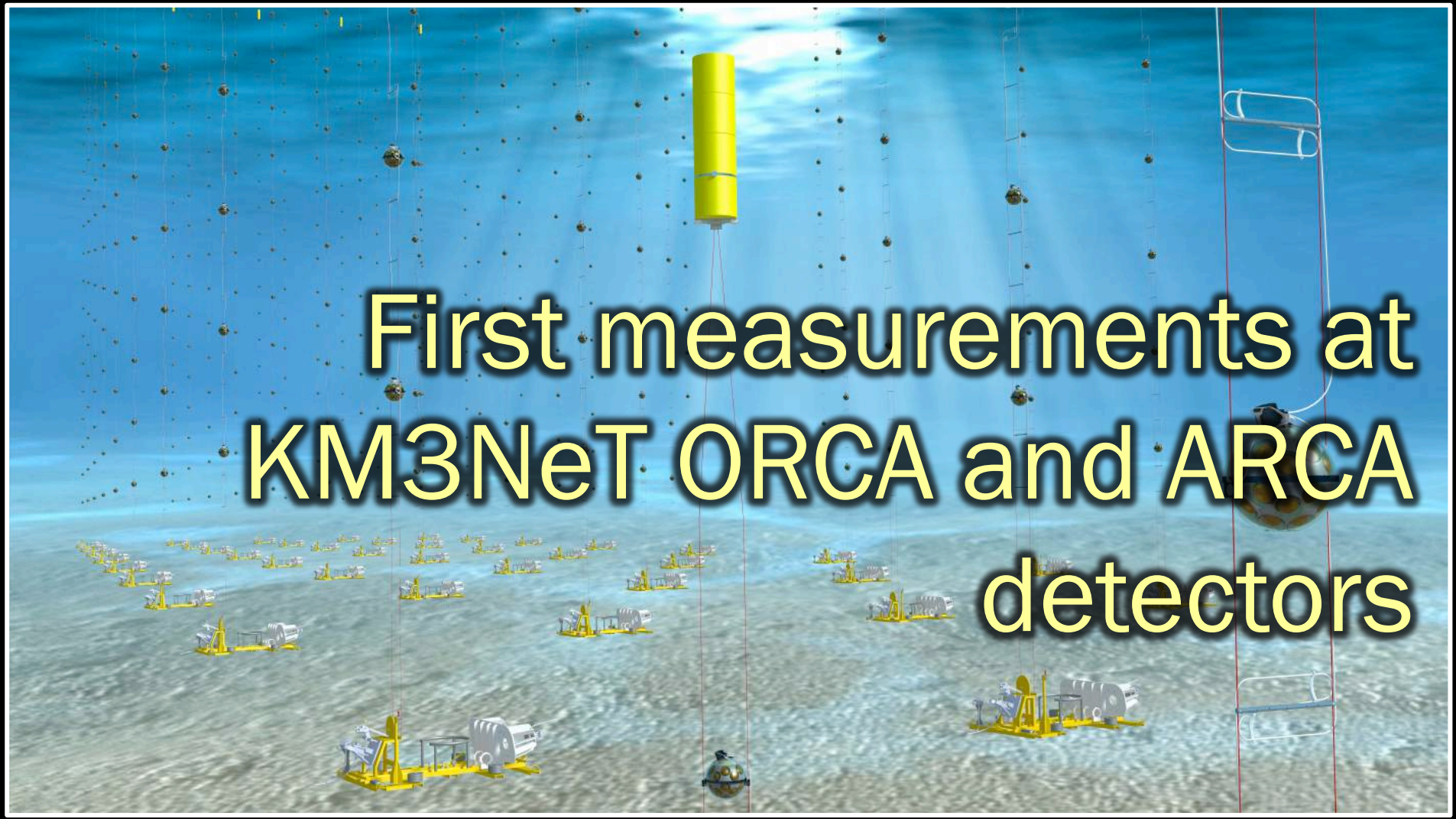
annual reporting seminar for 2019, 10/XII/2019



First measurements at KM3NeT ORCA and ARCA detectors

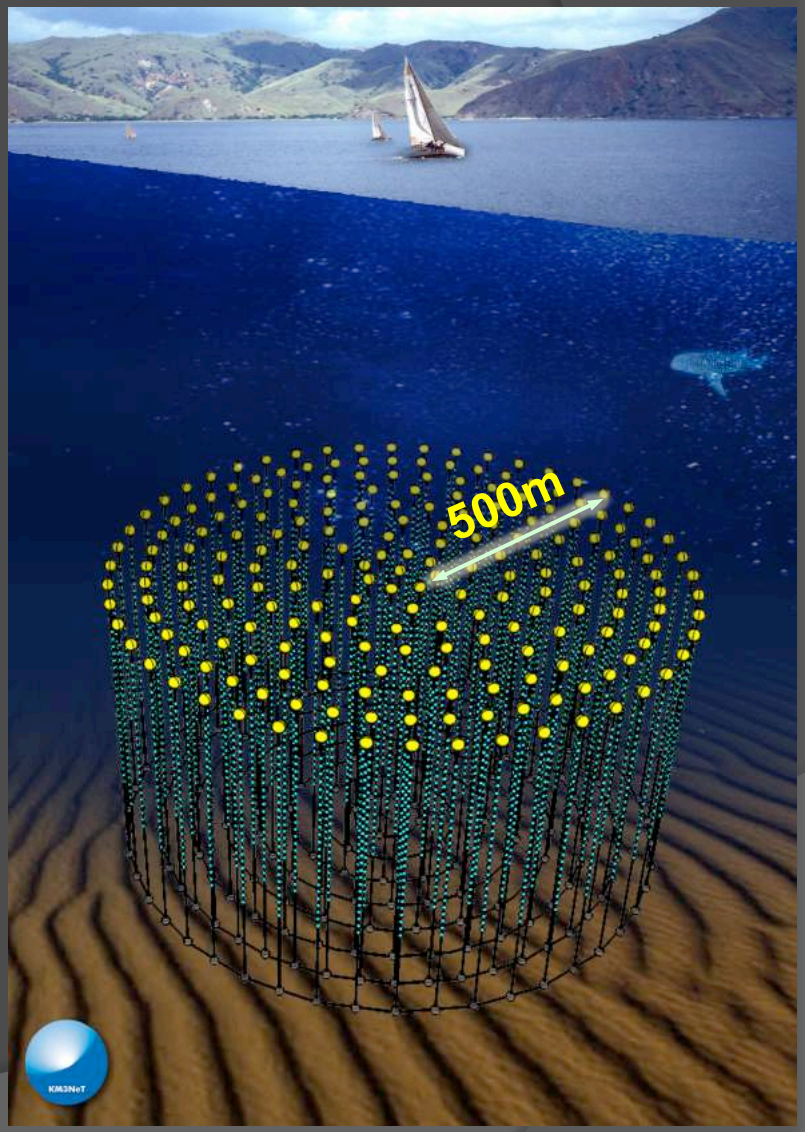
Piotr Mijakowski (BP3)

KM3NeT GROUP IN 2019

Part of Warsaw Neutrino Group led by prof. Ewa Rondio

- Piotr Mijakowski
  - SONATA BIS coordinator; KM3NeT roles: reviewer in Conference and Outreach Committee, machine learning editorial board member, representative in Insitute Board and Review & Resources Board
- Piotr Kalaczyński
  - PhD since December/2017
- Rafał Wojaczyński
  - post-doc since December/2018
- Topics: cosmic ray shower simulations (Piotr K.), self-veto studies (Rafał), machine learning applications to reconstruction (Piotr & Piotr), dark matter (Rafał & Piotr M.)

