HERA-B

F.Sánchez

Max-Planck-Institut für Kernphysik

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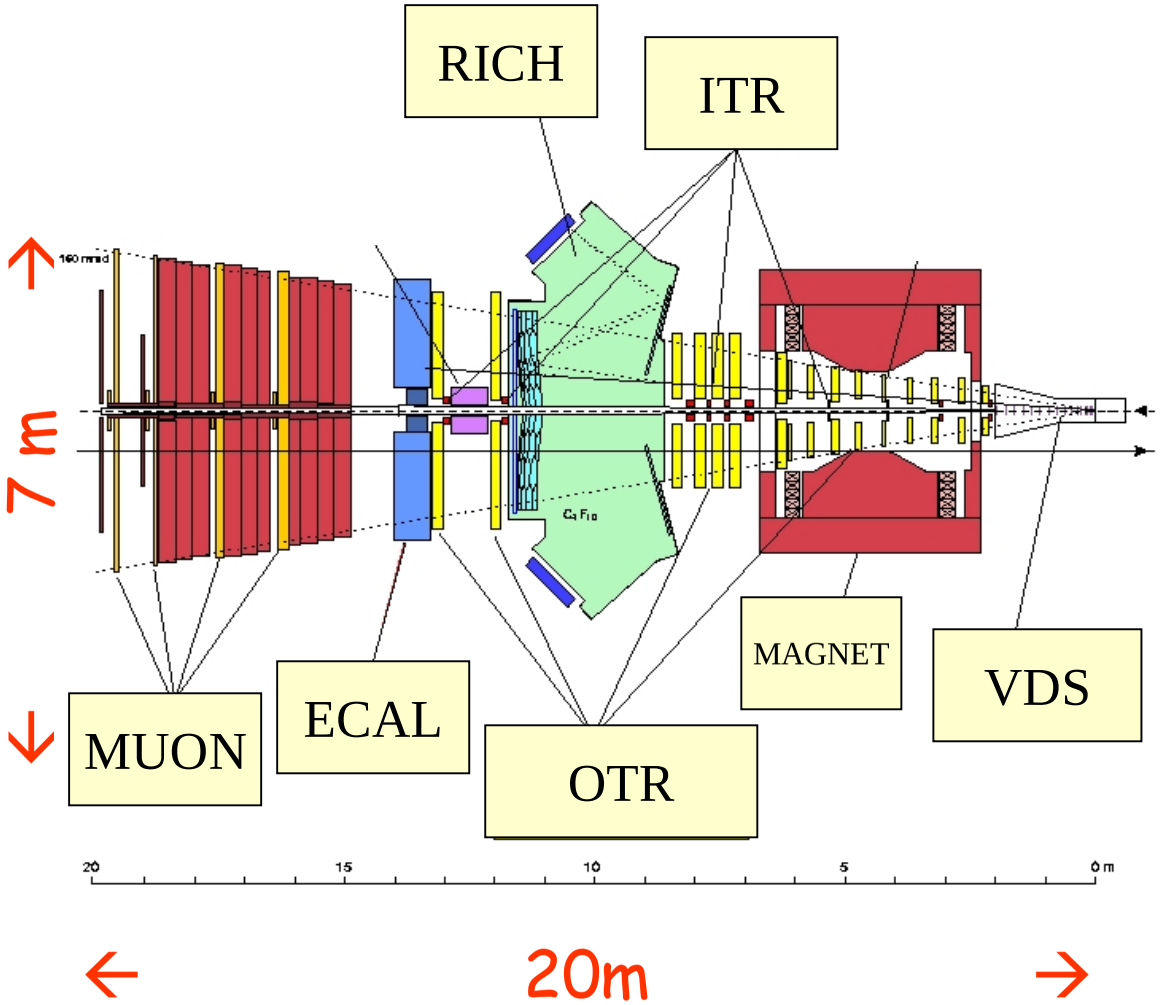
Outline

- Latest news from commissioning:
  - Status of detector components.
  - Status of First Level Trigger.
- Analysis of 2000 data.
- Physics program for 2002.
- Summary.

HERA-B experiment.



TRACKING

Vertex detector (VDS).

Inner tracker (ITR).

Outer tracker (OTR).

PID

Cerenkov detector(RICH).

Electromagnetic Calorimeter (ECAL).

MUON detector.

High p_t lepton
(μ & e) track trigger.

Target wires with
C, Al, Ti, Pd & W

Status of detector components.

- HERA-B detector operational in 2000 run.
- Improvements during 2001 shutdown:
  - Noise reduction (improved grounding):
    - increased efficiency.
    - improved resolutions.
  - Dead detector modules repaired.

	Status & actions during 2001 shutdown
VDS	Fully operational in 2000. Detector modules repaired.
ITR	Dead chambers repaired. Noise reduction (improved grounding). Installation of missing chambers.
OTR	Dead HV groups repaired. Noise reduction → Higher efficiency due to lower threshold cut.
RICH	Fully operational in 2000.
ECAL	Reduction of common noise (grounding improved) → better E resolution.
MUON	Dead channels repaired. Noise reduction → lower threshold, higher efficiency.

Status of First Level Trigger

The First Level trigger was not fully commissioned in 2000.
Low efficiency from detector and trigger performances.

Analysis of 2000 data finished:

single track muon efficiency ~ 20%. (expected ~50% in 2002.)
single track electron efficiency ~ 50%. (expected ~80% in 2002.)

