

# KM3NeT

*The next generation neutrino telescope  
in the Mediterranean*



XVI International Workshop on Neutrino Telescopes

2–6 March 2015, Venice, Italy.

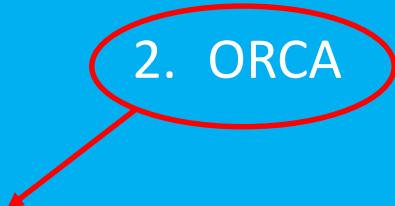
Maarten de Jong  
on behalf of the KM3NeT collaboration



# KM3NeT 2.0

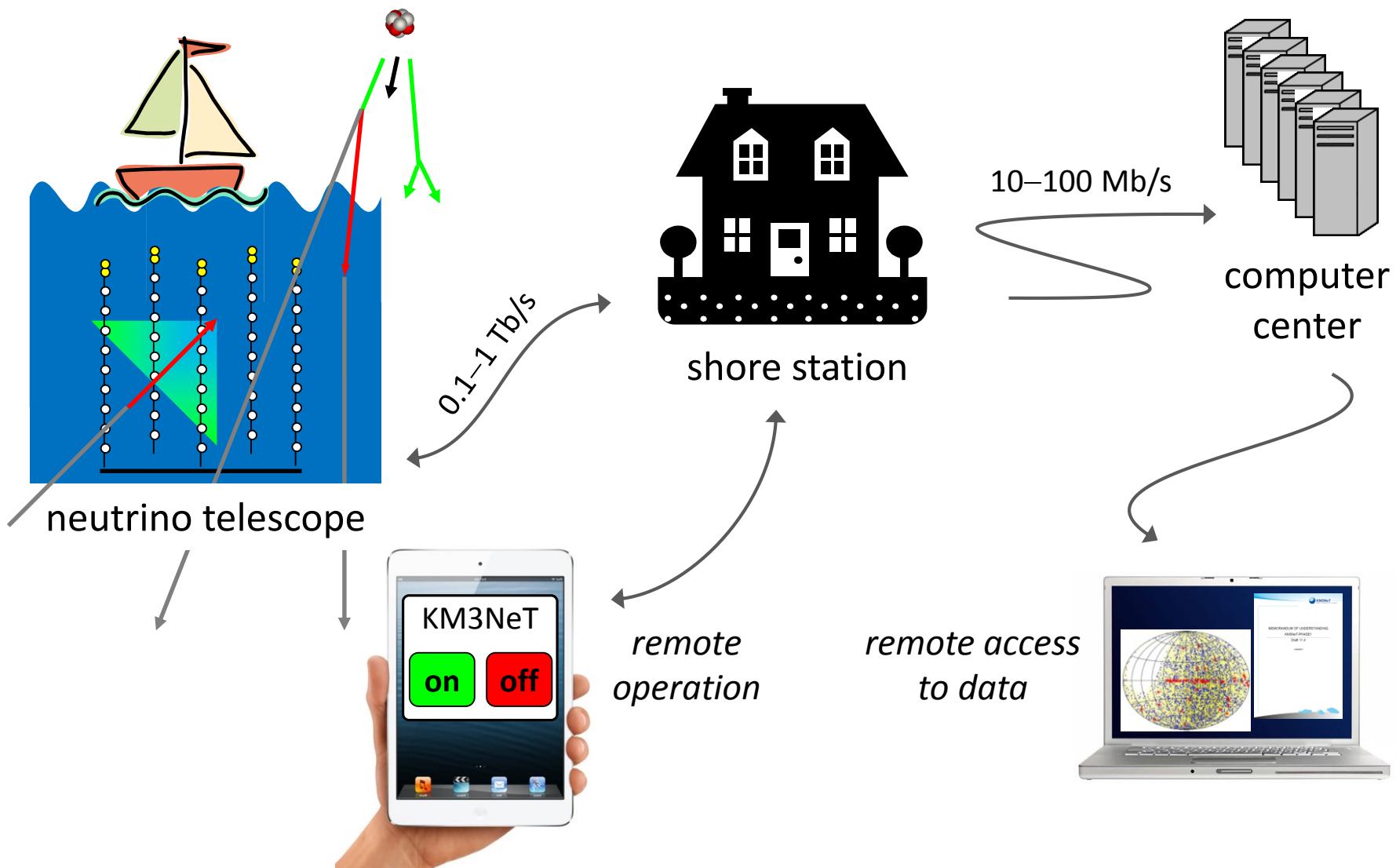
Astroparticle & Oscillations Research  
with Cosmics in the Abyss

- 1. ARCA → KM3NeT-Italy
- 2. ORCA → KM3NeT-France



Presentation of T. Eberl at this workshop

# Architecture



# Design

## Launcher vehicle

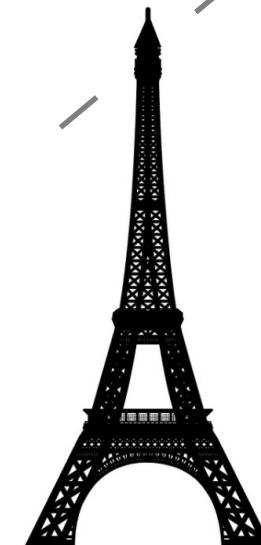


- *rapid deployment*
- *autonomous unfurling*
- *recoverable*

## Optical module



- *31 x 3" PMTs*
- *low-power HV*
- *LED & piezo inside*
- *FPGA readout*
- *White Rabbit*
- *DWDM*



# 3-inch PMTs

## Key features:

- timing  $\leq 2 \text{ ns (RMS)}$
- QE  $\geq 25\text{-}30\%$
- collection efficiency  $\geq 90\%$
- photon counting purity ~~100% (by hits, up to 7)~~
- price/cm<sup>2</sup>  $\leq 10'' \text{ PMT}$

