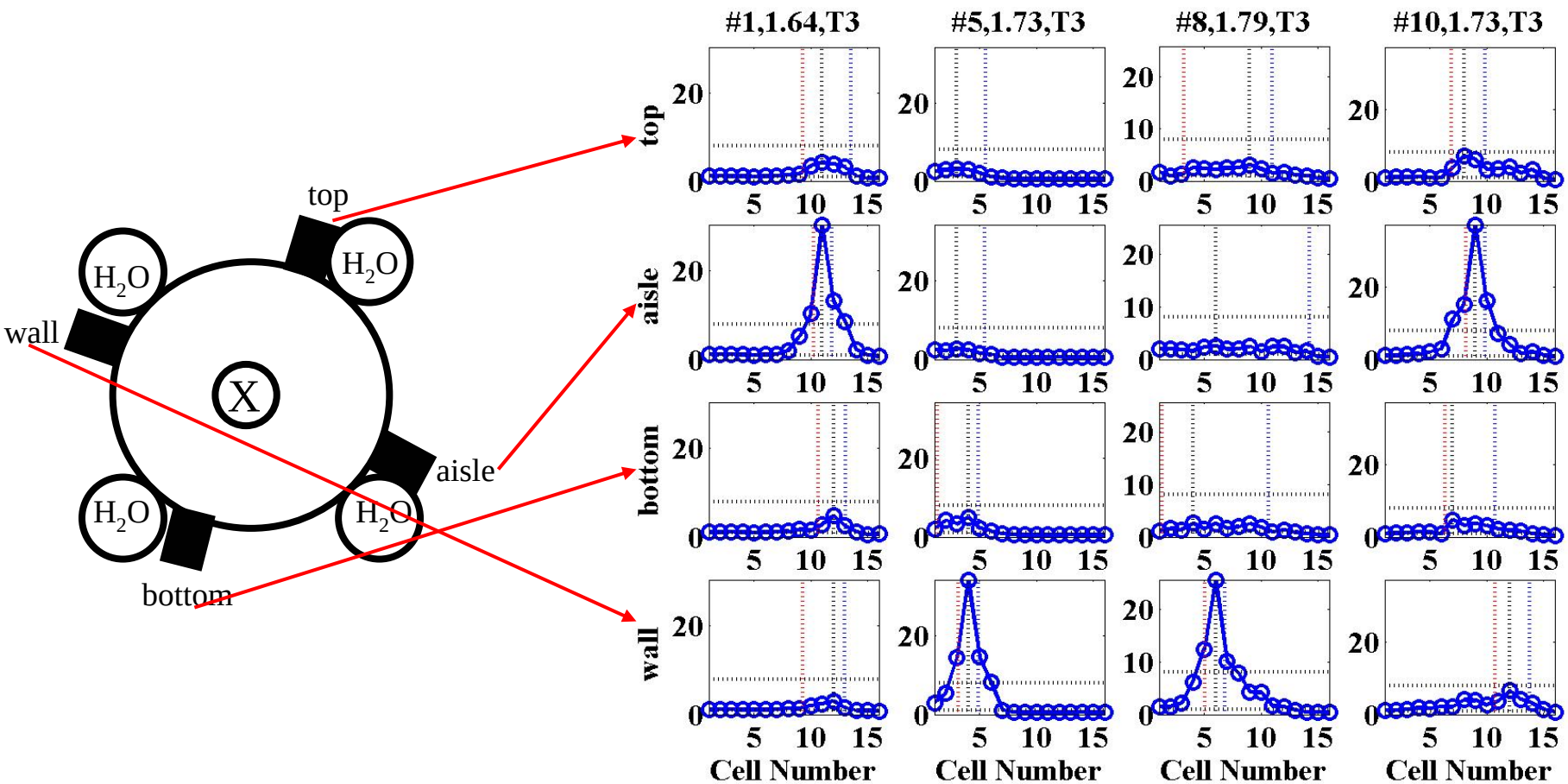
# Structure breakdown studies using Acoustic Emission

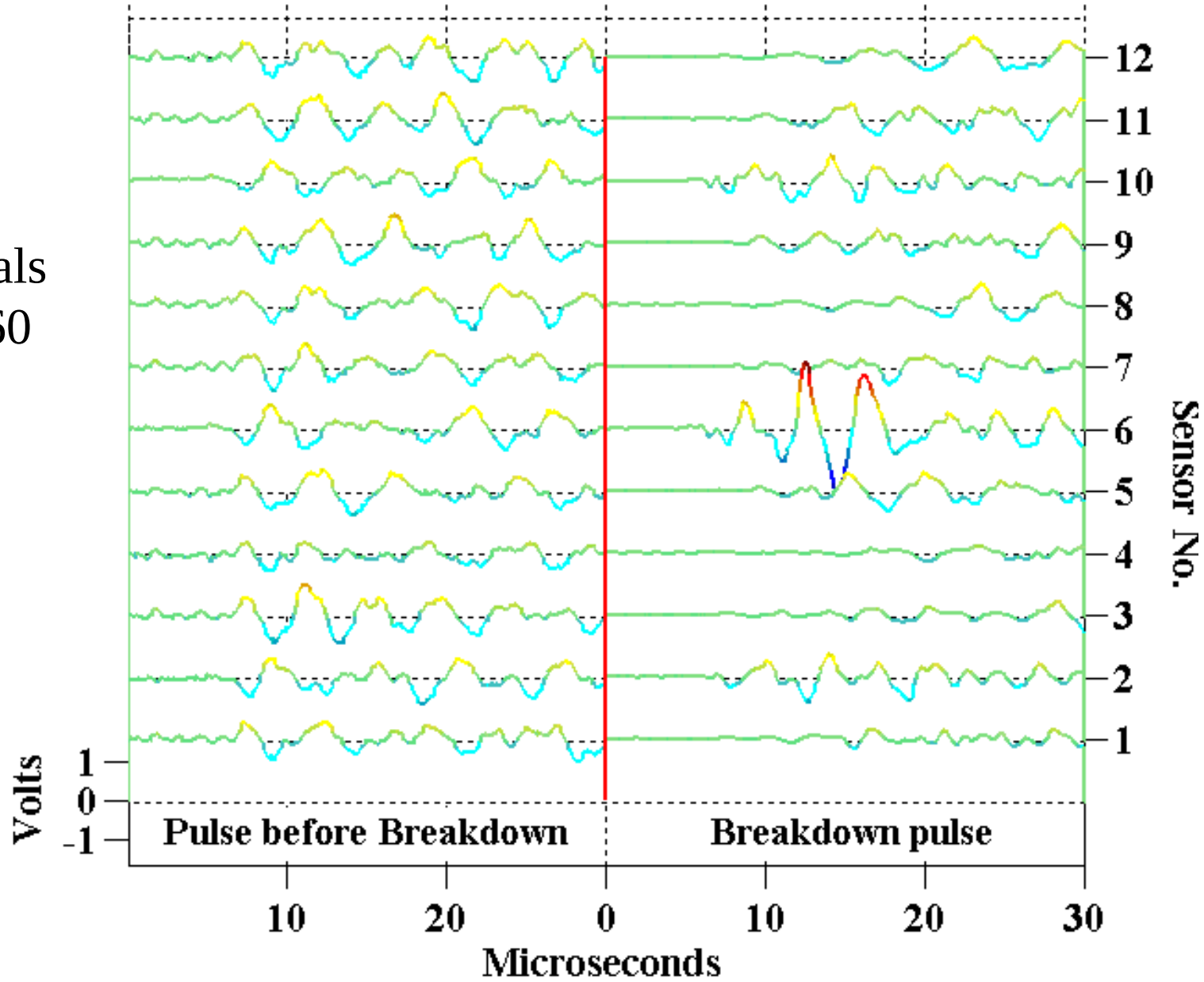
- Breakdown location resolution ~1 iris, 1/8 azimuth

- Contents:
  - Spitfest catalog
  - standing wave

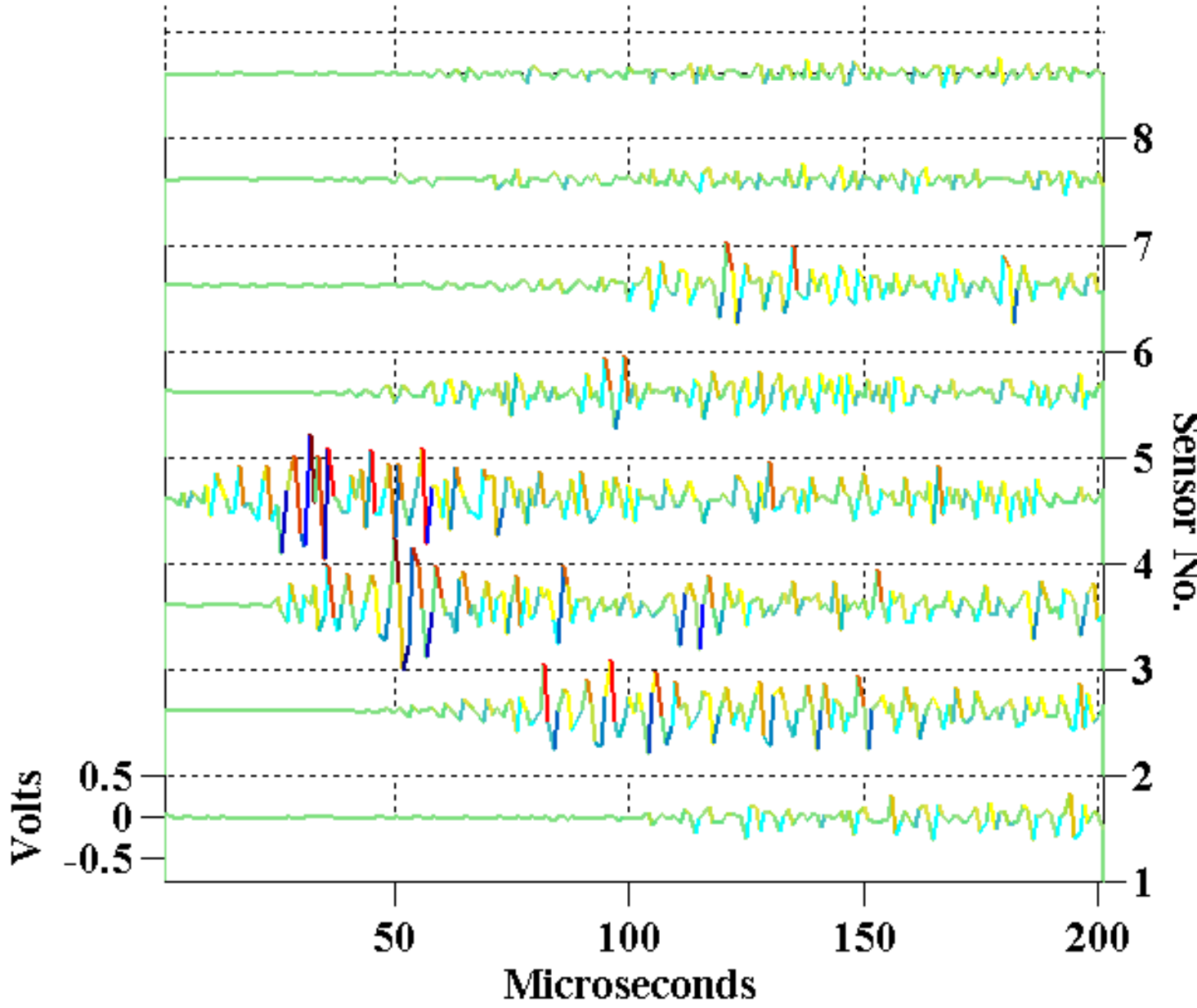
# Acoustic Sensors



Raw signals – H60

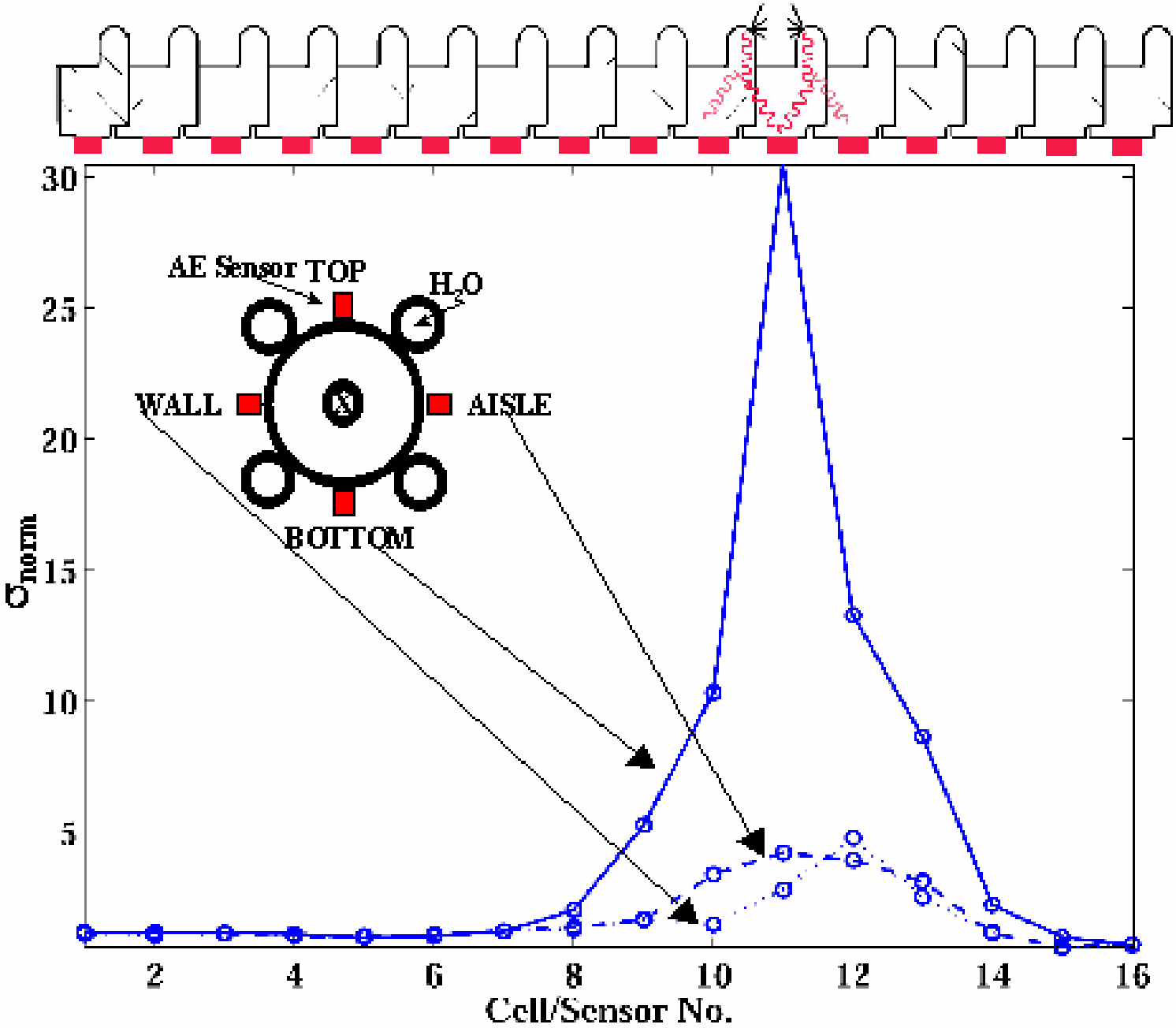


Raw signals – L-band standing wave TTF gun



Selected highly localized events:

showing 2 iris symmetry

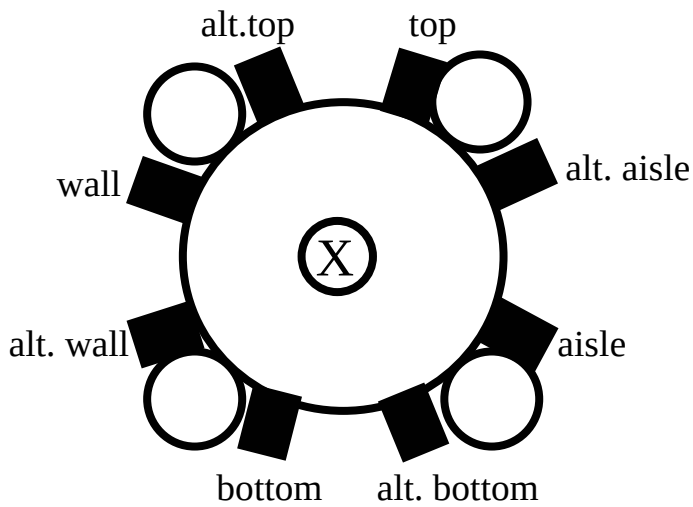


# Breakdown Study, H60VG3S6

- Why are most remaining breakdowns grouped in time/location (spitfests)?
- Using 64 AES sensors to look at spitfests (<3 min between bkdns) between 2/18 - 3/4/03 found 18 bkdn groups with signals within middle 12 cells
- Observations:
  - In about 50% of the groups, the breakdown stays in the same cell (not necessarily same azimuth)
  - In about 25% of the groups, the bkdn moves 2-3 cells
  - In about 25% of the groups, the bkdn moves >3 cells

# Sensor Layout

- 4 per cell – top, aisle, bottom, wall for cells 20-32 (slotted cells are 24-29)
- Added a 5th to cells 21-32 in a spiral pattern
  - Cell 21 has an extra on the top, cell 22 the 5th sensor is next to the aisle sensor, cell 23 the bottom, etc.



