CPEC Tracking System Optimization

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On behalf of the CEPC Tracker Team

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Contents

1. Main tool changed

LDT in Matlab → Python program

1. Research stage one

No drift chamber

6 pixels

1 VTX-shell

5 CMOS

How to optimize

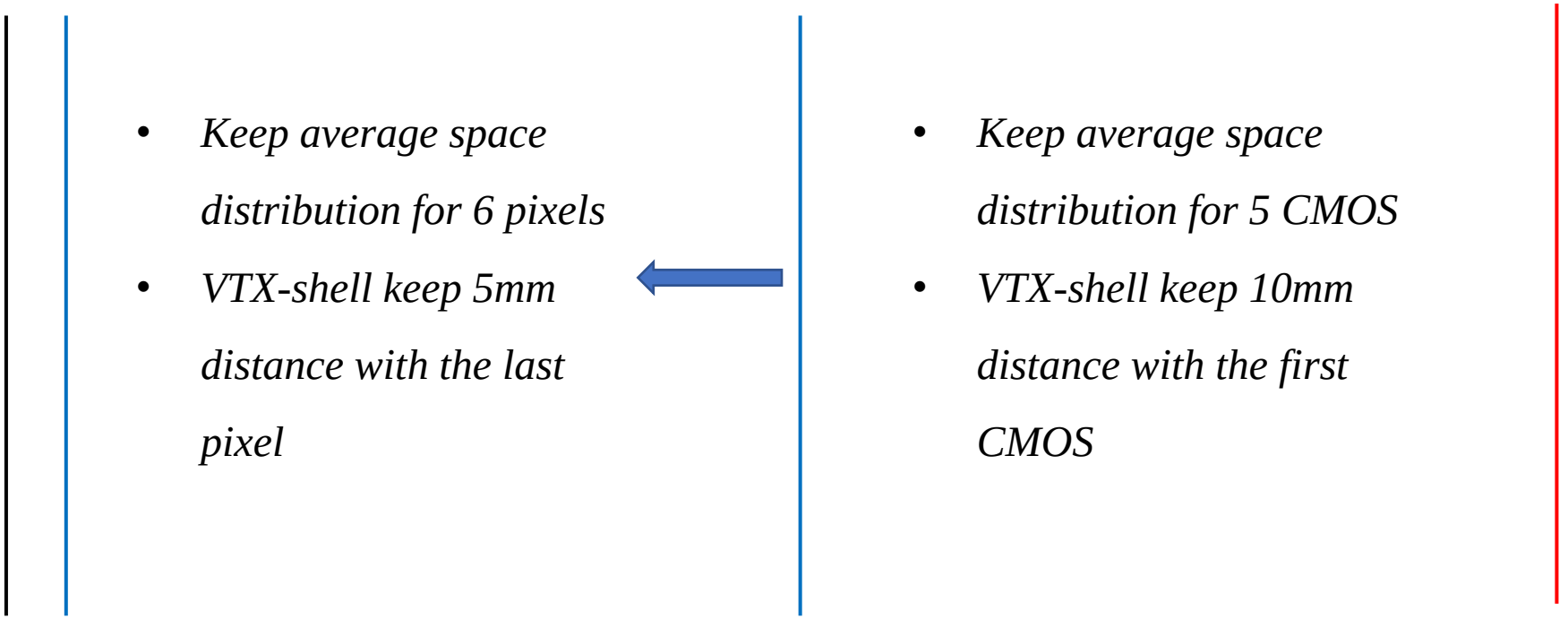
Beam tube –14.5mm
First pixel – 16mm

Outermost CMOS – 1811mm

1. Research stage one

Layers	$\sigma_{R\phi}$(mu)	σ_Z(mu)	Thickness($1/X_0$)
Beam Tube	-	-	0.0015
Pixels	2.8/6/4/4/4/4	2.8/6/4/4/4/4	0.001
Support for each pixel	-	-	0.001
VTX-shell	-	-	0.0015
CMOS	7.2	86.6	0.0065

