LHCb VeloPixel fast simulation

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TIMESPOT meeting - WP4

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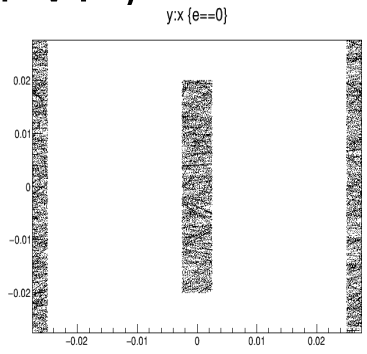
TIMESPOT sensor - simulation

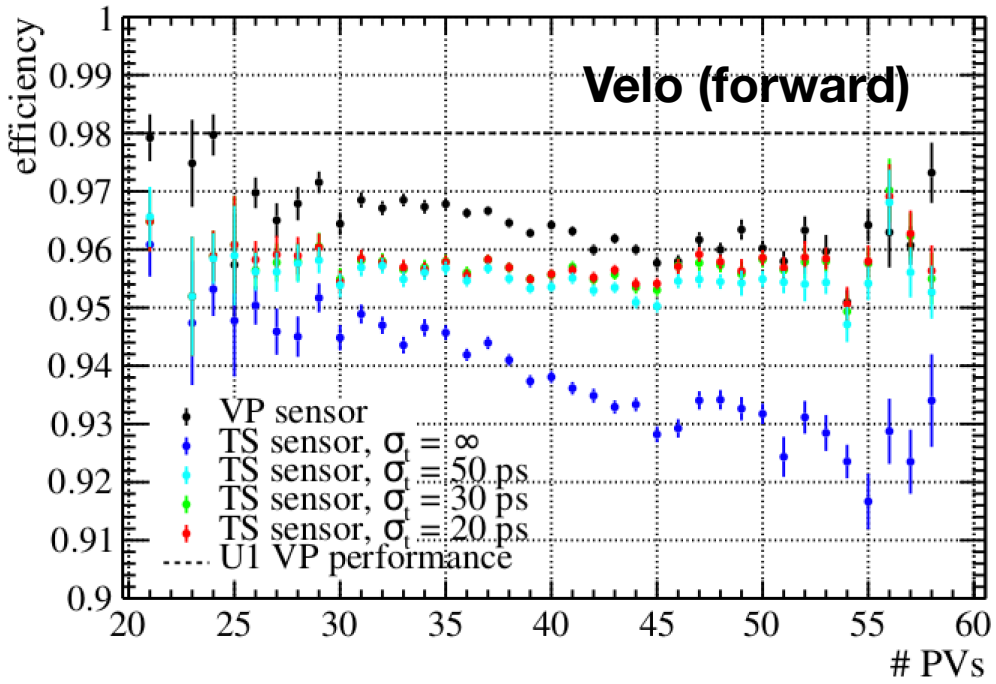
- Input: MChits from full simulation with VeloPixel (VP) where the Multiple Scattering is embedded

