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Edge TCT Measurements with Chess 1 – Status Update

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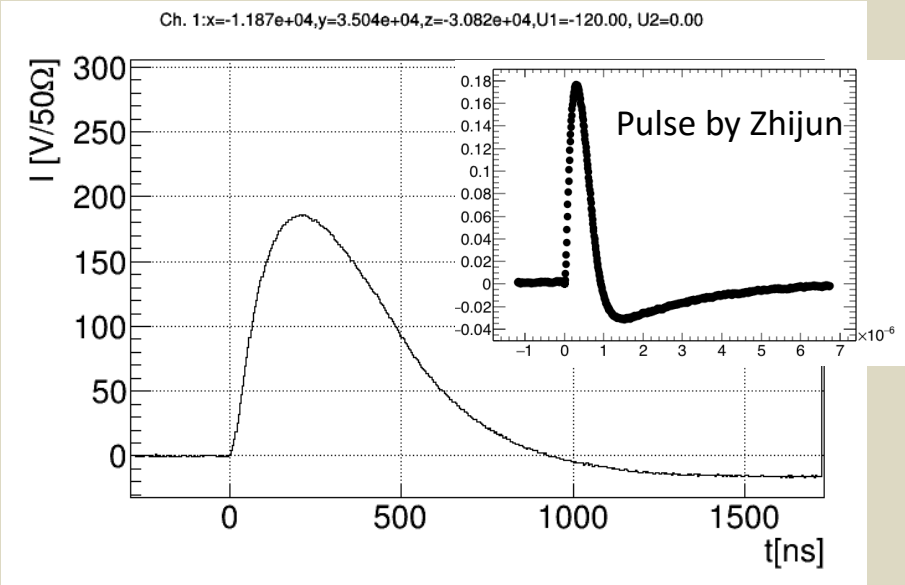
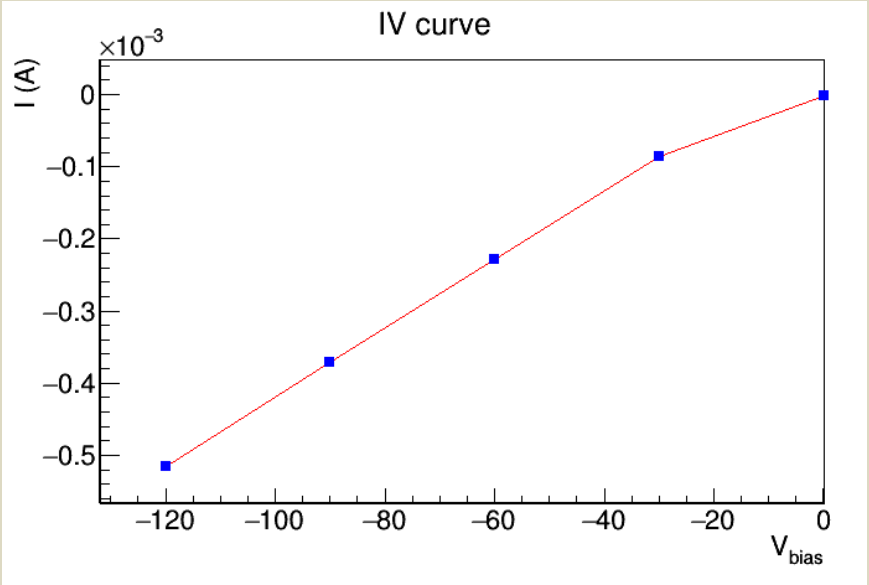
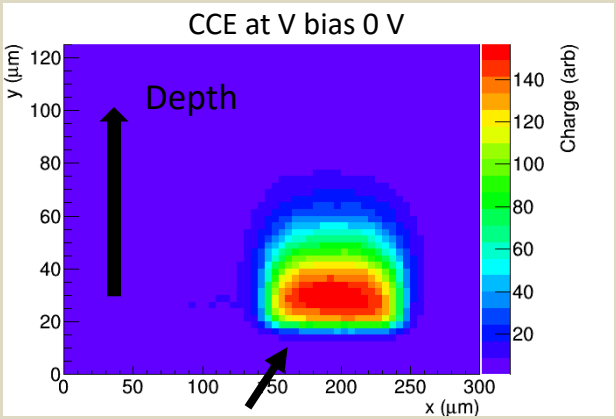
Chess 1 status

