On relative contributions in π^0 production at the $\sqrt{s} = 27$ GeV

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Models for π^0 hadronic production

1. LO perturbative QCD with $2 \to 2$ subprocesses
2. Collinear parton model and TMD parton model
3. Fragmentation approach for large-p_T production
4. Quark and gluon Sivers PDFs in $p^T + p \to \pi^0 + X$
5. Quark and gluon Boer-Mulders PDFs in $p + p \to \pi^0 + \pi^0 + X$, back-to-back configuration.

Partonic subprocesses

Gluon-gluon fusion

- $g + g \to g + g$
- $g + g \to q + \bar{q}$

Gluon-quark scattering

- $g + q \to g + q$
- $g + \bar{q} \to g + \bar{q}$

Quark-quark scattering

- $q + q \to q + q$
- $\bar{q} + \bar{q} \to \bar{q} + \bar{q}$
- $q + \bar{q} \to q + \bar{q}$
- $q + \bar{q} \to g + g$

Factorization in TMD PM (or GPM) for $pp \to \pi^0 X$

$$
\begin{aligned}
d\sigma(pp \to \pi^0 X) \quad &= \quad \sum_{i,j,k,l} F_{i/p}(x_1, q_{1T}, \mu) \bigotimes \\
&\bigotimes \quad d\hat{\sigma}(ij \to kl) \bigotimes F_{j/p}(x_2, q_{2T}, \mu) \bigotimes D_{k,l}^{\pi^0}(z, q_T, \mu) \quad (1)
\end{aligned}
$$

- $p_T^{\pi^0} > 1.0 - 1.5$ GeV as follows from fragmentation approach
- $\mu \simeq p_T^{\pi^0}$, $\alpha_S(\mu)$ should be small
- $F_{i/p}(x, q_T, \mu) \Rightarrow f_{i/p}(x, \mu)$, we use collinear approximation and MSTW2008lo PDFs
- $D_{k,l}^{\pi^0}(z, q_T, \mu) \Rightarrow D_{k,l}^{\pi^0}(z, \mu)$, $p_{\pi^0}^{\mu} = z p_{k,l}^{\mu}$, we use collinear approximation and FF from [Owens, Reya, PRD18(1978)]

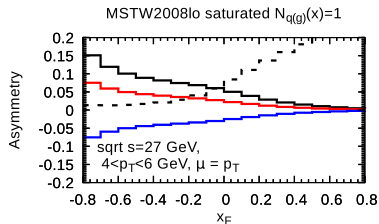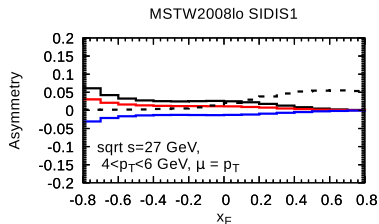# π^0 production at $\sqrt{s} = 62$ GeV

The comparison with Amaresh plot (left figure) and our calculation (right figure)
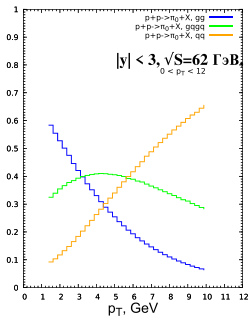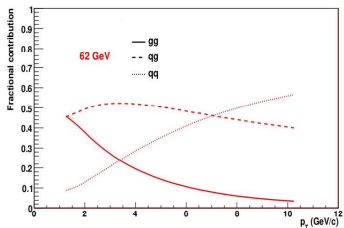
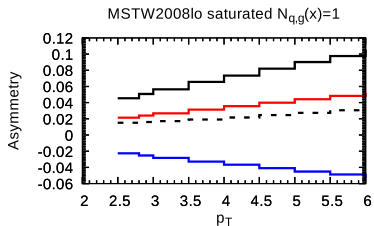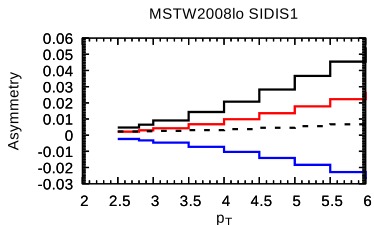# π^0 production at $\sqrt{s} = 27$ GeV
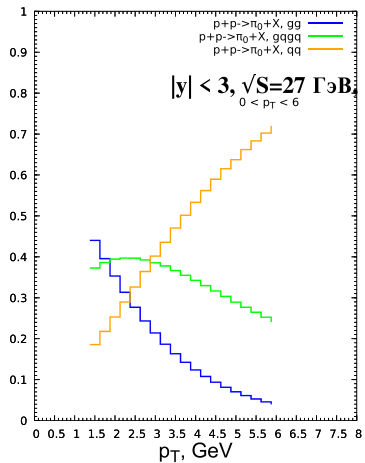
TSSA in prompt γ production at $\sqrt{s} = 27$ GeV

Gluon Sivers TMD PDFs f-type, d-type and sum – solid lines, quark Sivers TMD

TSSA in prompt γ production at $\sqrt{s} = 27$ GeV, $x_F = -0.3$

Gluon Sivers TMD PDFs f-type, d-type and sum – solid lines, quark Sivers TMD

MSTW2008lo SIDIS1

MSTW2008lo saturated $N_{q,g}(x) = 1$

Conclusions

- It may be possible to study gluon Sivers PDFs in $pp \to \pi^0 X$
- $1 \leq p_T \leq 3$ GeV
- $x_F < 0$ if polarized proton has $p_z > 0$.
- What is more perspective in the study of gluon Sivers PDFs, prompt γ or π^0 ?
- The exact calculation is needed.