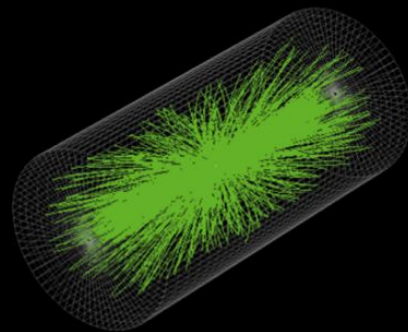
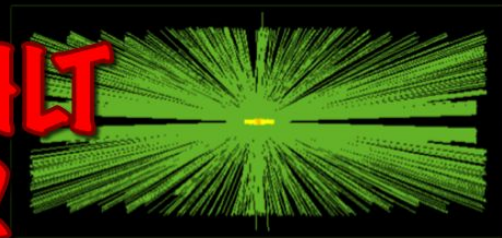


tracking at HLT for phase2

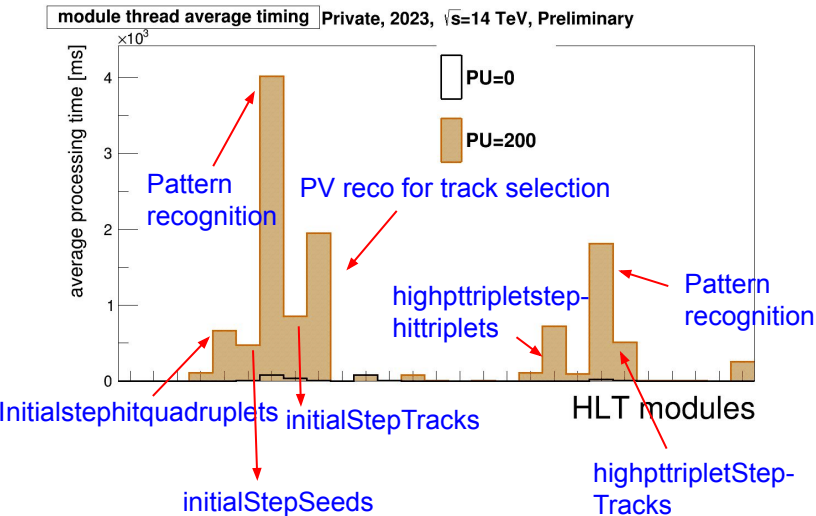
Hevjin Yarar (UniPD & INFN PD),
Mia Tosi (UniPD & INFN)

HLT Upgrade Workshop
February 13, 2020



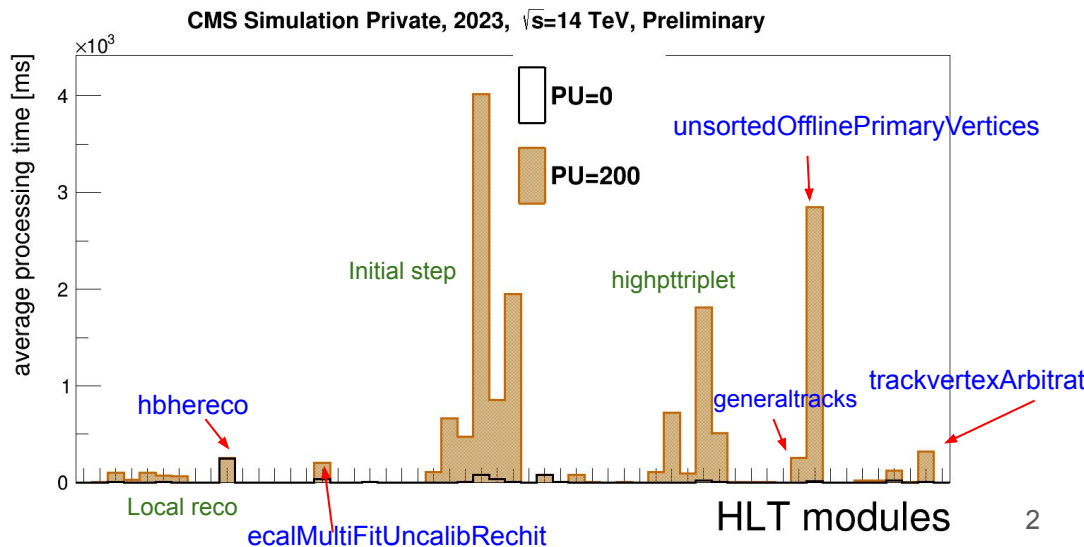
v2 - Baseline Timing

2028



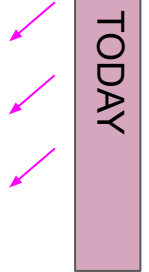
Inner tracking / total [% of total]
 PU=0: 0.255 / 0.600 s [42%]
 PU=200 : 11.537 / 15.985 s [72%]

Inner tracking: up to and including merging of the 2 iterations initialstep and highpttripletpstep (top left)
Total: including vertex reco (bottom right)



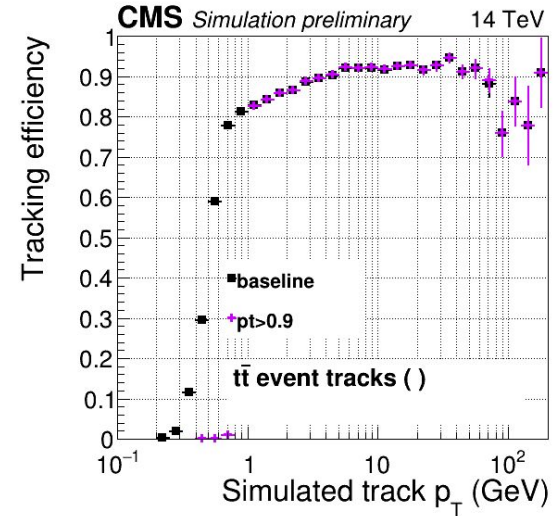
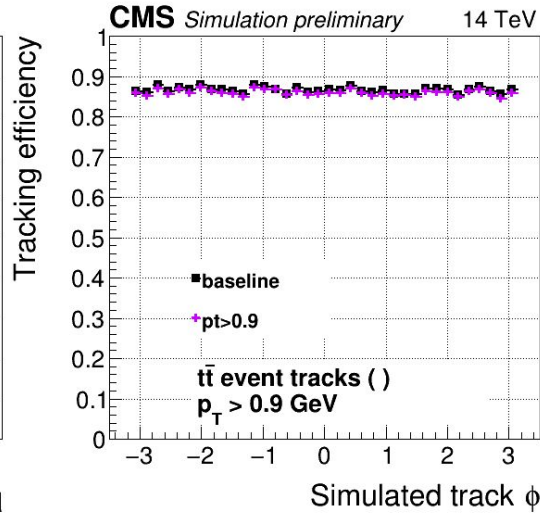
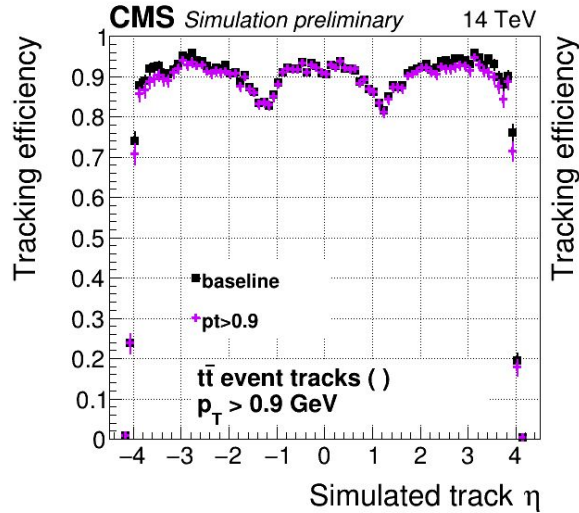
MC_Tracking current versions

cff file name	Description	Tracking Timing [s]
MC_Tracking_v2	2 iterations	11.4
MC_Tracking_v3	v2 + ($pt > 0.9$)	6.4
MC_Tracking_v4	v3 + track building optimized	5.5
MC_Tracking_v4_1	v4 + $ \eta < 3$ for PV reco for track selection	5.4
MC_Tracking_v4_1_1	v4_1 + $pt > 1.5$ or 2 for PV reco for track selection	
MC_Tracking_v4_2	v4_1 + ($ \eta < 3$)	
MC_Tracking_v5	v2 + using beamspot instead of vertices for track selection	work in progress
MC_Tracking_v5_1	v4_2 + using beamspot instead of vertices for track selection	work in progress
MC_Tracking_v6	v4 + pixelVertices	



v3 - Performance (I)

