

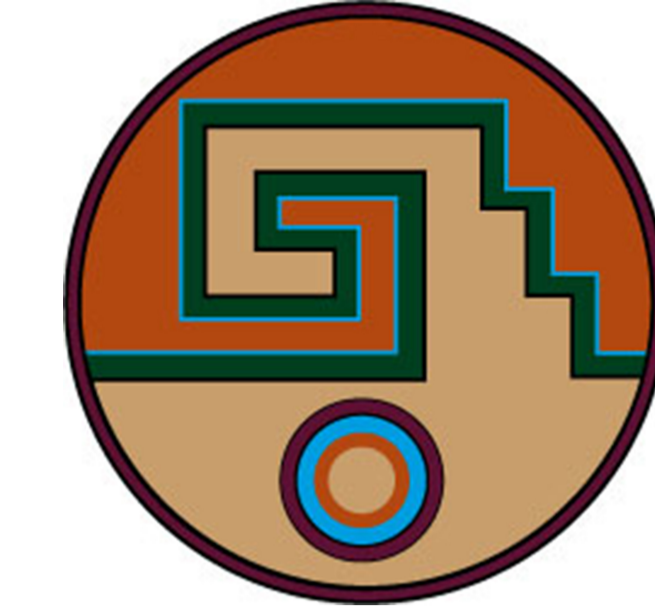


Deferred Optical Photon Simulation for the JUNO experiment

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1 Introduction

- The JUNO [1, 2] experiment under construction in southern China, will have a rich physics programme:
 - Neutrino mass ordering determination and a precise measurement of 3 oscillation parameters.
 - Reactor ν , supernova ν , geo- ν , atmospheric ν , solar ν etc.
- Energy resolution: 3% at 1 MeV

