S. E. Tzamarias
Hellenic Open University

Benchmark Detectors for Comparative Simulations

The detector architecture and all the relevant design parameters are heavily site dependent

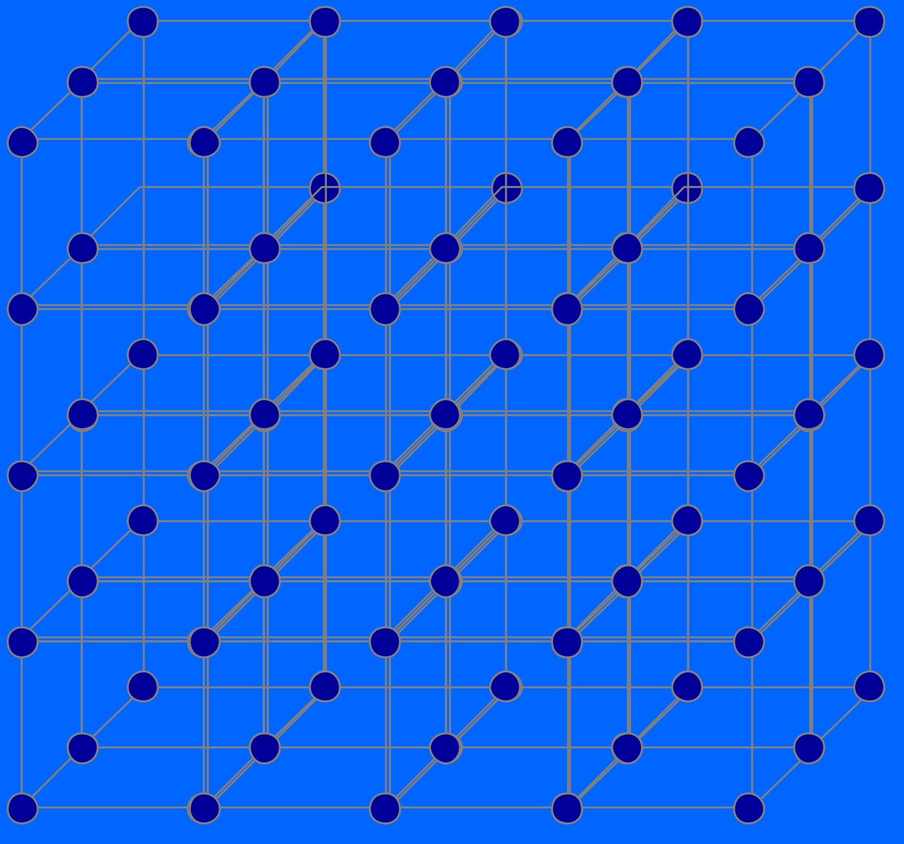
Design the detector ** **with the best physics performance at the given site** *

Compare the different designs in terms of performance, feasibility and cost

*** site: a set of environmental parameters (e.g. depth, water transparency, sedimentation etc)**

** ** e.g. the three best design options for the given site**

Can we use a generic, dense detector as the basic tool in our design studies?



