

Imaging TopoClustering on ScFi

Akshaya Vijay
Dr Wouter Deconinck
University of Manitoba

30/09/2025

ScFi Topo Clustering : Two Photon Simulation

- Energy of Photon : uniformly random energy between 0 and 20 GeV
Both Photons have same Phi and different theta (10 deg to 50 deg)
- sameLayerMode : xyz : 3cm,3cm,12cm
- DiffLayerMode : etaphi : 0.01, 0.01mrad to 0.08,008

Penalty:

Penalty Count = $\text{abs}(\text{cluster.size} - 2)$ for an event

Island Clustering

```
app->Add(new JOmniFactoryGeneratorT<CalorimeterIslandCluster_factory>(
    "EcalBarrelScFiProtoClusters", {"EcalBarrelScFiRecHits"}, {"EcalBarrelScFiProtoClusters"},
    {
        .adjacencyMatrix{},
        .peakNeighbourhoodMatrix{},
        .readout{},
        .sectorDist = 50. * dd4hep::mm,
        .localDistXY{},
        .localDistXZ = {80 * dd4hep::mm, 80 * dd4hep::mm},
        .localDistYZ{},
        .globalDistRPhi{},
        .globalDistEtaPhi{},
        .dimScaledLocalDistXY{},
        .splitCluster      = false,
        .minClusterHitEdep  = 5.0 * dd4hep::MeV,
        .minClusterCenterEdep = 100.0 * dd4hep::MeV,
        .transverseEnergyProfileMetric{},
        .transverseEnergyProfileScale{},
        .transverseEnergyProfileScaleUnits{},
    },
    app // TODO: Remove me once fixed
));
```

Imaging Topo Clustering

```
app->Add(new JOmniFactoryGeneratorT<ImagingTopoCluster_factory>(
    "EcalBarrelScFiProtoClusters_Topo", {"EcalBarrelScFiRecHits"},
    {"EcalBarrelScFiProtoClusters_Topo"},
    {
        .neighbourLayersRange = 2, // # id diff for adjacent layer
        .sameLayerDistXYZ      = {30.0 * dd4hep::mm, 30.0 * dd4hep::mm, 120.0 * dd4hep::mm},
        .diffLayerDistEtaPhi   = {10 * dd4hep::mrad, 10 * dd4hep::mrad},
        .sameLayerMode         = eicrecon::ImagingTopoClusterConfig::ELayerMode::xyz,
        .diffLayerMode         = eicrecon::ImagingTopoClusterConfig::ELayerMode::etaphi,
        .sectorDist            = 3.0 * dd4hep::cm,
        .minClusterHitEdep     = 0,
        .minClusterCenterEdep  = 0,
        .minClusterEdep        = 100 * dd4hep::MeV,
        .minClusterNhits       = 10,
    },
    app // TODO: Remove me once fixed
));
```

2 Photons of same Energy (between 0 and 20 GeV) and Phi

Theta_diff between the photons : 50.0deg

SameLayerMode : XYZ : 3cm_3cm_12cm

DiffLayerMode : EtaPhi : 0.01_0.01rad

Event : 550 - 555

Event Number	ScFi Cluster energy (GeV)		ScFi Topo Cluster Energy (GeV)	
	Cluster 1	Cluster 2	Cluster 1	Cluster 2
551	2.0449 (41 hits)	3.0397 (23 hits)	1.4454 (17 hits)	2.736 (20 hit)
552	14.6939 (49 hits)	10.8208 (46 hits)	12.9711 (19 hits)	4.1203 (13 hits)
553	5.5164 (40 hits)	6.1010 (42 hits)	3.306 (15 hits)	0
554	13.5371 (46 hits)	8.8025 (53 hits)	5.3665 (18 hits)	0
555	14.4678 (65 hits)	23.8954 (32 hits)	12.663 (30 hits)	23.208 (19 hits)

Island Clustering

```
app->Add(new JOMniFactoryGeneratorT<CalorimeterIslandCluster_factory>(
    "EcalBarrelScFiProtoClusters", {"EcalBarrelScFiRecHits"}, {"EcalBarrelScFiProtoClusters"},
    {
        .adjacencyMatrix{},
        .peakNeighbourhoodMatrix{},
        .readout{},
        .sectorDist = 50. * dd4hep::mm,
        .localDistXYZ{80 * dd4hep::mm, 80 * dd4hep::mm},
        .localDistXZ = {},
        .localDistYZ{},
        .globalDistRPhi{},
        .globalDistEtaPhi{},
        .dimScaledLocalDistXYZ{},
        .splitCluster = false,
        .minClusterHitEdep = 5.0 * dd4hep::MeV,
        .minClusterCenterEdep = 100.0 * dd4hep::MeV,
        .transverseEnergyProfileMetric{},
        .transverseEnergyProfileScale{},
        .transverseEnergyProfileScaleUnits{}
    }
),
app // TODO: Remove me once fixed
));
```

