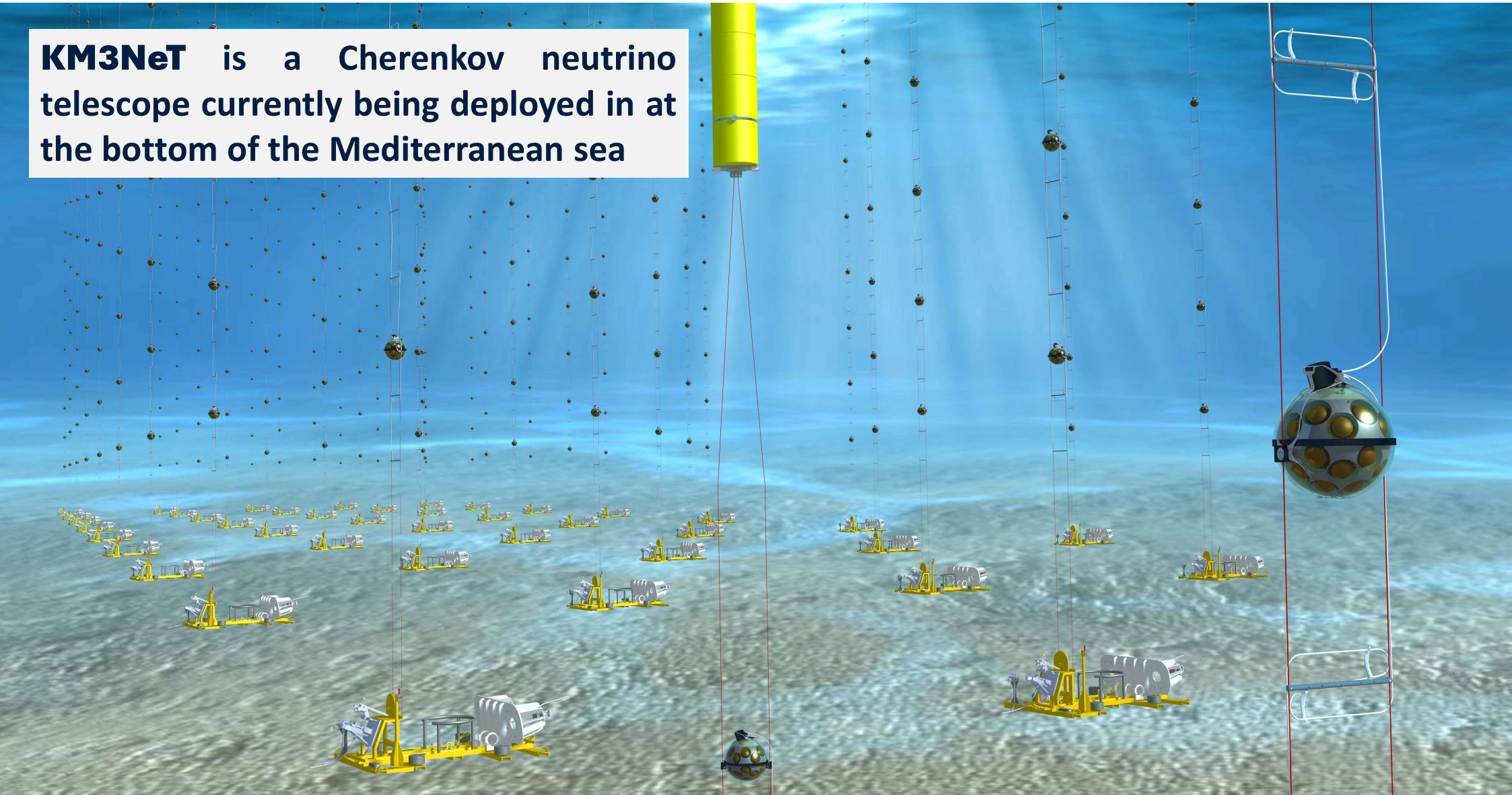
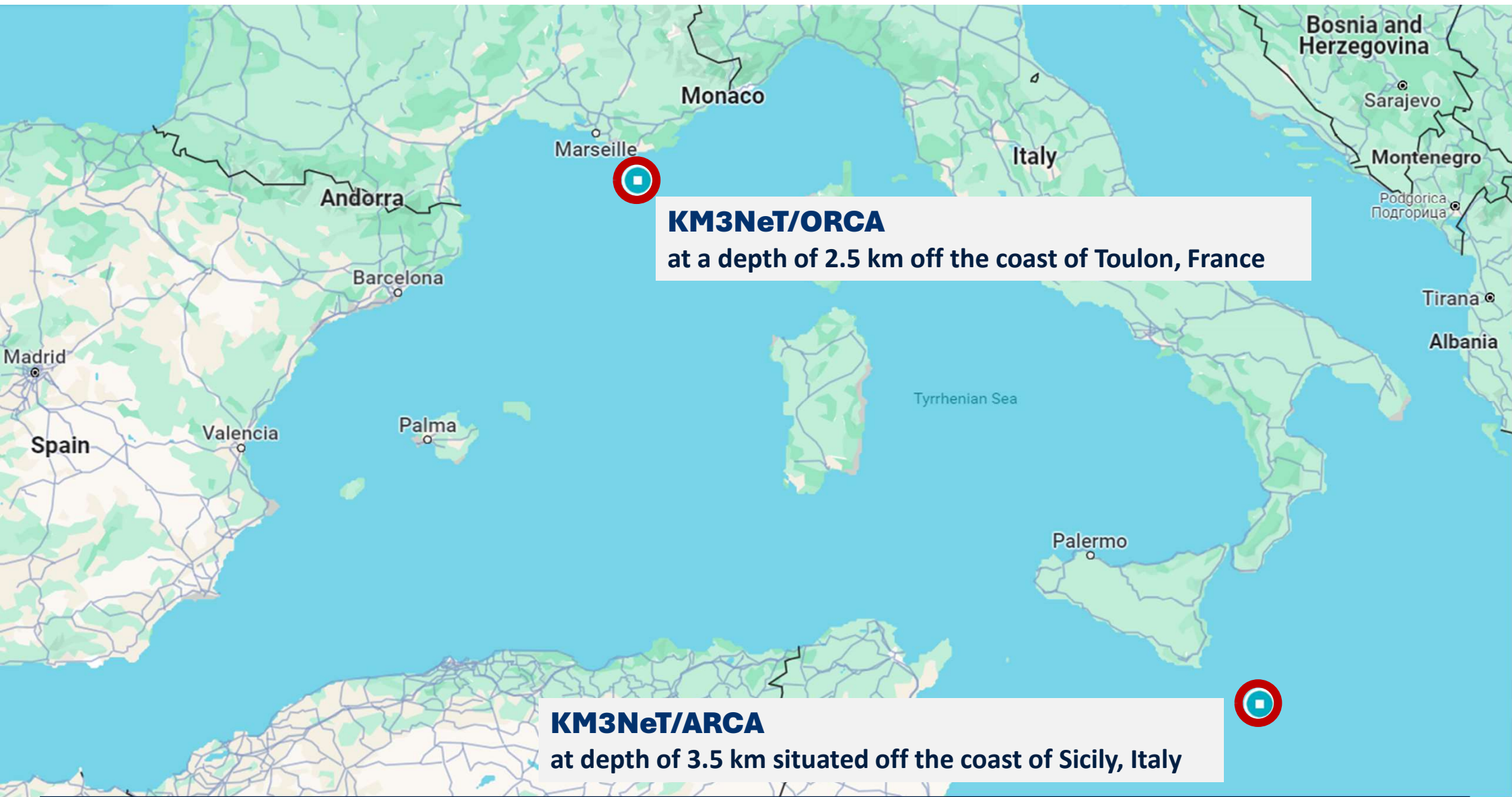


