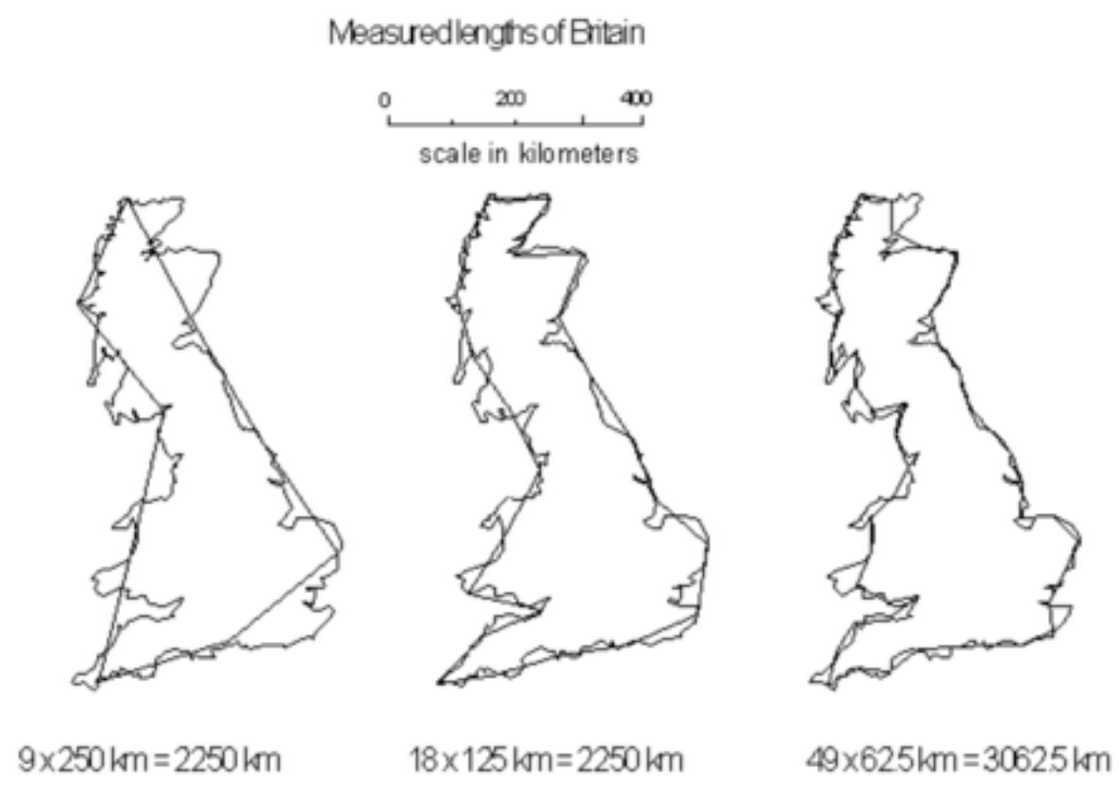
Fractal dimension of pi+/e+ clusters

Shpak Kostiantyn, LLR

Fractal dimension of pi+/e+ clusters

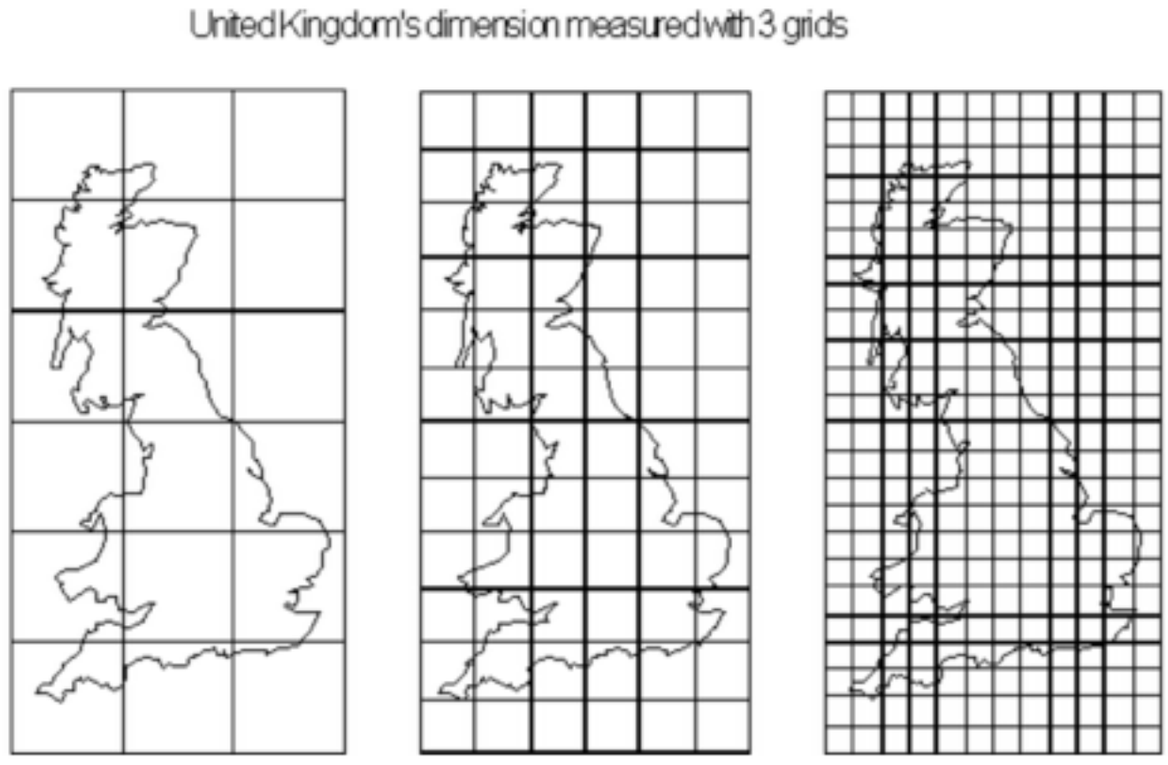
History and theory:

#lines with GB coastline



Difficult to apply for cluster dimension calculation, typical cluster has main core and some separated regions

#cells with GB coastline:



$$D_{box} = \frac{\log n(a) - \log n(b)}{\log(1/s_a) - \log(1/s_b)}$$

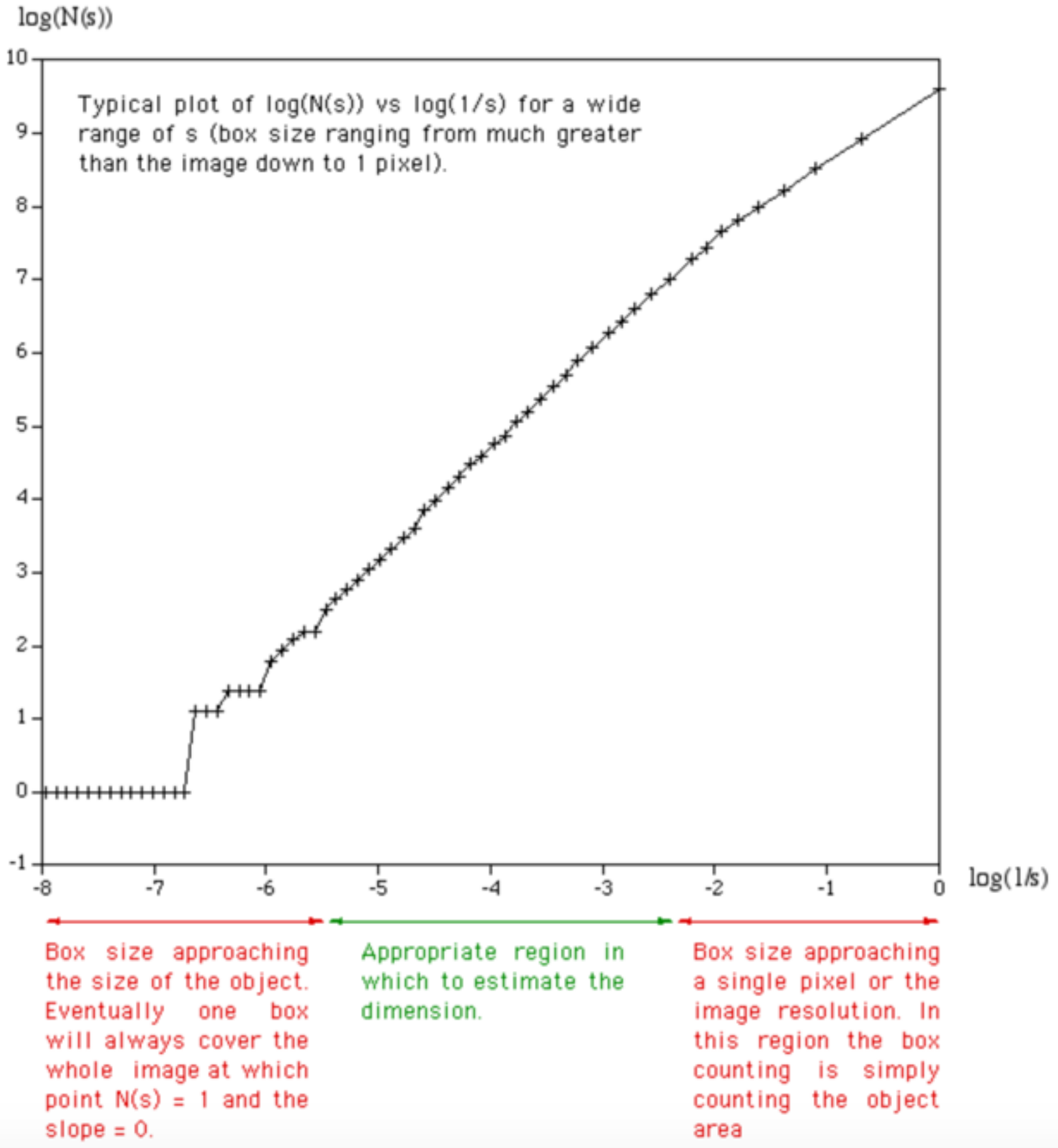
Possible to apply for cluster dimension calculation

Fractal dimension of pi+/e+ clusters

History and theory:

Box size range

The default range of box sizes is usually optimal but not always so. They should only be changed when you have some experience and understanding of the processes involved. The following graph is the result of performing the box counting where the box size ranged from being 5 times the width (or height) of the image to 1 pixel. For successful choice of the box size range it is important to understand the regions of the graph illustrated here.