3.1 The total radius of VTX

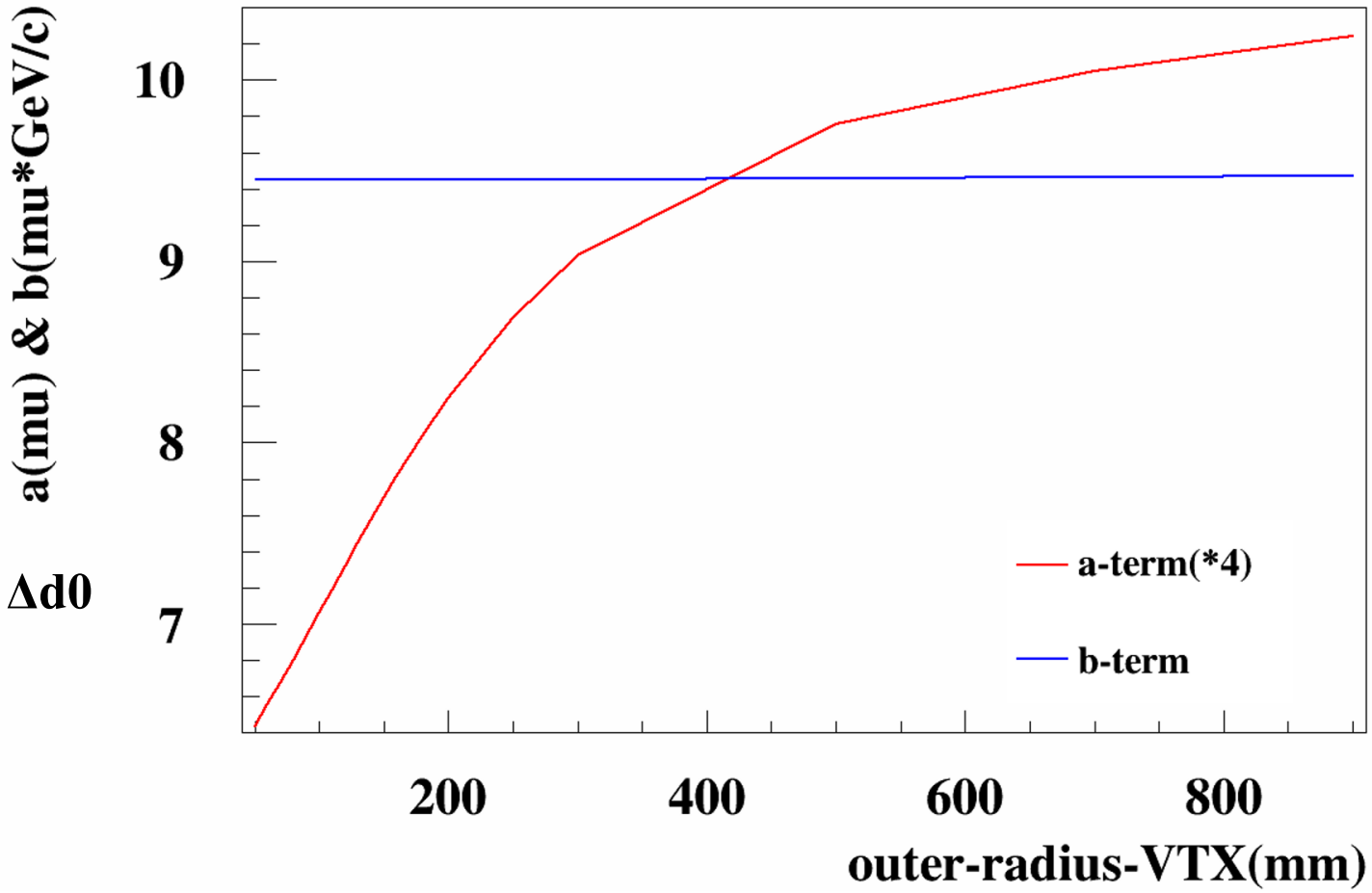


Beam tube –14.5mm
First pixel – 16mm

Outermost pixel
900mm → 50mm

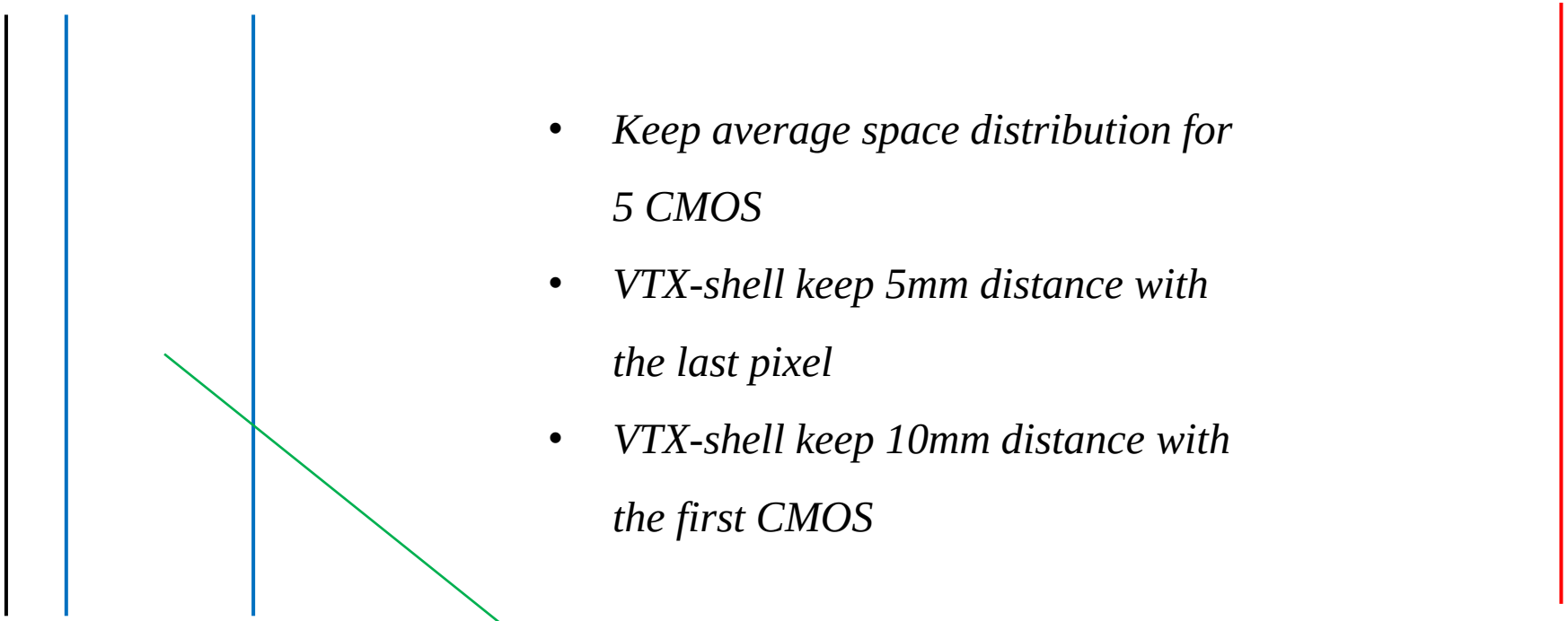
Outermost CMOS – 1811mm

3.1 The total radius of VTX



$$\Delta d_0 = a \oplus \frac{b}{p_T \sin^{\frac{1}{2}} \theta}$$

3.2 How to distribute space for VTX pixels



Beam tube –14.5mm
First pixel – 16mm

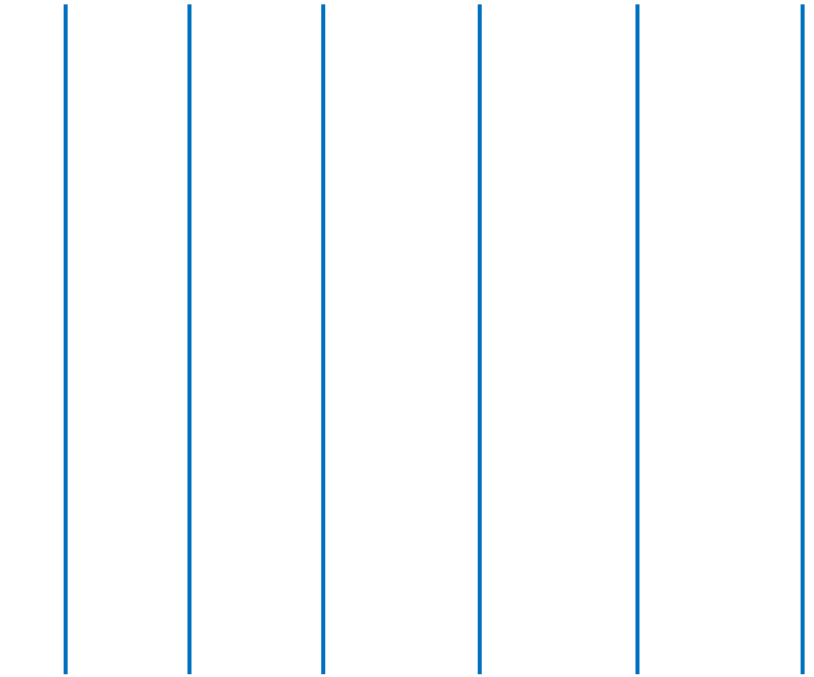
Outermost pixel
60mm

Outermost CMOS – 1811mm

- *Keep average space distribution for 5 CMOS*
- *VTX-shell keep 5mm distance with the last pixel*
- *VTX-shell keep 10mm distance with the first CMOS*

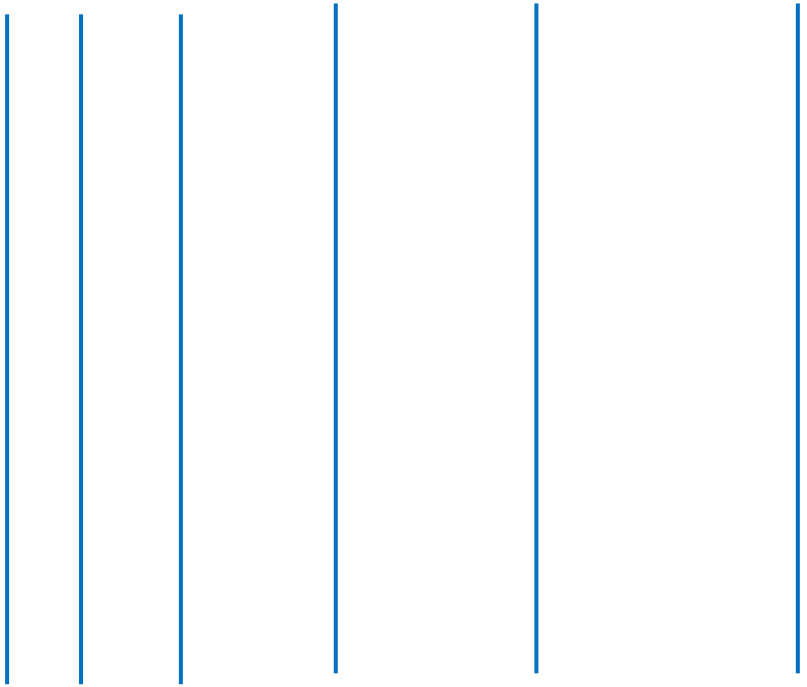
- *Change different space distribution for 6 pixels*

