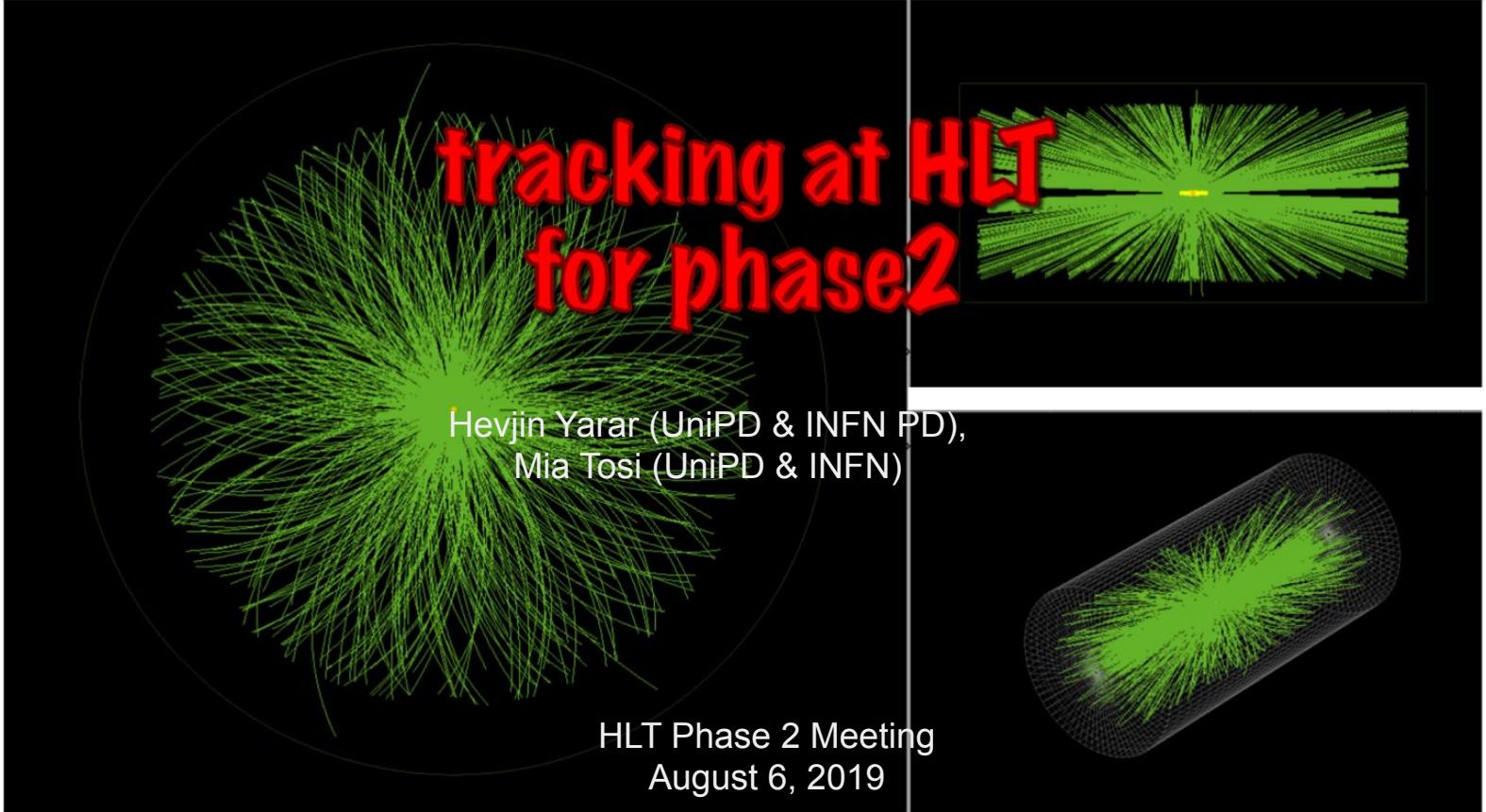


tracking at HLT for phase2

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HLT Phase 2 Meeting
August 6, 2019



Tasks

- Clean config ✓
 - MC_Tracking_v0 : it represents the minimum set of modules for the track reconstruction as it is done in the offline reconstruction
 - Performance and Timing Plots with this version ✓
- New MC_Tracking_v1 path with 3 iterations → performance + timing ✓
- New MC_Tracking_v2 path with 2 iterations → performance + timing ✓
- Introduce modularity with `cff` snippets ✓
- Switch to new release + Run on new samples (ongoing)
- New paths to make use of the beamspot for track selection (ongoing)
- Increase the thresholds (ongoing)
- Check pixel-only tracks for PV reconstruction
- Limit the amount of candidate in the pattern recognition
- Make the steps PV constraint, probably
- Try seed cleaning
- Make use of `pixelTracks`

Current Phase 2 Reconstruction Recipe

```
> cmsrel CMSSW_10_4_0_mtd5  
> cd CMSSW_10_4_0_mtd5/src/ && cmsenv  
> runTheMatrix.py -w upgrade -n | grep 2023 | grep trackingOnly  
> runTheMatrix.py -w upgrade -I 21224.1 --dryRun
```

build from scratch
using the release

Reconstruction and validation done with:

```
cmsRun step3_RAW2DIGI_RECO_VALIDATION_DQM.py
```

Cleaner version: /afs/cern.ch/work/h/hyarar/public/Phase2/MC_Tracking/step3_*.py

standalone scripts
→ next slide

List of TTbar Samples to work with:

PU0:

/store/mc/PhaseIIMTDRAutumn18DR/TTbar_TuneCP5_14TeV_pythia8/FEVT/NoPU_103X_upgrade2023_realistic_v2-v1/

PU200:

/store/mc/PhaseIIMTDRAutumn18DR/TTbar_14TeV_TuneCP5_Pythia8/FEVT/PU200_103X_upgrade2023_realistic_v2-v1/

In the step3 python script change the process.source from step2.root to the list of the samples:

```
process=cms.Process("RECO") ----> process = cms.Process("RECOHLT") #otherwise complains
```

