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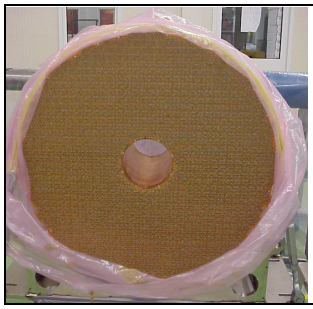
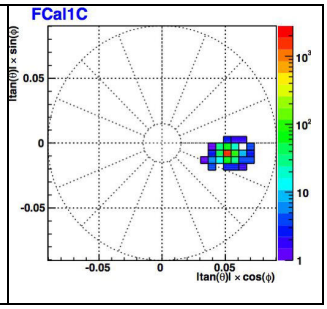
ATLAS FCal Test Beam 2003 Athena Analysis



This is a TWiki web page for the FCal community to cleary summarize and work on the Athena TB analysis. The figure to the right is an example of a 200 GeV electron event in the 4L position using the TopoCluster algorithm.



Contact Persons Louise Heelan

Run List: 4L

The following run lists are based on Peter Krieger's "Good Run List" and include runs that have been cut as the analysis progressed.

Electrons at 4L

The following table is a list of all the runs for electrons in the 4L position.

Energy [GeV]	Run Numbers	Comments
5	run3848-3864	
	run3866-3867	
10	run3608-3640	
20	run3568-3572	
	run3641-3658	
	run3662-3680	
40	run3574-3591	
60	run3242-3258	
80	run2543-2552	"Noisy"
	run2554-2560	
100	run2595-2612	"Noisy"
150	run2385	"Noisy"
	run2387-2401	
200	run2324-2340	
	run3128-3136	
	run3224-3233	

The following table lists runs that were previously deemed as good, but have since been cut from the analysis.

Energy [GeV]	Run Numbers	Comments
5		
10	run3516-3518	?
	run3519-3547	?
20		
40		
60	run3224-3233	?
	run3446-3463	?
80	run2553	very noisy run
	run3464-3480	?
100	run3429-3445	?
150	run2386	very noisy run (~900 GeV)
200	run1777-1779	?
	run1781-1793	?

Pions at 4L

The following table is a list of all the runs for pions in the 4L position.

Energy [GeV]	Run Numbers	Comments
10	run4006-4012	
	run4059-4064	

	run4070-4078	
	run4081-4106	
	run4213-4245	
20		no 20 GeV energy pions (really electrons)
40	run3870-3919	
	run3974	
	run3976-3997	
60	run3259-3279	
	run3280	
	run3283-3285	
	run3287-3292	
80	run2856-2889	
100	run2613-2618	
	run2620-2635	
120	run3094-3110	
150	run2344-2358	
	run2360-2367	
	run2376-2386	
	run3111-3127	
200	run1749-1765	
	run2284-2289	
	run2991-2312	
	run2315-2323	

The following table lists runs that were previously deemed as good, but have since been cut from the analysis.

Energy [GeV]	Run Numbers	Comments
10	run4023-4024	problem with beam envelope cut
20		
40	run3973	BPCs tripped - could not generate beam envelope/cleaning cuts
60	run3281	problem reduced evts in logTree (5449 instead of 11210)
80		
100	run2619	one of BPCs tripped - could not generate beam envelope/cleaning cuts
	run2636-2647 one BPC tripped	
	run2648 changing beam conditions	
150	run2375	no beam instrument intrument info - could not generate beam envelope/cleaning cuts
	un2359	
200	run2290	no beam instrument intrument info - could not generate beam envelope/cleaning cuts

Athena Analysis

Readout Channel Reconstruction

The **LArFCalTBChannelBuilder** algorithm was developed to reconstruct the energy for each individual readout channel. The following list are the steps used to determine the reconstructed energy for each readout channel:

- Pedestal Subtraction: Retrieves the pedestal value from the dB for each channel and substract for each time sample.
- Gain Correction: Applies a gain correcton based on the calibration data (see ITEP paper).
- Amplitude Reconstruction: Calculates the amplitude of the readout channel using the method chosen.

There are presently three methods reconstruct the amplitude:

- Max technique: uses the value of the maximum sample as the amplitude
- Parabola technique: applies a parabola fits the samples to determine the amplitude.
- OFC technique: uses the phase information to retrieve a set of OFC's then applies the OFC's on the samples to determine the amplitude.

Of the three methods, the OFC technique gives superior results and will be used for all future results.

