AE68: Ramped Beam Generation Using Dielectric Wakefield Structures

PI: G. Andonian

Collaborators: S. Barber (LBNL), F. O'Shea, M. Harrison (Radiabeam), N. Sudar, J. Rosenzweig, O. Williams (UCLA)

M. Babzien, M. Fedurin, K. Kusche, R. Malone, C. Swinson, BNL (ATF)

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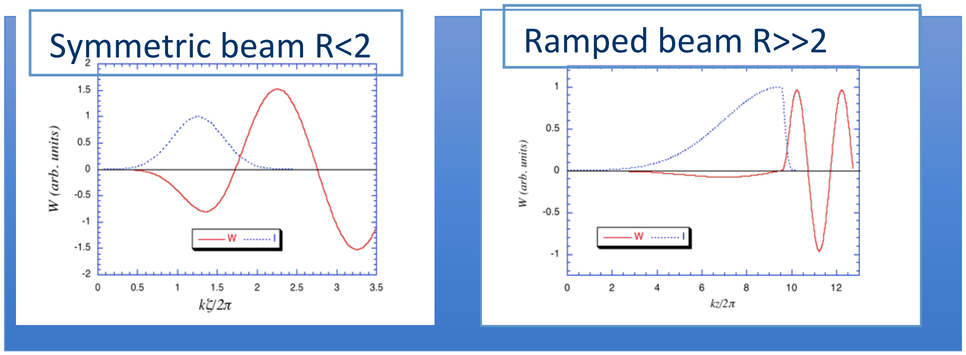
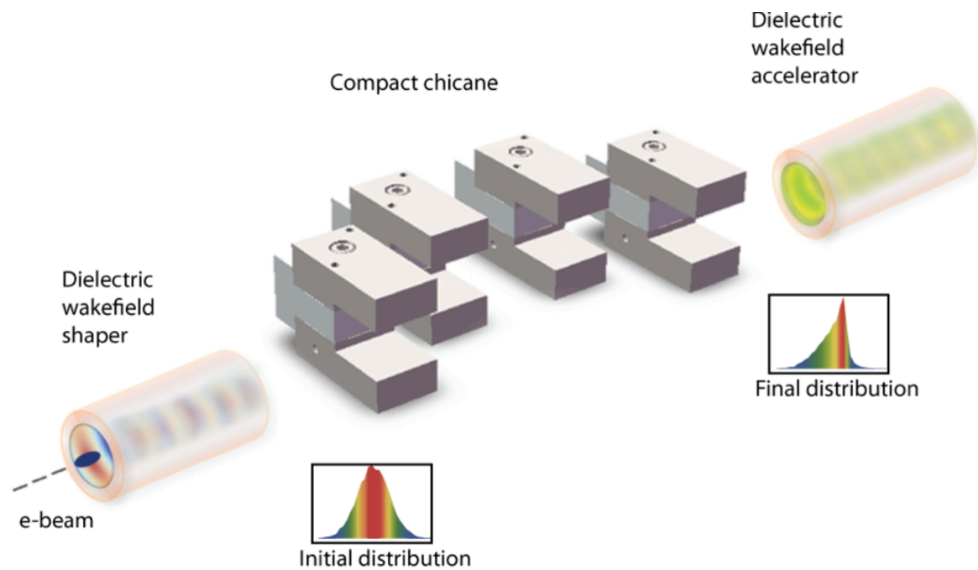
Status: * Awaiting final technical report