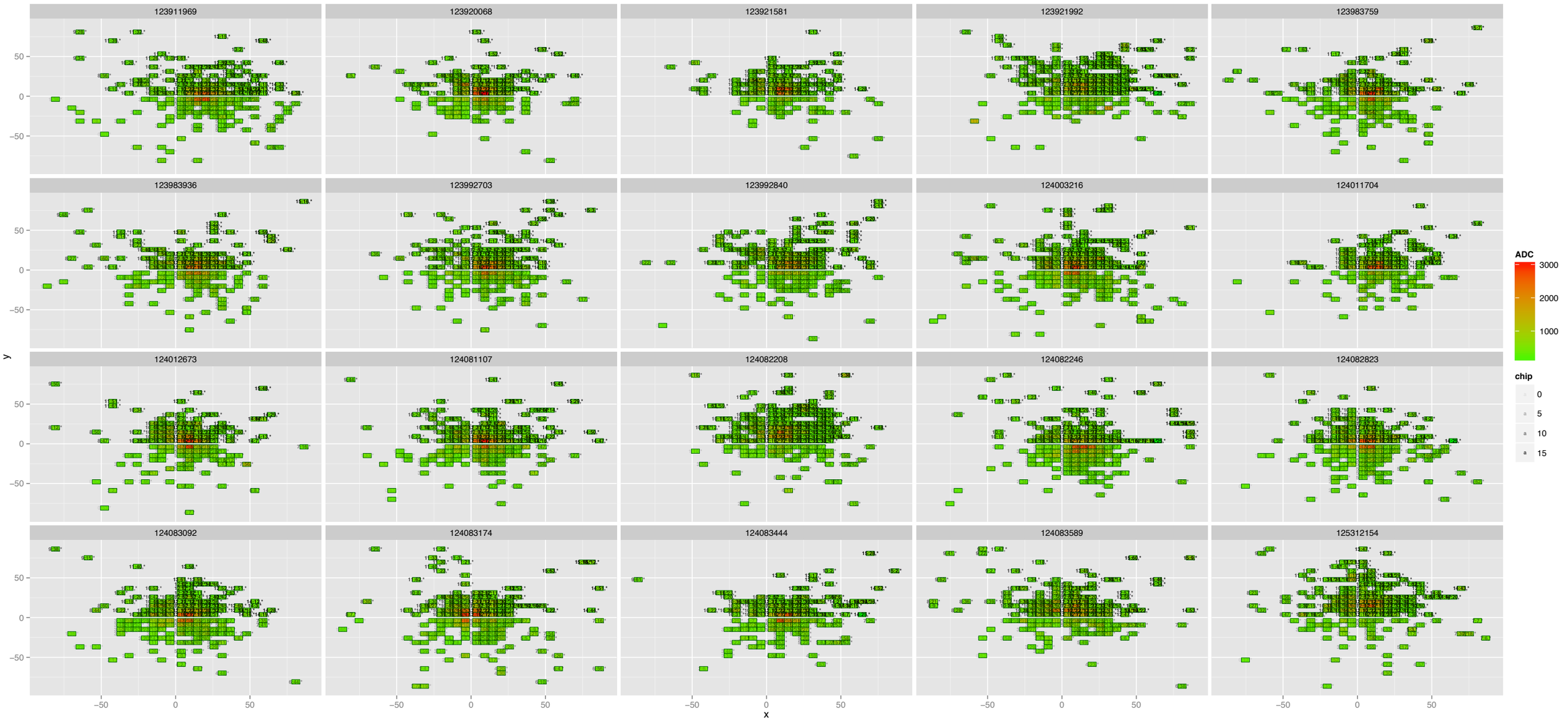


Fractal dimension of pi+/e+ clusters

- For tests 8.4 X0W detector configuration was chosen
- Trigger threshold 230 ADC
- e+ clusters (15, 30, 50, 100, 150GeV)
- pi+ clusters (50,100,150 GeV)
- for the beginning 20x8=160 particles were selected