Current Phase 2 Reconstruction Recipe

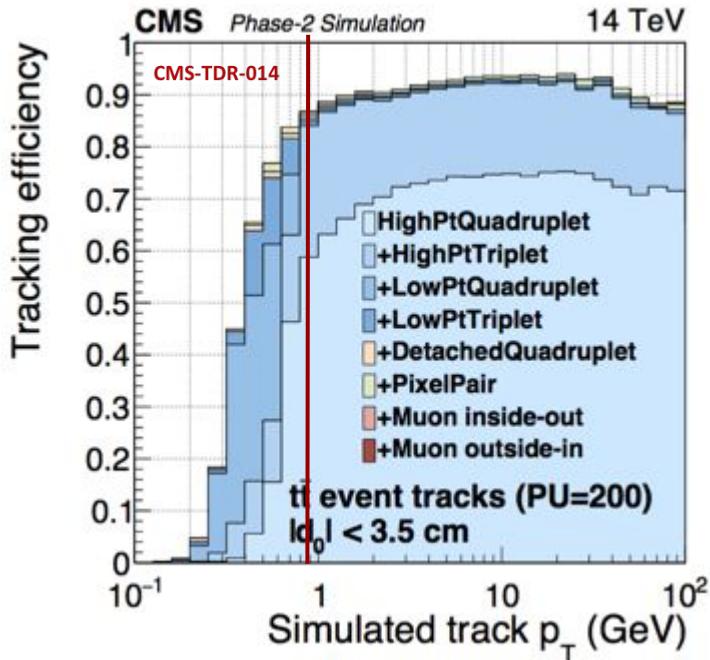
- Files are in: [/afs/cern.ch/work/h/hyarar/public/Phase2/MC_Tracking](https://afs.cern.ch/work/h/hyarar/public/Phase2/MC_Tracking)
- README.txt :

```
#####
step3_clean.py:  
Main file which includes everything. This file is reduced from the original step3.py included in the release by default.  
#####  
step3_timing.py:  
for timing studies with additional modules.  
#####  
step3_performance.py:  
for performance plots.  
#####  
step3_timing_modular.py  
needs:  
- input_TTbar_PhaseIIMTDRAutumn18DR-noPU_103X_upgrade2023_realistic_v2-v1_cff.py (input sample list)  
- input_TTbar_PhaseIIMTDRAutumn18DR-PU200_103X_upgrade2023_realistic_v2-v1_cff.py  
- raw2digi_step_cff.py  
- MC_Tracking_v0_cff.py  
#####  
step3_performance_modular.py  
needs:  
- input_TTbar_PhaseIIMTDRAutumn18DR-noPU_103X_upgrade2023_realistic_v2-v1_cff.py  
- input_TTbar_PhaseIIMTDRAutumn18DR-PU200_103X_upgrade2023_realistic_v2-v1_cff.py  
- raw2digi_step_cff.py  
- MC_Tracking_v0_cff.py  
- MC_prevalidation_v0_cff.py  
- dqmoffline_step_cff.py  
#####  
step4_HARVESTING.py  
step4_HARVESTING_timing.py
```

- > cmsrel CMSSW_10_4_0_mtd5
- > cd CMSSW_10_4_0_mtd5/src/ && cmsenv
- use grid certificate to access data:
 > voms-proxy-init --voms cms
- run and log into a file:
 > cmsRun step3_*.py &> output_*.log &
 > cmsRun step4_HARVESTING.py

Current Phase 2 Reconstruction

- the offline tracking for Phase2 is based on the **Iterative Tracking**



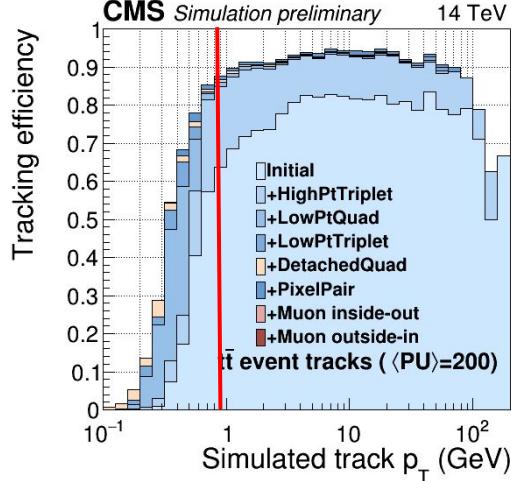
(only for the pixel recovery)

Step Name	Seeding	Target Tracks
* HighPtQuad	pixel quadruplets	prompt, high p_T
* HighPtTriplet	pixel triplets	prompt, high p_T , recovery
* LowPtQuad	pixel quadruplets	prompt, low p_T
LowPtTriplet	pixel triplets	prompt, low p_T , recovery
DetachedQuad	pixel quadruplets	displaced
* PixelPair	pixel pairs	high p_T , recovery
Muon Inside-Out	muon-tagged tracks	muon
Muon Outside-In	muon-tagged tracks	muon

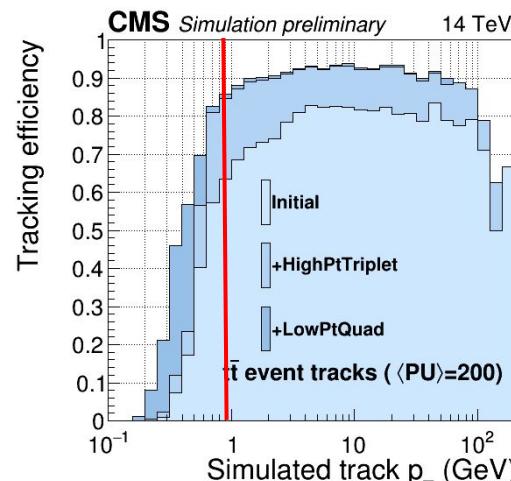
* iterations as we have in the current HLT configuration

Performance - Efficiency vs p_T

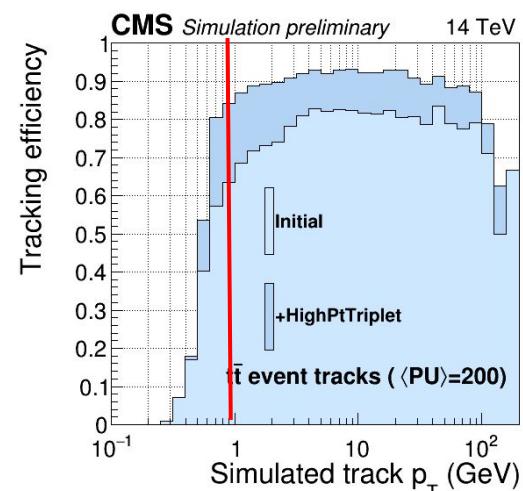
All Iterations



3 Iterations



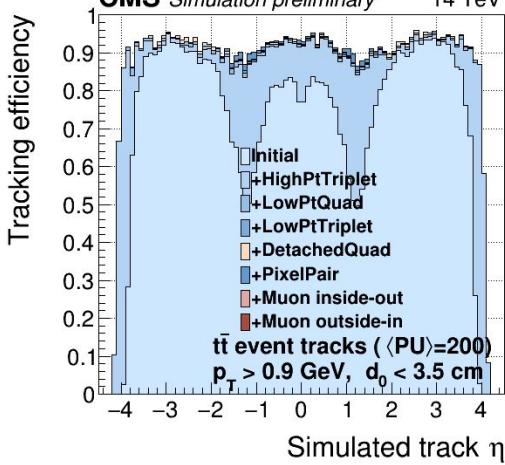
2 Iterations



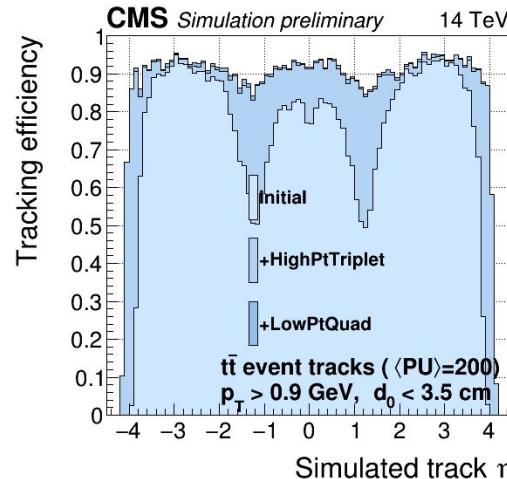
- LowPtTriplet, DetachedQuad, PixelPair, and Muon iterations
 - are meant for recovering the efficiency in phase-space which are probably not that relevant at HLT