KM3NeT
Opens a new window on our universe

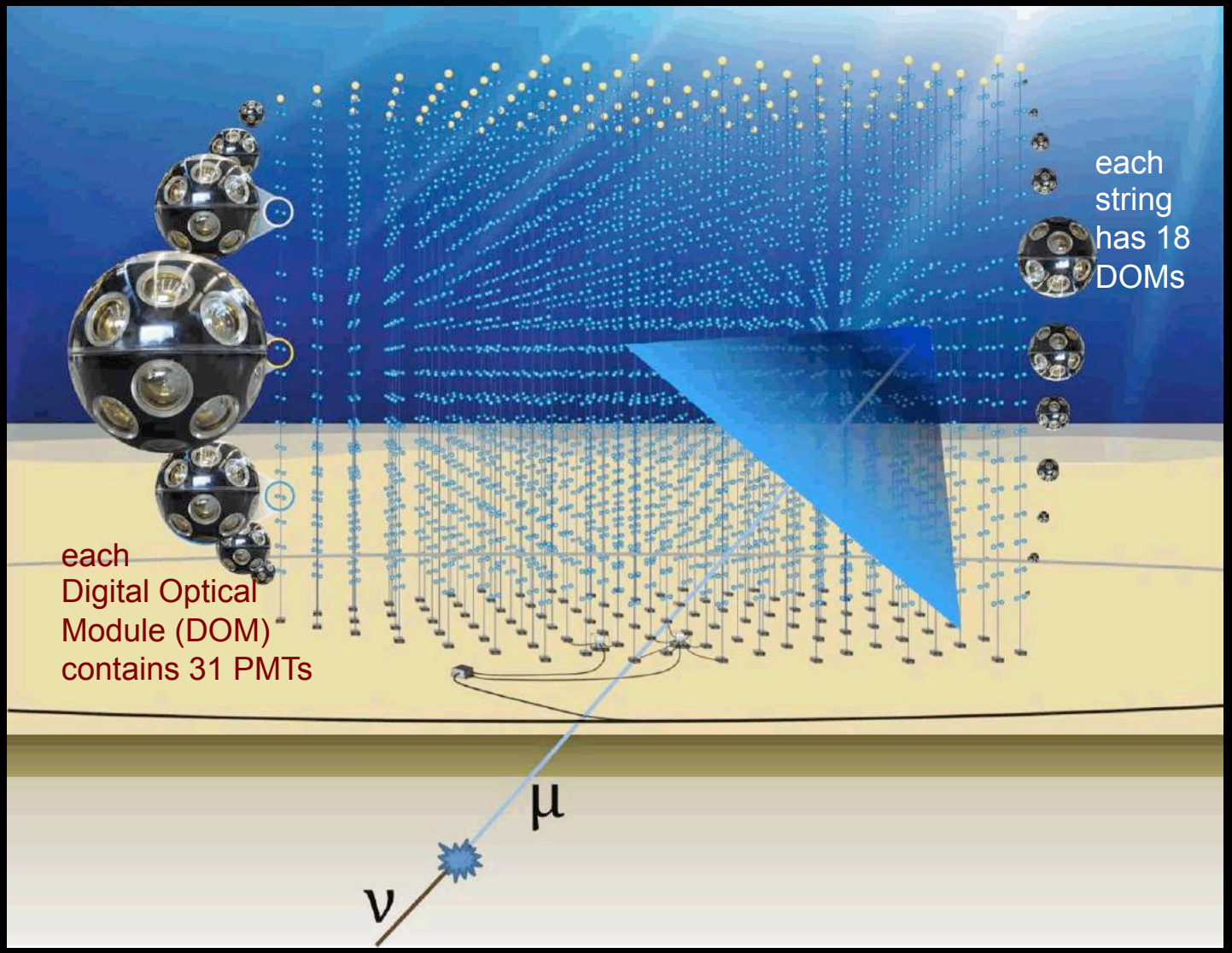


KM3NeT

Modular neutrino research infrastructure in the Mediterranean Sea

2 DETECTORS:

- ORCA Toulon (FR) ~2.5km depth
- ARCA Capo Pasero (IT) ~1km^3, ~3.5km depth

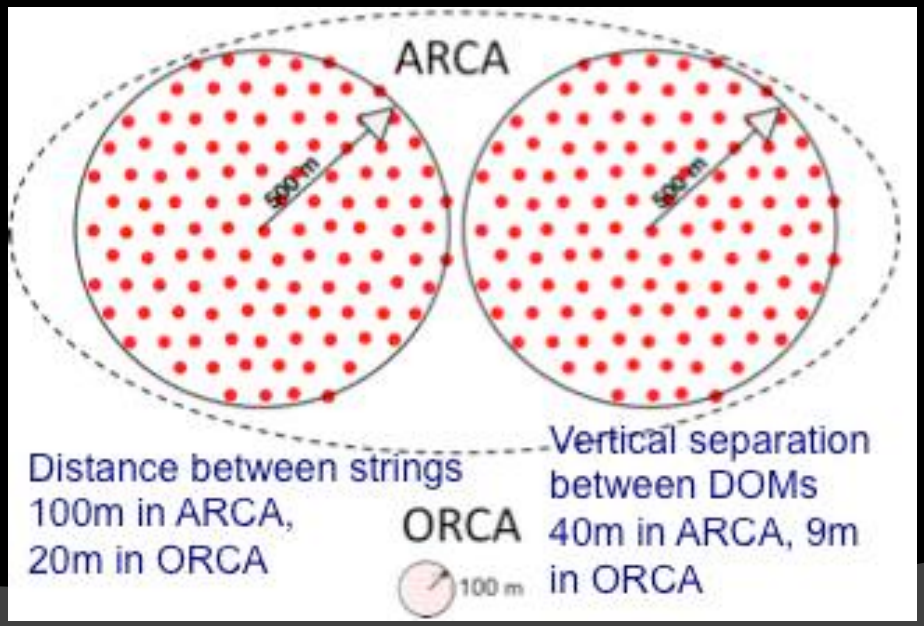


ARCA / ORCA

ARCA (Astroparticle Research with Cosmics in the Abyss)

