Vista:

A new method for an inclusive search of Tevatron Run II Data

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For the CDF Collaboration

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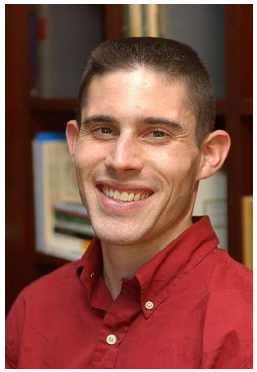


Bruce Knuteson

Motivation for Vista

- We expect physics beyond the Standard Model – but how to search for it?
- Vista is an attempt to simultaneously analyse all high-p_T data for discrepancies relative to our implementation of the Standard Model prediction

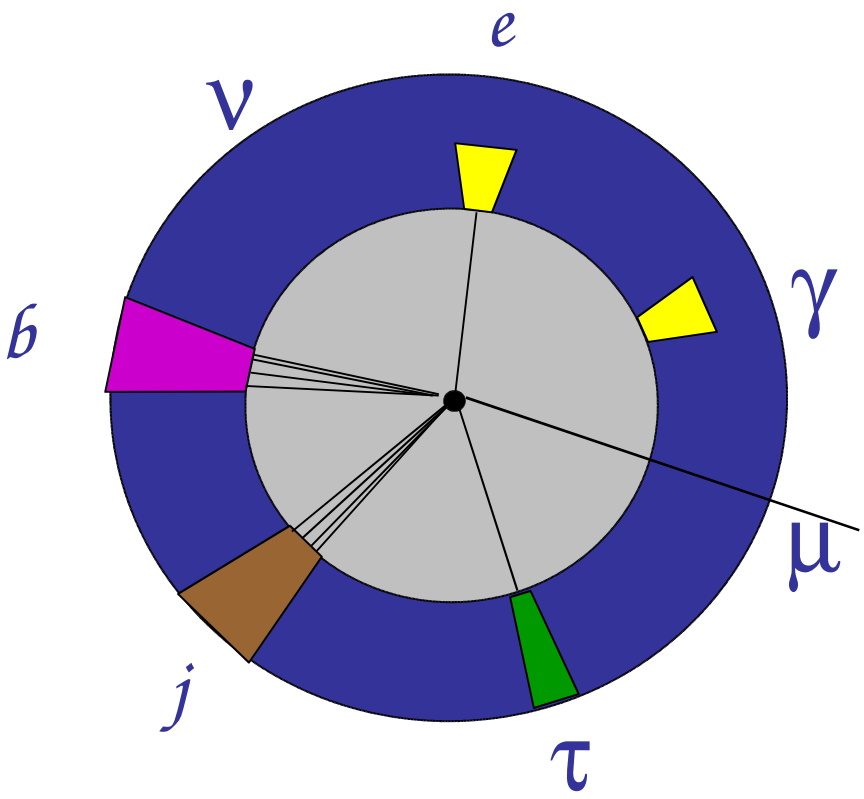
Tevatron at FNAL

Overview of Vista

- Identify objects
- Select events
- Partition events into final states
- Generate our implementation of Standard Model
- Determine 'Fudge Factors'
- Perform Vista global comparison
- Investigate discrepancies

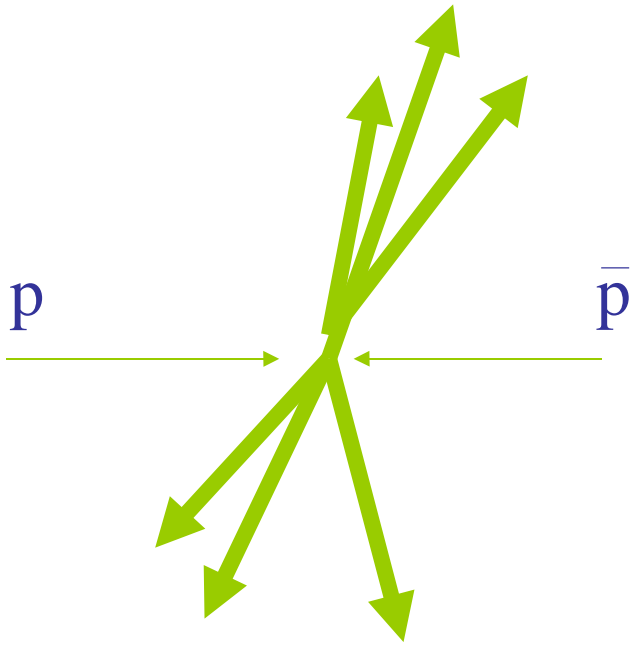
Object Identification in Vista

- Identify:
  - electrons
  - photons
  - muons
  - taus,
  - b-jets,
  - jets
  - missing energy
- All objects are required to have p_T>20 GeV



