Unconverted Photons

At truth level, photons are considered a *conversion* if
- (a) isGenStable == 1 and
- (b) at least one HepMC descendant is an electron.

The *author* of a reconstructed photon must have the AuthorPhoton(=0x4) bit mask set. A *tight* photon indicates that *isEM* has the PhotonTight (= 0x7FF3) bit mask clear.

We are concerned only with unconverted photons for the time being.

isEM Definitions

isEM is an integer variable containing information about the calorimeter and tracking, each bit indicating whether different variables have passed their respective cuts. The various cut values are defined in
Reconstruction/egamma/egammaPIDTools/egammaPIDTools/egammaPhotonCutIDTool.h.
The various variables are declared in
/Reconstruction/egamma/egammaEvent/egammaEvent/egammaParamDefs.h
The bit definitions are declared in
Reconstruction/egamma/egammaEvent/egammaEvent/egammaPIDdefs.h

ClusterHadronicLeakage is a measure of how much energy leaks into the hadronic calorimeter. In particular, the ratio of the energy deposited in the first compartment of the HCAL (***ethad1***) to the transverse cluster energy (***et***) is compared to a variable ***m_CutHadLeakage_photons***. . The variable is η-dependent.

e233 is the uncalibrated energy (sum of cells) of the middle sampling in a rectangle of size 3x3 (in cell units $\eta \times \phi$).

e237 is the uncalibrated energy (sum of cells) of the middle sampling in a rectangle of size 3x7 (in cell units $\eta \times \phi$).

e277 is the uncalibrated energy (sum of cells) of the middle sampling in a rectangle of size 7x7 (in cell units $\eta \times \phi$).

ClusterMiddleEratio37 indicates if the ratio **e237 / e277** is less than a value indicated by a variable ***m_ratio1_photons***.

ClusterMiddleEratio33 indicates if the ratio **e233 / e237** is less than a value indicated by a variable ***m_ratio2_photons***.

ClusterStripsWeta1c is a measure of the "shower width weighted by distance from the maximum one (weta1)".

100 GeV Photons

	total photons	unconverted photons	fraction
	1000	745	74.5 %
	converted photons	+AuthorPhoton	
FullSim	745	745	100.0 %
Atlfast	745	745	100.0 %

	converted photons	+tight	
FullSim	745	692	92.9 %
Atlfast	745	597	80.1 %

Bit/Mask	Variable	FullSim	Abs Eff	Atlfast	Abs Eff
0/0001	ClusterEtaRange	745/745	100.0 %	745/745	100.0 %
1/0002	ClusterHadronicLeakage	709/745	95.2 %	714/745	95.8 %
4/0010	ClusterMiddleEnergy	745/745	100.0 %	745/745	100.0 %
5/0020	ClusterMiddleEratio37	744/745	99.9 %	745/745	100.0 %
6/0040	ClusterMiddleEratio33	745/745	100.0 %	745/745	100.0 %
7/0080	ClusterMiddleWidth	744/745	99.9 %	745/745	100.0 %
8/0100	ClusterStripsEratio	718/745	96.4 %	731/745	98.1 %
9/0200	ClusterStripsDeltaEmax2	745/745	100.0 %	745/745	100.0 %
10/0400	ClusterStripsDeltaE	745/745	100.0 %	745/745	100.0 %
11/0800	ClusterStripsWtot	735/745	98.7 %	732/745	98.3 %
12/1000	ClusterStripsFracm	744/745	99.9 %	744/745	99.9 %
13/2000	ClusterStripsWeta1c	745/745	100.0 %	637/745	85.5 %
14/4000	ClusterIsolation	745/745	100.0 %	745/745	100.0 %

Efficiency Analysis

In this section, we examine the degradation of efficiency as a function of the cumulative cuts. We saw above that all reconstructed unconverted photons pass the *author* cuts. It makes sense to first factor out all the cuts with a 100% yield.

The following table is constructed as follows. The first column corresponds to the bit used to form the isEM mask. This mask is OR'd with the mask of all the lines before it. Therefore, each line indicates a cumulative cut for both Full Simulation and Atlfast. The absolute and relative efficiencies are also given. The absolute efficiency is the ratio of the number of unconverted photons passing the cumulative cut, to the total number of unconverted photons. The relative efficiency is the ratio of the number of unconverted photons passing the cumulative cut, to the number of unconverted photons passing the cumulative cut in the previous line.

