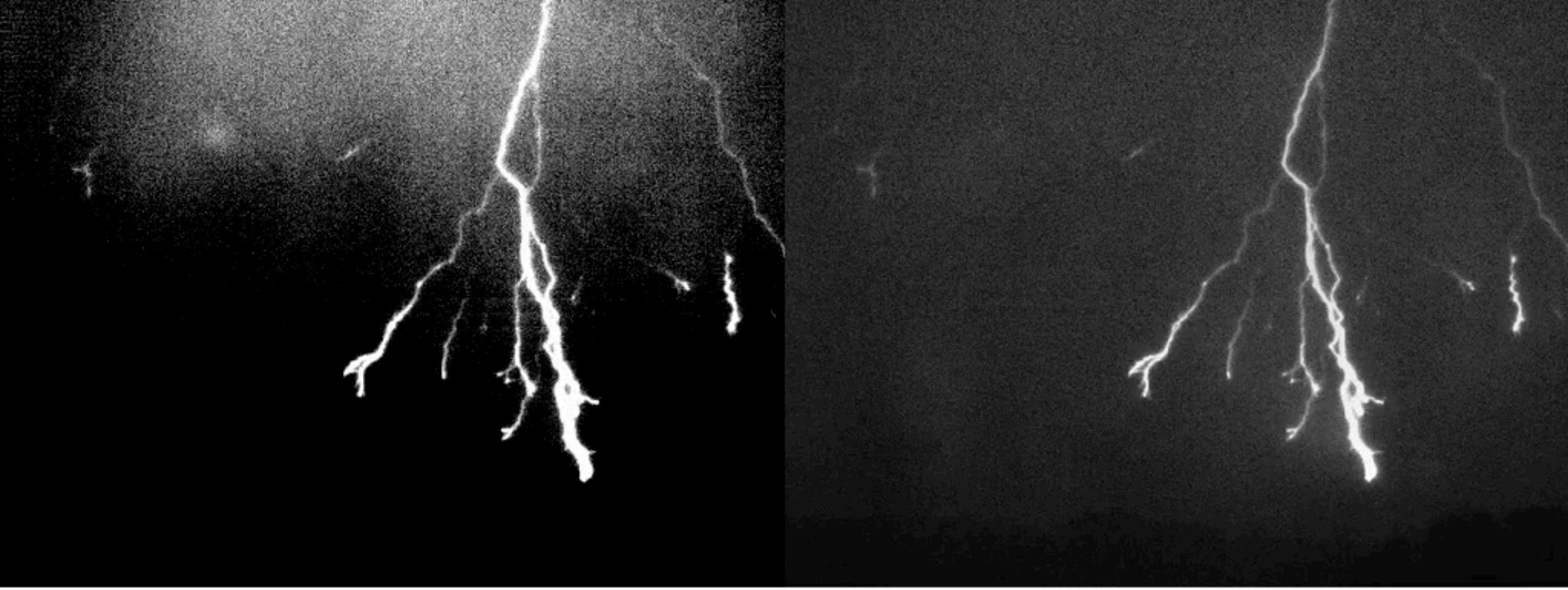
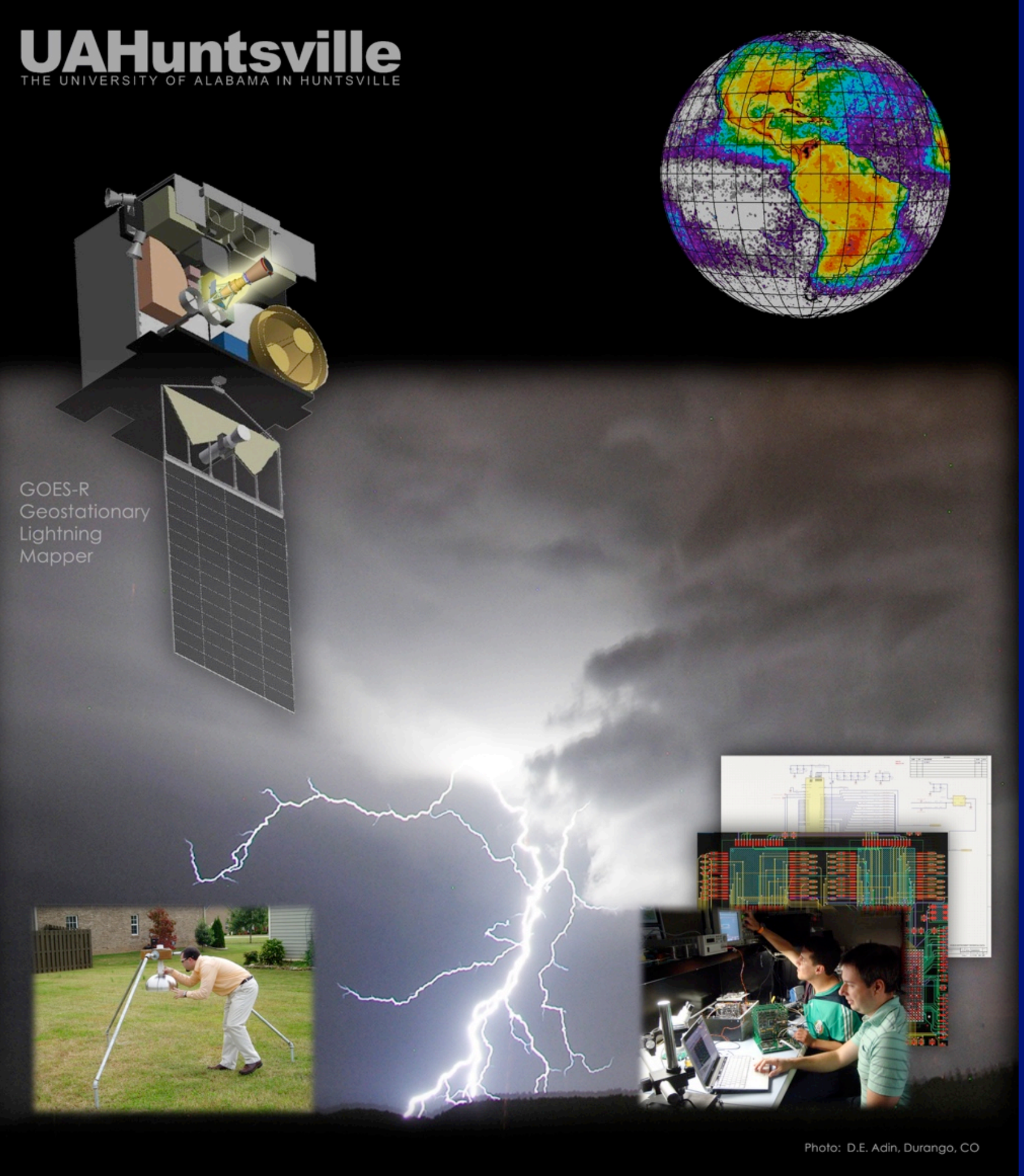

1•10^7
8•10^6
6•10^6
4•10^6
2•10^6
0
0
100
200
300
400
500
Fr. Num
−0.100
−0.160
−0.220
0.0
0.5
1.0
1.5
Milliseconds; Reference time of origin: 80982.272500
−0.100
−0.300
0
50
100
150
Milliseconds; Reference time of origin: 80982.250000
Frame 344

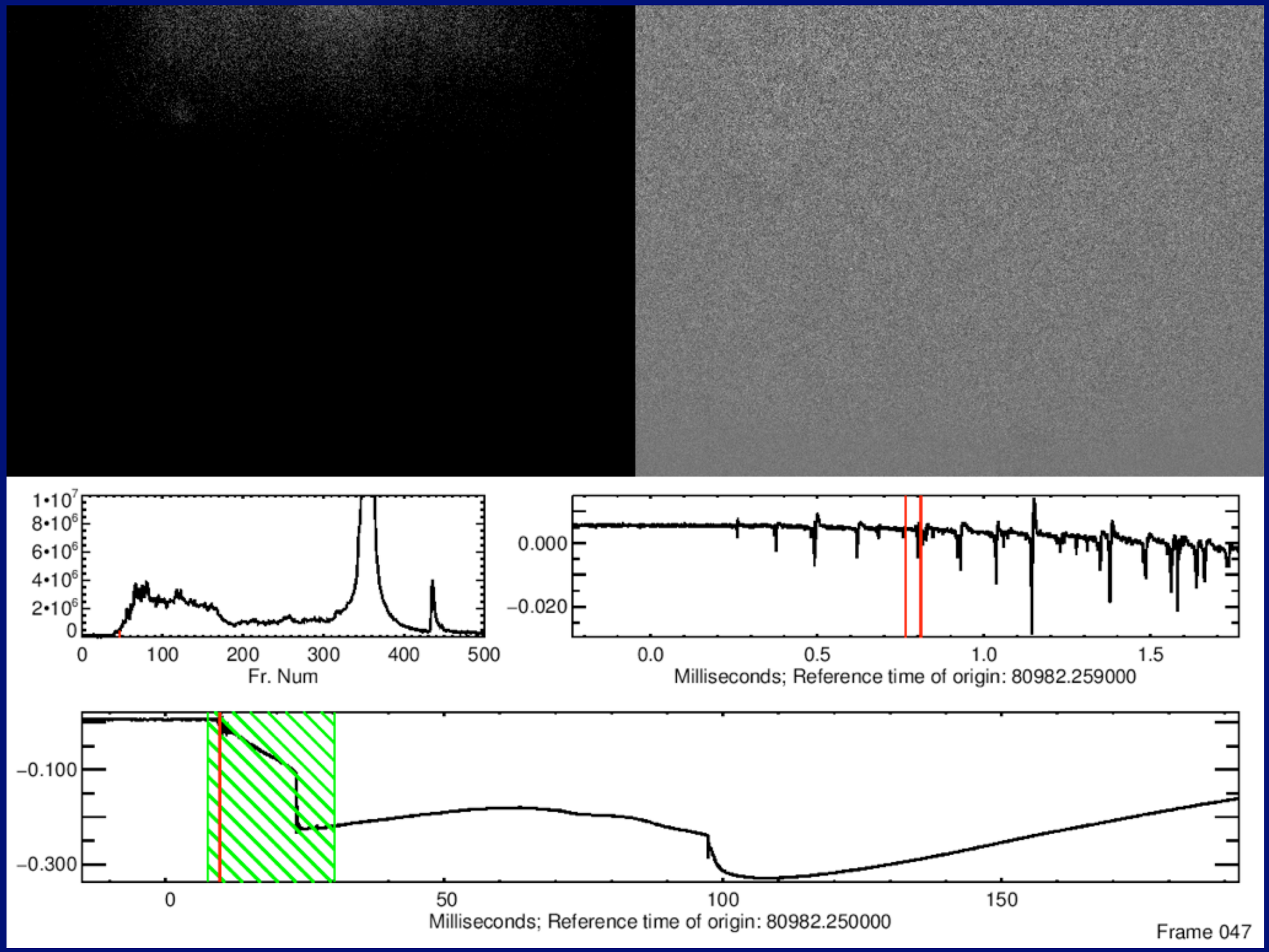
UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE



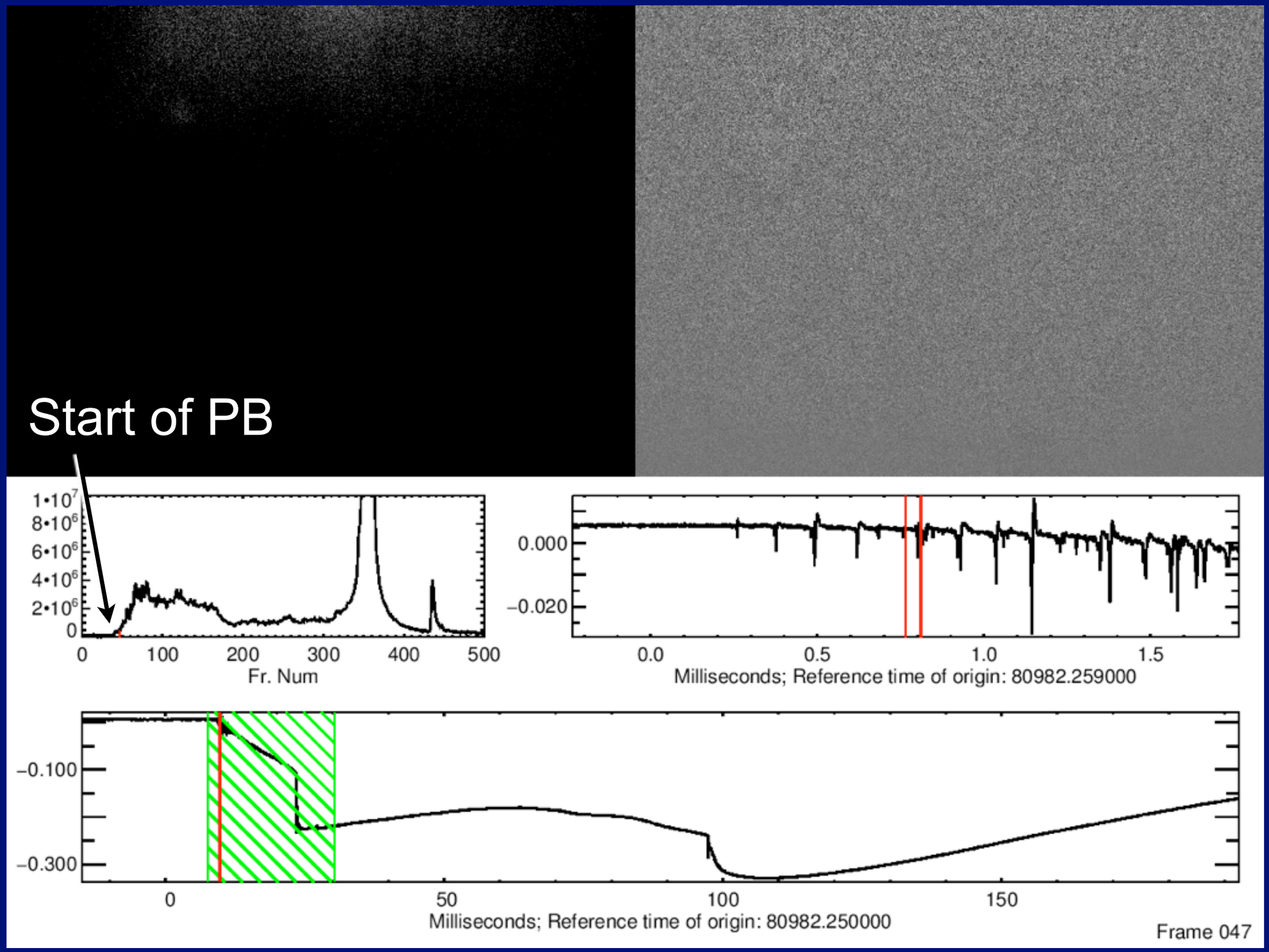
LIS Groups, Electric Flelds, and You

Phillip M. Bitzer, Hugh Christian, Veronica Franklin, Kelcy Brunner-Miller, Jeff Burchfield, Daniel Walker

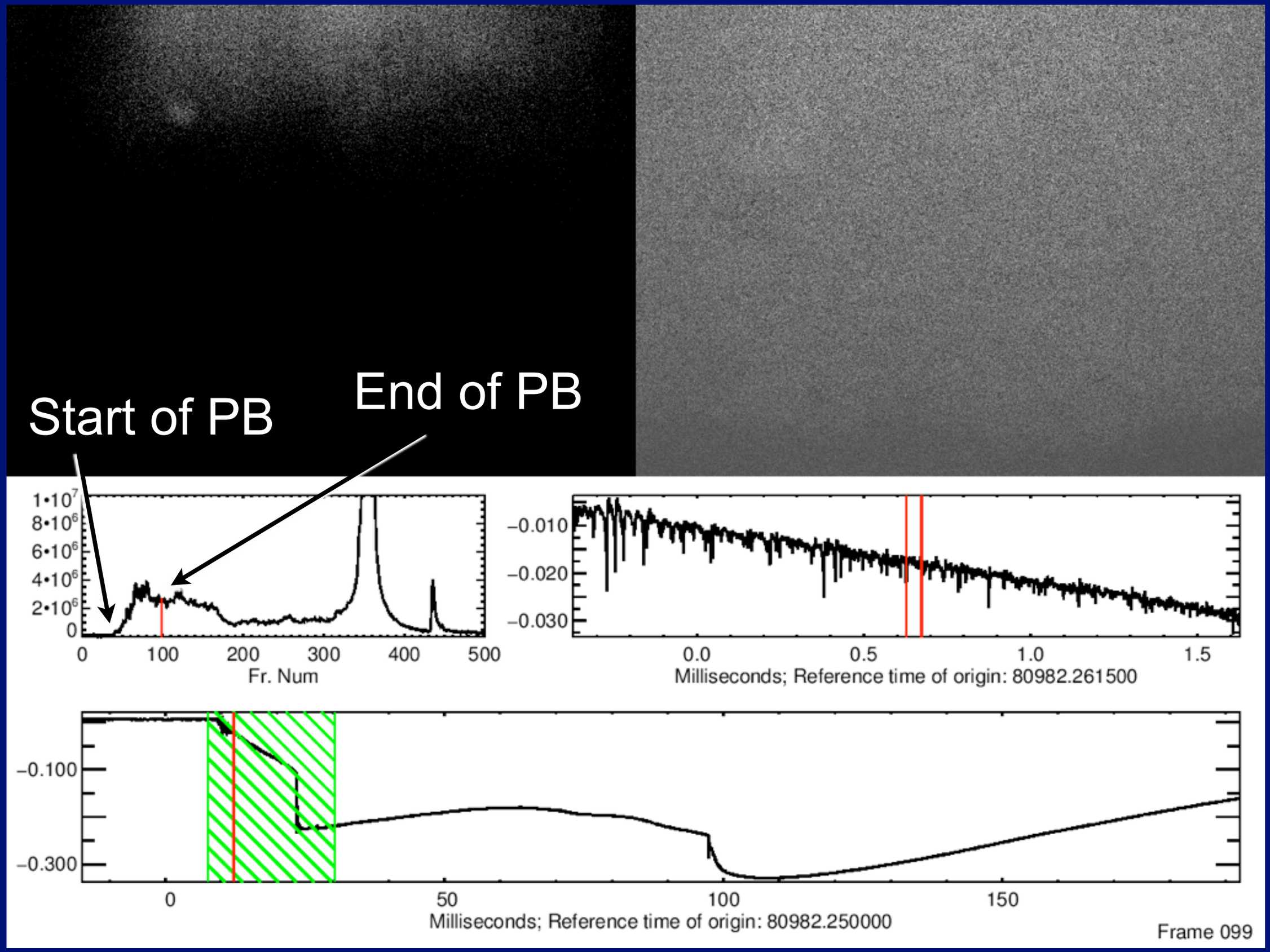
Mike Stewart, Scott Podgorny, David Corredor, Evgeny Kuznetsov



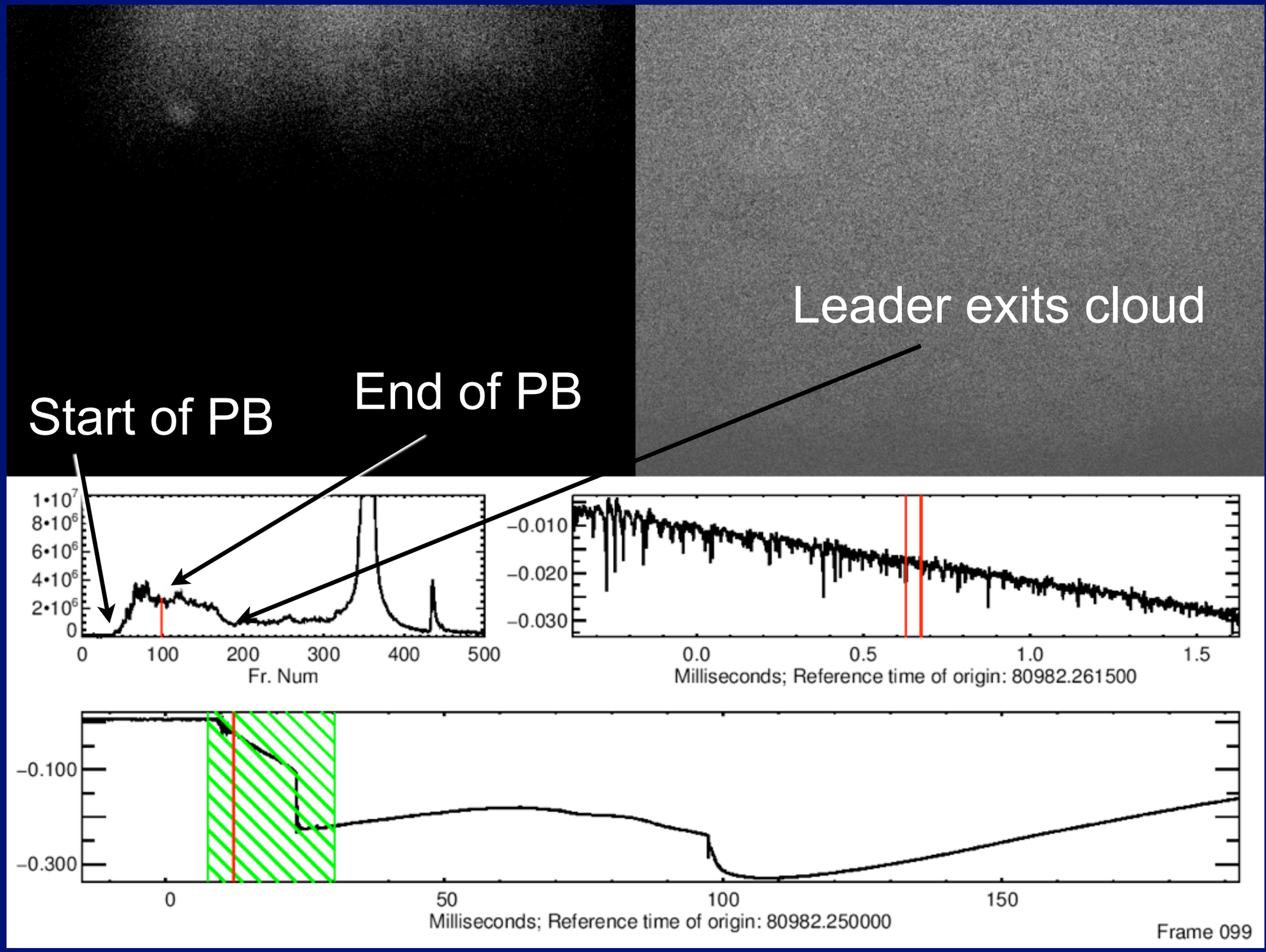
Back to the animation....



