Search for two-jet decays of W and Z bosons in Run IC dijet data

Olga Lobban, QCD meeting

November 15, 2002

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- Plug calorimeter calibration study
- Central calorimeter calibration study
- Central calorimeter jet corrections
- Run IC dijet data
- Signal expectations

} Talked about on October 18

- Procedure
- Results

} today

Plug calibration study

- See Note 5586 or NIM A 487 (2002) 381.
- Presented alternative method to set energy scale of hadronic calorimeter section.

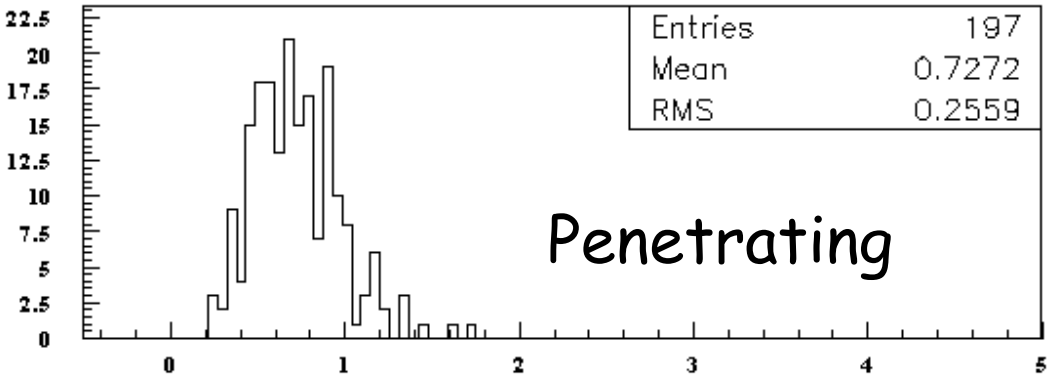
Method I
(traditional CDF method)
Pions which are mip-like in the em section are used to set the hadronic section energy scale

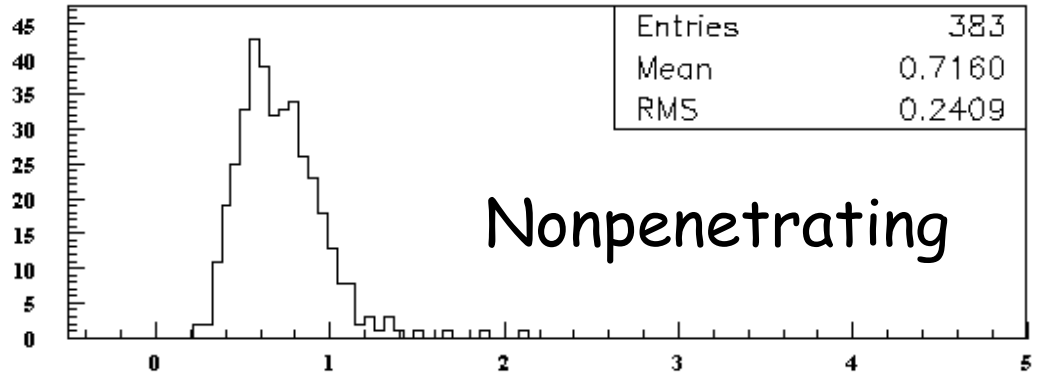
Method III
Set hadronic section energy scale such that early and late showering pions have, on average, equal reconstructed energies.

Central calibration study

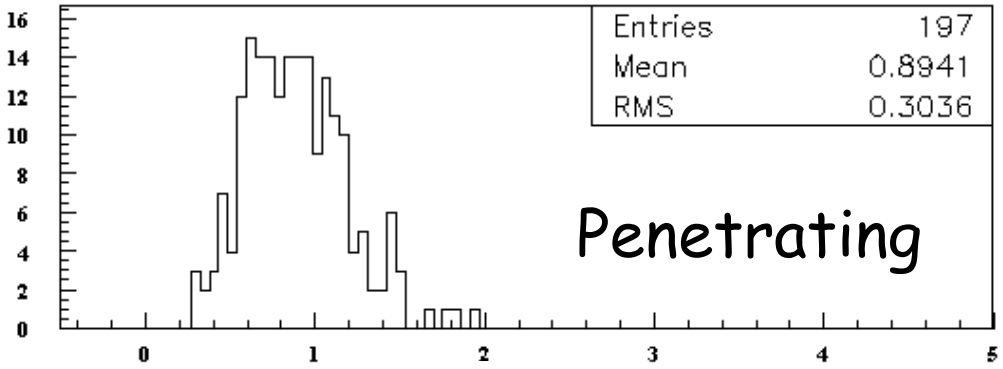
- See Note 5848.
- Repeated Plug analysis for Central calorimeter using Run IB minimum bias data
- Saw same effect as in Plug testbeam study → reconstructed energy of early and late showering pions is different
- Established Method III for the Central calorimeter.

