

## The ExaVolt Antenna (EVA)

A. CONNOLLY<sup>1</sup>, FOR THE EVA COLLABORATION.

<sup>1</sup> Dept. of Physics and CCAPP, 191 W. Woodruff Ave., Columbus, OH 43210

connolly@physics.osu.edu

**Abstract:** There are strong motivations for a flux of ultra-high energy (UHE) neutrinos that is observable on earth. Although they remain undetected, UHE neutrinos are expected to be produced when cosmic rays above  $10^{19.5}$  eV interact with cosmic microwave background photons through the GZK process, and they would also be produced through photohadronic interactions in the same sources that accelerate UHE cosmic rays. The radio Cerenkov technique is the most promising technique for a sustained program measuring the UHE neutrino flux and extracting its rich physics and astrophysics potential. ANITA is an antenna array that searches for neutrino interactions in the Antarctic Ice from 37 km altitude, launched under NASA's long-duration balloon program. ANITA boasts the best constraints on UHE fluxes above  $10^{19}$  eV and its third flight is planned for the 2013-2014 Austral summer. The proposed ExaVolt Antenna (EVA) uses a novel approach to increase the expected rate of neutrinos in a balloon-borne experiment 100-fold by turning a large portion of the stadium-sized balloon itself into an antenna reflector with receivers deployed on an inner membrane. EVA would be the world's largest airborne telescope with 1000 m<sup>2</sup> of collection area. The EVA concept becomes feasible with the development by NASA of Super Pressure Balloons, which hold a positive differential pressure and nearly constant volume under variations in temperature at altitude when compared with the Zero Pressure Balloons used for ANITA. I will present results from a scaled-down (1:30) prototype of an EVA reflector region built at the University of Hawaii, and review our plans for a 1:12 scale EVA prototype to be tested in a NASA hangar in 2014. I will conclude with the expected sensitivity of the full EVA experiment to UHE neutrinos, and additionally cosmic rays from the geomagnetic effect.

**Keywords:** exavolt antenna, eva, balloon, neutrino, cosmic ray, radio

### 1 Introduction

The ExaVolt Antenna (EVA) [?] is a next-generation balloon-borne neutrino and cosmic ray detector that would be the world's largest airborne telescope. EVA builds on the experience of the ANITA experiment, and both are designed to search for impulsive radio signals originating from ultra-high energy neutrino interactions and cosmic rays air showers. ANITA has flown twice under NASA's long duration balloon (LDB) program with a third flight planned for the 2014-2015 Antarctic summer season[?, ?, ?].

Figure ?? illustrates the EVA design concept. While the ANITA payload flies beneath the  $\sim 100$  m diameter LDB balloons, EVA proposes to turn the balloon itself into a gargantuan antenna with a reflector region near the equatorial region of the balloon and a receiver array in the balloon's interior. The resulting antenna array would have a collection area of 1000's of square meters in the frequencies of interest, approximately 150-600 MHz.

#### 1.1 Super Pressure Balloons

EVA is designed to take advantage of the new Super Pressure Balloons being developed for NASA's LDB program. ANITA 1 and 2 were both launched under Zero Pressure Balloons where the balloon pressure is at equilibrium with the ambient pressure at float altitude. For these type of balloons, the shape can change dramatically with the thermal environment. The ANITA balloon dropped in volume by about 40% while over east Antarctica compared to when it flew over warmer ice. With Super Pressure Balloons, the balloon pressure is higher than the outside pressure, and the

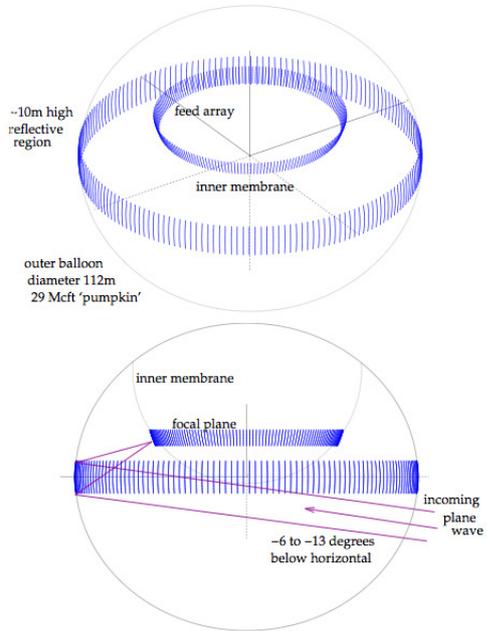
balloon maintains a near constant volume over the course of a flight.

NASA has been launching test flights of Super Pressure Balloons, achieving larger balloons of long duration flights. In December 2008, a Super Pressure Balloon of volume 7 million cubic feet (Mft<sup>3</sup>) flew over Antarctica for 54 days with a differential pressure of 7 Pa, change in altitude over the flight at 150 m, and change in height and diameter of about 1%. In early 2011, the Antarctic flight 616 of a 14 Mft<sup>3</sup> balloon maintained a differential pressure of 60-70 Pa during the day with an altitude variation of 500 m.

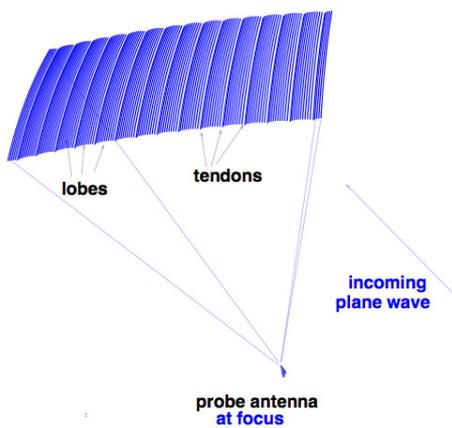
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#### References

- [1] P.W. Gorham *et al.*, *Astropart.Phys.* 35 (2011) 242-256.
- [2] P.W. Gorham *et al.*, *Phys.Rev.Lett.* 103 (2009) 051103.
- [3] S. Hoover *et al.* *Phys.Rev.* D85 (2012) 049901.
- [4] P.W. Gorham *et al.*, *Phys.Rev.* D85 (2012) 049901.



**Figure 1:** Illustration of the EVA design concept.



**Figure 2:** A portion of the reflector region for EVA as modeled in NEC2.