SPRACE – IFT/UNESP

Serach for High Mass Resonances in the Jets Missing E_T channel.

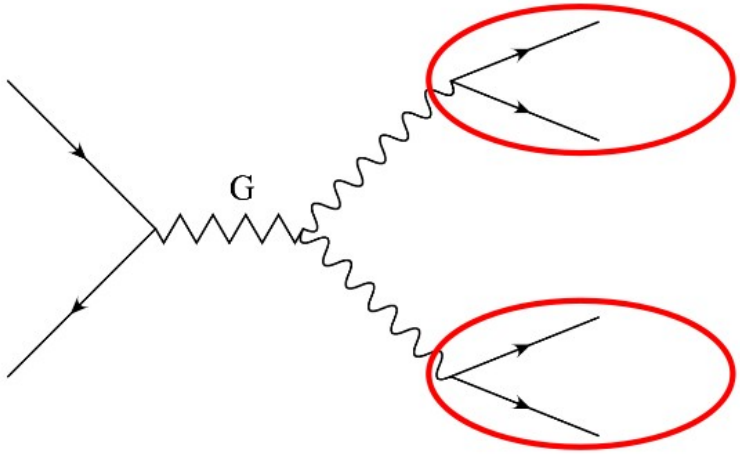
Thiago Tomei et al.

Outline

- TBA

Experimental Signature

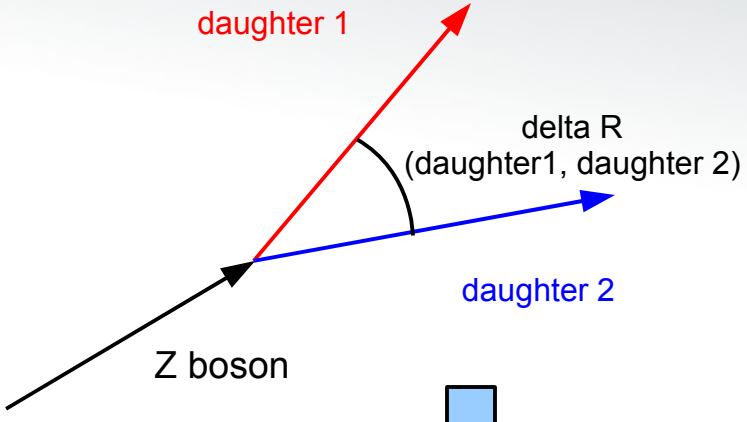
- Scenario: a high mass resonance leads to highly boosted massive decay products.
- Benchmark: pp → G* (RS Graviton) → ZZ → q qbar + nu nubar
  - Hadronic channel → higher branching ratio.
  - Visible Z boson: decays to quarks and gives rise to two hadronic jets, which MERGE and appear in the detector as a SINGLE JET. Main characteristcs of this jet: massive (~ Z mass), high p_T.
  - Invisible Z boson: decays to neutrinos and gives rise to high missing E_T.



