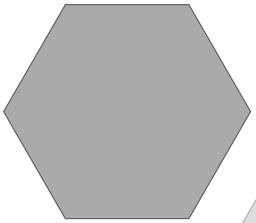
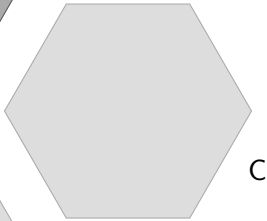
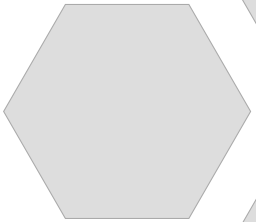
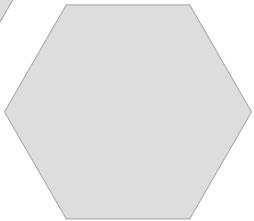
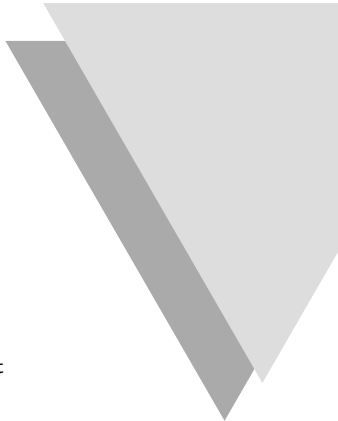






Ensembles

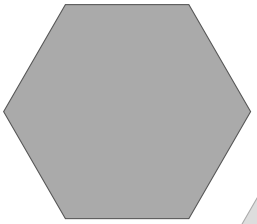
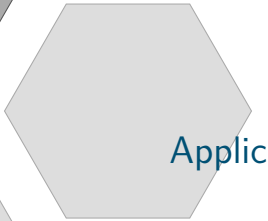
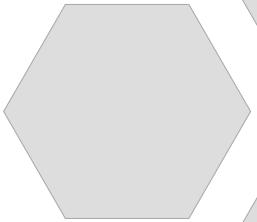
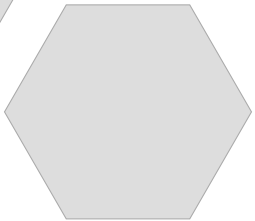
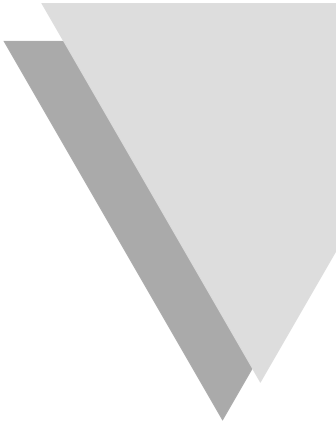
NNP Seminar

Christoph Beberweil

Institute of Applied Physics | Goethe University Frankfurt

November 9, 2023

Contents

Applications of ensembles

Focusing

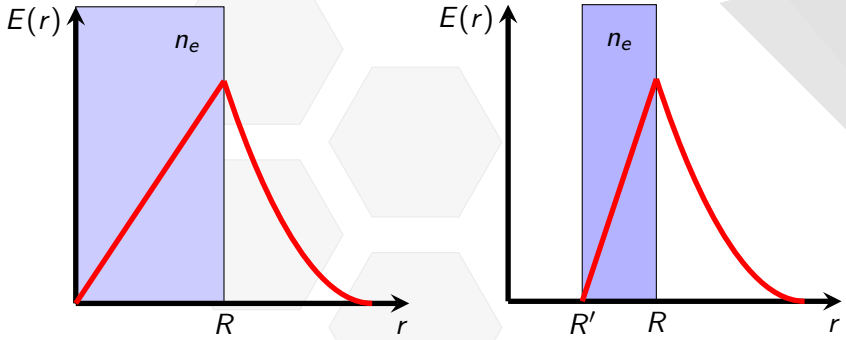


Figure: Sketch of the radial electric field of two electron distributions. Left: Homogeneous distribution. Right: Torus distribution.

