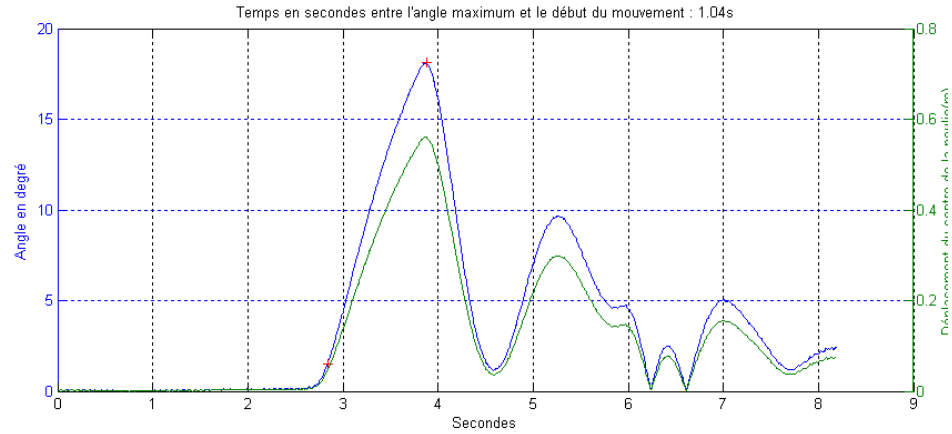
- What is the impact of the mobile sheave to the rope ?
- Fast camera was used (250 snapshots / seconde)

