

# A New GTT Based Low Q<sup>2</sup> DIS Trigger for the ZEUS Experiment and MVD Residual Studies

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27/6/2005

1st Year Transfer Talk

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#### Introduction to ZEUS

- One of two general purpose detectors at the HERA e<sup>±</sup>p collider, DESY.
- HERA collides 920 GeV protons with (currently) 27.5 GeV electrons to yield a centre of mass energy of 318 GeV.



# **Trigger Study Motivation**

- ZEUS has a 3-level trigger system.
- As the luminoisty at HERA increases the rate of the triggers is getting closer to the maximum allowed rate.
- Once the trigger rates become high enough it is expected that the cut on the photon virtuality (Q<sup>2</sup>) of DIS events will be raised.
- $\Rightarrow$  need new trigger to avoid loss of interesting events.
- Try to use "new" Global Tracking Trigger to improve on existing trigger efficiencies and rates.
- Start by looking at current NC DIS trigger GTT04 ("copy" of logic from older CTD sub-trigger). Try to optimise for low Q<sup>2</sup> events.
- The GTT04 logic comprises several calorimeter energy cuts and tracking cuts.

#### **Sample Selection**

- In order to design a new trigger we need to be able to predict its efficiency and rate. This requires a sample of DIS D\* events and a "passthrough" sample.
- D\* sample has 1911
  events which have Q<sup>2</sup> of <</li>
  10 GeV<sup>2</sup>. These are
  represented by the area
  under the peak to the right.
- Passthrough sample is composed of events that pass the calorimeter cuts but do not have any D\* candidates (~85000 events).



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### Trigger Variable Plots (1)

The sum of the highest 2  $P_t$  tracks is not used in the new trigger

Vertex z position. Not used in new trigger. Shows good distribution about 0



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### Trigger Variable Plots (2)

Number of vertexed tracks. Kept at >=2 in new trigger.



Number of found tracks. >=5 in existing trigger. Set to >=3 in new trigger.



### Trigger Variable Plots (3)

Another GTT based trigger (GTT03) uses an algorithm cut on the  $P_t$  sum of the vertex tracks.

The new trigger has a cut on this variable at 3. (Not used in original GTT04)



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# **Trigger Logic**

- The original trigger had the following logic:
- Remc >2.5 or Bemc >2.5 or Fhac >10 or Femc>10
- E-Pz (+ 2\*Elumig) >27
- Transverse energy of scattered electron > 4
- -40 cm < zvtx < 80 cm
- no of vertex tracks >= 2 .and. no of found tracks >=5 .and.
- (no of found tracks >= 16 .or. sum of two highest pt tracks > 0.8 )
- The new trigger has the same energy cuts but the following tracking logic:
- No of vertex tracks >=2 .and.
- No of found tracks >=3 .and.
- P<sub>t</sub> sum of vertex tracks >3 GeV

## **Trigger Performance**

 The three triggers have the performance characteristics seen to the right. HFL07 in high lumi shown in brackets

 Small increase in efficiency by using new trigger over GTT04 and a 44% decrease in the amount of events let though the tracking cuts (after they have passed the energy cuts).

• The efficiency may not seem that good but the important thing is the correlated efficiencies...

	HFL07	GTT04	GTT04 (mod)
% D* kept	95.7 (93.5)	94.0	96.4
% pass- through kept	65.2 (56.5)	45.6	25.5

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#### **Correlated Trigger Performance**

Trig fired	D* %	Pass %
GTT1	0.7	14.5
GTT3	1.0	1.7
GTT4	3.1	2.0
1 & 3	1.1	1.2
3 & 4	2.1	0.7
1 & 4	35.9	14.5
none	0.8	58.3
all	55.4	6.9

- The table to the left shows the efficiencies and rates for the correlated triggers.
- The main points concerning the new GTT04 are:
- 3.1% of D\* fire this trigger alone.
- For this increase in efficiency you only gain an additional 2% in unique rate.
- Only 0.8% of the low Q<sup>2</sup> D\* sample is missed by these 3 triggers together

## Trigger Study Summary

- A new GTT based trigger has been designed and implemented in anticipation of very high lumi running.
- The New trigger has an efficiency of 96.4% and rejects 74.5% of a passthrough sample that passes the non-tracking cuts.
- The rate of the new trigger is expected to be ~1/2 of the existing HFL07 rate.
- When the new trigger is used in conjunction with the two existing HFL GTT triggers 99.2% of the D\* sample is kept, 3.1% of this is unique to GTT04(mod).
- As of last week the trigger has been running during ZEUS data taking.

### MVD Residual Study - The ZEUS MVD

- The ZEUS MVD consists of barrel and forward regions. The barrel consists of 3 cylindrical superlayers made of a total of 600 square silicon strip sensors.
- Half of these sensors measure in the r-ø direction and the other half in the r-z.
- The forward region contains 4 wheels made from 112 trapazoidal sensors.



### **Motivation**

- In order to realise the potential of the ZEUS MVD it is necessary to know the exact physical position of the individual sensors.
- Previous alignment work has been carried out using cosmic tracks to minimise the hit residuals by iteratively altering the MVD geometry.
- Residuals are the distance between the sensor hit and the intersection of the reconstructed track with the sensor.
- If the detector is well aligned the distribution of these residuals will be a narrow Gaussian about zero.
- Cosmic alignment is limited by the relatively small number of cosmic tracks and the fact that these tracks are incident at grazing angles to the sides and forward wheels of the MVD ⇒ Use tracks from physics events.

### The Effect Of Cosmic Alignment (1)



• The effect on the residuals for the r-ø sensors is striking.

- The mean of the distribution has shifted from -0.0015 cm to ~0 cm.
- The  $\sigma$  of the Gaussian has also decreased by ~30%.
- •Similar changes are seen for the r-z sensor distributions.

### The Effect Of Cosmic Alignment (2)



• Even though the wheels have not been aligned using cosmics the residual distribution are improved due to the more accurate reconstruction of the tracks in the barrel regions.

• The offset in the mean is still an order of magnitude larger than the barrel offsets.

• The aligned distributions are optimistic as all tracks in the forward region have relatively few constraints meaning that tracks are strongly pulled toward MVD hit clusters.

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### The Effect Of Cosmic Alignment (3)

• Due to the limitations of the cosmic alignment not all of the barrel residual distributions are improved.



• Although the mean is improved after alignment the width of the distribution is unchanged  $\Rightarrow$ poor resolution.

## Comparison of Cosmic and Physics Residuals



•The excesses in the central bins and the tails can be seen in both of the distributions. These features are considerably enhanced in the physics tracks.

•Central bin excess probably due to inclusion of tracks with few MVD hits  $\Rightarrow$  poorly restrained and are pulled toward the hit cluster

### **Future Plans**

- Now that it has been confirmed that physics track residuals have a broadly Gaussian distribution it is possible to use a similar alignment method to that used for cosmics.
- The first step is to check the z-position of the forward wheels. This can be done by using the physical position of 3 r-ø and 2 rz barrel hits to reconstruct a helix unbiased by the nominal wheel position.
- Any non-zero mean observed in the resulting residual distribution would indicate a mis-alignment in the wheels.
- Eventually hope to use similar alignment for the barrel in order to move toward the design resolution of the MVD.