Bit	Variable	FullSim	abs eff	rel eff	Atlfast	abs eff	rel eff
0	ClusterEtaRange	745/745	100.0%	100.0%	745/745	100.0%	100.0%
4	ClusterMiddleEnergy	745/745	100.0%	100.0%	745/745	100.0%	100.0%
6	ClusterMiddleEratio33	745/745	100.0%	100.0%	745/745	100.0%	100.0%
9	ClusterStripsDeltaEmax2	745/745	100.0%	100.0%	745/745	100.0%	100.0%
10	ClusterStripsDeltaE	745/745	100.0%	100.0%	745/745	100.0%	100.0%
14	ClusterIsolation	745/745	100.0%	100.0%	745/745	100.0%	100.0%
5	ClusterMiddleEratio37	744/745	99.9%	99.9%	745/745	100.0%	100.0%
7	ClusterMiddleWidth	743/744	99.7%	99.9%	745/745	100.0%	100.0%
11	ClusterStripsWtot	733/743	98.4%	98.7%	732/745	98.3%	98.3%
12	ClusterStripsFracm	732/733	98.3%	99.9%	732/732	98.3%	100.0%
8	ClusterStripsEratio	715/732	96.0%	97.7%	728/732	97.7%	99.5%
1	ClusterHadronicLeakage	692/715	92.9%	96.8%	703/728	94.4%	96.6%
13	ClusterStripsWeta1c	692/692	92.9%	100.0%	597/703	80.1%	84.9%

Table 1: Cumulative Efficiencies for **isEM**

N-1 Plots

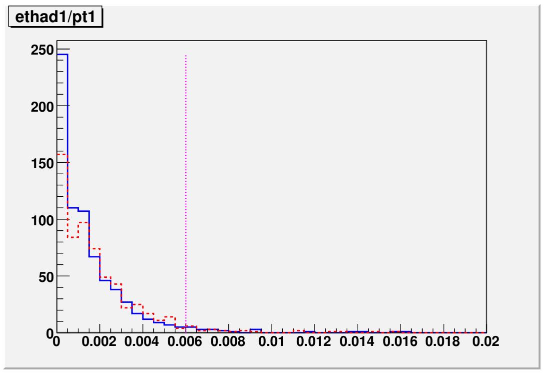

Figure 1: ETHAD1/PT for unconverted photons passing all cuts except for ClusterHadronicLeakage. Vertical line indicates the ClusterHadronicLeakage cut

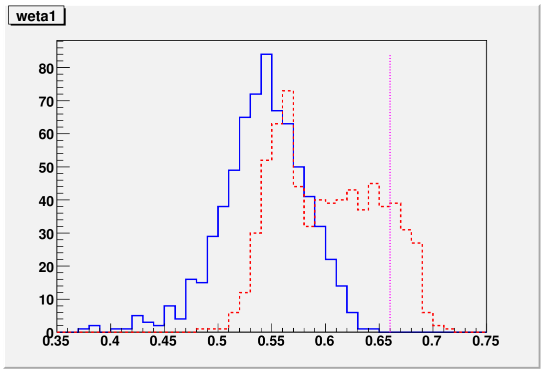

Figure 2: WETA1 for unconverted photons passing all cuts except for ClusterStripsWeta1c. Vertical line indicates the ClusterStripsWeta1c cut

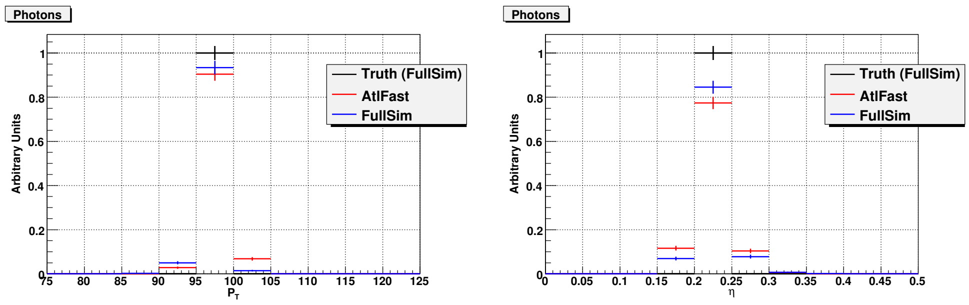

Figure 3: P_T and η distributions of the truth, fullsim and atlfast collections

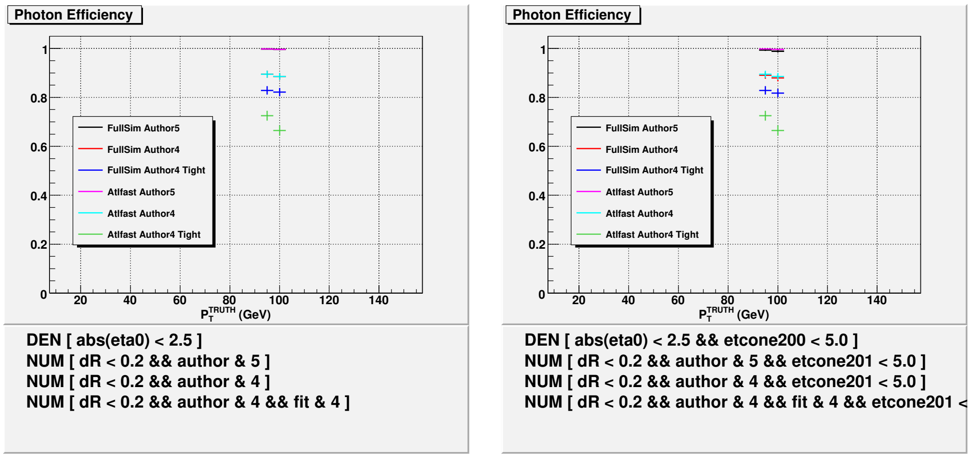

Figure 4: Reconstruction efficiency for photons as a function of P_T of the truth photon. Left: no isolation requirements. Right: etcone20 $<$ 5 GeV requirement