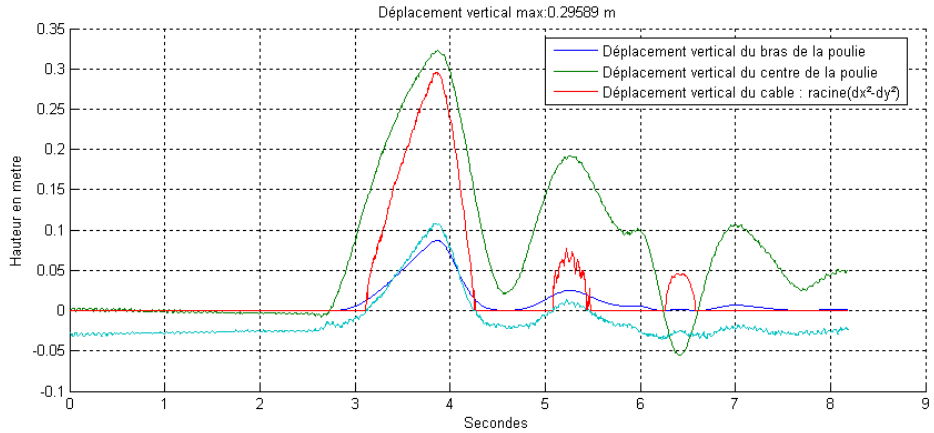


Synthetic rope and its impact on coring

Coring in deep water

- w : 47 kN
- l : 30 m
- d : 4525 m
- $\Delta z \approx 0{,}3$ m

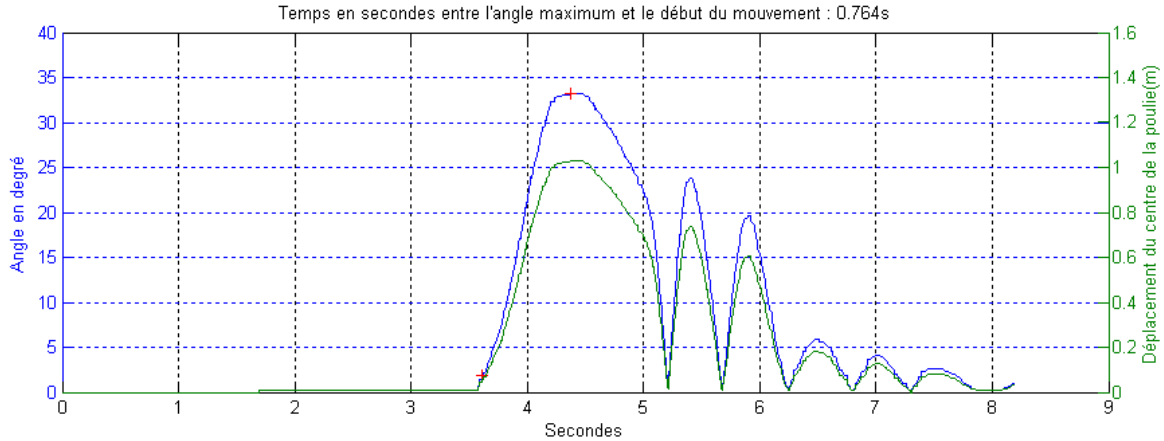


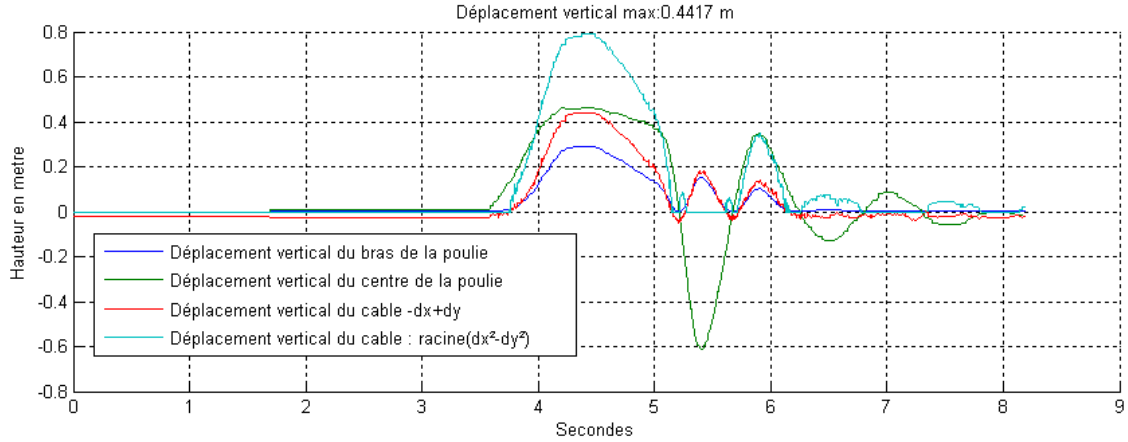


Synthetic rope and its impact on coring

Coring in shallow water

