Determining sampled luminosity in proton-proton collisions at $\sqrt{s}$=500GeV at STAR using the vernier scan technique

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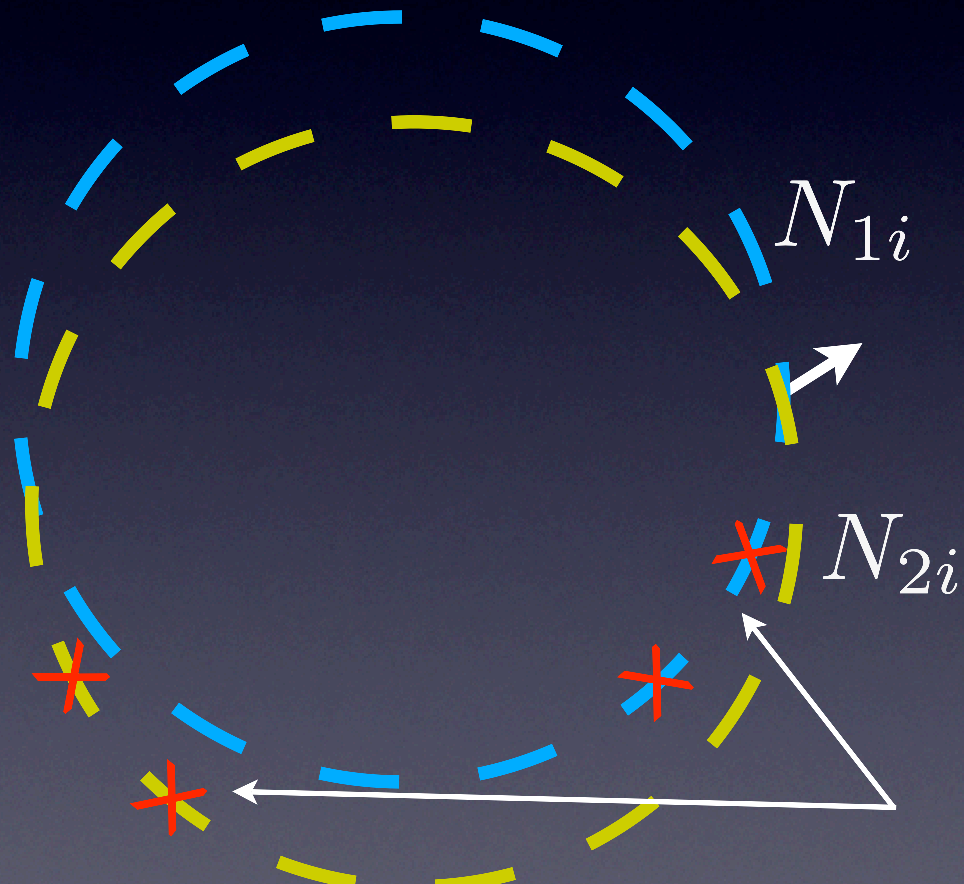
on behalf of the STAR collaboration

Outline

- The vernier scan technique
- Details of the vernier scans at STAR
- Computing luminosity
- Application to W cross section
- Conclusions

