Instrumentation for Optical Calibration: Laser Beacon and Nanobeacon

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OUTLINE

THE OPTICAL CALIBRATION PROPOSAL

- INTRA D.U CALIBRATION: NANOBEACON
- INTER D.U. CALIBRATION: LASER BEACON

NANOBEACON

- PPM
- NEMO TOWER PHASE II

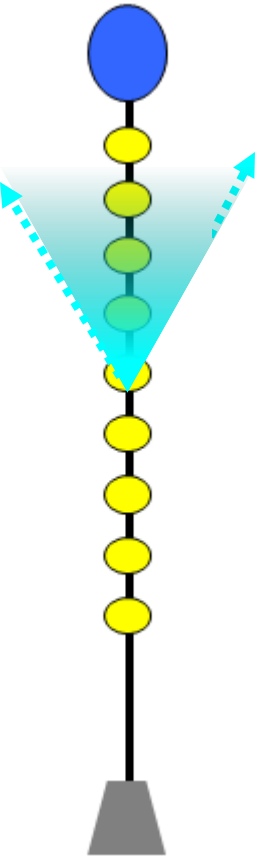
LASER BEACON

- IL11 ANTARES
- NEMO TOWER PHASE II

KM3NeT LASER BEACON: THE IFIC PROPOSAL

FINAL SUMMARY

TIME CALIBRATION SYSTEM



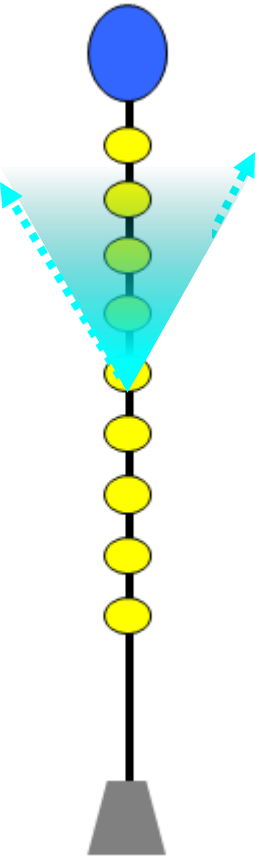
Decoupling inter-intra D.U. Calibration systems

INTRA D.U. Calibration:

Nano-Beacon **Upward single LED housed inside all DOMs**

- Less expensive and high redundancy
- Can be triggered internally to avoid electronic noise
- Frequency of several kHz depending on the DAQ system **(300 Hz @ ANTARES)**
- Avoid cumbersome synchronization process, only one LED

TIME CALIBRATION SYSTEM



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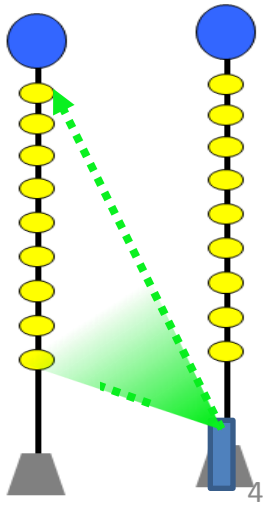
INTER D.U. Calibration:

Laser Beacons @ 532 nm

- Higher in intensity and shorter pulses < 1 ns
- No synchronization needed
- More expensive but less redundancy required
- Tunable by Liquid Crystal Optical attenuator
- Collimated beam -> Diffusion device needed



NANOBEACON

Consists of two boards:

Pulser

NCB: Nanobeacon Control Board

Nanobeacon Control Board:

Selects the intensity of flashing

Selects the trigger (external or auto-trigger)

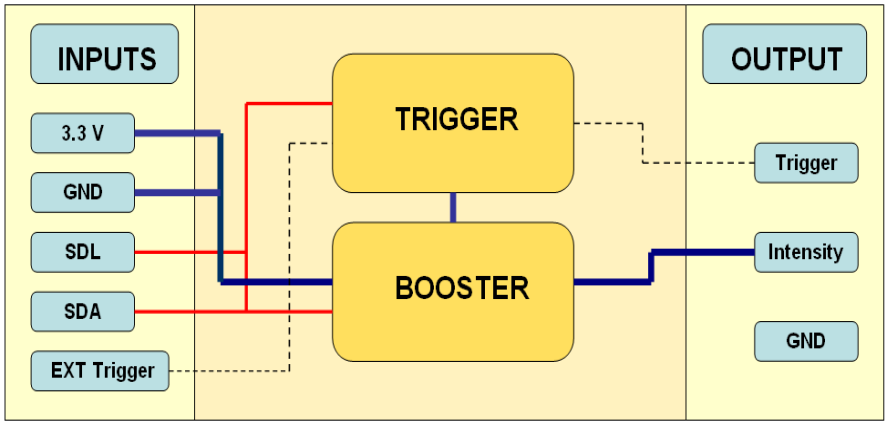
Selects the frequency of the internal trigger

