Progress report from Heavy Flavours and Gamma groups.

19.10.200

L. Gladilin
K. Daum
S. Sultansoy

Outline:

- status of April
- saturation effects with charm at THERA?
- CCFM predictions for HF at THERA
- charm and beauty from resolved processes
- real photon program
- new studies on low x_g in ep and γp collisions
- status of October

from April:

First Conclusions

- **THERA will provide HQ measurements at high Q^2 and high $P_\perp$ values. Proper place to varify ressumed NLO calculations.**
- **THERA is more competetive with HERA in beauty sector.**
- x_g range till 10^{-5} is kinematically available but hardly measurable. 10^{-4} is more realistic.
- Rear tracking (in addition to central, of course,) is crucial for charm studies.
- **Rear μ-detector (in addition to central, of course,) is crucial for beauty studies.**
- THERA is great machine for resolved processes and photon structure (g, c, b) measurements.

— o —

$\theta^{trk} > 0.4^{\circ}$

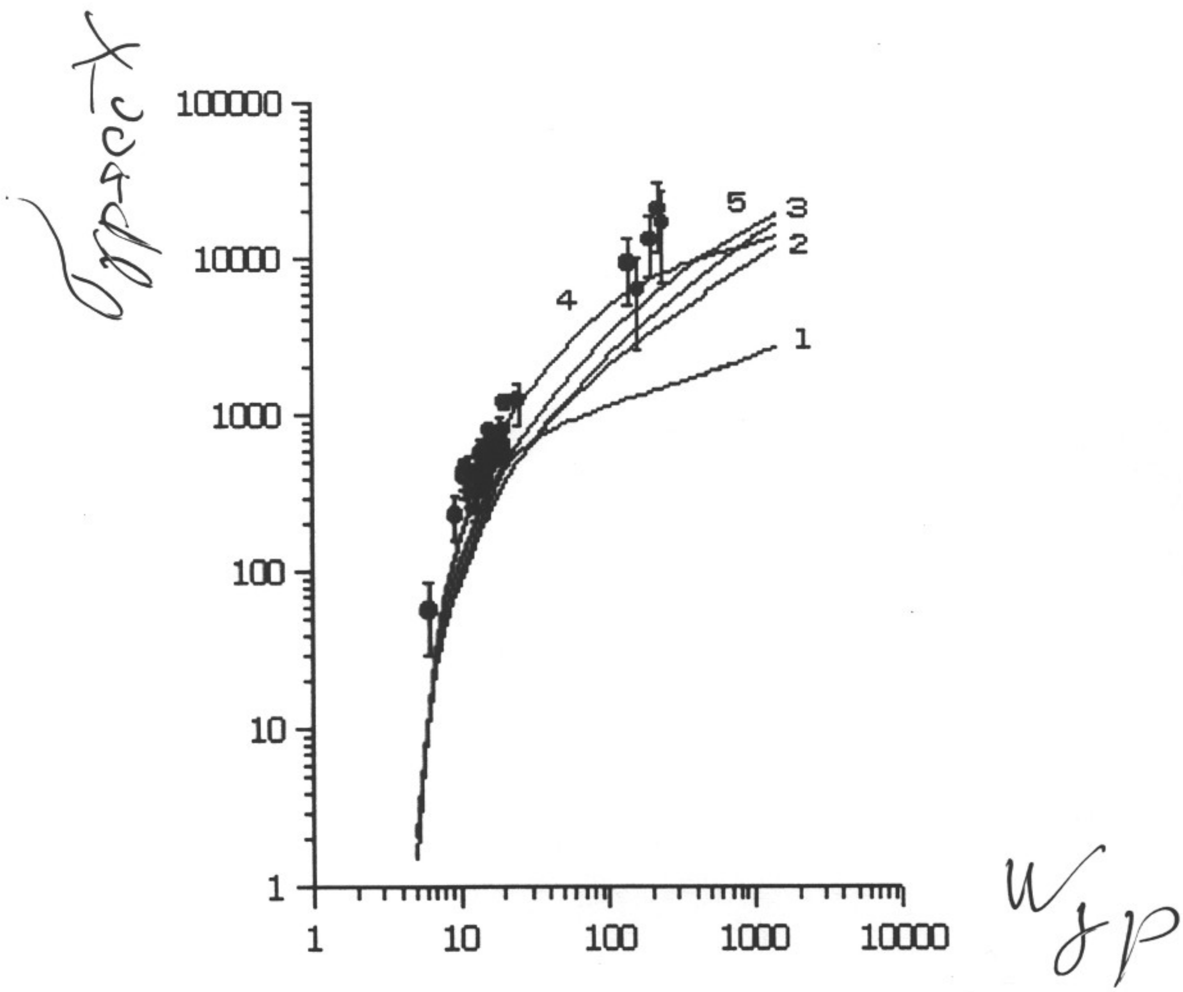
$P_\perp \sim 1$ GeV

$\sigma_{\gamma p \to c\bar{c}X}$ in Semi-Hard Approach

Nikolai Zotov

$k_\perp$ factorization approach $\longrightarrow$ unintegrated gluon distribution

an option for gluon density saturation at small $x(g)$ values



1 - **Standard Parton Model with MT $xg(x)$**

2 - **Standard Parton Model with GRV $xg(x)$ and $K = 2$**

3 - **Ryskin-Shabelski numerical solution of BFKL equation**

4 - **Levin-Ryskin-Shuvaev-Shabelski phenomenological parameterization with saturation effects (normalized to $b\bar{b}$ at TEVATRON)**

5 - **BFKL parametrisation (by Blumlein): LO solution of BFKL equation with $\delta = 0.35$**

4 is flatish while 3 and 5 are sharply growing

Can we catch the saturation effect at THERA ?

H. Jung
(LUND)

Heavy flavours at THERA from CCFM

- Basics CCFM
- unintegrated gluon
- HERA $\longrightarrow$ $b\bar{b}$ at TEVATRON
- pred. for THERA

Cross-sections at THERA

	HERA 27,5 x 920	THERA 250 x 920	500 x 920
charm $m_c = 1{,}5$	808,6 nb 670 nb	1567 nb 1700 nb	1875 nb
bottom $m_b = 5$	5,98 nb 4 nb	18,5 18 nb	24,9
top $m_t = 173{,}5$	–	$6{,}2 \cdot 10^{-6}$ $9 \cdot 10^{-6}$	$4 \cdot 10^{-5}$

– CASCADE (CCFM)
– RAPGAP (dir + res) GRV HO (DIS)

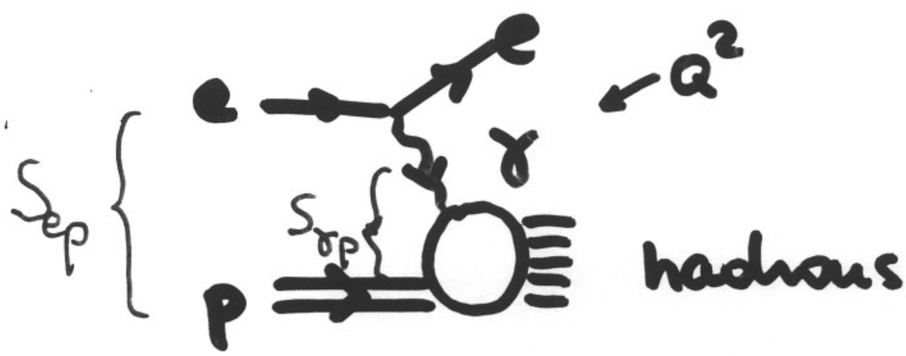
CCFM → from F_2 HERA
predict TEVATRON + THERA

➡ determination of
un integrated gluon!