Rate in a Circular Collider



$$R = \sigma \frac{1}{\Delta t} \frac{N_1 N_2}{A}$$

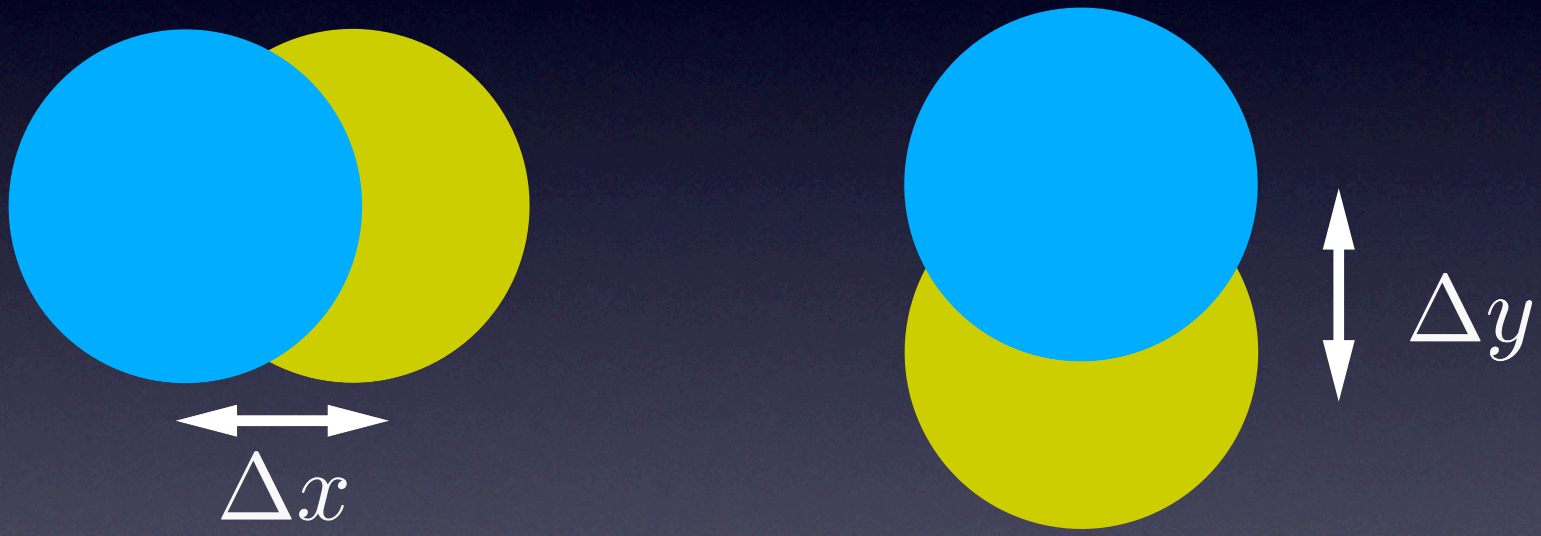
$$R = \sigma\, f_{rev} \Sigma_i \left(\frac{N_{1i}\, N_{2i}}{A_i} \right)$$

Frequency of revolution

Empty bunches for abort gap

The Vernier Scan Technique

$$R = \sigma\, f_{rev}\, \Sigma_i \int dA \frac{dN_{1i}}{dA}(x,y)\frac{dN_{2i}}{dA}(x+\Delta x, y+\Delta y)$$



$$\mathcal{L} = \frac{R}{\sigma}$$

Vernier Scan Model

- Event rate is a function of the cross section and the overlap integral of colliding beams
- Assuming gaussian beam profiles,

$$R(\Delta x, \Delta y) = \sigma \times (\text{beam params}) \times exp(\frac{-\Delta x^2}{2\sigma_x^2}) \times \ exp(\frac{-\Delta y^2}{2\sigma_y^2}) + \ R_{bkg}$$

