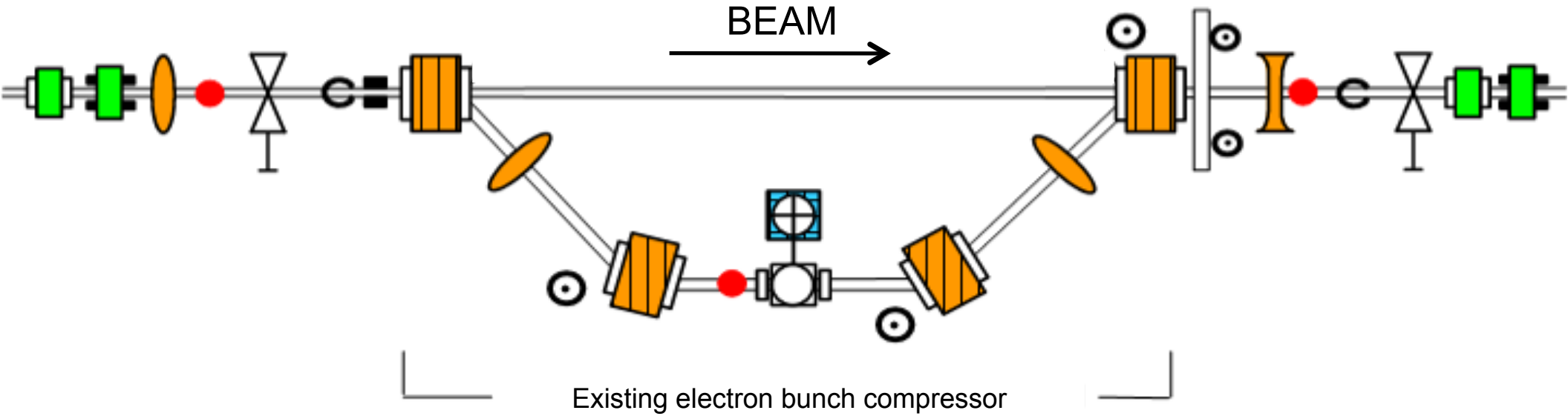
Coming Upgrades to FACET

- Upgrade to S10 chicane to allow e+ compression
- Experimenter PPS zone with 'Controlled Access' to S20
- Bunch length monitors after RTL, S10 chicane
- Notch Collimator
- 1m x-band TCAV (in the works but likely not ready until April 2012)
- Wire(s) in Li18 or Li19?
- Additional Toroids, BPMs?
- Improved camera support and diagnostics
- Experiment specific machine states and optics
- Sailboat chicane?

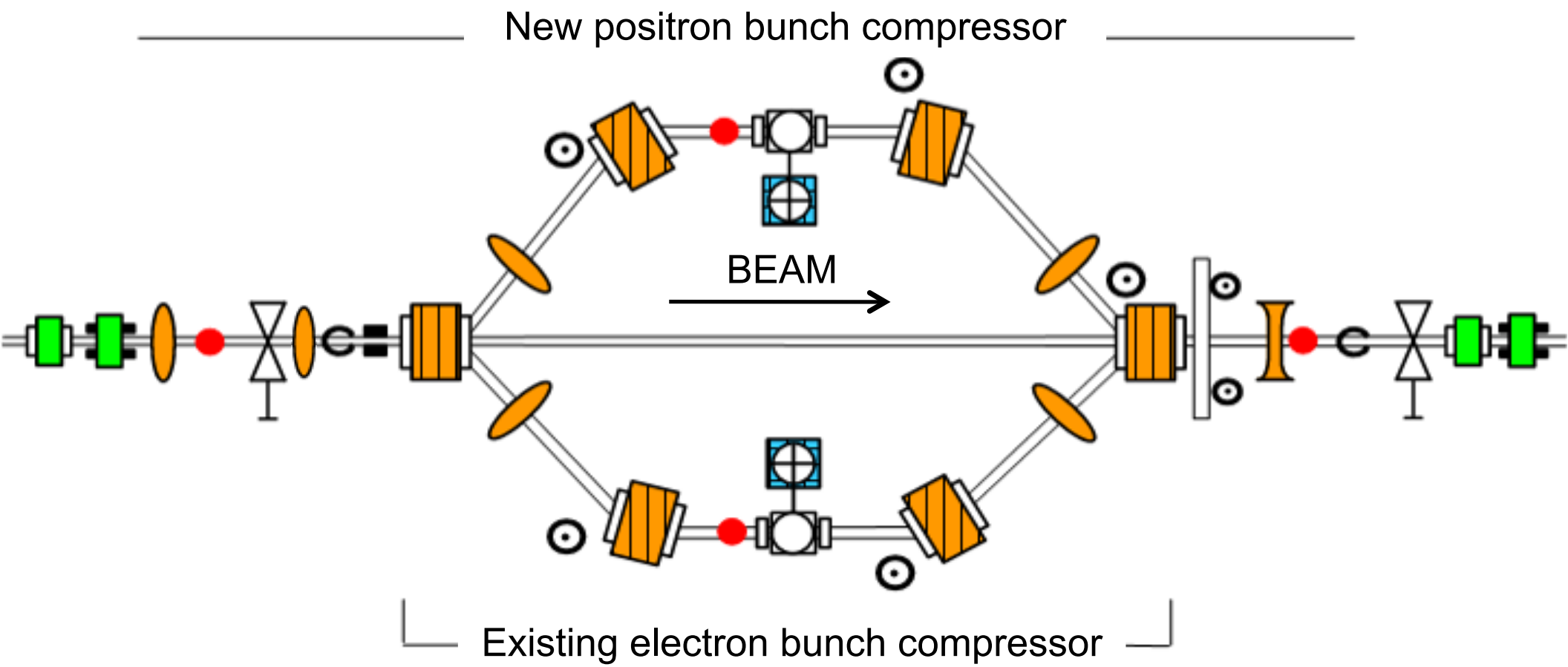
Existing Sector 10 SPPS Installation

* Secondary stage of bunch compression: 1.5 mm → 50 μm



New Sector 10 Installation

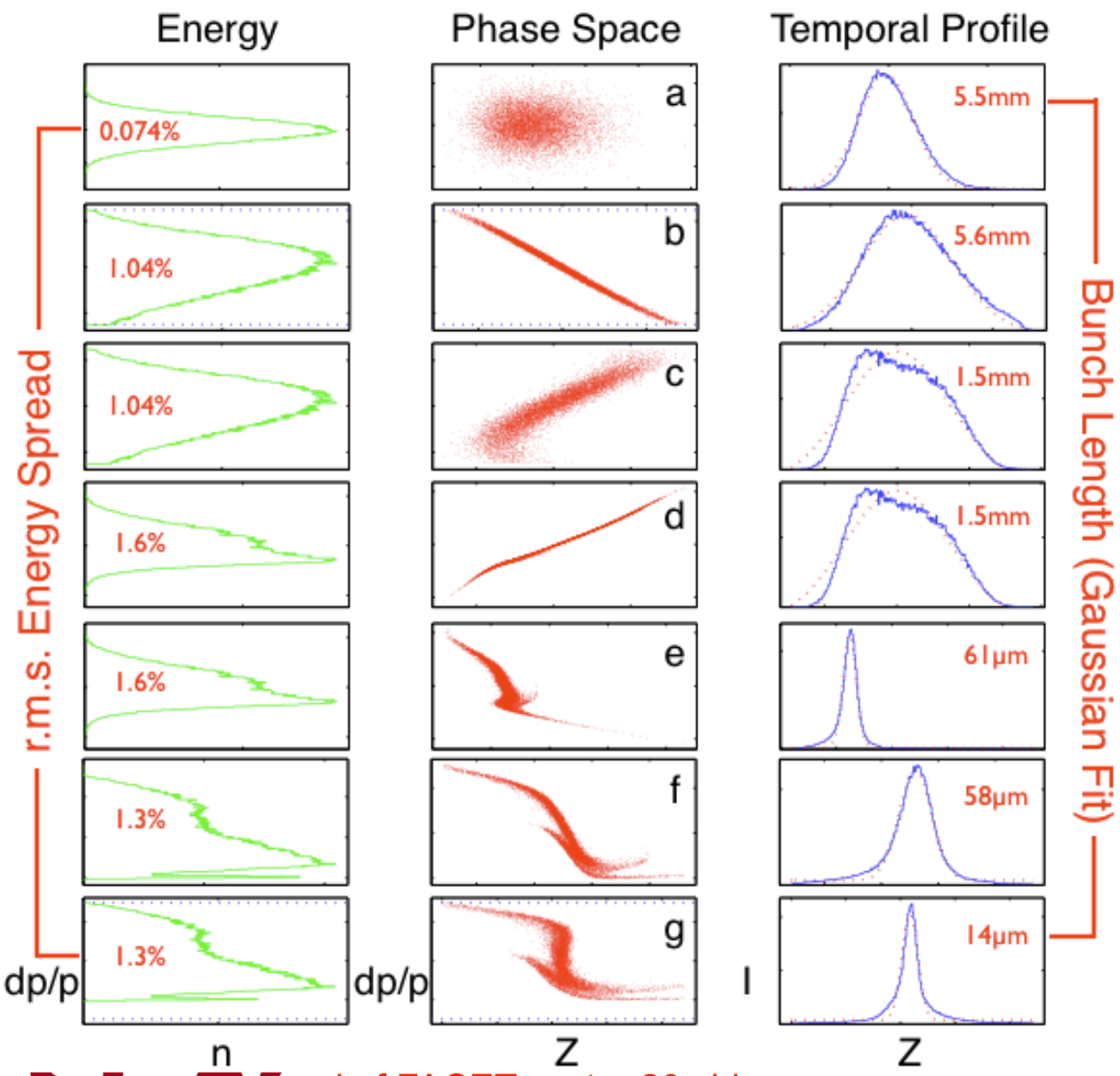
* Secondary stage of bunch compression: 1.5 mm → 50 μm
* Enables compressed positron bunches (needs to pass e^- too to get to positron target in sector 20

