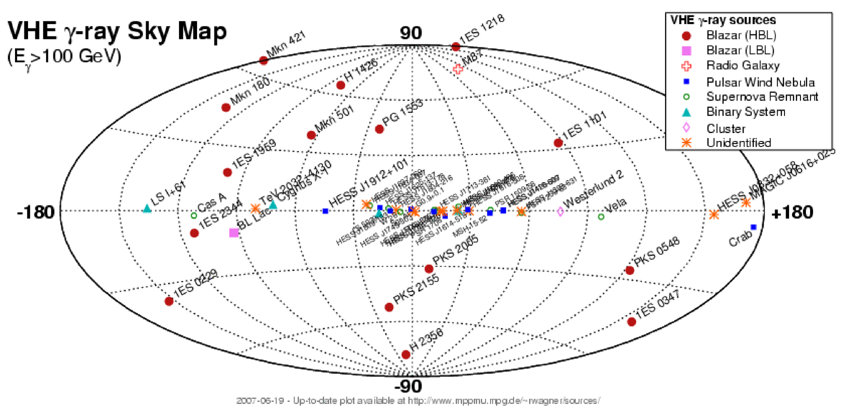
Sensitivity study for the cubic-kilometre deep-sea neutrino telescope - KM3NeT

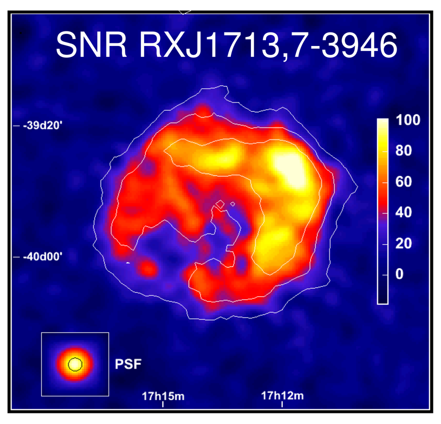
J. Carr[1], D. Dornic[1], F. Jouvenot[2], U.F. Katz[3], S. Kuch[3], G. Maurin[4], R. Shanidze[3] for the KM3NeT consortium

[1] CPPM – Centre de Physique des Particules de Marseille, CNRS/IN2P3 – France
[2] University of Liverpool, Oliver Lodge Laboratory - United Kingdom
[3] University of Erlangen-Nuremberg, Physics institute - Germany
[4] CEA Saclay - DSM/DAPNIA – Service de Physique des Particules - France

Introduction

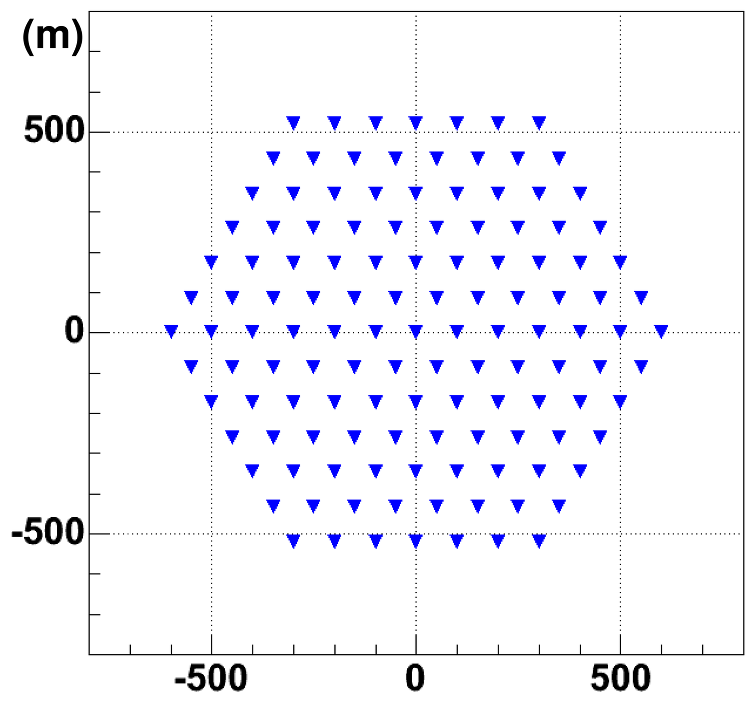
Most models of astrophysical source predict HE neutrinos emission. Stable and neutral, they can propagate through the Universe unaffected. Recent results from TeV gamma-ray astronomy indicate that **at least a km³ scale detector** is needed to detect potential neutrino sources (AGN, GRB, PWN, SNR...)

