

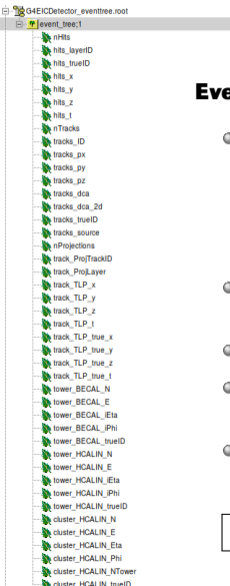
Detector Configurations in Simulations

ECCE Simulation Workshop

September 21, 2021

**Friederike Bock, Nicolas Schmidt, Raymond Ehlers
for the ORNL Relativistic Nuclear Physics Group**

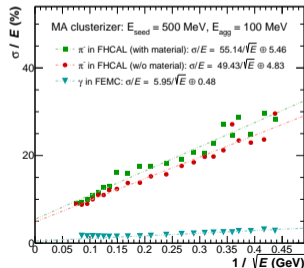
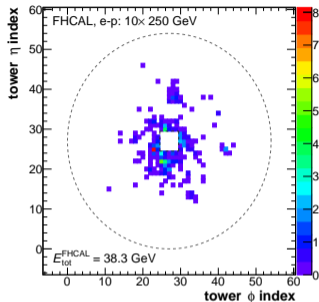
F. Bock, T. Cormier, L. Cunqueiro, M. Demarteau, R. Ehlers, M. Fasel, E. Glimos, H. Hassan,
F. Jonas, C. Loizides, J. Osborn, M. Poghosyan, K. Read, A. Russu, J. Schambach, N. Schmidt, S. Sorenson



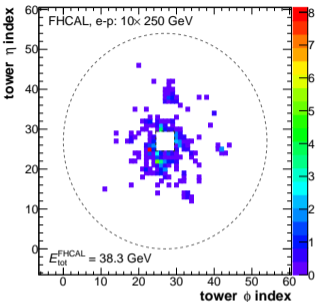
Event-based output with the EventEvaluatorEIC.cc/h

- Highly optimized event-based output for detailed studies
 - ▶ Hits, tracks, and track projections
 - ▶ Towers and clusters
 - ▶ Vertex
 - ▶ MC particles (primary and settable depth for secondaries)
- Allows for reclusterization, jet finding, tracking, and more on afterburner-level
- Can handle all currently implemented detector configurations!
- EventEvaluatorEIC is constantly evolving and new features and detectors added regularly!
- Afterburner code for event tree available in AnalysisSoftwareEIC

Help make it better and contribute!

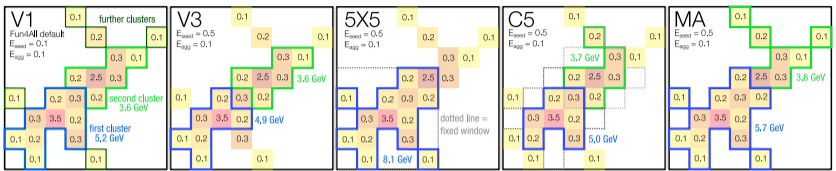
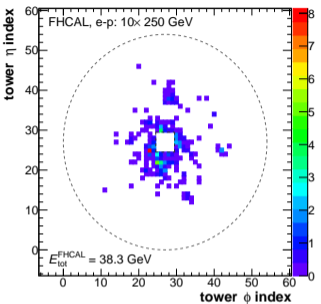


Clusterization



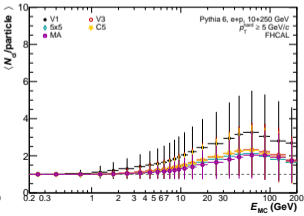
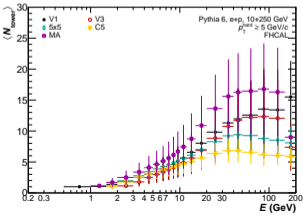
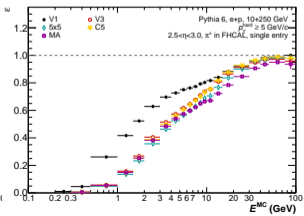
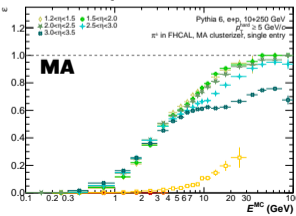
- **Cluster finding and association to single particle challenging task in forward/backward direction - opportunity for AI**
- **Software developments crucial - implemented different algorithms:**
 - Fun4All default w/o thresholds (V1)
 - simple splitting w/ thresholds (V3)
 - areas based: square (NxN) or circle (CN)
 - splitting including diagonals w/ thr. (MA)
- Different cluster finding efficiencies, resolutions & other properties

Clusterization



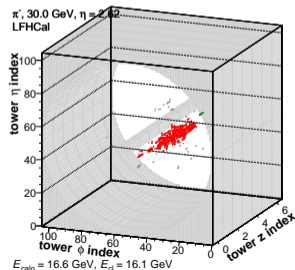
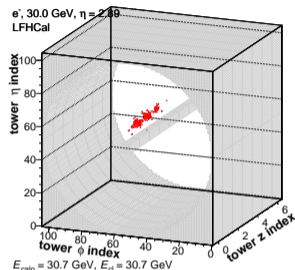
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FHCAL/EHCAL



Why do we need an afterburner?