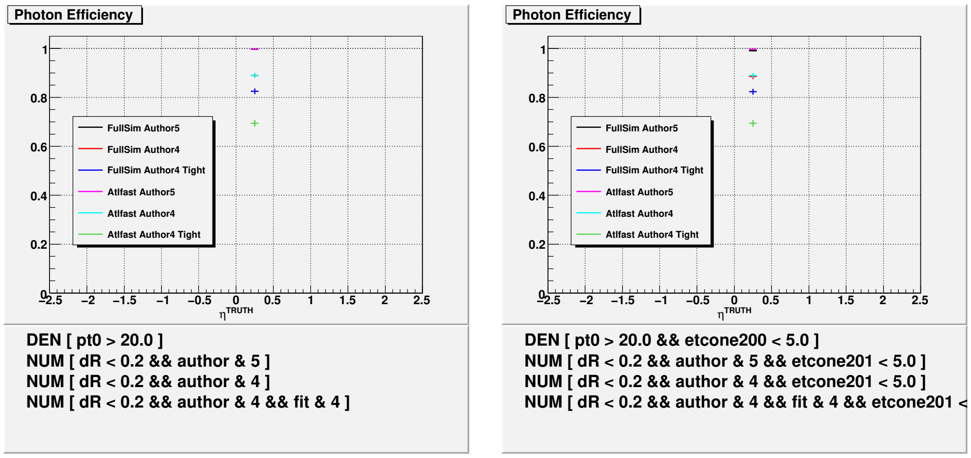

Figure 5: Reconstruction efficiency for photons as a function of η of the truth photon. Left: no isolation requirements. Right: etcone20 $<$ 5 GeV requirement

