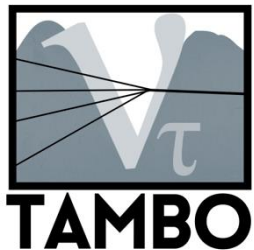
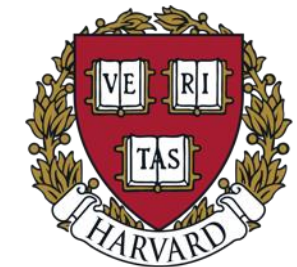


# TAMBO: Searching for $\nu_\tau$ in the Peruvian Andes

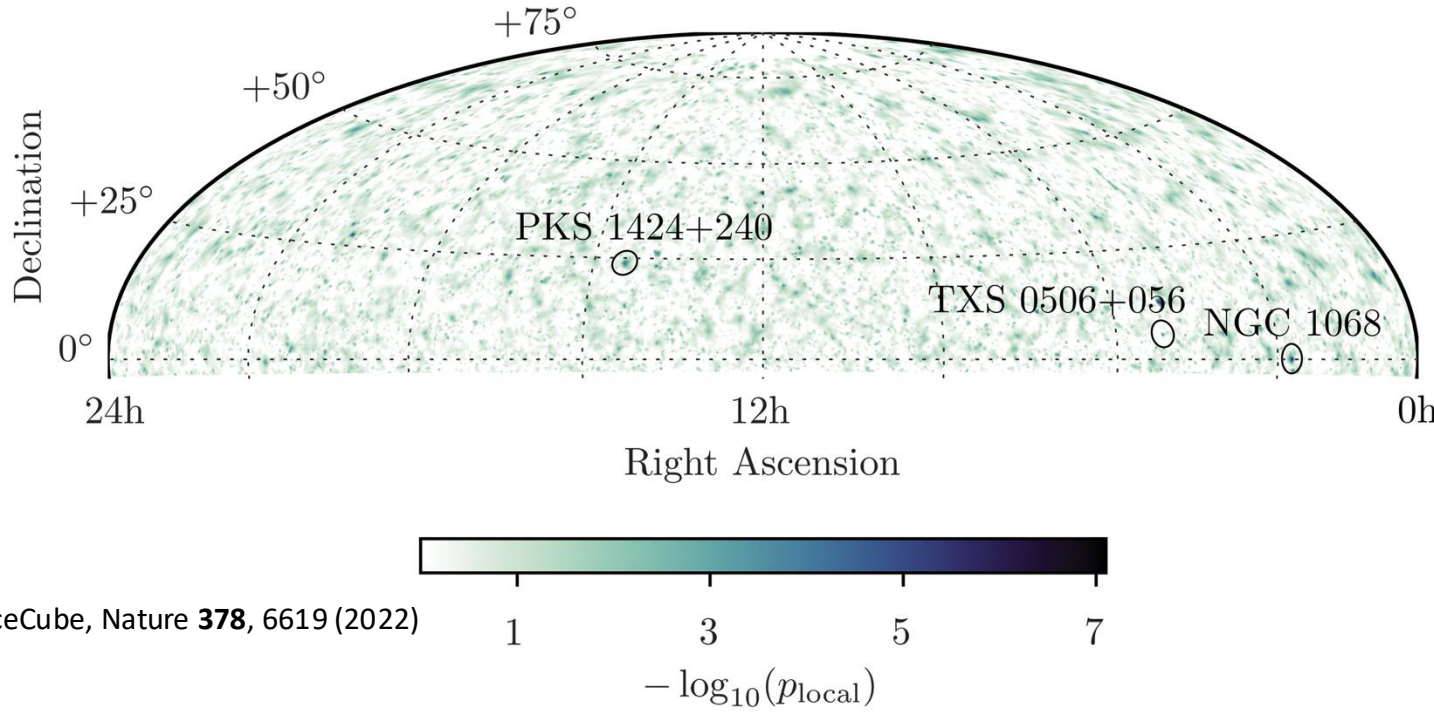
Will Thompson

TeVPA 2024

August 27<sup>th</sup>, 2024



# Where Are the Sources?

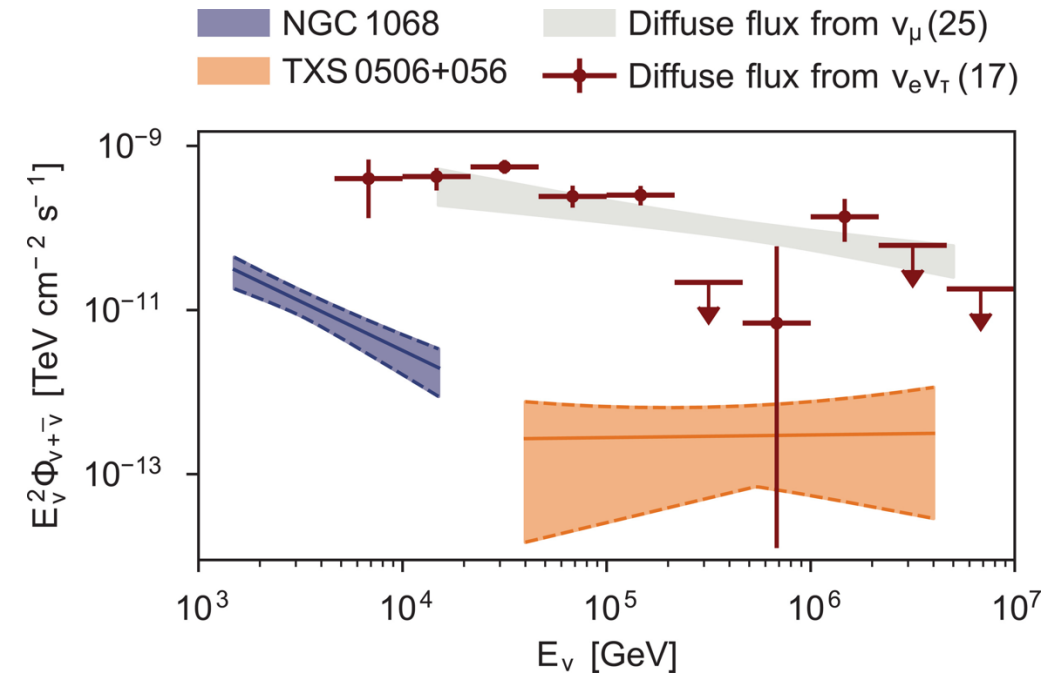
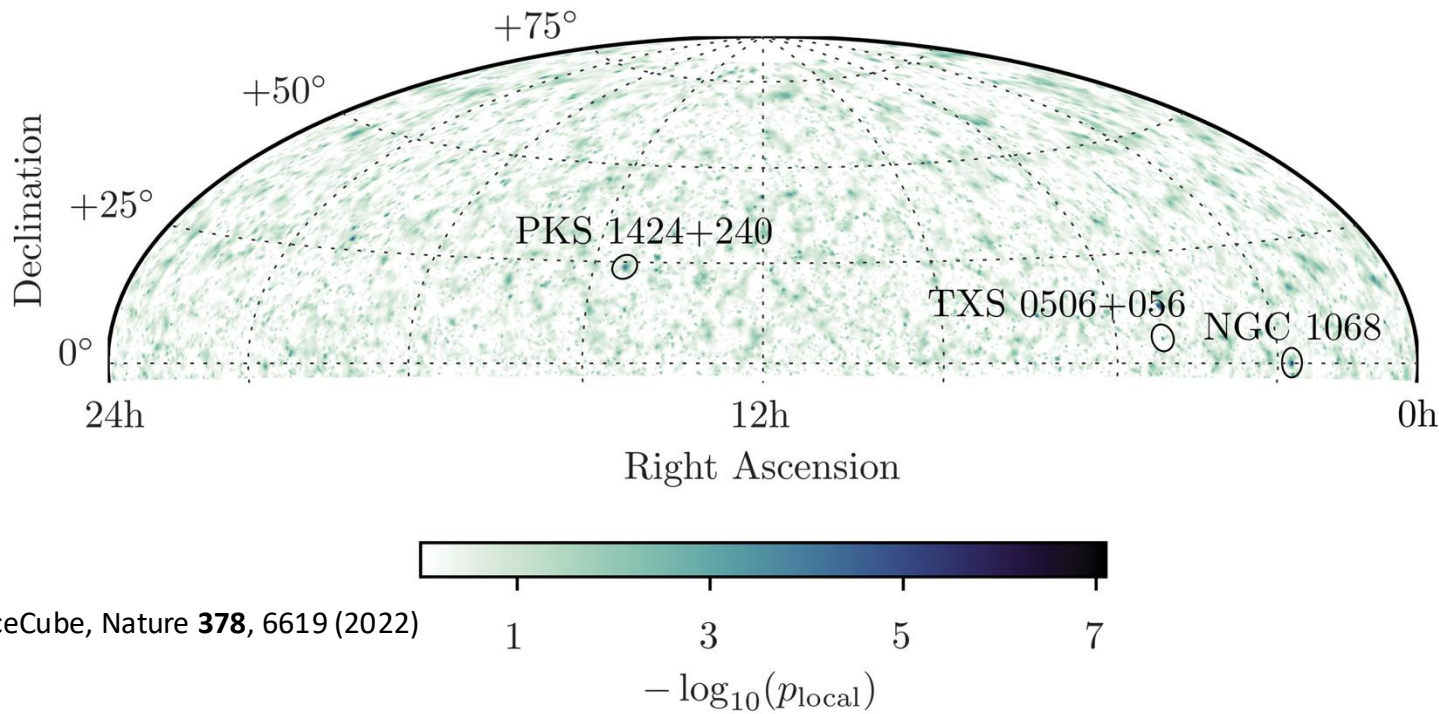