3.2 How to distribute space for VTX pixels



16mm 60mm

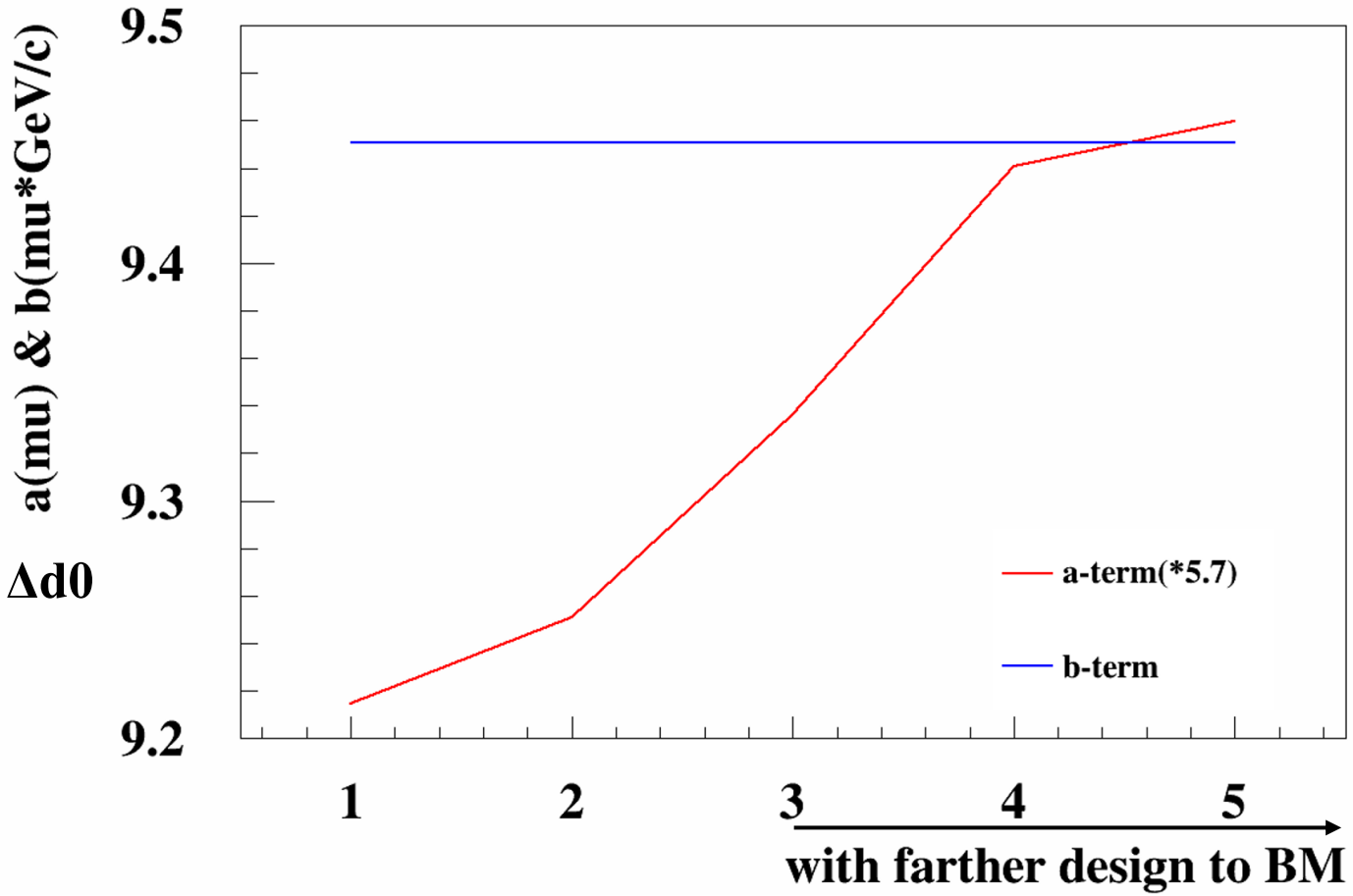
Use 1:1:1:1:1 space distribution for 6 pixels



16mm 60mm

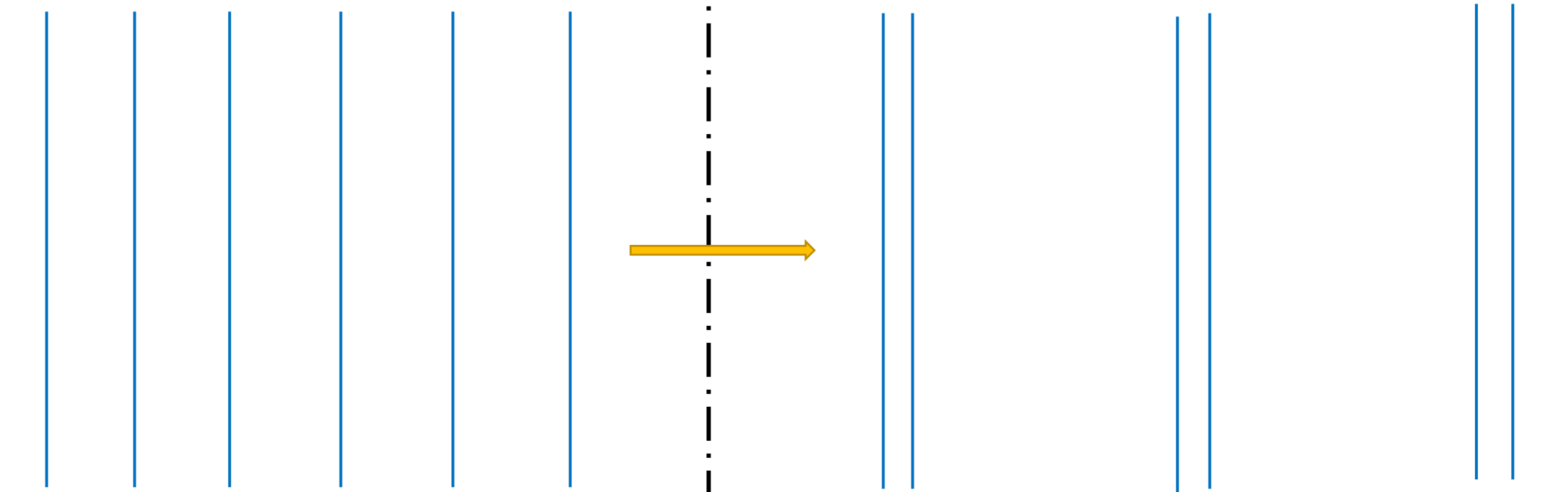
Use 1:2:3:4:5 space distribution for 6 pixels

