b-tag efficiency in HLT level 3 - tracking & toy simulation

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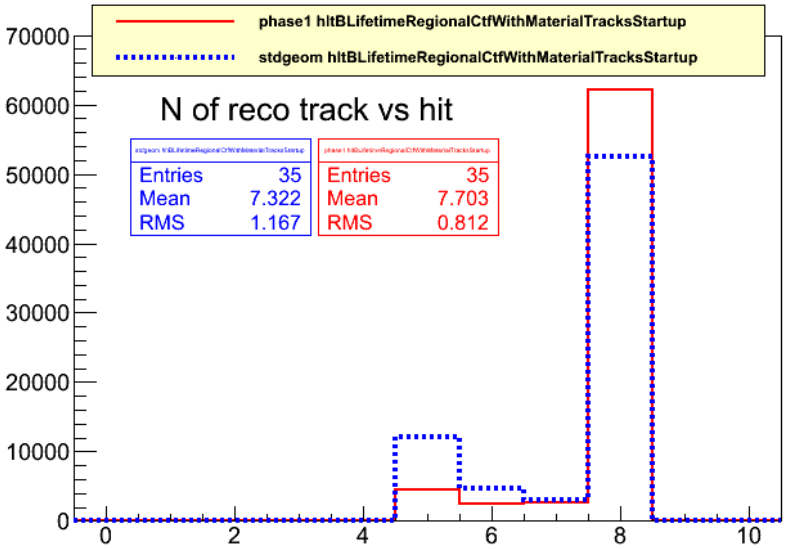
ctf tracking in HLT step 3



