RICHIESTE CALCOLO KM3NET

R. Coniglione per la collaborazione KM3NeT
LNS-INFN

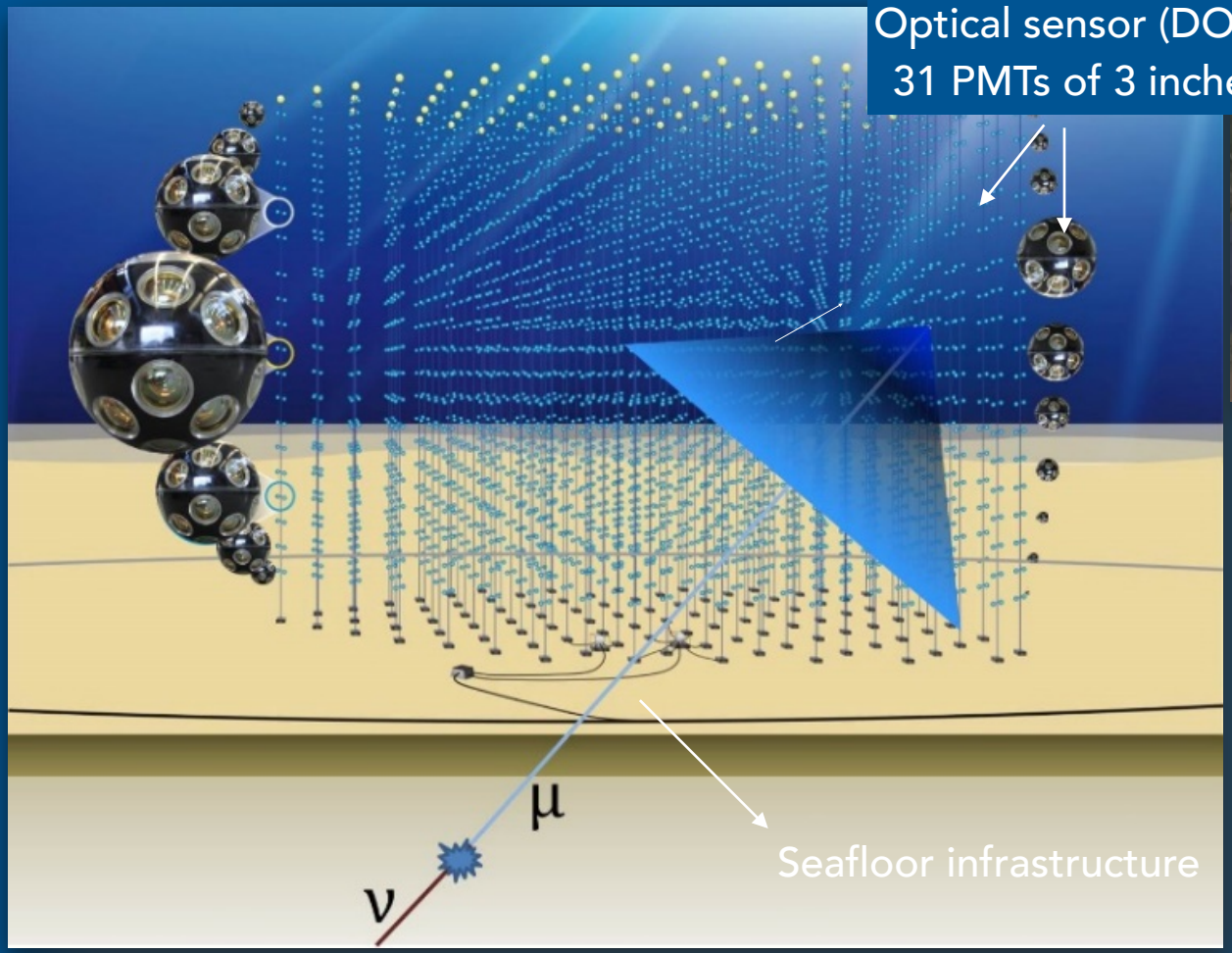
KM3NET

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

- KM3NeT/ARCA (Astroparticle Research with Cosmics in the Abyss)
  - observation of high energy (GeV ÷ PeV) neutrino sources ☛ a telescope offshore Capo Passero (Sicily-Italy) is in construction at a depth of 3500m
- KM3NeT/ORCA (Oscillation Research with Cosmics in the Abyss)
  - determination of the neutrino mass hierarchy ☛ a detector offshore Toulon (France) able to detect neutrinos of tens of GeV is in construction at a depth of 2500m

1 collaboration 1 technology 👉 2 detectors

THE KM3NET DETECTORS



A building block

👇

An array of 115 DU

Detection Unit (DU)