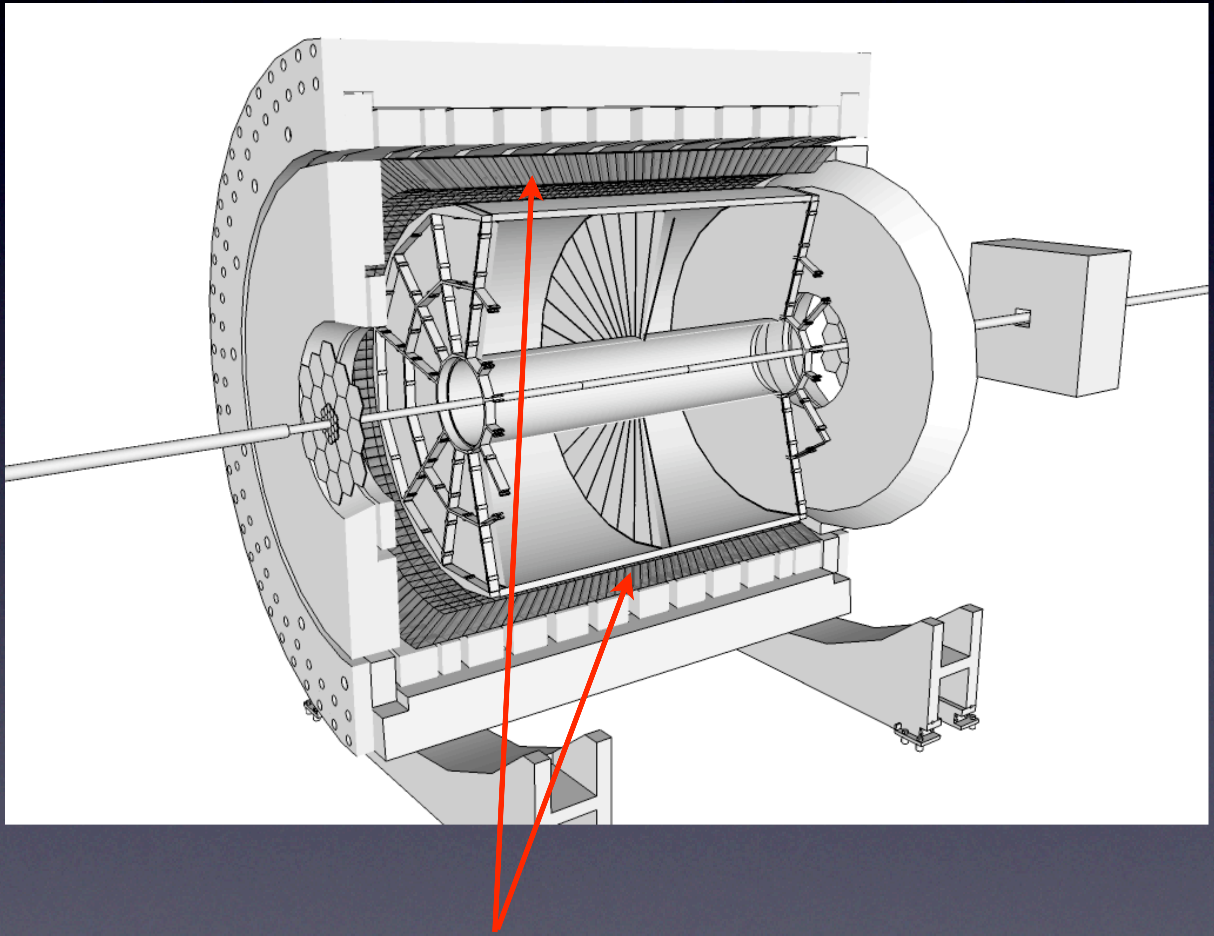
calculable beam parameters

relative position of beams

gaussians from overlap integral

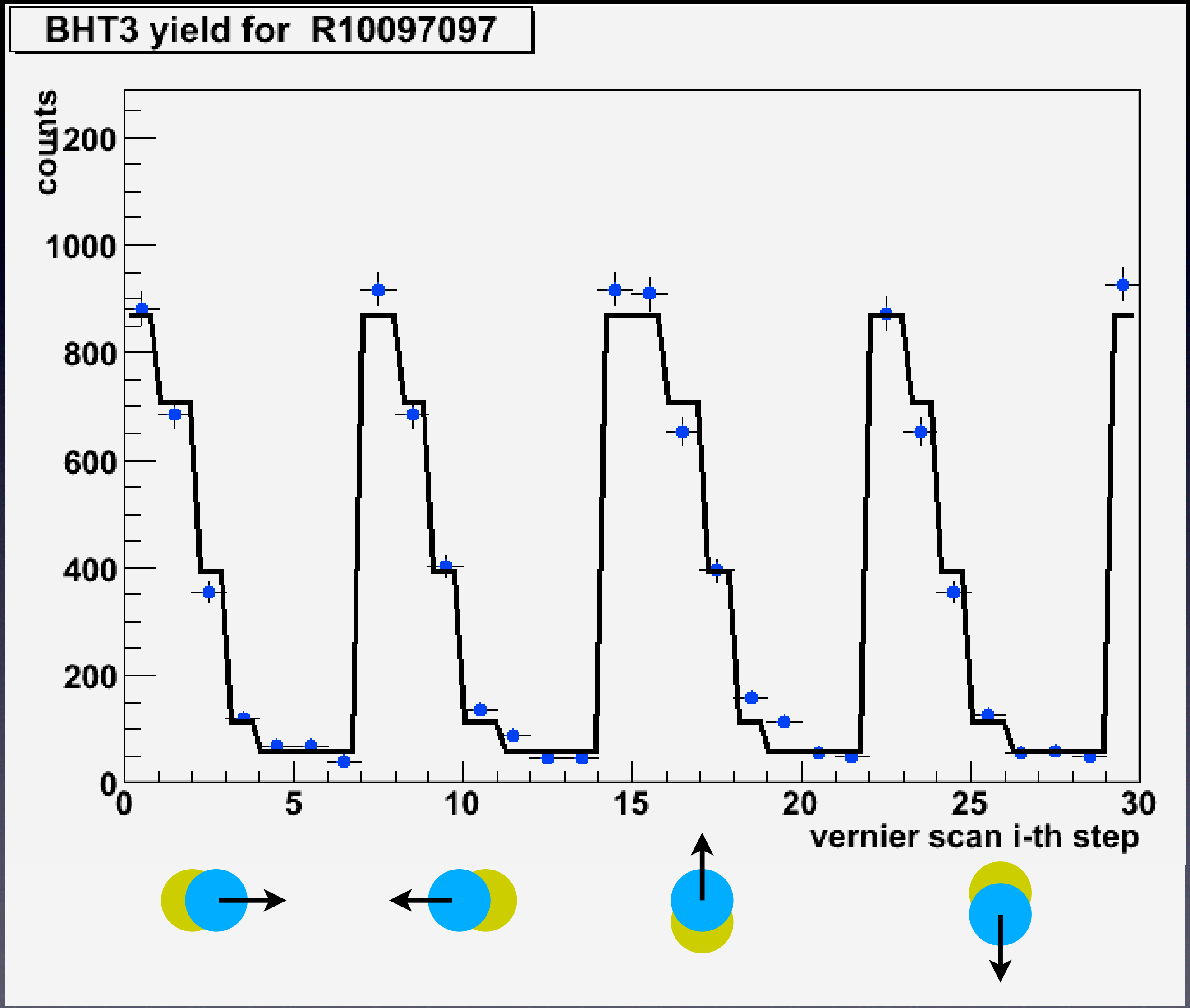
The Barrel Calorimeter

- Barrel calorimeter $-1<\eta<1$ with 4800 towers
- Barrel High Tower 3 (BHT3) trigger required 13 GeV transverse energy in a single tower

