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Multimessenger studies from above: The EUSO-SPB2 mission and first results

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The Extreme Universe Space Observatory on a Super Pressure Balloon 2 (EUSO-SPB2) mission launched from Wanaka NZ on May 13, 2023 and was terminated about 36h later over the Pacific Ocean due to a leak in the balloon. The payload included two main instruments. The Fluorescence Telescope (FT) pointed in nadir to search for the first Ultra-High Energy Cosmic Ray (UHECR) induced extensive airshower (EAS) signatures in fluorescence light from above. First analysis of our flight data does not indicate any observations of UHECRs. The Cherenkov Telescope (CT) looked for Cherenkov light signatures from EAS. These EAS can be induced by above the limb Cosmic Rays (CRs) as well as PeV-scale Earth-Skimming neutrinos. By using the Earth as a tau-neutrino to tau-lepton converter EUSO-SPB2 has sensitivities toward these Earth skimming tau-neutrinos. During a first analysis several above the limb CR candidates have been found, demonstrating the instruments ability to measure Earth-skimming neutrino signatures.
As part of EUSO-SPB2, we planned Target of Opportunity (ToO) observations to follow up on possible neutrino sources by catching parts of the sources'path across the sky in the CT's field of view. Possible neutrino source candidates include gamma ray bursts, tidal disruption events and other steady or flaring sources. During its descent, there was a loss of control over the payload azimuth rotation, interrupting plans for targeted ToO observations. However, some sources crossed the CT's field of view during the descent of the balloon. These chance-coincident observations allow us to demonstrate the viability of conducting ToO follow-up observations from a near space environment. Despite the short flight of EUSO-SPB2, we can show that our instruments were operational and prepared to do observations of CRs and neutrinos at high energies. The knowledge and experiences gained during the EUSO-SPB2 flight can be utilized in the planned POEMMA Balloon with Radio mission.

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