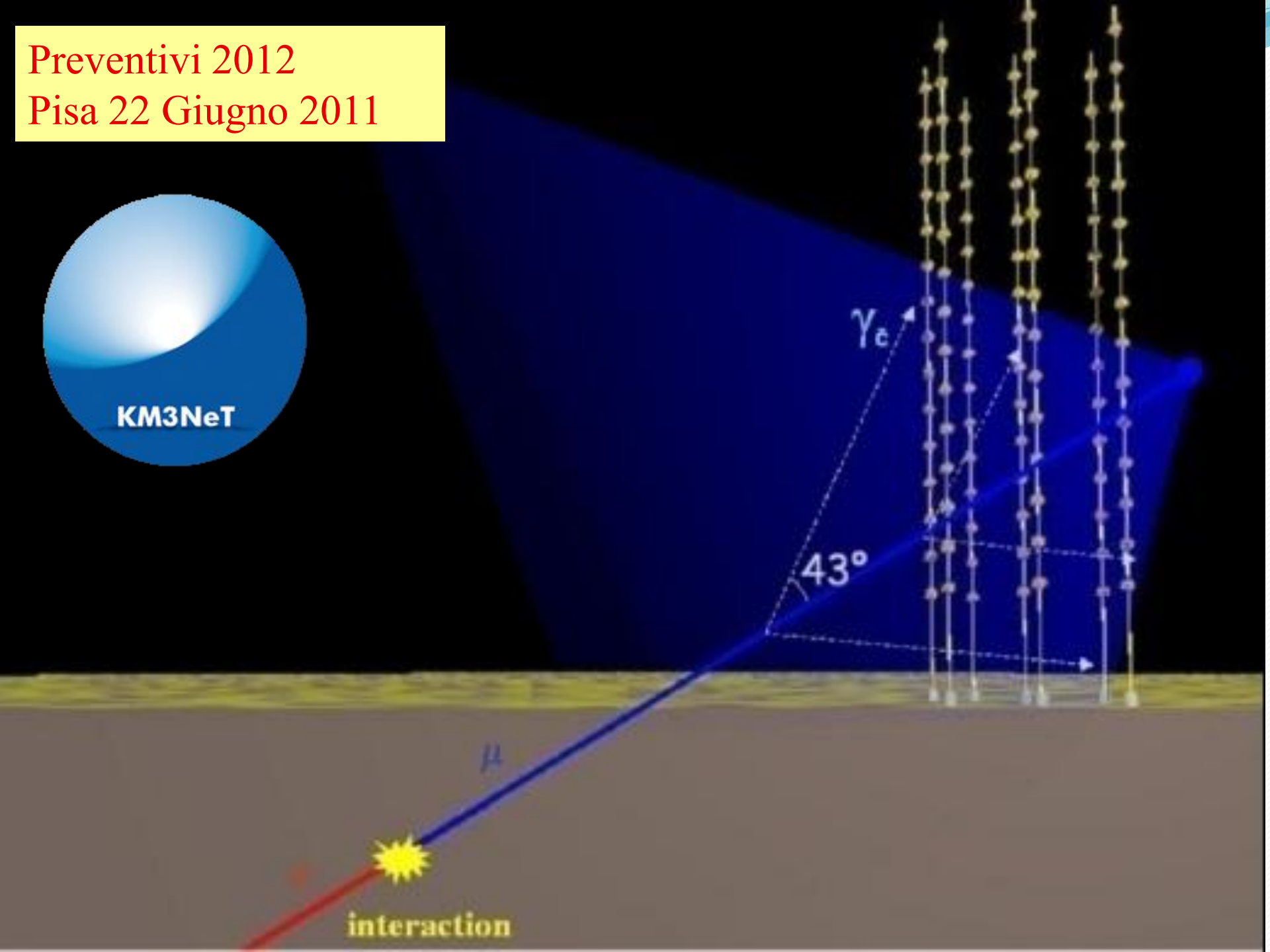
Preventivi 2012
Pisa 22 Giugno 2011



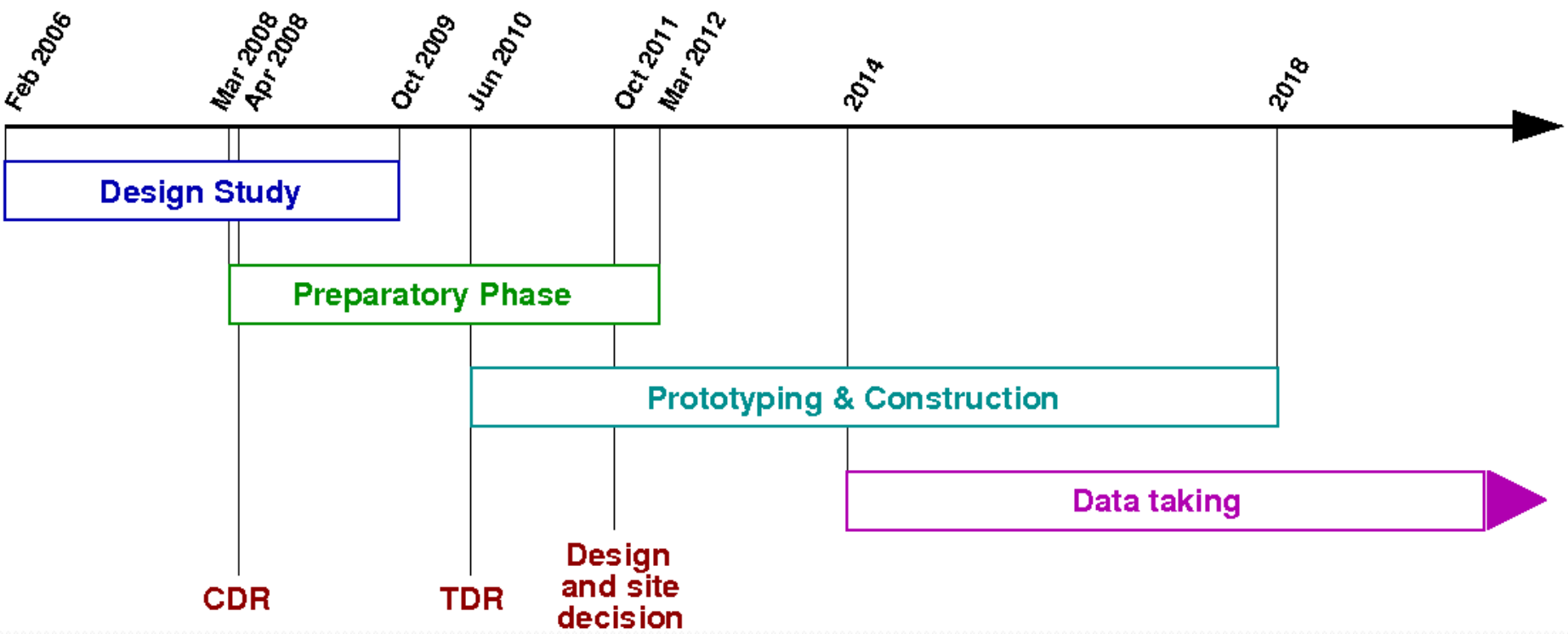
KM3NeT

- Central physics goals:
  - Neutrino Astronomy under the Mediterranean Sea
  - Investigate neutrino "point sources" in the 100 GeV-1 PeV energy range
  - Complement IceCube field of view
  - Instrumented volume > 5 km^3
- Implementation requirements:
  - Construction time ≤ 5 years
  - Operation over at least 10 years without "major maintenance"

- KM3NeT consortium consists of 40 European institutes, including those in Antares, Nemo and Nestor, from 10 countries (Cyprus, France, Germany, Greece, Ireland, Italy, The Netherlands, Rumania, Spain, U.K)
- KM3NeT is included in the ESFRI and ASPERA roadmaps
- Design Study (2006-2009) funded by the EU VIth Framework Program
- Conceptual Design Report (**ISBN** 978-90-6488-033-9) and Technical Design Report (**ISBN** 978-90-6488-031-5) available:
  www.km3net.org/public.php
- KM3NeT PreparatoryPhase (2008-2012)
  funded by the EU VIIth Framework Program

Final design, production plans for the detector elements and infrastructure features. In-situ prototype validation is underway. Legal, governance and funding aspects are also under study.

