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A User's Manual**

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Abstract

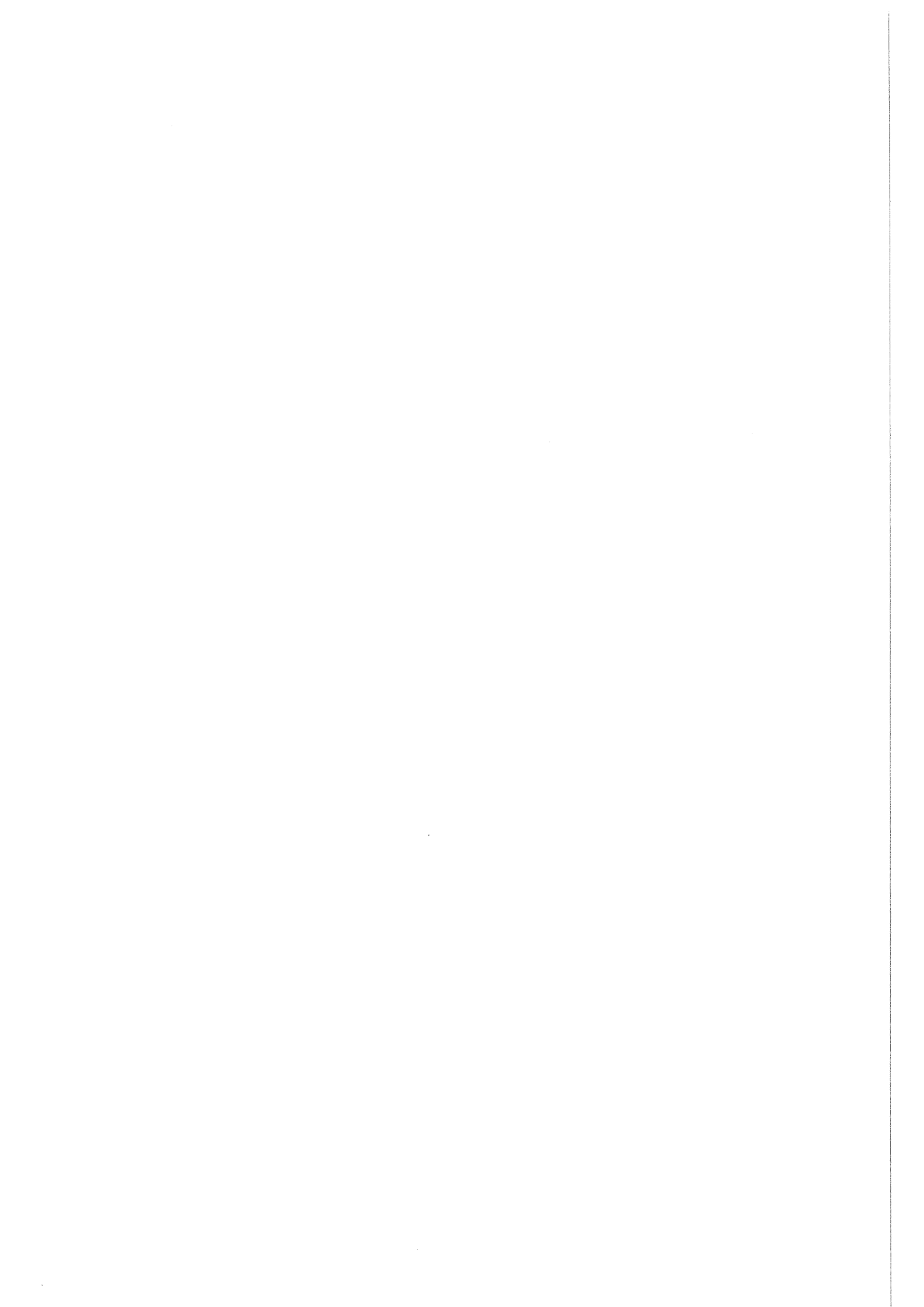
Extensive Air Shower Simulation with CORSIKA: A User's Manual

CORSIKA is a detailed simulation program for extensive air showers initiated by high energy cosmic particles. The manual explains the installation of the code, all the necessary input datasets, the selection of simulation parameters and the structure of the program outputs.