3.2 How to distribute space for VTX pixels



$$\Delta d_0 = a \oplus \frac{b}{p_T \sin^{\frac{1}{2}} \theta}$$

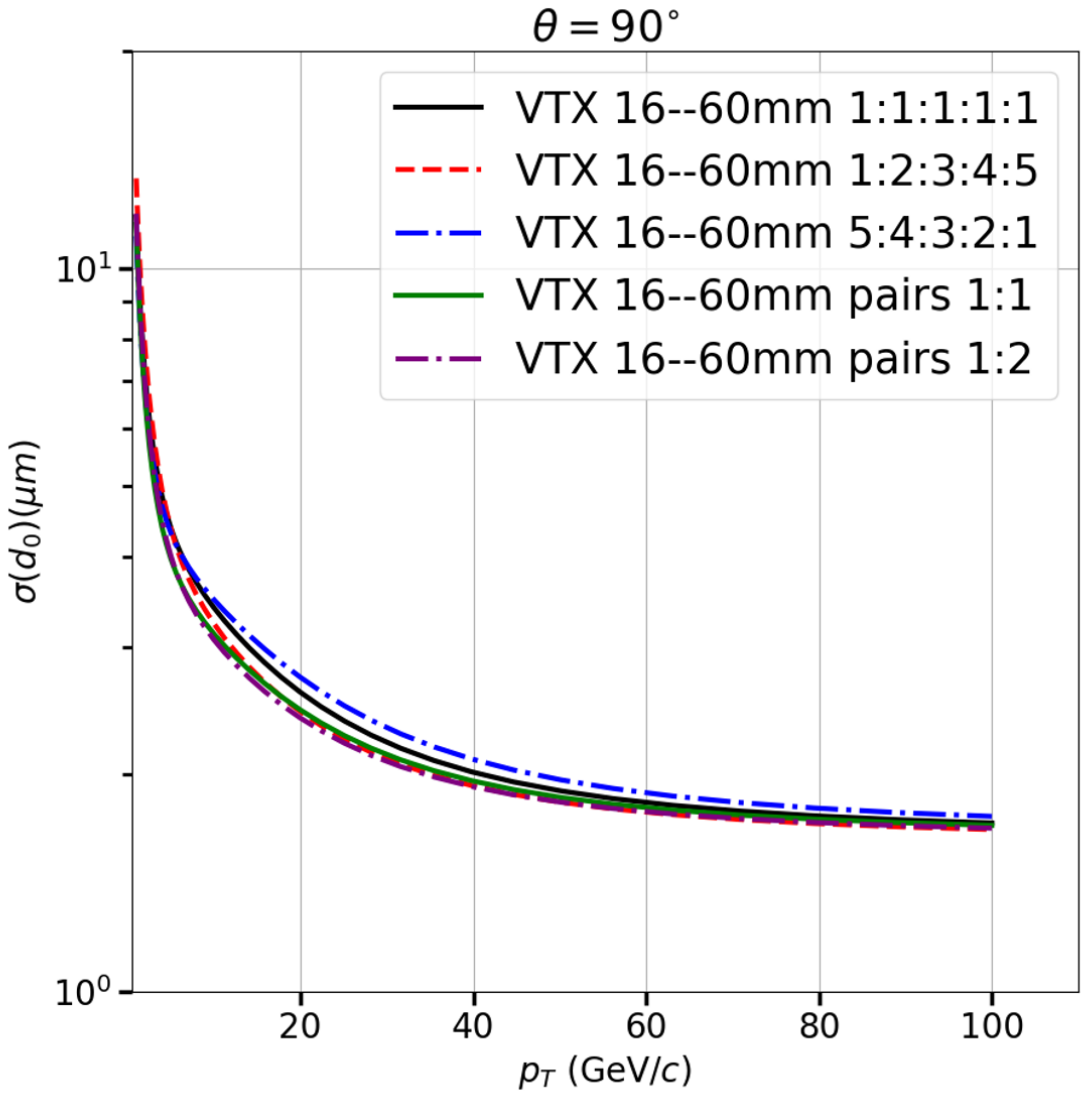
3.3 What about make two pixels a pair



- *Use every single pixel design*
- *Need 6 structural supports*

- *Make every two pixels a pair together*
- *Just need 3 structural supports*

3.3 What about make two pixels a pair



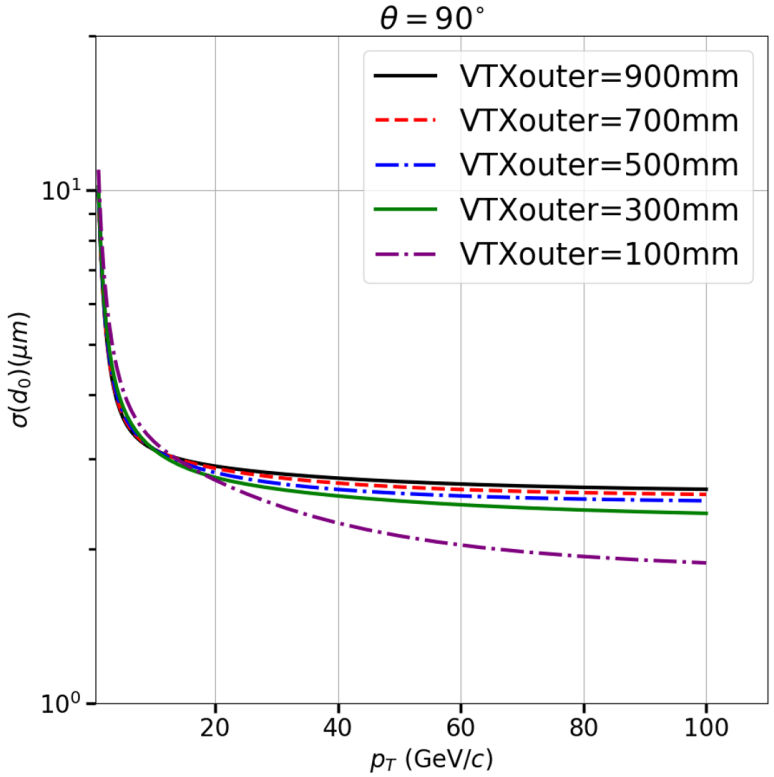
4. Brief conclusion

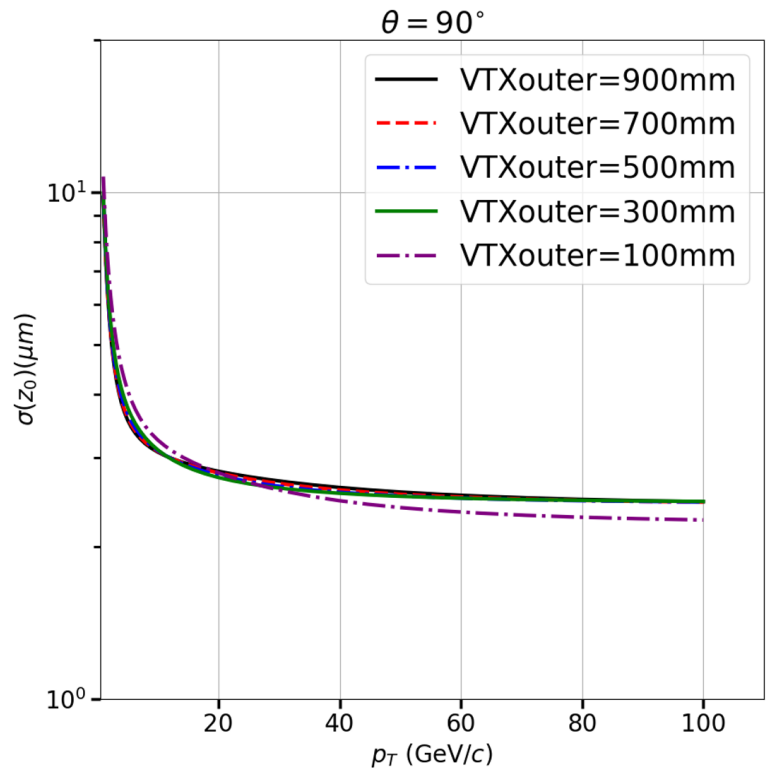
1. ΔZ_0 has the same trend as Δd_0
2. Δd_0 becomes better with pixels get closer to beam tube
3. Making two pixels a pair not only gets better resolution on d_0, but also decrease both material and money budget
4. ΔP_t changes little

