Charge collection and E-TCT measurements with CHESS-1 chip

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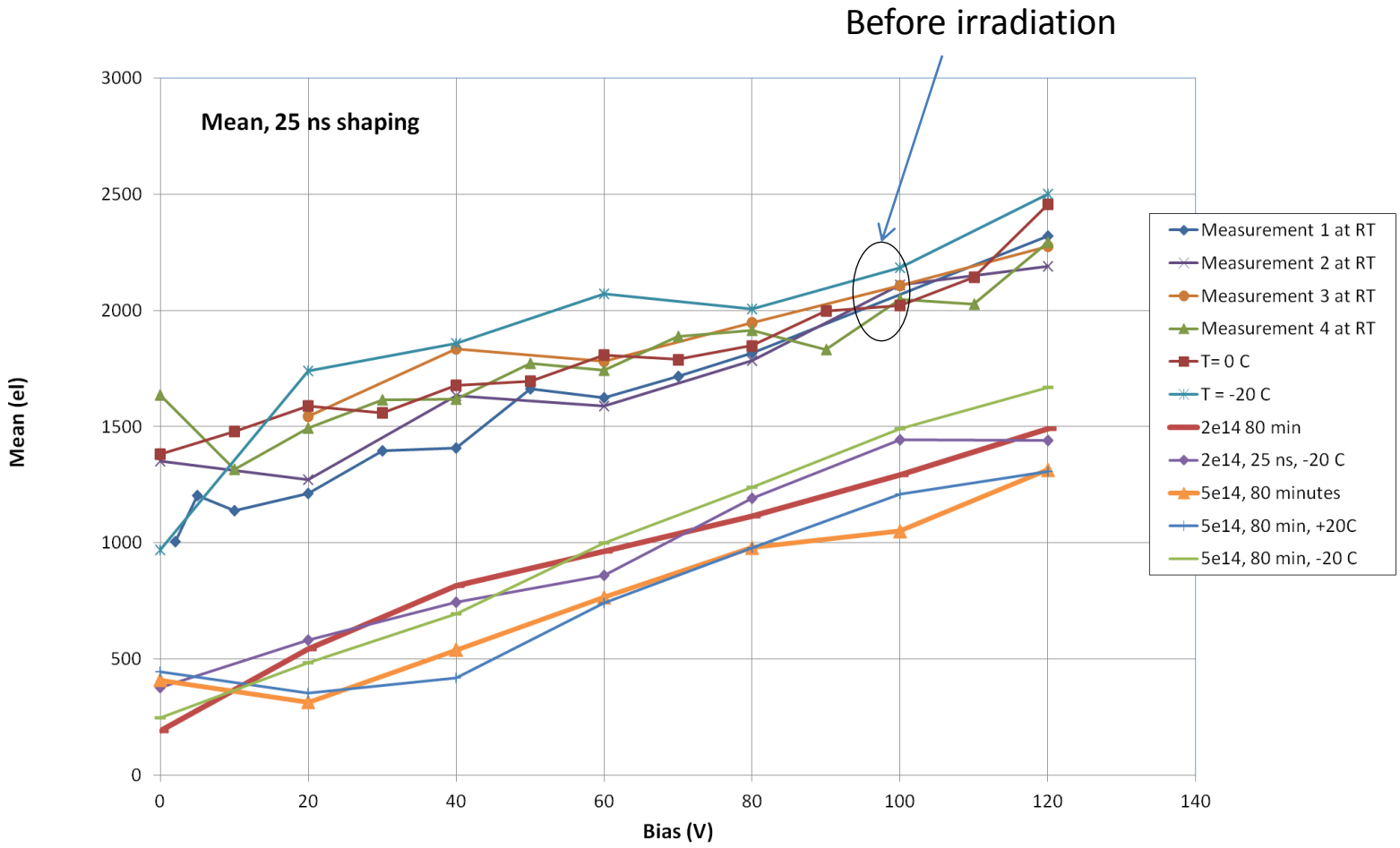
