

Exclusive production of K^+K^- pairs in proton-proton collisions

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Introduction

The 4-body reactions $pp \rightarrow p\pi^+\pi^-p$ and $pp \rightarrow pK^+K^-p$ constitutes an irreducible background to 3-body processes $pp \rightarrow pMp$, where e.g. $M = \sigma, \rho^0, f_0(980), \phi, f_2(1270), f_0(1500), f'_2(1525)$, χ_{c0} , glueball
→ these resonances are seen (or will be seen) "on" the $\pi\pi$ and/or KK continuum

Measurement of χ_c at Tevatron (CDF Collaboration)

$$\chi_c \rightarrow J/\psi(\rightarrow \mu^+\mu^-) + \gamma, \quad \frac{d\sigma_{\chi_c}}{dy}|_{y=0} = (76 \pm 14) \text{ nb}$$

[T. Aaltonen *et al.*, Phys. Rev. Lett. **102** (2009) 242001]

$M(J/\psi\gamma)$ resolution does not allow a separation of the different χ_{cJ} states!

Channel	$\mathcal{B}(\chi_{c0})$	$\mathcal{B}(\chi_{c1})$	$\mathcal{B}(\chi_{c2})$
$J/\psi\gamma$	$(1.16 \pm 0.08)\%$	$(34.4 \pm 1.5)\%$	$(19.5 \pm 0.8)\%$

but $\sigma(\chi_{c0})$ obtained within the k_t -factorization is much bigger than for χ_{c1} and χ_{c2}

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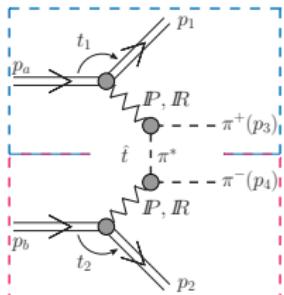
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Could other decay channels be used ?

Channel	$\mathcal{B}(\chi_{c0})$	$\mathcal{B}(\chi_{c1})$	$\mathcal{B}(\chi_{c2})$
$\pi^+\pi^-$	$(0.56 \pm 0.03)\%$	—	$(0.16 \pm 0.01)\%$
K^+K^-	$(0.610 \pm 0.035)\%$	—	$(0.109 \pm 0.008)\%$
$p\bar{p}$	$(0.0228 \pm 0.0013)\%$	$(0.0073 \pm 0.0004)\%$	$(0.0072 \pm 0.0004)\%$
$\pi^+\pi^-\pi^+\pi^-$	$(2.27 \pm 0.19)\%$	$(0.76 \pm 0.26)\%$	$(1.11 \pm 0.11)\%$
$\pi^+\pi^-K^+K^-$	$(1.80 \pm 0.15)\%$	$(0.45 \pm 0.10)\%$	$(0.92 \pm 0.11)\%$

Diffractive amplitude for $\pi^+\pi^-$ continuum



+ crossed diagram ($3 \leftrightarrow 4$)

P. Lebiedowicz and A. Szczurek, Phys. Rev. D81 (2010) 036003

$$\begin{aligned} \mathcal{M}_{pp \rightarrow pp\pi\pi}^{Born} &= M_{13}(s_{13}, t_1) F_\pi(\hat{t}) \frac{1}{\hat{t} - m_\pi^2} F_\pi(\hat{t}) M_{24}(s_{24}, t_2) \\ &+ M_{14}(s_{14}, t_1) F_\pi(\hat{u}) \frac{1}{\hat{u} - m_\pi^2} F_\pi(\hat{u}) M_{23}(s_{23}, t_2), \quad F_\pi(\hat{t}/\hat{u}) = \exp\left(\frac{\hat{t}/\hat{u} - m_\pi^2}{\Lambda_{off}^2}\right) \end{aligned}$$

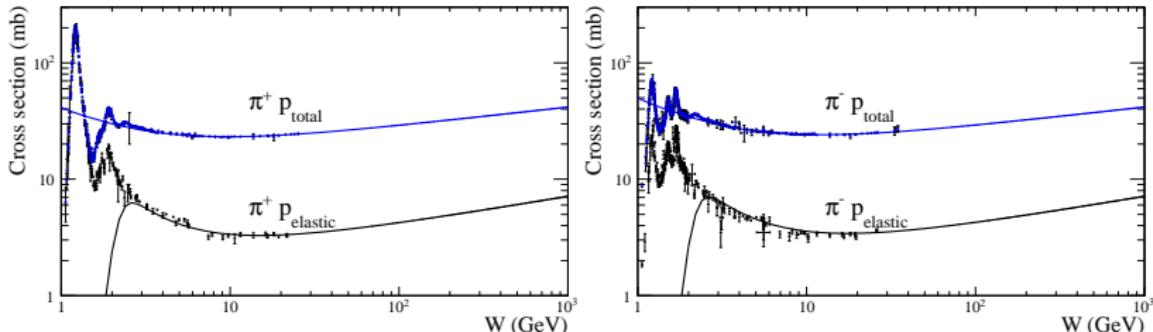
we propose to use a generalized propagator: $\frac{1}{\hat{t}/\hat{u} - m_\pi^2} \rightarrow \beta_M(\hat{s}) \frac{1}{\hat{t}/\hat{u} - m_\pi^2} + \beta_R(\hat{s}) \mathcal{P}^\pi(\hat{t}/\hat{u}, \hat{s}),$

$$\begin{aligned} \mathcal{P}^\pi(\hat{t}/\hat{u}, \hat{s}) &= \frac{1 + \exp(-i\pi\alpha_\pi(\hat{t}/\hat{u}))}{\sin \pi\alpha_\pi(\hat{t}/\hat{u})} \left(\frac{\hat{s}}{\hat{s}_0}\right)^{\alpha_\pi(\hat{t}/\hat{u})} \frac{\pi\alpha'_\pi}{2\Gamma(\alpha_\pi(\hat{t}/\hat{u}) + 1)} \\ \alpha_\pi(\hat{t}/\hat{u}) &= \alpha'_\pi(\hat{t}/\hat{u} - m_\pi^2) \text{ with a slope } \alpha'_\pi = 0.7 \text{ GeV}^{-2} \end{aligned}$$

functions of interpolation between meson and reggeon exchanges

$$\beta_M(\hat{s}) = \exp(-(\hat{s} - 4m_\pi^2)/\Lambda_{int}^2), \beta_R(\hat{s}) = 1 - \beta_M(\hat{s})$$

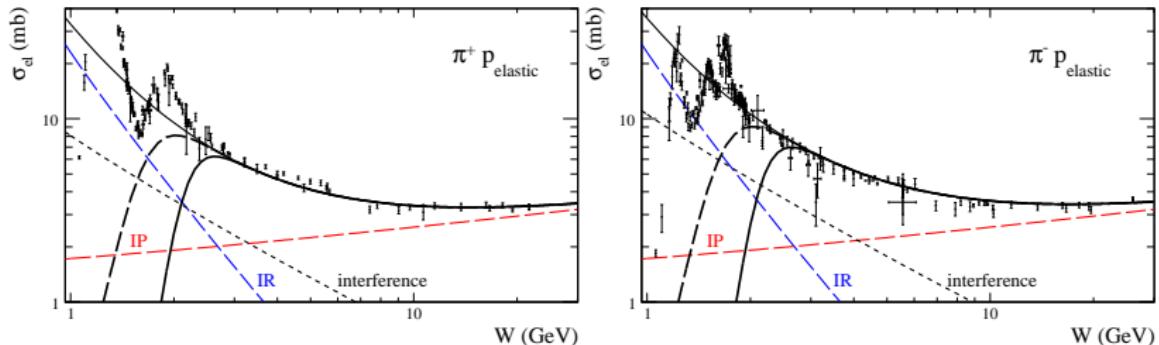
πp cross sections



- Donnachie-Landshoff parametrization for total πN cross section ($\sigma_{tot}^{\pi p} = C_i s^{\alpha_i(0)-1}$, $i = IP, IR$):
$$\sigma_{tot}^{\pi^+ p}: 13.63s^{0.0808} + 27.56s^{-0.4525}$$

