13th AGILE Science Workshop
"AGILE: 8 and counting"
May 25 and 26, 2015
ASI Headquarters, Via del Politecnico, Rome

In-flight measurements of high-energy radiation from lightning and thunderclouds

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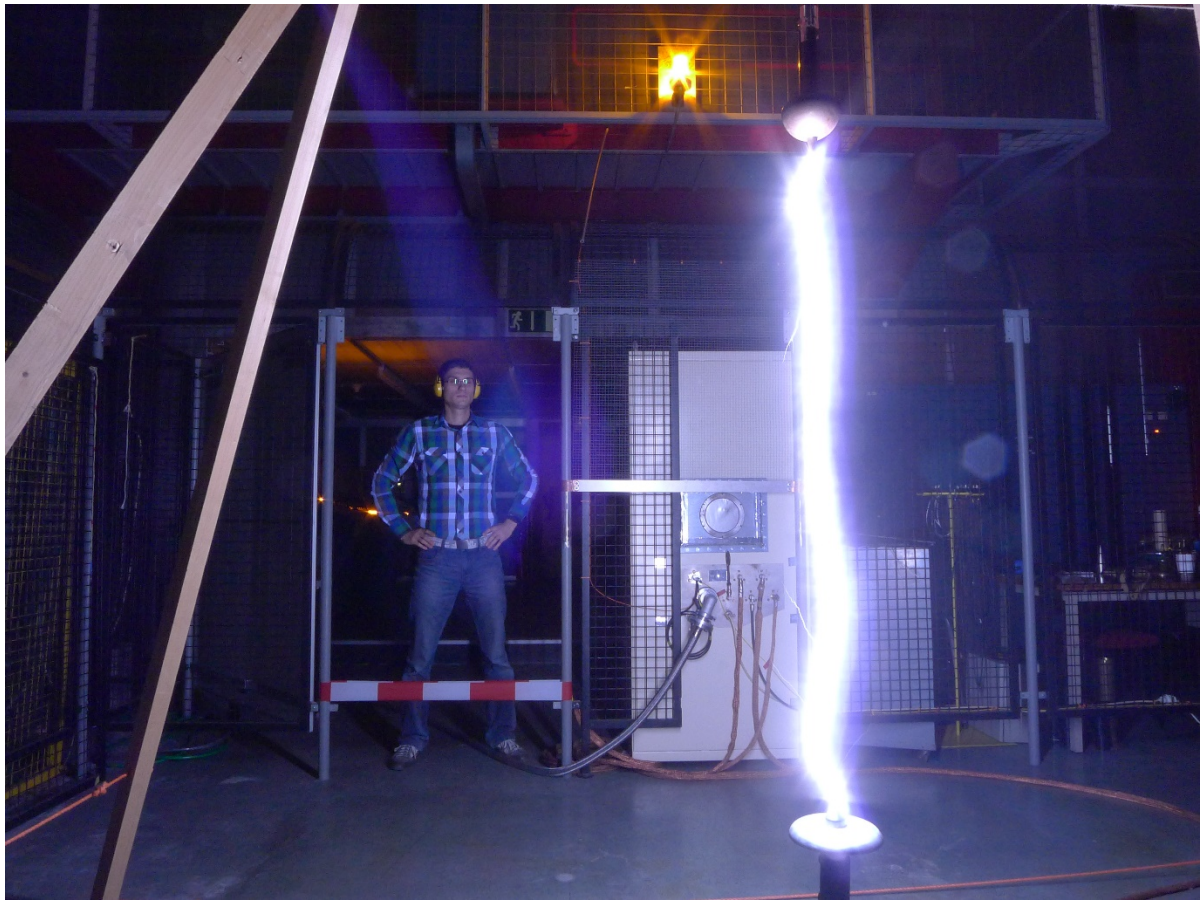
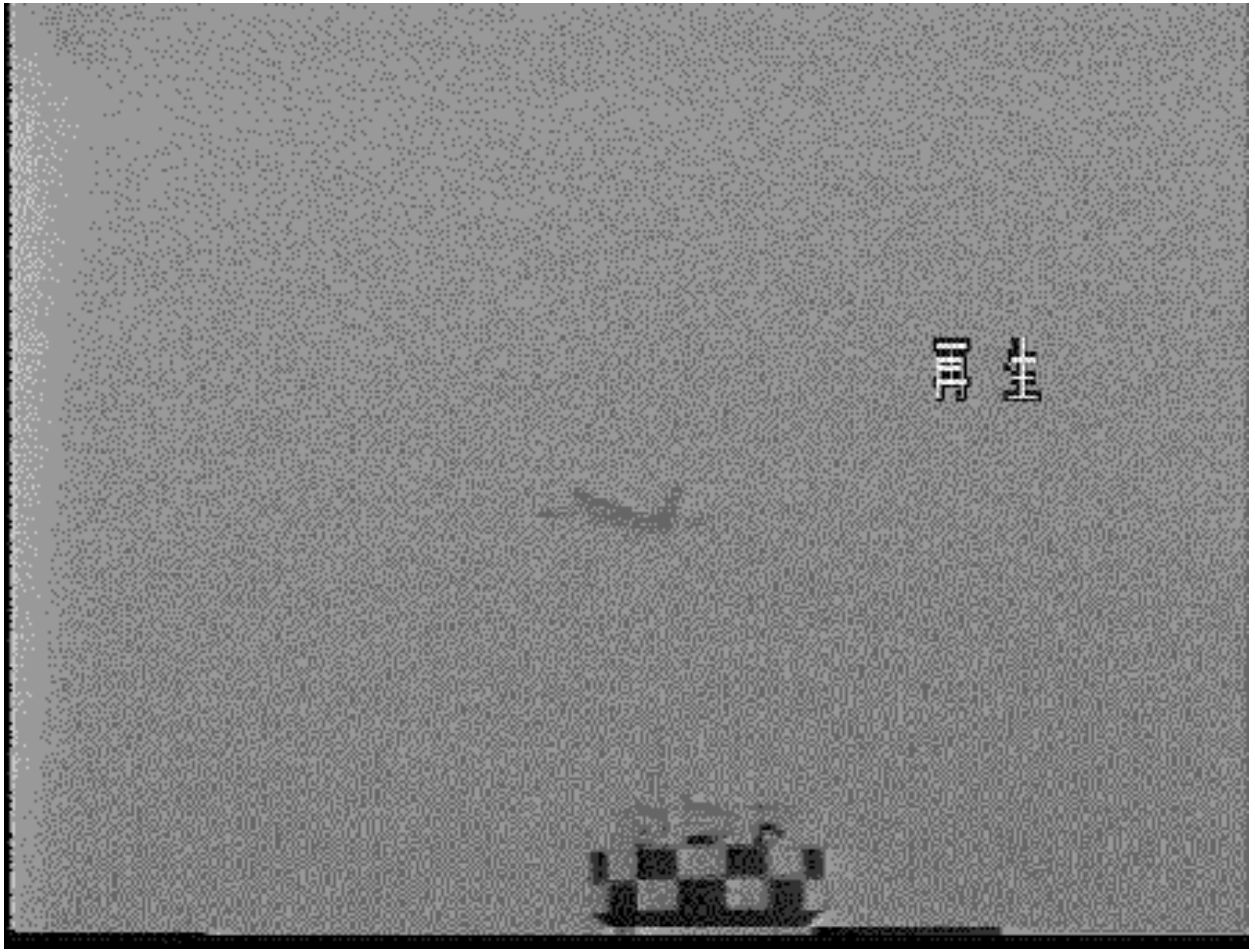
Long laboratory sparks



