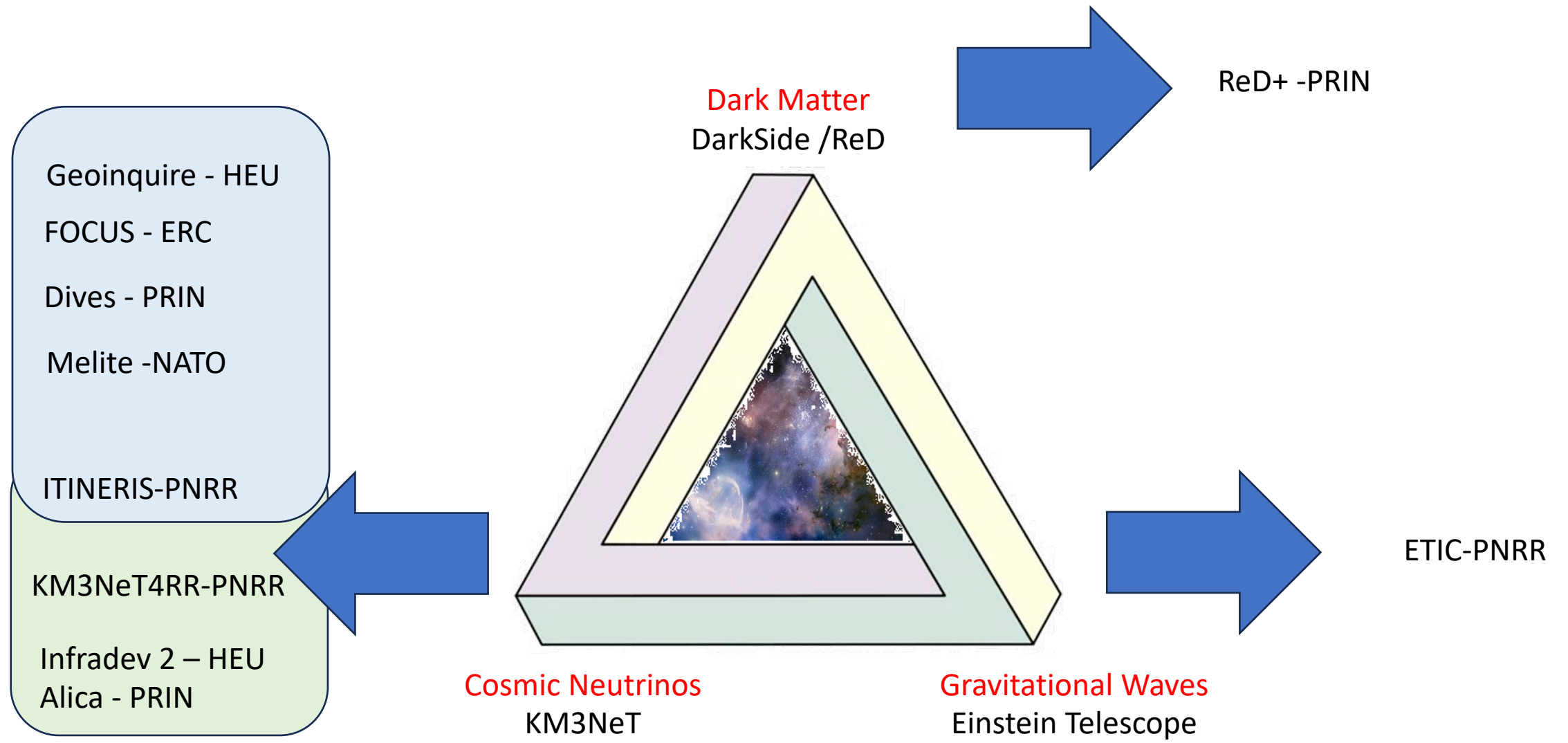


## Statements from 2022:

- The Astroparticle Physics experiments at LNS covers a wide range physics goals in a long-range programme of science
- Members of CSN-2 at LNS are constantly growing in number and responsibilities
- Role of LNS in international experiments is solid and respected

Same for 2023

Same for 2024





**KM3NeT**

Actual Phase: Construction, operation, data analysis  
Main science cases: neutrino astronomy (multimessenger), neutrino fundamental physics

**Large increase with PNRR  
Science on Stage!**

**ET**

Actual Phase: R&D  
main science cases: Gravitational waves detection (multimessenger)

**LNS plays a major role in civil works.  
Scientific component from LNS growing**

**DarkSide (ReD)**

Actual Phase: Transition from R&D to Construction  
Main science case: Dark Matter detection (multimessenger)

**Nu@Fnal (DUNE) Moved to CSN1**

**2024**

**39 Persons  
25.1 FTE**

**2025**

**42 Persons  
29.1 FTE**

DFA-UniCT

Master Student's Visit also in 2024 (since 2022)

Jointly funded by LNS, Sez. CT and DFA



2 CSN2 Grants for bachelor students  
assigned to LNS

KM3NeT

Darkside/Red

CSN2: Riunione di Bilancio 2023

18-22 Sept 2023

Open Session: INFN Sez Catania / DFA

Closed Session: Capo Passero



Many other Outreach and Dissemination activities



Sigla INFN KM3 + Sigle affini  
 Resp. Naz.: G. Cuttone  
 Resp. Loc.: R. Coniglione

Network of cabled observatories located in deep waters of the Med Sea

Neutrino astronomy: ARCA @ Capo Passero  
 3500 m water depth, 100 km offshore

2 building blocks  
 230 units (700 m Height)

Neutrino oscillations and Mass Hierarchy: ORCA @ Toulon  
 2500 m water depth, 40 km offshore

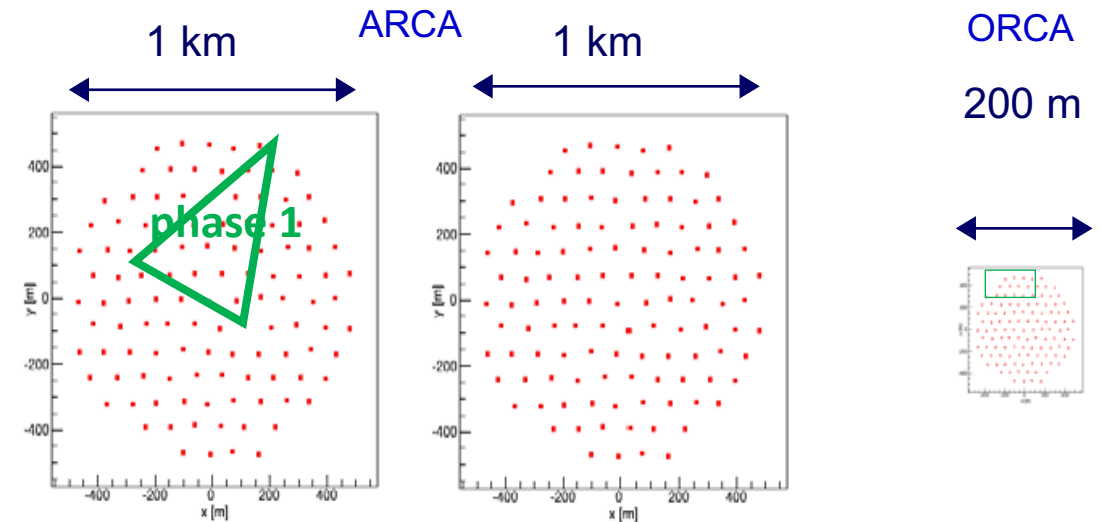
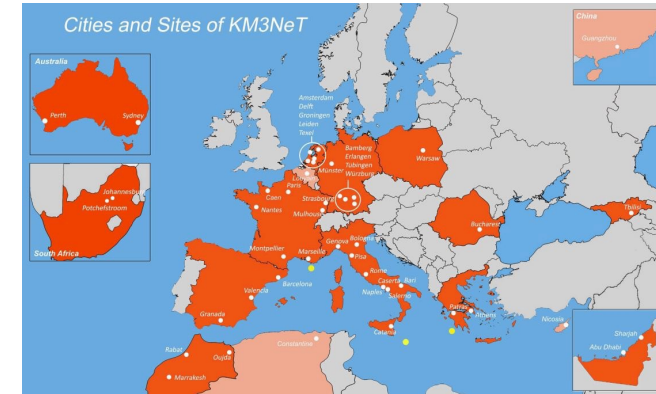
1 building block  
 115 units (250 m Height)

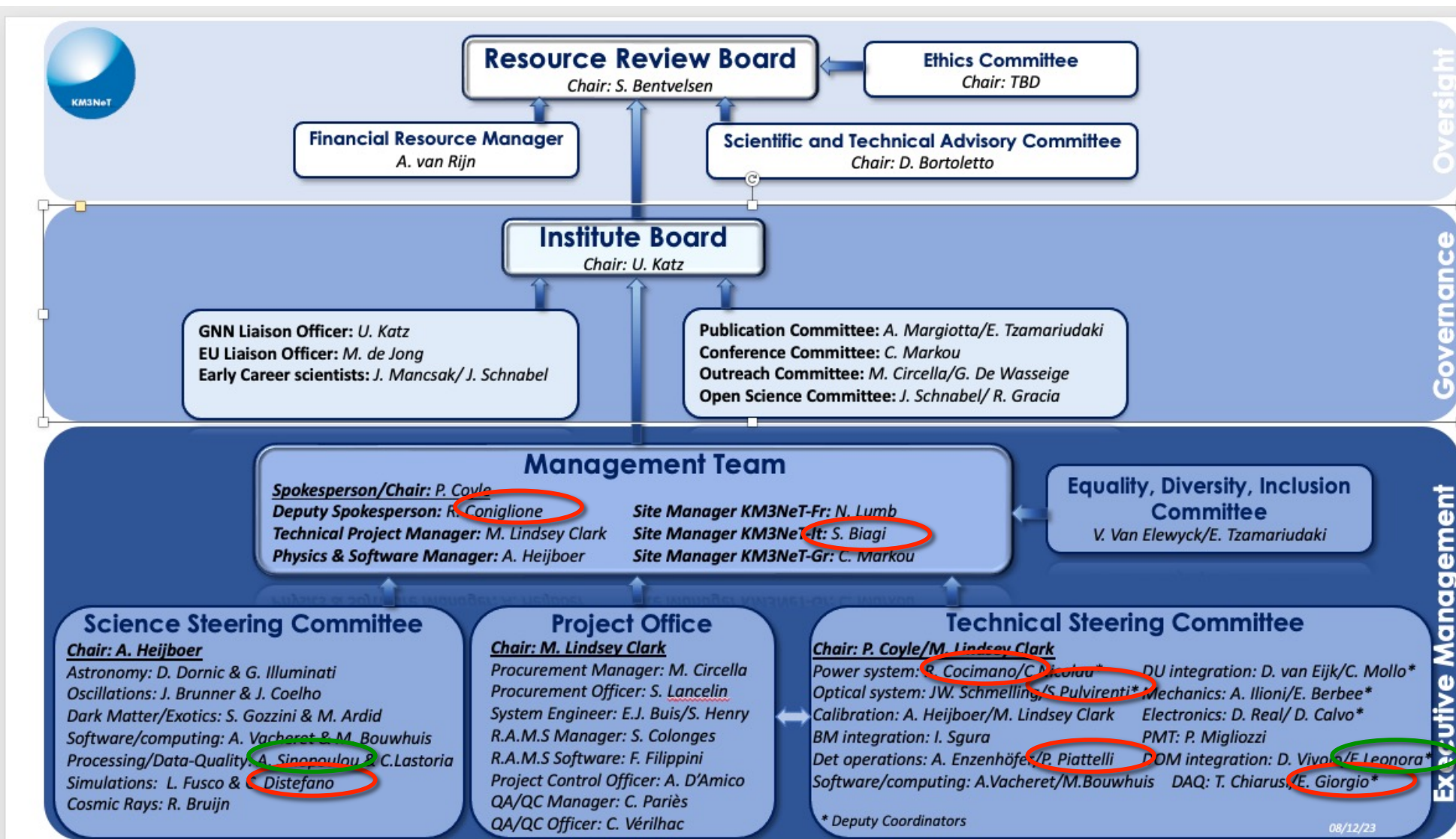
First undersea neutrino detector: ANTARES @ Toulon  
 2500 m water depth, 40 km offshore  
 13 units (300 m Height)

Decommissioned in 2022. Still in data-analysis

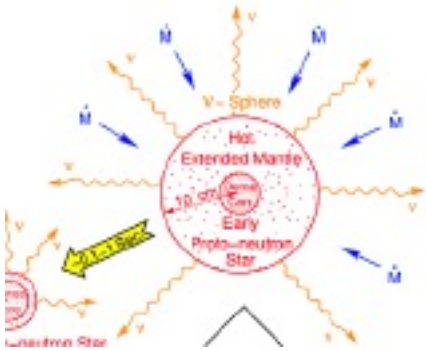
63 institutes, 22 Countries, >300 persons

+ Harvard University (USA) + Drexel University (USA)

