

First neutrinos with KM3NeT/ARCA

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On behalf of the KM3NeT Nikhef group

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KM3NeT

Nikhef

First neutrinos with KM3NeT/ARCA

Astroparticle Research with Cosmics in the Abyss.

The existence of cosmic neutrinos is proven by the IceCube, but sources unknown

Resolution is key!

ARCA in full configuration will be great at this + has good location to view galactic centre



KM3NeT

Nikhef

Detector configuration

6-8 Detection Units configuration

- Fraction of the total detection volume

ARCA6 Operated from May 2021 to September 2021

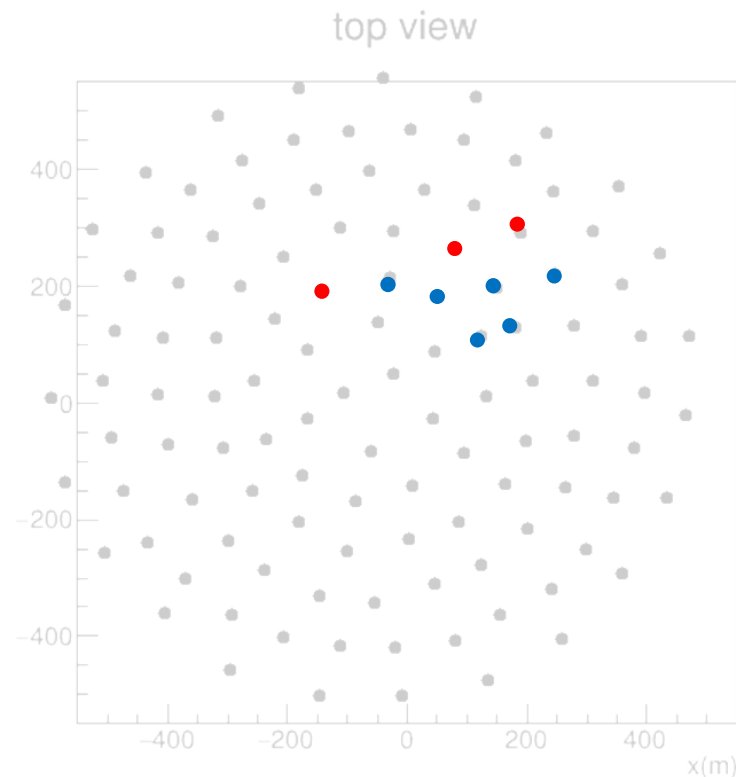
- ~100 days of physics-grade data

Sept 2021: DEPLOYMENT!

