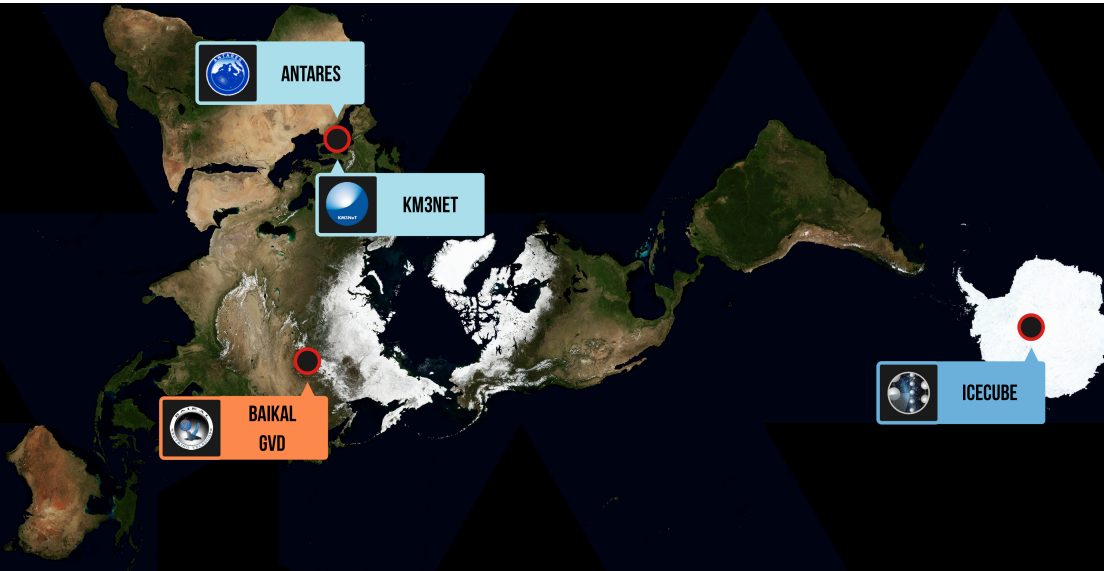


Status and perspectives of KM3NeT

piera sapienza

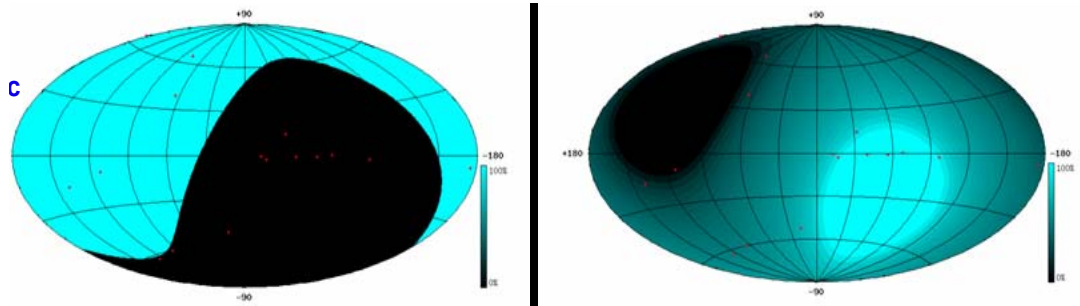
LNS user committee 11 december
2018

High energy neutrino telescopes

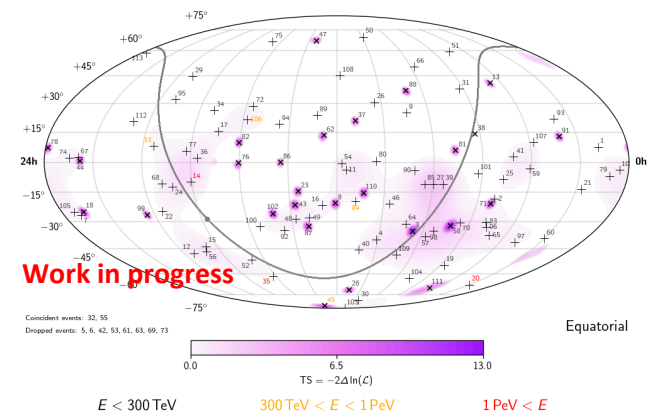


- IceCube 1 km³ running => first evidence of HE cosmic neutrino in 2013
- Antares 0.01 km³ running
- KM3NeT in construction (1 km³)
- Baikal in construction (1 km³)

Visibility for upgoing ν_μ from South Pole (left) and Mediterranean Sea (right)