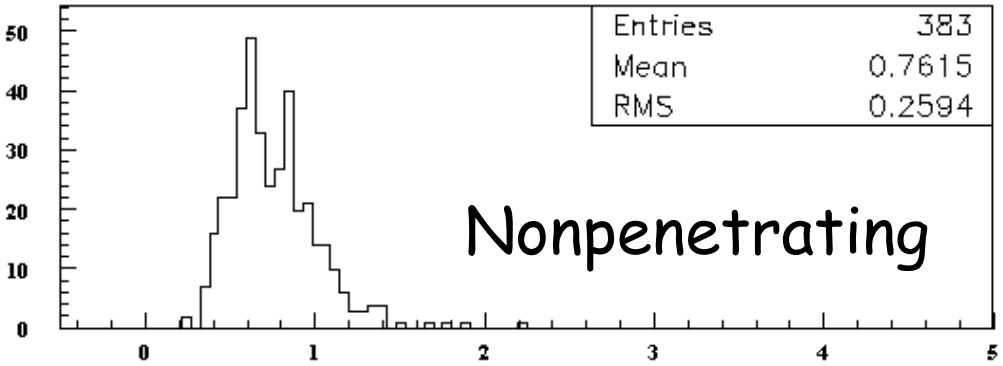
Method III


Entries 197
Mean 0.7272
RMS 0.2559
Penetrating
E/p


Entries 383
Mean 0.7160
RMS 0.2409
Nonpenetrating
E/p

Method I


Entries 197
Mean 0.8941
RMS 0.3036
Penetrating
E/p


Entries 383
Mean 0.7615
RMS 0.2594
Nonpenetrating
E/p

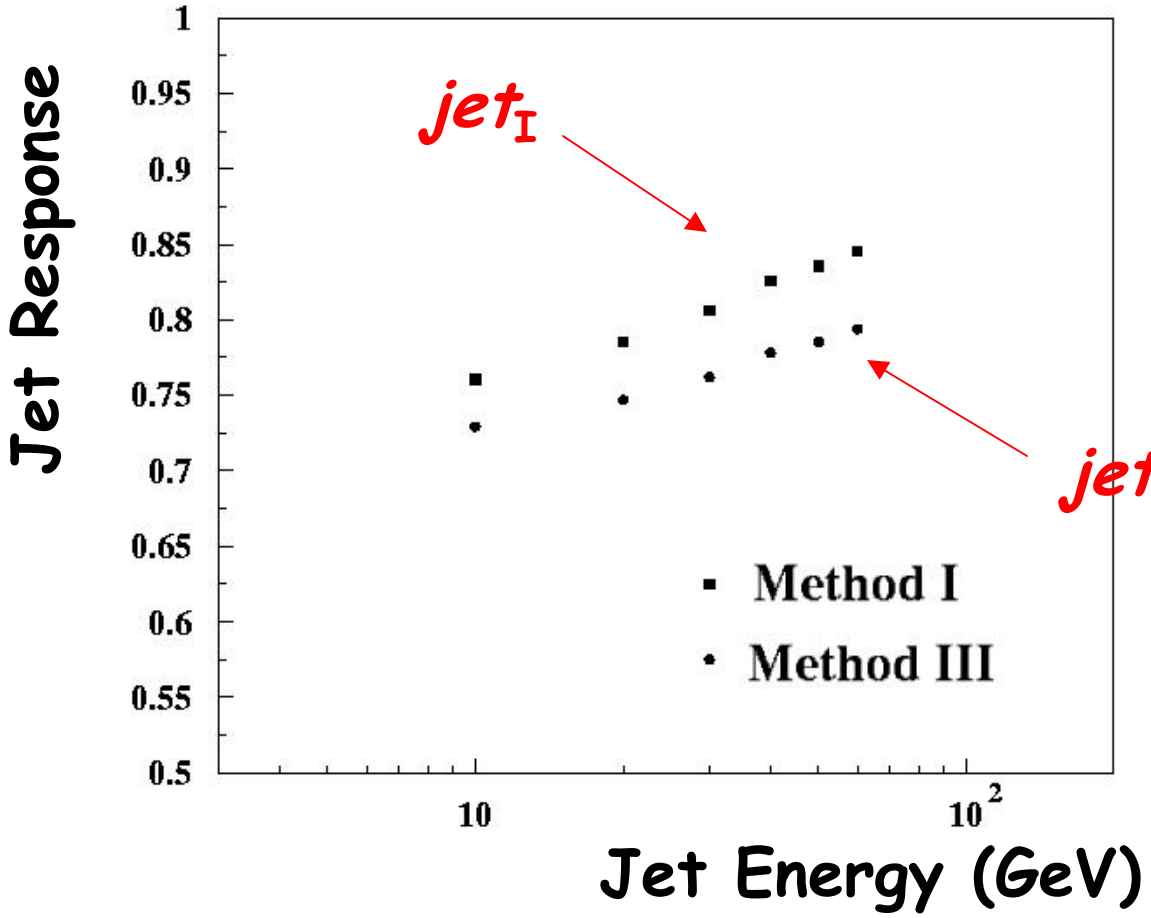
Central calorimeter Jet Corrections

- Established a new absolute jet-correction.
- Generated jet by randomly selecting particles with energy $E_i = zE_{jet}$ from fragmentation function

$$D(z) = \frac{(\alpha + 1)(1 - z)^{\alpha}}{z}$$

- 1/3 probability fragment is neutral
- 2/3 probability fragment charged
- Charged fragments → signal pulled from pion signal distribution from Run IB minimum bias data
- Neutral fragments → energy taken as is (em energy resolution better than hadronic resolution)

Jet Response Curves



Jet response is a function of jet energy

Central cal Jet Correction

- Method III jet correction:

$$E_{corr} = E_{raw} \cdot (1/jet_{III})$$

where $E_{raw} = E_{em} + k\,E_{had}$ and k is the constant needed to equalize the reconstructed energy of early and late showering pions found using Run IB minimum bias data