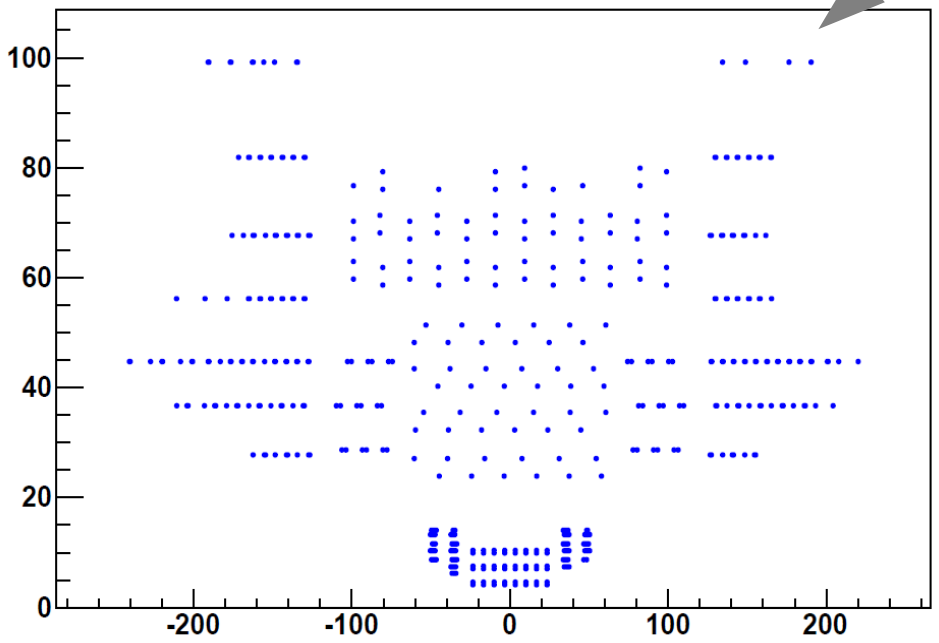
HLT step3 does ctfWithMaterialTracks -

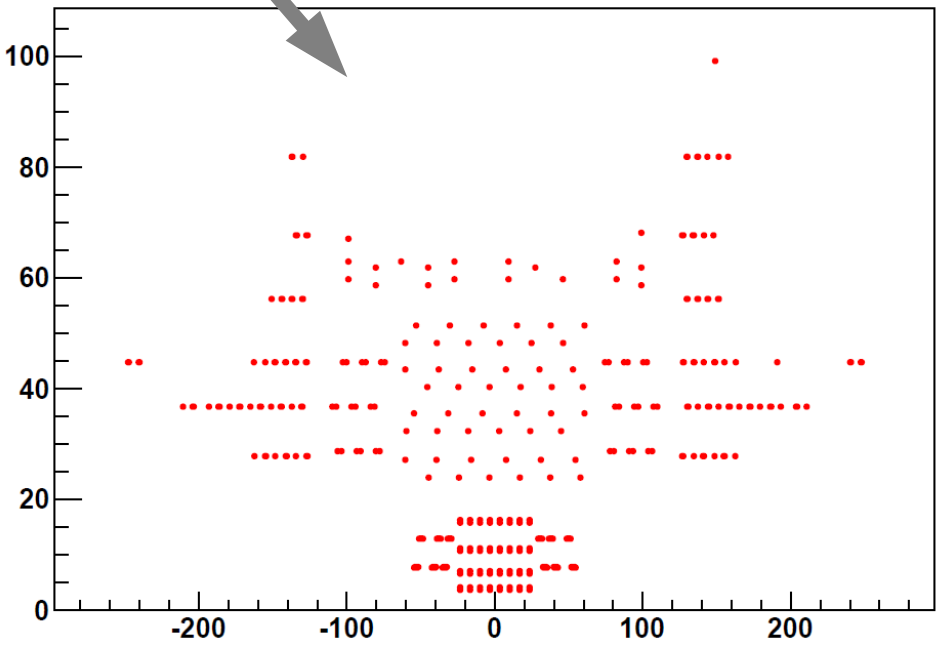
- hltBLifetimeRegionalCkfTrackCandidatesStartup
- hltBLifetimeRegionalCtfWithMaterialTracksStartup

Tracks seem to have at most 8 hits -

- would naively expect 9 hits in phase1 ??
- (higher 8-hit efficiency for phase1, though)
- seems to omit outer TEC/TOB layers for phase1

(already seen with track candidates)





Simple b-tag toy simulation

Goal is to better understand **qualitatively** the features & behavior of the **TrackCounting** algorithm

Simple simulation:

"track" object:

- basically an IP value + error (no other properties simulated)
- two different kinds of "tracks":
  - from B decays with random **IP of O(500μm)**
  - non-B tracks with **IP = 0**

} smeared with **random IP errors** distributed according to MTV plots & exp. dependence on p_T

"jet" object:

- basically a bundle of ***n*** tracks (with poisson ***n***, EV obtained from CMSSW results)
- two different kinds of "jets":
  - "b-jets" with a random fraction (~ 25%) of "B-tracks"
  - "light jets" with only "non-B-tracks"

additionally:

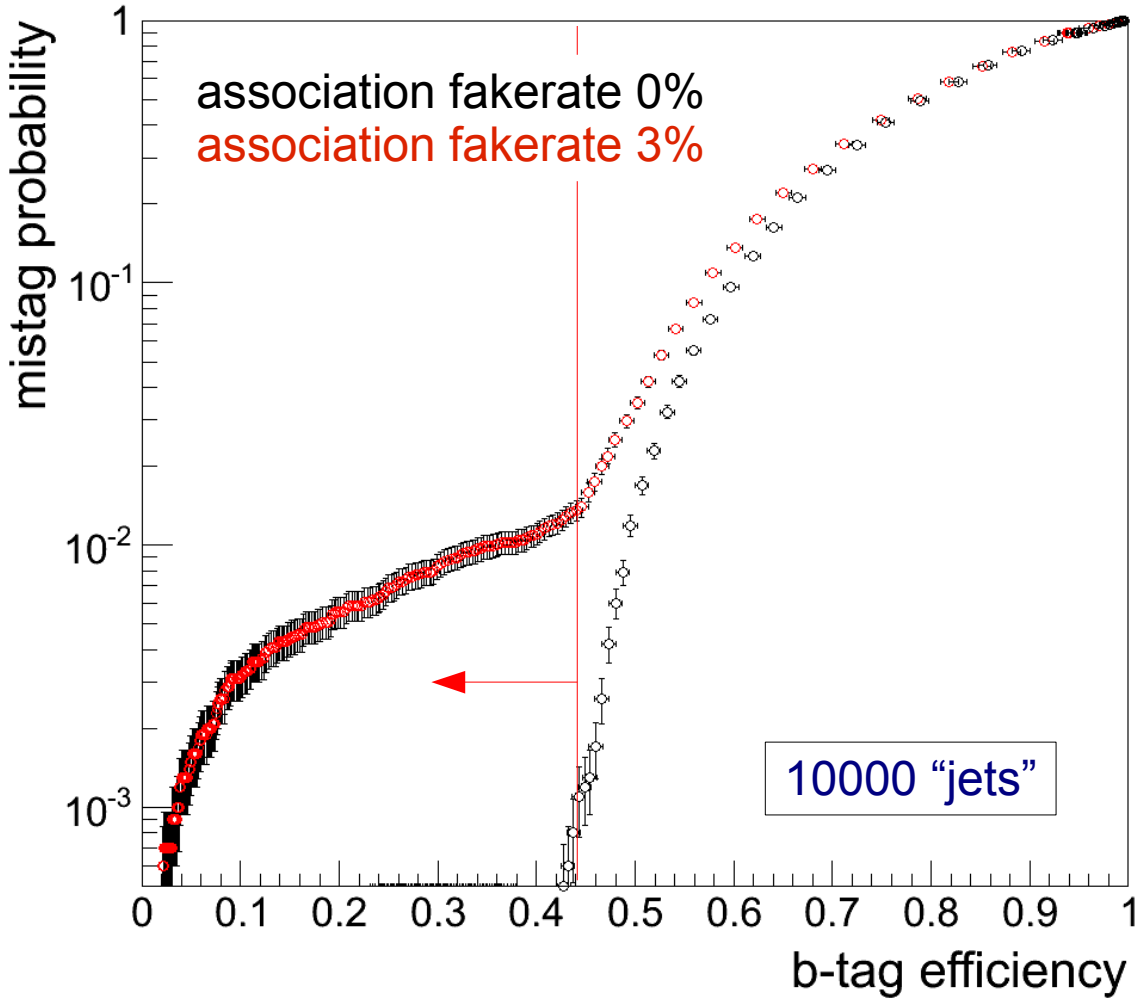
- jet <> parton association fake rate of 3%
- trackCounting high efficiency (n=2) algorithm

Many important effects not taken into account, e.g. η and p_T dependencies, track fake rates, cuts, material, etc. → this is only coarse & qualitative!

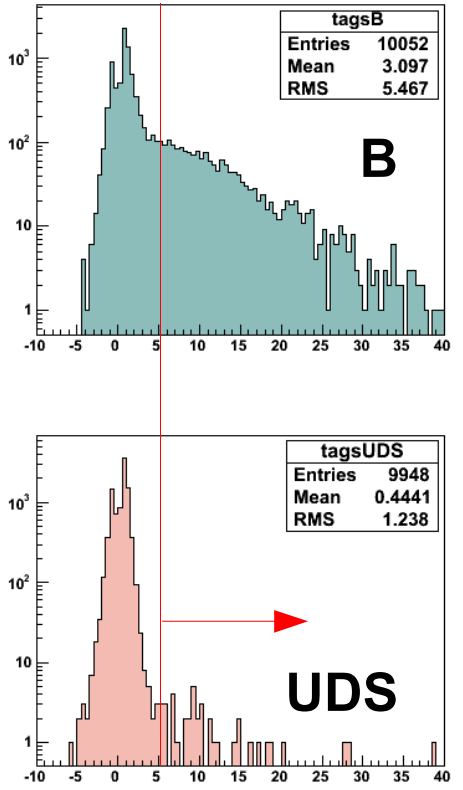
Simple b-tag toy simulation: association failures

Simple toy simulation can reproduce the basic features of efficiency vs. fake curves