KM3NeT


Feb 2006
Mar 2008
Apr 2008
Oct 2009
Jun 2010
Oct 2011
Mar 2012
2014
2018
Design Study
Preparatory Phase
Prototyping & Construction
Data taking
CDR
TDR
Design and site decision

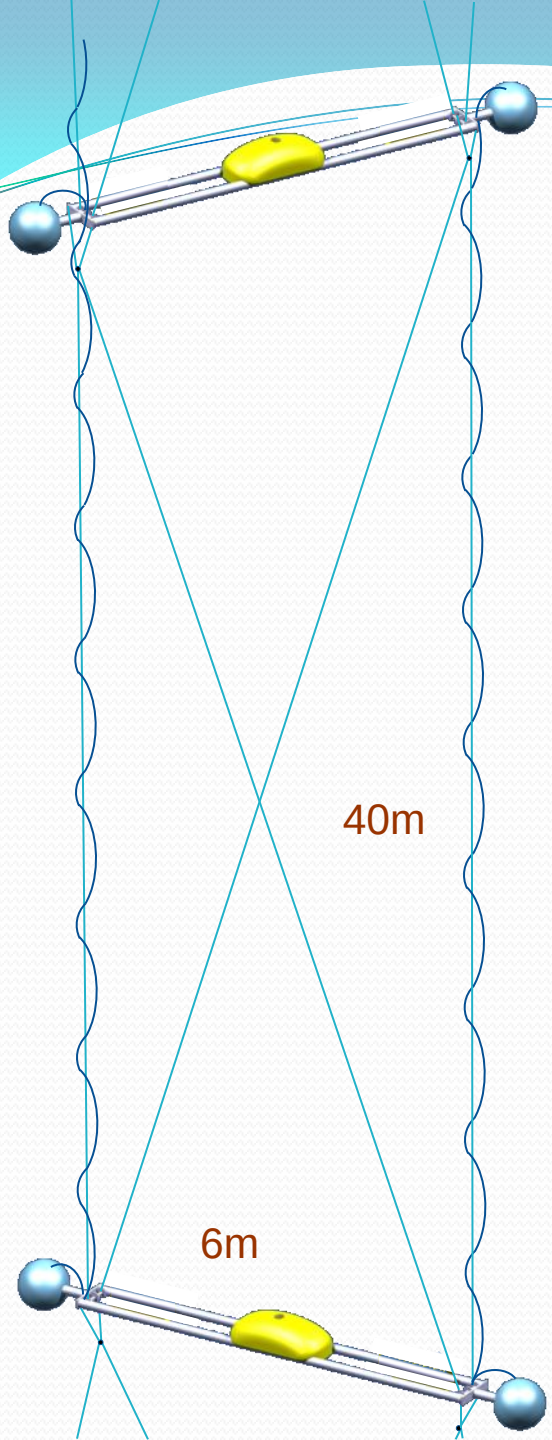
KM3NeT

Problems:

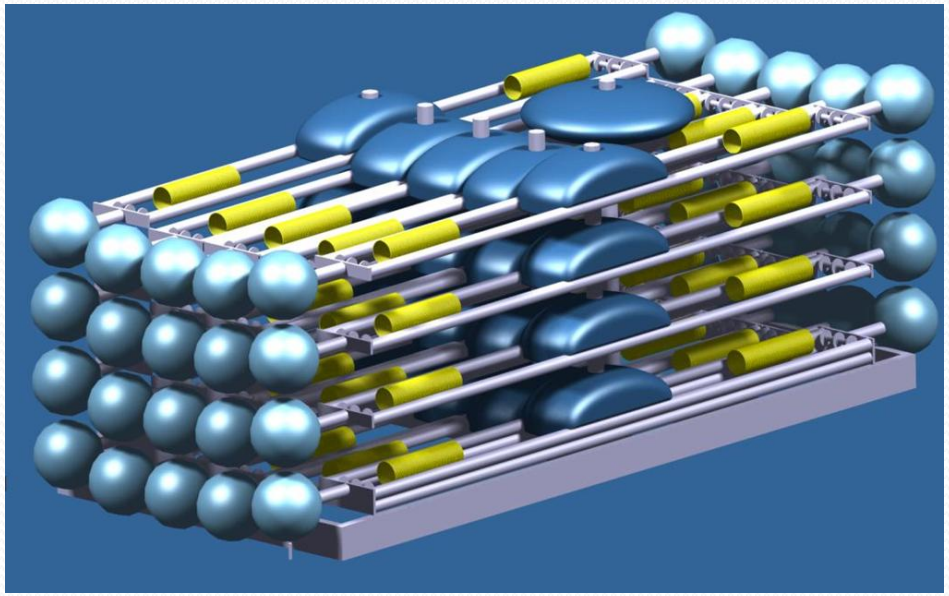
- *the ambient hydrostatic pressure;*
- *the corrosive environment of the seawater;*
- *the distance from shore for the communication;*
- *the force on the structure due to the sea currents;*
- *the backgrounds due to downward going muons;*
- *the backgrounds due to ^{40}K decay.*

- *optimal angular resolution of the reconstructed muon;*
- *large sensitive area facing the Galactic centre.*

The packed flexible tower (20 storeys)

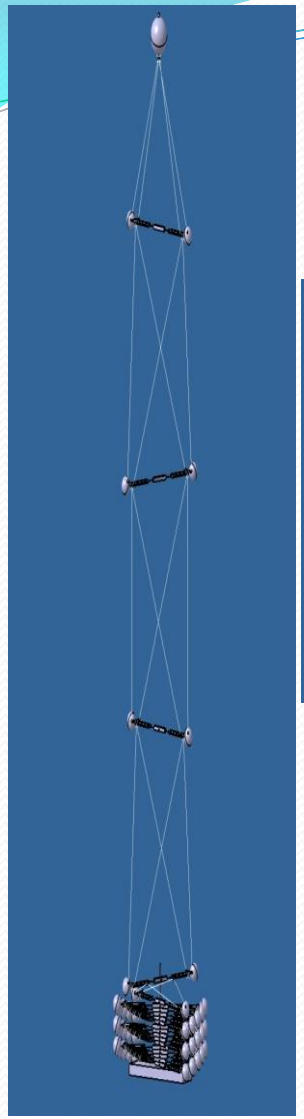


- Compact package
- Self unfurling
- Connection to seabed network by Remotely Operated Vehicle



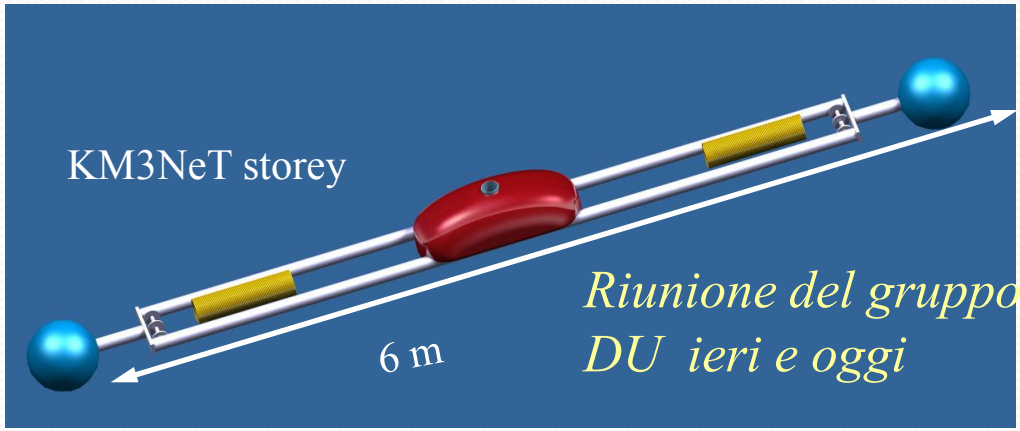
Storeys	20
Height	900m
Compact Package	6 x 2.5 x 2.5m
Top drift @ 30 cm/s	~120 m
Total buoyancy	~10 kN
EO Cable	2 x 6.35 mm OD

KM3Net Detection Unit



KM3NeT DU

20 storeys / 40 m distance (DU height ~ 900 m)
storey: bar of 6 m, with 2 multi-PMT OM
DOM: 31 x 3" PMT



KM3NeT "Building Block" configuration

DU	St/DU	OM/St.	PMT/OM	PMT
154	20	2	31	190 960

Multi-PMT Optical Module

Self-contained "plug-and-play" module (17" pressure-resistant sphere)

- Photo-sensors 31 (19+12) 3" PMTs Equivalent of 4 x 8" PMTs
- Includes: All read-out/control electronics and calibration devices
- Single colour point to point connection via DWDM between each OM and the shore station.