2019 ATF Users Meeting: Application for Continuation

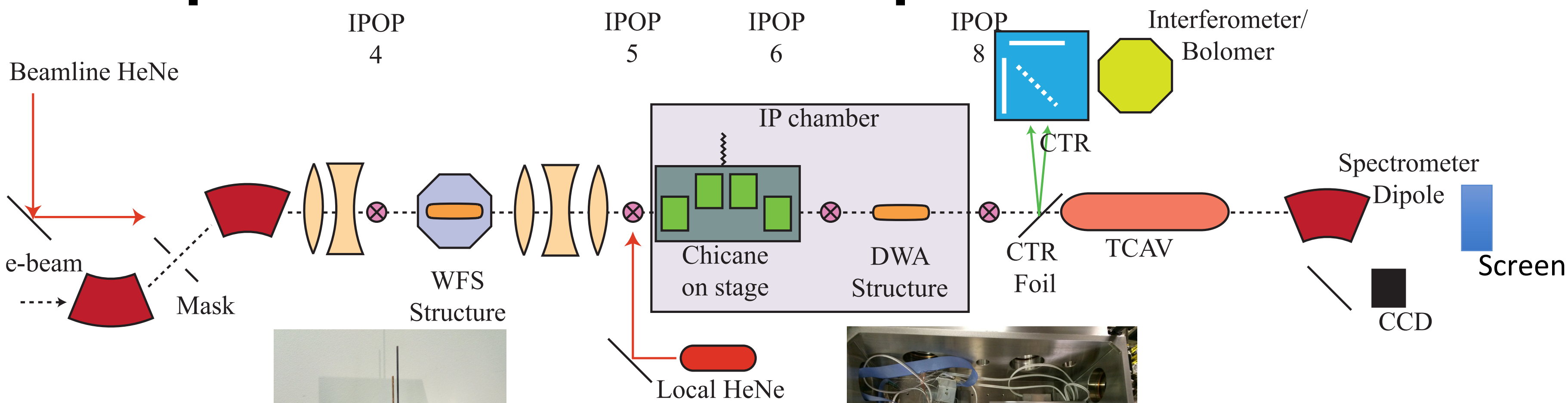
Scientific Case

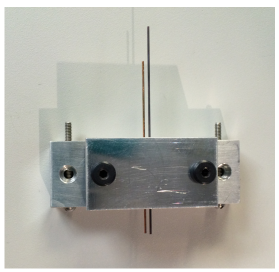
- Efficiency of DWA: Transformer Ratio
- TR enhancement from ramped beams
  - Triangle distribution, etc.
- Techniques:
  - EEX, laser shaping, masking
  - Recent paper from AWA
- Shaping with self wakes
  - Analogous to bunch train with DWA
  - No charge loss at mask

