MTD EVENT CONTENT FOR PHASE2

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CONTEXT OF THE DISCUSSION

- Revision of event content for Phase2 ongoing in Offline
  - Test production in 11_3_X (with requests for samples from our side) an opportunity to review this issue
  - See presentation at last RECO meeting https://indico.cern.ch/event/1046377/contributions/4395943/attachments/2262678/3840961/20210611-Phase2SW-EventContent.pdf

- MTD known to be one of the major contributors to AODSIM (~1/3)
  - (Re-)tuning of MVA quality flag for MTD hit-track association the main reason
  - Fully rerunning the trackExtenderWithMTD requires access to recoTrackExtras, while mtdTrackingRecHits can be reproduced from mtdClusters
    - No problem on RECOSIM

EXISTING MTD-RELATED EVENT CONTENT

- ## CMSSW_12_0_0_pre2,
- Wf. 34834.0 (scenario D76, PU200, average on 10 events)

```
11:54 farmui01 593> edmEventSize -v step3_inAODSIM.root | grep "_" | nl | grep -i 'mtd\|tofpid'
    2  recoTrackExtras_trackExtenderWithMTD__RECO. 4.0199e+06 2.97335e+06
    5  recoTracks_trackExtenderWithMTD__RECO. 2.11965e+06 709583
    8  TrackingRecHitsOwned_trackExtenderWithMTD__RECO. 5.98758e+06 538824
   15  FTLClusteredmNewDetSetVector_mtdClusters_FTLBarrel_RECO. 523807 123443
   16  FTLClusteredmNewDetSetVector_mtdClusters_FTLEndcap_RECO. 1.07318e+06 104572
   30  floatedmValueMap_trackExtenderWithMTD_generalTrackp_RECO. 29106.3 25427.7
   56  floatedmValueMap_trackExtenderWithMTD_generalTrackt0_RECO. 29108.6 11632
   57  floatedmValueMap_tofPID_t0safe_RECO. 29058 11607.8
   58  floatedmValueMap_tofPID_t0_RECO. 29048.8 11593.4
   59  floatedmValueMap_trackExtenderWithMTD_generalTracksigmat0_RECO. 29120.1 11386.7
   61  floatedmValueMap_trackExtenderWithMTD_generalTrackPathLength_RECO. 29127 10095.6
   62  floatedmValueMap_trackExtenderWithMTD_pathLength_RECO. 29096.6 10070
   63  floatedmValueMap_trackExtenderWithMTD_etlMatchTimeChi2_RECO. 29110.4 9886.2
   64  floatedmValueMap_trackExtenderWithMTD_generalTracktmtd_RECO. 29113.2 9875
   65  floatedmValueMap_trackExtenderWithMTD_etlMatchChi2_RECO. 29101.2 9853.8
   66  floatedmValueMap_trackExtenderWithMTD_tmtd_RECO. 29082.8 9848.2
   67  floatedmValueMap_tofPID_sigmat0safe_RECO. 29069.5 9675.3
   73  floatedmValueMap_trackExtenderWithMTD_generalTracksigmatmtd_RECO. 29124.7 8555.3
   74  floatedmValueMap_trackExtenderWithMTD_sigmatmtd_RECO. 29094.3 8528.5
   76  floatedmValueMap_trackExtenderWithMTD_generalTrackBeta_RECO. 29113.2 8501.8
   77  floatedmValueMap_tofPID_sigmat0_RECO. 29060.3 8490.9
   85  floatedmValueMap_mtdTrackQualityMVA_mtdQualMVA_RECO. 29094.8 7748.6
  114  floatedmValueMap_tofPID_probPi_RECO. 29058 6129.4
  123  floatedmValueMap_tofPID_probK_RECO. 29055.7 5507.5
  168  floatedmValueMap_trackExtenderWithMTD_btlMatchTimeChi2_RECO. 29110.4 3959
  173  floatedmValueMap_trackExtenderWithMTD_btlMatchChi2_RECO. 29101.2 3932.2
  180  floatedmValueMap_tofPID_probP_RECO. 29055.7 3809.9
  202  intedmValueMap_trackExtenderWithMTD_generalTrackassoc_RECO. 29110.1 3469.9
```

AODSIM

- ## in AODSIM ~35% of total is linked to MTD

```
11:52 farmui01 590> edmEventSize -v step3_inAODSIM.root | grep "_" | nl | grep -i 'mtd\|tofpid' | awk '{SUM+=$4} END{print SUM}'
4.65936e+06
11:52 farmui01 591> edmEventSize -v step3_inAODSIM.root | grep "_" | nl | awk '{SUM+=$4} END{print SUM}'
1.31094e+07
```

