

## Response to referee 1

1. We agree that the enumerated list describing the interleaved algorithm could be improved. We have significantly expanded it and have tied the steps more explicitly to the illustration in figure 1 (now figure 2). To keep the list itself relatively concise, some of the content (such as the scale definitions under point 2) were moved up into the body text in the introduction to section 2, which also allowed to comment more extensively on those choices, cf our response to point 3 of referee 2.
2. We have expanded the discussion on the resolution measure, and the relevance of the parameter  $R$ . In short, the exact form of the resolution measure is not of importance as long as it correctly separates the singular regions of phase space associated with each shower. For internal consistency, we have chosen to stay as close as possible to the more limited implementation in Pythia's default showers.
3. We have added two figures showing the computation time penalties for enabling interleaved resonance decays (fig 3) and the EW shower (fig 15). Regarding the point of validation of the individual EW splitting kernels, these have been validated to give identical collinear limits against the branching kernels of 2002.09248, which were calculated separately. We have added a note of this in the text. Furthermore, the tests shown in, for instance, figure 10 and 11 (now figs 12 and 13) serve as an indirect validation, as the EW shower would not be able to produce the correct spectra without the correct splitting kernels. This is also reflected in the text.
4. A check against a theoretical prediction is shown in figure 10 (now figure 12). We had struggled to format this figure, and accept that its message was not conveyed clearly. We have now revised it by emphasising the exact ME curve (which serves as theory baseline) by using a thick black line for that. We also dashed the lines that represent the individual components of the full Vincia result. Finally, to reduce number of curves, we also dropped the Pythia result, since that is anyway unrelated to the validation of the Vincia treatment as such. We hope that the figure now shows much more clearly that, if one does not enable the overlap veto, the sum of the QCD and the EW path overcount the exact matrix element by a large amount (left pane). On the other hand, with the veto enabled, the shower lines up quite well with the exact matrix element (right pane). We have tried to clarify this further in the text.
5. This should have been the jet radius  $R$  of the anti- $k_T$  algorithm. We have adjusted the figure accordingly.