Sesión 3:
Análisis de datos

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https://github.com/walterrq/coliderSummerSchool.git

Based on the following work:

Eric Conte, Benjamin Fuks, Guillaume Serret: 1206.1599
Eric Conte, Benjamin Fuks: 1808.00480.

¿Qué se abordará?

- Descripción de Madanalysis 5
- Análisis de los dato generados
- Aplicación de herramientas en la búsqueda de nueva física

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Search for the standard model Higgs boson decaying into two photons in pp collisions at $\sqrt{s} = 7$ TeV ☆

CMS Collaboration *

CERN, Switzerland

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ABSTRACT

A search for a Higgs boson decaying into two photons is described. The analysis is performed using a dataset recorded by the CMS experiment at the LHC from pp collisions at a center-of-mass energy of 7 TeV, which corresponds to an integrated luminosity of 4.8 fb^{-1}. Limits are set on the cross section of the standard model Higgs boson decaying to two photons. The expected exclusion limit at 95% confidence level is between 1.4 and 2.4 times the standard model cross section in the mass range between 110 and 150 GeV. The analysis of the data excludes, at 95% confidence level, the standard model Higgs boson decaying into two photons in the mass range 128 to 132 GeV. The largest excess of events above the expected standard model background is observed for a Higgs boson mass hypothesis of 124 GeV with a local significance of 3.1σ. The global significance of observing an excess with a local significance $\geqslant 3.1\sigma$ anywhere in the search range 110–150 GeV is estimated to be 1.8σ. More data are required to ascertain the origin of this excess.

1. Introduction

The standard model (SM) [1–3] of particle physics has been very successful in explaining experimental data. The origin of the masses of the W and Z bosons that arise from electroweak symmetry breaking remains to be identified. In the SM the Higgs mechanism is postulated, which leads to an additional scalar field whose quantum, the Higgs boson, should be experimentally observable [4–9].

constraints on mass

Direct searches at the LEP experiments ruled out a SM Higgs boson lighter than 114.4 GeV at 95% confidence level (CL) [10]. Limits at 95% CL on the SM Higgs boson mass have also been placed by experiments at the Tevatron, excluding 162–166 GeV [11], and by the ATLAS Collaboration at the Large Hadron Collider (LHC), excluding the ranges 145–206, 214–224, and 340–450 GeV [12–14]. Precision electroweak measurements indirectly constrain the mass of the SM Higgs boson to be less than 158 GeV at 95% CL [15].

The $H \to \gamma\gamma$ decay channel provides a clean final-state topology with a mass peak that can be reconstructed with high precision. In the mass range $110 < m_H < 150$ GeV, $H \to \gamma\gamma$ is one of the more promising channels for a Higgs search at the LHC. The primary production mechanism of the Higgs boson at the LHC is gluon fusion with additional small contributions from vector boson fusion (VBF) and production in association with a W or Z boson, or a $t\bar{t}$ pair [16–27]. In the mass range $110 < m_H < 150$ GeV the SM $H \to \gamma\gamma$ branching fraction varies between 0.14% and 0.23% [28]. Previous searches in this channel have been conducted by the CDF and D0 experiments [29,30], and also at the LHC by ATLAS [31].

This Letter describes a search for a Higgs boson decaying into two photons in pp collisions at a center-of-mass energy of 7 TeV, using data taken in 2011 and corresponding to an integrated luminosity of 4.8 fb^{-1}. To improve the sensitivity of the search, selected diphoton events are subdivided into classes according to indicators of mass resolution and signal-to-background ratio. Five mutually exclusive event classes are defined: four in terms of the pseudorapidity and the shower shapes of the photons, and a fifth class into which are put all events containing a pair of jets passing selection requirements which are designed to select Higgs bosons produced by the VBF process.

2. The CMS detector

A detailed description of the CMS detector can be found elsewhere [32]. The main features and those most pertinent to this analysis are described below. The central feature is a superconducting solenoid, 13 m in length and 6 m in diameter, which provides an axial magnetic field of 3.8 T. The bore of the solenoid is instrumented with particle detection systems. The steel return yoke outside the solenoid is instrumented with gas detectors used to identify muons. Charged particle trajectories are measured by the silicon pixel and strip tracker, with full azimuthal coverage