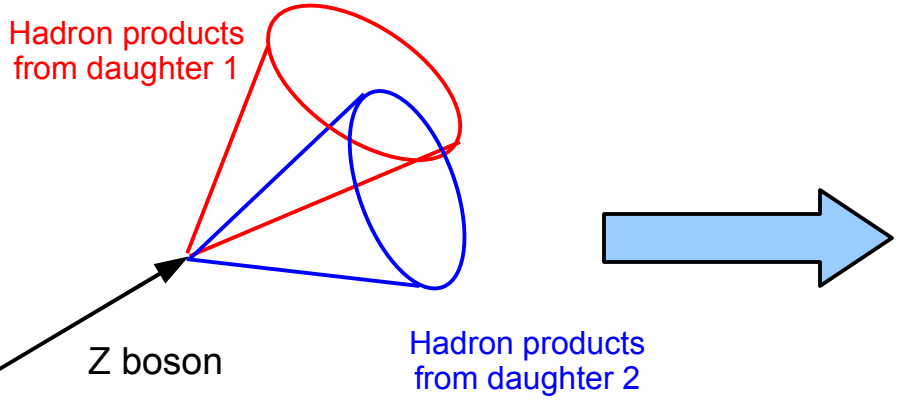
Single, massive jet

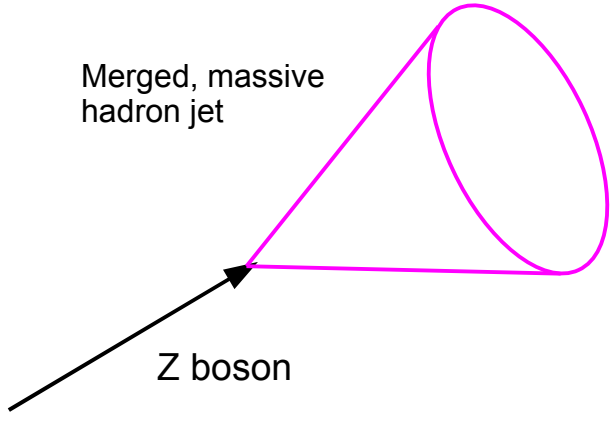
Missing E_T

The Jet Merging Phenomenon



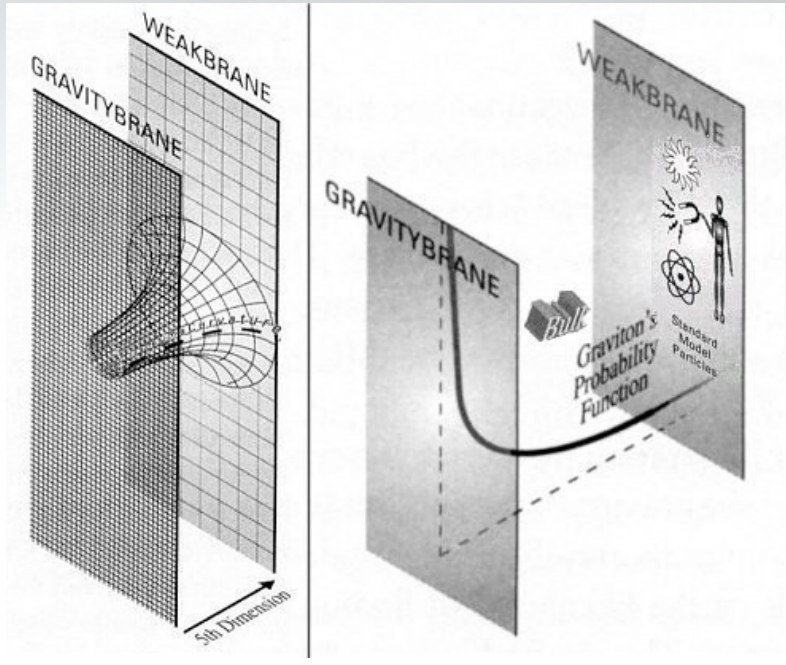
- Z boson daughters very close to each other and to the parent.
- Hadronization products of both daughters all very close among themselves.
- Reconstructed as a single jet.
  - Has the kinematics of the PARENT boson.





The Randall-Sundrum I Model

- Possible solution for the SM Hierarchy Problem
- "Braneworld model"
  - 5-dimensional warped bulk + two branes at fixed points.
  - Graviton probability function:
    - Large at the "Gravitybrane"
    - Exponentially small at the "Weakbrane".
- KK decomposition → effective Lagrangean in 4D
  - Series of Kaluza-Klein graviton resonances
  - Model parameters: k/M_{PL} and m_G
    - Coupling Λ_π related to those.

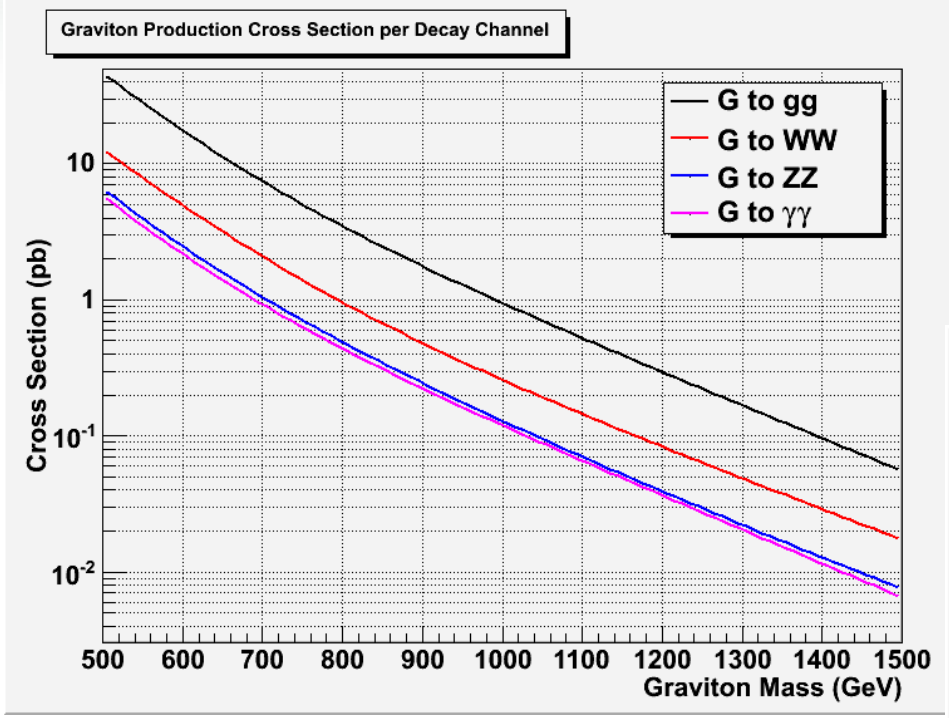


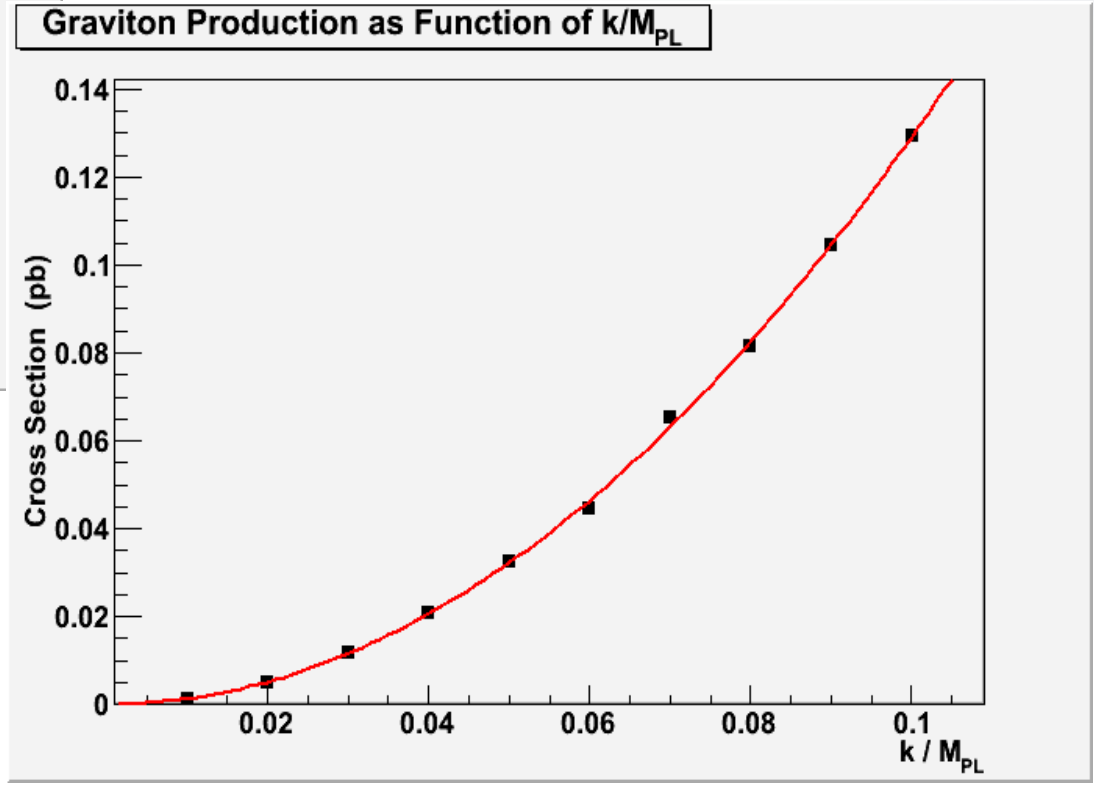
$$ds^2 = e^{-2kr_c|\phi|}\eta_{\mu\nu}dx^\mu dx^\nu + r_c^2 d\phi^2$$