Cut Variables

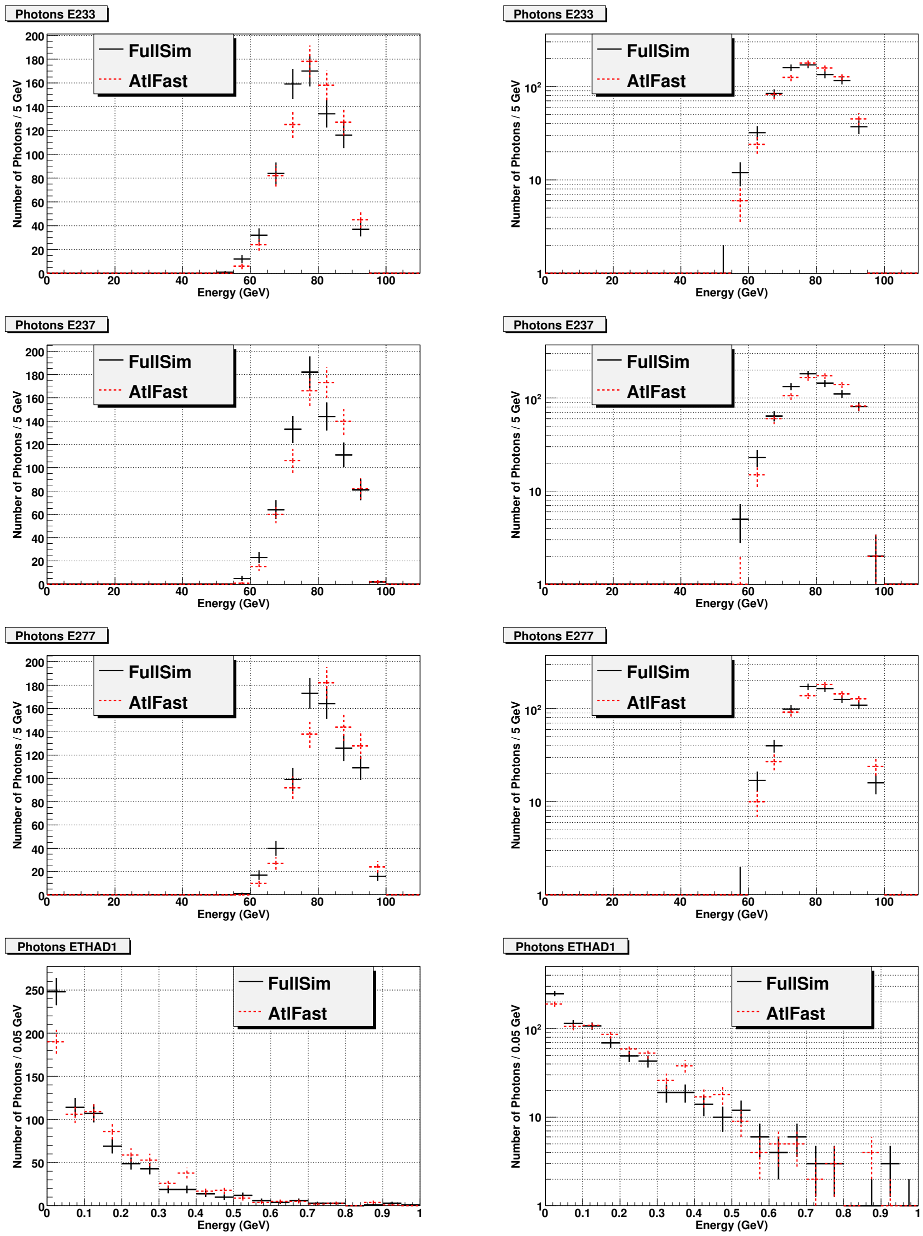

Figure 6: The various profiles of energy deposits in the ECAL. Plots on the left are linear scale; plots on the right are logarithmic scale. The bottom plot are the energy deposits in the first compartment of the HCAL.

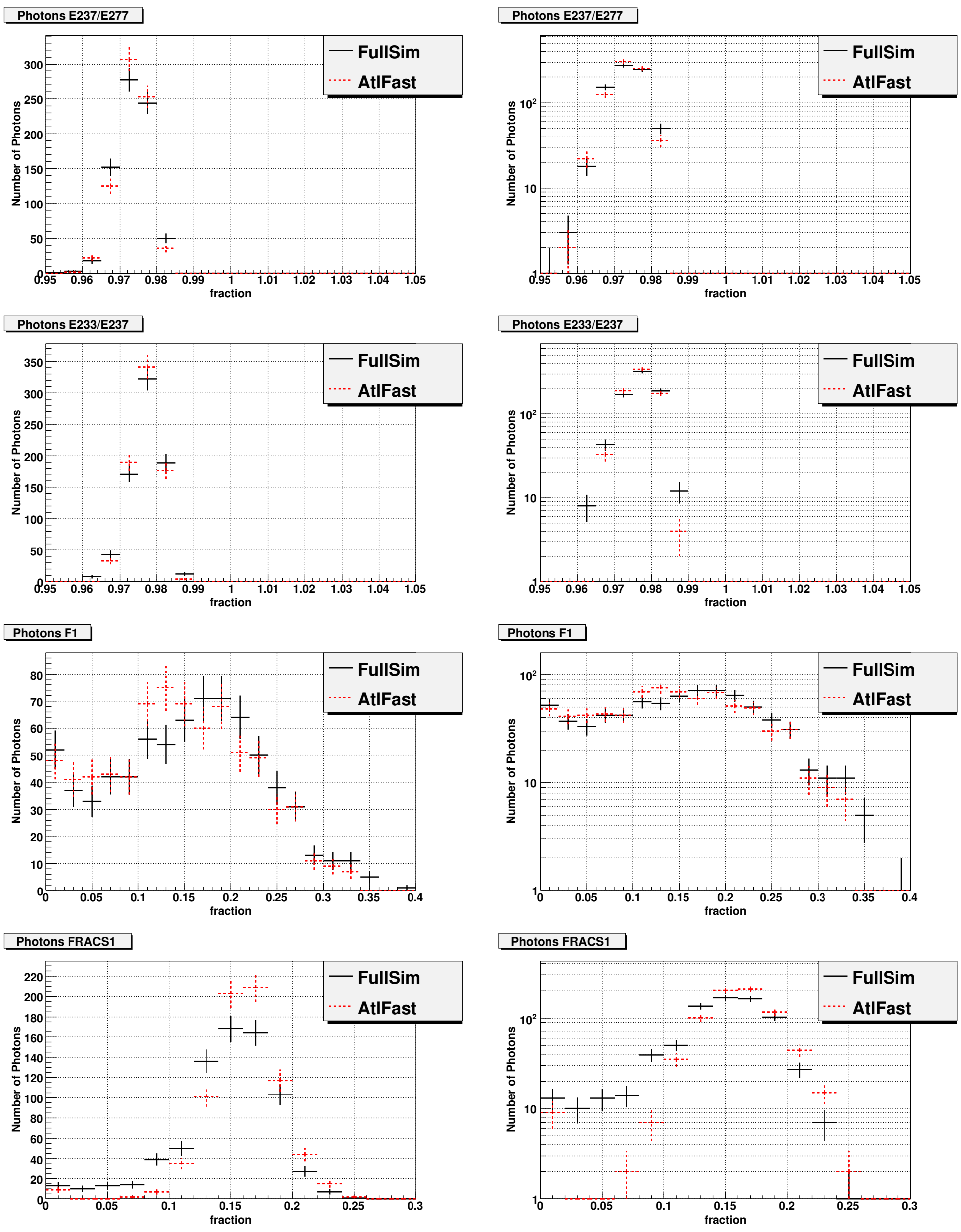

Figure 7: The various quantities used to make cuts for **isEM**.

