ePIC BHCal ClusteringU pdate

ePIC Clustering Task Force
February 23rd, 2022
Derek Anderson (ISU)

Changes to BHCal Readout
- `<id>system:8,sector:5,tower:6,tile:3</id>` → `<id>system:8,barrel:3,sector:6,tower:6,tile:9</id>`
- `(+ changes to volume IDs in *geo.cpp)`

Changes to BHCal Hit Merging
- `u_fields = {"tower","tile"} → {"tile"}`
- `u_refs = {1, 0} → {0}`

Changes to Digitization
- `m_capADC = 256 → 65536`
- `m_dyRangeADC = 50 MeV → 1.0 GeV`
- `m_resolutionTDC = 1.0 ns → 1.0 ps`
- `u_fields = {} → {"tile"}`
- `u_refs = {} → {0}`
- `m_geoSvcName = "ActsGeometryProvider" → "geoServiceName"`
- `m_readout = "" → "HcalBarrelHits"`
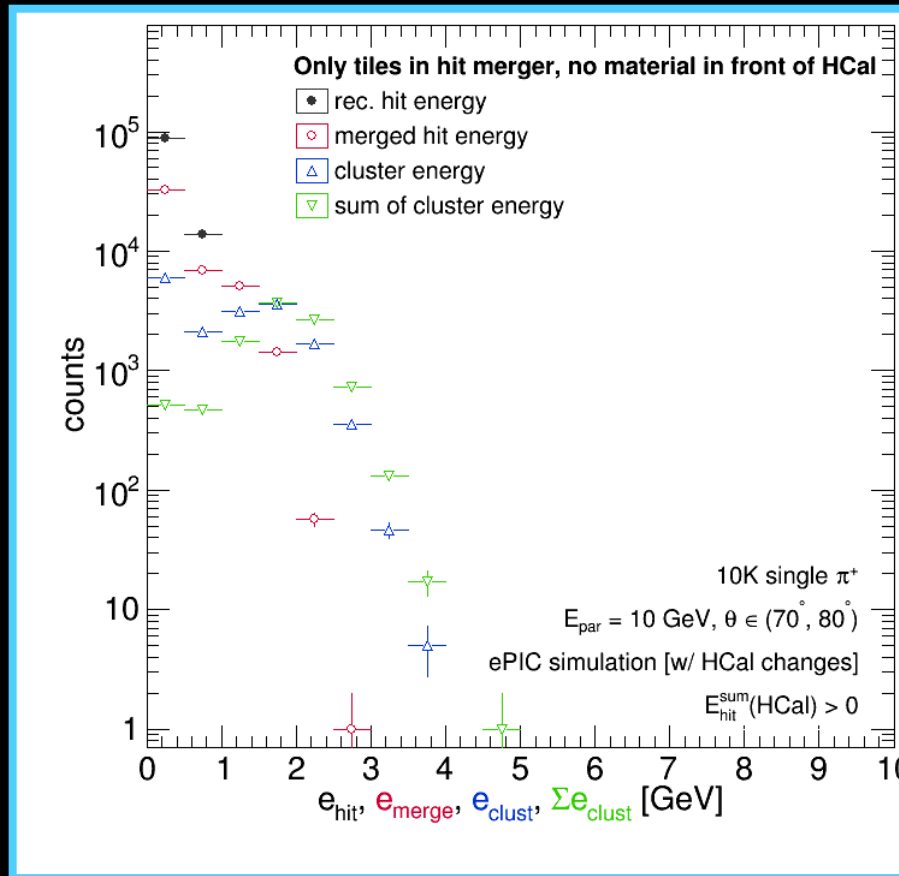- `(+ relevant changes to reco. hit parameters)`

