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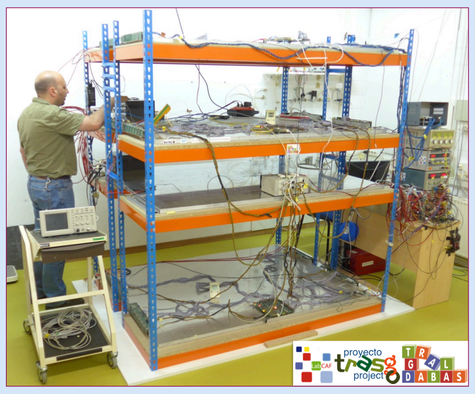
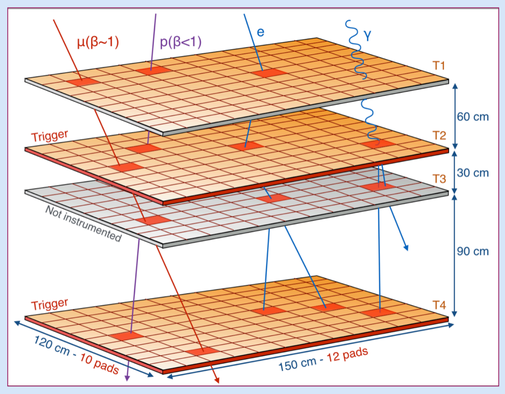
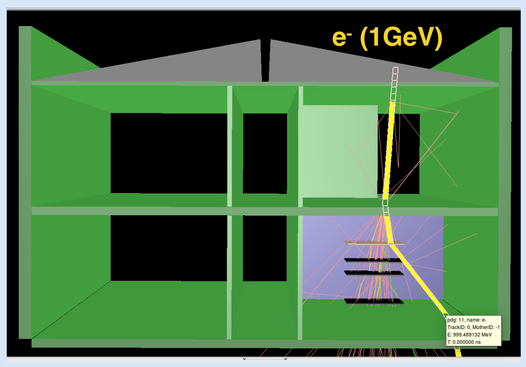
MIDAS: A particle identification tool for the TRAGALDABAS cosmic ray Telescope

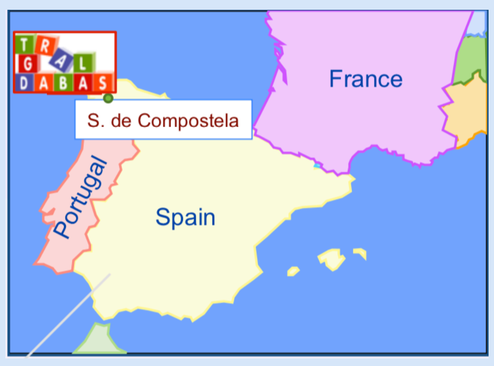
Y. Fontenla[1 2], P. Cabanelas[2] & J. A. Garzón[1 2]
(1 LabCAF, 2 IGFAE, Univ. Santiago de Compostela, Spain)
on behalf of the **TRAGALDABAS Collaboration**

Introduction: In this work, we develop MIDAS (Multisampling IdentificAtion Software), an algorithm intended to identify different particle species detected by the Tragaldabas system. Tragaldabas [1] is a timing-RPC-based Cosmic Ray telescope, a member of the Trasgo family [2]. MIDAS is based on the systematic analysis of the influence that different particles have over some dedicated observables. The behavior of such observables was parameterized by means of a simulation and applied later to real data to separate muons and electrons









The TRAGALDABAS detector at Faculty of Physics of the Univ. of Santiago de Compostela. Tragaldabas has been fully simulated within the EnsarRoot simulation and analysis framework [3].

