HF Filters on miniAOD

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Codes and Samples

CMSSW_10_3_3_pre1

- MB dataset (6960 events)
  - AOD:
    - /eos/cms/store/group/phys_heavyions/mnguyen/miniAOD/FF6B819E-F476-8E43-A322-77A7BE3E36EB.root

Recipe to do AOD->miniAOD

- https://twiki.cern.ch/twiki/bin/view/CMS/HiReco2021#Recipe_to_produce_mini_AOD_from

Options

1. Include filters as “triggers”
   - ❑ Same schema as used for MET
     - Only 11/72 bytes per filter per event
   - ❑ Need some modifications on important CMSSW files
     - For example: changes in ConfigBuilder.py
2. Make a producer to run on PAT
   - ❑ In that case we will save the # of towers in HF+ and HF- (min) for different thresholds (2,3,4 and 5 GeV)
     - Vector of integers with size 4 per event -> ~6 bytes/ev

Option 1

SAVE FILTERS AS “TRIGGERS”

Implementation (I)

Try to use toReplaceWith() on metFilterPaths_cff

```
from Configuration.Eras.Modifier_pp_on_AA_2018_cff import pp_on_AA_2018 #import era
from RecoHI.HiCentralityAlgos.hfCoincFilter_cff import * #import all filters
from RecoHI.HiCentralityAlgos.hiFilterPaths_cff import hfFilterPathsTask #import task with all filters
pp_on_AA_2018.toReplaceWith(metFilterPathsTask, cms.Task(metFilterPathsTask.copy(),hfFilterPathsTask)) #include filter task in met task
```

- hiFilterPaths_cff is similar to metFilterPaths_cff for HF filters
- metFilterPaths_cff is included in slimming_cff
- This way does not save the filters, but why?
  - Because this filters are save as flags, if we look into cfg made by driver
    - https://github.com/CmsHI/cmssw/blob/hiMiniAOD_103X/HeavyIonsAnalysis/Configuration/test/reMiniAOD_DATA_PAT.py#L123-L155
  - The flags are automatically created and included in the sequence, how?

Implementation (II)

Looking into metFilterPaths_cff

```
# individual filters
Flag_HBHENoiseFilter = cms.Path(HBHENoiseFilterResultProducer * HBHENoiseFilter)
Flag_HBHENoiseIsoFilter = cms.Path(HBHENoiseFilterResultProducer * HBHENoiseIsoFilter)
Flag_CSCTightHaloFilter = cms.Path(CSCTightHaloFilter)
Flag_CSCTightHaloTrkMuUnvetoFilter = cms.Path(CSCTightHaloTrkMuUnvetoFilter)
Flag_CSCTightHalo2015Filter = cms.Path(CSCTightHalo2015Filter)
Flag_globalTightHalo2016Filter = cms.Path(globalTightHalo2016Filter)
Flag_globalSuperTightHalo2016Filter = cms.Path(globalSuperTightHalo2016Filter)
Flag_HcalStripHaloFilter = cms.Path(HcalStripHaloFilter)
Flag_hcalLaserEventFilter = cms.Path(hcalLaserEventFilter)
Flag_EcalDeadCellTriggerPrimitiveFilter = cms.Path(EcalDeadCellTriggerPrimitiveFilter)
Flag_EcalDeadCellBoundaryEnergyFilter = cms.Path(EcalDeadCellBoundaryEnergyFilter)
Flag_ecalBadCalibFilter = cms.Path()
Flag_goodVertices = cms.Path(primaryVertexFilter)
Flag_trackingFailureFilter = cms.Path(goodVertices + trackingFailureFilter)
Flag_eeBadScFilter = cms.Path(eeBadScFilter)
Flag_ecalLaserCorrFilter = cms.Path(ecalLaserCorrFilter)
Flag_trkPOGFilters = cms.Path(trkPOGFilters)
Flag_chargedHadronTrackResolutionFilter = cms.Path(chargedHadronTrackResolutionFilter)
Flag_muonBadTrackFilter = cms.Path(muonBadTrackFilter)
Flag_BadChargedCandidateFilter = cms.Path(BadChargedCandidateFilter)
Flag_BadPFMuonFilter = cms.Path(BadPFMuonFilter)
Flag_BadChargedCandidateSummer16Filter = cms.Path(BadChargedCandidateSummer16Filter)
Flag_BadPFMuonSummer16Filter = cms.Path(BadPFMuonSummer16Filter)
```

- Easy to include this flags
  - Just add on metFilterPaths_cff
  - or, using hiFilterPaths_cff by

```
from RecoHI.HiCentralityAlgos.hiFilterPaths_cff import * #import task, flags and all filters
```

  - Problems:
    - Include the flags for all eras
    - Flags still not included on the sequence (will not save), why?