Changes to Clustering
- `m_input_tag = "HcalBarrelmergedHits" → "HcalBarrelRecHits"`
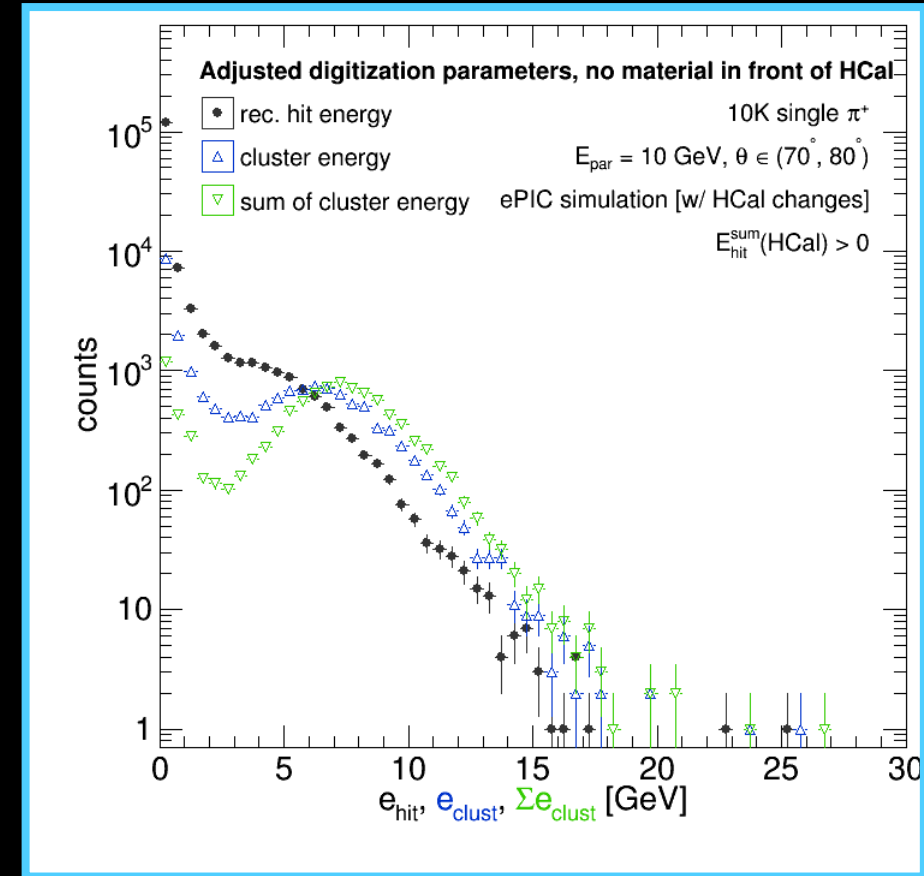
Changes to HCal.cc
- `comment out adding merged hits factory (line 48)`

Changes Made | impact of digitization changes

With Changes to Volume ID/Hit Merging

With Changes to Digitization

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Implementing Adjacency Matrix | some issues...

```
abs(tower_1 – tower_2) == 1
    ⇒  Evaluator::Object : syntax error

(abs(sector_1 – sector_2) + abs(tower_1 – tower_2)) == 1
    ⇒  Evaluator::Object : unpaired parenthesis

Modified SciGlass expression w/ row_i → sector_i
    ⇒  Runs!
    ⇒  Expression is in backup
    ⇒  (Not what we would want to cluster with, though)
```

Notes:
- This behavior is reproducible both in my local reposity w/ digitization changes **and** with EICrecon/main (no changes)
- the following line is included after setting the adjacency matrix:
  › 'std::remove(u_adjacencyMatrix.begin(), u_adjacencyMatrix.end(), ' ');

Backup

Simulation Parameters
– gun.energy = 10*GeV
– gun.particle = "pi+"
– gun.distribution = "cos(theta)"
– gun.thetaMin = 70*degree [$\eta \sim 0.35$]
– gun.thetaMax = 80*degree [$\eta \sim 0.18$]
– **23.01.0 Geometry [Arches] + changes described**

