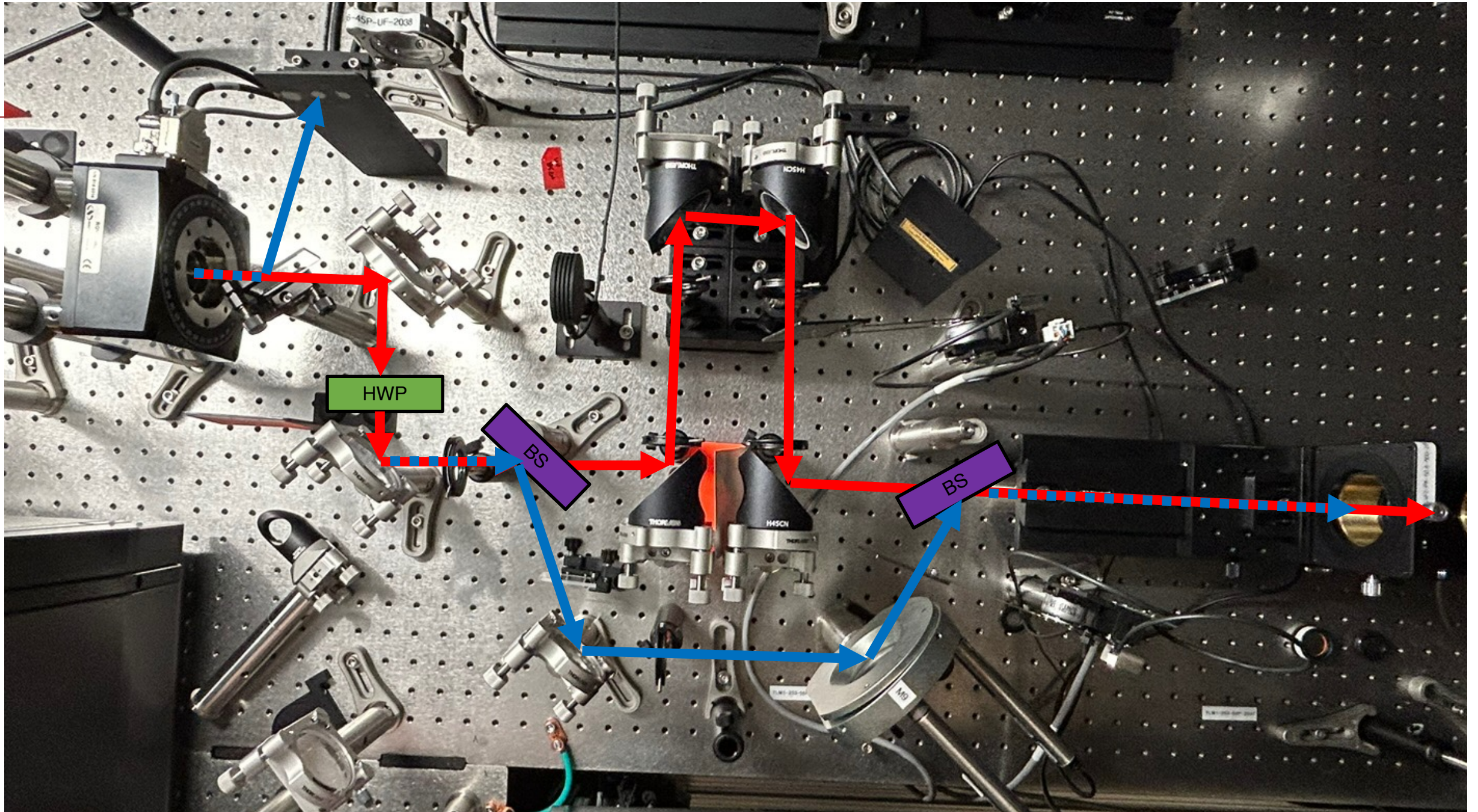


New and Evolving Beam Generation and Manipulation Capabilities

Nathan Majernik
E-300 Collaboration Meeting
2024-06-24

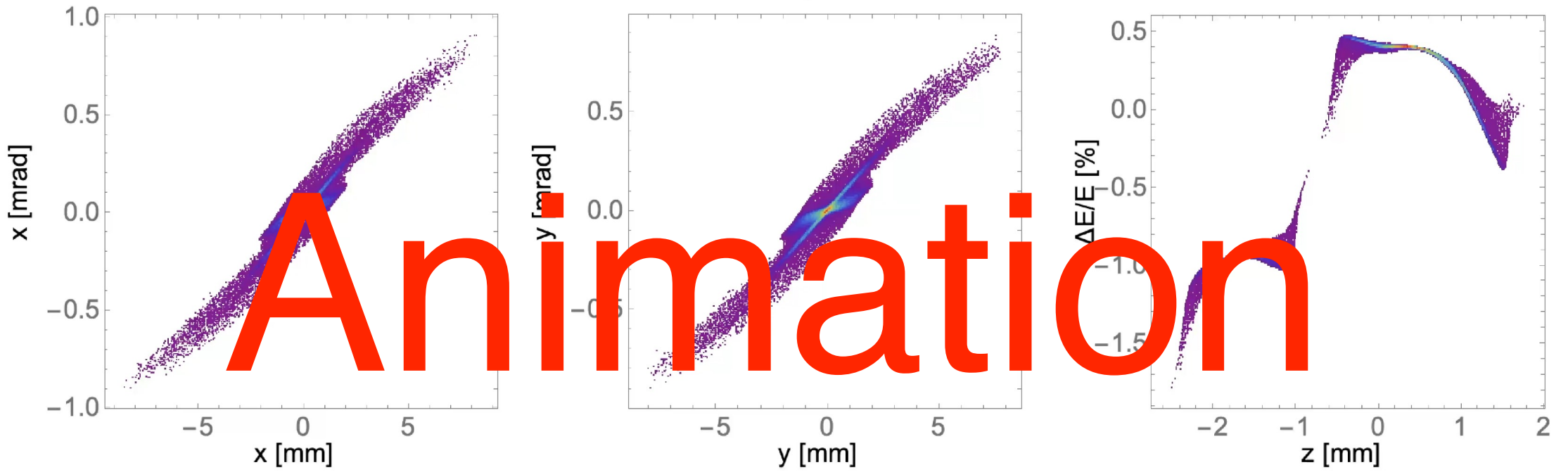
Outline

- Two bunch delivery
 - Stacker install
 - Simulations
 - Beam results
- XTCAV
 - Present state
 - Upgrades
- Laser heater
- Random phase plate