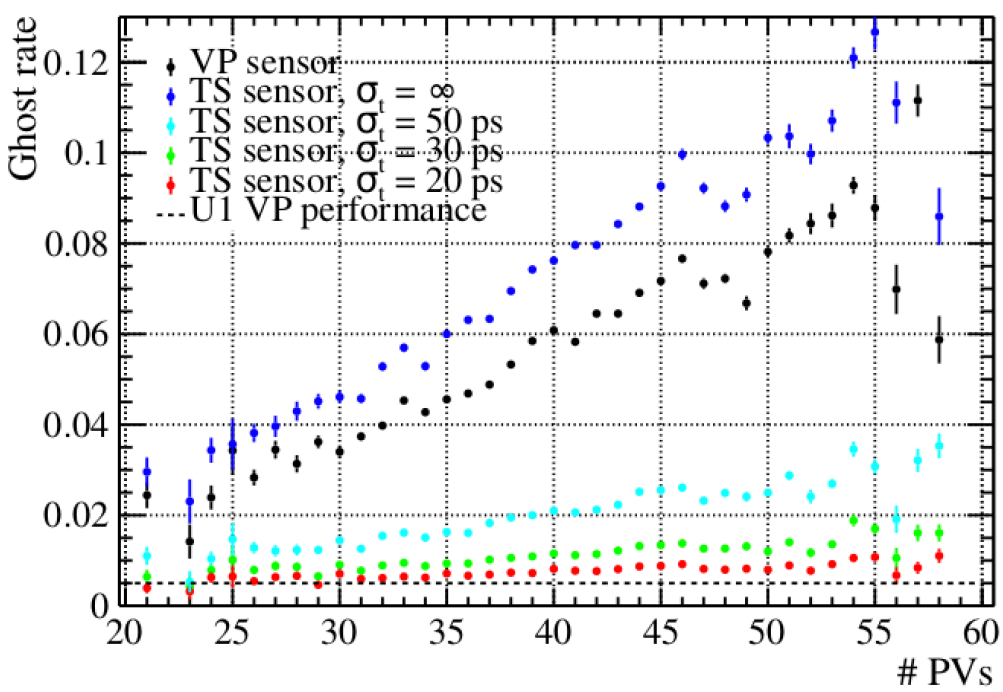
- Deposited charge taken from MCHit. Rescaled and distributed on the sensor pixels, and digitized considering the TIMESPOT (TS) sensor:
  - trench = 5x40 + **5x55** mum2 in XY (vs none in VP)
  - depth = 150 mum (vs 200 mum in VP)
  - noise = 300 e- (vs 130e- in VP)
  - threshold = 1500 e- (vs 1000e- in VP)
  - No diffusion in XY