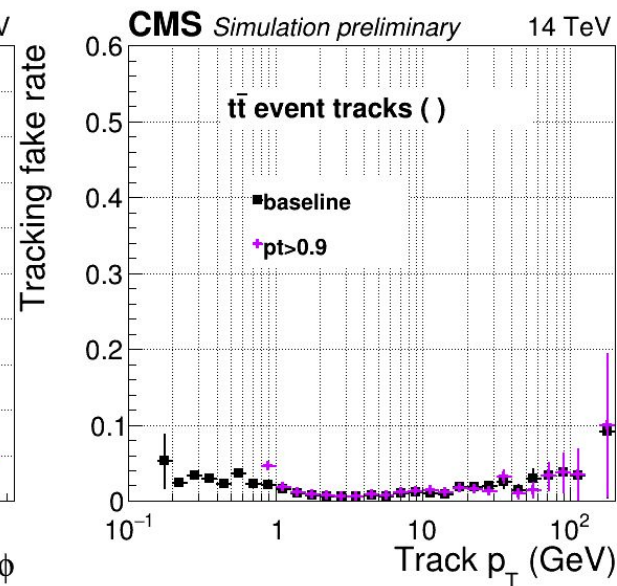
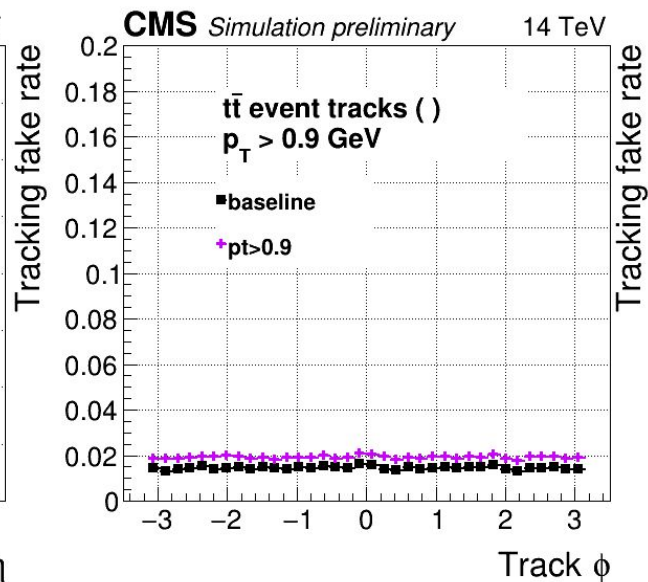
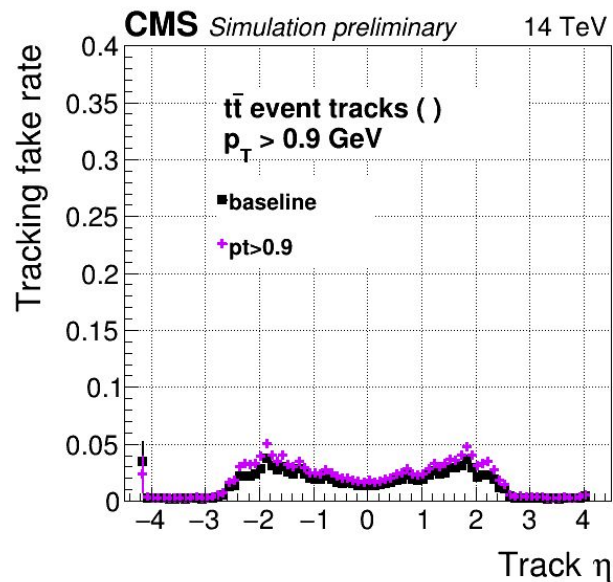
- $P_t > 0.9$



- Efficiency seems ok. Slight decrease at high eta (0.7 %).

v3 - Performance (II)

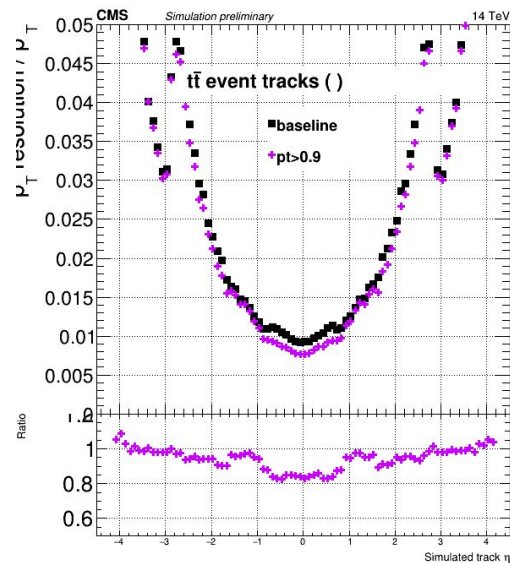
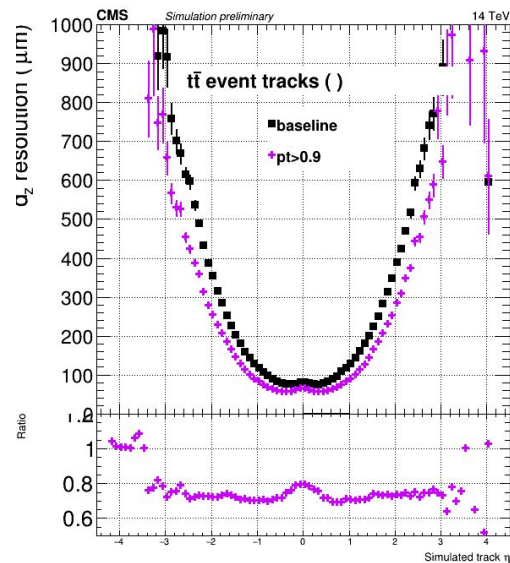
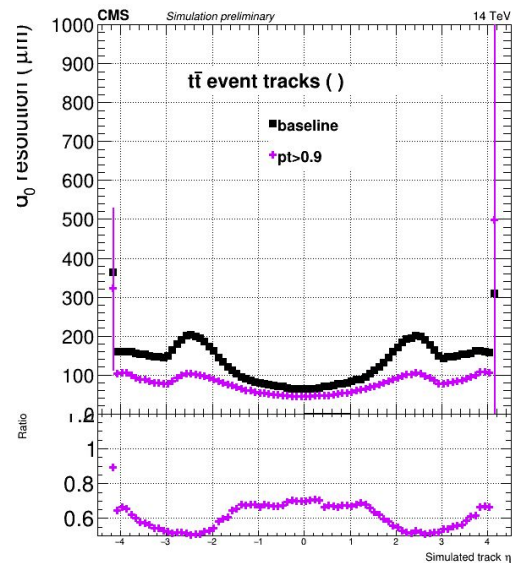
- $P_t > 0.9$



- Slight increase of fake tracks (0.3 %).

v3 - Performance (III)