ARCA7/8/9 Operated from September 2021 to NOW

- Not all data processed yet

Many physics analysis on-going with current data



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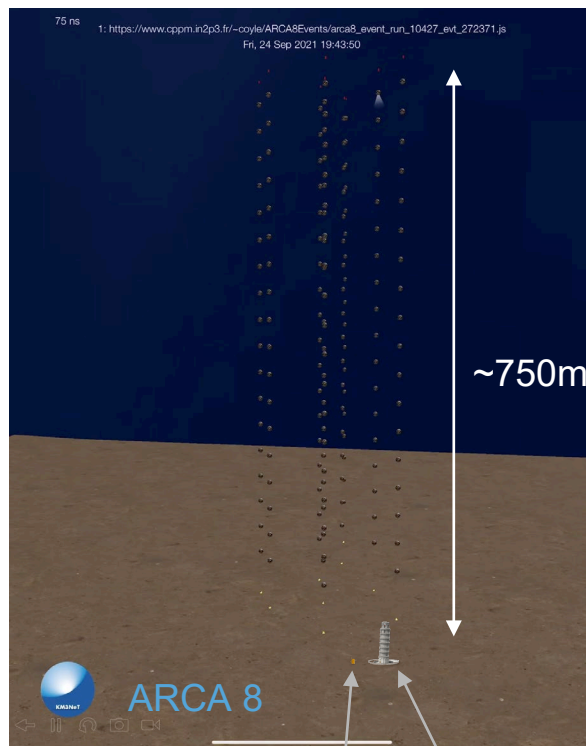
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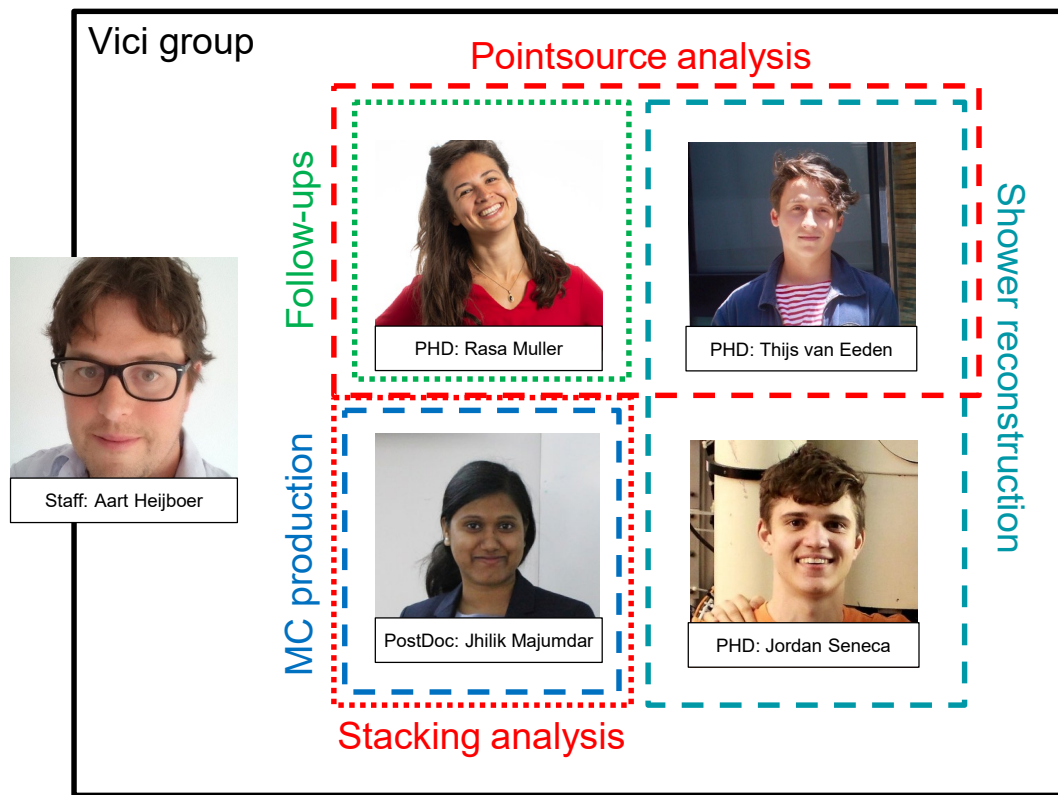
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*10m windmill for scale
58m tower of pisa for scale*

