



TARANIS XGRE and IDEE detection capability of terrestrial gamma-ray flashes and associated electron beams

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Abstract

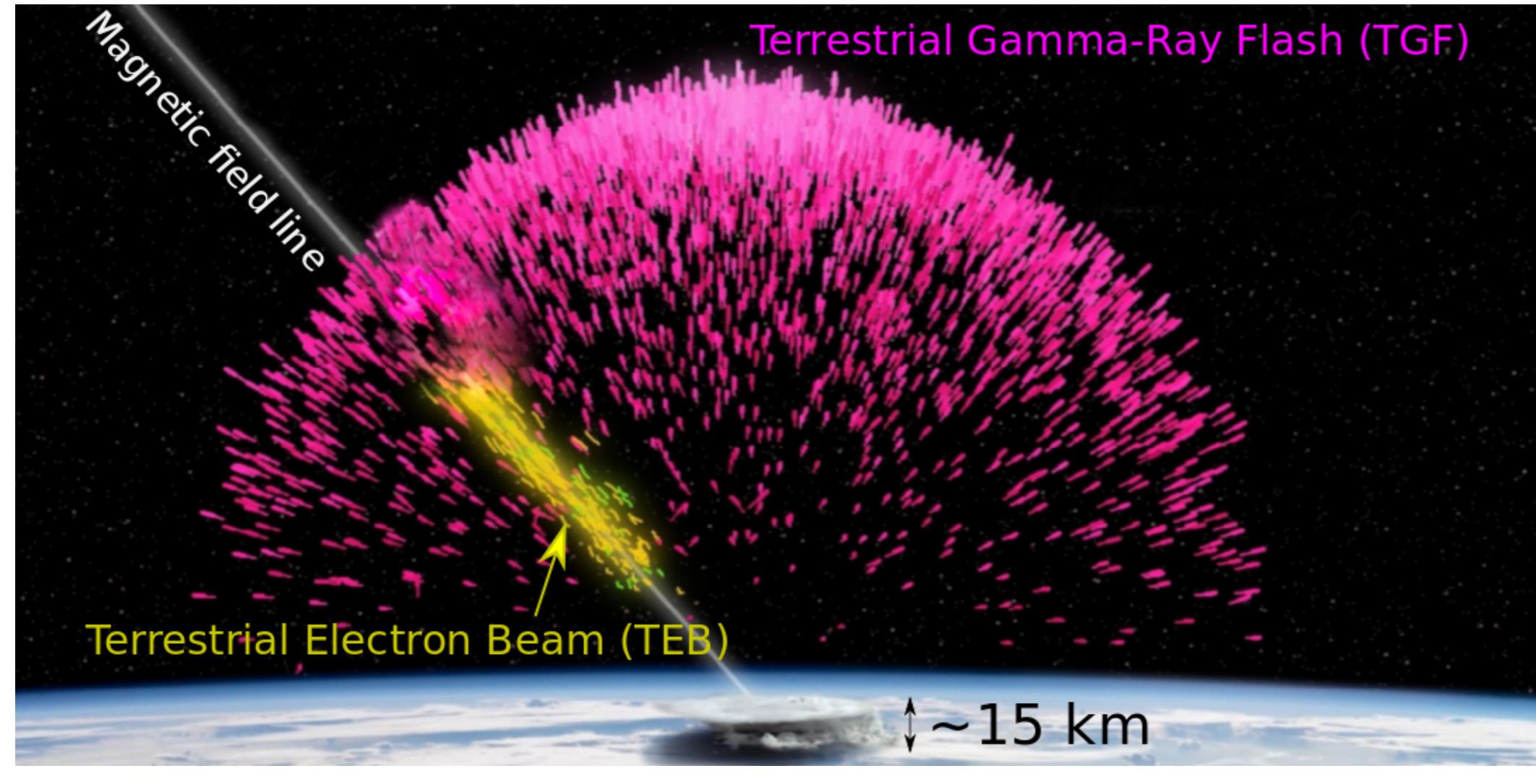
With a launch expected in 2019, the TARANIS microsatellite is dedicated to the study of transient phenomena observed in association with thunderstorms. On board the spacecraft, XGRE and IDEE are two instruments dedicated to studying terrestrial gamma-ray flashes (TGFs) and associated terrestrial electron beams (TEBs). XGRE can detect electrons (energy range: 1 to 10 MeV) and X- and gamma-rays (energy range: 20 keV to 10 MeV) with a very high counting capability (about 10 million counts per second) and the ability to discriminate one type of particle from another. The IDEE instrument is focused on electrons in the 80 keV to 4 MeV energy range, with the ability to estimate their pitch angles.