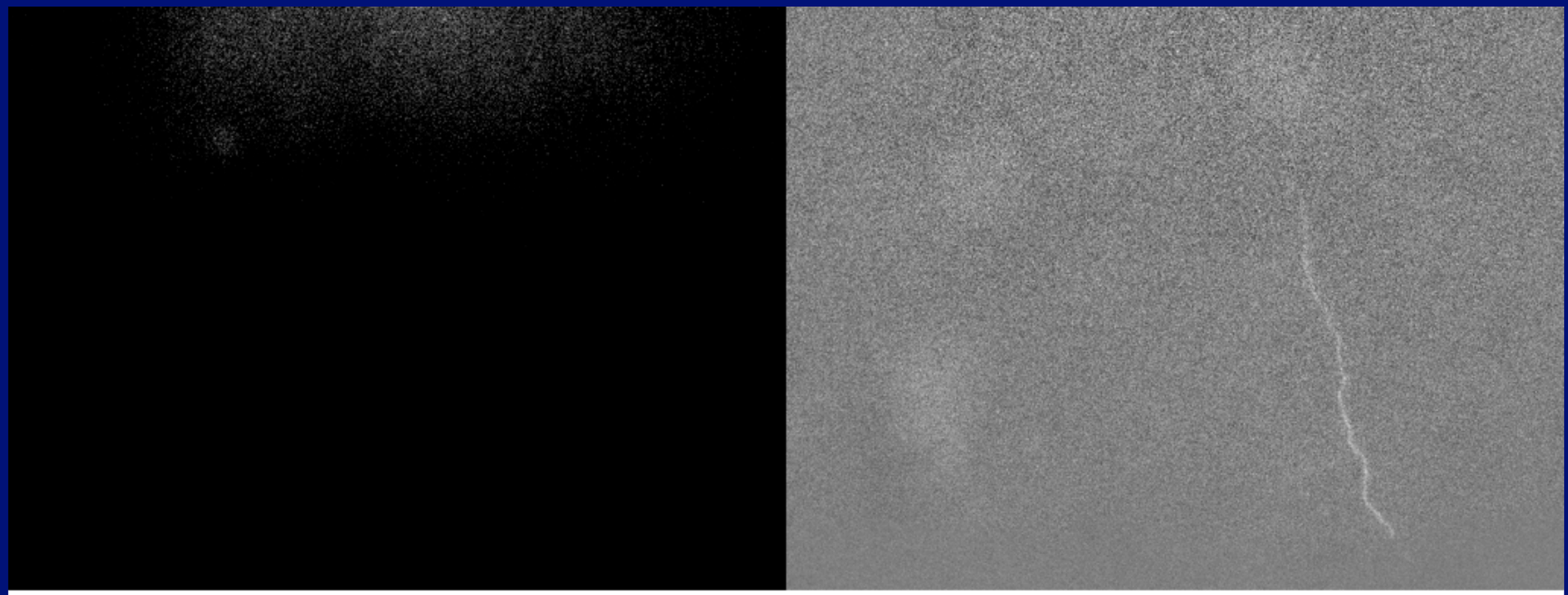
Back to the animation....



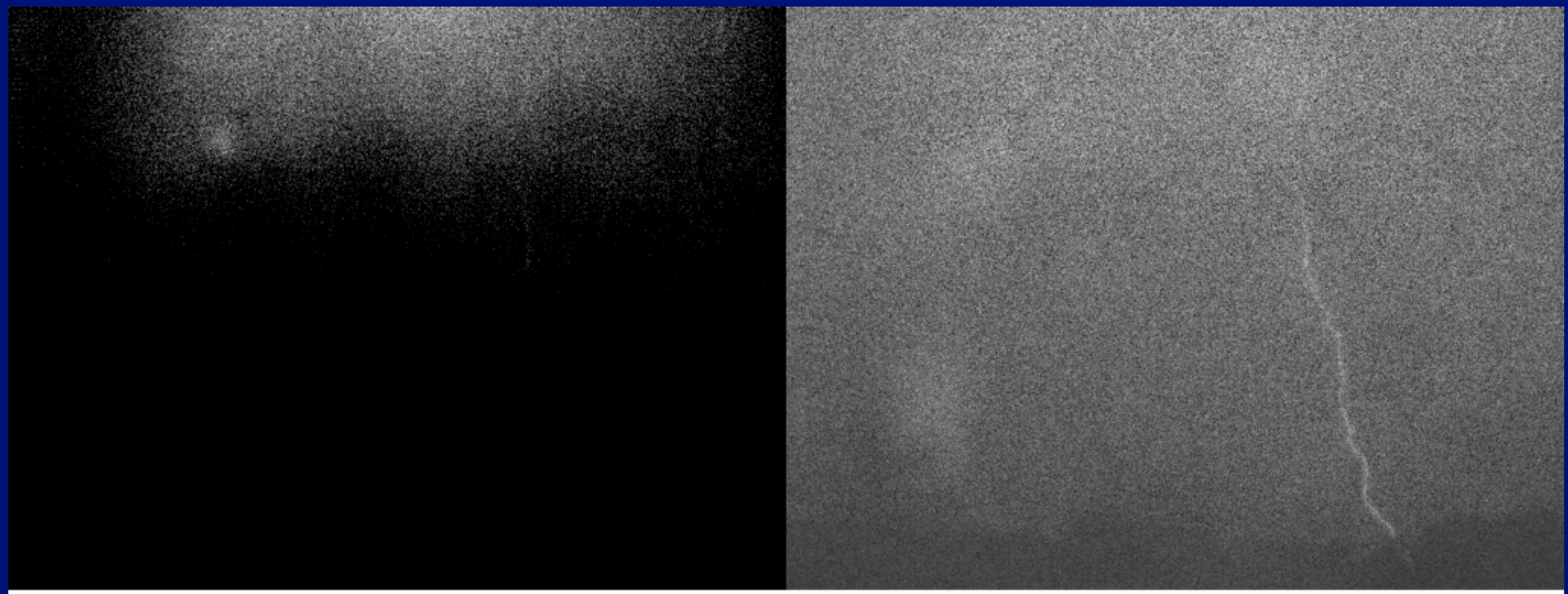
Back to the animation....



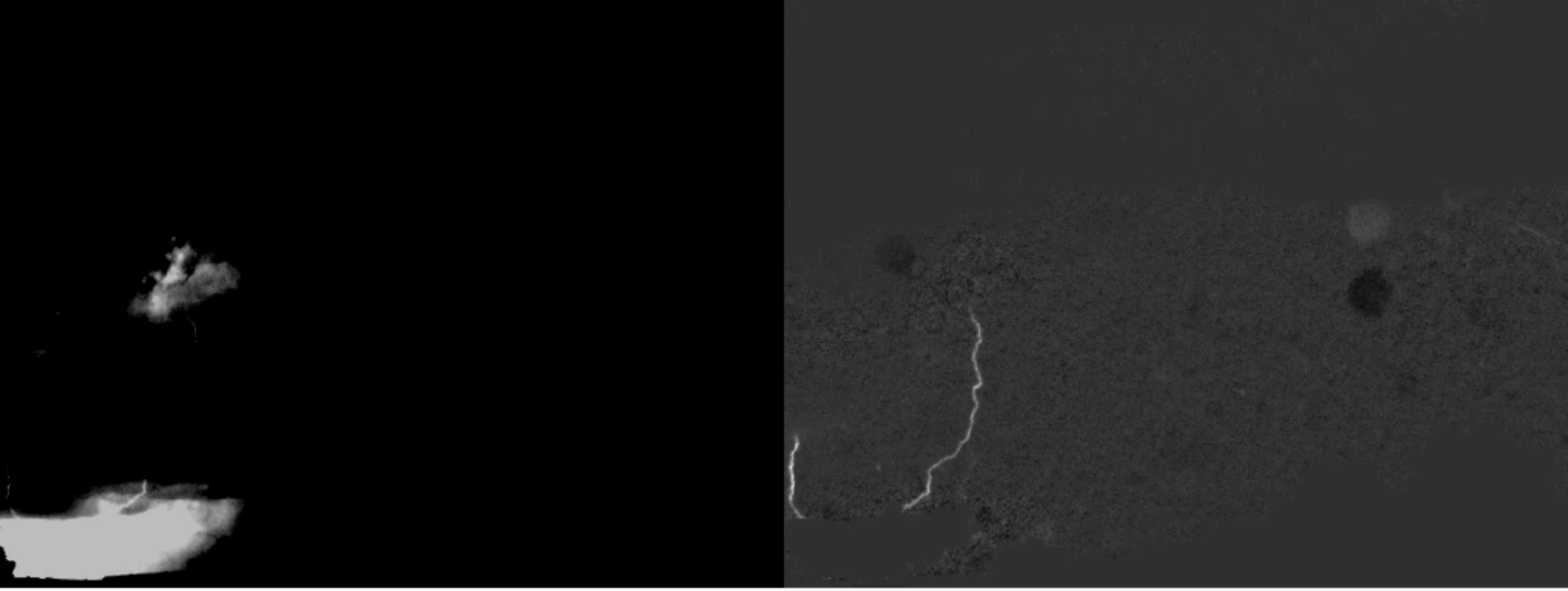
Back to the animation....

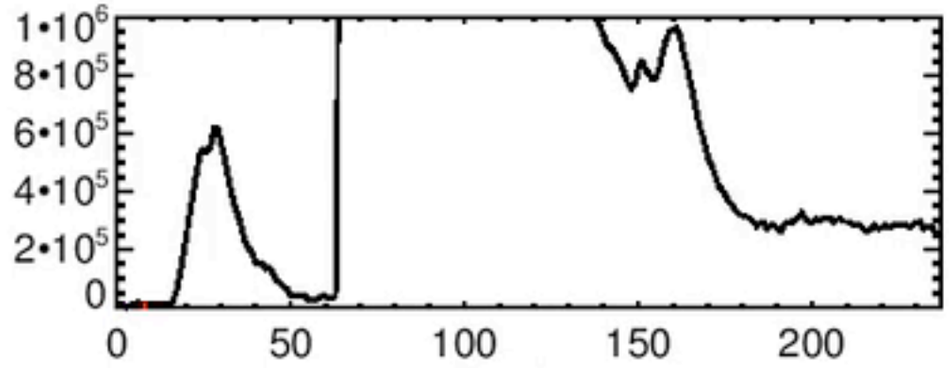


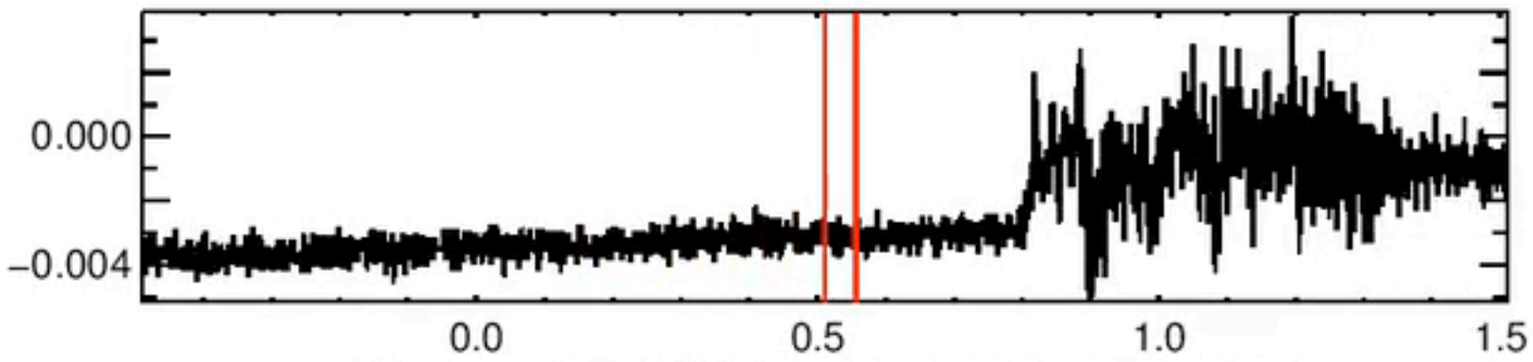
“K change” before

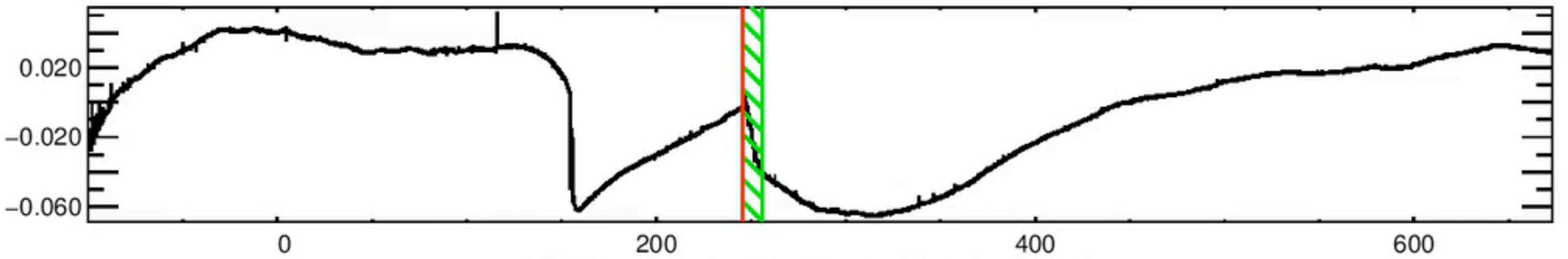


“K change” after

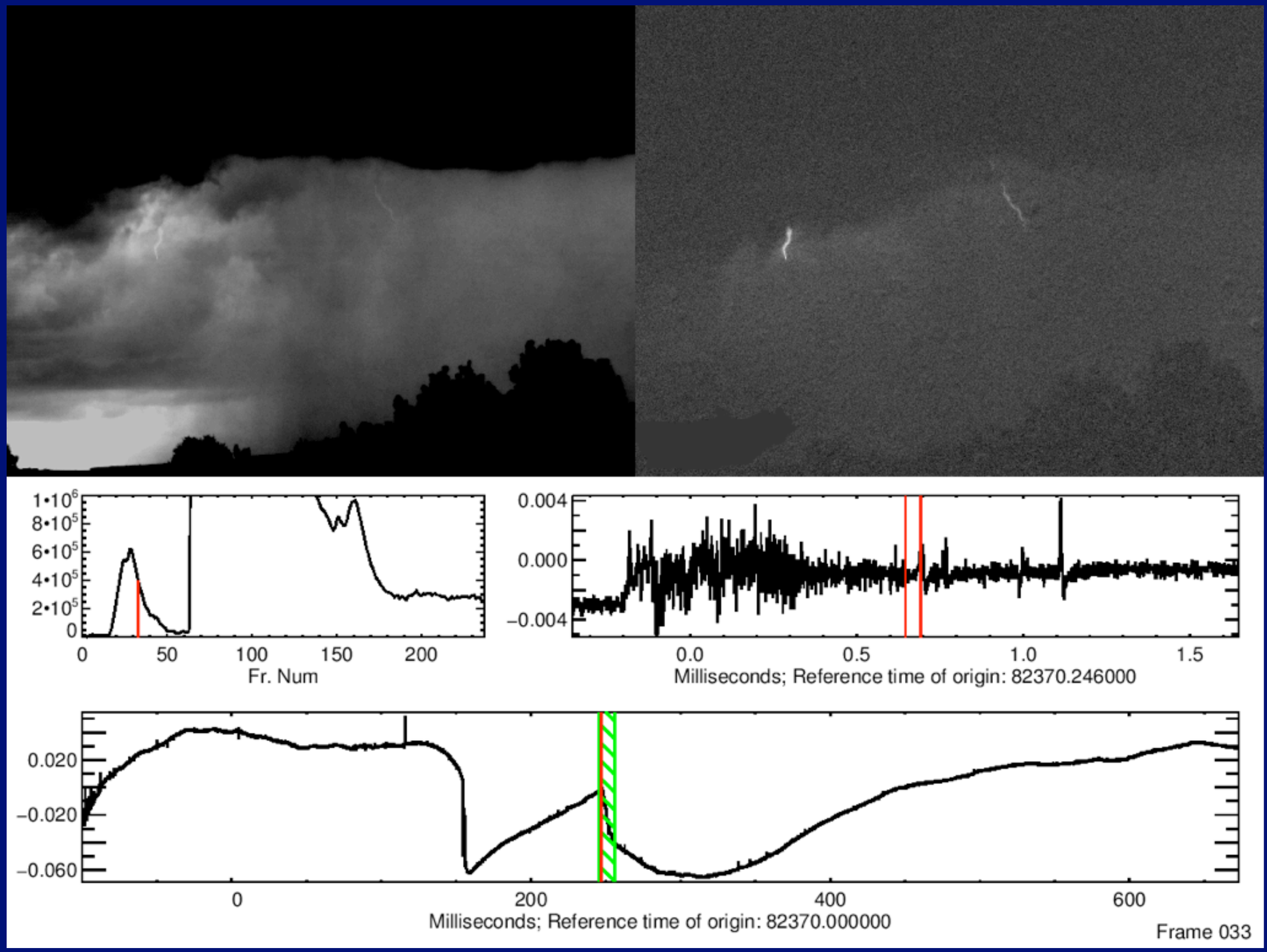

1•10^6
8•10^5
6•10^5
4•10^5
2•10^5
0
0 50 100 150 200 250 300
Fr. Num
0.012
0.008
0.0 0.5 1.0 1.5
Milliseconds; Reference time of origin: 82370.152000
0.020
−0.020
−0.060
0 200 400 600
Milliseconds; Reference time of origin: 82370.000000
Frame 252


1•10^6
8•10^5
6•10^5
4•10^5
2•10^5
0
0
50
100
150
200
Fr. Num

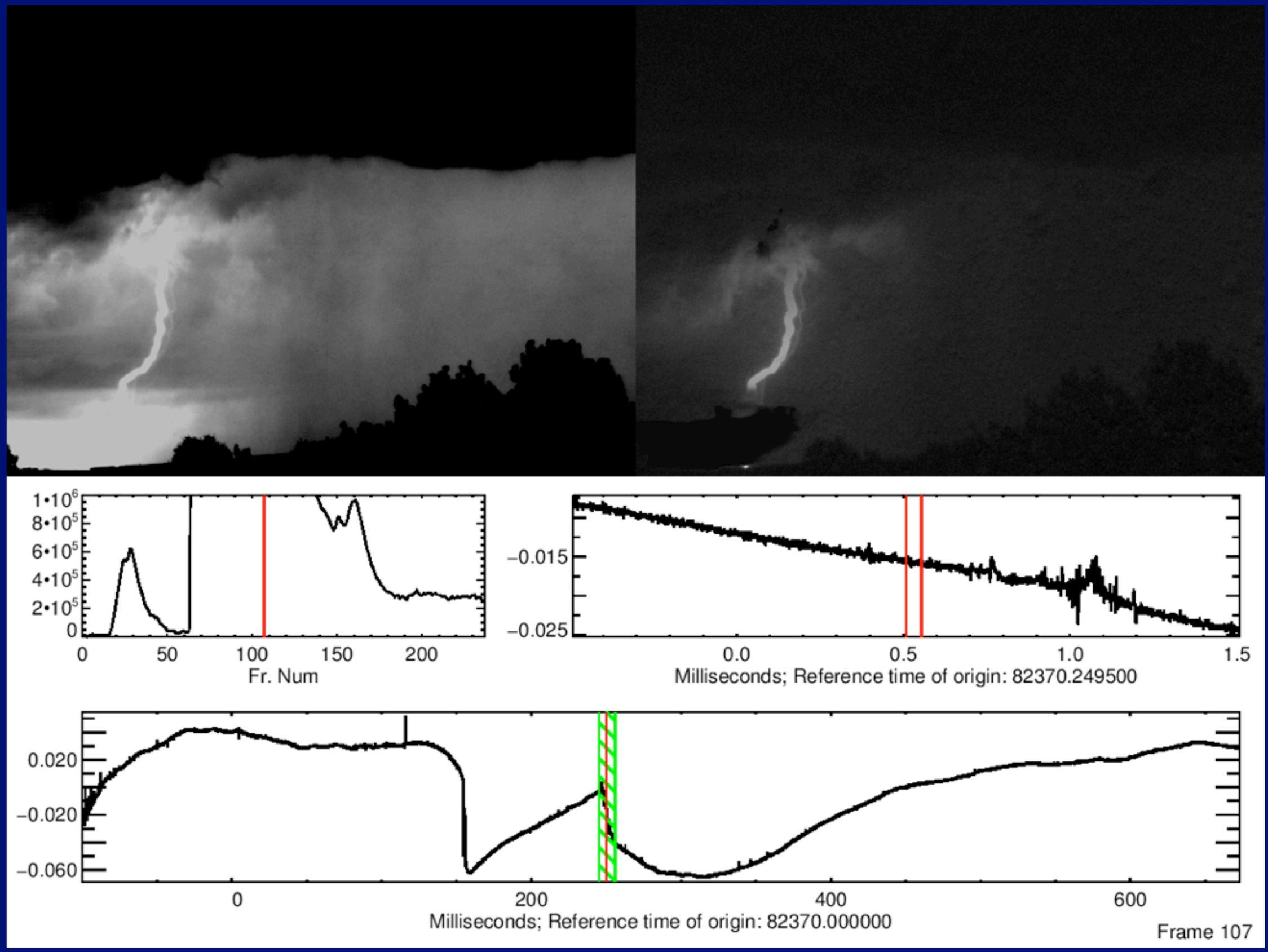

0.000
−0.004
0.0
0.5
1.0
1.5
Milliseconds; Reference time of origin: 82370.245000


0.020
−0.020
−0.060
0
200
400
600
Milliseconds; Reference time of origin: 82370.000000

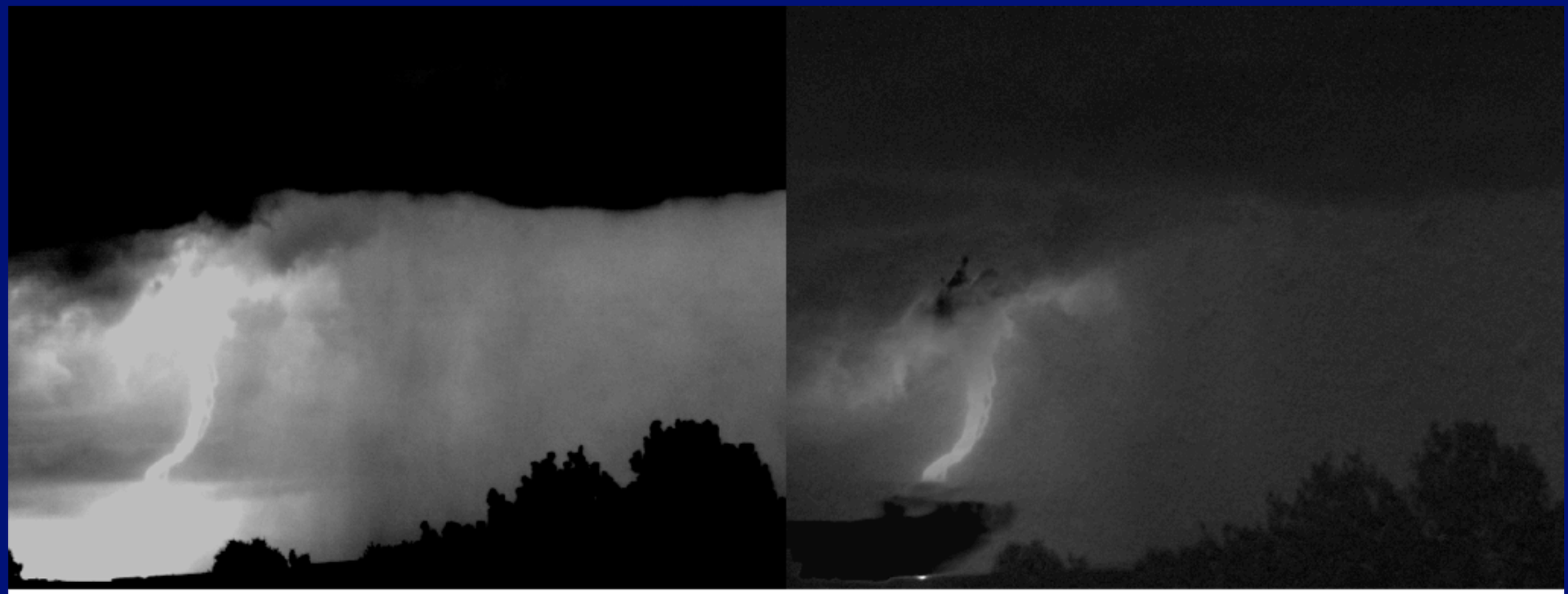
Frame 008



Chaotic/dart leader signature

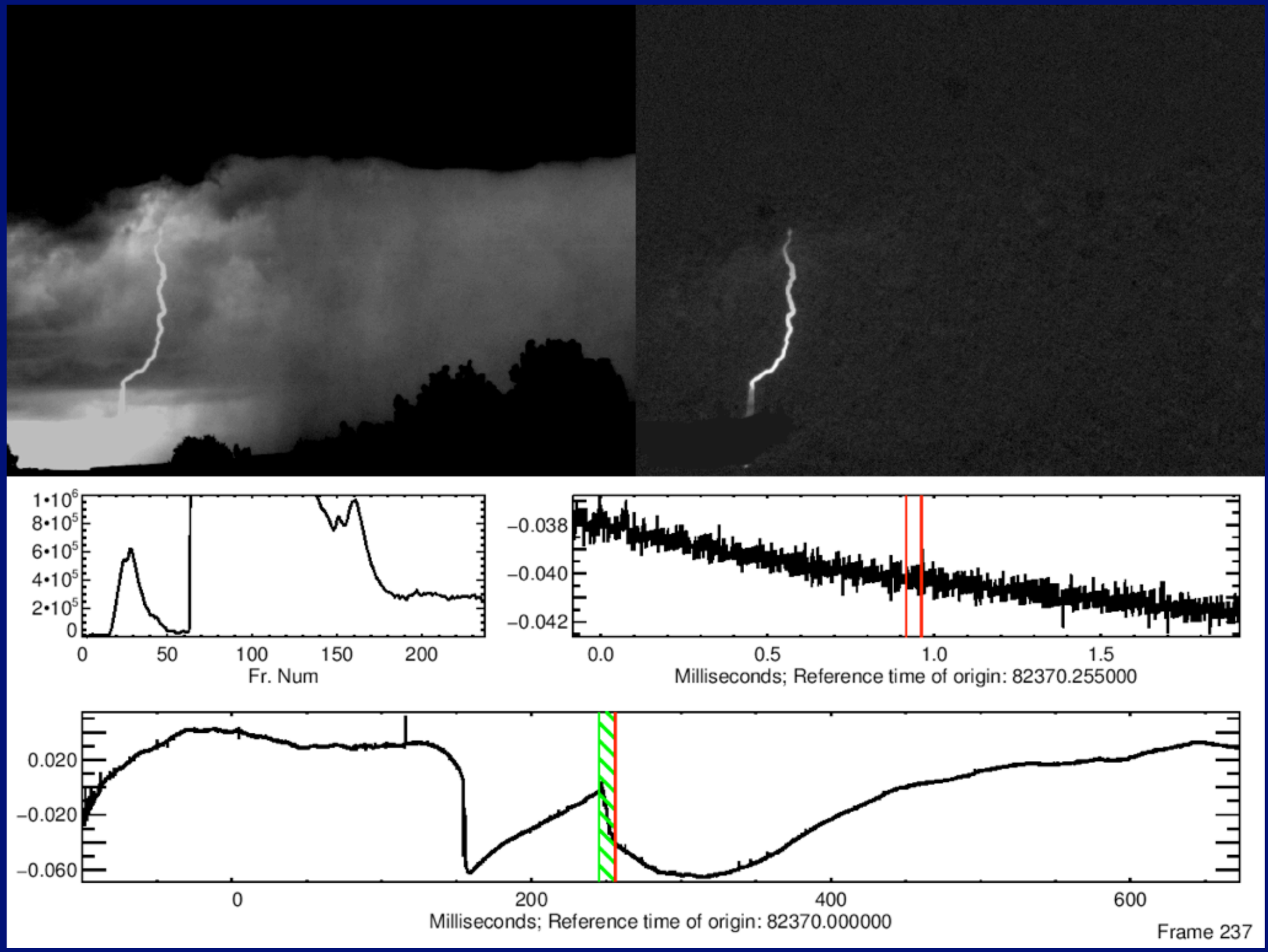


M component before



M component after

“K change” (probably...)

