

# Development of drone-borne aerial calibration pulser system for radio observatories of ultra-high energy air showers

Chung-Yun, Kuo for the TAROGE collaboration

## **Executive summary**

In recent years, radio technique has been regarded as a promising method to detect ultra-high energy cosmic rays and cosmic neutrinos. One of the most important data analysis methods in radio experiments is the interferometry technique which can provide arrival directions of radio pulses. A precise calibration, especially timing calibration, is a crucial experimental step for the interferometry technique. Conventionally, ground pulser, balloon-borne pulser, or bright cosmic sources are used as calibration references. However, sky coverage for those methods is limited. Multiple calibration stations would be deployed, which would not be a practical solution for some experiments such as TAROGE. We have developed a drone-borne cal-pulser that can be applied to various radio observatories. Similar ideas have been presented by AERA and Bleien Observatory. However, our system is the most advanced using a solid state impulse generator and differential GPS (D-GPS) technique, which provides a compact, light-weighted, portable, and accurate position information. The drone-borne cal-pulser was successfully developed and applied to the calibration of the TAROGE experiment in Taiwan and in Antarctica. With the preliminary result from the TAROGE-4 and TAROGE-M calibration, we believe this drone-borne pulser can be used for not only TAROGE but other radio observatories.