Event Selection

- Events are selected off-line if they meet one of these criteria:
  - electron, $p_T > 25$ GeV
  - muon, $p_T > 25$ GeV
  - photon, $p_T > 60$ GeV
  - jet, $p_T > 200$ GeV



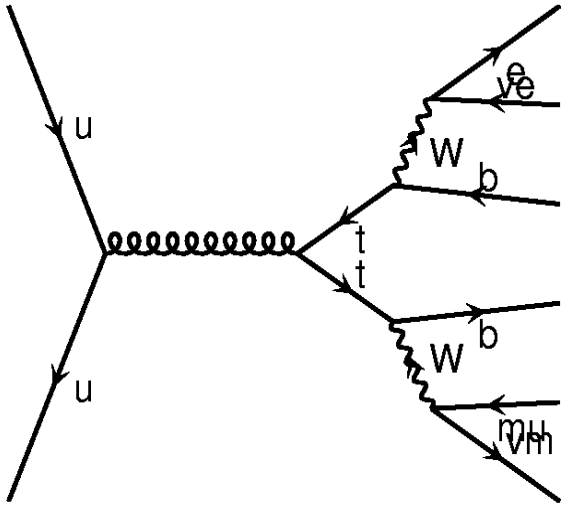
Exclusive Final States

- Events are partitioned into exclusive final states
- Example: the 'ej' bin contains exactly 1 electron and 1 jet; 'ejj' is exactly 1 electron and 2 jets, etc...

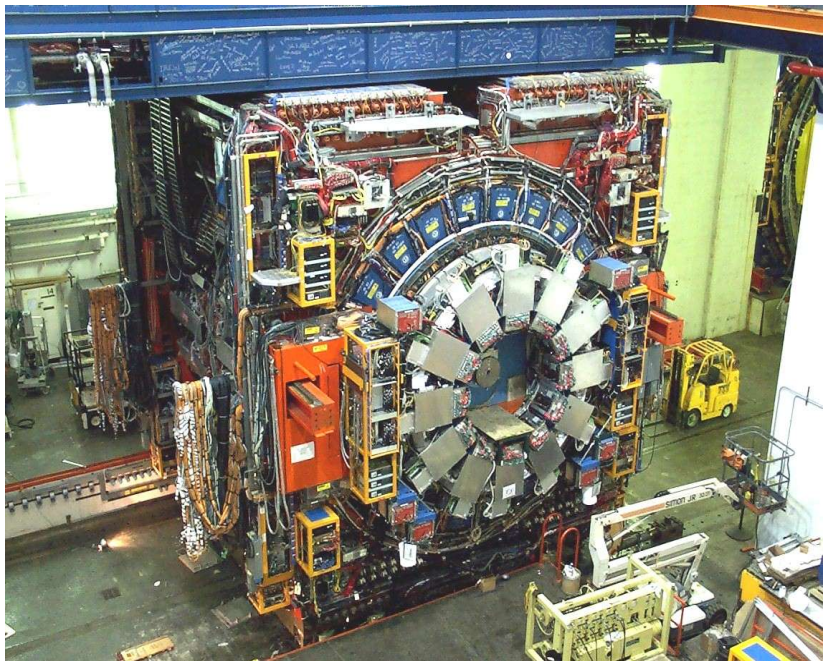
- Vista considers ~ 500 distinct final states

Standard Model Implementation

- Standard model implementation: from event generators Pythia and MadEvent



- Then events run through GEANT simulation of CDF detector



Vista 'Fudge Factors'

Nature =

Generated events ⊗ Detector Simulation ⊗ Fudge Factors

- 'Fudge Factors' are important parameters that we do not know precisely...
  - Luminosity of data sample
  - Theoretical k-Factors for cross-sections
  - Particle (mis-)identification probabilities
  - Trigger efficiencies
- At present, there are approximately 55 fudge factors used in Vista

