LHCb VeloPixel fast simulation

Serena Maccolini, Angelo Carbone

TIMESPOT meeting - WP4

8 July 2021

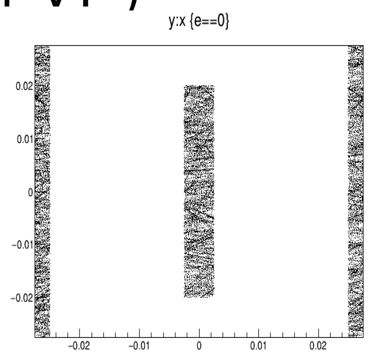
serena.maccolini@cern.ch

University of Bologna and INFN Bologna

TIMESPOT sensor - simulation

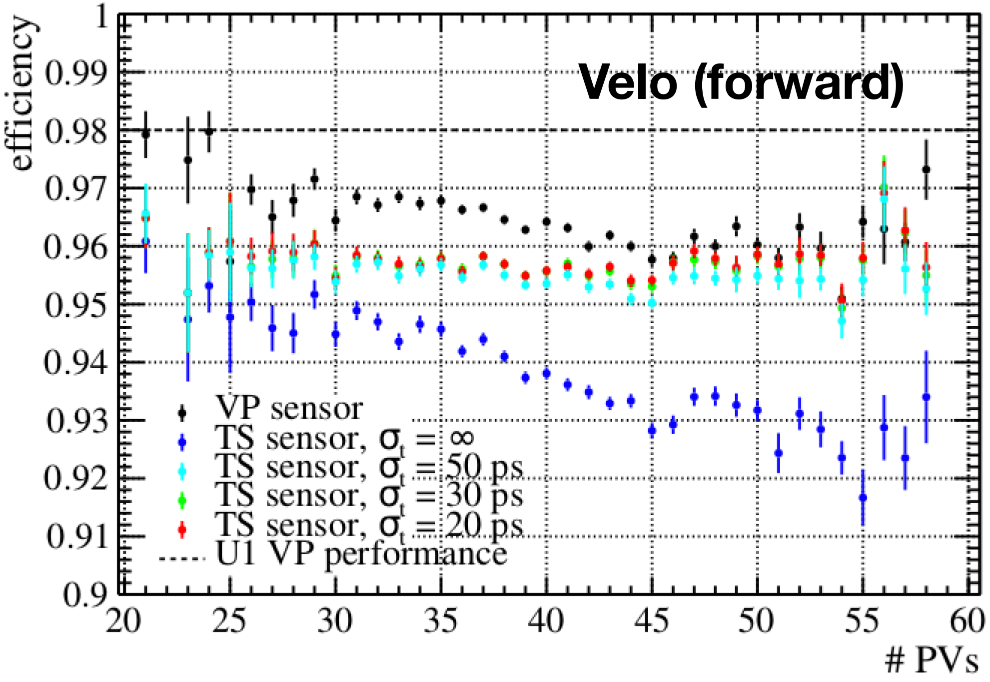
- Input: MChits from full simulation with VeloPixel (VP) where the Multiple Scattering is embedded