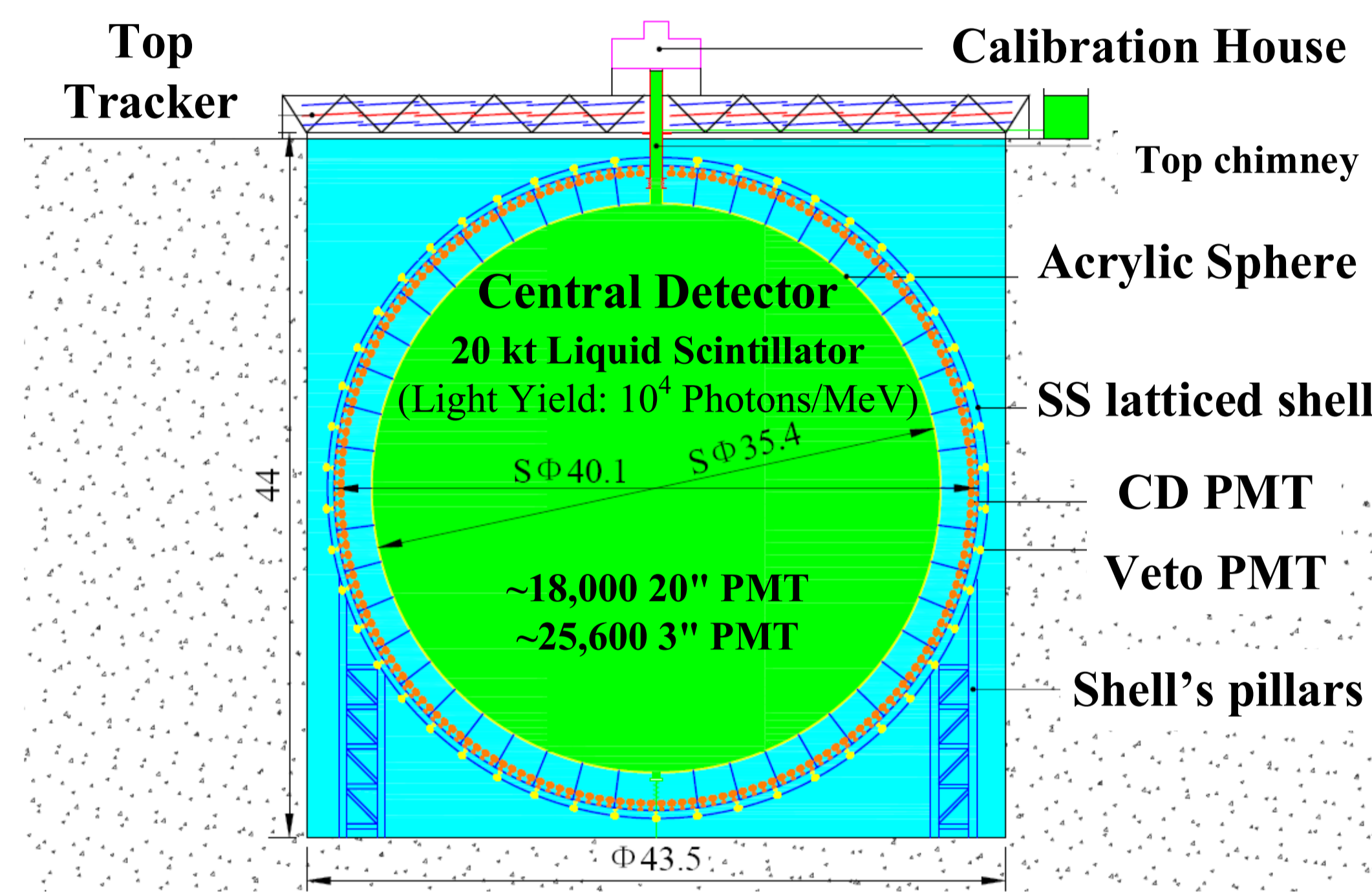


Figure 1: Schematic view of the JUNO detector

2 Motivation

- Monte Carlo simulation is a crucial tool for developing an understanding of the detector performance.
- Need a unified interface to integrate existing methods: Opticks [3], Voxel method [4], machine learning etc.
- Need optimization of the OP simulation. The challenge is the simulation of large samples of backgrounds with OP. Not all the events need the OP simulation. For example, most of the external radioactivity background could not reach the LS, however the photons are still simulated.

3 Designs and Implementation

3.1 A Unified Design for Deferred OP Simulation

The key idea is to simulate events initially without OP, only performing the OP simulation when user-specified criteria are met.

