Jet shapes in top quark pair events in the di-lepton channel

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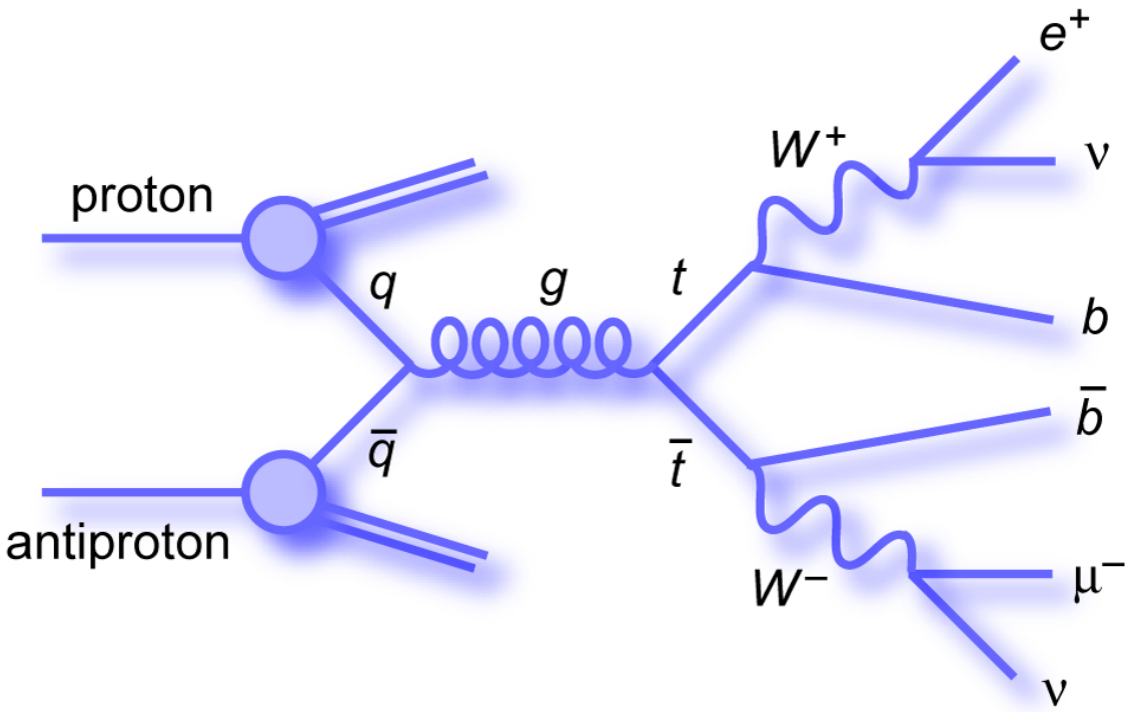
Introduction



- Analysis of Jets in $t\bar{t}$ events in the Di-Lepton channel
- How is the energy distributed inside the Jets?

Motivation

Questions to answer:

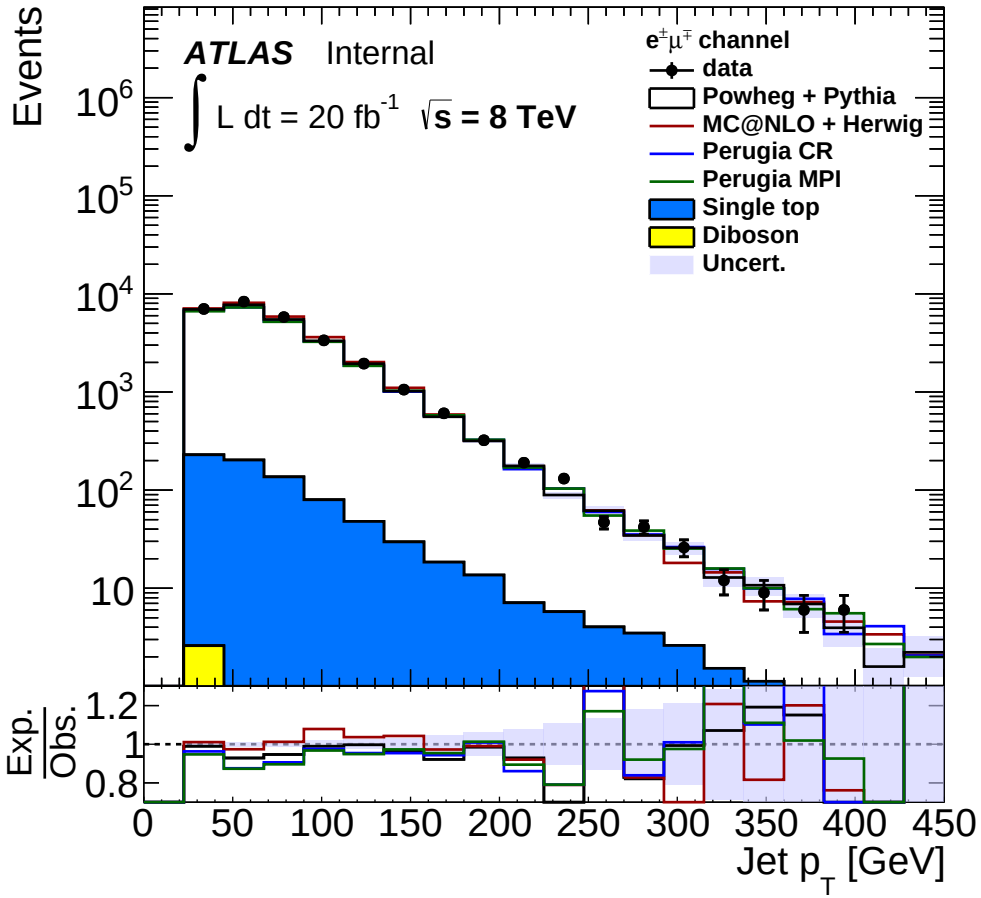
- Can Monte Carlo samples be used to describe jet shape variables based on tracks?
- Are the various MC tunes used at ATLAS sensible for $t\bar{t}$ events?
- Which Monte Carlo sample describes the data better, POWHEG + Pythia or MC@NLO + Herwig?

Selection Criteria

General event selection:

- exactly 2 Leptons
- $\geq$2 Jets
- 2 b-Jets (MV1)
- $e\mu$ channel only
- $H_T > 130\,\text{GeV}$

