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SA-CERN EXCELLENCE

# PROBING THE DEAD CONE USING THE PRIMARY LUND PLANE

## PHYSICS REPORT

Offence

The suppression of soft gluon radiation in the forward axis of a radiating quark (**Dead Cone** effect).

Suspect

Massive/Heavy Quark.

Basis

QCD predicts gluon radiation suppression at angular scales less than the ratio of an emitting quark's mass to its energy [1]:

$$\theta_{DC} = \frac{m_{radiator}}{E_{radiator}}$$

→The **Dead Cone** is more pronounced in heavy quarks than in light quarks.

## CONCLUSION

A hint of a suppression is observed.

However, not with a clear association to the **Dead Cone**.

## TO-DO

Study a wider jet $p_T$ range, with stronger $k_T$ selections.

## PROSPECTS

Perform analysis in *PbPb* collisions. We expect the meduim induced radiation of a heavy-flavour jet to fill the Dead Cone region[5].

## INVESTIGATION

Experimental Challenges

Accurate determination of the evolving quark direction during the shower process.

Hadronization effects and contamination of the Dead Cone from decaying hadrons in the jet.

*Isolating hadron decay particles is hard, even more so in a heavy ion environment.*

Resolution

1. Select bottom-tagged jets within a specific range:

30 GeV < Jet $p_T$ < 40 GeV

Suppress hadronization effects: $k_T > 0.2$ GeV

2. DECLUSTERING![2]

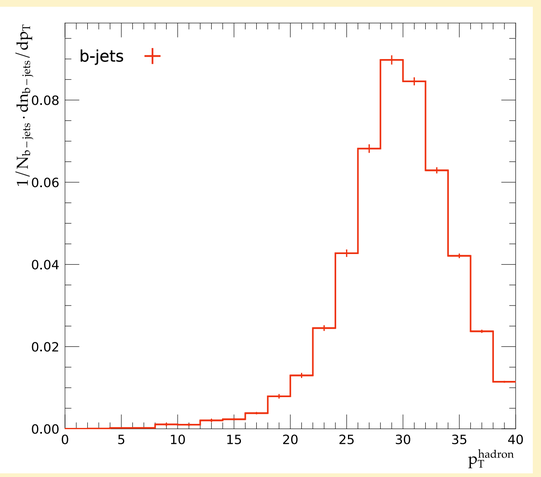
Cluster particles into jet *anti-$k_t$:* by $p_T$

Recluster particles into jet *Cambridge Aachen: by* θ

*Quark kinematic properties updated along splitting tree*

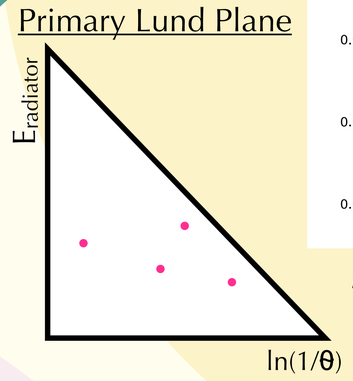
Decluster jet to get splittings *Lund:* ln(1/θ) & $E_{radiator}$