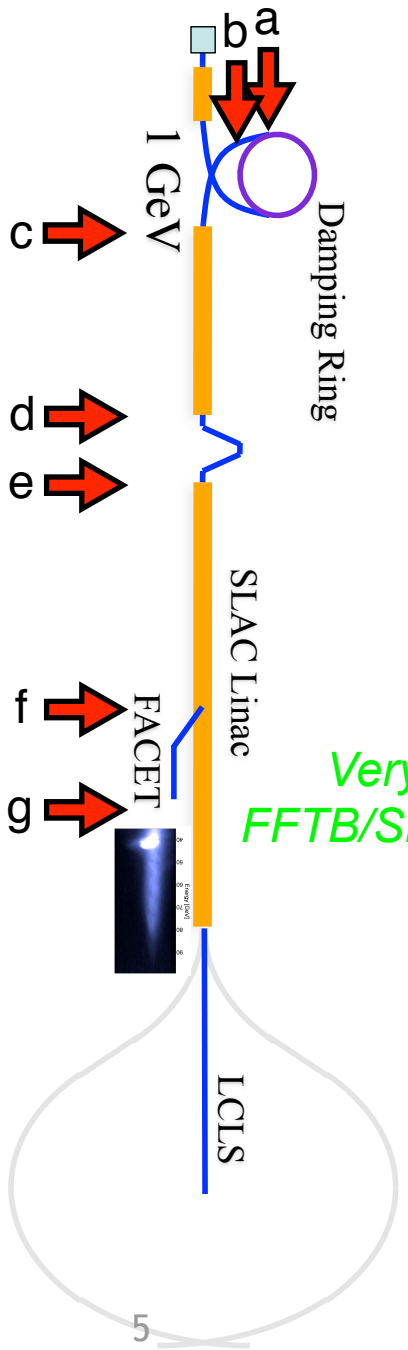


Experimental PPS Zone

- For now have ‘Guarded Access’
  - » Requires manpower from Ops, turn OFF VVS, longer recovery from cold state
- Would like dedicated experimental PPS Zone
  - » Would allow access after cool down period
  - » Leave linac in warm state that likely will recover quickly
  - » Latest cost estimate ($1.4M)!!!
    - Will look for opportunity for savings here but not clear yet that we will get it.
    - Make your voice heard

Bunch length monitors: FACET Uses a Three Stage Compression Process

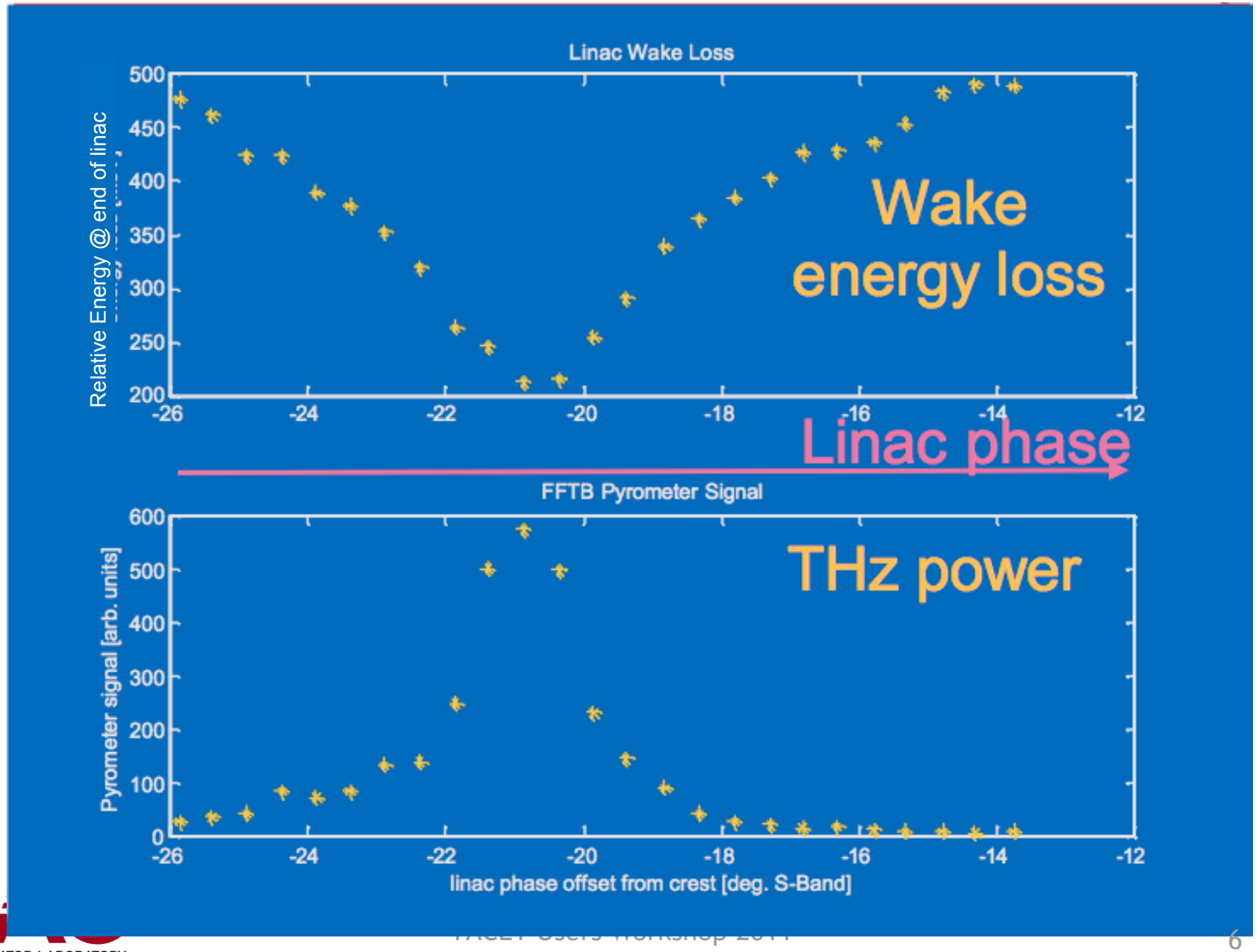




Very similar to FFTB/SPPS operation

end of FACET sector 20 chicane

FFTB Example of wakeloss vs pyro



First Measurements from FFTB

CTR Michelson Interferometer

- Fabry-Perot resonance:

$\lambda = 2d/nm$, m=1,2,…, n=index of refraction

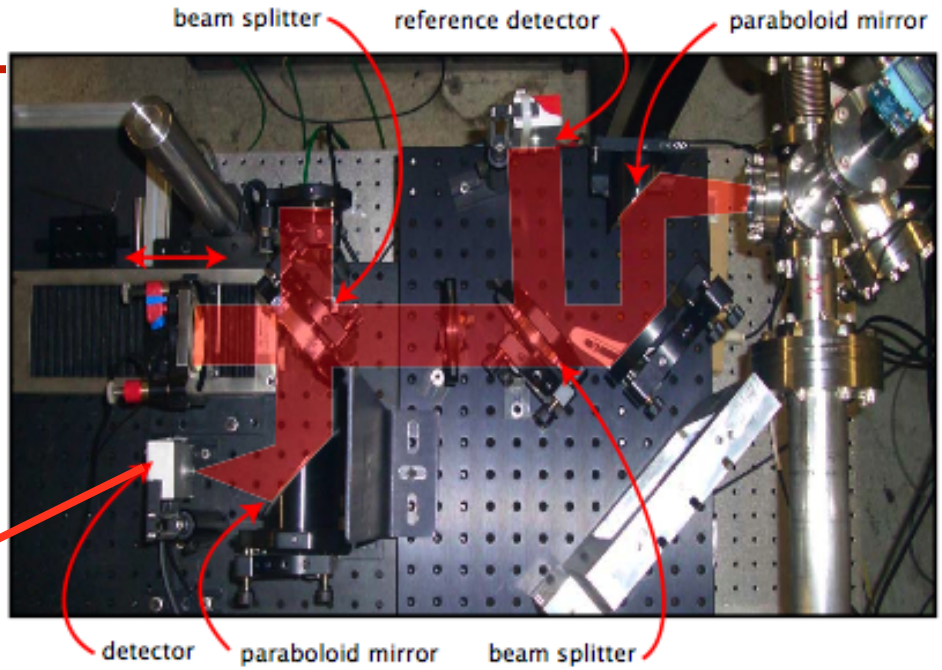
- Modulation/dips in the interferogram
- Smaller measured width:

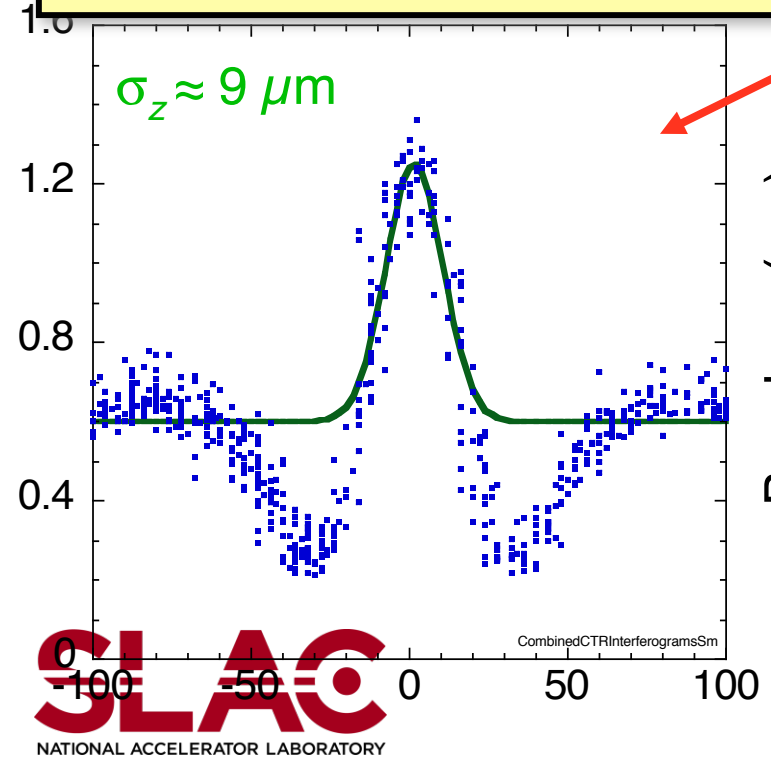
$$\sigma_{\text{Autocorrelation}} < \sigma_{bunch}\ !$$

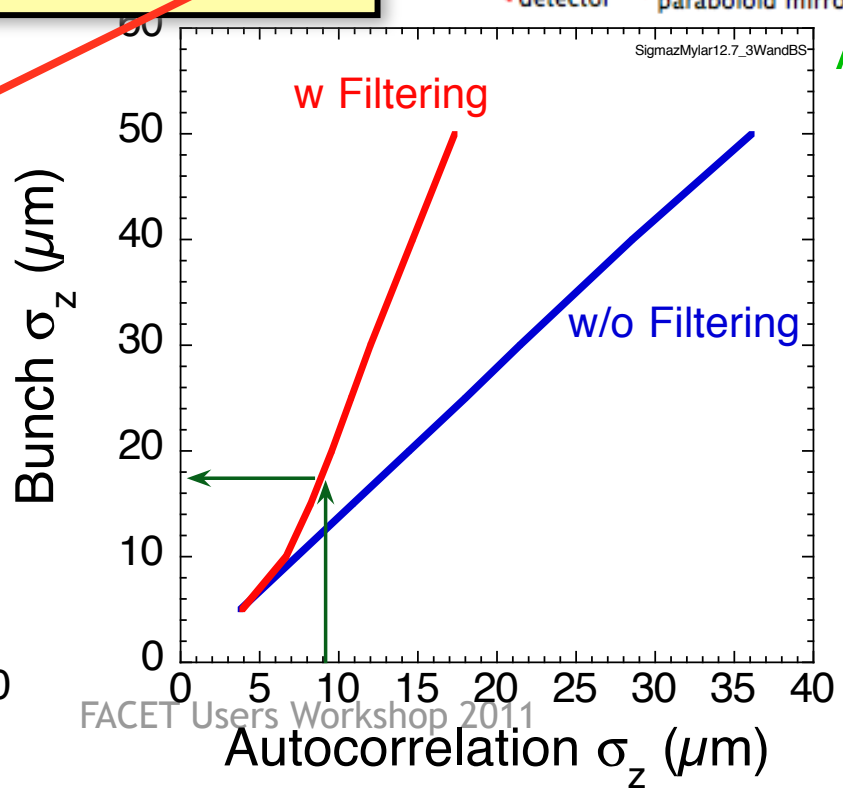
- Other issues under investigation:

- Detector response (pyro vs. Golay)
- Alternate materials:

HDPE, TPX, Si, Diamond ($$$)







Autocorrelation:

$\sigma_z \approx 9\ \mu m$

Gaussian Bunch

$\sigma_z \approx 18\ \mu m$

or

$\tau \approx 60$ fs

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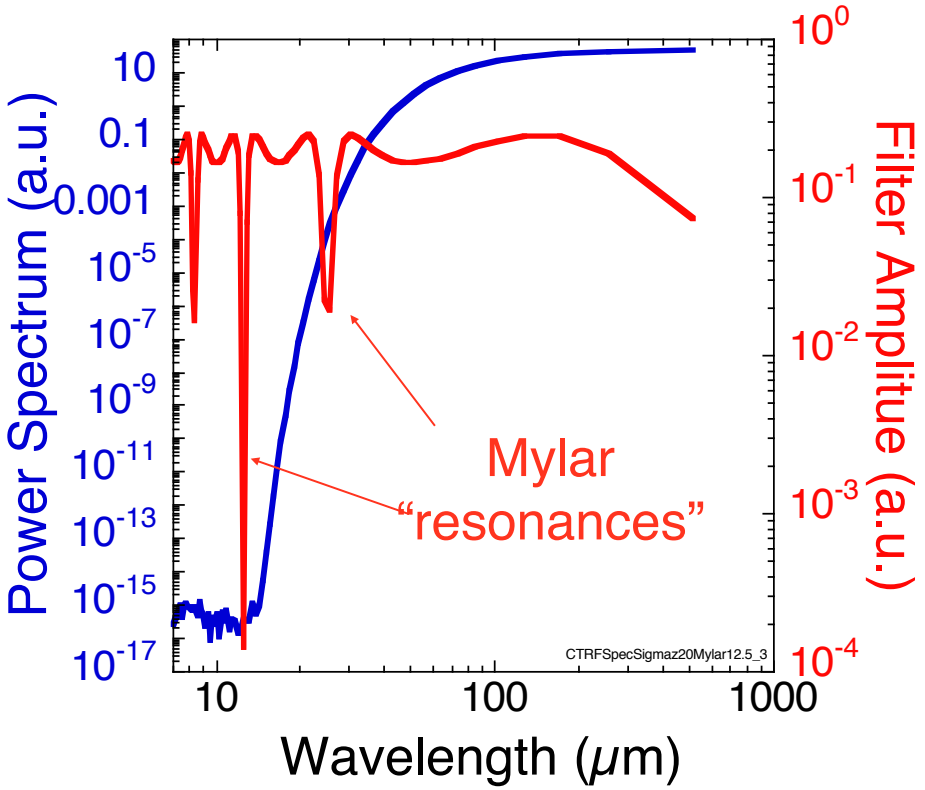
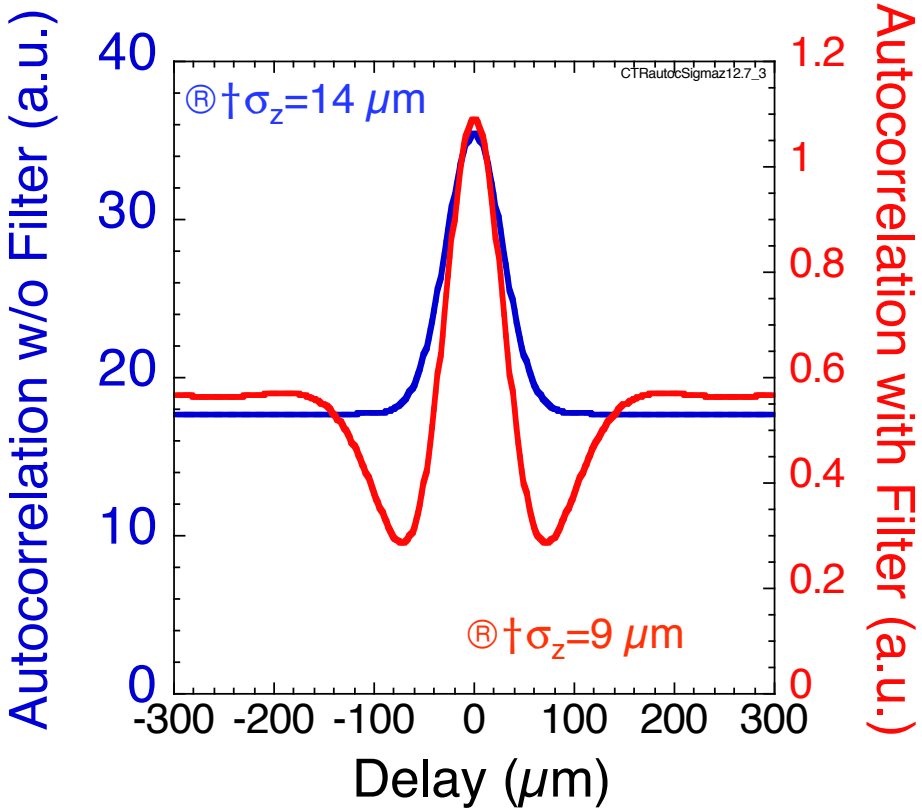
MYLAR FABRY-PEROT

