

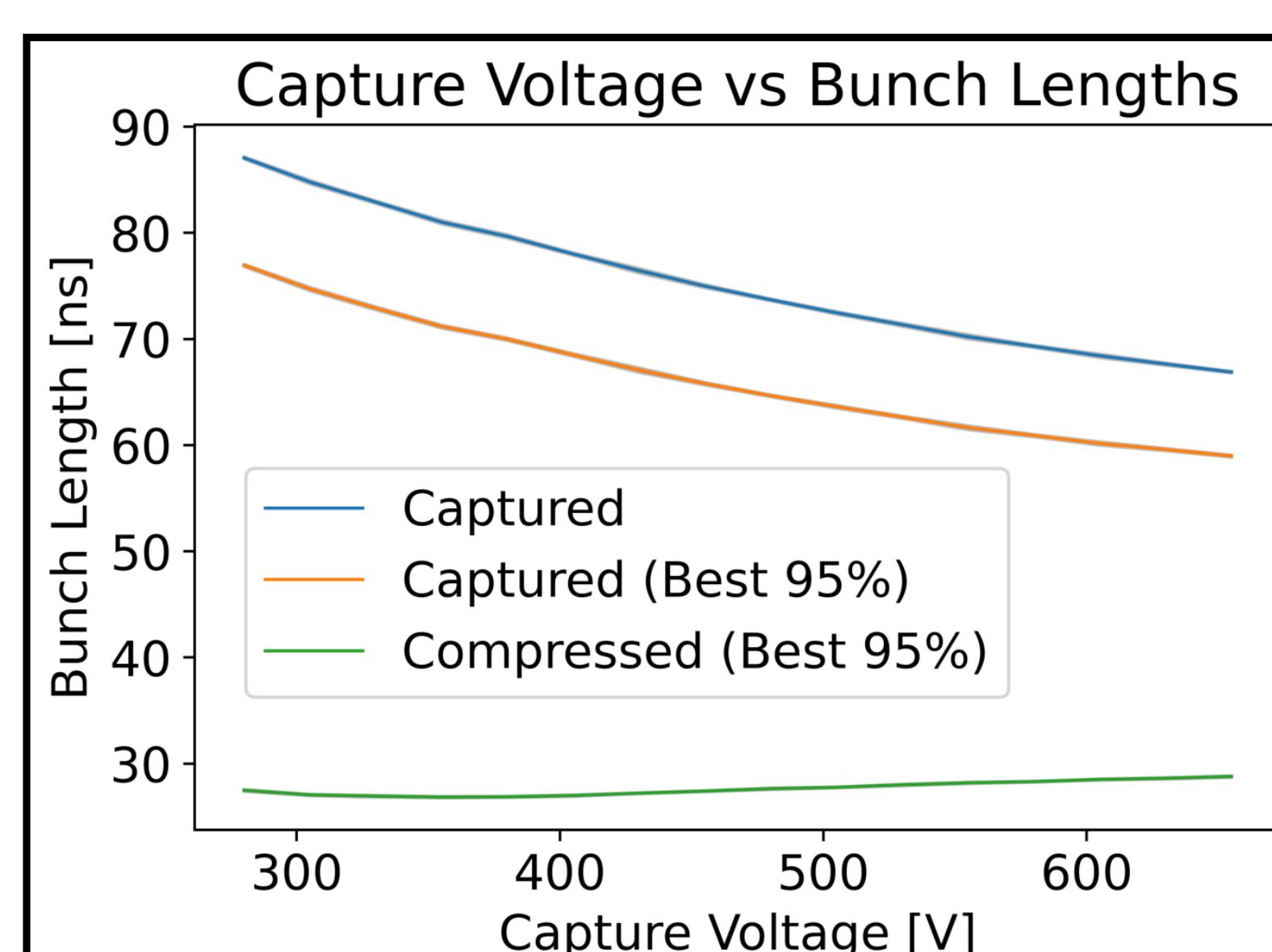
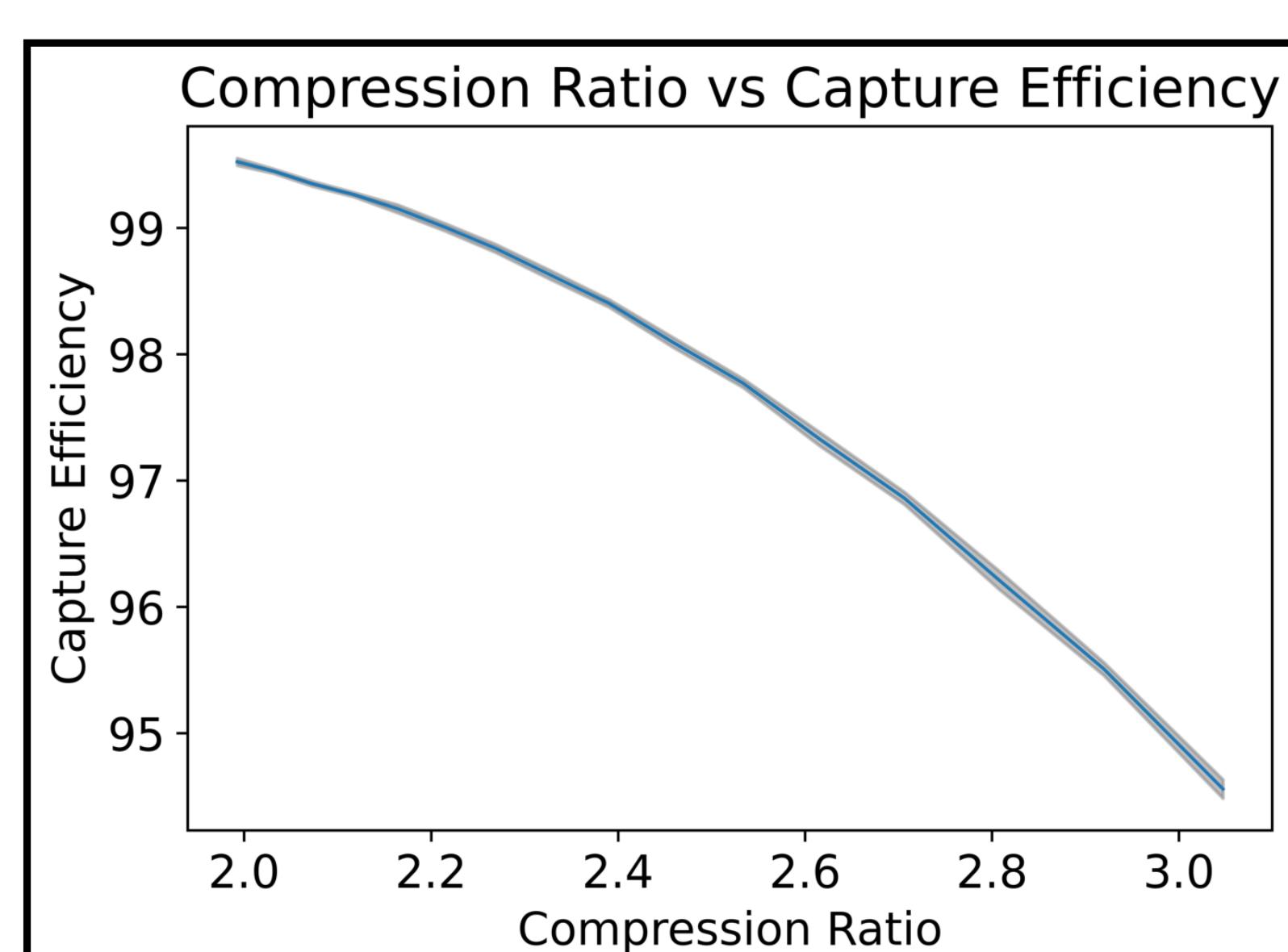
IOTA Experiment for Proton Pulse Compression at Extreme Space-charge

