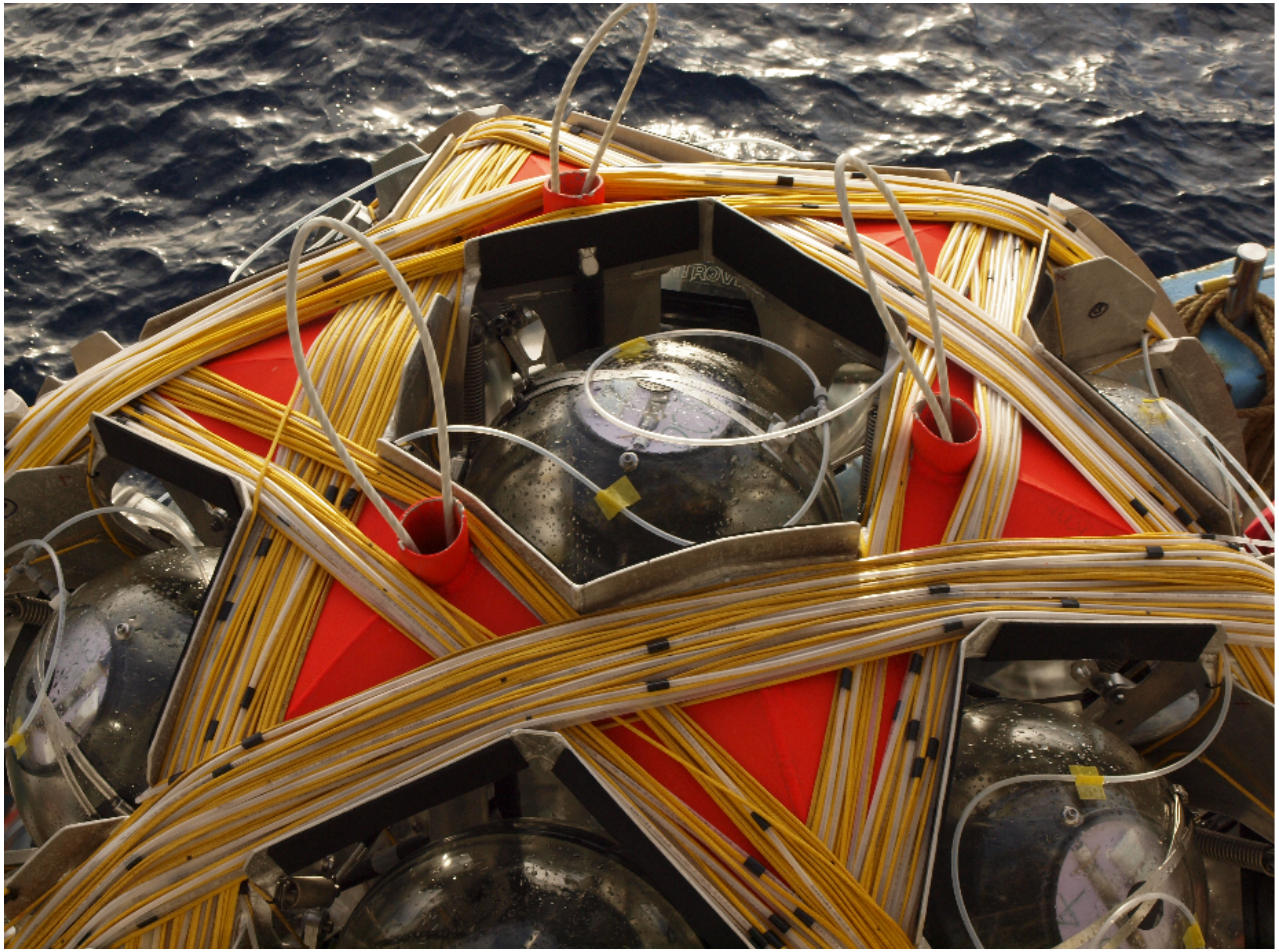
KM3NeT

ROSA CONIGLIONE FOR THE KM3NET COLLABORATION
INFN - LABORATORI NAZIONALI DEL SUD (ITALY)



KM3NeT

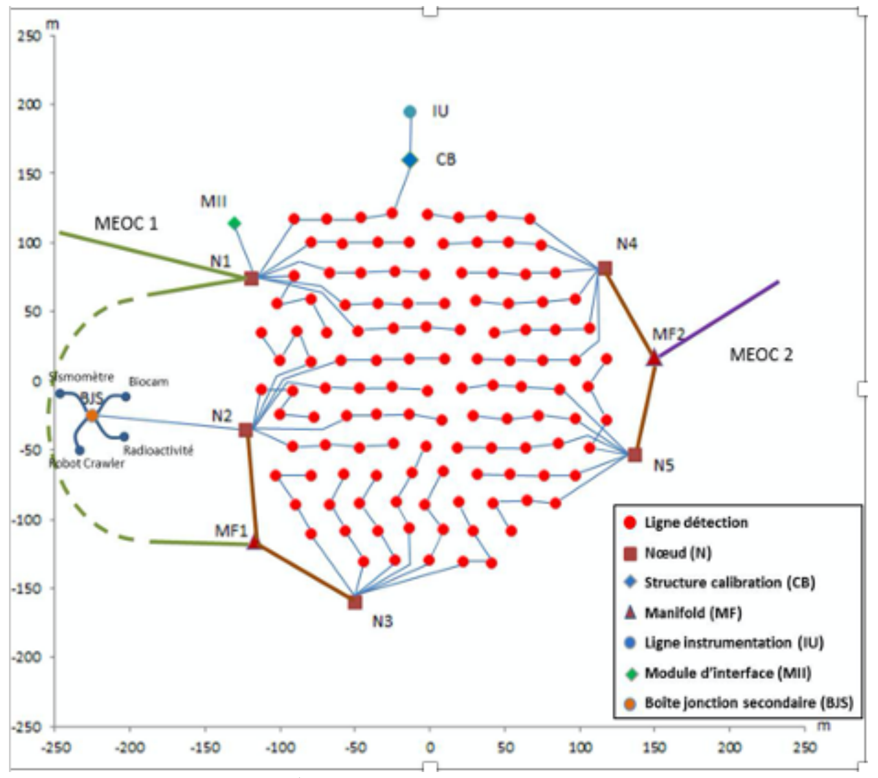
KM3NeT is a research infrastructure in the Mediterranean Sea hosting **two neutrino detectors**

KM3NeT/ORCA: Study of the physical properties of the neutrino – neutrino mass ordering
KM3NeT/ARCA: Discovery and observation of cosmic neutrino sources

Two different detectors but based on the same technology and operated by the same collaboration

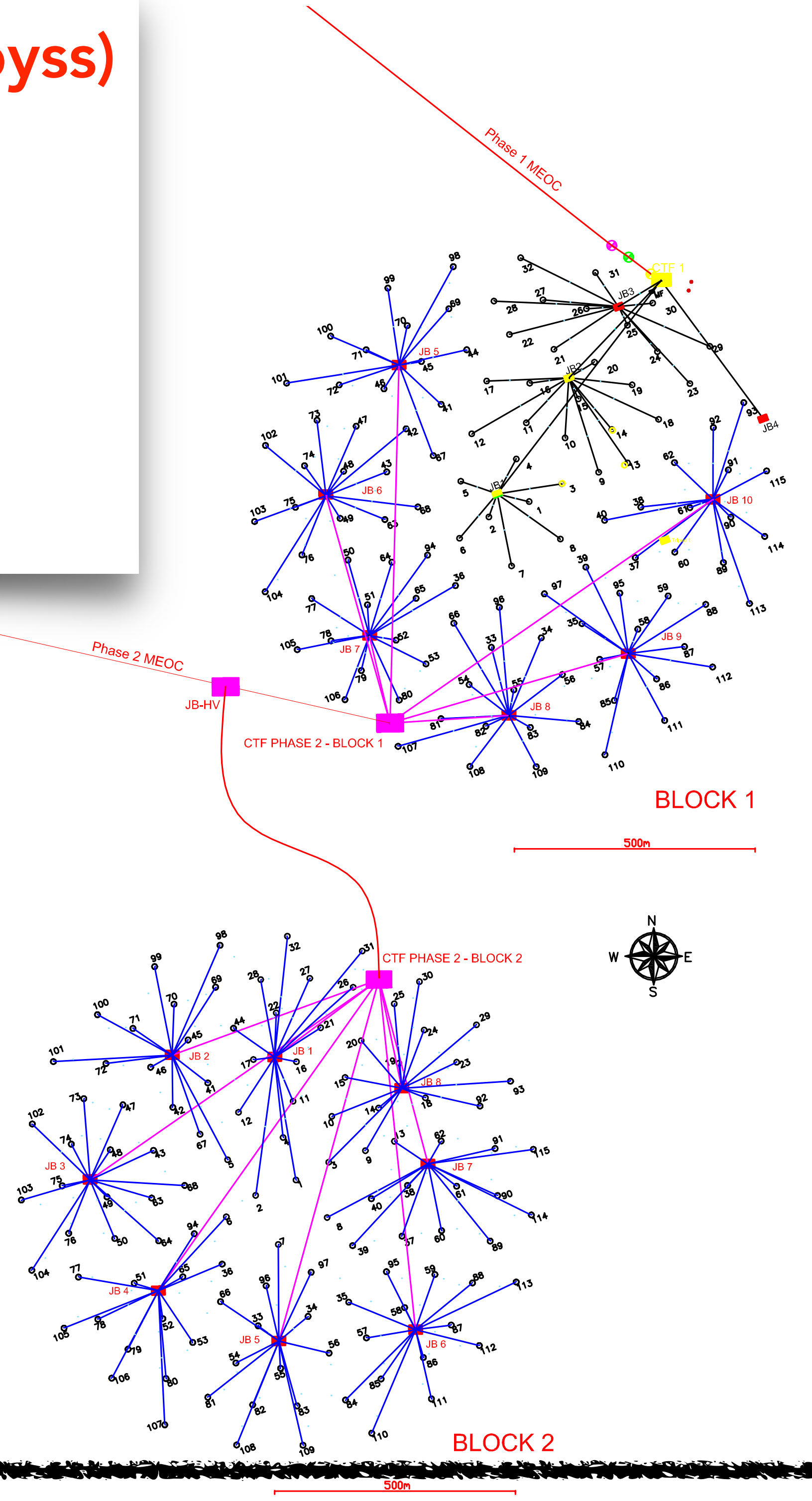
ORCA (Oscillation Research with Cosmic in the Abyss)

- **Depth ~2500 m**
- **One block of 115 Detection Units**
- **Average distance between Detection Units ~20 m**
- **Average vertical distance between DOMs ~9 m**
- **Volume ≈ 7 Mton**



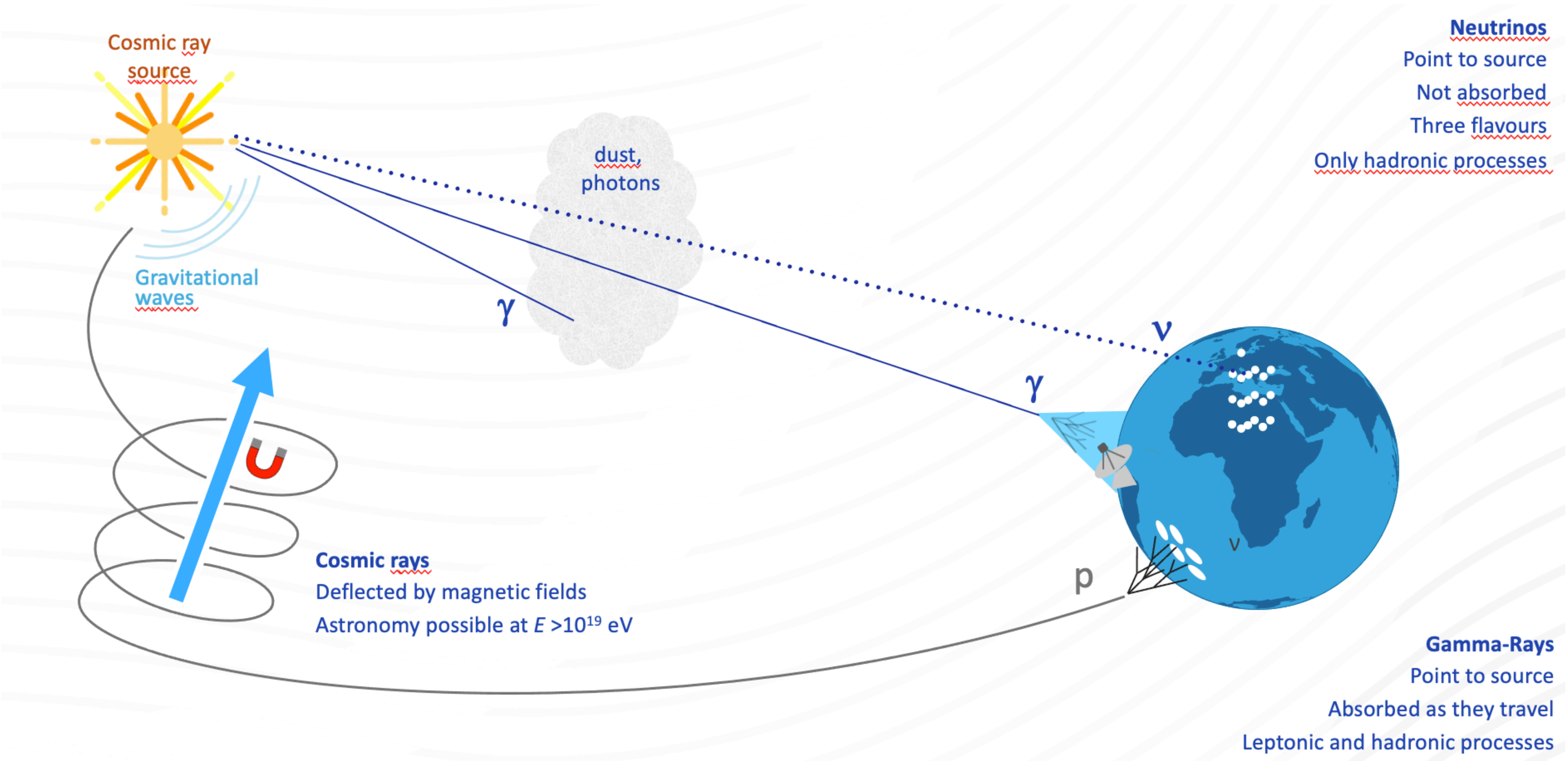
ARCA (Astroparticle Research with Cosmic in the Abyss)

- **Depth ~3500 m**
- **Two blocks of 115 Detection Units each**
- **Average distance between Detection Units ~90 m**
- **Vertical distance between DOMs ~36 m**
- **Volume (0.5 × 2) km³ ≈1 Gton**

