PWGPP-729: Electron bremsstrahlung correction + conditional PID momentum and position bias correction

Marian I Ivanov, Marian Ivanov, Benedict Heybeck
Mean energy loss correction and bremsstrahlung

Inter-detector matching and combined track properties

Conditional machine learning based correction of momenta and position bias (DCA, TOF)

- momentum bias
- TOF (space and time) and DCA residuals
- Optimally applicable in analysis

Similar conditional machine learning algorithm for the distortion correction - delta T0 as conditional variable
Bremstrahlung and energy loss correction in the reconstruction

The loss of energy in the detector material could significantly affect the properties of the particles. A considerable part of the energy lost during the propagation of the track from the production point to the outer detectors can lead to:

Consequences:
- momentum determination bias and particle extrapolation bias → deterioration of inter-detector matching (efficiency, $\chi^2$ ...)

Mean energy loss used to correct for the effect assuming particle identity known:
- In case of mis-identification the energy loss is biased
- In case of electron - mean energy loss not sufficient to correct for the bremstrahlung

Goal:
- Prepare PID conditional modification of track properties (pt, DCA, TOF matching)
TPC only tracks not sensitive to the bremsstrahlung in the ITS material

Bremstrahlung probability in TPC is small

- impact negligible in comparison to bremsstrahlung in service and ITS before TPC

Position and energy fraction of bremsstrahlung not known

The DCA properties (position, angle + $\Delta \frac{q}{pt(ITS/TPC)}$) depends on the bremsstrahlung position and bremsstrahlung loss

Bremstrahlung and PID misidentification correction (Random Forest)

qPt correction - geometrical interpretation

\[ \log\left(\frac{\text{prec}}{\text{ptrue}}\right) \text{- fractional momentum loss} \]

Input Variables:
- Geometrical: \( 'dcaDelta', 'phiDelta' \)
- PID and QA: "fPIDForTracking", 'tpcNcls'
- itsmask,
- qPt, tgl

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 fractional momentum loss due brestrahlung: (time section: )

- corrected data significantly narrower using std nor and quantile norm
- normalization of the mean and median bias depends on the cost function used (square residual, abs residuals, weighted mean)

Impact of PID miss-identification (cross at qPt~ 3) (time section: )

Work in progress:

- more data needed - more flat in parameter space
- adding local error estimator of the correction to dashboard
- use also dQpt between ITS and TPC as additional constraint