Vector test successful: download MC event into the hardware for bit wise comparison between the hardware and simulation outputs.
Independent confirmation of previous results.

Many improvements in hardware, algorithm, & simulation,
... implemented in 2001

Large improvement in performance expected for 2002.

Analysis of 2000 data.

2000
ANALYSIS TOPICS

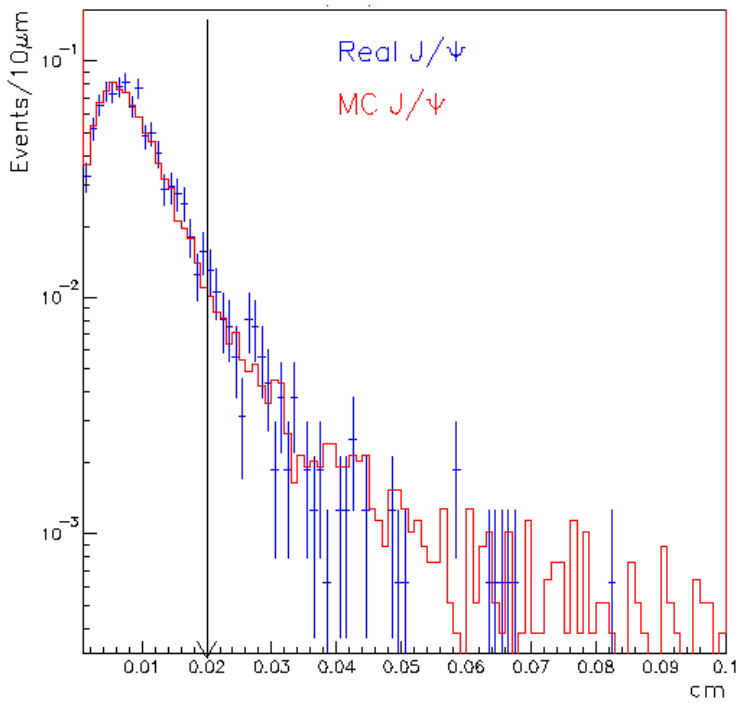
Different trigger conditions.

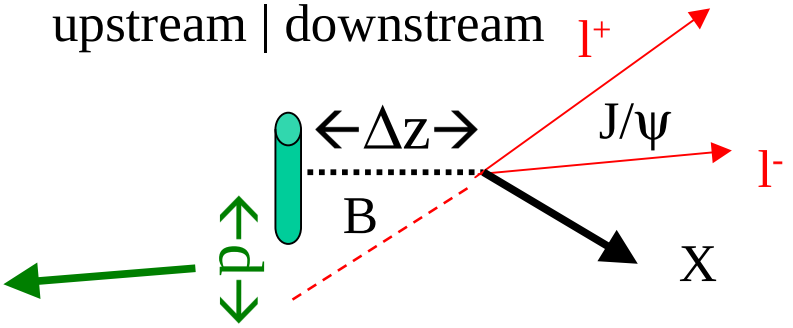
- Minimum Bias: (No trigger)
  - K_s^0 & Λ production cross section.
  - Inclusive particle productions.
  - Λ polarisation.
- $e^+ e^-$ pair (ECAL E_t trigger seed and tracking)
- $\mu^+ \mu^-$ pair (MUON track seed and tracking)
  - σ_{bb} production cross section.
  - J/ψ production cross section.
  - x_f and p_t inclusive J/ψ distributions.
  - Fraction of J/ψ from χ_c.
  - J/ψ suppression in different target materials.
- Single lepton (electron and muon trigger).
  - Open charm production cross-section.

pA→bb cross section (σ_{bb})

Principle of the measurement

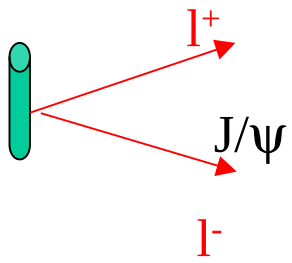
Look at the production chain: **pA → b b → B → J/ψ X** via detached J/ψ vertices.





and normalized to the inclusive J/ψ (prompt) cross section.

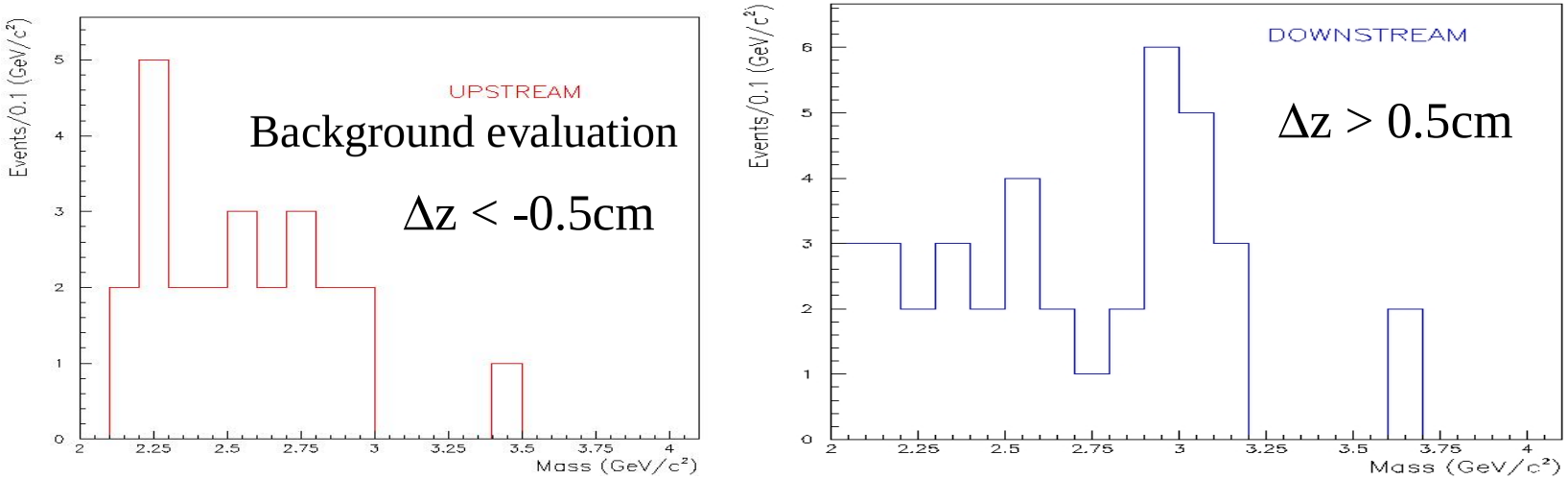
Comparison of lepton impact parameter between Data and MC for prompt J/ψ .



