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LINEAR COLLIDER IR AND FINAL FOCUS INTRODUCTION*

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Introduction

The Linear Collider subgroup of the Accelerator Physics working group concerned itself with all aspects of the Next Linear Collider (NLC) design from the end of the accelerating structure to and through the interaction region. Within this region are: i) a collimation section, ii) muon protection (of the detector from the collimator), iii) final focus system, iv) interaction point physics, and v) detector masking from synchrotron radiation and beam-beam pair production. These areas of study are indicated schematically in Fig. 1.

The parameters for the Next Linear Collider are still in motion, but attention has settled on a handful of parameter sets. Energies under consideration vary from 0.5 to 1.5 TeV in the center of mass, and luminosities vary from 10^{33} to 10^{34} cm^{-2}s^{-1}. To be concrete we chose as a guide for our studies the parameter sets labeled F and G, Table 1 from Palmer[1]. These cover large and small crossing angle cases and 0.4 m to 1.8 m of free length at the interaction point.

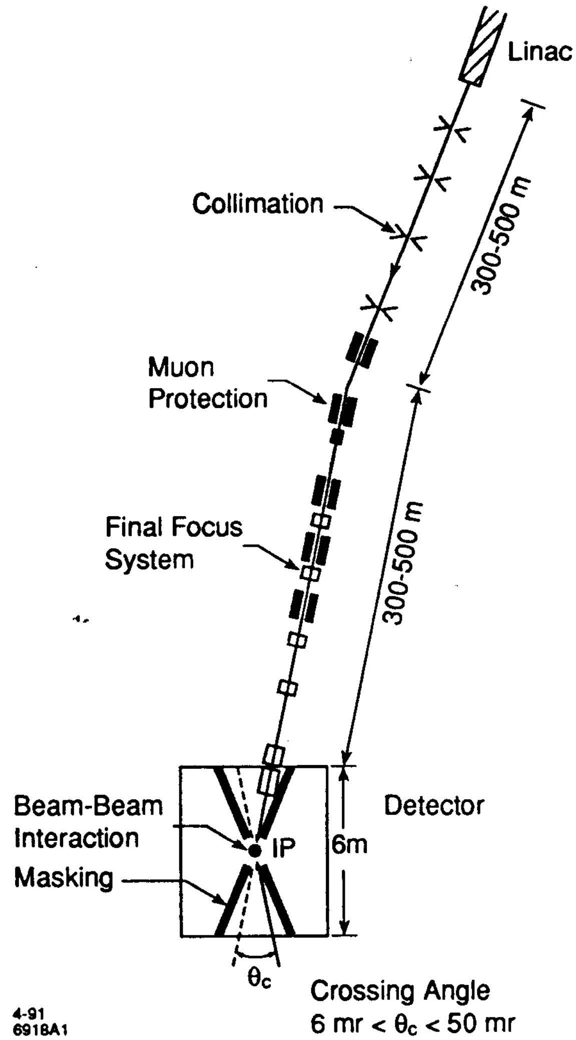

Fig. 1. End of linac to interaction point in the Next Linear Collider.

Collimation

At the beginning of the Snowmass workshop no real design for a collimation system existed. Two ideas had been proposed: i) Compton collimation with an intense laser beam, and ii) mechanical collimation assisted with nonlinear elements to increase beam size at scrapers. We decided to concentrate our attention on nonlinear collimation schemes to see if either we could come up with a specific feasible design or rule this idea out totally. A design was found[2] that scrapes the beam to 5σ in x, x', y, y', and energy, protects the collimators from a misteered beam, and has alignment tolerances no worse than typical final focus system tolerances. Both the eventual fate of all secondary particles created in the scrapers and the relationship of the collimation system to the final focus system need further scrutiny.

Muon Protection

Though we had no specific collimation design in hand, attention was directed to the problem of the muons that would certainly be created in collimators. Using the code MUCARLO[3] developed to design the SLC muon protection system,

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several geometric arrangements were studied to see what attenuations could be achieved. Dependence on final focus system bend angles, arrangements of toroids, placement of iron in the tunnel, and distance to source were investigated. As expected it is difficult to control muons at these energies, and first results at 250 GeV beam energy indicate[4] that only one in 10^4 particles of the primary beam can be collimated. As specific collimator designs emerge, these studies must be continued and extended to higher energies. And it will be important to find ways to improve the attenuation, preferably to 1 in 100.

Final Focus System

The final focus has perhaps to date received the most attention because the Final Focus Test Beam (FFTB)[5], now under construction at SLAC, has been under study for a couple of years. Its parameters were chosen to be similar to the parameters of an NLC Final Focus system as regards magnification and optical design. Though the NLC and FFTB are similar in design, the tolerances for the NLC are much smaller, as might be expected, because the emittance and beam size are much smaller. At Snowmass we decided to calculate the tolerances for two NLC final focus system designs that were in hand at that time, and to identify scaling laws associated with these tolerances[6].

Beam-Beam Physics

Interaction point beam-beam physics is a relatively mature subject: many authors have studied disruption, beamstrahlung, and pair production at the IP. The low energy pairs created during the beam-beam collision experience strong fields and are driven to substantial angles before escaping the interaction point. Interaction region designs have attempted to mitigate the effect of this background. Recently it was appreciated that during the pair production process itself one of the pairs may acquire a rather large angle, and that such particles may be troublesome. Efforts at Snowmass concentrated on determining the precise number and distribution in energy and angle of these particles[7].

Detector Backgrounds

There are presently two distinct strategies for handling the pair problem at the IP: i) large crossing angles in combination with a tilted solenoidal field to create a geometry where only a few low-energy pairs collide with the final quadrupole face or its support structure[8], or ii) small crossing angles with a conical shaped mask within the detector to absorb radiation that results when pairs collide with the final quadrupole face. Details of this second idea are presented in this report[9]. Unfortunately the number of large angle pairs calculated above which will hit the outside of the mask (2×10^3 per bunch train at 1 TeV cm energy) was not determined in time to be investigated. This matter is presently under study.

Conclusions

It is encouraging that as we look more closely at the details of an NLC design no fundamental obstacles to the successful construction of such a machine have arisen. Indeed, solutions to difficult problems continue to emerge. Though it would be premature to claim that the solutions to the collimation, final focus, and detector backgrounds of an NLC are in hand, it is not an exaggeration to say that reasonable and realistic designs addressing these problems continue to take shape.

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