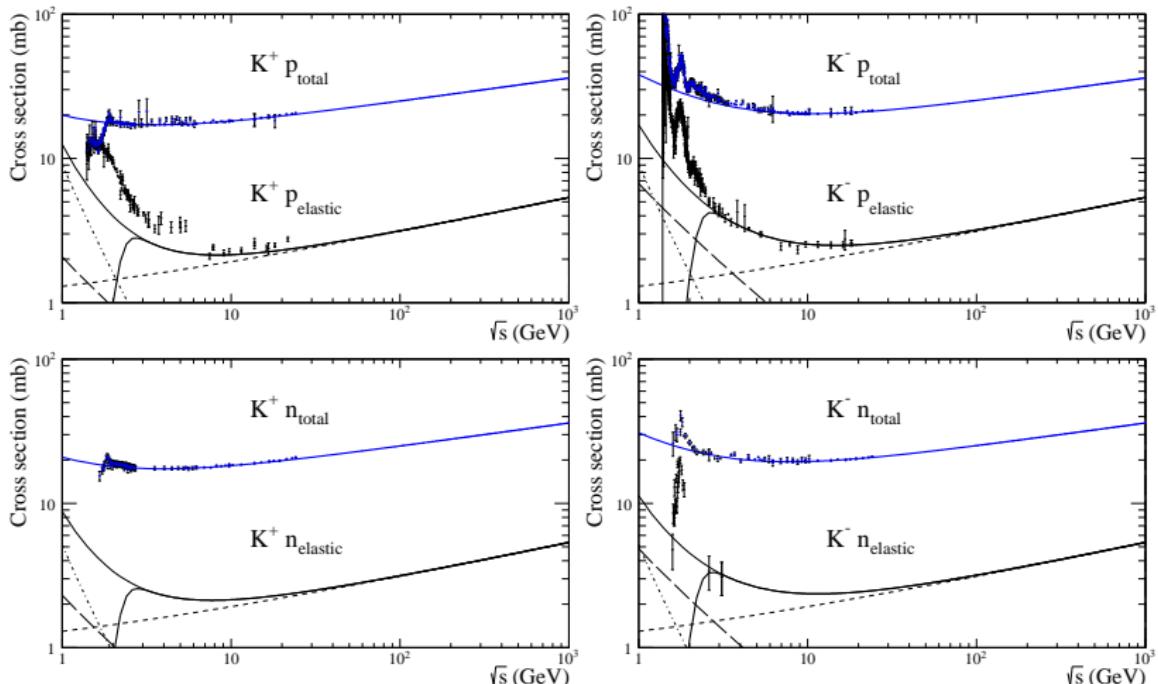
$$\sigma_{tot}^{\pi^- p}: 13.63s^{0.0808} + 36.02s^{-0.4525}$$
- The optical theorem: $\sigma_{tot}^{\pi p} \simeq \frac{1}{s} \text{Im}M_{el}^{\pi p}(s, t=0)$ (when s is large)
- $M_{\pi^\pm p}(s, 0) = A_{IP}(s) + A_{F_2}(s) \mp A_\rho(s)$
- $M_{\pi p \rightarrow \pi p}(s, t) = \eta_i \ s \ C_i \left(\frac{s}{s_0}\right)^{\alpha_i(t)-1} \exp\left(\frac{B_i^{\pi p}}{2} t\right)$
the values of pomeron and reggeon couplings to πp :
 $C_{IP} = 13.63 \text{mb}$, $C_{F_2} = 31.79 \text{mb}$, $C_\rho = 4.23 \text{mb}$

πp elastic scattering



- nicely describes the πp_{elastic} data for $\sqrt{s} > 2.5$ GeV with slope parameters $B(s) = B_i^{\pi P} + 2\alpha'_i \ln(\frac{s}{s_0})$: $B_{IP}^{\pi P} = 5.5 \text{ GeV}^{-2}$ and $B_{IR}^{\pi P} = 4 \text{ GeV}^{-2}$
- smooth cut-off correction factor $f_{\text{cont}}^{\pi N}(W) = \exp\left(\frac{W-W_{\text{cut}}}{a_{\text{cut}}}\right) / (1 + \exp\left(\frac{W-W_{\text{cut}}}{a_{\text{cut}}}\right))$ where $W_{\text{cut}} = 1.5$ GeV (dashed line) and 2 GeV (solid line), $a_{\text{cut}} = 0.2$ GeV
- model includes absorption effects in an effective way

Kp and Kn cross sections



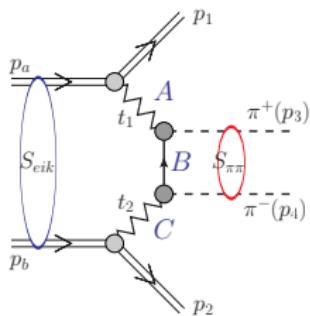
$$M_{K^\pm p}(s, 0) = A_{IP}(s) + A_{f_2}(s) + A_{a_2}(s) \mp A_\omega(s) \mp A_\rho(s)$$

$$M_{K^\pm n}(s, 0) = A_{IP}(s) + A_{f_2}(s) - A_{a_2}(s) \mp A_\omega(s) \pm A_\rho(s)$$

Absorption corrections

$$\mathcal{M}_{pp \rightarrow pp\pi\pi}^{full} = \mathcal{M}^{Born} + \mathcal{M}^{pp-rescatt.} + \mathcal{M}^{\pi\pi-rescatt.}$$

$$\mathcal{M}^{Born} = M_{13}(s_{13}, t_1) \frac{F_\pi^2(\hat{t})}{\hat{t} - m_\pi^2} M_{24}(s_{24}, t_2) + M_{14}(s_{14}, t_1) \frac{F_\pi^2(\hat{u})}{\hat{u} - m_\pi^2} M_{23}(s_{23}, t_2)$$



$$\mathcal{M}^{pp-rescatt.} = \frac{i}{8\pi^2 s} \int d^2 \mathbf{k}_t M_{NN}^{el}(s, k_t^2) \mathcal{M}^{Born}(\mathbf{p}_{a,t}^* - \mathbf{p}_{1,t}, \mathbf{p}_{b,t}^* - \mathbf{p}_{2,t})$$

