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ATLAS FCal Test Beam 2003 Athena Analysis

This is a TWiki web page for the FCal community to clearly 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.

<table>
<thead>
<tr>
<th>Energy [GeV]</th>
<th>Run Numbers</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>run3848-3864</td>
<td></td>
</tr>
<tr>
<td></td>
<td>run3866-3867</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>run3608-3640</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>run3568-3572</td>
<td></td>
</tr>
<tr>
<td></td>
<td>run3641-3658</td>
<td></td>
</tr>
<tr>
<td></td>
<td>run3662-3680</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>run3574-3591</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>run3242-3258</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>run2543-2552</td>
<td>&quot;Noisy&quot;</td>
</tr>
<tr>
<td></td>
<td>run2554-2560</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>run2595-2612</td>
<td>&quot;Noisy&quot;</td>
</tr>
<tr>
<td>150</td>
<td>run2385</td>
<td>&quot;Noisy&quot;</td>
</tr>
<tr>
<td></td>
<td>run2387-2401</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>run2324-2340</td>
<td></td>
</tr>
<tr>
<td></td>
<td>run3128-3136</td>
<td></td>
</tr>
<tr>
<td></td>
<td>run3224-3233</td>
<td></td>
</tr>
</tbody>
</table>

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

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

Pions at 4L

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

<table>
<thead>
<tr>
<th>Energy [GeV]</th>
<th>Run Numbers</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>run4006-4012</td>
<td></td>
</tr>
<tr>
<td></td>
<td>run4059-4064</td>
<td></td>
</tr>
</tbody>
</table>
The following table lists runs that were previously deemed as good, but have since been cut from the analysis.

<table>
<thead>
<tr>
<th>Energy [GeV]</th>
<th>Run Numbers</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>run4023-4024</td>
<td>problem with beam envelope cut</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>run3973</td>
<td>BPCs tripped - could not generate beam envelope/cleaning cuts</td>
</tr>
<tr>
<td>60</td>
<td>run3281</td>
<td>problem reduced evts in logTree (5449 instead of 11210)</td>
</tr>
<tr>
<td>80</td>
<td>run2619</td>
<td>one of BPCs tripped - could not generate beam envelope/cleaning cuts</td>
</tr>
<tr>
<td></td>
<td>run2636-2647</td>
<td>one BPC tripped</td>
</tr>
<tr>
<td></td>
<td>run2648</td>
<td>changing beam conditions</td>
</tr>
<tr>
<td>100</td>
<td>run2375</td>
<td>no beam instrument intrument info - could not generate beam envelope/cleaning cuts</td>
</tr>
<tr>
<td></td>
<td>run2359</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>run2290</td>
<td>no beam instrument intrument info - could not generate beam envelope/cleaning cuts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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 subtract for each time sample.
- Gain Correction: Applies a gain correction 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.TopoCluster.CellsNames = ["AllCalo"]
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:


Furthermore, 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.
Creating a noise file for the SimpleNoiseToolFromTextFile tool
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, cylindrical 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 result 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 jobOption 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>err | 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.

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

- "LHeelan_LArWeekSept2008.pdf": LAr Week: TB03 Analysis Update: TopoCluster and Inner Edge Studies

Publications

- "jinst8_02_p02002.pdf": FCal TB2003 publication for 4L data
- jinst8_02_p02010.pdf: The ATLAS Forward Calorimeters.

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

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Topic revision: r28 - 2010-08-12 - unknown