$$\mathcal{L} = -\frac{1}{\overline{M_P}}T^{\alpha\beta}(x)h^{(0)}_{\alpha\beta}(x) - \frac{1}{\Lambda_\pi}T^{\alpha\beta}(x)\sum_{n=1}^{\infty}h^{(n)}_{\alpha\beta}(x)$$

$$\Lambda_\pi = e^{-kr_c\pi}\overline{M_P} = m_1\overline{M_P}/kx_1$$

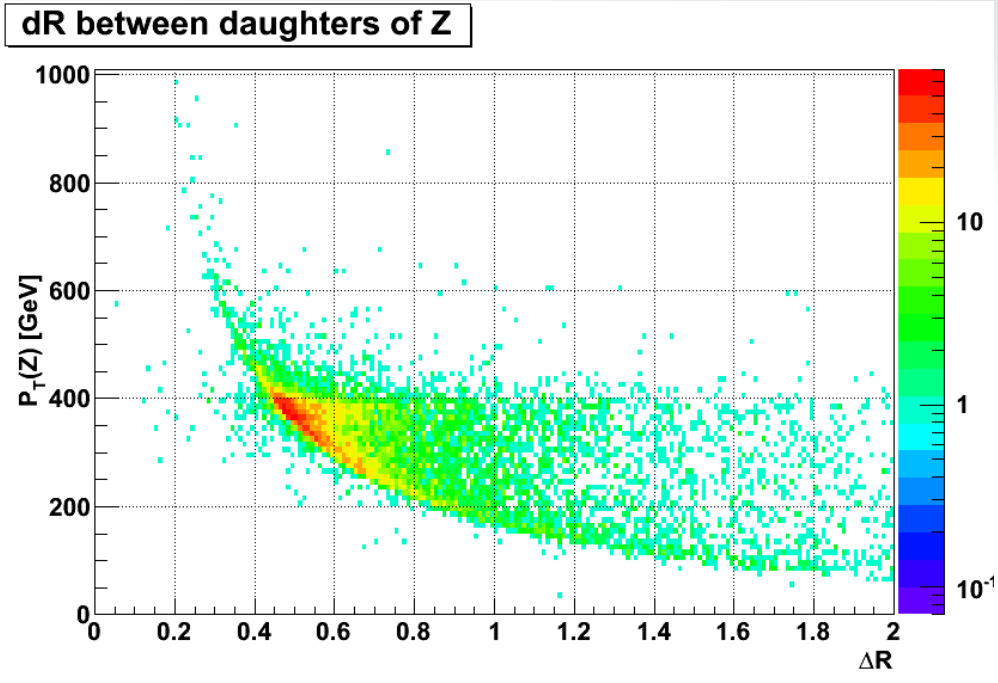
The Randall-Sundrum I Model

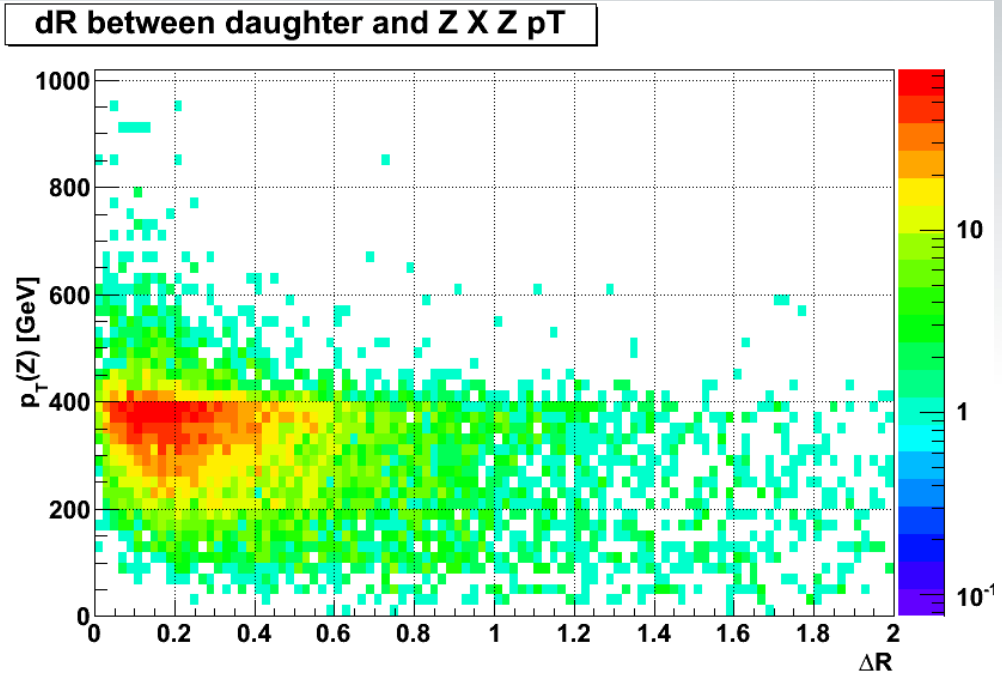




- Simulated with PYTHIA 6.420
- BRs reproduce Allanach et al. (JHEP 12 (2002) 039)
- Expected dependence with k/M_{PL}