pA→bb cross section (σ_{bb})

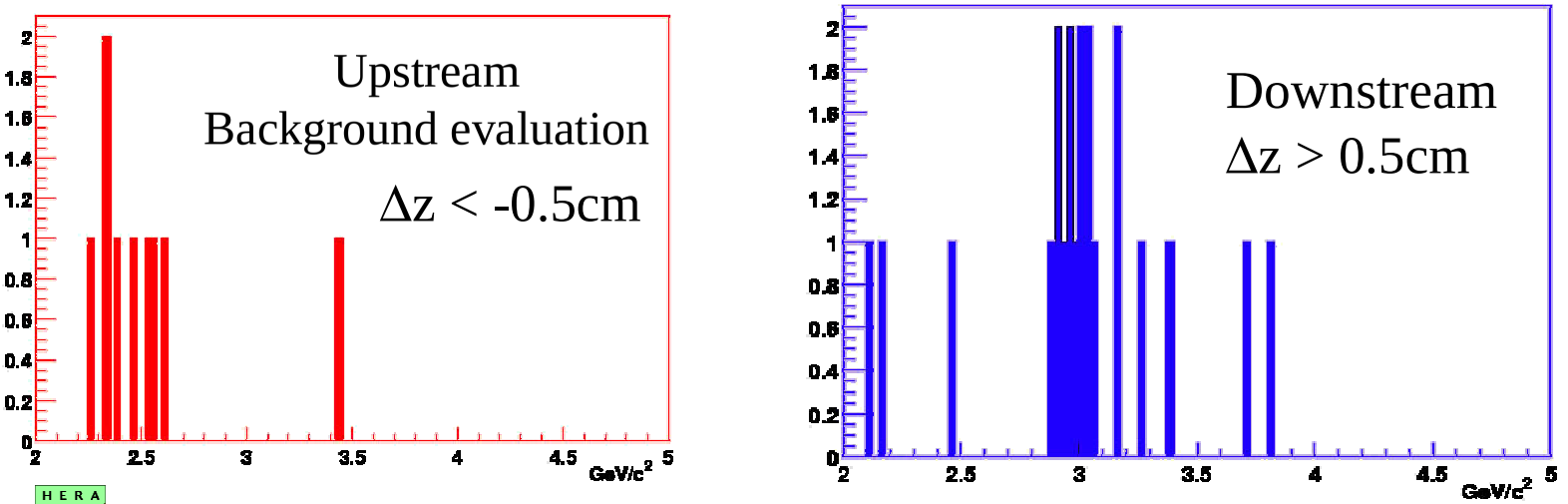
Excess of J/ψ downstream → indication of B decays.

Event by event J/ψ vtx. to primary vertex.



$J/\psi \rightarrow e^+ e^-$

Alternative method using the average target wire position → reduced primary error



$J/\psi \rightarrow e^+ e^-$

pA→bb cross section (σ_{bb})

$J/\Psi \rightarrow e^+ e^-$

Method 1 $\sigma_{bb} = 60 \pm 19$ nb

Method 2 $\sigma_{bb} = 55 \pm 22$ nb

$J/\Psi \rightarrow \mu^+ \mu^-$

Similar analysis gives upper limit:

$\sigma_{bb} < 98$ nb @ 90% C.L.

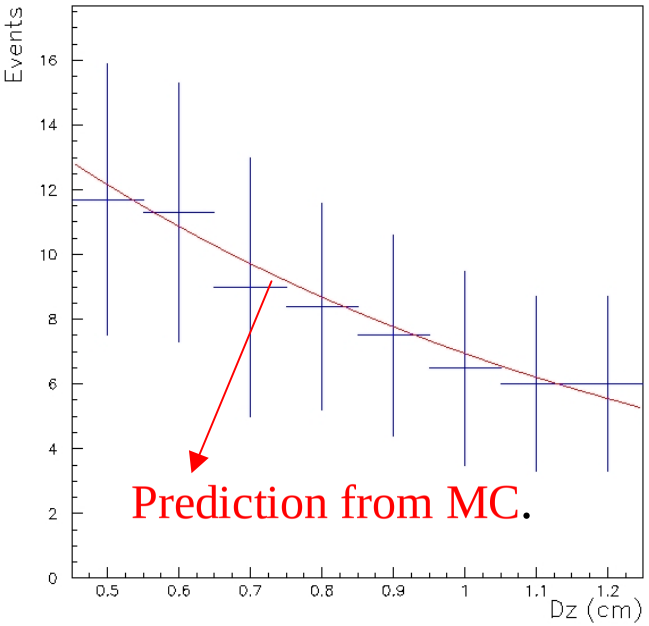
Published values (800 GeV):

E789: 5.7 ±1.5 ± 1.3 nb

E771: $43^{+27}_{-17} \pm 7 nb$

Very preliminary!!!

