Vertex optimization with full simulation

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2017.9.20

outline

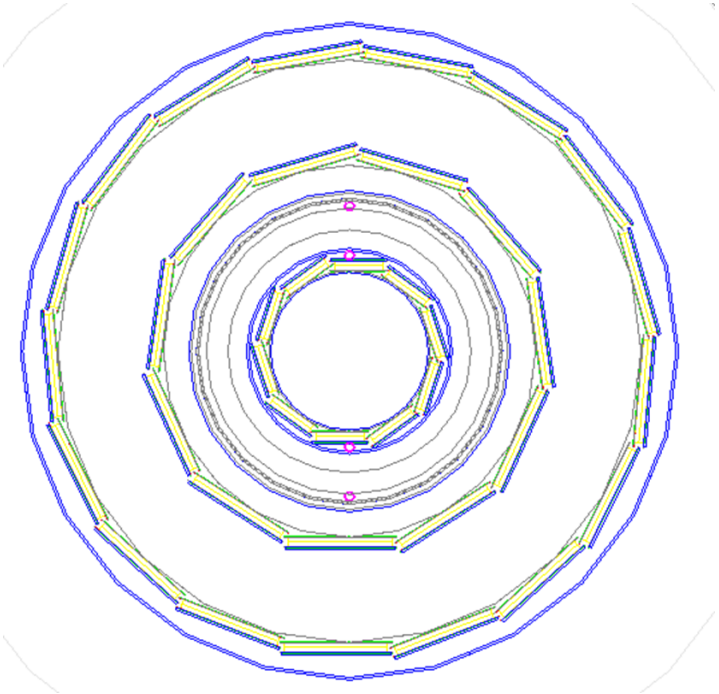
- optimization of material budget
- Impact parameter resolution

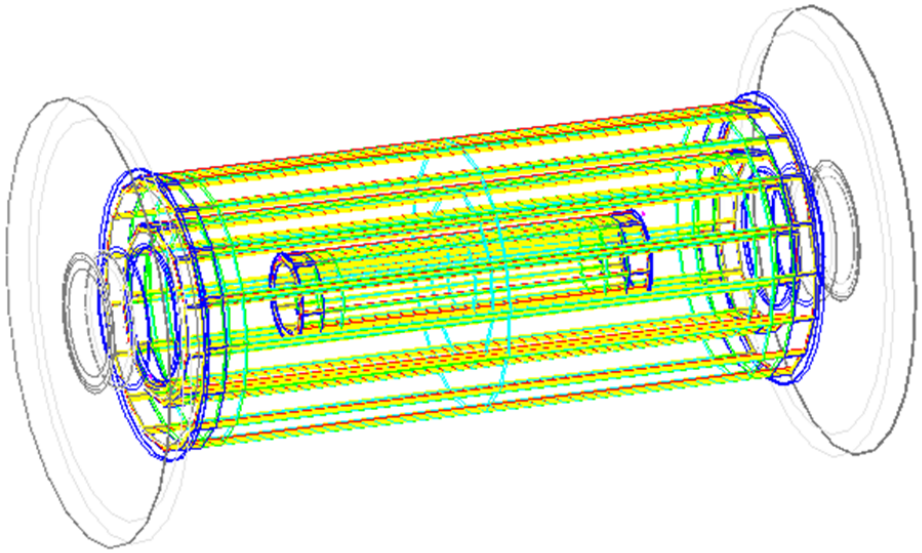
For comparisons

- optimization of distance to IP
- optimization of spatial resolution

VXD structure

- Material budget (baseline)
  - Silicon: 0.000534 X/X0@50um
  - Support: 0.000986 X/X0@1mm





method

- Change material budget in Mokka (by C. Fu)
  - /Mokka/init/globalModelParameter VXDSupportScale x
  - /Mokka/init/globalModelParameter VXDSiliconScale x
  - Change X from 0.4 to 1.6