Zusammenfassung

Simulation ausgedehnter Luftschauer mit CORSIKA: Eine Bedienungsanleitung

CORSIKA ist ein Programm zur detaillierten Simulation von ausgedehnten Luftschauern, die durch hochenergetische kosmische Strahlung ausgelöst werden. Die vorliegende Anleitung erläutert die Installation des Programms, alle nötigen Eingabedateien, die Wahl der Simulationsparameter und die Struktur der Ausgaben des Programms.



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1 Introduction

CORSIKA (COsmic Ray Simulations for KAscade) is a detailed Monte Carlo program to study the evolution of EAS in the atmosphere initiated by photons, protons or nuclei of energies up to 10^{17} eV. It was developed to perform simulations for the KASCADE experiment [1] presently under construction at Karlsruhe.

The CORSIKA program [2] is a complete set of routines written in standard FORTRAN77 including the EGS routines [3] modified for the use in extensive air shower simulation. No additional program libraries are required. Therefore, it runs without problems on all computers where FORTRAN77 is available.

The program exists in several types. The standard one allows to simulate the hadronic and muonic component of extensive air showers with or without the detailed simulation of the electromagnetic particles. Optionally versions are available to model in addition the generation of Cerenkov light in the atmosphere and showers under horizontal incident directions.

A detailed description of the hadronic and electromagnetic interaction models, the cross sections, the particle decays, and the program frame has been published in [2].

This report is a supplementary description of the technical handling of CORSIKA. It contains information about the installation of the program, the required input data, file formats, parameter settings, outputs, and some technical details.

If you have problems in installing or running the program, suggestions to improve the code concerning physics, computing, or handling, please contact :

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2 Installation

The CORSIKA source is kept as a HISTORIAN file. HISTORIAN [4] allows comfortably to keep several versions of one program with optional code by some simple commands and definitions. Users who do not have HISTORIAN available may easily understand the source file when knowing the following HISTORIAN commands:
***DK 'name'**

defines beginning of deck 'name'. A deck may be a subroutine, function, part of code etc.

***CD 'name'**

defines beginning of common deck 'name' that is defined once and used multiple (e.g. COMMON blocks).

***CA 'name1,name2,...'**

includes common decks 'name1', 'name2', ... at this place.

***IF DEF,logkey**

...

***EI**

the code between *IF and *EI is only used if the logical variable logkey is set. The code after a *IF -DEF,logkey is used if logkey is not set. *IF ... *EI blocks may be nested.

Unmarked code is used in any case.

At present code for the following logical variables exists in CORSIKA:

IBM selects code for calculation on the IBM3090 (machine dependent i/o operations)

TRANSP selects code for calculation on the Transputer farm (machine dependent i/o operations)

CERENK selects code for simulation of Cerenkov light

HORIZONTAL selects code for simulation of nearly horizontal showers

INTTST selects special features for the test of the interaction model (not yet complete, do not use!!)

Only a few per cent of the code is optional. With these remarks it should be possible to understand the source code in case of problems.

The CORSIKA distribution set consists of the source code (SOURCE) in HISTORIAN format, that contains the complete code, two compile files of the standard CORSIKA (COMPIBM) and of the Cerenkov version (COMPIBMC), two datasets containing the energy dependent cross sections for electromagnetic interactions (EGSDATA) and nucleon-nucleus processes (NUCNUCCS), several datasets with atmospheric data for different large inclination angles (ATMxx), an example input (INPUTS) to steer the simulation, a \LaTeX file containing this description, and a brief description of the changes in the program since the last version.

The program comprises some explanations, one main program and ca. 100 sub-routines and functions and is \approx 16000 lines long.