KM3NeT RESULTS AND ONGOING EFFORTS

J. Mauro
G. de Wasseige

KM3NeT is a Cherenkov neutrino telescope currently being deployed in at the bottom of the Mediterranean sea





KM3NeT/ORCA

at a depth of 2.5 km off the coast of Toulon, France

Physics Goal: Oscillations, Low-energy astro

KM3NeT/ARCA

at depth of 3.5 km situated off the coast of Sicily, Italy

Physics Goal: High-energy astro

KM3NeT/ORCA

at a depth of 2.5 km off the coast of Toulon, France

Physics Goal: Oscillations, Low-energy astro

Size: 1 building block (115 lines)

KM3NeT/ARCA

at depth of 3.5 km situated off the coast of Sicily, Italy

Physics Goal: High-energy astro

Size: 2 building blocks (230 lines)

KM3NeT/ORCA

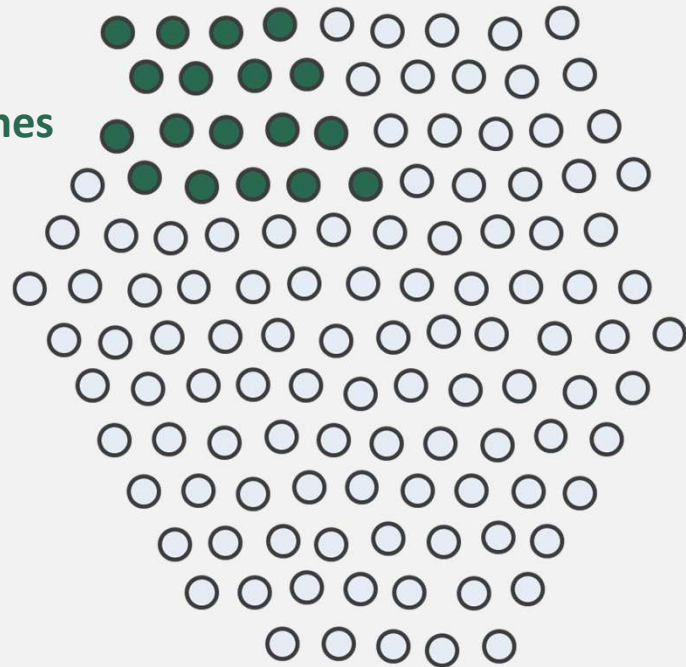
at a depth of 2.5 km off the coast of Toulon, France

Physics Goal: Oscillations, Low-energy astro

Size: 1 building block (115 lines),

Status:

18 lines



KM3NeT/ARCA

at depth of 3.5 km situated off the coast of Sicily, Italy

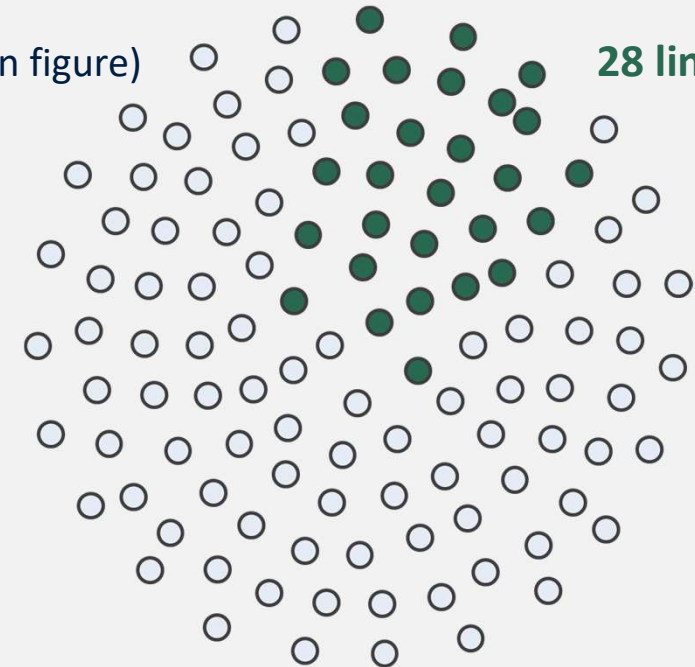
Physics Goal: High-energy astro

Size: 2 building blocks (230 lines),

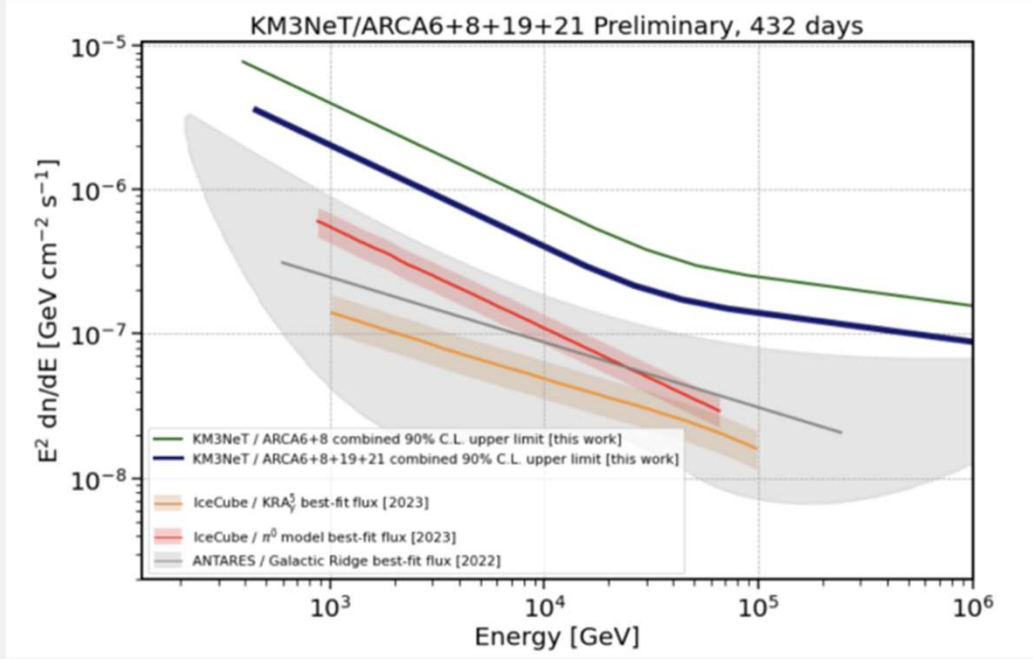
Status:

(1 block in figure)