  - Alignment of the trench with the pixel position
  - time resolution = 20,30,50 ps



Performances

Upgrade I	εVELO(%)	PGHOST(%)
VP No timing	98.0	0.5





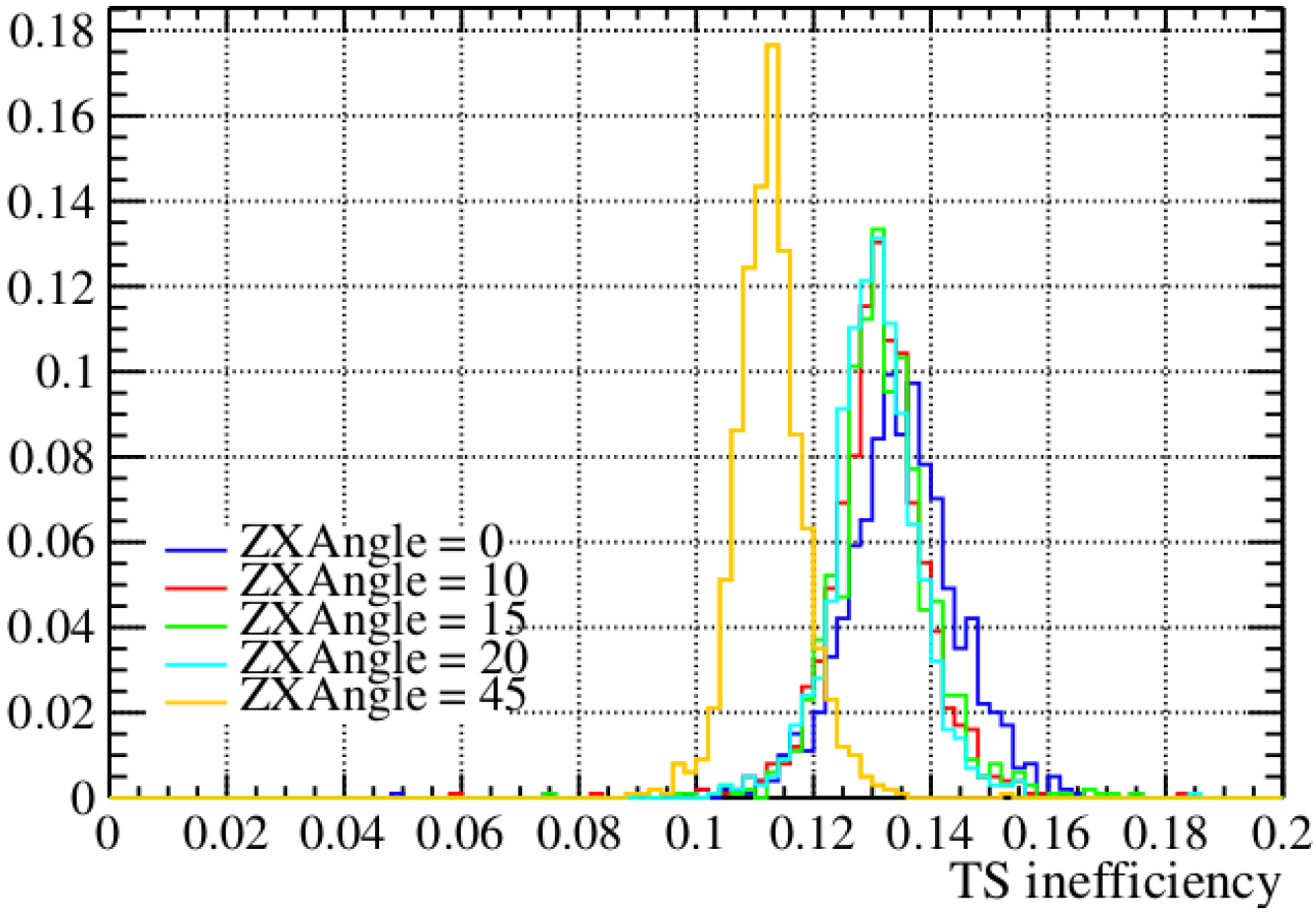
- Targeting Upgrade I VP performances
  Efficiency lower than U1
  Ghostrate comparable with U1
  -> exploding different tilting angles
  to improve efficiency