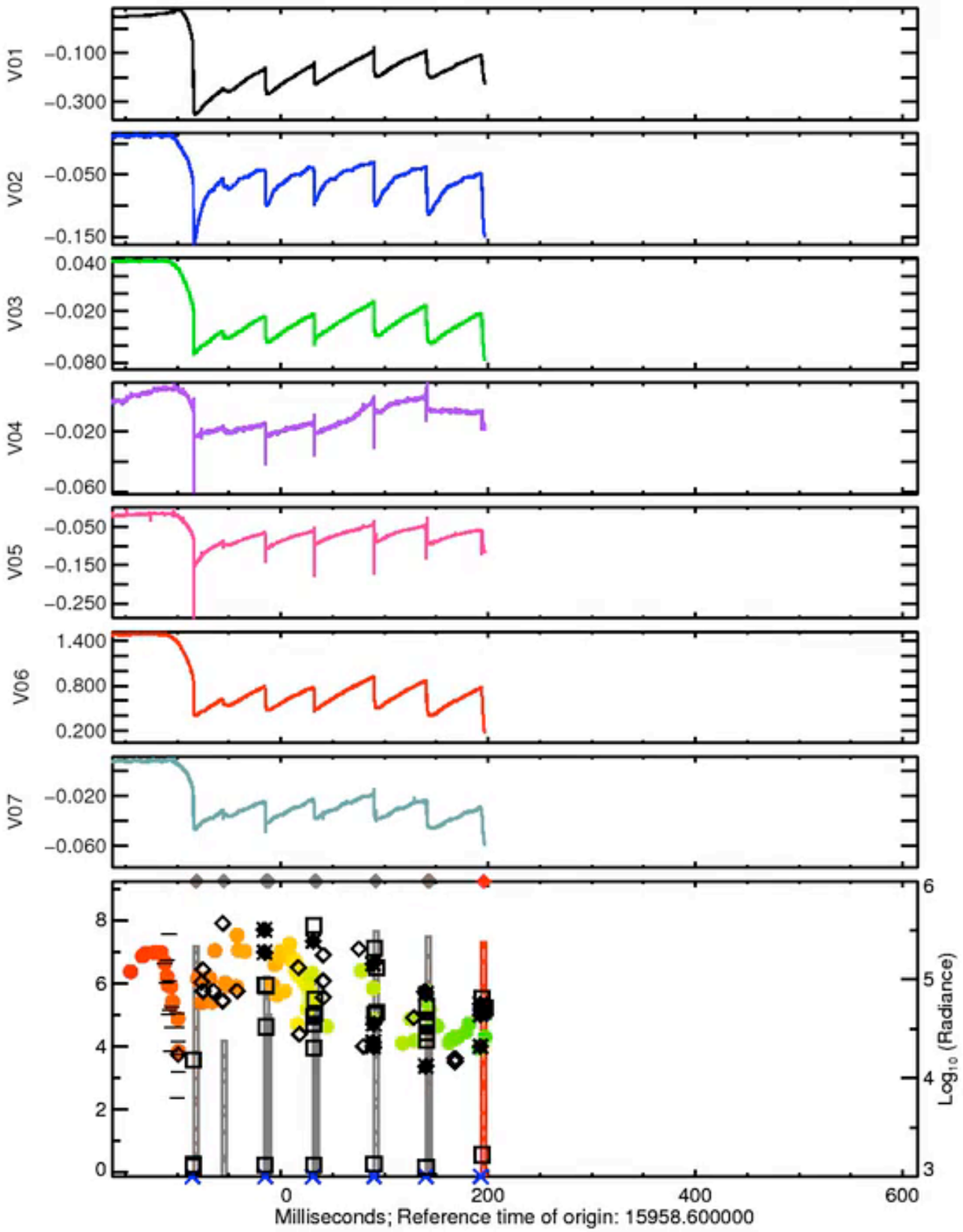


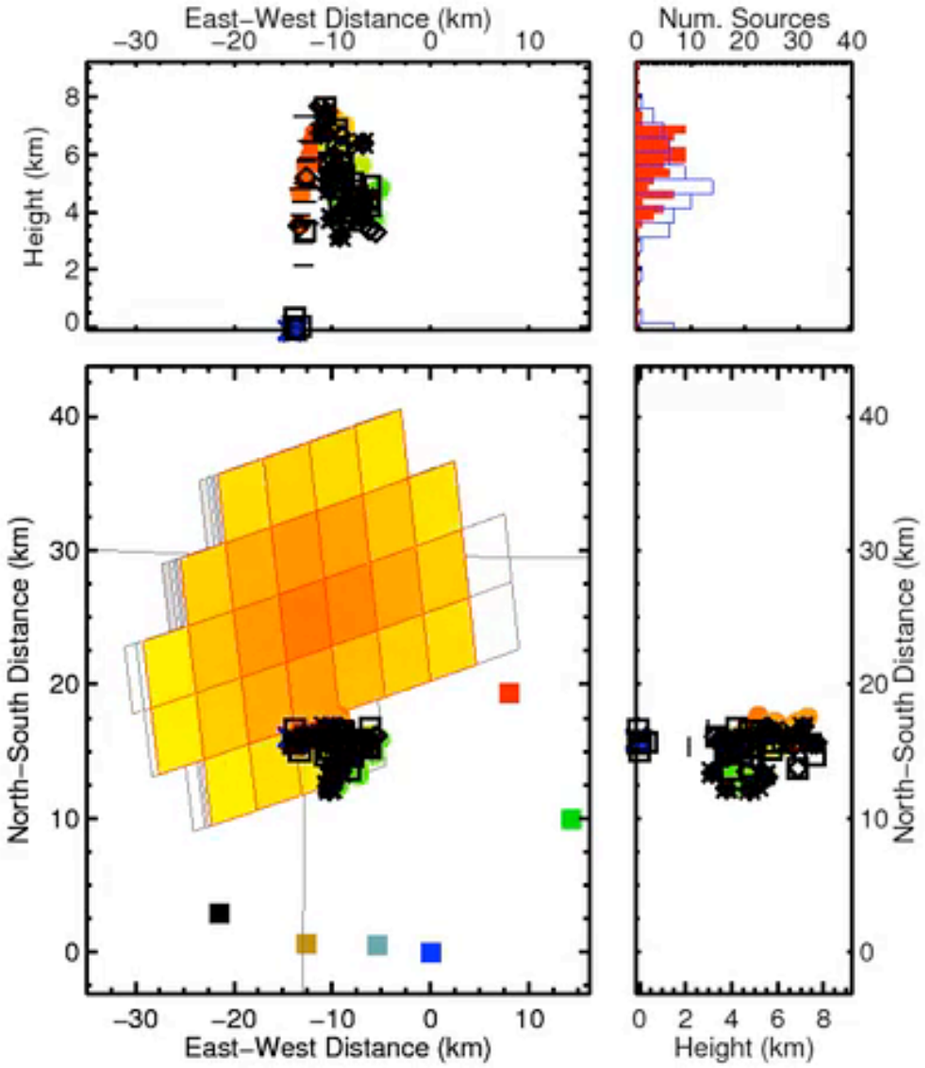
still going...optical/efield indicate continuing current

What exactly does LIS see?

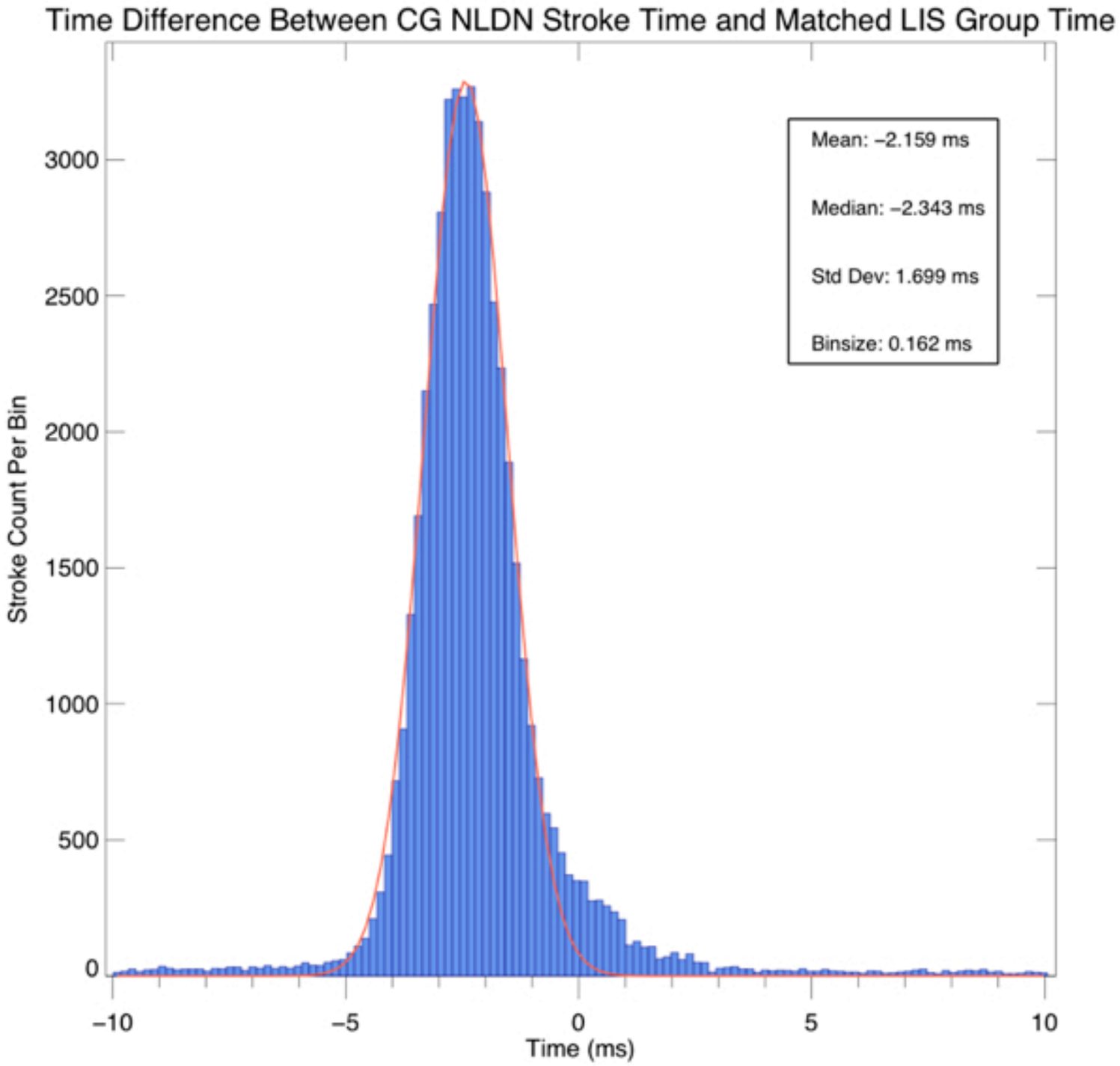
Why should I care?

