Summary of Wiggler Studies

S. Bettoni, S. Guiducci

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Reduction of the Non-Linearities in the DAFNE Main Rings Wigglers

- The work aimed at the reduction of the beam dynamics effects of the non-linearities of the DAΦNE wigglers.
- A method to reduce the integrated odd multipoles (the even ones tend to vanish for the periodicity of the magnet) by alternatively displacing the magnetic axis of the poles to compensate the integrated odd multipoles in each half-period of the wiggler has been found.
- In order to check the effectiveness of this approach, tracking studies have been performed. Tracking results have been used to tune the MAD model of the wiggler.

Simona Bettoni, *DAFNE Wiggler Optimisation*, ILC Damping Rings R&D Meeting ILCDR07, INFN-LNF, March 5-7, 2007, <u>http://www.lnf.infn.it/conference/ilcdr07/prog.html</u>

S. Bettoni et al. *Reduction of the Non-Linearities in the DAFNE Main Rings Wigglers*, PAC'07, June 25-29, 2007 and EUROTeV-Report-2007-051

Permanent magnet wiggler for ILC electron damping ring



*Large Aperture Permanent Magnet Wiggler for the ILC Damping Rings, A. Babayan , M. Preger, EUROTeV-Report-2007-004

Miro Preger, *Large Aperture Permanent Magnet Wiggler* ILC Damping Rings R&D Meeting ILCDR07, INFN-LNF, March 5-7, 2007, <u>http://www.lnf.infn.it/conference/ilcdr07/prog.html</u>

Permanent magnet wiggler for ILC electron damping ring

- A collaboration with the Yerevan Physics Institute has been set up to perform an optimization of the field quality for a permanent magnet wiggler.
- A hybrid structure with 80 mm pole width and pole shimming to improve the field homogeneity to 1.6x10-4 @±14 mm from the axis has been provided by Albert Babayan (YerPhi)
- The contribution of LNF consists in the analysis of the field maps to estimate the field quality from the point of view of nonlinear terms which may be harmful to beam dynamics
- This magnet could be an alternative solution for the wigglers of the electron damping ring which requires a smaller aperture with respect to the positron one.

Model of the permanent magnet wiggler for ILC e⁻ damping ring



The same modelling and tracking studies performed for the DAFNE wiggler have been done for the *Large Aperture Permanent Magnet Wiggler* in order to study the effect on the beam

S. Bettoni, LNF-Frascati

The field map



The beam trajectory

For each z the x of the beam trajectory is calculated from the field **ON** the particle interpolated from the values in the nodes (not exactly zero the exit angle).

The field of the terminal poles has been multiplied by a coefficient to minimize the angle and the position at the exit.



The optimized reference trajectory



Multipoles field expansion around the beam trajectory

$$B_{y}(x-x_{T}) = b_{0} + b_{1} \cdot (x-x_{T}) + b_{2} \cdot (x-x_{T})^{2} + b_{3} \cdot (x-x_{T})^{3} + b_{4} \cdot (x-x_{T})^{4}$$

 $x_T \rightarrow x$ beam trajectory



Tracking studies: x exit vs x entrance



Tracking studies: x' exit vs x entrance vs x entrance



The MAD model

Each inner (terminal) pole has been modeled by an S-Bend+three (two) lenses.



The MAD model: reference trajectory



The values of the MAD variables ANGLE have been tuned to match the reference trajectory obtained from the tracking program.

The MAD model: tracking studies: x exit vs x entrance



The MAD model: tracking studies: x' exit vs x entrance



The permanent magnet wiggler in the ILC DR



K₁ of QDWH and QFWH has been slightly modified:
▶ Present values: -5.956951E-01 and 6.565377E-01
▶ Modified values: -5.96391577423E-01 and 6.30574401699E-01

Conclusions

DONE:

- The field map of the 12 poles wiggler has been built starting from the one of the design of the 6 poles
- A MAD model of the wiggler section has been done (comparison with tracking and matching)

TO BE DONE:

> Refine the calculations with the "real" map (design of the 12 poles wiggler)

Comparison between the tracking curves of the superconducting and the permanent magnet wiggler

> Dynamic aperture calculation with the corresponding model





3rd EUROTeV Annual Meeting

WP3: Damping Rings

S. Guiducci, INFN-LNF

LNF - 24 January 2008

ILC Activity - Damping Rings R&D

- After the publication of the ILC Reference Design Report (RDR) the GDE started the organization for the next phase of Engineering Design Report (EDR). The WP3 participants have contributed to this process.
- A task force of the GDE R&D Board (S3 task force) has published an international coordinated R&D plan for the Damping Rings, defining objectives and priorities
- WP3 activity is well inserted in this plan, in particular e-cloud and kickers activities (ECLOUD and RFSEP tasks) have been assigned a very high priority
- Two workshops on Damping ring R&D have been held with an active participation of WP3:
 - ILCDR07, INFN-LNF, Frascati, March 5-7, 2007
 - ILCDR07_KEK, KEK, Tsukuba, December 18-20, 2007

Damping Ring WP3 Tasks

- ECLOUD: Studies of Electron Cloud and other Instabilities (CERN, DESY, INFN, CCLRC)
- RFSEP: Application of RF Separators and Fast Kickers to DR injection (INFN)
- WGLRDYN: Wiggler Field Modelling and Impact on Dynamic Aperture (INFN)
- LETS: Low Emittance Tuning Simulations (DESY, CCLRC)

LETS

Task reporter: J. Jones

- Comparative studies of tuning algorithms has concentrated on the production of a generic simulation platform, which has been applied to the reference DR lattice.
- The results have so far shown that the damping rings have reasonable tolerances in terms of extracted emittances, and that these emittances can be maintained for extended periods with periodic application of the tuning algorithms. Results have been presented at the ILCDR07 workshop at Frascati.
- After the choice of the nominal DR lattice for the EDR (by Marc 08) the various tuning algorithms will be applied to produce specifications on the location and number of diagnostics required.