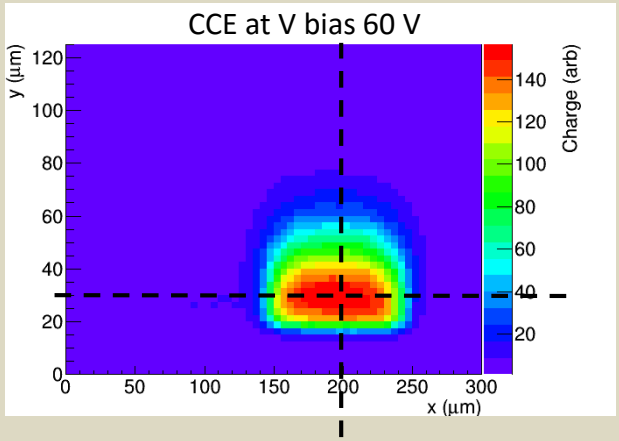
- Chess 1 chip returned from fixing at UCSC (I_{leak}(120 V) = 0.5 mA)
- Remeasured APA02 with bias voltage applied (unirradiated)
  - 3x3 pixel array 100 x 45 µm
  - Two pixels read out (pixel 3 and pixel 4 – motherboard channel 49, 50)
- Pulse shape (config 8)

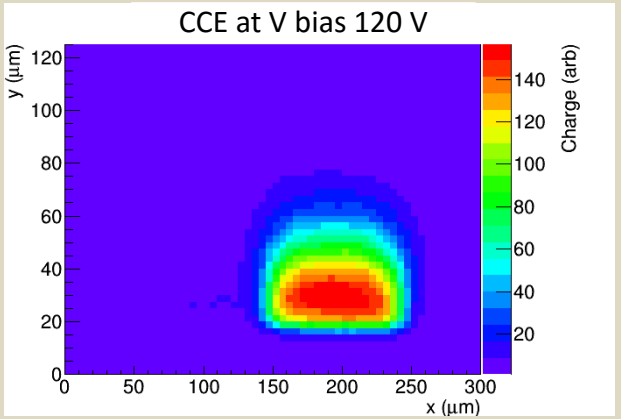




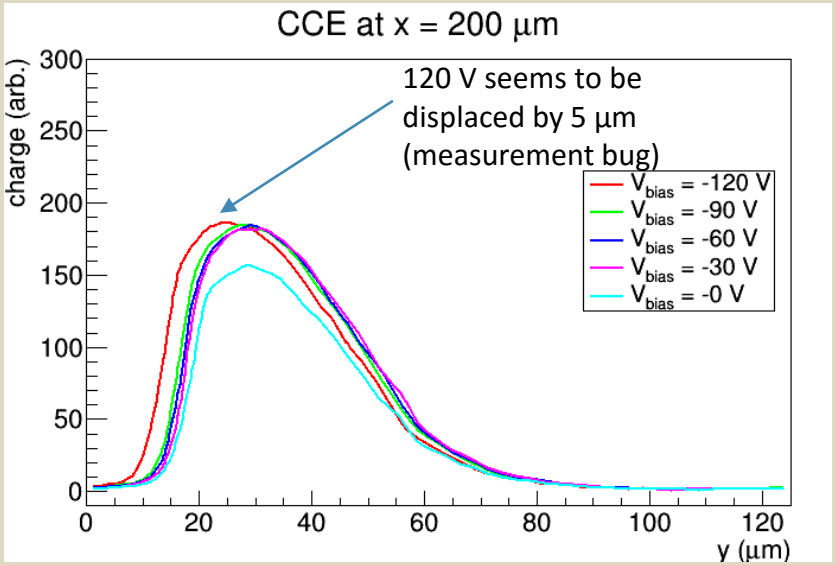
Charge Collection Efficiency (APA02 pix 4)