➡ also for diffraction!

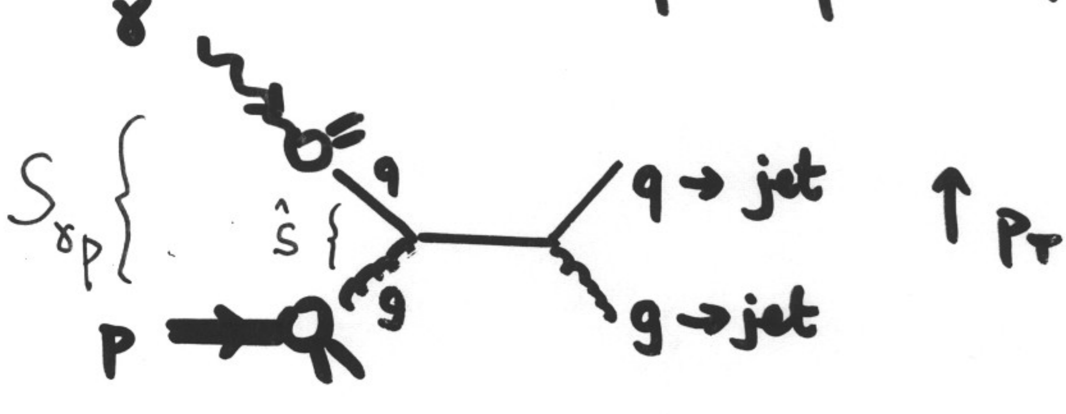
⇒ consistent picture!

Photon-hadron interaction at high energy ~ 1 TeV



- **HARD PROCESSES** for $\underline{Q^2 \lesssim 1\,\mathrm{GeV}^2}$
  with $E_\gamma = y E_e$ $\quad y \in 0.2-0.8$

⇝ resolved photon processes in photoproduction



$$\boxed{\hat{s} = x_p\, x_\gamma \underbrace{y\, S_{ep}}_{S_{\gamma p}}} \qquad \hat{s} \geqslant 4p_T^2$$