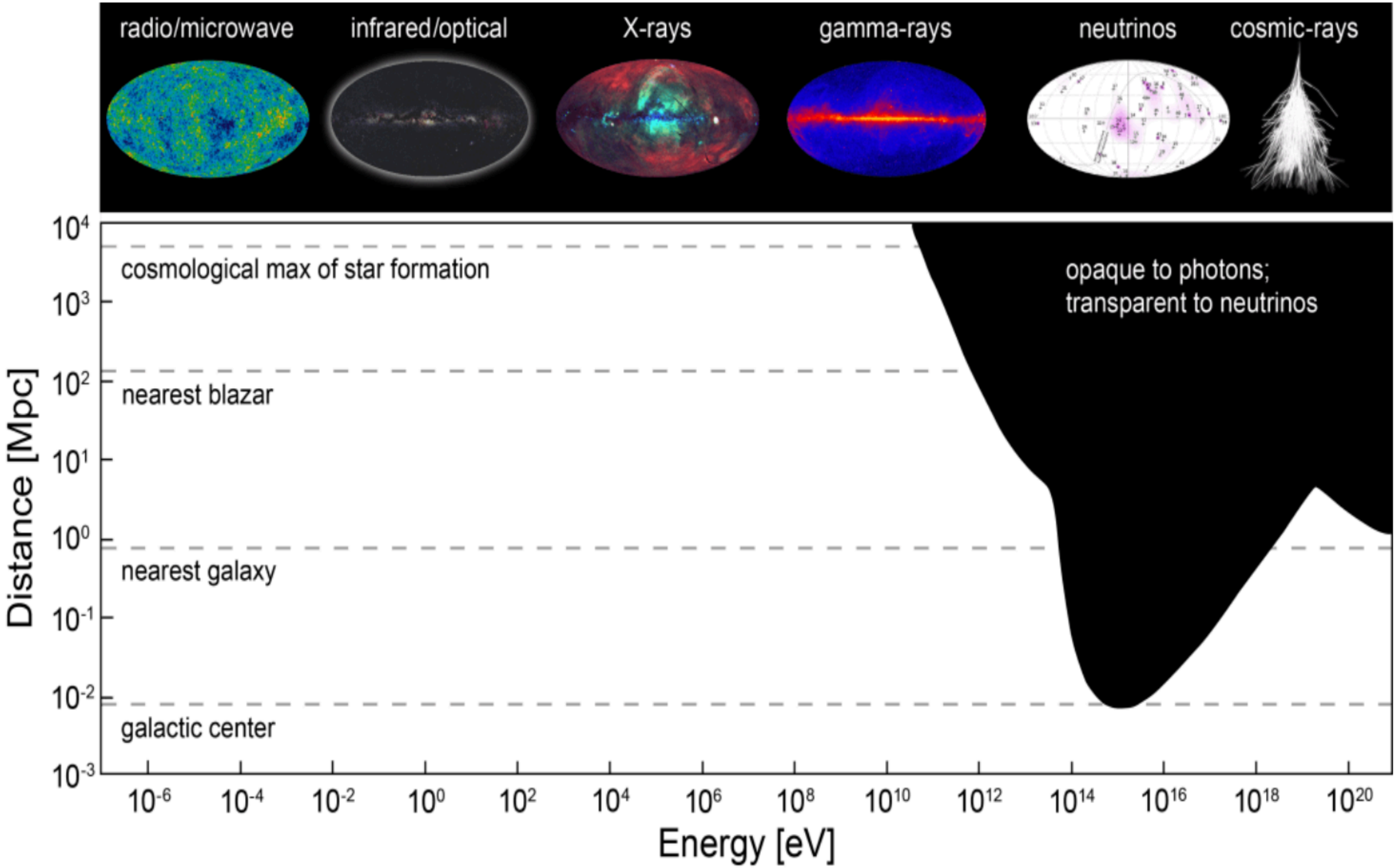


The scientific motivation

Why astronomy with neutrinos



Why astronomy with neutrinos

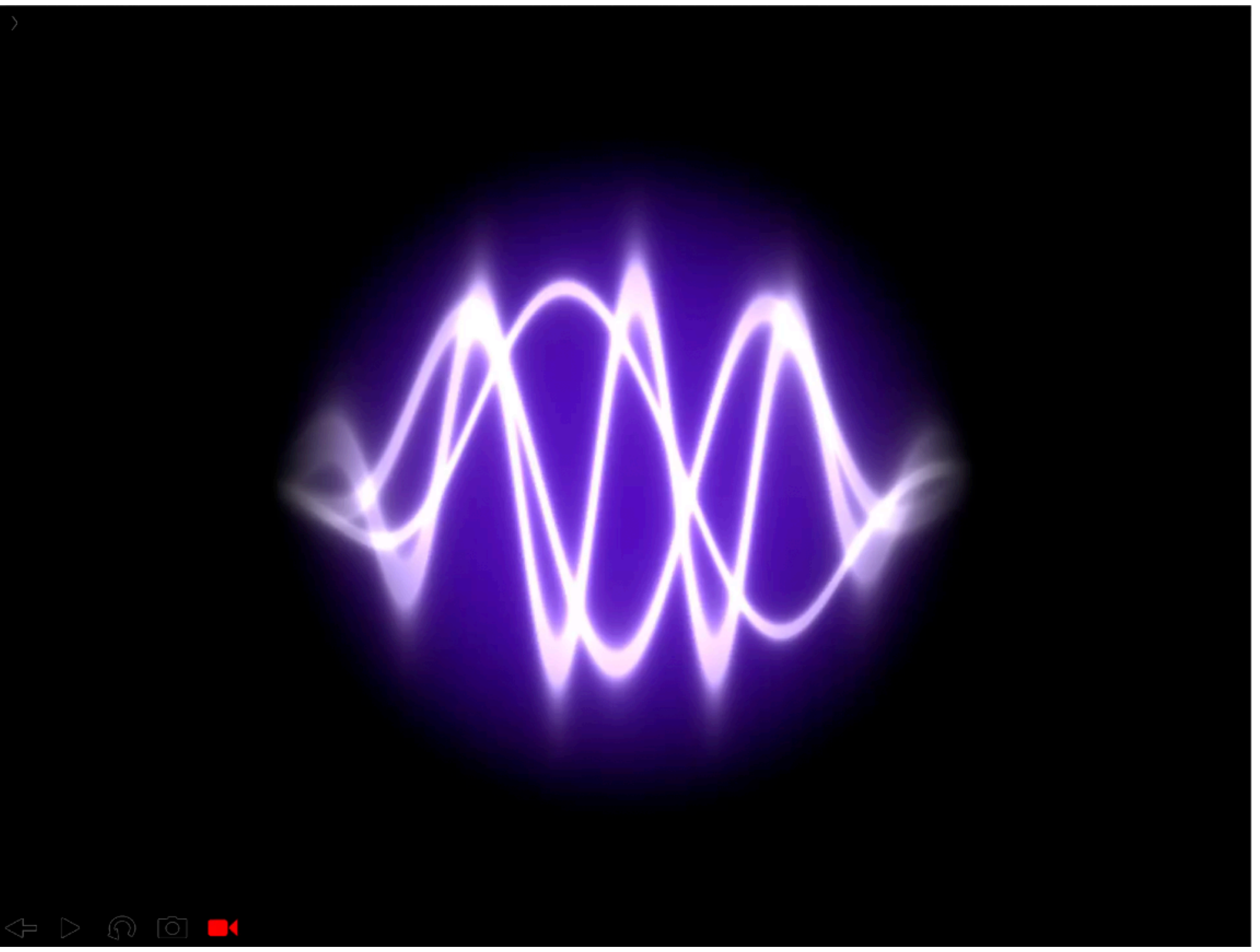


Science of KM3NeT

Study the fundamental properties of neutrinos

Exploration of the neutrino universe

Exploration of the abyss

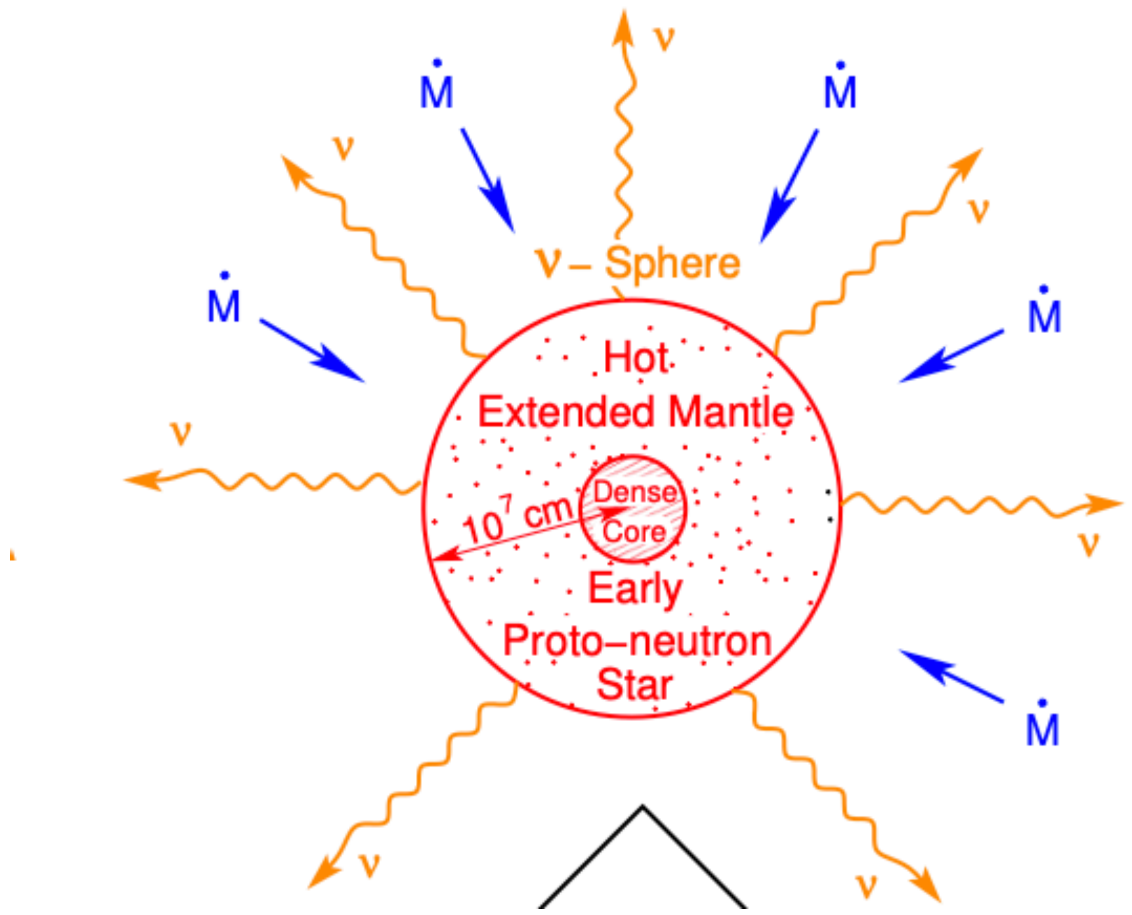


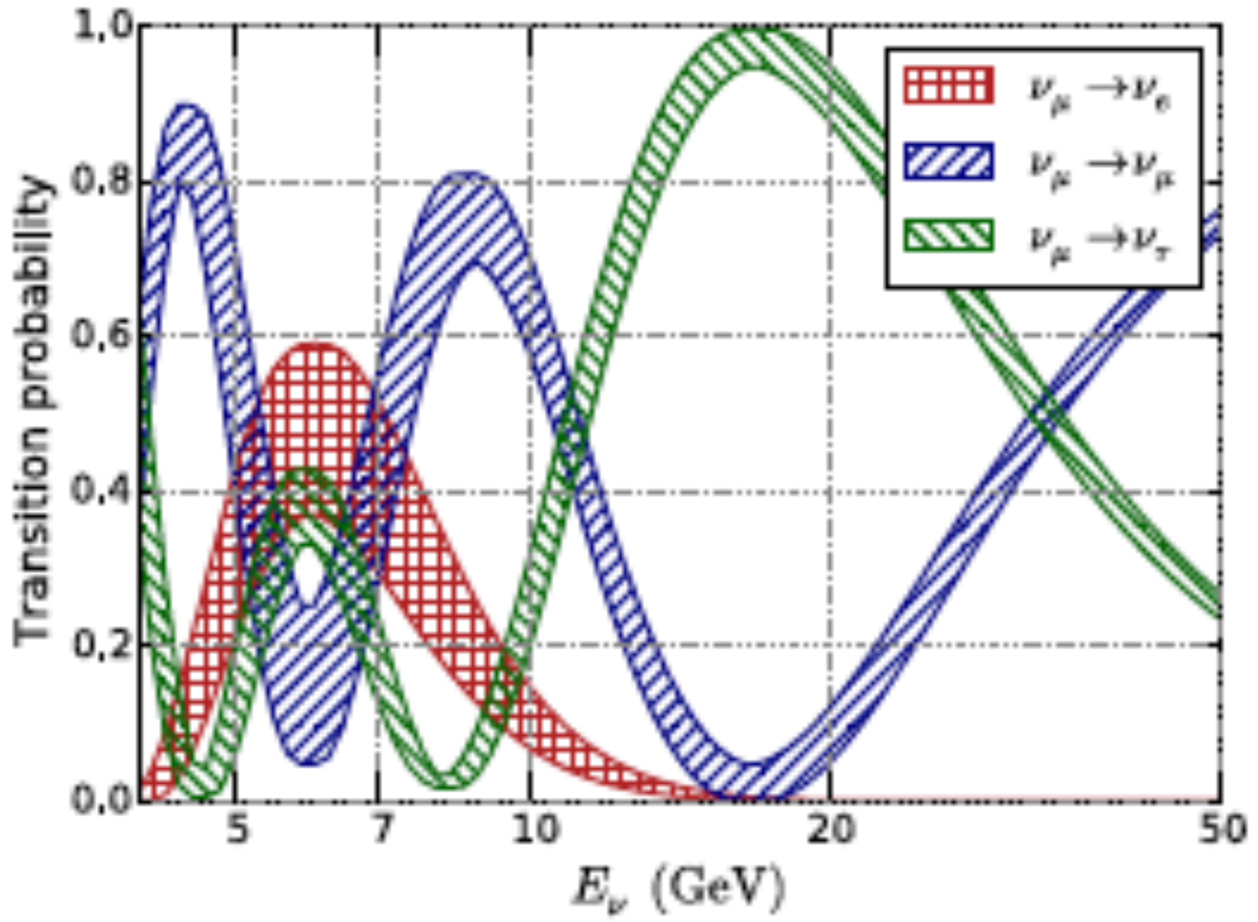
ORCA

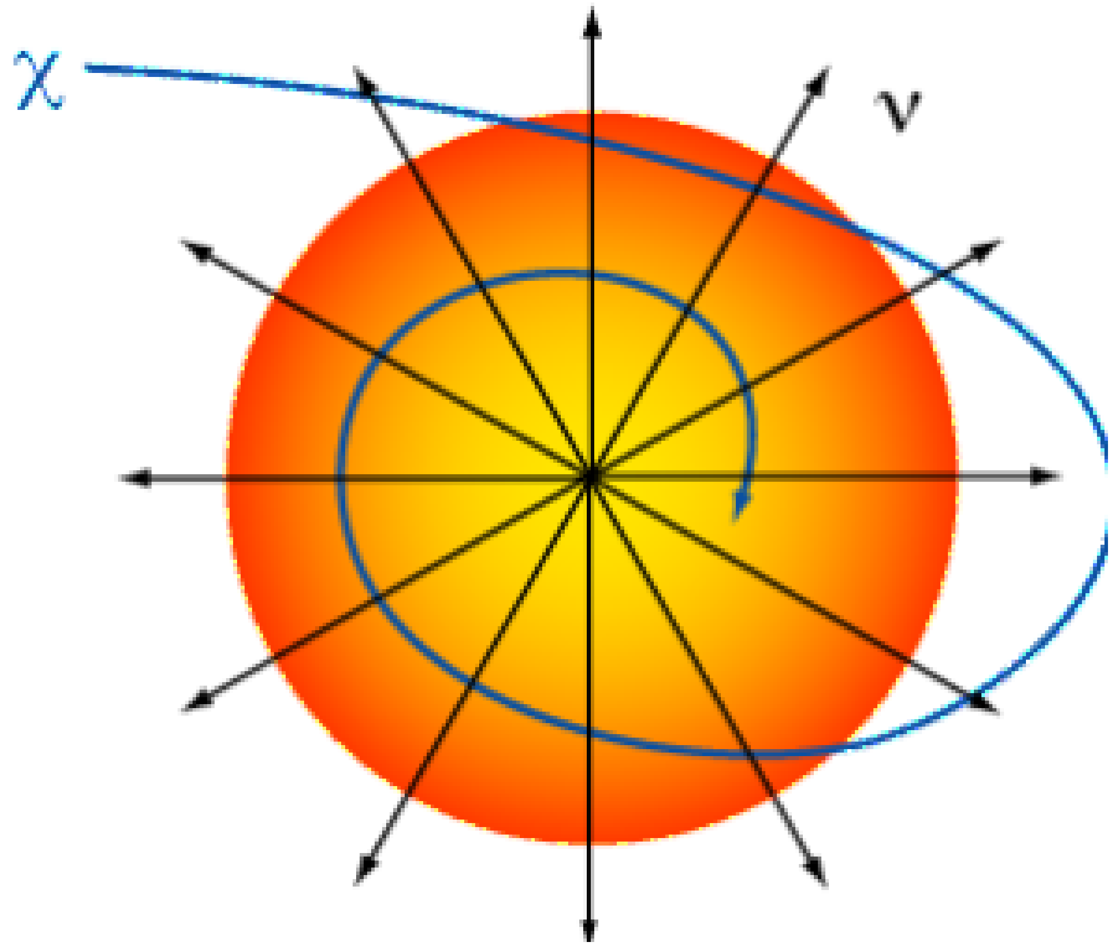
ARCA

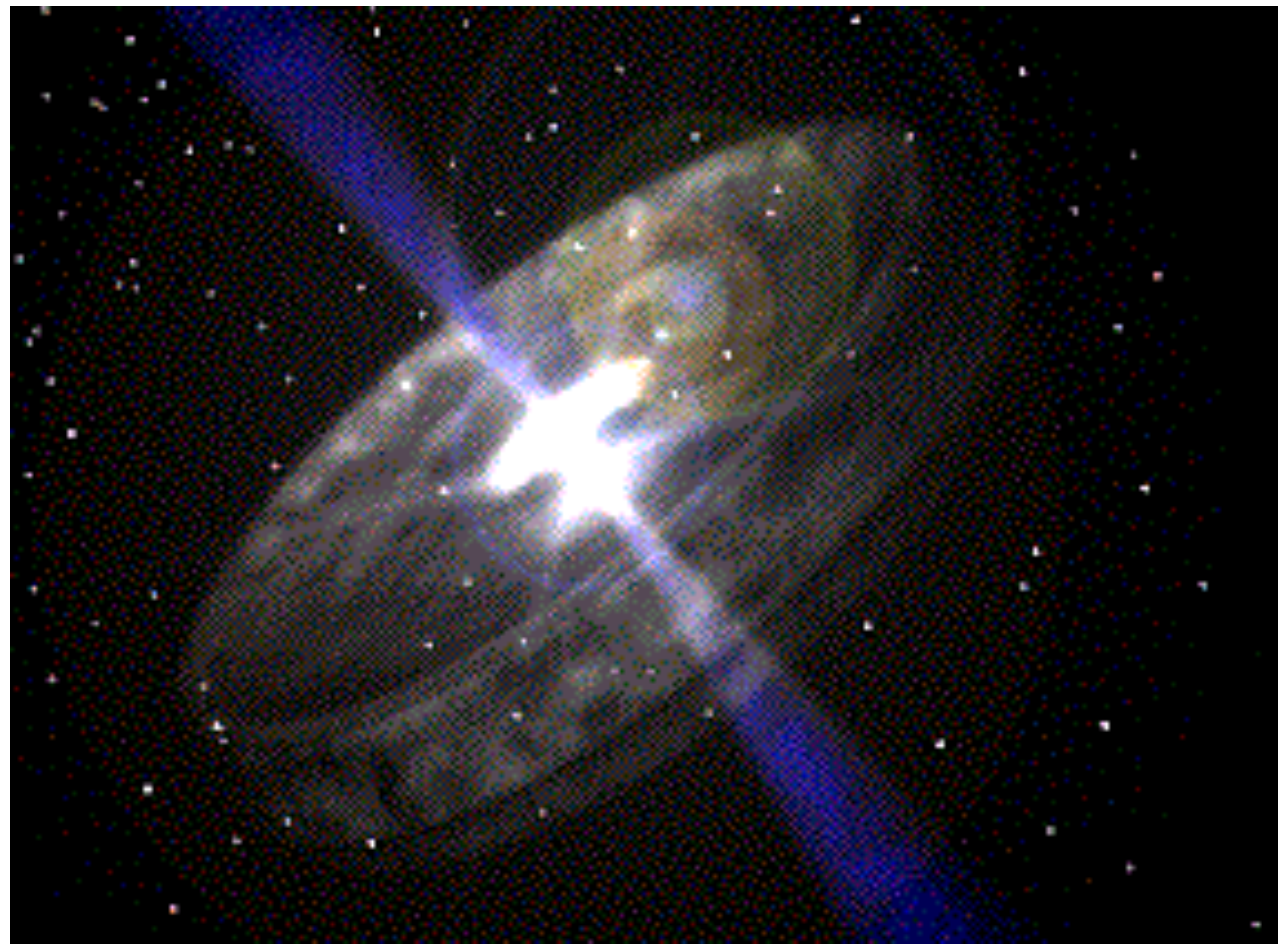
ORCA + ARCA

Science of KM3NeT









Supernova explosions

ORCA + ARCA

Neutrino oscillation

ORCA

Dark Matter

ORCA + ARCA

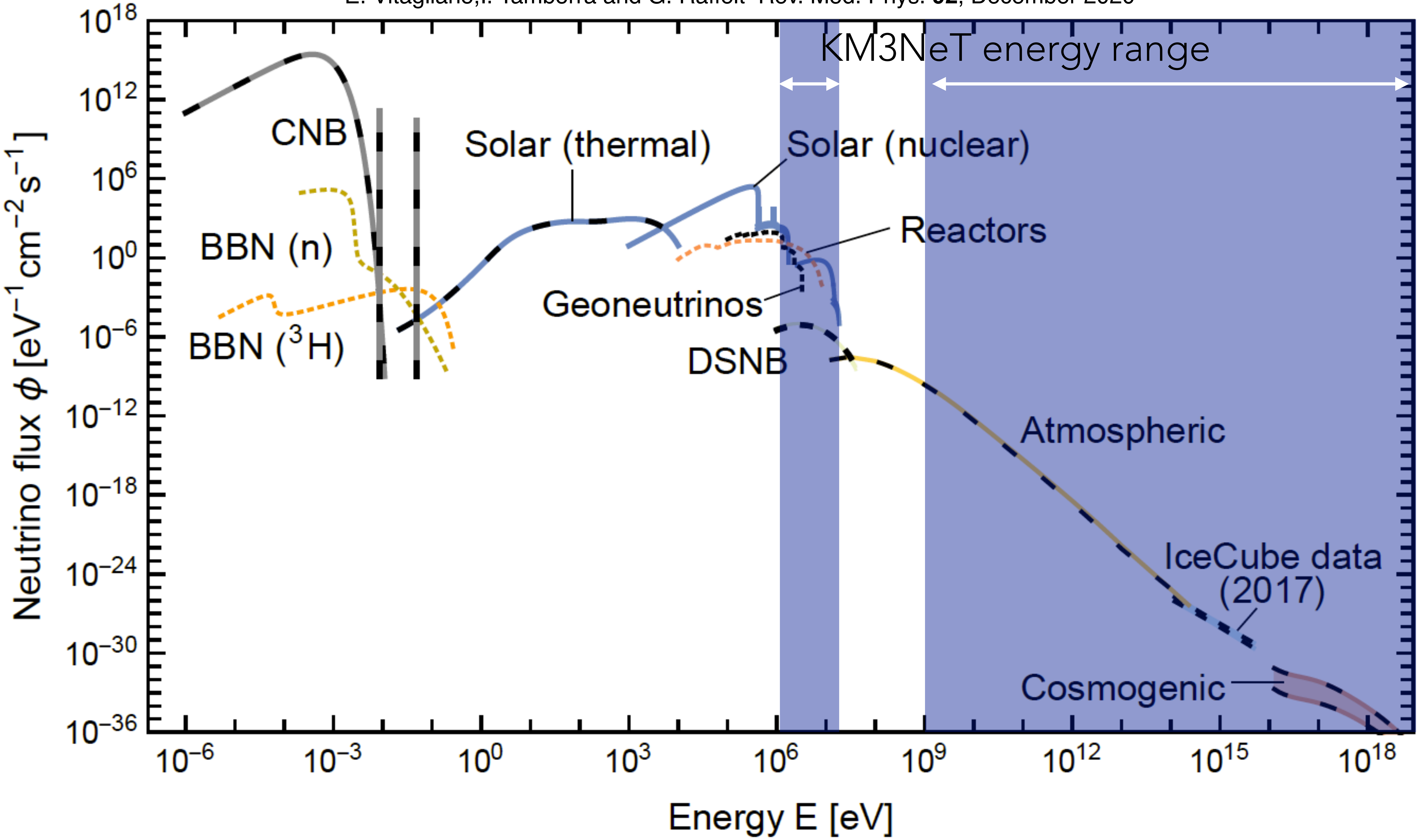
Multi-messenger program

ARCA

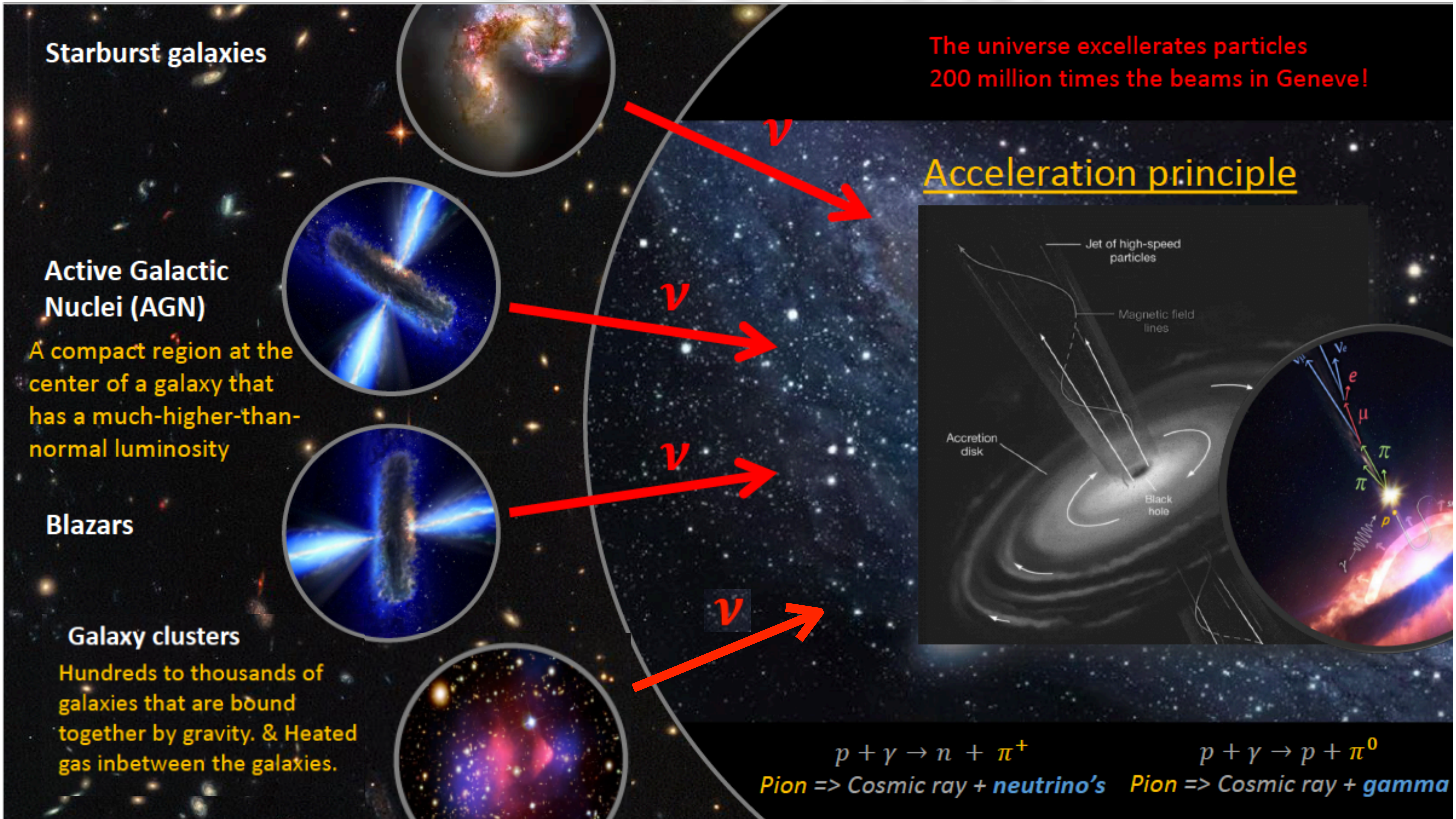
From MeV … …. to PeV

Science of KM3NeT

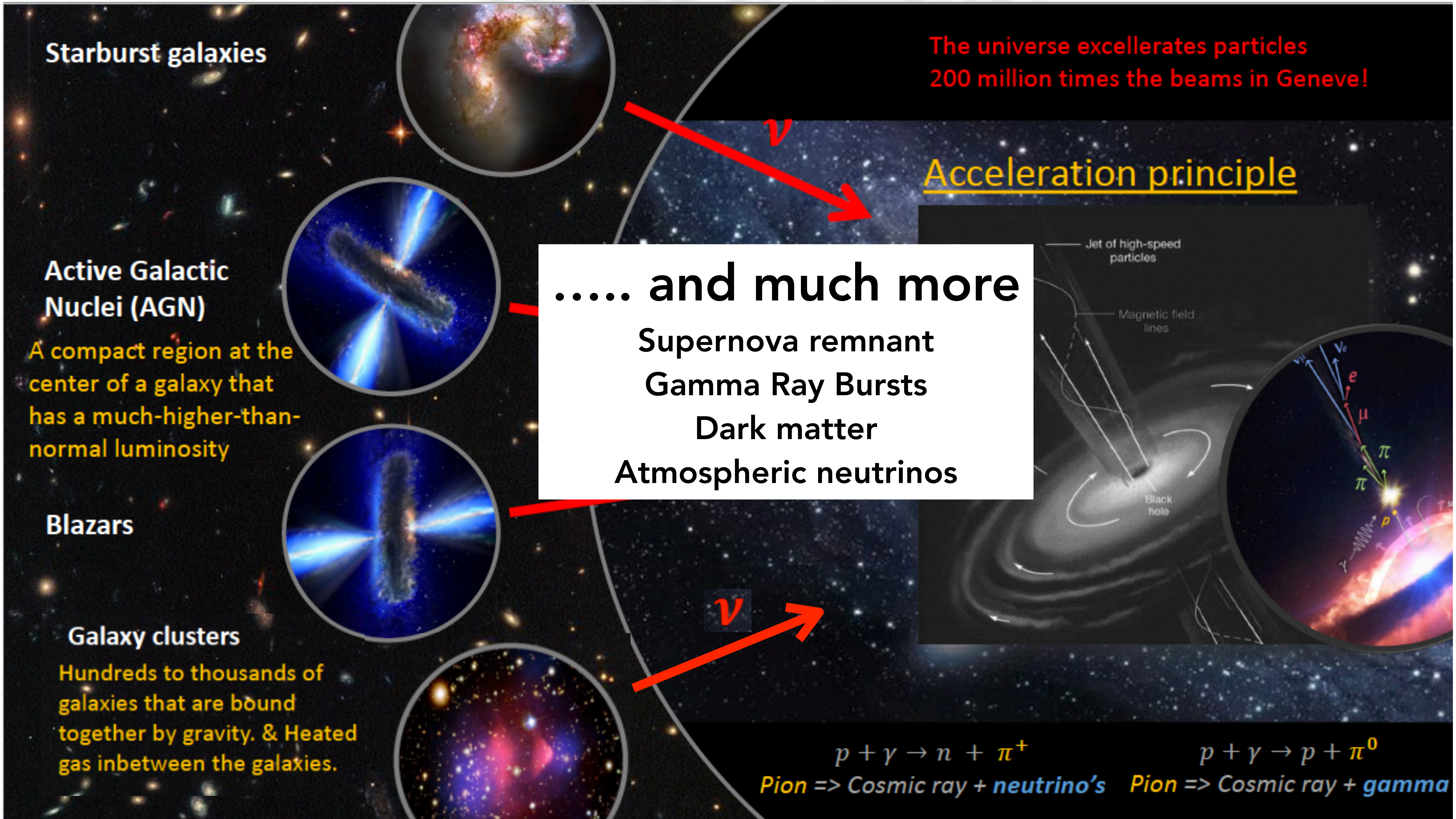
E. Vitagliano,I. Tamborra and G. Raffelt Rev. Mod. Phys. **92**, December 2020



Science of KM3NeT



Science of KM3NeT



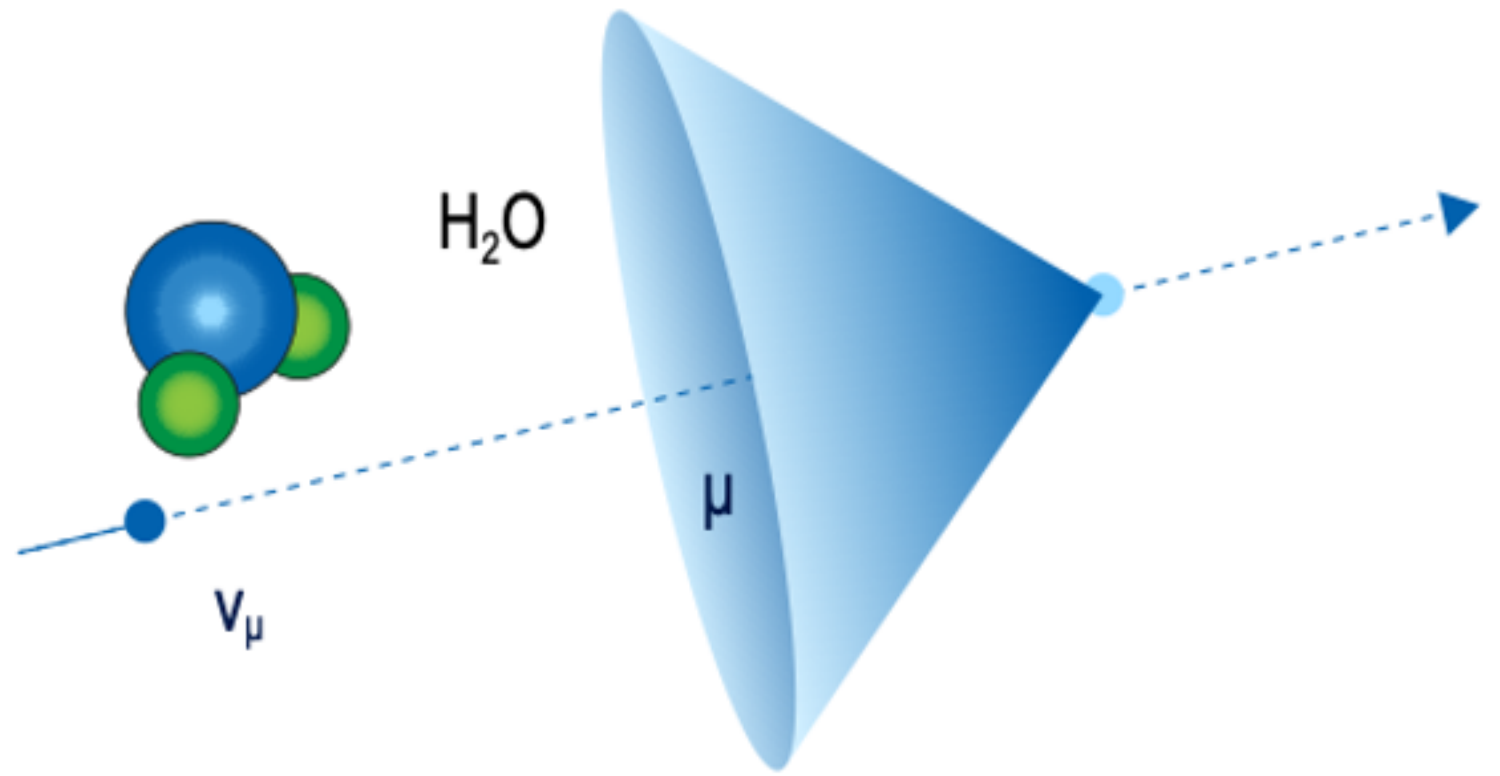
Open questions

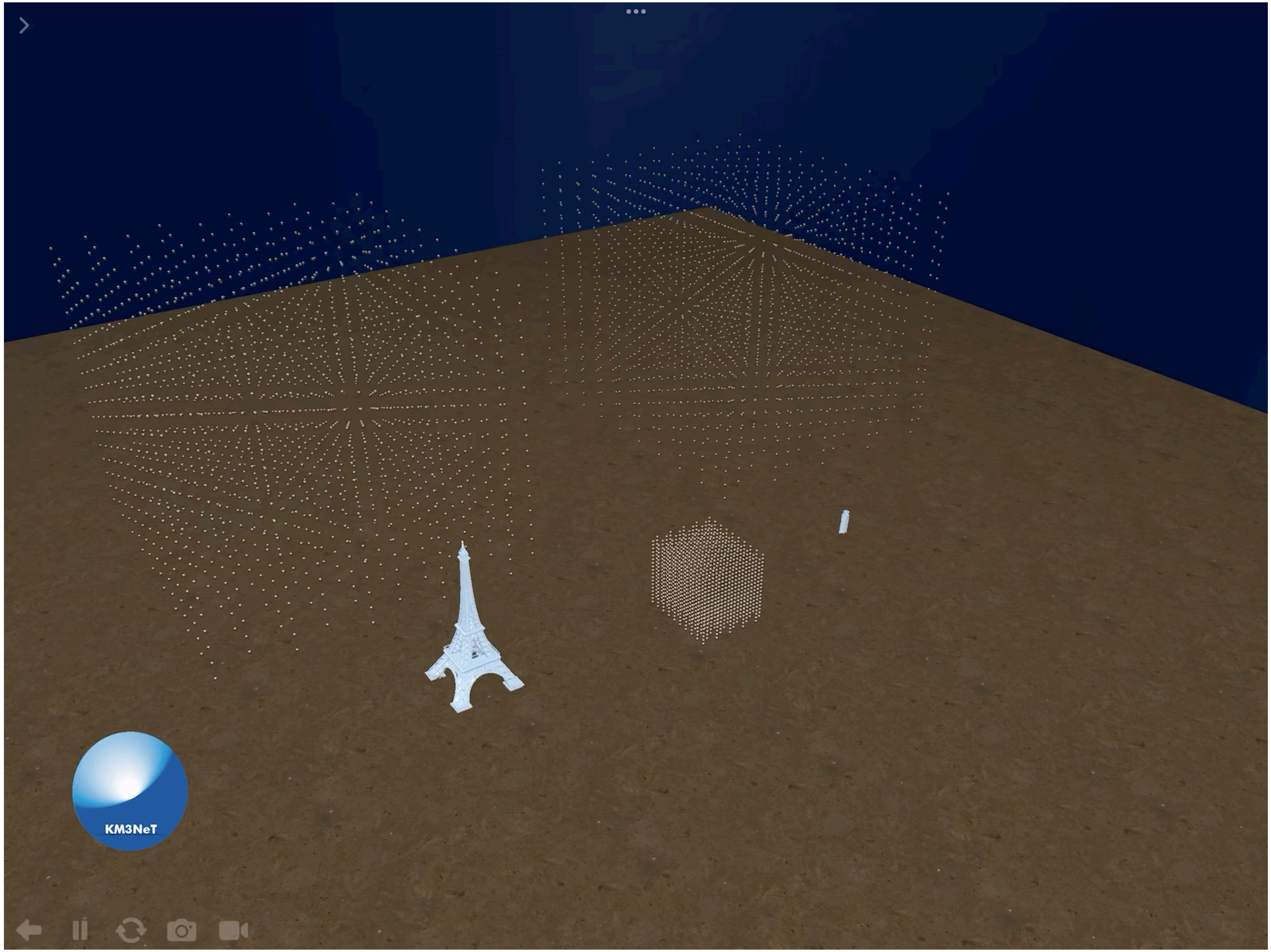
- Which classes of sources contribute to the observed diffuse neutrino flux.
  - IceCube discoveries: Neutrino of cosmic origin discovered from AGN (blazar TXS 0506+056 https://arxiv.org/pdf/1807.08794.pdf and) , active galaxy NGC1068
- Which mechanism is responsible for the neutrino emission p-p or/and p-γ ?
- Which is the flavor composition ?
- Are neutrinos and gammas/CR observed from the same sources?
  - Yes from blazar TXS 0506+056. No from NGC1068
- Which is the contribution of neutrino from the Galactic plane ?
  - Recent discovery from IceCube a cosmic flux (model dependent)
- Production mechanism and origin of neutrino of extreme energies
  - Recent discovery from KM3NeT of a 220 PeV neutrino

The detection principle

Detection principle

The detectors are arrays of optical sensors able to detect Cherenkov light of secondary particle produced in the interaction of neutrinos with the medium surrounding the detector