Accumulated detached Ψ vs. distance J/Ψ vertex to primary.



HERA-B sees B mesons with low statistics.

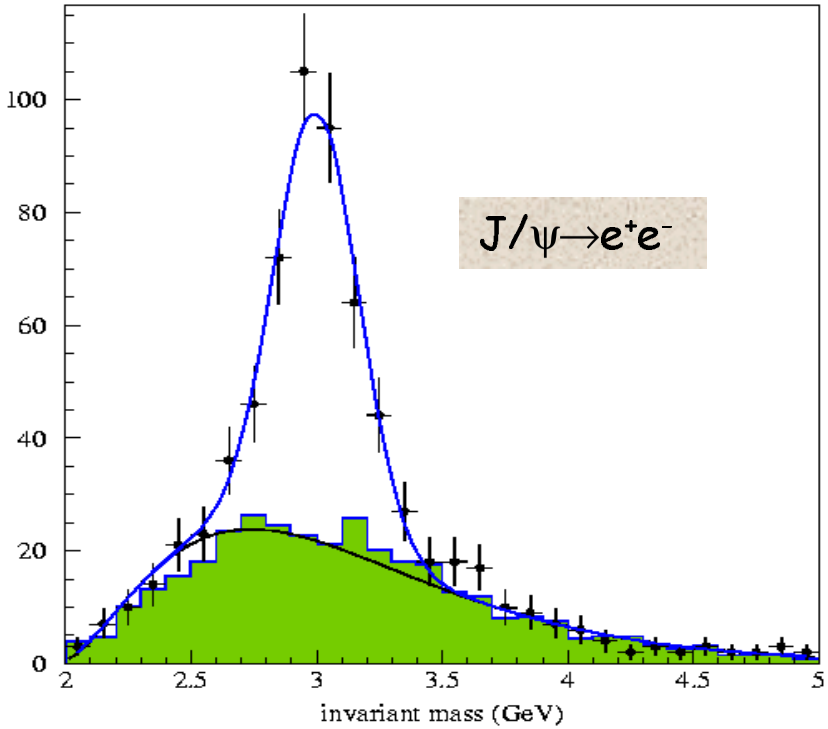
HERA-B will be able to measure σ_{bb} in 2002:

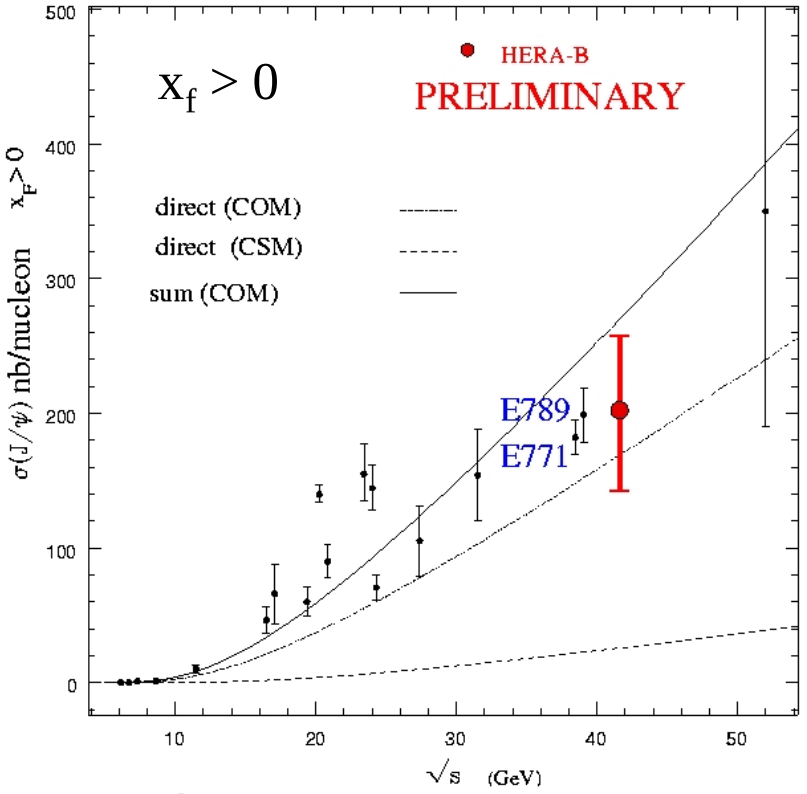
- expected error limited by J/ψ direct cross section (20%).
- possibility of measuring cross section vs. material nuclear mass (A)(NEW!).

Absolute J/ψ cross section

HERA-B is able to measure an absolute cross-section comparable to previous experiments.

Trigger efficiency & Luminosity determination (from reference minimum bias) can be controlled.