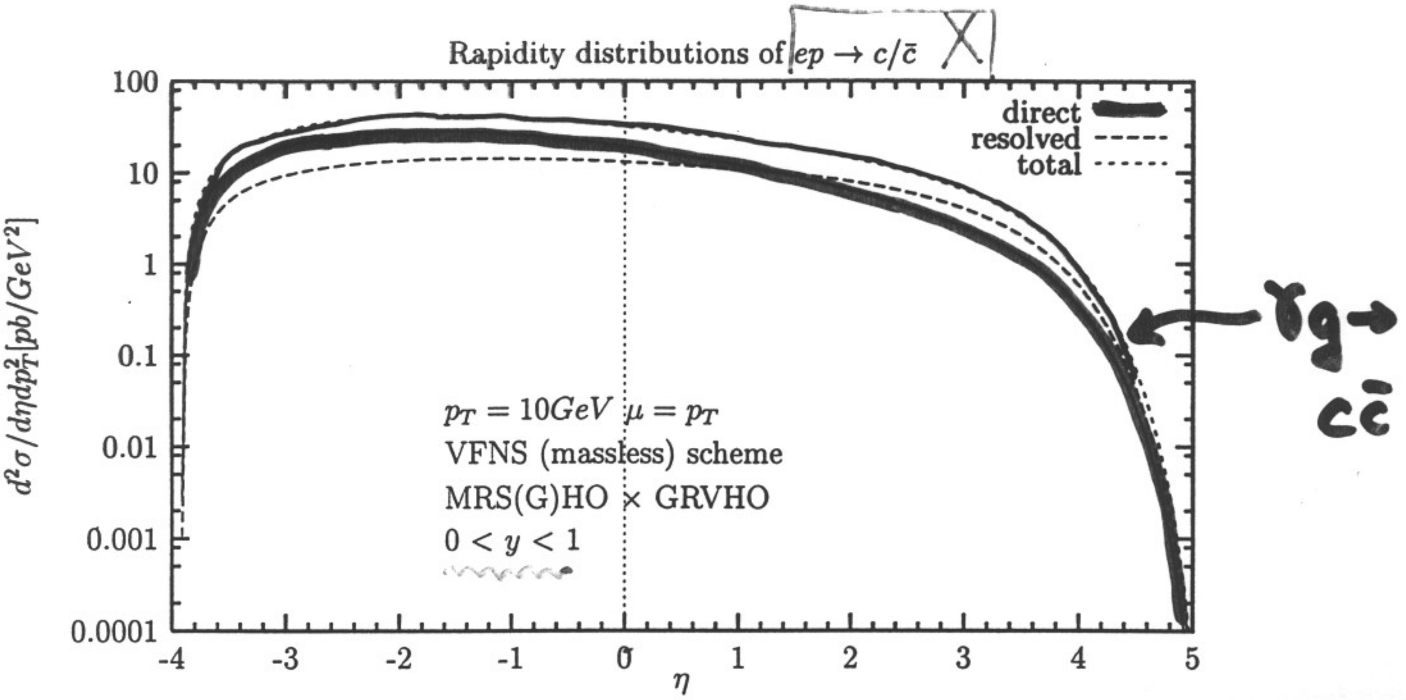


Figure 3: $c/\bar{c}$ production, THERA, $Ep = 920$ GeV, $Ee = 250$ GeV

$P_T = 10$ GeV

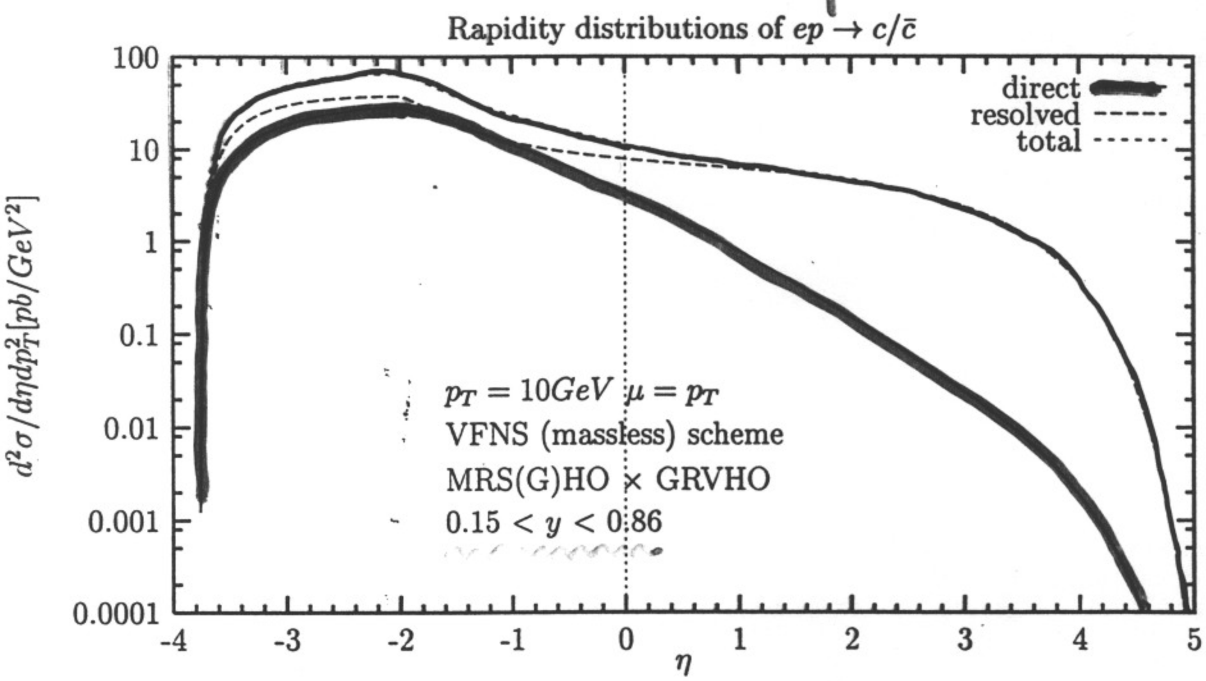


Figure 4: $c/\bar{c}$ production, THERA, $Ep = 920$ GeV, $Ee = 250$ GeV

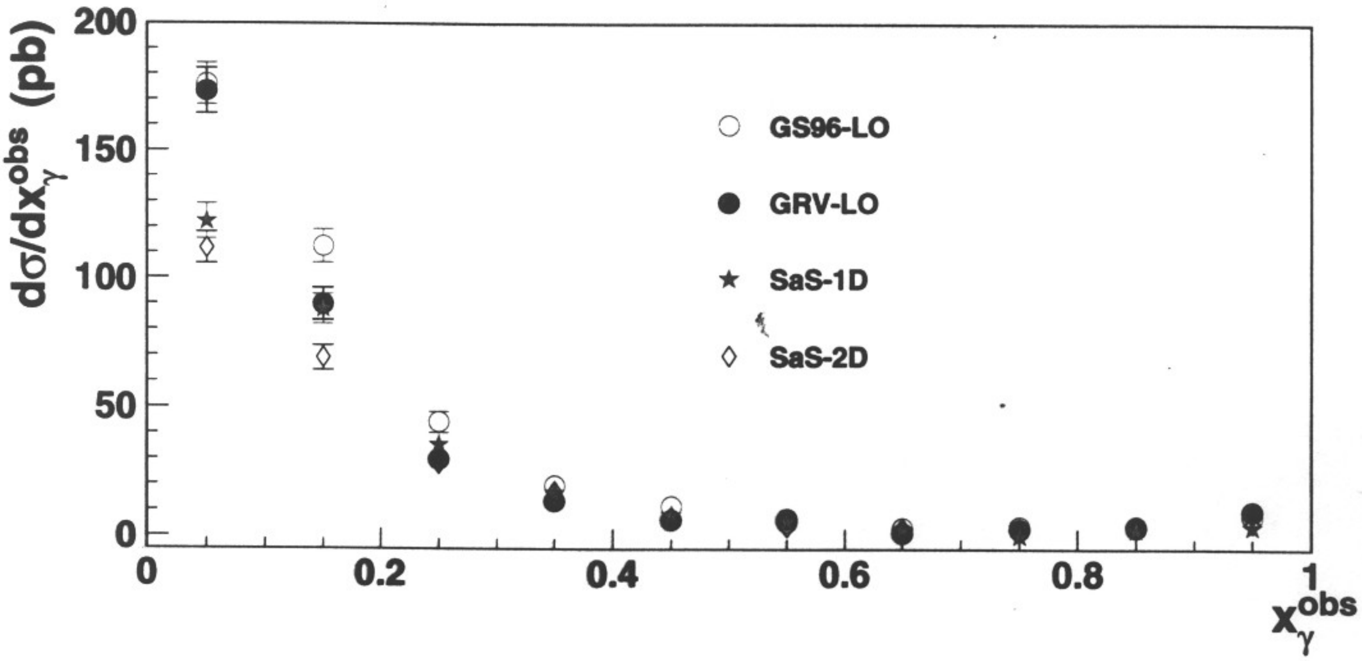
7

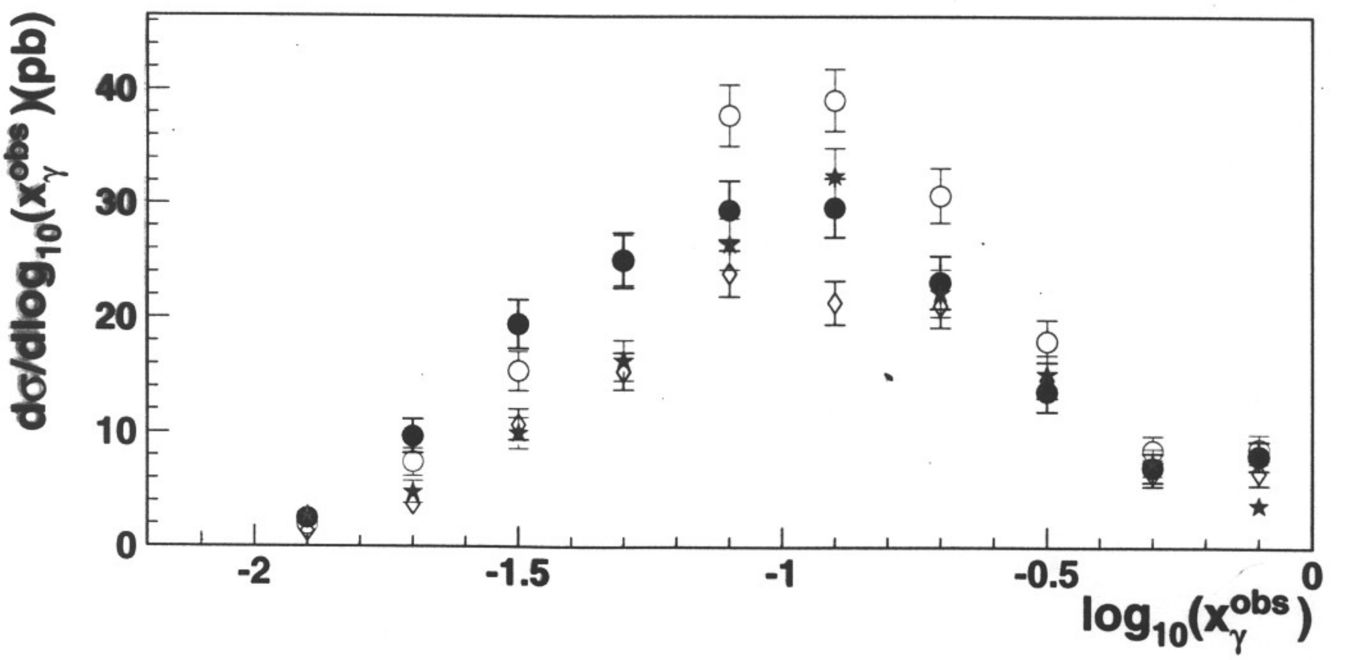
M. Wing

$E_T^{jet1(2)} > 7\,(6)$ GeV

$-1. < \eta^{jets} < 2.$

$p_\perp(D^{*+/-}) > 3$ GeV ; $|\eta(D^{*+/-})| < 1.5$





Heavy Flavours at Gamma Options of THERA

S. Sultansoy

Deutsches Elektronen-Synchrotron DESY, Notke Str. 85, D-22607 Hamburg, GERMANY

Physics Dept., Faculty of Arts and Sciences, Gazi Univ., 06500 Ankara, TURKEY

Institue of Physics, Academy of Sciences, H. Cavid avenue 143, Baku, AZERBAIJAN

1. γp option

2. γA option

3. Fixed Target option

Heavy Quarks at Gamma Options of THERA (summary)

