Workshop CCR-INFN GRID 2010

Computing for high energy neutrino experiments

Tommaso Chiarusi

INFN Sez. Bologna & Phys. Dep. Univ. Bologna

Talk overview

- The reasons for neutrino astrophysics

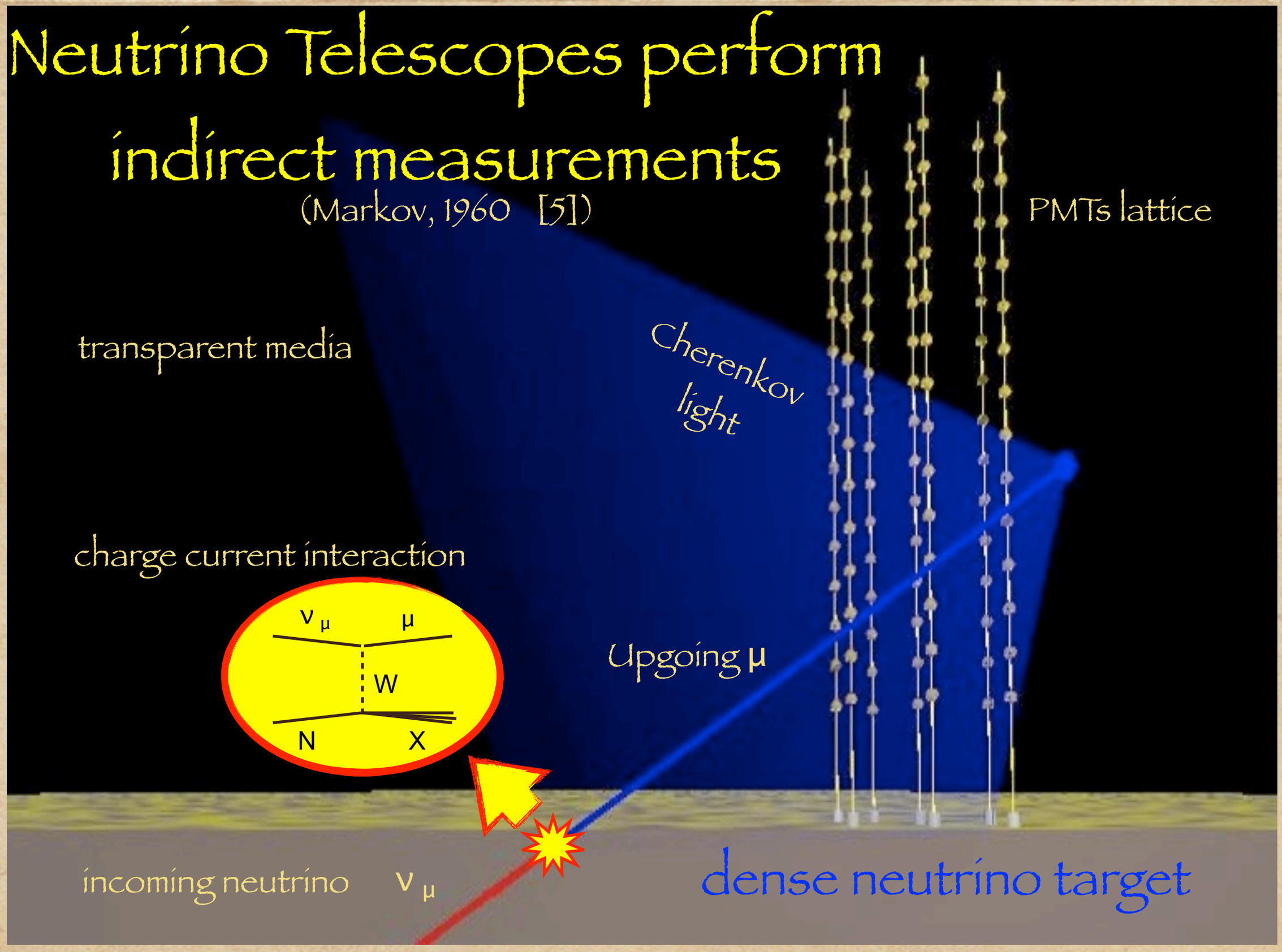
... and why in the Mediterranean Sea [1]

So... computing for:

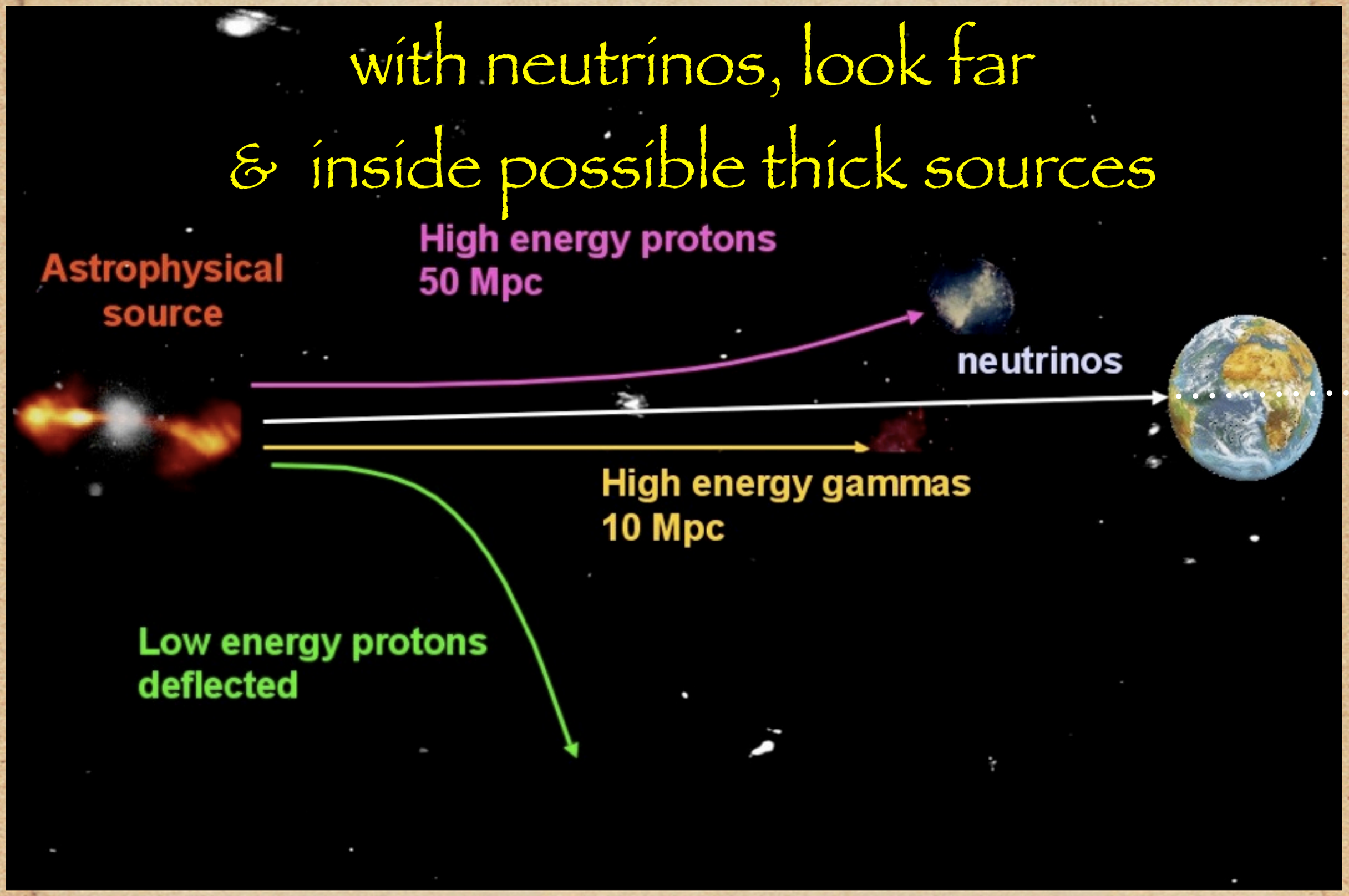
- the ANTARES experiment [2]
- the NEMO project [3]
- the KM3NeT Consortium [4]

Neutrino Telescopes perform indirect measurements

(Markov, 1960 [5])



with neutrinos, look far & inside possible thick sources



⊙ very small neutrino cross-sections with matter $\sigma \sim 7.8\ 10^{-36} (E^{0.4}/\mathrm{GeV})\ \mathrm{cm}^2$

enhanced astrophysical neutrino fluxes w.r.t. atmospheric background above 10 TeV,

so small fluxes, $dF/dE \sim 10^{-7.5}\ E^{-2} / (\mathrm{GeV\ s\ sr\ cm}^2)$

➠ Telescope Vol > 1 km^3 for some events/year

⊙ big volumes ➠ save money with the cheapest materials

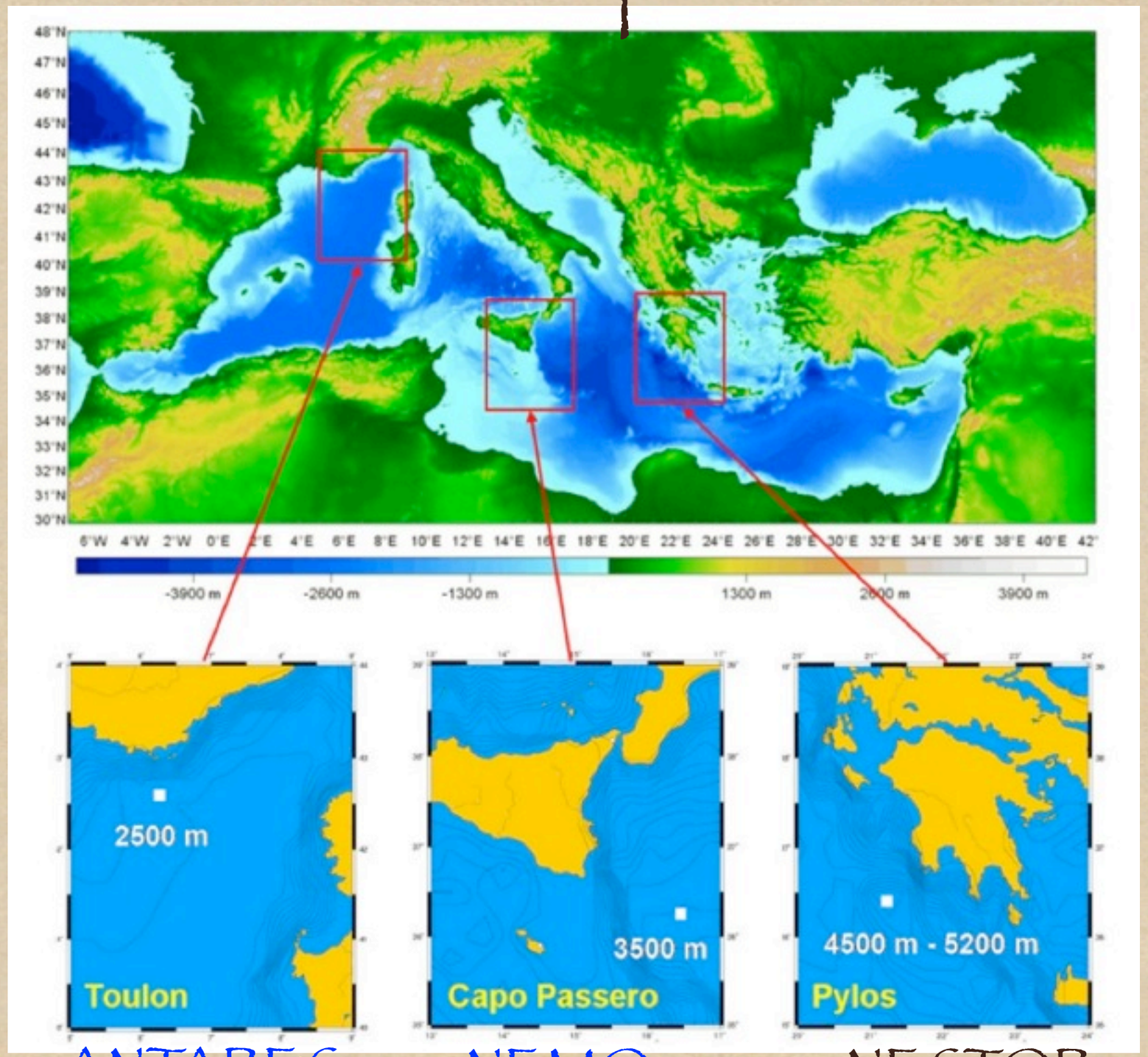
➠ use of sea water (or lake & polar ice...not discussed here)

BUT atmospheric background is less when staying deeper

➠ DEEP sea water (below 2000 m usl)

these are the main Mediterranean nu-Tel. features

Neutrino Telescopes "CLUB-MED"



ANTARES NEMO NESTOR

current projects

Constraints for a "Mediterranean" computing model

- big volumes +

  water optical properties (absorption & scattering of blue-green photons ~ 70-100 m) +

  good angular resolution (.2 °) for usefully pointing (that's neutrino ASTRONOMY)

➠ Many detection elements (N. PMTs > 5000/km^3)

- signal-to-noise ratio extremely disfavored :

  muon rate (atmospheric's dominate) : 100 Hz/km^3

  ^{40}K decays (constant) : 40 kHz/PMT (10", 0.5 p.e. thld)

  Bioluminescence* (occasional) : up to some MHz/PMT (10", 0.5 p.e. thld)

+

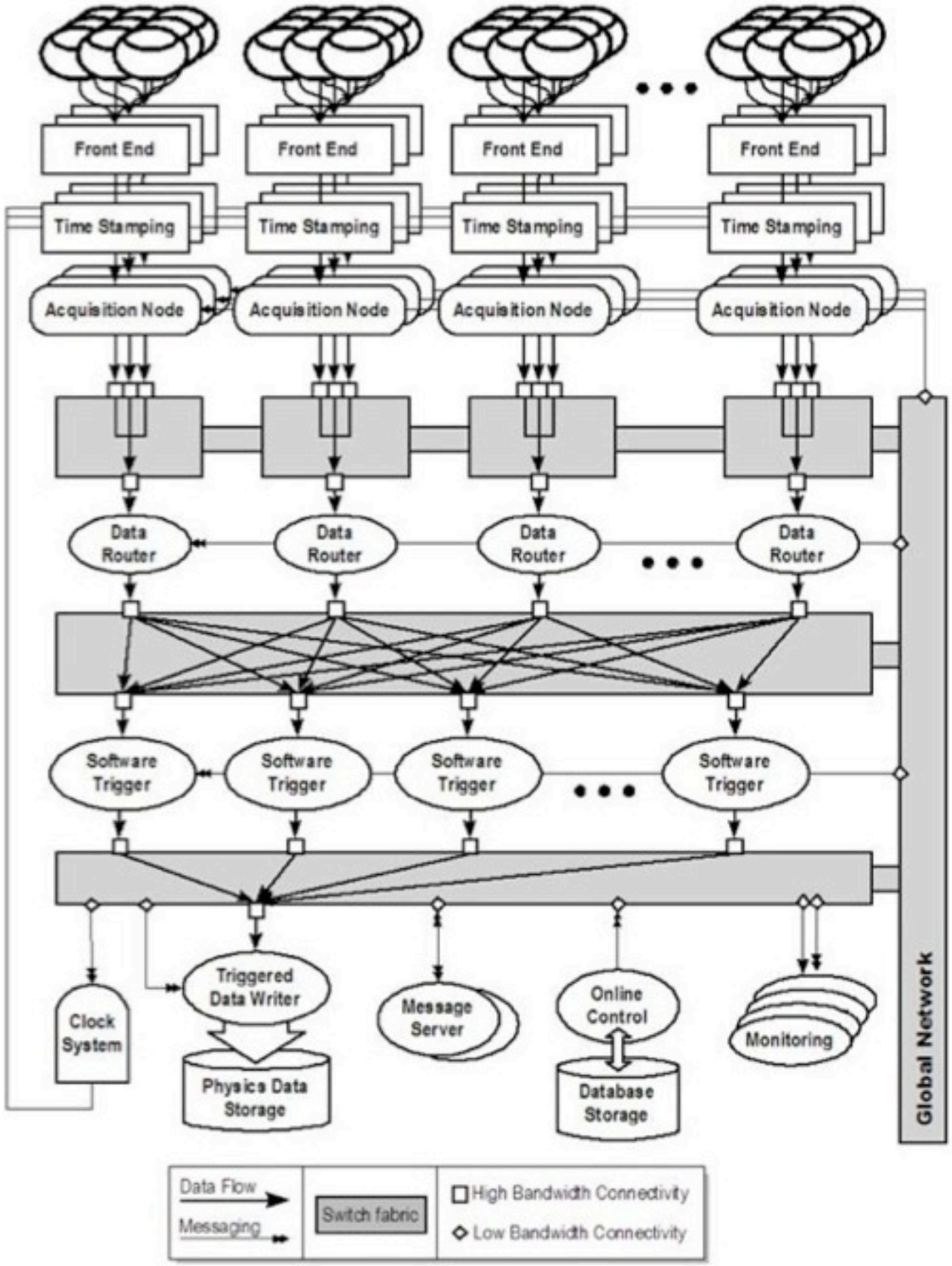
No "beam crossing" reference such as for experiments at Colliders

+

complex DAQ structures in extreme conditions (mandatory: minimal underwater maintaining)

➠ ALL DATA TO SHORE approach

* should disappear below 2500 m u.s.l



Data Aggregation

- Data are received on-shore according to a given Detector-TriDAS farm topology
- Time slices management

Data Routing

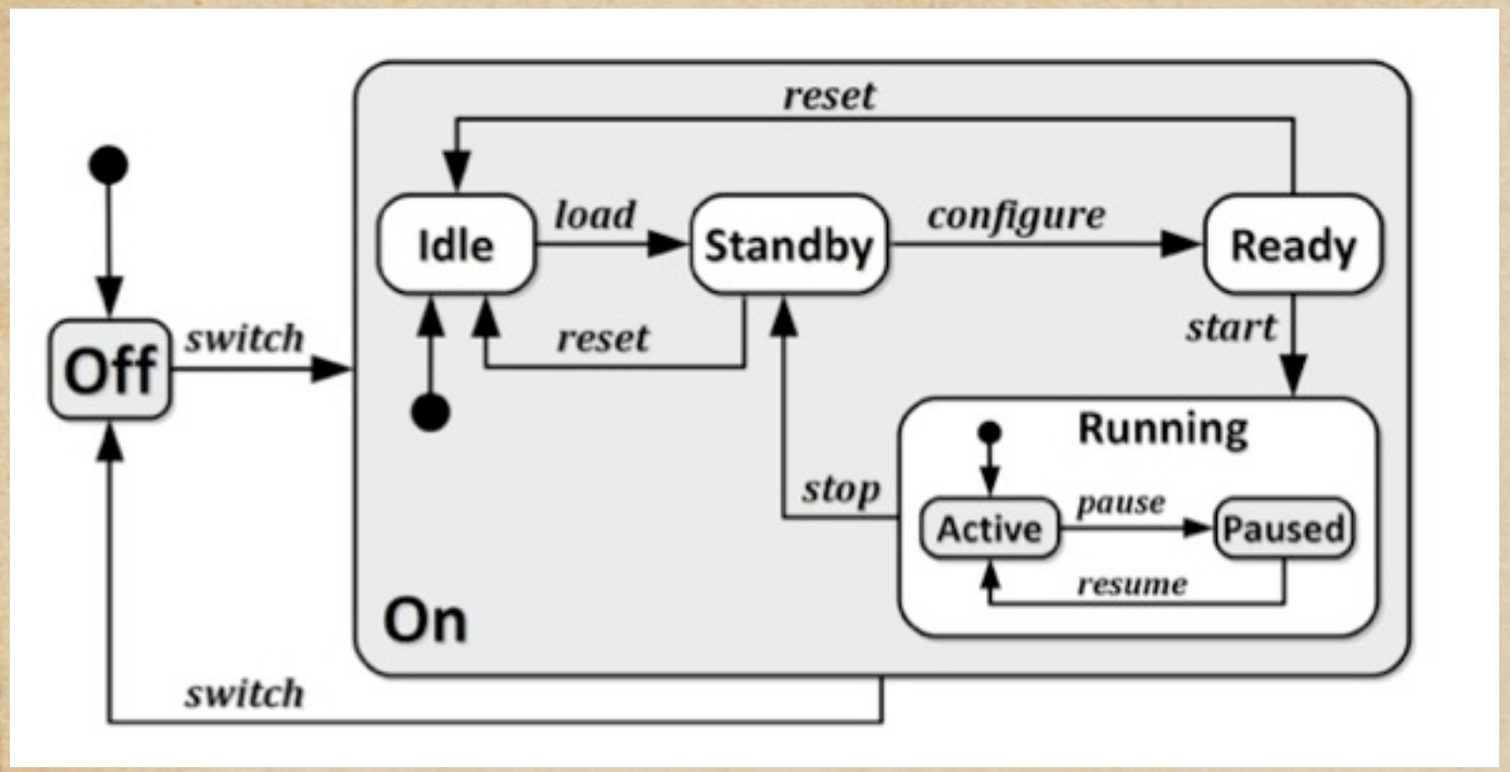
- Packet switching: Time slices are transferred to the Trigger servers (via firmware or software)

Data Processing

- Calibration correction
- System & Data monitoring
- Data selection
- Event building

Data Storage

- Transient Data (RAM - local storage)
- Temporary storage (local storage)
- Permanent storage (metadata in DB)

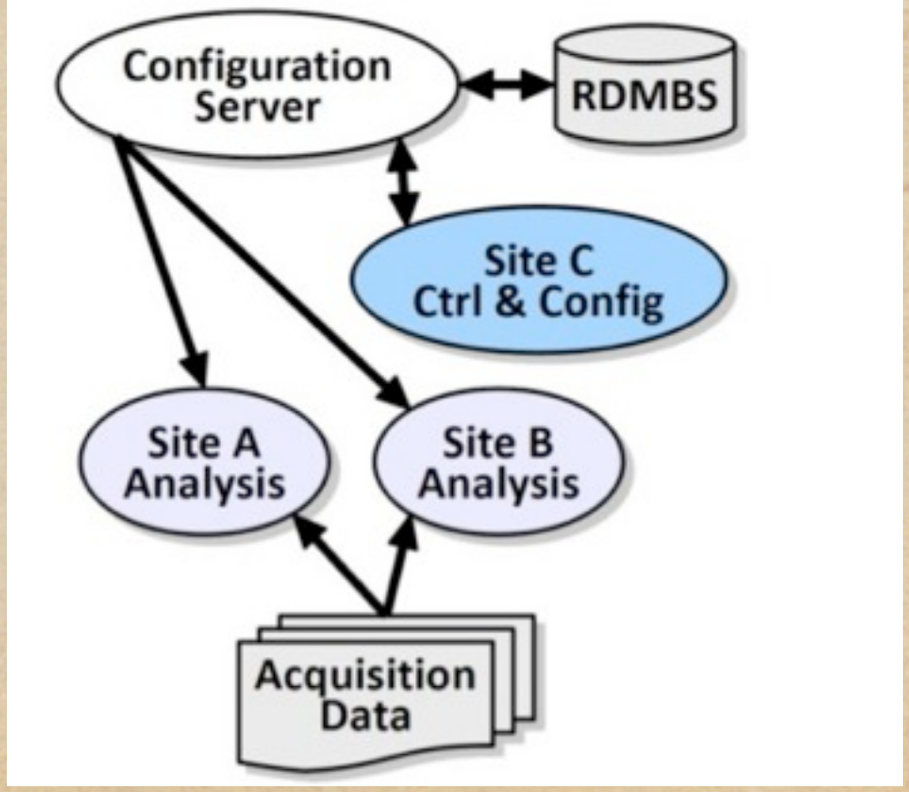


- Metadata management
- Configuration history
- Run conditions management
- Multiple programming languages access
- Caching
- Database access performance

DAQ model defined with finite state machines.

