HEP@home : A Volunteer Computing Project to Run Fast Simulation with Delphes for CEPC

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1 Introduction

Delphes is a C++ framework to perform a fast multipurpose detector response simulation. The Circular Electron Positron Collider (CEPC) experiment runs fast simulation with a modified Delphes based on specific scientific objectives. To get more computing resources for CEPC and make CEPC better known by public, a Volunteer Computing project based on BOINC, HEP@home, is developed to run Delphes as its first application.
The architecture of the HEP@home project is shown in Figure 1. Five parts are developed including CEPC Delphes App, work generator, validator, assimilator and project web site.

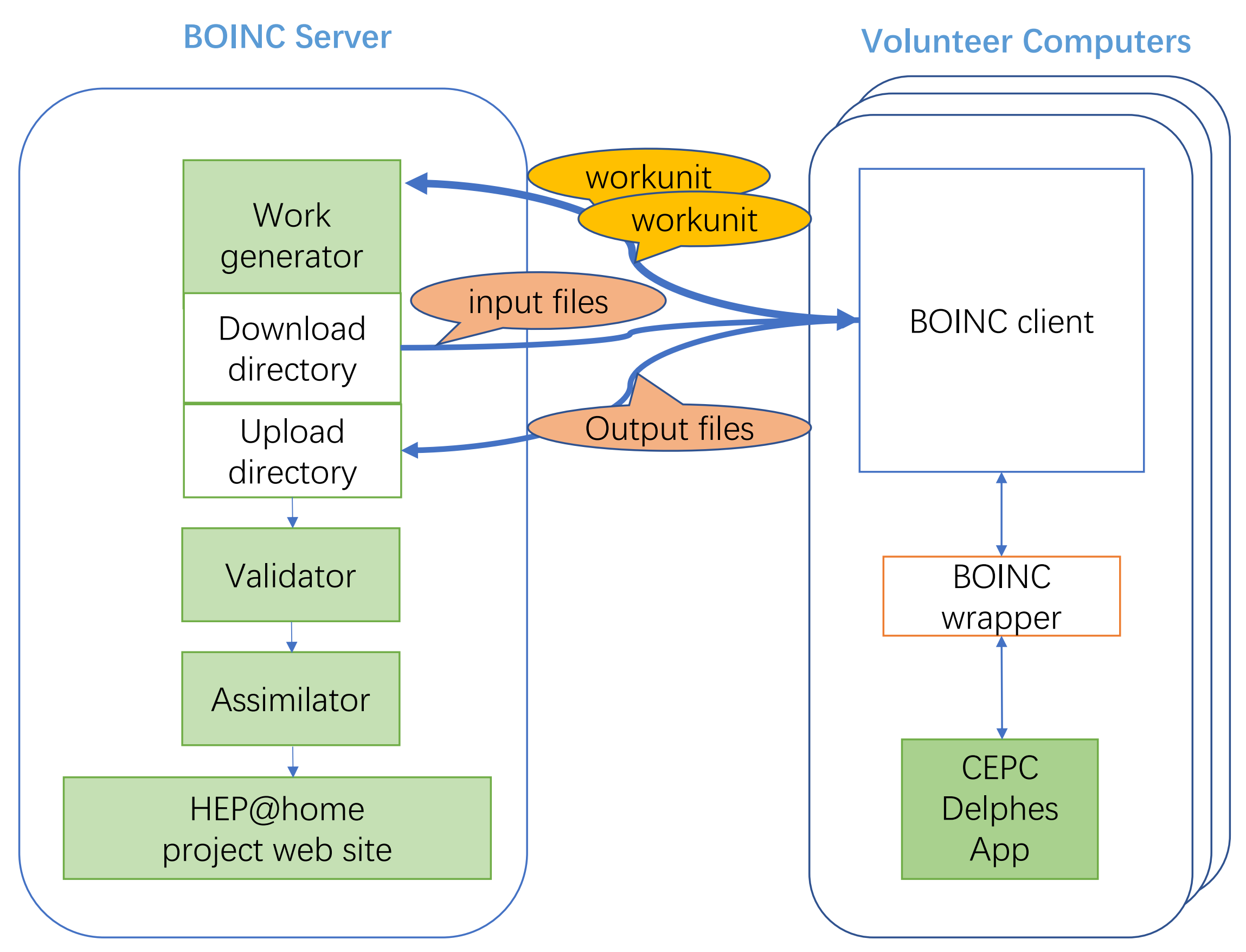
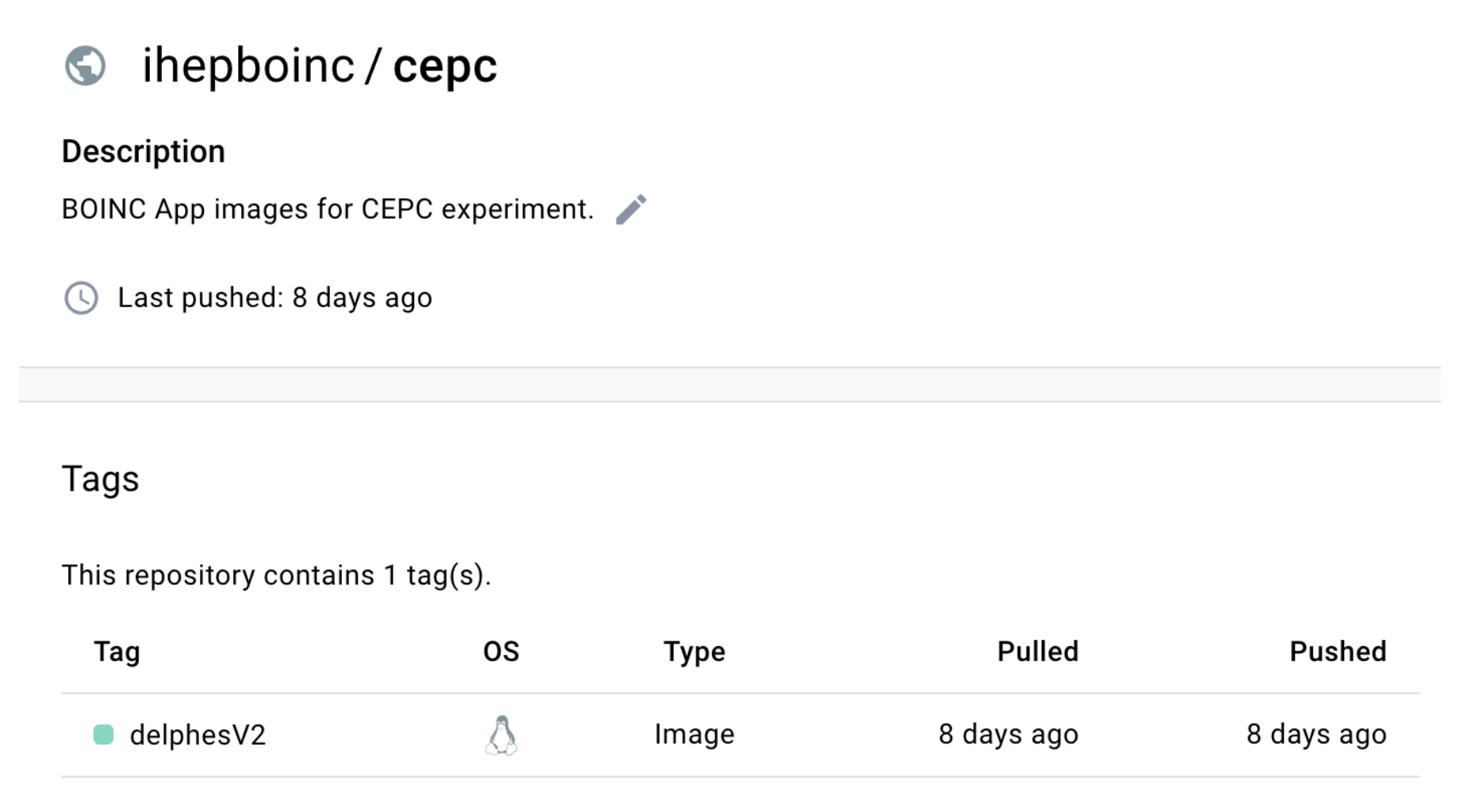


Figure 1: Architecture of the HEP@home project.