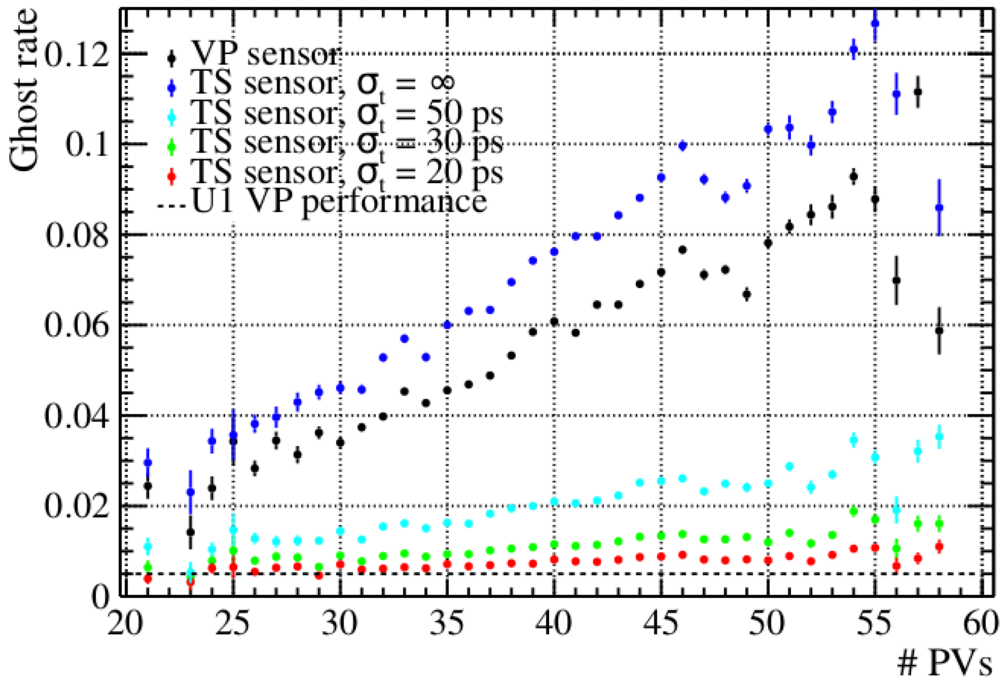
- Deposited charge taken from MCHit. Rescaled and distributed on the sensor pixels, and digitized considering the TIMESPOT (TS) sensor:
  - trench = 5x40 + **5x55** mum2 in XY (vs none in VP)
  - depth = 150 mum (vs 200 mum in VP)
  - noise = 300 e- (vs 130e- in VP)
  - threshold = 1500 e- (vs 1000e-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