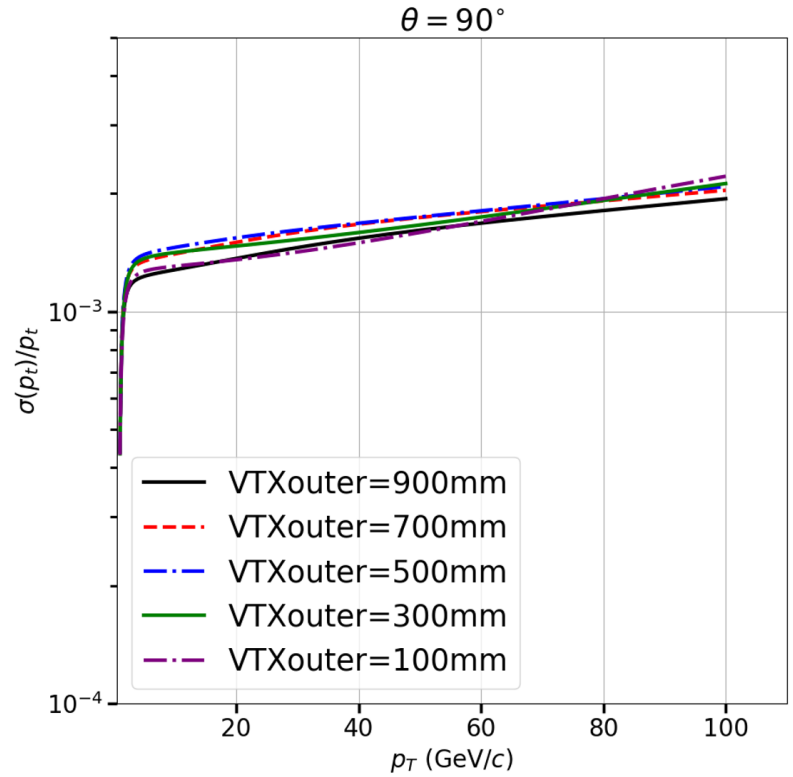
thanks

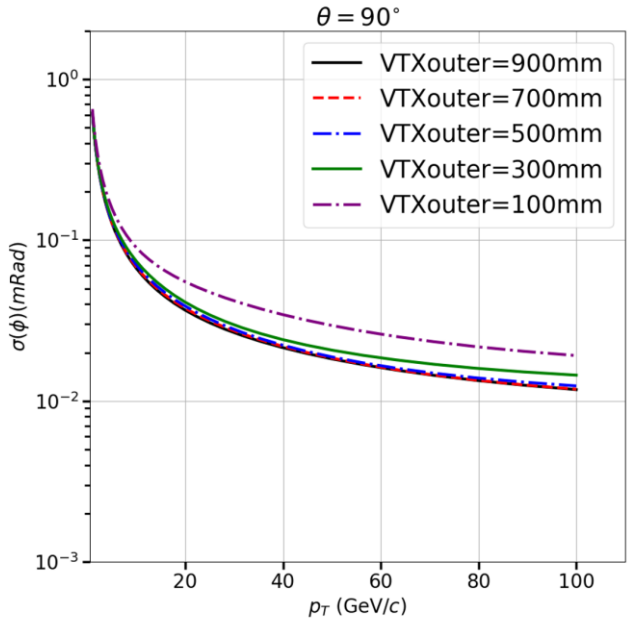
Back up

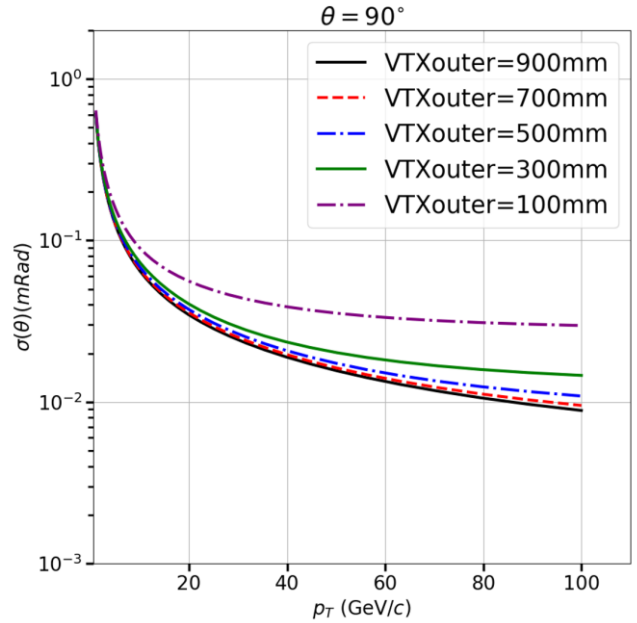
For : 3.1 The total radius of VTX

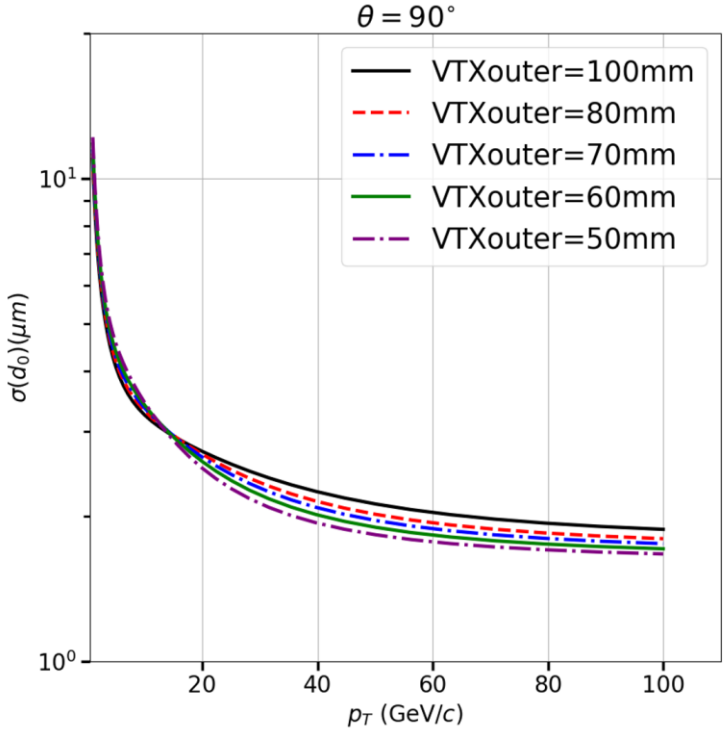

$\theta = 90^\circ$
VTXouter=900mm
VTXouter=700mm
VTXouter=500mm
VTXouter=300mm
VTXouter=100mm
$\sigma(d_0)(\mu m)$
10^1
10^0
20
40
60
80
100
p_T (GeV/c)

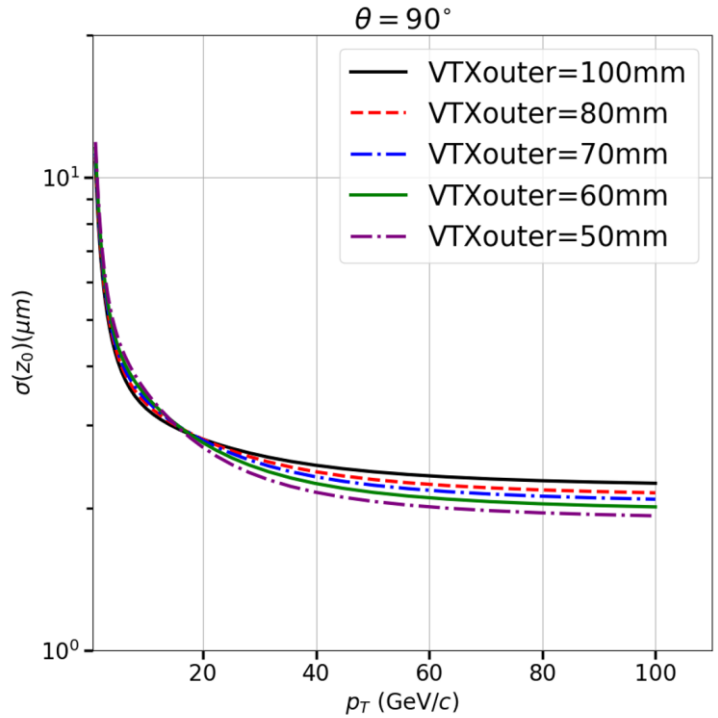

$\theta = 90^\circ$
VTXouter=900mm
VTXouter=700mm
VTXouter=500mm
VTXouter=300mm
VTXouter=100mm
$\sigma(z_0)(\mu m)$
10^1
10^0
20
40
60
80
100
p_T (GeV/c)

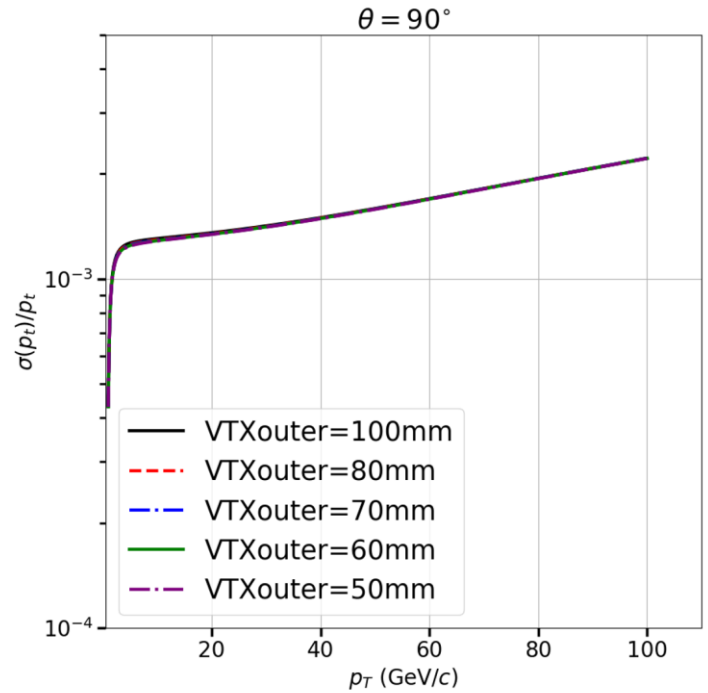

$\theta = 90^\circ$
VTXouter=900mm
VTXouter=700mm
VTXouter=500mm
VTXouter=300mm
VTXouter=100mm
$\sigma(p_t)/p_t$
10^{-3}
10^{-4}
20
40
60
80
100
p_T (GeV/c)

