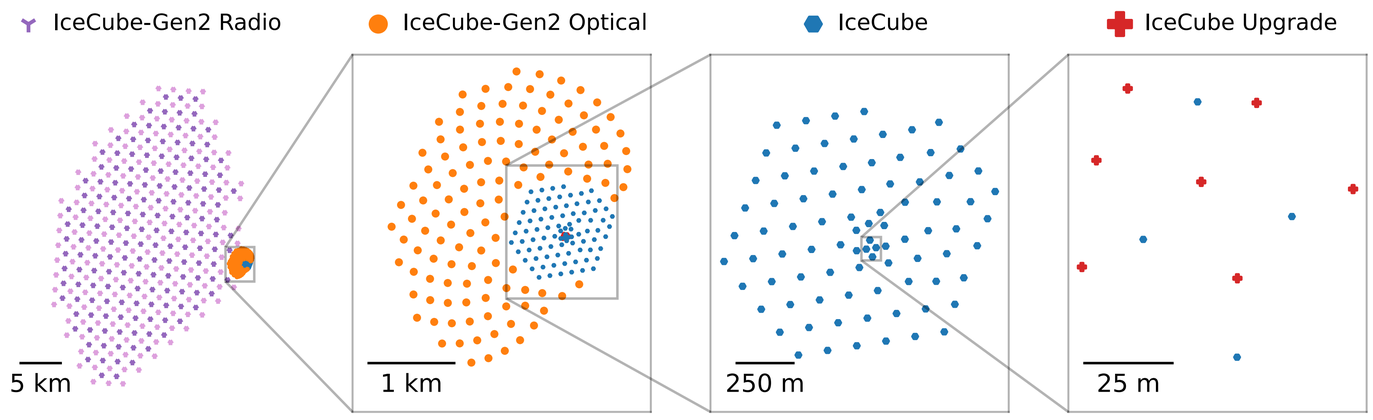
Towards

The Window to the Extreme Universe

Anna Nelles for the IceCube-Gen2 Collaboration

- **Significantly enlarged optical array with improved optical modules**
- **Significantly extended neutrino energy range, due to an in-ice radio array**
- **Enlarged and enhanced surface array targeting air showers**
- **IceCube Upgrade (under construction) sets the stage for IceCube-Gen2**



`toise` framework for sensitivity estimates

- **toise** [1] uses parameterized detector responses for
  - effective area
  - analysis efficiency
  - energy & angular resolution
  - backgrounds

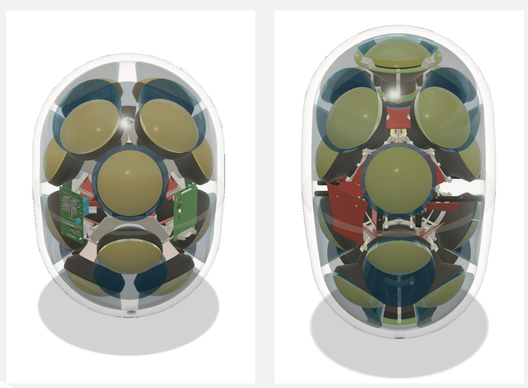
✓ allows to combine multiple instruments and livetimes
✓ provides several flux models and likelihood functions
✓ Can be used for any other neutrino detector

toise is used to predict event rates and estimate detector performance for IceCube-Gen2

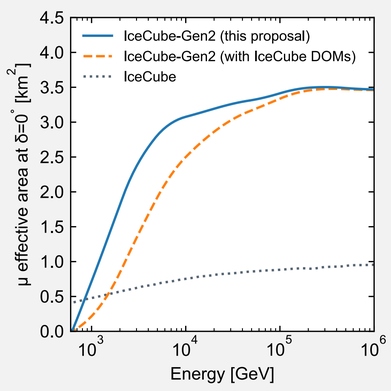
Publicly available at https://github.com/icecube/toise

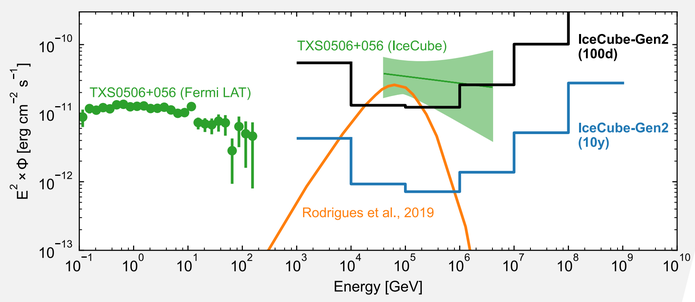
Optical Array

- Additional 120 strings with ~9600 new optical sensors
- Multiple PMT module, larger cathode area, isotropic acceptance of photons, more efficient sensor: DOM-16 or DOM-18 (TBD)