Upgrade II	εVELO(%)	PGHOST(%)
TIMESPOT σ_t = 20 ps	95.6	0.7
TIMESPOT σ_t = 30 ps	95.6	1.1
TIMESPOT σ_t = 50 ps	95.4	2.0
VP No Timing	96.4	5.6

TS inefficiency on pixels (onlyFORWARD)

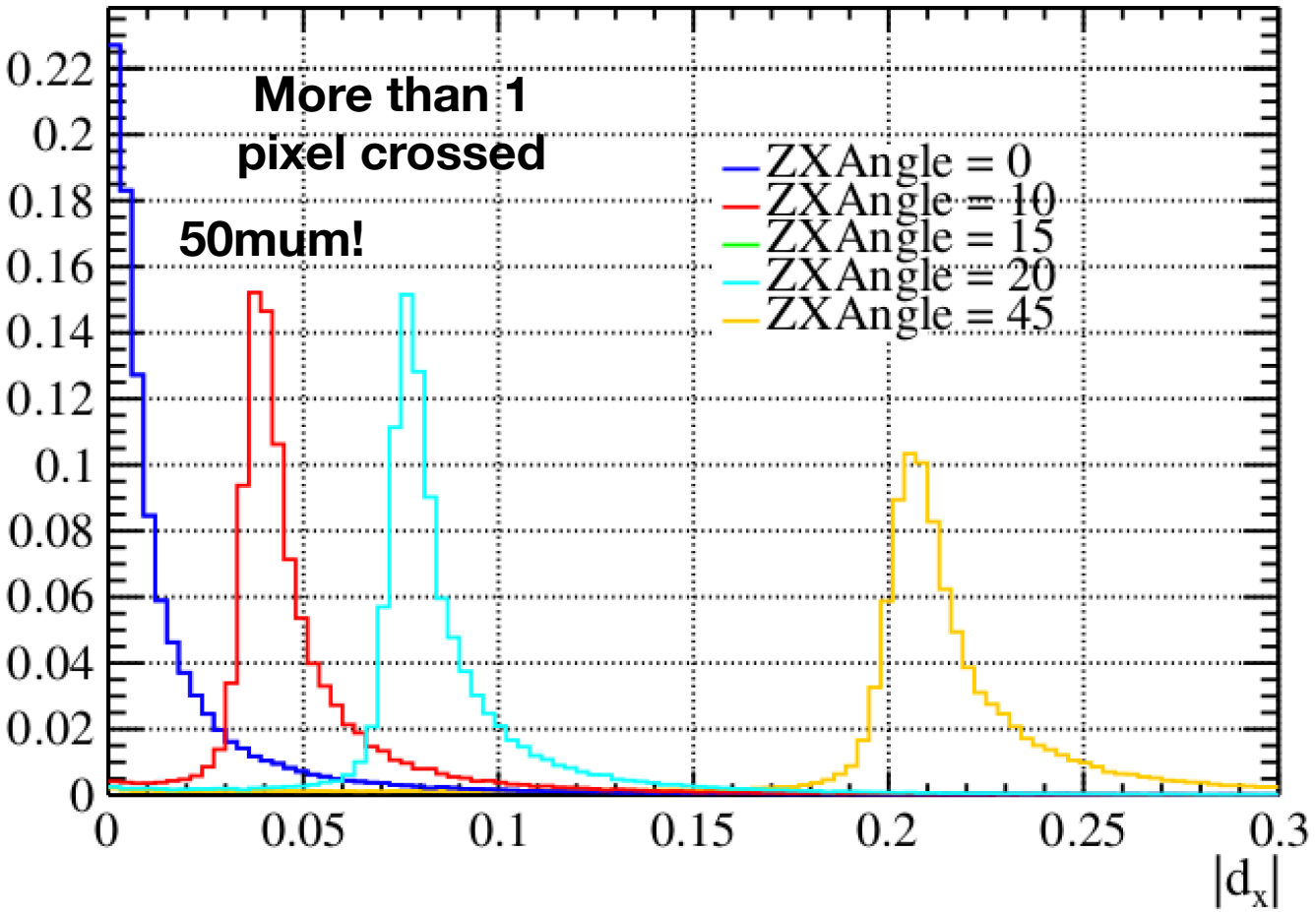
- Np = N active pixels

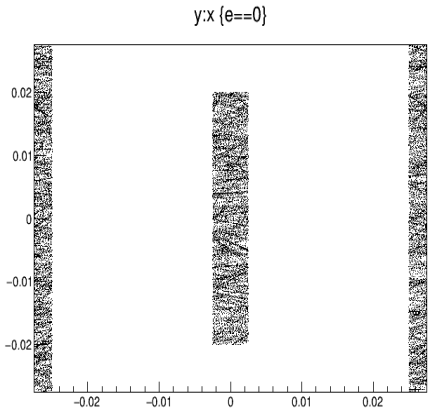
$$1 - \epsilon_{TS};\ with\ \epsilon_{TS} = \frac{N_p^{TS}}{N_p^{VP}}$$



Caveat: In addition to trenches VP and TS have different configurations (noise, threshold, thickness,…)

d_X(onlyFORWARD)



