Square-events in SiWECAL prototype

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Square-event:

Reason: Big energy deposition at the sensor boundary due to capacitive coupling of silicon sensor guard ring with peripheral pixels.

Result: Many boundary pixels are fired via the cross-talk through the guard ring

Other information about square events studies:

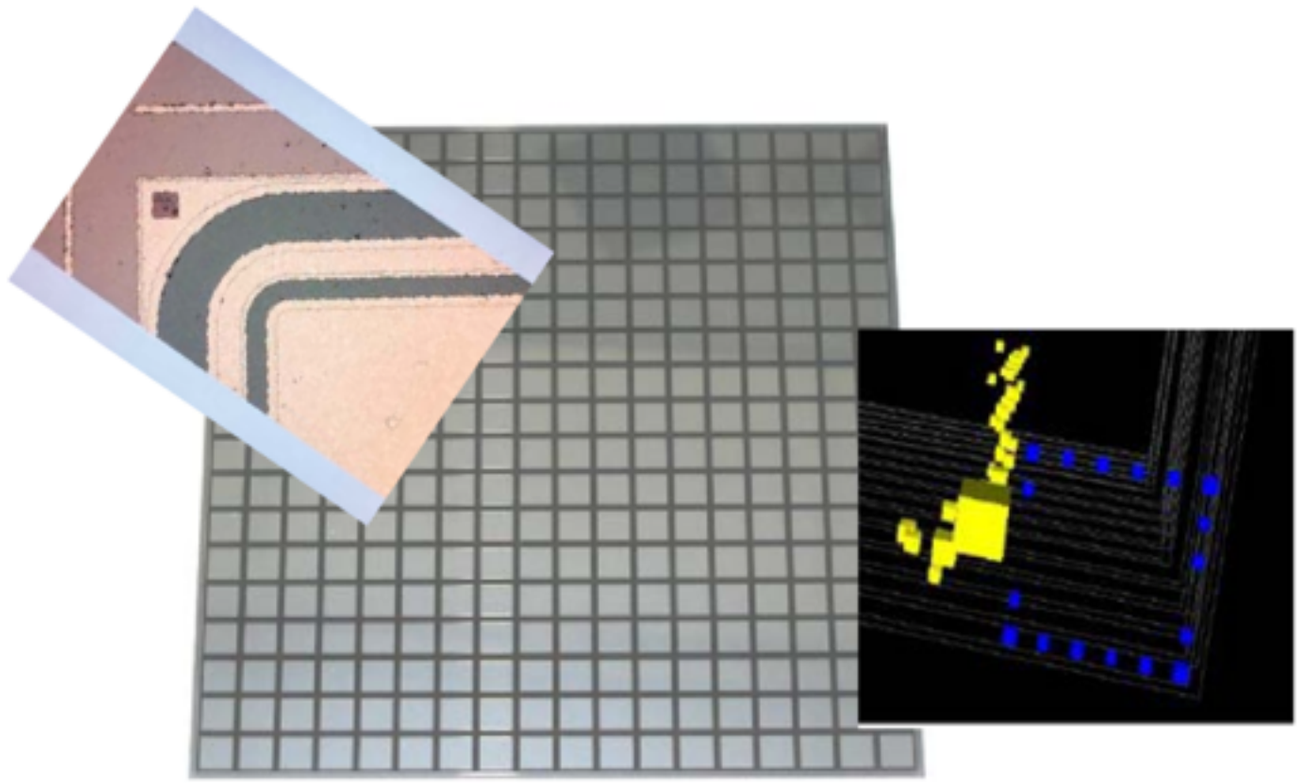
LCWS2013 V.Balagura slides:

https://agenda.linearcollider.org/event/6000/session/38/contribution/122/material/slides/0.pdf

"Square" event

Guard ring at silicon sensor edges ensures HV stability and low dark currents. Potential is not fixed (for cost reasons, connection is technologically difficult), but left floating → electrical cross talk betwen guard ring and peripheral pixels due to capacitive coupling.

