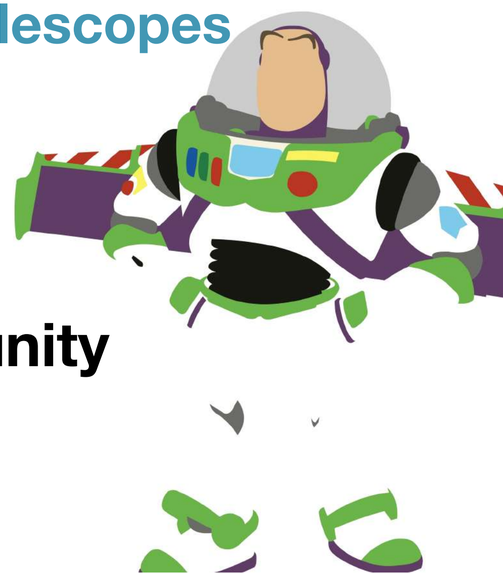
Neutrino Target of Opportunity (NToO) for CTA

Evaluation of the Cherenkov Telescope Array performance to the gamma-ray emission from neutrino sources detectable by the IceCube and KM3NeT neutrino telescopes



1st VHEGAM meeting: LST proposals by the Italian community

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16/01/2024, Bologna

Neutrino Target of Opportunity (NToO)

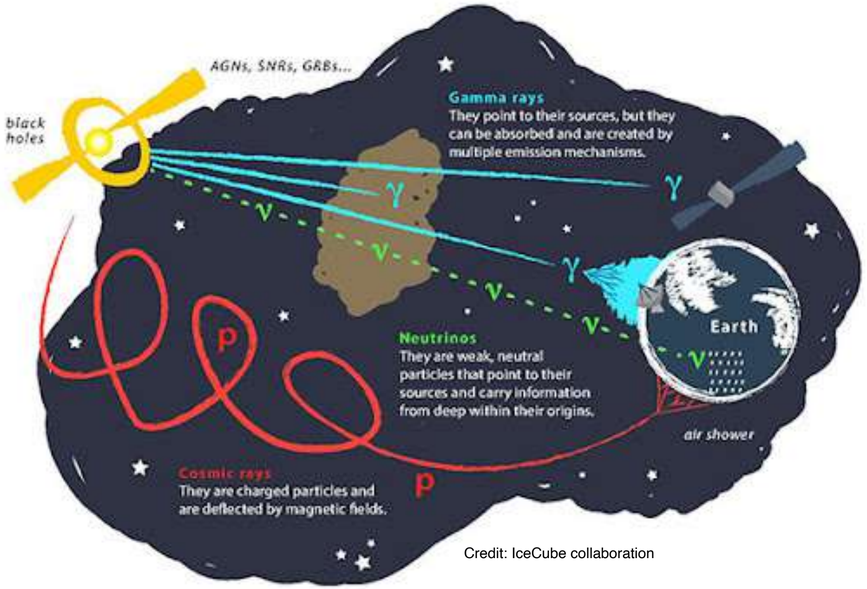
Transient working group @ CTA

arXiv:2108.05217v

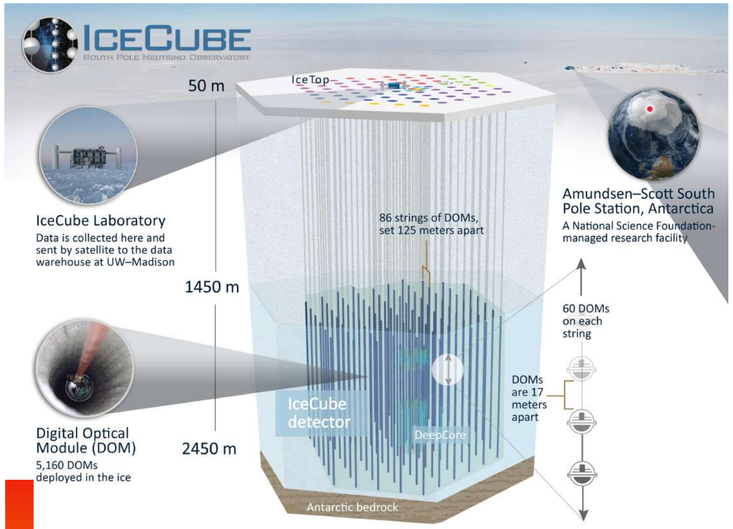
CTA will be able to look for **a γ-ray counterpart** from **a neutrino source alert.**