Detection principle

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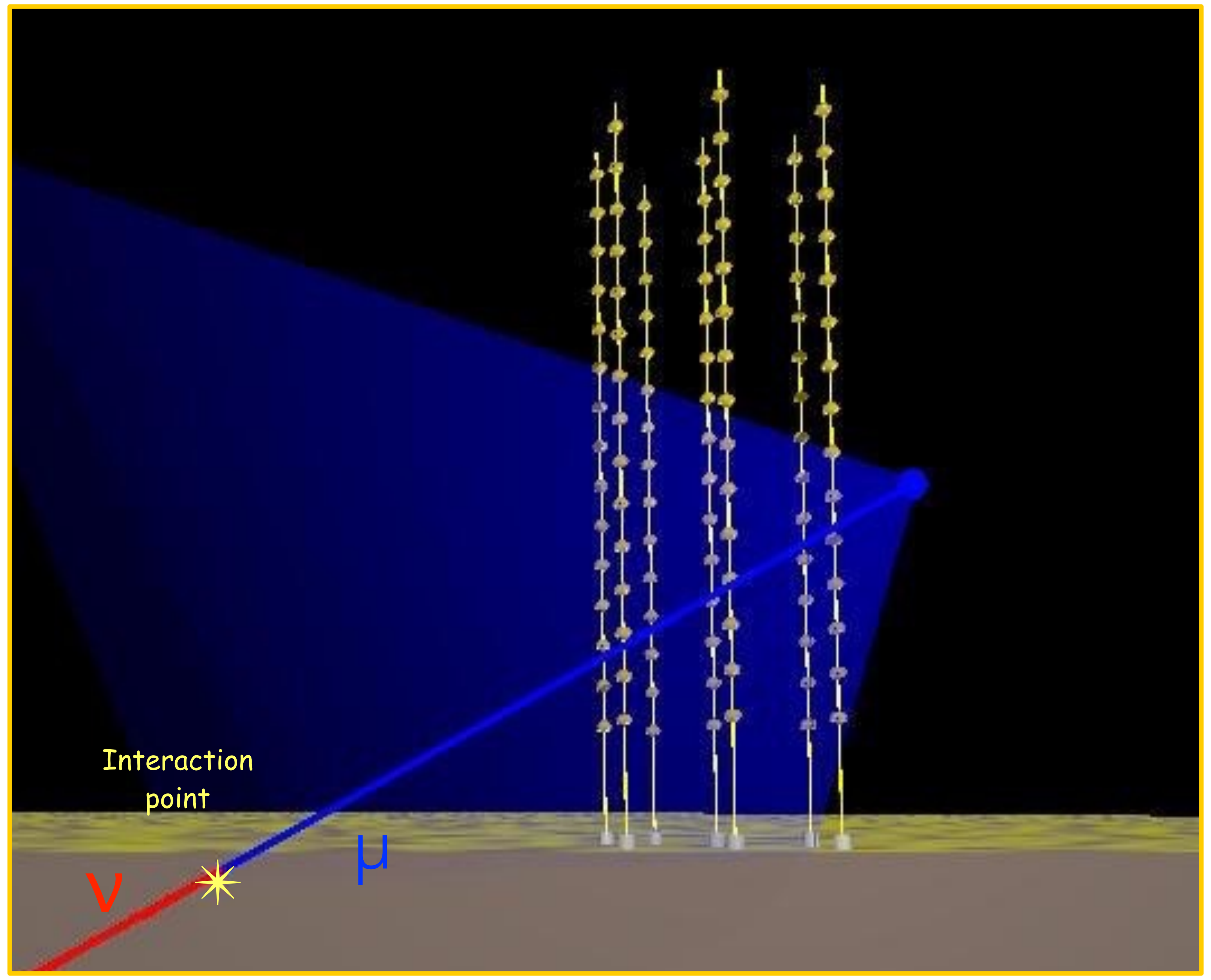
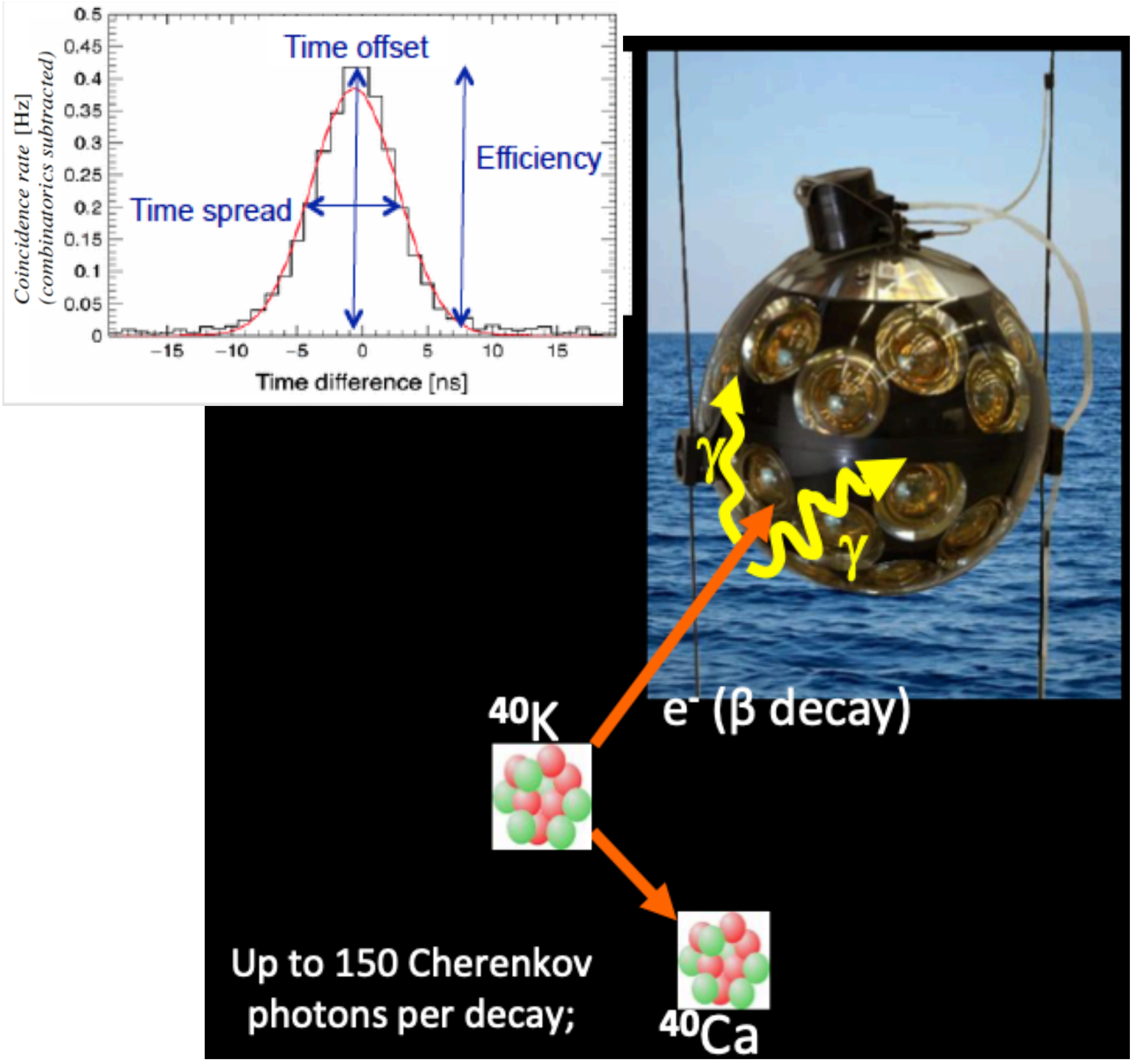


- The neutrinos interact in the water/ice or rocks around the detector and produce secondary particles that emit Cherenkov light in a cone at 42° w.r.t the particle direction.
- Light detected by means of optical sensors (photomultipliers)
- From the arriving time of photons and from the positions of the photomultipliers is possible to determine the direction of the secondary particles.
- If muons, generated by ν_μ, the precision in the reconstruction of the direction is very high (0.1°-0.2°). High energy neutrinos are collinear with muons
- Detection of ν_e also possible

Detector calibration

Time calibration precision at level of 1 ns



From K40 also PMT efficiency

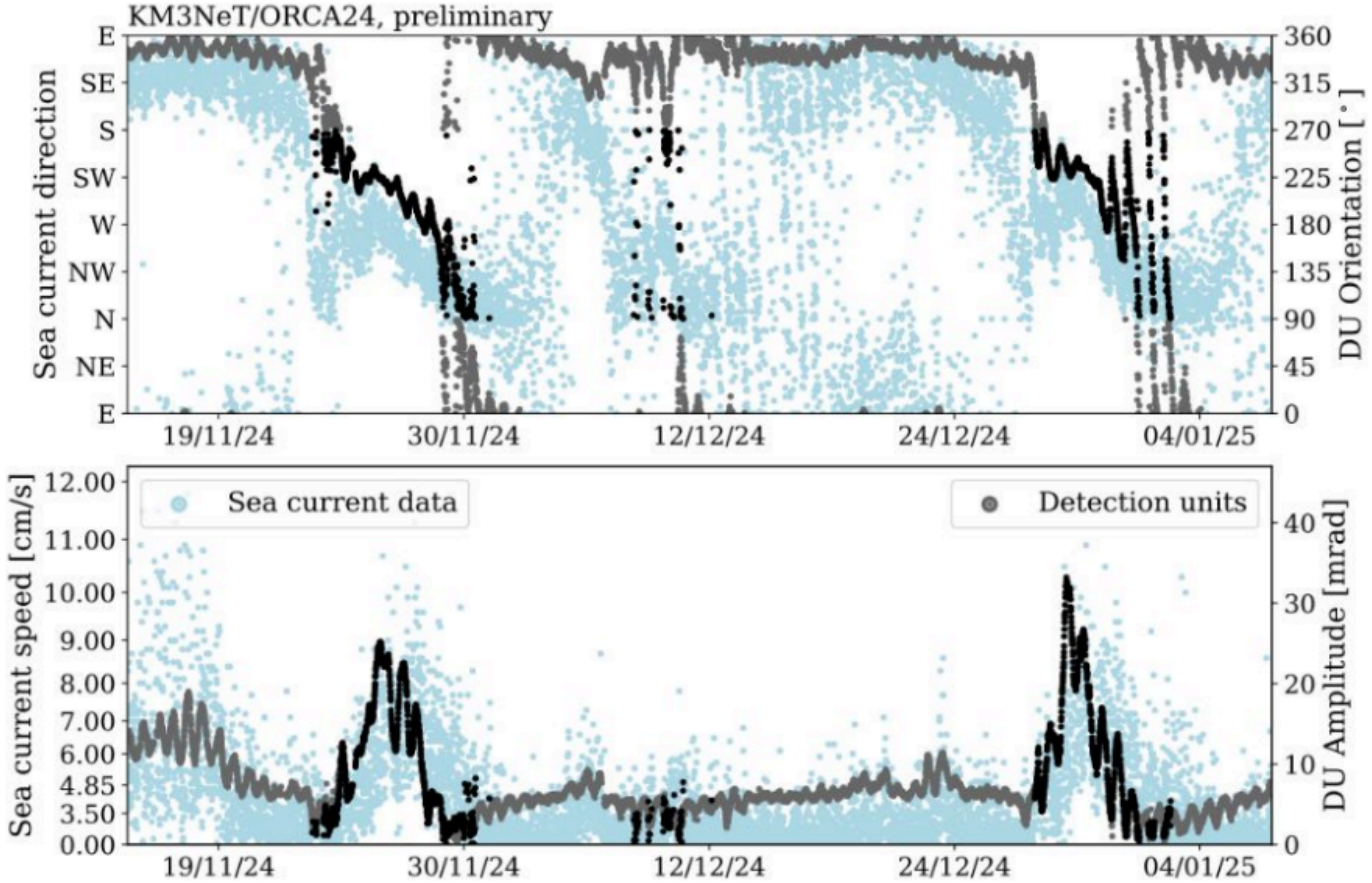
Time offsets:

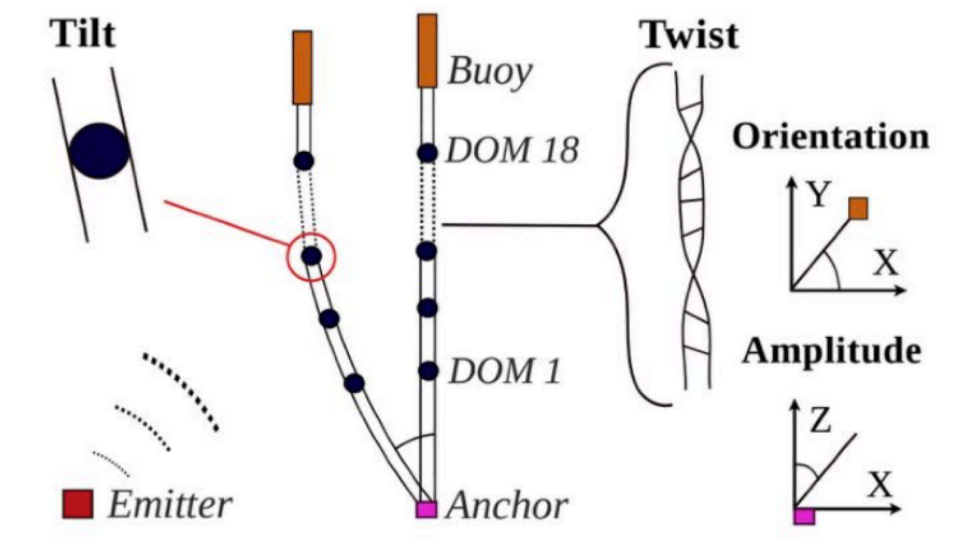
- Intra DOM PMT time offset 👉 K40
- Inter DOM time offset 👉 LED beacon & atm. muons
- Inter Line time offset 👉 White Rabbit based + laser beacon

Atmospheric muons a good probe to test time calibrations

Position measurement precision at level of 10 cm

Based on acoustic beacon and hydrophone & piezo
Measurement each 10 minutes





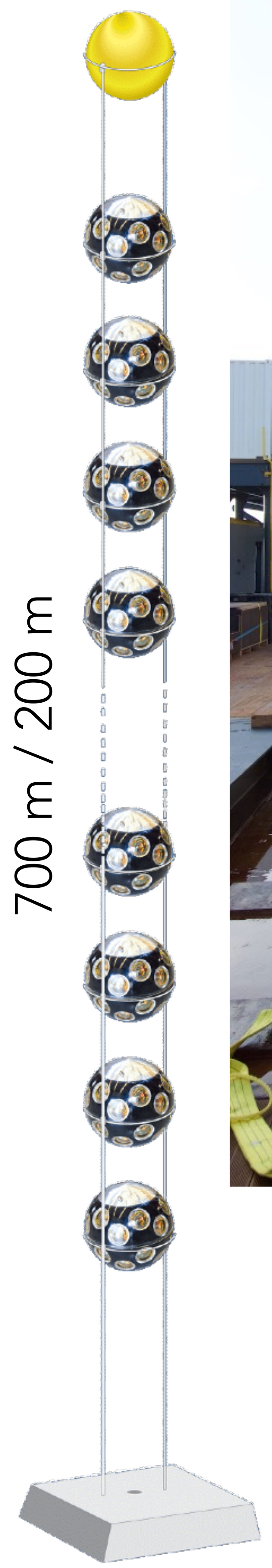
The detector

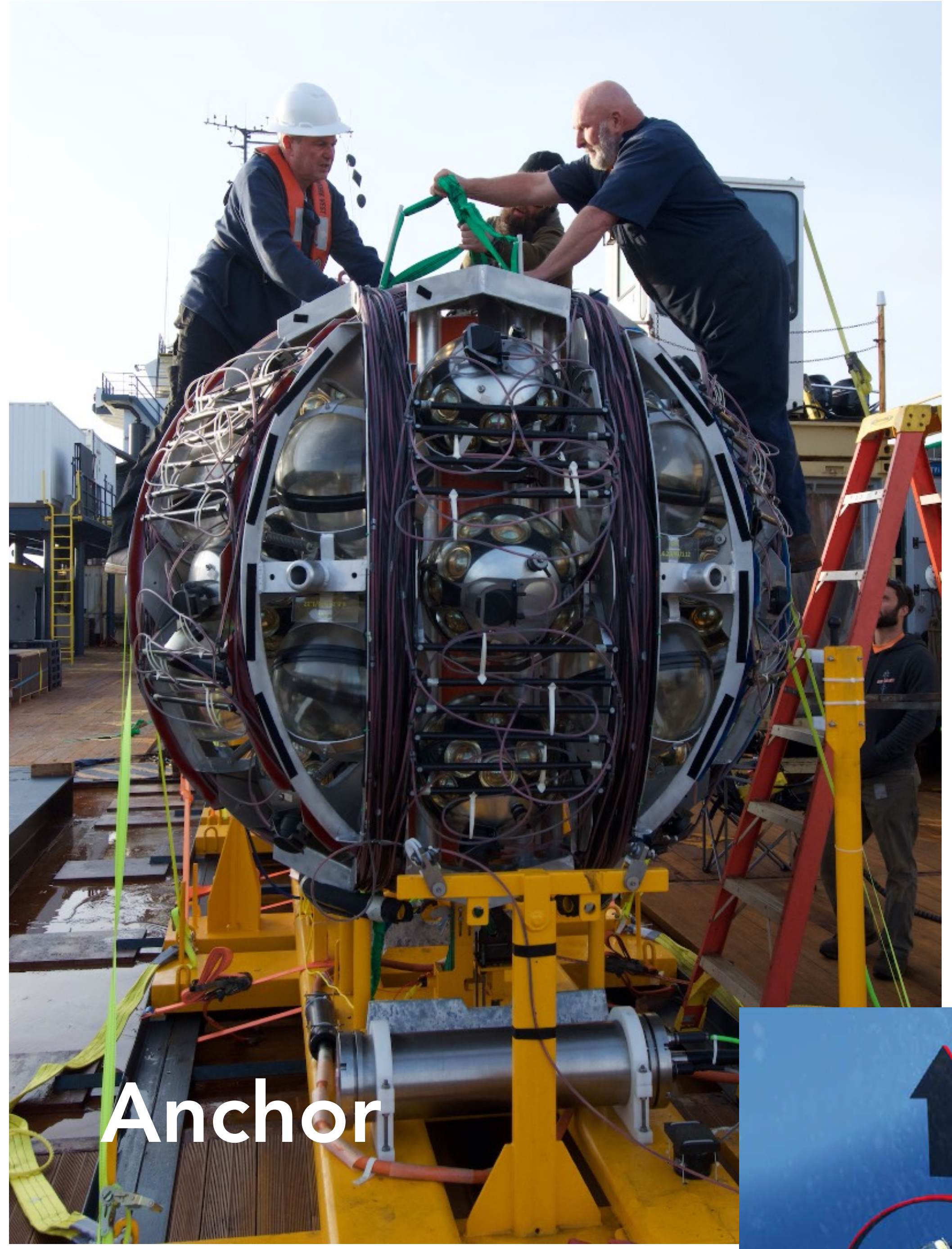
Detector basic elements

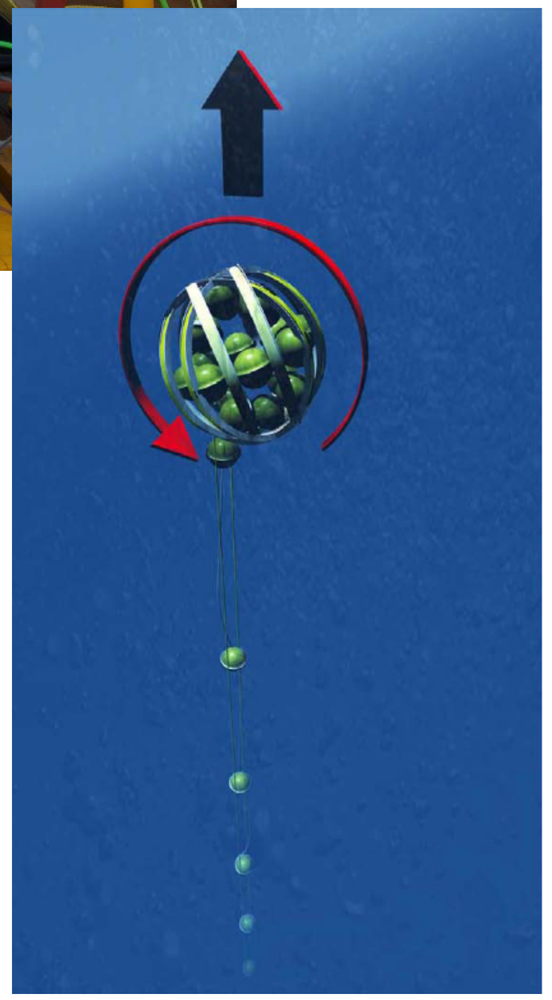
The optical sensor

31 3 inches photomultipliers + electronics inside a glass sphere

The String

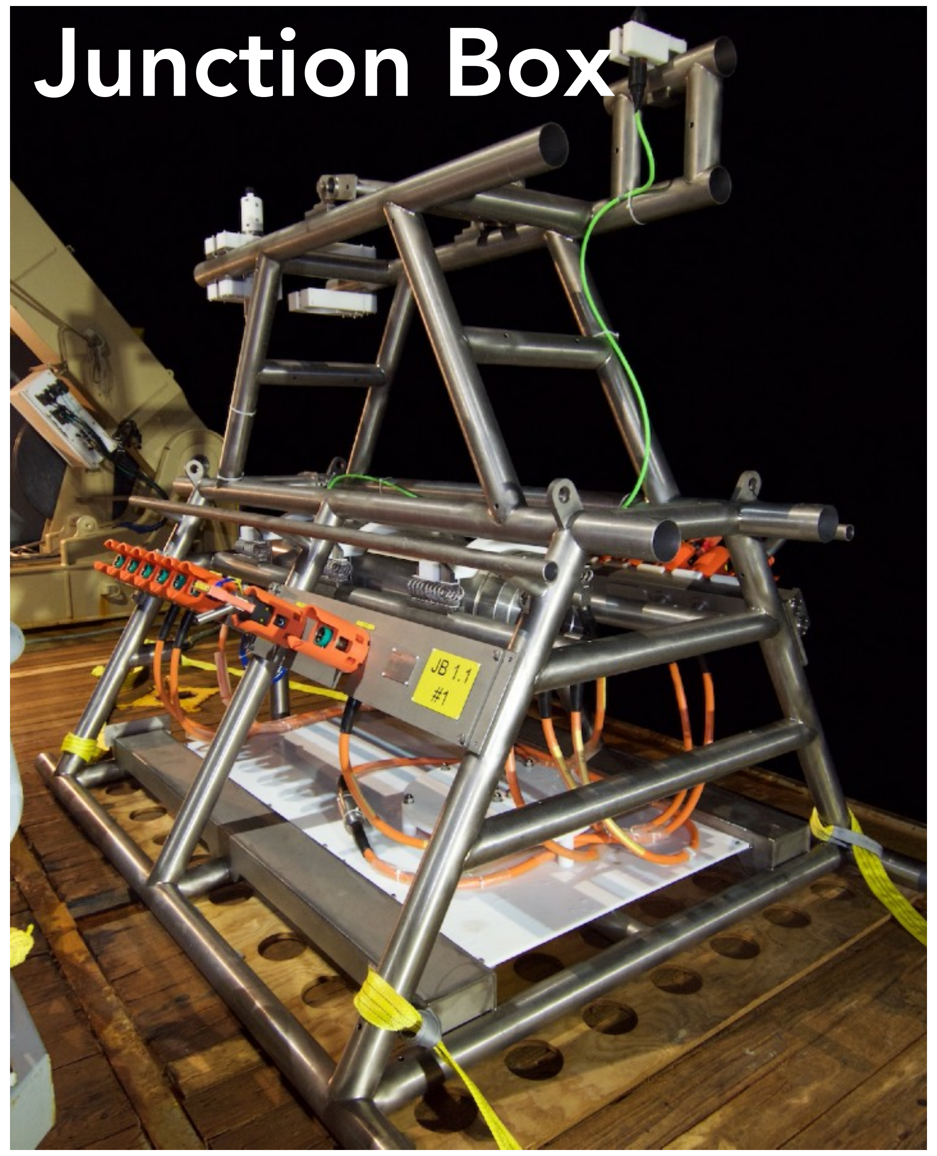






18 optical sensors in a string

The sea floor network



Network of electro-optical cables and Junction-Boxes to distribute power and collect signals from deep sea to shore

The optical sensors

The digital optical module (DOM)

Innovative design

Optical sensors designed and assembled inside the collaboration

Hamamatsu photomultipliers + electronics inside a 17” pressure resistant glass sphere

- 31 PMTs 3 inches (12 in the top hemisphere, 19 in the bottom)
- Readout electronics Gbit/s optical fibre transmission (all data to shore) White Rabbit time synchronisation
- LED beacon for auto-calibration
- Acoustic sensor for position reconstruction
- Tiltmeter/compass chip

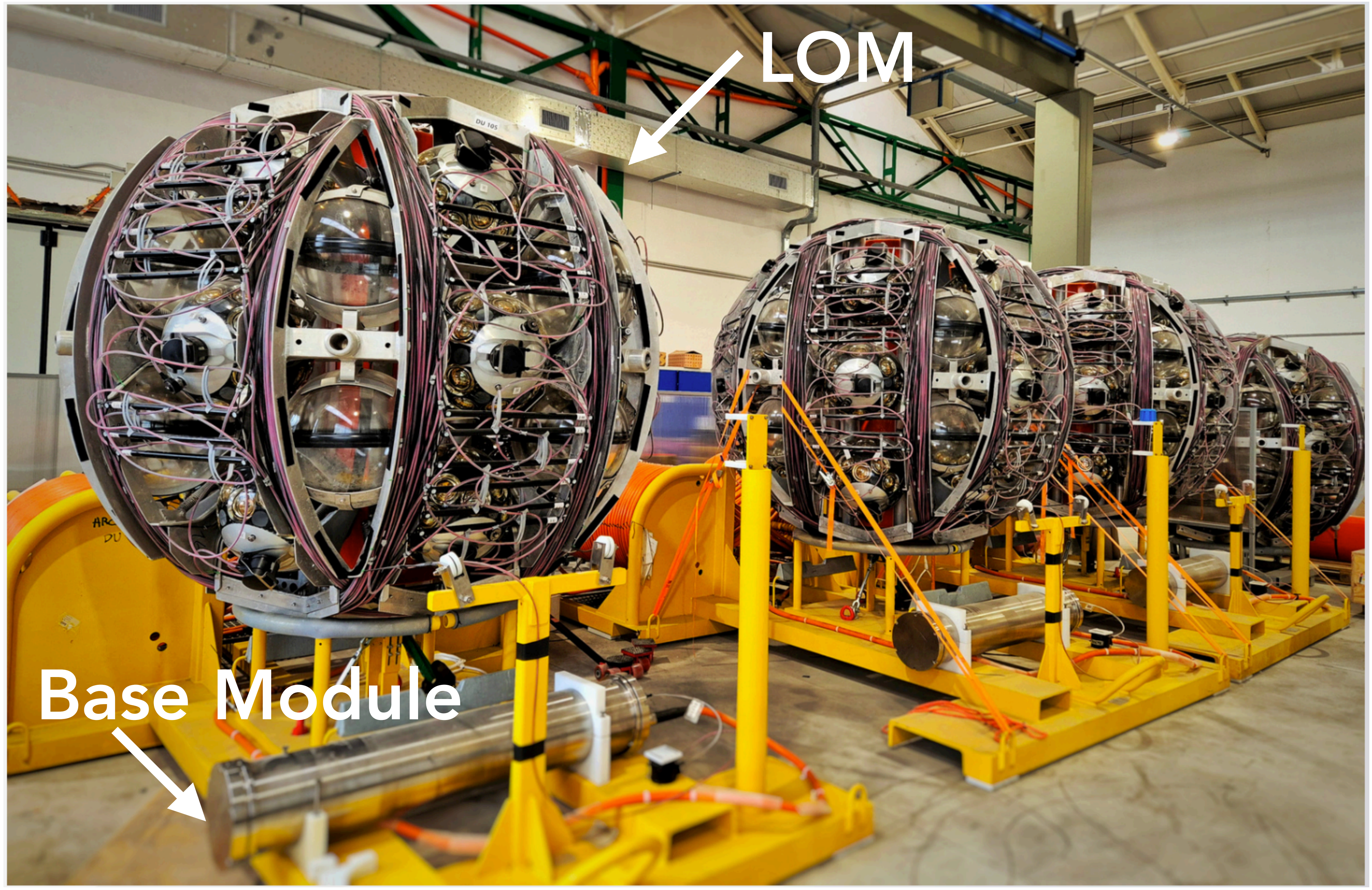
The segmentation of the photocathode area provides sensitivity for the incoming direction of the detected photons, and, in combination with the nanosecond timing accuracy, an effective tool for the reduction of background from light induced by 40K decay and bioluminescence in seawater

The Detection Unit

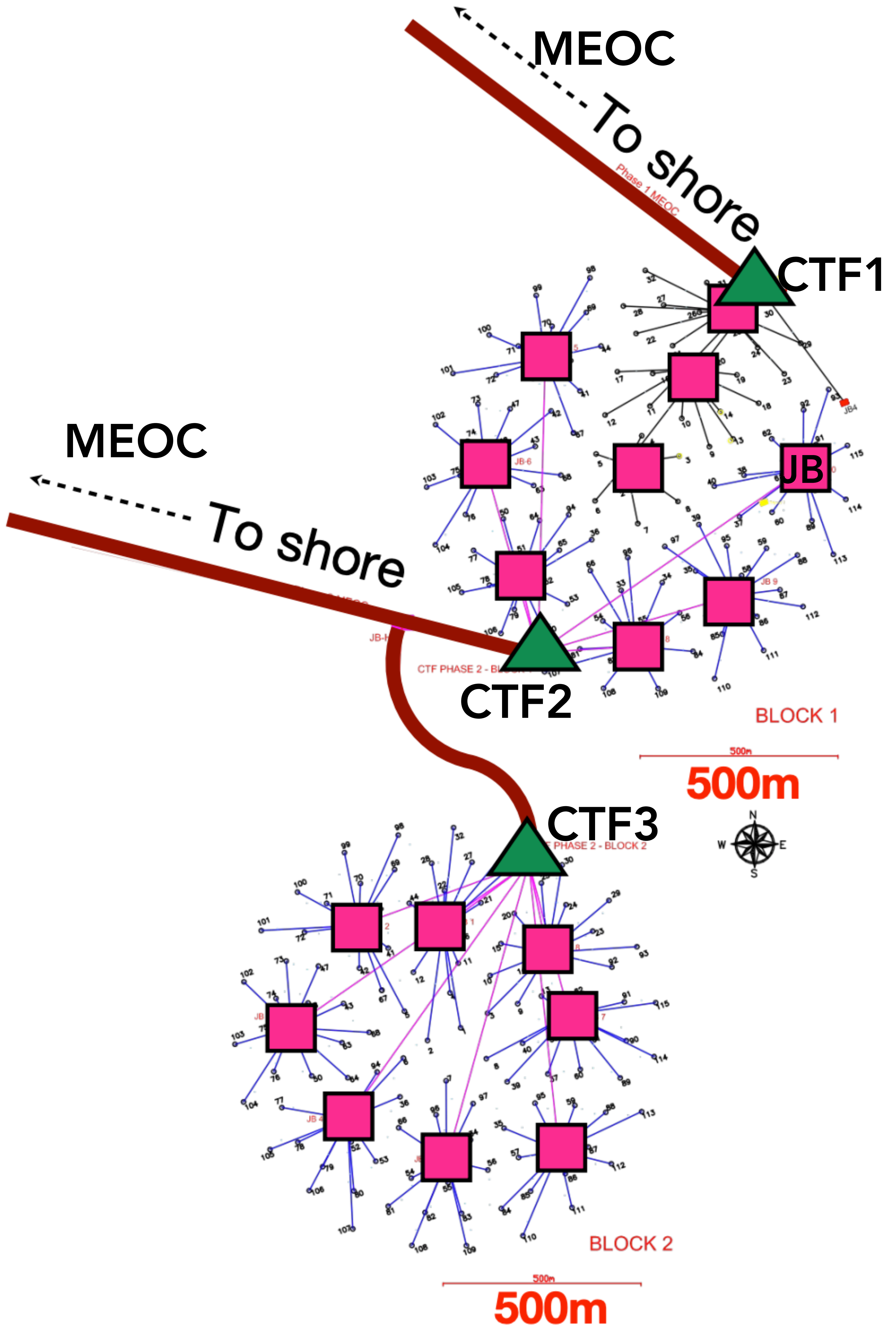
18 DOMs are connected by a Vertical ElectroOptical Cable: a Pressure-compensated oil-filled polyethylene (PE) assembly.

