Feasibility studies for the open-charm production in proton-antiproton reactions for the PANDA experiment

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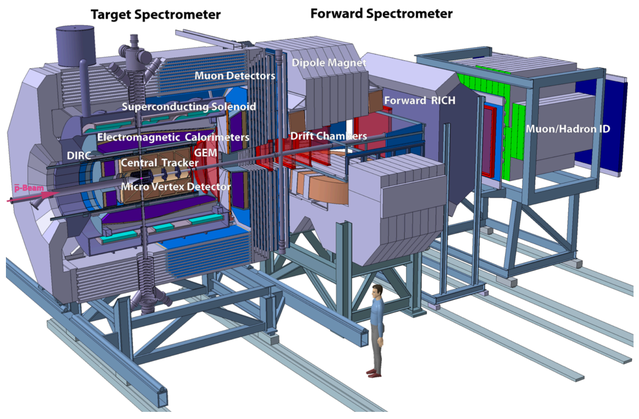
PANDA experiment

Physics program

Non perturbative QCD



- ✦ Charmonium spectroscopy
- ✦ Gluonic excitations
- ✦ Hypernuclear physics
- ✦ Hadrons in nuclear matter
- ✦ Electromagnetic processes
- ✦ Open-charm spectroscopy

Detector capabilities

- ✦ 4π acceptance
- ✦ High tracking resolution
- ✦ Very good particle identification and calorimetry

High Energy Storage Ring (HESR)

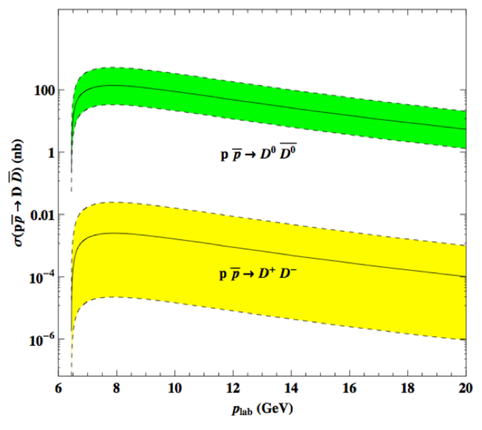
- ✦ Momentum range: 1.5 - 15 GeV/c
- ✦ Luminosity: up to 2 x 10^{32} $cm^{-2}sec^{-1}$
- ✦ Production rate: max 2 x 10^{7} sec^{-1}
- ✦ $\bar{p}$ momentum resolution: ~10^{-4} - 10^{-5}

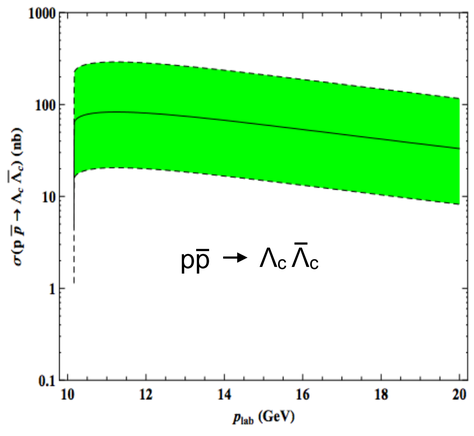
Motivation

Open charm physics

- ✦ Search for exotic states and missing (high L) open-charm mesons and baryons
- ✦ Electroweak decays of open-charm hadrons: search for new physics
- ✦ Charmonium spectroscopy above open-charm thresholds
- ✦ Open-charm production mechanisms in $p\bar{p}$ annihilations
- ✦ Urgently needed: obtain cross sections for associative open-charm production (this work)

$$p\bar{p} \longrightarrow D^0\bar{D}^0 \longrightarrow K^+\pi^-K^-\pi^+$$
$$p\bar{p} \longrightarrow \Lambda_c\bar{\Lambda}_c \longrightarrow pK^-\pi^+\bar{p}K^+\pi^-$$



