A Simulation of the DØ Run IIB Level 1 Calorimeter Trigger

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Abstract

We describe tsim_l1cal2b, a DØ framework package that simulates the DØ Run IIB Level 1 Calorimeter Trigger.

1 Introduction

The tsim_l1cal2b package is a DØ framework package that simulates the DØ Run IIB Level 1 Calorimeter Trigger. It was originally developed by Emmanuelle Perez and Jiri Bystricky and was based on the Run IIA package tsim_l1cal, written by Josh Kalk. Greg Pawloski and Sabine Lammers studied several electromagnetic clustering algorithms and optimized the final algorithm for efficiency and rejection. Wendy Taylor inherited the standalone tsim_l1cal2b package and integrated it into the DØ framework, adding the computation of many of the trigger terms and formatting and sending the data to L1CalTrack, L1Frm, L2, and L3. Ernest Aguiló developed the code that computes the remaining trigger terms and is the current developer of the package.

The package contains two processes:

- **tsim_l1cal2b** is the main process and it prepares data and simulates its treatment by the Analog to Digital and Filter card (**ADF**), the Trigger Algorithm Board (**TAB**), and the Global Algorithm Board (**GAB**).
- **Verify** is used to test the package results. It reads the output chunks and prints out all the found triggers.

Other classes of import:

- **TriggerAlgorithmBoard** specifies which calorimeter trigger algorithms will be performed and instantiates TriggerCalo to perform each trigger search.
- **TriggerCalo** defines one trigger and the corresponding calorimeter regions, reads the most recent **L1Cal2bDataChunk**, finds local maxima and creates the **L1CalTot2bChunk, L1CalJet2bChunk, L1CalEle2bChunk** or **L1CalTau2bChunk** objects for global, jet, electron and τ triggers, respectively. If the **NtupleMgr** is called, trigger n-tuples are created.
- **GlobalAlgorithmBoard** simulates the GAB construction of the E_T sums and trigger terms.
- **L1Frm** forms and sends the outputs to the Level 1 framework.
- **L1CalTrack** forms and sends the appropriate outputs to L1CalTrack.
- **L2L3Output** forms and sends the outputs to Level 2 and Level 3.

tsim_l1cal2b has four modes of operation, depending on the input data type:

1. The normal mode of operation for Monte Carlo data is to read the contents of the **L1CalTTChunk**.
2. The Run IIA raw calorimeter data (often called precision data) can be read from the **CalDataChunk**.
3. The raw Run IIA trigger tower data (MBT channel output) is read from the **L0CALTowerData** IOgen object.
4. The output of data processed by the Run IIA simulation, tsim_l1cal, can be read from the **L1L2Chunk**.

Four versions of the tsim_l1cal2b.rcp file are provided to switch between the operation modes. The functionality to read the raw Run IIB data will be implemented soon.

RCP-driven options allow the addition of **ICR** energy to neighbouring calorimeter towers, and the smearing of the trigger tower energies in the **L1CalTTChunk** and the **CalDataChunk** In addition, one can add Gaussian noise and round or truncate the tower energies. The resulting data is written to an intermediate chunk called **L1CalDataChunk**. Then the Trigger Algorithm Board and the Global Algorithm Board functionality are simulated.

2 Compiling and Running the Code

To compile the latest stable version of the code, follow the instructions in the tsim_l1cal2b/doc/README file in the devel version of CVS. They will look something like this:

```
>setup D0RunII p17.04.00
>newrel -t p17.04.00 mydir
>cd mydir
>setup d0cvs
>addpkg -h l2iogen
>addpkg tsim_l1cal2b v00-02-24
>addpkg l2io v02-02-04
>addpkg l2base v00-03-17
>addpkg d0trigsim v01-03-11
>addpkg tsim_l1l2 v00-10-12
>d0setwa
>gmake l2iogen.all
>gmake all
>cd tsim_l1l2/rcp
>cp /work/yoho-clued0/wendyt/test/tsim_l1l2/rcp/tsim.rcp .
---->>> turn off the STT code, which was crashing, and turn on l1cal2b
>cp /work/yoho-clued0/wendyt/test/tsim_l1l2/rcp/l2_global.rcp .
---->>> turn off the STT inputs
>cp /work/yoho-clued0/aguiloe/mydir/tsim_l1l2/rcp/tsim_data.rcp .
>---->>> equivalent to tsim.rcp if you want to run with RunIIa data
>cd ../../
---->>> you will need this:
>cp /work/yoho-clued0/wendyt/p1704/trigsim/level1_2b.sim trigsim
>cp /work/yoho-clued0/wendyt/p1704/trigsim/andor2b.config trigsim
```

