Maximizing aperture while minimizing instrumentation and energy threshold I

GRAND-BEACON workshop

Penn State, Jan 11 2024

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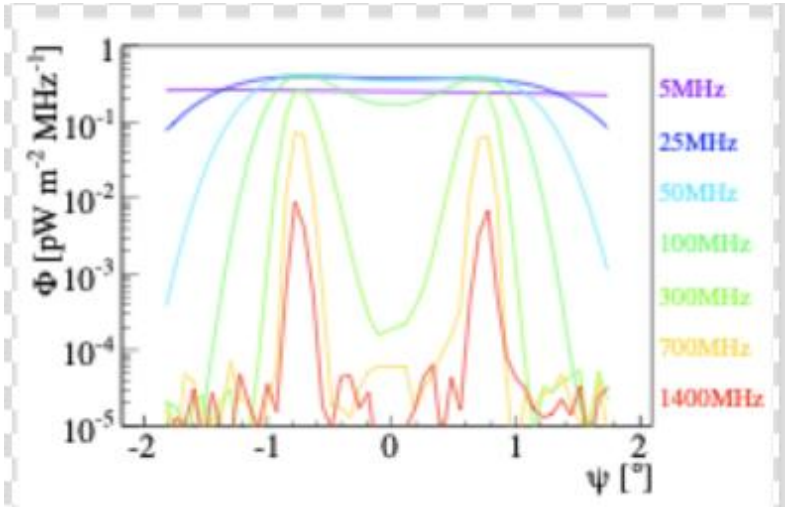
Q1: What is the best case scenario?

- What is the effective area of a <u>perfect</u> detector (ie detector 100% efficiency for all realistic* showers)?
  - Realistic ⇔ realistic opening angle & distance to τ decay point
  - Benchmark existing simulation tools?
  - Include topography as parameter?



Alvarez-Muniz et al, arXiv:1502.02117

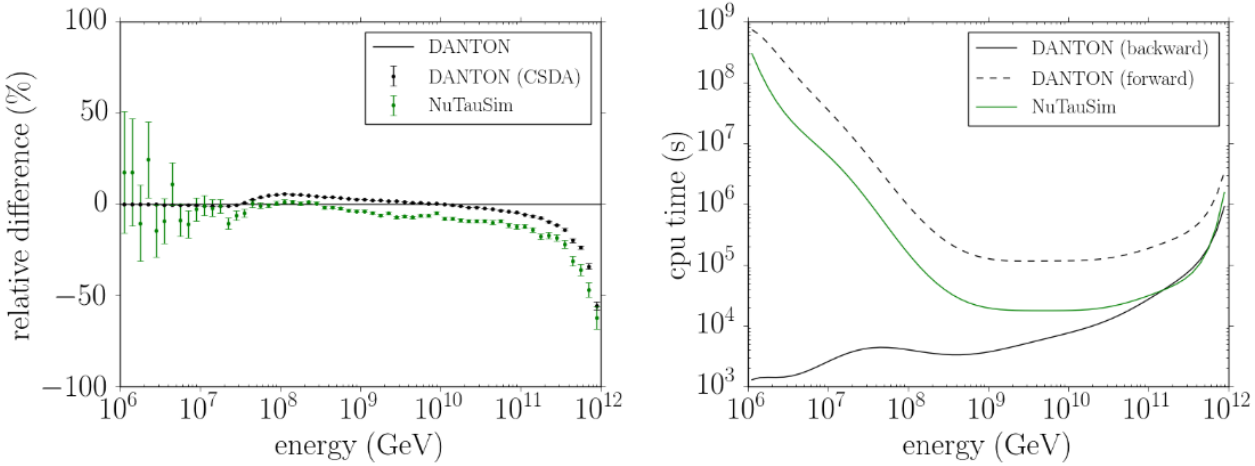


Figure 4: Comparison of NuTauSim and DANTON for the upward τ flux emerging from the Earth with an elevation angle of 1 deg and for a $\frac{1}{E^2}$ primary ν_τ flux. Left: relative difference to DANTON. Right: CPU time needed for reaching a 1 % Monte-Carlo accuracy.