IceCube, Nature **378**, 6619 (2022)

- Number of known neutrino sources increased by  $\infty\%$  in last six years



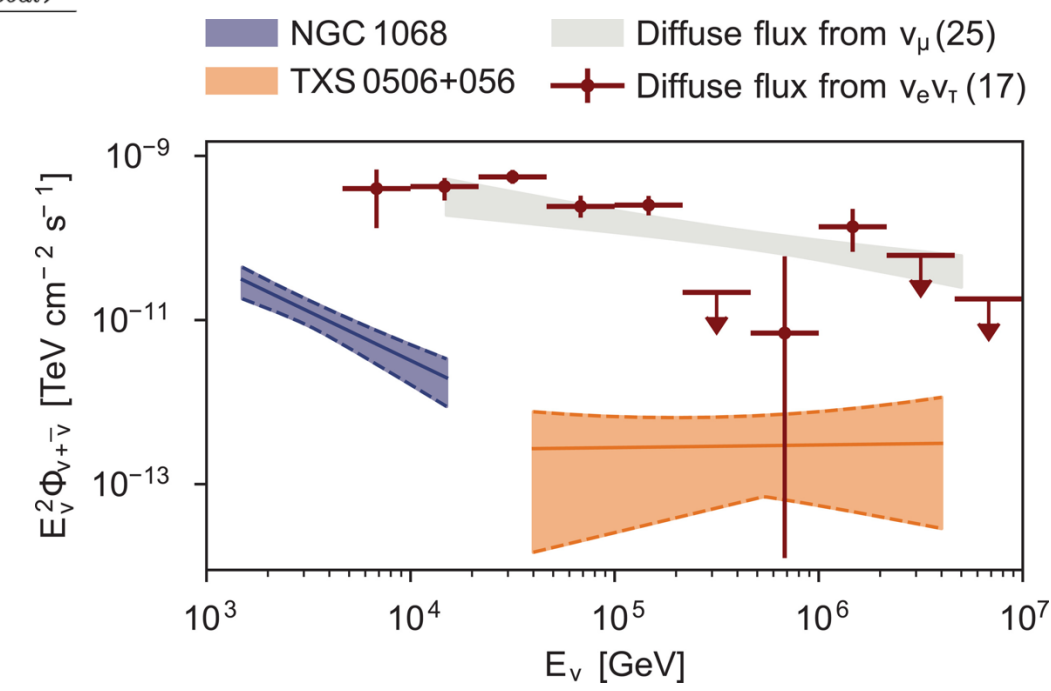
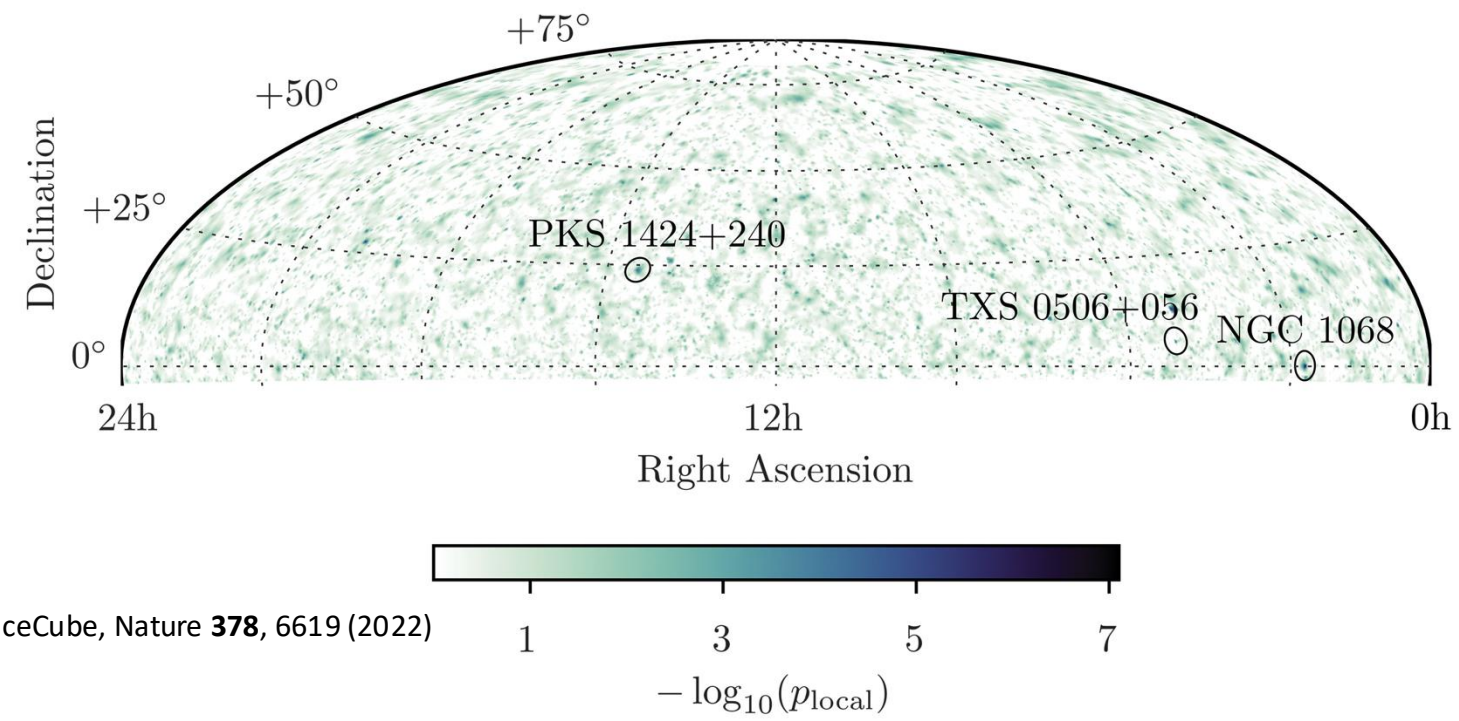
# Where Are the Sources?