2010/10/25 04:25:58

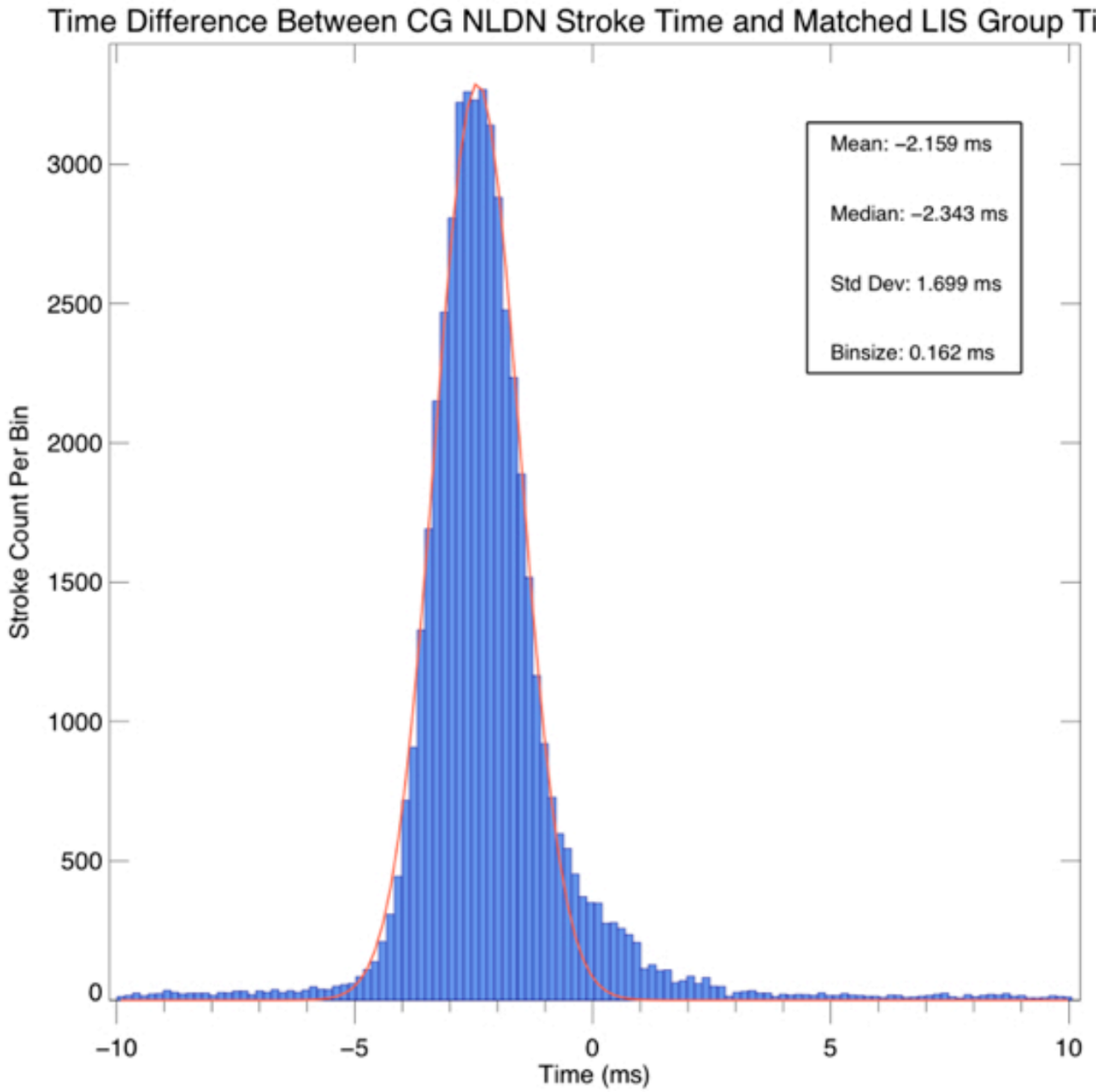




Base time:	15958.437142
Stop time:	15958.797142
Time Elapsed:	0.360000

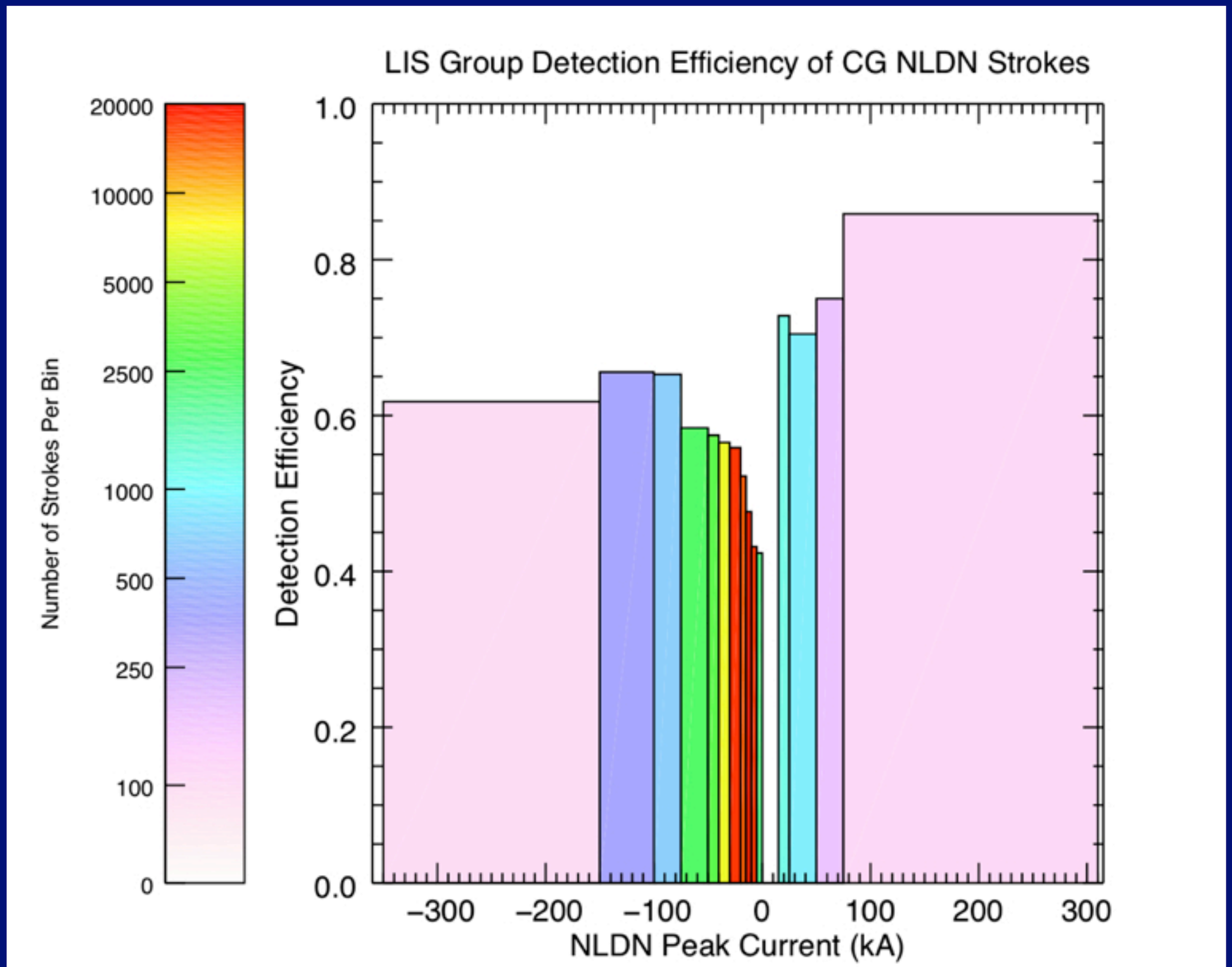


V. Franklin, 2013

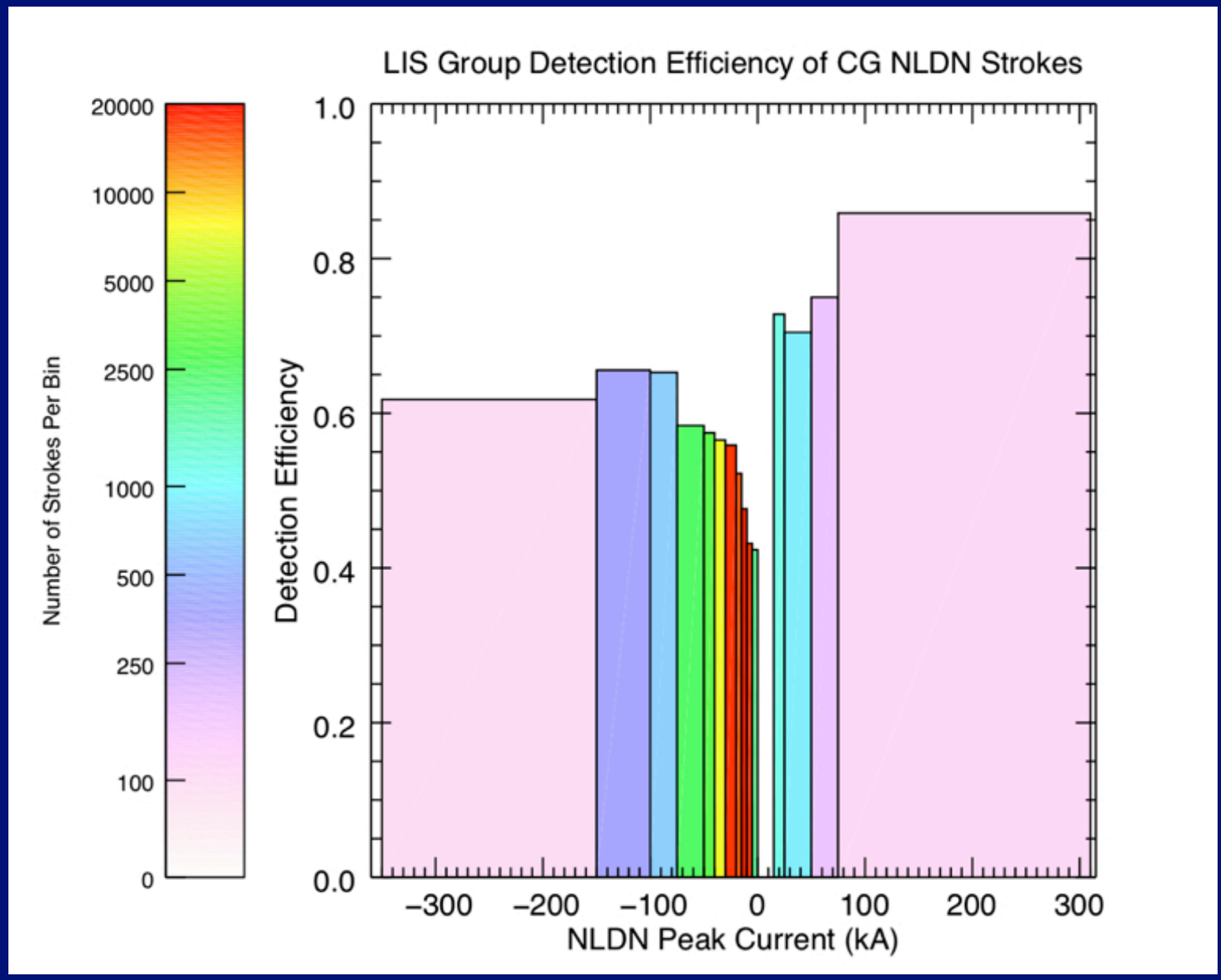


V. Franklin, 2013

The small time separation implies LIS (directly) detects the return stroke



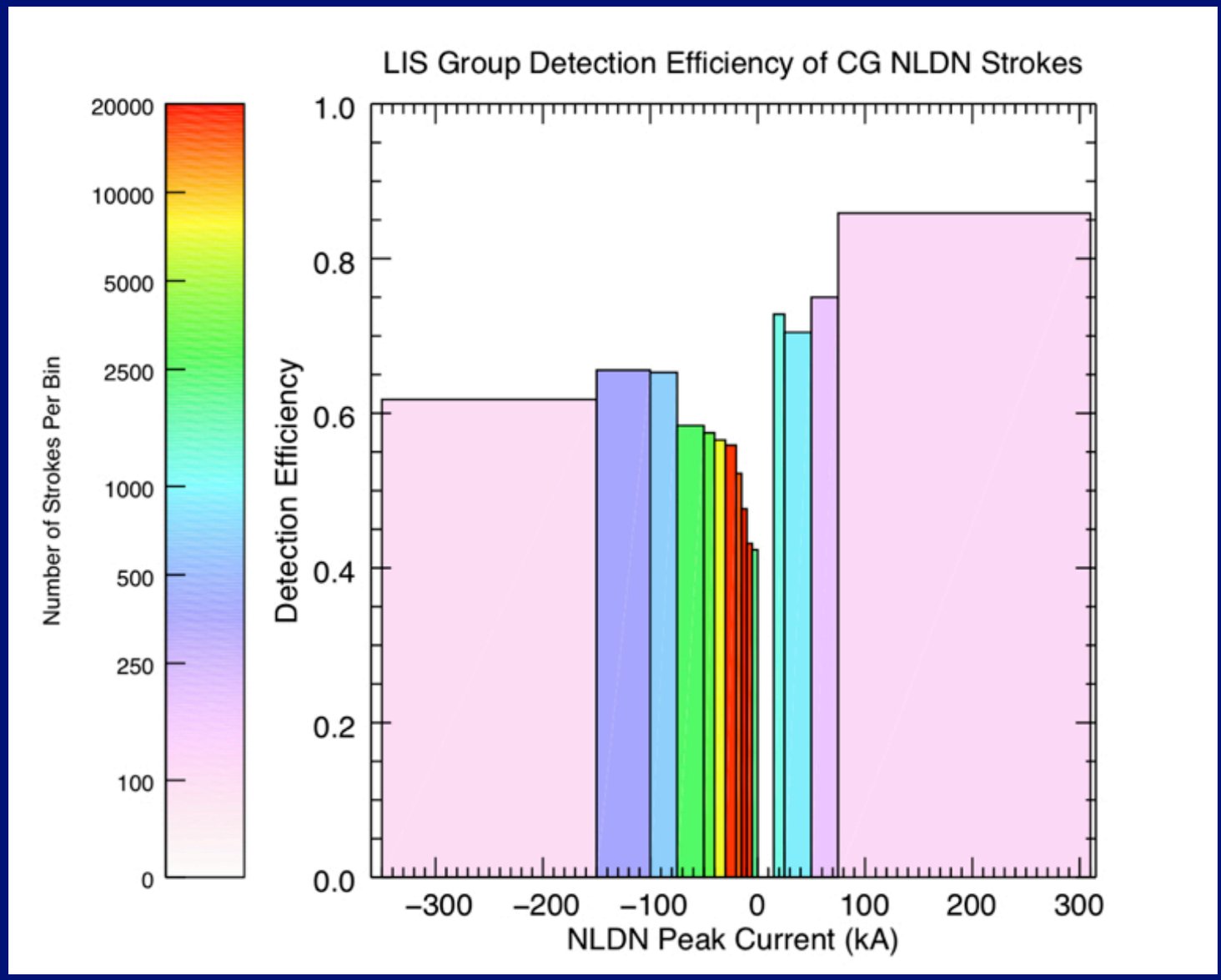
V. Franklin, 2013



V. Franklin, 2013

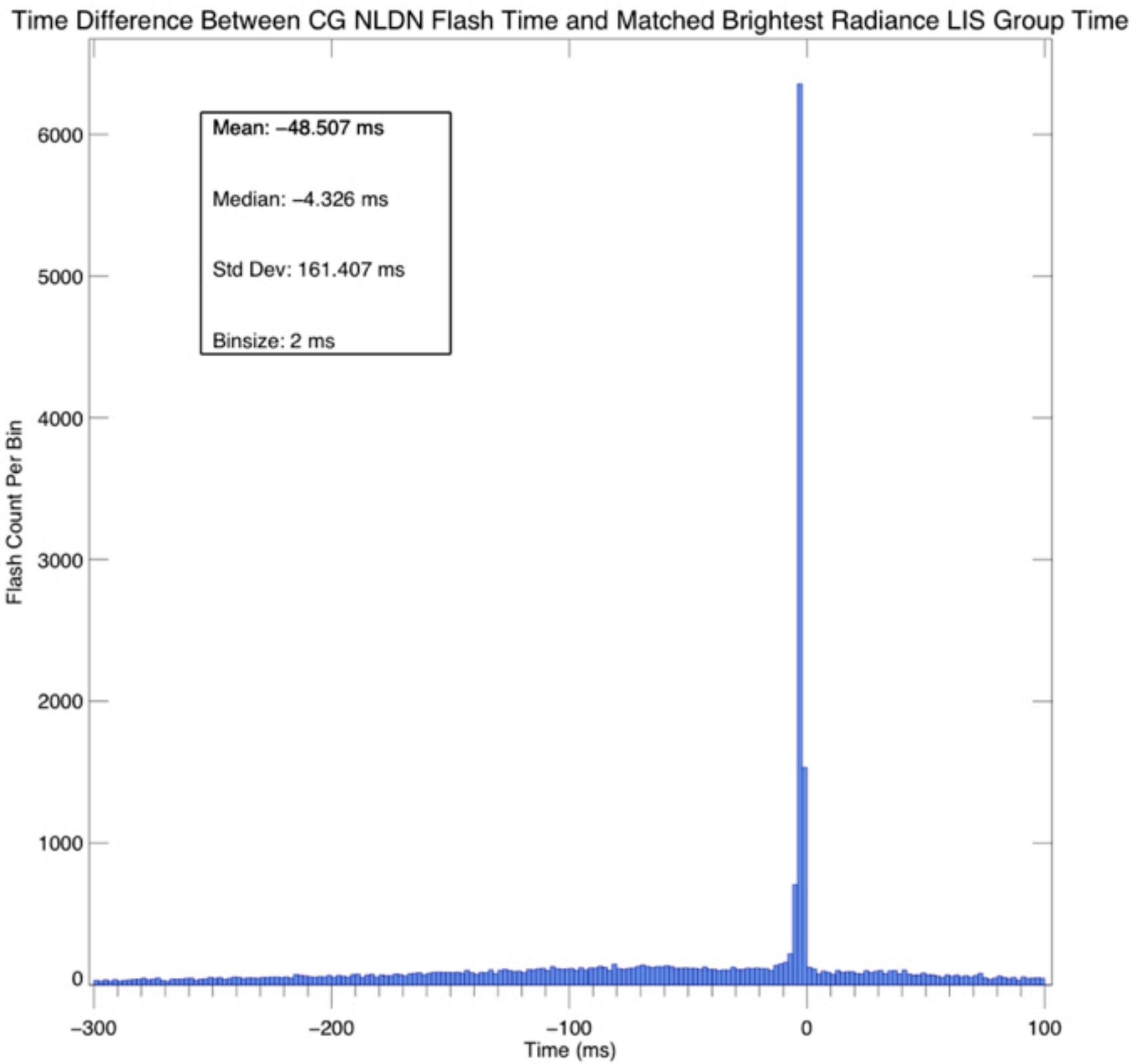
LIS (directly) detects 52% of NLDN detected CG return strokes

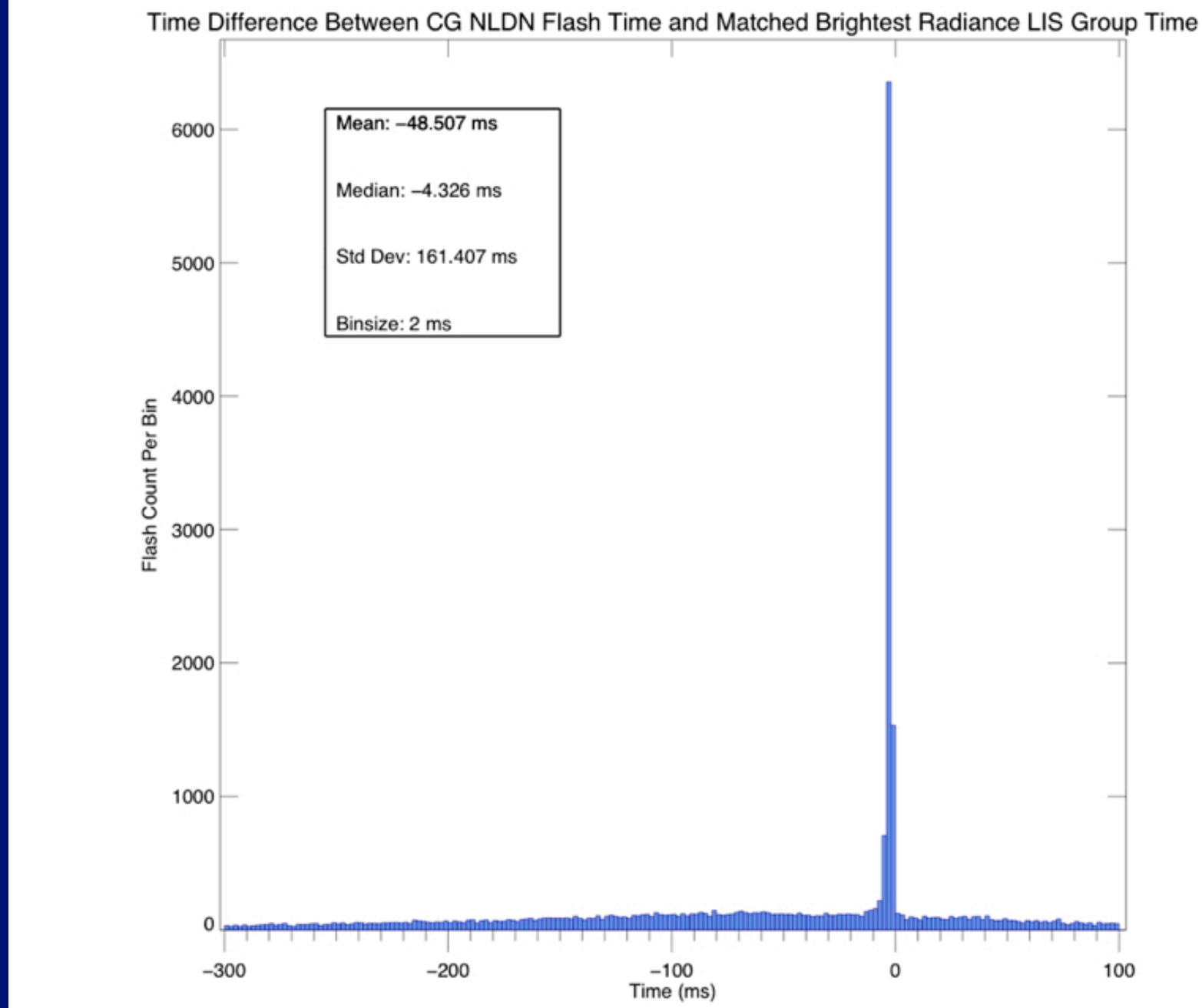
A NLDN stroke is simultaneous with 10% of LIS groups



A NLDN stroke is simultaneous with 10% of LIS groups

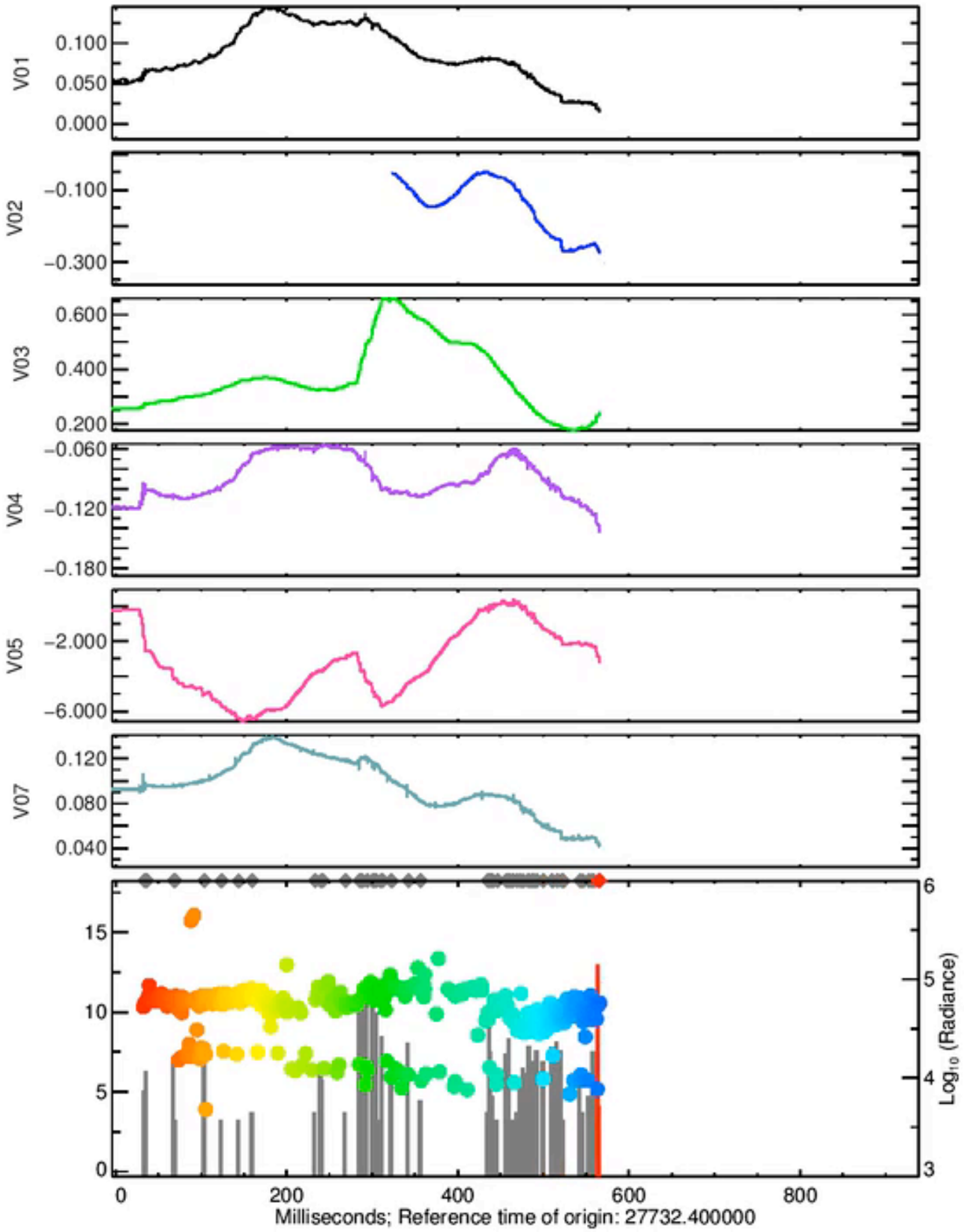
There's a lot of information in the group level data!

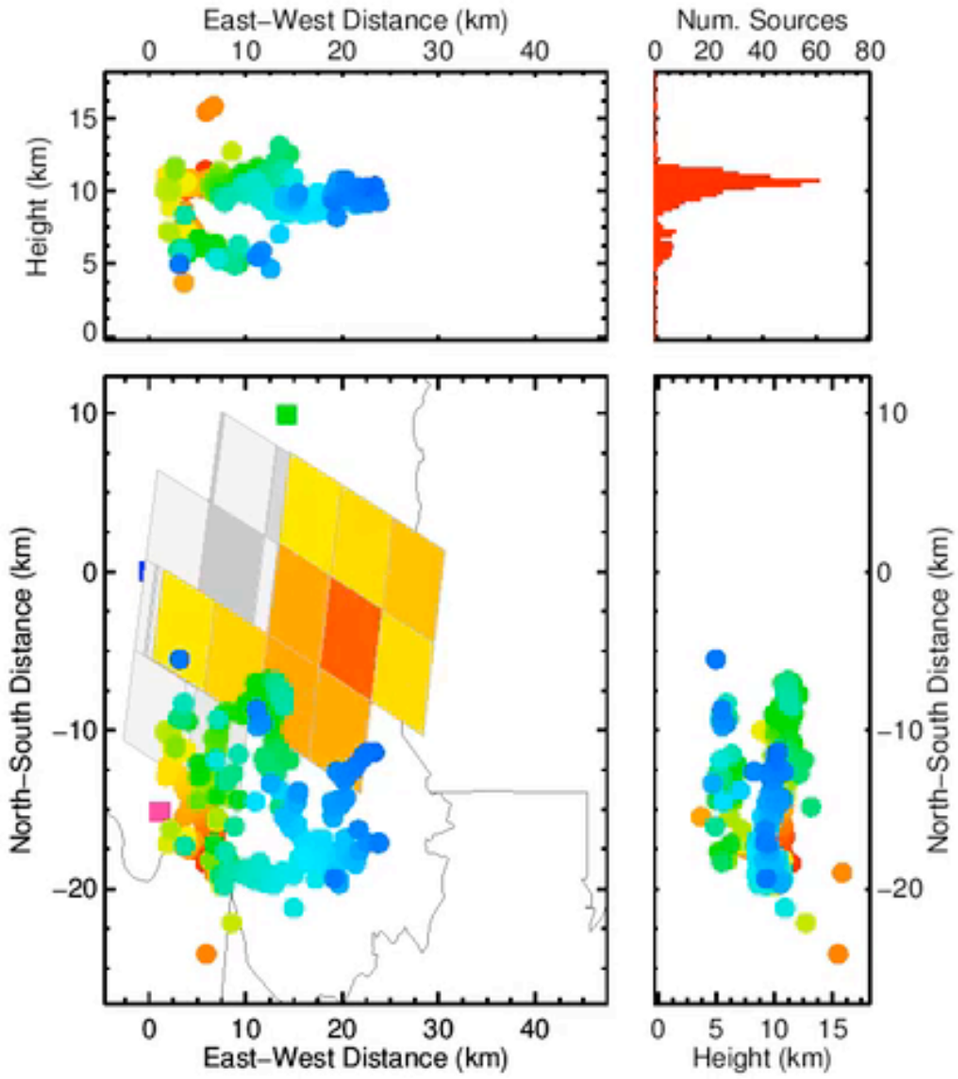

Time Difference Between CG NLDN Flash Time and Matched Brightest Radiance LIS Group Time
Mean: –48.507 ms
Median: –4.326 ms
Std Dev: 161.407 ms
Binsize: 2 ms
Flash Count Per Bin
6000
5000
4000
3000
2000
1000
0
–300
–200
–100
0
100
Time (ms)



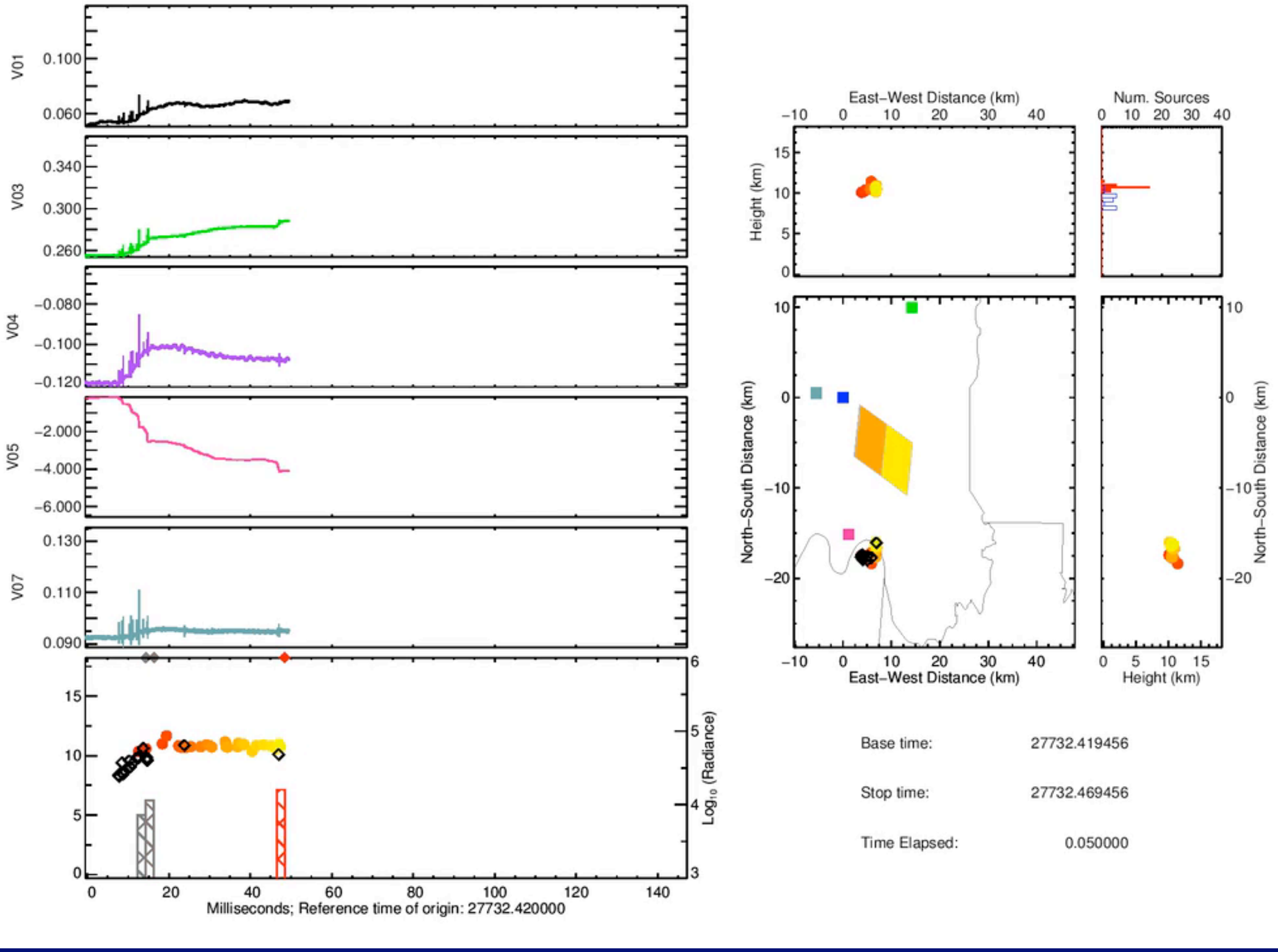
The first stroke is also the brightest group 31% of the time