The cross sections for the EGS4 routines are contained in the dataset EGSDATA with a length of 901 lines. It is connected to the logical unit KMPI (by default 12).

The nucleon-nucleus cross sections are listed in NUCNUCCS which is 2873 lines long. They are read via logical unit NUCNUC (NUCleus-NUCleus interactions, by default 11).

The program version for horizontal showers requires additional data on the atmosphere's density (501 lines). They are expected to be stored in ATMOSPH and are requested via logical unit ATMI (ATMosphere Input, by default 44).

Beside these two datasets CORSIKA needs the input of steering commands to

Name	Def.	I/O	File
KMPI	12	I	EGSDATA, EGS cross sections
NUCNUC	11	I	NUCNUCCS, nucleus-nucleus cross sections
ATMI	44	I	ATMOSPH, atmosph. data for horiz. showers
MONIIN	5	I	INPUTS, steering cards
MONIOU	6	O	Simulation controll output on line printer
MDEBUG	99	O	Debug output if DEBUG it selected
EXST	96	I/O	External particle stack, temporary dataset
PATAPE	90	O	Particle output and simulation results
CETAPE	91	O	Cerenkov photon output

Table 1: Logical units for in- and output with their default values

select the subject of the simulation. They are read via logical unit MONIIN (MONItor INput, by default 5). The format of the steeringcards and their effect is described in detail is sec. 5.

There are several streams of the output of CORSIKA. One is control information about the simulation run itself which is directed to the logical unit MONIOU (MONItor OUtput, by default 6).

In case of a debugging run very much information is written to the logical unit MDEBUG (MonItor for DEBUgging, by default 99).

The second output stream contains the information about all the particles that reach the observation level. It is directed to unit PATAPE (PARticle TAPE, by default 90).

A last output file contains the compressed information of the Cerenkov photons. It is directed to unit CETAPE (CErenkov TAPE, by default 91).

During the calculation the program uses a temporary dataset as an external particle stack if the internal one is overfull. This data set is connected to unit EXST (EXternal STack, by default 96).

The values of the in- and output units may be redefined by changing their values in one of the two BLOCK DATA subprograms. The units are listed with their default values in table 1.

As the CORSIKA program was developed to run on any FORTRAN machine, the major part of the program is machine independent by using only FORTRAN77 standard statements.

Nevertheless, there are a few points where computer specific changes may be necessary, concerning for example the file types and connections for in- and output, some code to avoid time out and end of tape errors on our IBM3090, and the routines delivering an actual date and time. Those crucial places are marked with the comment lines

C--MACHINE DEPENDENT CODE

....

C--MACHINE DEPENDENT CODE

in the code.

3 Cerenkov version

The routines treating the Cerenkov radiation have been supplied by the HEGRA Collaboration and are not described in the CORSIKA report [2]. The Cerenkov light production by electrons, positrons, and hadrons is considered in the routines CERENE and CERENH respectively. The photons are restricted to the wavelengths band of 300 to 450 nm. Atmospheric absorption of the Cerenkov photons is not taken into account.

Charged particles create Cerenkov photons at each tracking step when the condition $\beta > 1/n$ ($\beta = v/c$ and $n =$ refractive index) is fulfilled.

The step is subdivided in smaller substeps such that the number of Cerenkov photons per substep is less than the fixed number CERSIZ, predefined by an input data card. In such a substep all the photons are sent in a compact bunch along a straight line, defined by the emission angle θ_C relative to the electron's or hadron's direction and a random value for the angle ϕ around this direction.

For higher primary energies it is still impossible to write all the bunches of one shower to tape. Therefore only the bunches are recorded which hit an array of 27×27 squares of 1 m^2 each and a gridspacing of 15 m at observation level. Each bunch is represented by 7 words which are the number of Cerenkov photons, the x and y coordinates at the observation level, direction cosines u and v , arrival time and height of production above sea level.