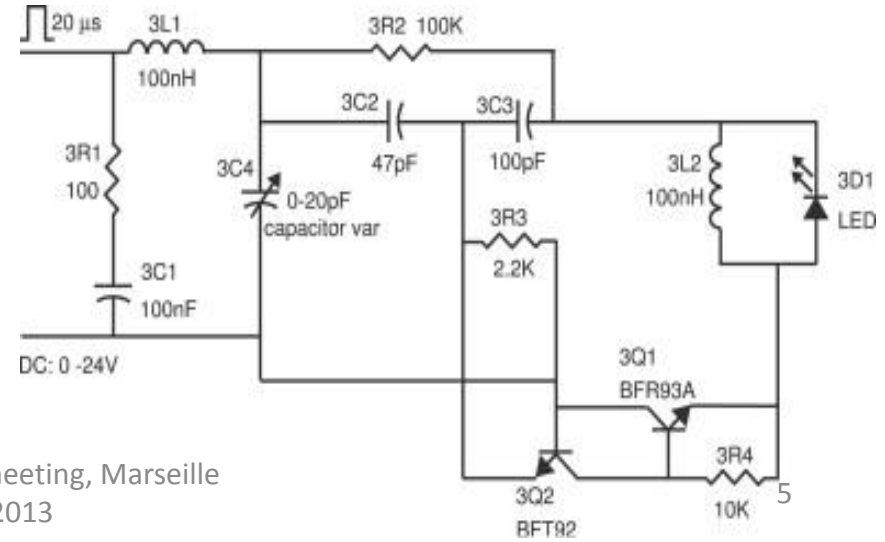
Pulser:

Creates a short light pulse

Intensity set by the voltage generated by the NCB

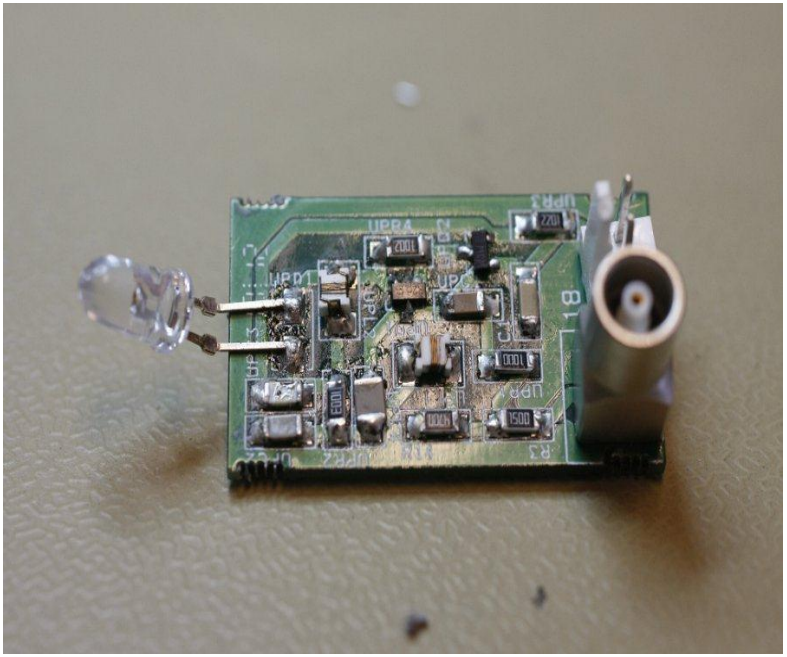
Frequency set by the trigger generated at the NCB or by the external trigger

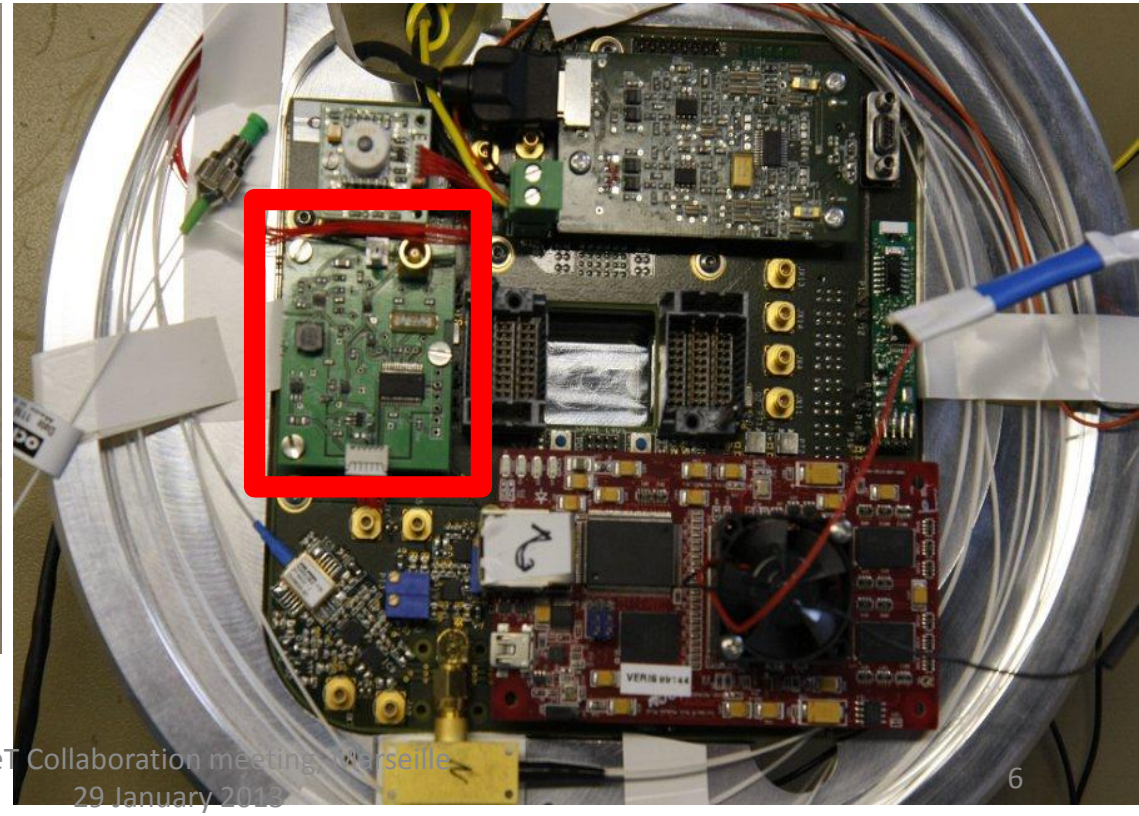




NANOBEACON STATUS - PPM

- One Nanobeacon already integrated on the PPM DOM
- Three already produced and ready for integration at the PPM DU (@470 nm)