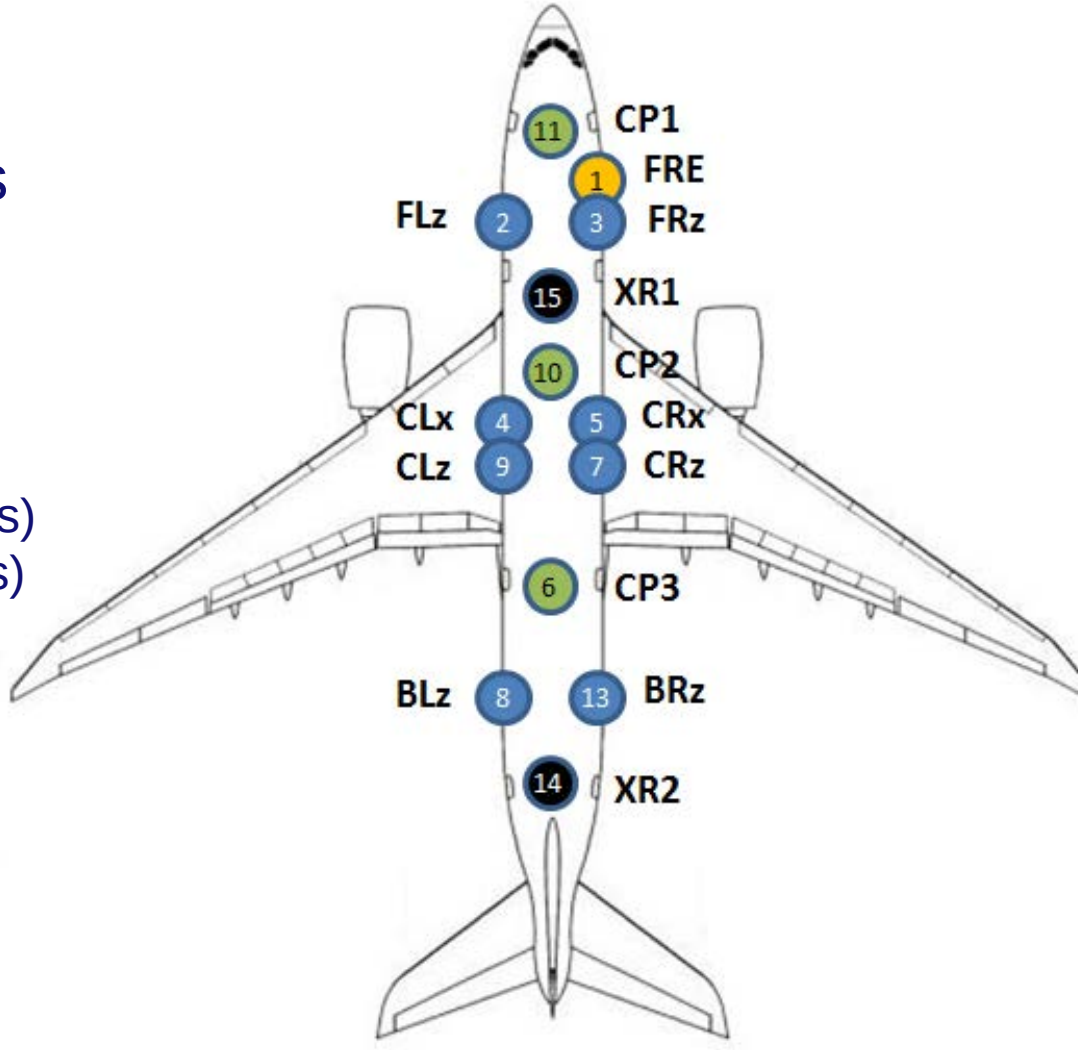
Problem



ILDASystem

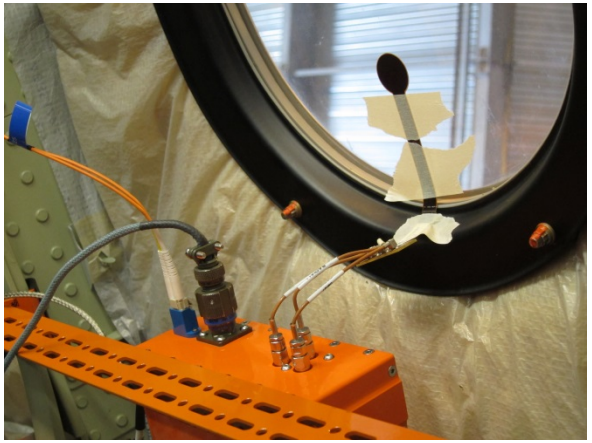
- 1 E-field sensor
- 8 window H-field sensors
- 2 X-ray detectors

- Continuous data (15 ms intervals)
- High-speed data (10 ns intervals)

