MAGIC - TDAS 02-10
020730/D.Sobczyńska

Mmcs from CORSIKA 6.014

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July 30, 2002

Abstract

Monte Carlo simulations for MAGIC were based on CORSIKA code version 5.20. In 2002 we decided to change the version of original program to the newest 6.014. Now we may simulate the showers with large zenith angle, because curved atmosphere model is one of the CORSIKA's options. In this paper you may find the modification of standard CORSIKA which were done to change the program to our purpose and keep the same output format. One part is describing input card parameters.

Contents

1. Option chosen in cmz card

The main part of CORSIKA is kept as cmz-file. To get a fortran code of the program you should select cmz option. The following options were chosen to extract the fortran code from cmz-file (detailed descriptions you

may find in CORSIKA User's Guide):
1)UNIX
2)byterecl (to create *-linux version of mmcs)
3)timerc
4)VENUS
5)venussig
6)cerenkov
7)atmext
8)curved
9)viewcone

2. From CORSIKA to mmcs

The first mmcs was made by Jose Carlo Gonzalez from CORSIKA version 5.20. It was modified by C. Bigongiari in 2001. Now the latest version of CORSIKA has number 6.014 and it has a possibility to simulate showers with large zenith angle. There was a need to change this version of program to new mmcs at least to have the same output file format. Additionally in new version, where the curved atmosphere is using, the magnetic field influence on the primary charge particle from the top of the atmosphere. This effect change a direction of particle up to 5 -10 deg for large zenith angle. To avoid situation that we must simulate larger view cone for protons and nuclei, we decided to remove magnetic field before first interaction take place.
All the changes were done in the fortran code taken from cmz card with option listed in **1.**
Below you may find a list of subroutines, which were modified a little bit in standard CORSIKA code.

1) PROGRAM AAMAIN
It this part of the program some additional declarations were added and the initialization of the output system (this was copied from old) mmcs. Also the simulation of the core axis position was changed. Now the core axis position is simulated in the ring from radius R1 to R2 in the plane perpendicular to the core. In standard the core position was simulated in the rectangular shape on the horizontal plane. New logical flag (fmfb) was added and here is set to true for first interaction. The reason of it is to remove magnetic field

influence before first interaction.

2) SUBROUTINE BOX3
I have added the flag (fmfb) here.

3) SUBROUTINE DATAC
Reading telescope parameters was added as well as needed declarations (this was simply copied from mmcs 5.2o)

4) SUBROUTINE INPRM
The lines responsible for opening standard CORSIKA output were commended (in the same way like in old mmcs)

5) SUBROUTINE MUTRAC
I have added the flag (fmfb) here.

6) SUBROUTINE TOBUF
Writing information about particles in the shower is now done like in old mmcs (using jcdatasave subroutine written by J. C. Gonzales)

7) SUBROUTINE UPDATC
I have added the flag (fmfb) here.

8) SUBROUTINE UPDATE
I have changed treatment of the calculation the actual position and direction particle. If it is primary particle magnetic field is not taken into account up to place where first interaction appears.

9) SUBROUTINE CERENK
Like usually some declarations were added and additionally the wavelength of cherenkov photon is simulated (copied from old mmcs). Checking if cherenkov photons may hit telescope's dish is now done differently from old mmcs. In old mmcs we checked if photon may cross the area of sphere, which cover our telescope. In new mmcs information about cherenkov photon is written in output file if the distance between center telescope and position of photon (on the plane perpendicular to the core) is smaller then 10 m (this value might be changed in input card - telescope definition).

10) SUBROUTINE OUTPT2
In this subroutine we coded the information about wavelength and "parent" of cherenkov photon (in old mmcs we had only the wavelength).

