

Institut de Physique Nucléaire de Lyon
Internship carried out from 2018/03/12 to 2018/07/13

Master 2 internship report

Signal vs background discrimination γ+jet events, recorded by the CMS experiment at LHC.

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Acknowledgments

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Acronyms and abbreviations

IPNL	Institut de Physique Nucléaire de Lyon
CERN	Centre Européen pour la Recherche Nucléaire
LHC	Large Hadron Collider
CMS	Compact Muon Solenoid
MC	Monte-Carlo
MVA	MultiVariate Analysis
ANN	Artificial Neural Network

Introduction

INTRODUCTION blablabla...

γ+jet event classification in LHC collisions

1.1 CMS experiment at LHC

blabla CMS blablabla....

1.2 Hadronic jets in proton-proton collisions

Les jets....ca en jette !!

Collision data

Y en a beaucoup...

2.1 Monte-Carlo simulation

Tres jolie ville !

2.2 CMS data

blabla cms !

2.3 MVA variables

CHiso γ: Charged Hadron isolation

NHiso γ: Neutral Hadron isolation

Photoniso γ: Photon isolation

$\sigma_{i\eta i\eta}$: Energy weighted spread within the 5x5 crystal matrix centred on the crystal with the largest energy deposit in the supercluster. Obtained by measuring position by countinig crystals.

$\sigma_{i\eta i\varphi}$: Energy weighted spread within the 5x5 crystal matrix centred on the crystal with the largest energy deposit in the supercluster. Obtained by measuring position by countinig crystals.

η_{width} γ: Shower width in η

φ_{width} γ: Shower width in φ

R_9 γ: Energy sum of the 3x3 crystals centred on the most energetic crystal in the supercluster divided by the supercluster's energy. Lower values of R_9 for converted photons than those of unconverted photons.

Had/Em : Hadronic calorimeter energy deposit over Electromagnetic calorimeter energy deposit

$\mathbf{E_{nxm}/E_{5x5}}$ **:** Energy of most energetic nxm crystal set over energy of 5x5 crystal set

ρ**:** Pile-up energy, median of the transverse energy density per unit area.

Input variable analysis

A large set of variables is available from CMS data. MVA training can be time consumming and the "dimensionality curse" forces us to select only a few of them based on two main criteria :

Background vs Signal discrimination : Variables with most differences of shape for background and signal will be picked.

Low correlation between variables : Needed in order to reduce redundancy of input data and thus will permit to reduce MVA complexity (for example number of hidden neurons in ANN).

reference [Collaboration 2015].

3.1 Background vs Signal discrimination

It is necessary to pick the smallest set of input variable for the MVA. This selection is done by looking at variable shape for background and signal data from MC simulation.

3.2 Variable correlations

Training data needed-quantity increases with network complexity. So correlation between variables must be avoided in order to get the minimum redundancy.

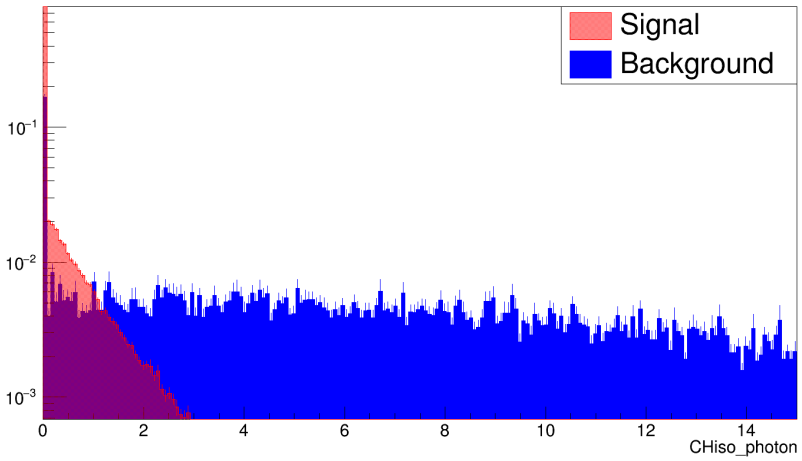

Figure 3.1: Charge hadron isolation for background and signal, here is a good discrimination between them

MultiVariate Analysis

4.1 Boosted Decision Tree

Yep !

4.2 Artificial Neural Network

Le train de tes injures roule sur le rail de mon indiférence....

4.3 Results

Conclusion and future outlook

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