ETEL D792



Hamamatsu R12199

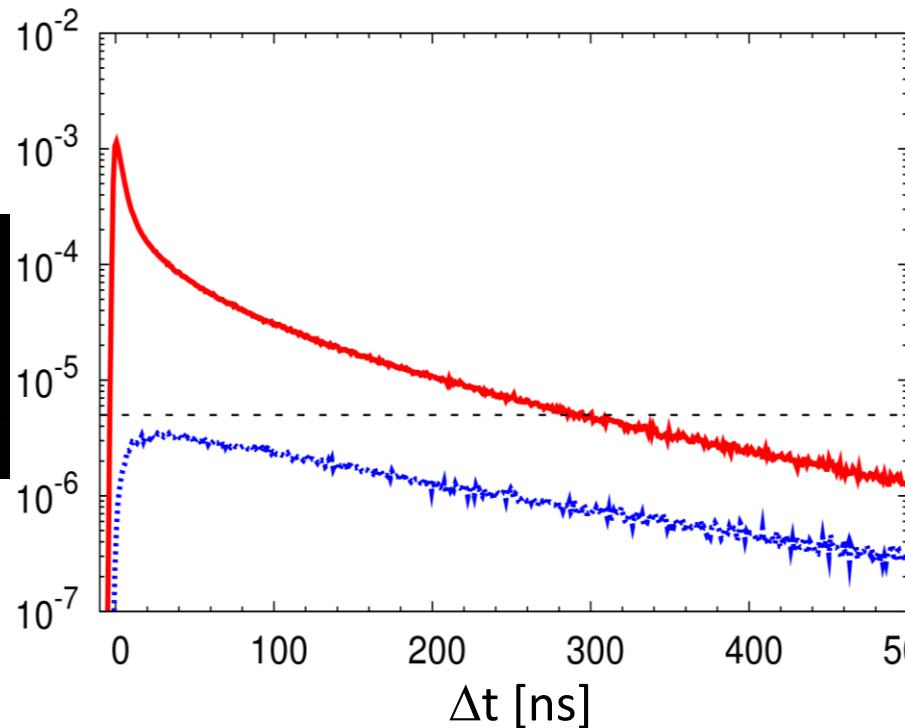


HZC XP53B20

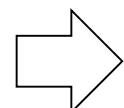
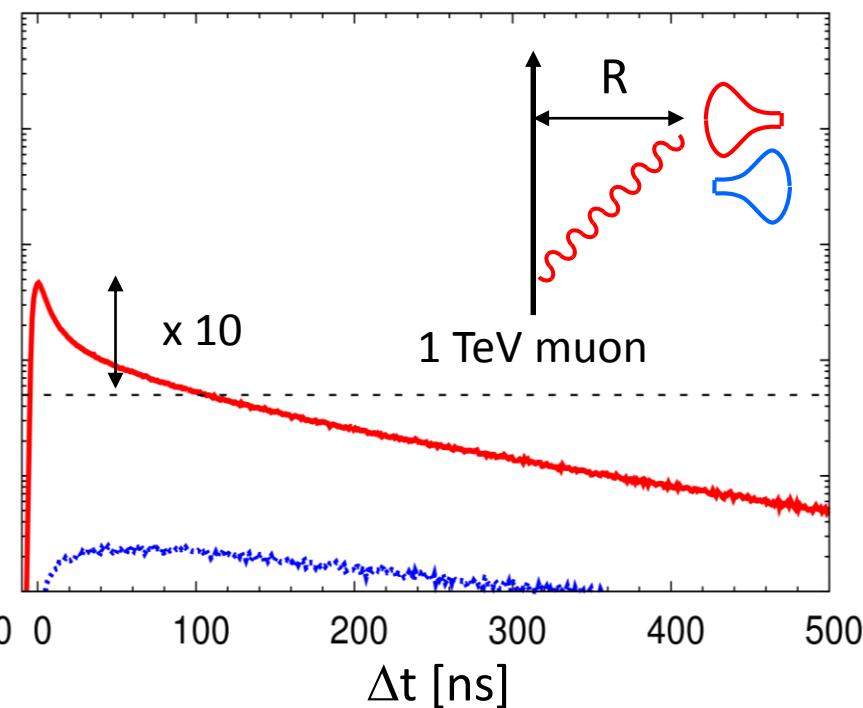


# PDF of muon light

KM3NeT PRELIMINARY: PMT at R=50m

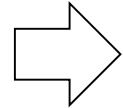
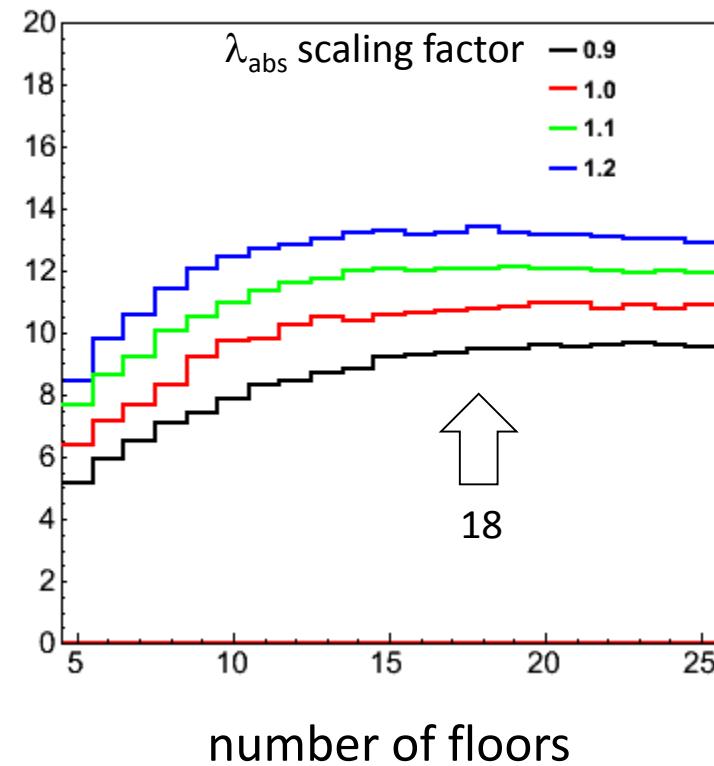
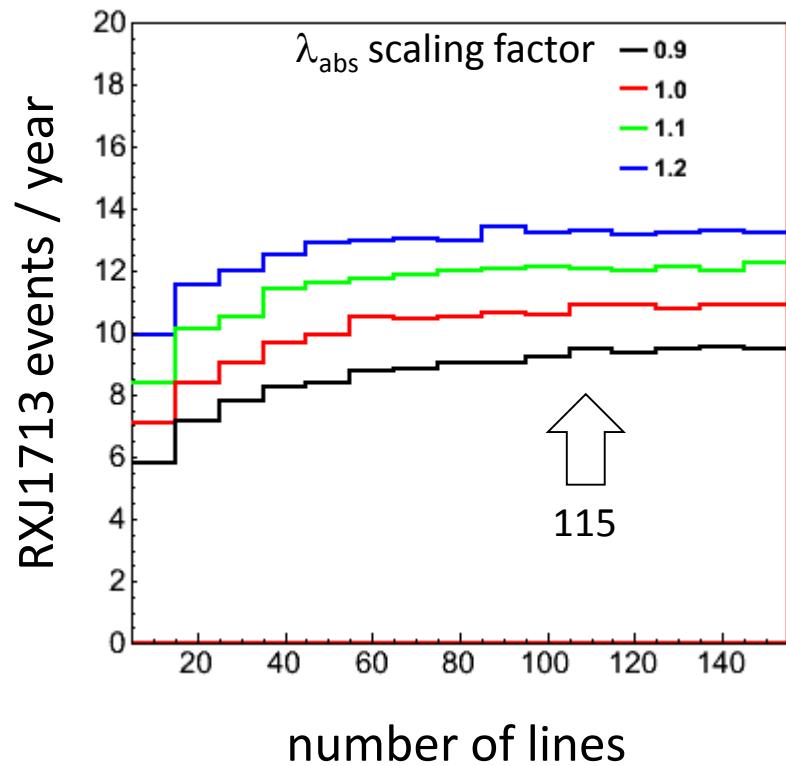