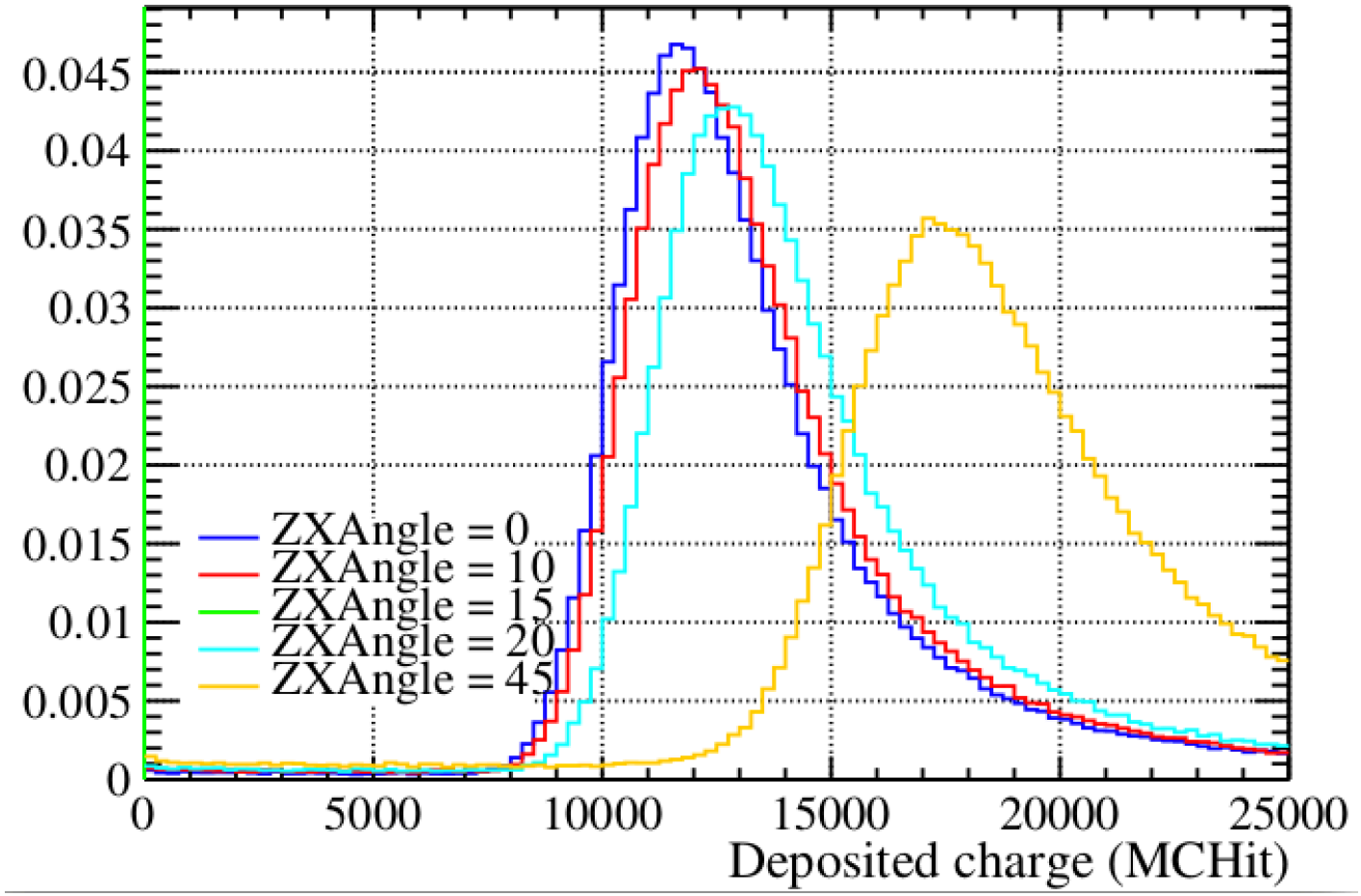


55mum width!!