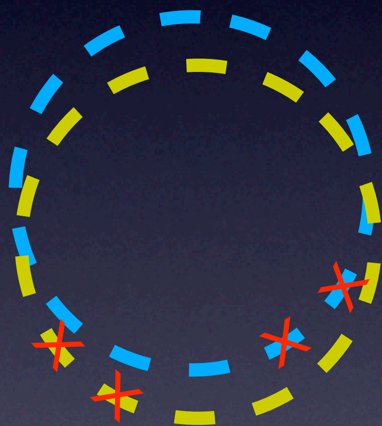


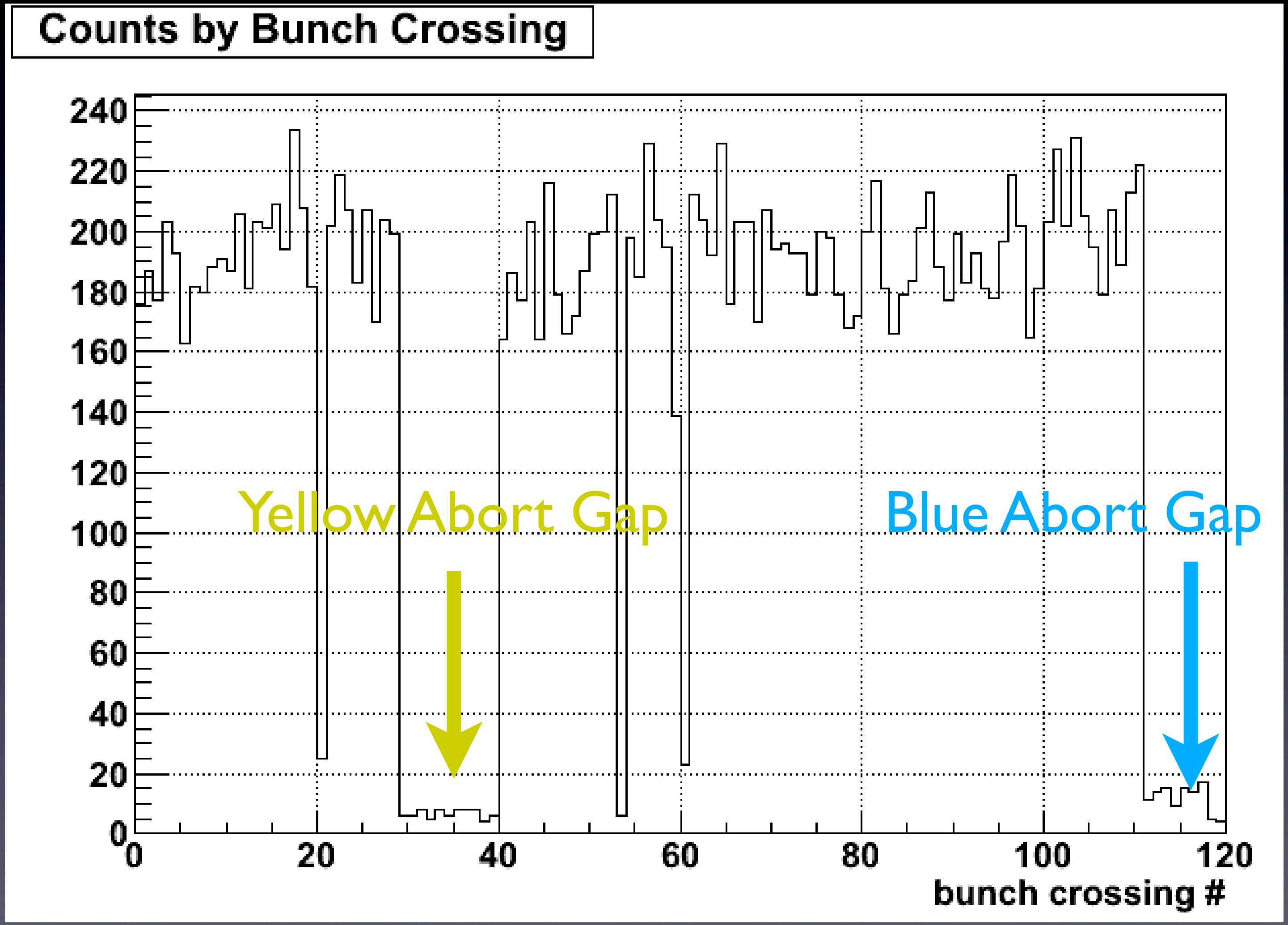
Barrel Calorimeter

Vernier Scans at STAR



Checking the Background





Cross Section Results

- Correcting for small variation of the BHT3 efficiency in each of the two runs, the final average cross section for the BHT3 is:

$$\sigma_{BHT3} = 481\,\mathrm{nb} \pm 10(\mathrm{stat}) \pm 110\,(\mathrm{syst})$$

