

Beam loss mechanisms in the PIP-II linac and beam transfer line at Fermilab

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Beam loss in high-intensity H⁻ linacs, such as the PIP-II linac at Fermilab, is a critical challenge that requires comprehensive study and understanding to ensure efficient and safe operation. This study explores the various beam loss mechanisms encountered in the PIP-II linac and its beam transfer line, drawing parallels from other high-intensity H⁻ linacs. Key loss mechanisms include residual gas stripping, where H⁻ ions interact with residual gas molecules leading to electron detachment; field stripping, caused by the interaction of H⁻ ions with magnetic fields; and intra-beam stripping, resulting from interactions within the beam itself. Beam halo formation, particularly due to Twiss function mismatch, is another significant source of beam loss, which can be exacerbated by Landau damping mechanisms. Adhering to the 1 W/m loss criterion is essential to maintain hands-on maintenance capability and ensure the longevity of the accelerator components. By understanding these mechanisms and implementing targeted mitigation strategies, the PIP-II linac can achieve its design goals while maintaining safe and efficient operations.

Footnotes

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