VEOC this connected to the Base Module. It collects the data arriving from the 18 DOMs via the VEOC. Packs and transmits data to the on-shore station through the sub-marine infrastructure. Distributes to the DOMs the power and the communications broadcasted from shore

These 18 connected DOMs are systematically loaded to a Launcher Optical Modules



The Sea floor network



2 Main Electro-Optical Cables (MEOC)

3 cable termination frame (2 deployed)

9 + 8 Junction Boxes (JB) (5 deployed)

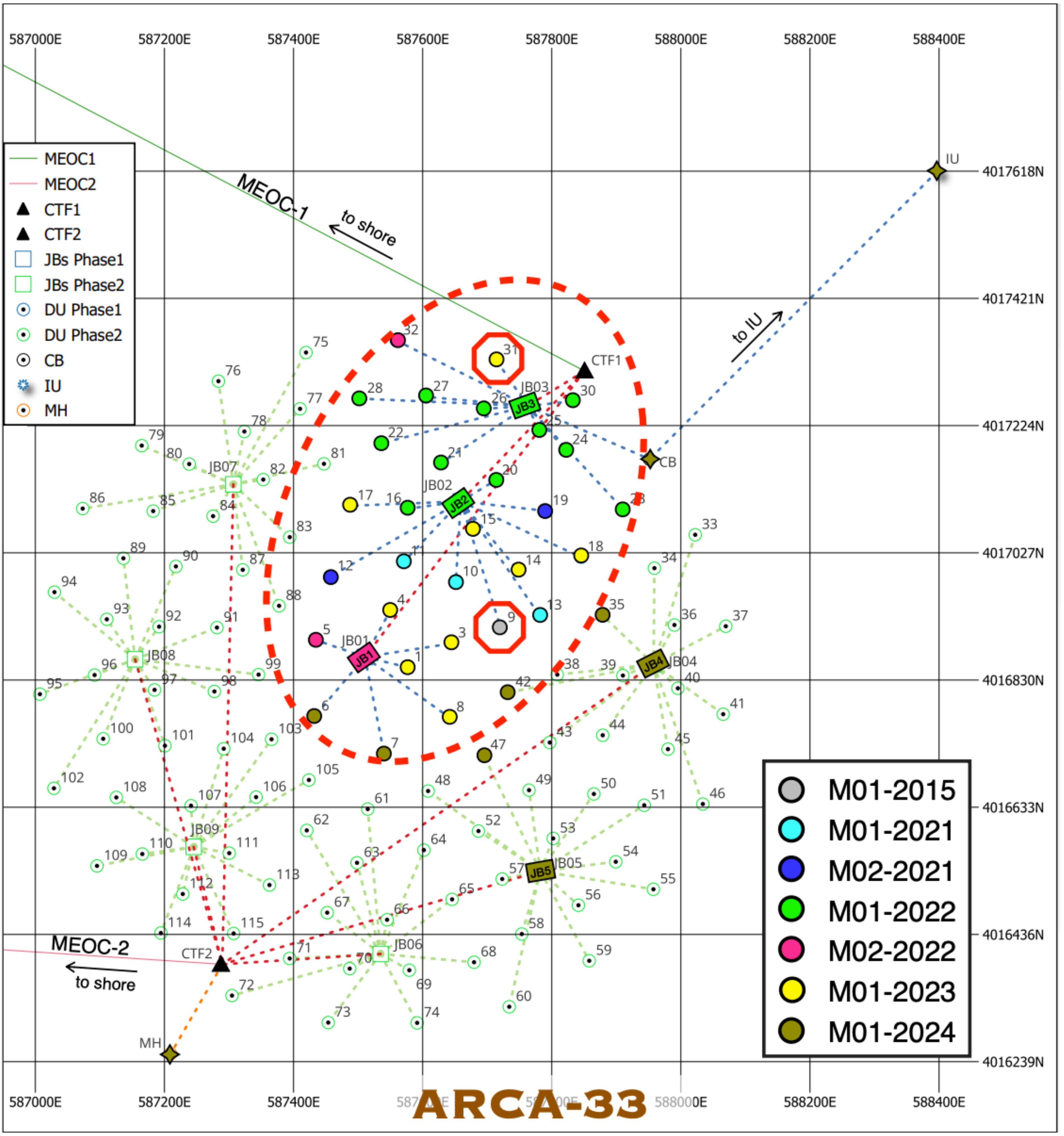
A network of Interlink cables: from JB to CTF and from DU to JB

Status

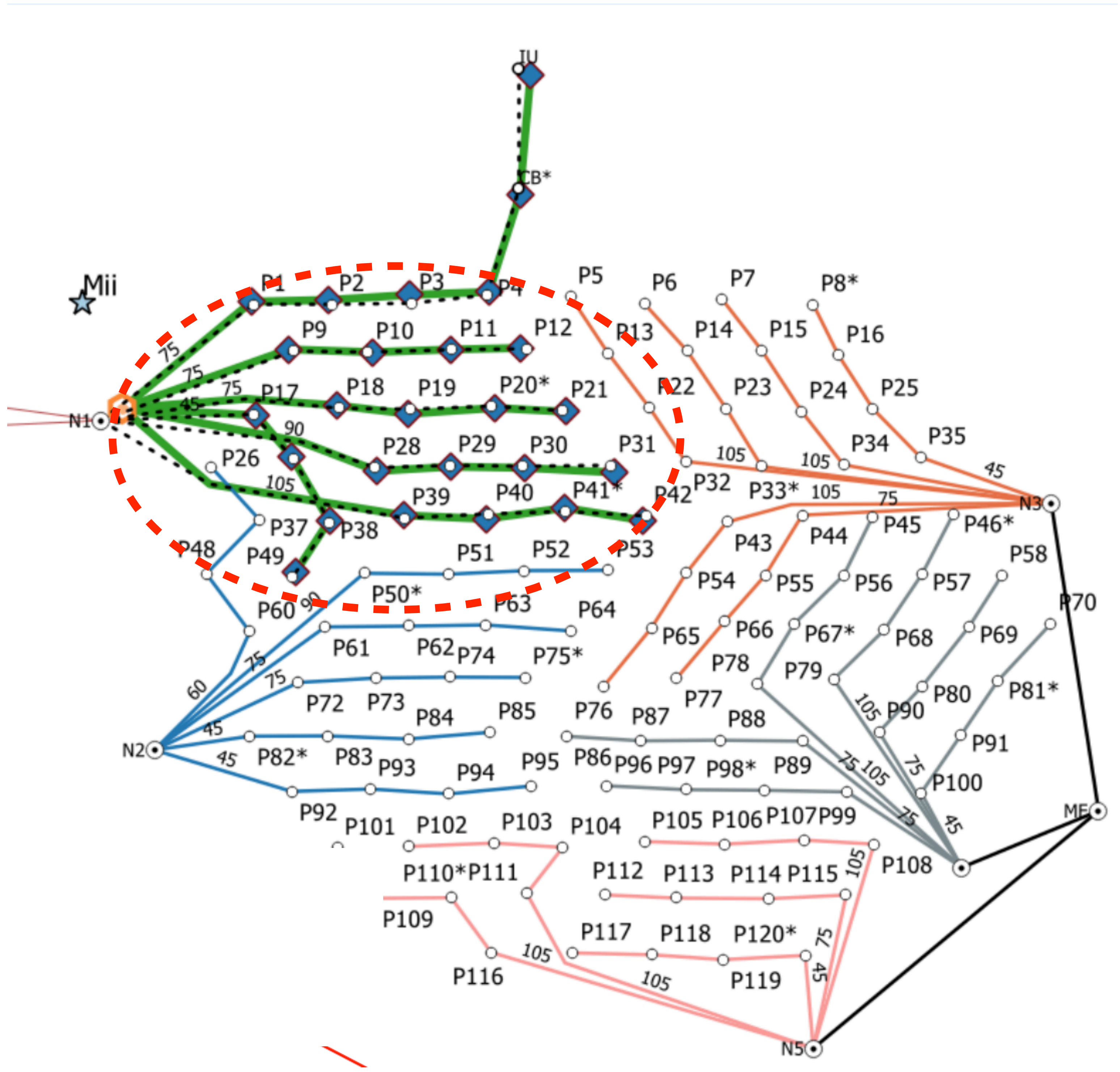
KM3NeT status

KM3NeT detectors are under construction

ARCA



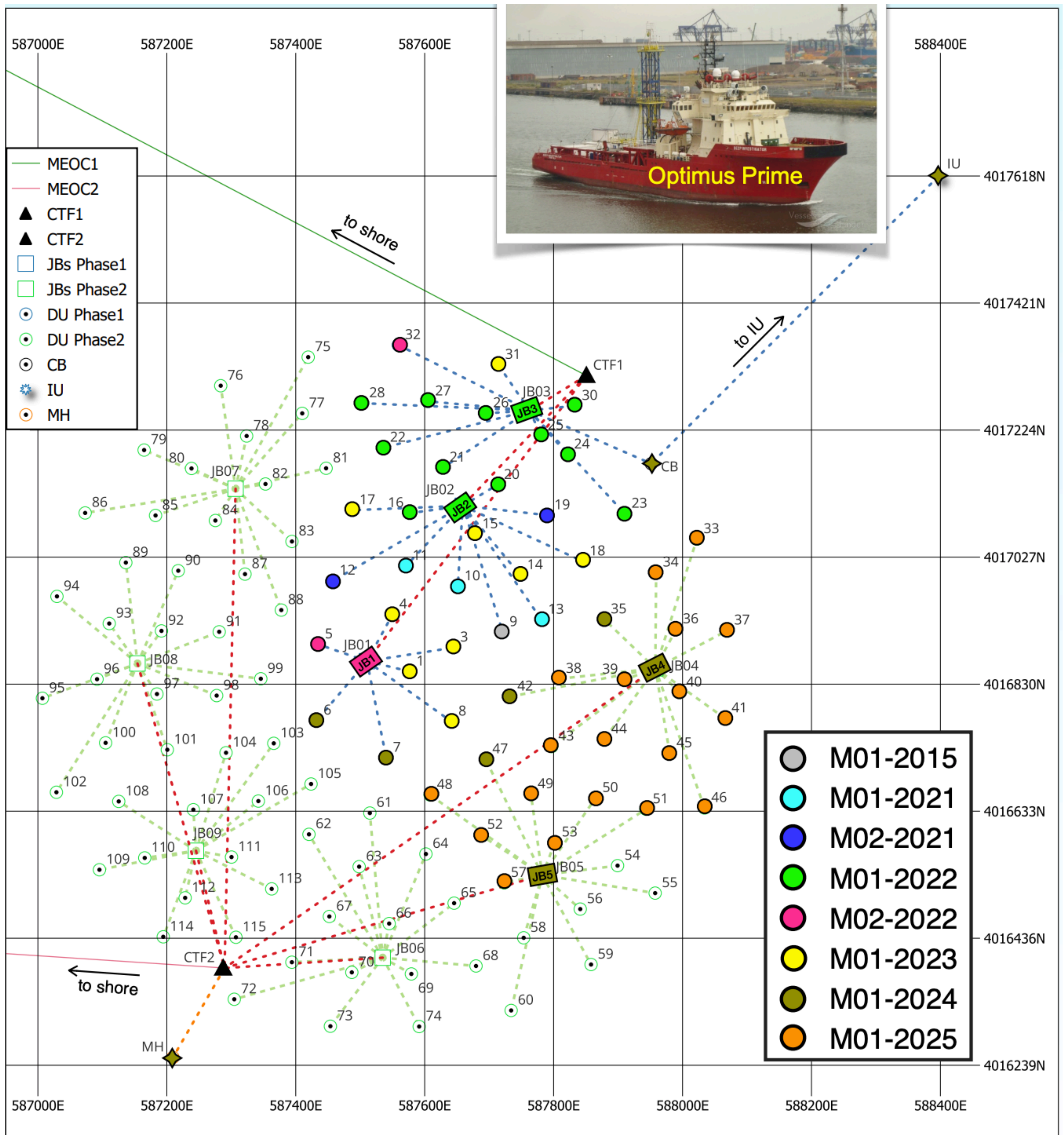
ORCA



Present Status

- ARCA 33 strings deployed (30% of one building block). 3 taking data
- ORCA 28 strings deployed (24% of the full detector). 24 taking data

The next ARCA sea campaign



Sailing from Malta: July 8th
Return to Malta: July 23rd

Campaign split in two hitches

July sea campaign plan

- 19 DUs
- 3 Trypod Autonomous Beacons (TAB)
- Inspection CTF-1
- Absolute position measurement

Main results

The KM3NeT ultra-high-energy event

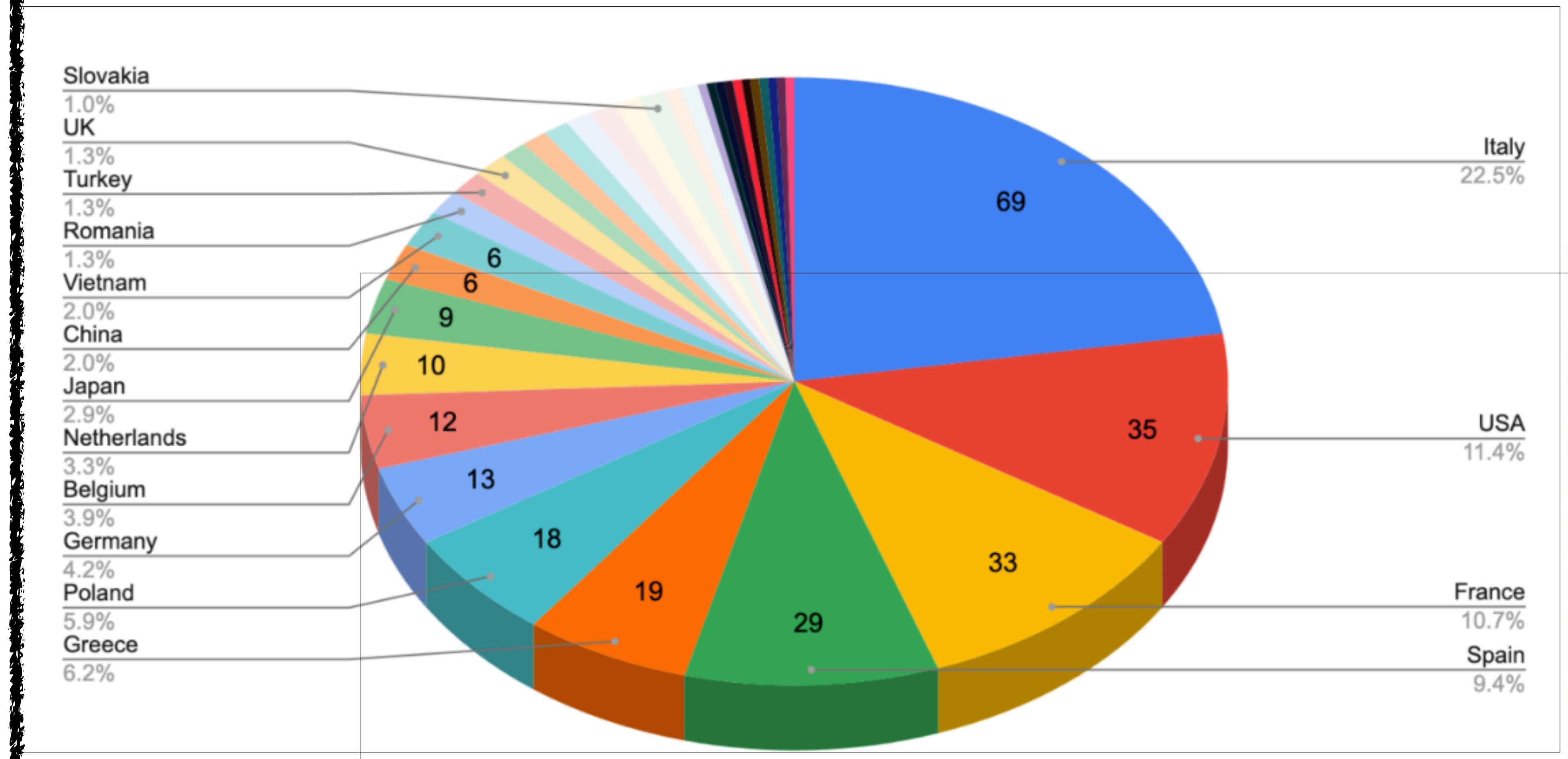
Publication on Nature the 12 of February 2025 - Nature 638, 376–382 (2025) and public announcement on youtube

The February 13 2023 an event with the highest energy ever seen has been detected with ARCA when it consisted of 21 Lines

The KM3NeT detector has observed a cosmic neutrino with energy well above 100 PeV (petaelectronvolt)

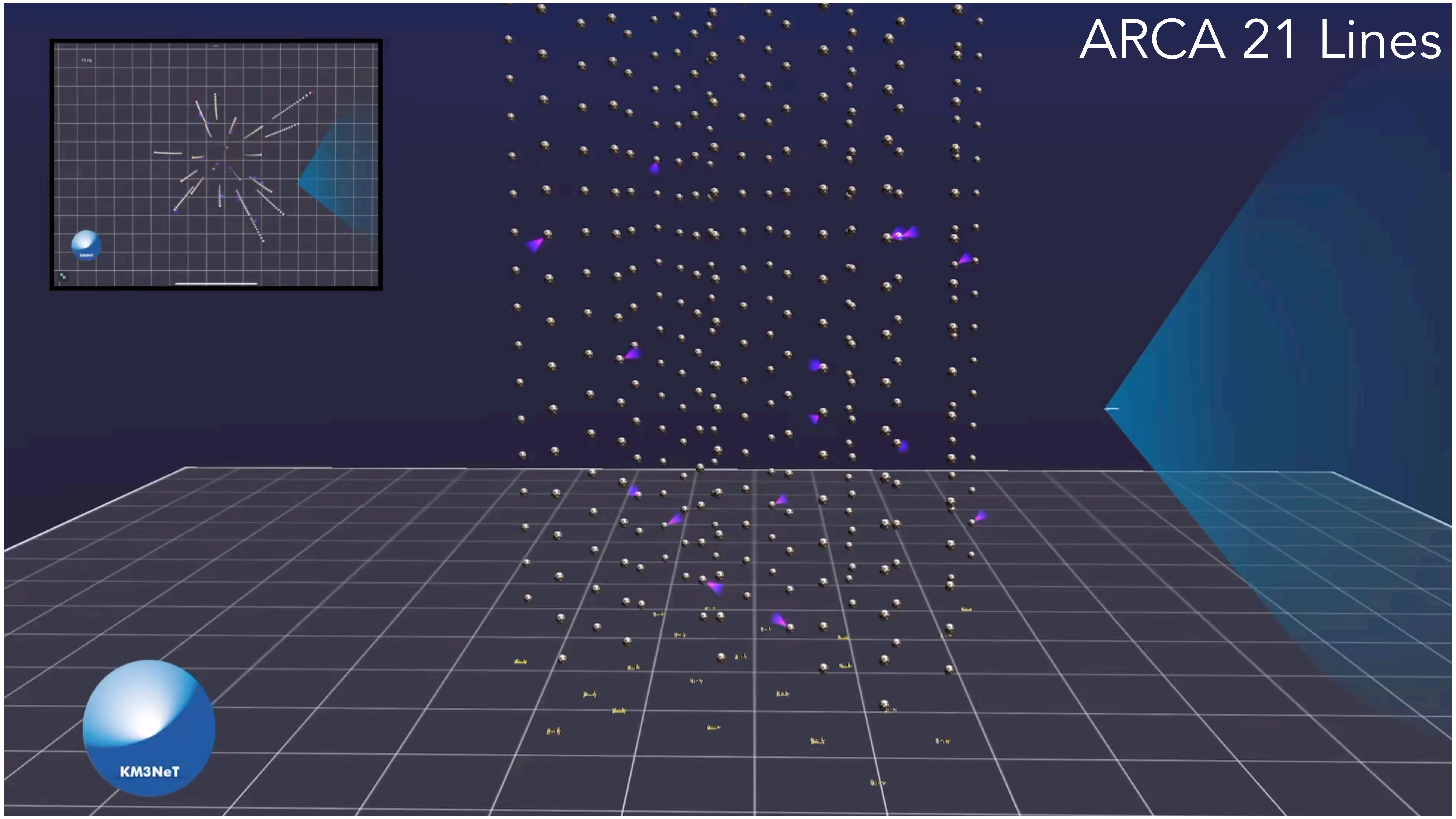
30 times higher the most energetic neutrino detected so far

306 articles/media appearances in 35 countries



The KM3NeT ultra-high-energy event

Huge amount of light detected 👉 35% of the total number of photomultipliers were triggered



- **Energy is measured from the amount of light:**

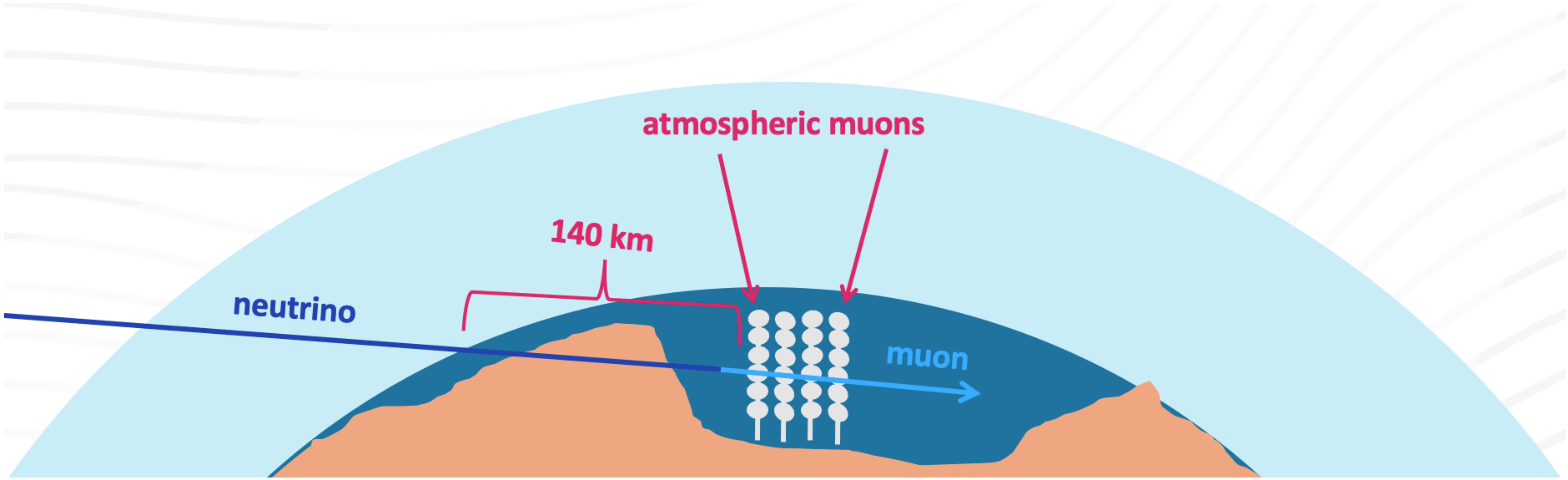
$$E_\mu = 120^{+110}_{-60}\ \mathrm{PeV}$$

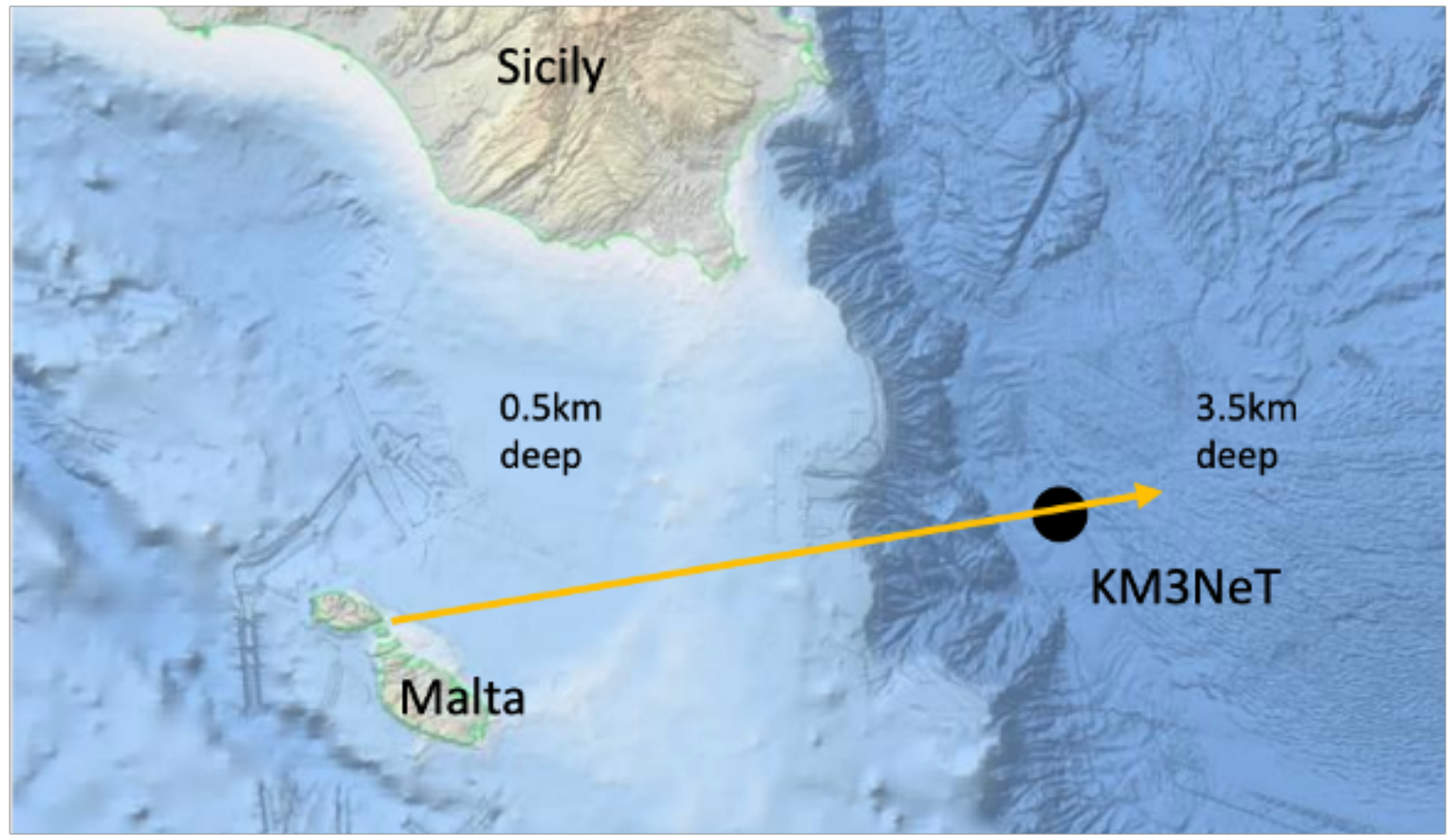
(10 000 times the energy of the LHC)

- **The neutrino Energy is higher:**

$$E_\nu = 220^{+570}_{-100}\ \mathrm{PeV}$$

The KM3NeT ultra-high-energy event

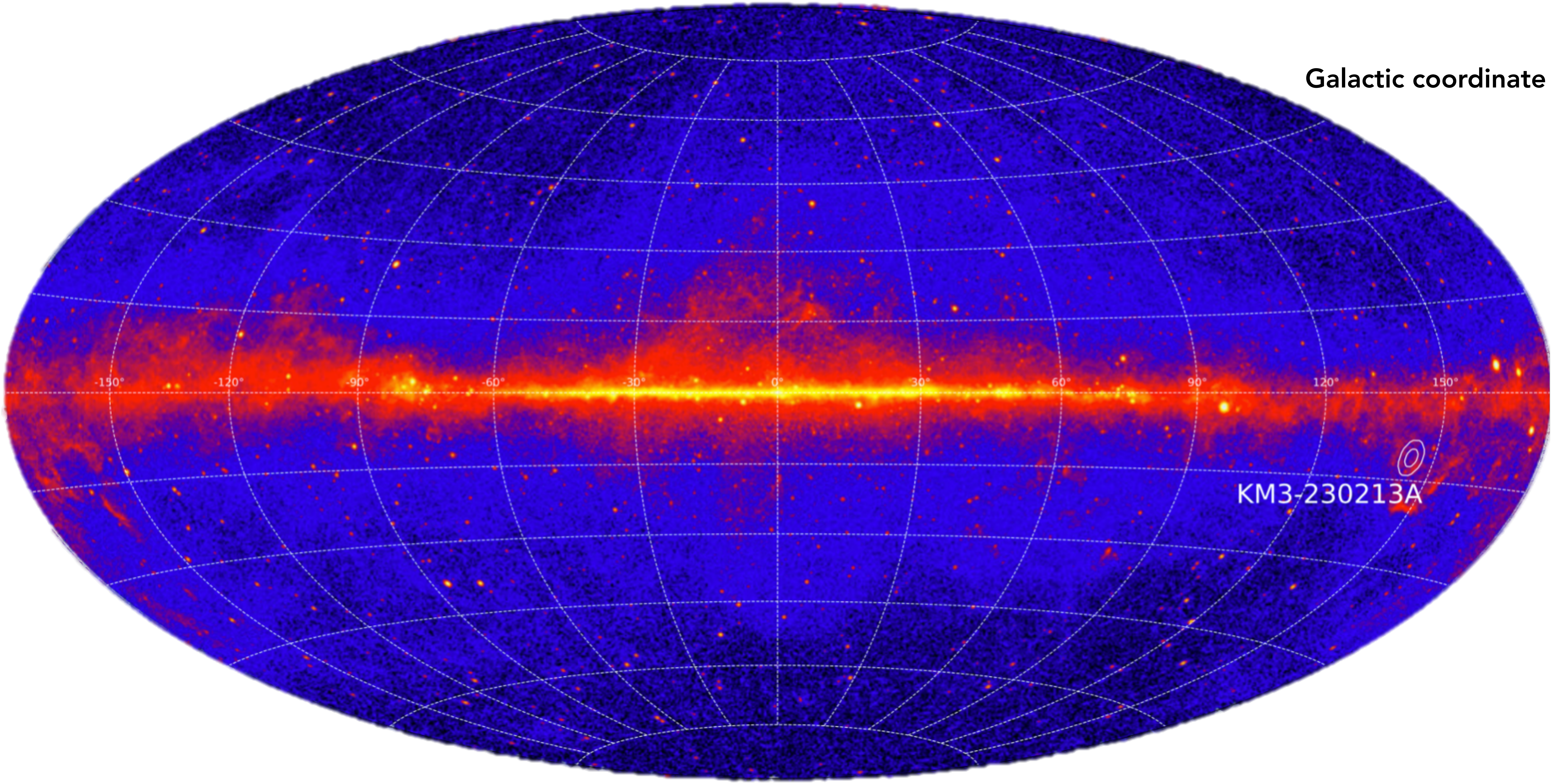




- It is not an atmospheric neutrino or atmospheric muon background
  - Given the detected energy and direction the expected rate of atmospheric muon is « 10^{-10} per year.
  - At this energies (>100 PeV) the expected rate of an atmospheric neutrino (prompt component) is of 1–5 10^{-5} events per year