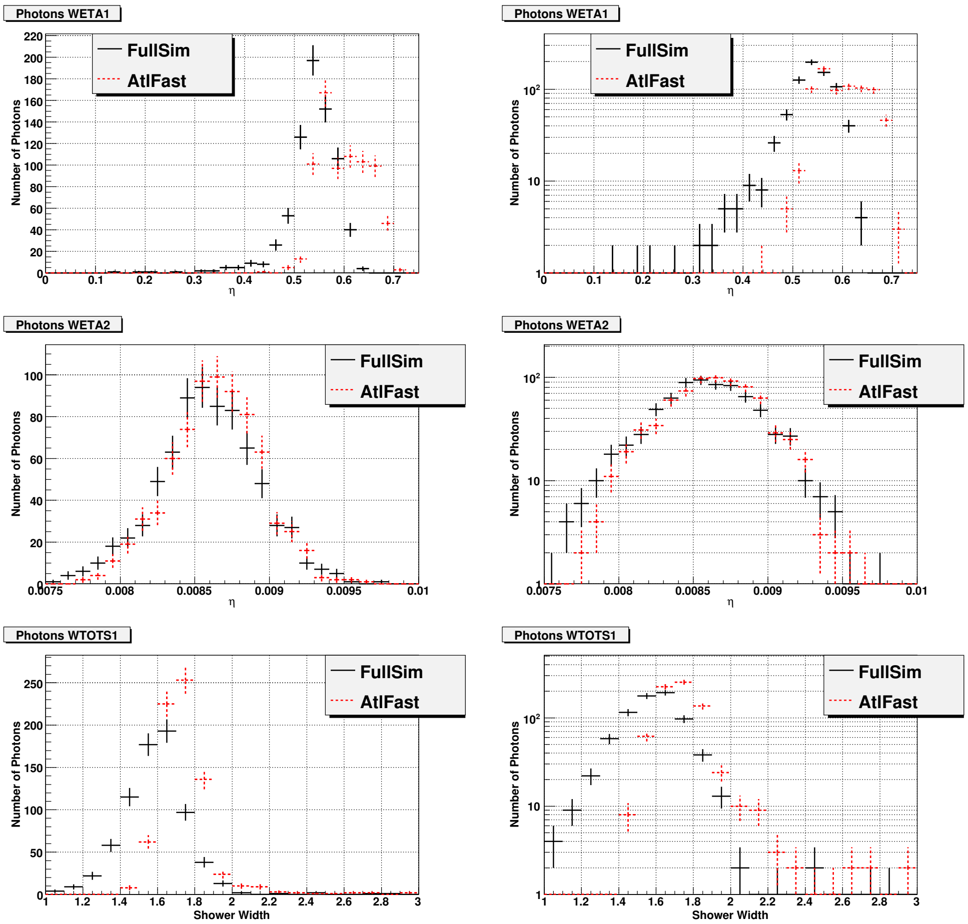

Figure 8: The various quantities used to make cuts for **isEM**.

50 GeV Photons

	total photons	unconverted photons	fraction
	1000	725	72.5 %
	converted photons	+AuthorPhoton	
FullSim	725	724	99.9 %
Atlfast	725	724	99.9 %
	converted photons	+tight	
FullSim	725	670	92.4 %
Atlfast	725	627	86.5 %

Bit/Mask	Variable	FullSim	Abs Eff	Atlfast	Abs Eff
0/0001	ClusterEtaRange	725/725	100.0 %	725/725	100.0 %
1/0002	ClusterHadronicLeakage	694/725	95.7 %	725/725	100.0 %
4/0010	ClusterMiddleEnergy	725/725	100.0 %	725/725	100.0 %
5/0020	ClusterMiddleEratio37	723/725	99.7 %	725/725	100.0 %
6/0040	ClusterMiddleEratio33	725/725	100.0 %	725/725	100.0 %
7/0080	ClusterMiddleWidth	724/725	99.9 %	725/725	100.0 %
8/0100	ClusterStripsEratio	713/725	98.3 %	712/725	98.2 %
9/0200	ClusterStripsDeltaEmax2	724/725	99.9 %	725/725	100.0 %
10/0400	ClusterStripsDeltaE	724/725	99.9 %	725/725	100.0 %
11/0800	ClusterStripsWtot	720/725	99.3 %	717/725	98.9 %
12/1000	ClusterStripsFracm	714/725	98.5 %	716/725	98.8 %
13/2000	ClusterStripsWeta1c	722/725	99.6 %	649/725	89.5 %
14/4000	ClusterIsolation	724/725	99.9 %	725/725	100.0 %