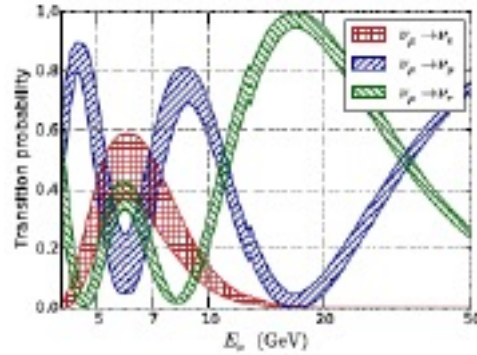




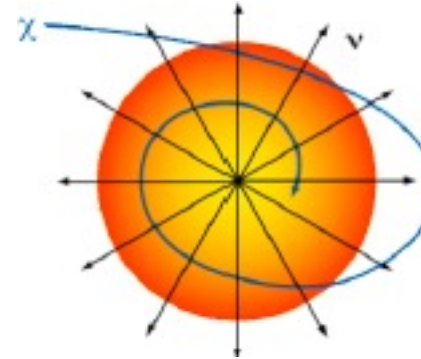
# Project: KM3NeT Objectives



Supernova explosions  
ARCA+ORCA



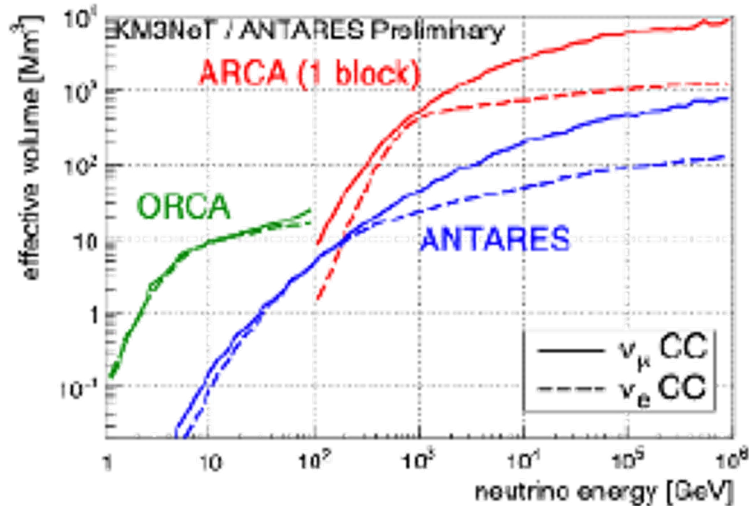
Mass Hierarchy  
ORCA



Dark Matter  
ORCA



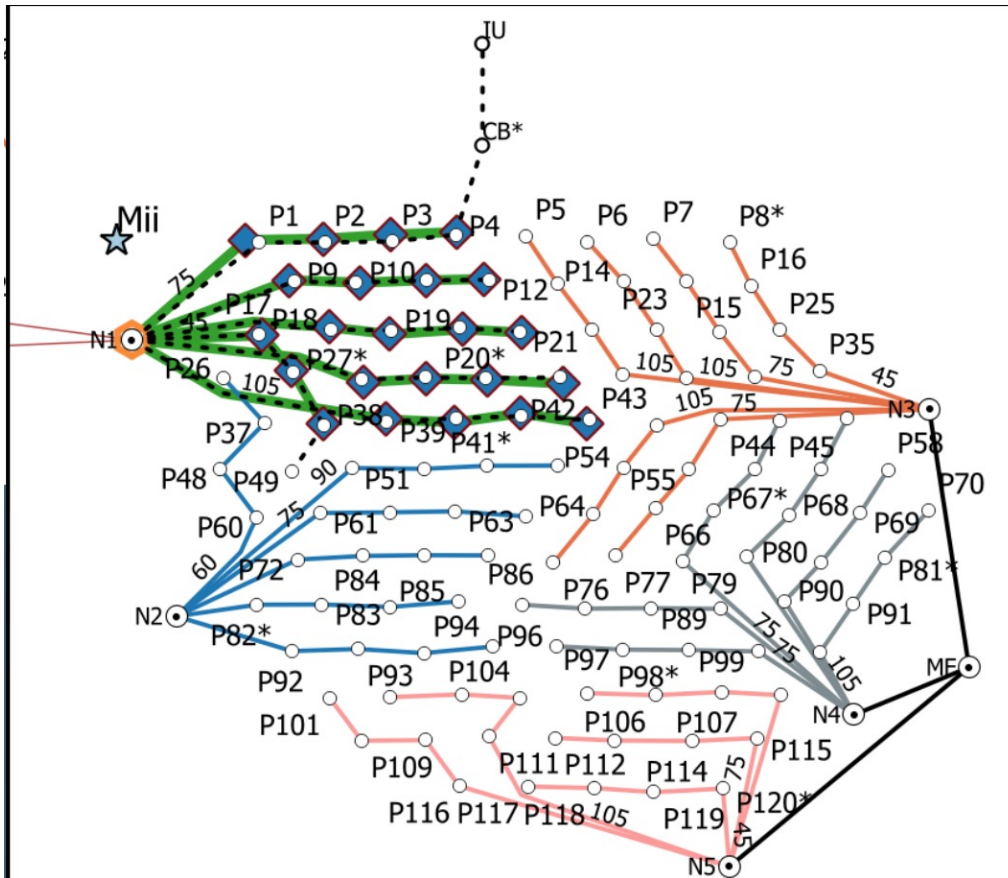
High Energy Neutrino Astronomy  
ARCA



Antares dismantled

Science on Stage!

KM3NeT larger than Antares volume since 2023



Status: 23 Detection Units deployed

Next sea operations 2024:

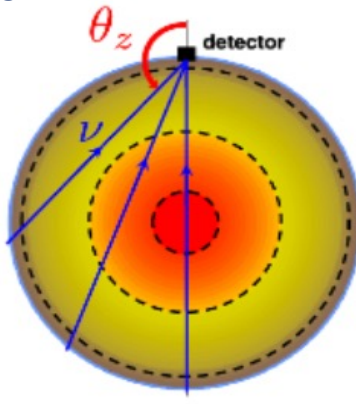
complete the DUs of node1  
deploy the node2 and 4 or 5 Dus

20% of the full detector

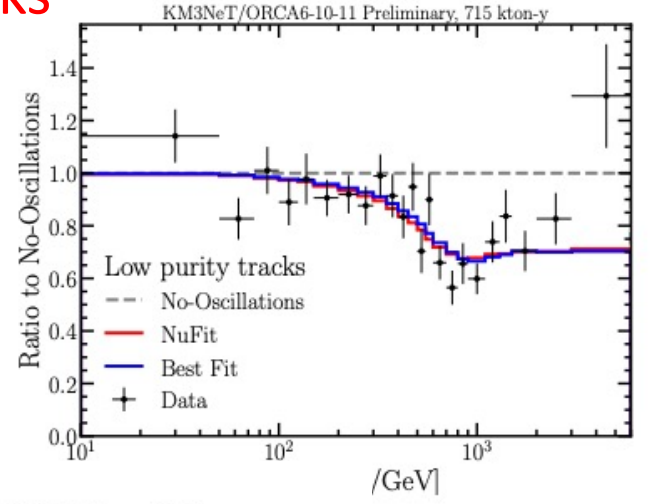
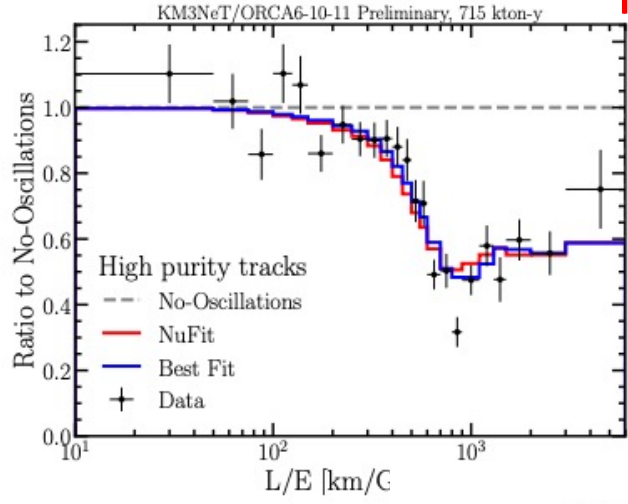


## ORCA6-7-11 data

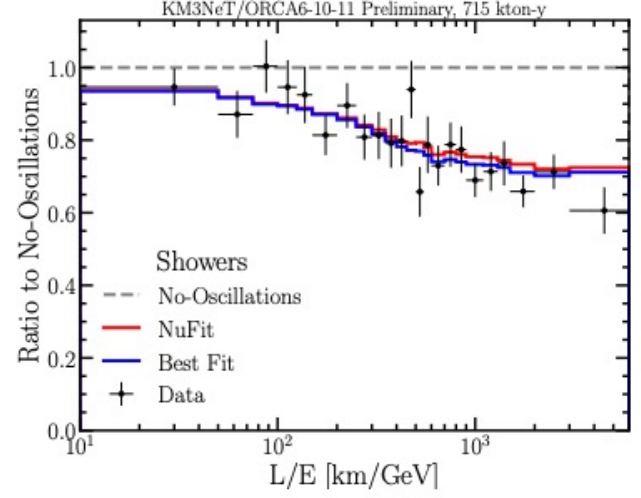
Oscillations clearly seen both in track and shower events



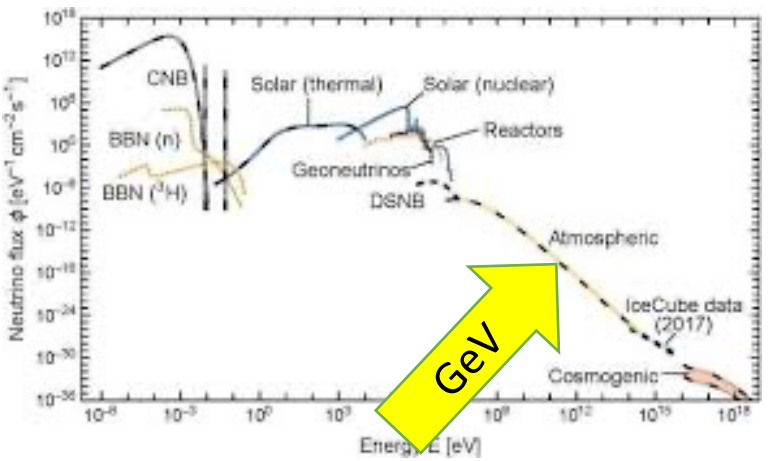
Tracks



Showers



Preliminary

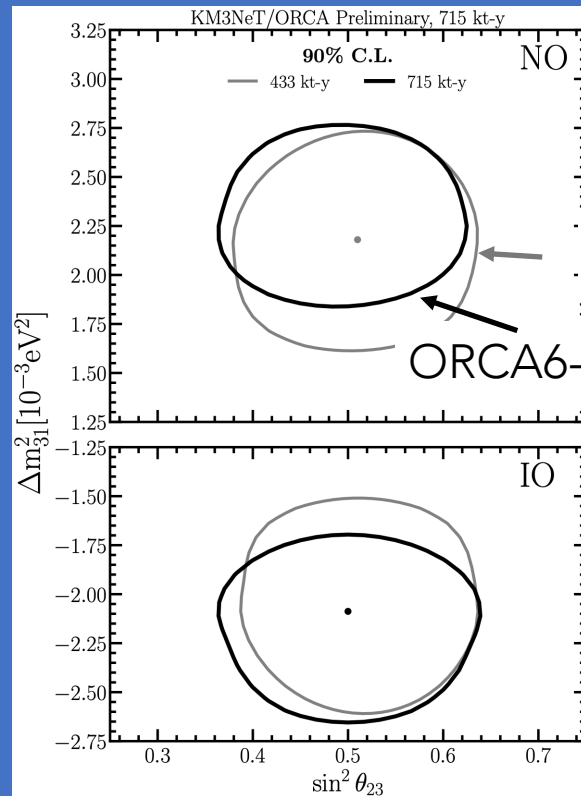


increased the exposure



From 433kt-yr to 715 kt-yr

$\Delta m^2_{32}$  vs  $\sin^2 \theta_{23}$



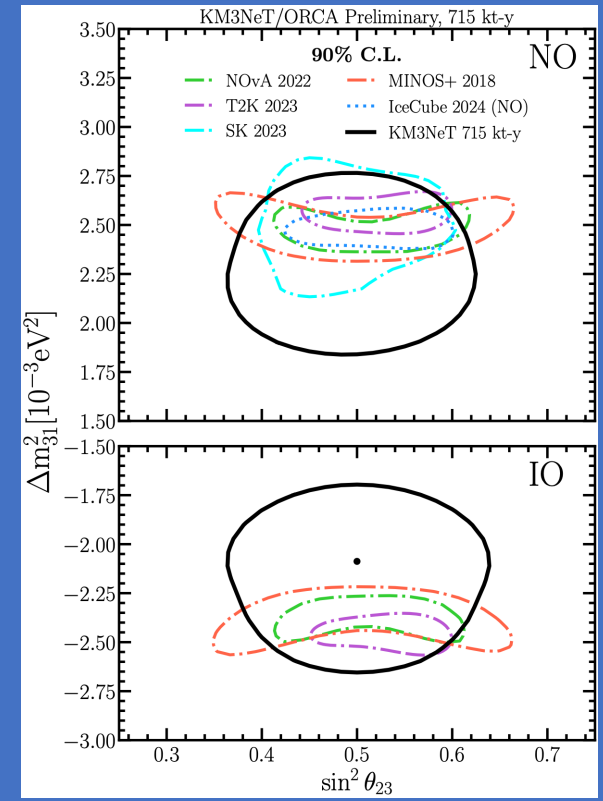
ORCA6 🖐️ 433 kton-yr  
ORCA6-10-11 🖐️ 715 kton-yr

$$\Delta m^2_{31} = \begin{cases} -2.09^{+0.17}_{-0.21} \times 10^{-3} \text{eV}^2, & \text{IO} \\ [2.10, 2.37] \times 10^{-3} \text{eV}^2, & \text{NO} \end{cases}$$

$$\sin^2 \theta_{23} = 0.50 \pm 0.07$$

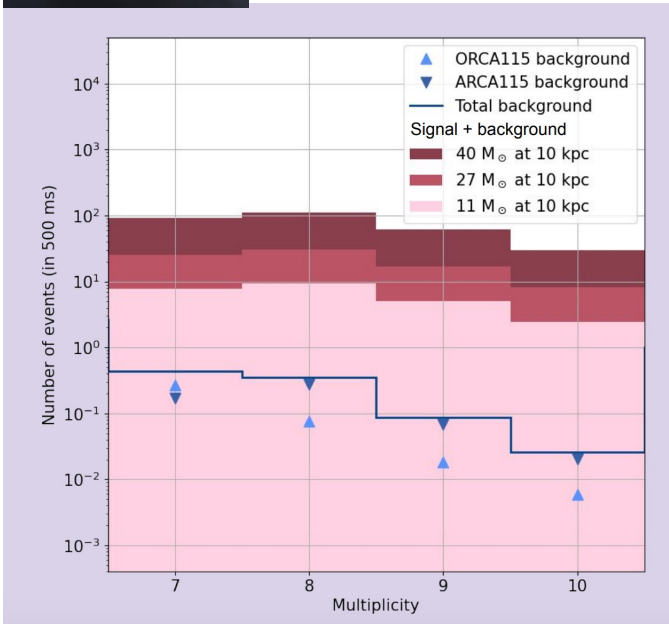
$$2 \log(\mathcal{L}_{IO}/\mathcal{L}_{NO}) = 0.61$$