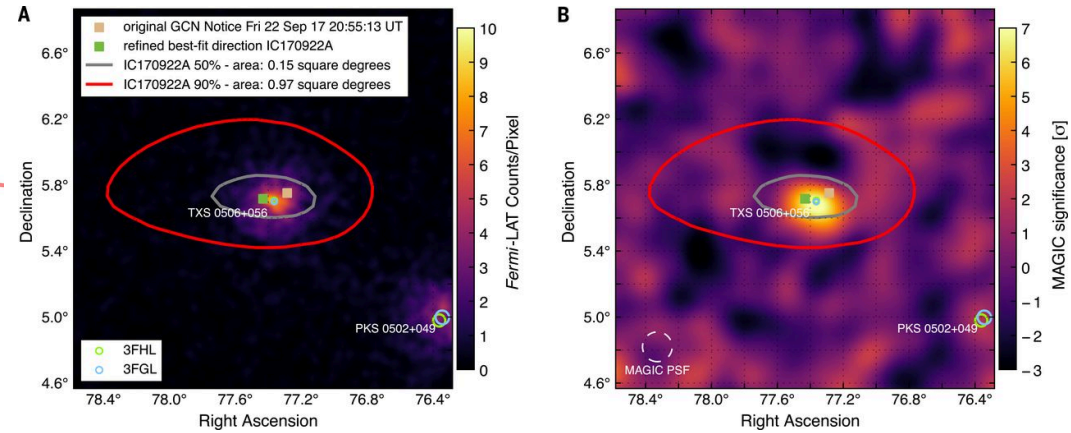
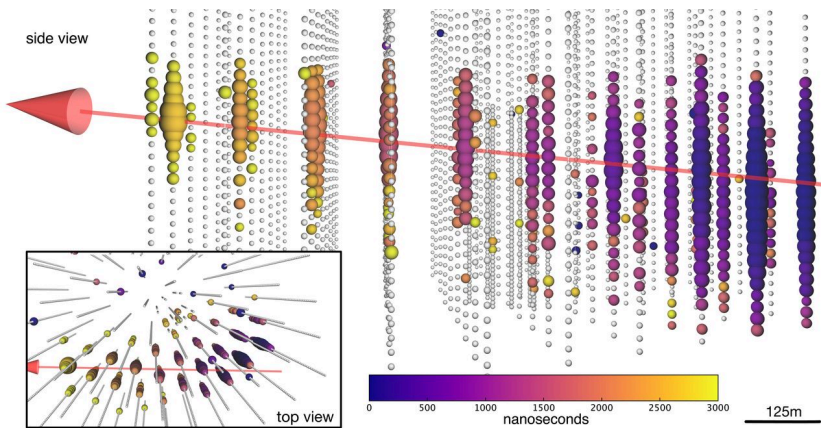


ICECUBE SKY MAP



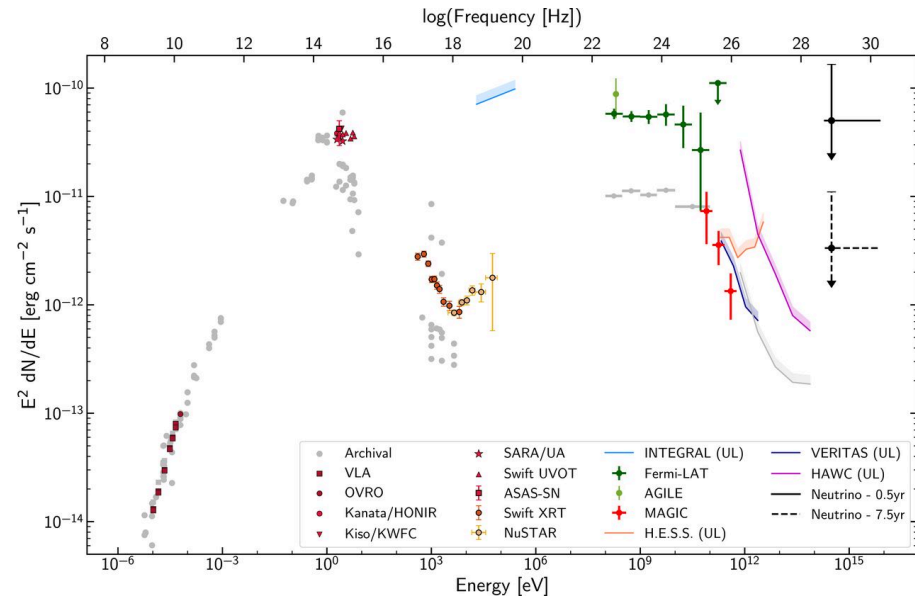
Multimessenger ν astronomy

The IceCube Collaboration et al. Science 2018;361:eaat1378



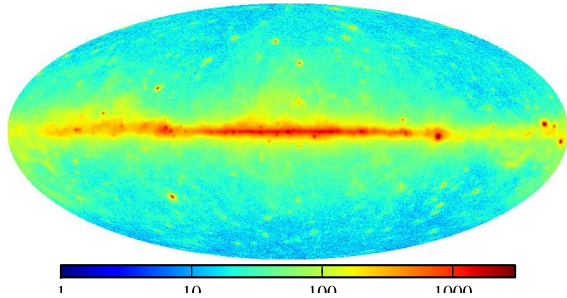
Alert sent by IceCube on 22 September 2017

The coincident observation of a IceCube high energy neutrino with gammas from Fermi and Magic indicate, with 3σ significance, that blazars may be sources of cosmic rays