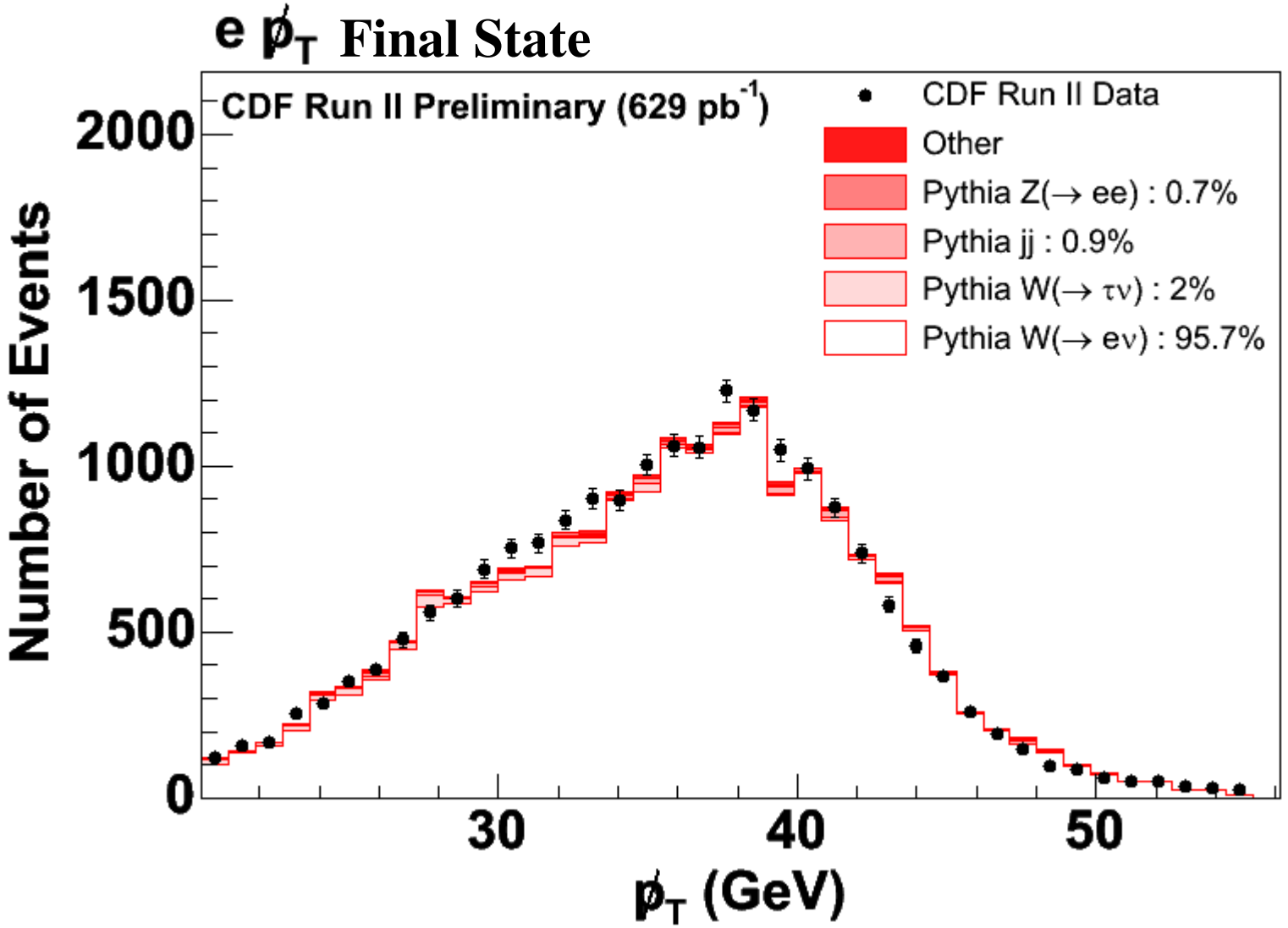
Fitting for Fudge Factors

- Obtain values for fudge factors by fitting to the observed data

$$\chi^2(\vec{s}) = \sum_{i \in \text{bins}} ((\text{Data}_i - \text{SM}_i)/(\delta \text{SM}_i))^2$$

