

The Injector Process Driven Setup Status

(Improving the Process for Setting Up the CEBAF Injector)

Alicia Hofler

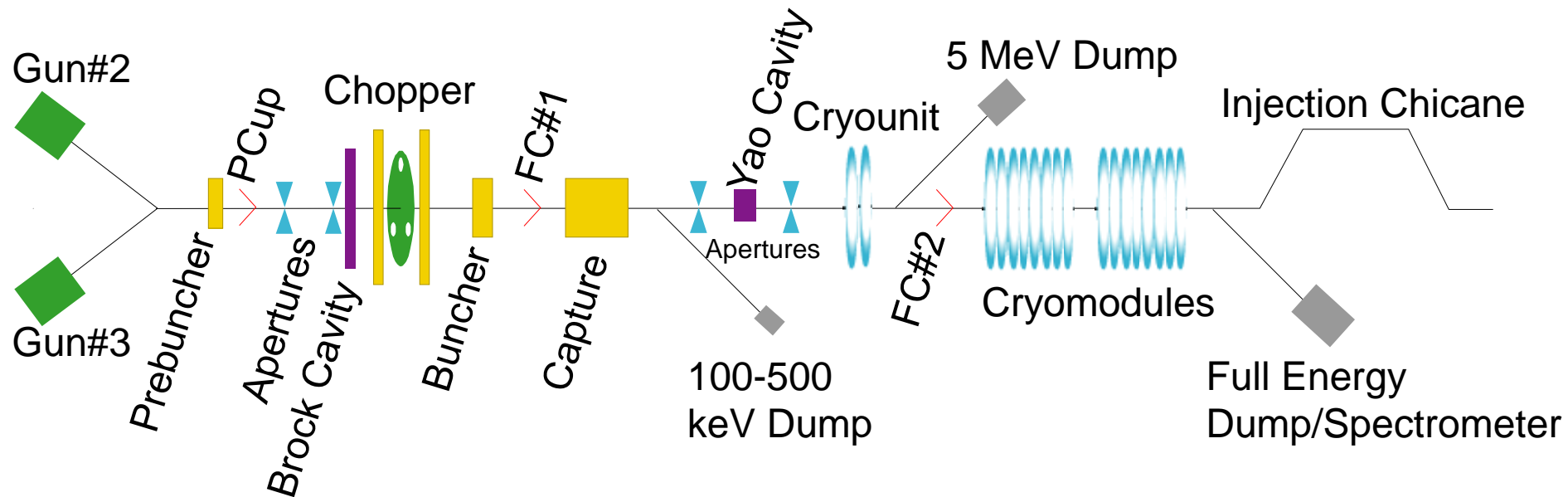
Fay Hannon

Reza Kazimi

Yan Wang

Outline

- Image problem
- Status and Plan
- Odds and ends requests
- Observation
- Summary



Problem: Perception vs. Reality

- Reza sits in the chair with little or no plan and does magic while his Injector acolytes watch
 - Reza has a standard set up process
 - On-going effort to update procedure documentation
 - Time spent diagnosing and working around unanticipated ramifications of injector hardware changes
 - RF calibration constants lost
 - Chopper solenoid setpoint reproducibility
 - Laser amplifiers and DC beam mode
 - 250 MHz laser phase changes
 - Chopper amplifier replacement
 - Available machine PSS configuration incompatible with beam set up goals
- Injector group makes rogue choices and changes
 - Undocumented solenoid changes – software bug
 - Linac quad change – outdated configuration file
- Poor communications
 - Routinely bring stakeholders together at group meetings to plan running and discuss operational problems
 - Room for improvement
 - Elog entries often sketchy and sporadic
 - Tech notes system underutilized
 - Follow-through on requests