- Significantly enlarged detector volume with larger string spacing, optimized for higher energies
- At least a factor of 5 improvement in point source sensitivity to resolve the high energy neutrino sky
- Realtime alerts for the multi-messenger community

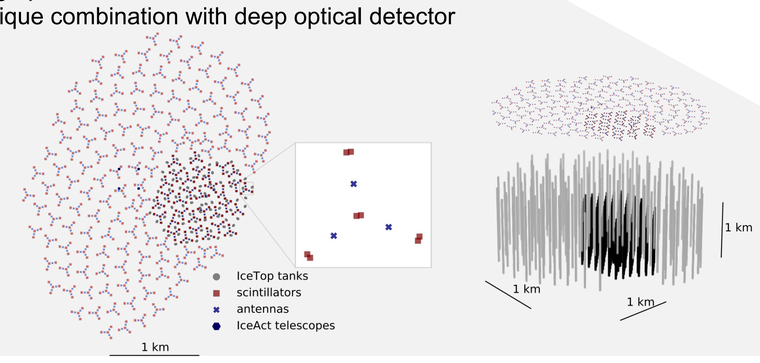




5σ discovery potential of IceCube-Gen2 for a flux of muon neutrinos in relation to observations of the Blazar TXS0506+056. Figure from [2,3]

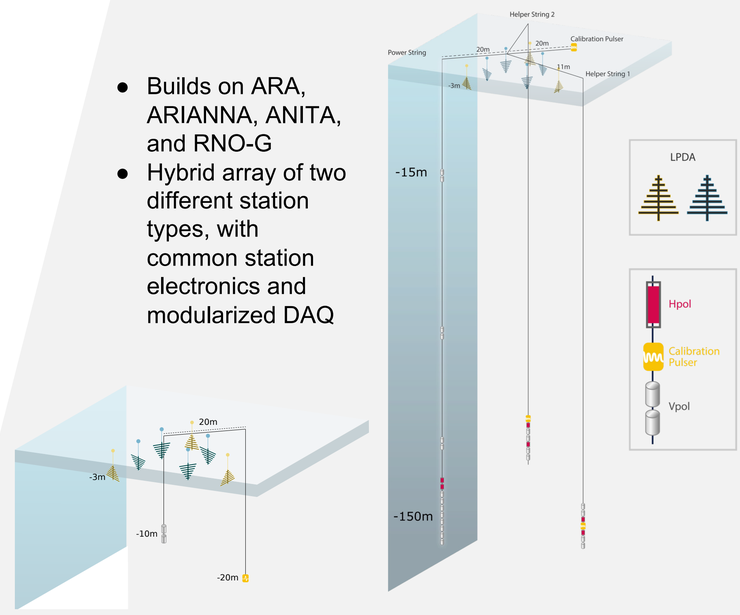
Surface Array

- For every optical string, four pairs of scintillators and three radio antennas
- Improved muon veto for optical array
- High precision air shower measurements with unique combination with deep optical detector

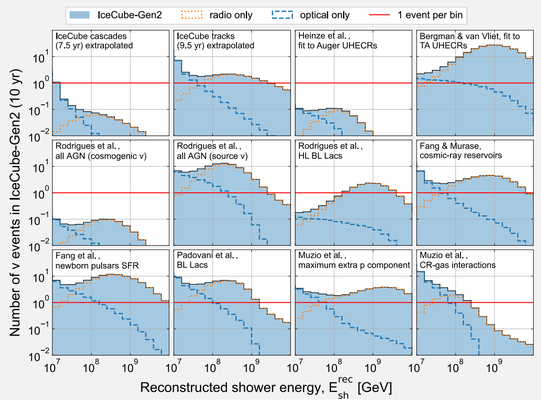


Radio Array

- Builds on ARA, ARIANNA, ANITA, and RNO-G
- Hybrid array of two different station types, with common station electronics and modularized DAQ