Faces of ARCA at @Nikhef



Dynamic calibration

Track reconstruction

Computing

DU integration



Dark matter

Cosmic Rays

ARCA full building block

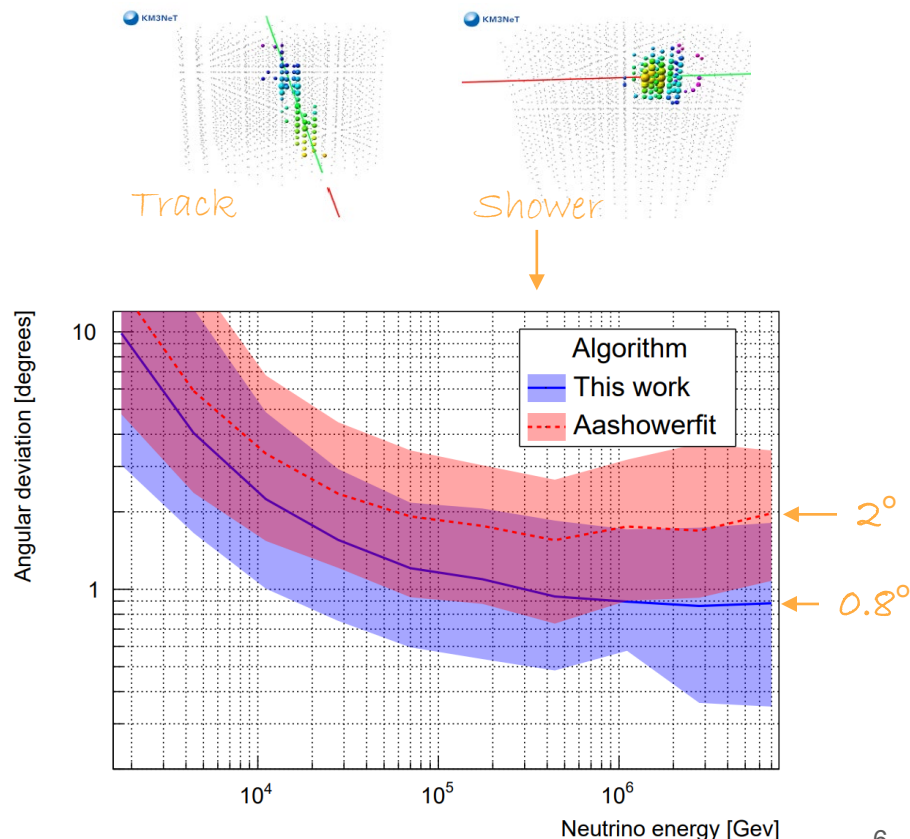
Shower reconstruction

High-energy reconstruction for single and double cascades using the KM3NeT detector

- degree-level resolutions of cascade reconstruction are further refined to sub-degree by:
 - making a more **detailed model** of the neutrinos events
 - including additional information on the **hit times**



<https://pos.sissa.it/395/1089/pdf>



ARCA full building block

Pointsource analysis

Prospects for full building-block ARCA are presented at conference

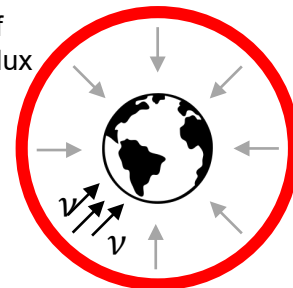
- Un-binned likelihood
- For diffuse, E^{-2} point sources (gauss/disk)
- Sample: 99.4% purity with 80% signal efficiency



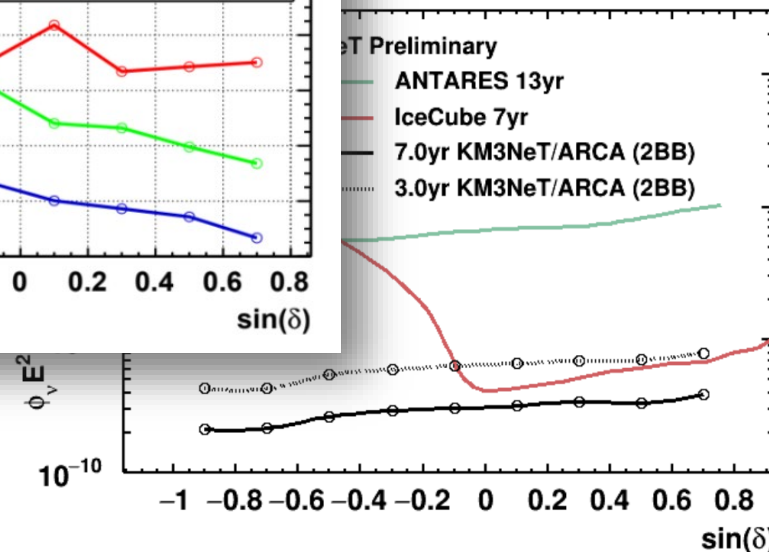
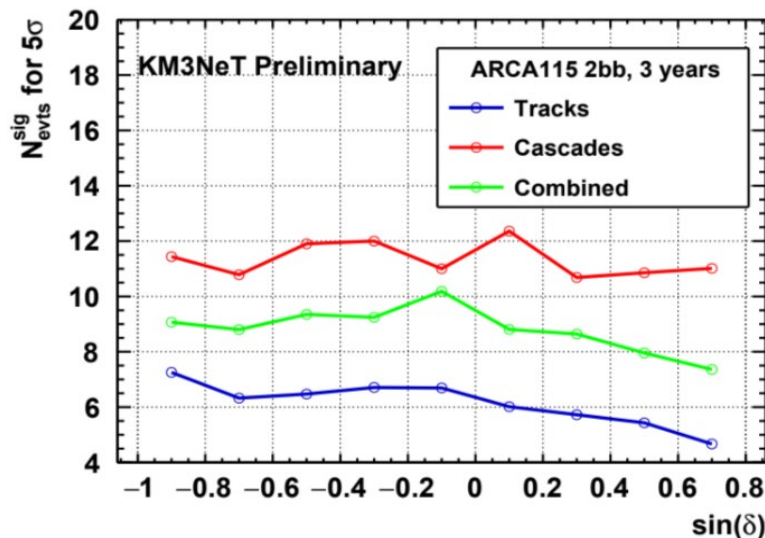
<https://pos.sissa.it/535/1077/pa>



