SUMMARY SESSION V: COMPARISONS AND PLASMA APPROACHES

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1 PRESENTATIONS

The talks in session V covered a wide range of topics:

1. Electron cloud instability.
2. Instabilities with concurrent beam-beam and electron cloud.
3. Plasma wakefields and plasma modelling for electron cloud.
4. Synchrotron radiation effects on electron clouds.
5. Theory of holes in particle beams.
6. Vlasov-Poisson equations for proper non-linear description.
7. Experimental, simulation, and theoretical results for the PS, SPS, BEPC, BEPCII, SLAC plasma experiments, Heavy Ion Fusion.

The session illustrated that the modelling and understanding of the electron cloud is an area with a large scope of issues and interests, bringing together a wide range of diverse expertise. In the following we summarize the main results presented.

Electron build-up and instability: Comparison between observation and numerical simulations for the CERN PS (G. Rumolo et al) G. Rumolo presented that and electron cloud build up and instability can be observed in the PS. Simulations aimed at understanding the observations, especially the observed and unexpected horizontal instability. He showed that the detailed magnetic configuration is an important input to simulations. Including the combined function magnets into the model, a strong horizontal wake function can indeed be predicted. He presented results on the electron cloud density in saturation, versus different beam intensities. It is not understood why the equilibrium cloud density decreases with increasing beam population.

Combined phenomenon of the beam-beam and the beam-electron effects (K. Ohmi et al) K. Ohmi showed theory and simulation results for e^+e^- colliders that indicate that the concurrent effects from beam-beam and electron cloud can lower the instability threshold significantly. This complex phenomenon should exist, though the predictions from linear theory and strong-strong simulation with a soft Gaussian model disagree. Further work is required for a more detailed understanding, including the effect from strong Landau damping due to beam-beam.

Simulation study on electron cloud instability for BEPC and its upgrade plan BEPCII (J. Xing et al) J. Xing reported that a photo electron detector has been installed in the BEPC ring. Electron production is observed with this monitor, however, without any saturation in electron density, if the beam intensity is increased. This is consistent with simulations of electron production for different yields, reflectivities, and beam currents. Electron cloud is a potential concern for the two ring upgrade BEPCII, where it could limit the maximum intensity in the positron ring. BEPCII will have more bunch intensity than KEK-B with the same bunch spacing and lower beam energy (1.9 GeV). J. Xing showed that the electron cloud seems not to be a serious problem for BEPCII, possibly because it will be below the TMCI threshold of the electron cloud volume density.

Plasma modelling of wakefields in electron clouds (T. Katsouleas et al) T. Katsouleas presented experimental results from plasma wakefield acceleration experiments and the corresponding simulations. He demonstrated the advanced state of plasma simulation (both 3D and 2D), visible from the excellent agreement of simulation with observation. Applying these tools to the SPS parameters he found good agreement in the predicted longitudinal wakefield with results from F. Zimmermann and G. Rumolo, however, without some unphysical artefacts in the beginning and end of the bunch. He also raised the point of the image charge tune shift due to the electron cloud itself that had so far not been included correctly into simulations. He concluded that it is possible to build a powerful tool that combines the best of plasma and accelerator tools.

On the transparency of the electron cloud to synchrotron radiation (D. Kaltchev) D. Kaltchev analyzed the effect of synchrotron radiation on the electron cloud. He concluded that there is a negligible effect for LHC parameters.

Kinetic theory of periodic holes in debunched particle beams (H. Schamel et al) H. Schamel discussed the appropriate theoretical treatment of plasmas. He questioned the ”standard wave concept in plasma theory” that small amplitude waves can be predicted by a linearized theory and that non-linear effects become important only for larger amplitudes. Based on experimental results he demonstrated for electro-static phase space structures that nonlinearity starts from the onset, even at infinitesimal amplitudes. This is adequately described by a solution of the Vlasov-Poisson system with a potential method.

Electron cloud effects in intense ion beam linacs; theory and experimental planning for heavy ion fusion (M. Furman) M. Furman presented the plans for a fusion power plant, relying on 100-200 simultaneous heavy ion, singly ionized beams. The energy would be 1-4 GeV with an energy of several MJ. There is a concern that the electron cloud could affect the focusing of the beams which must overlap with a small spot size in the fusion point. Studies have started and extensive instrumentation has been proposed for electron detection in the test facility HCX.

2 MAJOR QUESTIONS RAISED FOR FURTHER WORK

- What is the explanation for lower equilibrium e-cloud density with higher beam intensity, as predicted from simulations for the PS?
- Why do the linear and Gaussian beam-beam approximations for beam-beam with electron cloud give somewhat different results? What is the tune dependence of the effect?
- Can one do meaningful experiments on this effect at PEP-2 (maybe explaining the difference between horizontal and vertical observation in PEP-2)?
- What is the expected combined effect of beam-beam and electron cloud in proton-proton colliders like the the LHC?
- Can the build-up of the electron cloud be integrated into the plasma modelling codes, instead of staring from an existing electron cloud density?
- Can the effect of damping and diffusion be included into the theory of holes?
- Can the fringe fields be included into electron cloud simulations to maybe explain the differences in horizontal and vertical observations in PEP-2 (similar to the effect of combined function magnets in the PS)?