- **steady neutrino emitters**
- **transient neutrino source**

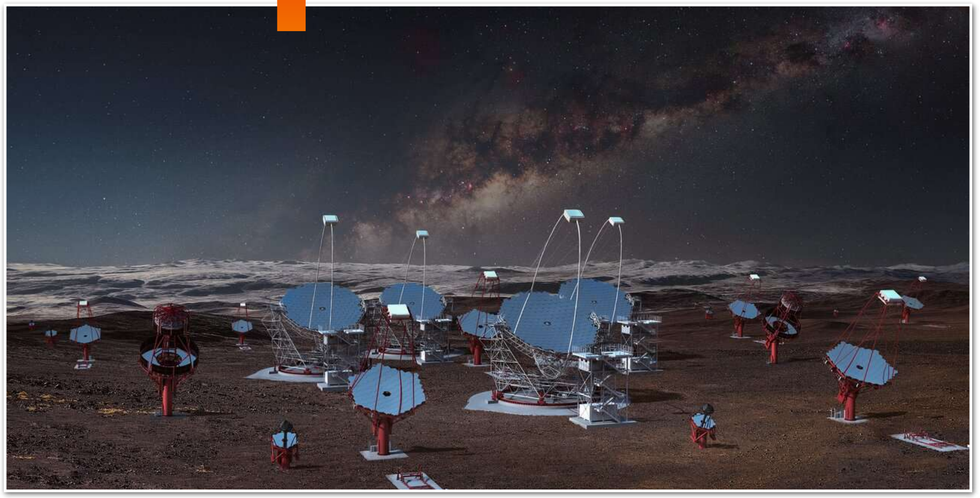
The **CTA detection probability** is calculated for both CTA sites (CTA-south and CTA-North)



Credit: IceCube collaboration



Credit: www.icecube.wisc.edu



Credit: www.eso.org

Paper in preparation: The sensitivity of the Cherenkov Telescope Array to the gamma-ray emission from neutrino sources detected by IceCube

My Ph.D. work

CTA+ PNRR

Simulation of **neutrinos population** with **FIRESONG**, that generates of **list of neutrino-emitting blazars** and I treat them as possible **gamma-ray sources** to simulate observations with **CTA**

Comparison with **discovery potential** to evaluate neutrino sources that could be detected by the **IceCube** (*paper in preparation...*) and **KM3NeT/ ARCA230** telescopes

Study of **gammapy** for the simulation of gamma-ray sources detectable by CTA and for the analysis of the **gamma counterpart from neutrino alerts**

Combined real analysis of **LST** (or LST+MAGIC) and **IceCube** and implementation of **KM3NeT** in real data analysis

Multi Messenger Team

- Giovanna Ferrara (UniCT & KM3NeT)
- Iara Tosta (KM3NeT)
- Maria Letizia Pumo (UniCT)
- Giulio Manicò (UniCT & INFN Catania)
- Stefano Pio Cosentino (Ph.D. - UniCT)

NToO group for CTA

- A.M. Brown (coordinator)
- A. Rosales de Leon
- O. Sergijenko

Me, Gloria Maria Cicciari
(UniPa & INFN Catania)

Dott.ssa Manuela Mallamaci
(UniPa & INFN Catania)