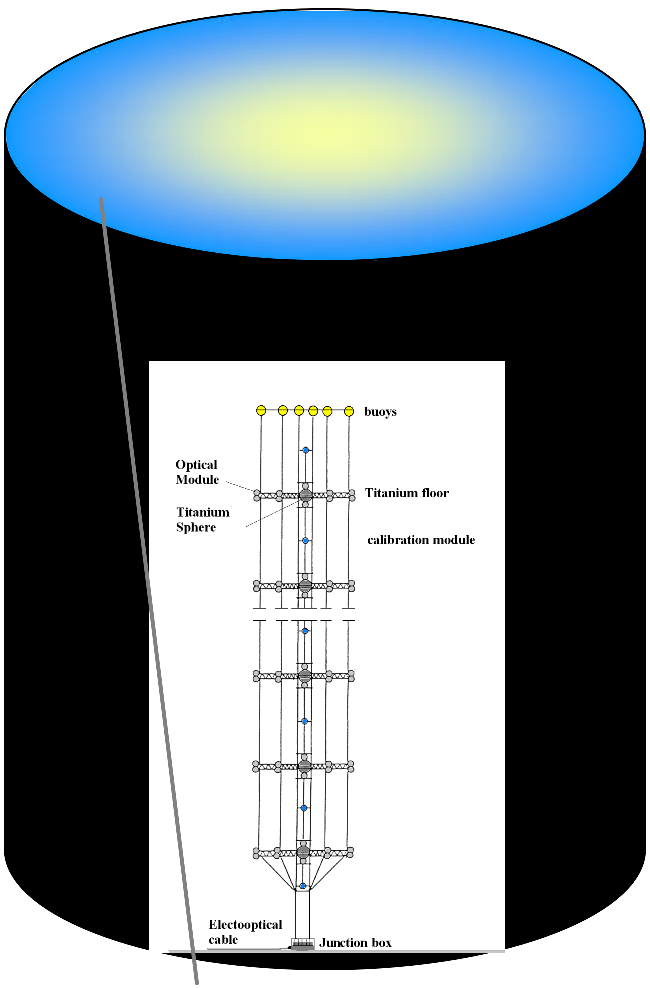
A GRID type Detector

Dimensions of the Grid detector

Examples of km^3 designs:

What do we mean by : "a km^3 Neutrino Telescope"?

Effective Area OF THE ORDER OF or GREATER THAN **1 km^2**



Geometrical acceptance Ä Reconstruction Efficiency

Estimated by Monte Carlo Integration

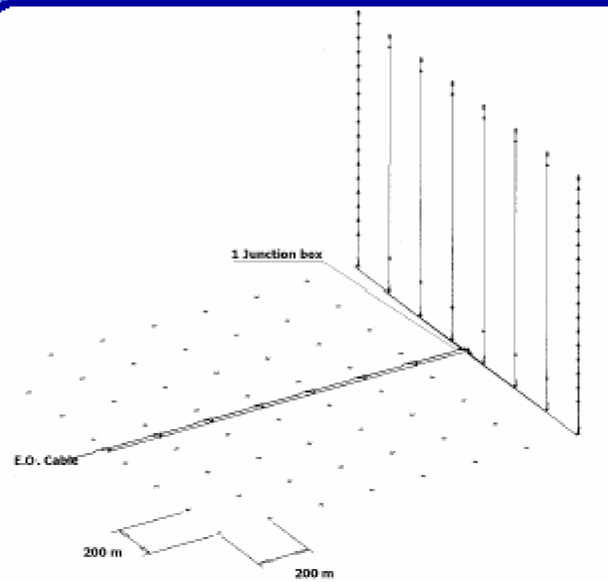
$$(\mathbf{area})\cdot\left(\frac{N_{\text{reconstructed}}}{N_{\text{generated}}}\right)$$

Dependent on:

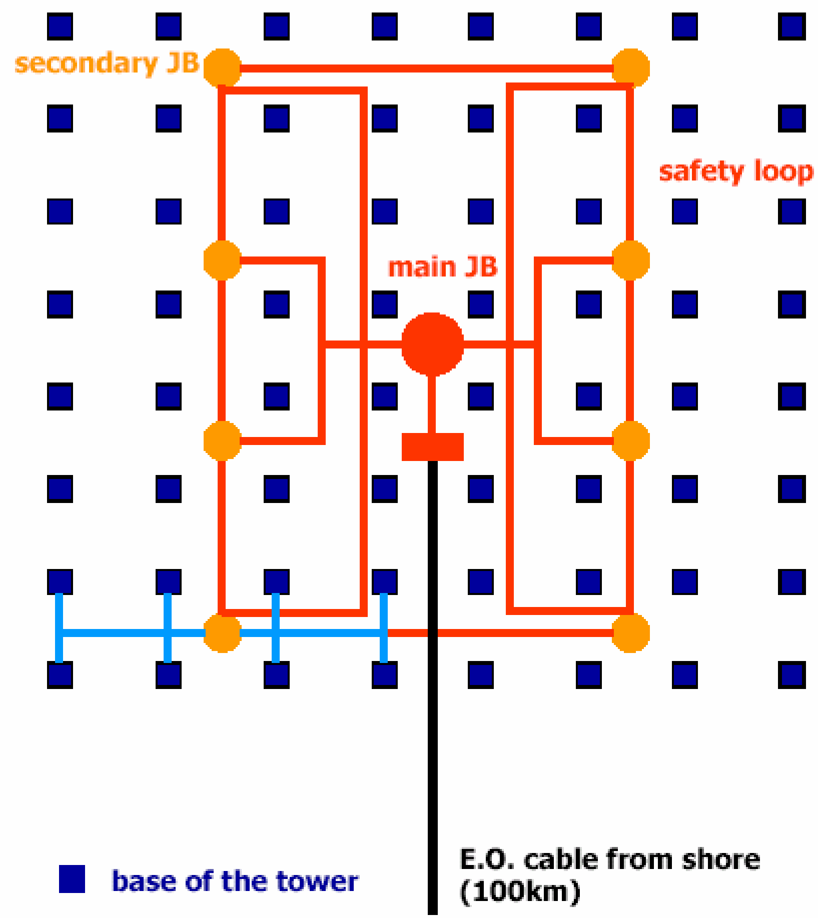
- **Energy**
- **Direction**
- **Tracking Accuracy**