KM3NeT
DOM: multi-PMT OM

Distinguish single from multiple photon hits:

- Photon counting = PMT counting
- Background rejection – ^{40}K

Looking upward:

- Background rejection – atmospheric muons
- More uniform angular acceptance

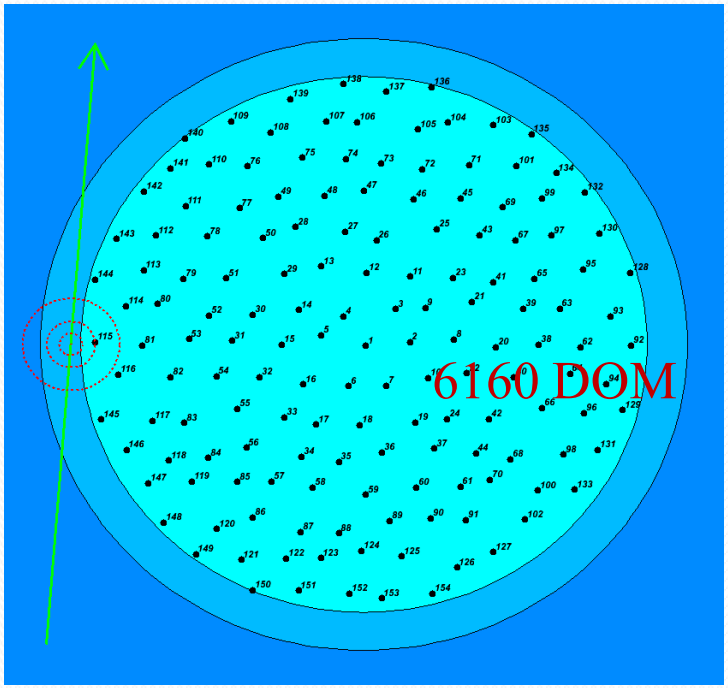
Directionality:

- Signal photons from one side

Ageing:

- lower gain ~10^6
- charge spread over multiple dynode chains

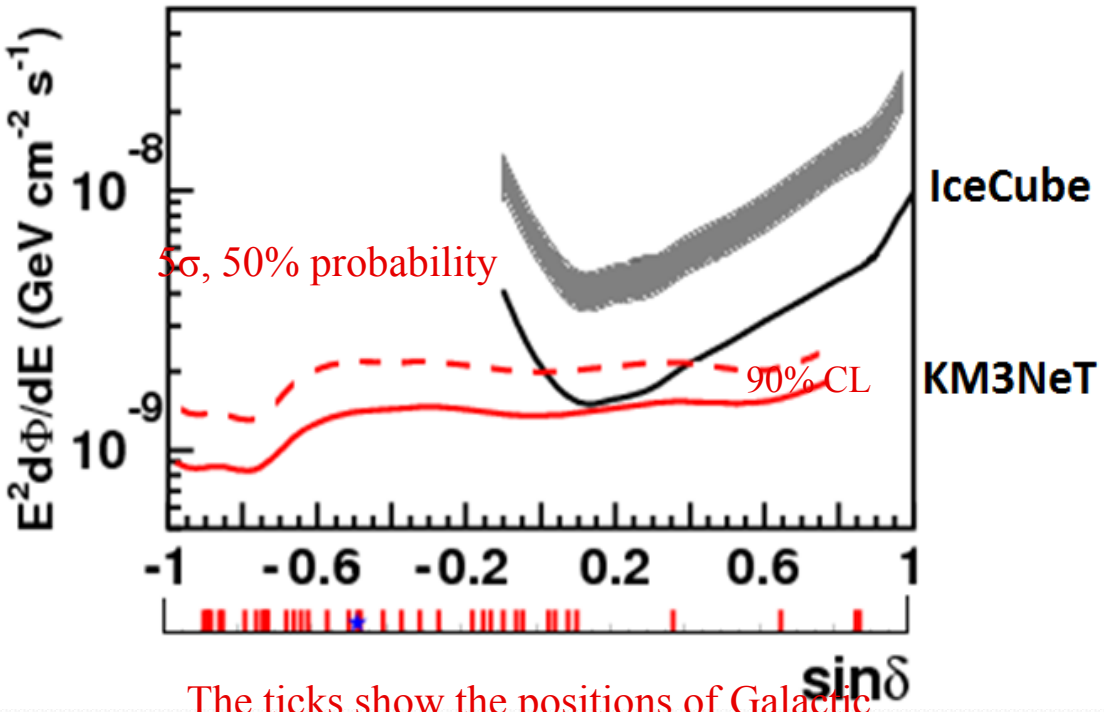
Building Block:
Currently considered option:
"Randomized Hexagon"



Surface area = $\pi R^2 = 4.2$ km^2
R = 1160 m
Instrumented volume = $\pi R^2 h$
h = 760m (19x40)
$V_{inst} \approx 3$ km^3

Flux sensitivity to neutrino point source
One year of observation

ANTARES today: ~10^{-7} GeV cm^{-2} s^{-1}

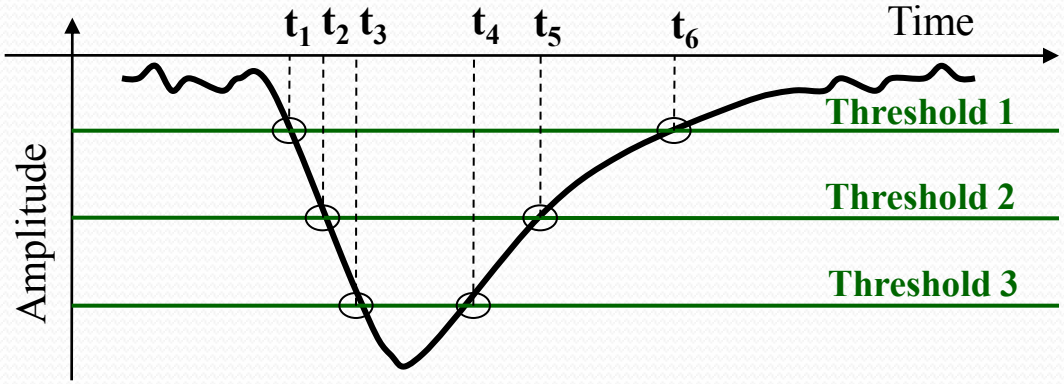


The ticks show the positions of Galactic gamma ray sources. The position of the Galactic Centre is indicated by a blue star.

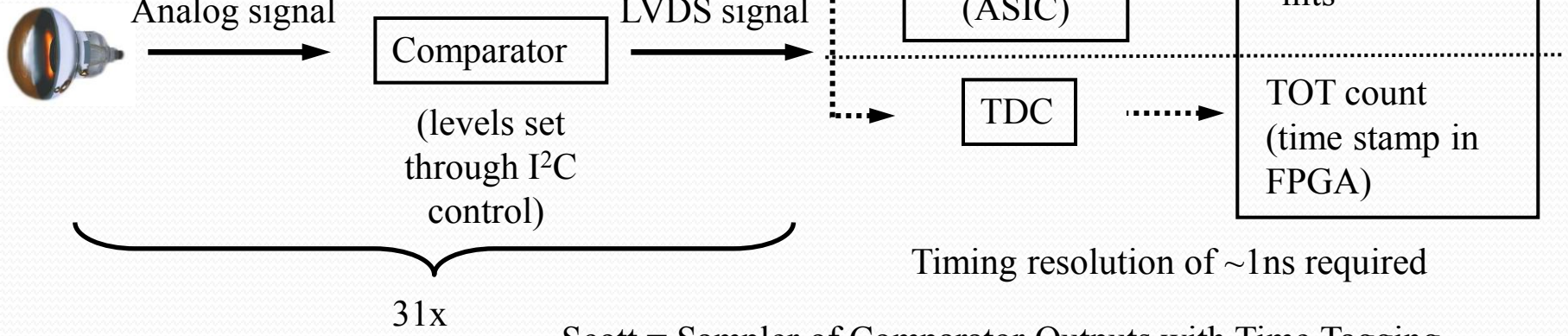
Building Blocks will make up KM3NeT?

Front End Electronics

Time over threshold (TOT):



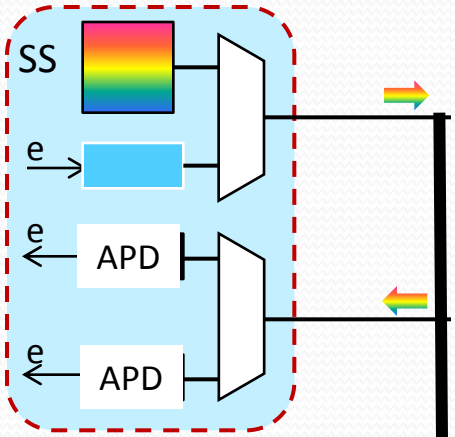
Two options for readout



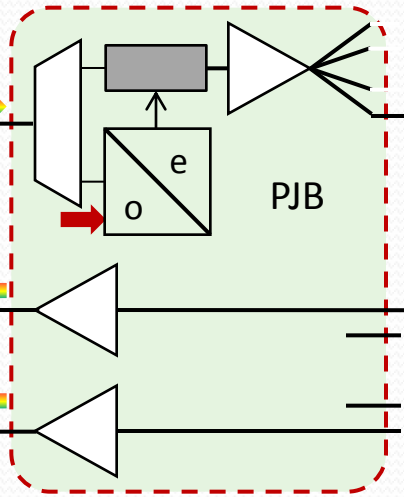
Scott = Sampler of Comparator Outputs with Time Tagging
TDC = Time to Digital Converter