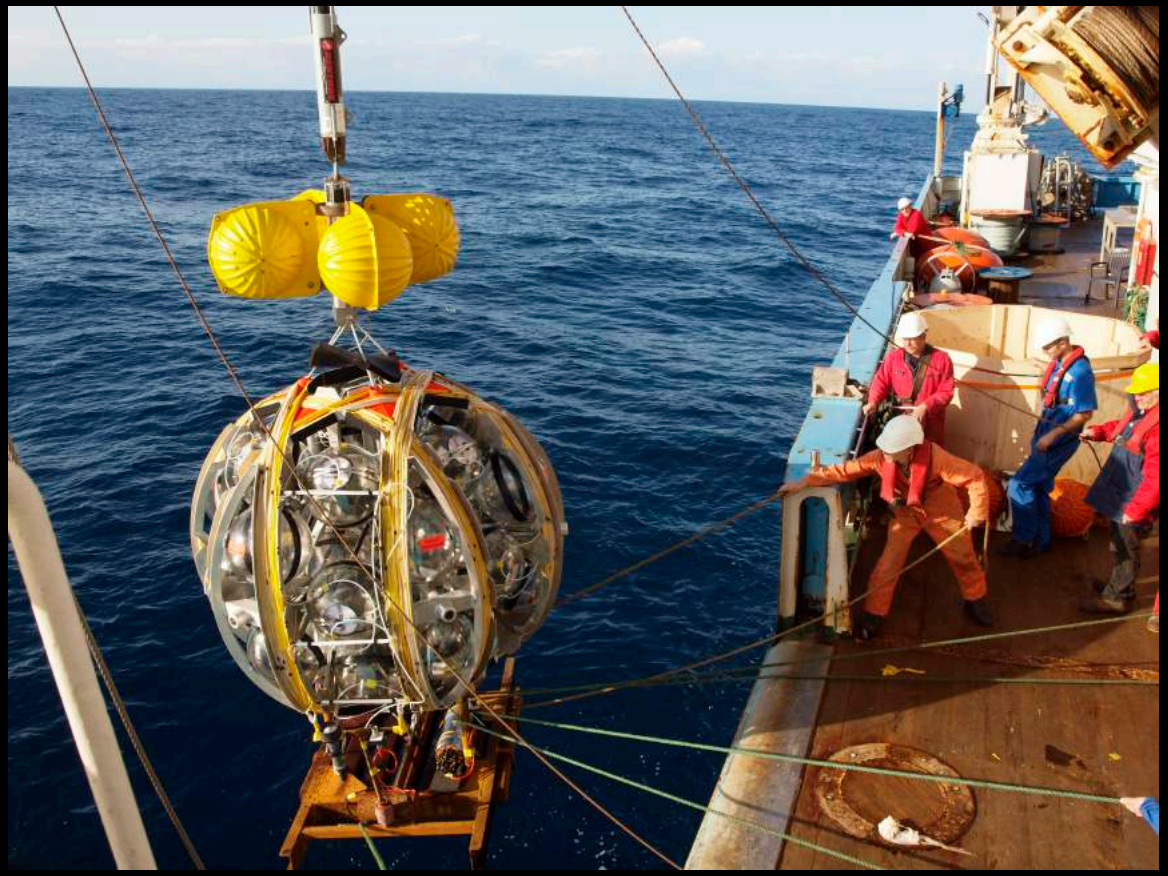
- GOAL: 2x115 strings, ~1km^3
- Phase I: 24 strings, 0.1 km^3

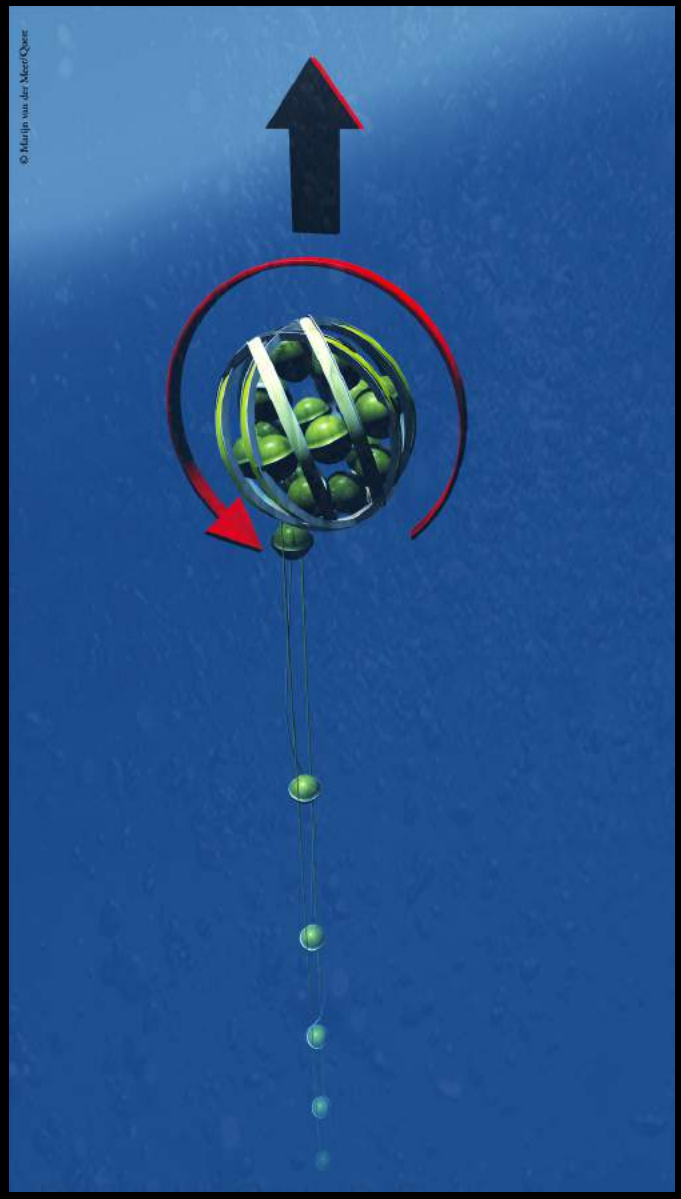
Currently 1 string taking data (more were deployed but suspended)



ORCA
(Oscillation Research with Cosmics in the Abyss)

- study of atmospheric ν
- 1st stage: 6 strings in KM3NeT-FR (Toulon) already funded, 4 strings already taking data working
- next phase: 115 strings, 3.7Mton (x20 bigger than Hyper-K)




© Marijn van der Meer/Quest

Cosmic ray muon and neutrino simulations @ NCBJ

CORSIKA-based cosmic ray shower simulations for both ARCA and ORCA detectors, *Piotr Kalaczyński*

- atmospheric ν and muons are main bkg in search for astrophysical neutrinos
- full detector simulation chain: CORSIKA → shower products @ sea level → propagation in water → interactions in detectors → light prod. simulation → trigger → detector reconstruction
- goal: compare with cosmic ray muon data from phase-1 ARCA & ORCA detectors
- *CIŚ used for some of these simulations*

$$\pi^+ \rightarrow \mu^+ + \nu_\mu \quad \mu^+ \rightarrow e^+ + \nu_e + \bar{\nu}_\mu$$

$$\pi^- \rightarrow \mu^- + \bar{\nu}_\mu \quad \mu^- \rightarrow e^- + \bar{\nu}_e + \nu_\mu$$