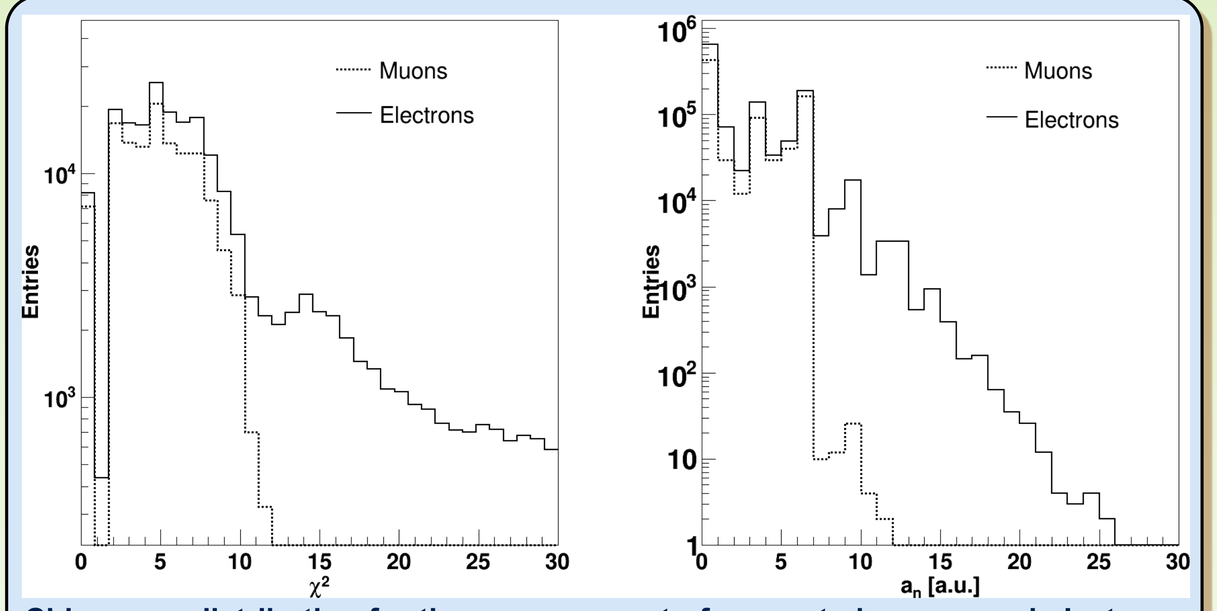
Some observables were deeply studied for each kind of simulated particle and a phenomenological description was performed.

1.- **M, the number of hits:** that is, valid signals, in the event

2.- **an**: the **distance** reached by a track or a shower, **weighted** by the **hit multiplicity** in each plane.

3.- χ^2: **the chi-square of the track fitting** performed using the TimTrack method [4].

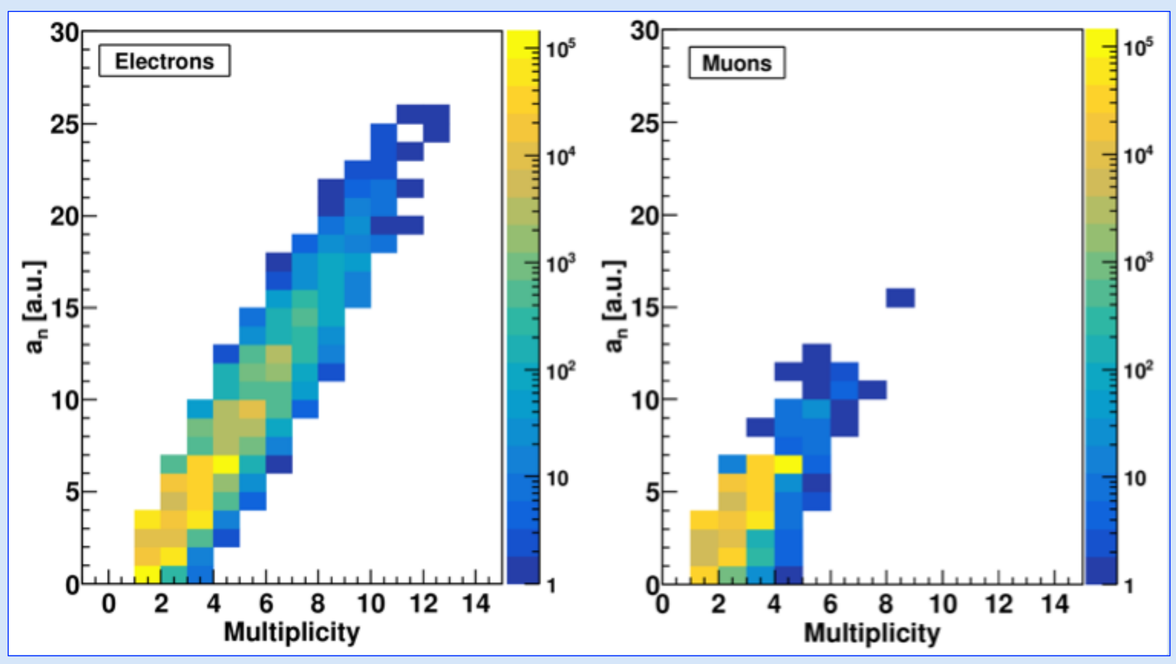
A combination of the three observables makes possible the **particle identification**. The algorithm provides the probability of identification, P(Id), of being either a muon or an electron. In addition to the particle nature, **the minimum energy E_{min} is estimated for electrons**