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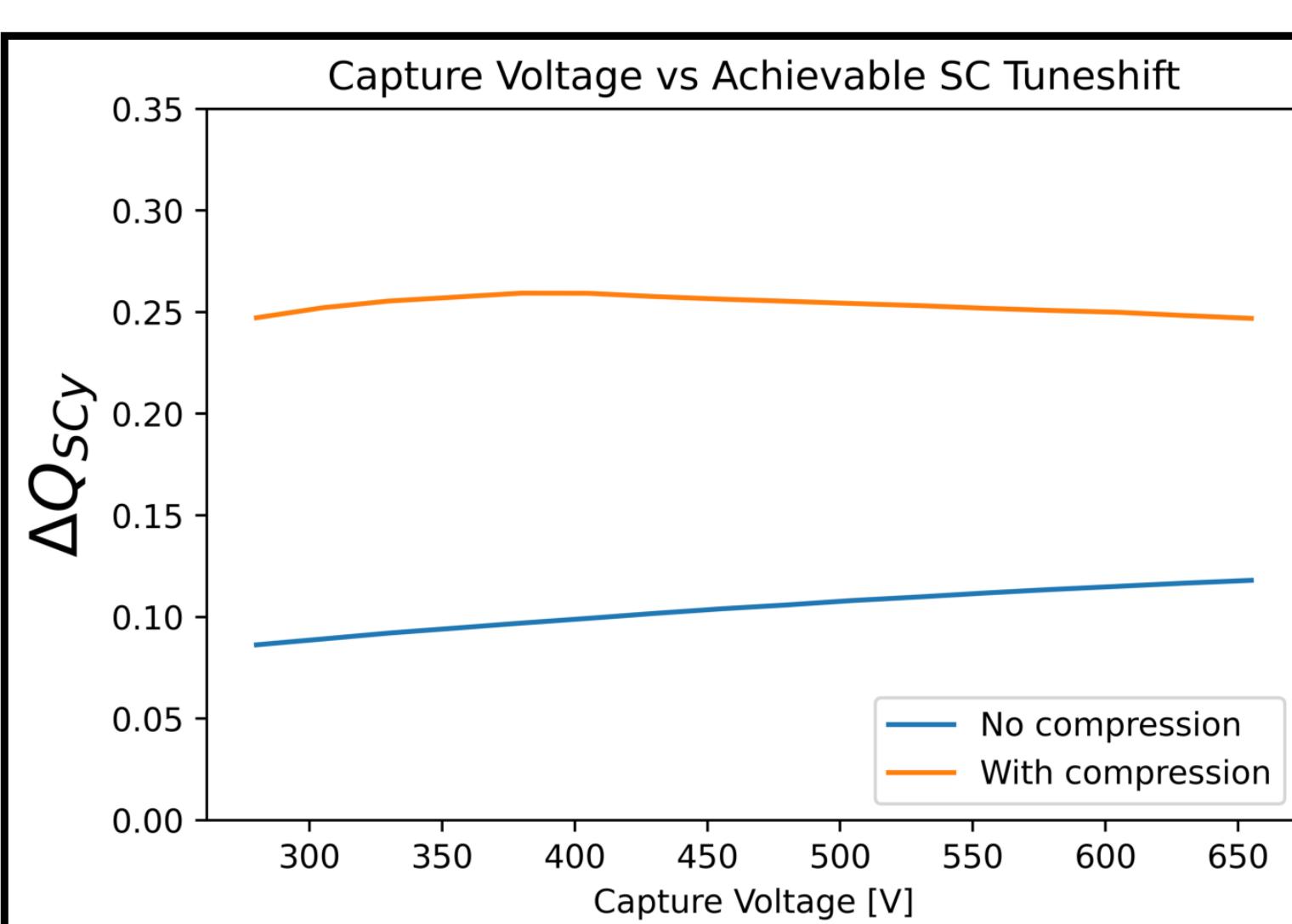
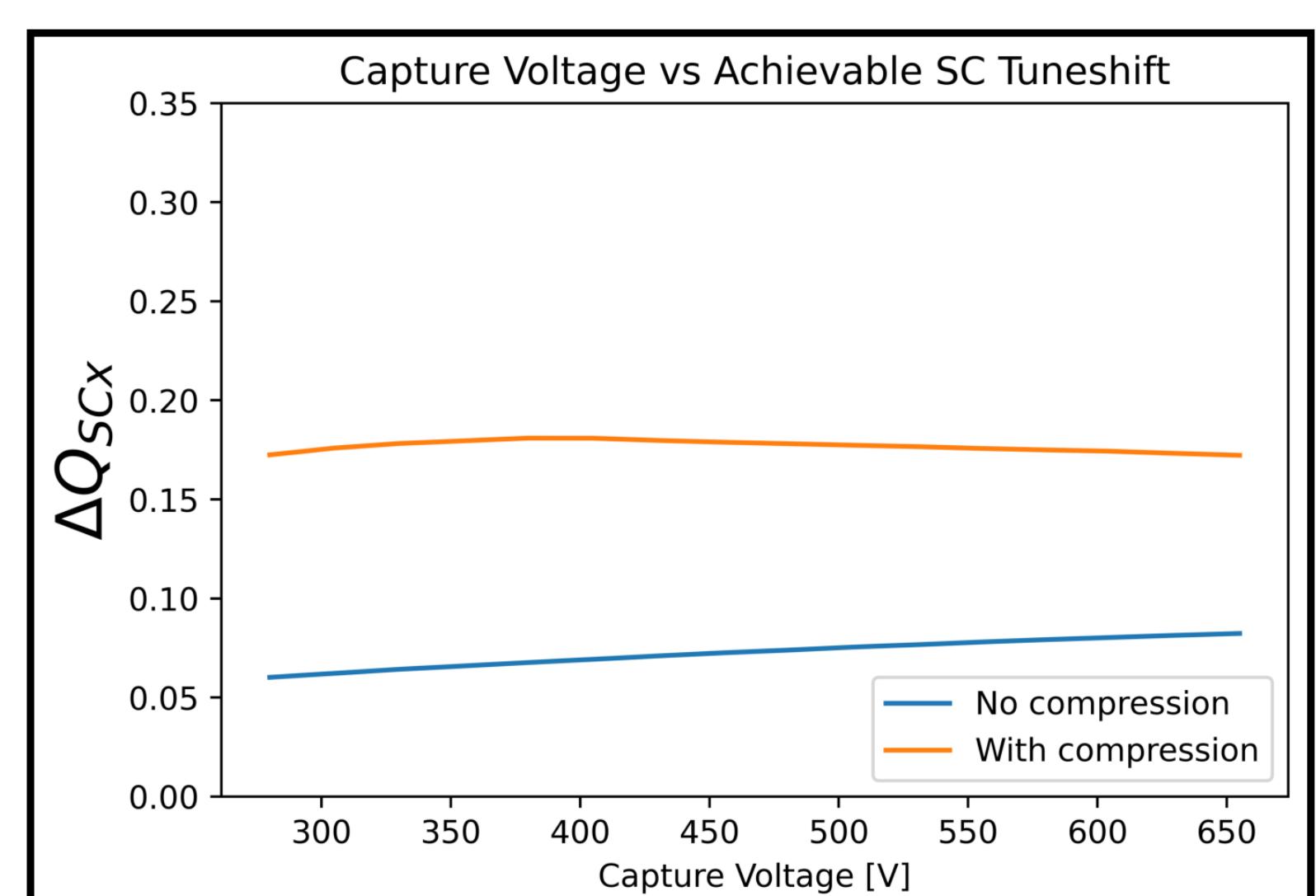
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IOTA is a compact fixed-energy storage ring that can circulate **2.5 MeV protons** with varying beam parameters and lattice configurations. We are designing an experiment that will demonstrate a **longitudinal bunch compression factor of at least 2** while examining the impact of **extreme space-charge** effects on the compression process.