$$budget = \frac{thickness \times density}{RadLength}$$

Method

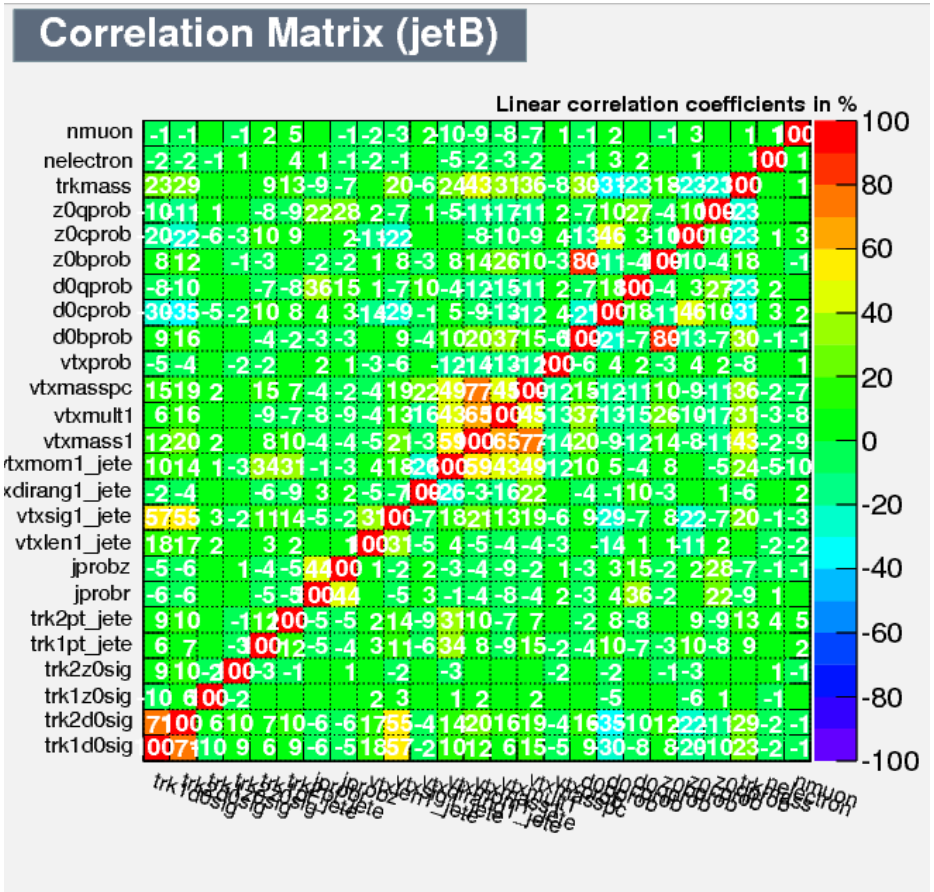
- Event
  - 50000 z->bb, 50000 z->cc, 50000 z->ll(uds pairs)

generator → **Mokka** → **Marlin**

$z \rightarrow bb, cc, ll$ → Detector simulation → Digitial reconstruction → JetClustering → train

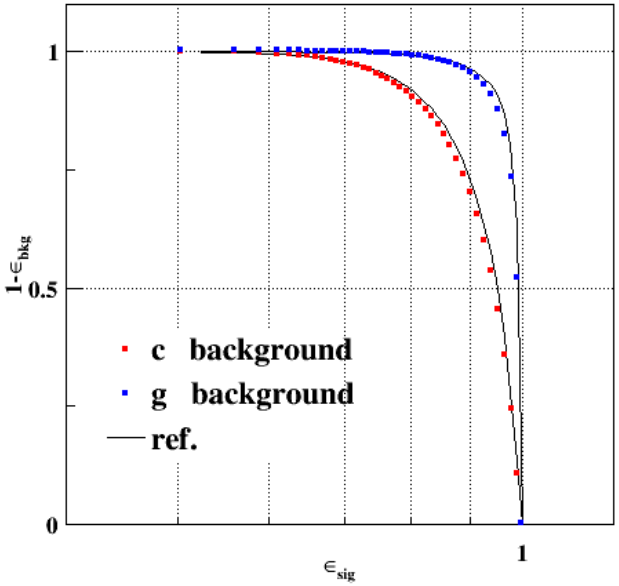
result

- CorrelationMatrix

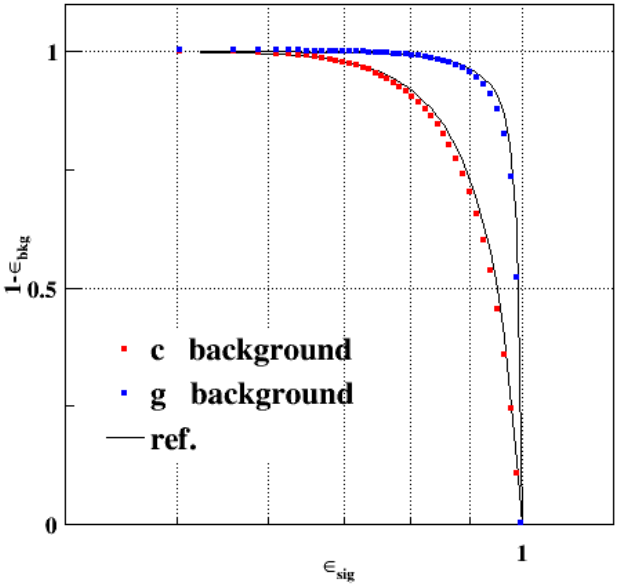


result

- Training (baseline)