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

Performances



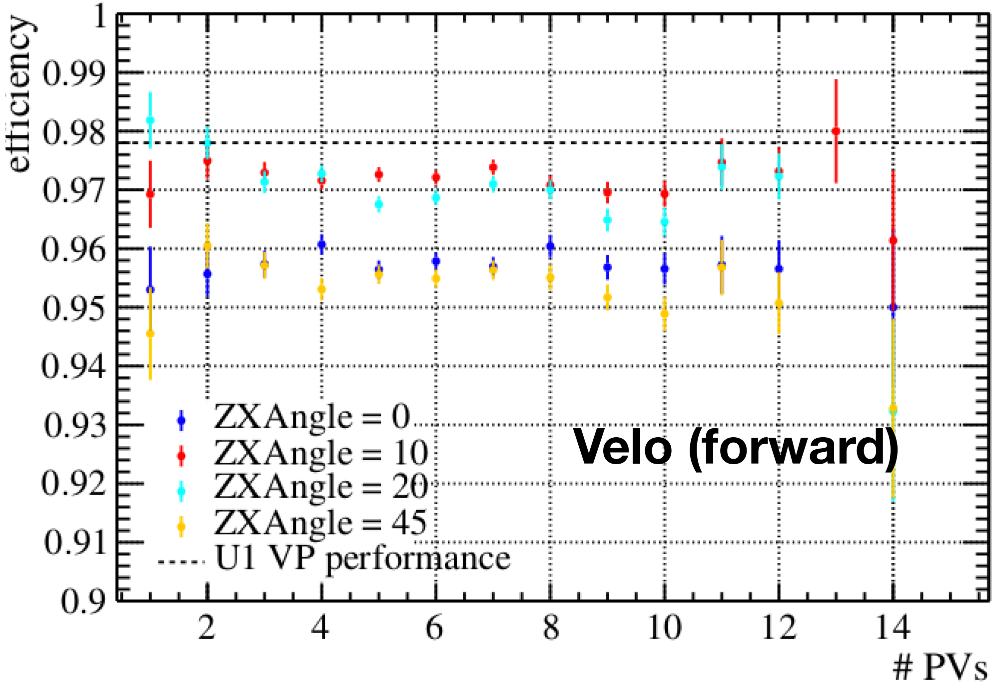


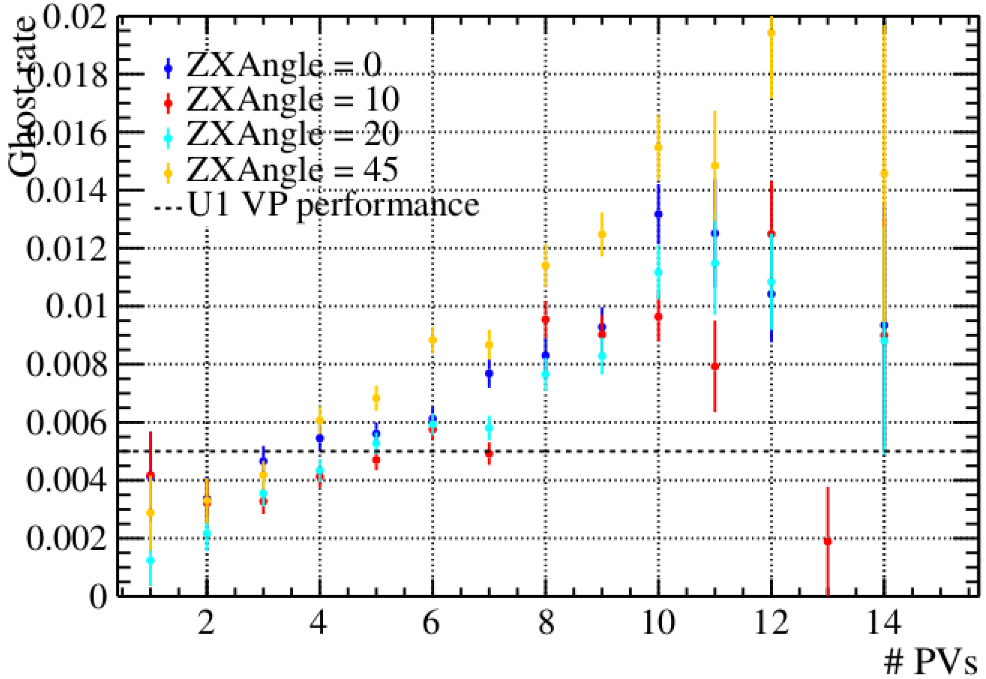
- Targeting Upgrade I VP performances
  Efficiency lower than U1
  Ghostrate comparable with U1
  -> exploding different tilting angles
  to improve efficiency

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

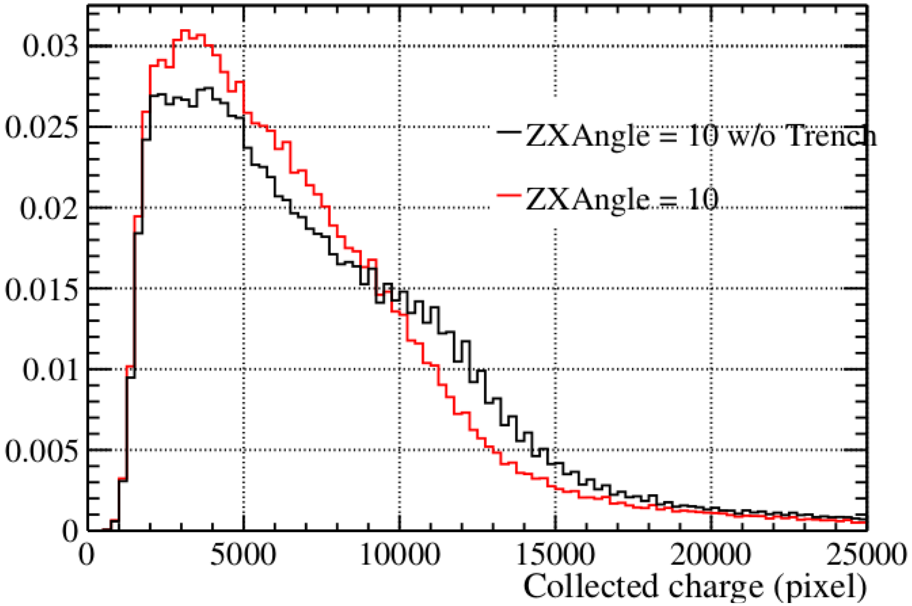
Exploring different tilting angles (in XZ) to increase efficiency