Kinematics Before Hadronization

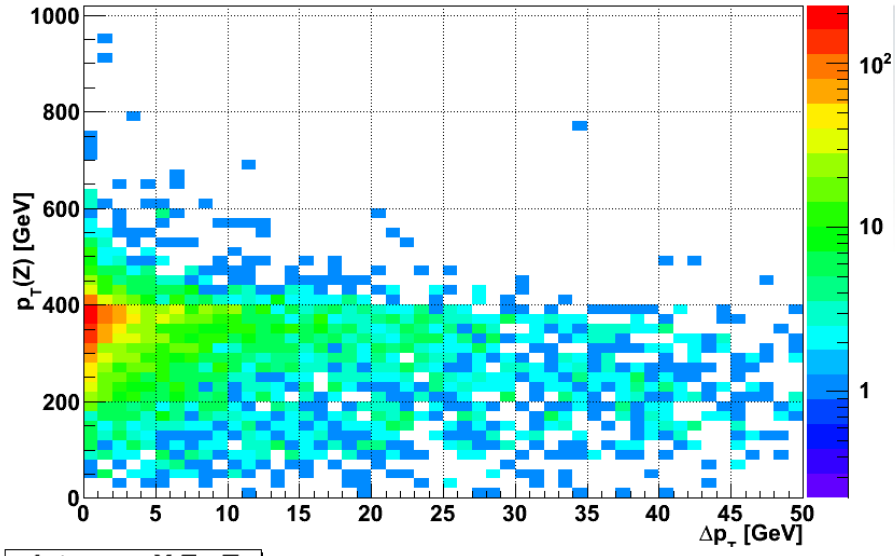




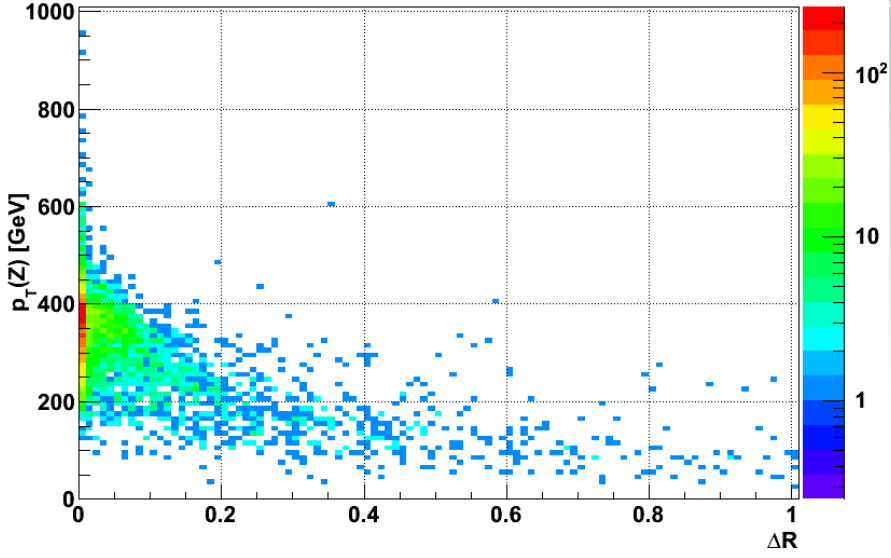
- Example distributions for M_G = 800 GeV
- At high transverse momentum, the Z boson and its daughters (as well as the daughters themselves) are very close in η−Φ space.

