

Background, Intentions

The Standard Model (SM) in particle physics has achieved significant success yet explaining its stability and addressing dark matter prompts study of beyond-SM (BSM) theories. Many of these models inherently generate collision events containing bottom quarks. Understanding the radiation patterns of b-quarks is hence key for testing BSM.

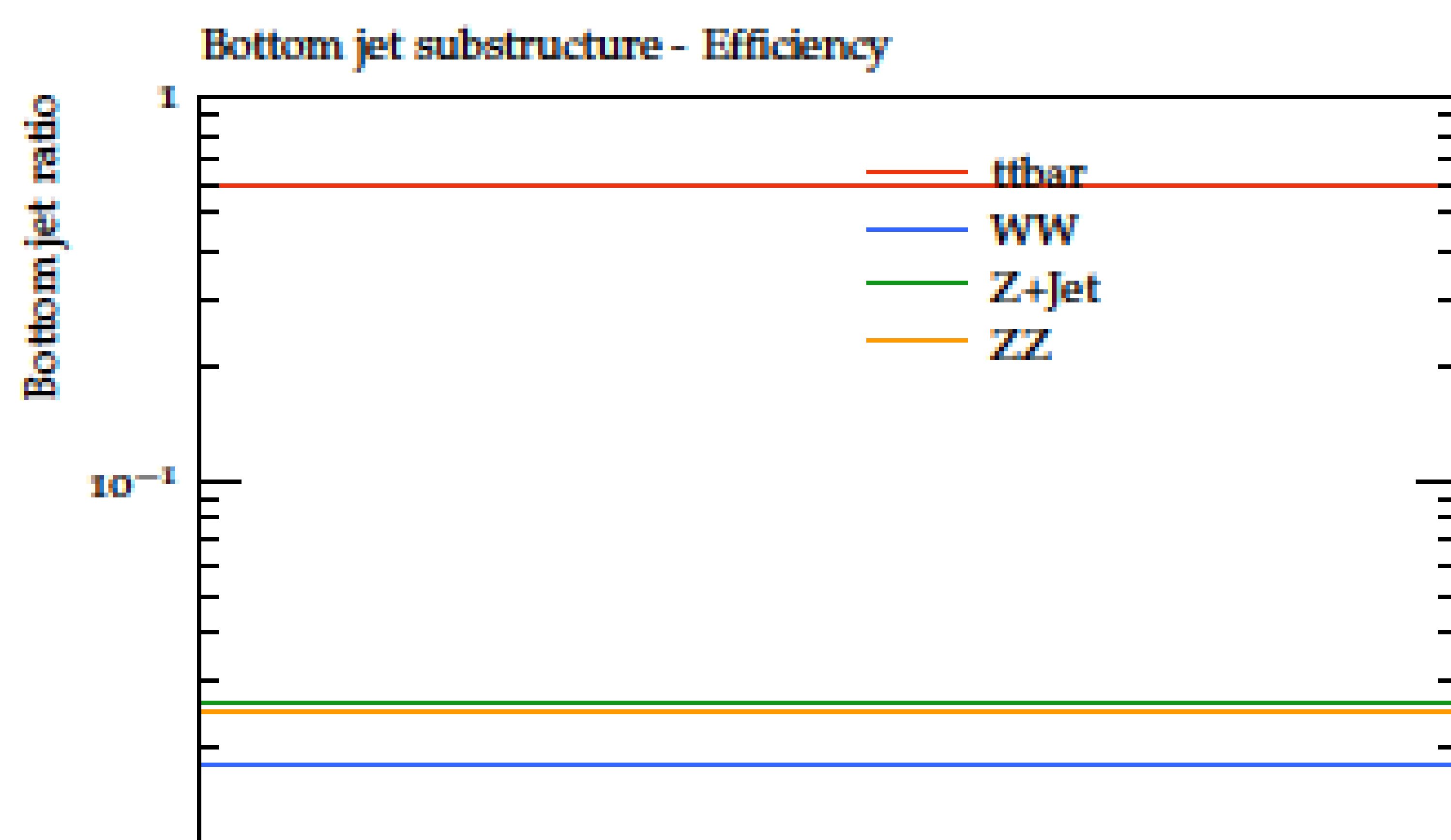
Approach

Jets are collimated particle sprays from hadronization of quark and gluon in collisions. Through:

- Simulations and b-jet reconstruction
- Real data analysis from the Large Hadron Collider

The substructures, characterizing features of the momentum distribution, reveal the scattering patterns of the particle sprays.

Particles Colliding Model – Monte Carlo Simulation



Significance in identifying b-quarks (b-tagging):

- Perfect jet-flavour labelling (Impossible in lab-settings)
- Utilize DOUBLE b-jets purity in top and anti-top decay channel for trouble-free investigations.