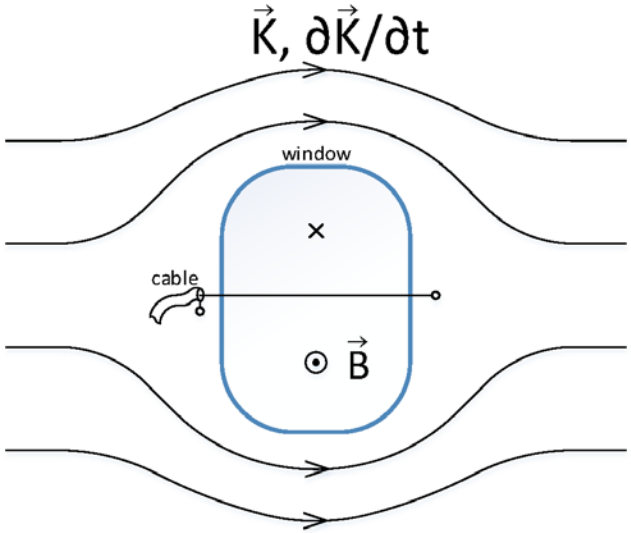


D/I measurements in aircraft

- Differentiating sensor
- Transport by cable
- Integrator
- Registration in EMC cabinet



E-field



H-field window sensor

IE3 J. Sens. 11 (2011) 199

D/I measurements in aircraft

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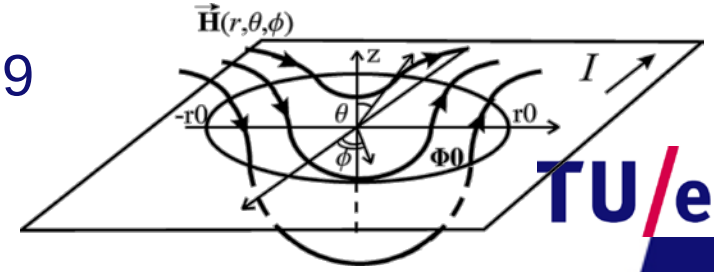
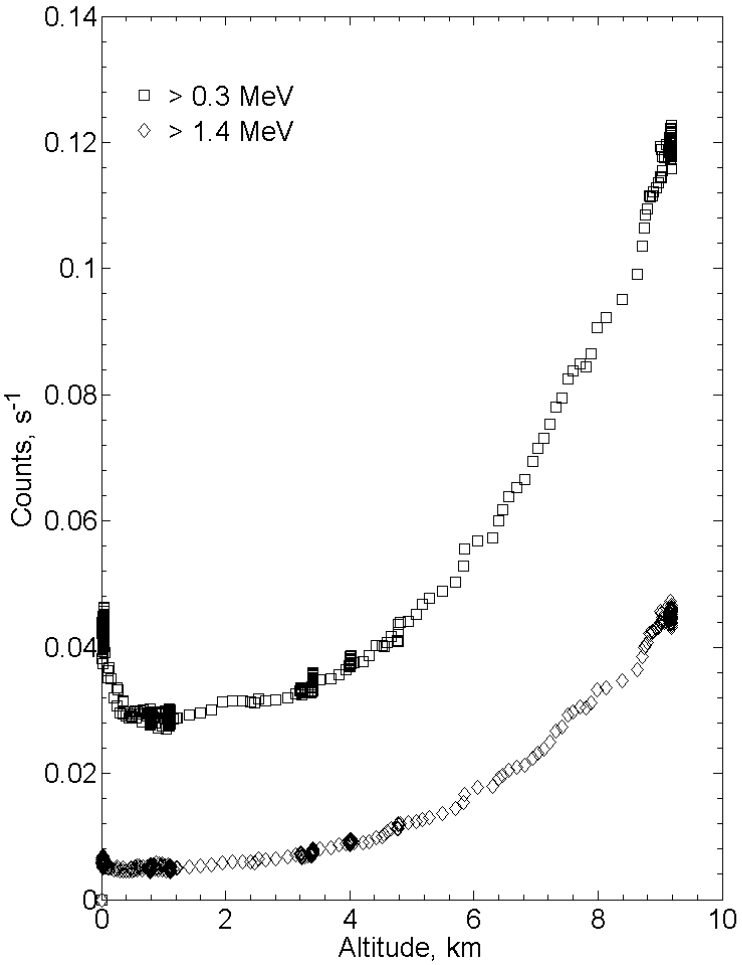
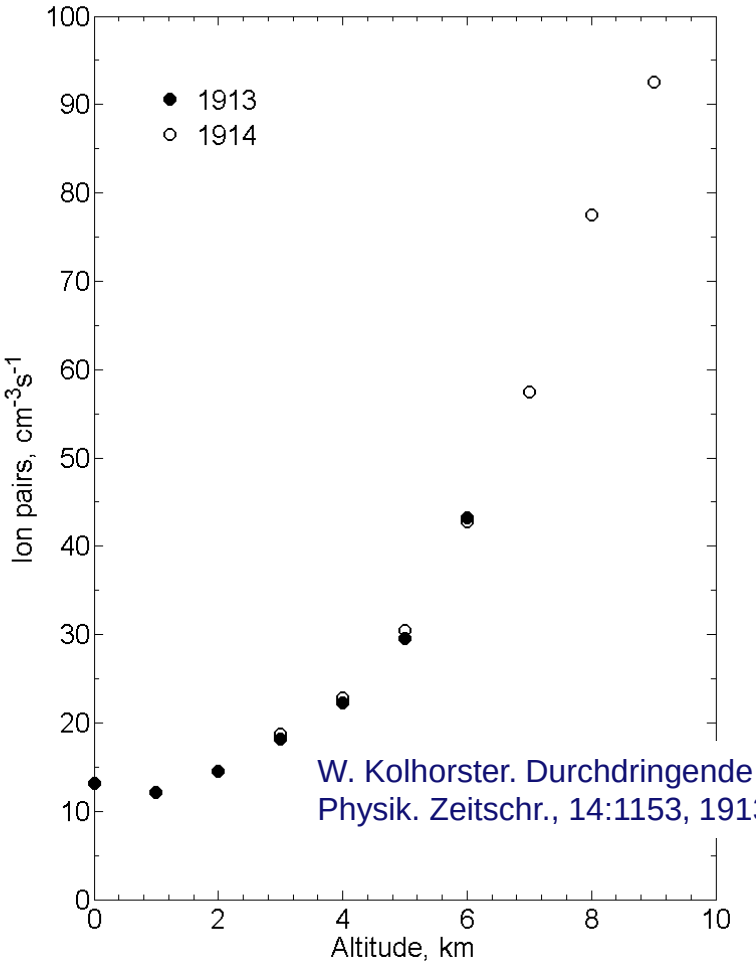
H-field window sensor