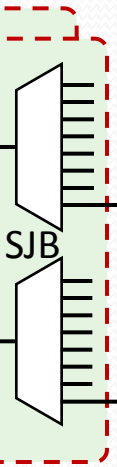
Optical Network

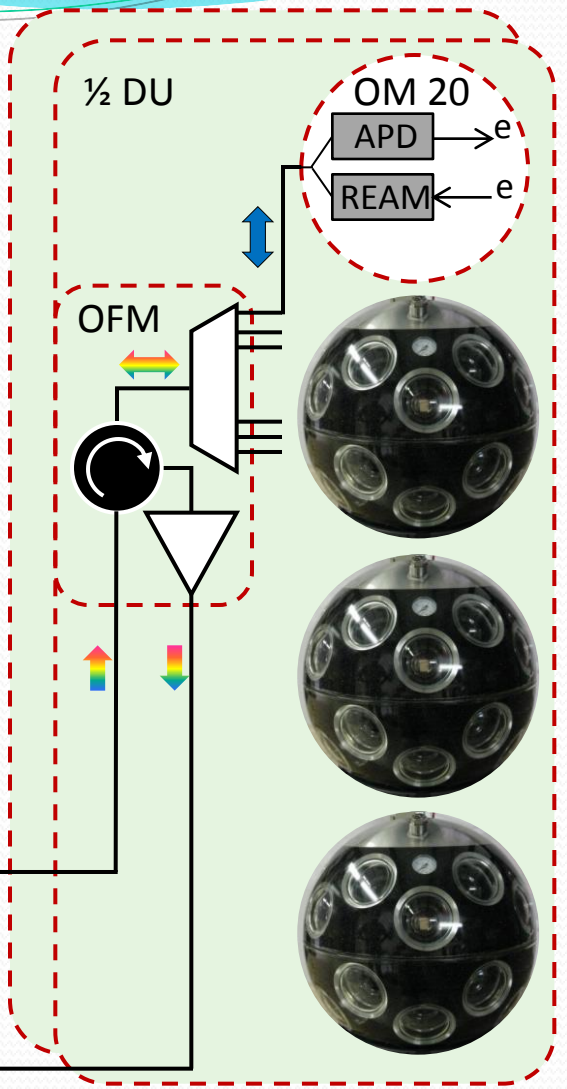
Dense Wavelength Division Multiplexing:
Following ITU Grid Specification:
C (1530-1570 nm) or L band (1570-1610 nm)
with 25GHz separation

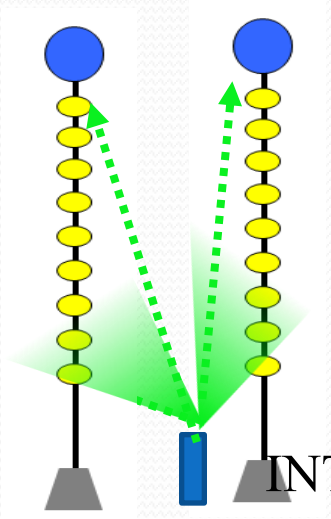


Up tp ~80 λ / fibre
< 10 Gbps P2P
Up to ~70 fibres in main cable
Time delay measurements possible





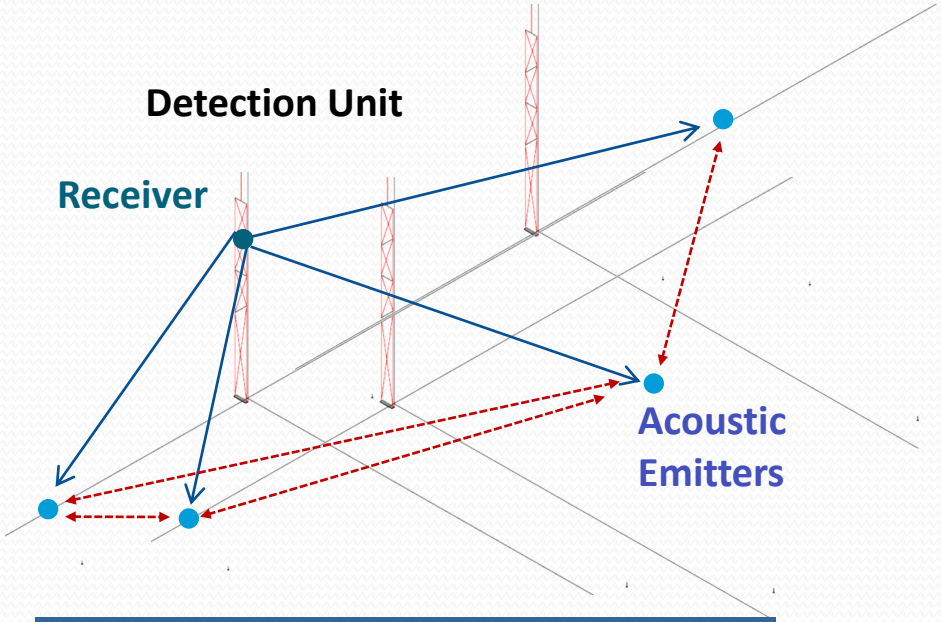


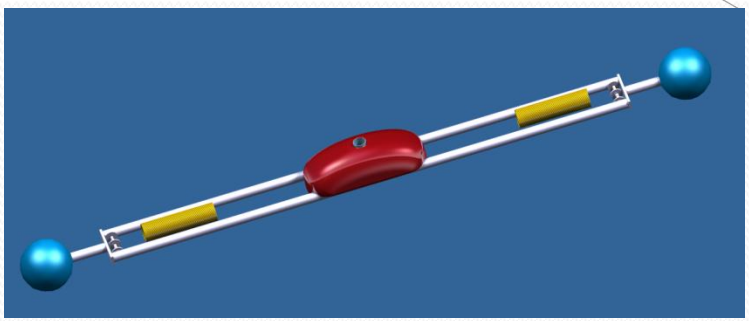


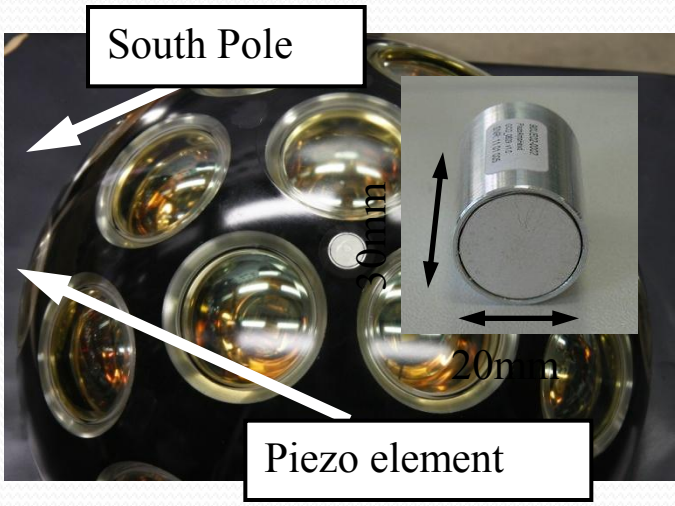
INTER DU Calibration Laser Beacons @ 532 nm

Acoustic Position Calibration

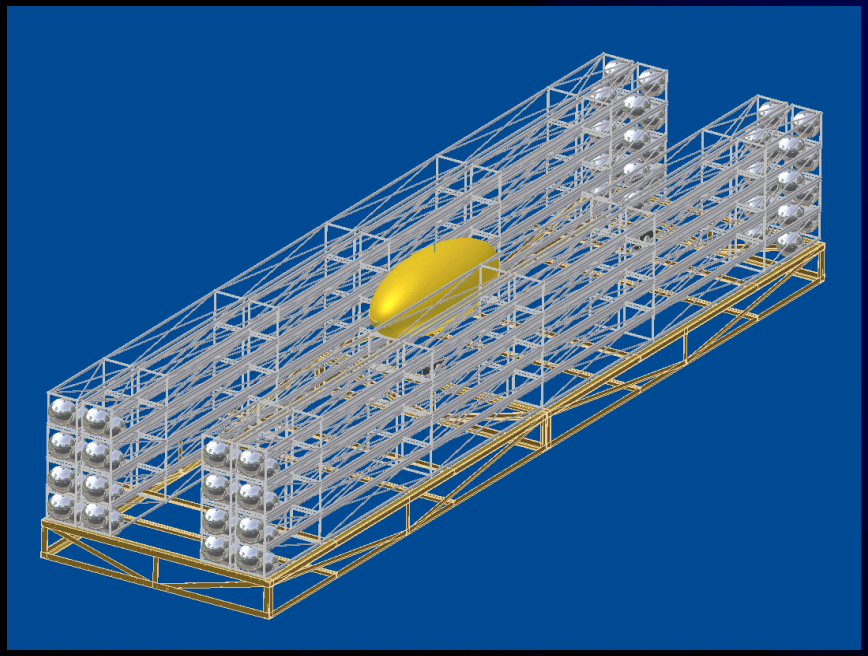
Options “piezo in sphere” and standard hydrophones investigated







NEUTRINO MEDITERRANEAN OBSERVATORY



γ_c

43°

μ

interaction

Pubblicazione del bando per il potenziamento delle infrastrutture (fondi PON)

Scadenza 21-8-2011 Inporto massimo 45 milioni di euro

In preparazione una proposta per la realizzazione di una infrastruttura di ricerca

che individua il sito di Portopalo (Capo Passero) come uno dei

networked KM3NeT nodes

[1 Meuro da Miur su progetti speciali]

Continua l'attività NEMO phase II: in costruzione, immersione fine 2011

Torre con 8 piani (ℓ=6m, d=40 m), 4 OM (PMT Hamamatsu 10", sfera da 13") per piano

Uno o due piani per test (DOM etc...)