- Considering the TS sensor with no timing

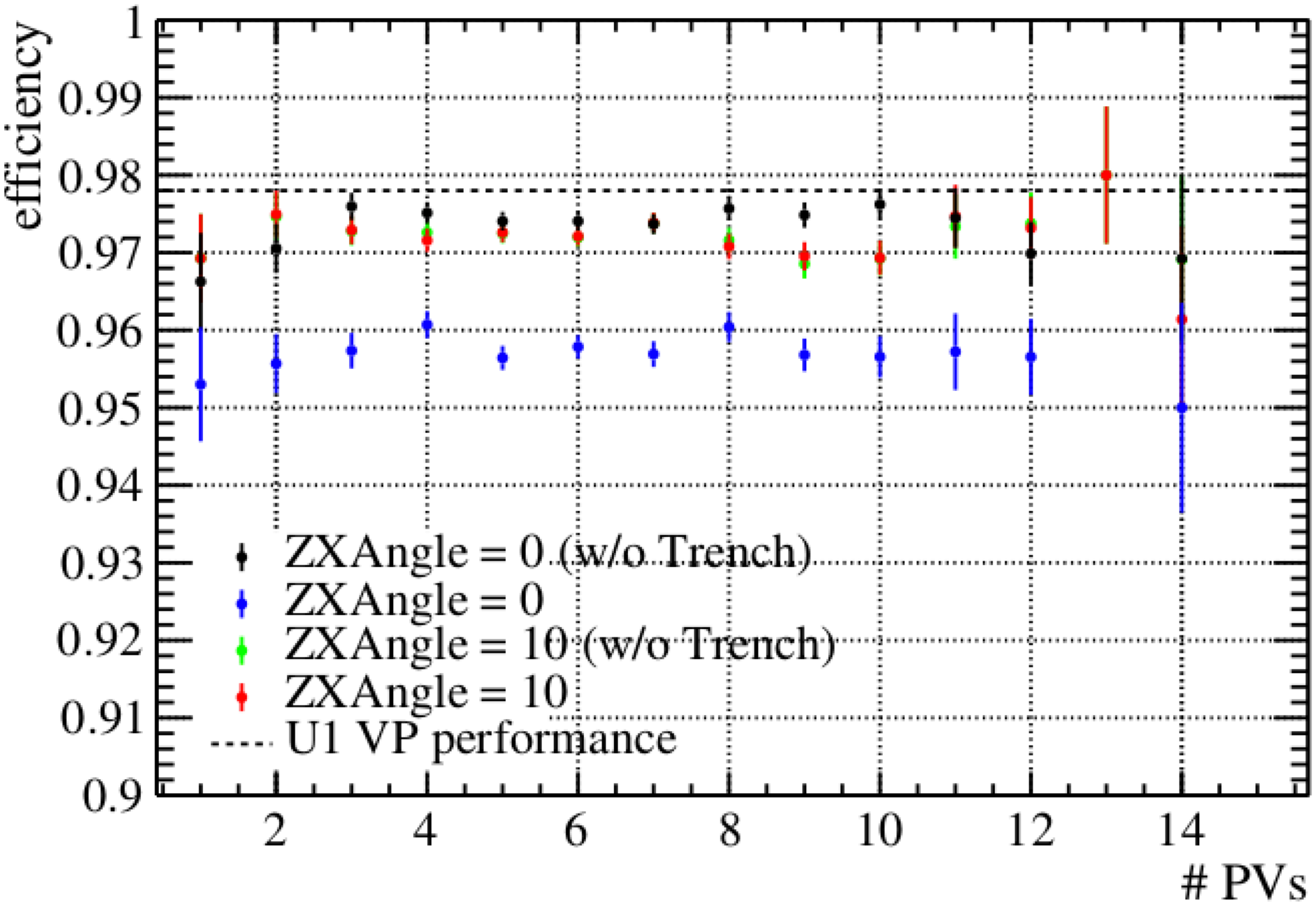




- It seems that improvements can be found with tilting angles lower than 10°, ie [1°,3°,5°] possibly in U2 scenario!