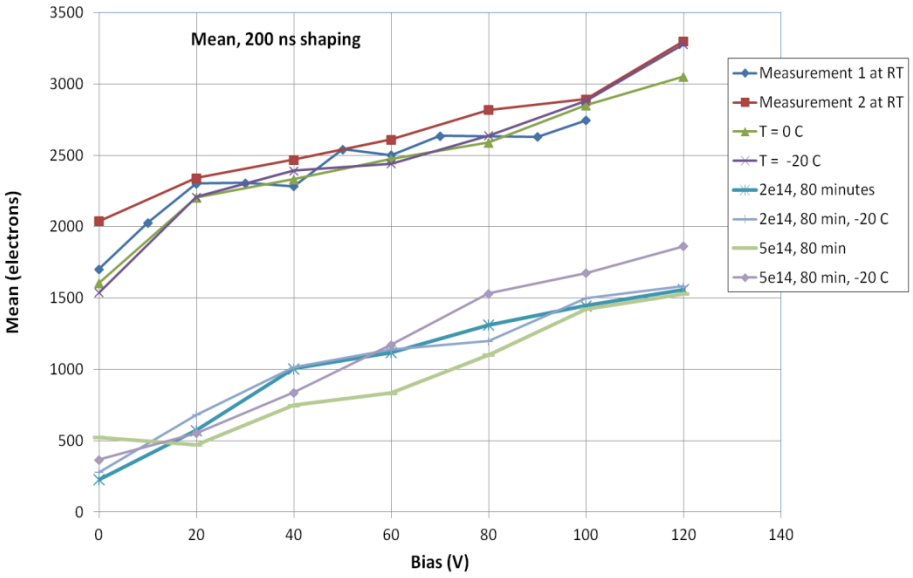
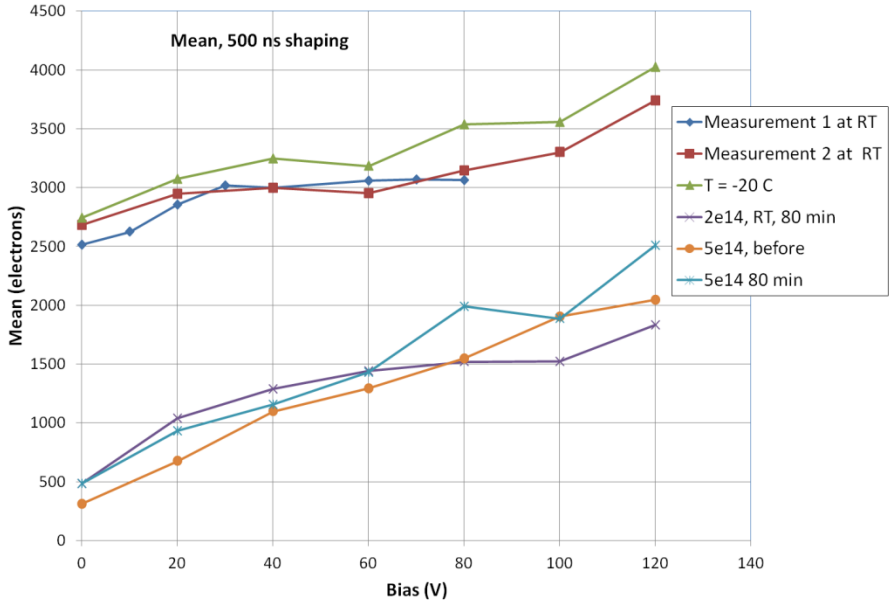
CCE with irradiated large passive array