- $P_t > 0.9$



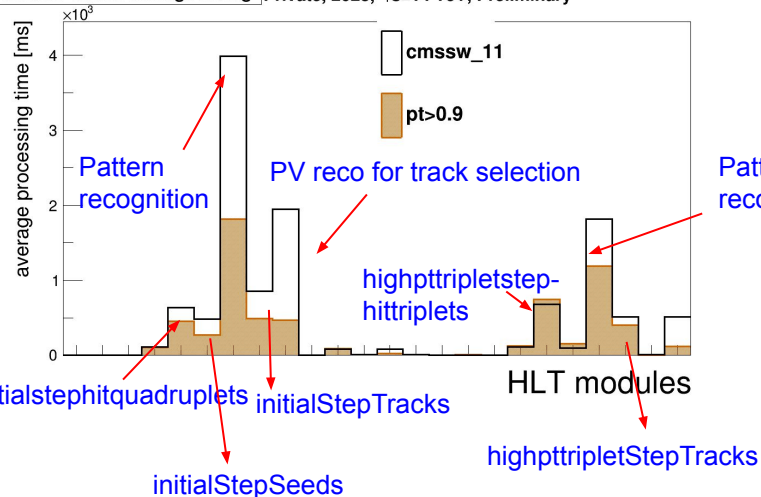
- IP resolution improves as expected by looking at only high- p_t tracks.

v3 - Timing

- Pt > 0.9

- 5 s decrease for inner tracking
- Slight increase for highpttripletstep seeds

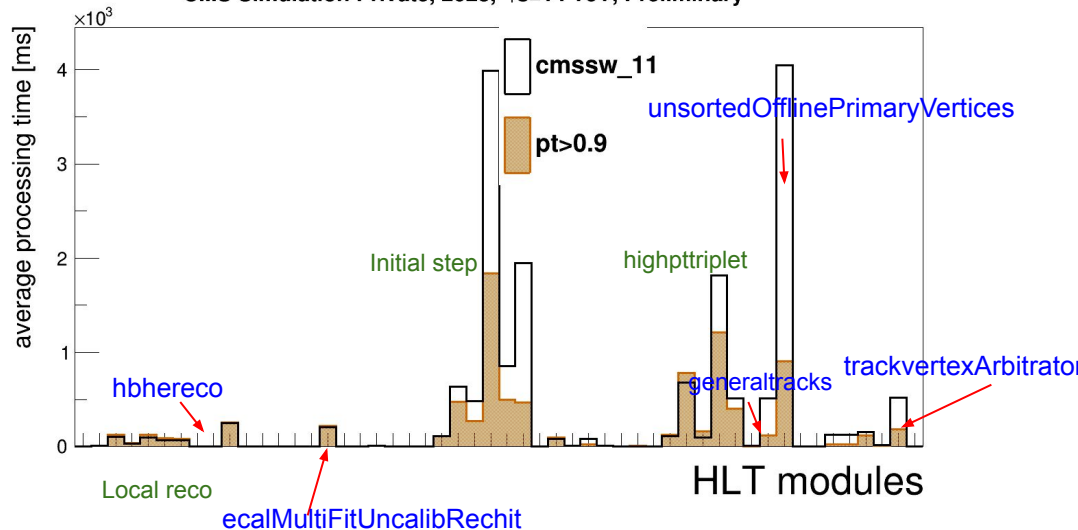
module thread average timing Private, 2023, $\sqrt{s}=14$ TeV, Preliminary



Inner tracking [% of total]
 cmssw_11 --> 11.4 s [64.3 %]
 pt>0.9 --> 6.4 s [73.4 %]

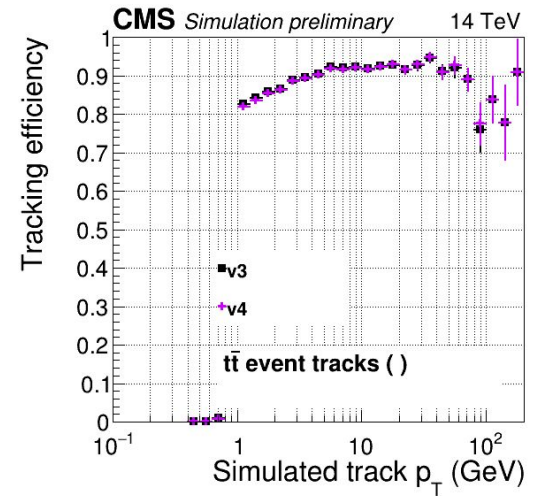
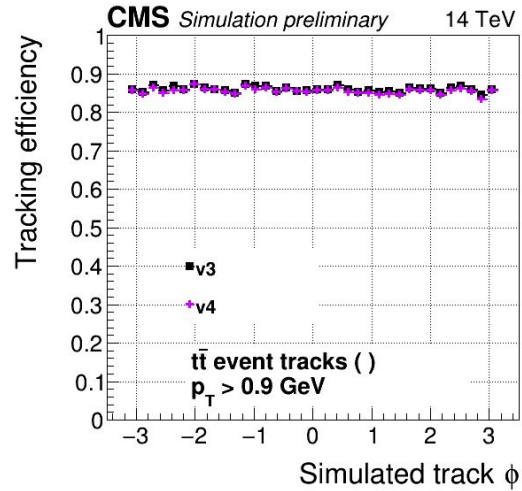
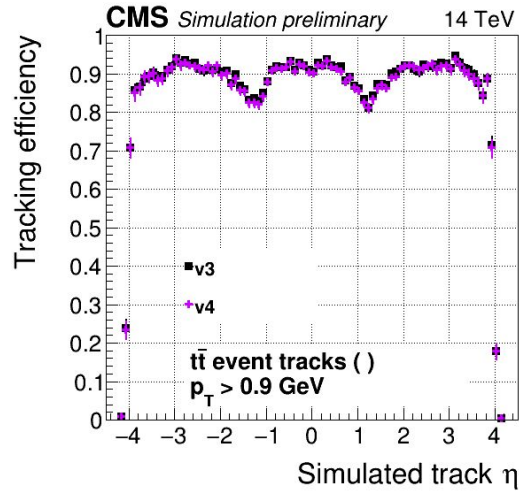
Timing gain: 5s (44%)

CMS Simulation Private, 2023, $\sqrt{s}=14$ TeV, Preliminary



v4 - Performance (I)