Measure spectral properties of isotropic astrophysical neutrino flux



Find clustered signal and measure properties

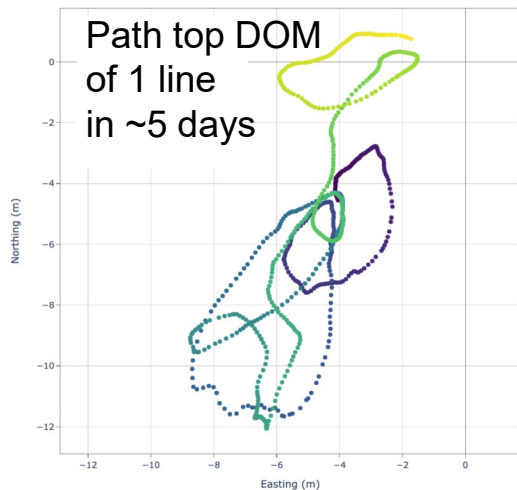


Now look at DATA!

ARCA8

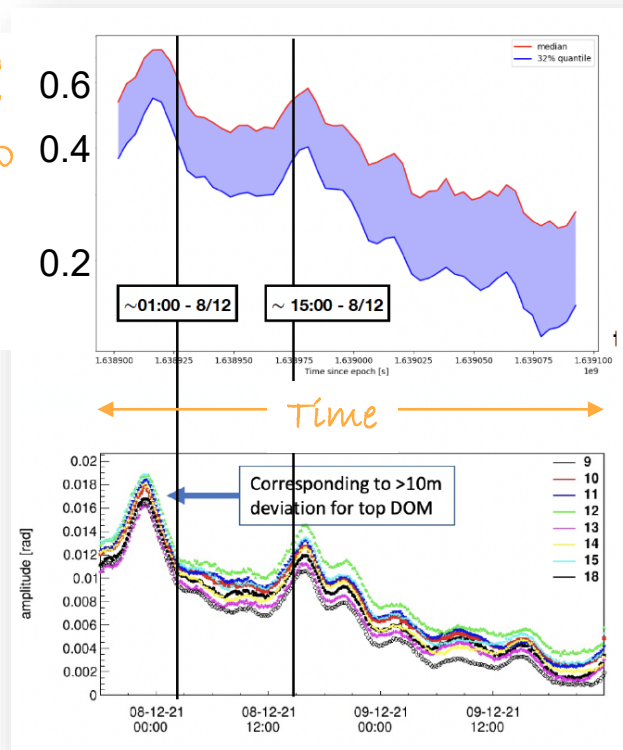
Calibration

- Every 10 min:
 - Dynamic **detector positioning**: From the time-of-arrival and waveform of acoustic emitters-receivers
 - Dynamic **DOM orientation**: From compass accelerometer and magnetic field sensor

