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INTERSECTING STORAGE ACCELERATOR NOTES

Background Rates in a 4π Detector at ISABELLE

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BACKGROUND RATES IN A 4π DETECTOR AT ISABELLE

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Any proposed " 4π " solid angle detector at ISABELLE requiring maximum available luminosity would encounter a large background of real pp events which might prevent complete event reconstruction.

The maximum design luminosity, $L \approx 10^{34} \text{ cm}^{-2} \text{ sec}^{-1}$, can be achieved either with or without rf structure in the beams, and with collinear collisions. Since the total pp cross section is $\sigma_{\text{tot}} \approx 4 \times 10^{-26} \text{ cm}^2$, the average reaction rate would be (if there were no rf beam structure):

$$R \approx 4 \times 10^8 \text{ sec}^{-1}.$$

Assuming that beam-gas interactions are negligible in comparison, this still leads to a formidable background problem. For instance, in any large calorimeter or MWPC system with a resolving time $\Delta t \sim 25 \text{ nsec}$, there would be tracks from 10 events recorded for each trigger. Since each event might involve an average of around 20 charged tracks and 20 photons from π^0 decay, we are talking about a background of 200-400 particles. This must be kept in mind when contemplating any 4π detector designs.

In order to obtain reliable energy information, it would be essential to place a very short strobe on a calorimeter (which must itself have a very fast response time). However, it seems extremely unlikely - to me - that reliable gating could be done for analog signals at the sub-nanosecond level which would be required to get a clean signal, even if a very fine structure were used for the forward calorimeter. It is difficult to imagine keeping the counters and response uniform to $\approx 0.25 \text{ nsec}$ over periods of weeks or months.

For the particular class of weak interactions where a neutrino is produced,

$$p + p \rightarrow \nu + \ell + \chi_{\text{hadronic}},$$

only the information from the charged lepton direction and momentum would be available. The existence of the neutrino would be inferred from the large missing transverse momentum, but it might not be possible to know:

$$q_{\nu\ell}^2 = (p_\nu + p_\ell)^2 .$$

Unless the cross section for this process is orders of magnitudes larger than predicted by Berman (which would allow measurement at substantially lower luminosity), it will not be possible to determine the energy carried off by the χ_{hadronic} system. This would be unfortunate if there were a breakdown in either scaling or the Fermi theory, such as production of heavy leptons, etc.