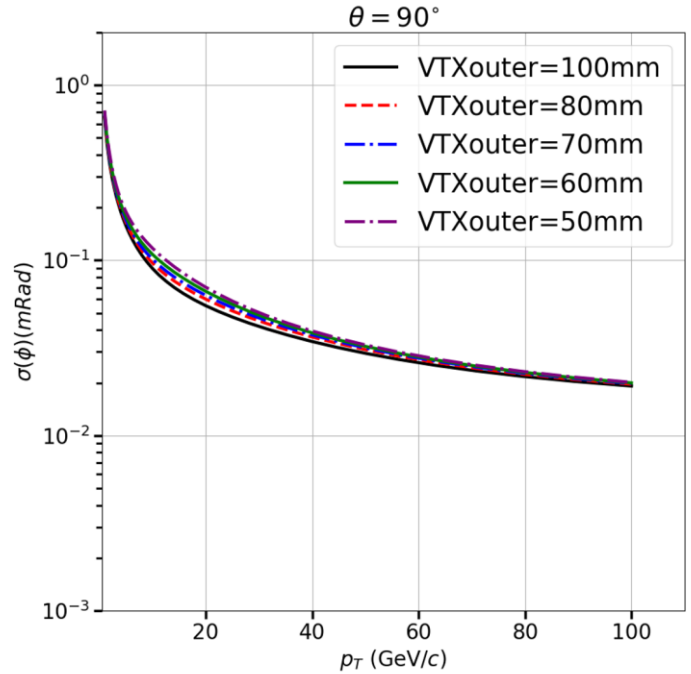

$\theta = 90^\circ$
VTXouter=900mm
VTXouter=700mm
VTXouter=500mm
VTXouter=300mm
VTXouter=100mm
$\sigma(\phi)(mRad)$
10^0
10^{-1}
10^{-2}
10^{-3}
20
40
60
80
100
p_T (GeV/c)

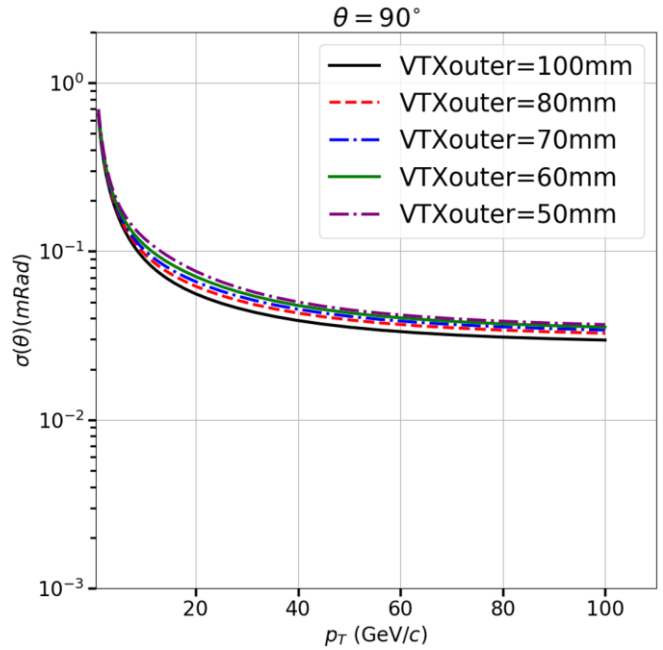

$\theta = 90^\circ$
VTXouter=900mm
VTXouter=700mm
VTXouter=500mm
VTXouter=300mm
VTXouter=100mm
$\sigma(\theta)(mRad)$
10^0
10^{-1}
10^{-2}
10^{-3}
20
40
60
80
100
p_T (GeV/c)


$\theta = 90^\circ$
VTXouter=100mm
VTXouter=80mm
VTXouter=70mm
VTXouter=60mm
VTXouter=50mm
$\sigma(d_0)(\mu m)$
p_T (GeV/c)


$\theta = 90^\circ$
VTXouter=100mm
VTXouter=80mm
VTXouter=70mm
VTXouter=60mm
VTXouter=50mm
$\sigma(z_0)(\mu m)$
p_T (GeV/c)


$\theta = 90^\circ$
VTXouter=100mm
VTXouter=80mm
VTXouter=70mm
VTXouter=60mm
VTXouter=50mm
$\sigma(p_t)/p_t$
p_T (GeV/c)


$\theta = 90^\circ$
VTXouter=100mm
VTXouter=80mm
VTXouter=70mm
VTXouter=60mm
VTXouter=50mm
$\sigma(\phi)(mRad)$
p_T (GeV/c)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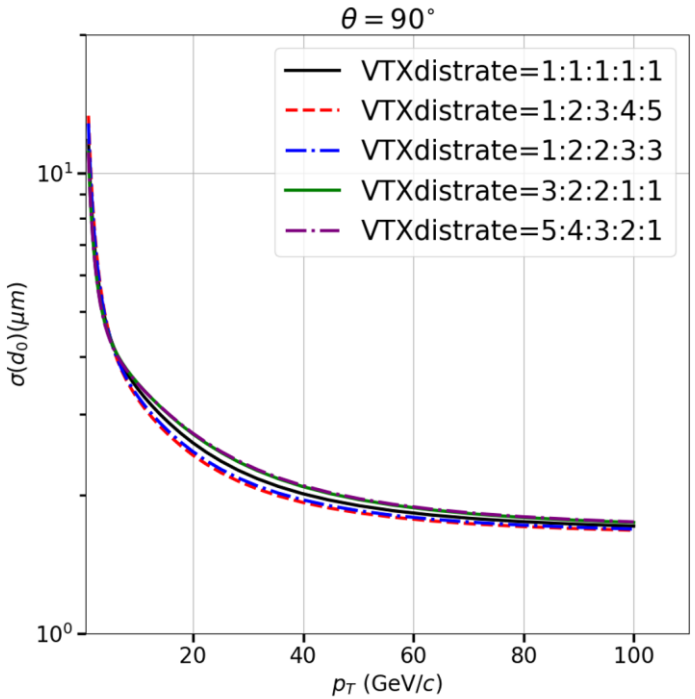
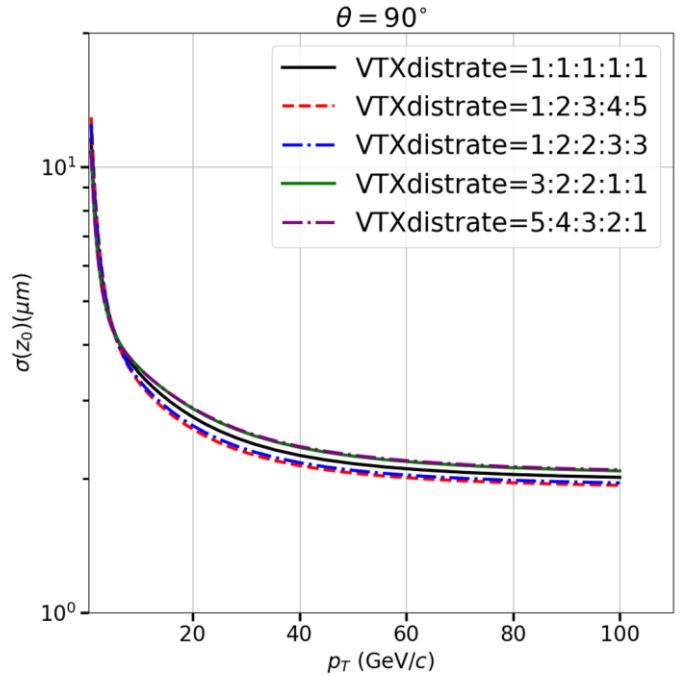
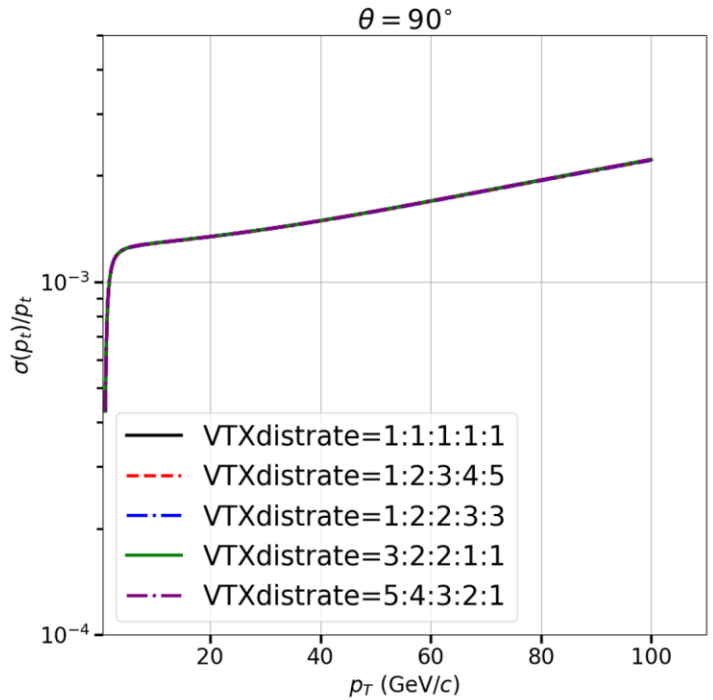
VTXouter=100mm
VTXouter=80mm
VTXouter=70mm
VTXouter=60mm
VTXouter=50mm
$\sigma(\theta)(mRad)$
p_T (GeV/c)