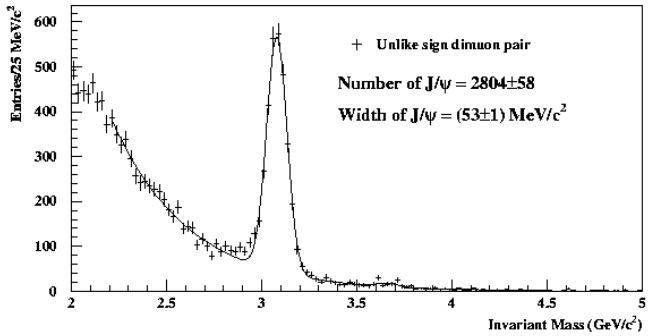
J/Ψ P_t and x_f spectra.

$$\frac{dN}{dx_f} = A(1-|x_f|)^C$$

Phenomenological dependency.

x_f

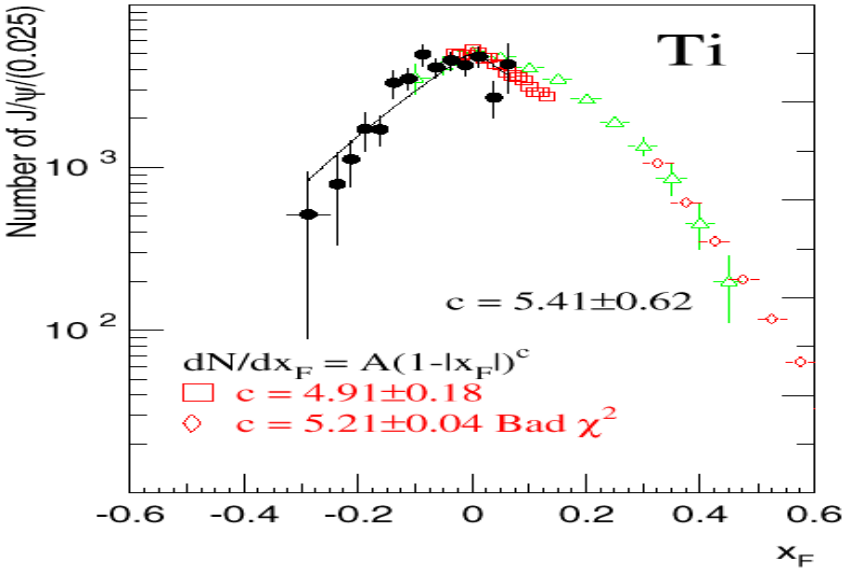
$J/\Psi \rightarrow \mu^+ \mu^-$
Samples for C and Ti.

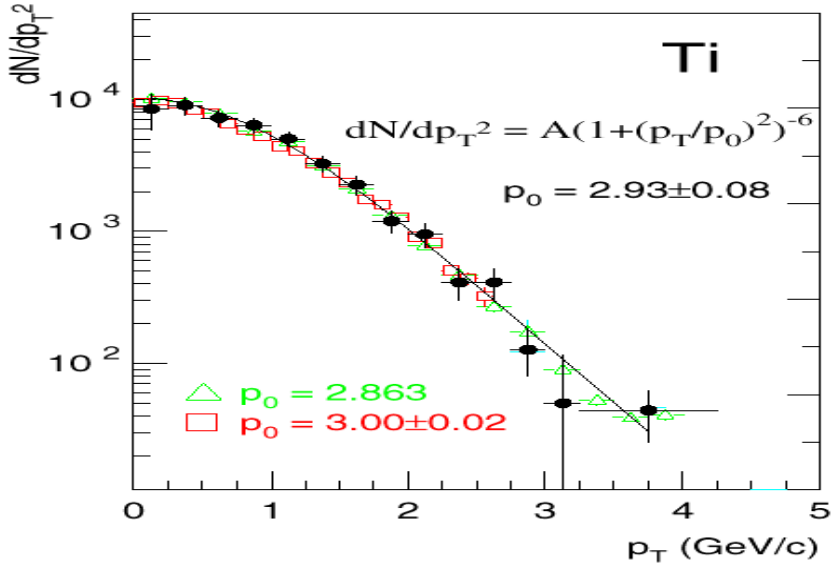


Phenomenological dependency.

p_t

$$\frac{dN}{dp_t^2} = A(1+(p_t/p_o)^2)^{-6}$$





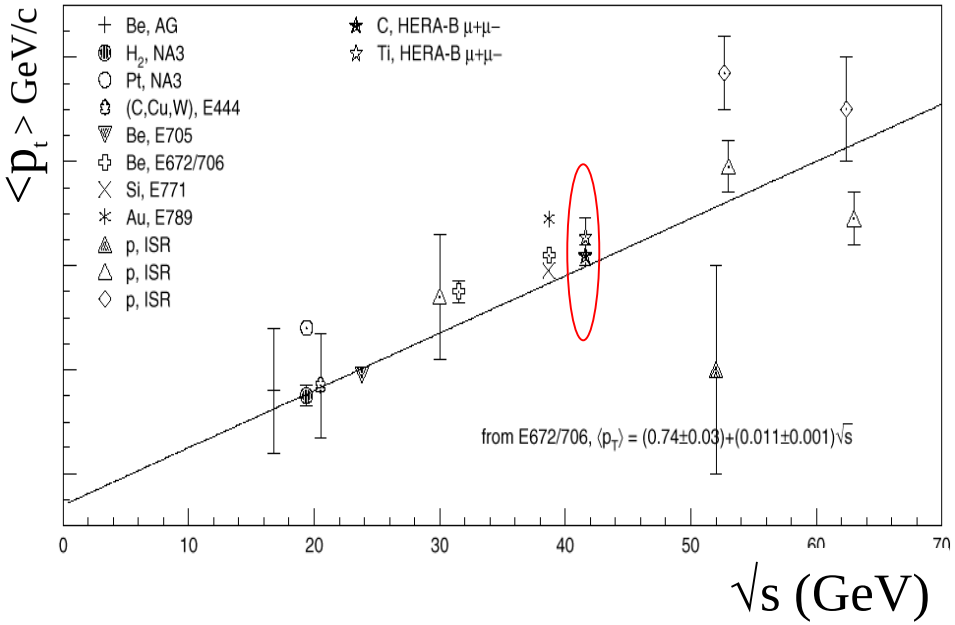
J/ψ P_t and x_f spectra.