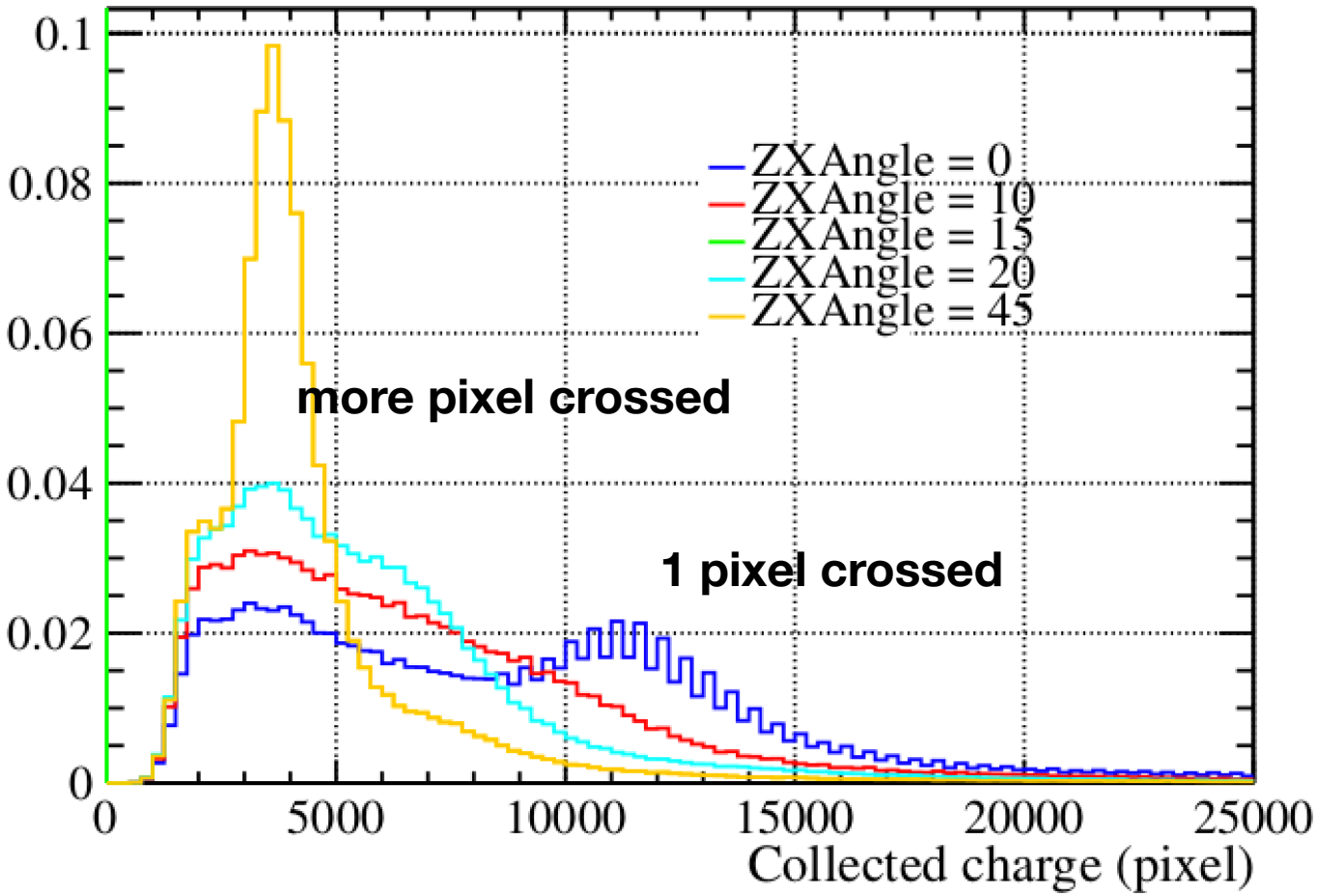
Smaller angles could be enough!

