

# Sprites in rapid succession - ELF electromagnetic signatures and current moment waveforms AE31B-3410

Janusz Mlynarczyk<sup>1</sup>, Andrzej Kulak<sup>2</sup>, Martin Popek, and the Krakow ELF Research Team

e-mail: januszm@agh.edu.pl

<sup>1</sup> AGH University of Science and Technology, Department of Electronics, Krakow, Poland <sup>2</sup> Astronomical Observatory, Jagiellonian University, Krakow, Poland <sup>3</sup> AMSos, Eurosprite, Nýdek, Czech Republic.

## Background

A sprite is a type of Transient Luminous Event (TLE), an optical phenomenon that occurs in the upper atmosphere and is directly related to the electrical activity of a thunderstorm.

An intense thunderstorm that passed over Central Europe on August 6 and 7, 2013, generated a large number of sprites. Some of them occurred in rapid succession – a few sprites in less than 1 second.

The thunderstorm was located only a few hundred kilometers away from our ELF station. The video images were registered even closer, in Nydek, Czech Republic.

Based on the recorded ELF signal we reconstructed the current moment waveforms and calculated the charge moment changes of the most interesting cases of sprites in rapid succession.

## Measurements

### ELF electromagnetic field measurements at the Hylaty station in Poland

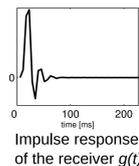
Our station is located in a sparsely populated area of the Bieszczady Mountains (49.204°N, 22.544°E)



Hylaty ELF station specifications [Kulak et al., 2014]:

- Two ELF receivers: 0.03 to 55 and 0.03 to 300 Hz
- Two signal channels NS and EW for each receiver
- Sampling frequencies: 175 and 900 Hz
- Sensitivity 0.05 pT/sqrt(Hz) at 10 Hz
- Dynamic range 16 bit / 96 dB

ELF data recording since 1993,  
Automatic data acquisition since 2005



### Video recordings of the Transient Luminous Events in the Czech Republic

The optical observation site is located in Nydek (49.668°N, 18.769°E) 482 m amsl.

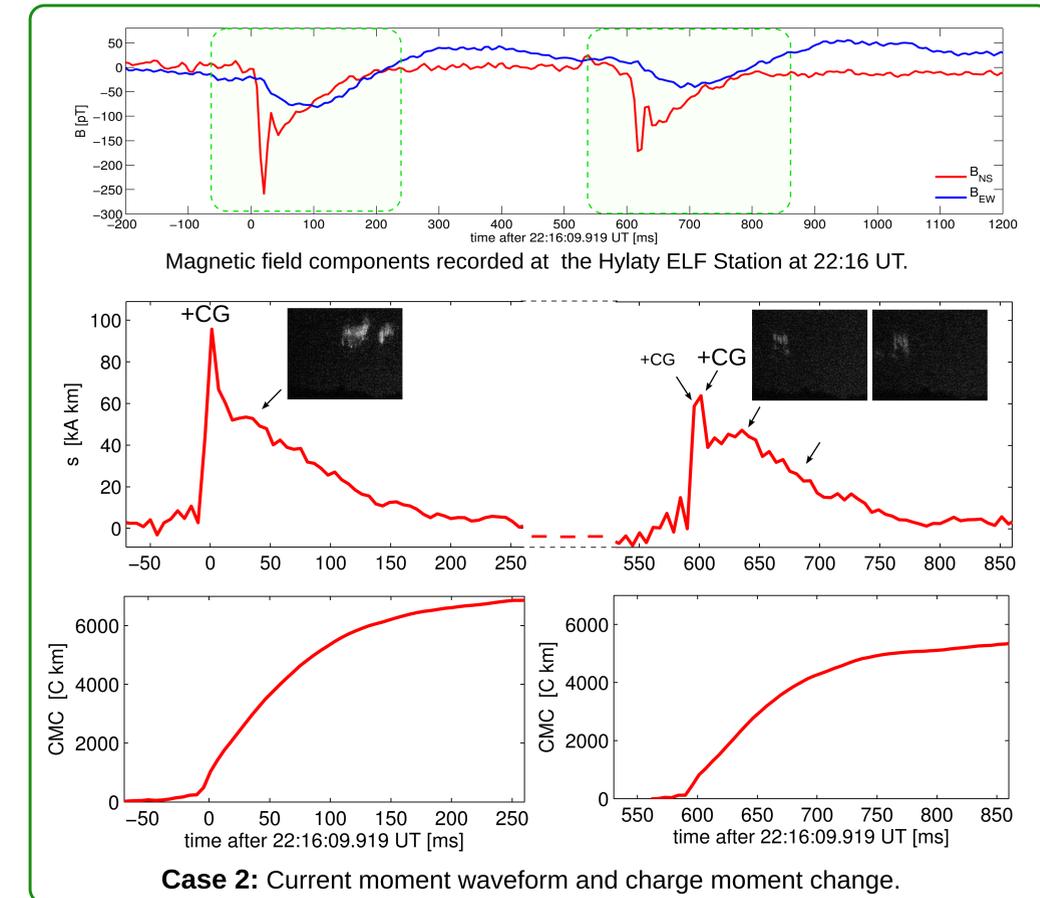
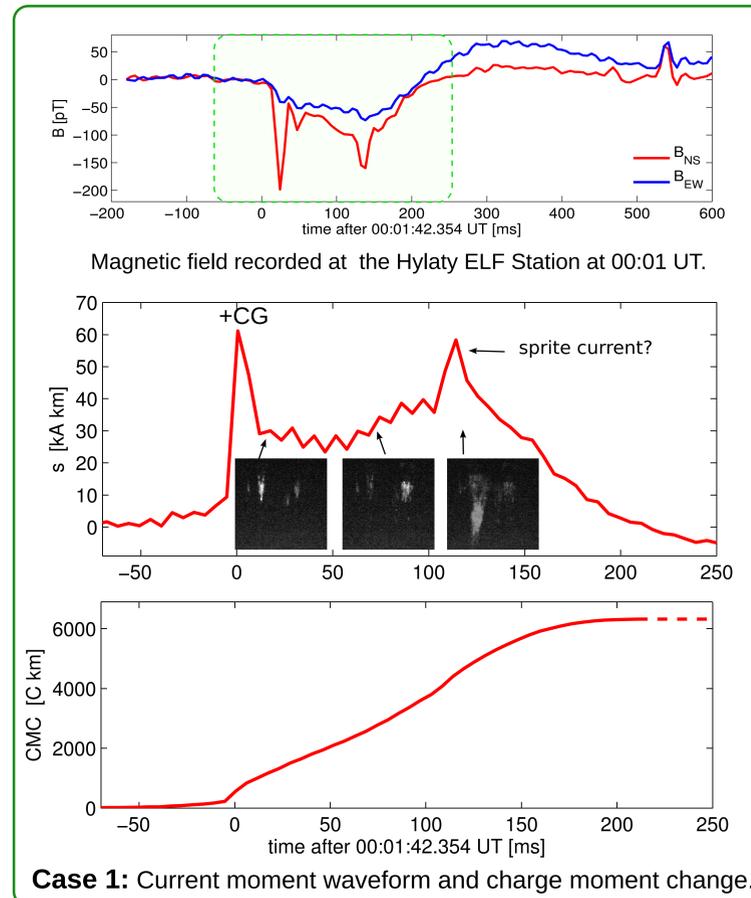


