Exploring jet substructure in semi-visible jets

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ISMD
Flash Talk - Jets and QCD at High Scales
12th July 2021

Alongwith Deepak Kar

Introduction

We haven't found new physics ... yet!

- Look at unusual topologies & hidden phase space corners
- Dark hadrons decay <u>promptly</u> in a QCD-like fashion partially back to visible sector (**semi-visible jets "SVJ"**)
    - *Showering using Pythia hidden valley module - at best a guesstimate!*

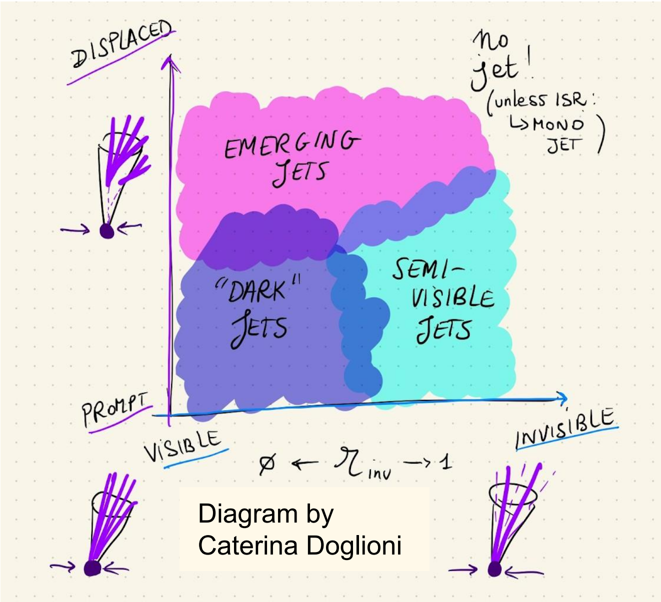
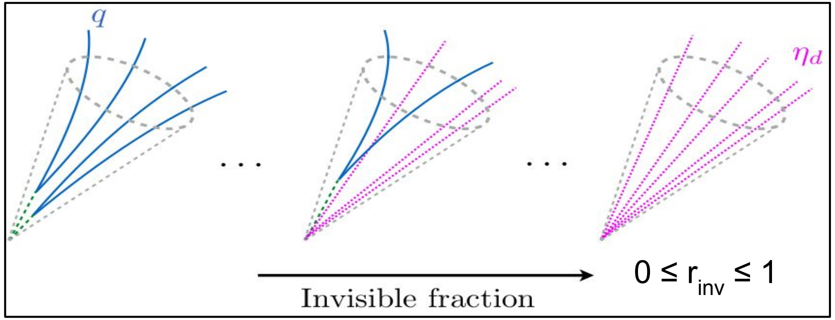
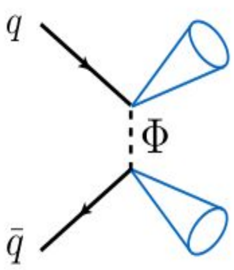


Diagram by Caterina Doglioni

Based on the Paper: arXiv: [1707.05326]



t-channel



Model Parameters:

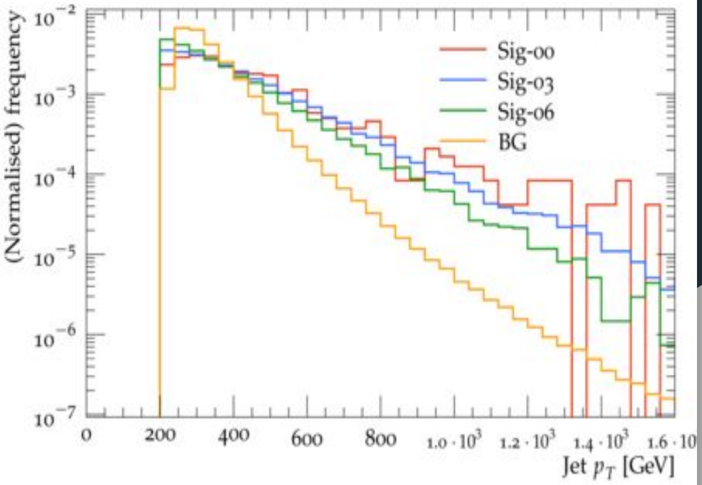
1. M_{Φ} = Mass of Scalar Bi - fundamental mediator
2. M_d = Mass of dark hadrons
3. $r_{inv} = \frac{\text{no. of stable dark hadrons}}{\text{no. of hadrons}}$