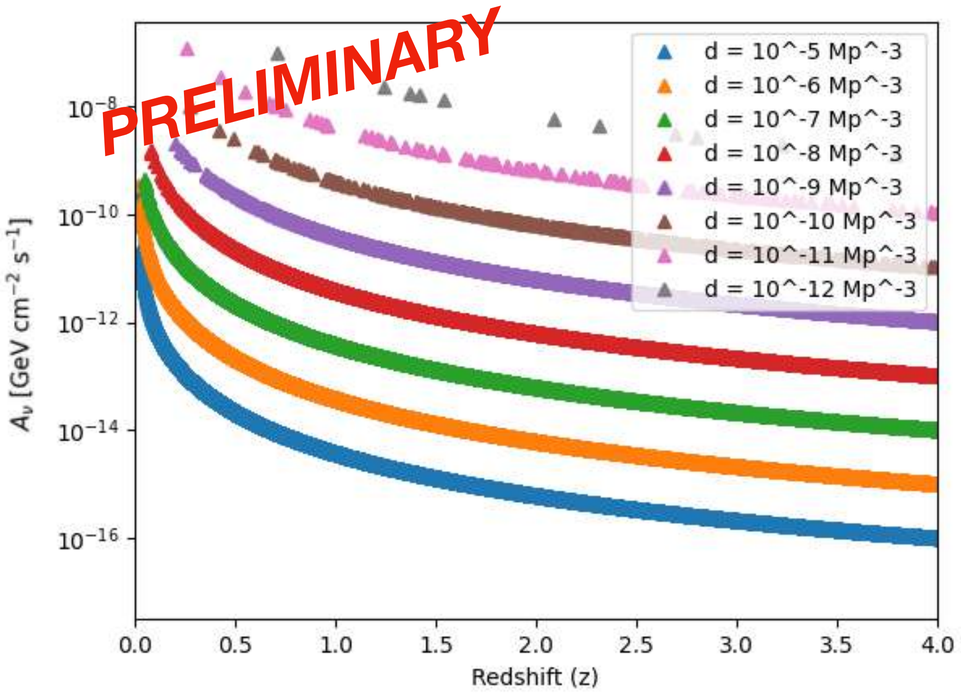
Prof. Giovanni Marsella
(UniPa & INFN Catania)

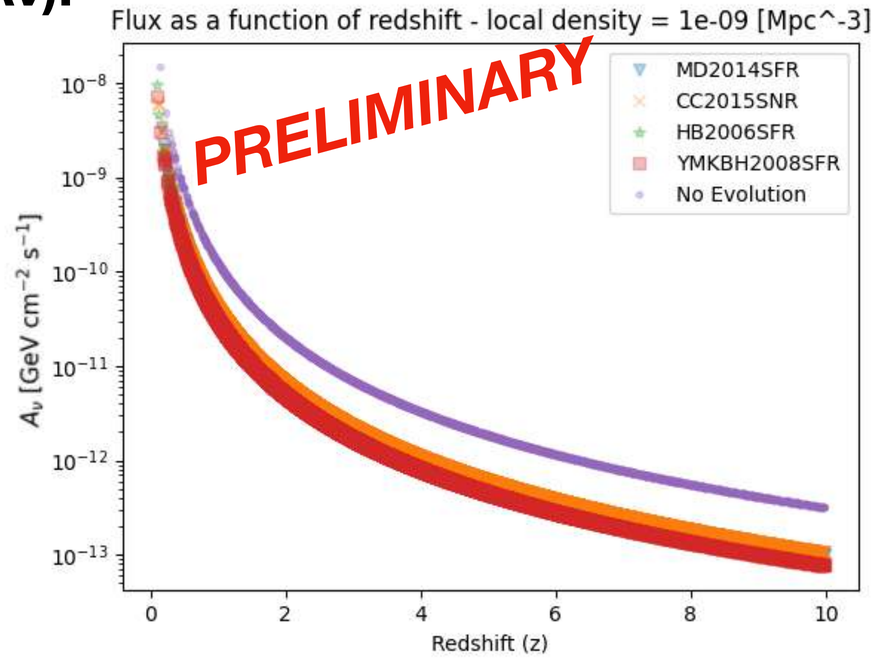
FIRESONG

FIRst Extragalactic Simulation Of Neutrino and Gamma-ray

```
def firesong_simulation(outputdir, filename='Firesong.out', density=1e-09,
                        Evolution='MD2014SFR', Transient=False, timescale=1000.0,
                        zmin=0.0005, zmax=10.0, bins=10000, fluxnorm=1.44e-08,
                        index=2.28, LF='SC', sigma=1.0, luminosity=0.0,
                        emin=10000.0, emax=10000000.0, seed=None, verbose=True)
```

The output from **FIRESONG simulations** is a list of **hot-spots:**
- redshift (z)
- declination (δ)
- the value of the neutrino flux @100 TeV (Av).

