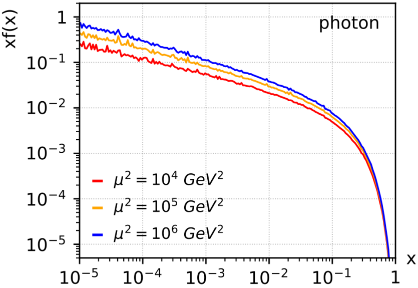
The Transverse Momentum Dependent PDF of the Photon

We generated photon TMDs using the parton branching method in uPDFevolv

- since $\alpha \sim \alpha_s^2$: NLO QCD splitting are used
- no intrinsic photon density
- introduction of photon PDF, LO-QED splitting kernels (P_{qq}, $P_{q\gamma}$, $P_{\gamma q}$)
- sudakov FF for photon
- running LO-QED coupling with matching at quark-mass thresholds

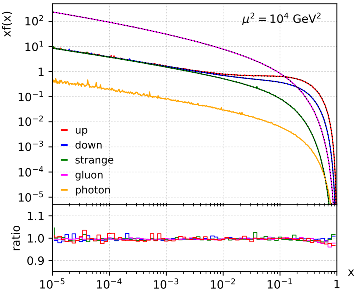
Collinear photon PDF

Collinear PDFs generated by uPDFevolv

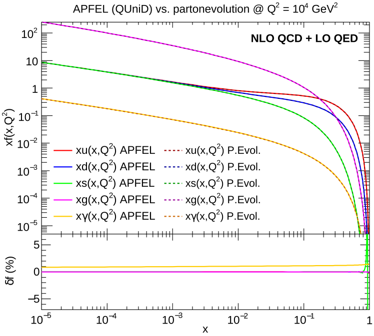


Collinear photon PDF

Comparison of collinear photon PDF



Benchmark comparison
ratio of uPDFevolv over the QCDNUM

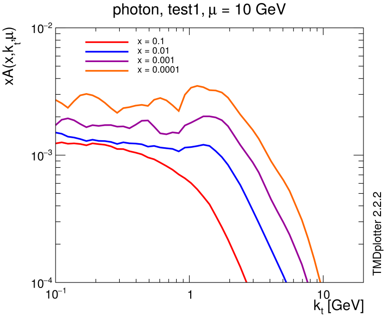


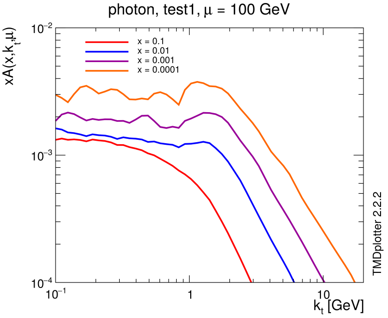
*APFEL and partonevolution**

*Stefano Carrazza. Parton distribution functions with QED corrections. 2015. arXiv: 1509.00209 [hep-ph].

Photon TMD

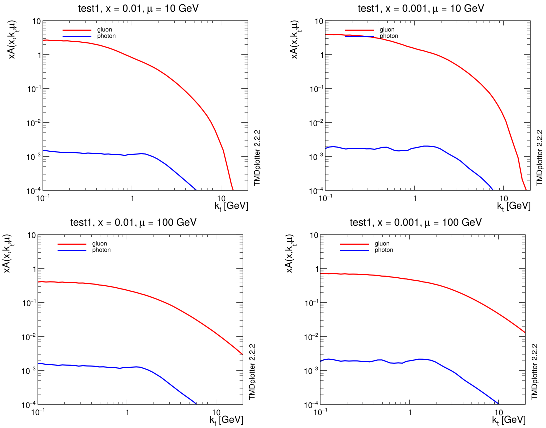
Parton Branching can be used to generate photon TMDs.





- fluctuation at low k_t: To generate small k_t, no branching at high t (unlikely) $\Rightarrow$ statistical fluctuations
- Increasing x $\Rightarrow$ decreases TMD photon density: Region for a resolvable branching $z \in [x, z_m]$
- plateau for 0.1 GeV$\leq k_t \leq \mu_0 = 1.4$ GeV: Caused by how k_T is generated?
  - Branching at $t = \mu_0^2 \rightarrow k_t^2 = (1-z)\mu_0^2 \rightarrow k_t^2 \leq \mu_0^2$
  - for $x \rightarrow 0$: Large phase space $\Rightarrow$ all different kt values can be generated
  - for $x \rightarrow z_m$: Smaller phase space $z \approx z_m$, $k_t^2 \approx (1-z_m)\mu_0^2 \ll \mu_0^2 \Rightarrow$ higher k_t requires smaller z (unlikely) TMD becomes rounder

gluon TMD & photon TMD



$$\mathcal{A}(x, k_t, p) = \mathcal{A}_0(x, k_t, p) + \int \frac{dz}{z} \int \frac{dq^2}{q^2} \, \Theta(p - zq) \times \Delta_s(p, zq) P(z, q, k_t) \, \mathcal{A}\left(\frac{x}{z}, k_t + (1 - z)q, q\right) ,$$

$$\mathcal{A}_0(x, k_t, p) = \mathcal{A}_0(x, k_t, q_0) \, \Delta_s(p, q_0)$$