The global system can be seen as a collection of hierarchically organized subsystems that are dynamically instantiated or destroyed during state transitions

(CORBA, ICE, CHSM)



Principal Information Channels

optical data : the highest unidirectional throughput, from off- to on-shore
it determines the TriDAS specifics (~ 100 Mbps/PMT)

slow control : bidirectional, no filtering, low band occupying

clock : could be an external or main-stream embedded information

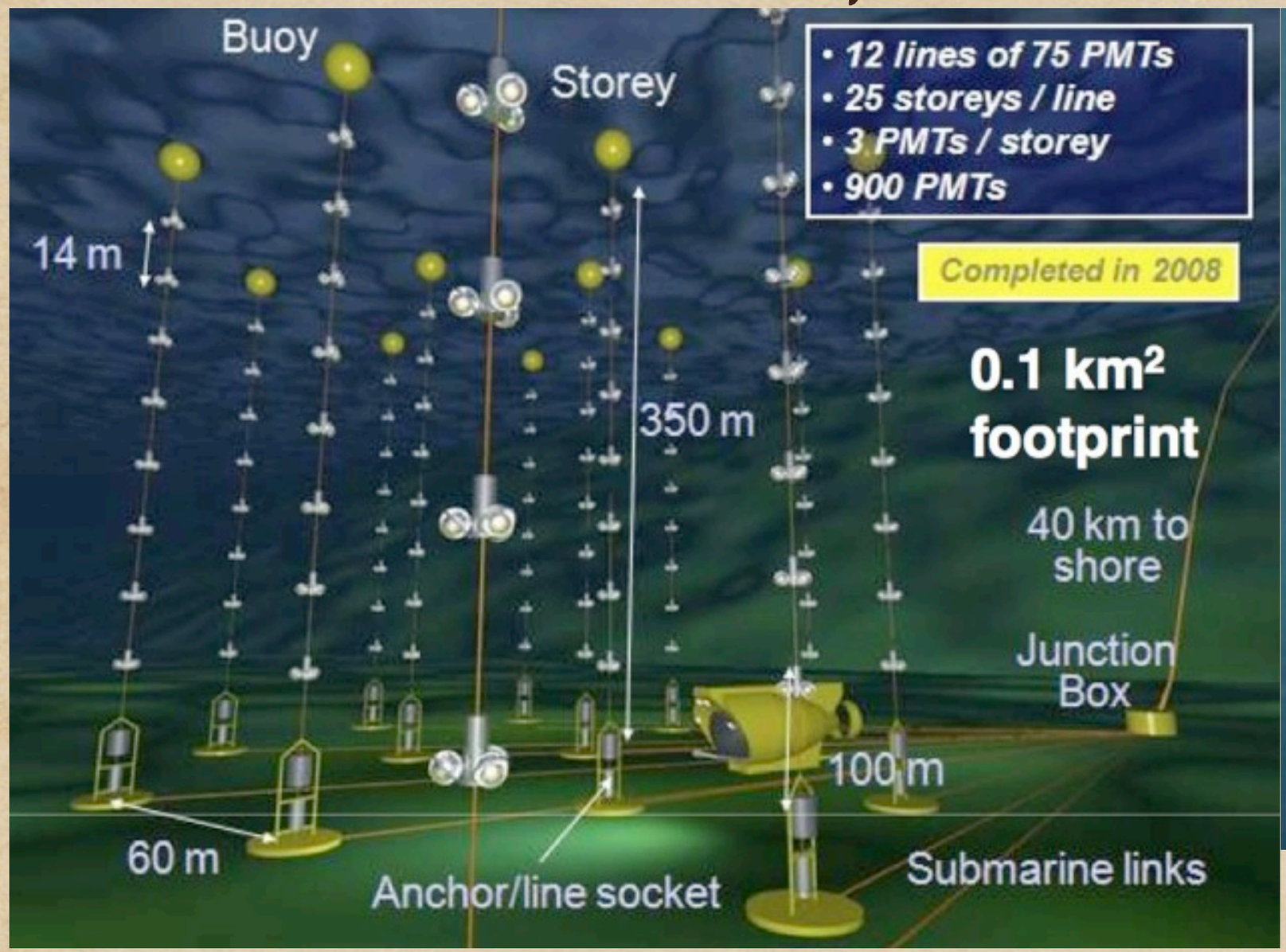
acoustic positioning : from off- to on-shore;
low band consuming (~10 Mbps/hydr.pair)

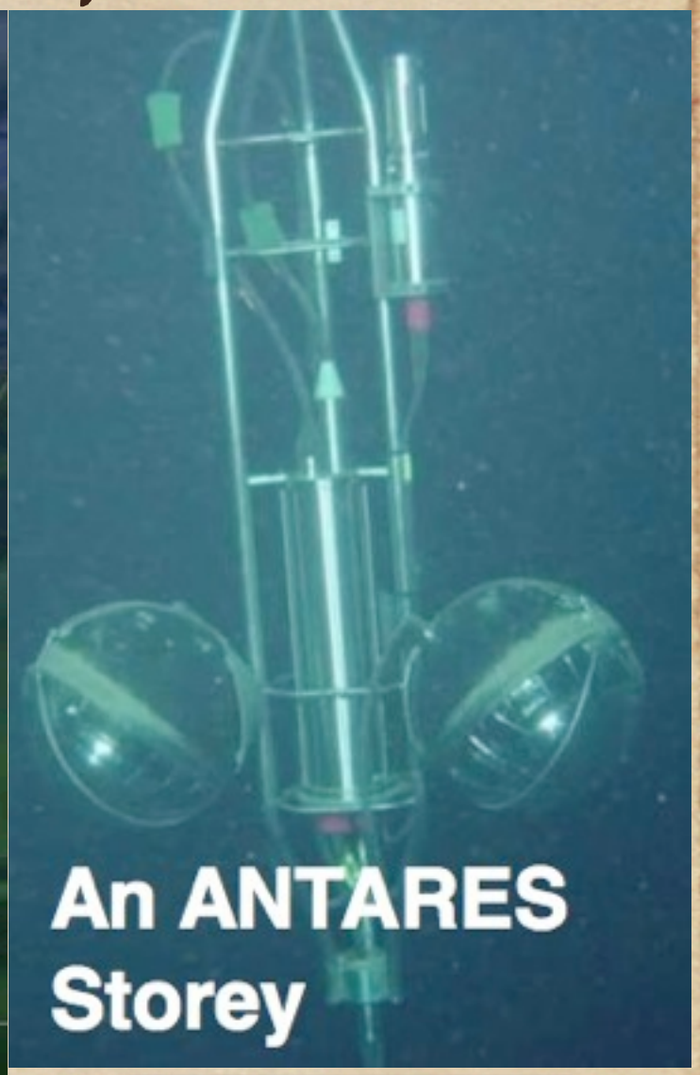
acoustic detection : (possibly) embedded in acoustic positioning data

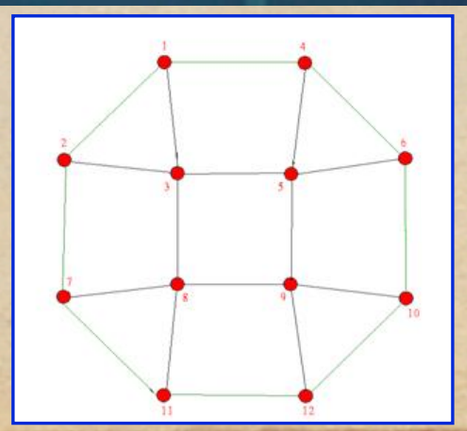
environmental sensor : scheduled or on-demand;
low band consuming (~ 100 kbps/instrument)

The ANTARES "pioneer" experience

artist's view

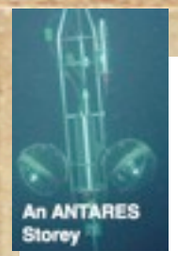


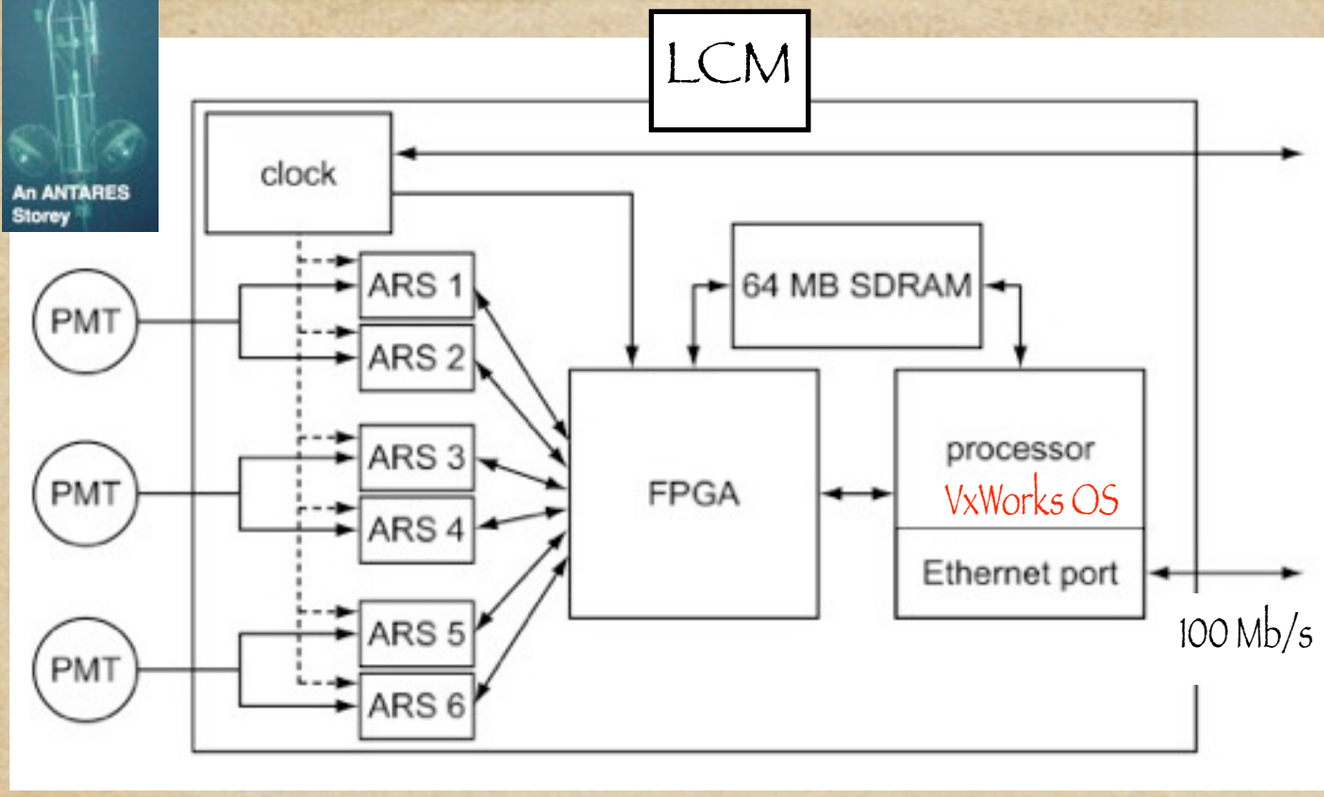




Instrumented volume 0.05 km³

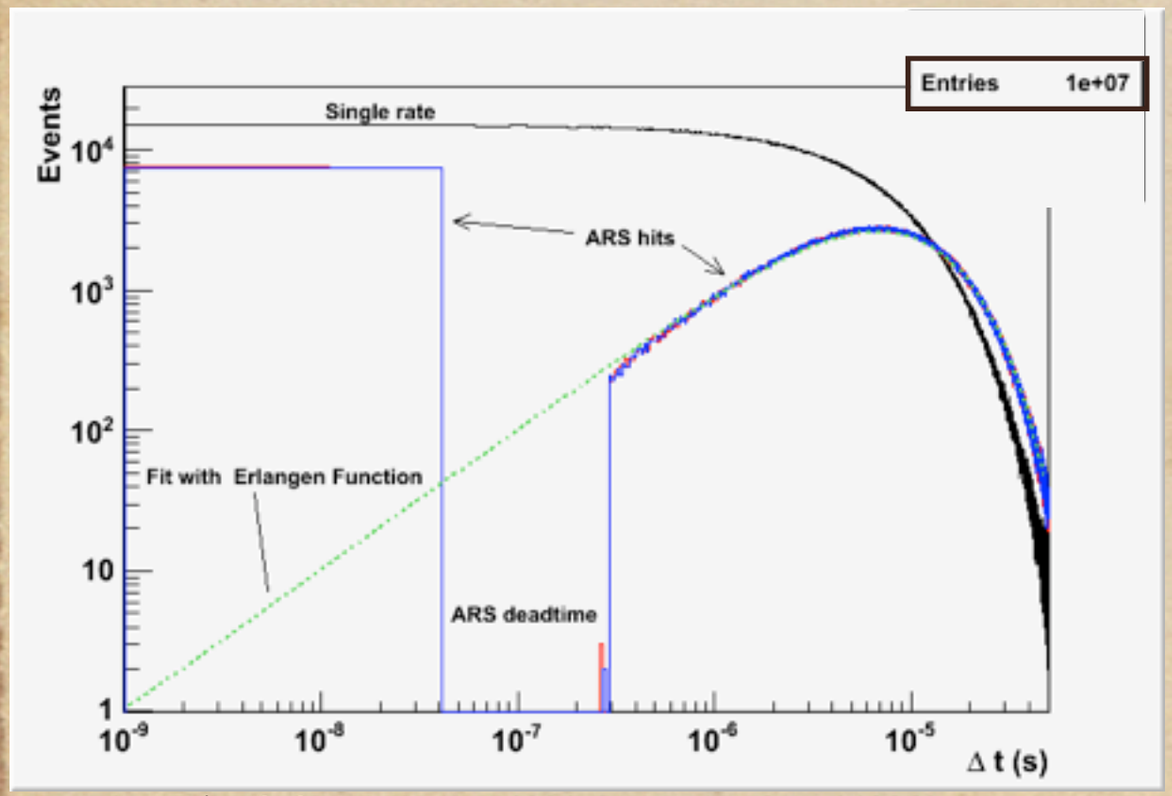
➠ high PMT density





The single photon-electron hit on a PMT is sized 6 bytes - timestamp + total charge; the pulse wave-form is not used but for special acquisitions .
@ 350 kHz/PMT , the LCM trhoughput is 50 Mb/s
(on 100 Mb/s output: factor 2 safety)

The continuous data stream is stored in the SDRAM subdivided into 10-100 ms "timeslices"

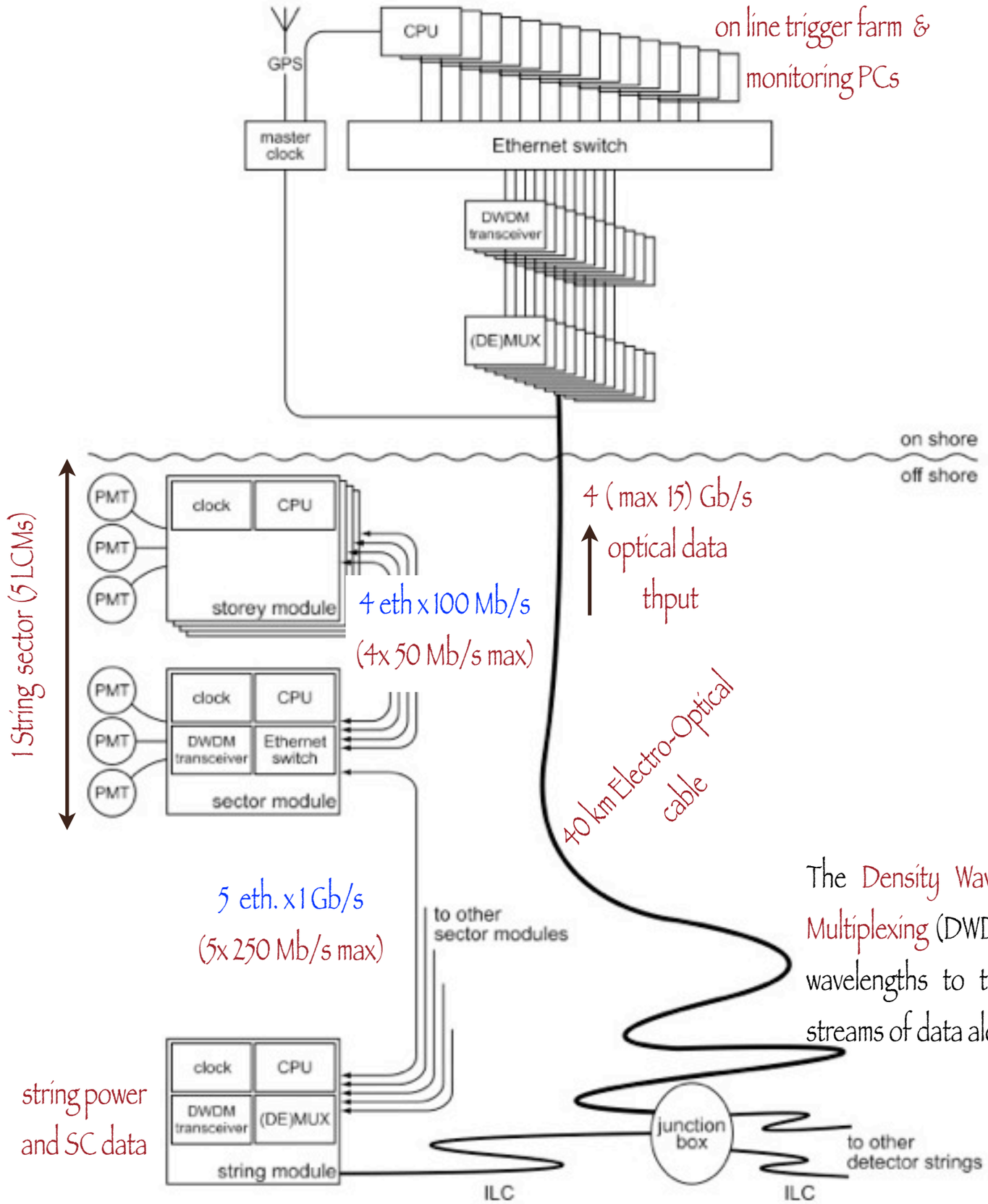



```
ARS1 estimed freq. (Hz):74934.5 ...   x 2 = 149869
ARS2 estimed freq. (Hz):74937.4 ...   x 2 = 149875
estimed ARS deadtime: 0.04 %
```

Each PMT has a ARS pair in a token ring for minimizing the total sampling dead time (<0.04%). NOTE that the effective ANTARES dead time is bigger and it is the convolution of many other factors (see ahead).

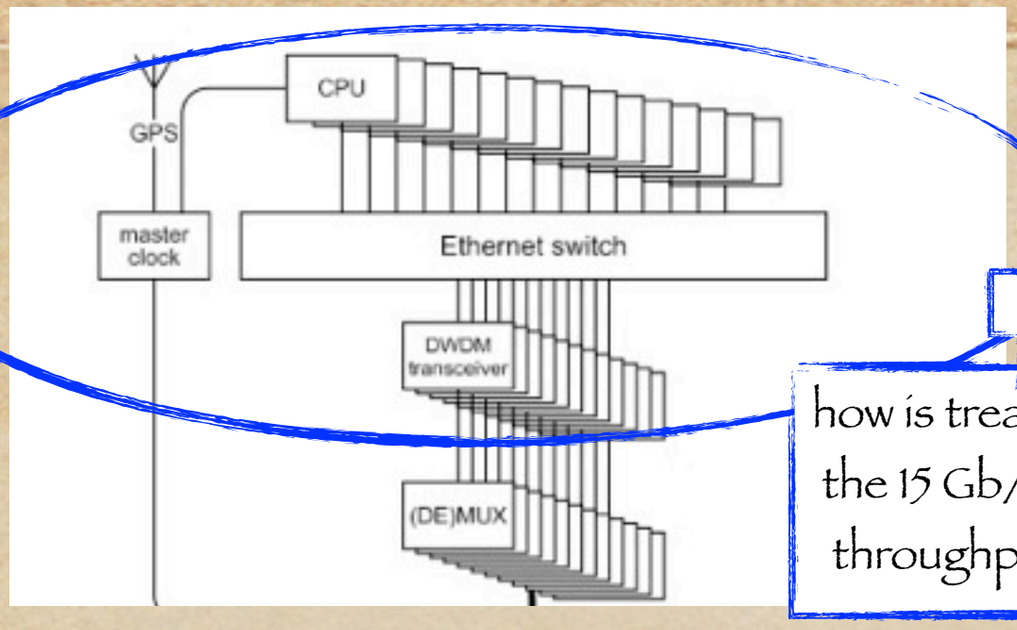
The Clock system 20MHz, provides common clock signal to all the ARS chips, with accuracy of 100 ns. The ARSs, with local counters, push time resolution to ~ 1 ns.