Implementation (III)

Sequence is included in ConfigBuilder.py

```
def prepare_PATFILTER(self, sequence=None):
    self.loadAndRemember("PhysicsTools/PatAlgos/slimming/metFilterPaths_cff")
    from PhysicsTools.PatAlgos.slimming.metFilterPaths_cff import allMetFilterPaths
    for filt in allMetFilterPaths:
        self.schedule.append(getattr(self.process,'Flag_'+filt))
```

Using the list allMetFilterPaths in metFilterPaths_cff

```
#add your new path here!!
allMetFilterPaths=['HBHENoiseFilter','HBHENoiseIsoFilter','CSCTightHaloFilter','CSCTightHaloTrkMuUnvetoFilter','CSCTightHalo2015Filter','globalTightHalo2016Filter','globalSuperTightHalo2016Filter',
'HcalStripHaloFilter','hcalLaserEventFilter','EcalDeadCellTriggerPrimitiveFilter','EcalDeadCellBoundaryEnergyFilter','ecalBadCalibFilter','goodVertices','eeBadScFilter', 'ecalLaserCorrFilter',
'trkPOGFilters','chargedHadronTrackResolutionFilter','muonBadTrackFilter', 'BadChargedCandidateFilter','BadPFMuonFilter','BadChargedCandidateSummer16Filter','BadPFMuonSummer16Filter',
'trkPOG_manystripclus53X','trkPOG_toomanystripclus53X','trkPOG_logErrorTooManyClusters','METFilters']
```

- Possibility: just add a list with out filter names (this will be applied for all eras)

```
allMetFilterPaths = allMetFilterPaths + allhfFilterPaths #add HIon filters
```

Implementation (IV)

Or, change the list by a Pset

```
allMetFilterPaths = cms.PSet(
    filters = cms.untracked.vstring(
        'HBHENoiseFilter',
        'HBHENoiseIsoFilter',
        'CSCTightHaloFilter',
        'CSCTightHaloTrkMuUnvetoFilter',
        'CSCTightHalo2015Filter',
        'globalTightHalo2016Filter',
        'globalSuperTightHalo2016Filter',
        'HcalStripHaloFilter',
        'hcalLaserEventFilter',
        'EcalDeadCellTriggerPrimitiveFilter',
        'EcalDeadCellBoundaryEnergyFilter',
        'ecalBadCalibFilter',
        'goodVertices',
        'eeBadScFilter',
        'ecalLaserCorrFilter',
        'trkPOGFilters',
        'chargedHadronTrackResolutionFilter',
        'muonBadTrackFilter',
        'BadChargedCandidateFilter',
        'BadPFMuonFilter',
        'BadChargedCandidateSummer16Filter',
        'BadPFMuonSummer16Filter',
        'trkPOG_manystripclus53X',
        'trkPOG_toomanystripclus53X',
        'trkPOG_logErrorTooManyClusters',
        'METFilters'
    )
)
```

- ❑ This require a small change in ConfigBuilder.py
  - allMetFilterPaths -> allMetFilterPaths.filters
- ❑ Turns possible to use toModify() option for HI

```
pp_on_AA_2018.toModify(allMetFilterPaths, filters = allMetFilterPaths.filters + allhfFilterPaths)
```

  - using list this is not possible
- ❑ However, still have to change pp cfg because of flags still there

In order to not modified so much the pp structure, we prepare the option 2.

Cross-Check using *hfCoincFilter2Th4*

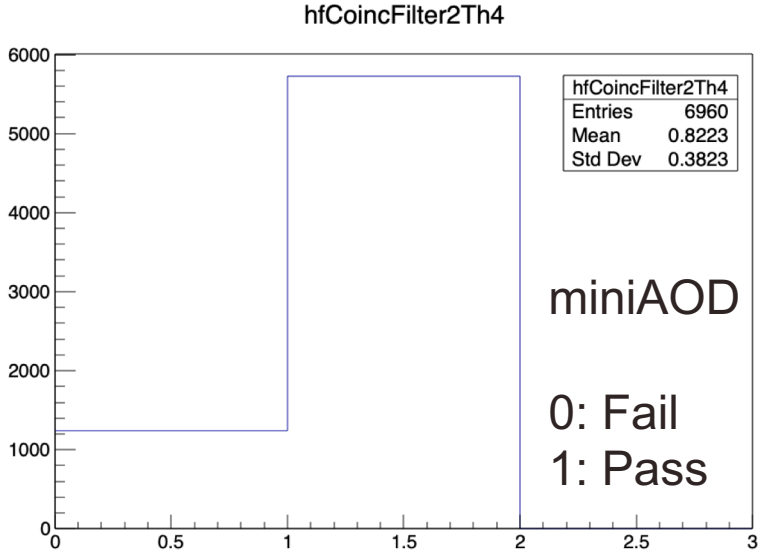
hfCoincFilter2Th4 is a default filter used for 2018 PbPb data

AOD (default centrality filter on cfg file)

```
TrigReport ---------- Event  Summary ------------
TrigReport Events total = 6960 passed = 5723 failed = 1237
```

miniAOD (using the example code)

```
Total of events: 6960
Pass: 5723
Fail: 1237
```



- Number of tracks removed by filter: 142 in both AOD and miniAOD
- A table with all hfCoincFilter checks can be found on backup slides.