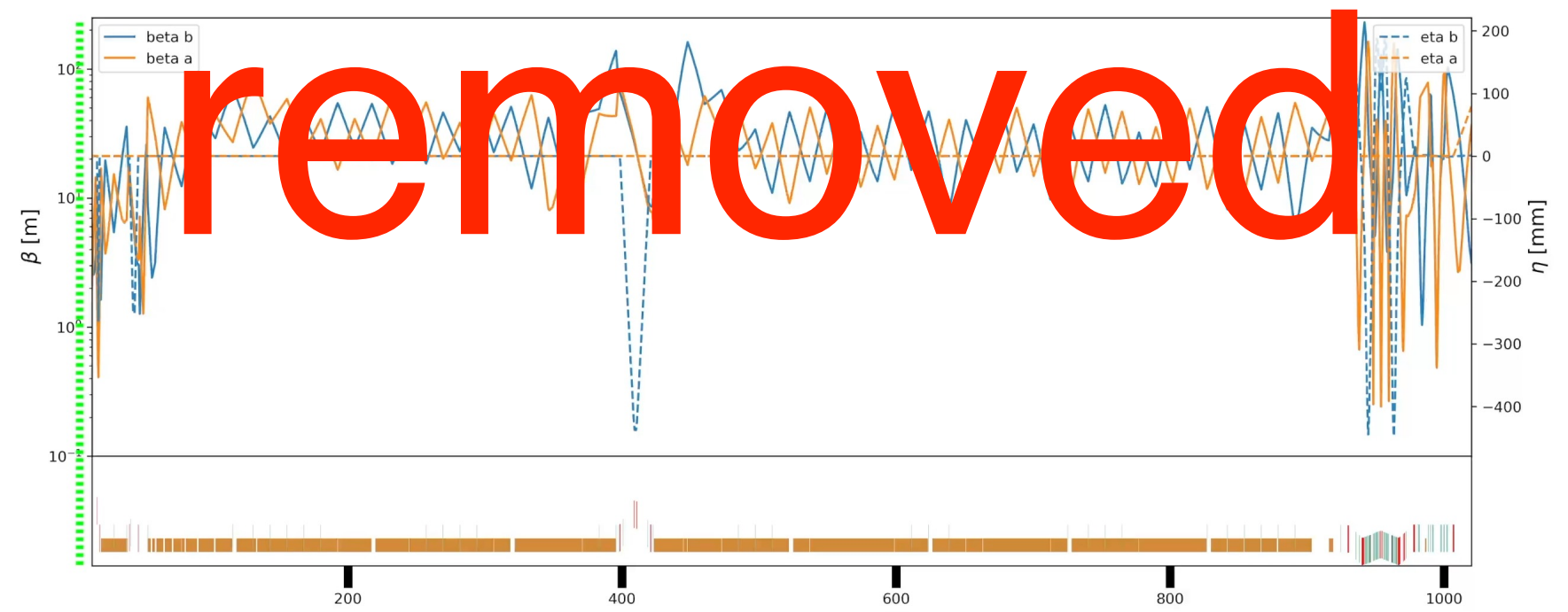


Newly installed UV pulse stacker hardware

L0: $z = 4.1$, $E_0 = 0.1$ GeV

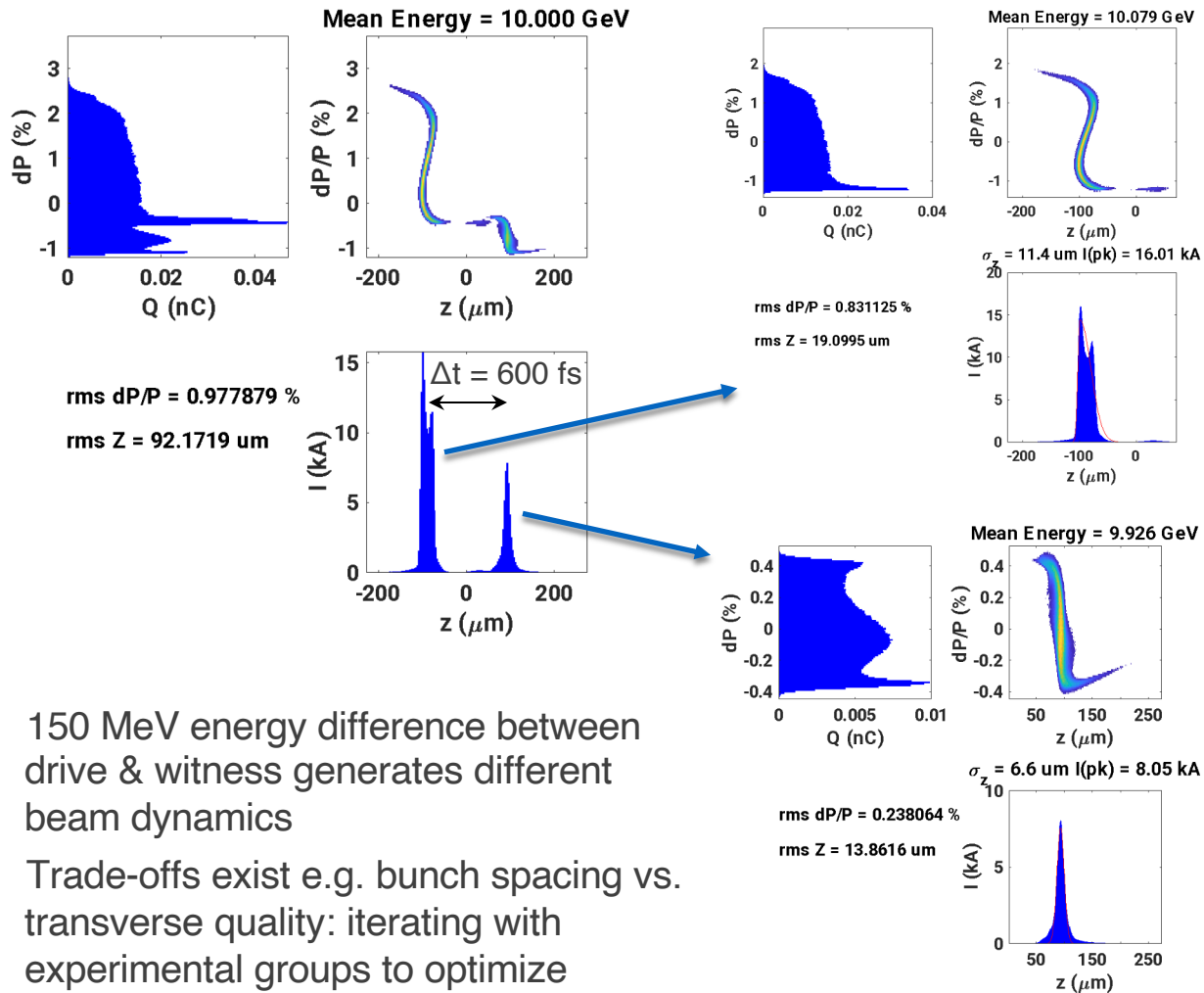


Animation



removed

Simulations: Upper bound on two-bunch performance



Drive
Bunch

Witness
Bunch

$\gamma\epsilon = 73 \times 35$ μm-rad

β^* longitudinal waist
offset
due to energy difference

$\Delta W_{x,y} = 22.8, 17.3$ cm

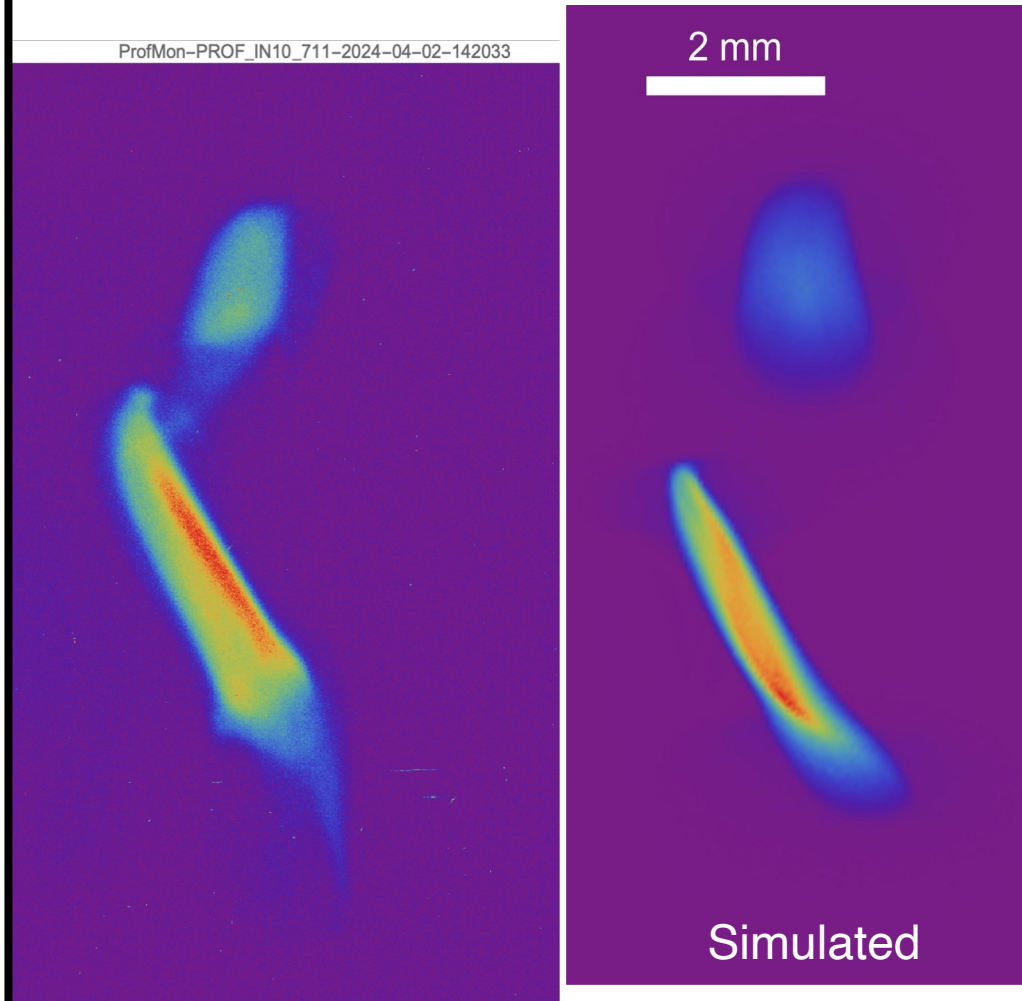
$\gamma\epsilon = 4.5 \times 2.6$ μm-rad