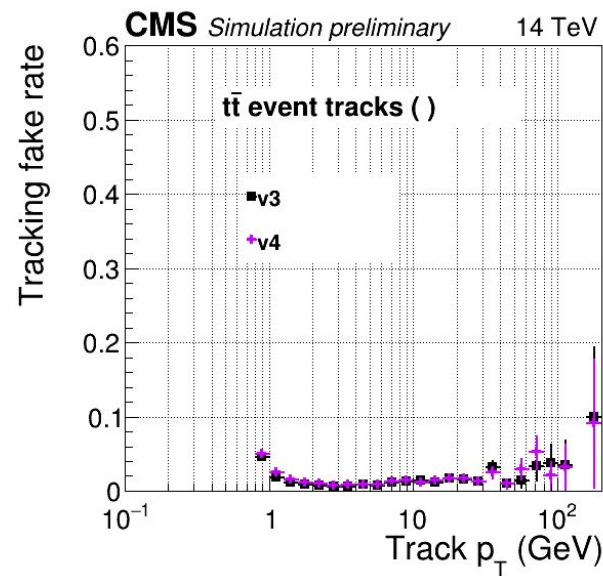
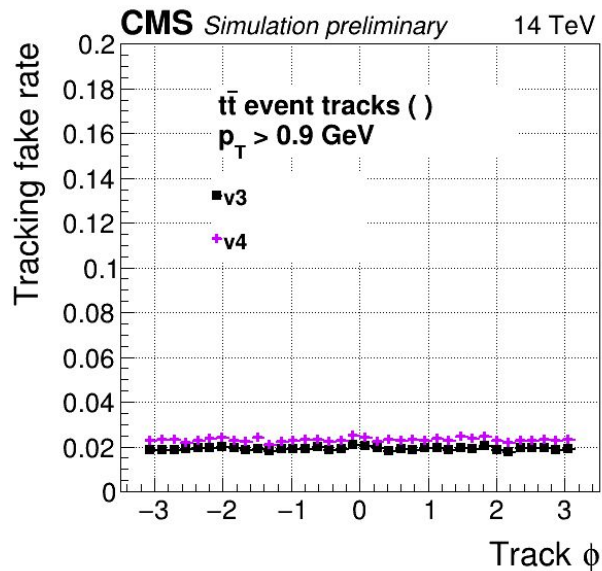
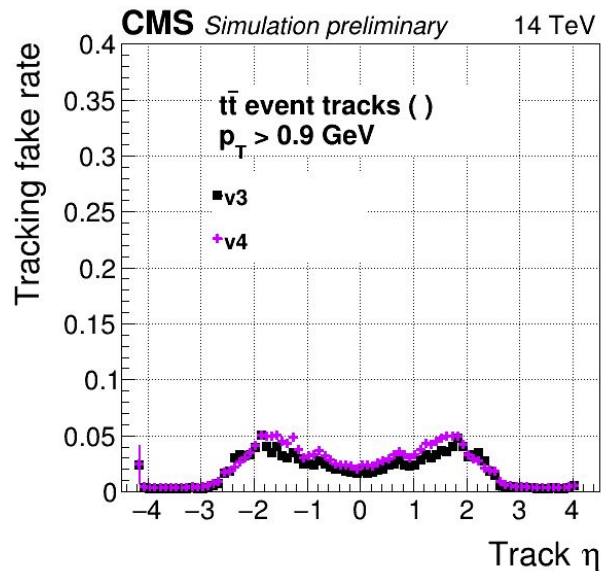
- $P_t > 0.9$
- Track building optimized (see backup for changes)



- Efficiency seems the same.

v4 - Performance (II)

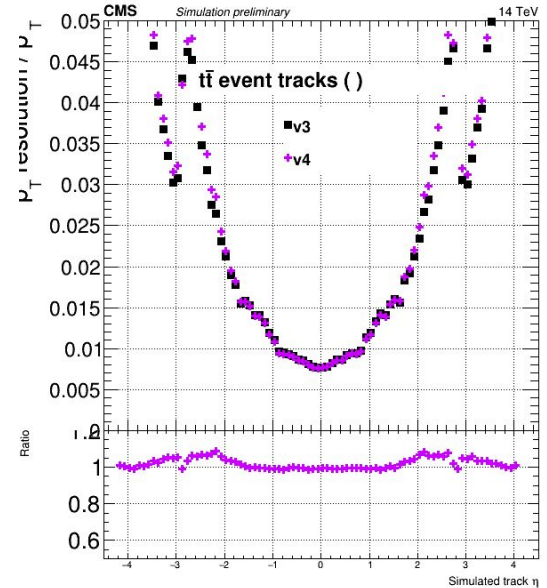
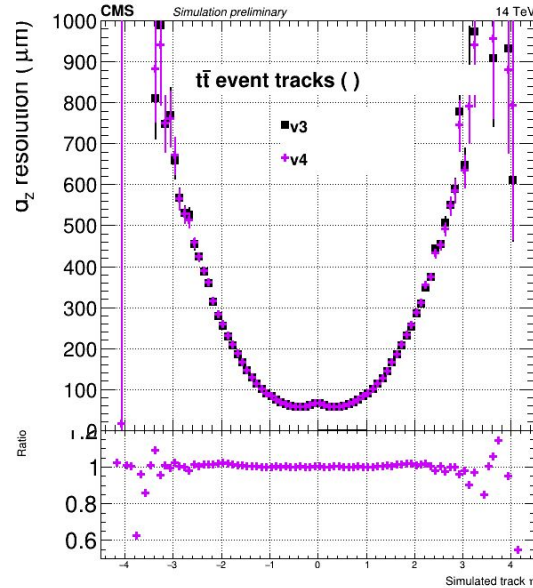
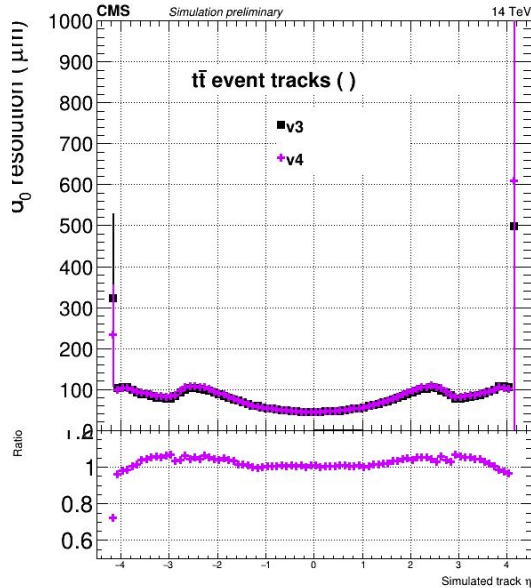
- $P_t > 0.9$
- Track building optimized (see backup for changes)



- Slight increase of fake tracks.

v4 - Performance (III)

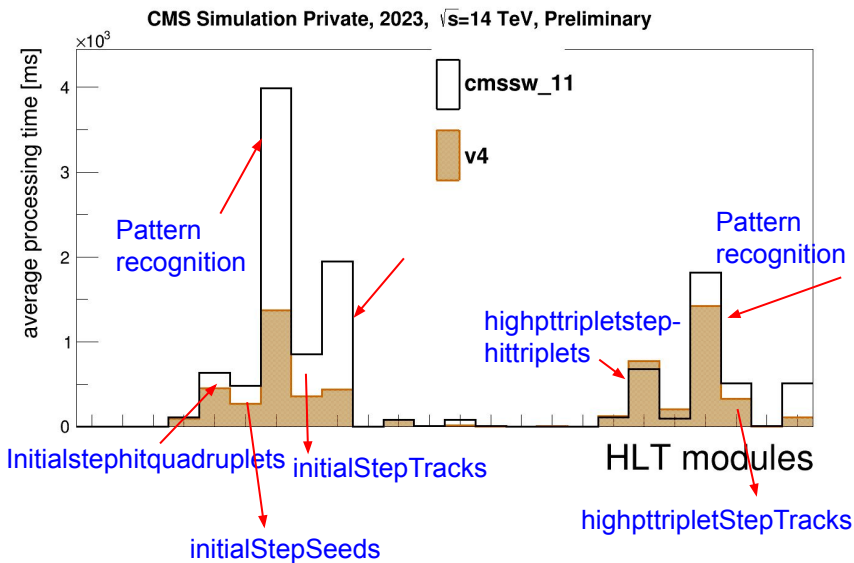
- $P_t > 0.9$
- Track building optimized (see backup for changes)



- Looks similar (slight difference at high eta) .

v4 - Timing

- $P_t > 0.9$
- Track building optimized
- ~ 0.9 s decrease
- Pattern recognition for second iteration takes slightly more time (~ 0.25 s)