Kinematics After Hadronization

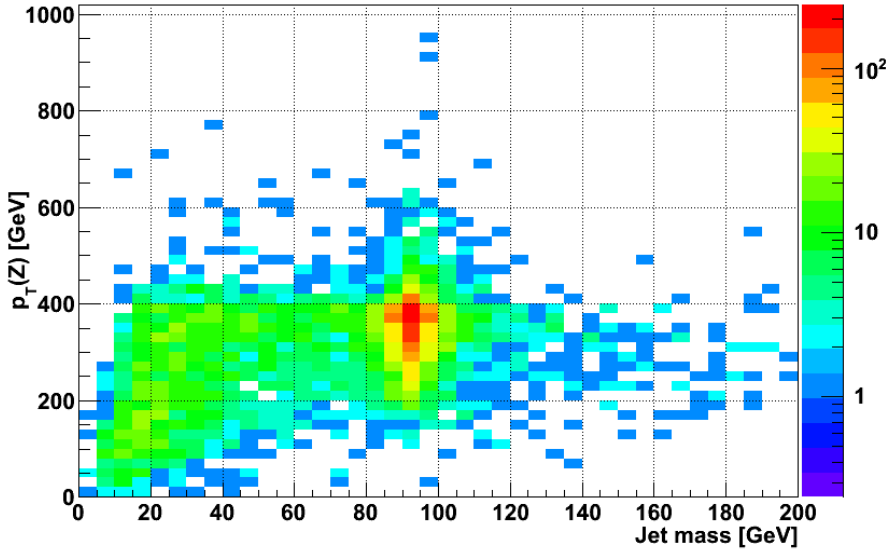
dpT between jet and Z X Z pT



dR between jet and Z X Z pT



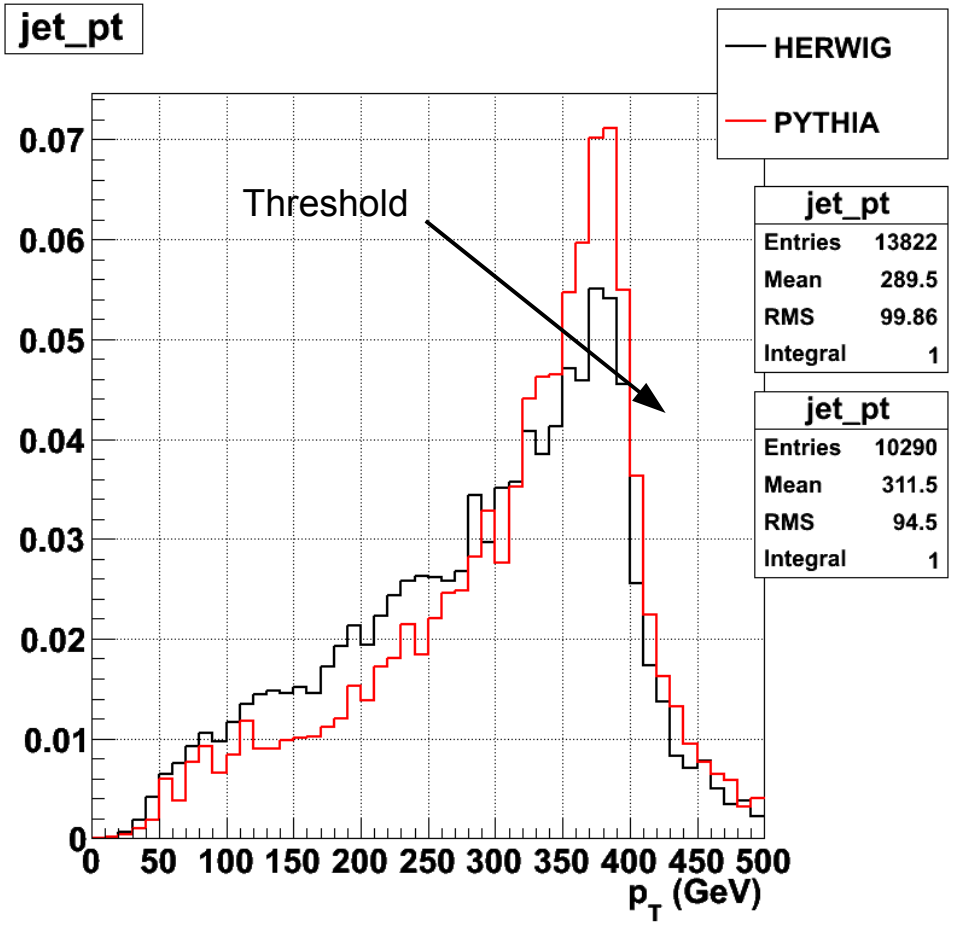
Jet mass X Z pT

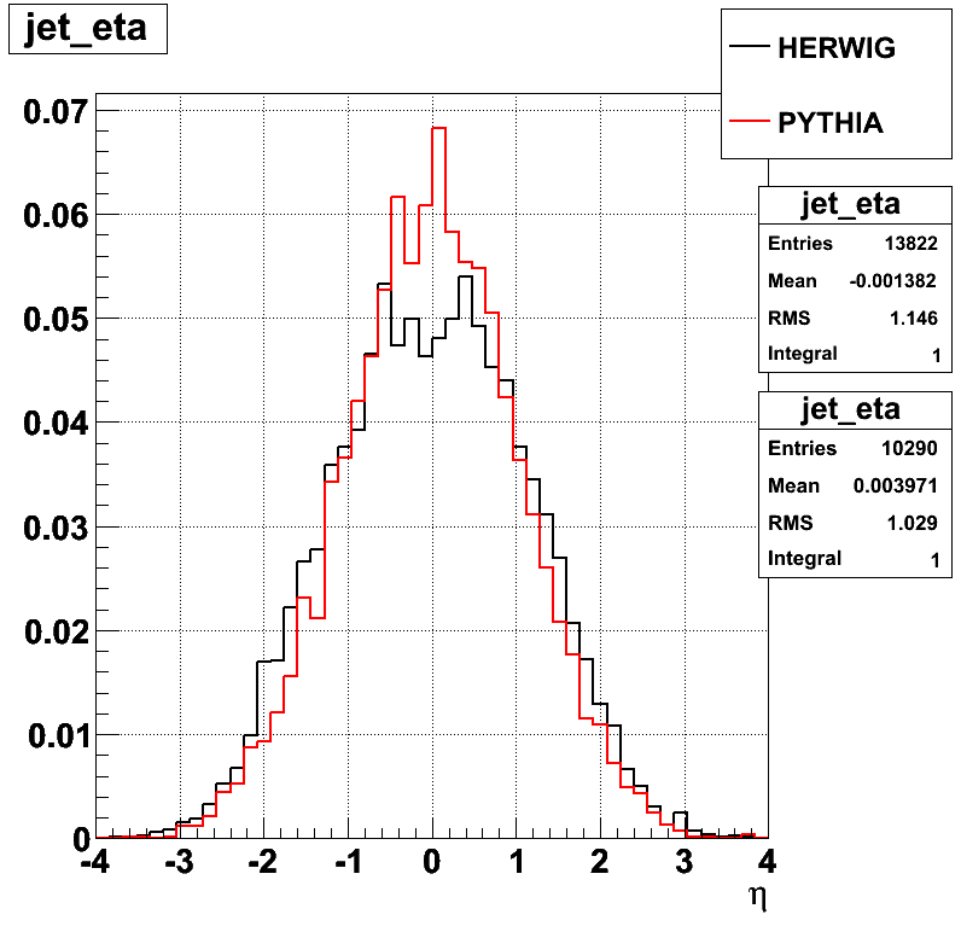


- The leading generator level jet matches kinematically the hadronically-decaying Z.
- Similar results for different mass points.