The properties of **LArFCalTBChannelBuilder** algorithm are:

- `TBLArRawChannelBuilder.DigitContKey = "FREE"`
- `TBLArRawChannelBuilder.RecoMode = "OFC"`
- `TBLArRawChannelBuilder.OFC_Key = "LArOFC"`
- `TBLArRawChannelBuilder.ADCtoMeVFCAL = [1,1,1]`
- `TBLArRawChannelBuilder.TBPhaseKey = "TBPhase"`
- `TBLArRawChannelBuilder.PhaseQuality = 0`
- `TBLArRawChannelBuilder.UsePedestalDB = TRUE`
- `TBLArRawChannelBuilder.PedestalKey = "LArPedestal"`
- `TBLArRawChannelBuilder.PedestalOffset = 1`
- `TBLArRawChannelBuilder.GainFactor = 9.2`
- `TBLArRawChannelBuilder.FixGainFactor = FALSE`
- `TBLArRawChannelBuilder.LArRawChannelKey = "LArRawChannels"`

Clustering

Will be added soon...

Using TopoCluster for the 2003 Test Beam

Due to electrode and nearest neighbor table mismapping the topological clustering is not currently used in the analysis (however stay tuned from the upgrade to Athena 13). For general information the text below has been kept.

The basic idea behind the **CaloTopoClusterMaker** algorithm is to group cells based on their neighbor relations and on the significance of their energy with respect to their noise. The properties set for the topocluster are:

- `CaloTopoClusterMaker.ClustersOutputName ="CaloTopoCluster"`
- `CaloTopoClusterMaker.ClusterMakerTools =["CaloTopoClusterMaker/TopoCluster"]`
- `CaloTopoClusterMaker.TopoCluster.CellsNames =["AllCalo"]`
- `CaloTopoClusterMaker.TopoCluster.CalorimeterNames =["LARFCAL"]`
- `CaloTopoClusterMaker.TopoCluster.UseCaloNoiseTool =TRUE`
- `CaloTopoClusterMaker.TopoCluster.UsePileUpNoise =FALSE`
- `CaloTopoClusterMaker.TopoCluster.NeighborOption ="all3D"`
- `CaloTopoClusterMaker.TopoCluster.CellThresholdOnAbsEinSigma =0.0`
- `CaloTopoClusterMaker.TopoCluster.NeighborThresholdOnAbsEinSigma =2.0`
- `CaloTopoClusterMaker.TopoCluster.SeedThresholdOnEorAbsEinSigma =4.0`
- `CaloTopoClusterMaker.TopoCluster.CellThresholdOnAbsEt =-1`
- `CaloTopoClusterMaker.TopoCluster.NeighborThresholdOnAbsEt =-1`
- `CaloTopoClusterMaker.TopoCluster.SeedThresholdOnEtorAbsEt =-1`
- `CaloTopoClusterMaker.TopoCluster.ClusterEtorAbsEtCut =-1`
- `CaloTopoClusterMaker.TopoCluster.SeedSamplingNames =["FCAL0","FCAL1","FCAL2"]`
- `CaloTopoClusterMaker.TopoCluster.SeedCutsInAbsE =TRUE`

For more up-to-date information about the topocluster go to the TopoCluster TWiki.

Using the SimpleNoiseToolFromTextFile tool

To improve the accuracy of the clustered cells using the **CaloTopoClusterMaker** algorithm we use a noise tool which was developed to read a ascii file. This ascii file contained the channel ID and the reconstructed noise for each readout cell. To use this noise tool, you must invoke the tool as follows:

- `CaloTopoClusterMaker.TopoCluster.CaloNoiseTool="SimpleNoiseToolFromTextFil`

Futhermore, you must set the properties of the noise tool:

- `CellNoiseFileName = "/files4/mschram/AtlasWork/11.0.2/fcaltb03/Noise2324_to2340.txt"`
- `CellNoiseUnits = MeV`
- `CellNoiseDefault = 3.20*MeV`
- `CellNoiseDefaultWarning = TRUE`