2 CEPC Delphes App

Delphes is a High Throughput Computing (HTC) application with small input and output files. Besides, to compile and run Delphes, only ROOT software is dependent, which makes it appropriate to run as a Volunteer Computing application.
To run CEPC Delphes on Windows, a customized docker image is composed. This image contains all dependent software to run Delphes. Besides, to get high availability, this image is uploaded to three docker registries. Figure 2 shows the image uploaded to dockerhub.



ihepboinc / cepc

Description

BOINC App images for CEPC experiment.

Last pushed: 8 days ago

Tags

This repository contains 1 tag(s).

Tag	OS	Type	Pulled	Pushed
delphesV2		Image	8 days ago	8 days ago

Figure 2: Dockerhub image of the CEPC Delphes App to run on volunteer computers.

3 Work Generator

The work generator is developed to submit workunits(jobs) in batches. To make submission in order, a MariaDB database delphes_task_db is designed and adopted. All the metadata of stdhep input files are organized into a three-level hierarchy consisted with tasks, subtasks and input files.
Besides, to make sure the server load is under control, submitted workunits will be hold and saved into a buffer if the server load is heavier than threshold. When the load dropped back to a normal level, buffered workunits will be resubmitted. Figure 3 shows the components of the work generator.

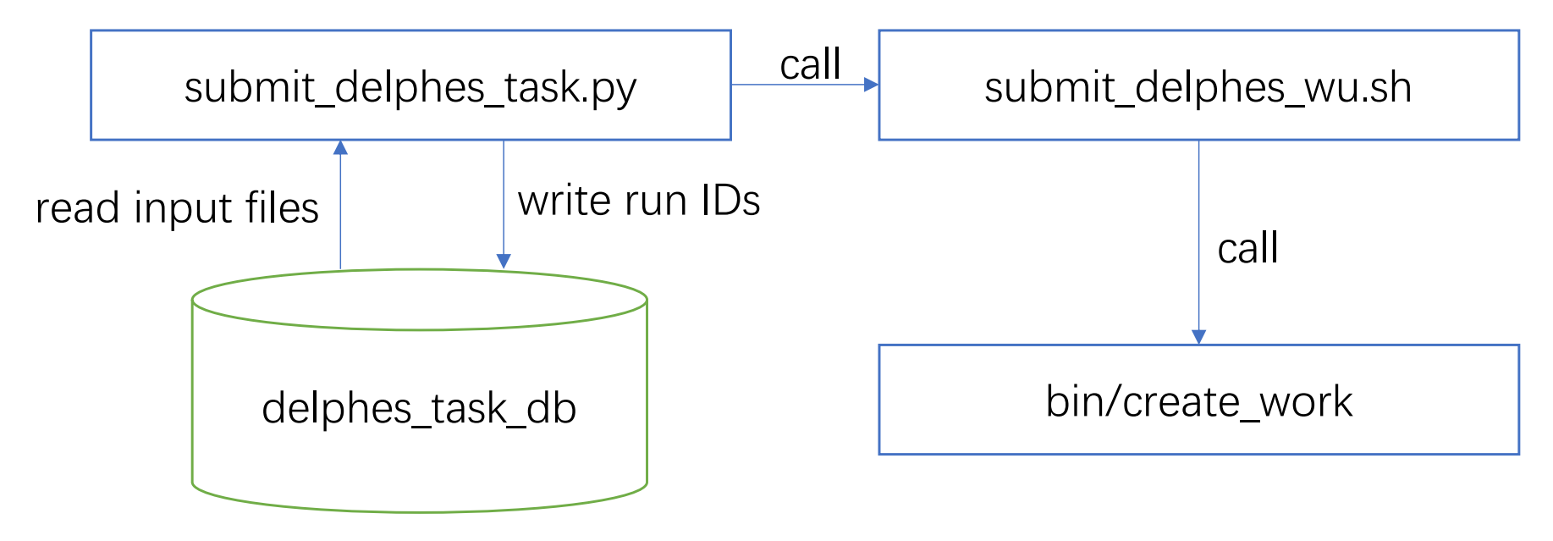


Figure 3: Components of the work generator.

4 Validator

Each output root file generated by Delphes on volunteer computers will be uploaded back to the server. When the output files are uploaded, the validator will be called to double check based on the requirements of application, and the volunteers will get a number of credits if output files are valid.
Different applications have specific validation metrics, in our case, the validation metrics are number of events, number of particles, momentum resolution and energy resolution. Figure 4 show the components of the validator for Delphes application.

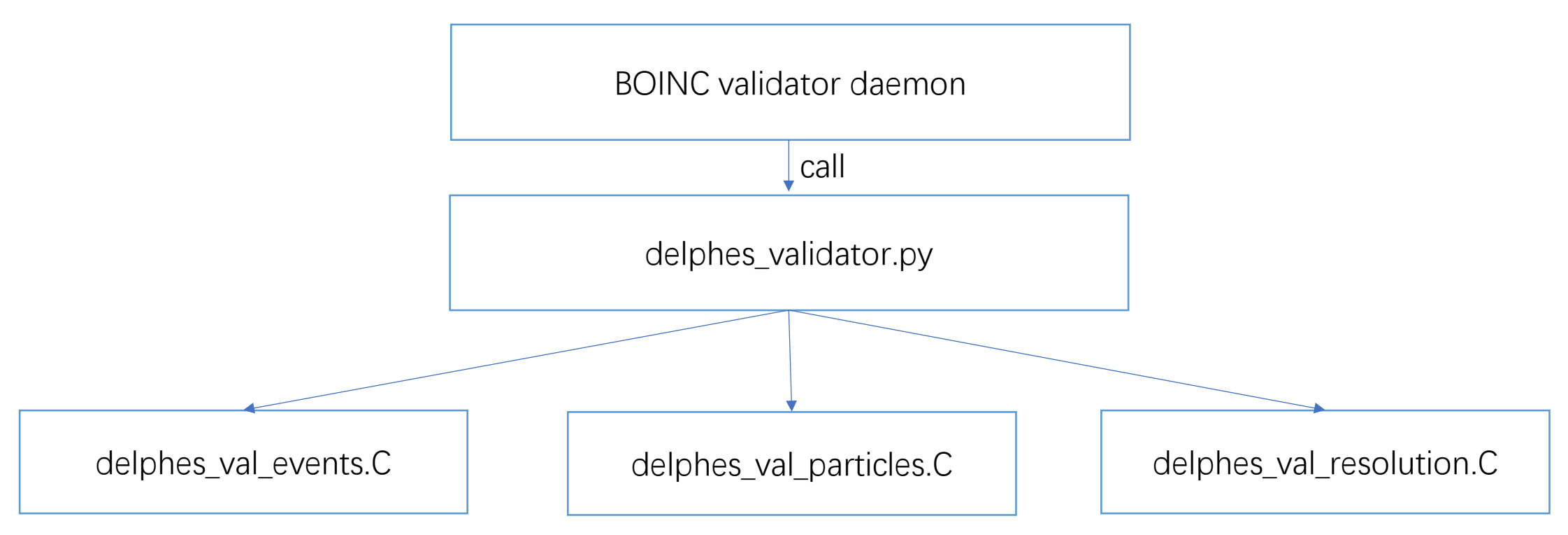


Figure 4: Components of the validator.

