DIFFRACTIVE PRODUCTION OF W, Z, TOP, + ??? AT THE SSC

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The SSC with $\sqrt{s}$ = 40 TeV offers us the opportunity to study the Pomeron-proton interaction at enormously large energies. For example, in the reaction

$$P_i P \rightarrow P_f + X \qquad (1)$$

if the Feynman-x of P_f = 0.998, the mass of X is the full 1.6 TeV of the Tevatron. P_f contains the valence quarks of P_i and and X is produced from the interaction of P with a soft color-singlet component of P_i. The possibility to produce very heavy flavors (top or higher ??) as well as heavy vector bosons (W, Z + ??) with the mysterious Pomeron will likely open a new domain of high energy physics.

The purpose of this note is to outline a detector and fix its key parameters. A forward detector with aperture large enough to "catch" all components of the system X (most of the time) will allow a detailed study of the system. In particular, for a relatively modest expense, a modular detector can be built which comprises full particle identification, tracking and momentum measurement, muon measurement, forward microvertex detection and calorimetry.

One signature of the events of interest is a summed longitudinal energy of 20 TeV in coincidence with a recoil proton with Feynman-x near unity in the opposite arm (seen in a silicon detector inside the vacuum pipe, as the Pisa group is doing in CDF). Transverse energy distribution gives the mass of X and simultaneous missing transverse energy signals the presence of neutrinos.

Prior experience with forward detectors at the ISR and planning for the SPS-collider leads us to suggest the configuration for the vacuum pipe, shown in Fig. 1. We note that the vacuum pipe design is a crucial element for such a detector.

The vacuum pipe is a series of 4 conical structures with thin (100 micron or less) stainless steel windows at Z = 1, 20 and 100 meters. Three independent spectrometers follow those windows. Each of these contains tracking chambers, magnet, ring imaging Cerenkov counter (RICH), E.M. and hadronic calorimetry and muon capability. The entire detector length is essentially governed by 3 factors:

(i) the minimum angle we desire to reach (a physics question).
(ii) the closest distance of approach of the vacuum pipe to the beam at the positions of the 3 thin windows (a machine question).
(iii) the necessary length of the RICH counter in spectrometer #3 which must effect particle identification up to 2 TeV (a detector technology question).

We have assumed for (ii) a pipe ID of 4 cm and for (i), somewhat arbitrarily, a θ_{min} = 0.2 mr (corresponding to a pseudo-rapidity of η = 6 in the rest frame of a forward-going 1.6 TeV mass system).

These 2 parameters place the third window at Z = 100 m. The necessary length of spectrometer #3 then fixes the total length of the IR. This last question is answered with reference to a report by Tom Ypsilantis, "Particle Identification at the SSC" which contains Figure 2. It shows the relationship between the momentum at which a 1% misidentification occurs and the length of the radiator. We see that a length < 100m will give us π, K, P separation well over 1 TeV. We conclude that the third spectrometer will require the free space 100 < Z < 200m.

In Table I, the angular acceptance apertures are shown for each spectrometer. Also shown are the

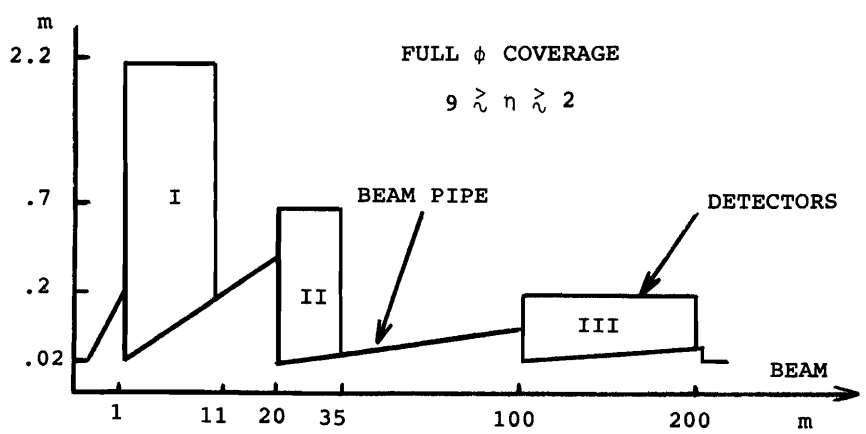

Figure 1
(Note square root scales)

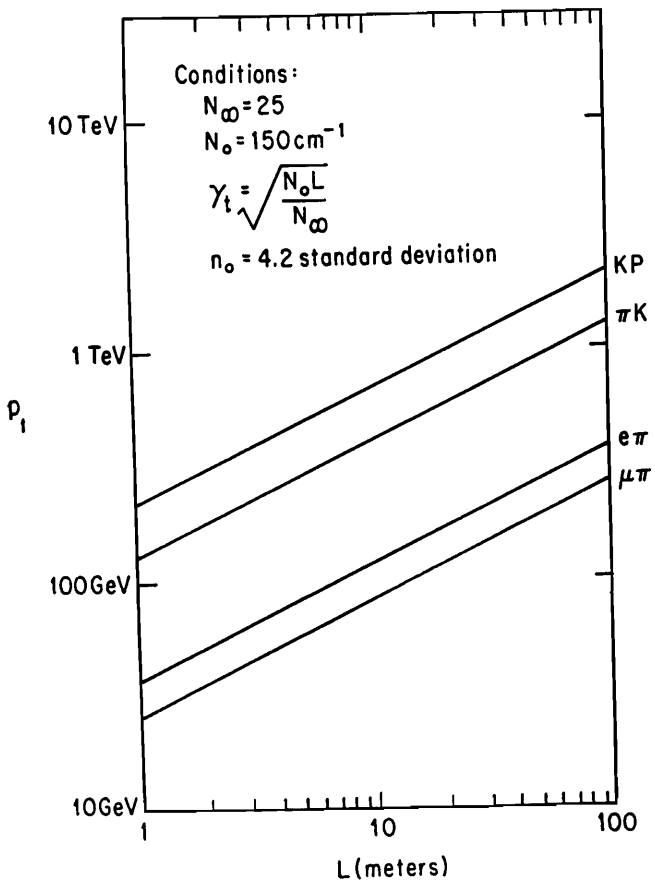

Figure 2

momenta expected at each aperture (for particles which have an average P_t = 0.4 GeV/c).

We see that the first spectrometer has a momentum range characteristic of an ISR spectrometer (Experiments R603,R608). A 10 m length is sufficient. The angular aperture then fixes the transverse dimensions at y = ± 2.2m. We have the following tentative parameters for the 3 spectrometers.

Spectrometer	Angular aperture	Momentum range	Length	Transverse dimension
#1	20-200mr	20-2GeV	10m	± 2.2m
#2	1-20 mr	400-20GeV	15m	0.7m
#3	0.2-1m	2000-400GeV	100m	0.2m

References

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