Performance - Efficiency vs eta

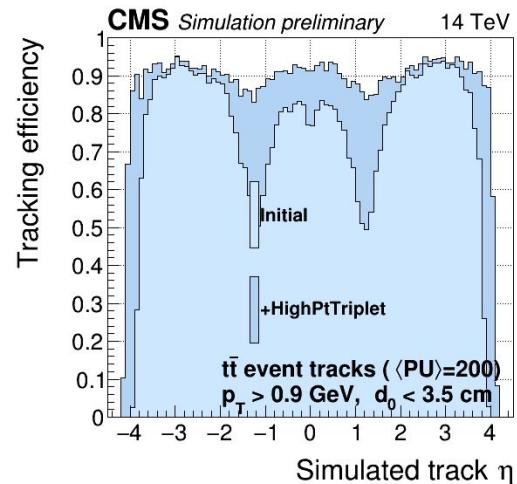
All Iterations



3 Iterations



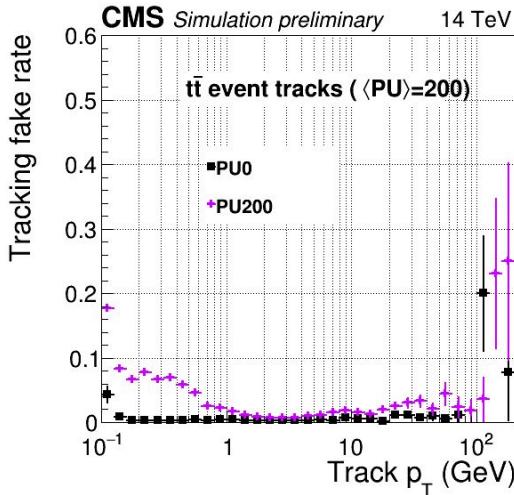
2 Iterations



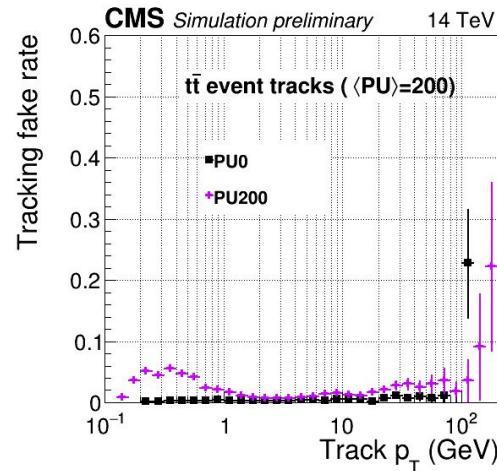
- The efficiency is recovered by the HighPtTriplet step, LowPtQuad does not add much.

Performance - Fake Rate vs p_T

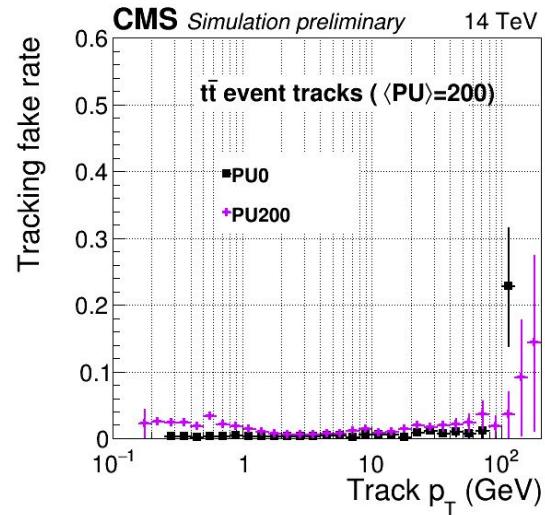
All Iterations



3 Iterations



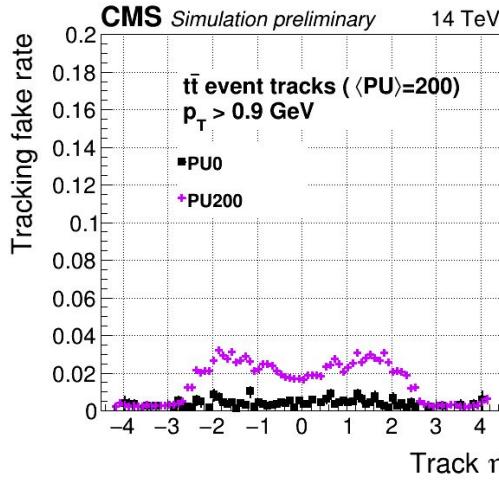
2 Iterations



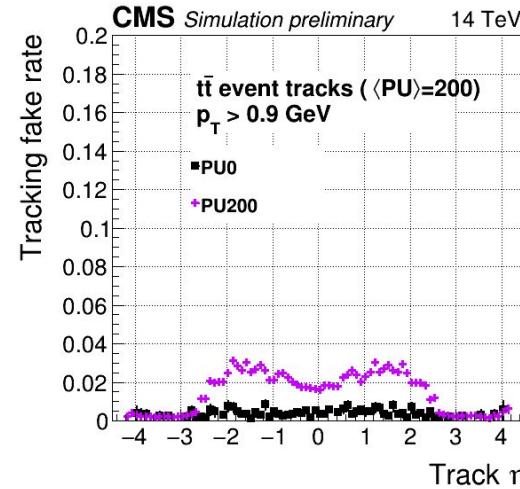
- Less fakes in the high p_T tracks at PU200 with two iterations.

Performance - Fake Rate vs eta

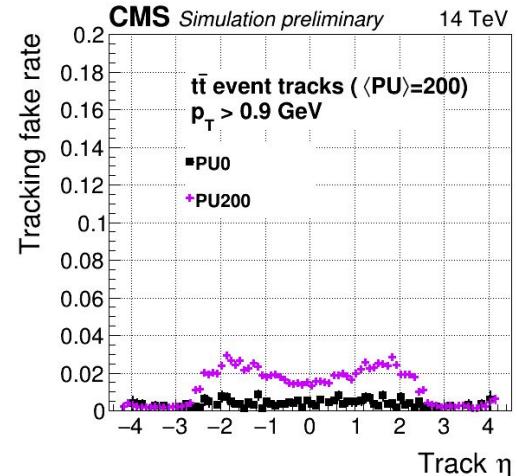
All Iterations



3 Iterations



2 Iterations

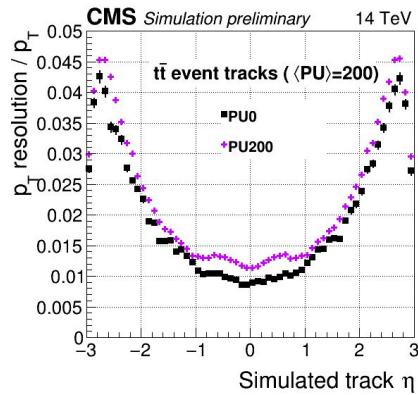


- Slightly less fakes ($-1 < \text{eta} < 1$) at PU200 with two iterations.