- new irradiation step to 5e14 n/cm^2
  → small difference between 2e14 and 5e14

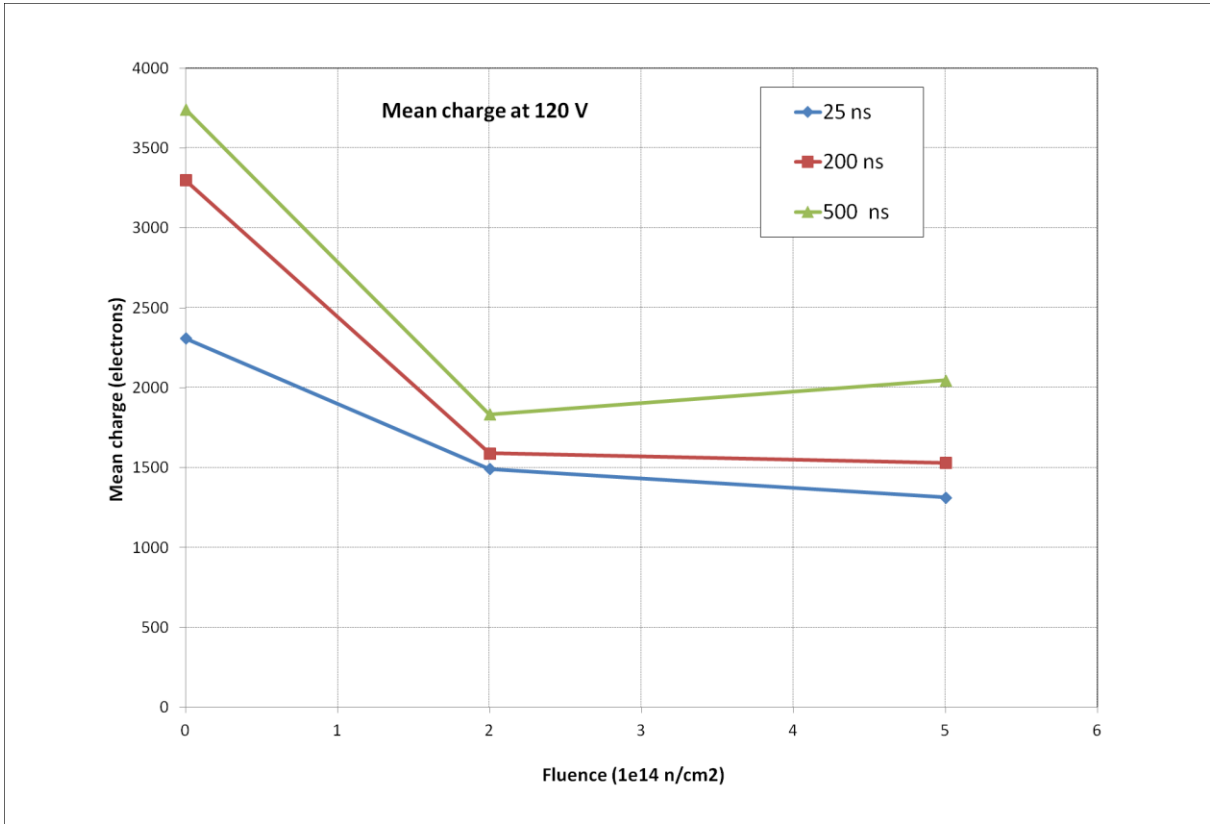


- similar at longer shaping times



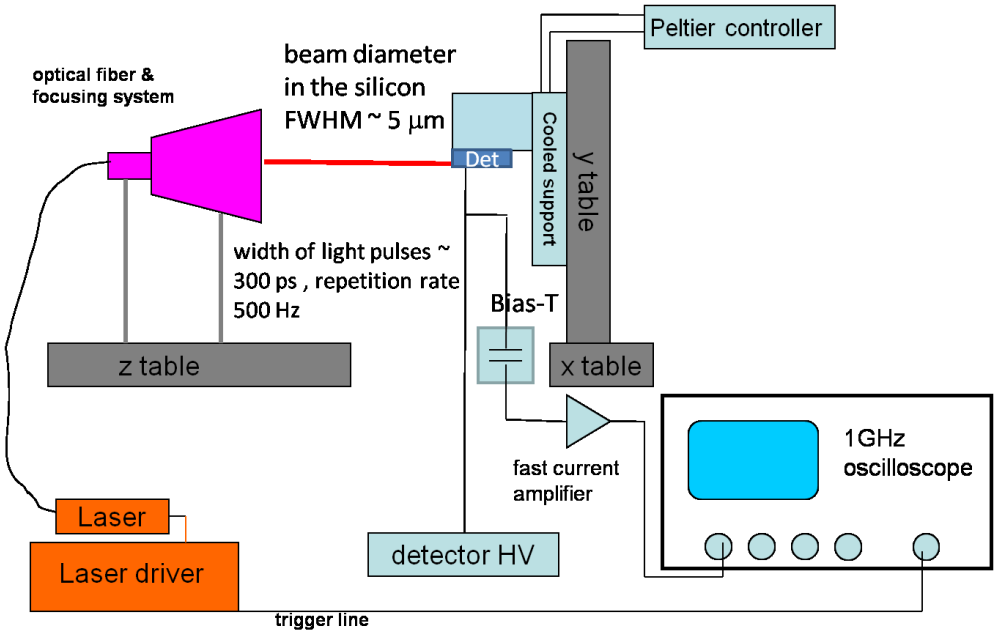


- mean charge vs. Fluence: almost no change between 2e14 and 5e14
  → next point at 1e1 5
  → start measurements with another device to get some statistics

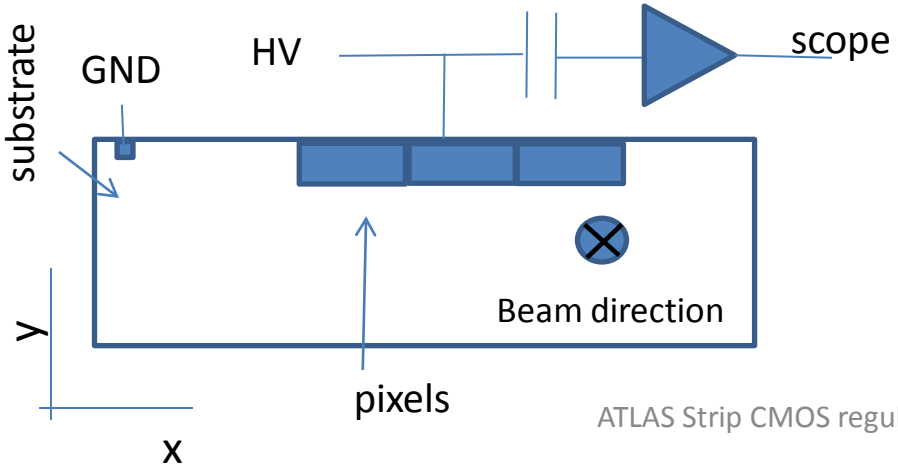


- consistent with measurements with HVFEI42 (G. Kramberger at 25th RD50 workshop):
  https://indico.cern.ch/event/334251/session/1/contribution/15/material/slides/0.pdf

