

# D Mesons at SPD

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## D Meson Production at SPD

- We want to estimate expected statistics of D meson cross-section and asymmetry measurements at SPD using Pythia8 event generator + SpdRoot detector Geant4
- We test event generator by comparing with theoretical estimates
- Our Samara colleagues (Karpishkoff et al.) calculated inclusive  $D^0/\bar{D}^0$  and  $D^+/D^-$  cross-sections
- We generate 10 Million open charm events (gg2ccbar+qqbar2ccbar) in PYHTIA8 using default (NNPDF23 LO) PDF : total process cross-section  $1.514 \times 10^{-3}$  mb for  $\hat{p}_{T\min} = 1$

# Inclusive D Production Cross-sections

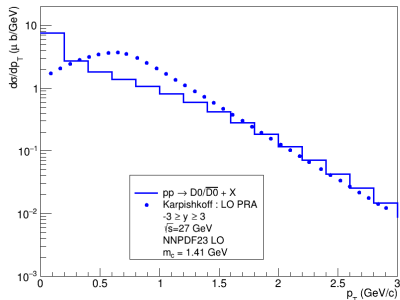


Figure 1: Neutral D mesons

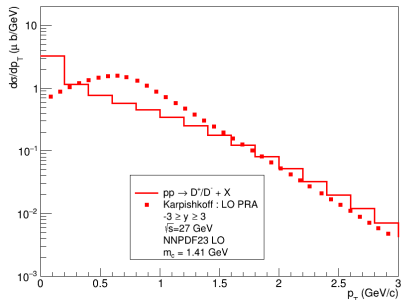


Figure 2: Charged D mesons

At very low  $p_T$ , event generator deviates by large amount from theoretical estimates

# Partonic Kinematic Range Probed in D Measurements

For open charm events with two detected D mesons :

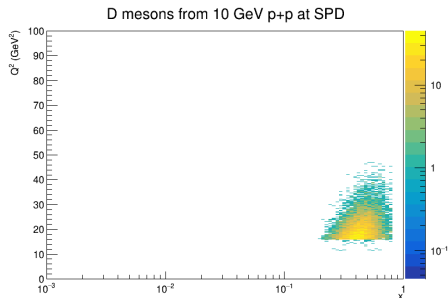


Figure 3: Partonic kinematic coverage for 10 GeV  $p + p$  collision at SPD

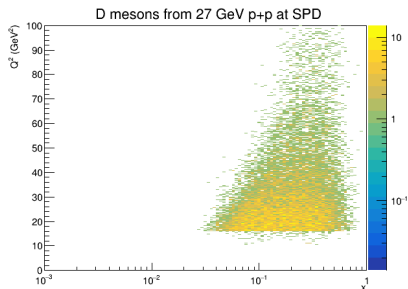


Figure 4: Partonic kinematic coverage for 27 GeV  $p + p$  collision at SPD

# Partonic Kinematic Range Probed in high $x_F$ D Asymmetries

For open charm events with two detected D mesons :

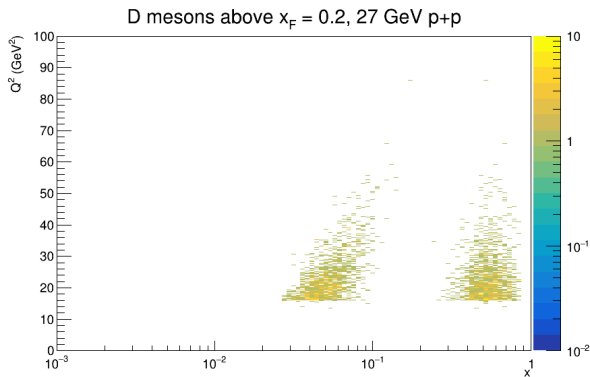


Figure 5: Parton kinematics for 27 GeV  $p + p$  collision at SPD for  $x_F^D \geq 0.2$

# D Meson Detection at SPD

- Looking at D meson detection at SPD using decays into pions and kaons
- $D^0 \rightarrow \pi^+ K^-$
- $D^+ \rightarrow \pi^+ \pi^+ K^-$
- SpdRoot simulation : version 4.1.3
- SpdRCKFpartV0Finder for secondary vertex
- Signal : 'gg2ccbar + qqbar2ccbar' : Pythia8

# Detected Neutral D Meson Distributions

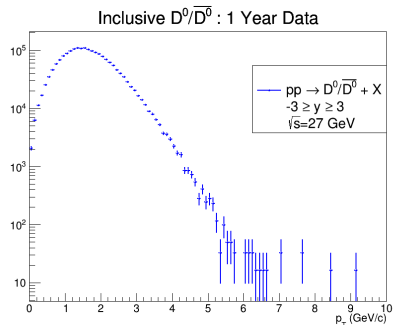


Figure 6: Transverse momentum distributions of inclusive neutral D mesons

As per CDR : 360 M of  $D^0 \rightarrow \pi^+ K^-$  or charge conjugate in one year for 27 GeV  $p + p$  produced