Generator Cross-Validation

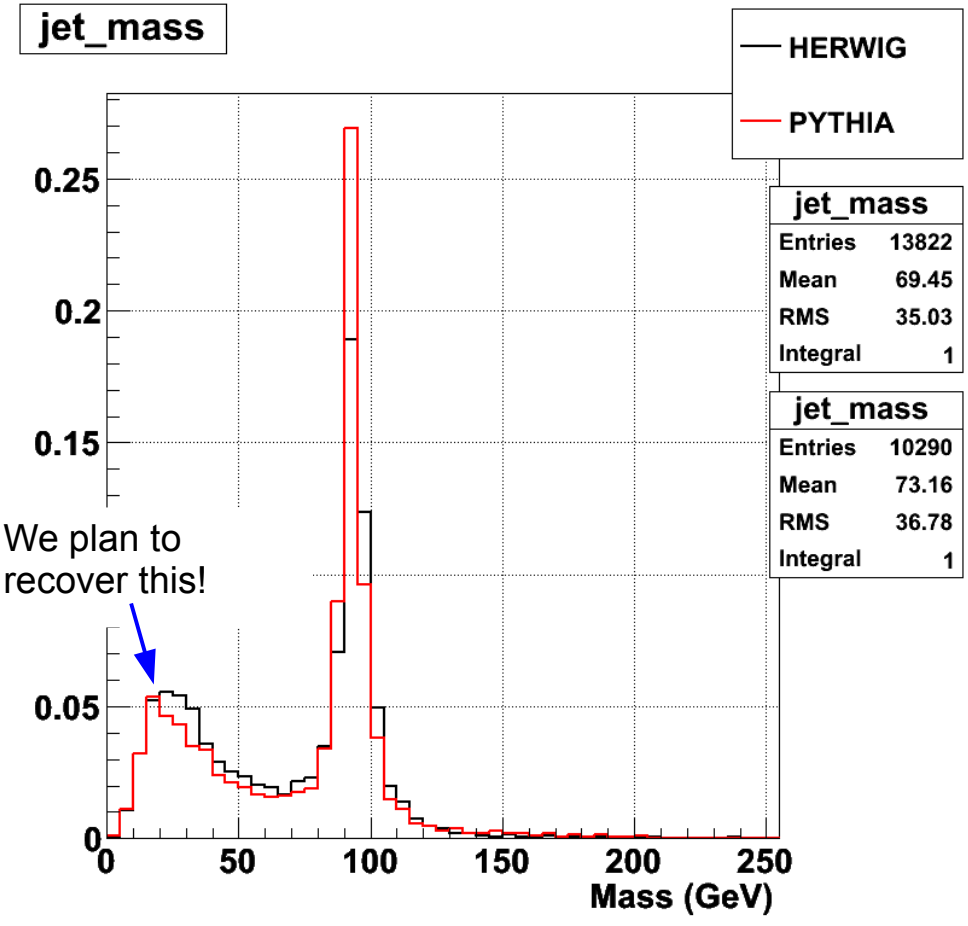
- Leading jet kinematics at generator level.