# Spitfest Groups

| Group 1 | |
|---|---|
| 24 | 3.45 |
| 24 | 2.22 |

| Group 2 | |
|---|---|
| 20 | 3.25 |
| 20 | 2.20 |

| Group 3 | |
|---|---|
| 20 | 3.84 |
| 23 | 10.59 |

| Group 4 | |
|---|---|
| 20 | 3.05 |
| 20 | 3.35 |

| Group 5 | |
|---|---|
| 20 | 2.20 |
| 20 | 3.68 |

| Group 6 | |
|---|---|
| 22 | 2.35 |
| 20 | 4.42 |
| 22 | 2.20 |

| Group 7 | |
|---|---|
| 25 | 1.92 |
| 26 | 9.21 |
| 29 | 3.99 |
| 22 | 7.54 |
| 22 | 1.53 |
| 20 | 4.48 |
| 20 | 2.01 |

| Group 8 | |
|---|---|
| 20 | 2.32 |
| 23 | 1.89 |

| Group 9 | |
|---|---|
| 29 | 2.31 |
| 31 | 4.95 |

| Group 10 | |
|---|---|
| 30 | 4.97 |
| 30 | 10.45 |

| Group 11 | |
|---|---|
| 21 | 2.20 |
| 21 | 10.79 |
| 22 | 9.63 |

| Group 12 | |
|---|---|
| 32 | 4.87 |
| 30 | 4.90 |
| 30 | 9.07 |

| Group 13 | |
|---|---|
| 31 | 9.26 |
| 32 | 5.89 |
| 31 | 6.78 |
| 32 | 3.29 |
| 32 | 2.47 |
| 31 | 5.60 |
| 29 | 5.46 |
| 30 | 5.38 |

| Group 14 | |
|---|---|
| 21 | 3.34 |
| 30 | 3.16 |

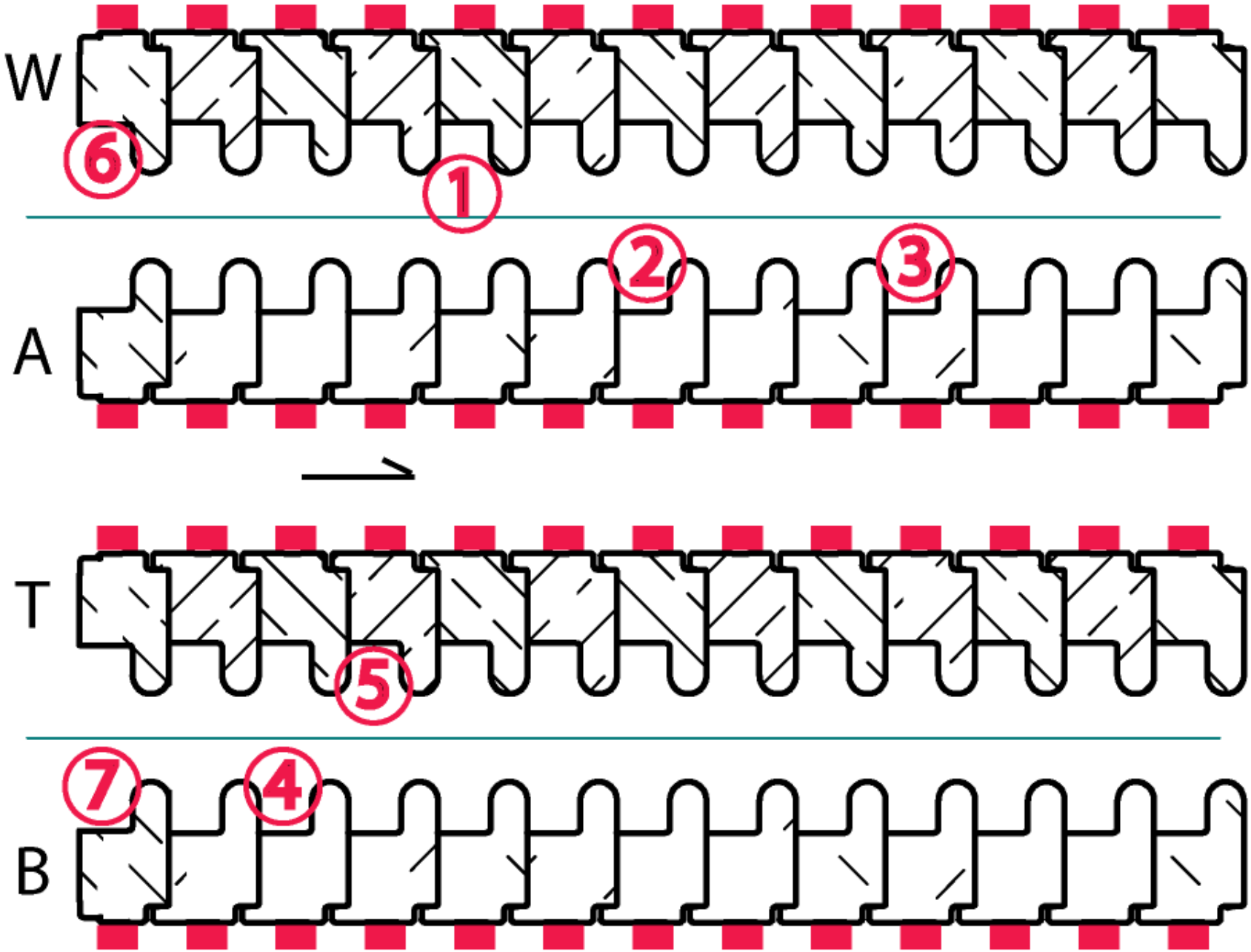
| Group 15 | |
|---|---|
| 30 | 3.54 |
| 21 | 3.03 |
| 30 | 4.97 |
| 32 | 2.22 |

| Group 16 | |
|---|---|
| 31 | 3.69 |
| 25 | 9.95 |

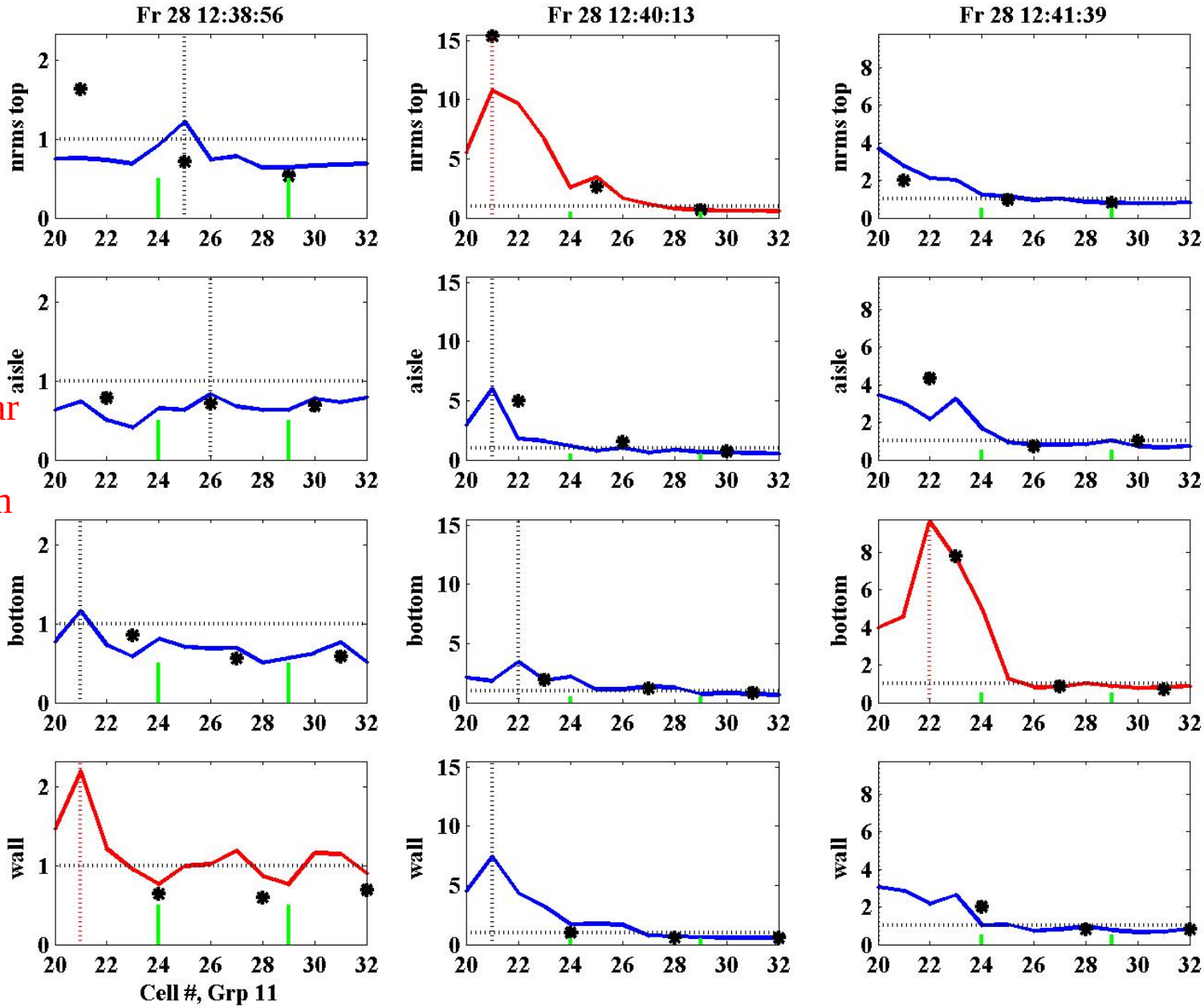
| Group 17 | |
|---|---|
| 22 | 3.23 |
| 22 | 2.03 |

| Group 18 | |
|---|---|
| 21 | 3.83 |
| 20 | 8.41 |

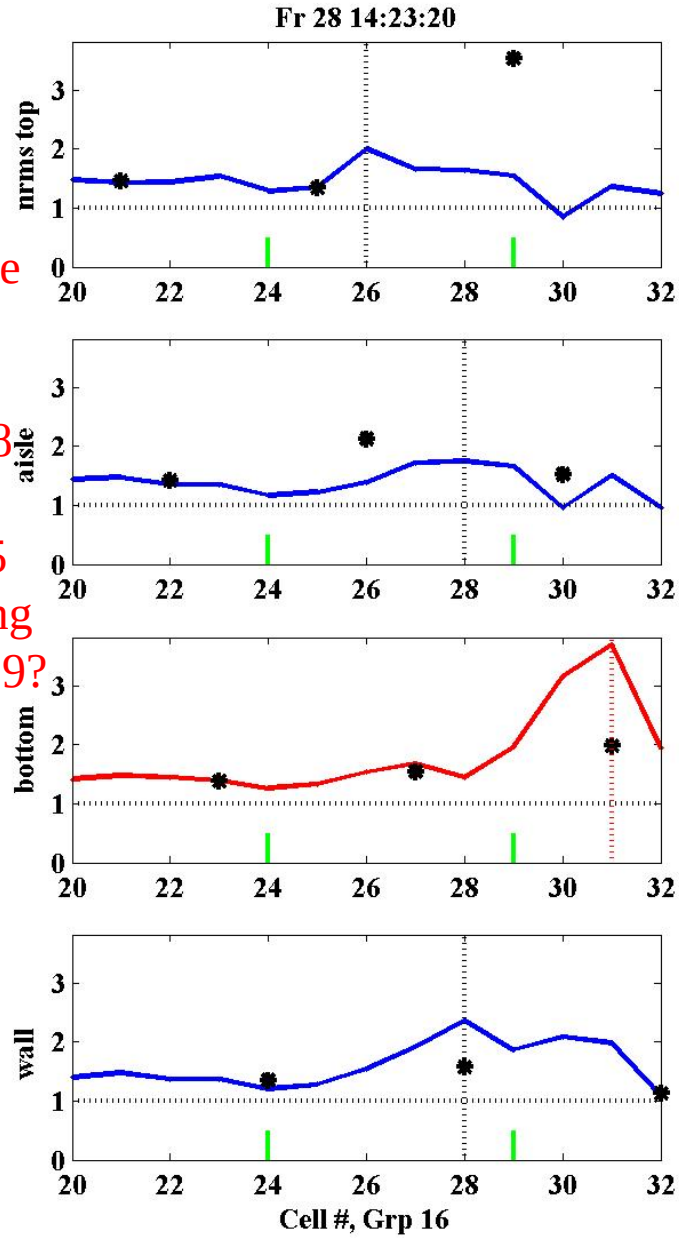
# Spitfest sequence

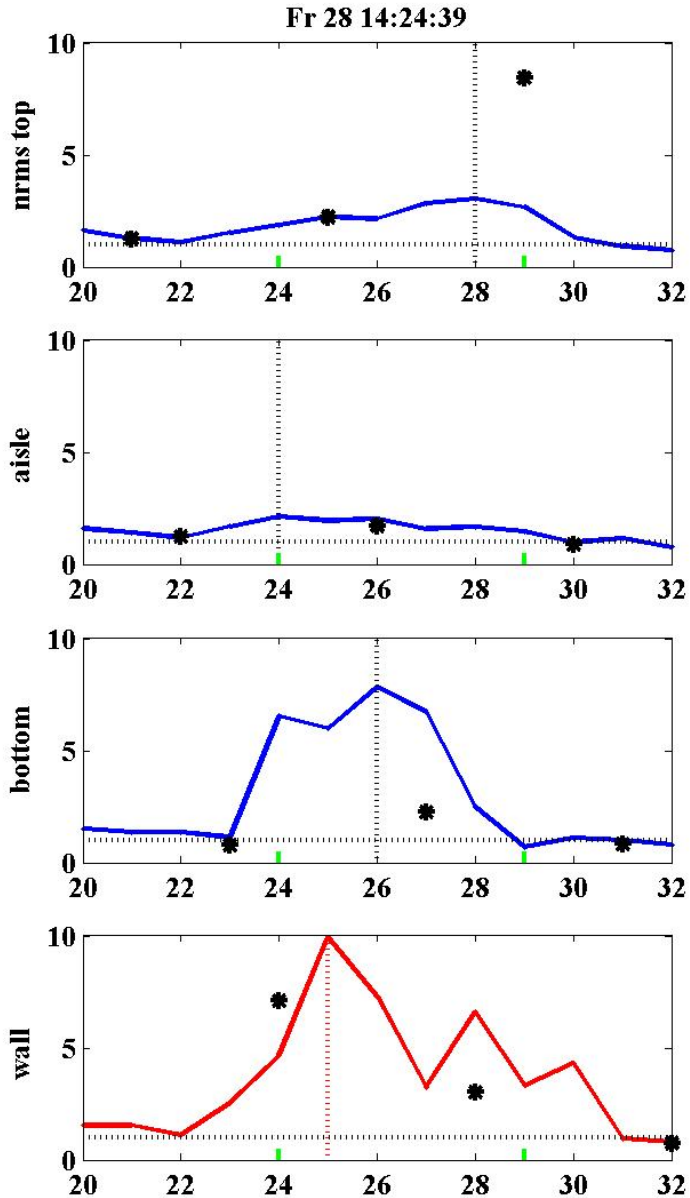


Same/similar
Moving
Downstream
Event 1:
big C21
little C25
Event 2:
big C21
little C25
Event 3:
big C22
little C23