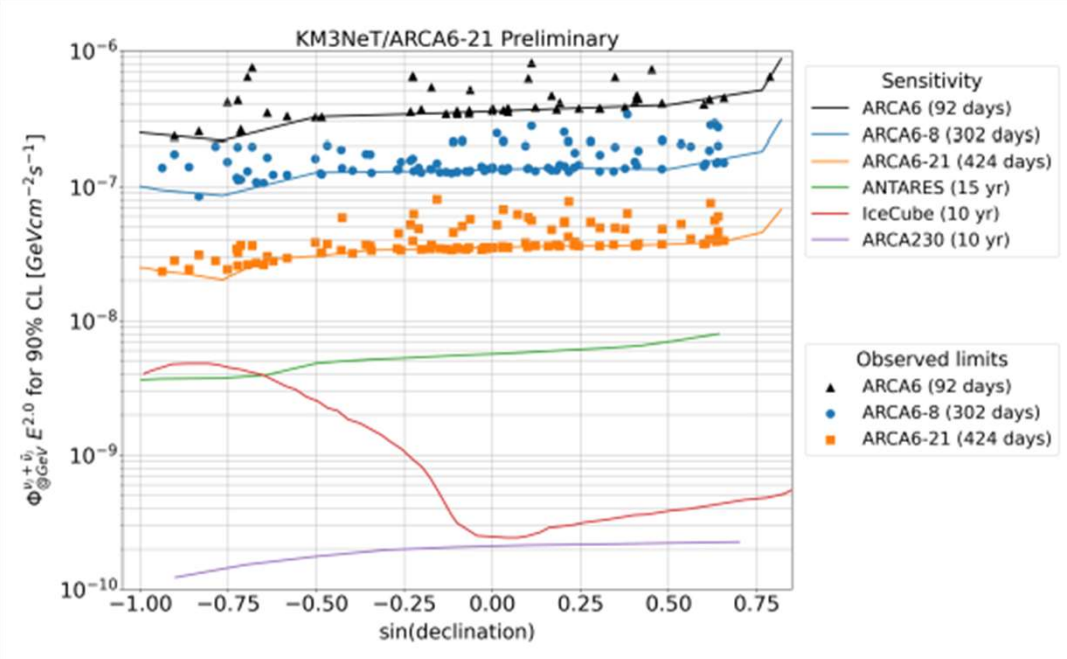
28 lines



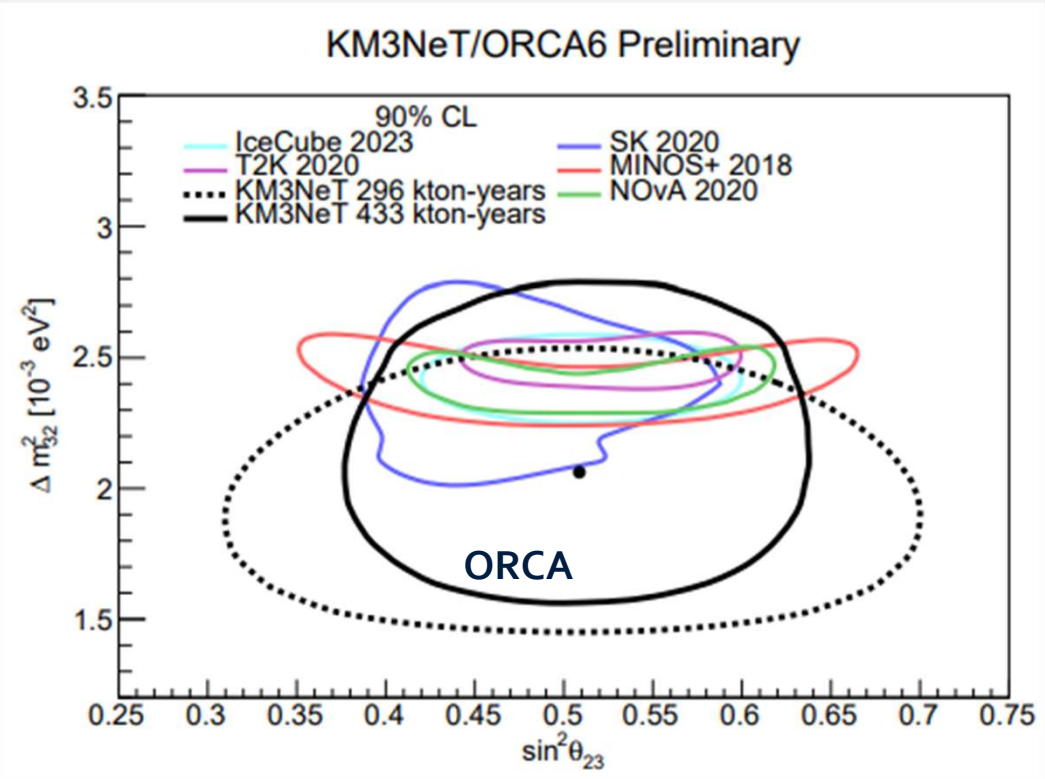
Search for a diffuse astrophysical neutrino flux from the Galactic Ridge using KM3NeT/ARCA data (2023)



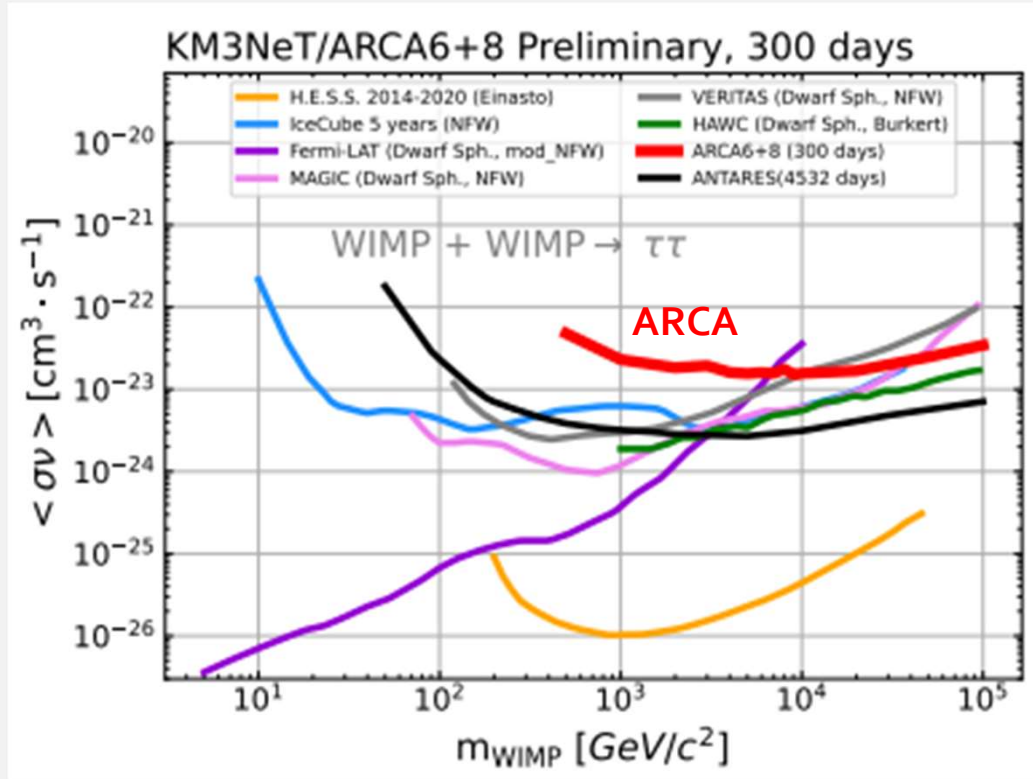
Search for cosmic neutrino point sources and extended sources with 6-21 lines of KM3NeT/ARCA (2023)