The Cerenkov output file is started with 7 words of header information containing the particle identification of the primary particle, its energy, the incident angles θ and ϕ in radians, the maximum grouping size (CERSIZ), the version number of CORSIKA, and an empty word.

The end of the Cerenkov output file is indicated by 7×0 . The data structure of the Cerenkov output dataset is given in table 9.

4 Horizontal shower version

The standard CORSIKA program models the earth's atmosphere as a flat disc where the density of the air decreases with the height following the U.S. standard atmosphere. The shower calculations and tracking in CORSIKA are using cartesian coordinates and do not account for the curvature of the earth's surface. The thickness of the atmosphere increases then with $1/\cos\theta$. This is a good approximation for inclined showers if their zenith angles are below $\approx 75^\circ$. Above this value the differences between a flat and a curved atmosphere become more and more important.

At 90° eventually the thickness of the flat atmosphere becomes infinite whereas the correct thickness is $\approx 37000g/cm^2$.

Since we did not like to introduce spherical coordinates to CORSIKA we simulate showers under large zenith angles as if they would be exactly vertical showers traveling through an atmospheric profile corresponding to the desired angle. The modified profiles are stored in the files ATM90 ... ATM85 and the desired one has to be copied into the input dataset ATMOSPH. The routine RHOF, THICK, and HEIGH that delivered the density and thickness versus the height and the height versus the thickness are replaced by other routines with the same names that use the data from ATMOSPH.

This procedure may be not the best solution as now the shower develops always along the density gradient whereas in reality the gradient is almost perpendicular to the direction of flight. The different orientation of the observation levels in this approach has consequently to be taken into account.

5 Steering of the simulation

The simulation of air showers is steered by commands that have to be given in a certain format on unit MONIIN (MONItor INput). A command consists of an up to 6 character long keyword and one or more values in the form

```
KEYWRD  var1 var2 var3 ....
```

The valid keywords, the internal variable names, the formats of the input values, their default settings, and the description are listed in the following.

```
RUNNR      NRRUN
```

Format = 1I10, Default = 1

NRRUN : Run number of this simulation.

```
EVTNR      SHOWNO
```

Format = 1I10, Default = 1

SHOWNO : Event number of first shower. The second shower will get number SHOWNO+1 and so on.

```
NSHOW      NSHOW
```

Format = 1I10, Default = 10

NSHOW : Number of showers to be generated in a run.

OBSLEV OBSLEV(i)

Format = 1E10, Default = 110.E2

OBSLEV(i) : Observation level i above sea level (in cm). This keyword has to appear once for each level to be defined. At maximum up to 10 observation levels are possible. It should be noted that the output of particles rises drastically for more than one observation level.

PRMPAR PRMPAR(1)

Format = 1I10, Default = 14

PRMPAR(1) : Particle type of the primary particle. See section 6 for the particle codes.

THETAP THETAP

Format = 1F10, Default = 0

THETAP : Zenith angle θ (in $^\circ$) of primary particle ($\theta = 0^\circ$ is vertical).

PHIP PHIP

Format = 1F10, Default = 0

PHIP : Azimuth angle ϕ (in $^\circ$) of primary particle ($\phi = 0^\circ$ is north, $\phi = 90^\circ$ is west).

ERANGE LLIMIT ULIMIT

Format = 2E10, Defaults = 1.E4, 1.E4

LLIMIT : lower limit and

ULIMIT : upper limit of the primary particle energy range (in GeV). The primary energy is selected at random out of this interval. If LLIMIT = ULIMIT, the primary energy is fixed at this value.

ESLOPE PSLOPE

Format = 1E10, Default = 0

PSLOPE : Exponent γ of the differential primary energy spectrum. The primary energy is taken at random from an exponential energy spectrum of the form $dN/dE_0 \propto E_0^\gamma$. PSLOPE has no meaning in case of fixed primary energy.

