Fast parameterised simulation option in LHCb simulation framework

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On behalf of the LHCb Collaboration

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Who am I?

- Benedetto Gianluca Siddi
- Started my PhD in Ferrara in 2015 working on Lepton Flavour Universality Tests
  - Topic of my PhD thesis
  - Two articles (PRD and PRL) came out from the analysis
- In the meantime started to work on the implementation of a Parametrized Fast Simulation option to be integrated in the LHCb Simulation framework
- PhD thesis defended in February 2018
- INFN Fellow in scientific computing in Ferrara from January 2018
  - Continuing the work on FastSimulation and future upgrades for LHCb and simulation part of TimeSpot project

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Editors' Suggestion

Test of lepton flavor universality by the measurement of the $B^0 \to D^{*-}\tau^+\nu_\tau$ branching fraction using three-prong τ decays

R. Aaij *et al.**
(LHCb Collaboration)

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The ratio of branching fractions $\mathcal{R}(D^{*-}) \equiv \mathcal{B}(B^0 \to D^{*-}\tau^+\nu_\tau)/\mathcal{B}(B^0 \to D^{*-}\mu^+\nu_\mu)$ is measured using a data sample of proton-proton collisions collected with the LHCb detector at center-of-mass energies of 7 and 8 TeV, corresponding to an integrated luminosity of 3 fb^{-1}. The τ lepton is reconstructed with three charged pions in the final state. A novel method is used that exploits the different vertex topologies of signal and backgrounds to isolate samples of semitauonic decays of b hadrons with high purity. Using the $B^0 \to D^{*-}\pi^+\pi^-\pi^+$ decay as the normalization channel, the ratio $\mathcal{B}(B^0 \to D^{*-}\tau^+\nu_\tau)/\mathcal{B}(B^0 \to D^{*-}\pi^+\pi^-\pi^+)$ is measured to be $1.97 \pm 0.13 \pm 0.18$, where the first uncertainty is statistical and the second systematic. An average of branching fraction measurements for the normalization channel is used to derive $\mathcal{B}(B^0 \to D^{*-}\tau^+\nu_\tau) = (1.42 \pm 0.094 \pm 0.129 \pm 0.054)\%$, where the third uncertainty is due to the limited knowledge of $\mathcal{B}(B^0 \to D^{*-}\pi^+\pi^-\pi^+)$. A test of lepton flavor universality is performed using the well-measured branching fraction $\mathcal{B}(B^0 \to D^{*-}\mu^+\nu_\mu)$ to compute $\mathcal{R}(D^{*-}) = 0.291 \pm 0.019 \pm 0.026 \pm 0.013$, where the third uncertainty originates from the uncertainties on $\mathcal{B}(B^0 \to D^{*-}\pi^+\pi^-\pi^+)$ and $\mathcal{B}(B^0 \to D^{*-}\mu^+\nu_\mu)$. This mea… measurements.

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Editors' Suggestion

Measurement of the Ratio of the $B^0 \to D^{*-}\tau^+\nu_\tau$ and $B^0 \to D^{*-}\mu^+\nu_\mu$ Branching Fractions Using Three-Prong τ-Lepton Decays

R. Aaij *et al.**
(LHCb Collaboration)

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The ratio of branching fractions $\mathcal{R}(D^{*-}) \equiv \mathcal{B}(B^0 \to D^{*-}\tau^+\nu_\tau)/\mathcal{B}(B^0 \to D^{*-}\mu^+\nu_\mu)$ is measured using a data sample of proton-proton collisions collected with the LHCb detector at center-of-mass energies of 7 and 8 TeV, corresponding to an integrated luminosity of 3 fb^{-1}. For the first time, $\mathcal{R}(D^{*-})$ is determined using the τ-lepton decays with three charged pions in the final state. The $B^0 \to D^{*-}\tau^+\nu_\tau$ yield is normalized to that of the $B^0 \to D^{*-}\pi^+\pi^-\pi^+$ mode, providing a measurement of $\mathcal{B}(B^0 \to D^{*-}\tau^+\nu_\tau)/\mathcal{B}(B^0 \to D^{*-}\pi^+\pi^-\pi^+) = 1.97 \pm 0.13 \pm 0.18$, where the first uncertainty is statistical and the second systematic. The value of $\mathcal{B}(B^0 \to D^{*-}\tau^+\nu_\tau) = (1.42 \pm 0.094 \pm 0.129 \pm 0.054)\%$ is obtained, where the third uncertainty is due to the limited knowledge of the branching fraction of the normalization mode. Using the well-measured branching fraction of the $B^0 \to D^{*-}\mu^+\nu_\mu$ decay, a value of $\mathcal{R}(D^{*-}) = 0.291 \pm 0.019 \pm 0.026 \pm 0.013$ is established, where the third uncertainty is due to the limited knowledge of the branching fractions of the normalization and $B^0 \to D^{*-}\mu^+\nu_\mu$ modes. This measurement is in agreement with the standard model prediction and with previous results.