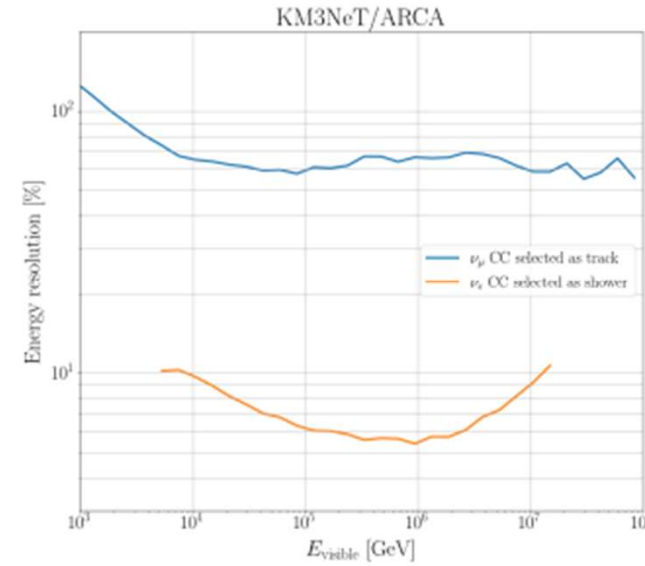
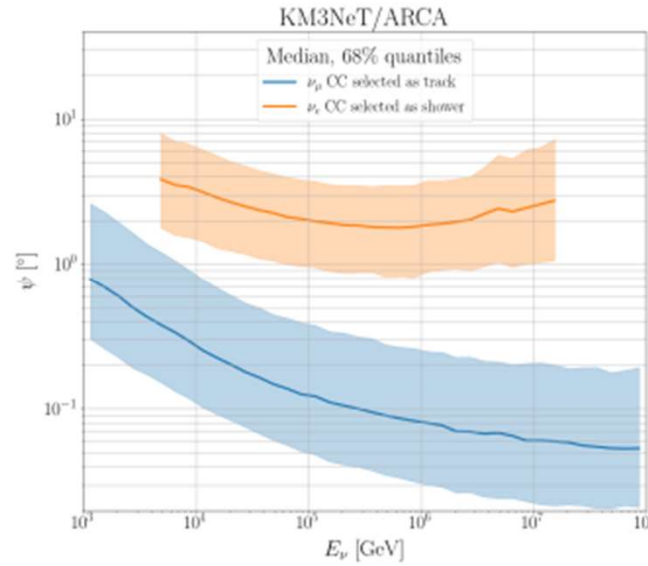
Determining the neutrino mass ordering and oscillation parameters with KM3NeT/ORCA (2023)



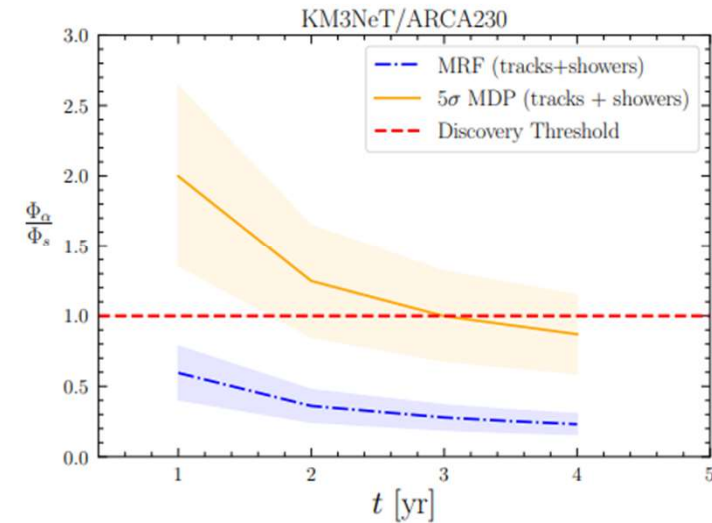
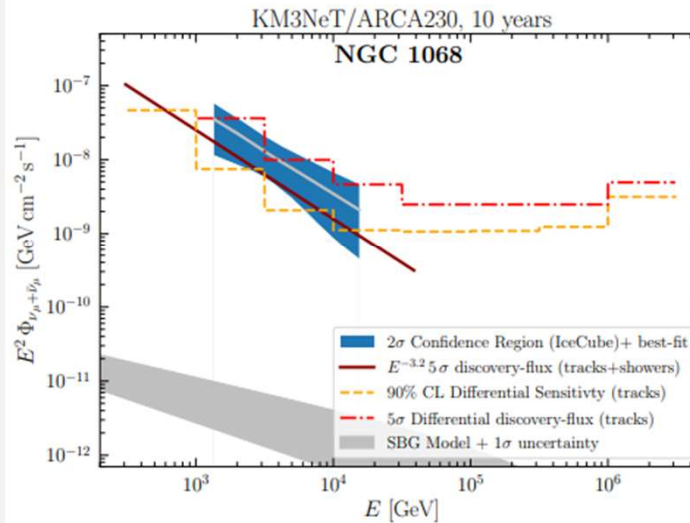
Indirect Search for Dark Matter with the KM3NeT Neutrino Telescope (2023)



Astronomy potential of KM3NeT/ARCA (2024)



Differential Sensitivity of the KM3NeT/ARCA detector to a diffuse neutrino flux and to point-like source emission: exploring the case of the Starburst Galaxies (2024)



Observer status
2021-2024

Full Membership
since 2024

Funded by  **fnrs**
LA LIBERTÉ DE CHERCHER

KM3NeT.be

2 Professors:

Gwenhaël de Wasseige (PI)

Vincent Lemaitre

1(+1) PostDocs:

Mathieu Lamoreux

Open position (Osc) (**Closed**)

1(+1) PhDs:

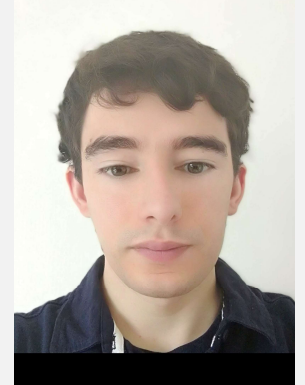
JM

Open position (nu + GW)

