Perceiving the Emergence of Hadron Mass through **AMBER@CERN**

10 – 13 May 2022
CERN, Geneve - Switzerland

Dimuon production with RF separated beams

Stephane Platchkov

Paris-Saclay University, CEA/IRFU, France

RF-separated beam parameters

- RF kaons: expected parameters…
  - Energy: up to 80 GeV
  - Flux: ~5x10^5 kaons/s (instead of ~40 more, optimistically assumed)

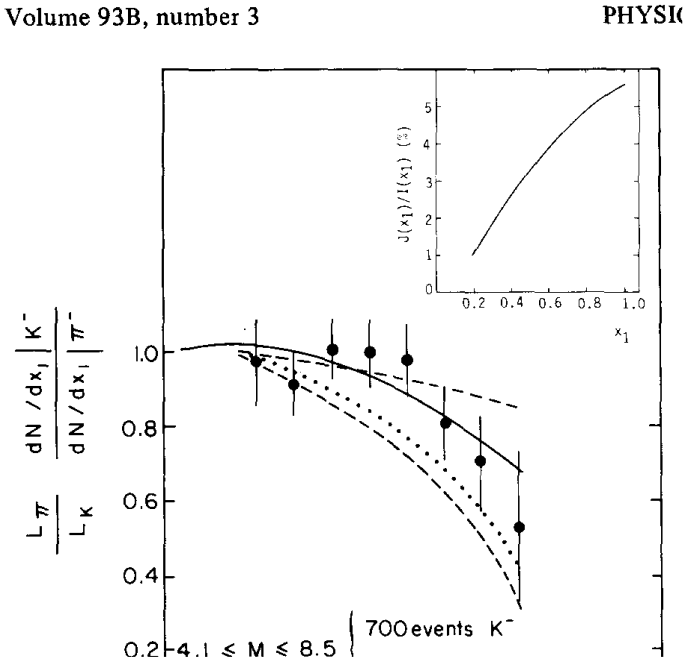
- Corollary
  - Drell-Yan measurements: no significant improvement vs available data
  - Charmonium measurements: much larger cross sections => yes, possible

- Thinking positive…
  - Low intensity allows for an open spectrometer => better mass resolution
  - At lower energies the $q\bar{q}$ term (in J/ψ prod.) becomes dominant (vs gg)

The celebrated 40y old kaon data from NA3

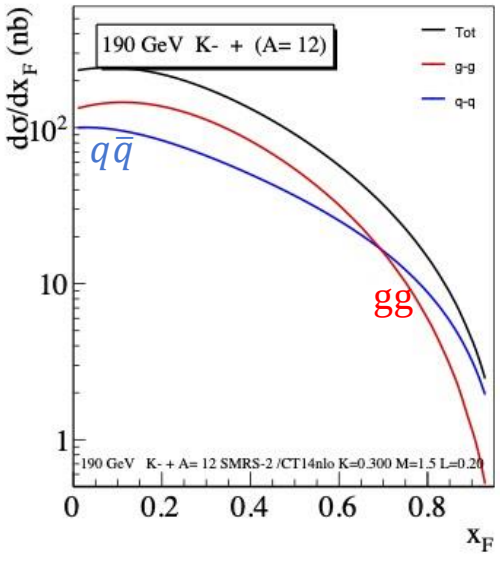
- Kaon DY data (actually a K/π ratio)
  - only information on the kaon PDF.
  - AMBER RF: marginal improvement…
  - A good news: K^- and π^- same beam
- Kaon-induced J/ψ production data
  - also from NA3, no PDF information