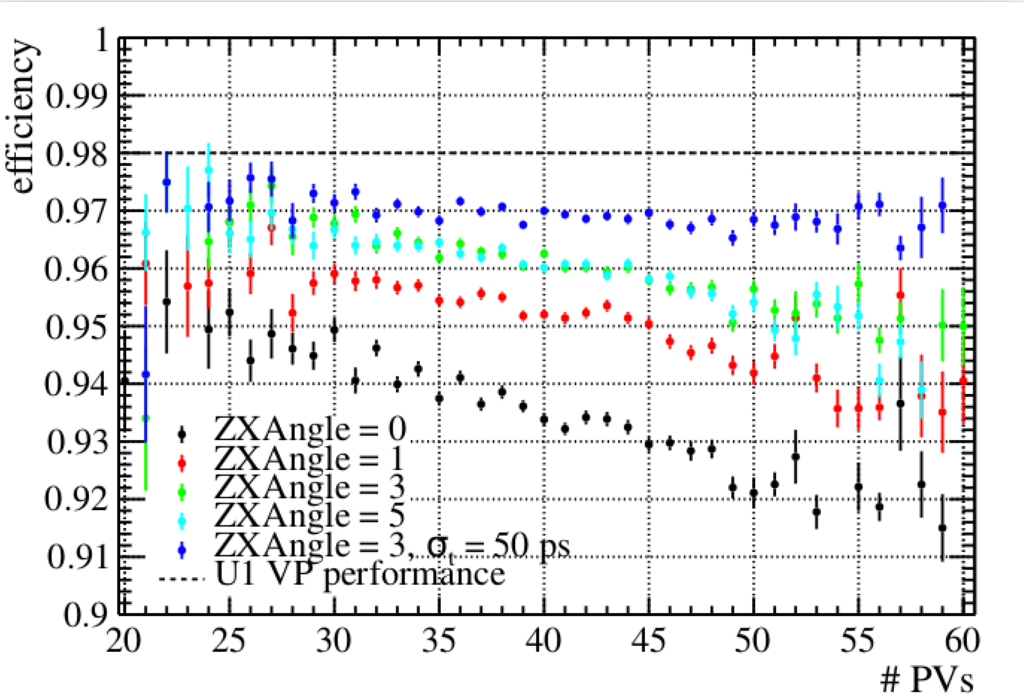


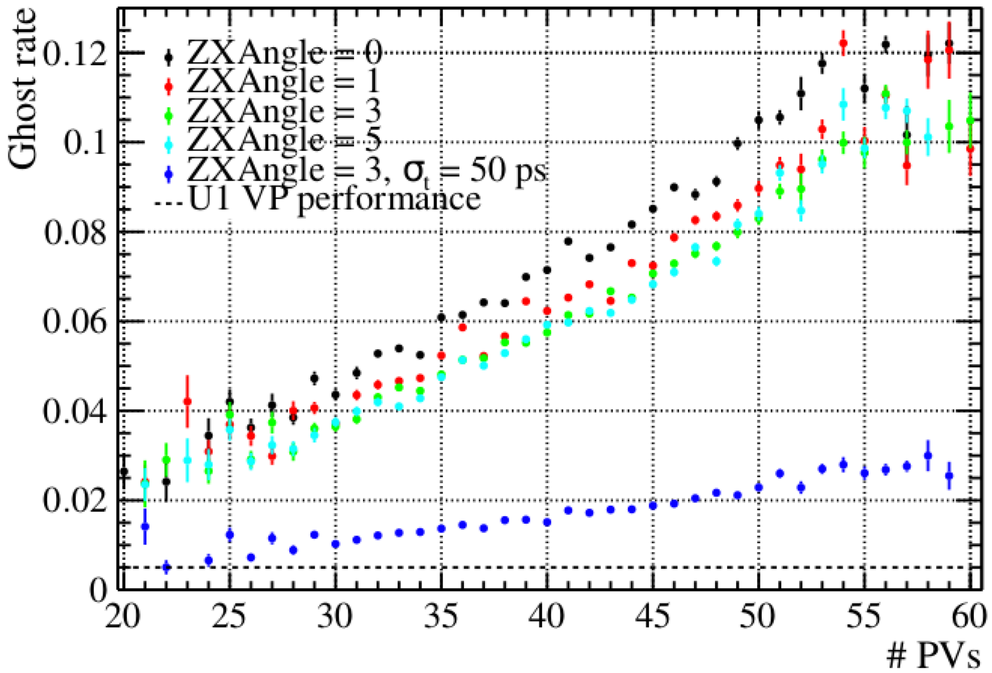
0.03
0.025
0.02
0.015
0.01
0.005
0
0
5000
10000
15000
20000
25000
Collected charge (pixel)
ZXAngle = 10 w/o Trench
ZXAngle = 10



efficiency
1
0.99
0.98
0.97
0.96
0.95
0.94
0.93
0.92
0.91
0.9
2
4
6
8
10
12
14
# PVs
ZXAngle = 0 (w/o Trench)
ZXAngle = 0
ZXAngle = 10 (w/o Trench)
ZXAngle = 10
U1 VP performance

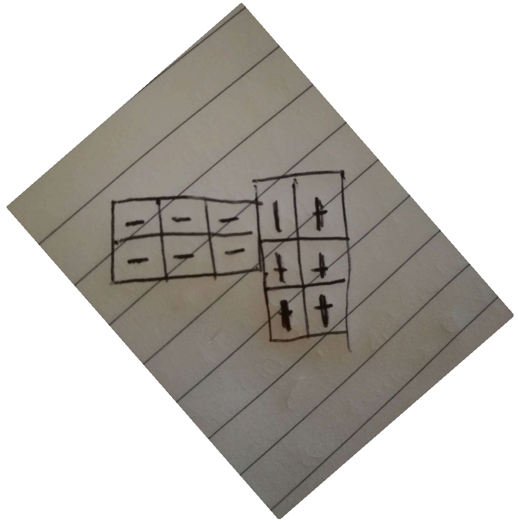
U2


efficiency
1
0.99
0.98
0.97
0.96
0.95
0.94
0.93
0.92
0.91
0.9
20
25
30
35
40
45
50
55
60
# PVs
ZXAngle = 0
ZXAngle = 1
ZXAngle = 3
ZXAngle = 5
ZXAngle = 3, σt = 50 ps
U1 VP performance


Ghost rate
0.12
0.1
0.08
0.06
0.04
0.02
0
20
25
30
35
40
45
50
55
60
# PVs
ZXAngle = 0
ZXAngle = 1
ZXAngle = 3
ZXAngle = 5
ZXAngle = 3, σt = 50 ps
U1 VP performance

Concernings

- Non 100% optimized (L-shaped modules instead of C-shaped modules)
- Marco: same chip in the vertical and horizontal sensors of the module



- Improve timing algorithm (?)
- Test other angles? Maybe 2°