Jet-substructure study

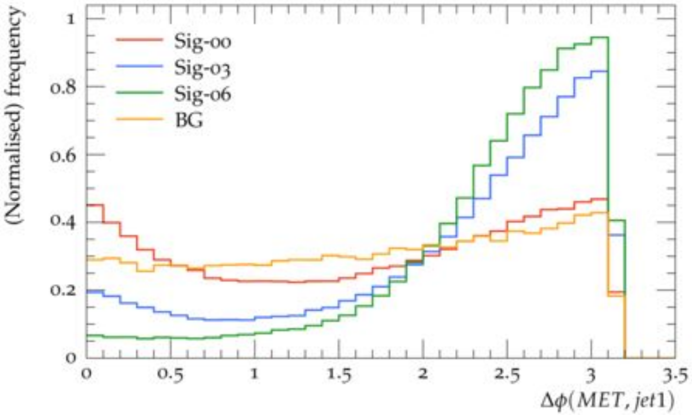
D.Kar & SS: SciPostPhys.10.4.084

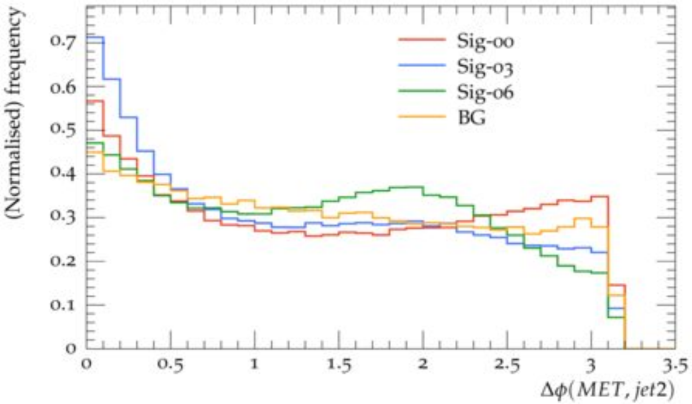
- Comparing jet substructure variables to see if SVJ substructure is different from light quark/gluon jets (BG). Do they behave more multi-pronged as opposed to mostly single prong?
- Comparison can be done in p_T bins or in m/p_T bins, picked the former, as there is no resonance.

t-channel makes it more challenging as no resonance peak



Subleading jets tend to align more with MET, which makes it harder to study

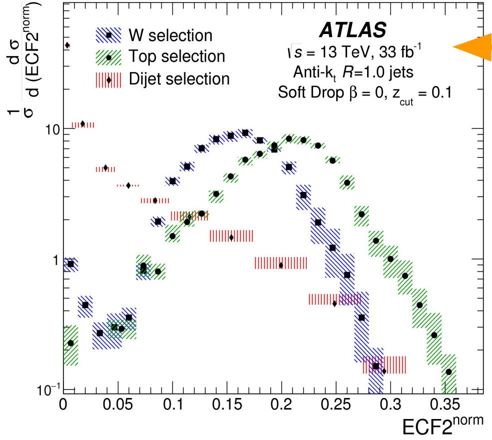




Signals (r_{inv} = 0, 0.3, 0.6) and multijet background generated using MG5 + Py8

Normally signals are generated with upto two extra jets!

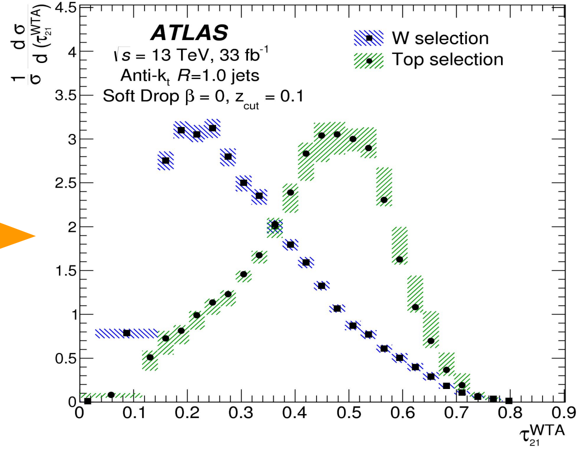
Plots from ATLAS to explain how the JSS observables behave