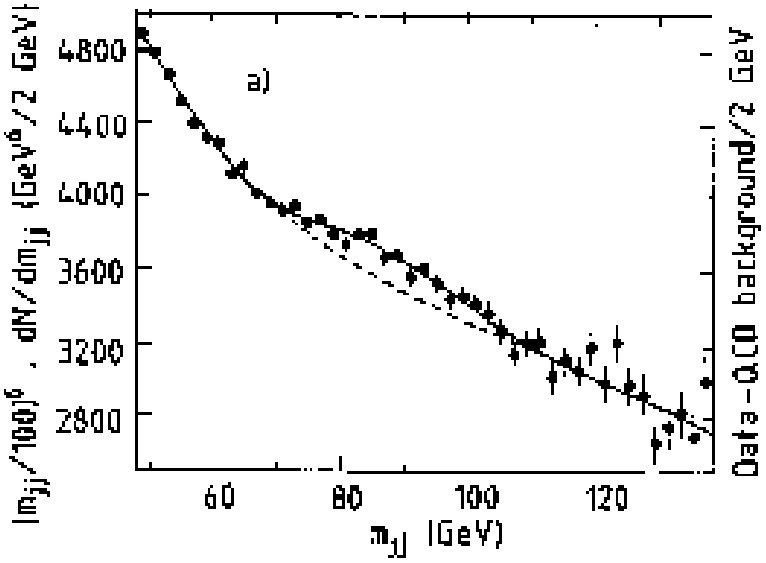
Run IC Dijet Data

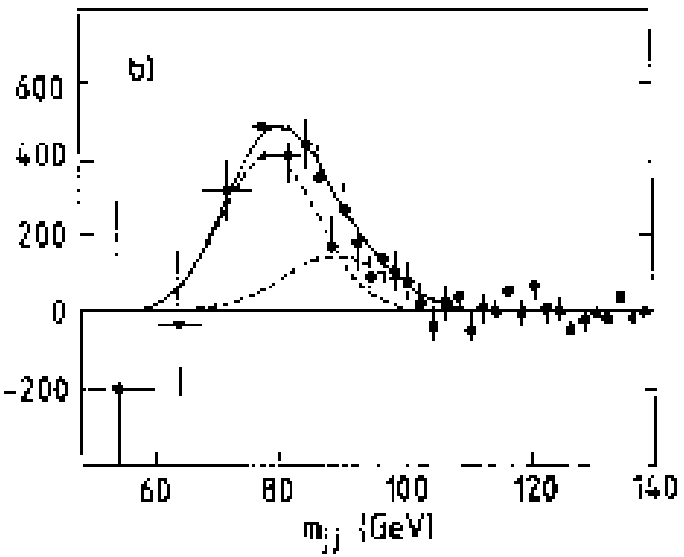
- In Run IC, half of the CTC was turned off → what better time to take a low-threshold dijet trigger (thanks to W. Wester)

- **Level 1:** At least 1 CEM and 1 CHA tower with E_T > 4 GeV
- **Level 2:** Primitive clustering algorithm applied → see tower with E_T > 3 GeV, all adjacent towers with E_T > 1 GeV included in cluster

- **1.9 pb^{-1} recorded**
- This data sample is much bigger than entire Run I single jet trigger, JET_20, sample.

UA2 Result





4.7 pb^{-1}

6805 events

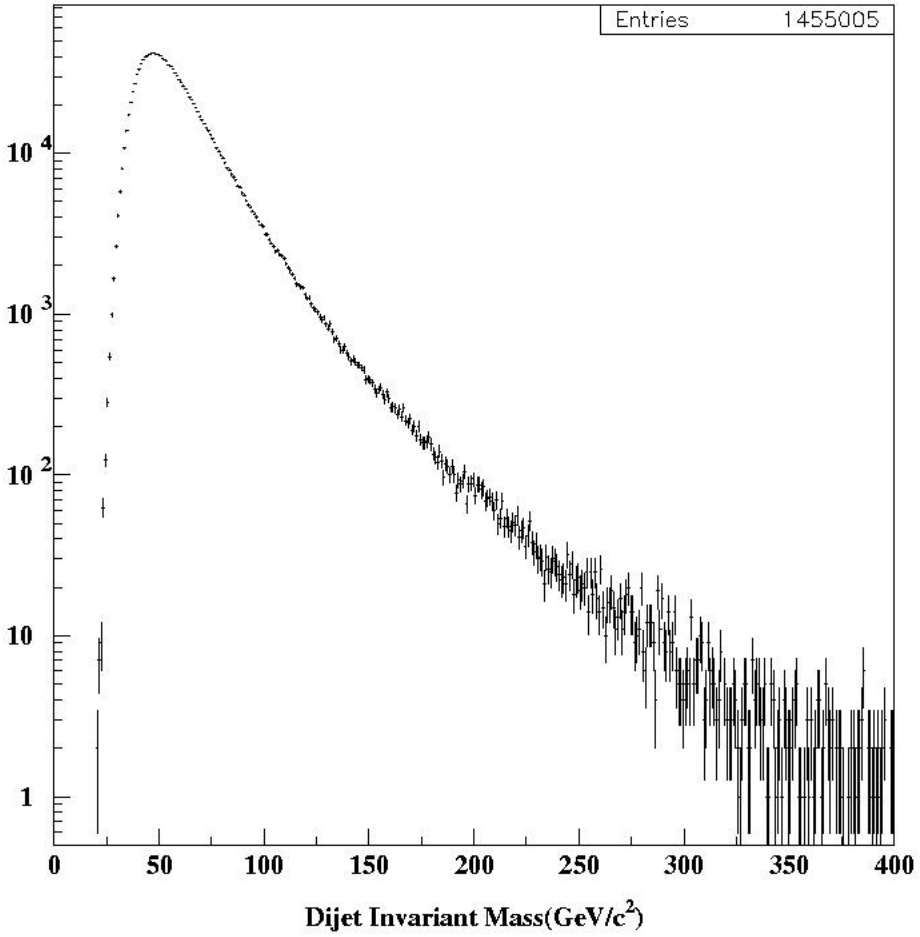
$\sqrt{s}$ = 630 GeV

Signal Expectation

	No cuts	$\|\eta\| < 1.1$ (trigger)	$\cos(\Phi) < -0.4$ (offline)	Jet 3 E_T (offline)
W	29,740	6270	5100	4280
Z	9120	2090	1650	1370

