How to combine WGRad & ResBos?

Csaba Balázs (Argonne) with

C.-P. Yuan (MSU), P.Nadolsky (SMU)

http://www.hep.anl.gov/~balazs/Physics/Talks/2003/11-FNAL

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%> g77 -c WGRad.f
%> g77 -c ResBos.f
%> g77 -o WGRBos.x WGrad.o ResBos.o
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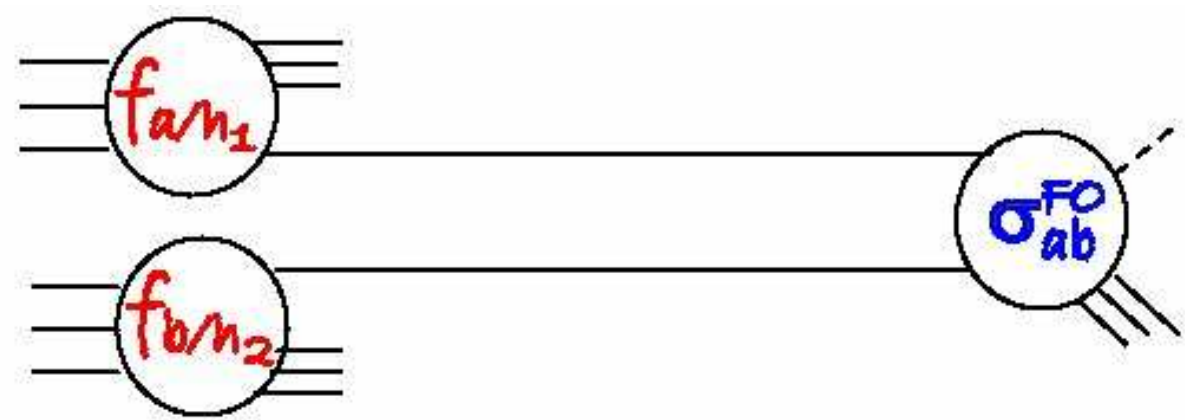
Factorization and Q_T



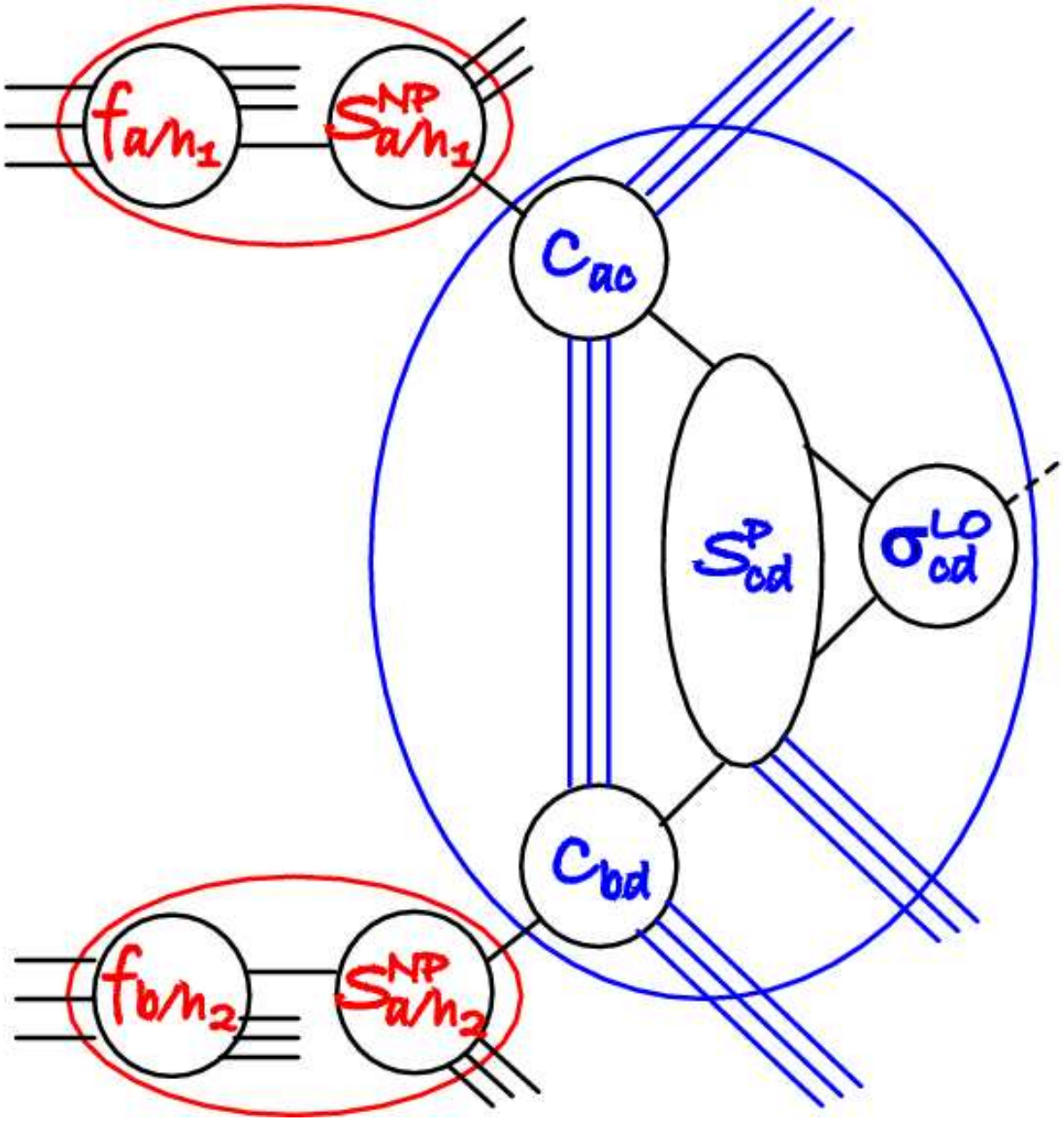
$$\frac{d\sigma}{dQ_T^2} \sim f(x_1, Q) \otimes H(Q, Q_T, x_1, x_2) \otimes f(x_2, Q)$$