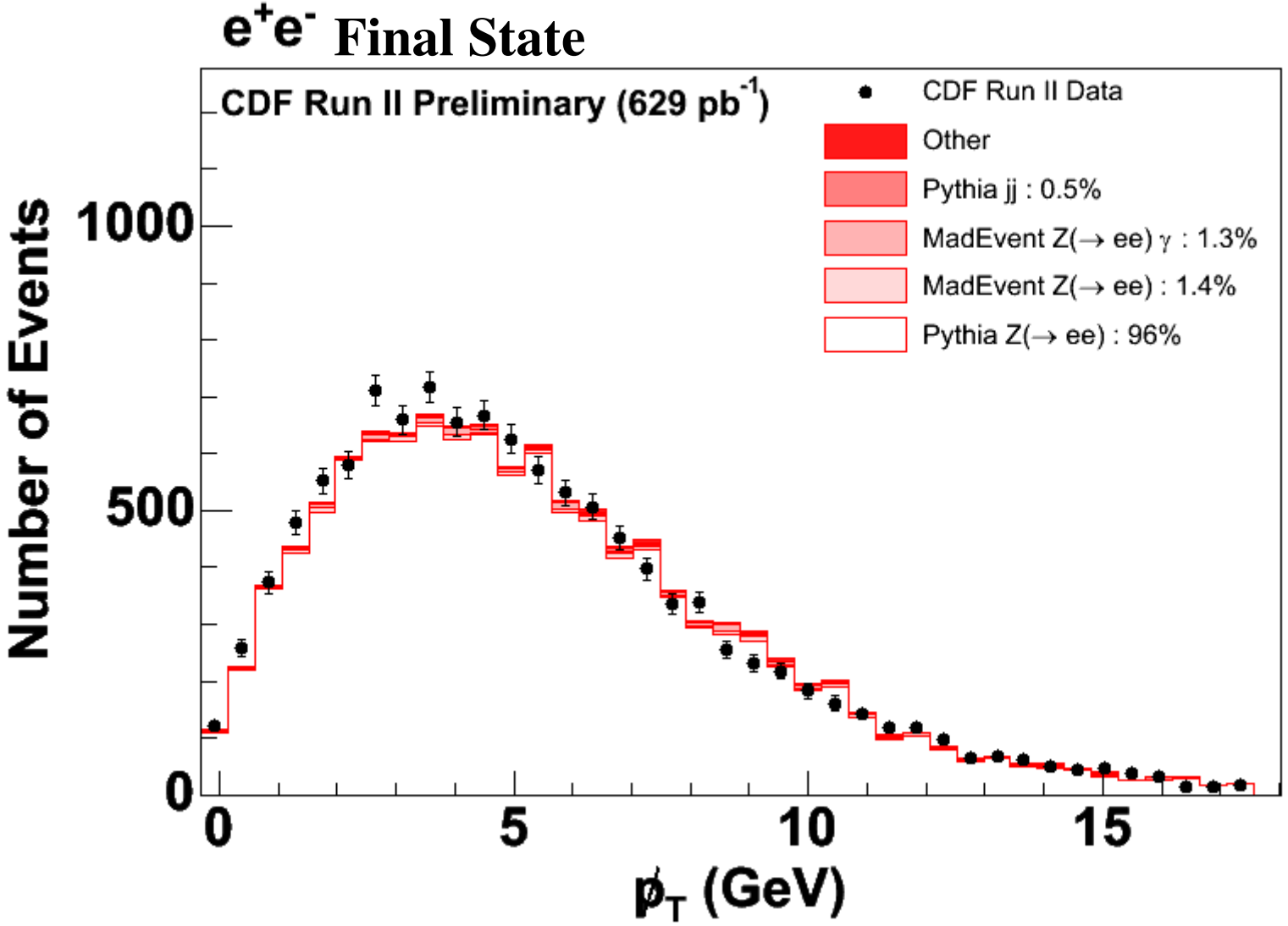
- Fit seeks to maximise global agreement between our Standard Model implementation and the data
- When external information is available, we can use that to constrain the fudge factor fit
- Fit provides best-values, errors on those values, and complete correlation matrix of all fudge factors

k-Factors for W & Z Production



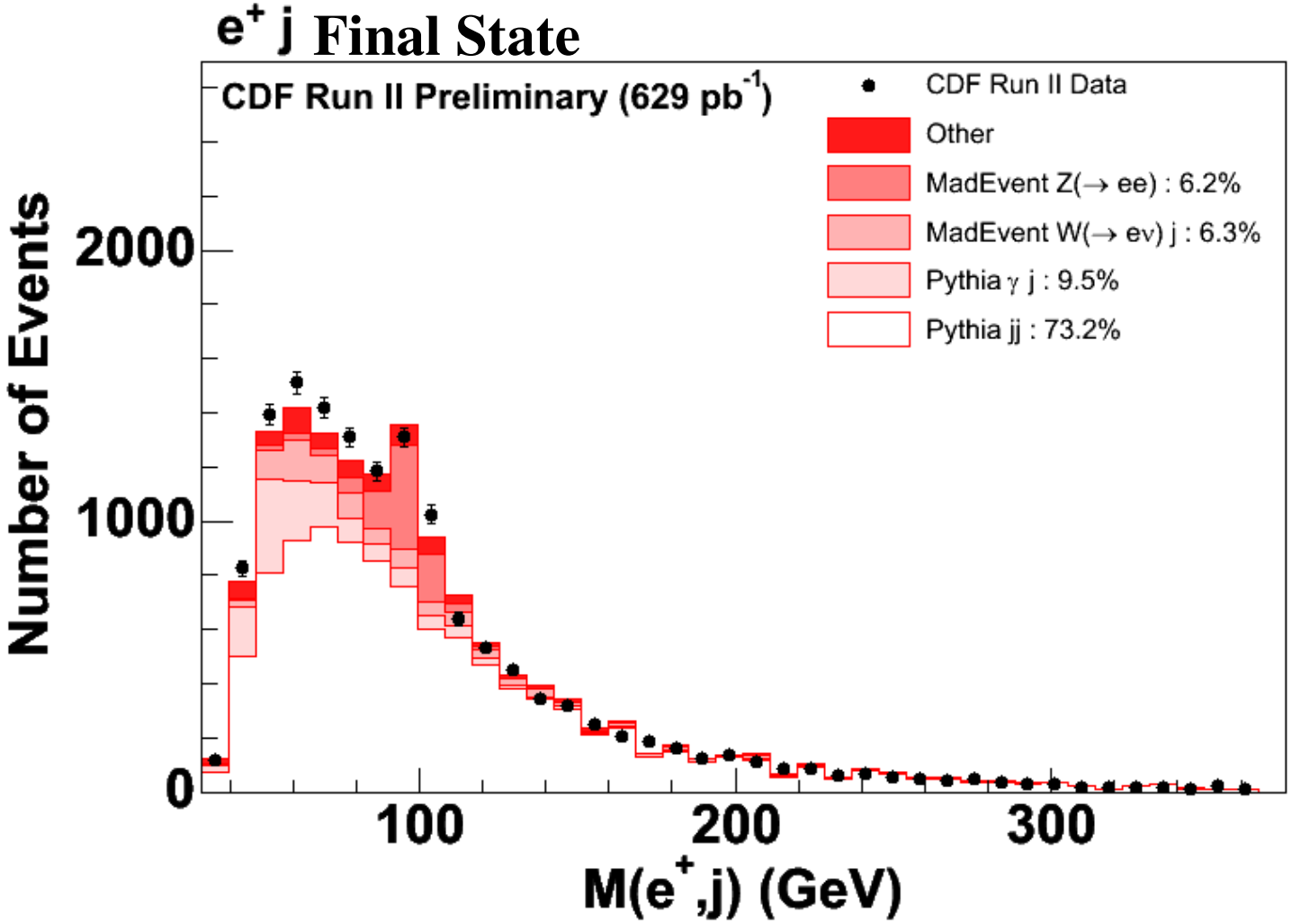
- W & Z k-Factors well-known from NNLO; act as constraints on luminosity