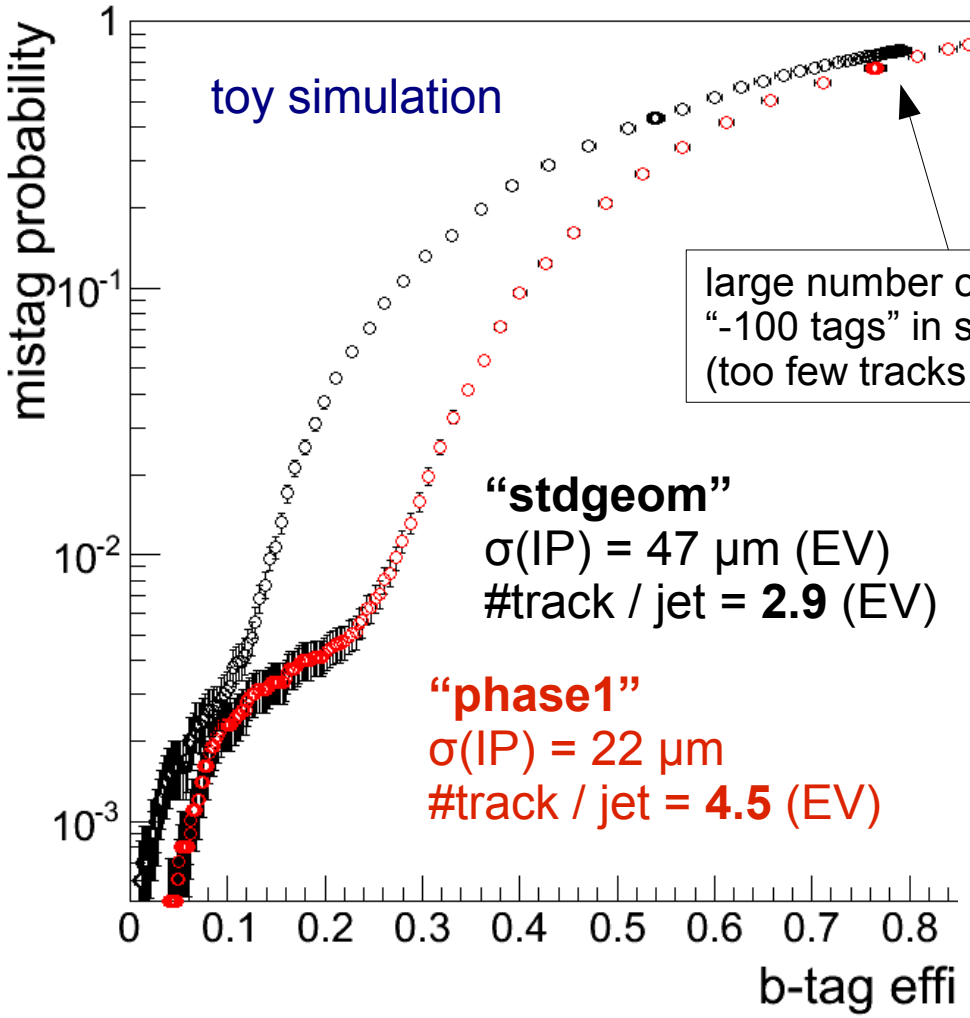
jet<>parton association failure has significant impact only for low efficiencies
("knee" corresponds to the upper limit of the bulk tag distribution for light jets)



simulated tag distributions



Simple toy simulation: pixel-only "tracks"



