Update on fast simulation in Geant4

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SFT Simulation R&D meeting

April 28, 2020

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- create tools that are common for (many) fast simulation models (some based on GFlash)
- not yet presented at Generic Processes WG
- prototyped inside example application on gitlab, to be included as core source and an example;

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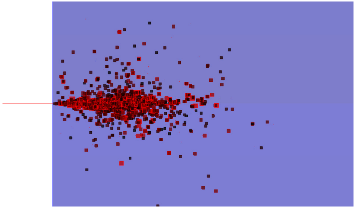
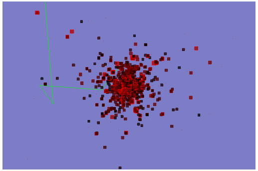
Most often deposit energy means place energy E in $\bar{r}$, no other information is passed to hit.
$\longrightarrow$ tools for energy deposition can be generalised.

Depositing energy in calorimeter

Full simulation





- 10 GeV e^-
- Showing deposits $E > 1\text{MeV}$

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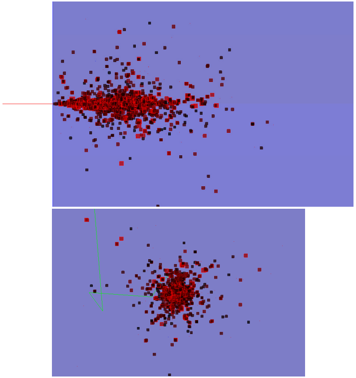

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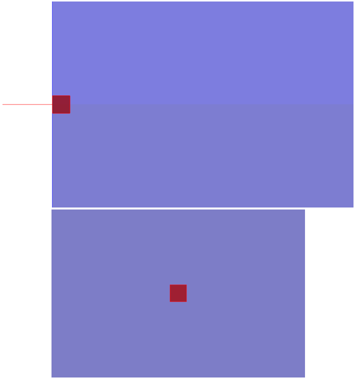

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- to make more: user's responsibility

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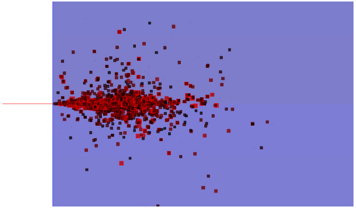

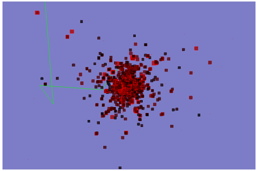

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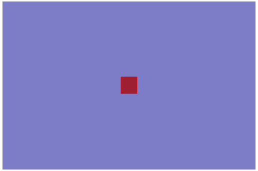

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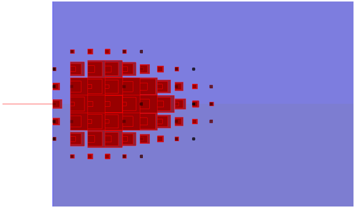

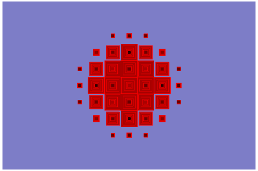

- generic tool looking for SD, placing hits mimicking full sim
- how energy is distributed still up to the user

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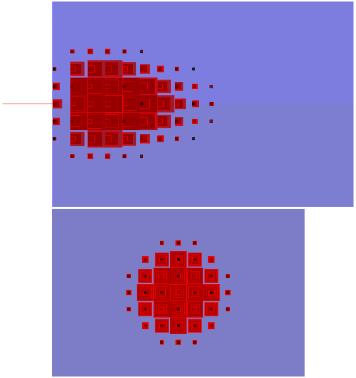

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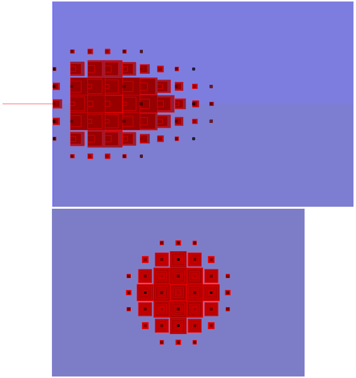