Completa di strumenti oceanografici e Idrofoni per la calibrazione spaziale

1998-2004 NEMO R&D and site selection

NEMO
NEUTRINO MEDITERRANEAN OBSERVATORY

Extensive site exploration of Mediterranean Sea:
selected Capo Passero (depth 3500 m, shore distance 100 km)

– best optical properties out of investigated sites

L_a ~70m @ 440nm

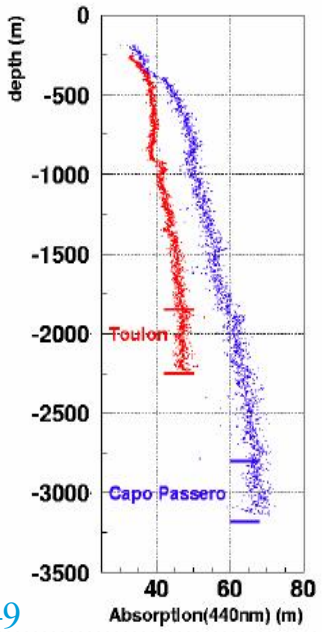
– no seasonal variations of water optical properties

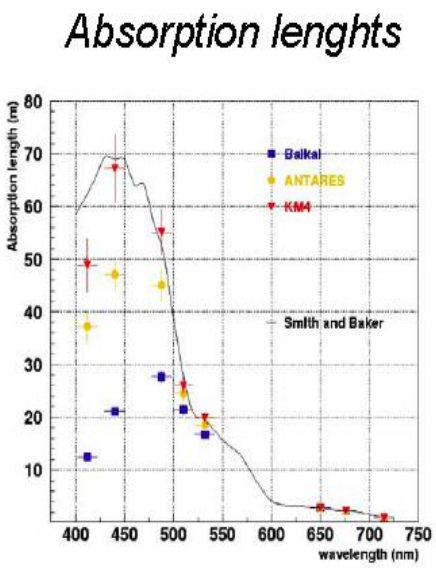
– extremely low background from bioluminescence

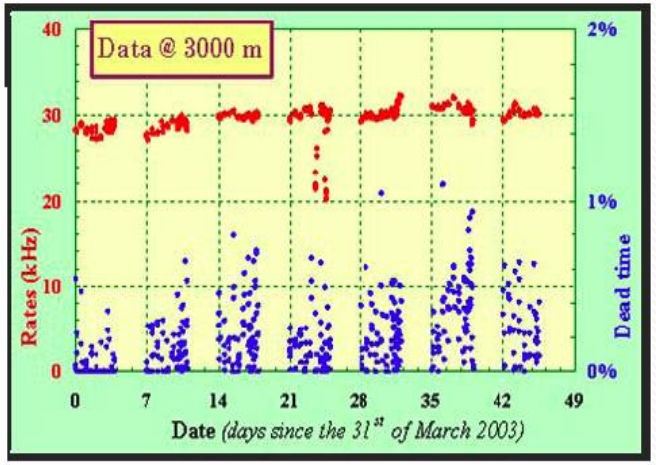
f ~ 30 kHz ($\varnothing_{PMT}$=10")

– deep-sea water currents are low (3cm/s avg.) and stable

– wide abyssal plain, far from the shelf break, allows for possible reconfigurations of the detector layout





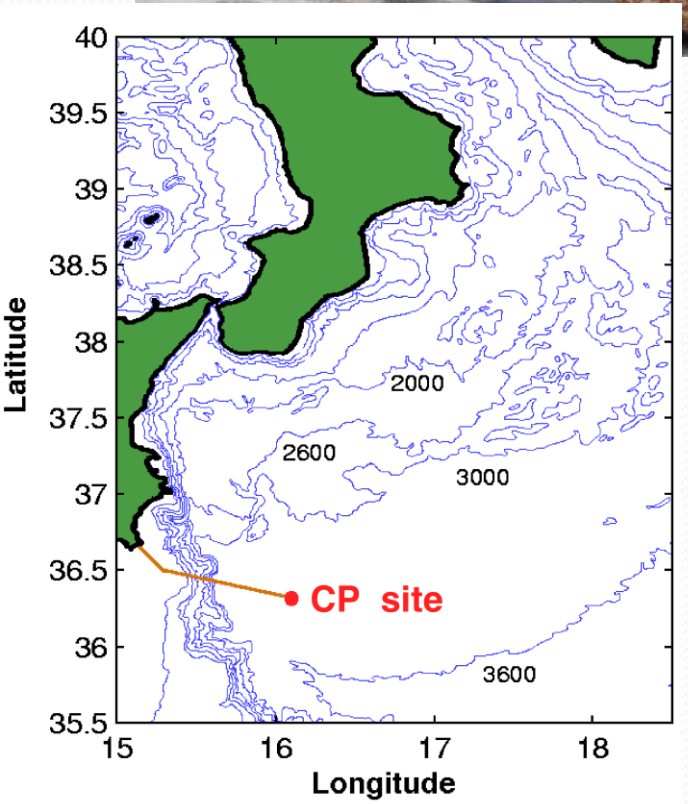


- PMT: 10"
- Thres: ~.5 SPE

Fraction of time
R > 200 kHz

Astrop. Phys. 27 (2007) 1–9

Portopalo

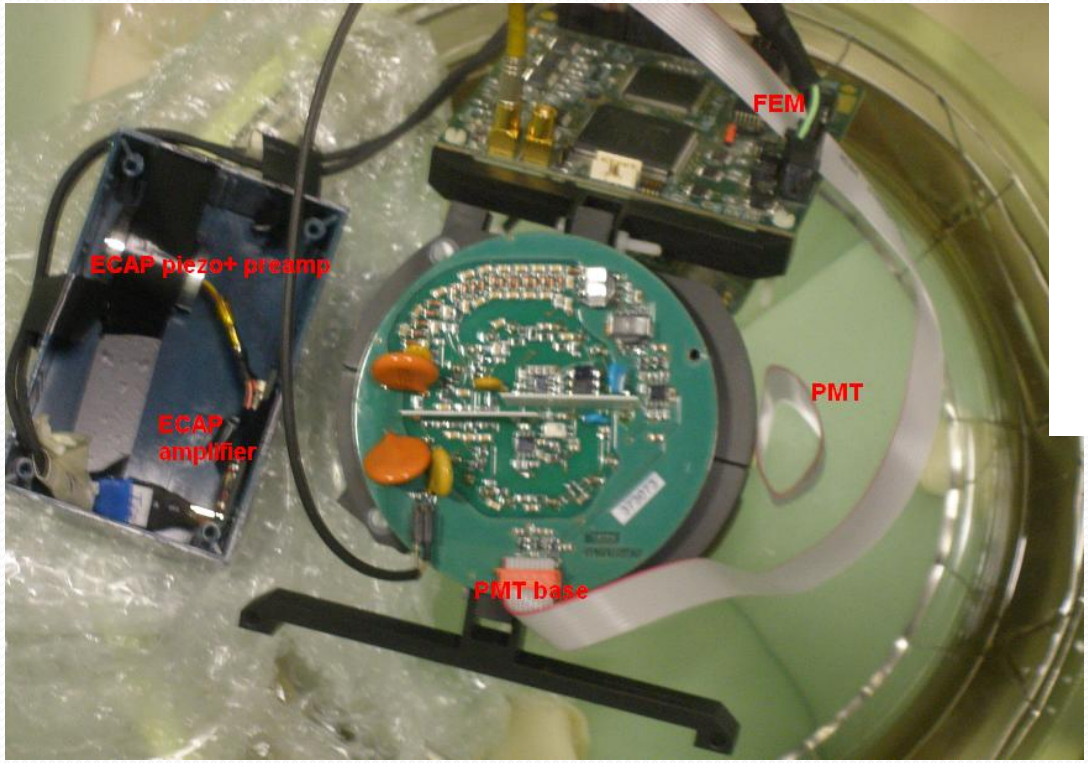


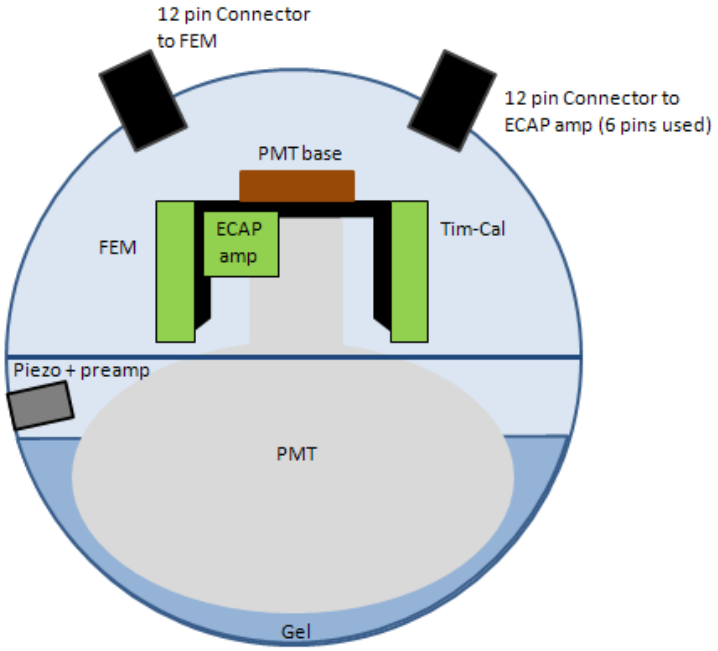
Cable and Power System installed end tested

