MILOU DVCS Generator: Status and Plans

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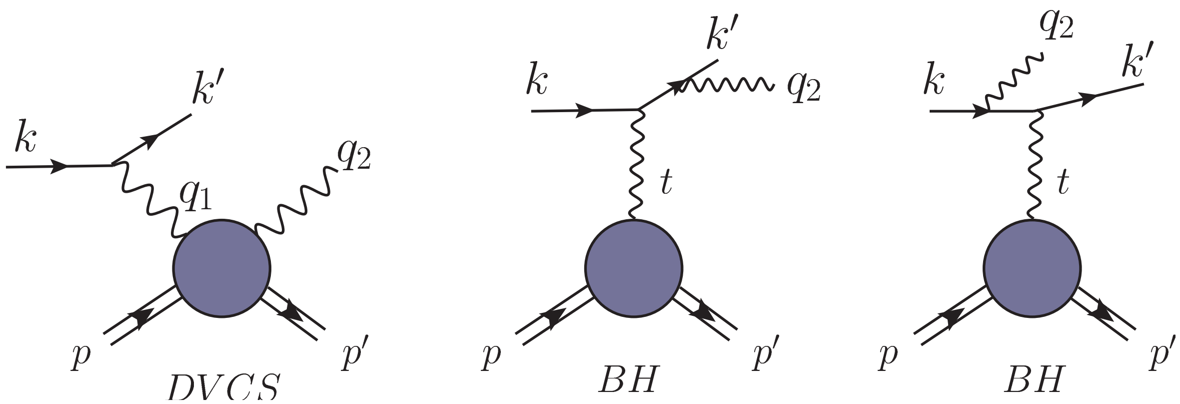

Meeting on Coherent Nuclear DVCS

March 17, 2020

MILOU

Written by E. Perez, L Schoeffel, L. Favart [arXiv:hep-ph/0411389v1]

The code MILOU contains two different models for DVCS simulation:

FFS

Based on: Frankfurt, Freund and Strikman (FFS)
[Phys. Rev. D 67, 036001 (1998). Err. Ibid. D 59 119901 (1999)]

$$\frac{d^3 s^{DVCS}}{dx dQ^2 dt} = \frac{p^2 a^3 s(1+(1-y)^2)}{2xR^2Q^6} e^{-b|t|} F_2^2(x,Q^2)(1+r^2)$$

- Old model: written before data came out!
- Used by H1 and ZEUS for their DVCS measurements
- The ALLM parametrization for F2 is used

GPDs-based

Based on: A. Freund and M. McDermott
All ref. in: http://durpdg.dur.ac.uk/hepdata/dvcs.html

- GPDs, evolved at NLO by an independent code which provides tables of CFF
  - at LO, the CFFs are just a convolution of GPDs:

$$\mathcal{H}(\xi, Q^2, t) = \sum_{u,d,s} \left[\frac{e_i^2}{1 - x/\xi - i\varepsilon} \pm \{\xi \rightarrow -\xi\} \right] H_i(x, \xi, t) dx$$

MILOU

- **provide the real and imaginary parts of Compton form factors (CFFs), used to calculate cross sections for DVCS and DVCS-BH interference.**

$$\frac{d\sigma}{dx\,dy\,d|t|\,d\phi\,d\varphi} = \frac{\alpha^3 x_B y}{16\pi^2 Q^2\sqrt{1+\varepsilon^2}}\left|\frac{I}{e^3}\right| \qquad \begin{array}{l}\phi = \phi_N - \phi_l \\ \varphi = \Phi_T - \phi_N\end{array} \qquad \varepsilon \equiv 2x\frac{m_N}{Q}$$

$$|I_{\mathcal{BH}}|^2 = \frac{e^6}{x^2y^2(1+\varepsilon^2)^2\Delta^2\mathcal{P}_1(\phi)\mathcal{P}_2(\phi)}\left\{c_0^{BH} + \sum_{n=1}^{2} c_n^{BH}\cos(n\phi) + s_1^{BH}\sin(\phi)\right\}$$

$$|I_{\mathcal{DVCS}}|^2 = \frac{e^6}{y^2Q^2}\left\{c_0^{DVCS} + \sum_{n=1}^{2}\left[c_n^{DVCS}\cos(n\phi) + s_n^{DVCS}\sin(n\phi)\right]\right\}$$

$$|I|^2 = \frac{\pm e^6}{xy^3\Delta^2\mathcal{P}_1(\phi)\mathcal{P}_2(\phi)}\left\{c_0^I + \sum_{n=1}^{3} c_n^I\cos(n\phi) + s_1^I\sin(\phi)\right\}$$

- **The B slope is allowed to be constant or to vary with Q^2:**

$$d\sigma/d|t| = \exp(B(Q^2)\cdot t);\;\; \text{with: } B(Q^2) \gg \ln(Q^2)$$

  - Functional form of *t* dependence can be controlled: exp, dipole
- **Proton dissociation ($ep \rightarrow e\gamma Y$) can be included**
- **Can simulate light ions setting the A and different *t*-dependences (not tested)**

Current version

Instructions on the code and its output files are on the wiki page:
https://wiki.bnl.gov/eic/index.php/MILOU

List of improvements a.r.o. the original version used by H1:

1) **Fixed the FORTRAN common blokes:** they where rewritten by bases and did not preserve the random seed as set in the cards. That caused one had to recalculate the integral every generation (which take days). Now the integral can be calculated ones per energy conf. and the same grid used for each generation.

1) **Corrected ALLM parameterization for F2 implemented (relevant when running in FFS-model mode)**. this caused a disagreement between the GPD and the FFSs models of a factor two or more in the cross sections even at HERA energies. The correct ALLM is taken from the original ALLM paper hep-ph/9712415v2, so the agreement between the two models at HERA energies and with the predictions from the GenDVCS Monte Carlo (also using FFS and used by the ZEUS Collaboration) it is now satisfactory.

1) **The output is not not only in the form of a PAW ntuple but the code creates a text file in the Pythia-like ascii format**, in the same standard of other MCs for EIC. Output description is on the web-page.

Ongoing and future plans

- **Use new tables of CFFs to update tables in MILOU:**
  - **from Partons (GK model) → help from: Jinlong Zhang, Pawel Sznajder, PARTONS group**
  - **from GEPARD (KM model)→ help from: K. Kumericki**
- **Perform impact studies, including the feasibility of extracting the D-term**
- **Test and improve DVCS on light ions**
  - **help is very welcome from this group**