Simple model: Gaussian, σ_z=20 μm, d=12.7 μm, n=3 Mylar window+splitters

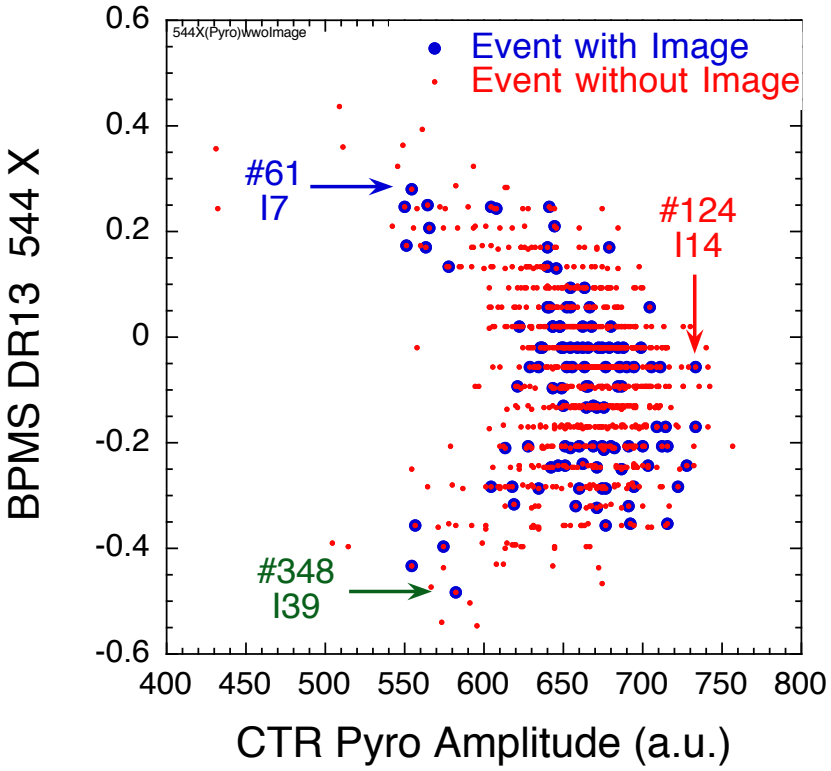


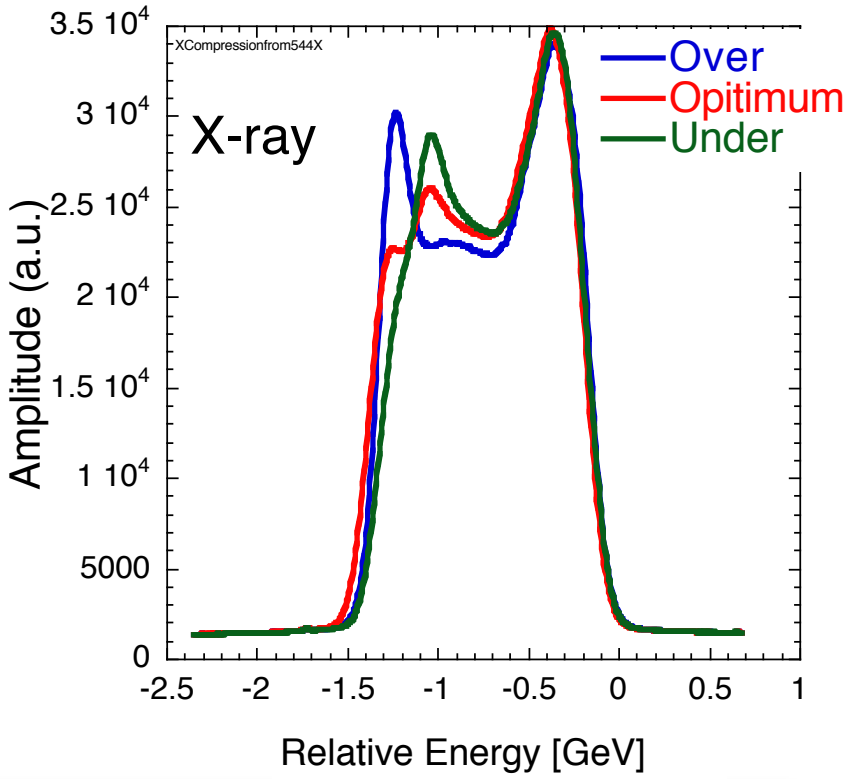


- Fabry-Perot resonance: λ=*2d/nm*, m=1,2,…, *n*=index of refraction
- Signal attenuated by Mylar beam splitter: $(RT)^2$
- Modulation/dips in the interferogram
- Smaller measured width: $\sigma_{Autocorrelation} < \sigma_{bunch}$!
- Other issues under investigation:
  - Detector response (pyro vs. Golay)
  - Alternate materials (HDPE, TPX, Si, Diamond ($$$))

Pyro is not the whole story - details of the spectra (SYAG) are important

Example: Jitter from North Damping Ring:

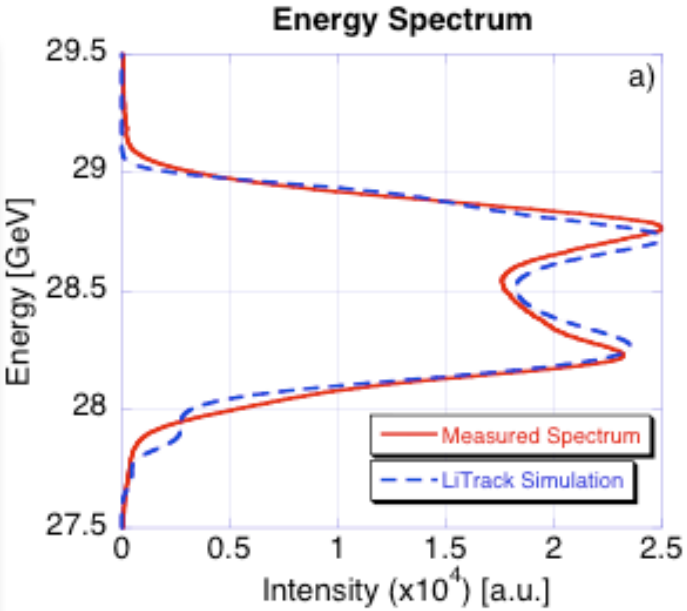


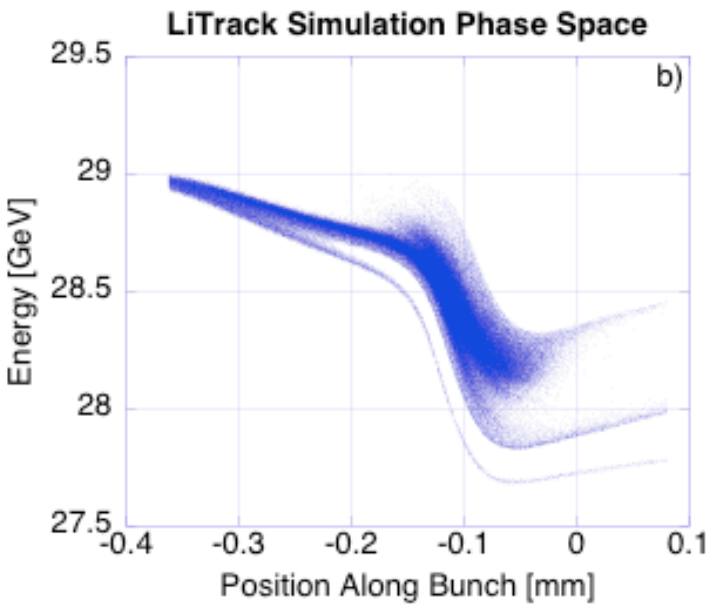


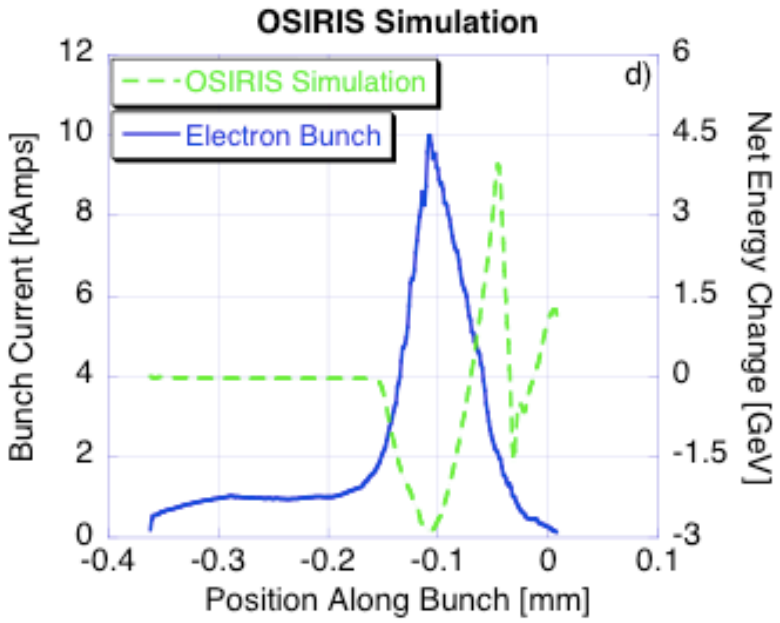
- **Pyro amplitude is ambiguous**
- **Energy spectra are not**
- **They are complimentary diagnostics**
- **Clear correlation between energy spectrum and E-164X outcome**

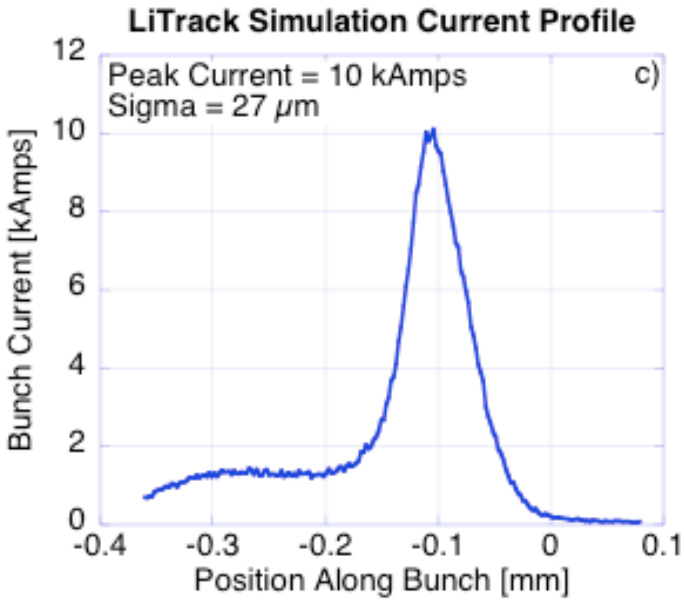
Phase Space Retrieval via LiTrack

- Extension of previous work on SLC
  - More compression stages
  - More free parameters
  - Shorter bunches
- Requires good measurements, good intuition or really good guessing!
- Not automated (yet!)
- Single shot and non-destructive!









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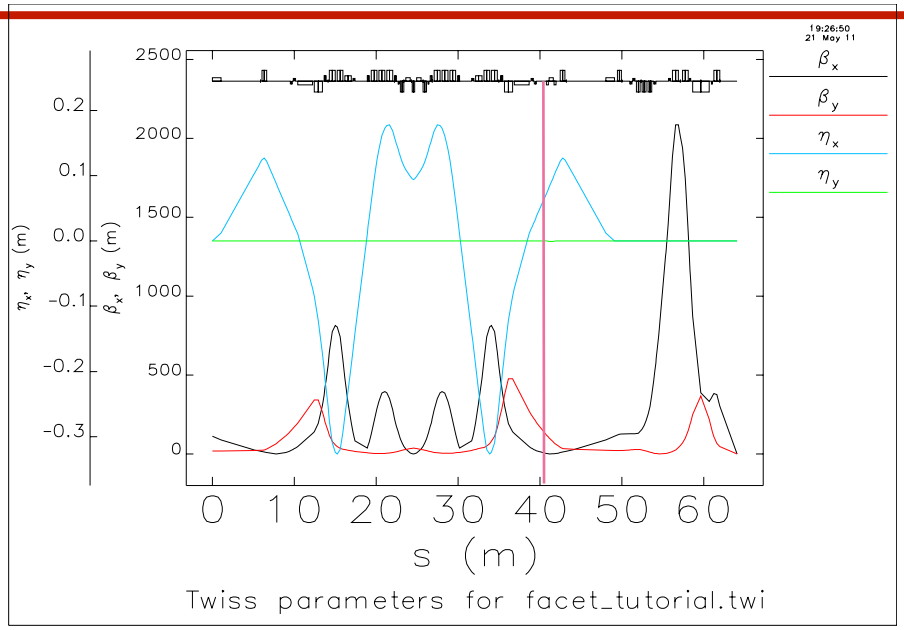
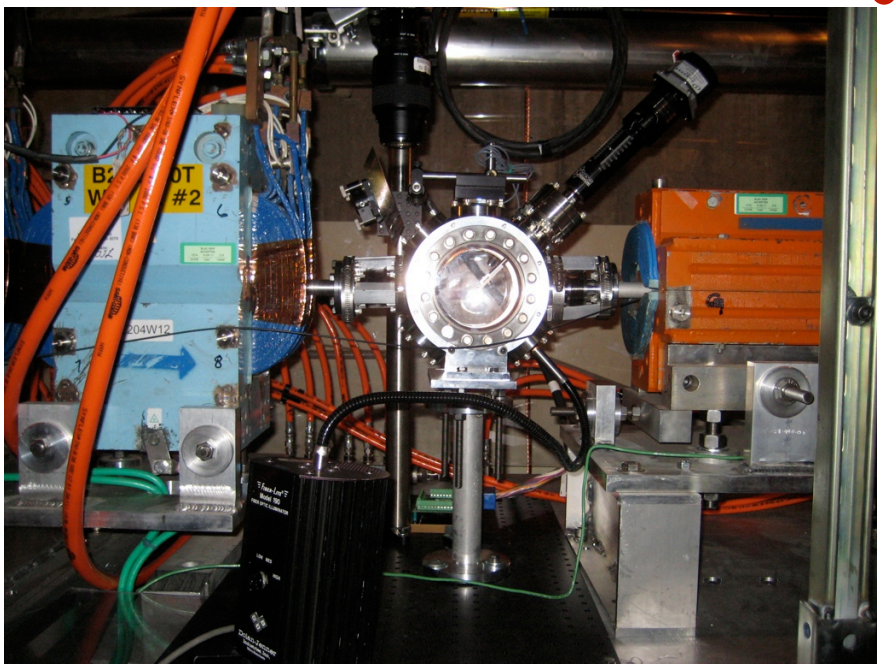
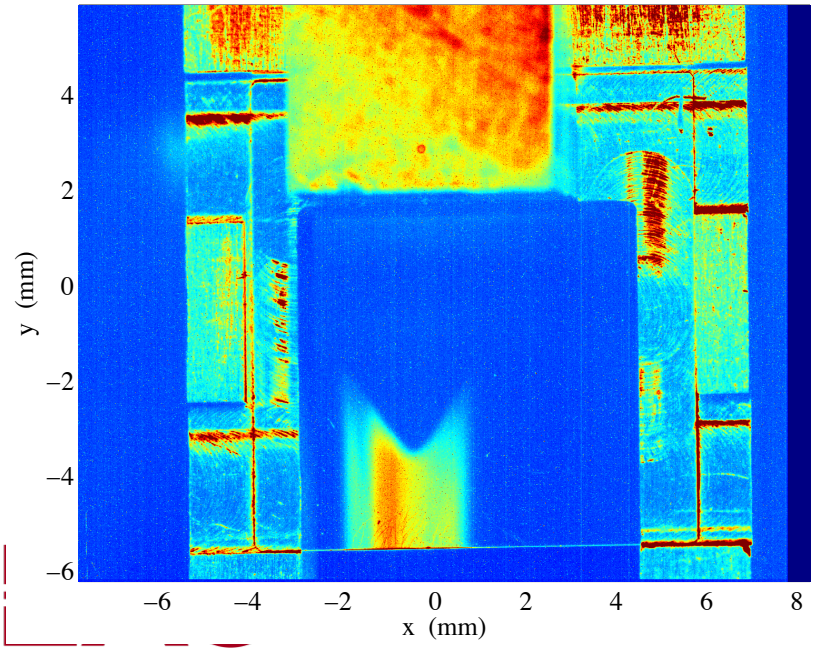
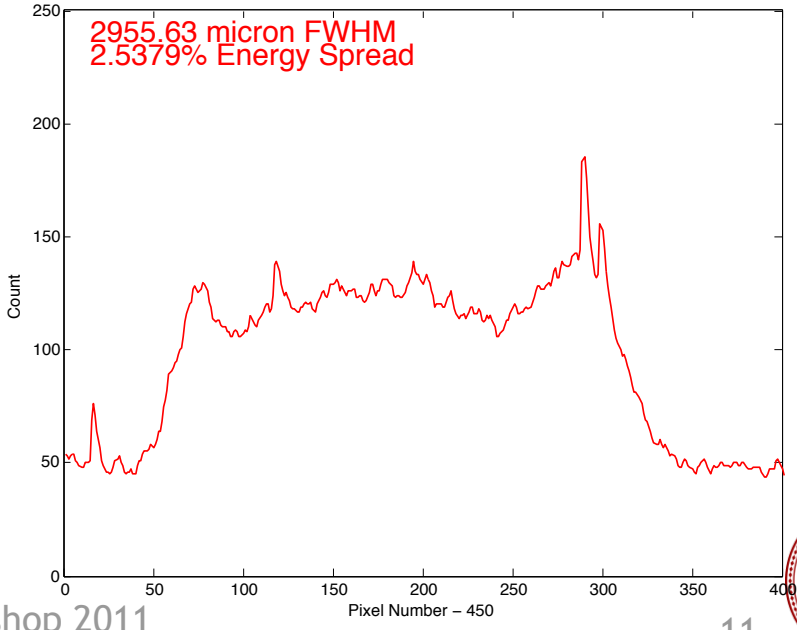
SYAG: Incoming Energy Spread