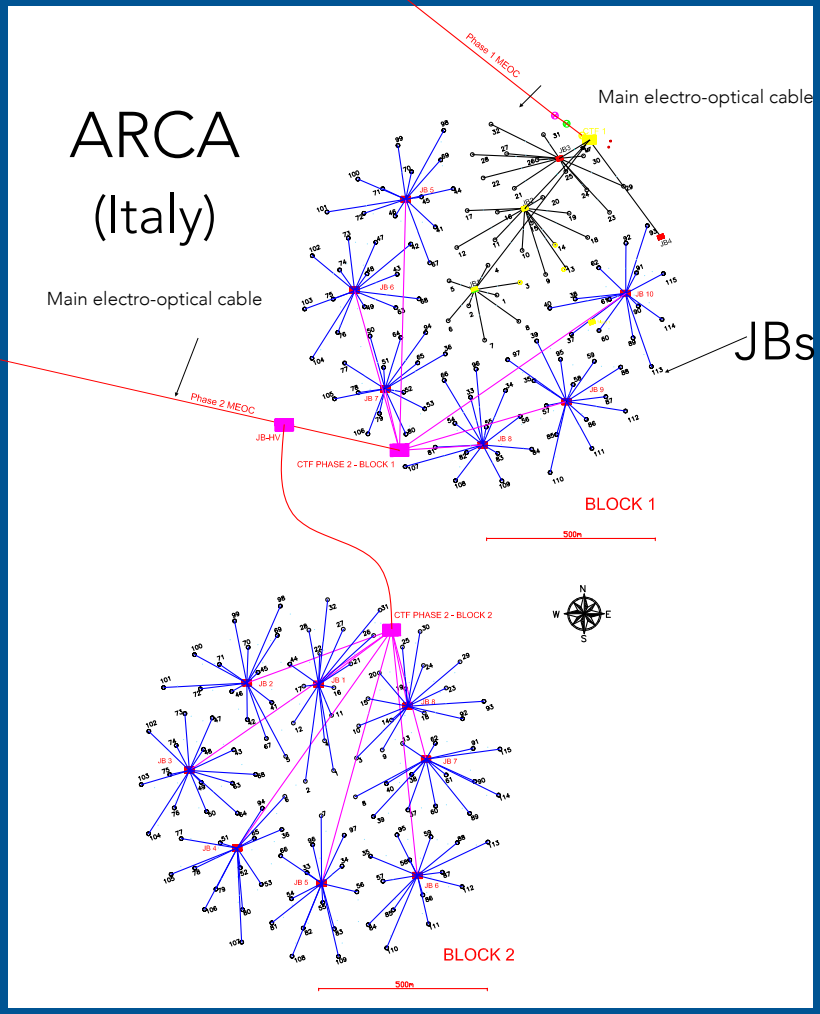
Detectors in construction

THE KM3NET/ARCA DETECTOR

Focused on neutrino astronomy

ARCA

- 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**

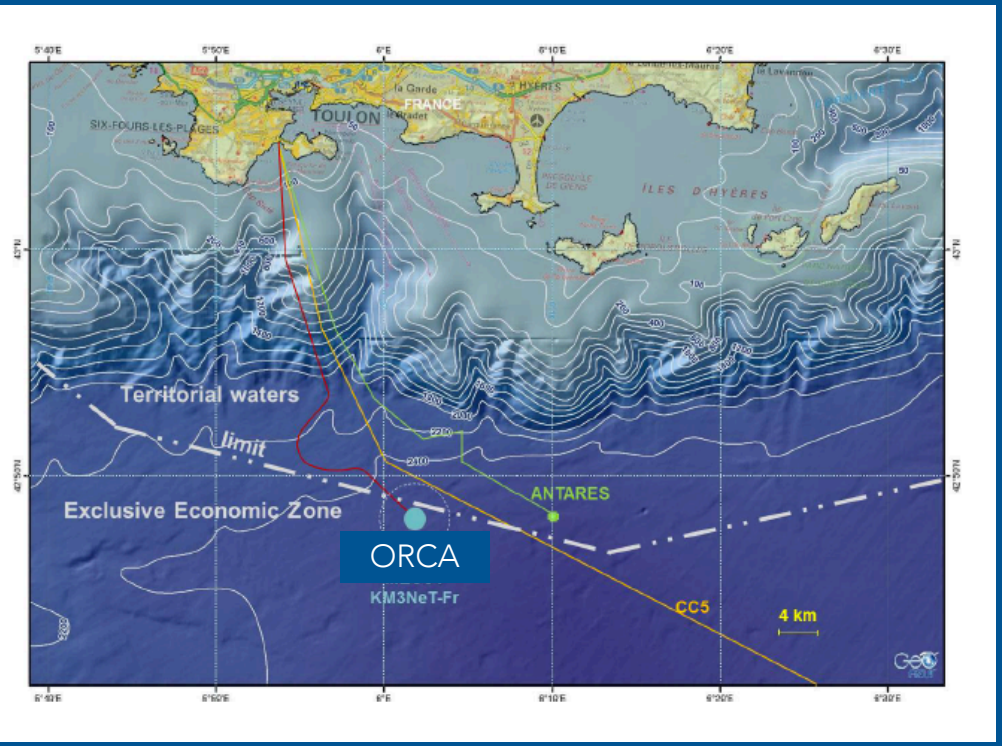


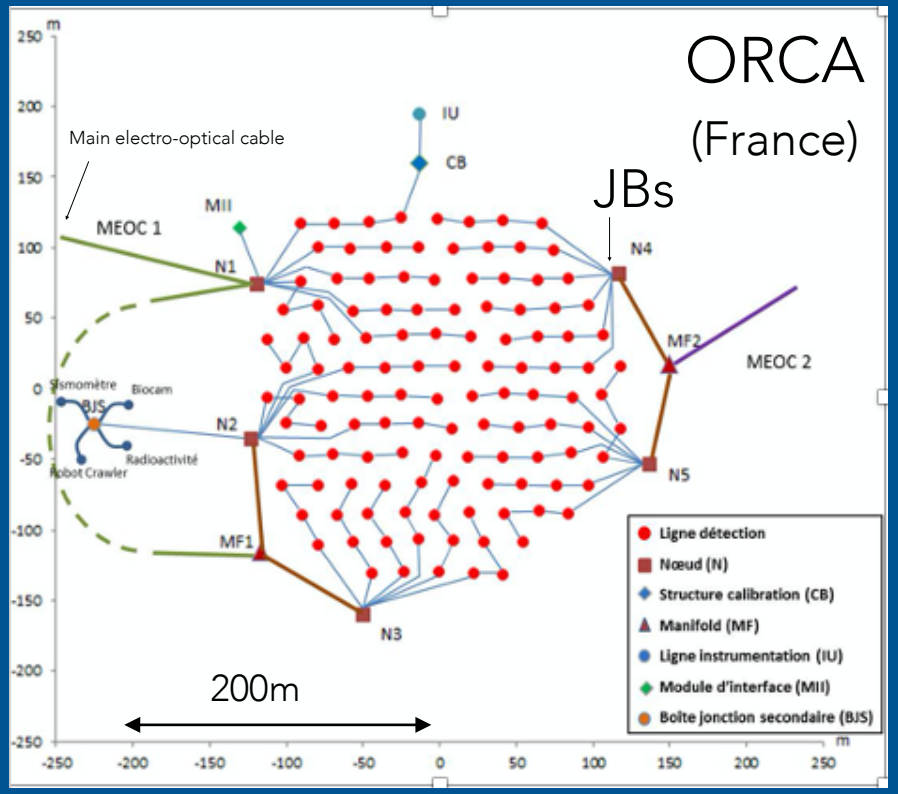
THE KM3NET/ORCA DETECTOR

Focused on the study of neutrino properties

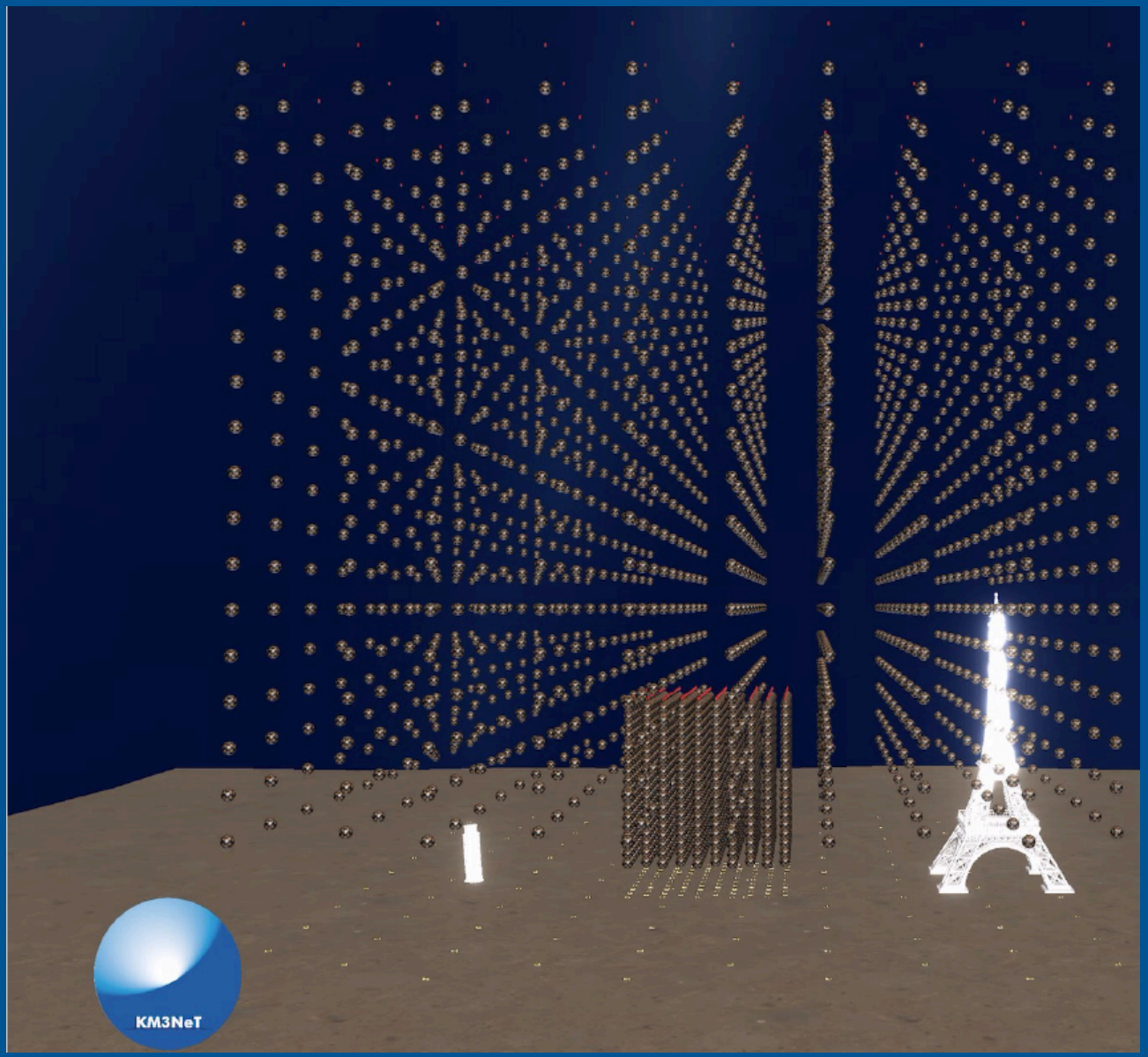
ORCA

- 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**



