dE/dx - Q correction
N-dimensional pipeline

Perform Toy-MC to create trees (c++)
https://github.com/AliceO2Group/AliceO2/pull/8196

Filtering of the data (c++)

N-dim Random forest regression (python, scikit-learn)
https://indico.cern.ch/event/1135398/contributions/4764024/subcontributions/370741/attachments/2402893/4109728/ML_5D_RF.py

Interactive visualisation of RF-model and polynomials (RootInteractive)
https://indico.cern.ch/event/1135398/contributions/4764024/subcontributions/370741/attachments/2402893/4109757/RootInteractive_visualisation.ipynb

Parametrisation of trained RF-model with N-dim polynomials (python, scikit-learn)
https://indico.cern.ch/event/1135398/contributions/4764024/subcontributions/370741/attachments/2402893/4109743/make_polynomial_fits_and_create_RootInteractive_trees.py

Creating c++ objects of N-dim polynomials
https://indico.cern.ch/event/1135398/contributions/4764024/subcontributions/370741/attachments/2402893/4109780/Create_c_Polynomials.cxx
Track topology correction

- Cluster charge $Q_{Tot}$ and $Q_{Max}$ depends strongly on the topology of the track.
Track topology correction

- Cluster charge $Q_{Tot}$ and $Q_{Max}$ depends strongly on the topology of the track

1. Diffusion: Drift length of the electrons

\[ z_1 = v_D \cdot t_1 \]
\[ z_2 = v_D \cdot t_2 \]
Track topology correction

- Cluster charge $Q_{Tot}$ and $Q_{Max}$ depends strongly on the topology of the track

1. Diffusion: Drift length of the electrons

2. Local track inclination angle $\theta$

\[
Q^* = \begin{cases} 1 & \text{Track 1} \\ \text{Track 2} & \end{cases}
\]

Read out plane

Pad

Toy-MC

Track 1

100 < z < 150 | sin(\varphi) | < .2

region 0

Toy-MC

Track 2

100 < z < 150 | sin(\varphi) | < .2

region 0

$Q_{Max}$ (a.u.)

$Q_{Tot}$ (a.u.)

$\tan(\theta)$

$\tan(\theta)$

$\tan(\theta)$

$\tan(\theta)$
Track topology correction

- Cluster charge $Q_{Tot}$ and $Q_{Max}$ depends strongly on the topology of the track

1. Diffusion: Drift length of the electrons
2. Local track inclination angle $\theta$
3. Local track angle $\phi$ over pads

![Diagram showing track topology correction](image)
Track topology correction

- Cluster charge $Q_{Tot}$ and $Q_{Max}$ depends strongly on the topology of the track

1. Diffusion: Drift length of the electrons
2. Local track inclination angle $\theta$
3. Local track angle $\varphi$ over pads
4. Relative pad position of the track
Track topology correction

- Cluster charge $Q_{Tot}$ and $Q_{Max}$ depends strongly on the topology of the track
  
1. Diffusion: Drift length of the electrons

2. Local track inclination angle $\theta$

3. Local track angle $\phi$ over pads

4. Relative pad position of the track

5. Relative time position of the track
Track topology correction

- Cluster charge $Q_{Tot}$ and $Q_{Max}$ depends strongly on the topology of the track
  
  1. Diffusion: Drift length of the electrons
  2. Local track inclination angle $\theta$
  3. Local track angle $\varphi$ over pads
  4. Relative pad position of the track
  5. Relative time position of the track
  6. Zero suppression threshold
     - Only $Q_{Tot}$
Track topology correction

- Cluster charge $Q_{Tot}$ and $Q_{Max}$ depends strongly on the topology of the track

1. Diffusion: Drift length of the electrons
2. Local track inclination angle $\theta$
3. Local track angle $\varphi$ over pads
4. Relative pad position of the track
5. Relative time position of the track
6. Zero suppression threshold
7. $dE/dx$: Only $Q_{Tot}$
Track topology correction

- Cluster charge $Q_{\text{Tot}}$ and $Q_{\text{Max}}$ depends strongly on the topology of the track

1. Diffusion: Drift length of the electrons
2. Local track inclination angle $\theta$
3. Local track angle $\phi$ over pads
4. Relative pad position of the track
5. Relative time position of the track
6. Zero suppression threshold

7. $dE/dx$: Only $Q_{\text{Tot}}$
  - $Q_{\text{Tot}}$ is measured: convert $dE/dx$ to $\langle Q_{\text{Tot}} \rangle$
  - $\langle Q_{\text{Tot}} \rangle$ extracted by multidimensional Random Forrest fit
N-dimensional pipeline