To run the code on Monte Carlo, simply do the following

```
>setup d0tools -t
>cp /work/yoho-clued0/wendyt/test/zee.list .
```

```
---->>>or use your favourite Monte Carlo file
>cp tsim_l1cal2b/rcp/tsim_l1cal2b_TT.rcp tsim_l1cal2b/rcp/tsim_l1cal2b.rcp
>runD0TrigSim -filelist=zee.list -format=mc -localbuild -localfwkrcp
 -localrcp -l1l2only -num=10
```

To run the code on raw Run IIA trigger tower data, do

```
>setup d0tools -t
>cp /work/yoho-clued0/aguiloe/mydir/runIIa.list .
---->>>or use your favourite Run IIA data file
>cp tsim_l1cal2b/rcp/tsim_l1cal2b_MBT.rcp tsim_l1cal2b/rcp/tsim_l1cal2b.rcp
>runD0TrigSim -filelist=zee.list -format=data -localbuild -localfwkrcp
 -localrcp -l1l2only -num=10
```

3 Controlling the Code Operation via RCPs

There are many RCP files provided with this package. The main file that users will modify is tsim_l1cal2b.rcp. The following RCPs will be most interesting to the average user.

- string **InputData** =
  - "L1CalTTChunk" - reads MC data
  - "CalDataChunk" - reads Run IIA precision data
  - "L1L2Chunk" - reads Run IIA tsim_l1cal data in L1L2Chunk
  - "MBT" - reads raw Run IIA trigger tower data
- bool **doL1** - turns on/off the output to L1Frm
- bool **debugL1** - turns on/off verbose L1 debug information
- bool **doL1CalTrack** - turns on/off the output to L1CalTrack
- bool **debugL1CalTrack** - turns on/off verbose L1CalTrack debug information
- bool **doL2L3** - turns on/off the output to L2/L3
- bool **debugL2L3** - turns on/off verbose L2/L3 debug information
- int **debug_level** =
  - 0 - prints parameter values

- 1 - same as 0 plus event numbers, RCP IDs, chunk IDs
- 2 - same as 1 plus a list of trigger towers after digitization
- 3 - same as 2 plus a list of trigger towers before digitization
- 4 - same as 3 plus a list of trigger towers as read by TriggerAlgorithmBoard from the L1CalDataChunk

The remaining RCPs are primarily for expert studies.

4 Verification of tsim_l1cal2b

The L3 output of tsim_l1cal2b gets stored in the RawDataChunk in Crate number 0x2D. Five thousand $Z \rightarrow e^+e^-$ Monte Carlo events were processed by tsim_l1cal2b. Todd Adams's unpacker was used to unpack the tsim_l1cal2b data in the RawDataChunk and the trigger tower basic data format was verified. The correct number of headers and trailers were present, the L2 data type was consistent in the header and trailer and the number of words between the header and trailer was correct.

The L1Cal2b EM and jet objects found in the $Z \rightarrow e^+e^-$ Monte Carlo sample were compared to L2Global Run IIA objects. First the objects were matched in η and ϕ, then the difference distributions were plotted. Figure 1 shows the deviation in η and ϕ for L1Cal2b EM objects from that found by Run IIA L2Global. Figure 2 shows the deviation in E_T for L1Cal2b EM objects from that found by Run IIA L2Global.

Figure 3 shows the deviation in η and ϕ for L1Cal2b jet objects from that found by Run IIA L2Global. Figure 4 shows the deviation in E_T for L1Cal2b jet objects from that found by Run IIA L2Global.