*Follow the hardest prong at each declustering step*

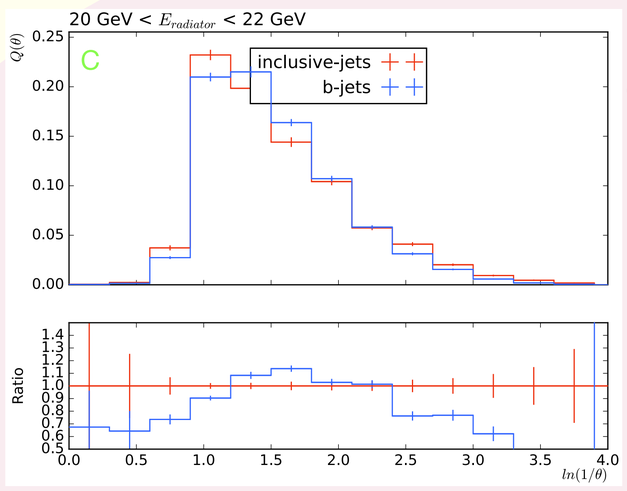


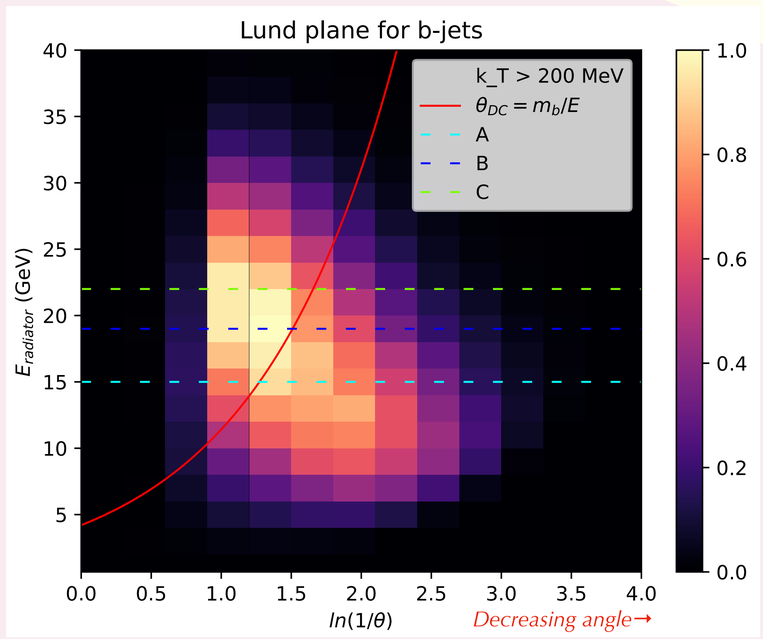

*Plot showing $p_T$ of B-Hadrons in b-jets.*

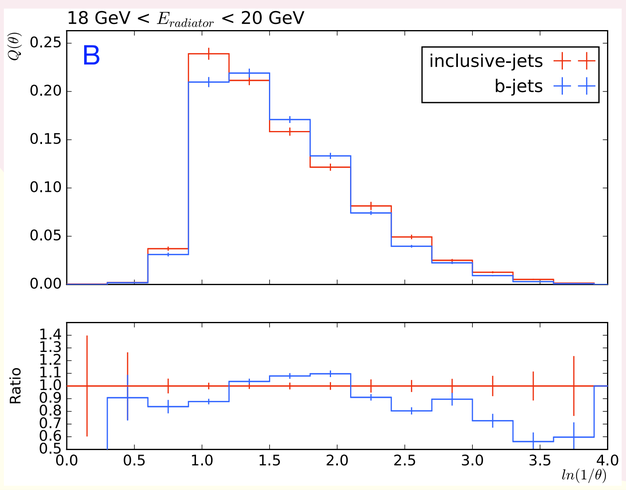
Primary Lund Plane




## FINDINGS

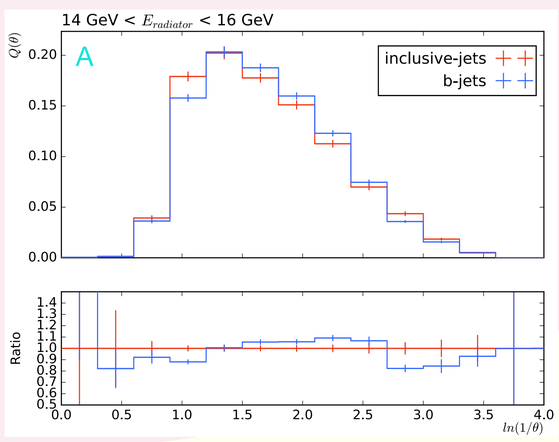



$$Q(\theta) = \frac{dn_{jets}}{N_{jets} dln(1/\theta)}$$

jets{b, inclusive}




*Follow the same procedure for inclusive jets sample and compare*

## ANALYSIS TOOLS

Use RIVET Analysis toolkit to generate a Primary Lund Plane [3] of bottom-tagged jets from a million PYTHIA8 generated *pp* collisions.

This was motivated by the first direct observation of the **Dead Cone** effect in charm-tagged jets, achieved by the ALICE Collaboration[4]

1. Dokshitzer YL, Khoze V A and Troyan S 1991 Journal of Physics G: Nuclear and Particle Physics 17 1602.
2. Leticia Cunqueiro and Mateusz Plosko´n. In: Physical Review D 99.7 (2019), p. 074027: arXiv:1812.00102
3. Dreyer F A, Salam G P and Soyez G 2018 Journal of High Energy Physics 2018 1-42: arXiv:1807.04758
4. ALICE Collaboration, 2022 Nature 605 440-446: arXiv:2106.05713
5. Cunqueiro L, Napoletano D and Soto-Ontoso A 2023 Physical ReviewD 107 094008: arXiv:2211.11789