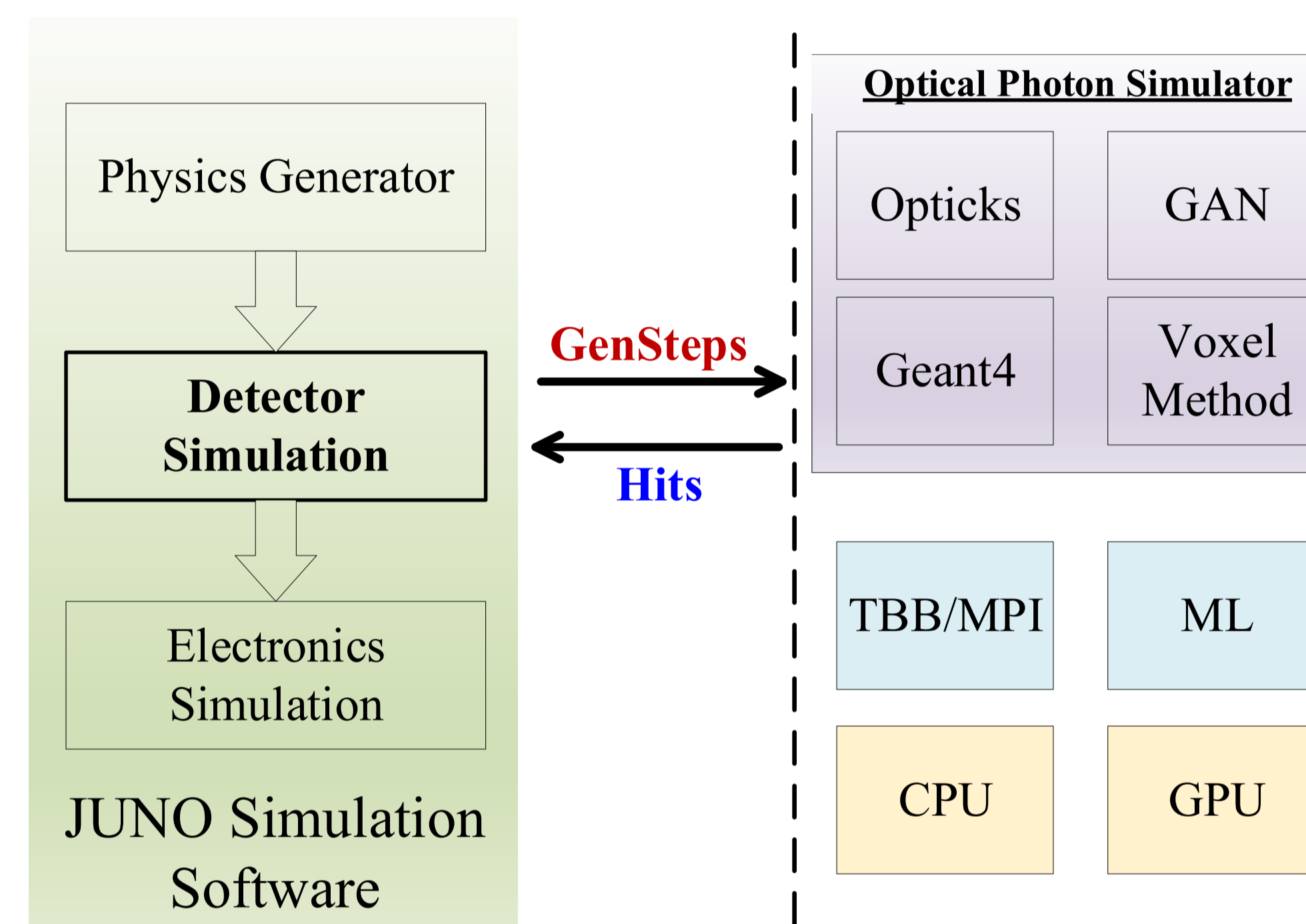


Figure 2: The unified interface for different OP simulators

3.2 The OP Simulator Implemented based on Geant4

A deferred optical photon simulation workflow is implemented on a customized Geant4 kernel.

