ESCAPE

European Science Cluster of Astronomy & Particle physics ESFRI research Infrastructures

ConCORDIA

Cristiano Bozza - UNISA & INFN – 22/1/2021

On behalf of Luisa Arrabito, C.B., Johan Bregeon, Rosa Coniglione, José Luis Contreras, Matthias Fuessling, Luigi Fusco, Gareth Hughes, Daniel Nieto, Jutta Schnabel, Bernardino Spisso, Simona Maria Stellacci, Andrei Tsaregorodtsev, Daniele Zito

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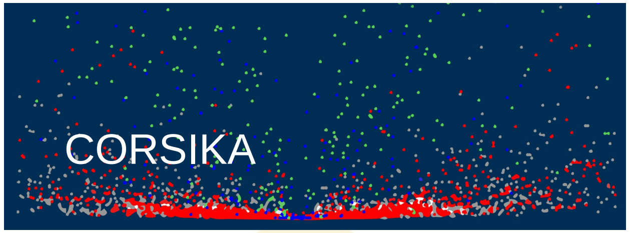
ConCORDIA – What it is

Containers for **COR**SIKA on **DI**R**A**C

- Set of turnkey containers for CORSIKA simulation hosted on DIRAC
- GUI/scripting environment to quickly tweak-tune new CORSIKA setups
- Use DIRAC for integration with ESAP platform (WP5)

  + *integrate storage with RUCIO (WP2) ?*



DIRAC
THE INTERWARE

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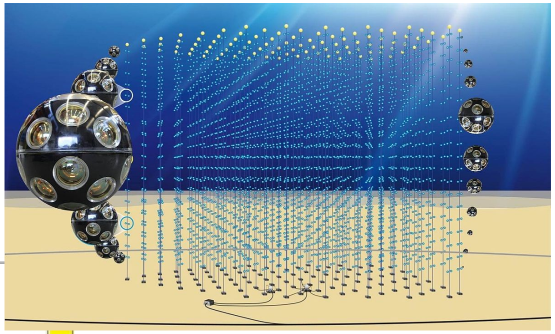
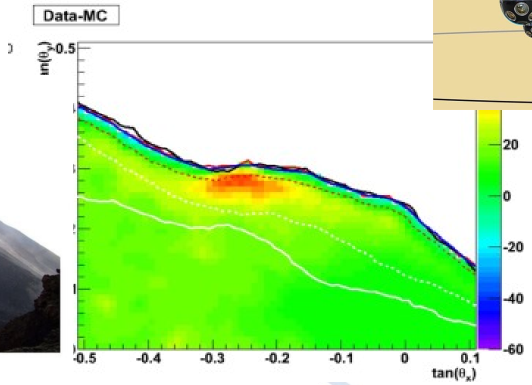
Motivation

- To provide turnkey tools for cosmic ray simulation in a wide range of research and application fields
  - Air-shower experiments
  - Underwater Cherenkov neutrino detectors
  - Under-ice Cherenkov neutrino detectors
  - Muography of large objects



- To help and foster comparison and optimization of simulations to match data



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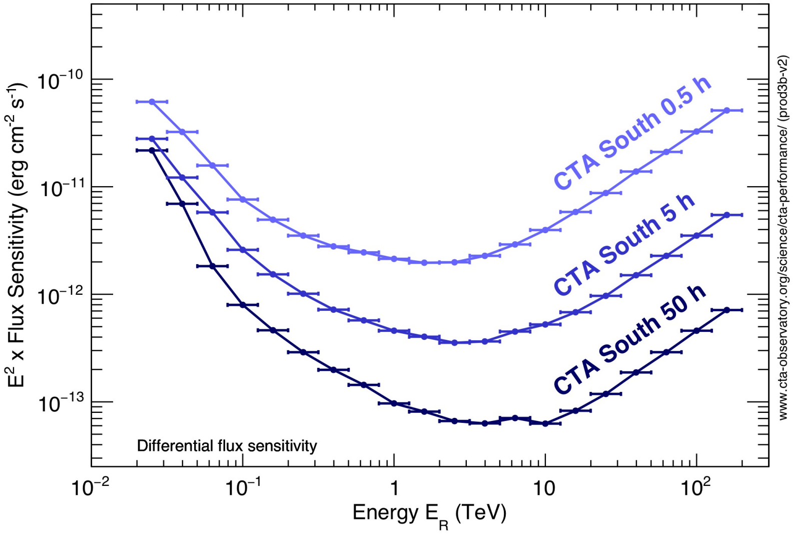
Use cases: CTA