Profile Monitor YAGS:LI20:2432 19–Aug–2011 16:13:54





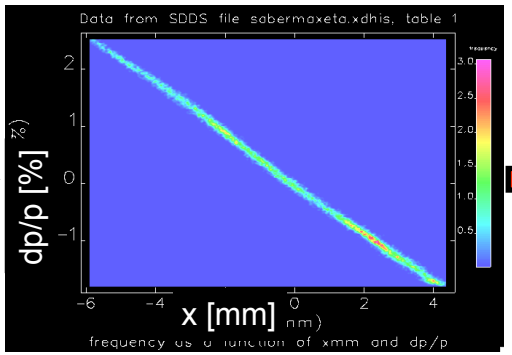
Two bunch experiments will require additional bunch length diagnostics

- Collimation system to craft drive/witness bunch from single bunch (similar to BNL ATF wire system)

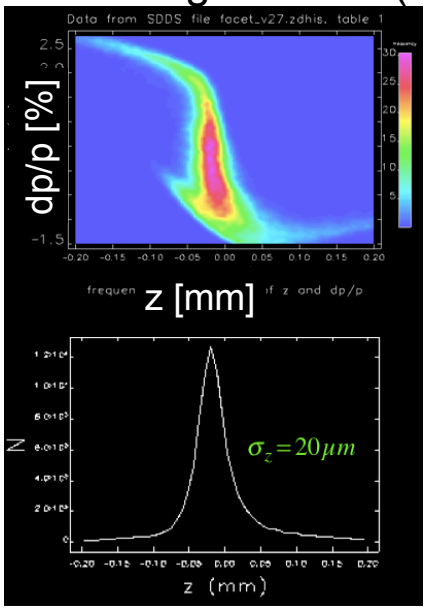
Disperse the beam in energy

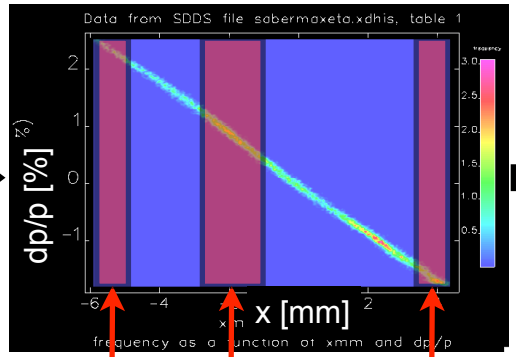
$$x \propto \Delta E/E \propto t$$

Adjust final compression



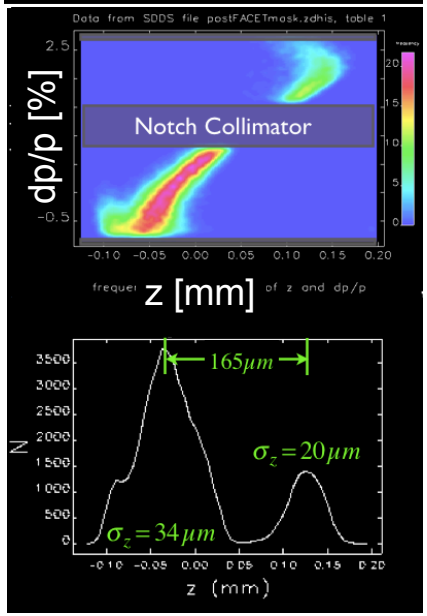
R56 = 4mm



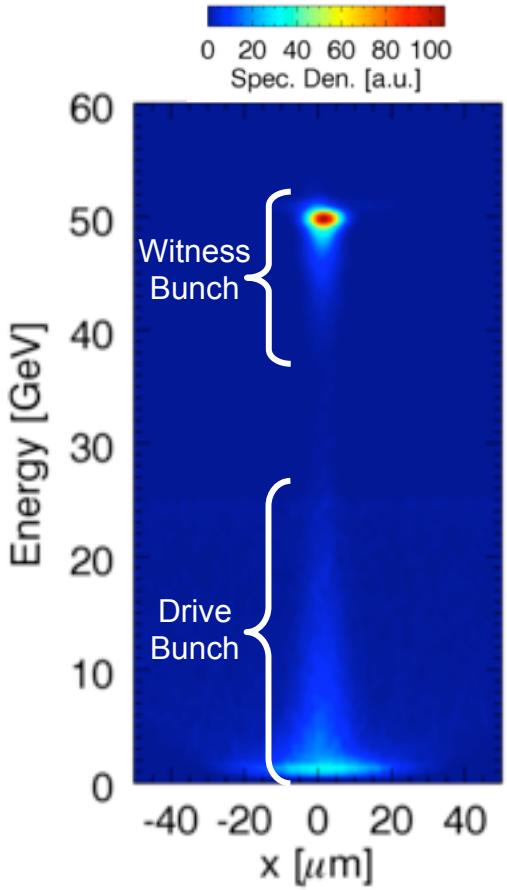


...selectively collimate

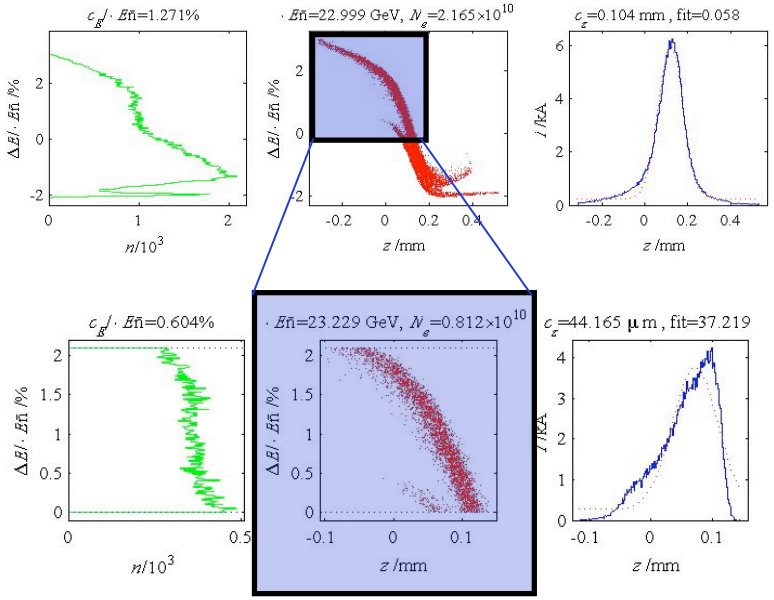
R56 = 10mm

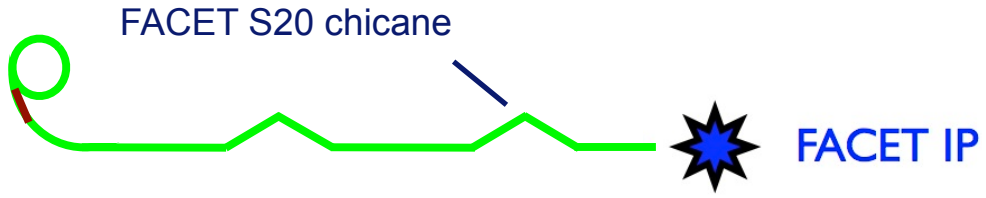


Plasma



