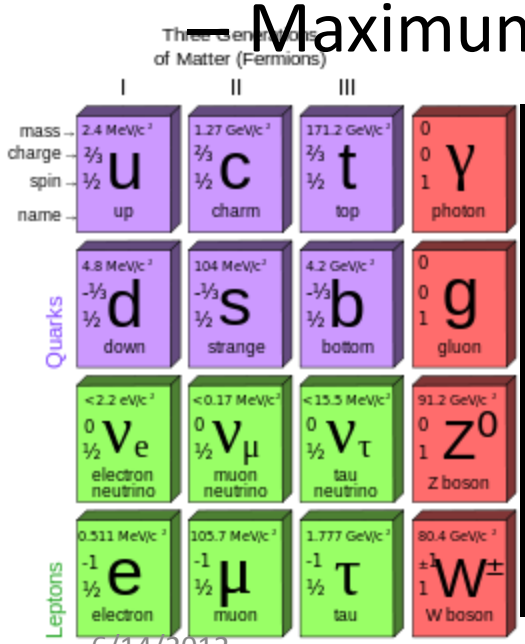
Northern Illinois University nicadd Fermilab

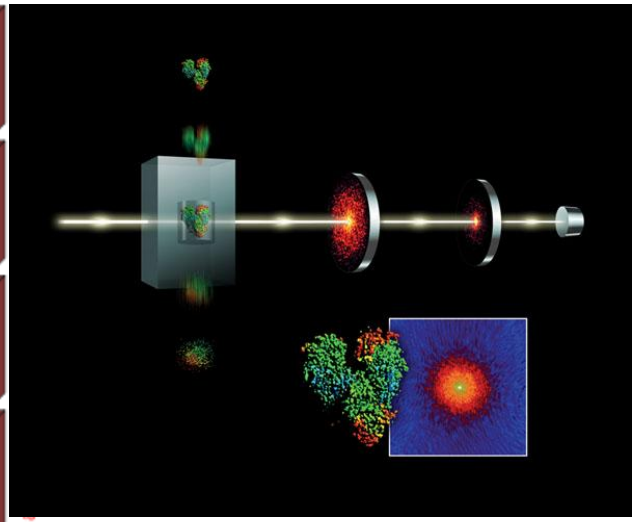
Dielectric Wakefield Acceleration

François Lemery

Motivation

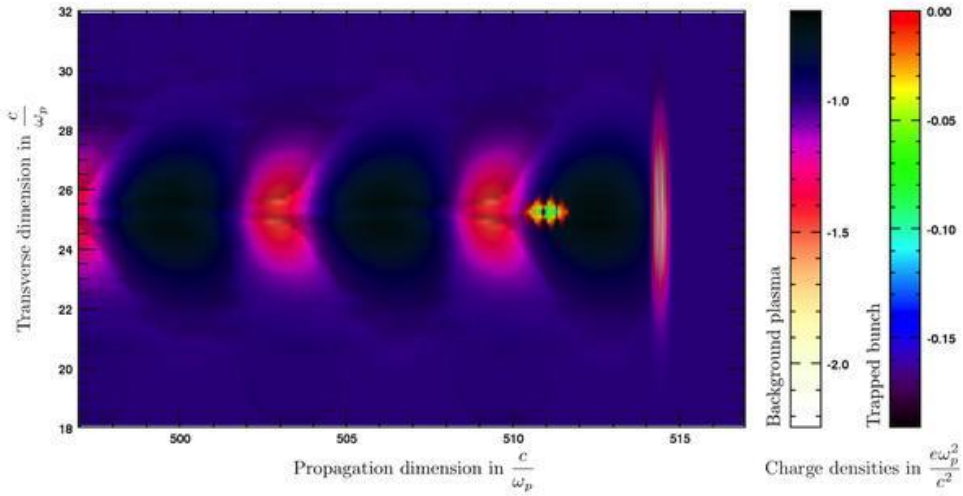
- Accelerators have led to new science:
  - HEP
  - Light sources (Chemistry, Biology, Materials)
  - Cost
  - Maximum RF gradients ~ 100MV/m.





Types of Wakefield Accelerators

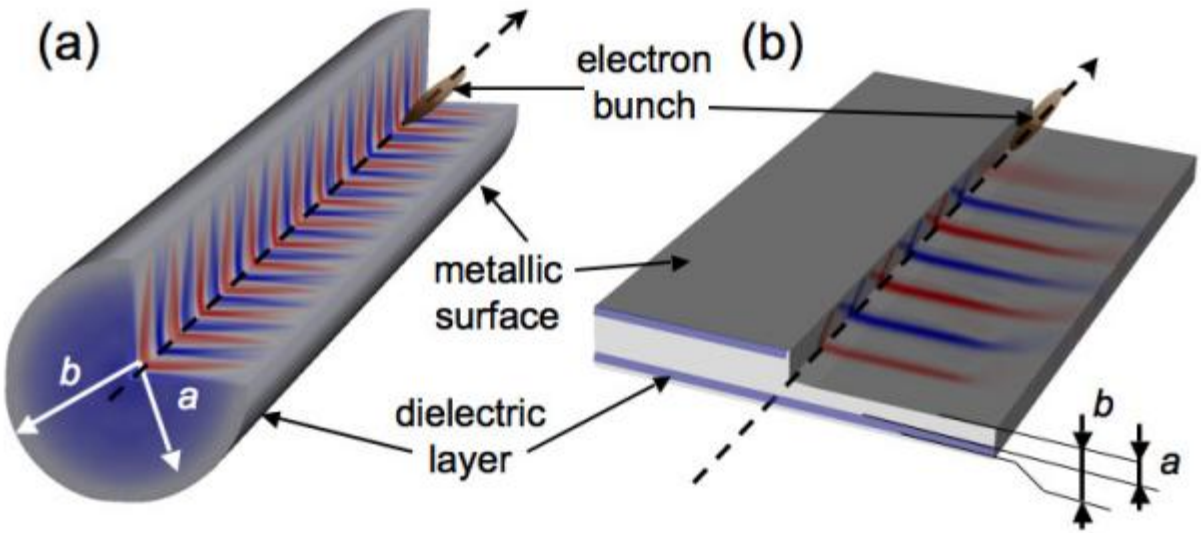
- Laser driven plasma wakefield acceleration
- Beam driven plasma wakefield acceleration
- Dielectric Loaded Waveguides (DLW)



