Challenge

- **Predict W+4 jet Production @ Tevatron**
  - Background to Top Quark Measurements
  - Need a Matrix Element (Feynman diagram) calculation
    - No soft/collinear approximations
  - Also want to estimate THEORY error
    - Many runs w/ different physics parameters
      - Simplifies combination of CDF and D0 data

Standard Algorithm

- **Write down all the Feynman graphs**
  - Rules inside a computer program (automated)
  - # grows quickly: ~10x per added QCD parton
    - W+bb~jj has 1354 unique diagrams
    - 1 diagram = 1 amplitude = 1 function
  - Use VEGAS (adaptive Monte Carlo integration)
    - Integrate Square of Summed Amplitudes

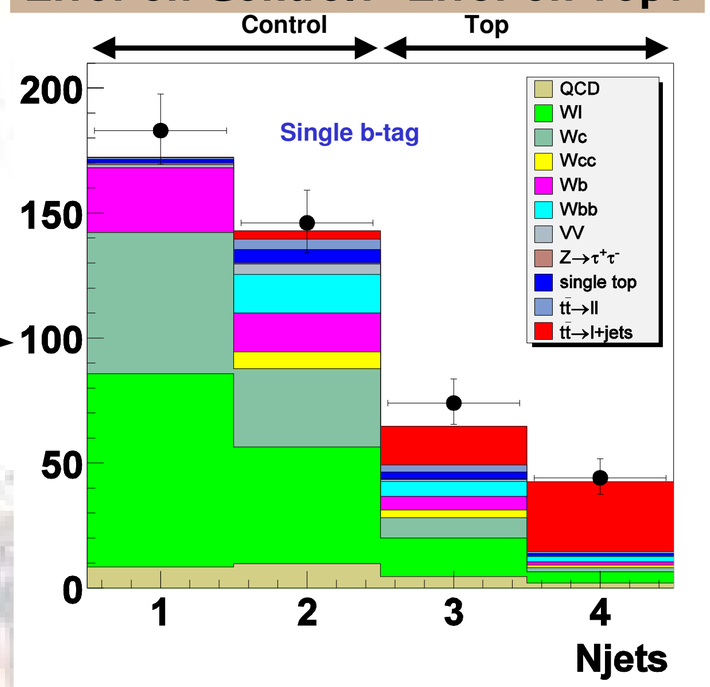
Solution

- **Multi-channel Integration**
  - Treat each Amplitude^2 with a separate MC run
    - Interference terms ($A_1 A_2^*$) added in
  - Sum individual (independent) results
    - Small contributions don't need to be known well to get accurate numbers or distributions
  - More efficient for unweighting
    - Roughly flat distribution of weights
- Fully automated choices with MADGRAPH

Calculations on FNAL Computing Farms

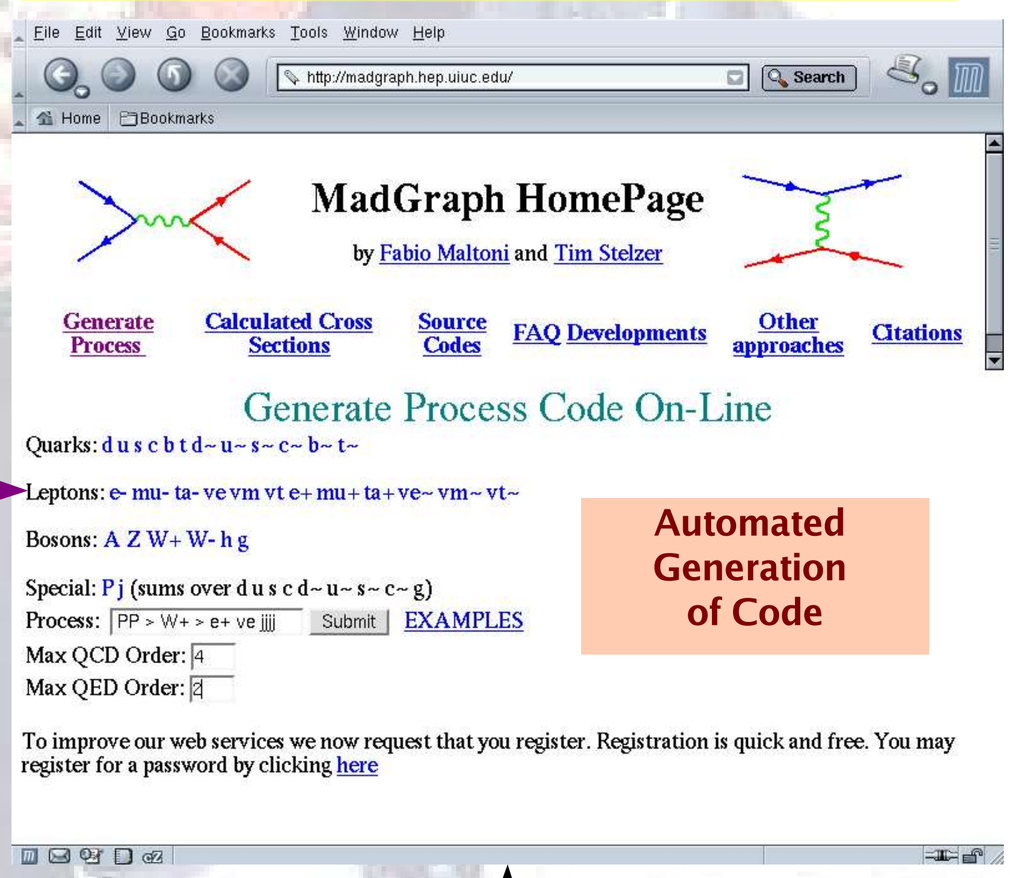
- 1 Feynman diagram = 1 batch job
- Distributed farm (dfarm) disk storage for intermediary steps
- Final results on Enstore mass storage