Use High Transformer Ratio to Maximize Efficiency and Energy Gain per Stage

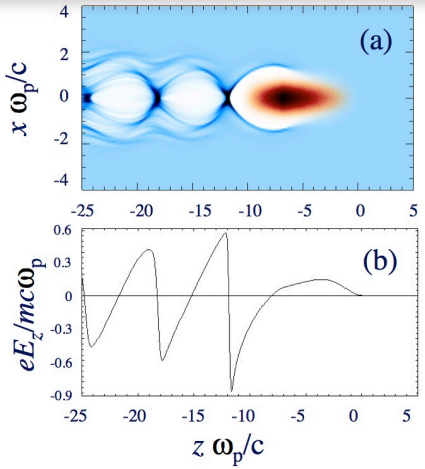




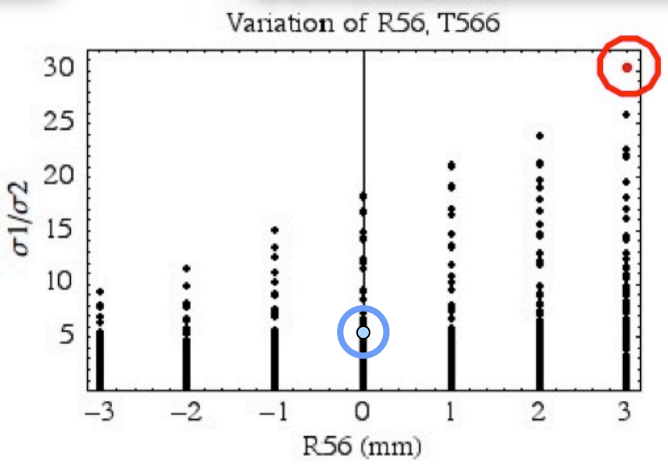
Due to upstream compression, need R56 = T566 = 0 in dogleg
Collimators (part of existing design) can remove low-E tail.

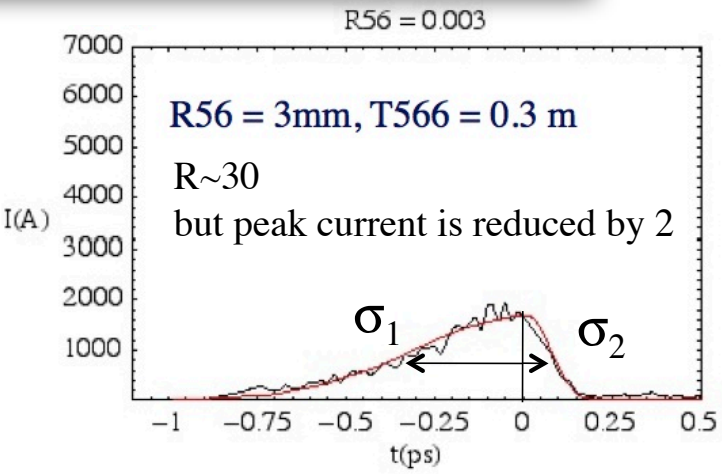
Ramped bunch has L = 200 µm ; Ipeak = 4 kA ; n_b/n_0 = 7
Transformer Ratio = 10 for plasma n_0 = 3x10^{17} cm^{-3}

QuickPIC gives unloaded T=6



Beamline & collimator optimization ongoing

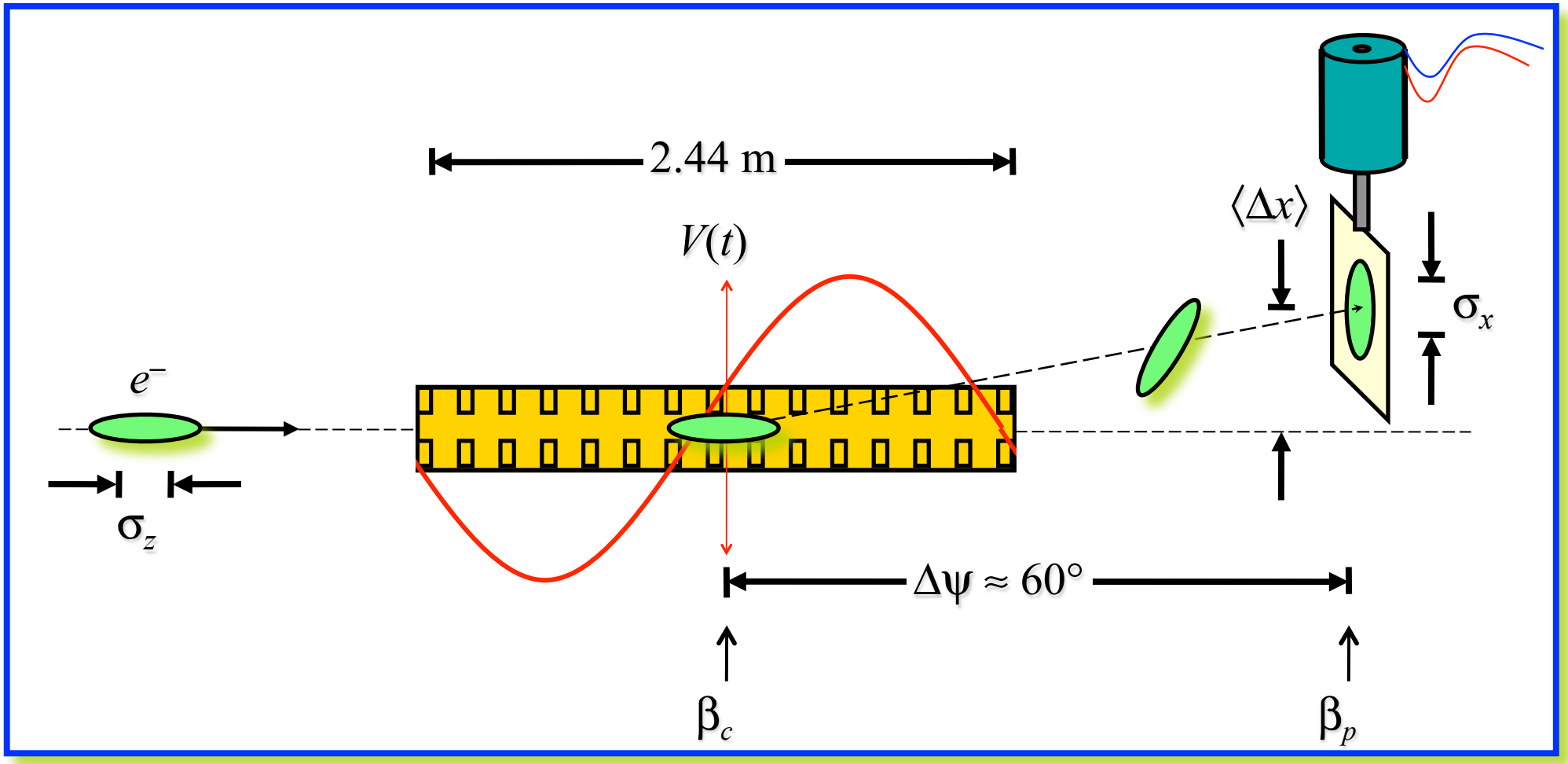




- Open questions: pre-ionized plasma, witness bunch, hosing...

TCAV

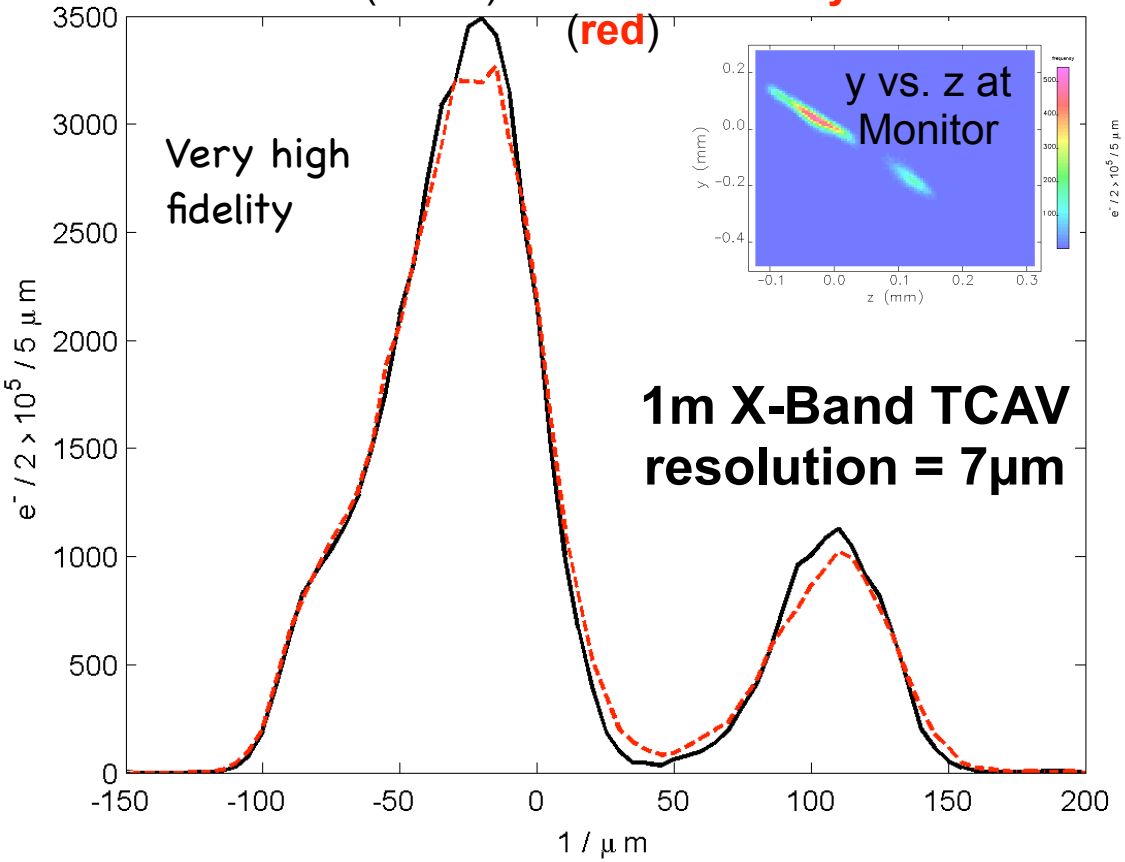
- RF transverse deflecting cavity (TCAV)