where $p_a^* = p_a - k_t$ and $p_b^* = p_b + k_t$ with momentum transfer k_t

$$M_{NN}^{el}(s, k_t^2) = M_0(s) \exp(-Bk_t^2/2)$$

from optical theorem: $\text{Im}M_0(s, t=0) = s\sigma_{tot}(s)$

$$B(s) = B_{IP}^{NN} + 2\alpha'_{IP} \ln\left(\frac{s}{s_0}\right)$$

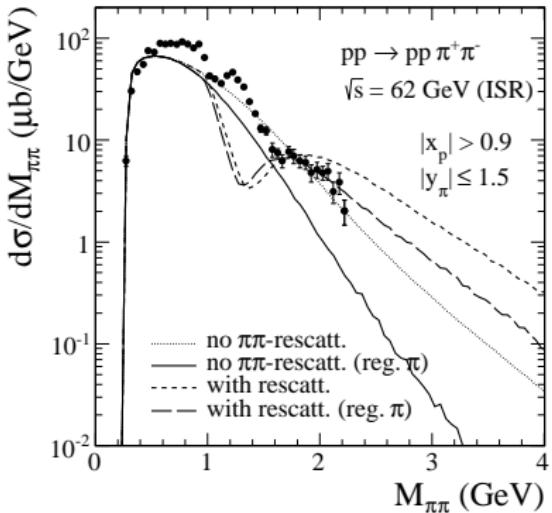
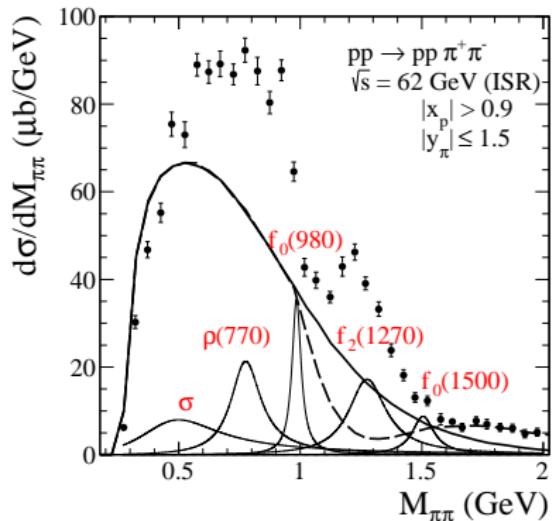
where $s_0 = 1 \text{ GeV}^2$, $\alpha'_{IP} = 0.25 \text{ GeV}^{-2}$, $B_{IP}^{NN} = 9 \text{ GeV}^{-2}$

$\pi\pi$ -rescatt.

$$\frac{F_\pi^2(\hat{t})}{\hat{t} - m_\pi^2} \rightarrow \frac{i}{16\pi^2 \hat{s}} \int d^2 \kappa \frac{F_\pi^2(\hat{t}_1)}{\hat{t}_1 - m_\pi^2} M_{\pi^+ \pi^- \rightarrow \pi^+ \pi^-}(\hat{s}, \hat{t}_2)$$

$$\frac{F_\pi^2(\hat{u})}{\hat{u} - m_\pi^2} \rightarrow \frac{i}{16\pi^2 \hat{s}} \int d^2 \kappa \frac{F_\pi^2(\hat{u}_1)}{\hat{u}_1 - m_\pi^2} M_{\pi^- \pi^+ \rightarrow \pi^- \pi^+}(\hat{s}, \hat{u}_2)$$

Our model of $\pi\pi$ -continuum vs ISR data



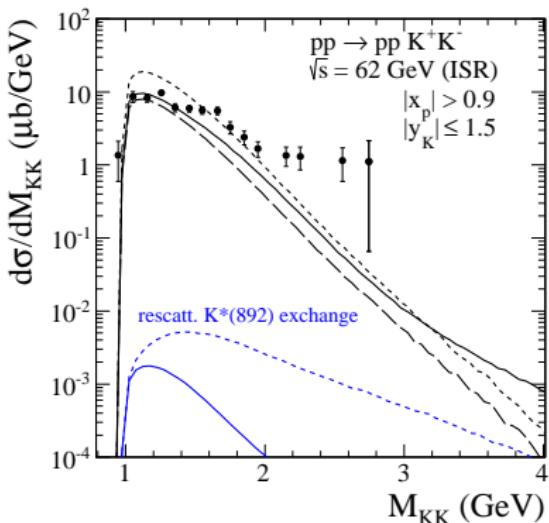
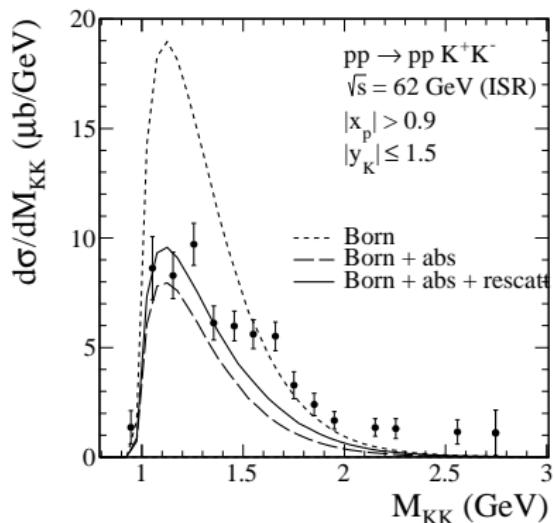
data from A. Breakstone *et al.* (ABCDHW Collaboration), Z. Phys. **C48** (1990) 569
 cross section: $\sigma = (79 \pm 13) \mu\text{b}$

Regge-type interaction $M_{\pi\pi \rightarrow \pi\pi}^{\text{Regge}}(\hat{s}, \hat{t}/\hat{u}) = \eta_i \hat{s} C_i^{\pi\pi} \left(\frac{\hat{s}}{\hat{s}_0}\right)^{\alpha_i(\hat{t}/\hat{u})-1} \exp\left(\frac{B_i}{2} \hat{t}/\hat{u}\right)$, where $C_i^{\pi\pi} = \frac{(C_i^{\pi N})^2}{C_i^{NN}}$, $i = IP, f_2, \rho$

applies at higher energies so we multiply $\mathcal{M}^{\pi\pi-\text{rescatt.}}$ by threshold factor:

$$S_{thr}(\hat{s}) = \begin{cases} 0, & \hat{s} \leq \hat{s}_{thr} = 4m_K^2, \\ 1 - \exp(-(\hat{s} - \hat{s}_{thr})/\Delta\hat{s}), & \hat{s} > \hat{s}_{thr} = 4m_K^2, \quad \Delta\hat{s} = 9 \text{ GeV}^2 \end{cases}$$

Our model of KK -continuum vs ISR data

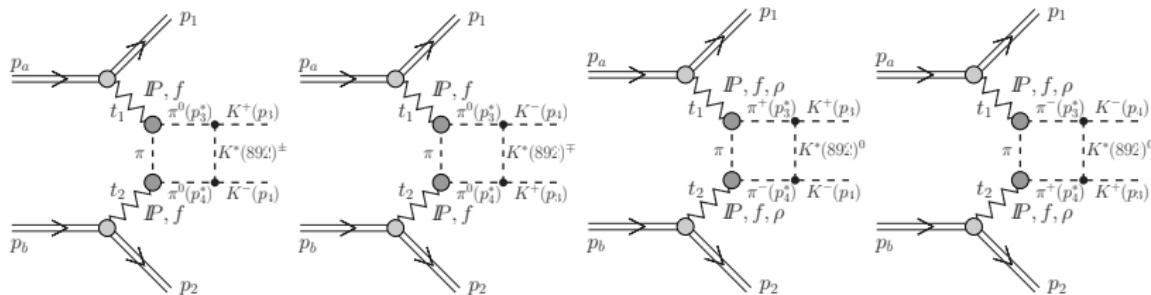


data from A. Breakstone *et al.* (ABCDHW Collaboration), Z. Phys. C42 (1989) 387

cross section: $\sigma = (6.5 \pm 1.7) \mu\text{b}$

where in $\mathcal{M}^{KK-\text{rescatt.}}$ we have $M_{KK \rightarrow KK} = \beta_M(\hat{s}) M^{\rho, \omega, \phi - \text{meson exch.}} + \beta_R(\hat{s}) M^{\text{Regge}}$
 with $\beta_M(\hat{s}) = \exp(-(\hat{s} - 4m_K^2)/\Delta\hat{s})$, $\beta_R(\hat{s}) = 1 - \beta_M(\hat{s})$, $\Delta\hat{s} = 9 \text{ GeV}^2$

