Shower shape variables for photons in 900 GeV collisions and MC comparison

ECAL

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- First data from collisions
- First comparison between data/MC
- Milano group involved in photon sector
- Milano group involved in `Photon Analysis Utils` used in this analysis
- ATLAS Note: "Electron and photon reconstruction and identification in ATLAS: expected results at high energy and observed performance in 900 GeV data"

Data 900 GeV min bias:

- 384186 events COLL CAND
- 1772 photons
- good run list (luminosity block) $\simeq 1/2$ statistics:
  - (tracker, LAr (EM barrel + endcap + had endcap), Tile)$\geq$ yellow
  - 450 GeV beam energy
  - B fields on

/storage/fanti/data09_900GeV/user10.LeonardoCarminati.data09_900GeV.00141749-00142383.physics_

MinBias.merge.DESD_COLLCAND.r988_p62.egGRL-Dec09reprocessing900GeV.NTUP.rel15614.PAU-00-00-96.

v1/

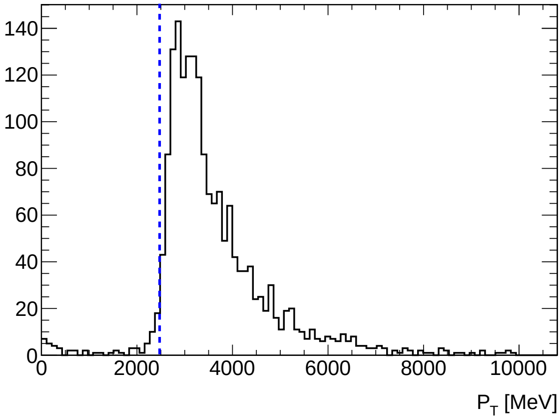
MC 900 GeV min bias:

- $\lesssim$10M events
- 102393 photons ($\lesssim$3934 scaled!)
- photons from: background, q/g, not associated.

/storage/fanti/mc09_900GeV/group09.PhotonAnalysis.mc09_900GeV.105001.pythia_minbias.recon.AOD.

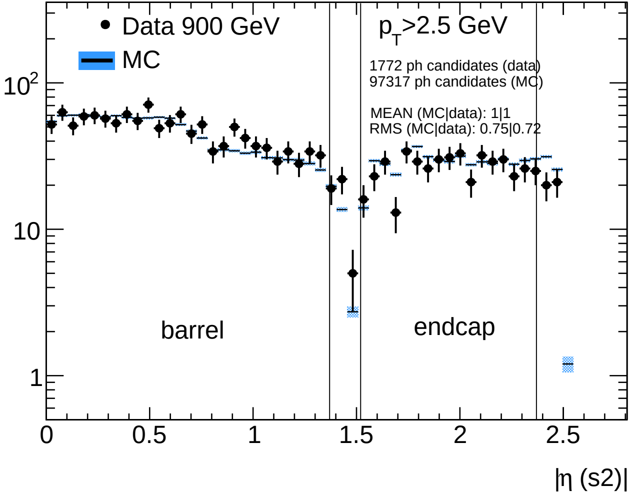
e500_s655_s657_d257_r1023.NTUP.rel1561.PAU-00-01-07.v2/

$P_T > 2.5\mathrm{GeV}$



Fiducial cuts

$$|\eta(s2)| < 1.37,\ 1.52 < |\eta(s2)| < 2.37$$



$P_T > 2.5\mathrm{GeV}$ + fiducial cuts (etaS2)

Loose cuts on: hadronic leakage, second sampling shower shape variables

Tight cut on: same as loose with stricter thresholds and cuts on five shower shape variables of the first layer

data		barrel	endcap
	1684	$1246_{(74\pm1)\%}$	$438_{(26\pm1)\%}$
Loose	$441^{(26\pm1)\%}$	$318^{(25\pm1)\%}_{(72\pm2)\%}$	$123^{(28\pm2)\%}_{(28\pm2)\%}$
Tight	$123^{(7.3\pm0.6)\%}$	$84^{(6.7\pm0.7)\%}_{(68\pm4)\%}$	$39^{(9\pm1)\%}_{(31\pm4)\%}$