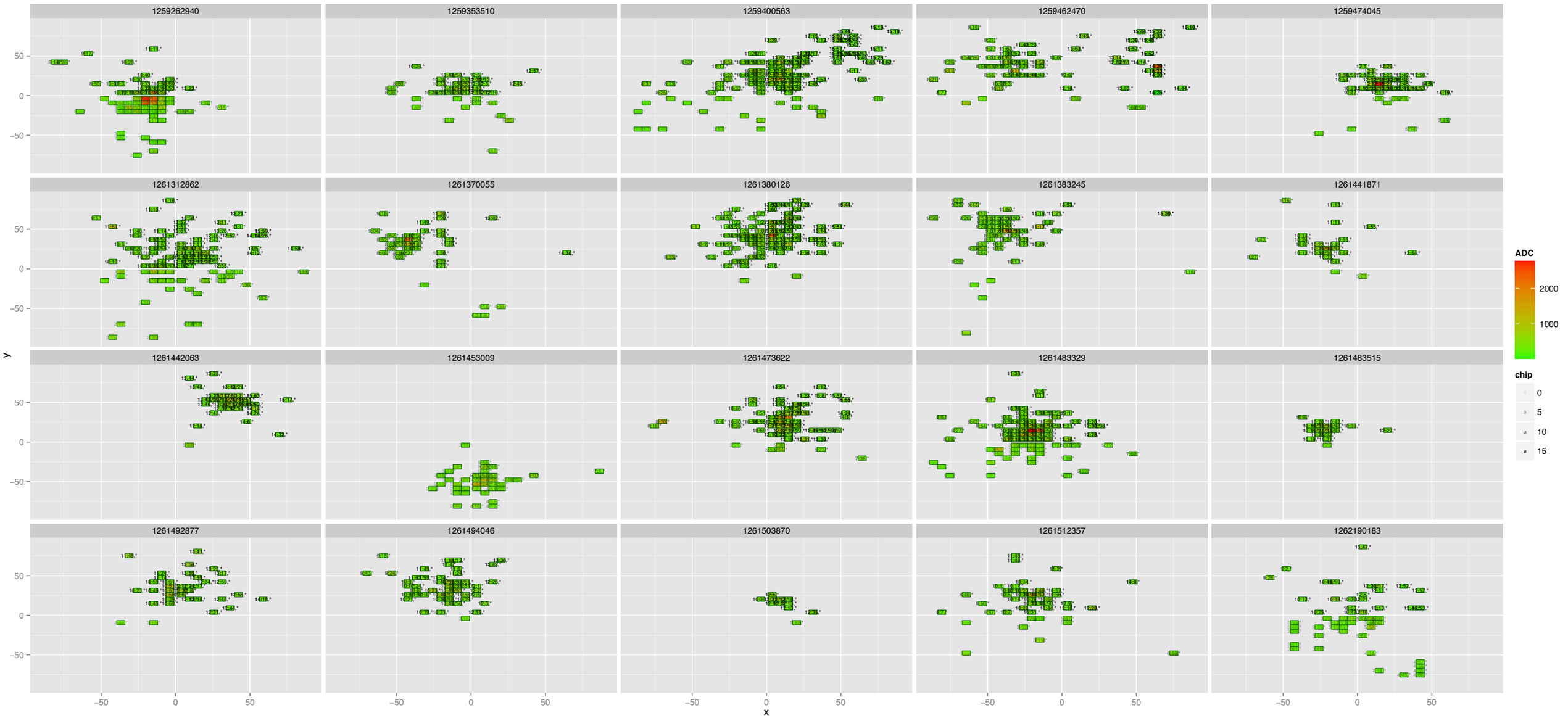
Fractal dimension of pi+/e+ clusters

150GeV e+ DIF 1 run086

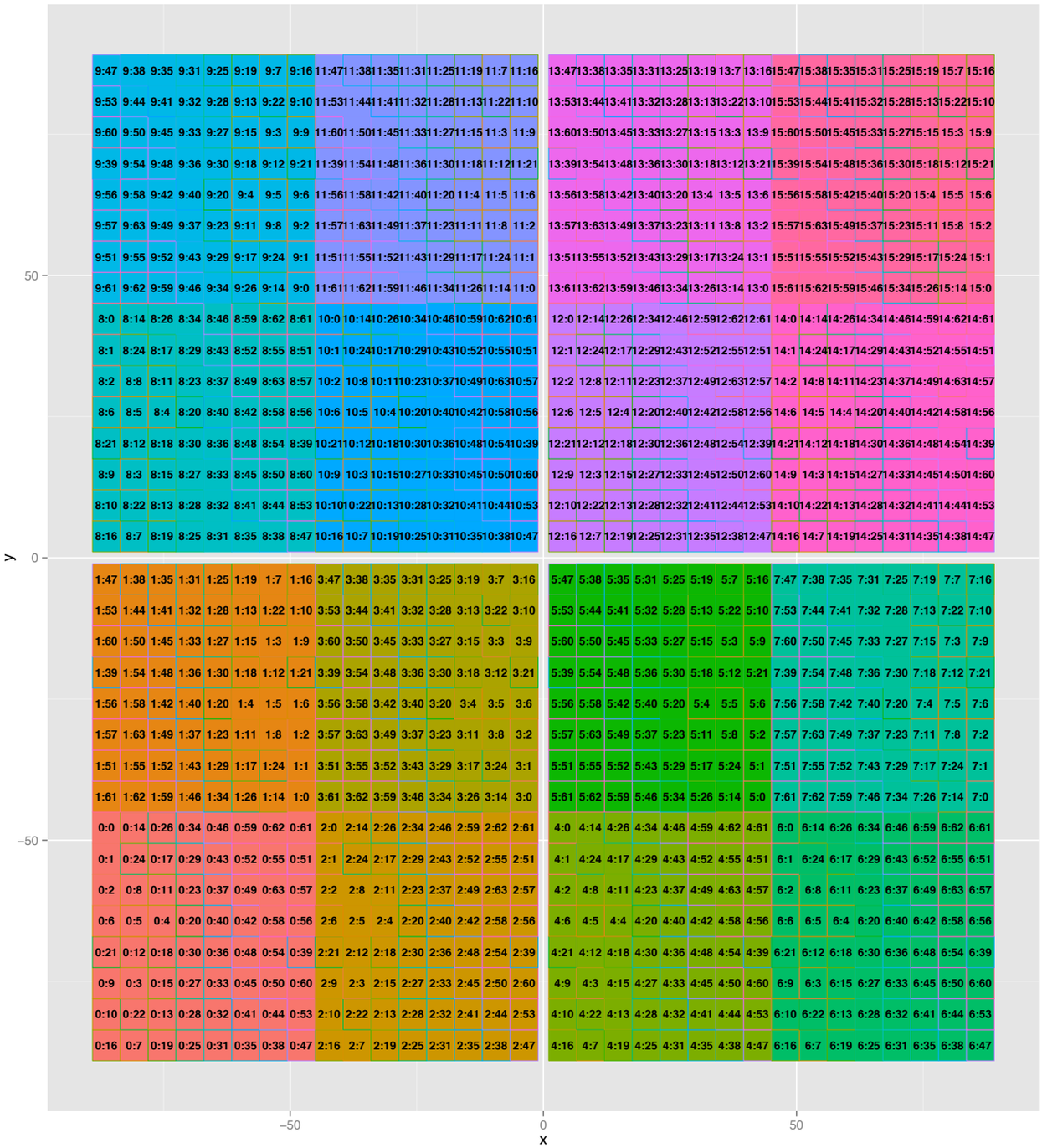


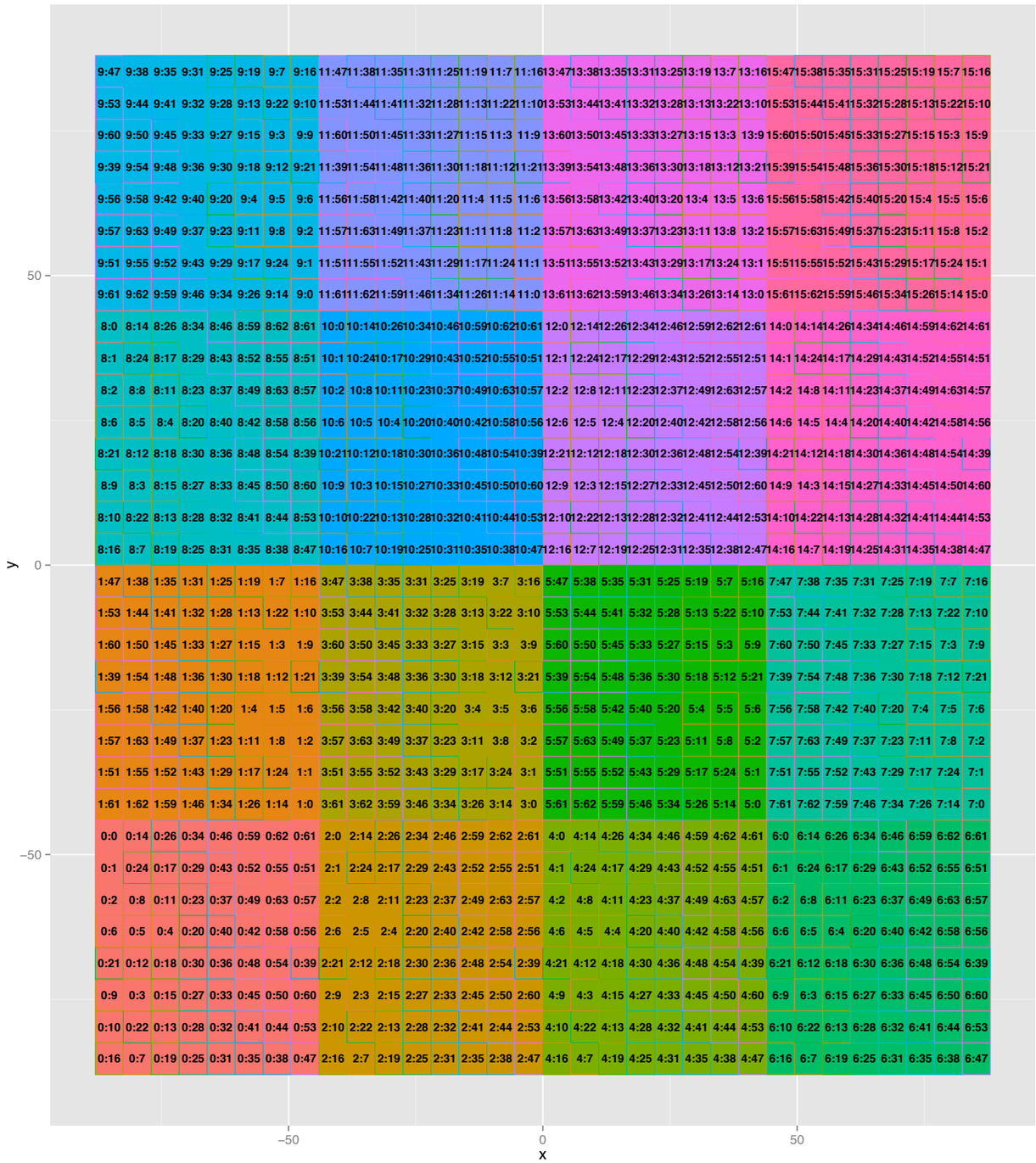
Fractal dimension of pi+/e+ clusters

150GeV pi+　　DIF 1 run247



Fractal dimension of pi+/e+ clusters





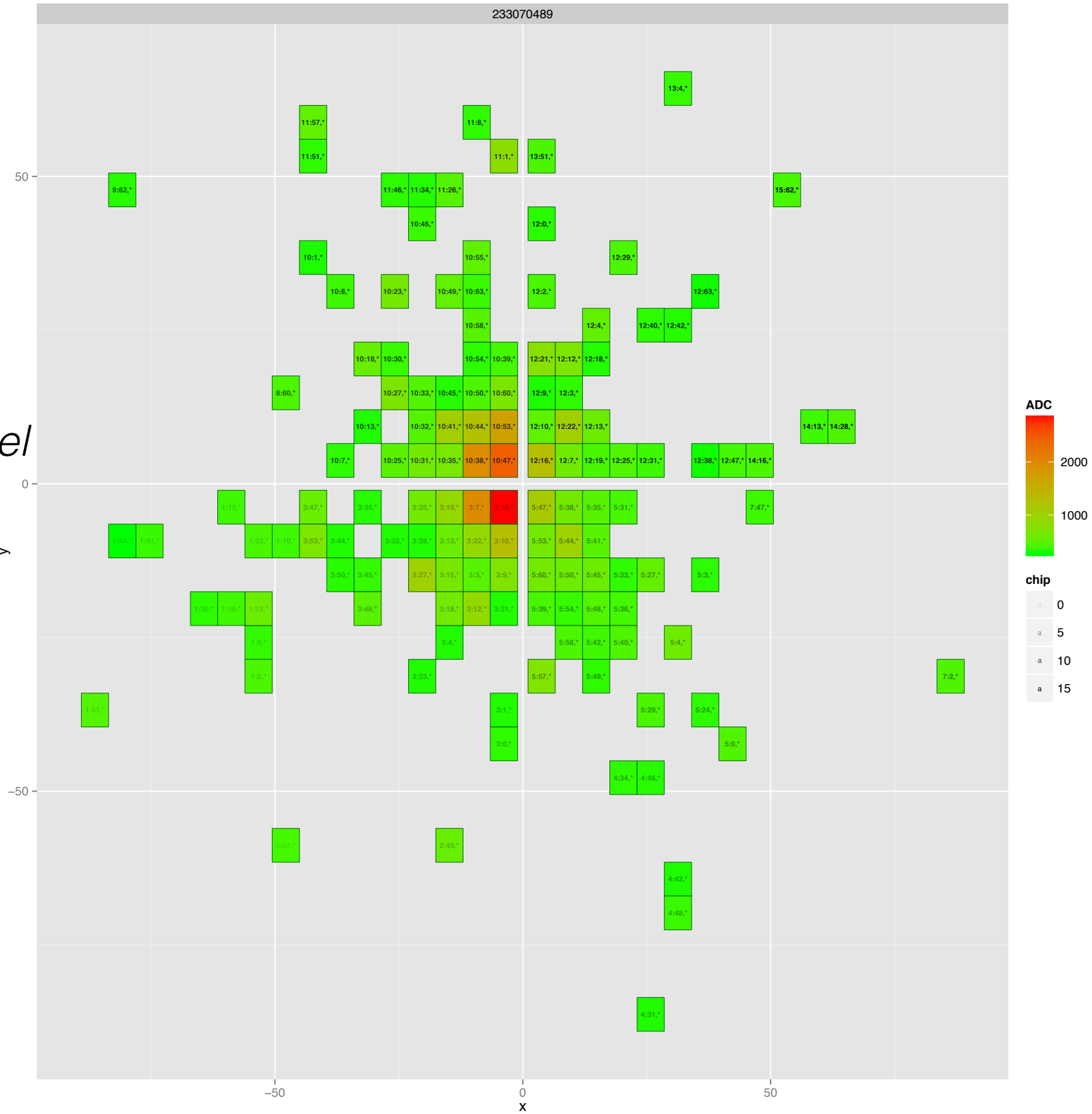
Chip~channel map: no gap between sensors

Fractal dimension of pi+/e+ clusters

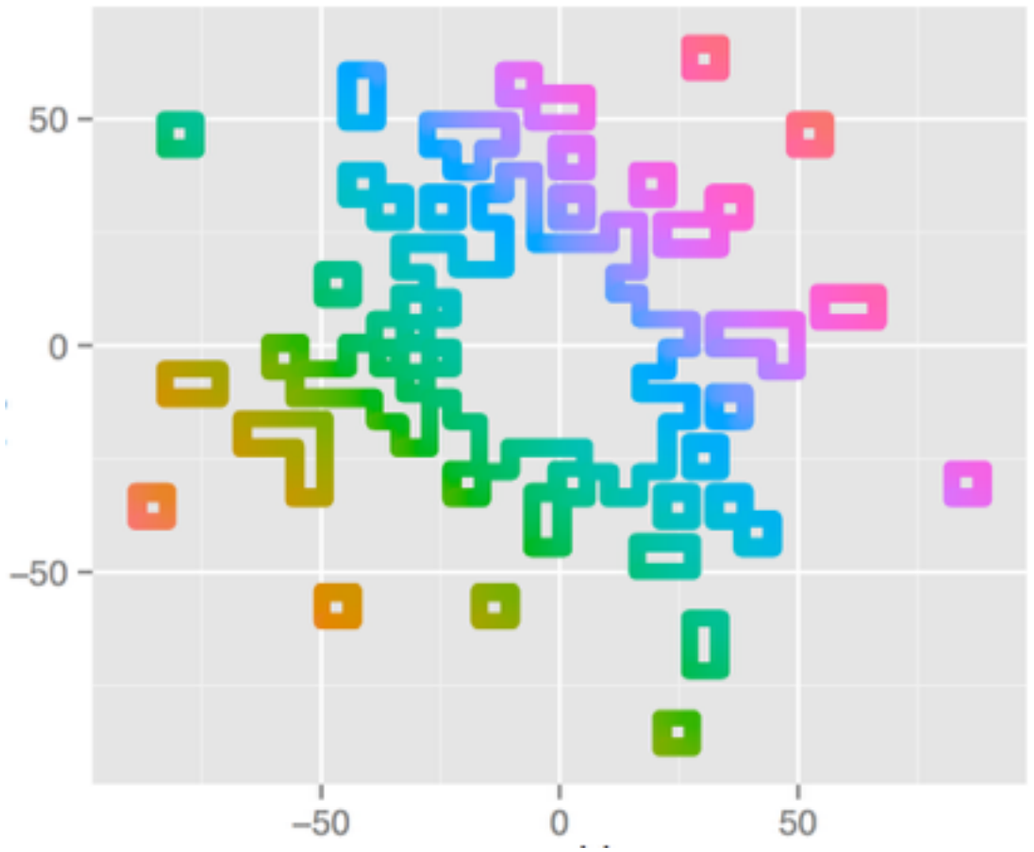
1st method

Procedure:

1) no intersensor gap
2) covering of event with different size grids:
from *grid_cell<<prototype_pixel*
to *grid_cell>>prototype_pixel*
3) grid center at (0,0)
4) counting of #boxes with part of event perimeter
5) prototype_pixel=5.5mm
6) minimal grid_cell=0.1mm
7) maximal grid_cell=900mm



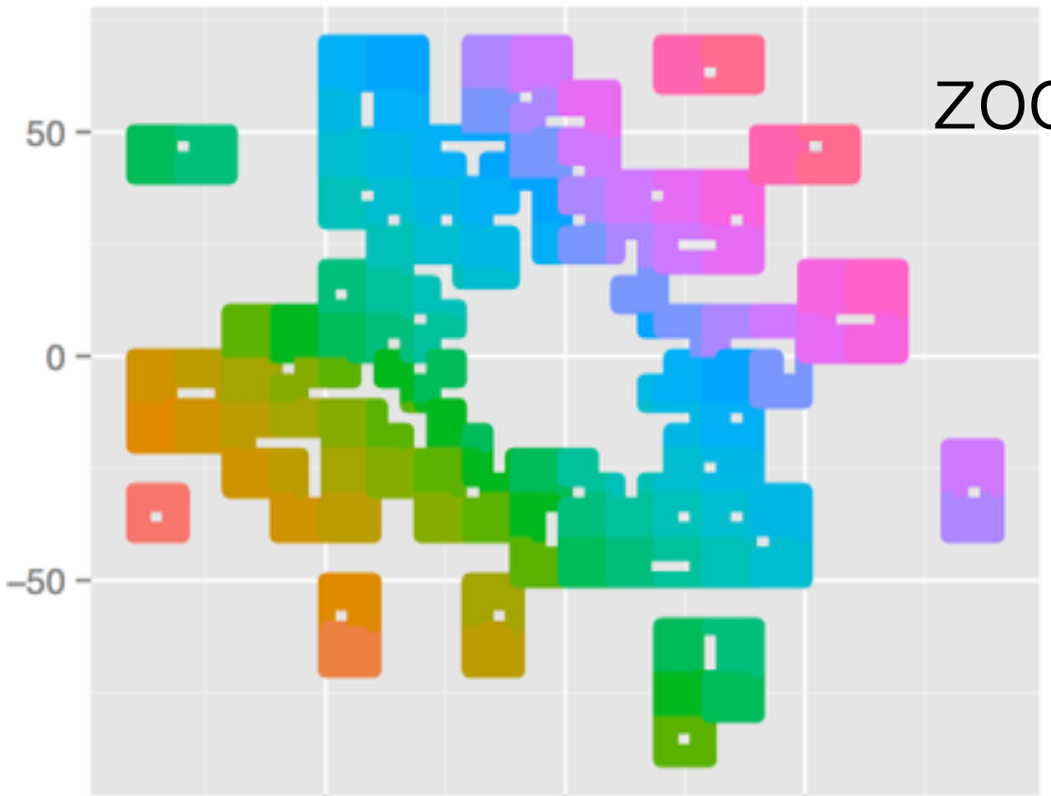
Fractal dimension of pi+/e+ clusters



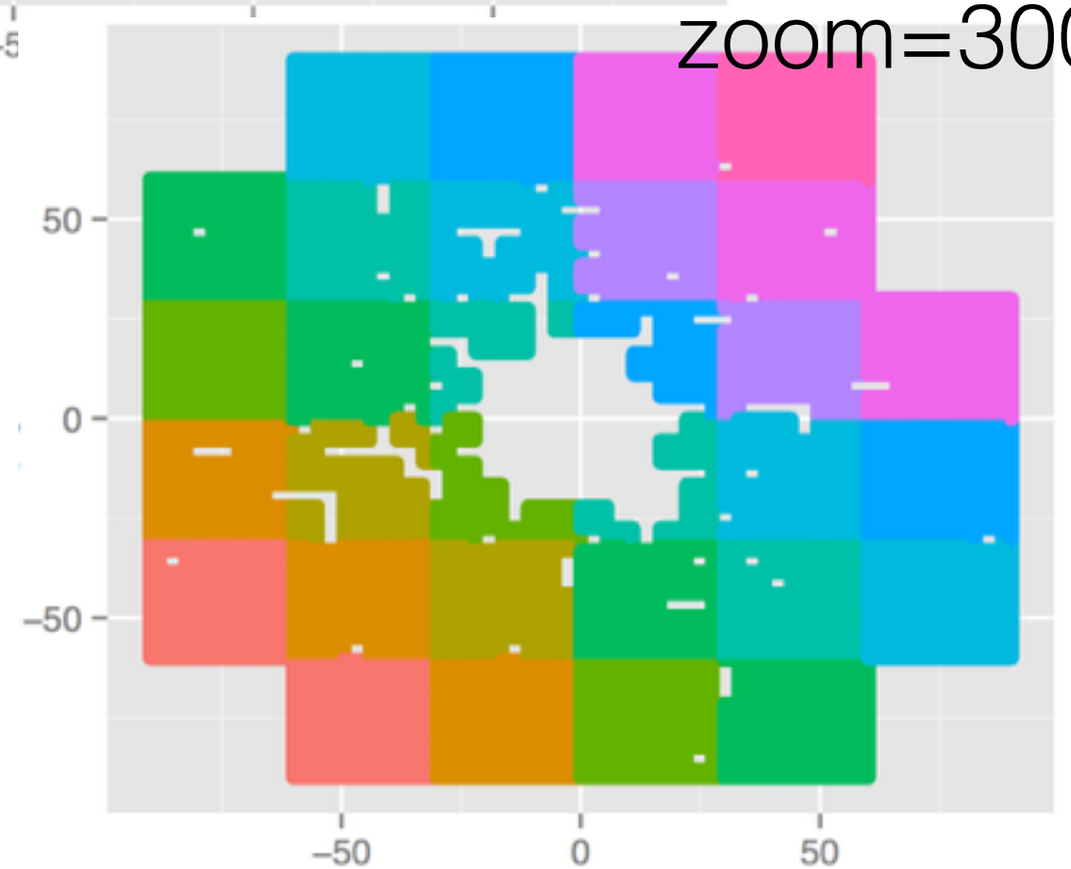
zoom=10

grid_cell=zoom x 0.1mm

We should count #grid_cells

