# TOPIXS

TOPIXS computes the inclusive top-quark pair production cross section in hadron collisions at next-to-next-to-leading logarithmic accuracy in soft and Coulomb resummation, including the contribution from bound states, as described in Refs. [1, 2]. A detailed manual is available together with the program package at the URL

`http://users.ph.tum.de/t31software/topixs/`

TOPIXS uses HPLOG [3] for the numerical evaluation of harmonic polylogarithms and QUADPACK [4] for numerical integrations. PDF sets are included via the LHAPDF [5] library. The determination of the auxiliary parameter $\beta_{\rm cut}$ and the fixed soft scale, which are used in the computation of the resummed cross section, uses routines from the GNU Scientific Library [6].

The program package consists of several FORTRAN and C++ programs which implement the calculation of the total cross section as well as that of the parameter $\beta_{\rm cut}$ and the fixed soft scale. The user interface consists of a BASH shell script, called `topixs`, which automatically compiles and executes these programs. The user can change the program settings by editing a single text file. Examples of such a configuration file are included in the program package.

Several approximations of the cross-section can be chosen. A fixed-order calculation is possible to NLO or (approximate) NNLO accuracy. In the latter case, the full result for the $q\bar{q}$ channel from Ref. [7] can be included by setting the value of the variable `QQNNLOEXACT` to `1` in the configuration file. The resummed cross section can be evaluated in all of the different approximations defined in [1], i.e. (N)NLL$_1$ and (N)NLL$_2$ with fixed soft scale, and (N)NLL$_2$ with running soft scale. The option `BOUNDS` allows the user to decide whether or not to include the contribution from bound states.

The default setting is to use a running soft scale (`MUSRUN=1`) and include the bound-state contribution (`BOUNDS=1`). The full result for the $q\bar{q}$ channel is included in the computation of NNLO$_{\rm app}$ and NNLL$_2$ (`QQNNLOEXACT=1`). These settings will be used unless the variables are explicitly reset in the configuration file.

The main parameters of the calculation are the top-quark mass, the collider type (proton-proton or proton-antiproton) and energy, and the PDF set to be used. All of them can be chosen by the user. The default settings are $m_t = 173.3$ GeV (`MTOP=173.3`), LHC with $\sqrt{s} = 8$ TeV (`COLLIDER=1` and `SQRTS=8000`), and MSTW08 [8] (`PDFSET=MSTW08`). There are four additional predefined PDF sets: ABM11 [9], NNPDF2.1 [10], JR09 [11], and CT10 [12, 13]. For these sets the computation of the PDF+$\alpha_s$ error is completely automated and it is possible to vary the value of $\alpha_s(M_Z)$ (except for JR09 where no fits with different values of $\alpha_s(M_Z)$ are provided). Other sets can be used by specifying the grid file name using the option `PDFGRID`.

The theory error is determined by the variation of the various scales (hard, soft, factorization, resummation, and Coulomb) and other parameters like $\beta_{\rm cut}$. The central values of these scales can be chosen by the user. The variation is done automatically by evaluating the cross section at several equidistant points between twice and half the central value.

The number of points can also be chosen by the user. Alternatively, the user can vary the scales by hand by performing the calculation without error computation (`NOERR=1`) for different values of the scales. This also makes it possible to evaluate the cross section for specifically chosen points.

The computation time strongly depends on the choice of the PDF set, with ABM11 being the fastest and NNPDF2.1 the slowest. On an AMD Phenom 9850 processor with 2.5 GHz, the computation of a single cross section point (without any error estimates, using the default settings) takes approximately 15 seconds for ABM11, 75 seconds for MSTW08, and 6 minutes for NNPDF2.1. Using the default configuration file to perform the computation of the $\mathrm{NNLO}_{\mathrm{app}}$ and $\mathrm{NNLL}_2$ approximations with MSTW08, including the full theory and PDF+$\alpha_s$ error, requires the evaluation of several hundreds of cross section points and takes about ten hours.

# References


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