IE3 J. Sens. 11 (2011) 199



Background





W. Kolhorster. Durchdringende Strahlung. Physik. Zeitschr., 14:1153, 1913.

TU/e Technische Universiteit Eindhoven University of Technology

We did just the opposite

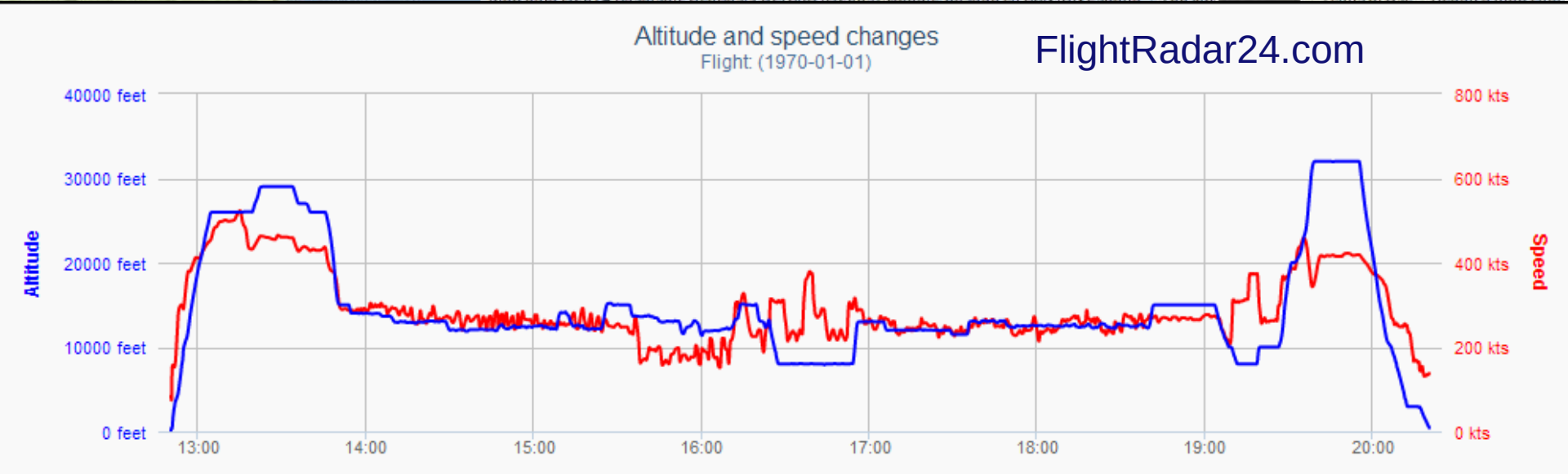
“*We* started every day the same way: looking at weather reports all over Europe and phoning national weather stations to try and find the right kind of storm.

On the radio, we would hear other pilots asking air traffic control to guide them around storm cells.

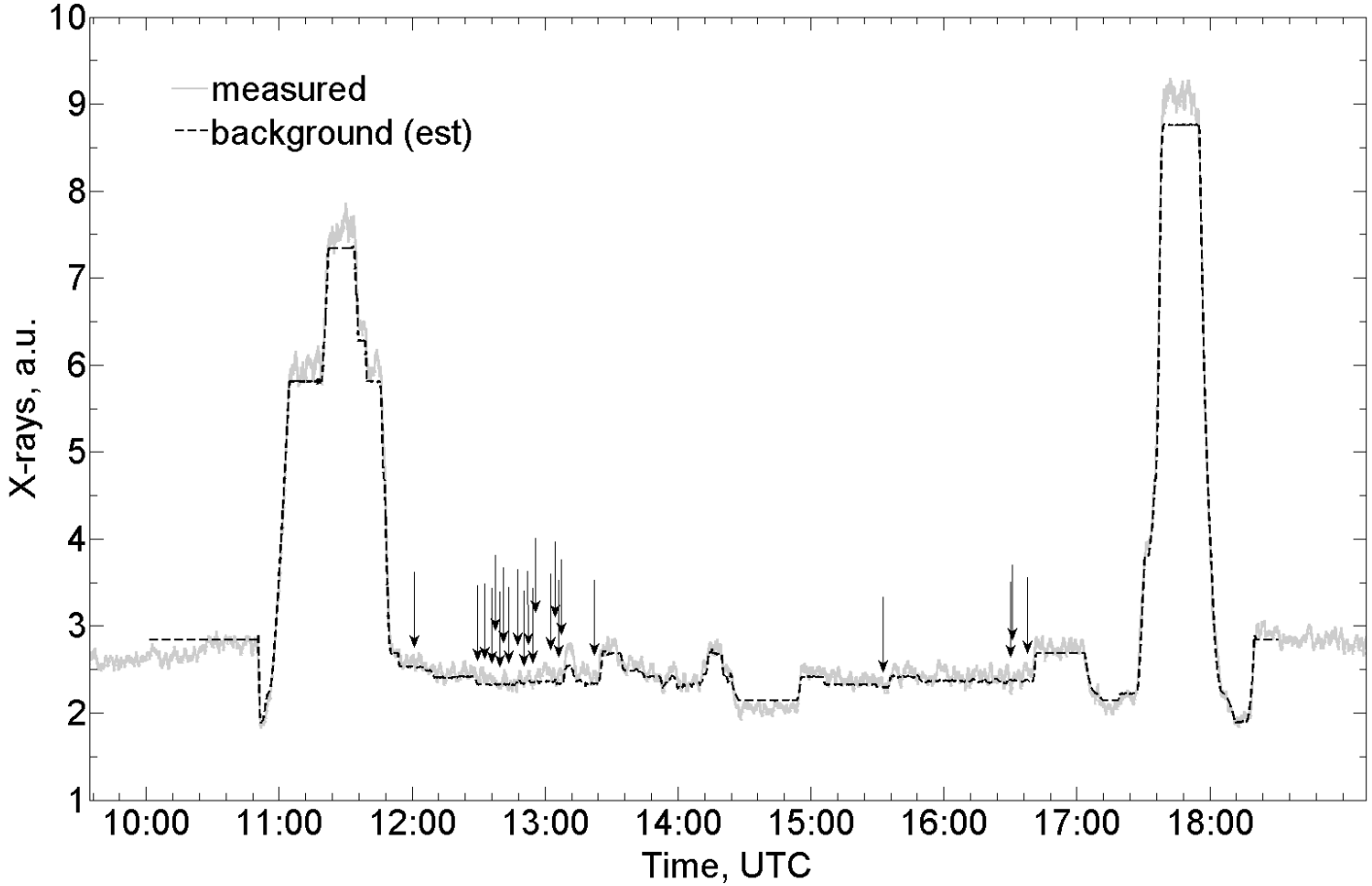
We did just the opposite: we asked to go directly into them. Those other pilots must’ve thought we were crazy.”