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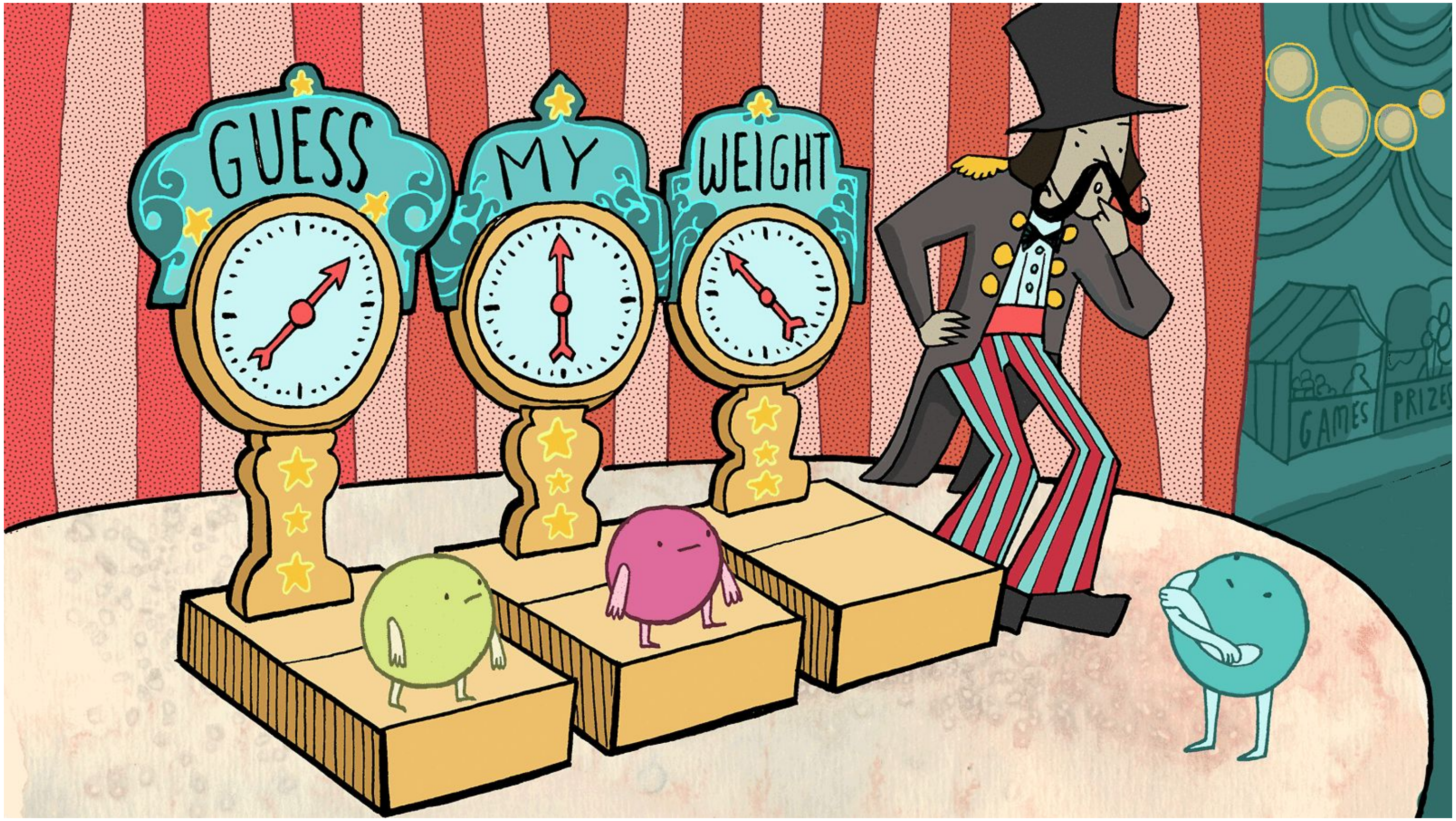
Modelo Type I Seesaw: Neutrinos y una nueva física



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Modelo Type I Seesaw: Neutrinos y una nueva física

$$\mathcal{L} = \mathcal{L}_{SM} - \bar{L}_a \,(Y_\nu)_{as}\, \nu_{R_s} \tilde{\phi} - \frac{1}{2} \bar{\nu}^c_{R_s} (M_R)_{st}\, \nu_{R_t} + \text{h.c.}$$