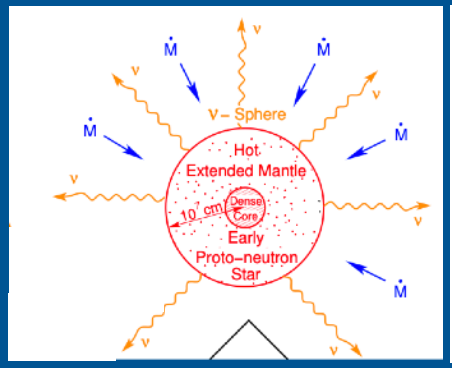


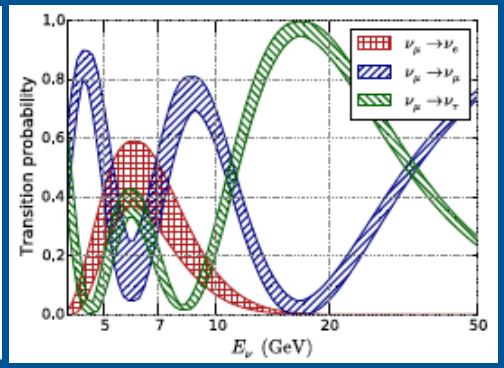
THE KM3NET DETECTORS

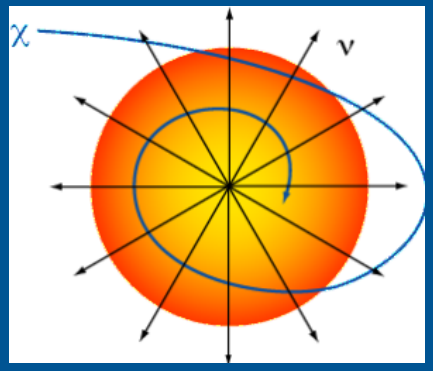


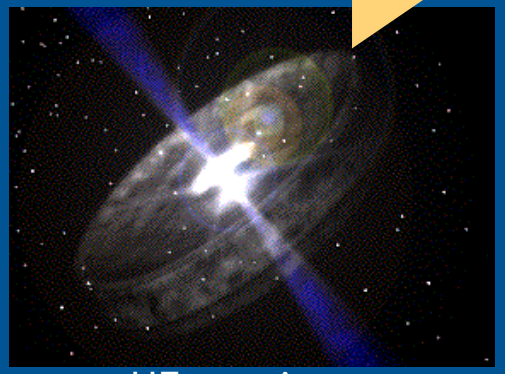
THE PHYSICS

Neutrino Energy from MeV to PeV









Super Novae explosion
MeV

Neutrino oscillation
GeV

Dark Matter
TeV

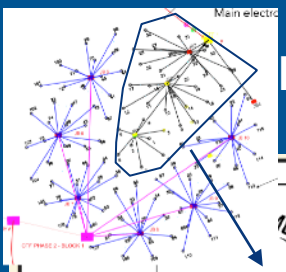
HE neutrinos
Multi-messenger program
PeV