Simulate the response of CTA for IRF generation

- Instrument response functions (IRFs) derived from Monte Carlo simulations are produced for the data analysis steps. IRFs are required for the transformation of CTA data products (e.g. photon lists, data, and atmospheric quality, and instrument monitoring information) to CTA science products (e.g. sky maps, light curves, spectral distributions). For all use cases related to gamma-ray astronomy, the required IRFs are typically:
  - effective areas vs true and reconstructed energy
  - the energy dispersion matrix
  - the gamma-ray point-spread function vs energy
  - a model for the distribution of background events vs reconstructed energy and direction.
  - IRFs are provided with an explicit time dependency or for a period of stable observing conditions.



http://www.cta-observatory.org/science/cta-performance/ (version prod3b-v2)

MC productions for the estimation of systematic uncertainties

- The aim for CTA is to provide IRFs which allow the reconstruction with well determined systematic uncertainties inside the required values. Systematic uncertainties are generally functions of different parameters (e.g., of telescope elevation, level of night sky background or event energy) and vary with time. 'Bracketing' IRFs, with simulation model parameters varied inside their expected uncertainties (e.g., by varying the uncertainties, changing the hadronic interaction model, using different methods for the derivation of the simulation model parameters) are used to estimate the systematic uncertainties.

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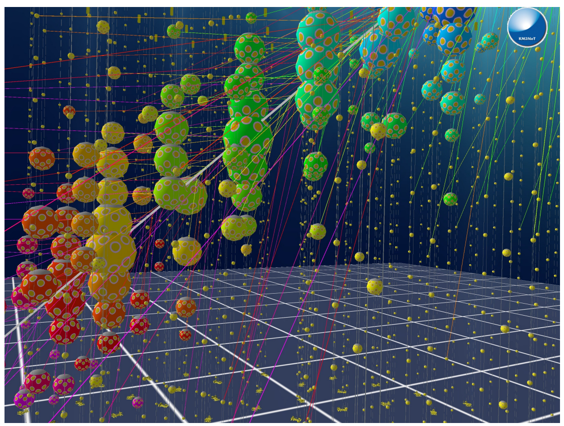
Use cases: KM3NeT

Assessment of detector performances

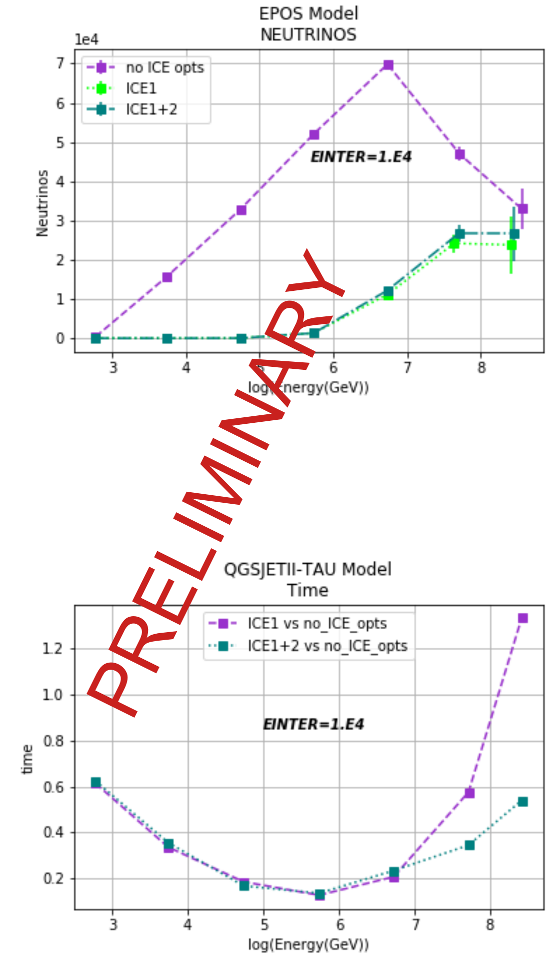
- Detailed shower profile
  - Propagate particles through water
  - Obtain Cherenkov radiation in water towards detector
  - Simulate photon counts (hits) in the detector.
    Depends on the particles, direction and energy produced

https://www.km3net.org



Computation of Instrument Response Function of the detector

- Mostly the Effective Area
- Repeatedly run simulations
  Detectors are being incrementally built: also optimize computing resource usage



