The Matrix Element Method and Vector Quark Identification

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- ATLAS.
- Working with the Matrix Element Method.
- Determines likelihoods of events based on measured momenta and theoretical model.
- Testing to determine if the MEM can identify a vector top partner.
- Not model specific, but assumes a decay to top quark and Higgs.

Figure: Example of vector quark process.

Figure: Example of background process.
The Matrix Element Method

- Computes likelihood of processes based on four-momenta of final state particles.
- Ratio of process likelihoods can be used to separate signal events from background.

**Figure:** Signal hypothesis likelihood for $m_T = 900$ GeV.

**Figure:** Discriminant values for $m_T = 900$ GeV.
Even with Gaussian smearing to simulate detector resolution, signal and background can be separated.
Additionally, by computing likelihoods for different parameter values, those values can be estimated.

This functions very effectively even after applying Gaussian smearing to the data.
Figure: Autogenerated plot of b-Jet energy spectrum.

- Automated plotter in ROOT for the output of MEMTool (done).
- Creation of script that optimizes automatically generated matrix element calculation code (done).
Future Work

- Increased realism of transfer functions to better compensate for actual detectors.
- Further optimization of computation by reducing integration phase space.
**Things Learned**

- Using C++/ROOT for data processing and visualization.
- Fundamentals of particle physics and matrix element computations.
- MEMTool and the matrix element method.
- How to present scientific results.

**Figure:** Using the MEM to identify Higgs bosons.
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