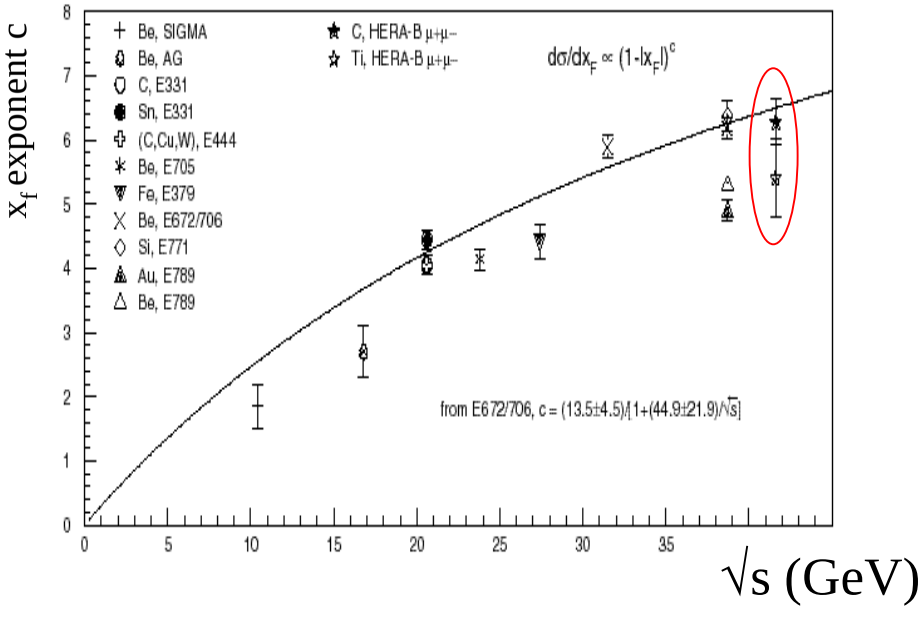
HERA-B will be able to measure the p_t and x_f spectra in 2002 with comparable precision to the existing data.

It will extend for the first time data to the negative Feynman x.

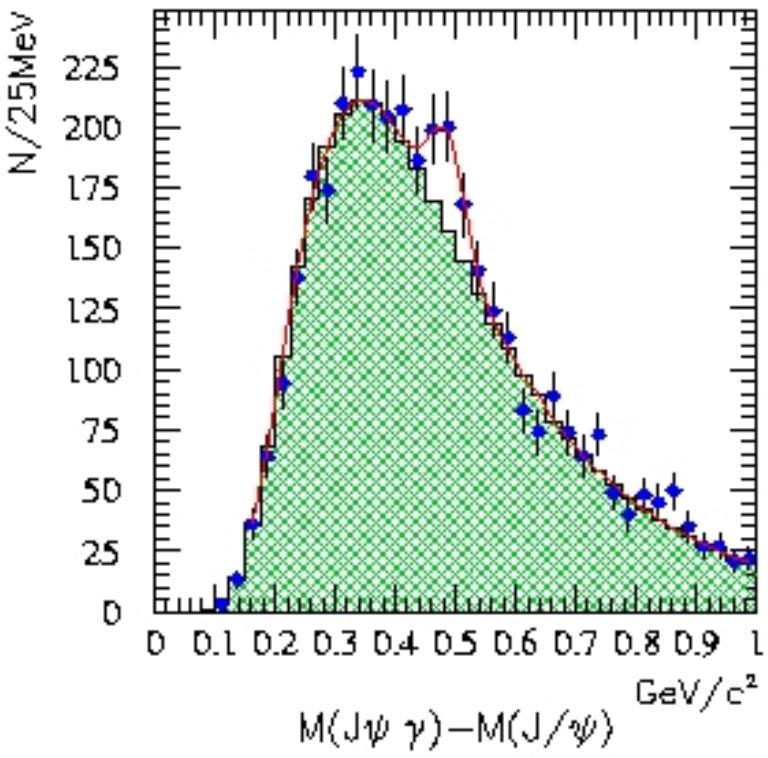
Errors will be limited by the modelling of trigger and detector acceptance.