ARCA + ORCA

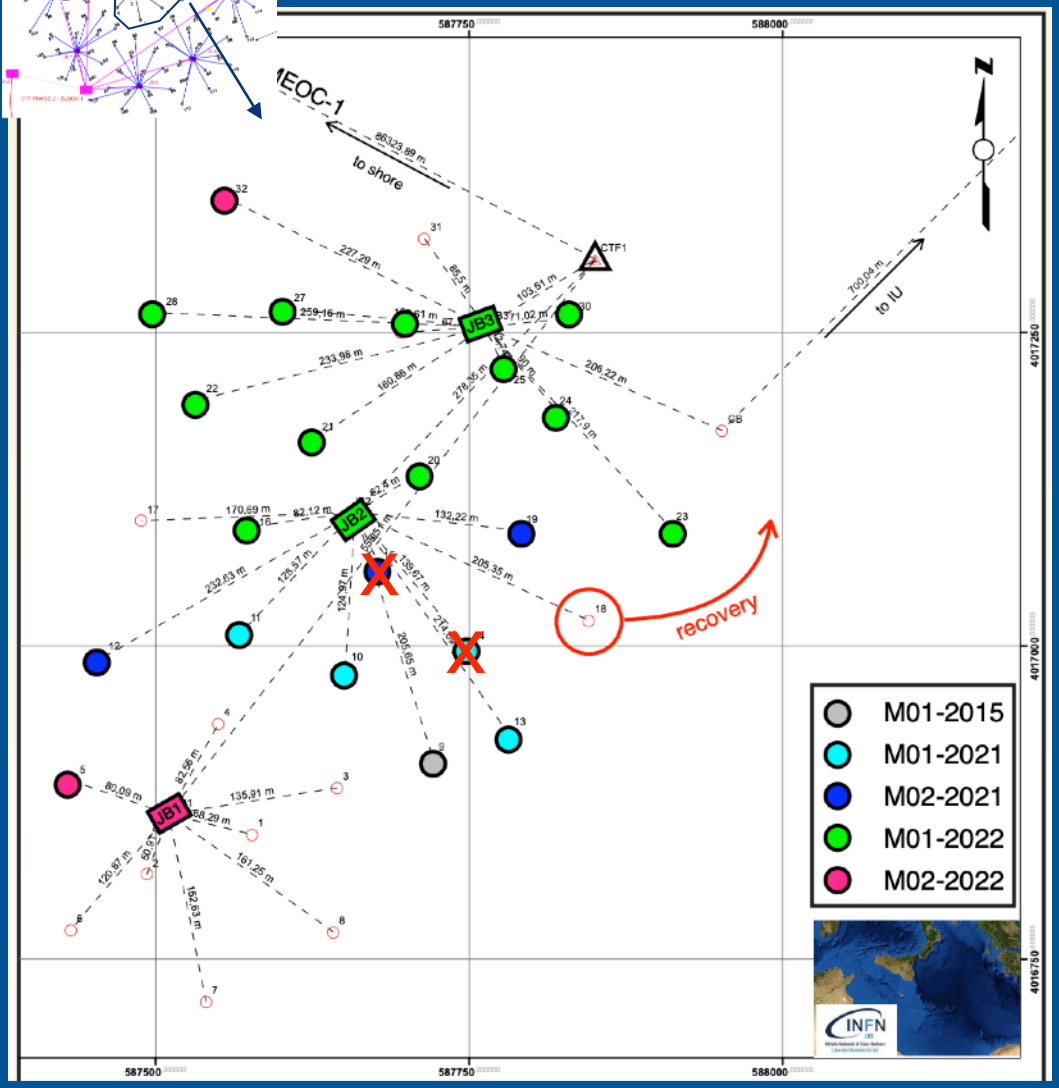
ORCA

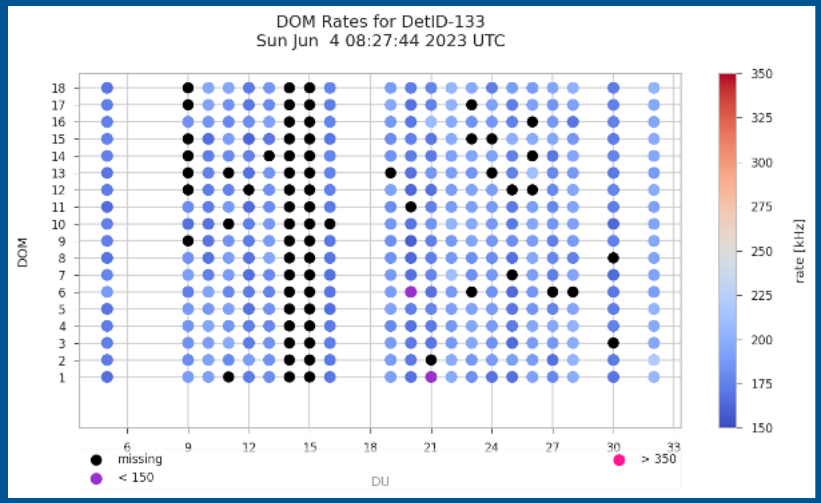
ARCA

ARCA PRESENT STATUS



From September 2022 21 DUs in water 👉 19 in data taking

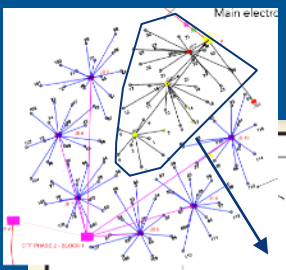




September 2022 -> deployed 2 DU + JB1
recovered DU18

20/04/23: Lost DU14 (Deployed in April 2021)
19/05/23: Lost DU15 (Deployed in September 2021)