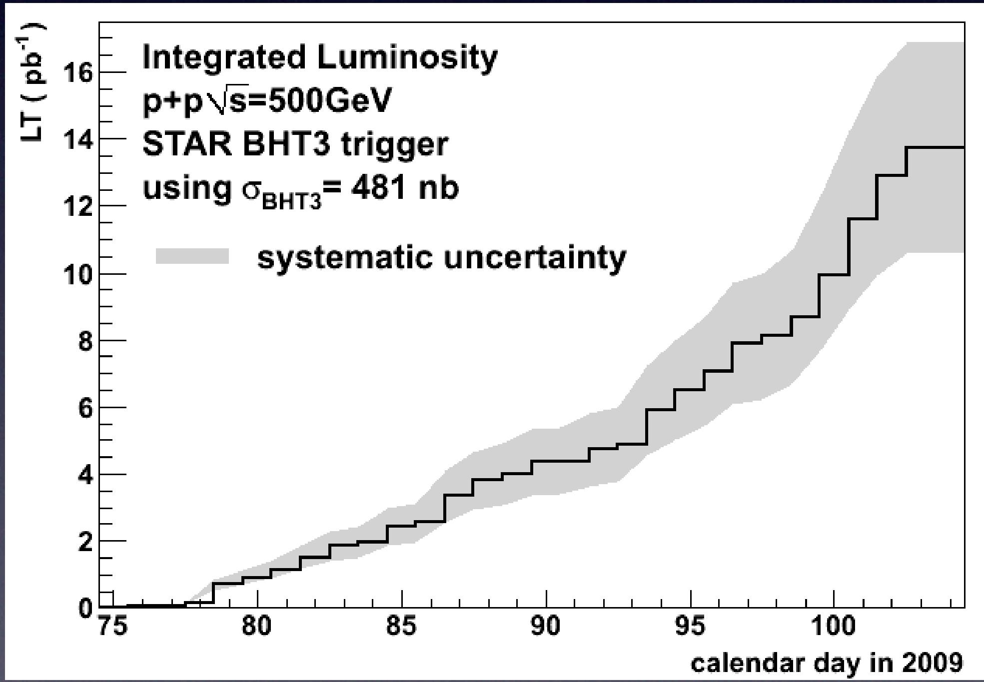
- The largest contribution to the systematic error (60nb) comes from non-gaussianity in the tails of the vernier scan data.

Computing Luminosity

- In each run that included the BHT3 trigger, we determine the background rate by scaling the event rate in the abort gaps

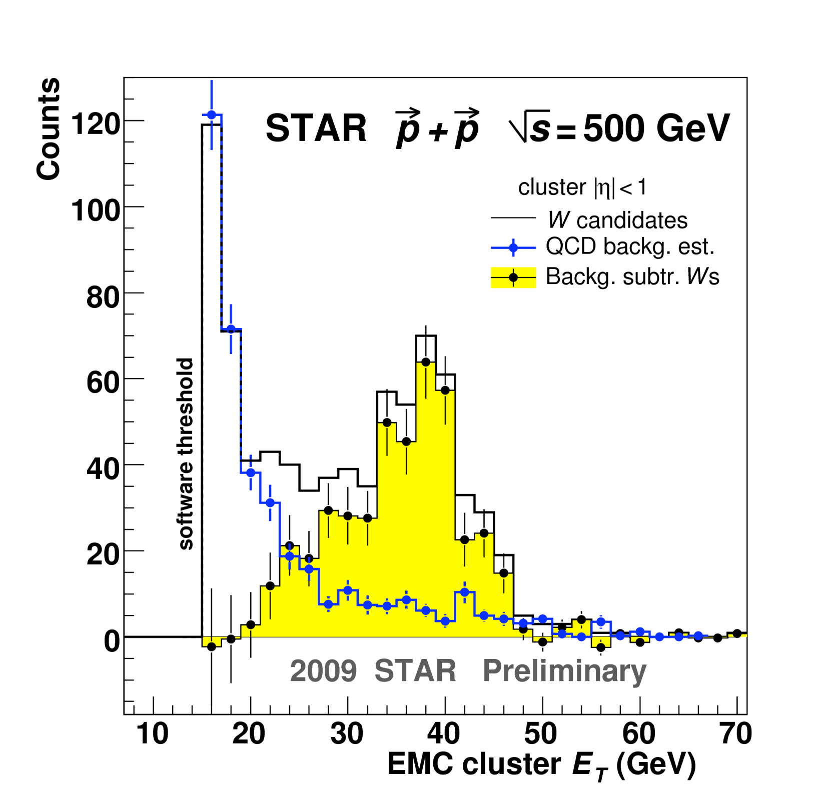
- Background-subtracted event rate is then corrected for run-dependent efficiency

- Scaling by $1/\sigma_{BHT3}$ yields the luminosity per run in pp500



Application to W Cross Section

- This luminosity will now be used to compute the first W cross section at 500GeV



(See talk by Justin Stevens, X11.00009: Measurement of the Cross Section for W Boson Production at √s=500GeV at STAR)

Conclusions

- The vernier scan technique was successful in determining the BHT3 trigger cross section
- Crucial component of the W cross section
- Better modeling of the beam profile should reduce systematic uncertainty.
- Technique can be extended to any desired STAR trigger for future runs