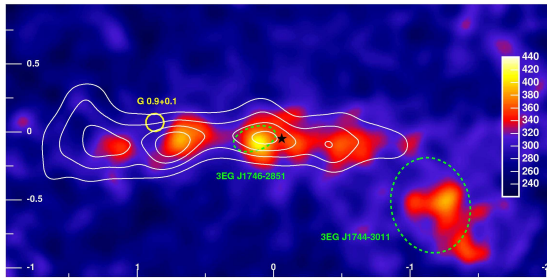


Antares limits on ν flux from point-like sources and Galactic Ridge

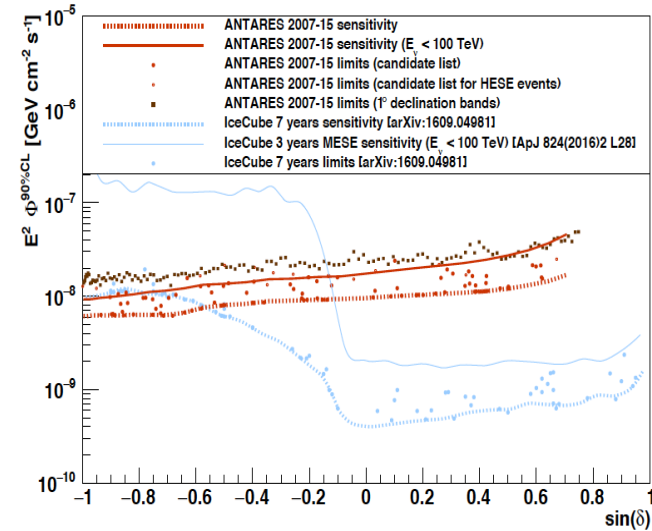
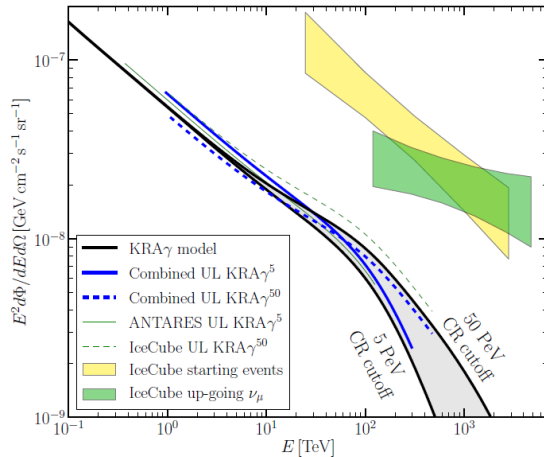
Enhanced γ emission observed in Fermi data and also by HESS around the Galactic Center



Fermi-LAT - M. Ackermann et al. *Astrophys. J.*, 2012



HESS- F. Aharonian et al. *Nature*, 2006



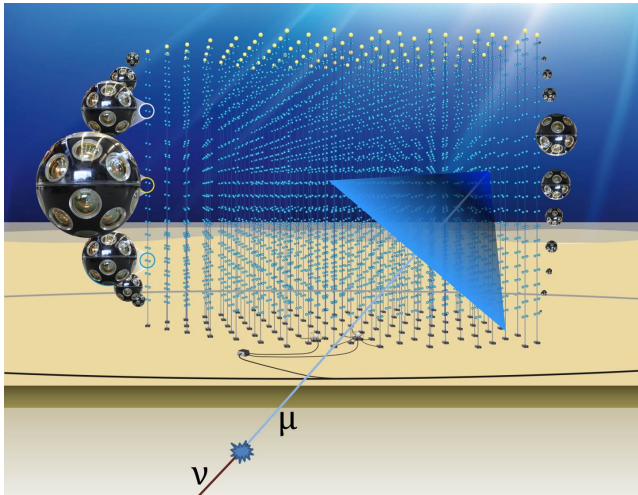
Antares puts the strongest limits in a large part of the southern hemisphere, especially at high energy

All flavour GR neutrino search ANTARES with 9 years data taking (2007-2015) show upper limit close to KRA- γ model with 50 PeV cut off and put a limit on percentage of IceCube events from Galactic Plane

THE KM3NET TELESCOPE

KM3NeT is a network of neutrino telescopes, using the same technology, under construction in the deep Mediterranean Sea aiming at

- observe high energy cosmic neutrinos and discover their sources with KM3NeT/ARCA @ 3500 m depth off shore Capo Passero, Italy
- determine Neutrino Mass Hierarchy with KM3NeT/ORCA @2500 m depth off shore Toulon, France

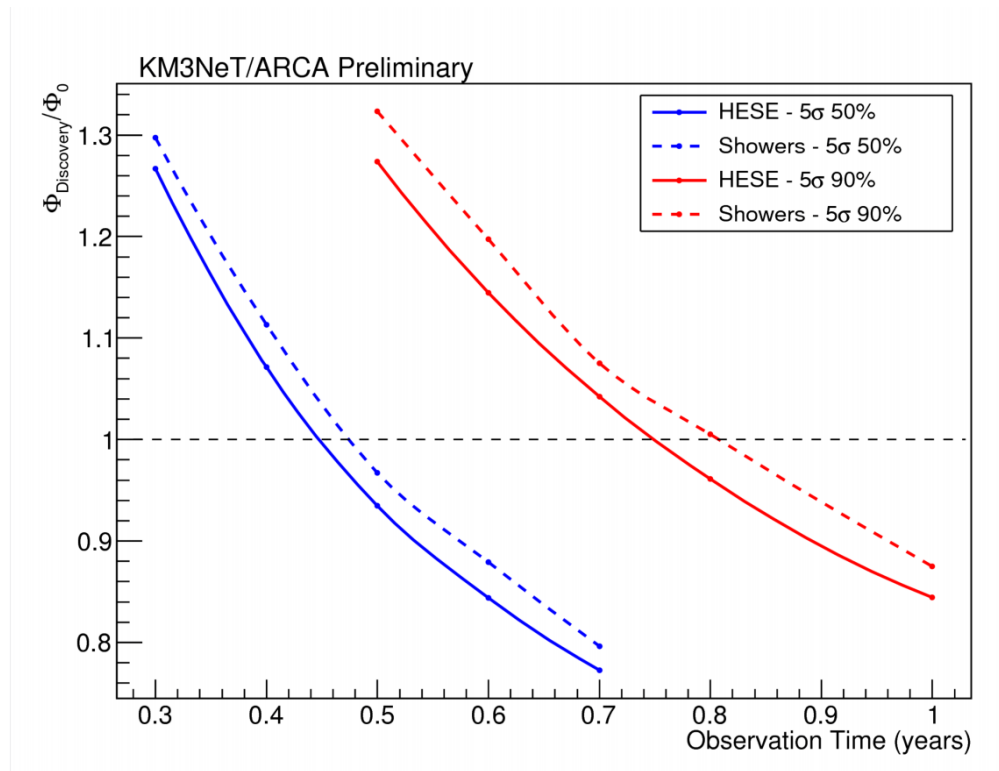


ARCA - 1 km³ of sea water equipped with a 3D array of innovative optical sensors (multi-PMT)

- two building blocks of 115 Detection Units (DU)
 - each DU hosts 18 multi-PMT Digital Optical Modules (DOM) with 36 m spacing
 - a backbone cable with breakouts at DOMs distributes power and data
- Sea network of submarine cables and Junction Boxes provide power and data transmission to shore via a main electro-optical cable
- All data to shore data transmission
- KM vs IC

Very hostile environment due to huge pressure (350 bar), corrosion, very difficult access (installation, maintenance) ...