Electron Cooling

- Velocity of electrons matches velocity of ion beam
- Heat transfer between both beams
- Heat is removed from the system as the electrons are extracted

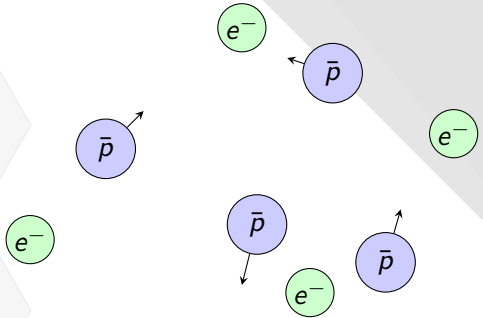
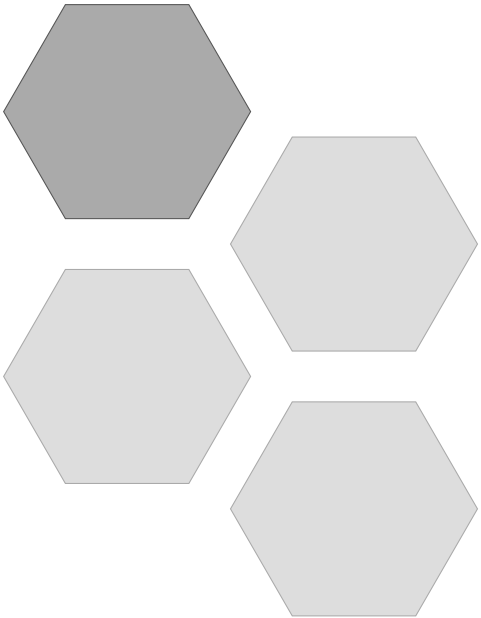


Figure: Electrons and ions in the electrons rest frame



Machines

Fermilab IOTA

- Pulsed Electron lens act as nonlinear optics by applying kicks to a circulating beam
- Investigation of a large tune spread in a storage ring

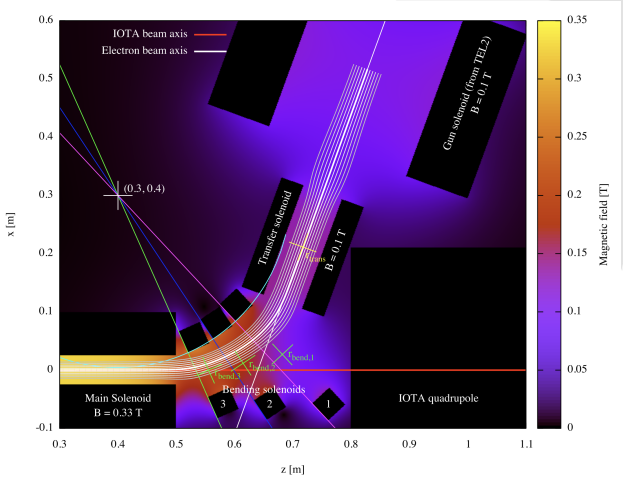
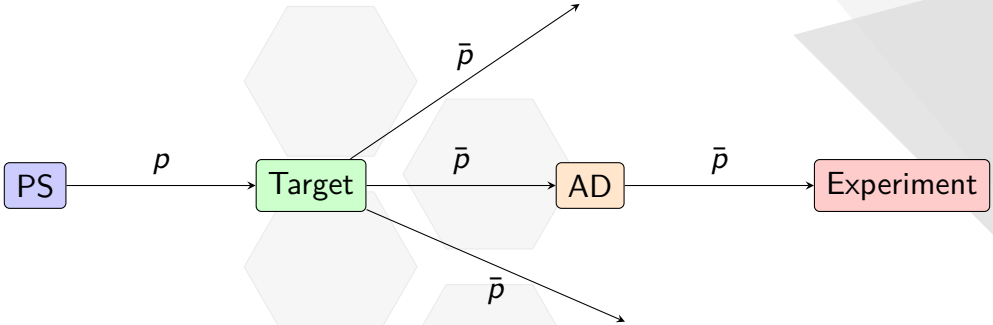


Figure: Simulation and schematic of the initial electron lens design at Fermilab IOTA[1]