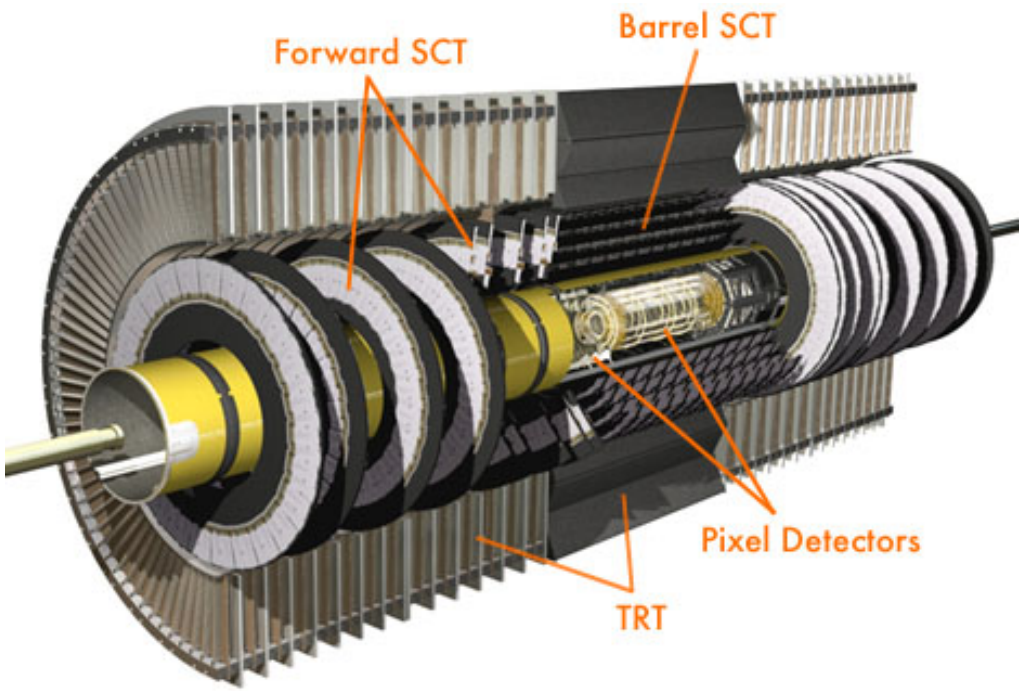
$\Rightarrow$ Almost no background



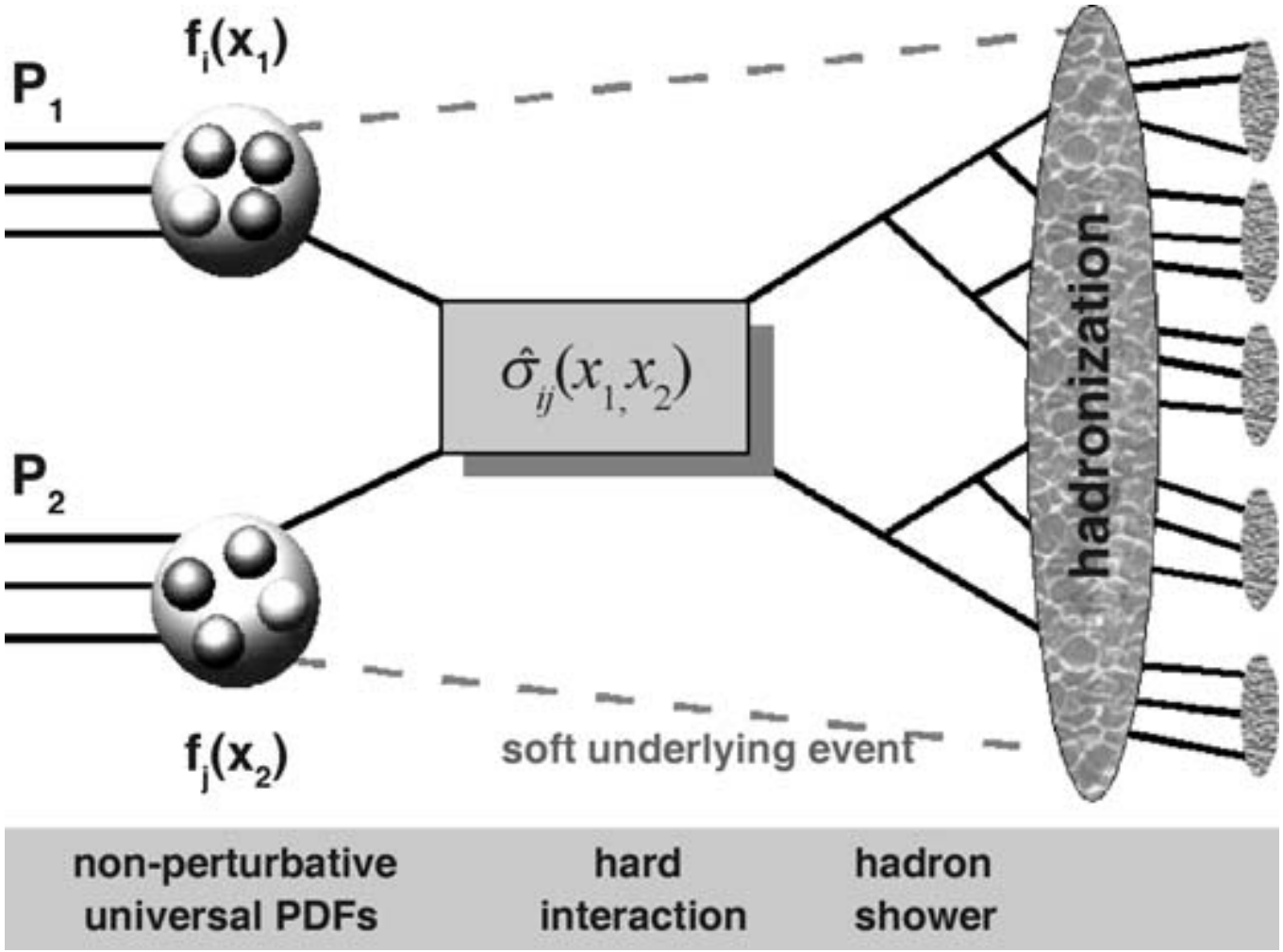
Selection Criteria

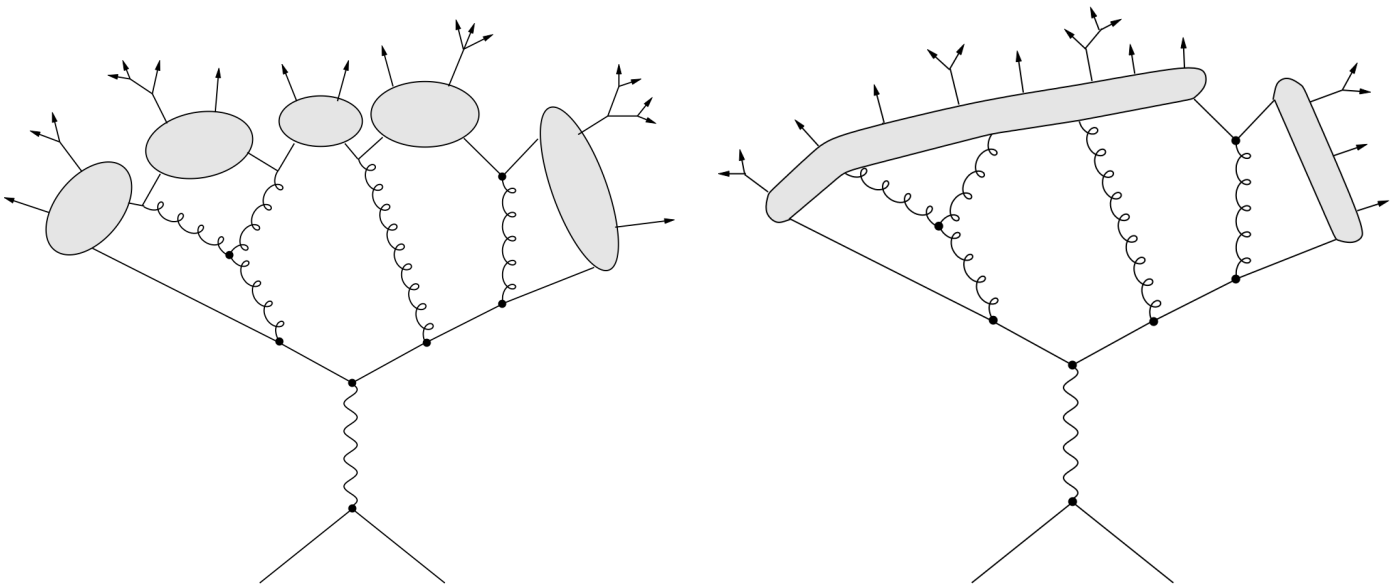
Track selection:

- ≥ 6 hits in the SCT
- ≥ 1 hit in the pixel detector
- $p_T \geq 1\,\text{GeV}$
- $\eta \neq 0$



Parton interaction:





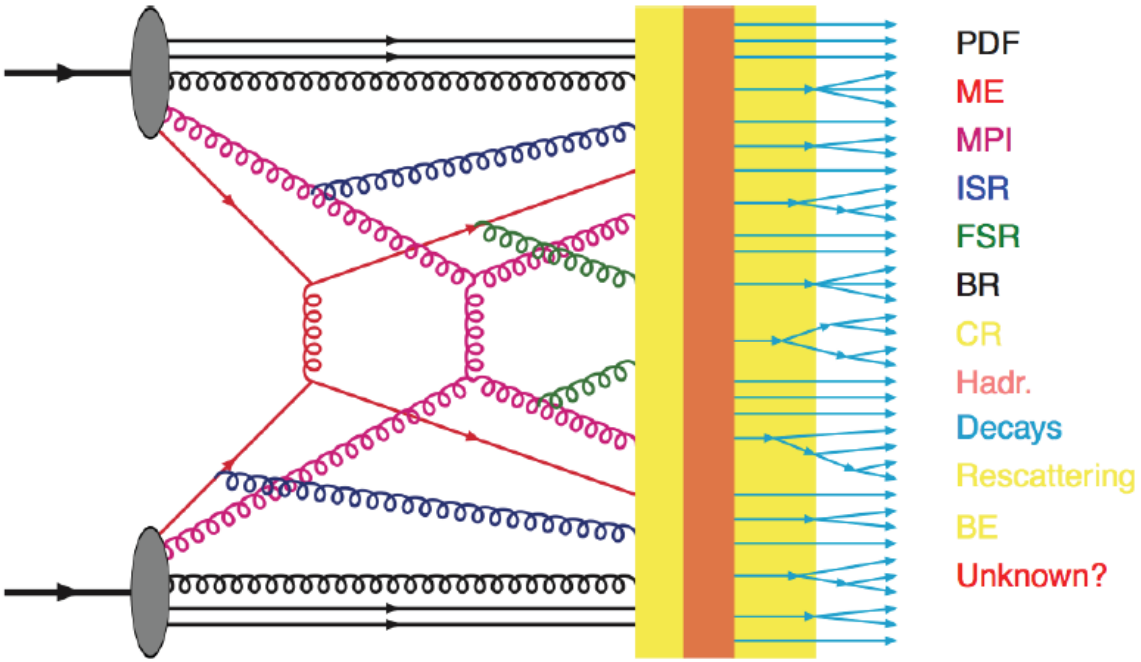
(a) Cluster model (b) String model

Figure: Different Hadronization models

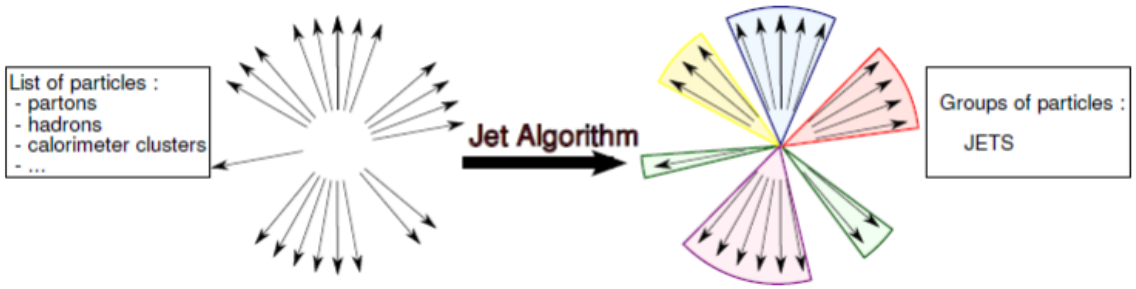
MC tunes

Perugia P2011C tunes:

- Tunes created from Di-Jet events
- not yet been tested in Top-Antitop regime at 8 TeV
- Modification of Multi Parton Interaction (MPI) and Color reconnection (CR)



Definition



Use tracks inside Jets to describe energy distribution.