Comparison with previous experiments



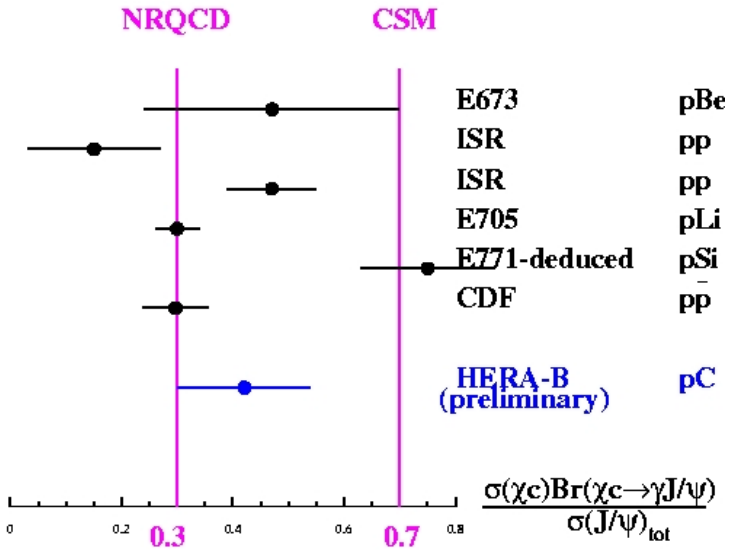


Fraction of J/ψ from χ_c



$\chi_c \rightarrow J/\psi\,\gamma$ (sum of eeγ and $\mu\mu\gamma$)

Background model from mixed events.



HERA-B spectrometer allows to look at more than the dileptons.
HERA-B will be able to reconstruct a large sample of χ_c in 2002:

- first measurement of suppression in nuclear matter.
- study of production ratios between J/ψ , χ_c and Ψ‘.

Physics program for 2002

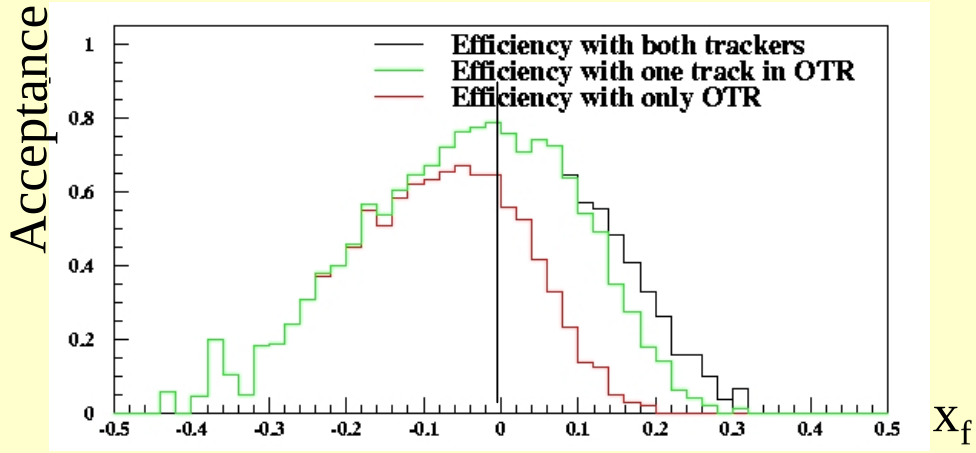
- Next year HERA-B will run a dilepton trigger (μ & e).
- Expected number of events:

	2002	2000
J/ψ (μ channel)	~2 10^6	~4 10^3
$\chi_c \rightarrow J/\psi\,\gamma$	~2 10^5	~1 10^2
Ψ´	~3 10^4	~2 10^1

Distributed over different target materials: C, Ti and W. (possibly Al & Pd)

With a large acceptance into the negative Feynman x [-0.4,0.3].

Acceptance from MC



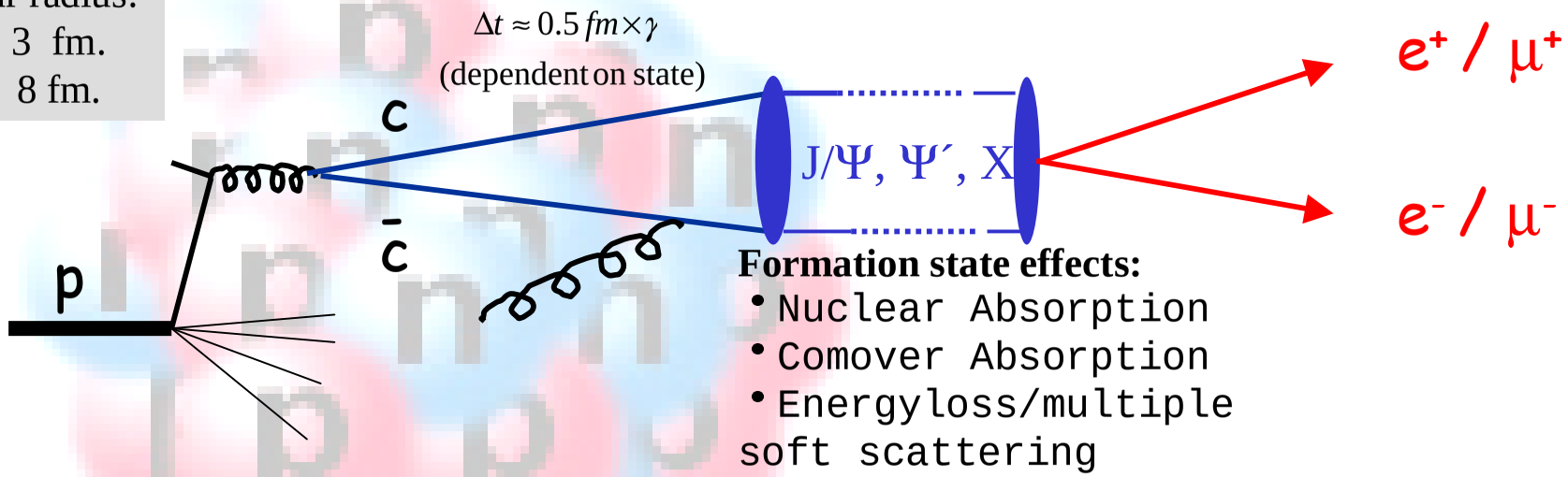
Physics program for 2002

Study of charmonium supression

x_f measures the distance the ccg state travels before charmonium formation.