$K^*(892)$ meson-exchange



$$\frac{F_\pi^2(\hat{t})}{\hat{t} - m_\pi^2} \rightarrow \frac{i}{16\pi^2 \hat{s}} \int d^2 \kappa \frac{F_\pi^2(\hat{t}_1)}{\hat{t}_1 - m_\pi^2} M_{\pi\pi \rightarrow K^+K^-}^{K^*-\text{exch.}}(\hat{s}, \hat{t}_2),$$

$$\frac{F_\pi^2(\hat{u})}{\hat{u} - m_\pi^2} \rightarrow \frac{i}{16\pi^2 \hat{s}} \int d^2 \kappa \frac{F_\pi^2(\hat{u}_1)}{\hat{u}_1 - m_\pi^2} M_{\pi\pi \rightarrow K^-K^+}^{K^*-\text{exch.}}(\hat{s}, \hat{u}_2),$$

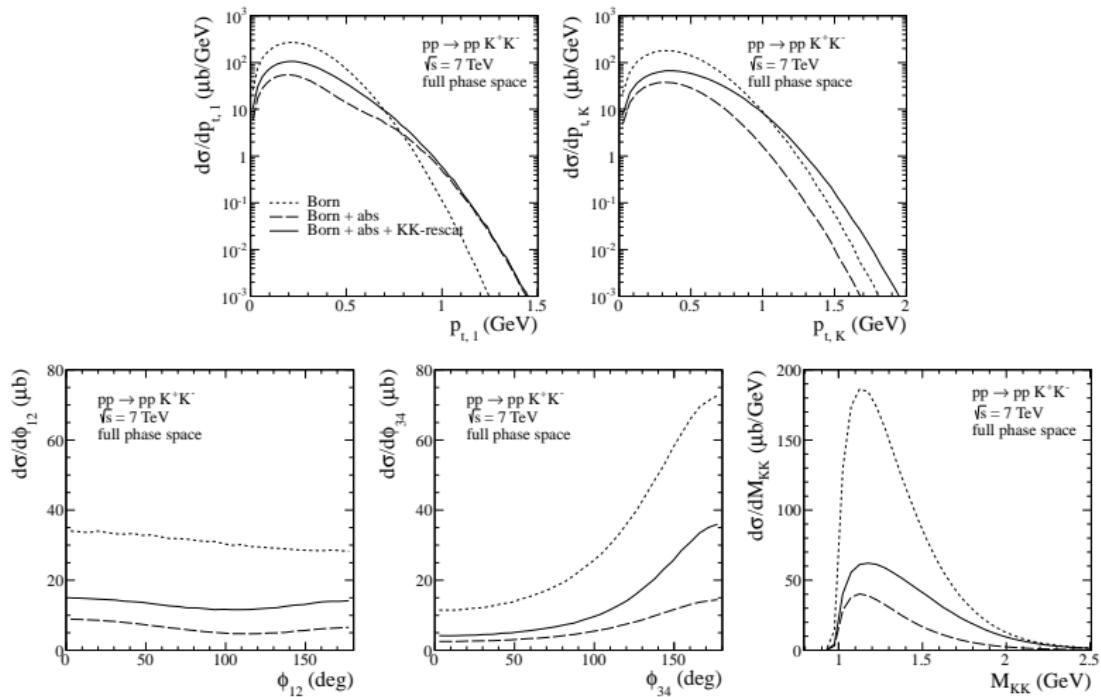
$$M_{\pi\pi \rightarrow K^+K^-}^{K^*-\text{exch.}}(\hat{s}, \hat{t}_2) = g_{\pi KK^*} F_{\pi KK^*}(\hat{t}_2) \frac{(p_3^{*\mu} + p_3^\mu) P_{\mu\nu} (p_4^{*\nu} + p_4^\nu)}{\hat{t}_2 - m_{K^*}^2 + i\Gamma_{K^*} m_{K^*}} g_{\pi KK^*} F_{\pi KK^*}(\hat{t}_2) \left(\frac{\hat{s}}{\hat{s}_0} \right)^{\alpha_{K^*}(t_2)-1}$$

$$M_{\pi\pi \rightarrow K^-K^+}^{K^*-\text{exch.}}(\hat{s}, \hat{u}_2) = g_{\pi KK^*} F_{\pi KK^*}(\hat{u}_2) \frac{(p_3^{*\mu} + p_4^\mu) P_{\mu\nu} (p_4^{*\nu} + p_3^\nu)}{\hat{u}_2 - m_{K^*}^2 + i\Gamma_{K^*} m_{K^*}} g_{\pi KK^*} F_{\pi KK^*}(\hat{u}_2) \left(\frac{\hat{s}}{\hat{s}_0} \right)^{\alpha_{K^*}(u_2)-1}$$

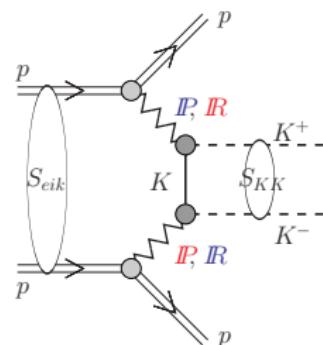
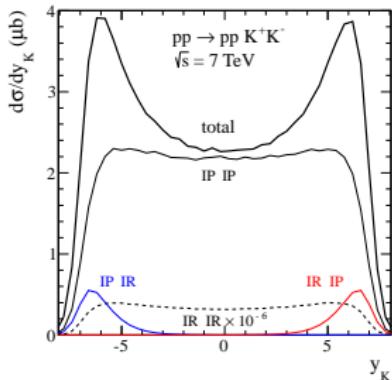
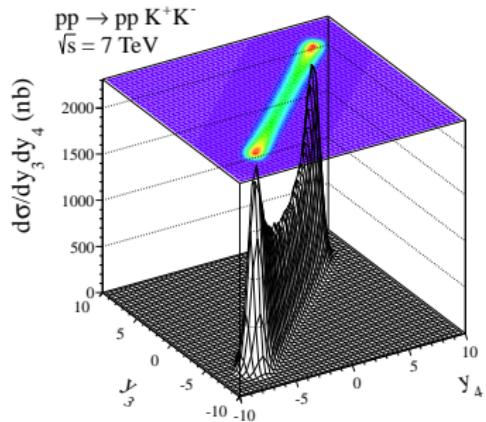
where $P_{\mu\nu}(k) = -g_{\mu\nu} + k_\mu k_\nu / m_{K^*}^2$

We take K^* meson trajectory as $\alpha_{K^*}(k^2) = 0.25 + \alpha'_{K^*} k^2$, with $\alpha'_{K^*} = 0.83 \text{ GeV}^{-2}$.