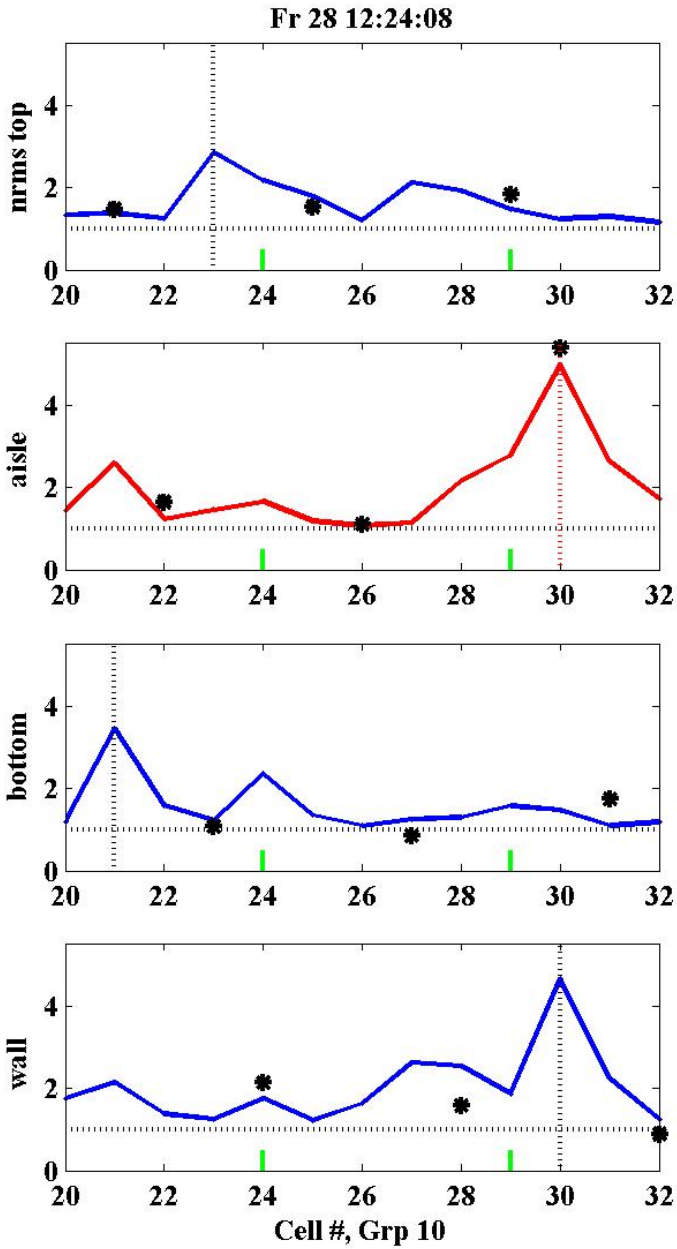


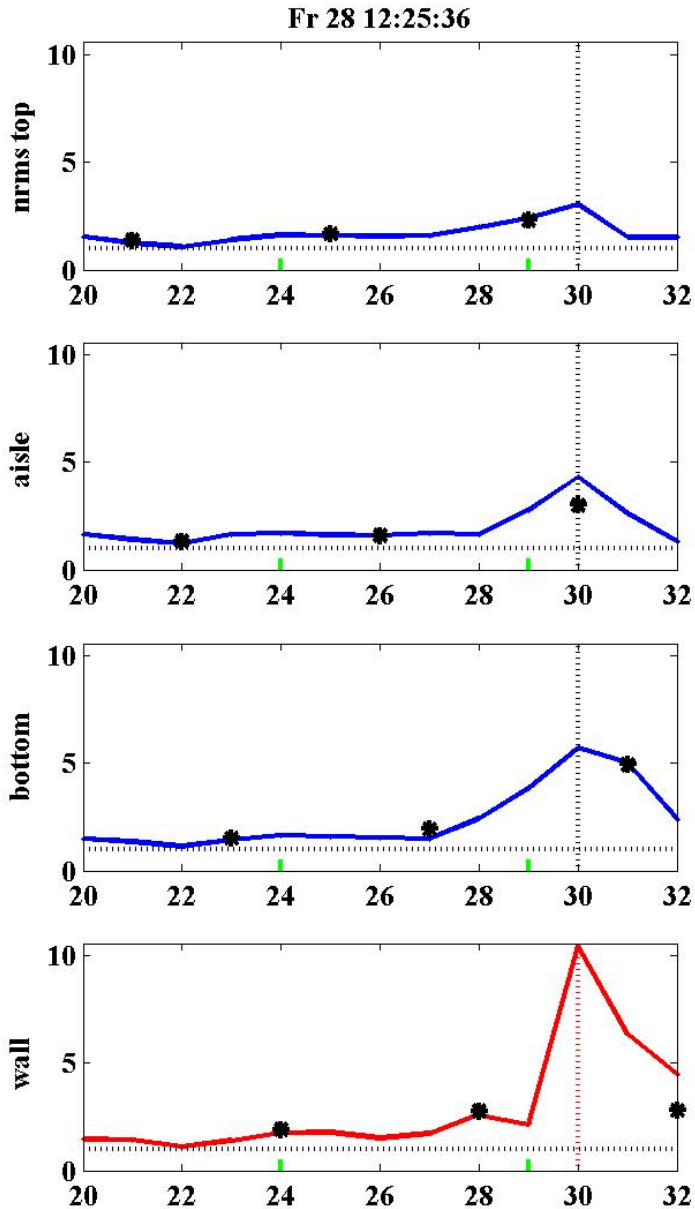
Big move
Event1:
big C21
little C28
Event 2:
BIG C25
something
in C27-29?



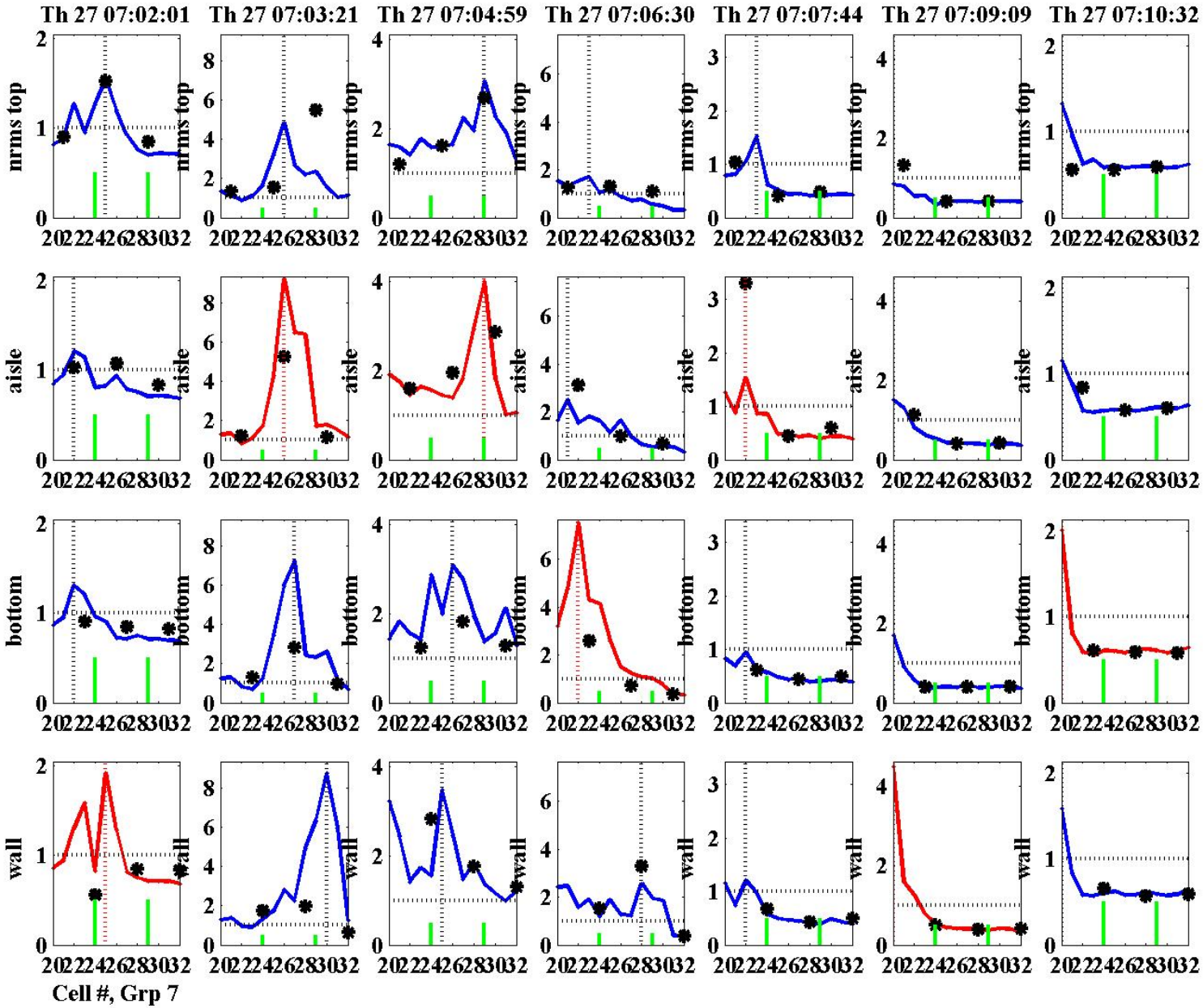



Same/similar
Event 1
big C30
little
C21,27?
Event 2
BIG C30

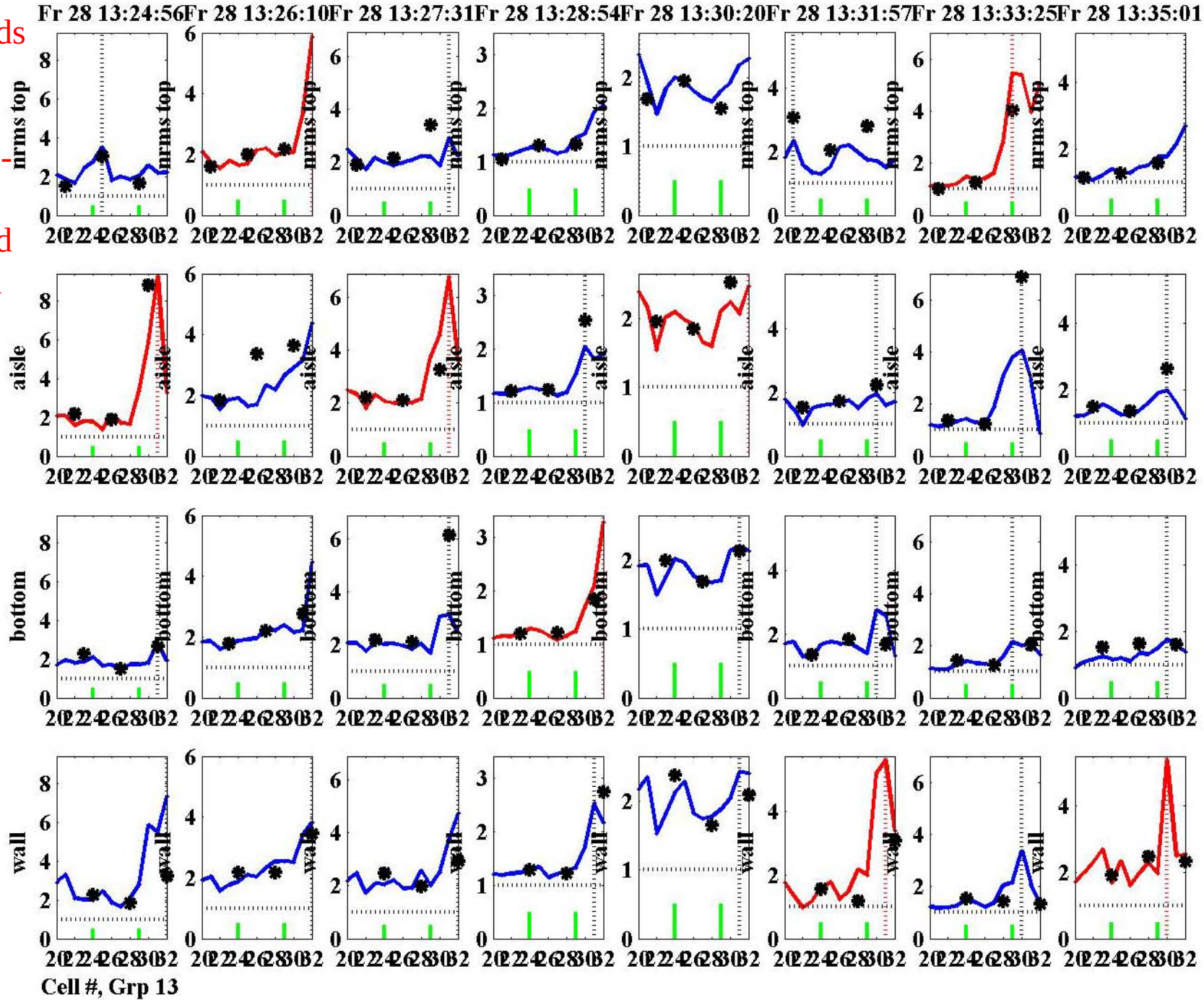


Moves around a lot

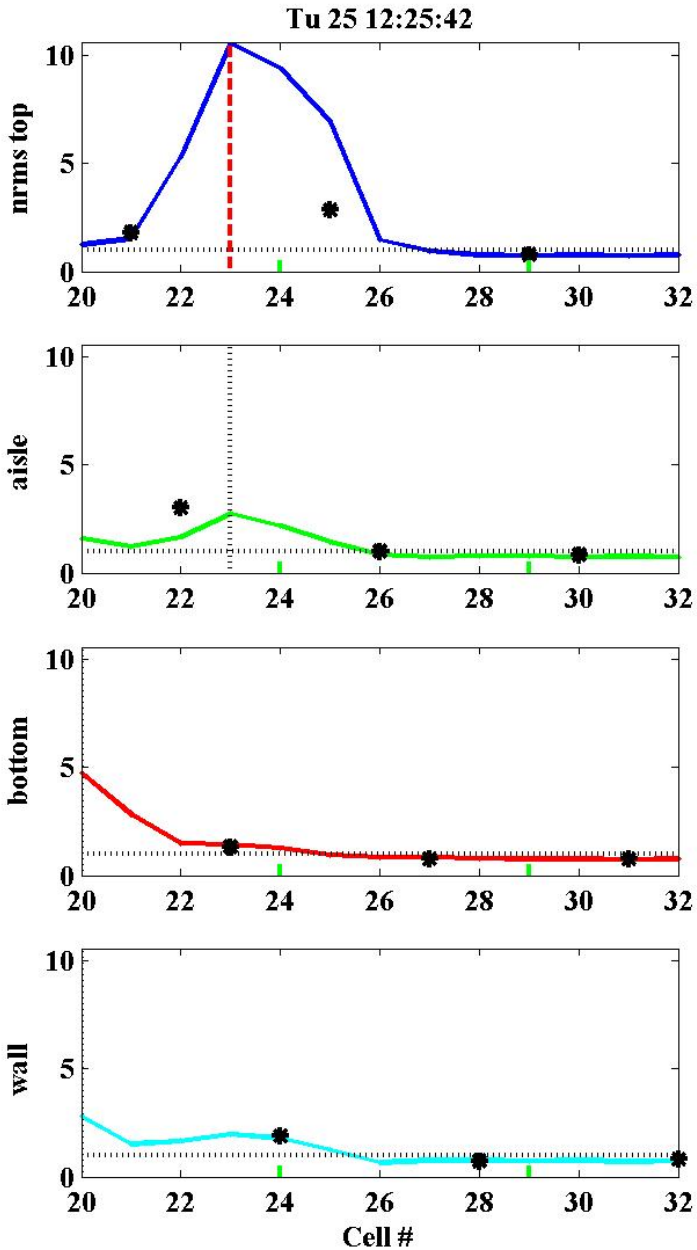


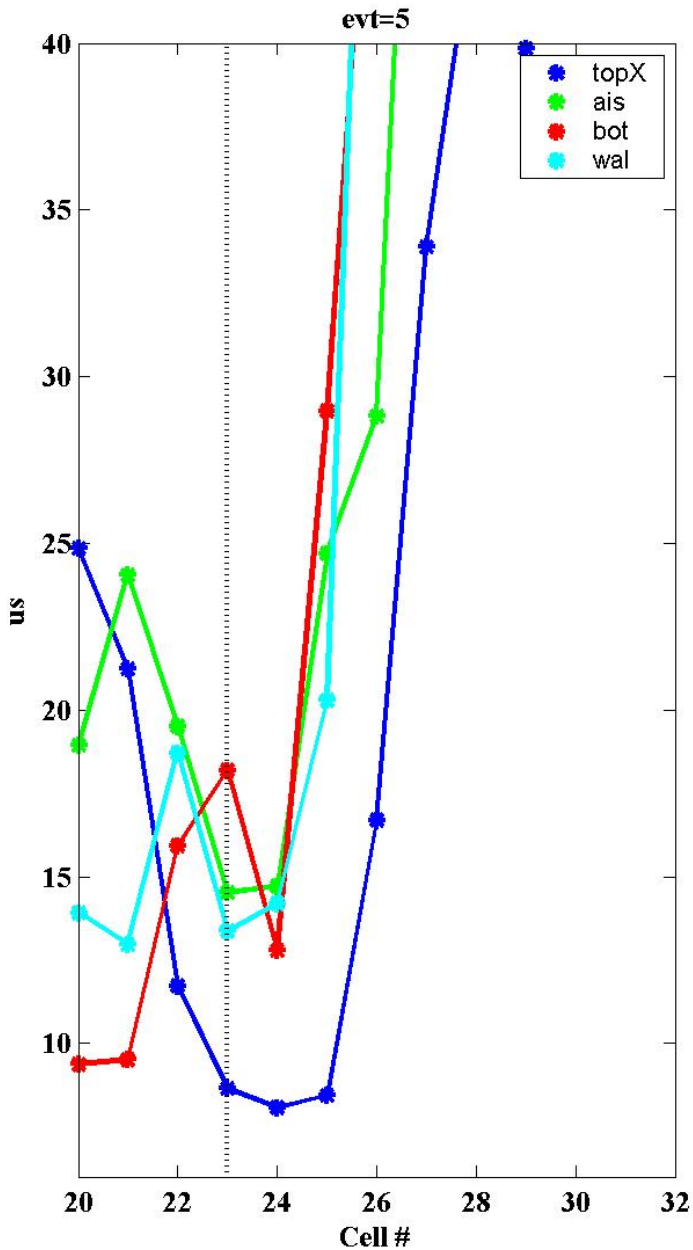
Most towards the end, bounc-ing around with a dud