- 150 MeV energy difference between drive & witness generates different beam dynamics
- Trade-offs exist e.g. bunch spacing vs. transverse quality: iterating with experimental groups to optimize

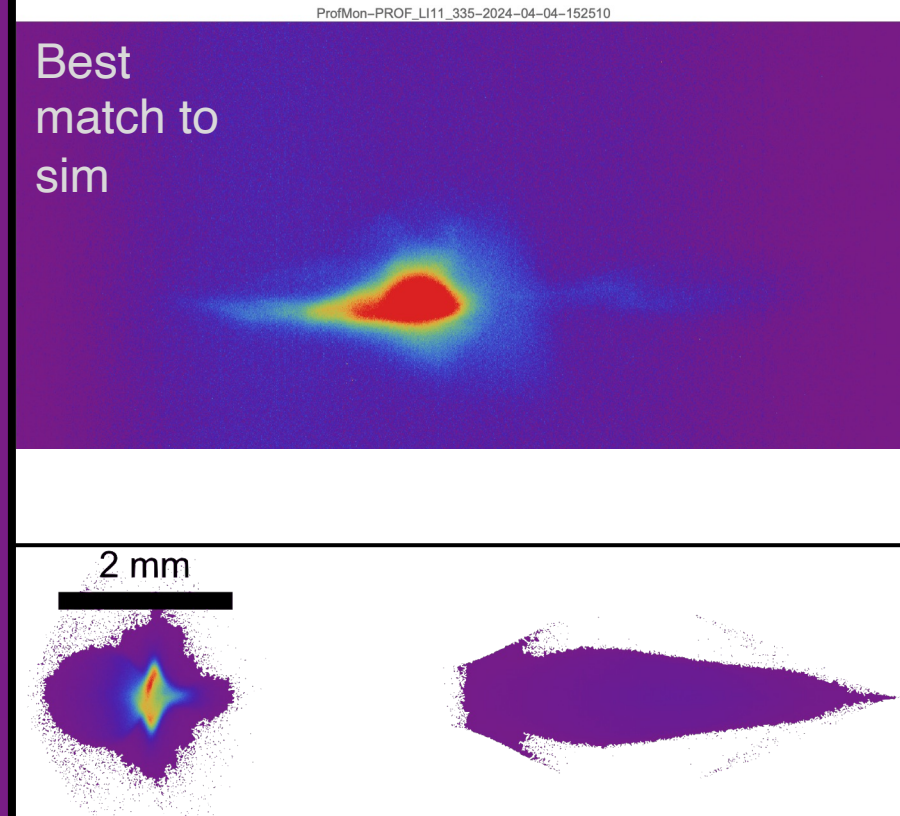
Injector measurements vs simulation

- 1.2 + 0.4 nC
- 9 ps separation off cathode
- Witness biased config:
 - Drive: 10.1 x 7.8 μm -rad
 - Witness: 4.0 x 5.1 μm -rad
- Decent agreement up to PR10711
- Unable to match PR11335

