Trap

Rotating wall and Temperature monitor

박관형

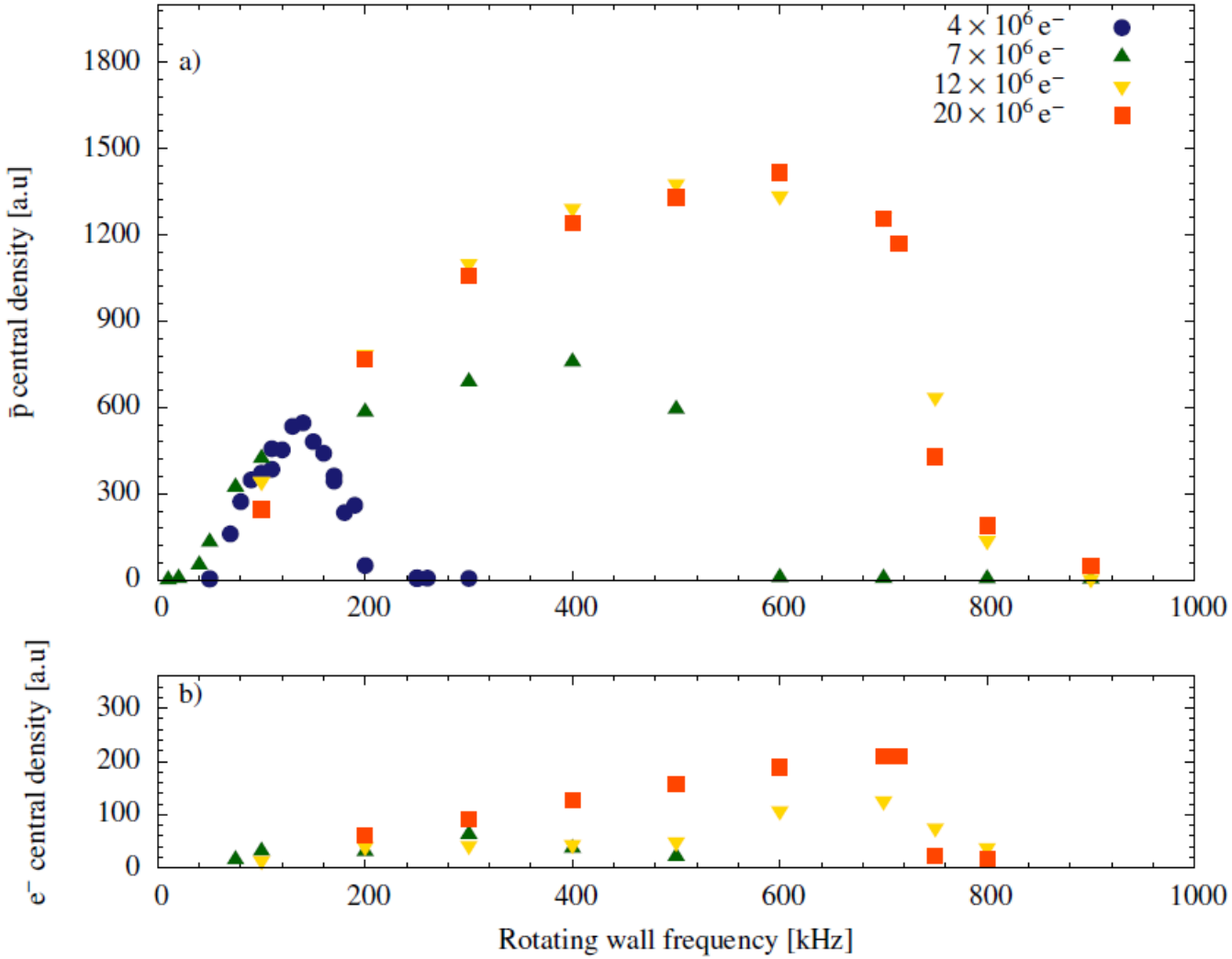

Figure 6.4: Central density after applying the rotating wall for 100 s, at 1 V and at a chosen frequency. a) Antiproton central density when cooled by different number of electrons. b) Electron central density from the same measurements in a). No points are shown for 4×10^6 electrons, because the electron plasma was not visible and a fit could not be performed. The arbitrary units (a.u.) are the same for antiprotons and electrons.

