Trigger on minimum bias p+p run

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Problem

- We do not have a good trigger device for p+p collisions at 200 GeV and 130 GeV (if RHIC runs for comparison data for this year's Au+Au run)
- It has been well known that the trigger efficiency of BBC (N*S) is low for p+p minimumb bias collisions
  - Study by H. Ohinishi
  - Trigger efficiency was found to ~50 % at 200 GeV (PYTHIA)
    - Trigger efficiency at 130 GeV should be lower
- The cause the low trigger efficiency is that the BBC coverage ($3.05 < \eta < 3.85$) is not large, and expected number of charged particle in the acceptance is only ~1.5 (see next slide)
- Triggering with BBC can introduce a bias that selects only high multiplicity p+p collisions.

Pseudorapidity Distributions in $\overline{p}p$ Interactions

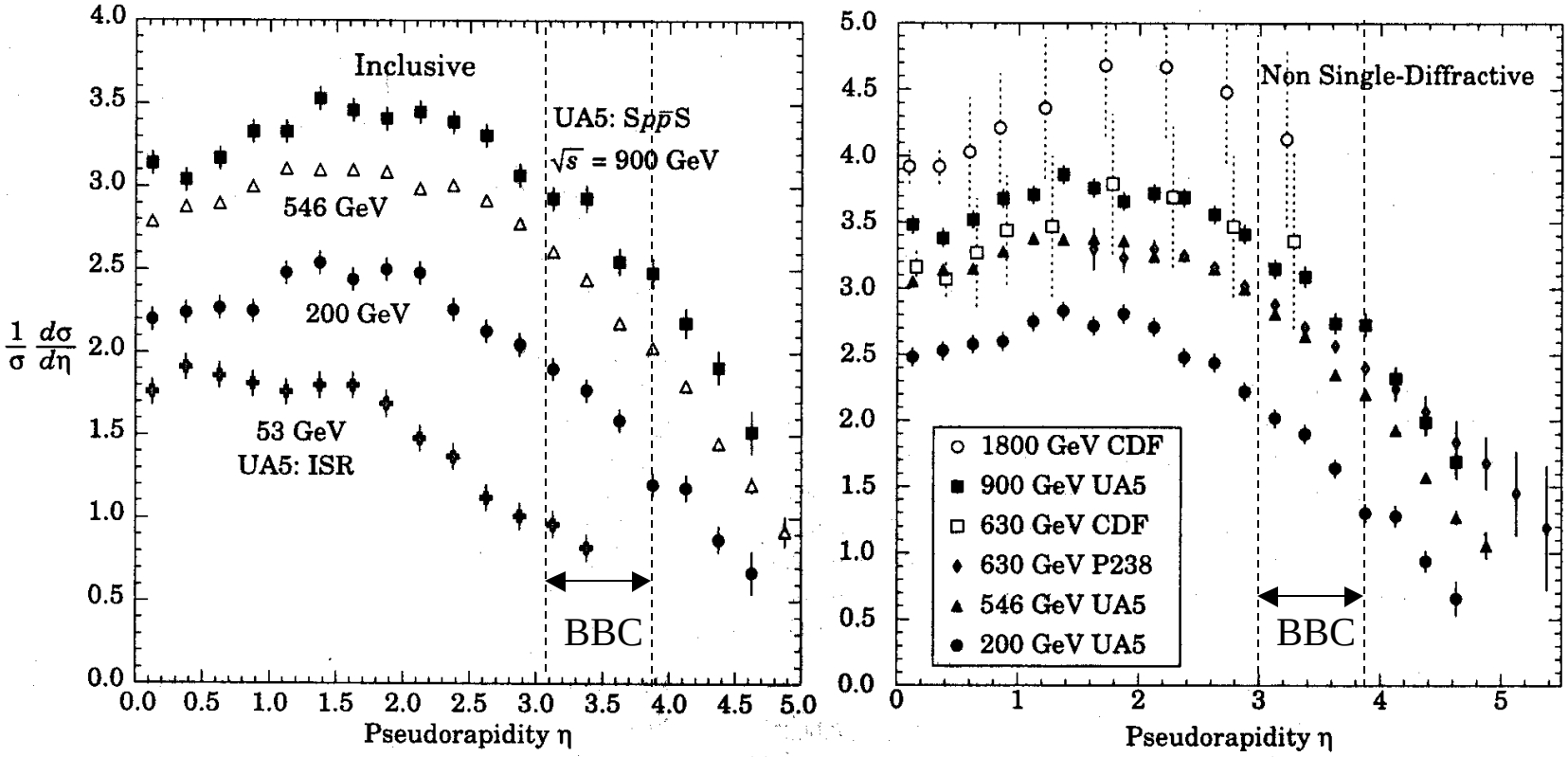

Figure 37.10: Charged particle pseudorapidity distributions in $p\overline{p}$ collisions for 53 GeV $\leq \sqrt{s} \leq$ 1800 GeV. UA5 data from the S$p\overline{p}$S are taken from G.J. Alner *et al.*, Z. Phys. **C33**, 1 (1986), and from the ISR from K. Alpgøard *et al.*, Phys. Lett. **112B**, 193 (1982). The UA5 data are shown for both the full inelastic cross-section and with singly diffractive events excluded. Additional non single-diffractive measurements are available from CDF at the Tevatron, F. Abe *et al.*, Phys. Rev. **D41**, 2330 (1990) and Experiment P238 at the S$p\overline{p}$S, R. Harr *et al.*, Phys. Lett. **B401**, 176 (1997). (Courtesy of D.R. Ward, Cambridge Univ., 1999.)