NANOBEACON STATUS – PPM D.U

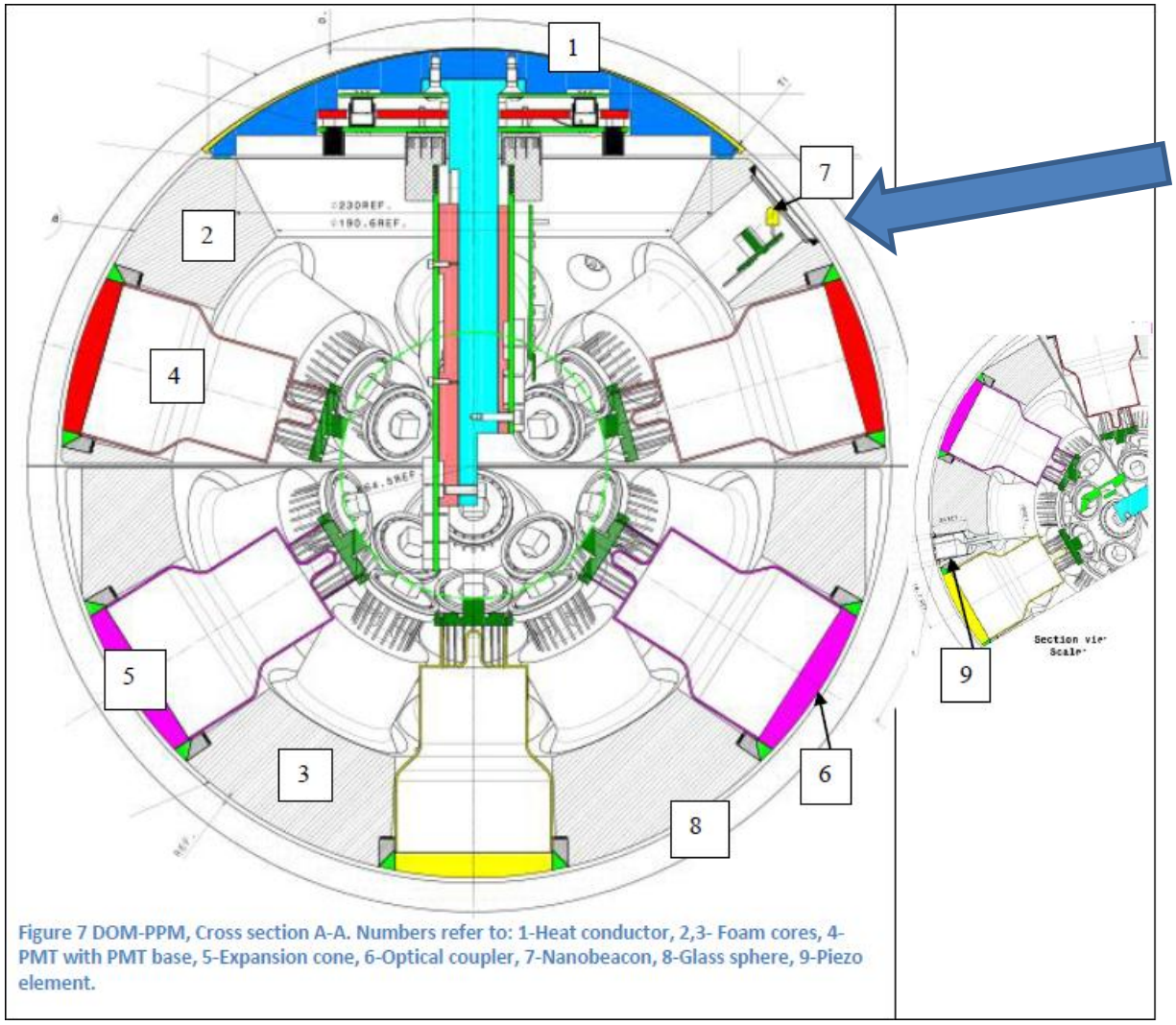
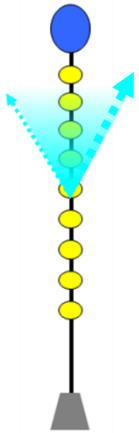


Figure 7 DOM-PPM, Cross section A-A. Numbers refer to: 1-Heat conductor, 2,3- Foam cores, 4-PMT with PMT base, 5-Expansion cone, 6-Optical coupler, 7-Nanobeacon, 8-Glass sphere, 9-Piezo element.