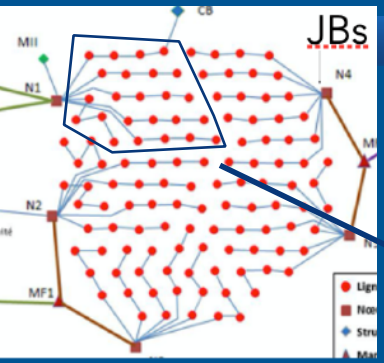
ARCA FROM NEXT WEEK

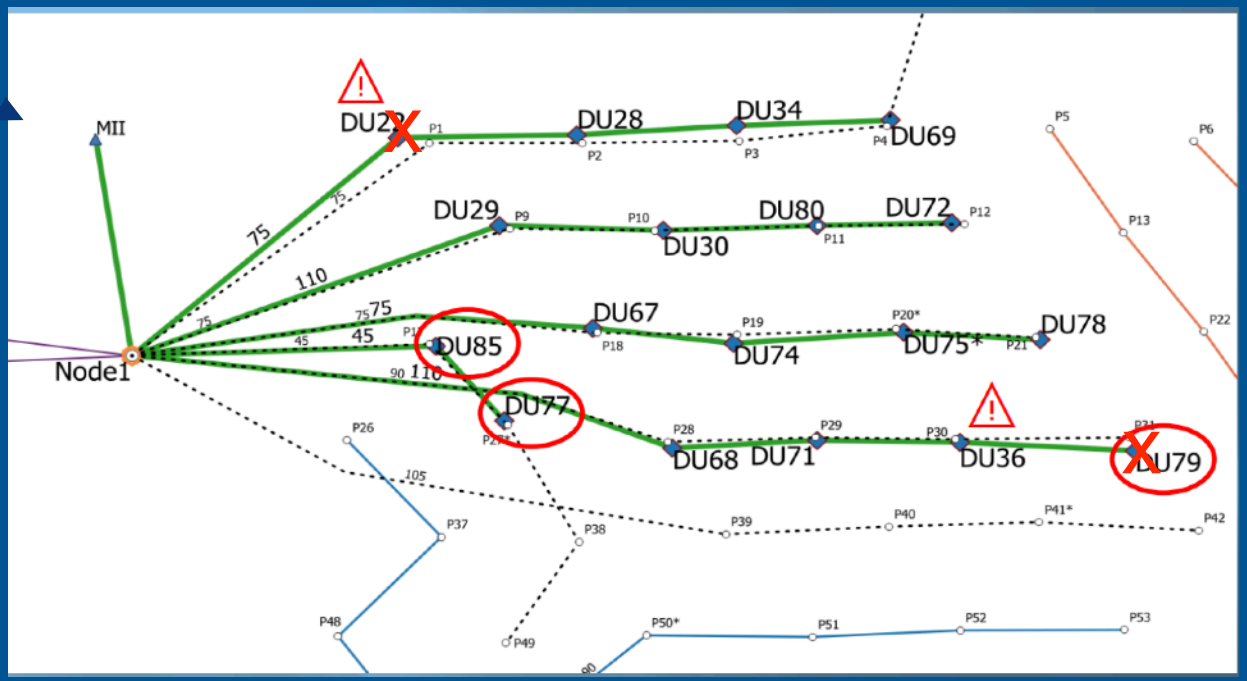


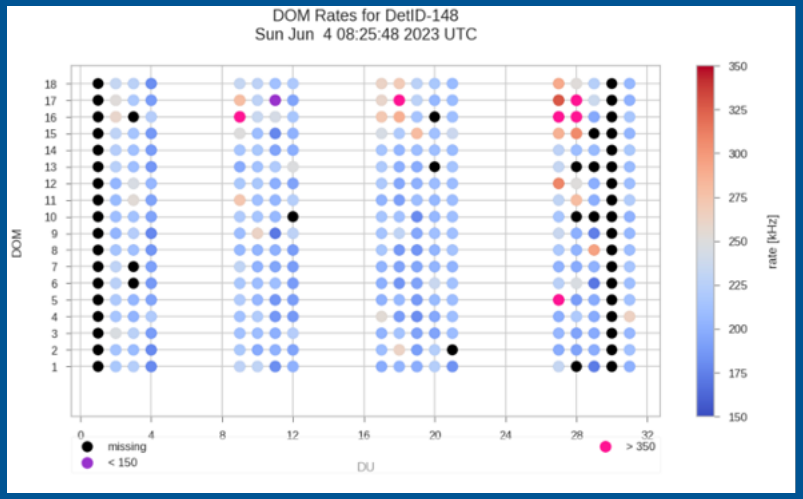
Next sea campaign 👉 +10 DUs 👉 in total 29 DUs