- Number of known neutrino sources increased by  $\infty\%$  in last six years
- ... but these comprise only a small fraction of the diffuse flux

# Where Are the Sources?

Test type	Pre-trial p-value ( $p_{local}$ )	Post-trial p-value ( $p_{global}$ )
Northern Hemisphere scan	$5.0 \times 10^{-8}$ ( $5.3 \sigma$ )	$2.2 \times 10^{-2}$ ( $2.0 \sigma$ )

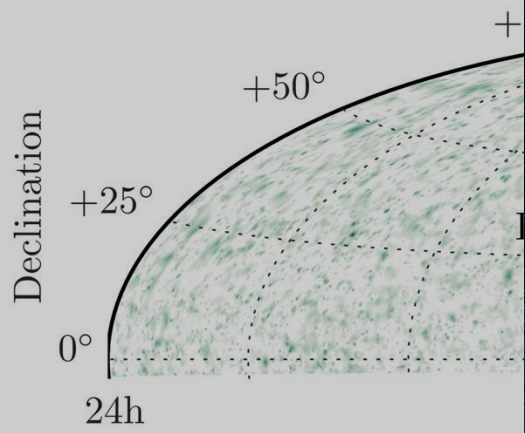


- Number of known neutrino sources increased by  $\infty\%$  in last six years
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# Where Are the

Test type  
Northern Hemisphere scan

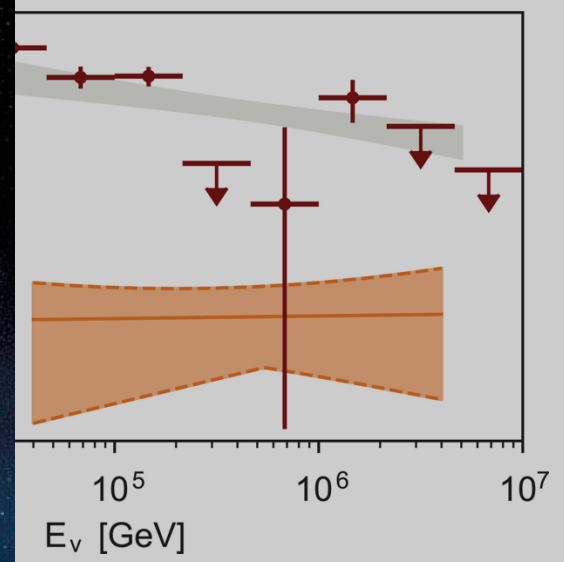


IceCube, Nature **378**, 6619 (2022)

- Number of known
- ... but these com



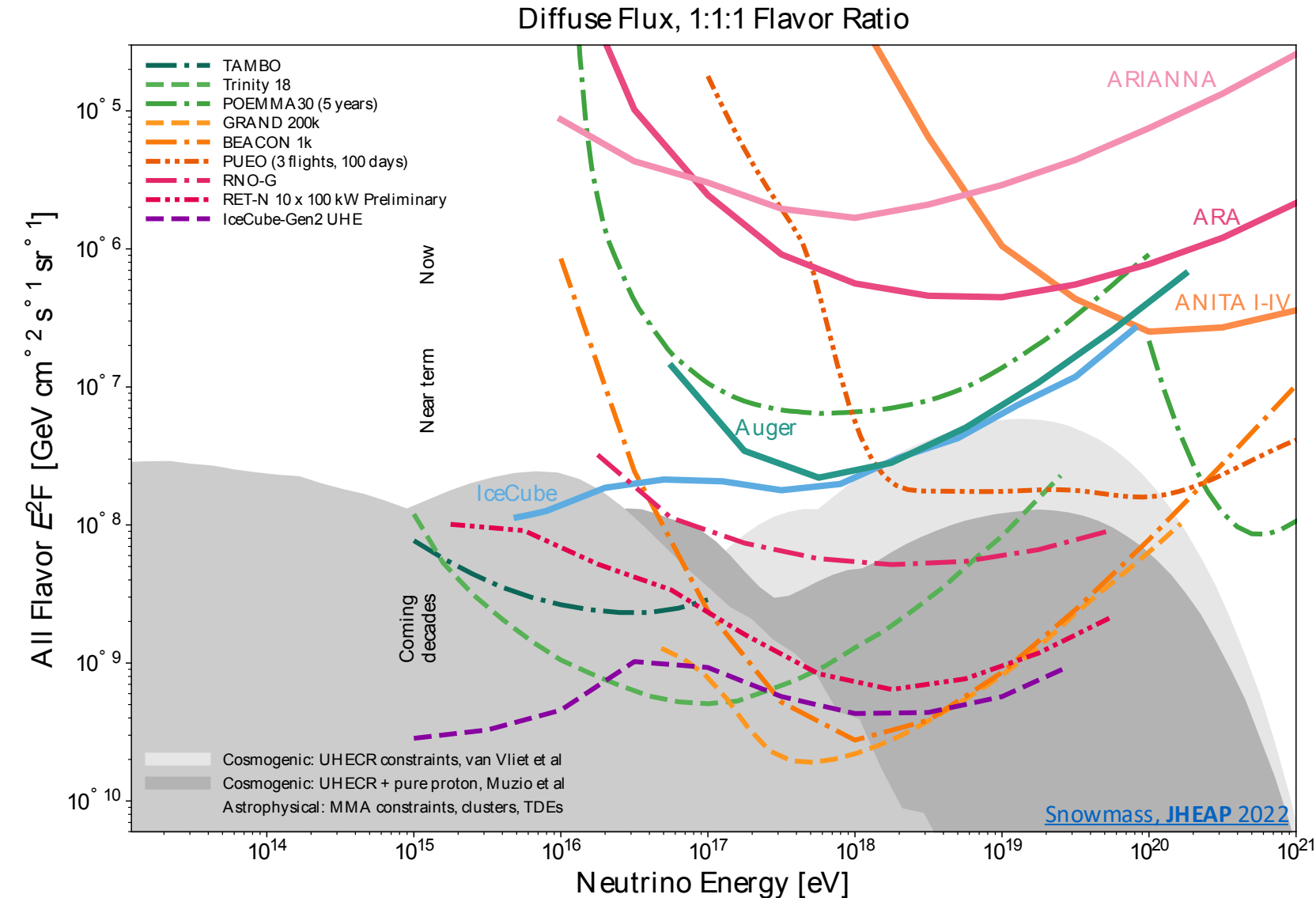
■ Diffuse flux from  $\nu_\mu$  (25)  
 + Diffuse flux from  $\nu_e\nu_\tau$  (17)



years




# Next-Generation Prospects



- Community has heeded call for UHE neutrino observatories
  - But fewer experiments planned for 1-100 PeV
- TAMBO bridges the gap between HE & UHE observatories



**Queen's**  
UNIVERSITY



Niels Bohr Institute



**UNLV**  
UNIVERSITY OF NEVADA LAS VEGAS



**COLUMBIA**  
UNIVERSITY



**Jet Propulsion Laboratory**  
California Institute of Technology



**HARVARD**  
UNIVERSITY



**PennState**



**UTEC**  
UNIVERSIDAD DE INGENIERIA Y TECNOLOGIA



**PUCP**



Universidad del País Vasco  
Euskal Herriko Unibertsitatea  
The University of the Basque Country