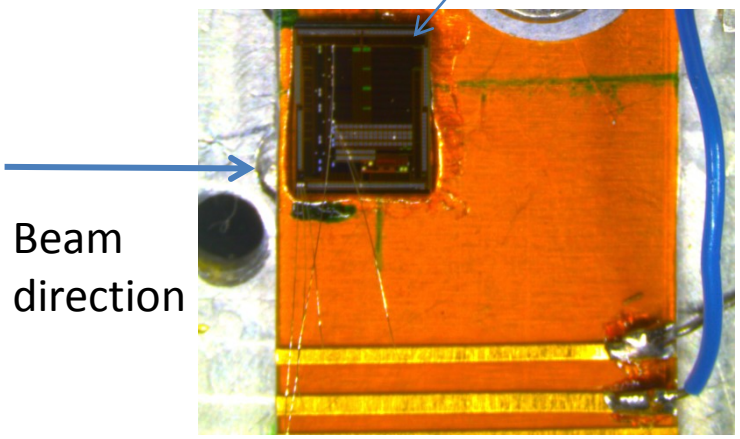
Edge TCT measurements with CHESS1



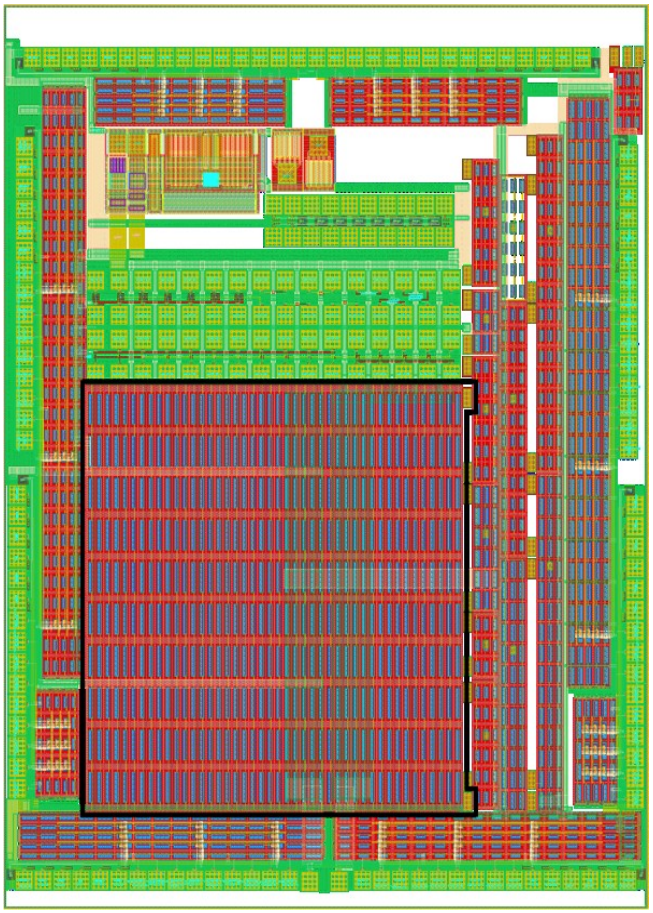
Detector connection scheme:



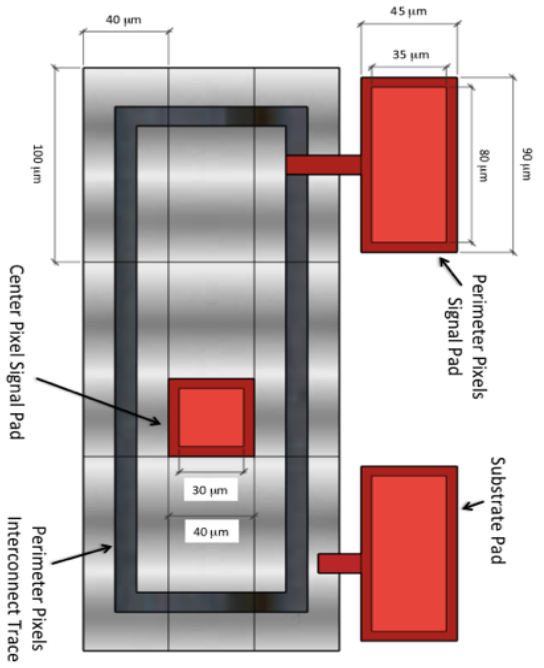
CHESS1



• measure with passive array in the corner



Beam direction



Beam

Two connection versions:

1) perimeter to high voltage
   signal to high voltage and to readout
2) signal and perimeter to high voltage and to readout

TCT:

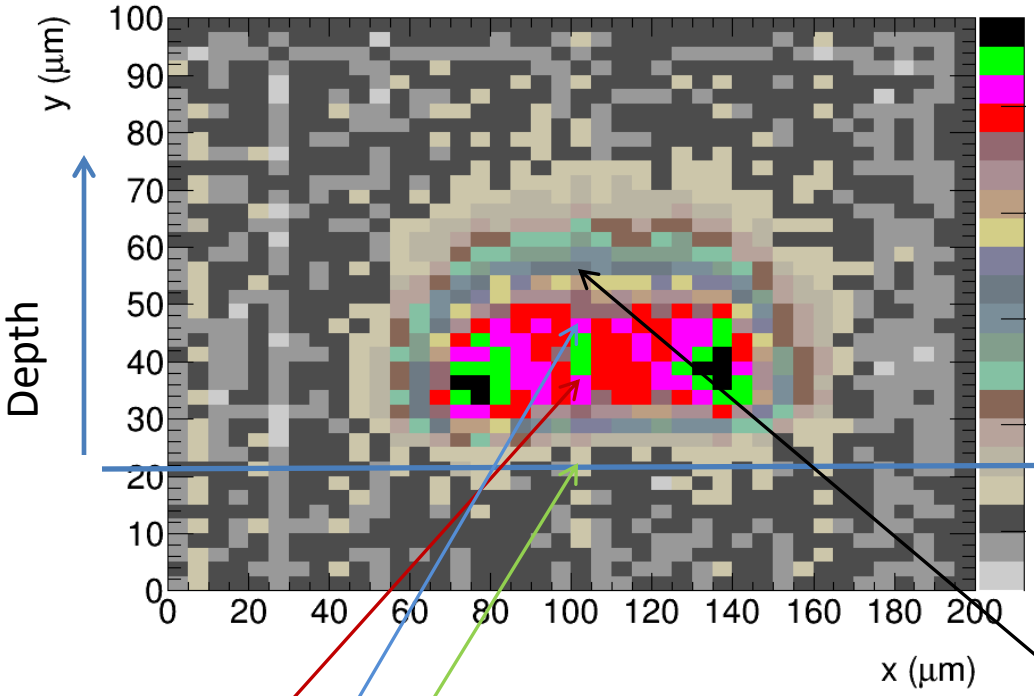
• measure induced current vs. time after a short laser pulse:
(Ramo's theorem: $I \approx q\vec{E}_w \cdot \vec{v}, \quad \vec{E}_w$ weighting field , $\vec{v}$ carrier velocity, *q* carrier charge)

1) charge: integral of induced current pulse

2) velocity profile (in E-TCT): induced current immediately after the laser pulse
gives information about carrier velocity ➔ electric field at location of laser beam

$$I(x,y,t\sim 0) \approx qE_w(x,y)\left[\bar{v}_e(x,y)+\bar{v}_h(x,y)\right]; \quad \bar{v}_e(x,y)+\bar{v}_h(x,y) \propto E$$

Charge (25 ns), signal pixel, **Bias = 120 V**



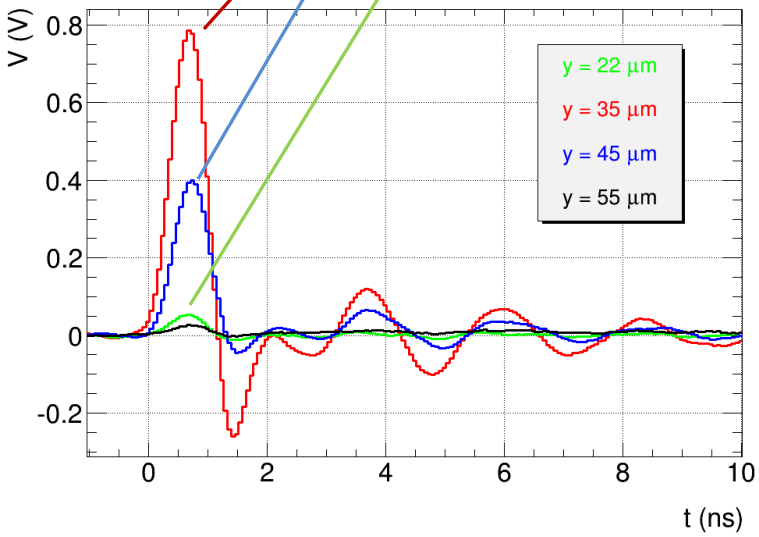
Scan:

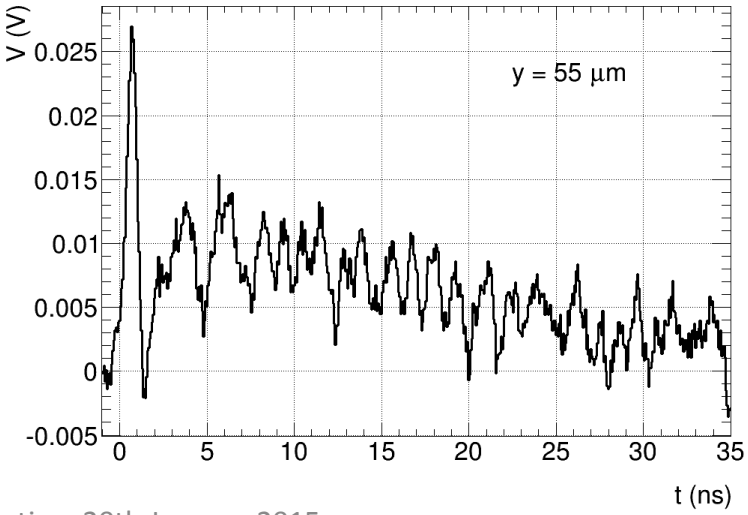
5 um steps in y

2.5 um steps in x

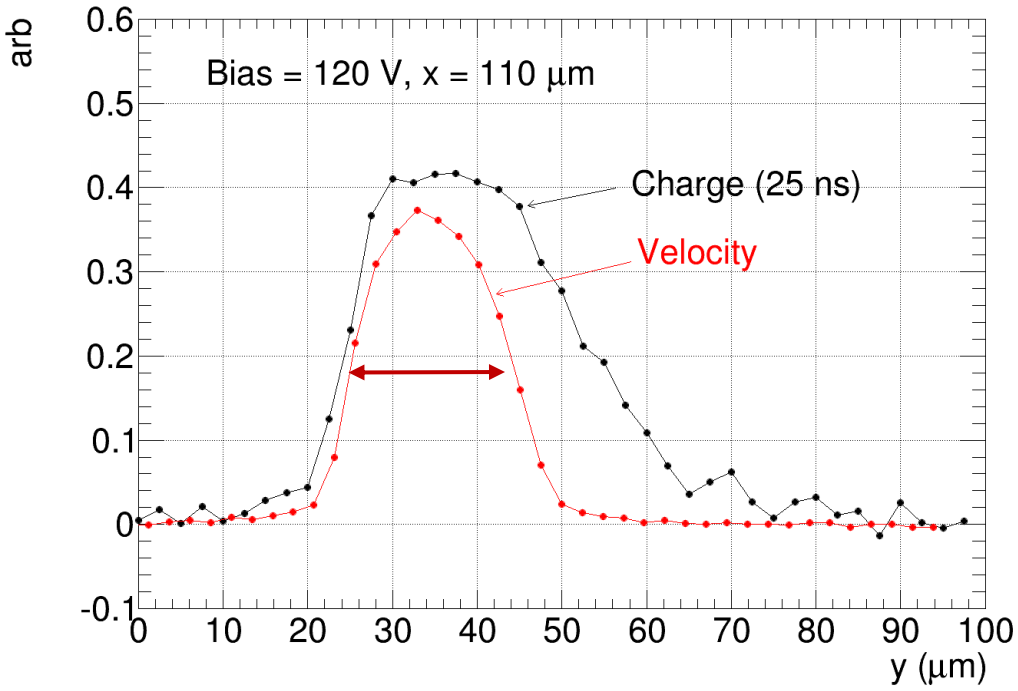
Beam direction

Chip surface





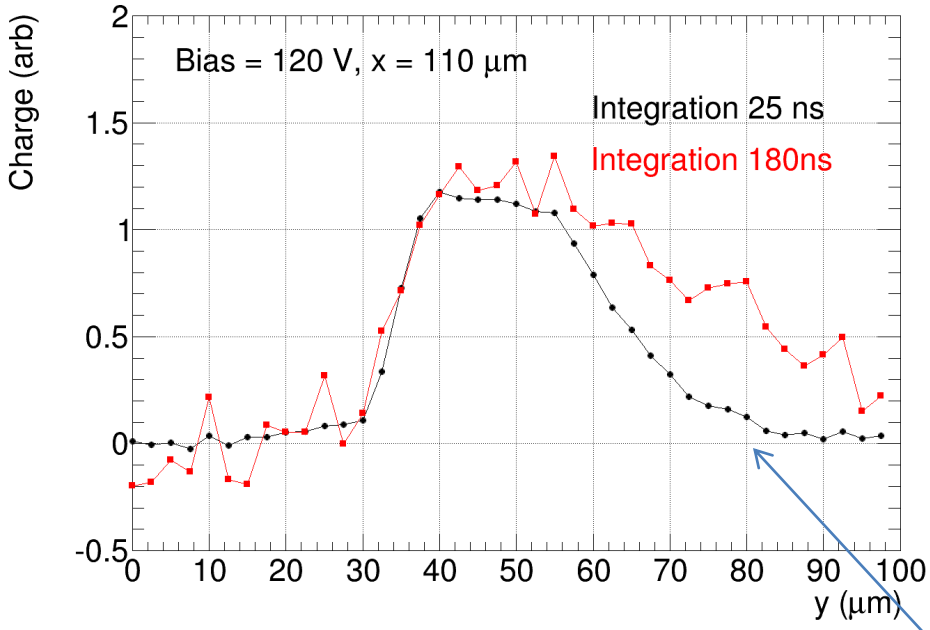
Charge and velocity profiles across centre of the pixel