Ethernet: ok

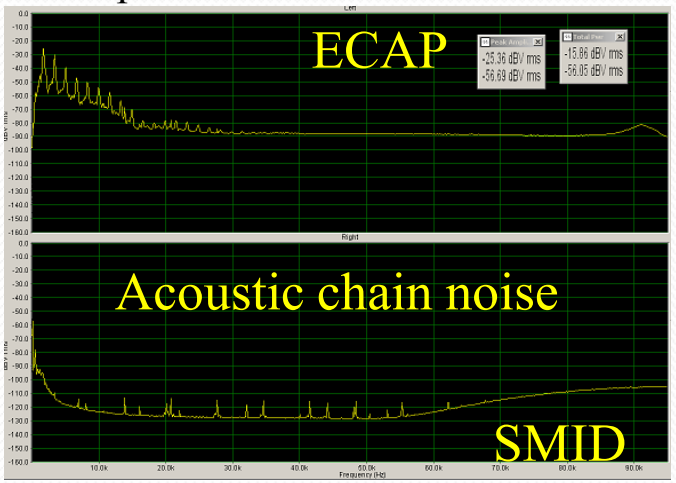
Nemo phase II: Settember 2011→

KM3 2012 → ??

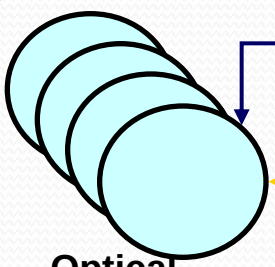




Studio di nuove soluzioni per la calibrazione spaziale e temporale



DAQ and time - space calib.

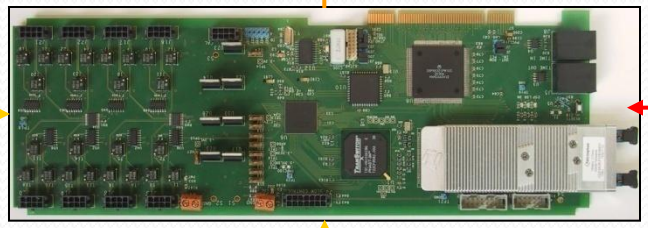


Optical modules

Time calibration Board

SPI

SPI



FCM Interface on Shore

STM-1 (optical)

Gbit Ethernet

Hydrophones

SPI

Floor Control Module Board

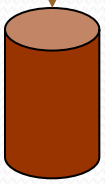
analog

Acoustic positioning system Board

RS-232

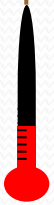
Slow Control Interface Board

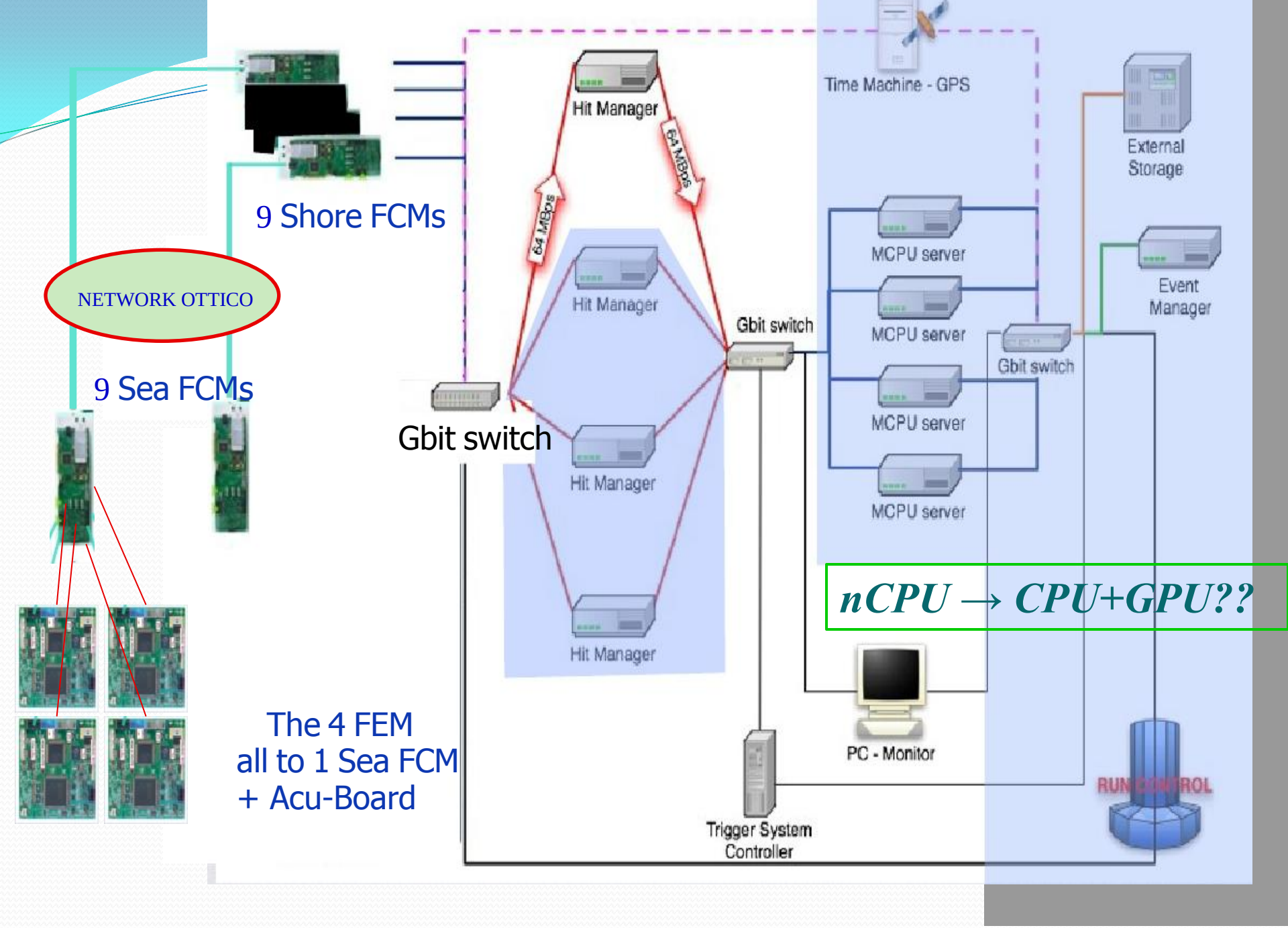
RS-232



Oceanographic Instrument

Internal Sensors




9 Shore FCMs
NETWORK OTTICO
9 Sea FCMs
The 4 FEM
all to 1 Sea FCM
+ Acu-Board
Hit Manager
64 MBps
64 MBps
Hit Manager
Hit Manager
Hit Manager
Gbit switch
Gbit switch
Time Machine - GPS
External Storage
MCPU server
MCPU server
MCPU server
MCPU server
Gbit switch
Event Manager
nCPU → CPU+GPU??
PC - Monitor
Trigger System Controller
RUN CONTROL