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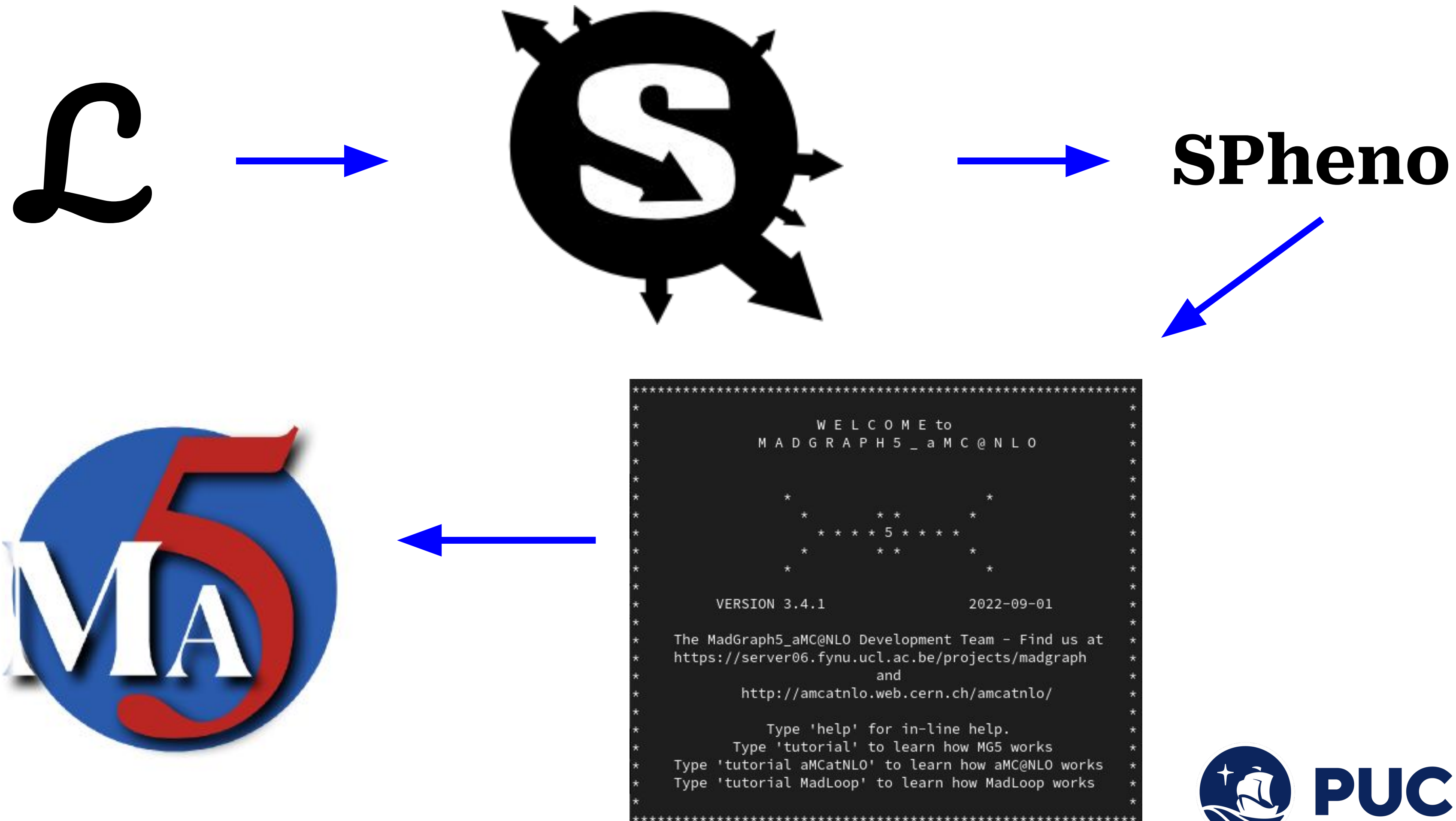
Simuladores Monte Carlo de colisionadores de partículas