Z Production



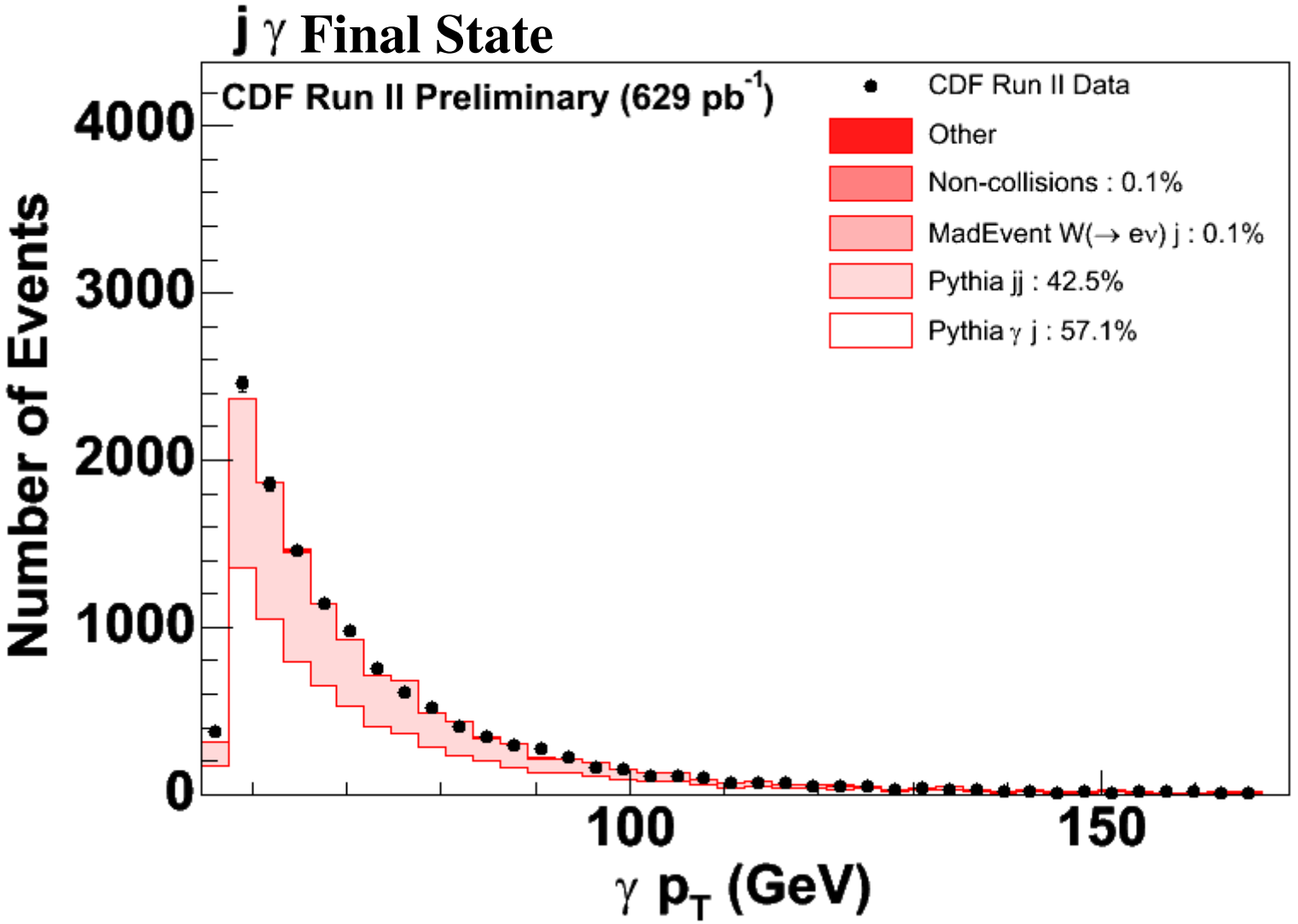
- Large intrinsic k_T needed to describe Z production ...