2 Technicians:

Jerome de Faverau

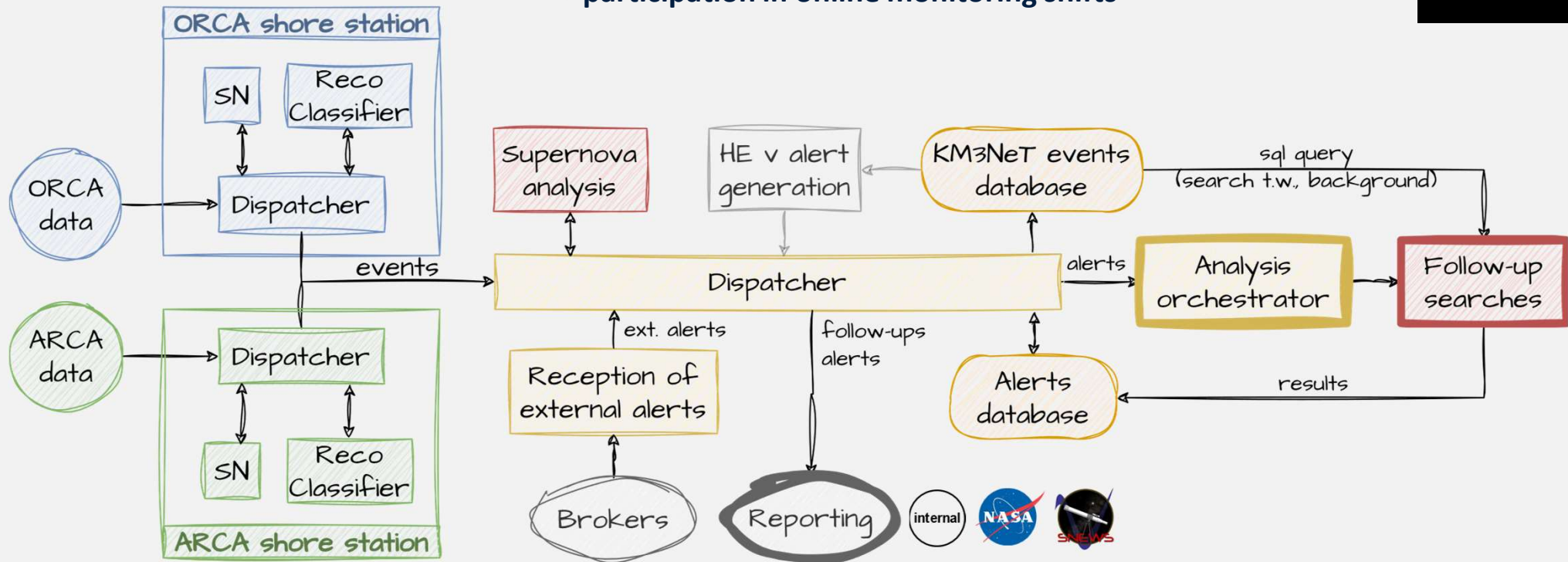
Pavel Demin



Realtime Multi-messenger framework

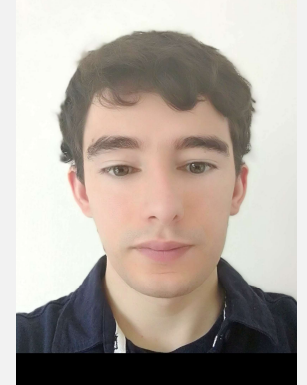
Quick searches for neutrinos in coincidence with external alerts (GRBs, GWs, IceCube v)

- Development of software orchestrating follow-ups + tool for shifters
- Definition of follow-up strategies (event selection, background estimation ...) + participation in online monitoring shifts



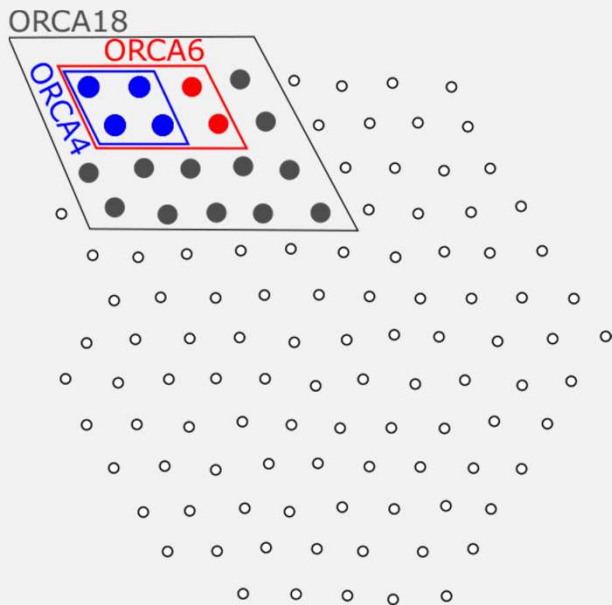
Astronomy with KM3NeT/ORCA detector

Mathieu Lamoureux

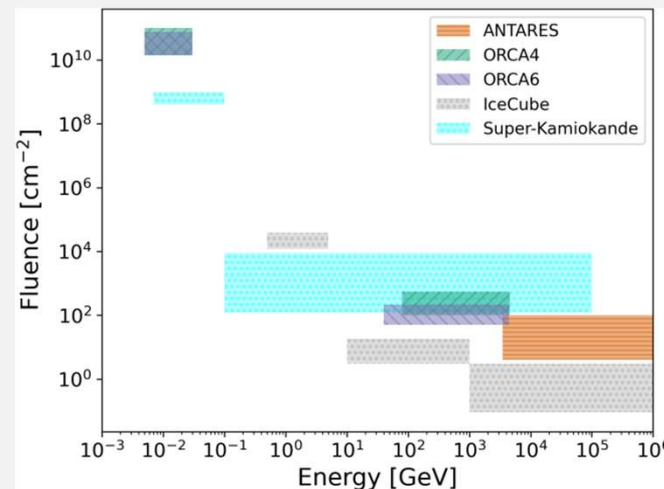


Follow-up of gravitational wave events during LVK 3rd Observing Run with ORCA4-6 using MeV neutrinos and upgoing tracks (GeV-TeV) [arXiv:2311.03804, JCAP].

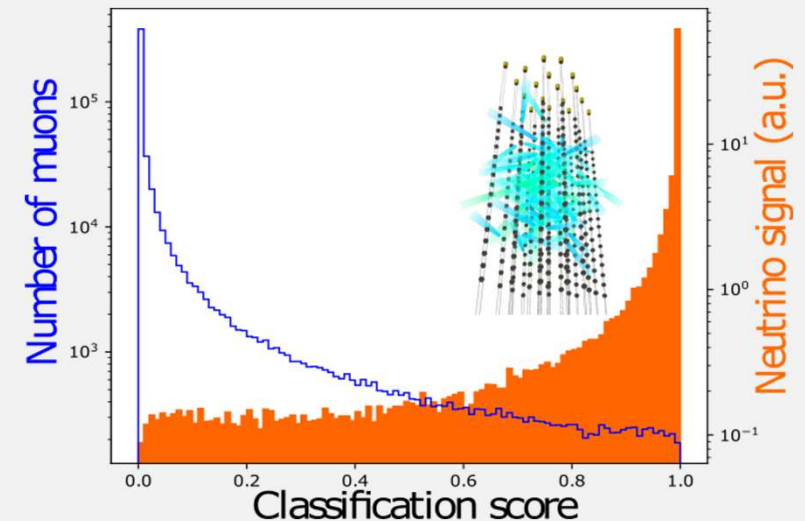
First selections of astrophysical downgoing track events and shower-like events with ORCA18 (to be used in point-source/transient searches)