September 2023 -> to be deployed 10 DU + recover DU14 and DU15

ORCA STATUS



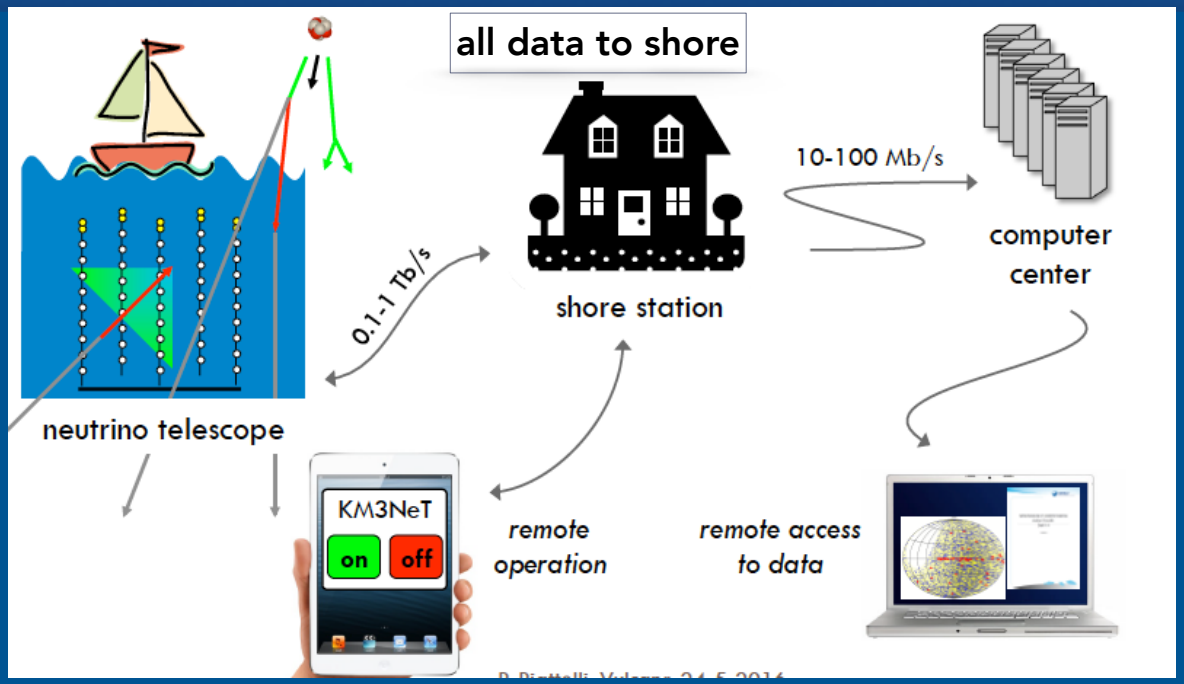




18 DU deployed 👉 16 taking data

+8 DUs for the end of the year 👉 24 DUs

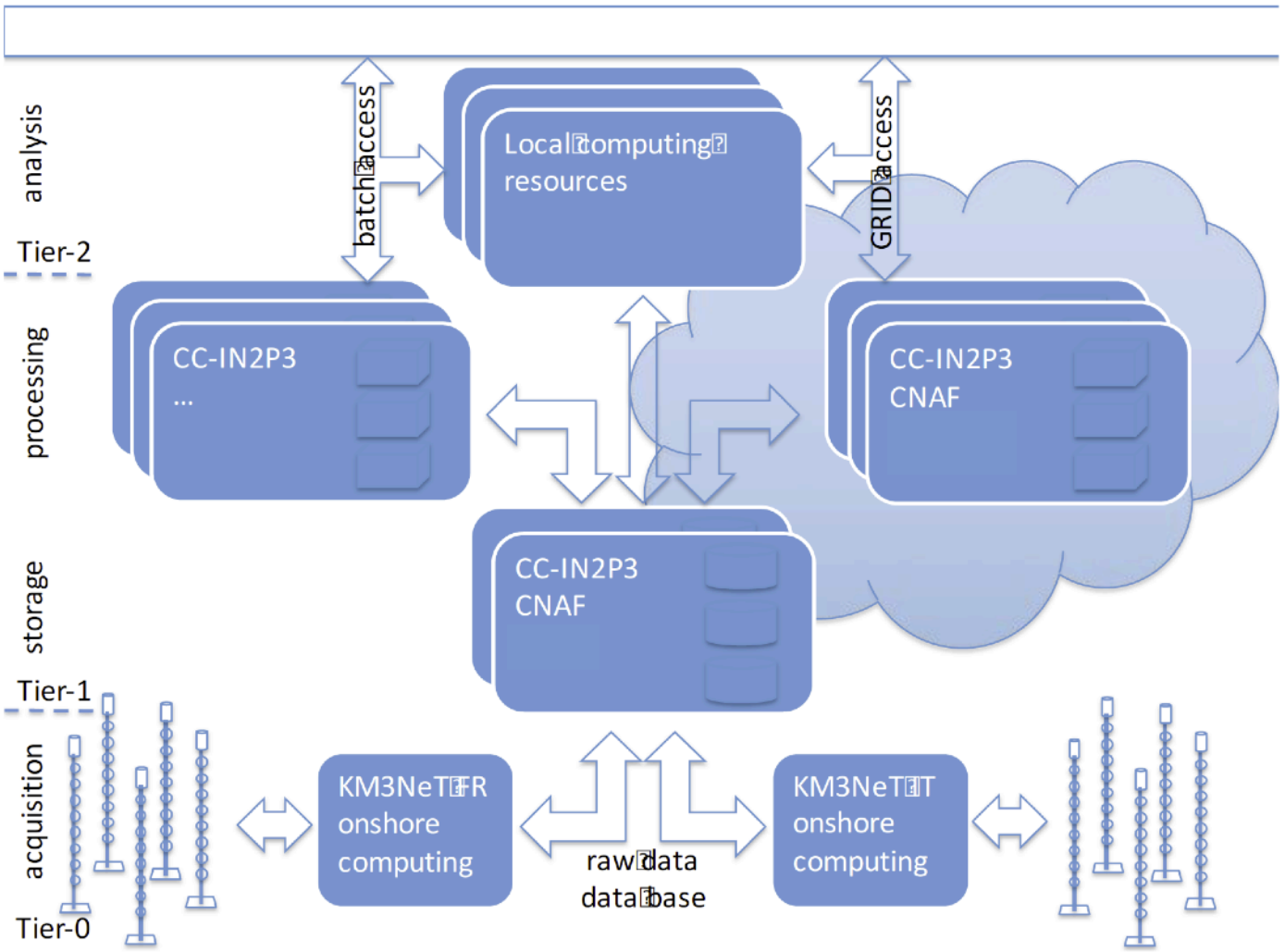
THE KM3NET ARCHITECTURE



ORCA shore station

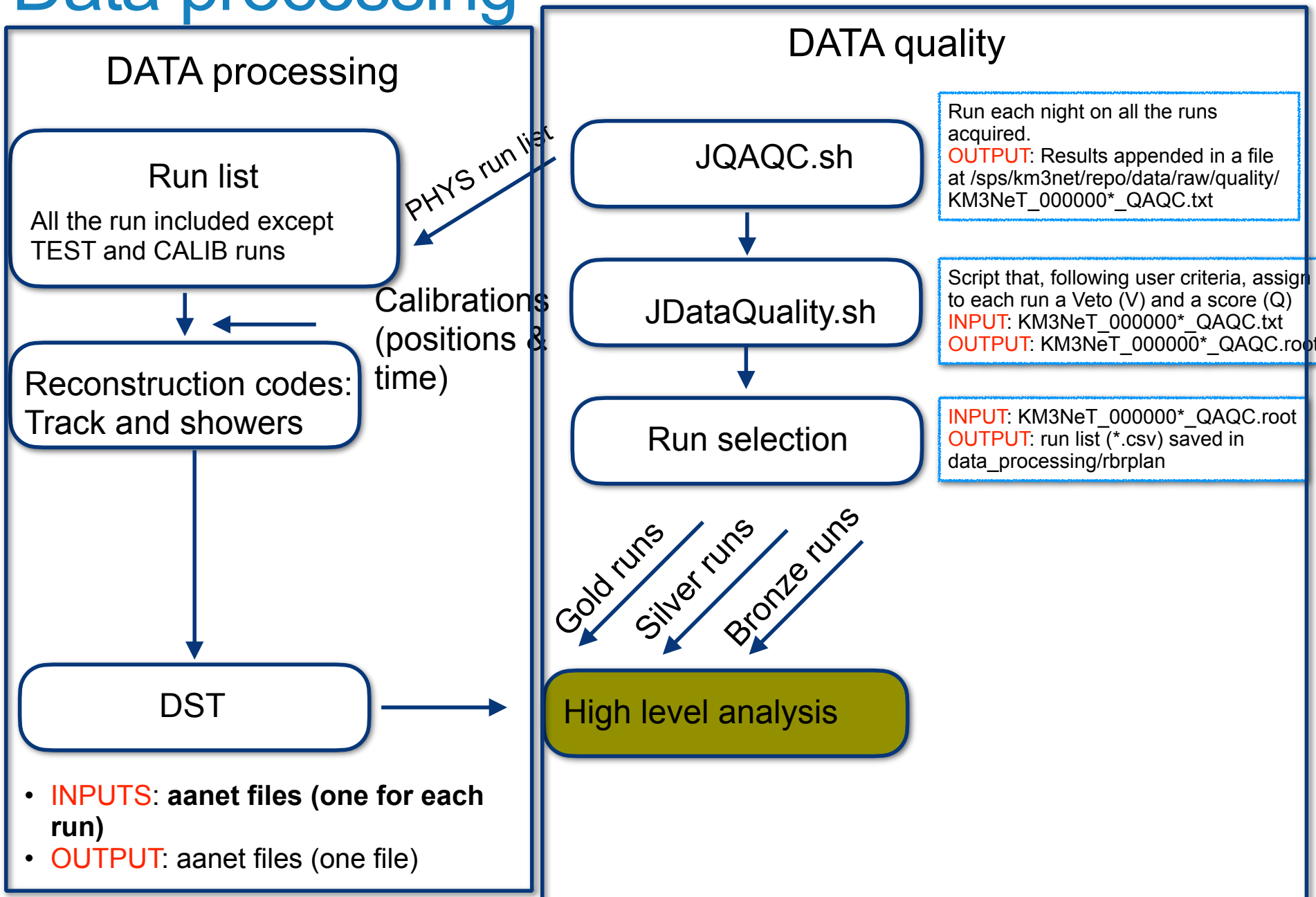
ARCA shore station

Computing model



CC-IN2P3 https://cc.in2p3.fr/en/

Data processing



MC in run-by-run mode

Run-by-run mode 👉 the number of working PMTs, the rate of 40K the PMT efficiency are extracted from the data file and applied to the MC simulation

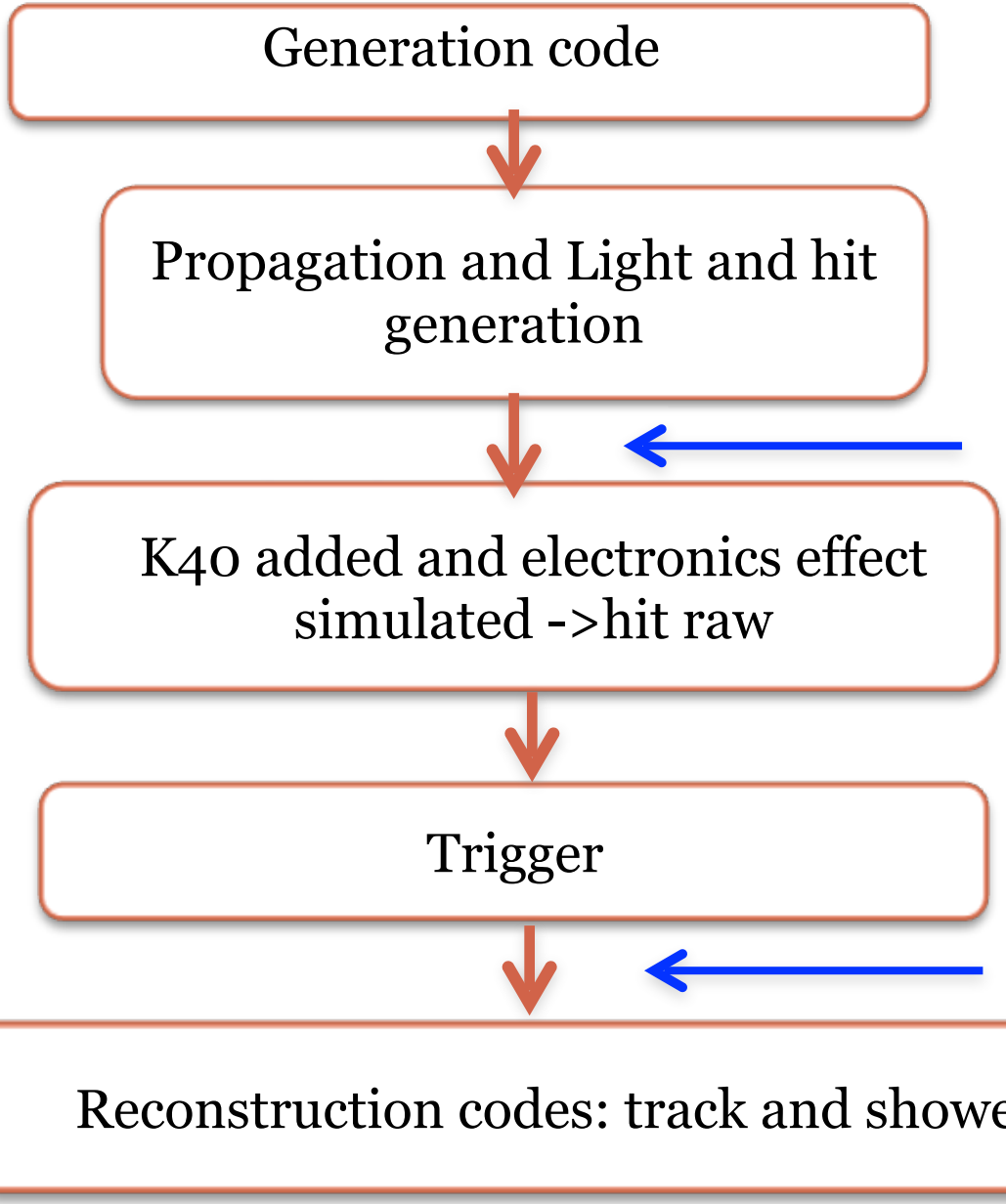
For each run of data a set of MC events are produced:

Neutrino signals and atmospheric neutrino background 👉 all flavours in Neutral Current (NC) and Charge Current (CC)👉Two files per flavors (v & anti-v) and in NC and CC 👉 (8 file per data runs)

Atmospheric muon background 👉 Many files (~10) for each data run to simulate events with the double of live time of data

Pure noise events 👉 to be defined

MC in run-by-run mode



K40 rate from data
PMT efficiency from data

From calibration:
- PMT Positions (dynamic)
- Time offsets

Pledge 2023

2023 Pledge

CPU (HS06)	DISCO (TB)	TAPE (TB)
3000 (~300 cores)	450	250

The current pledge has been used for:

- Storage of raw data of ARCA and ORCA
- Implementations of the software needed to process data and MC
- Implementation and tests of the workflow based on snakemake
- Tests for the evaluation of the CPU time for the present request.