For : 3.2 How to distribute space for VTX pixels


$\theta = 90^\circ$
VTXdistrate=1:1:1:1:1
VTXdistrate=1:2:3:4:5
VTXdistrate=1:2:2:3:3
VTXdistrate=3:2:2:1:1
VTXdistrate=5:4:3:2:1
$\sigma(d_0)(\mu m)$
p_T (GeV/c)


$\theta = 90^\circ$
VTXdistrate=1:1:1:1:1
VTXdistrate=1:2:3:4:5
VTXdistrate=1:2:2:3:3
VTXdistrate=3:2:2:1:1
VTXdistrate=5:4:3:2:1
$\sigma(z_0)(\mu m)$
p_T (GeV/c)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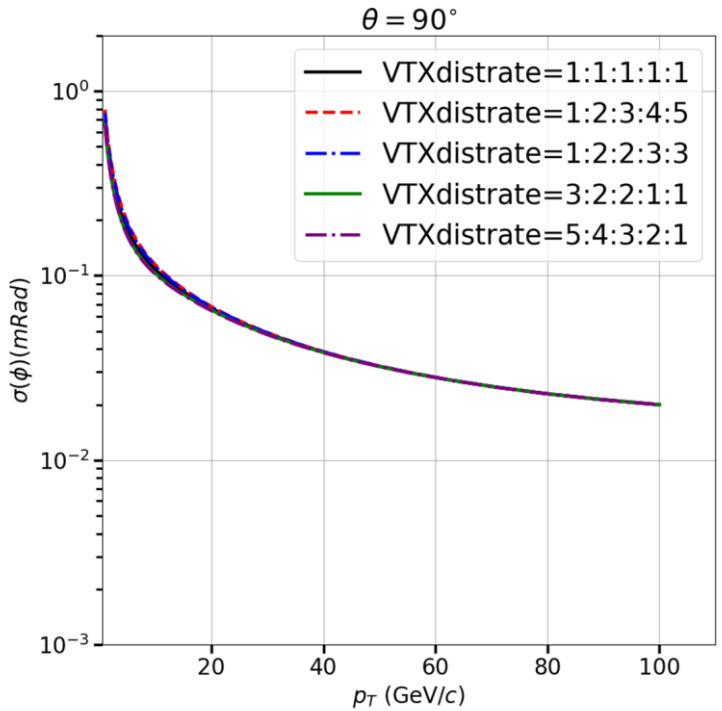
VTXdistrate=1:2:3:4:5
VTXdistrate=1:2:2:3:3
VTXdistrate=3:2:2:1:1
VTXdistrate=5:4:3:2:1
$\sigma(p_t)/p_t$
p_T (GeV/c)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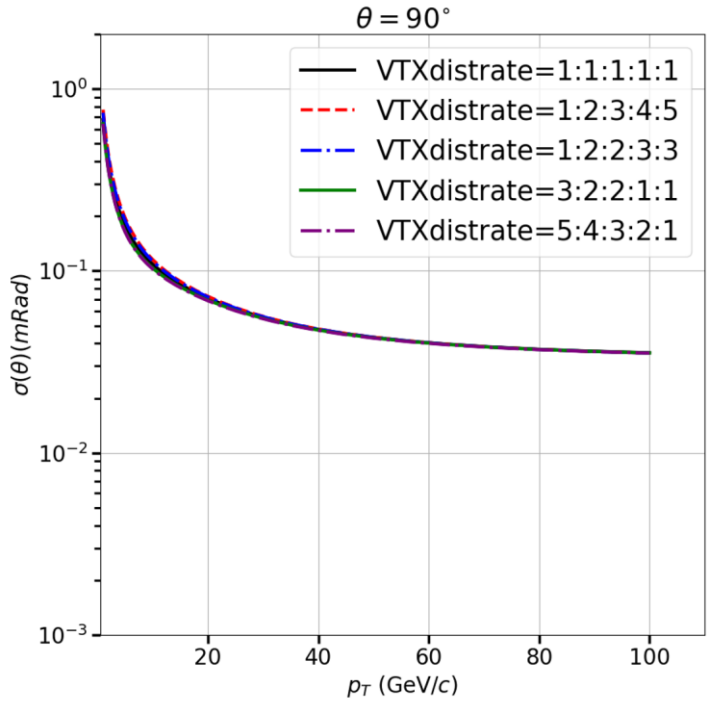
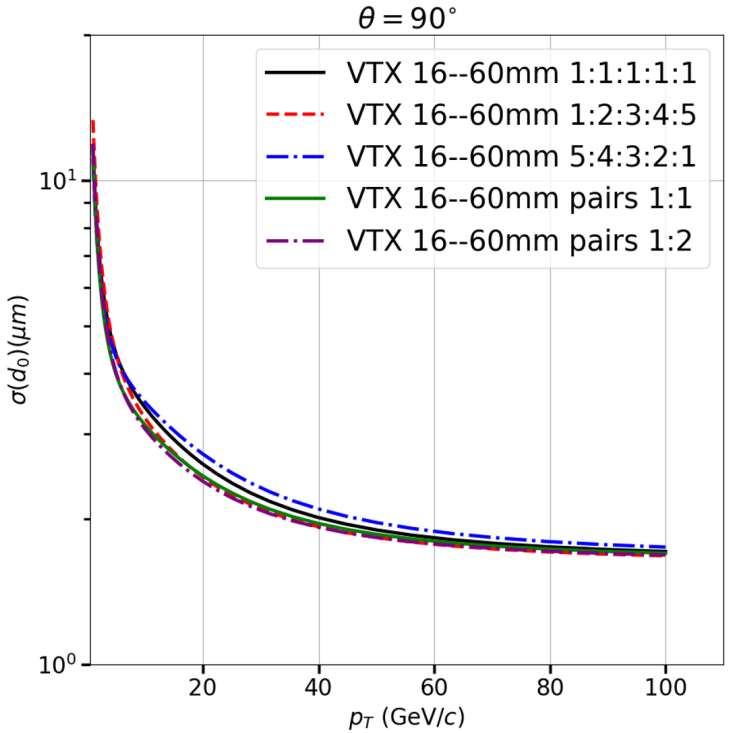
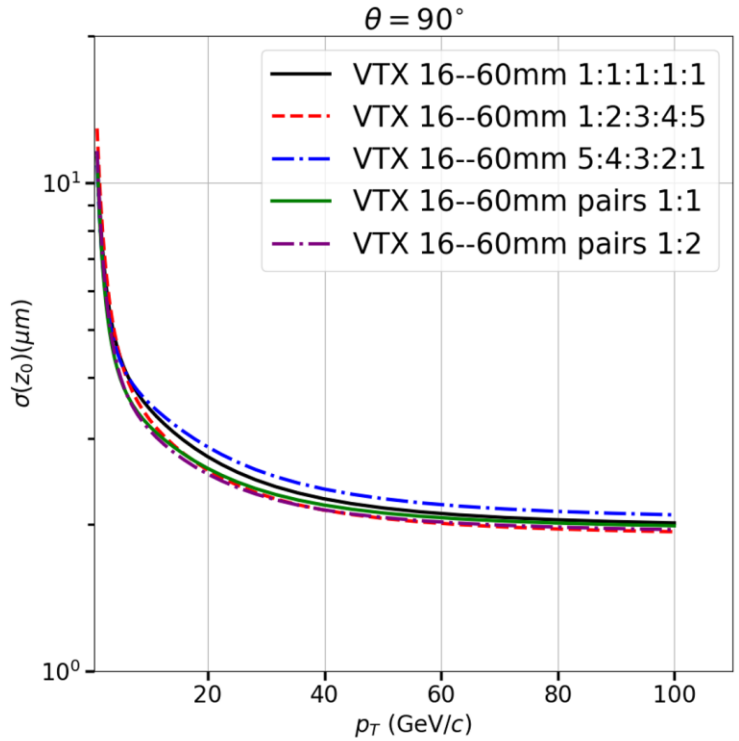
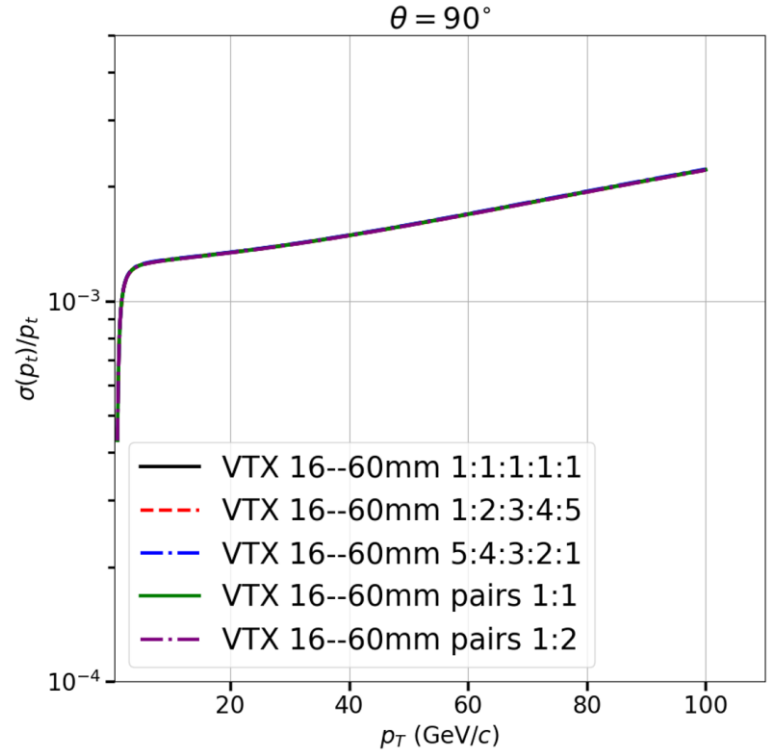
VTXdistrate=1:2:3:4:5
VTXdistrate=1:2:2:3:3
VTXdistrate=3:2:2:1:1
VTXdistrate=5:4:3:2:1
$\sigma(\phi)(mRad)$
p_T (GeV/c)