$\Delta m^2_{32}$  vs  $\sin^2 \theta_{23}$

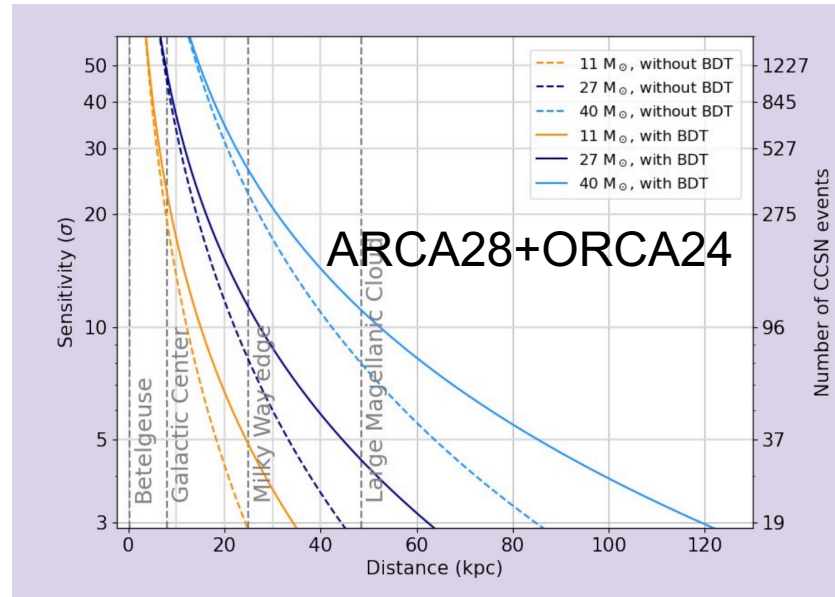


KM3NeT/ORCA competitive

An on-line alert system for Supernova explosion detection  
Alert System already implemented : integrated in SNEWS

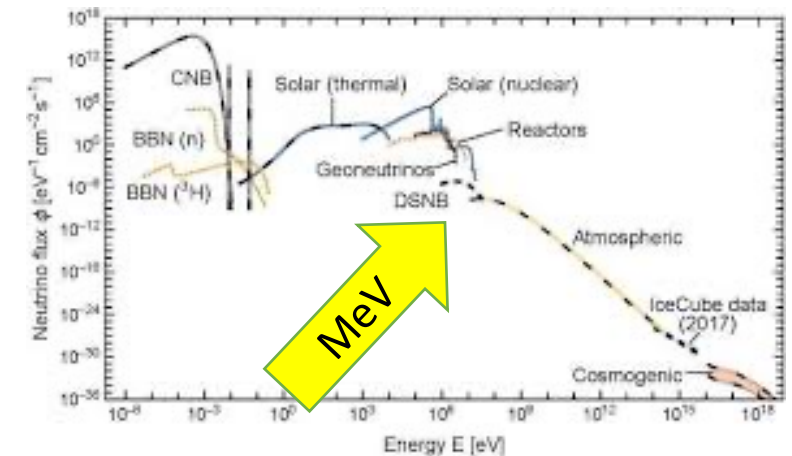


Signal expected above background

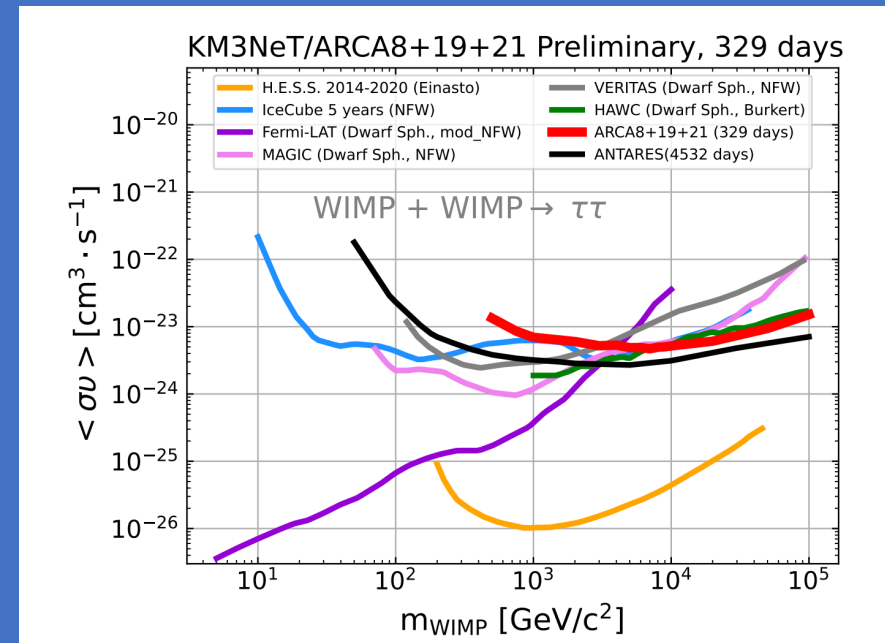
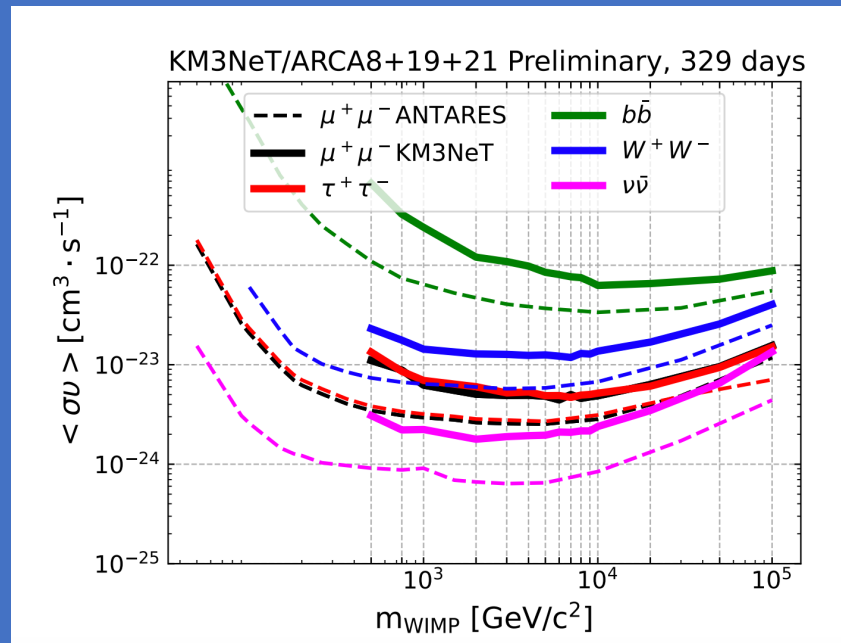


Preliminary

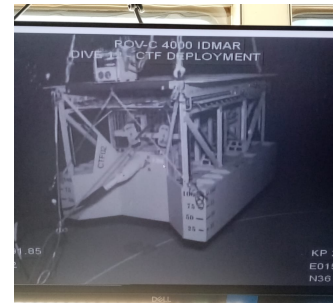
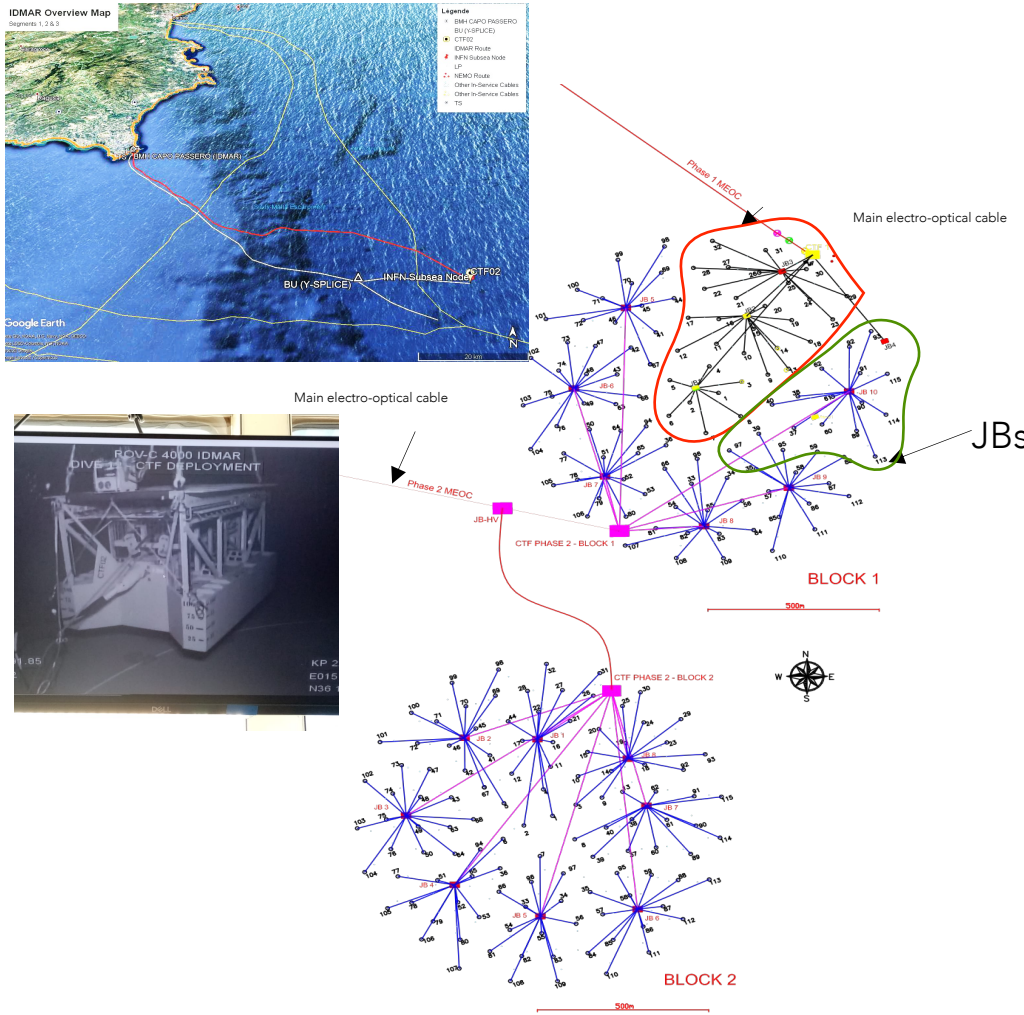
>5 $\sigma$  for ARCA+ORCA for 27M<sub>⊙</sub> at a distance <50kpc (till Large Magellanic Cloud)



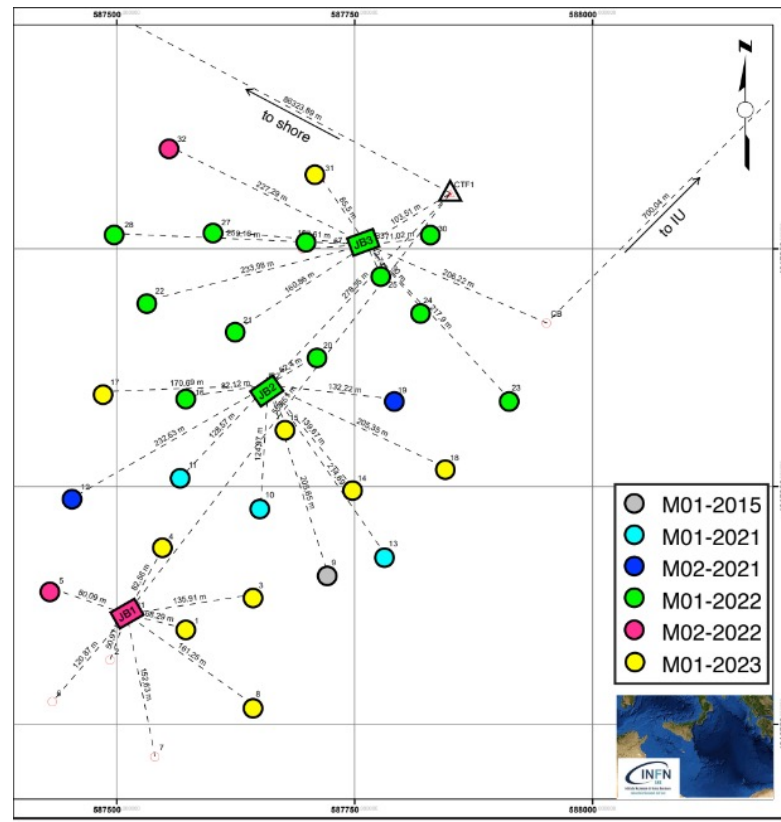
## (indirect measurement of) Dark Matter From the Galactic Center



KM3NeT quickly reaching the ANTARES limits



till Sep 2023: 21 DUs deployed  
 till Sep 2024: 28 DUs deployed  
 from Sep 2024: 48 DUs deployed



new Offshore Ship since 2024

## An enormous work in 2024 in view of the sea operation for the Upgrade of KM3NeT

Connection of JB4 and JB5 on the new IDMAR infastructure (MEOC-2):

- new Power feeding equipment on-shore
- new Cable Termination Frame

Transition of Data Transport, Data Acquisition, Calibration to full White Rabbit:

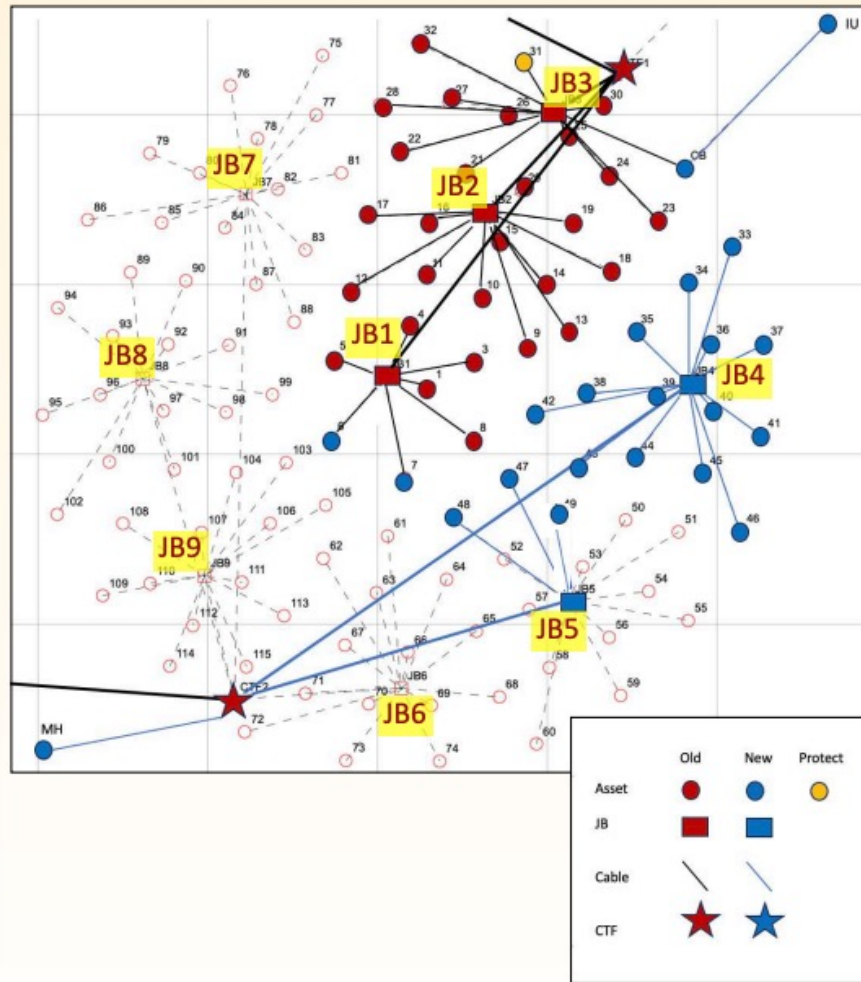
- upgraded power system
- upgraded DAQ & optical system
- new DU base (Base Module, anchor)
- upgraded time calibration procedure

Test, construction, integration, Reviews (QA/QC) !

Finalisation of Calibration Base and Instrumentation Unit for seawater properties measurements

Advanced Positioning System design and deployment:

INFN+EXAIL: Absolute Positioning System (EXAIL) fusion with Relative Positioning System (KM3NeT)

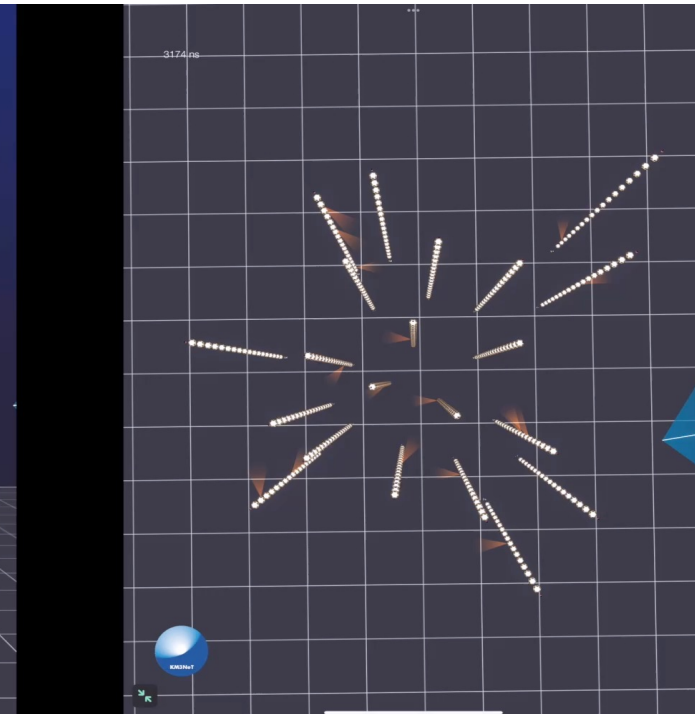
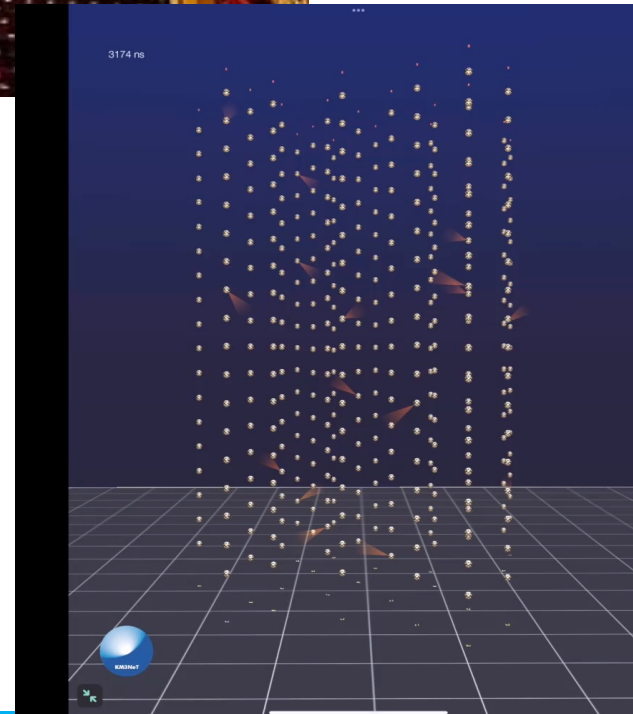


\* Interlinks IL.0002, IL.0006, and IL.0007 are on the seafloor, connected to JB and protected on DU-side.

- Deploy
  - 2 x DU (Phase-1) to JB1
  - CB in position 29 with its IU
  - JB4 and JB5, with related interlinks
  - 14 x DU to JB4
  - 3 x DU to JB5
  - Marine Hazard (MH) to CTF2, interdiscipl. proj.
- Recovery
  - ARCA.0031 (low priority)
  - ARCA.0009 (very-very low priority)
  - Interlink.0002 (ARCA.0002 removed from map)
  - 1 non-working acoustic tripod
- Acoustic positioning (approx 3 full days)
  - Deploy 4 tripods with EXAIL transponders + KM3NeT beacons — final coordinates needed by CALIB WG after feedback from EXAIL†
  - Box-in procedure for improved positioning

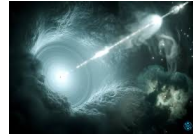
† See Lilian's talk

# Project: KM3NeT ARCA Science on stage

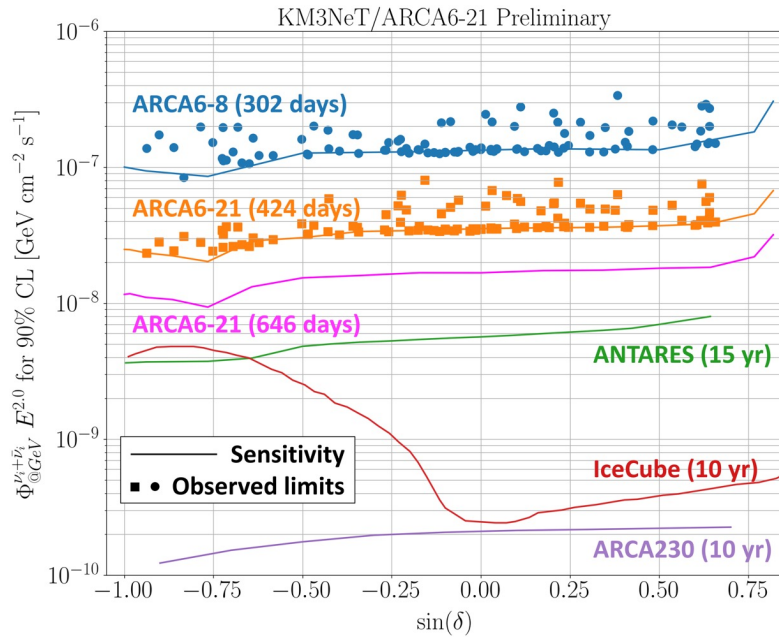




## Point Like Fluxes

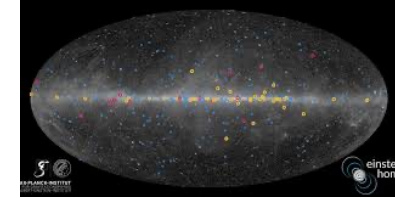


KM3NeT upper limits are quickly reaching the ANTARES 15yr limits

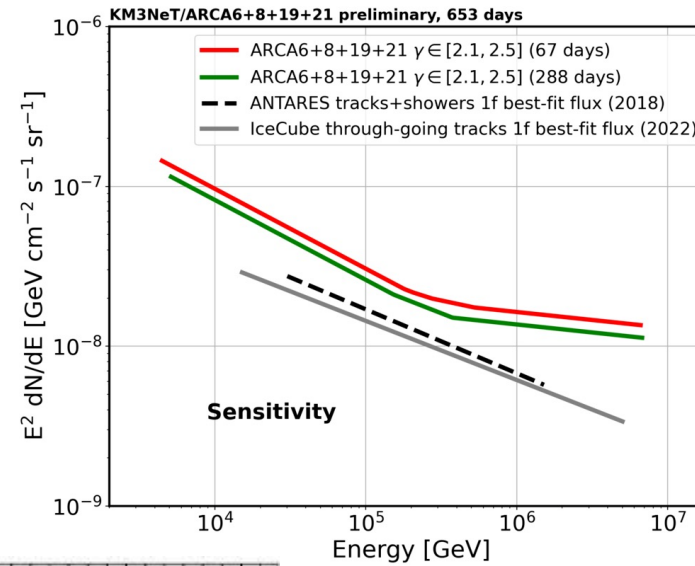


Large improvement in sensitivity is expected with ARCA48 from sept 2024

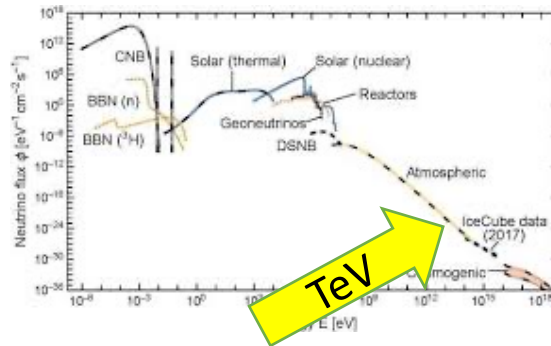
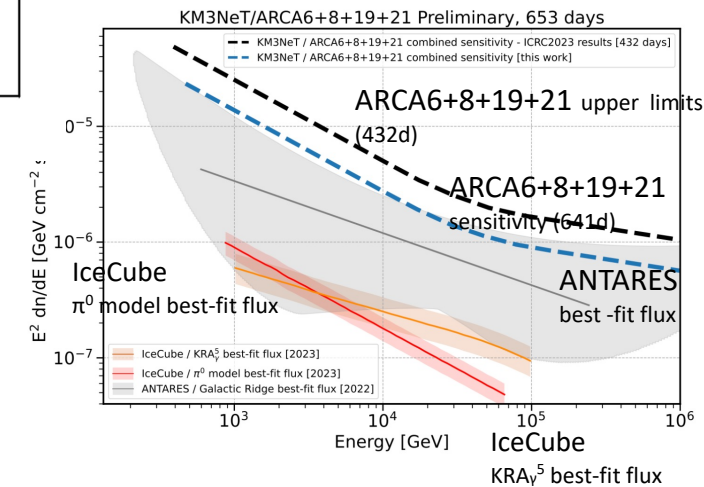
## Diffuse Fluxes