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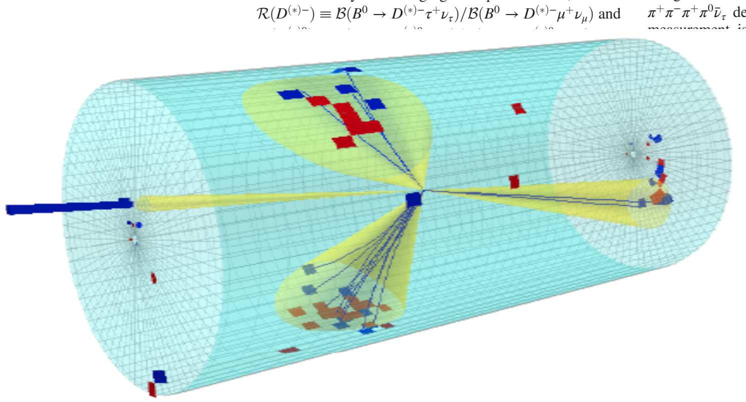
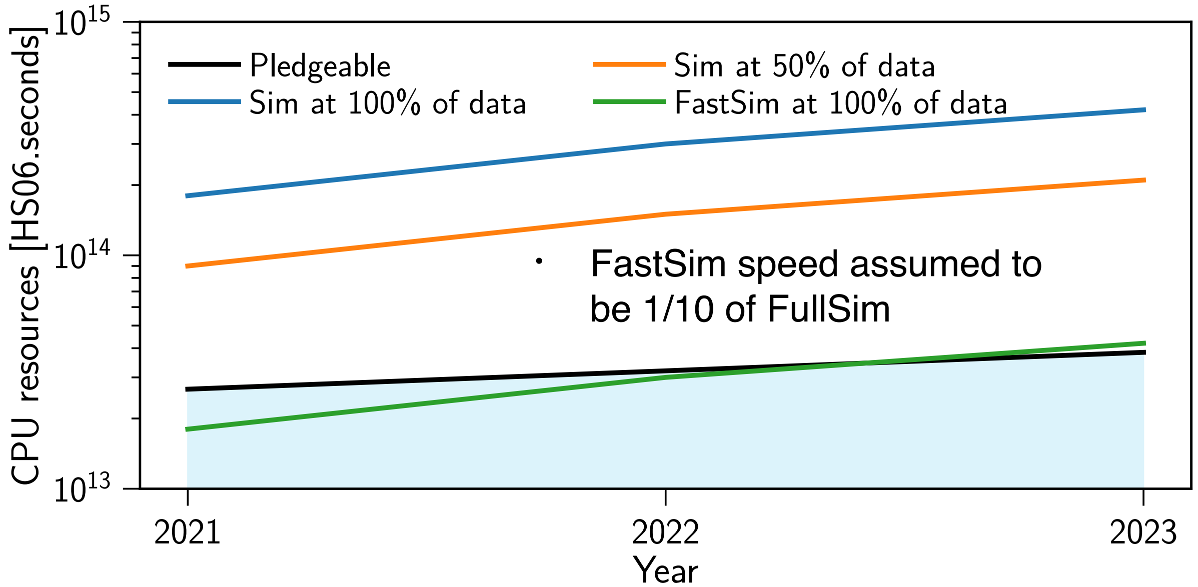