γp: $x_g \simeq \dfrac{5 \cdot m^2_{c(b)}}{0.8 \cdot S_{ep}}$, "Q^2" $= \mathcal{O}(m^2_{c(b)})$

$\gamma p \to$	$\bar{c}cX$	$\bar{b}bX$	$\bar{t}tX$
x_g	10^{-5}	10^{-4}	0.04
N/year	$10^7 \div 10^8$?!	$10^6 \div 10^7$?!	$10^2 \div 10^3$

See talk given by L. Gladilin

$\gamma p \to \gamma A$: $x_g \to \dfrac{A}{Z} x_g$, $N \to \dfrac{1}{10} N$

$\gamma p \to t X$

$\gamma u \to t \to W^+ b$

$\left\{ \begin{array}{l} \gamma c \to t \to W^+ b \\ \gamma \bar{c} \to \bar{t} \to W^- \bar{b} \end{array} \right.$

$\gamma d(s) \to b$??

---

f.t. $\gamma^{\uparrow\downarrow} N^{\uparrow\downarrow} \to \bar{c}cX, \bar{b}bX$

x_g: 0.02 0.2

$\left.\dfrac{\Delta G}{G}\right|_{syst} < 1\%$?!

S.I. Alekhin et al, Eur. Phys. J. C 11 (1999) 301

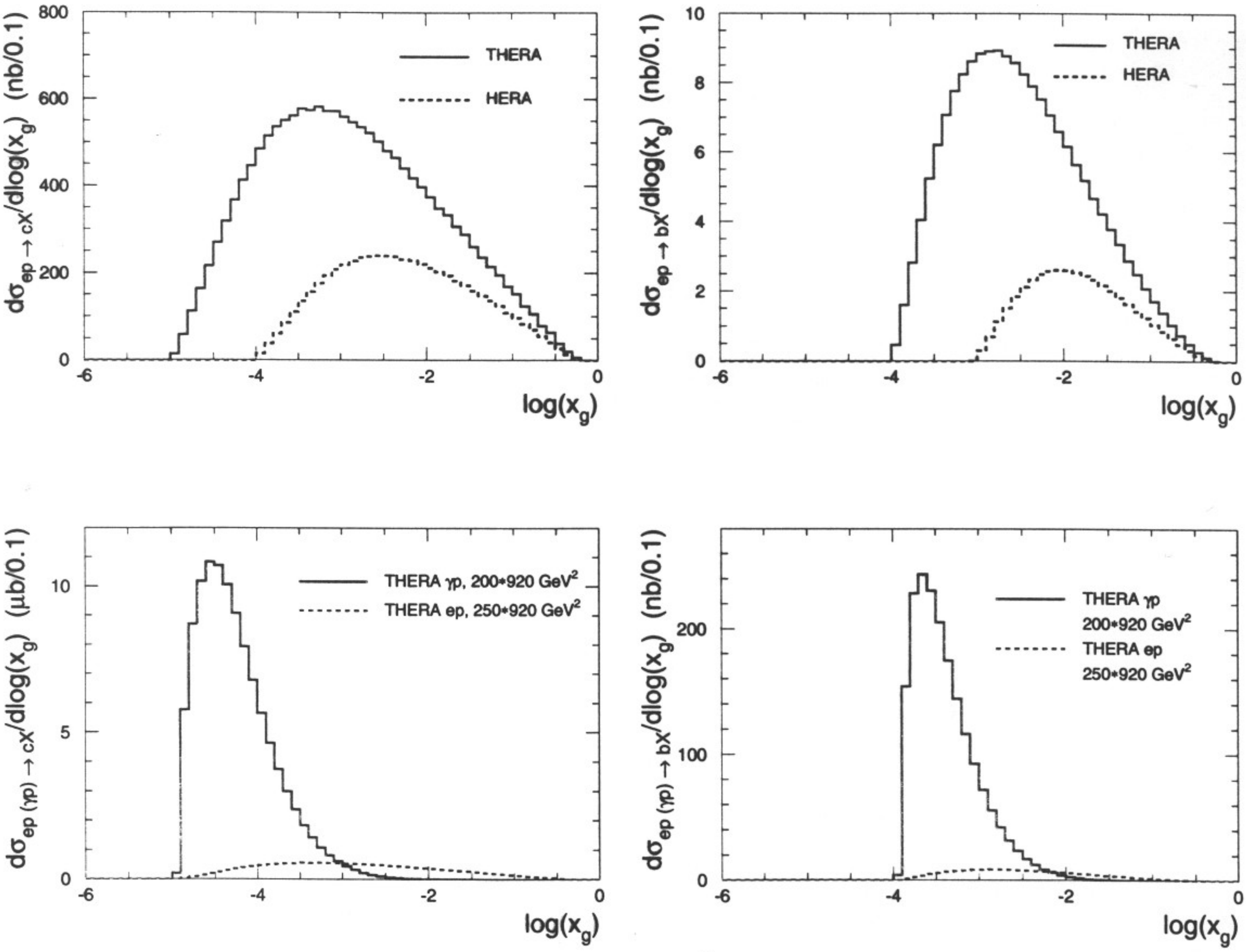
$\gamma^{\uparrow\downarrow} p^{\uparrow\downarrow}$ <u>collider</u> option — unique tool for gluon polarization

