Future Electron Cloud Studies at CERN and plans in the Accelerator Physics group

Our priority is to study e-cloud effects & cures for LHC, SPS, PS.

- Input parameters: do we need more lab 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 simulation codes: magnetron effect and plasma approach?

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 ($\sigma_{x,y,z}$)
  - machine energy, tunes, chromaticities
  - linear and nonlinear optics (β-functions, beam offsets, detuning with amplitude, ...)
  - 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 strongly encourage:

- further reflectivity measurements
- further SEY measurements in the lab 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, for the SEY at low energy and at high energy including reflected and re-diffused electrons.

Simulations of e-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 $\Longrightarrow$ SPS machine experiment
- heat load in COLDEX and WAMPAC
- simulations of scrubbing time $\Longrightarrow$ SPS scrubbing test
- documentation of the ECLOUD and HEADTAIL codes
- standardization of input-output format across different labs?

Simulations of electron cloud instabilities

- include image charges from e-cloud $\Longrightarrow$ add boundary to the code HEADTAIL (use module by Tom Katsouleas?)
- confirm explanation of PS horizontal instability by combined function magnets. Include sextupole field? Understand PEP-II results.
- Include linear coupling and check stabilizing effect $\Longrightarrow$ test in the PS
- systematic comparison of simulated and measured instability growth rates
- simulate spectrum of multi-bunch instabilities $\Longrightarrow$ compare with SPS measurements and results by Su su Win
- 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 among e-cloud wakefields computed at CERN and elsewhere? Why spikes are absent from KEK results?

Benchmark simulation codes with multipacting tests

- start 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)

Other simulations include:

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