Recent detections of anomalous events by ANITA have been shown to be inconsistent with a diffuse flux origin. These constraints can be evaded if the events originated from bright astrophysical sources. We look for IceCube events in the direction of ANITA events, and as we find no significant coincidences, constrain a variety of astrophysical hypotheses. As any ultra-high-energy (UHE) Earth-traversing $\nu_\tau$ flux should be accompanied by $\beta(\text{PeV})$ secondaries, these limits are constraining regardless of the assumption on the intrinsic spectrum.

**Overview:**

We search for neutrino events in IceCube data coincident with ANITA events for various temporal hypotheses. The localization uncertainty of the ANITA events is incorporated as a weight in the likelihood, $P_A$:

$$
\mathcal{L} = \prod_{i=1}^{N} \left( \frac{n_x}{n_x + n_b} S(x_i, x, \alpha) + \frac{n_b}{n_x + n_b} B(x_i, x) \right) P_A(x_i)
$$

Different signal hypotheses tested (see Fig. 1) -
- **Prompt** (include a time window around ANITA detection)
- **Rolling** (find single most significant flare of neutrinos)
- **Steady** (search for steady flux)

**ANALYSIS METHOD**

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$$

**Background** parameterized from data

**ANITA event PDF**

**Figure 1:** Schematic of different signal hypotheses tested

**Different signal hypotheses tested (see Fig. 1)**
- **Prompt** (include a time window around ANITA detection)
- **Rolling** (find single most significant flare of neutrinos)
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**Figure 2:** Skymaps (top) and TS distributions (bottom) for one of the ANITA events for the prompt (left), rolling (middle) and steady (right) analyses.

**Figure 3:** Upper limits (90% CL) on incident muon neutrino fluxes assuming an $E^{-2}$ spectrum for the anomalous ANITA events (AAE) and the event found in a search for Askaryan radiation (AAC).

**Figure 4:** Ultra-high energy $\nu_\tau$ fluxes traversing the Earth will have a regenerated component which peaks at PeV energies for the angles of the AAE.

Under conservative spectral assumptions, our limits are violated by the regenerated component of any flux that produces events at ANITA (Fig. 5), for various timescales.

We show that anomalous ANITA events are inconsistent with an array of point-like astrophysical hypotheses, suggesting more strongly that they may point to exotics or systematics. This method of constraining UHE fluxes with optical Cherenkov detectors can also be used for future joint analyses with next generation radio detectors.

**POINT SOURCE CONSTRAINTS**

In following up 3 ANITA neutrino candidate events (two “anomalous,” one candidate from an Askaryan emission search), we find no significant signal. When compared to pseudo-experiments from scrambled background data, our results are consistent with background (Fig. 2). In the absence of a significant detection, we constrain fluxes for a variety of timescales (Fig. 3).

**Figure 5:** For the 1000 s followup, our limits (blue) constrain the regenerated flux (magenta histogram). The maximum allowed normalization (magenta arrow) is overshot by the implied flux from the ANITA detection (black).

**Figure 6:** Upper limits (90% CL) on incident muon neutrino fluxes assuming an $E^{-2}$ spectrum for the anomalous ANITA events (AAE) and the event found in a search for Askaryan radiation (AAC).

**EFFECTS OF $\nu_\tau$ REGENERATION**

If the anomalous ANITA events are interpreted as $\nu_\tau$ signatures, they should be accompanied by regenerated lower energy neutrinos, see [2].

**DISCUSSION**

We show that anomalous ANITA events are inconsistent with an array of point-like astrophysical hypotheses, suggesting more strongly that they may point to exotics or systematics. This method of constraining UHE fluxes with optical Cherenkov detectors can also be used for future joint analyses with next generation radio detectors.