- w : 24 kN
- l : 12 m
- d : 73 m
- $\Delta z \approx 0{,}8$ m

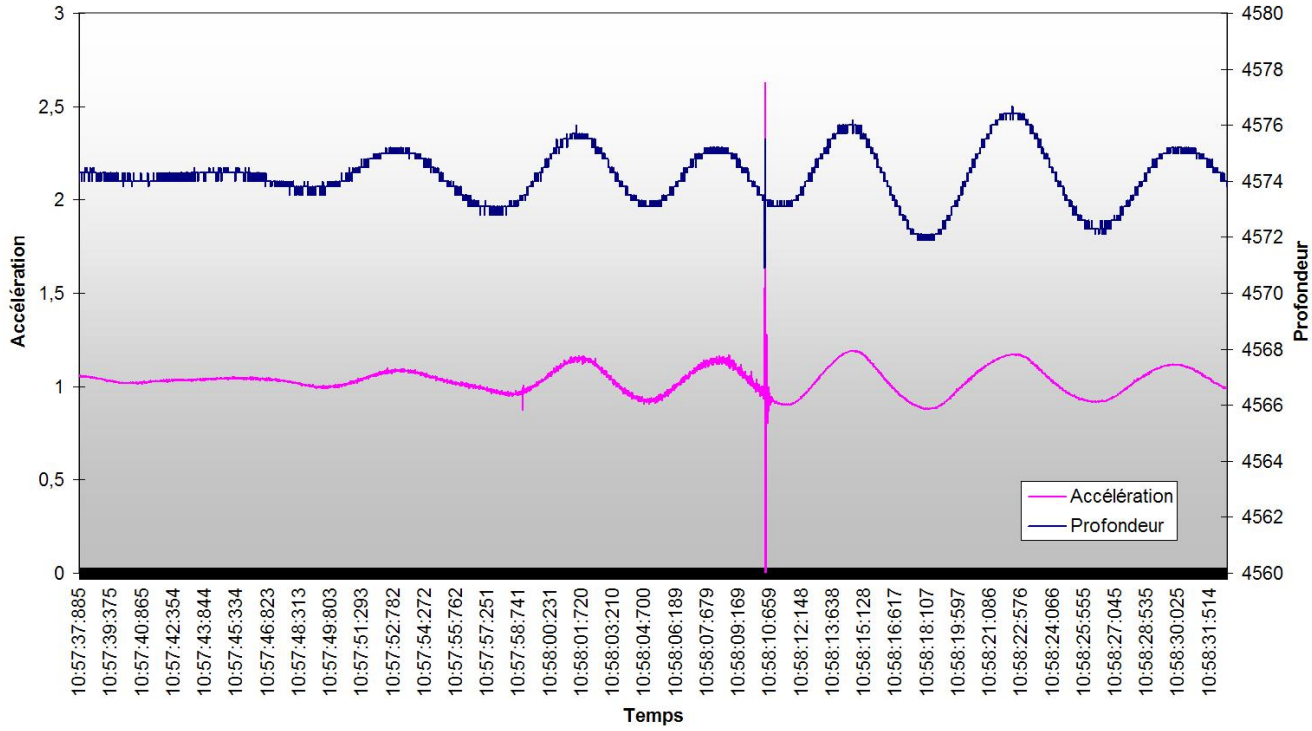




Synthetic rope and its impact on coring

The speed of messenger

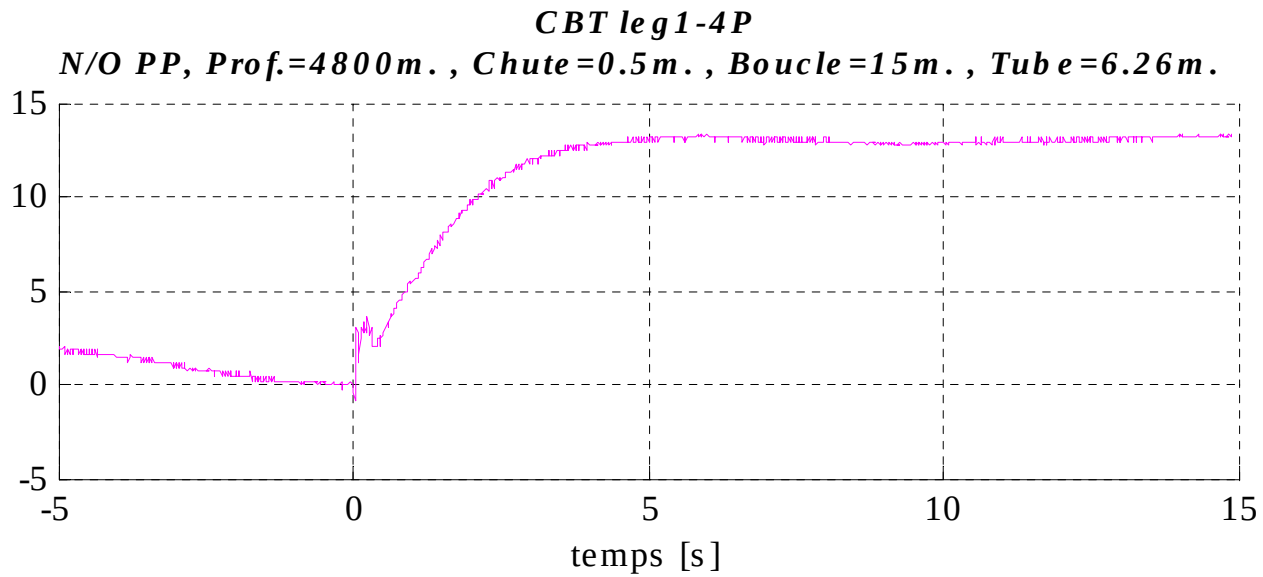
- In order to optimize the waiting period, the speed of messenger was measured; $6,0^{\pm 0,2}$ m/s