The NEMO Collaboration

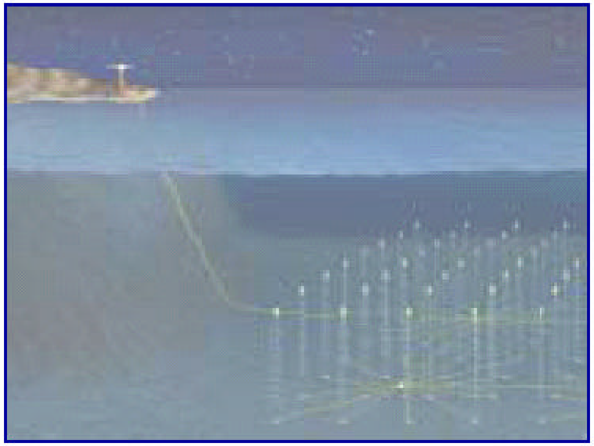
The layout of the telescope



4096	Optical Modules
64	vertical structures (towers)
200m	distance between towers
1	main Junction box
1	main panel
8	secondary junction boxes (each serves 8 towers)



The telescope proposed by NEMO



Simulations show that a detector of:

4096	Optical Modules
64	Towers
600m	height
200m	distance between towers
75m	L_a (Capo Passero)

May acheive:

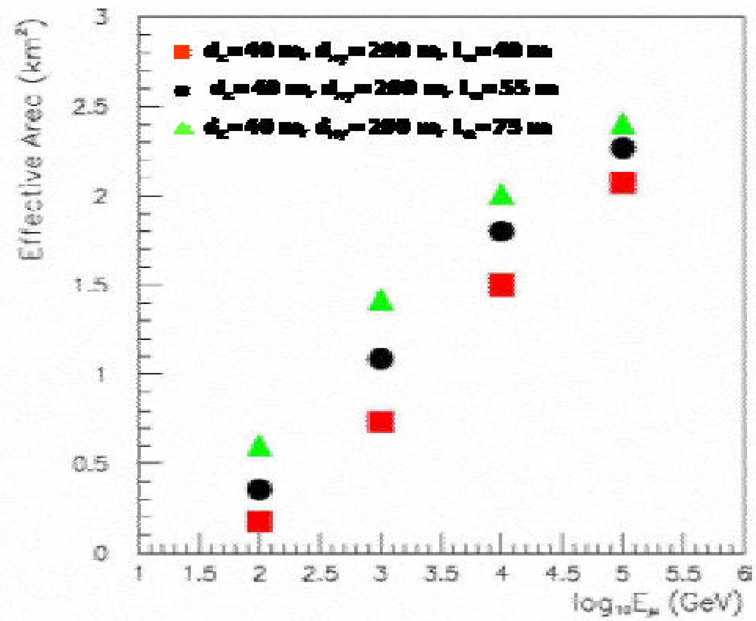
$>2km^2$ trigger area

$<0.3°$ angular resolution (median angle)

OPNEMO:

fast montecarlo code is designed to study the telescopeperformance as a function of:

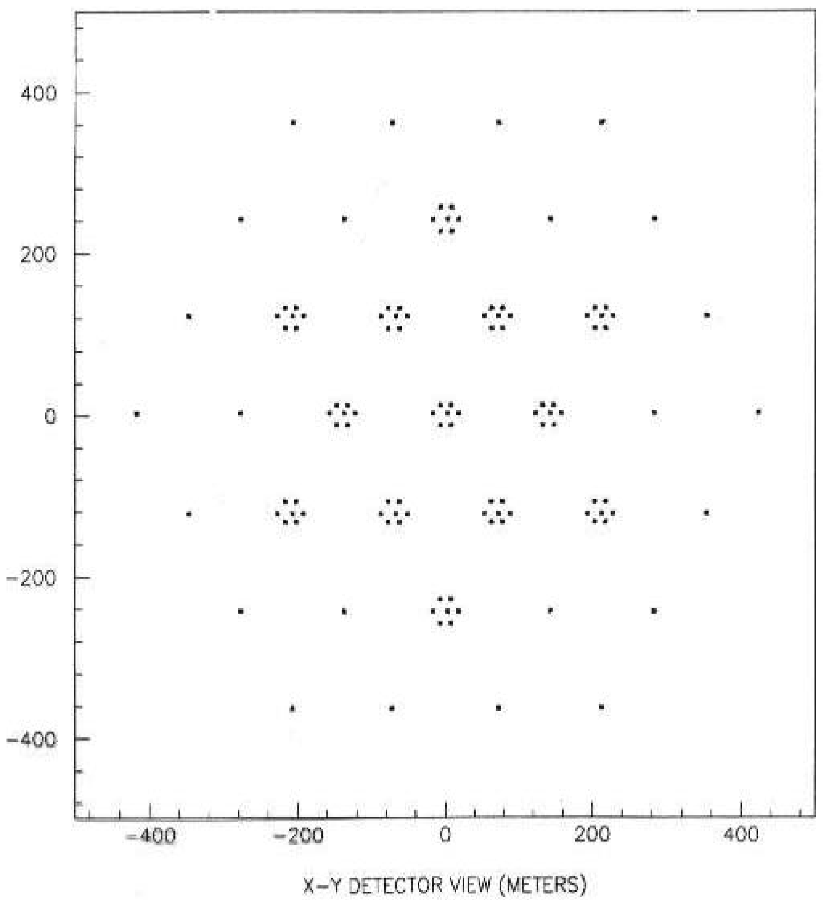
- detector geometry
- PMT dimensions, TTS
- water optical properties

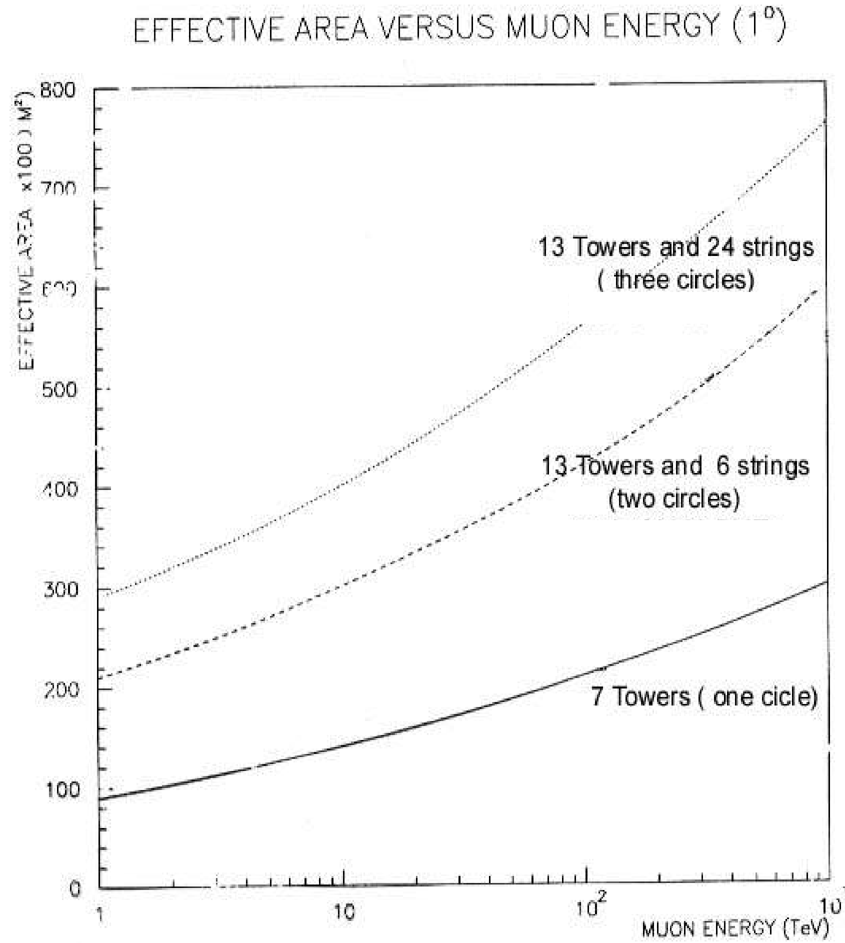


Km^2 NESTOR Detector

13 towers+24 strings (24 PMT's each)