GLOBAL SKETCH of ANTARES DAQ

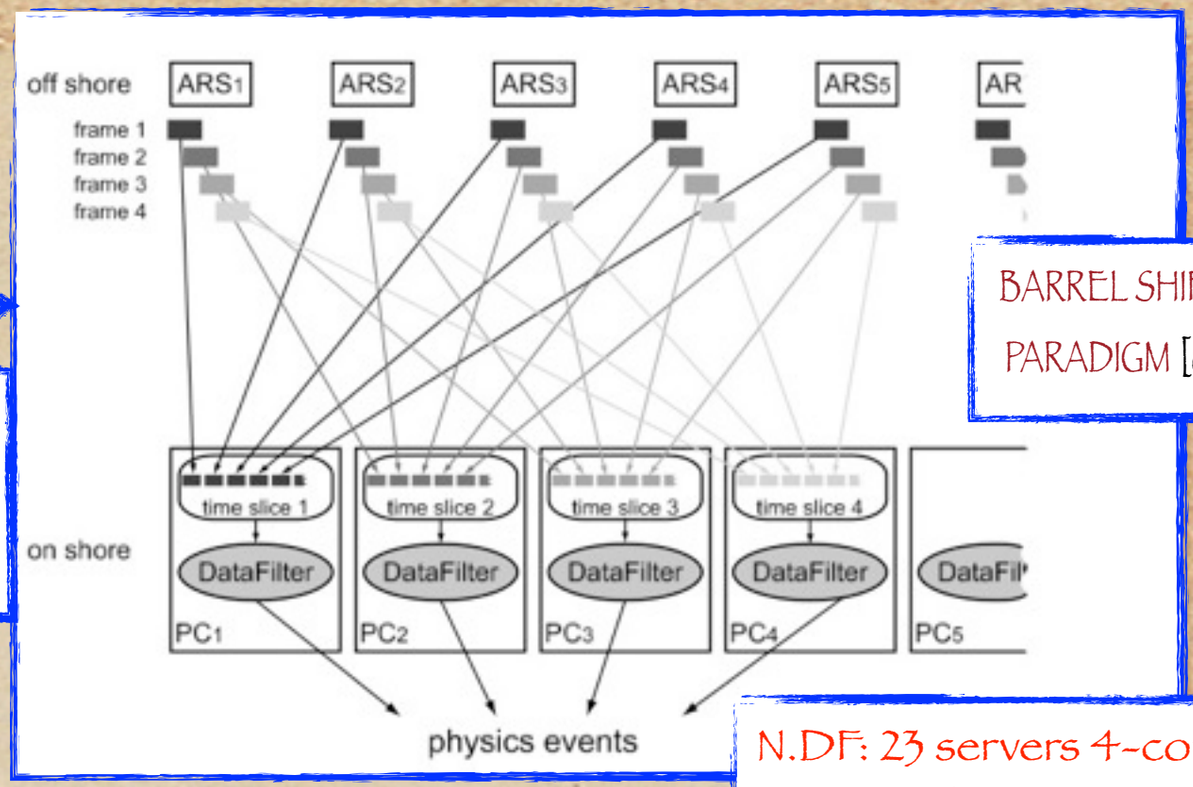


- TCP/IP PROTOCOL
- 12 OPTICAL FIBRES (1/STRING)
- 15 Gb/s maximum throughput (@ 350 kHz/PMT)
  (normal conditions 4 Gb/s @ 80 kHz)

The Density Wavelenght Division Multiplexing (DWDM) uses multiple wavelengths to transmit different streams of data along a single fibre



how is treated the 15 Gb/s throughput

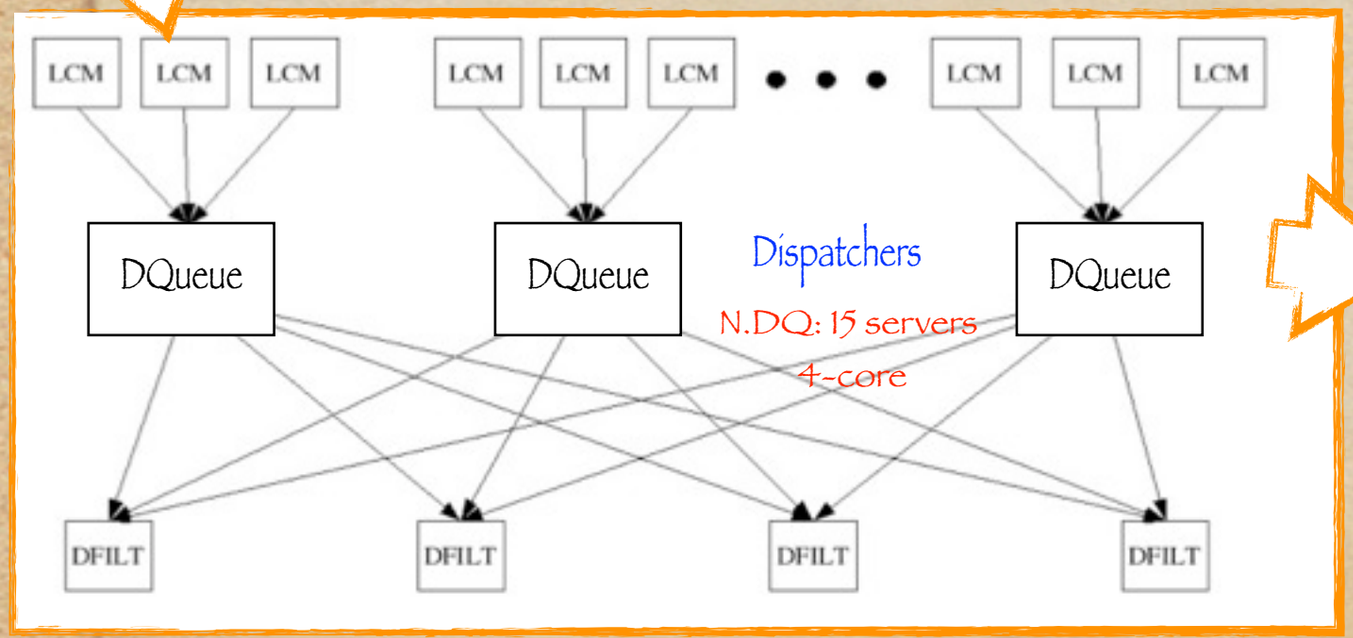


BARREL SHIFT PARADIGM [6]

N.DF: 23 servers 4-core
92 DataFilter processes

VxWorks OS on the LCMs
cannot open a high number of sockets

Software Routing with CONTROL-HOST [7]



✶ Barrel Shift delay: multiple of TimeSlices duration. It determines the number of concurrent transmitting LCMs.
Limit: the FPGA buffer (64 MB).

✶ The number of DQueue server cannot be arbitrary.

Too few DQueues ➠ too much throughput from LCMs.

Too many DQueues ➠ too much delay for LCMs

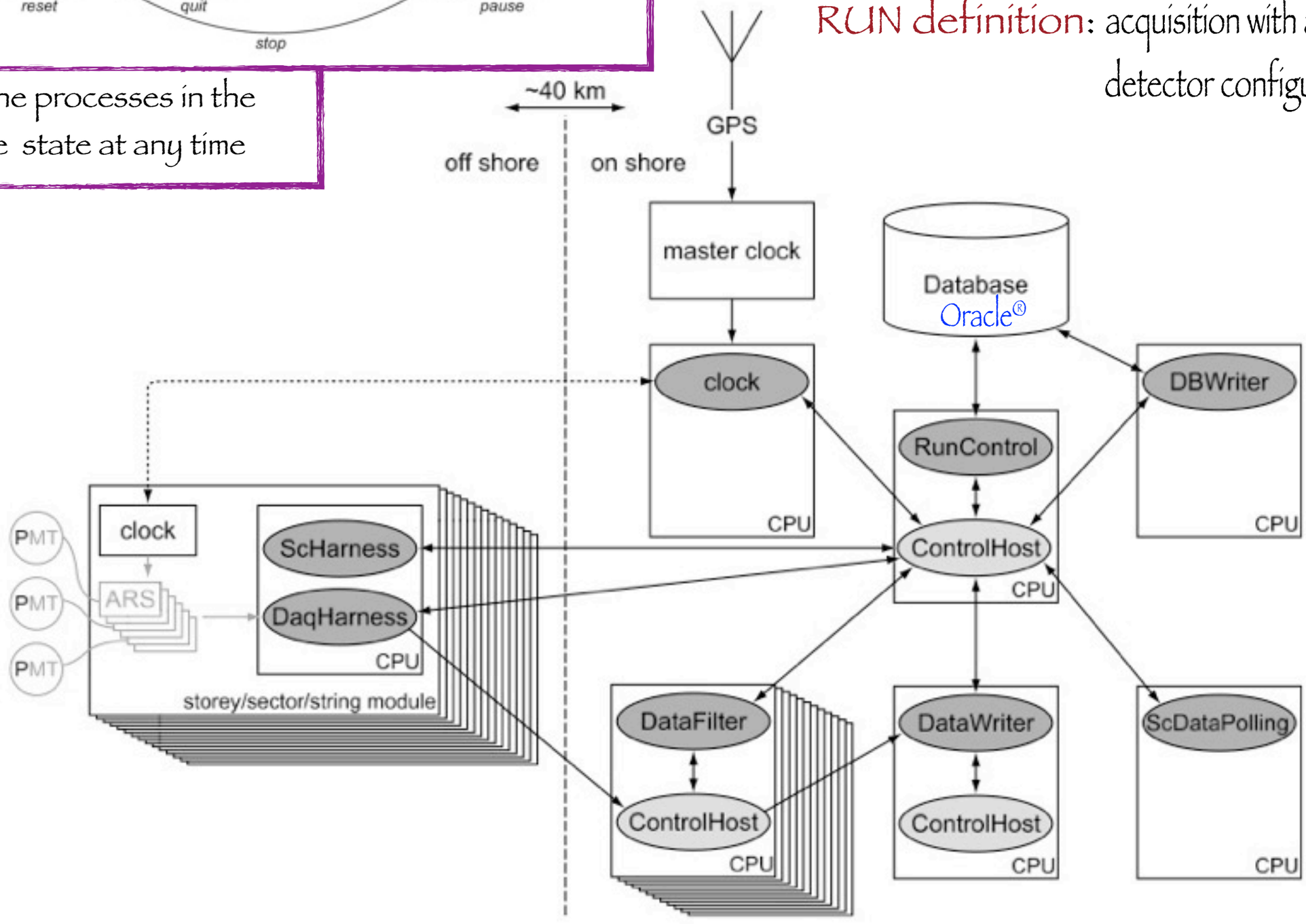
When high rates:
VETO on LCM data sending ➠ Dead Time (10-20 %)

ANTARES DAQ model

Concurrent Hierarchical State Machine sync-ing

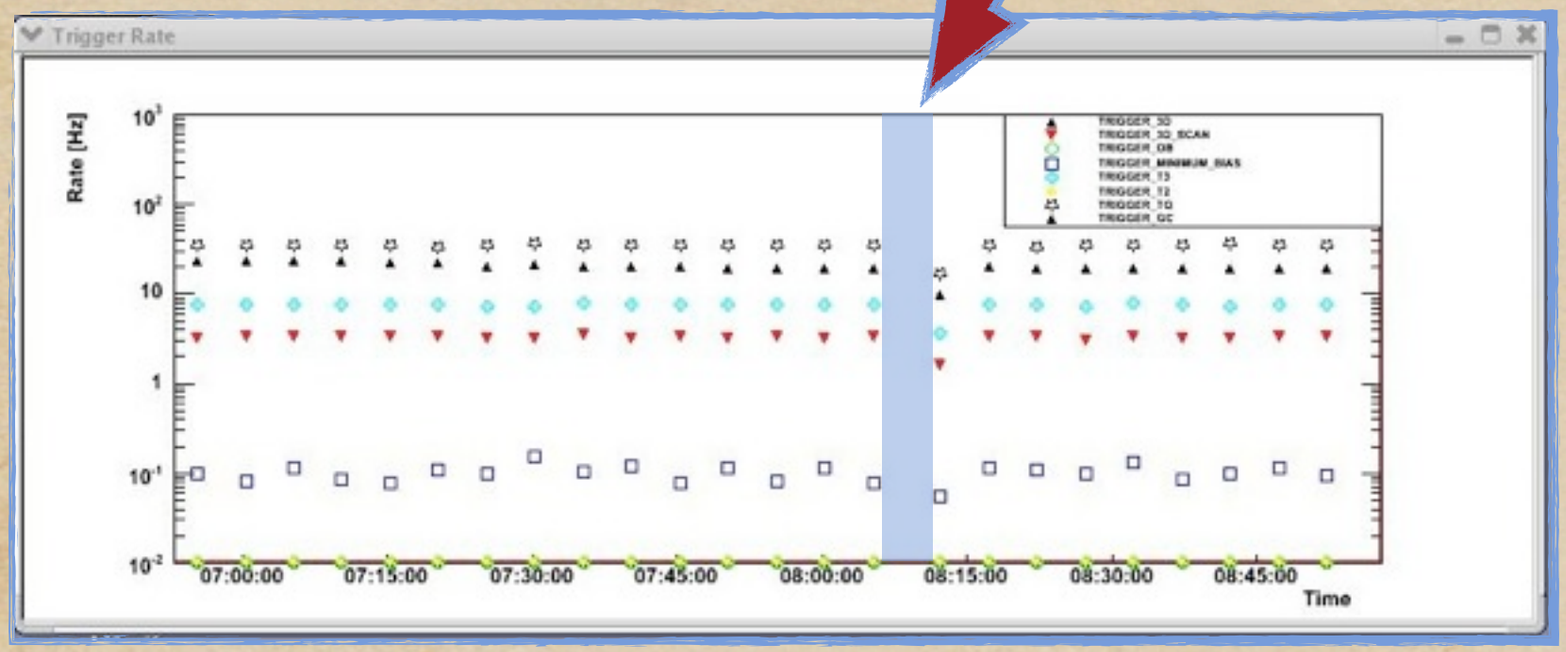
All the processes in the same state at any time

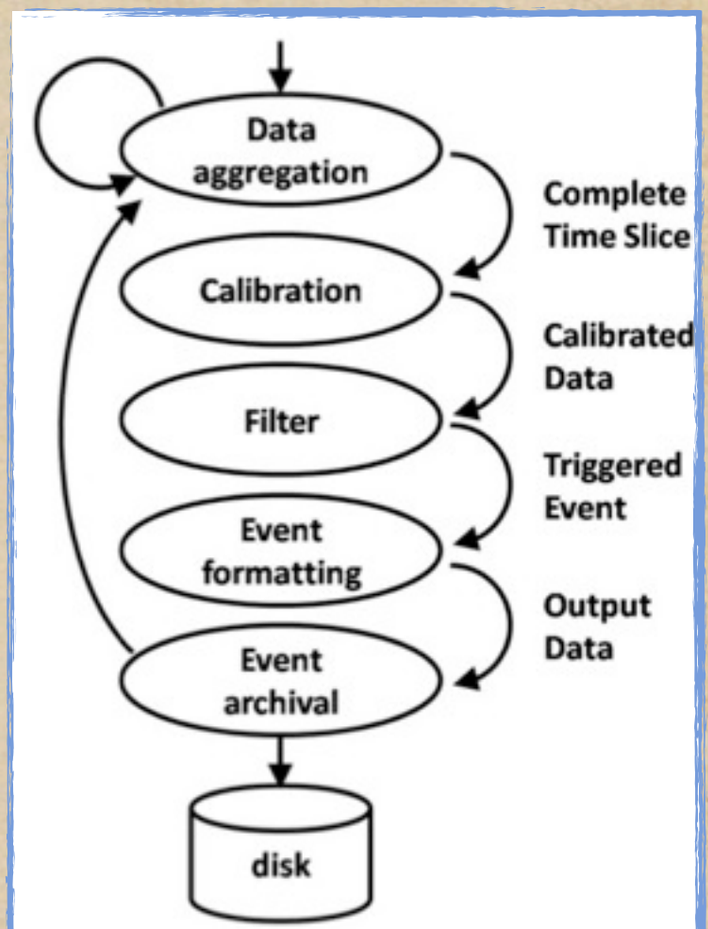
RUN definition: acquisition with a stated detector configuration



ANTARES DATA Processing

automatic run restart





DFilter machines: 23 Intel Xeon 4 core 2.6 GHz CPU

Basic Trigger: the so called L1: - pair of coincidences in 20 ns on the same storey
- charge over threshold

Other Triggers: complex 1D or 3D scan, Special Pointing (Galactic Center, TQ),
Magnetic Monopoles, "minimum bias"

data suppression: from "normal" 0.5 GB/s incoming to 2 GB/h stored (factor 10^{-3})

ANTARES data Storage, Bookkeeping and Access

From date: 12-03-2010 To date: 13-03-2010
From run: To run:
Type of run: ALL Comments:
Setup: User: All
Submit Reset

58 matching runs found

1 | 2

RUN	SETUP	DATE	DURATION	COMMENT	FILE	EVENTS (BYTES)	USER
47276	IL-07-Amadeus Test: G10 DS2 R0 noStatstimer	13-3-2010 23:18:41	1h 21m 4s	RunControl started new run automatically	/data/Antares_047276.root	43956 (2000766034)	Kay Graf
47275	IL-07-Amadeus Test: G10 DS2 R0 noStatstimer	13-3-2010 20:16:12	3h 0m 45s	recovered clock	/data/Antares_047275.root	37117 (1358885814)	Kay Graf
47274	IL-07-Amadeus Test: G10 DS2 R0 noStatstimer	13-3-2010 19:36:20	37m 49s	RunControl started new run automatically	/data/Antares_047274.root	16858 (684867996)	Kay Graf
47273	Line 6 Repair Sector 4 SPE Background	13-3-2010 19:32:34	8h 25m 8s	RunControl started new run automatically	/data/root/Antares_047273.root	29148 (77357480)	Colas Riviere
47272	Line 1-12 OM Reduced HVs (-20% on ampl. part) SCAN	13-3-2010 19:23:09	4h 48m 34s	RunControl started new run automatically	/data/Antares_047272.root	2751 (2000042862)	Anne Deschamps
47271	Biocam DAQ SCAN	13-3-2010 16:57:05	20h 5m 19s	RunControl started new run automatically	/data/IL07/Antares_047271.root	0 (242376156)	Bjoern Herold
47270	IL-07-Amadeus Test: G10 DS2 R0 noStatstimer	13-3-2010 16:34:31	3h 0m 28s	RunControl started new run automatically	/data/Antares_047270.root	56858 (2011688280)	Kay Graf
47269	Line 1-12 OM Reduced HVs (-20% on ampl. part) SCAN	13-3-2010 14:32:34	4h 47m 56s	RunControl started new run automatically	/data/Antares_047269.root	2719 (2000165511)	Anne Deschamps
47268	IL-07-Amadeus Test: G10 DS2 R0 noStatstimer	13-3-2010 13:36:18	2h 56m 36s	recovered IL07F02	/data/Antares_047268.root	69183 (2000189870)	Kay Graf
47267	IL-07-Amadeus Test: G10 DS2 R0 noStatstimer	13-3-2010 12:02:31	1h 29m 5s	RunControl started new run automatically	/data/Antares_047267.root	31691 (821519575)	Kay Graf
47266	Line 6 Repair Sector 4 SPE Background	13-3-2010 11:06:06	8h 25m 8s	RunControl started new run automatically	/data/root/Antares_047266.root	28692 (77326541)	Colas Riviere
47265	Line 1-12 OM Reduced HVs (-20% on ampl. part) SCAN	13-3-2010 09:35:34	4h 53m 19s	physics Trigger 3N+2T3+K40 reduced	/data/Antares_047265.root	2834 (2000053345)	Anne Deschamps
47264	IL-07-Amadeus Test: G10 DS2 R0 noStatstimer	13-3-2010 08:59:32	3h 0m 48s	RunControl started new run automatically	/data/Antares_047264.root	45384 (1666178975)	Kay Graf

- Every night data are copied from local disks to storage's
- All data stored at CC Lyon [8]
- Concurrent data delivery
- Storage access via web/terminal within the SRB middleware [9]

Storage Request Broker (SRB)

View All Metadata

Collection: data
Parent Collection: /in2p3
Owner: ant_write@ccin2p3

Metadata describing entity *data*

Move Up | Ingest File | Create File | Register File | Register Directory | Register URL | Register SQL | Register ORBData | Register Command | Make Collection | Make Container | Browse Query | ExtSchm Query | Update ExtSchm | Other Info | Online Help | Exit MySRB

/in2p3/data

	Function	SubCollection	Creation Time	Owner
1	-- Choose Collection Action --	Real	2007-07-16-16.02.59	ant_write@ccin2p3
2	-- Choose Collection Action --	CalReal	2008-08-08-15.07.00	ant_write@ccin2p3
3	-- Choose Collection Action --	reprocess	2006-10-20-17.10.52	ant_write@ccin2p3
4	-- Choose Collection Action --	raw	2006-07-27-14.40.15	ant_write@ccin2p3
5	-- Choose Collection Action --	TriggerProcessor	2007-08-01-16.22.46	ant_write@ccin2p3
6	-- Choose Collection Action --	Calibrate	2007-07-12-19.18.22	ant_write@ccin2p3
7	-- Choose Collection Action --	grb	2006-11-03-10.51.44	ant_write@ccin2p3

Move Up | Ingest File | Create File | Register File | Register Directory | Register URL | Register SQL | Register ORBData | Register Command | Make Collection | Make Container | Browse Query | ExtSchm Query | Update ExtSchm | Other Info | Online Help | Exit MySRB

ANTARES data Storage, Bookkeeping and Access

From date: 12-03-2

From run:

Type of run: ALL

Setup:

Sub

58 matching runs found

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/in2p3/data

	Function	SubCollection	Creation Time	Owner
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2	-- Choose Collection Action --	CalReal	2008-08-08-15.07.00	ant_write@ccin2p3
3	-- Choose Collection Action --	reprocess	2006-10-20-17.10.52	ant_write@ccin2p3
4	-- Choose Collection Action --	raw	2006-07-27-14.40.15	ant_write@ccin2p3
5	-- Choose Collection Action --	TriggerProcessor	2007-08-01-16.22.46	ant_write@ccin2p3
6	-- Choose Collection Action --	Calibrate	2007-07-12-19.18.22	ant_write@ccin2p3
7	-- Choose Collection Action --	grb	2006-11-03-10.51.44	ant_write@ccin2p3

Move Up | Ingest File | Create File | Register File | Register Directory | Register URL | Register SQL | Register ORBData | Register Command | Make Collection | Make Container | Browse Query | ExtSchm Query | Update ExtSchm | Other Info | Online Help | Exit MySRB