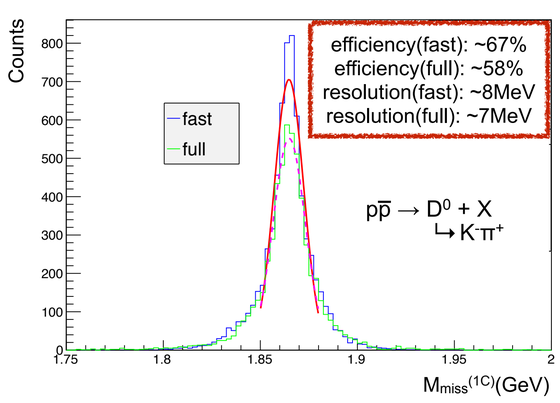


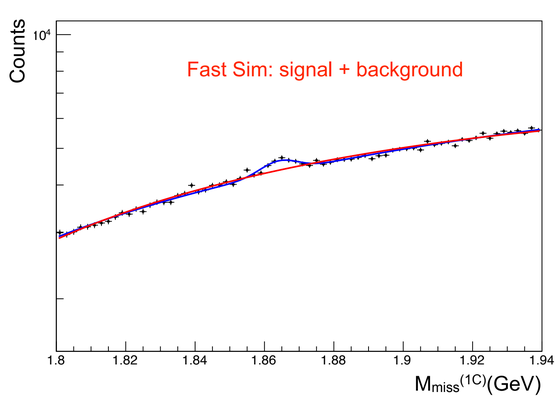
A.Khodjamirian et al, arXiv:1111.3798v2 [hep-ph] (2012)

MC simulation results I

$$p\bar{p} \longrightarrow D^0\bar{D}^0 \longrightarrow K^+\pi^-K^-\pi^+$$

- ✦ Full simulation: GEANT3 simulation with full transport of particles
- ✦ Fast simulation: Parameterization of detector response
- ✦ Fast Sim vs Full Sim @ 8 GeV/c, 10^4 signal events
- ✦ Fast Sim @ 8 GeV/c, 5 x 10^3 signal events + 2.5 x 10^9 background events

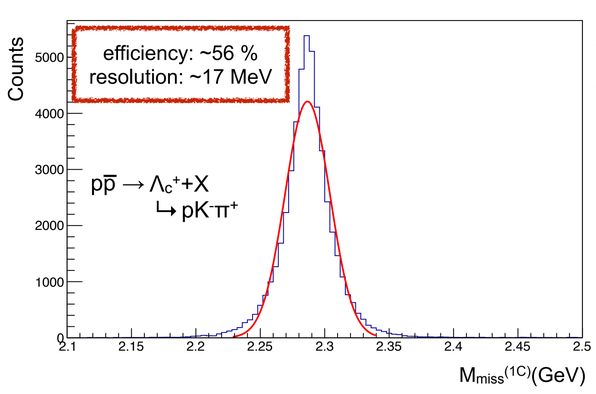




MC simulation results II

$$p\bar{p} \longrightarrow \Lambda_c\bar{\Lambda}_c \longrightarrow pK^-\pi^+\bar{p}K^+\pi^-$$

- ✦ Fast simulation: Parameterization of detector response
- ✦ Fast Sim @ 14 GeV/c, 10^5 signal events+10^9 background events



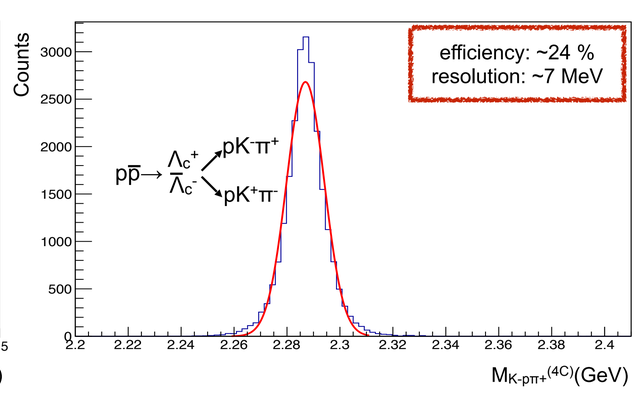


Figure of Merit (FOM)

- ✦ Background cross section: ~ 50 mb
- ✦ Branching fraction ($p\bar{p} \to D^0\bar{D}^0$): $(3.9 \times 10^{-2})^2$ for exclusive mode, $2 \times (3.9 \times 10^{-2})$ for inclusive mode
- ✦ Branching fraction ($p\bar{p} \to \Lambda_c^+\bar{\Lambda}_c^-$): $(5.0 \times 10^{-2})^2$ for exclusive mode, $2 \times (5.0 \times 10^{-2})$ for inclusive mode
- ✦ Background suppression : for both channels 10^7 for exclusive (double tag) and 10^4 for the inclusive (single tag) mode was obtained by applying cuts on the event topologies and by using kinematic fits
- ✦ Improvements are in progress: studying vertex displacements and adding other decay modes

Sensitivity of 100 nb feasible with a luminosity of 10^{30} cm^2 sec^{-1} or better for an inclusive (single tag) analysis