PR10711

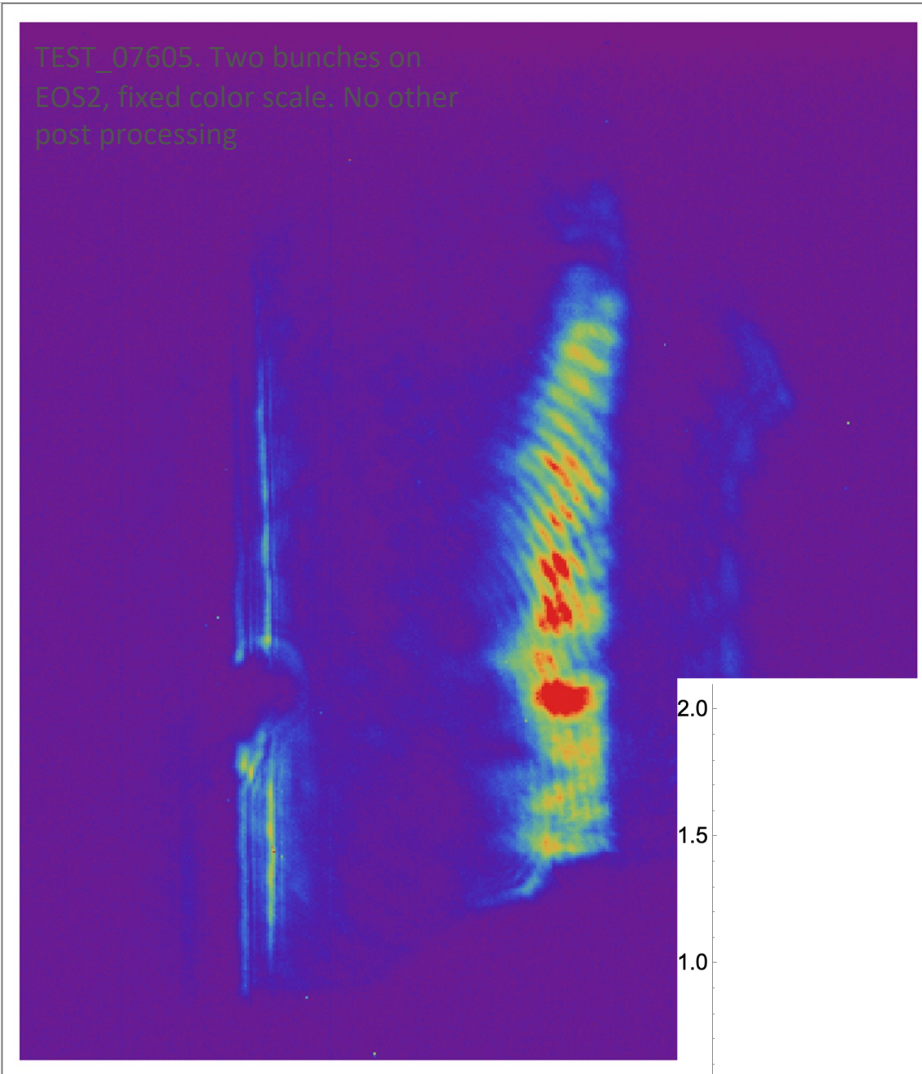


PR11335

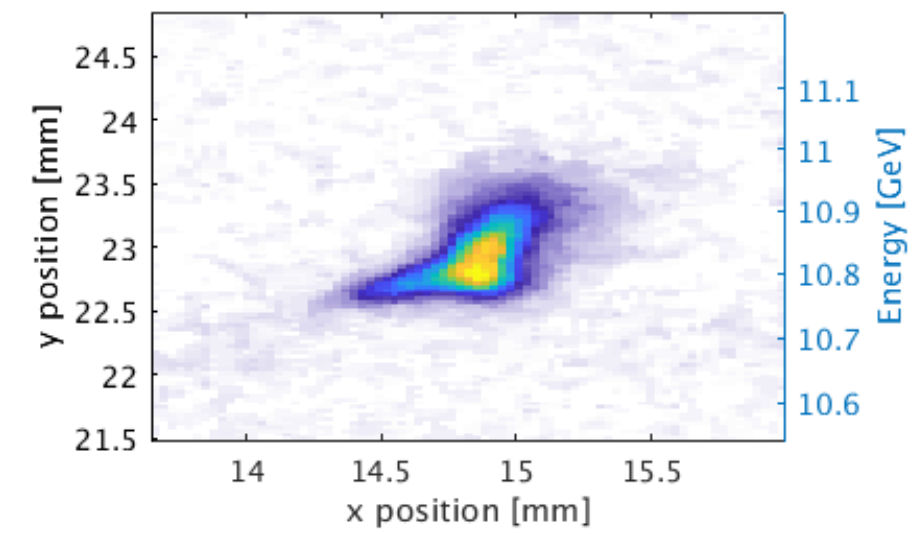
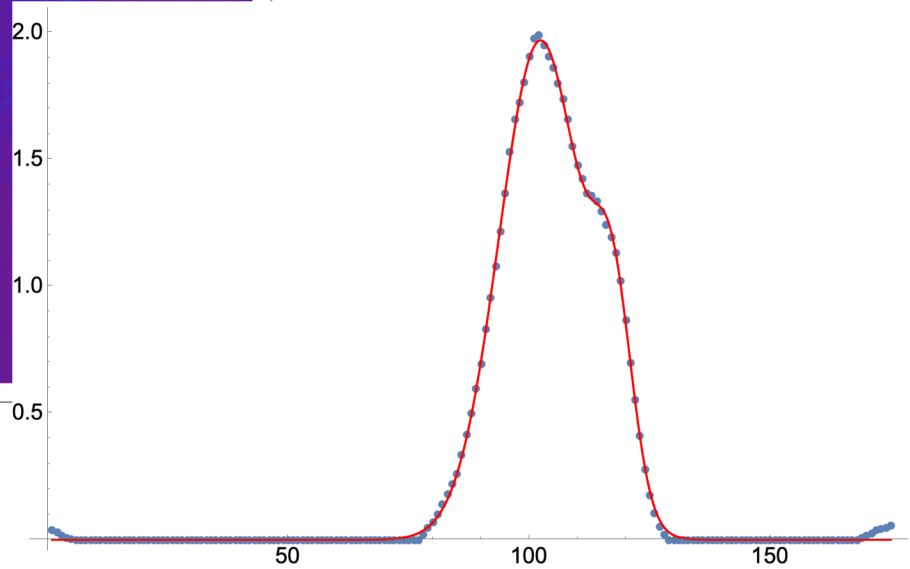
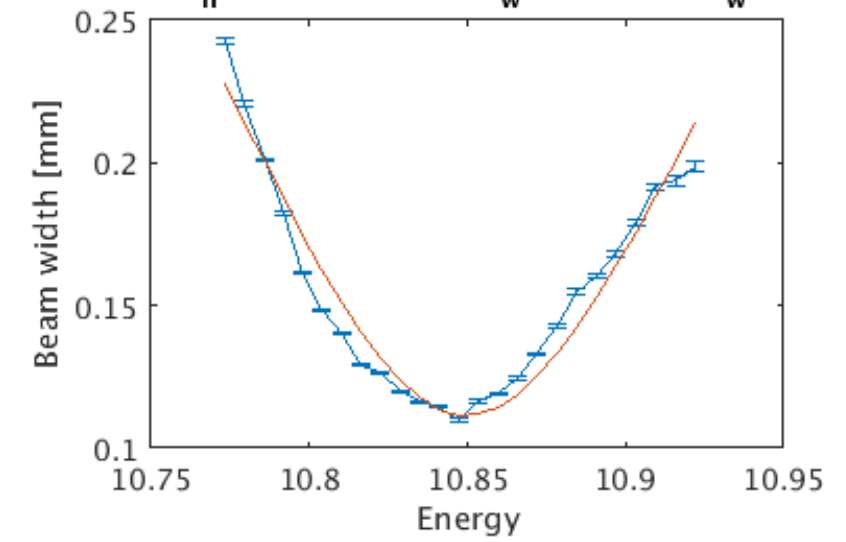