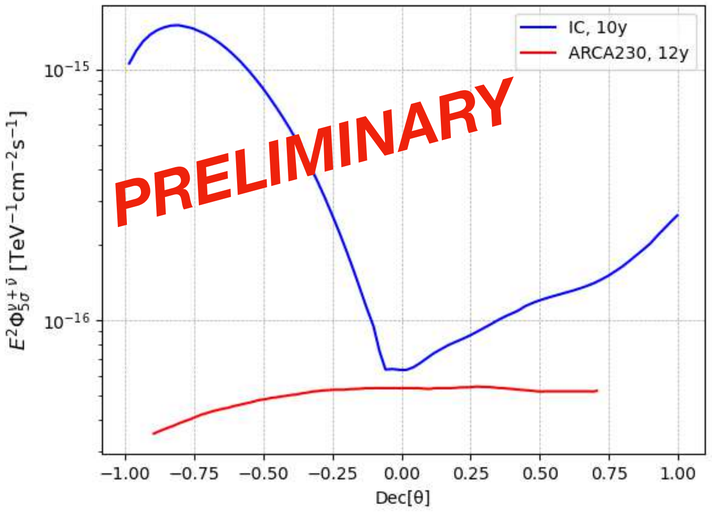




Comparison with the discovery potential

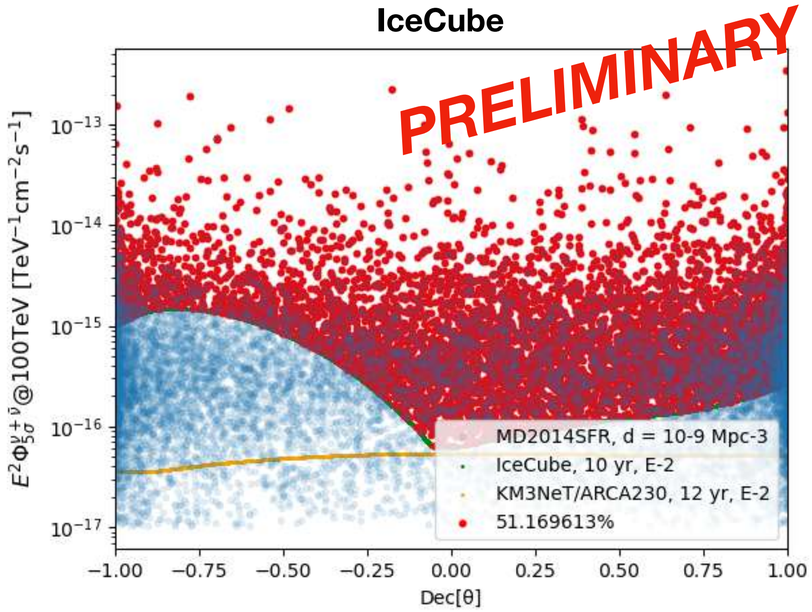
IceCube and KM3NeT/ARCA230

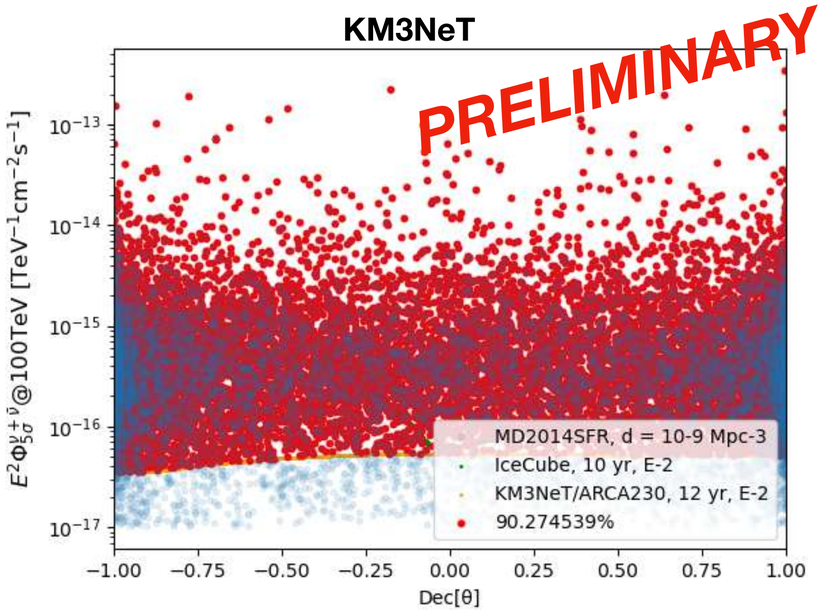
Discovery potential curves obtained from published data



(Time-integrated Neutrino Source Searches with 10 years of IceCube Data, 2019 and Astronomy potential of KM3NeT/ARCA230, 2023)

Comparison of **neutrinos sources simulated** with FIRESONG and the **discovery potential** (with a confidence level of 5σ) for IceCube and KM3NeT/ARCA230.