X-Band TCAV is Only Viable Longitudinal Diagnostic for Two-Bunch FACET Beam

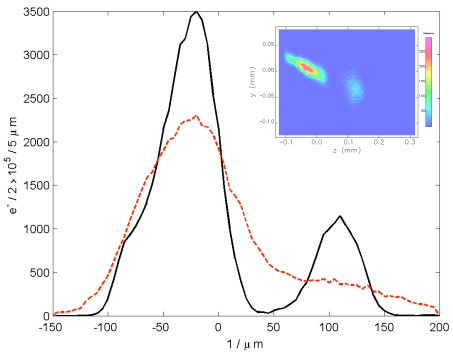
Simulated Longitudinal Charge Profile:

Actual (**black**) and **Measured by XTCAV** (**red**)

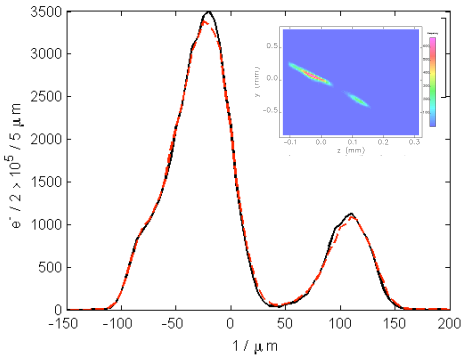


Correlation between y and z is linear, so signal interpretation is extremely clear.

S-Band TCAV



2m X-Band TCAV



Comparison against alternative methods

Method	Resolution
2m XTCAV	3.5μm
1m XTCAV	7μm
STCAV	25μm
Electro-Optic	30μm
Streak Camera	>60μm

Requirement to resolve FACET beam: < 10μm

Additional/Improved Diagnostics

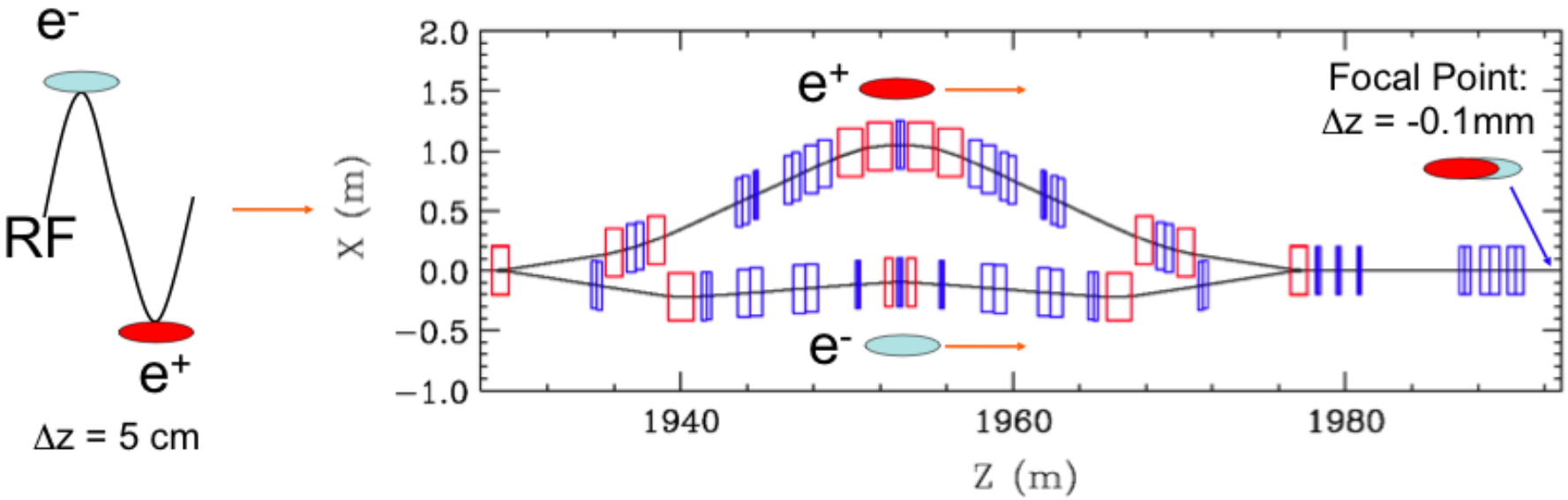
- Wire(s) in Li18 or Li19?
- Additional Toroids, BPMs?
- Improved camera support and diagnostics
  - Improved bit depth, gated
  - Lifetime of components
  - Remote focusing and control of FOV
  - Remote
- Need your input!

Optics Knobs for Experiments

- E200:
  - Waist shift/plasma matching
  - Spectrometer imaging
  - R56 (0-10mm)
  - Dispersion @ IP
- E201:
  - Waist shift
  - Beta*
  - Aspect ratio
- E202:
  - Waist shift
- E203:
  - Waist
- T500:
  - Aspect ratio @THz foils

FACET Design is Forward Looking and Flexible, e.g. Sailboat Chicane Upgrade

- Extract e^- & e^+ from damping rings on same linac pulse
- Accelerate bunches to sector 20 while 5.25 cm apart
- Use 'Sailboat Chicane' to put them within 100μm at entrance to plasma



Opens up many new avenues of research:

- Positron acceleration on electron driven wakes
- Platform for evaluating proton driven PWFA concept

Proposals Requesting Sailboat Chicane

Title	Spokesperson(s)	SAREC Ranking	Sailboat Chicane
Multi-GeV Plasma Wakefield Acceleration Experiments	Mark Hogan (SLAC), Chan Joshi (UCLA), Patric Muggli (USC)	Excellent	Yes e+ acceleration
Determination of the time profile of 50fs long bunches by means of coherent Smith-Purcell radiation.	Armin Reichold (Univ. Oxford)	Excellent	No
Study of Ultrafast Processes in Magnetic Solids following Excitations with Electron Beams	Hermann Durr (SLAC)	Excellent	Yes Double Pump
Wakefield Acceleration in Dielectric Structures	Mark Hogan (SLAC), James Rosenzweig & Gil Travish (UCLA), Patric Muggli (USC)	Very Good	Yes e+ grad limits
High-gradient Dielectric Wakefield Measurements at FACET	Alexei Kanareykin (Euclid LLC)	Good	Yes Long range W
Testing of Metallic Periodic Structures at FACET	Sami Tantawi (SLAC)	Good	No
Investigations of Optical Diffraction Radiation as a Non-intercepting Beam-size Monitor at High Energy and Charge Density	Alex Lumpkin (FNAL)	Fair	No
Afterburner Based on Particle Acceleration by Stimulated Emission of Radiation at FACET	Levi Schächter (Technion)	N/A	No
Letter of intent for a program of measurements for the CLIC study at the FACET facility	Daniel Schulte (CERN)	Proposal Encouraged	Yes Long range W
Expression of Intent for THz Program at FACET	Joe Frisch (SLAC)	Proposal Encouraged	Yes – Double pulse THz

Summary

- These are things we have in mind
- We have finite resources (money, people) and need to prioritize
- Charge to the working groups:
  - What has worked and what has not
  - What do we need to do in the coming down time to be ready to hit the ground running next run (CY2012)
    - Hardware, software, controls, data access, scheduling, optics
    - Thoughts about requirements beyond FACET
  - First half of time tomorrow group by activity (PWFA, DWFA, THz...)
  - Second half compare lists and look for common needs
  - Schedule - how much time, how much time in between?