TRIDENT: Progress Toward a Next-Generation Deep-Sea Neutrino Observatory

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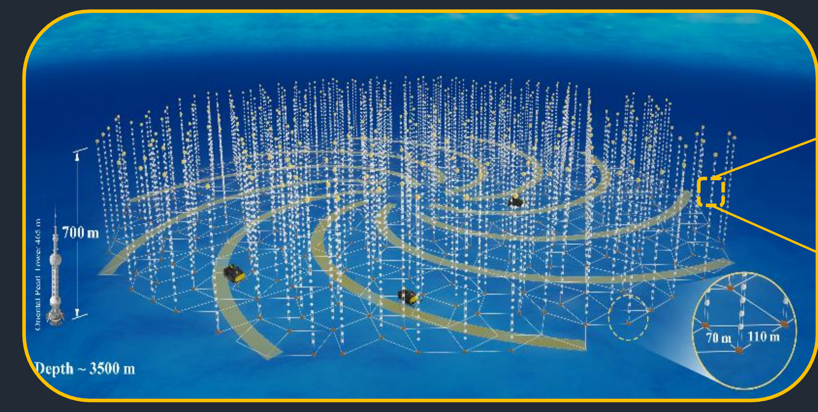
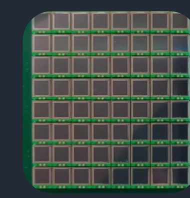
NEUTRINO '26
International Conference on Neutrino Physics and Astrophysics
June 22nd - 26th, 2026
UCI Department of Physics & Astronomy



Detector site in the South China Sea
- 3.5 km deep
- Large, flat plane "Hai-ling Basin"

PMTs:
< 2ns TTS
~30% QE



SiPMs:
< 0.3 ns jitter

~8 km^3
~1000 strings
70-110 m string spacings

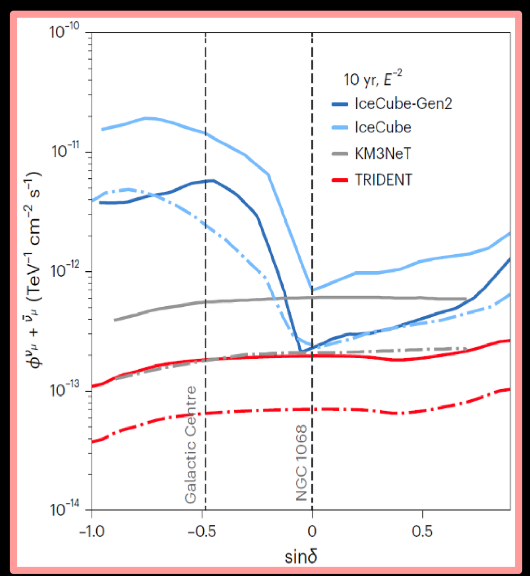
Source Discovery with All Flavours

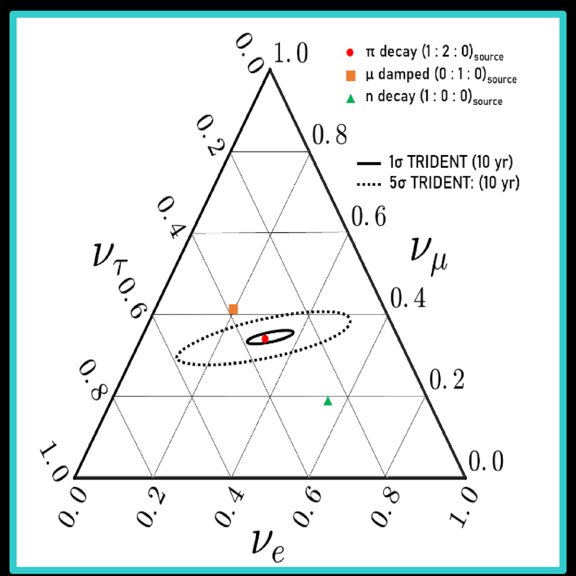
TRIDENT Experimental goals:
1) Rapidly discover neutrino sources
2) Sensitivity to all flavors

Detector Design:
- Bigger is better?
- Want to optimize for both goals simultaneously

Point source sensitivity/ Discovery potential vs declination with tracks

"A multi-cubic-kilometre neutrino telescope in the western Pacific Ocean", Nature Astronomy, (2023)



