Optimizing the P0D Fiducial Cuts for CC inc analysis

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Fiducial Cuts: The method

• Optimize the expression (look for a minimum)

\[
\frac{\delta N_s}{N_s} = \sqrt{(\delta N_{tot})^2 + (\delta N_{bg})^2} = \frac{\sqrt{N_{tot} + N_{bg}}}{N_s}
\]

• Assuming \( N_{tot} = N_s + N_{bg} \)

• Use Monte Carlo samples

• Each reconstructed track falls into a “signal” (s) or “background” (bg) bin using MC Truth
Fiducial Cuts: Step-by-Step

• Run on MC (Neut) sample: MCp4 Run2 water
• Select events
  ➢ only 1 reconstructed global track
  ➢ FrontPosition upstream of TPC1 (Z<-930)
  ➢ up to 1 truth vertex in VtxP0D container
• Signal = 1 VtxP0D that has ReactionCodes 1→26
• Background = Everything else

• Vary one boundary while the rest are fixed
• Starting X/Y fixed values ±800 mm

* ReactionCodes ref. http://www.t2k.org/t2ksk/code/neutmodes
Fiducial Cuts: How does it look

Can change start and end scan boundaries
Can change the scan steps

\[
\frac{N_S}{N_{bg}}
\]

\[
\frac{N_S + 2N_{bg}}{N_S^2}
\]

All scales are in mm
Fiducial Cuts: How does it look

\[ N_s \]

\[ \frac{N_s}{N_{bg}} \]

\[ N_{bg} \]

\[ \frac{N_s + 2N_{bg}}{N_s^2} \]

All scales are in mm
Fiducial Cuts: How does it look

$N_s \quad N_{bg}$

$N_s + 2N_{bg}$

$N_s^2$

All scales are in mm
Fiducial Cuts: Preliminary values

• P0D CC inclusive Fiducial volume
  -1020 < X < 990
  -1010 < Y < 1150

• For comparison:
  The values used in the CC inc analysis
  -1038 < X < 995
  -1060 < Y < 1100
Fiducial Cuts: To Do

- Run on the full MCp4 Run 2
- (Current values extracted using ~1.2% of the events)
- Cross check with MCp4 Run 1

- The Z boundary
- Data has more backgrounds like sand muon

- Comments/suggestions/tests
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