Cosmic ray muons @ KM3NeT

work of Piotr Kalaczyński (NCBJ), poster @ ICRC 2019

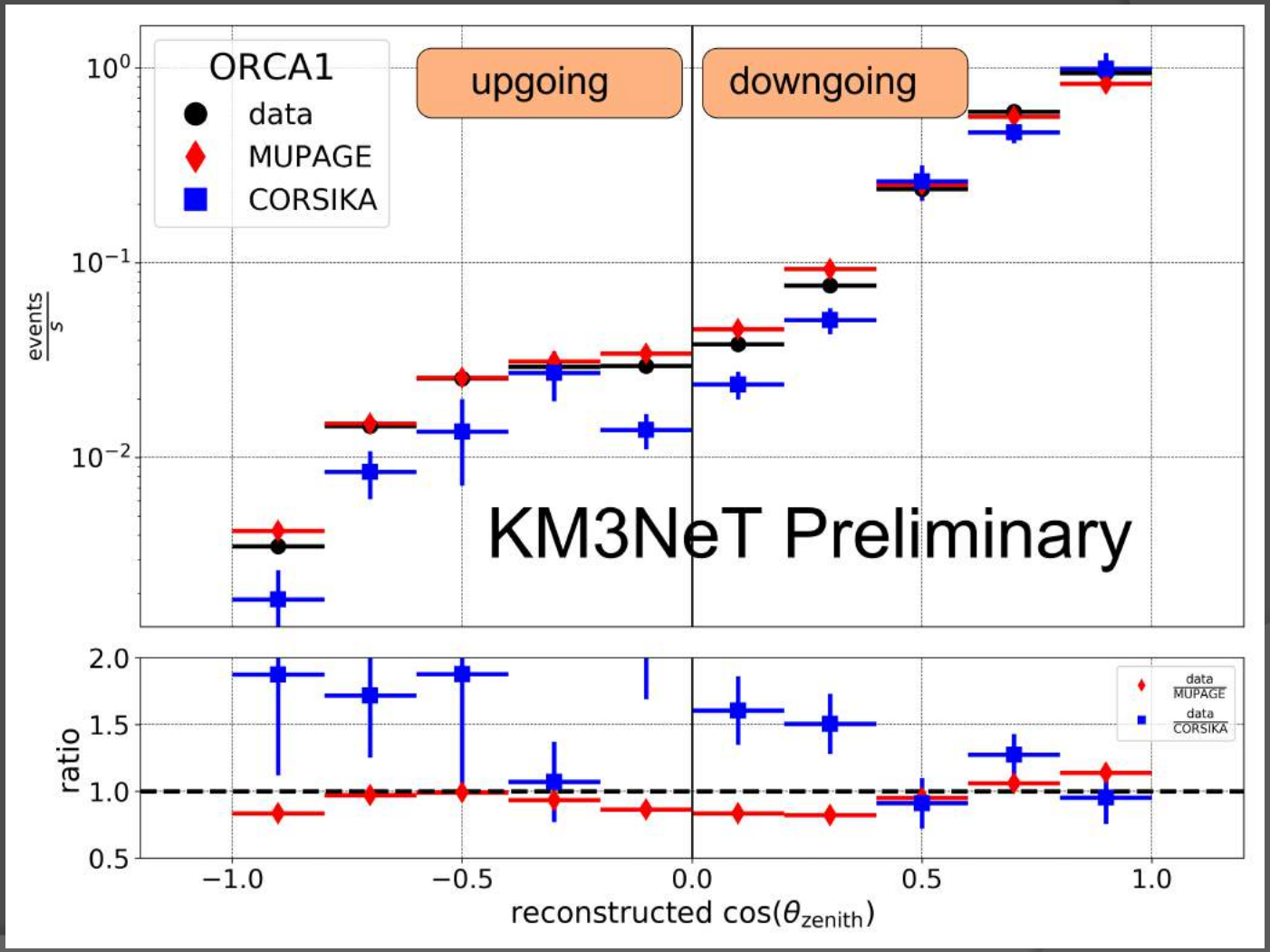
cosmic ray muons seen at ORCA (2.5 km depth)

ORCA data release based on 1 string (currently have more)

2 Monte Carlo generators:

CORSIKA run at CIŚ &

MUPAGE parametrized simulation



Cosmic ray muons @ KM3NeT

work of Piotr Kalaczyński (NCBJ), poster @ ICRC 2019

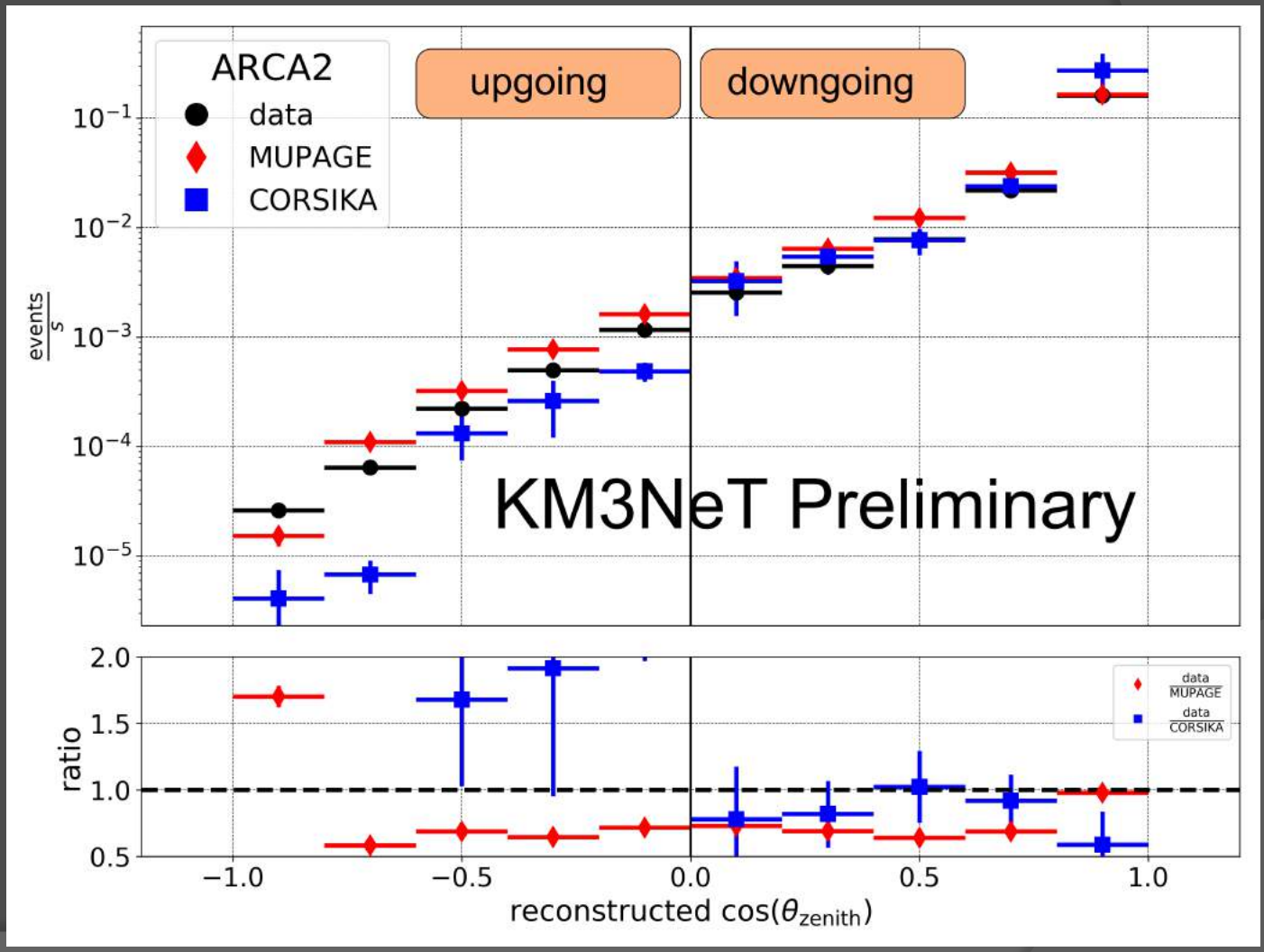
cosmic ray muons seen at ARCA (3.5km depth)

