

# *Hands-on at the 5th Lisbon-school on (Astro) Particle Physics*

**Ruben Conceição**



**TÉCNICO  
LISBOA**

# Hands-On



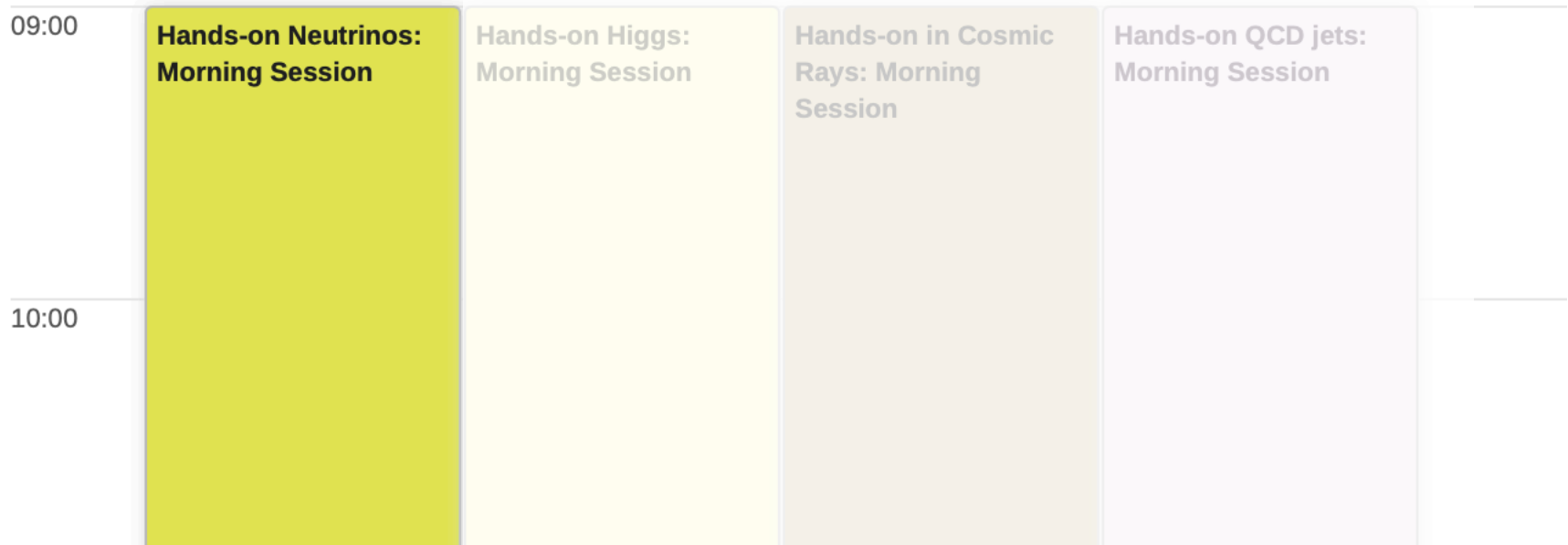
- ✧ Four hands-on: Neutrinos, Higgs, Cosmic rays, QCD jets
- ✧ 3.5 hours for each hands-on
- ✧ Each person can do one Hands-On in the morning and another in the afternoon

# Requirements

- ✧ Eagerness to put the hands on a specific topic
  - ✧ Learn, discuss, try, play...
- ✧ Basic knowledge of C++
  - ✧ Or any other programming language
- ✧ Have ROOT installed in your PC to try the scripts we have prepared for you
  - ✧ <https://root.cern.ch/content/release-61804>
  - ✧ Talk with me if you have trouble installing it



# Hands-On Neutrinos



*Valentina Lozza, Ivo Varzelas*

# Hands on NEUTRINOS

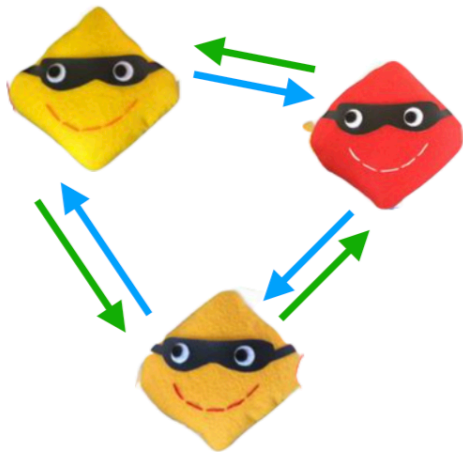
Tomorrow we will answer the question:  
Do neutrinos have mass?