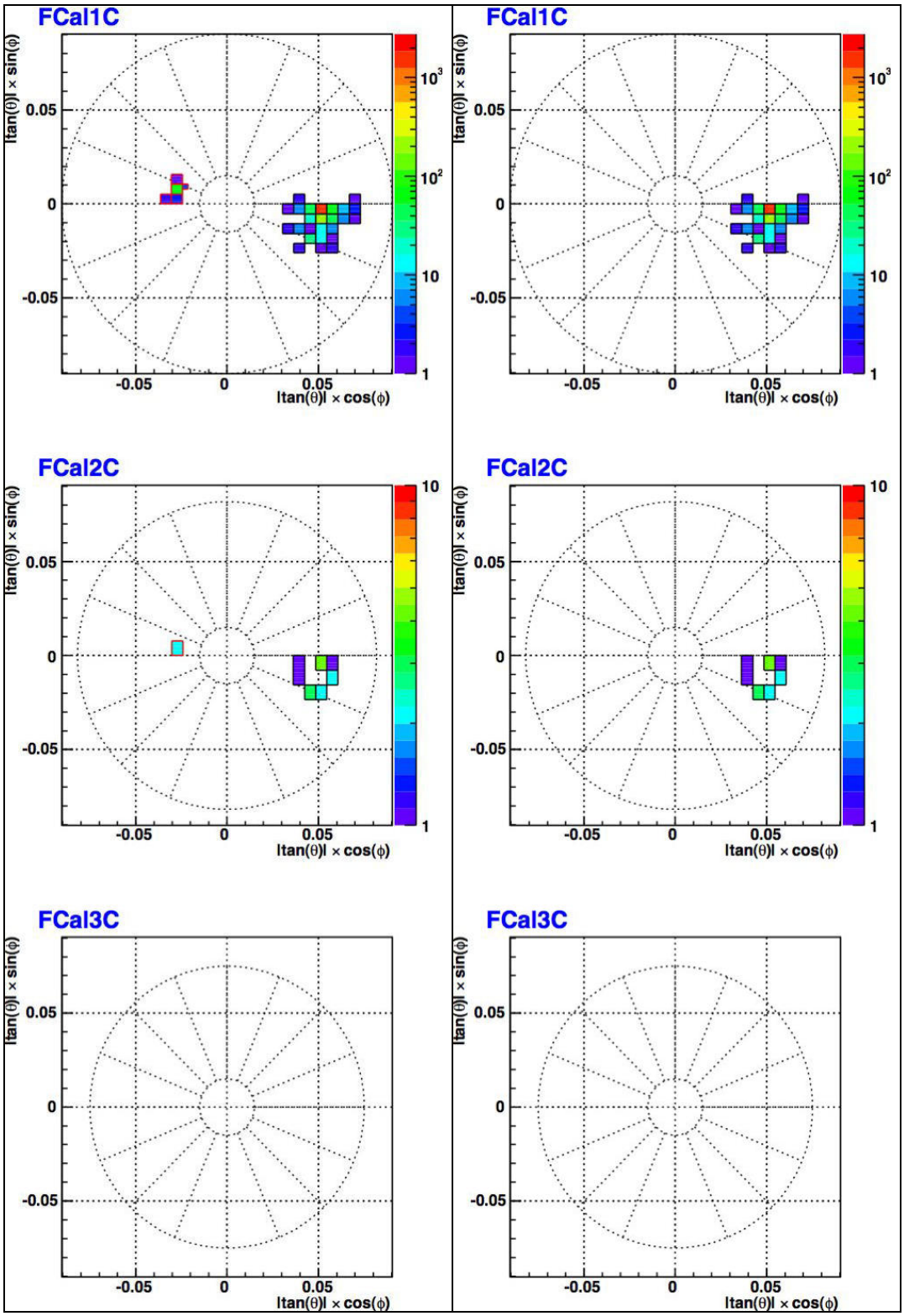
Creating a noise file for the SimpleNoiseToolFromTextFile tool

The **LArFCalTBNoiseFileMaker** algorithm was developed to create a noise file needed by the **SimpleNoiseToolFromTextFile** tool. It retrieves a set of OFC's from the dB and calculates the amplitude (reconstructed noise) from the random runs. The properties of **LArFCalTBNoiseFileMaker** algorithm are:

- `LArFCalTBNoiseFileMaker.DigitContKey = "FREE"`
- `LArFCalTBNoiseFileMaker.OutputNoiseFile = "Noise2324_to2340.txt"`
- `LArFCalTBNoiseFileMaker.ADCtoMeVFCAL = [1,1,1]`
- `LArFCalTBNoiseFileMaker.OutputLevel = DEBUG`

A sample job option script will be put in cvs as LArFCALTBNoiseMakerSample.py asap.

The plots below are of 200 GeV electron in the 4L position using **CaloTopoClusterMaker** with fixed noise (left) and using the noise tool (right). We can clearly is a second cluster in the left plot which should not be there.


FCal1C
FCal1C
FCal2C
FCal2C
FCal3C
FCal3C
|tan(θ)| × sin(φ)
|tan(θ)| × cos(φ)
0.05
0
-0.05
10³
10²
10
1

Root Analysis

All of this code is in cvs, and should be run in the order listed below.

Merger Code

Does the merging of the physics analysis root files and random root files, cylinderical clustering, and application of the radial weights (optional). Also clusters the noise.

Beam Cleaning

Removes contaminating particles in the beam, upstream decays, multiple hits, etc.