The Plan

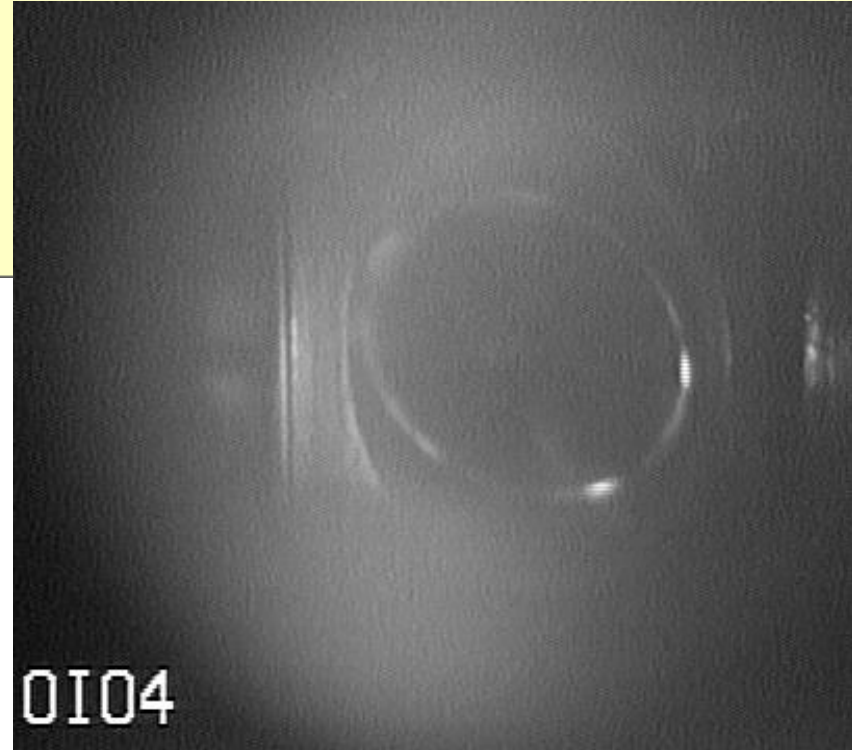
- Improve operational procedures
- Continue developing the injector model and optimization
- Verify model and operational settings
- Move to model-based injector set up

Procedure Status



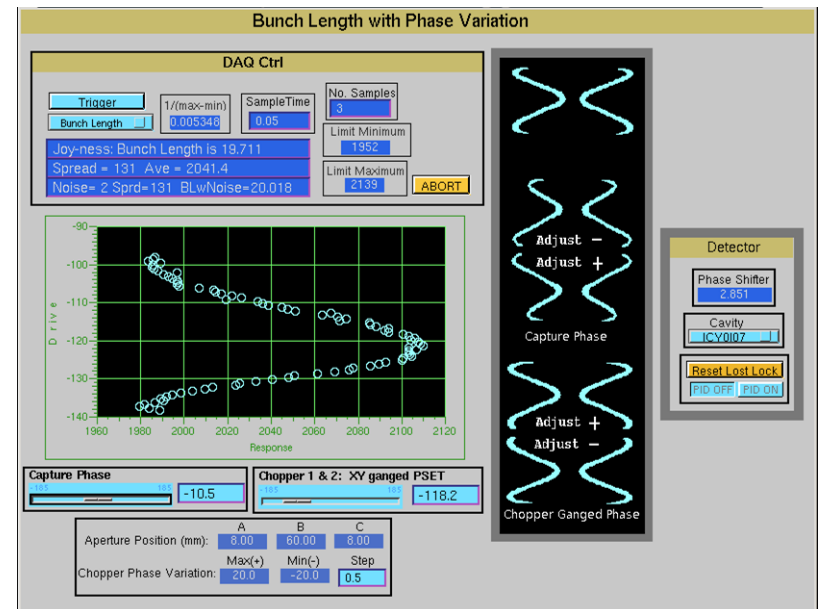
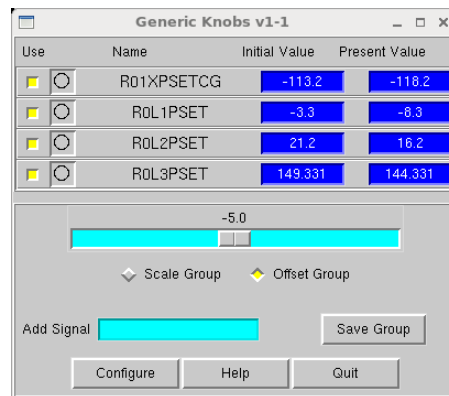
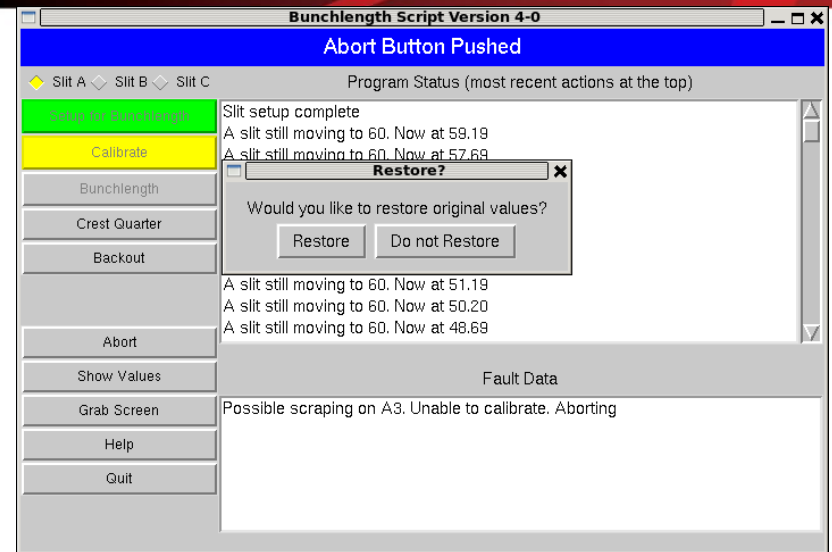
The screenshot shows a web interface with a blue header on the left containing the text 'HELP' and 'MCC Ops Docs'. The main header is yellow and contains a search bar with 'Title Search' and a 'GO' button, a 'Documents by Category' section with a dropdown menu and another 'GO' button, and a 'What's New' section with a 'What's New' dropdown menu. The word 'Procedures' is displayed in large red letters on a yellow background.