2010/10/25 07:42:12

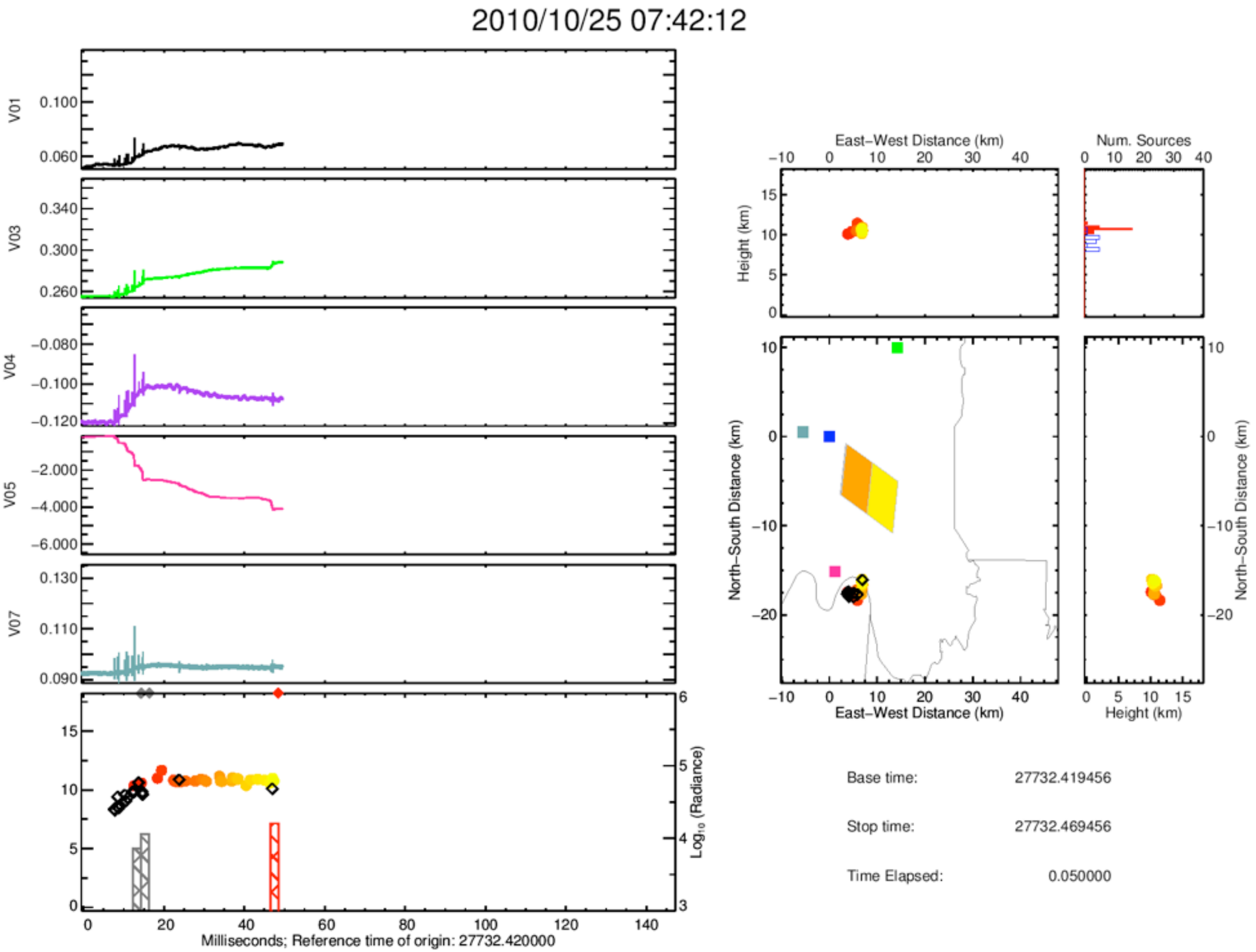




Base time:	27732.396001
Stop time:	27732.966001
Time Elapsed:	0.570000



When we see “significant” efield change in the leader, LIS also detects optical emissions (KNB)



Lightning isn’t “dark” after all...

Group level data can be roughly equivalent to return strokes

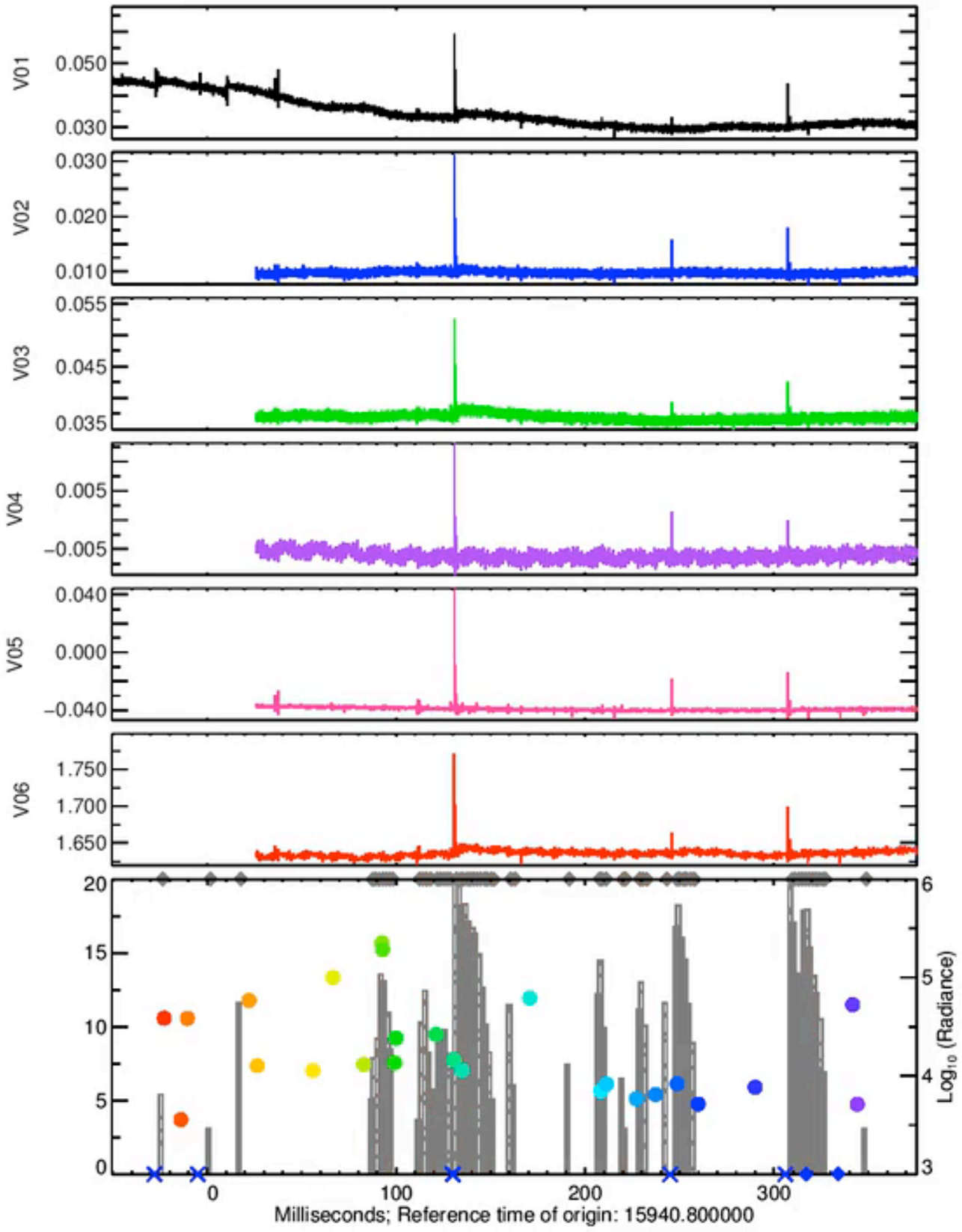
Group level data can be roughly equivalent to return strokes and IC strokes (or discharges)

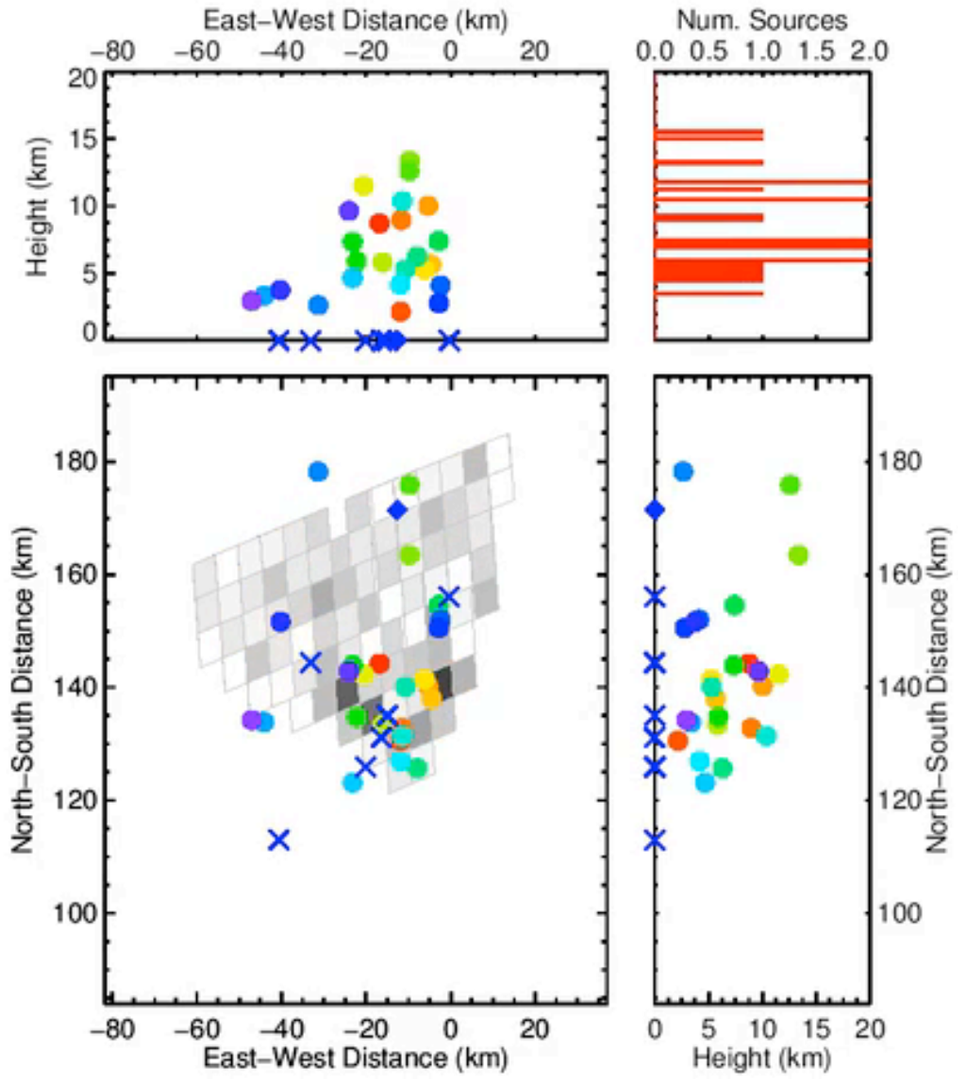
Group level data can be roughly equivalent to return strokes

and IC strokes (or discharges)

What else can groups tell us?

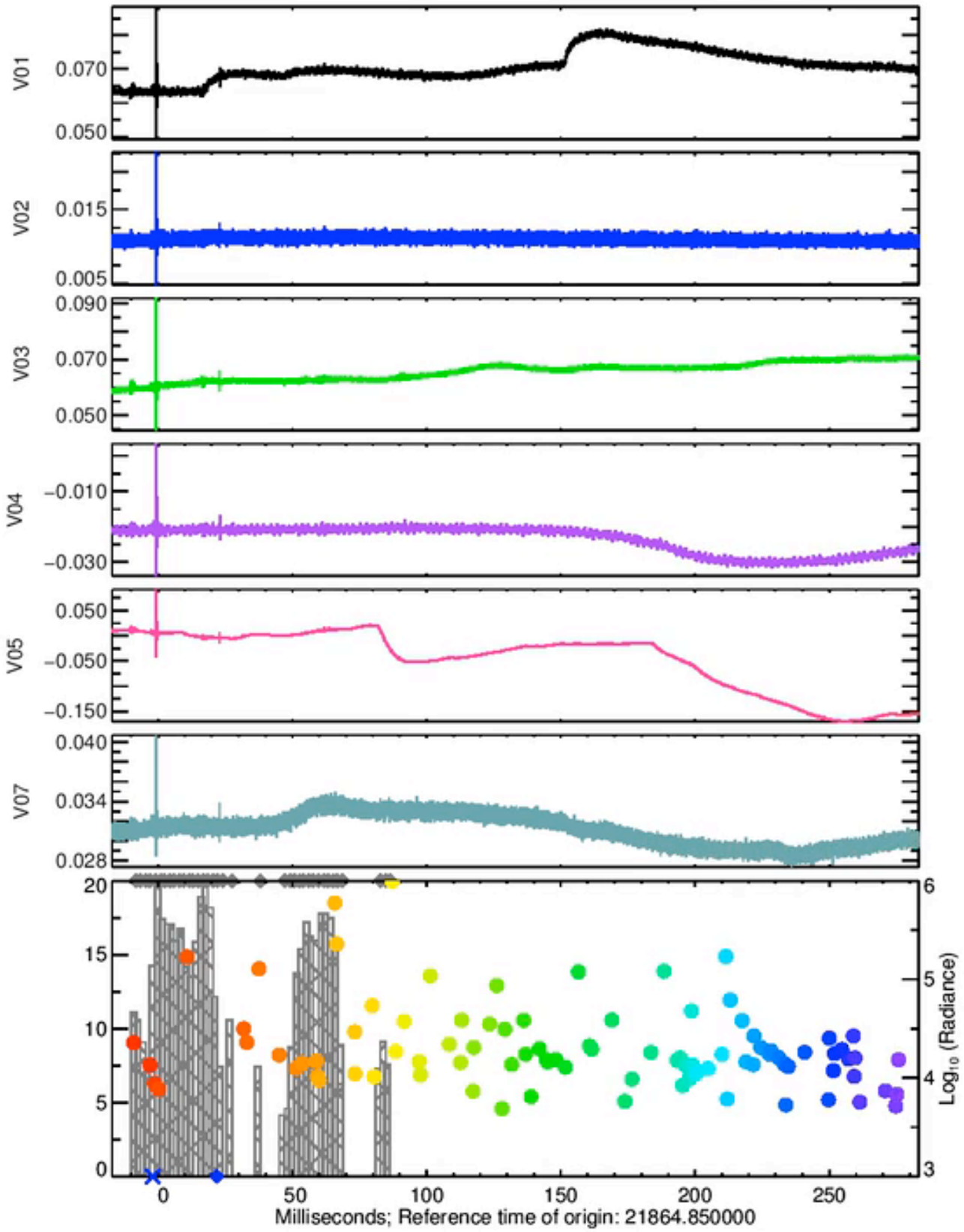
2010/10/25 04:25:40

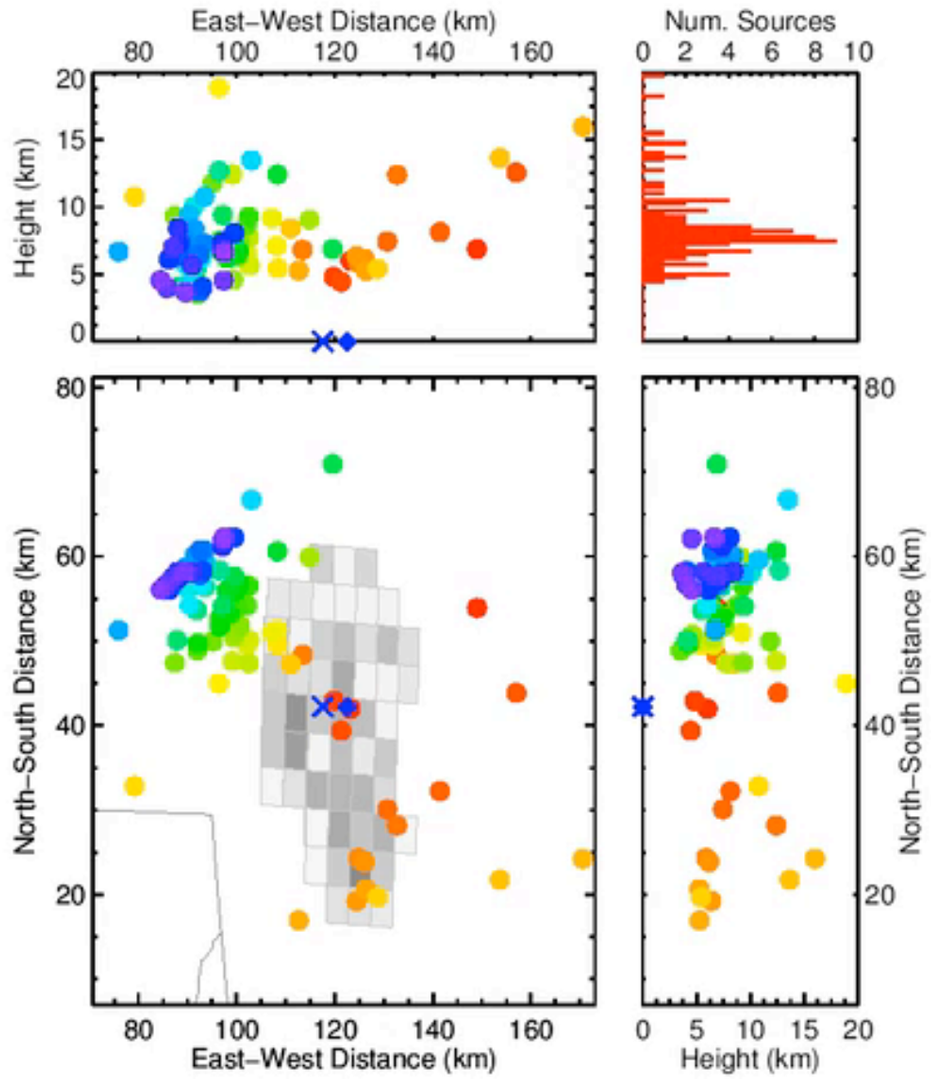




Base time:	15940.749509
Stop time:	15941.175593
Time Elapsed:	0.426083

2010/10/25 06:04:24





Base time:	21864.832860
Stop time:	21865.133299
Time Elapsed:	0.300439

Group level data can tell me about continuing current

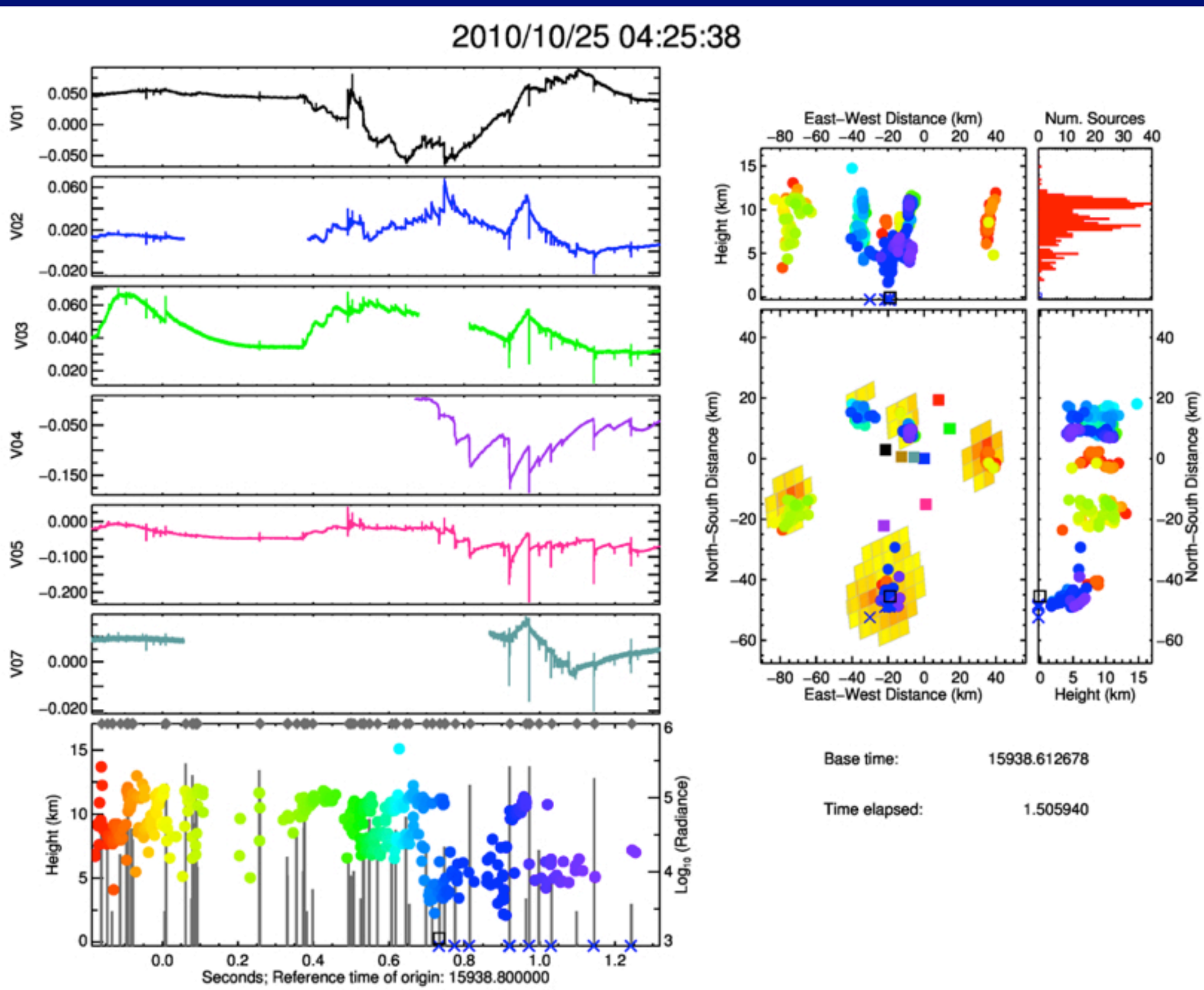
Group level data can tell me
about continuing current

(and hence, “significant” charge neutralization)