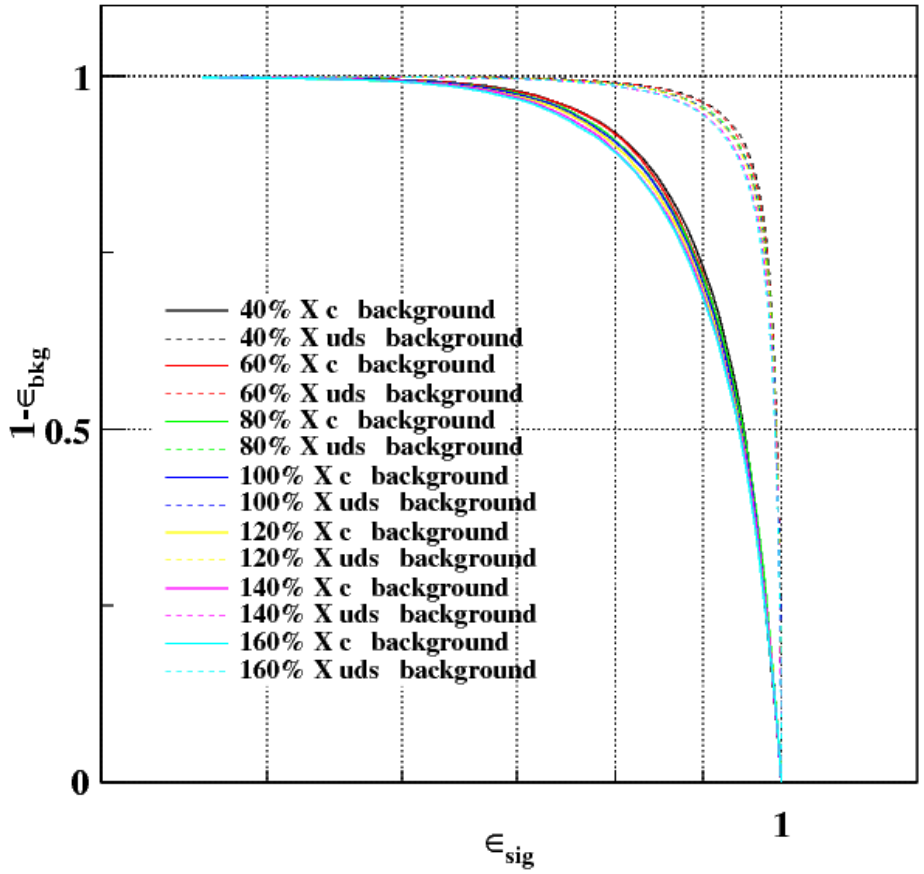
train



test

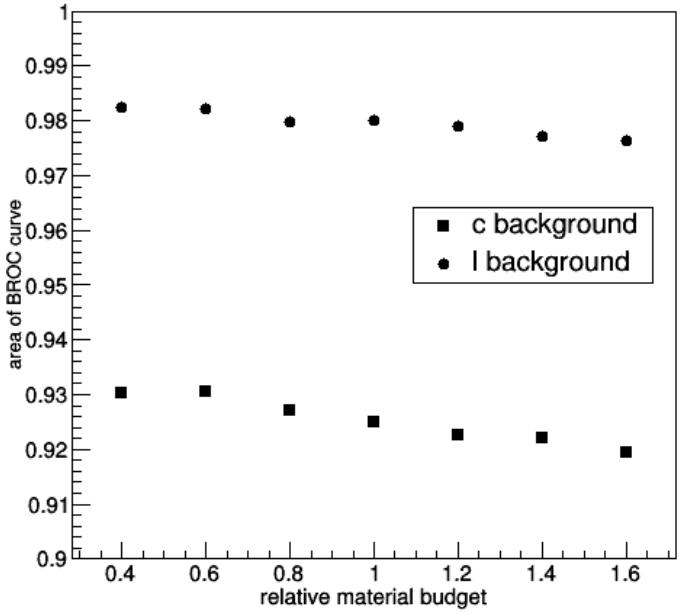
result

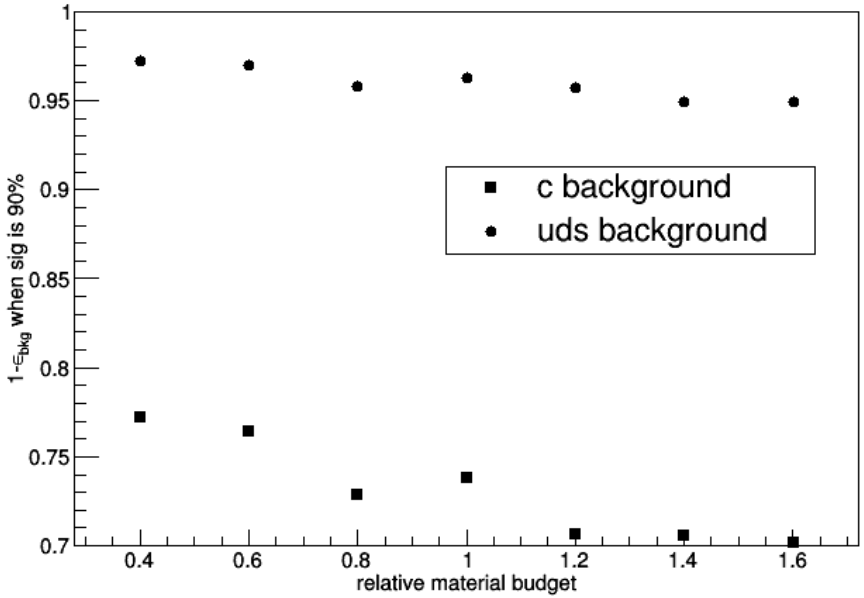
- BROC


1
0.5
0
1
$1-\epsilon_{bkg}$
ϵ_{sig}
40% X c background
40% X uds background
60% X c background
60% X uds background
80% X c background
80% X uds background
100% X c background
100% X uds background
120% X c background
120% X uds background
140% X c background
140% X uds background
160% X c background
160% X uds background