WP3 Meetings

- 2nd EUROTeV Scientific Workshop, Daresbury, UK, January 8-11 2007, <u>http://www.astec.ac.uk/ELC/</u>
- CARE-HHH mini-Workshop on E-Cloud Cloud Clearing (ECL2), CERN, Geneva, 1-2 March 2007, Proceedings CARE-Conf-07-007-HHH, <u>http://care-hhh.web.cern.ch/CARE-HHH/ECL2/default.html</u>
- ILC Damping Rings R&D Meeting (ILCDR07), INFN-LNF, Frascati, March 5-7, 2007, http://www.lnf.infn.it/conference/ilcdr07/prog.html
- International Workshop on Electron Cloud Effects (ECLOUD07), Daegu, Korea, 9-12 April 2007, <u>http://chep.knu.ac.kr/ecloud07/home.php</u>
- IEEE Particle Accelerator Conference (PAC'07), Albuquerque 25-29 June, 2007, <u>http://pac07.org/</u>
- KEK ILC meeting on electron-cloud studies at KEKB-DRt, KEK, 17.12.2007.
- ILC Damping Rings R&D Workshop (ILCDR07_KEK), KEK, Tsukuba, December 18-20, 2007, <u>https://wiki.lepp.cornell.edu/ilc/bin/view/Public/DampingRings/ILCDR07_KEK/WebHome</u>
- Fifth ATF2 Project Meeting and ATF Technical Board & System/Group Coordinators Meeting, KEK, Tsukuba, December 19-21, 2007, <u>http://acfahep.kek.jp/subg/ir/bds/atf2/meeting/3rd-project/</u>
- International Linear Collider Workshop (ILC07), Hamburg, Germany, 30 May 2 June 2007, http://lcws07.desy.de/

WP3 Reports

- Proceedings of Joint EUROTEV and CARE mini-Workshop on E-Cloud Cloud Clearing (ECL2), CERN, Geneva, 1-2 March 2007; F. Caspers, W. Scandale, D. Schulte, F. Zimmermann (eds), EUROTEV-Report-2007-060
- F. Zimmermann et al., Modeling Incoherent Electron Cloud Effects, Proc. PAC07, Albuquerque, June 25-29, 2007
- L. Wang, F. Zimmermann, Electron Cloud in the Wigglers of The Positron Damping Ring of the International Linear Collider, Proc. PAC07, Albuquerque, June 25-29, 2007
- F. Casper, et al., A New Type of Distributed Enamel Based Clearing Electrode, Proc. PAC07, Albuquerque, June 25-29, 2007
- S. Casalbuoni et al., Measurements of the Beam Heat Load in the Cold Bore Superconductive Undulator Installed at ANKA, Proc. PAC07, Albuquerque, June 25-29, 2007
- W. Bruns, D. Schulte, F. Zimmermann, Improvements in FAKTOR2, a Code to Simulate Collective Effect of Electrons and Ions, Proc. PAC07, Albuquerque, June 25-29, 2007
- G. X. Xia, E. Elsen, D. Kruecker, Study of Fill Patterns for the ILC Electron Damping Ring, Proc. PAC07, Albuquerque, June 25-29, 2007
- G. Xia, E. Elsen, Ion Effects Estimation in the ILC Damping Ring, EUROTeV-Report-2007-013
- M. Zobov et al., Impact of Ion Clearing Electrodes on Beam Dynamics in DAFNE, EUROTeV-Report-2007-016
- W. Bruns, Faktor2: Usage, EUROTeV-Report-2007-07
- W. Bruns, Faktor2: Rationale, EUROTeV-Report-2007-071
- A. Babayan , M. Preger, Large Aperture Permanent Magnet Wiggler for the ILC Damping Rings, EUROTeV-Report-2007-004
- S. Bettoni et al. Reduction of the Non-Linearities in the DAFNE Main Rings Wigglers, Proceedings of PAC'07, Albuquerque, New Mexico, June 25-29, 2007 and EUROTeV-Report-2007-051

WP3 Deliverables

4.3.3.4 Deliverables of this Work Package:

Deliverable number	Deliverables	Dissemination level
1	Documented and experimentally benchmarked code for e-cloud simulations.	PU
2	Report on impact of e-cloud and fast-ion instabilities on DR performance, including recommendations for controlling the effects.	PU
3	Report on impact of wiggler dynamics on DR dynamic aperture.	PU
4	Report on comparative studies of beam based alignment.	PU

Conclusions

- The WP3 participants dedicated a large effort to the ECLOUD task since this subject is crucial for the ILC DR and also for the present and future European colliders.
- Good progress has been achieved also in the other tasks
- EUROTEV participants are providing a substantial contribution to the DR design for the ILC Global Design Effort