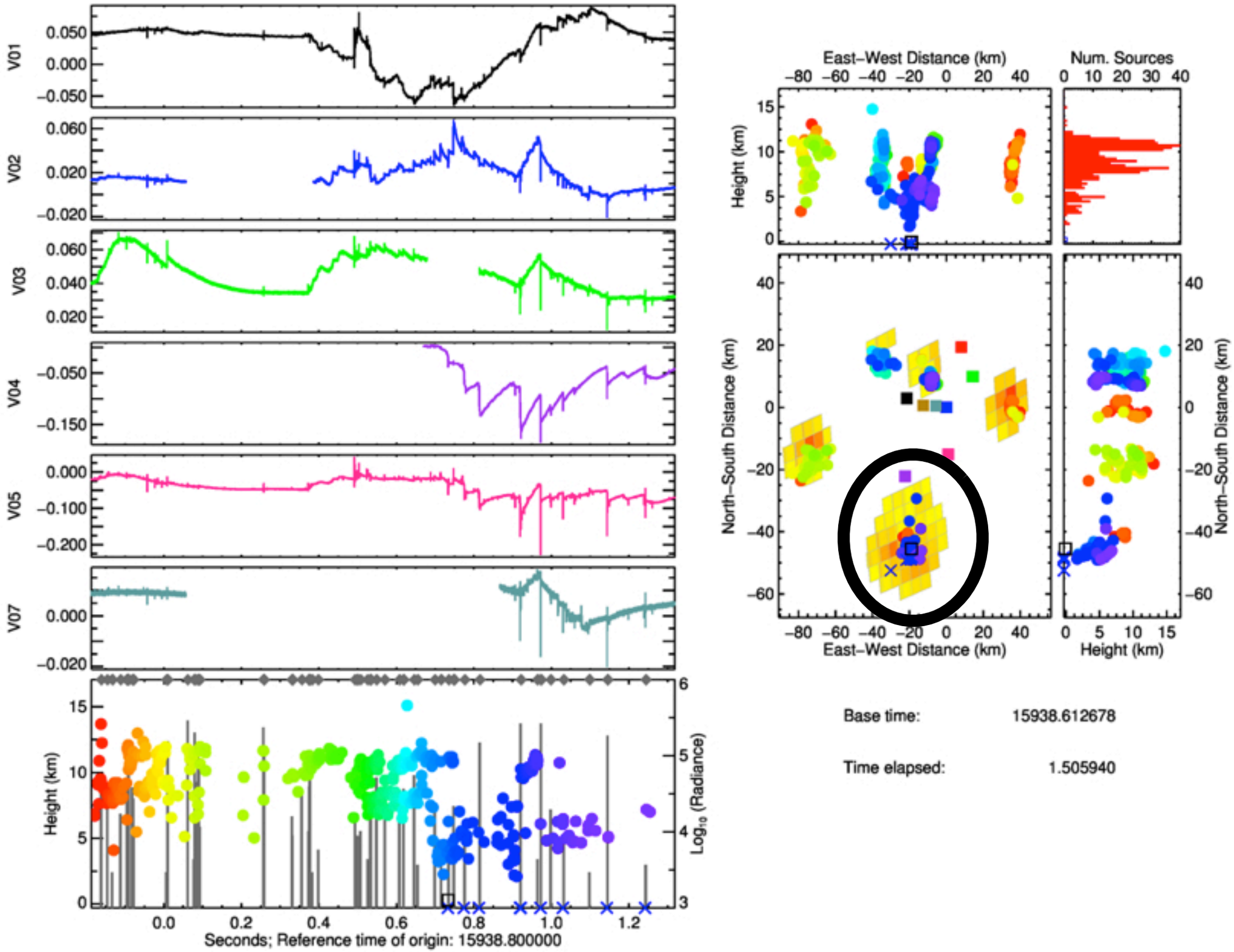
Group level data can tell me
about continuing current

(and hence, “significant” charge neutralization)

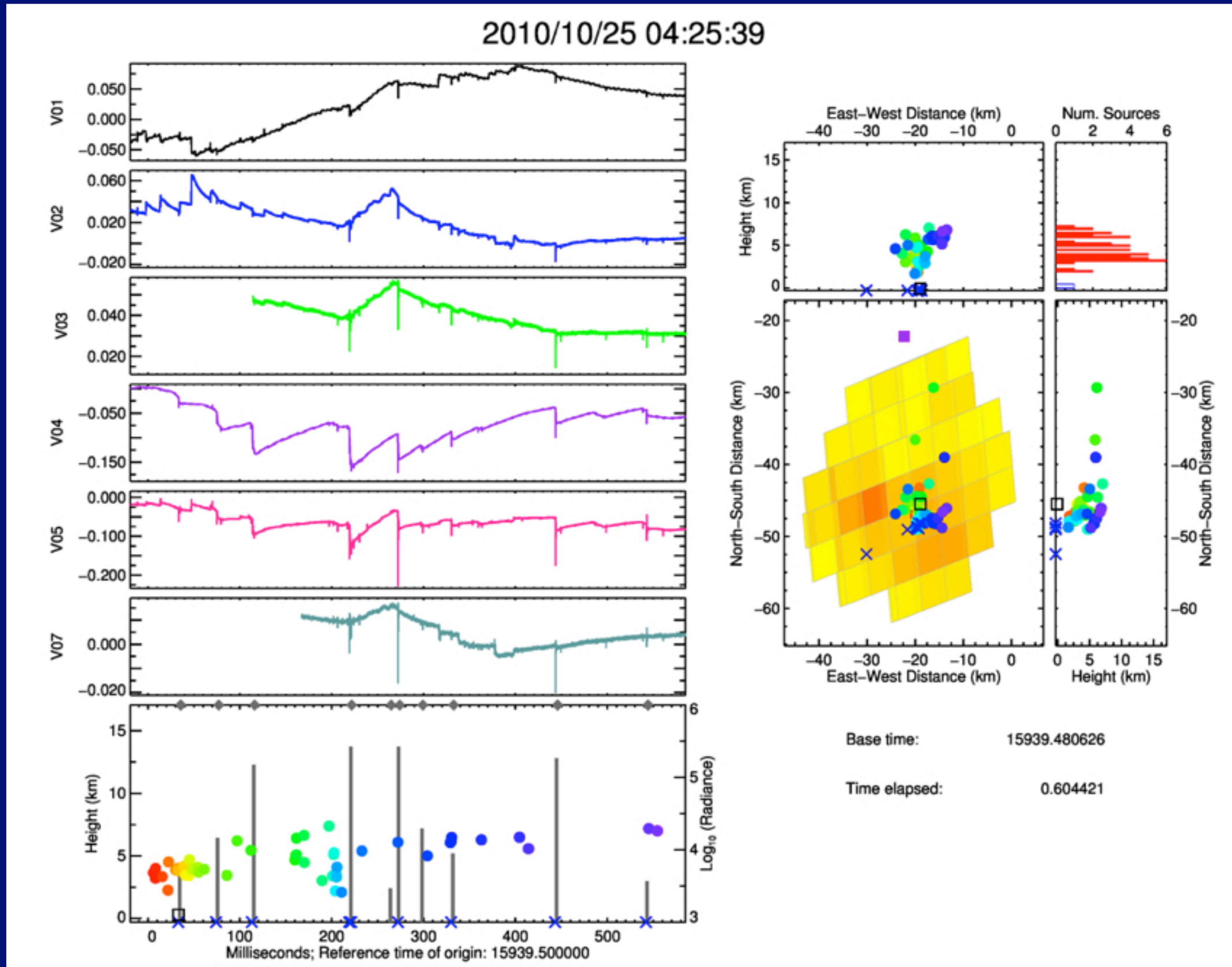
What else?



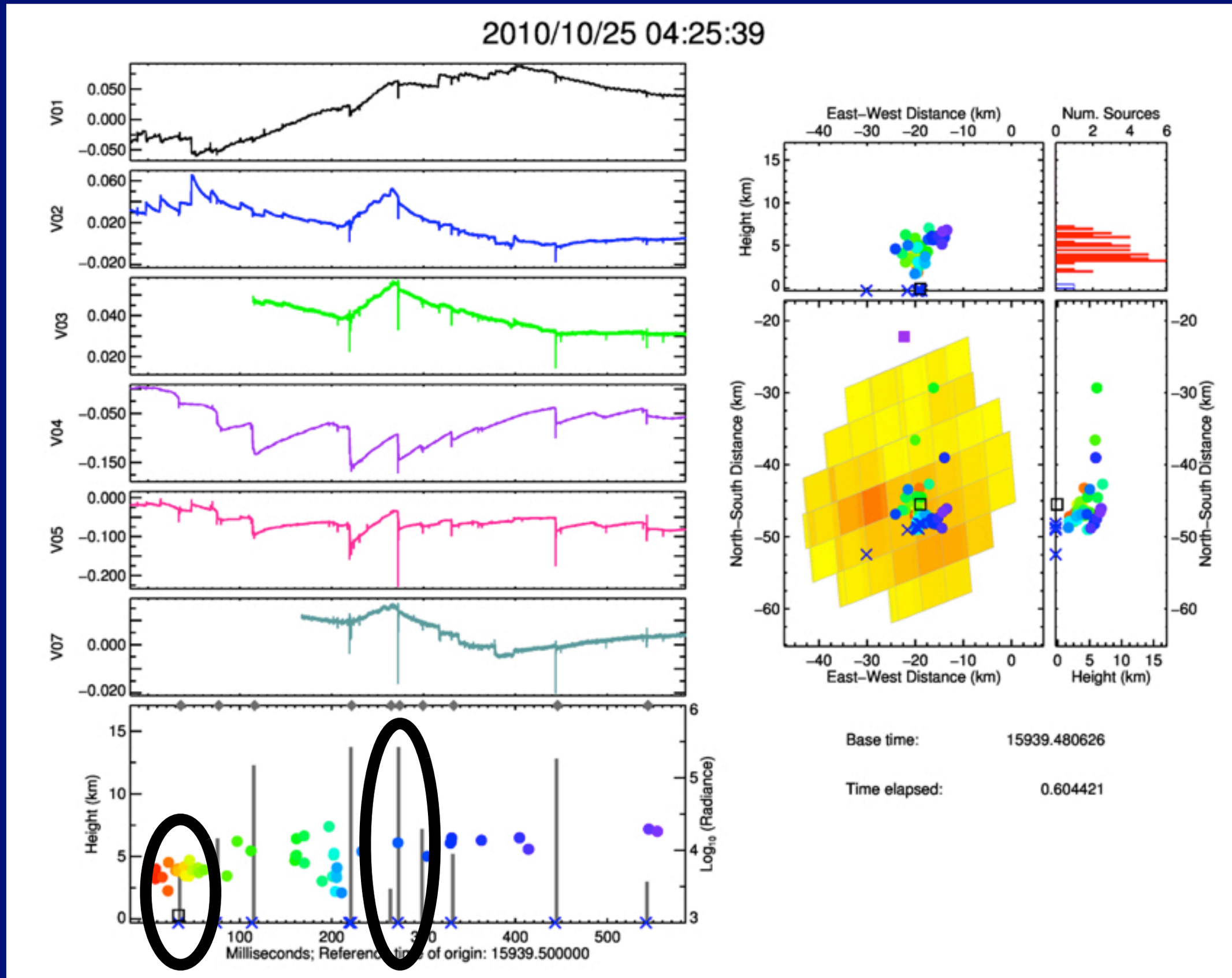
*A **lot** of flashes occurring simultaneously*



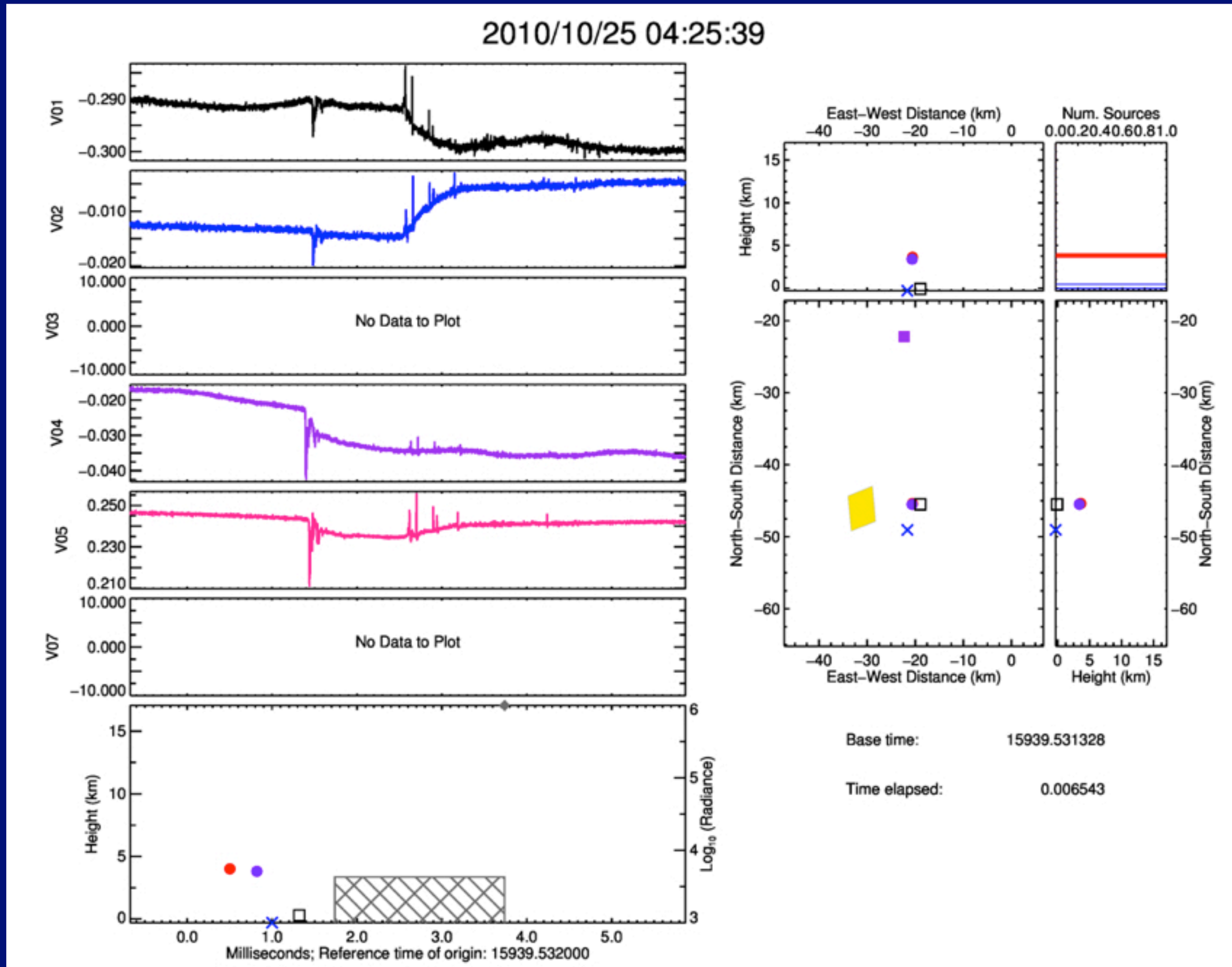
*A **lot** of flashes occurring simultaneously*


2010/10/25 04:25:39
V01
V02
V03
V04
V05
V07
Height (km)
Log10 (Radiance)
Milliseconds; Reference time of origin: 15939.500000
East–West Distance (km)
Num. Sources
North–South Distance (km)
Base time: 15939.480626
Time elapsed: 0.604421

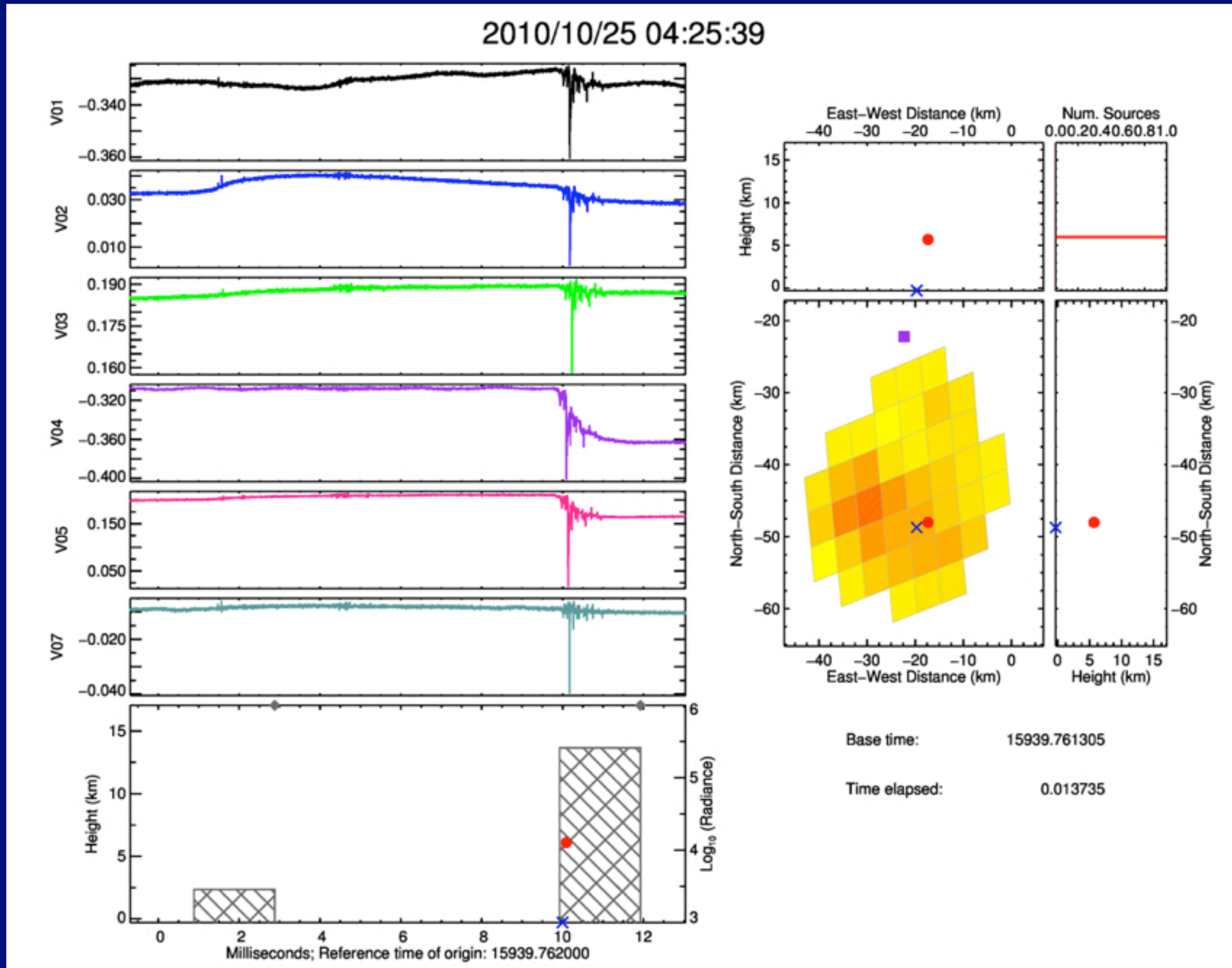
One is a -CG...


2010/10/25 04:25:39
V01
V02
V03
V04
V05
V07
Height (km)
Log10 (Radiance)
Milliseconds; Reference time of origin: 15939.500000
East–West Distance (km)
Num. Sources
North–South Distance (km)
Base time: 15939.480626
Time elapsed: 0.604421

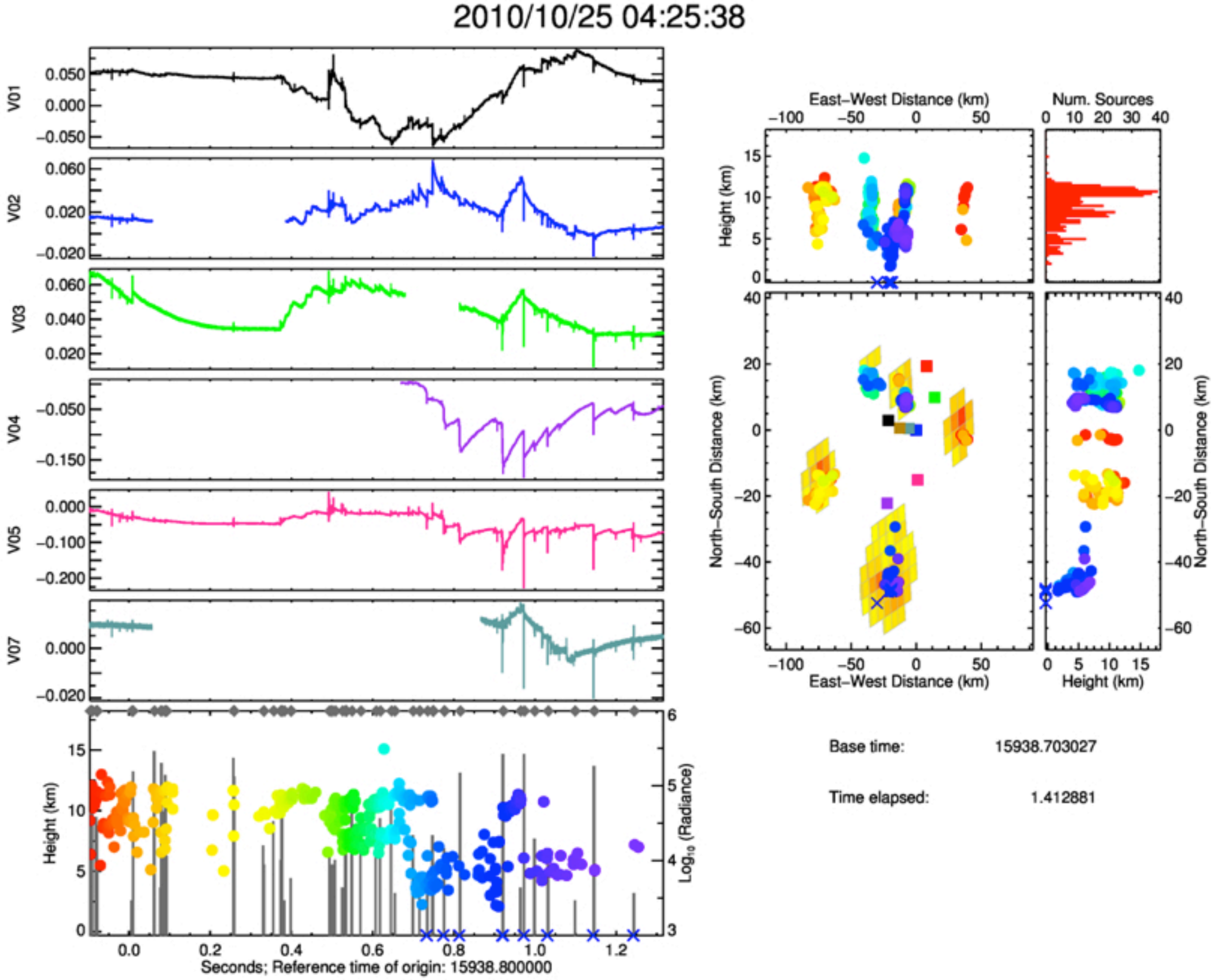
One is a -CG...