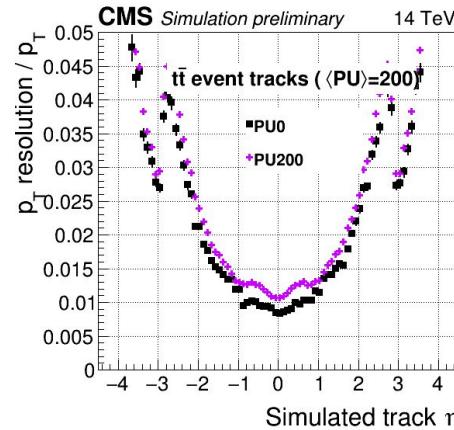
$pT > 0.9$ GeV

Performance - Resolution - p_T vs eta

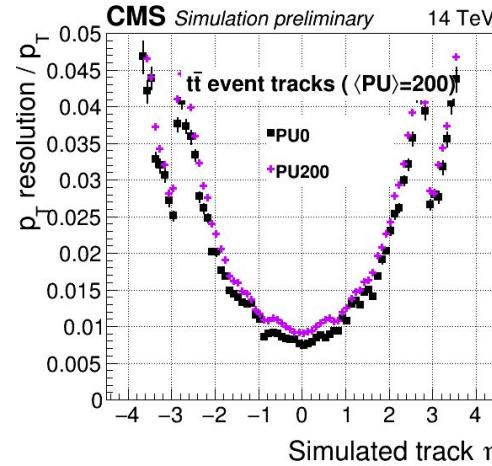
All Iterations



3 Iterations



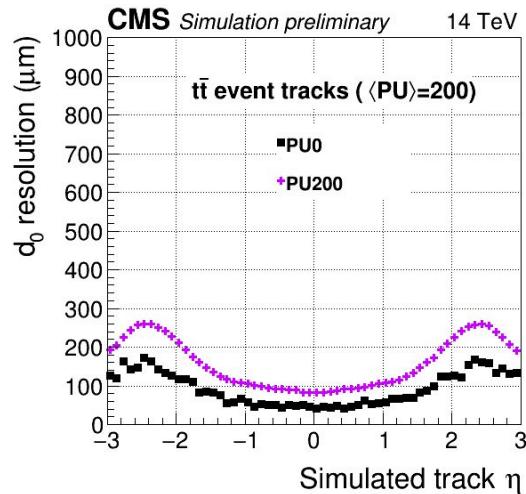
2 Iterations



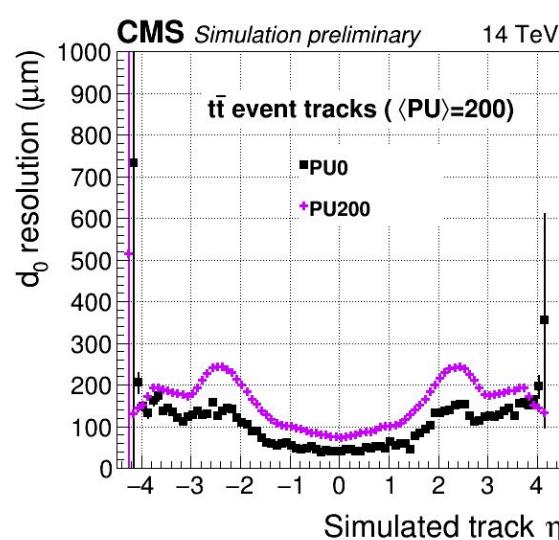
- Pt vs eta degrades slightly close to eta ~ 0

Performance - Resolution - d_{xy} vs eta

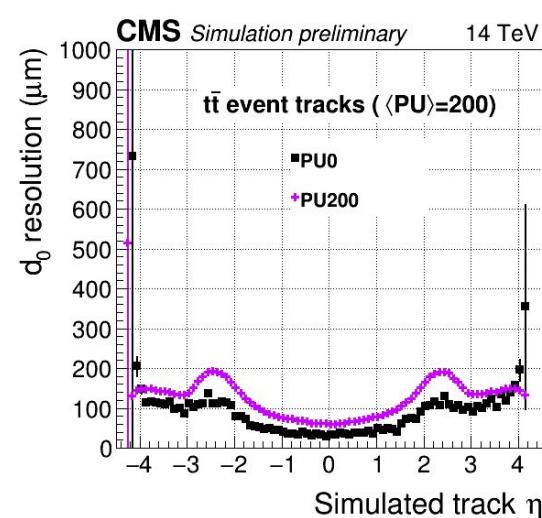
All Iterations



3 Iterations



2 Iterations



- Dxy vs eta decreases close to $|\text{eta}| \sim 2.5$

Timing

Running on

- vocms004 machine
- 1k events
- TTbar_14 events (PhaseIIMTDTDRAutumn18DR campaign:
CMSSW_10_4_0_mtd5, 103X_upgrade2023_realistic_v2 ,)
- Multithreaded
 - 16 cores `process.options.numberOfStreams = cms.untracked.uint32(16)`
`process.options.numberOfThreads = cms.untracked.uint32(16)`

Timing

MC_Tracking		tracking path <timing> per event [ms]	inner tracking-only modules <timing> per event [ms]
v0	<PU>=0	460	280 (61 %)
	<PU>=200	38 600	25 100 (65 %)
v1	<PU>=0	360	250 (70 %)
	<PU>=200	29 000	18 800 (65 %)
v2	<PU>=0	290	190 (66 %)
	<PU>=200	18 350	11 700 (64 %)

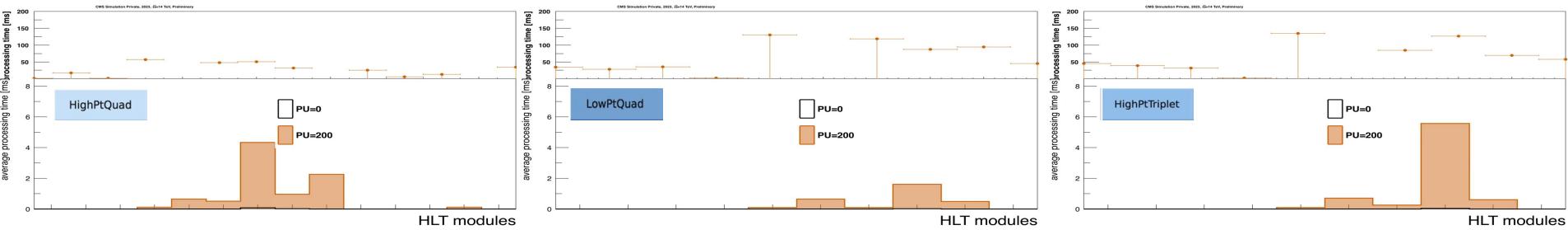
per thread

- We are still far from having something running online, 18 s per event is unaffordable.

Timing per iteration

	Efficiency [%]		Fakerate [%]			<timing> per event [ms]		
	<PU>=0	<PU>=200	<PU>=0	<PU>=200		<PU>=0	<PU>=200	
HighPtQuad	77	74	0.25	1.8	x7	140	6600	x50
HighPtTriplet	15	15	0.7	25	x36	28	3000	x115
LowPtQuad	0.8	0.9	0.3	7.8	x26	60	7300	x120
LowPtTriplet	0.05	0.09	1	35	x35	10	1600	x180
DetachedQuad	0.6	0.5	0.7	17	x24	12	3900	x350
PixelPair	1	1	2	55	x27	6	450	x90