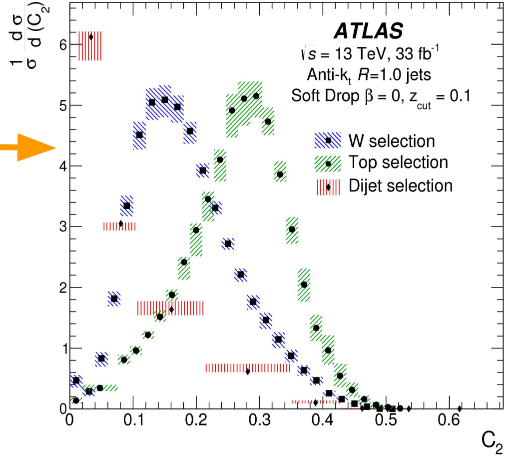
Energy correlation functions:
ECF2:
multi-prong has higher values

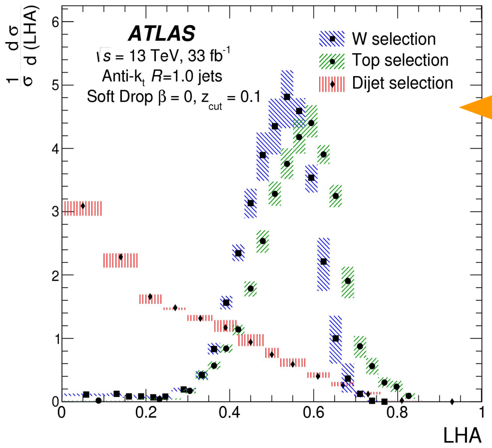
N-Subjettiness:

τ_{21}: Lower values indicate more 2 subjet like behaviour



Energy correlation double ratios:
C2:higher value has more subjets

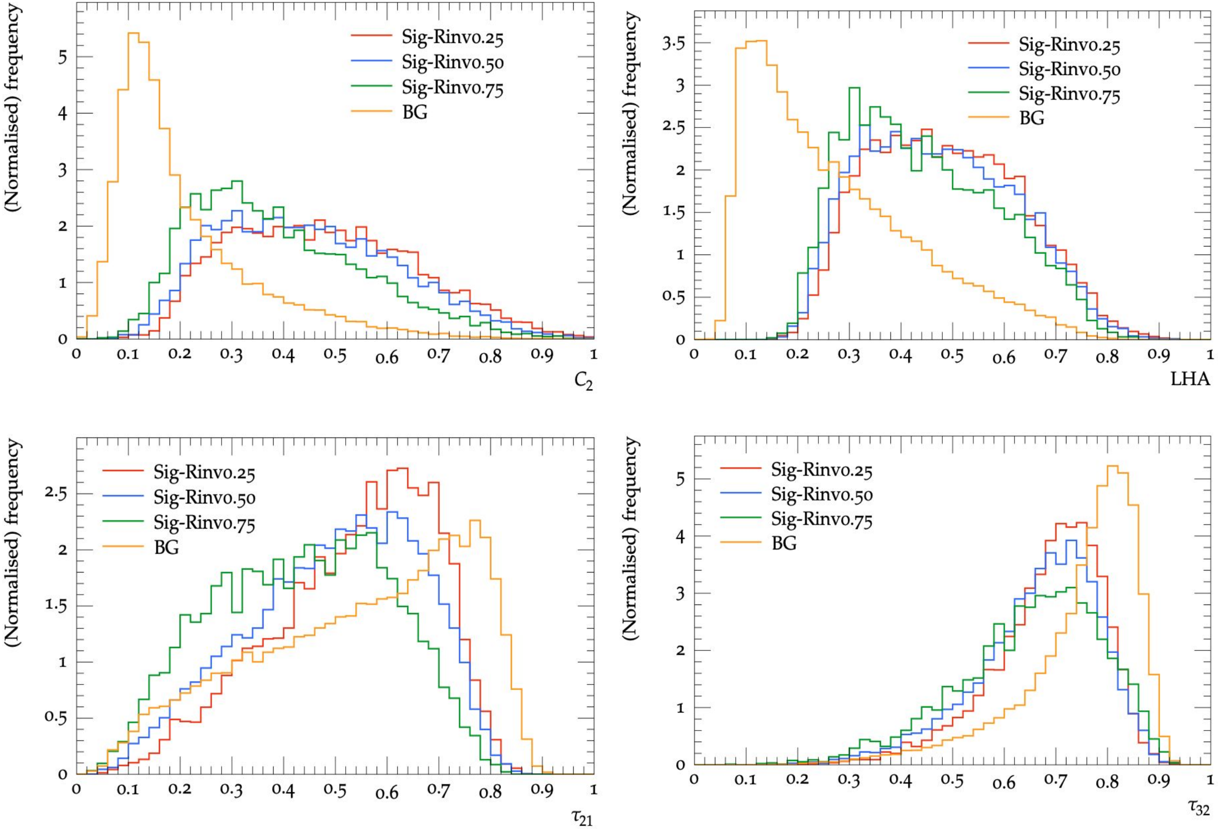




Les Houches Angularity:
higher value means hard radiations are more separated

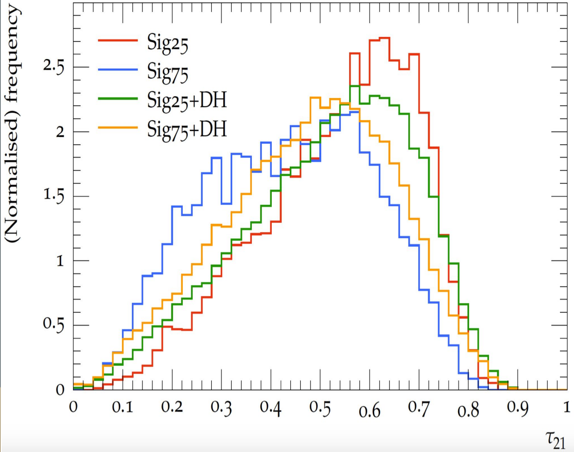
[Link to paper]

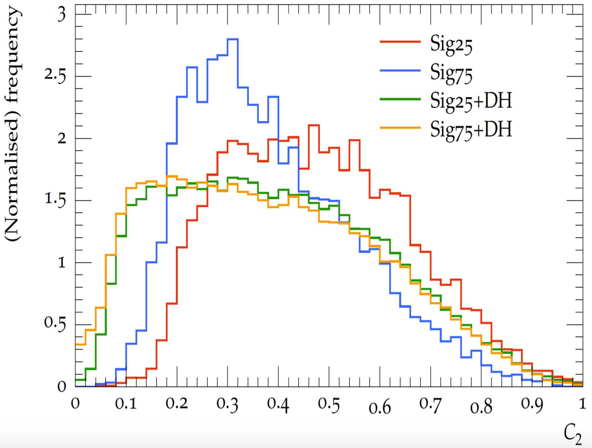
What effects are responsible for specific jet-substructure of semi-visible jets?



For finite r_{inv} values, when only the visible hadrons are clustered in jets, subtle substructure difference observed for different Rinv values.

What effects are responsible for specific jet-substructure of semi-visible jets?





If the final dark hadrons are also clustered in the jets ---> expect this difference to go away ----> the different amount of missing hadrons in each case presumably is responsible for the difference.

Conclusions:

1. The substructure becomes less two-pronged with visible and dark hadrons in them, and the absence of the dark hadrons create the two-pronged structure ---> The substructure is created by the interspersing of visible hadrons with dark hadrons.
2. Specific hidden valley parameter configurations can reduce the dark shower model dependent features of the signal jets.

Next steps

- Mostly due to presence of only one dark shower module, so far, all studies are somewhat model dependent ---> *exploring the possibility of Herwig dark shower module to gain a better estimate of theory associated uncertainties*
- Several other observables may be out there, that can help discriminate these unconventional jets from the standard q/g jets ---> *Looking for new observables, preferably from a IRC safe linear basis like energy-flow polynomials*

For more details, keep an eye out for the topic in the poster sessions :-)