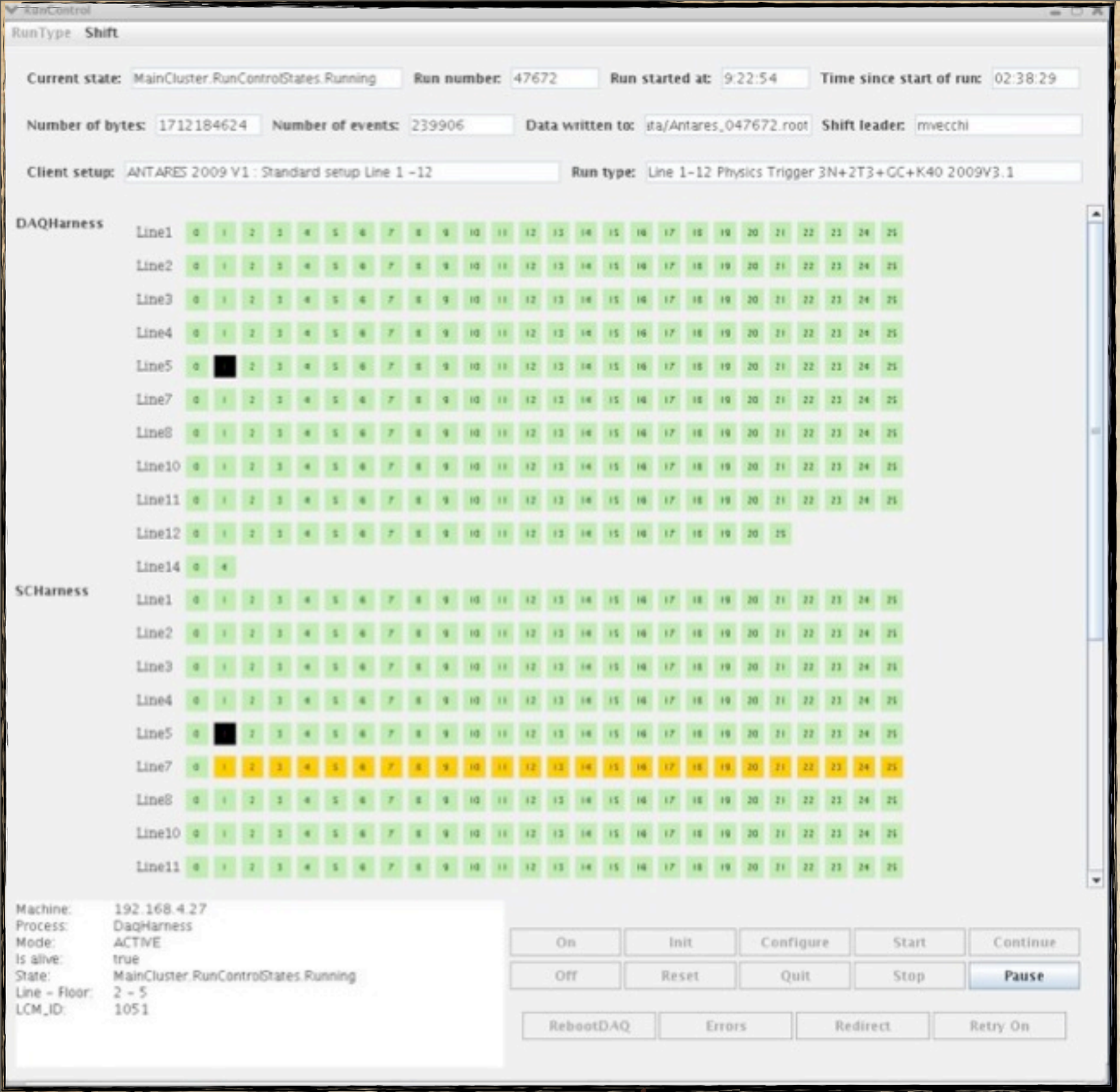
Views from the ANTARES Control Room

Institute Michel Pacha @ La Seyne sur Mér

MONITORING PARADE

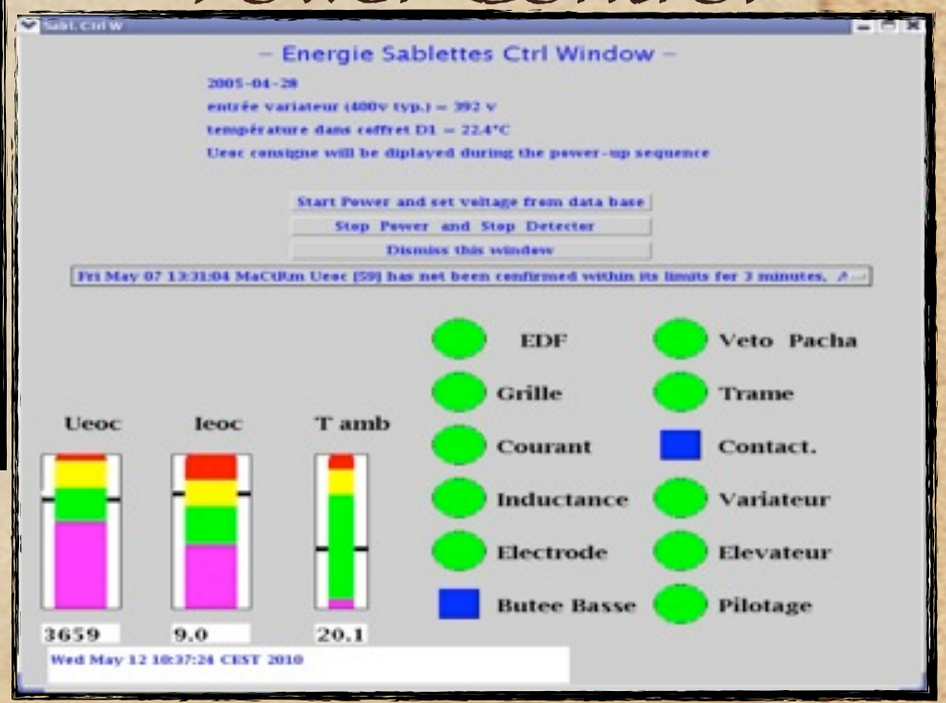
Java

C++

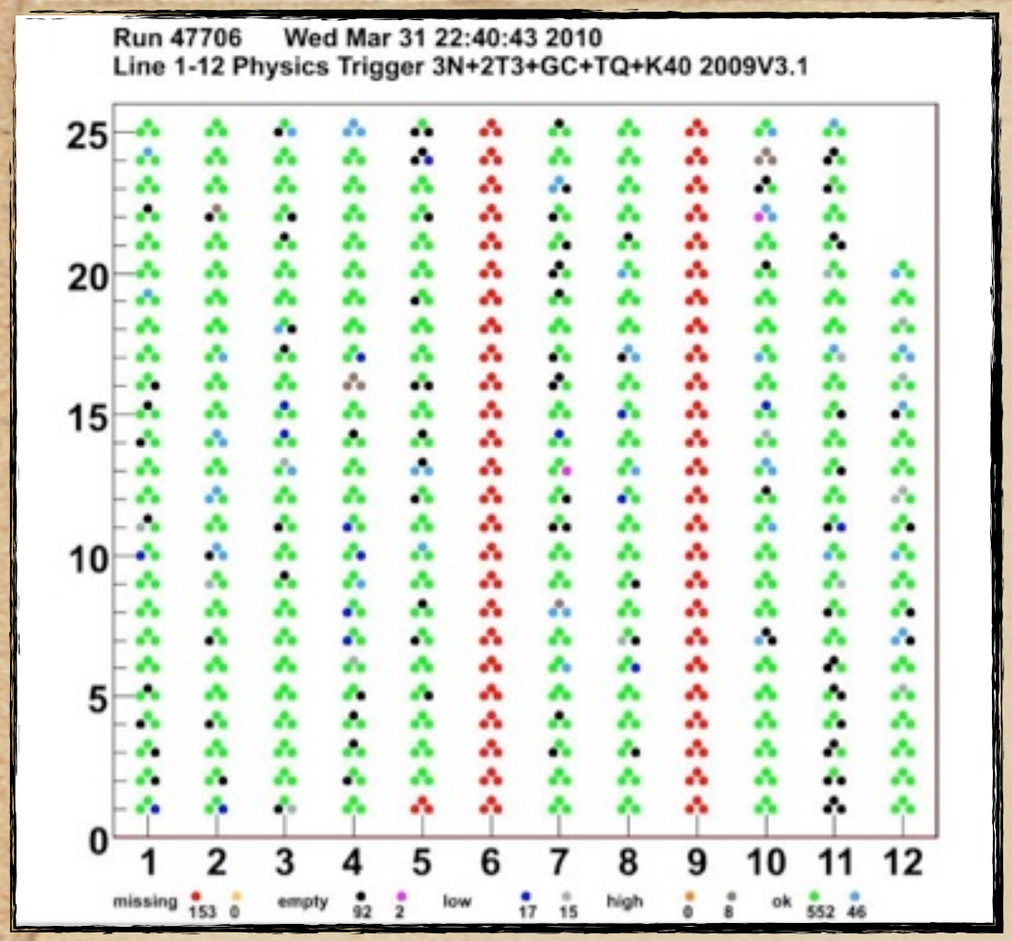


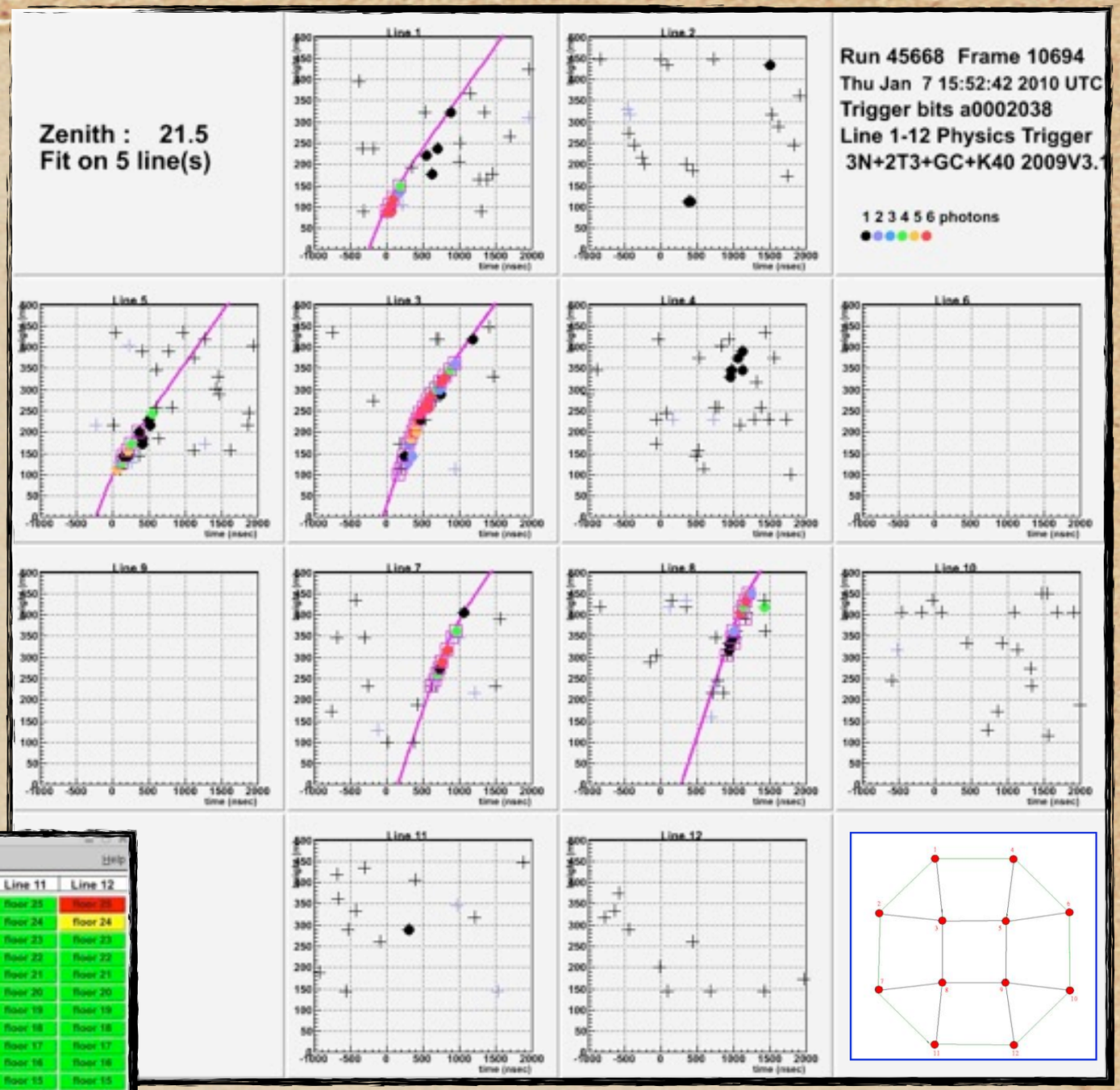
Run Control

Power Control



OMs status





On line event reco

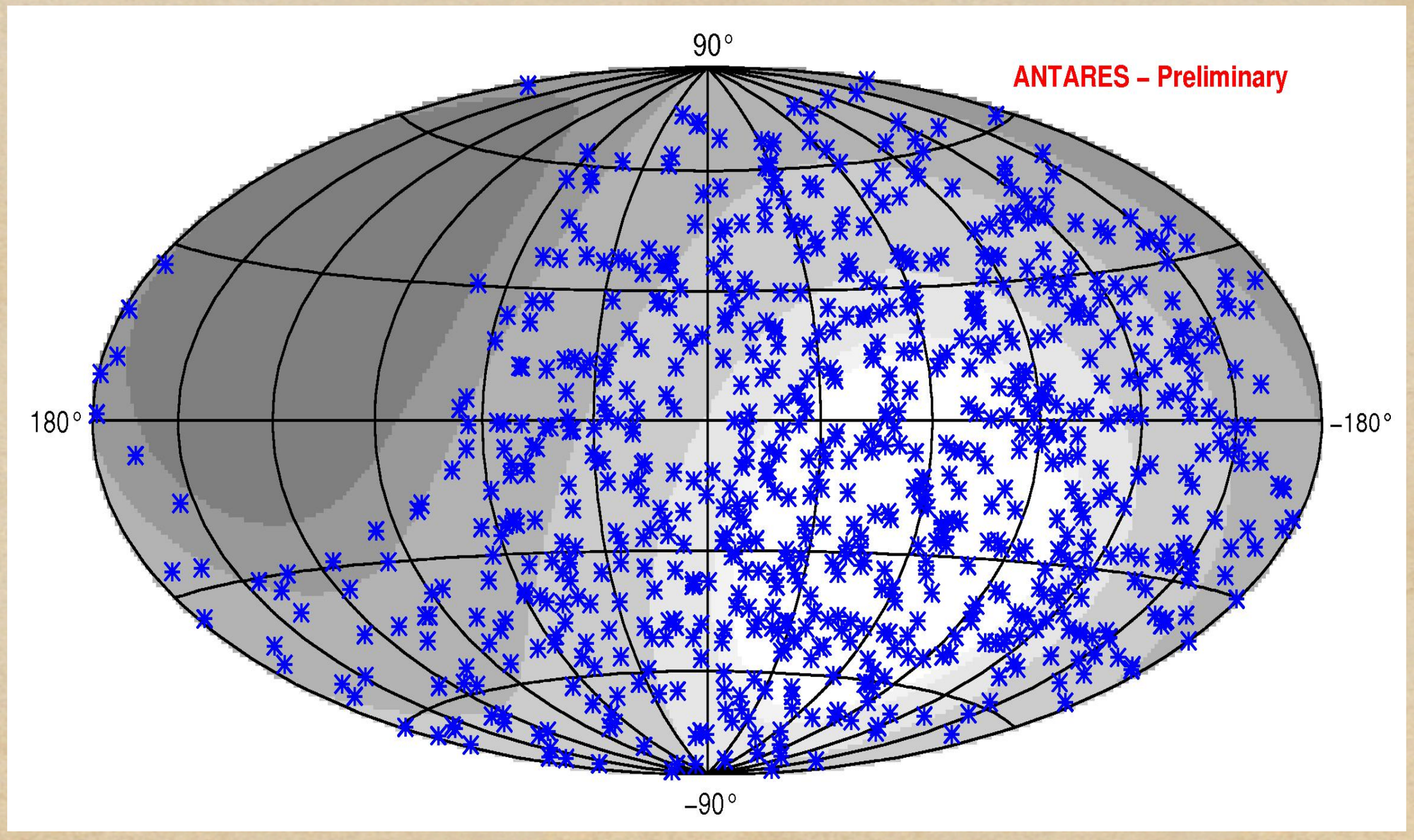
Slow Control

C++ / ROOT

Tommaso Chiarusi

Workshop CCR-INFN Grid 2010

The ANTARES (preliminary) upgoing neutrino sky map



NEUTRINO MEDITERRANEAN OBSERVATORY

The NEMO mission is optimizing the telescope features to the KM3 scale

1. NEMO Phase 1

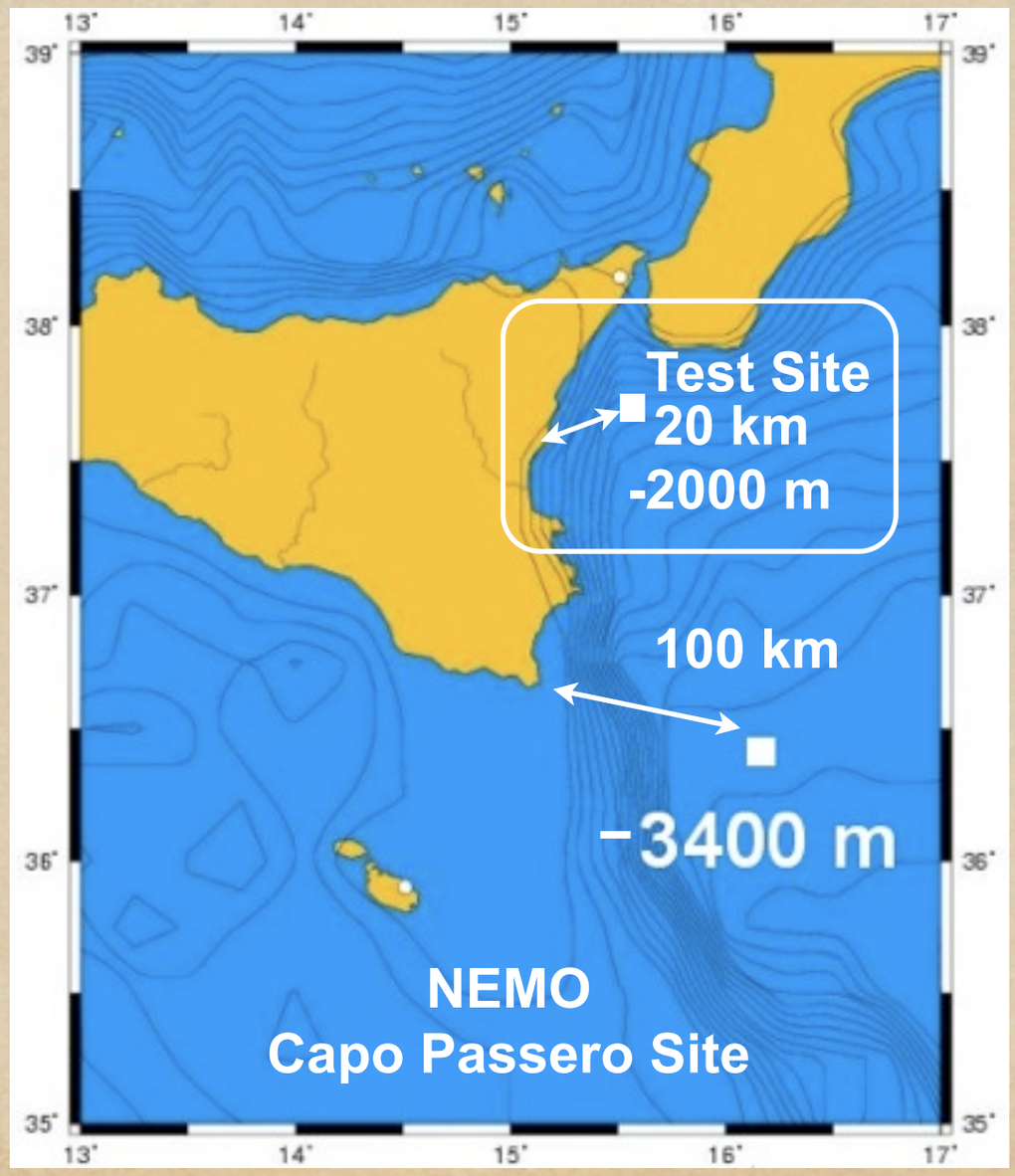
the Minitower @ the Test Site

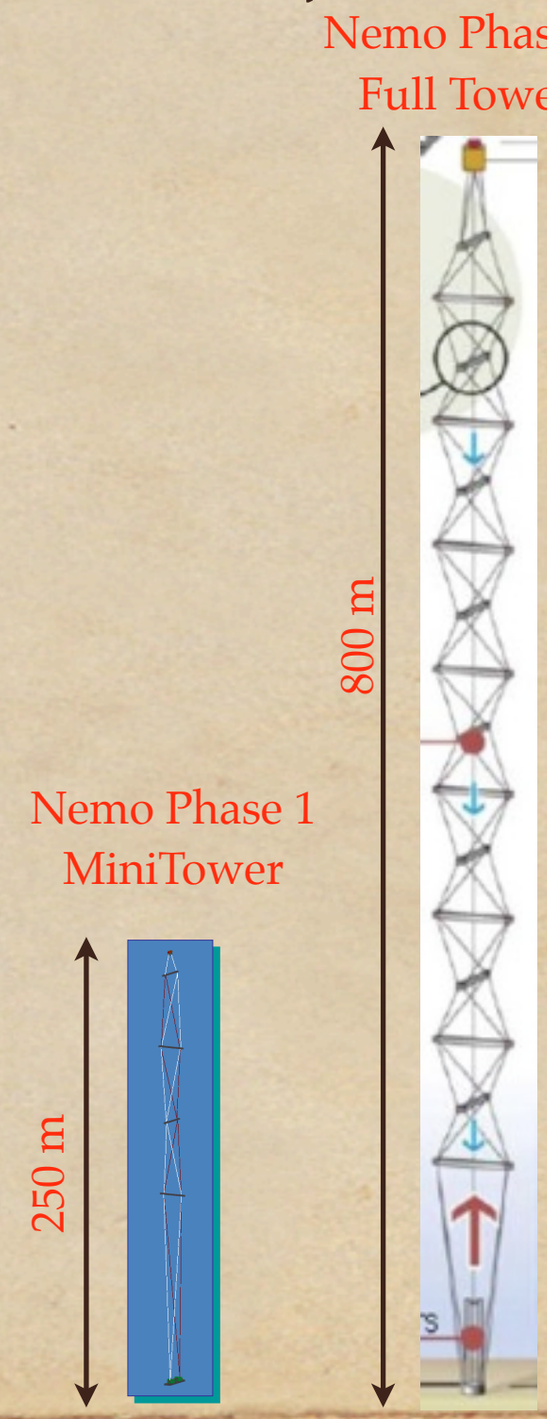
2. NEMO Phase 2

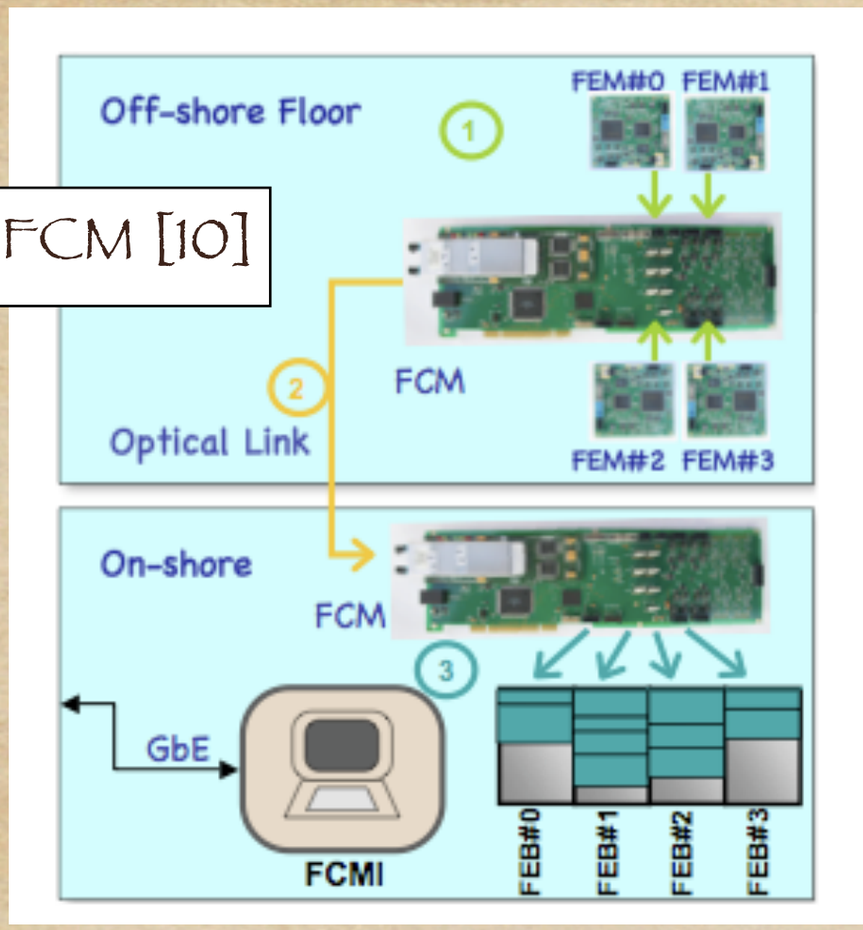
Full NEMO Tower @ Capopassero

3. NEMO KM3

Project within KM3NeT







S.P.E. HIT SIZE:

Hit PMT Info

+

Hit Time

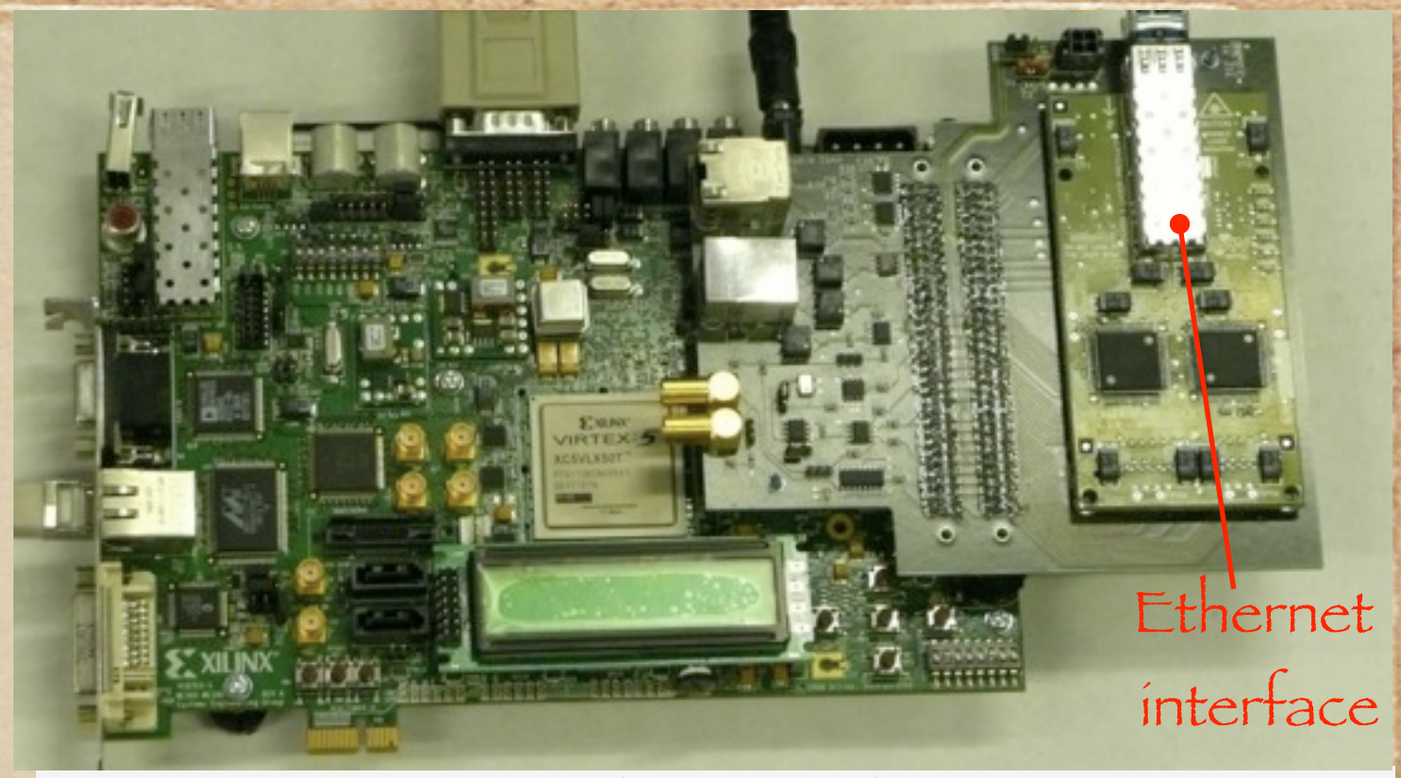
+

Hit Charge

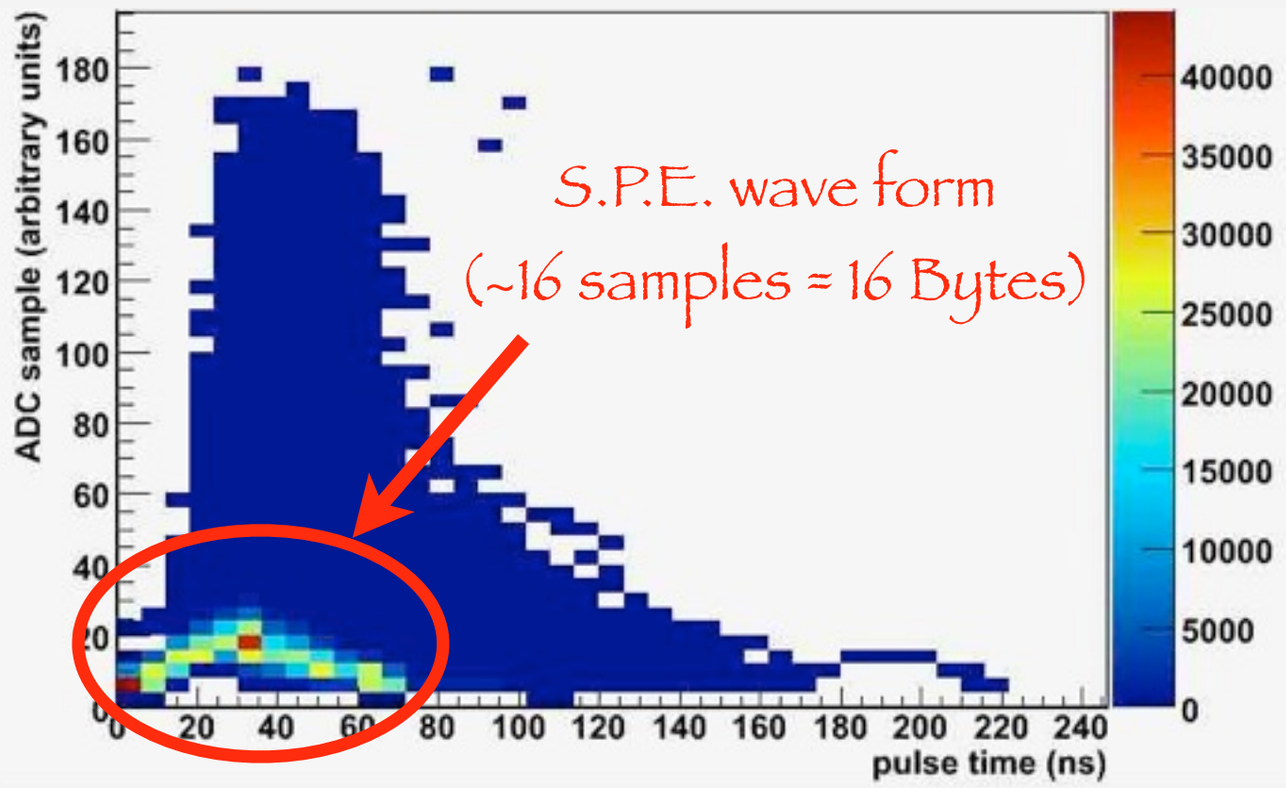
+

Hit Wave Form (samples)

28 Bytes



Hit samples Vs. pulse time
on a 10" PMT with 0.5 p.e. thr. (NEMO Ph.1 data)



Expected Data Rates

10" PMT single rate (kHz)	Data Rate per PMT (Mbps)	Data Rate per Floor* (Mbps)	Data Rate per D.U.** (Gbps)	Data Rate per km³ *** (Gbps)
40 (bare ^{40}K)	8.8	35.2	0.5	50
80 (NEMO Ph. 1)	16.8	67.2	1.1	110
150 (present DAQ)	32	128	2.0	200
375 (expanded DAQ)	64	256	5.0	500

*4 PMT/ Floor **16 Floor/D.U. **100 D.U.

Approximative computations according to the KM3 document

Atmospheric Muon Signal (@ 3000 m depth)

assuming
- Rate $_{\mu\ atm}$: **100 Hz**
- Rate $_{bkg}$: **300 kHz**
- N. PMTs: **8000**
- Rec. time window: **6 μs**

Post-Trigger data rate: ~ 40 MBps
Stored data /day ~1 TB !!!!

Upgoing Neutrino Signal

assuming
- Rate $_{\nu}$: **< 4 10^{-3} Hz**
- Rate $_{bkg}$: **300 kHz**
- N. PMTs: **8000**
- Rec. time window: **6 μs**

Post-Trigger data rate: ≲ 2 kBps
Stored data /day ≲ 150 MB !!!!

For 1 D.U. the throughput is to reduce from 256 MBps → 400 kBps (3 GB/day)

The TriDAS reduces the data rate by filtering the data stream bunched in **Time Slice (TS)**.
A TS contains all data *from all* (or *part of*) the detector occurred in a given time interval (**~100 ÷200 ms**).

WHAT IS SCALABLE?

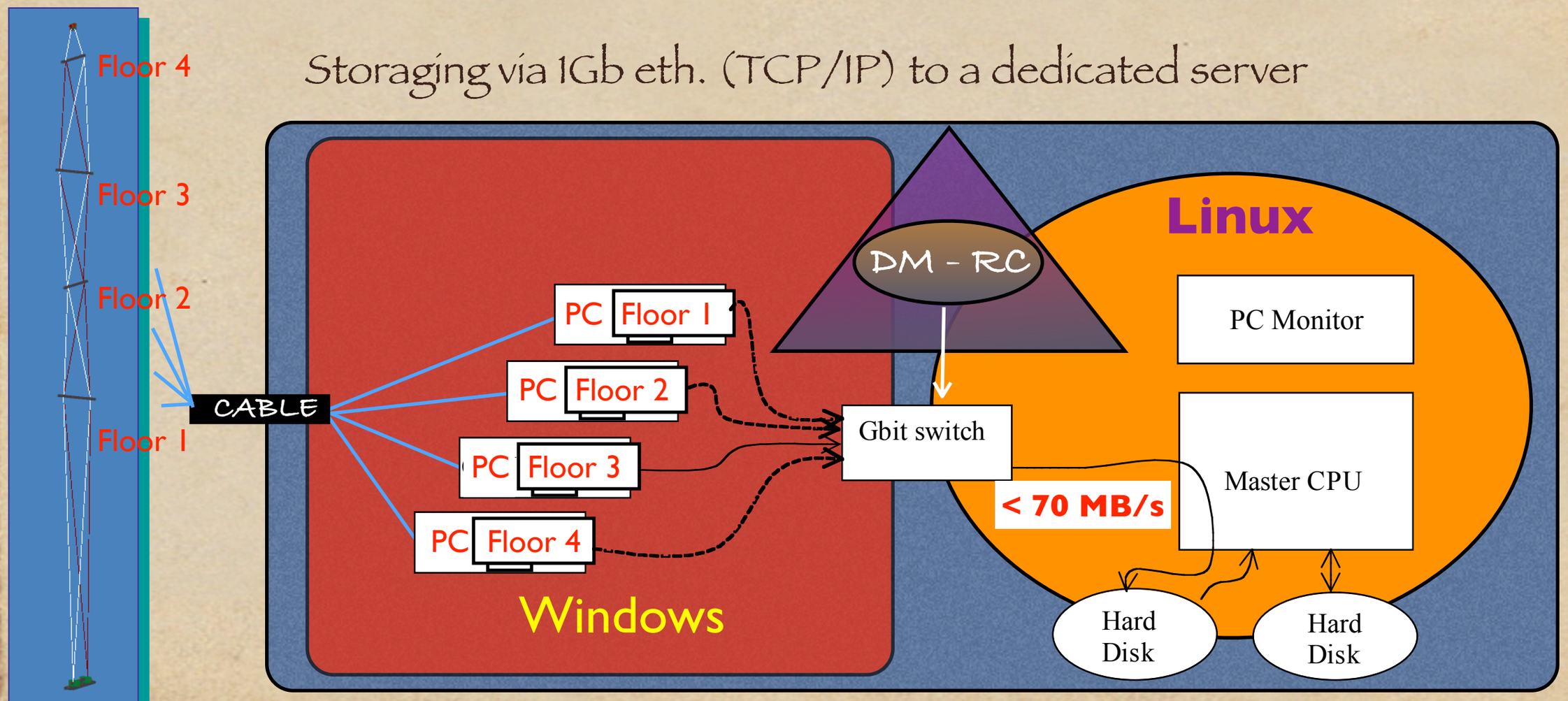
The TriDAS principal elements:

- Trigger System Controller **(TSC)**: monitors and serves the TriDAS - (1 GbE I/O)
- Hit Managers **(HM)**: receive optical data; prepare and distribute the TS to the TCPU
- TriggerCPUs **(TCPU)**: apply the trigger logics to the assigned TS and transfer the selected data to the EM;
- Event Manager **(EM)**: receives the triggered data from TCPUs and build the Post-Trigger events data file

TriDAS for NEMO Ph.1

The maximum throughput of the MiniTower was ≤ 512 Mbps

One Machine, the Master CPU (cpu: 2x 2.3 GHz, ram: 4 GB, HD: 2 x160 GB, OS: SL 3.3), playing all the roles (Hit Manager, Trigger, Event Manager) with multi-threading (posix threads).

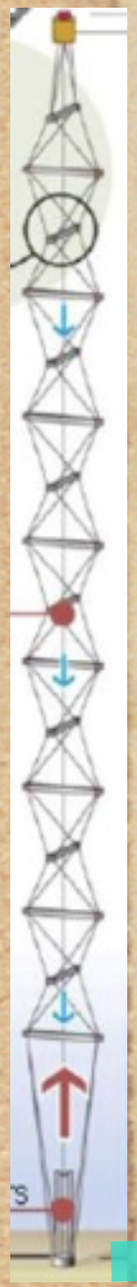


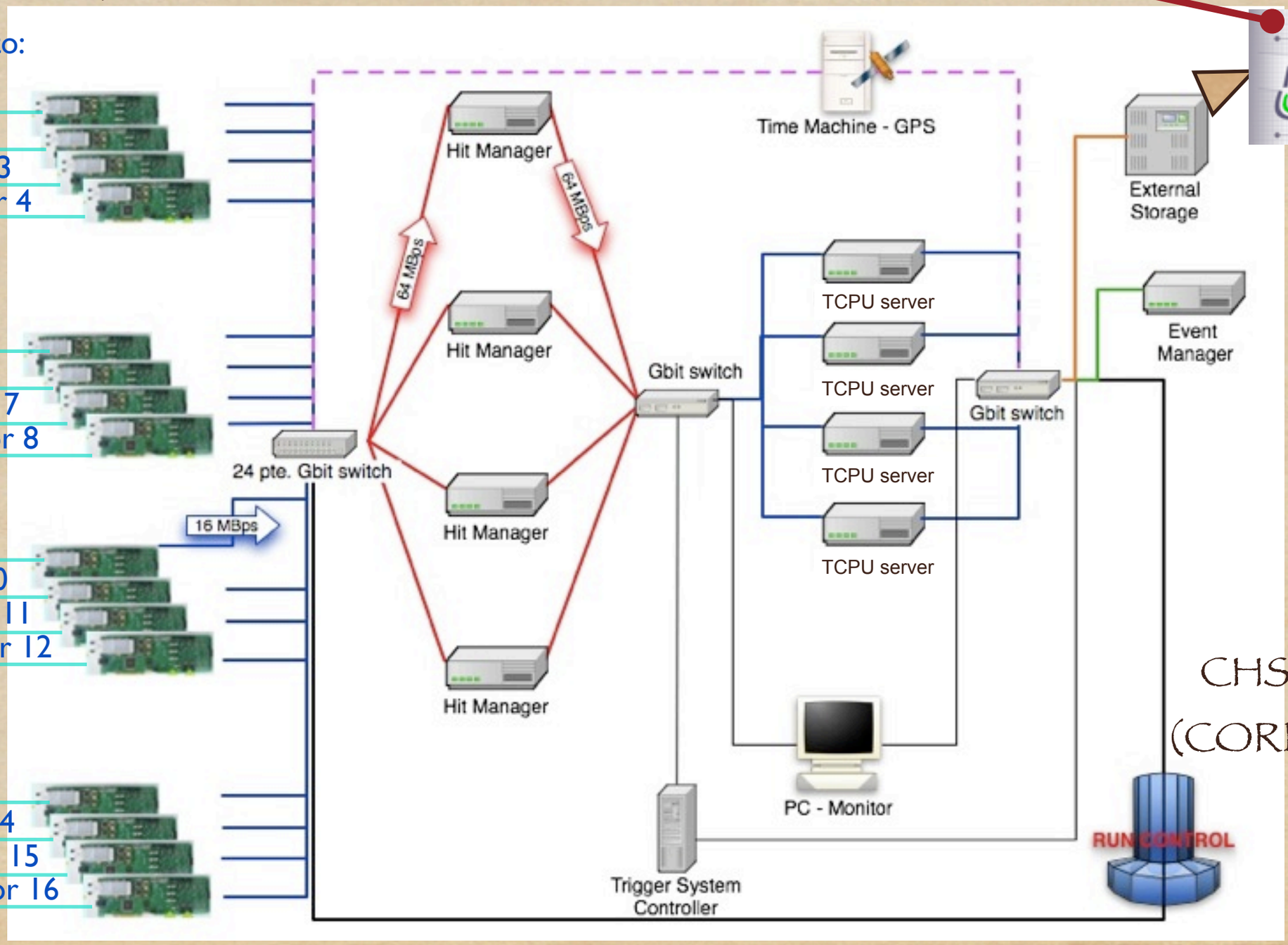
TriDAS for a first prototype Detection Unit with 16 Floors;

expected through-put ≤ 2 Gbps standard 1 GbEthernet Networking

10 servers HP cpu: 8-core 32 bit 2 GHz, ram: 6 GB, HD: 160+500/160 GB, OS: SL5

Counting room @ Capo Passero, to be 1 Gb eth connected to LNS for off-line analysis





Number of Available Clock Cycles per CPU per TS:

$$N_{ACC} = \frac{R_{CPU}\, S_{Hit}}{D_{rate\ HM \rightarrow TCPU}}$$

$D_{rate\ HM \rightarrow TCPU} = 1$ Gbps

$S_{Hit} = 224$ b

$R_{CPU} = 2.3$ GHz

$\Rightarrow N_{ACC} = 515$

Estimed number of necessary TCPU:

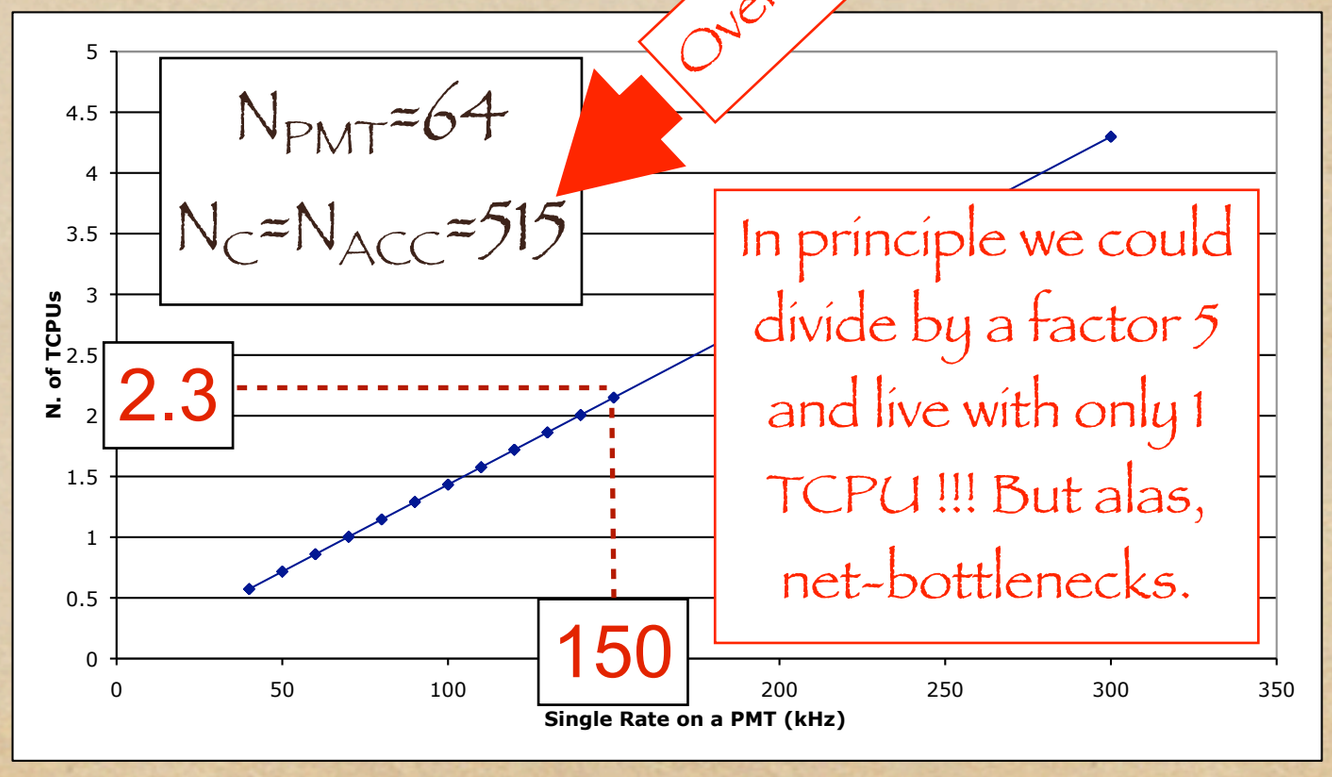
$$N_{TCPU} = \frac{\nu_K N_C N_{PMT}}{R_{CPU}}$$

If the req. $N_C > N_{ACC}$

(i.e. trigger algo. is slow)

ADD TCPU!