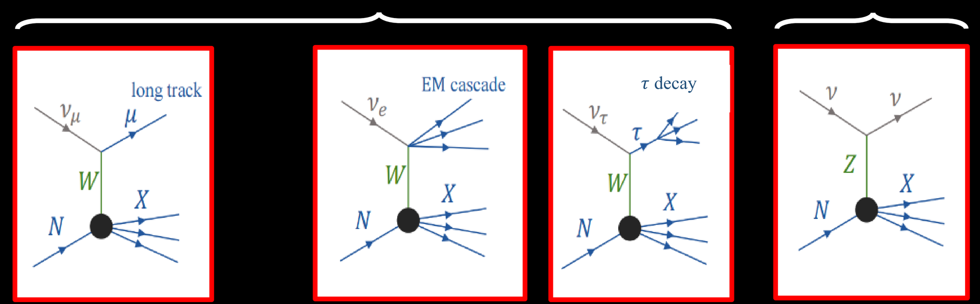


TRIDENT neutrino flavour ratio sensitivity with tracks, cascades and ν_τ double-pulse identification

"Enhancing Neutrino Flavour Sensitivity in TRIDENT with Tau Neutrino Identification": PoS (ICRC2025) 1195

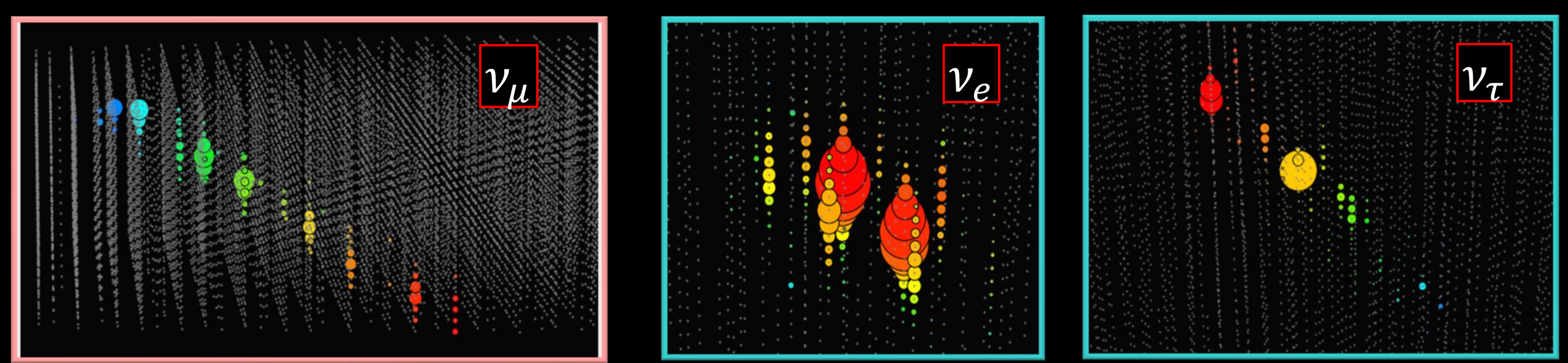
Combine both goals into a single figure of merit?

Charged-Current | Neutral-Current

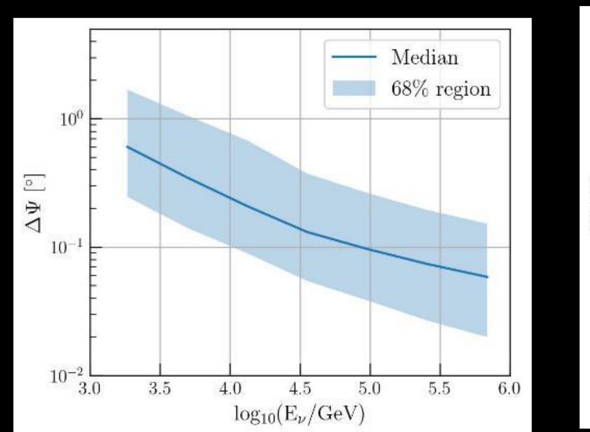


Muon tracks | Cascades (τ decay can also produce muons)