FIXHEI FIXHEI

Format = 1E10, Default = 0

FIXHEI : The fixed height (in cm) of the first interaction for all showers in a run. If FIXHEI = 0 the height of the first interaction is varied at random according to the appropriate mean free path.

HADFLG NFLAIN NFLDIF NFLPIO NFLPIF NFLCHE NFRAGM

Format = 6I10, Defaults = 6 × 0

Steering flags of the high energy hadronic interaction model (DPM).

NFLAIN : The number of interactions of a projectile in a target nucleus may fluctuate (NFLAIN = 0) or is calculated as an average value (NFLAIN = 1).

NFLDIF : No diffractive interactions are allowed in case of more than 1 interaction in the target (NFLDIF = 0), or diffractive interactions are possible (NFLDIF = 1).

NFLPIO : The rapidity distribution of π^0 is taken different from that of charged pions as indicated by collider data (NFLPIO = 0), or is taken as for charged pions (NFLPI = 1).

NFLPIF : The number of π^0 fluctuates exactly as the number of charged pions (NFLPIF = 0), or fluctuates independently as parametrized from collider data (NFLPIF = 1).

NFLCHE : Charge exchange reactions for the projectile and target particles are allowed (NFLCHE = 0), or inhibited (NFLCHE = 1).

NFRAGM : A primary nucleus fragments at the first interaction completely into free nucleons (NFRAGM = 0), or successively by assuming that the non interacting nucleons proceed as one new nucleus down the atmosphere (NFRAGM = 1).

ELMFLG FNKG FECS

Format = 2L10, Defaults = T F

Steering flags for the electromagnetic interaction.

FNKG : The NKG mechanism is switched on for electromagnetic subcascades by FNKG = T .

FECS : FECS = T selects EGS to calculate all interactions of e^+ , e^- and photons in the atmosphere explicitly. (The second random number sequence may be initialized for use in the EGS part. Otherwise the default initialisation is taken.)

The two options may be selected or disabled at the same time.

ECUTS ELCUT(i), i=1... 4

Format = 4E10, Defaults = 4 × 0.3

ELCUT(i) : The low energy cut-off (in GeV) of the particle's kinetic energy may be

selected different for hadrons ($i = 1$), muons ($i = 2$), electrons ($i = 3$) and photons ($i = 4$).

ECTMAP ECTMAP

Format = 1E10, Default = 1.E4

ECTMAP : Defines a cut in the particles' γ factor above which they are printed out on the logical unit MONIOU when passing an observation level.

SEED ISEED(i,k), i=1... 3

Format = 3I10, Defaults = k , 0, 0

ISEED(1, k) : Contains the seed of the random number sequence k .

ISEED(2..3, k) : Contain the number of calls N_{in} to the generator that are performed for initialization such that $N_{in} = \text{ISEED}(2, k) + 10^9 \cdot \text{ISEED}(3, k)$. At present at most 3 sequences are used. One for the standard hadron shower, one for the EGS part and one for the calculation of Cerenkov photons.

MAXPRT MAXPRT

Format = 1F10, Default = 10

MAXPRT : Is the maximum number of events that produce a detailed printout during the simulation run.

MAGNET BX BZ

Format = 2F10, Defaults = 20.0, 42.8

BX : Is the component of the earths magnetic field (in μT) to the north and

BZ : Is the component of the earths magnetic field (in μT) downwards.

The default values represent the values from central europe.

DEBUG DEBUG MDEBUG

Format = 1L10, 1I10, Defaults = F, MONIOU

DEBUG : If true, additional output for debugging purposes on is given on logical unit MDEBUG.

MDEBUG : Logical unit of debugging information.

CERSIZ CERSIZ

Format = 1F10, Default = 100.

CERSIZ : Defines the bunch size of Cerenkov photons that are treated together. This keyword is only available in the program version for Cerenkov calculations.

DIRECT DSN

Format = 1A19, Default = 'ANYNAMEUPTO19CHARS.'

DSN : May be used to define a name of an output directory.