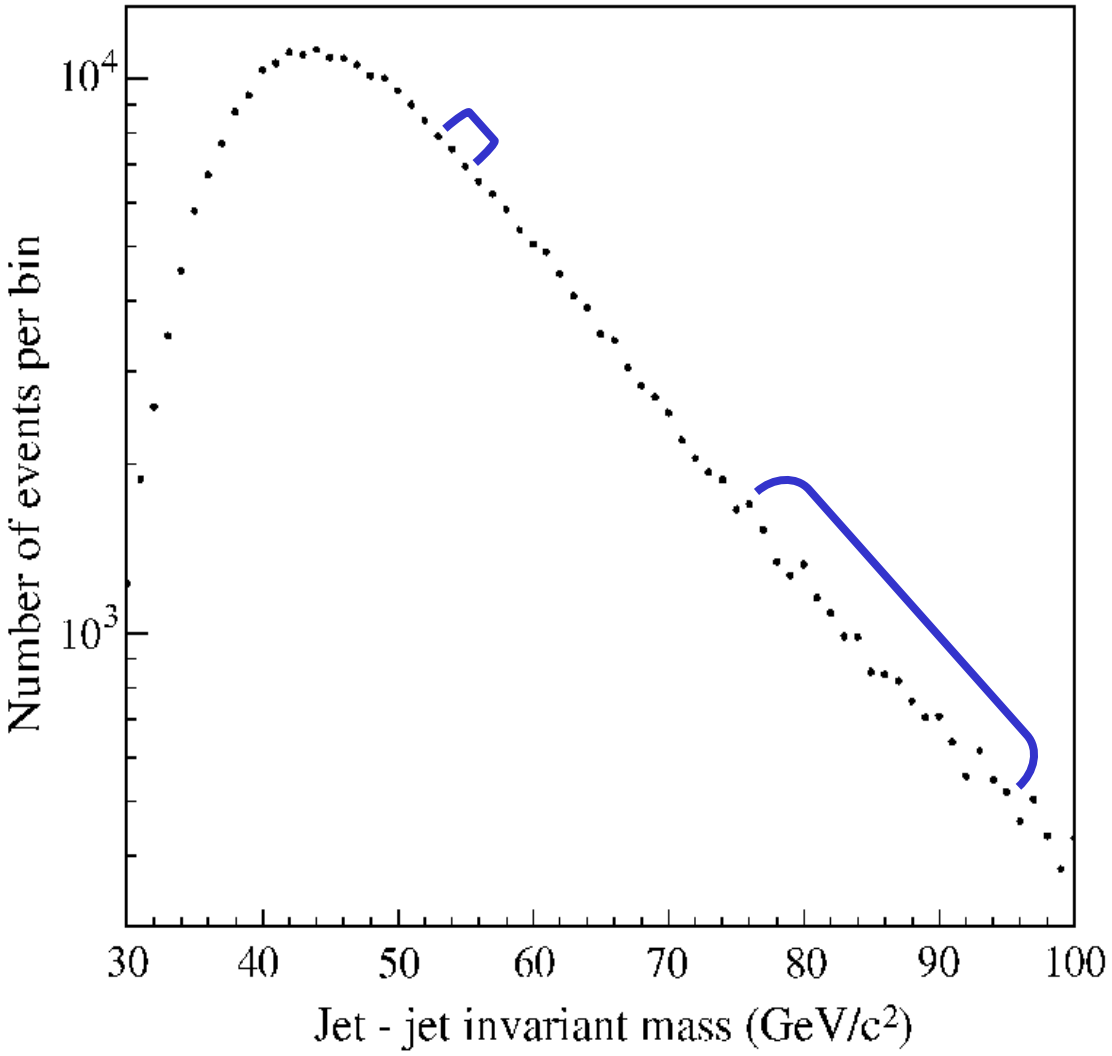
Total = 5650 events

Raw Dijet Mass Spectrum



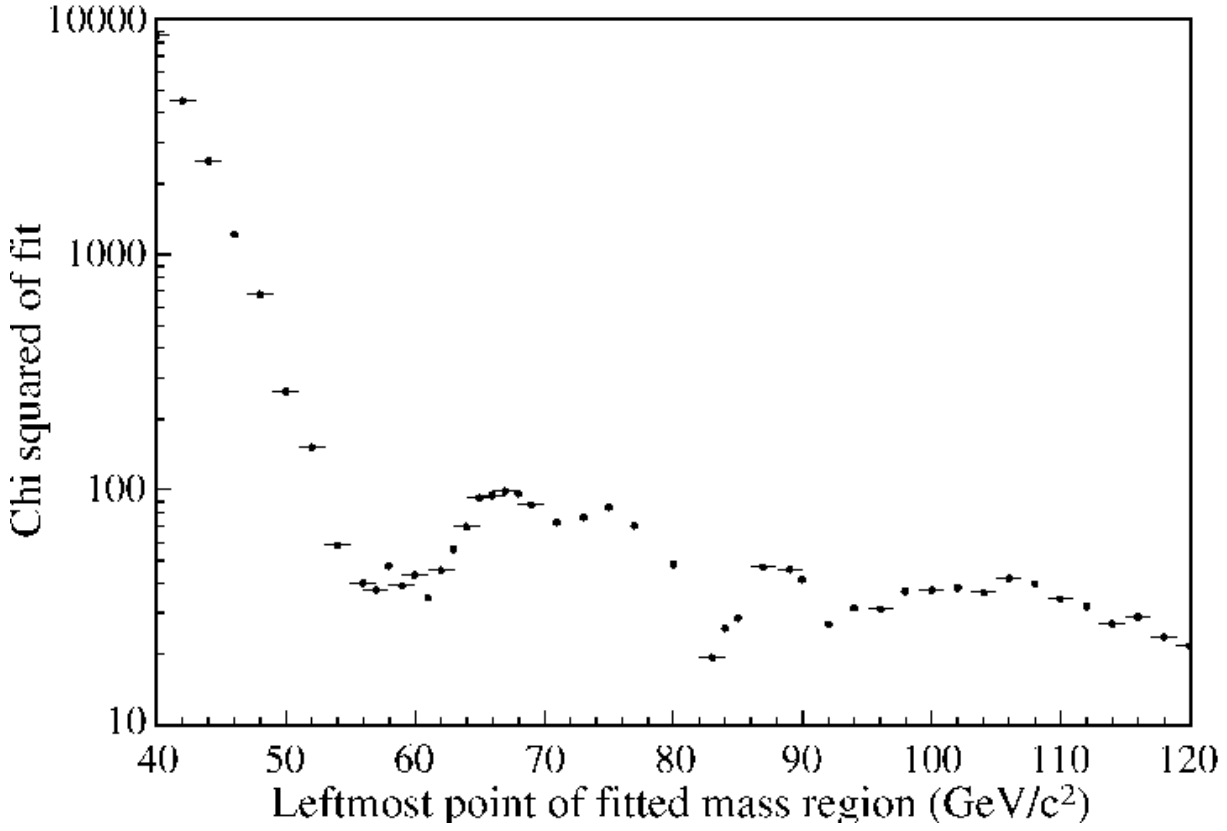
Initial Search Procedure

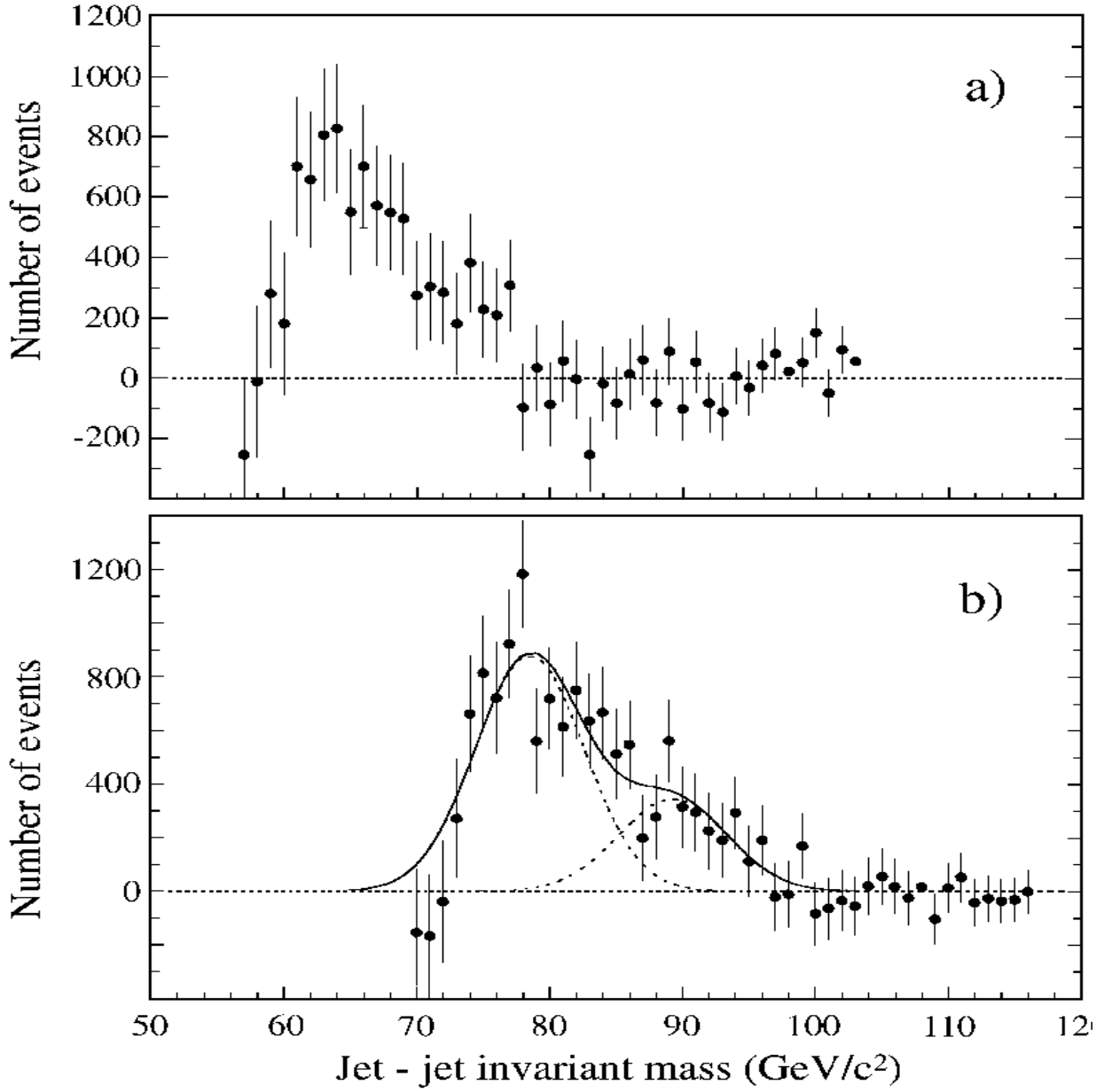
- How well is background described by an exponential in a limited dijet mass region (~50 GeV/c^2) ?
- Fit **3 points left** of expected signal region and **20 points right** of expected signal region.



Initial Search Procedure

χ^2 values for many such fits.





Method I
(raw data)