The Nanobeacon will be included in 3 of the DOM allocated in the active storeys of the PPM DU

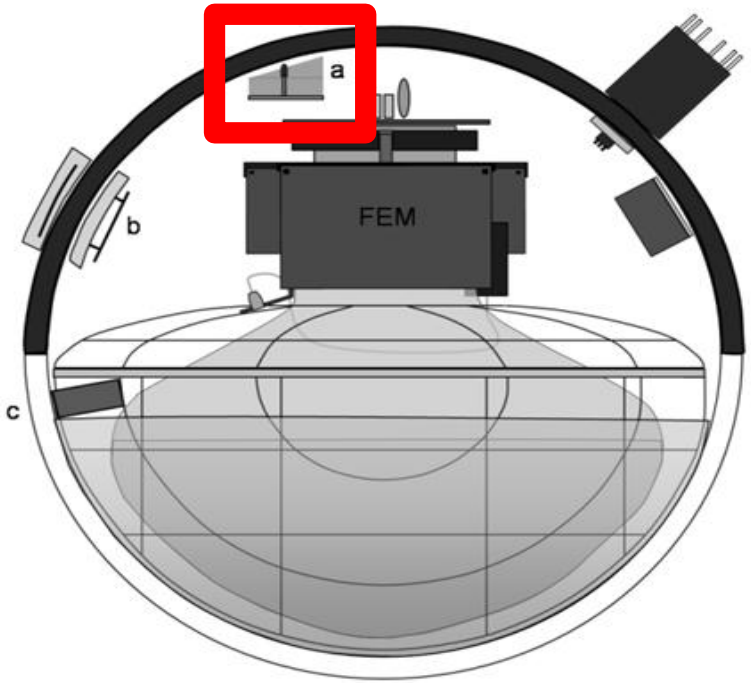


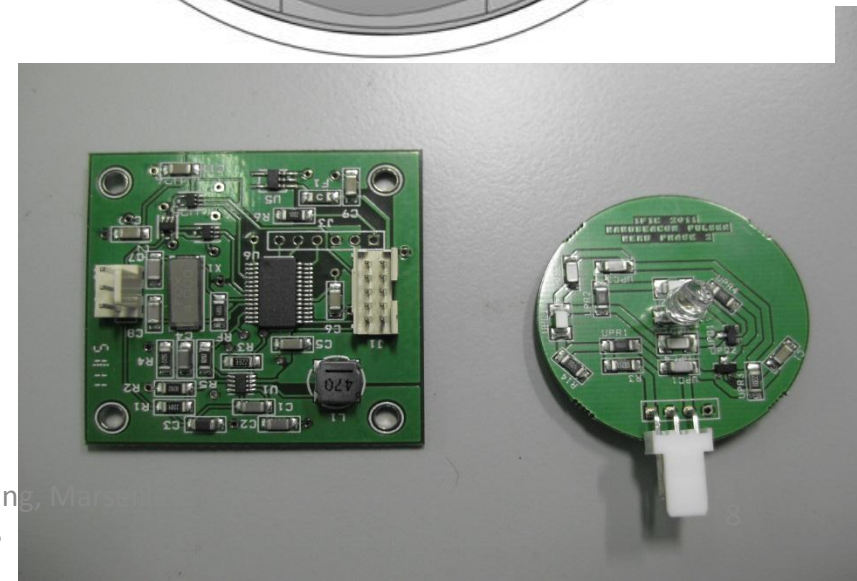
FWHM angular distribution ~ 15 º

NANOBEACON STATUS – NEMO TOWER PHASE II

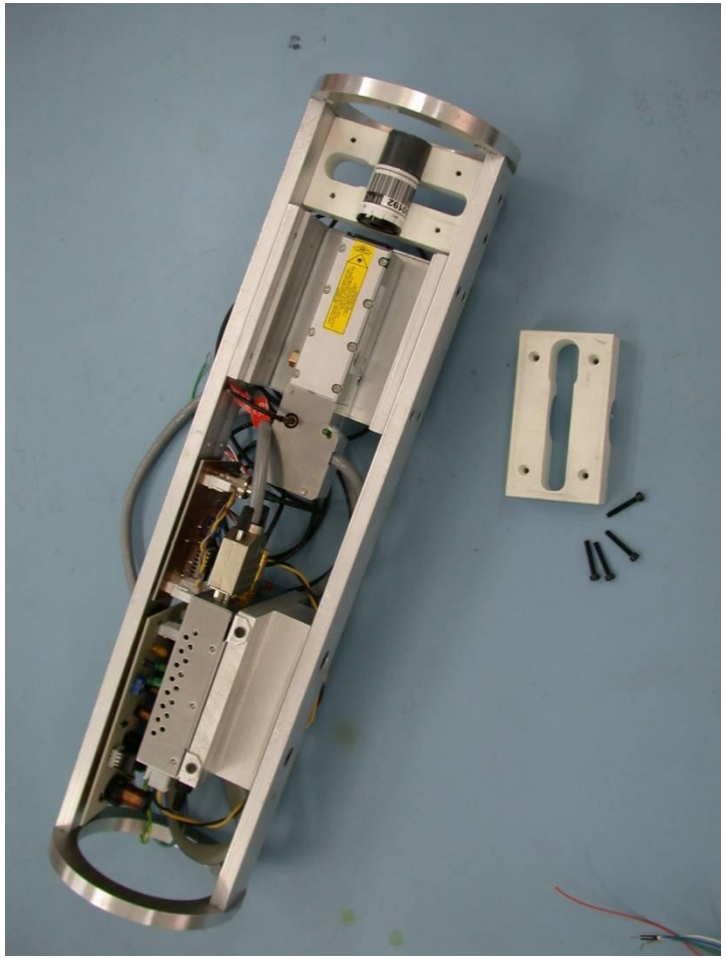
8 upwards-orientated LED Nanobeacons of different wavelengths have been integrated