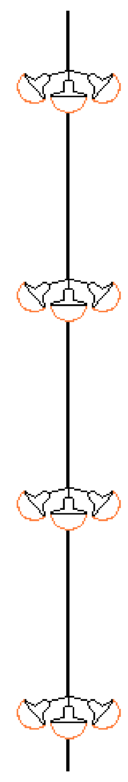




Today, the European consortium, KM3NeT, works on a design study for a large deep-sea neutrino telescope. Placed in the northern hemisphere (Mediterranean sea), it will survey a large part of the Galaxy, including Galactic Centre and be complementary with the IceCube telescope currently in construction in the South Pole.

Configuration 1: hexagonal





127 strings (6 crowns)	25 storeys	Optical module (OM)
spaced by 100 m	spaced by 15 m	3 x 10'' PMTs
		Orientation: π/4

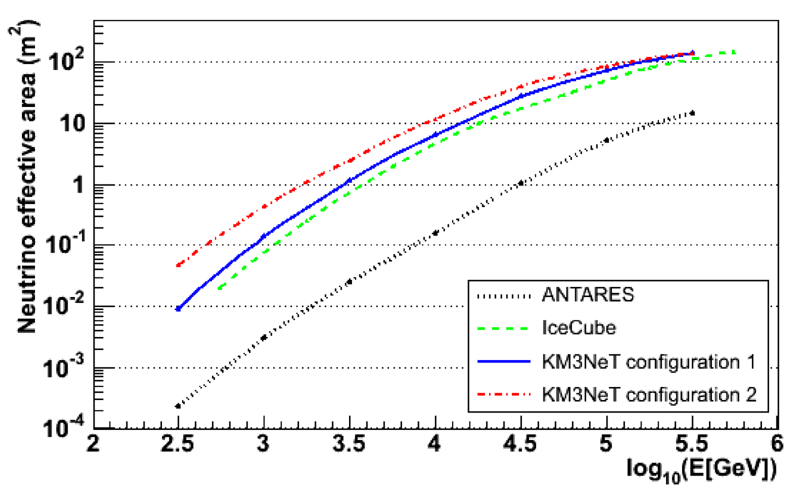
(J. Carr et al, this conference)

Neutrino effective area

Obtained after a full simulation and reconstruction chain

Configuration 1:
- Instrumented volume: 0.36 km³
- photo-cathode = 4 390 m² (9 525 x 10'' PMTs)