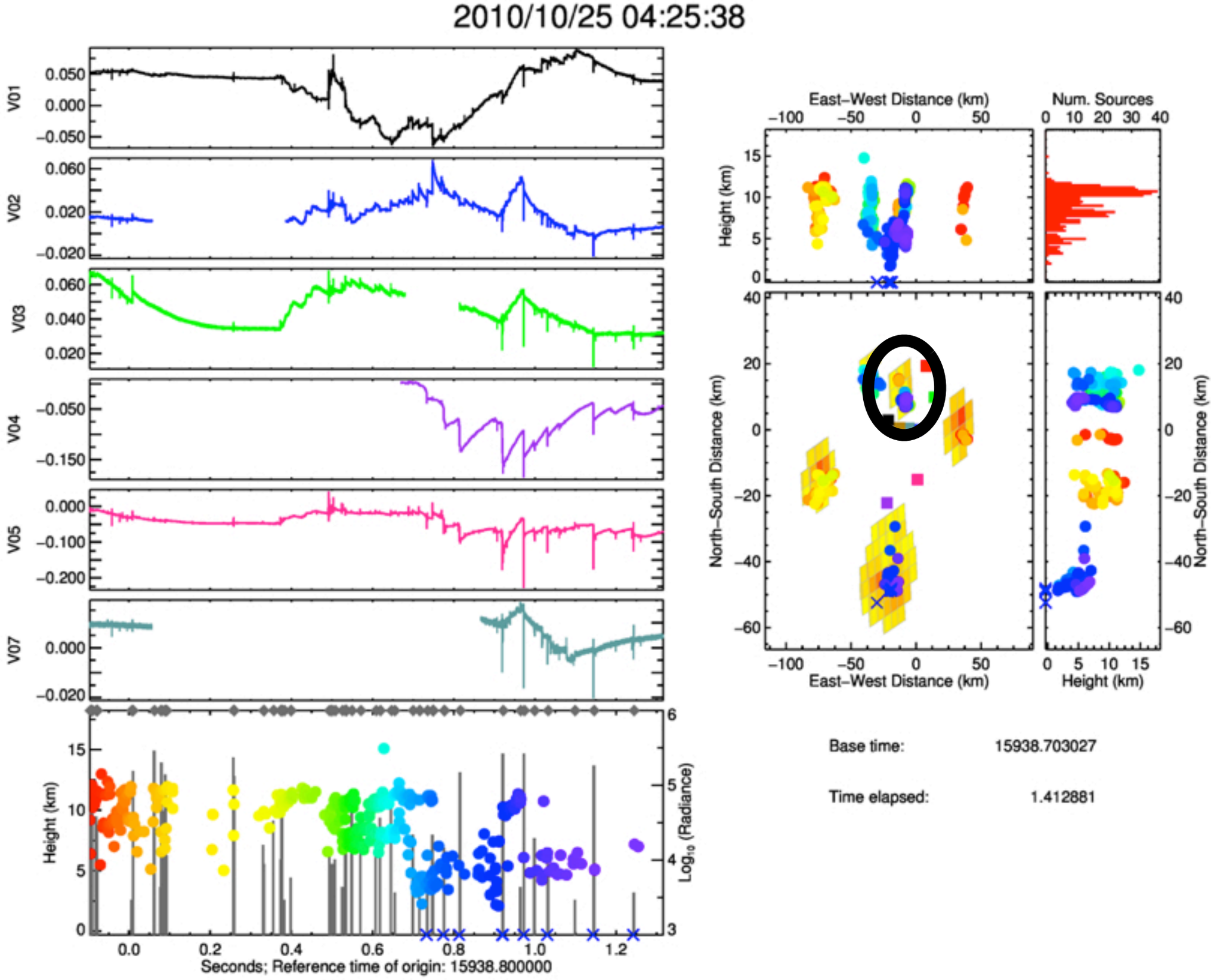
First RS dim, very little electrostatic



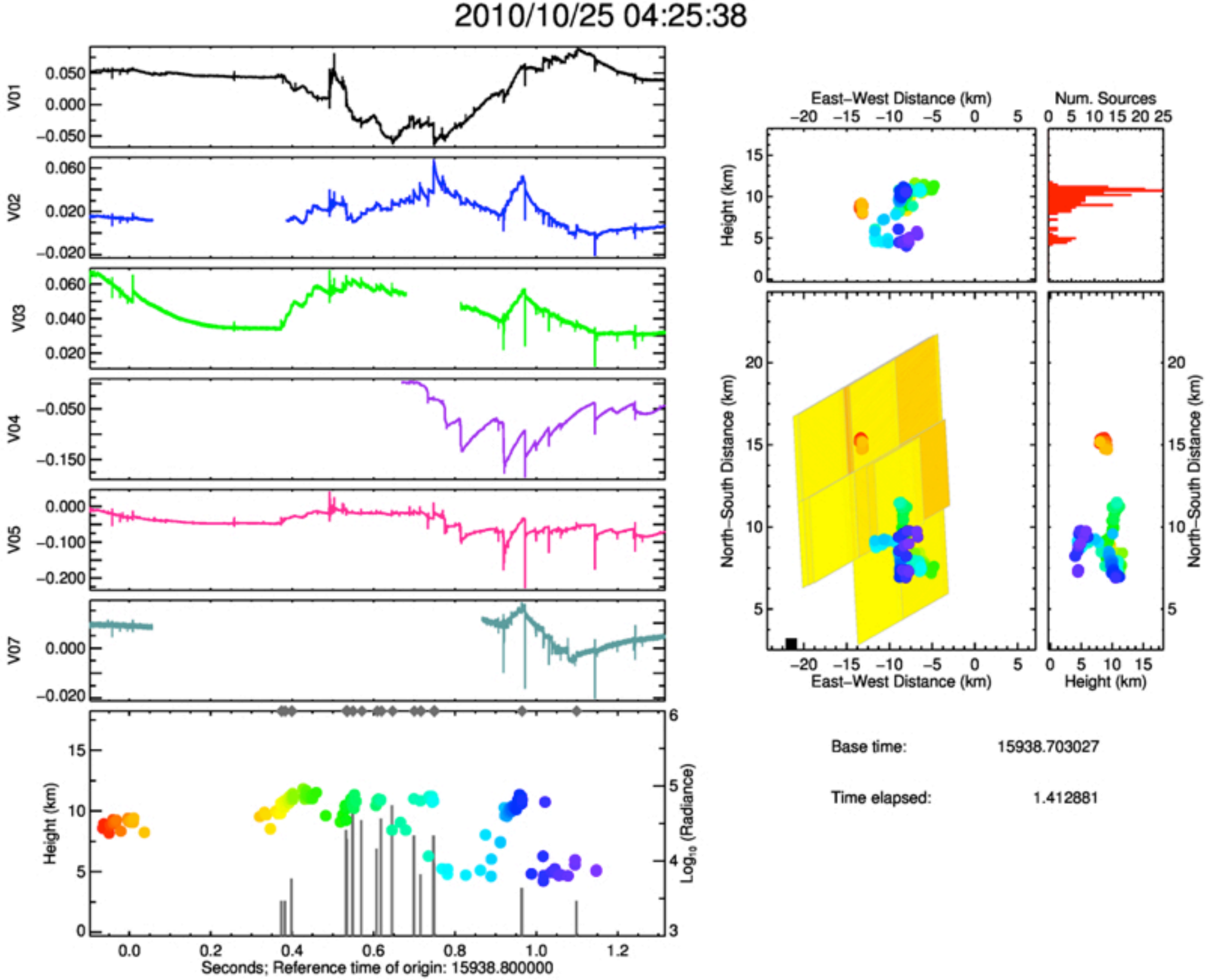
Brightest group not 1st RS...and light with leader!



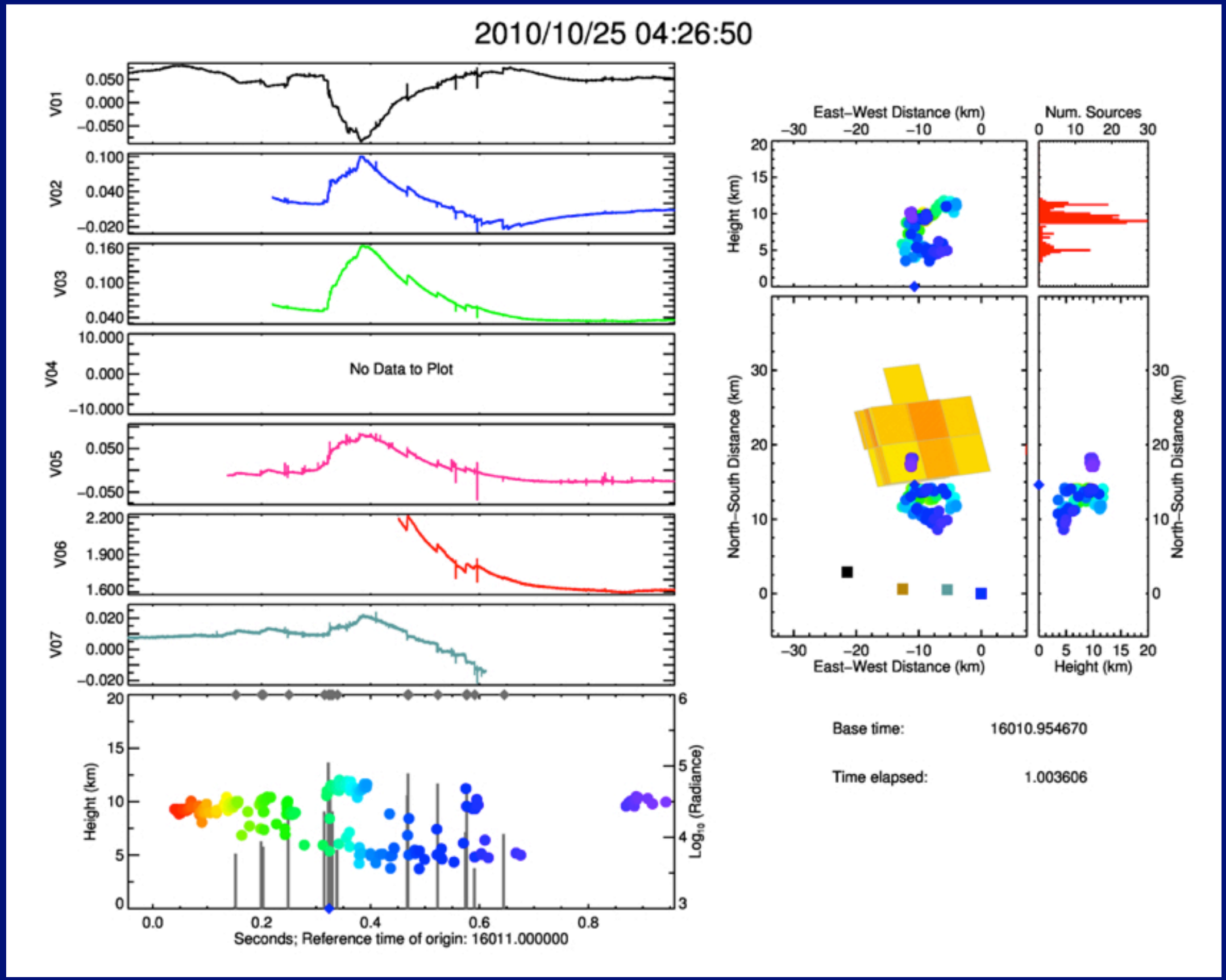
*A **lot** of flashes occurring simultaneously*



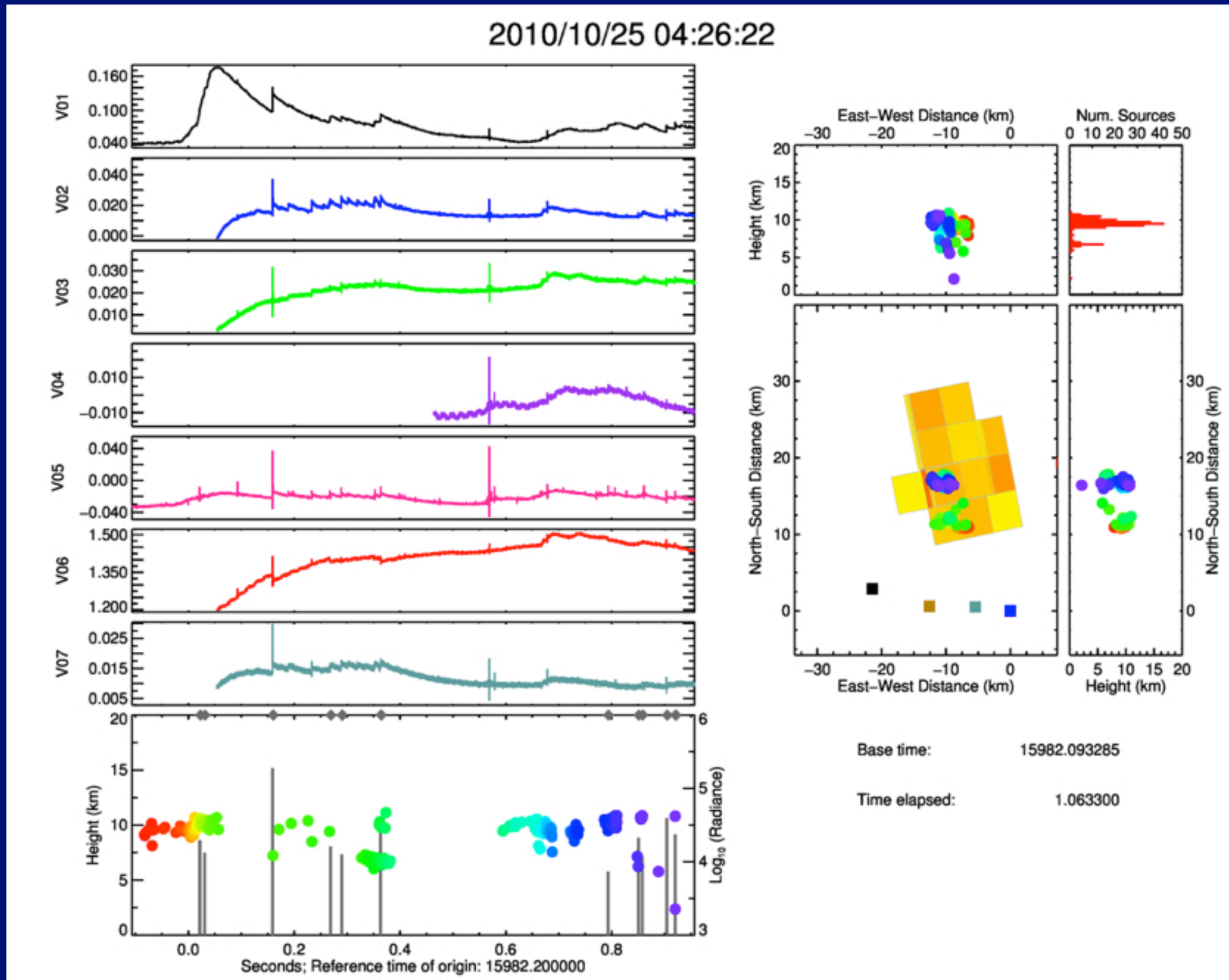
*A **lot** of flashes occurring simultaneously*



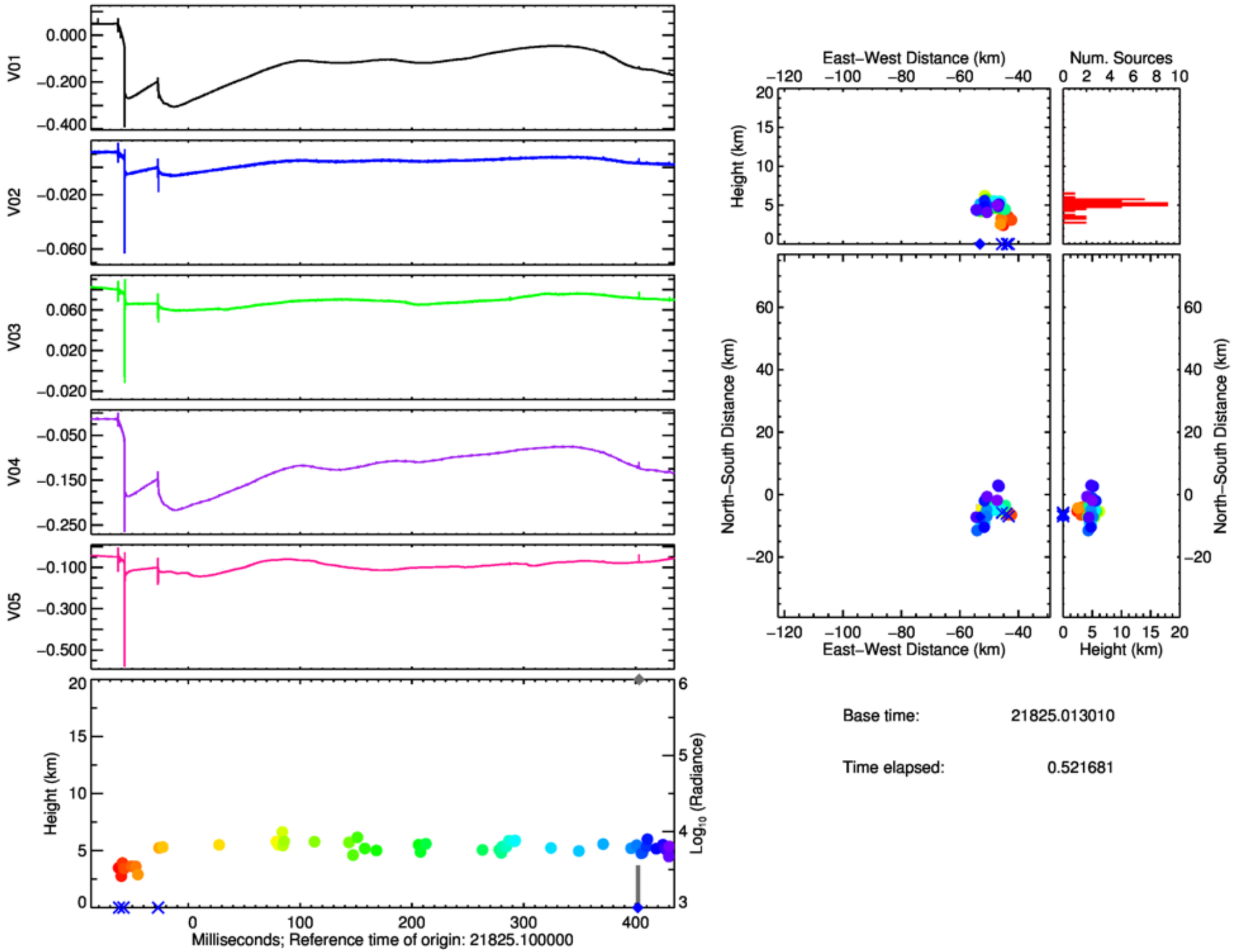
Two ICs (?), but one much more energetic



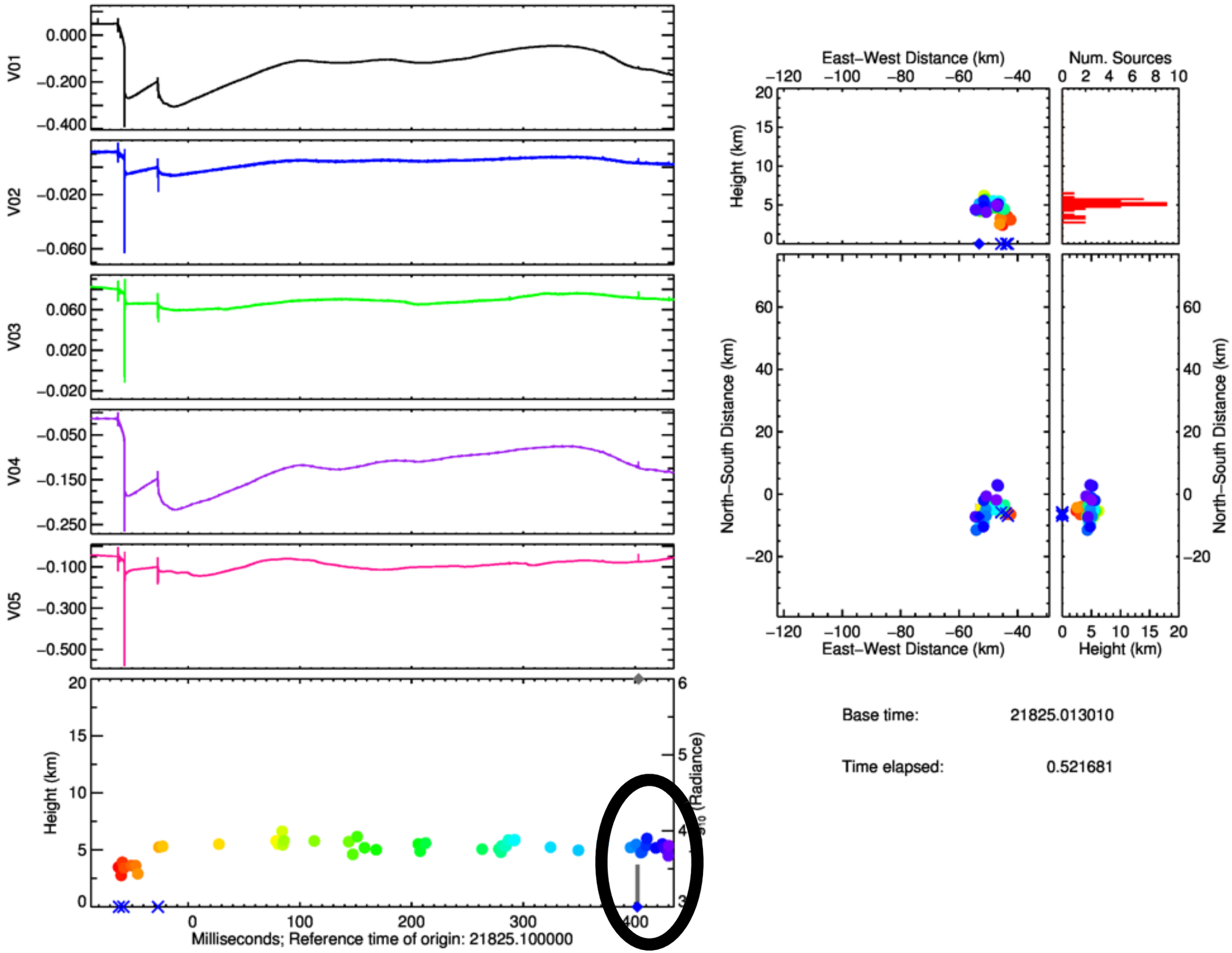
LIS groups associated with electrostatic change



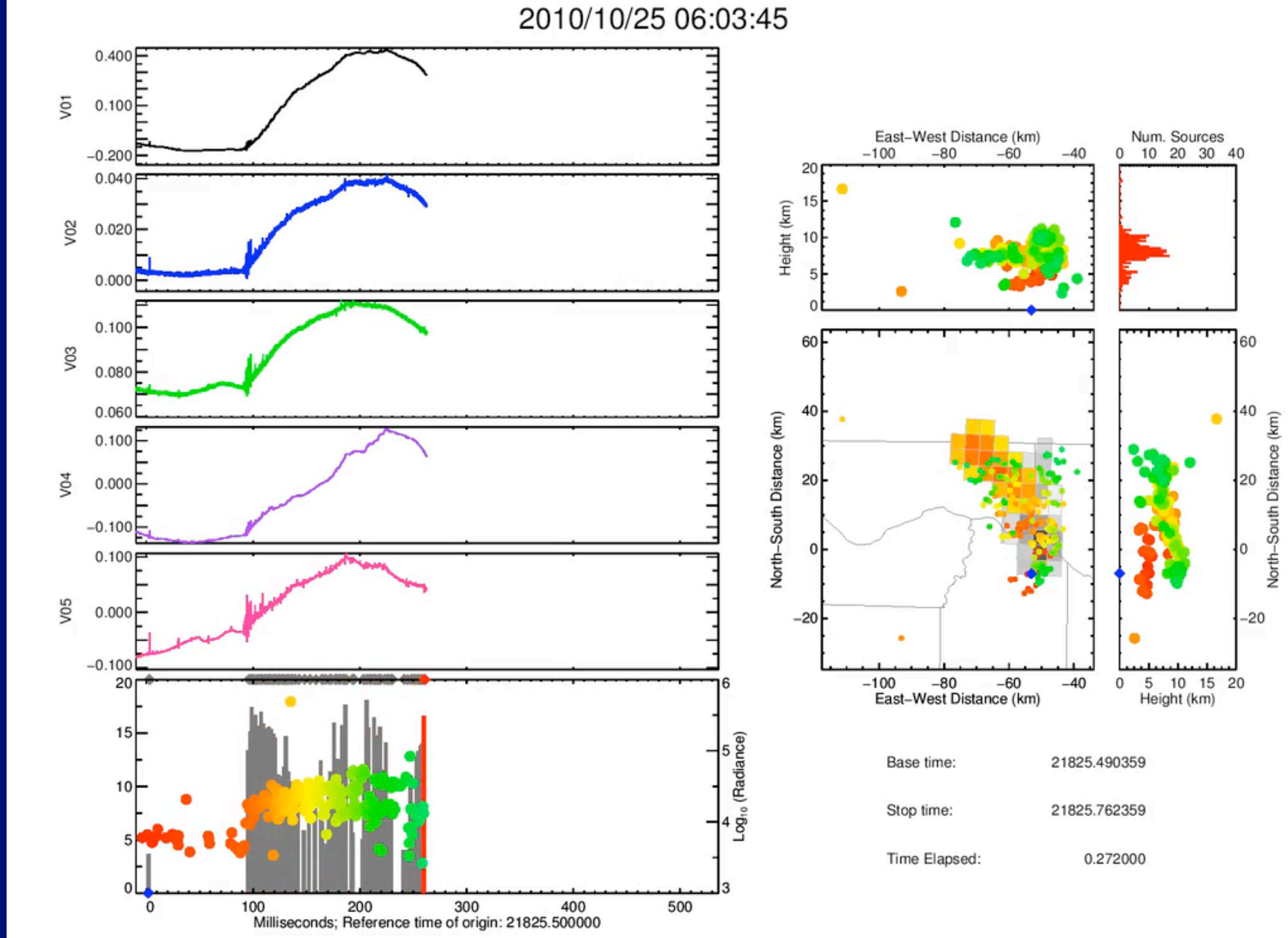
Two ICs, one much brighter and energetic