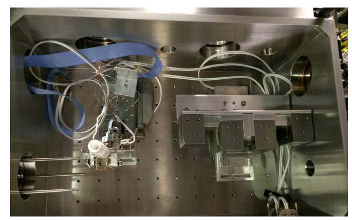




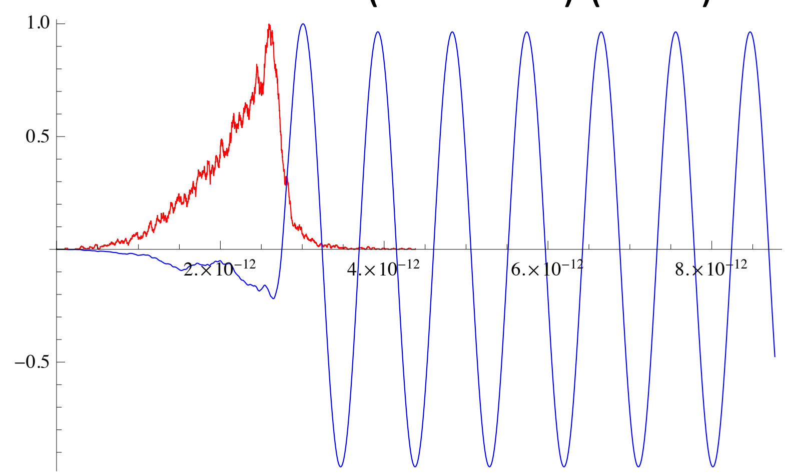
Experimental Setup







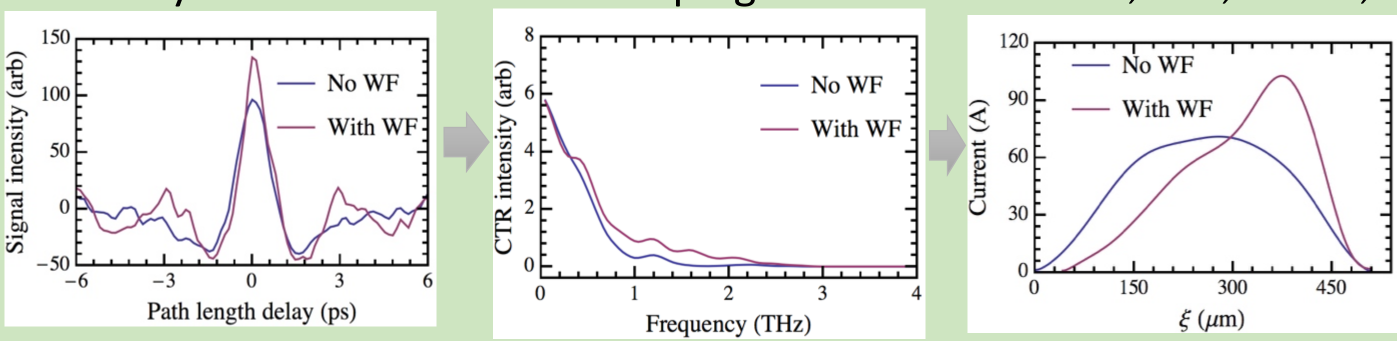
DWS+ DWA (f=1.1 THz) (TR~5)



- Second stage: TR measurement
  - Split beam into drive/witness pair
  - Observe energy shift of d/w at spectrometer
  - Alternate: use DWS upstream,
    - Then chicane + DWA

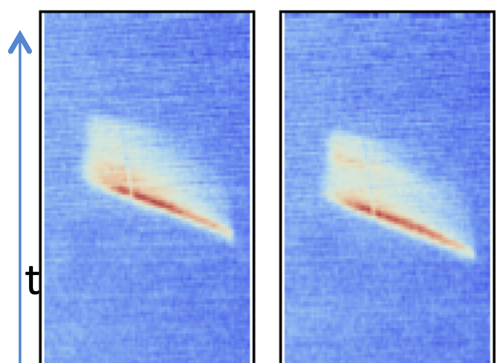
Progress:

First run: only shaping structure + chicane
CTR interferometry demonstrates beam shaping *G. Andonian, et al., PRL 118, 054802 (2017)*

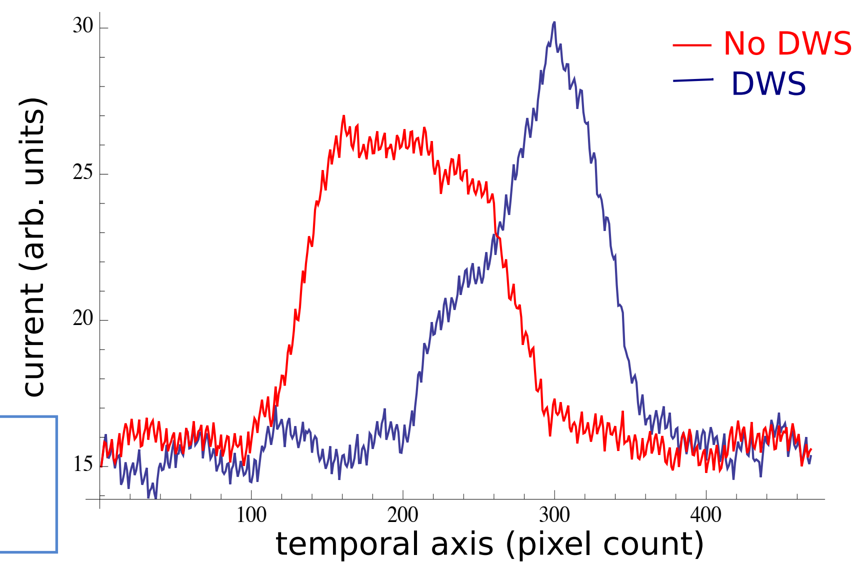


- Second run: first time deflector powered for e-beam use
- Compare CTR results to streaker

