Track-cluster Match Study

- TM consistency calculation
- Testing the performance
- Compare with old algo results
- Calculating TM purity
- Conclusions

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TM consistency calculation

- Assuming double Gaussian $\Delta \phi$ and $\Delta \theta$ distributions, TM consistency is defined to be:

$$C_{TM} = C_{\Delta \theta} C_{\Delta \phi} (1 - \ln(C_{\Delta \theta} C_{\Delta \phi}))$$

where

$$C(x) = \frac{(C_N(x) + RC_W(x))}{(1 + R)}$$

- Consistencies for value $x(\Delta \theta/\Delta \phi)$ for the narrow and wide sigma distributions are evaluated using standard definition:

$$C(x) = \frac{\int_{L<L(x)} f(x')dx'}{\int_{-\infty}^{\infty} f(x')dx'}$$

- Here $f(x')$ denotes the un-normalized Gaussian distribution
TM efficiency calculation

- Find out the fraction of tracks that has TM consistency, $C_{TM}$, greater than some fixed value (currently $10^{-6}$):

$$\epsilon = \frac{N_{select}}{N_{total}}$$

and, error on that:

$$\Delta \epsilon = \sqrt{\frac{\epsilon(1 - \epsilon)}{N_{total}}}$$

- One can then evaluate TM efficiency vs. momentum and $\theta$ and compare with the old algo
TM efficiency vs. momentum

- TM efficiency vs. momentum for −ve and +ve pions over full detector fiducial region θ — real and MC data
• TM efficiency vs. $\theta$ for $-$ve and $+$ve pions over full accessible kinematic range — real and MC data
Compare with the old algo results

- Above plot is extracted out of John’s thesis
- Comparing the bottom one with page #14, we notice:
  - Improvement in efficiency for low momentum pions
  - Checked with John that this is the right plot
TM efficiency vs. momentum - Electron

- TM efficiency vs. momentum for \(-ve\) and \(+ve\) electrons integrated over \(\theta\), using pion coefficients – real and MC data
- TM efficiency vs. $\theta$ for $-ve$ and $+ve$ electrons integrated over momentum, using pion coefficients — real and MC data
Compare with the old algo results

Above plot is extracted out of John’s thesis

Comparing the bottom one with page # 17, we find:

- Significant (5-6%) improvement in TM efficiency for low momentum electrons
Finding out the purity

- Find out the fraction of bumps that MC truth matched to neutral (\(\gamma/\pi^0/K_L^0/K_S^0/n/\bar{n}\)) however is matched to a charged track (i.e. has TM consistency, \(C_{TM} \geq 10^{-6}\)):

\[
\Pi = 1 - \frac{N_{neutral}}{N_{sel}}
\]

and, error on that:

\[
\Delta\Pi = \sqrt{\frac{\Pi(1 - \Pi)}{N_{select}}}
\]

- Evaluate TM purity vs. momentum and \(\theta\) to see the problematic regime

- Figure out optimal cut position for the TM consistency by exploring interdependence between efficiency and purity
- TM purity vs. momentum and $\theta$ for $-ve$ and $+ve$ pions computed in MC data

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TM purity - electron sample

- TM purity vs. momentum and $\theta$ for $-ve$ and $+ve$ electrons computed in MC data

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Optimal position for TM consistency

- TM efficiency vs purity for different TM consistency cut values - red arrow indicates the current value

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Track Match Study
Conclusions

- Track-match parameters are ready to go
- Comparison shows improvement in the performance
- Parameters available in flat file and can be read by EmGeomTrkMatchMethod module with bit of modification
- Regarding Dave Brown’s suggestion for 3D POCA method, please refer to my recent recoCalor hypernews posting:
  - 3D POCA method doesn’t improve TM performance compared to POCA XY method
  - In fact, the latter slightly better than what Dave suggests