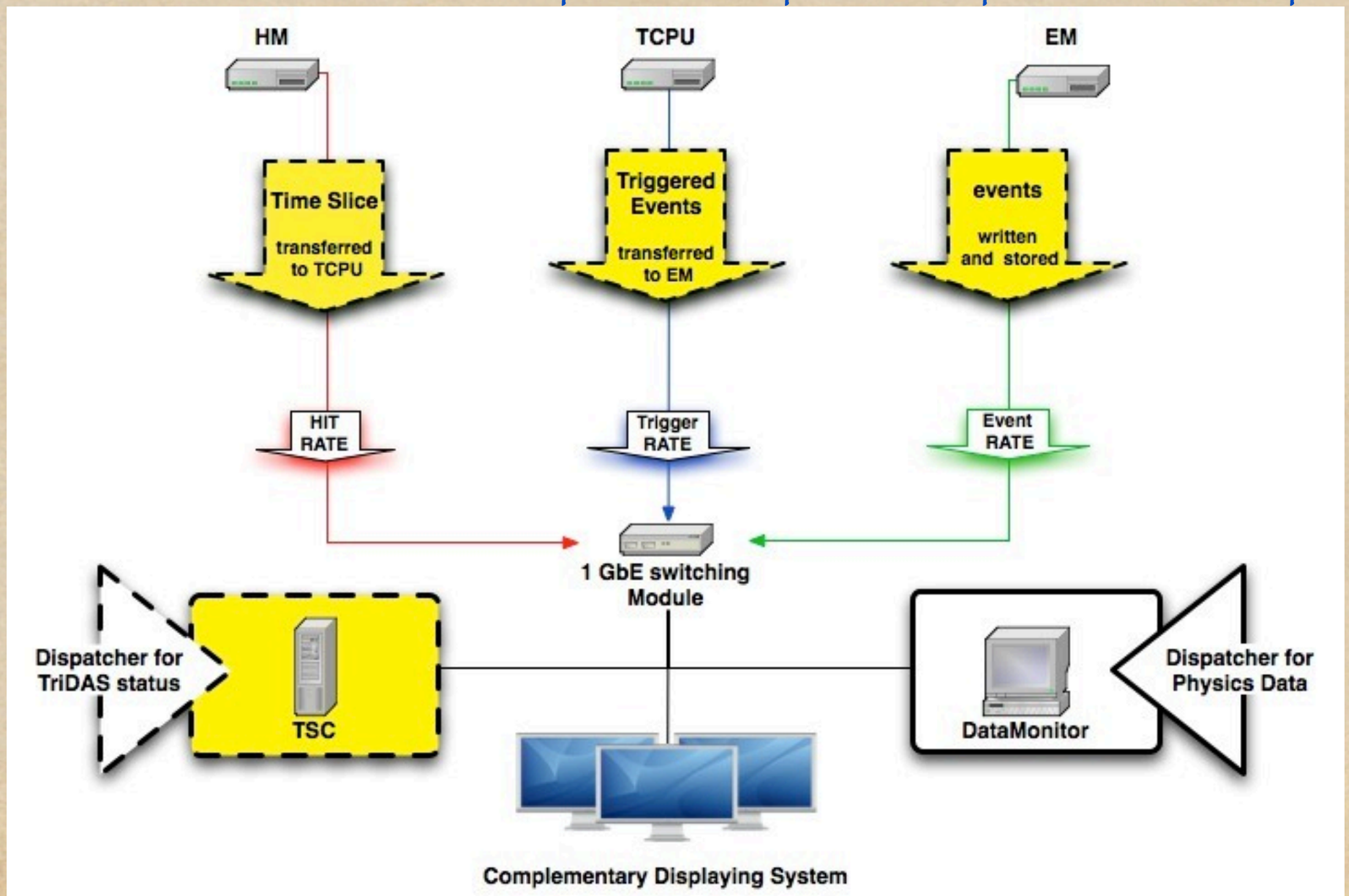
Oversized-assumption



Monitoring

Via ControlHost: a Tag Controlled Data Dispatching

[V. Maslenikov et al. CASPUR, http://afs.caspur.it/temp/ControlHost.pdf]



Multi purpose on-line Visualizer (QT4+ROOT)

	tag	dispatcher	gruppo	stato	allarme	soglia allarme	valore istantaneo	media	media dall'inizio	descrizione
1	so	lxantares3.bo.i...	HM	connesso	disattivato	20	73.31 MB/s	70.84 MB/s	71.22 MB/s	HM 3 out
2	si	lxantares3.bo.i...	EM	connesso	disattivato	20	19.26 MB/s	29.14 MB/s	29.87 MB/s	EM in
3	n2i	lxantares3.bo.i...	MCPU	connesso	disattivato	20	73.86 MB/s	70.69 MB/s	71.08 MB/s	MCPU 1 in
4	n1i	lxantares3.bo.i...	MCPU	connesso	disattivato	20	73.54 MB/S	70.94 MB/S	71.08 MB/S	MCPU 0 in
5	a9o	lxantares3.bo.i...	HM	connesso	disattivato	20	73.96 MB/s	70.65 MB/s	71.02 MB/s	HM 2 out
6	a8o	lxantares3.bo.i...	HM	connesso	disattivato	20	73.01 MB/s	48.66 MB/s	71.02 MB/s	HM 1 out
7	a7o	lxantares3.bo.i...	HM	connesso	disattivato	20	73.00 MB/s	70.65 MB/s	71.02 MB/s	HM 0 out
8	a6i	lxantares3.bo.i...	MCPU	connesso	disattivato	20	73.79 MB/S	3.09 MB/S	71.07 MB/S	MCPU 2 in
9	a5o	lxantares3.bo.i...	MCPU	connesso	disattivato	20	829.17 kB/s	7.43 MB/s	8.13 MB/s	MCPU 3 out
10	a5i	lxantares3.bo.i...	MCPU	connesso	disattivato	20	73.66 MB/s	70.91 MB/s	71.07 MB/s	MCPU 3 in
11	a3o	lxantares3.bo.i...	TSC	connesso	disattivato	20	8.64 kB/S	10.02 kB/S	11.47 kB/S	TSC out

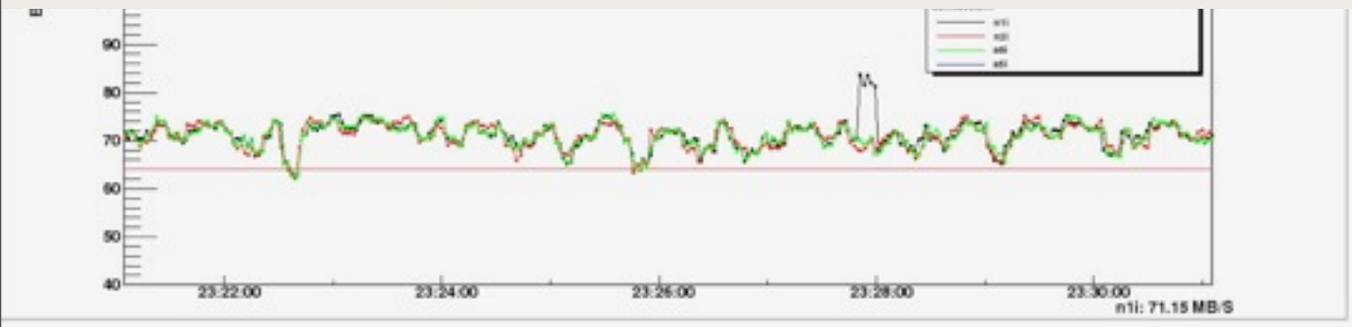
Grafici temporali — colonne: 1 righe: 1 — SELEZIONAT — mostra

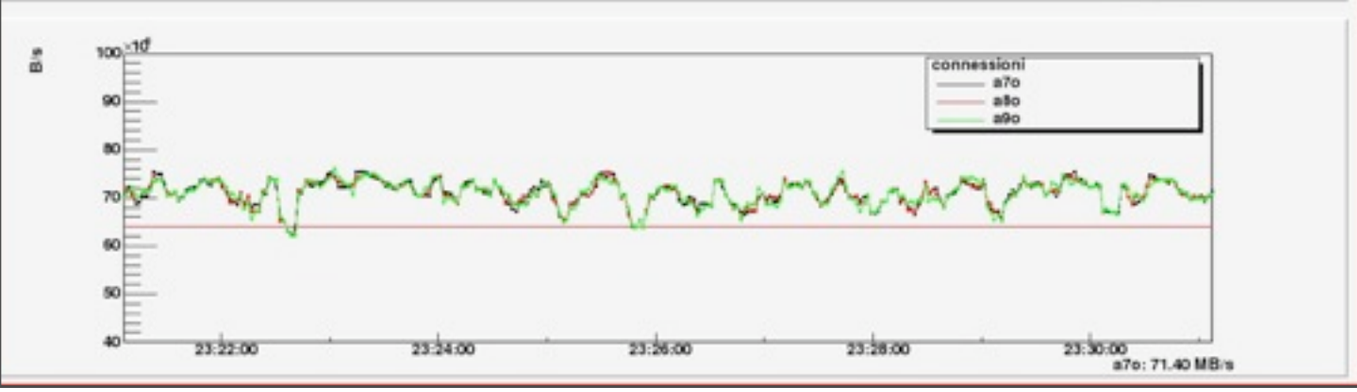
aggiunta grafici temporali — finestra: 1 pad: 1 — SELEZIONAT — inserisci

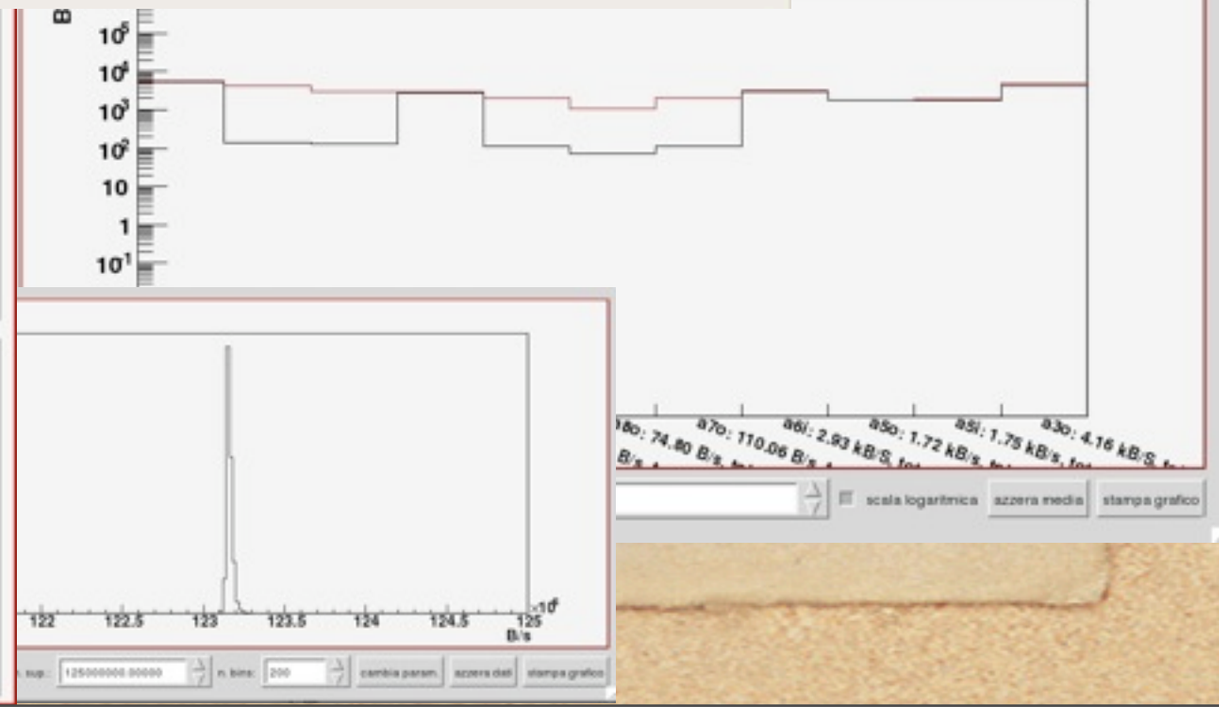
Grafici sinottici — SELEZIONATI — mostra

Allarmi — SELEZIONATI — attiva — disattiva

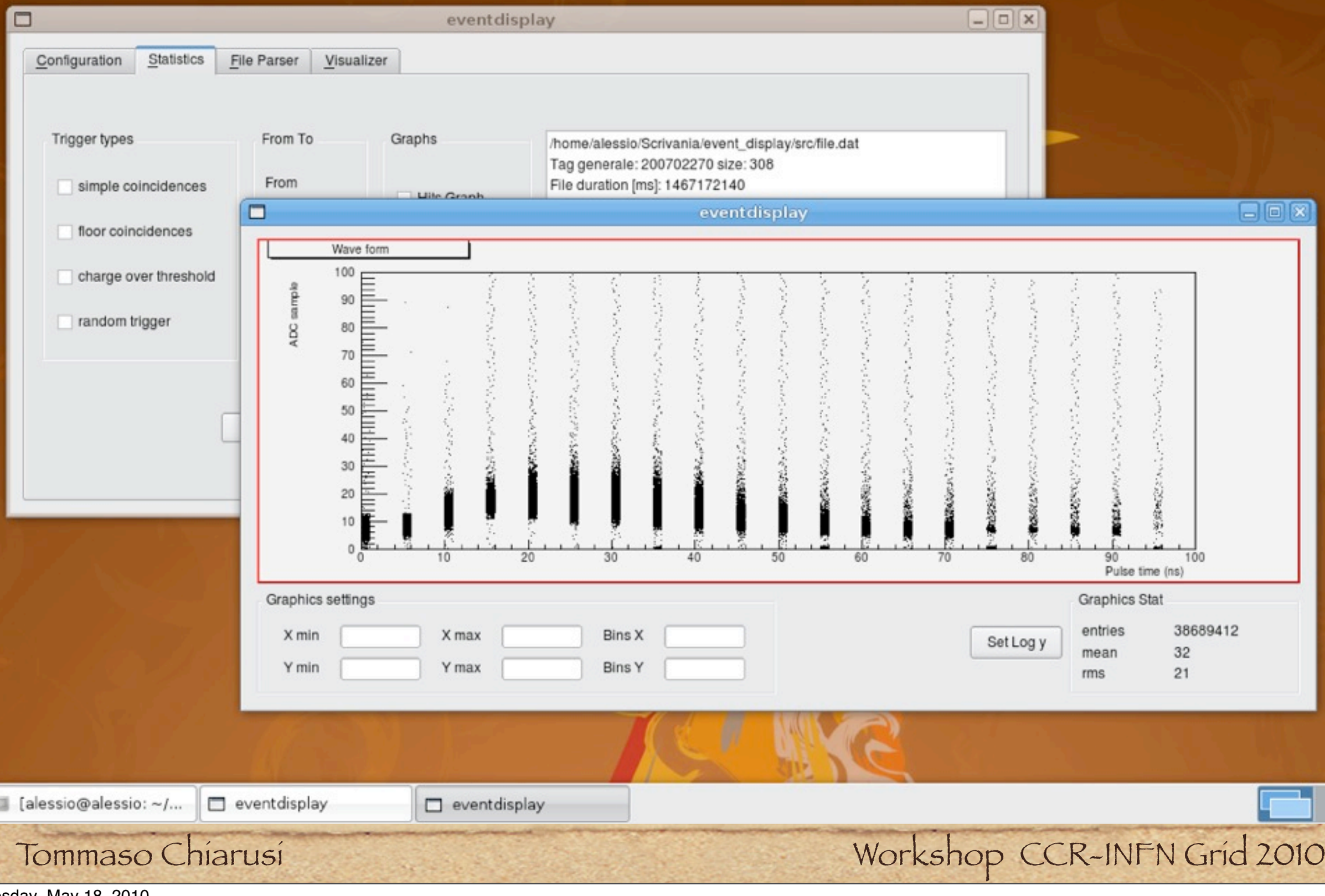
azzera dati — SELEZIONATI — azzera media — azzera media dall'inizio





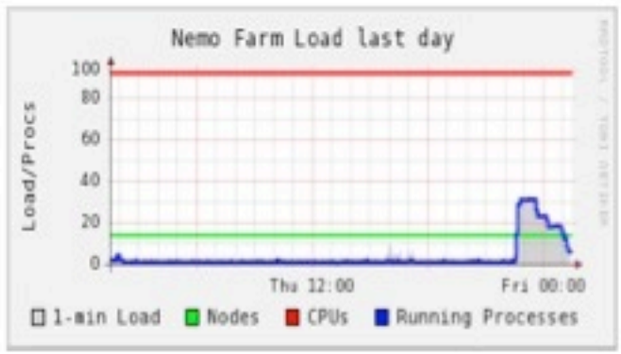


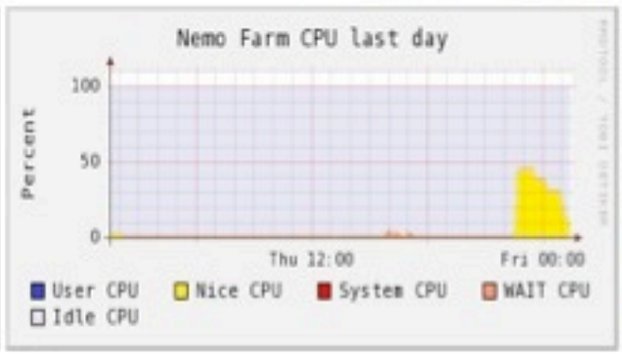
On(Off)-line Event Display

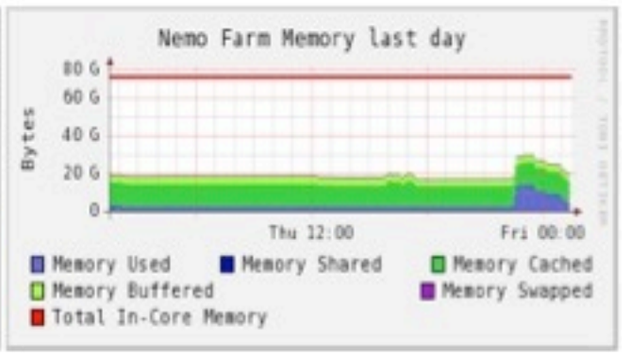


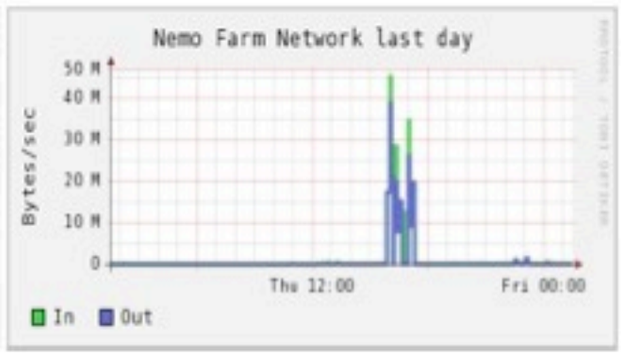
GANGLIA publish on the web XXX-vs.-time plots

Overview of Nemo Farm



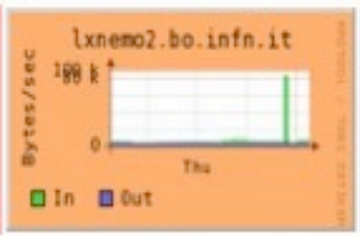


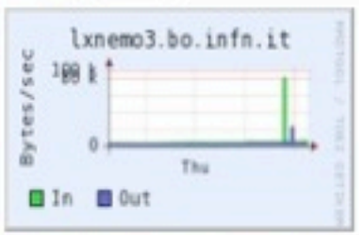


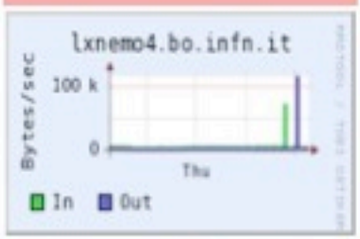


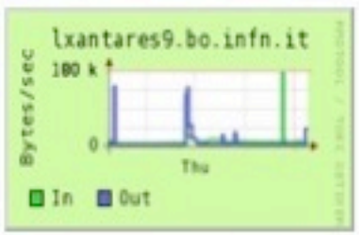
Show Hosts: yes ⊙ no ○ | Nemo Farm network_report last day sorted descending | Columns 4

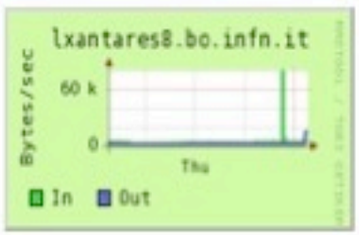
lxantares5.bo.infn.it
network_report: **down**
Last heartbeat 13 days, 2:44:14 ago

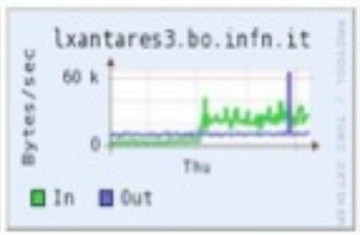


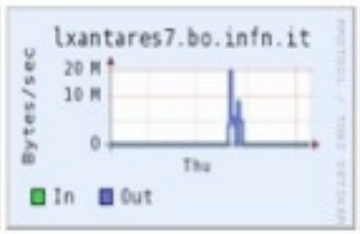












(Nodes colored by 1-minute load) | Legend

with A. Paolucci

(CCL Bologna)