# Acoustic Sensors, H60VG3S6

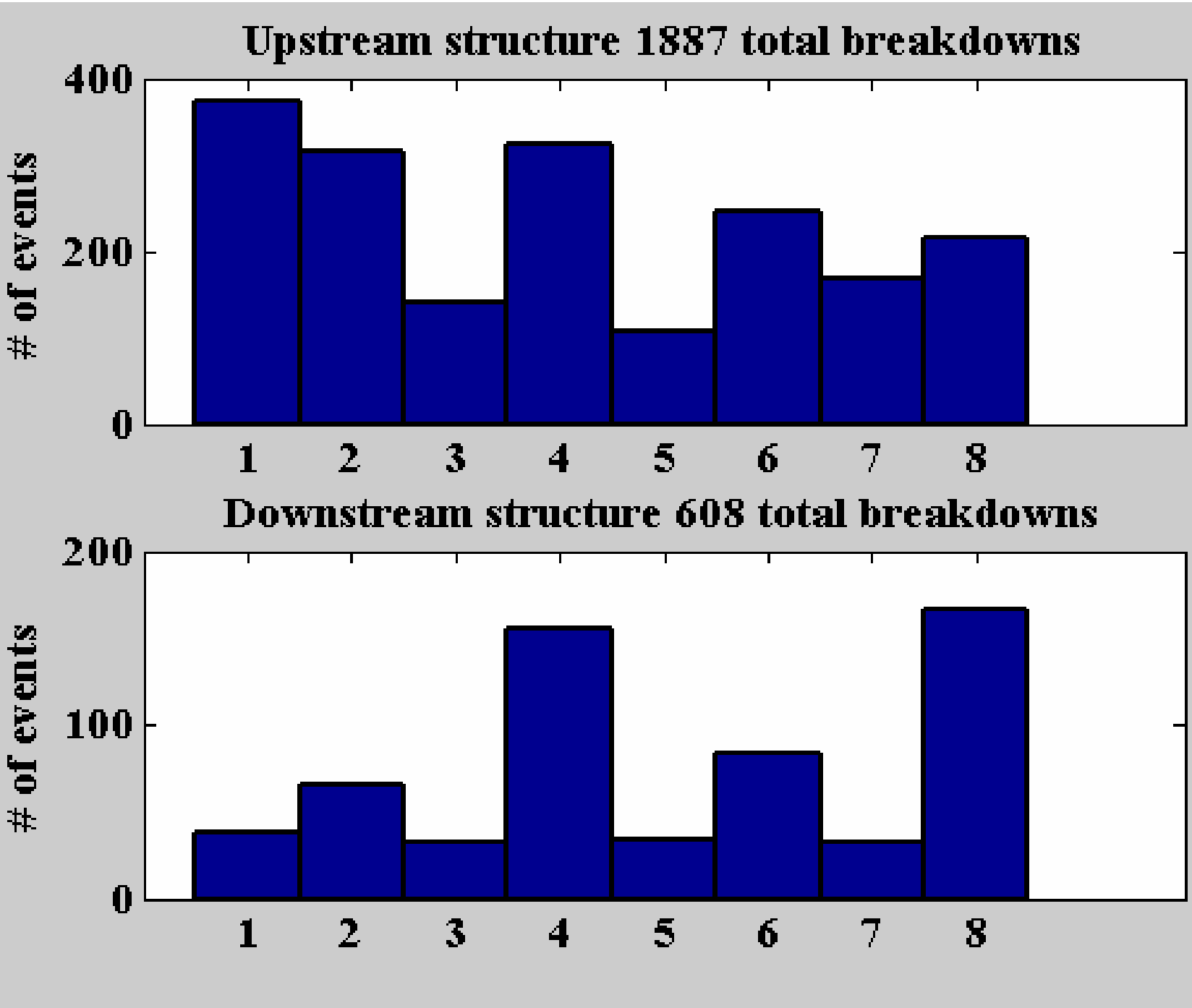
- Data from 2/18 - 3/4/03
  - 288 files total, 99 show a signal at least as large as n-2 signal in the region with sensors
- “standard” analysis:
  - Normalized rms200: st. dev. of each sensor’s signal for first 20 μs divided by the same for the n-2 pulse
  - To calculate timing:
    - Calculate integrated rms (std(1:n)), divide by same for n-2 pulse
    - Subtract offset during time before RF turn on
    - Measure where signal crosses a threshold (0.5 in our case)