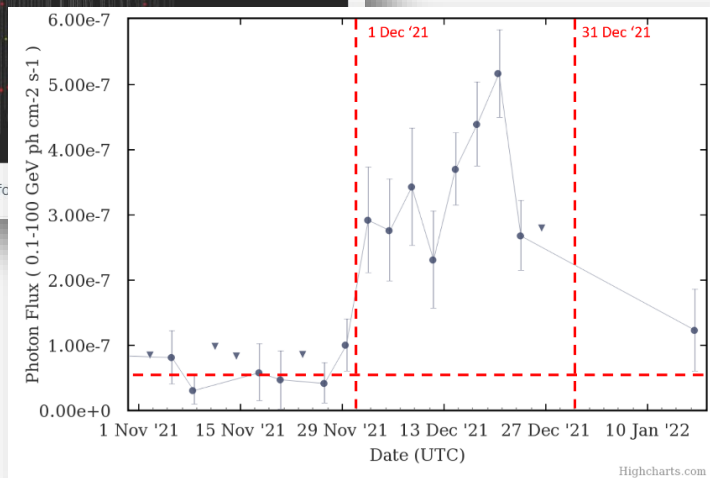
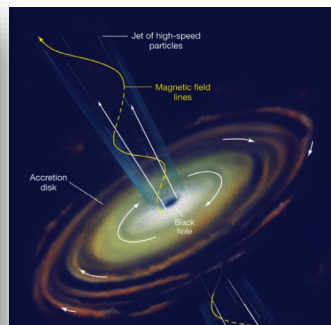
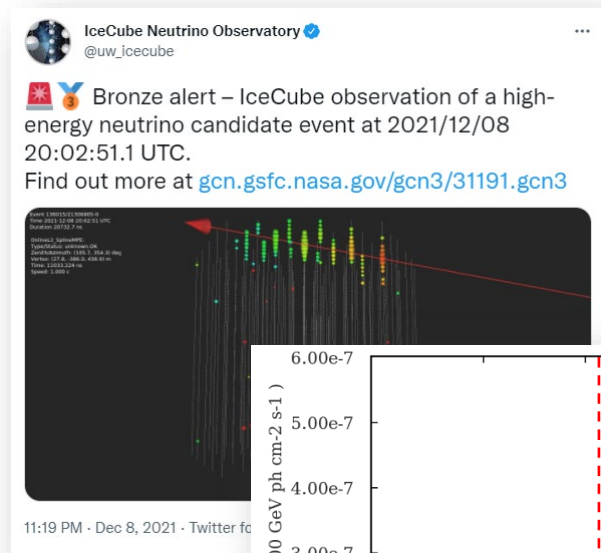


Angular diff
stat \leftrightarrow dyn [°]

tilt of the lines



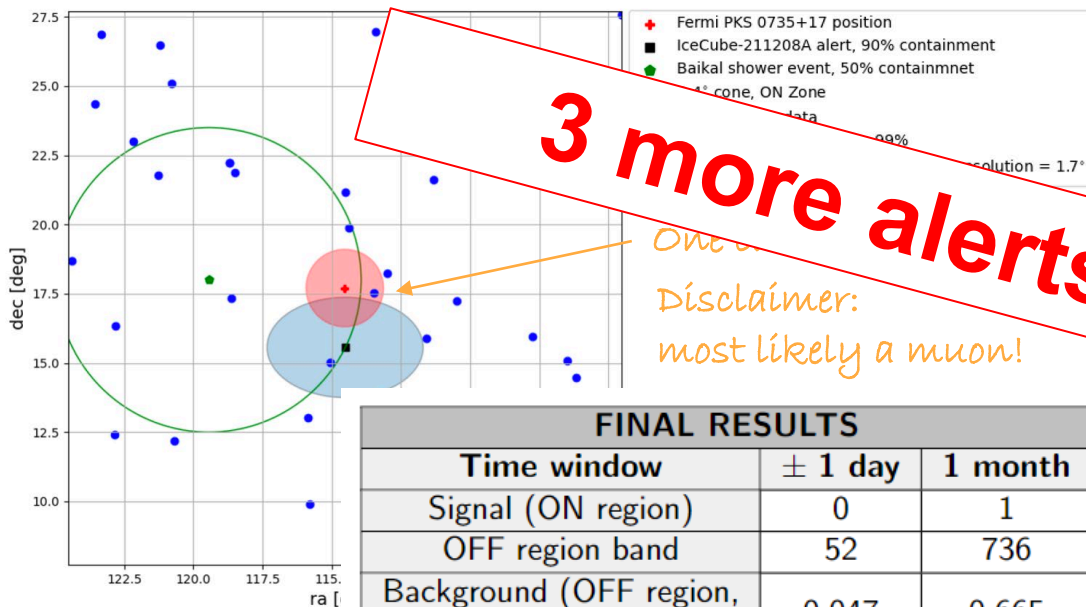
We did our first ever **follow-up**!