The KM3NeT ultra-high-energy event

We can measure the neutrino direction with high precision



The KM3NeT ultra-high-energy event

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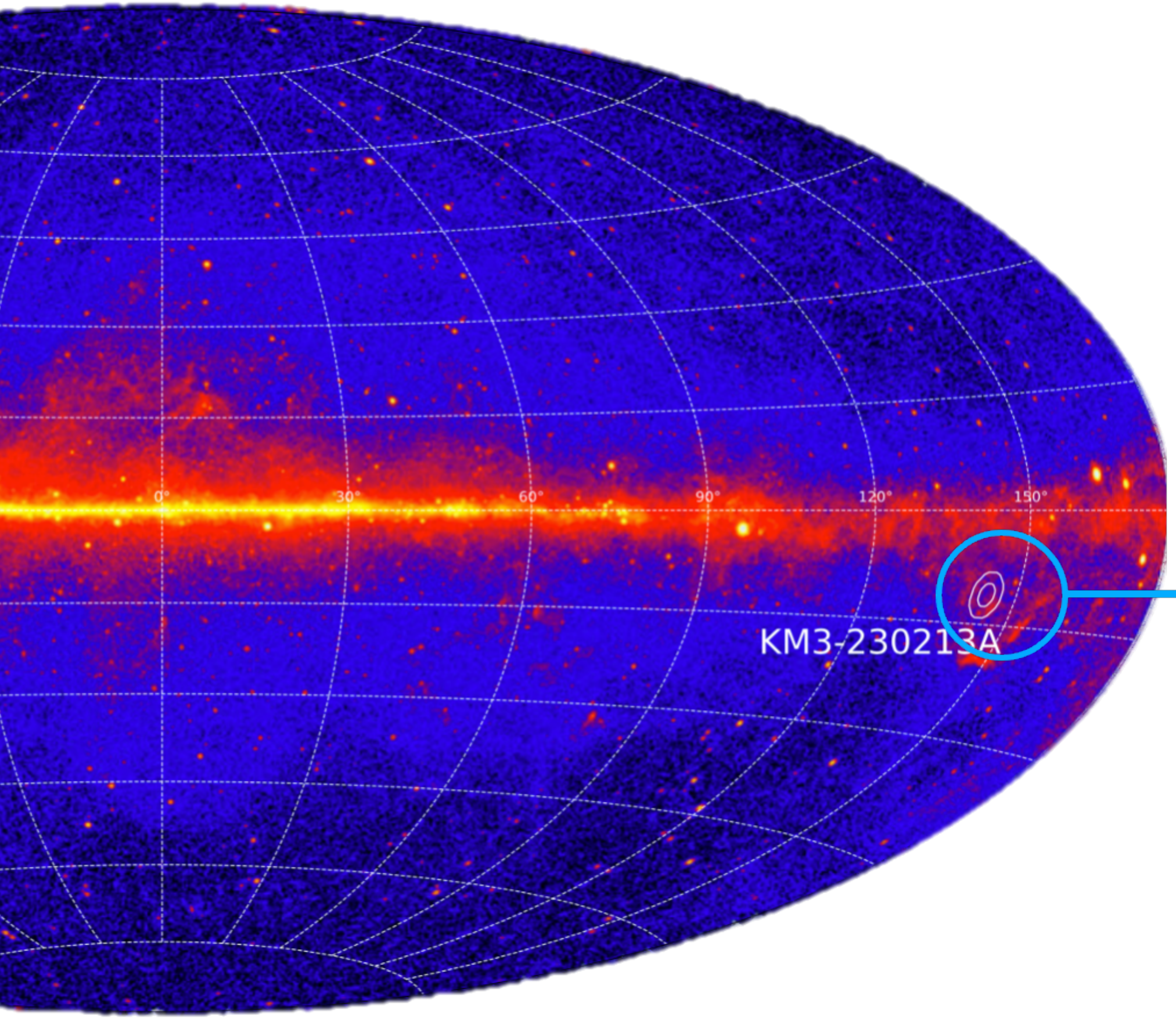
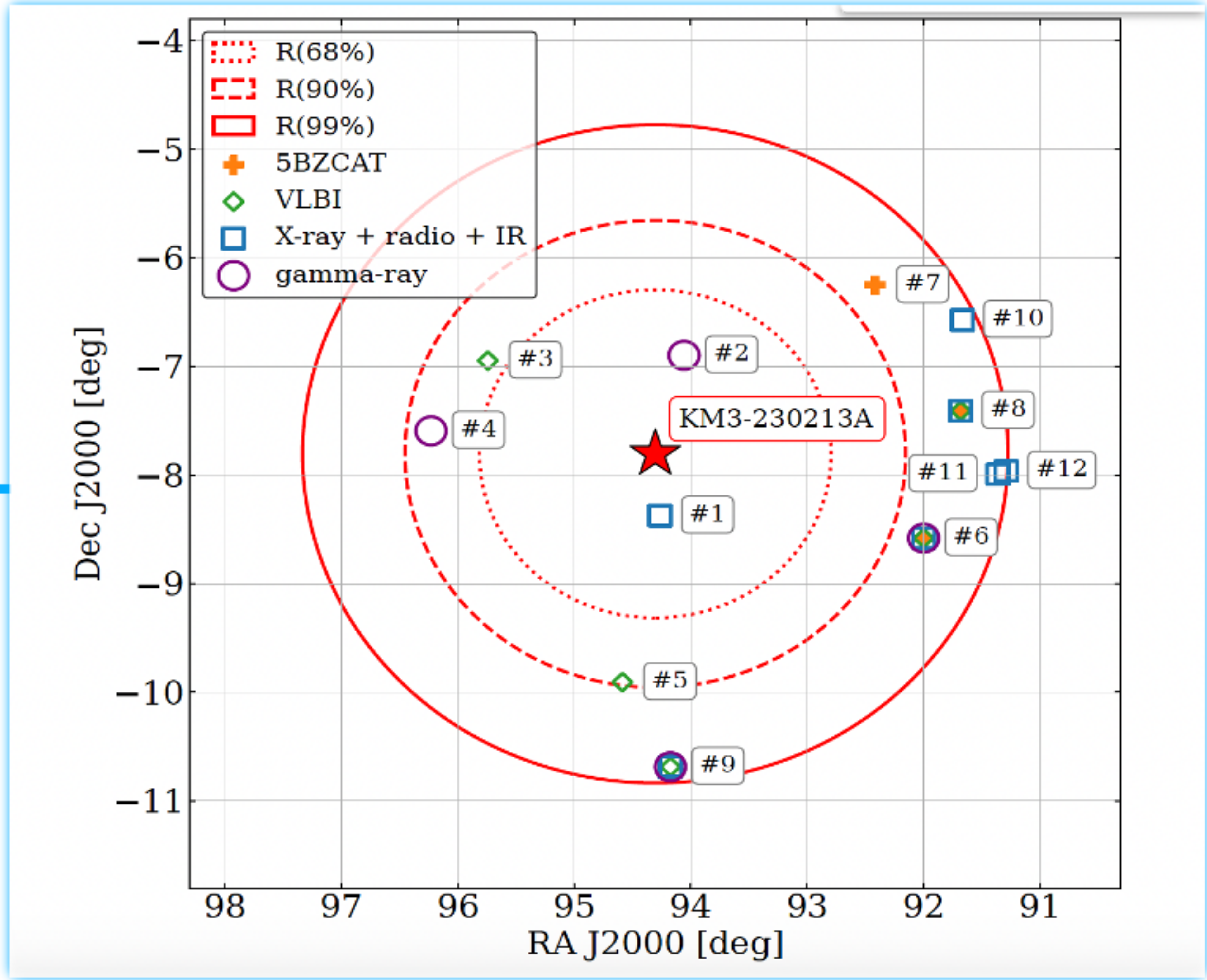
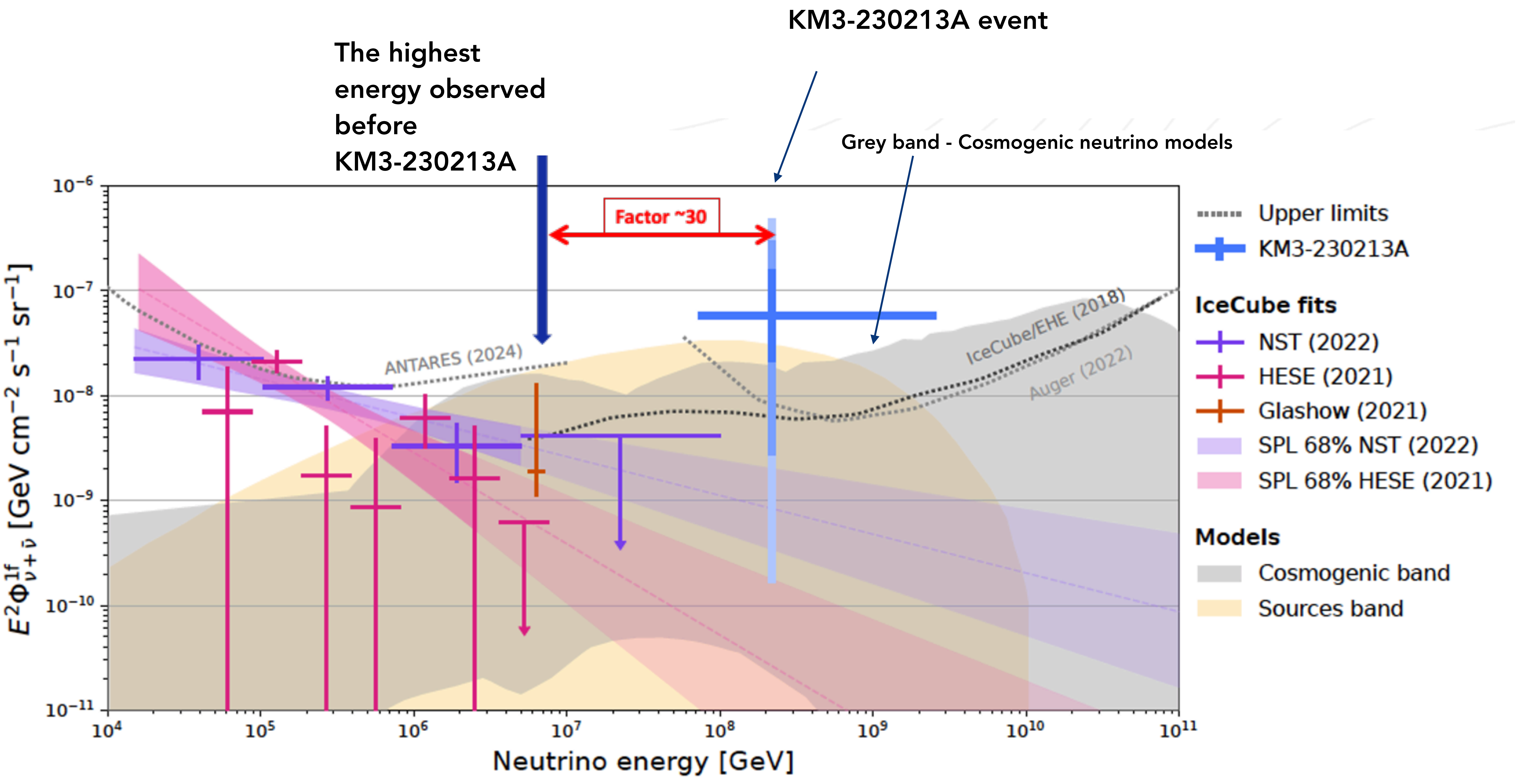




No strong correlation was found with any source

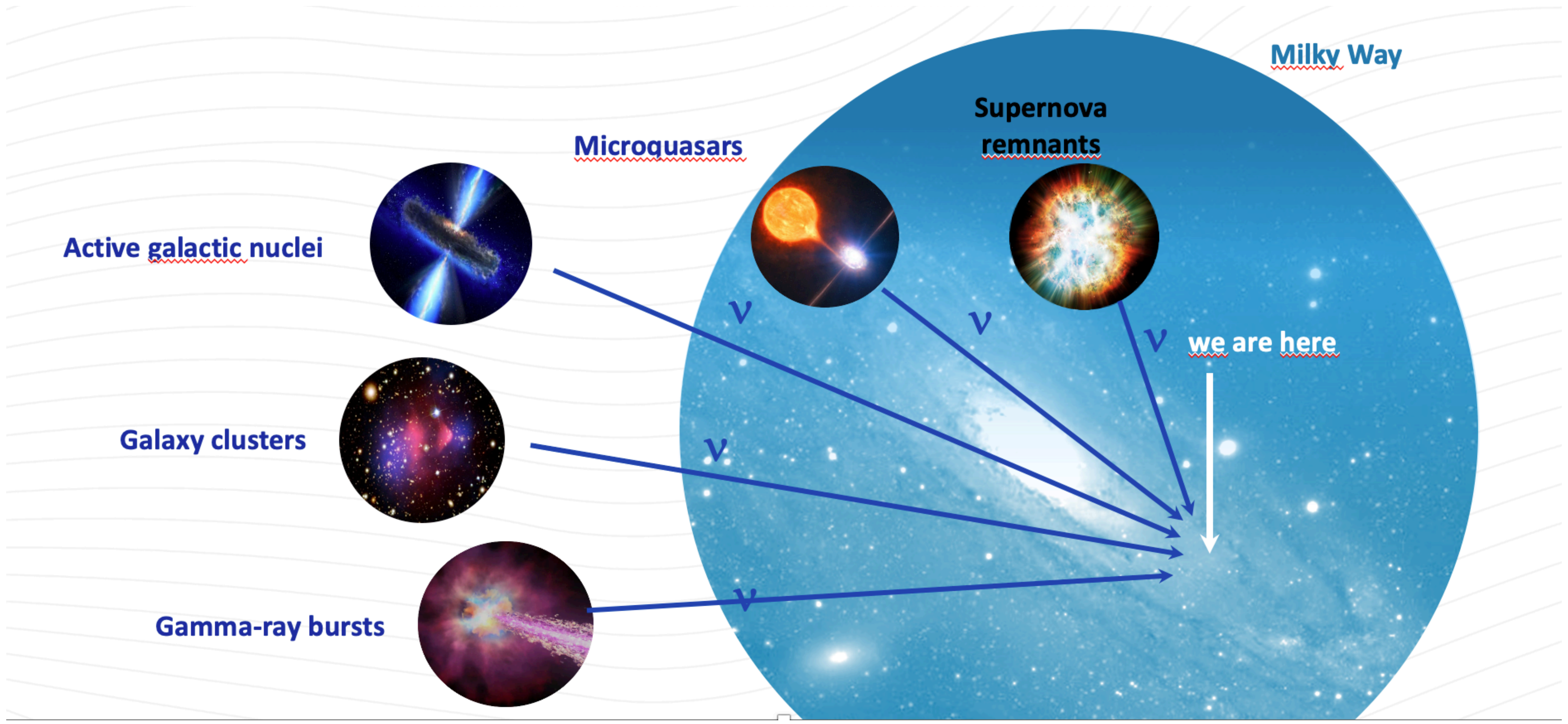
The Ultra-High-Energy: KM3-230213A



The possible origin

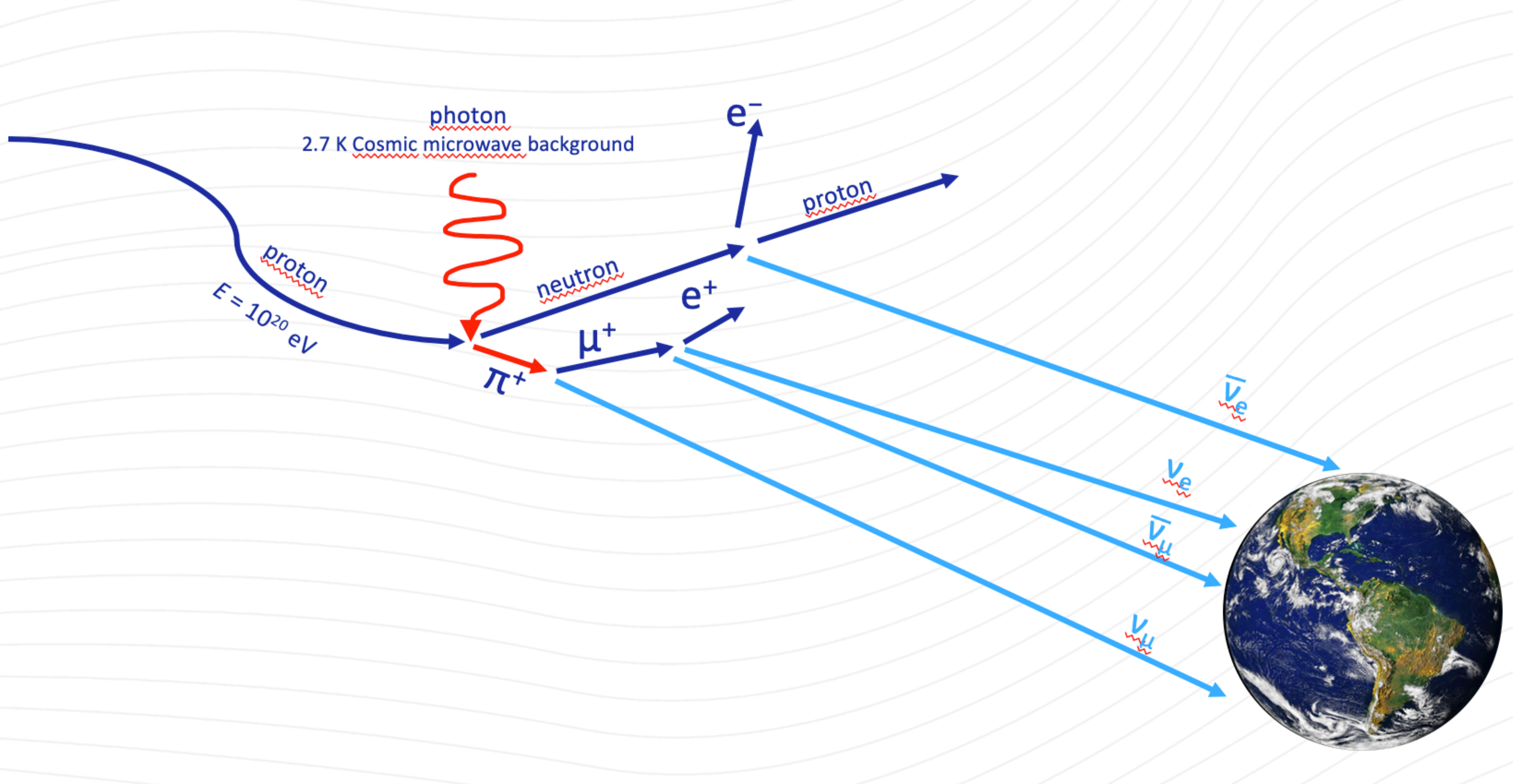
Neutrino sources

In the universe there are very powerful accelerators where particles can reach much higher energies than in the most powerful accelerators in our laboratories



Cosmogenic Neutrinos

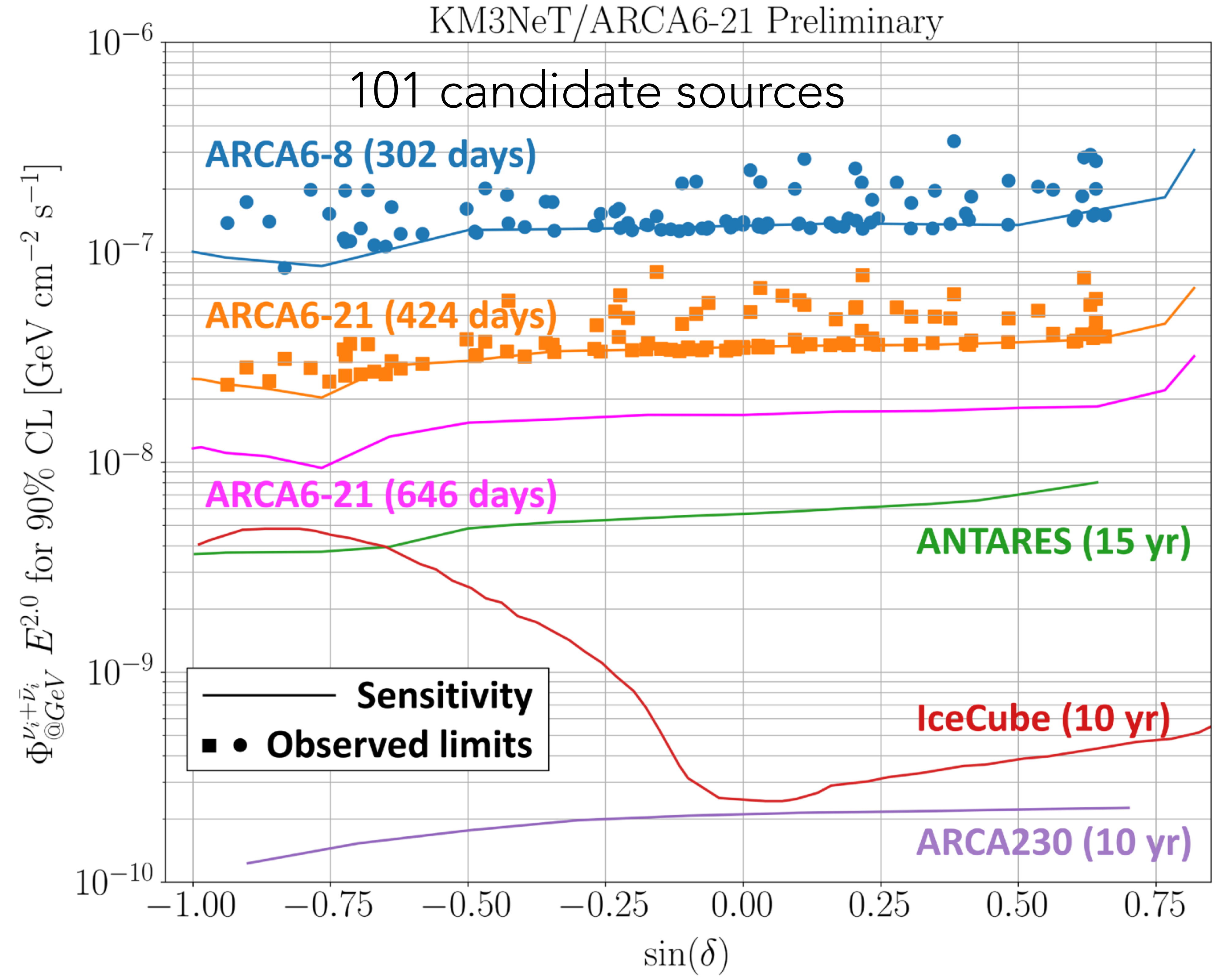
Ultra high energy neutrinos can also be produced in the interaction of Ultra High Cosmic Rays, in particular protons, with the photons of the intergalactic cosmic background (mainly with the Cosmic Microwave background). They are detected at Earth as a diffuse neutrino flux and are called cosmogenic neutrinos



More exotic interpretations also possible

Search for point-like sources

ARCA21 unblinded until December 2022
Unblinding of ARCA21 data full period expected very soon

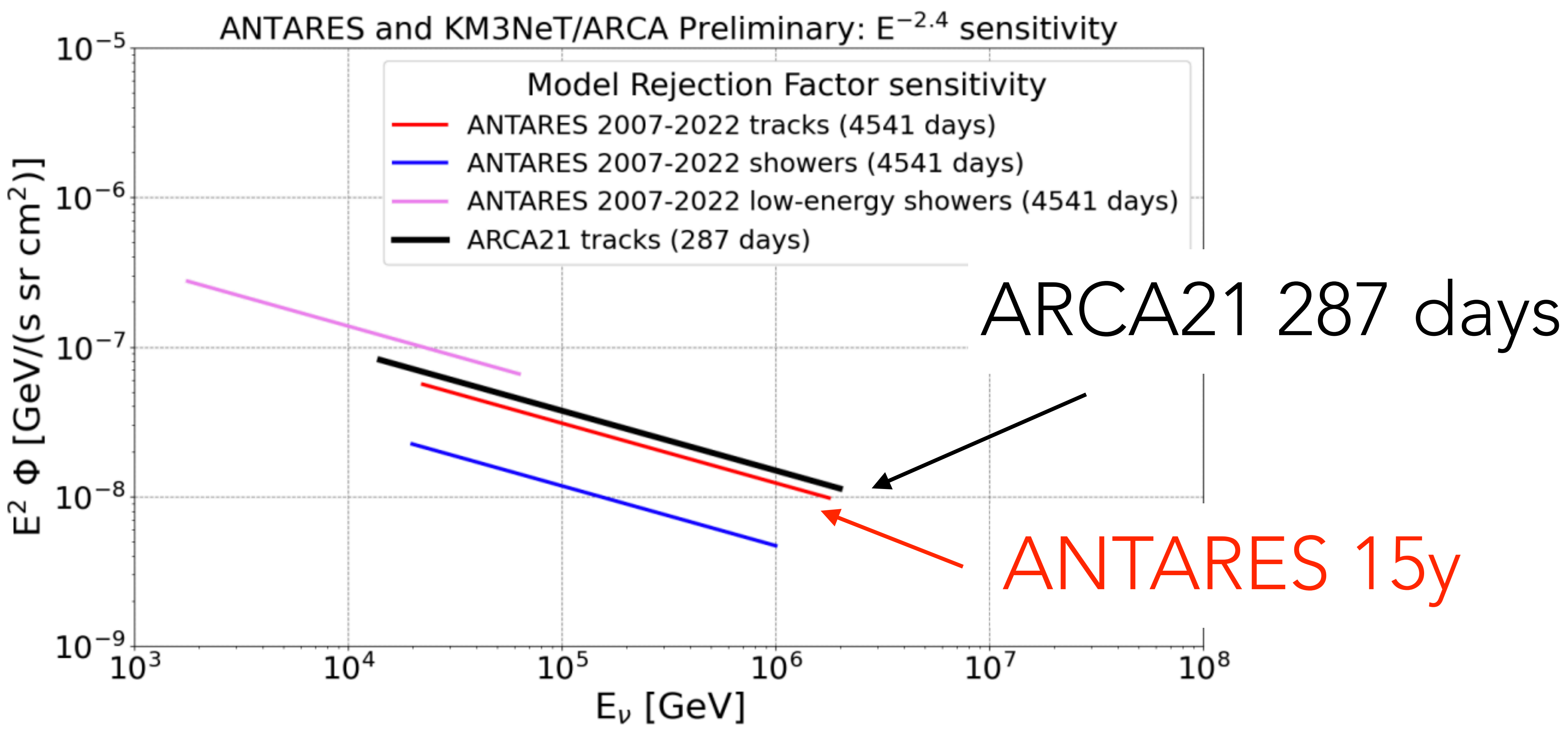


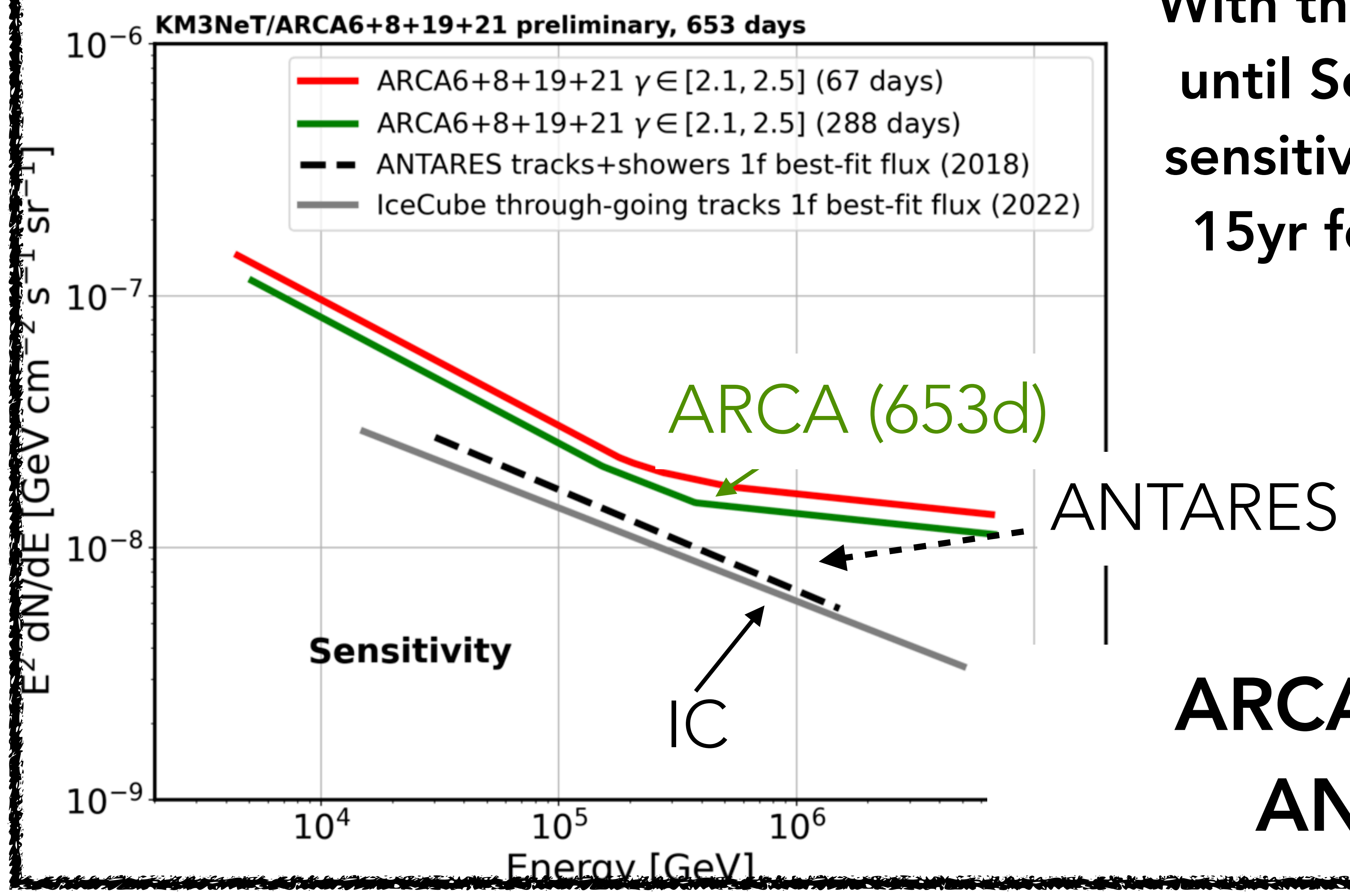
Large improvement in sensitivity is expected in the next year:
+ ARCA28 from sept 2023 + ARCA47 (?) from November 2024