Emanuele Costanzo, flight test engineer

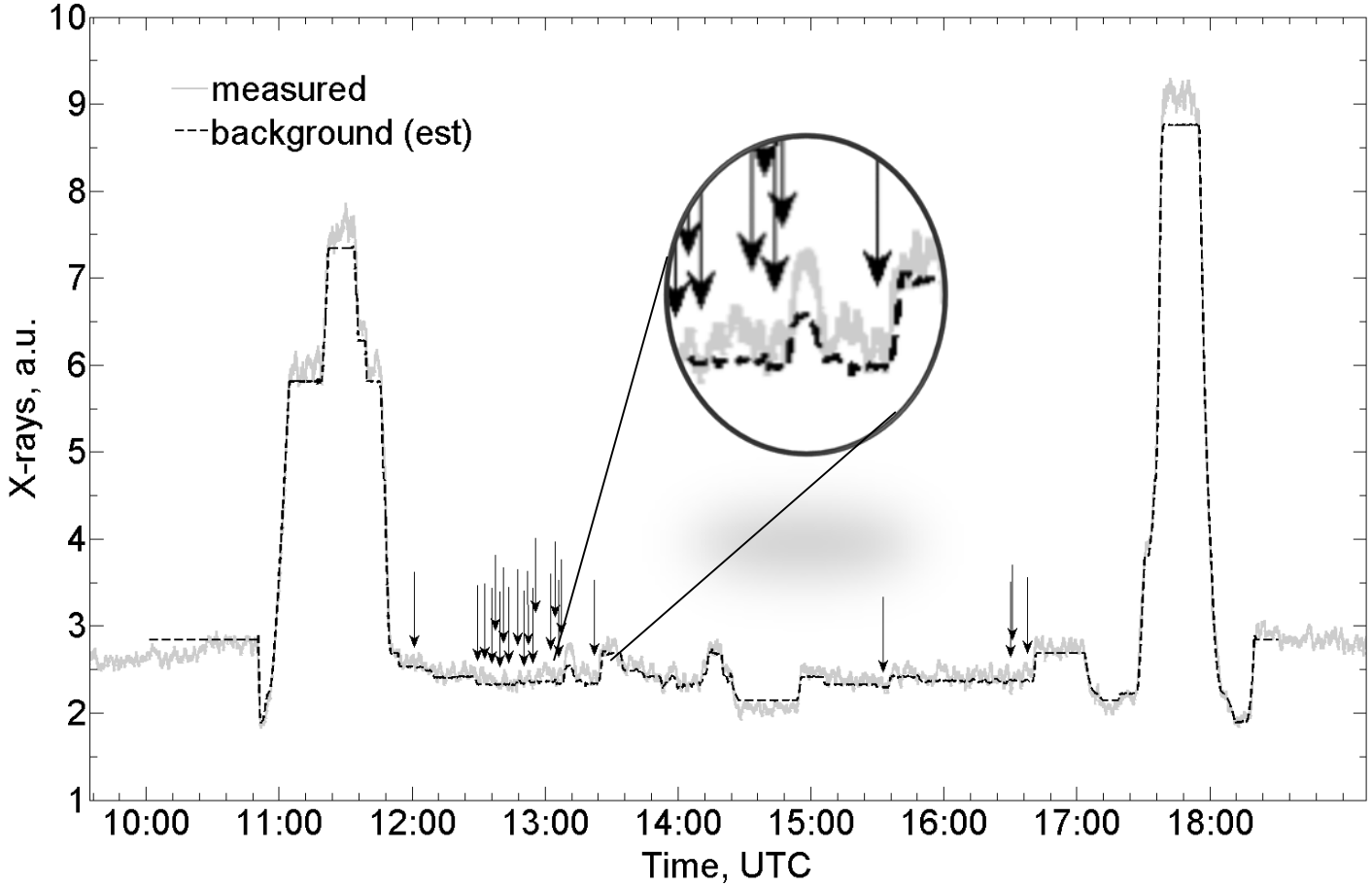
30 April, 2014



Radiation


measured
background (est)
X-rays, a.u.
10
9
8
7
6
5
4
3
2
1
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
Time, UTC