Option 2

SAVE VECTOR OF INTEGERS

EDProducer implementation

Make a EDProducer to save a vector of integers with size 4:

- The size is for different thresholds: [0] = 2, [1] = 3, [2] = 4 and [3] = 5 GeV
- The integer value is: TMath::Min(nTowersHF+, nTowersHF-)

```
vector<int>                    "hihffilter"              "HIhfFilters"     "PAT"
```

- Size:
  - with vector: 255226067 bytes; without vector: 255184626 bytes;
  - This gives us ~6 bytes/ev

Cross-Check using *hfCoincFilter2Th4:*

```
ev=ev+1;
if((*filt)[2]<2){evfail=evfail+1;}else{evpass=evpass+1;}
```

- Result:

```
Total of events: 6960
Passed: 5723
Failed: 1237
```

Summary

Option 1

- Total size of the files with filters increases ~ 11 bytes per event
- The application of the filter in miniAOD remove exactly the same number of events and same number of tracks as in AOD
- Is quite simple to apply the filters in a EDAnalyzer using the Boolean triggerBits->accept(i)
- Requires changes on ConfigBuilder.py and metFilterPaths_cff (pp stuff)

Option 2

- Total size of the files with filters increases ~ 6 bytes per event
- Also, the results are exactly the same as in AOD
- Is also easy to apply (one line of code)
- Only need to be included on HI era as done for pixel tracks

Based on the studies presented, the Option 2 looks like the best option and should be included on PR #285

Backup

Checking filter in miniAOD

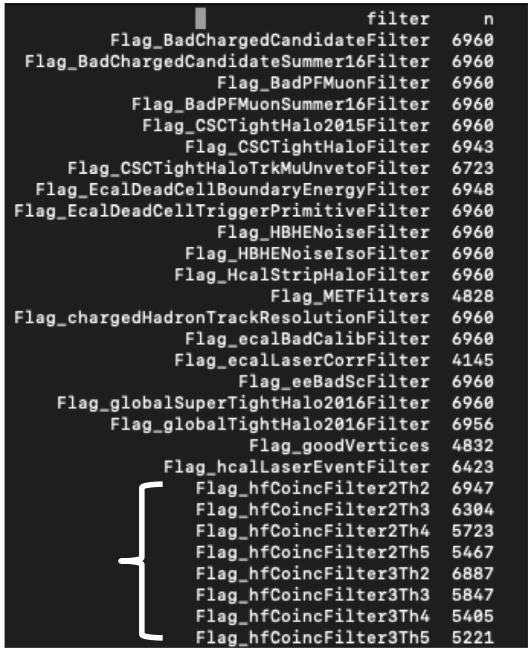
Is possible to check that using this code: [github]

No centrality filter

filter	n
Flag_BadChargedCandidateFilter	6960
Flag_BadChargedCandidateSummer16Filter	6960
Flag_BadPFMuonFilter	6960
Flag_BadPFMuonSummer16Filter	6960
Flag_CSCTightHalo2015Filter	6960
Flag_CSCTightHaloFilter	6943
Flag_CSCTightHaloTrkMuUnvetoFilter	6723
Flag_EcalDeadCellBoundaryEnergyFilter	6948
Flag_EcalDeadCellTriggerPrimitiveFilter	6960
Flag_HBHENoiseFilter	6960
Flag_HBHENoiseIsoFilter	6960
Flag_HcalStripHaloFilter	6960
Flag_METFilters	4828
Flag_chargedHadronTrackResolutionFilter	6960
Flag_ecalBadCalibFilter	6960
Flag_ecalLaserCorrFilter	4145
Flag_eeBadScFilter	6960
Flag_globalSuperTightHalo2016Filter	6960
Flag_globalTightHalo2016Filter	6956
Flag_goodVertices	4832
Flag_hcalLaserEventFilter	6423
Flag_muonBadTrackFilter	6960
Flag_trkPOGFilters	6960
Flag_trkPOG_logErrorTooManyClusters	6960
Flag_trkPOG_manystripclus53X	6960
Flag_trkPOG_toomanystripclus53X	6960