From left to right: (L) Compression ratio after rotating vs adiabatic capture efficiency (R) Capture Voltages vs peak bunch charges, both after adiabatic capture and after rotation.



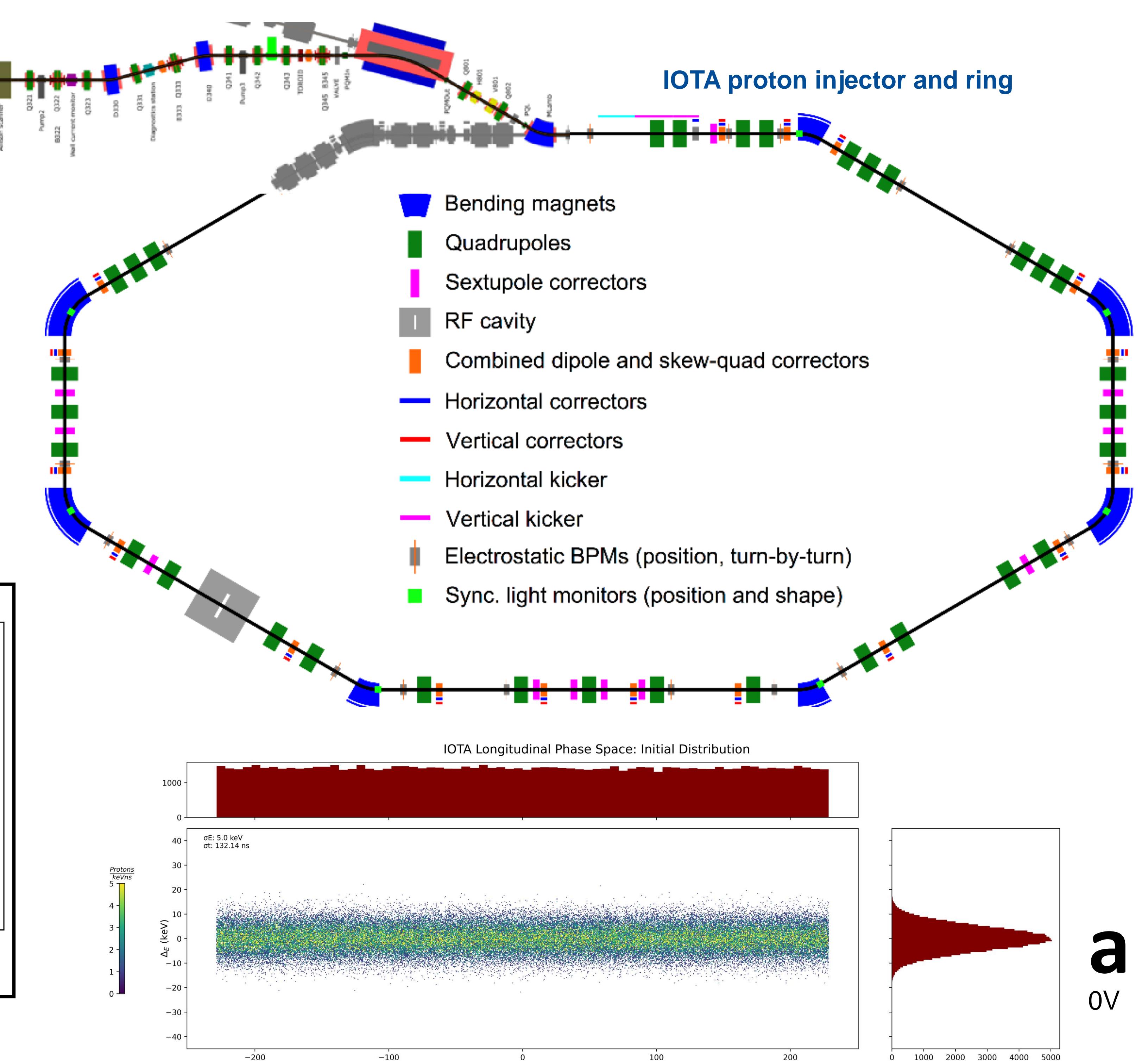
From left to right: (L) Capture voltage vs achievable SC tune shift for X (R) Capture voltage vs achievable SC tune shift for Y. All analysis done using an average current of 0.5 mA.