$$\sum_{\text{Tracks}} p_T$$

- Inclusive Analysis
- Differential Analysis

P_T of Tracks inside the Jets

- Looking at sum of transverse momenta of the tracks
- Varying Radius ΔR

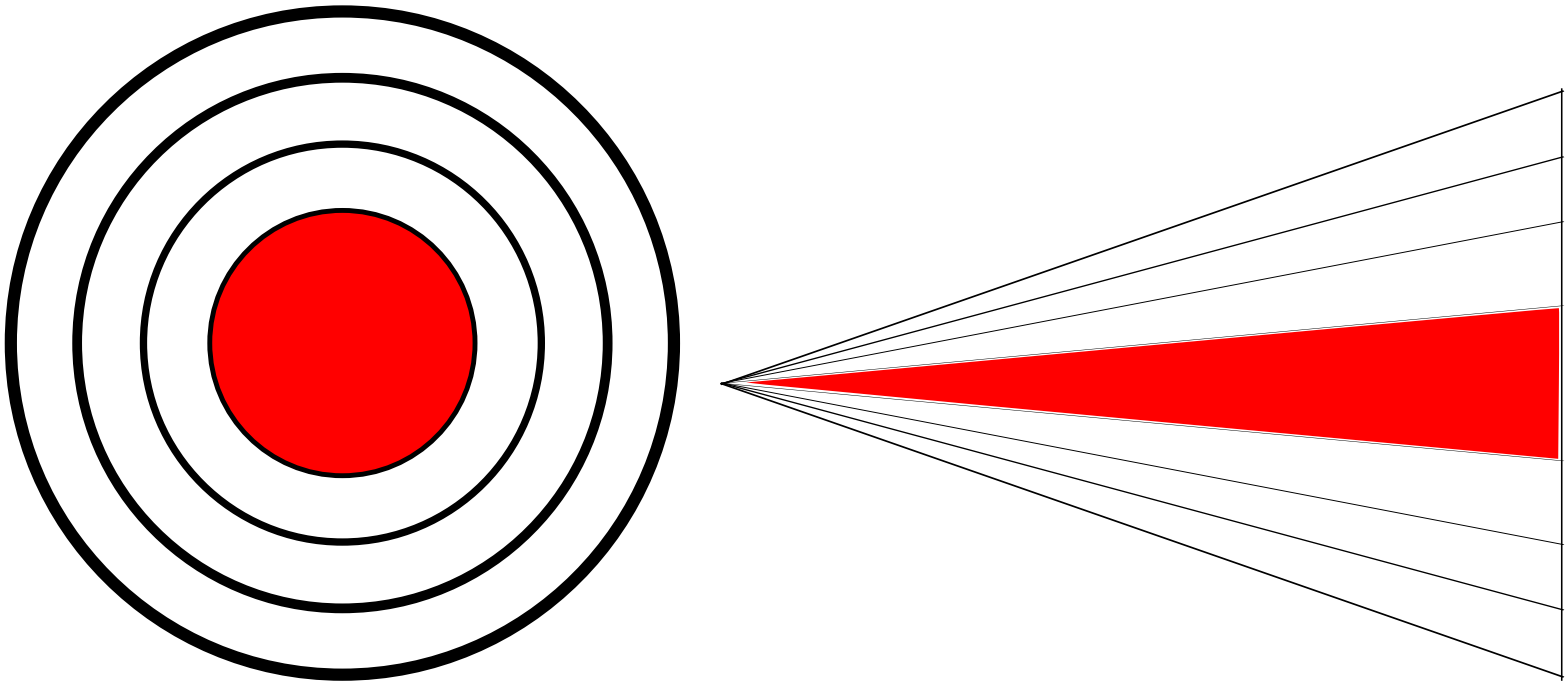
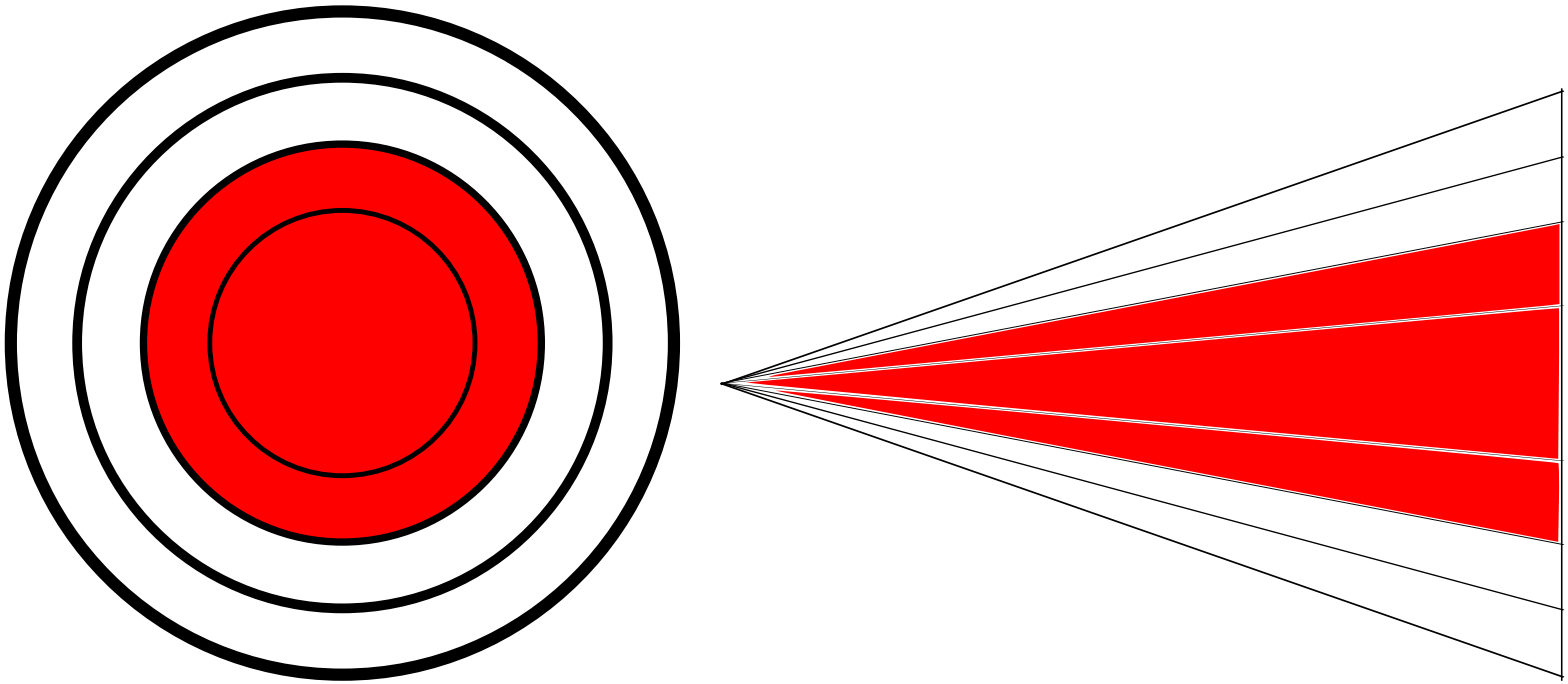


Figure: Top and side view of Jet

P_T of Tracks inside the Jets

- Looking at sum of transverse momenta of the tracks
- Varying Radius ΔR



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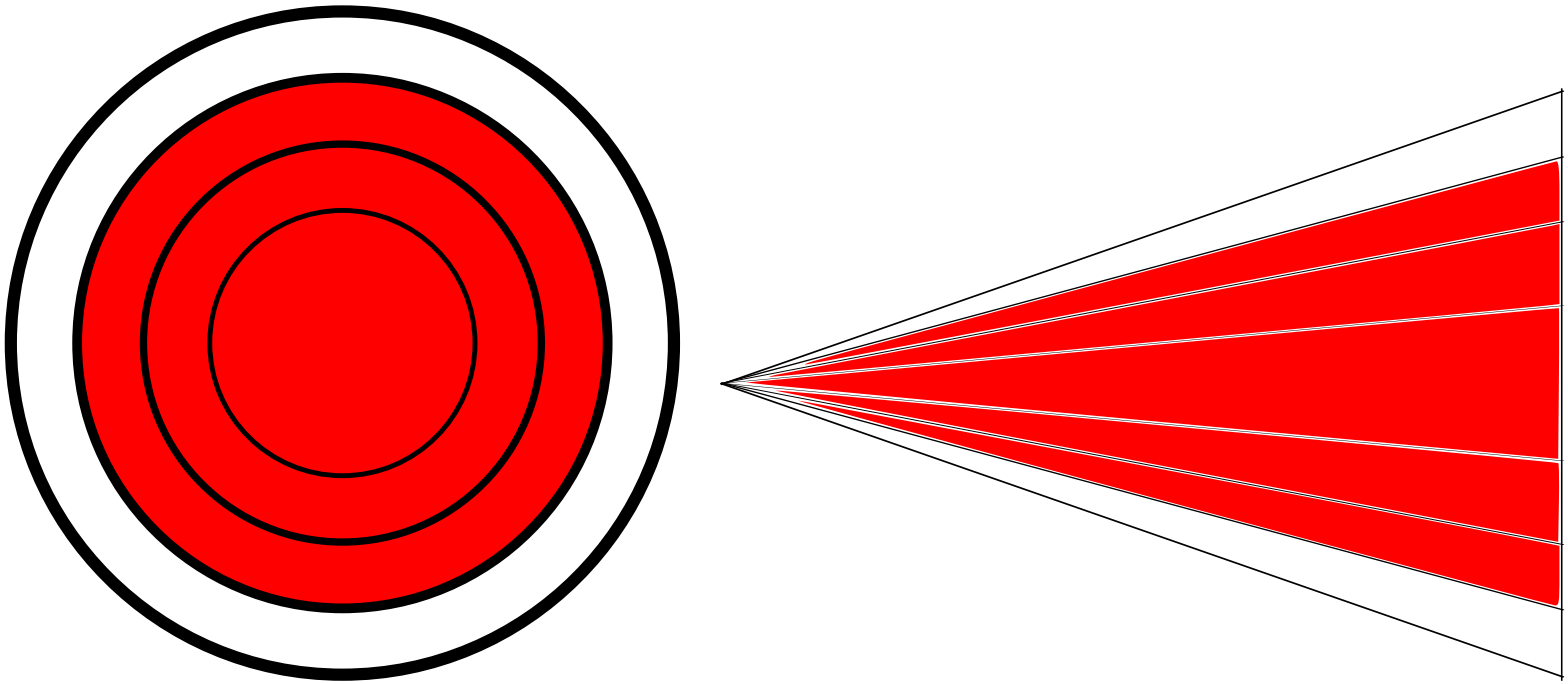

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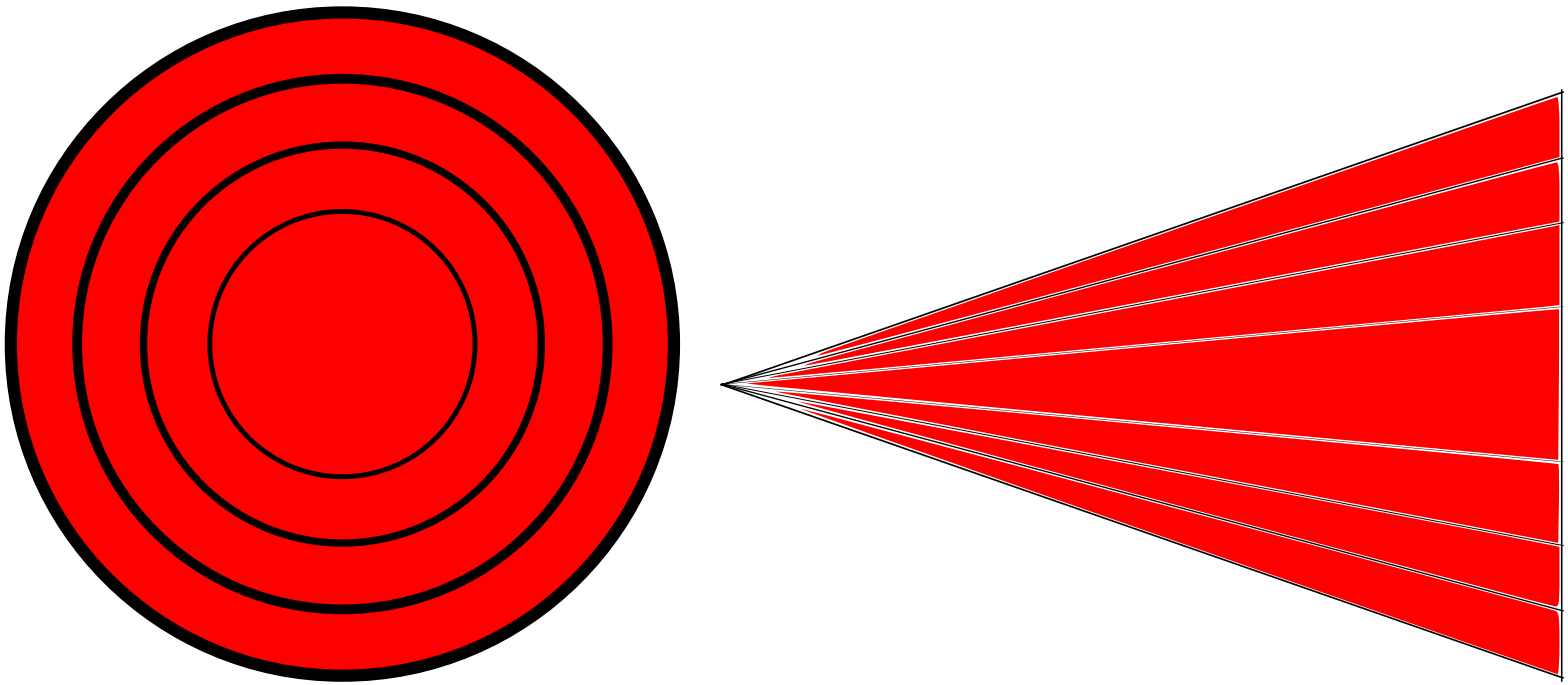