Why it is a problem

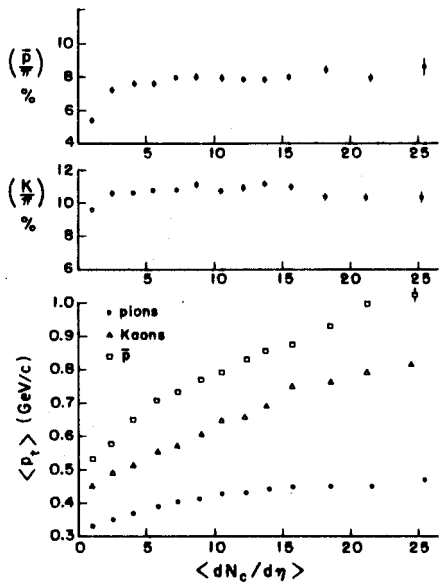

FIG. 19. Average transverse momentum, $\langle p_t \rangle$ and K/π and $\bar{p}/\pi$ ratios as a function of charged particle density ($dN_c/d\eta$). Systematic errors are not shown in the figure but given in Tables II(a) and II(b).

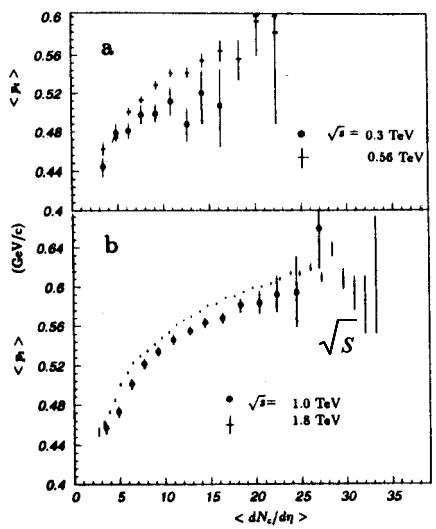

Fig. 2. $\langle p_t \rangle$ as a function of event charged multiplicity for four different center of mass energies. The particle density ($\langle dN_c/d\eta \rangle$) is calculated by dividing N_c by 6.5. The $\langle p_t \rangle$ is calculated with particles with $0.15 < p_t < 3.0$ GeV/c.

Multiplicity dependence of particle production measured by E735 (C0) at Tevatron collider at 0.3, 0.54, 0.9, and 1.8 TeV.
T. Alexopoulos et. al. , PRD48(1993)984
T. Alexopoulos et. al., PLB336(1994)599

- We need a high quality comparison data in p+p to understand our Au+Au collisions data.
- It is known that particle production at high energy has a strong multiplicity dependence. The average transverse momentum <Pt> and pariticle ratios (p/π, K/π) changes significantly with dN/dη. (AFS, UA1, E735)
- Triggering with the present BBC can introduces a bias which we do not understand and we can not correct for.

