

Motivation

- The impact of EFT on spin correlation observables.
- Check the consistency between SMEFT@NLO model and Dim6Top model at LO.
- Use spin correlation observables to cross-validate our implementation.

Objectives

- Introduce spin observables.
- Results.
- Parametrization of EFT impact.

How to probe the spin observables

- The spin correlations defined as the angular correlation of the decay products between the top quark and anti-top quark:

$$\frac{1}{\sigma} \frac{d^2\sigma}{d\cos(\theta_+^a) d\cos(\theta_-^b)} = \frac{1}{4} (1 + B_+^a \cos(\theta_+^a) + B_-^b \cos(\theta_-^b) - C(a, b) \cos(\theta_+^a) \cos(\theta_-^b)) \quad (1)$$

- $C(a, b) = -9 < \cos(\theta_+^a) \cos(\theta_-^b) >$ spin correction observables (9 correlations).
- $B^a = 3 < \cos(\theta^a) >$ are polarisation observables (6 polarisations).

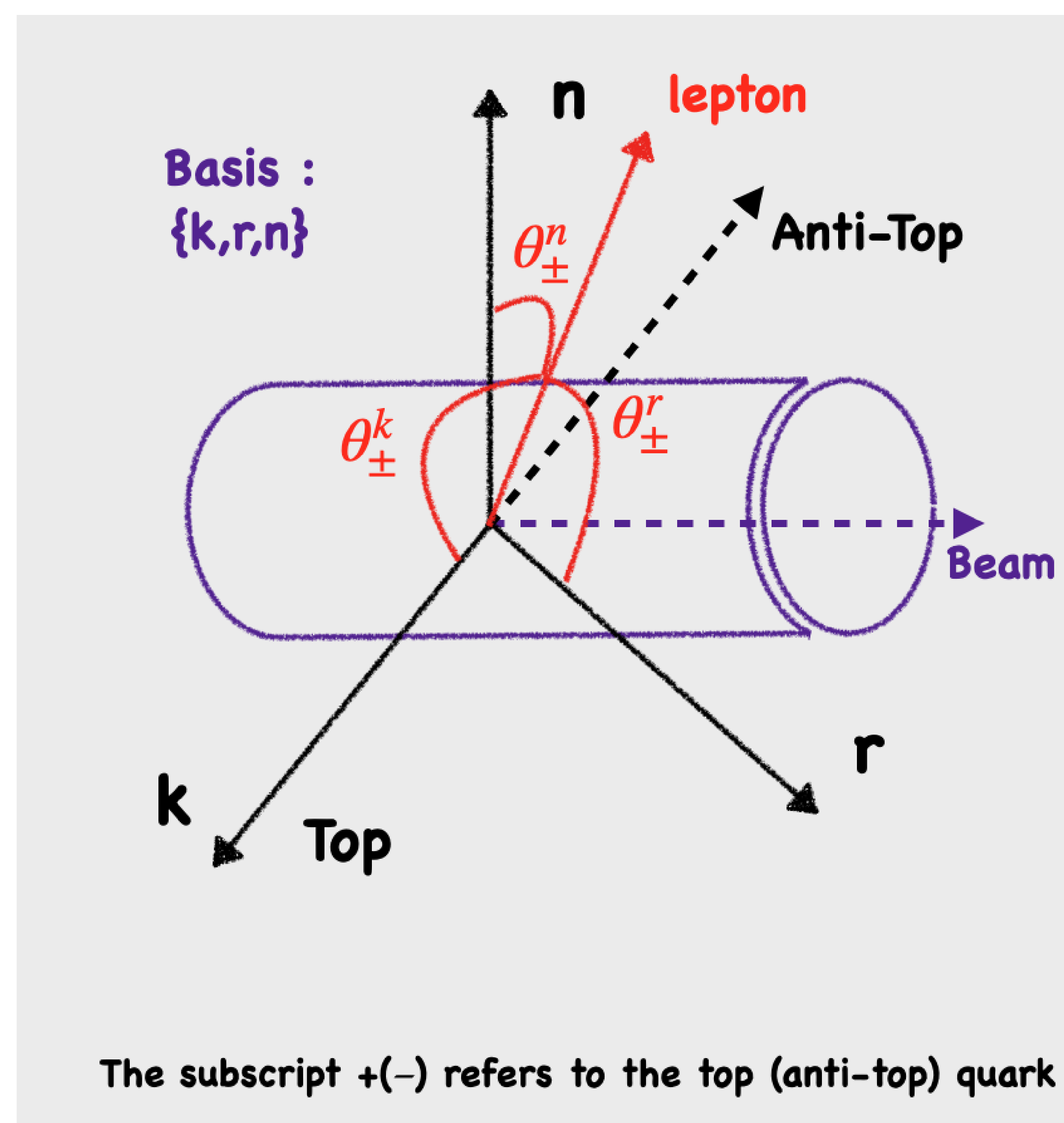
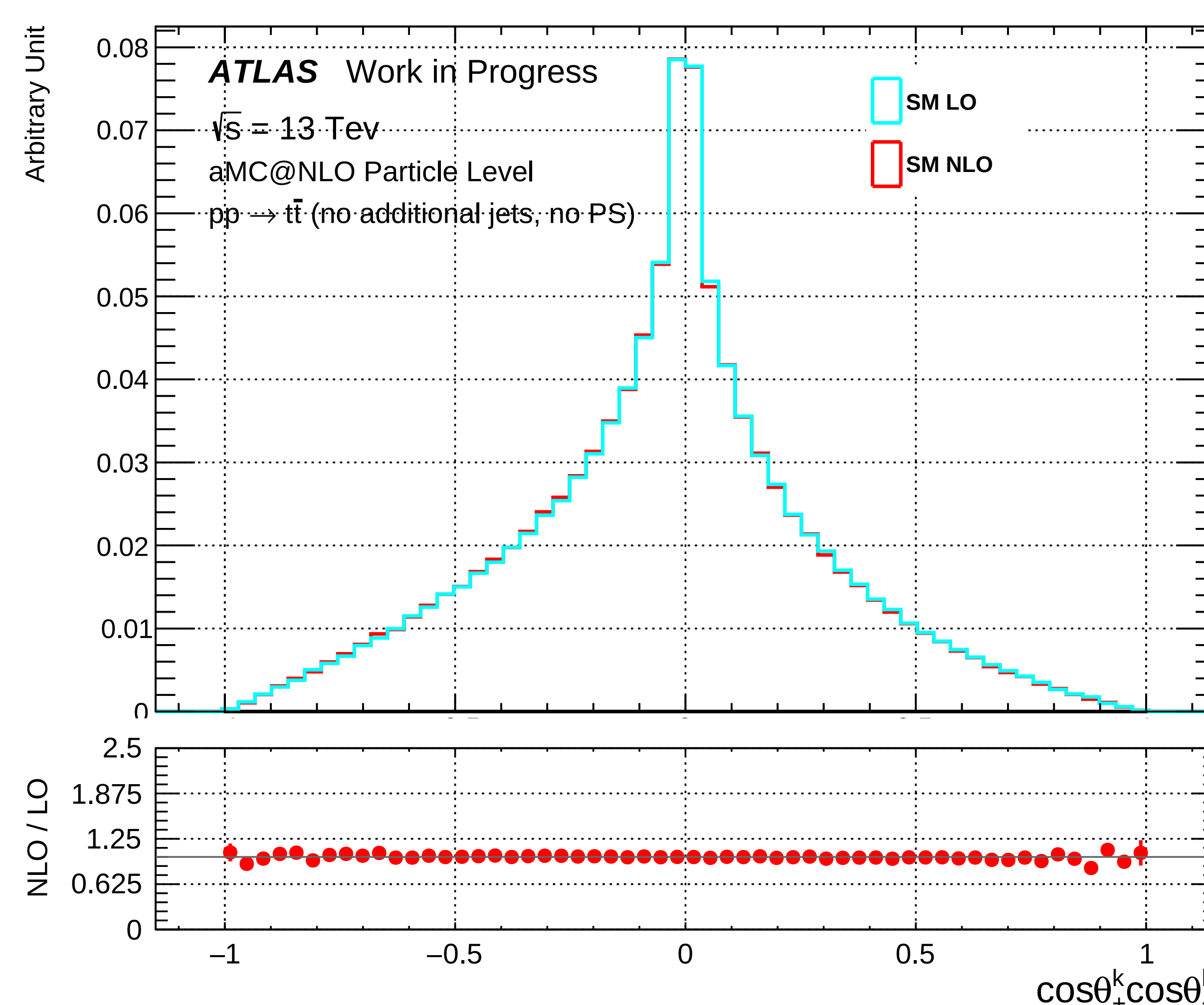


Figure 1. The generic spin basis for the top (anti-top) quark in its rest frame.

- These 15 coefficients completely characterise spin dependence of $t\bar{t}$ production and can be measured experimentally.