Backup 1 - iterations

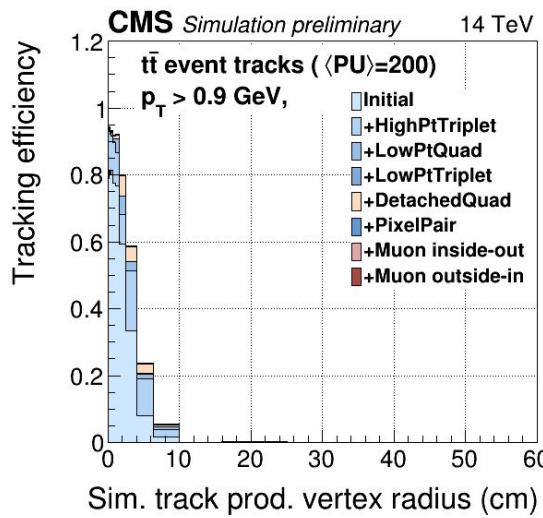


we have to squeeze the timing

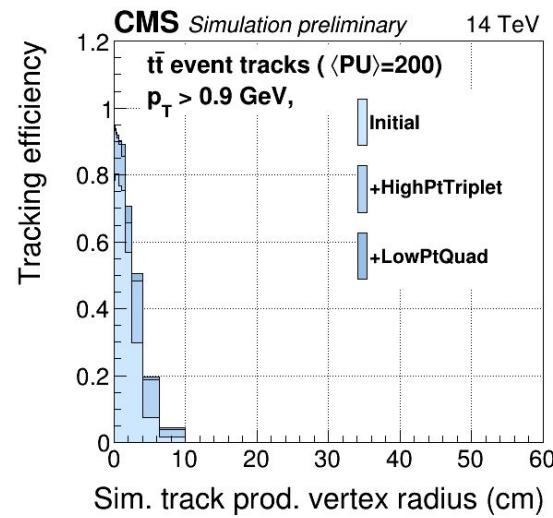
- limit the amount of fakes (and duplicates) already at seeding level
- limit the amount of candidates in the pattern recognition step

Backup 2 - Performance: Efficiency vs vertex radius

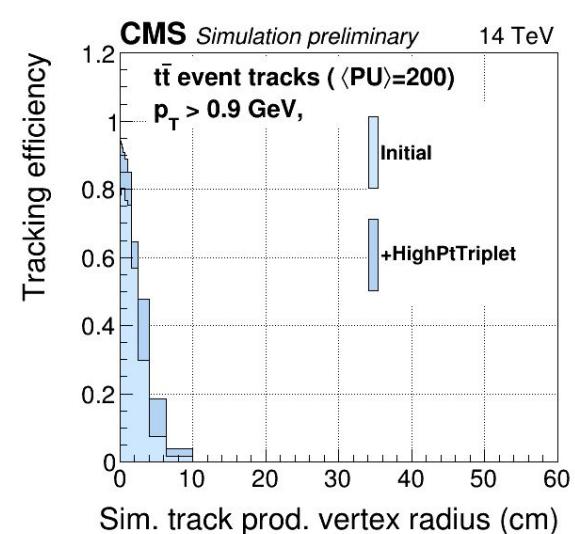
All Iterations



3 Iterations



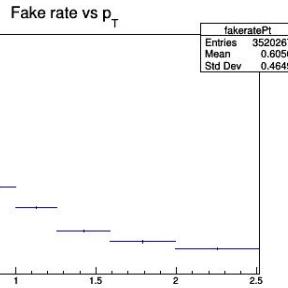
2 Iterations



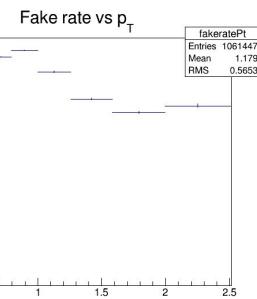
Backup 3: Baseline Performance - Fake Rate per iteration

Tracks (after fitting and selection)