The agreement in the plots is not expected to be exact, as the objects aren't equivalent, but all the distributions indicate that tsim_l1cal2b is giving similar results as Run IIA L2Global for EM and jet objects. This study was not performed for τ objects, as they are not found by Run IIA L2Global.

A detailed verification of the tsim_l1cal2b performance compared to Monte Carlo is currently underway.

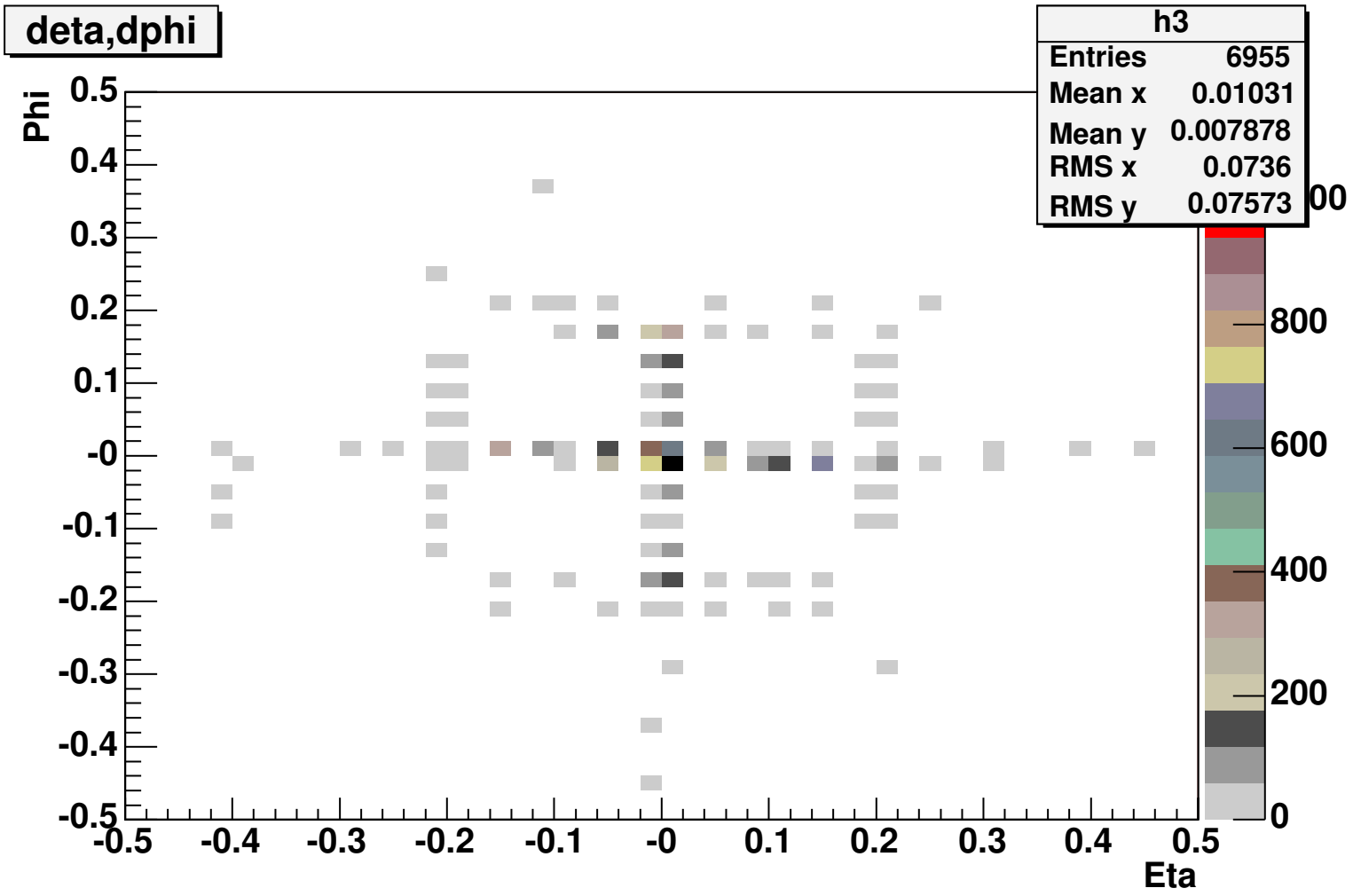

Figure 1: ϕ(L2Global)-ϕ(L1Cal2b) vs η(L2Global)-η(L1Cal2b) for EM objects

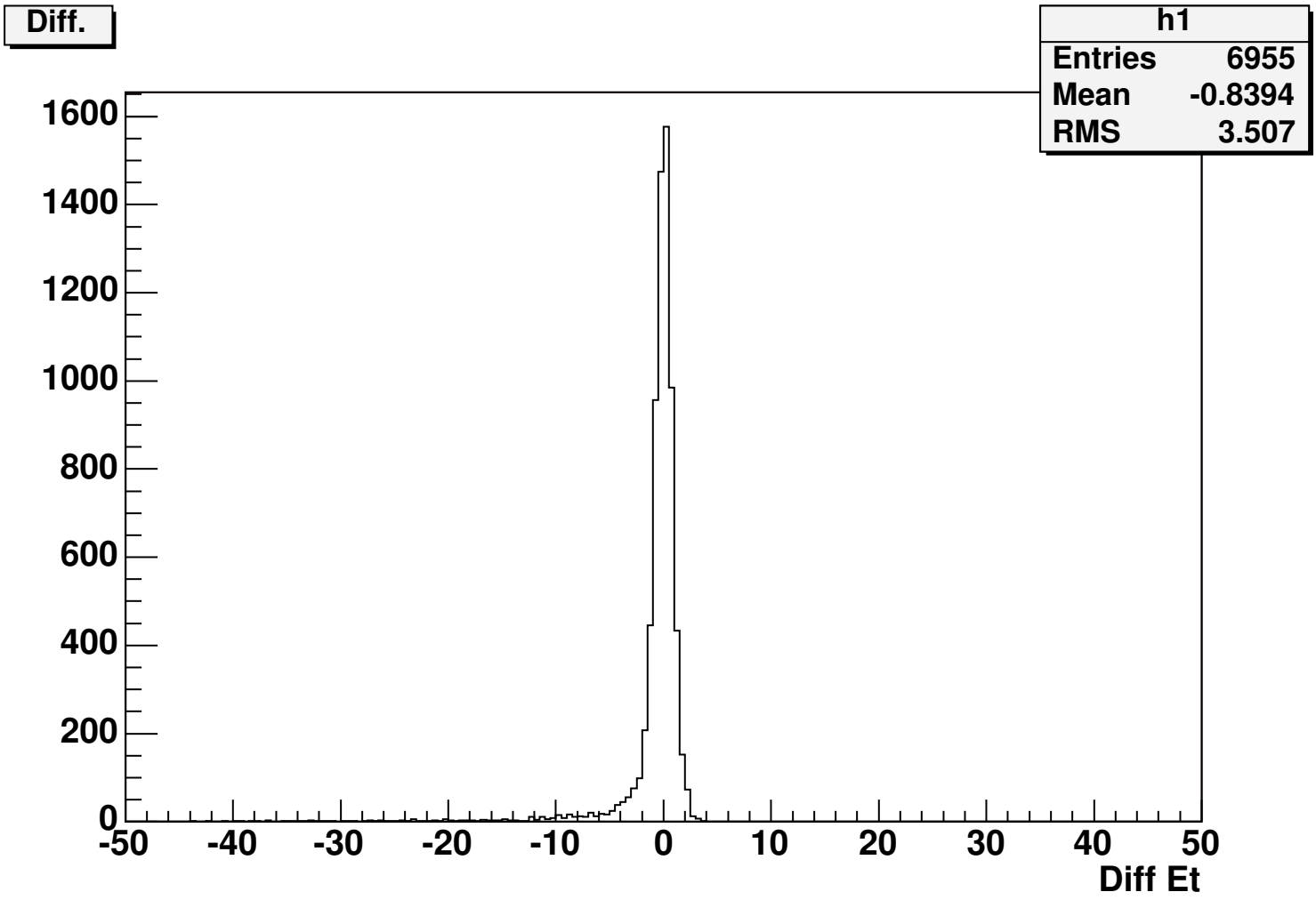

Figure 2: E_T(L2Global)-E_T(L1Cal2b) for EM objects