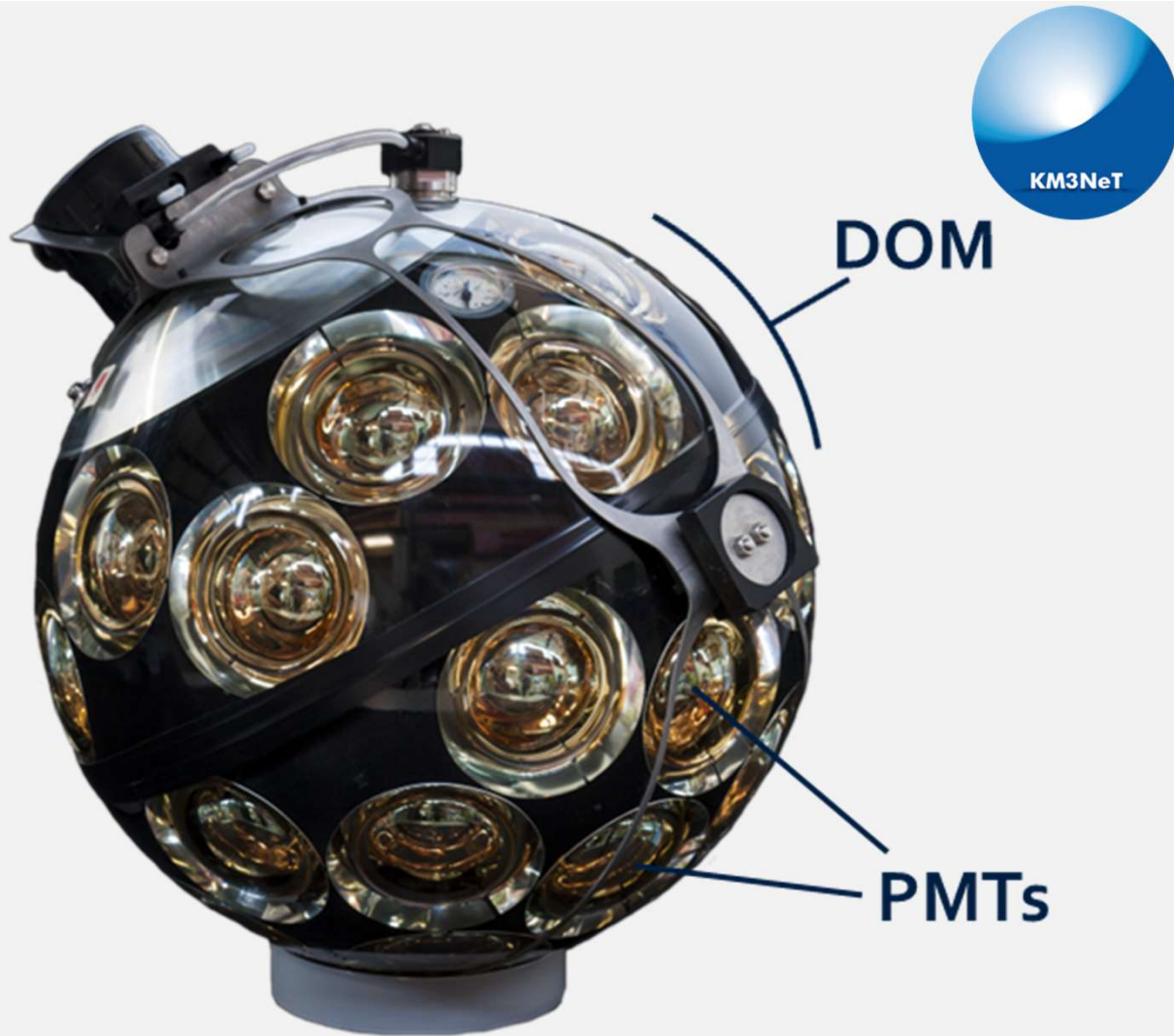
Limits on neutrino emission from O3 gravitational wave sources



Separation between atmospheric muons and neutrino showers



DATA MINING FOR LOW-ENERGY @UCL



KM3NeT's Digital Optical Module (DOM) is made of **31 3" PMTs**.

KM3NeT's DOM allows for better reconstruction at high energies, and for noise rejection at single-DOM level.

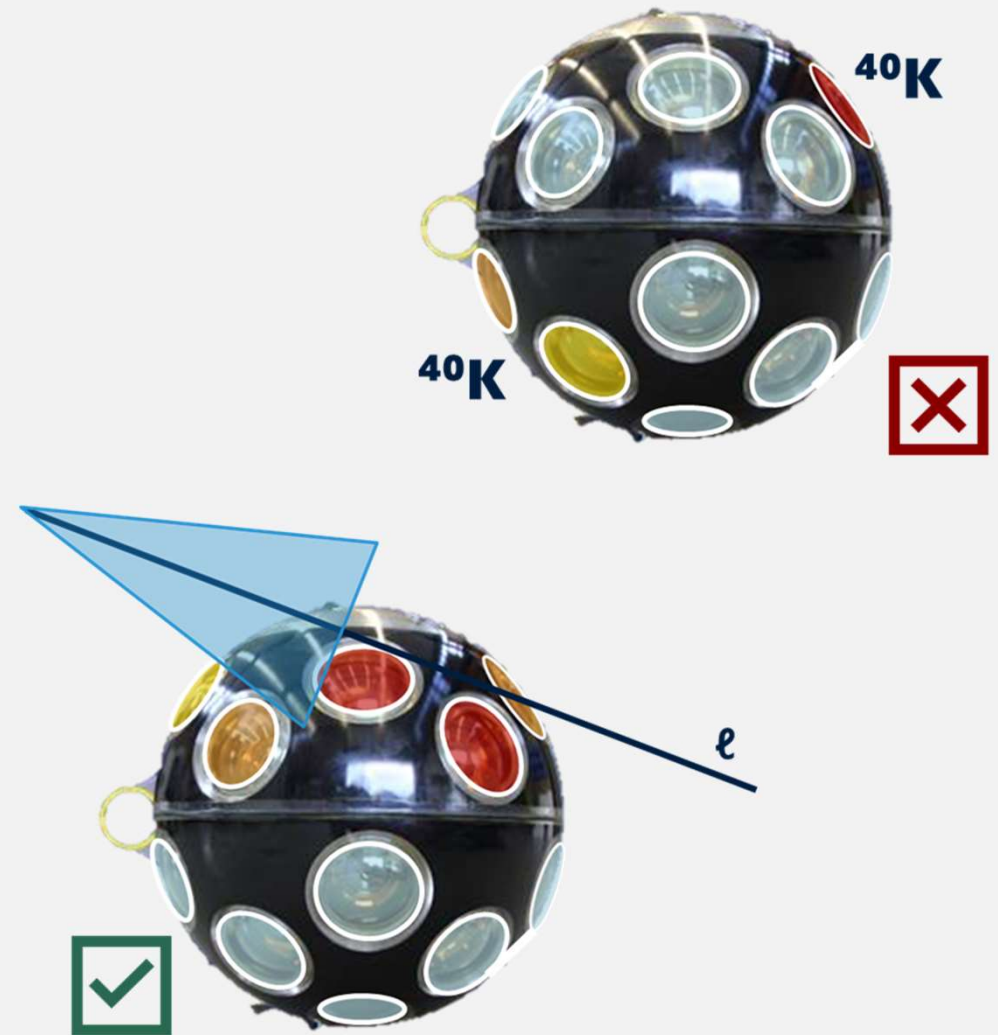
Low-level data stored by KM3NeT is filtered requiring at least two-hits coincidences on the same DOM.

Low-level data originates mostly from ^{40}K decay and **bioluminescence**

A MeV-GeV event selection targeting astrophysical transients (Solar Flares, GRBs, GW).

Using single-DOM events, coincident hits passing some loose trigger conditions.