Efficiency Analysis

Bit	Variable	FullSim	abs eff	rel eff	Atlfast	abs eff	rel eff
0	ClusterEtaRange	723/723	100.0%	100.0%	724/724	100.0%	100.0%
4	ClusterMiddleEnergy	723/723	100.0%	100.0%	724/724	100.0%	100.0%
6	ClusterMiddleEratio33	723/723	100.0%	100.0%	724/724	100.0%	100.0%
14	ClusterIsolation	723/723	100.0%	100.0%	724/724	100.0%	100.0%
5	ClusterMiddleEratio37	722/723	99.9%	99.9%	724/724	100.0%	100.0%
7	ClusterMiddleWidth	721/722	99.7%	99.9%	724/724	100.0%	100.0%
11	ClusterStripsWtot	716/721	99.0%	99.3%	716/724	98.9%	98.9%
12	ClusterStripsFracm	705/716	97.5%	98.5%	708/716	97.8%	98.9%
8	ClusterStripsEratio	697/705	96.4%	98.9%	701/708	96.8%	99.0%
1	ClusterHadronicLeakage	673/697	93.1%	96.6%	701/701	96.8%	100.0%
13	ClusterStripsWeta1c	670/673	92.7%	99.6%	627/701	86.6%	89.4%

Table 2: Cumulative Efficiencies for **isEM**

N-1 Plots

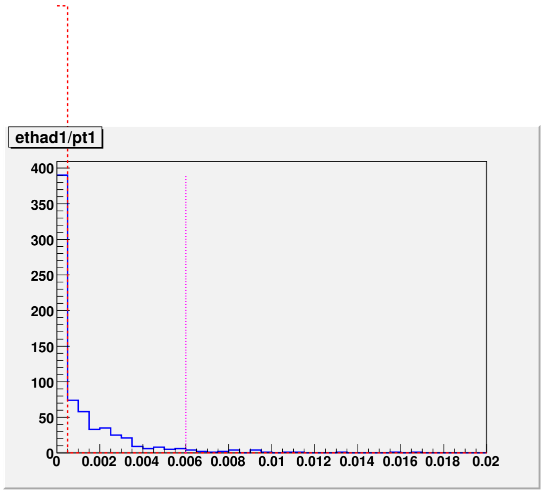

Figure 9: ETHAD1/PT for unconverted photons passing all cuts except for ClusterHadronicLeakage. Vertical line indicates the ClusterHadronicLeakage cut

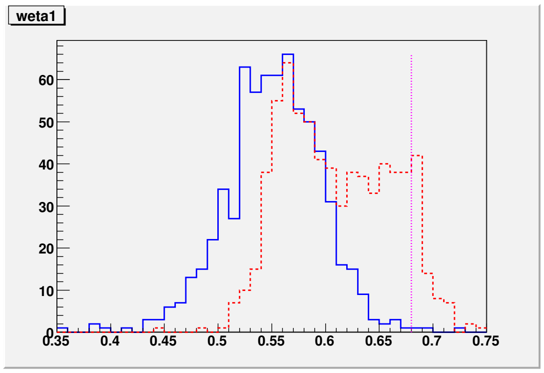

Figure 10: WETA1 for unconverted photons passing all cuts except for ClusterStripsWeta1c. Vertical line indicates the ClusterStripsWeta1c cut