Monte Carlo simulations of the TARANIS instruments, using a preliminary model of the spacecraft, allow sensitive area estimates for both instruments. This leads to an averaged effective area of 425 cm² for XGRE, used to detect X- and gamma-rays from TGFs. The combination of XGRE and IDEE gives an average effective area of 255 cm² which can be used to detect electrons/positrons from TEBs. We then compare these performances to previous instruments that were able to detect TGF: RHESSI, AGILE and Fermi GBM. We use data extracted from literature for the TGF case, and Monte Carlo simulations using their mass models for the TEB case.

Combining this data with the help of the MC-PEPTITA Monte Carlo simulations of TGF propagation in the atmosphere, we built a self-consistent model of the TGF and TEB detection rates of RHESSI, AGILE and Fermi. It can then be used to estimate that TARANIS should detect about 200 TGFs per year and 25 TEBs per year.

What are Terrestrial Gamma-ray Flashes ?

Terrestrial Gamma-ray Flashes (TGFs) are the highest energy natural particle acceleration phenomena occurring on Earth



Characteristics:

- Correlated to thunderstorms
- 20 micro-second to 2 milli-second duration
- Energy up to **40 MeV**
- associated with electron beams (TEBs) (> 5 ms duration)

Still poorly understood :

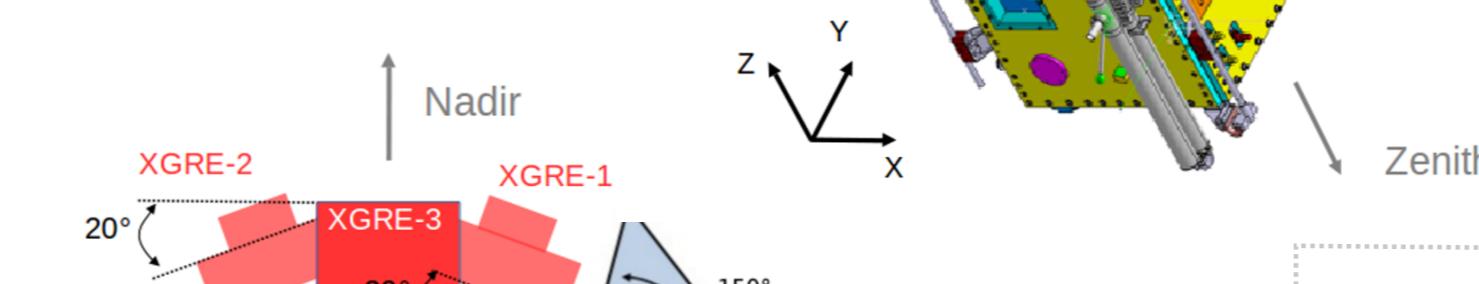
- Production mechanism ? Two candidates
- Occurrence rate ? estimated 4×10^5 to 10^8 per year
- Is every lightning producing a TGF ?
- How to properly define a TGF ?

Potential impacts:

- Ozone layer [2]
- Natural production rate of isotopes [3]
- Aircraft safety [4]

The TARANIS satellite and the XGRE and IDEE instruments

Views of the TARANIS Satellite



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