Error on Control? Error on Top?



Complications

- **Each amplitude has unique singular behavior**
  - Difficult to converge on a stable answer
  - Inefficient in generating unweighted events
  - Often, small subset of large weights dominates
  - Want all weights roughly the same



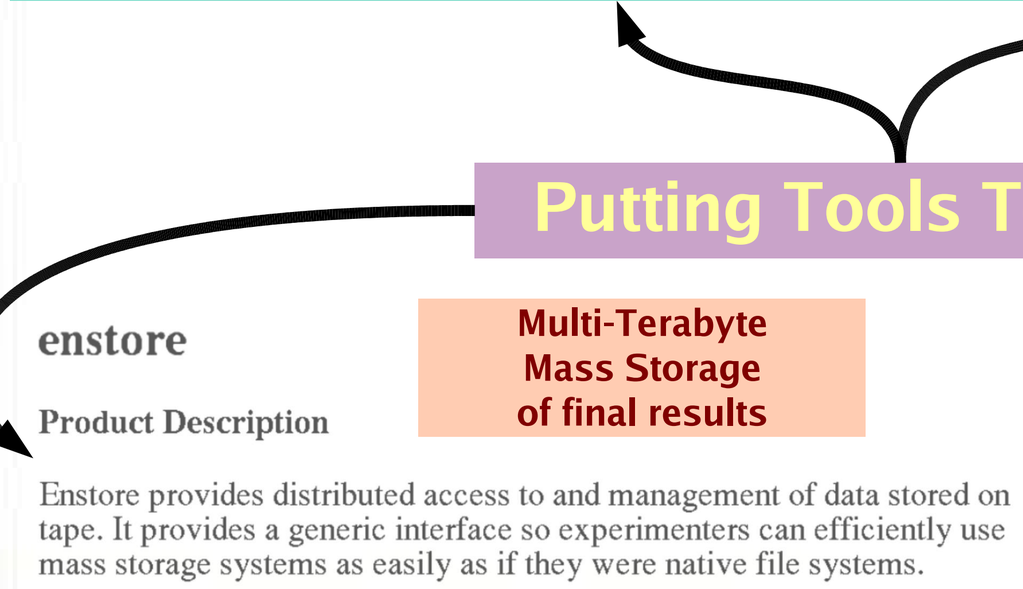
Automated Generation of Code

~ 200 worker & 2 I/O nodes

Disk storage for results of intermediate steps

Putting Tools Together

Multi-Terabyte Mass Storage of final results



Standardized Structure for Datasets

STDHEP & MCFIO

```
 PARAMETER (NMXHEP=4000)
 COMMON/HEPEVT/NEVHEP,NHEP,ISTHEP(NMXHEP),IDHEP(NMXHEP),
&JMOHEP(2,NMXHEP),JDAHEP(2,NMXHEP),PHEP(5,NMXHEP),VHEP(4,NMXHEP)
 DOUBLE PRECISION PHEP, VHEP
```