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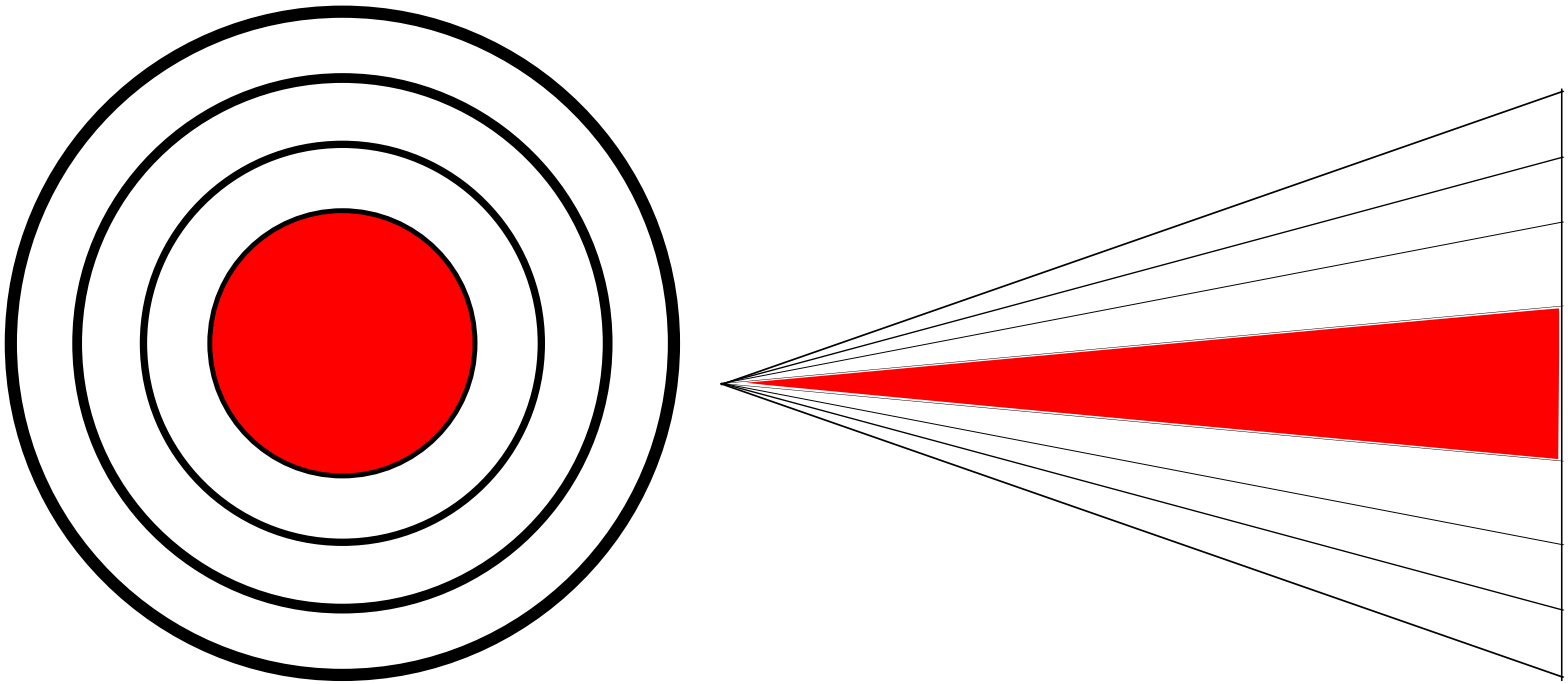

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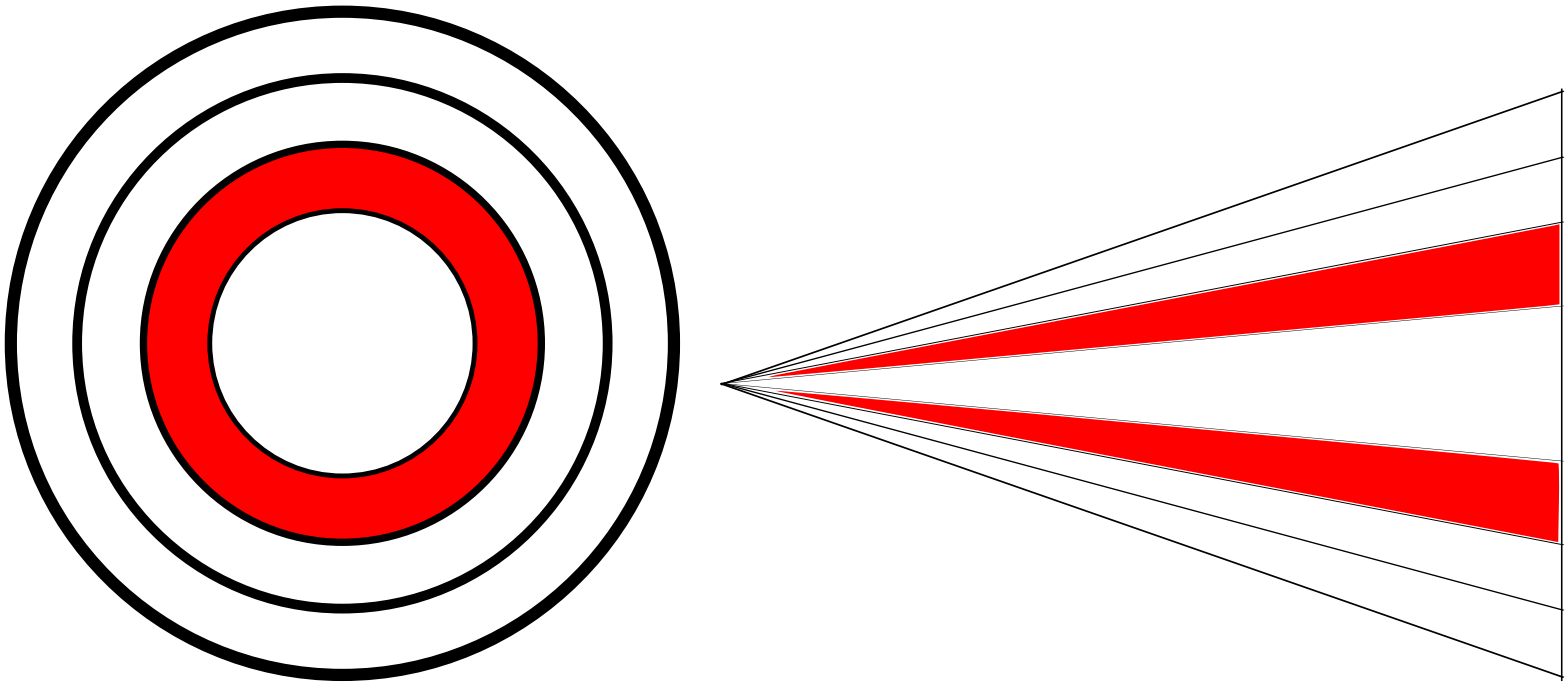

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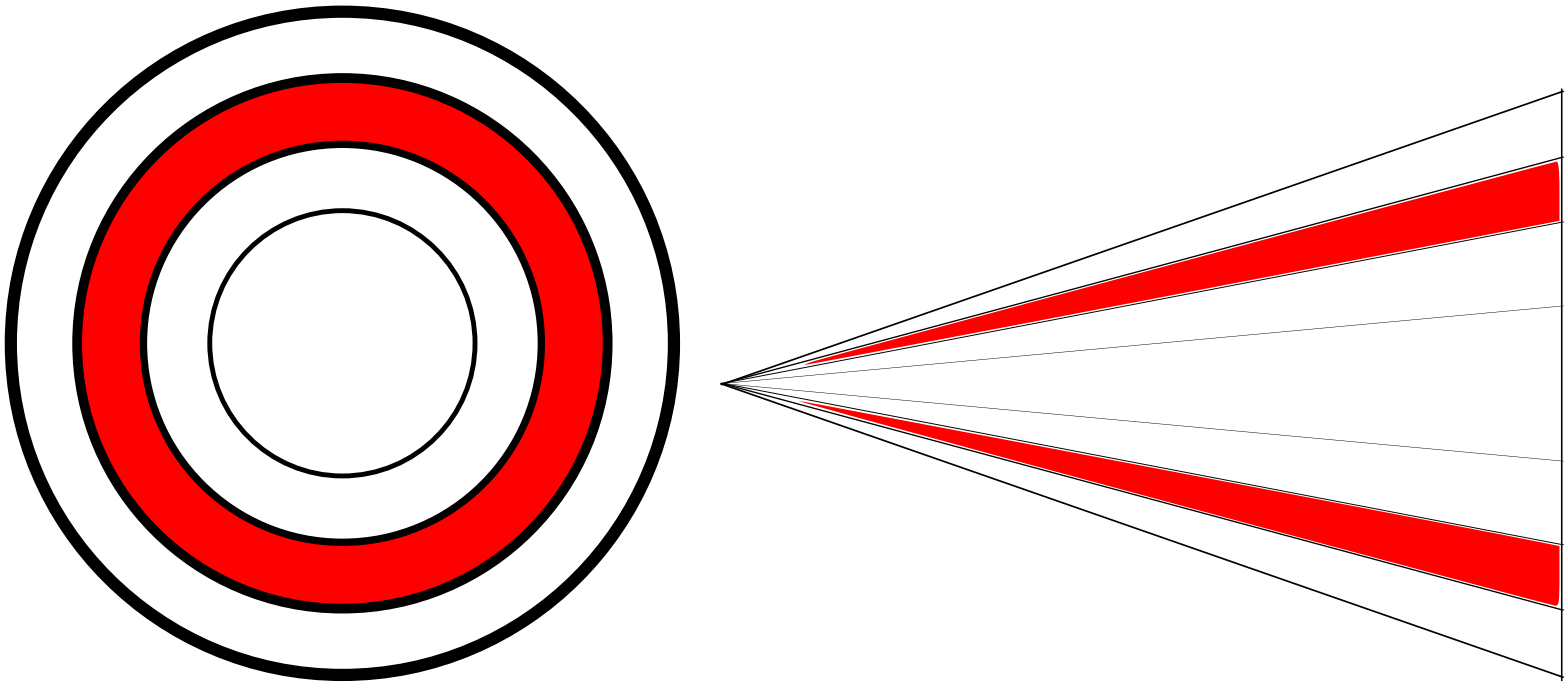