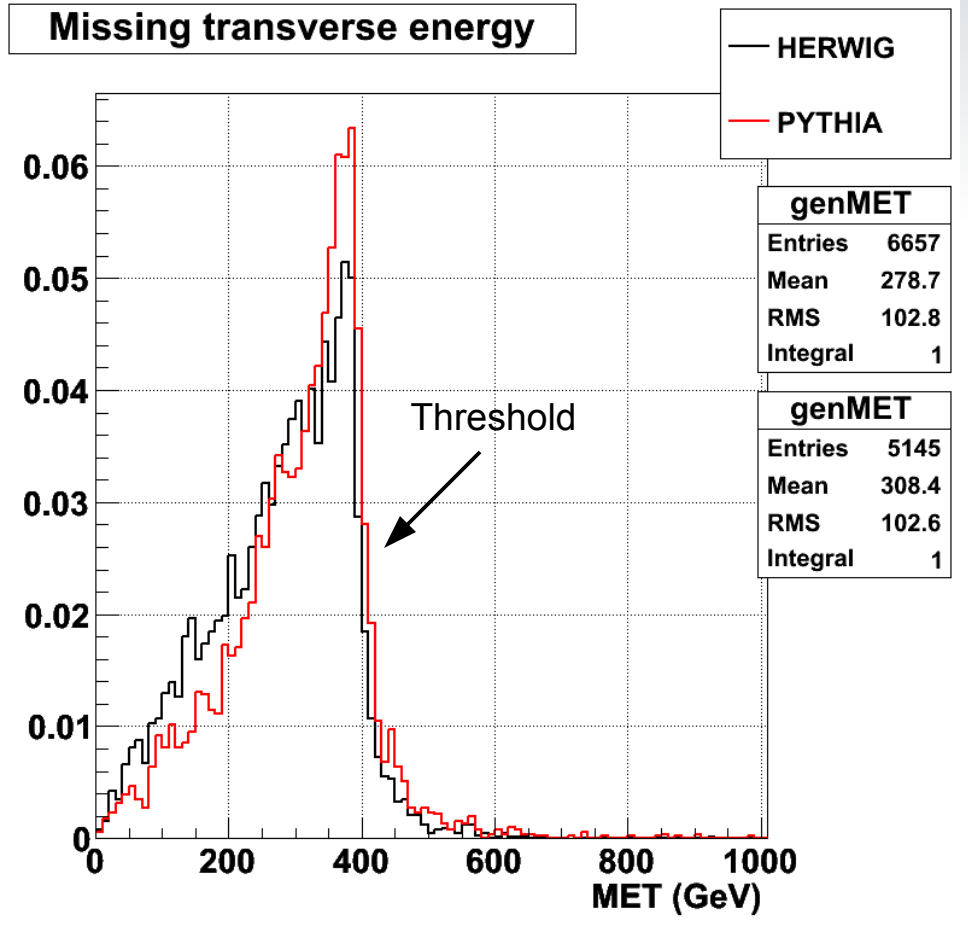




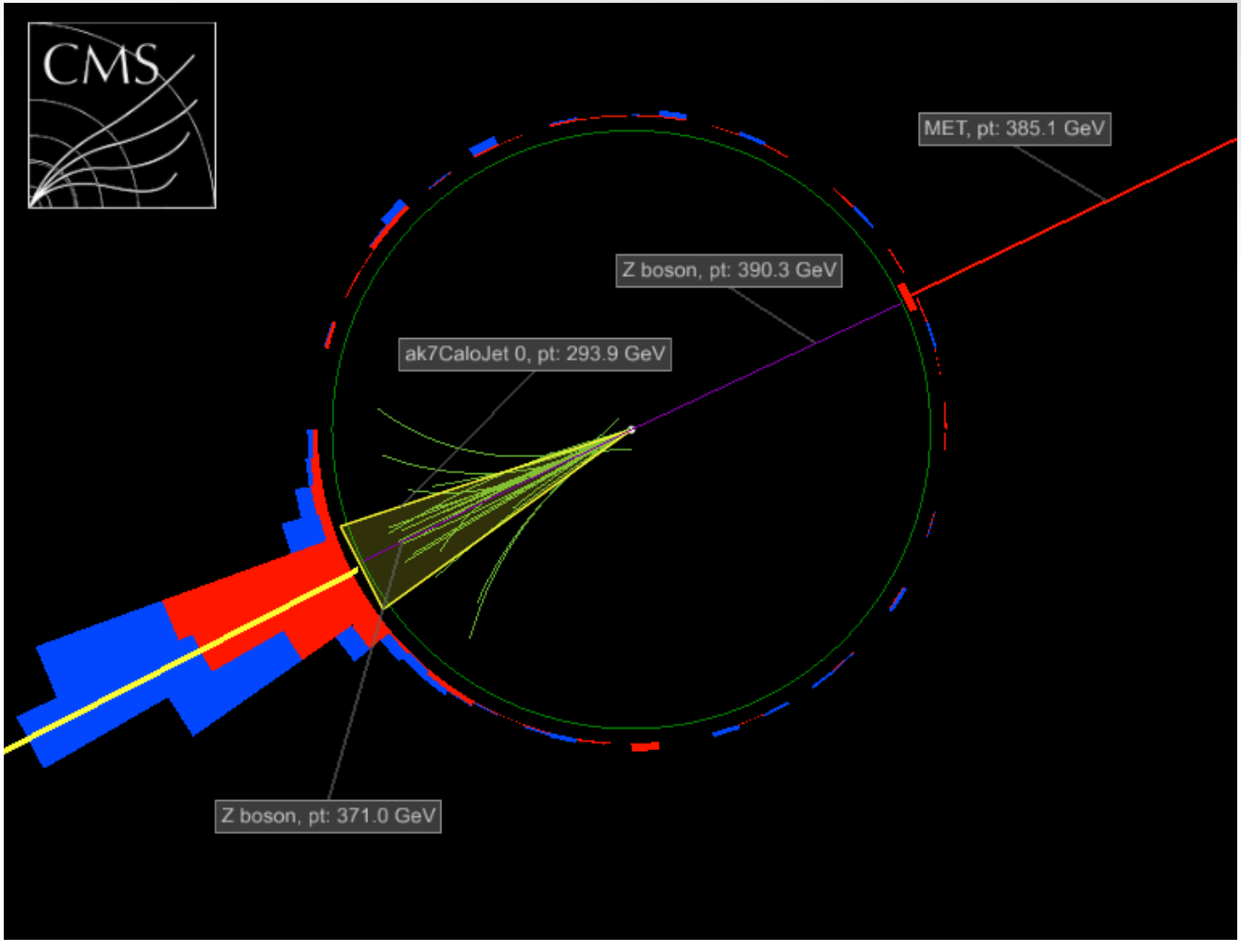
Generator Cross-Validation

- Leading jet mass and event missing E_T at generator level.