- First cluster versions in Fun4All for all calorimeters (on DST trees)
- Currently in optimization stage for clusterizers:
 - ▶ Only rough idea which algorithm works best for different calorimeters & purposes
 - ▶ Detailed clusterizer settings i.e thresholds for seed and aggregation under developments
 - ▶ Cluster properties needed not clear yet
- Reprocessing/Reclusterization on DST trees significantly more inconvenient & slower
- Advice: for optimum jet & calo performance use EventEvaluator outputs



Aim & Structure of Afterburner

Disclaimer: This is a development package and subject to frequent changes. You are welcome to contribute!

Aim:

Provide an easy to use afterburner and modular framework, which reads in the EventEvaluator trees and returns histograms/trees of specific analysis modules (i.e. resolution studies).

Currently implemented features

- clusterization with different clusterizers
- track-to-cluster matching
- jet finding
- various resolution & pid studies (jets, tracks, clusters)
- first physics analysis

Structure

- **treeAnalysis**
main directory for post processing of EventEvaluator outputs converting the tree output into analysis histograms
- **common**
location for common header files for binning or plotting valid across the whole repo
- **visualizationGeomAndClusters**
development directory for clusterization (single event/calor visualization)
- **clusterProperties, resolutionCalo, resolutionJETS, startTimeAndPID, trackingresolution**
dedicated directories for post processing of outputs generated from treeAnalysis directory

Main steering macro

treeAnalysis/treeProcessing.C:

```
void treeProcessing(
    TString inFile           = "",
    TString inFileGeometry  = "geometry.root",
    TString addOutputName   = "",
    bool do_reclus          = true,
    bool do_jetfinding      = false,
    // Double_t maxNEvent = 1e5,
    bool hasTiming          = true,
    bool isALLSILICON       = true,
    Double_t maxNEvent      = -1,
    Int_t verbosity        = 0,
    bool doCalibration      = false,
    // Defaults to tracking from all layers.
    unsigned short primaryTrackSource = 0,
    std::string jetAlgorithm = "anti-kt",
    double jetR              = 0.5,
    double tracked_jet_max_pT = 30
)
```

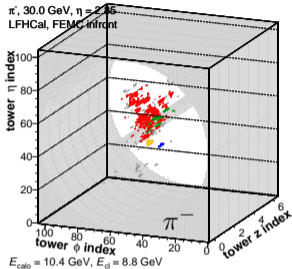
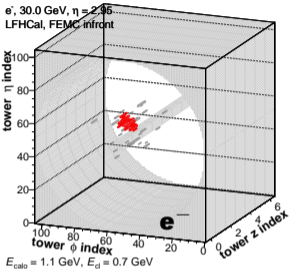
- `inFile`: input file (*.root) or input file list (*.txt), will automatically switch between TTree and TChain
- `inFileGeometry`: geometry file needed for clusterization (produced by EventEvaluatorEIC in addition)
- `do_reclus`: enable reclusterization
- `do_jetfinding`: enable jet finding

- `hasTiming`, `isALLSILICON`: switches for TTL usage & ALLSILICON (needs to be expanded for new ECCE tracker geom)
- `maxNEvent`: events to be processed (-1 == run all)
- `verbosity`: change debug level
- `doCalibration`: post calibration for clusters
- `primaryTrackSource`: which tracking input
- `jetAlgorithm`, `jetR`, `tracked_jet_max_pT`: jet finder settings

Main processing steps

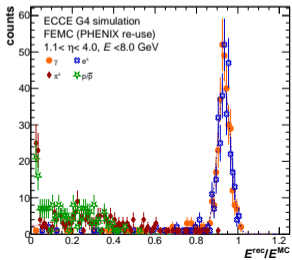
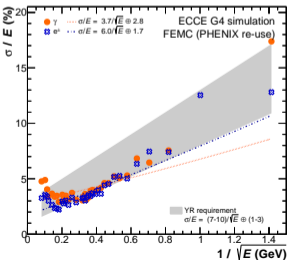
- **clusterization:** [treeAnalysis/clusterizer.cxx](#): - `runclusterizer()`
- **track-to-cluster matching:** [treeAnalysis/clusterizer.cxx](#): - `isClusterMatched()`
- **fill HCal clusters to jetfinder:** [treeAnalysis/calohheader.h](#): - `fillHCalClustersIntoJetFindingInputs()`
- **fill ECal clusters to jetfinder:** [treeAnalysis/calohheader.h](#): - `fillECalClustersIntoJetFindingInputs()`
- **find jets :** [treeAnalysis/jet_finder.cxx](#): - `findJets()`
- **examples of analysis:** [treeAnalysis/jetresolutionhistos.cxx](#), [treeAnalysis/trackmatchingstudies.cxx](#), [treeAnalysis/hitstudies.cxx](#), [treeAnalysis/resolutionhistos.cxx](#), [treeAnalysis/trackingefficiency.cxx](#), [treeAnalysis/trackingmatchingstudies.cxx](#) ...

h-going Calorimeter Performance

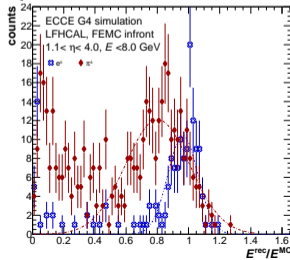
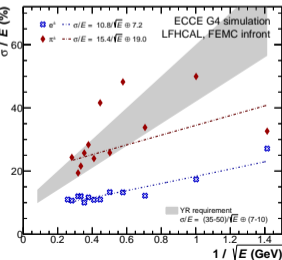


- Example plots for visualization [visualizationGeomAndClusters/plot3DTowerTree.C](#)
- Example plots for performance [resolutionCalo/energyResolutionCalorimeters.C](#)

FEMC standalone



LFHCAL w/ FEMC in front



Questions & Discussion

Feel free to also ask questions in [Mattermost](#)!

Backup