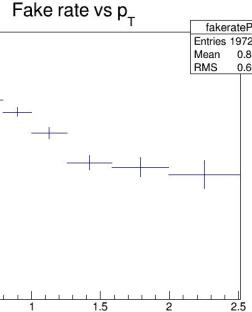
InitialStep



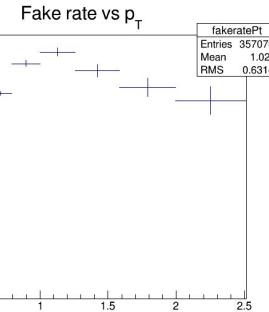
HighPtTriplet



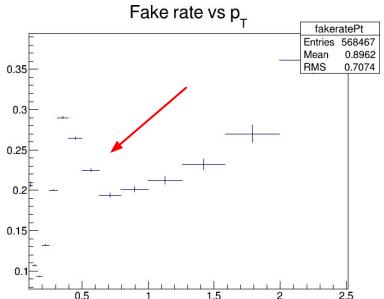
LowPtQuad



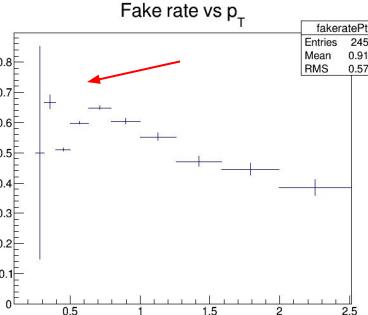
LowPtTriplet



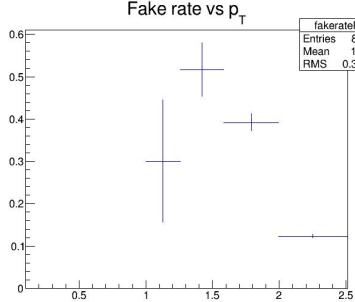
DetachedQuad



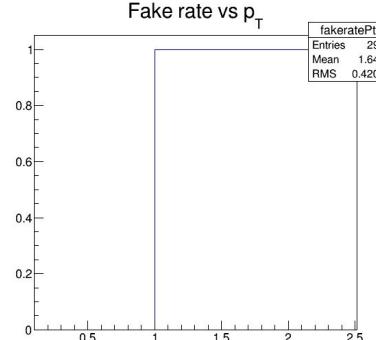
PixelPair



Muon inside-out

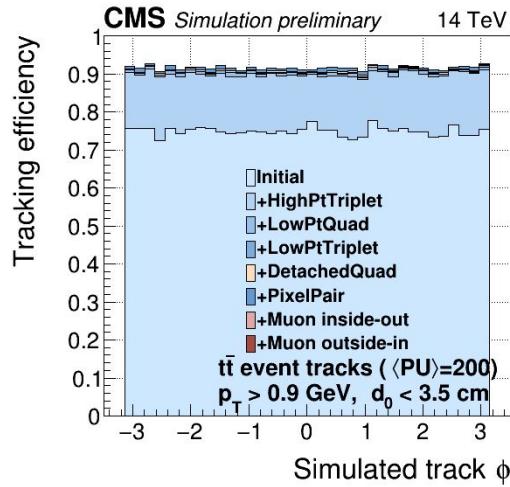


Muon outside-in

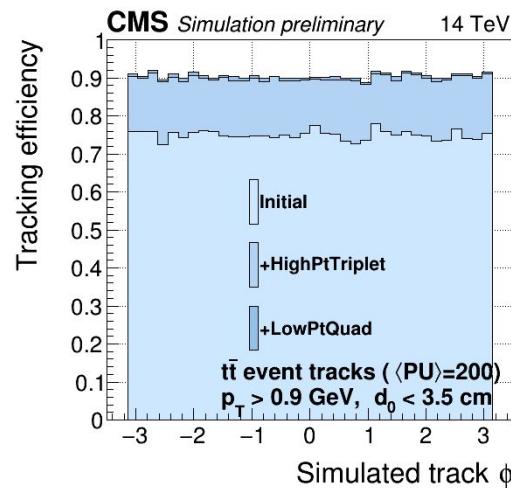


Backup 4: Performance - Efficiency vs Phi

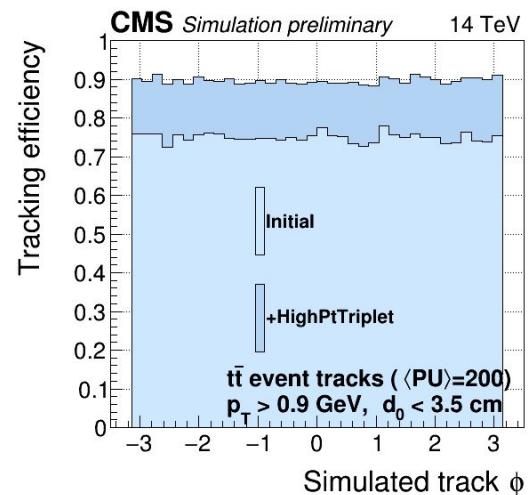
All Iterations



3 Iterations

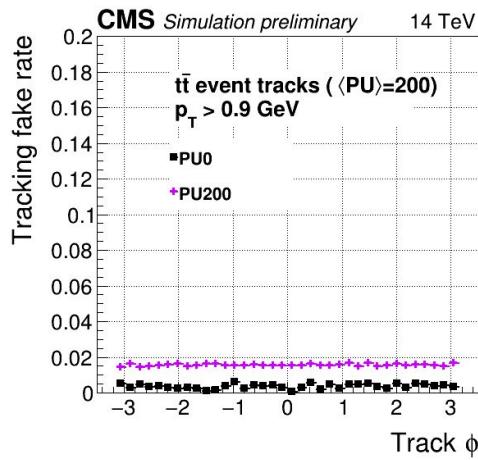


2 Iterations

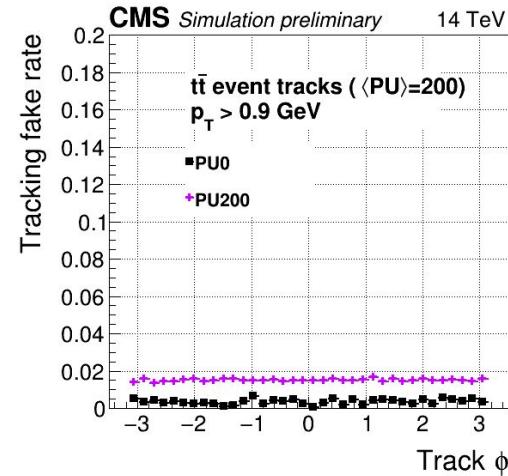


Backup 5 - Performance - Fake Rate vs phi

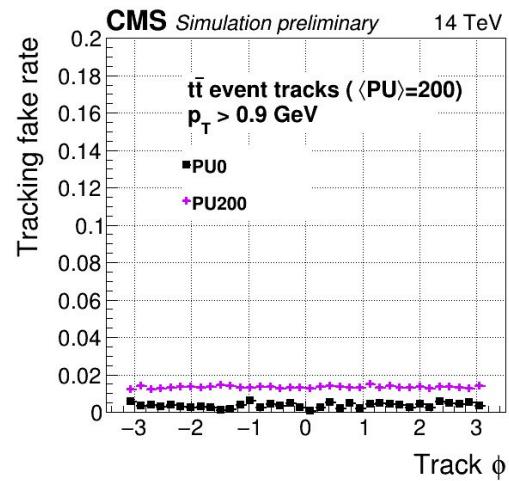
All Iterations



3 Iterations

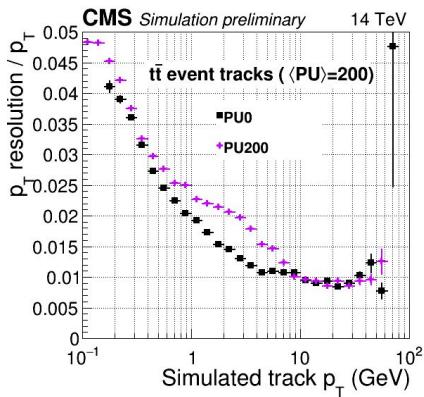


2 Iterations

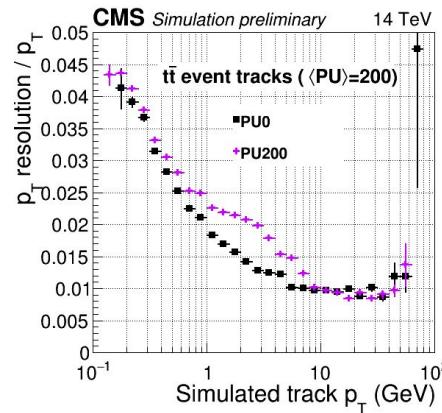


Backup 6: Performance - Resolution - p_T vs p_T

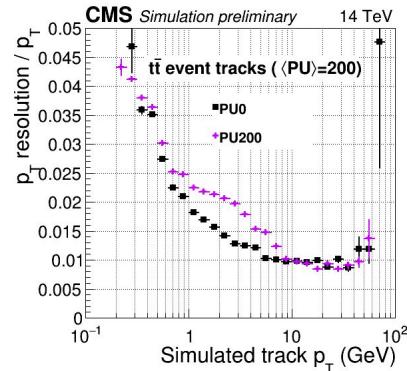
All Iterations



3 Iterations



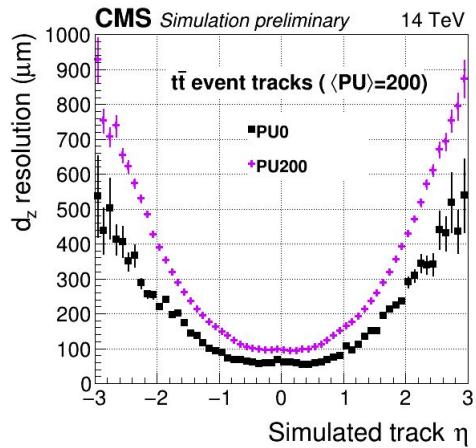
2 Iterations



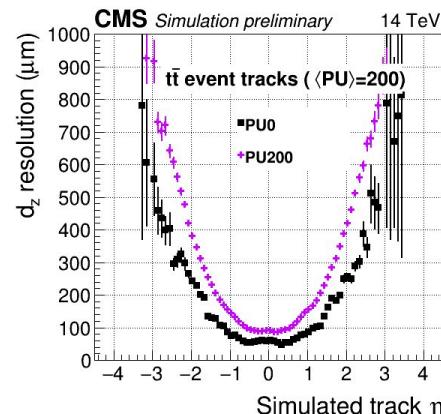
- Pt vs pt is the same

Backup 7: Performance - Resolution - d_z vs eta

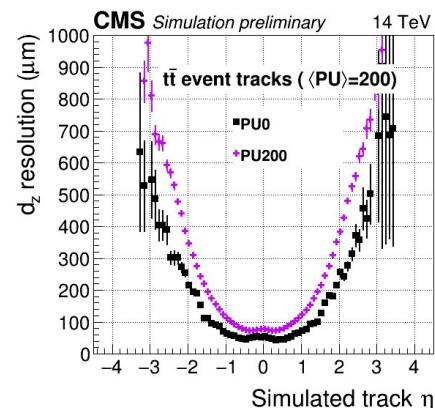
All Iterations



3 Iterations



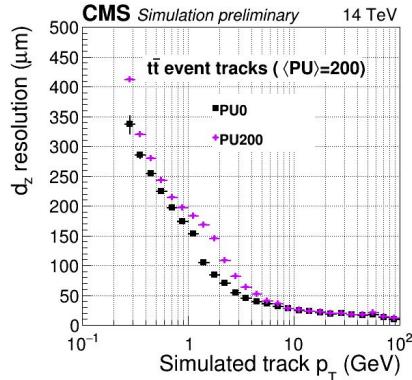
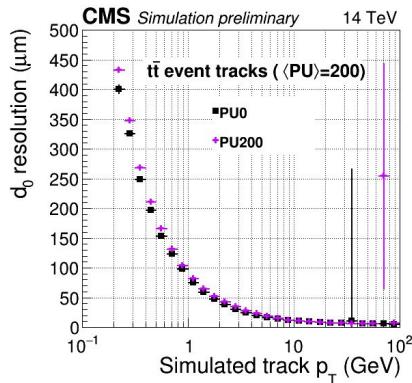
2 Iterations



