Summary of the IR/Optics + operations, Reliability, Instrumentation, Injection Working Group

Yoshihiro Funakoshi (KEK)

(1) What were done in the working group?

1) Talks on specific topics -> U. Wienands
2) Discussions or/and talks based on two working lists

(2) Working list (1)

- What are performance limiting issues at each machine?
- Method of optics parameter measurement (beta function, x-y coupling, dispersion)
- Method of correction
- Dynamic aperture: Method of measurement
- What limit dynamic aperture
- Detector beam background situation
- Minimum β_y^*
- Other issues?

(3) Working list (2): Charge to WG's

- Review present designs and operational status of your working group topics
- How well have parameters measured up to expectations in existing machines?
- What are the problems and operational difficulties common to several machines?
- How much further can parameters be pushed to improve machine performance?
- What are the critical steps in doing this?
-
-

	Present Design and Operation Status (performance limiting issues)	**Prameter vs. Expectations**	**Problem and Operational** **Difficulties**
CESR-B	Running (parasitic x-ing)	Expectations have been met.	Solenoid compensation reproducibility rf trip
KEKB	Running @ 1/2 of design Lum. (e- cloud, bunch spacing, beam-beam)	ε blowup larger ξy- smaller # of bunches smaller (Ib higher)	change of ring circumferen Luminosity instability abort (rf trip, Belle) x-y coupling @ IP lifetime decrease (need b cl
PEP II	Running @ 133% of design Lum. (beam current (heat,rf), beam-beam, e-cloud)	Vertical beam size bigger (Σ 8 vs.) ξy- smaller	machine drift, reproducibil feedback loops rf trips, rf loop, backgrounc injection, x-y coupling
DAΦNE	Running @below design Lum. Lum/bunch ~25% (beam-beam, background, ion trapping)	ξy smaller (1/2) τ smaller (<1/2) # of bunches smaller, Ib 15mA	injection after downtime background x-y coupling
Super KEKB	in design		
Super B-Factory	parameter search		

	How far can parameters be pushed?	Critical steps in doing so	Working point
CESR-B	βy* -> 1cm Lum. ->3*10^32 (design@1.9GeV)(CESR-C) E -> 1.5~2.5geV (CESR-C)	Wigglers (14)(CESR-C)	(.53, .58)
KEKB	βy* -> 0.5cm overcome e- cloud instability ξy- -> 0.05 Design beam current Lum. -> 2* 10^34	e+ in HER, e- in LER (Linac upgrade) Installation of ante-chamber Crab cavityies	(.51, .58) (LER) (.53, .59) (HER)
PEP II	β* ->35cm, <1cm HER I -> 1.5A LER I -> 3.8A Lum -> <10^34	HER rf (2 sections) Replace Q2 chamber, Q1 Replace FB kickers may need wiggler on again	(.64,.57) (LER) (.57,.63) (HER)
DAΦNE	βy* ->? ξ -> 0.04, Ib -> 25~30mA # of bunches Lum. ->10^32	Tune change Octupole, shim wiggler 3rd harmonic rf ? (cavity prototype exists)	(.15, .21) (electron) (.12, .17) (positron)

	Performance limiting issues	beta measurement	x-y coupling measurement	Dispersion measurement
CESR-B	Parasitic crossing	phase advance from turn-by-turn BPM	Forced (betatron) oscillation. See the x-y coupling.	
KEKB	e- cloud instability, bunch spacing problem beam-beam	Single kick of usual steering	Single kick of usual steering	RF frequency cl
PEP II	beam current (heat,rf) beam-beam e- cloud instability	phase advance from turn-by-turn BPM	Orbit coupling using gloal closed orbit wave	RF frequency cl
DAΦNE	beam-beam wiggler nonlinearity Touschek beam background ion trapping			

	correction of optics errors	Dynamic aperture Method of measurement	Dynamic aperture Measurement, What limit?	Other issues
CESR-B			Transeverse: consistent with physical aperture	
KEKB	Online using SAD	Transverse: pulse kicker magnet Longitudinal: RF phase kick	Transeverse: consistent with physical aperture (H) poor data (V) Longitudinal: typically 1% chromaticity correction	Heating of IR components SVD chamber v bukcet sp. IR chabmer due SR from IP
PEP II	Offline using Lego, MAD Online using beta-function mesurement	Transverse: Horizontal pulse kicker No vertical pulse kicker Londitudinal: Beam lifetime vs. rf voltage & Touschek analysis	Transever: very few data not significant issues Longitudinal: in data analysis	Reproducibility machine after periods wi beam
DAΦNE				

Commonality

- In all of 4 machines, the x-y coupling correction is important.
- In both PEP II and KEKB, ξ_y^- is limited at 0.03 due to the electron cloud instability.
- In the relatively low energy machines (DAΦNE, CESR-C), wiggler magnets are required and their nonlinearity could be an issue (especially in the DAΦNE case).
- In the relatively low energy machines including PEP II LER and KEKB LER, the Touschek effect is important to some extent.

Difference

- In DAΦNE, no electron cloud instability is observed.
- Difference in the bunch length might be relevant.
- The bunch spacing problem at the KEKB seems very different from other machines cases (In DAΦNE has some similar problem).

Issues not so serious as was expected

- Dust trapping
- Fast ion instability

Issues not dealt with in this workshop

- General lattice design issues
  - Solenoid compensation
  - Method of chromaticity correction
  - Tunability of optics
- These issues should be discussed in the workshop on next generation factories if held.

Discussion on zero-current beam size

Question: Is the zero-current beam size important for the high luminosity?
(By Dave Rice)

PEP II: The flip-flop effect may indicate similar issue. Balance of bunch lifetime avoids one beam getting weak.

CESR: Coupling correction first; i.e. Yes

DAΦNE: Yes. Both beam using skew quad. (ε+ < ε-, κ 0.3% vs. 0.5%)

KEKB: Need to enlarge HER beam size. LER beam size is determined by electron cloud instability. Zero-current beam size is not very important.

VEPP-2M: Reduce coupling but increase beam size with vertical dispersion,

Conclusion?:
When the beam-beam blowup is weak, definitely yes. When the beam-beam blowup is serious, an intentional enlargement of the beam size may help in some cases.

My personal conclusion (impression) on the workshop

(1) CESR seems to be a well-understood and mature machine, although seems still developing. I hope that accelerator activity at Cornell will be preserved well or even developed.

(2) PEP II and KEKB are still growing machines. Even now, there are a lot of challenging issues to be solved. Particularly the electron cloud instability seems to be very important not only their own purposes but also considering impacts to other future machines.

(3) DAΦNE also seems a challenging machine. There are a lot of issues on which accelerator physicists and engineers can work. A lack of machine flexibility (for change of tune etc.) from its small size seems to make the situation even more challenging.

(4) This workshop is quite small. However, we could have deep knowledge of other machines through many discussions. Maybe this is a true “workshop” rather than “talkshop”.

I really appreciate Dave Rice for his continuous efforts for the workshop.