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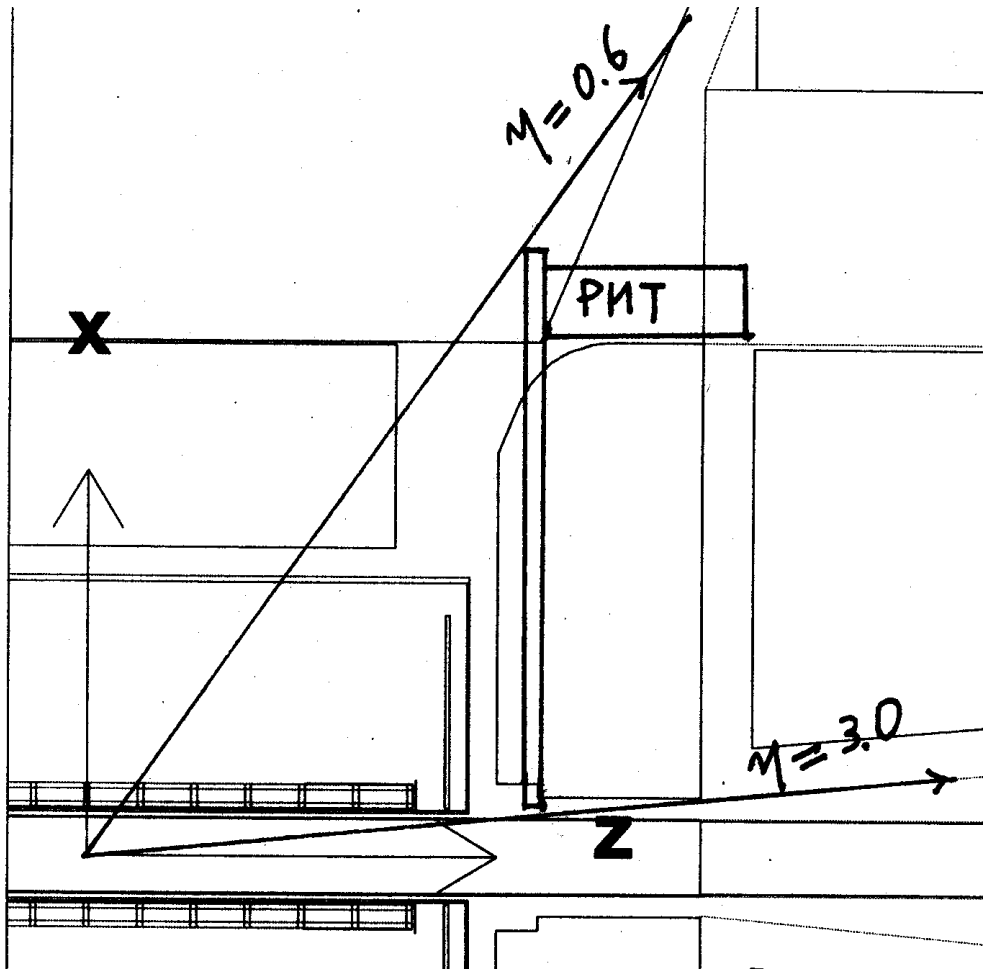
“Do Nothing” solutions

- We can take data with beam crossing trigger.
  - This is a possibility if RHIC delivers 100% of design luminosity. The interaction rate at L = 0.8 x 10^{30} cm^{-2}/s is about 300 kHz, or 6 % of beam crossing (5 M Hz). Not good, but not terribly bad.
  - However, it is probably too optimistic to ask for 100% luminosity at the first p+p year. If Au+Au case is the guide, we can expect less than 1% at the beginning, and 5 – 10 % at the end. In this case, beam crossing trigger is not an acceptable solution.
- Trigger on one side of BBC
  - Requiring only one side of BBC should have ~80-90% efficiency for p+p minimum bias collisions.
  - It triggers on beam-gas event. The beam-gas interaction rate with 10^{-9} torr vaccuum is about 20 kHz (10 kHz per 10 m beam) at design beam current (10^9 proton per bunch with 60 bunch per beam). S/B is > 10 if design luminosity is reached, but can be <1 at the beginning. BBC singles rate can also be a problem. (Note that multiplicity requirement for BBC LL1 should be 1 for p+p collisions).
  - How to distinguish beam-gas event and beam-beam event? In most cases, one or zero track is recorded in the central detector. (Full coverage of MVD will help on this).

Possible p+p trigger counter (I)



- Place a layer of scintillation counters on the surface (or inside) of the nose cone.
- Read-out by meshed dinode PMTs. (D0 RUN-II monitor use R-408, which works at 1 Tesla field in a similar geometry)
- Good acceptance (0.6<h<3.0) and high efficiency for p+p collision is possible
- Problem:

  No space is left between MVD and the present nose cone.