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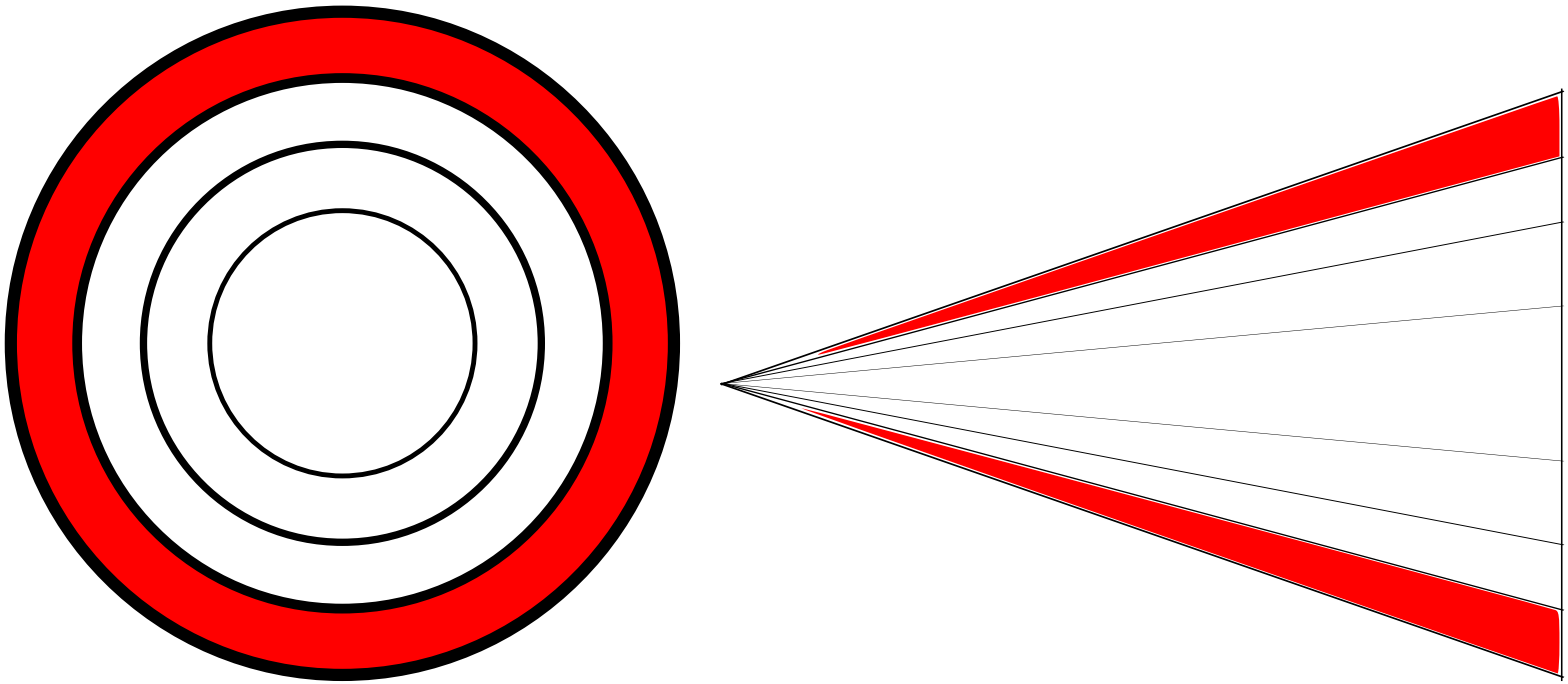
P_T of Tracks inside the Jets



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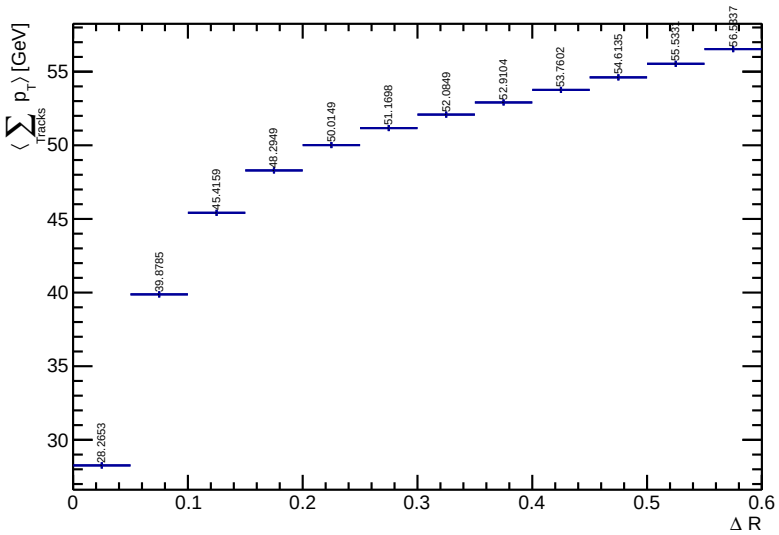
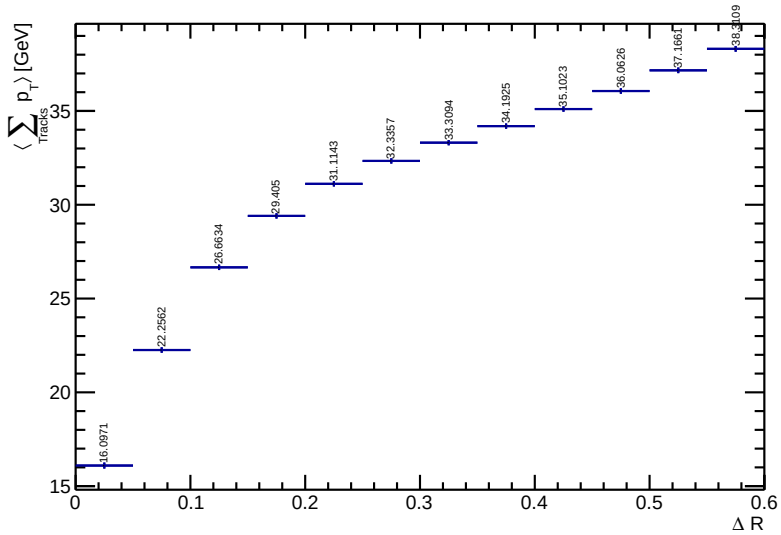
P_T of Tracks inside the Jets