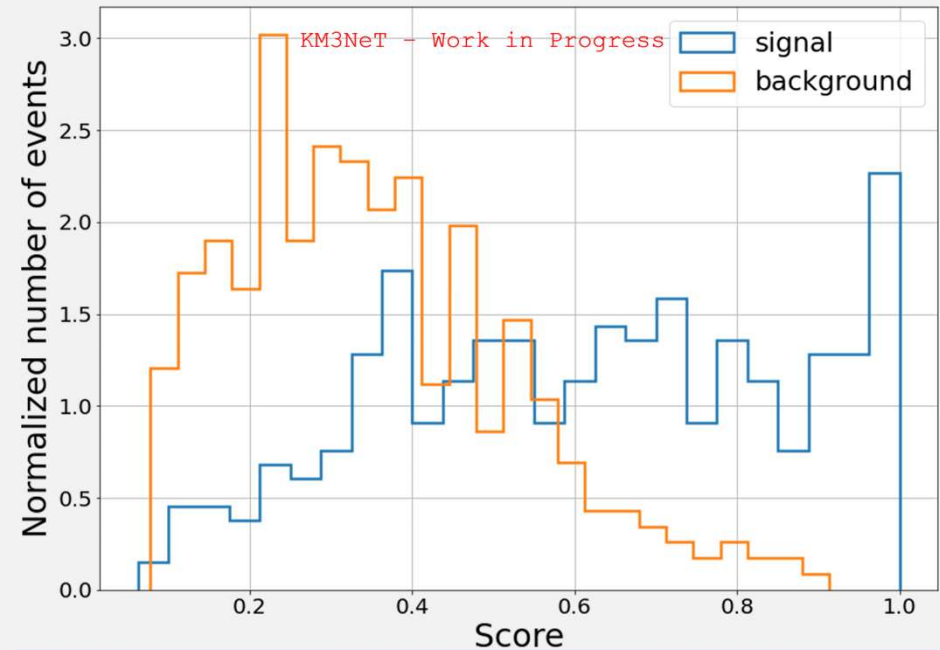
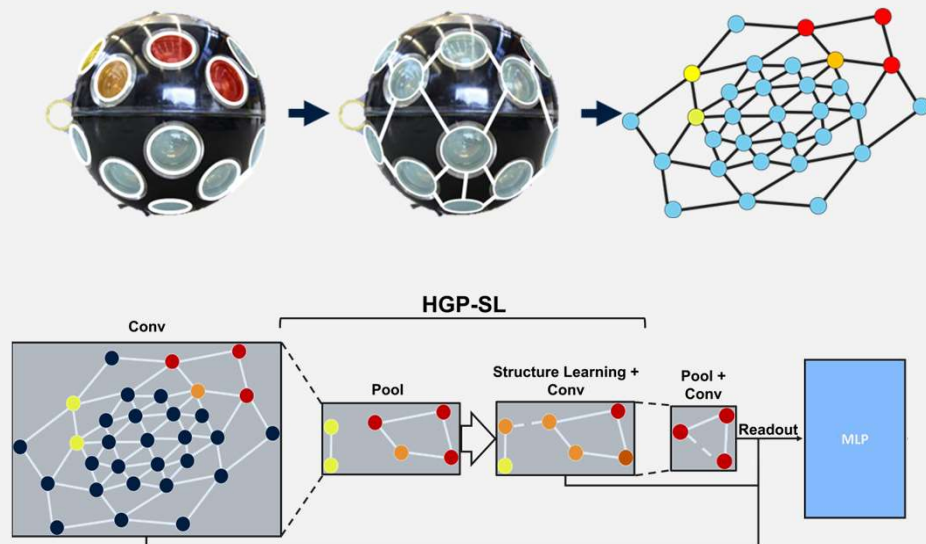
We expect to be able to identify the coherent signature of MeV-GeV neutrinos versus environmental noise



We build a training dataset comparing **low-level data (background)** with **MeV-GeV neutrino simulations (signal)**.

Each event is a graph which reproduces the geometry of the DOM and contains timing and charge information.

These events are used to train a GNN for classification.



HitSpooling in IceCube

Separate DAQ temporarily saving all hits

- 2-week lifespan
- Can be requested remotely

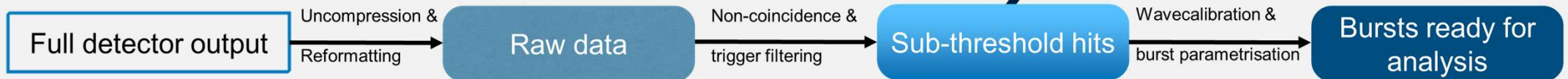
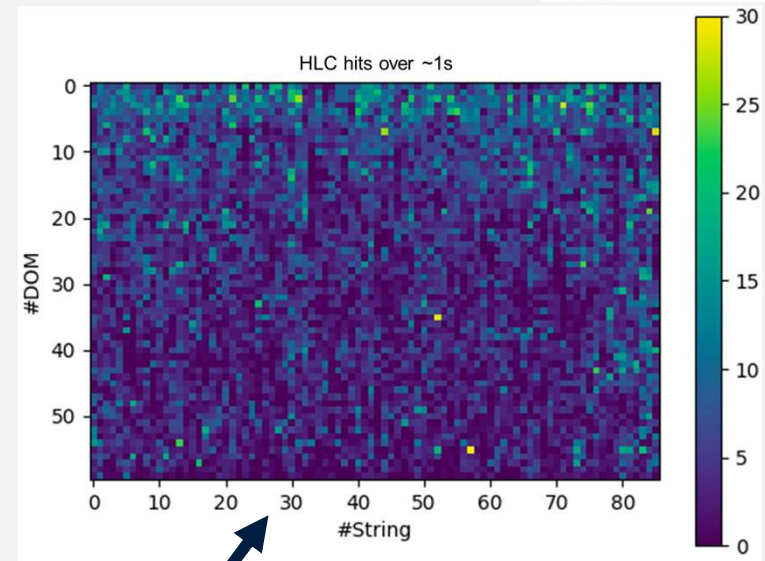
Updating framework — **work in progress**

