Operational Experience of the new Booster Cryomodule at the Upgraded Injector Test Facility

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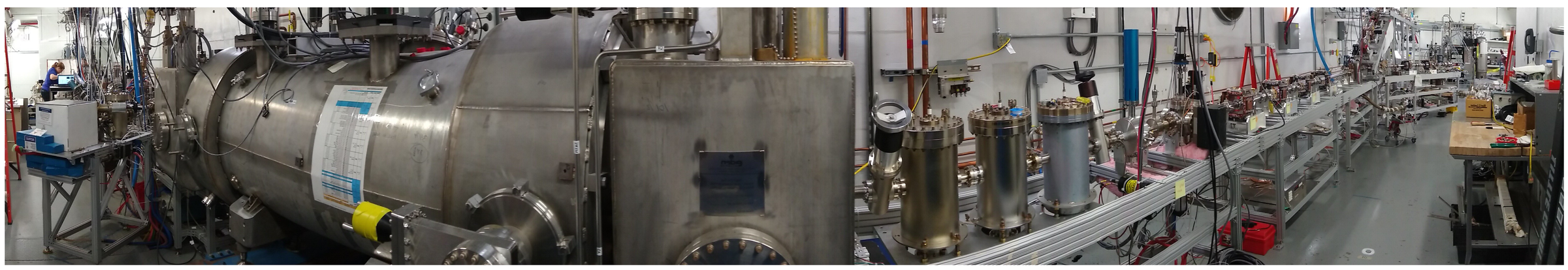
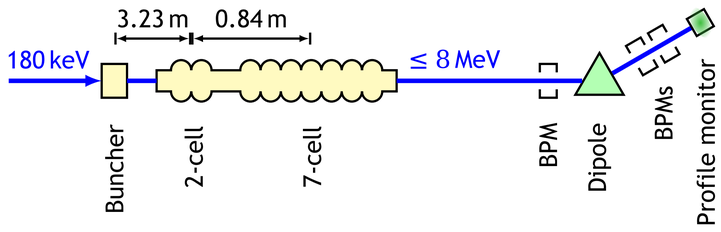
Upgraded Injector Test Facility (UITF)



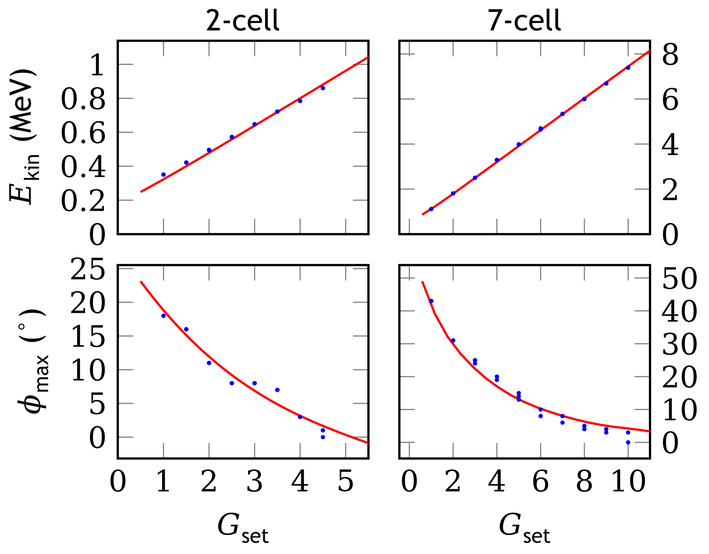
- Test setup for gun studies and component tests, but also beam experiments
- 180 kV gun, soon 200 kV (for CEBAF injector upgrade)
- SRF booster for CEBAF injector upgrade
- Final beam energy: ≤ 8 MeV
- Maximum average current: 100 nA (MeV beam, limited by radiation shielding)
- All cavities run at 1497 MHz