result

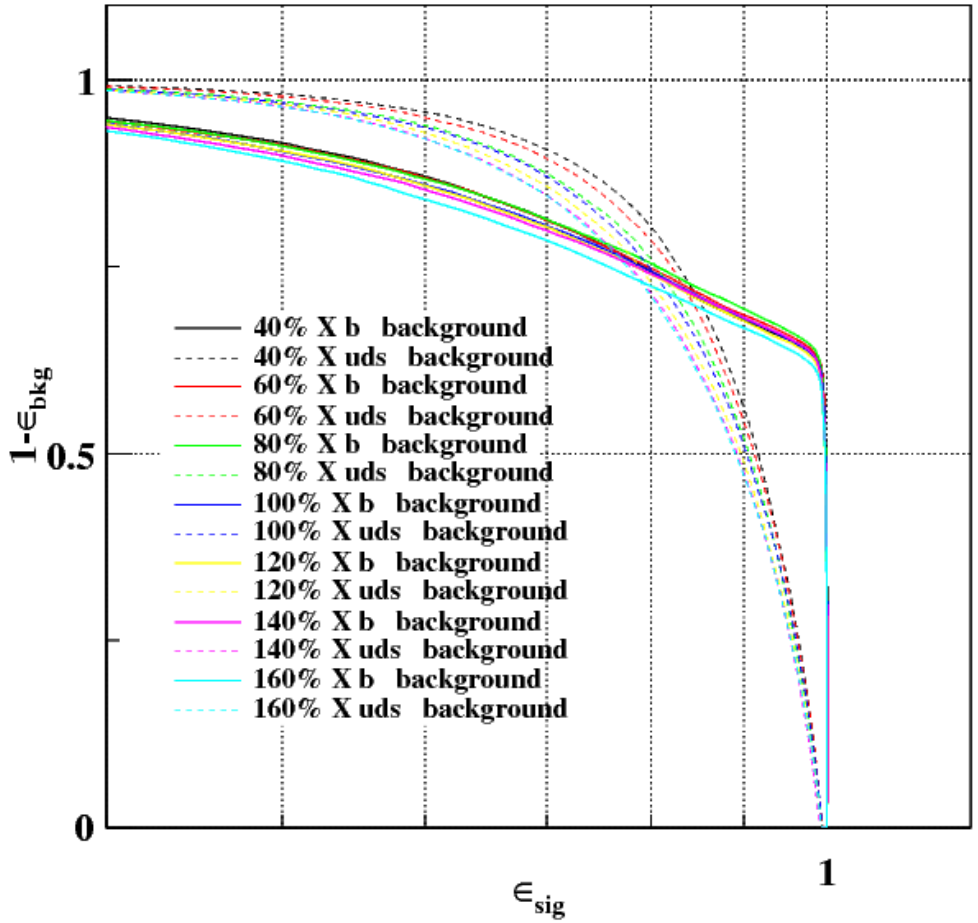
- BROC
  - The reduce of material is inefficient to b-tagging





result

- CROC


1
0.5
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1
$1-\epsilon_{bkg}$
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40% X b background
40% X uds background
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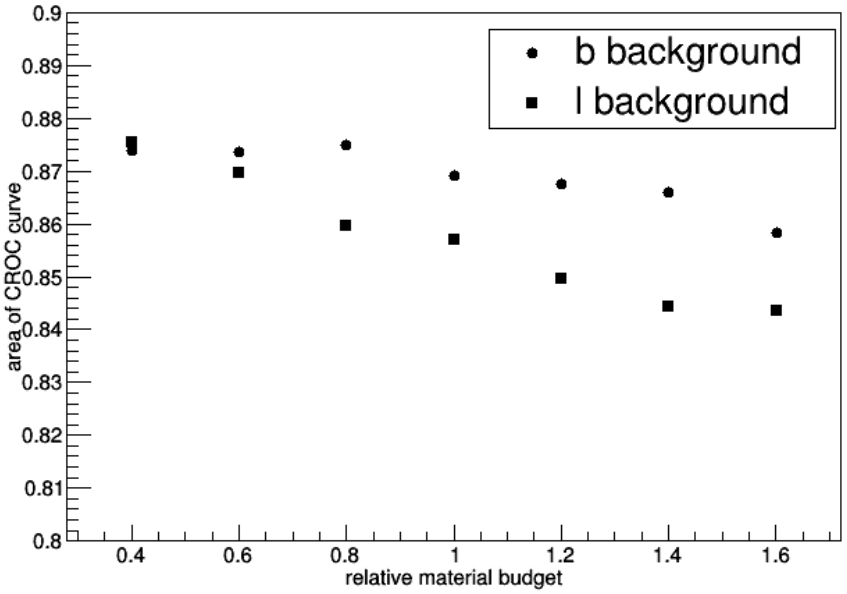
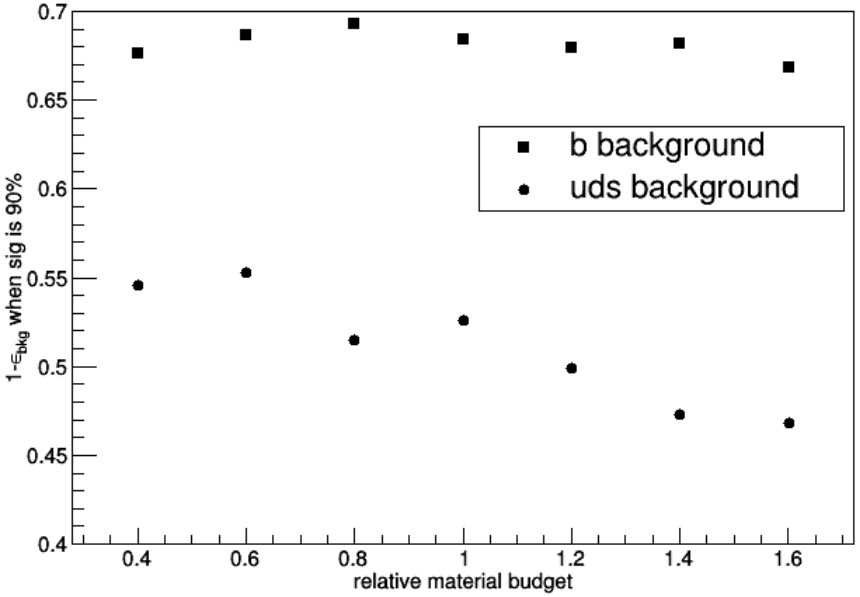
80% X b background
80% X uds background
100% X b background
100% X uds background
120% X b background
120% X uds background
140% X b background
140% X uds background
160% X b background
160% X uds background