Parameter	Value	
	$h=56$	$h=4$
KE (MeV)	2.5	
Momentum (MeV/c)	65.5	
β	0.0723	
γ	1.00266	
dp/p	0.001	
σ_E (keV)	5.0	
Circumference (m)	39.97	
Period (ns)	1829.13	
I_{ave} (mA)	0.5	
f_0 (MHz)	30.6	2.187
N_{bunch} (protons)	1.019×10^8	1.427×10^9
$V_{cap}, \Delta E = 3\sigma_E$ (V)	9045	645
$V_{rot}, \Delta E = 3\sigma_E$ (V)	36180	2600
$\nu_s, V=1$ kV	0.0407	0.0109

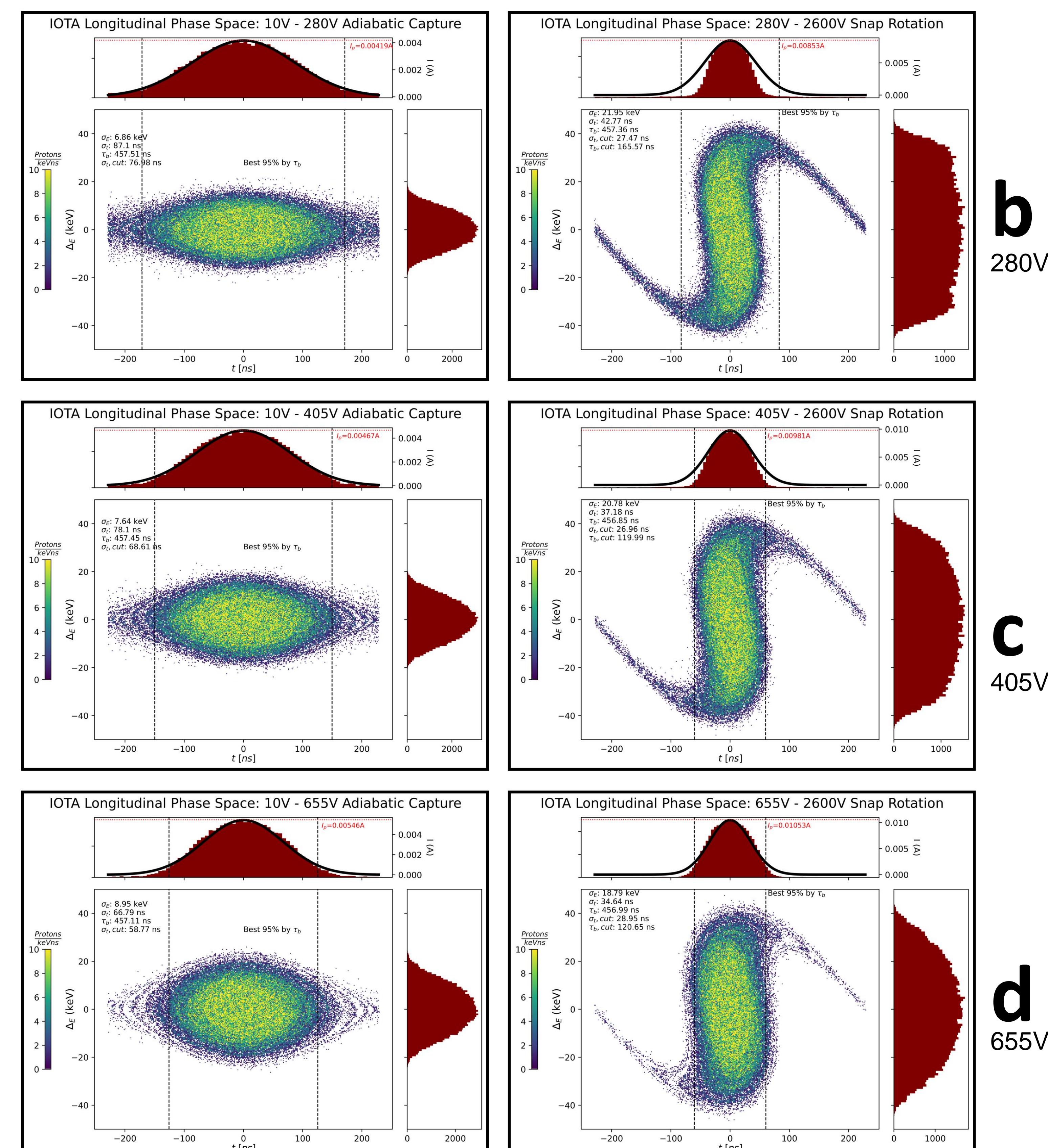
Table 1: Nominal parameters for considered RF systems.

Outlook

Results from this experiment, including the space-charge effects (more rigorous simulations w/SC are ongoing), are important for informing future Muon Collider (MC) designs. For more information on proton driver parameters for MCs, see the companion paper by Jeff Eldred, et al., TUPC41 “Adaptation of the Fermilab proton source to support new muon facilities”.



Adiabatic Capture and Snap Rotation



$\leftarrow t (ns) \rightarrow$

From top to bottom: (a) Initial debunched beam in IOTA ring (b) Compression factor of 3.0 and capture voltage of 280V (c) Compression factor of 2.5 and capture voltage of 405V (d) Compression factor of 2.0 and capture voltage of 655V