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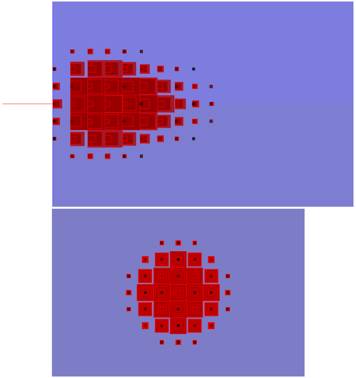

- Gamma (Gauss) distribution for longitudinal (transverse) profile, with arbitrary parameters (example only!)
- Can be used for parameterisations with previously tuned parameters (e.g. GFlash-like-mesh-based parameterisation)
- Can be used to deposit energy, e.g. from inference of NN models.
- Needed input:
  - any input to calculations (parameters, weights & model)
  - 3D tensor of values for energy deposits;
  - size and number of cells (XYZ);
  - input particle direction (for rotations);

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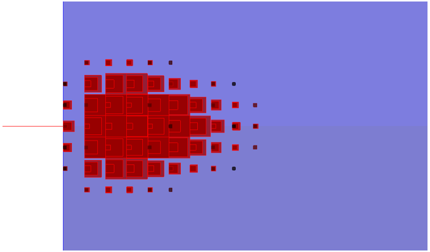
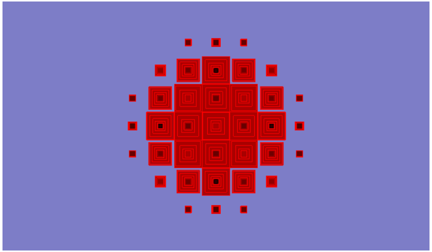
- `G4FastHit` binding energy deposit and its position;
- `G4FastSimHitMaker` that keeps track of volumes, readout geometry, and calls sensitive detector to deposit energy;
- `G4VFastSimSensitiveDetector` is a base class for user's SD (additional to G4VSensitiveDetector) that includes method for processing hits based on `G4FastHit` (instead of the usual `G4Step`)

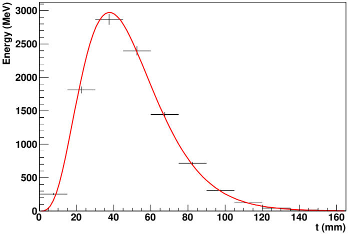
Simple analysis: fast simulation

In order to quickly verify fast simulation performance.
Implemented in event action (analysis of hit collection at the end of the event).

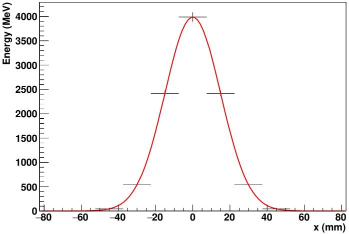




Longitudinal profile

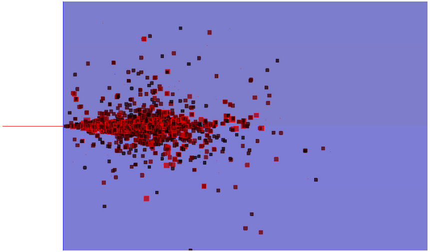


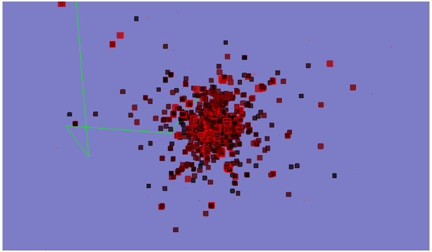
Transverse (x) profile



Simple analysis: full simulation

It uses the same class to describe hit, so can be applied to both full and fast simulation.





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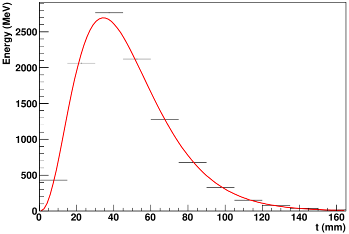

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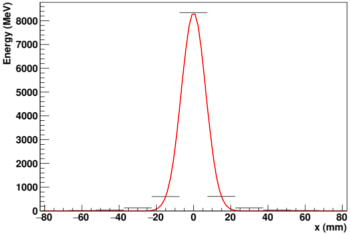

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- Longitudinal and transverse average profiles, first and second moments;
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- Create robust messengers that allow to setup e.g. mesh size, input parameters,…