Differential cross section at $\sqrt{s} = 7$ TeV

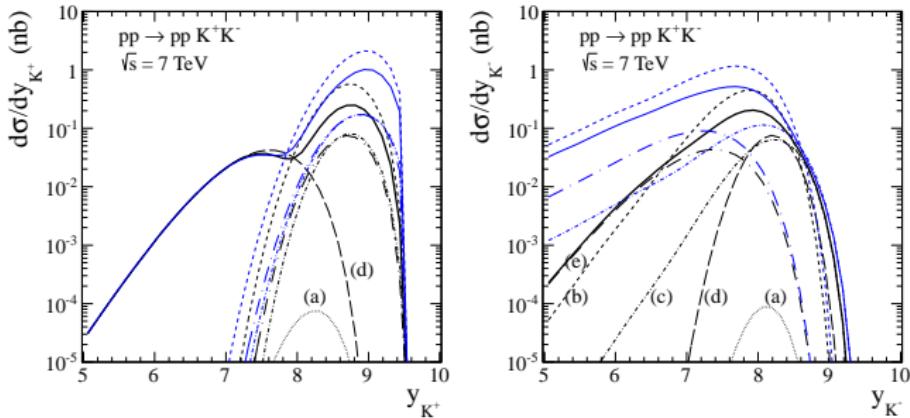
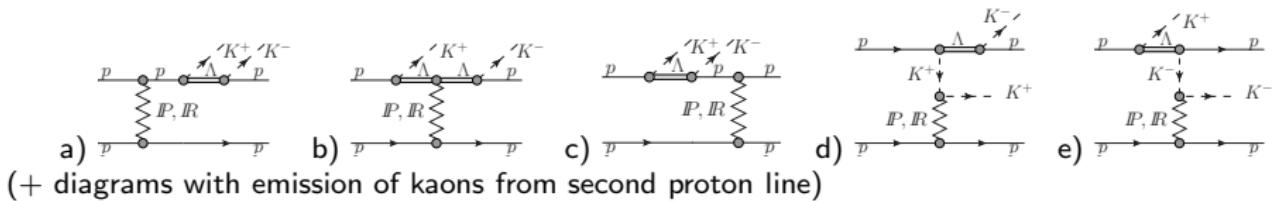


Differential cross section in rapidity space at $\sqrt{s} = 7$ TeV

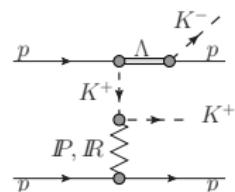
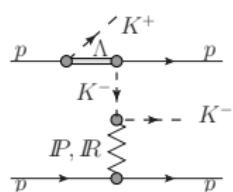
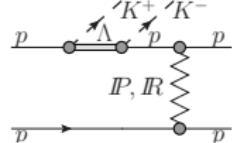
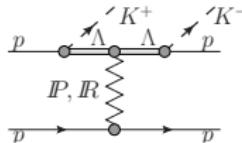
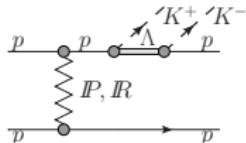
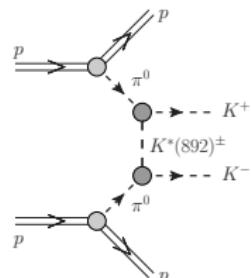
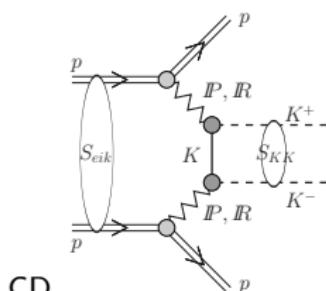
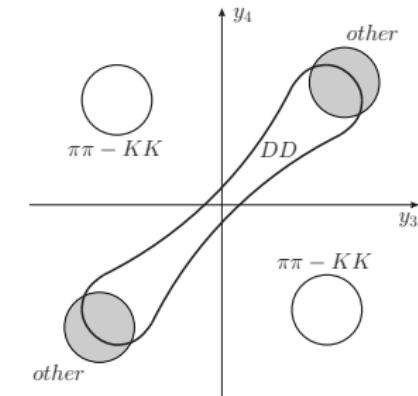


Center panel: Decomposition of cross section in ($y_K = y_3 \cong y_4$)
when all (upper line) and only some components in the amplitude are included
($IP \otimes IR$ and $IR \otimes IP$ peaks at backward and forward y_K)

Other diffractive processes

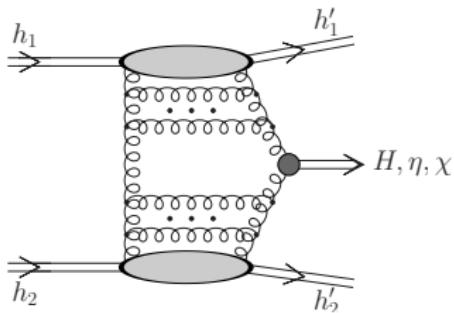


Localization of mechanisms at high energies



other mechanisms

Diffractive QCD mechanism



- QCD mechanism proposed by Kaidalov, Khoze, Martin, Ryskin (KKMR approach)

V.A. Khoze, A.D. Martin and M.G. Ryskin, Phys. Lett. **B401** (1997) 330; Eur. Phys. J. **C23** (2002) 311
A.B. Kaidalov, V.A. Khoze, A.D. Martin and M.G. Ryskin, Eur. Phys. J. **C23** (2003) 387; **C33** (2004) 261

- to apply KKMR QCD mechanism to heavy quarkonia production ($H \rightarrow \chi_c$)

R.S. Pasechnik, A. Szczurek and O.V. Teryaev, Phys. Rev. **D78** (2008) 014007 (χ_{c0} meson)

R.S. Pasechnik, A. Szczurek and O.V. Teryaev, Phys. Lett. **B680** (2009) 62 (χ_{c1} meson)

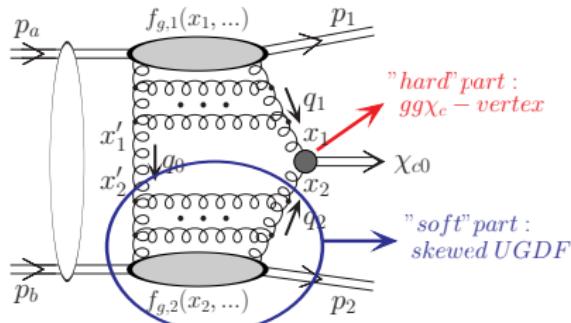
R.S. Pasechnik, A. Szczurek and O.V. Teryaev, Phys. Rev. **D81** (2010) 034024 (χ_{c2} meson)

L.A. Harland-Lang, V.A. Khoze, M.G. Ryskin and W.J. Stirling, Eur. Phys. J. **C65** (2010) 433

L.A. Harland-Lang, V.A. Khoze, M.G. Ryskin and W.J. Stirling, Eur. Phys. J. **C71** (2011) 1545

- It is interesting to test KKMR approach for diffractive light mesons production at high energies
 - a good probe of nonperturbative dynamics of partons described by UGDFs.