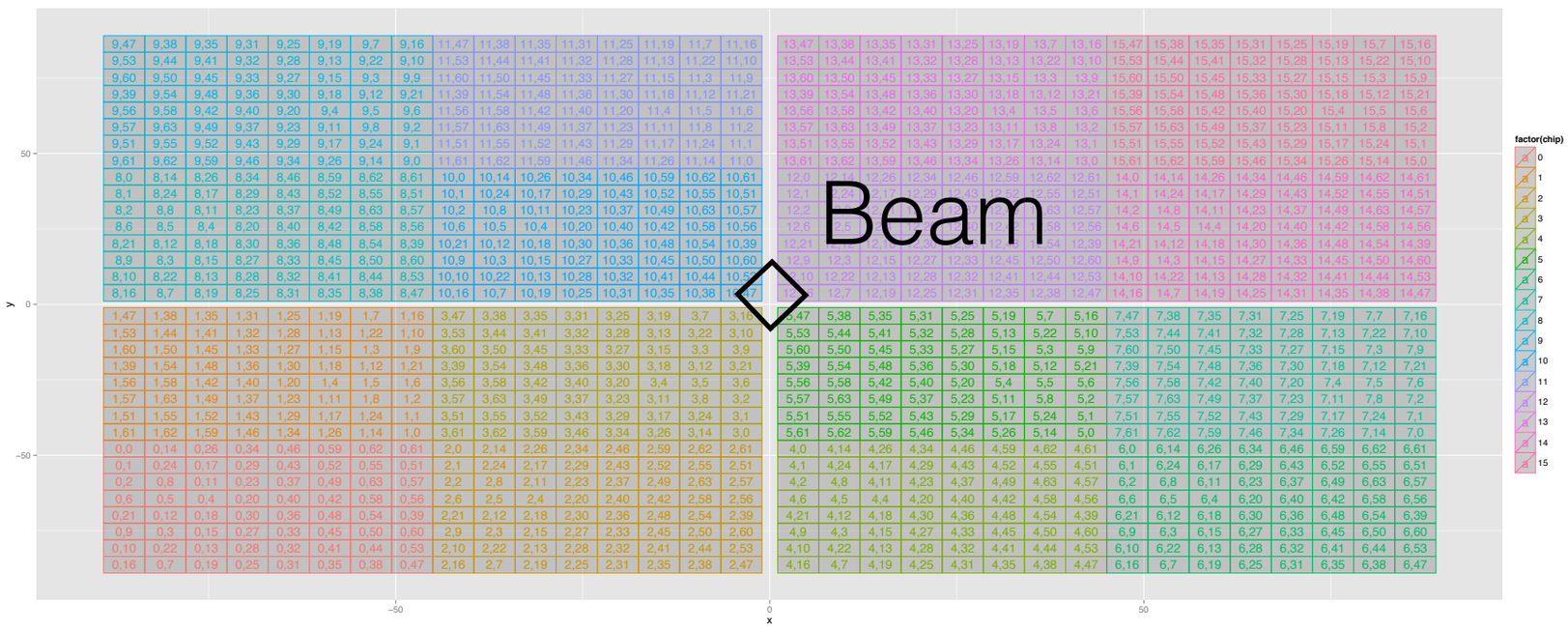
High signal at the boundary may trigger all peripheral pixels: "square events" seen in physics prototype.



Based on extensive simulation (electrical, analytical, TCAD, PhD and several CALICE notes) and measurements with electrical injection to Hamamatsu sensors, a segmentation of the guard ring was proposed to reduce cross talks. Sensors with several guard ring designs have been produced. First measurements with laser started (this talk).