Nagios

General
- Home
- Documentation

Monitoring
- Tactical Overview
- Service Detail
- Host Detail
- Hostgroup Overview
- Hostgroup Summary
- Hostgroup Grid
- Servicegroup Overview
- Servicegroup Summary
- Servicegroup Grid
- Status Map
- 3-D Status Map
- Service Problems
- Host Problems
- Network Outages

Show Host:

- Comments
- Downtime
- Process Info
- Performance Info
- Scheduling Queue

Reporting
- Trends
- Availability
- Alert Histogram
- Alert History
- Alert Summary
- Notifications
- Event Log

Configuration
- View Config

Current Network Status
Last Updated: Fri Mar 5 01:35:15 CET 2010
Updated every 90 seconds
Nagios® 2.12 - www.nagios.org
Logged in as *nagios*

View History For all hosts
View Notifications For All Hosts
View Host Status Detail For All Hosts

Host Status Totals

Up	Down	Unreachable	Pending
15	1	0	0

All Problems	All Types
1	16

Service Status Totals

Ok	Warning	Unknown	Critical	Pending
75	0	0	5	0

All Problems	All Types
5	80

Service Status Details For All Hosts

with A. Paolucci CCL Bologna

Host	Service	Status	Last Check	Duration	Attempt	Status Information
lxantares1.bo.infn.it	/ Partition	OK	03-05-2010 01:30:11	10d 13h 19m 38s	1/4	DISK OK - free space: / 9383 MB (68% inode=96%):
	/home Partition	OK	03-05-2010 01:31:11	10d 13h 18m 48s	1/4	DISK OK - free space: /home 196719 MB (99% inode=99%):
	Check Remote Load	OK	03-05-2010 01:32:11	9d 7h 59m 42s	1/4	OK - load average: 1.03, 1.04, 1.00
	Current Users	OK	03-05-2010 01:33:11	10d 13h 17m 6s	1/4	USERS OK - 0 users currently logged in
	Total Processes	OK	03-05-2010 01:34:11	10d 13h 16m 16s	1/4	PROCS OK: 177 processes with STATE = RSZDT
lxantares2.bo.infn.it	/ Partition	OK	03-05-2010 01:30:14	10d 13h 10m 16s	1/4	DISK OK - free space: / 7577 MB (63% inode=96%):
	/home Partition	OK	03-05-2010 01:31:14	10d 13h 19m 35s	1/4	DISK OK - free space: /home 201340 MB (99% inode=99%):
	Check Remote Load	OK	03-05-2010 01:32:14	7d 20h 6m 53s	1/4	OK - load average: 0.08, 0.04, 0.00
	Current Users	OK	03-05-2010 01:33:14	10d 13h 17m 53s	1/4	USERS OK - 0 users currently logged in
	Total Processes	OK	03-05-2010 01:34:14	10d 13h 17m 3s	1/4	PROCS OK: 170 processes with STATE = RSZDT
lxantares3.bo.infn.it	/ Partition	OK	03-05-2010 01:30:18	9d 14h 2m 47s	1/4	DISK OK - free space: / 7506 MB (62% inode=96%):
	/home Partition	OK	03-05-2010 01:31:18	9d 14h 2m 56s	1/4	DISK OK - free space: /home 11226 MB (21% inode=98%):
	Check Remote Load	OK	03-05-2010 01:32:18	9d 14h 3m 6s	1/4	OK - load average: 0.24, 0.13, 0.10
	Current Users	OK	03-05-2010 01:33:18	9d 14h 0m 16s	1/4	USERS OK - 0 users currently logged in
	Httpd Service	OK	03-05-2010 01:34:18	9d 12h 36m 25s	1/4	HTTP OK HTTP/1.1 200 OK - 3962 bytes in 0.003 seconds
	Total Processes	OK	03-05-2010 01:30:22	9d 14h 3m 34s	1/4	PROCS OK: 149 processes with STATE = RSZDT
	UPS Service	OK	03-05-2010 01:31:22	8d 8h 42m 47s	1/4	Battery Charge: 100
	UPS Service New	OK	03-05-2010 01:34:11	7d 8h 41m 4s	1/4	BATTERY OK: Battery Charge 100%
lxantares4.bo.infn.it	/ Partition	OK	03-05-2010 01:33:22	21d 15h 48m 52s	1/4	DISK OK - free space: / 9713 MB (70% inode=96%):
	/home Partition	OK	03-05-2010 01:34:22	21d 15h 37m 21s	1/4	DISK OK - free space: /home 257141 MB (99% inode=99%):
	Check Remote Load	OK	03-05-2010 01:30:26	30d 8h 36m 19s	1/4	OK - load average: 0.14, 0.11, 0.04
	Current Users	OK	03-05-2010 01:31:26	30d 11h 37m 28s	1/4	USERS OK - 0 users currently logged in

NAGIOS allows to define "observables" for monitoring the good/critical status of the machines, and sends alarms (mails, "beeps", "red lights"...)

Tommaso Chiarusi

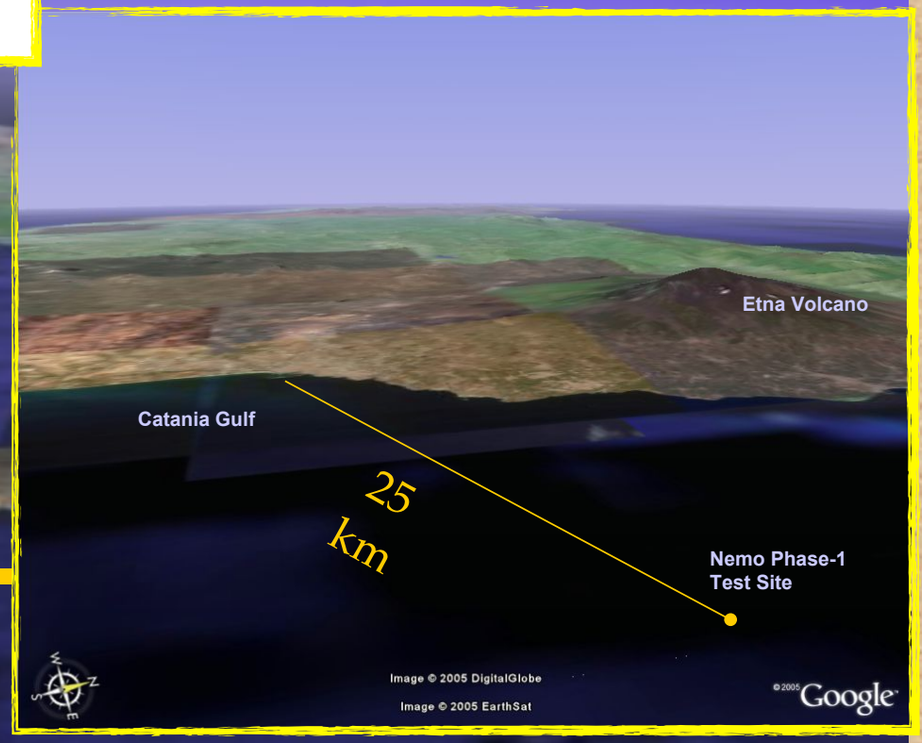
Workshop CCR-INFN Grid 2010

NEMO Sites and shore stations

Shore laboratory, Port of Catania

NEMO Phase 1

- 100 km electro-optical cable (>50 kW, 20 fibres) deployed in 2007
- DC/DC power converter built by Alcatel tested and working; installation in 2009
- On-shore laboratory (1000 m2) inside the harbour area of Portopalo completed

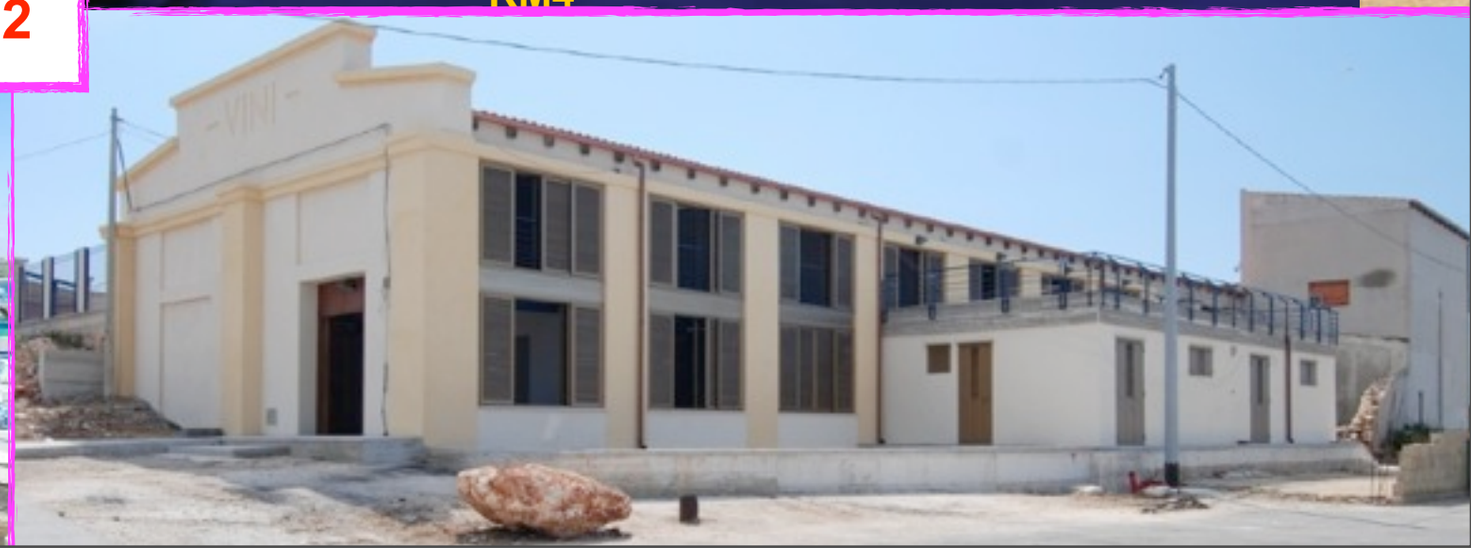


Capo Passero

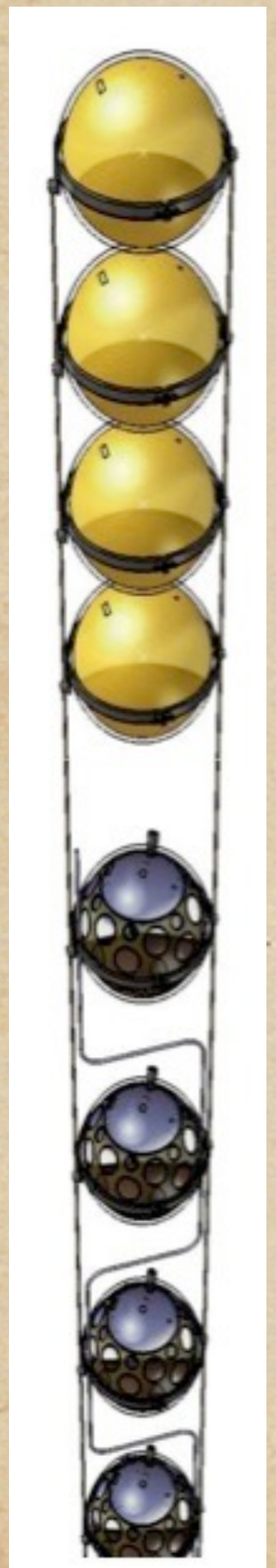
~80 km

KM4

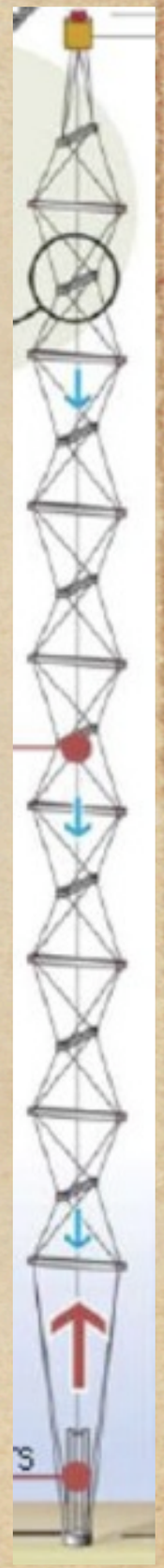
NEMO Phase 2



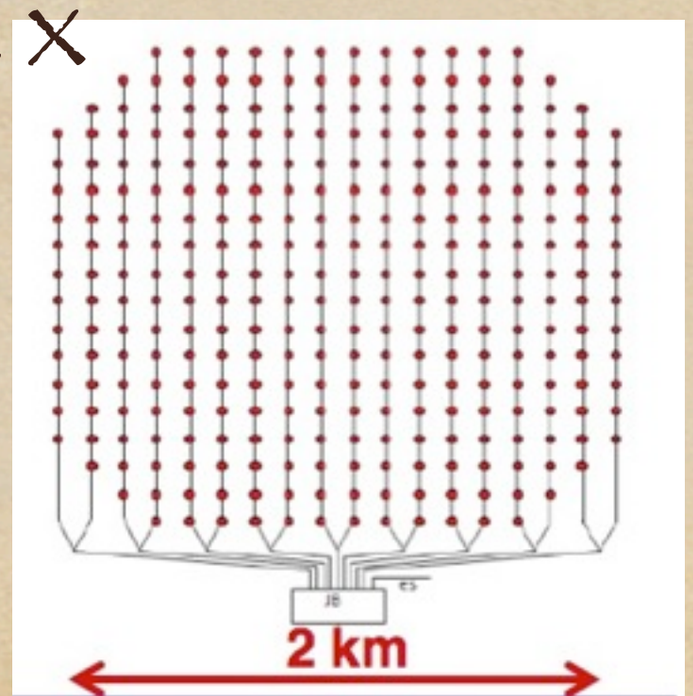
KM3NeT



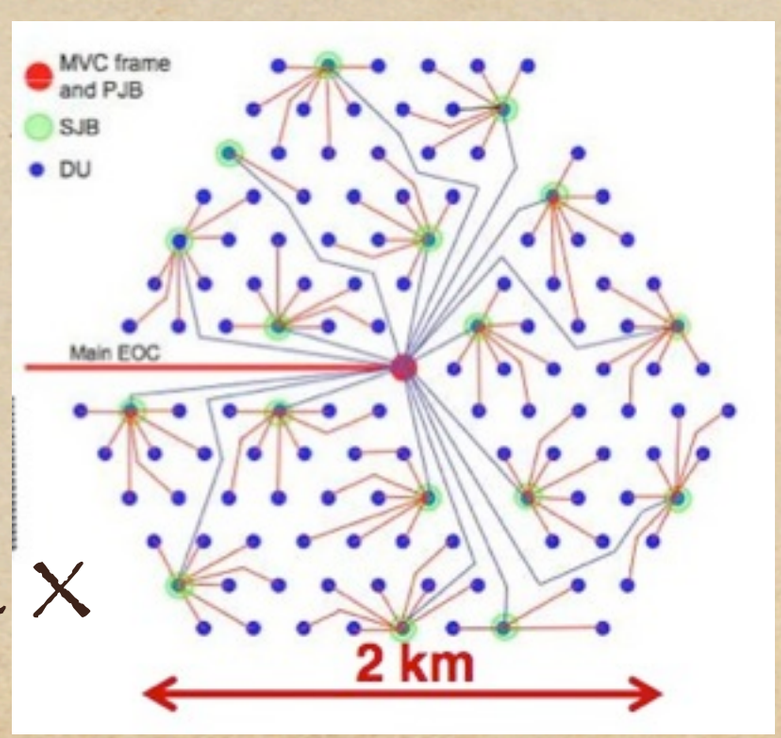
Single PMT OM (10” - 8” PMTs)



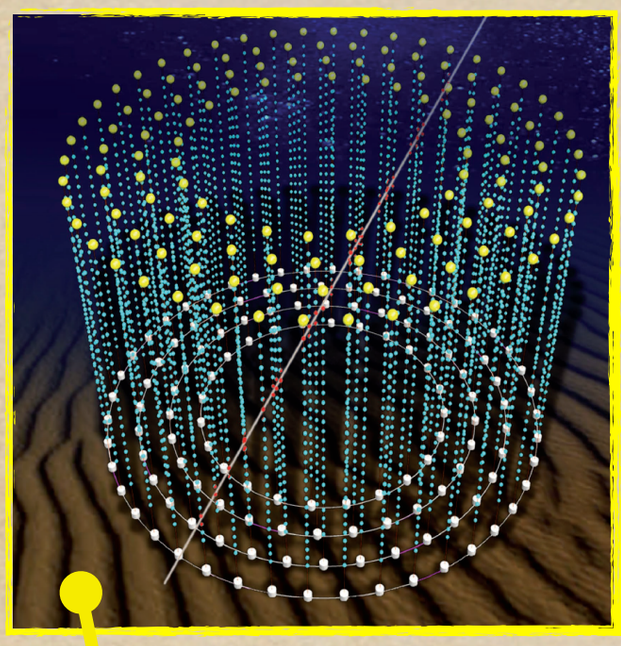
2 x



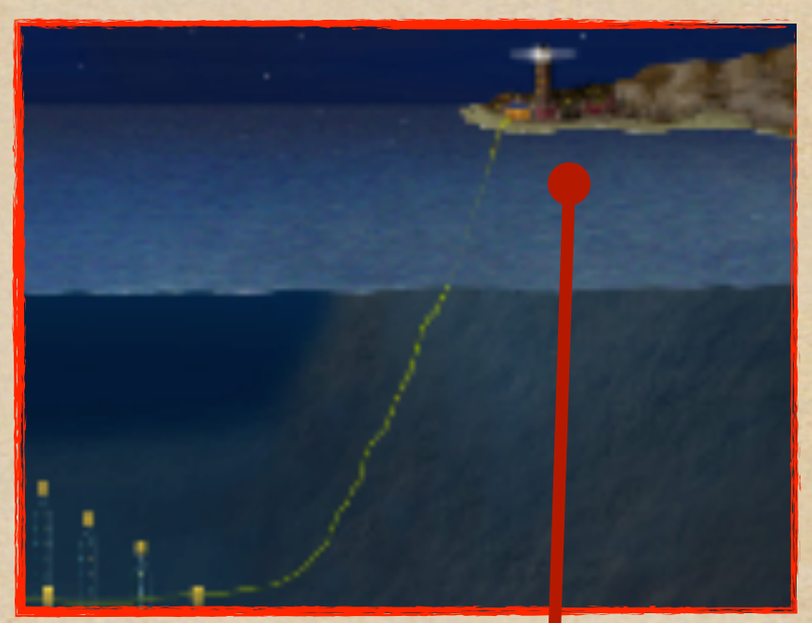
2 x



... in any case: the off- ➠ on-shore communication is stated to 2.5(max 5)Gbps/D.U.



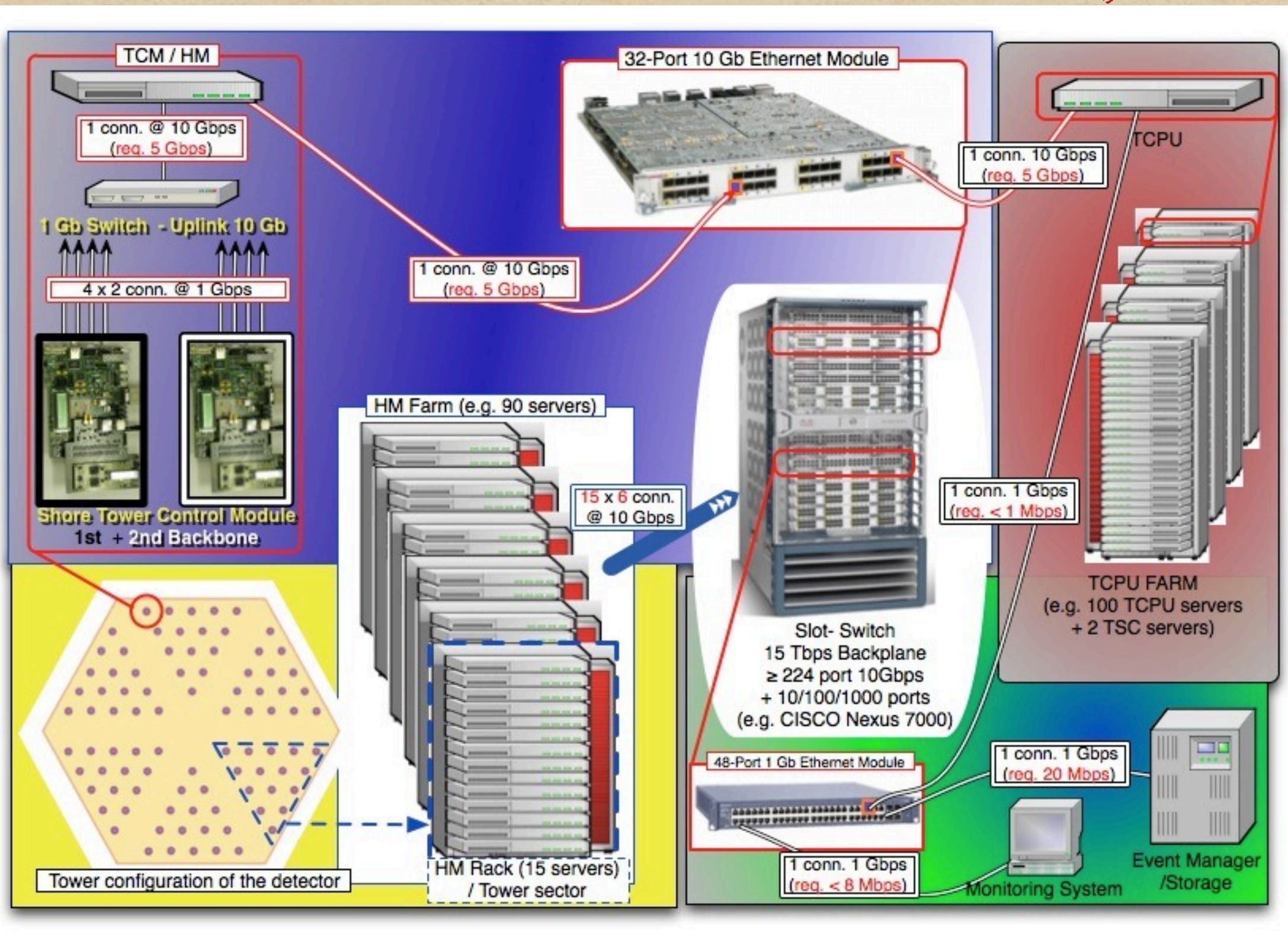
DWDM



Implemented functions	Offshore		Onshore	
	Firmware	Software	Firmware	Software
Control/configuration of frond end chips	●	○	×	●
Primary readout of front-end chips	●	×	×	×
Control/configuration of PMT and instrumentation	○	○	×	●
Primary readout of instrumentation	○	○	×	×
Data transmission (over network)	○	○	○	○
Data routing	○	○	○	○
Data filtering	×	●	×	●
Data storage	×	●	×	●

●=indispensable ○=possible ×=not needed

Possible Network infrastructure for km³ TriDAS (90 D.U.)