MC		barrel	endcap
	91767	$65632_{(71.5\pm0.2)\%}$	$26135_{(28.4\pm0.2)\%}$
Loose	$28380^{(30.9\pm0.2)\%}$	$19417^{(29.6\pm0.2)\%}_{(68.4\pm0.3)\%}$	$8963^{(34.3\pm0.3)\%}_{(31.6\pm0.3)\%}$
Tight	$9833^{(10.7\pm0.1)\%}$	$6219^{(9.5\pm0.1)\%}_{(63.2\pm0.5)\%}$	$3614^{(13.9\pm0.2)\%}_{(36.8\pm0.5)\%}$

$P_T > 2.5\mathrm{GeV}$ + fiducial cuts (etaS2)

data		conv	not conv
	1684	$235_{(14.0\pm0.8)\%}$	$1449_{(86.1\pm0.8)\%}$
Loose	$441^{(26\pm1)\%}$	$49^{(21\pm2)\%}_{(11.1\pm2)\%}$	$392^{(27\pm1)\%}_{(89\pm2)\%}$
Tight	$123^{(7.3\pm0.6)\%}$	$16^{(7\pm1)\%}_{(13\pm3)\%}$	$107^{(7.4\pm0.7)\%}_{(87\pm3)\%}$

MC		conv	not conv
	91767	$12307_{(13.4\pm0.1)\%}$	$79460_{(86.6\pm0.1)\%}$
Loose	$28380^{(30.9\pm0.2)\%}$	$3377^{(27.4\pm0.4)\%}_{(11.9\pm0.2)\%}$	$25003^{(31.5\pm0.2)\%}_{(88.1\pm0.2)\%}$
Tight	$9833^{(10.7\pm0.1)\%}$	$1535^{(12.5\pm0.3)\%}_{(15.6\pm0.4)\%}$	$8298^{(10.4\pm0.1)\%}_{(84.4\pm0.4)\%}$

Plots

P_T

E_T^{had1}/E_T

E_T^{had}/E_T

R_η

R_ϕ

$Weta2$

ΔE

$R2max$

ΔE^{rel}

$Fside$

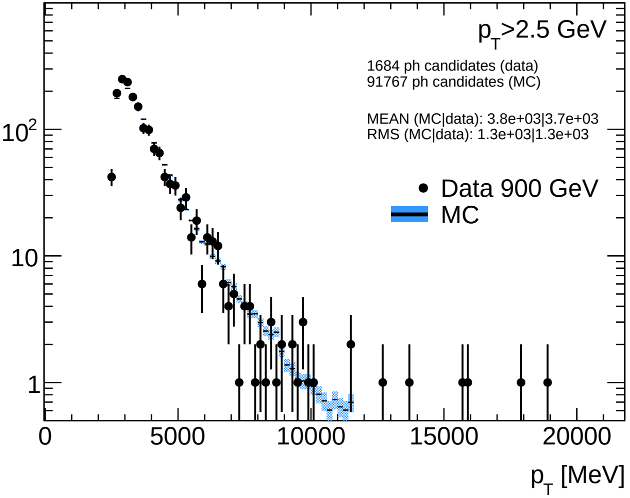
w3strips

wtot

Normalized area

All plots available on:
`http://www.mi.infn.it/~fanti/900GeV/`

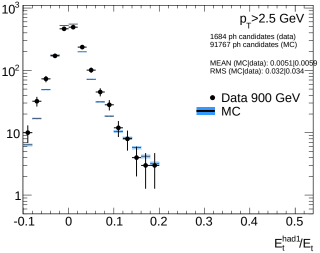
P_T



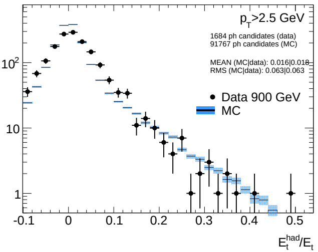
p_T>2.5 GeV
1684 ph candidates (data)
91767 ph candidates (MC)
MEAN (MC|data): 3.8e+03|3.7e+03
RMS (MC|data): 1.3e+03|1.3e+03
Data 900 GeV
MC
10^2
10
1
0
5000
10000
15000
20000
p_T [MeV]

Normalized hadronic leakage

E_T^{had1} and E_T^{had} are are the transverse energies deposited respectively in the first and all layers of the hadronic calorimeter, normalised by the total transverse energy of the photon candidate