Spin Correlations : C (k,k)

- The following Figure shows the distribution of $\cos(\theta_k^+) \cos(\theta_k^-)$ at LO and NLO using MadGraph@NLO w/o additional jets and w/o parton showering:



- SM NLO : $C(k,k) = 0.366313 \pm 0.0042$ (stat)
- SM LO : $C(k,k) = 0.341856 \pm 0.0042$ (stat)

Comparison between SMEFT@NLO and Dim6Top model

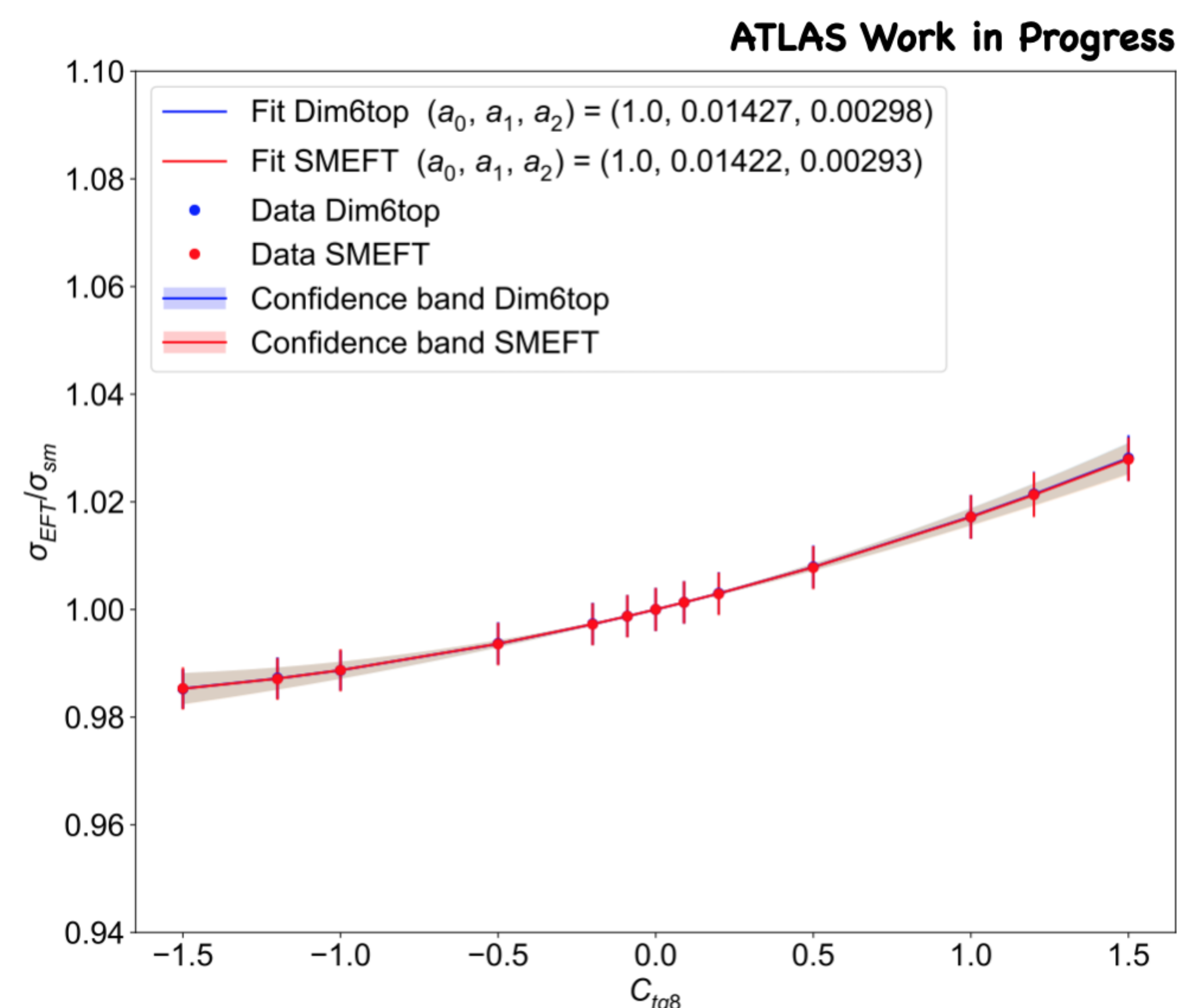


Figure 2. The distribution of the total cross section of different benchmarks mode normalized to the total cross section of Standard Model (ctq8=0.0)

Note

- Note that each EFTs model rely on different default setting, operator bases, electroweak input parameters, particle decay width and tools. which we have monitored and adopted so both EFTs model can predict the same physical predictions.

