

# MOCHI: MOdified Corsika Hadronic Interactions



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... made possible by Ralf Ulrich and Tanguy Pierog

R. Ulrich, R. Engel, M. Unger: Phys.Rev.D83:054026,2011 (arXiv 1010.4310)

- modified CONEX to test effect of changes in interactions
- smooth increase of magnitude from threshold up
- change: cross section, multiplicity, elasticity, charge ratio ...

MOCHI: use the same code in CORSIKA via CONEX in CORSIKA

- get 3D observables
- allow comparison with current data

Additonally:

- explore parameter space (combine changes of variables)
- more combinations of primaries/models (if possible)

# **CONEX** modifications adapted by Ralf Ulrich to CONEX in CORSIKA

What we did so far (talk outline):

- checked CORSIKA with CONEX vs. "normal" CORSIKA
- checked if modification makes sense to do in CORSIKA like this
- tested CONEX modifications in CORSIKA, fixed small bugs
  - FORTRAN/C++ interface "unsafe", consistency critical
    - check your MxpltIxs
  - proper random seed initialization
- adapted code to allow parallel changes of multiplicity/elasticity
  - changed steering card format accordingly
  - tested that
- looked into the problem of nuclear interactions (confusedly)
- made same bold plans and mused about parameter space

#### CORSIKA with CONEX vs. "normal" CORSIKA



#### Handover of particles between CONEX and CORSIKA



# Modified interaction CORSIKA with CONEX vs. CONEX (paper)







SIBYLL 2.1 proton

### Effect of changing multiplicity on elasticity



### Reproducing requested change in multiplicity



## Iron primaries and CONEX modifications for QGSJET vs. SIBYLL





#### Iron primaries and CONEX modifications for QGSJET vs. SIBYLL





Iron primaries and CONEX modifications for QGSJET vs. SIBYLL

What is the difference?

- SIBYLL gives nucleon-nucleon interaction separately -> treated as such in "resampling"
- how does that affect multiplicity (multiplication is distributive)?

```
Also:
#ifdef CONEX EXTENSIONS
       factMod=1.d0
       if (np.le.7) then ! excludes muons + nuclei !
          call modifiercx(factMod, ek, np)
       endif
       if (Siginemb.gt.0.d0) then
C
           write(*,*)'vypis factMod:',factMod
          rlam = Ameanair/(avog*Siginemb*factMod)
       endif
 #else
       if(Siginemb.gt.0.d0)rlam = Ameanair/(avog*Siginemb)
      CONEX EXTENSIONS
 С.
 #endif
```

#### How to set thresholds for modifications?

https://doi.org/10.1051/epjconf/201920802002

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Rough ideas (for discussion): cross-section ~  $10^{17}$  eV, multiplicity ~  $10^{15}$  eV, elasticity ~  $10^{13}$  eV

#### Parameter space scan or additive effects?

Sibyll 2.3c proton CONEX  $E_{prim}$ =10<sup>18.7</sup>  $E_{th}$ =10<sup>17</sup>



Additivity check = value(combined) - value(cross section) - value (multiplicity) + value( $f_{19}$ =1)

Plans for simulations

CORSIKA 7.74 (fixed Xmax binning and strange baryons) E<sub>prim</sub> = 10<sup>18.7</sup> eV, thresholds as discussed zenith angles 0,30,40,50,60 degrees p, He, O, Fe SIBYLL 2.3d, EPOS-LHC, QGSJET-II-04 3-dim scan in cross section, multiplicity, elasticity, 5 values per axis - possible "prescan" in CONEX for areas "excluded by data"? FLUKA or UrQMD, radial thinning, Auger ground (only 1 with CONEX)

CPU time: ~N hours per shower,  $125 \times 3 \times 4 \times 5 = 7500$  sets, 500/set -> ~4N×10<sup>6</sup> CPUhours = 55N days on a 3000-CPU cluster

- possibly doable, smart strategies still useful

Data output ~ 1 PB if 300 MB/shower (depends on radial thinning)

Conclusions

MOCHI: a simple idea, devil in many details

- everyone welcome to join in and give good advice (and CPU time)
- but we must start soon before CORSIKA 8 makes us obsolete!

Talk to us at any time:

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