System specifications:

- Two Watec 902H2 Ultimate (CCIR)+Computar 8/1,3, Watec 910HX+ Computar 3,5-10,5 and Auto Revuenon 55/1,4/UFO Capture
- Time information: PC time
- Analog-to-digital converter: Dazzle DVC 100
- Camera position: manually controlled
- Observer: Martin Popek

## Results

We analyzed two interesting cases: a dancing sprite recorded on August 7 at 00:21 UT and a sequence of sprites recorded on August 6 at 22:16 UT



## Discussion

Each sequence of sprites was triggered by a +CG discharge that had a very long continuing current - its duration was between 200 and 250 ms.

**Case 1** was a dancing sprite event, triggered by a 28kA +CG discharge. This +CG had a particularly long continuing current with an unusual shape. After the return stroke the current did not decrease exponentially but remained at a quite high but constant level for about 70 ms. During this time the first cluster of sprites appeared in the video recordings. Then the current started to rise slowly, which coincided with apparition of the second cluster of sprites. The second peak in the current moment waveform coincided with a large carrot sprite. No +CG or other lightning were detected by the LINET network at this time or within about 100 ms before or after this peak. Therefore, the second peak is most probably due to the mesospheric current in the large carrot sprite. The charge moment change of the whole event was 6300 C km. The return stroke phase of the triggering +CG discharge contributed 350 C km.

**Case 2** featured two sprites in rapid succession, each triggered by a different +CG, located nearly 50 km away from each other. The charge moment change of the first sprite event was 6800 C km. It included 800 C km associated with the return stroke phase of the 53kA +CG. The second cluster of sprites occurred only 600 ms after the previous sprite, triggered by an 81 kA +CG, preceded by a weaker 12 kA +CG. The CMC of the second sprite event was 5300 C km, including 700 kA contributed by the return stroke of the two +CGs.

It is worth noting that these sprite events were associated with an ultra low frequency waveform (below 5 Hz) in the antenna that was nearly parallel to the discharge locations and could not record any strong magnetic field components generated directly by the discharge current.

## Acknowledgment

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