NA3, CERN 1980

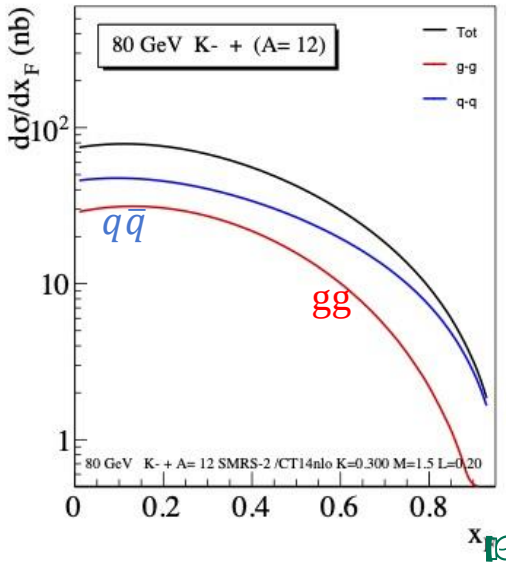


Beam energy dependence: 190 GeV vs 80 GeV

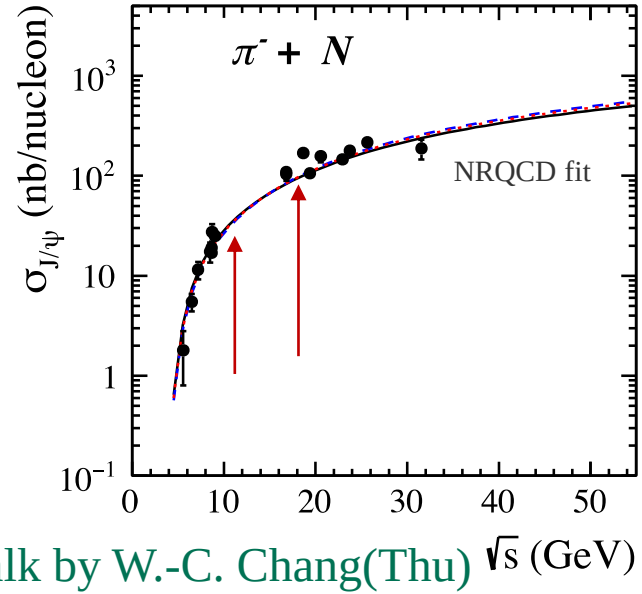
190 GeV



80 GeV



Integrated cross section

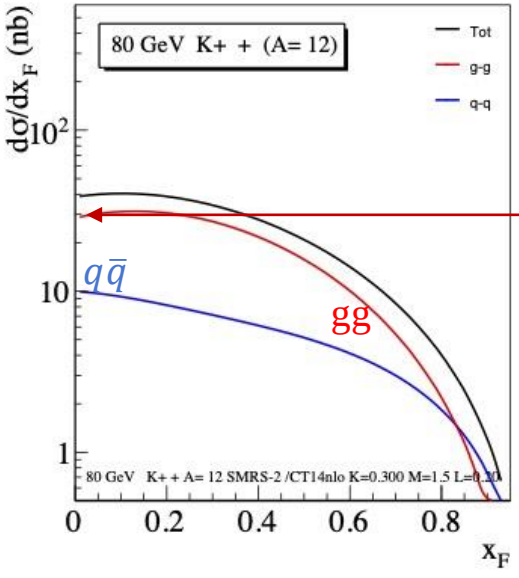


☞ talk by W.-C. Chang(Thu)

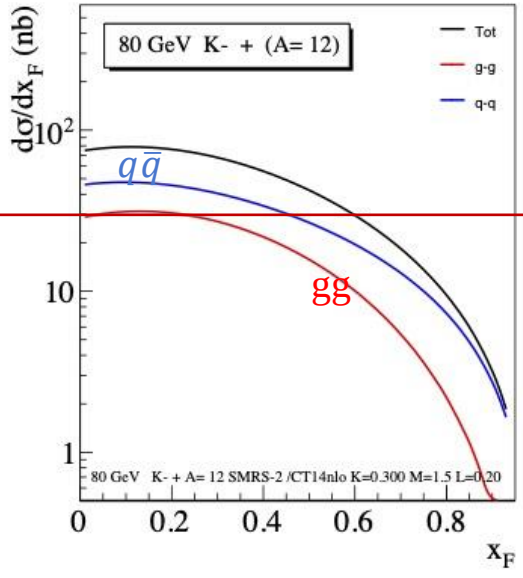
Lower energy = smaller cross section, but also:
much smaller *gg* contribution; the $q\bar{q}$ term is dominant

Beam charge dependence: K^+ vs K^- 80 GeV

K^+ beam



K^- beam



identical gg contributions

u-valence term dominates for K^-; absent for K^+

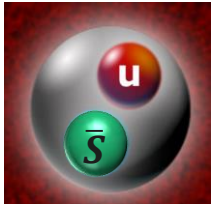
The K^+ cross section is smaller than the K^- one