n: number of events passing the filter

With centrality filter



filter	n
Flag_BadChargedCandidateFilter	6960
Flag_BadChargedCandidateSummer16Filter	6960
Flag_BadPFMuonFilter	6960
Flag_BadPFMuonSummer16Filter	6960
Flag_CSCTightHalo2015Filter	6960
Flag_CSCTightHaloFilter	6943
Flag_CSCTightHaloTrkMuUnvetoFilter	6723
Flag_EcalDeadCellBoundaryEnergyFilter	6948
Flag_EcalDeadCellTriggerPrimitiveFilter	6960
Flag_HBHENoiseFilter	6960
Flag_HBHENoiseIsoFilter	6960
Flag_HcalStripHaloFilter	6960
Flag_METFilters	4828
Flag_chargedHadronTrackResolutionFilter	6960
Flag_ecalBadCalibFilter	6960
Flag_ecalLaserCorrFilter	4145
Flag_eeBadScFilter	6960
Flag_globalSuperTightHalo2016Filter	6960
Flag_globalTightHalo2016Filter	6956
Flag_goodVertices	4832
Flag_hcalLaserEventFilter	6423
Flag_hfCoincFilter2Th2	6947
Flag_hfCoincFilter2Th3	6304
Flag_hfCoincFilter2Th4	5723
Flag_hfCoincFilter2Th5	5467
Flag_hfCoincFilter3Th2	6887
Flag_hfCoincFilter3Th3	5847
Flag_hfCoincFilter3Th4	5405
Flag_hfCoincFilter3Th5	5221

...continue…

Comparison w/filter and wo/filter

Size

- Adding centrality filters, the file is 76201 bytes bigger for 6960 events
  - All the 72 filters are taking ~ 11 bytes per event

Timing

- Small time difference: without filter is 0.0134 s/ev and with filter: 0.0139 s

No differences using edmDumpEventContent

An example code, how to access/use this filters can be found on:

- https://github.com/denerslemos/Centrality_Filters_in_miniAOD/blob/master/DemoAnalyzer.cc

Check using *hfCoincFilter2Th4* sequence

hfCoincFilter2Th4 sequence in hfCoincFilter_cff.py is given by

```
hfCoincFilter2Th4 = cms.Sequence(
    towersAboveThresholdTh4 *
    hfPosTowersTh4 *
    hfNegTowersTh4 *
    hfPosFilter2Th4 *
    hfNegFilter2Th4)
```

In order to check, I added the following line

```
_towersAboveThresholdTh4 && _hfPosTowersTh4 && _hfNegTowersTh4 && _hfPosFilter2Th4 && _hfNegFilter2Th4
```

result

```
Total of events: 6960
Passed: 5723
Failed: 1237
Check Passed: 5723
Check Failed: 1237
```

Filter	AOD	miniAOD
hfCoincFilter2Th2	Pass: 6947; Fail: 13;	Pass: 6947; Fail: 13;
hfCoincFilter2Th3	Pass: 6304; Fail: 656;	Pass: 6304; Fail: 656;
hfCoincFilter2Th4	Pass: 5723; Fail: 1237;	Pass: 5723; Fail: 1237;
hfCoincFilter2Th5	Pass: 5467; Fail: 1493;	Pass: 5467; Fail: 1493;
hfCoincFilter3Th2	Pass: 6887; Fail: 73;	Pass: 6887; Fail: 73;
hfCoincFilter3Th3	Pass: 5847; Fail: 1113;	Pass: 5847; Fail: 1113;
hfCoincFilter3Th4	Pass: 5405; Fail: 1555;	Pass: 5405; Fail: 1555;
hfCoincFilter3Th5	Pass: 5221; Fail: 1739;	Pass: 5221; Fail: 1739;
hfCoincFilter4Th2	Pass: 6772; Fail: 188;	Pass: 6772; Fail: 188;
hfCoincFilter4Th3	Pass: 5573; Fail: 1387;	Pass: 5573; Fail: 1387;
hfCoincFilter4Th4	Pass: 5255; Fail: 1735;	Pass: 5255; Fail: 1735;
hfCoincFilter4Th5	Pass: 5111; Fail: 1849;	Pass: 5111; Fail: 1849;
hfCoincFilter5Th2	Pass: 6596; Fail: 364;	Pass: 6596; Fail: 364;
hfCoincFilter5Th3	Pass: 5406; Fail: 1554;	Pass: 5406; Fail: 1554;
hfCoincFilter5Th4	Pass: 5164; Fail: 1796;	Pass: 5164; Fail: 1796;
hfCoincFilter5Th5	Pass: 5038; Fail: 1922;	Pass: 5038; Fail: 1922;