Cut Variables

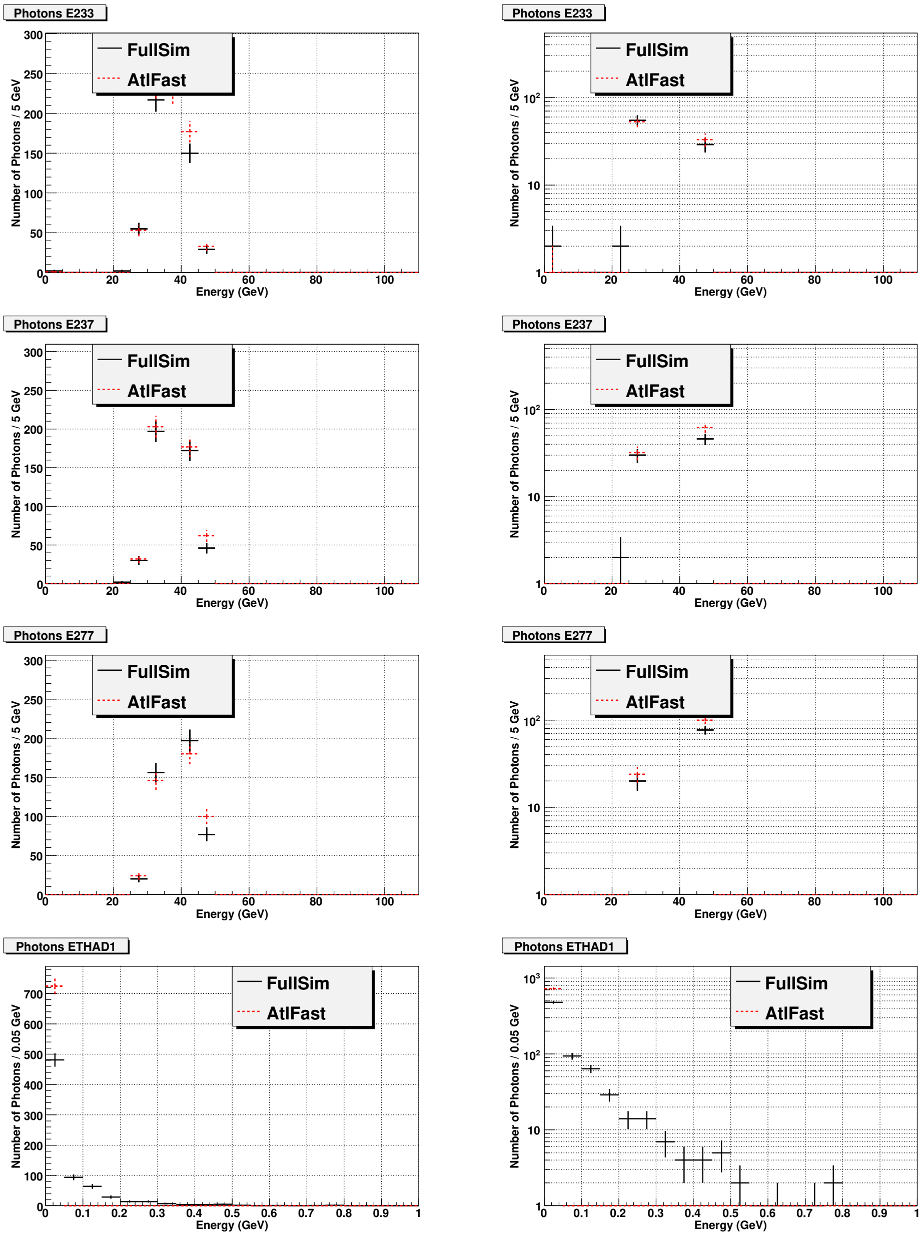

Figure 11: The various profiles of energy deposits in the ECAL. Plots on the left are linear scale; plots on the right are logarithmic scale. The bottom plot are the energy deposits in the first compartment of the HCAL.