MisIdentification: jet -> electron



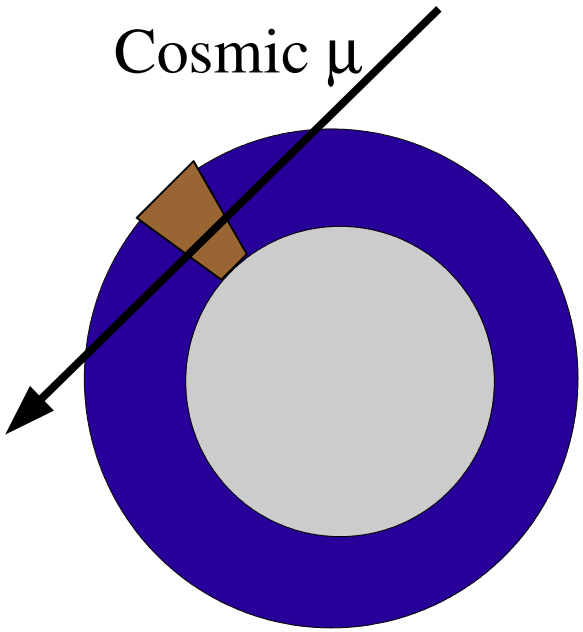
- ej final state dominated by jets reconstructed as electrons
- Also a peak at Z-mass, where electron is reconstructed as a jet