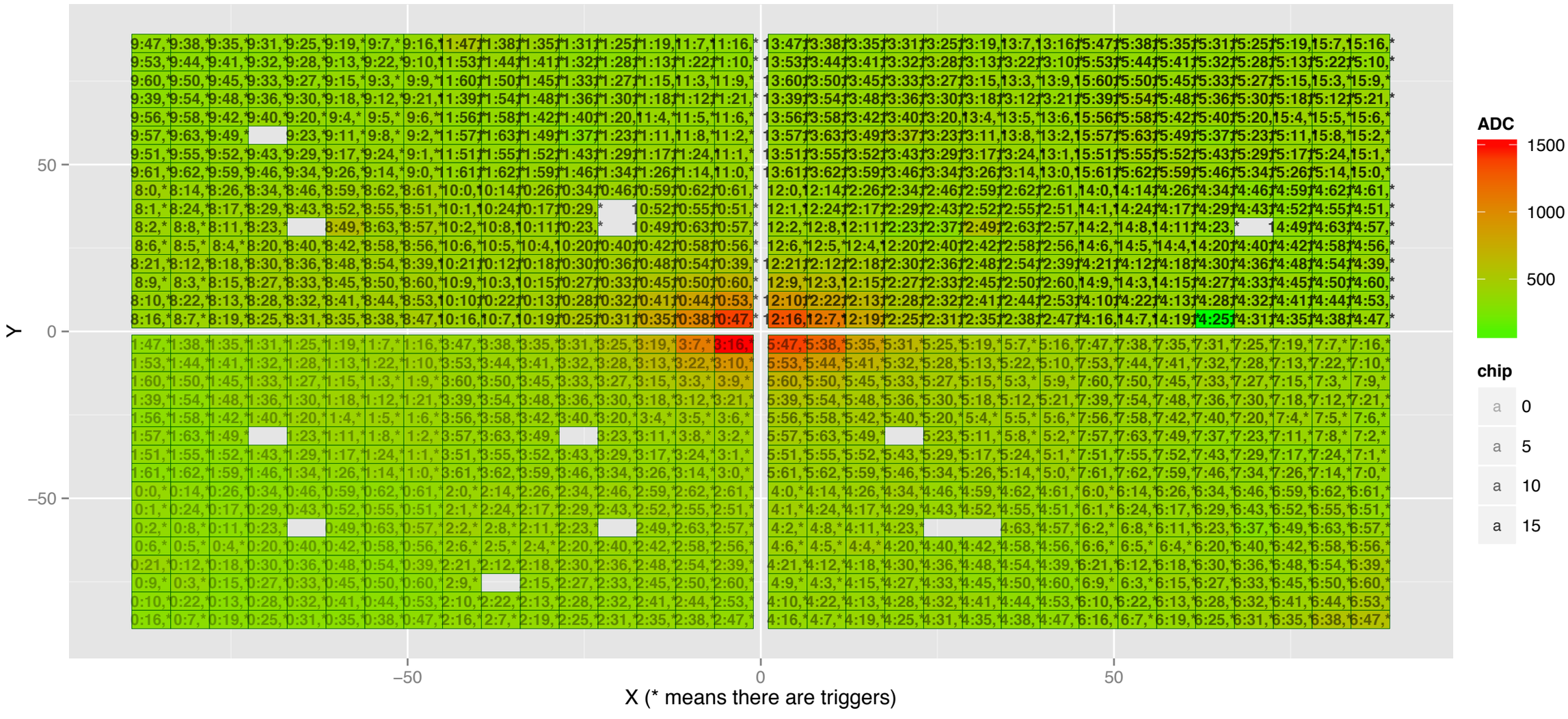
Square-events in SiWECAL prototype

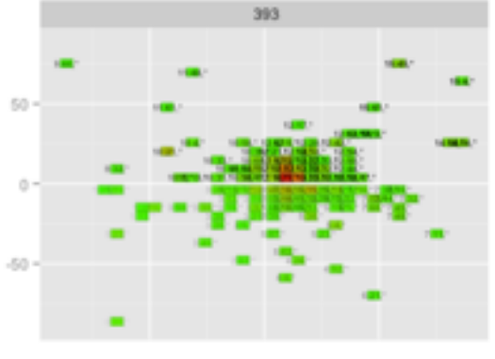
- For square event search I took **100GeV electron run 211** with beam in the prototype centre: all 4 sensors of every DIF are reachable
- I did simple calculation of #boundary & #inner hits per sensor for every event, currently I'm testing some other criteria
- Number of square events is low for "traditional" detector usage
- Every DIF has square-events



Square-events in SiWECAL prototype

Beam shape DIF1, plane events are not fully cut



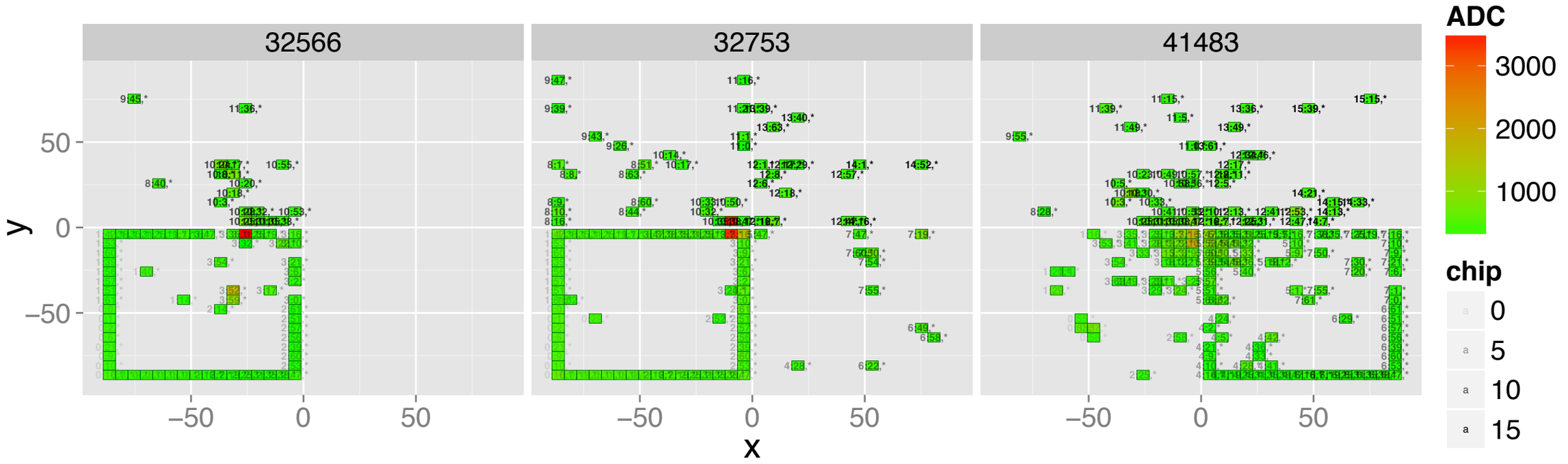


Example of normal event

Square-events in SiWECAL prototype

- DIF0 run211

only 3 square events detected
(acq, bx)
(32556, 1768)
(32753, 3847)
(41483, 1568)