EXIT

EXIT : Ends the data card input.

6 The particles in CORSIKA

CORSIKA is able to treat the particles that are listed in table 2. The particle codes have in general been chosen according to the convention in the GEANT detector simulation code [5]. Exceptions are the resonances (ρ , K^* , and Δ), the η particles which are split in 4 types according to their decays, the different types of neutrinos (to be implemented in the next CORSIKA version), and the nuclei.

7 Running the CORSIKA program

The CORSIKA program needs roughly 800kB memory.

The computing time on our IBM 3090-60J is $\approx 2min$ per shower for primary protons of energy $10^{15}eV$, vertical incidence, with one observation level at 110m a.s.l., without EGS, and with the hadron and muon energy cut at 0.3 GeV. Under the same conditions a primary iron nucleus consumes $\approx 2.7min$ per shower. The computing time scales roughly with the energy.

Most of our calculations we did on a transputer farm [6] with 24 transputers T800. The program runs independently on each of the 24 processors in parallel. A transputer has about 1/17 of the computing power of the IBM processor. So one proton shower (NKG only) of $10^{17}eV$ runs 57 hours on a transputer.

The full EGS version is roughly a factor of 40 slower than the NKG version.

We do not have much experience up to now what the time consumption is for the Cerenkov version. As it requires the full EGS simulation and does not tolerate some accelerating tricks, the time consumption will be even higher.

CORSIKA produces as well a lot of output data. The printout on unit MONIOU informs about the general run, the program version, the parameter setting, and the primary particle (160 lines). For each shower it gives a printout of roughly 400 lines.

Identification	Particle	Identification	Particle
1	γ	51	ρ^0
2	e^+	52	ρ^+
3	e^-	53	ρ^-
		54	Δ^{++}
5	μ^+	55	Δ^+
6	μ^-	56	Δ^0
7	π^0	57	Δ^-
8	π^+	58	$\overline{\Delta}^{--}$
9	π^-	59	$\overline{\Delta}^-$
10	K_L^0	60	$\overline{\Delta}^0$
11	K^+	61	$\overline{\Delta}^+$
12	K^-	62	K^{*0}
13	n	63	K^{*+}
14	p	64	K^{*-}
15	\bar{p}	65	\overline{K}^{*0}
16	K_S^0	66	ν_e
		67	$\bar{\nu}_e$
18	Λ	68	ν_μ
19	Σ^+	69	$\bar{\nu}_\mu$
20	Σ^0		
21	Σ^-	71	$\eta \rightarrow \gamma\gamma$
		72	$\eta \rightarrow 3\pi^0$
25	\bar{n}	73	$\eta \rightarrow \pi^+\pi^-\pi^0$
26	$\bar{\Lambda}$	74	$\eta \rightarrow \pi^+\pi^-\gamma$
27	$\overline{\Sigma}^+$		
28	$\overline{\Sigma}^0$		
29	$\overline{\Sigma}^-$		
$A \times 100 + Z$	nucleus of Z protons and $A - Z$ neutrons ($A \leq 59$)		

Table 2: Particle identifications as used in CORSIKA

It contains the random generator status, the primary particle at the place of the first interaction, the number of secondaries reaching the observation levels with energies above ECTMAP, the stack statistics, the energy and momentum balance of all particle producing processes, the energy multiplicity matrix, the energy-elasticity matrix, an interaction statistics for nucleons, pions, kaons and strange baryons per kinetic energy interval, an interaction length statistics for the above particles and muons, the particle statistics for all particles that are recorded on tape, and eventually the NKG output with the longitudinal development of the shower and, for at maximum two observation levels, the local ages and the lateral electron distribution along 8 radial directions up to 200 m core distance. For low energy primaries and high statistics, this printout per event may not be necessary and can be suppressed by selecting a maximum number of showers to be printed (MAXPRT). At the end of each run a short run summary is printed with similar tables as for single showers, but averaged over all showers of the actual run. These printouts are for control purposes only. All the information about the shower is contained as well on the particle tape (PATAPE).