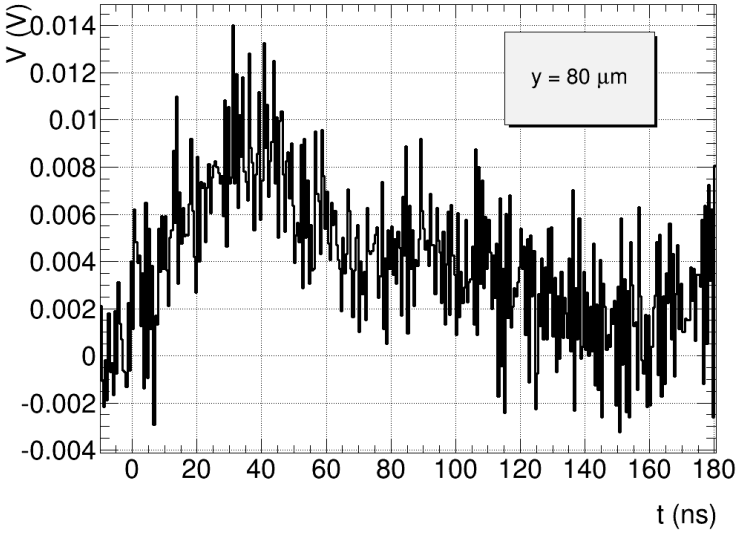


- field (drift) depth ~ 20 µm
- charge collection region deeper (diffusion) ~ 30 µm

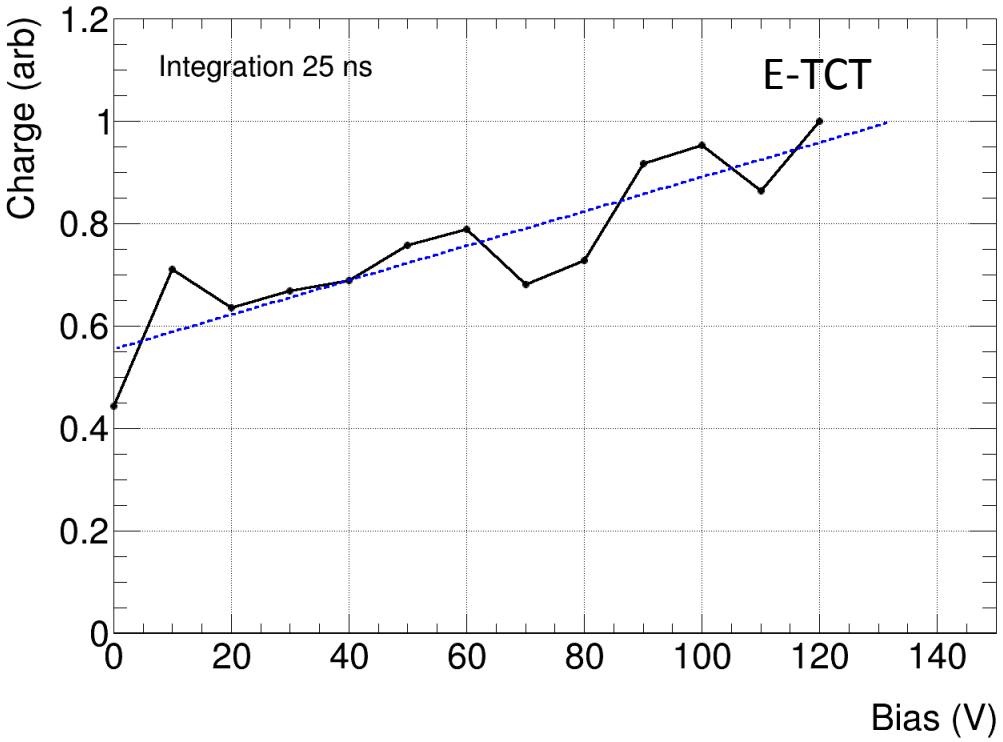
➔ collection region approximately consistent with ~ 2500 electrons measured with Sr90

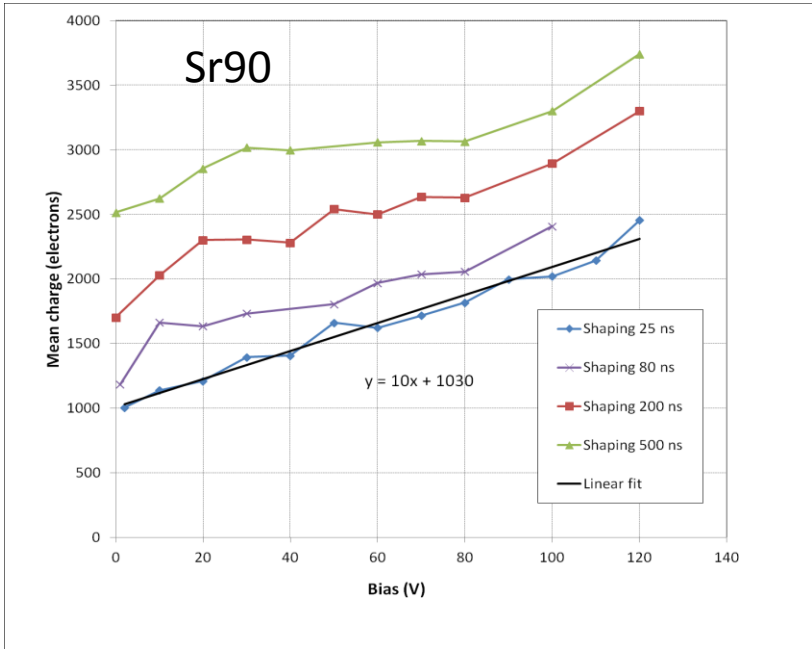
• longer integration, more charge collected deeper in the pixel (diffusion)





