Raimondi-Seryi Final Focus for e+e- Factories?

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A compact final-focus system with a local chromatic correction would likely improve the performance of factory upgrades.

1. MOTIVATION

Two primary challenges encountered in B factory upgrade designs are the need to place stronger quadrupoles closer to the IP and a limited dynamic aperture, both of which are closely linked to the reduction of β_y^* at the collision point. In this article I attempt to revive interest in an alternative final focus that, until now, does not appear to have drawn an adequate attention from the factories community.

2. DESIGN HISTORY

In 2000, P. Raimondi and A. Seryi revolutionized the final-focus design for linear colliders, by proposing a new compact final-focus system [1], which offers a number of distinctive advantages compared with earlier design concepts. Since then, the NLC and CLIC linear collider designs have adopted the new type of final focus, and a compact optics for TESLA is being worked on [2]. A prototype final-focus system of the Raimondi-Seryi type was also designed by S. Kuroda for the ATF-2 project at KEK [3]. The conceptual difference between the new and old concepts was vividly illustrated by N. Walker [4], whose schematics we reproduce in Fig. 1.

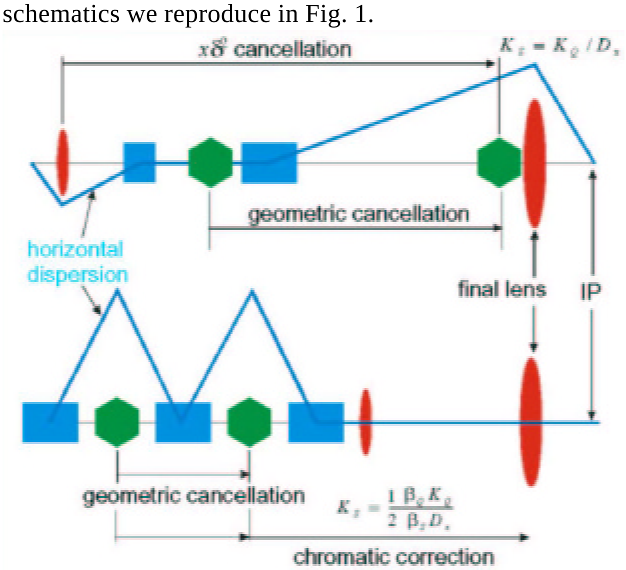

Figure 1: Schematic of the novel compact final focus with truly local chromaticity correction and nonzero slope of dispersion at the interaction point (IP), as developed by P. Raimondi and A. Seryi (top), and of the traditional final-focus design with a non-local chromatic correction, as pioneered by K. Brown around 1985 (bottom) [4] [N.J. Walker, 2002].

The compact system features a truly local chromatic correction where the sextupoles are placed next to the final low-beta quadrupoles. The nonzero dispersion then required in this region either translates into a nonzero slope of dispersion at the interaction point (IP) [1] or it could be generated – or rather cancelled – by a downstream dipole magnet, such as the permanent dipole B1 in PEP-II.

The compact system offers numerous advantages over earlier design schemes, such as an increased momentum bandwidth, much shorter length, fewer and weaker quadrupoles, the possibility of a larger free distance between the last quadrupole and the IP, and an improved dynamic aperture.

The only possible disadvantage is the slope of dispersion at the IP, which could drive synchro-betatron resonances. The effect should be similar to that of a crossing angle of size

$$\theta_{eff} = \frac{D'^* \sigma_\delta}{\sigma_z}$$

Since the ratio σ_z/σ_δ is of order 5-10, the maximum acceptable slope of IP dispersion is 5-10 times larger than the maximum tolerable crossing angle [5] - in case there is a limit on the latter as suggested by some of the strong-strong beam-beam simulations [6].

That the compact system can support an outstanding performance not only for single-pass applications, but for storage rings as well was demonstrated in 2001, when within a single day P. Raimondi designed a system for the highly demanding parameters of a 30-TeV muon collider with a large geometric emittance and an already appreciable amount of synchrotron radiation. Designs of conventional systems for the same parameters either could not be finalized or fell far short of the desired performance. By contrast, the compact optics of Raimondi displayed an excellent performance over multiple turns and, in addition, a huge momentum acceptance [7].

3. THE CHALLENGE

Quoting the 2001 hallmark paper by P. Raimondi and A. Seryi [1], it is obvious that “similar design could also be considered for high luminosity factories based on storage rings, where the dynamic aperture could be improved even with very small vertical beta functions at the IP.” Given the overwhelming reception that the compact design has experienced in the linear-collider community, it is surprising that nobody has yet taken up this idea for the factory upgrades.

General design recipes for this type of system, at linear colliders, have been published by several authors, e.g., by A. Seryi and co-workers [8,9], by J. Urakawa and co-workers

[3], and by F. Zimmermann and co-workers [10]. At Nanobeam2002 the confidence in this type of system was so high that any experimental tests prior to the construction of the real final focus were considered 'not necessary' [11].

Therefore, I close with two questions: (1) Why are all the upgrade designs, e.g., for PEP-II, KEKB, DAFNE-2, etc., still based on the ancient schemes? (2) Can this workshop make progress towards the first modern factory interaction-region design?

References

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