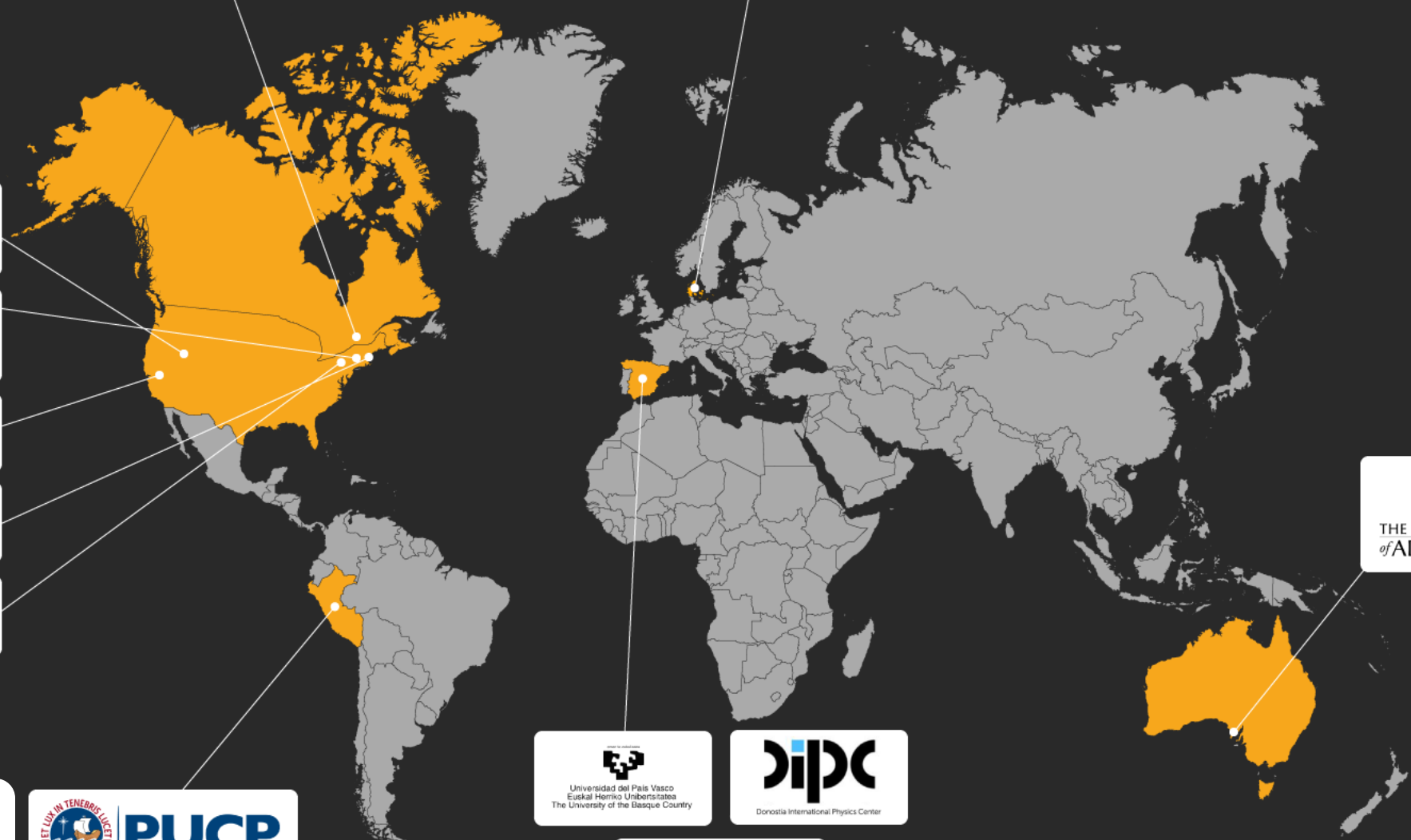
**DIPC**  
Donostia International Physics Center