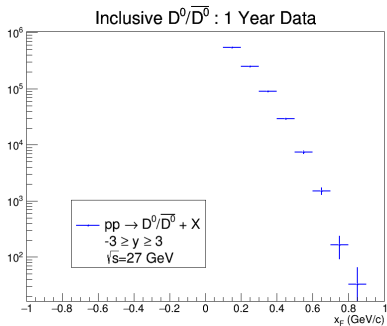


Figure 7: Feynman-x distributions of inclusive neutral D mesons

# Detected Charged D Meson Distributions

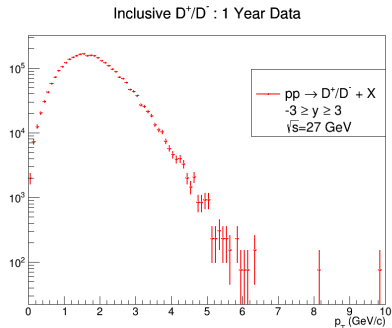


Figure 8: Transverse momentum distributions of inclusive charged D mesons

As per CDR : 520 M of  $D^+ \rightarrow \pi^+ \pi^+ K^-$  or charge conjugate in one year for 27 GeV  $p + p$  produced

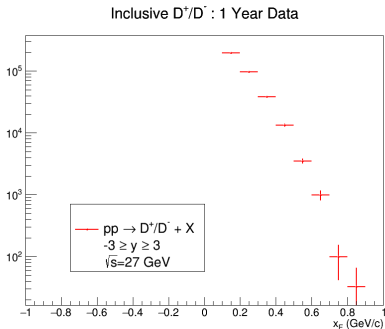


Figure 9: Feynman-x distributions of inclusive charged D mesons



# Caveats

- The numbers are probably more of a guiding ballpark number than realistic expected statistics
- They might change in real data analysis for
- These depend on cut sets to suppress heavy background from MinBias events
- Also depend on performance of crucial detectors

## Secondary Vertex Resolution

- In regular physics meetings, we have shown, for  $D^0$  reconstruction :
  - 1 MicroMegas perform really poorly
  - 2 MAPS performs 35-45 % better than DSSD
  - 3 3 layers of DSSD performs slightly better than 5 layers of DSSD
- Concluding 3 layers DSSD is a decent option if MAPS is unavailable
- We extend the study to  $D^+ \rightarrow \pi^+ \pi^+ K^-$  decays that we aim to detect at SPD

## Dependence on Vertex Detector

- To study performance of possible Inner Trackers, considered :
- 5 layers of DSSD (default in SPDRoot,  $300\mu m$  thickness)
- 3 layers of DSSD ( $300\mu m$  thickness)
- 4 layers of MAPS
- Signal events only

# Secondary Vertex Resolutions : X-dir

$D^0$  decay length  $\sim 120\mu$ ,  $D^+$  decay length  $\sim 310\mu$

$D^0 \rightarrow \pi^+ + K^-$  : secondary vertex X resolution

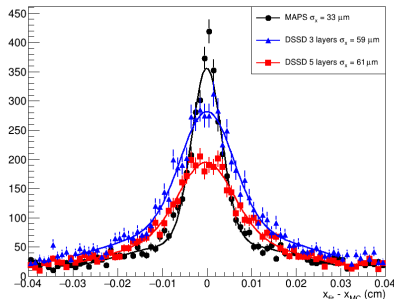


Figure 10:  $D^0$  secondary vtx. res. perpendicular to beam dir. for three configs.

$D^+ \rightarrow \pi^+ \pi^+ K^-$  : secondary vertex X resolution

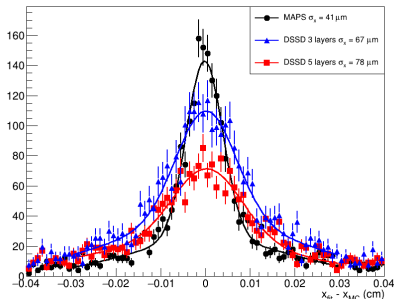


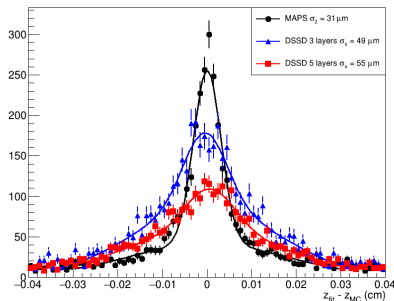
Figure 11:  $D^+$  secondary vtx. res. perpendicular to beam dir. for three configs.

Charged D meson reconstruction has 13-24 % worse resolution perpendicular to the beam direction

# Secondary Vertex Resolutions : Z-dir

$D^0$  decay length  $\sim 120\mu$ ,  $D^+$  decay length  $\sim 310\mu$

$D^0 \rightarrow \pi^+ + K^-$  : secondary vertex Z resolution



$D^+ \rightarrow \pi^+ \pi^+ K^-$  : secondary vertex Z resolution

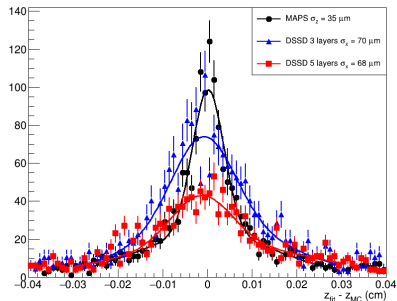


Figure 12:  $D^0$  secondary vtx. res. along beam dir. for three configs.

Figure 13:  $D^+$  secondary vtx. res. along beam dir. for three configs.

Charged D meson reconstruction has 12-27 % worse resolution along the beam direction

# Outlook

- Below 1 GeV/c transverse momentum, Pythia production may not be reliable for estimates
- Statistics for asymmetry measurements will depend on cut sets to suppress background
- Detected counts will be corrected by detection efficiency for cross-section measurements
- Detection efficiency and efficiency of cuts will depend on performance of PID detector(s) and inner tracker
- Resolution of reconstructed vertex for three hadron decay of charged D mesons is not significantly worse than 2 hadron decays of neutral D
- DSSD inner tracker with 3 layers still looks a decent replacement for MAPS

# Thank You