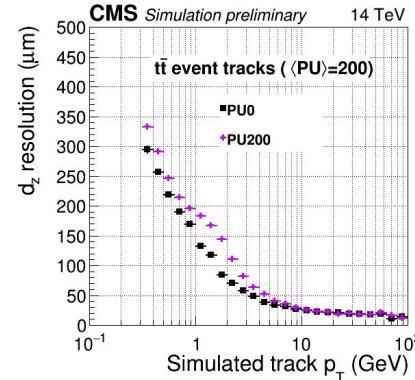
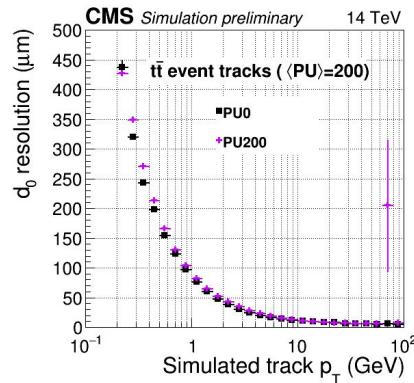
- Dz vs eta looks the same

Backup 8: Performance - Resolution - d_{xy}/dz vs p_T

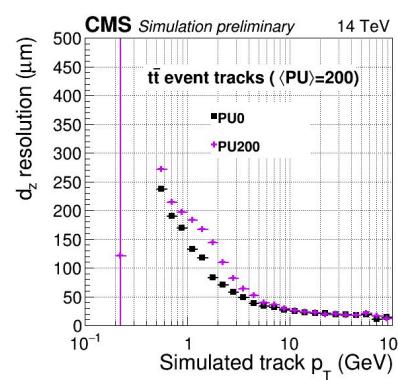
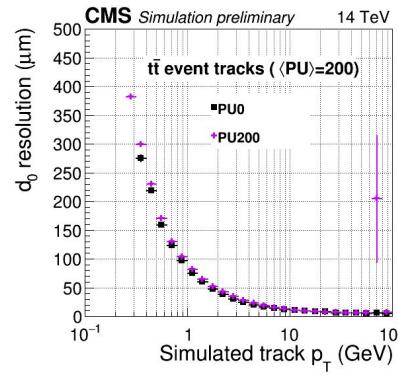
All Iterations



3 Iterations



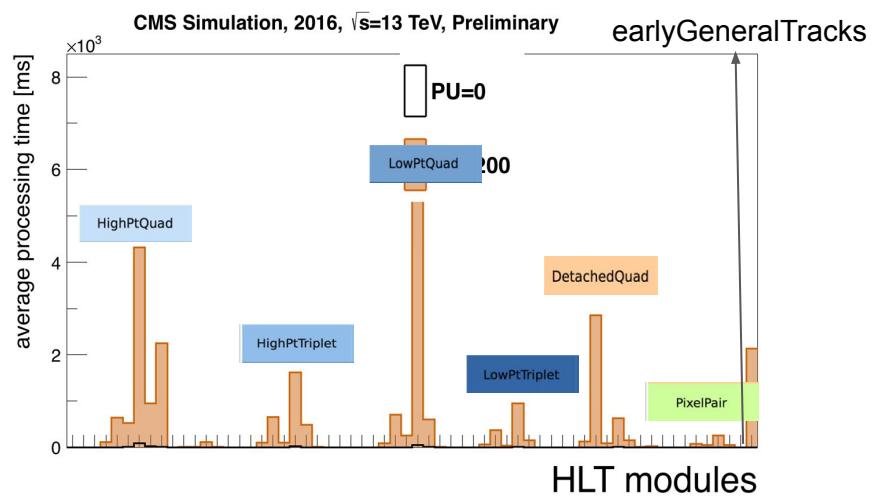
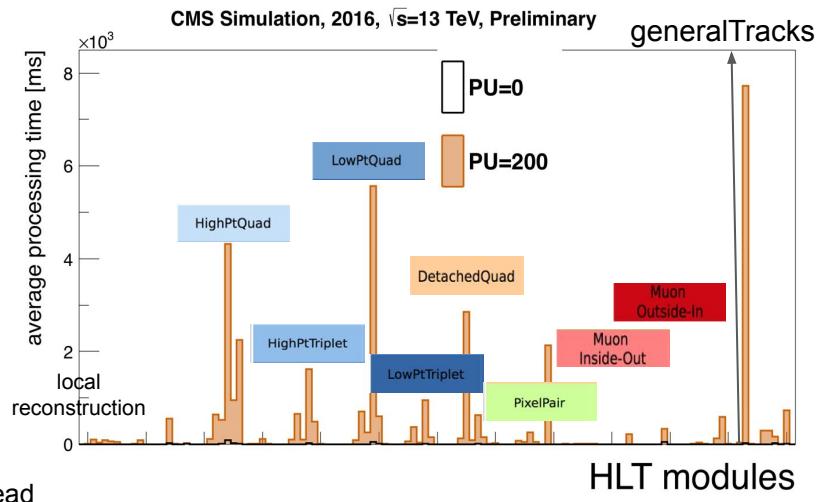
2 Iterations



- They look the same (above ~ 0.5 GeV)

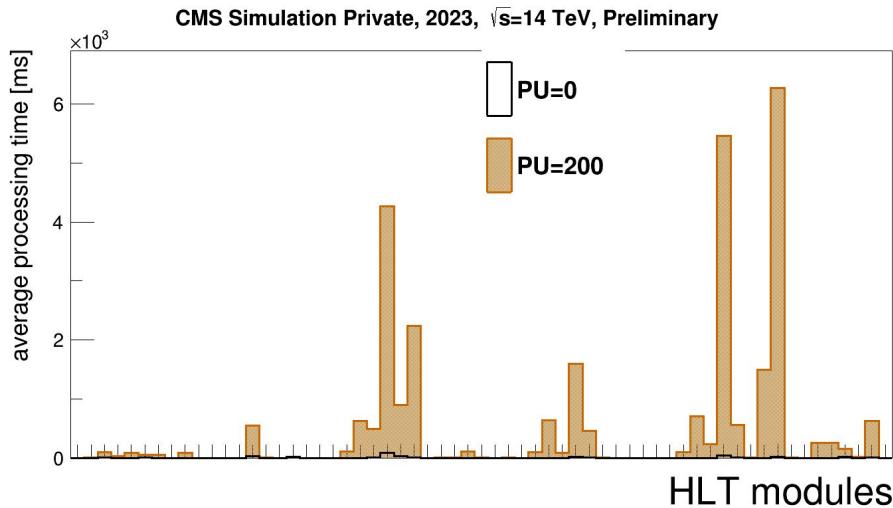
Backup 10: Timing - all iterations - previous study

	process <timing> per event [ms]	tracking path <timing> per event [ms]	tracking-only modules <timing> per event [ms]	inner tracking-only modules <timing> per event [ms]
$\langle \text{PU} \rangle = 0$	900	450 (50 %)	350 (78 %)	260 (58 %)
$\langle \text{PU} \rangle = 200$	39 300	38 900 (99 %)	28 600 (74%)	25 000 (64 %)