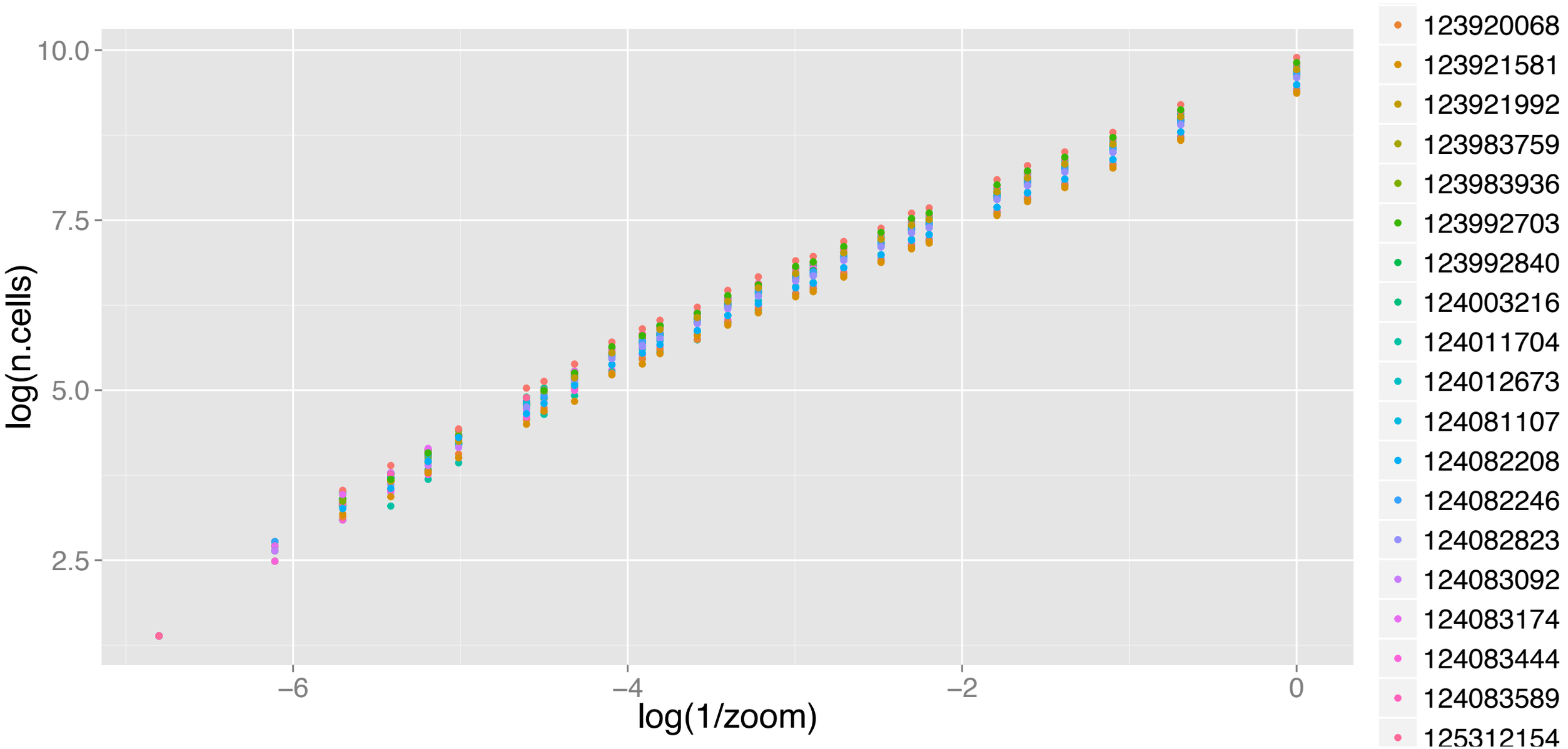


zoom=100



zoom=300

Fractal dimension of pi+/e+ clusters



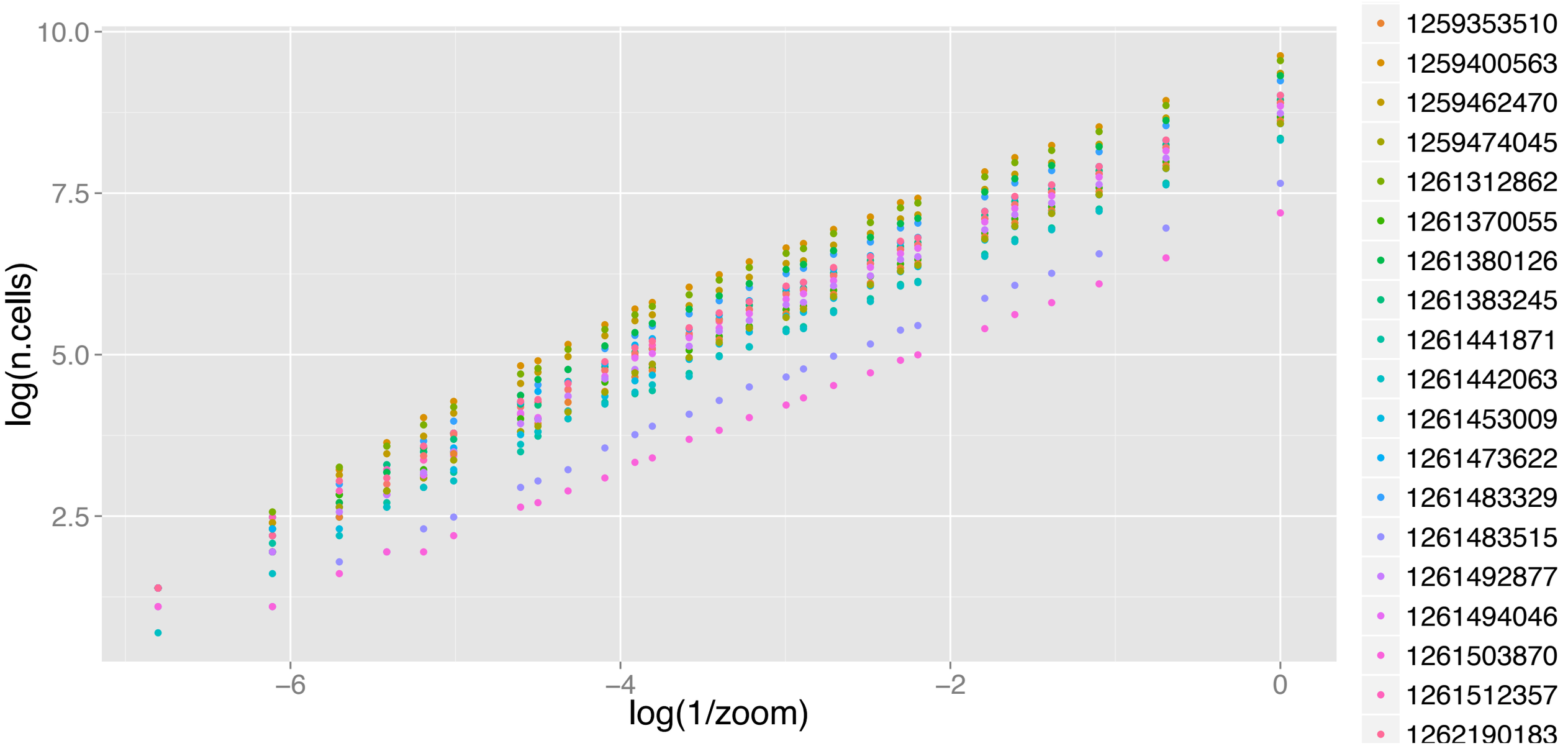
e+150GeV

log(1/zoom)> -6.0

log(1/zoom)< -3.6

slope in this region gives us FD

Fractal dimension of pi+/e+ clusters

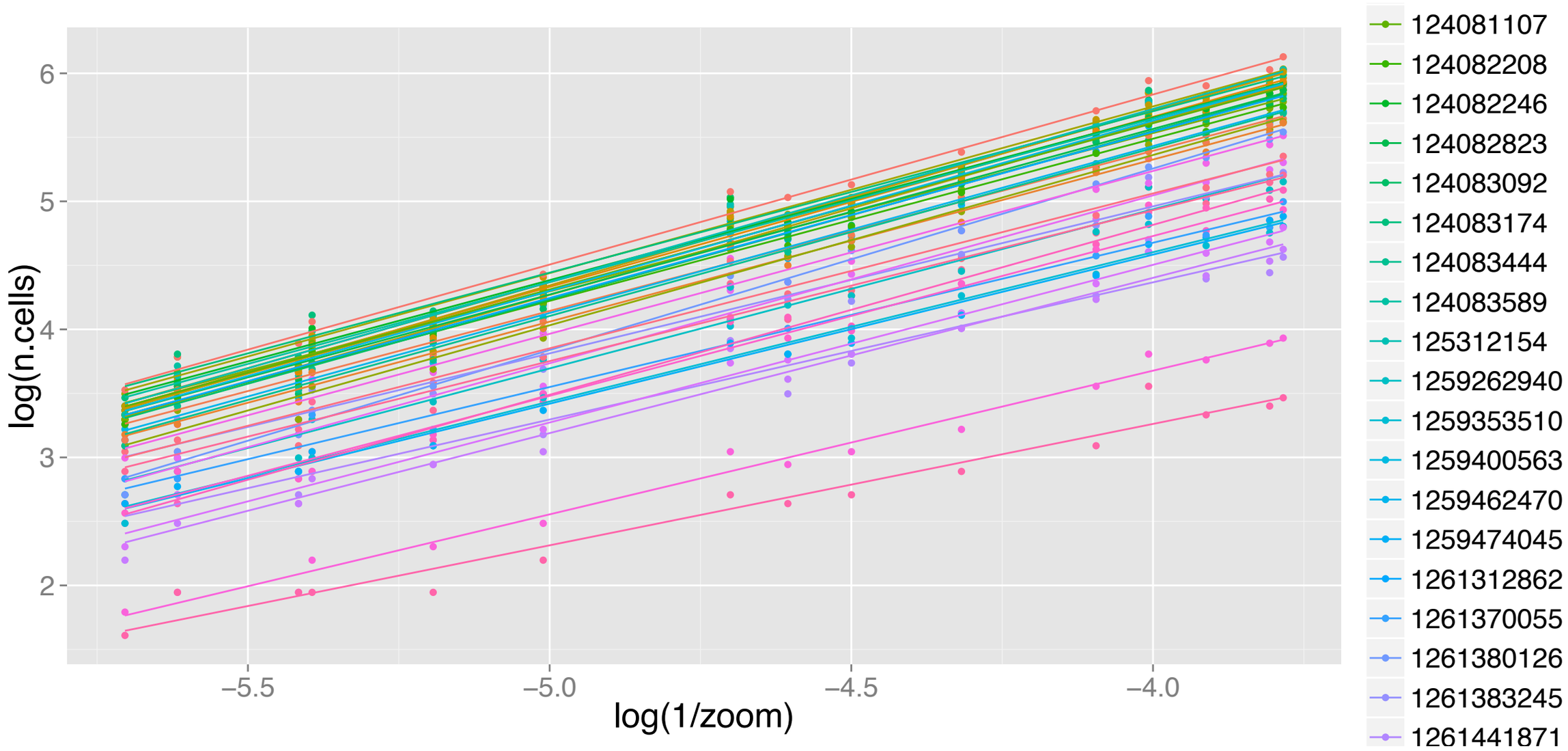


pi+150GeV

log(1/zoom)> -6.0
log(1/zoom)< -3.6

slope in this region gives us FD

Fractal dimension of pi+/e+ clusters

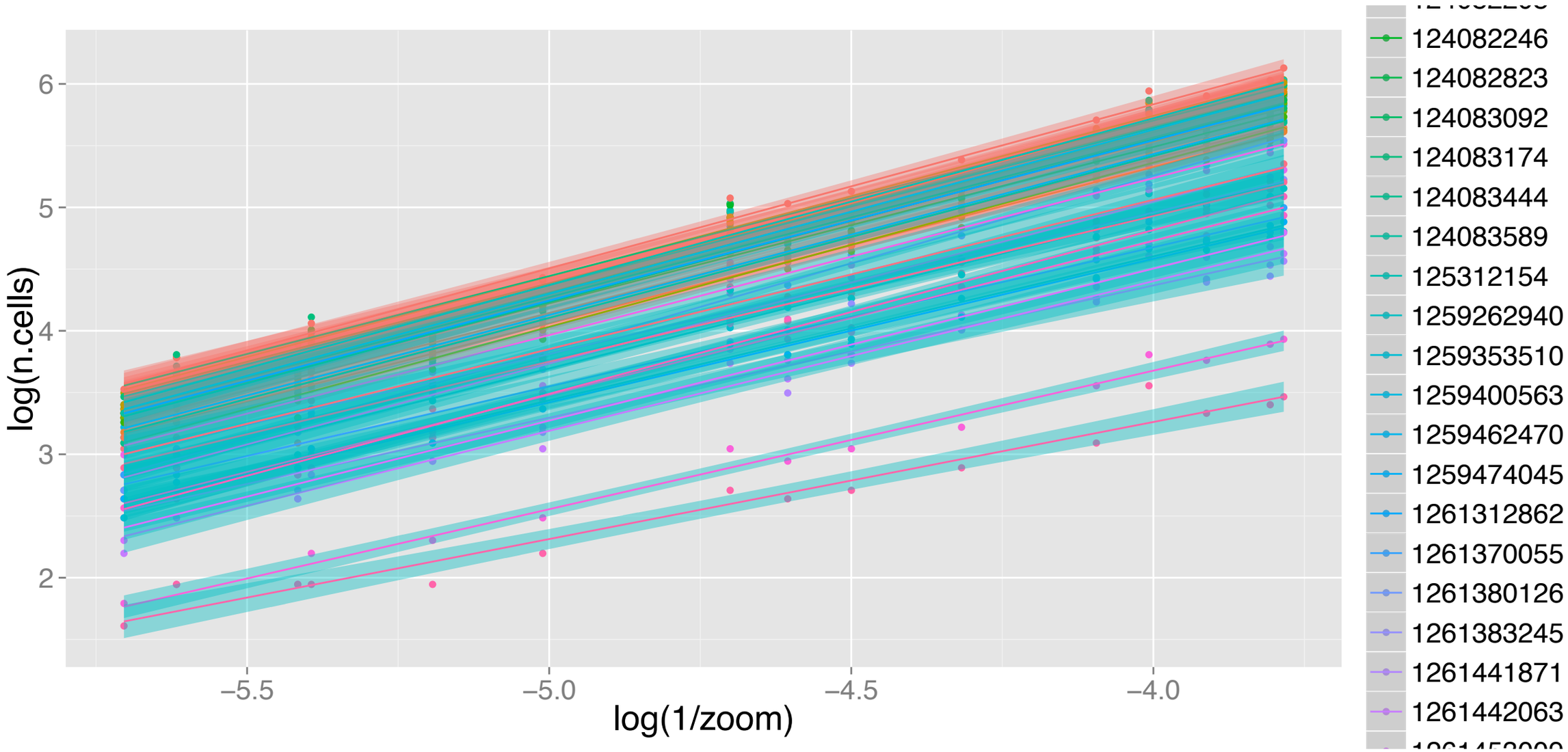


slopes (FD) for 150GeV e+/pi+

log(1/zoom)> -6.0

