PØD-Tracker CC inclusive analysis: Production 4 & 5 Update

Erez Reinherz-Aronis
Alex Clifton, Rajarshi Das, Walter Toki

Colorado State University
Productions and Matching

• Productions
  ▪ Prod-4
  ▪ Prod-5

• Matching methods
  ▪ Global tracks
  ▪ Tracker-to-PØD

• Run periods (PØD water bags are filled)
  ▪ Run 1
  ▪ Run 2

• Momentum bins: 0-2, 2-5, 5-10, 10+ [GeV]
Match methods

• ‘Global’ matching
  ▪ Use Global tracks

• Tracker-to-PØD match (T2P)
  ▪ Identify Tracker Trks that start at the first layer of TPC1 (Z < -750 mm)
  ▪ Pair each of the above with a PØD Trk when:
    o PØDTrk last node is in the last two PØDules (-1016 mm < Z)
    o Check Tracks time stamp (±100 ns)
    o $Sin\theta$ between last and first nodes directions < 0.365
    o $R^2 = \Delta X^2 + \Delta Y^2$ between last and first nodes positions < 85$^2$ mm$^2$

Note:
Trk quality cuts are apply on both Tracker and PØD Trks
Samples and POT’s

<table>
<thead>
<tr>
<th>Production-Spin</th>
<th>Data</th>
<th>MC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4D</td>
<td>4C</td>
</tr>
<tr>
<td>Run 1</td>
<td>2.95x10^{19}</td>
<td>54.5x10^{19}</td>
</tr>
<tr>
<td>Run 2</td>
<td>4.30x10^{19}</td>
<td>110x10^{19}</td>
</tr>
</tbody>
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<table>
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<tr>
<th>Production-Spin</th>
<th>5B</th>
<th>5C</th>
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<tr>
<td>Run 1</td>
<td>2.96x10^{19}</td>
<td>98.9x10^{19}</td>
</tr>
<tr>
<td>Run 2</td>
<td>4.31x10^{19}</td>
<td>130x10^{19}</td>
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</tbody>
</table>

- In both periods PØD water bags are full
- Data used passed DQ checks
- NEUT MC samples
Reminder: Analysis flow

• Beam and Data Quality information
  o Each spill (ND280 Event) should be checked that
    ▪ BeamSummaryData→GoodSpillFlag == 1
    ▪ DQ: ND280OffFlag == 0

• Individual Trk information
  o Each Trk in spill
    ▪ Start Position in the PØD Fiducial volume (Water-Targets; TN-073)
    ▪ Have a TPC1 piece
    ▪ Sort into bunches

• Bunch time window information
  o (in) Each bunch
    ▪ Select the negative Trk with the highest momentum
Global: Run 1

Prod-4

Prod-5

Point = Data
(4D) (5B)

Histo = MC
(4C) (5C)

Note:
- Normalized by POT
- Corrected by Beam flux (11bv3.1)
Global: Run 2
Prod-4

Prod-5

Point = Data (4D) (5B)
Histo = MC (4C) (5C)

Note:
• Normalized by POT
• Corrected by Beam flux (11bv3.1)
Point = Data (4D) (5B)
Histo = MC (4C) (5C)

Note:
- Normalized by POT
- Corrected by Beam flux (11bv3.1)
T2P: Run 2
Prod-4

Prod-5

Point = Data
(4D) (5B)

Histo = MC
(4C) (5C)

Note:
• Normalized by POT
• Corrected by Beam flux (11bv3.1)
Data/MC Plots

- **T2P Run 1**

Point = Data (4D)
Histo = MC (4C)

Note:
- Normalized by POT
- Corrected by Beam flux (11bv3.1)

- A fast ‘Norm by area’ check shows that the Muon Trk kinematic distribution are described good by MC
Data/MC Ratios: Global & T2P

• ‘Global’ matching

\[
\begin{array}{cccccc}
\text{Prod-4}^* & 0 - 2 \text{ GeV} & 2 - 5 \text{ GeV} & 5 - 10 \text{ GeV} & 0-10 \text{ GeV} \\
\text{Run 1} & 0.937\pm0.020 & 0.868\pm0.029 & 0.770\pm0.052 & 0.904\pm0.016 \\
\text{Run 2} & 0.892\pm0.017 & 0.860\pm0.023 & 0.771\pm0.042 & 0.872\pm0.013 \\
\text{Prod-5} & 0 - 2 \text{ GeV} & 2 - 5 \text{ GeV} & 5 - 10 \text{ GeV} & 0-10 \text{ GeV} \\
\text{Run 1} & 0.984\pm0.019 & 0.922\pm0.028 & 0.768\pm0.048 & 0.950\pm0.015 \\
\text{Run 2} & 0.950\pm0.015 & 0.871\pm0.022 & 0.836\pm0.041 & 0.919\pm0.012 \\
\end{array}
\]

• Tracker-to-PØD match (T2P)

\[
\begin{array}{cccccc}
\text{Prod-4}^* & 0 - 2 \text{ GeV} & 2 - 5 \text{ GeV} & 5 - 10 \text{ GeV} & 0-10 \text{ GeV} \\
\text{Run 1} & 0.889\pm0.019 & 0.901\pm0.028 & 0.647\pm0.041 & 0.870\pm0.015 \\
\text{Run 2} & 0.912\pm0.016 & 0.878\pm0.022 & 0.792\pm0.039 & 0.892\pm0.012 \\
\text{Prod-5} & 0 - 2 \text{ GeV} & 2 - 5 \text{ GeV} & 5 - 10 \text{ GeV} & 0-10 \text{ GeV} \\
\text{Run 1} & 0.918\pm0.019 & 0.846\pm0.027 & 0.752\pm0.045 & 0.881\pm0.015 \\
\text{Run 2} & 0.987\pm0.017 & 0.931\pm0.024 & 0.928\pm0.043 & 0.965\pm0.013 \\
\end{array}
\]

* Mass correction apply to MC
Summary

• PØD-Tracker CC-inc analysis includes
  ▪ Two different matching methods (Global, T2P)
  ▪ Was preformed for
    o Production 4
    o Production 5
  ▪ Where the PØD water bags are full in
    o Run 1
    o Run 2

• The ratios include flux correction (11bv3.1)

• The final ratios
  ▪ Should include Tracking efficiencies - ongoing effort
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Prod-4 Data/MC Ratios

• ‘Global’ matching

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• Tracker-to-PØD match (T2P)

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* Mass correction

• Tracker (Thanks to Federico)

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<td>0.879±0.065</td>
<td>0.760±0.120</td>
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<tr>
<td>Run 2</td>
<td>0.962±0.019</td>
<td>0.933±0.040</td>
<td>0.839±0.075</td>
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