SUMMARY OF WORKING GROUP 2: OPTICS*

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INTRODUCTION

We had four sessions of optics in the Higgs Workshop 2014, Beijing. The first section was dedicated to the overall consideration of optics in circular Higgs factory (CHF), and the existing designs from IHEP and CERN. The second one focused on single-particle beam dynamics, in particular dynamic aperture in SuperKEKB and CHF. The third session was a joined one together the working group 3: interaction region (IR) and machine detector interface. The topic was final focus system (FFS) and local chromatic compensation. Three approaches by IHEP, CERN, and BINP were presented. In the final session we had a discussion of beamstralung, beam-beam interaction, and IR magnets.

TALKS

There were 15 talks in the optics sessions:

1. “Overall consideration, main challenges and goals", Yunhai Cai (SLAC)
2. “Single ring multi-bunch operation and beam separation", Richard Talman (Cornell)
3. “Challenges and status of the FCC-ee lattice design", Bastian Harer (CERN)
4. “Status of the CEPC lattice design", Huiping Geng (IHEP)
5. “Analysis of nonlinear dynamics", Yunhai Cai (SLAC)
6. “Dynamic aperture optimization in SuperKEKB", Yukiyoshi Ohnishi (KEK)
7. “The effect of IR imperfection on dynamic aperture in SuperKEKB / dynamic aperture study of CEPC", Hiroshi Sugimoto (KEK)
8. “Beam lifetime and Injection consideration", Cui Xiaohao (IHEP)
9. “CEPC IR optics", Yiwei Wang (IHEP)
10. “Status of the FCC-ee interaction region design", Roman Martin (CERN)
11. “Crab waist interaction region", Anton Bogomyagkov (BINP)
12. “Beamstrahlung and energy acceptance", Kazuhito Ohmi (KEK)
13. “Interaction region magnets", Eugenio Paoloni (INF)
14. “Beam-beam effects in the CEPC", Yuan Zhang (IHEP)
15. “Wide-band long-focus optics for detection systems infrared synchrotron accelerator diagnostics", Marina Maltseva (TENZOR)

Here are our conclusive remarks on the optics in CHF.

MAIN CHALLENGES

Compared with LEP2, we need a factor of 100 increase of luminosity at beam energy of 120 Gev with an affordable cost. Without any major technology advances, we have put all burdens squarely on the optics:

- Low emittance lattice at high energy,
- High packing factor of magnets,
- Strong final focusing,
- Large momentum acceptance,
- Short bunches.

Any one of the listed item represents a significant challenge. With all of them combined, we have not yet found any solution since the last workshop two years ago. Most likely, something has to give or new concept has to be discovered.

ARC LATTICE

To reduce synchrotron radiation of the bending magnets, we all use FODO cell in CHF because of its large packing factor. It lacks of flexibility in optics. Specifically, the interlaced sextupoles generated huge tune shifts at high betatron amplitudes. As a result, any perturbation will degrade the dynamic aperture, mostly noticeable with a pretzel orbit or insertion of the IR. A way to mitigate this effect is to consider increase circumference to accommodate other type of cells with non-interlace sextupoles in arcs.

FINAL FOCUS SYSTEM

Many progresses have been made since the last meeting (Feb, 2014), but the momentum aperture of the collider with realistic arcs remains too small. Possible solutions:

- Add octupoles near the final doublet,
- Consider asymmetric dispersion at the paired sextupole in FFS,
- Simplify the transition between CCY and CCX to reduce the phase advance from 3π to 2π

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PARAMETER

The bunch length is lengthened to 2.8 mm after adding the contribution from the beamstrahlung. It is too long compared to the 1.2 mm beta function at the interaction point (IP) in the vertical plane due to the hour-glass effects. The simulation shows a further degradation of luminosity in the beam-beam interaction. In fact, there is not much gain from the 1.2 mm beta compared to the 2 mm one. Therefore, we strongly recommend increasing the vertical beta function at the IP to 2 or 3 mm. This change will greatly help to develop a lattice with a large dynamic aperture.

TECHNICAL ISSUES

There are many technical issues in the design of CHF. Some R&D may be necessary. Among them, most important ones are:

- 300 T/m gradient of quadupole near the IP
- a thin septum (2 mm) or alternative injection scheme
- Dipole in the interaction region may be still too strong
- Injected beam may be too large, especially with a pretzel scheme

GOALS

Here are a set of goals for our working group:

- Clarify where we are and identify main design issues,
- Compare different designs and identify their trade-offs,
- Collect ideas to resolve the technical blocks such as off-momentum aperture,
- Obtain a set of requirements that consistent with other systems,
- Define or have a baseline design?

We believe that they can be useful to the near-term development of the lattice in CHF. A definable baseline not only adds credibility to the project but also lays a foundation for further improvement. Technically, it simplifies any comparisons among different designs.

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