  This means that we need to modify the nose cone to install the counter. (1 week of work at the IR + shop works)

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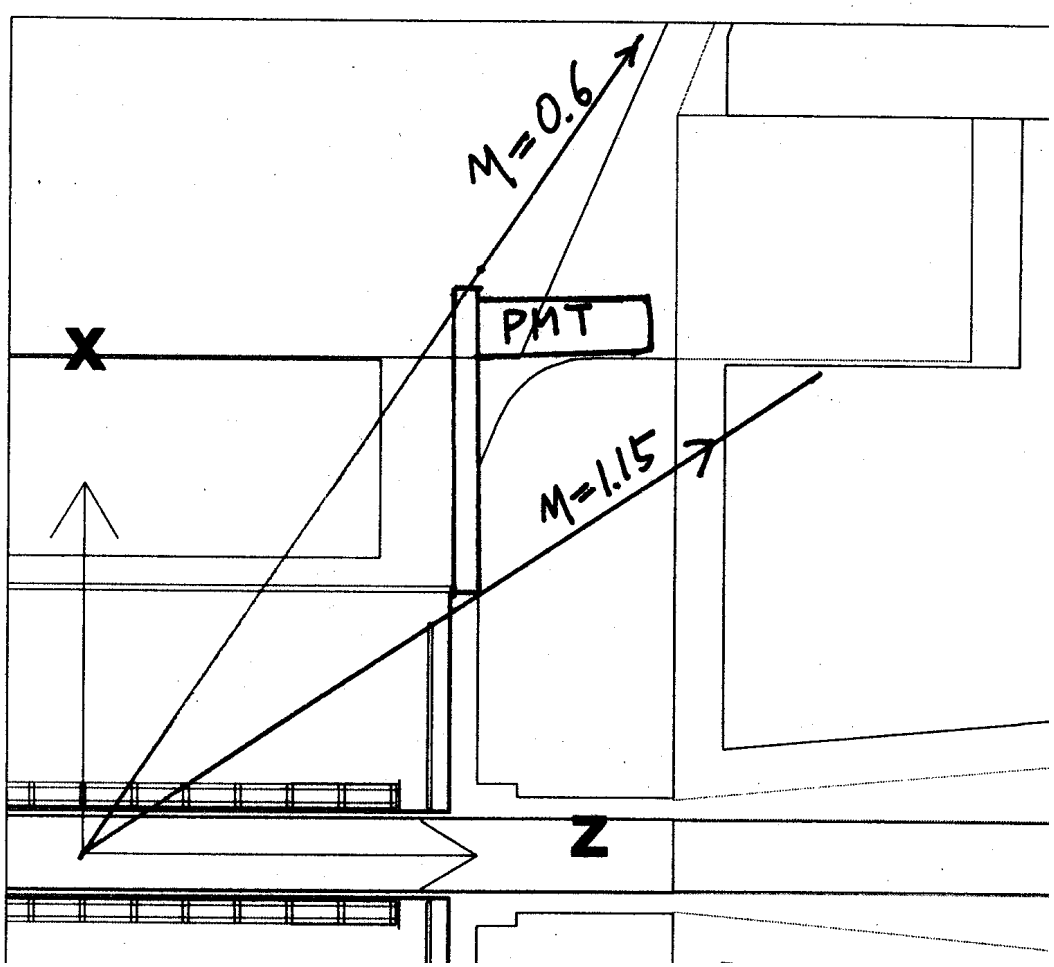
Possible p+p trigger counter (II)



Place the Scintillation counter paddles just outside of the MVD

+ Mechanically feasible
- Acceptance is small ($0.6 < \eta < 1.15$) and trigger efficiency is low.

However, the combined Trigger efficiency with the BBC can be acceptable.

Efficiency can be increased by adding a photon converter (~1 X0) to detect photons.

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Trigger efficiency estimate

- Use PYTHIA (p+p at 130 GeV and 200 GeV). Select Non Single Diffractive (NSD) events.
- Counts number of charged particles and photons in 3.05<h<3.85 (BBC) and 0.6<h<1.15 (Additional Trigger Counter) to estimate the trigger efficiency. (No GEANT Monte Carlo)

- Results

	130 GeV	200 GeV
BBC_N & BBC_S	40 %	45 %
(BBC_N | ACT_N)&(BBC_S | ATC_S)		
w. no photon detection efficiency	70 %	75 %
w. ATC photon efficiency 70%	79 %	82 %
w. ATC and BBC photon efficiency 70%	85 %	87 %

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Summary

- We do not have an efficient trigger detector for p+p collisions
- The trigger with BBC can introduce an bias that we do not understand, and it will reduce the value of “comparison data”.
- Additoinal trigger detector on the surface of the nose-cone can be a good trigger detector for p+p. Smaller trigger detetor, just ouside of MVD, can have a sufficient trigger efficiency, if it is combined with BBC and if it can also detect photons (with ~1 X0 converter).

- Need someone to work on this problem, if we want to ready for data taking in p+p collisions in the next year.