CERN Generation of antiprotons



- Proton Synchrotron emits a proton beam on a metal target
- Antiprotons are generated with a wide distribution of energy and velocity
- Some antiprotons can be injected into the Antiproton Decelerator
- Antiprotons are decelerated and cooled for experiments

AD-Cooler

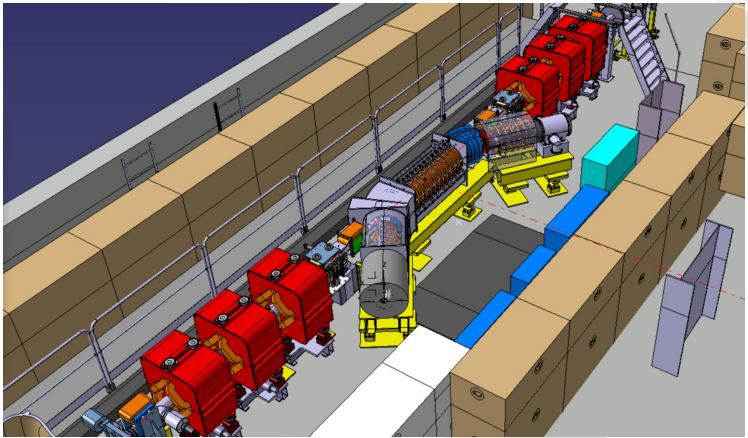


Figure: Computer rendering of the AD-Cooler in the Antiproton Decelerator at CERN [2]

Cooling

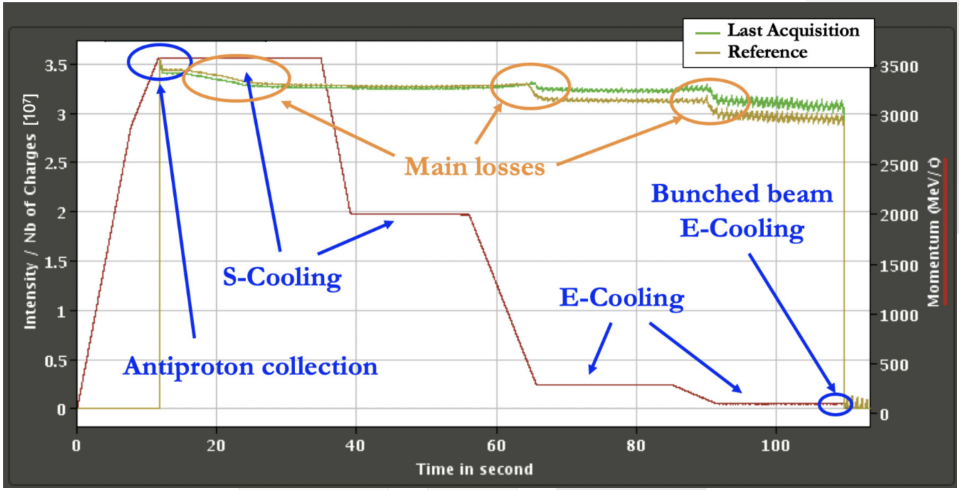
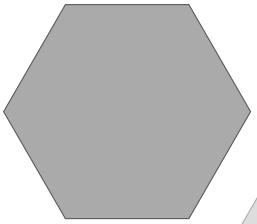
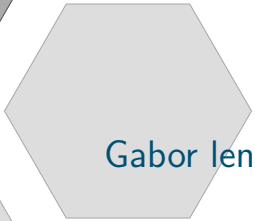
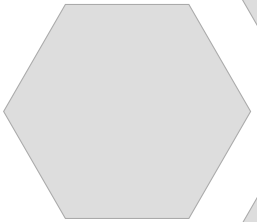
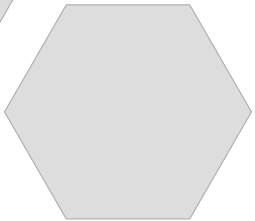
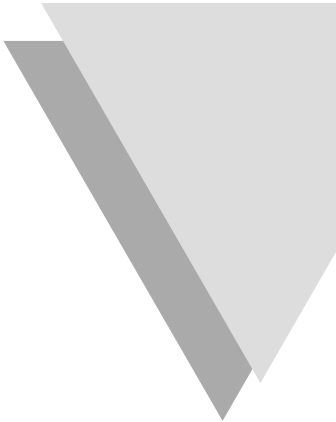