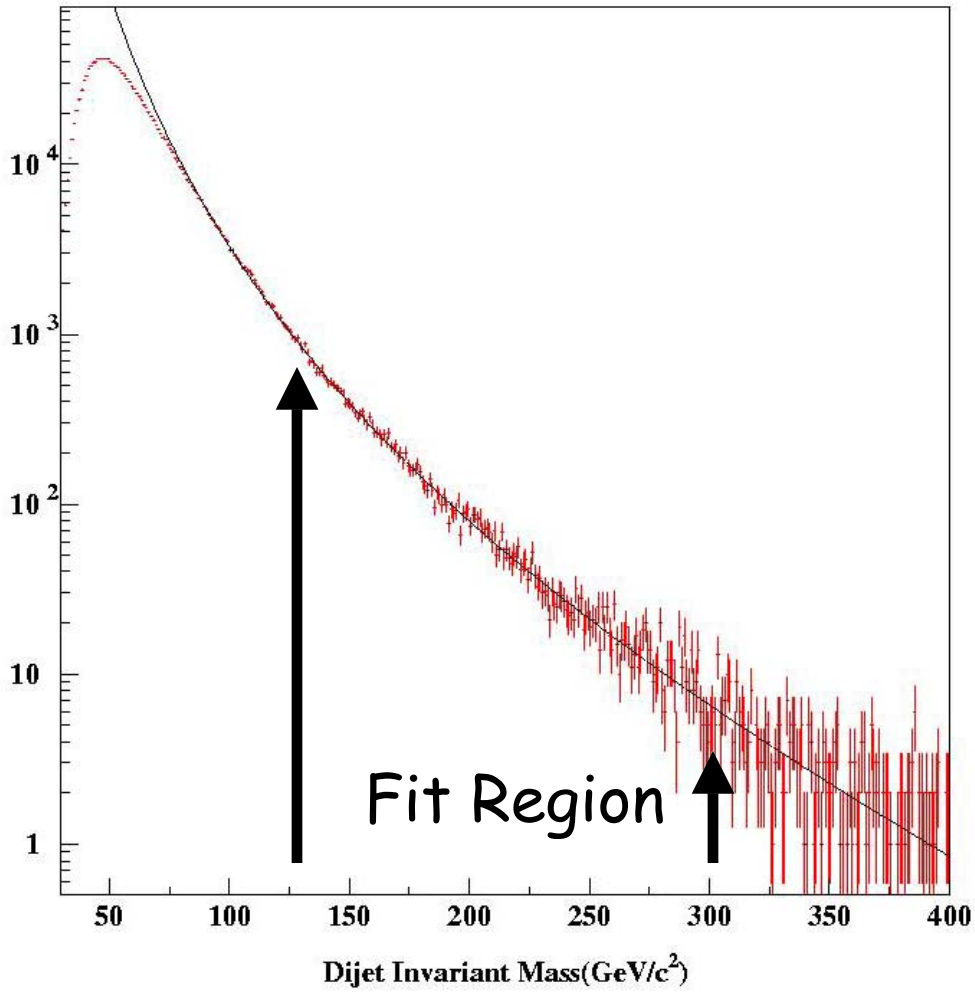
Method III

Preliminary Conclusions

- There seems to be an excess over background.
- Excess occurs at 60-75 GeV/c^2 mass region in raw data.
- When our jet correction is applied, excess shifts to W/Z mass region.
- Double-peak structure: W/Z ratio ~ 3/1, peaks are separated by ~10 GeV/c^2.
- To determine a cross section, we need to know the trigger efficiency…

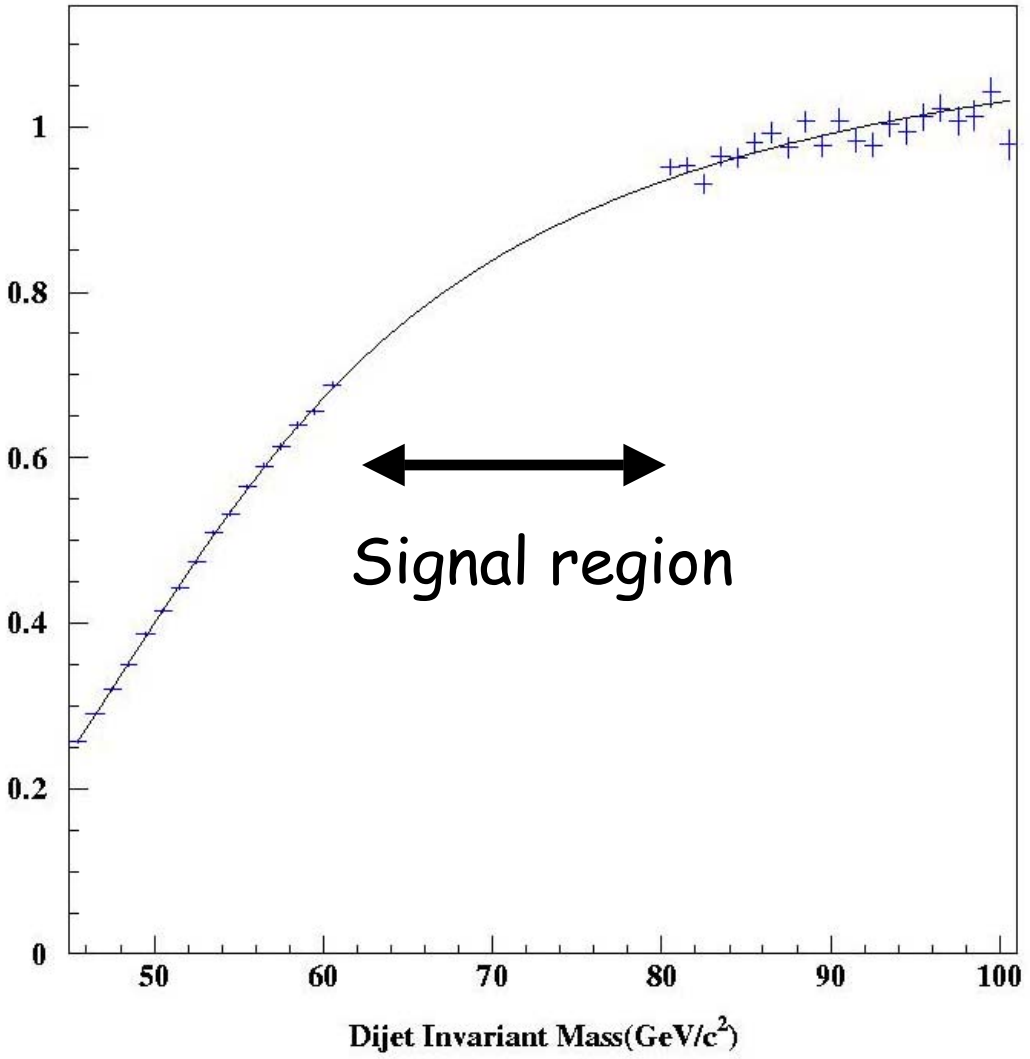
Background Fit

- Fit spectrum where
  - Expect no signal
  - Trigger efficiency is 100%
- Divide original data by background fit to find trigger efficiency curve

