

**SDA - APiTOF field campaign: Impact of cosmic rays on the air ionization
“SDA ms – pulses”**

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- **Scientific objectives and motivation**

Secondary aerosol formation (Kulmala et al. 2013) is a significant source of climatically relevant particles (Kerminen et al. 2012). However, the role of atmospheric ions to aerosol formation is a controversial topic (Kirkby et al. 2011). At the ground level typical ion-pair production is not sufficient to explain the observed aerosol formation rate (Laakso et al. 2004) and the analysis has indicated a minor role of ion to the overall process (Gagne et al. 2008). However, directly opposite arguments have been raised pointing towards the dominant role of ion in the initial formation (Yu and Turco, 2008). The measurement data from Hyytiälä indicates that on a larger scale, galactic cosmic rays do not affect the formation of aerosol particles (Kulmala et al. 2010). However, scientifically still an unknown issue is the small scale variability and the effect of intensive short term bursts of ionization radiation and their role in the ion pair production and atmospheric ion chemical composition.

Regarding ions, there are observations that intrigue us during the last years. These observations were performed with Short Dipole Antenna (SDA) electric field instrument developed in LATMOS/France and represent short \sim milliseconds pulses of particular shape with amplitudes up to few tens on mV recorded in SDA AC channels. These pulses were observed in auroral and equatorial stratosphere (SDA balloon flights from Esrange/Suede and Bauru/ Brazil), and also on the ground (Paris, Esrange, Eldorado and Owens dry lakes/USA). In parallel, measurements made with Atmospheric pressure interface time-of-flight (APiTOF) mass spectrometer (private discussions with J. Duplissy/CERN and H. Junninen/UHEL) show the same types of pulses which could be interpreted as air ionization caused by cosmic ray interaction with the atmosphere.

- **Method and experimental set-up**

We propose to carry simultaneous and coordinate observations with two instruments, i.e. SDA/LATMOS electric field instrument and APiTOF/UHEL mass spectrometer. Two instruments were installed close to each other, but far from the sources of electromagnetic perturbations. The exact accommodation will be defined and tested during first day of observations. Two instruments have to be time synchronized.

The Short Dipole Antenna (SDA) developed in LATMOS is the electric field instrument which is capable of measuring electric fields up to \sim few tens of kV m⁻¹ from DC to \sim 3 kHz with very high sensitivity, about \sim 10 μ V m⁻¹ Hz^{-1/2}. The SDA consists of 3 cylindrical electrodes mounted on the top of electronic box with insulated masts. Each electrode measures the potential with respect to the reference box.

SDA characteristics:

- Passive and autonomous
- Weight: 2.7 kg
- Dimensions (without masts): 16cm x 16cm x 24cm
- Power: internal batteries, autonomy > 10h
- Consists of electronics inside of aluminium box + 3 masts + 3 electrodes + GPS for data datation
- Data are recorded on -board and transferred after observation sequence through Ethernet link to PC.

- **Reason for choosing station**

APiTOF was installed and running at the SMR station in May-June 2013.

- **Preliminary results and data analysis**

The following steps were performed during/after campaign:

- Tests and analysis of on-site electro-magnetic perturbations
- Synchronisation of SDA and APiTOF dating
- Observation sequences of SDA and APiTOF in different configurations
- Observation sequences of SDA, Cosmic Ray Counter (CRC), APiTOF
- Preliminary analysis of measurements made by the instruments
- Preliminary analysis of datation of each instrument



Fig. 1 (left) SDA installed on the roof of APiTOF shelter; **(right)** SDA and CRC placed in the forest of SMR station