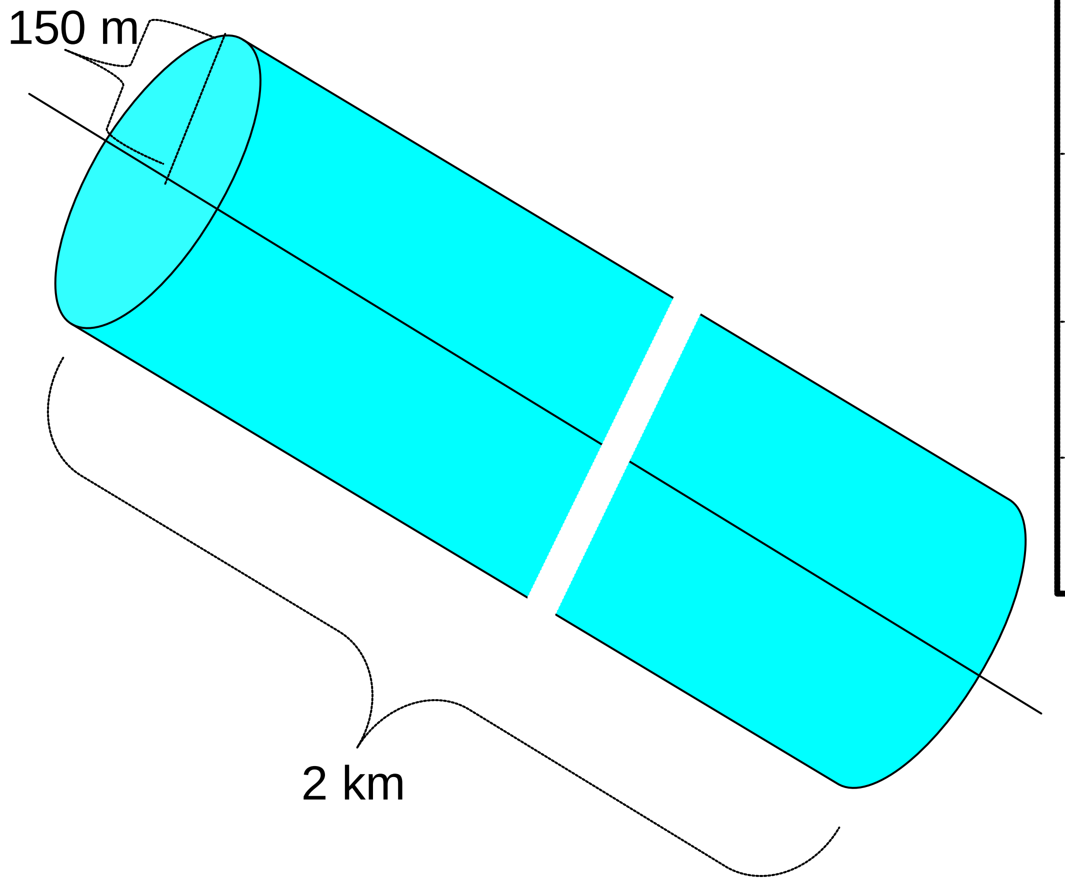
2448 Photomultiplers





	Instrumented Volume	Minimum distance between PMTs	PMT Density ($PMTs/m^3$)
NEMO	$1400x1400x600\ m^3$	20m	$3.5\ 10^{-6}$
NESTOR	$900x900x400\ m^3$	15m	$7.6\ 10^{-6}$
ANTARES		14m	$8\ 10^{-5}$
GRID	$1400x1400x600\ m^3$	10m	10^{-3}

Mean Number of "Candidate" PMTs per "Track"



	Mean Number of "Candidate" PMTs per Track
NEMO	550
NESTOR	1070
ANTARES	11000
GRID	140000