- Injector set up procedures
 - Solenoid and aperture centering
 - Warm RF
 - Prebuncher
 - Chopper
 - Buncher
 - Capture
- Development opportunities
 - Calibrated chopper viewer digitization (e.g. e-log 3321188)
 - Operational version of prototype “CircleABC” tcl script
 - Reliable seamless viewer video routing to the Wall/operator consoles
 - Viewer image persistence



Bunchlength Optimization System

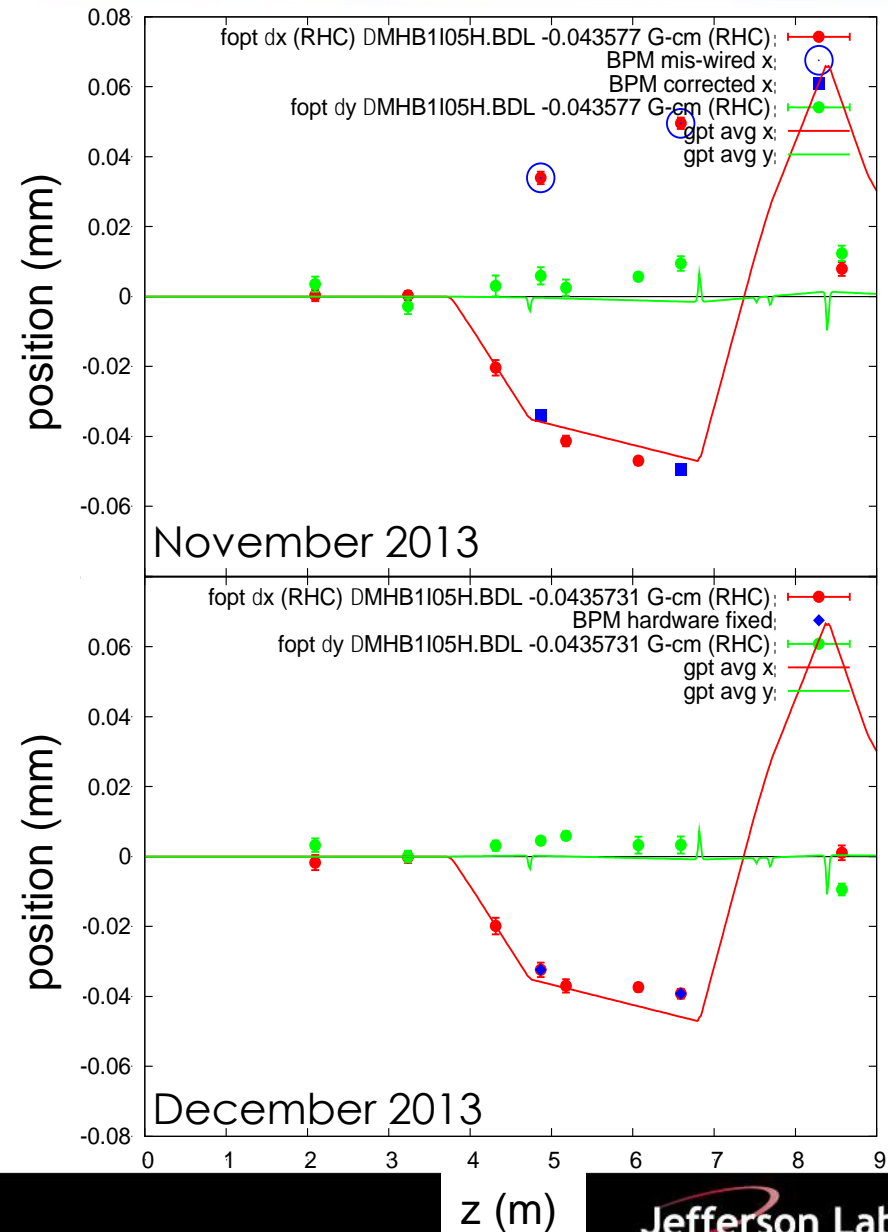
- System owners/experts?
 - Orphan system
 - Calibration reliability
- Ganged phase for warm RF (lasers, prebuncher, and choppers)
 - 1500 MHz Prebuncher
 - 250 MHz lasers
 - Now 10° 250 MHz = 10° 500 MHz
 - With Increased phase shift?
- Yao cavity system in 1D line?