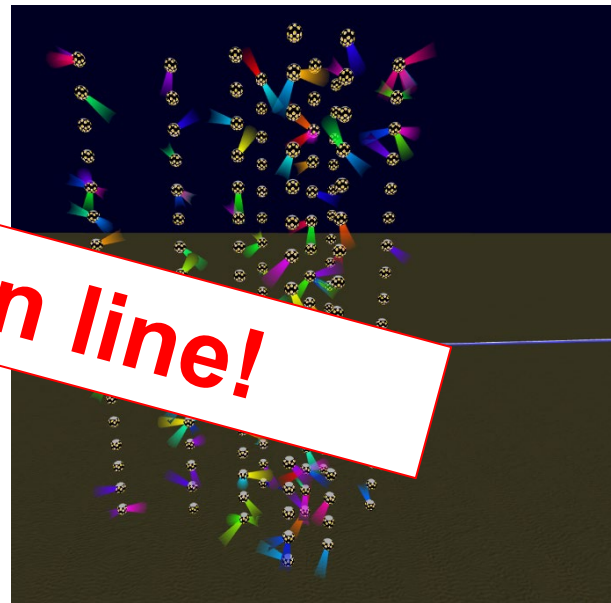
- On December 8th, 2021 a detection of a **“bronze” event** was reported by the IceCube Collaboration with a moderate probability (signalness 50.2%) to be explained by an astrophysical neutrino.
- A prominent **radio and gamma-ray blazar** PKS 0735+17 is located just outside the 90% ‘Point-Spread-Function’ containment of the IceCube event.
- Follow-up:
Look in data for time & space correlation!

We did our first ever follow-up!

Sky map PKS 0735+17, December 2021



FINAL RESULTS		
Time window	± 1 day	1 month
Signal (ON region)	0	1
OFF region band	52	736
Background (OFF region, after solid angle factor)	0.047	0.665
Poisson significance	—	1.06 σ

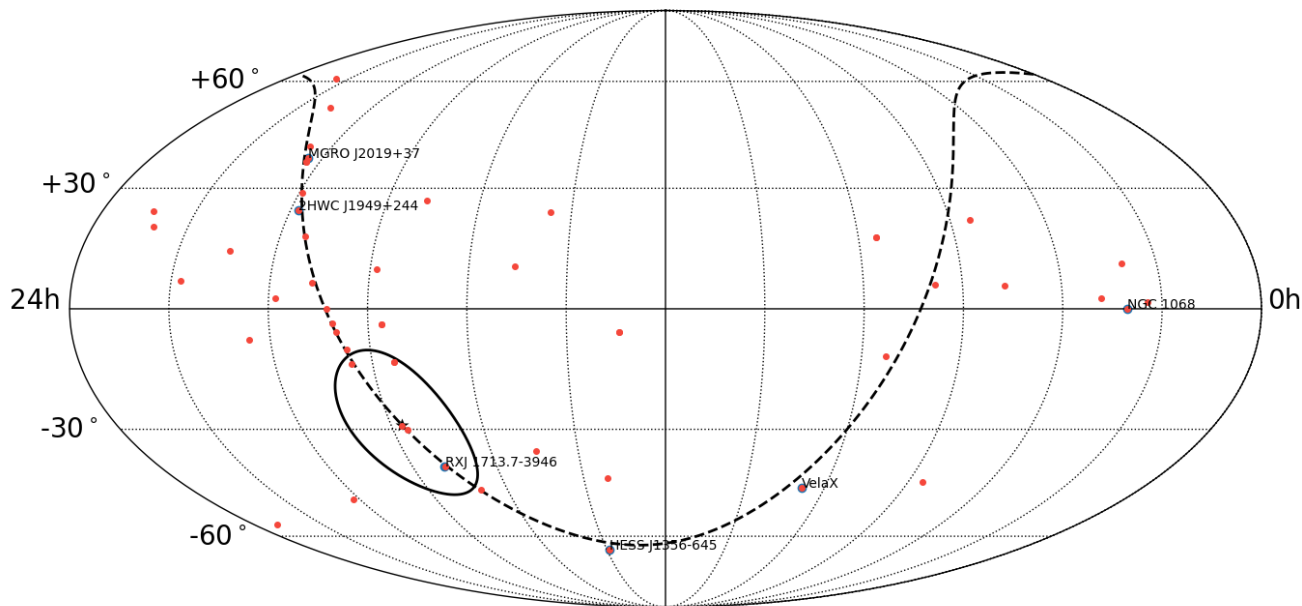


ATel:

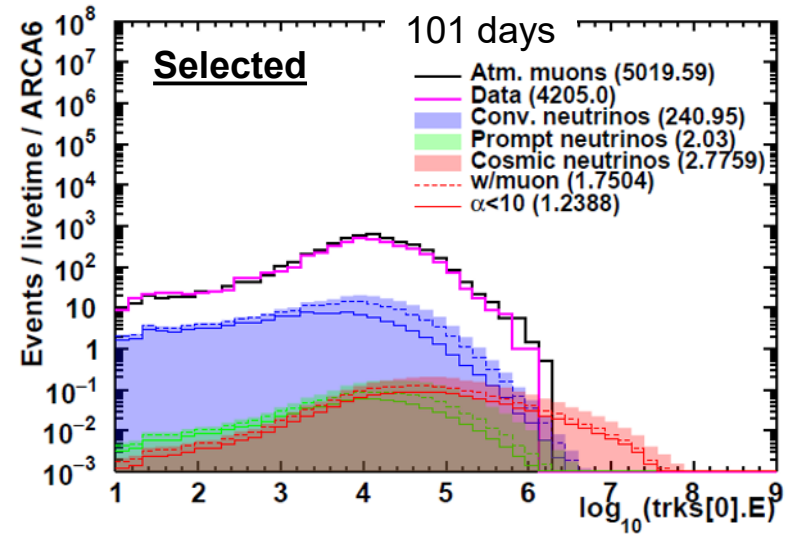
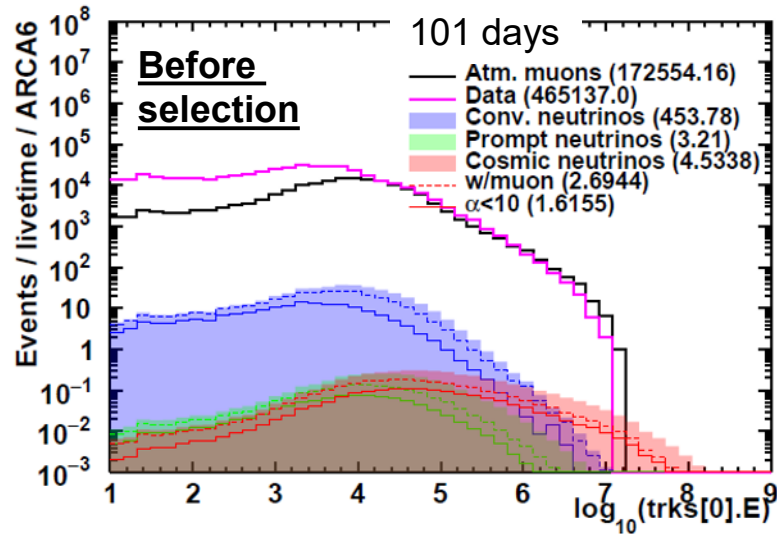
<https://www.astronomerstelegram.org/?read=15290>