At Optimal configuration,
(10~750 kHz)
Radius: ~4mm → ~0.2 mm
Central density: 1E+8 cm-3
P-bar: 1.5E+5

cf) sympathetic compression,
(10~25MHz)
Radius: ~4mm → ~0.4 mm
P-bar: 11000

Gutierrez, A., Ashkezari, M.D., Baquero-Ruiz, M. et al. Hyperfine Interact (2015) 235: 21. https://doi.org/10.1007/s10751-015-1202-4

Electron without p-bar

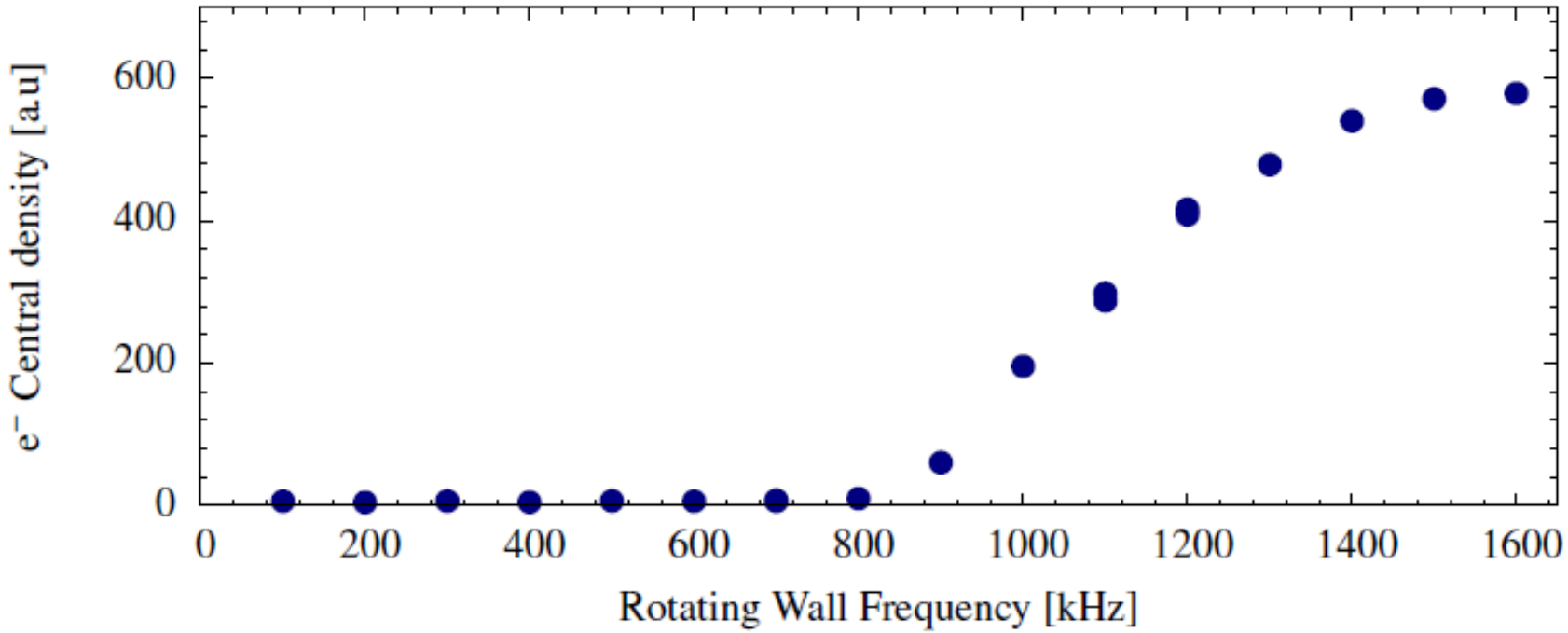

Figure 6.6: Central density of an electron plasma of about 20×10^6 electrons as a function of the rotating wall frequency. The rotating wall was applied for 100 s with an amplitude of 1 V. The plasma radially compresses above 750 kHz.