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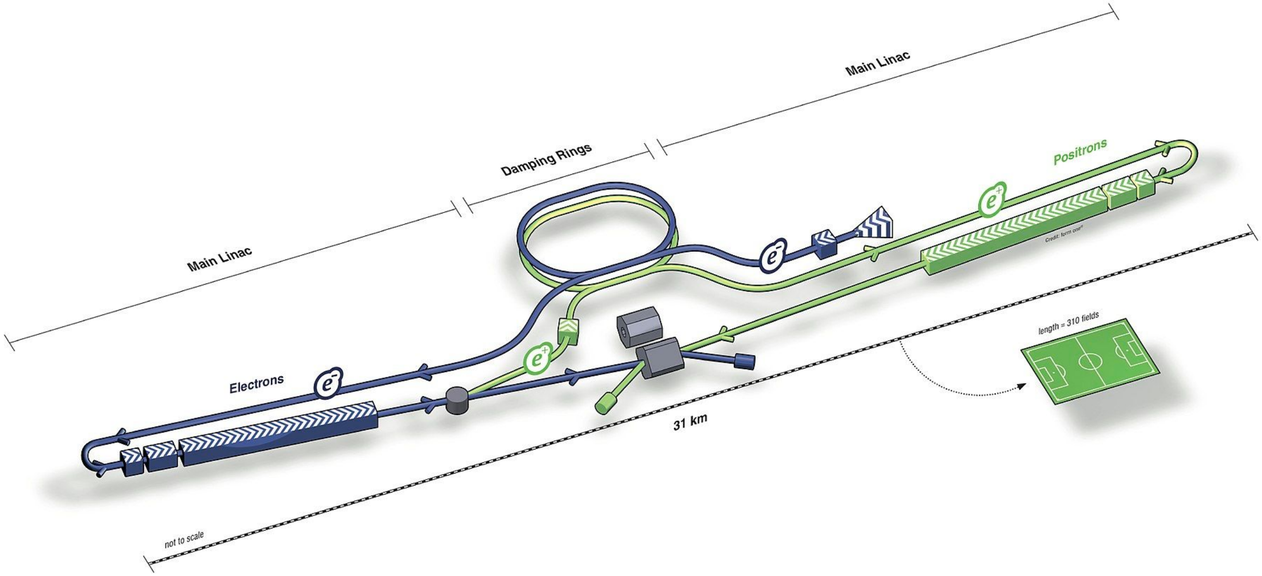
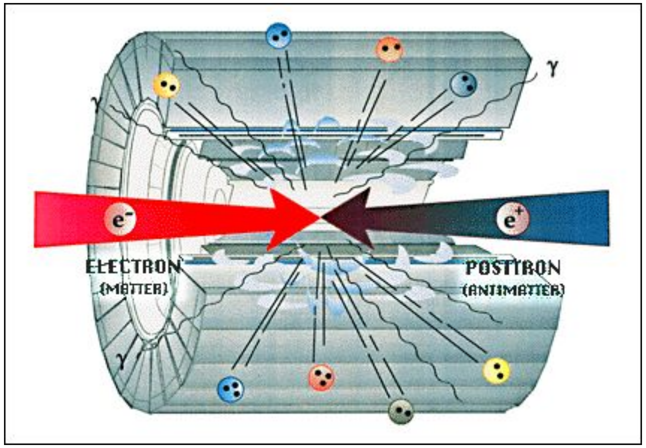
Búsqueda de Neutrinos pesados en el ILC





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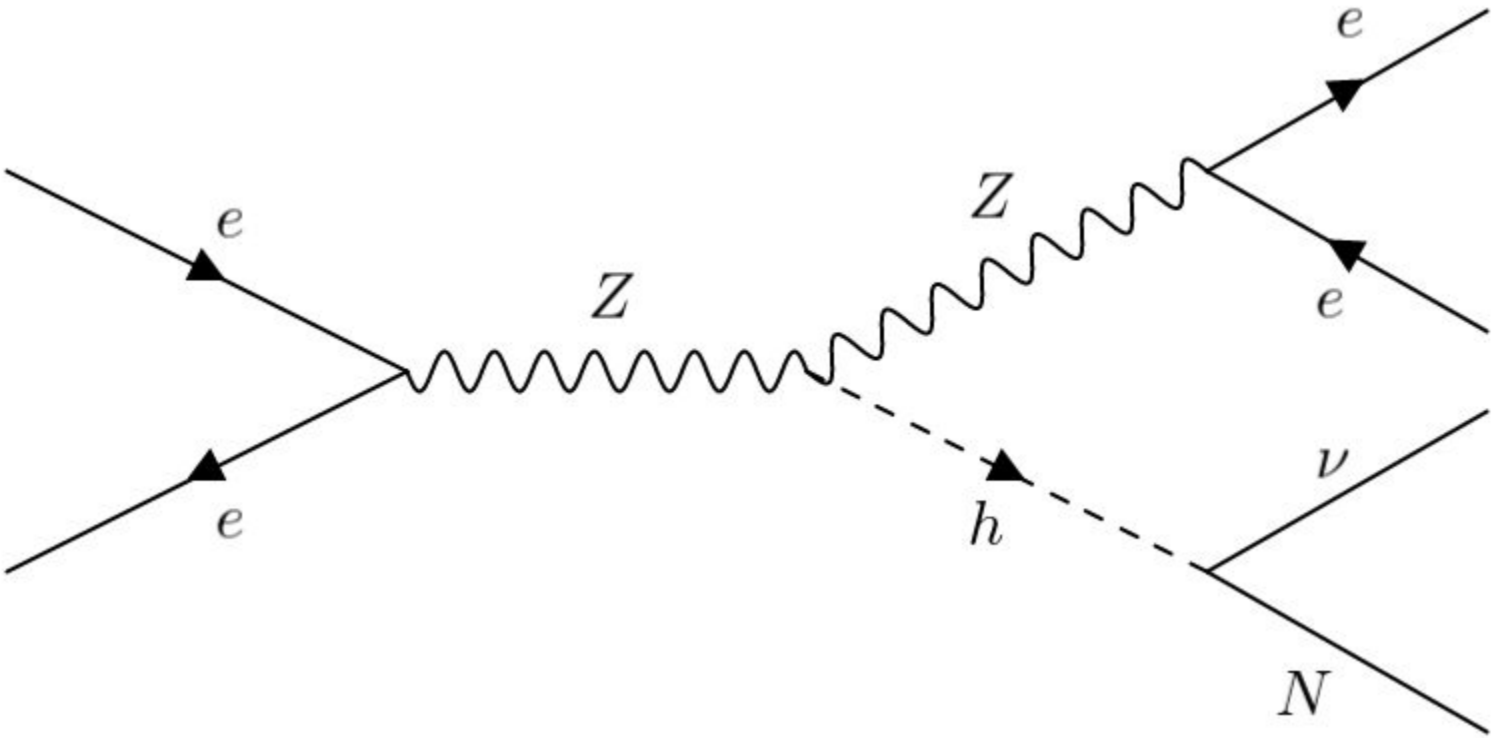
Búsqueda de Neutrinos pesados en el ILC: Canal escogido



