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## Laser cooling of relativistic ion beams

We present an overview of laser cooling as a new method to cool highly relativistic beams at future research facilities such as FAIR and HIAF. We first dive into understanding the mechanisms of laser cooling at relativistic energies, giving estimates for cooling times and their scaling with beam energy and ion charge state for a given accelerator. We further look into the specific beam dynamics of ultracold ion beams and the need for and prospects of using optical diagnostics to investigate the longitudinal dynamics of laser cooled beams as a complimentary technique to high resolution Schottky dynamics. We will present results from laser cooling of ion beams at various storage rings, including ESR and CSRe, that illustrate the technical requirements for successful laser cooling with special emphasis on the development of suitable laser systems. We conclude by focusing on the exciting physics that become accessible with ultracold, highly relativistic ion beams.

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