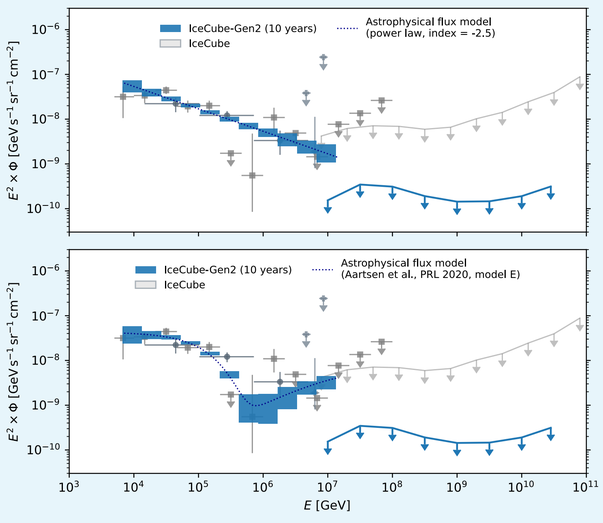


- Deep antennas with phased array trigger for high sensitivity per station
- Log-periodic dipole antennas for high-gain detection and easy installation
- Both components have different systematics, angular coverage and uncertainties, and risks, making it **a robust discovery experiment** for EeV neutrinos

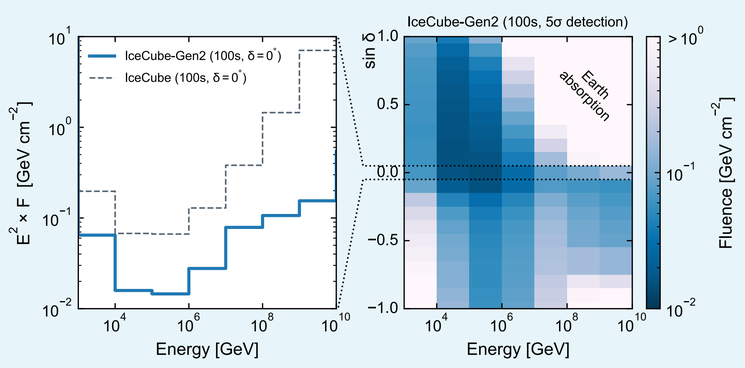


Average expected number of events in IceCube-Gen2, after 10 years of operation, for different predicted diffuse UHE neutrino flux models. Figure from [2,3]

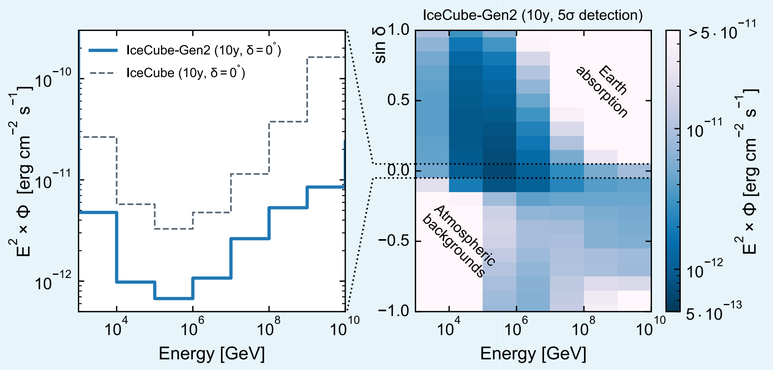
Combined sensitivity of IceCube-Gen2



Projections of the sensitivity and precision for the measurement of the diffuse astrophysical neutrino spectrum. The predicted unfolded diffuse spectrum assuming 10 years of IceCube-Gen2 data is shown in blue with error bands representing 68% confidence intervals up to 10 PeV. The upper panel assumes a single power law model with a spectral index of -2.5. The lower panel assumes a two component spectrum, consisting of a power law with an exponential cutoff at approximately 100 TeV, and a component which peaks at tens of PeV. Figure from [3].



Sensitivity for the discovery (5σ discovery potential) of a generic short neutrino burst of 100 s duration as a function of energy and declination of the source. IceCube and IceCube-Gen2 sensitivities are calculated separately for each decade in energy, assuming a differential flux dN/dE ∝ E−2 in that decade only. The neutrino fluence is shown as the per-flavor sum of neutrino plus anti-neutrino fluence, assuming an equal fluence in all flavors. Figure from [3].



Sensitivity for the discovery for a persistent point sources and a 10 year observation time. Flux is shown instead of fluence. Figure from [3].

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References

[1] J. van Santen, B. A. Clark, R. Halliday, S. Hallmann, A. Nelles; toise: a framework to describe the performance of high-energy neutrino detectors, JINST, in press, arXiv:2202.1112

[2] The IceCube-Gen2 Collaboration; IceCube-Gen2-The Window to the Extreme Universe, J. Phys. G: Nucl. Part. Phys. **48** 060501, arXiv:2008.04323

[3] The IceCube-Gen2 Collaboration; IceCube-Gen2 Technical Design Report (in preparation)