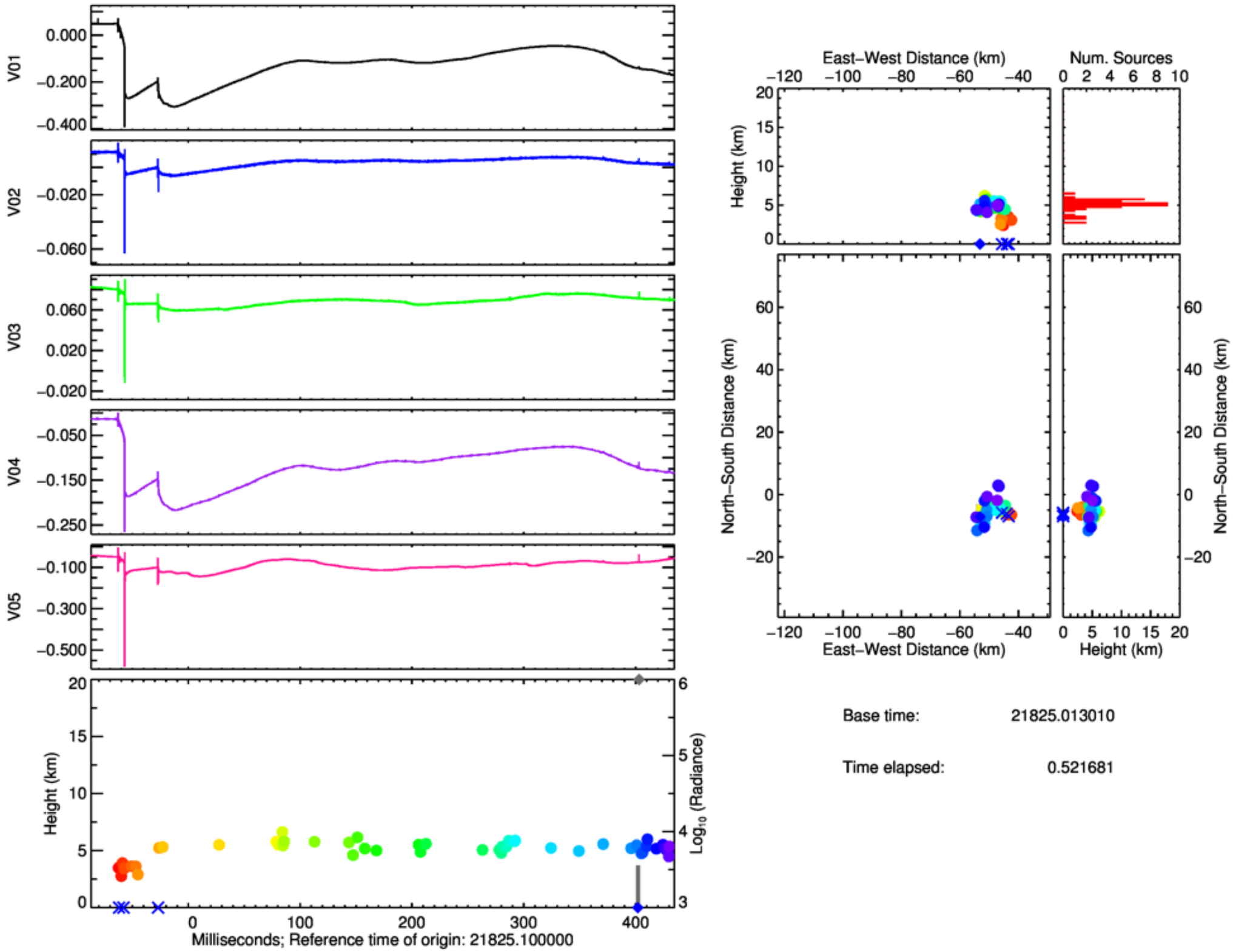
This is just the beginning of a "flash"...



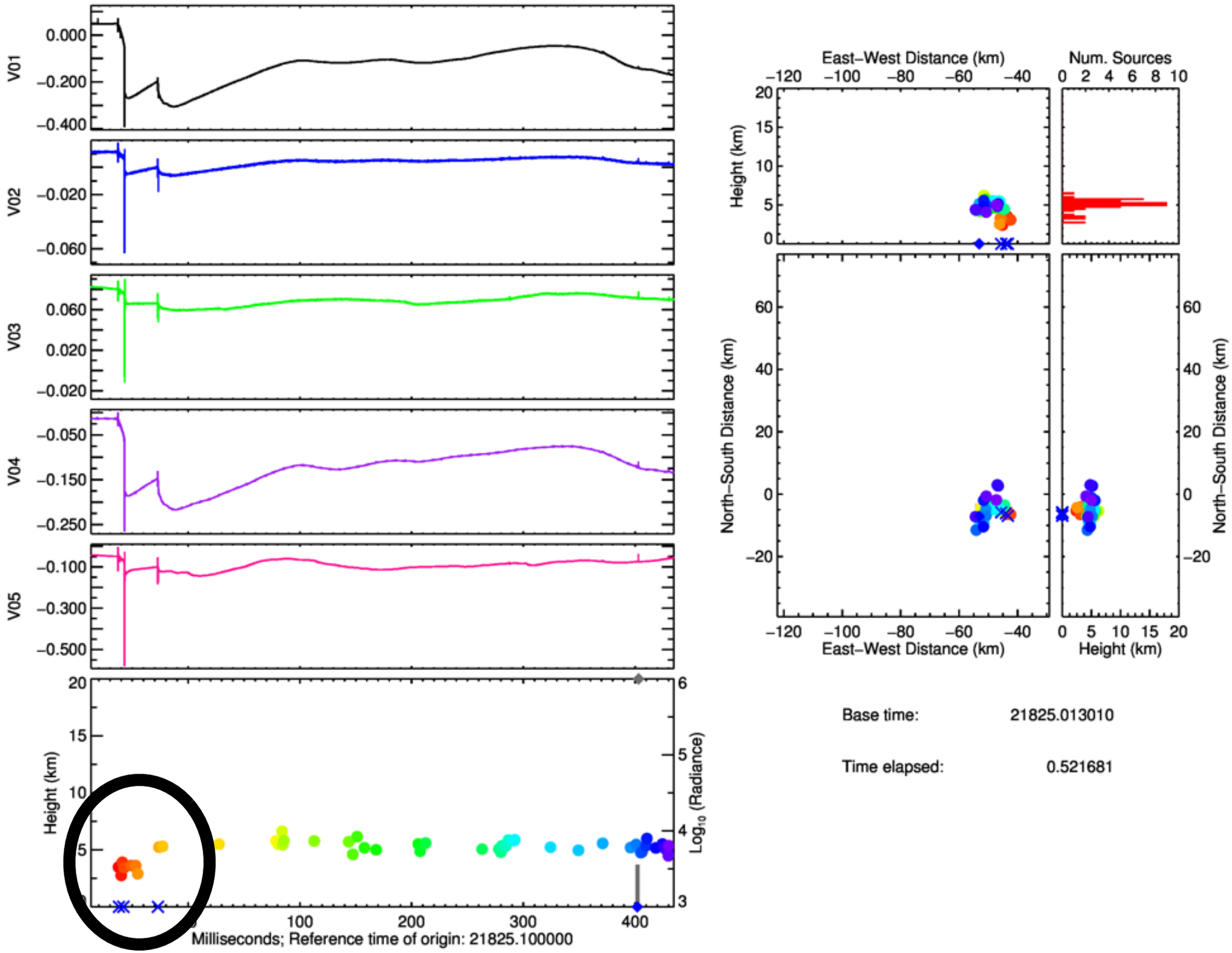
This is just the beginning of a "flash"...



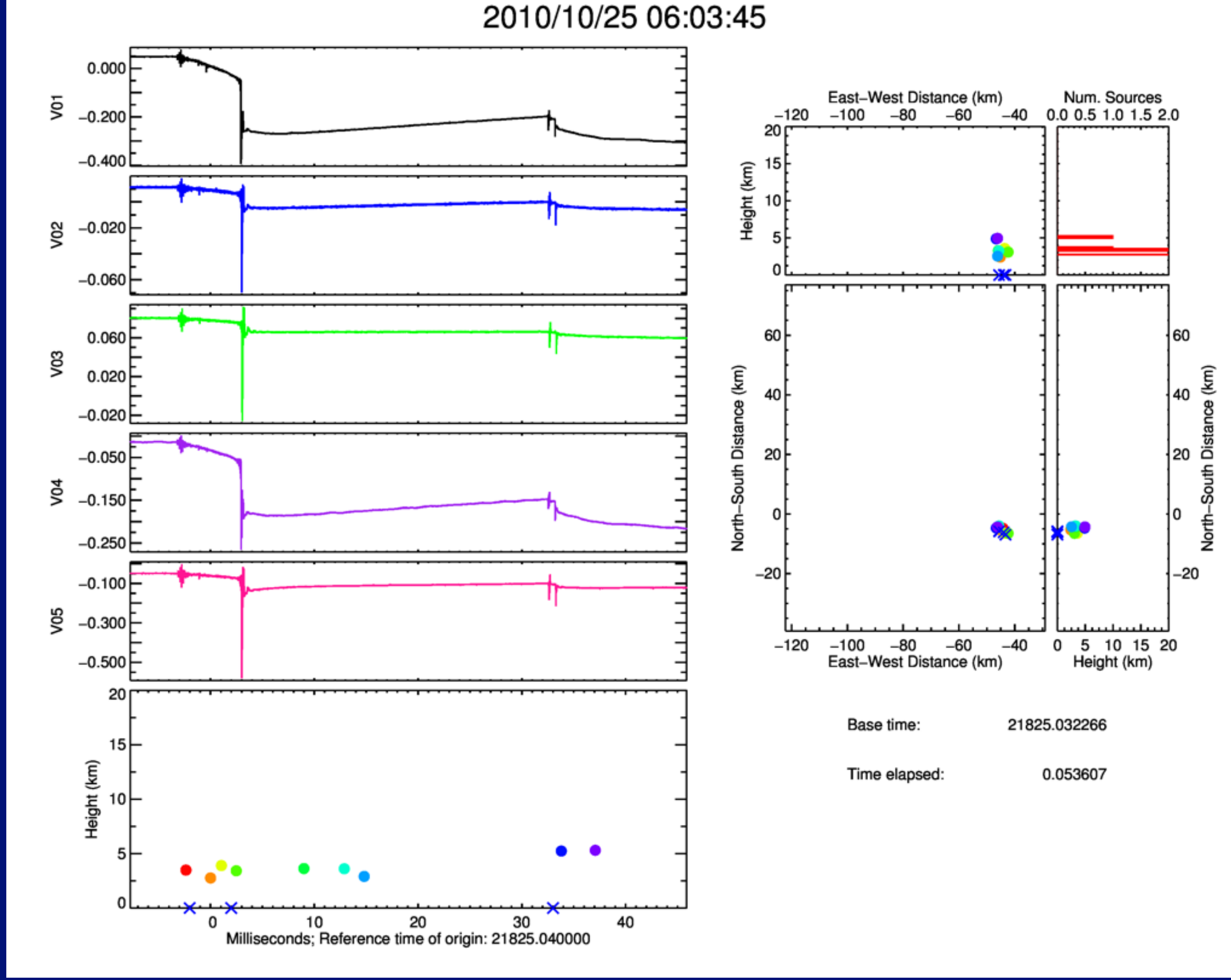
LIS groups start → electrostatic change; this is quite energetic!



This is just the beginning of a "flash"...



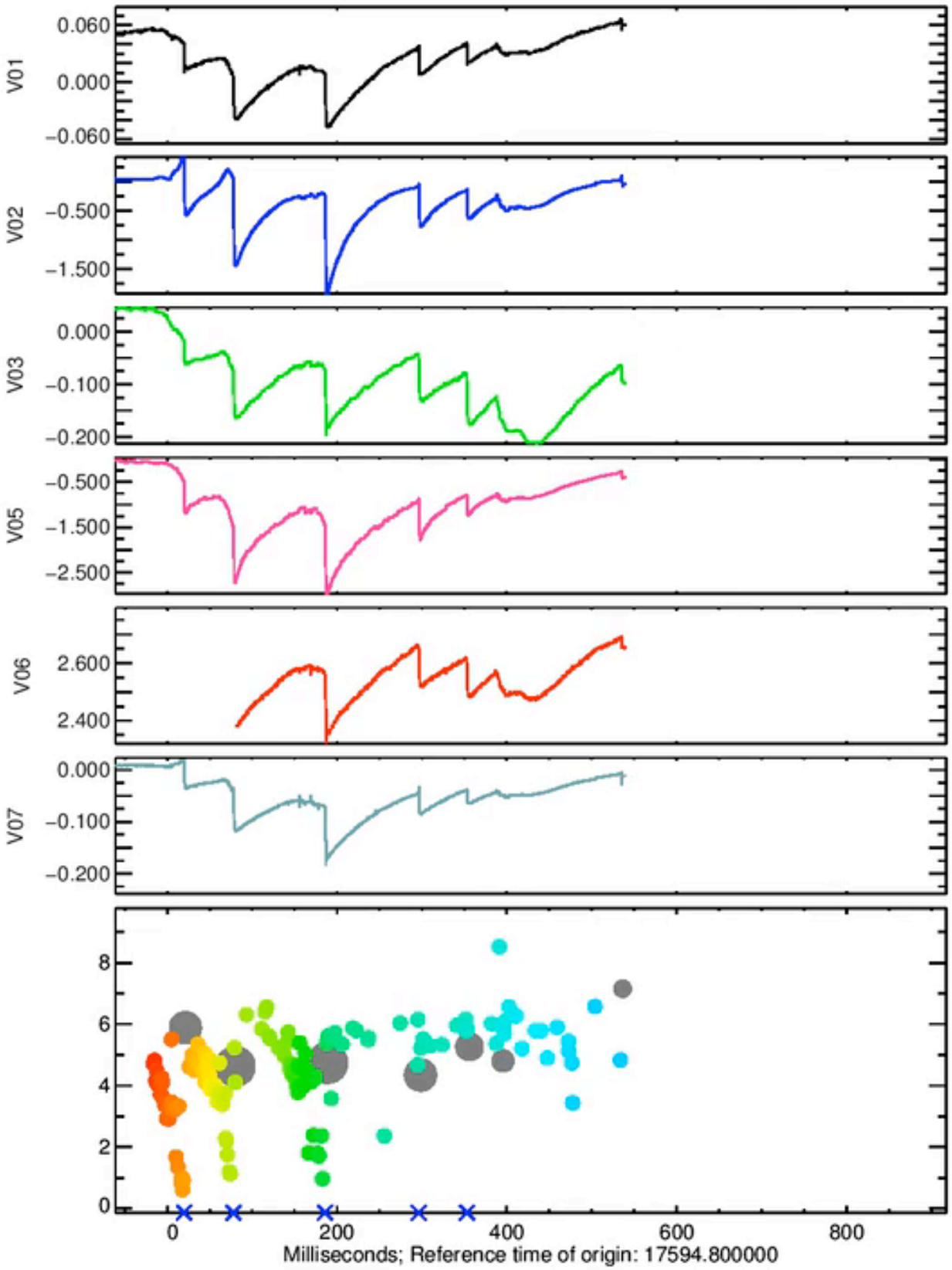
This is just the beginning of a "flash"...

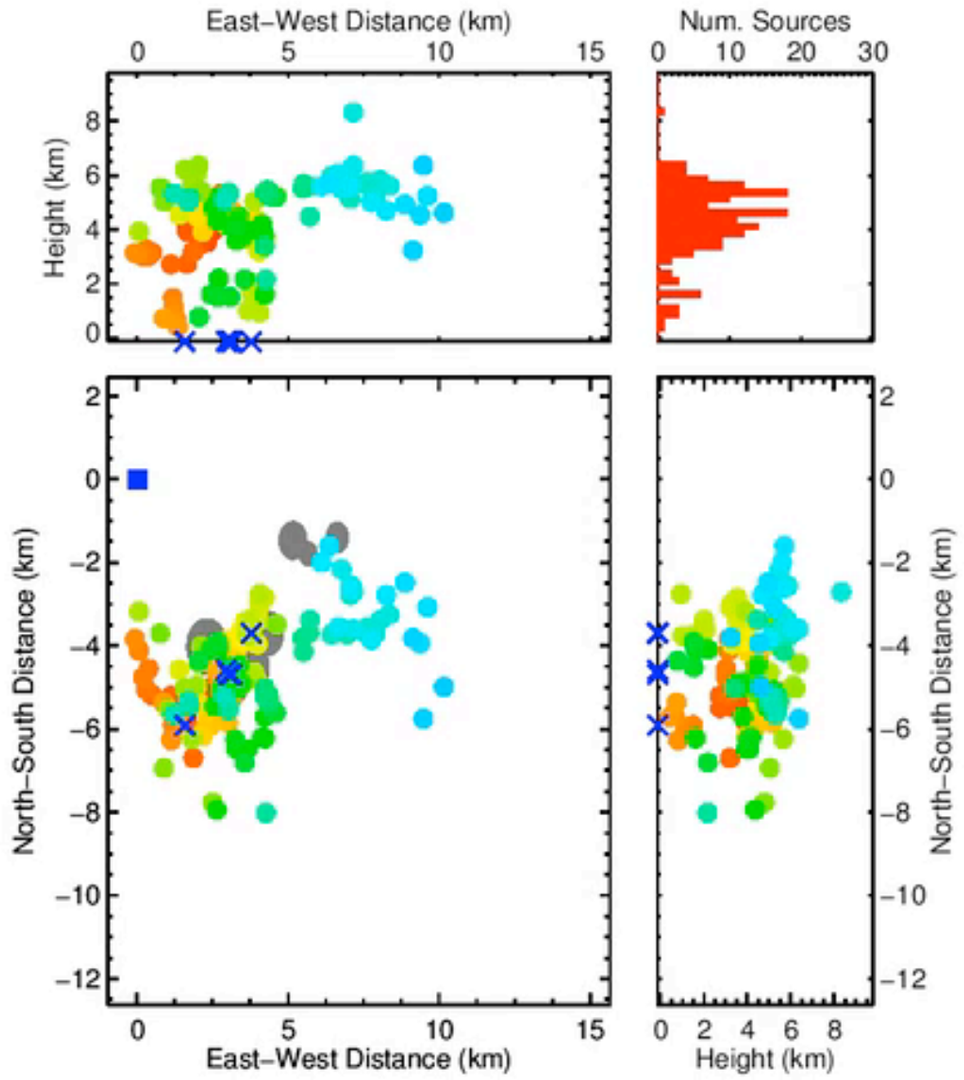


LIS misses the return strokes, but these are unusual...

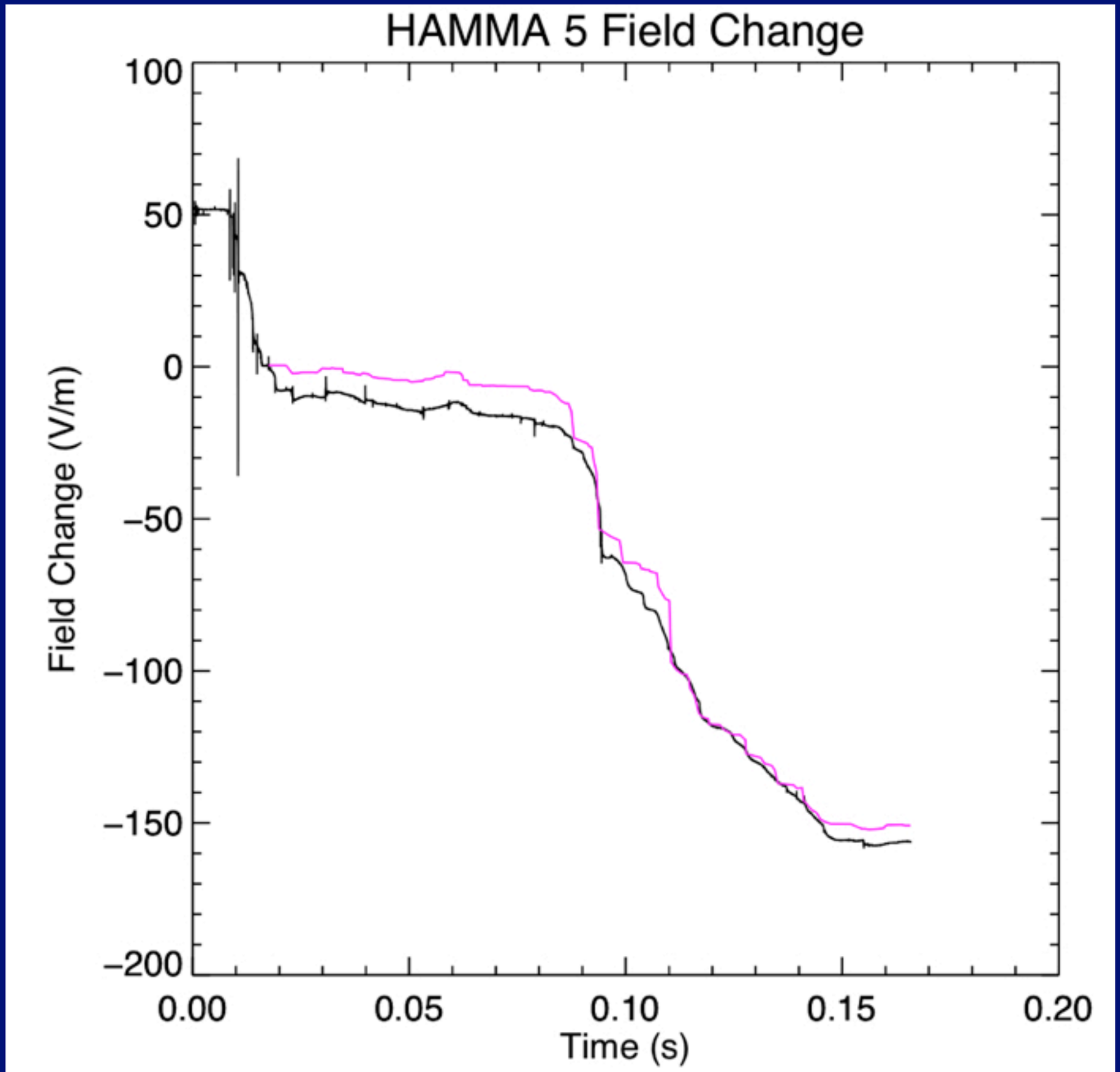
What are you working on now?

2010/10/25 04:53:14





Base time:	17594.739189
Stop time:	17595.339189
Time Elapsed:	0.600000


HAMMA 5 Field Change
100
50
0
−50
−100
−150
−200
Field Change (V/m)
0.00
0.05
0.10
0.15
0.20
Time (s)

What exactly does LIS see?

Processes that are well correlated with electric field

Energetic discharges

Why should I care?

Going to group level can yield information about the energetics associated with a “flash”

Lot more information than just “flashes”!