- **4 LEDs of 470 nm have been mounted on the first two floors from the bottom**
- **2 LEDs of 440 nm on the third floor**
- **and 2 LEDs of 400 nm on the fourth floor**





LASER BEACON



- LASER BEACON
  - + Titanium Container
  - + Voltage-controlled attenuator
  - + LASER head
  - + Anti-Biofuling System
  - + Connector
  - + Slow Control Interface
  - + Photodiode Signal

LASER BEACON DEVELOPMENTS

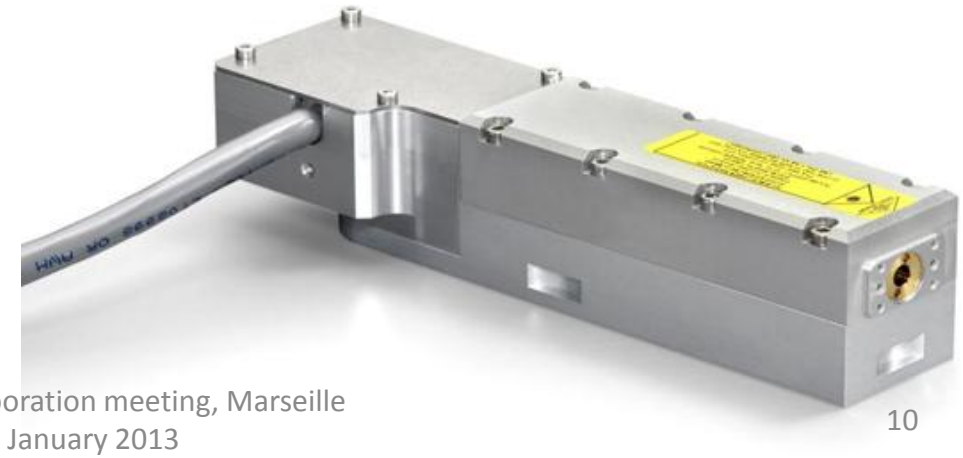
- **1 laser beacon integrated in the ANTARES IL11**
- **1 laser beacon integrated in the KM3NeT "Nemo Tower Phase II"**