Modeling

Past:

- Injector modeling originally done in PARMELA
- Genetic Algorithm (GA) optimizations with A Space Charge Tracking Algorithm (ASTRA)
 - 130 kV gun injector (NA-PAC2011 WEP288)
 - 200 kV gun and new (2-7) quarter injector (NA-PAC2011 WEP288; IPAC2012 TUPPR055)
 - Simulation and optimization studies (beam, RF, BBU (NA-PAC 2011 WEP085), etc.) completed before cutting metal
- ASTRA models → General Particle Tracer (GPT) (IPAC2012 TUPPR055)
- Model and machine comparison
 - Fast Optics (fOpt) difference orbits (IPAC2015 TUPMA037)

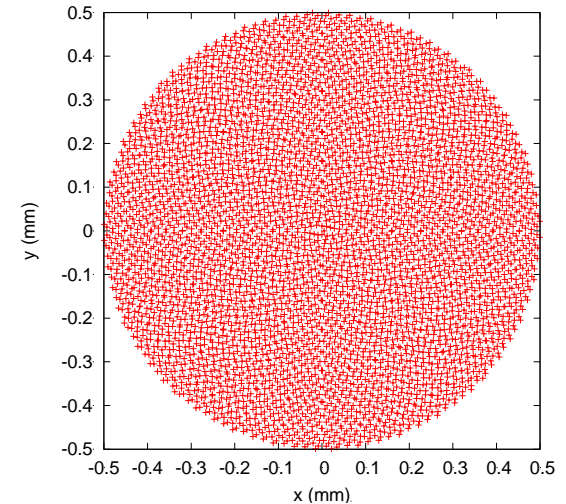


Modeling

Next steps:

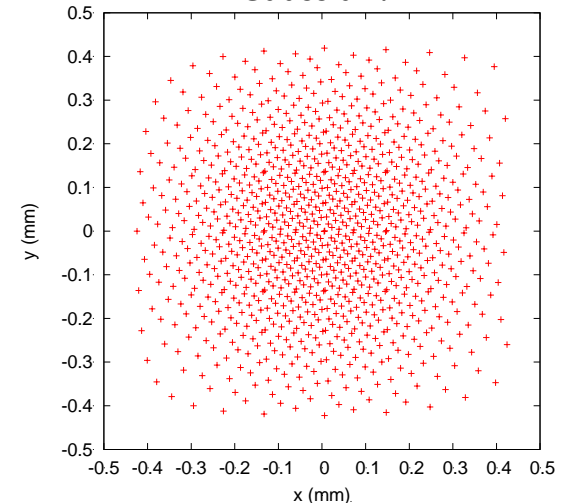
- Model improvements
 - Accurate representation of the beam at the cathode
 - Spatial characteristics
 - Temporal profile
 - Momentum distribution
 - New solenoid field maps
 - Missing elements
 - Identify model limitations
- Vet ASTRA-GA system against GPT's GA capability
- Integrate Injector model with CED
- Reconcile differences between elegant and GPT for overlap region
- Higher-order effects

Initial particle distribution



Cylindrically symmetric?

Gaussian?



Verification: Machine Development

Functional checks:

- fOpt difference orbits
- Model and machine calibration
 - Model vs. control system units
 - 1D, 2D, 1st chicane dipole calibrations for energy measurements
- RF resolution
 - Attempts to download optimization derived settings have been problematic
 - Achievable and verifiable
 - Reproducibility

Model and optimization verification:

- Identify sources of orbit drift and injector stability
- Verify performance of optimized Injector set up
- Establish process for downloading optimized injector setup

Model-Based Injector Set Up

- Routine operations
 - Reproducible set up
 - Monitor for orbit drifts
 - Minimal measurement set to confirm meeting performance criteria
 - Identified set of knobs to re-establish performance
 - Procedure for operations
- Minimize cases where experts are needed