Long gamma-ray glow

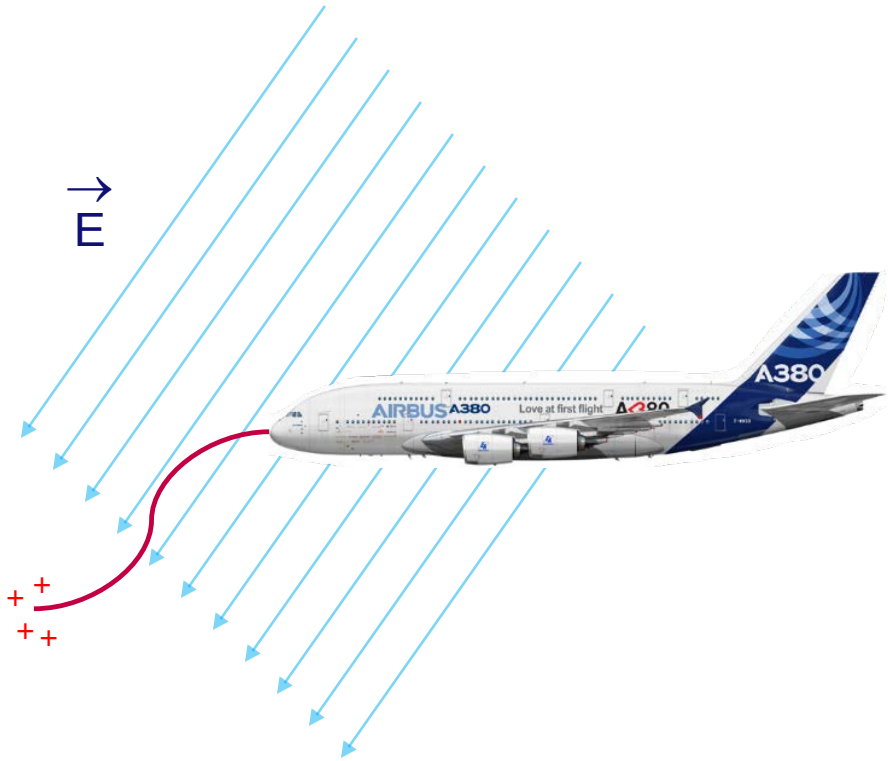


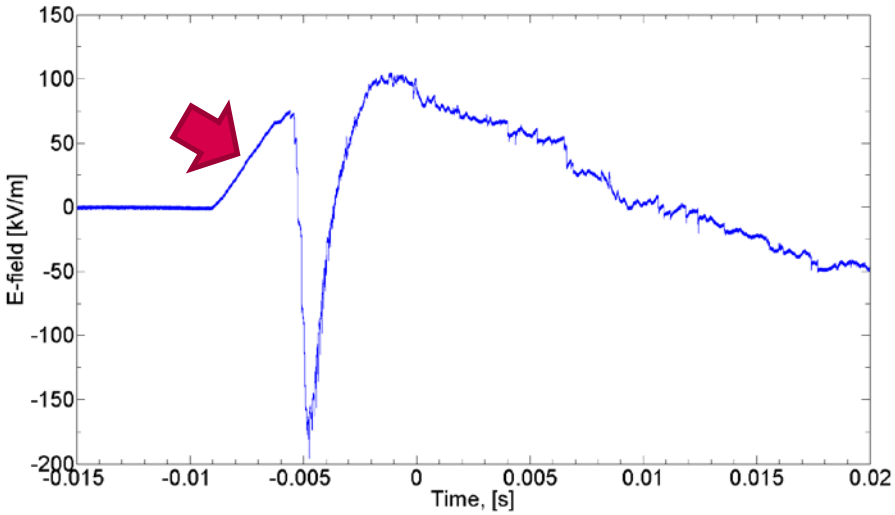
Lightning interaction with an aircraft

- **Aircraft-intercepted (a few percent)**
- **Aircraft-initiated (most often)**

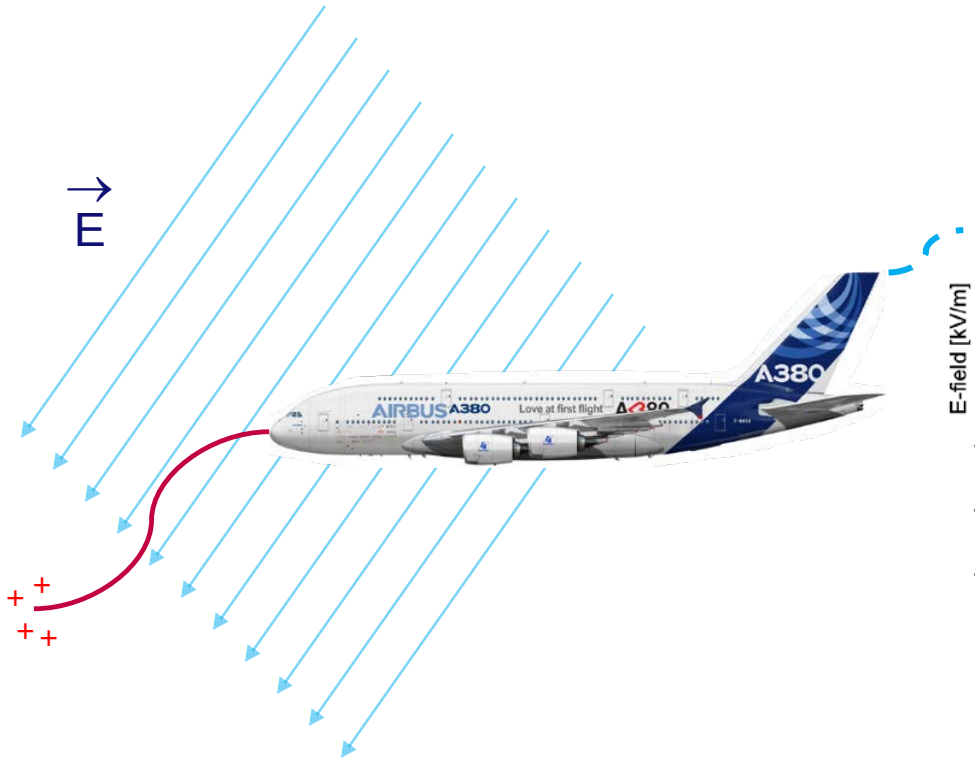
Aircraft-initiated lightning

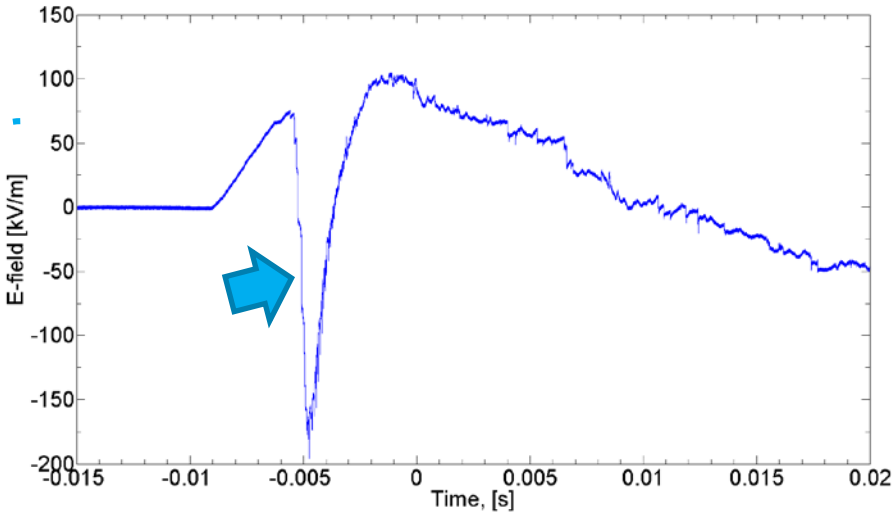
Aircraft-initiated lightning



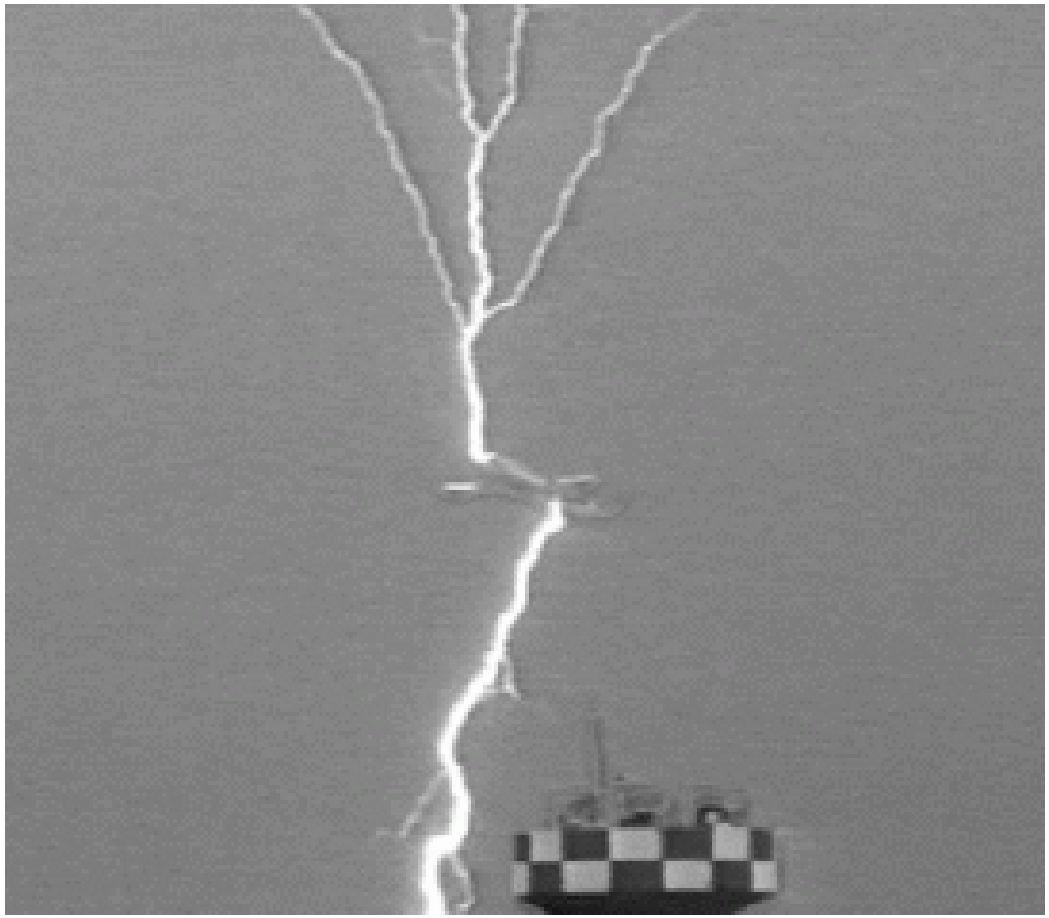