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Use cases: Muography

- Investigation of deep structure of volcanoes and faults
  - Thick objects penetrated by high-energy muons (100 TeV and beyond)
    - Large uncertainty on absolute muon flux – comparison of models needed
    - Affects density estimation
    - Rock type/magma/conduit identification

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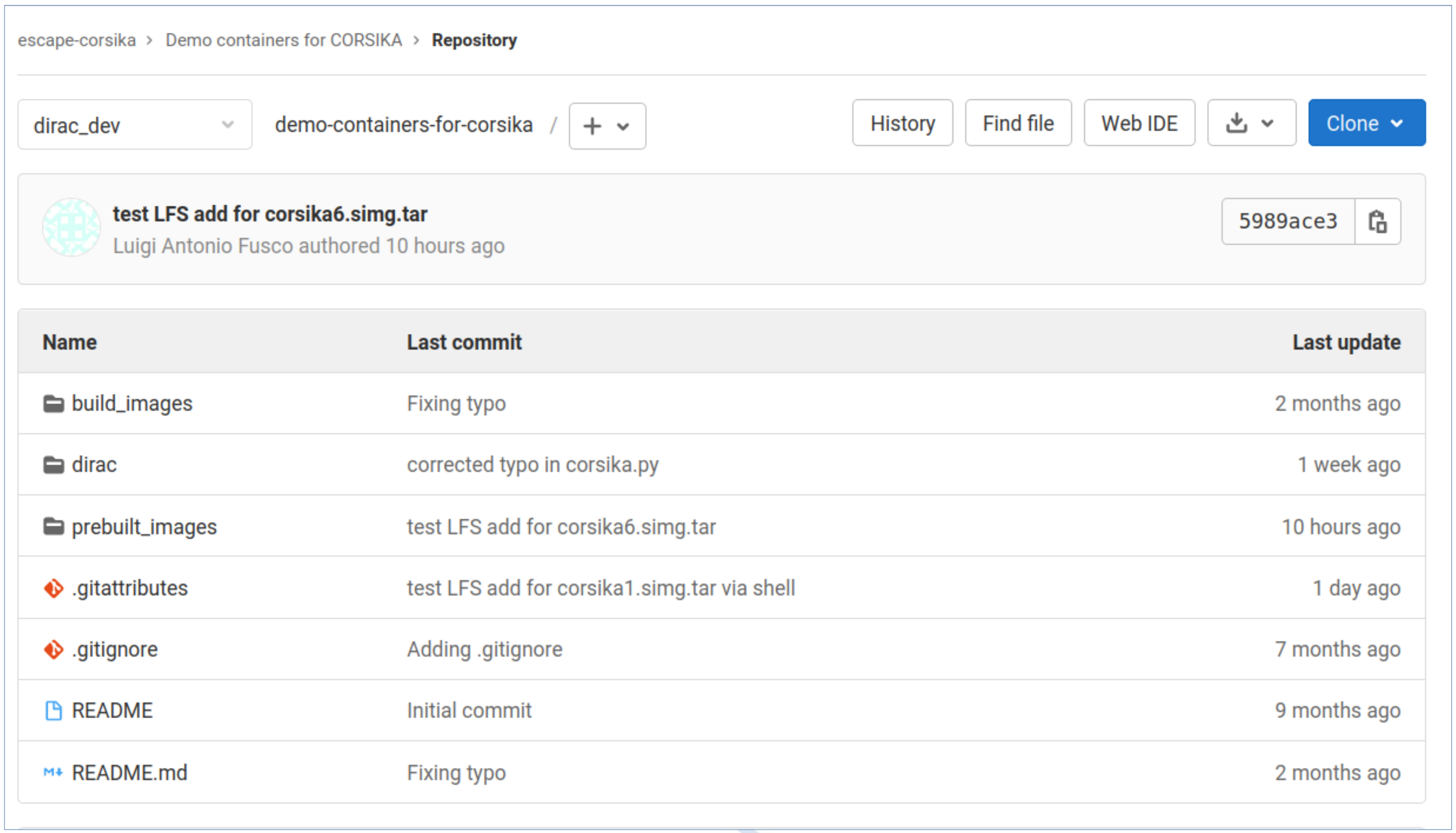
Development