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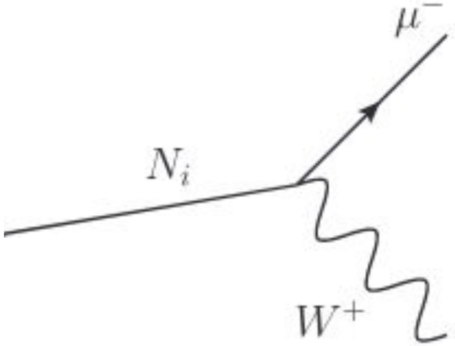
Búsqueda de Neutrinos pesados en el ILC

¿Qué buscamos?

Queremos ver la desintegración del neutrino pesado. En este caso, se espera una desintegración en muón y jets.



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Ejecución de la simulación para el evento del ILC

Número de eventos	10000
Masa del neutrino pesado (nu4)	15 GeV
Modelo del simulador	Seesaw Type I SM
Energía total para el primer haz	500 GeV
Energía total para el segundo haz	500 GeV

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Análisis de Resultados: Parte reconstruida

Initial number of events	**#**
9997	#nentries
PT(leptón) > 27.0 GeV	**Trigger**
8421	#nentries
Tener al menos un par electrón positrón	**1st cut**
6447	#nentries
Tener al menos un muón	**2nd cut**
875	#nentries
PT(e_leading) > 10.0 GeV	**3rd cut**
841	#nentries
PT(mu_leading) > 10.0 GeV	**4th cut**
668	#nentries
p(e+ e-) ∈ [85, 95] GeV	**5th cut**
662	#nentries

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Análisis de Resultados: Parte Reconstruida

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Análisis de Resultados: Parte Reconstruida

Regiones de análisis	1 muón y 0 jets	662 eventos
	1 muón y 1 jet	6 eventos
	1 muón y 2 o más jets	0 eventos

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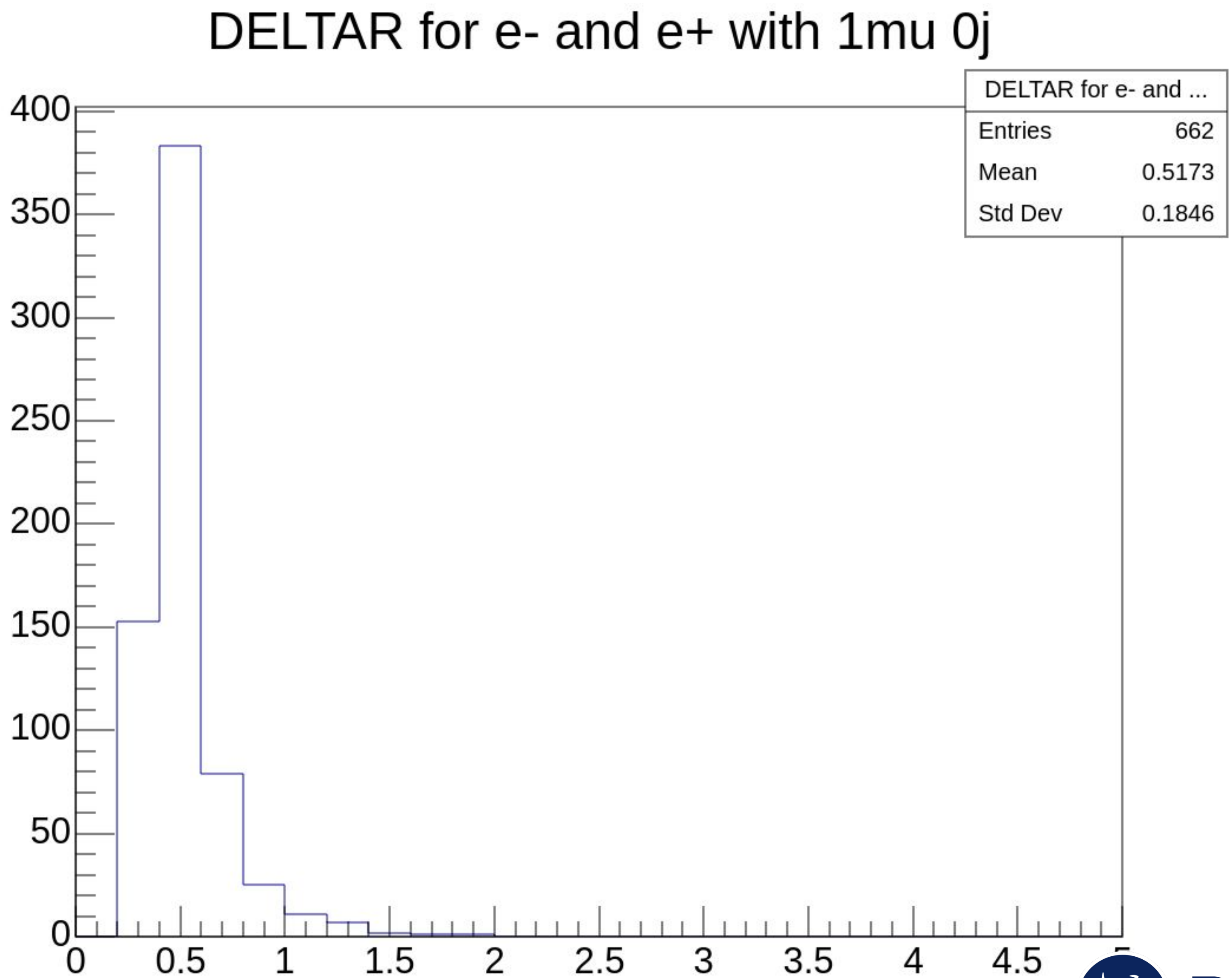
Parte Reconstruida: 1 muón y 0 jets



