First Optics Design for a Transverse Monochromatic Scheme for the Direct s-Channel Higgs Production at FCC-ee Collider

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Abstract

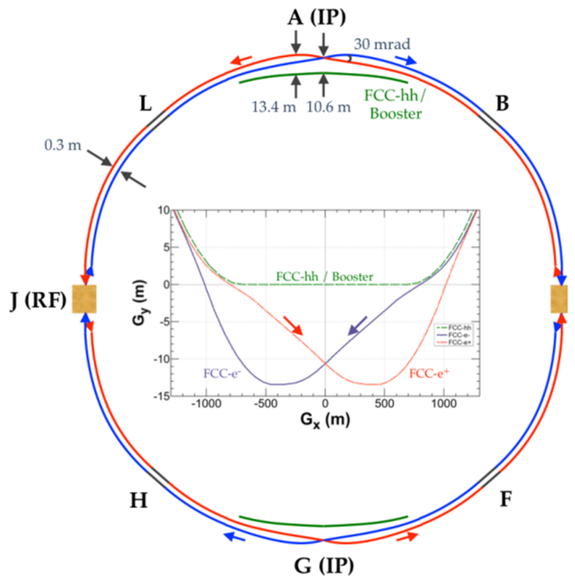
The FCC-ee collider baseline foresees four different energy operation modes: Z, WW, H(ZH) and ttbar. An optional fifth mode, called s-channel Higgs production mode, could allow the measurement of the electron Yukawa coupling, in dedicated runs at 125 GeV centre-of-mass energy (CM), provided that the CM energy spread, can be reduced by at least an order of magnitude (5-10 MeV). The use of a special collision technique: a monochromatization scheme is one way to accomplish it. There are several methods to implement a monochromatization scheme. One method, named transverse monochromatization scheme, consists of introducing a dispersion function different from zero but opposite sign for the two colliding beams at the Interaction Point (IP). In this paper we will report about the first attempt to design a new optics to implement a transverse monochromatic scheme by means of dipole magnets for the FCC-ee Higgs production totally compatible with the standard mode of operation without dispersion at the IP.

Introduction: Physics requirements

FCC-ee energy operation modes

- **Standard modes:**
  Z, WW, H(ZH) and ttbar
- **The optional fifth mode:**
  s-channel Higgs production mode

The measurement of the electron Yukawa coupling, in dedicated runs at 125 GeV with CM energy spread(5-10 MeV). But the natural collision energy spread, due to the synchrotron radiation (SR), is about 50MeV.

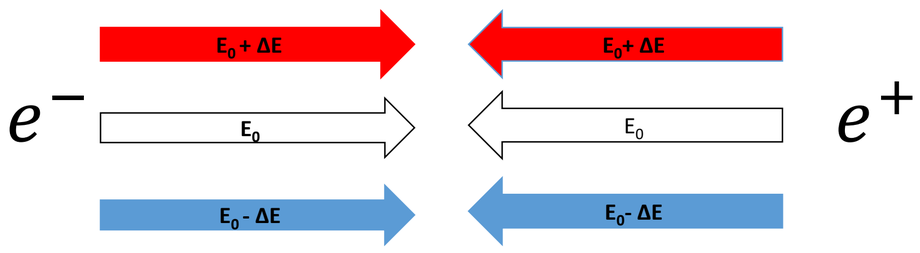


Requirements

Reduce the CM energy spread from 50MeV to 5MeV, which is comparable to the resonant width of the standard model Higgs Boson itself (4.2MeV).
There is a great interest from the particle-physics community. The only known pathway to measure an important property of the Higgs boson and to understand the origin of the electron mass.

Monochromatization

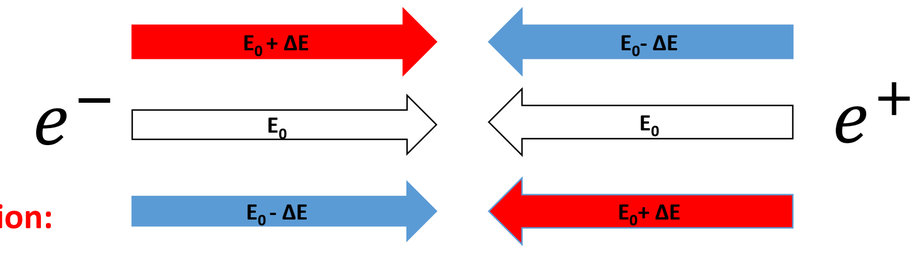
Standard mode



Monochromatization can reduce the C.M. energy spread by an order of magnitude with the natural energy spread, due to the SR.