Aircraft-initiated lightning

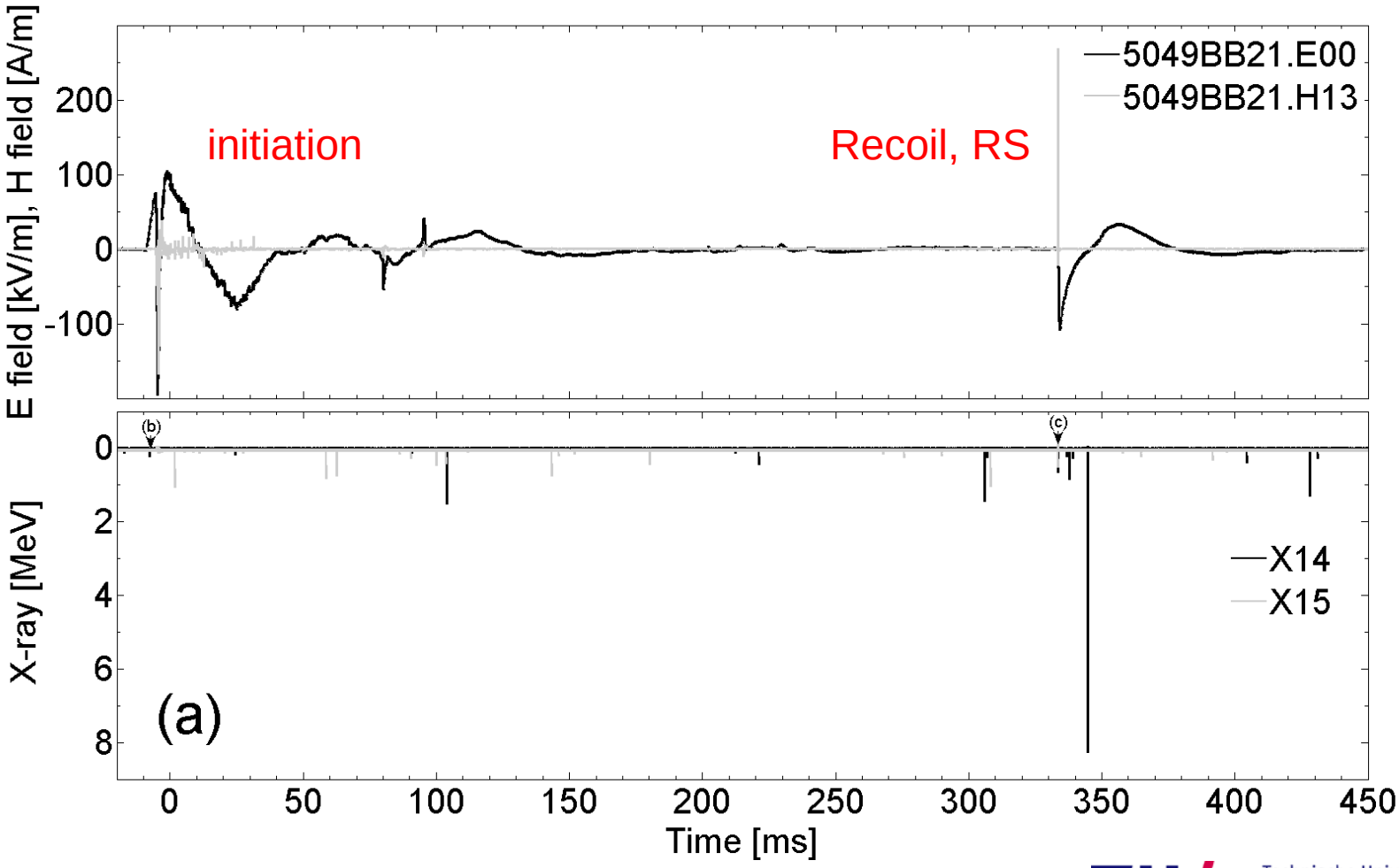




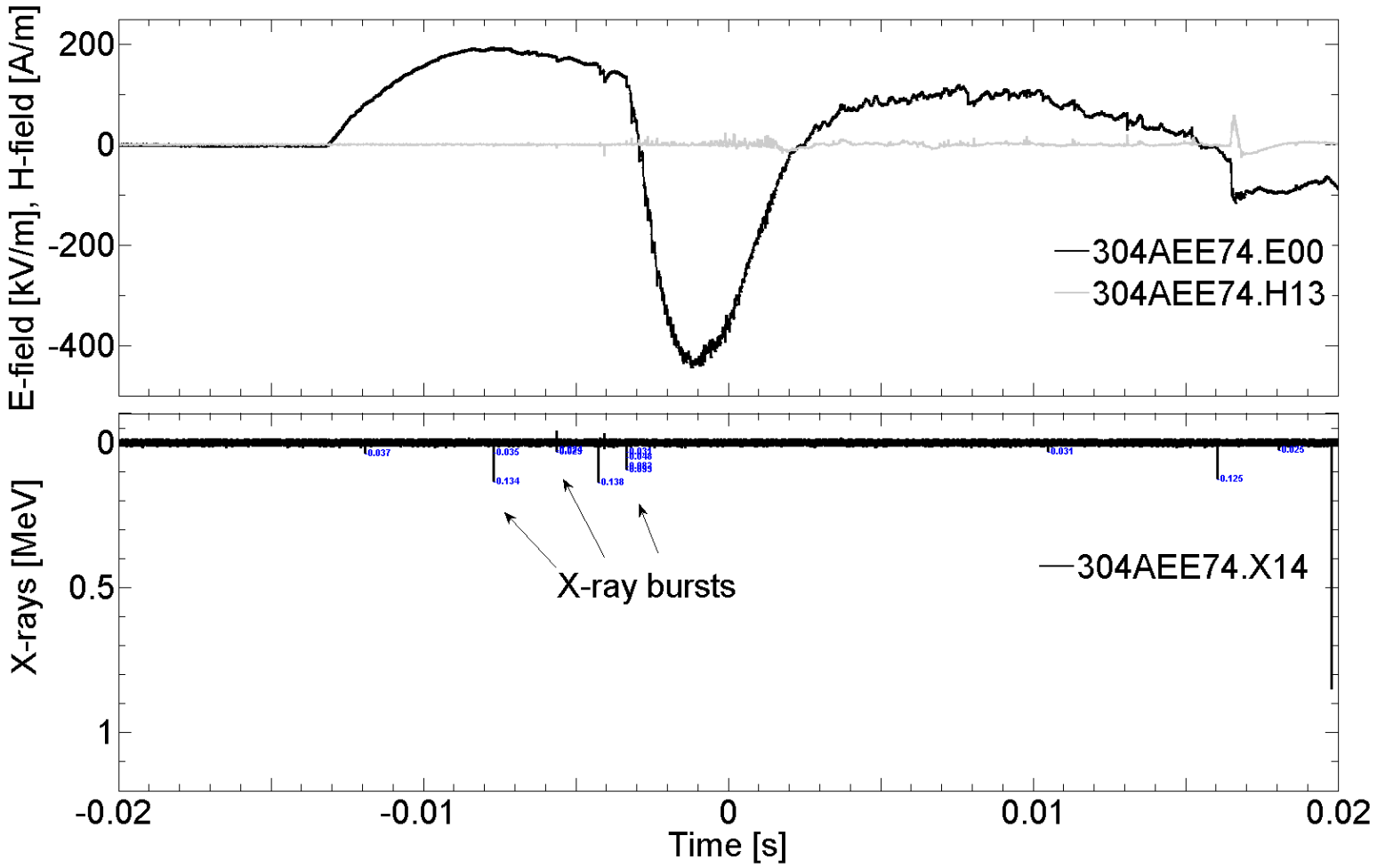
Aircraft-initiated lightning



Lightning strike



X-rays from negative corona



Technische Universiteit Eindhoven University of Technology

To conclude

- Ildas + 2 × x-rays operating
- X-rays linked to - initiating negative leader steps and
  - recoil processes a.o. return stroke
- 1 - 4 μs x-ray bursts immediately (< 1 μs) precede the current of the recoil processes.
- X-ray energies up to 10 MeV. Single photon?
- X-ray intensity and spectral distribution known
- Association with the current distribution….
- CDF provides weak indication for long gamma ray glow.
- New flights this month, improved x-ray part

- No positrons in our data

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