Nuclear Dependence of Nutral-D-Meson Production by 800GeV/c Protons

M.J.Leitch et all. E789 Collaboration

800GeV/c protonを使った neutral D mesons の原子核効果をFermlab E789実験にてxF=0の領域で測定した。Be,Auターゲットからの D mesons生成を二つのスペクトロメーターとSilicon Vertex detectorでD　Kpiを通して測定した。dSigma/dxFとしては、平均xFが0.031で、58+-3+-7 microbarn/nucleon。全xF領域における断面積は、17.7+-0.9+-3.4micro barn/nucleonとなり過去の測定と一致している。

Introduction

- p-A Collision においてJ/phi や Upsilon のsuppressionが測定されていたが、J/phiのopen-charm pairへのnucleus中でのConversionなどクリアーではない。D-mesonの測定もない。他にInitial-stateやPDFの原子核効果も明らかではない。
- 過去のデータ: E605,E772
  - J/phi,phiのA-dependence
    - Large xF : strong suppression
    - Small xF : small suppression
- D-meson production はどうなっているだろうか？

Fermilab E789

- D0 measurement
  - 400D0 Kpi at Be,Au
    - D0 K-pi+ 3.83%
    - 1864.5MeV
    - ct=124.4microm
    - Target
      - Be: 160micro x 1.8mm
      - Au: 110micro x 0.8mm
  - Silicon vertex detector
    - 16 x 5x5cm^2 x 300micro
    - 50micro pitch
    - 20 to 60mr covered
    - 37 and 94 cm downstream
    - y(vertical) and u/v plane
    - 8544 strips
    - Trigger cut at 51micro from vertex by factor 5 to 20.

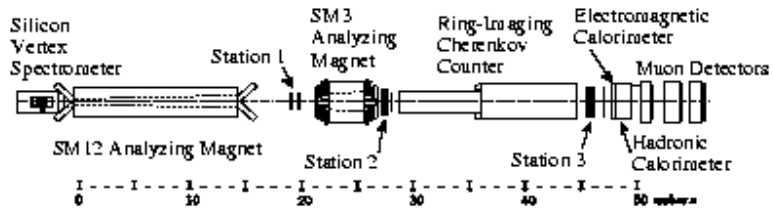


Figure 1: Plan (x-z) view of E789 apparatus.

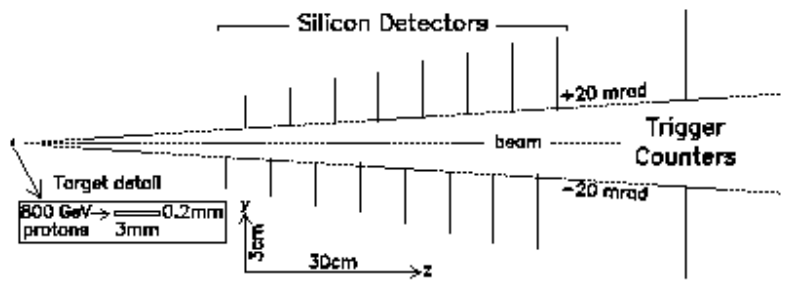


Figure 2: Elevation view of E789 vertex telescopes; note that the target dimensions indicated correspond to the beauty running, and thinner targets were used for the charm running.

Fermilab E789

- Spectrometer magnet(SM12)
  - 900A setting for Be,Au run
  - 1000A setting for a substantial data only for Au
- Beam
  - 0.5 – 1.9x10^9 protons/s
    - 17pb-1 for 900A setting Be
    - 13pb-1 for 900A seting Au
    - 35pb-1 for 1000A seeting Au
  - Multiplicities: 5-13 hits per events at silicon vertex
  - 3.8x10^8 events were recorded
  - Beam Flux normalization
    - Four element scintillator telescope at 90deg
    - Secondary-emission monitor(SEM)
    - 4% uncertainties between Be and Au targe

Analysis

- D0 reconstruction: Fig.1
  - Background rejection by lifetime > 7.2
  - D0 pi+K- and Dbar0 pi-K+
  - Width
    - 5MeV/c^2 for correct decay-product assignment
    - 50MeV/c^2 for incorrect
  - Cotinuum background : pairs misidentified as downstream events
  - Fit by a narrow/wide Gaussian and polynomial for BG
    - For D0 and Dbar0

Analysis

- Loosest vertex cut study results in no systematic effects
- Detailed MC simulation
  - for acceptance, random hits, multiple scattering, other decay production, and efficiencies of all detectors
    - Acceptances + efficiencies
      - 1.4x10-3 (900A) 6.4x10-4(1000A)
    - Lifetime cut
      - 0.19(900A) 0.24(1000A)
    - Level-one trigger efficiency
      - 0.42+-0.04(900A) 0.46+-0.04(1000A)
      - Addtional 0.70 to 0.74