$x(g)$ at HERA and THERA ep and γp

NLO QCD (FMNR), $\gamma g \to c\bar{c}(b\bar{b})$

proton s.f. GRV 98, $\mu_r = \mu_f = m_\perp, m_c = 1.5, m_b = 4.75$

	charm $[\mu b]$	**beauty** $[nb]$
HERA ep, $Q^2 < 1\,\mathbf{GeV}^2$	**0.56**	**4.2**
THERA ep $Q^2 < 100\,\mathbf{GeV}^2$	**1.62**	**18.0**
THERA γp	**107.6**	**188.7**

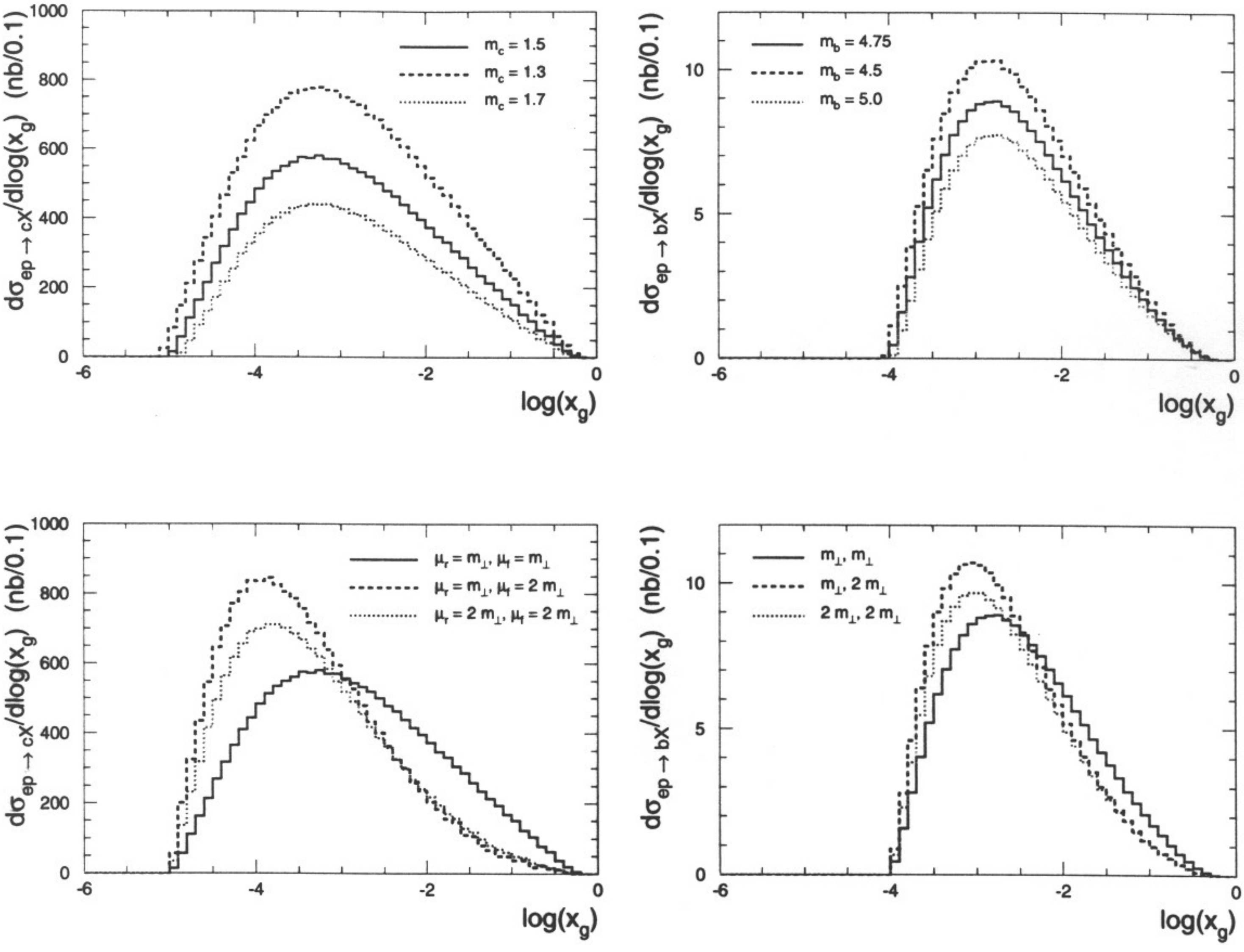


$10^{-5} < x_g < 10^{-3}$: THERA region

Different masses and scales