  Both use a 3.5 uJ laser head from Teemphotonics

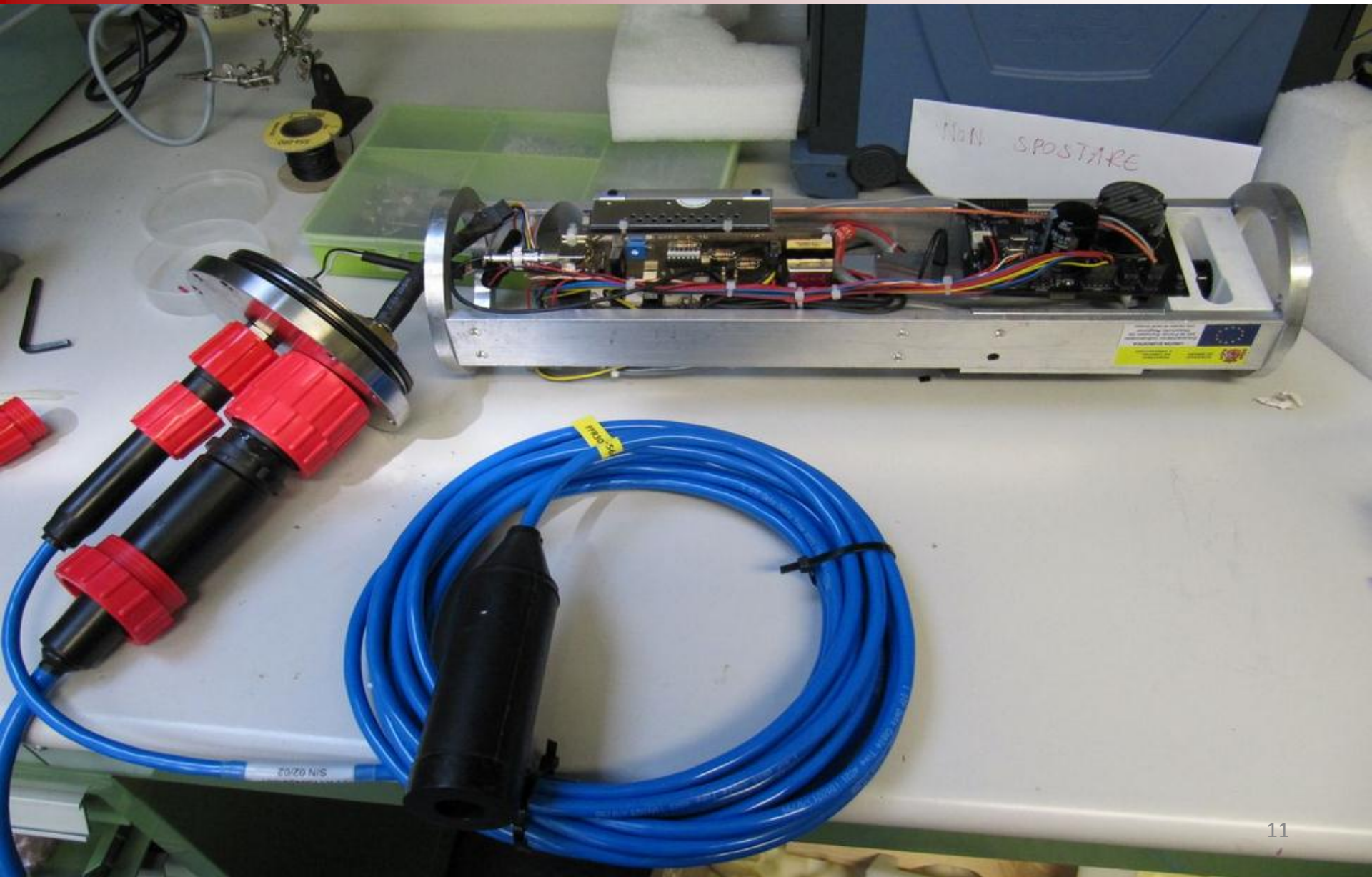
TABLE I
LASER PROPERTIES

Parameter	Value
Pulse width (ns)	400
Energy / Pulse (µJ)	3.5
Peak Power (kW)	10
Repetition rate (kHz)	
Average Power (mW)	

Twice more powerful than the ANTARES Laser Beacons



LASER BEACON: NEMO TOWER PHASE II



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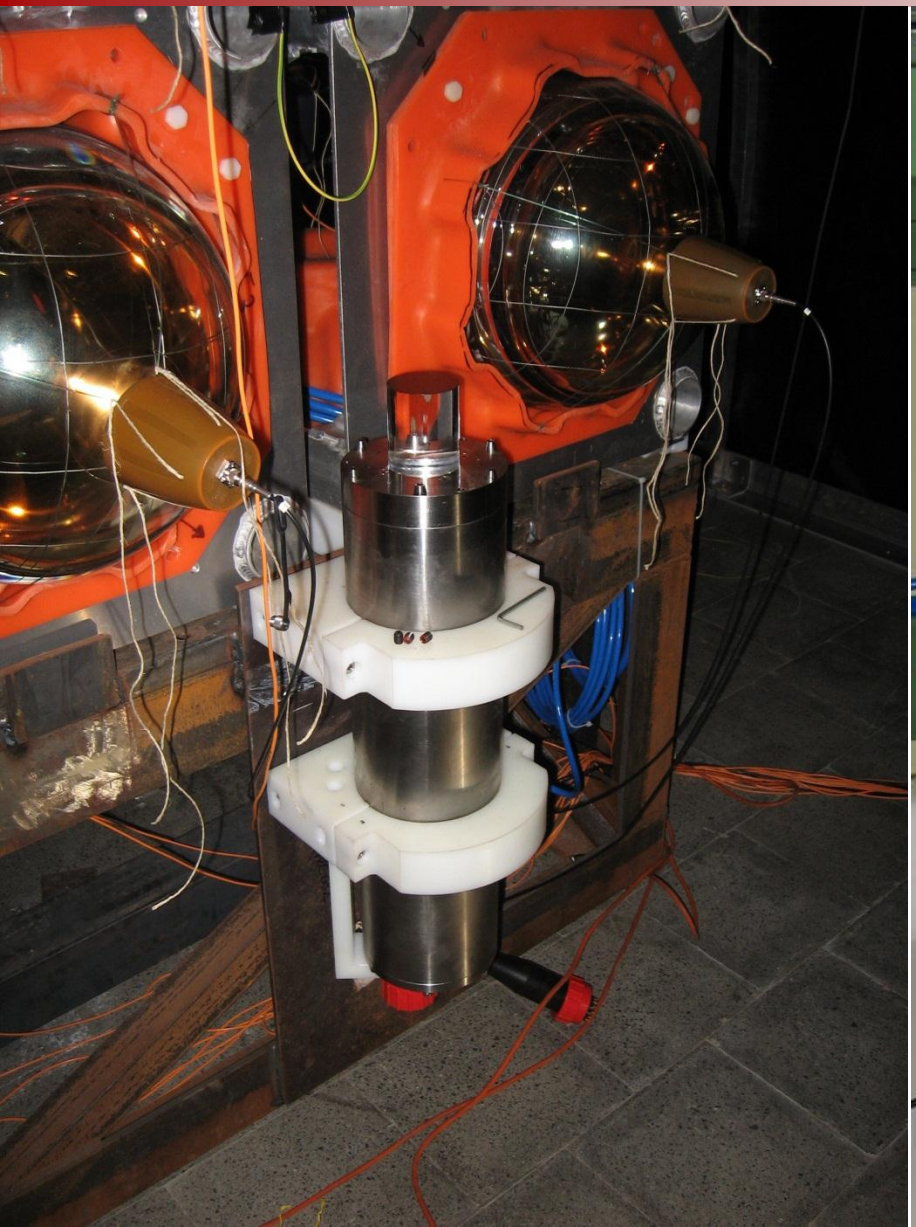


KM3NeT LASER BEACON

New laser head. More powerful
25 uJ per pulse versus 3.5 uJ of previous head.
@532 nm
New power supply and control needed

Model	PNP-B06010	PNP-B08010	PNG-B02010
Energy/Pulse (µJ)	70	90	25
Pulse Width (ps)	400	400	300
Peak Power (kW)	175	220	80
Repetition rate (Hz)	1,000	1,000	1,000
Average Power (mW)	70	90	25