KM3NeT PRELIMINARY: PMT at R=100m



Angular resolution  $\sim 0.1$  degrees

# Building blocks



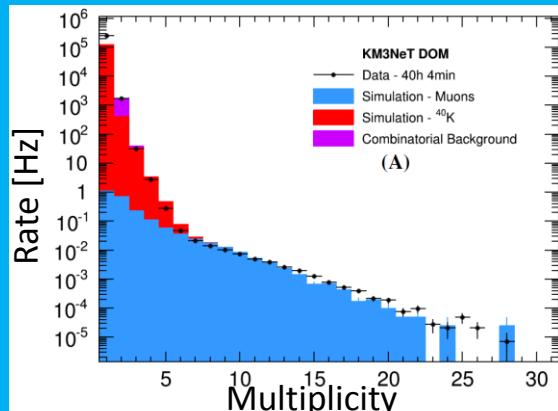
Smallest detector with optimal efficiency  $\sim 1/6$  total size

# Phased implementation

Phase	Blocks	Primary deliverables
1	0.2	Proof of feasibility and first science results;
2.0	2	Measurement of neutrino signal reported by IceCube; All flavor neutrino astronomy;
	1	Neutrino mass hierarchy;
3	6	Neutrino astronomy including Galactic sources;

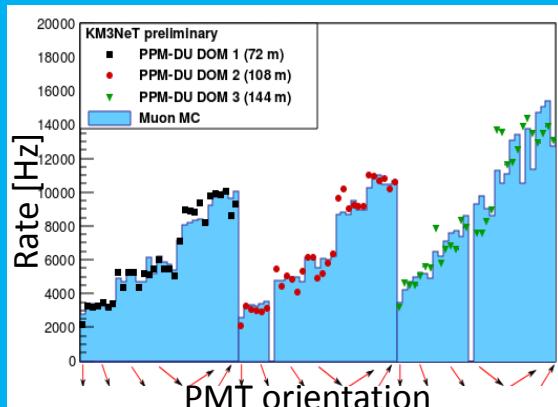
# Prototyping

1) Optical module deployed at Antares April 2013 (2500 m)



Eur. Phys. J. C (2014)  
74:3056

2) Mini string deployed at Capo Passero May 2014 (3500 m)



Poster of R. Bormuth  
at this workshop

# Phase-1

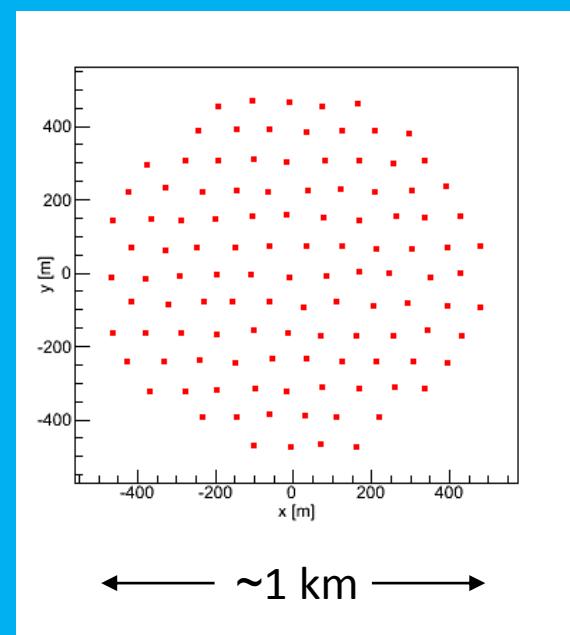
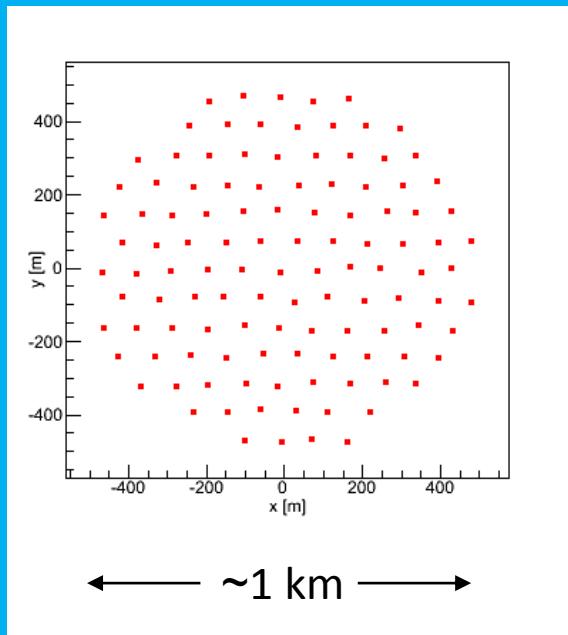
- ✓ First string assembled end of last year



- First string to be deployed in April at KM3NeT-France
- Completion Phase-1 by end 2016
  - 24 strings in KM3NeT-Italy
  - 6 more strings à la ORCA in KM3NeT-France