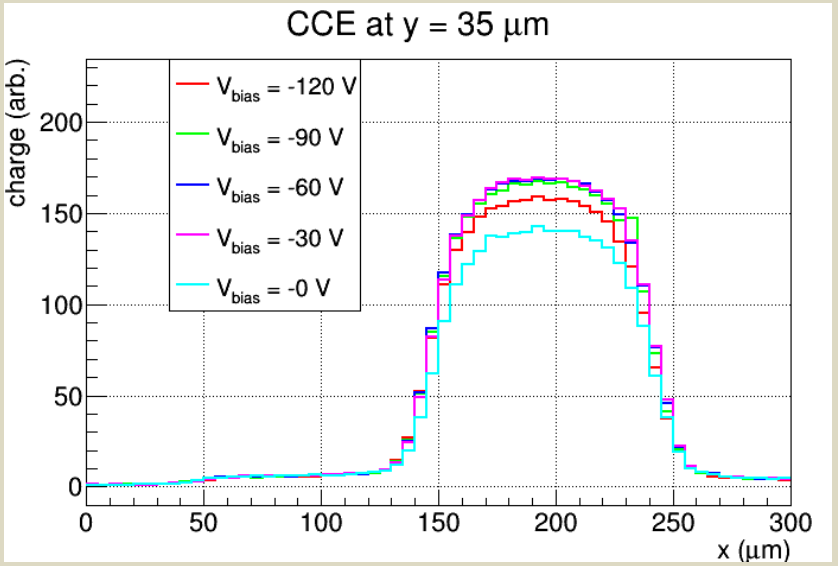




Slice at fixed x (depth profile)

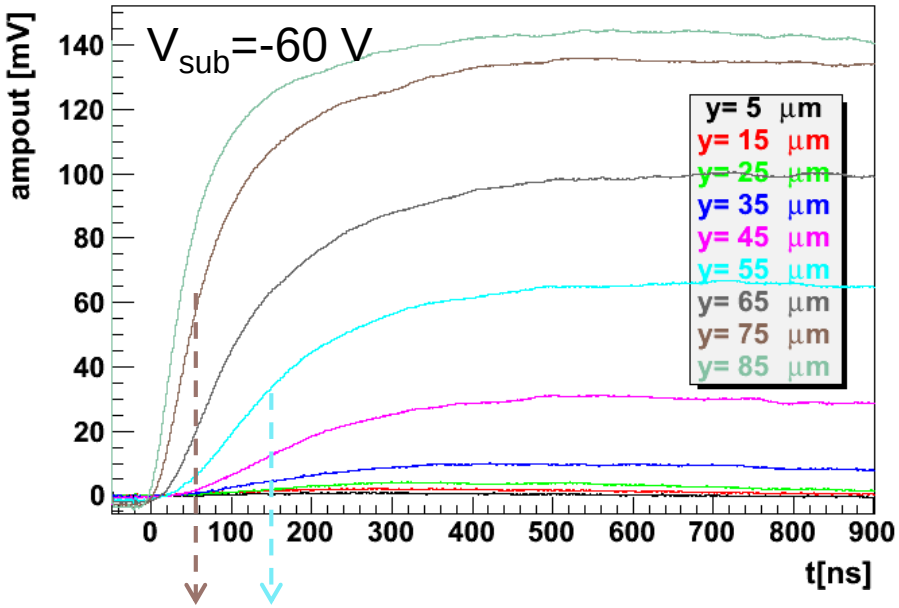


Slice at fixed y (cross profile)