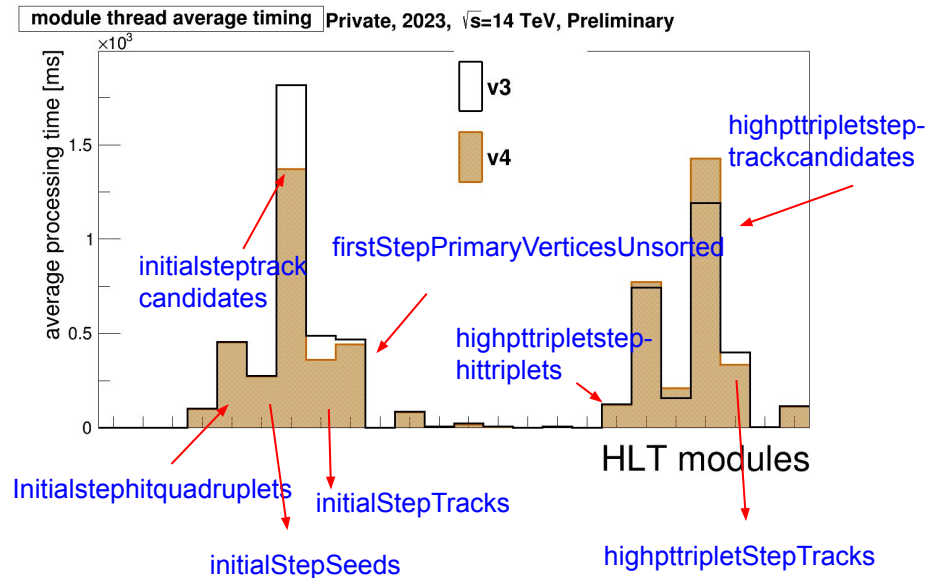


cmssw_11 --> 11.4 s [64.3 %]

v4 --> 5.5 s [70.5 %]

v4 vs Baseline

Timing gain: ~ 0.9 s (15%)



v3 --> 6.4 s [73.4 %]

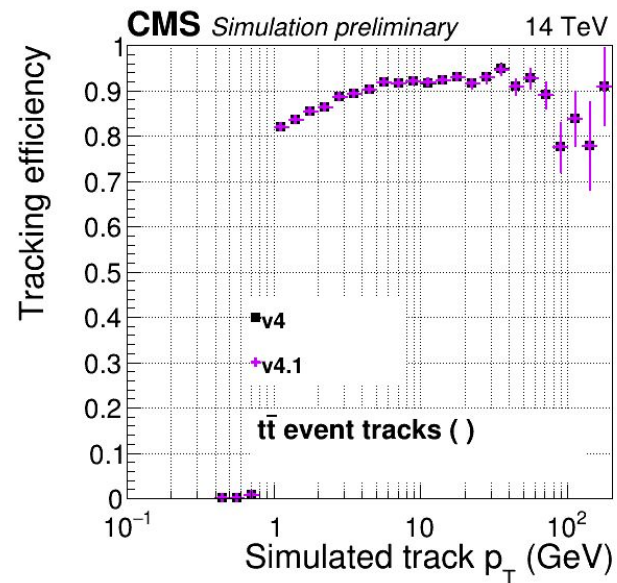
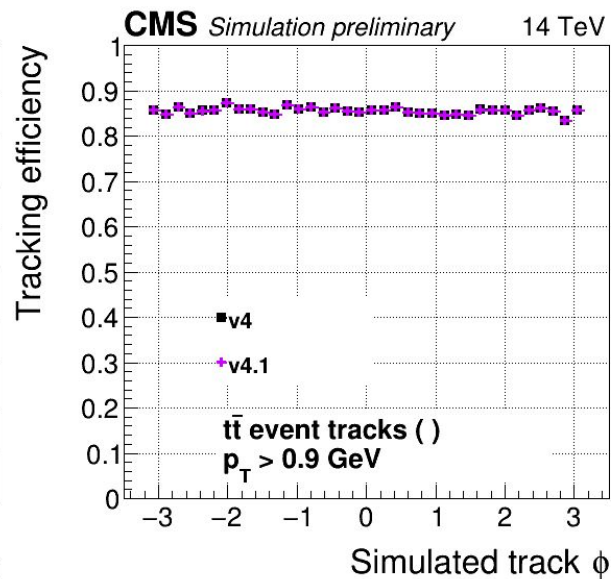
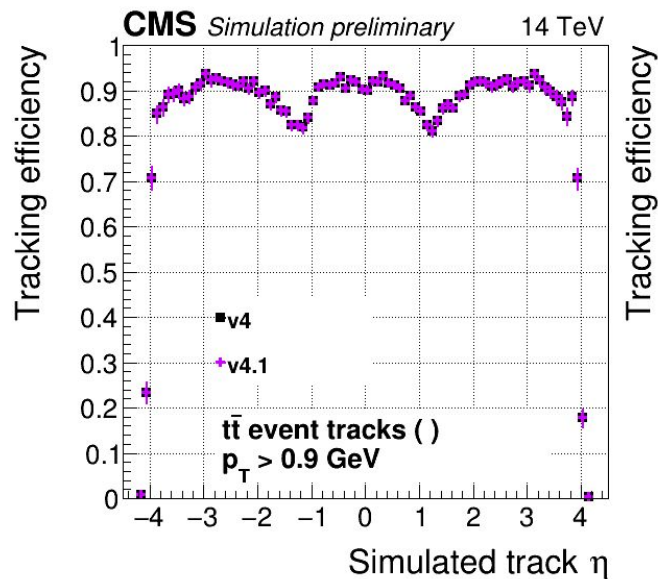
v4 --> 5.5 [70.5 %]

v4 vs v3

Plots with all HLT 11
Modules in Backup

v4.1 - Performance (I)

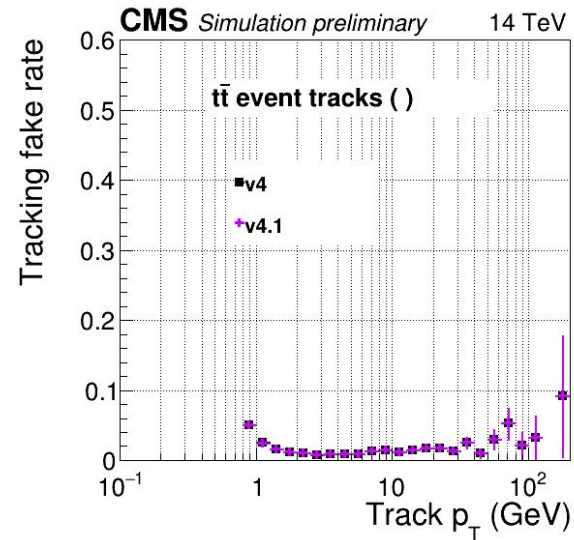
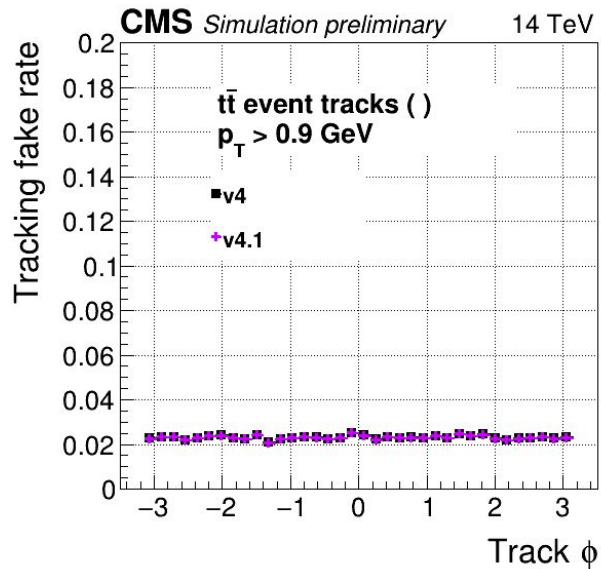
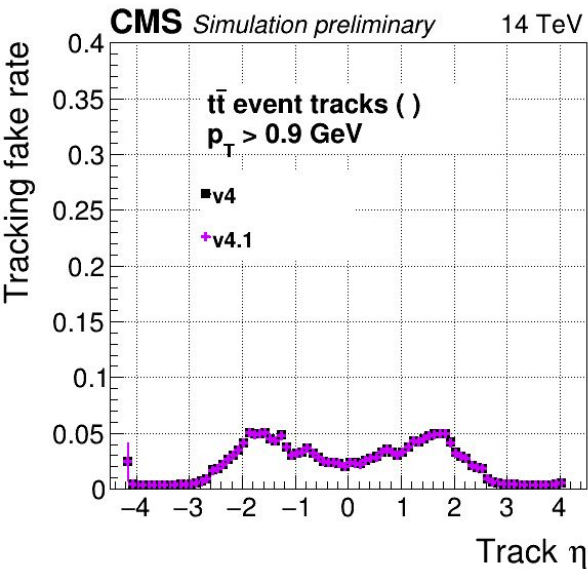
- $P_t > 0.9$
- Track building optimized
- $|\eta| < 3$ for PV reco for track selection