result

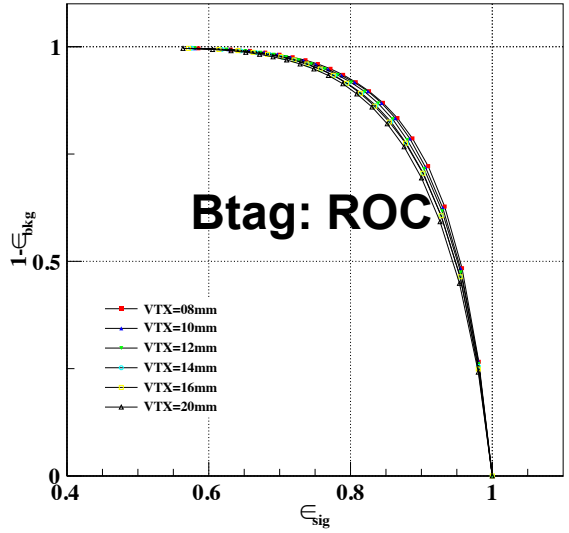
- CROC
  - The reduce of material is efficient to c-tagging (especially uds background)

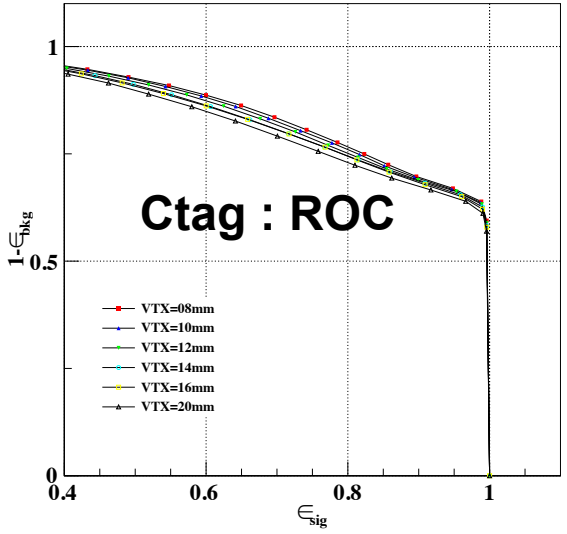




For comparison

- pushing vertex to IP (by Li.gang)
  - pushing vertex to IP improve Ctag significantly





For comparison

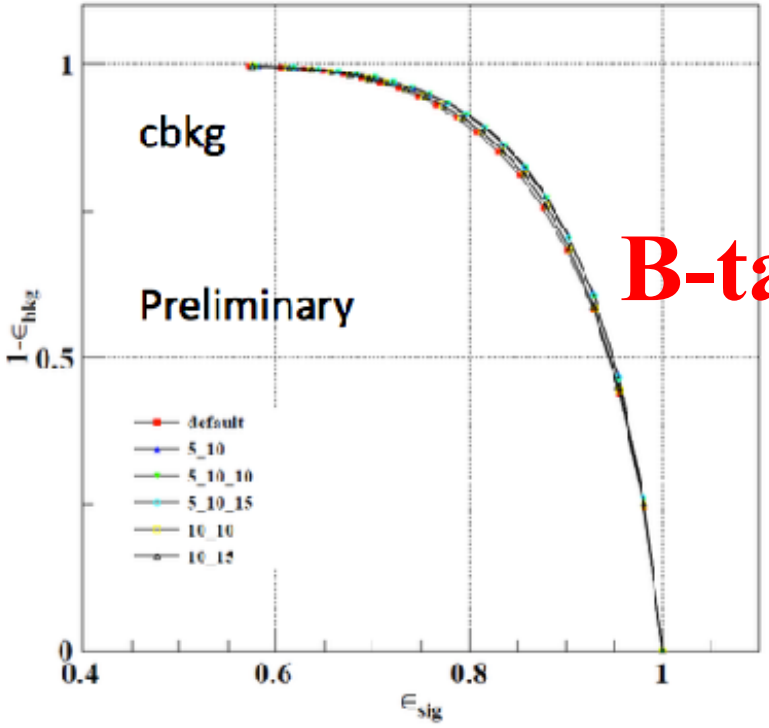
- Change resolution (by Li.gang)