log(1/zoom)< -3.6

Fractal dimension of pi+/e+ clusters



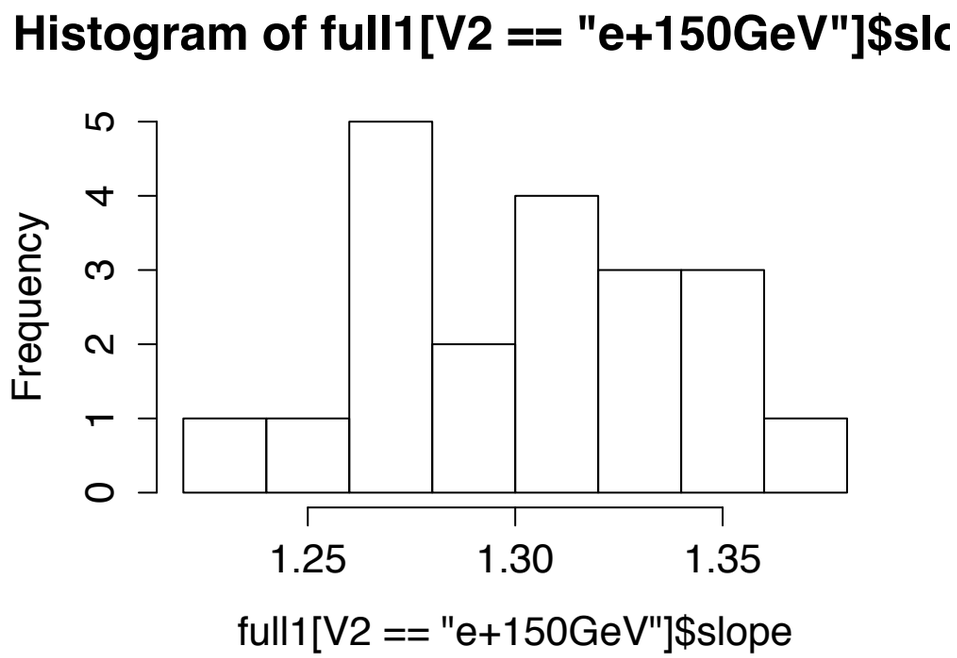
slopes (FD) for 150GeV e+(red)/pi+(blue)

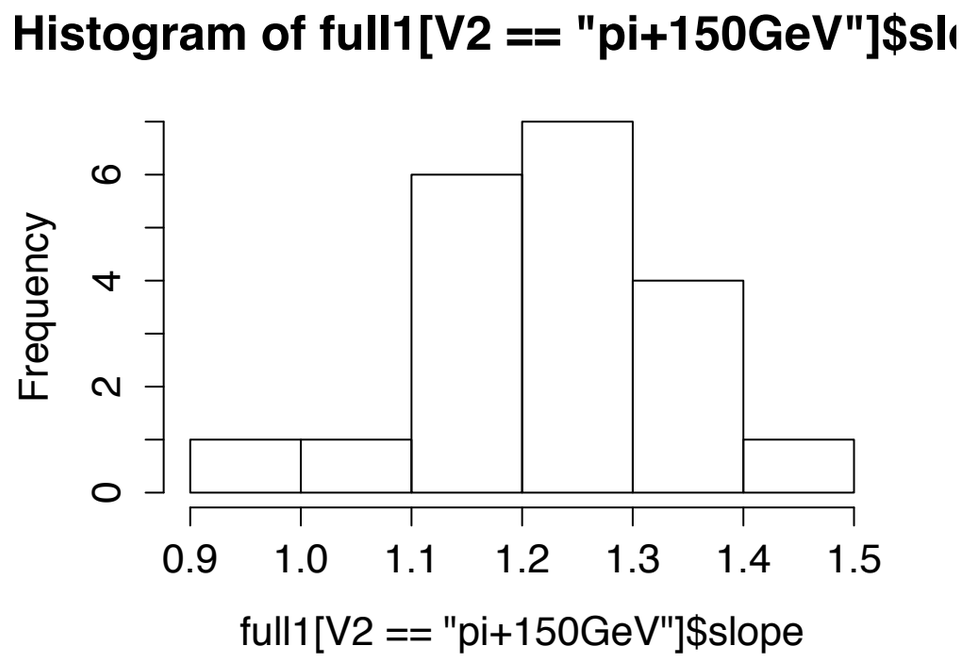
log(1/zoom)> -6.0

log(1/zoom)< -3.6

Fractal dimension of pi+/e+ clusters

slopes (FD) for 150GeV e+/pi+





mean_slope(pi+150GeV)=1.216598
mean_slope(e+150GeV)=1.303072

log(1/zoom)> -6.0
log(1/zoom)< -3.6

Fractal dimension of pi+/e+ clusters

2nd method

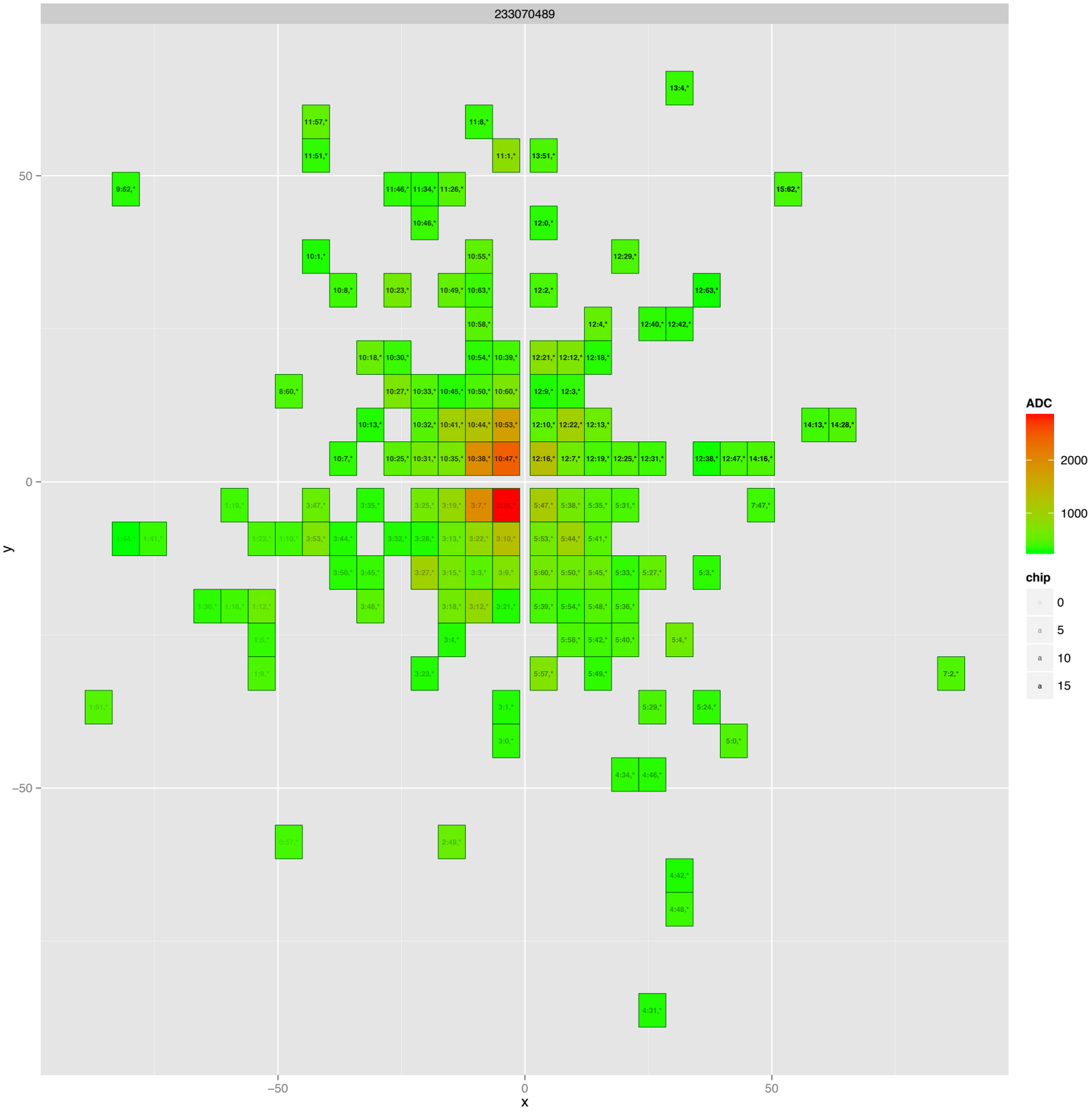
Procedure:

1) no intersensor gap
2) covering of event with few size grids:

*grid_cell=m*prototype_pixel*

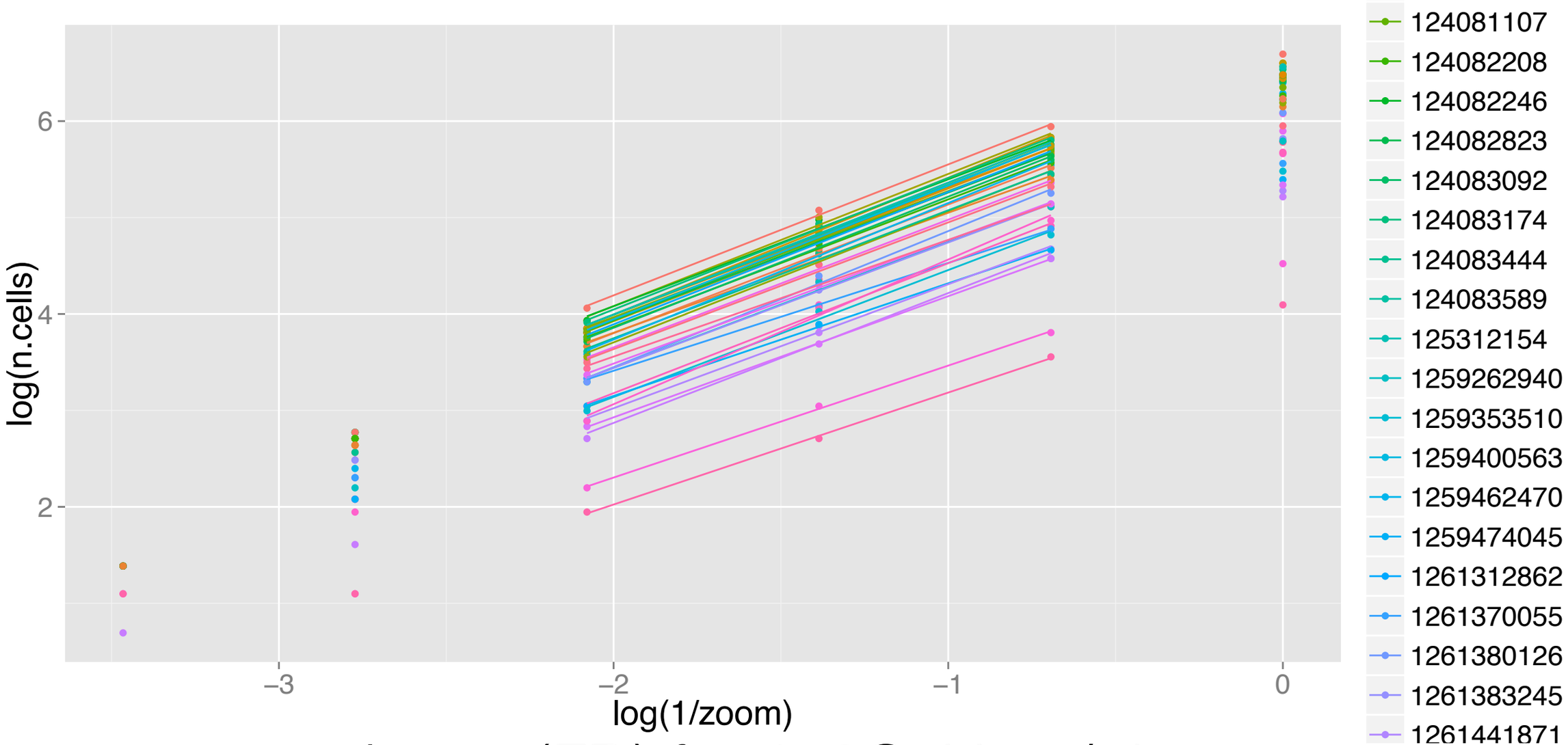
m - integer 1,2,4,8,16

3) grid center at (0,0)
4) counting of #boxes with part of event perimeter
5) prototype_pixel=5.5mm
6) minimal grid_cell=5.5mm
7) maximal grid_cell=88mm entire sensor