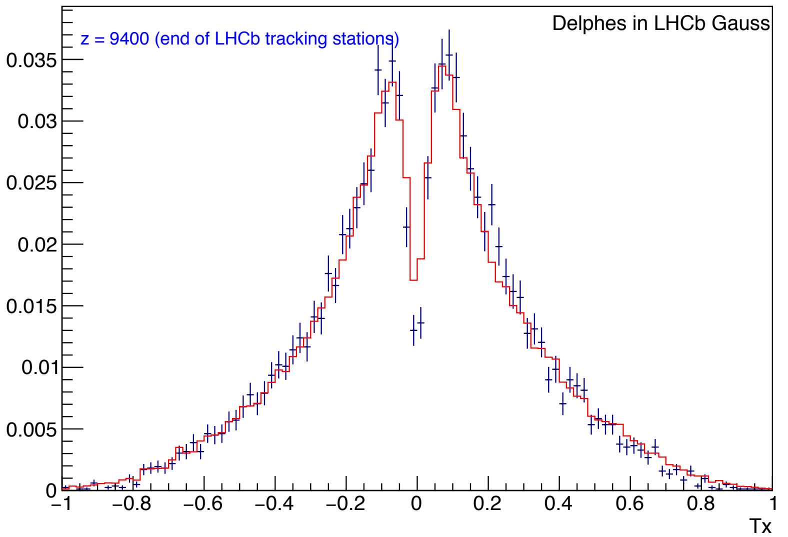
FastMC: Integration of Delphes in LHCb simulation framework

- The role of Monte Carlo simulation in high energy physics experiment is to mimic the behaviour of a detector to understand experimental conditions and performance

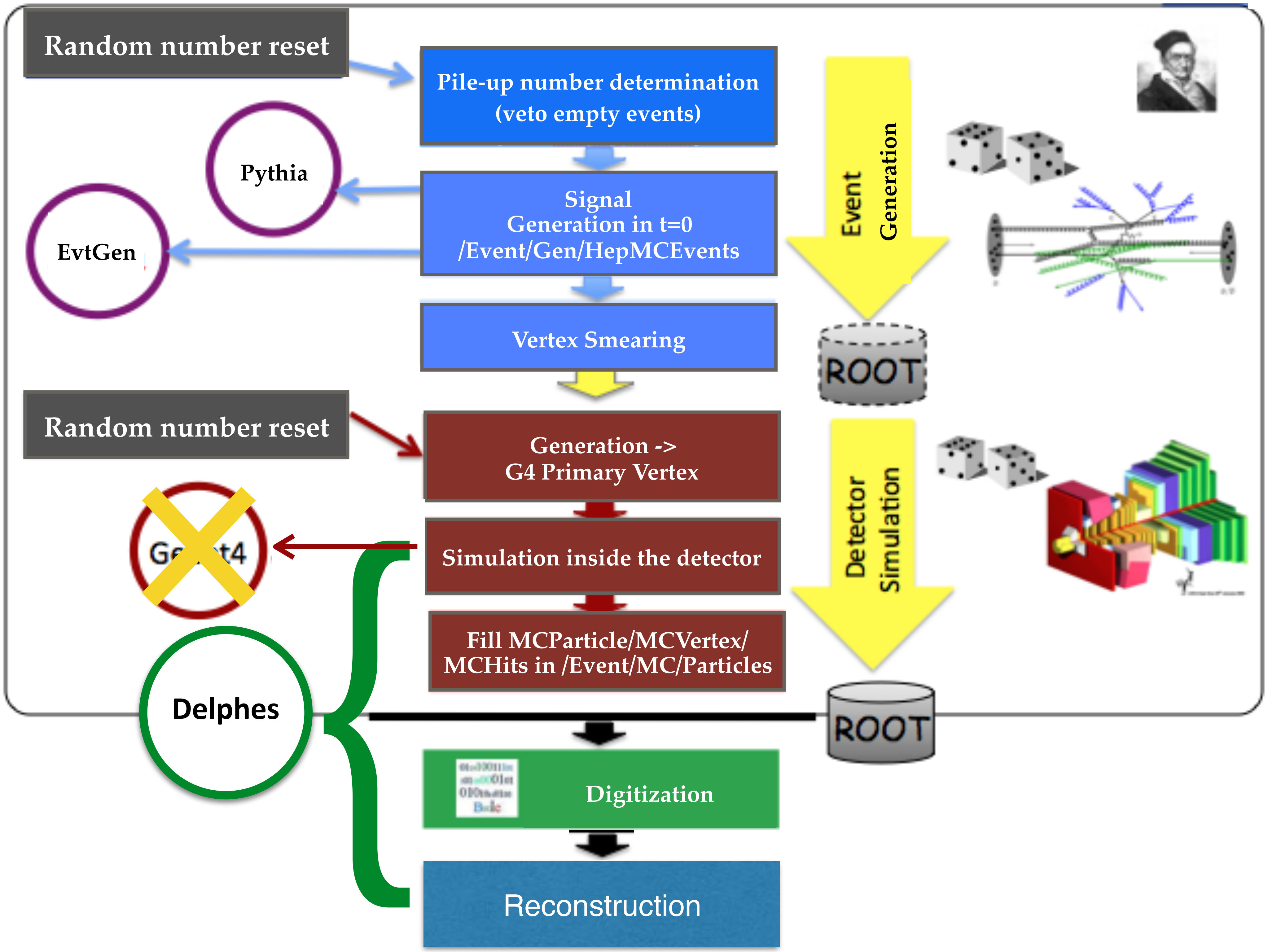
- Systematics uncertainties in most of the analysis are dominated by the MC
- Large MC samples → large resources
- New simulation options needs to be investigated