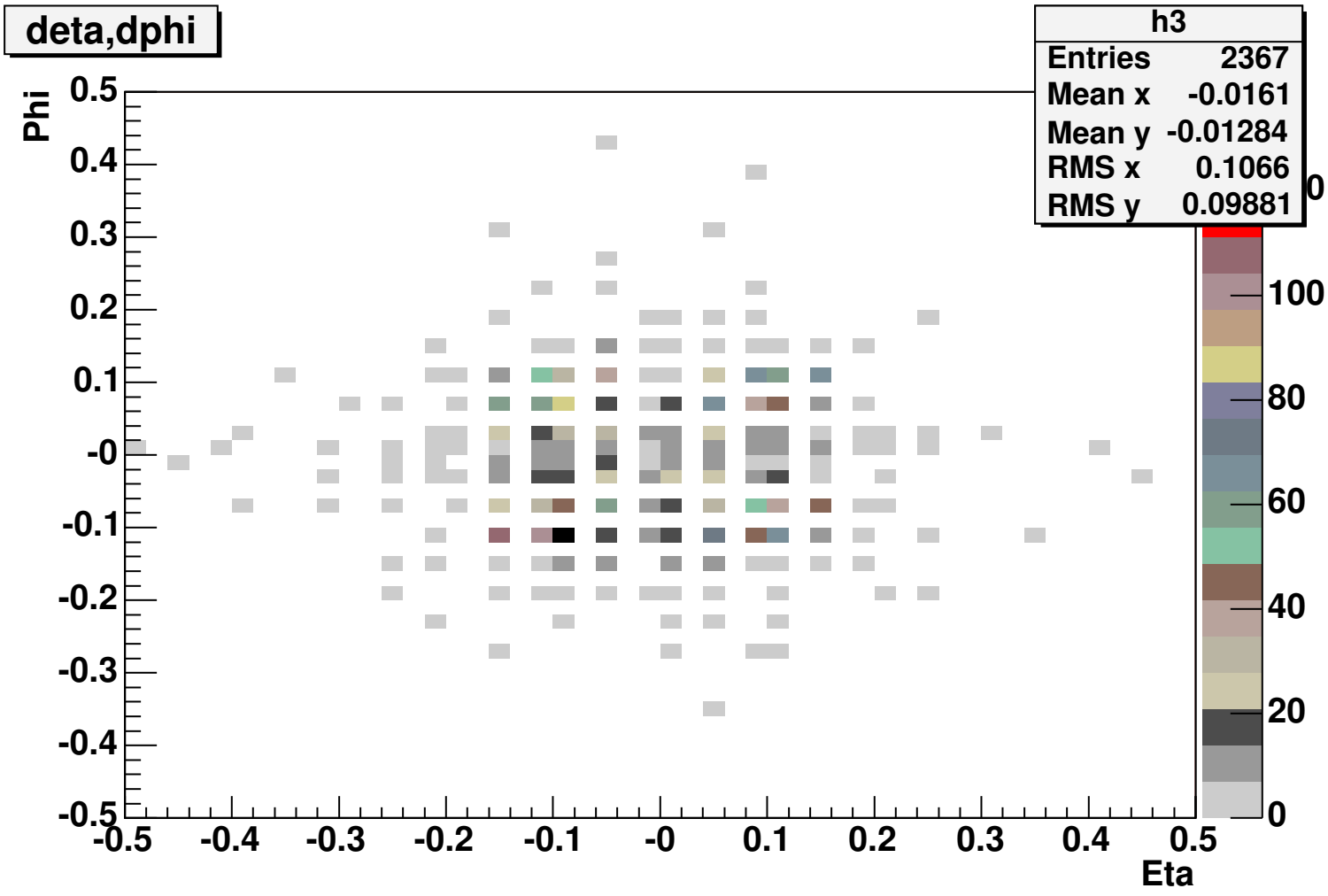

Figure 3: ϕ(L2Global)-ϕ(L1Cal2b) vs η(L2Global)-η(L1Cal2b) for jet objects

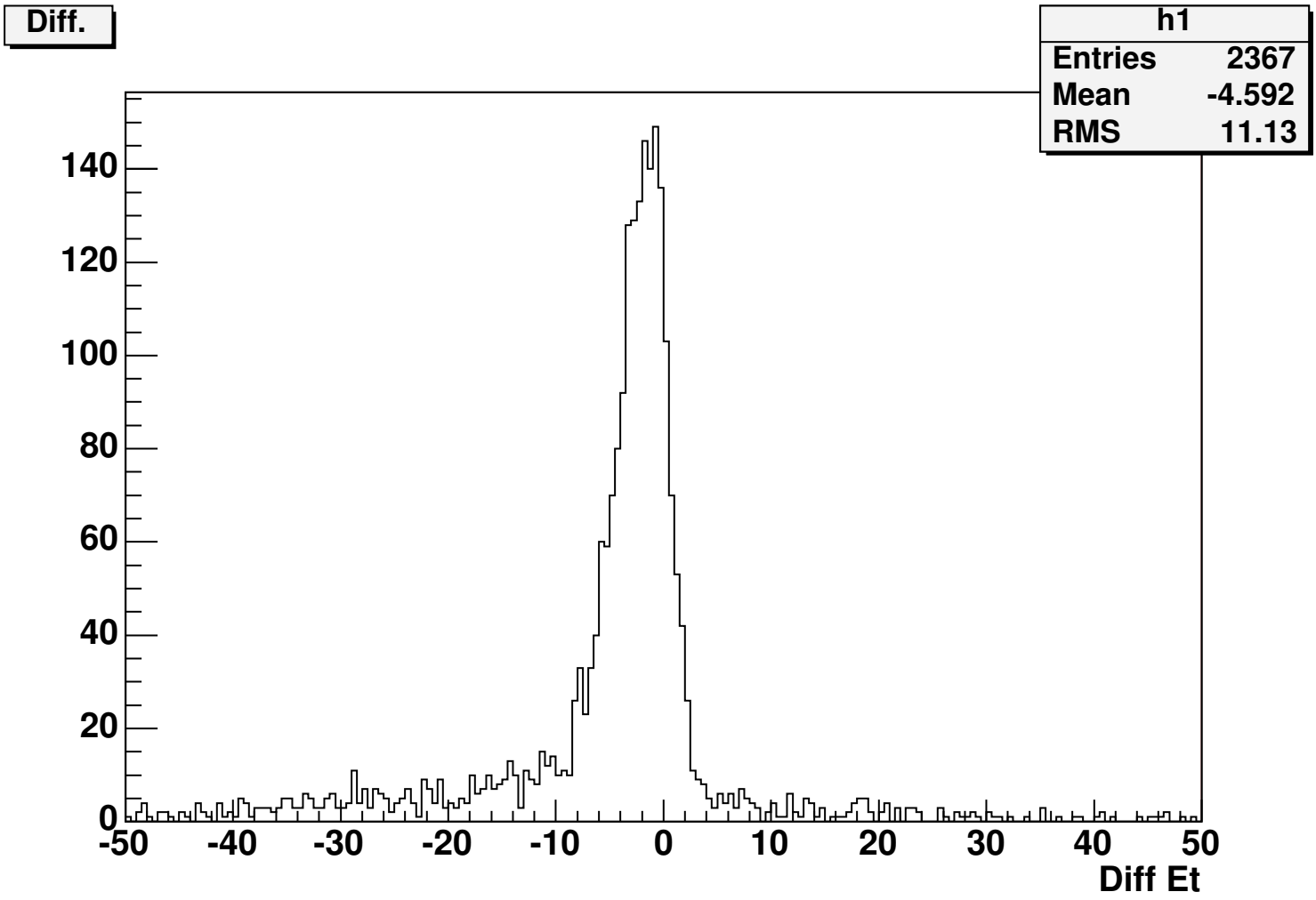

Figure 4: E_T(L2Global)-E_T(L1Cal2b) for jet objects