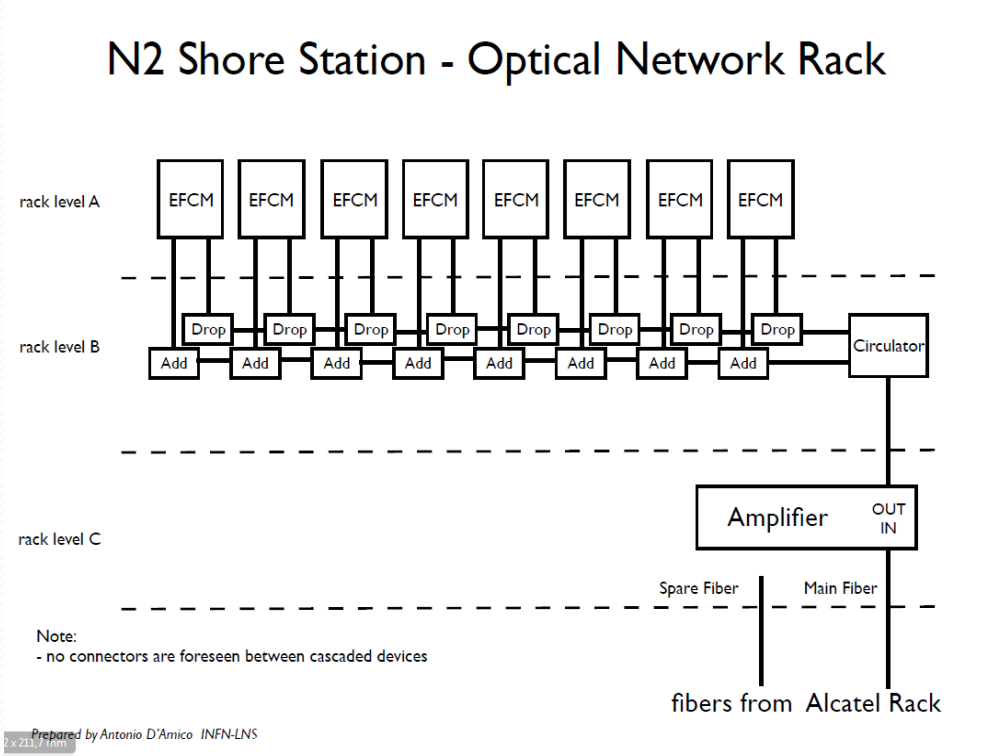
NEMO FASE-2: NETWORK OTTICO

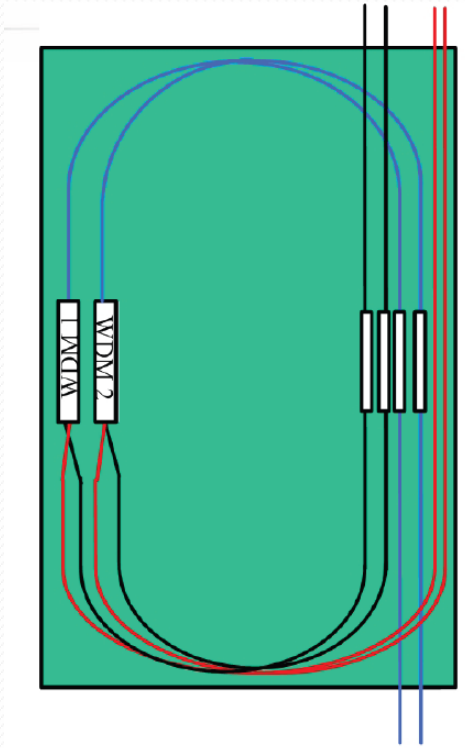
- Costruito il modulo ottico che con filtri MUX/DEMUXD connette i Transceivers delle 9 schede eFCM (con lunghezze d'onda definite) al circolatore ottico DWDM

- Possediamo la tecnologia per effettuare le giunzioni ottiche e gli strumenti ottici per verificare la bontà delle connessioni e la loro attenuazione

- Gli ADD&Drop sono giuntati ad un connettore standard ottico SC. Si è verificato che siano conformi alle specifiche.

- Un pannello frontale permette la connessione con bretelle fra amplificatore Raman (da e verso il mare) e schede eFCM

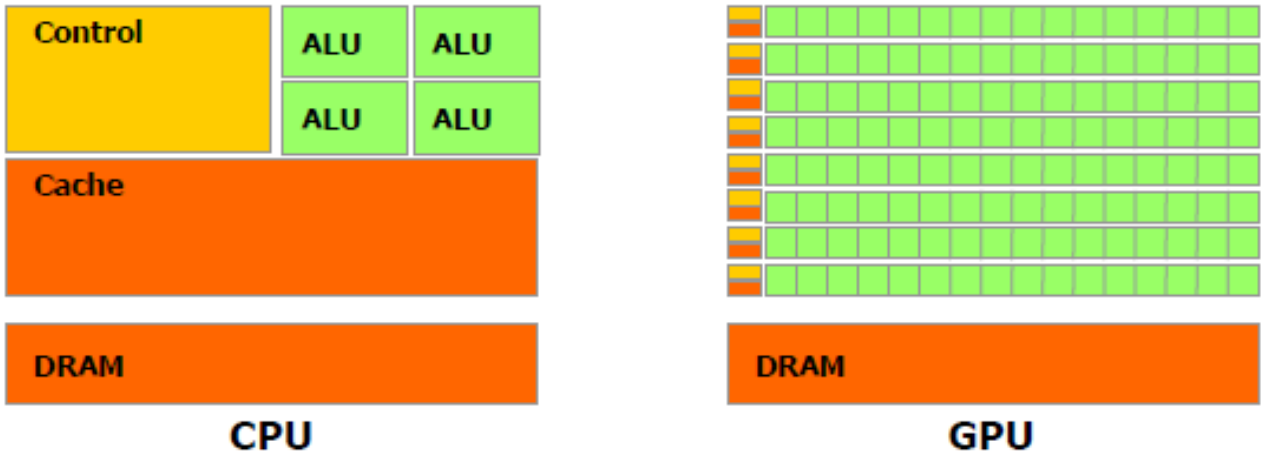




Trigger on GPU

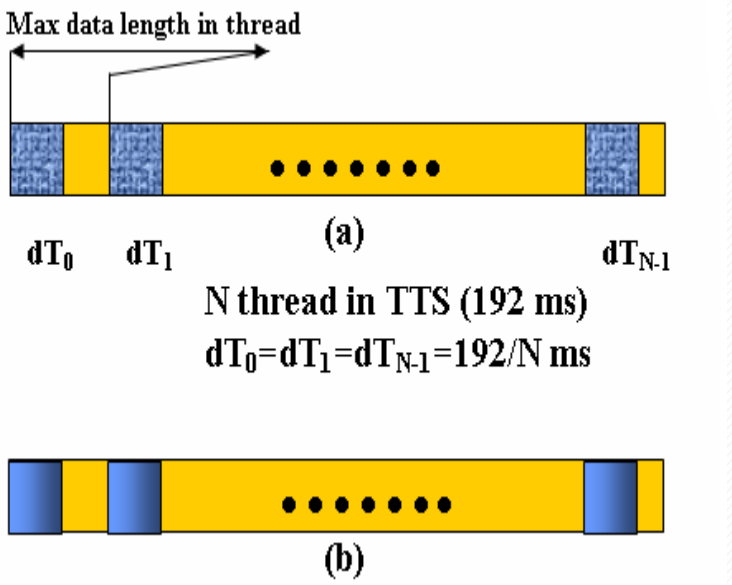
Montecarlo *(muoni da neutrini + 50 KHz di background):*
4 TTS da 192 ms di dati (torre di 16 piani)
Ciascuna TTs è suddivisa in miniTTS da 12ms
In ogni miniTTS gli hits) sono ordinati secondo il numero di PMT e per tempo.
Le traccie (≥3 hit, hit spread < 3.5 μs) da muoni sono distribuite nelle TTS e hanno fra loro la stessa distanza temporale (100 μs>> 3.5 μs)

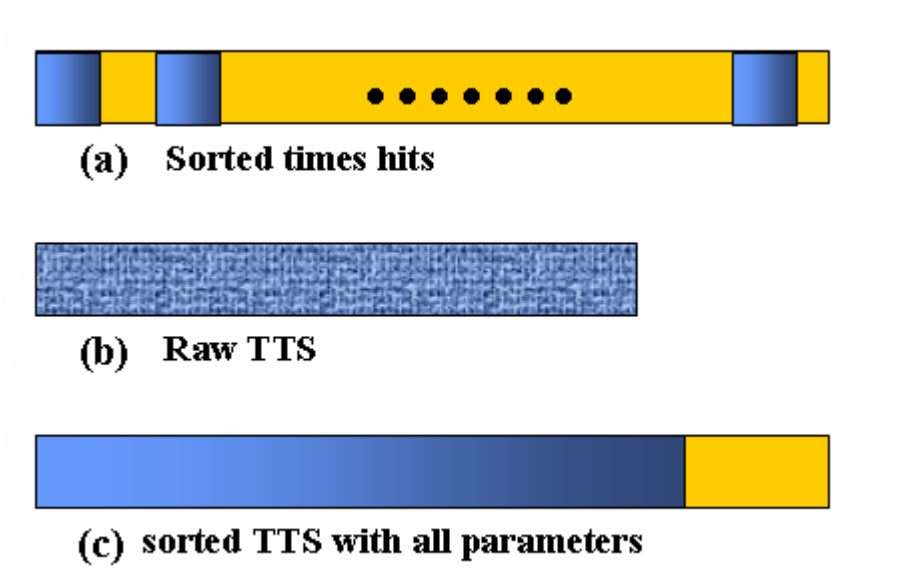
Nella GPU sfruttando il calcolo parallelo:
- *gli hit vengono ordinati temporalmente mescolando i 64 PMT*
- *si studia un algoritmo di trigger che individui la traccia nel background.*



I processi nella GPU sono organizzati in blocchi di threads

TTS Reading and Sorting





Send times and relative hit positions to GPU

- divide the hits in time intervals (*number of intervals = number of threads per block*)
- sort data using quicksort algorithm.