X_f	Dist.
0.2	15fm
0.0	5fm
-0.2	1.5fm

Nuclear radius:
C ~ 3 fm.
W ~ 8 fm.



Formation state effects:
- Nuclear Absorption
- Comover Absorption
- Energyloss/multiple soft scattering

Initial state effects:
- Shadowing
- Parton energy loss
- Intrinsic charm

•Positive x_f → ccg abandons the nucleus before it forms a bound state.

•Negative x_f → charmonium is formed before leaving the nucleus.

Physics program for 2002

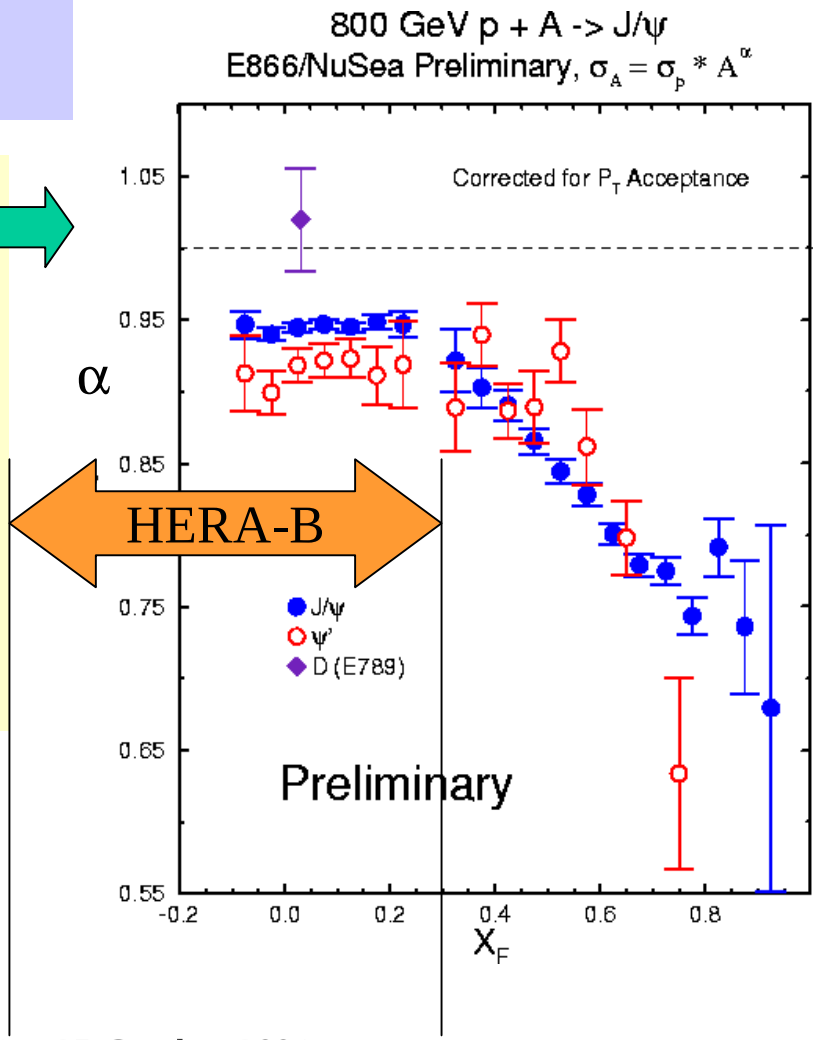
Study of charmonium suppression

The charmonium cross section versus nuclear mass:

$$\sigma = \sigma_0 A^{\alpha(xf)}$$

$\alpha(x_f)$ measures the charmonium suppression in nuclear matter. (α=1 → no suppression)

- E-866 has measured the suppression in nuclear matter for positive x_f.
- HERA-B will measure the charmonium suppression in the negative x_f region.
- HERA-B explores the charmonium-N cross-section for J/ψ and Ψ‘.
- HERA-B will measure the suppression of χ_c in nuclear matter for the first time.



Expected precision similar to existing data in the common x_f range.

Summary

- First analysis of 2000 data shows the capabilities of the detector to provide interesting physics.
- Improved performance of the HERA-B spectrometer for 2002.
- HERA-B will cover an unexplored area of proton-nucleus collisions with $x_f<0$.
- Large statistics of charmonium states expected for year 2002. (factor of ~60 increase of production rate)

Summary (physics program)

Base line physics program for 2002

- Charmonium suppression.
- bb production cross section.

Possible extensions

- Drell-Yan (e.g. angular distribution).
- Direct photon production at high p_t.
- Limit on Br($D^0 \rightarrow \mu^+\mu^-$).
- Open charm production.
- Minimum bias (e.g. Inclusive particle production).

Summary

HERA-B is anxiously waiting for the new data to come.