Communications Opportunity

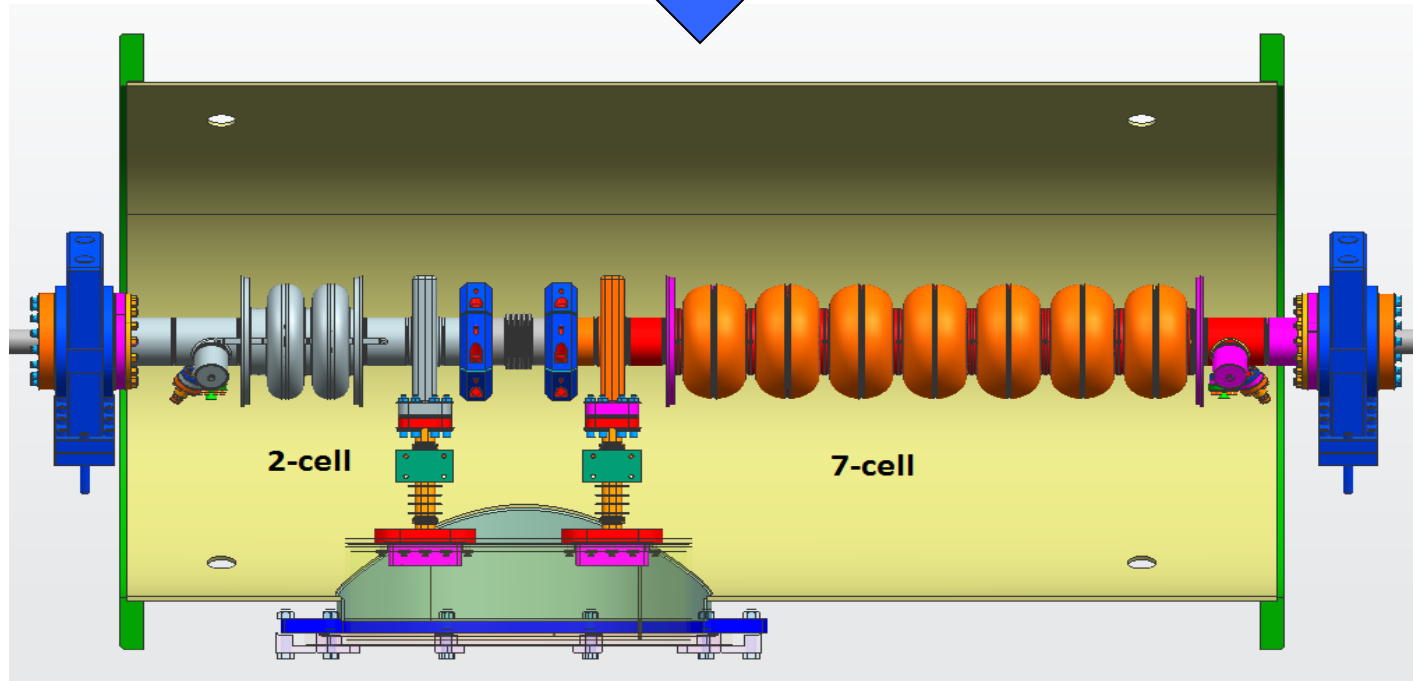
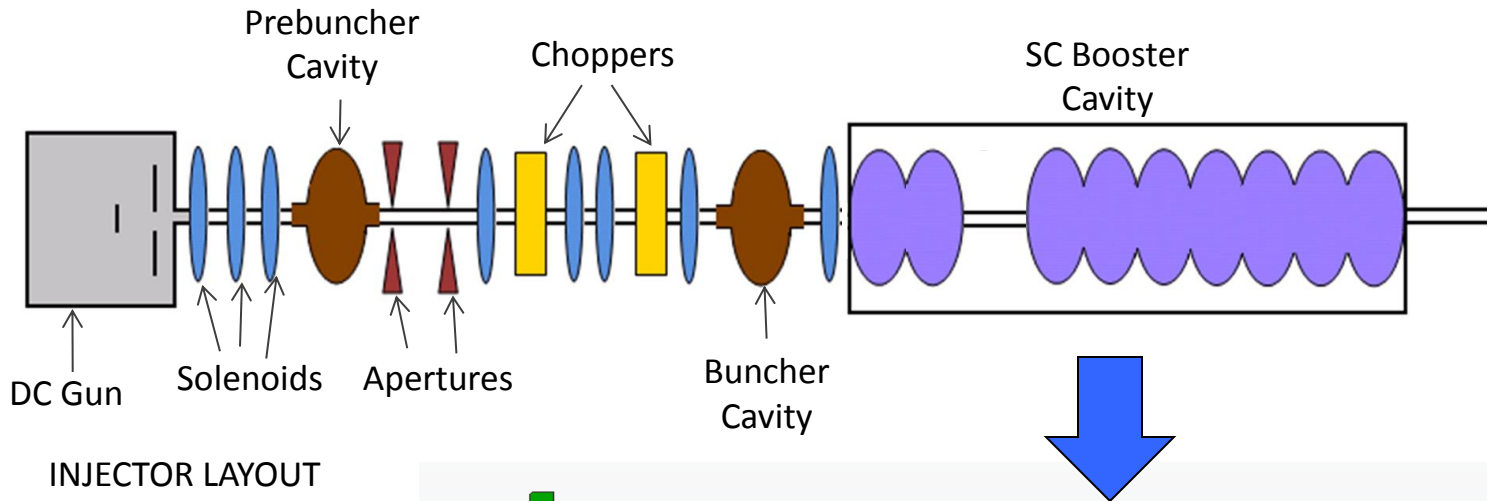
- OPS-PRs not always effective or efficient means of communication
 - Problems sit in system due to initial filing problem
 - JELI OPS-PR/CED selections/decision tree make it difficult to direct problems to correct parties
 - Solution: Separately access OPS-PR in web form and reassign
 - Recategorization between hardware and software does not happen routinely
- Directly contacting people to discuss problems is discouraged
 - Disruptive to individuals work flow
 - Subverts established communications pathway (OPS-PR system)
- Some groups have other problem management systems
 - Problems moved to alternate system and OPS-PR closed
 - Easy tracking from OPS-PR system lost
- Request: review for system effectiveness

Summary

- Injector group is working to cross-train and document our expertise
- Modeling effort is progressing
- Machine development time unconstrained by production beam delivery requirements needed
 - Better understanding of the differences between the model, the control system settings, and measurements for the 130 kV machine lays the ground work for commissioning the injector upgrade to a 200 kV gun with the 2-7 new quarter
- Injector reproducibility and stability are important to us
- Goal is model-based machine operations