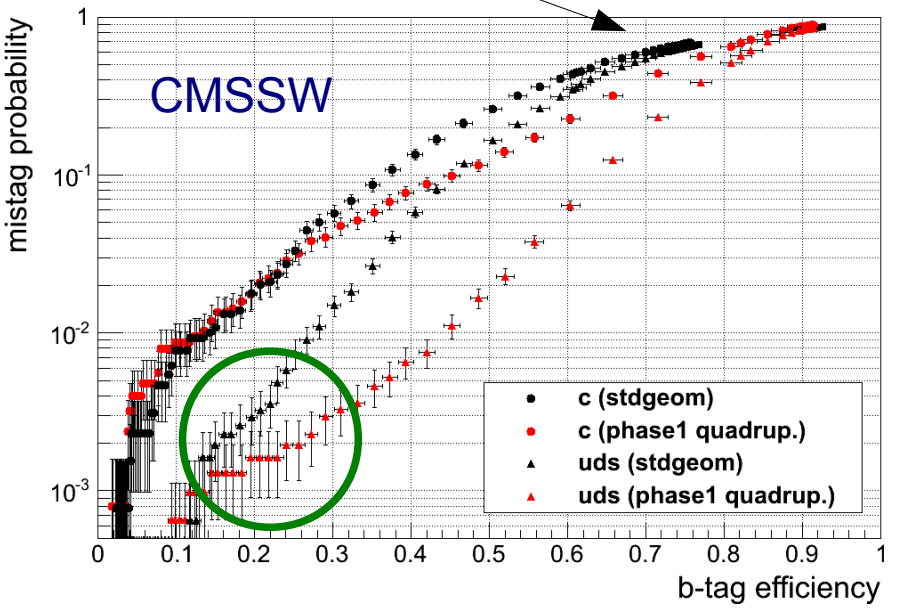
large number of failed "-100 tags" in stdgeom (too few tracks in jet)

"stdgeom"
σ(IP) = 47 μm (EV)
#track / jet = **2.9** (EV)

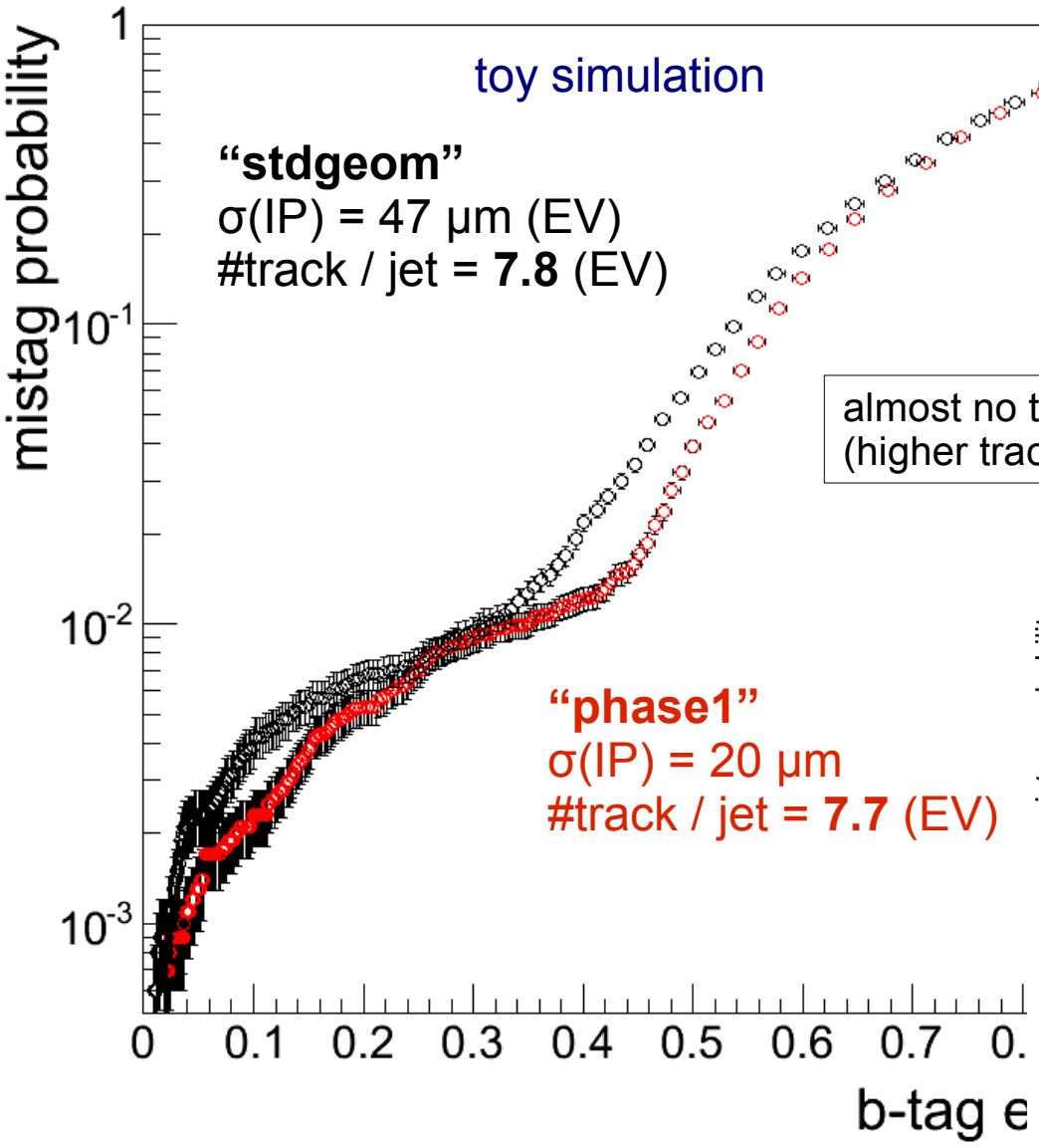
"phase1"
σ(IP) = 22 μm
#track / jet = **4.5** (EV)