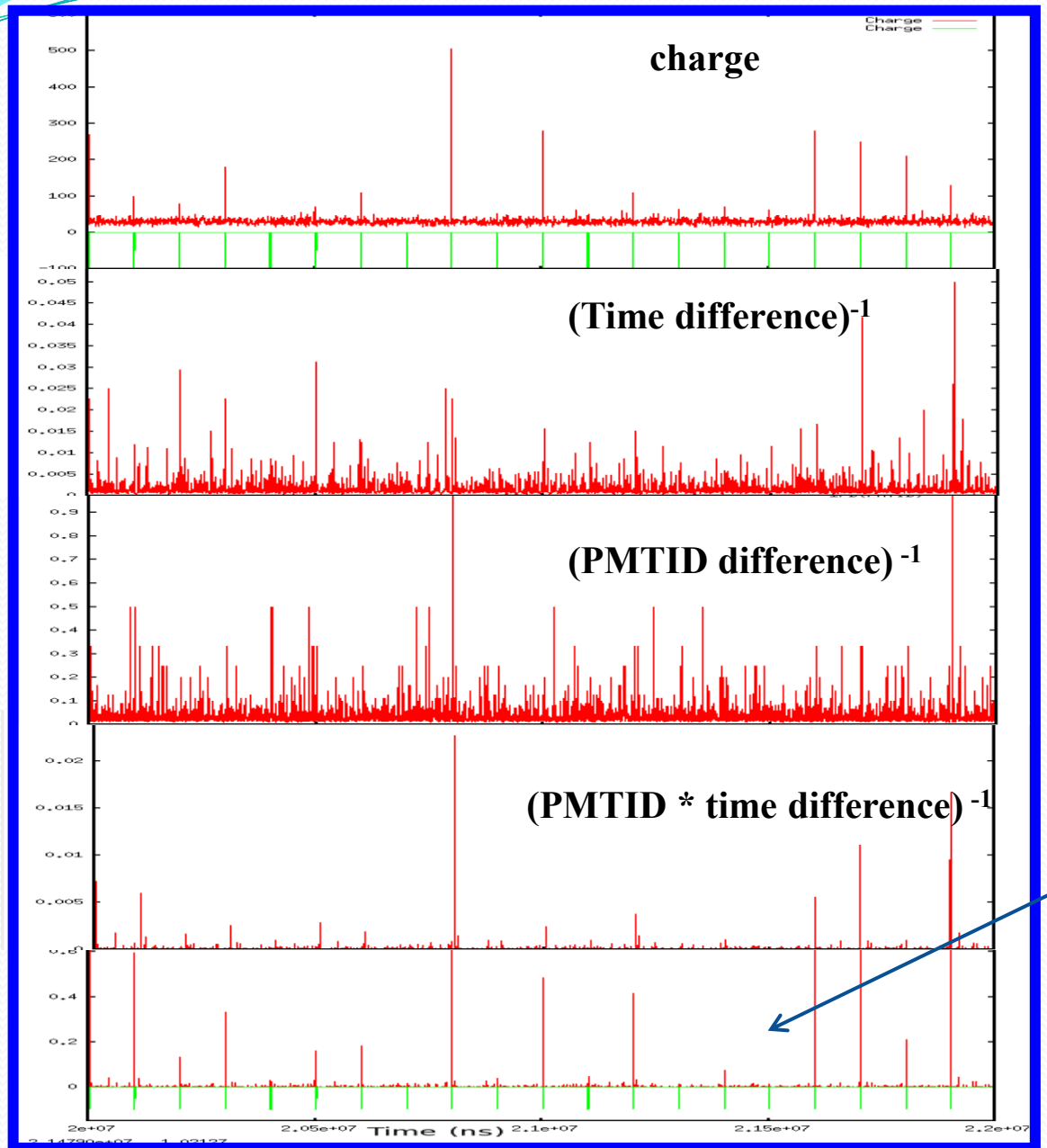
→ CPU group all data → the TTS is ready for trigger

Trigger algorithms in GPU

After the sorting step, we have know an equivalent TTS, which we call it TTS_s. the paramters to be worked on by triggers are: time hits $t_{h[i]}$, its charges $Q_{h[i]}$, and PMT_{id} the work of our first trigger is as follow:

- each thread will work on portion of data, where three tasks to do:
- each hit $h[i]$,and the two next, we calculate the sum of its charges $Q_m = Q_i + Q_{i+1} + Q_{i+2}$.
- for each hit $h[i]$, we calculate the time difference δT between the current hit $t_{h[i]}$, and $t_{h[i+2]}$.
- for each hit $h[i]$, we calculate sum of pmt_{id} differences $\equiv id_m$ e.g. $\mid id_{h[i]} - id_{h[i+1]} \mid$, and $\mid id_{h[i]} - id_{h[i+2]} \mid$.
- the minimum values of time difference and sum of the pmt_{id} differences would be considered as a trigger for an event, hence $\frac{1}{\delta T \times id_m}$ can be used as trigger.
- to include the charge effect, we will use $\frac{Q_m}{\delta T \times id_m}$.

Trigger algorithms in GPU



ΔT for 4 TTS = 768ms

Ordering and trigger search
250ms

Algoritmi semplici:
5 somme, 1 prodotto, 1 una divisione

$$\frac{\text{Charge}}{(\text{PMTID} * \text{time difference})}$$

Software per la gestione della documentazione

- Software Web-Server (su INFN-Pisa)
- Compilatore di documenti di test tramite interfaccia grafica guidata (lavora su template definiti e approvati dalla collaborazione)
- DB delle componenti di progetto , strutturato ad albero (componente/sottocomponente), con la possibilità di allegare alla singola unità tutta la documentazione del proprio ciclo vita
- L' inserimento della documentazione/nuova componente/modifiche/test/upgrade..etc comporta l'invio automatico alla mailing list definita
- Differenti profili d'accesso (Admin, User..)
- Differenti modalità di interrogazione
- Manuale Utente

=> necessario per il QA e RA

Attività 2012

- KM3:
  - progettazione meccanica per KM3
  - partecipazione costruzione e test del prototipo della DU
  - QA - RA

- Nemo Phase II
  - fine della fase d'integrazione della torre ad 8 piani
  - sistema di acquisizione e trigger/on-line
  - continua lo sviluppo di un trigger con GPU
  - acquisizione ed analisi dati
  - QA - RA

Percentuali 2012

Andrea	**Betti**	contratto Univ
Nicolò	**Beverini**	PA
Bachir	**Bouhadef**	Assegno Univ
Mauro	**Morganti**	PS Accademia
Andrea	**Verlicchi**	Ric. Accademia
Calogero	**Sollima**	Art. 2222 in scadenza
Enrico	**Maccioni**	Tecnico Univ.
Fabio	**Stefani**	Assegno Univ
Francesco	**Francesconi**	Tecnico Univ.
Stefano	**Galeotti**	INFN
Fabrizio	**Raffaelli**	INFN
Giuseppe	**Terreni**	INFN

Antonio Marinelli non è più associabile

NEMO + Antares : Percentuali da decidere

NEMO Pisa: preventivo 2012

	M I	M E	Cons	App.	Inv	T.	Tot.
Riunioni di collaborazione: 3CM*2persone* 1,1 k€	6,6						
Tec. Board: 6TB*1persone*0,7 k€	4,2						
integrazione torre, test, presa dati: 8missioni*1persone*1settimana*1,7k€	13,2						
Meeting di lavoro: 8 missioni * 1 persona * 0,5 k€	4,0						
Missioni per contatti con istituti stranieri (convergenza)		8,0					
Consumo per costruzione e integrazione (ripartizione spese)			4,0				
Trasporti e Assicurazioni						2,0	
Totale	28,0	8,0	4,0	0,0	0,0	2,0	**42,0**

I preventivi verranno discussi all'inizio di luglio. Sono solo indicate le previsioni di spesa per: trasferte, consumo e trasporti

Risorse di sezione 2012

- Progettazione mecc. ~ 3mu

Contributo alla progettazione della DU di KM3

- Officina mecc. ~ 4 mu

Partecipazione a fine integrazione e test

- Elettronica > 0

E' sufficiente l'Ing. Stefani

- Calcolo

G.Terreni che svolto un lavoro fondamentale seguendo tutte le fasi del progetto del DAQ a terra: da eFCM a Data Storage