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On behalf of the LATTES team



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Simulation Framework

- LATTES simulation chain
 - End-to-end simulation
 - Shower Monte Carlo
 - Detector Simulation
 - Analysis



Simulation Framework

- Showers simulated using CORSIKA
 - Photon and proton showers
 - Altitude: 5200 m and 4100m
 - Fixed energies and
 - Continuous energy spectrum
 - E⁻¹ distribution; events weighted afterwards.





Detector Simulation

- LATTES detector simulation package
 - Based on the Geant4 toolkit;
 - Interfaced to read directly
 CORSIKA simulations output
 binary files;
 - Resampling of the showers with randomized core.



Analysis

Shower Simulation

Detector Simulation

Analysis

- Detector simulation output
 - Format is a ROOT tree
 - Functions to access specific simulated

shower parameters

- WCD signal
- RPC hits
- Detector configuration and parameters
- Shower simulation parameters
- Lightweight and easy to re-process
 for higher-level analyses



ROO

LATTES station in Geant4



Realist description of the detector

- $-1 X_0$ lead converter (Pb)
- Resistive Plate Chambers (RPC)
 - 2 RPCs per station
 - 4x4 readout pads each
- Water Cherenkov Detector (WCD)
 - 2 PMTs; 15 cm diameter
 - tank dimensions : 1.5 m x 3 m x 0.5 m
 - inner walls covered with white diffusing Tyvek

RPC structure in Geant4





WCD optical properties



C_{bs}R

- Explore Geant4 capabilities to simulate optical photon propagation;
- λ dependence of all relevant processes/materials taken into account
- Water

– Attenuation length ~ 80 m @ λ = 400 nm

• PMT



- Dielectric-metal interface in G4
- Tyvek
 - Described using the G4 UNIFIED optical model
 - Specular and diffusive properties;
 - R ~ 95%, for λ > 450 nm

• 80% of which is diffusively reflected and 20% is reflected around the specular reflection direction, with $\sigma_{\alpha} \sim 0.2^{\circ}$

8

surfac

(A. Levin and C. Moisan)

UNIFIED model

Single station signal



WCD signal uniformity



- Good uniformity across the tank area
- PMT spots visible

The LATTES array

• Full array configuration included in Geant4 simulation



90 x 40 station: 140 x 140 m²

See Ruben's talk for further details.

LATTES reconstruction



LATTES reconstruction

	file:///Users/ruben/WORK/IACTs/LATTESrec/doxygen/html	/files.html Č	0 1
LATTESrec: Main Page	LATTESrec: Compactness Class Reference	× LATTESrec: F	ile List +
LATTESrec v1			
Main Page Classes - Files -			Q* Search
File List			
Here is a list of all files with brief descriptions:			
~			[detail level 1 2]
V include			
AxisRec.h			
Compactness.h			
CoreRec.h			
EbinInput.h			
FisherCoef.h			
Functions.h			
Tree.h			
V Src			
AxisRec.cc			
Compactness.cc			
CoreRec.cc			
EbinInput.cc			
FisherCoefs.cc			
Functions.cc			
Tree.cc			
LATTESrec.cpp			

LATTES reconstruction

	file:///Users/ruben/WORK/IACTs/LATTESrec/doxvaen/html/files.html	c A a
	file:///Users/ruben/WORK/IACTs/LATTESrec/doxygen/html/classCompactness.html#a5c	
LATTESrec: Main Page	LATTESrec: Compactness Reference	LATTESrec: File List
LATTESrec		
Main Page Classes • Files •		Q. Search
Compactness Class Reference		Public Member Functions I Private Attributes I List of all mem
#include <compactness.h></compactness.h>		
Public Member Functions		
Compactness () Constructor. More		
~Compactness () Destructor. More		
void AddStation (double r, double signal) Add point to LDF. More		
double GetCompactness (TF1 *fNKG)		
double GetDerivative (double binWidth)		
void GenerateLDF (std::vector< double > &rdist, s	std::vector< double > &signal)	
Private Attributes		
TGraphErrors gLDF		
double fCompactness		
double fDeriv10_20		
double fDeriv20 40		

Detailed Description

Definition at line 19 of file Compactness.h.

Constructor & Destructor Documentation

Summary

- Modular end-to-end simulation framework
 - from showers to high-level analysis;
- Realistic and detailed description of the LATTES concept using Geant4;
- Allows to:
 - Single station simulations (detailed **optimization studies**);
 - Full LATTES array simulations for detector performance
- **Different designs** can be simulated:
 - RPC position, segmentation, tank dimension, PMT position, ...

— ...

- Reconstruction algorithms integrated in a single module
- LATTES simulation and reconstruction codes available in GIT repositories.

END