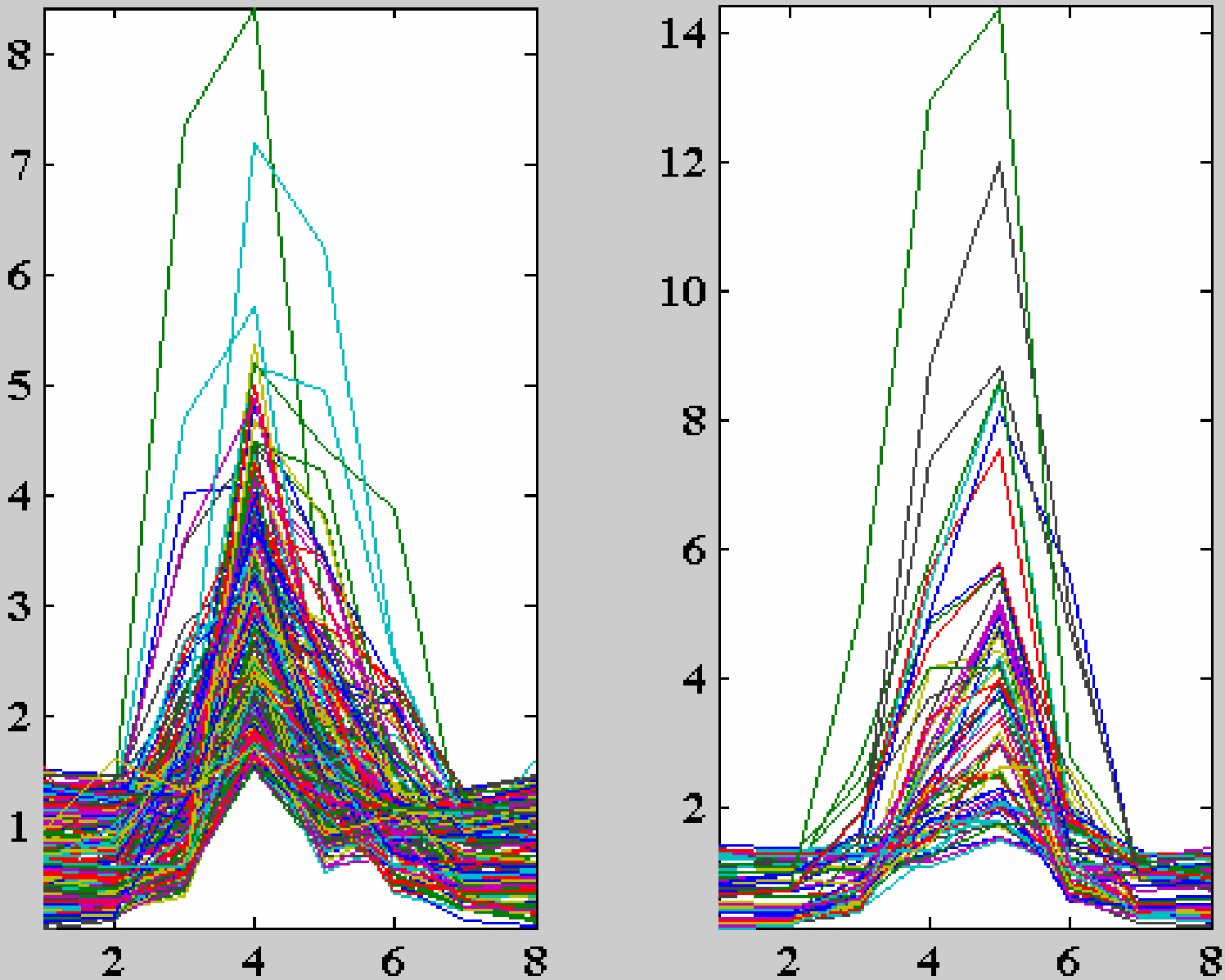

Tu 25 12:25:42
nrms top
aisle
bottom
wall
Cell #

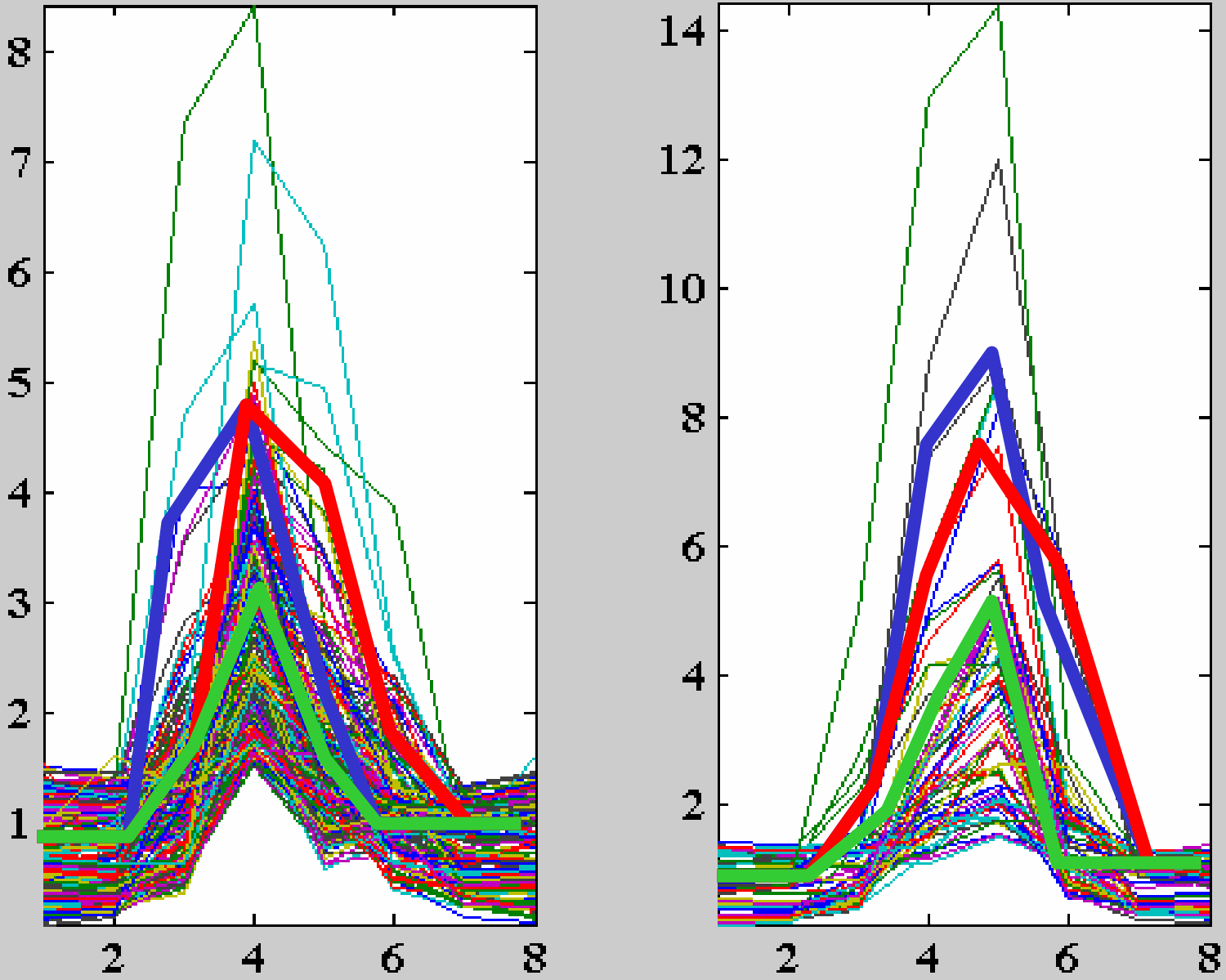

evt=5
topX
ais
bot
wal
us
Cell #

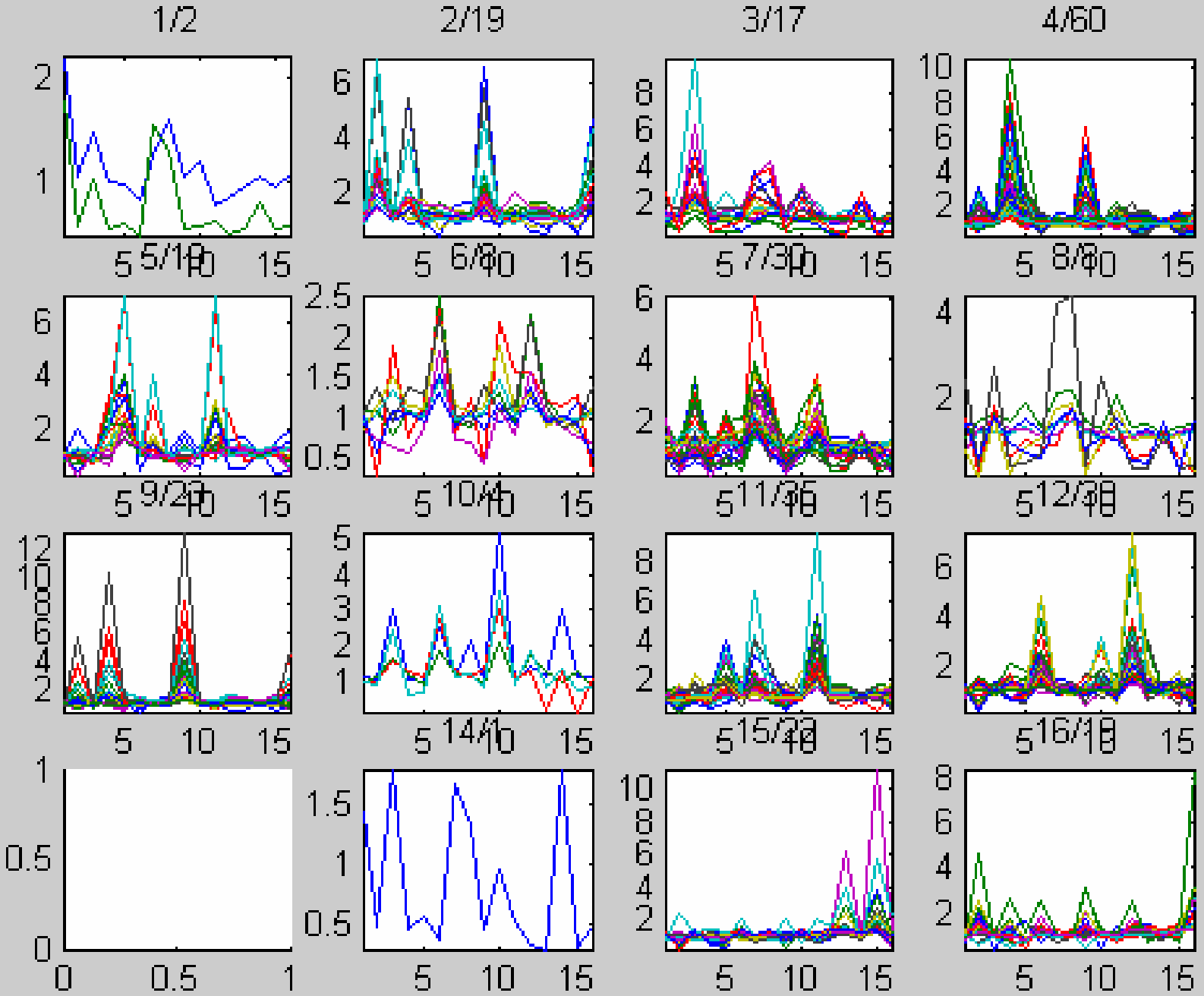
# SW20a275 AES analysis

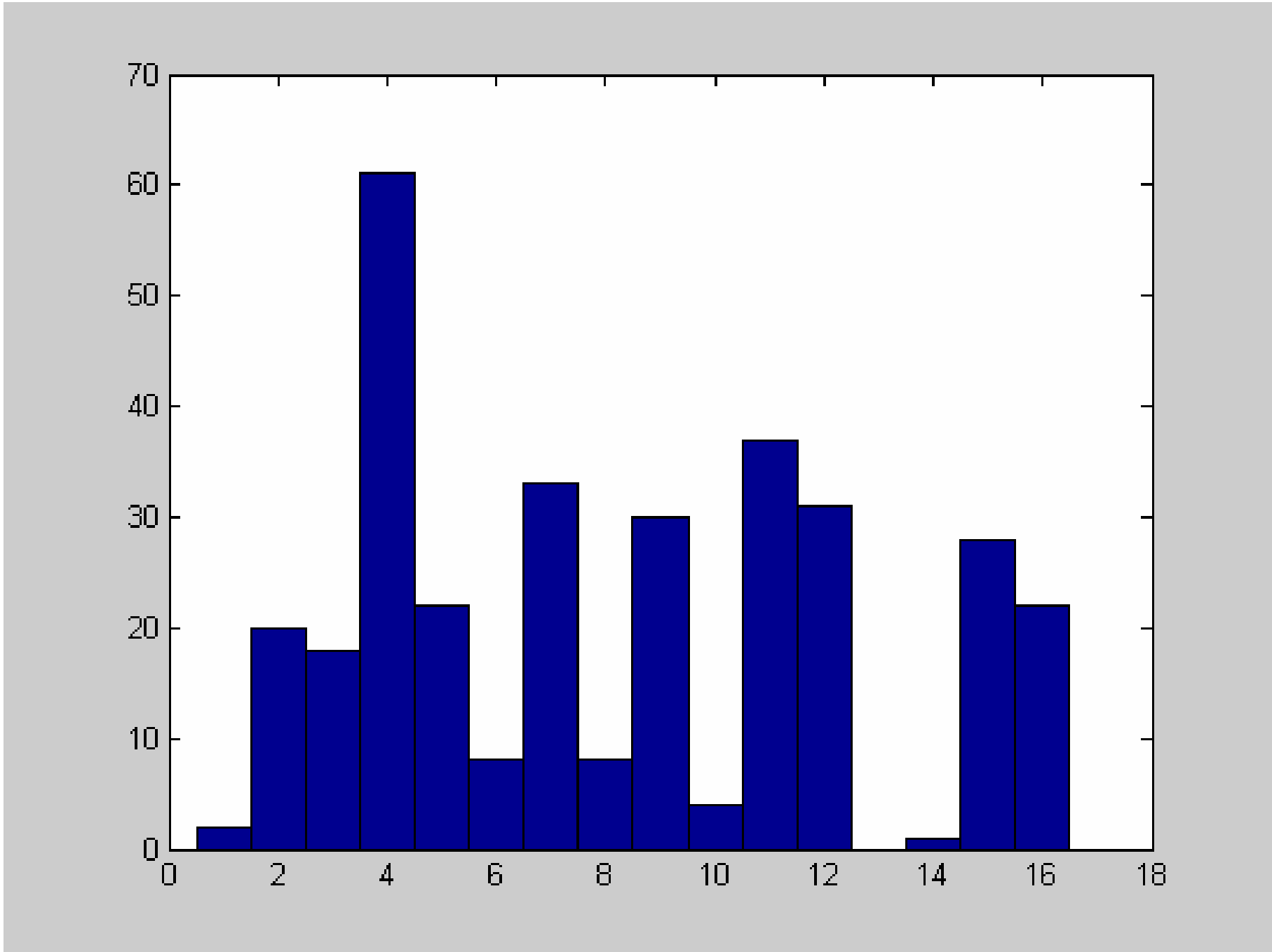
- 16 sensors total on the two structures
- data from 2500 events between 5/29 15:00 and 6/5 18:30 (PW=135ns – 2-step pulse)


Upstream structure 1887 total breakdowns
# of events
400
200
0
1
2
3
4
5
6
7
8
Downstream structure 608 total breakdowns
# of events
200
100
0
1
2
3
4
5
6
7
8

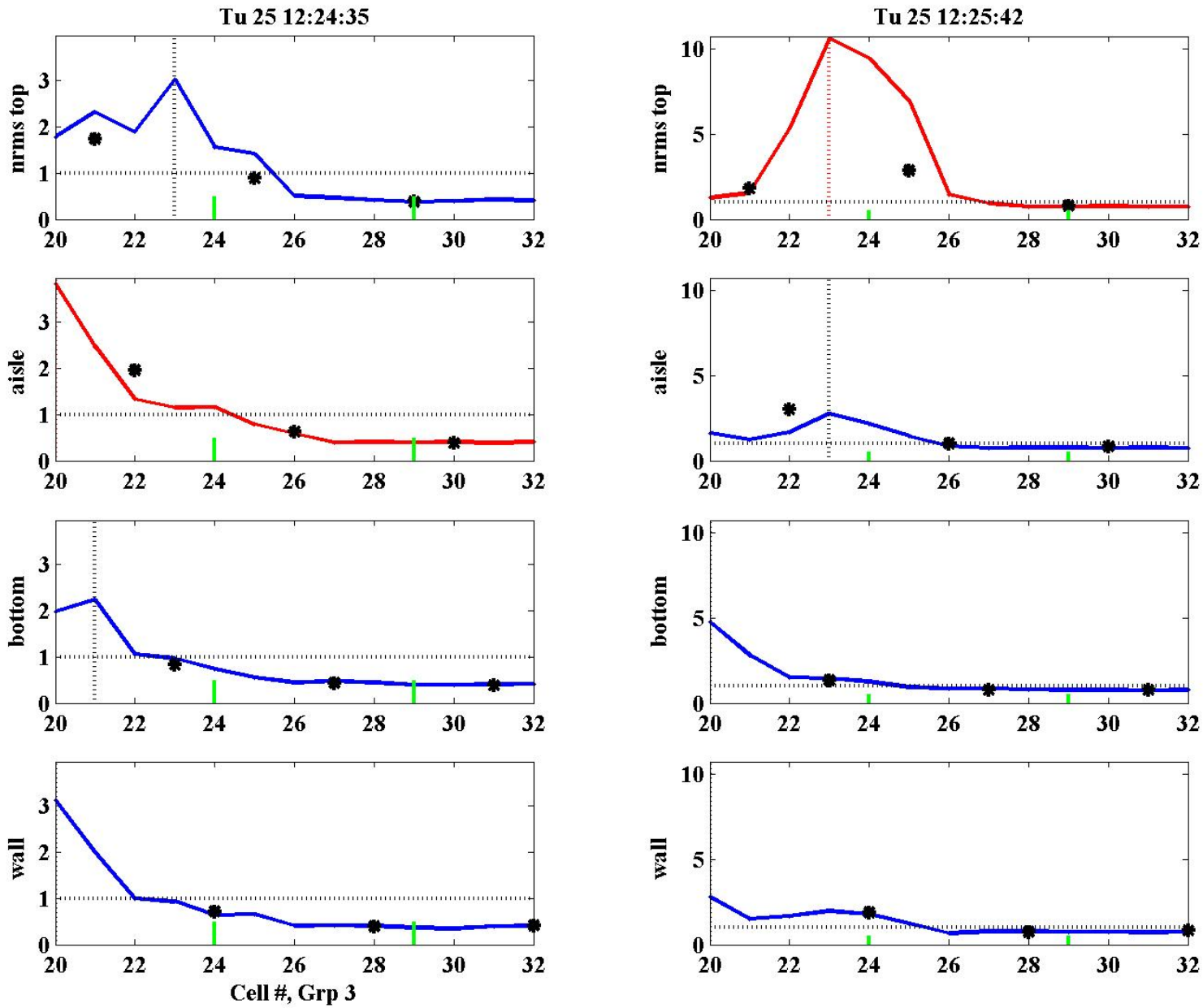

8
7
6
5
4
3
2
1
2
4
6
8
14
12
10
8
6
4
2
2
4
6
8


8
7
6
5
4
3
2
1
2
4
6
8
14
12
10
8
6
4
2
2
4
6
8

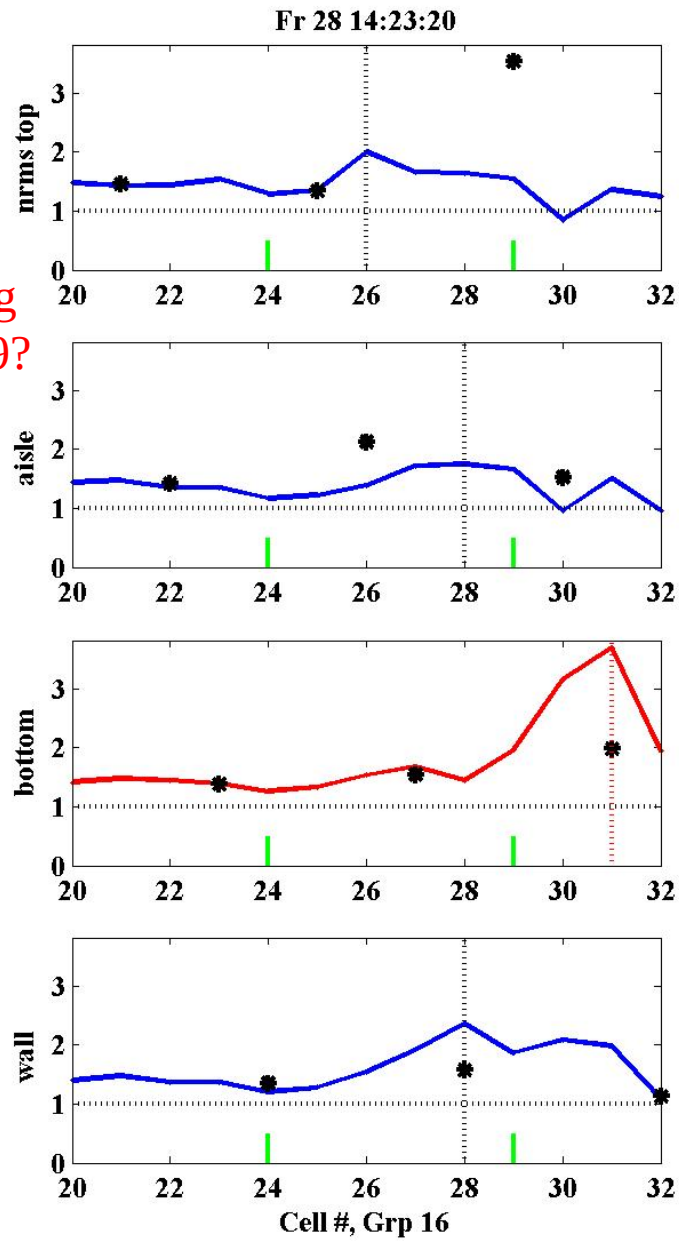

1/2
2/19
3/17
4/60
5/10
6/8
7/30
8/8
9/23
10/4
11/35
12/38
14/1
15/23
16/18

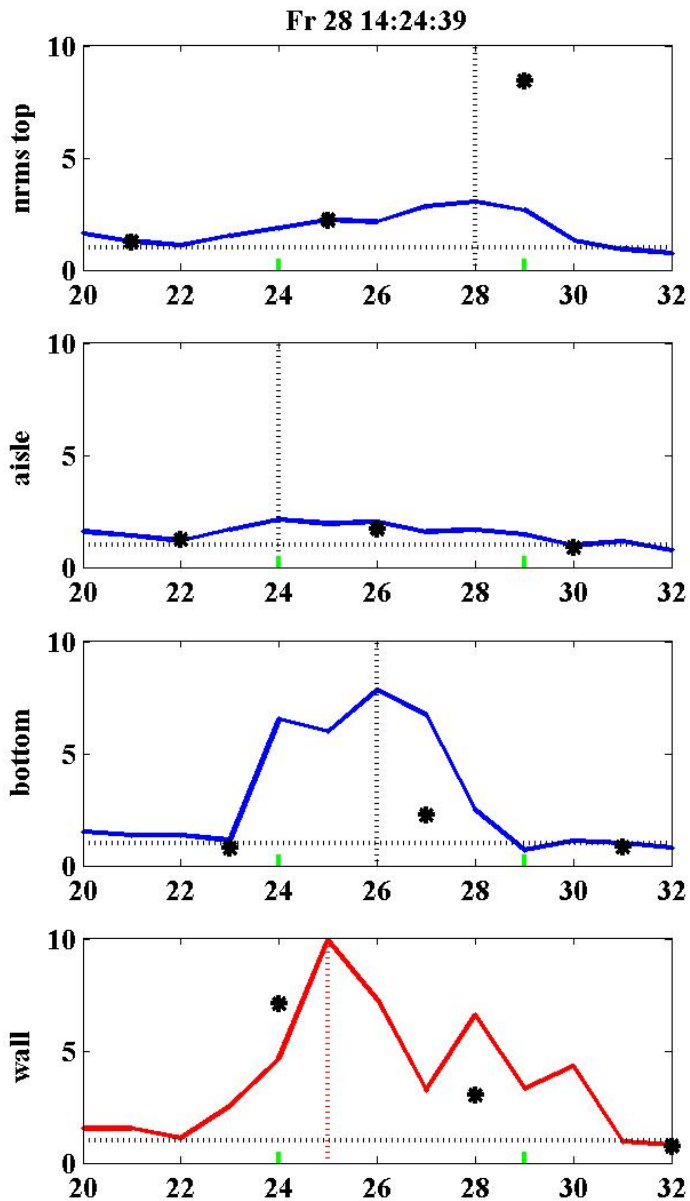

70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
18

Maybe little one leads to big one?
Event1: big upstream and little C23
Event 2: little upstream BIG C23