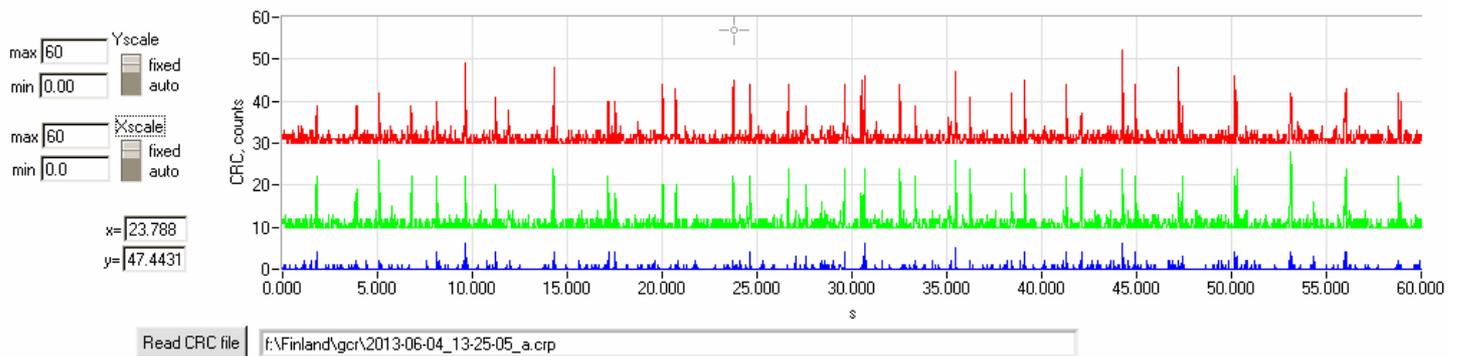


Fig. 2 Example of the CRC 60-s measurements on June, 4

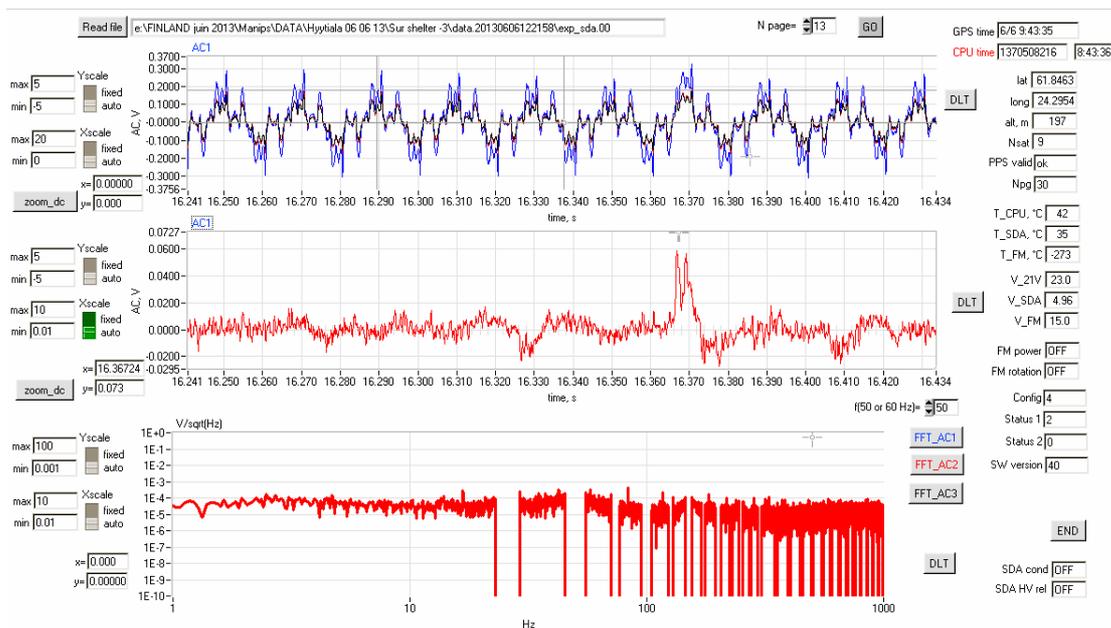


Fig. 2 SDA observations: (top) AC raw data; (middle) AC filtered data; (bottom) power spectrum of AC signal

• Outcome and future studies

Critical point of simultaneous observations made with different instruments is the absolute data datation, which has to be better than mili-second. The SDA instrument uses a GPS with PPS analog signal for datation of the electric field data, which ensure such accuracy of absolute timing. In addition we made a request for EUCLID/NORDLIS lightning data, which will allow to ensure the timing precision better than micro-second. APITOF and CRC are using PC datation.

We are waiting for the results of detailed data analysis of the APITOF instrument to perform the analysis of two data sets.

The next steps will be:

- Detailed analysis of two data sets
- Looking for a solution of the data timing synchronization

Additional field campaigns will possibly need to confirm the results and improve the data synhronisation / interpretation.

• References

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