Niess & Martineau, arXiv:1810.0197

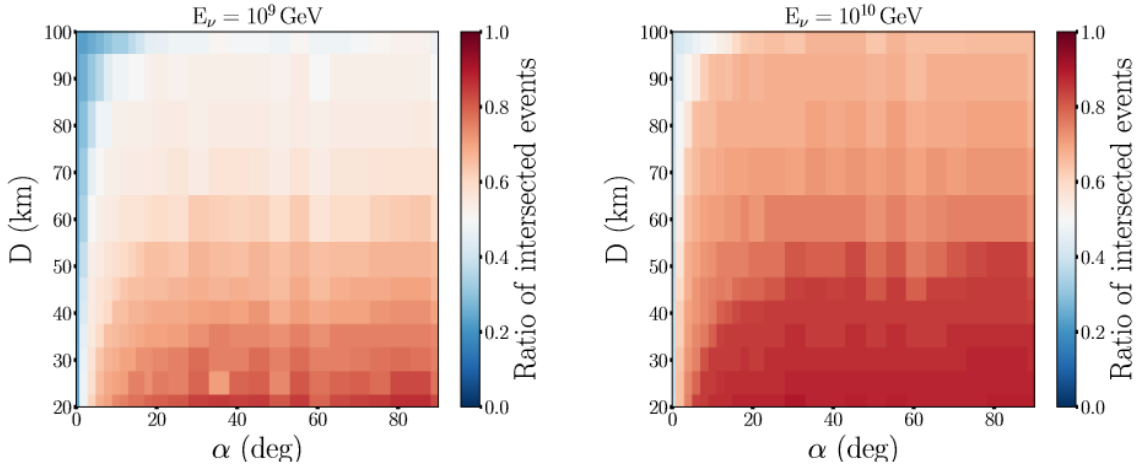


Figure 12: *Left:* Fraction of events intersecting the detection area as a function of distance D and slope α for the simulation set with a primary neutrino energy of 10^9 GeV. *Right:* Same for a primary neutrino energy of 10^{10} GeV.

Decoene et al., arXiv:1903.10466

Q2: how far from the best case scenario can reality be?

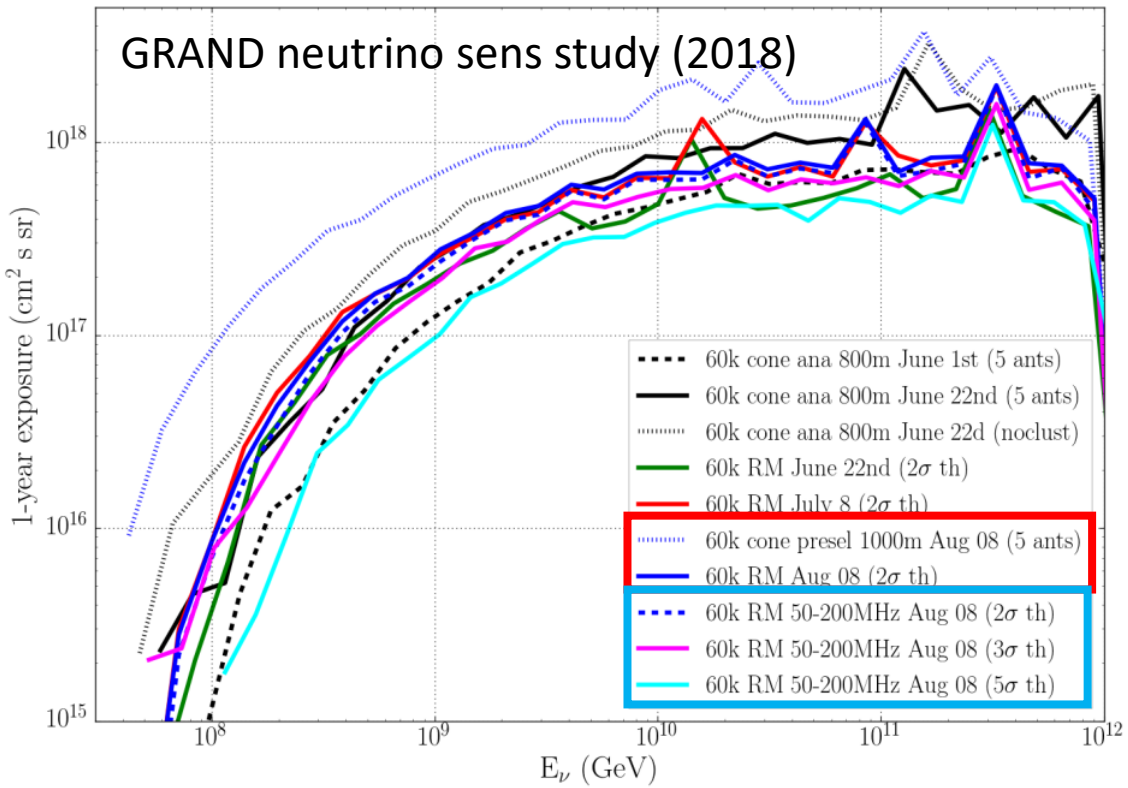
- Handles?
  - Topography (a la BEACON, a la GRAND, …)
  - Improved trigger threshold:
    - Phased array?
    - Denser arrays?
    - Reducing background noise
    - Clever trigger methods (ML, signal processing, etc…)