Compute α_i and β_i

For a given EFT model e.g Dim6Top or SMEFT, MC samples are generated as following :

- Generate samples for a given BSM operators e.g c_{tq8}
- Compute $C(k,k)$ for each sample.
- Do the interpolation ==> Extract the value of α_i and β_i

$$C(k, k)_{EFT} \approx C(k, k)_{SM} + \alpha_{tg} \frac{c_{tg}}{\Lambda^2} + \beta_{tg} \frac{c_{tg}^2}{\Lambda^4} \quad (2)$$

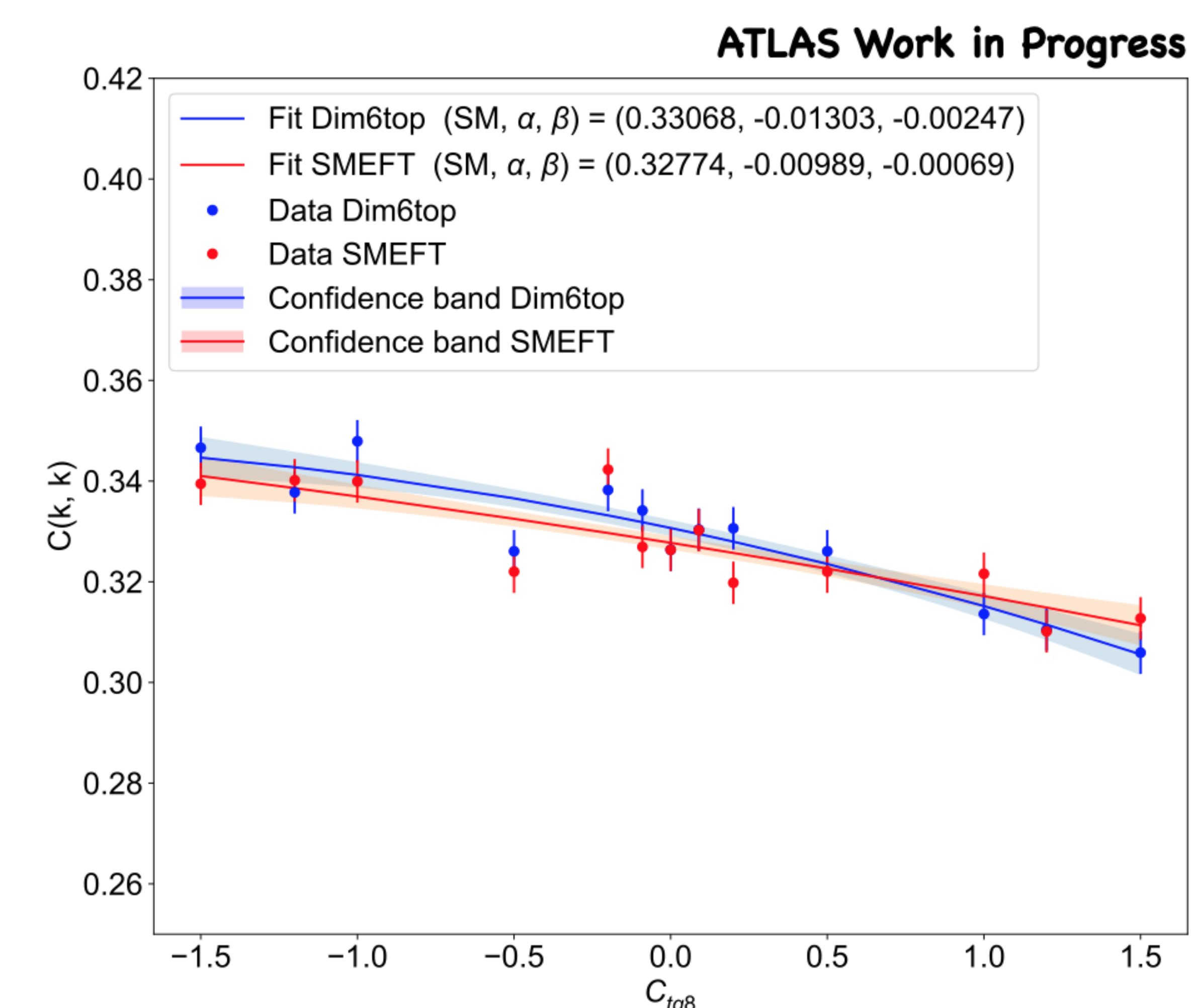


Figure 3. The distribution of spin correlation observable $C(k, k)$ for various value of c_{tq8} coefficient. Standalone