Vertex detector optimization:

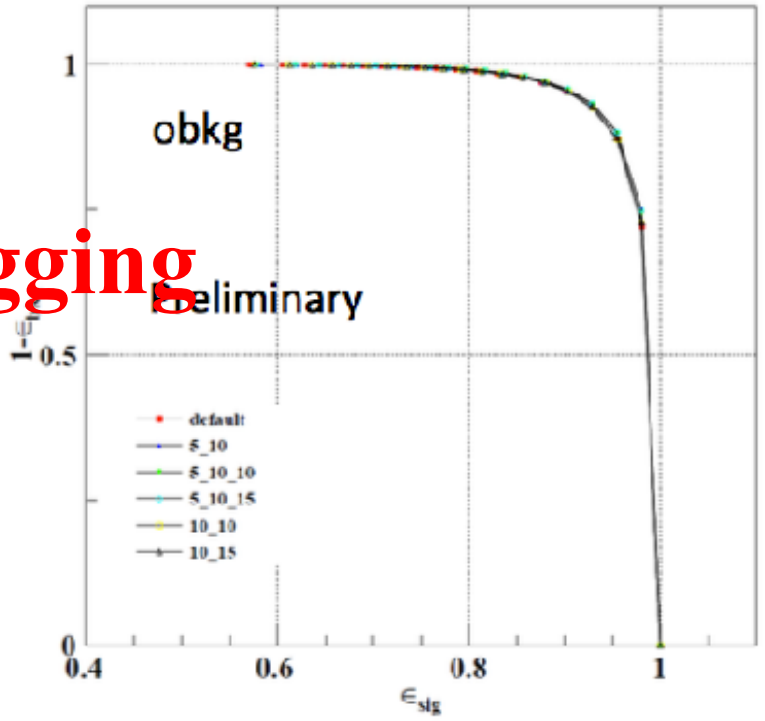
- CEPC v1 as default:
- 5_10: VXD 1-6 and FTD_pixel 5μm, SIT/SET and FTD_strip 10μm
- 5_10_10: VXD 1 and FTD_pixel 5μm, VXD 2-6 10μm, SIT/SET and FTD_strip 10μm
- 5_10_15: VXD 1 and FTD_pixel 5μm, VXD 2-6 10μm, SIT/SET and FTD_strip 15μm
- 10_10: VXD 1-6 and FTD_pixel 10μm, SIT/SET and FTD_strip 10μm
- 10_15: VXD 1-6 and FTD_pixel 10μm, SIT/SET and FTD_strip 15μm