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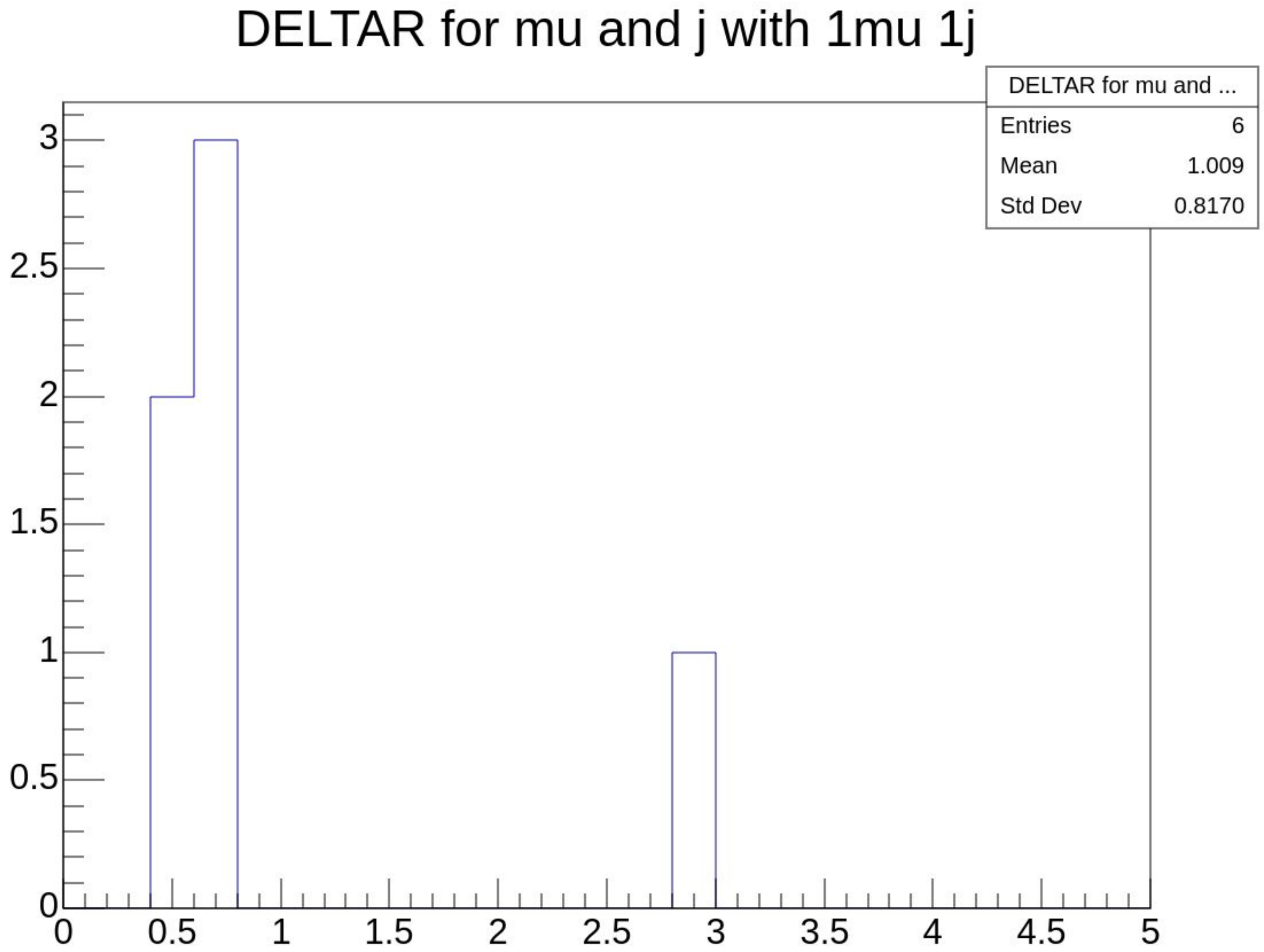
Parte Reconstruida: 1 muón y 1 jets