Work out the basics of **neutrino oscillations**



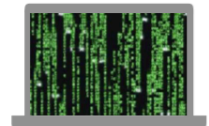
1. We will do Nobel Prize winning physics



2. We will plan a neutrino experiment



3. We will see if it works  
(bring your own computer with ROOT installed)



# Hands-On Higgs

09:00	<b>Hands-on Neutrinos: Morning Session</b>	<b>Hands-on Higgs: Morning Session</b>	<b>Hands-on in Cosmic Rays: Morning Session</b>	<b>Hands-on QCD jets: Morning Session</b>
10:00				

*Rute Pedro, Jorge Romão*



# Hands on the Higgs boson

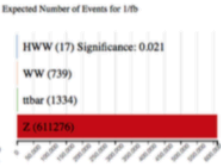
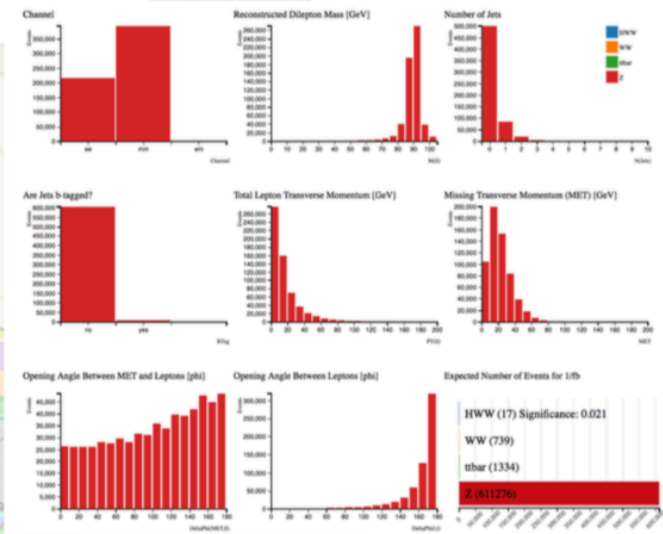
Run Number: 182796,  
Event Number: 7456644  
Date: 2011-05-30, 06:54:29 CET

EtCut>0.3 GeV  
PtCut>2.0 GeV  
Vertex Cuts:  
Z direction  
Rphi <1cm

Muon: blue  
Electron: Black  
Cells: Tiles, EMC

In this session you will:

- Learn about the LHC experiments and the Higgs boson discovery
- Get an idea of what is involved in the analysis of collider data
- Use ATLAS Open Data to do a simplified data analysis using LHC collisions



# Hands-On Cosmic Rays

09:00	<b>Hands-on Neutrinos: Morning Session</b>	<b>Hands-on Higgs: Morning Session</b>	<b>Hands-on in Cosmic Rays: Morning Session</b>	<b>Hands-on QCD jets: Morning Session</b>
10:00				

*Pedro Assis, Ruben Conceição, Bernardo Tomé*



# Hands-on: Cosmic Rays

## ✧ **Cosmic rays**

- ✧ Charged particles accelerated in the cosmos that continuously bombard Earth

## ✧ Questions:

- ✧ *Can these harmful particles reach the Earth?*
- ✧ *If yes, what's their rate?*
- ✧ *Does the flux depends on the direction?*