NLO QCD (FMNR), $\gamma g \to c\bar{c}(b\bar{b})$

proton s.f. GRV 98



m_c is better known already now

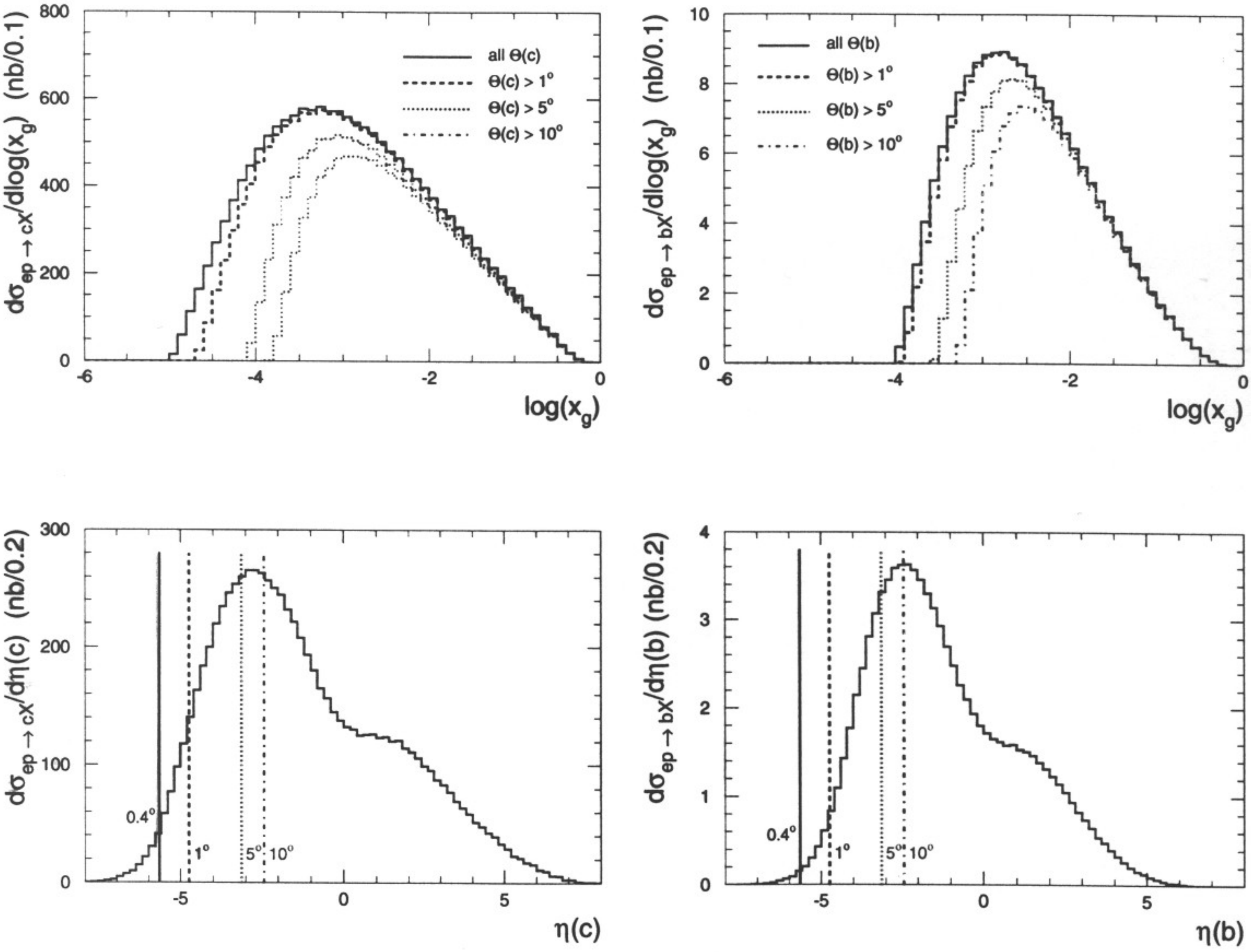
scale? => NNLO => N^3LO

major theoretical progress is needed!

$x(g)$ and $\eta(c,b)$; ep collisions

NLO QCD (FMNR), $\gamma g \to c\bar{c}(b\bar{b})$

proton s.f. GRV 98, $\mu_r = \mu_f = m_\perp, m_c = 1.5, m_b = 4.75$

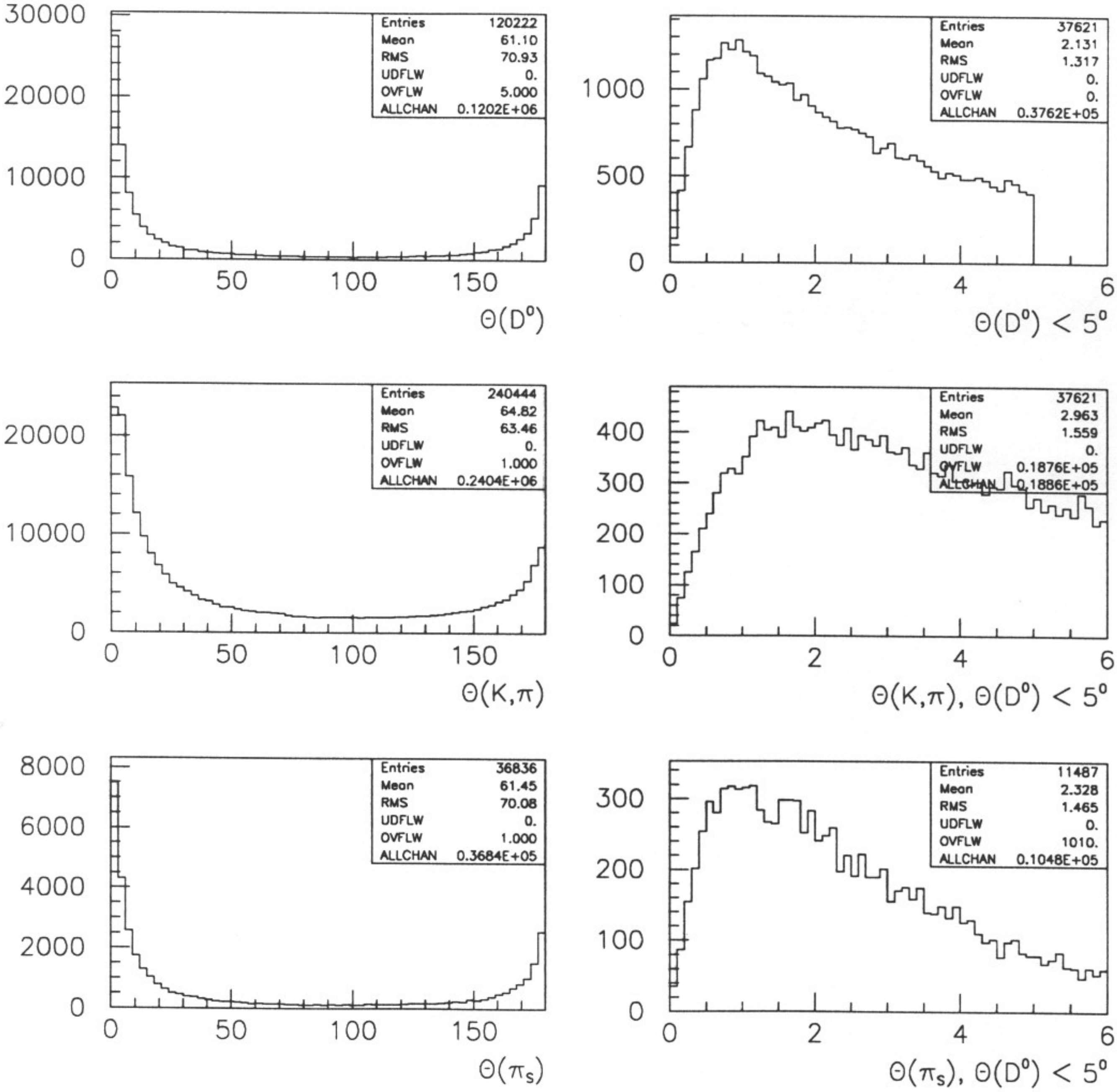


$\Theta(c) < 5^\circ$ is the region of major interest!