ARCA data release based on 2 strings (currently only 1 in operation)

2 Monte Carlo generators:

CORSIKA run at CIŚ &

MUPAGE parametrized simulation



Cosmic ray muons @ KM3NeT

work of Piotr Kalaczyński (NCBJ), poster @ ICRC 2019

ARCA data release based on 2 strings (currently only 1 in operation)

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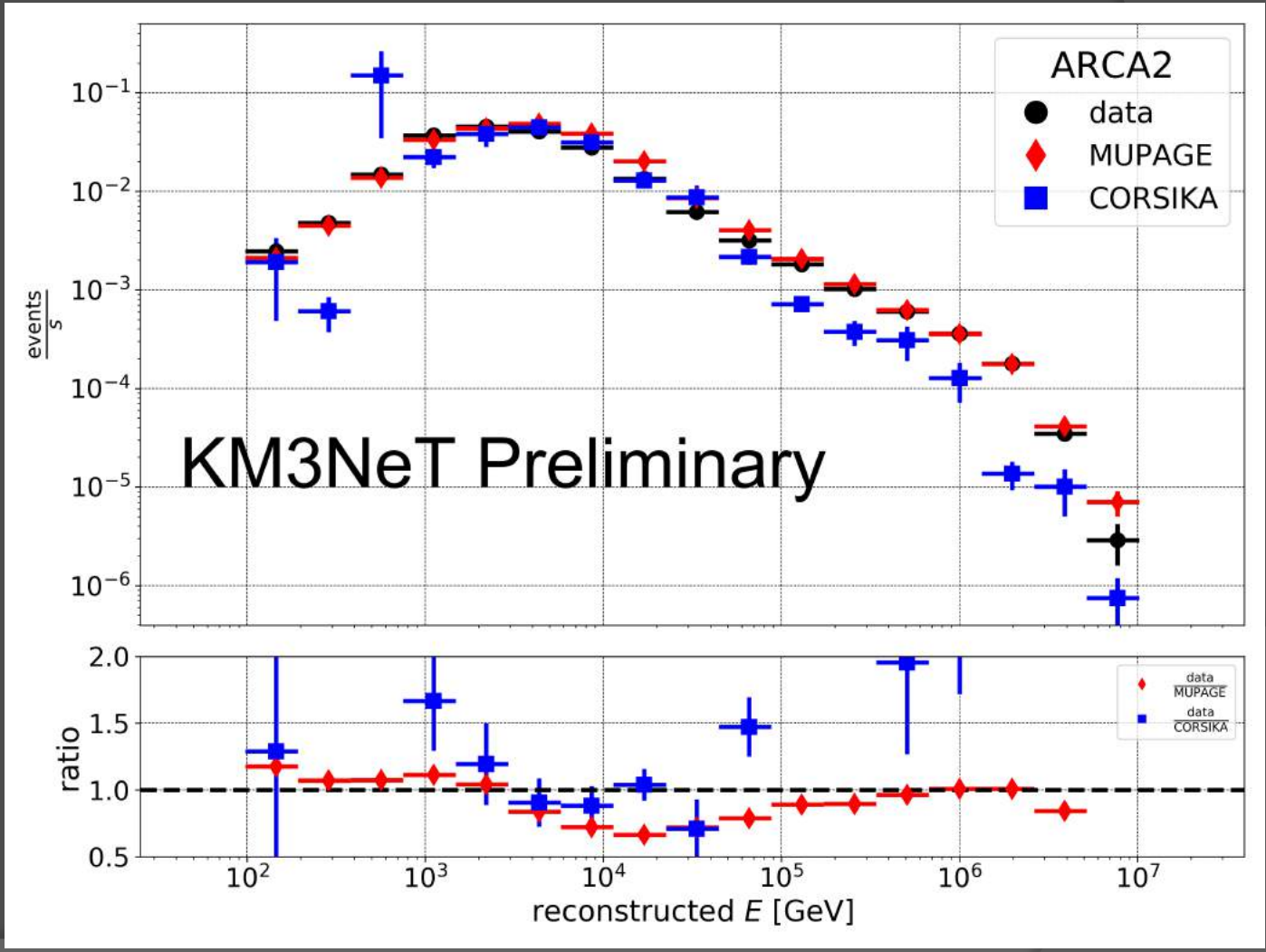
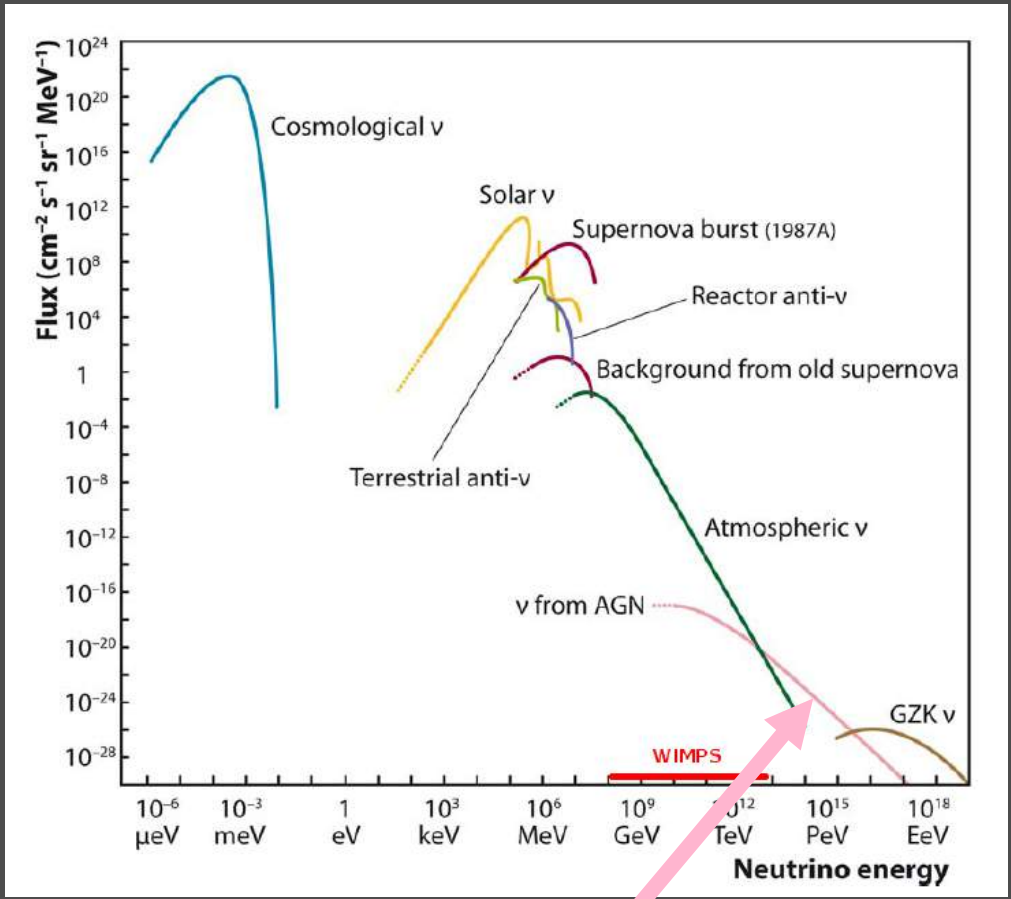
cosmic ray muons seen at ARCA (3.5km depth)