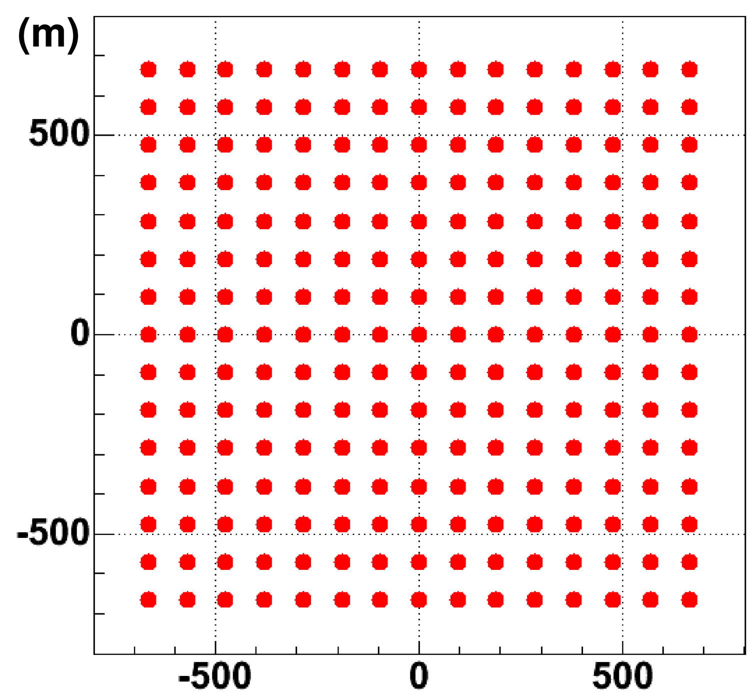
Configuration 2:
- Instrumented volume: 1.2 km³
- photo-cathode = 7 050 m² (170 100 x 3'' PMTs)

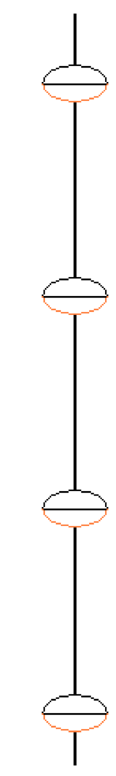


Angular resolution: < 0.2° for the two configurations

For a generic E^{-2} sources, the sensitivities in 1 year data taking are:
- Config. 1: 2.4×10^{-12} TeV^{-1} cm^{-2} s^{-1} ≈ 100 ANTARES sensibility
- Config. 2: 7.7×10^{-12} TeV^{-1} cm^{-2} s^{-1}

Configuration 2: multi-PMTs





225 strings (15 x 15)	36 storeys	1 multi-PMT
spaced by 95 m	spaced by 16.5 m	21 x 3'' PMTs

(S. Kuch, Nucl. Inst. Meth. A, 567, 2006)

Expected events from main galactic sources observed in TeV gamma-ray astronomy

Expected neutrino flux from TeV gamma-ray measurements:
- Pure hadronic model is assumed: high energy gamma rays produced only in p-p collisions
- Galactic sources: no significant absorption of γ radiations during their propagation
- After to neutrino oscillations, the number of ν_μ (including anti-neutrinos) from the source is equal to the number of gamma produce by π^0 disintegration
- For the background, only atmospheric neutrinos are simulated (no atmospheric muon)
- Extended sources (high background from atmospheric neutrinos)

$$\varphi(E) = k_\nu \left(\frac{E}{1TeV}\right)^{-\alpha} \exp\left(-\sqrt{\frac{E}{\varepsilon}}\right)$$

k_ν : flux normalisation factor

α : spectral index

ε : cut-off energy

					N_υ / N_{atm} with $E_\upsilon > 1$ TeV after 5 year			
					Detection		Reconstruction	
Source Name	$\phi(\circ)$	κ_υ	Γ_υ	ϵ_υ	Conf. 1	Conf. 2	Conf. 1	Conf. 2
Vela X	0,80	11,75	0,98	0,84	5.0 / 4.2	23.6 / 34.0	2.1 / 1.9	10.0 / 13.0
RXJ1713.7-3946	1,30	15,52	1,72	1,35	3.4 / 17.3	15.8 / 61.0	1.4 / 8.1	6.4 / 23.3
RXJ0852.0-4622	2,00	16,76	1,78	1,19	3.5 / 43.3	15.8 / 154.5	1.4 / 19.6	6.4 / 59.0

In conclusion, we need few 10 years to detect extended galactic sources like SNR and PWN.

➡ **The detector needs to be bigger than 1 km³**

Contacts: ddornic@cppm.in2p3.fr
gilles.maurin@cea.fr

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