- No changes, as expected

v4.1 - Performance (II)

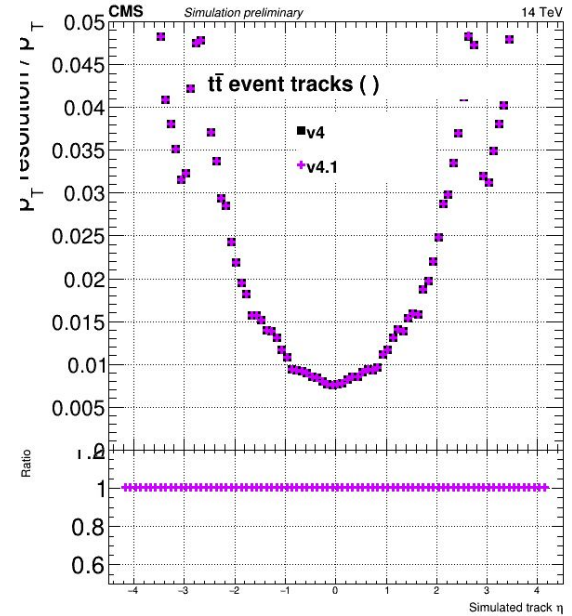
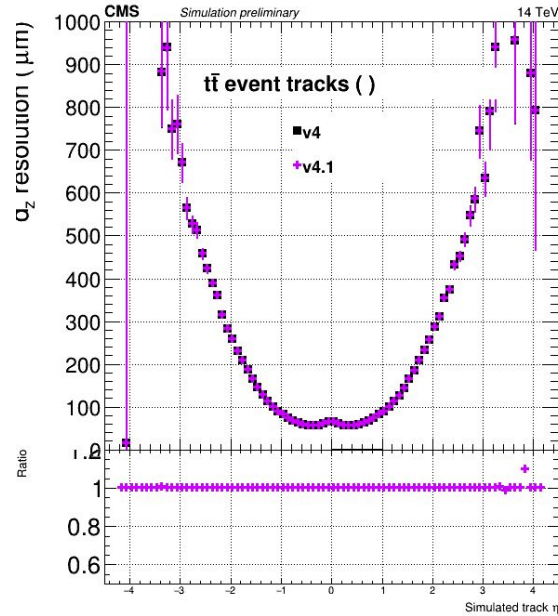
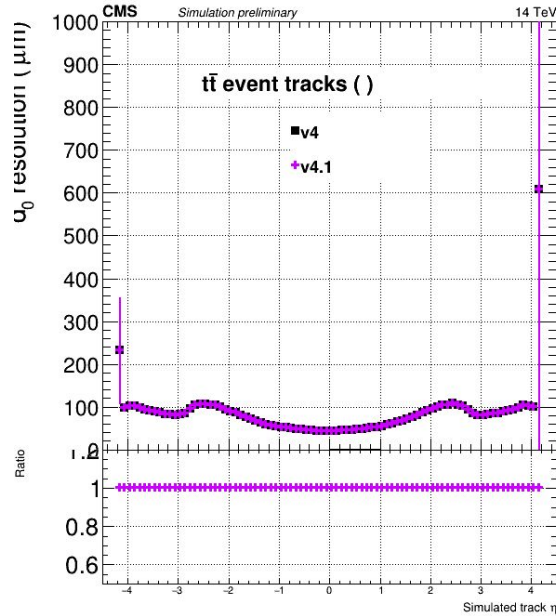
- $P_t > 0.9$
- Track building optimized
- $|\eta| < 3$ for PV reco for track selection



- No changes, as expected

v4.1 - Performance (III)

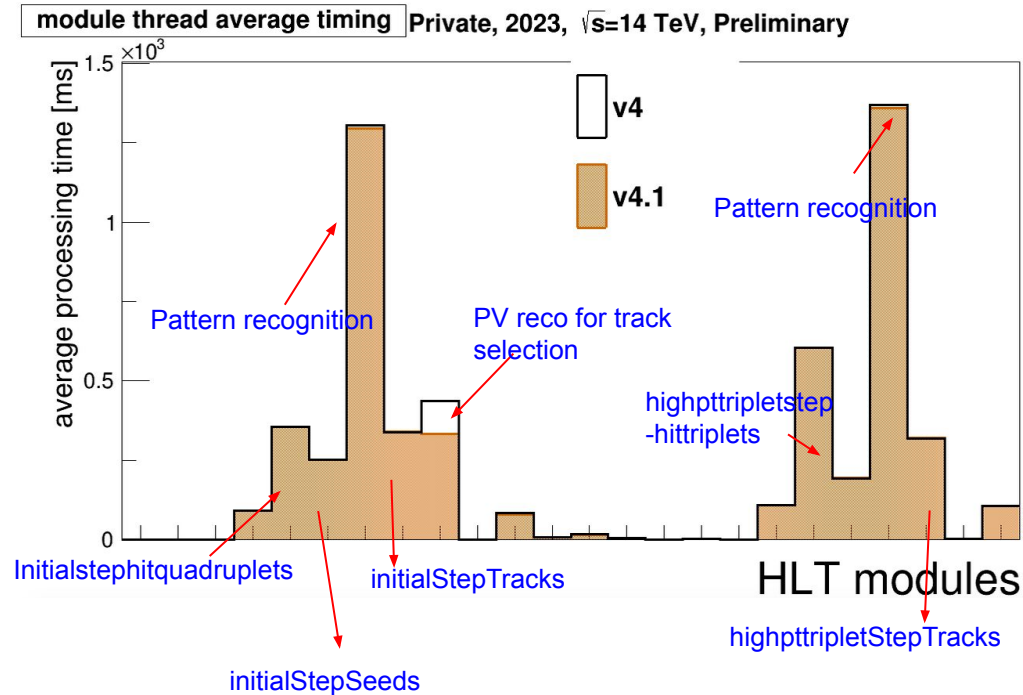
- $P_t > 0.9$
- Track building optimized
- $|\eta| < 3$ for PV reco for track selection



- No changes, as expected

v4.1 - Timing

- $P_t > 0.9$
- Track building optimized
- $|\eta| < 3$ for PV reco for track selection



- Slight decrease for initialstep pv reco (persistant among fluctuations)

v4 --> 5.5 [70.5 %]
v4.1 --> 5.4 [70 %]

Summary

- V2 timing (11.4 s) is decreased to 5.5 s with a cut on $p_t > 0.9$ GeV and an optimization of pattern recognition
- Additional eta cut is being studied for further timing reduction
- Further decrease of ~ 0.5 s expected with the use of pixelVertices for track selection at the end of the first iteration

BACKUP

Track Building Optimization

initialStepChi2Est	hltESPChi2ChargeMeasurementEstimator9
initialStepTrajectoryBuilder	HLTIter0PSetTrajectoryBuilderIT
initialStepTrajectoryFilter	HLTIter0PSetTrajectoryFilterIT
initialStepTrackCandidates	hltIter0PFlowCkfTrackCandidates