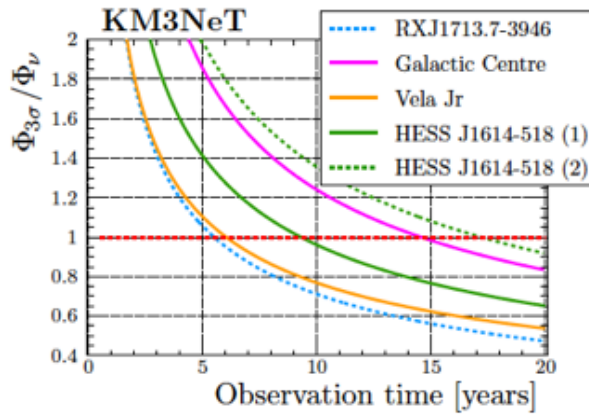
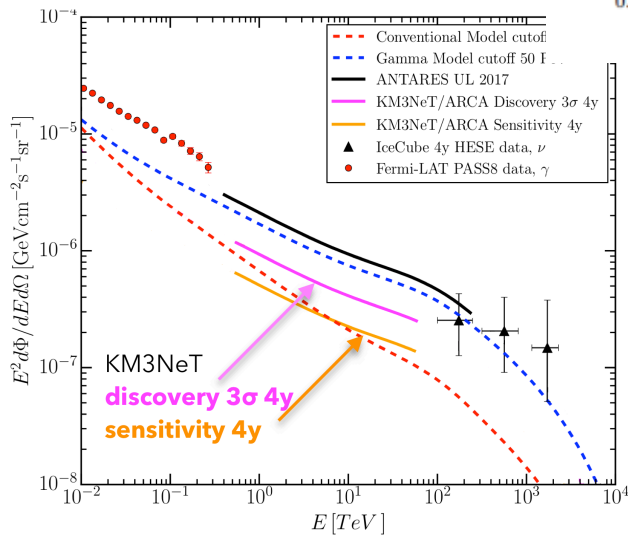
KM3NeT sensitivity to IceCube neutrino flux



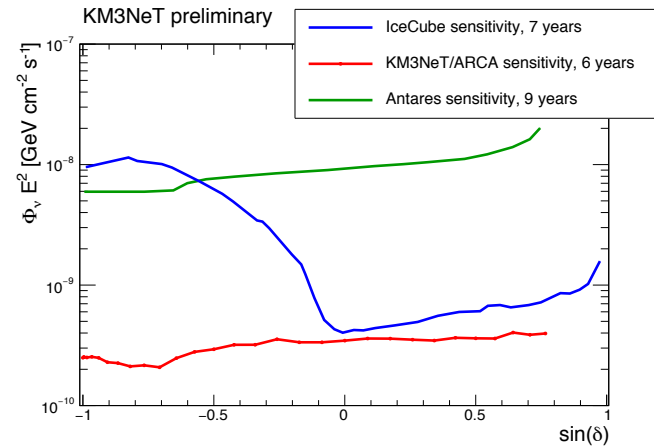
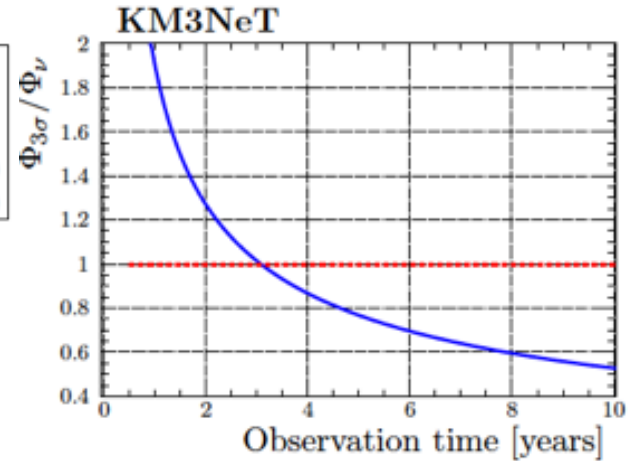
Discovery at 5 σ significance (50% probability) in few months with combined analysis
KM3NeT Letter of Intent

Galactic ridge, galactic sources and extragalactic point-like sources

Neutrino flux estimates from high energy gamma measured gamma flux (Vissani et al.) for several galactic sources