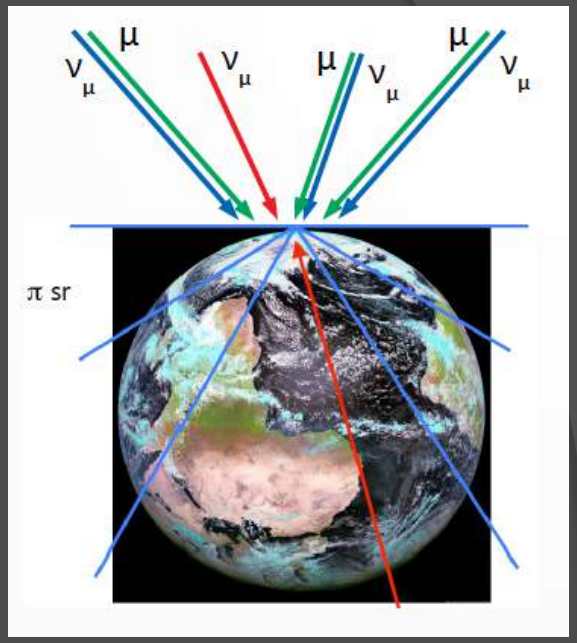


Self-veto studies @ NCBJ

work of Rafał Wojaczyński (NCBJ)

neutrino sources & spectra in nature





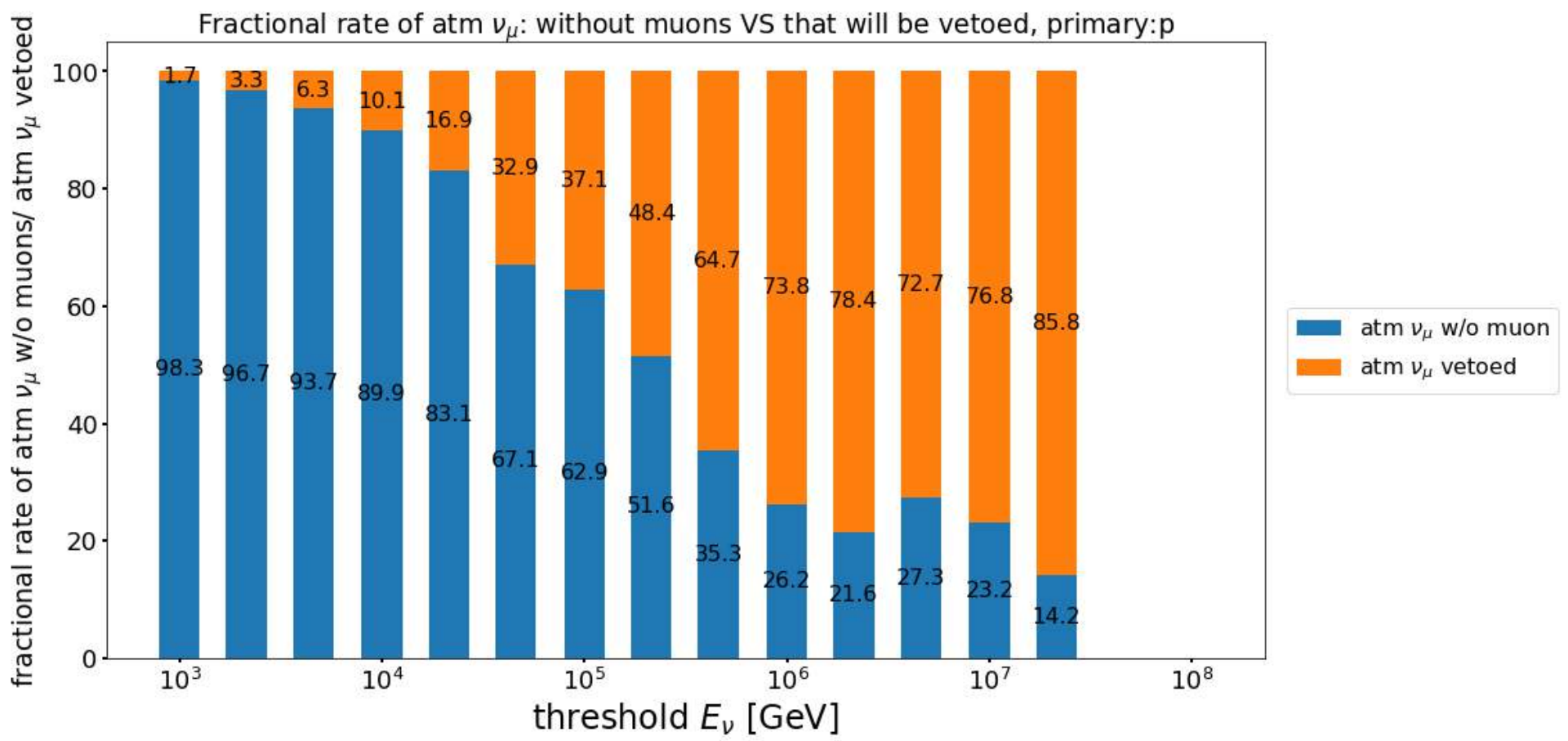
- We are looking for <u>cosmic neutrinos</u> with ARCA
- Background: atmospheric neutrinos, especially dominant below several tens of TeV

- IDEA: if downward-going ν interacts we cannot tell whether it is cosmic or atmospheric… unless it is accompanied by muon produced in same shower! Then, we can tell statistically how many single int. atm. νs should be in our sample given observation of ν interactions with accomp. muons