ARCA rapidly approaching ANTARES sensitivities



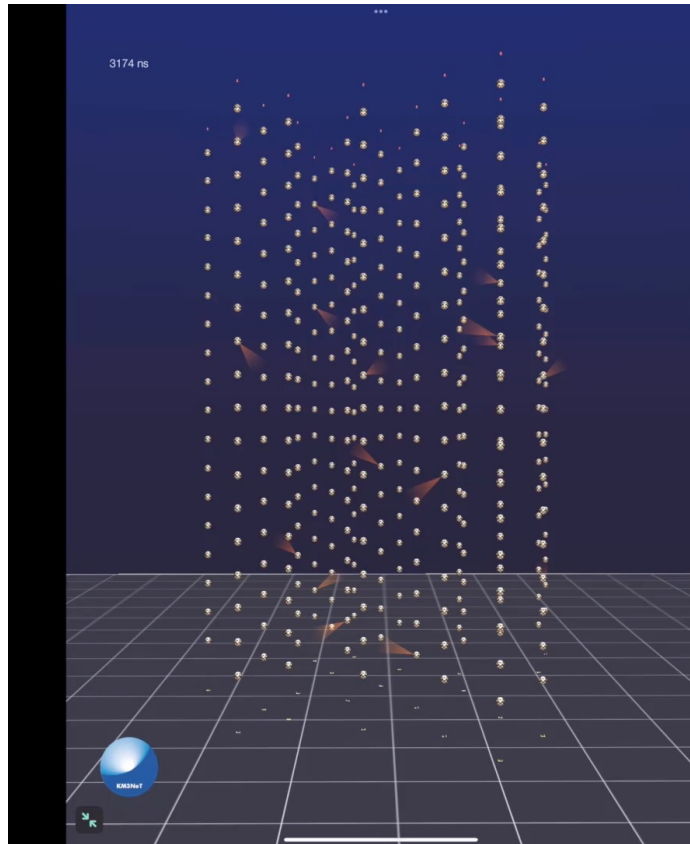
## Full sky



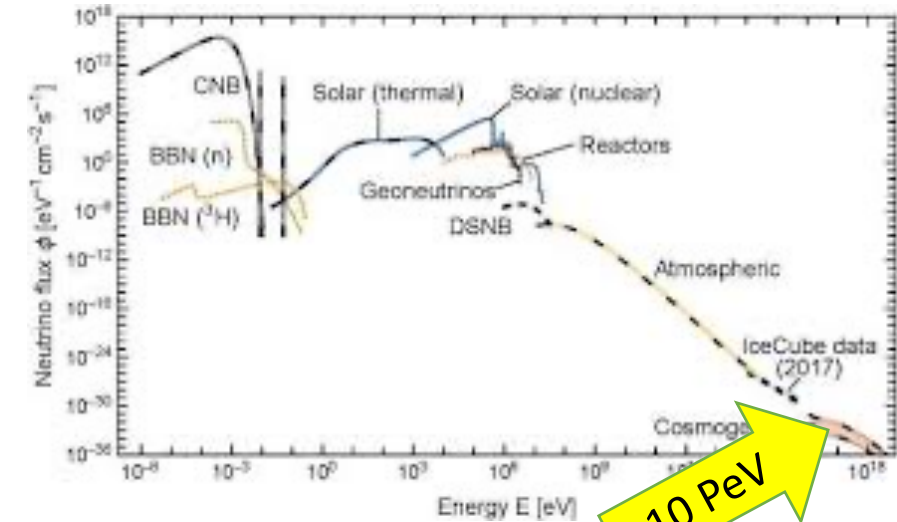
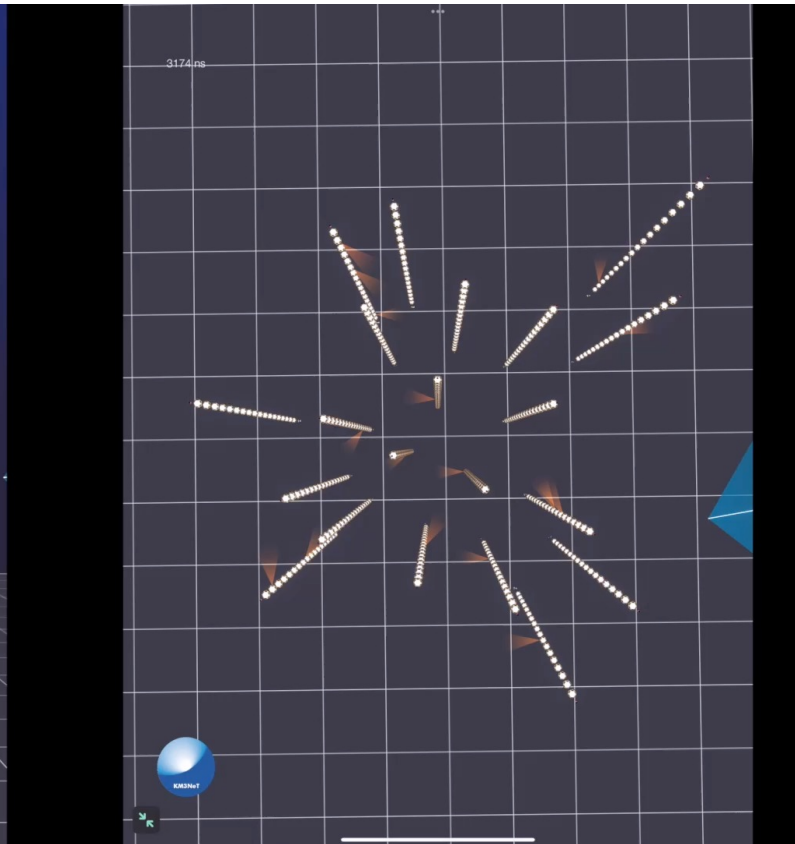
## A very energetic cosmic event detected

ARCA21

Side view



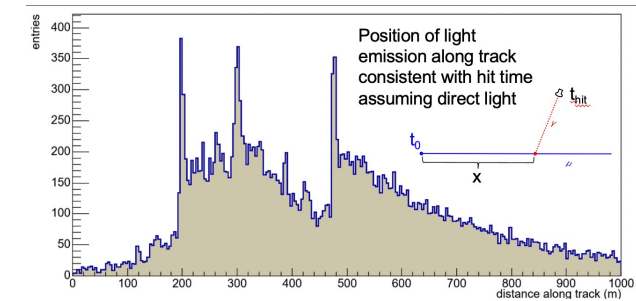
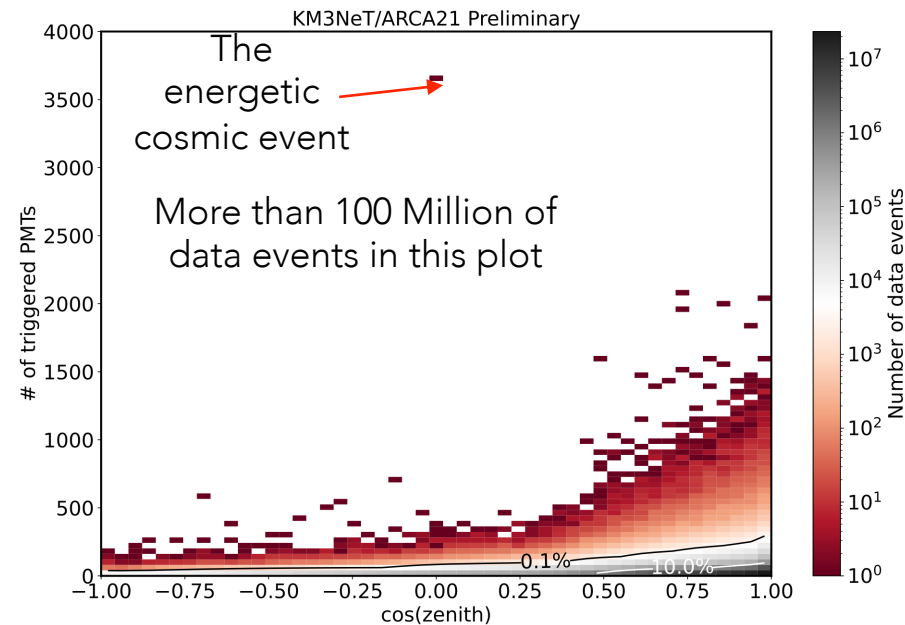
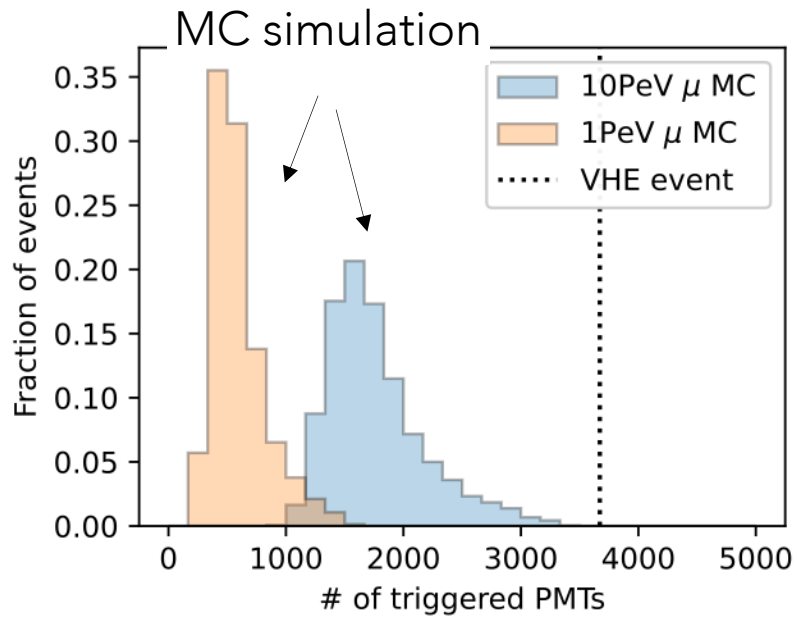
Top view



## A very energetic cosmic event detected

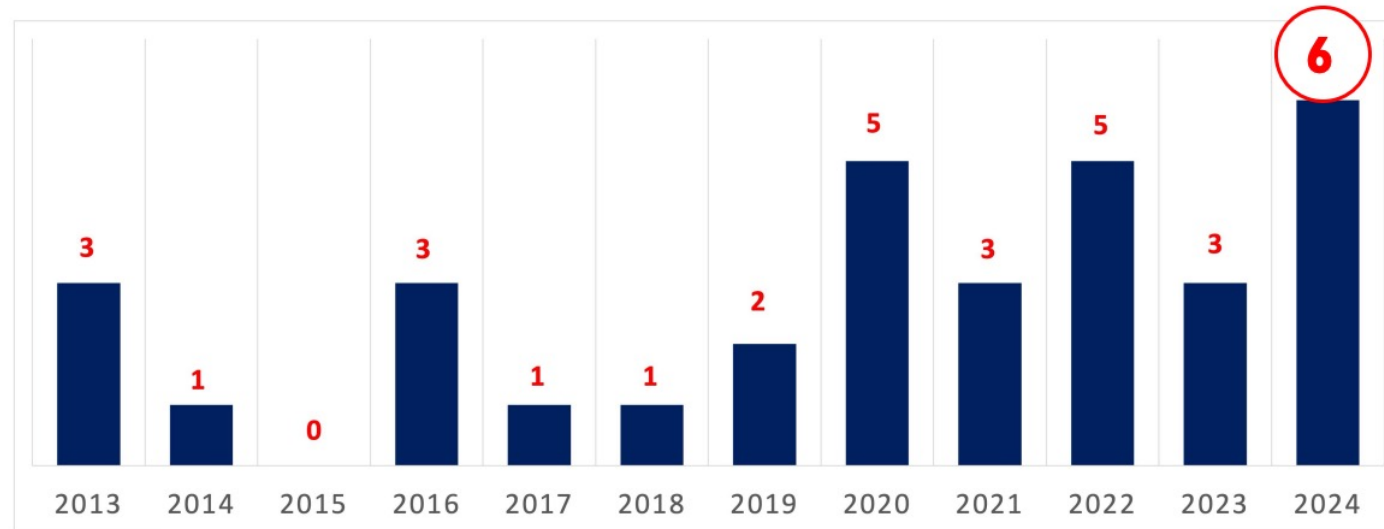
The event is a horizontal event ( $1^\circ$  above the horizon) with energy above 10 PeV

Huge amount of light detected 🖱️ 35% of the total number of PMTs were triggered



Hit times consistent with 1 track and 2 (co-linear) showers

## KM3NET IN PEER-REVIEWED JOURNALS – PAPERS/YEAR



- **KM3NeT CLB Embedded software**, *Computer Physics Communications* **296** (2024) 109036 (arXiv:2308.01032) – c.a.: V. van Beveren, D. Real
- **Prospects for combined analyses of hadronic emission from  $\gamma$ -ray sources in the Milky Way with CTA and KM3NeT/ARCA**, *European Physics Journal C* **84** (2024) 112 (arXiv:2309.03007) – c. a.: T. Unbehaun, L. Mohrmann (CTA consortium)
- **Searches for neutrino counterparts of gravitational waves from the LIGO/Virgo third observing run with KM3NeT**, *Journal of Cosmology and Astroparticle Physics* **04** (2024)026 (arXiv:2311.03804) – c. a.: M. Lamoureux, S. Le Stum, G. Vannoye
- **The Power Board of the KM3NeT Digital Optical Module: design, upgrade, and production**, *Electronics* **13** (2024) 2044 (arXiv:2311.14872) – c.a.: D. Real, D. Calvo
- **KM3NeT/ARCA Differential Sensitivity for Diffuse and Point-Like Emissions: Probing Starburst Galaxies Emissions**, *Astrop. Phys.* **162**(2024) 102990 (arxiv:2406.11946) – c. a.: A. Ambrosone, W. Idrissi Ibsnalih, A. Marinelli
- **Atmospheric muons measured with the KM3NeT detectors in comparison with updated numeric predictions** (arXiv:2403.11946) – c.a.: V. Kulikovskiy, A. Romanov; **JUST ACCEPTED FOR PUBLICATION ON EPJ C**

KM3NeT4RR 🖱️ WP a responsabilità LNS:

- WP1 - Management
- WP2 - On shore infrastructures (P. Piattelli) - tenders on going
- WP5 - Sea Floor Network (S. Biagi) - tenders on going
- WP7 - Implementation of multi messenger liasons (R. C.) - [post docs at INAF and Universities almost all hired + 3 PhDs - first meeting in Bologna 24/5/2023](#)
  
- At LNS 🖱️ [1 project manager + 2 tecnologi \(+2 su ITINERIS\) + 8 tecnici](#)

## Tenders all assigned - People hired

INFRADEV2: EU project started 1st of January 2023

- WP2 - Legal Entity (P. Sapienza) - [AISBL in definition](#)
- WP3 - Accelerating implementation - [a post doc for RAM software analysis hired \(R = reliability, A = Availability, M = Maintainability\) \(Bologna\)](#)
- WP5 - Sustainability and socio-economic impact - [a post doc for socio-economic impact study hired \(LNS\)](#)
  
- PRIN 🖱️ ALICA - Atmospheric Leptons In Cherenkov Arrays
  - PI Matteo Sanguineti Genova
  - At LNS 🖱️ 66k€ - 1 year post-doc - Call opened
  - [Project started](#)

## PNRR-ITINERIS

Seafloor data “e-highway”: optical data link and power connection for EMSO-ERIC stations in Capo Passero  
Seafloor acoustic data hub at LNS.