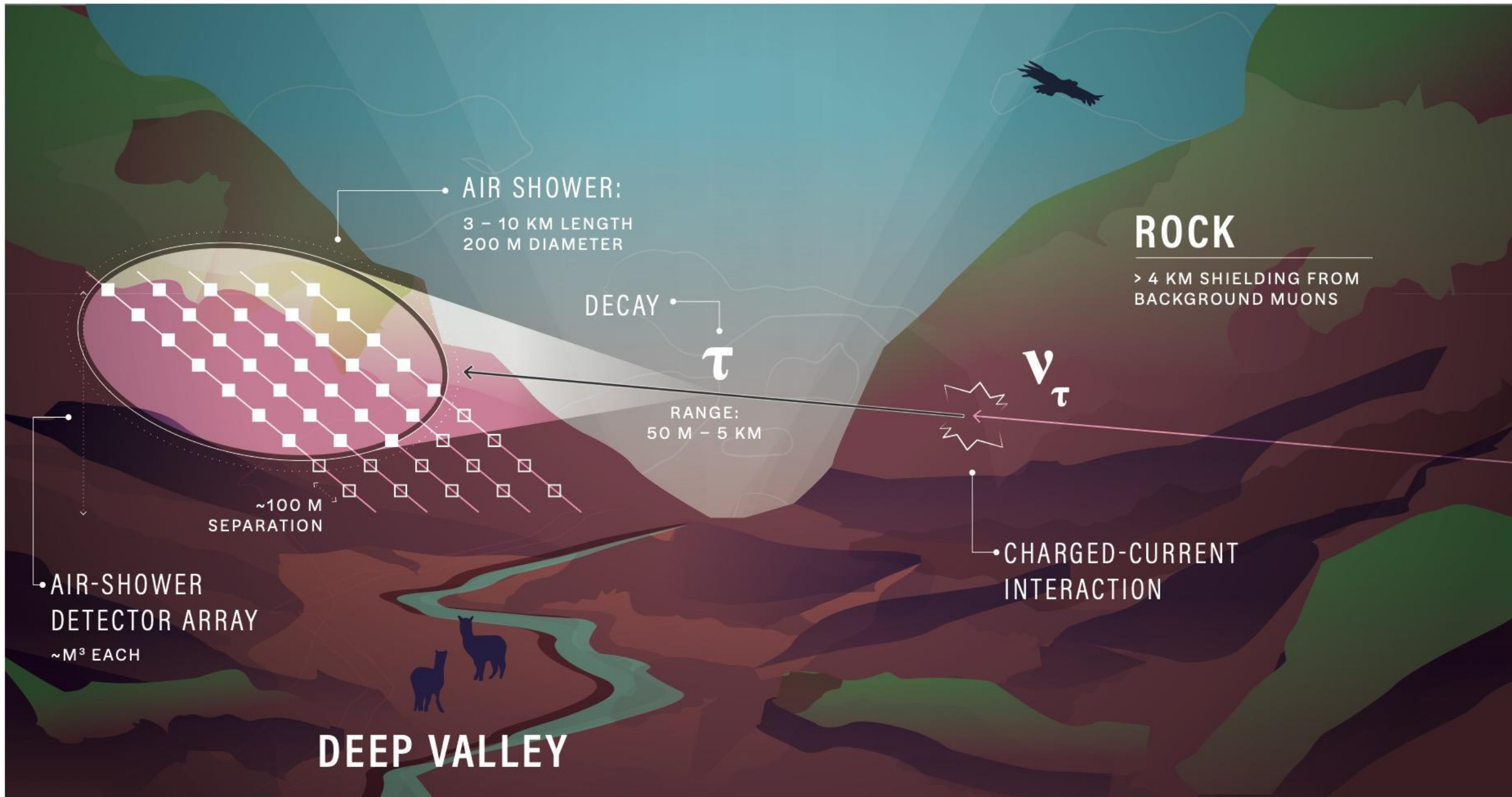


**USC**  
UNIVERSIDAD DE SANTIAGO DE COMPOSTELA



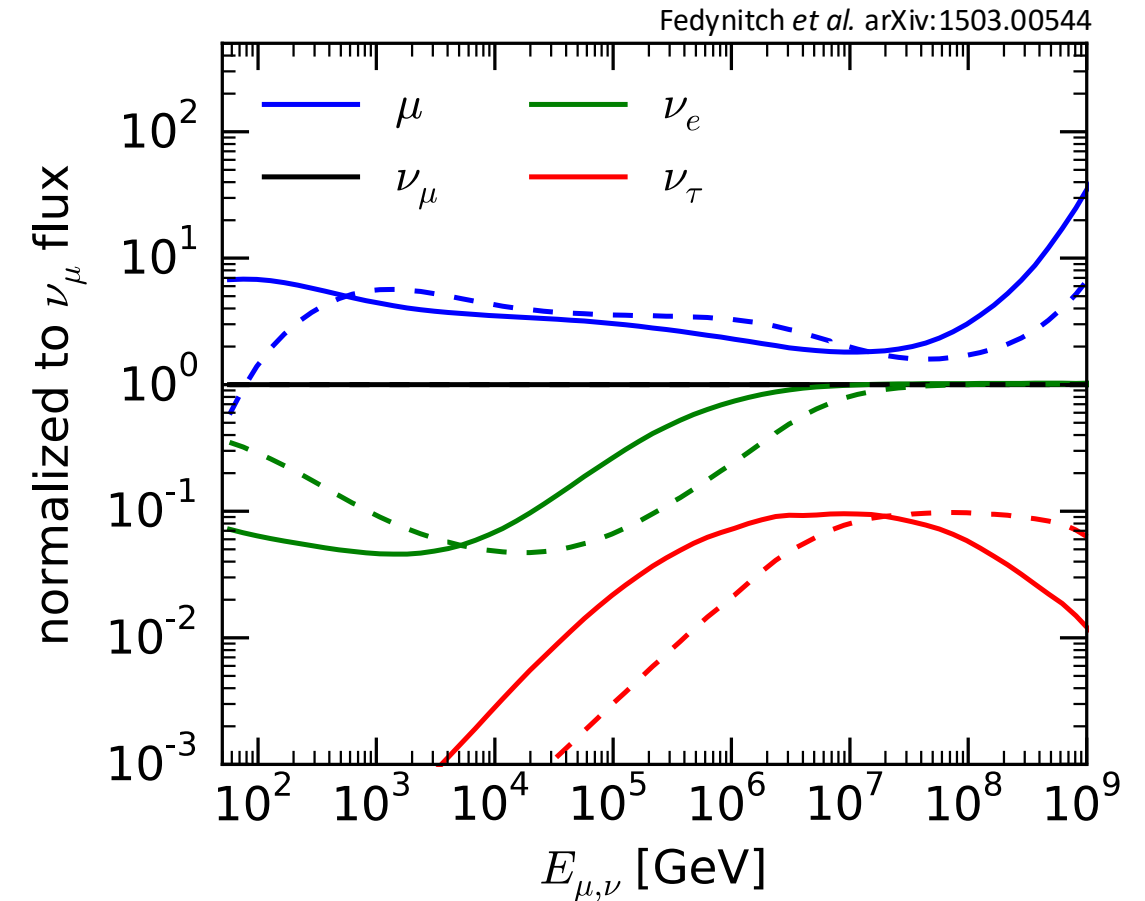
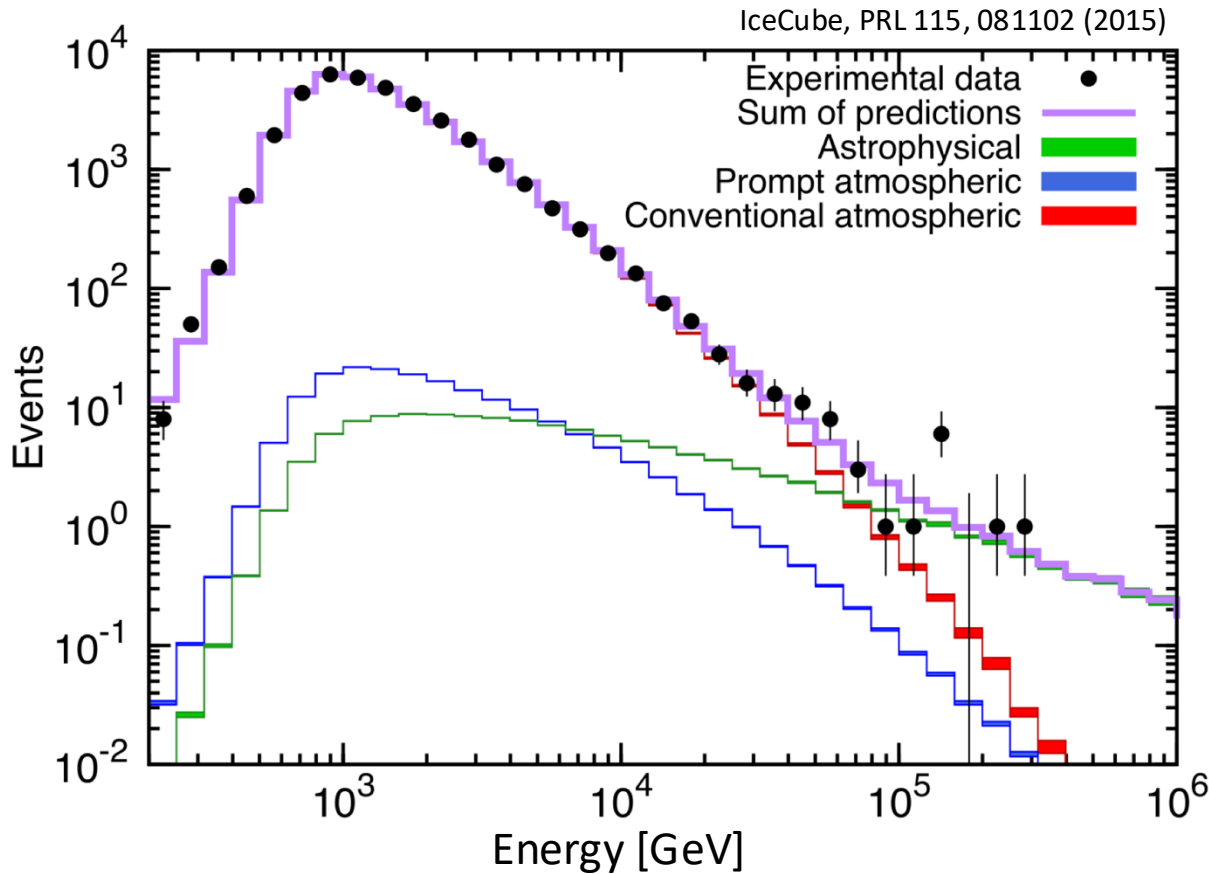
**THE UNIVERSITY**  
of **ADELAIDE**