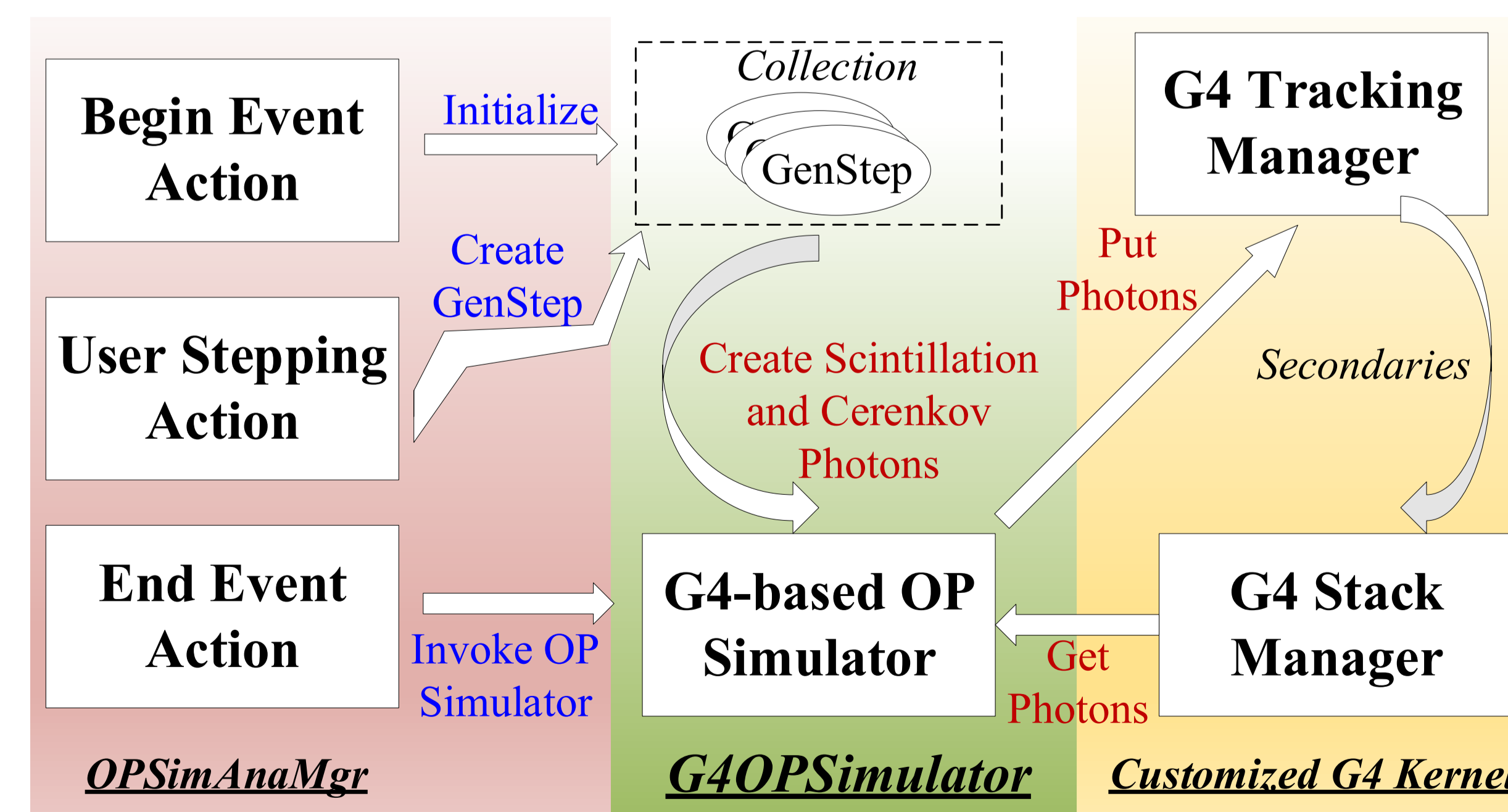


Figure 3: Geant4 based Optical Photon simulator

4 Results

By reducing the simulated events with OP simulation, the method could improve the speed. As shown in Fig 4, the performance is linear with number of events with OP. The speed-up factor, which is defined as $T(\text{default}) / T(\text{deferred, ratio})$, is very close to the ideal factor.

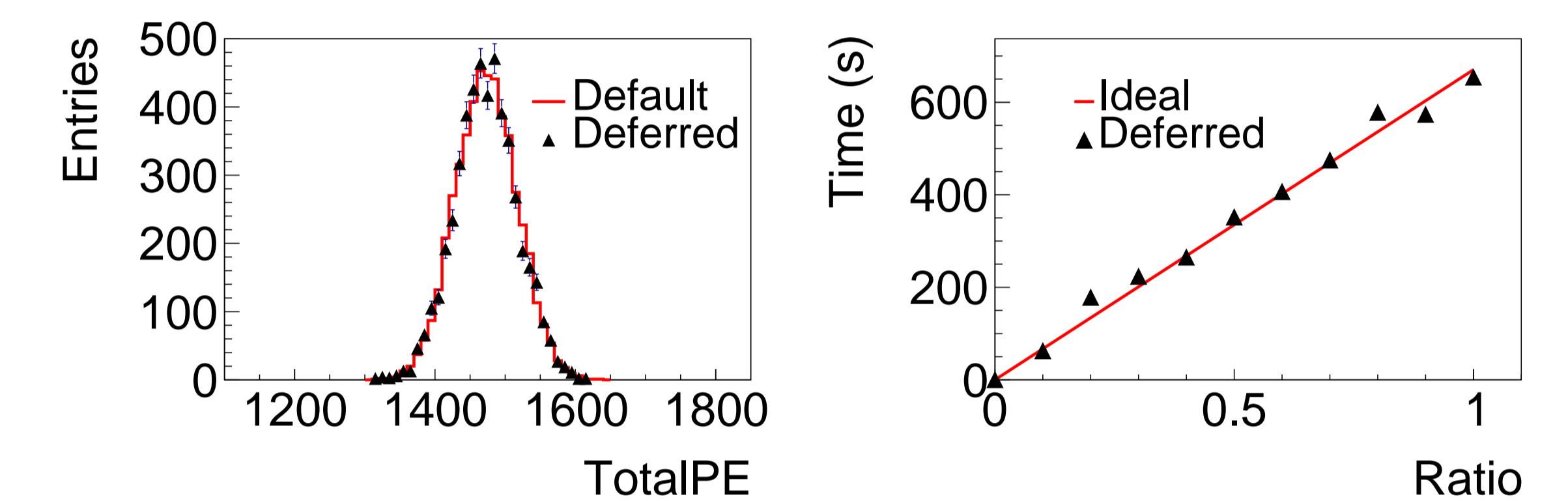


Figure 4: The performance of the OP simulator. The left figure shows the identical result using deferred and default simulation. The right figure shows the simulation time vs the number of simulated events with OP. The ratio is defined as $N(\text{events with OP}) / N(\text{all events})$. The red ideal line is based on the ratio $\times T(\text{default})$, while the ideal speed-up is $1/\text{ratio}$.

5 Conclusions

A unified interface and a Geant4 based OP simulator is implemented to defer the OP simulation. By applying the deferred simulation to the rare events, the simulation time could be reduced.

Acknowledgements

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References

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