- All source on gitlab.in2p3.fr
- https://gitlab.in2p3.fr/escape-corsika/demo-containers-for-corsika/-/tree/dirac_dev/



Name	Last commit	Last update
build_images	Fixing typo	2 months ago
dirac	corrected typo in corsika.py	1 week ago
prebuilt_images	test LFS add for corsika6.simg.tar	10 hours ago
.gitattributes	test LFS add for corsika1.simg.tar via shell	1 day ago
.gitignore	Adding .gitignore	7 months ago
README	Initial commit	9 months ago
README.md	Fixing typo	2 months ago

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Available containers

- ~20 pre-built containers
- WebGUI used for building Docker and Singularity images

escape-corsika › Demo containers for CORSIKA › **Repository**

dirac_dev | demo-containers-for-corsika / prebuilt_images / + | History | Find file | Web IDE | Clone

test LFS add for corsika6.simg.tar
Luigi Antonio Fusco authored 10 hours ago | 5989ace3

Name	Last commit	Last update
..		
build1.tar LFS	Testing LFS on *.tar	7 months ago
build10.tar LFS	Adding remining docker images	7 months ago
build11.tar LFS	Adding remining docker images	7 months ago
build12.tar LFS	Adding remining docker images	7 months ago
build13.tar LFS	Adding remining docker images	7 months ago
build14.tar LFS	Adding remining docker images	7 months ago
build15.tar LFS	Adding remining docker images	7 months ago
build16.tar LFS	Adding remining docker images	7 months ago
build17.tar LFS	Adding remining docker images	7 months ago

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Running containers on DIRAC

- Run the docker DIRAC client (diracgrid/client:egi) binding the cloned git repo
- Python job launcher

corsika.py $CONTAINER_ID $CORSIKA_RUN_INPUT

corsika.py -h returns the help, with the ID description

```
[root@4bf9adf8d6b2 dirac]# python corsika.py -h
usage: corsika.py -c <corsika_container> -i <corsika_inputs>
corsika containers are available with the following CORSIKA compilation options:

ContainerID: 1;   AO: [], DG: 1 - horizontal flat detector array , EHIM: 2 - EPOS LHC , LEHIM: 3 - URQMD 1.3cr

ContainerID: 2;   AO: [1a - Cherenkov version, 1 - Photons counted only in the step where emitted , 1 - Emission angle is wavelength independent ], DG: 1 - horizontal flat detector array , EHIM: 2 - EPOS
LHC , LEHIM: 3 - URQMD 1.3cr

ContainerID: 3;   AO: [1d - Auger Cherenkov longitudinal distribution], DG: 1 - horizontal flat detector array , EHIM: 2 - EPOS LHC , LEHIM: 3 - URQMD 1.3cr

ContainerID: 4;   AO: [], DG: 1 - horizontal flat detector array , EHIM: 1 - DPMJET-III (2017.1) with PHOJET 1.20.0, LEHIM: 3 - URQMD 1.3cr

ContainerID: 5;   AO: [4a - NUPRIM primary neutrino version with HERWIG], DG: 1 - horizontal flat detector array , EHIM: 2 - EPOS LHC , LEHIM: 3 - URQMD 1.3cr

ContainerID: 6;   AO: [], DG: 1 - horizontal flat detector array , EHIM: 3 - NEXUS 3.97, LEHIM: 3 - URQMD 1.3cr

ContainerID: 7;   AO: [7b - UPWARD particles version], DG: 1 - horizontal flat detector array , EHIM: 2 - EPOS LHC , LEHIM: 3 - URQMD 1.3cr

ContainerID: 10;   AO: [7a - CURVED atmosphere version], DG: 1 - horizontal flat detector array , EHIM: 2 - EPOS LHC , LEHIM: 3 - URQMD 1.3cr

ContainerID: 11;   AO: [1a - Cherenkov version, 3 - No Cherenkov light distribution at all, 1 - Emission angle is wavelength independent ], DG: 1 - horizontal flat detector array , EHIM: 2 - EPOS LHC , LE
HIM: 3 - URQMD 1.3cr

ContainerID: 12;   AO: [1e - TRAJECTory version to follow motion of source on the sky], DG: 1 - horizontal flat detector array , EHIM: 2 - EPOS LHC , LEHIM: 3 - URQMD 1.3cr
```