Search for sub-threshold bursts

- burst = correlated sub-trigger hits



Per Myhr

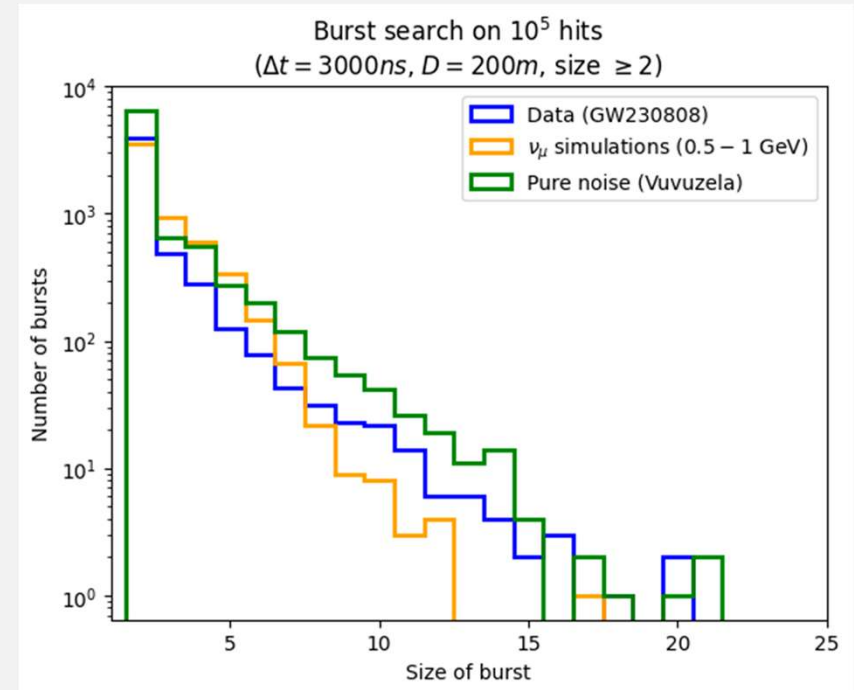
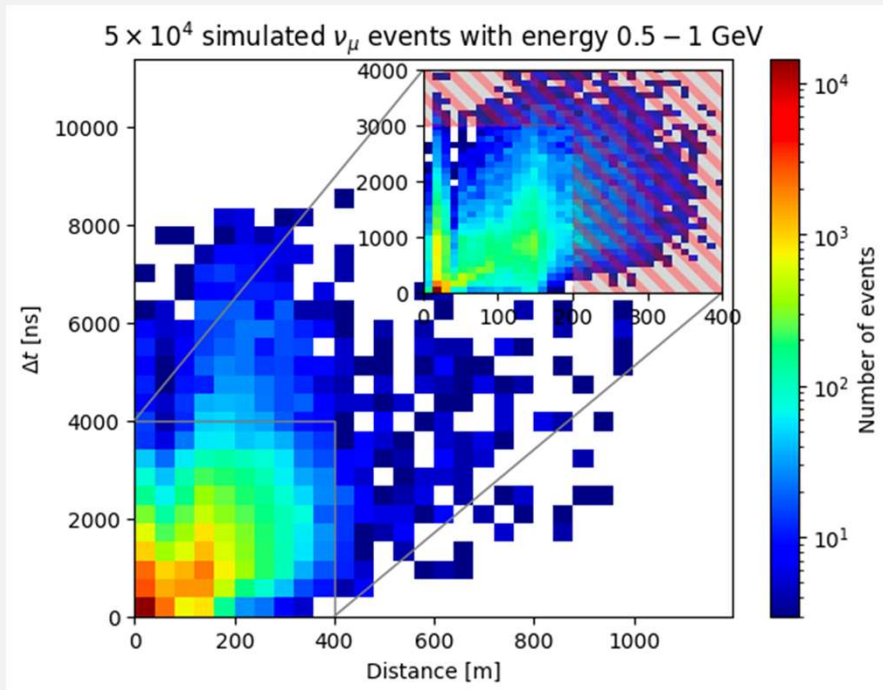


Sub-threshold burst search

Maximum size (distance) and duration (Δt) inferred from simulations.

Preliminary results from test on data, low-energy simulations and pure noise simulations.

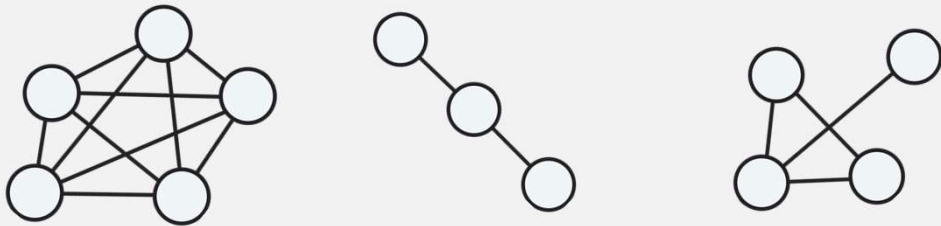
Per Myhr



CLUSTERING ALGORITHM FOR POPULATION STUDIES

A data exploration tool suited for astrophysical catalogs.

Based on an HCA (friend of friend algorithm) implemented with graph clustering techniques.



Currently being developed on benchmark datasets and real astrophysical observations

Finding sub-populations of optimal neutrino emitters



GRBs Karlijn Kruiswijk



AGNs Chris Raab



GWs Emile Moyaux



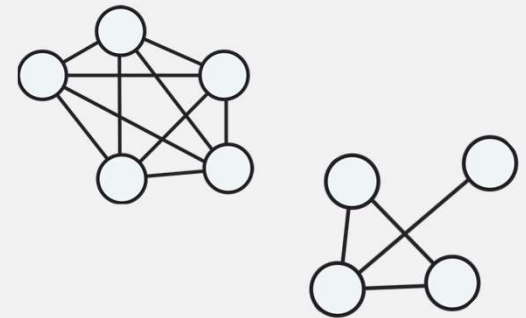
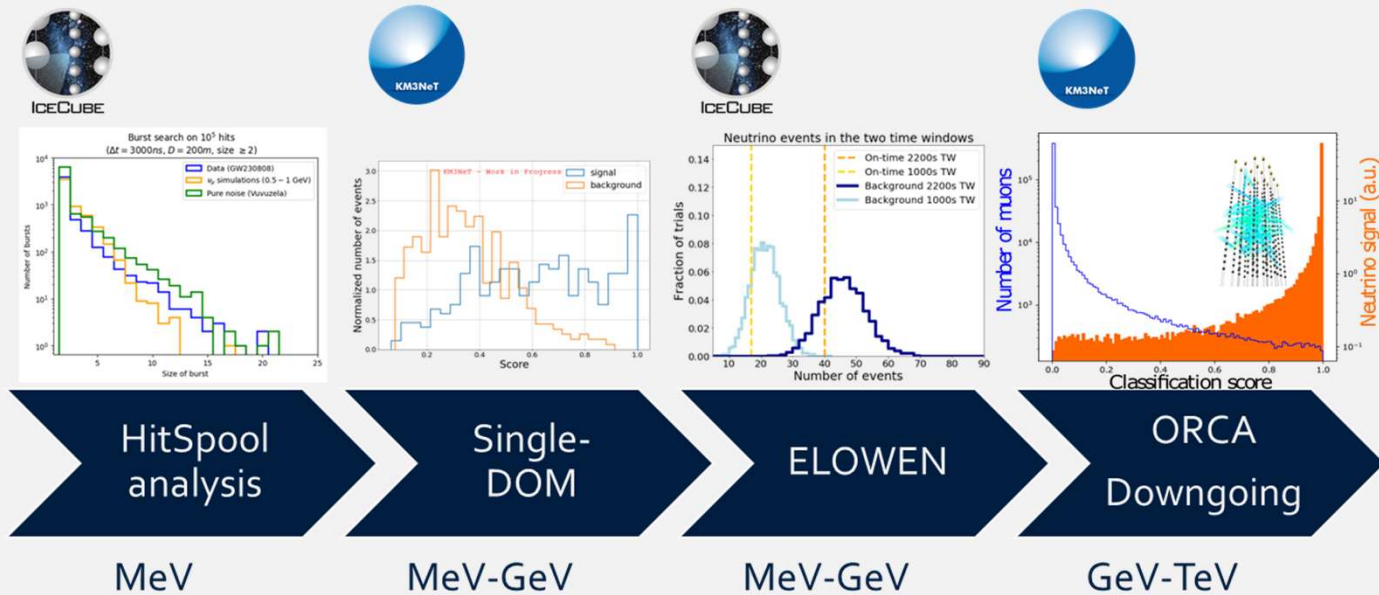
Solar Flares JM

Summary

Developing event selections in KM3NeT and IceCube from MeV to TeV

✚ Tools for population studies of astrophysical objects.

Searching for optimal neutrino emitters



BACKUP SLIDES