Synthetic rope and its impact on coring

The elastic rebound

- Principle : we measure the vertical movement of the trigger during the falling down of a heavy load
- Result : we obtain a modulus around 23-24 GPa



Synthetic rope and its impact on coring

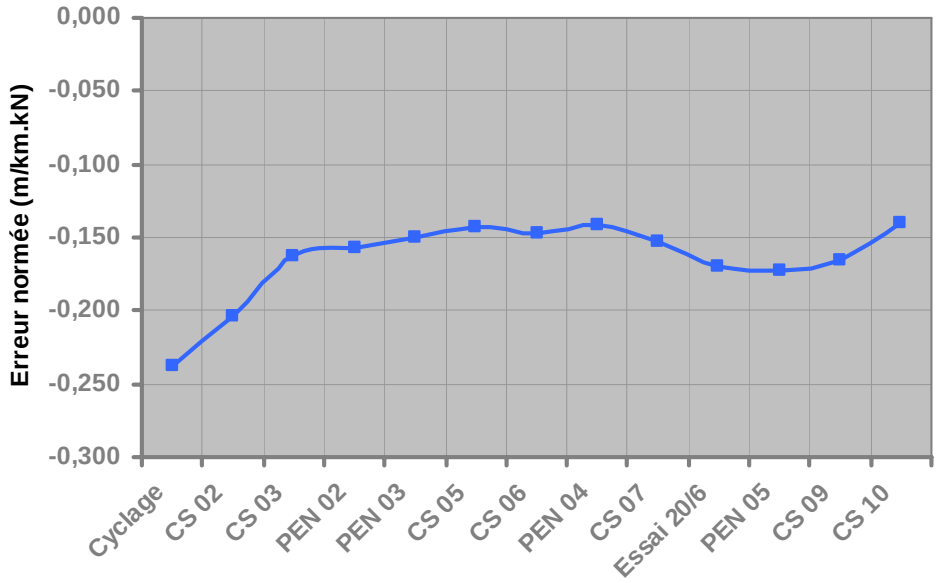
The construction elongation

- With a new rope, a construction elongation is expected; (≈5% for 12-strand Dyneema)
- Its depends on the load level and the number of cycles (or also of the holding time of a constant load)
- This phenomenon is visible on the display of paid-out and paid-in length (offset)
- Beware; this elongation may be confused with normal elongation or creep elongation

Synthetic rope and its impact on coring

The construction elongation

	Length	Load	Offset	Drift
	(m)	(kN)	(m)	(m/kN.km)
Cyclage	4200	35	-35,0	-0,238
CS 02	2104	35	-15,0	-0,204
CS 03	2100	35	-12,0	-0,163
PEN 02	2078	57	-18,6	-0,157
PEN 03	4403	57	-37,6	-0,150
CS 05	4436	41	-25,9	-0,142
CS 06	4428	44	-28,6	-0,147
PEN 04	4150	57	-33,4	-0,141
CS 07	4202	43	-27,6	-0,153
Essai 20/6	4185	37	-26,2	-0,169
PEN 05	915	57	-9,0	-0,173
CS 09	982	43	-7,0	-0,166
CS 10	974	44	-6,0	-0,140