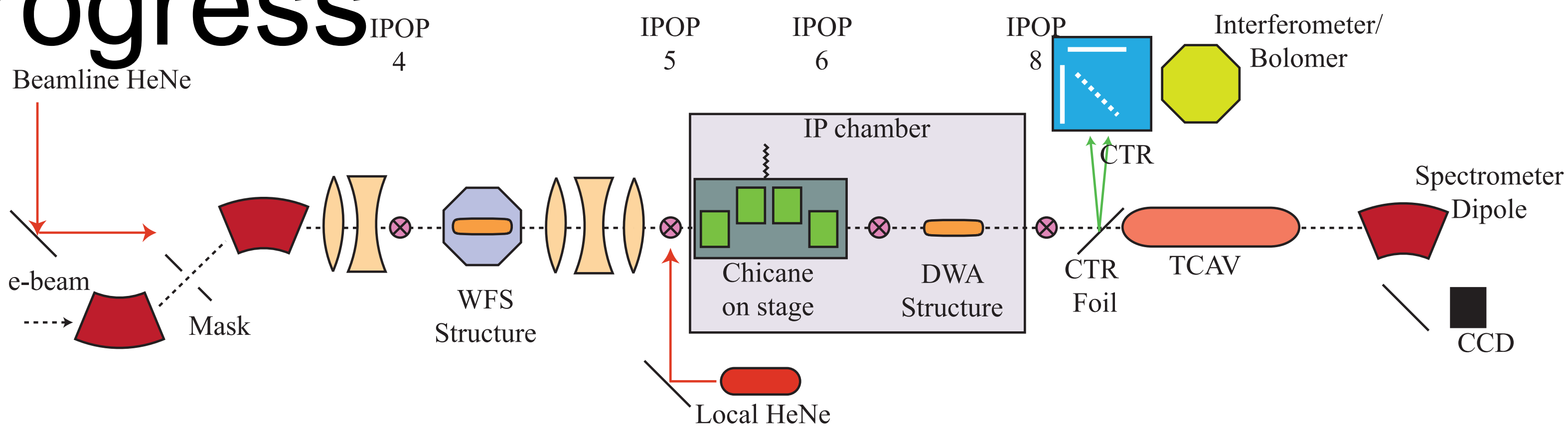
- Compression
- Asymmetry
- Good qualitative agreement w/ CTR results



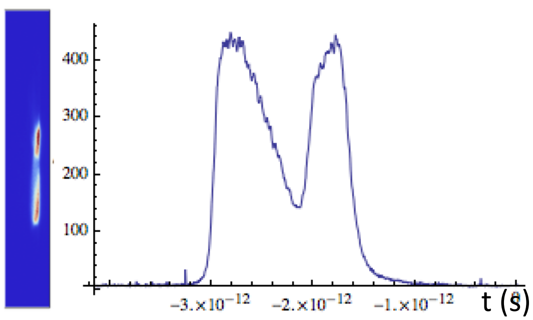
Deflector
(sample raw images)



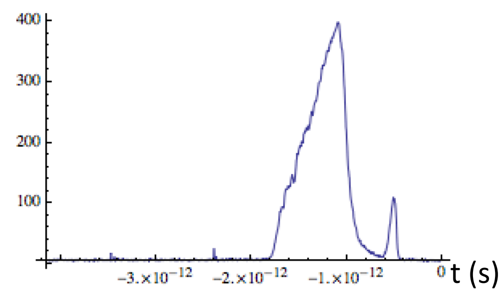
Progress

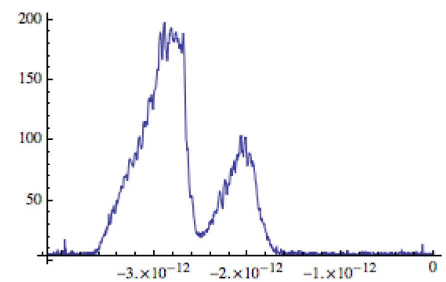


Drive/witness + TCAV (2018 run)