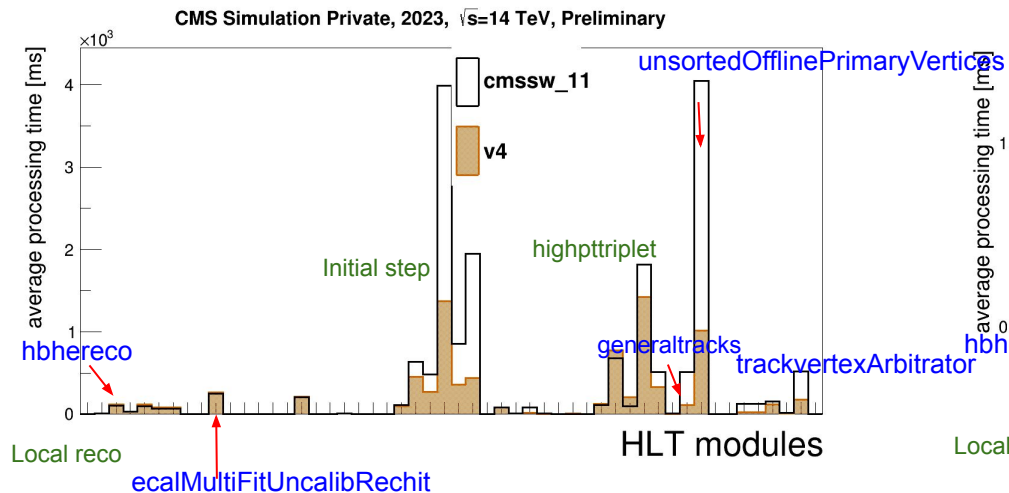
highPtTripletStepChi2Est	hltESPChi2ChargeMeasurementEstimator16
highPtTripletStepTrajectoryBuilder	HLTIter2PSetTrajectoryBuilderIT
highPtTripletStepTrajectoryFilterBase highPtTripletStepTrajectoryFilterInOut	HLTIter2PSetTrajectoryFilterIT
highPtTripletStepTrackCandidates	hltIter2PFlowCkfTrackCandidates

- Following HLT_FULL.py config for the modules in the table

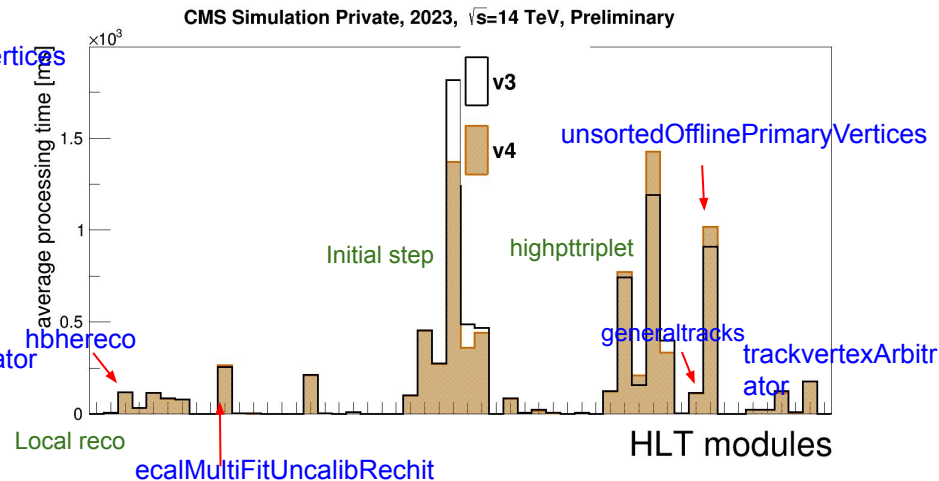
v4 - Timing

ALL HLT Modules

- $P_t > 0.9$
- Track building optimized



v4 vs baseline

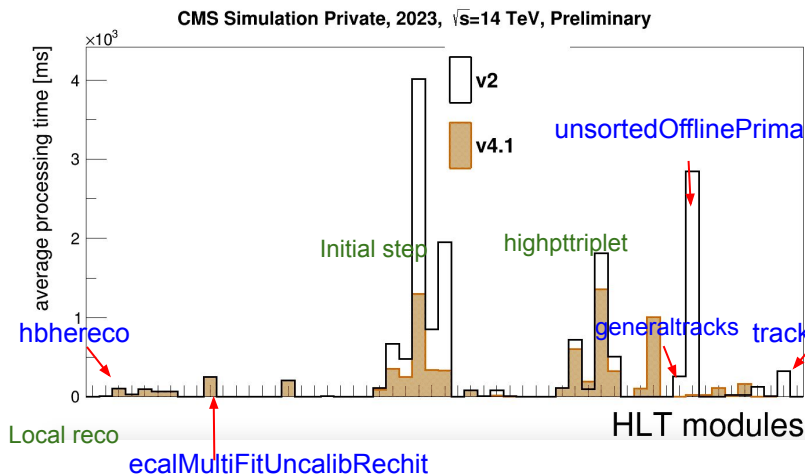


v4 vs v3

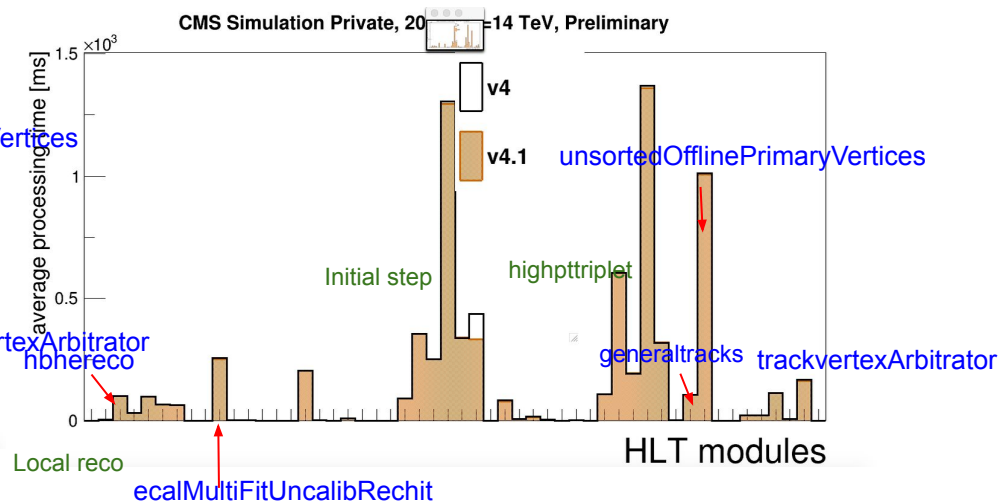
v4.1 - Timing

ALL HLT Modules

- $P_t > 0.9$
- Track building optimized
- $|\eta| < 3$ for PV reco for track selection