Topo Clustering

```
app->Add(new JOMniFactoryGeneratorT<ImagingTopoCluster_factory>(
    "EcalBarrelScFiProtoClusters_Topo", {"EcalBarrelScFiRecHits"},
    {"EcalBarrelScFiProtoClusters_Topo"},
    {
        .neighbourLayersRange = 2, // # id diff for adjacent layer
        .sameLayerDistXYZ = {80.0 * dd4hep::mm, 80.0 * dd4hep::mm, 4350.0 * dd4hep::mm},
        .diffLayerDistXYZ = {80.0 * dd4hep::mm, 80.0 * dd4hep::mm, 4350.0 * dd4hep::mm},
        // .diffLayerDistEtaPhi = {10 * dd4hep::mrad, 10 * dd4hep::mrad},
        .sameLayerMode = eicrecon::ImagingTopoClusterConfig::ELayerMode::xyz,
        .diffLayerMode = eicrecon::ImagingTopoClusterConfig::ELayerMode::xyz,
        .sectorDist = 3.0 * dd4hep::cm,
        .minClusterHitEdep = 0,
        .minClusterCenterEdep = 0,
        .minClusterEdep = 100 * dd4hep::MeV,
        .minClusterNhits = 10,
    }
),
app // TODO: Remove me once fixed
));
```

Photons of same Energy (between 0 and 20 GeV) and Phi

Theta_diff between the photons : 50.0deg

SameLayerMode : XYZ : 8cm_8cm_435cm

DiffLayerMode : XYZ : 8cm_8cm_435cm

localDistXY : 8cm_8cm

Event : 550 - 555

Event Number	ScFi Cluster energy (GeV)		ScFi Topo Cluster Energy (GeV)		
	Cluster 1	Cluster 2	Cluster 1	Cluster 2	Cluster3
551	5.0914 (65 hits)	0	4.847 (50 hits)	0.1676 (13 hits)	0
552	25.6741 (104 hits)	0	0.223(17 hits)	24.427(57 hits)	1.049(35 hits)
553	11.760 (89 hits)	0	11.640 (80 hits)	0.126 (12 hits)	0
554	22.380 (103 hits)	0	0.0188 (97 hits)	0	0
555	38.6541 (107 hits)	0	0.2119 (15 hits)	38.4687 (97 hits)	0

sameLayerXYZ : 3,3,435 and 8,8,435 (cm)

DiffLayerXYZ : 3,3,435 and 8,8.435 (cm)

locDistXY : 8,8 (cm)

Event : 550 - 555

sLayer__dLayer: s_3_3_435__d_3_3_435

Theta	Avg SciFi Penalty	Avg Topo Penalty	#Events
10	1	0.2	5
20	1	1	5
30	1	0.6	5
40	1	1	5
50	1	0.4	5

sLayer__dLayer: s_8_8_435__d_3_3_435

Theta	Avg SciFi Penalty	Avg Topo Penalty	#Events
10	1	0.2	5
20	1	1	5
30	1	0.6	5
40	1	1	5
50	1	0.4	5

Penalty:

Penalty Count = $\text{abs}(\text{cluster.size} - 2)$ for an event

sLayer__dLayer: s_3_3_435__d_8_8_435

Theta	Avg SciFi Penalty	Avg Topo Penalty	#Events
10	1	0.8	5
20	1	0.6	5
30	1	0.8	5
40	1	0	5
50	1	0.4	5

sLayer__dLayer: s_8_8_435__d_8_8_435

Theta	Avg SciFi Penalty	Avg Topo Penalty	#Events
10	1	0.8	5
20	1	0.6	5
30	1	0.8	5
40	1	0	5
50	1	0.4	5

1000 Events

sLayer__dLayer: s_8_8_435__d_3_3_435			
Theta	Avg SciFi Penalty	Avg Topo Penalty	#Events
10	1.006	0.64	1000
20	0.99	0.658	1000
30	1.003	0.665	1000
40	0.997	0.703	1000
50	0.996	0.7	1000

sLayer__dLayer: s_8_8_435__d_8_8_435			
Theta	Avg SciFi Penalty	Avg Topo Penalty	#Events
10	1.006	0.648	1000
20	0.99	0.66	1000
30	1.003	0.626	1000
40	0.997	0.654	1000
50	0.996	0.631	1000