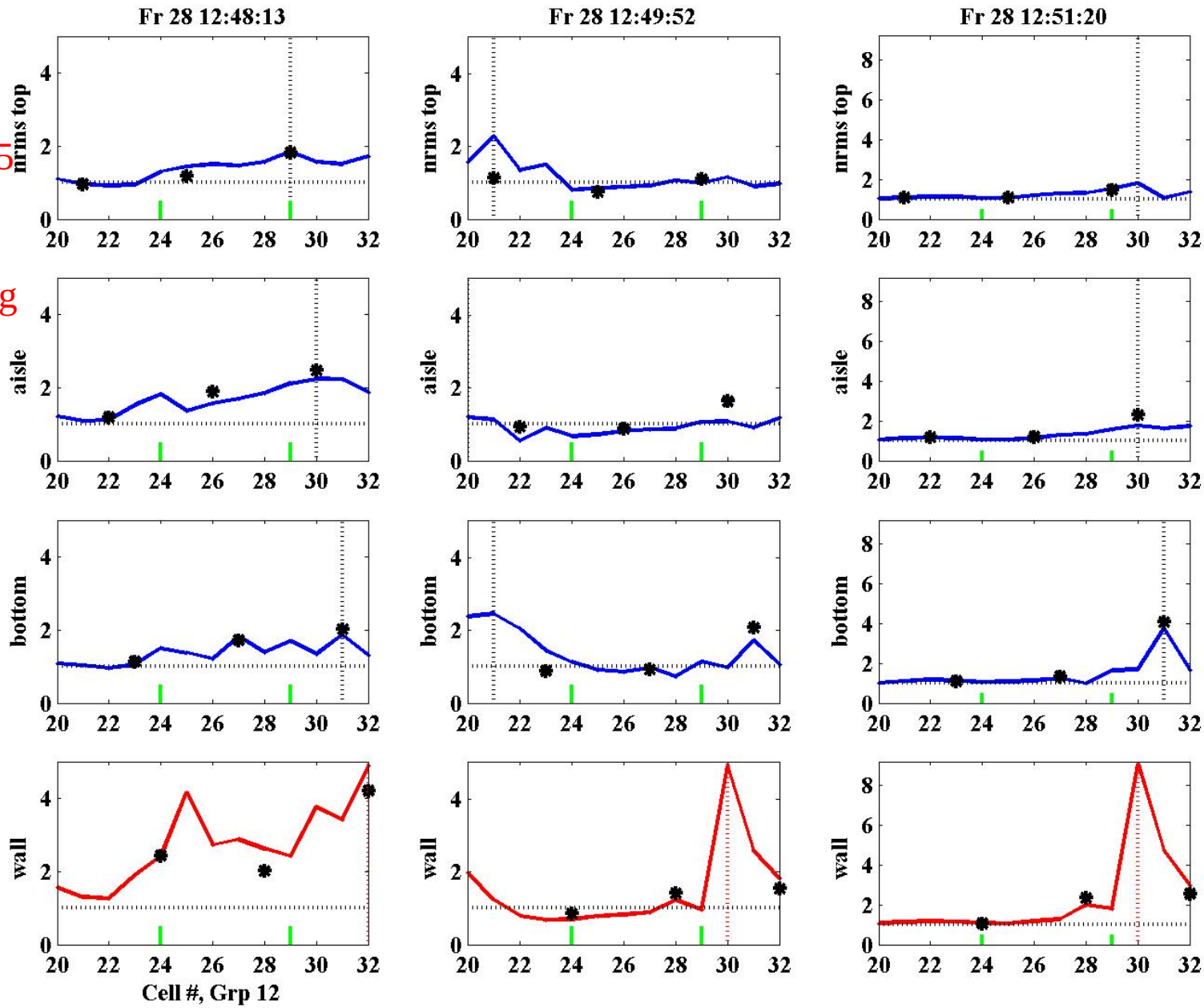


Big move
Event1:
big C21
little C28
Event 2:
BIG C25
something
in C27-29?

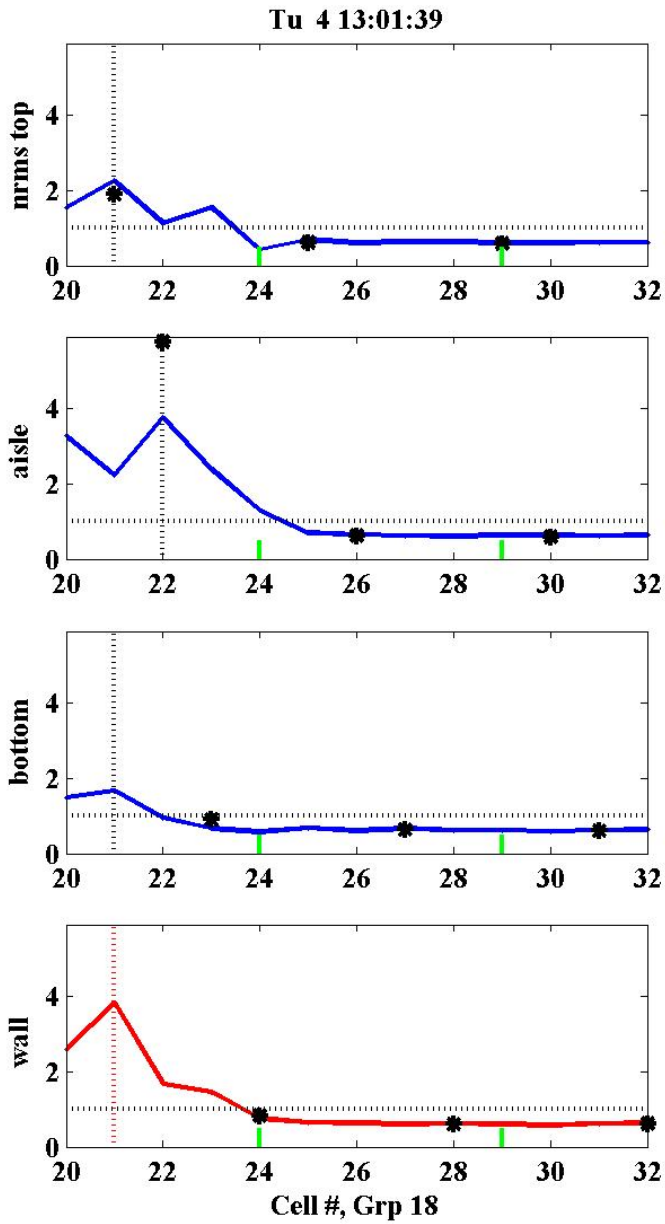


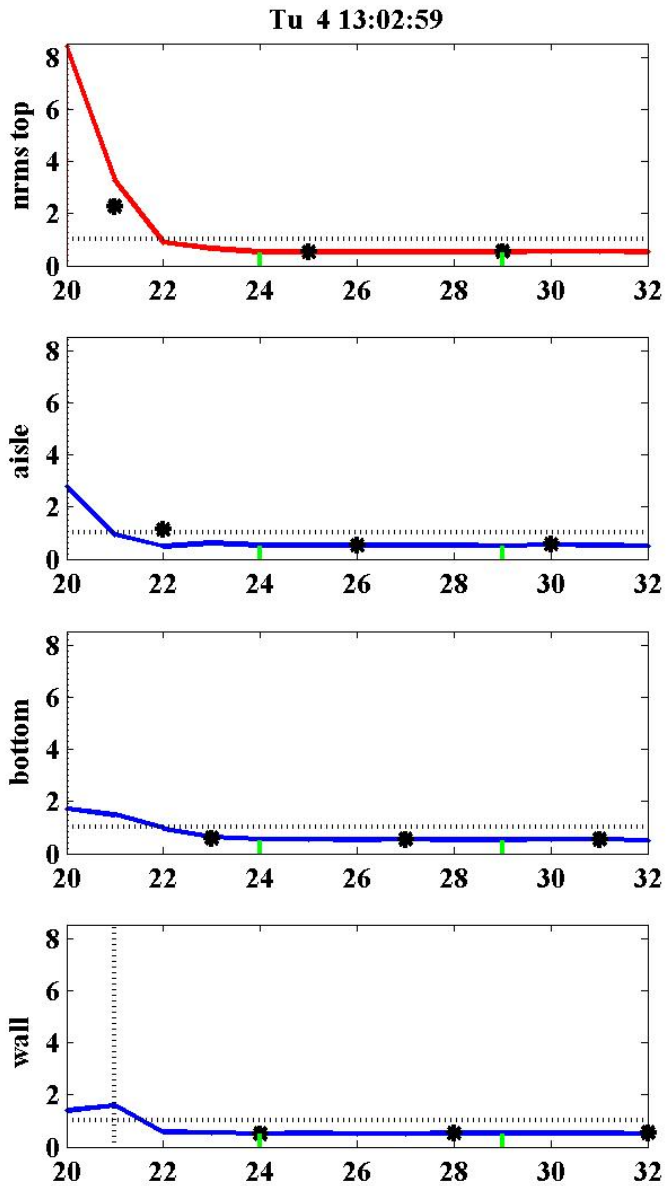



Events 2&3 similar
Event1: big C>32 littler C25
Event 2: Big C30 something <C20
Event 3: BIG C30

