The Problem

Colour and Logarithmic Accuracy in Final-State Parton Showers

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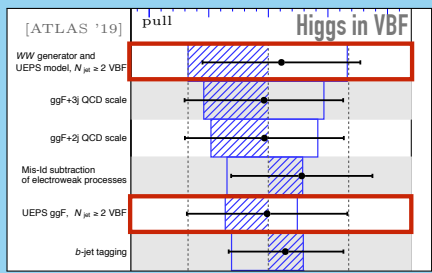
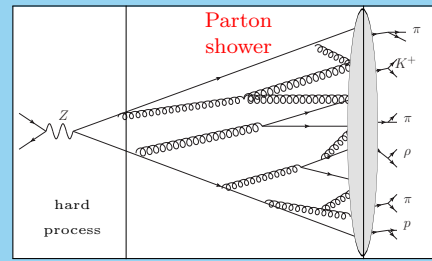
Based on [2011.10054]



- Today parton shower errors can dominate analysis

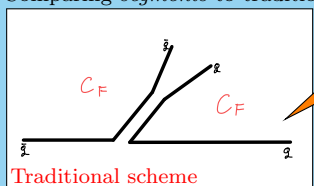
- Parton showers in experimentalists' daily arsenal.
- Traditional parton showers neglect $1/N_c^2$ effects. Error $\sim \alpha_s$ = next order contribution.
- **Goal**: Develop accurate algorithm to *reintroduce colour* into showers.
  1st step: Final state showers



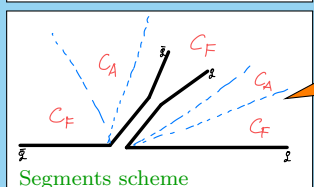
The Solution

- We developed two new algorithms based on *coherent emissions* and compared to existing methods
  - **Segments**: Exact when emissions are strongly ordered in angle
  - Nested ordered double soft scheme **NODS**: correct for pairs of energy-ordered commensurate-angle emissions

Comparing *segments* to traditional algorithms

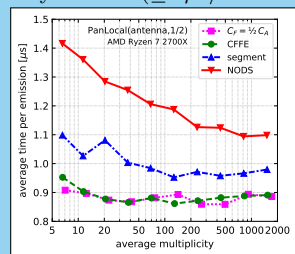


Wrongly assigns C_F everywhere



Assigns C_F/C_A according to colour coherence

Speed penalty is small ($\leq 1\mu s$/emission)

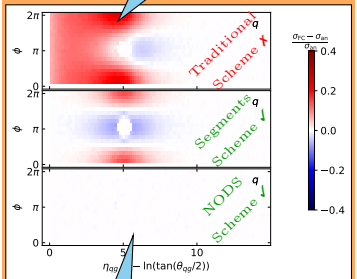


- Both algorithms reproduce full colour resummation results up to NLL for large classes of collider observables

Results and Conclusions

- Evaluate correctness based on how well schemes reproduce known matrix element: $q\bar{q}g_1 \to q\bar{q}g_1 + g$ example

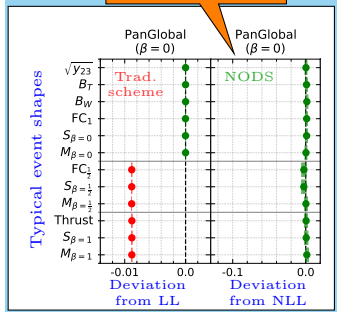
Wrong colour factor in log enhanced region



Right colour factor

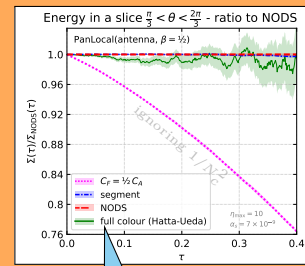
- Algorithms reproduce NLL resummation

Accurate shower = accurate full colour



- LL: Resums terms $\alpha_s^n L^{n+1}$
- NLL: Resums terms $\alpha_s^n L^n$

- Testing non-global observables: Radiation into rapidity slice



compared to dedicated calculation [1304.6930]

- NODS/Segment schemes don't reproduce full-colour NLL for non-global logarithms.
  Open question: why do they come so close numerically?