Reweighting

- Reweighting consists in using a sample of events generated under given values of c_{tq8} and in associating with those events an additional weight that corresponds to a new value of c_{tq8}

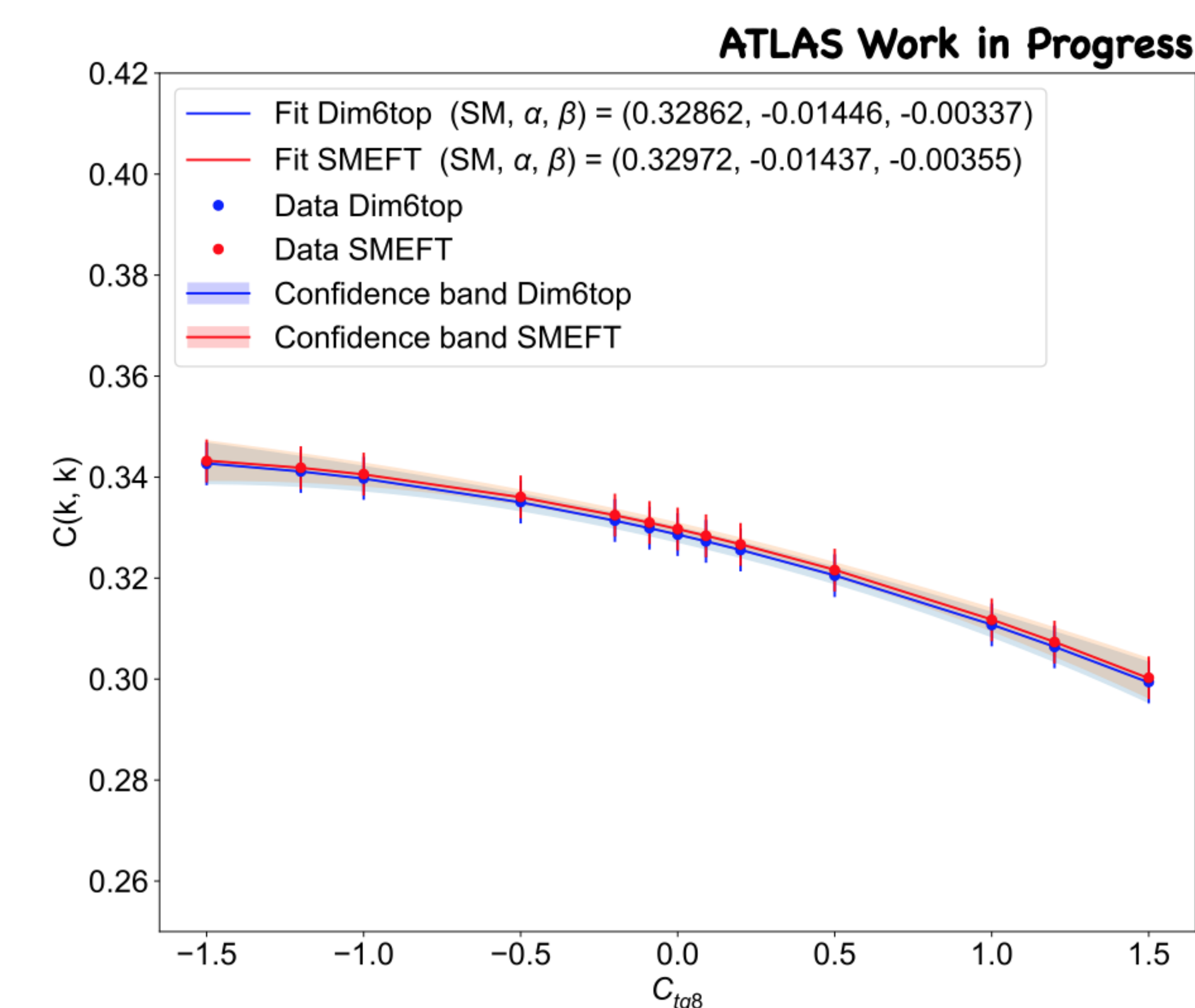


Figure 4. The distribution of spin correlation observable $C(k, k)$ for various value of c_{tq8} coefficient. Reweighting