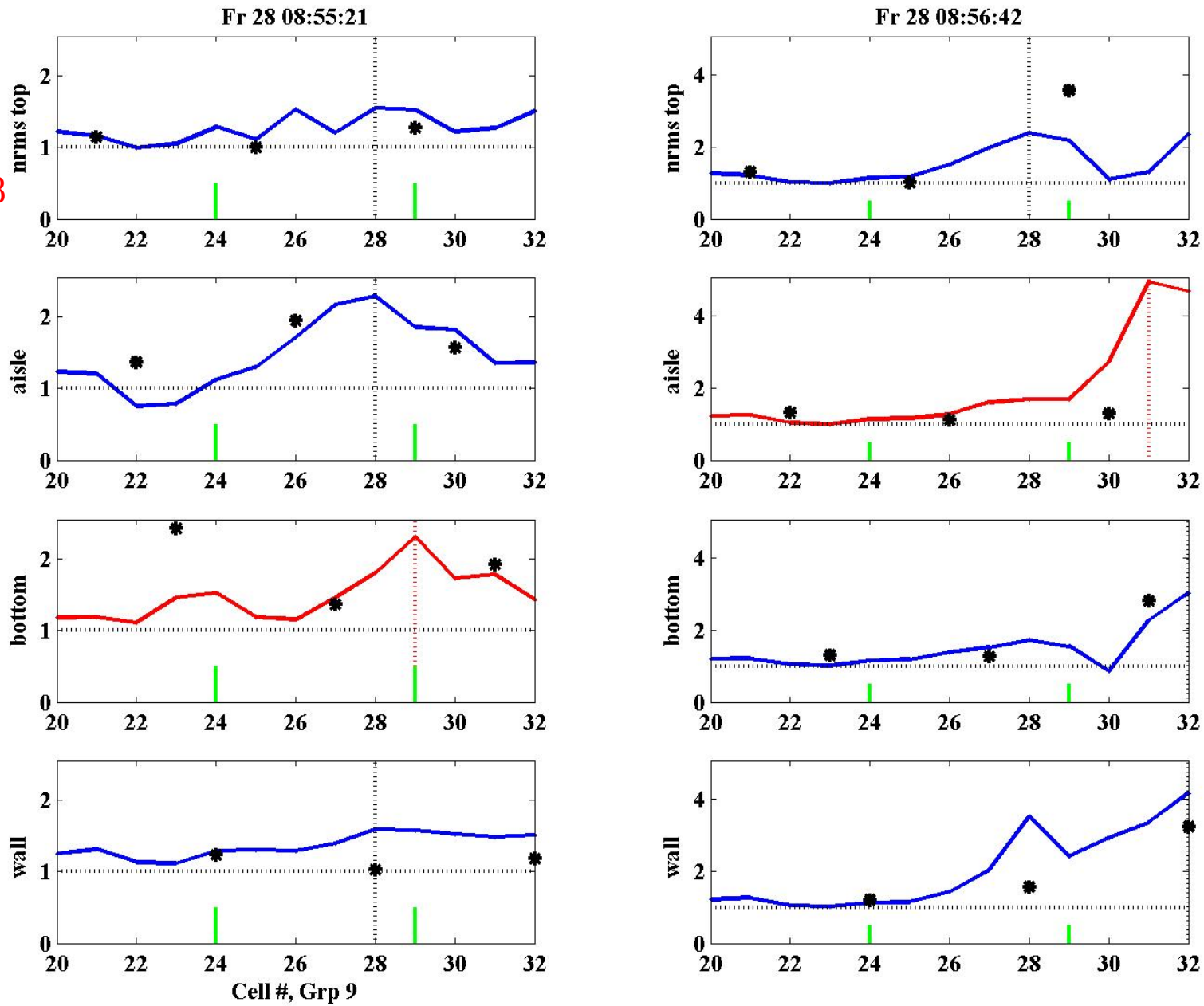


Move >2
Event1:
big C21
something
C22
Event 2:
Big <C20

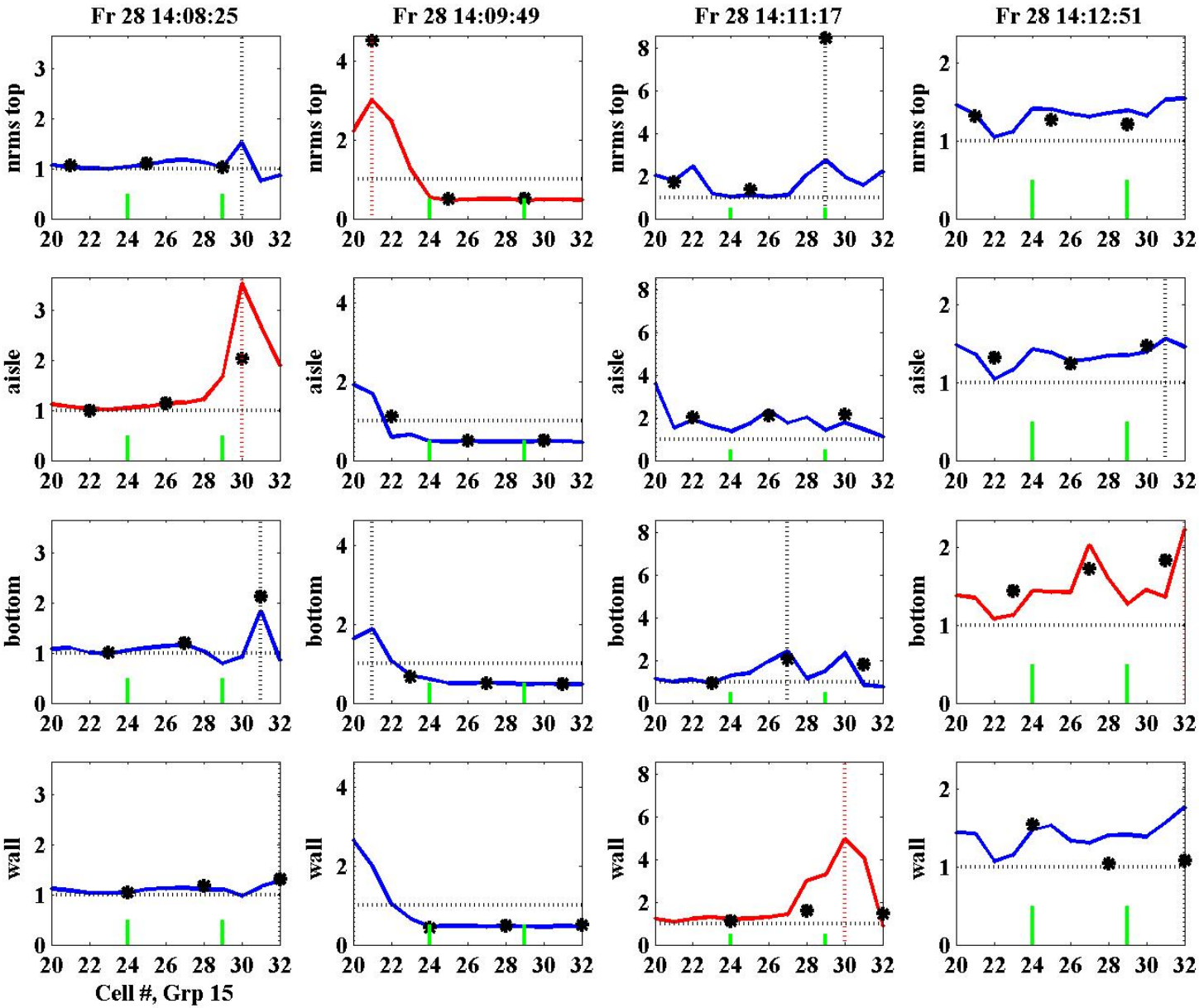


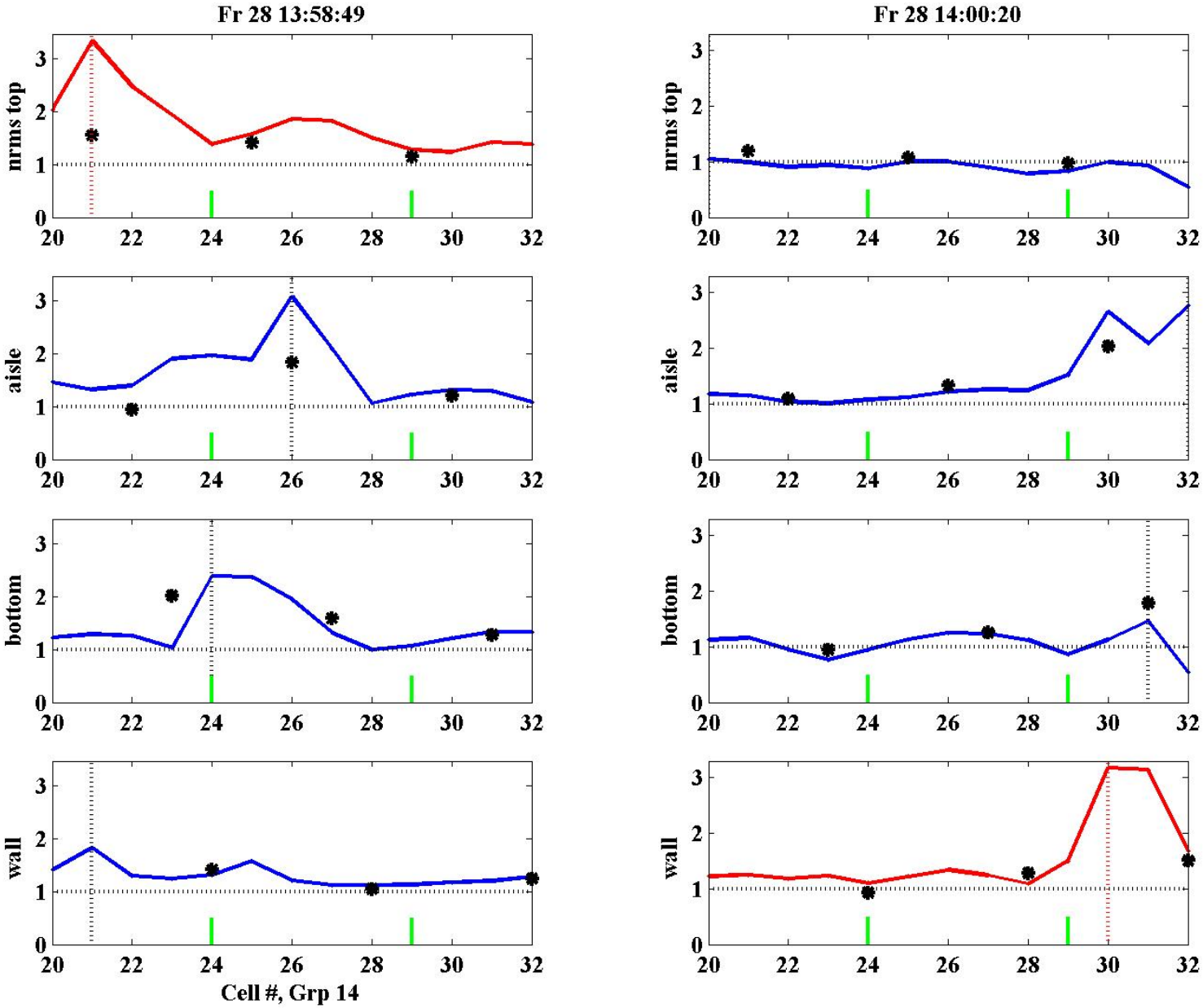
Moves a bit
Event 1:
C29
Event 2:
big C31
little C28



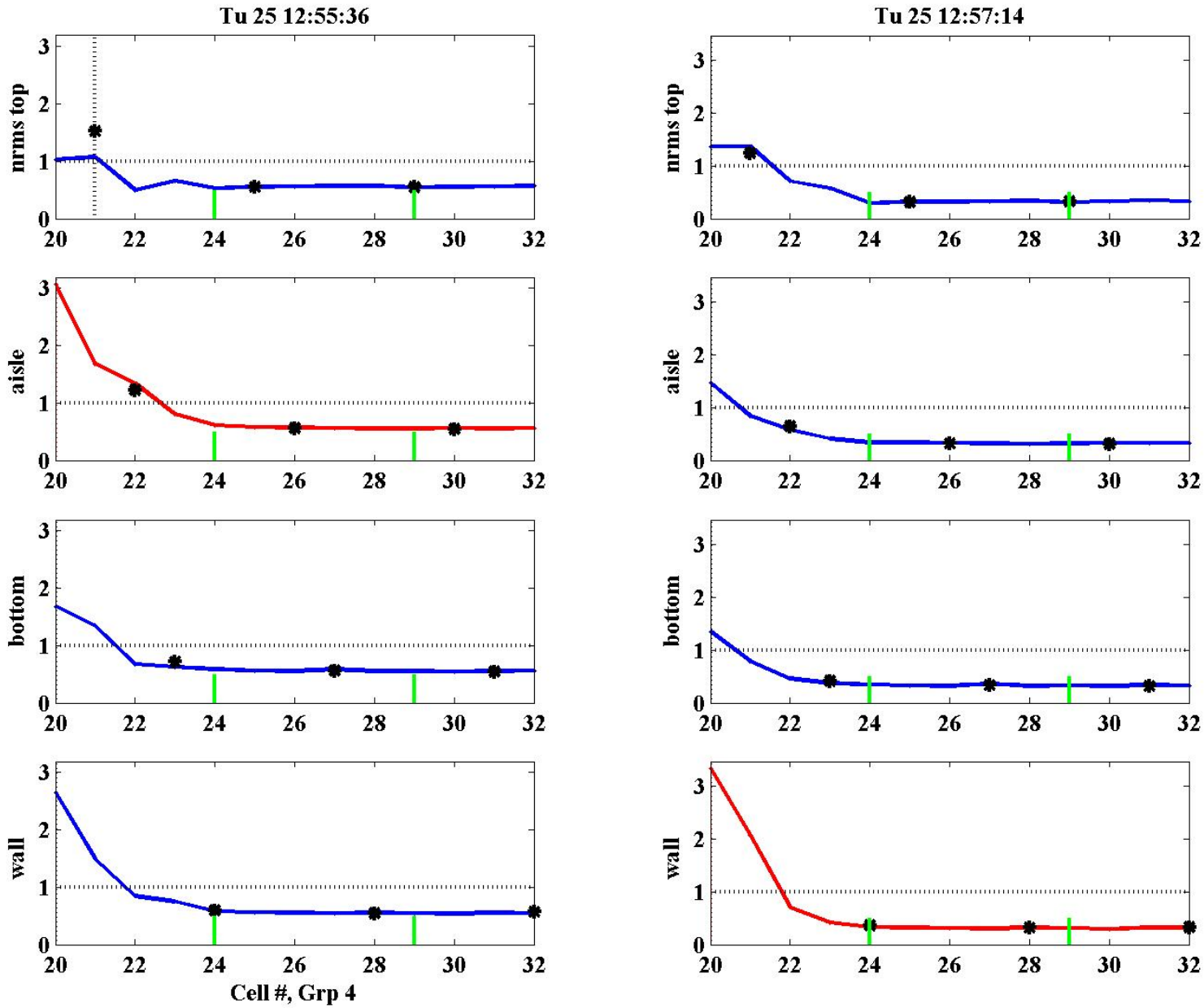
C30,
C21
C30,
??
Events
1&3
v similar



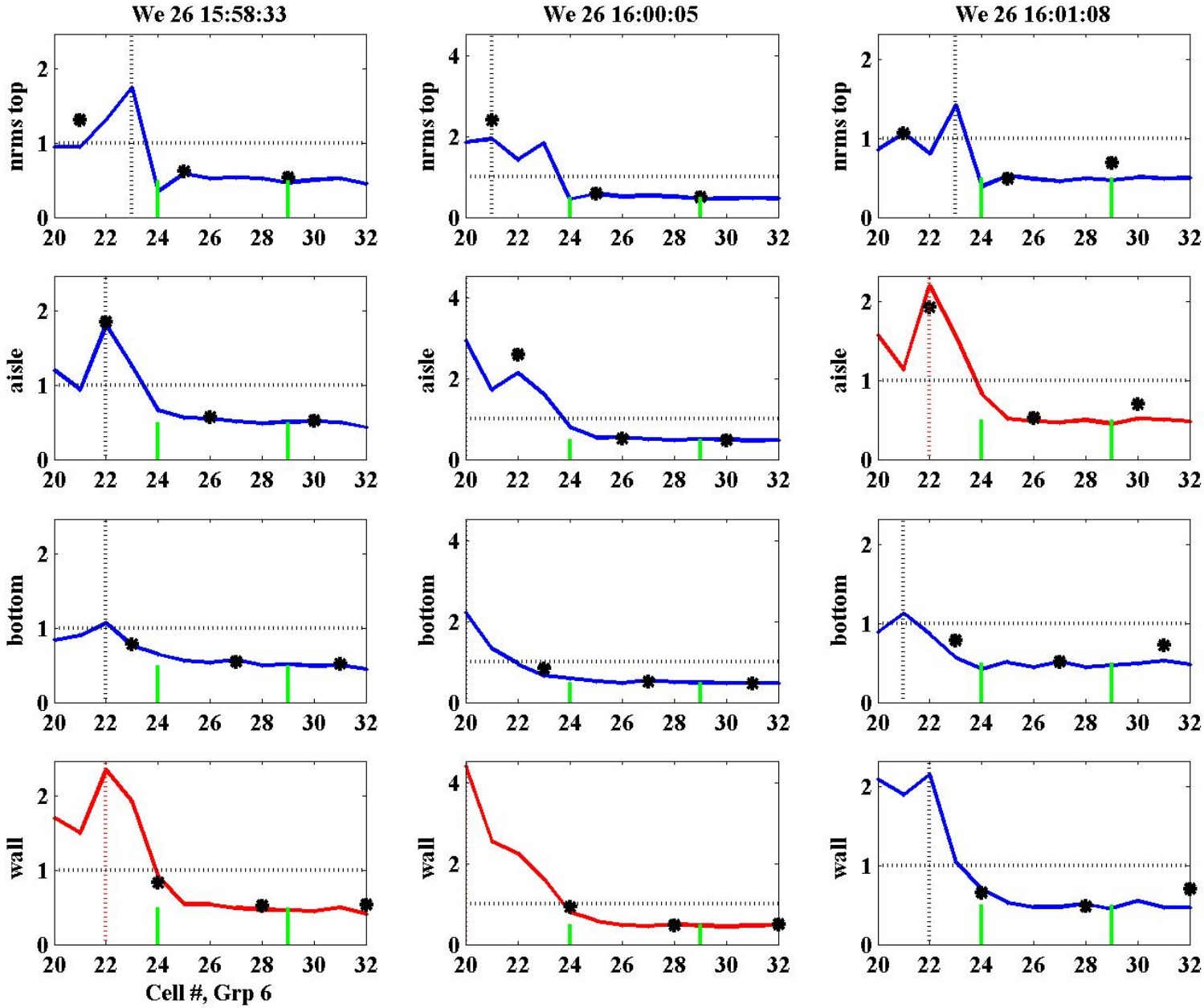
Very different



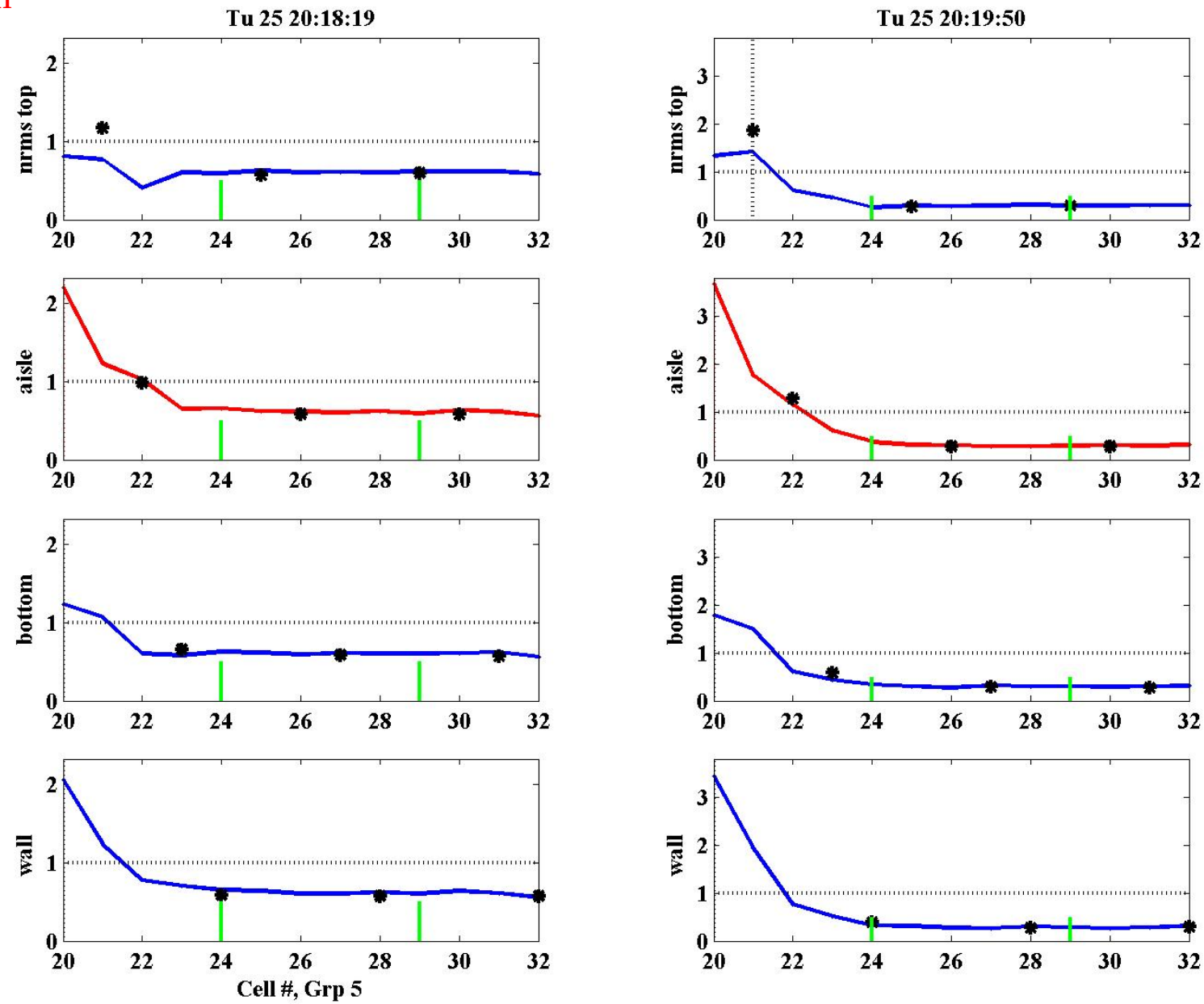
Both upstream



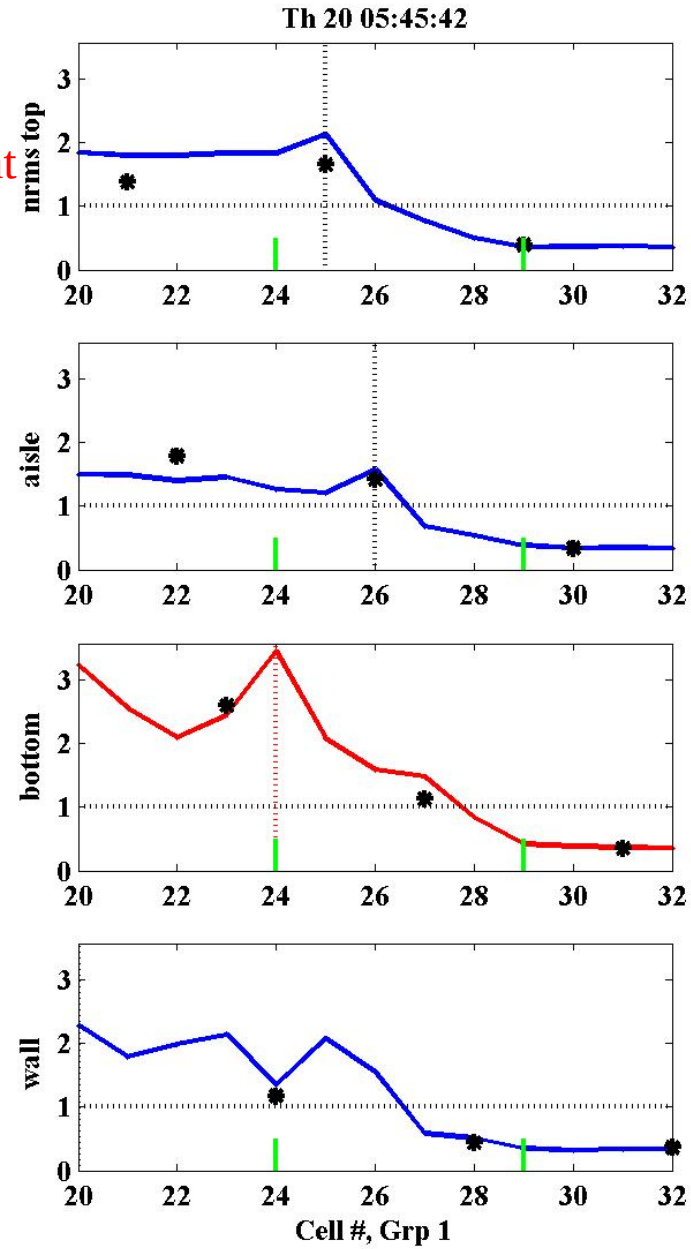
Events 1&3 similar Event 2 at least 3C away