Figure: Cooling modes of the AD. Stochastic(kicker) & electron cooling.[3]

Gabor lenses and Electron sources

Gabor lenses and Electron sources

Figure: Electron Source. Physicists at work [4]

Gabor lenses and Electron sources

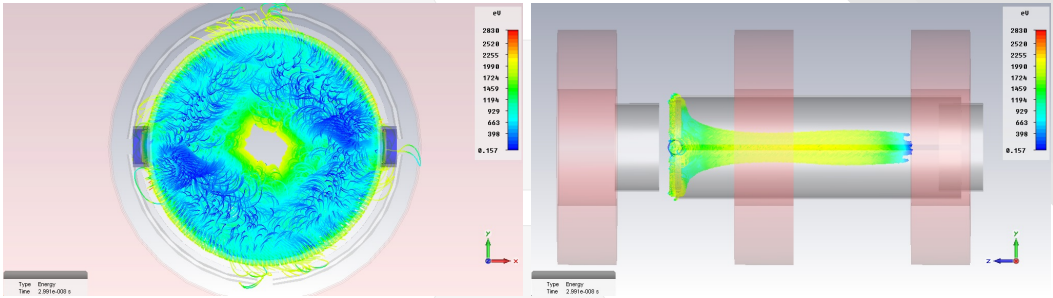


Figure: Gabor Cusp Design for injecting electrons in a Gabor lens. CST. [4]

Gabor lenses and Electron sources

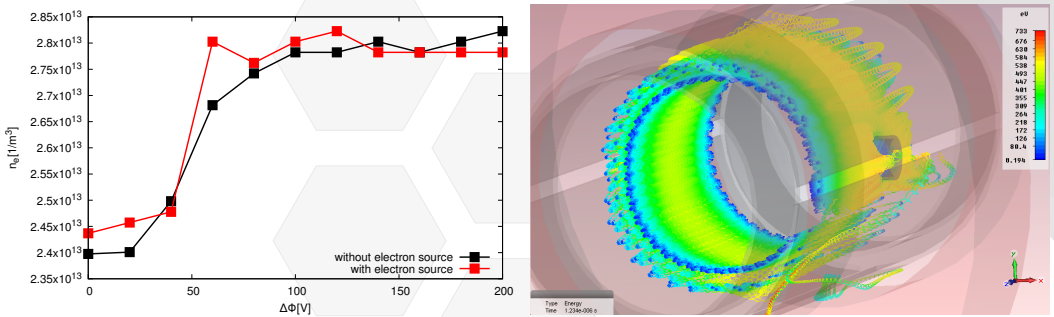


Figure: Density boosting in a Gabor lens using an electron source. Left: Density Measurement via momentum spectrum. Right: CST Simulation of electron movement with an internal electron source. [4]

Gabor lenses and Electron sources

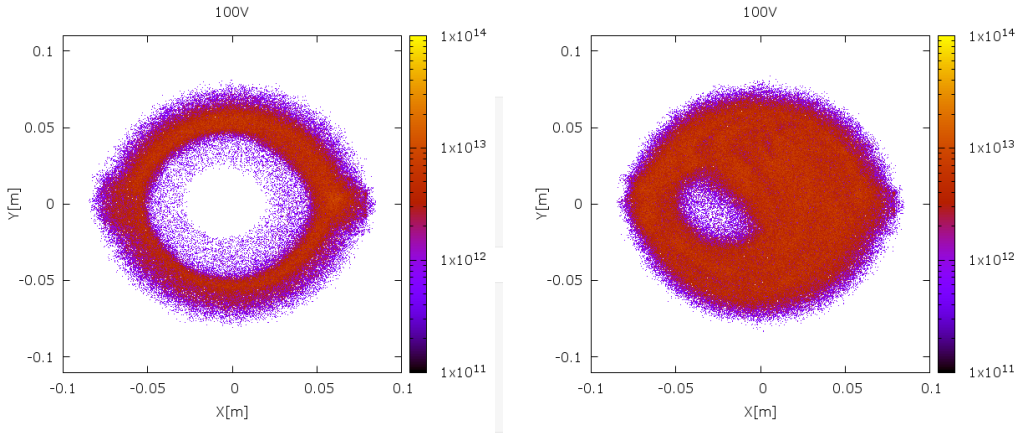


Figure: Long time simulations of externally supplied electron and their drifts in a Gabor Lens. Bender. 5,000ns and 50,000ns simulation time. [4]