2 TD hired

## Marine Hazard

Multidisciplinary seafloor station in Capo Passero

## ECCSEL-ERIC: IPANEMA

Monitoring of CO<sub>2</sub> with acoustic antennas and chemical sensors

two stations: in Panarea (20 m depth- in operation) and Catania (2100 m depth, Sep 2021)

3 post docs hired

## FOCUS-ERC (LNS beneficiary)

Monitoring of seismic phenomena with Brillouin Optical time reflectometry using the fibers of the subsea cable of the Port of Catania Test Site

approx. 2 papers/year published

2 post docs in hiring

## Geo-Inquire EU (K. Fleming PI, GFZ, G. Riccobene PI INFN) – Ends in 2026

Transnational access activity to use optical fibers of the subsea cable at the port of Catania for seismic and volcanic monitoring

1 post-doc hired

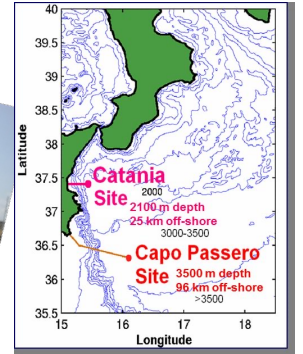
## DIVES-PRIN : Deep-sea Investigation with a View to protect Elusive cetacean Species (SZN leads, S. Pulvirenti PI LNS)- Ends in 2025

## MELITE-NATO : new optical technologies for deep sa (CNRS, INFN, LNS)- Ends in 2025

Strong collaboration with CSFNSM for developing (optical&acoustic) deep sea monitoring technologies

INFN in EMSO-ERIC/Italia - JRU

test new technologies  
multidisciplinary plan  
and new personnel



small impact and excellent good reward

KM3NeT & Co.:

22,7 FTE (+0,7 wrt 2004)

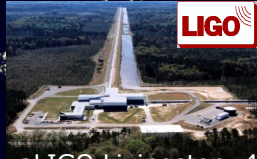
Budget requests to CSN2 (in k€):

Transfers	250
Common Funds	632
Consumables	39
Transports	54

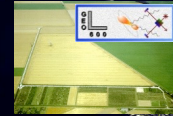
# Project: ET (and VIRGO)



aLIGO Hanford, 4 km



aLIGO Livingston, 4 km



GEO, Hannover, 600 m

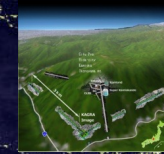


AdV, Cascina, 3 km



~2026

It will operate as part of the LIGO Network and Collaboration



KAGRA Collaboration:

- 410 collaborators
- 14 countries
- 5 computing centres
- ~16.4 G¥ of construction costs

LIGO Scientific Collaboration:

- 1400+ collaborators (including GEO)
- 19 countries
- 8 computing centres
- ~1.5 G\$ of total investment

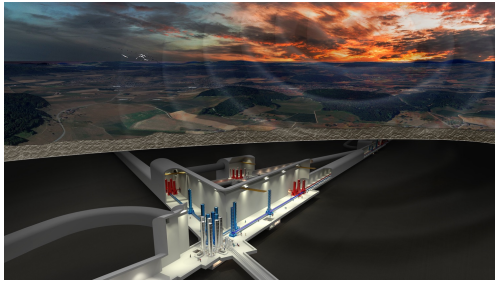
Virgo Collaboration:

- 850 collaborators
- 16 countries
- 4 computing centres
- ~0.5 G€ of total investment



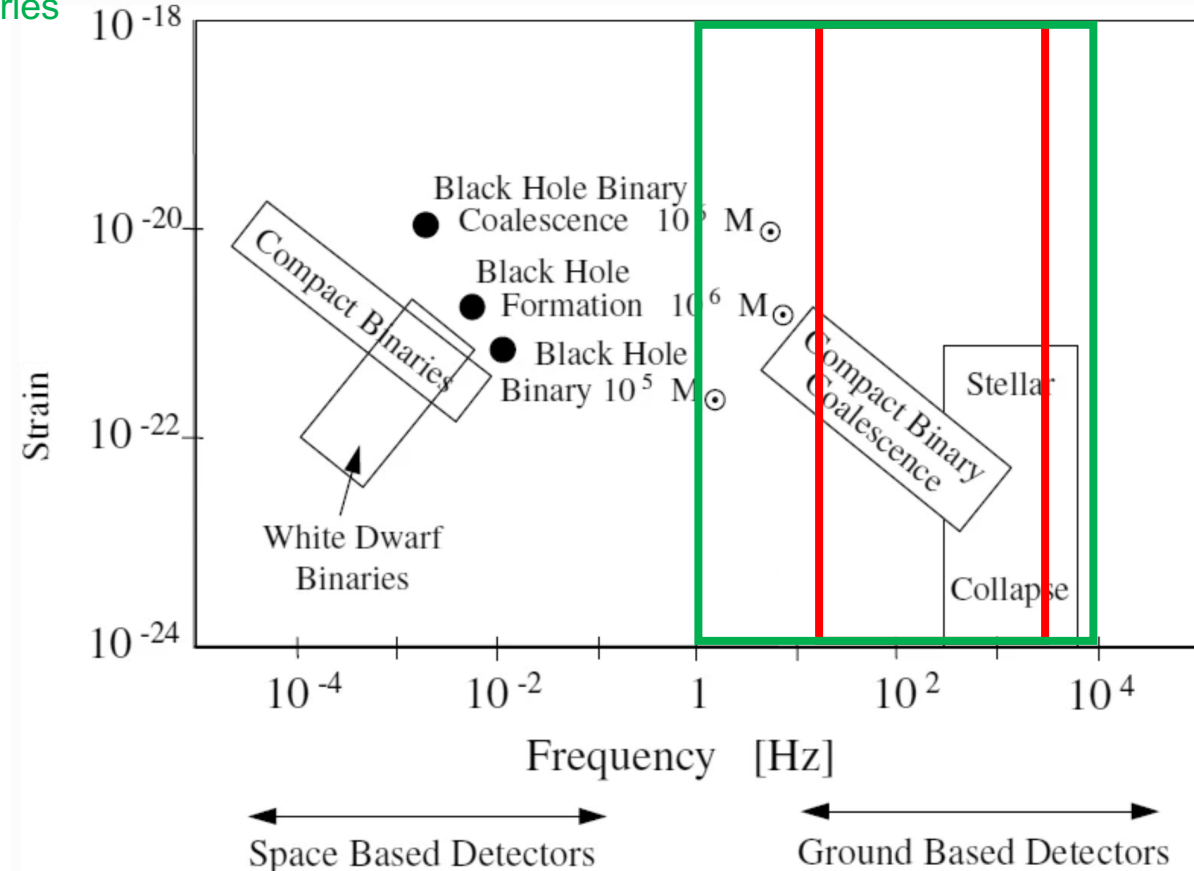
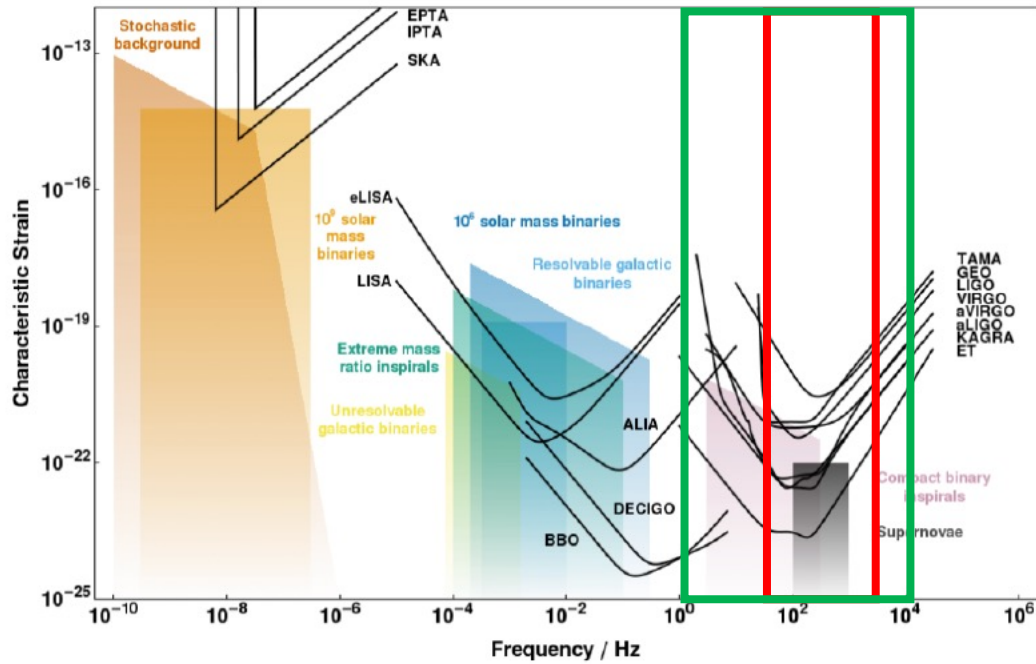


# Project: ET Objectives



Virgo: 20-2000 Hz  
compact binary inspirals (BBH, BNS and BH-NS), supernovae and bursts.  
O4 started!

Einstein telescope: 1-10000 Hz  
Precision measurements AND new discoveries

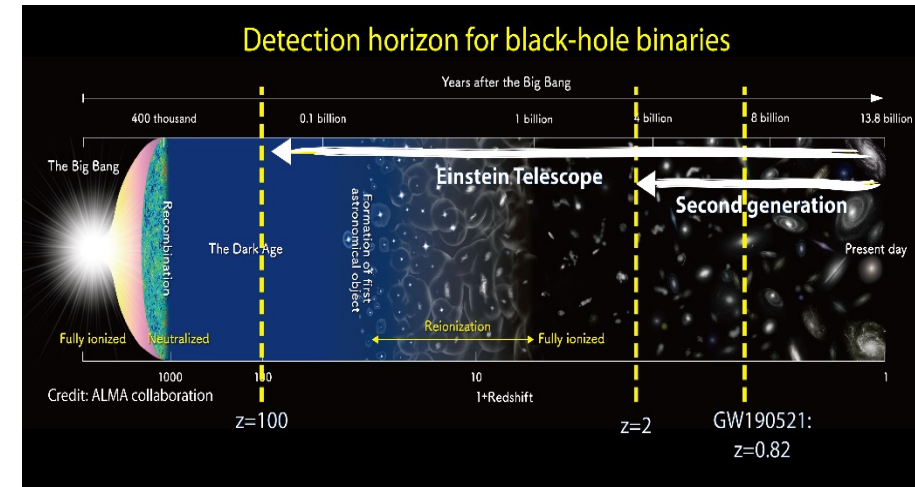
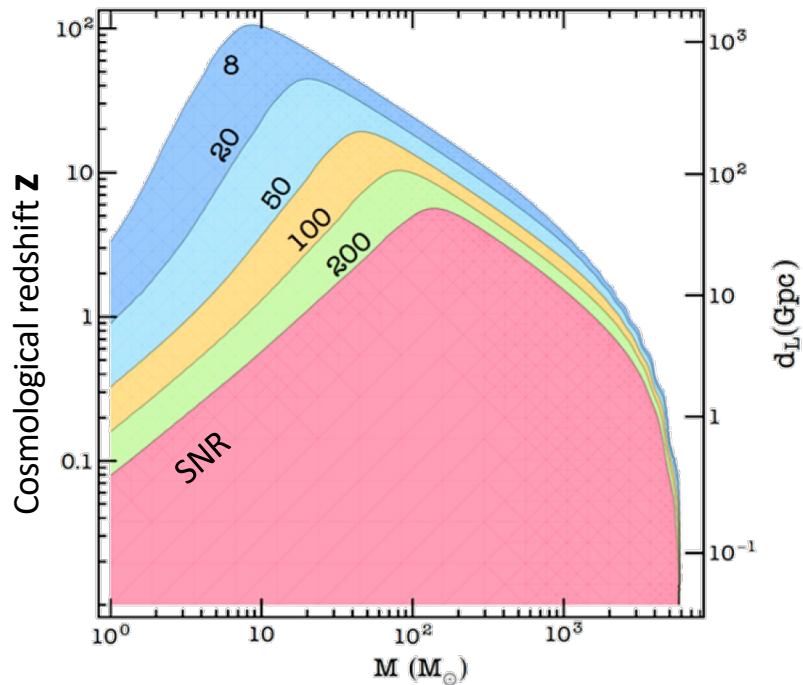




Collaboration birth in 2022: 1200 scientists from USA, Europe and Japan

ET will be a new discovery machine:

will explore almost the entire Universe listening the gravitational waves emitted by black hole, back to the dark ages after the Big Bang



ET will be a precision measurement observatory:

will detect, with high SNR, hundreds of thousands coalescences of binary systems of Neutron Stars per year, revealing the most intimate structure of the nuclear matter in their nuclei

## Requirements

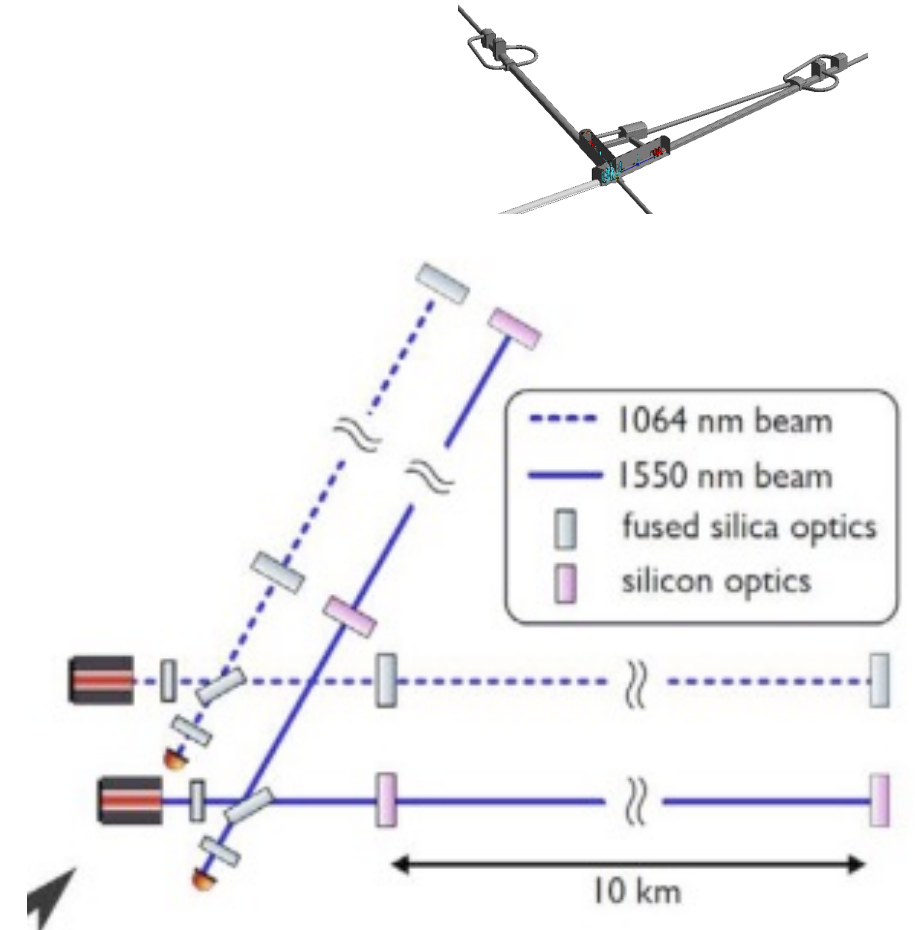
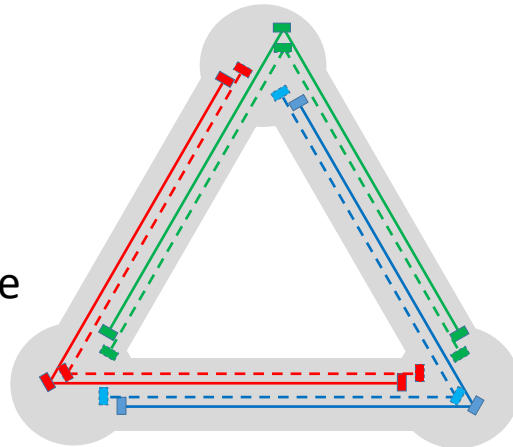
- Wide frequency range
- Massive black holes (LF focus)
- Localisation capability
- (more) Uniform sky coverage
- Polarisation disentanglement
- High Reliability (high duty cycle)
- High SNR

