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An improved trigger for Askaryan radio detectors

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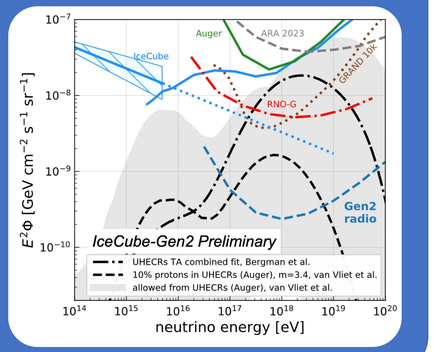
Ultra-high energy neutrino astronomy

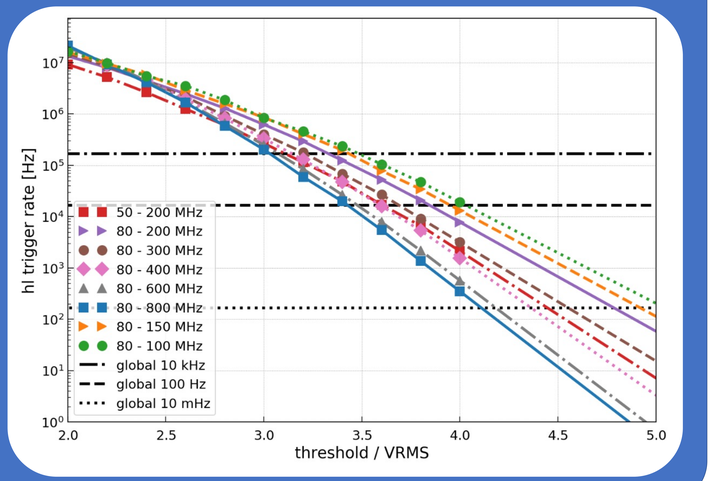
- Measurement of EeV neutrinos next milestone in astroparticle physics
- Radio technology explored in test-bed arrays
- Now, several mid and large-scale arrays being constructed or planned
  - RNO-G (Greenland, under construction, *#1058*)
  - ARIANNA-200 (Ross Ice shelf, planned *#1190)*
  - IceCube-Gen2 (South Pole, planned *#1183*)
- **Challenge:** Low flux and small interaction cross section → low statistics
- **Solution:** Optimize sensitivity of each detector station
  - here: optimization of trigger bandwidth

overview of experiments and flux expectations, from *#1183*



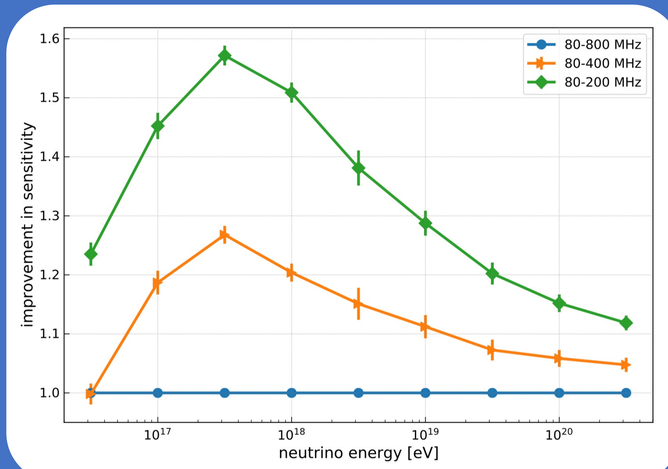
Method to compare different trigger schemes

- Trigger rate dominated by thermal noise fluctuations → max. data rate defines the threshold
- Correct comparisons of trigger schemes:
  - Calculate trigger thresholds that yield the same noise trigger rate
- Studied here:
  - high/low amplitude threshold trigger
  - additional coincidence requirement
    2 out of 4 antennas
  - noise trigger rates depend on threshold **and** bandwidth
- Method can also be used to compare a power integration trigger with an amplitude threshold trigger
  → *see JINST 16 T05001 (2021) for details*



Sensitivity improvement

- Current Askaryan detectors operate at large bandwidth of 80 MHz to ~1 GHz
- Studied here:
  - ARIANNA detector on Ross Ice Shelf
- Restricting trigger bandwidth to 80-200 MHz
  - **50% improvement between 10^{17} and 10^{18}eV**

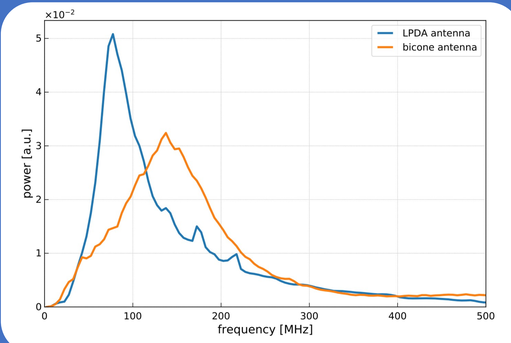


Reason for improvement

1. Off-cone events with low frequency content are frequent
2. Antennas more sensitive at low frequencies
   - sensitivity ~ 1/frequency
3. Noise RMS flat in frequency
   → noise can be reduced by reducing bandwidth

Average measured frequency spectrum shows clear peak at low frequencies

Averaged measured frequency spectrum of simulated neutrinos with an energy of 10 17eV



Optimization of trigger bandwidth → 50% increase in neutrino sensitivity for radio detectors