Self-veto studies @ NCBJ

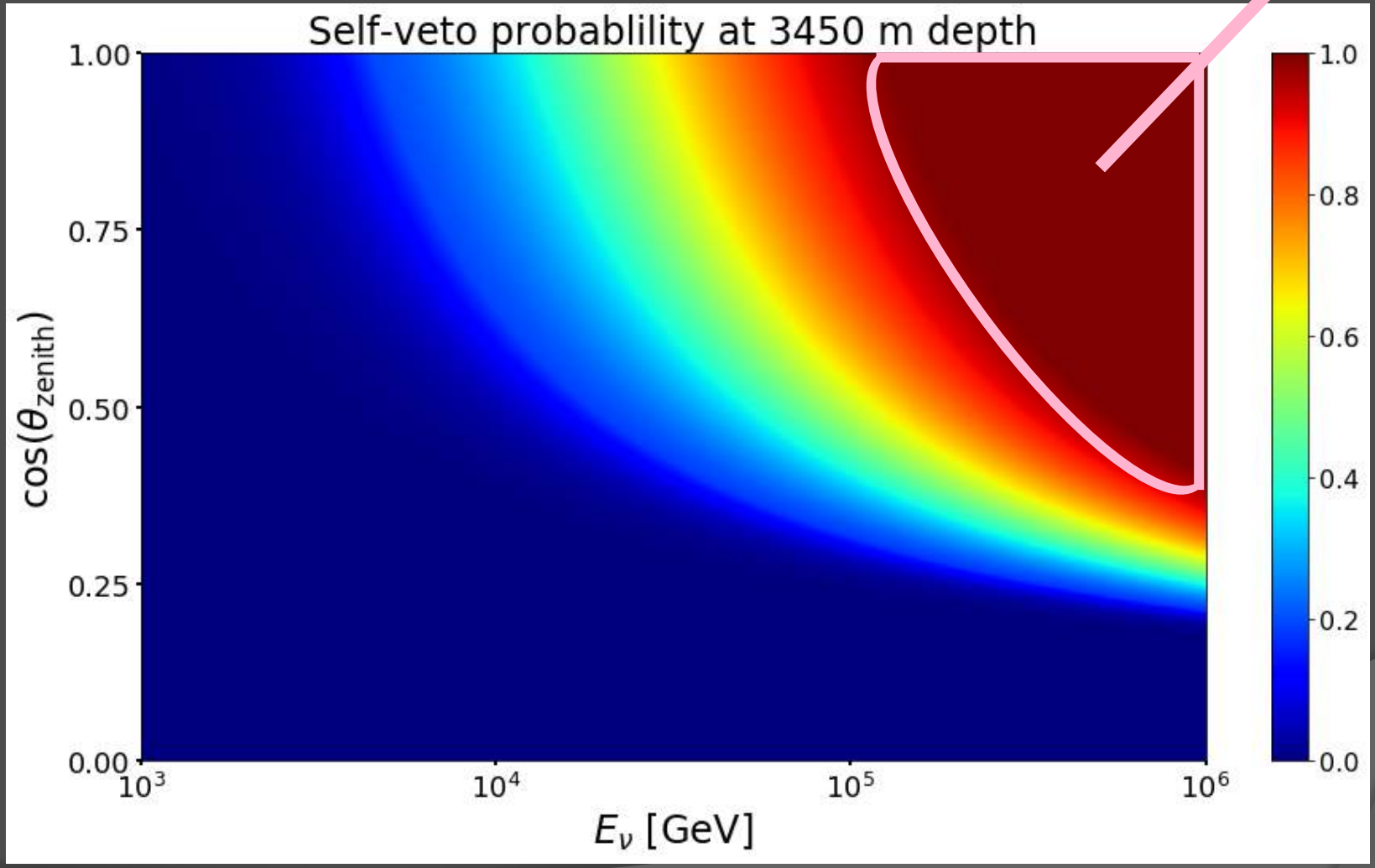
work of Rafał Wojaczyński (NCBJ)

- Expectation for full ARCA detector (2 blocks, 115 strings each) for 1 year of operation above 30 TeV threshold: 14 cosmic neutrinos, ~64 atmospheric neutrinos. Can we reduce the latter?



Self-veto studies @ NCBJ

work of Rafał Wojaczyński (NCBJ)

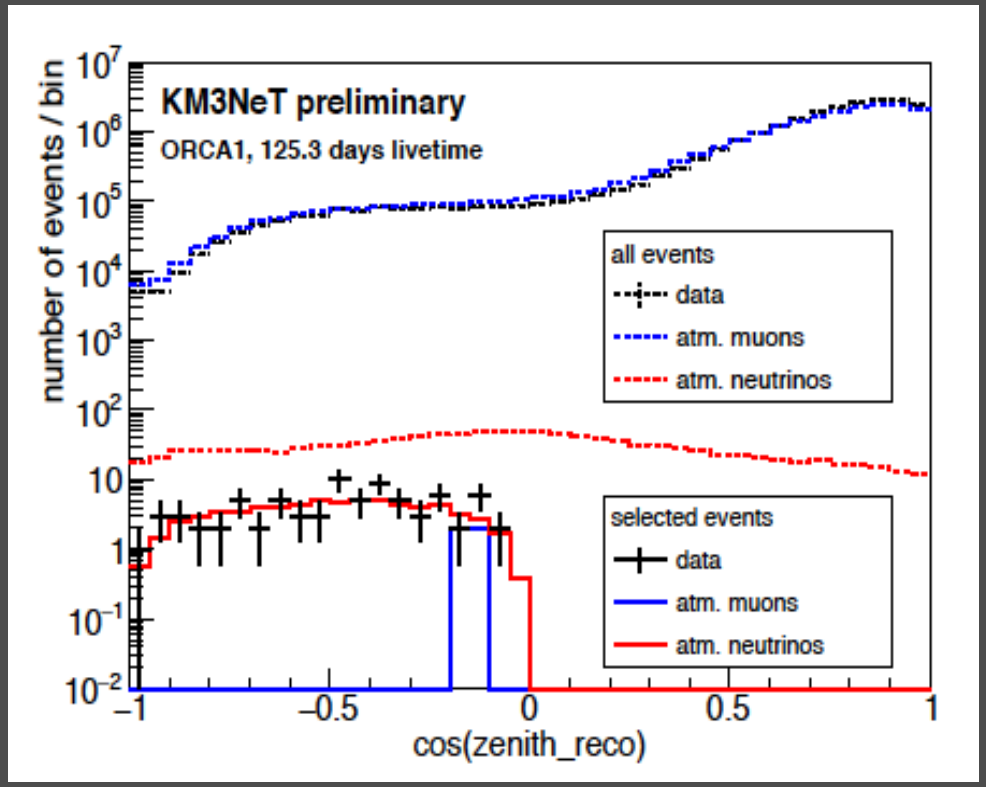


Every atmospheric neutrino willl have muon companion

First atm. neutrino candidates @ KM3NeT

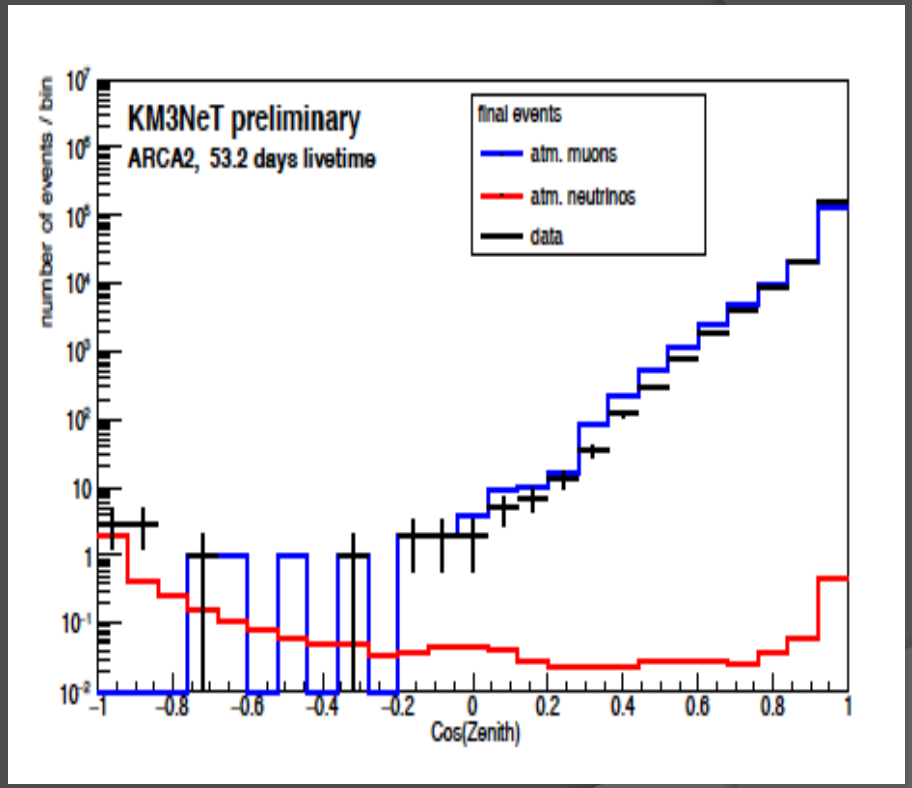
collaboration work, Jannik Hofestädt et al. poster @ ICRC 2019