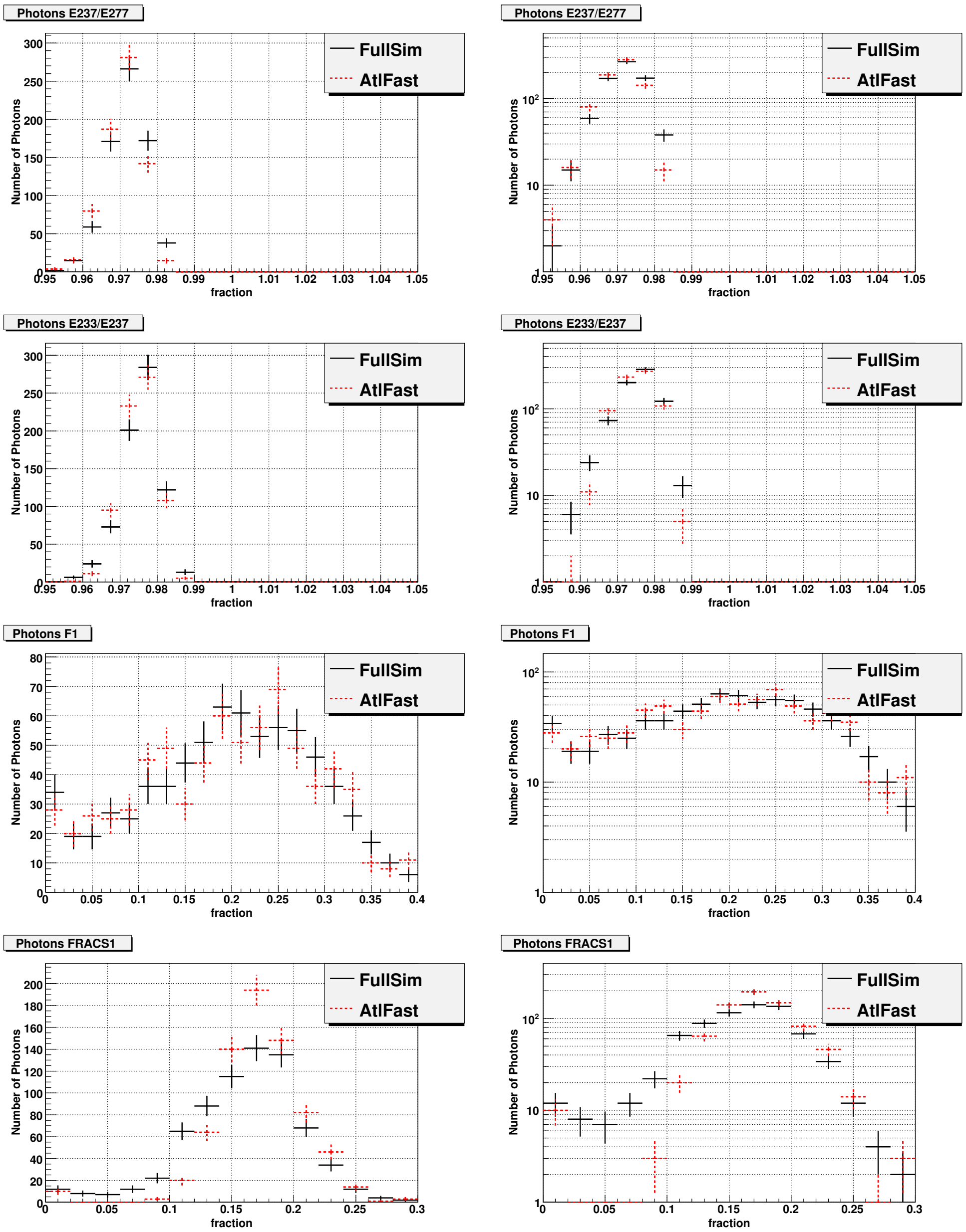

Figure 12: The various quantities used to make cuts for **isEM**.

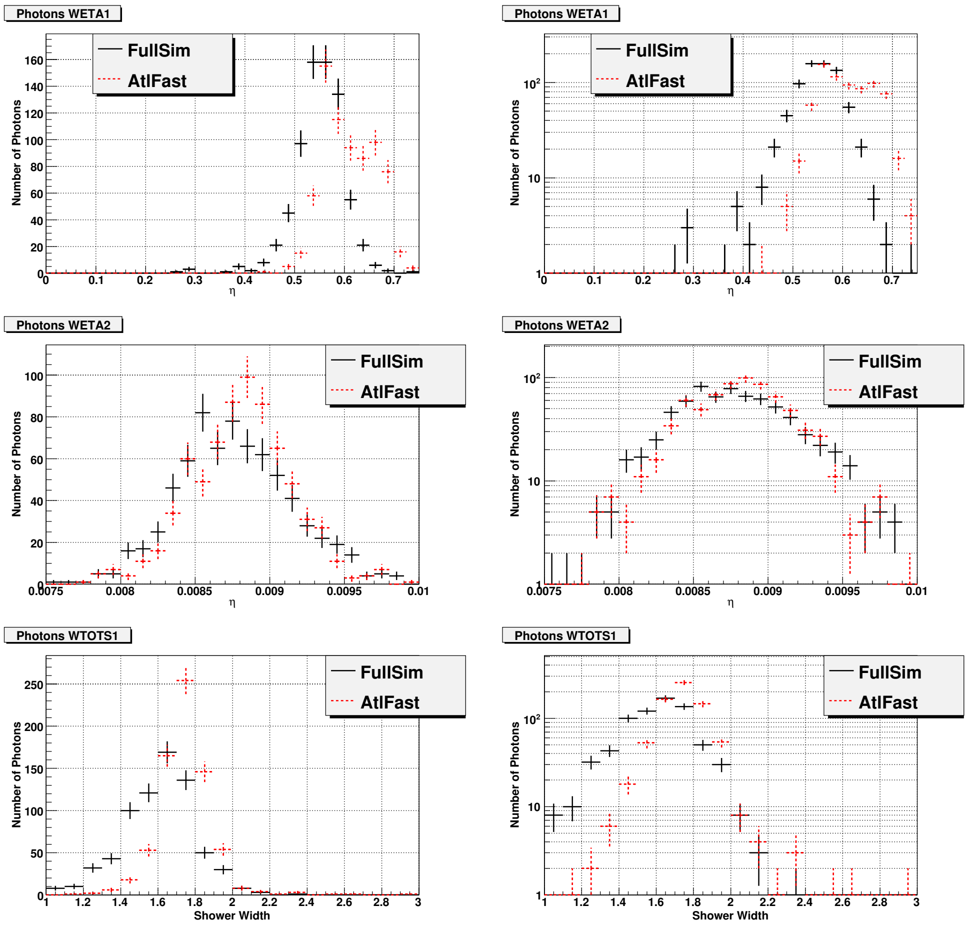

Figure 13: The various quantities used to make cuts for **isEM**.