Teaser: S20 measurements

Figure from D. Storey

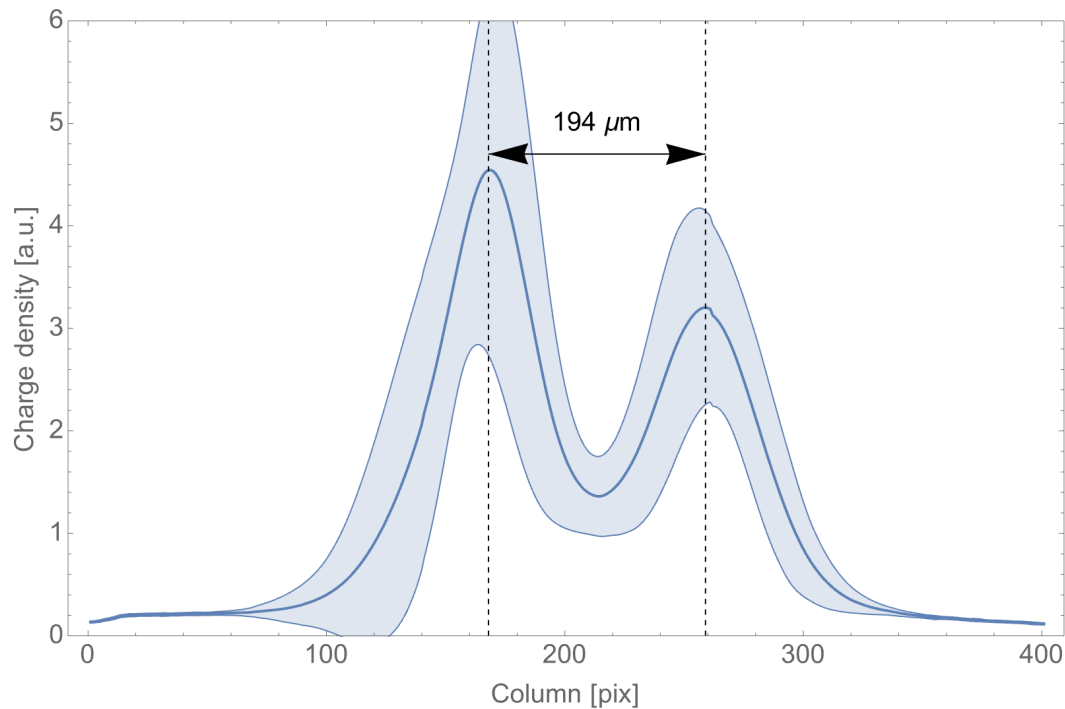


DAQ E300 8369 - shot 465
Fit: $\epsilon_n = 253.6\mu\text{m}$, $\beta_w = 5.1\text{cm}$, $dz_w = 0.172\text{m}$

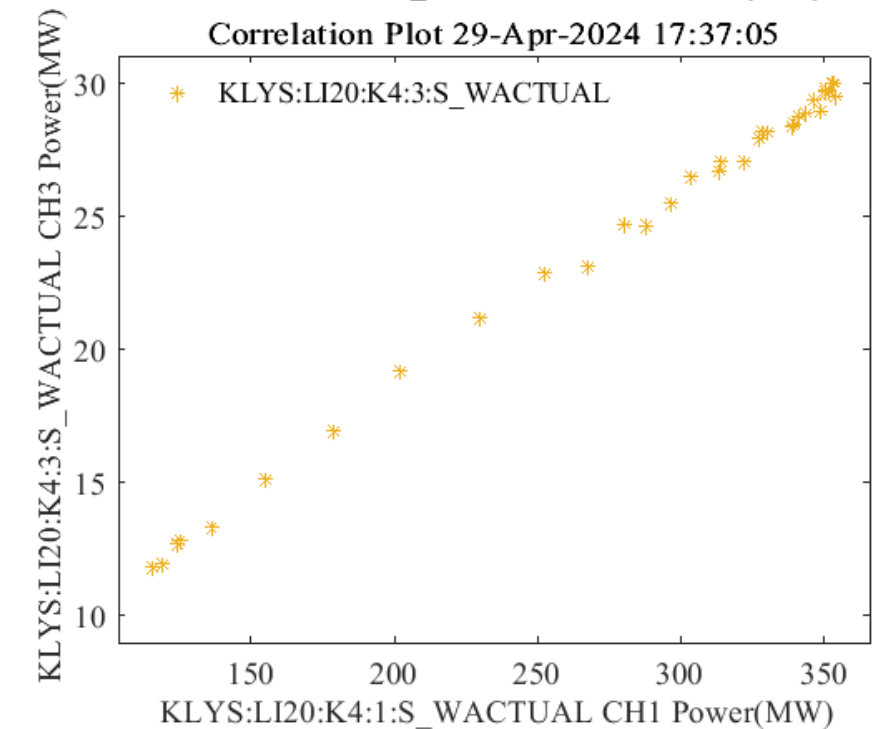
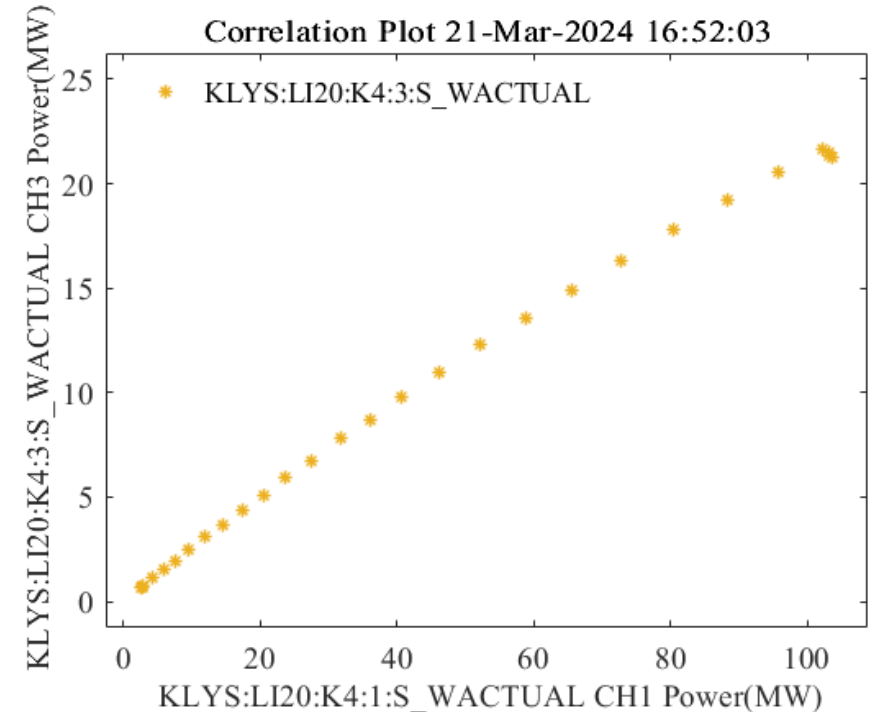