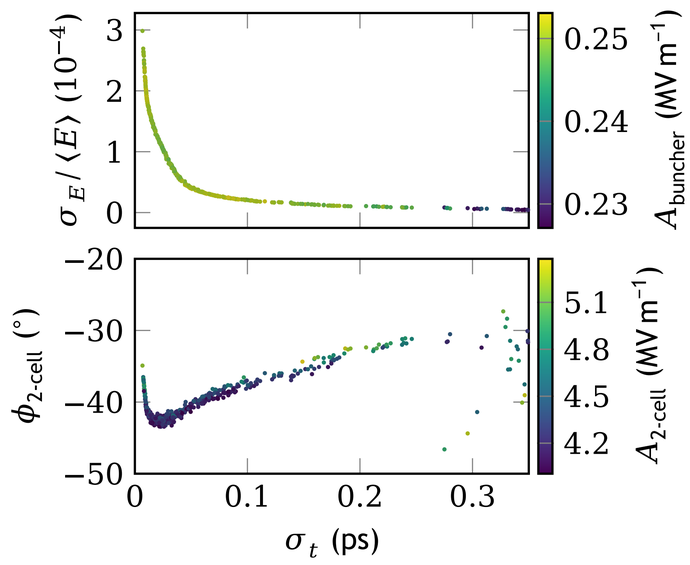
- Buncher creates temporal beam waist at 2-cell cavity
- $\beta \approx 0.9$ at exit of 2-cell, then accelerate to any energy
- Diagnostic dipole + BPM measures p_0 and $\delta p/p_0$

Design parameters	2-cell	7-cell
Final kinetic beam energy (MeV)	0.533	5
Peak on-axis E field (MV m^{-1})		
nominal	4.6	13.2
maximum	8.0	26.0
Beam current (mA)		
nominal	0.38	
maximum	1.0	
Q_0 min.	4×10^9	8×10^9

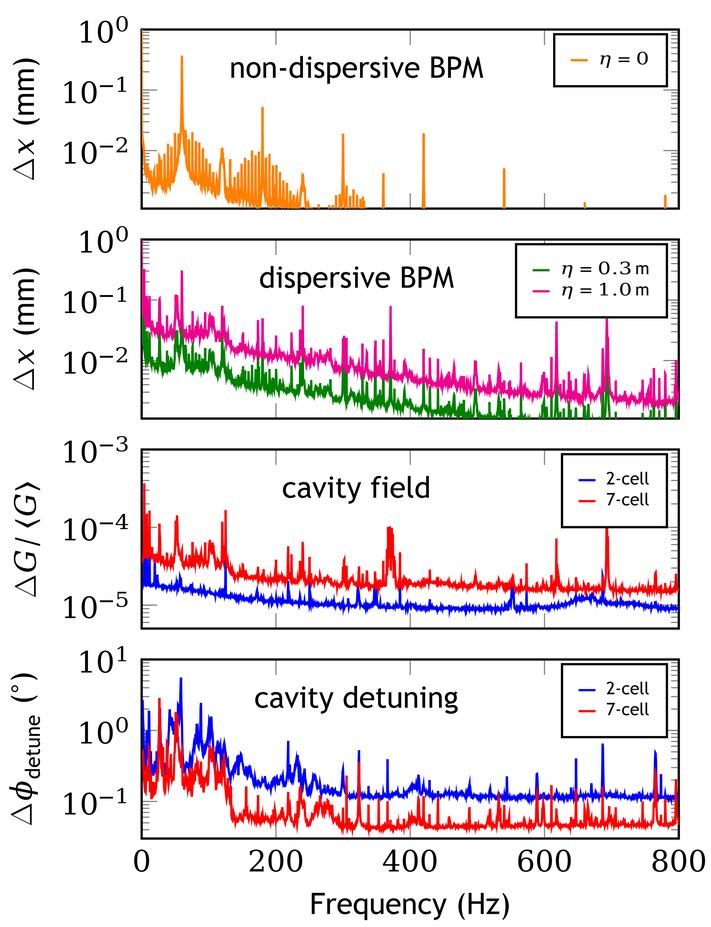
Cavity field calibration and phase space simulations