(a) E_T^{had1}/E_T



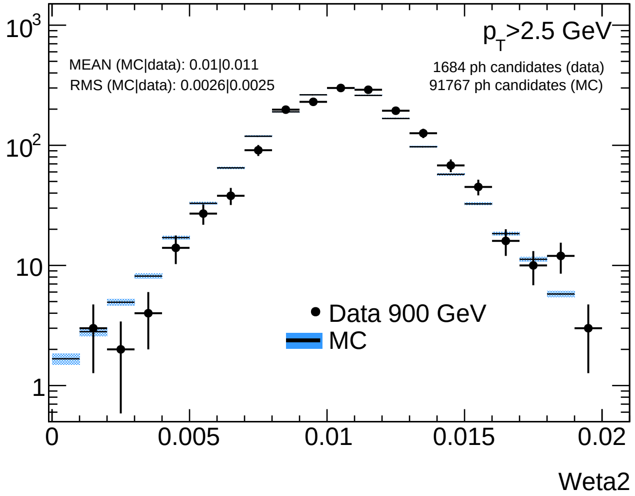
(b) E_T^{had}/E_T

Second sampling variables (ω_{η_2})

The width of the shower in the second sampling of the electromagnetic calorimeter is computed in the η direction by:

$$\omega_{\eta_2} = \sqrt{\frac{\sum_i E_i \eta_i^2}{\sum_i E_i} - \left(\frac{\sum_i E_i \eta_i}{\sum_i E_i}\right)^2}$$

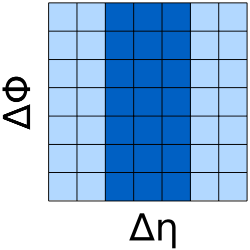
where the sum is carried out on a window of 3×5 cells of the second sampling, using the ηs and energies of each cell (η_i and E_i).



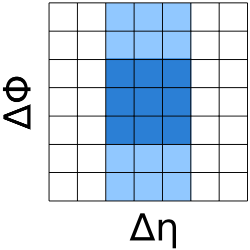
p_T>2.5 GeV
MEAN (MC|data): 0.01|0.011
RMS (MC|data): 0.0026|0.0025
1684 ph candidates (data)
91767 ph candidates (MC)
Data 900 GeV
MC
Weta2

Second sampling variables (R_η, R_ϕ)

- The lateral development in the shower in the η direction, $R_\eta = \frac{E_2(3\times7)}{E_2(7\times7)}$, is defined as the ratio between the energy deposited by the shower in a window of $\Delta\eta \times \Delta\phi = 3 \times 7$ cells and the one in a window of 7×7 cells, both centered around the cluster seed.
- The lateral development in the ϕ direction, $R_\phi = \frac{E_2(3\times3)}{E_2(3\times7)}$, is defined as the ratio between the energy deposited by the shower in a window of 3×3 cells and the one in a window of 3×7 cells.

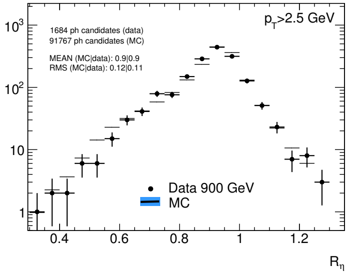


(c) $R_\eta = \frac{E_2(3\times7)}{E_2(7\times7)}$

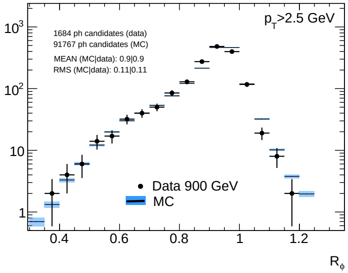


(d) $R_\phi = \frac{E_2(3\times3)}{E_2(3\times7)}$

Second sampling variables (R_η, R_ϕ)



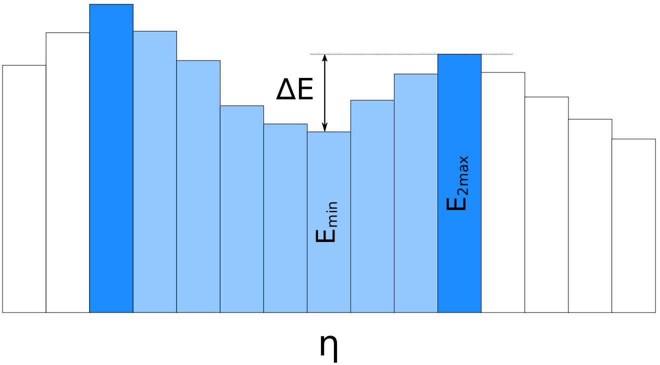
(e) $R_\eta = \frac{E_2(3\times7)}{E_2(7\times7)}$