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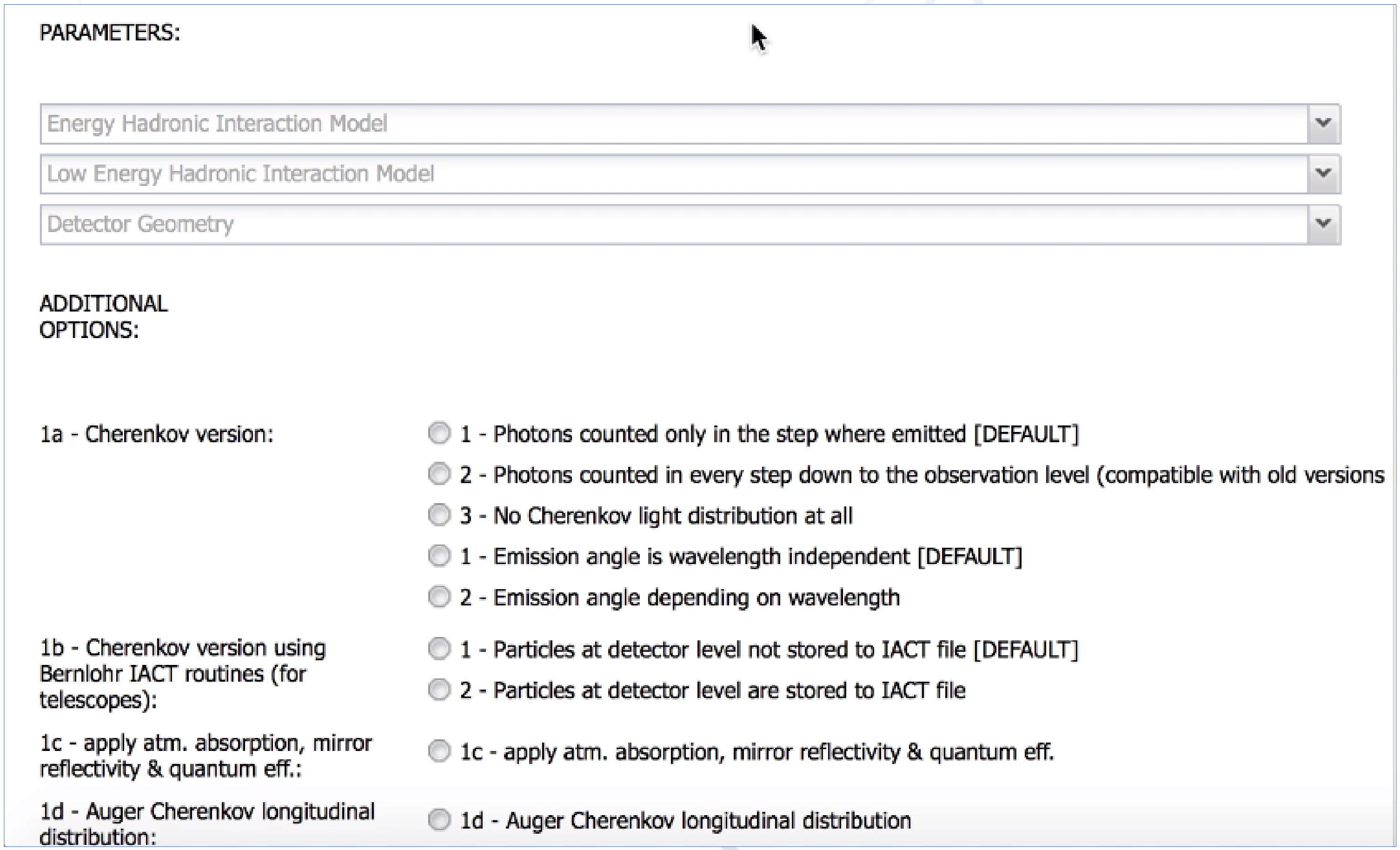
Building containers

- Web GUI for container generation



PARAMETERS:

Energy Hadronic Interaction Model

Low Energy Hadronic Interaction Model

Detector Geometry

ADDITIONAL OPTIONS:

1a - Cherenkov version:	1 - Photons counted only in the step where emitted [DEFAULT]
	2 - Photons counted in every step down to the observation level (compatible with old versions
	3 - No Cherenkov light distribution at all
	1 - Emission angle is wavelength independent [DEFAULT]
	2 - Emission angle depending on wavelength
1b - Cherenkov version using Bernlohr IACT routines (for telescopes):	1 - Particles at detector level not stored to IACT file [DEFAULT]
	2 - Particles at detector level are stored to IACT file
1c - apply atm. absorption, mirror reflectivity & quantum eff.:	1c - apply atm. absorption, mirror reflectivity & quantum eff.
1d - Auger Cherenkov longitudinal distribution:	1d - Auger Cherenkov longitudinal distribution

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Building containers

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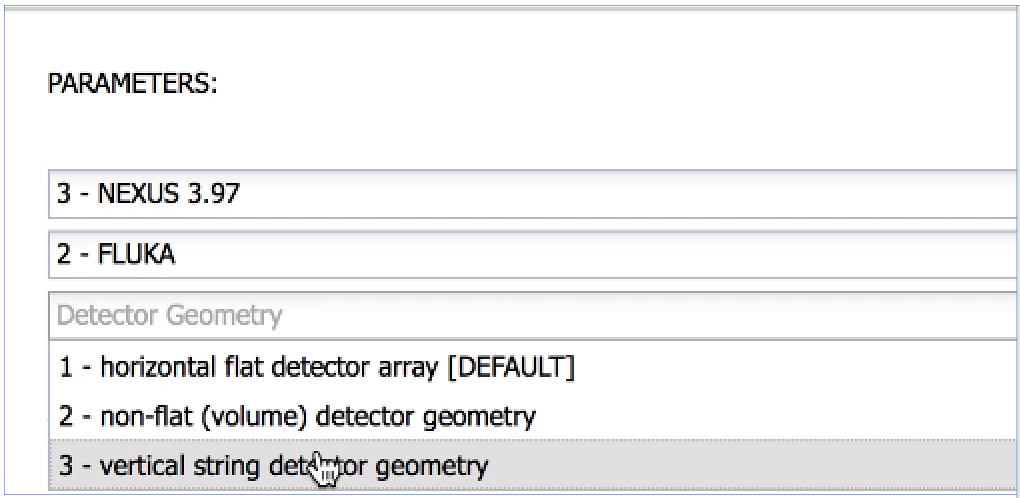