XTCAV: YTD improvements

- Test, replacement, and repair of connectors, cables and SSSB
- 20* MW to 30 MW
 - Still not driving klystron to saturation



*Calibration issues; take with grain of salt



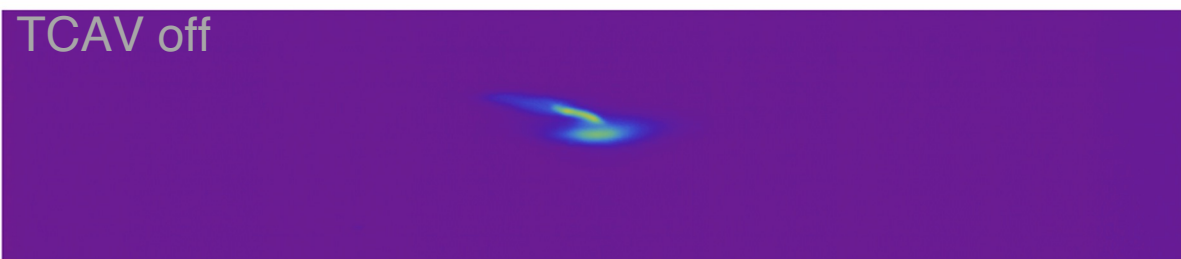
XTCAV: Ongoing work

- Calorimetric klystron measurements
- SLED
 - ~Double kick voltage
- Post-processing
 - Slice-wise information

Positive crossing



TCAV off



Negative crossing

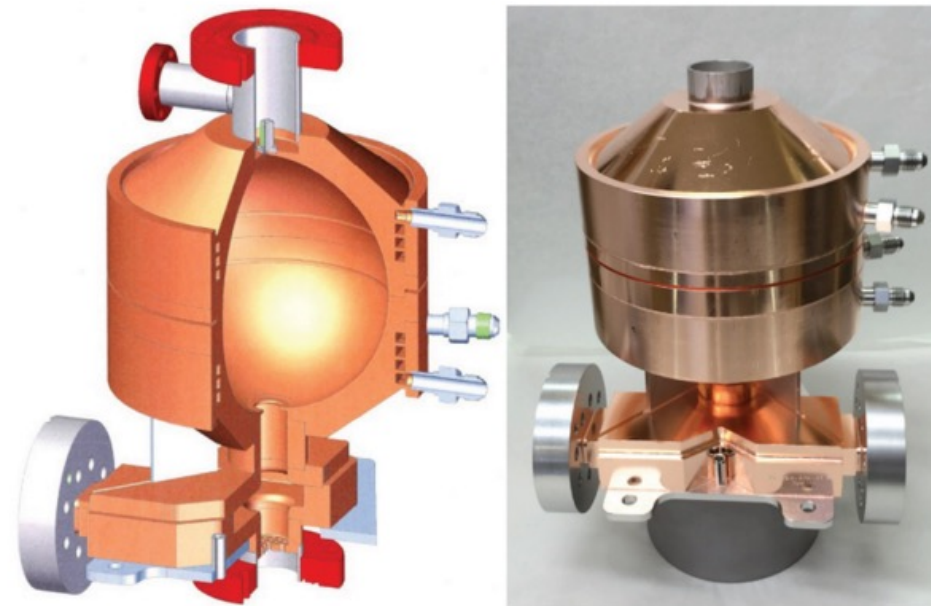
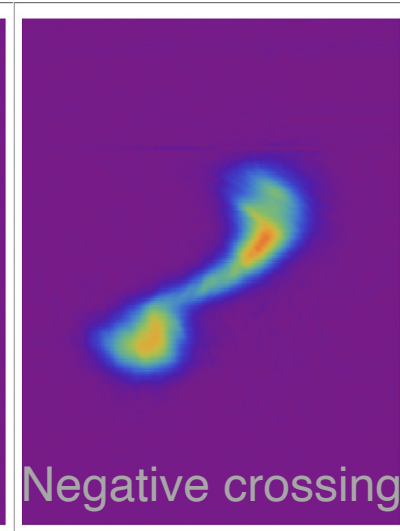
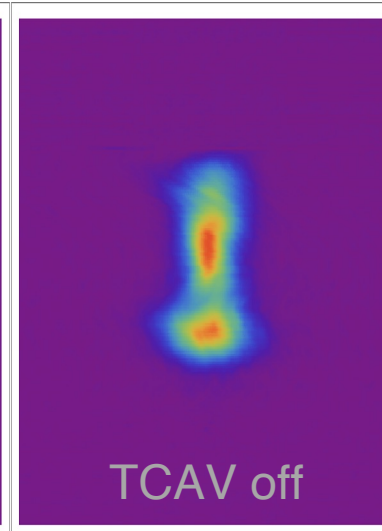
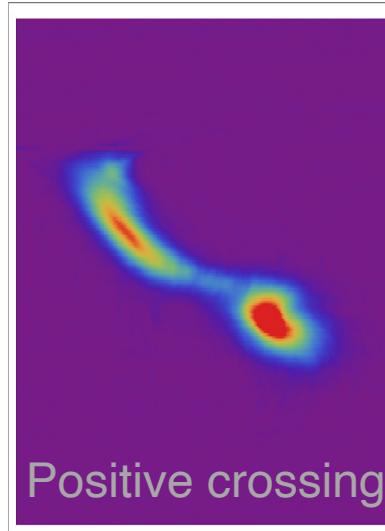
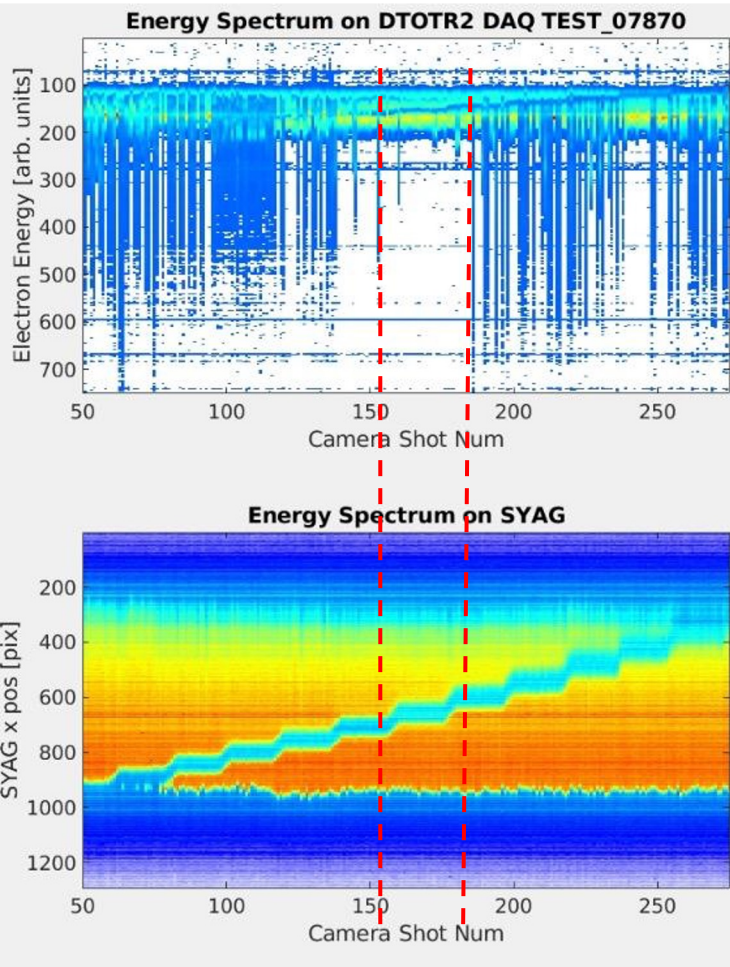