Plans for 2024

More and more larger detectors 👉 Lyon no longer sufficient to analyze data and run MC simulations for ARCA and ORCA

New and more precise calibrations available

New Software versions 👉 improvements

👇

Reanalyze all the data collected so far for ARCA

Redo the ARCA MC simulations

First analysis with the new configuration 👉ARCA29

ARCA: Two mass productions foreseen in 2024 (spring and autumn)

In the other period mini production to check the new software and calibration and to verify/improve the data-MC agreement

ARCA: DATA COLLECTED SO FAR

	Starting date	Ending date	From calendar (days)	Live time of PHYS runs (days)	Phys run / calendar %	Not Vetoed runs (days)	Not Vetoed / calendar %	#files
ARCA6	***12 may 2021***	***10 sept 2021***	***121***			***101.5***	***84***	***500***
ARCA8	***26 sept 2021***	***1 june 2022***	***248***	***234.4***	***94***	***222.0***	***89***	***1550***
ARCA19	***13 july 2022***	***7 sept 2022***	***56***	***53.3***	***95***	***52.8***	***94***	***560***
ARCA21	***22 sept 2022***	***4 sept 2023***	***347***	***299***	***86***	***293***	***84***	***2500***

ARCA6 & ARCA8 & ARCA19 fully analyzed 👉 results presented at ICRC2023

ARCA21 partially analyzed (ARCA21 till December 2022) 👉 results presented at ICRC2023

About 5000 ARCA files to be reanalyzed in 2024

2024 requests

CPU time estimated for one file data file of ARCA6

	CPU time (days/run)
Dati	0.87
Neutrino	3.66
Atmospheric muons	0.40
Pure noise	0.13
SUM	5.06

5.06*5000*10.8 ≈ 270000 days of HPSPEC6

Conversion factor between CPU time e HSPEC06

With the present CPU about 90 days to have all the production.
270000/3000 ≈ 90

No errors and interruptions in this estimate

Not considered:

- Detector configuration with increased sizes. Estimates based on ARCA6. Currently 21 DUs in water and next year 29 DUs
- CPU time for calibration (dynamic positioning each 10 minutes)
- MC simulation for the training of the ML

2024 requests

¤	CPU·(HS06)¤	DISCO·(TB)¤	TAPE·(TB)¤
INCREMENTO¤	~31200¤	0¤	0¤
PLEDGE¤	34247¤	450·TB¤	250·TB¤

- A factor 10 of more CPUs requested (~3000 core in total)
- No additional storage requested

Referenti:
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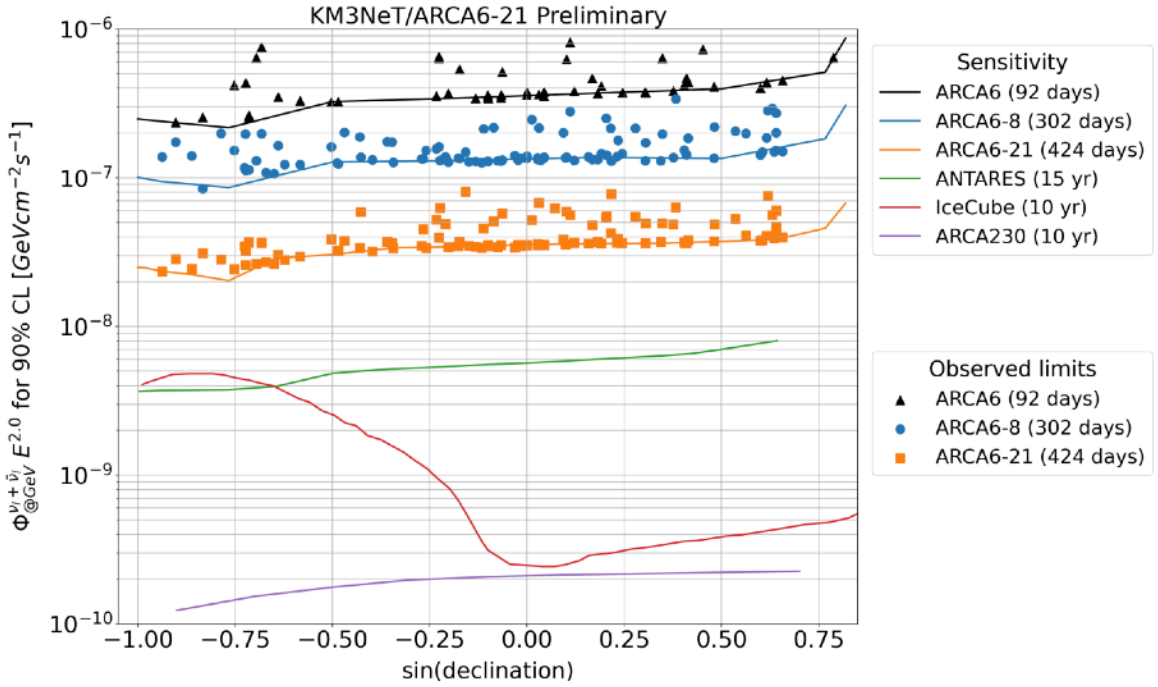
Mieke Bouwhuis - Nikhef The Netherland - bouwhuim@nikhef.nl

Summary

- ARCA detector is increasing in size 👉 computing more and more demanding
- First results already presented at the conference and more and more analyses in the pipeline for the next years

ICRC2023 PoS 1018

Upper limits and sensitivities for point-like sources



- In 2024 ARCA data analysis and MC simulation @ CNAF 👉 a factor 10 more in CPU requested