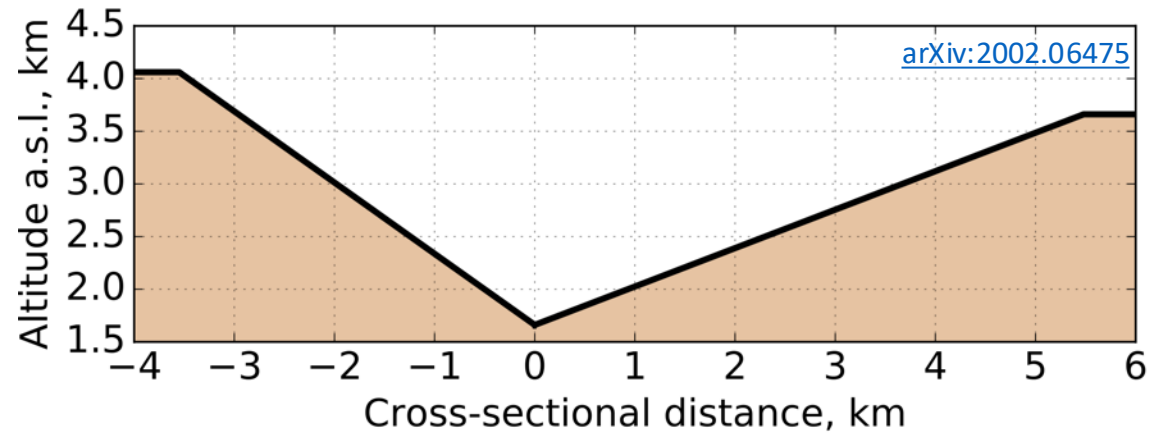
# Why $\nu_\tau$ ?



- Complementary flavor measurements with IceCube-style detectors
- High-purity astrophysical neutrino sample

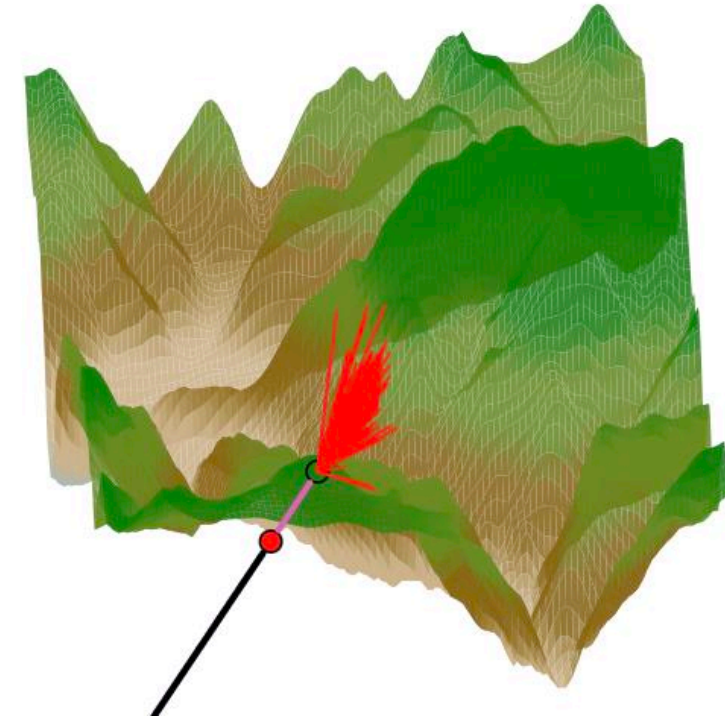
# Developing Full Simulation

## Preliminary Simulation



- Simplified geometry
- No treatment of  $\tau$  energy losses
- Approximation of air shower physics

## Updated Simulation

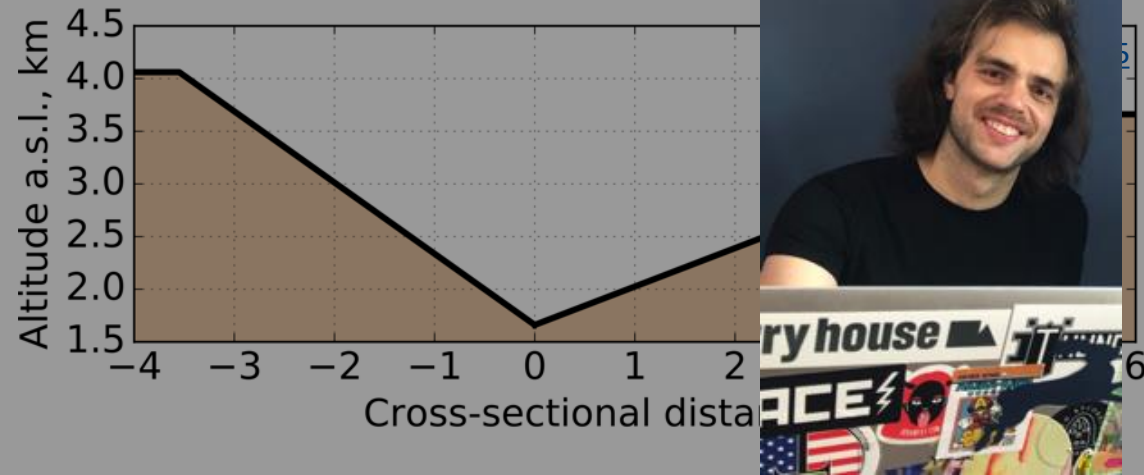


- Realistic geometry
- Full treatment of  $\tau$  energy losses
- Air shower simulation with CORSIKA 8