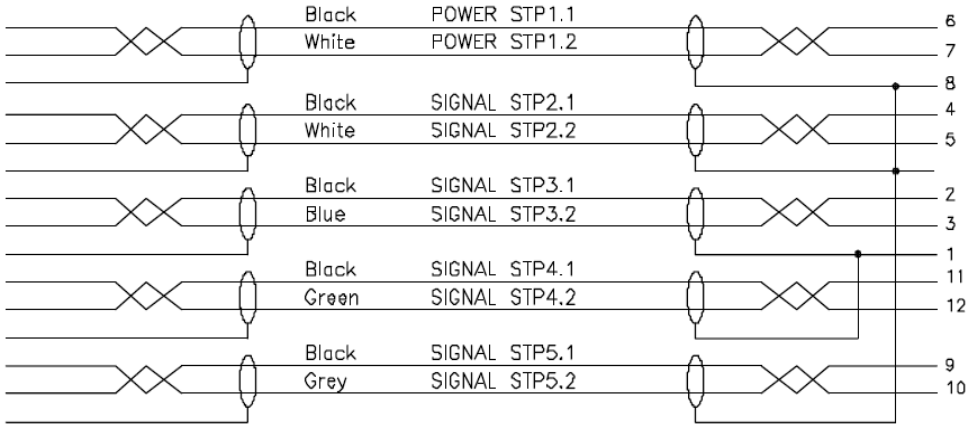
Typical values

KM3NeT LASER BEACON

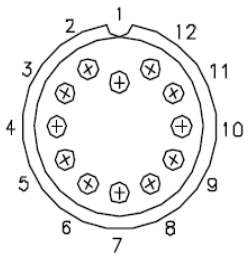
The connector to use in the KM3NeT laser beacon has to be chosen. Our proposal:

Use the same connector as in the ANTARES IL11

A titanium connector from the company **MacArtney** is used to input and output the laser required signals



Wiring diagram



Face view

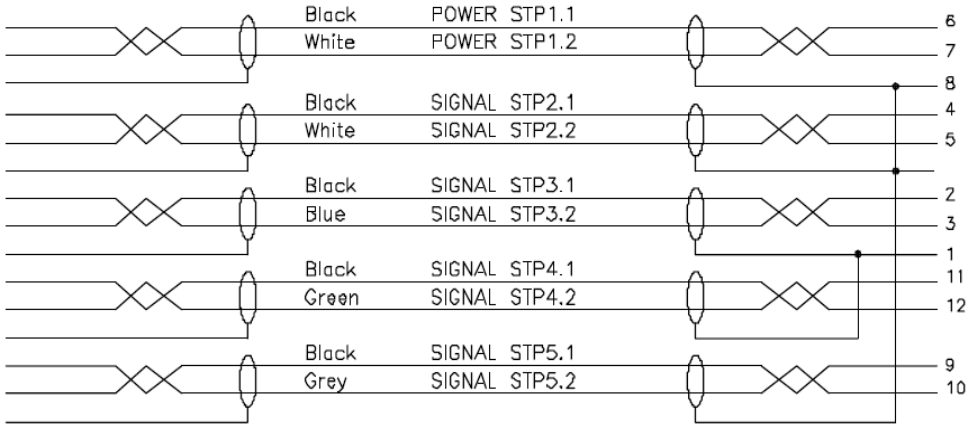
Wires	Description	Colour	Function
9 and 10	CLOCK	Grey	CLK signal
		Black	Ground
4 and 5	I^2C wires	White	SDA
		Black	SDL
11 and 12	PD signal (readout)	Green	Read out signal
		Black	Ground
6 and 7	Power supply	White	+ 48 V
		Black	Ground
2 and 3	NOT USED	Blue	NOT USED
1 and 8	Shielding	Black	NOT USED

KM3NeT LASER BEACON

The power supply to the laser beacon has to be chosen. Our proposal:

Use 48 Volts @ 2 Amps (~ 100 Watts)

A titanium connector from the company MacArtney is used to input and output the laser required signals



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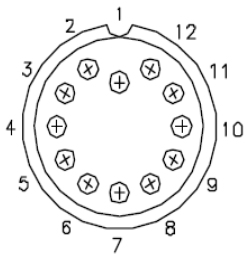

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KM3NeT LASER BEACON

The communications with the laser beacon has to be chosen. Our proposal:

Use I2C

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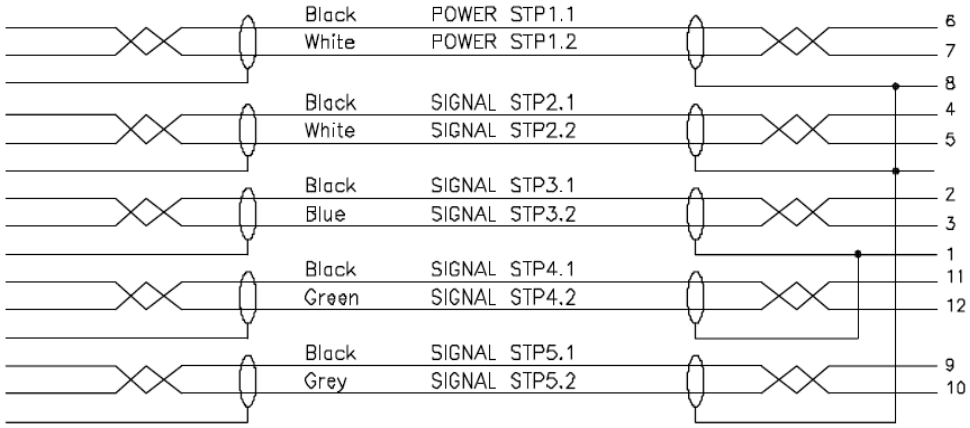