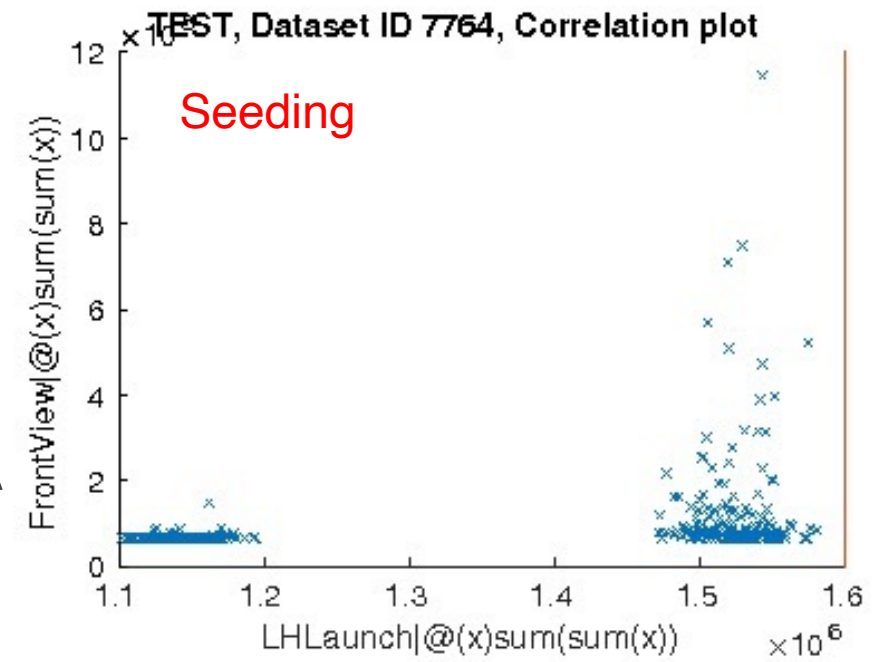
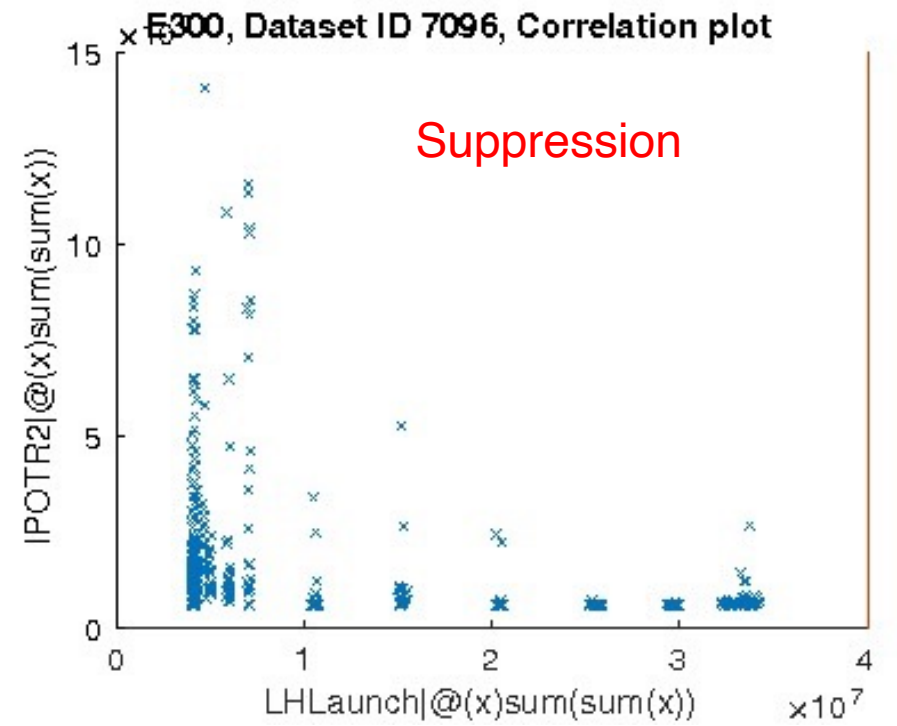
Figure 2: Cut-away view of the X-band SLED cavity together with a photo of the brazed cavity and coupler assembly.



Laser heater progress



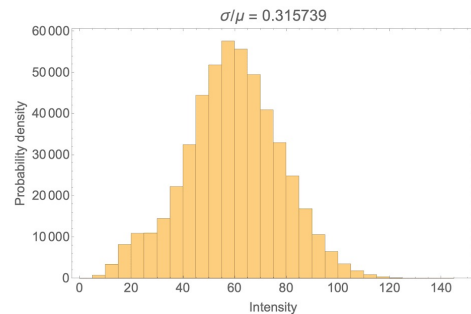
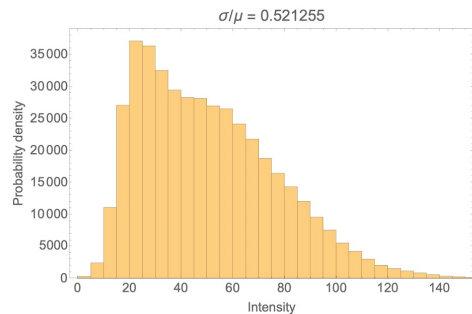
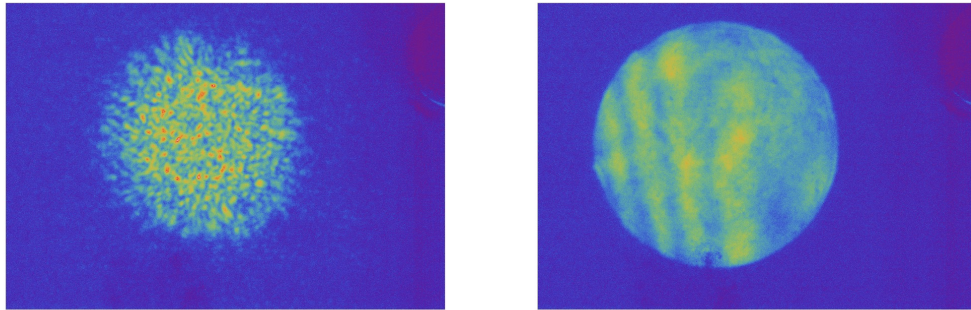
- Effective suppression of buffer gas ionization
 - At 100 cm beta; less effective at 50 cm
 - More power = more better?
- Also demonstrated ability to seed a spike
 - Spectro-temporal shaping with cardboard
 - Can provoke ionization, on-demand
 - Estimated spike ≈ 100 kA



