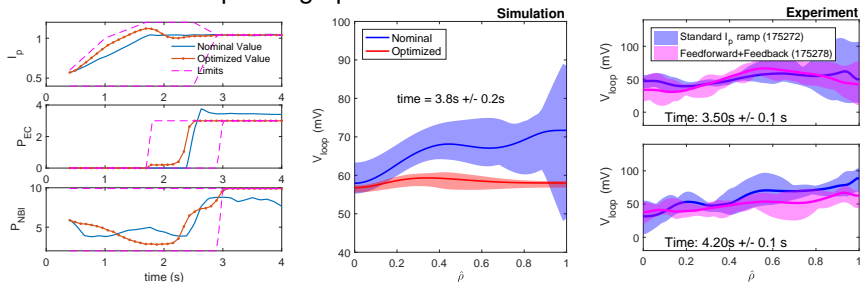


# Advanced Steady-state Scenarios Enabled by Model-based Real-time Optimization in DIII-D

- Optimize actuator waveform to minimize  $J$  which quantifies flatness of the loop voltage profile,  $\min_u J = \int_{t_1}^{t_2} \int_0^1 (V_{\text{loop}}(t, \hat{\rho}) - V_{\text{loop}}(t, 1))^2 d\hat{\rho} dt$
- Overshoot in the  $I_p$  ramp combined with certain timing of ECCD and NBI to reach flat loop voltage profile



- Feedforward control is combined with model-predictive feedback control (real-time optimization) to help track a plasma state evolution that is predicted to evolve to a flat loop voltage profile