Crucial point is the higher efficiency due to the increased number of tracks per jet (higher track eff.)

Impact of better IP accuracy is rather small



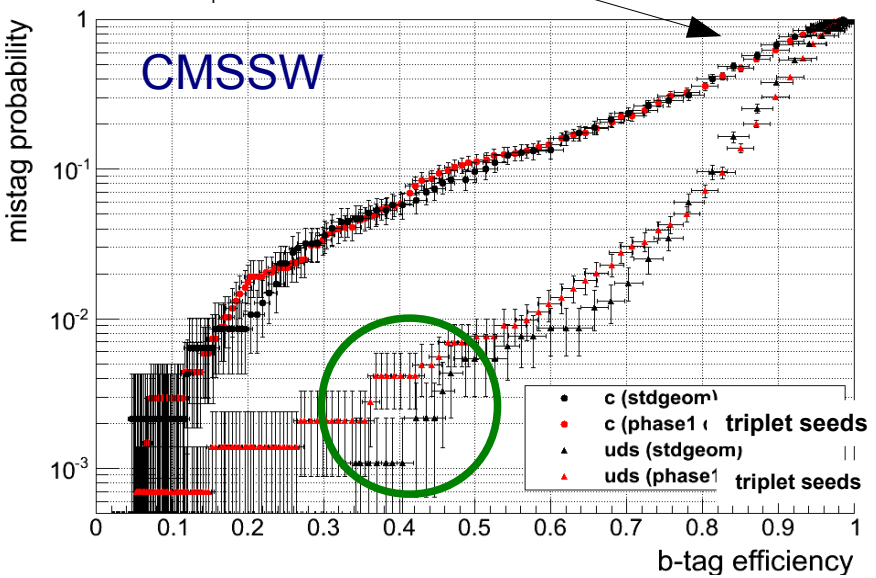
Simple toy simulation: all-silicon "tracks"



almost no tagging failures
(higher track multiplicity)

- Approx. same (high) number of tracks in jets
- better resolution has little impact
- approx. same efficiency

(fake tracks, cuts, etc. not considered, low statistics from CMSSW)



Conclusions

The track counting tagger n=2 (as used in HLT) is:
- quite **insensitive** to improvements in **IP resolution**
- **very sensitive** to the seeding & **tracking efficiency**, when the number of tracks / jet is relatively small (e.g. for pixel-only tracks)

Different impact on the individual trigger stages:
- large improvement in b-tag efficiency in pixel-only step 2.5
- (almost) no improvement in all-silicon ctf step 3

Seems to agree with other observations:
- no b-tag improvement seen with iterative tracking & trackCounting in CMSSW_336
- get a large improvement in step 2.5 already with triplets (→ higher pixel-only tracking efficiency due to redundancy)

significances of tracks in a jet
4.4829
1.70443
1.42458
1.30713
0.759941
0.680078
0.531902
0.336469
-0.252833
-0.436671
-0.445463
-0.618676
-0.985043
-1.67557
-3.0648

tag (n=2)

→ use current settings & concentrate now on HLT physics studies