The role of LST

LST neutrino strategies are derived from Magic+IceCube strategies already exploited (MoU)

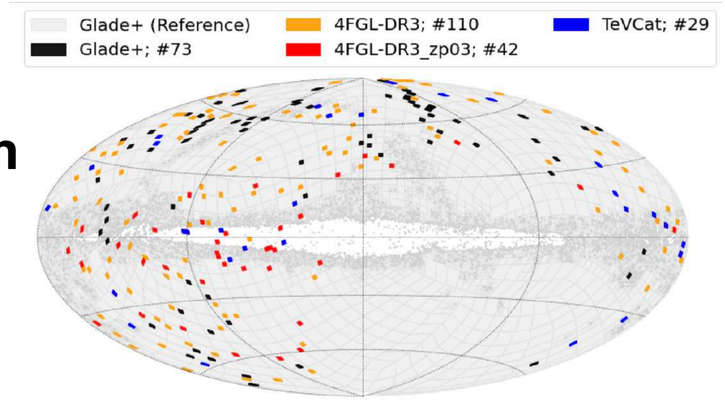
1.Gamma Follow Up (GFU) program

2.Single track events

3.Multiplet all-sky

4.Cascade

Koji Noda @LST meeting (08 Nov 2023)



GFU map of sources, K. Soda @ICRC2023

The prototype of the Large-Sized Telescope, the LST-1, operating at the CTAO-North. Credit: Tomohiro Inada.

GRBs *procedure*

↓

Nus procedure

Clear and ***"procedural"*** collaboration between the Cherenkov and neutrinos telescopes

↓

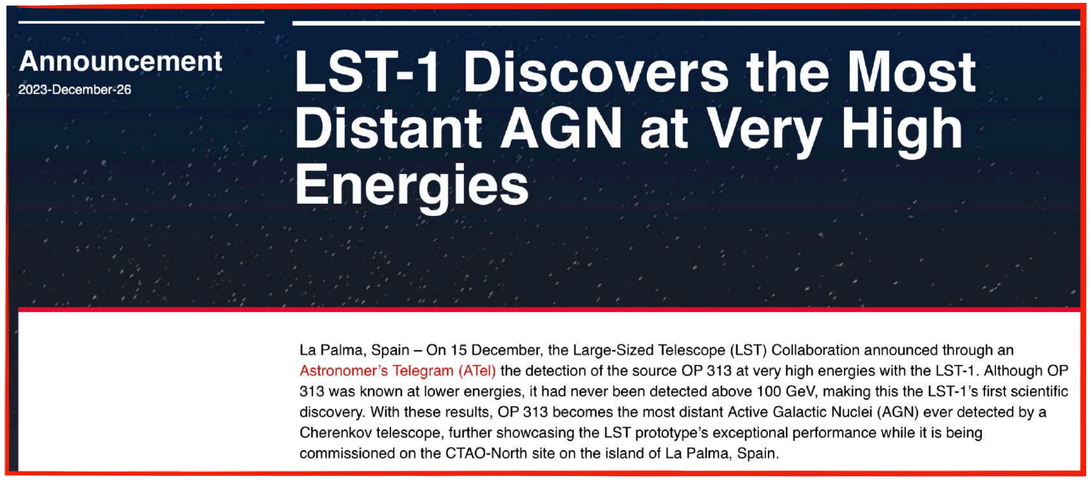
LST and IceCube or KM3NeT

Takeaway messages

- The **NToO program for CTA** performed a **large number of neutrino and gamma-ray simulations** to predict **the detection probability of the blazar-like**, steady point-source populations able **to saturate the IceCube diffuse flux**, and produced **performance plots for both CTA sites** to evaluate the **combined detection probability (IceCube + CTA).**

- One of the aims of my Ph.D.work is to include **a neutrino observatory** in the **northern hemisphere with similar capabilities as IceCube,** like **KM3NeT.**

- The gamma counterpart of neutrino alerts is important for **multi-messenger astrophysics**, so a **strong**, **clear** and **well-regulated** collaboration between gamma and neutrino telescopes such as LST and IceCube or KM3NeT is required.



IT'S TIME!!!