Perform Toy-MC to create trees (c++)
https://github.com/AliceO2Group/AliceO2/pull/8196

Filtering of the data (c++)

N-dim Random forrest regression (python, sklearn)
https://indico.cern.ch/event/1135398/contributions/4764024/subcontributions/370741/attachments/2402893/4109728/ML_5D_RF.py

Parametrisation of trained RF-model with N-dim polynomials (python, sklearn)
https://indico.cern.ch/event/1135398/contributions/4764024/subcontributions/370741/attachments/2402893/4109743/make_polynomial_fits_and_create_RootInteractive_get_trees.py

Interactive visualisation of RF-model and polynomials (RootInteractive)
https://indico.cern.ch/event/1135398/contributions/4764024/subcontributions/370741/attachments/2402893/4109757/RootInteractive_visualisation.ipynb

Creating c++ objects of N-dim polynomials
https://indico.cern.ch/event/1135398/contributions/4764024/subcontributions/370741/attachments/2402893/4109780/Create_c_Polynomials.cxx
Track topology correction

Perform regression of the dependencies using Random Forrest ML algorithm

- $Q_{Tot}$: Fit $Q_{Tot} \frac{dE}{dx} (z, \tan(\theta), \sin(\varphi), threshold, \langle q\text{Tot} \rangle)$
  - rel. pad and rel. time is neglected
- $Q_{Max}$: Fit $Q_{Max} \frac{dE}{dx} (z, \tan(\theta), \sin(\varphi), rel.\text{ Pad}, rel.\text{ Time})$

Application during reconstruction

- Fit the trained RF model for each region using fourth degree 5D-polynomials
N-dimensional pipeline

Perform Toy-MC to create trees (c++)

https://github.com/AliceO2Group/AliceO2/pull/8196

Filtering of the data (c++)

N-dim Random forest regression (python, sklearn)

https://indico.cern.ch/event/1135398/contributions/4764024/subcontributions/370741/attachments/2402893/4109728/ML_5D_RF.py

Interactive visualisation of RF-model and polynomials (RootInteractive)

https://indico.cern.ch/event/1135398/contributions/4764024/subcontributions/370741/attachments/2402893/4109757/RootInteractive_visualisation.ipynb

Creating c++ objects of N-dim polynomials

https://indico.cern.ch/event/1135398/contributions/4764024/subcontributions/370741/attachments/2402893/4109780/Create_c_Polynomials.cxx

Parametrisation of trained RF-model with N-dim polynomials (python, sklear)

https://indico.cern.ch/event/1135398/contributions/4764024/subcontributions/370741/attachments/2402893/4109743/make_polynomial_fits_and_create_RootInteractive_trees.py
**Track topology correction**

Perform regression of the dependencies using Random Forrest ML algorithm

- $Q_{\text{Tot}}$: Fit $\frac{Q_{\text{Tot}}}{dE/dx} (z, \tan(\theta), \sin(\phi), \text{threshold}, \langle q_{\text{Tot}} \rangle)$
  - rel. pad and rel. time is neglected
- $Q_{\text{Max}}$: Fit $\frac{Q_{\text{Max}}}{dE/dx} (z, \tan(\theta), \sin(\phi), \text{rel. Pad, rel. Time})$

**Application during reconstruction**

- Fit the trained RF model for each region using fourth degree 5D-polynomials
  - RootInteractive dashboards for easy multidimensional representation

**Graphs**

- $Q_{\text{Max}}$ dependencies
- $Q_{\text{Tot}}$ dependencies
N-dimensional pipeline

Perform Toy-MC to create trees (c++)
https://github.com/AliceO2Group/AliceO2/pull/8136

Filtering of the data (c++)

N-dim Random forest regression (python, sklearn)
https://indico.cern.ch/event/1135398/contributions/4764024/subcontributions/370741/attachments/2402893/4109728/ML_5D_RF.py

Filtering of the data

Creating c++ objects of N-dim polynomials
https://indico.cern.ch/event/1135398/contributions/4764024/subcontributions/370741/attachments/2402893/4109780/Create_c_Polynomials.cxx

Interactive visualisation of RF-model and polynomials (RootInteractive)
https://indico.cern.ch/event/1135398/contributions/4764024/subcontributions/370741/attachments/2402893/4109757/RootInteractive_visualisation.ipynb

Parametrisation of trained RF-model with N-dim polynomials (python, sklearn)
https://indico.cern.ch/event/1135398/contributions/4764024/subcontributions/370741/attachments/2402893/4109743/make_polynomial_fits_and_create_RootInteractive_trees.py
Track topology correction

Remaining residual dependencies due to: uncertainty of electron attachment in Toy-MC, cluster below threshold…