Deposited charge charge (onlyFORWARD)

MS effects expected to be negligible for small angles

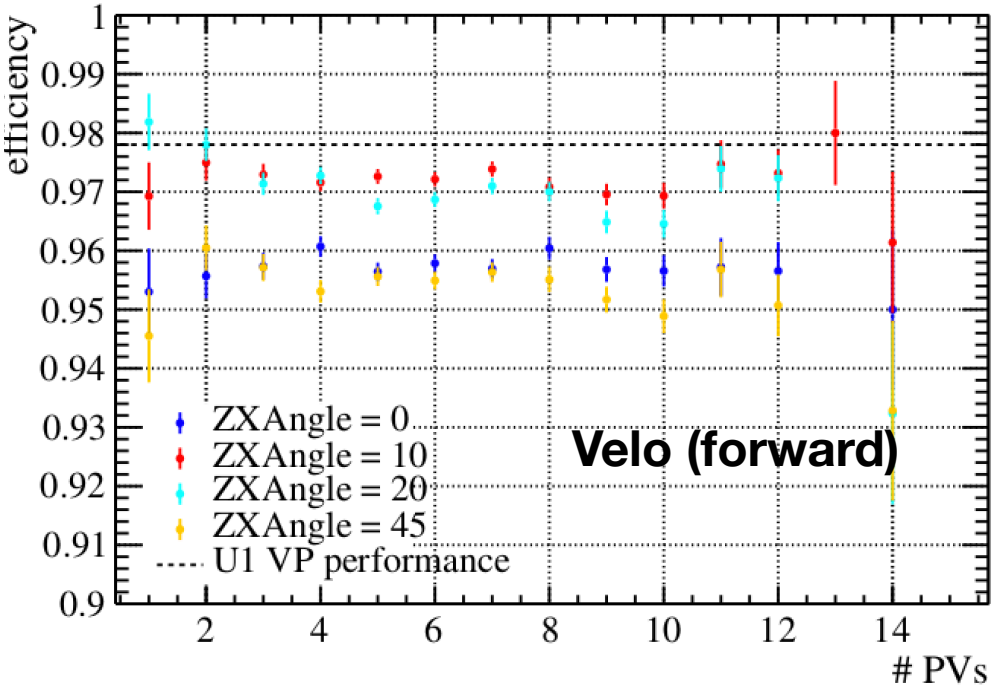


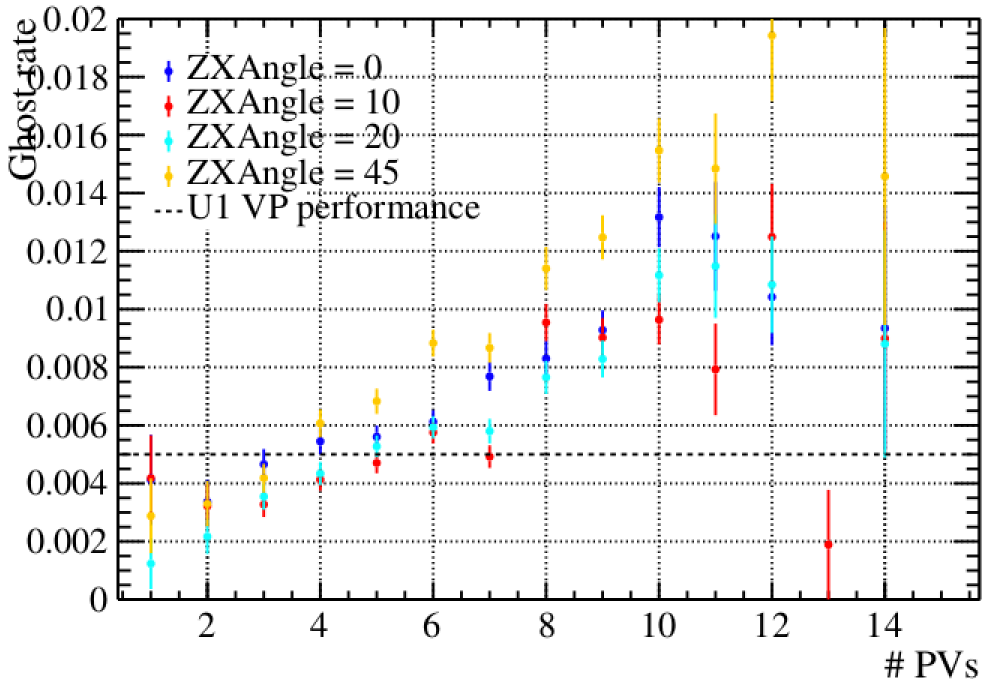
Collected charge (onlyFORWARD)



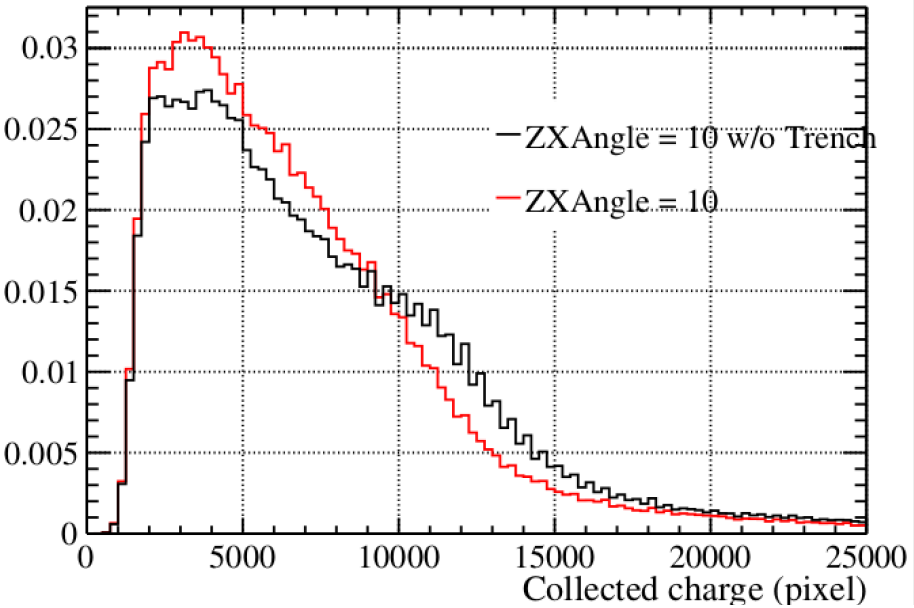
Exploring different tilting angles (in XZ) to increase efficiency

