Estimation of particle position and momentum for LHCb electromagnetic calorimeter

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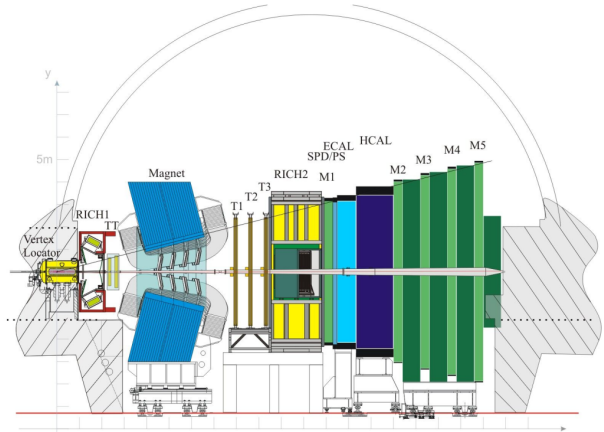
LHCb experiment

LHCb is a forward arm spectrometer with pseudorapidity range $2 < \mu < 5$ that was originally designed for the study of b-physics.



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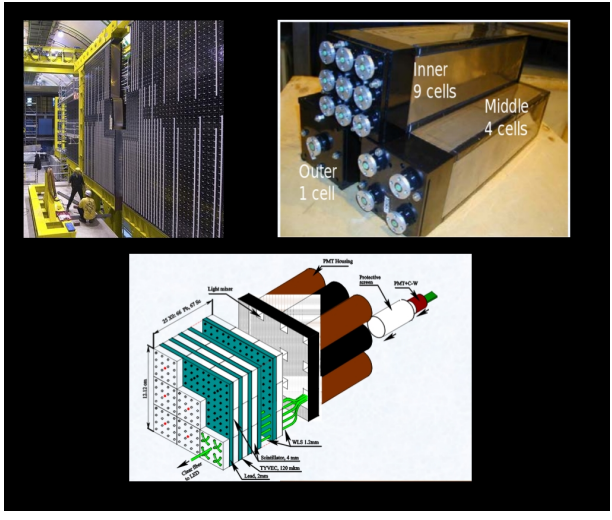
Electromagnetic calorimeter



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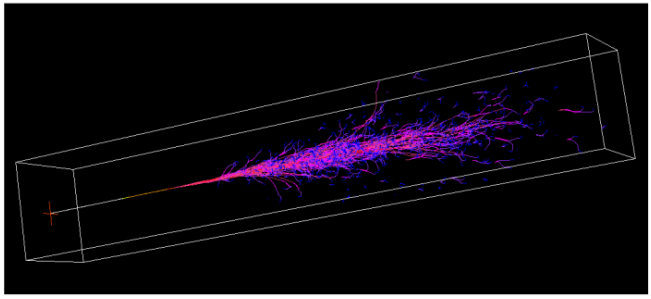
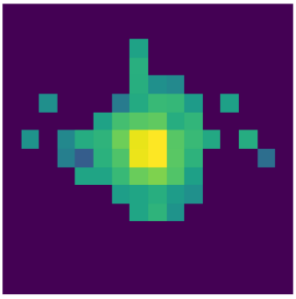
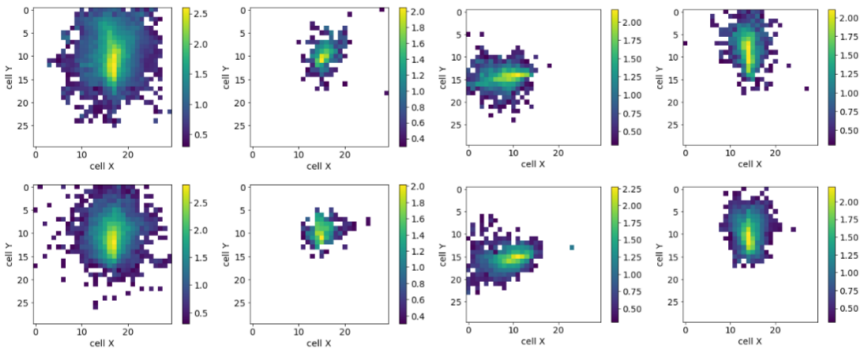
Electromagnetic samples





Dataset

Dataset consists of 150 000 samples of calorimeter(divided on train/val/test) responses on particles with different initial position, energy, momentum and type(either e^- or γ).