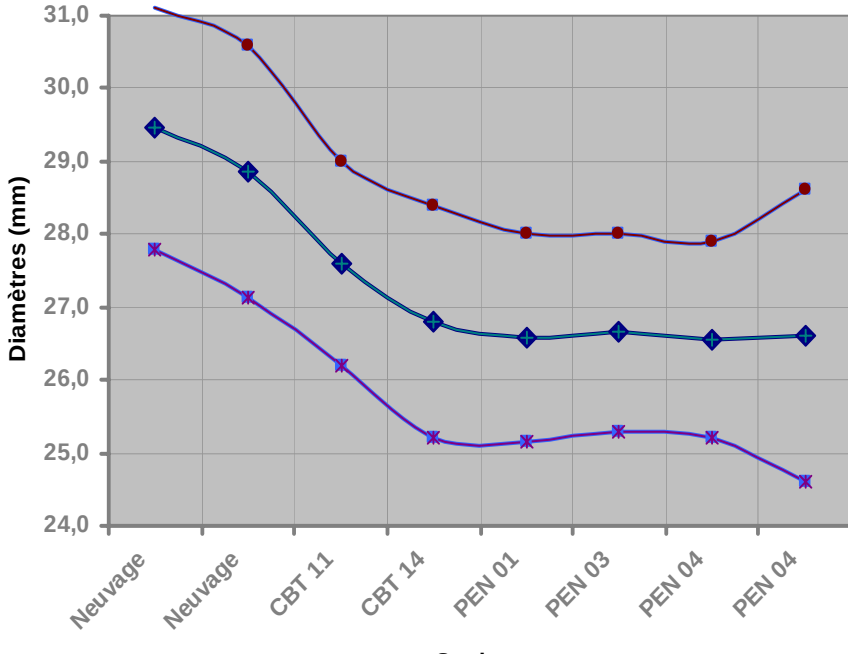


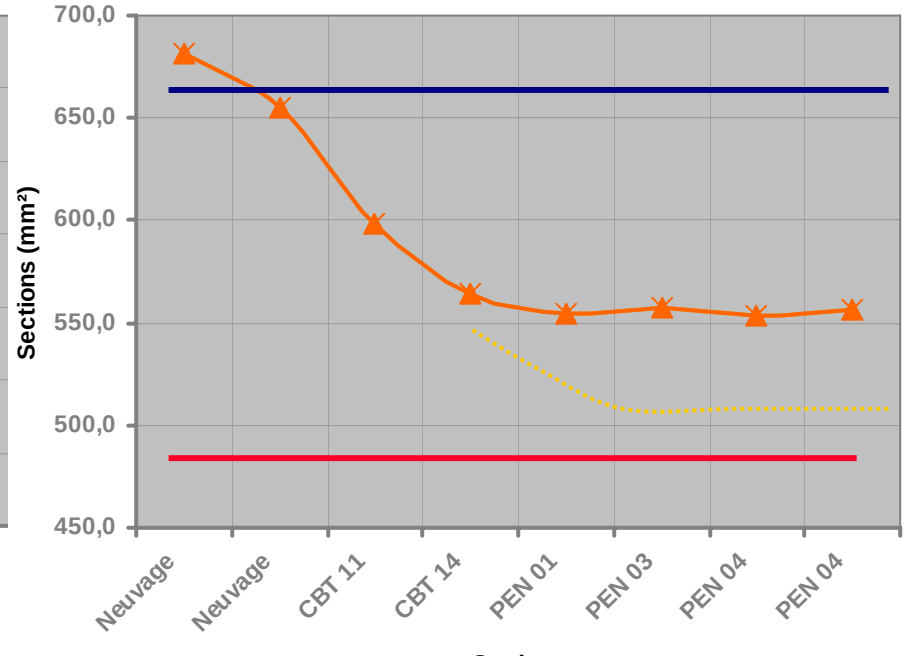
⇒ we must pre-load the rope with a load higher than the service load (≈100 kN)

Synthetic rope and its impact on coring

The bedding-in and the diameter

- If the rope is lengthened (construction elongation), we also have a diameter reduction

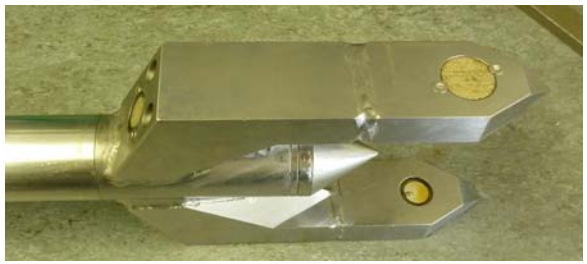




Synthetic rope and its impact on coring

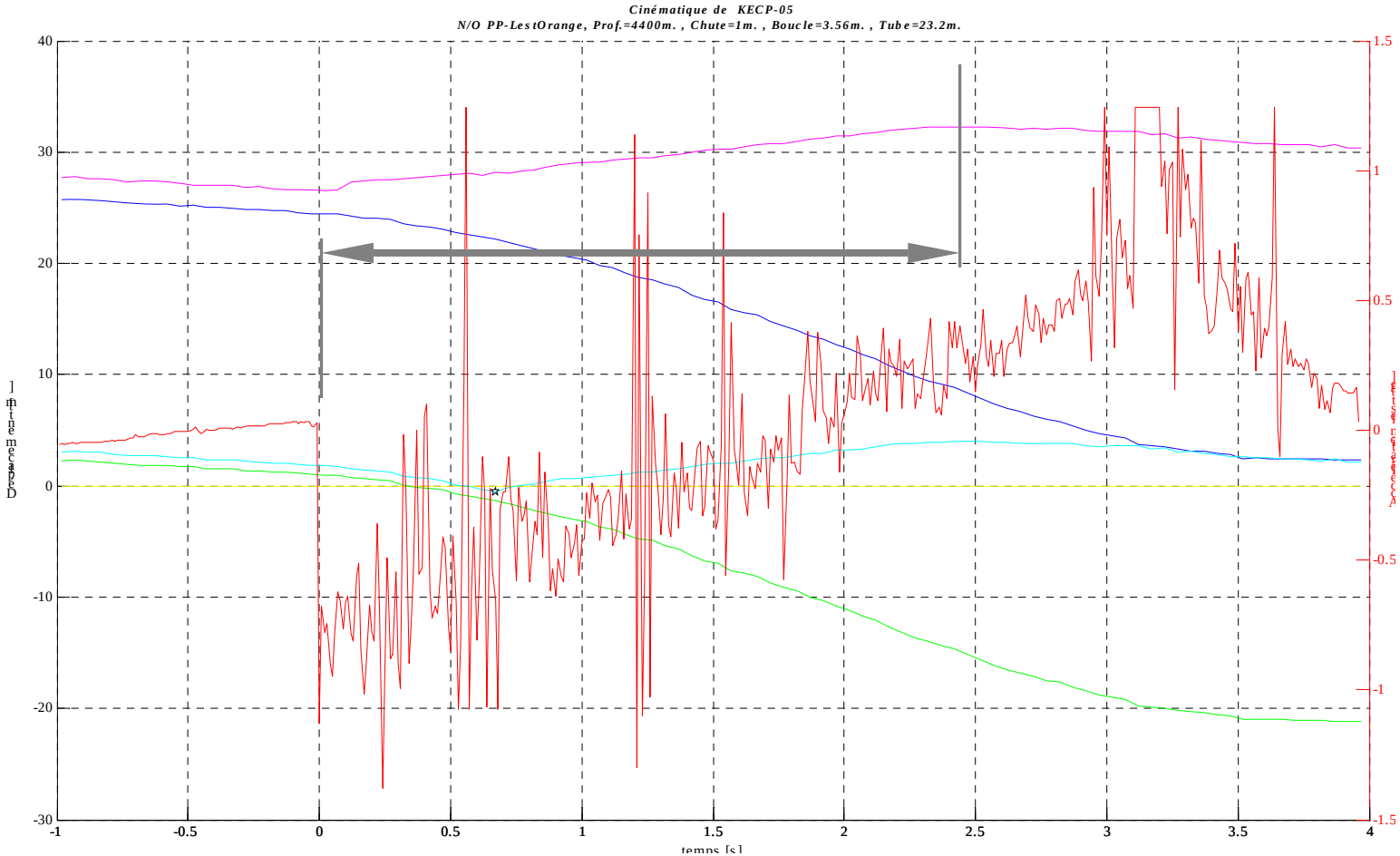
Operations achieved

- 11 corings have been done
  - ✓ the recovery rate is around 90%
  - ✓ the quality index is between 4 and 5
- 5 operations with Penfeld (of which 2 at 4400m)
  - ✓ 2 penetrations with Vp tip (1300-2200 m/s),
  - ✓ 3 penetrations with CPT tip (0-70 bar)