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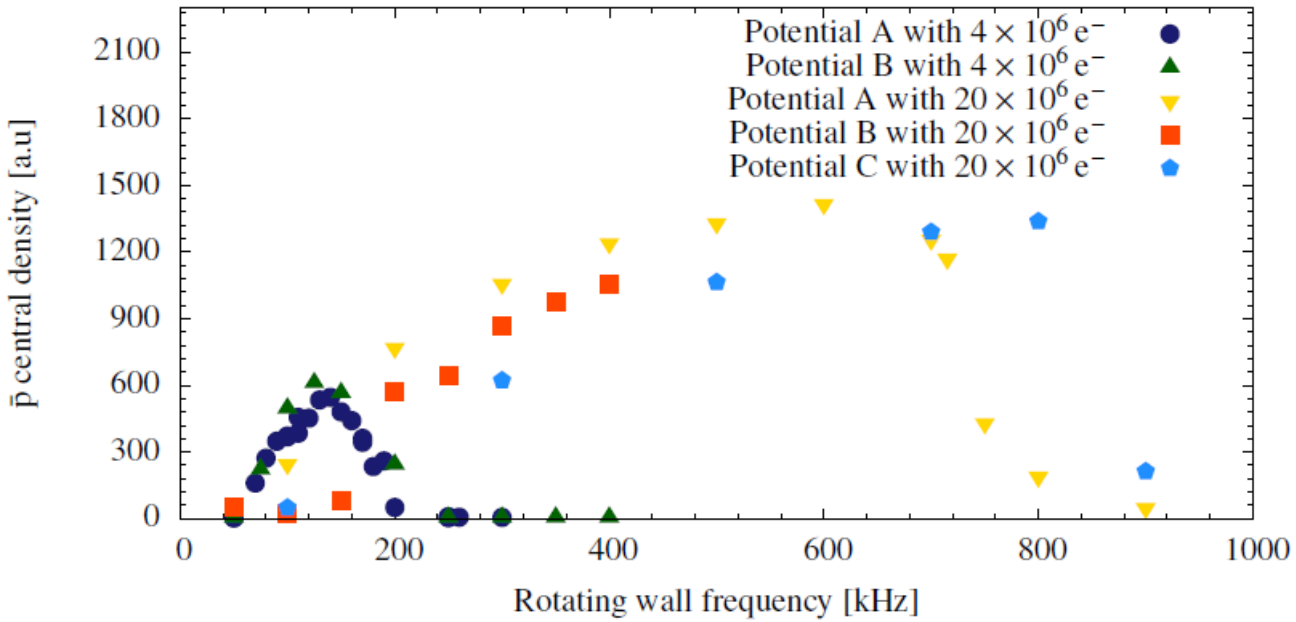
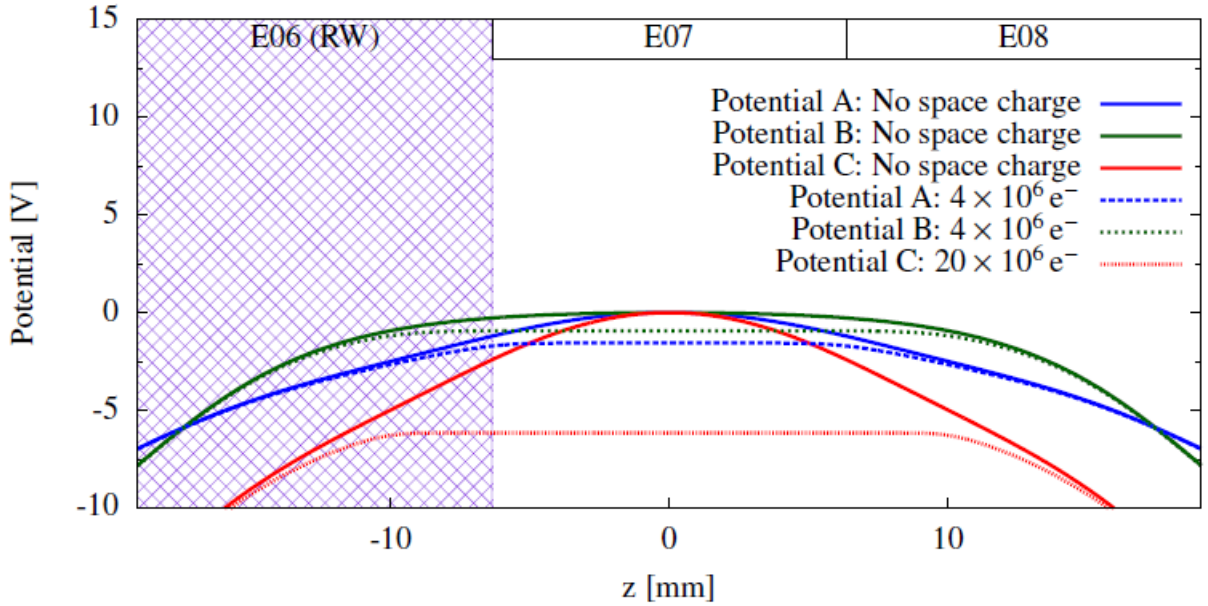
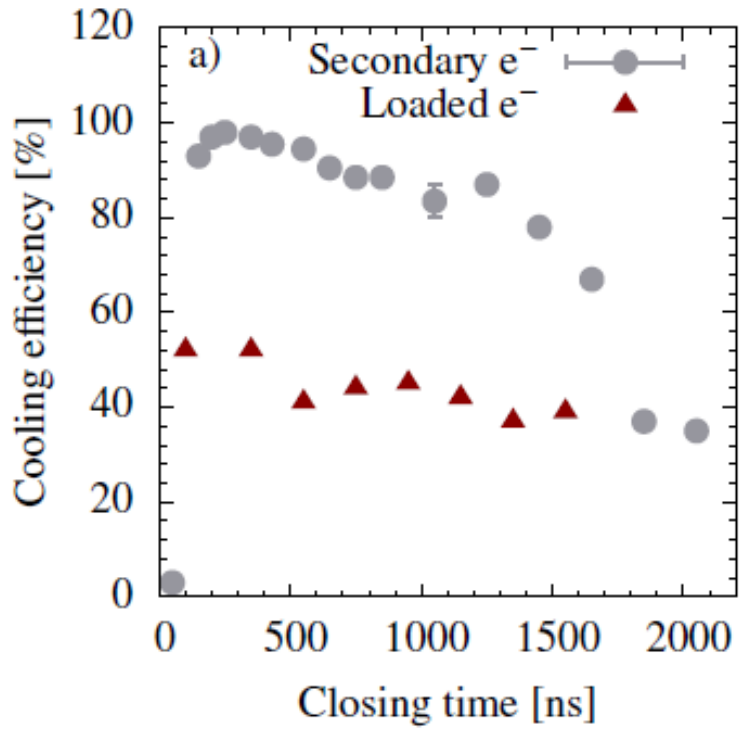
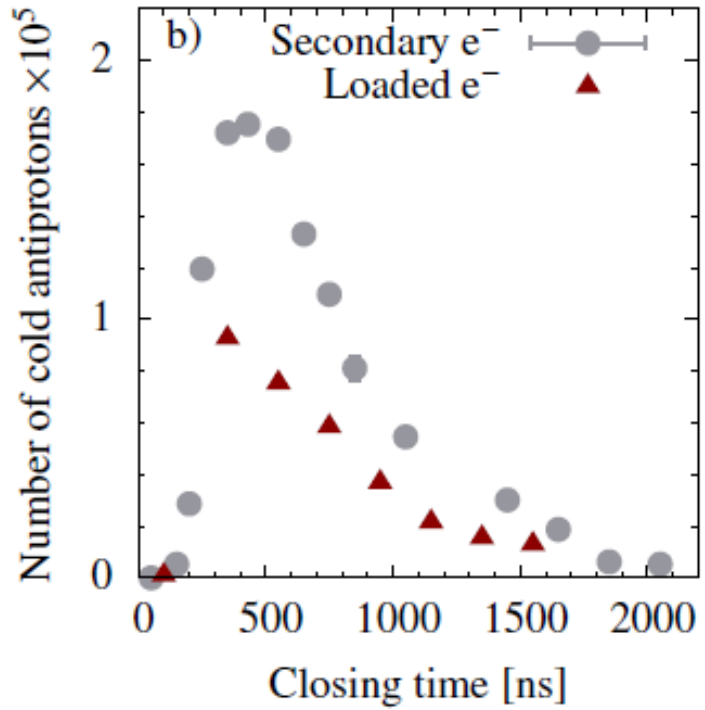