Enhancement of CM energy resolution:

Monochromatization mode

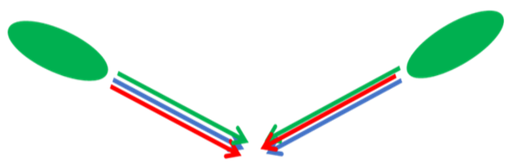


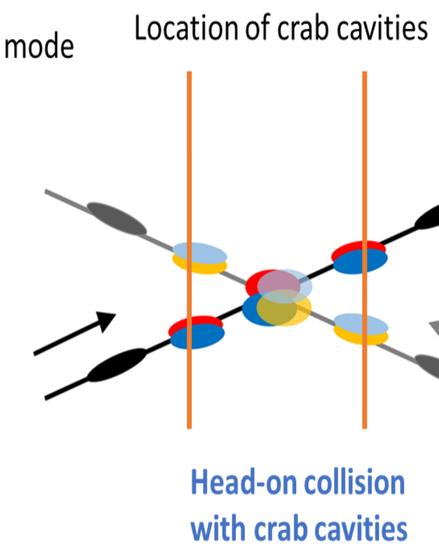
$w = 2(E_0 + \Delta E)$:The Centre-of-Mass energy expression: $w = 2E_0 + O(\Delta E)^2$

Implementing Monochromotization in FCC-ee

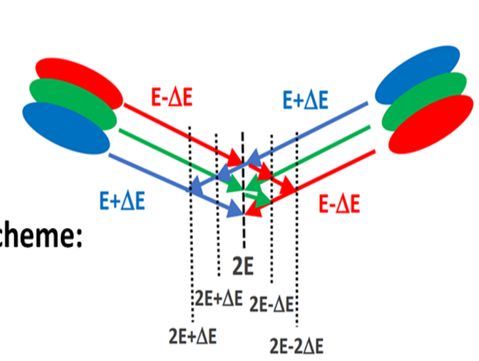
The transversal scheme with crossing angle and crab cavities:

Standard collision mode:





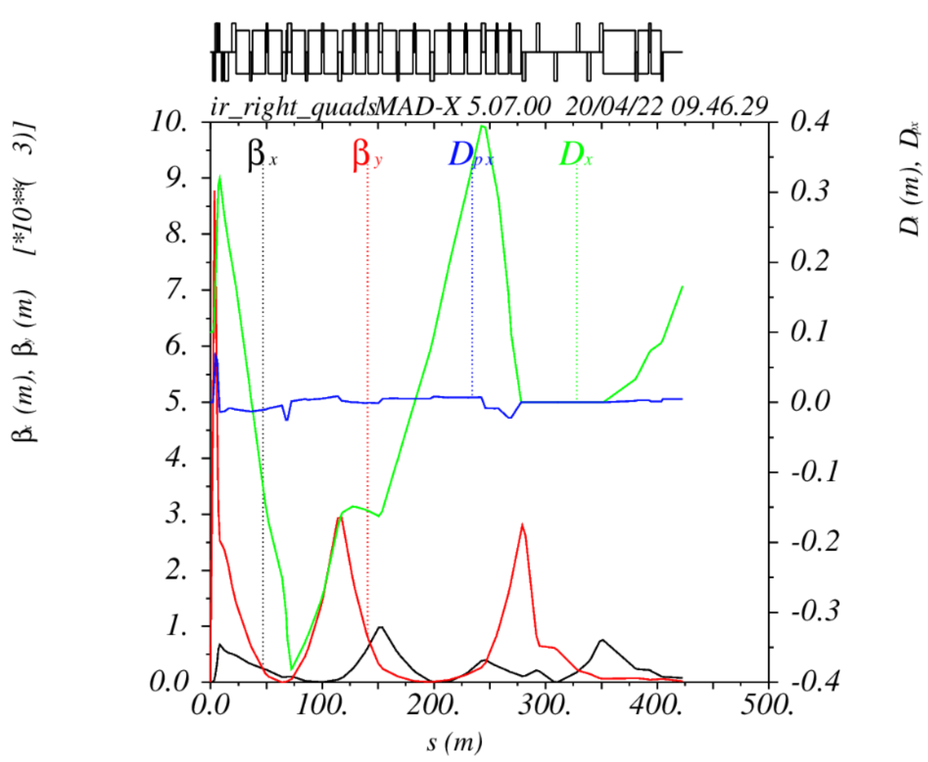
Transversal mono scheme:



Without crab cavities

Head-on collision with crab cavities

The primary flexible Interaction Region(IR) Optics for transversal scheme



Conclusions:

- We are designing a new IR optics to meet all the constraints at the last optimized IR optics and we are trying to solve all of the drawbacks before implement the monochromatization scheme in FCC-ee.
- We have a strong working team (**CNRS IJCLab**, CERN, ANL, SLAC, Univ. of Guanajuato, …)

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