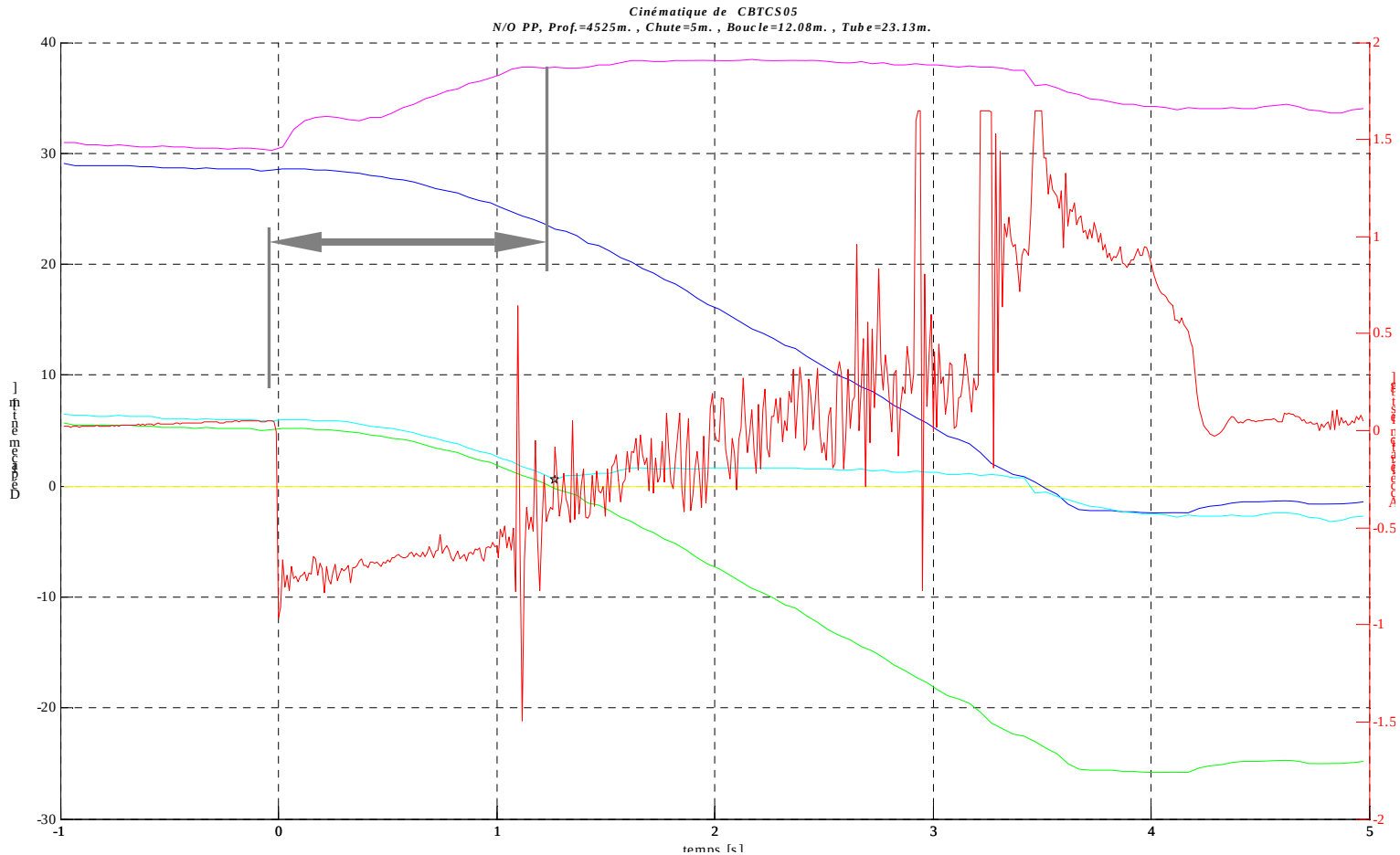
Synthetic rope and its impact on coring

The coring with steel cable



Synthetic rope and its impact on coring

The coring with synthetic rope



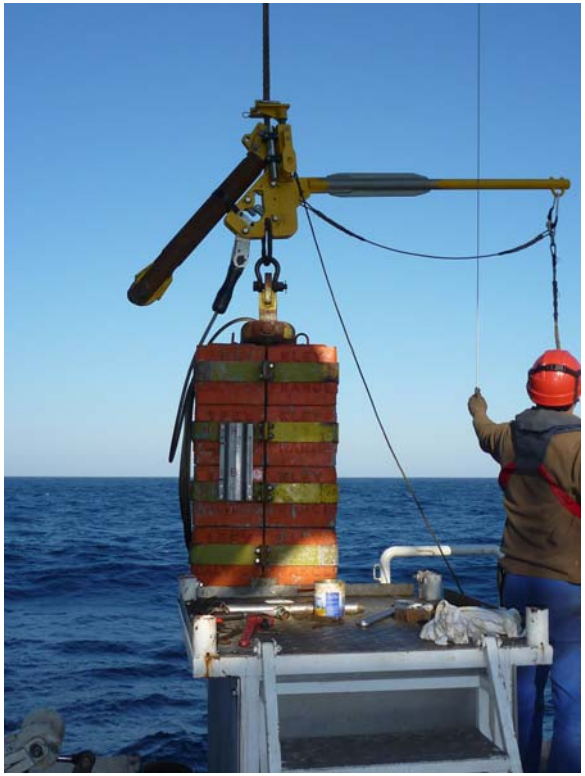
Synthetic rope and its impact on coring

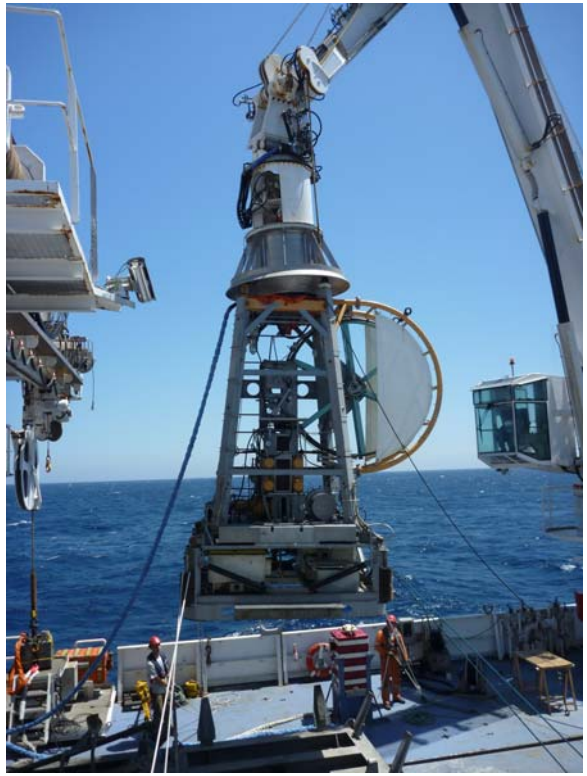
Contributions of the synthetic rope

- capacity to work deeper (positive buoyancy)
- winch system less loaded especially with bad weather
- elastic rebound is higher as steel cable but the potential energy is smaller
  - ✓ the free elastic rebound lasts 5 secondes
  - ✓ the elastic rebound with corer stops as soon as the loop is taut

Synthetic rope and its impact on coring

Thank you for your attention

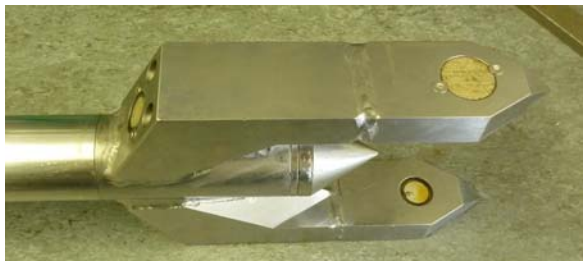


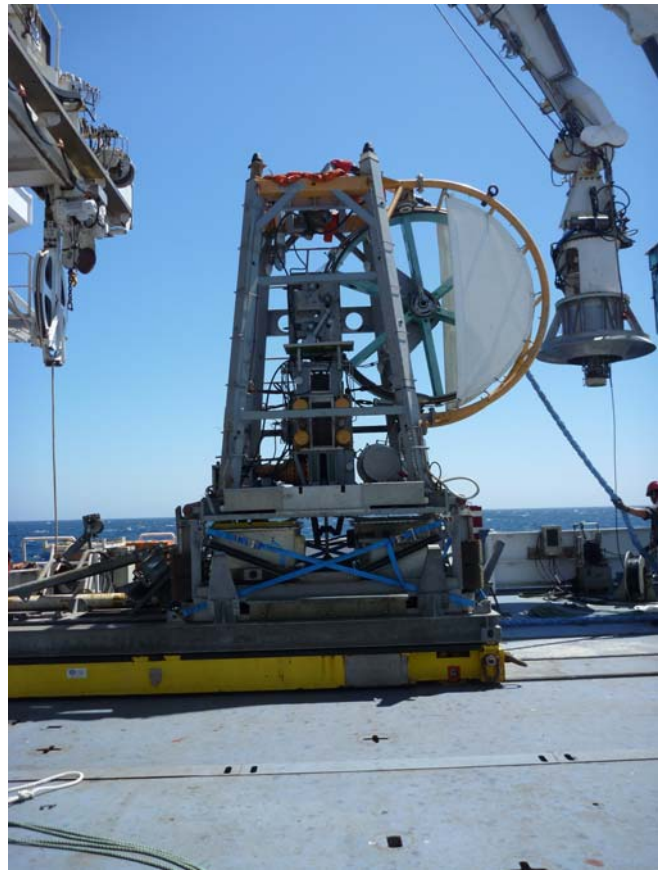


Synthetic rope and its impact on coring

The penetrometer Penfeld

- pulling-out force up to 30 kN
- 30 meters long rod
- CPT tip or Vp tip
- self-powered
- weight in air 67 kN