Amplitude for exclusive process $pp \rightarrow pp\chi_{c0}$



$$\mathcal{M}_{pp \rightarrow pp\chi_c}^{full} = \mathcal{M}_{pp \rightarrow pp\chi_c}^{Born} + \mathcal{M}_{pp \rightarrow pp\chi_c}^{abs}$$

$$\mathcal{M}_{pp \rightarrow pp\chi_c}^{Born} = \text{const} \cdot \Im \int d^2 q_{0,t} V(\mathbf{q}_{1,t}, \mathbf{q}_{2,t}) \frac{f_{g,1}^{off}(x_1, x'_1, q_{0,t}^2, q_{1,t}^2, t_1) f_{g,2}^{off}(x_2, x'_2, q_{0,t}^2, q_{2,t}^2, t_2)}{q_{0,t}^2 q_{1,t}^2 q_{2,t}^2}$$

$gg \rightarrow \chi_{c0}$ vertex [Pasechnik, Szczerba and Teryaev]

$$V(\mathbf{q}_{1,t}, \mathbf{q}_{2,t}) = K_{NLO} \frac{8ig_s^2}{M_\chi} \frac{\mathcal{R}'(0)}{\sqrt{\pi M_\chi N_c}} \frac{3M_\chi^2 \mathbf{q}_{1,t} \mathbf{q}_{2,t} - 2\mathbf{q}_{1,t}^2 \mathbf{q}_{2,t}^2 - (\mathbf{q}_{1,t} \mathbf{q}_{2,t})(\mathbf{q}_{1,t}^2 + \mathbf{q}_{2,t}^2)}{(M_\chi^2 + \mathbf{q}_{1,t}^2 + \mathbf{q}_{2,t}^2)^2}$$

here active gluon virtualities (transverse momenta) are explicitly taken into account!

$$g_s^2 = 4\pi\alpha_s(M_\chi^2) - \text{Shirkov-Solovtsov}, \mathcal{R}'_{\chi_{cJ}}(0) = \sqrt{0.075} \text{ GeV}^{5/2}, K_{NLO} \simeq 1.68$$

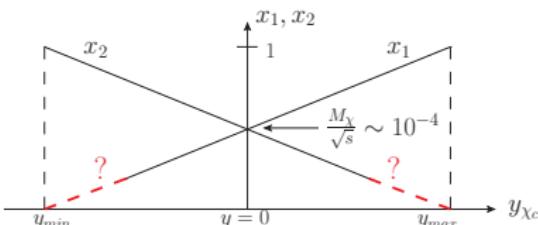
KMR UGDF

two gluon kinematics \rightarrow one gluon "effective" kinematics with $Q_{1/2,t}^2 = \min(q_{0,t}^2, q_{1/2,t}^2)$

$$f_g^{KMR}(x, x', Q_t^2, \mu^2; t) = R_g \frac{\partial}{\partial \ln q_t^2} [x g(x, q_t^2) \sqrt{T_g(q_t^2, \mu^2)}]_{q_t^2 = Q_t^2} F(t)$$

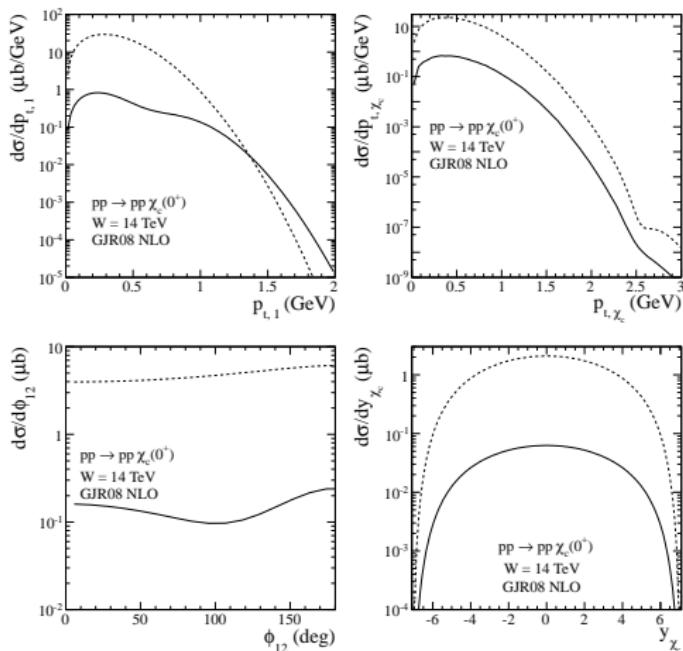
accounts for skewed effect integrated density, defined at $Q_t > Q_0$ Sudakov f.f. (ensures the purity of rapidity gaps) effective f.f. $F(t) = \exp(bt/2)$, $b = 4 \text{ GeV}^{-2}$

- "hard" scale $\mu^2 = M_\chi^2$
- we use GRV and GJR NLO collinear gluon distributions ($Q_t^2 > 0.5 \text{ GeV}^2$)
- skewed KMR UGDFs does not explicitly depend on x' , assuming $x' \ll x \ll 1$;
- in terms of the meson rapidity
 $s x_1 x_2 = M_\chi^2 + |\mathbf{P}_\perp|^2 \equiv M_\perp^2$
 $x_{1,2} = \frac{M_\perp}{\sqrt{s}} \exp(\pm y)$



at $\sqrt{s} = 14 \text{ TeV}$

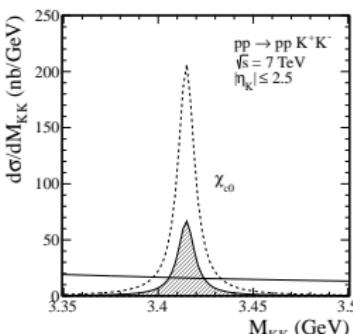
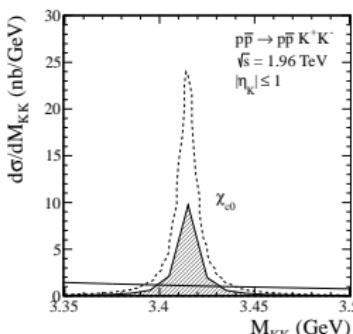
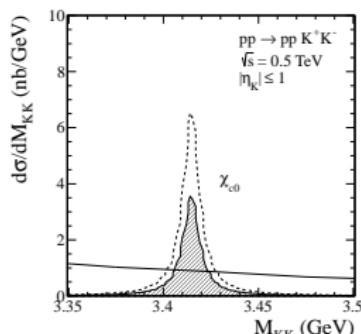
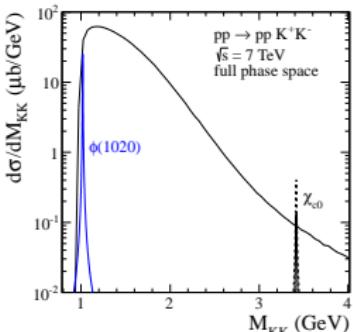
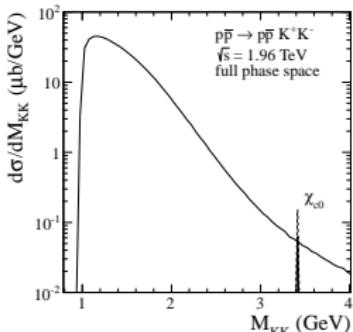
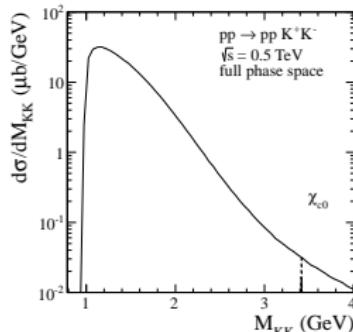
Differential cross sections for the $pp \rightarrow pp\chi_{c0}$ reaction