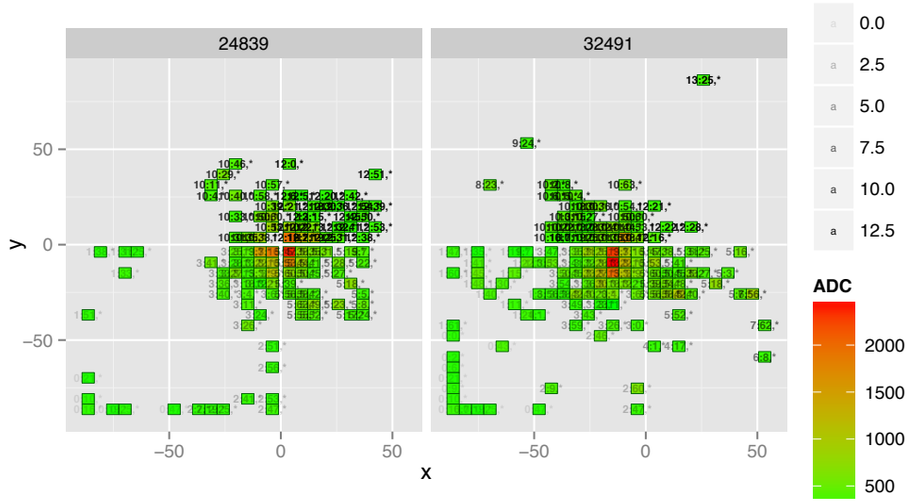


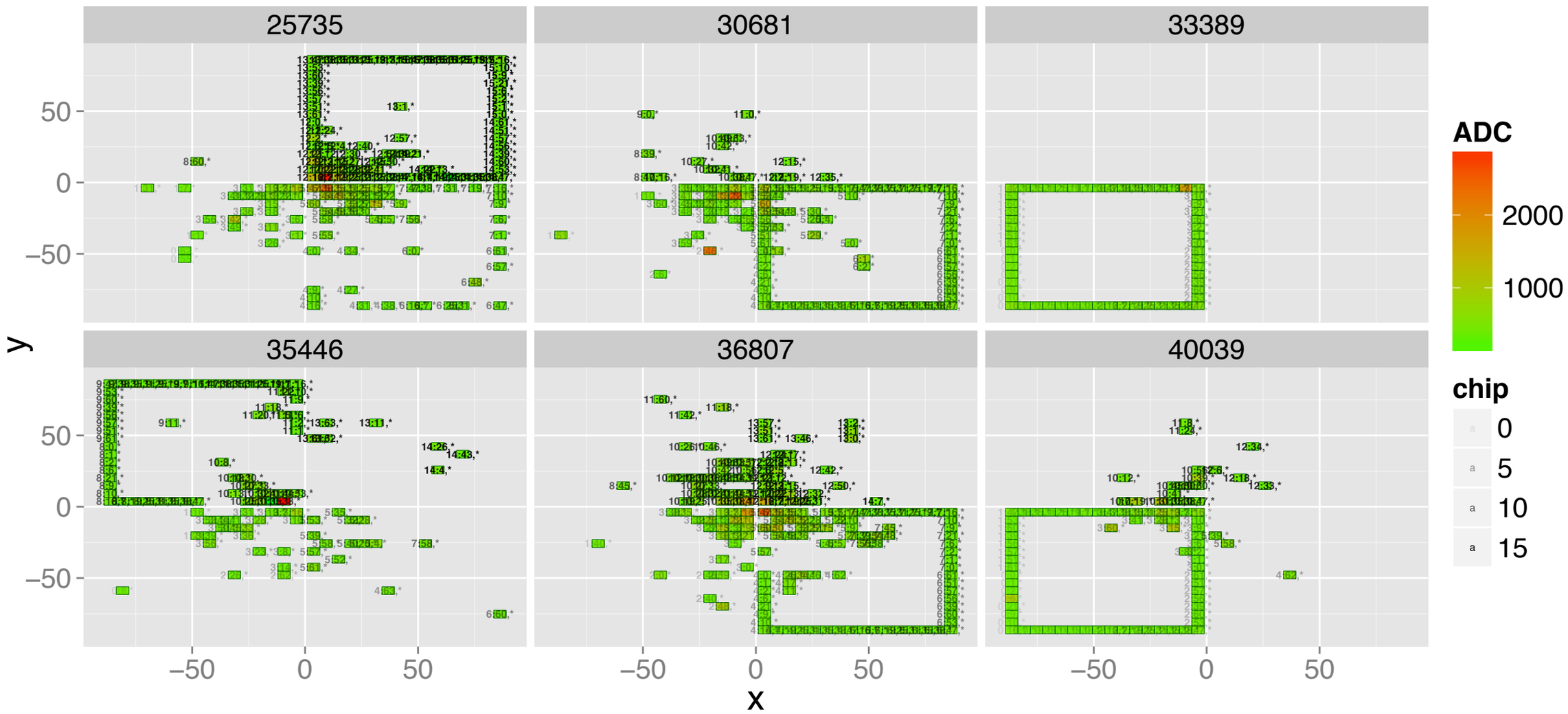
Square-events in SiWECAL prototype

- DIF1 run211

only 6 fully square events detected
(acq, bx)
(25735, 941) -probably, this is double square event
(35446, 3243)
(30681, 1241) (36807, 1406)
(33389, 3615) (40039, 2668)