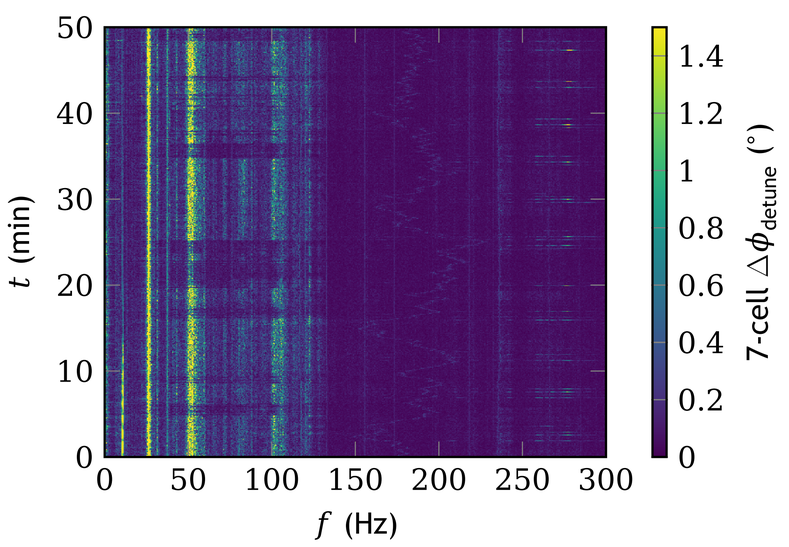


- Calibrate unit of field setpoint G_{set} vs. physical peak field A at phase of maximum energy gain ϕ_{max}
  - Measure $E_{kin}(G_{set})$ at $\phi_{max}(G_{set})$ with dipole
  - Simulate $E_{kin}(A)$ at $\phi_{max}(A)$ with GPT
  - Fit $E_{kin} = \alpha G_{set}$
    - $\alpha_{2\text{-cell}} = 2.017(15)$ MV m^{-1}
    - $\alpha_{7\text{-cell}} = 1.915(4)$ MV m^{-1}
  - Allowing for a global phase offset, good agreement
- Pareto optimization of bunch length σ_t and energy spread $\sigma_E/\langle E\rangle$
  - Ignore initial energy spread and transverse phase space for now
  - Slight overbunching at 2-cell is preferred
  - Operate 2-cell on rising RF slope to post-bunch

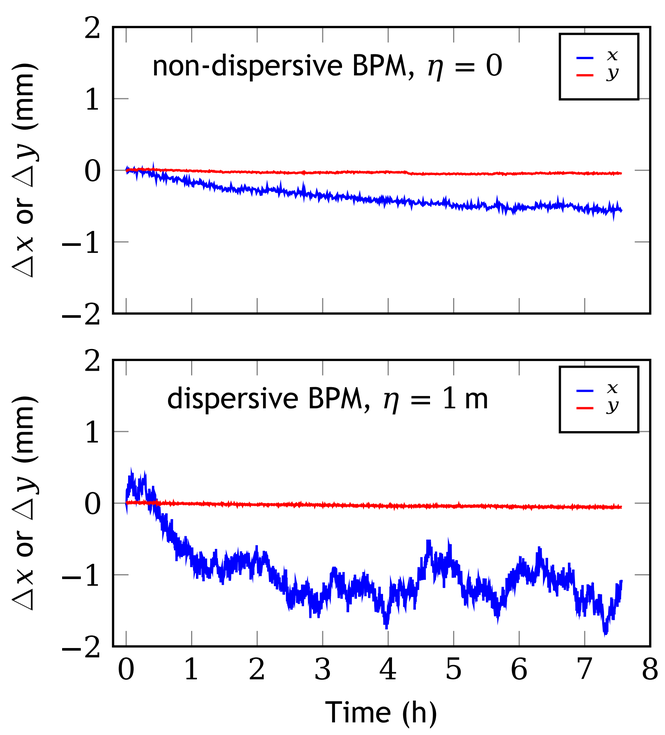


Microphonics and field stability





- Significant microphonic detuning, mostly environmental (machinery etc.)
- Field modulation is imprinted on beam
- Frequent sharp detuning spikes visible in spectrogram; source to be investigated
- Disturbances impact operational stability and effective beam quality



- Long-term study reveals non-dispersive orbit drift
- Relative beam momentum varies by several 10^{-4} in addition

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