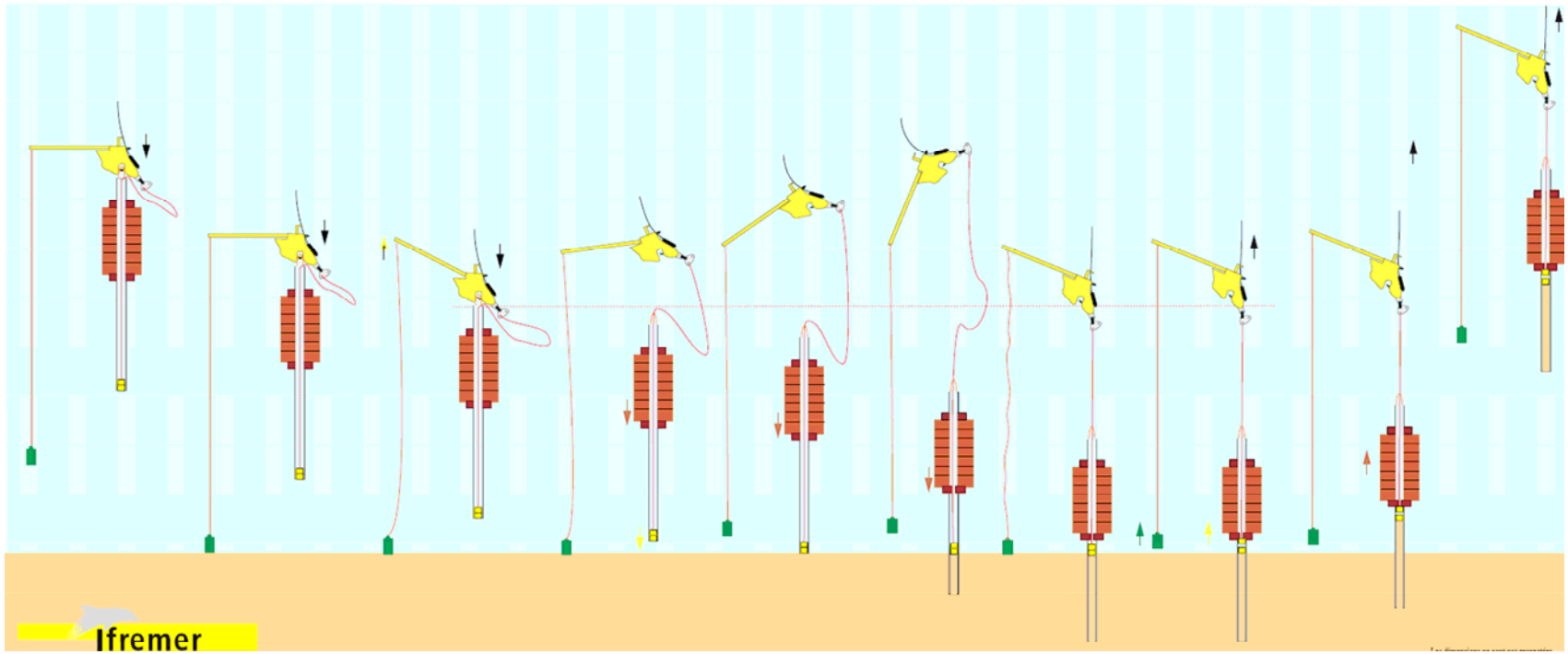




Synthetic rope and its impact on coring

The Küllenberg corer

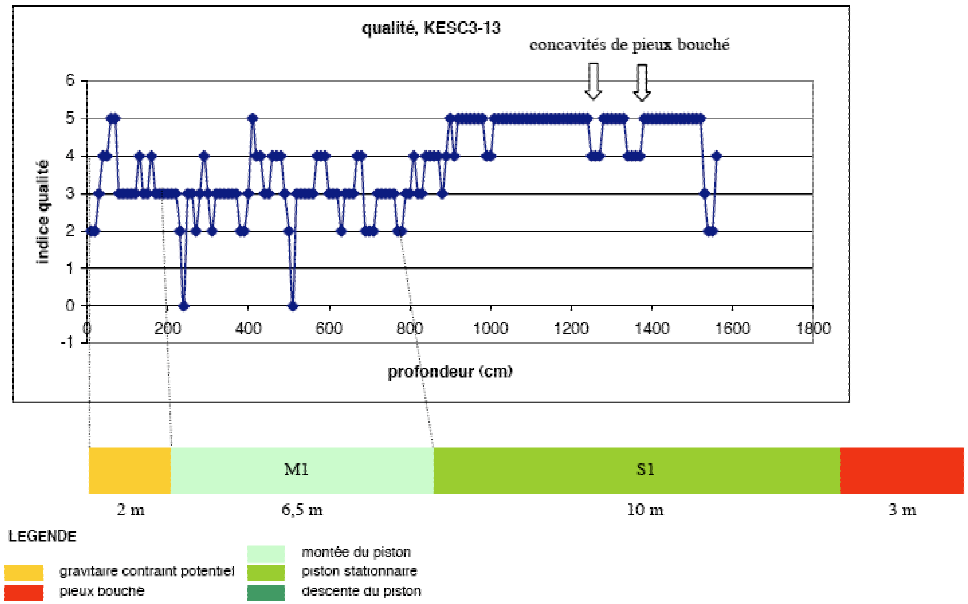
- a complex kinematics of coring operation