# ARCA

Measurement of neutrino signal  
reported by IceCube

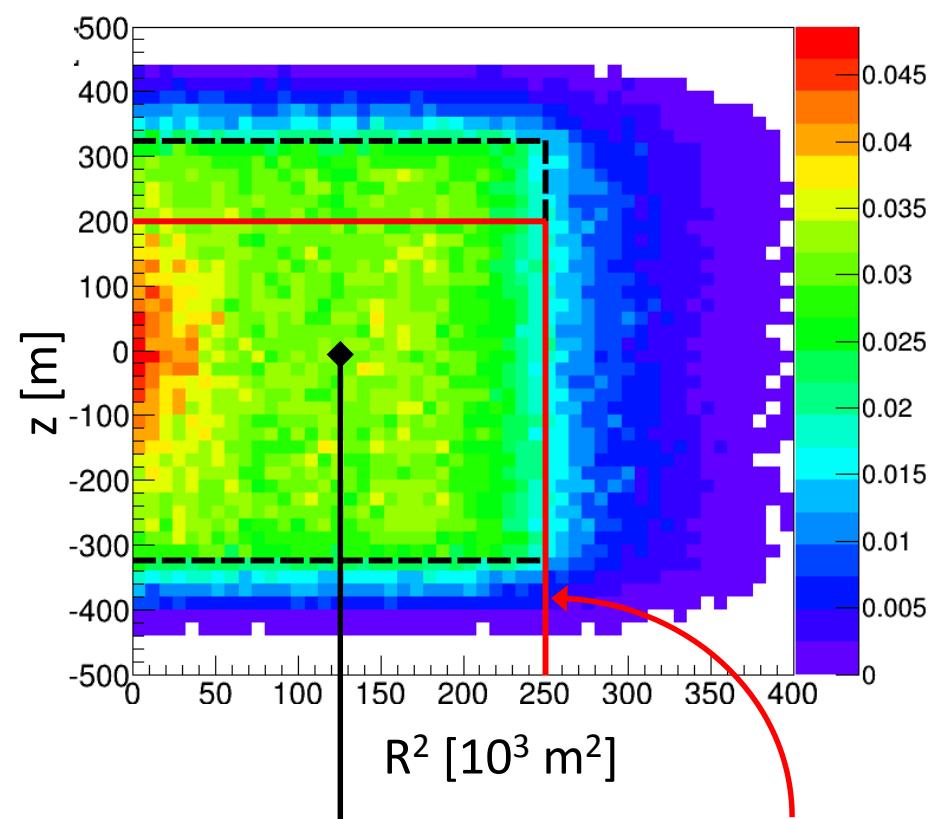


# Cascade analysis 1.0 – cut & count

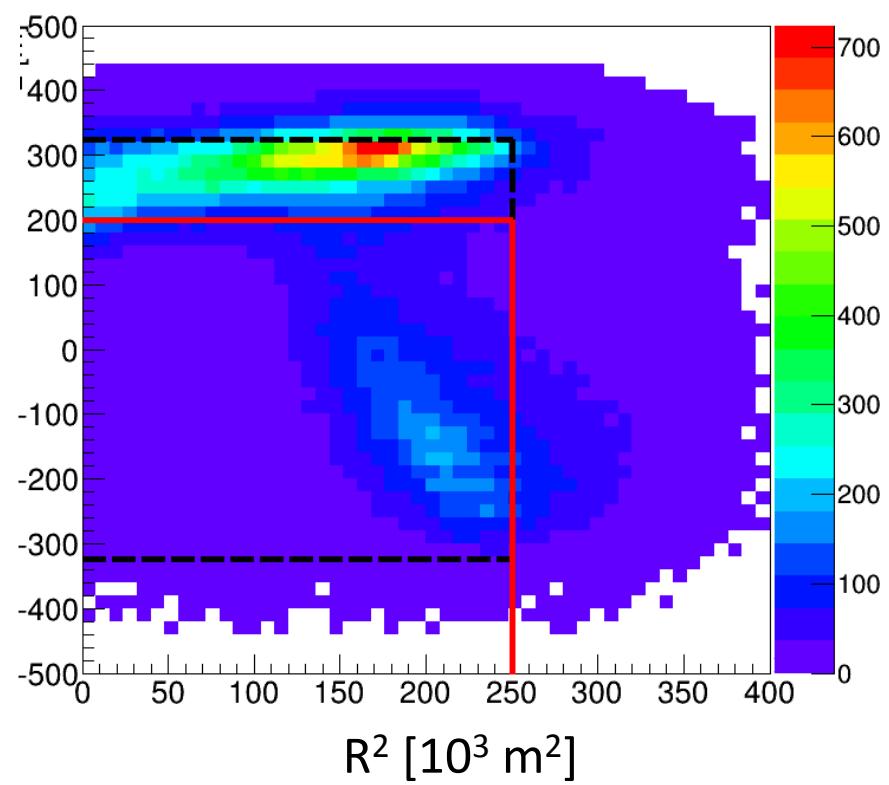
1. Online data filter
  - 5 (or more) coincidences between PMTs in same optical module ( $\Delta T = 10$  ns)
2. Event filter
  - number of hits  $\geq 2000$
3. Vertex cut
  - veto atmospheric muons
4. Energy cut
  - total time-over-threshold  $\geq 12 \mu s$
5. MRF/MDP cut
  - 2D cut based on Boosted Decision Tree & energy estimate