For comparison

- Change resolution

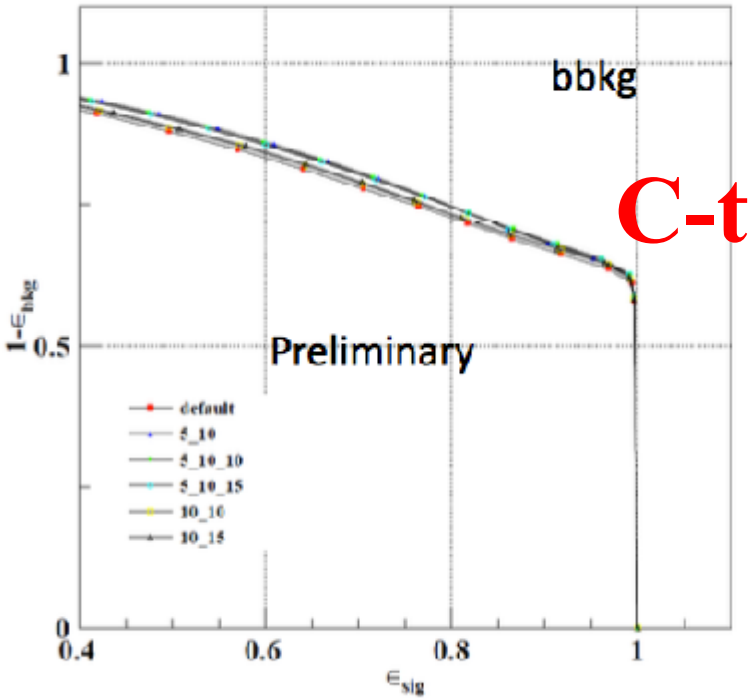


B-tagging

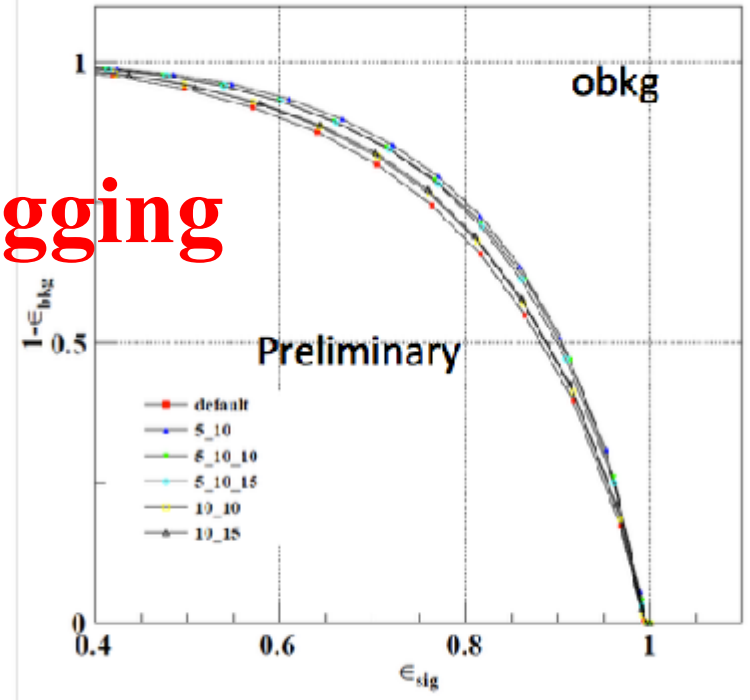


For comparison

- Change resolution



C-tagging



conclusion

- The optimization of vertex improves c -tagging significantly, while has little influence on b-tagging

transverse impact parameter resolution

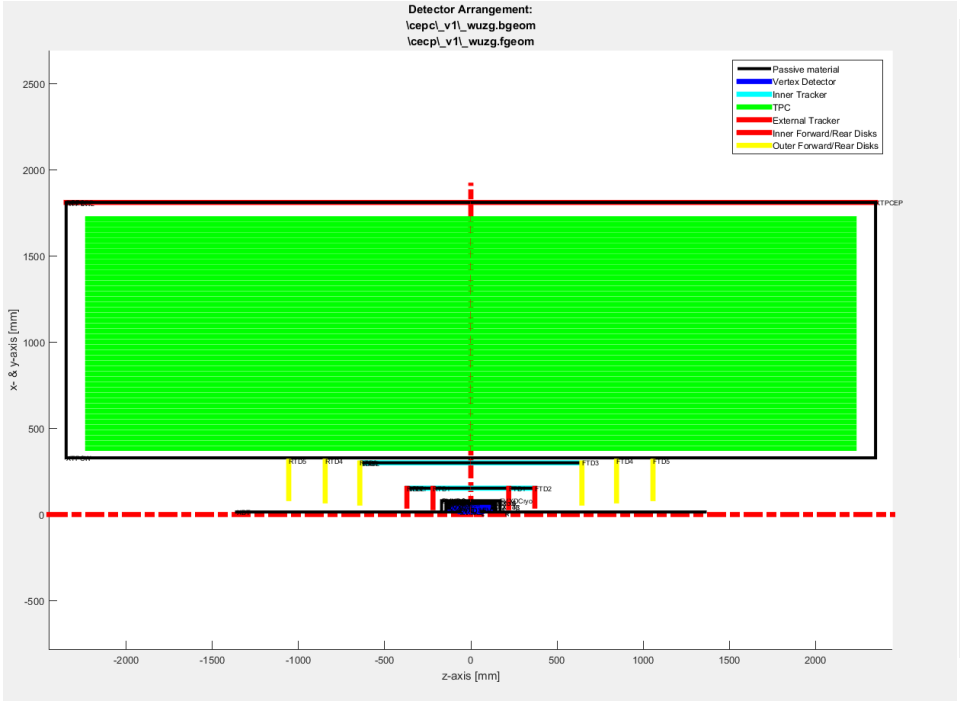
- Definition
  - The resolution of impact parameter in R-φ
    - The closest distance from IP to track
- Theoretical formula (pre-CDR)