Discovery potential at 3 σ



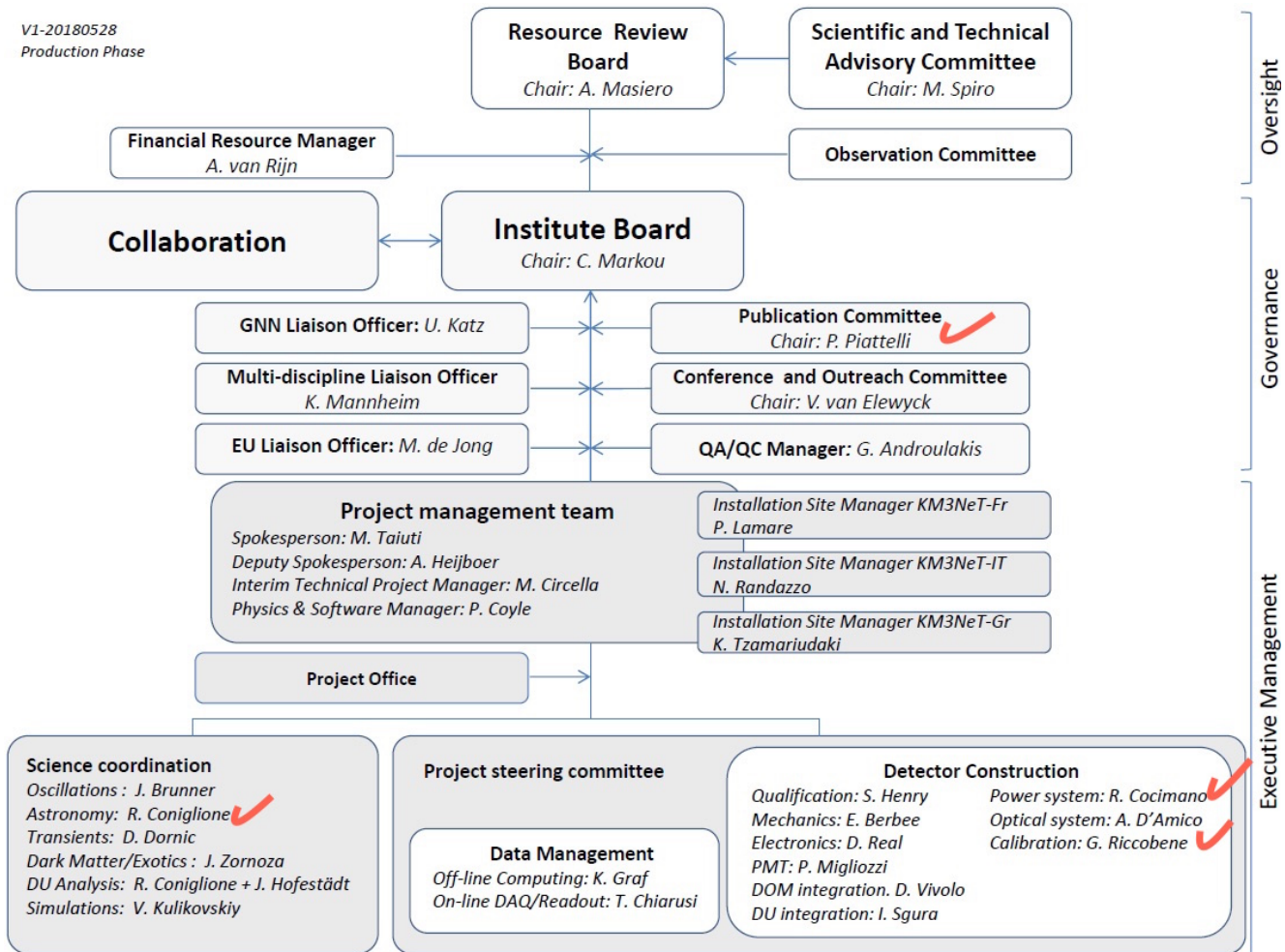
ARCA will survey almost the whole sky with a discovery potential @ 5 σ about one order of magnitude better than IceCube in the Southern hemisphere for equivalent exposure

Collaboration and integration sites



KM3NeT Organigram

VI-20180528
Production Phase



Detection Unit integration at LNS: P. Sapienza
 Detector operation at Capo Passero: S. Biagi
 ARCA Data analysis: S. Biagi and R. Coniglione

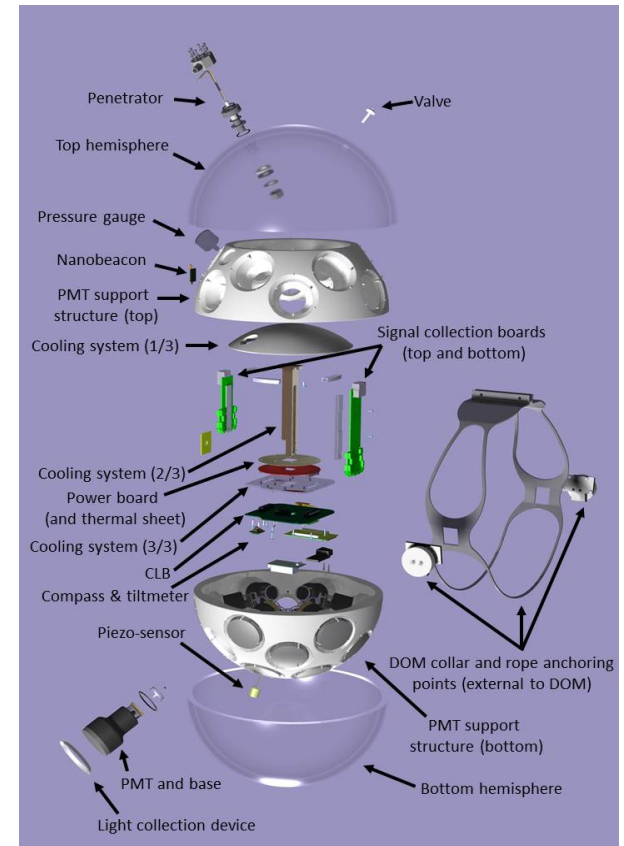
KM3NeT Digital Optical Module (DOM)



