Session summary
- Updates from Operating Machines -
Morning – October 8, 2010

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Five Talks in this session

- “Recent Studies of the Electron Cloud Induced Beam Instability at the Los Alamos PSR”, R. Macek
- “Electron Cloud Measurements at Fermilab”, R. Zwaska
- “Recent Experimental Results on Amorphous Carbon Coating for Electro Cloud Mitigation in CERN SPS”, C. Y. Valigren
- “Can Electron Multipacting Explain the Pressure Rise in a Cold Bore Superconducting Undulator?”, S. Casalbuoni
- “Emittance Growth and Tune Spectra at PETRA III”, R. Wanzenberg
“Recent Studies of the Electron Cloud Induced Beam Instability at the Los Alamos PSR”, R. Macek

• Short pulses are now significantly more unstable than longer pulses, contrary to experience for many years before ~2006-7.

• What is different now?
  – Operating the ring at 72.070 instead of 72.000 subharmonic of the linac bunch frequency. The 72.000 subharmonic operation introduces some high frequency structure to the longitudinal profile of the beam pulse
  – Beam scrubbing over time changes SEY

• The 72.070 sub-harmonic operation produced significantly less longitudinal structure on the beam and made the beam somewhat more stable against e-p.

• The short pulse instability phenomenon for the operation at 72.070 subharmonic ring frequency was unexpected and is not well understood.: Why were short pulses more stable when operating at the 72.000 subharmonic?

• Need a systematic study of unstable motion, mode spectra and growth rates to see any trends between the 72.000 and 72.070 subharmonic regimes.
In the early run of MI, pressure bursts were observed at several locations: due to EC. The threshold beam intensity, however, increased gradually, and no pressure burst is seen now for highest beam intensity. $\delta_{\text{max}} < 1.3$.

Mitigation measures may be required in the Project X, which will operate with significantly beam intensities.

Coating of the stainless steel vacuum chamber with both TiN and a-C coatings has been tried.

Scrubbing is effective in the MI which is different from other proton machine (PSR or SNS). The intensity is much higher for MI but is similar to SPS.

**Plans:**

- Develop new instrumentation, particularly for the dipoles, to measure ecloud
- Measure SEY conditioning in MI with Cornell station and eventually in a dipole
- Simulation program to be able to extrapolate the observed conditioning
- Bench experiments with coatings and conditioning
“Recent Experimental Results on Amorphous Carbon Coating for Electron Cloud Mitigation in CERN SPS”, C. Y. Valigren

• New solution – Amorphous Carbon Coating
  – Can be implemented in the present SPS-dipoles without aperture reduction
  – Does not require bake-out
  – SEY is low. $\delta_{\text{max}}=0.9-1.1$
  – Not very reactive,

• Four different coating configurations were used. (DC magnetron sputtering)

• EC signal is $10^4$ higher on StSt than a-C. (SPS, using ECM)

• No sign of ageing in the SPS.

• The coatings of liners do not show ageing (increase of SEY) after more than 1 year of exposure in the SPS.

• The future activities:
  – modifying the coating to coat beam pipes on a large scale with the same quality
  – develop a deeper understanding of a-C thin film both in the lab and in the SPS
  – develop a deeper understanding of the relationship between dynamic pressure rise and e-cloud effect
  – determine the mechanical stability of the coatings – flaking, etc.
“Can Electron Multipacting Explain the Pressure Rise in a Cold Bore Superconducting Undulator?”, S. Casalbuoni

• In ANKA, the performance is limited by an excessively high beam heat load - beam heat load observed cannot be explained by synchrotron radiation from upstream bending and resistive wall heating.
• Equations of gas dynamic balance were developed.
• Taking into account the contribution of molecules desorbed by electrons, it is possible to reproduce the observed behavior of the pressure by varying the input parameters through a the range of values found in the literature.
• A common cause of electron bombardment is the buildup of an electron cloud that depends strongly on the chamber surface properties – especially for cryosorbed gas layer. Steep rise in electron current once a threshold is reached – multipacting.
• Heat load from simulations using the ECLOUD code is about an order of magnitude lower than the measurements.
• More detailed calculations under way with the inclusion of the ion cloud potential in ECLOUD code.
“Emittance Growth and Tune Spectra at PETRA III”, R. Wanzenberg

- Vertical emittance growth has been observed at PETRA III for long bunch trains with 8 ns and 16 ns bunch spacing.
- There a “upper-sidebands” in the tune spectra with a clear build-up along the bunch train and the measured tune spectra show characteristics that have been observed at other storage rings in connection with electron cloud effects.
- Instability threshold (coasting beam model) is $1.4 \times 10^{12}$ m$^{-3}$ electron cloud density with an estimated center density $\sim 2.5 \times 10^{12}$ m$^{-3}$ using ECLOUD 4.0.
- The tune shift is much larger than expected from estimates based on the average charge density (neutrality condition).
- A filling pattern has been found (40 x 4 bunches and 60 x 4 bunches) with no significant emittance growth. But simulations indicate the same center density for both filling patterns...?.
Comments

- Various ECLOUD-related phenomena are now reproduced by simulation codes. But the quantitative agreement still has room for improvement (e.g., electron beam case).
- a-C coatings as well as TiN coatings are very promising. Controlling the surface properties of the coatings is the major remained problem for the application of these coatings on a large scale.
- Better understanding of the conditioning of the surfaces is needed.