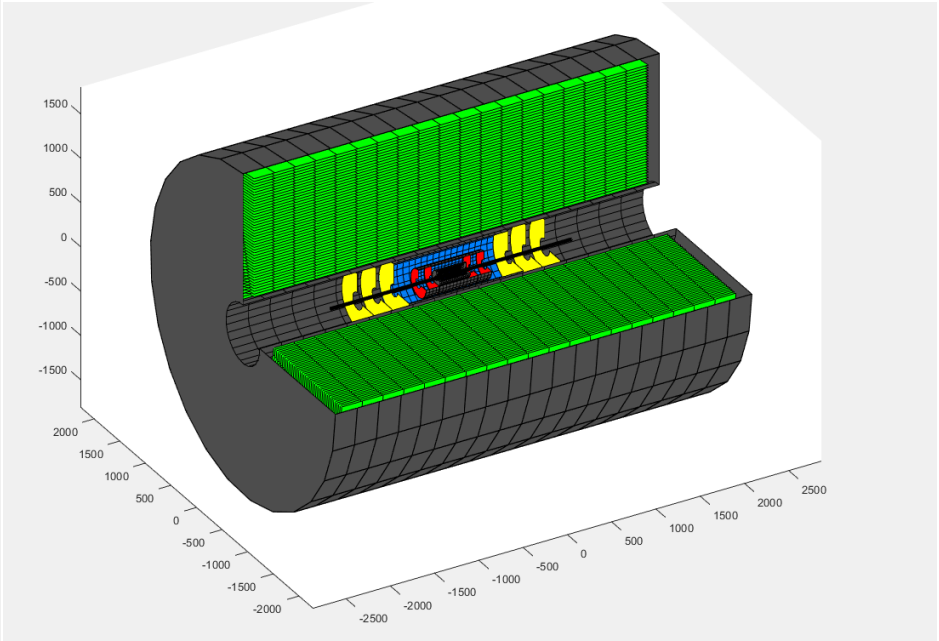
$$\sigma(r\phi) = a \oplus \frac{b}{p(\mathrm{GeV})\sin^{3/2}\theta}\ \mu\mathrm{m}$$

when a=5,b=10

Fast simulation

- Based on MatLab (by Liu.Beijiang)
  - Include VXD FTD SIT SET TPC support cooling
  - Change the detector structure to CEPC_V1





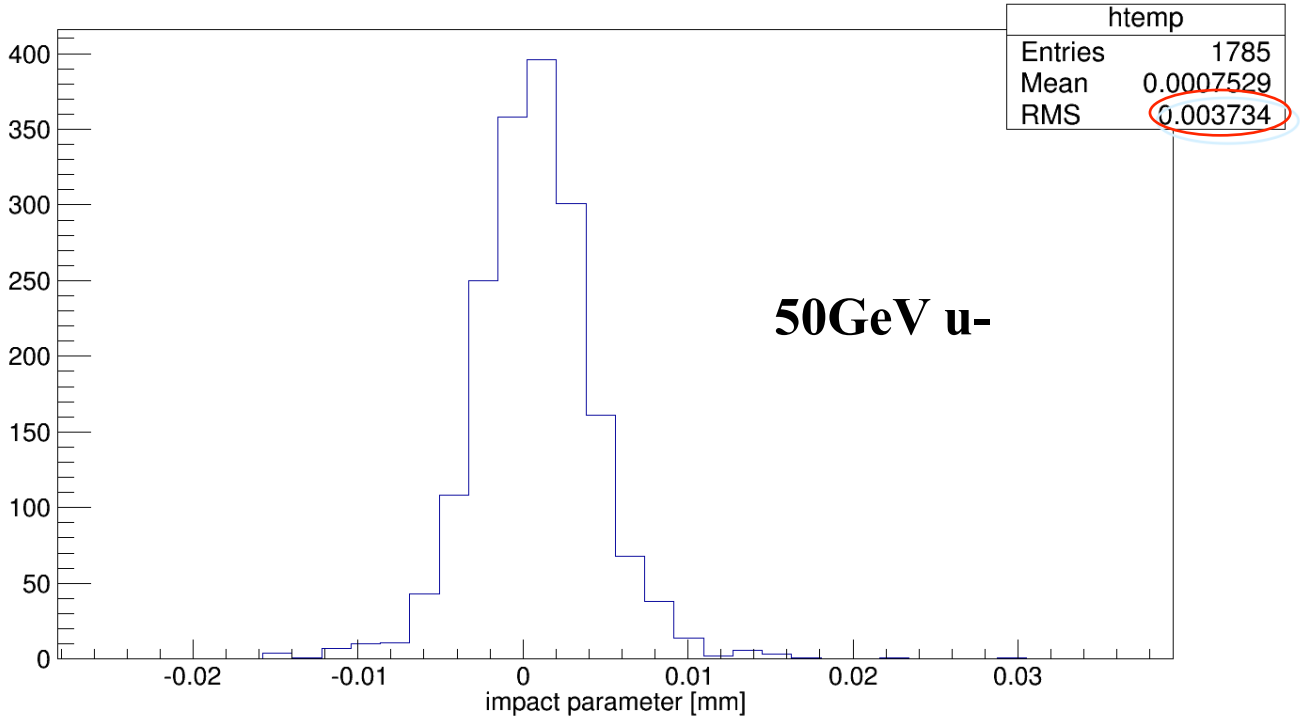
Full simulation

- Based on Mokka and Marlin
  - Method: TrackImpl.h--->getD0()--->impact parameter

Collection name	algorithm
SiTracks	SiliconTracking_MarlinTrk(VXD、SIT、FTD)
ForwardTracks	ForwardTracking(FTD)
SubsetTracks	Combine SiTracks and ForwardTracks
MarlinTrkTracks	Combine SubsetTracks and TPC

Full simulation

- Event
  - 2000 u- : momentum from 1GeV to 100GeV
  - Cut: impact parameter from -0.1mm to 0.1mm



result

- Simulation based on u-, θ = 90 , Vertical incidence