Chi-square distribution for the same amount of generated muons and electrons within the full energy range considered.

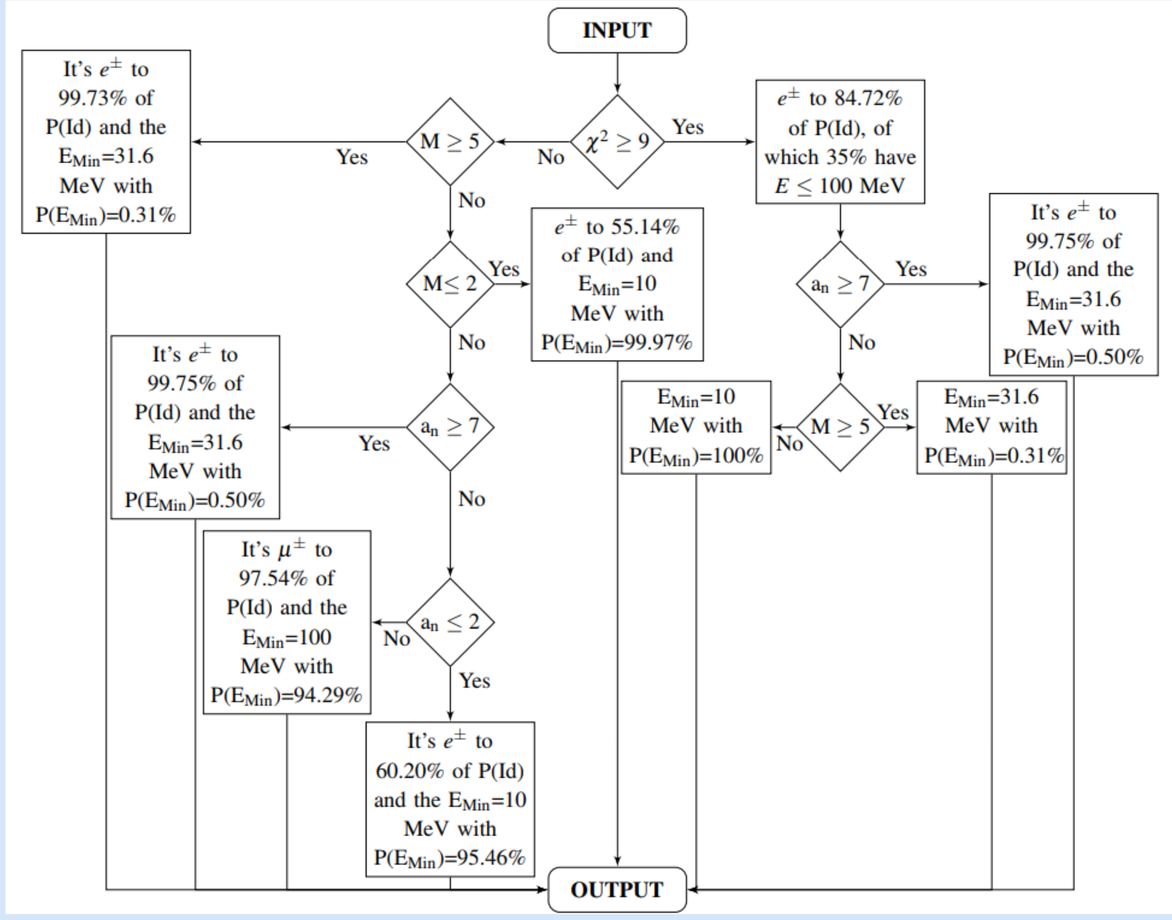
Left: χ^2 **distributions;** only electrons have a χ^2 greater than 12.