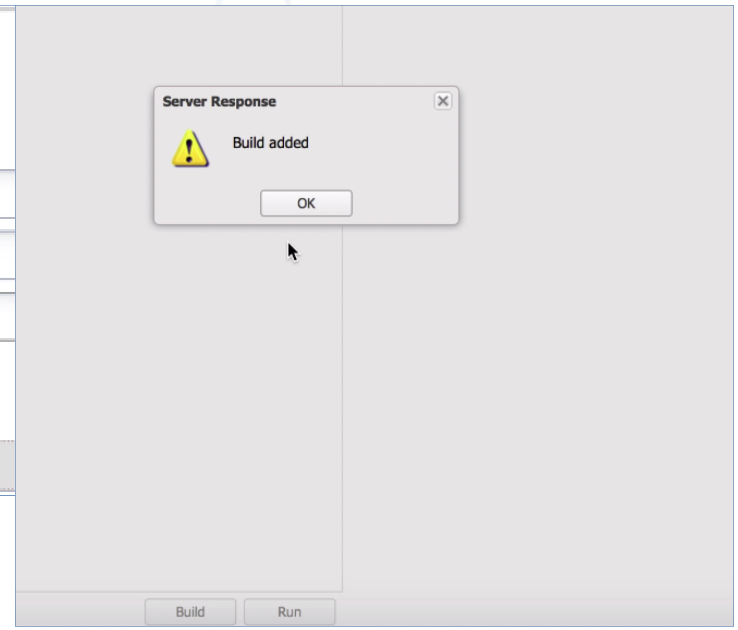

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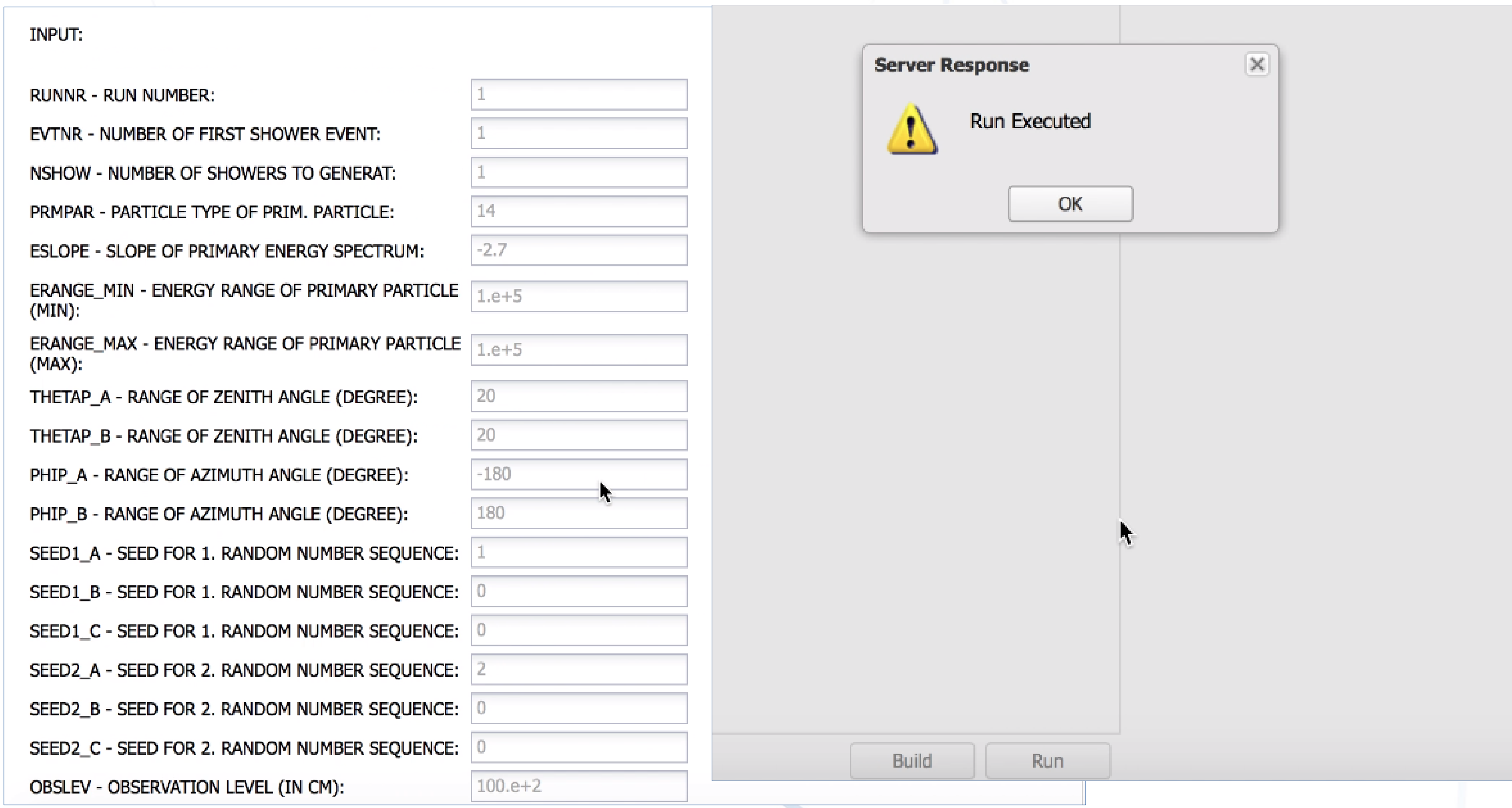
Running containers