Charge symmetry: the *gg* contributions are equal

J/ψ – access to the kaon valence PDF

- Quark content in the kaon:

$$K^+(u\bar{s}); \quad K(\bar{u}s)$$



- Production cross section for K^+ and K^-

$$K^-(\bar{u}s)+p(uud)\propto gg+\left[\bar{u}_v^K u_v^p\right]+\left[\bar{u}_v^K u_s^p+s_v^K s_s^p\right]+\left[\bar{u}_s^K u_v^p\right]+\left[\bar{u}_s^K u_s^p+u_s^K \bar{u}_s^p+s_s^K \bar{s}_s^p+\bar{s}_s^K s_s^p\right]$$

$$K^+(u\bar{s})+p(uud)\propto gg+\left[\text{- - -}\right]+\left[u_v^K \bar{u}_s^p+\bar{s}_v^K s_s^p\right]+\left[\bar{u}_s^K u_v^p\right]+\left[\bar{u}_s^K u_s^p+u_s^K \bar{u}_s^p+s_s^K \bar{s}_s^p+\bar{s}_s^K s_s^p\right]$$

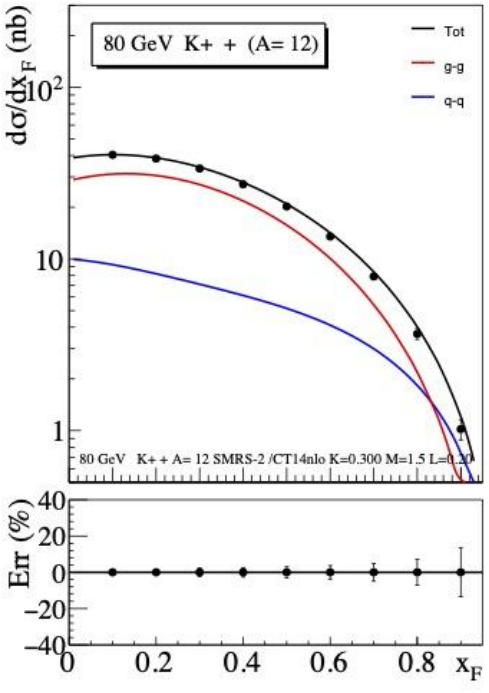
val-val | val-sea | sea-val | sea-sea

  - The cross section difference isolates the val-val term: $s(K^-)-s(K^+)\mu\,\bar{u}_v^K u_v^p$

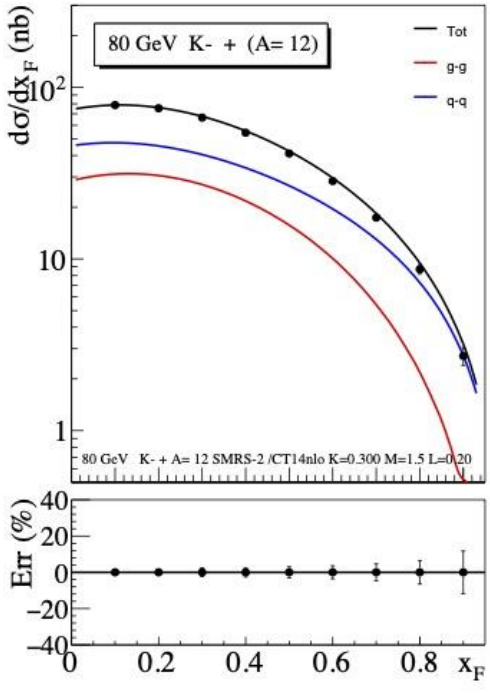
Error estimates FOR K^- and K^+ J/ψ cross sections: 80 GeV

- Assumptions
  - Flux: 5.10^5/s
  - ~10 000 events for each beam (conservative number)
  - Beam sharing: ~70 d of K− and ~210 d of K+
  - 3 carbon targets, length of 25cm each
  - x_F coverage: 0.00 – 0.95
- Lower panel: statistical errors in %

