

# Terrestrial gamma-ray flashes analysis for aircraft transport safety

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## Introduction

The terrestrial gamma-ray flashes are one of the most energetic phenomena in the universe and are associated with the strengthening phase of a storm, the cumulonimbus clouds. These are clouds of great vertical development, creating an electric field between its base and the top.

When an airplane flies within a TGF channel, radiation interacts with the aircraft's electronics and with the crew and passengers. [1]

The AGILE space mission provides TGF detection mainly in the equatorial region. [2]

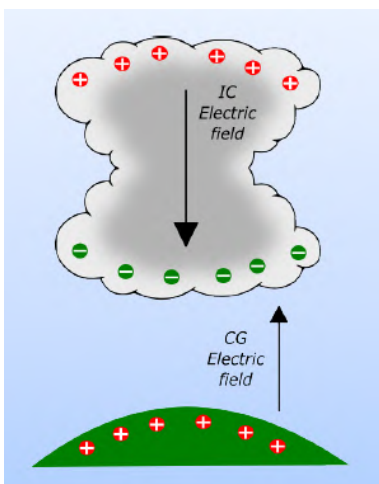


Figure 1: Representation of the electric field in a cloud [3]

## TGF Hazards for Aviation Safety

- Airplanes must withstand electromagnetic discharges caused by lightning and high radiation levels in the atmosphere.
- TGFs have accelerated particles, namely electrons and positrons, and can also provide a large flow of neutrons, affecting aircraft electronics.
- The TGFs emissions are similar to explosions whose photon energy ranges from 10 keV to 40 MeV. [1,4]

## Objectives

- Evaluate typical TGF flux at commercial flight altitude (10 km)
- Evaluate the potential dose absorbed crew
- Find the probability of being caught by TGF in certain types of flight routes
- Based on simulation results, we will design and optimize a CdTe detector to be implemented onboard an aircraft to provide optimal record of dangerous and to inoffensive TGFs



Figure 2: CdTe detector

## Future work

After intensive research and information gathering, the next steps will be to simulate real situations through Monte Carlo simulations. This will be implemented in GEANT4 or MEGALib. Then, based on simulations result, find the best TGF detector to be deployed on an airplane. This detector, installed on the plane, will cover and find TGFs, promoting safety.

## References

- [1] M. Tavani, A. Argan et al, Possible effects on avionics induced by terrestrial gamma-ray flashes, 2013
- [2] M. Tavani, G. Barbiellini et al, Science with AGILE, november, 2004
- [3] A. Ursi, Detection of terrestrial gamma-ray flashes by the AGILE satellite, eAstrogam workshop, march 2017, Padova
- [4] J. R. Dwyer et al, Observation of a gamma-ray flash at ground level in association with a cloud-to-ground lightning return stroke, 2012