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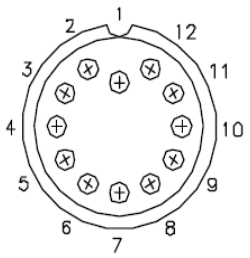

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SUMMARY

- **1 Nanobeacon** integrated on the PPM DOM
- **3 Nanobeacons** already produced and ready for integration in the PPM DU DOMs
- **8 upwards-orientated LED Nanobeacons** of different wavelengths (@ 470-440-400 nm) have been integrated in "Nemo Tower Phase II"
- **1 laser beacon** integrated in the ANTARES IL11 **(3.5 µJ)**
- **1 laser beacon** integrated in "Nemo Tower Phase II" **(3.5 µJ)**
- Proposal to use a new laser head. More powerful with **25 µJ** per pulse

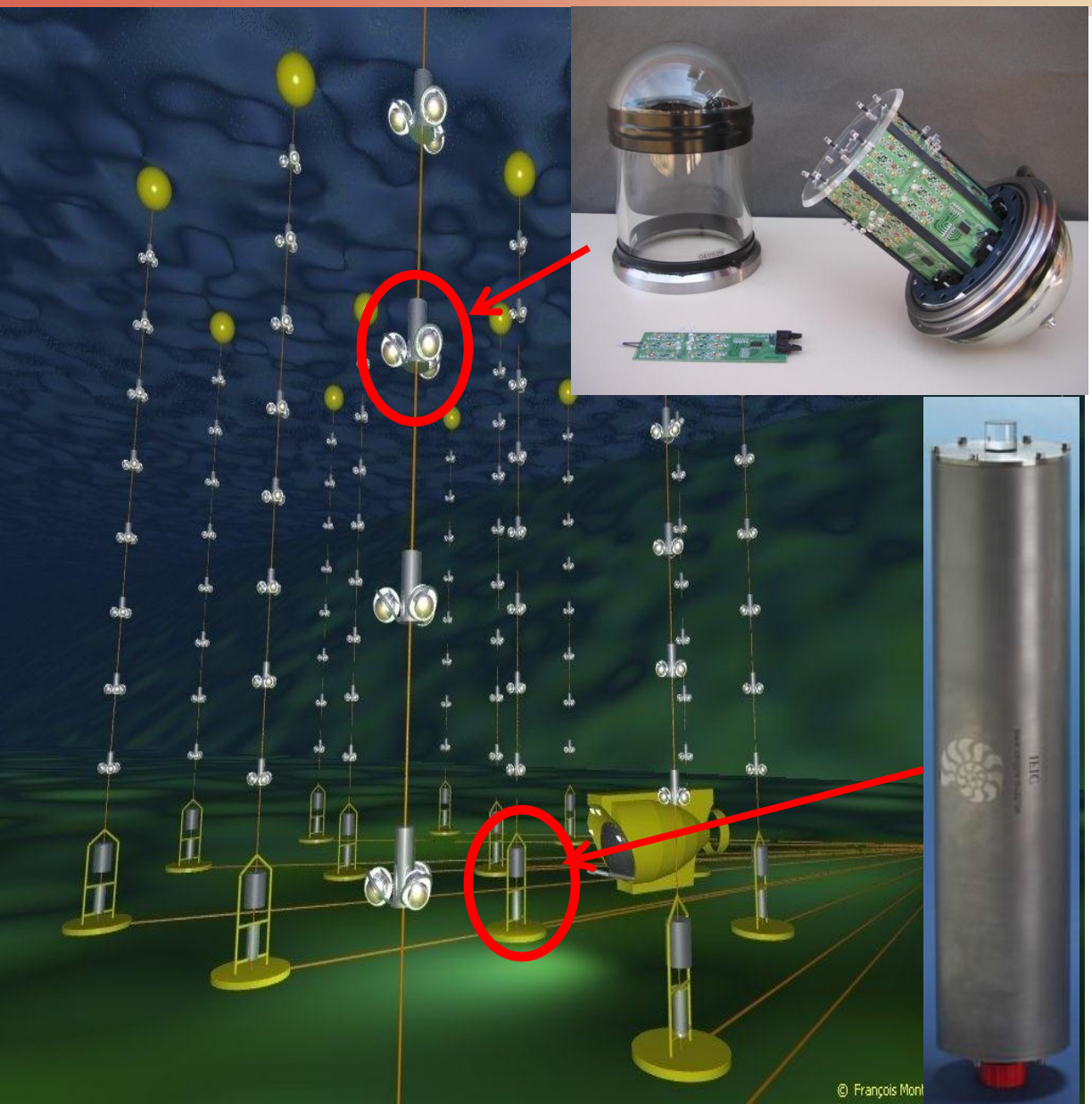
  Before star the development of the electronics it has to be chosen:

  - **Connector**
  - **Power Supply**
  - **Communications**

TIME CALIBRATION PROPOSAL

THANKS FOR YOUR ATTENTION!

THE ANTARES SYSTEM



47 LED OPTICAL BEACONS:

- **4 LOB** per Line (**472 nm)** located every 90 m along the line.
- LEDs cleaved for widening angular distribution
- Successful **Intraline** calibration along the line.
- **Interline** calibration cumbersome due to line movements and rotation.

2 Laser BEACONS:

- At bottom of central lines (**532 nm)**
- **Interline** calibration
- Positioning crosscheck
- Possibility of calibrating first storeys