K^+ beam



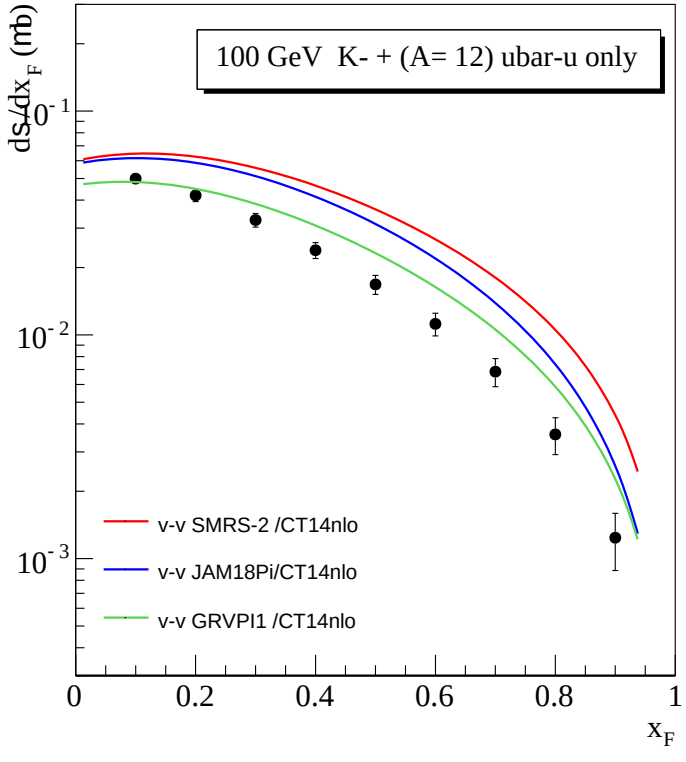
K^- beam



The difference between K^- and K^+ -induced J/psi production

- Assumptions
  - Both K charges measured with ~10^4 events
- Plotted quantity
  - The valence-valence part ($\bar{u}u$) of the J/ψ production cross section for K^-
  - 3 different models for the pion PDF-u
  - The errors include both statistical and systematic (4%) uncertainties

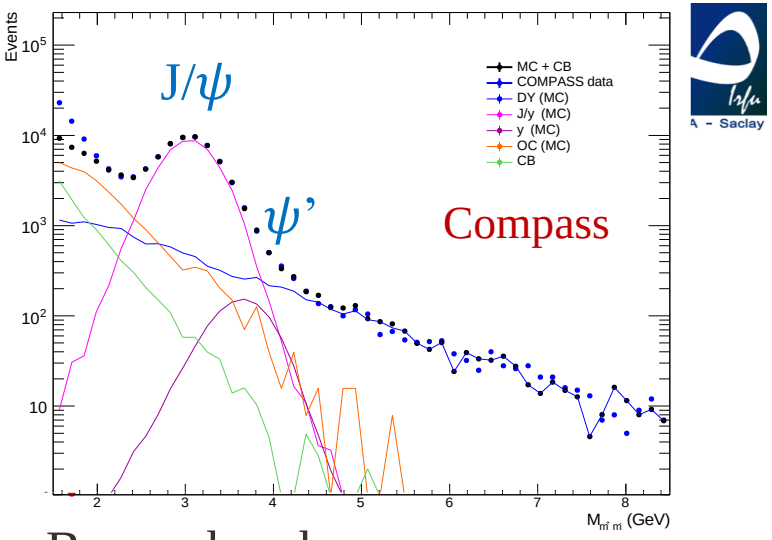
valence-valence term of K- only.



Additional opportunities

- Kaon-induced ψ' production
  - Unknown: can be measured for both kaon charges

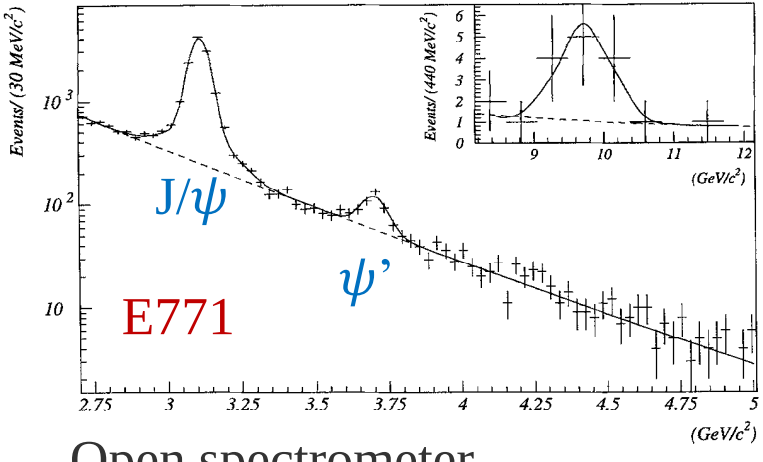
☞ talk by J.-C. Peng (Thu)



Beam absorber

E771 Collaboration / Physics Letters B 374 (1996) 271–276

- χ_c production and decay to J/ψ
  - detect photons in coincidence
  - not known for kaon beams



Open spectrometer

Conclusions on RF separated K beams

- Drell-Yan data: very limited statistics
  - Only marginal improvement of the available data

- Charmonium production: mass resolution=> good J/ψ and ψ' separation
  - J/ψ production: can be used to determine the kaon valence PDF with very good accuracy
  - ψ' production: has never been measured with kaon beams. Brings information on the kaon structure
  - χ_c production: never measured for kaons; can be done by detecting photons in coincidence.