### 3.) Atmospheric muon veto

**cosmic neutrinos**

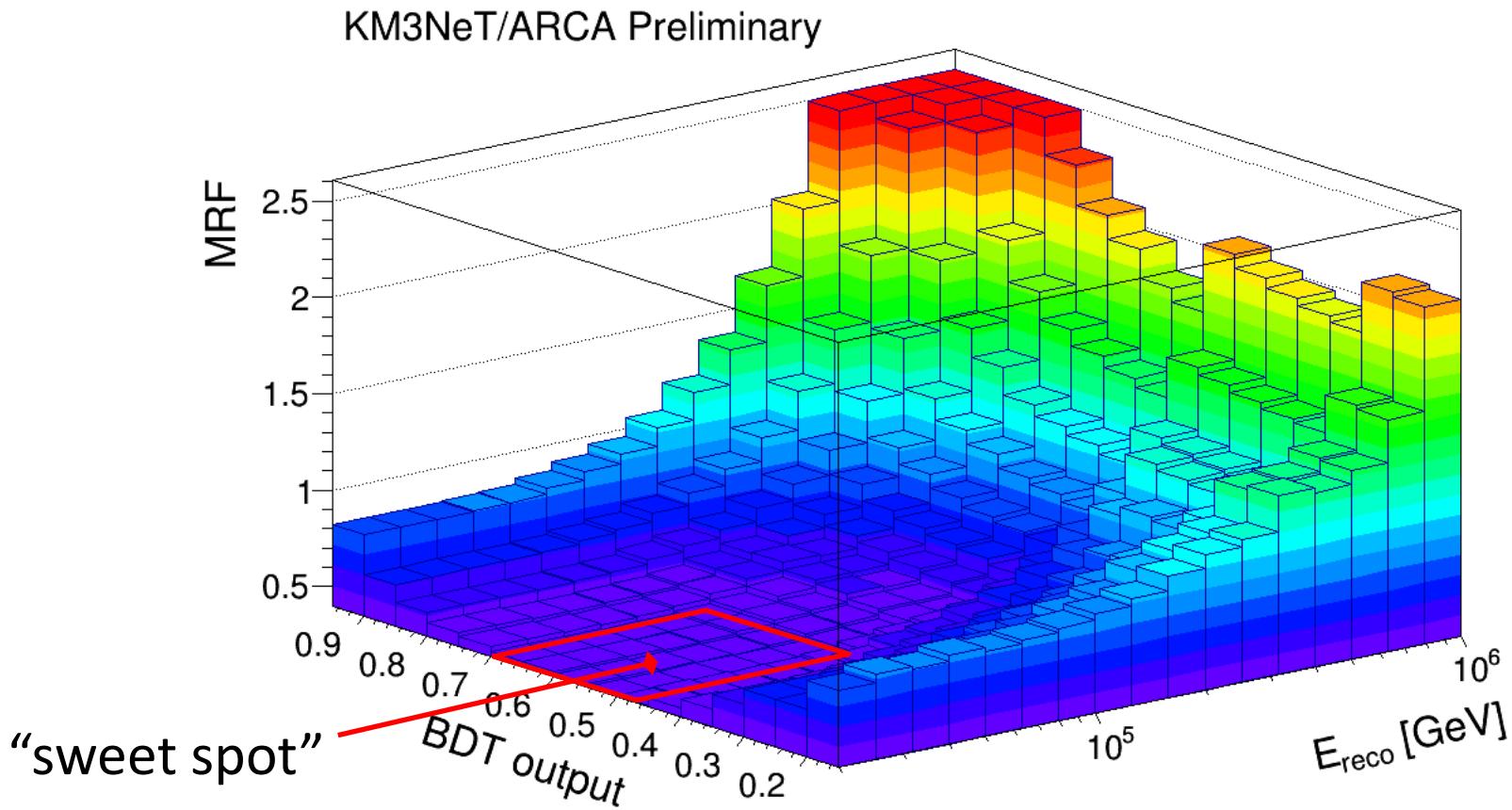


**atmospheric muons**

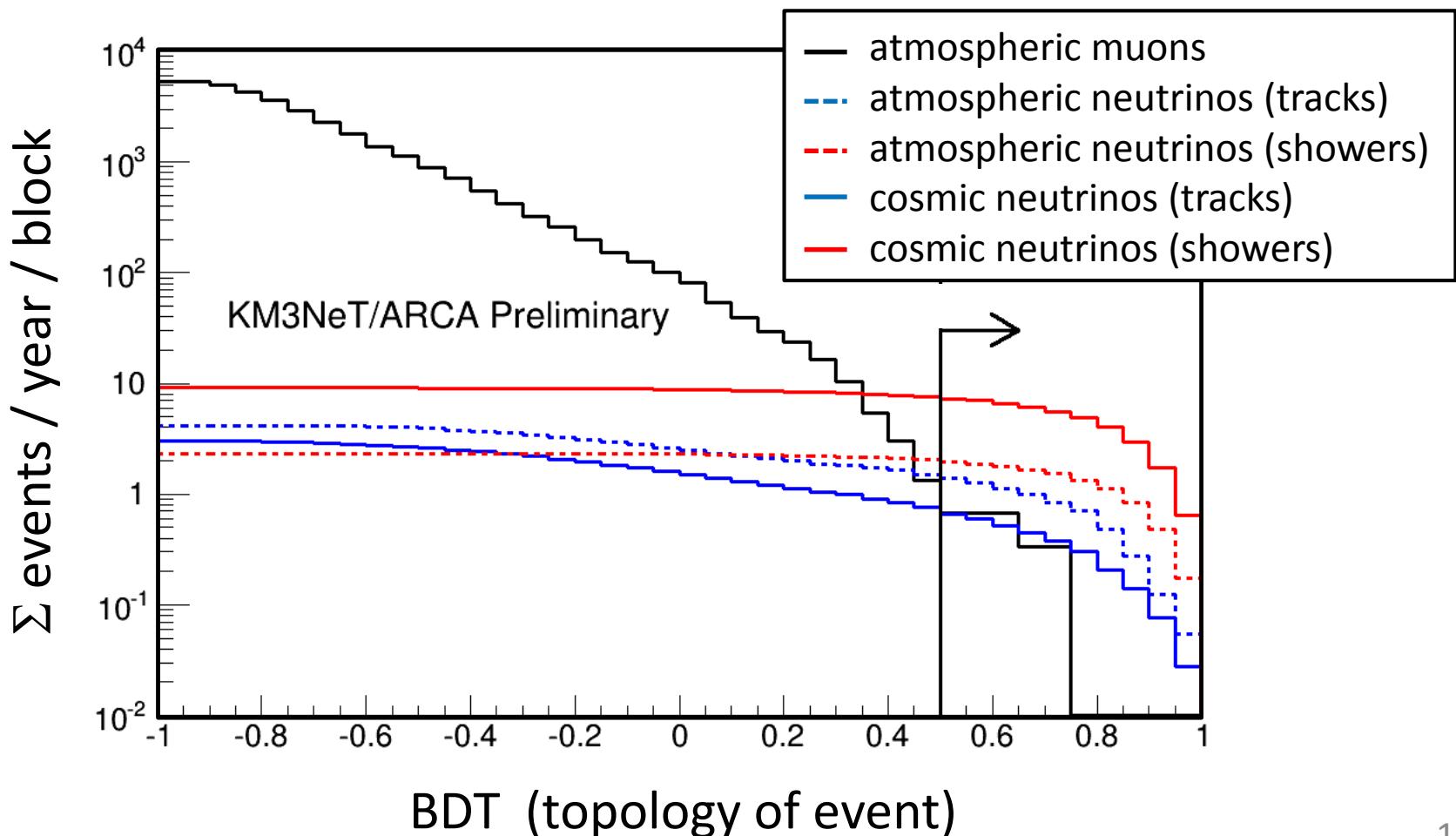


detector volume  $\otimes$  vertex cut  $\equiv 80\%$

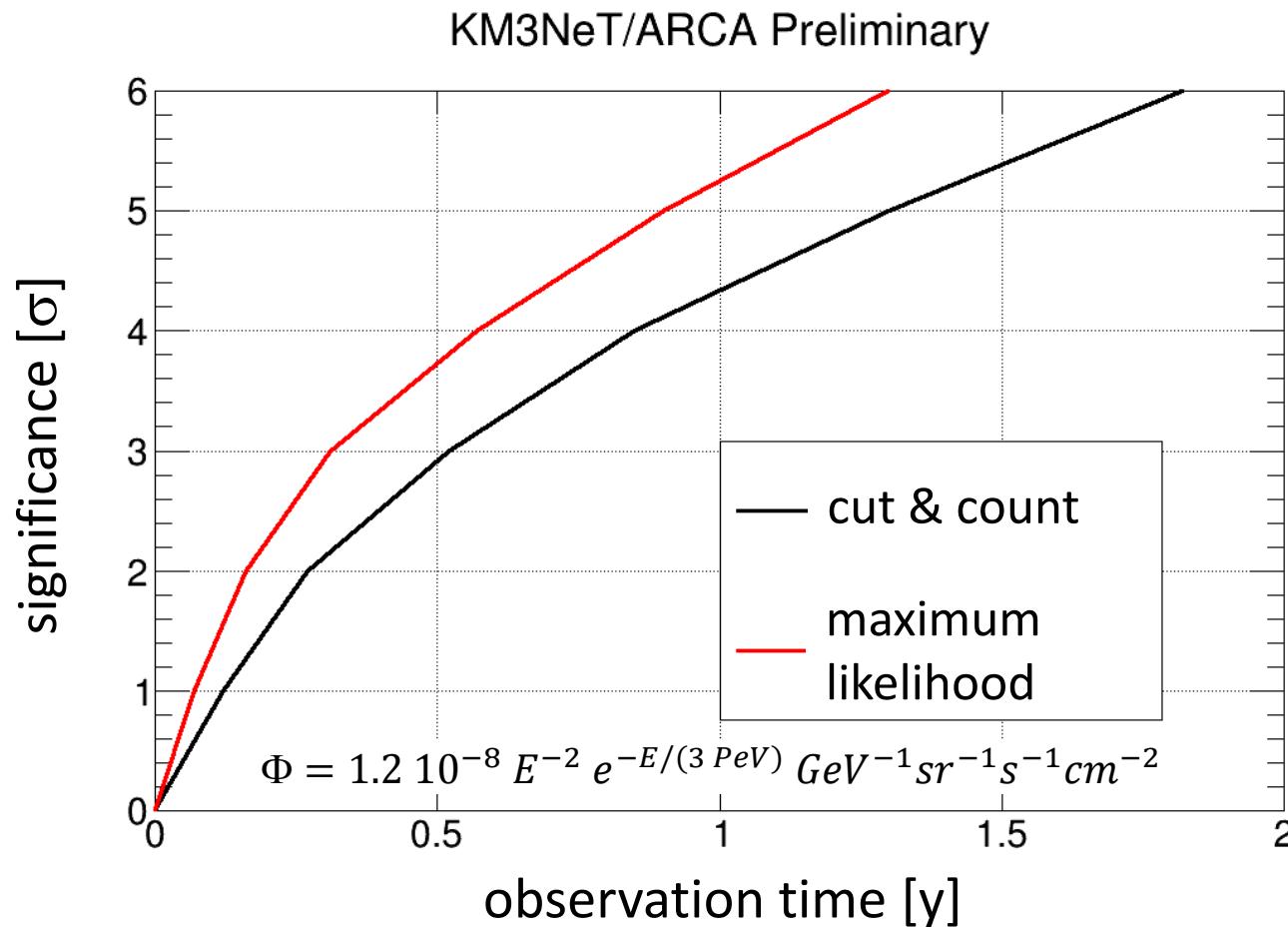