Right: **an distributions;** values greater than 7 correspond to electrons



Chi-square distribution for the same amount of generated muons and electrons within all their energy ranges. Left: Only electrons will have a χ^2 greater than 12. Right: an distributions in the same conditions as for the χ^2. This case, it is clear how a value greater than 7 corresponds to a detected electron.

MIDAS PID Algorithm



Flow chart for the MIDAS particle identification algorithm in the Tragaldabas detector. The solution procedure when 4 active RPC planes are available is shown.

The accuracy of the MIDAS algorithm was studied. It was calculated a right guess close to 99% for the simplest simulation. However, the accuracy decreased down to 90% for the realistic case where the CRY cosmic ray generator [5].

Active Planes	Realistic Simulation	Simple Simulation
4	87.9 ± 1.5	99.3 ± 0.2
3	90.2 ± 1.4	99.3 ± 0.2

Summary: The MIDAS particle identification algorithm for cosmic rays has been developed for the Tragaldabas cosmic ray detector, the first device of the Trasgo family. After performing and studying different observables an accuracy close to 100% was obtained for separating electrons and muons, while a value of 90% was reached in the most realistic simulations.

TRAGALDABAS Collaboration: A. Blanco A.[4], J.J. Blanco[1], P. Cabanelas[10], F.C. Clemencio[4], J. Collazo[11], J. Cuenca[11], D. García Castro[11], J. Flores[8], Y. Fontenla[11], J.A. Garzón[11], T. Kurtukian[2], L. Lopes[4], C. Loureiro[4], A. Morozova[3], A. Pais[3], V. Pérez Muñuzuri[9], P. Rey[7], I. Riádigos[9], J. Saraiba[4], M. Seco[10], V. Villasante,[6] J. Xuna[11],
Laboratories: 1) U. Alcalá, A.Henares, Spain. 2) CENBG-IN2P2 Bordeaux-Gradignan, France. 3) CITEUC-U.Coimbra, Portugal. 4) LIP-Coimbra, Portugal. 5) TU-Darmstadt, Germany. 6) IGN, Madrid, Spain. 7) CESGA- S. de Compostela, Spain. 8) CITIUS. Univ. S. de Compostela, Spain. 9) GFNL, Univ. S. de Compostela, Spain. 10) IGFAE. Univ. S. de Compostela, Spain. 11) LabCAF, Univ. S. de Compostela, Spain.
Reference: [1] H. Álvarez-Pol et al., *Tragaldabas: A new high resolution detector for the regular study of cosmic rays,* J.Phy.:Conf.Ser.632(2015), no. 1, 012010. [2] D. Belver et al., *TRASGO: A proposal for a timing RPCs based detector for analyzing cosmic rays air showers*, Nuclei.Ins:Meth. A,661 (2012) S163-S167. [3] P. Cabanelas et al., EnsarRoot: *The framework for simulation and data analyzis for ENSAR*, J.Phy:Conf.Ser. 1024 (2018) 012038. [4] J.A. Garzón and P. Cabanelas, *TimTrack: A matrix formalism for a fast time and track reconstruction with timing detectors,* Nucl.Inst.Meth.Phys.Res. A, 661 (2012) S210-S213. [5] C.Hagmaann et al., *Cosmic-Ray Shower Generator (CRY) for Monte Carlo Transport Codes*, IEEE Nuclear Science Symposium Conference Record, 2007.