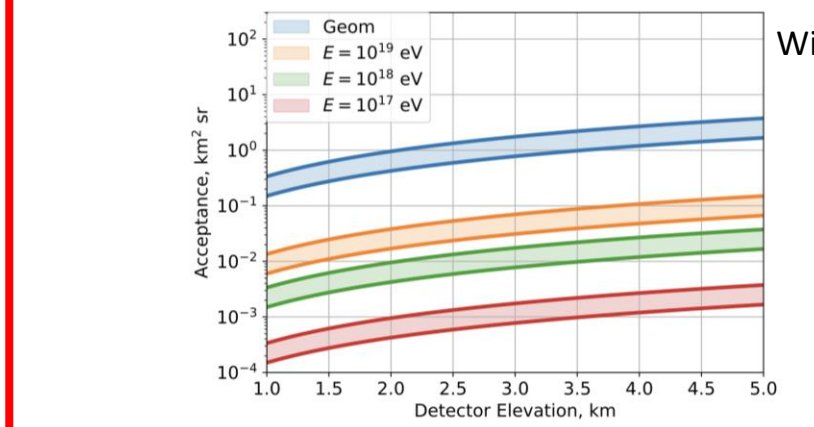
Improving ν sensitivity?

- **Role of topography: up to x3** (see eg Decoene et al., arXiv:1903.10466)
- **Trigger threshold** improvement could surely allow to increase effective area,

  BUT probably by factor of a few only (at least for $E_\nu \geq 10^{17}$eV)
  - GRAND sims: 5σ ➔ 3σ: A_{eff} x 1.6; 5σ ➔ 2σ: A_{eff} x 2.5
- Bottom line: ν-induced EAS are seldom!... And we already detect a significant fraction with standard trig (TBC).
  - **GRAND sims : factor ~2-3 between full efficient & 2σ threshold**
  - Pieroni PhD with similar results

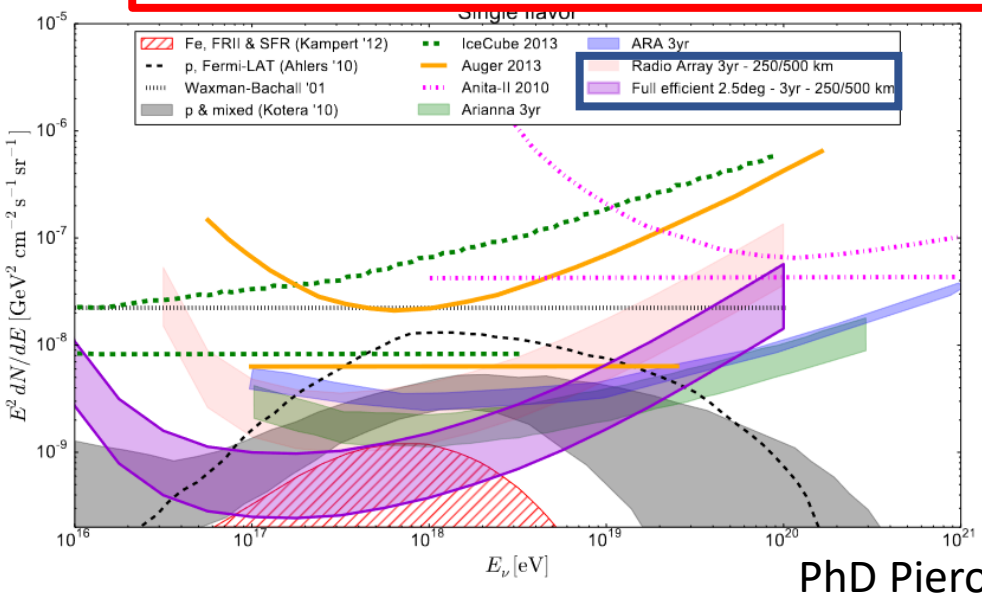
➔ **Discuss more at « effective area » session!**





Wissel et al., 2004.12718

Figure 2. Order of magnitude estimates for the acceptance of a single high elevation station. The blue band shows the maximum geometric acceptance based on Eqn 3.5, assuming a factor of 1/3 to account for an expected 120° field of view. The acceptance at three neutrino energies $\mathcal{E}_\nu$ is estimated from peak $p_{\rm exit}$ values of Ref. [40]. The width of each band illustrates the impact of the maximum view angle over which the detector can trigger $\theta_{\rm cut}$, assuming a range of $[1.0°, 1.5°]$.



PhD Pieroni (2015)

Figura 11.28: Se agrega como banda violeta a la figura 11.27 el límite diferencial al 90 % C.L. que presentaría un detector 100 % eficiente entre 90° y 92.5°, con un tamaño de entre 250 km y 500 km de lado y para 3 años de medición. Esta banda permite formar una idea los límites que tiene la detección de neutrinos con SD de antenas de radio.