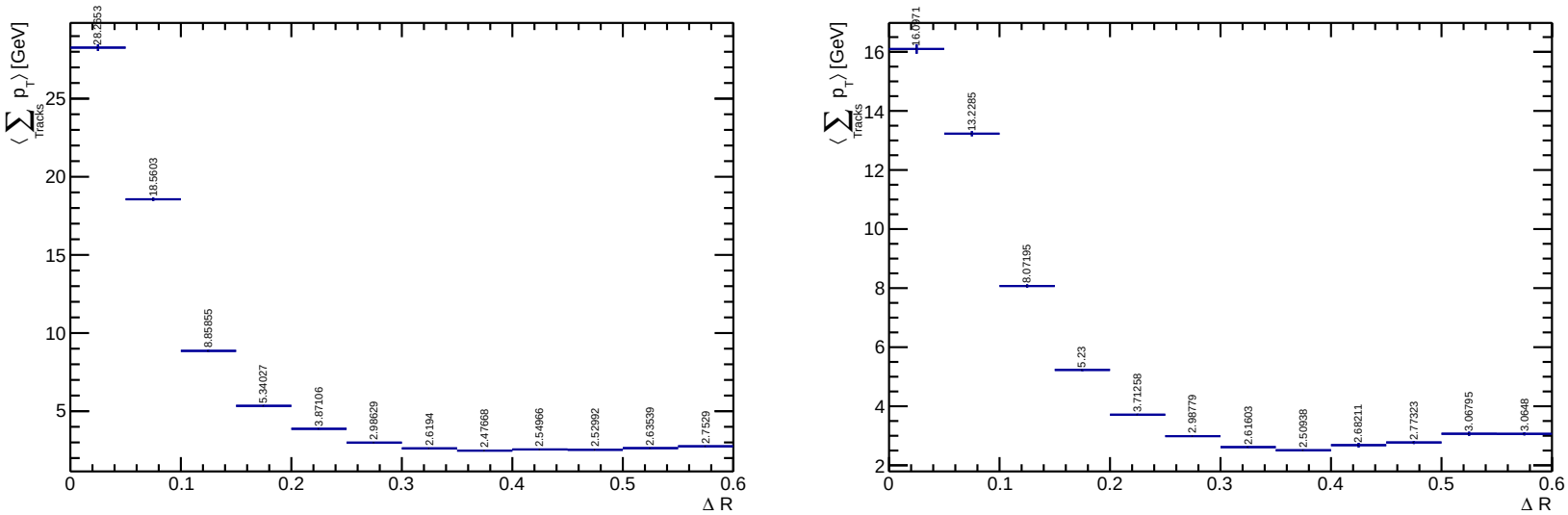
(a) Leading Jet



(b) Sub-Leading Jet

Figure: Inclusive Sum

P_T of Tracks inside the Jets



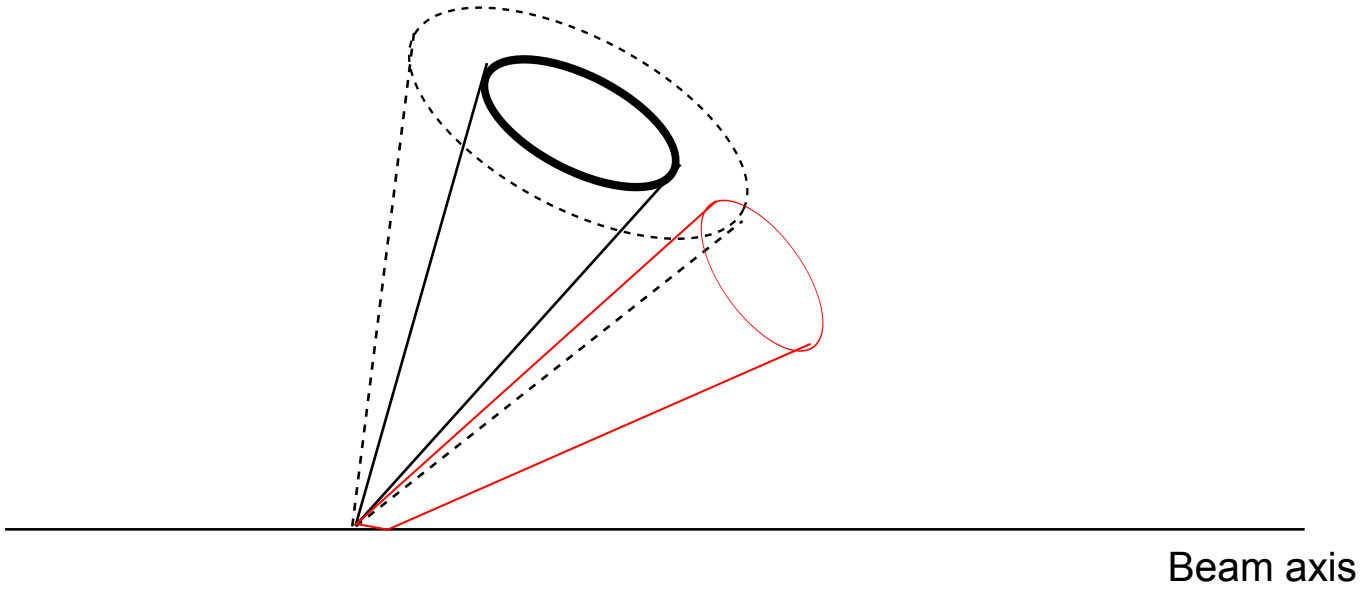
(a) Leading Jet

(b) Sub-Leading Jet

Figure: Differential Sum

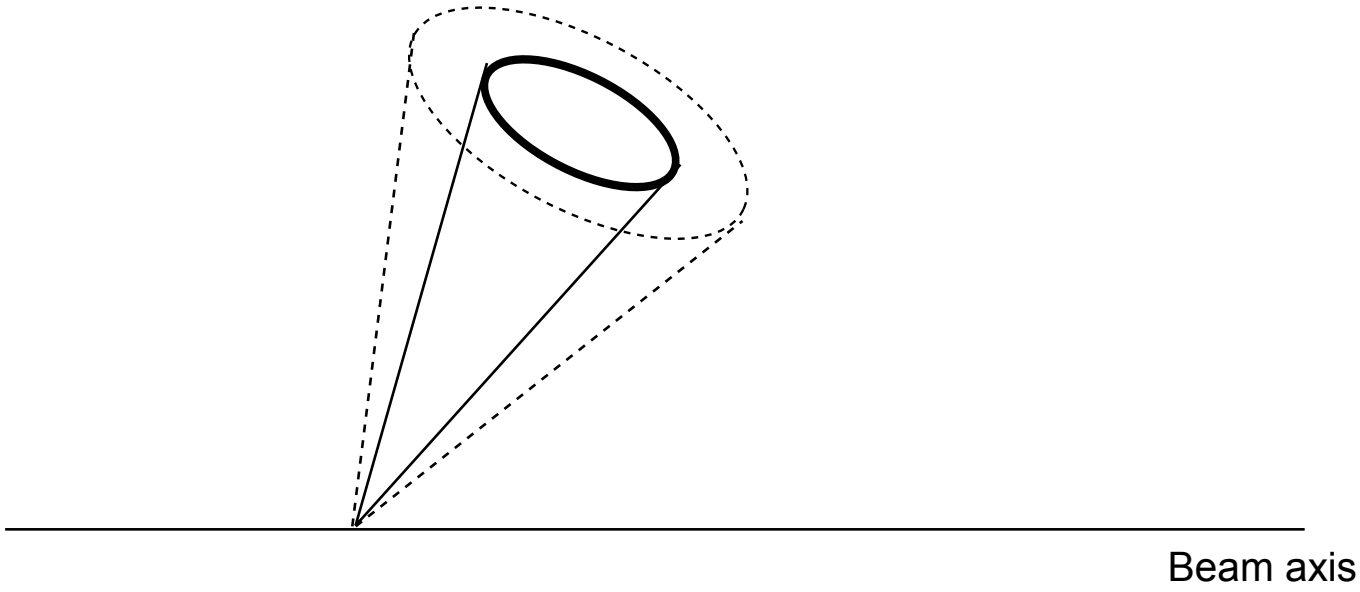
Jet overlap removal

- Jets at ATLAS use $R = \sqrt{\Delta\eta^2 + \Delta\phi^2} = 0.4$
- Rise in differential plots because of other jets being to close



Jet overlap removal

- Jets at ATLAS use $R = \sqrt{\Delta\eta^2 + \Delta\phi^2} = 0.4$
- Rise in differential plots because of other jets being to close $\Rightarrow$ Remove jets by hand