Shadowing

NESTOR: $0.4\ 10^{-3}$

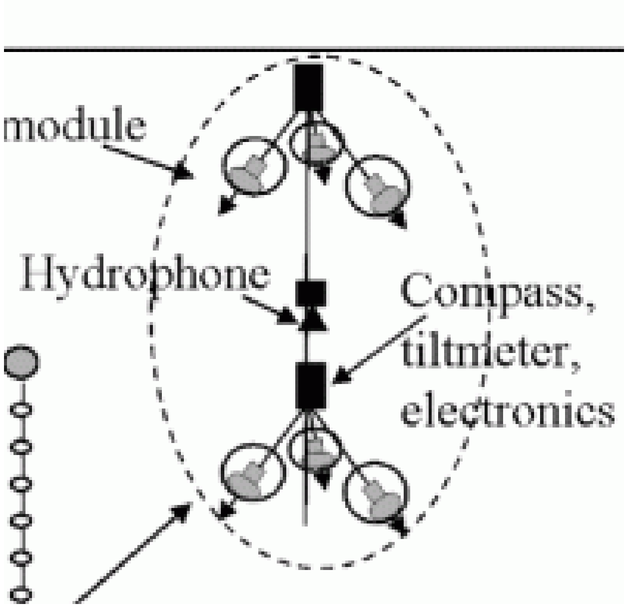
GRID: $12\ 10^{-2}$

The most difficult task …

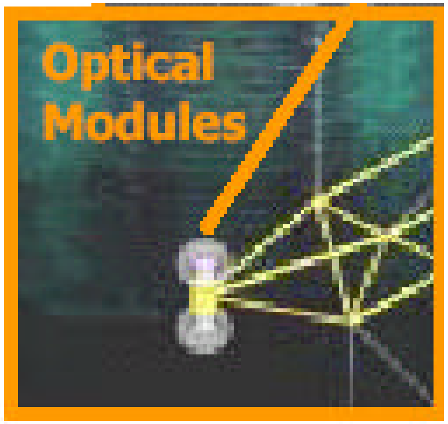
Incorporate to the same generic detector PMTs of different sizes, grouping and orientation.

It seems that the generic GRID detector is not the way to proceed !

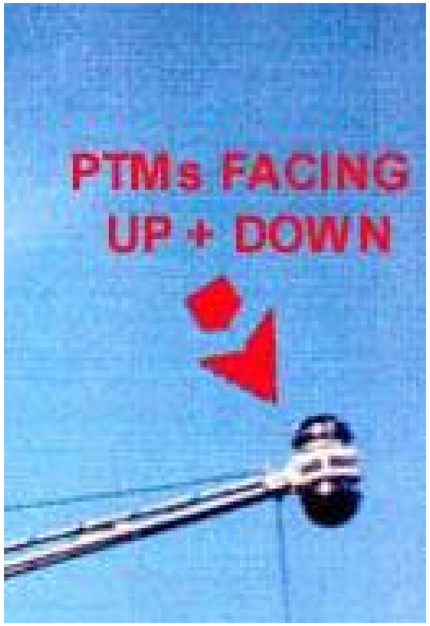
ANTARES



NEMO



NESTOR



The "obvious" way to proceed

Define the values of the relevant environmental parameters, for the candidate sites, based on published data (water optical properties, K40 background, bioluminescence activity, bio-fouling, atmospheric background fluxes and absorption)

Simulate the response of an optimum detector (at a given site) to e, μ and t (vertices). Events are produced equal (or almost equal) probably in phase space.

Use standard tools to simulate the physics processes. Include in the simulation the K40 background.

Simulate in detail the OM response and ignore effects of (in a first approximation will be the same to all the different designs) the readout electronics, triggering and DAQ.

Produce "event tapes" including the "generation" information and the detector response (e.g. deposited charge and arrival time of each PMT pulse). The "event tapes" and the relevant data basis should be available to the other groups.

Reconstruct the events and produce DST's including the "generation" and reconstructed information (e.g. direction, impact parameter, flavor, energy) for each event. The DSTs should be available to the other groups.

Produce tables (Ntuples) to express the tracking efficiency and resolution as a function of the direction and energy (and impact parameter)

We can factorize our studies

The detector response to every (signal or background) Physics channel can be estimated by:

convoluting the differential fluxes and cross sections with the differential efficiency or/and resolution of the detector, using the DST's or the NTUPLES

- Estimate effects due to the degradation of the OM transparency and efficiency
- Bioluminescence effects are trivially estimated as a shortening of the active experimental time

However . . .

The expected differential cross sections and fluxes could be used to weight the production of simulated events.

Detector looking downwards ±50º around Nadir