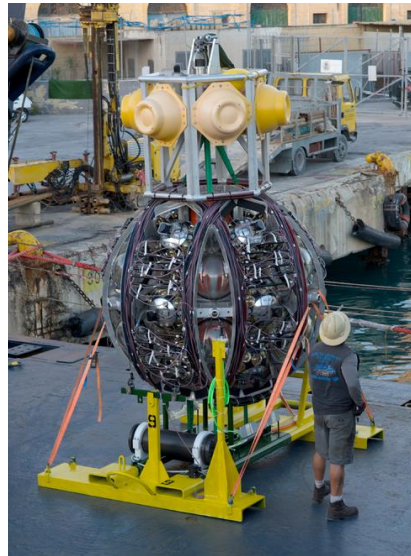
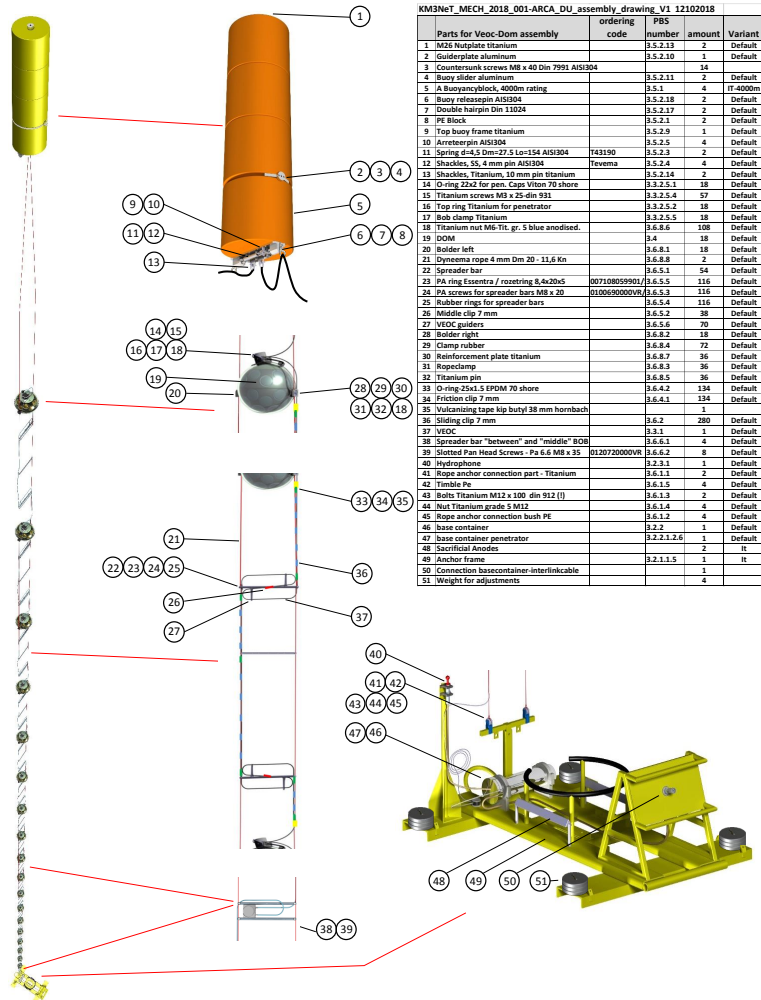
← 17" →

- Digital photon counting
- Improved rejection of optical background
- Directional information and wide angle of view
 - high acceptance (nearly 4π)
 - good reconstruction (also for down-going events)
- Compact and cost effective design: 1 DOM equivalent to 3 Antares/IceCube OMs
- Photocathode Area ARCA = 2.35 X IceCube

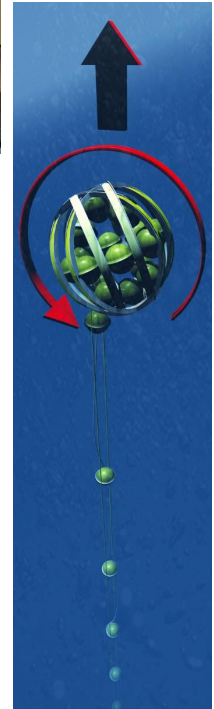
- 31 x 3" PMTs
- LED & acoustic piezo inside
- Tiltmeter/compass
- Gbit/s fibre DWDM
- Hybrid white rabbit



KM3NeT DETECTION UNIT (DU)



