

## Preface

A Mini-Workshop on Electron-Cloud Simulations for Proton and Positron Beams (E-CLOUD'02) was held at CERN from 15 to 18 April 2002. The workshop was organized by members of the Accelerator Physics group in the CERN SL Division, with the help of an international organizing committee, comprising representatives from BNL, CERN, DESY, FNAL, KEK and SLAC. The E-CLOUD'02 workshop received an enthusiastic response from the international accelerator-physics community as reflected by more than 60 participants from 17 different institutes, which underlines a growing consensus that electron cloud effects have to be fully understood and mastered, since they may otherwise become a performance limit for many next generation high-intensity rings. Participants included several members from the CERN SL Operation group, PS Experimental Areas group, and the LHC Vacuum group. Also SLAC, KEK, and BNL displayed a strong interest with 6, 5 and 3 participants, respectively.

Beam induced multipacting, instabilities and beam blow-up driven by the accumulated electrons have been observed at many accelerators around the world, for example at CERN with the LHC proton beam in the SPS and in the PS, at the SLAC and KEK B factories, at the Los Alamos PSR, at the Beijing Electron Positron Collider, etc. The pressure increase caused by the electron cloud, its impact on beam diagnostics and, for the LHC, the heat load on the beam screen and cold bore are further primary concerns. Simulations for future linear colliders and intense proton drivers suggest that in these machines electrons in the vacuum chamber may reach densities higher by up to a factor 10–100 than in existing machines.

The electron cloud induces betatron tune shifts, tune spread, and transverse single- and multi-bunch instabilities. A variety of theoretical and simulation approaches have addressed these possibilities. A number of simulation codes have also been developed, using different approximations and including different physics. E-CLOUD'02 has reviewed the present analytical, simulation and modelling approaches to the electron-cloud problem, determined the important outstanding questions, and developed a strategy for further R&D. Reports on the current status of experimental observations world-wide served as a motivation and benchmark for the simulation studies.

In this spirit, experimental work carried out at many different laboratories (KEK, SLAC, CERN, LANL, BNL, LBNL, IHEP, ANL) was reported in the two opening sessions (I+II) of the workshop on Monday 15 April. The second session also included results from laboratory measurements of secondary emission and of electron energy spectra, which are an invaluable input for the electron-cloud modelling. Tuesday's sessions (III+IV) were entirely devoted to the simulations of the electron cloud build up and of the associated beam instabilities. They included presentations of the physics models which form the basis of the existing simulation codes, discussions of simulation results and comparisons of simulations and observations. In particular, several reports on the simulation of single-bunch instabilities driven by the electron cloud, e.g., by K. Ohmi (KEK), G. Rumolo (CERN), Y. Cai (SLAC), and J. Xing (IHEP), and on theoretical studies by S. Heifets (SLAC), E. Metral (CERN) and E. Perevedentsev (BINP) demonstrated the recent fast progress in the field.

Wednesday's two sessions (V+VI) concentrated on plasma physics approaches and on future research and development as well as possible remedies to the electron cloud problems, respectively. A highlight was the presentation by T. Katsouleas (University of Southern California) who applied the sophisticated and well bench-marked plasma simulation codes which were developed at USC/UCLA to the electron cloud in the CERN SPS, and who also pointed out the importance of cloud image forces. A further intensified collaboration with the USC group is foreseen. Another interesting simulation result is the surprising strength of the horizontal wake field in a combined function magnet, presented by G. Rumolo (CERN).

During the workshop, F. Caspers (CERN) drew attention to the possible interaction of microwaves with the electrons. At the banquet, he proposed an experimental study of trapped modes near the PEP-II colimators and their effect on the electron cloud. This experiment was indeed performed by F.-J. Decker soon after the workshop, on May 16. Its encouraging results have been posted on the workshop web site. F. Caspers stressed that rf waves could intentionally be fed into the vacuum chamber as a possible means to either suppress the cloud or to enhance surface conditioning.

The workshop was summarized in Session VII on Thursday morning by R. Macek (LANL), O. Gröbner (CERN), M. Furman (LBNL), A. Wolski (LBNL), R. Assmann (CERN), and W. Chou (FNAL), who highlighted the necessity of strengthening the international collaboration on electron-cloud effects. With this goal in mind, a few key contact persons were selected from different institutes, who agreed to coordinate the future worldwide activities related to laboratory measurements (F.-J. Decker, SLAC; F. Ruggiero, CERN; S. Kato, KEK), theoretical approaches (A. Chao, SLAC; M. Furman, LBNL; S. Heifets, SLAC), and simulation-code comparisons (F. Zimmermann, CERN).

E-CLOUD'02 programme, presentations, and papers are posted on the workshop web site <http://wwwslap.cern.ch/collective/ecloud02>. The proceedings are structured according to the seven workshop sessions:

- Session I: Experimental Observations at Existing Accelerators and Concerns for Future Machines (chair R. Macek, secretary G. Arduini)
- Session II: Further Observations, Laboratory Measurements, and Modelling (chair O. Gröbner, secretary M. Jimenez)
- Session III: Simulations of Electron-Cloud Build Up (chair M. Furman, secretary G. Rumolo)
- Session IV: Simulations of Electron-Cloud Instabilities (chair T. Raubenheimer, secretary F. Zimmermann)
- Session V: Specific Comparisons and Plasma Approaches (chair T. Katsouleas, secretary R. Assmann)
- Session VI: Discussions of Future Studies, Collaborations, and Possible Solutions (chair W. Chou, secretary O. Brüning)

- Session VII: Summary Talks (chair S. Myers, secretary F. Ruggiero)

These proceedings have been published in paper and electronic form. The paper copy is in black and white; the electronic version contains colour pictures. Electronic copies can be retrieved through: <http://wwwslap.cern.ch/collective/ecloud02/proceedings>. In addition, workshop participants were encouraged to submit their contributions to a special E-CLOUD'02 conference edition of Physical Review Special Topics - Accelerators and Beams.

The compilation of these proceedings would not have been possible without the help of the chairmen, scientific secretaries, and speakers of all the sessions. In particular, we would like to thank all the participants for their stimulating contributions.

Geneva, 10 June 2002

F. Ruggiero, G. Rumolo, J. Thomashausen, and F. Zimmermann