B-tagging Efficiency Visualization:

- Study of b-jet reconstruction efficiencies
- 80% b-jet identification in ttbar event
- ~1% from background contamination

Do reconstructed jet-flavour taggers introduce a bias in jet structure measurements when utilizing said structure for classification purposes?

Data from ATLAS@LHC - Direct Vs Tag & Probe Analysis

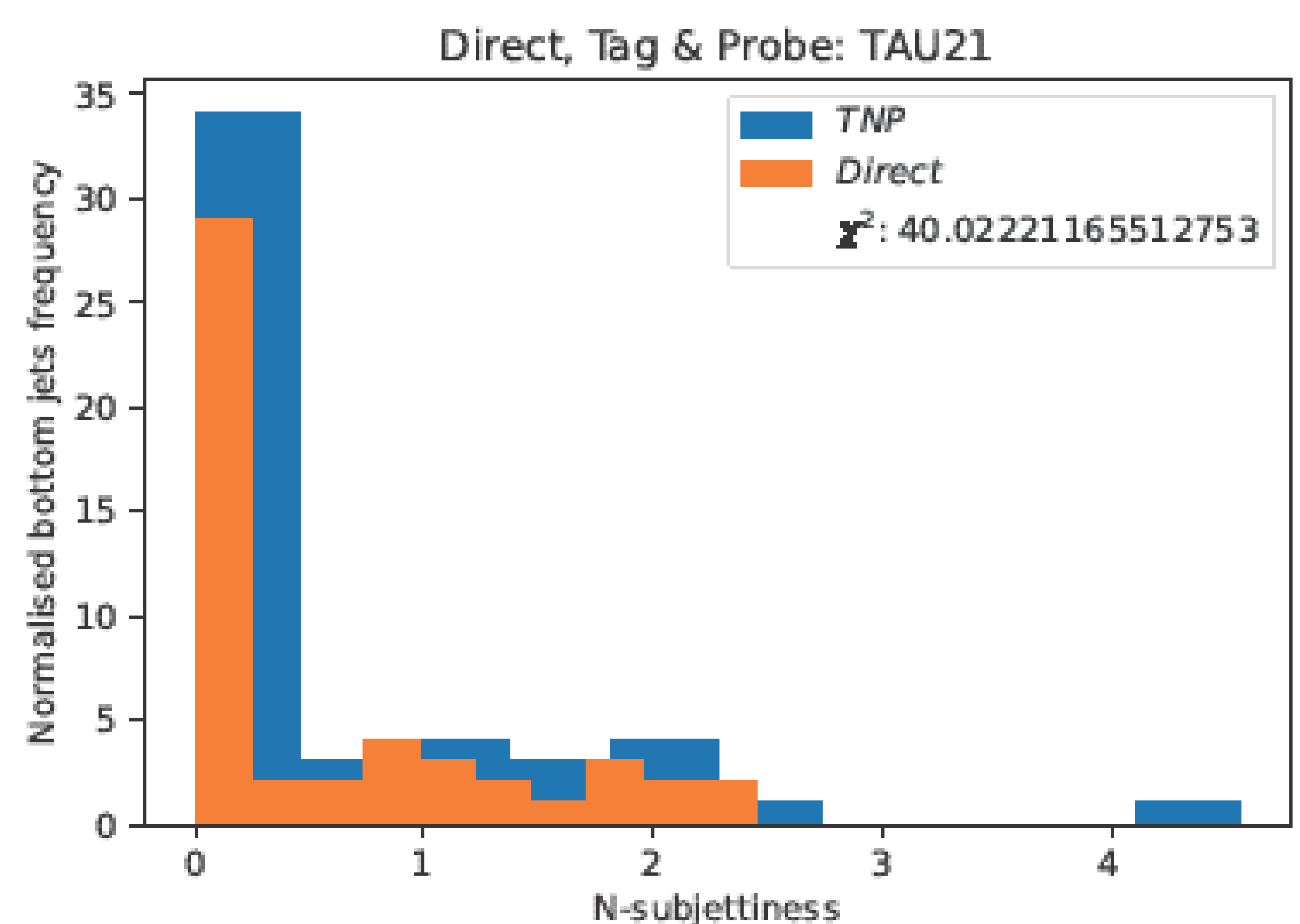
Tag & Probe (T&P) method reduces selection bias in b-jet measurements:

- Tag: Identify a well-understood bottom quark as “b-tag” with aid from simulation.
- Probe: Instead of measuring the “b-tag”, assess the substructure of its pairing b-jet.

N-Subjettiness Ratio (*Tau21*) Visualization:

- $Tau21 = 0$ indicates event with a 2-jet-like structure rather than a 1-jet-like configuration.
- Wider blue peak indicates the presence of more 1-prong b-jets than what the tagger returns.

The Tag and Probe (T&P) method reveals previously overlooked single bottom quarks in direct analysis.



Chi-squared (χ^2) Fitting Test:

$\chi^2 = 0$ denotes perfect symmetry in data across analytical plots.