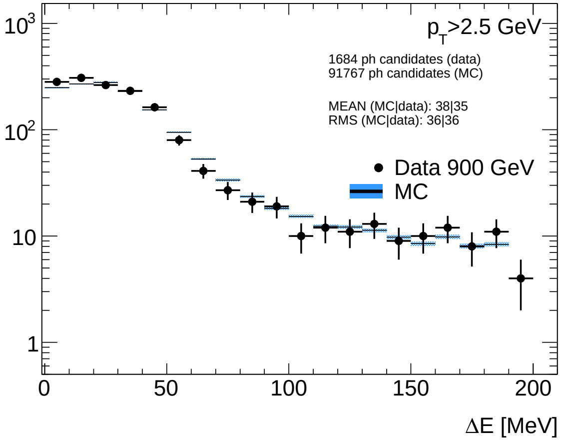
(f) $R_\phi = \frac{E_2(3\times3)}{E_2(3\times7)}$

First sampling variables (ΔE)

The variable $\Delta E = E_{2max} - E_{min}$ is the difference between a second maximum E_{2max} of energy in strip and the minimum E_{min} of the energy between the strips of the first and second maxima.

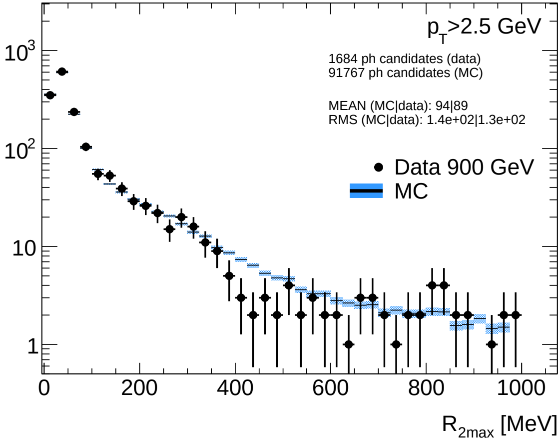


First sampling variables (ΔE)



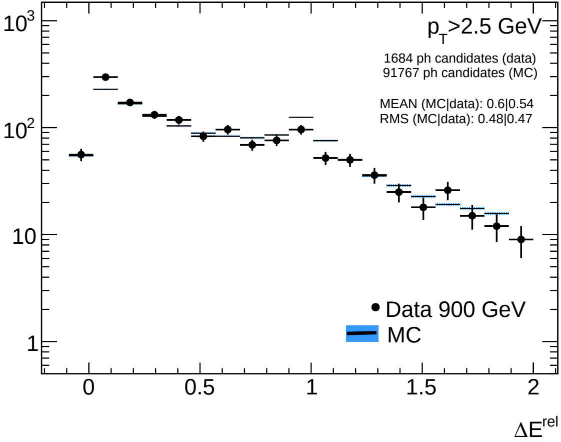
First sampling variables (R_{2max})

The rescaled second maximum variable $R_{2max} = E_{2max}/(1 + 9 \times 10^{-3} E_T)$ (where E_T is expressed in GeV) is the ratio between the energy of the second maximum and a threshold which depends on the transverse energy E_T of the electromagnetic cluster, in order to be as independent as is possible of the statistical fluctuations of the shower



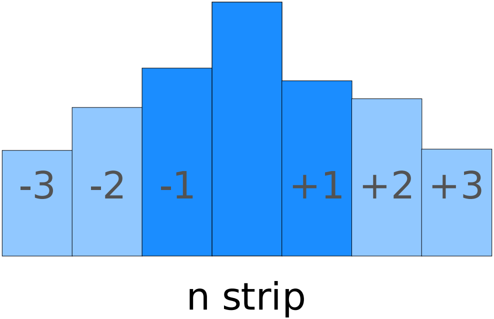
First sampling variables (ΔE^{rel})

$$\Delta E^{rel} = \frac{E_{2max} - E_{min}}{E_{2max} + E_{min}}$$



First sampling variables (F_{side})

$$F_{\mathrm{side}} = \frac{E(\pm 3) - E(\pm 1)}{E(\pm 1)}$$



First sampling variables (F_{side})