PROCEEDINGS OF SCIENCE

Development of a general purpose air shower simulation tool COSMOS X

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Extended COSMOS, COSMOS X, is a major upgrade of the air shower simulation tool COSMOS, which has been developed since 1970's. To be compatible with the environment of the modern personal computers, COSMOS X can be compiled with gfortran and intel fortran helped by cmake. In addition to the earth's atmosphere, particle tracking in the arbitrary spherical media with a common center is available with COSMOS X. This allows seamless simulations in air, water, ice, soil, concrete and also simulations in the atmosphere of stars and planets. For the design of new experiments and calculations of cosmic-ray interactions in the non-earth environments, COSMOS X opens wide possibilities. Basic functions and some interesting applications of COSMOS X are presented in the conference.

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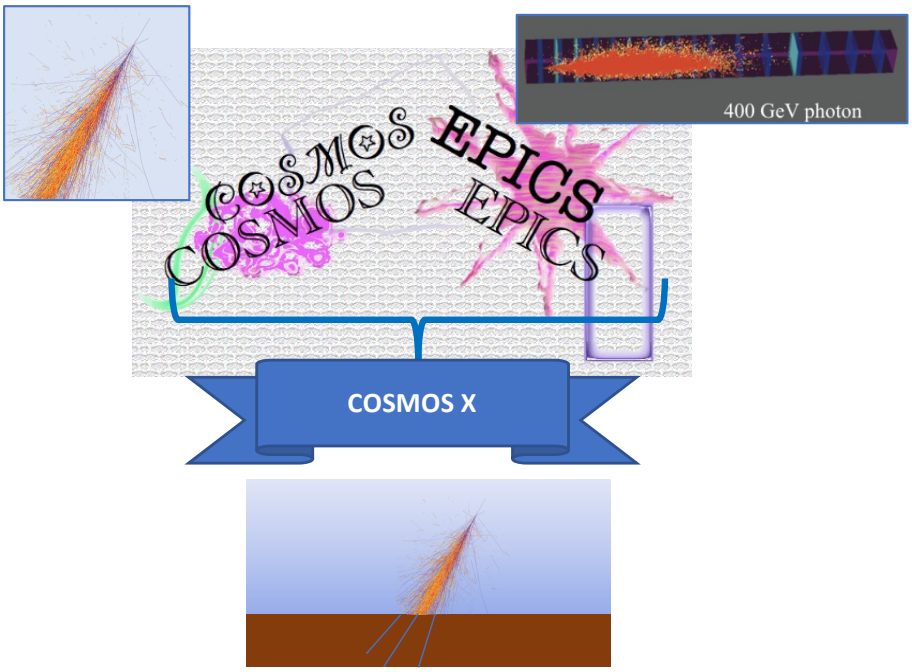

Figure 1: Origin of COSMOS X.

1. Introduction

Developments of the air shower observation technic and the applications of the secondary cosmic-ray detection in the various scenes increase the importance of air shower simulation. While CORSIKA [1] is the world standard now, a major update of CORSIKA version 8 is under progress [2]. COSMOS has been an alternative simulation tool satisfying necessary requirements [3]. In this paper, an update of COSMOS to COSMOS X is described.

2. COSMOS X

COSMOS X [4] means the extended COSMOS, which is born as a combination of the air shower simulation tool COSMOS and the detector simulation tool EPICS [5]. Thanks to the inclusion of the detector simulation tool, COSMOS X enables a seamless particle tracking from the atmosphere to, for example, soil, water, ice and concrete materials. Interesting application is already found in the geophysics researches [6]. Because the basic structure of COSMOS X was reported in ICRC 2021 [4], an example of new developments is described here.

Fig.2 is a shower in ice developed from a charge current interaction of a 30 GeV ν_μ with an oxygen atom. In this calculation the first interaction and particle generation were calculated by the neutrino generator NEUT [7]. The particle list of the NEUT output is formatted as a COSMOS X input where input of particle list is allowed as the incident particle. This is still a two step process and not convenient for the users while the choice of the neutrino generator code is not restricted to NEUT. This update of neutrino shower generation will be included in the next release.

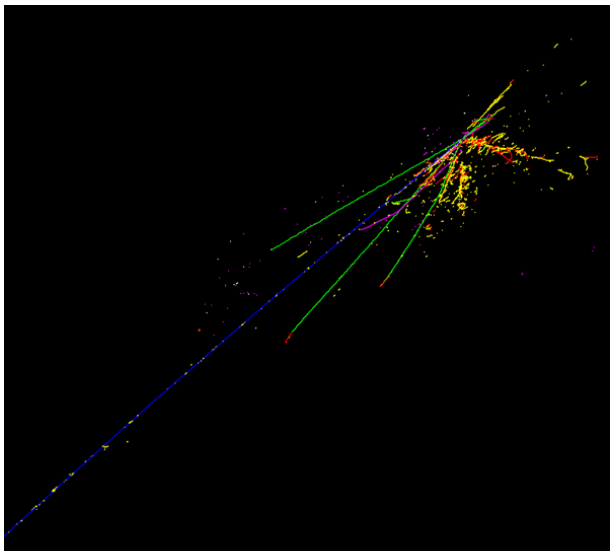

Figure 2: A neutrino interaction in ice. Interaction is generated by NEUT [7] and imported to COSMOS X.

3. Summary

COSMOS X is a new type of air shower simulation tool kit convenient for the design of new experiments not only for the cosmic-ray physics and calculations of cosmic-ray interactions in the non-earth environments. The release version is available in the web page [8].

Acknowledgements

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References

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