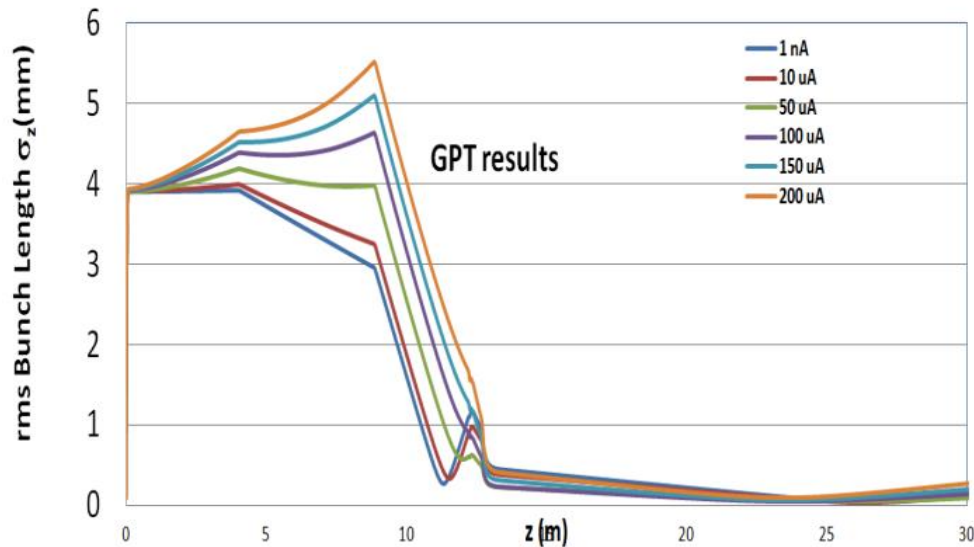
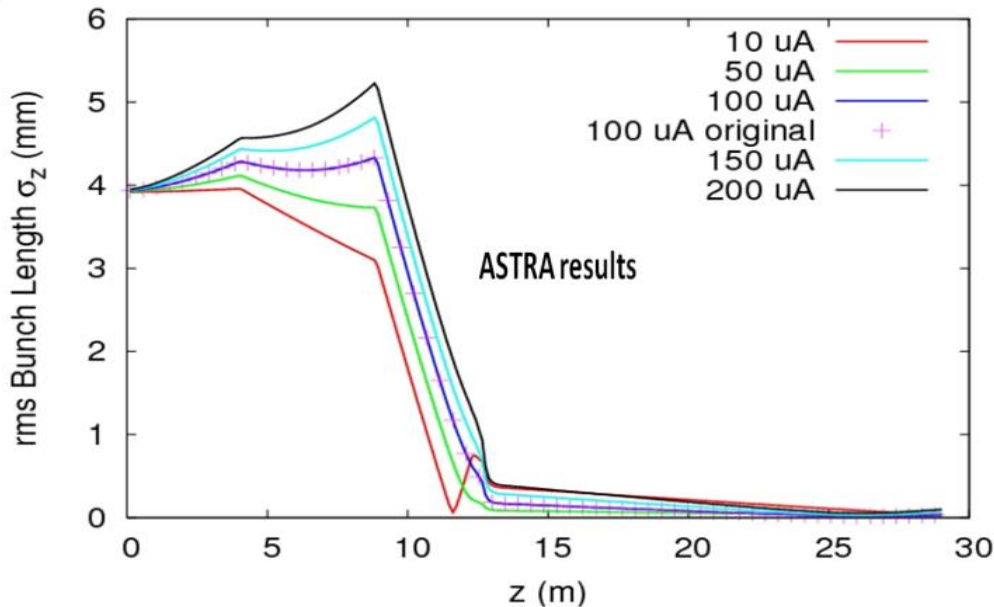
Thank you.

200 kV gun and new (2-7) quarter injector



NA-PAC2011 WEP288
IPAC2012 TUPPR055

200 kV gun and new (2-7) quarter injector



- Results checked with two codes
- Bunch length for different currents.
 - This accelerator has to work for both low and high beam currents at the same time!
- The currents are for 499 MHz cw beam structure.

NA-PAC2011 WEP288
IPAC2012 TUPPR055

Odds and Ends

- Viewer master light behavior
- PSS injector only mode: 100/500 keV dipole setting limits
- Real time bunchlength measurement in chicane