Results

- Lifetime
  - 0.418+-0.018ps
- No Asymmetry
  - D0/Dbar0 = 0.97+-0.12
- Acceptance
  - 0.0<xF<0.08
  - 0.0<pT<1.1GeV/c: <pT> = 0.50GeV/c
- Differential cross section
  - D0+Dbar0 = 58+-3+-7 microbarn/nucleon
    - Uncertainties
      - Proton beam flux +-10%
      - Branching ratio +-5.8%
      - Fitting and statistics +-4.9%
      - Trigger efficiencies +-3.2%
      - Lifetime 3%
      - Processor efficiency +-2%
  - dsigam/dpT = pT exp(-n pT^2)
    - N = 0.91+-0.12 (GeV/c)-2

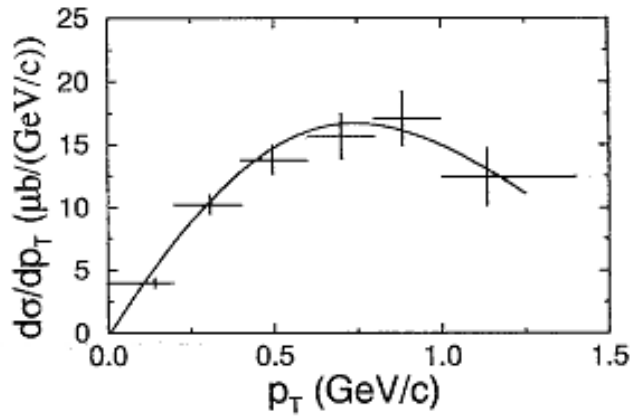
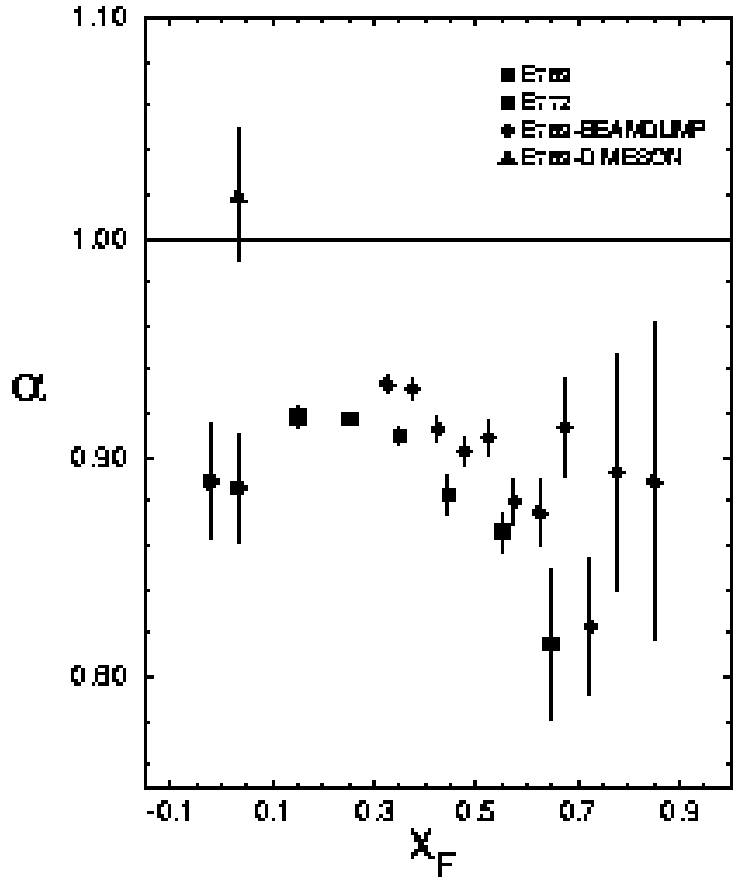


FIG. 3. Differential cross section per nucleon, $d\sigma/dp_T(D^0) + d\sigma/dp_T(\bar{D}^0)$, versus p_T for our 1000 A data. Uncertainties shown are statistical only and do not include an additional systematic uncertainty of 12.8%. The solid line represents the fit described in the text.

A-dependence

- Table.1
  - R=Au/197 / Be/9 = 1.06+-0.11(stat)+-0.07(syst)
    - Uncertainties
      - Statistics +-10%
      - Processor efficiency +-4%
      - Relative luminosity +-4%
  - A = 1.02+-0.03+-0.02
- Previous measurement
  - 0.75 to 1.04
  - 1.00+-0.05+-0.02 (E769)
  - 0.92+-0.06 (all D: WA82)
  - 1.03+-0.11 (D0: WA82)
- Compared with J/phi
  - Phys.Rev.D51(1995)52
  - Hep-ex/9610003



Discussion and Conclusion

- Gluon shadowing
  - At large xF == Small x2
    - x2 may be influenced by shadowing effect
      - DDbar pair production suppressed?
    - x2 calculation by E653 0.05 well above the shadowing region
    - Beam dump measurement
      - xF > 0.05 == small x2 and shadowing is valid.
- Intrinsic-charm model
  - Higher-twist calculation
- Conclusion
  - D0 mesons: lack of nuclear dependence suggests
    - J/phi, phi' is not the result of initial state effects and gluon structure functions outside of shadowing region
  - With other measurement suggests
    - (large xF region and pi-beam production)
    - Shadowing and charm with valence recombination may play important roles in detemining th nuclear dependence