some smaller effects also detected

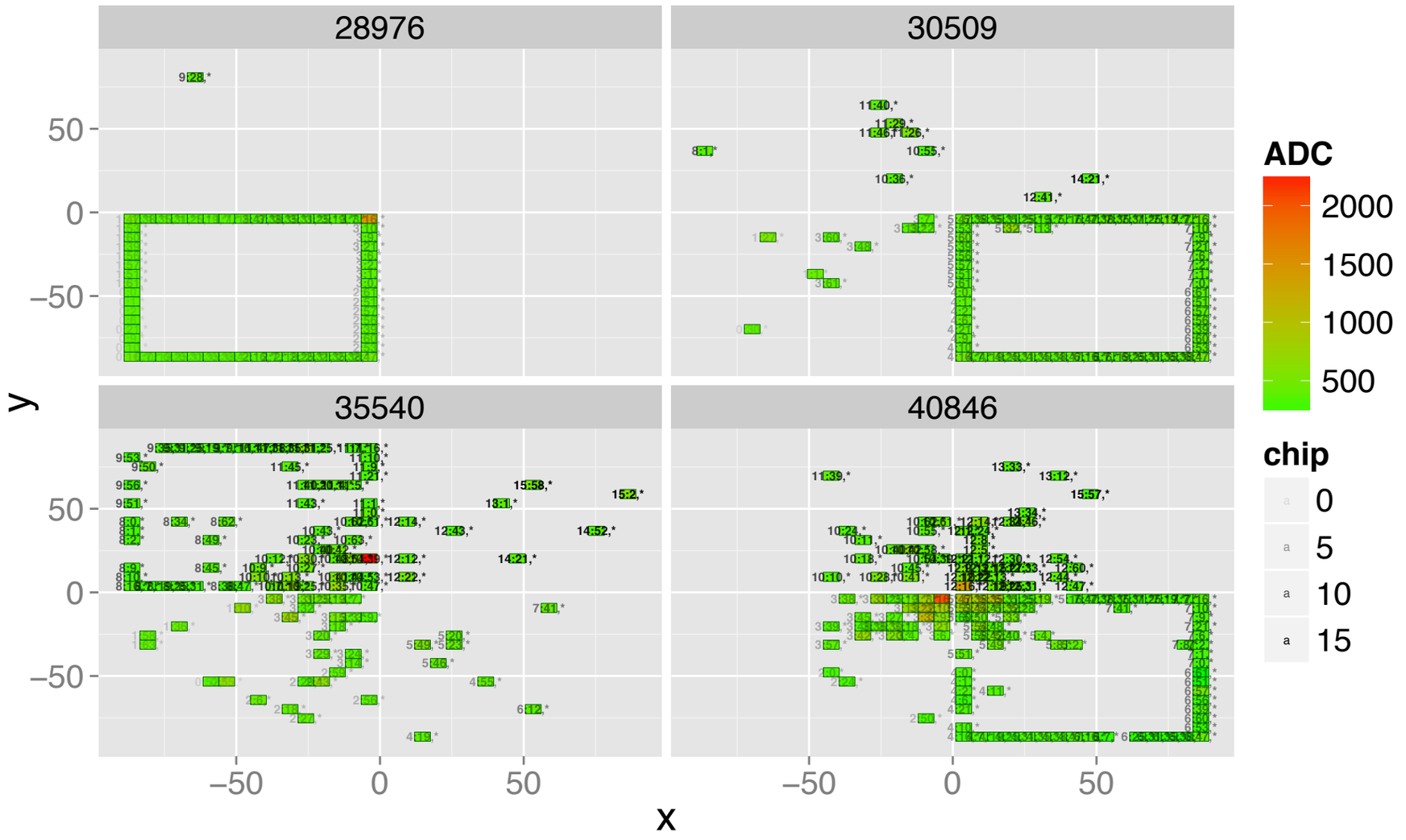




Square-events in SiWECAL prototype

- DIF2 run211

only 4 square events detected
(acq, bx)
(28976, 3439) (35540, 1664)
(30509, 2669) (40846, 3815)



Square-events in SiWECAL prototype

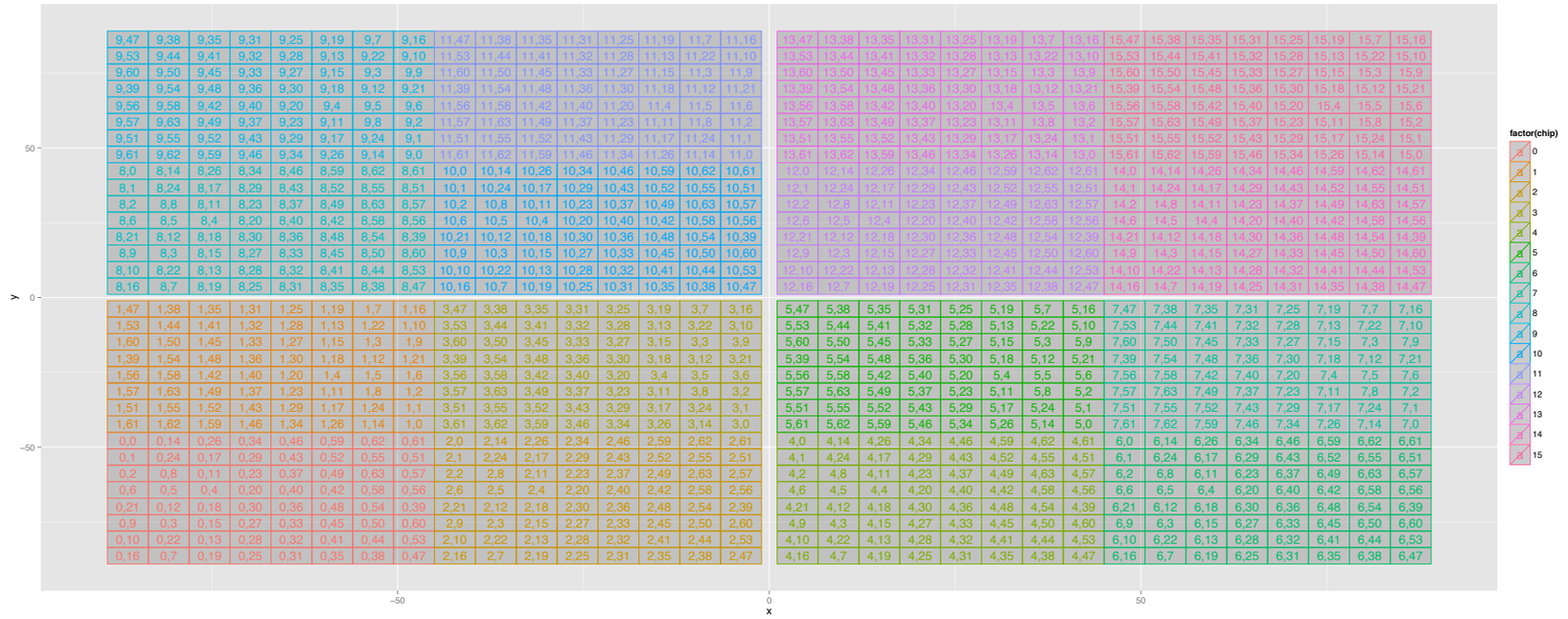
Square-event:

New idea: Lets use **turned detector configuration** to increase #square events

Run information: **run 472, 150 GeV pi+**

Result: Now particle which goes through the detector has higher probability to cross the guard-ring, in some rare cases in can cross the guard ring four times or even pass significant distance inside the guard-ring

Beam



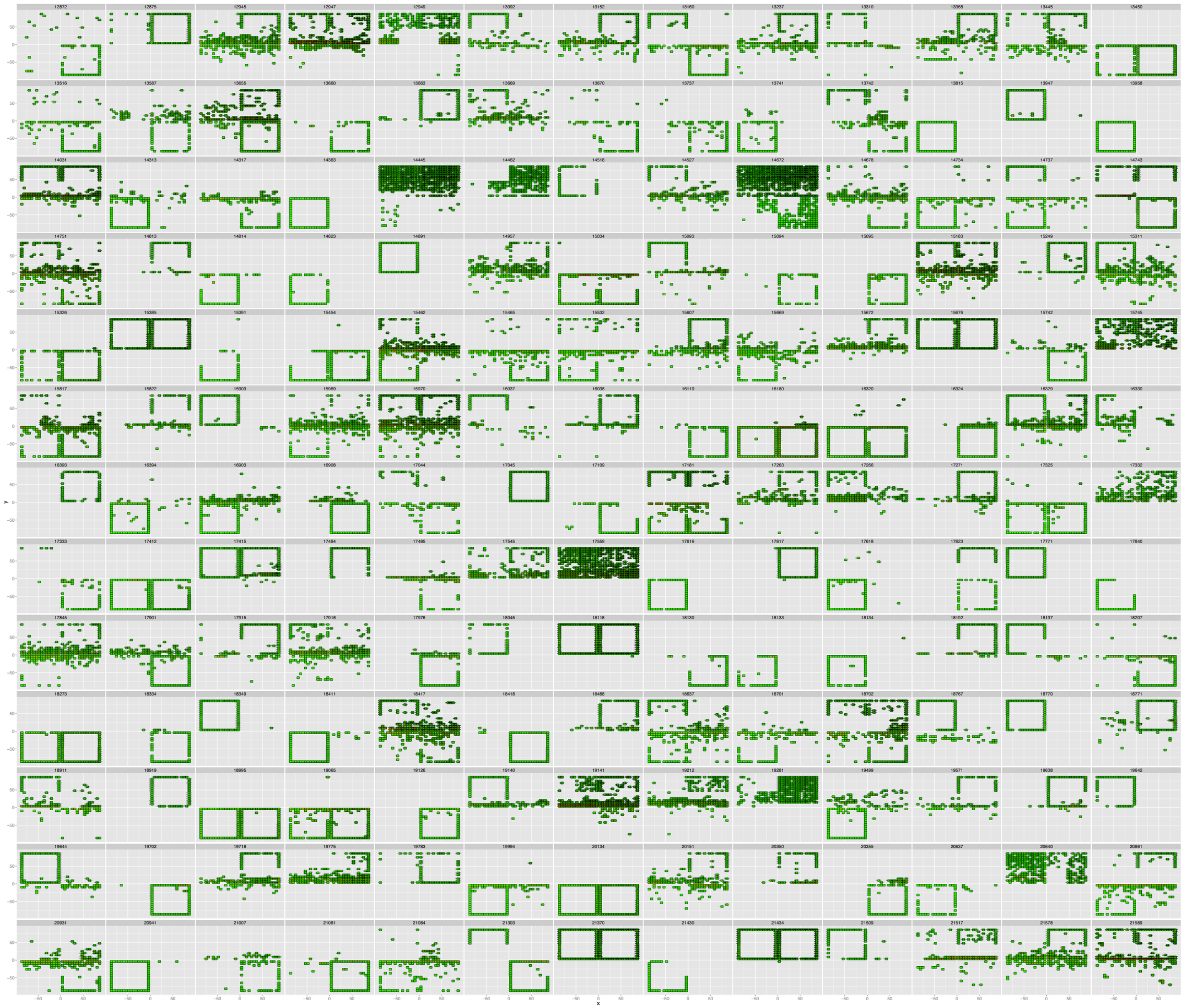
Square-events in SiWECAL prototype

- DIF1 run472

Huge amount of square events~170 (next slide)
with at least 1 traditional single square event
Also we see:
- double square events
- partially square events (half or quarter)