Análisis de Resultados: Parte Reconstruida

¿Por qué no se tienen eventos en el análisis?

- La reconstrucción no se puede realizar debido a que la trayectoria del muón está alrededor del beam line.
- Gran parte de los muones no son reconstruidos debido a que tienen una energía muy baja.
- Como el neutrino está muy boosteado, los productos de desintegración están muy colimados. Esto da un deltaR chico e impide un aislamiento.

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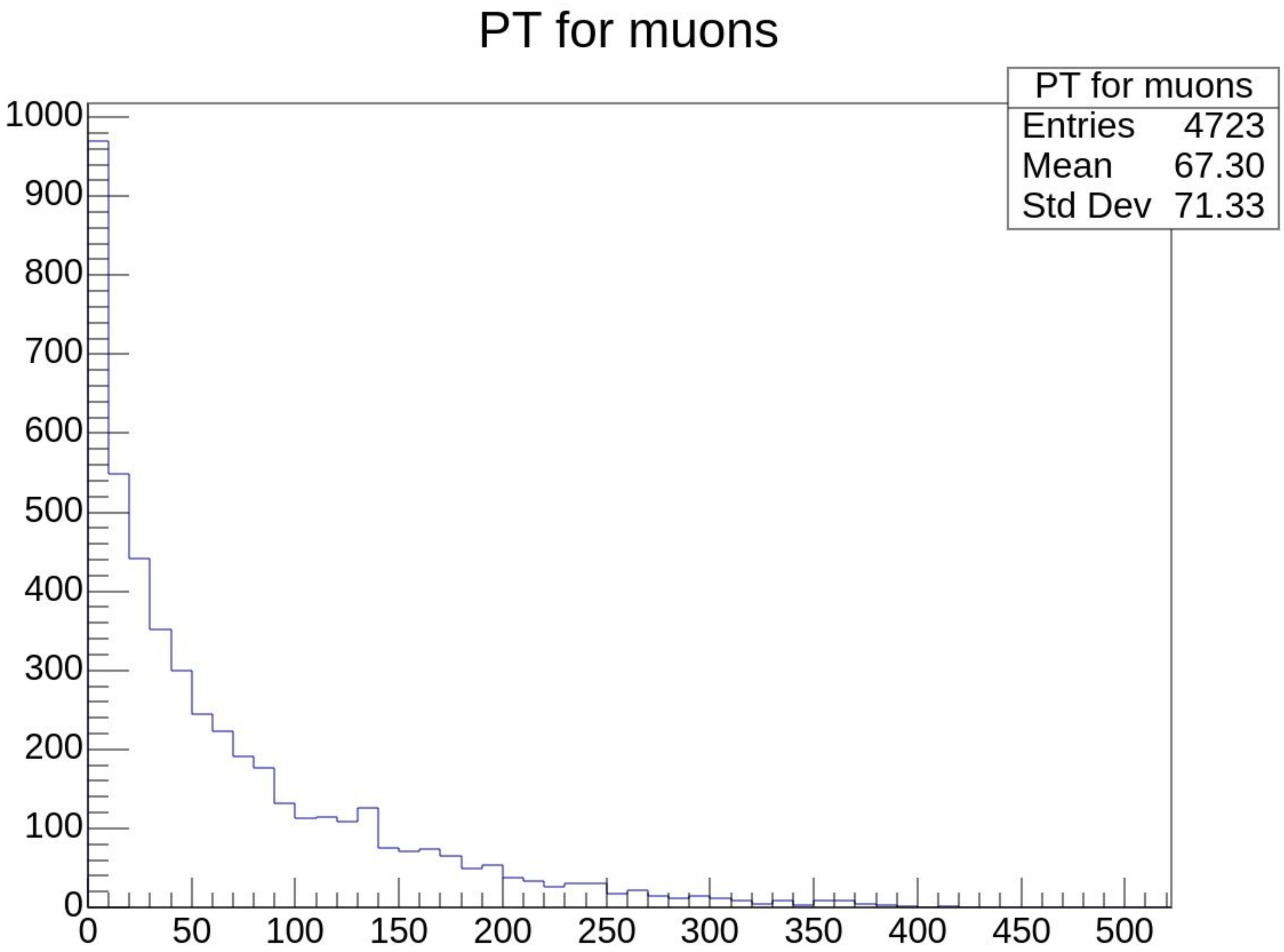
Análisis de Resultados: Parte Real