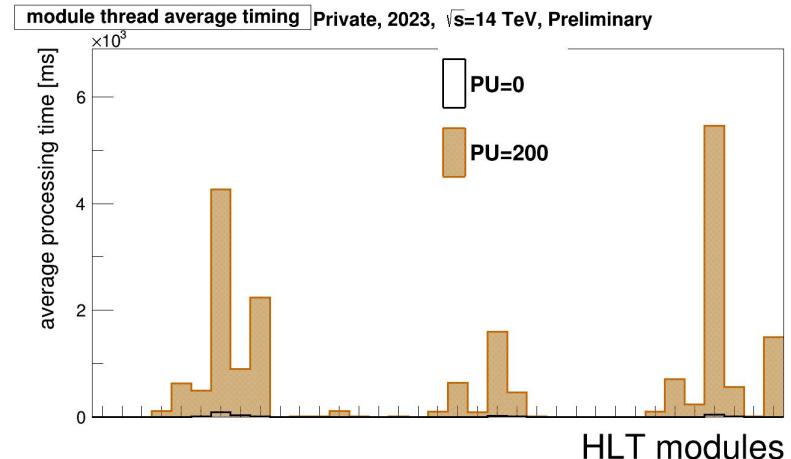


Backup 11: Timing - 3 iterations

By modules

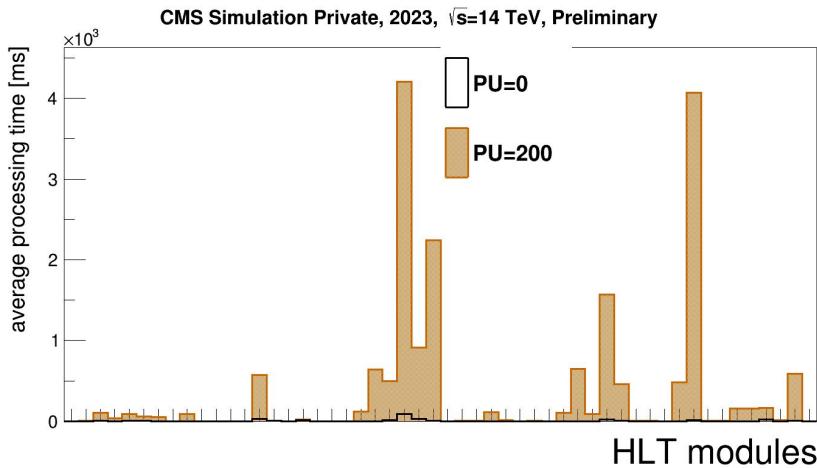


Early general tracks → General Tracks

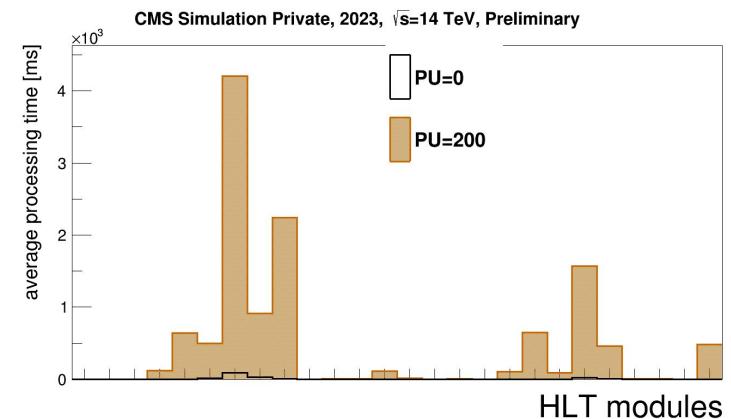


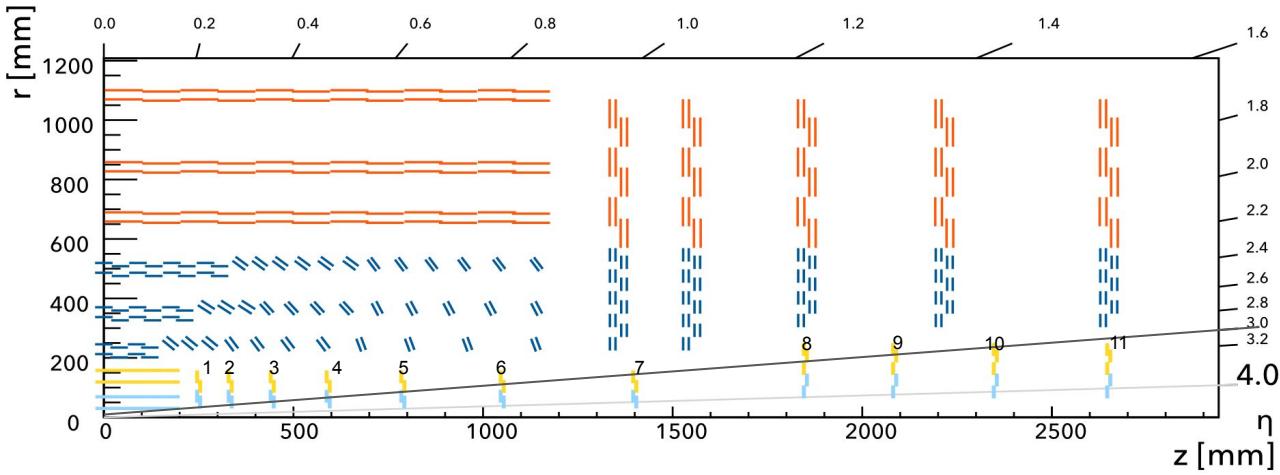
Backup 12: Timing - 2 iterations

By modules



Early general tracks → General Tracks





'BPix1+BPix2+BPix3+BPix4',
 'BPix1+BPix2+BPix3+FPix1_pos',
 'BPix1+BPix2+BPix3+FPix1_neg',
 'BPix1+BPix2+FPix1_pos+FPix2_pos',
 'BPix1+BPix2+FPix1_neg+FPix2_neg',
 'BPix1+FPix1_pos+FPix2_pos+FPix3_pos',
 'BPix1+FPix1_neg+FPix2_neg+FPix3_neg',
 'FPix1_pos+FPix2_pos+FPix3_pos+FPix4_pos',
 'FPix1_neg+FPix2_neg+FPix3_neg+FPix4_neg',
 'FPix2_pos+FPix3_pos+FPix4_pos+FPix5_pos',
 'FPix2_neg+FPix3_neg+FPix4_neg+FPix5_neg',
 'FPix3_pos+FPix4_pos+FPix5_pos+FPix6_pos',
 'FPix3_neg+FPix4_neg+FPix5_neg+FPix6_neg',
 'FPix4_pos+FPix5_pos+FPix6_pos+FPix7_pos',
 'FPix4_neg+FPix5_neg+FPix6_neg+FPix7_neg',
 'FPix5_pos+FPix6_pos+FPix7_pos+FPix8_pos',
 'FPix5_neg+FPix6_neg+FPix7_neg+FPix8_pos',
 'FPix6_pos+FPix7_pos+FPix8_pos',
 'FPix6_neg+FPix7_neg+FPix8_neg'