# Developing Full Simulation

## Preliminary Simulation



Jeff Lazar

## Updated Simulation



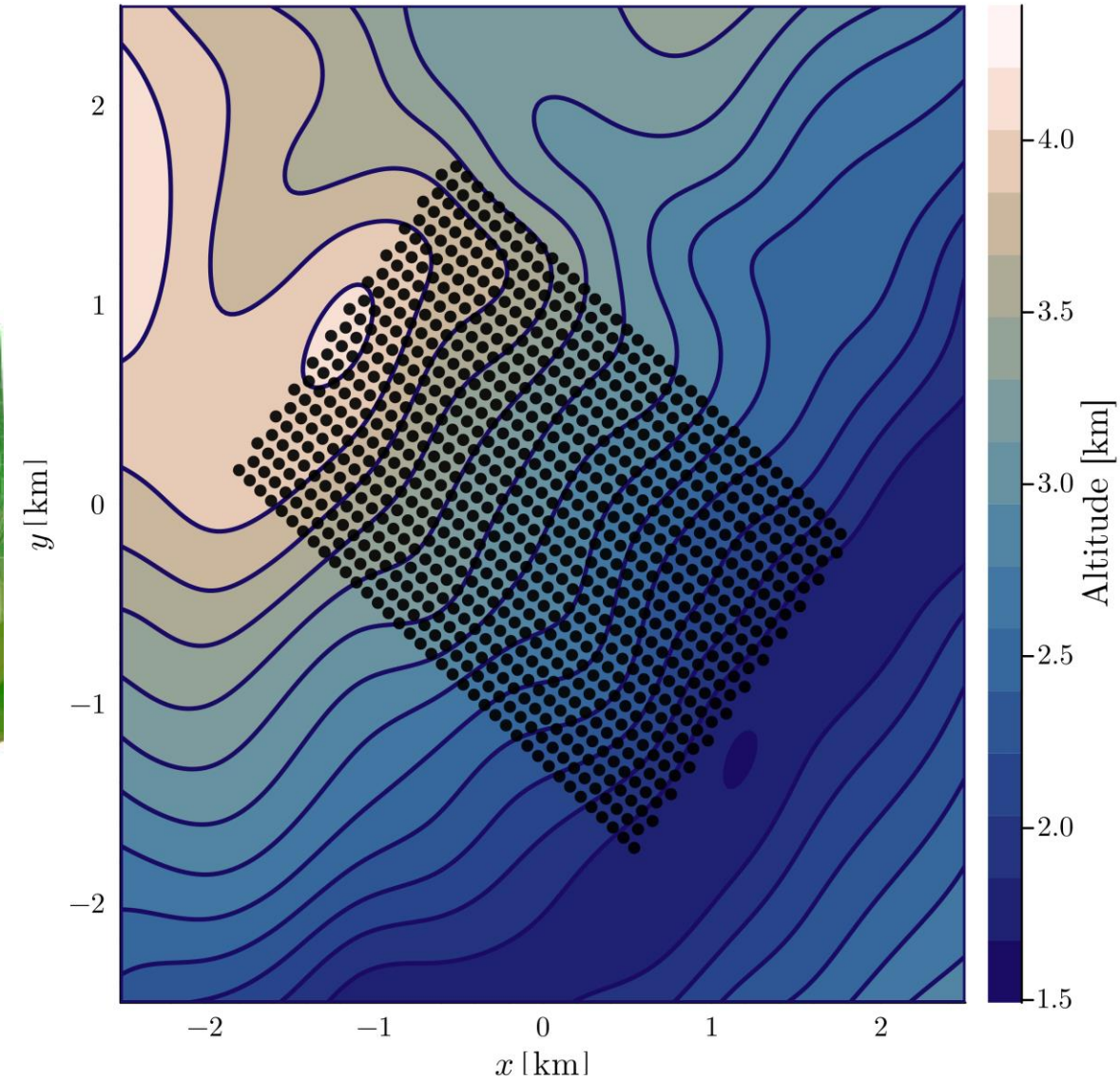
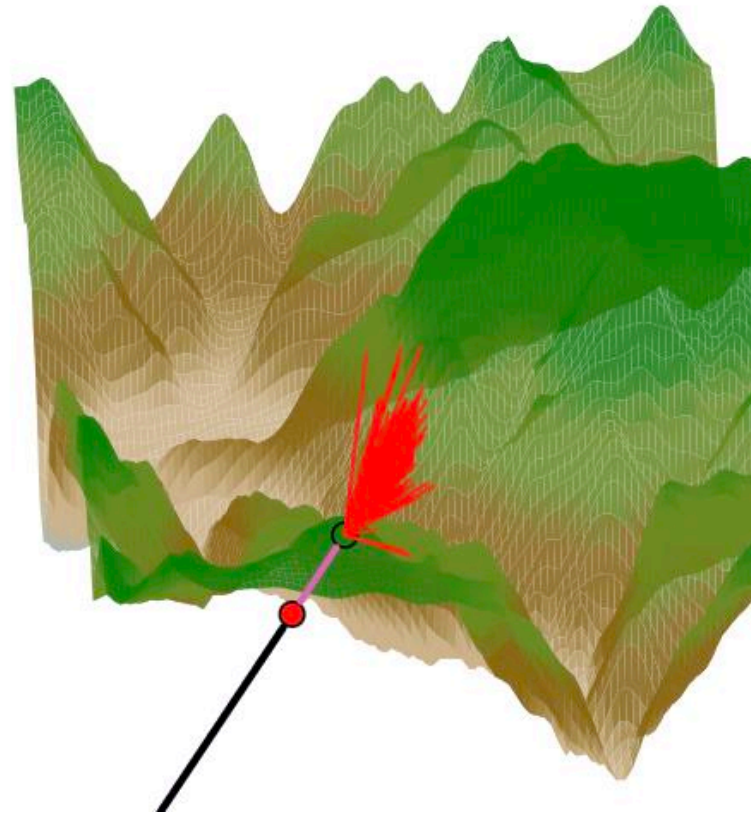
Pavel Zhelnin

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- Full treatment of  $\tau$  energy losses
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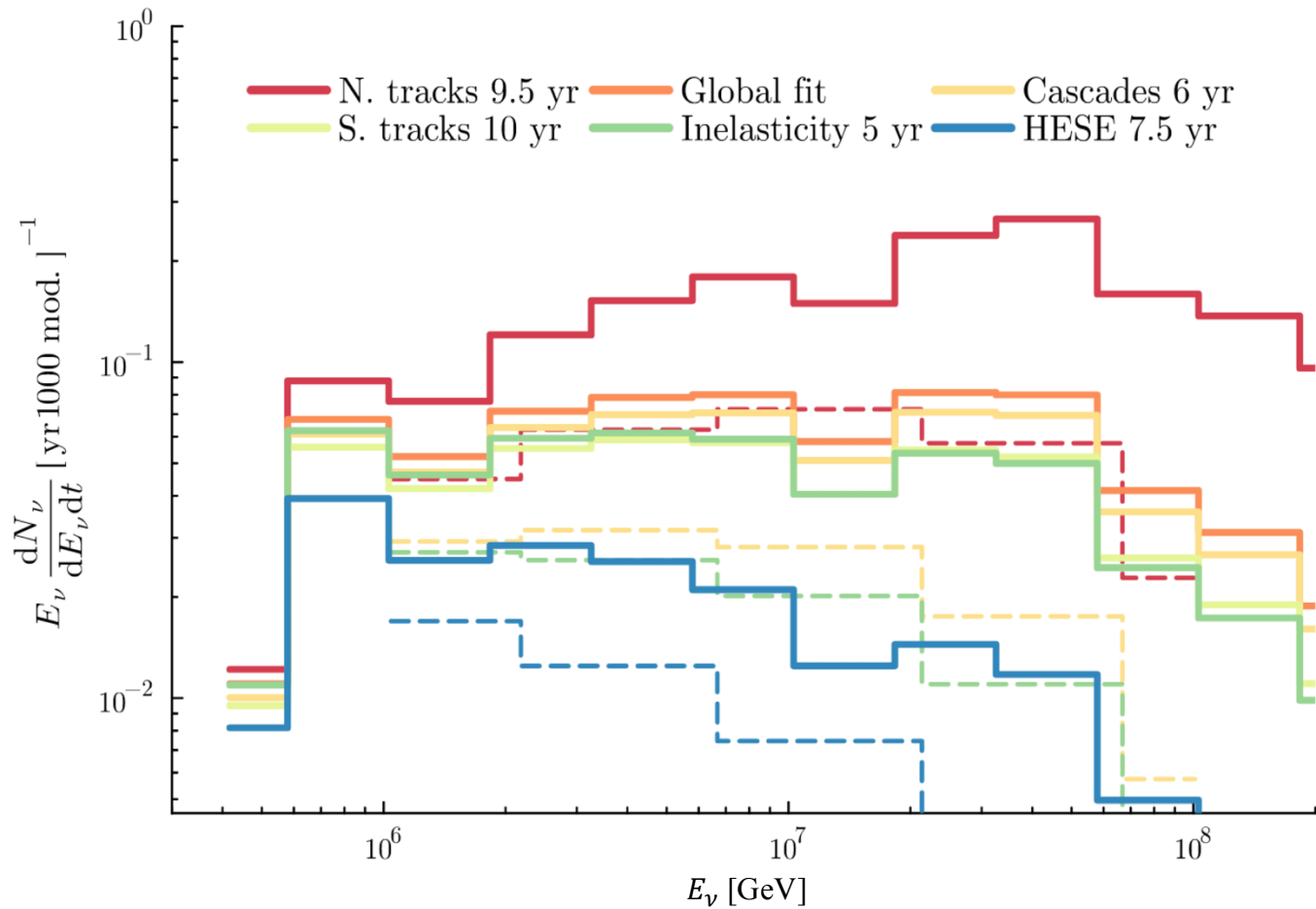
# Air-Shower Simulation

- CORSIKA8 tracks individual particle energies & arrival times
- Enables in-depth rate & reconstruction studies