at $\sqrt{s} = 14$ TeV

without (upper lines) and with (lower lines) absorption effects

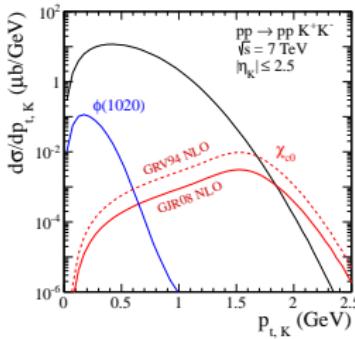
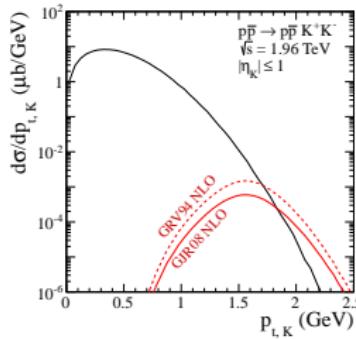
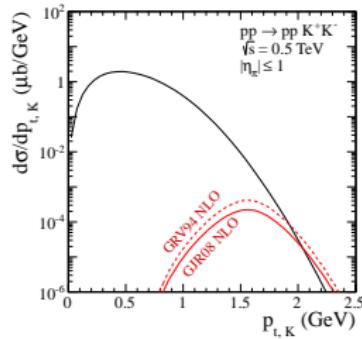
$M_{K^+K^-}$ distribution at $\sqrt{s} = 0.5, 1.96, 7$ TeV



$$\frac{d\sigma_{\chi c0}}{dM_{KK}} = \mathcal{B}(\chi c0 \rightarrow K^+K^-) \sigma_{pp \rightarrow pp\chi c0} 2M_{KK} \frac{1}{K} \frac{M_{KK}\Gamma}{(M_{KK}^2 - M^2)^2 + (M_{KK}\Gamma)^2}$$

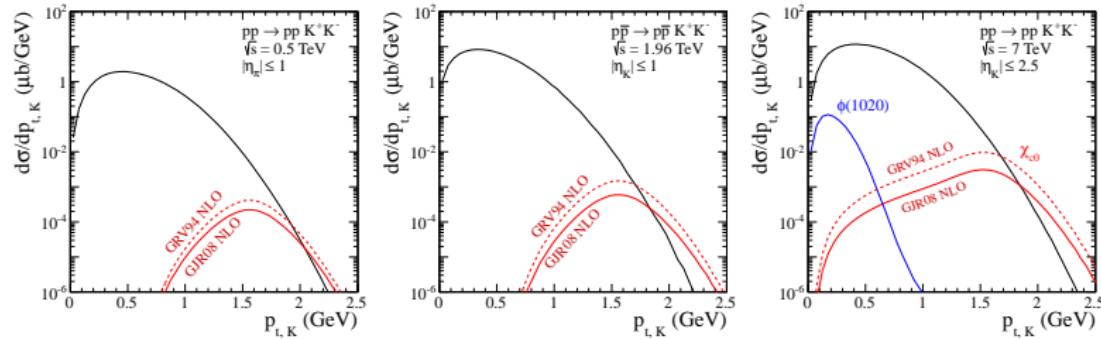
$$\sigma_{pp \rightarrow pp\chi c0} = 177.1 \text{ nb (GJR)} - 548.6 \text{ nb (GRV)} \text{ at } \sqrt{s} = 7 \text{ TeV with cuts on } |\eta_K| < 2.5$$

$p_{t,K}$ distribution with cuts on η_K

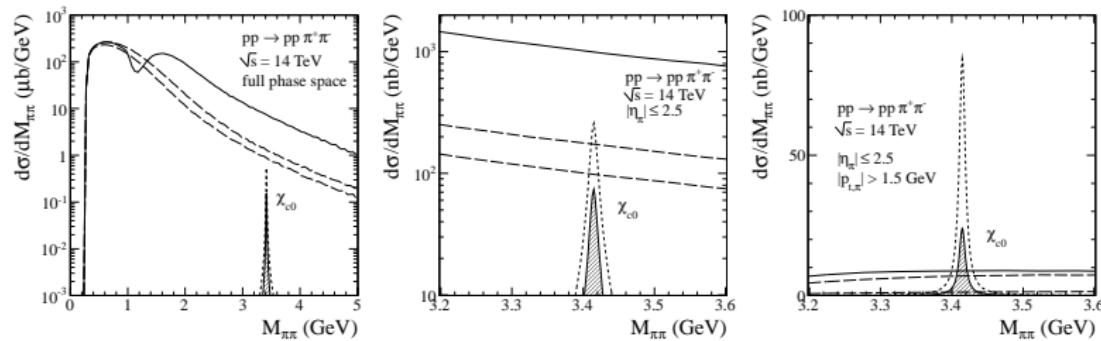


Kaons from χ_{c0} decay are placed at slightly larger p_t

$p_{t,K}$ distribution with cuts on η_K



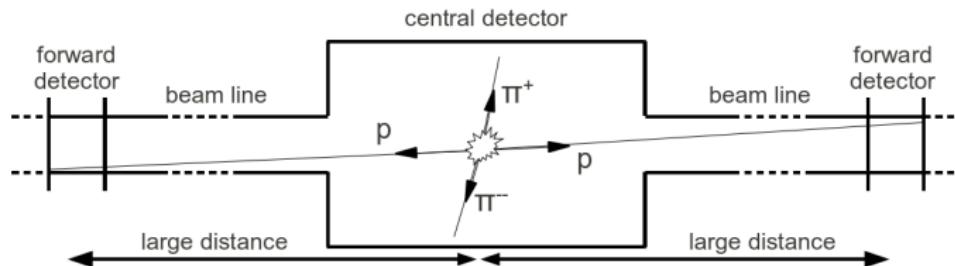
Kaons from χ_{c0} decay are placed at slightly larger p_t



Exclusive $\pi^+\pi^-$ Production at the LHC with Forward Proton Tagging

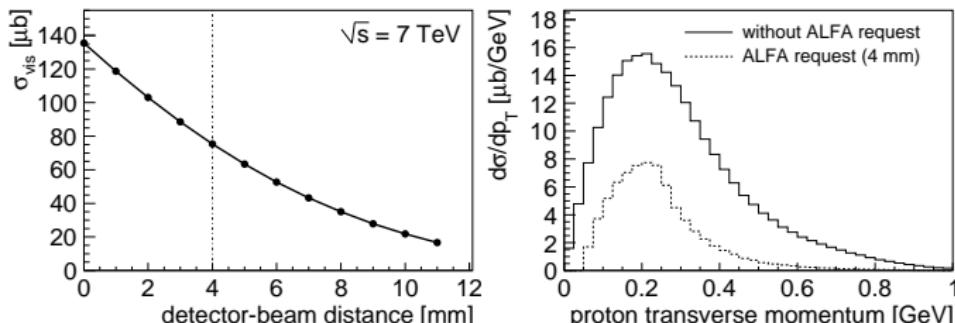
R. Staszewski, P. Lebiedowicz, M. Trzebiński, J. Chwastowski, A. Szczurek,
Acta Phys. Polon. B 42 (2011) 1861

Huge total cross-section for $pp \rightarrow pp\pi^+\pi^-$: more than 200 μb for $\sqrt{s} = 7$ TeV
(see P. Lebiedowicz, A. Szczurek, Phys. Rev. D81 (2010) 036003)



Pions detected in the ATLAS detector (tracker or calorimeter).
Protons tagged in the ALFA stations (~ 240 m far from IP).
Calculations done for $\beta^* = 90$ m LHC optics, $\sqrt{s} = 7$ TeV.