5 Assimilator

Valid output files will be handled by the assimilator. The assimilator for the Delphes application will save root files and image files in Lustre file system and a database named hep_assimi_db. The root files saved in the Lustre File System can be accessed by physicists for later use, and meta data of these foot files are saved in hep_assimi_db. Meanwhile, image files saved in hep_assimi_db will be displayed on the project web site. Figure 5 shows the components of the assimilator.

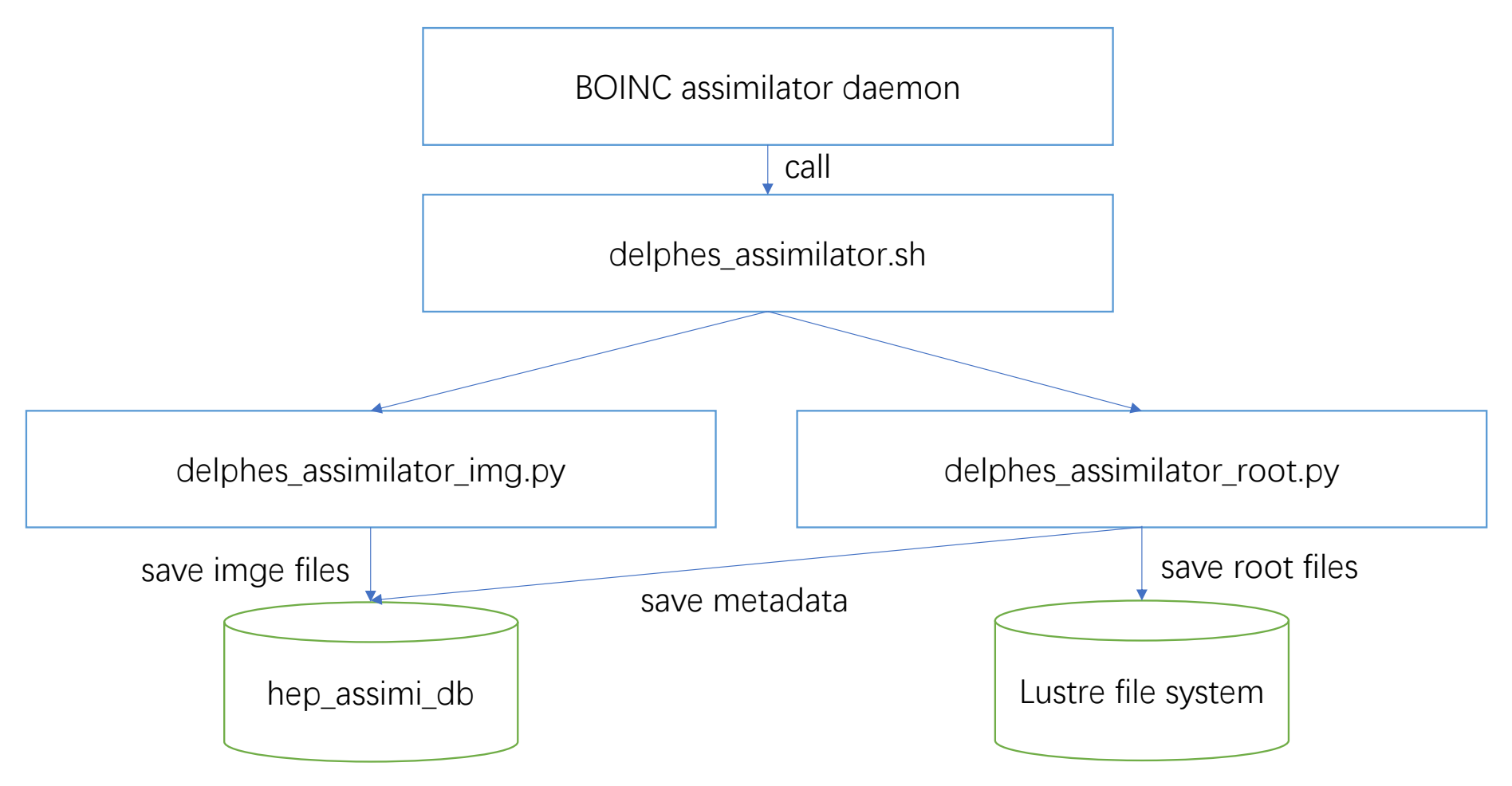
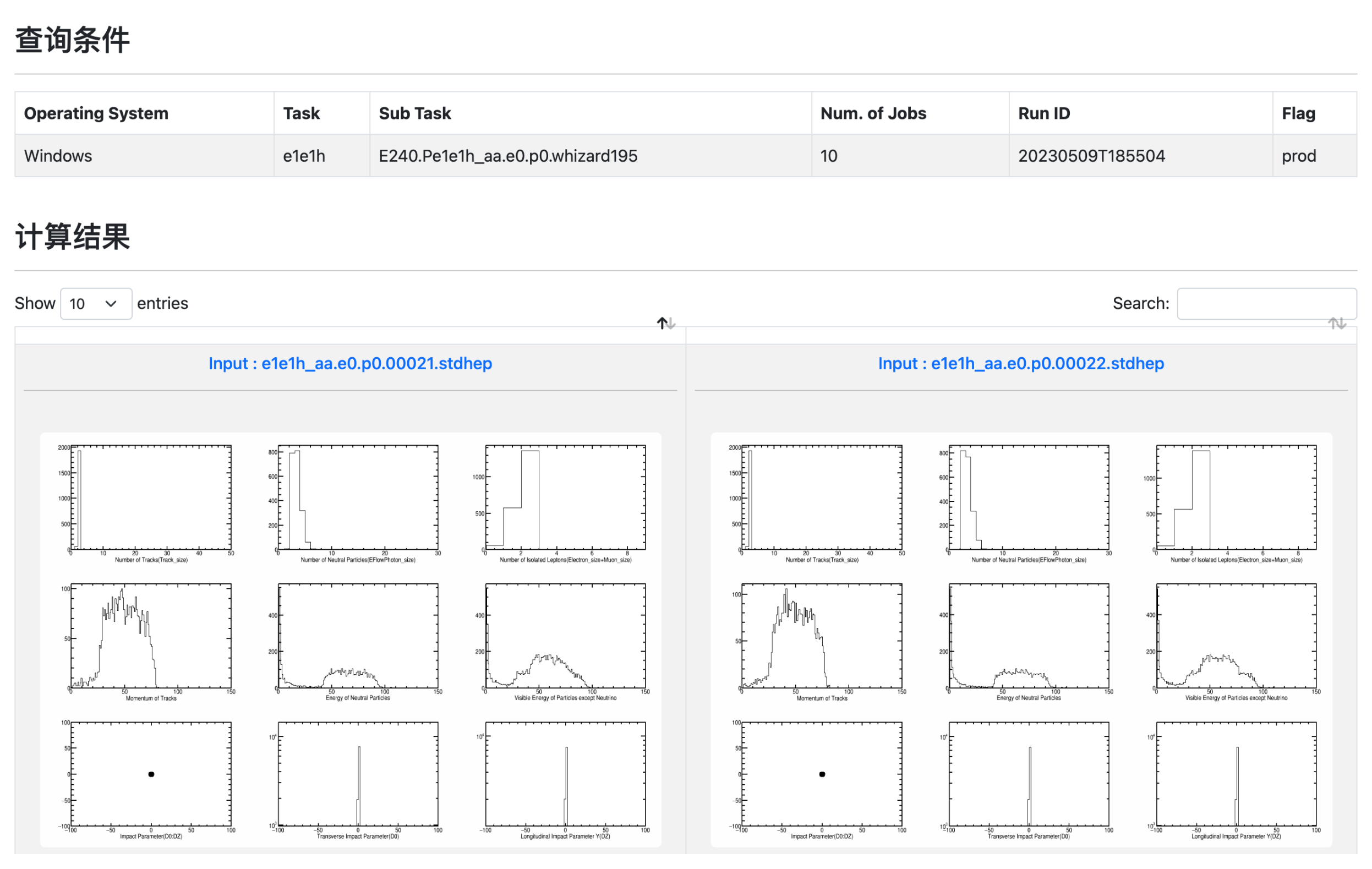


Figure 5: Components of the assimilator.