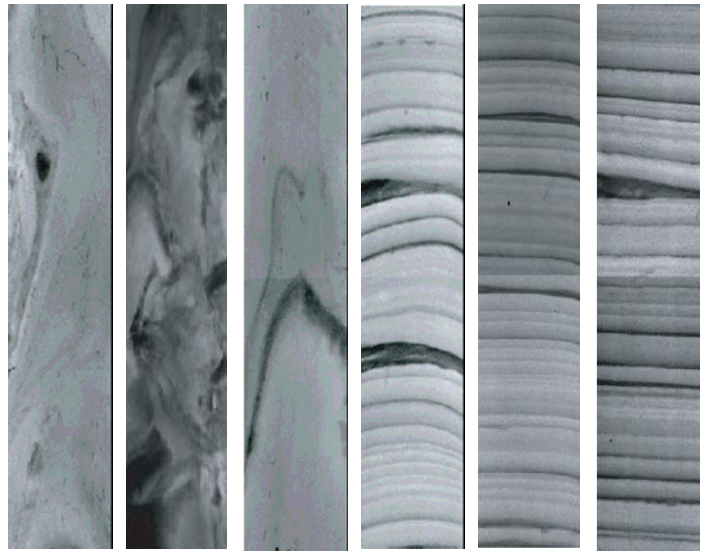


Synthetic rope and its impact on coring

The work of the piston

- estimation of the quality of the cores according to the work of the piston

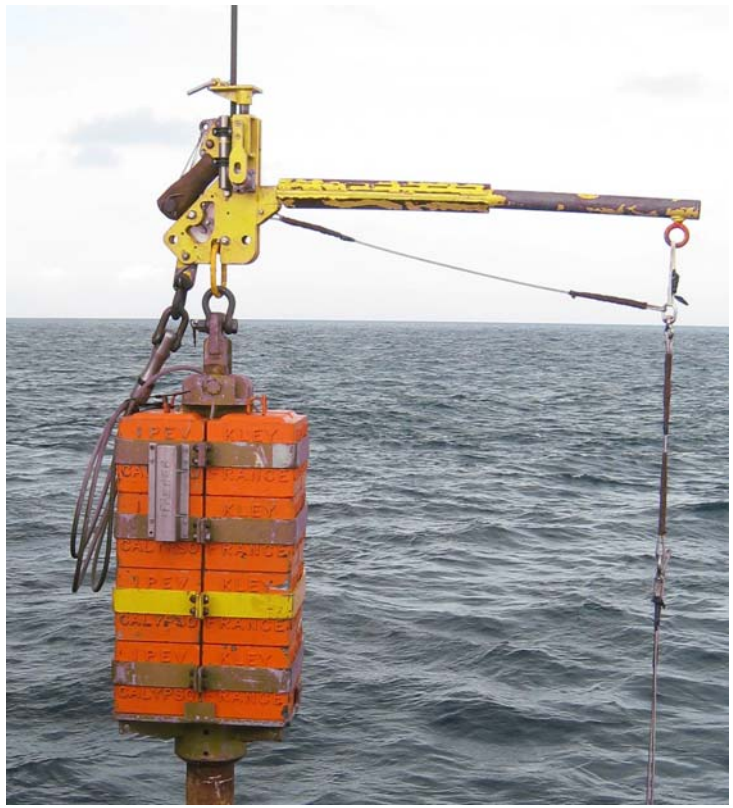




Synthetic rope and its impact on coring

The 'Cinema' sensors

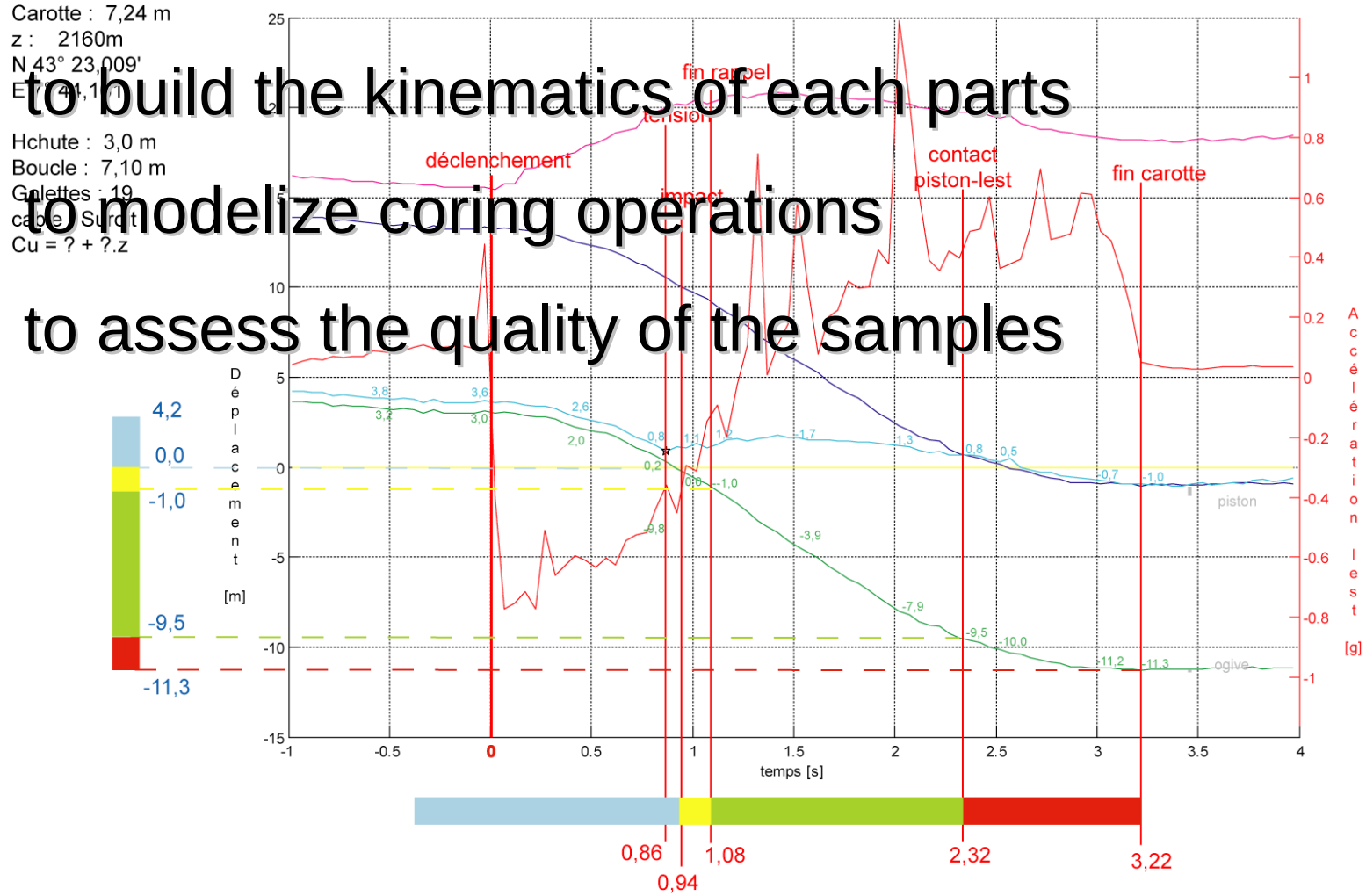
- accuracy of the accelerometers 1%
- pressure sensor 660 bar
- resolution in depth 20 cm
- sampling rate 100 Hz
- wireless communication
- housing made of titanium



Synthetic rope and its impact on coring

The 'Cinema' software

- to build the kinematics of each parts
- to modelize coring operations
- to assess the quality of the samples



Synthetic rope and its impact on coring

- That seems possible to avoid that …