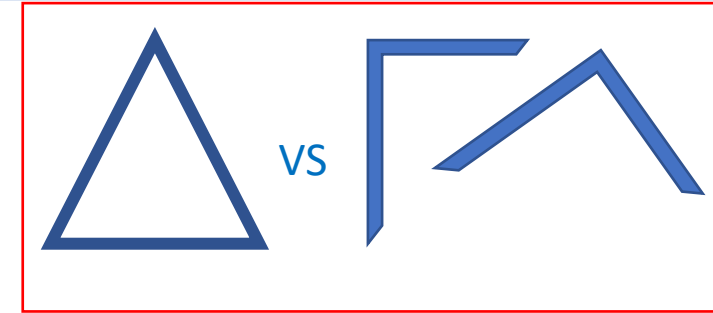


## Design Specifications

- Xylophone (multi-interferometer) Design
- Underground
- Cryogenic
- Triangular shape
- Multi-detector design
- Longer arms

6 arms: 1 LF and 1 HF arm in each side





**COst Benefit Analysis committee (COBA)** *several independent codes used, same results*

Triangle (10,15 km) vs 2L (15-20 km, parallel or 45°), keeping xylophone.

2L (15km, 45° oriented) give better science return with respect to 10km triangle and similar to 15km triangle.

L configuration ↔ two sites.

2L only High Frequency (HF) is better than single 10km triangle full xylophone (HF+LF)!

Two stage approach possible: commissioning of HF with a good science return, then moving to full HF-LF at room temperature and then cryogenic.

200-pages document and a publication submitted: **2L configuration is generally favoured.**

**ET Risk Assessment committee (ETRAC)** *experts in commissioning, led by L. Barsotti (LIGO)*

Identified risk categories\*, defined a risk metric, applied risk metric to risk categories ranked the possible configurations, focusing on two of them: **10km-triangle vs 15km-2L.**

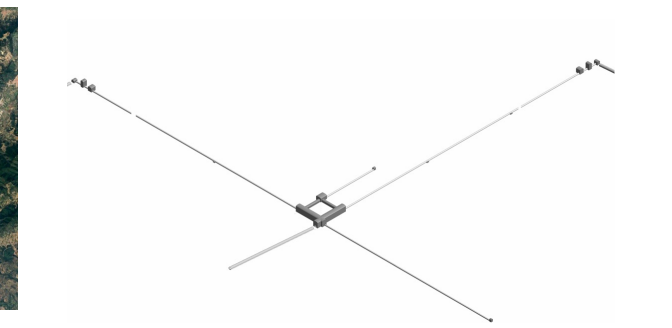
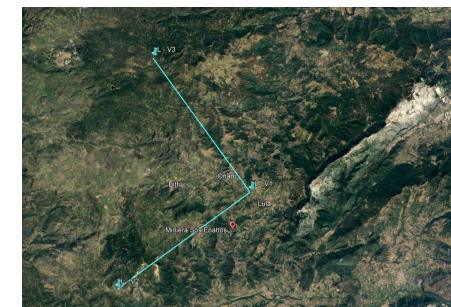
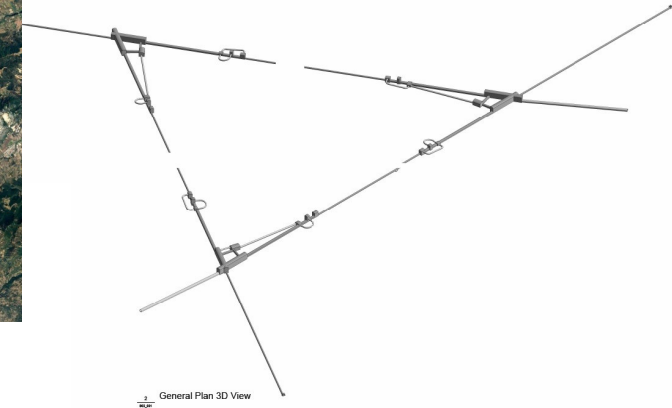
First report under evaluation/review for further steps of the analysis (e.g. risk mitigation).

**2L configuration seems strongly favoured.**

ET-0084A-23: <https://apps.et-gw.eu/tds/ql/?c=16584>

\*excluded: political, financial

# Project: ET The Sardinian site



ORIZZONTE TEMPORALE LAVORI: 6-7 ANNI

POSIZIONAMENTO PER LA CONFIGURAZIONE A 'TRIANGOLO' (T11km) → **fatto, marzo 2024**

POSIZIONAMENTO PER LA CONFIGURAZIONE A 'ELLE' (L16km) → **fatto, aprile 2024**

RILIEVI PRELIMINARI DI SUPERFICIE NEI VERTICI → **fatto, per T11km ed L16km**

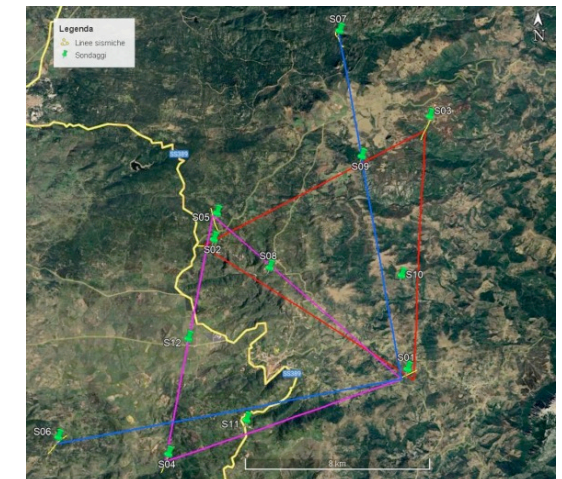
PIANO DELLE INDAGINI E DEI SONDAGGI (T1,T2) → **fatto maggio 2024**

ESECUZIONE DI INDAGINI E SONDAGGI IN PROFONDITA' → **inizio luglio 2024**

proposta nuova configurazione a triangolo (T2)

## piano delle indagini geognostiche

- **10 sondaggi** nel caso di scelta della configurazione T1
- **11 sondaggi** nel caso della scelta della configurazione T2



## Sicurezza generale e Antincendio

- Ottenuto il consenso preventivo dalla competente autorità **VVF**
- Impiego di criteri di sicurezza analoghi a quelli del **CERN**
- Adozione del sistema push-pull e di sistemi di spegnimento diretti nelle gallerie principali in caso di incendio;
- Individuazione di una serie di **vie di evacuazione** verticali dotate di impianti elevatori.

## Ventilazione e climatizzazione

- Sono stati studiati e chiariti i principali aspetti legati alla ventilazione sanitaria
- E' stato sviluppato un modello molto performante sia per prestazioni che per economia
- Viene sfruttata **l'inerzia termica** (serbatoio «infinito» di calore) dell'ammasso roccioso ospitante il complesso.

## Edifici in superficie

- E' stata condotta un'interazione approfondita con ogni soggetto locale al fine di valutare le migliori ipotesi per l'ubicazione degli edifici in superficie
- Attualmente **tre ipotesi** sono al vaglio dell'INFN

## Autorizzazioni amministrative e ambientali

- Avviate tutte le interlocuzioni con gli enti locali preposti al rilascio di un parere al fine di indire una apposita **conferenza dei servizi** nei primi mesi del 2025 finalizzata ad una approvazione di indirizzo.

## Pozzi

- **15 pozzi** verticali per Passaggio impianti e ventilazione
- Sezione circolare di diametro 6-7m
- Altezza variabile da 200 a 400m
- Realizzati con tecnica **raise borer** (fresa verticale dal basso verso l'alto)
- Rivestimento perimetrale in C.A.
- Volume di scavo previsto 250.000 m<sup>3</sup>

## Impianti in sottosuolo (gallerie e caverne a 400m di profondità)

- 40 km di impianti meccanici e di trattamento aria
- 30 centrali Hvac per trattamento e gestione dell'aria
- Distribuzione e canalizzazione a 400 metri di profondità
- 6 centrali per la gestione dell'aria di emergenza a 400 metri di profondità
- 1 MEGAWATT di potenza impegnata per ogni centrale di emergenza
- 120 Km di tubazione diametro 1m in acciaio inox
- 2000 castelletti metallici di sostegno tubazioni
- 200 Km di canale metalliche per posa cavi

## FABBRICATI IN SUPERFICIE

- 10 CENTRALI PER GESTIONE E TRATTAMENTO ARIA HVAC

## Caverne «tradizionali»

- Gallerie di vario diametro e sezione
- 30 caverne di altezze variabili da 12 a 30 m
- larghezze variabili da 12 a 27 m e lunghezze fino a **120 m**
- Ulteriori 2.000.000 m<sup>3</sup> di volume scavato
- Successiva messa in sicurezza con sostegni provvisori e spritz beton

## Caverne realizzate con TBM

- **3.000m** di sondaggi verticali a carotaggio continuo
- **40 km** di gallerie scavate con TBM
- diametro interno **7m**, diametro di scavo 7,70 m
- rivestimento in conci di c.a. spessore 35 cm
- Volume complessivo di scavo con TBM circa **2.000.000 m<sup>3</sup>**.
- Estrazione di tutto il materiale scavato in corrispondenza di un solo punto



Sun Lab – Area ex-rimisa (Miniera Sos Enattos)

**realizzazione di una nuova struttura multifunzionale** posta in superficie e un nuovo laboratorio sotterraneo, in collaborazione con l'INGV e l'INAF.



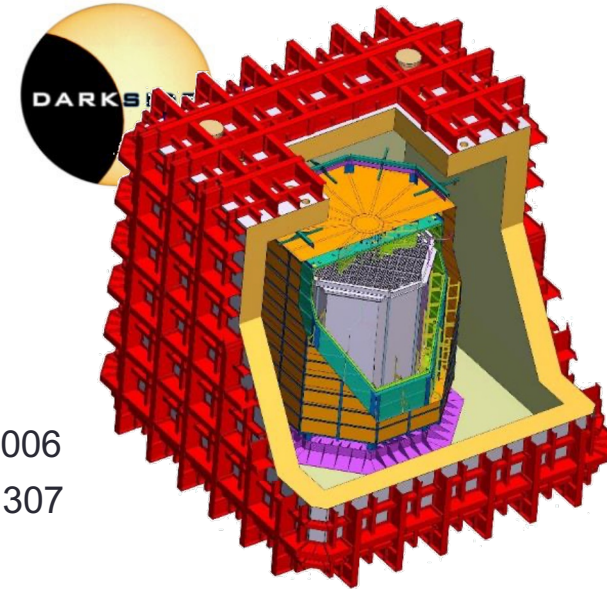
ET/ETIC & Co.:  
+ FTE (+0,4 wrt 2004)

3,8

Budget requests to CSN2 (in k€):

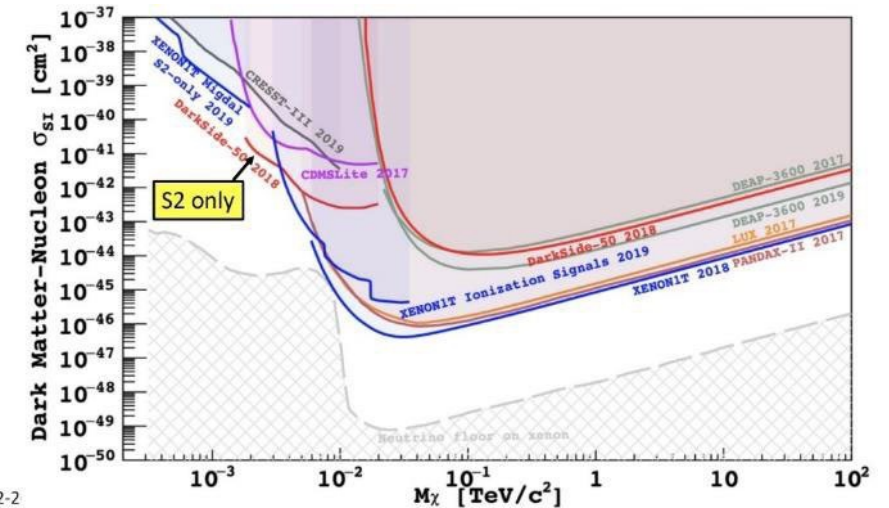
not yet defined (small)

- Search for **dark matter** in the form of Weakly Interacting Massive Particles (**WIMPs**)
- Signature: **low energy (< 100 keV) nuclear recoil** produced by WIMP elastic scattering
- **DarkSide** at Gran Sasso Laboratory, WIMPs search using a **dual-phase TPC** with **low- radioactivity LAr**
  - Operated a **50 kg TPC** (DarkSide-50)
  - Next step: 50 ton (20 ton fiducial) LAr **TPC** (DarkSide-20k)
    - Novel light **readout** with **SiPM**
    - Getting ready for data in **2026**, exposure O(100) ton yr
  - Next-next step: global worldwide effort (ARGO, 300 ton LAr)
- More sensitive to **low-mass WIMP** than Xe, due to the **lighter target**