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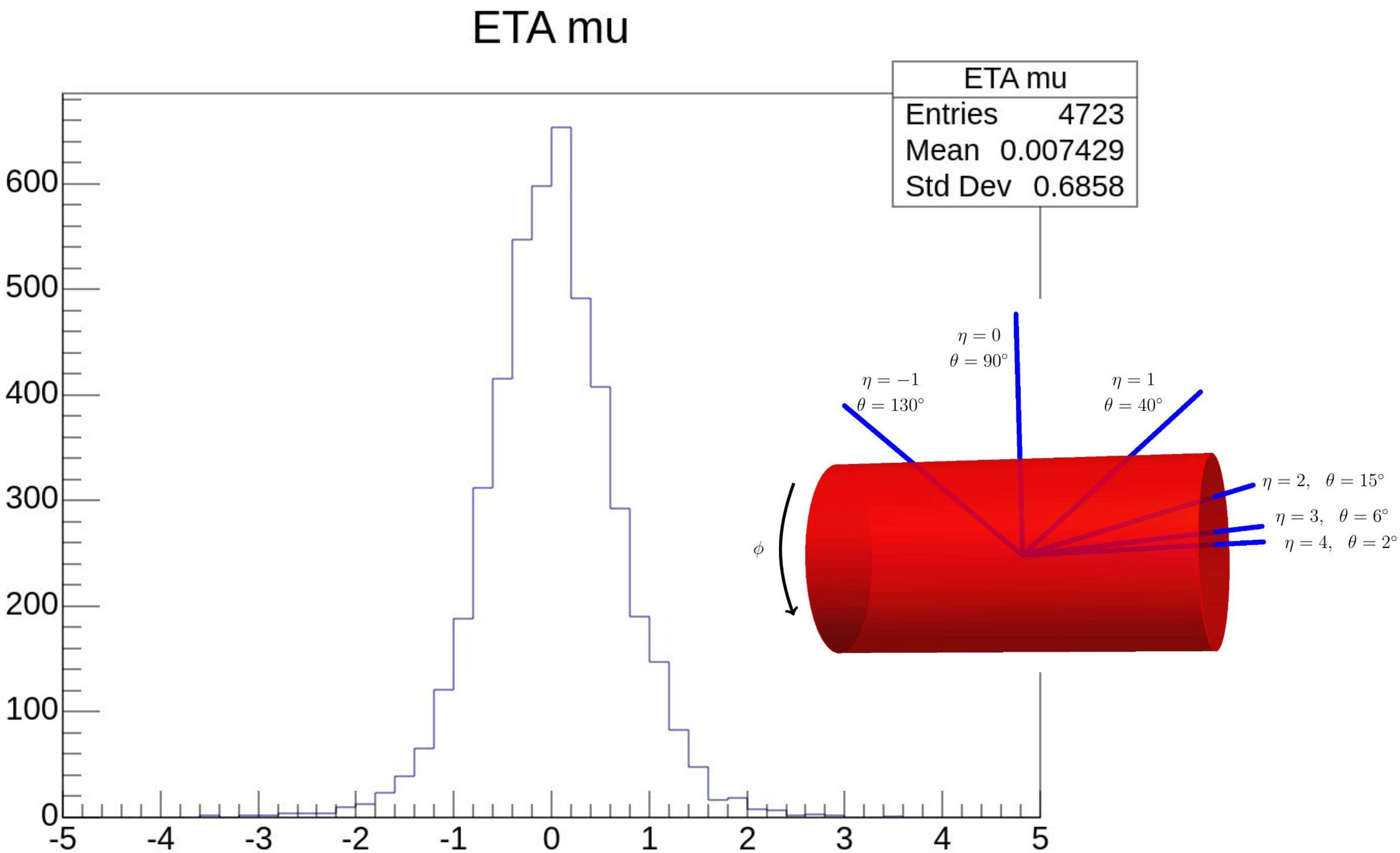

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