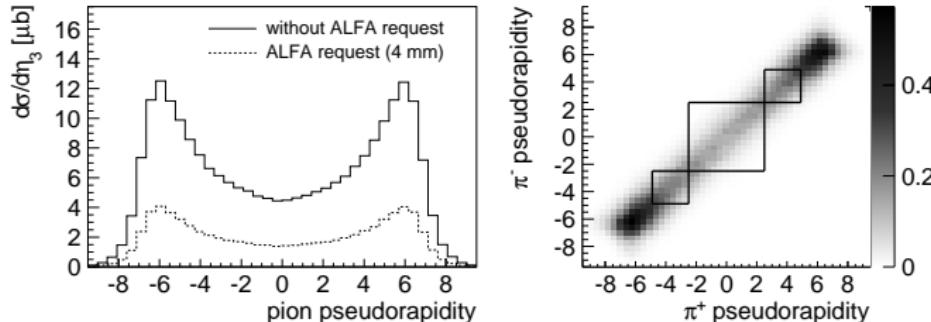
Exclusive $\pi^+\pi^-$ Production at the LHC with Forward Proton Tagging



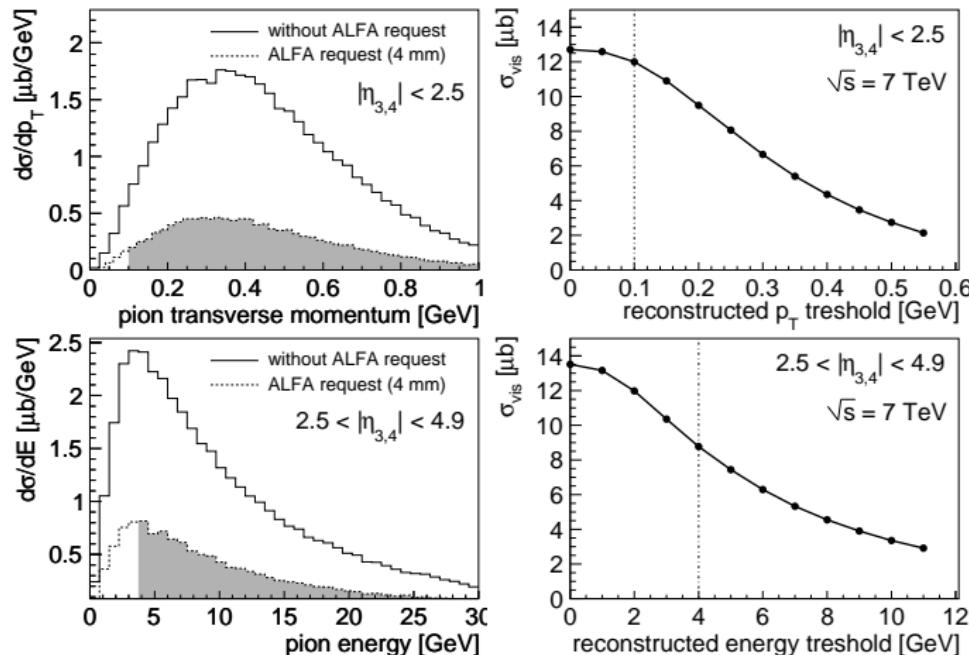
Left: Cross section visible in the ALFA detectors (both protons tagged) as a function of the distance between the detectors and the beam centre. Distance of 4mm corresponds to 75 μb of cross-section visible in the ALFA detectors.

Right: The proton p_t distribution; the dotted line marks the distribution for the events with both protons tagged by ALFA detectors positioned at 4 mm.

Most of outgoing protons are in ALFA acceptance region!



Exclusive $\pi^+\pi^-$ Production at the LHC with Forward Proton Tagging

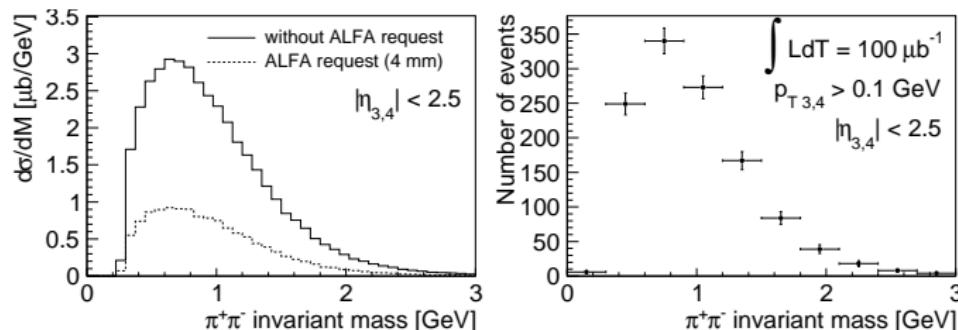


The grey area and the vertical dash-dotted line marks the lower boundary of the region accessible by ATLAS.

Clearly, the cross section falls very steeply with increasing thresholds values.

$\sigma_{vis} = 21 \mu b$ (with detector-beam distance 4 mm and $p_{t,\pi} = 0.1$ GeV, $E_\pi = 4$ GeV).

Exclusive $\pi^+\pi^-$ Production at the LHC with Forward Proton Tagging



Right: Possible measurement of the $\pi^+\pi^-$ invariant mass distribution for $L = 100 \mu\text{b}^{-1}$ (luminosity: $10^{27} \text{ cm}^{-2}\text{s}^{-1}$, data collecting time: 30h). Only the statistical errors are plotted.

With enough statistic it should be possible to see:

$f_2(1270)$, glueball candidates (e.g. $f_0(1500)$), charmonia (e.g. χ_{c0}).

→ Measurements of exclusive $\pi^+\pi^-$ is possible!

→ It requires ALFA trigger and low- p_T tracking.

→ Similar production of K^+K^- and $p\bar{p}$

Conclusions

- Difficulty to separate $\chi_c(0^+)$, $\chi_c(1^+)$, $\chi_c(2^+)$ in the $J/\psi\gamma$ channel
- Possible in the $\pi^+\pi^-$, K^+K^- channels (at RHIC, Tevatron and LHC)
→ $pp\chi_{c0}$ grows much faster with \sqrt{s} than $pp\pi^+\pi^-$, ppK^+K^-

P. Lebiedowicz, R. Pasechnik and A. Szczurek, Phys. Lett. **B 701**, 434 (2011)

P. Lebiedowicz and A. Szczurek, arXiv:1110.4787

- χ_c amplitudes can be written in terms of off-diagonal UGDF's
- Several differential distributions for $pp \rightarrow pp\chi_{c0}$, $pp\pi^+\pi^-$, ppK^+K^- processes including absorptive corrections are calculated
- Integrated cross sections in μb for exclusive K^+K^- and χ_{c0} production

\sqrt{s} (TeV)	full phase space		with cuts on η_K	
	K^+K^-	χ_{c0} (GJR-GRV)	K^+K^-	χ_{c0} (GJR-GRV)
0.5	18.47	0.04 - 0.08	1.21	0.01 - 0.02
1.96	27.96	0.17 - 0.41	1.37	0.03 - 0.06
7	41.14	0.35 - 1.08	7.38	0.18 - 0.55

$|\eta_K| < 1$ at RHIC and Tevatron, $|\eta_K| < 2.5$ at LHC

- Influence of kinematical cuts on the S/B ratio has been investigated