RecoTiming for Halfling Removal

Events that have been poorly timed, and have not been cut out with the basic timing quality cuts (they results in a reconstructed energy of half the expected). Suspect wrong set of OFCs used.

Final Analysis Code

Production of linearity and resolution figures for electrons and pions with the final cuts. Also can regenerate the flat weights (constrained or unconstrained).

Analysis Goals

Data Analyses

- Inner edge study with position 1,2,3 scans: examine the energy losses due to the beam pipe, and characteristics of the energy splashes across the beam pipe. Develop a correction factor (like a dead material correction) that depends on the cluster center. Work needs to be done to understand how clusters of one interaction are split across the beam pipe, and examine how the energy in those clusters are related (use cluster with maximum energy, but cluster all energy in event - but think about how this works with real jets, and multiple jets - how is this dealt with using the default athena clustering algorithms).

- Position 4H: Examine the electron and pion energy resolution and linearity with the presence of the added upstream material. How does this compare to the ideal 4L position? Are we still within the required performance for ATLAS? Can we apply some dead material correction?

...more

Monte Carlo Studies

- Validate the MC with the 4L position (most simple - minimal upstream material, fully contained)

- Use the MC and the data to determine the best physics lists to use in ATLAS (other test beams have influence the use of the QGSP_BERT physics lists, although it requires 2x as much computing)

- Do a range cut study in the FCal - the default may not be necessary with our granularity.

- Inner edge studies: ensure the MC correctly simulates the splashing and energy loss as compared to the data. Can also use to confirm energy loss down the beam pipe. And will need for other beam energies (only 200 GeV pions and electrons with data).

...more?

How to Setup the Package in Release 15

1. Setup a 15.X.Y athena area (15.2.0 and 15.3.0 tested so far, July 24 2009). Instructions for how to setup athena at Carleton are at: http://www.physics.carleton.ca/~dgillber/work/April.html#Setup
2. Check out the following packages:

```
# cd $TestArea
cmt co -r LArTools-00-07-06 LArCalorimeter/LArTools
cmt co -r LArFCALTBCnv-00-04-03 LArCalorimeter/LArCnv/LArFCALTBCnv
cmt co -r LArFCALTBAna-00-03-06 LArCalorimeter/LArTestBeam/LArFCALTBAna
```

3. Run the setup script and follow the instructions:

```
cd LArCalorimeter/LArTestBeam/LArFCALTBAna/
./scripts/setup_FCalTB03.sh
```

4. Done! Can now test to run. The release 15 jobOpiton files are in the the "run" folder:

```
cd run

# first modify location of data input file in jobOption file below, then run!
athena FCal_TB2003_NoiseFileMaker.py 2>&1 | tee noise_maker.log

grep ERR noise_maker.log # hopefully no errors...
```

5. If there are errors (Tom had errors), a clean re-compilation of the analysis package in a **new shell** (terminal window) should solve it:

```
cd LArCalorimeter/LArTestBeam/LArFCALTBAna/cmt
source setup.sh
cmt bro gmake clean
cmt bro gmake
```

   Repeat the step in the previous check, and it should all be fine (if the errors are about the event selector, do the same thing but for the LArFCALTBCnv package).

Analysis Documents

- "BeamCleaningAndEnvelope.pdf" (May 9, 2008): A quick check of the effect of the beam envelope cut on electrons and pions in 4L.
- "TB2003_TopoAnd4LPosition_Electrons.pdf" (May 14, 2008): A first look at the topological clustering with electrons in the 4L position.
- "TB2003_TopoAnd4LPosition_Pions_v3.pdf" (June, 2008): A first look at the topological clustering with pions in the 4L position.

Monte Carlo

- "instructions_TB2003.ppt": Instructions for setting up MC simulation, digitization, and reconstruction.
- "DigiAndRecoInstruction.txt": Additional instructions for MC digitization and reconstruction (following from the above)

Presentations

- "KriegerComo2007.pdf": FCal testbeam presentation,Como, Oct. 2007 (Proceedings)
- http://indico.cern.ch/conferenceDisplay.py?confId=28542 Performance of the ATLAS Forward Calorimeter, Calor2008, May 2008
- "LHeelan_LArWeekSept2008.pdf": LAr Week: TB03 Analysis Update: TopoCluster and Inner Edge Studies

Publications

- "jinst8_02_p02002.pdf": FCal TB2003 publication for 4L data
- jinst7_11_p11001.pdf. Prototype FCal 1998 test beam results.
- jinst8_02_p02010.pdf. The ATLAS Forward Calorimeters.

Major updates:
-- Main.mschram - 05 Feb 2006 -- Main.mschram - 02 Feb 2006

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