$\gamma g \to c\bar{c}$, $D^0 \to K^- \pi^+$ + c.c.

$D^{*+} \to D^0 \pi_s^+$ + c.c.

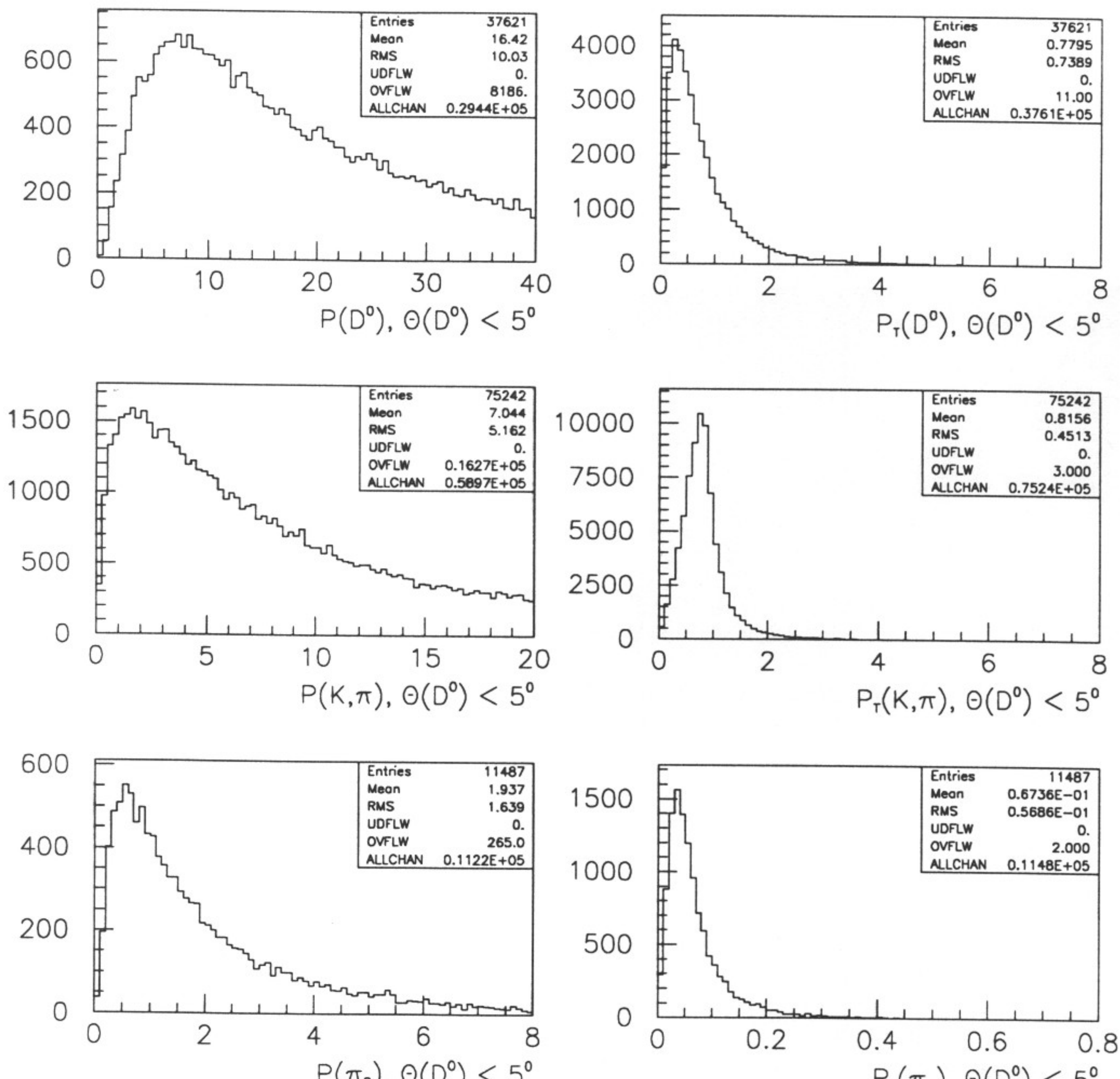
Herwig 5.9, $\Theta(D^0)$, $\Theta(K,\pi)$, $\Theta(\pi_s)$



"$\theta^{trk} > 0.4^\circ$" will accept charm events!

Track parameters.

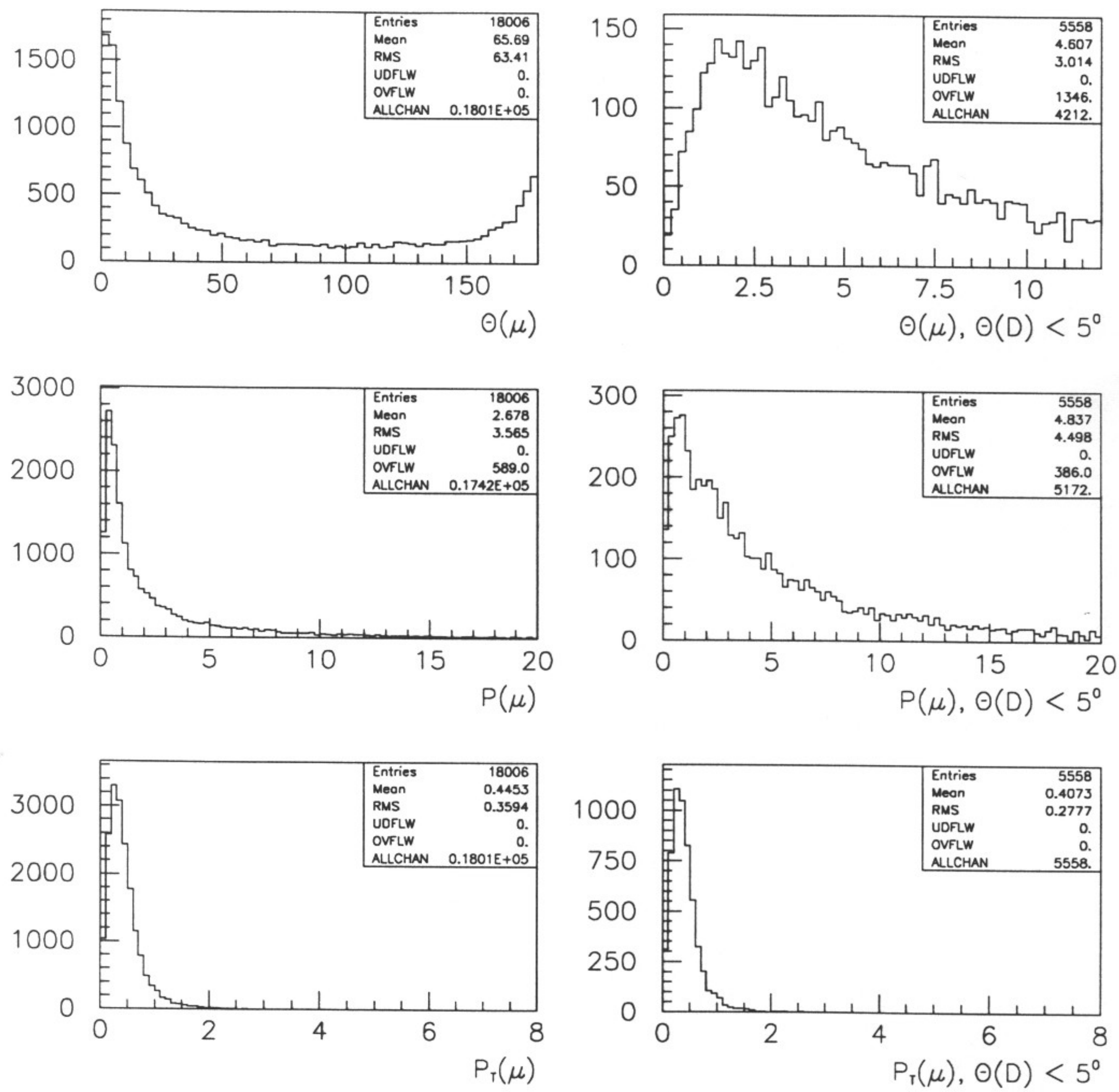
Herwig 5.9, P,$P_T(D^0)$, P,$P_T(K,\pi)$, P,$P_T(\pi_s)$



