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High-energy radiation from natural lightning observed in coincidence with a VHF Lightning Interferometer

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In the last two decades, it has been discovered that lightning strikes can emit high-energy radiation.
In particular, a phenomenon has been observed from space called "Terrestrial Gamma-ray Flash" (TGF), which consists of an intense burst of gamma radiation that can be produced during thunderstorms. This phenomenon has met with considerable interest in the scientific community and its mechanism is still not fully understood. Nowadays several satellites for astrophysics like AGILE and FERMI are able to detect and map TGFs and specific instruments like the ASIM detector on the ISS are studying this phenomenon from space.
In the atmosphere, the high-energy radiation undergoes a strong absorption exponentially proportional to the air density which makes it more difficult to detect TGFs on the ground. Nonetheless, ground measurements were conducted and observed that even in cloud-to-ground lightning high-energy radiation were produced. In particular, the works of Moore et al. [2001] and Dwyer et al. [2005] highlight two lightning processes in which the X-ray emission could be produced: downward negative stepped leader and dart leader. Currently, it is not clear if the emissions revealed on the ground and the TGFs observed in space are essentially the same phenomenon or how these phenomena are related. For these reasons, it is particularly interesting to study high-energy emissions also from ground instruments because, despite the strong absorption of the high-energy radiation, ground observations can reach a better accuracy in time and space and provide crucial information to investigate the origin and conditions under which these emissions occur.
A privileged instrument for this research is the VHF Lightning Interferometer, a system of antennas that allows you to map lightning through the very high frequency (VHF) emission. Due to the high resolution of this instrument, should be possible to locate the origin of the high-energy emissions and hopefully provide a better understanding of the radiation mechanism.
The aim of this research is, therefore, to develop a 3D interferometry system to identify as accurately as possible the origin and the conditions in which the X-ray emission occurs in cloud-to-ground lightning and investigate the relation of the VHF emissions with the TGFs.
Recently an observation campaign was conducted in Colombia with two VHF Lightning Interferometers and two X-rays detectors. This interferometry system was installed in the coverage area of a Lightning Mapping Array (LMA) and LINET to take advantage of the complementary information that these lightning location networks could provide. At the moment, about 15 lightning events with X-ray emissions were observed, including five X-ray bursts from

downward negative leaders and two emissions from dart leaders. Further studies and analysis of the collected data are still ongoing.