v4.1 vs baseline

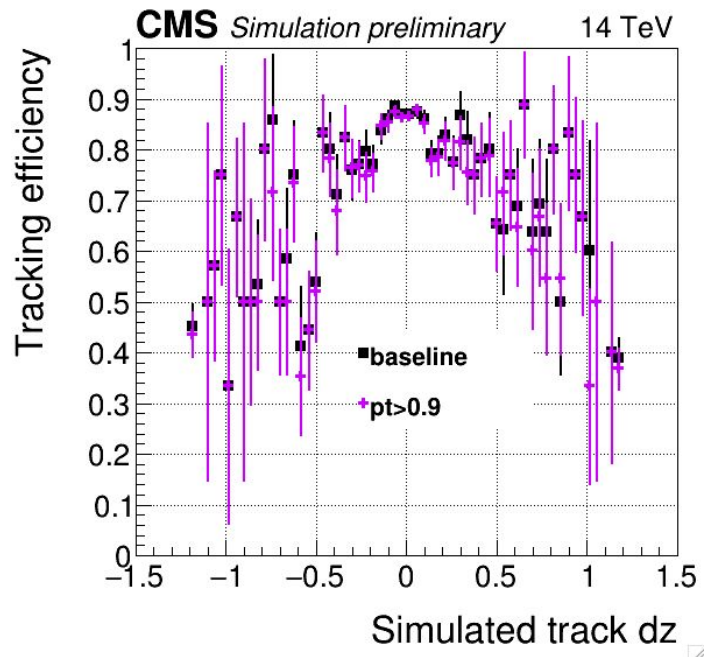
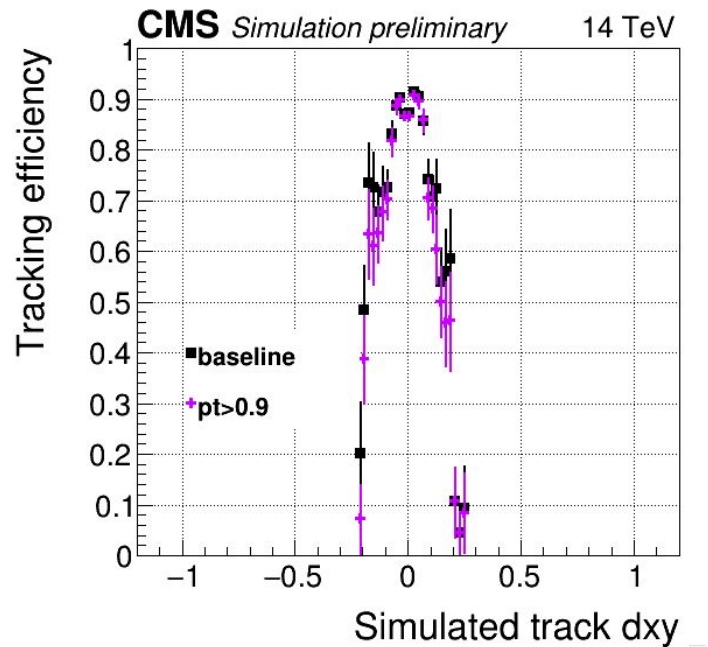


v4.1 vs v4

v3 - Performance (IV)

Track efficiency vs IP

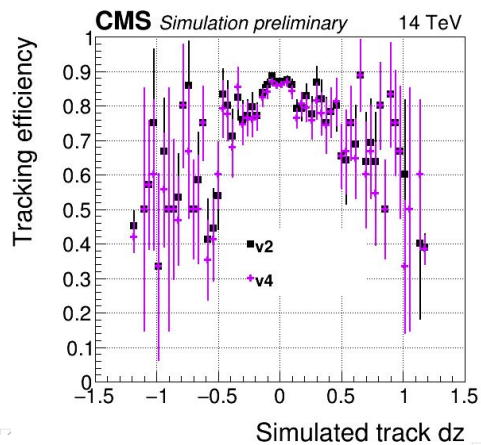
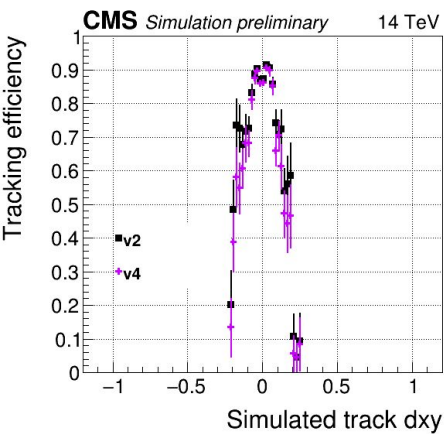
- $P_t > 0.9$



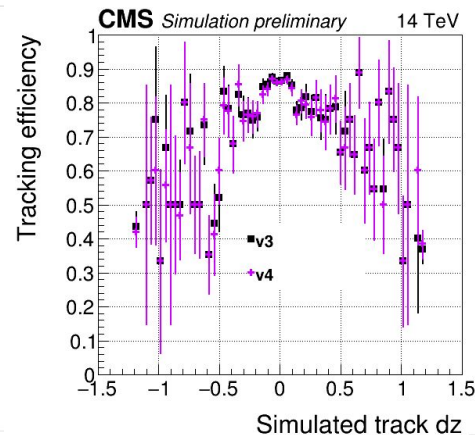
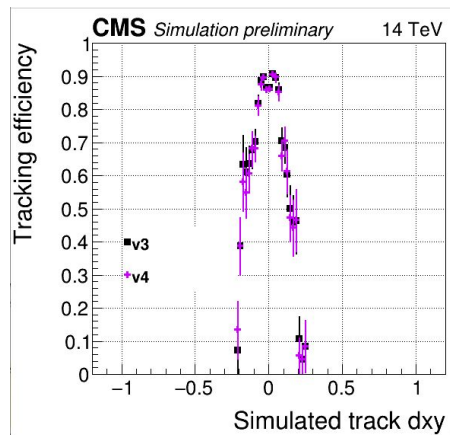
v4 - Performance (IV)

Track efficiency vs IP

- $P_t > 0.9$
- Track building optimized (see backup for changes)



v4 vs baseline

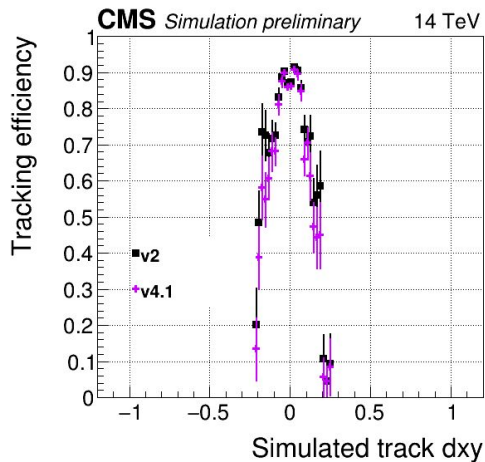


v4 vs v3

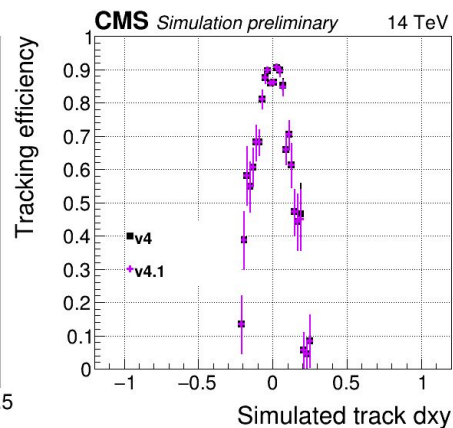
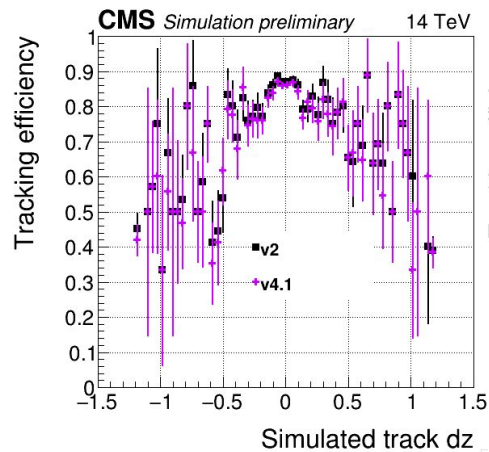
v4.1 - Performance (IV)

Track efficiency vs IP

- $P_t > 0.9$
- Track building optimized
- $|\eta| < 3$ for PV reco for track selection



v4.1 vs baseline



v4.1 vs v4