# 5.) Signal to Noise



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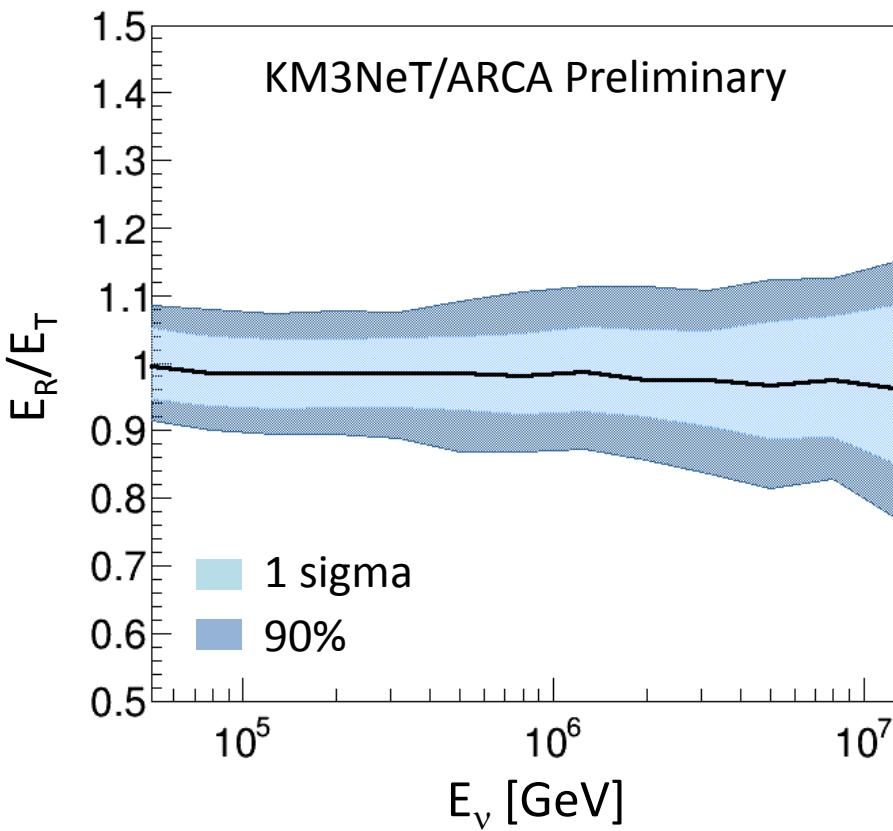
# Sensitivity<sup>¶</sup>



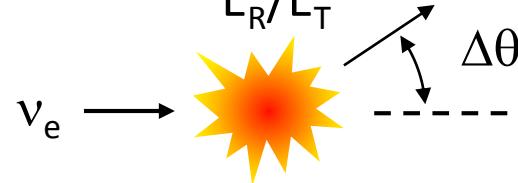
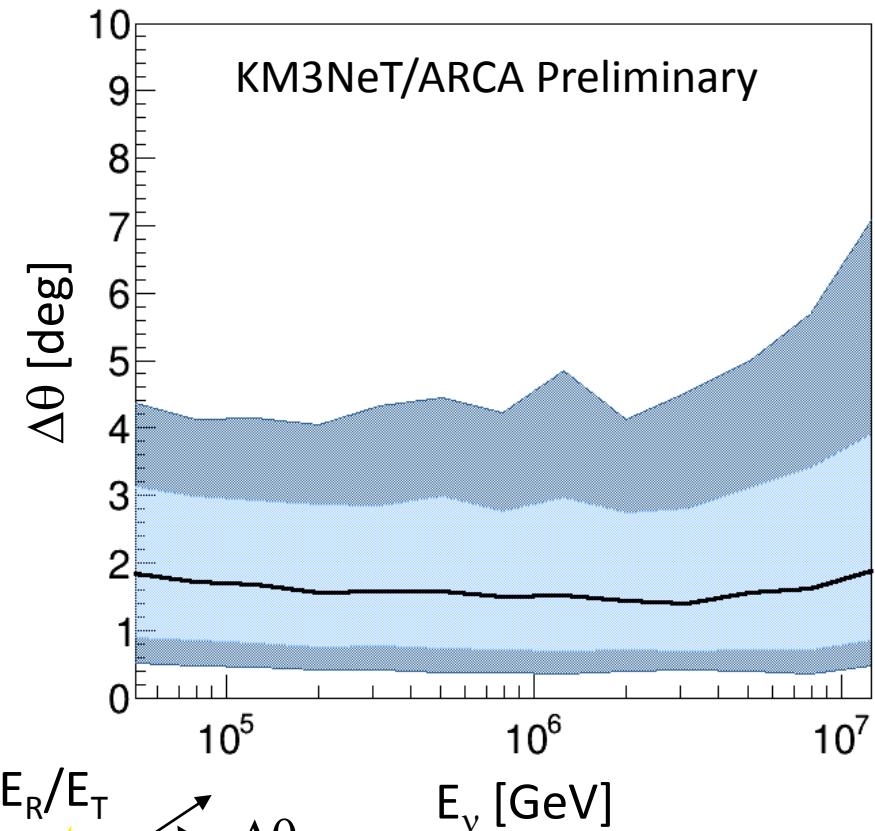
<sup>¶</sup> Vetoing of atmospheric neutrinos not included.