Random phase plate

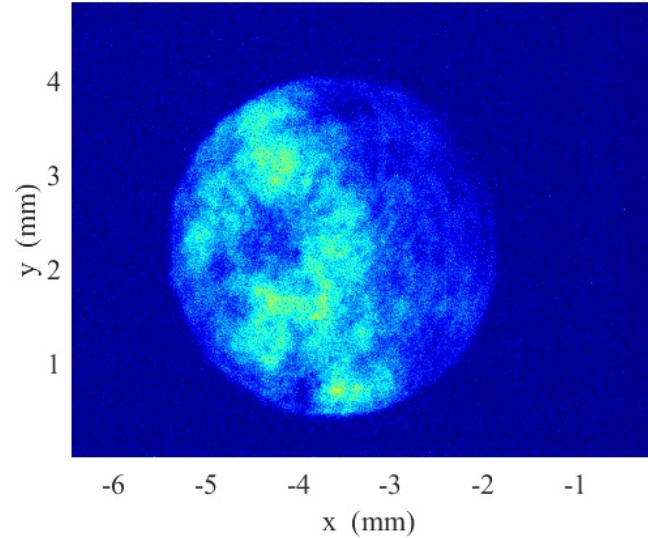
- Testing a new diffractive optic to homogenize UV laser spot
 - Trade low frequency noise for high frequency noise
- Particularly useful for two bunch where the S- and P- arms have different asymmetries

Blur rad = 0 pix



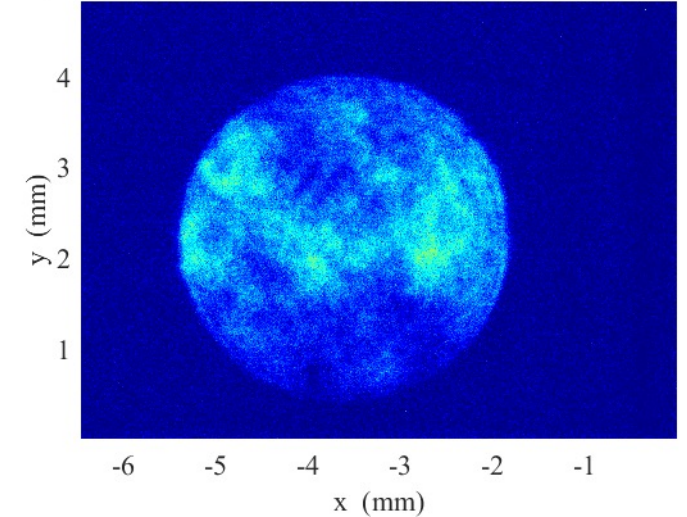
P-arm

Profile Monitor CAMR:LT10:900 10-Jun-2024 09:24:31

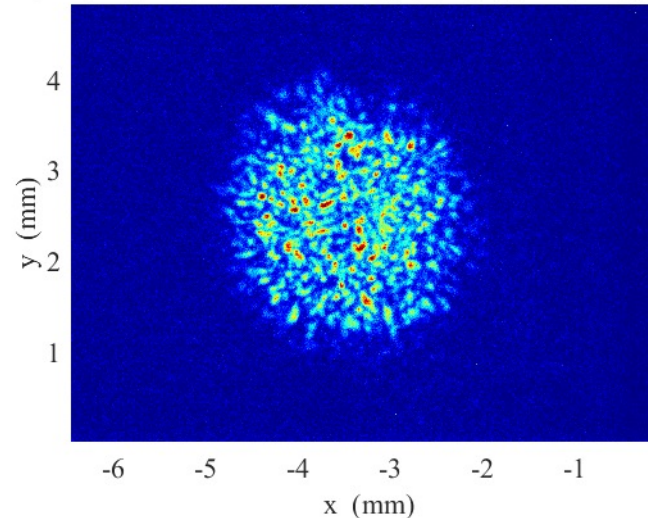


S-arm

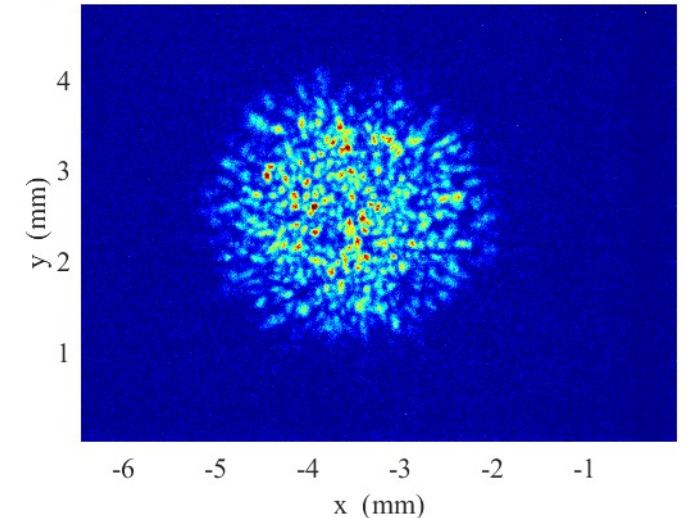
Profile Monitor CAMR:LT10:900 10-Jun-2024 09:24:42



Profile Monitor CAMR:LT10:900 10-Jun-2024 09:26:00



Profile Monitor CAMR:LT10:900 10-Jun-2024 09:26:10



Summary

- Pulse stacker two-bunch has been demonstrated
 - Tuning up from single bunch is increasingly procedure-based
 - Consistently delivering high-quality beams is ongoing work
 - Characterization is challenging but we have new tools and techniques
- XTCAV has the potential to be a valuable tool for understanding final LPS; upgrades should enhance resolving powers
- The laser heater is quite versatile: have demonstrated ability to both suppress and provoke spikes/ionization
- Random phase plate shows initial promise but requires dedicated MD time to quantify

New and evolving capabilities continue to support and extend the E-300 program