EXISTING MTD-RELATED EVENT CONTENT

- CMSSW_12_0_0_pre2,
- Wf. 34834.0 (scenario D76, PU200, average on 10 events)

- No MTD-related information in MINIAODSIM
  - Time and time error in PF candidates if the MVA quality variable is above 0.5
  - 4D vertices available, but no jet based on them

- Motivation for existing event content:
  - Rerun trackExtenderWithMTD and return MVA quality variable on AODSIM
    - O(1M) events needed, FEVTDEBUGHLT is quite heavy
    - But the needed information is available in RECOSIM, if this is available on demand, no need to inflate AODSIM
    - In the long term trackExtenderWithMTD should be replaced by addition of MTD to regular tracking

POSSIBLE EVENT CONTENT EVOLUTION

- See [fabiocos/cmssw at fc-mtdevcont (github.com)](github.com)

```
12:13 farmui01 598> edmEventSize -v step3_inAODSIM.root | grep "_" | nl | grep -i 'mtd\|tofpid'
    25  floatedmValueMap_trackExtenderWithMTD_generalTrackp_RECO. 29106.3 25427.7
    51  floatedmValueMap_trackExtenderWithMTD_generalTrackt0_RECO. 29108.6 11632
    52  floatedmValueMap_tofPID_t0safe_RECO. 29058 11607.8
    53  floatedmValueMap_tofPID_t0_RECO. 29048.8 11593.4
    54  floatedmValueMap_trackExtenderWithMTD_generalTracksigmat0_RECO. 29120.1 11386.7
    56  floatedmValueMap_trackExtenderWithMTD_generalTrackPathLength_RECO. 29127 10095.6
    57  floatedmValueMap_trackExtenderWithMTD_etlMatchTimeChi2_RECO. 29113.2 9892.2
    58  floatedmValueMap_trackExtenderWithMTD_generalTracktmtd_RECO. 29113.2 9875
    59  floatedmValueMap_trackExtenderWithMTD_etlMatchChi2_RECO. 29104 9854.6
    60  floatedmValueMap_tofPID_sigmat0safe_RECO. 29069.5 9675.3
    66  floatedmValueMap_trackExtenderWithMTD_generalTracksigmatmtd_RECO. 29124.7 8555.3
    68  floatedmValueMap_trackExtenderWithMTD_generalTrackBeta_RECO. 29113.2 8501.8
    69  floatedmValueMap_tofPID_sigmat0_RECO. 29060.3 8490.9
    77  floatedmValueMap_mtdTrackQualityMVA_mtdQualMVA_RECO. 29094.8 7748.6
   106  floatedmValueMap_tofPID_probPi_RECO. 29058 6129.4
   115  floatedmValueMap_tofPID_probK_RECO. 29055.7 5507.5
   154  intedmValueMap_trackExtenderWithMTD_npixEndcap_RECO. 29094 4144.6
   161  floatedmValueMap_trackExtenderWithMTD_btlMatchTimeChi2_RECO. 29113.2 3957.4
   166  floatedmValueMap_trackExtenderWithMTD_btlMatchChi2_RECO. 29104 3932.6
   173  floatedmValueMap_tofPID_probP_RECO. 29055.7 3809.9
   195  intedmValueMap_trackExtenderWithMTD_generalTrackassoc_RECO. 29110.1 3469.9
   268  intedmValueMap_trackExtenderWithMTD_npixBarrel_RECO. 29094 2041
```

AODSIM

- Updated fraction of total event taken: ~2%

```
>>> 187329./8.63742e+06
0.02168807352195447
```

POSSIBLE EVENT CONTENT EVOLUTION

- This new AODSIM event content allows MVA quality to be computed
  - Code adapted accordingly

- Interest of users to try different qualities
  - Add flag to MINIAODSIM and relax selection in PFProducer timing importer? Or anyway allow users to remake jets with a different selection on timing MVA?

- Recalculation of jets using 4D verteces needed
  - Any study at present biassed by jets being based on 3D input verteces
  - In touch with PUPPI experts, working to produce a user-friendly recipe to recompute PUPPI jets using 4D vertices
  - Add additional jet collection in the event?
    - On MINIAODSIM it would mean at present ~0.8% of total

```
10:00 farmui01 2088> edmEventSize -v step3_inMINIAODSIM.root | grep "_" | nl | grep -i "Puppi4D"
    20  patJets_slimmedJetsPuppi4D__RECO. 14213.2 2607.3
```

SUMMARY

- Code is available to signifcantly reduce the impact of MTD on the AODSIM event content size
  - Target for 12_0_X

- In case of need RECOSIM may become available for possible developments/MVA retuning
  - Longer term target: integrate MTD as standard part of tracking