(a) $E_0 = 63.7$ GeV (b) $E_0 = 6.5$ GeV (c) $E_0 = 15.6$ GeV (d) $E_0 = 15.9$ GeV

Dataset

Dataset is in npz-format and consists of 4 numpy-arrays:

- EnergyDeposit: $[30 \times 30]$ images of ECAL responses
- ParticleMomentum: p_x, p_y, p_z of initial particle
- ParticlePoint: x, y position of initial particle
- ParticlePDG: e^-, γ, i.e. particle type

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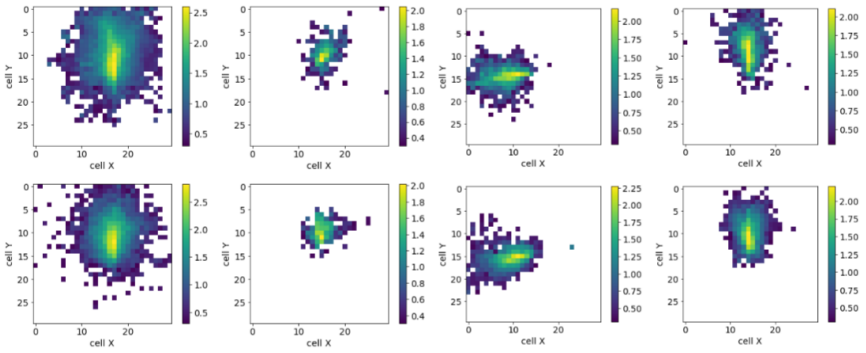
Dataset



(a) $E_0 = 63.7$ GeV

(b) $E_0 = 6.5$ GeV

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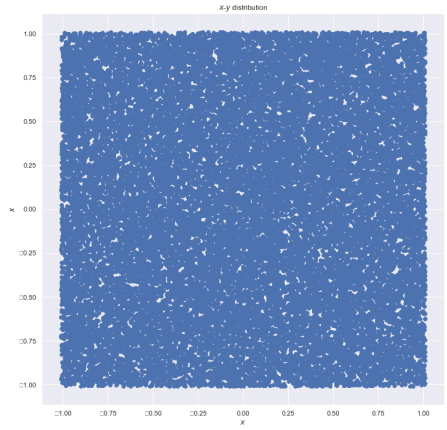
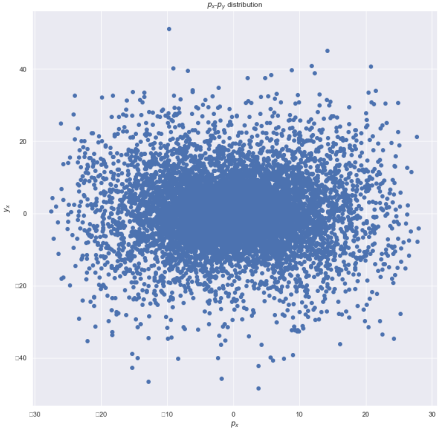
Problem statement

Estimate initial position of particle in xy-plane and p_x, p_y





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Metric

Sum of relative MSE:

- RMSE:

$$\mathrm{MSE}(y, \hat{y}) = \frac{1}{N} \sum_i (y_i - \hat{y}_i)^2$$

- RelMSE:

$$\mathrm{RelMSE}(y, \hat{y}) = \frac{\mathrm{MSE}(y, \hat{y})}{\mathrm{MSE}(y, \bar{y})} = \frac{\sum_i (y_i - \hat{y}_i)^2}{\sum_i (y_i - \bar{y})^2}$$

- Final metric:

$$\mathrm{Metric} = \sqrt{\mathrm{RelMSE}(x, \hat{x}) + \mathrm{RelMSE}(y, \hat{y}) + \mathrm{RelMSE}(p_x, \hat{p}_x) + \mathrm{RelMSE}(p_y, \hat{p}_y)}$$

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Competition organization information

Coopetition link:

`https://codalab.coresearch.club/competitions/70`

Start of competition:

01.07.2019

End of competition:

30.07.2019

Some additional information

To simplify your workflow I have prepared ready-to-go docker with all pre-installed stuff:

For CUDA9.0: vbelavin/gpu

For CPU: vbelavin/cpu

To run it you need only two lines of code:

```
sudo docker pull vbelavin/{gpu/cpu}
sudo docker run -v {your_work_dir_full_path}/:/root/workdir -p {choose_port}:8888 vbelavin/cpu
```

And you will be able to open IPython notebook immediately in your browser.

Let’s go to the practice!

Starter-kit:

`https://github.com/SchattenGenie/mlhep2019_1_phase`

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