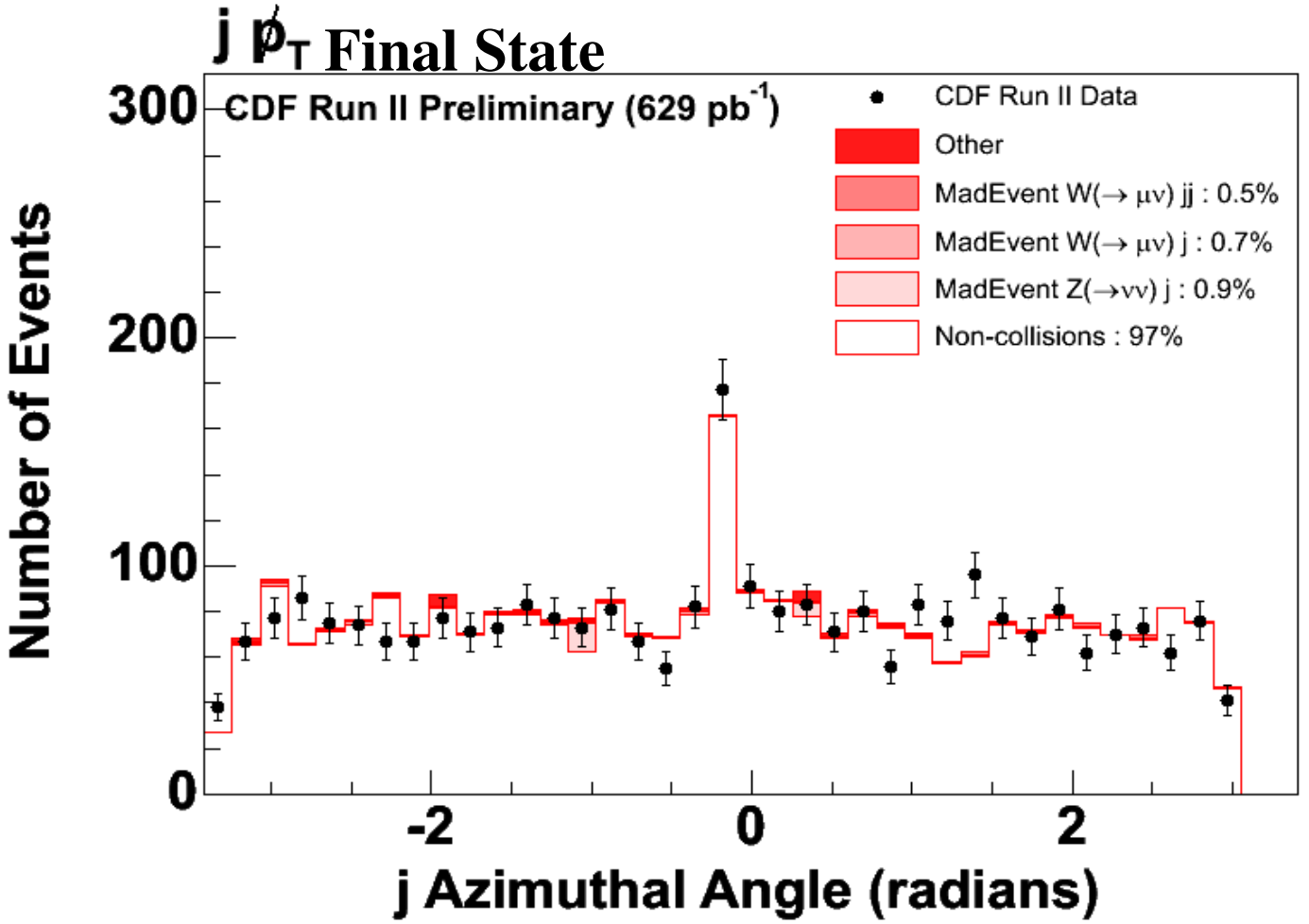
1jet 1photon Final State



- Real photon+jet production, plus di-jets with a jet faking a photon

Non-collision Background



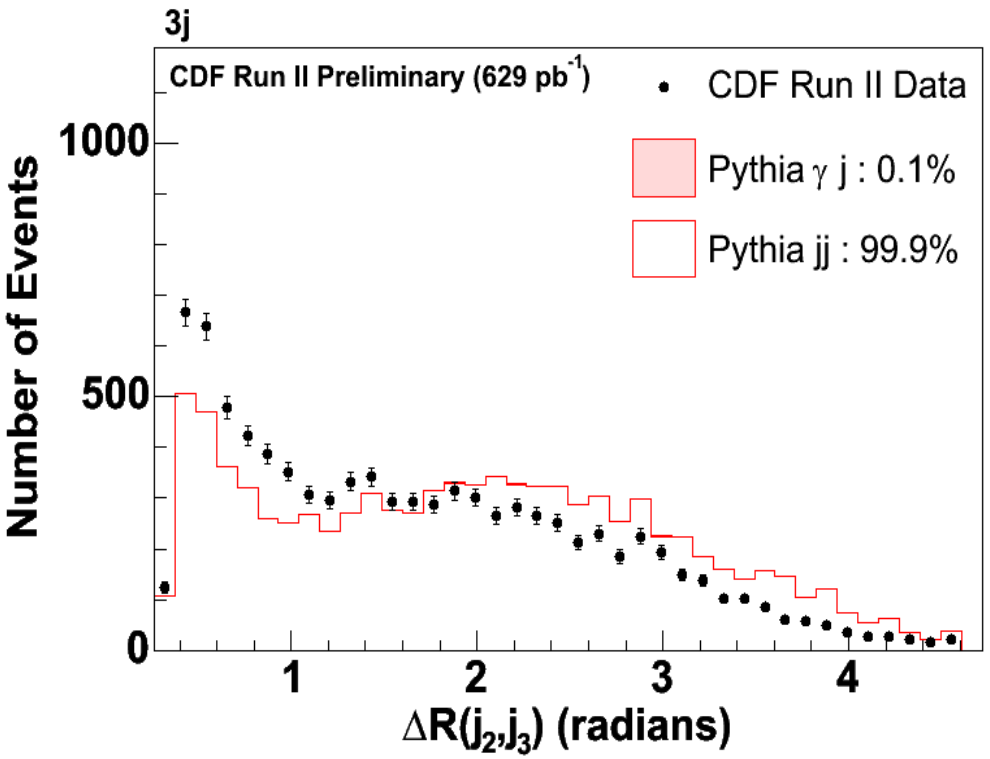


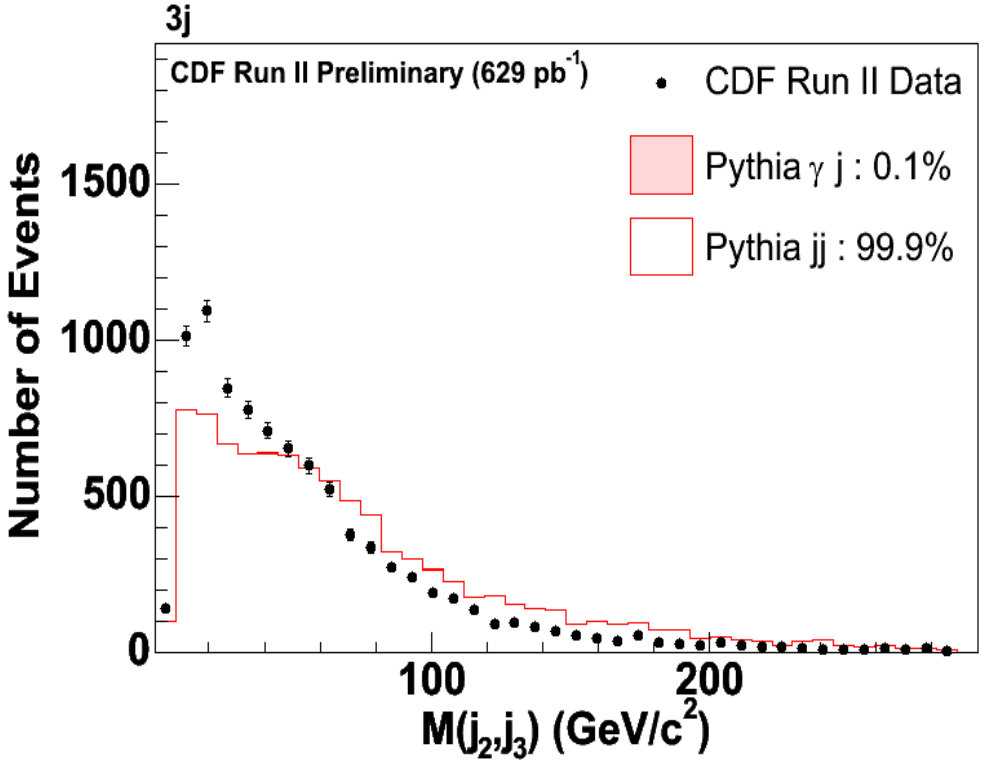
- Estimate non-collision background from events with no tracks
- Can describe flat cosmics contribution and beam-halo spike at phi=0

The Vista Global Comparison

- Vista performs a global comparison between our implementation of the Standard Model and the observed high-p_T data
- For each final state, we obtain the deviation of the Standard Model estimate from the data
- Then we start investigating discrepancies

Example of a Vista Discrepancy: 3j





- For 3j state, data on 2nd and 3rd jet distributions show discrepancy with our SM implementation (based on Pythia Tune AW used at CDF)

- In conjunction with Rick Field and Steve Mrenna, a new Tune BW was developed and is expected to resolve this

Beyond Vista?

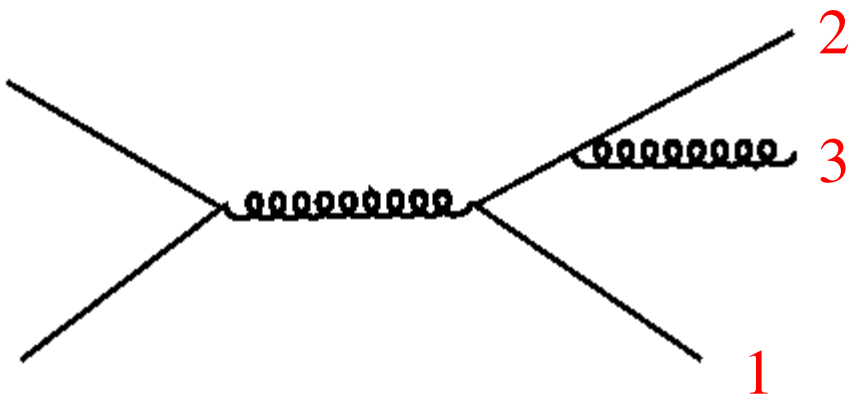
- Vista is a work in progress – the goal is to make a statement about the global understanding of high-p_T collider data in terms of the Standard Model
- Signs of new physics expected in high-p_T tails – Sleuth is a quasi-model independent search for these
  - See talk by Georgios Choudalakis in later session
- If we see a signal, how do we interpet it in terms of new physics? - Bard and Quaero
  - See talk by Bruce Knuteson in later session

Summary

- Vista attempts to understand bulk features of high-p_T collider data in terms of the Standard Model
- Identify objects, select and partition events, implement Standard Model prediction
- Novel approach to determine 'fudge factors'
- Perform global comparison of Standard Model to data
  - Then investigate discrepancies
- Beyond Vista? Sleuth -> Bard + Quaero
  - (see later talks by Georgios Choudalakis and Bruce Knuteson)

Backup Slides

3j Discrepancy Resolved?



- Pythia parameter parp(67) controls scale for radiating gluons
- In tune AW, was set too high, allowing for too hard radiation
- In tune BW, it is reduced, better matching observations