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Title: Systematics of quark/gluon tagging

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Referee report

This paper carries out a systematic and extensive analysis of quark/gluon tagging in both $e+e^-$ and pp collisions, a topic that has been gaining increasing importance over recent years. The is clearly written, considers essentially all the issues that are known today to be relevant to quark/gluon tagging and is remarkable in the way in which it is able to put together analytic results as well as predictions from essentially all of the Monte Carlo parton-shower programs that are on the market. I believe it will be an important reference for years to come, documenting not only the current state of affairs, but also highlighting future measurements that would serve to constrain Monte Carlo generators. Overall this article certainly meets the high standards required for publication in JHEP.

Prior to publication I have one semi-substantial technical comment that should be addressed and a handful of more minor comments.

1. The main technical comment concerns the definition adopted for Casimir scaling, Eq. (4.25). While it is logical that Ω_0 should scale with the colour factor, it is far from trivial that Ξ_0 should. In Eq. (4.21), Ξ_0 is the effective average transverse momentum of individual non-perturbative "emissions", normalized in such a way that total average p_T emitted in

a given kinematically accessible angular slice is independent of Ξ_0, and instead proportional to the prefactor Ω_0. Thinking of a string fragmentation model, a gluon would be composed of two colour strings while a quark would be composed on one. That gives the Casimir scaling for Ω_0. The Casimir scaling for Ξ_0 corresponds to the statement that non-perturbative "emissions" from a gluon typically have p_T's that are C_A/C_F times higher than those from quark lines. I believe that it would make more sense for Ξ_0 to be taken independently of the colour factor. I would invite the authors either to change their definition of Casimir scaling or to give a motivation for their specific choice (e.g. perhaps it is grounded in some understanding of what is done in Monte Carlo hadronisation models?).

They might also want to comment on the $\beta = 1$ limit of Eq. (4.21), i.e. the fact that the correction goes as $\ln RE_J/\Xi_0$.

2. p.2, first paragraph: the statement that color coherence is subleading is not, I think correct: at the very least, old Monte Carlo showers that did not implement coherence (effectively similar to angular ordering) gave very different results, e.g. for the multiplicity.

3. p.3: though it's implied later, it would be useful here to specify which shower is being used in Herwig++ 2.7.1, i.e. the angular-ordered shower or the dipole shower.

4. p.6: for the "maximum p_T quark parton" it might useful to indicate at which stage of the shower this is defined (e.g. if it's after showering, then perturbatively it's collinear unsafe).

5. p.34, top paragraph: I suggest the authors drop "where color correlations [...] impede a universal definition of quark and gluon jets", because I'm not sure it adds much: any procedure involves some choice, even the procedure adopted by the authors in e^+e^-, and so it is necessarily non-universal.

6. p.37: "Fig. 19a below" should just be "Fig. 19a" (since the figure is actually above in my version).

7. Ref. 139: there's an issue of missing characters with diacritical marks in some author names. Perhaps it's worth checking the issue doesn't appear in other references too.