# Resolution

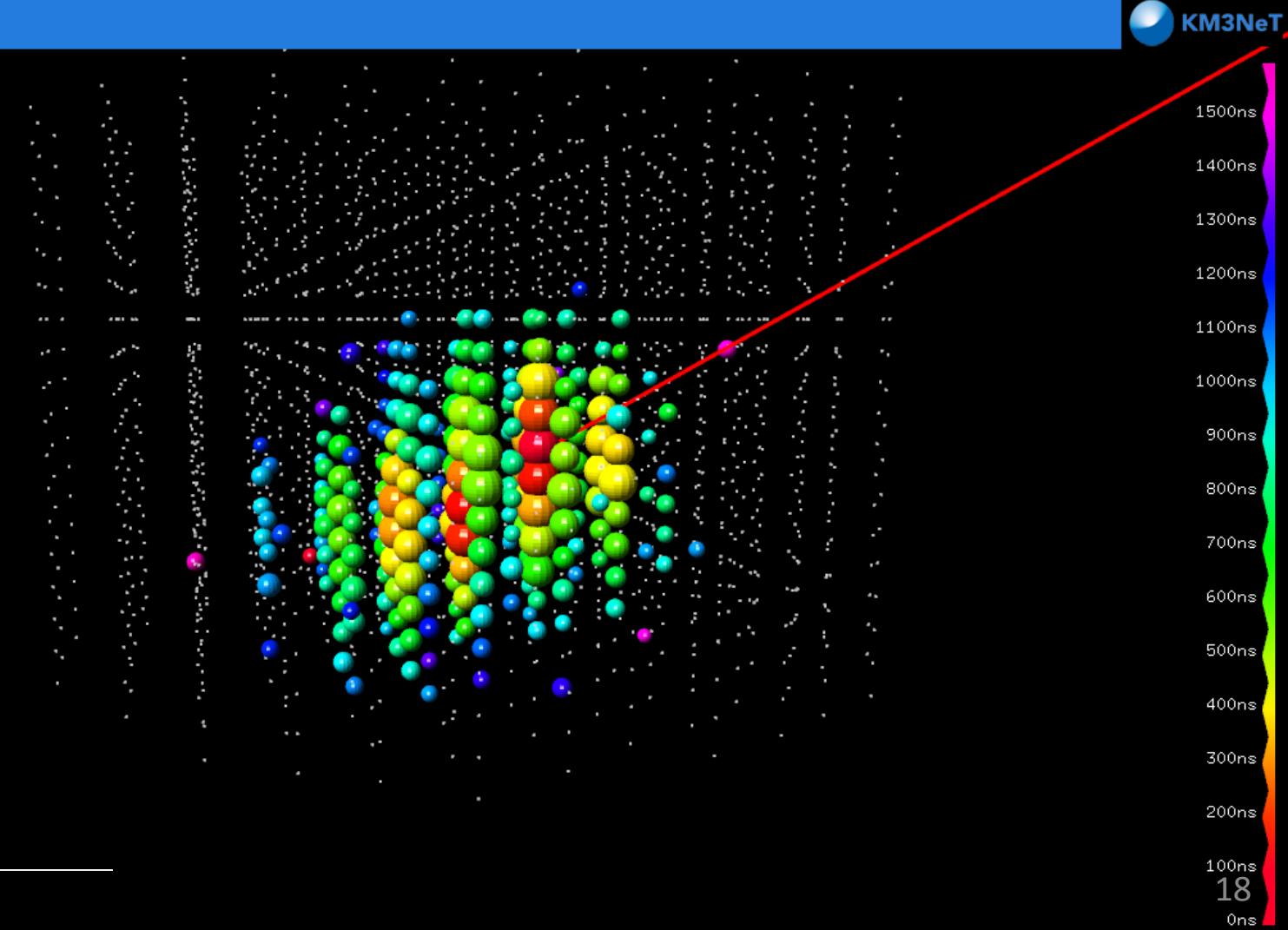
## Energy



## Direction

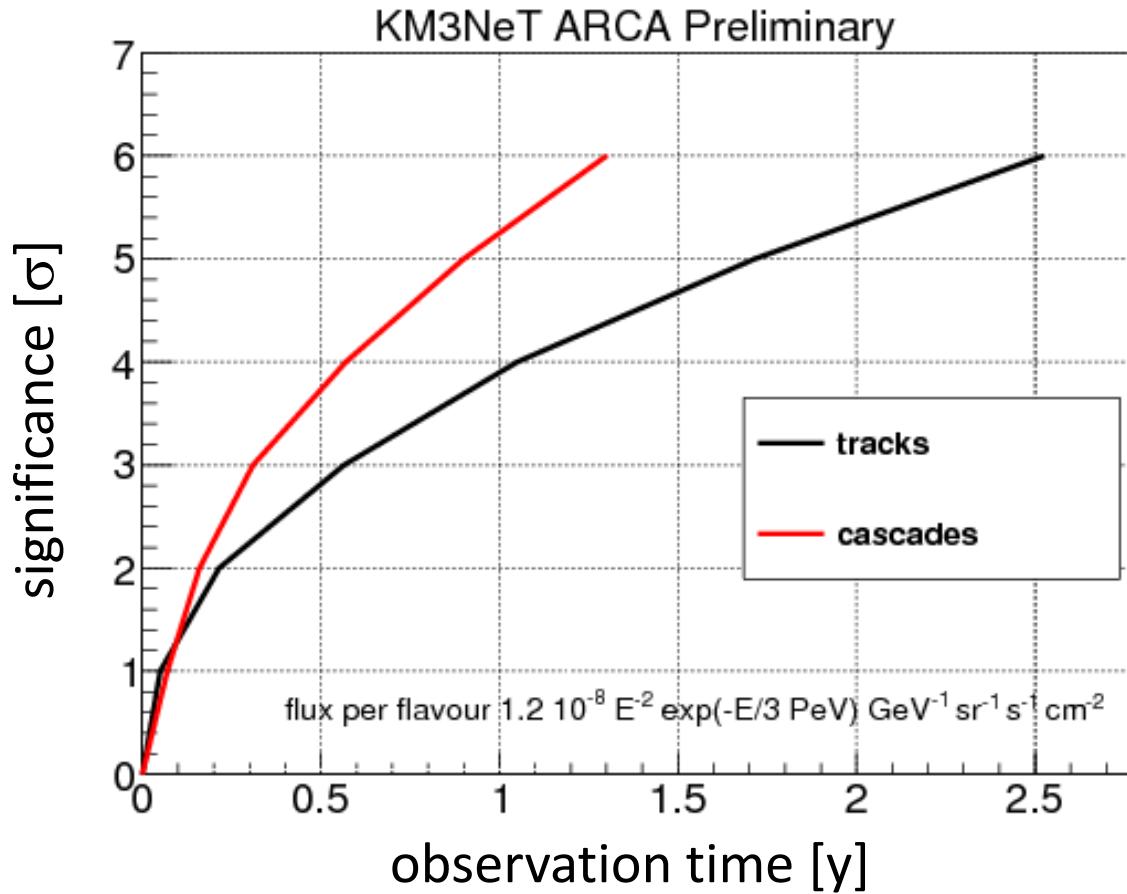


# Simulation of 1.5 PeV $\nu_\tau$ event<sup>¶</sup>



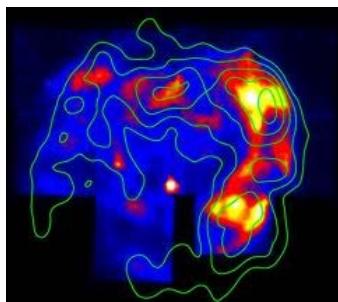
<sup>¶</sup> Passes all cuts

# Diffuse muon analysis

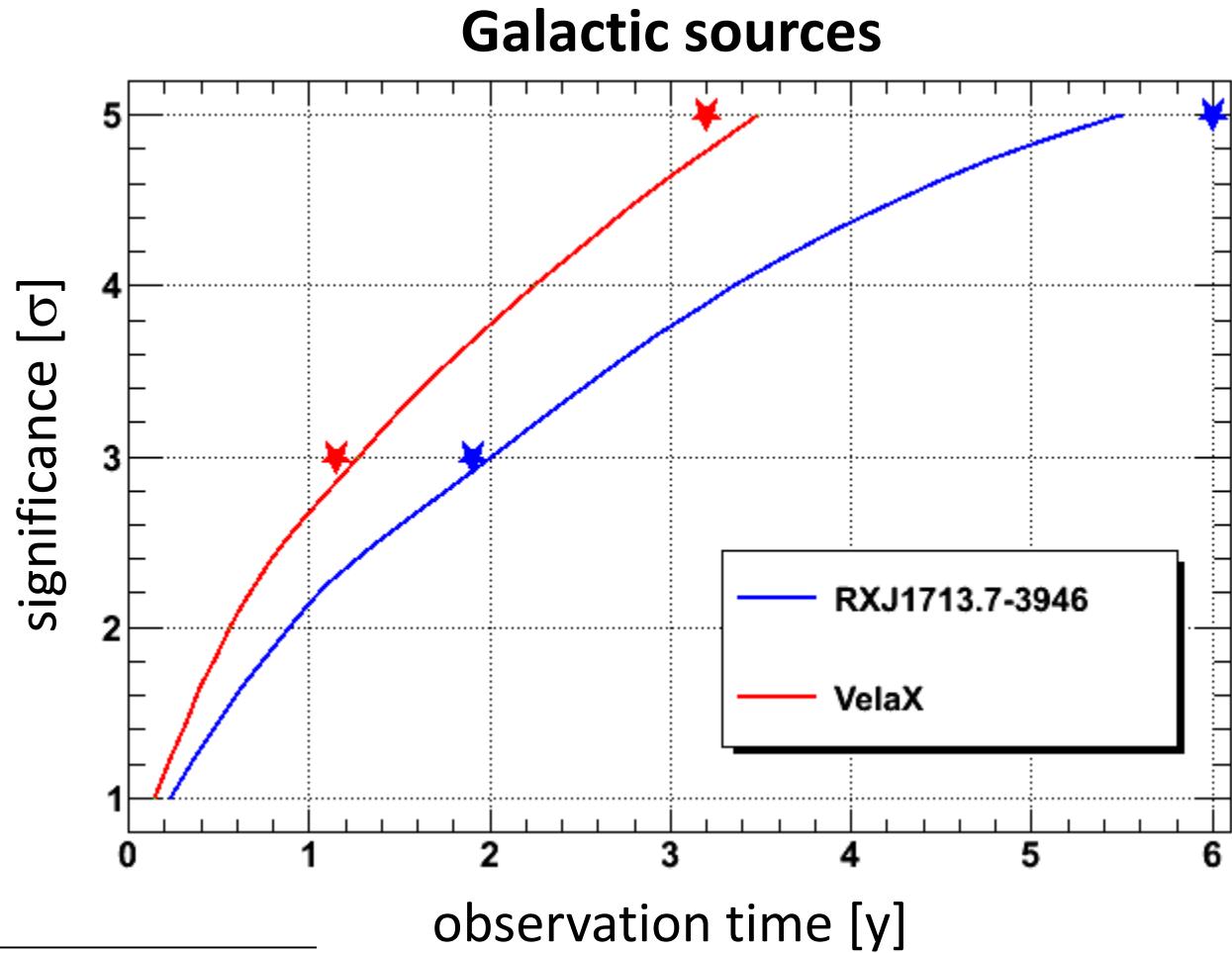
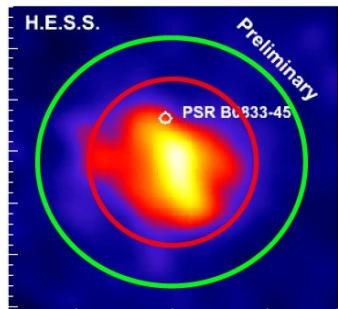


# Phase 3: 6 building blocks

RXJ1713<sup>¶</sup>



Vela X<sup>§</sup>



<sup>¶</sup> S.R. Kelner, et al., Phys. Rev. D 74 (2006) 034018.

<sup>§</sup> F.L. Villante and F. Vissani, Phys. Rev. D 78 (2008) 103007.

# KM3NeT status & outlook

- Feedback from prototypes confirm key specifications
  - timing, counting, pointing, etc.
- Phase-1 going ahead as planned
- Decision KM3NeT 2.0 expected before end of 2016
- ARCA:
  - Measurement of IceCube flux with different methodology, complementary field of view and improved resolution

All flavour neutrino astronomy