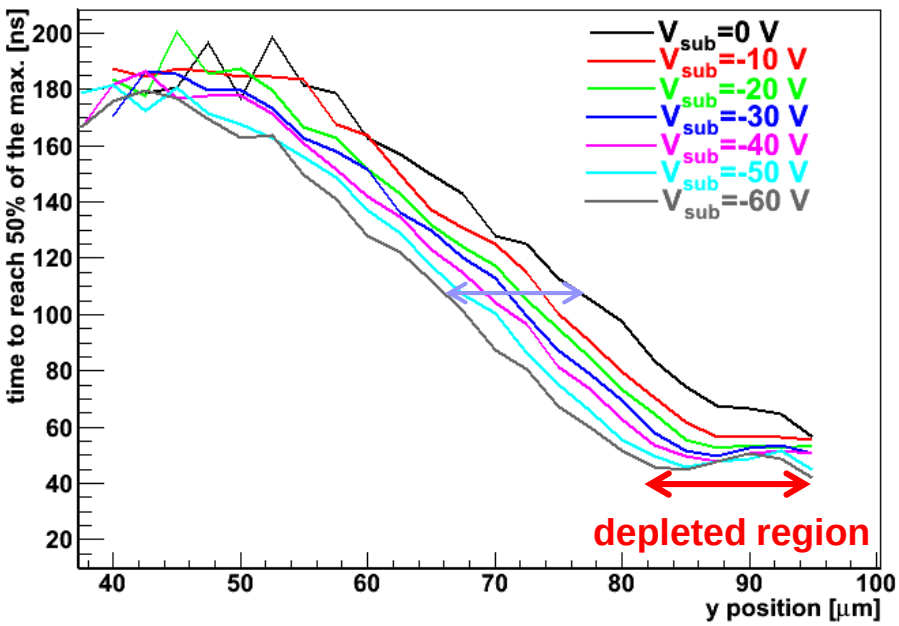


Depletion depth from amplifier curve

x in the middle of the pixel



t_{th} as a function of y position at different voltages



Different times needed to cross 50% of the max charge

Delay needed to cross the “threshold” is mainly due to carriers arriving by diffusion (any contribution from the drift is on this time scale prompt)

Shift in “threshold time” t_{th} with voltage at given y can be used as an indication of the depletion depth.

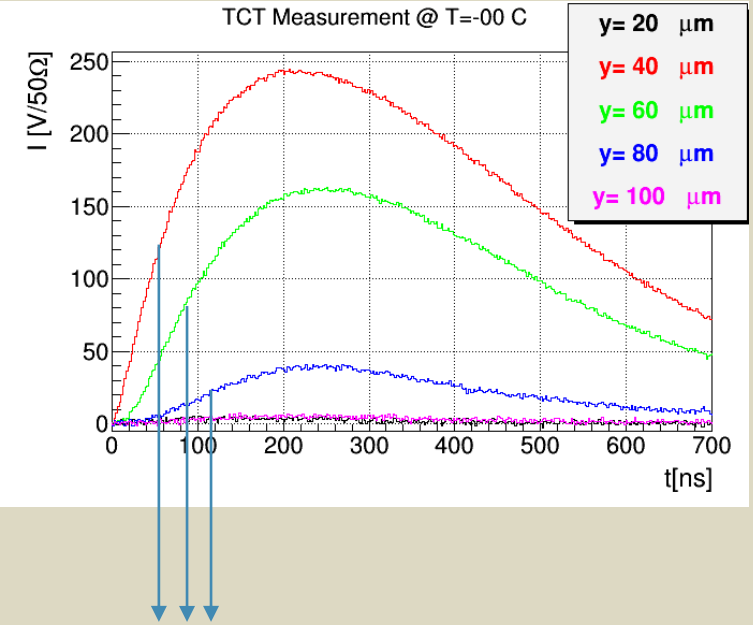
Flat part close to the surface (hockey stick like shape) indicates depleted region:

- at 0 V – hard to estimate – if, only few μm at most
- at 60 V some 10-15 μm

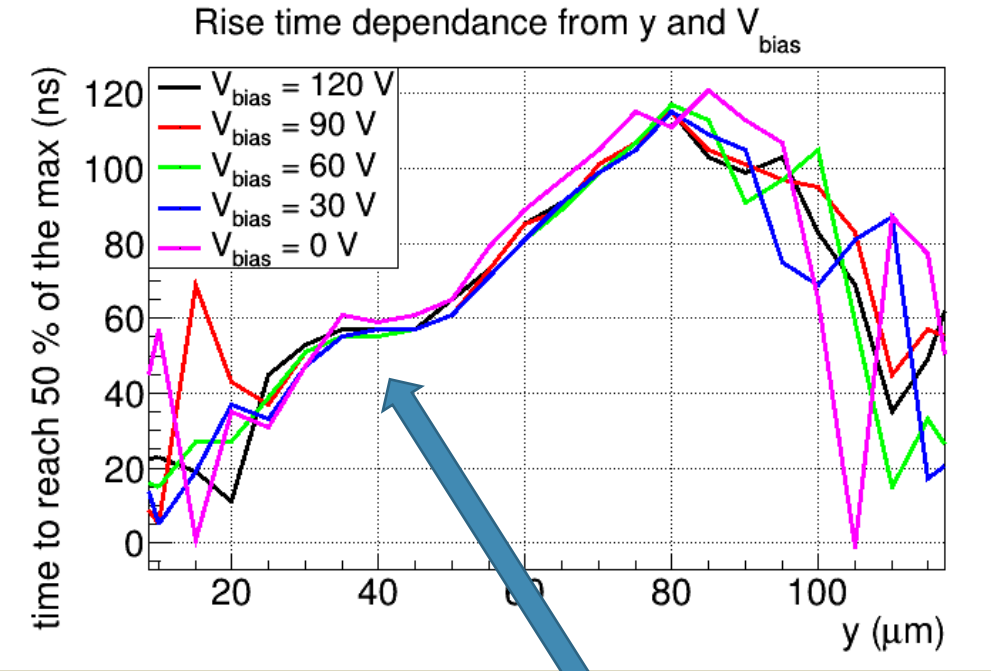
Shift in y-position for the required t_{th} is related to change in the depleted region – less distance for carriers to cross by diffusion. 60 V amounts to around 10 μm of depleted region (blue arrow)

By G. Kramberger, IJS

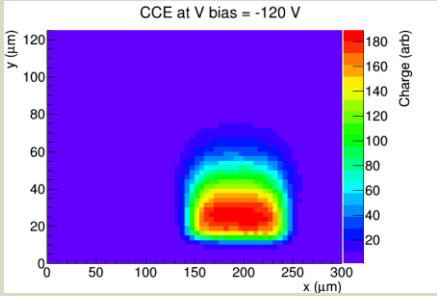
Drift Contribution



Time of crossing the threshold



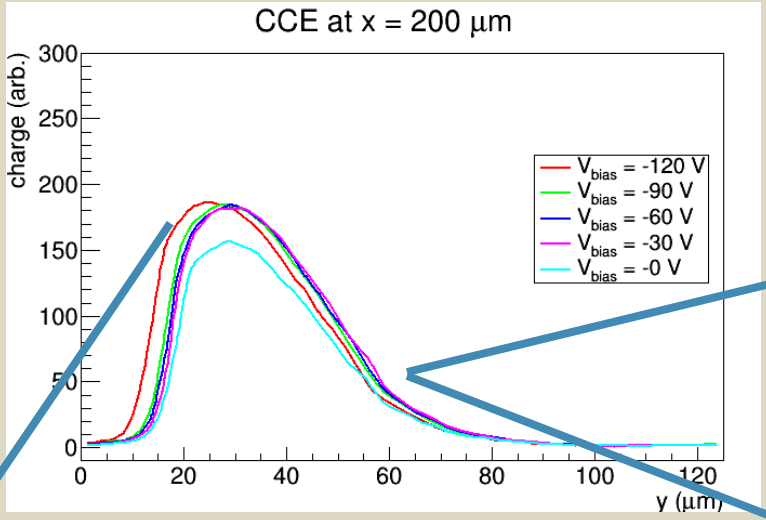
"Hockey stick"