When errors occur the debug option may be chosen. This entails a very detailed printout of the simulation process, that easily fills large disks when enabled for many showers.

The particle output format is described in section 8. For each particle that penetrates an observation level 7 words with 4 bytes each are stored on file. Proton showers at $10^{15}eV$ deliver at sea level roughly 0.8 MB particle output when calculated with the NKG option ($E_h, E_\mu > 0.3GeV$). With EGS we obtain ca. 30 MB due the huge amount of photons and electrons that are explicitly stored ($E_e, E_\gamma > 3MeV$). The energy cuts in brackets correspond to the thresholds of the KASCADE array detectors. The particle output in the Cerenkov version is additionally increased as the Cerenkov photons are stored separately on the Cerenkov output tape CETAPE.

While running, the CORSIKA program generates plenty of secondaries that are stored in an internal stack. The size of internal stack is large enough to keep $NP = 680$ particles, as each particle needs 12 words to be stored. It may be enlarged by increasing the size of the array STACK and the counter ISTK to the value $NP \times 12$.

If the size of the internal stack is full, 680 particles are intermediately stored on the external stack. If the internal stack is empty 340 particles are reread from the external stack. We read back only half of the internal stack to avoid a permanent shifting of data from and to the internal stack if it is just full and the number of secondaries oscillates with a small amplitude around 680.

8 Outputs

The particle output is structured as shown in the tables 3 to 8 and listed in the beginning of the CORSIKA code. The information is stored on tape in a fixed block structure with a block length of 22932 bytes. A block consists of 5733 words each 4

bytes long. Each block consists of 21 subblocks of 273 words. These subblocks can be a RUN HEADER, EVENT HEADER, DATABLOCK, EVENT END, or a RUN END subblock. A data tape has then the structure as shown in table 3. As can be seen from this table a run may be written to a tape that contains already simulation data. The new run is appended to the old one. The contents of the subblocks is described in tables 4 to 8.

9 In case of problems . . .

In spite of our care to avoid faults in the physics model and errors in the programming of CORSIKA, and writing this installation and user's guide, you may have problems of technical or physical nature with the code or the results you obtain from it. Please report all problems to the addresses mentioned in section 1.

We are specially interested in comparisons of CORSIKA simulations with experimental cosmic ray data.

Suggestions to improve CORSIKA in any respect are welcome.

References

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- [6] H.J. Gils et al., Comp. Phys. Comm. 56 (1989) 105

Subblocks
RUN HEADER 1
EVENT HEADER 1
DATABLOCK
DATABLOCK
...
...
EVENT END 1
EVENT HEADER 2
DATABLOCK
DATABLOCK
...
...
EVENT END 2
...
...
EVENT HEADER nevt
DATABLOCK
DATABLOCK
...
...
EVENT END nevt
RUN END 1
RUN HEADER 2
...
RUN END 2
...
RUN HEADER nrun
...
RUN END nrun

Table 3: Subblock structure of the particle tape.

Run header : (once per run)	
No. of word	Contents of word
1	'RUNH'
2	run number
3	date of begin run (yymmdd)
4	version of program
5	number of observation levels (maximum 10)
5+i	height of level i in cm
16	slope of energy spectrum
17	lower limit of energy range
18	upper limit of energy range
19	flag for EGS4 treatment of em. component
20	flag for NKG treatment of em. component
21	kin. energy cutoff for hadrons in GeV
22	kin. energy cutoff for muons in GeV
23	kin. energy cutoff for electrons in GeV
24	energy cutoff for photons in GeV
	physical constants and interaction flags
24+i	C(i), i=1,50
74+i	CC(i), i=1,20
94+i	CKA(i), i=1,40
134+i	0 , i=1,6 no longer used
154+i	CAN(i), i=1,50
204+i	CANN(i),i=1,50
254+i	AATM(i),i=1,5
259+i	BATM(i),i=1,5
264+i	CATM(i),i=1,5
270	NFLAIN (as real)
271	NFLDIF (as real)
272	NFLPIO + 100 × NFLPIF
273	NFLCHE + 100 × NFRAGM

Table 4: Structure of the run header subblock.