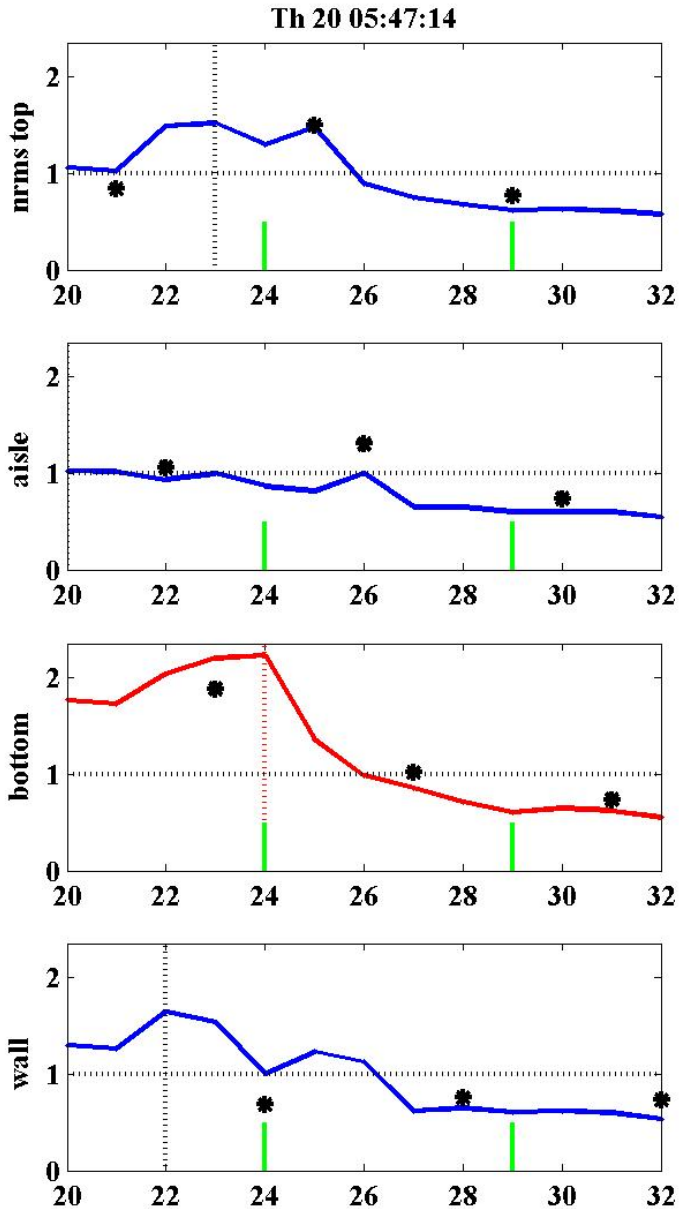


Both upstream

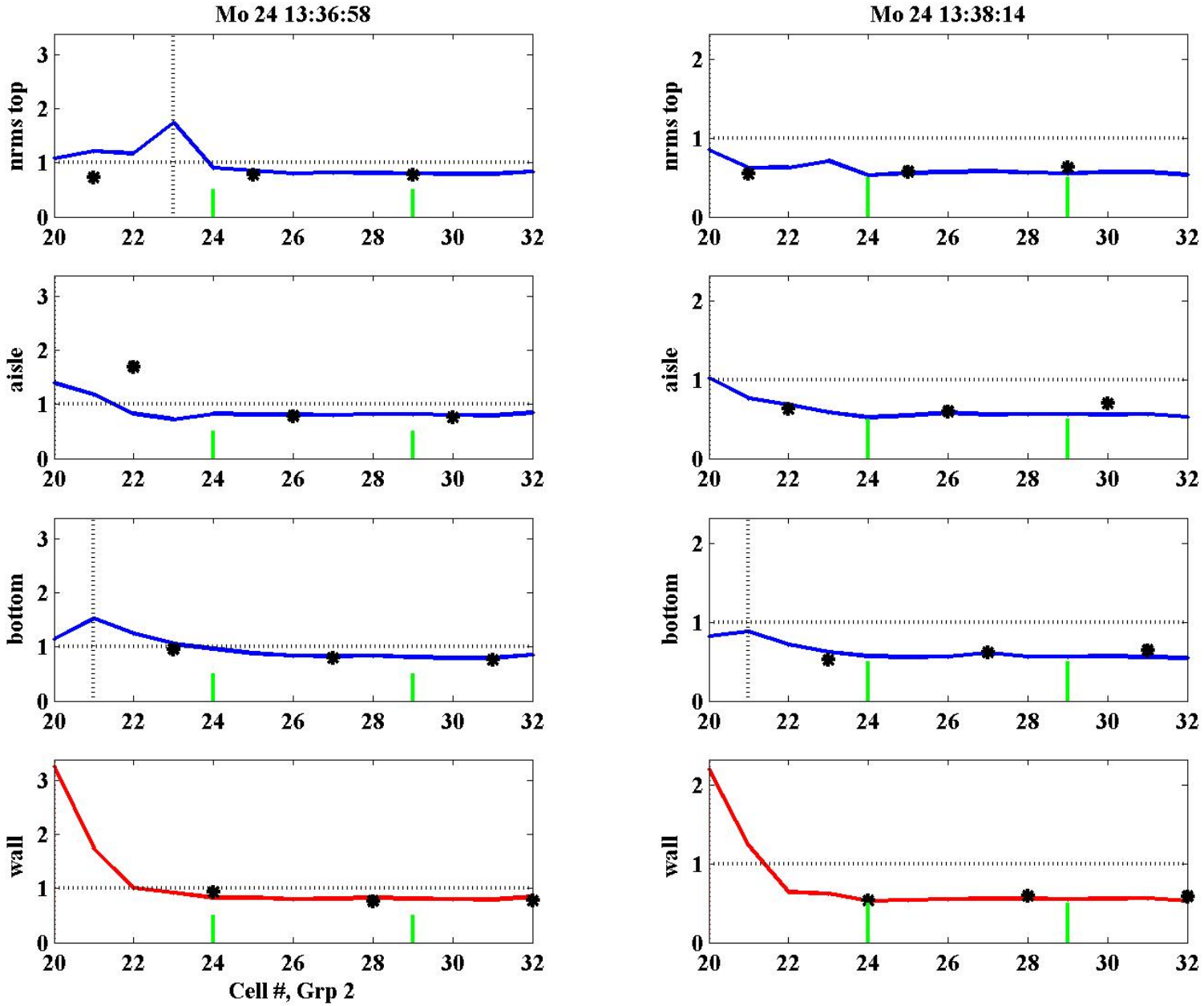


Both have upstream event and C24 event

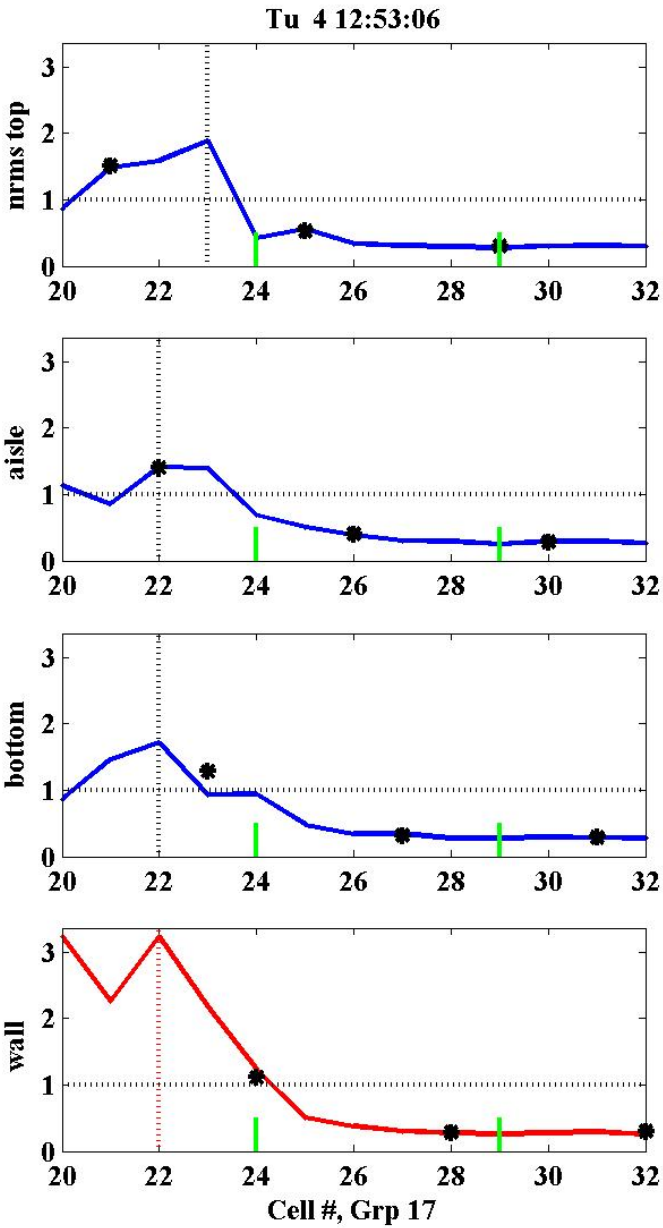


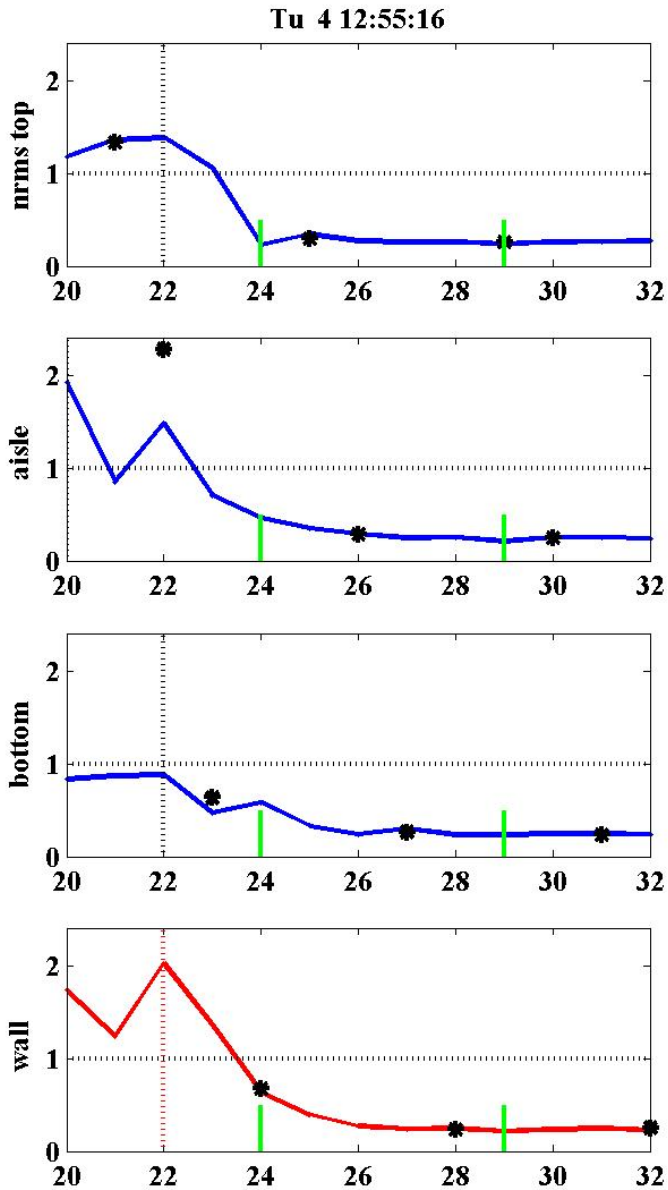
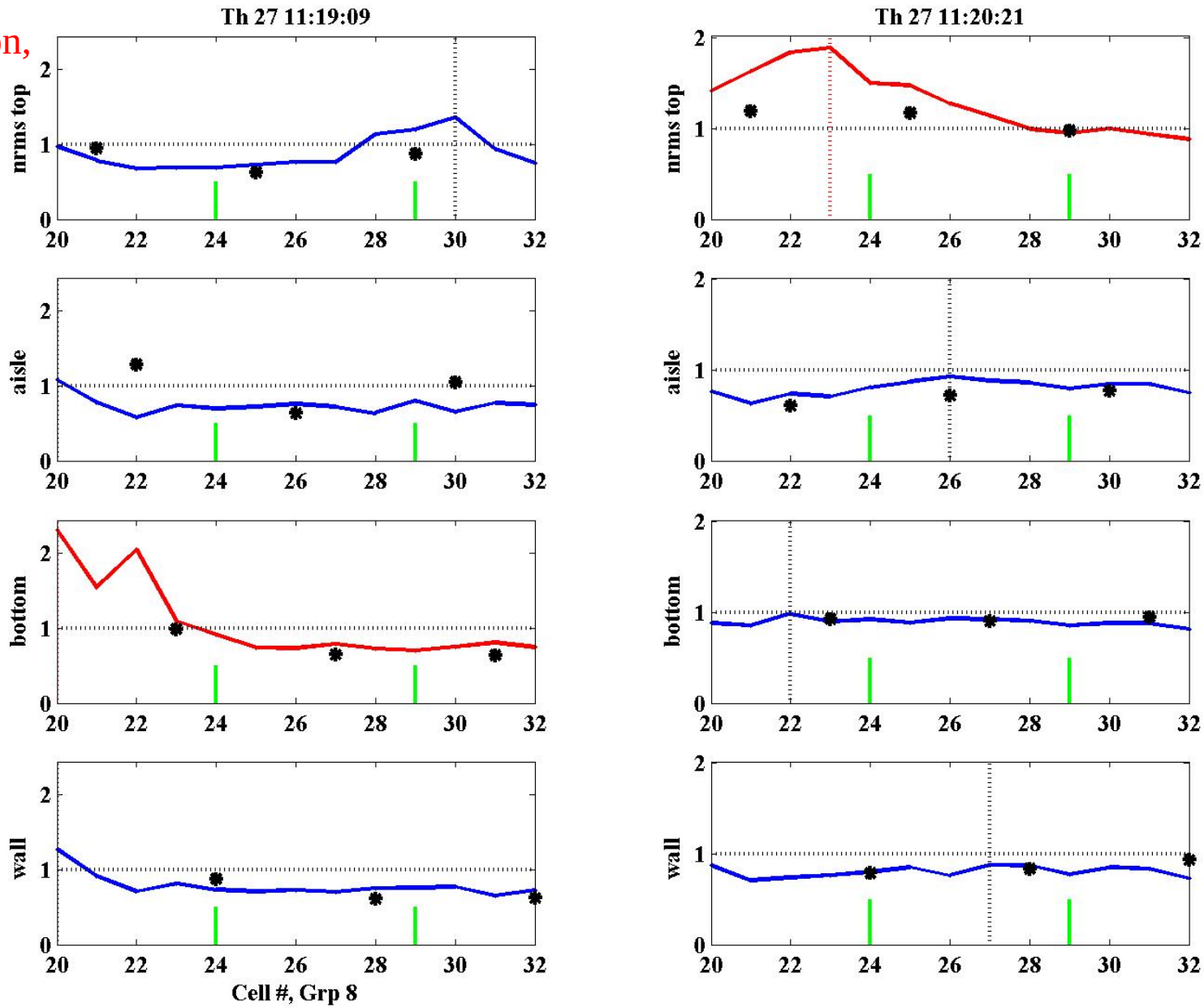



Both upstream



Almost identical






Both early in our section, different shapes