ORCA (2.5km depth)



77 neutrino candidates

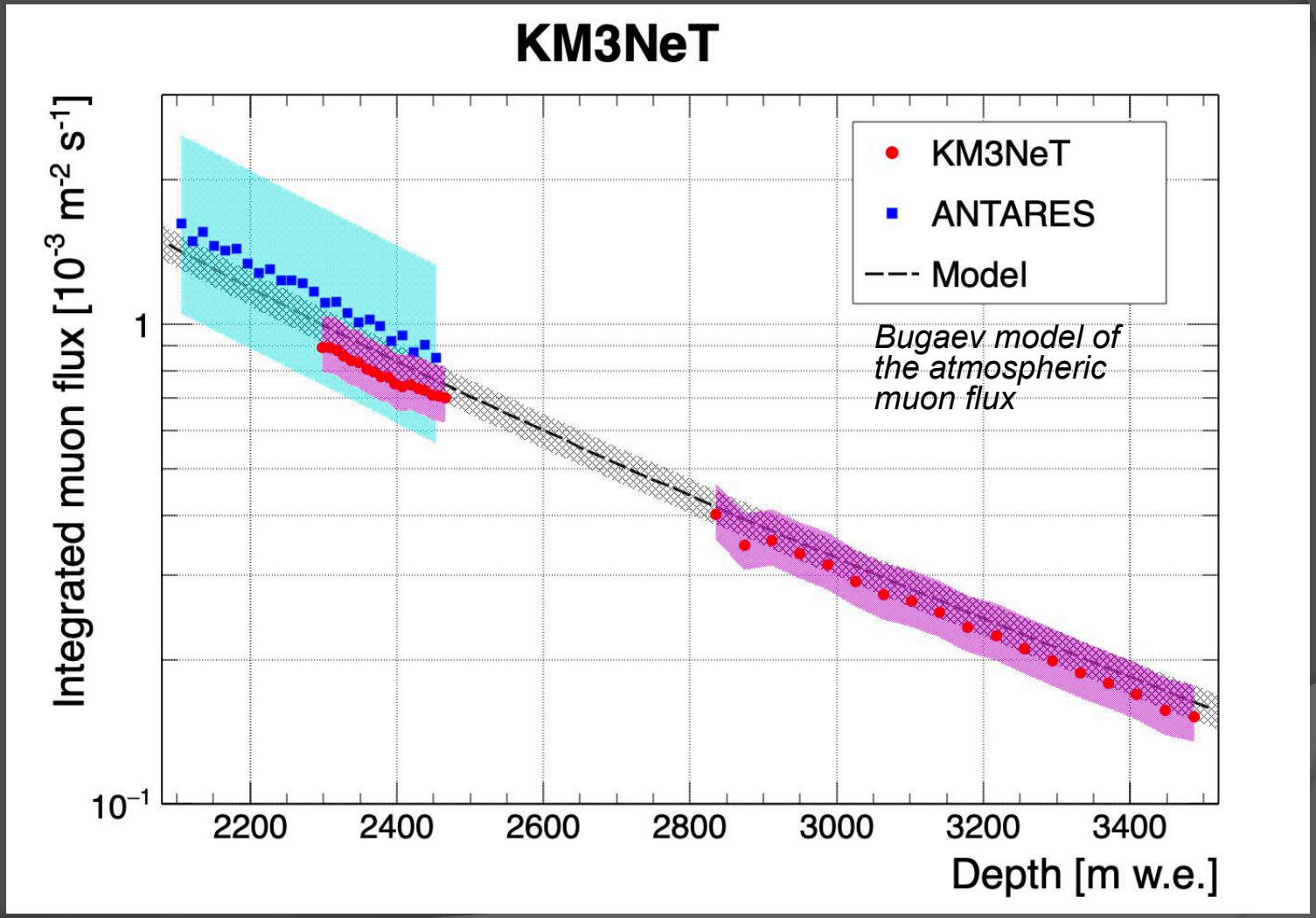
ARCA (3.5km depth)



6 neutrino candidates

Muon rate dependence

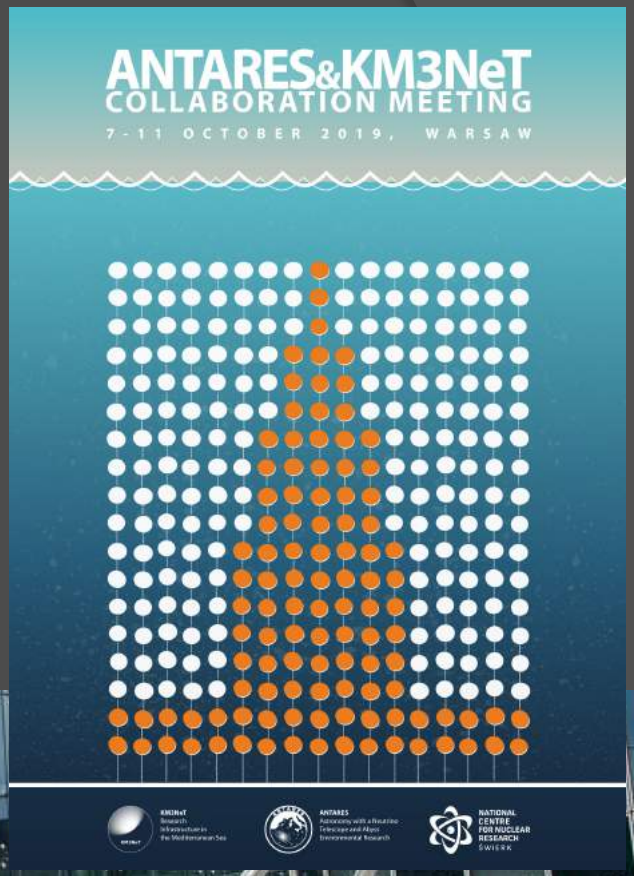
collaboration work, paper "Dependence of atmospheric muon flux on seawater depth measured with the first KM3NeT detection units" submitted to Eur. Phys. J. C



first direct muon measurement ever reaching depth of 3.5 km

KM3NeT SUMMARY FOR 2019

- KM3NeT is taking its first data and our group is actively contributing by being responsible for Monte Carlo studies and their comparison with data
- We organized ANTARES & KM3NeT collaboration meeting in Warsaw, 7-11 October, 2019
  (5 days, 95 people, @CeNT-I)



BACKUP

FINANCING 2019

For KM3NeT + Super-Kamiokande + Hyper-Kamiokande

NCN SONATA-BIS 5, coordinator: P.Mijakowski, 1.13 mln PLN, May/2016-2020 (will be extened to May 2021),

SIMULATION CHAIN