# Modeling and Validating RF-Only Interferometric Triggering with Cosmic Rays for BEACON

Andrew Zeolla on behalf of the BEACON Collaboration

## BEACON and its Prototype

**B**eamforming
**E**levated
**A**rray for
**Co**smic
**N**eutrinos

**Concept:** radio interferometer atop a mountain, sensitive to the radio emission of extensive air showers induced by the decay of earth-skimming tau neutrinos [1].

**Prototype:** 4 crossed-dipole antennas, 30-80 MHz band, phased array trigger. Located at the White Mountain Research Station in California. Collecting data since 2018, with 4 antenna upgrades.

**Goal:** Measure the well-known flux of cosmic rays to validate the detector model and study inclined events.

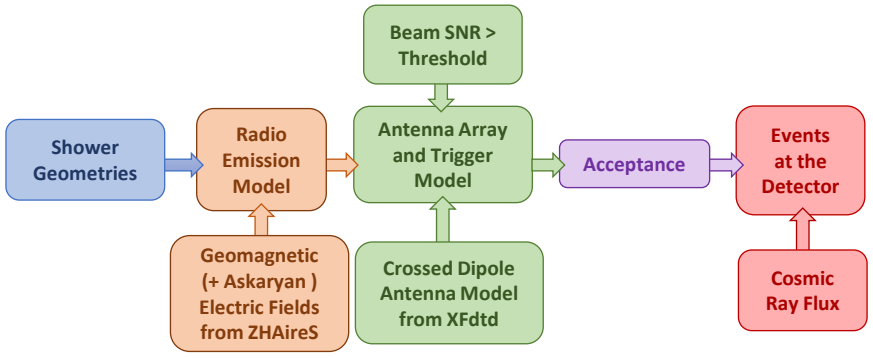
## Cosmic Ray Simulation

**Cranberry: Cosmic Ray Simulation for a Beamforming Elevated Array**

$$\langle A\Omega(E)\rangle = \iint_{\Omega} d\Omega \iint_{A} dA\ \hat{n}\cdot\hat{r}\ P_{obs}$$

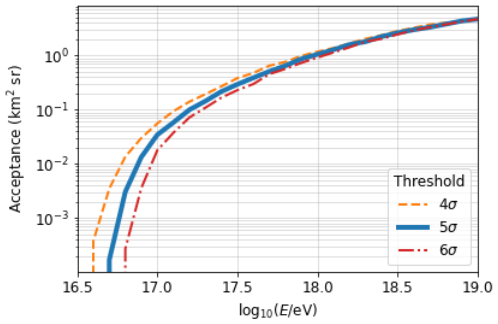
$$\rightarrow\ \pi \times (\text{test area}) \times \frac{\#\text{ of showers that trigger}}{\text{Total }\#\text{ of showers}}$$

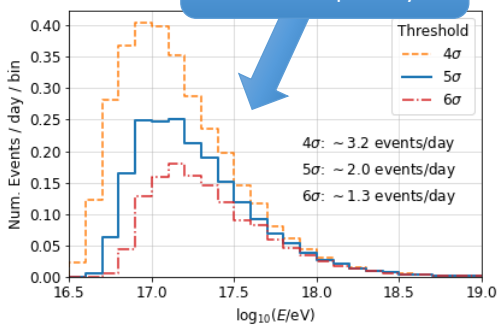
- Monte Carlo simulation for cosmic ray acceptance
- Showers simulated with random zenith and azimuthal angles in an area around the array.
- Voltage at the array estimated with electric fields from ZHAireS [2], an XFdtd model of the antenna, and assuming the beamformed voltage $SNR \sim \sqrt{N_{antennas}}$.
- If beamformed $SNR$ > chosen threshold, trigger is formed.
- Outputs triggered events & rates for given cosmic ray flux [3].

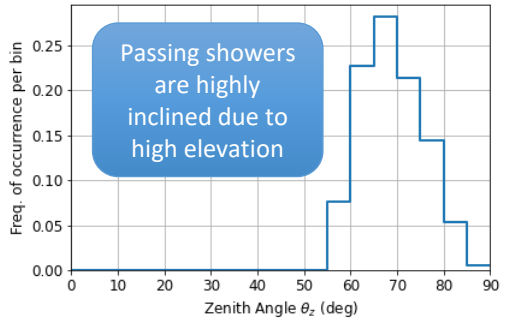


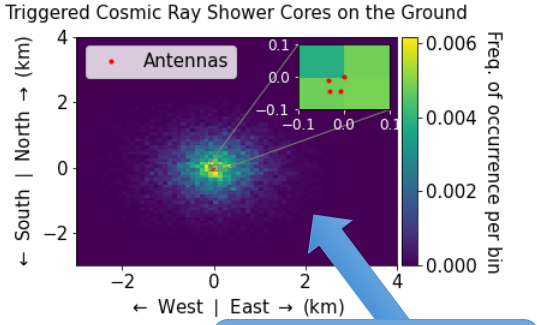

## BEACON Prototype Cosmic Ray Events

- Results are for a 4-antenna array at the prototype site (Mount Barcroft, elevation: 3.875 km) with a 120° field of view. Nominal trigger threshold 5 × thermal RMS, $\sigma$




## Conclusion

- Several highly-inclined events per day expected in search for cosmic rays at prototype
- Cosmic ray search [4] will inform future studies of inclined showers (both cosmic ray and tau neutrinos) in mountaintop geometries and in presence of RFI.

1) S. Wissel et al., arXiv:2004.12718
2) J. Alvarez-Muñiz et al., arXiv:1107.1189
3) Auger, ICRC 2017, DOI = 10.22323/1.301.0486
4) D. Southall, ICRC 2021