KM3NeT upper limits are quickly reaching the ANTARES 15yr limits

Search for diffuse flux

From the full sky





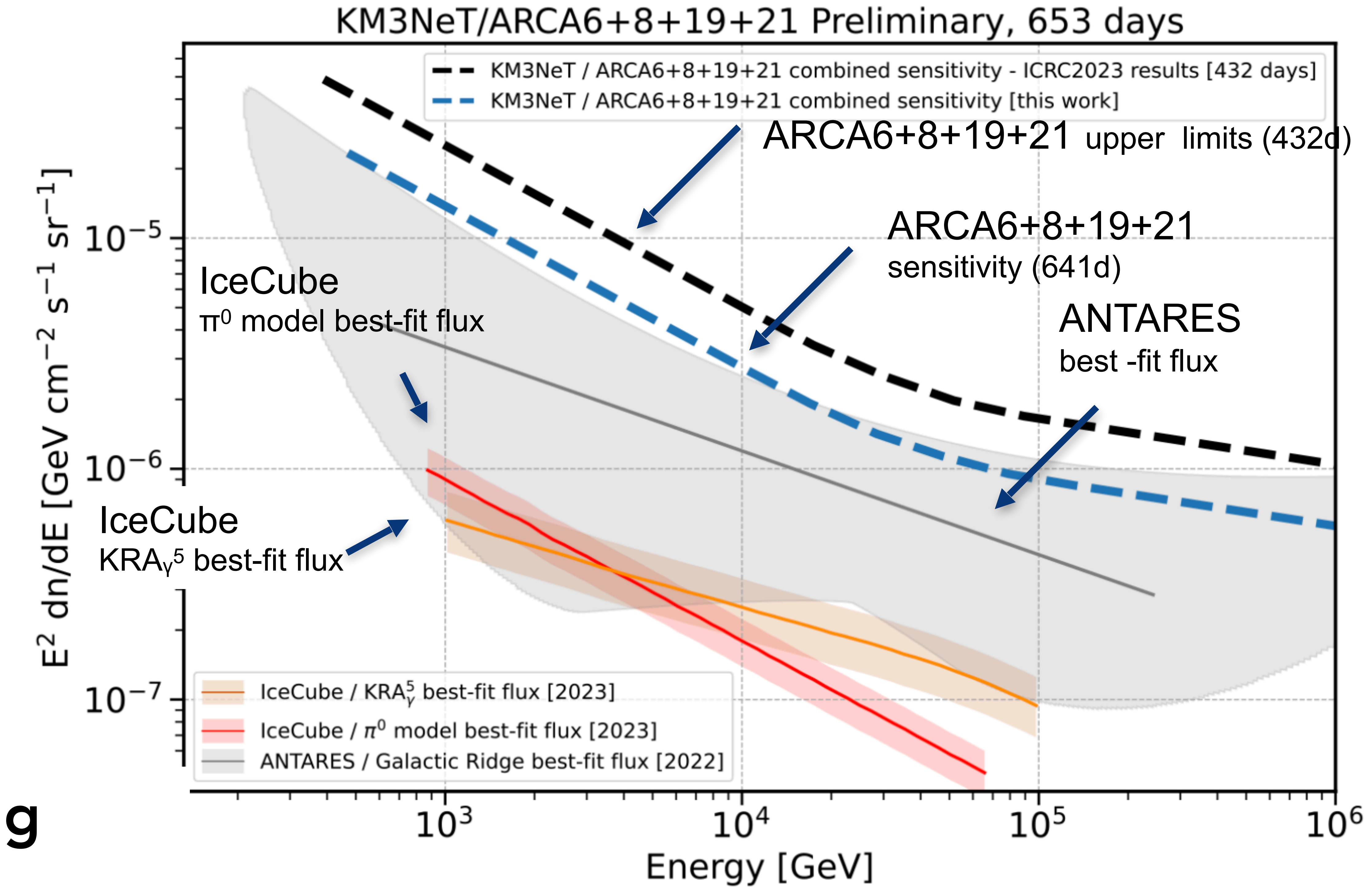
With the data collected until Sept. 2023 same sensitivity of ANTARES 15yr for track events

From the galactic plane

ARCA6 & ARCA8 & ARCA19 fully analyzed
ARCA21 partially analyzed (until December 2022)

On-Off zone analysis

|l| < 31° and |b| < 5° for KM3NeT/ARCA6-8 and
|l| < 31° and |b| < 4° for KM3NeT/ARCA19-21

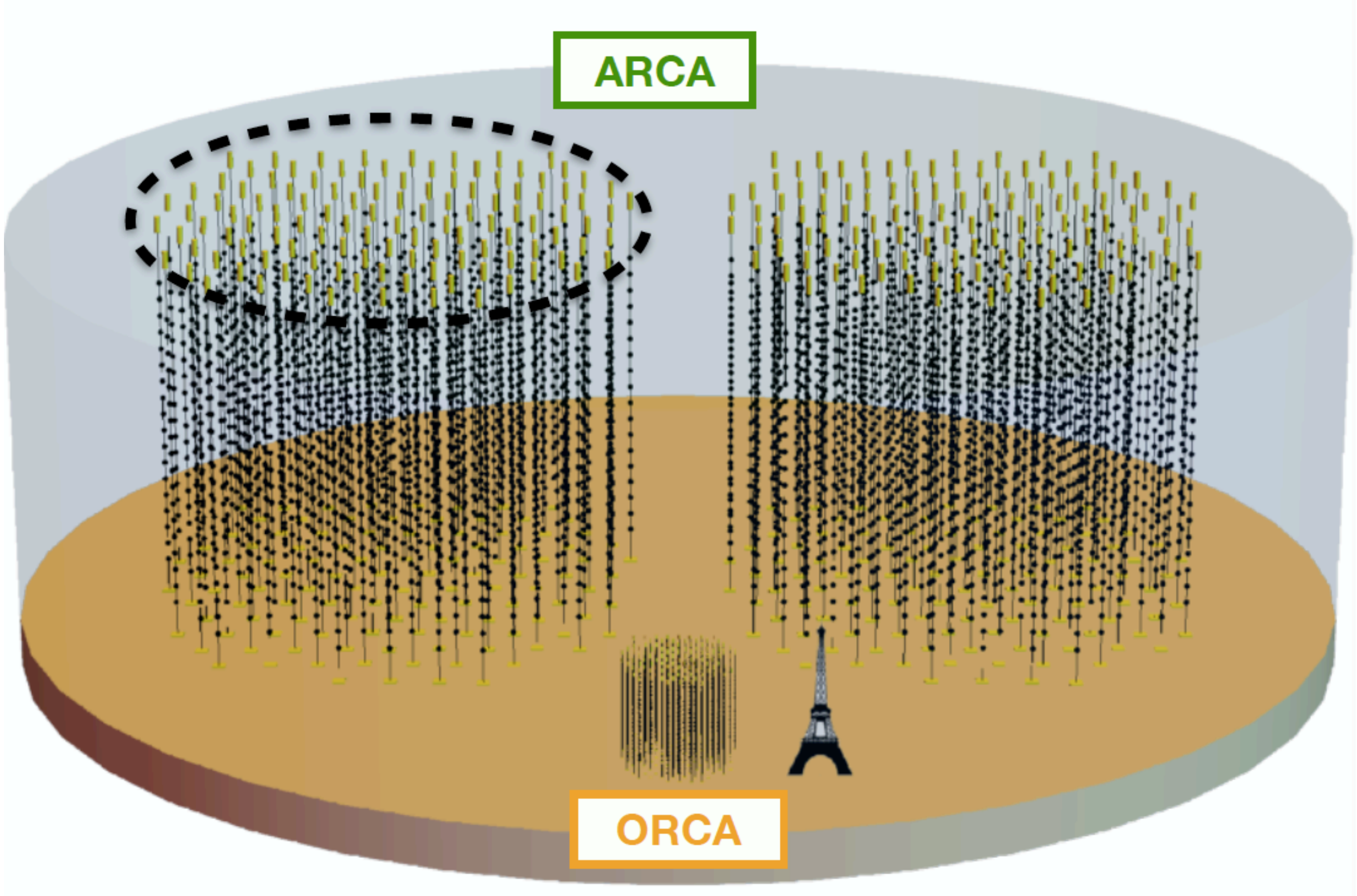


ARCA rapidly approaching ANTARES sensitivities

Multimessenger program

Multimessenger program

A dedicated software runs at the shore stations for Real-Time Analysis (RTA)



Sending alerts

Send neutrino alert to external communities

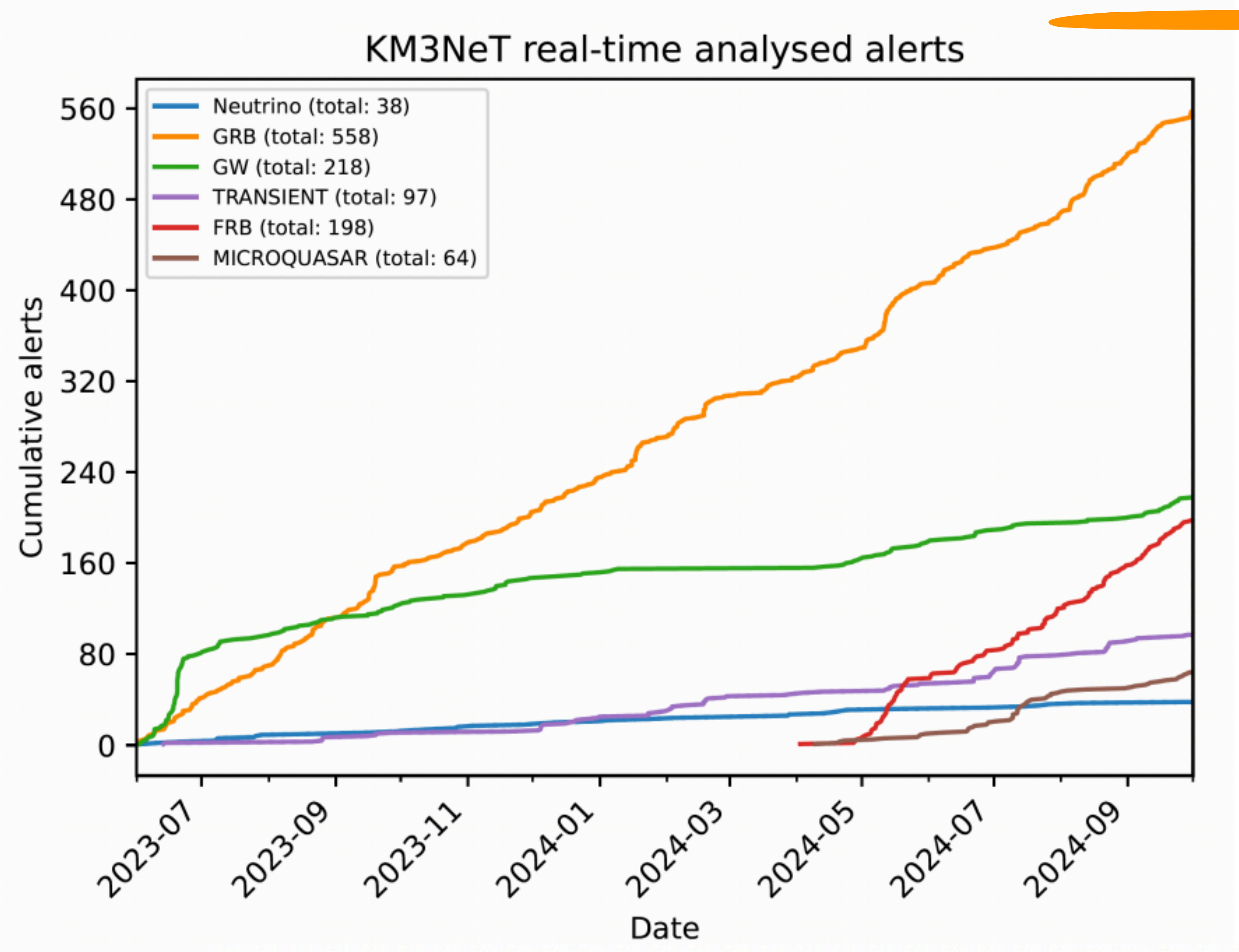
Receiving alerts

Receive alert from external communities - on-line analysis and follows ups

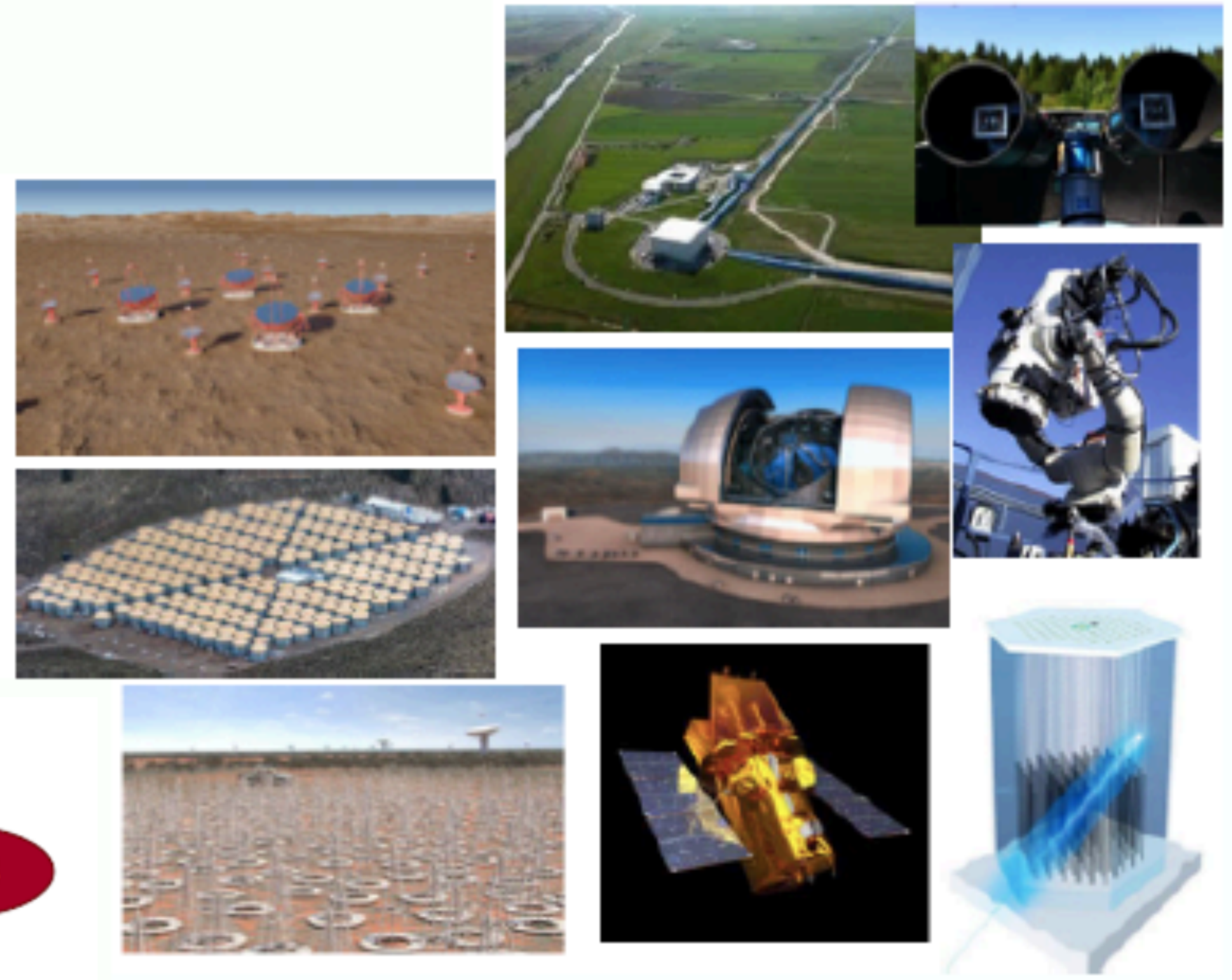
Receiving alert system operative 👉 RTA platform already active from November 2022 in ARCA and in ORCA detectors

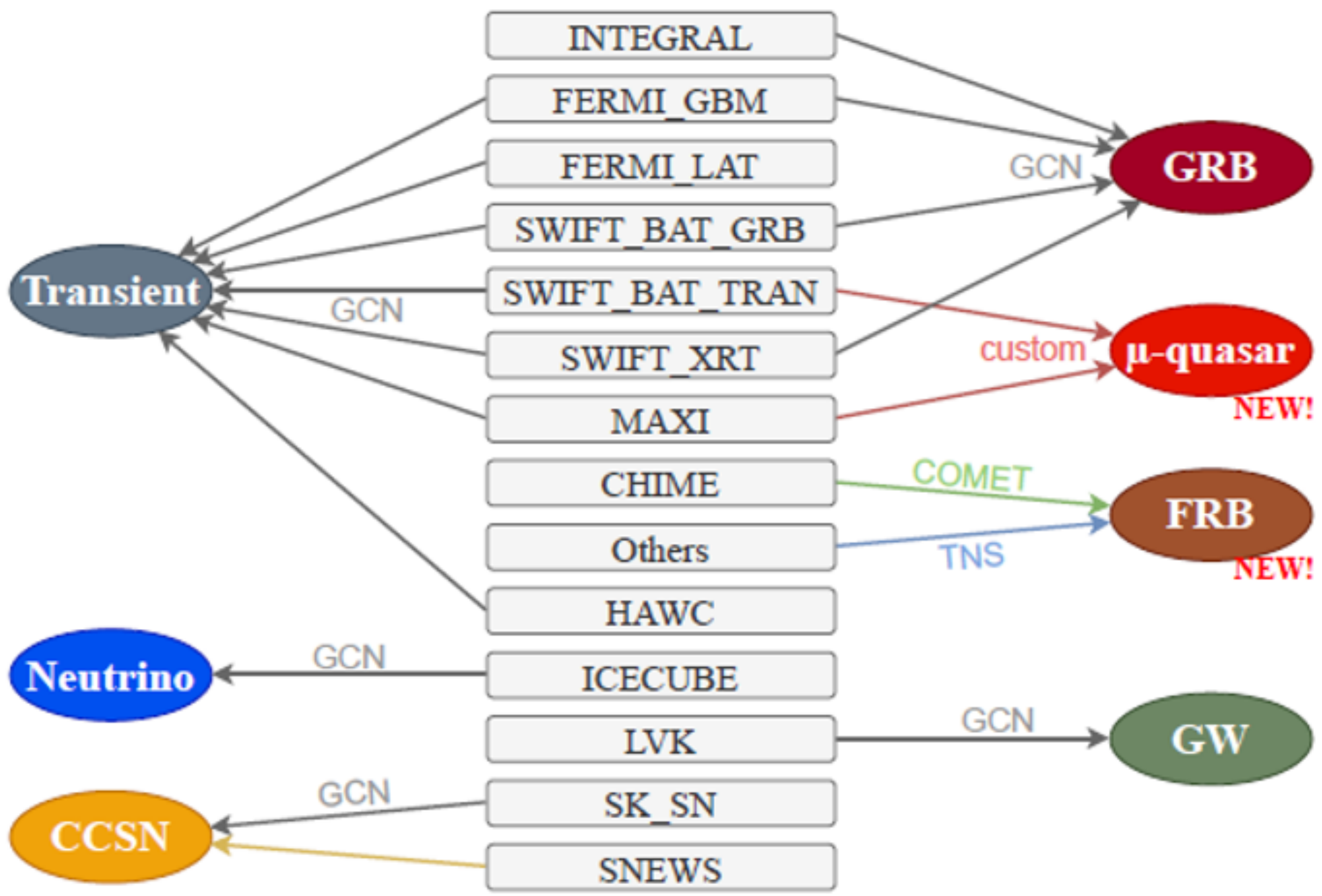
Sending alert system 👉 High-energy neutrino alerts will be sent in real-time soon. System under test

The Multimessenger program



EM/MM external communities





CCSN alert sending already active
HE neutrino alert sending soon

A thousand of alert received and analyzed in real time 👉 so far no significant excess found in any of the observed alerts

The collaboration


France
CNRS Nucléaire et Particules
Astroparticle and Cosmology Laboratory, Université Paris Cité, CNRS
Centre for Particle Physics of Marseille, Aix-Marseille Université, CNRS
Laboratoire d'Astrophysique de Marseille
Mediterranean Institute of Oceanography, CNRS
Terre et Univers, Marseille
Université de Toulon, Chaire IA ADSIL, CIAN, CNRS
Institut Pluridisciplinaire Hubert Curien, Université de Strasbourg, CNRS
Subatech, IMT Atlantique, Nantes Université
Laboratoire Univers et Particules de Montpellier
Laboratoire de Physique Corpusculaire de Caen, Université de Caen, CNRS
United Kingdom
University of Hull
The Netherlands
NWO-I, Nikhef, Amsterdam
Universiteit van Amsterdam
Universiteit Leiden
NIOZ, Texel
TNO, Technical Sciences, Delft
Germany
Friedrich-Alexander-Universität Erlangen-Nürnberg
Max-Planck-Institut für Radioastronomie, Bonn
Universität Würzburg
Universität Erlangen, Remeis Sternwarte, Bamberg
Universität Münster
Italy
INFN Laboratori Nazionali del Sud, Sezione di Catania, Università di Catania
INFN Sezione di Firenze, Università di Firenze
INFN Sezione di Genova, Università di Genova
INFN Sezione di Napoli, Università della Campania L. Vanvitelli, Università di Napoli Federico II
INFN Sezione di Roma, Sapienza Università di Roma
INFN Sezione di Bari, Politecnico di Bari
INFN Sezione di Bologna, Università di Bologna
INFN Sezione di Padova, Università di Padova
Università di Salerno, INFN Gruppo Collegato di Salerno
Slovakia
Univerzita Komenského v Bratislave
Slovenská akadémia vied, Kosice
Czech Republic
Czech Technical University in Prague, Institute of Experimental and Applied Physics
Poland
AGH University of Krakow
NCBJ - National Centre for Nuclear Research, Warsaw
Nicolaus Copernicus Astronomical Center, Particle Astrophysics Science and Technology Centre, Warsaw
Romania
Institute of Space Science - INFLPR Subsidiary, Magurele
Greece
Institute of Nuclear and Particle Physics, NCSR Demokritos, Athens
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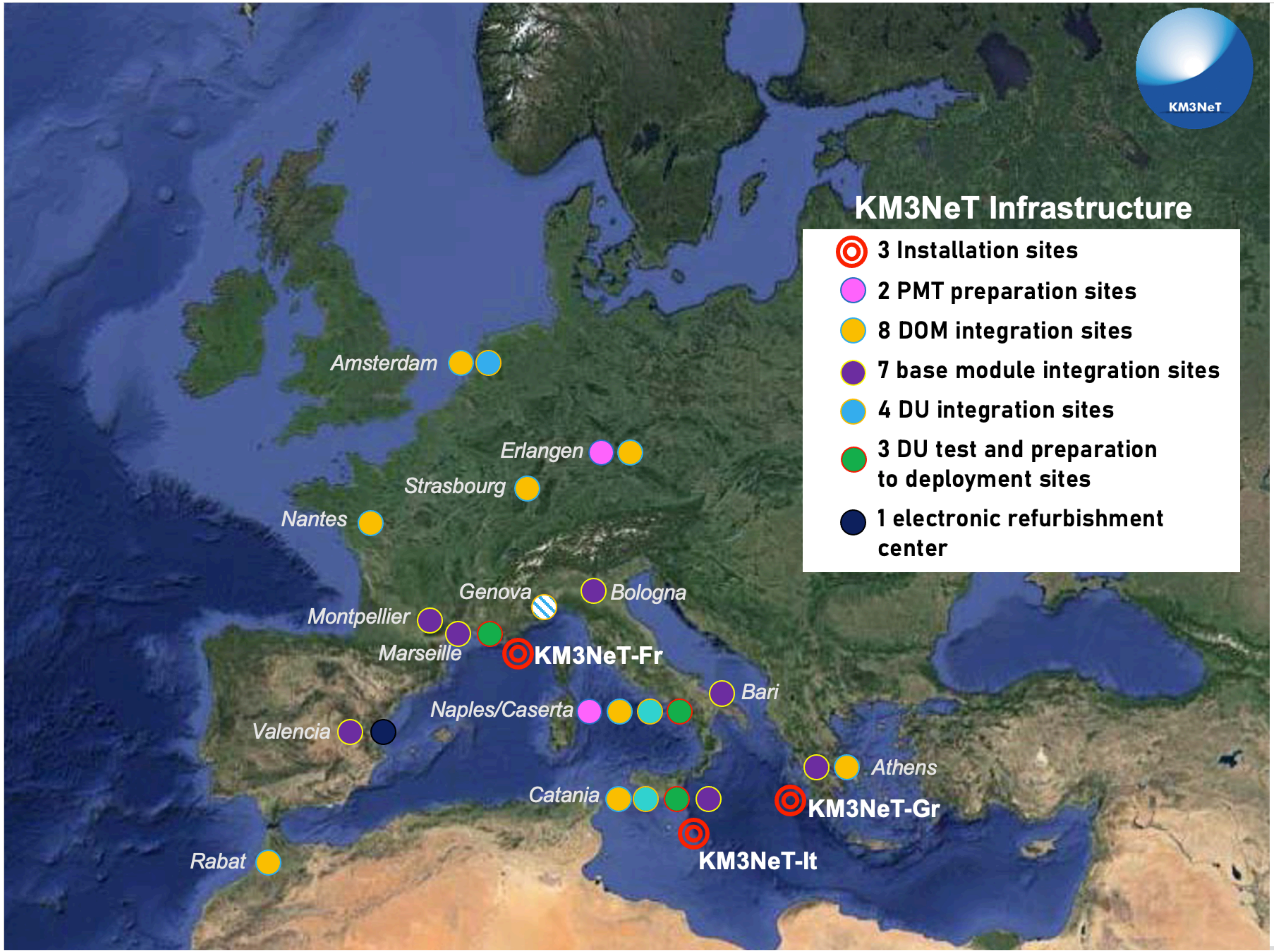
Université Libre de Bruxelles
Spain
Consejo Superior de Investigaciones Científicas (CSIC)
Instituto de Física Corpuscular, Universitat de València, CSIC
Universitat Politècnica de València, IGIC, Gandia, València
Universidad de Granada
Centro Oceanográfico de Murcia (IEO-CSIC)
Laboratori d'Aplicacions Bioacústiques, Universitat Politècnica de Catalunya, Vilanova i la Geltrú
Instituto de Ciencias del Mar, CSIC, Barcelona
United States of America
Harvard University, Cambridge
Drexel University, Philadelphia
KM3NeT Collaboration
5 continents, 21 countries, 68 institutes
KM3NeT
China
Sun Yat-Sen University, Zhuhai
Algeria
Center of Research in Astronomy, Astrophysics, and Geophysics, Bouzaréah
Université Badji Mokhtar, Annaba
University of Constantine
Mohamed Boudiaf University, M'sila
Morocco
University Mohammed V, Rabat
National Center of Energy of Sciences and Nuclear Techniques, Rabat
University Mohammed Ier, Oujda
Cadi Ayyad University, Marrakesh
Mohammed VI Polytechnic University, Ben Guerir
Full members
Observer members
South Africa
University of Johannesburg
University of the Witwatersrand, Johannesburg
North-West University, Potchefstroom
Georgia
Tbilisi State University
University of Georgia, Tbilisi
United Arab Emirates
University of Sharjah
Khalifa University of Science and Technology, Abu Dhabi
Australia
Western Sydney University
© KM3NeT Collaboration, 01/02/2025

KM3NeT Italia

Integration sites map



KM3NeT-Italia sites

- Genova (DU Integration P1-P2-P3)
- Bologna (BM Integration)
- Napoli/Caserta (DOM/BM/DU Integration)
- Salerno (Soon DOM integration)
- Bari (BM and soon DU integration P1-P2-P3)
- Catania (LNS & Sezione) (DOM/BM/DU integration)

The organigram

KM3NeT

Oversight

Resource Review Board
Chair: V. Poireau

Ethics Committee
Chair: TBD

Financial Resource Manager
A. van Rijn

Scientific and Technical Advisory Committee
Chair: C. Timmermans

Governance

Institute Board
Chair: A. Kouchner

GNN Liaison Officer: *TBD*
EU Liaison Officer: *M. de Jong*
Early Career scientists: *S. Peña Martinez, A. Bariego Quintana*

Publication Committee: *A. Margiotta, E. Tzamariudaki*
Conference Committee: *C. Markou*
Outreach Committee: *M. Circella, R. Muller*
Open Science Committee: *J. Schnabel*

Executive Management

Management Team

Spokesperson/Chair: *P. de Jong*
Deputy Spokesperson: *D. Dornic*
Technical Project Manager: *A. D'Amico*
Physics & Software Manager: *R. Coniglione*
Site Manager KM3NeT-Fr: *N. Lumb*
Site Manager KM3NeT-It: *S. Biagi*
Site Manager KM3NeT-Gr: *C. Markou*

Equality, Diversity, Inclusion Committee
V. Van Elewyck, E. Tzamariudaki

Science Steering Committee

Chair: R. Coniglione
Astronomy: G. Illuminati, M. Lamoureux, A. Marinelli
Cosmic Rays: R. Bruijn, A. Romanov
Dark Matter/Exotics: A. García-Soto, S. Gozzini
Oscillations: J. Brunner, V. Carretero Cuenca
Processing/Data-Quality: C. Lastoria, A. Sinopoulou
Simulations: C. Distefano, L. Fusco
Software/computing: L. Aphecetche, R. Bruno, J. Schnabel

Project Office

Chair: A. D'Amico
Project Control Officer: TBC
Procurement Manager: M. Circella
Procurement Officer: S. Lancelin
QA/QC Manager: C. Vérilhac
QA/QC Officer: L. Morales Gallegos
R.A.M.S Manager: S. Colonges
R.A.M.S Software: F. Filippini
System Engineer: E-J. Buis, S. Henry

Technical Steering Committee

Chair: P. de Jong/A. D'Amico
Calibration: V. Pestel
*DAQ: T. Chiarusi, E. Giorgio**
Det operations: A. Enzenhöfer, P. Piattelli
*Electronics: D. Real, D. Calvo**
*Mechanics: A. Ilioni, E. Berbee**
*Optical system: J-W. Schmelling, S. Pulvirenti**
PMT: P. Migliozzi
*Power system: R. Cocimano, C. Nicolau**
Software/computing: L. Aphecetche, R. Bruno, J. Schnabel
BM integration: I. Sgura
*DOM integration: D. Vivolo, E. Leonora**
DU integration: A. Marini, C. Mollo

** Deputy Coordinators*

21/03/2025

KM3NeT membership

New collaborators can join KM3NeT as

- **Full member (as Institute)**
  - Full access to the data
  - Common funds contribution due
  - Sign all the papers
  - Member of the IB with voting rights

- **Observer (as Institute)**
  - Prospect to apply as full member after three years
  - Full access to the data
  - Common funds contribution NOT due
  - Sign only papers to which a significant contribution is given
  - Member of the IB with NO voting rights

- **Associated member (as individual person and based on a research plan)**
  - Full access to the data
  - Common funds contribution NOT due
  - Sign only papers to which a significant contribution is given
  - NO IB Member

The KM3NeT members

From the KM3NeT MoU

Associated member

Article 7: Associated membership

Individual scientists who desire to use KM3NeT data for research that is of scientific or strategic interest to the KM3NeT Collaboration but not pursued inside the Collaboration with sufficient expertise or intensity, may apply for a temporary Associate Membership (AM) in KM3NeT. An AM does not require the support of the applicant's home institution, nor will this institution be associated to the KM3NeT Collaboration. For AMs the following regulations apply:

1. The application needs to comprise a research plan detailing the objectives intended to be pursued by the use of KM3NeT data. Researchers to be included in the AM (in general members of the applicant's research group) need to be named explicitly.