- Requirements for a FastMC:
  - Two orders of magnitude faster than GEANT4
  - Less CPU consuming
  - Reconstructed particle information in order to use the standard LHCb tools for analysis
  - As close as possible to the full simulation

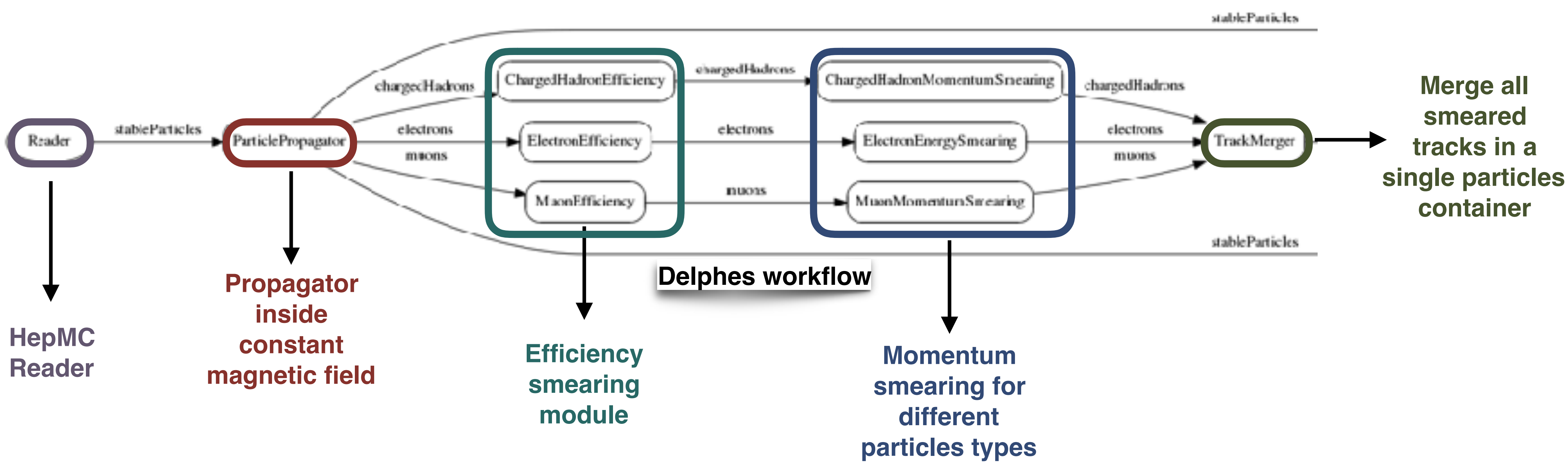


Fast simulation with Delphes in LHCb



Delphes

- Delphes + modifications for LHCb, has been integrated in LHCb simulation framework Gauss.
  - It takes in input particles generated from the generator part of Gauss,
  - It writes as output objects in the format necessary for LHCb analysis framework.
- No lower level reconstructed objects!



- Working on implementing relevant quantities of reconstructed tracks, e.g., covariance matrices, fit χ^2, ghost probabilities
- Work to be done :
  - Particle Identification probabilities, calorimeter response for charged and neutral particles.
  - Finalize the output of the objects filled with the information needed to be used in the LHCb analysis framework in order to perform physics analyses
  - Review the code in order to make it thread safe and multithreading to be used in the new LHCb Framework.