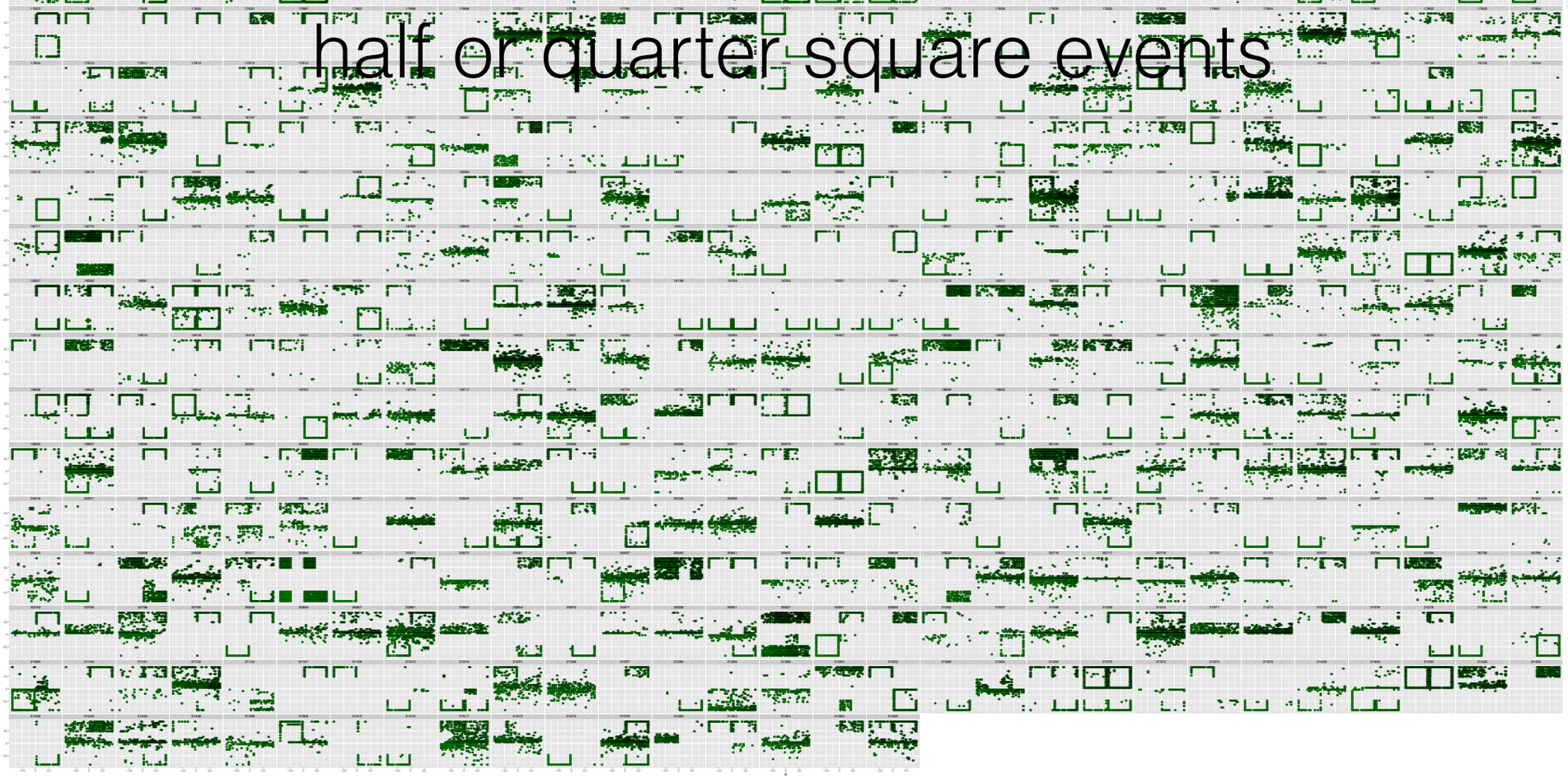
DIF1

square events



DIF1

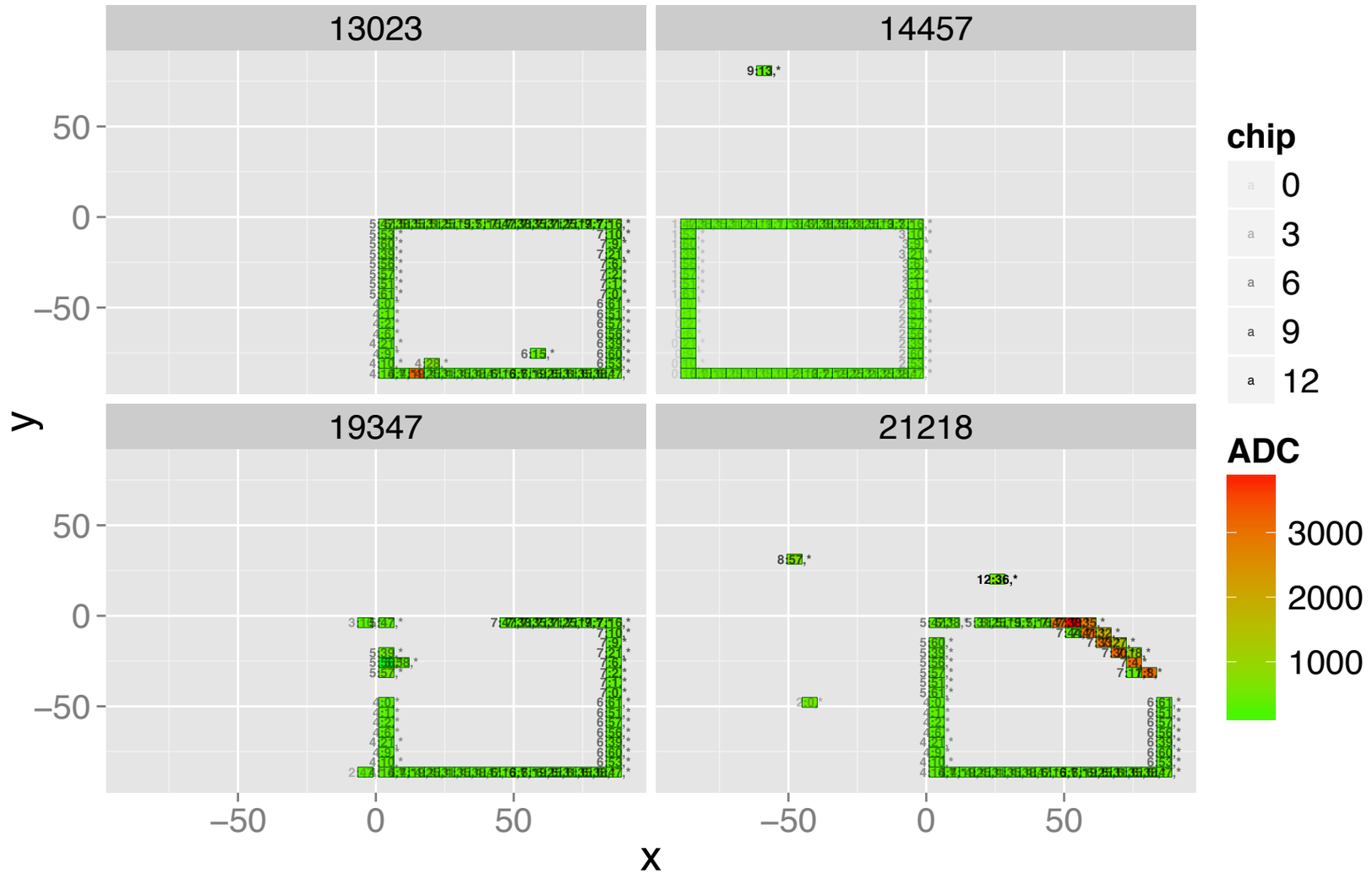
square events:
criteria on #boundary pixels
are not so strong and
we see some