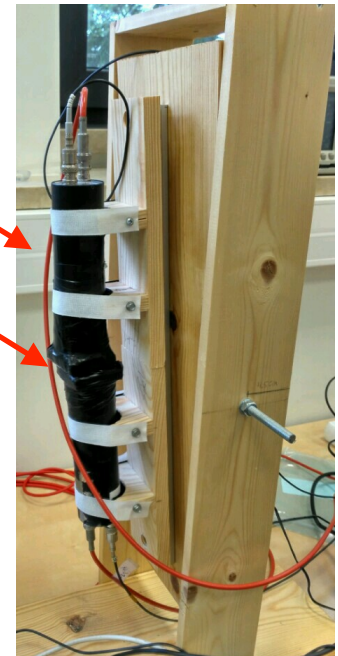


Photomultiplier

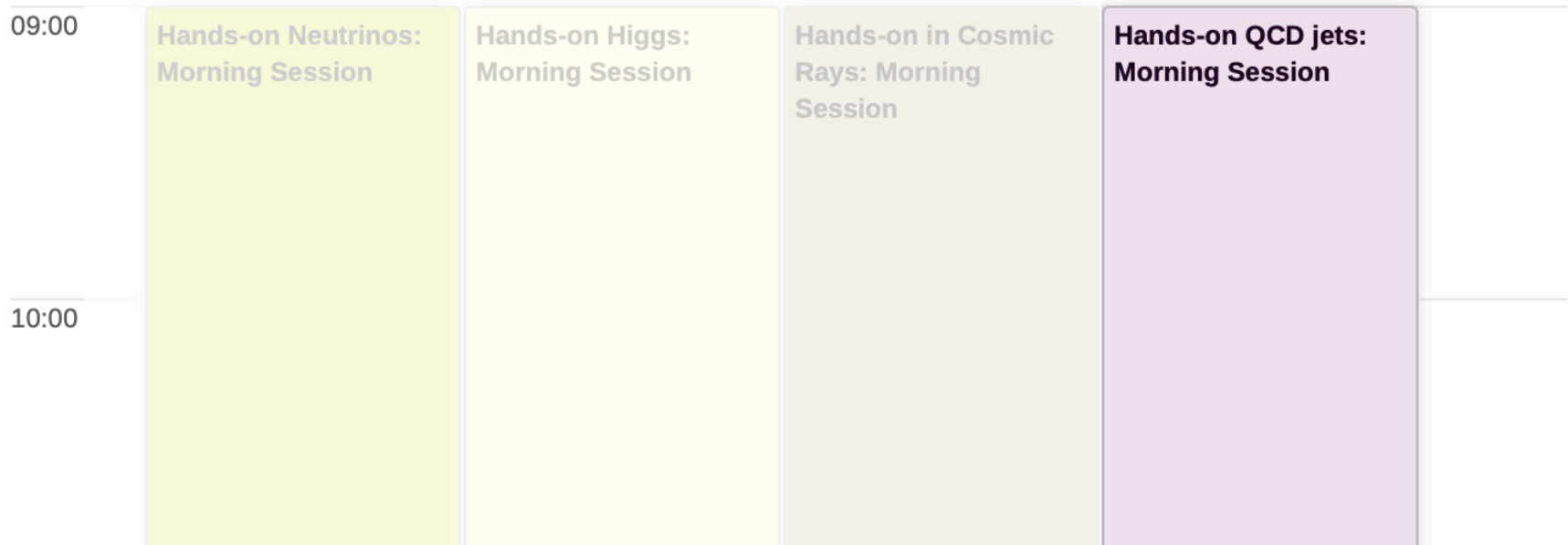
Scintillator

DAQ system

Perform smart  
Tests ;-)



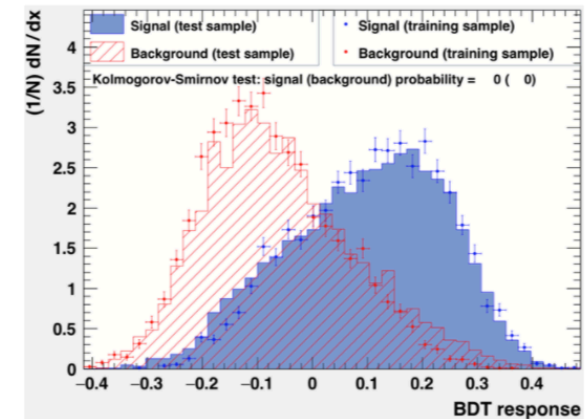
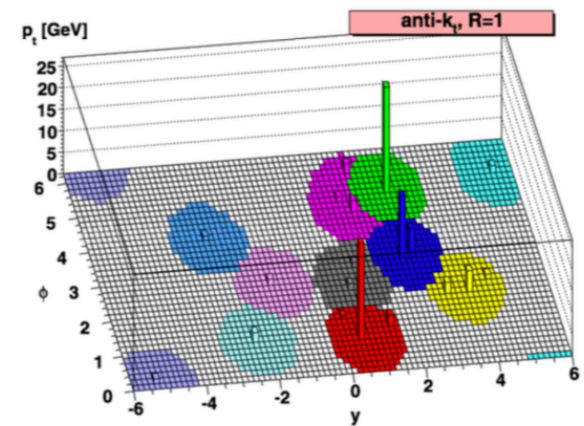
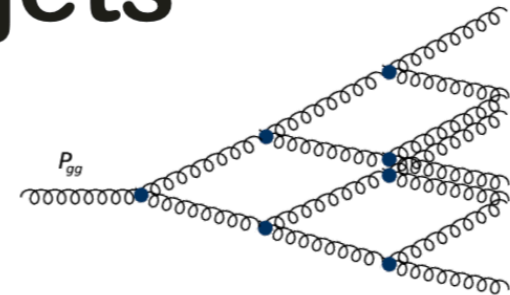
# Hands-On QCD jets



*Liliana Apolinário, Tiago Vale*

# Hands-on: QCD jets

- ◆ What exactly is a jet?
  - ◆ Simple visualisation exercise to build a picture of a jet
- ◆ How can we reconstruct a jet?
  - ◆ Attempt to reconstruct and visualize a jet
    - ◆ C/C++ & ROOT (basic visualisation tools)
- ◆ What can we do with jets?
  - ◆ Classification problem: Quark vs Gluon-initiated jets
    - ◆ C/C++, ROOT (Multivariate Algorithms - e.g.: Neural Network)



# Selection of Hands-On

- ✧ Put your name in two hands-on (morning and afternoon)
- ✧ List to be provided after this talk and filled by hand
- ✧ Each Hands-On should have ~ 8 persons

Hands-On on Higgs

Morning	Afternoon

Hands-On on QCD Jets

Morning	Afternoon

Hands-On on Neutrinos

Morning	Afternoon

Hands-On on Cosmic Rays

Morning	Afternoon



Enjoy!!

# Acknowledgements



**REPÚBLICA  
PORTUGUESA**



**TÉCNICO  
LISBOA**

# Backup slides