• Q : integral of charge profile along *y* (from 10 um to 80 um)



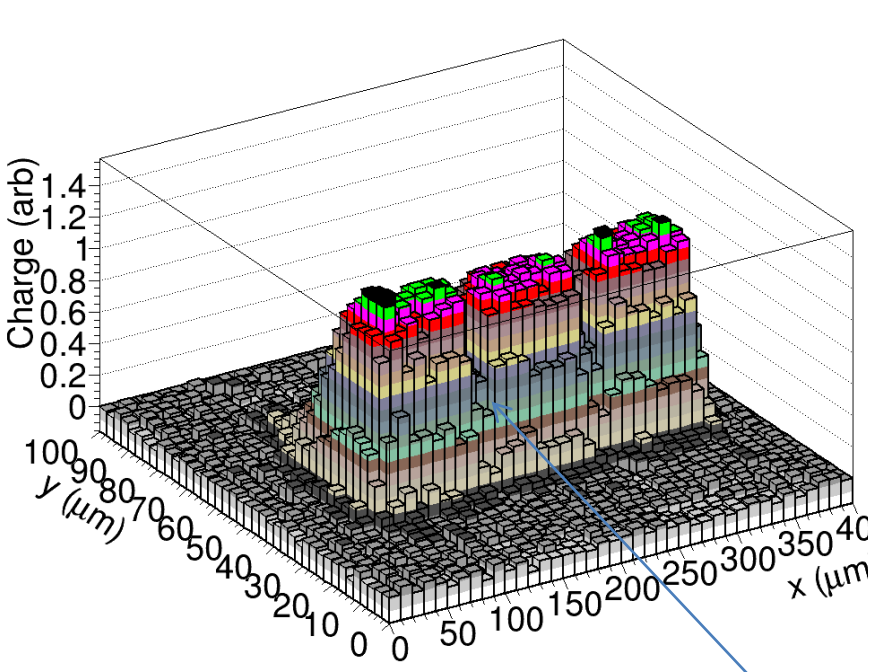


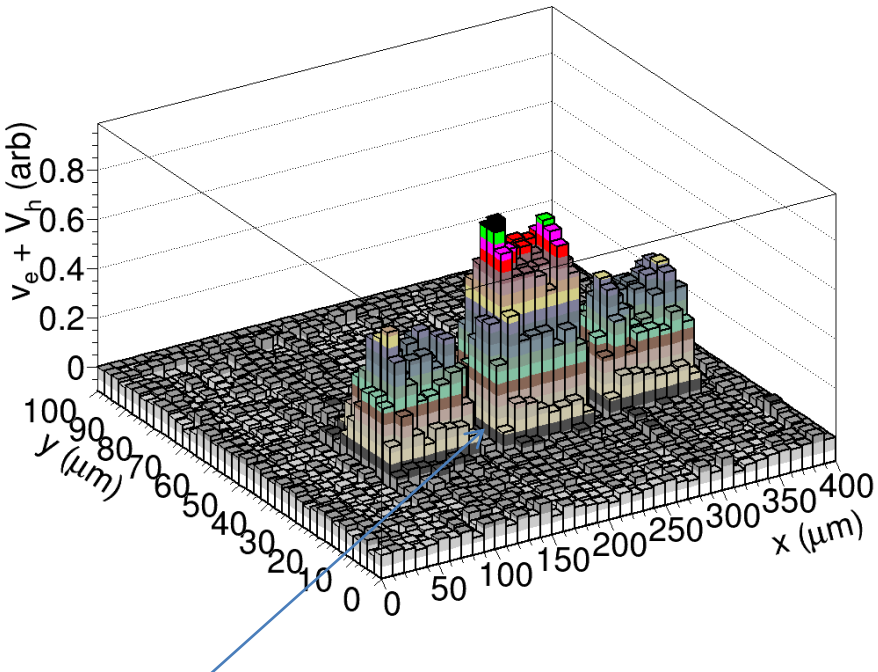
• linear increase of charge with bias

•E-TCT: Charge = 0.56 + 0.0034*Bias [V]

• Sr90 measurement: Charge = 0.46 + 0.0045*Bias[V] (normalized to charge = 1 at 120 V)

• signal + perimeter to readout





Low charge, low field between pixels (~ 10 um wide)

• are low field regions expected?
• are there such regions also in the large passive array?

Future work:

- irradiate Sr90 sample to reach 1e15
- Sr90 measurement with second (E-TCT) sample before irradiation
- irradiate second sample with 2e14, measure E-TCT and Sr90 after irradiation