6 Join HEP@home Project

As we mentioned earlier, image files generated by the assimilator will be displayed on the project web site as shown in Figure 6(a). Figure 6(b) shows the procedure of running Delphes on a volunteer computer. Because the requirements of CEPC computing resources are quite large, we expect more and more volunteers and computers will join us. Scan the QR code and visit HEP@home website, You are warmly welcomed to join us by scanning the QR code.



查询条件

Operating System	Task	Sub Task	Num. of Jobs	Run ID	Flag
Windows	e1e1h	E240.Pe1e1h_aa.e0.p0.whizard195	10	20230509T185504	prod

计算结果

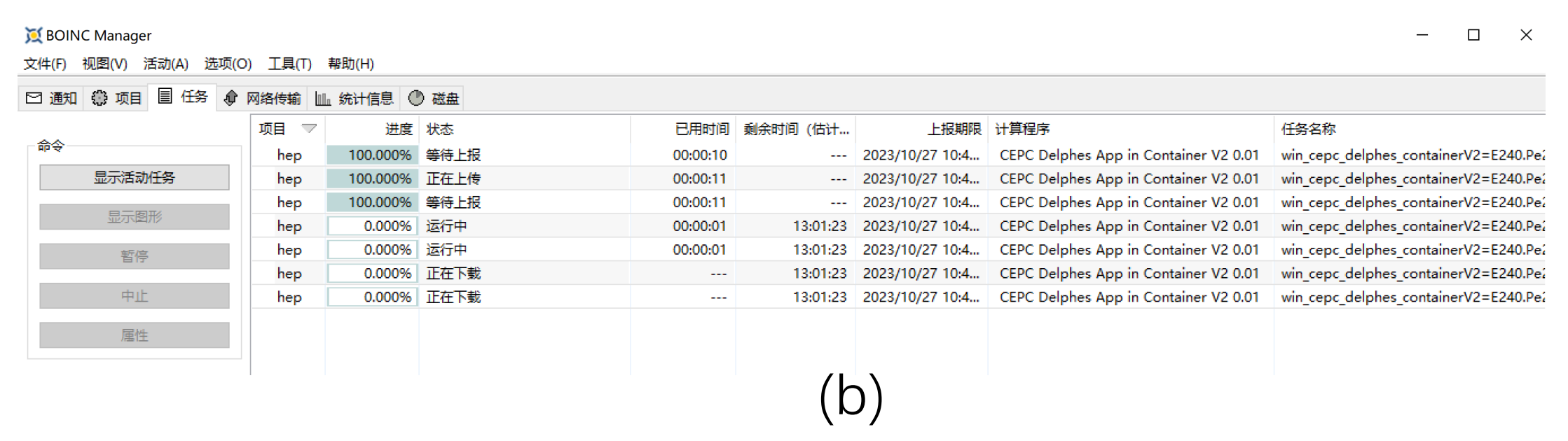
Show 10 entries Search:

Input : e1e1h_aa.e0.p0.00021.stdhep

Input : e1e1h_aa.e0.p0.00022.stdhep

Number of Tracks(Track_size)
Number of Neutral Particles(EFlowPhoton_size)
Number of Isolated Leptons(Electron_size+Muon_size)
Momentum of Tracks
Energy of Neutral Particles
Visible Energy of Particles except Neutrino

(a)



(b)

Join HEP@home
https://ihepboinc.ihep.ac.cn/hep

(c)

Figure 6: (a)Output images of Delphes application. (b)Delphes workunits run on a volunteer computers. (c)QR code of HEP@home project.