TRIDENT simulation

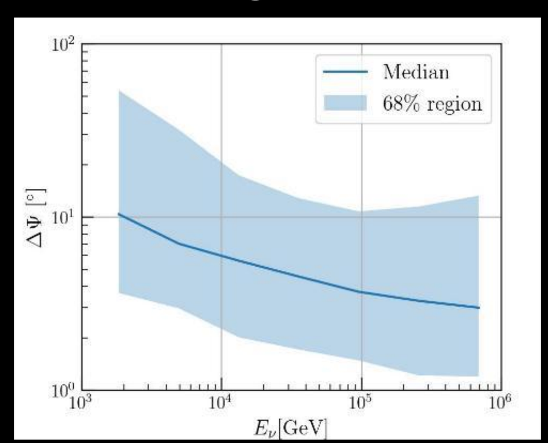


Track angular resolution



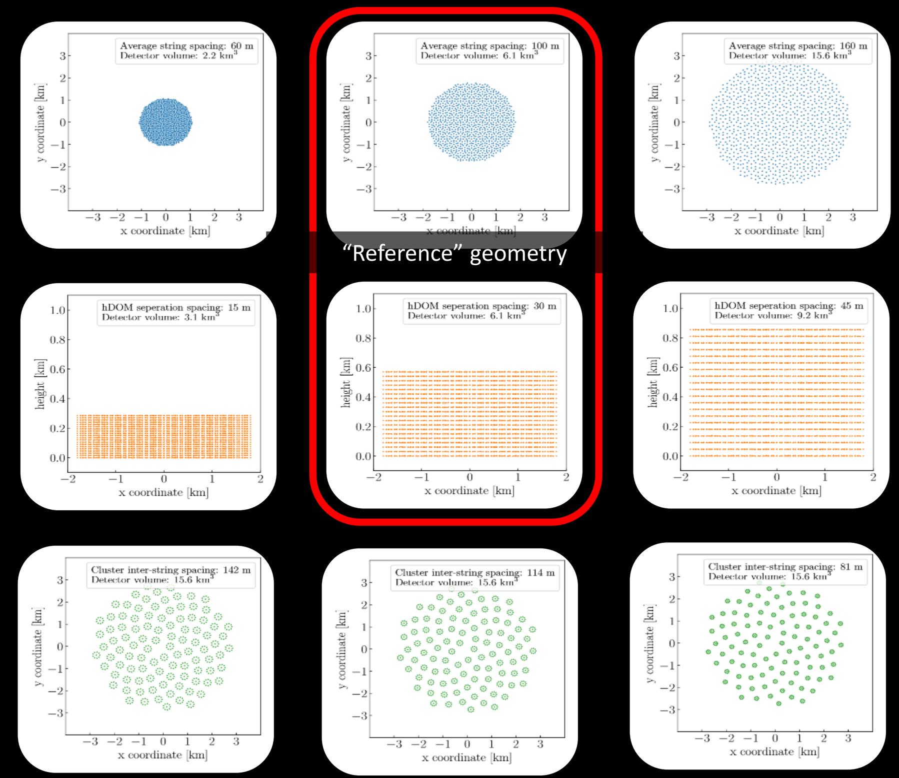
+ ~ 0.1° @ 100TeV
- Poorer energy resolution

Cascade angular resolution



~ Moderate pointing ~3° @ 100TeV
+ Improved energy resolution
+ Lower atmospheric background

Detector Design



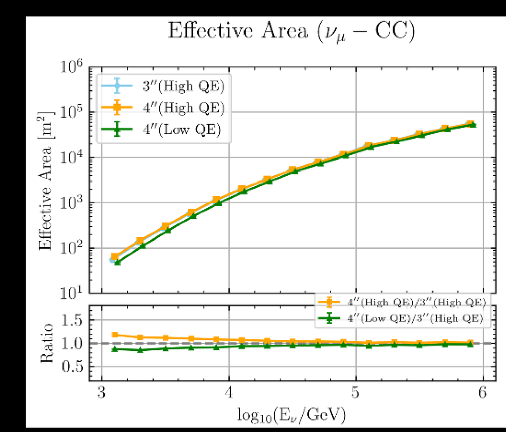
Given N number of strings, how should they be arranged?