LOM
 deployed to seabed
 Released
 by ROV
 Unfurled
 Frame
 recovered



The KM3NeT/ARCA detector

12

To be installed in the Italian site of the KM3NeT infrastructure

115 detection units per building block

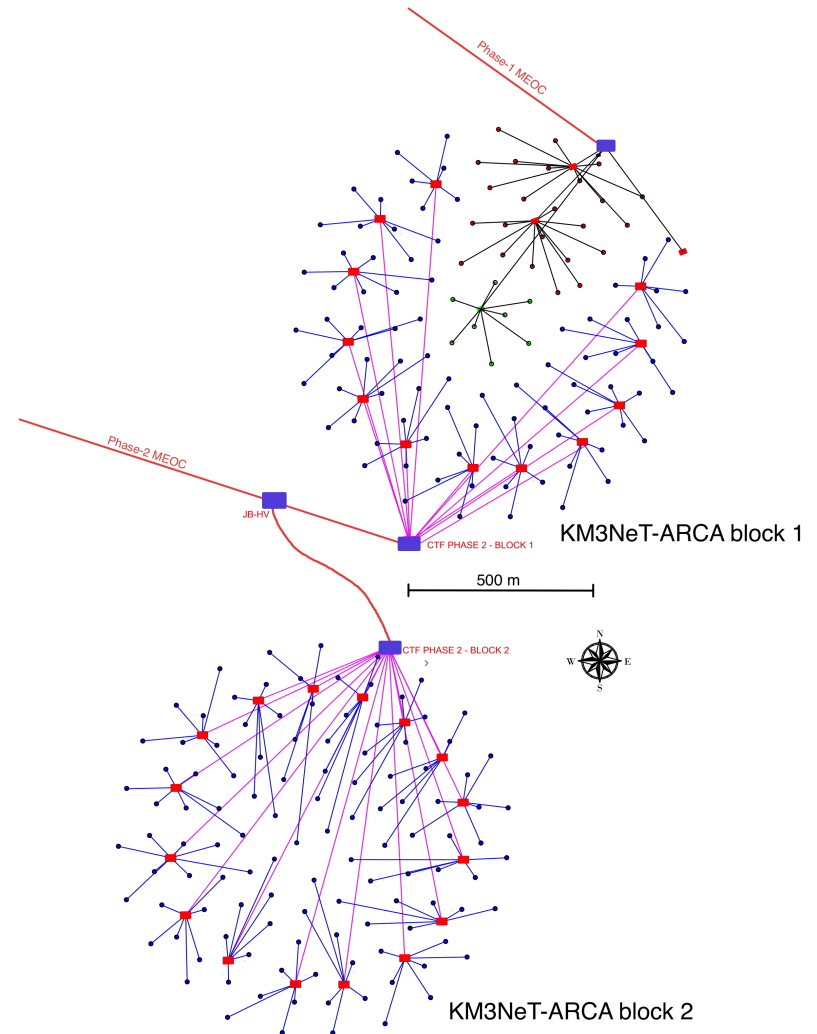
18 DOM per DU

Vertical DOM spacing 36 m

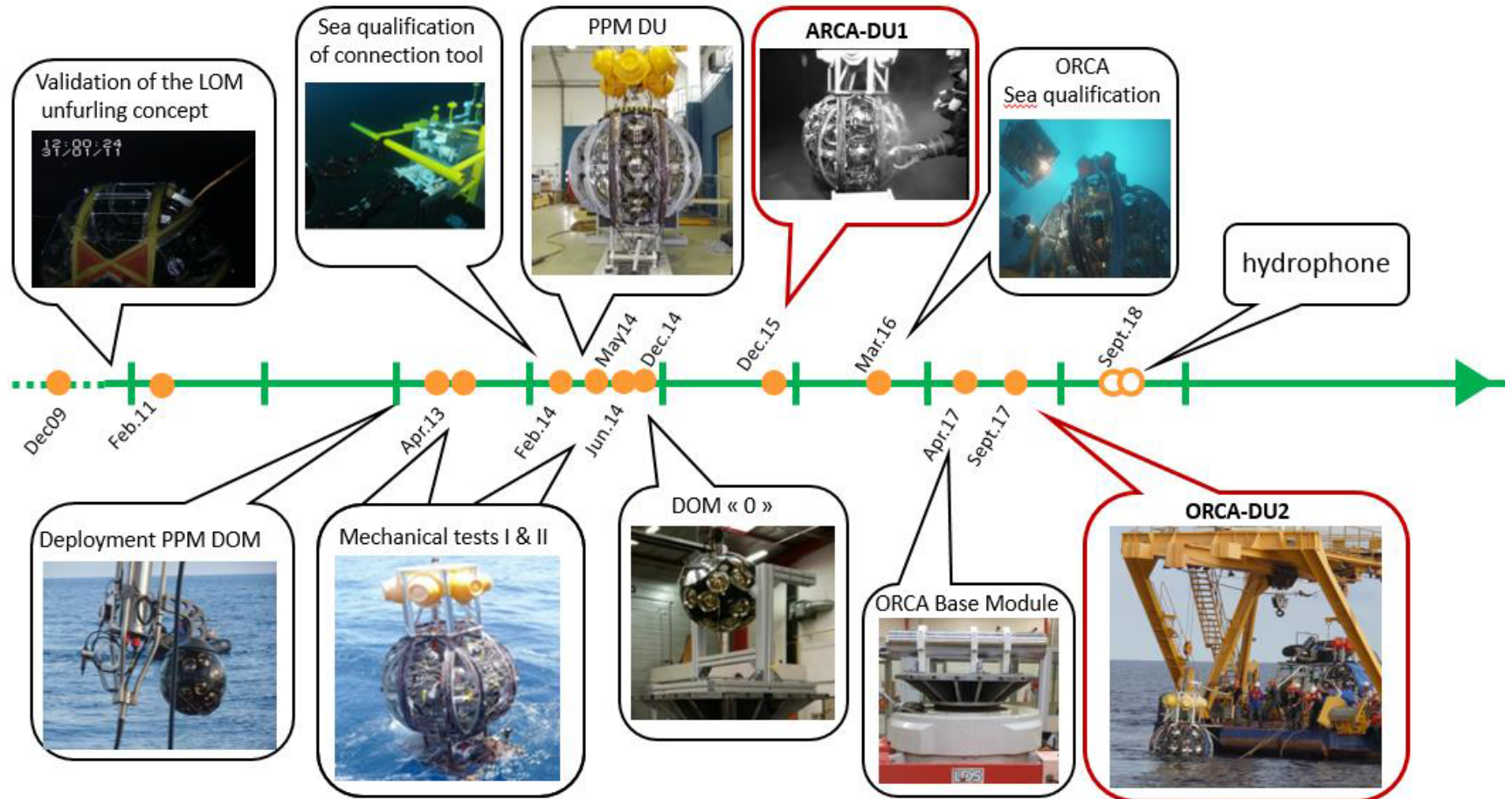
Inter-DU spacing 90 m

2 building blocks

Total volume $\approx 1 \text{ km}^3$



Validation, construction, reviews => mass production

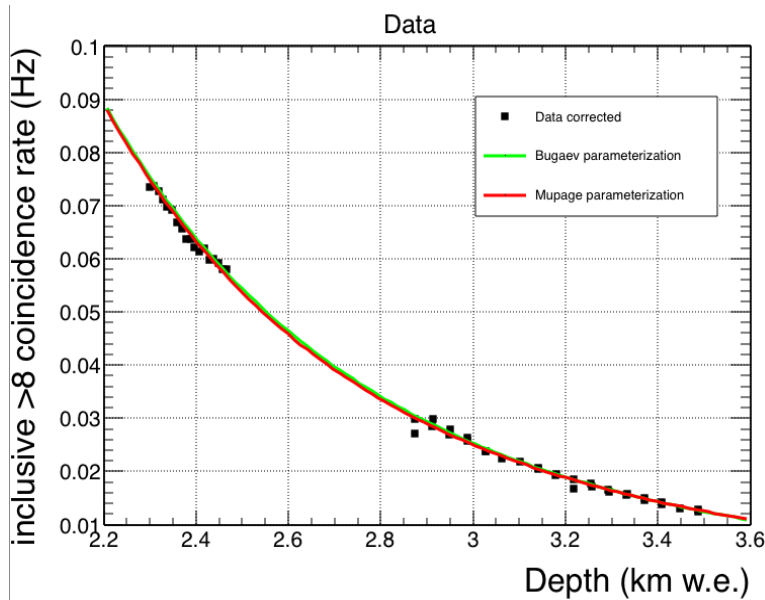


Main activities at LNS

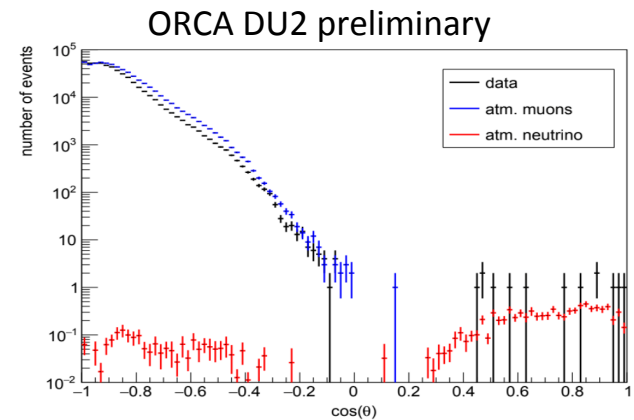
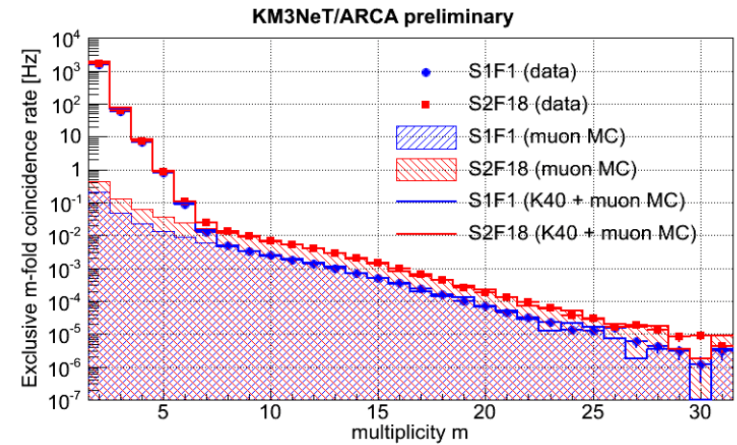
- Simulation and data analysis
- ARCA operation, data transmission and data taking
- Power system design production and tests, PFE
- ARCA Sea floor network
- DU integration
- Calibration
- Establishment of an ERIC as legal entity for KM3NeT
- ...

KM3NeT - atmospheric events

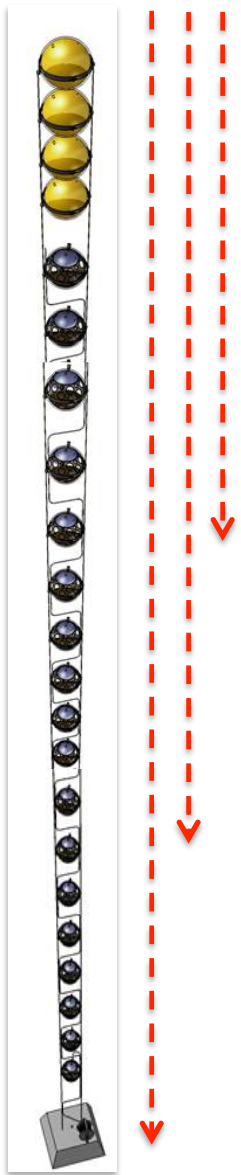
Two ARCA DUs installed at nominal position at 3500 m depth more than one year
 data collected data analysis in progress system off due to short circuit



DOM rate for $m \geq 8$ as a function of the depth of DOM => atmospheric muons flux depth dependence



ORCA DU2 recovered to repair cable



Status and perspectives

- Two ARCA DUs have been installed in Capo Passero
 - sea campaign foreseen in early January to recover functionality after a short cut occurred in 2017
- One ORCA DU was installed in Toulon in September 2017
 - to be redeployed after repair of main cable (December 2018)
- Data analysis on atmospheric muons (and neutrinos) ongoing
- Mass production will start soon incorporating review outcome

Conclusions

- Neutrino telescopes provide a unique probe for high energy Universe and neutrino physics
- IceCube discovered a cosmic neutrino flux and detected the first neutrino HE event in coincidence with gamma telescopes (plus follow-up in several other wavelenght)
 - Coincidence with Gravitational Waves not detected yet
- KM3NeT will measure neutrinos with unprecedented angular resolution and large sky coverage including most of galactic plane and Galactic Center
- Mass production and detector installation is the main effort of the collaboration in the near future and LNS has key roles and responsibilities in almost all the items