Jet overlap removal

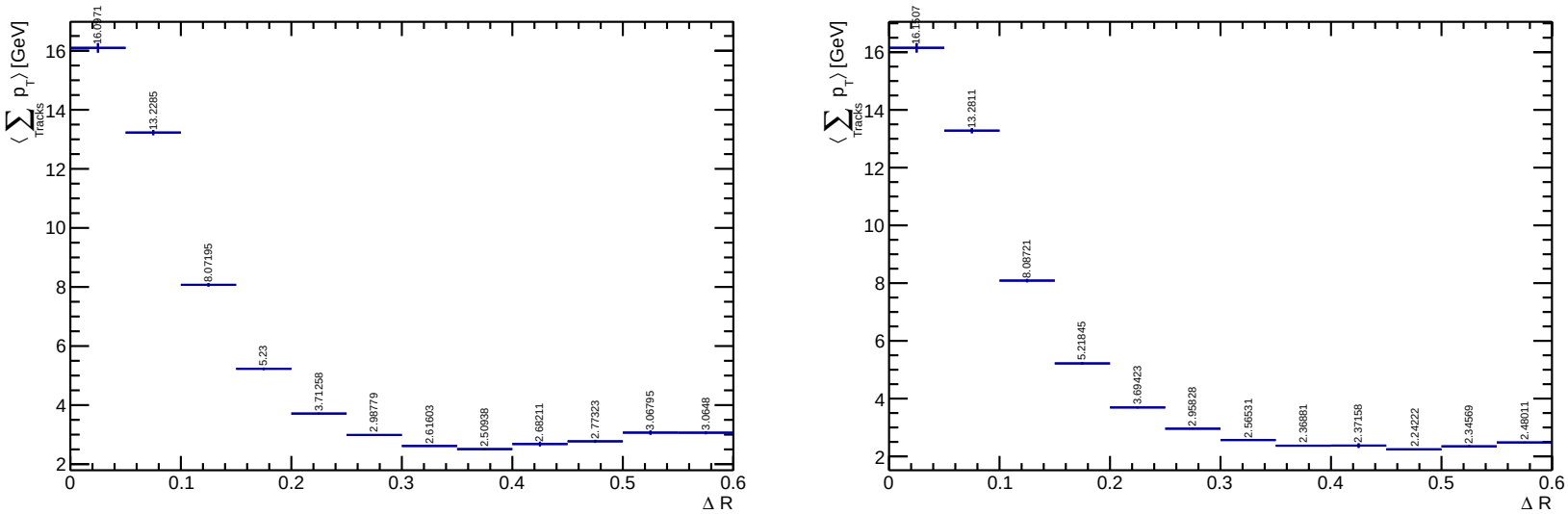


Figure: Comparison of distribution shapes with and without jet removal

MPI and Low Color reconnection tune

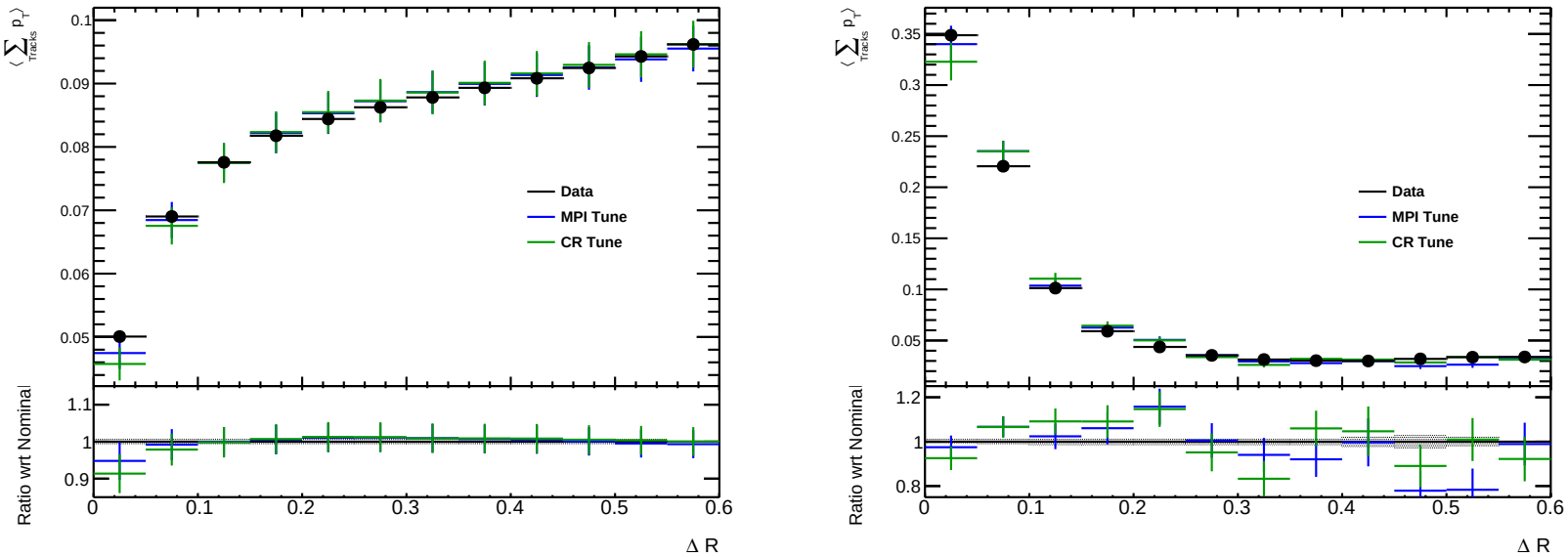


Figure: Leading Jet

MPI and Low Color reconnection tune

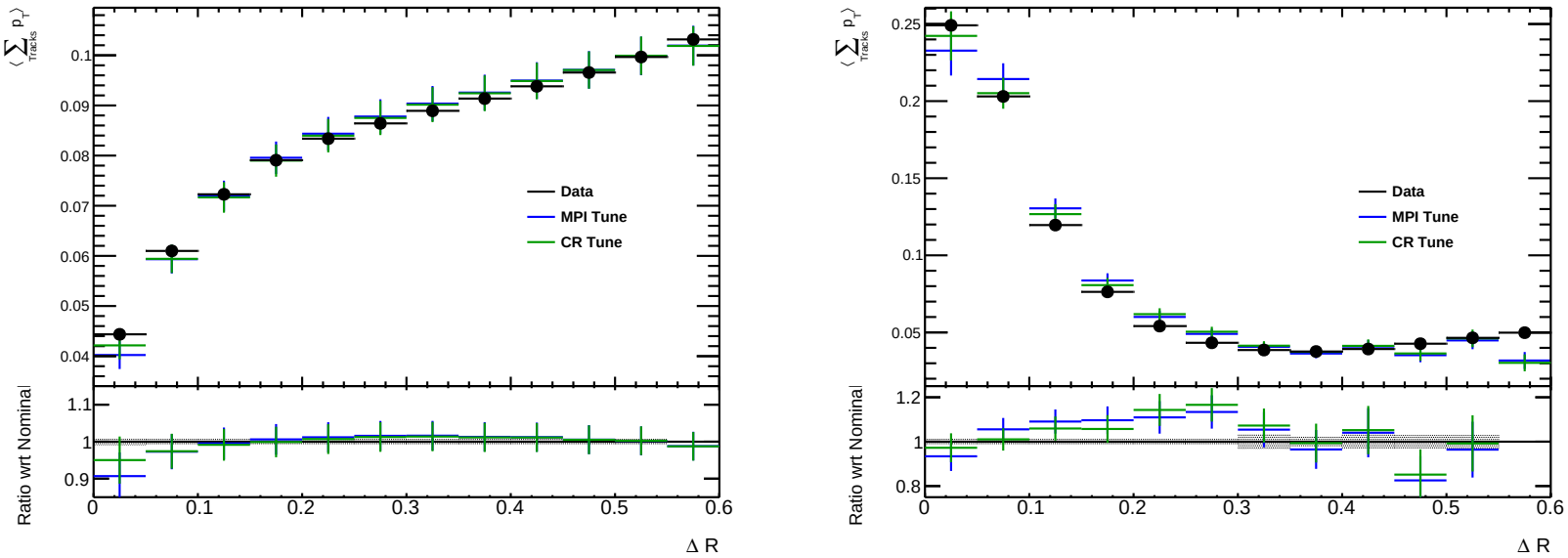


Figure: Sub-Leading Jet

MPI and Low Color reconnection tune

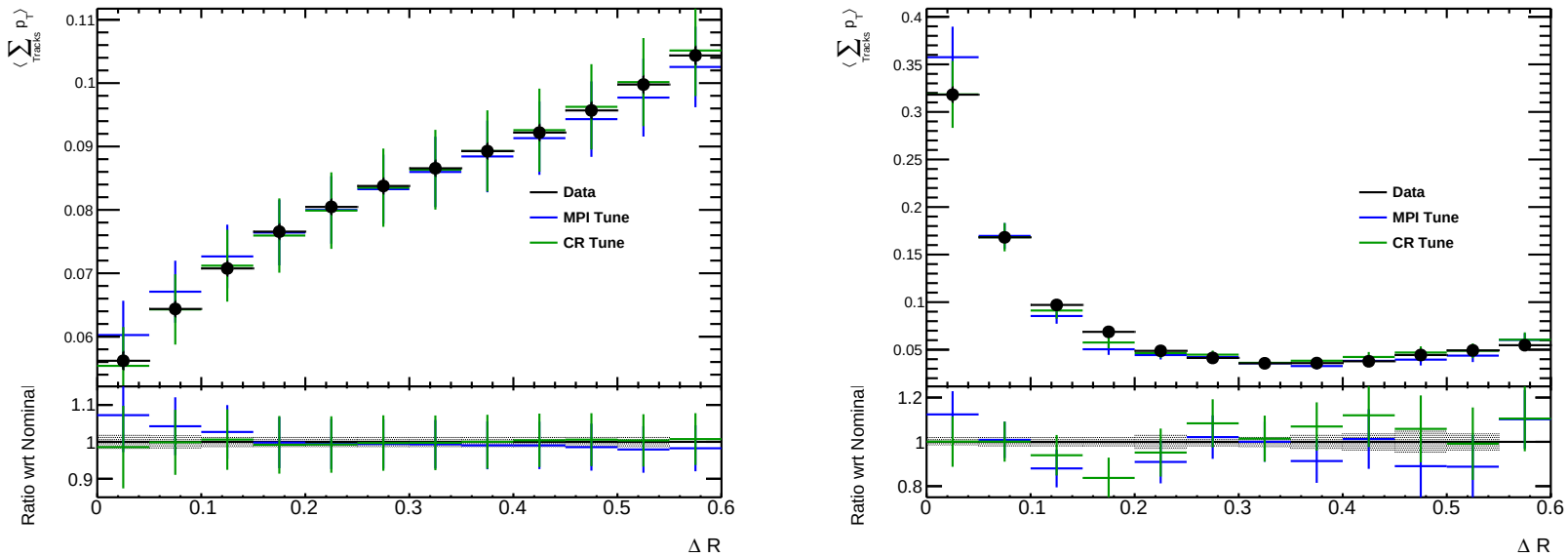


Figure: Extra Jet

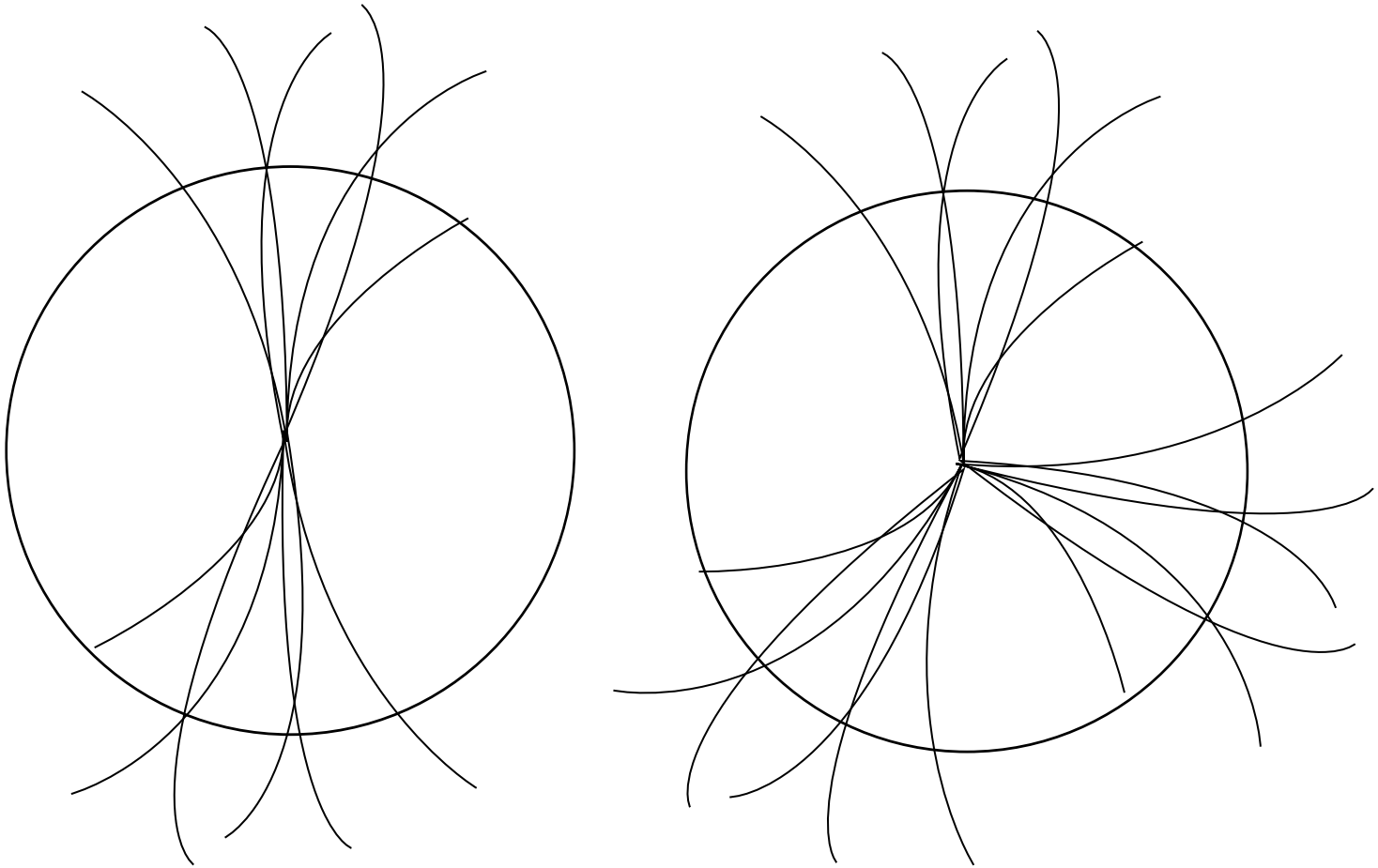
ϕ Distributions

- "normal" Azimuthal difference: $\Delta\phi(\phi_b, \phi_{\bar{b}})$
- "weighted" Azimuthal difference: $\Delta\phi(\bar{\phi}_b, \bar{\phi}_{\bar{b}})$
  see: *"Effects of color reconnection on $t\bar{t}$ final states at the LHC."(2014). by Spyros Argyropoulos and Torbjrn Sjstrand.*

$$\bar{\phi}_{\text{jet}} = \phi_{\text{jet}} + \frac{\sum_i \Delta\phi_i}{n} \qquad \text{with} \qquad \Delta\phi_i = \phi_i - \phi_{\text{jet}}$$