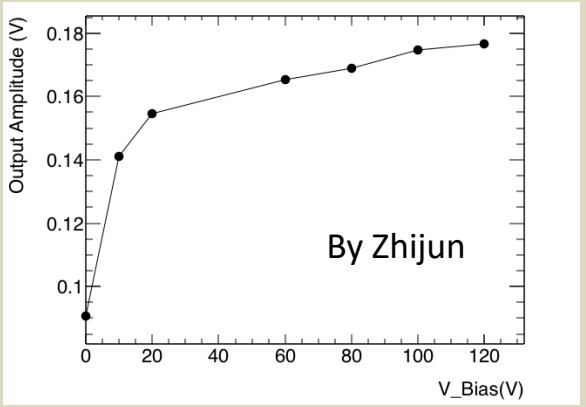


Difficult to observe changes of the depletion depth

Maybe more significant measurements of depletion depth from irradiated samples (low diffusion)

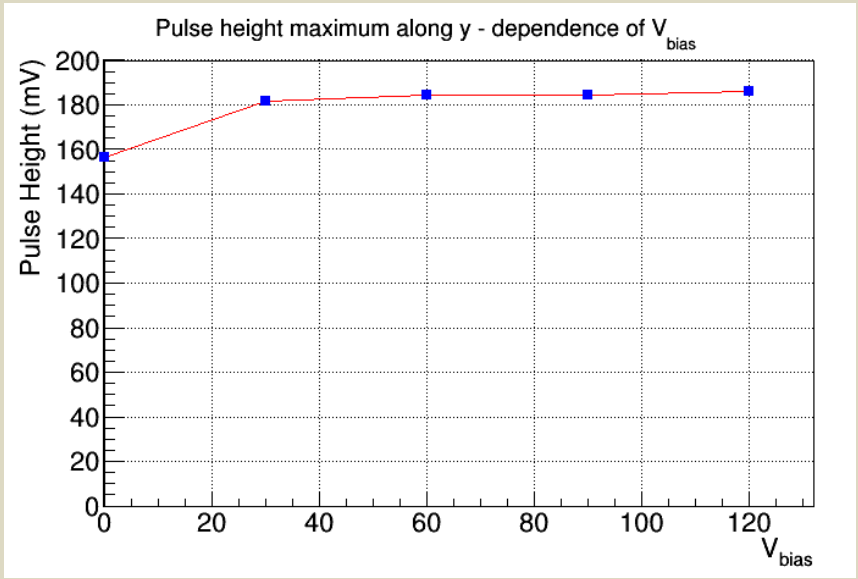
Pulse Height dependence from V_{bias}

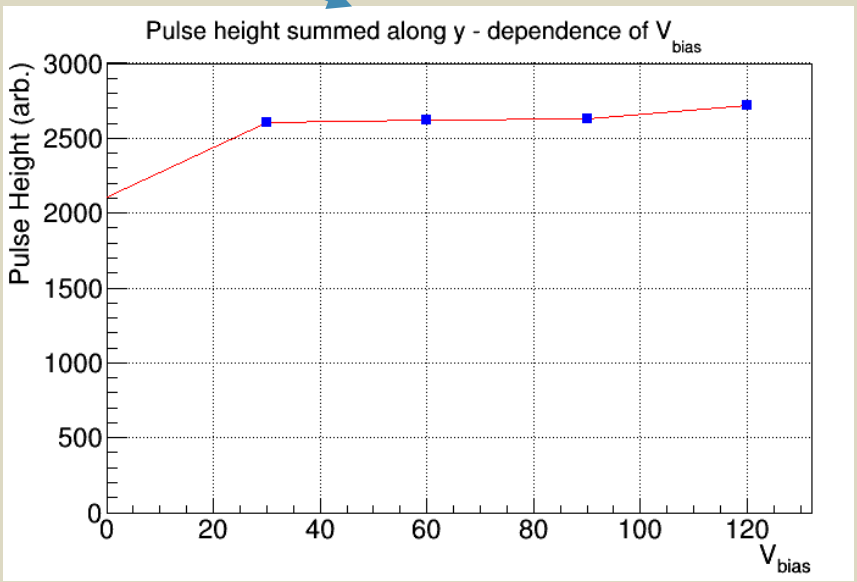




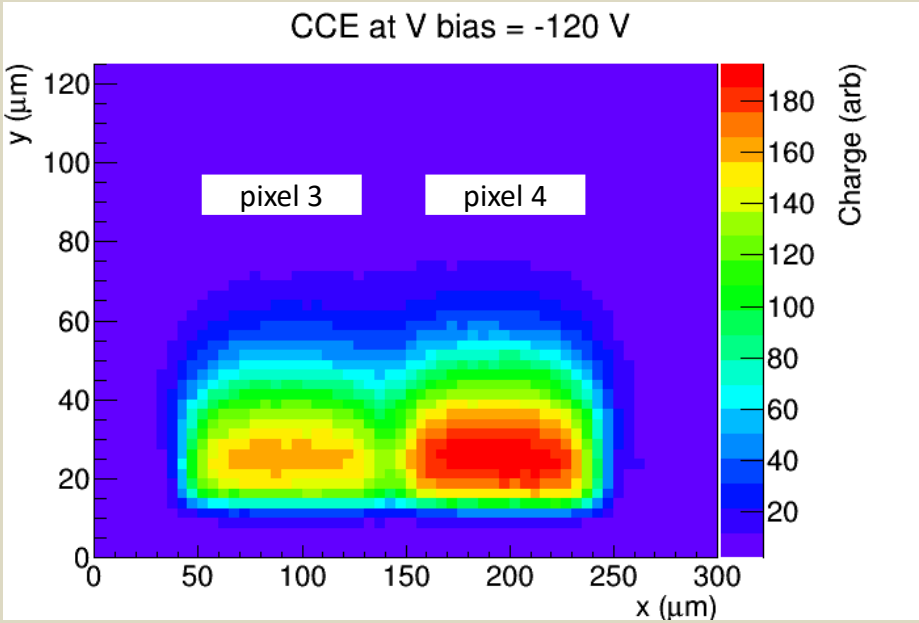
Method 1:
Maximum pulse height at any y

Method 2:
Integral along y of all pulses
Rough simulation of top TCT





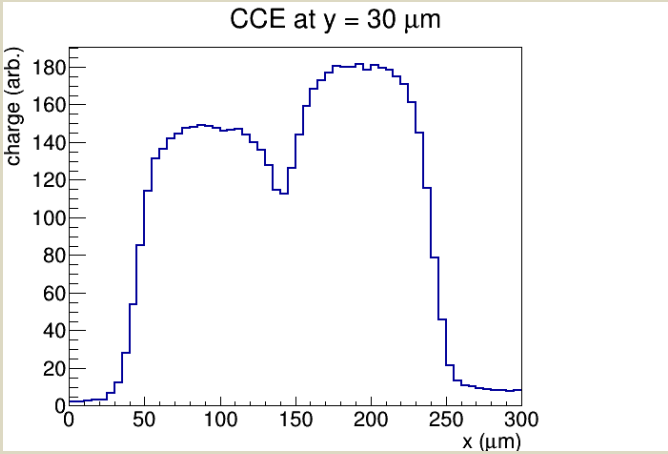
Two pixels combined



3	6	9
2	5	8
1	4	7

Beam direction

cross section



Difference in the amount of collected charge comes from absorption in silicon
(l = 1 mm for λ = 1064 mm)

Summary

- Measured charge collection efficiency in APA02 by e-TCT
  - Diffusion is dominant charge collection mechanism
  - Only a small influence of V_{bias} on pulse height – less than expected (significant between $V_{bias} = 0$ V and $V_{bias} \neq 0$ V)
  - Difficult to estimate depletion depth
- Next steps:
  - Repeat the tests on APA08
  - Comparison to proton irradiated chips