Reconstruction
– EICRecon

```
//------------------------------------------
// Init
void Init() override{
    auto app = GetApplication();
    m_input_tag = "HcalBarrelMergedHits";

    m_splitCluster=false;              // from https://eicweb.phy.anl.gov/EIC/detectors/athena/-/blob/master/calibrations/ffi_zdc.json
    m_minClusterHitEdep=3.0 * dd4hep::MeV;    // from https://eicweb.phy.anl.gov/EIC/detectors/athena/-/blob/master/calibrations/ffi_zdc.json
    m_minClusterCenterEdep=30.0 * dd4hep::MeV; // from https://eicweb.phy.anl.gov/EIC/detectors/athena/-/blob/master/calibrations/ffi_zdc.json

    // adjacency matrix
    m_geoSvcName = "GeoSvc";
    u_adjacencyMatrix = "(abs(tower_1 - tower_2) + (abs((sector_1 - sector_2) * 5 + tower_1 - tower_2) == 1) + (abs((sector_1 - sector_2) * 5 + tower_1 - tower_2) == (24 * 5 - 1))) == 1
";

    std::remove(u_adjacencyMatrix.begin(), u_adjacencyMatrix.end(), ' ');
    m_readout = "HcalBarrelHits";

    // neighbour checking distances
    m_sectorDist=5.0 * dd4hep::cm;            // from ATHENA reconstruction.py
    u_localDistXY={15*dd4hep::mm, 15*dd4hep::mm};      //{this, "localDistXY", {}};
    u_localDistXZ={};      //{this, "localDistXZ", {}};
    u_localDistYZ={};      //{this, "localDistYZ", {}};
    u_globalDistRPhi={};   //{this, "globalDistRPhi", {}};
    u_globalDistEtaPhi={};//{this, "globalDistEtaPhi", {}};
    u_dimScaledLocalDistXY={50.0*dd4hep::mm, 50.0*dd4hep::mm};// from https://eicweb.phy.anl.gov/EIC/detectors/athena/-/blob/master/calibrations/ffi_zdc.json


    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:splitCluster",            m_splitCluster);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:minClusterHitEdep",  m_minClusterHitEdep);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:minClusterCenterEdep",      m_minClusterCenterEdep);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:sectorDist",    m_sectorDist);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:localDistXY",   u_localDistXY);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:localDistXZ",   u_localDistXZ);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:localDistYZ",   u_localDistYZ);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:globalDistRPhi",    u_globalDistRPhi);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:globalDistEtaPhi",    u_globalDistEtaPhi);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:dimScaledLocalDistXY",    u_dimScaledLocalDistXY);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:adjacencyMatrix", u_adjacencyMatrix);
```

```
37,9          Top
```

```cpp
//-------------------------------------------
// Init
void Init() override{
    auto app = GetApplication();
    m_input_tag = "HcalBarrelMergedHits";

    m_splitCluster=false;              // from https://eicweb.phy.anl.gov/EIC/detectors/athena/-/blob/master/calibrations/ffi_zdc.json
    m_minClusterHitEdep=3.0 * dd4hep::MeV;     // from https://eicweb.phy.anl.gov/EIC/detectors/athena/-/blob/master/calibrations/ffi_zdc.json
    m_minClusterCenterEdep=30.0 * dd4hep::MeV; // from https://eicweb.phy.anl.gov/EIC/detectors/athena/-/blob/master/calibrations/ffi_zdc.json

    // adjacency matrix
    m_geoSvcName = "GeoSvc";
    u_adjacencyMatrix = "(abs(sector_1 - sector_2) + abs(tower_1 - tower_2)) == 1";
    std::remove(u_adjacencyMatrix.begin(), u_adjacencyMatrix.end(), ' ');
    m_readout = "HcalBarrelHits";

    // neighbour checking distances
    m_sectorDist=5.0 * dd4hep::cm;              // from ATHENA reconstruction.py
    u_localDistXY={15*dd4hep::mm, 15*dd4hep::mm};     //{this, "localDistXY", {}};
    u_localDistXZ={};      //{this, "localDistXZ", {}};
    u_localDistYZ={};      //{this, "localDistYZ", {}};
    u_globalDistRPhi={};   //{this, "globalDistRPhi", {}};
    u_globalDistEtaPhi={};//{this, "globalDistEtaPhi", {}};
    u_dimScaledLocalDistXY={50.0*dd4hep::mm, 50.0*dd4hep::mm};// from https://eicweb.phy.anl.gov/EIC/detectors/athena/-/blob/master/calibrations/ffi_zdc.json

    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:splitCluster",              m_splitCluster);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:minClusterHitEdep",  m_minClusterHitEdep);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:minClusterCenterEdep",       m_minClusterCenterEdep);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:sectorDist",    m_sectorDist);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:localDistXY",    u_localDistXY);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:localDistXZ",    u_localDistXZ);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:localDistYZ",    u_localDistYZ);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:globalDistRPhi",     u_globalDistRPhi);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:globalDistEtaPhi",     u_globalDistEtaPhi);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:dimScaledLocalDistXY",     u_dimScaledLocalDistXY);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:adjacencyMatrix", u_adjacencyMatrix);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:geoServiceName", m_geoSvcName);
    app->SetDefaultParameter("HCAL:HcalBarrelIslandProtoClusters:readoutClass", m_readout);
    m_geoSvc = app->template GetService<JDD4hep_service>();

    AlgorithmInit(m_log);
}
```

```
[2023-02-23 11:40:18.032] [HcalBarrelIslandProtoClusters] [error] Evaluator::Object : unpaired parenthesis
[2023-02-23 11:40:18.032] [HcalBarrelIslandProtoClusters] [error] Evaluator::Object : unpaired parenthesis
[2023-02-23 11:40:18.032] [HcalBarrelIslandProtoClusters] [error] Evaluator::Object : unpaired parenthesis
...
[2023-02-23 11:40:18.476] [HcalBarrelIslandProtoClusters] [error] Evaluator::Object : unpaired parenthesis
^C[FATAL] Exiting gracefully...
[INFO] JArrow: Finalized JEventSource '../forAdjacencyMatrixTest.e5th70nlKpip.d22mly2023.edm4hep.root' (JEventSourcePODIOsimple)
[INFO] JArrow: Finalized JEventProcessor 'JEventProcessorPODIO'
[INFO] JArrow: Finalized JEventProcessor 'JCalibrateHCalProcessor'
nightly> danderson@sphnx02:~/eic/EICrecon$ ^C
nightly> danderson@sphnx02:~/eic/EICrecon$ ^C
nightly> danderson@sphnx02:~/eic/EICrecon$
```