Number of Available Clock Cycles per CPU per TS:

$$N_{ACC} = \frac{R_{CPU}\, S_{Hit}}{D_{rate\ HM \rightarrow TCPU}}$$

$D_{rate\ HM \rightarrow TCPU} = 10$ Gbps

$S_{Hit} = 224$ b

$R_{CPU} = 2.3$ GHz

$\Rightarrow N_{ACC} = 51$

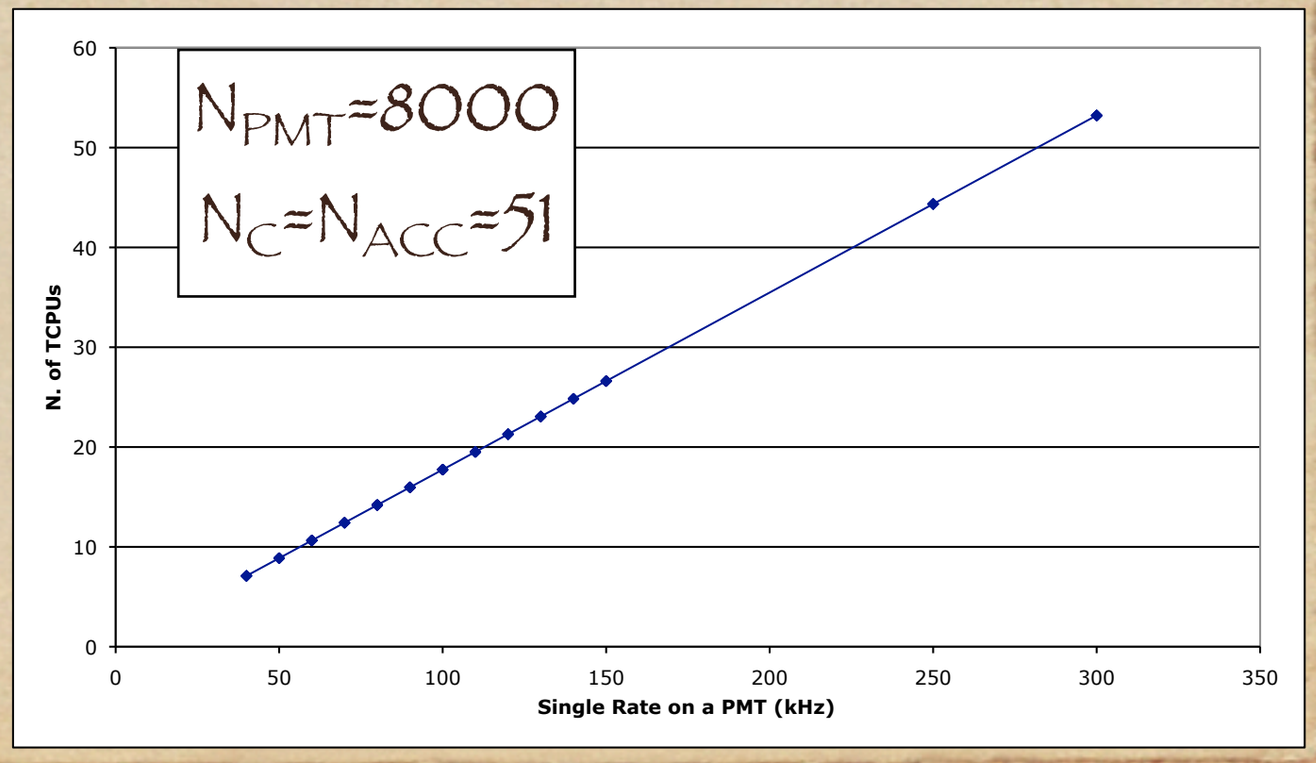
Estimed number of necessary TCPU:

$$N_{TCPU} = \frac{\nu_K N_C N_{PMT}}{R_{CPU}}$$

If the req. $N_C > N_{ACC}$

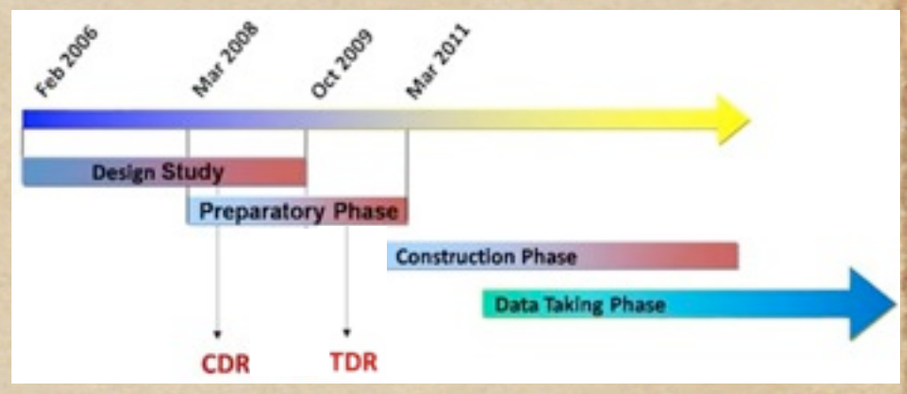
(i.e. trigger algo. is slow)

ADD TCPU!



Conclusions

- "all data to shore" is a challenging BUT feasible strategy for km^3 underwater ν-telescope;
- scalable TriDAS architecture suppliyng high data-stream (up to 500 Gbps) is possible and affordable with the present technology;
- ANTARES & NEMO pioneered the TriDAS for a undersea neutrino telescope in the Mediterranean. KM3NeT TDR will be delivered with the stated architecture.



- The NEMO Collaboration is developing a scaled TriDAS for a prototype Detection Unit (deployment scheduled for mid 2011).

THANK YOU!

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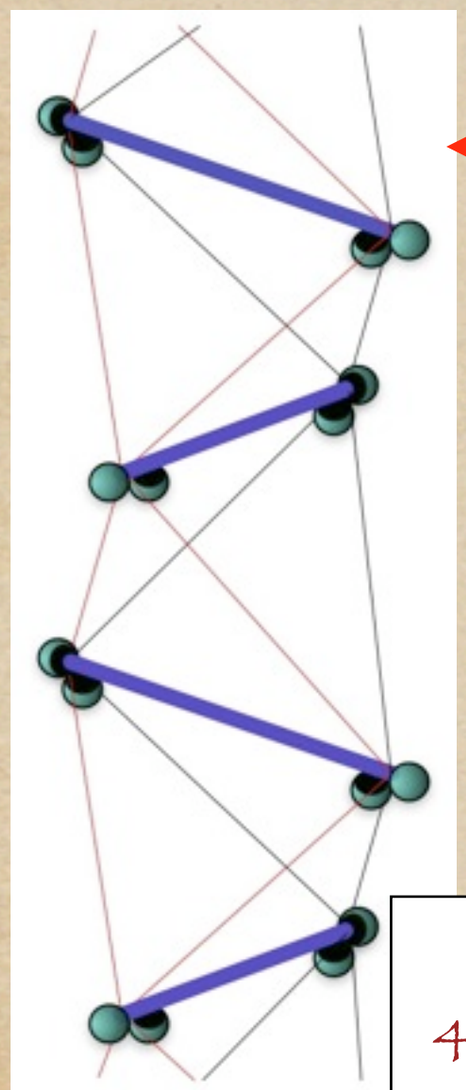
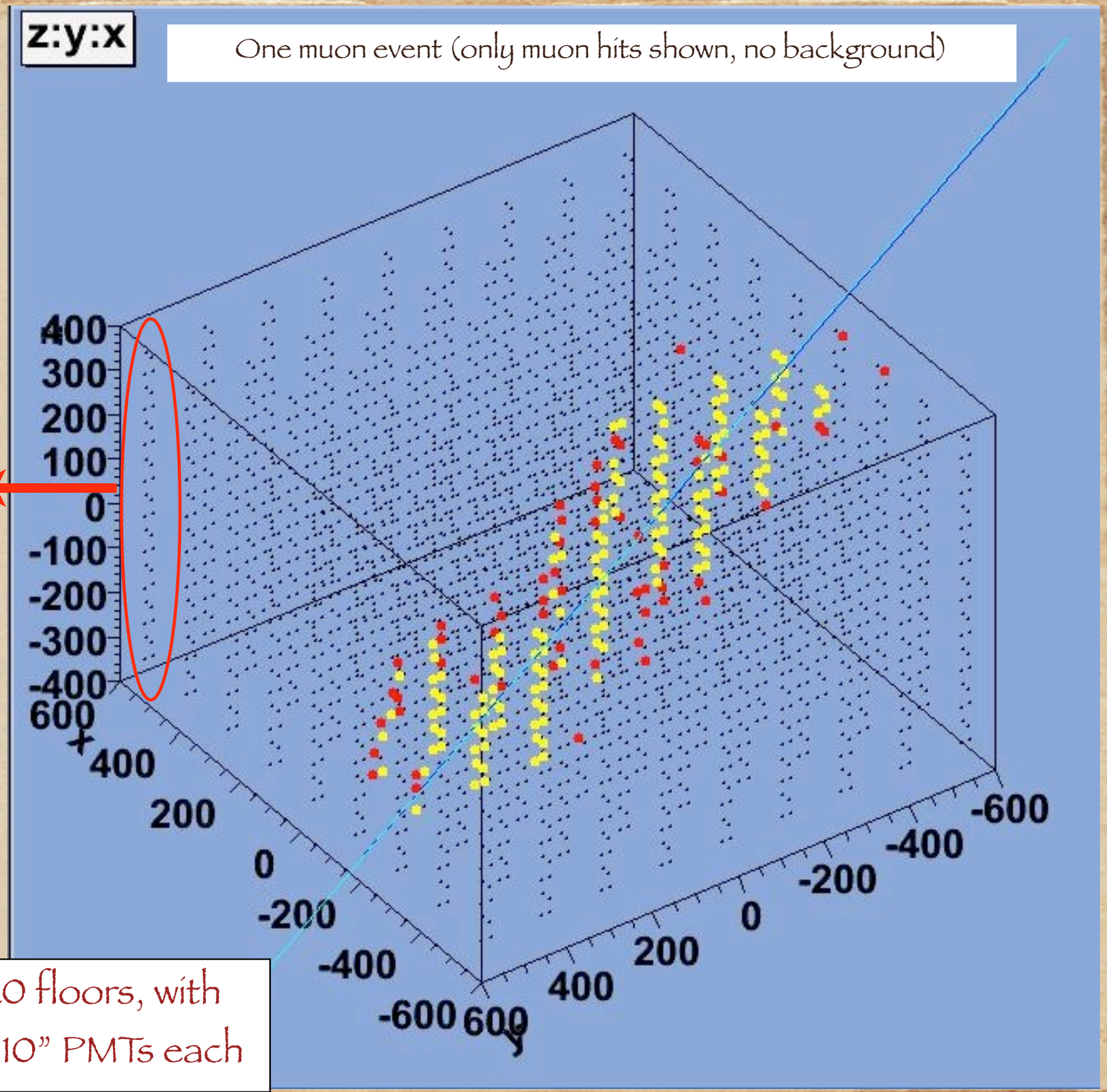
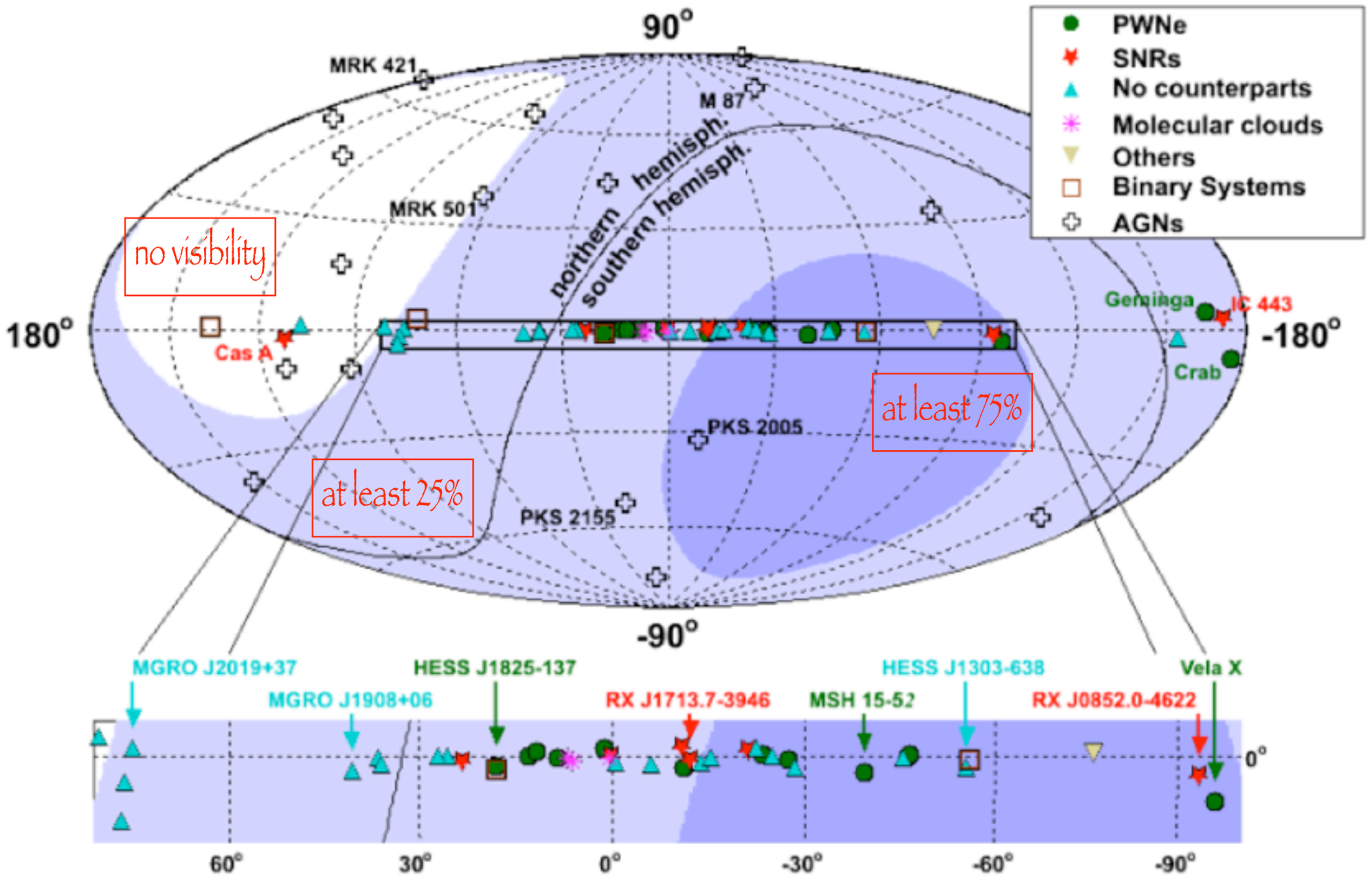
the Telescope is made of DETECTION UNITS



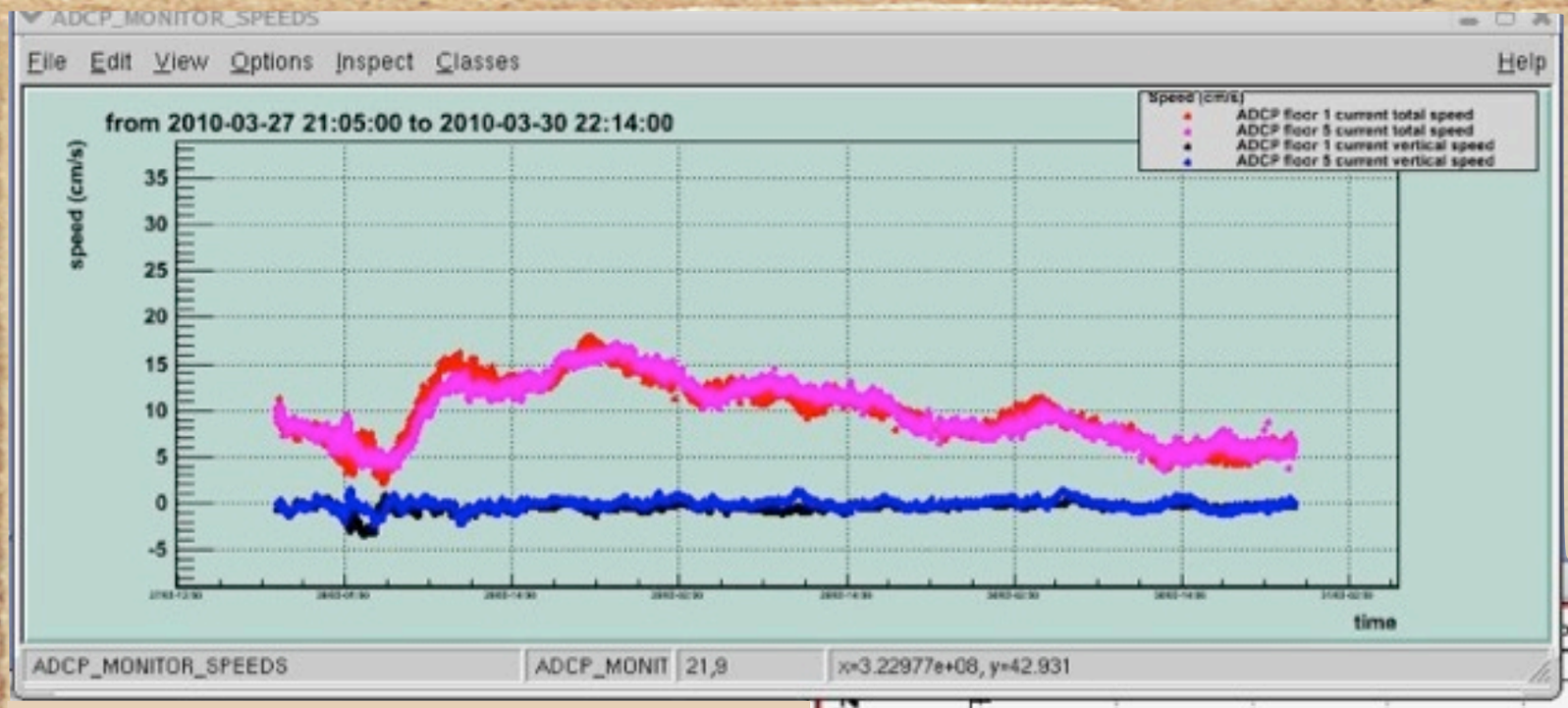
20 floors, with
4 10" PMTs each



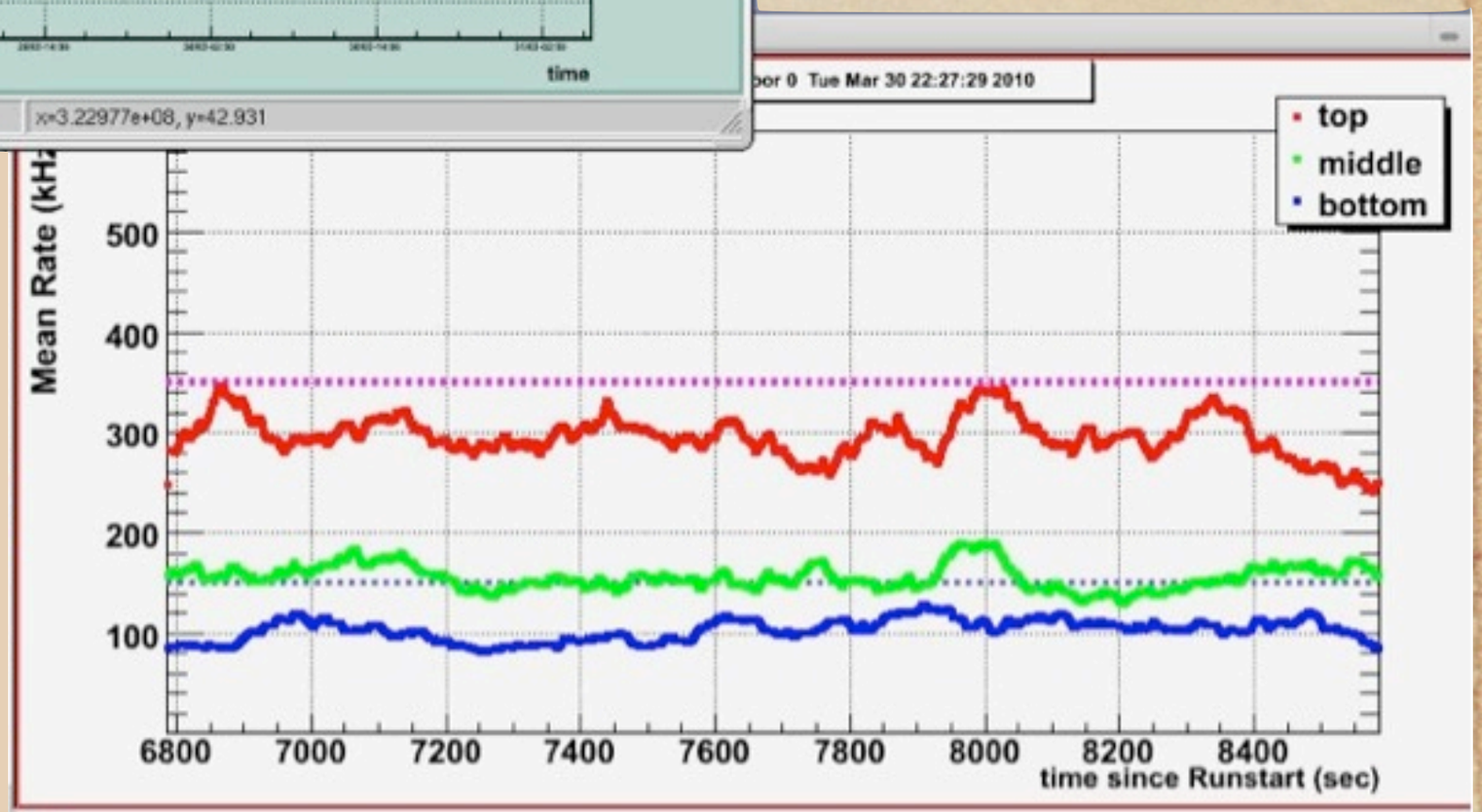
Sky for a neutrino Mediterranean Telescope



Galactic Center visibility: 67 %



Sea Currents



Rate monitor

MONITORING PARADE