Gutierrez, A., Ashkezari, M.D., Baquero-Ruiz, M. et al. Hyperfine Interact (2015) 235: 21. https://doi.org/10.1007/s10751-015-1202-4


a)
Secondary e⁻
Loaded e⁻
Cooling efficiency [%]
120
100
80
60
40
20
0
0
500
1000
1500
2000
Closing time [ns]


b)
Secondary e⁻
Loaded e⁻
Number of cold antiprotons ×10⁵
2
1
0
0
500
1000
1500
2000
Closing time [ns]

- **Weak drive**: For weak rotating wall excitations, it was shown that electric fields transfer torque to the plasma by exciting Trivelpiece-Gould plasma modes [191]. The Trivelpiece-Gould modes carry angular momentum that can be transferred to the particles by a wave-particle coupling [189] as discussed above, also see section 7.1.3.

- **Strong drive**: When a larger amplitude rotating electric field coupled with a source of cooling is used, compression over a broad range of frequencies, without the need to couple the plasma to a specific mode, is observed [195–197].

- **Sideband cooling**: The sideband cooling mechanism in the single particle regime relies on the coupling of the cyclotron or axial motion with the magnetron motion of the particle produced by the rotating electric field. For example, the excitation of the cyclotron mode leads to a decrease of the radius of the magnetron mode, which results in the "axialization" of particles (i.e. the particle radially moves towards the axis), see section 7.1.6.

- **Bounce resonant transport**: The resonance on the bounce transport (axial and rotation motion) of particles (plasma or single particle regime) can result in compression (see section 7.1.7) .

Most likely

- **Sympathetic compression**: With two species of particles, compressing one species with the rotating wall can cause the other species to follow via Coulomb collisions [63]. ALPHA performs this type of compression, by applying a rotating wall to an antiproton-electron plasma, to compress the electron plasma that sympathetically compresses the antiproton cloud (see section 4.4).

Temperature monitor

- USB, Ethernet Comm only
- It may possible to integrated in LabVIEW but only via PC not cRIO