- Web GUI to manage ConCORDIA jobs



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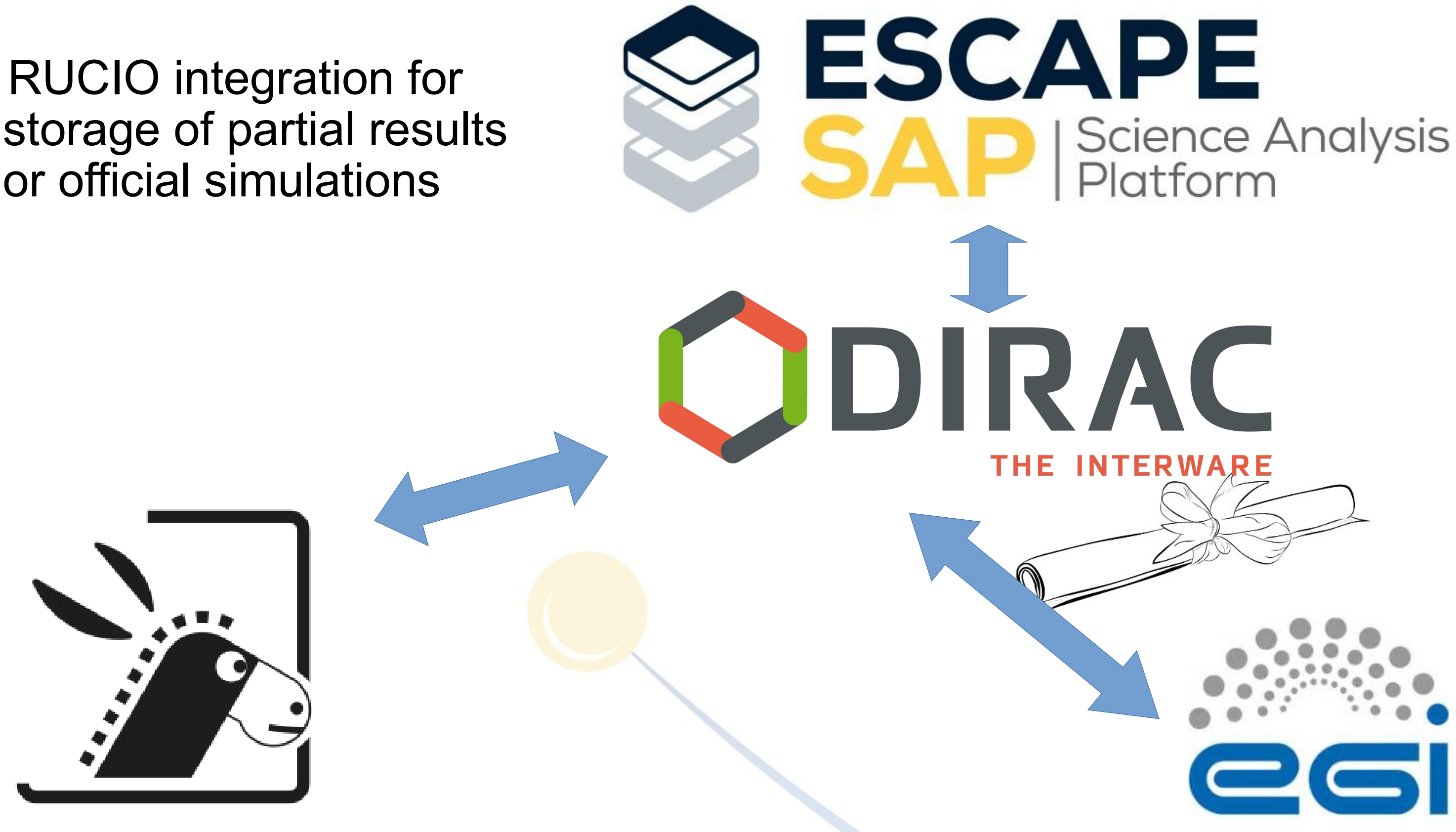
ConCORDIA on ESAP

- DIRAC is an external service linked to ESAP
- Authentication on VOs via EGI certificates
- RUCIO integration for storage of partial results or official simulations



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Container distribution

- Containers will be published on Zenodo
- Available via ESAP
- Each container comes as:
  - Highlights of physics output documented through small productions
  - Computing resource usage estimates
  - Storage resource usage estimates (for output)
- Documentation to assist users in picking best containers for their applications:
  - Hadronic interaction data models
  - Cherenkov radiation
  - Options (mostly to enhance speed)

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Status and outlook

- Stand-alone web GUI for container creation √
- Scripting access for DIRAC √
- Web GUI access for DIRAC #
- Container specifications (CTA, KM3NeT) √
- Container data quality and performance assessment #
- ESAP integration #
- RUCIO integration #
- Workflow documentation via JSON files #

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