Summary: Electron Cloud Effects and Two-Stream Instabilities at High Intensity, Medium Energy Proton Rings

Robert L. Kustom

Bob Macek and Andy Bowman presented a comprehensive review of the experimental data that has been accumulated on the PSR instability. The experimental evidence from the PSR is highly suggestive of an e-p instability as previously observed on the ISR. The measurements of relative threshold values for instability level as a function of RF voltage is consistent with calculated values using the original theory developed at CERN (by Zotter and others) as presented in this Workshop by Bruno Zotter. There is supporting evidence for the e-p instability provided by the existence and growth of high frequency oscillations in the transverse plane at the bounce frequencies of electrons in the potential well of the beam and by recent measurements on electron production.

The recent electron measurements were made using an electron probe designed by Richard Rosenberg of Argonne National Laboratory modified by Andy Browman. The electron detector signal indicates a large pulse of electrons hits the wall as the end of the beam bunch passes. The number of electrons hitting the wall is considerably larger when the beam goes unstable, but it has not been possible to quantify the increase because the amplifiers saturate.

A stainless steel vacuum pipe section was tested for electron generation with and without a titanium nitride coating. The addition of a TiN coating reduced the electron production by about a factor of 100.

The RF cavity was driven with a dual harmonic drive that provided a bunching field that was the sum of a voltage at the fundamental frequency and approximately 50% of the voltage at the second harmonic. The charge distribution of the bunch was made much more uniform, as expected. The threshold curve for the instability, however, was defined by the voltage of the fundamental component only and was identical to threshold values without any contribution from the second harmonic component.

Inductive liners sufficient to passively compensate longitudinal space charge were also installed in the PSR and the instability threshold values were measured. The addition of the inductive liners reduced the voltage on the fundamental cavity for comparable values of instability threshold.

Behavior similar to the PSR instability on other machines was reported at the workshop. Notably the AGS Booster at BNL (presented by M. Blaskiewicz) and on machines at Novosibirsk (presented by V. Dudnikov) under certain conditions exhibited similar behavior.

T. Wang, R Davidson, A. Alexandrov, H. Qin, and M. Blaskiewicz presented analytical/numerical studies on the e-p instability. The instability behavior can be

predicted to a level that allows relative scaling of threshold values and specification of the accumulator and storage ring hardware for providing Landau damping.

There is no satisfactory theory for the formation of the electrons with the bunched beam and their survival during the beam gaps. As a result, the absolute values for instability threshold cannot be predicted from nominal beam parameters, and so, no basis exists for predicting whether the performance of new rings will be affected by the instability, and if so, at what level of stored beam.