2. Researchers in an AM group will have no authorship rights except for publications to which they make major contributions and which correspond to the AM's research plan. AMs will have no obligation to contribute financially (e.g. Common Fund) or with human resources (e.g. shifts) to construction, maintenance and operation of the KM3NeT research infrastructure.

3. An AM is granted for a maximum of three years; any extension requires a new application including a new research plan. The AM enters into force once PSM and IB have endorsed it and applicant and SP have signed a bilateral agreement between applicant and Collaboration laying down the rules of the AM (including details of data and software access; publication rules; confidentiality; intellectual property rights; maximal duration if shorter than three years) and the rights and commitments of both signatories.

4. AMs are not represented in the IB or the RRB.

5. All researchers included in an AM are entitled to be members of KM3NeT expert working groups. Their credentials will be included in the data base and the relevant KM3NeT mailing lists.

6. The AM will be terminated at the end of its validity period, but latest when these Bylaws will become invalid. It can be terminated earlier by a corresponding declaration of the Associated Member or by decision of the IB.

Observer

2.8 In special cases, an Observer status may be granted to Institutes. Observer status is granted on the assumption that the Observer intends to apply as Institute within three years from the date that Observer status is granted. Observers are exempt from financial contributions to KM3NeT. Their representatives can participate in meetings of the Institution Board without voting rights. Observers have access to KM3NeT data, Software and Data Base according to the publication rules of the Collaboration. Scientists of observer institutes will not sign papers, unless they are the main author. This restriction does not apply to PhD students.

KM3NeT and ESFRI

- KM3NeT is an ESFRI project since 2006 and as KM3NeT2.0 since 2016
- Very good mid term evaluation (https://www.esfri.eu/latest-esfri-news-project-landmarks-news/esfri-monitoring-2016)
- 2025 is our last year on the roadmap as ESFRI Project, next status would be ESFRI Landmark -> a legal entity is needed

Mid-term evaluation

The ESFRI WGs consider that KM3NeT project has been developing very well toward implementation in the 10-year framework. The WGs do not identify any critical issues. A particular recommendation highlights the need to keep the timeline of the project, since the scientific impact is expected to be very significant if the project is implemented on time.

MONITORING OF ESFRI 2016 PROJECTS			
	cientific Case	*nplementation Case*	*Overall*
CTRIS	High	High	High
ANUBIUS	ledium/High	Medium	Medium
-RIHS	Medium	Medium	Medium
ST	High	Medium	Medium/High
MPHASIS	ledium/High	Medium/High	Medium/High
M3NeT	Very High	High	ligh/Very High

KM3NeT INFRADEV2

1.5 ME/3 years
Submitted: Jan 20, 2022

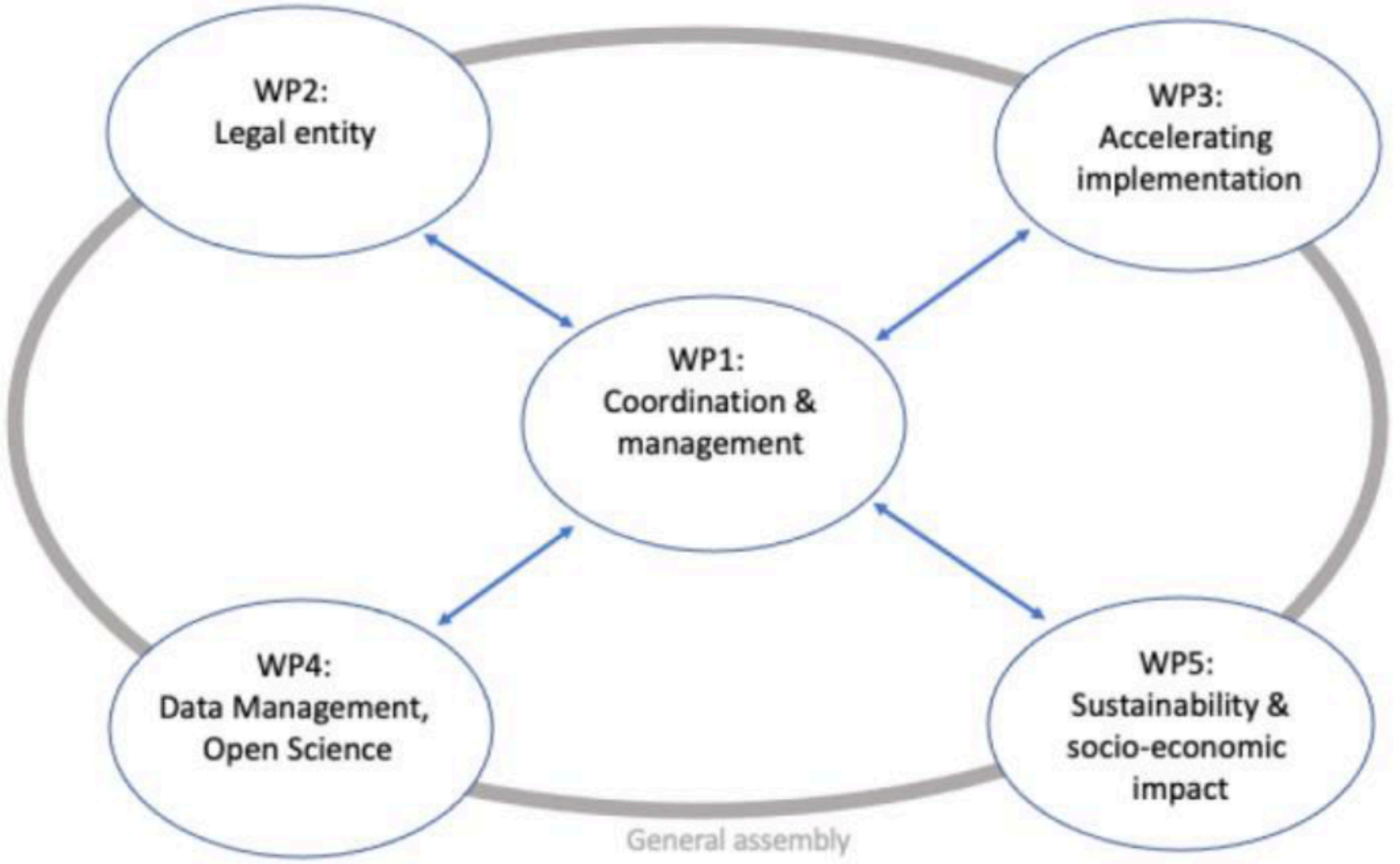
WP1: Management (Paschal-CNRS)

WP2: Legal Entity (Piera-INFN)

WP3: Accelerating implementation (Miles-CNRS)
Procurement officer (Fr), RAMS officer (Italy)

WP4: Data management/open science (Jutta-FAU)
3 postdocs (IFIC, Nikhef, Erlangen)

WP5: Sustainability & socio-economic impact (Christos-NCSR)
1 postdoc (Greece)



Motivation for a legal entity for KM3NeT

The establishment of a legal entity for KM3NeT will have many advantages for the development of the project and its sustainability. In particular the legal entity will make possible:

- independent action in its full legal capacity
- financial autonomy: collects and administrates membership fees
- emission of orders and issue invoices or receipts
- possibility to receive subsidies and be partner in projects
- better organized internal structure
- employment/secondment of personnel
- increased possibility of fund raising at regional, national and EU level
- stronger commitment of the participating agencies and institutions
- improved sustainability on medium and long term
- easier and straightforward participation in EU call and grant
- gain of visibility in the European science funding landscape

Example of legal entity for RI

LEGAL ISSUES

ERIC ----→ Not-for-profit, limited liability regime, legal personality, tailor-made for pan-EU single-sited and distributed RI's

AISBL----→ Not for profit, limited liability regime, legal personality, not tailor-made for the needs of pan-EU RI's

CONSORTIUM---→ Not-for-profit, limited liability regime, legal personality,

SCARL -----→ Not for profit, limited liability regime, legal personality

FINANCIAL AND FISCAL ISSUES

ERIC ------→ No capital required, contributions are cash and in-kind, enjoys VAT exemption

AISBL -----→ No capital required, contribution are cash and in-kind, Partial exemption or reduced % rates depending on the type of activity pursued

CONSORTIUM ---→ Initial contributions required only by the Founding members, contributions are cash and in-kind, enjoys No VAT exemption

SCARL-----→Initial minimum capital required, contributions are cash and in-kind, enjoys No VAT exemption but reduced %rates on income tax depending on the mutual purpose pursued

ADMINISTRATIVE ISSUES

ERIC-----→ 3 MS Established by EU Council regulation but lengthy 2-steps process (average 2-3 years), amendments to statutes need EC approval

AISBL -----→ 2 Founding members, established by notarial deed or private act, approved by royal decree within 3 months

CONSORTIUM----→ 2 Founding members, established by notarial deed, effective among its members on the date of Statutes' signature and towards third parties from the date of registration in the national Commercial Register.

SCARL--→2 Founding members, established by notarial deed, effective from the date of registration in the national Commercial Register.

LIABILITY

ERIC -----→ Financial liability of the company and financial protection of Members

AISBL-----→ Members are not liable for the obligations contracted by the Association, but managers or administrators liable in case of Statute's violation or misconducts.

CONSORTIUM----→ Members are not personally and jointly liable towards third parties with their assets for the obligations contracted by the Consortium. Third parties can exert their rights exclusively on the Consortium fund.

SCARL-----→ Members are not personally and jointly liable towards third parties with their assets for the obligations contracted by the Company. Third parties can exert their rights exclusively on the Consortium fund

The KM3NeT legal entity

- The AISBL chosen as legal entity form
- AISBL governance only on KM3NeT telescope
- Service Level Agreements between the AISBL and Sea Floor Network and Shore Station Host Sites (INFN and IN2P3)
- AISBL signature on 18th June 2025

- **Name:** KM3NeT-AISBL (currently being formed)
- **Purpose:** The KM3NeT-AISBL has as its non-profit purpose, both in Belgium and abroad, alone or in collaboration with third parties, the provision of a sustainable governance structure for the construction, installation, operational, maintenance, scientific exploitation and decommissioning activities for the KM3NeT infrastructure under its direct authority, as well as for the supervision of those activities for the KM3NeT infrastructure executed under the direct legal responsibilities of contributing entities."
- **Registered office:** The View Building - Rue de l'Industrie 26-38, 1040 Brussels, Belgium.
- **Term**: Unlimited.
- **Administration:** The following persons shall be part of the Executive Board de KM3NeT-AISBL:
  - Marco Pallavicini (INFN)
  - Nicolas Leroy (CNRS)
  - Jorgen D'Hondt (NWO-I)
  - Juan de Dios Zornoza (Universidad de Valencia)
  - Ekaterini Tzamariudaki (INPP/NCSRD)

INAF and KM3NeT

KM3NeT4RR and INAF

Inside the PNRR (Piano Nazionale di Ripresa e Resilienza) a call dedicated to the reinforcement of existing research infrastructures has been published at the end of 2021. The project KM3NeT4RR has been submitted and funded with 67M€. This fund will allow the completion of the first building block and part of the second block of the ARCA detector.

WP7 dedicated to physics

- WP7 – Multimessenger liasons - This WP addresses items that are strictly related to the multimessenger activities. The upgrade to higher frequencies of an INAF radio telescope located near Noto (Sicily) is requested. Recent studies and some experimental evidence point out that high frequency radio emitting sources are good neutrino candidates thus making this upgrade and collaboration even more important. Follow-ups of sources in the radio and gamma emission band are also foreseen. Modelization of neutrino emission from other sources of cosmic neutrinos and activities for training of Phd students are also comprises in this WG.

Institutes participant:

- INAF - Osservatorio Catania
- INAF - Osservatorio Palermo
- Università Federico II - Napoli
- Università di Genova
- Università di Catania
- Università La Sapienza - Roma

WP7 financed with 1.7M€

- Personnel 745.6k€
- Scientific instrumentation 499k€
- Training activities (PhD) 109.6k€
- Indirect cost (7%) 94.8k€

INAF Osservatorio Catania

- Upgrade of the INAF radio antenna in Noto (Sr) - Refurbishment of the Noto radio telescope (https://www.noto.ira.inaf.it/) to high frequencies (up to 100GHz). The Noto radio Antenna is part of the VLBI network and can operate as element of the network or a Single Dish.
- Observation and follow-ups of neutrino sources - Regular observation and followups of radio-sources that can be neutrino sources and also of sources observed by other INAF facilities at different bands of the electromagnetic spectrum

1. Procurement of a new sub reflector and all the ancillary instrumentation (Automation for a quick switch between receivers, data acquisition system, server for data reduction and storage, software for control and monitoring and data analysis)
2. 2 units of personnel (1 researcher and 1 technologist)

INAF Osservatorio di Palermo

- Modelization of Galactic SNR neutrino emission - Magento-hydrodynamics simulation of SNR and simulation of the neutrino emission. Expectation of KM3NeT for the expected neutrino flux

1. Procurement of computer cluster for simulation and storage
2. 1 units of personnel (1 researcher)


The KM3NeT detector
KM3NeT
By Miles Lindsey CLark

Spare

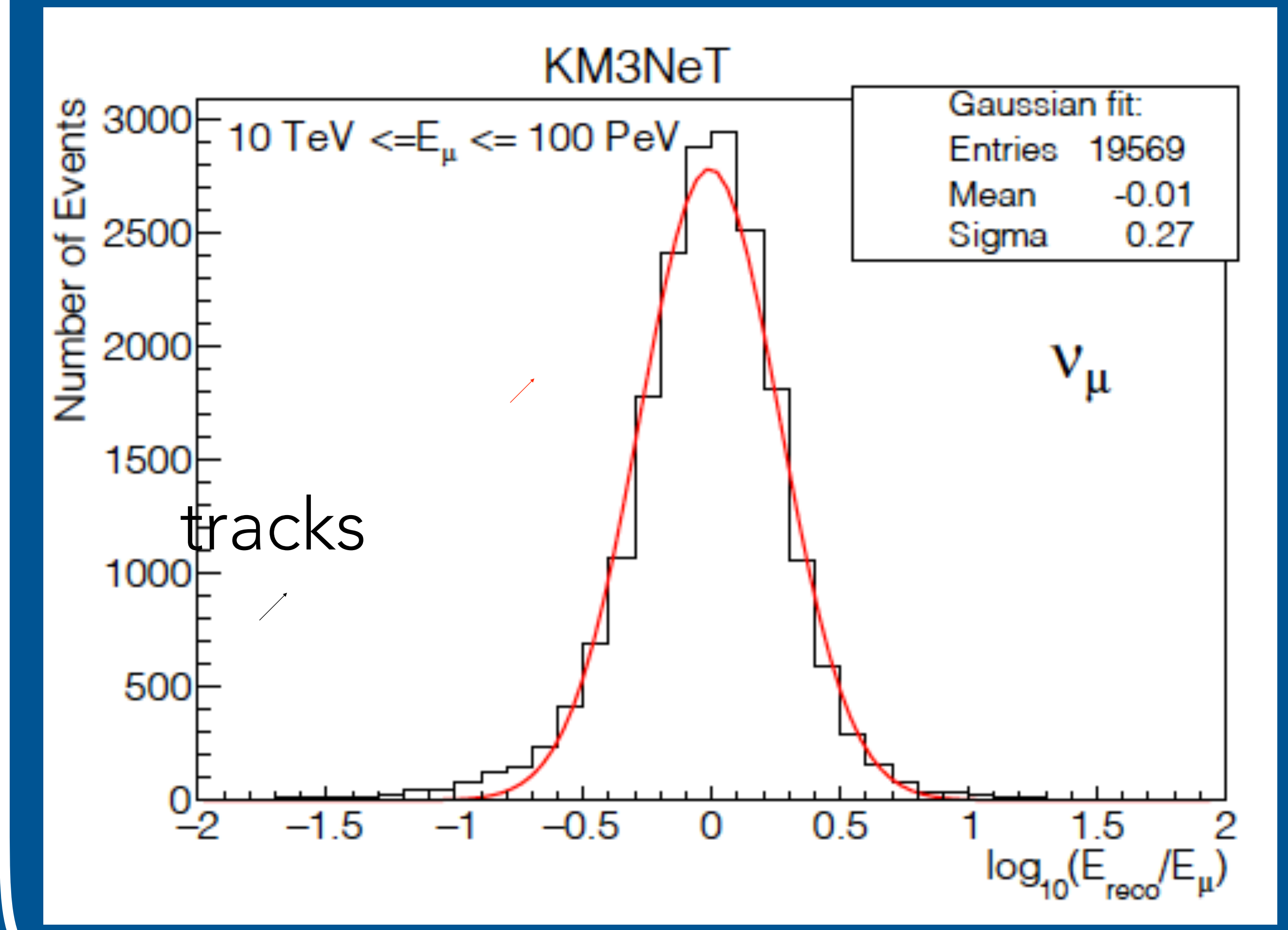
EVENT TYPE AND ENERGY RESOLUTION

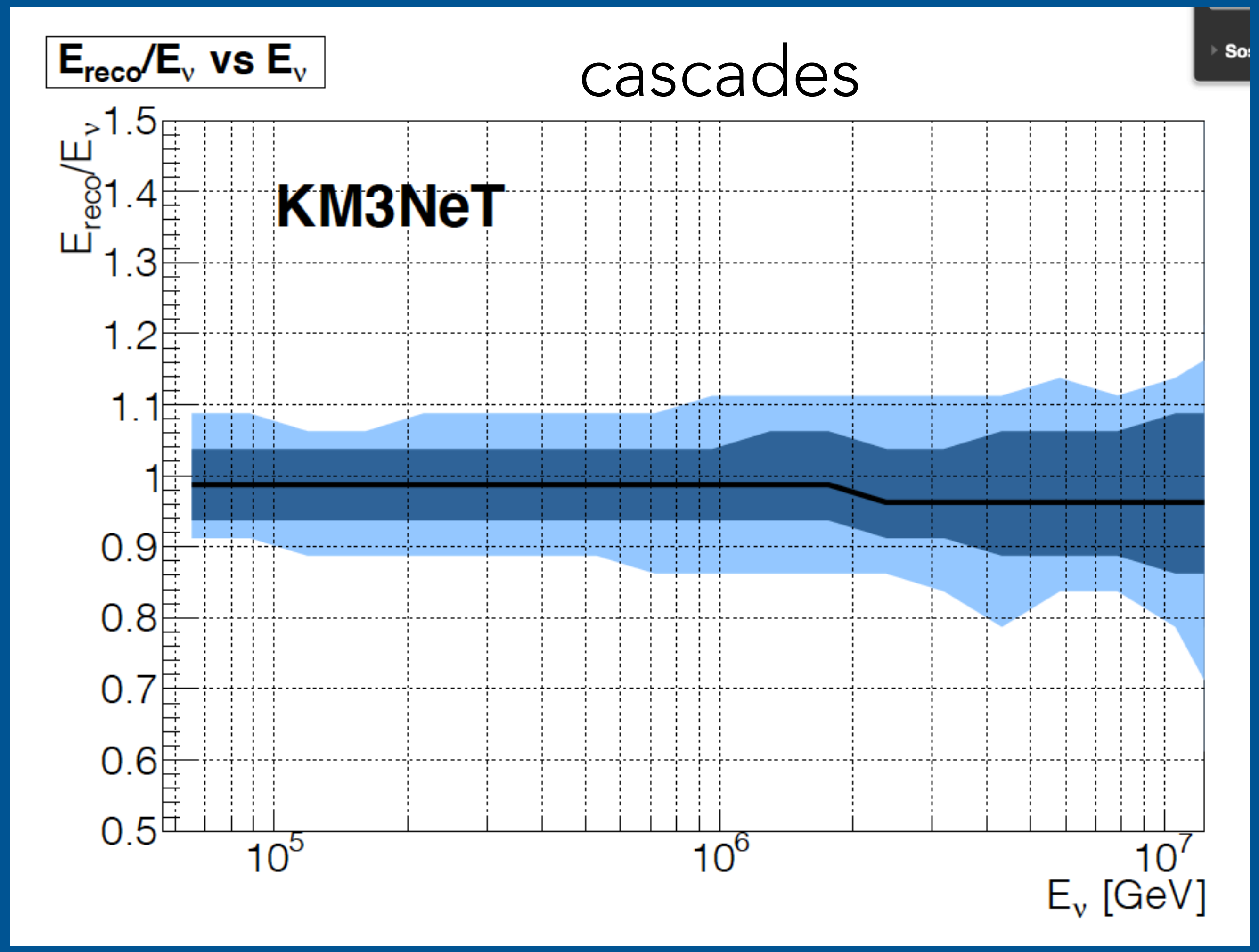
Tracks: very long path (Eμ>1TeV several km)
Neutrino interaction vertex far from the detector
- Modest energy resolution

Cascades: small path (E_{casc} >1TeV some tens of meters)
All the energy released inside the detector
- Good energy resolution

	TRACK IN LOG(E)	CASCADE
ANTARES	35%	5%
KM3NET	27%	5%
ICECUBE	~ 30%	10%
BAIKAL -GVD		

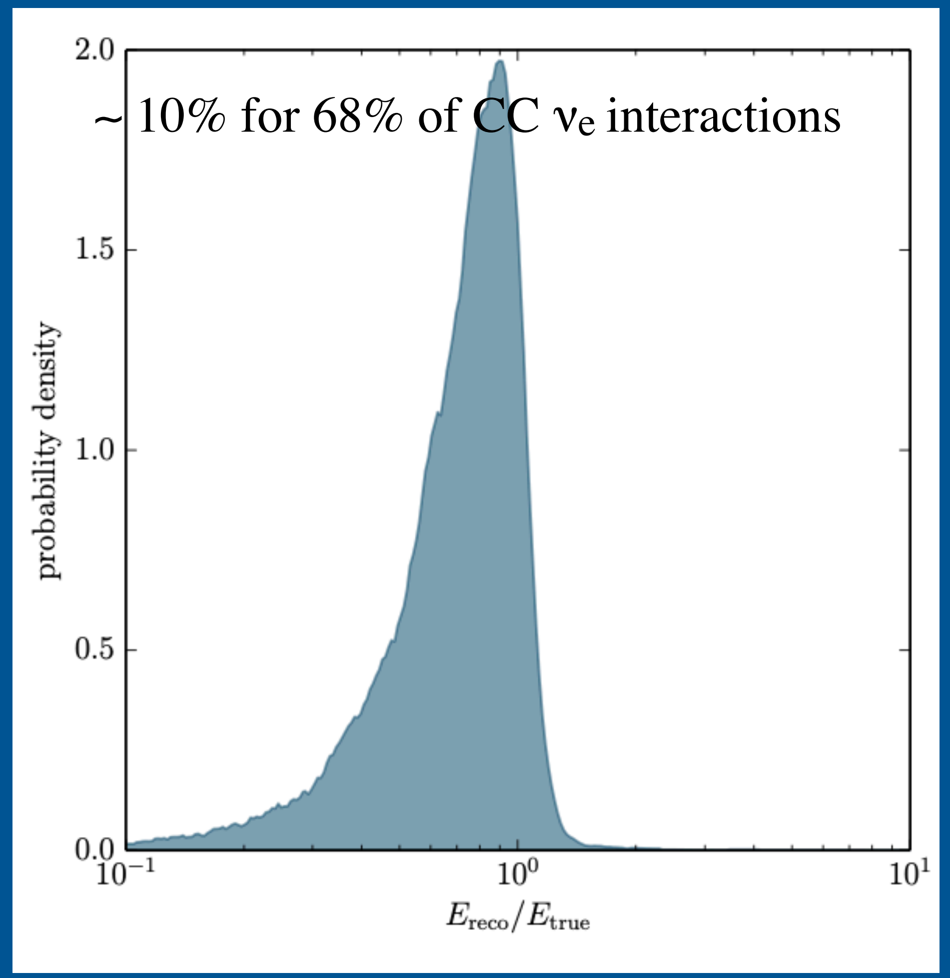
KM3NeT





IC energy resolution for cascades

ArXiv:1705.02383



EVENT TYPE AND ANGULAR RESOLUTION

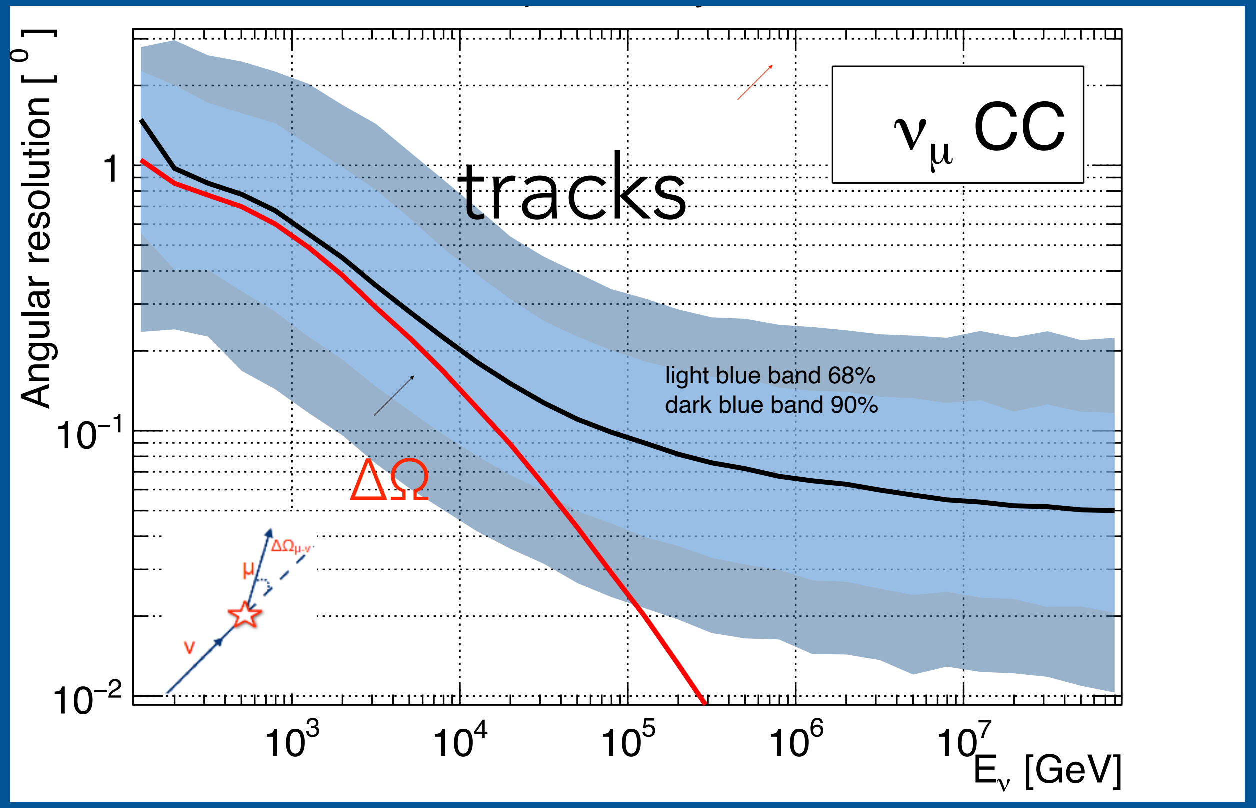
	TRACK*	CASCADE*
ANTARES	0.3°	3°
KM3NET	0.1°	1.5°
ICECUBE	0.3°	7°-8°
BAIKAL -GVD	0.25°	3° - 3.5°