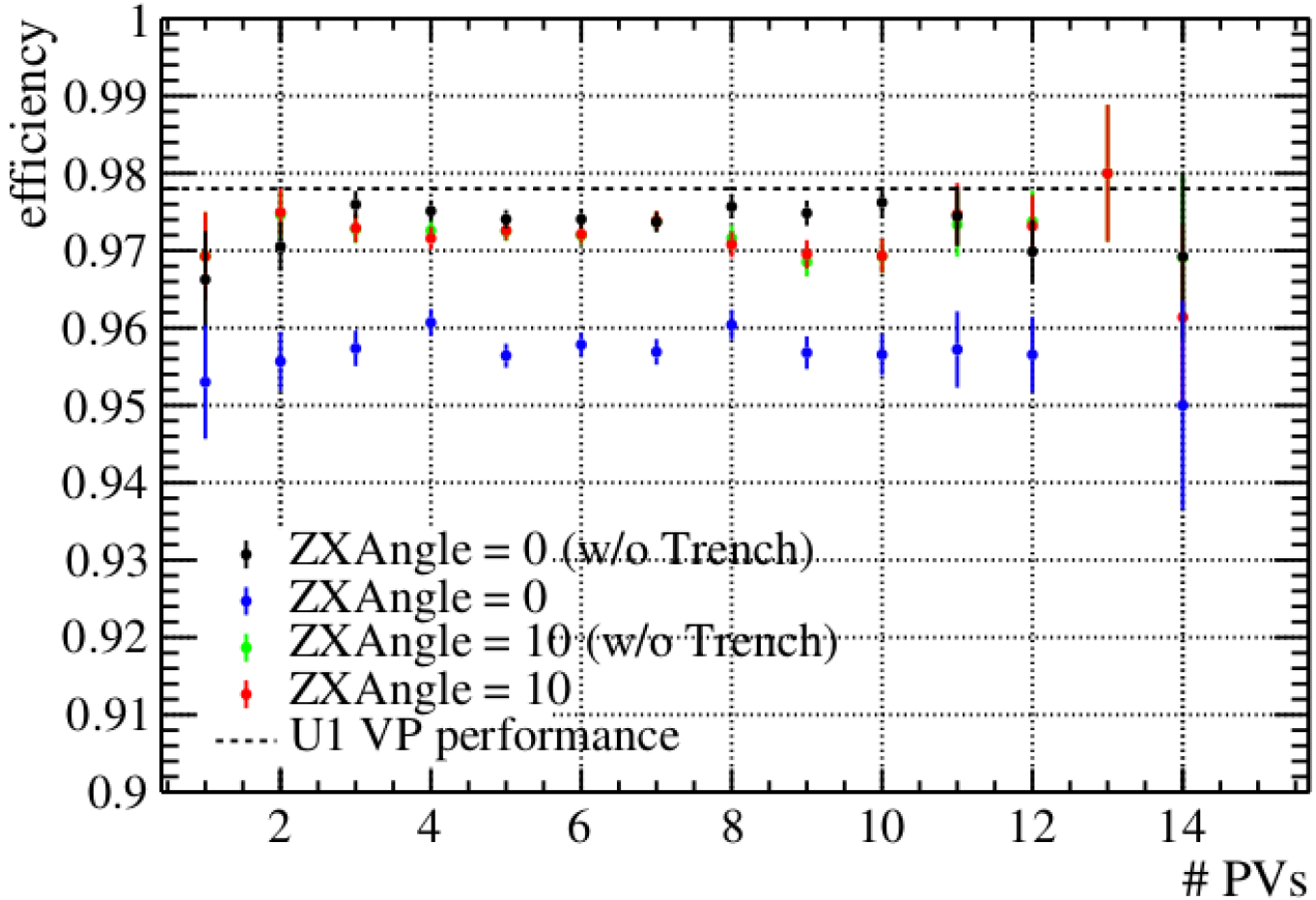
- Considering the TS sensor with no timing





- It seems that improvements can be found with tilting angles lower than 10°, ie [1°,3°,5°] possibly in U2 scenario!


ZXAngle = 10 w/o Trench
ZXAngle = 10
Collected charge (pixel)


efficiency
ZXAngle = 0 (w/o Trench)
ZXAngle = 0
ZXAngle = 10 (w/o Trench)
ZXAngle = 10
U1 VP performance
PVs