$$H\big|_{LO} \sim \delta(Q_T) \qquad\qquad L = \ln\left(\frac{Q^2}{Q_T^2}\right)$$

$$H\Big|_{N^nLO} \xrightarrow[Q_T \to 0]{} \frac{1}{Q_T^2}\, \alpha_s^{\,n}\, c_{n,m}\, L^m + O\left(\frac{1}{Q_T}\right), \qquad (0 \le m \le 2n-1)$$

- Factorization works if radiated partons are hard ($Q_T \sim Q$)
- Soft gluons radiated ($Q_T \ll Q$) $\Rightarrow \alpha_s L > 1 \Rightarrow$ ~~perturbative convergence~~
- Soft partons in $H \Leftrightarrow$ breakdown of factorization

reΦactorization — taking it apart



reΦactorization → re$\sum_{i=1}^{\infty}$ummation

— RG evolution for $Q_T \ll Q$:

$$\frac{d\sigma}{dQ_T} = W(Q_T, Q) + Y(Q_T, Q) \quad \text{where } W \text{ contains } \ln(Q/Q_T)$$

$$W(Q_T, Q) = \int d^2 k_T\, \tilde{C}_{i/h_1}\left(\vec{k}_T, Q\right) \mathcal{H}_{ij}(Q_T, Q)\, \tilde{C}_{j/h_2}\left(\vec{Q}_T - \vec{k}_T, Q\right)$$

$$W(Q_T, Q) = \int d^2 b\, e^{i \vec{Q}_T \vec{b}}\, \tilde{W}(b, Q)$$

$$\partial_{\ln Q}\, \tilde{W}(b, Q) = -\left(\int_{C_1^2/b^2}^{C_2^2 Q^2} \frac{d\bar{\mu}^2}{\bar{\mu}^2}\left[A(\mu, C_1) - B(C_1, C_2 Q)\right]\right) \tilde{W}(b, Q)$$

- solution leads to exponentiated logs:

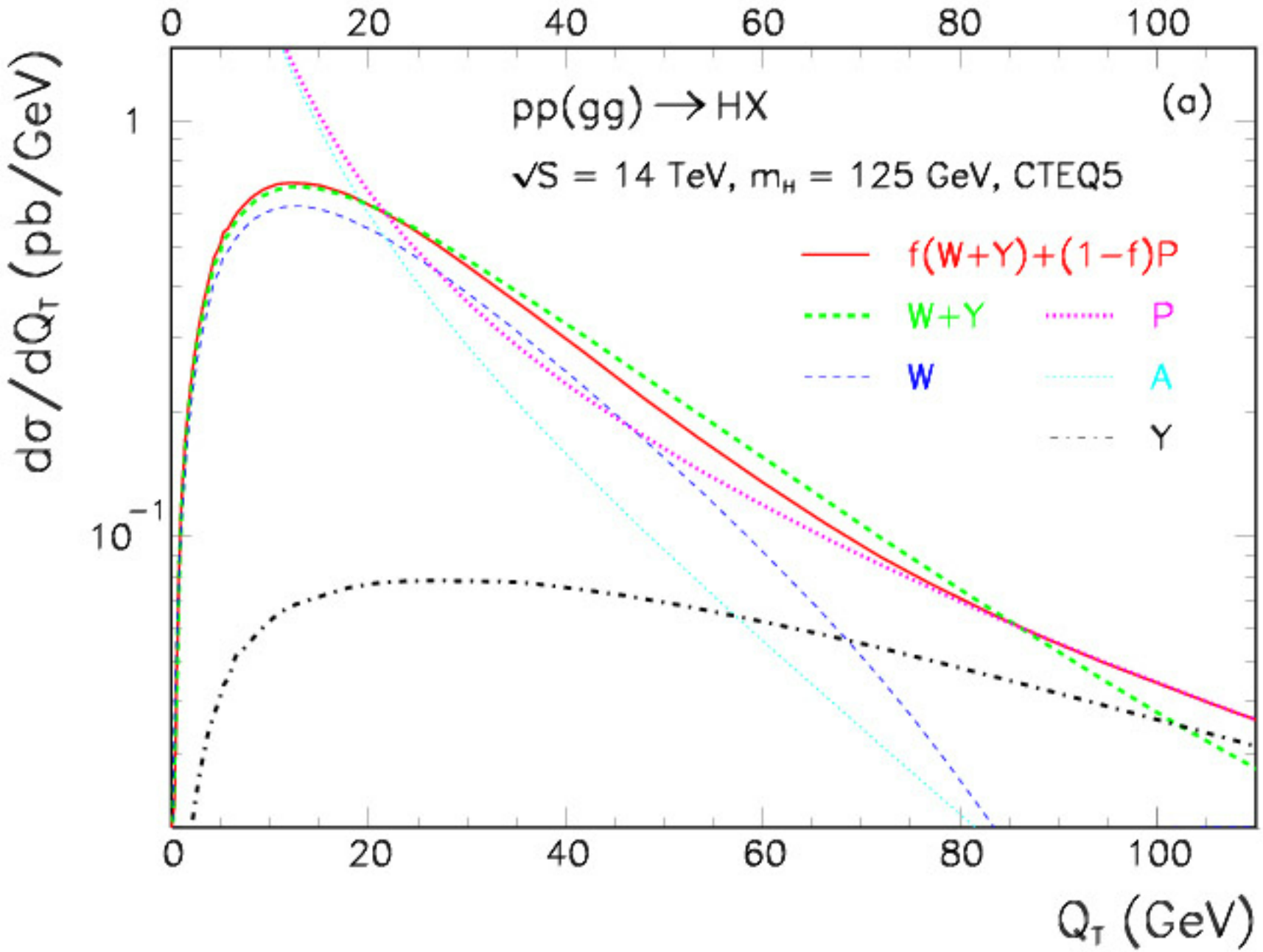
$$\tilde{\mathcal{H}}_{ij}(b, Q) = \sigma_{ij}(Q)\, e^{-S(b,Q)}$$

$$S(C_1/b, C_2 Q) = \int_{C_1^2/b^2}^{C_2^2 Q^2} \frac{d\bar{\mu}^2}{\bar{\mu}^2}\left[A(\mu, C_1) \ln\left(\frac{C_2^2 Q^2}{\bar{\mu}^2}\right) - B(\mu, C_1, C_2)\right]$$

- incorporating the higher order QCD corrections

$$A(\mu) = \sum_{i=1}^{\infty} \left(\frac{\alpha_s(\mu)}{\pi}\right)^i A^{(i)}, \text{ ditto } B \text{ \& } C(b, \mu) = \sum_{i=0}^{\infty} \left(\frac{\alpha_s(\mu)}{\pi}\right)^i C^{(i)}(b)$$

Putting it all together



Conclusion

~~%> g77 -c WGRad.f~~

~~%> g77 -c ResBos.f~~

~~%> g77 -o WGRBos.x WGrad.o ResBos.o~~