EXPERIMENT ON 30 nm SPOTS

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In this Working Group there were long discussions on the feasibility of very small beam spots for colliding beams, smaller even than those of the SLC. One can make general studies on ground motion and surveying (and since the Workshop I have had valuable discussions with J. Gervais and received from J. Rees the most comprehensive notes from G. Fischer), but our Group felt that actual experiments on small beam spots would be most valuable in developing a feeling for what is possible with the type of equipment we are used to, genuine quadrupoles etc.

I'm sure a case can be made for carrying out such studies with the SLAC beam, benefiting from its extremely small intrinsic emittance, but I chose to design an experiment based on a special SPS beam, H8, being built by H. Atherton and N. Doble for experiment NA34. This has the advantage that the momentum, 450 GeV, is in the range in which we are actually interested, and that the collimation has been carefully designed to reduce the intrinsic emittance and end up with a flux allowing one to detect individual particles.

When the SPS is tuned for maximum brightness, it could give about $\sim 10^{12}$ protons in an emittance of $\sim 10^{-6}$m. The H8 beam now provides three stages of collimation and clean-up with sextupole corrections to produce at a fourth focus a beam of $\sim 10^{8}$ particles with an emittance of $\sim 10^{-8}$m in each axis. That emittance is not itself small enough to be very interesting for us, but I propose to add one more stage to the beam, increasing the number of collimating and clean up stages by one. I would cut the number of particles per pulse to 10^{2}, with a vertical emittance of 5×10^{-13}m and a horizontal emittance of 2×10^{-10}m. The last focus should have $\beta_y = 2$ mm, $\beta_x = 12.5$ mm. The rms beam sizes would then be:

$$\sigma y = 30 \text{ nm}$$

$$\sigma x = 1.5\ \mu\text{m}$$

The aspect ratio of the image, 50:1, is large but I have once dealt with the same value in a separated beam without great alignment problems.

I would detect the position of individual particles by making an array of strips of different elements each 20 nm wide in the y direction and 20 μm along the beam. The characteristic X-rays excited by the particle would then be detected in a nearby Ge crystal, and the ability to distinguish individual elements would allow a measurement of y to ±10 nm. I would measure the auto-correlation function of y(t) during the beam pulse. This would tell me the spectrum of motions in y, the desired goal of the experiment.