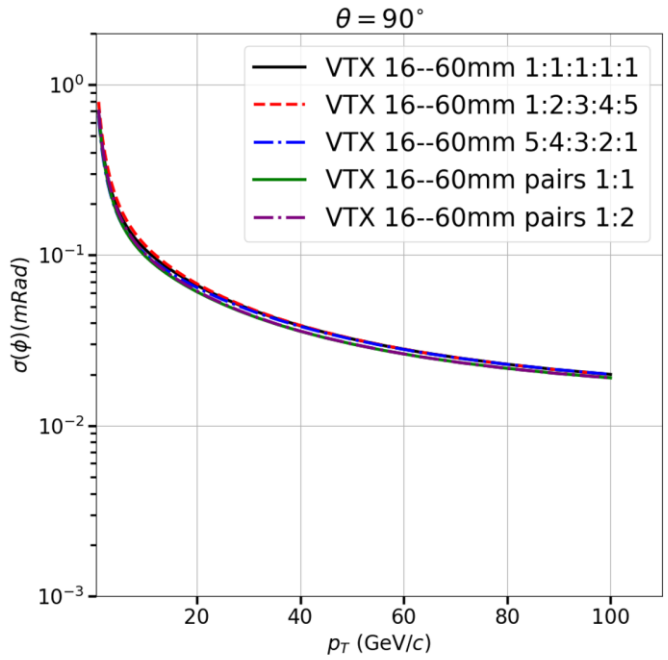

$\theta = 90^\circ$
VTXdistrate=1:1:1:1:1
VTXdistrate=1:2:3:4:5
VTXdistrate=1:2:2:3:3
VTXdistrate=3:2:2:1:1
VTXdistrate=5:4:3:2:1
$\sigma(\theta)(mRad)$
p_T (GeV/c)

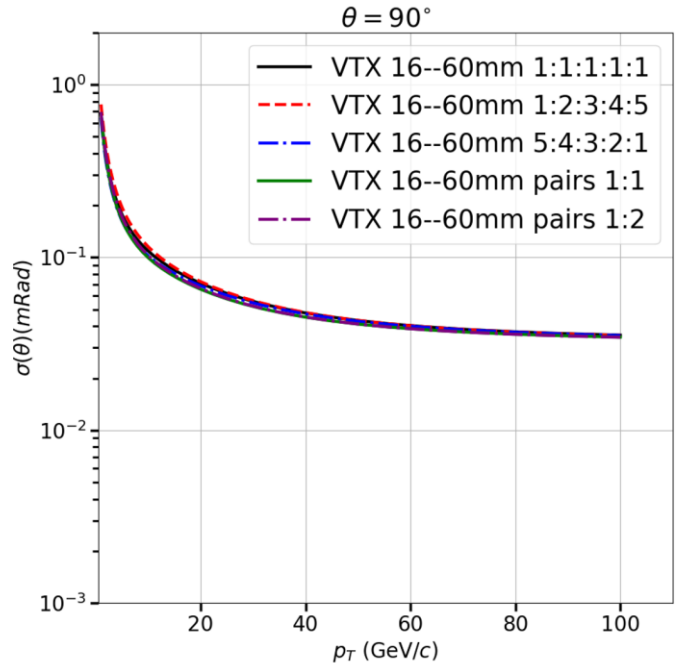
For : 3.3 What about make two pixels a pair


$\theta = 90^\circ$
VTX 16--60mm 1:1:1:1:1
VTX 16--60mm 1:2:3:4:5
VTX 16--60mm 5:4:3:2:1
VTX 16--60mm pairs 1:1
VTX 16--60mm pairs 1:2
$\sigma(d_0)(\mu m)$
p_T (GeV/c)


$\theta = 90^\circ$
VTX 16--60mm 1:1:1:1:1
VTX 16--60mm 1:2:3:4:5
VTX 16--60mm 5:4:3:2:1
VTX 16--60mm pairs 1:1
VTX 16--60mm pairs 1:2
$\sigma(z_0)(\mu m)$
p_T (GeV/c)


$\theta = 90^\circ$
VTX 16--60mm 1:1:1:1:1
VTX 16--60mm 1:2:3:4:5
VTX 16--60mm 5:4:3:2:1
VTX 16--60mm pairs 1:1
VTX 16--60mm pairs 1:2
$\sigma(p_t)/p_t$
p_T (GeV/c)


$\theta = 90^\circ$
VTX 16--60mm 1:1:1:1:1
VTX 16--60mm 1:2:3:4:5
VTX 16--60mm 5:4:3:2:1
VTX 16--60mm pairs 1:1
VTX 16--60mm pairs 1:2
$\sigma(\phi)(mRad)$
p_T (GeV/c)


$\theta = 90^\circ$
VTX 16--60mm 1:1:1:1:1
VTX 16--60mm 1:2:3:4:5
VTX 16--60mm 5:4:3:2:1
VTX 16--60mm pairs 1:1
VTX 16--60mm pairs 1:2
$\sigma(\theta)(mRad)$
p_T (GeV/c)