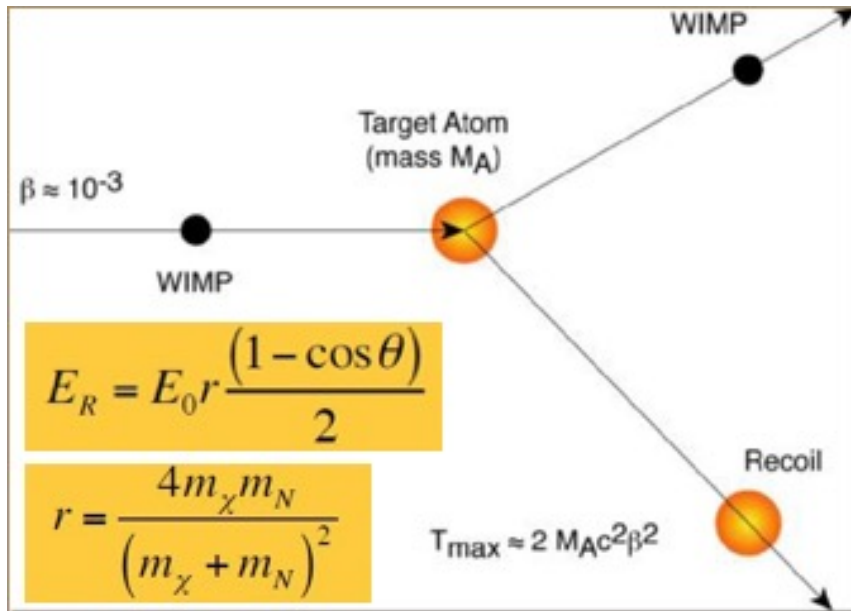
PRD 98 (2018) 102006

PRL 121 (2018) 081307

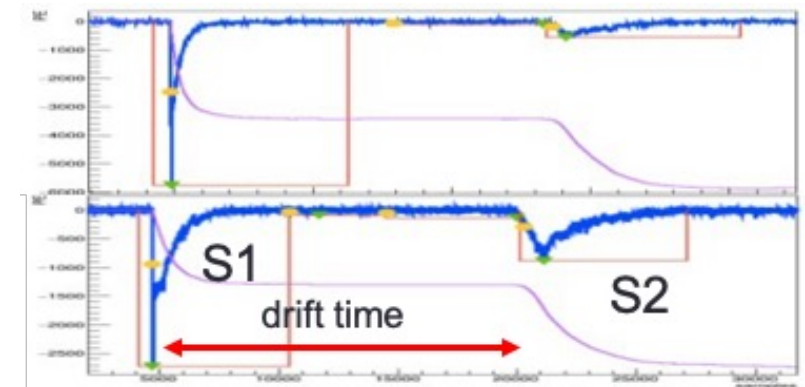
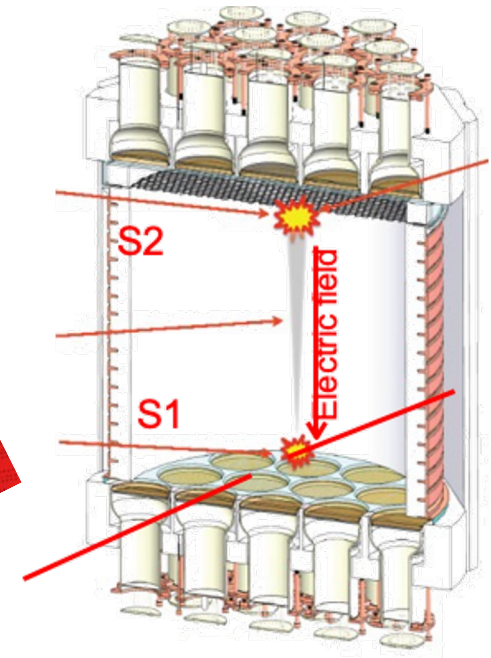


22-12-2

- Search for **low-mass WIMPs** by the detection of the **S2 signal only** (recoils **<1 keV**)
  - **A few GeV**, instead of "standard" 100 GeV
- Needs **calibrations** to characterize the detector response
  - Lowest point for Ar in literature at **~6 keV**



**REcoil Directionality**

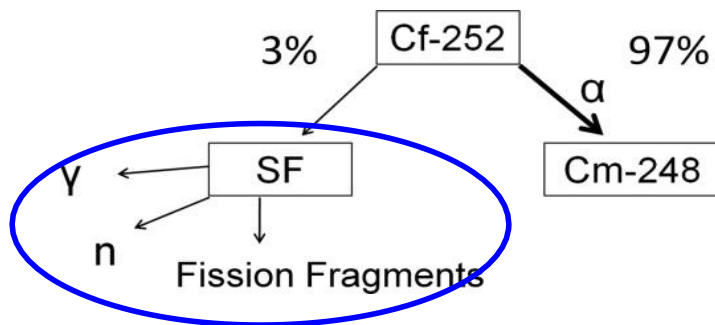


- Goal: produce **Ar recoils** in the TPC of known energy (a few keV!) by (n,n')
- Neutrons from a  $^{252}\text{Cf}$  fission source
  - Neutrons from  $^{252}\text{Cf}$  are  $O(2 \text{ MeV}) \rightarrow$  appropriate for  $E_{\text{rec}} \sim \text{few keV}$
  - Recoil energy in the TPC determined by **2-body kinematics**

$$E_{NR} = \underbrace{2K}_{\text{Time of flight}} E_{\text{neutron}} \frac{m_n m_{Ar}}{(m_n + m_{Ar})^2} (1 - \underbrace{\cos\theta_{\text{scatt}}}_{\text{Fixed by geometry}})$$

Time of flight

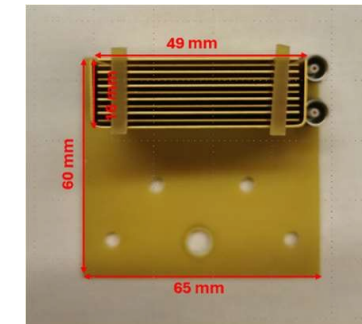
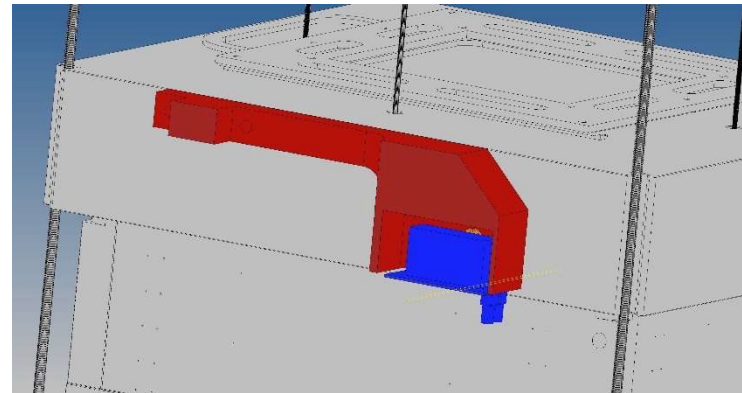
Fixed by geometry



- **Confirmed** the sensitivity down to  $2 \text{ keV}_{\text{nr}}$  (*terra incognita*)
- Some preliminary results at the TAUP2023 Conference

- Will operate a **TPC** (7 kg active mass), equipped with the very same **readout SiPM tiles** developed for DS-20k
- LNS contributing by **design** and **realization** of **mechanical parts** to host a **capacitive levelmeter**
  - Important to **monitor the level of liquid argon**  *not available* in ReD
- First **cooldown** in July 2024
- Will contribute to **data taking, shifts** and data **analysis**
- ... and also **shifts at NOA** for SiPM assembly (1 week in 2024)

## Activity 2024Proto0-@Na



- **Finalize data analysis**
  - **Confirmed** the sensitivity **down to 1-2 keV<sub>nr</sub>**
  - Need to **consolidate** the measurement of  $g_2$  and to **extract the final ionization yield (in e-/keV)** □ **allows to compare with the literature**
- ReD – as a part of the TDR of DarkSide – is **completed** □
  - Collaboration **focused** on the **construction** of the **DarkSide-20k detector**
- Still the calibration of Dark Matter detectors for **very low- energy nuclear recoils** is a hot topic!
- **Two follow-ups** in Catania to further improve and push sensitivity:
  - **ReD+**: New improved calibration with  $^{252}\text{Cf}$ 
    - Funded as a two-year **PRIN project**, INFN, UniCt, UniNa (183k€)
    - Started in September 2023
  - Measurement using **2.4 MeV neutrons from a DD gun**
    - Joint project with **University of Sao Paulo** (DDgun funded as a FAPESP grant)
    - **Delivered** to USP: it will be commissioned and shipped to LNS



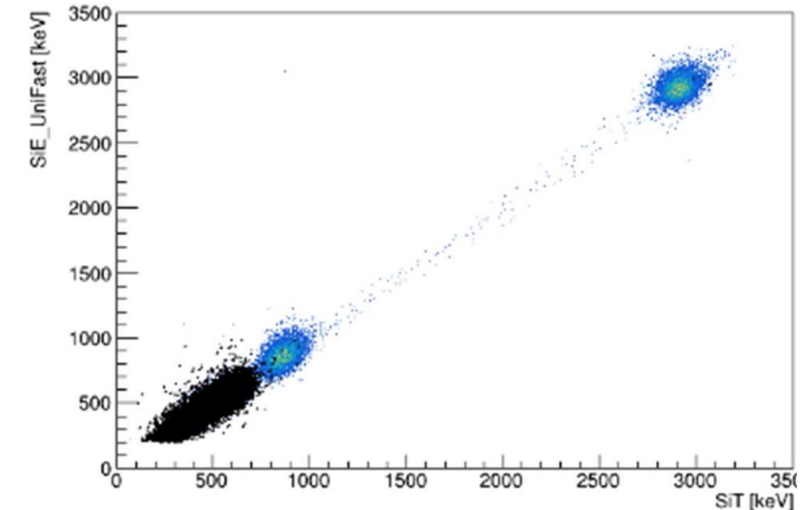
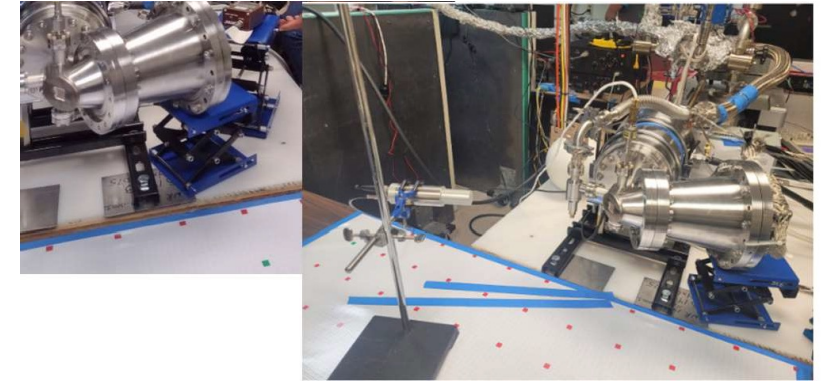
- Sigla **PRIN\_2022JCYC9E** (LP: 23%)
  - INFN funding: [60k \(incl. OH\)](#)
- Goal: **Extend coverage** of ReD down to **0.4 keV** using the same approach ( **$^{252}\text{Cf}$  source**) but **optimized components**
  - [New TPC](#), [bigger](#) than the old one (and [cylindrical](#))
  - Larger [neutron spectrometer](#) (18 more Psci ordered)
- Timeline:
  - First phase: [Monte Carlo studies](#) to define the TPC design (now)
  - Production and characterization of the TPC (and spectrometer) in 2024
  - [Integration](#) of the system in [spring 2025](#)
- Additional **manpower**:
  - Un AdR (concorso da espletare)
- Will follow up into the **activity 3.2.G1** of **DRD2**
  - "Understanding Microphysics of noble liquid (NL) response"
  - Was already [included in the proposal](#) (250 k€ in total, Na+LNS)



- ReD+ and DD gun measurements both require an **improved TPC** and the **refurbishment** of the cryogenic system
  - TPC being **redesigned** and **built**, **SiPM readout** (UniNA & INFN)
  - Increase the solid angle by **doubling** the **neutron spectrometer**
  - Funding available under the PRIN
  - Use the **lessons learnt** from the ReD run of 2023
    - Reduce accidental background (which limited the ReD measurement)
    - Less passive volumes, higher  $g_2$ , longer  $T_{\text{drift}}$
- Comparable **timelines** for the two measurements
  - ReD+: **Oct 2023-Oct 2025** (PRIN)
  - DD gun: **early 2025**
  - Need of a "radioprotected" **experimental area** at LNS
- Push sensitivity down to **0.4 keV<sub>nr</sub>**

## DD-Gun

- **Commercial** DD gun (Adelphi)
- Mono-energetic **2.4 MeV**
- **Neutron tagging** via **associated  $^3\text{He}$** 
  - **Demonstrated** experimental tests at Adelphi on October 2023
- Very **small x-ray background**
- Assuming a conservative flux of  **$10^6$  n/s** (achieved @Adelphi), signal rate **comparable to ReD+**
  - Different systematics
- **Delivered** to USP on **June 5<sup>th</sup>**
  - Could be shipped at LNS in **early 2025**



- Attività 2025:
  - [Finalizz](#)
  - [azione](#) analisi dati, preparazione [pubblicazione](#)
  - Non sono previste spese
- Attività legate al PRIN **ReD+** e al progetto **DDgun**, poi **DRD2**
  - Finanziamenti extra-CSN2
- Attività 2025 sotto l'ombrello di **DarkSide CSN2**:
  - **Contributo** all'attività sperimentale di **Proto-0 a Napoli** e test **SiPM**
  - **Sviluppo software** (offline, Monte Carlo, analisi) e **fenomenologia** per DarkSide-20k
  - Possibili **turni a NOA** (già nel 2023-4: 4 settimane)
- Richieste **finanziarie ridotte**
- [Missioni](#) per meeting ed [attività a Napoli](#)
- Da integrare per eventuale [turnistica](#)
- Materiale di [consumo](#) per attività di [Proto-0](#) (da concordare)

Darkside & Prin.:

1,6 FTE (+0,9 wrt 2004)

Budget requests to CSN2 (in k€):

Transfers	7
Consumables	10