K and π from D^0 are, probably, measurable. And π_s looks not too promissing.

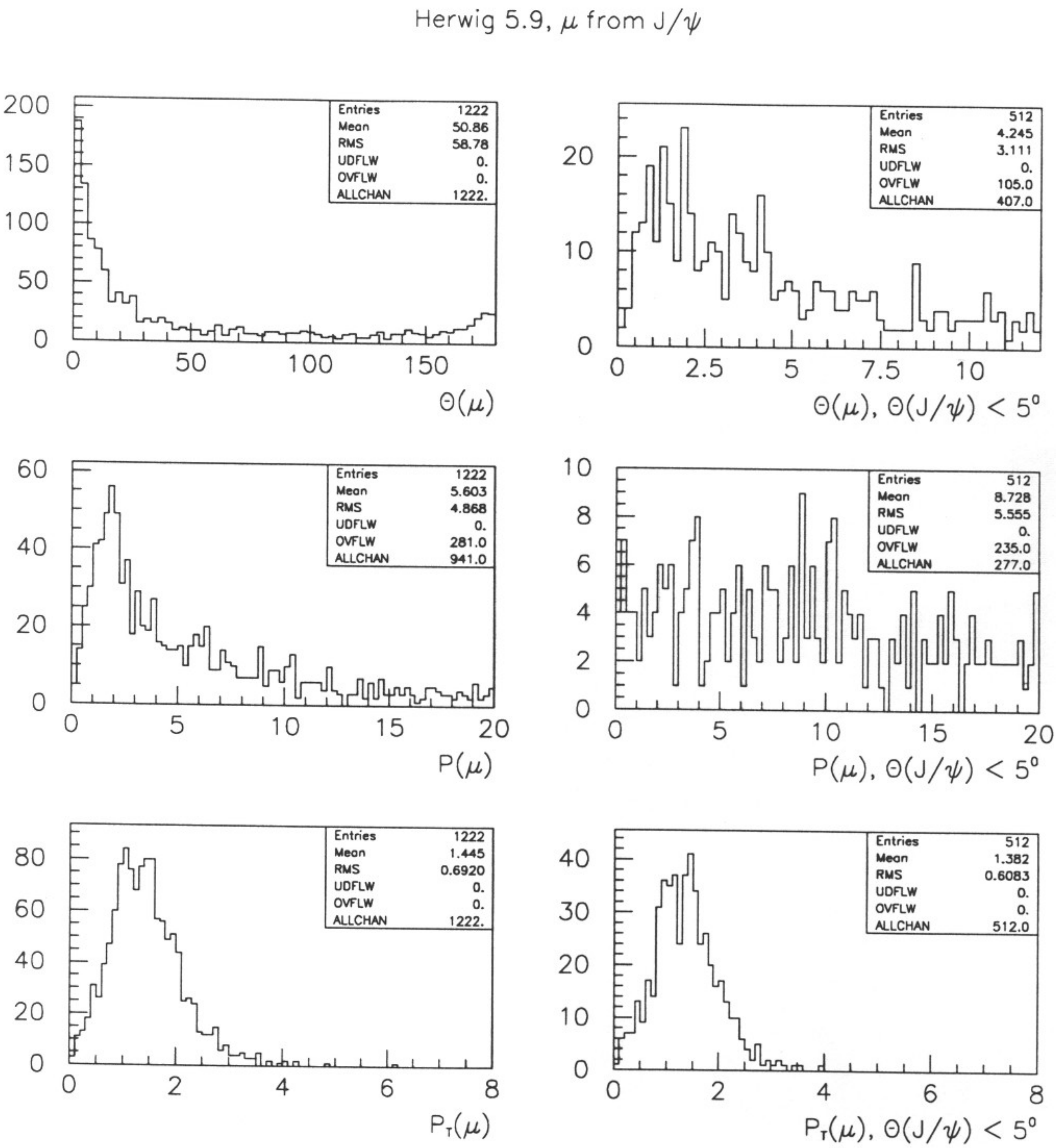
$\mu^{\pm}$ from charm s/l decays

Herwig 5.9, μ from D^0, D^+, D_s and Λ_c decays



Some substantial fraction of s/l muons can be measured!

$\mu^{\pm}$ from J/ψ decays



J/ψ is reconstructable!

Conclusions

Program for HF studies is generally clear:

- F_2^c, F_2^b at large Q^2
- QCD test at large scale values
- $K_\perp$ and collenear approaches verification
- saturation probing
- studies of (g, c, b) content of photon till $x_\gamma \approx 10^{-2}$
- x_g till 10^{-5} !

γp collisions would provide a factor of ~10 in c and b cross sections

---

- diffractive c (b?) production
- charm from charged current
- $t\bar{t}$ in γp collisions
- ?