- Number of Jets fixed to 2 or 3

ϕ Distributions



Low Color reconnection tune

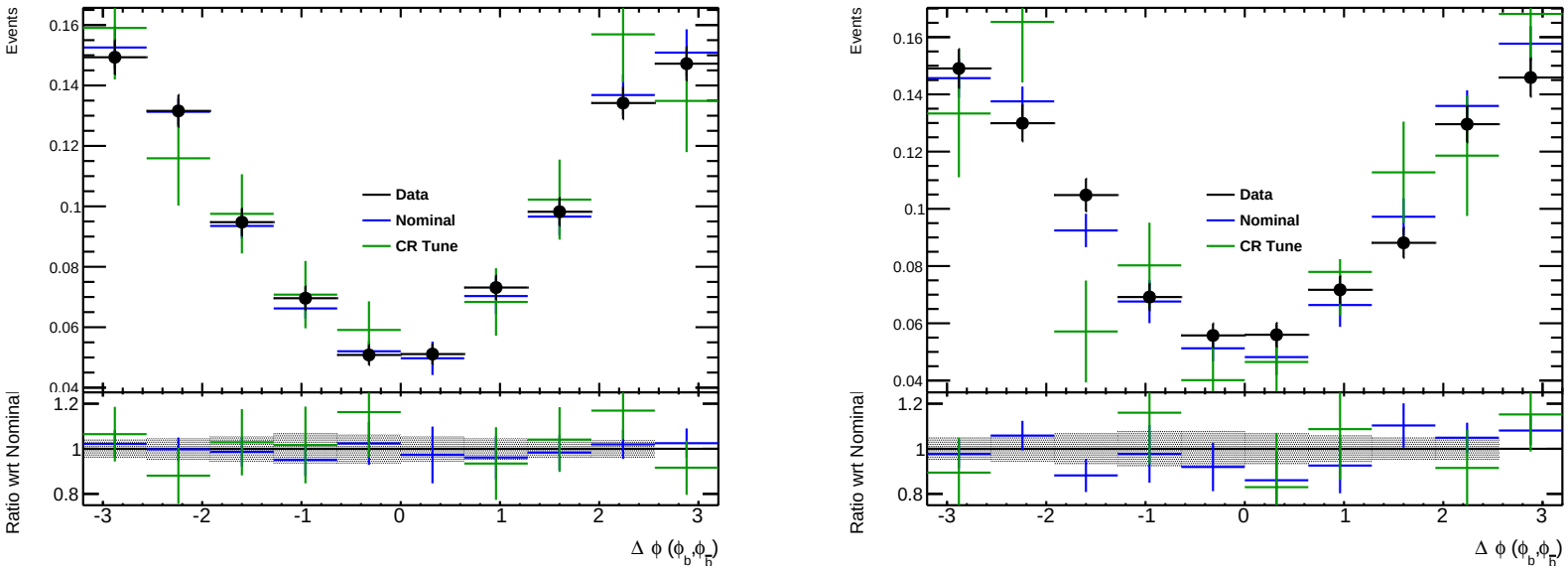


Figure: $\Delta\phi$ between Leading and Sub-Leading B-Jet (Weighted ϕ)

Data Comparison

- Comparing Data with POWHEG + Pythia and MC@NLO + Herwig Monte Carlo

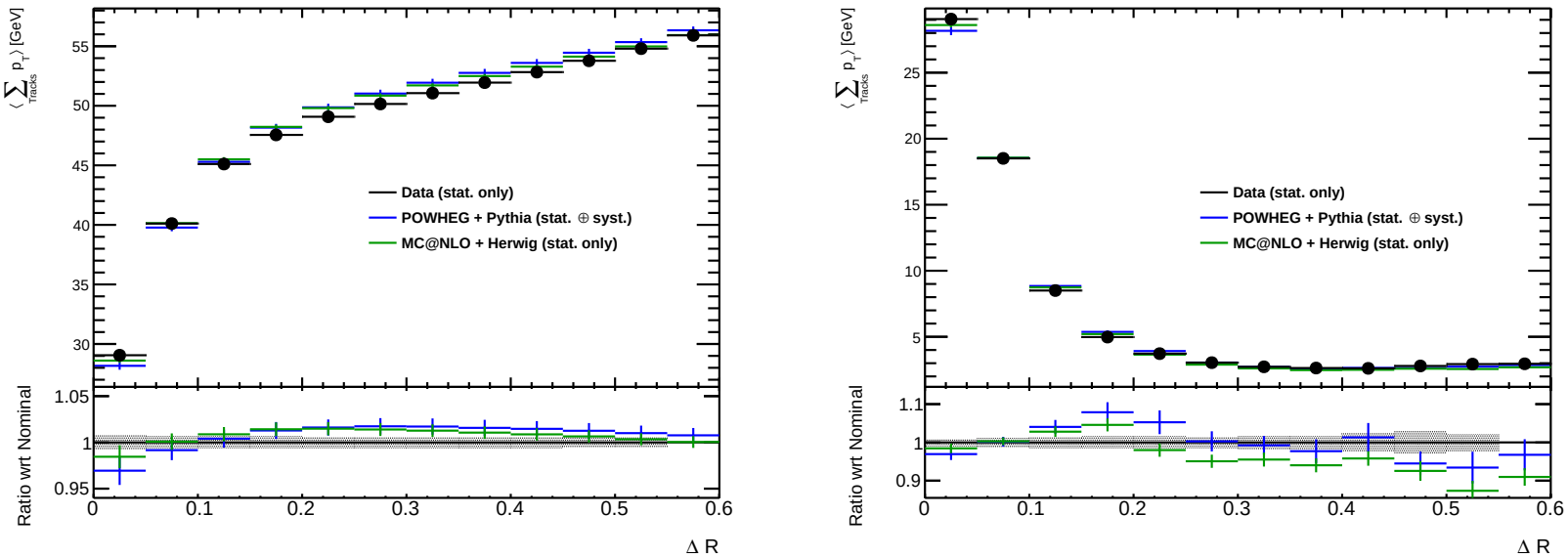
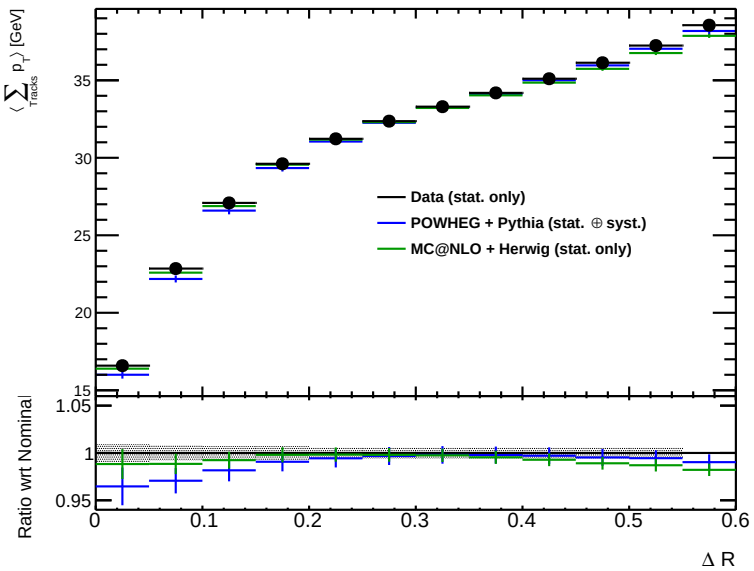


Figure: Leading Jet

Data Comparison



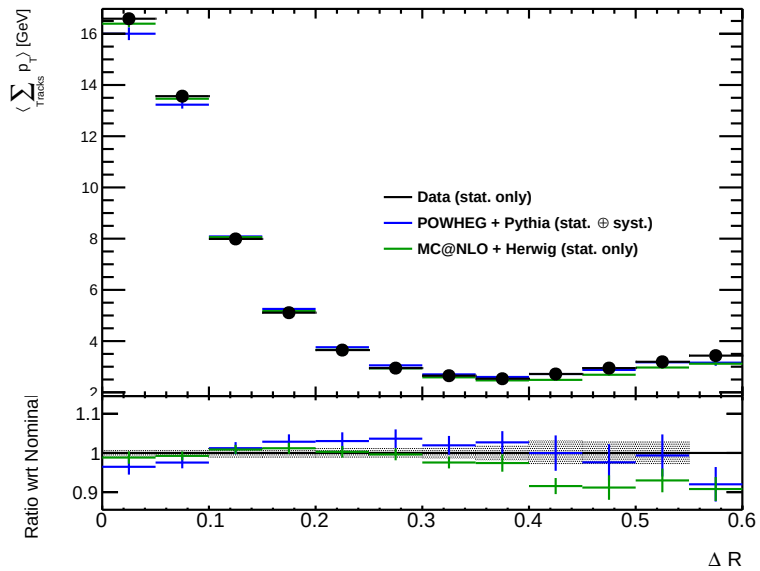
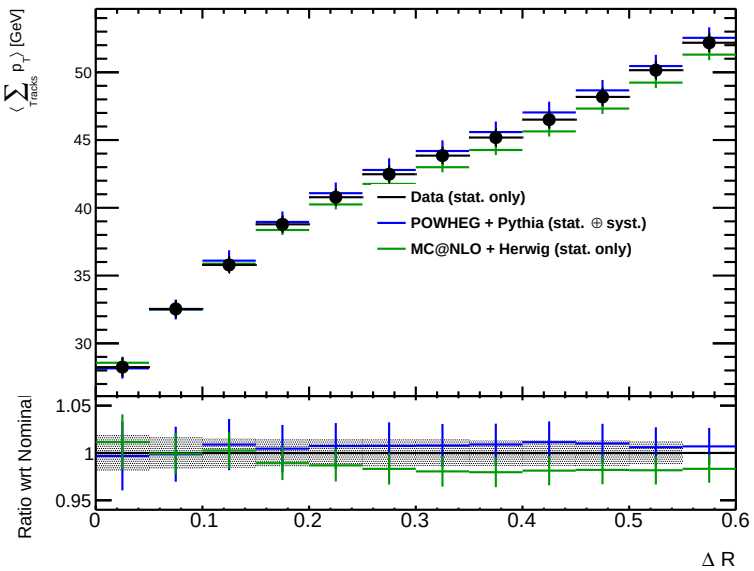


Figure: Sub-Leading Jet

Data Comparison



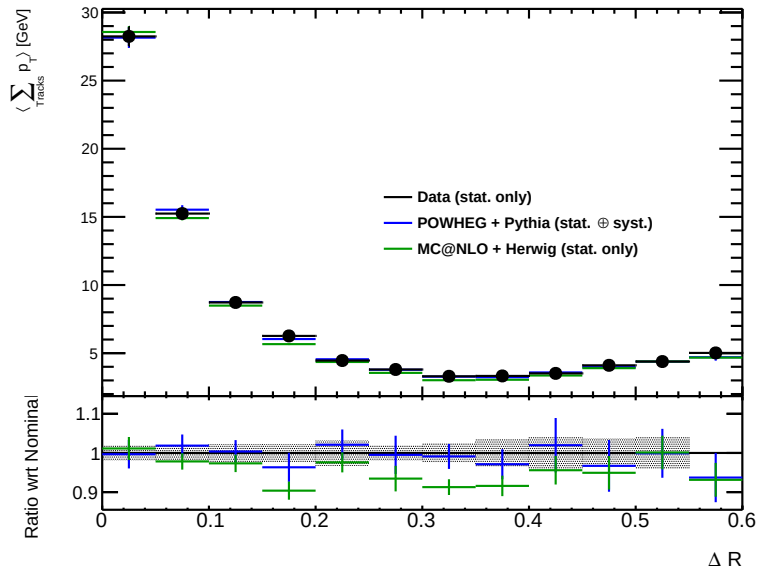


Figure: Extra Jet

Summary

- Jet shapes can be described by Monte Carlo samples
- Both tunes sensible for $t\bar{t}$ events
- Pythia and Herwig describe data equally good

Thank you for your attention