Fractal dimension of pi+/e+ clusters

2nd method



slopes (FD) for 150GeV e+/pi+

log(1/zoom)> -2.5

log(1/zoom)< -0.5

used grids: 1x pixel

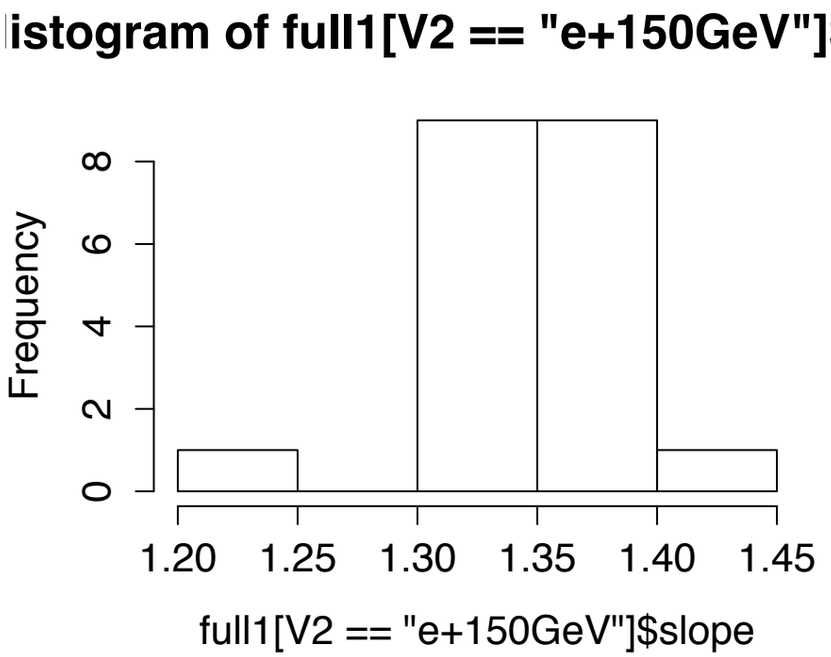
2x pixel

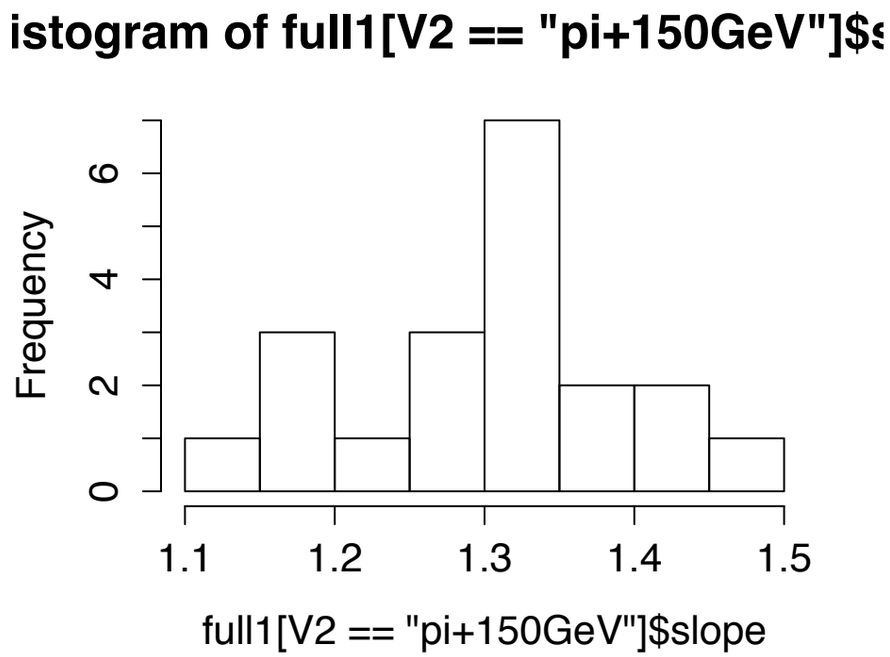
4x pixel

Fractal dimension of pi+/e+ clusters

slopes (FD) for 150GeV e+/pi+

2nd method





mean_slope(pi+150GeV)=1.299266
mean_slope(e+150GeV)=1.344744

log(1/zoom)> -2.5
log(1/zoom)< -0.5

Fractal dimension of pi+/e+ clusters

3rd method

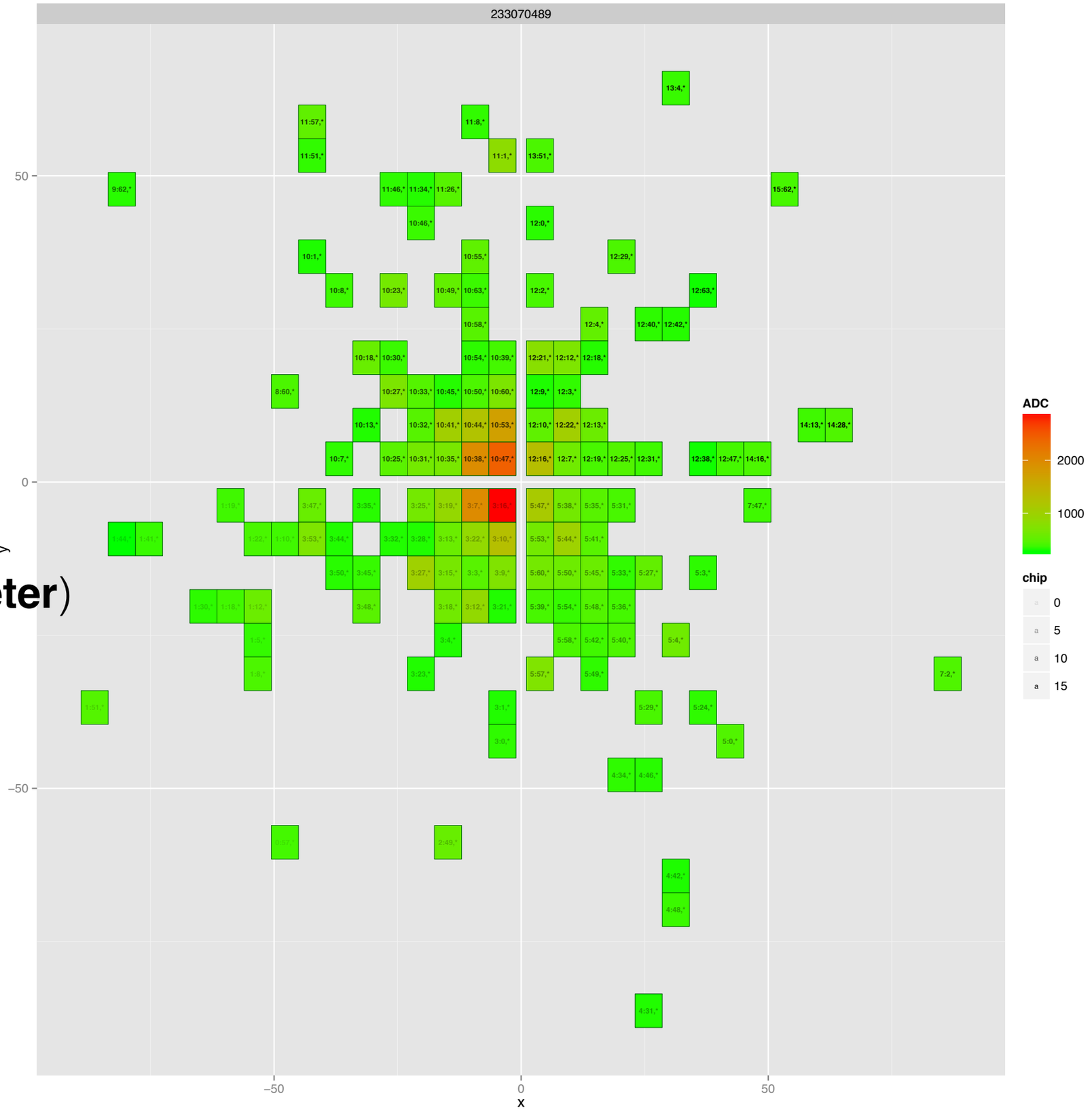
Procedure:

1) no intersensor gap
2) covering of event with few size grids:

*grid_cell=m*prototype_pixel*

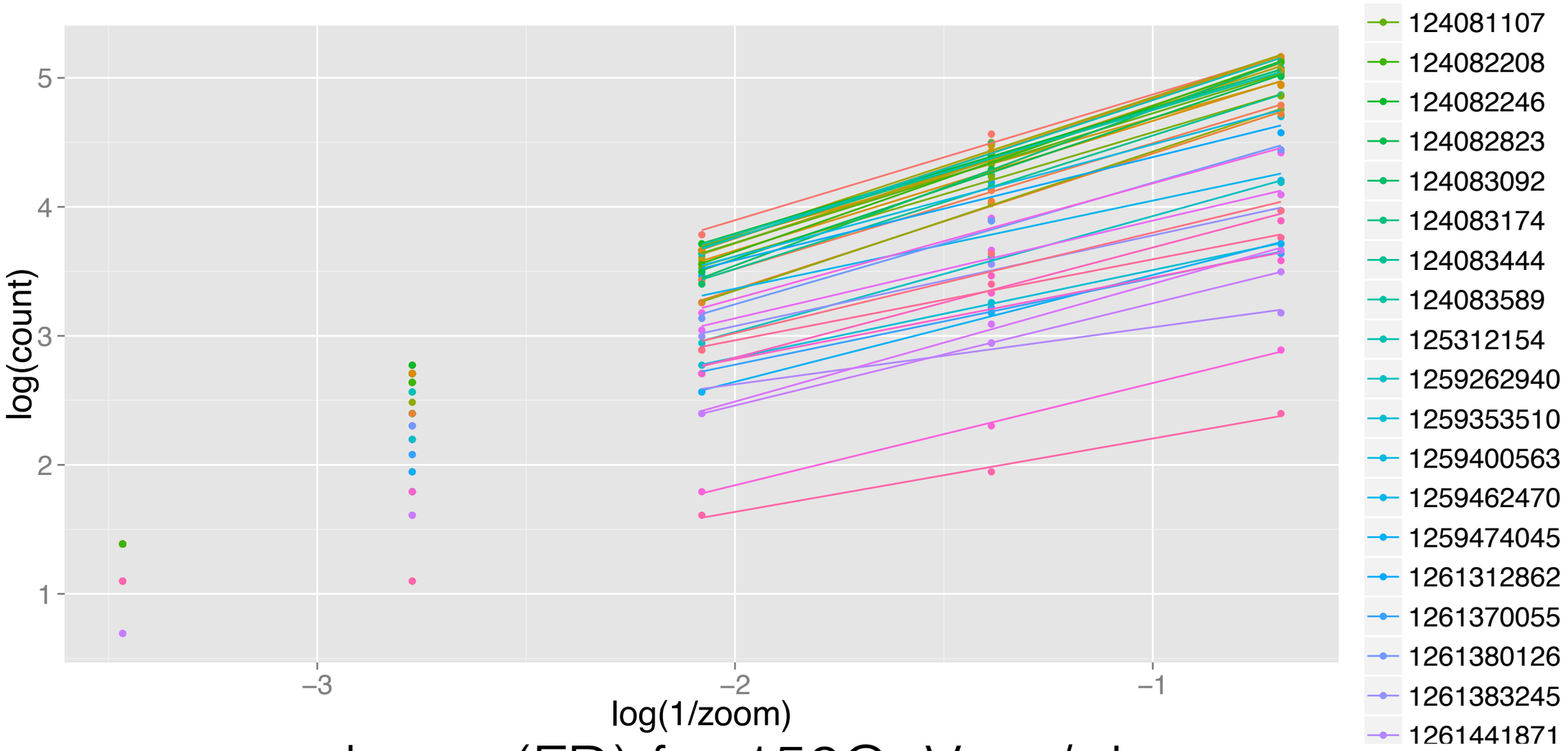
m - integer 1,2,4,8,16

3) counting of #boxes with part of event (**not only perimeter**)
4) prototype_pixel=5.5mm
5) minimal grid_cell=5.5mm
6) maximal grid_cell=88mm entire sensor



Fractal dimension of pi+/e+ clusters

3rd method



slopes (FD) for 150GeV e+/pi+

used grids: 1x pixel
2x pixel
4x pixel

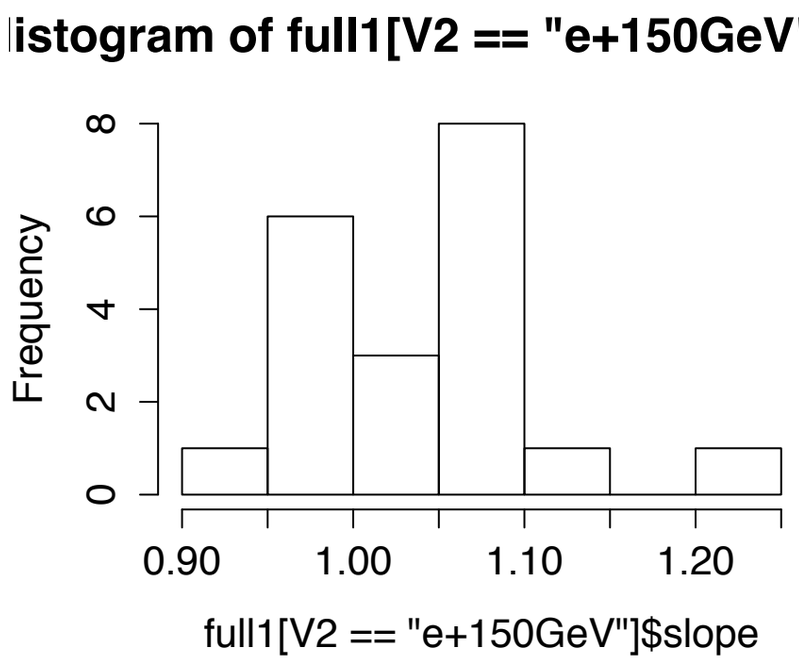
log(1/zoom)> -2.5

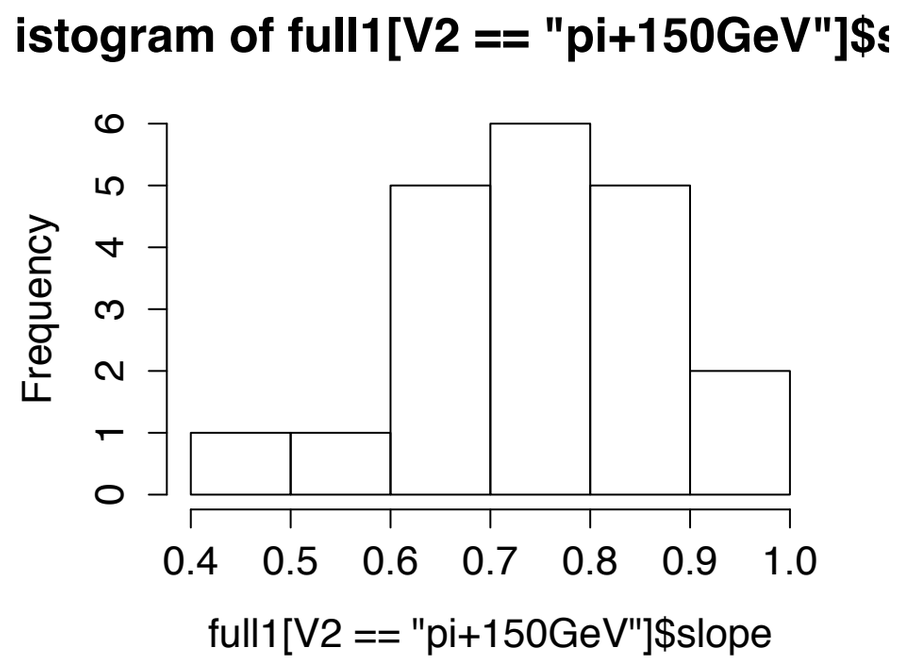
log(1/zoom)< -0.5

Fractal dimension of pi+/e+ clusters

slopes (FD) for 150GeV e+/pi+

3rd method





mean_slope(pi+150GeV)=0.7563569
mean_slope(e+150GeV)=1.0357420

log(1/zoom)> -2.5
log(1/zoom)< -0.5

Fractal dimension of pi+/e+ clusters

Possible to do in future:

1) use 3 slab minimal configurations
2) different thresholds (to implement energy)
3) some cross checks (for example, to estimate purity of the beam)