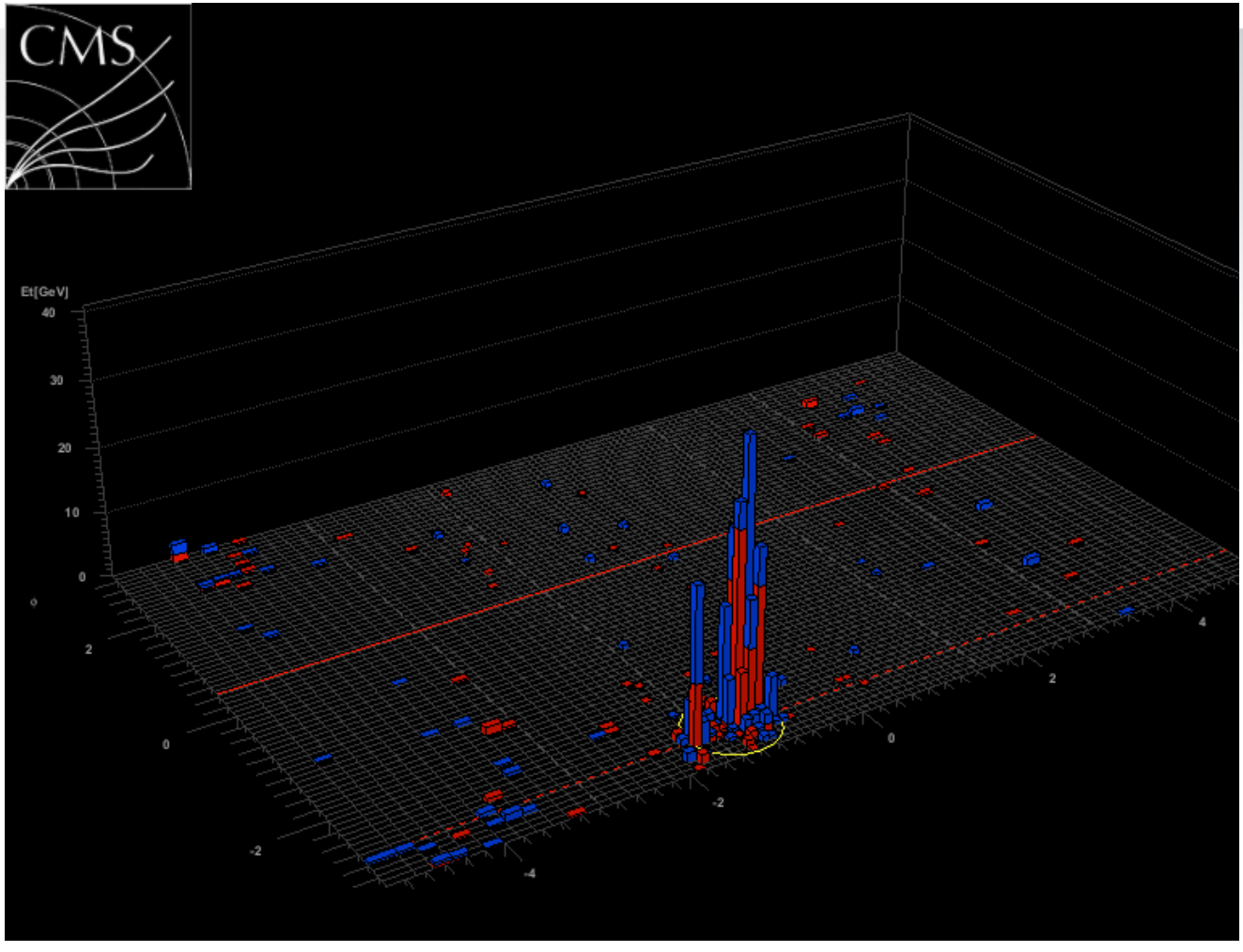


Reconstructed Event



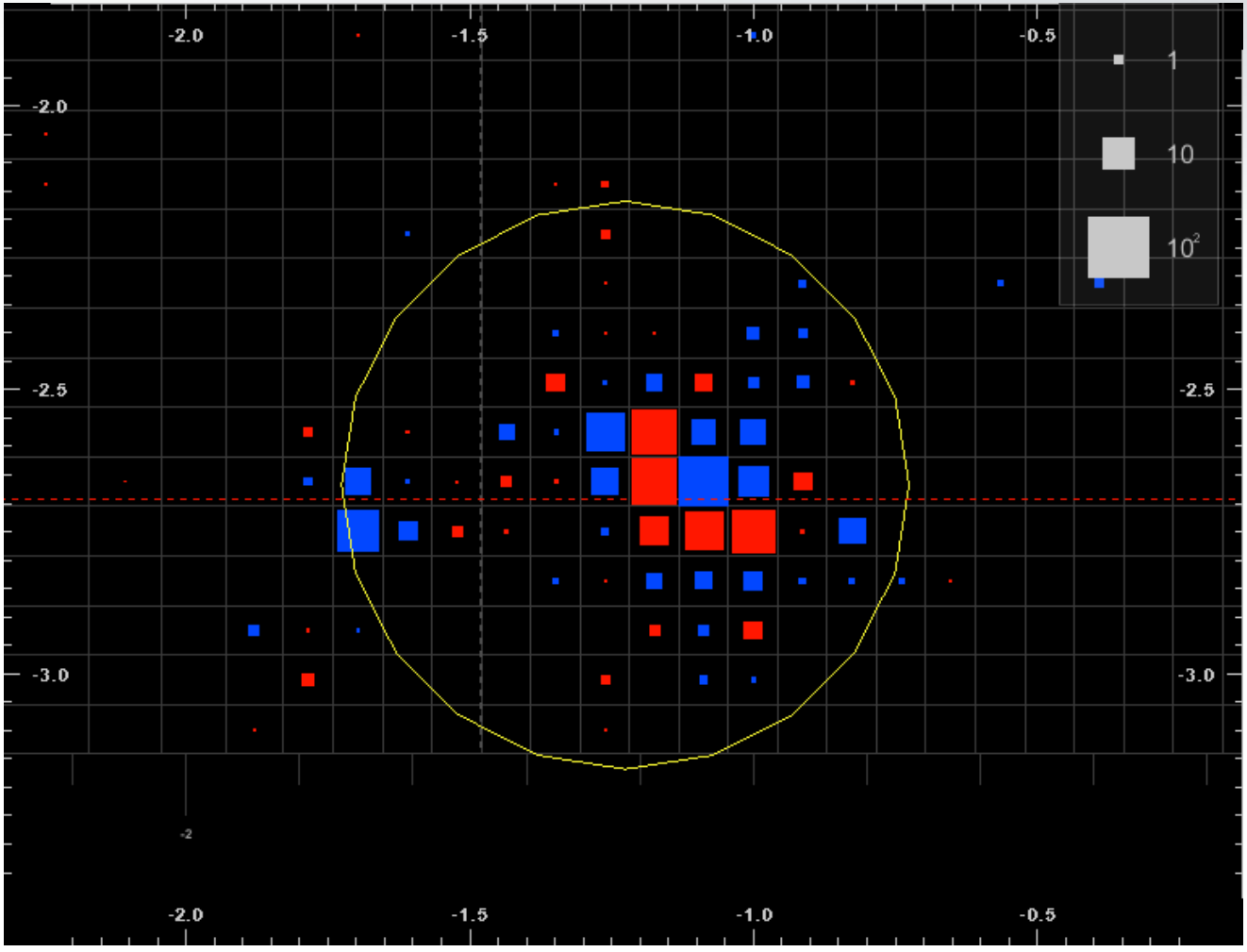
- Ideal event signature
  - High p_T jet
  - High missing E_T
- Deviations from ideal:
  - Underlying event
  - Strong final state radiation
  - Non-merging of jets

Reconstructed Event



- Jet substructure

Reconstructed Event



- Possibility to use jet pruning algorithms.
  - Ellis, Vermilion and Walsh (2009)
    - k_T algorithm
  - Kaplan, Rehermann, Schwartz, Tweedie (2008)
    - C-A algorithm

Reconstructed Event