Event header : (once per event)	
No. of word	Contents of word
1	'EVTH'
2	event number
	primary particle
3	particle id (particle code or $A \times 100 + Z$ for nuclei)
4	total energy in GeV
5	not used
6	not used
7	z- coordinate (height) of first interaction in cm
8	px momentum in x direction in GeV
9	py momentum in y direction in GeV
10	pz momentum in z direction in GeV
11	zenith angle θ in radian
12	azimuth angle ϕ in radian
13	number of different random number sequences (maximum 10)
$11+3*i$	integer seed of sequence i
$12+3*i$	number of offset random calls (mod 10^6) of sequence i
$13+3*i$	number of offset random calls ($/ 10^6$) of sequence i
44...273	not used yet

Table 5: Subblock structure of begin event subblock.

Data block : (up to 39 particles, 7 words each)	
No. of word	Contents of word
$7*(n-1)+1$	particle description (part.id \times 1000 + generation \times 10 + no. of obs.level)
$7*(n-1)+2$	px, momentum in x direction in GeV
$7*(n-1)+3$	py, momentum in y direction in GeV
$7*(n-1)+4$	pz, momentum in z direction in GeV
$7*(n-1)+5$	x- coordinate in cm
$7*(n-1)+6$	y- coordinate in cm
$7*(n-1)+7$	t time since first interaction in nsec
	for n = 1... 39
	last block may not be completely filled

Table 6: Structure of the data subblock.

End event subblock : (once per event)	
No. of word	Contents of word
1	'EVTE'
2	event number
	statistics for one shower :
3	number of photons written to tape
4	number of electrons written to tape
5	number of hadrons written to tape
6	number of muons written to tape
7	total number of particles written to tape
	NKG output (208 words) if selected
7+i	i=1,21 lateral distribution in x direction for 1. level
28+i	i=1,21 lateral distribution in y direction for 1. level
49+i	i=1,21 lateral distribution in xy direction for 1. level
70+i	i=1,21 lateral distribution in yx direction for 1. level
91+i	i=1,21 lateral distribution in x direction for 2. level
112+i	i=1,21 lateral distribution in y direction for 2. level
133+i	i=1,21 lateral distribution in xy direction for 2. level
154+i	i=1,21 lateral distribution in yx direction for 2. level
175+i	i=1,10 electron number in steps of $100g/cm^2$ 1. level
185+i	i=1,10 age in steps of $100g/cm^2$ 1. level
195+i	i=1,10 distance bins for local age 1. level
205+i	i=1,10 local age 1. level
215+i	i=1,10 not used
225+i	i=1,10 not used
235+i	i=1,10 distance bins for local age 2. level
245+i	i=1,10 local age 2. level
256..273	not used

Table 7: Structure of the end event subblock.

End run subblock : (once per run)	
No. of word	Contents of word
1	'RUNE'
2	runnr
3	statistics for run: number of events processed
4...273	not used yet

Table 8: Structure of the end run subblock.

Cerenkov photon data block:	
No. of word	Contents of word
	Header : (only in first subblock)
1	particle id
2	primary energy in GeV
3	zenith angle θ in radian
4	azimuth angle ϕ in radian
5	max. grouping size
6	CORSIKA version
7	0
	per bunch :
$7*n+1$	number of Cerenkov photons in bunch
$7*n+2$	x- coordinate in cm
$7*n+3$	y- coordinate in cm
$7*n+4$	u direction cosine to x axis
$7*n+5$	v direction cosine to y axis
$7*n+6$	arrival time since first interaction in nsec
$7*n+7$	height of production of bunch in cm

Table 9: Structure of Cerenkov data subblock.