11) SUBROUTINE TOBUFC
Writing information about Cherenkov photons is now done like in old mmcs (using jcdatasave subroutine written by. C. Gonzales)

3. How to install mmcs

Decompress the file using: gunzip Mmcs*.gz

Unpack the tar file with: tar xvf Mmcs*.tar

Change the directory to sources: cd MagicProgs/Simulation/Corsika/Mmcs614

Type in: make

Compile the program with: make all SYSTEM=[yoursystem]

If everything is OK you should have executable file called c614nx-[yoursystem]

4. How to run mmcs

You need input card to start the program. You may find it in MagicProgs/Simulation/Corsika/Mmcs614/input.
To start simulations you should change the input card according to description below. All files which are necessary to run MC are included in Mmcs*.tar and you don't need to take care about them. To start simulation you should type:

c614nx-[yoursystem] < input

5. Input card description

Detailed description of parameter in input card you may find in **A User's Guide for for CORSIKA** except this which are connected to changes (see **2.**) They are written by bold letters below:
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RUNNR	1				run number
PRMPAR	14				particle type
ERANGE	100	1000			energy range in GeV
EVTNR	1				number of first shower event
NSHOW	100000				number of showers to generate
ESLOPE	-2.73				slope of primary energy spectrum
THETAP	0.	0.			range of zenith angle (degree)
PHIP	90.	90.			range of azimuth angle (degree)
VIEWCONE	0.	5.			view cone definition
DIRECT	results/				data directory managed by daemon
SEED	1	3	0		seed values managed by daemon
SEED	6	3	0		seed values managed by daemon
SEED	1	3	0		seed values managed by daemon
OBSLEV	2200.E2				observation level (in cm)
ELMFLG	F	T			em. interaction flags (NKG,EGS)
RADNKG	200.E2				outer radius for NKG lat.dens.det.
MAGNET	29.5	23.0			magnetic field at LaPalma
VENUS	T	0			use venus for high energy hadrons
VENSIG	T				use VENUS hadronic cross sections
ECUTS	0.3	0.3	0.02	0.02	energy .cuts: had, mu, elec, photon
MUADDI	F				additional info for muons
MUMULT	T				muon multiple scattering angle
LONGI	T	10.	T	F	longit.distr. , step, size , fit
MAXPRT	0				max. number of printed events
ECTMAP	1.E4				cut on gamma factor for printout
STEPFC	0.1				mult. scattering step length fact.
DEBUG	F	6	F	1000000	debug flag and log.unit for out

CWAVLG	290. 600.	Cherenkov wavelength band
CSCAT	1 0. 40000.	scatter Cherenkov events
CERSIZ	1.	bunch size Cherenkov photons
CERFIL	T	Cherenkov output to extra file
CERTEL	1	
	0. 0. 0. 0. 0. 20000. 17000.	Location and size of each CT
DATBAS	T	write .dbase file
USER	yourname	user
ATMOSPHERE	6 T	atmosphere definition
EXIT		terminates input

****

1) VIEWCONE is working if both parameter in THETAP are the same and both parameter in PHIP are the same (like in example above)

2) CSCAT has 3 parameters:
- first: number of uses of each event,
- second: inner radius of the ring to simulate core location in cm on the plane perpendicular to core,
- third : outer radius of this ring also in cm.

3) CERTEL is the definition of the telescopes. In this line you may put number of telescopes you want to use. Next lines should contain 7 parameters (for historical reason - it was in mmcs520), but we are using only 3 (they are bold in list below):
-**x coordinate of telescope position in cm.**,
-**y coordinate of telescope position in cm.** ,
- z coordinate of telescope position in cm.,
- zenith angle of telescope axis in deg.,
- azimuth angle of telescope axis in deg.,
-**diameter of telescope's dish in cm.**,
- focal length of the telescope.

5. References

If you are user of CORSIKA don't forget to attach the references to paper you write based on Monte Carlo:

Heck D.and Knapp J., (2002), EAS Simulation with CORSIKA: A User's Manual

Authors of CORSIKA gave us also the list of references, where we may find more information about CORSIKA and using models.

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