Square-events in SiWECAL prototype

- DIF0 run472

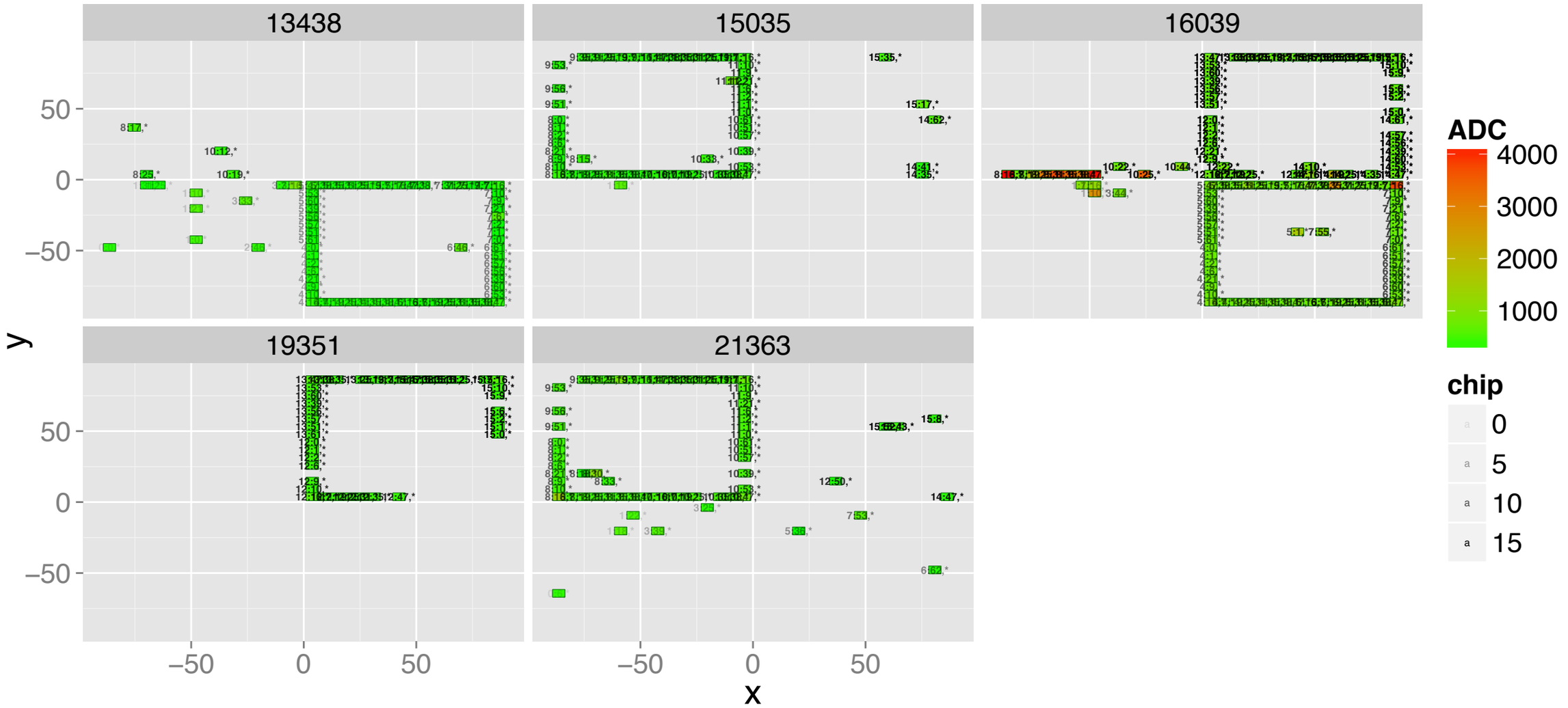
just 4 square events acq=13023,14457,19347,21218
beam in DIF1



Square-events in SiWECAL prototype

- DIF2 run211

just 5 square events, acq=13438,15035,16039,19351,21363
beam in DIF1



Square-events in SiWECAL prototype

To be done with square events:

- optimisation of search procedure
- percent of affected particle detections
  (exclude all plane events and other noises to get correct number of detected particles)
- cross-talk study