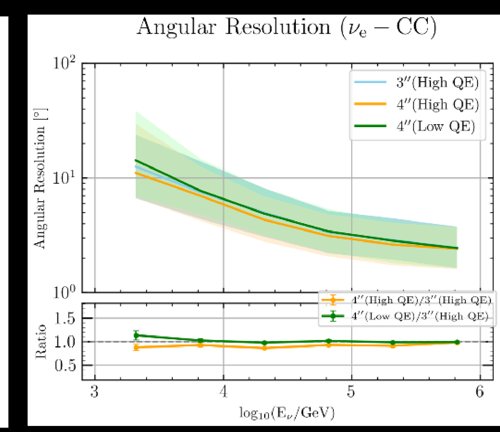
Tested wide variety of geometries
- String separation
- String Height
- String Clustering

3-inch PMT hDOM design
- 31 3" PMTs
- 24 SiPMs (4x8 array)

4-inch PMT hDOM design
- 19 4" PMTs
- 5 SiPMs (8x8 array)

Check / compare performances for various designs: e.g. neutrino detection efficiency + angular resolution





"A Cost Effective Optimization of the hybrid-DOM Design for TRIDENT", arXiv:2507.10256 (2025)

Source Discovery vs Geometry

"Optimising Underwater Neutrino Telescopes for All-Flavour Point Source Sensitivity", PRD 113, 043030 (2026)

Assuming the "standard" geometry takes 5 years to discover a given source

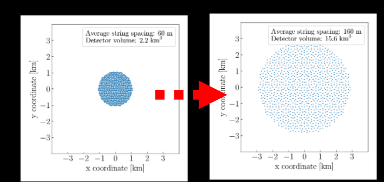
$$\phi(E_\nu) \propto \begin{cases} E^{-2} & \text{"hard" source} \\ E^{-3} & \text{"soft" source} \end{cases}$$

How much slower/faster can each geometry discover same source?

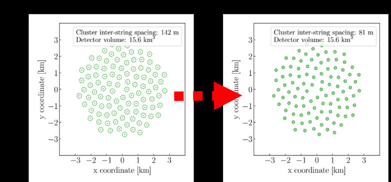
Bigger detector is **not** necessarily better
- Worse at low energies tracks and cascades:
- Worse at high energies tracks and cascades:

Dense detector favours low energy events

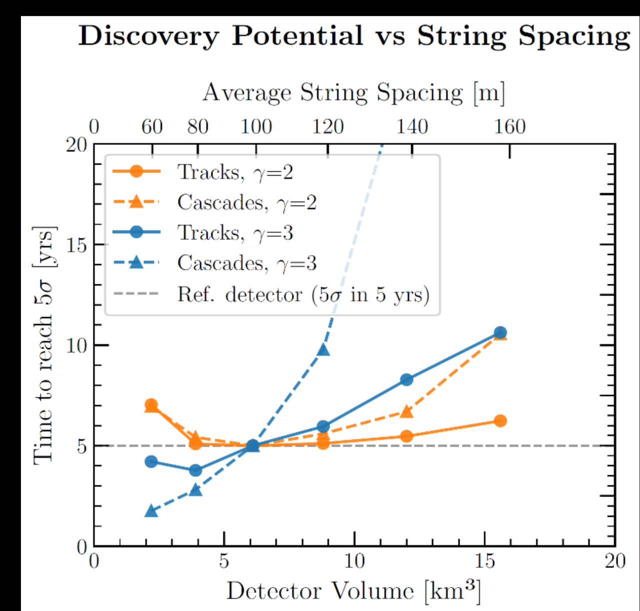
String Spacing

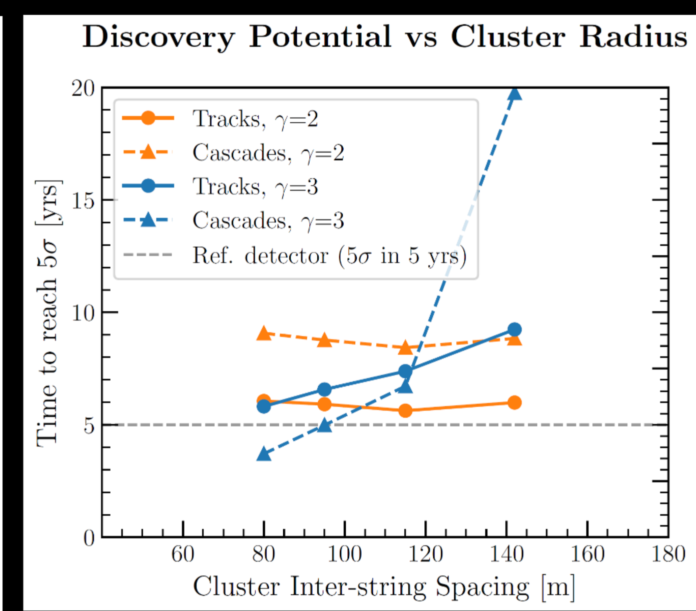


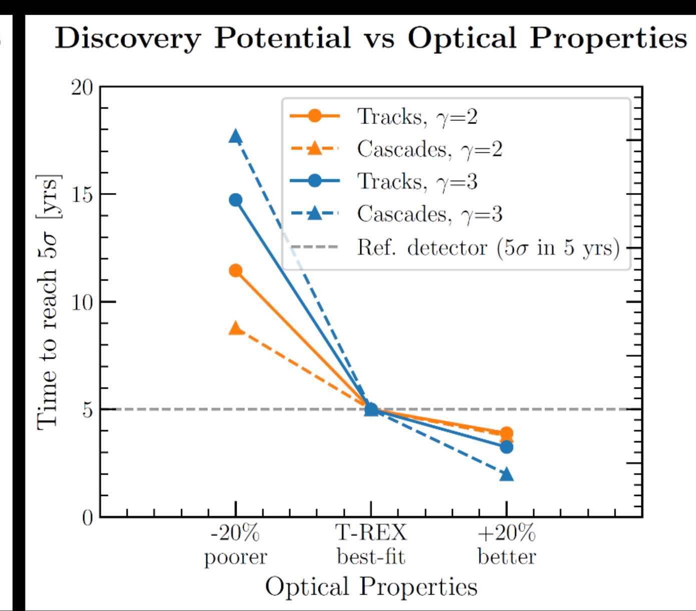
String Clustering



Optical Properties



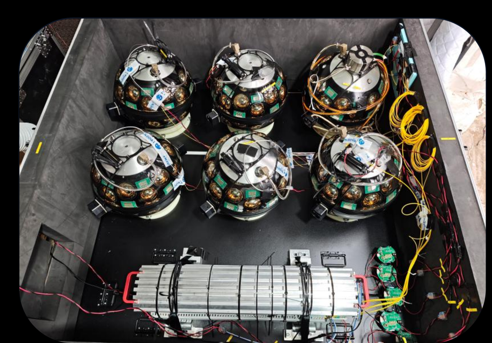




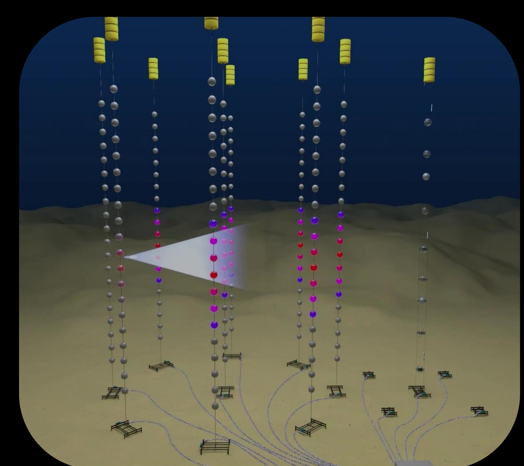
While geometry choice is significant, water optical properties are essential!
→ Attenuation length can have larger impact than geometry choices

Phase-I Incoming

Ongoing: first Prototype hDOM-string testing



hDOMs prepared, electronic tests at low temperatures

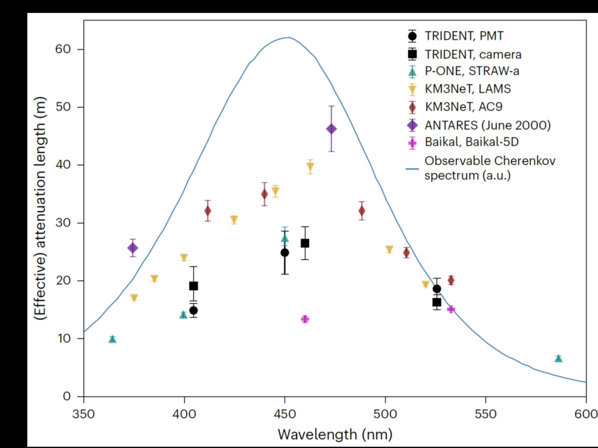


First 10 hDOM strings + 1 calibration string

Key technology demonstrator:
- Long-distance power/data transmission
- Deployment and maintenance strategies
- Precision Cherenkov light detection with hDOMs
- Dynamic calibration strategies
- Data acquisition
- Neutrino detection

Deployment planned for 2027

Early deployments must guide the future deployment



Nature Astronomy 7, 1497–1505 (2023)