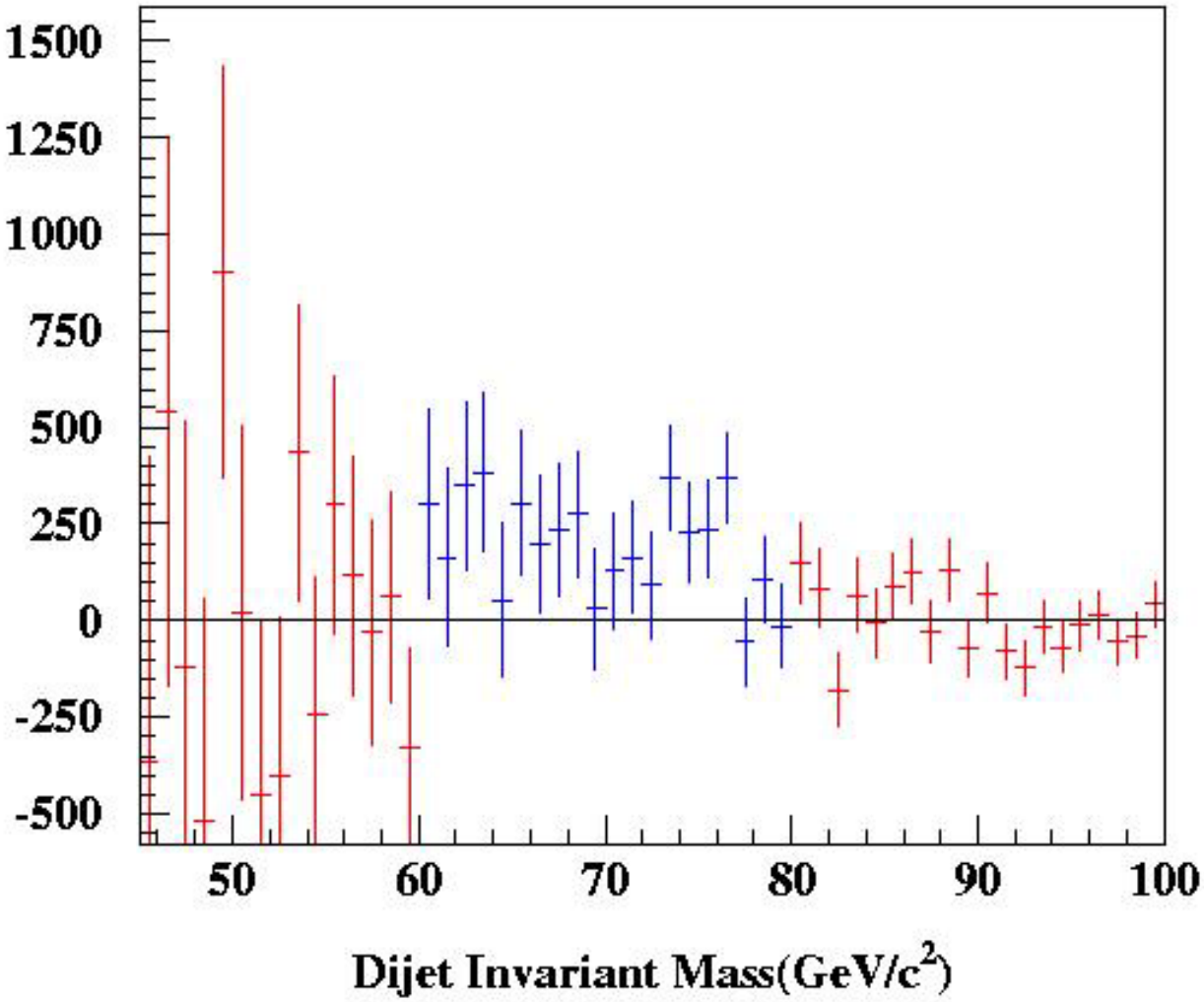


Trigger Efficiency

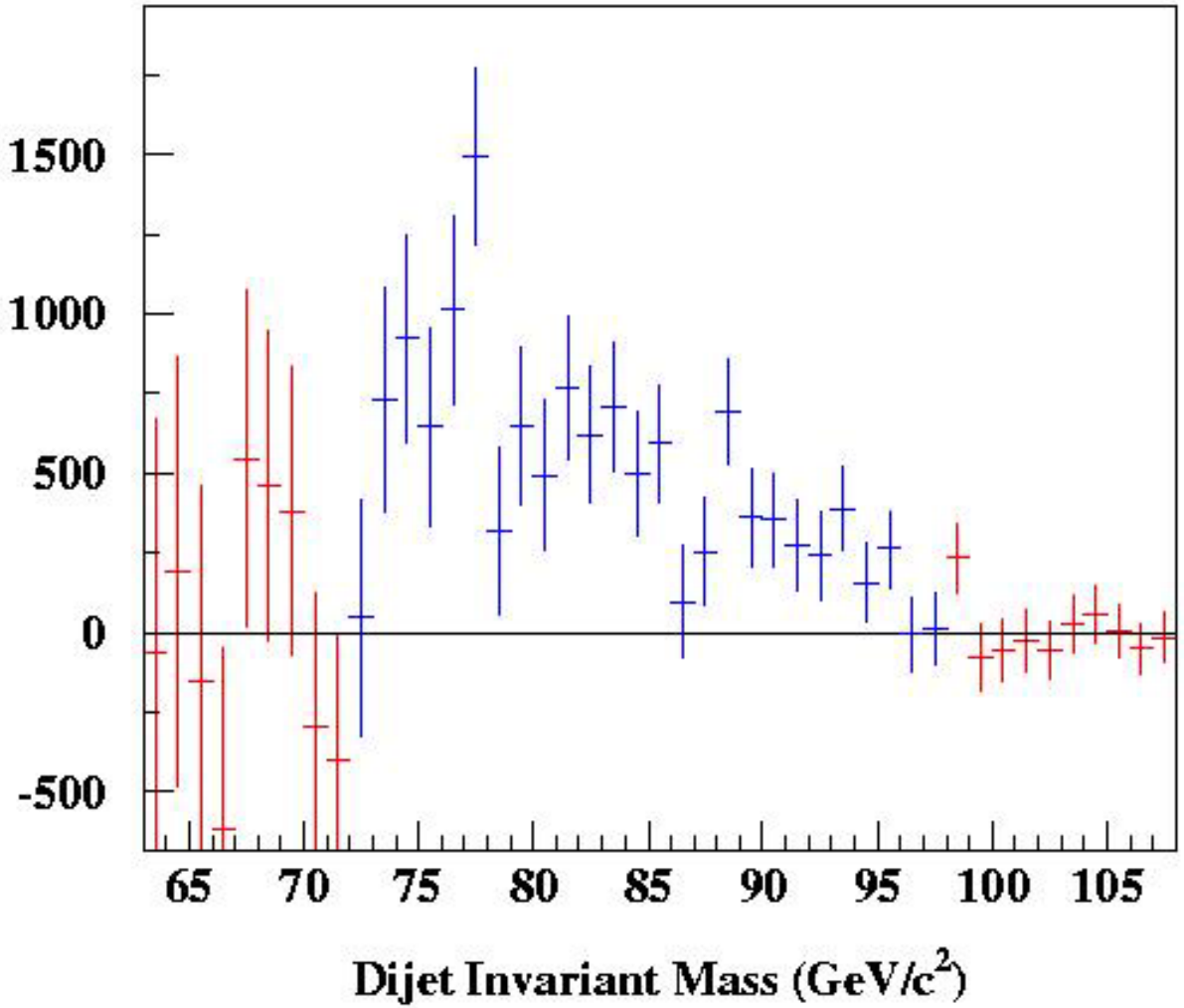
- 70-90% efficient in signal region
- Fit curve with atan and tanh functions
- Divide original data by trigger fit to find trigger-corrected dijet mass spectrum



Typical Example of Residuals-- Raw data



Typical Example of Residuals -- Method III



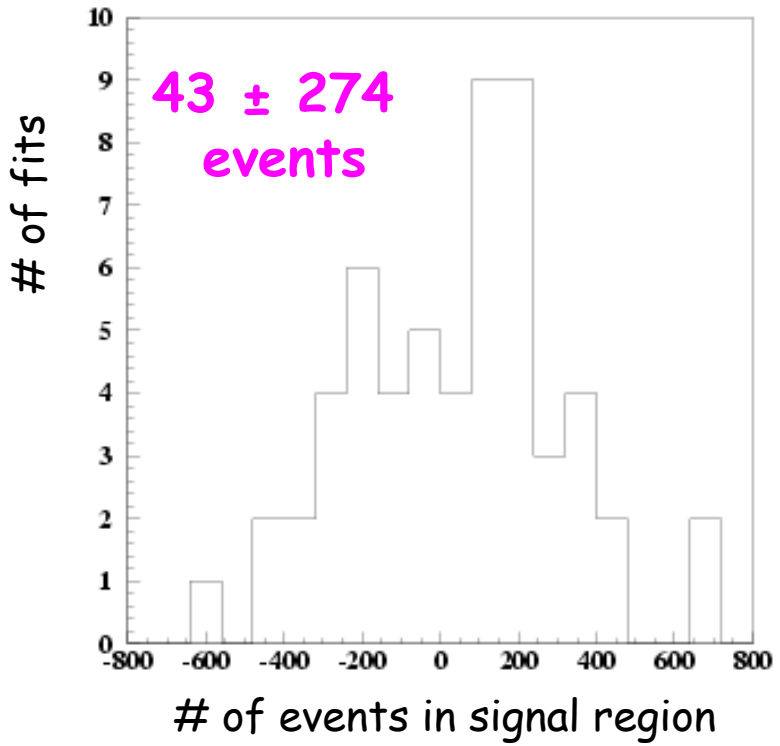
Results

- Fit trigger efficiency curve in many different ways
  - Function (atan or tanh)
  - different numbers of points on left and right of signal region
  - Fit procedure (chi-squared or likelihood)
- Raw Data
  - 43 measurements
  - Average signal = 3670 events
  - RMS = 1300 ← **Systematic error**
- Method III
  - 112 measurements
  - Average signal = 9870 events
  - RMS = 3950 ← **Systematic error**

Check of method

- Looked in raw dijet mass spectrum for signal in region where we would NOT expect it
- 57 fits with $\chi^2 < 1.1$
- Mean = 43 event
- RMS = 274 events
- Consistent with zero

Residuals



Results

- Event selection efficiency = 14.6%
- Cross section times hadronic branching ratio

$\sigma \cdot B(W,Z \rightarrow \text{jets}) = 35.6 \pm 14.2\ (sys) \pm 4.1\ (stat)$ nb

- Standard Model prediction:

$\sigma \cdot B(W,Z \rightarrow \text{jets}) = 20$ nb

Results

- UA2 quoted a cross section 1.5 s.d. larger than $O(\alpha_s^2)$ calculation.
- The ratio

$$R = \frac{\sigma \cdot B(W, Z \to q\bar{q})}{\sigma \cdot B(W \to e\nu) \cdot \frac{\Gamma(W \to q\bar{q})}{\Gamma(W \to e\nu)} + \sigma \cdot B(Z \to ee) \cdot \frac{\Gamma(Z \to q\bar{q})}{\Gamma(Z \to ee)}}$$

  is expected to be unity in the Standard Model.
- **UA2 quoted R = 1.71 ± 0.45**
- **This analysis: R = 1.74 ± 0.72**