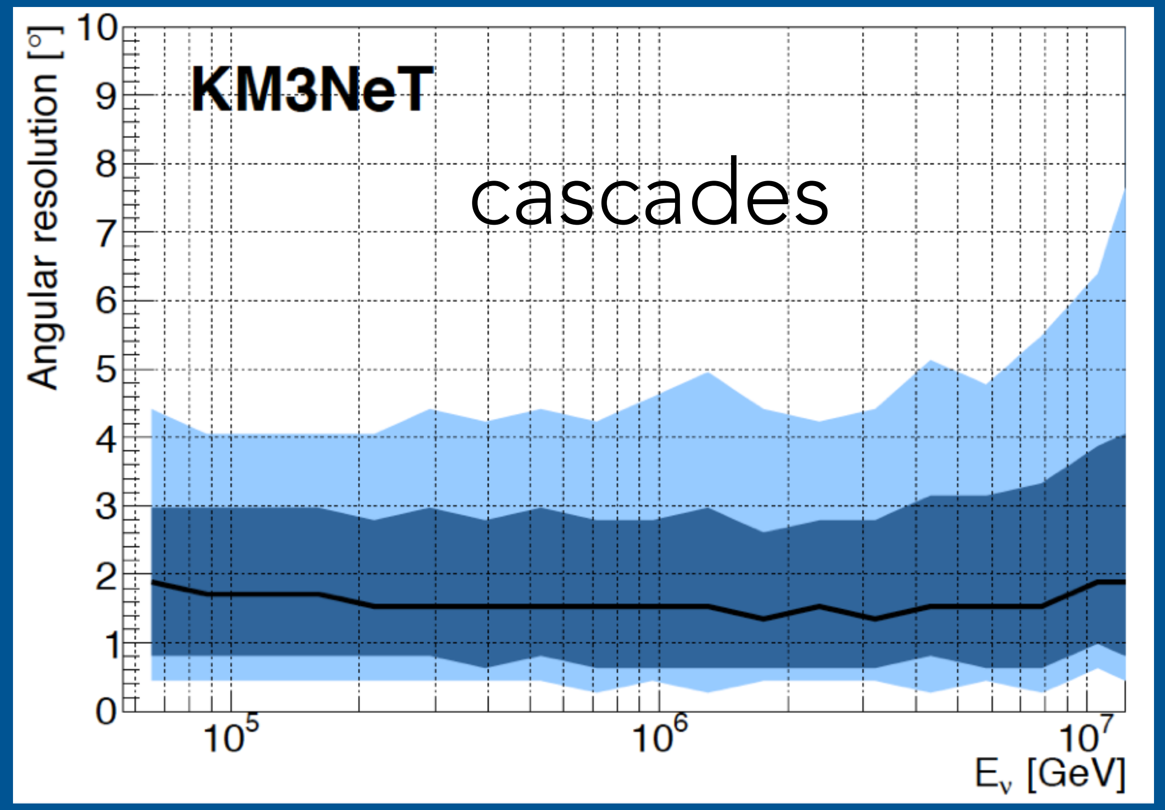
*Resolution at 100 TeV

Tracks: very long path (Eμ>1TeV several km)
Big lever arm
- Good angular resolution

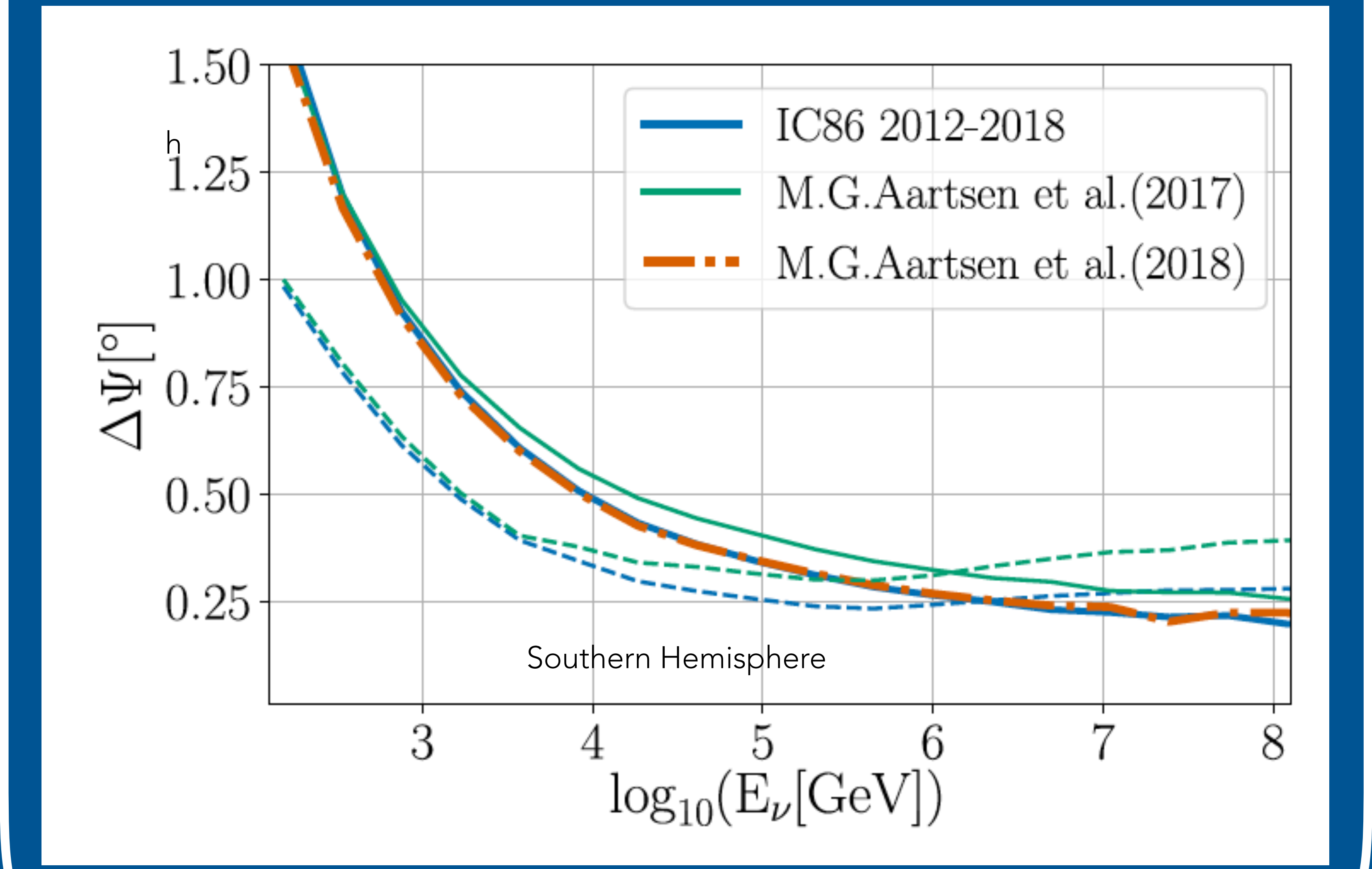
Cascades: small path (Ecasc >1TeV some tens of meters)
- Modest angular resolution

KM3NeT





IC resolution for tracks
from arXiv:1910.08488, 15 October 2019

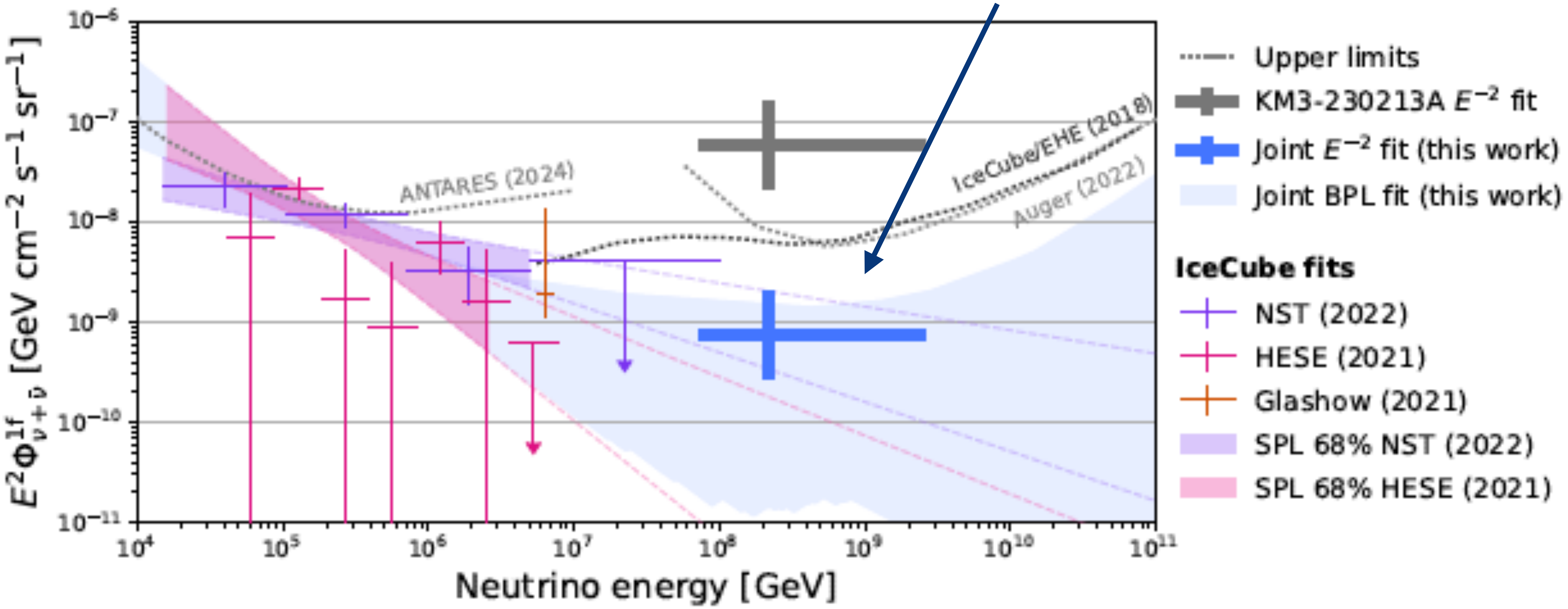


The Ultra-High-Energy event companion papers

The ultra-high-energy event KM3-230213A within the global neutrino landscape, arXiv:2502.08173

- IceCube and Auger non observation at the KM3NeT event energy taken into account
- Global fit with low energy IceCube events. Single Power Law (SPL) and Broken Power Law (BPL) fits taken into account

Flux estimate taking into account the IC and Auger results



A preference for a SPL or BPL is not clear

A stronger preference for a break appears if only the KM3NeT data is considered in the ultra-high-energy region

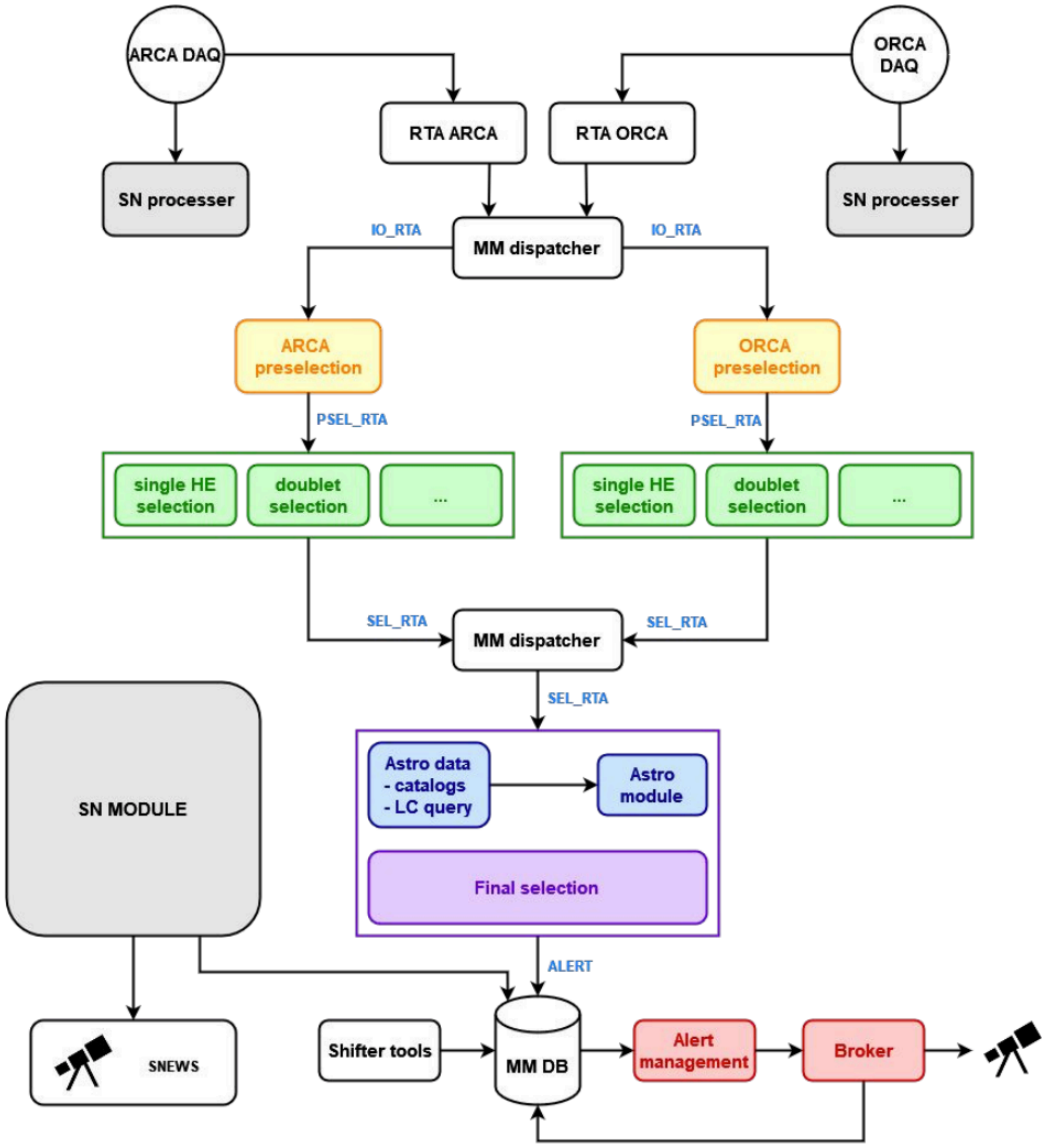
The Multimessenger program

Sending alerts

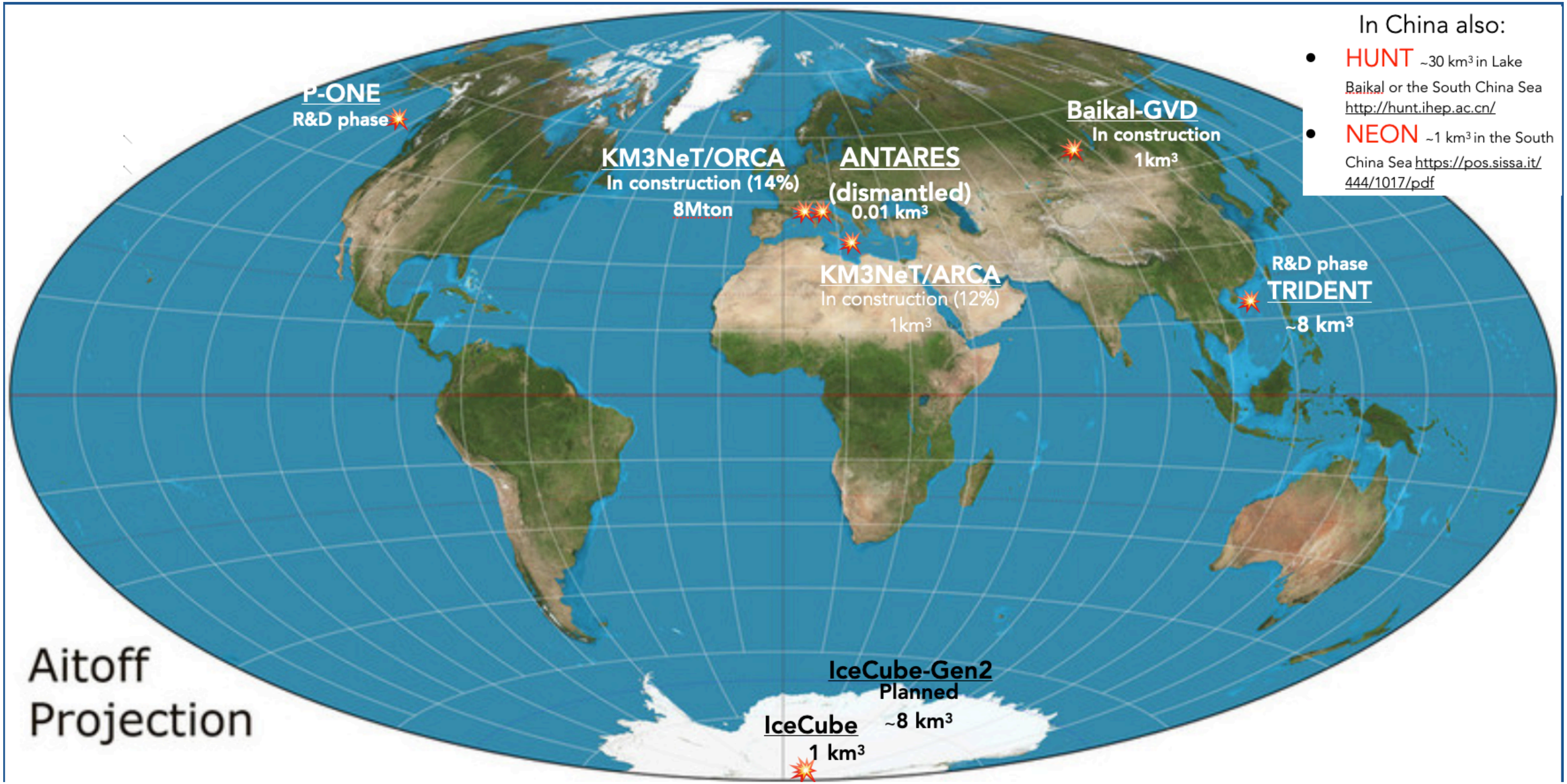
Send neutrino alert to external communities

Near to real-time (~1 min) trigger:

1. Acquire & process data: Online reconstruction (RTA)
2. Data reduction: Fixed preselection
3. Analyses for selection
4. Search for astro counterparts
5. Archive the information into DB
6. Alert broadcast: Provide useful information (Time, Position, Energy, FAR, counterparts, …)



The international context

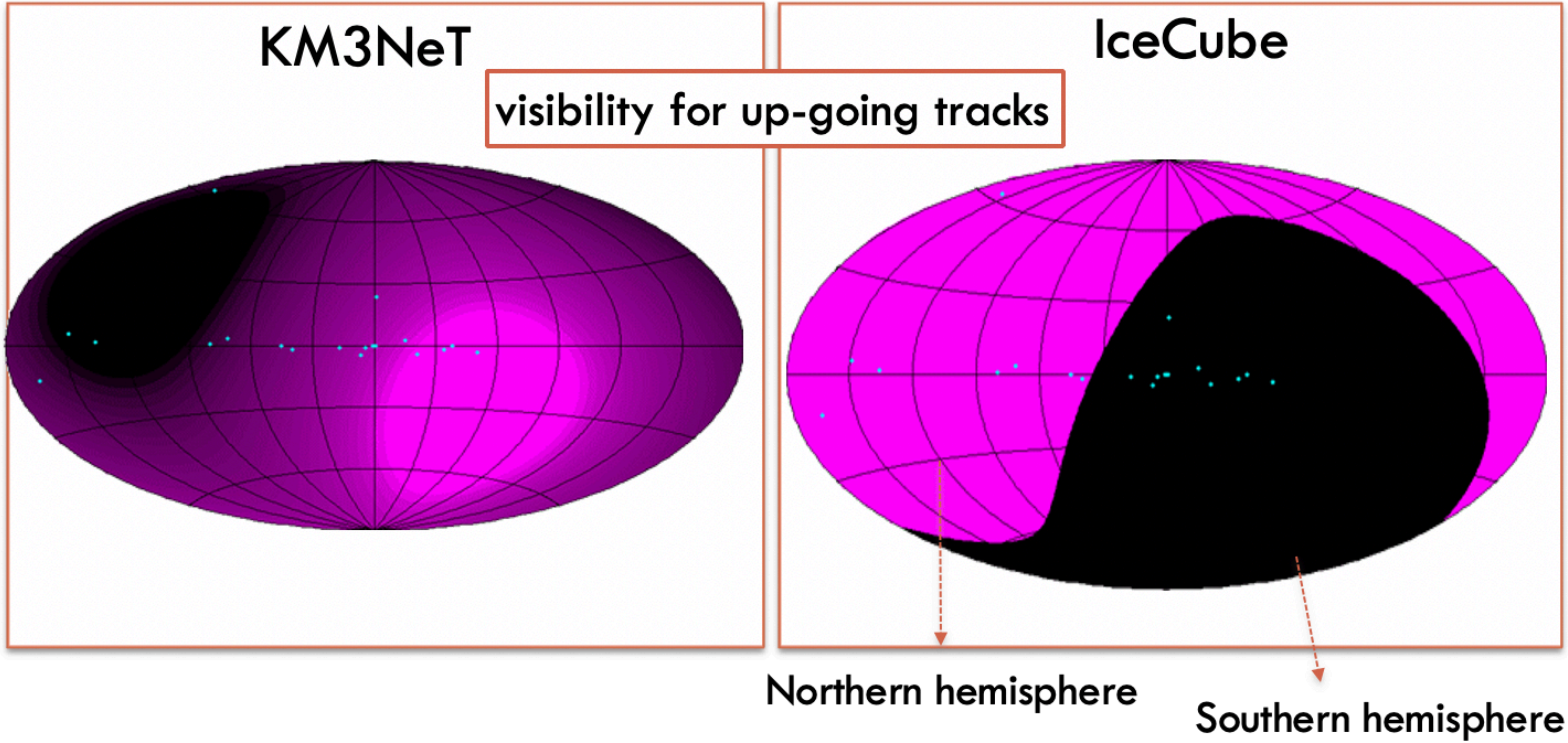


In China also:

- HUNT ~30 km³ in Lake Baikal or the South China Sea http://hunt.ihep.ac.cn/
- NEON ~1 km³ in the South China Sea https://pos.sissa.it/444/1017/pdf

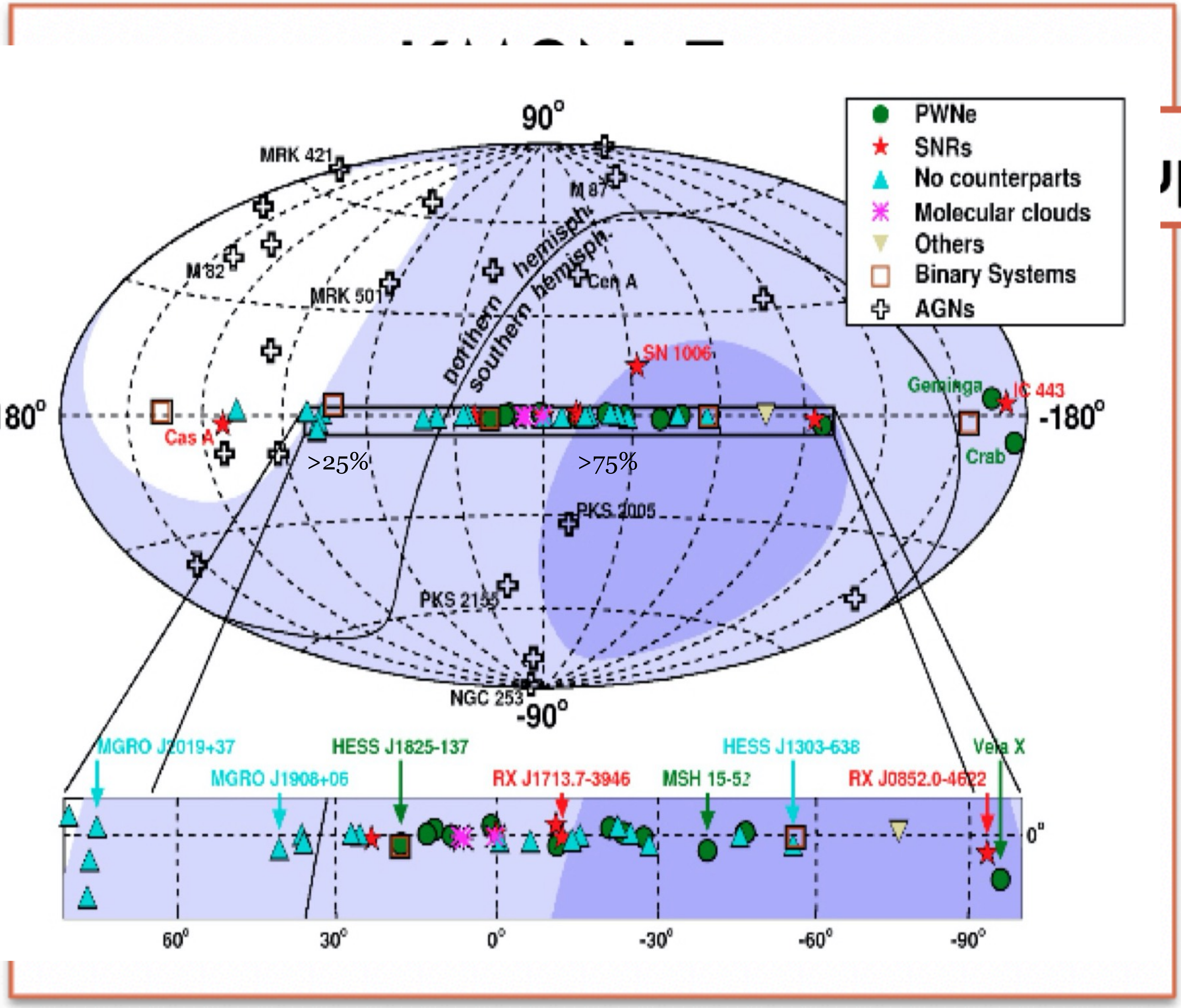
The complementarity

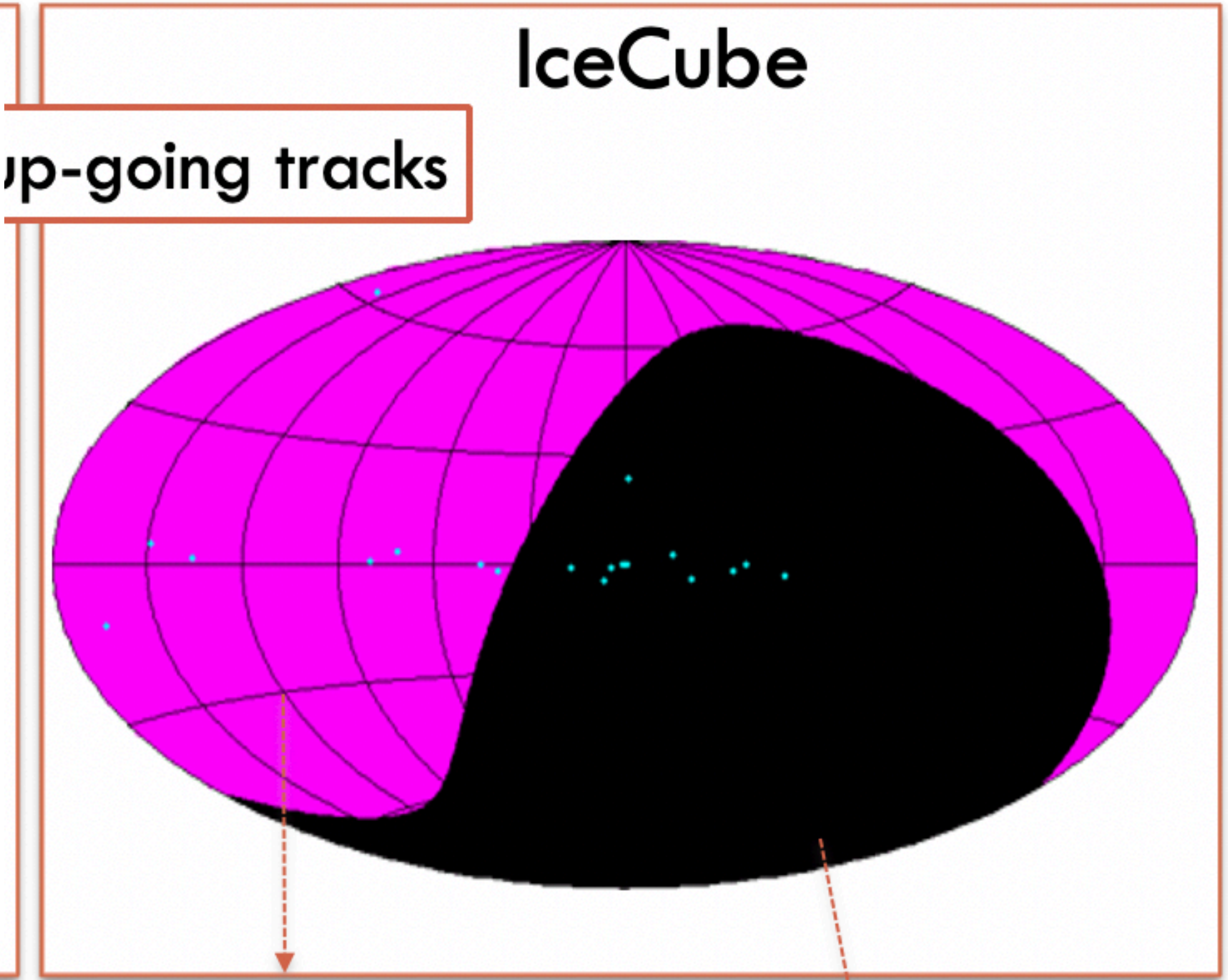
Galactic coordinates



The complementarity

Galactic coordinates





Northern hemisphere

Southern hemisphere