Planned Simulations

Fields and beam Propagation of the AD Cooler Structure

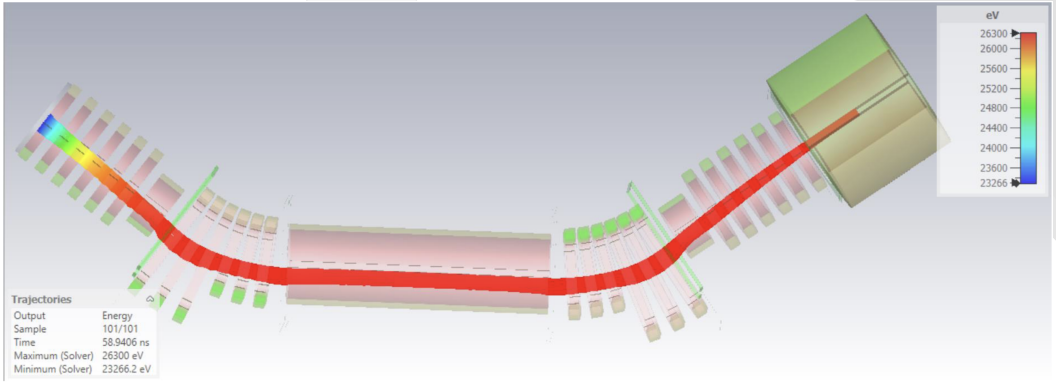
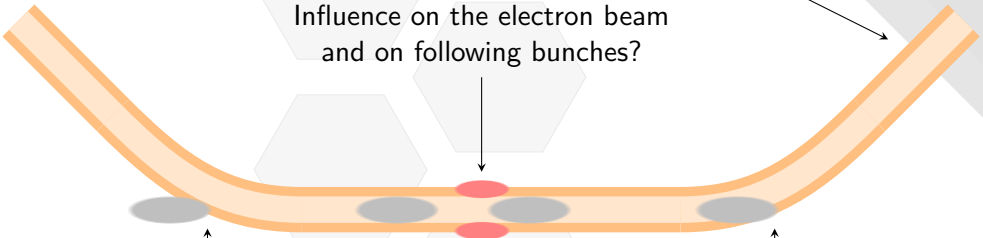


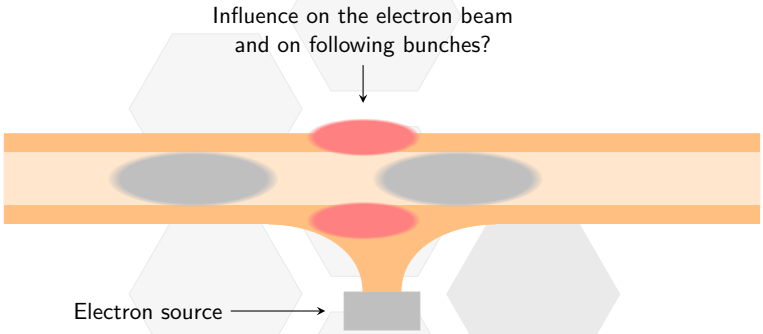
Figure: CST simulation of electron trajectories in the AD Cooler. [5]

Space charge effects of both beams



Static alternative for the AD-Cooler

- Realize the interaction section by using a Gabor lens
- Entry and exit are clear
- Plasma parameters can be adjusted



Thank you

Questions? Remarks?

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Christoph Beberweil, Martin Droba, S Klaproth, O Meusel, D Noll, H Podlech, K Schulte, KI Thoma, S Gammino, D Mascali, et al.

Investigation of electron beam assisted density boosting in plasma traps using the example of a Gabor plasma lens.

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Gunn KHATRI (CERN).

Ad cons e-cooler: first simulation of complete system.