# Expected Event Rates



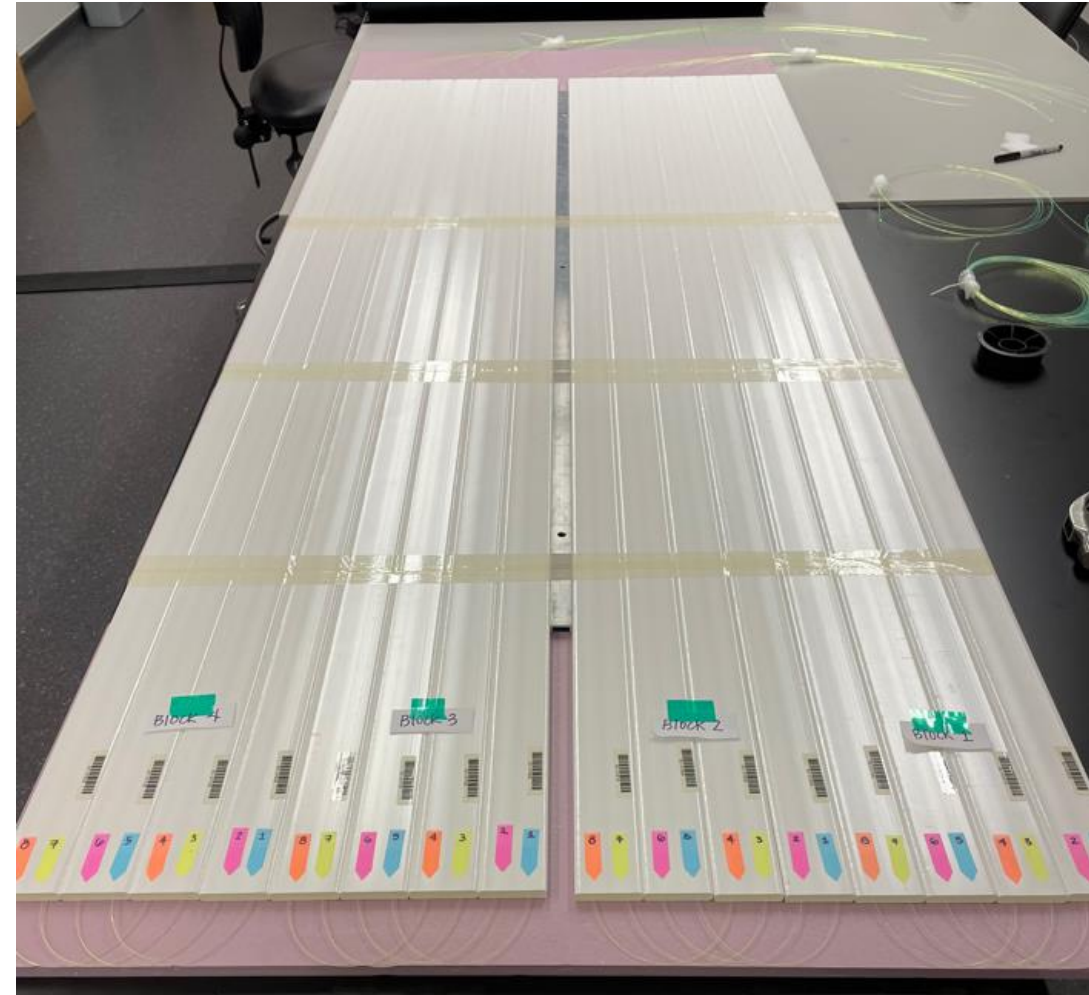
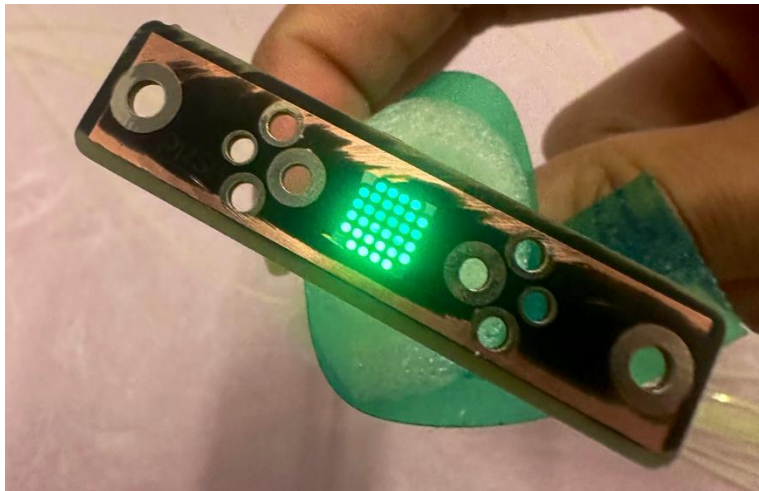
- Updated simulation predicts  $\sim 3x$  higher rates!
- Expect  $O(1)$  neutrino source discovered per year with 5000 modules

# Detector Research & Development

- Detector technology: either water Cherenkov or plastic scintillator
  - Both well-experienced technologies!
- Special considerations for TAMBO:
  - Difficulty of deploying detectors in canyon
  - Cost of producing thousands of detectors



Diyaselis Delgado







- Want local community to embrace project, not just accept
- First steps: workshop with Peruvian social scientists & officials



- TAMBO will:
  - Enable the discovery of hidden neutrino sources
  - Bridge gap between HE and UHE neutrino telescopes
- Fully-featured simulation nearing completion
- Development of prototype detectors underway
- Interested in joining? Contact (me or Carlos Argüelles) at [will\\_thompson@g.harvard.edu](mailto:will_thompson@g.harvard.edu), [carguelles@g.harvard.edu](mailto:carguelles@g.harvard.edu)





Thanks for your attention!



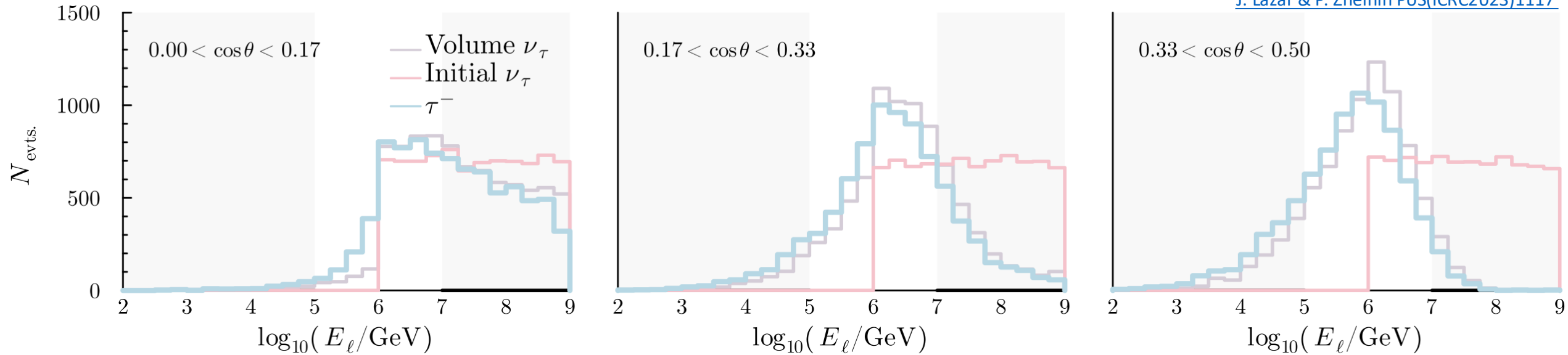






# Taking Advantage of Tau Regeneration

J. Lázár & P. Zhelnin PoS(ICRC2023)1117



- Incoming  $\nu_{\tau}$  can undergo several  $\nu_{\tau} \leftrightarrow \tau$  conversions in the Earth
- Results in higher rates than predicted by preliminary simulation
- Updated simulation handles tau regeneration via TauRunner