

FUTURE ELECTRON CLOUD STUDIES AT CERN AND PLANS IN THE ACCELERATOR PHYSICS GROUP

F. Ruggiero, CERN, Geneva, Switzerland

Abstract

I sketch future plans for electron cloud studies at CERN, discussing input parameters and reliability of simulations performed in the Accelerator Physics group.

1 INTRODUCTION

Our priority is to study electron cloud effects and cures for LHC, SPS, and PS. The following is a list of relevant future activities that I will shortly discuss:

- Input parameters: do we need more laboratory measurements?
- Simulations of electron-cloud build up and heat load
- Simulations of electron-cloud instabilities
- Scrubbing scenarios and possible other cures
- Benchmark simulation codes by machine experiments
- Benchmark simulation codes by multipacting tests
- New physics and different approaches for our simulation codes: magnetron effect and plasma approach?

2 INPUT PARAMETERS: DO WE NEED MORE LAB MEASUREMENTS?

Input parameters required for electron cloud simulations include:

- Beam and machine parameters
 - bunch population and bunch train pattern
 - vacuum chamber geometry and bunch dimensions (σ_x , σ_y , and σ_z)
 - machine energy, tunes, chromaticities
 - linear and nonlinear optics (β -functions, beam offsets, detuning with amplitude, etc.)
 - machine impedance (wakefields, trapped modes)
- Primary electron sources
 - residual gas pressure and ionization cross section
 - beam losses
 - photon flux
- Surface properties vs electron and photon(?) scrubbing dose
 - surface reflectivity vs photon energy and incidence angle
 - energy spectrum of reflected photons vs angle of reflection
 - photoelectron yield
 - SEY vs primary electron energy and incidence angle
 - energy spectrum of secondary electrons

We need reliable input parameters for our simulations and therefore *we strongly encourage*:

- further reflectivity measurements
- further SEY measurements in the laboratory and in-situ, for Cu and SS
- an experimental scrubbing test in *cold LHC conditions*

We need *certified and representative* experimental data, possibly with recommended fits agreed by experts at CERN and in other laboratories, for the SEY at low energy and at high energy including reflected and re-diffused electrons.

3 SIMULATIONS OF ELECTRON CLOUD BUILD-UP, HEAT LOAD, SCRUBBING TIME

- definition of a threshold current (10% of saturation?)
- scaling of threshold current with bunch spacing
- scaling of threshold current with bunch dimensions
- stripe location (with 25 vs 50 ns bunch spacing?)
- role of satellite bunches \implies SPS machine experiment
- simulations of heat load in COLDEX and WAMPAC
- simulations of scrubbing time \implies SPS scrubbing test
- documentation of E-CLOUD and HEADTAIL codes
- systematic comparison of predictions by different codes \implies standardization of input-output format across different labs?

4 SIMULATIONS OF ELECTRON CLOUD INSTABILITIES

- explore plasma approach and include image charges from electron cloud \implies add boundary to the code HEADTAIL, use module from plasma code by Tom Katsouleas and set up collaboration with USC
- confirm explanation of PS horizontal instability by combined function magnets. Include sextupole field? Understand PEP-II results.
- Include linear coupling and check stabilizing effect \implies test in the PS/SPS
- systematic comparison of simulated and measured instability growth rates
- simulate spectrum of multi-bunch instabilities \implies compare with SPS measurements and results by Su su Win at KEK
- use improved SPS impedance model (from measured coherent tune shifts and spectra of high order head-tail modes) and use it in simulation with space charge and electron cloud impedance

- is there a discrepancy between electron cloud wake-fields computed at CERN and elsewhere? Why spikes are absent from KEK results?

5 BENCHMARKING SIMULATION CODES BY MULTIPACTING TESTS

- repeat multipacting tests with realistic LHC-like RF pulse trains
- simulate results
- test and simulate stripes in a dipole field?
- test and simulate trapping in a quadrupole field?
- compare with results of other codes (e.g. Lanfa Wang at KEK)

6 OTHER SIMULATIONS

- electron cloud and trapped modes \implies implication for LHC collimation? Heat load in experimental chambers?
- study very high intensity regime proposed by Sam Heifets for PEP-II upgrade \implies 5 ns bunch spacing for LHC upgrade?
- simulations for CLIC damping rings

7 ACKNOWLEDGMENTS

Many of the ideas sketched here have been triggered by contributions to the E-CLOUD'02 workshop [1]. In particular, I would like to thank Frank Zimmermann for several useful discussions and hints.

8 REFERENCES

- [1] Proc. of the Mini-Workshop on 'Electron-Cloud Simulations for Proton and Positron Beams' (E-CLOUD'02), CERN, 15–18 April 2002, edited by G. Rumolo and F. Zimmermann, CERN Yellow Report 2002-001, and <http://slap.cern.ch/collective/eccloud02/>.