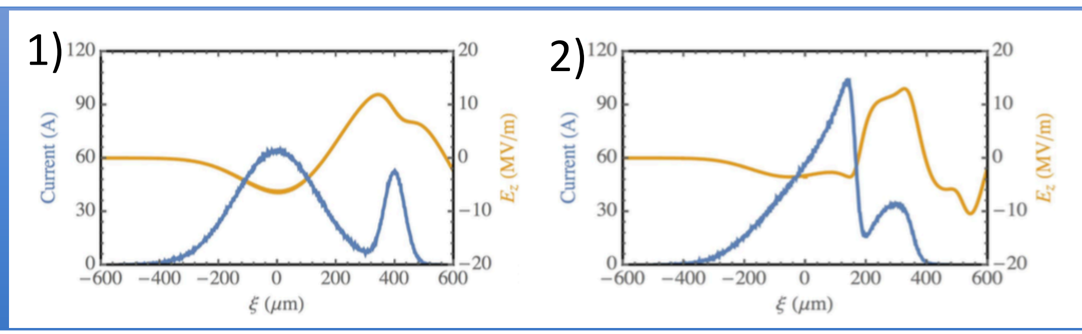


Unperturbed beam





Sample images after structure + chicane



Simulations:
1) No structure
2) Structure

Plans

- Previous run results
  - Demonstrated ramped beam using CTR reconstruction
  - First deflector run showed good qualitative agreement
  - Second run with d/w beam showed ramped
- Next run
  - Send through second DWA to measure TR
  - Full LPS with dipole and TR
  - Characterize TCAV with slits for improved resolution
- Request for time
  - ~1-2 week for beamline setup + e-beam only run
  - Aligning structures - challenge
- Experimental requirements:
  - Need masking
  - Need complete deflector calibration
  - Dipole spectrometer for LPS
  - Bolometer/interferometer as backup?

Electron Beam Requirements

Parameter	Nominal	Requested Experiment Parameters
Beam Energy (MeV)	50-65	*50MeV*
Bunch Charge (nC)	0.1-0.5	*0.3nC*
Compression	Down to 100 fs (up to 1 kA peak current)	*No*
Transverse size at IP (sigma, um)	30 − 100 (dependent on IP position)	*30µm round at IP, 30-40µm round at 2nd IP*
Normalized Emittance (um)	1 (at 0.3 nC)	*1 mm-mrad*
Rep. Rate (Hz)	1.5	*1.5*
Trains mode	Single bunch	*Single bunch*

Special Equipment: TCAV, Mask, bolometer/interferometr

CO_2 Laser Requirements –NONE e-beam only

The following options are available at the laser source. Note that the maximum power available at your experiment interaction point will depend on the laser transport method.

OPTION 1 (full power, ~1 shot per minute)
regular gas in final amplifier (winter-spring 2018)
1 TW max (3.5 ps, 5 J, 30% of energy in post-pulses)
10.25 um
M^2 ~2
linear polarization

isotopic final amplifier (may be available late 2018)
2 TW max (2 ps, 4 J, single pulse)
9.25 um
M^2 ~2
linear polarization

OPTION 2 (regen only, 1.5 or 3 Hz)
3 GW max (2 ps, 6 mJ)
9.25 um
M^2 ~1.5
linear polarization (circular available at slightly reduced power)

Interaction Point location: Laser room/ electron experiment hall - *delete as necessary*

2019 Experiment Time Estimates

Run Hours (include setup time in hours estimate):120hrs

Number of electron beam only hours: 80hrs

Number of CO_2 laser hours delivered to laser experiment hall (”FEL room”): 0

Number of CO_2 laser hours, + ebeam, delivered to electron beam experiment hall: 0

Overall % setup time: 50%

Hazards & installation requirements:

Large installation (chamber, insertion device etc…): Y (large chamber to house chicane)

Laser use (other than CO_2): Y (Local HeNe)

Cryogens: Maybe (Helium for bolometer)

Introducing new magnetic elements: Y (mini-chicane)

Introducing new materials into the beam path: Y (dielectric structure)

Any other foreseeable beam line modifications: Y (BL2)