<https://arxiv.org/abs/2204.05060>

We are preparing our first pointsource study with data



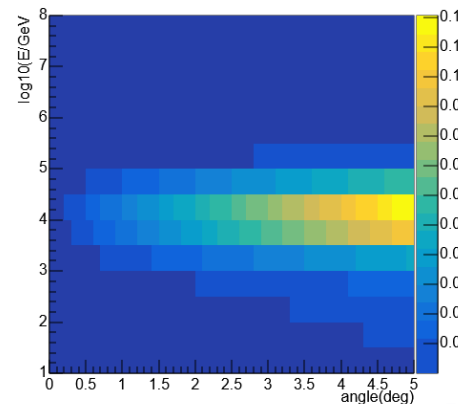
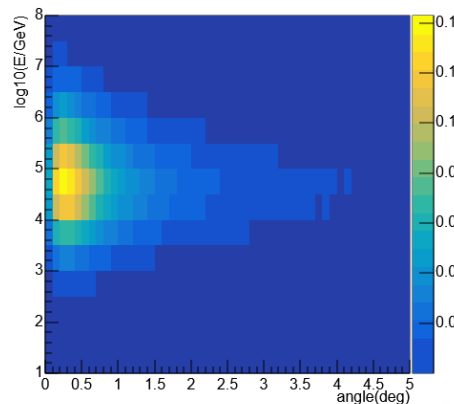
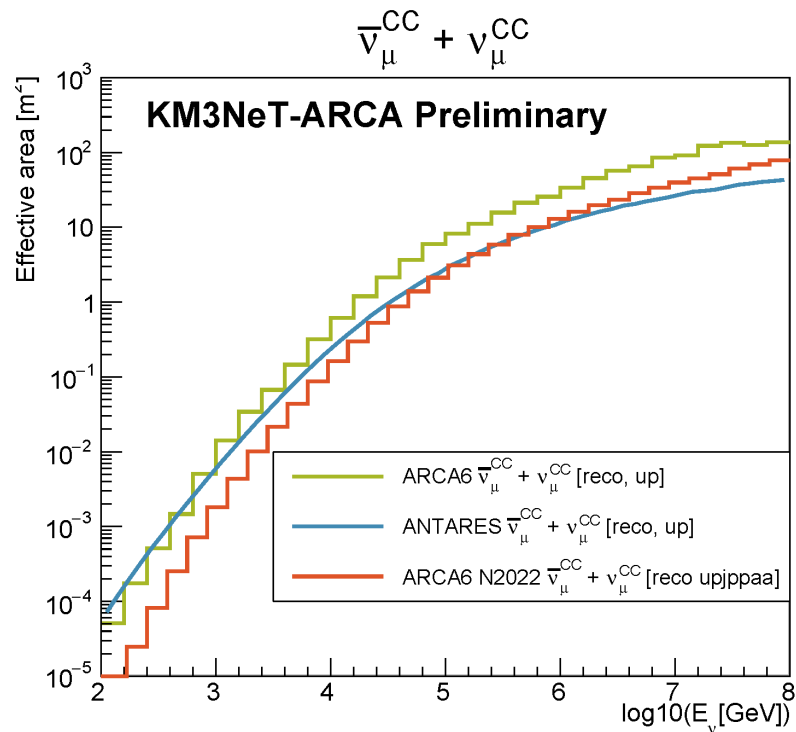
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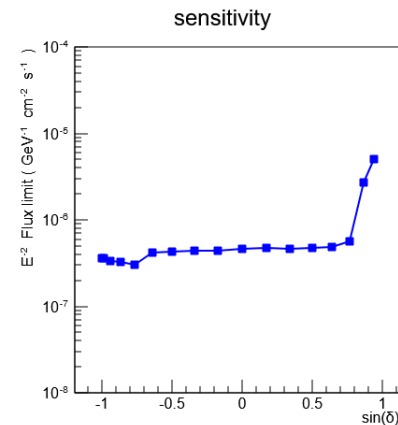
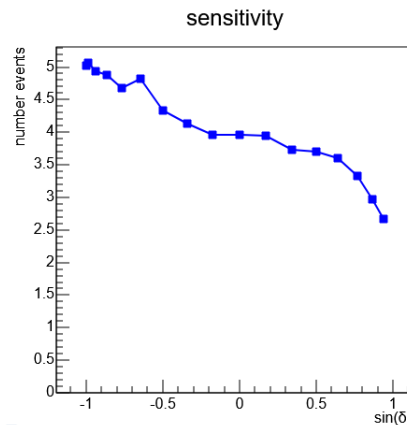
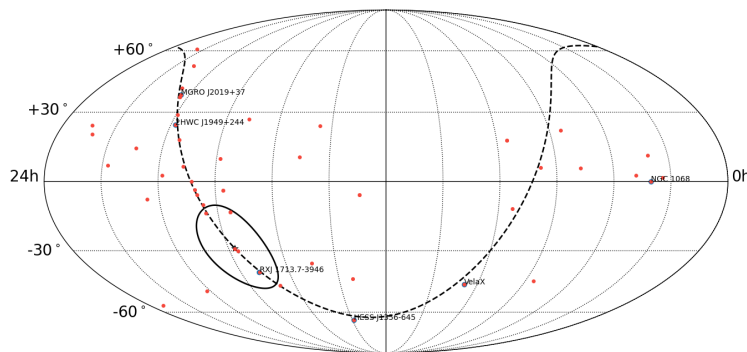
Before selection: Per day: 1708 atm muons, 4.5 atm neutrinos, 0.04 cosmic neutrinos

Selected: in 101 days: 2.8 neutrinos candidates. High atm muon background

We are preparing our first pointsource study with data



We are *preparing* our first pointsource study with data



Determine sensitivity for selected list of known sources

Conclusion and outlook

KM3NeT collaboration already exploiting physics-grade data with ARCA6 (and a little bit ARCA8):

- Framework to do pointsource study is in place
- We can respond to (neutrino) alerts!

Prospects

- A lot of work ongoing to improve reconstruction, muon simulations, automatise analysis
- Combined analysis with ANTARES foreseen



KM3NeT/ARCA is on its way to be a major contributor to neutrinos astrophysics!

We need some more time + more lines would be great

Questions?