Dielectric Loaded Waveguides

Cylindrical, Slab…

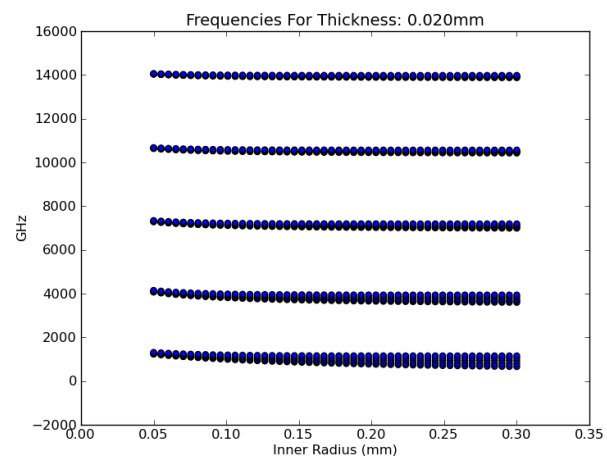
δ = b - a



*Dielectric restricts phase velocities < c!

Understanding

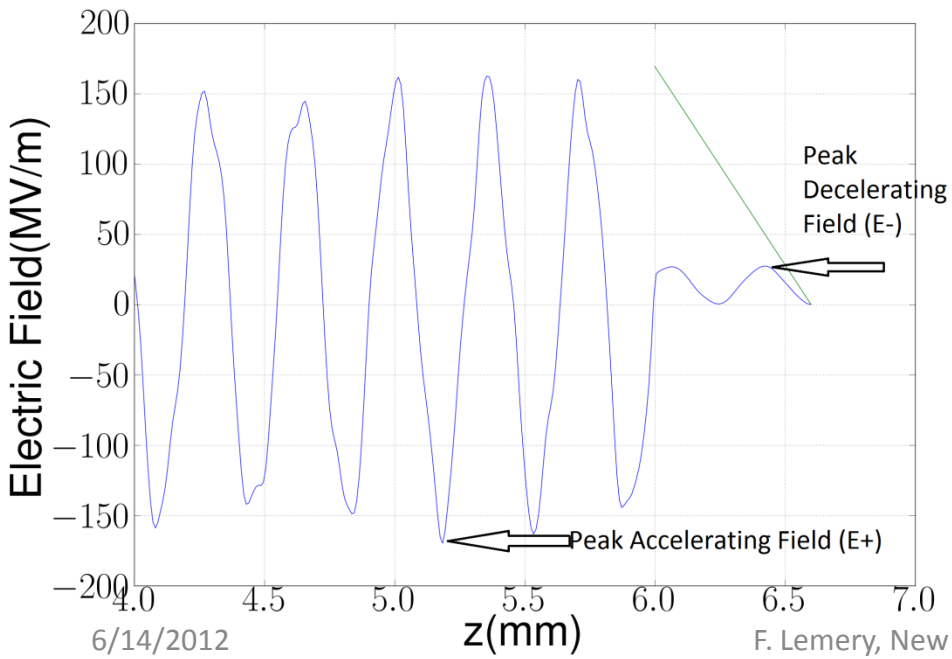
- Resonant frequencies(monopole, dipoles ..)
  - Dispersion equation
- Mode coupling
  - Understood by looking at the frequency space of current profile.

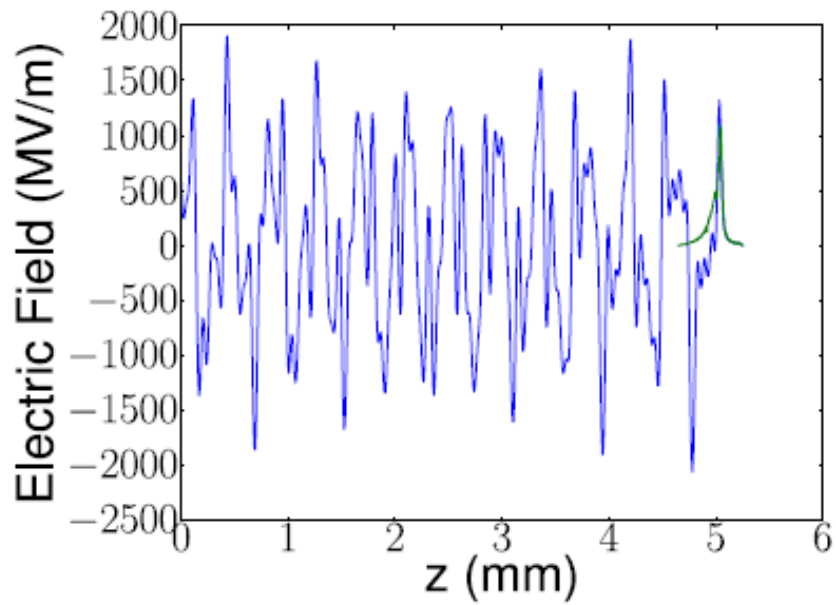


Slab geometry

Understanding the Wake

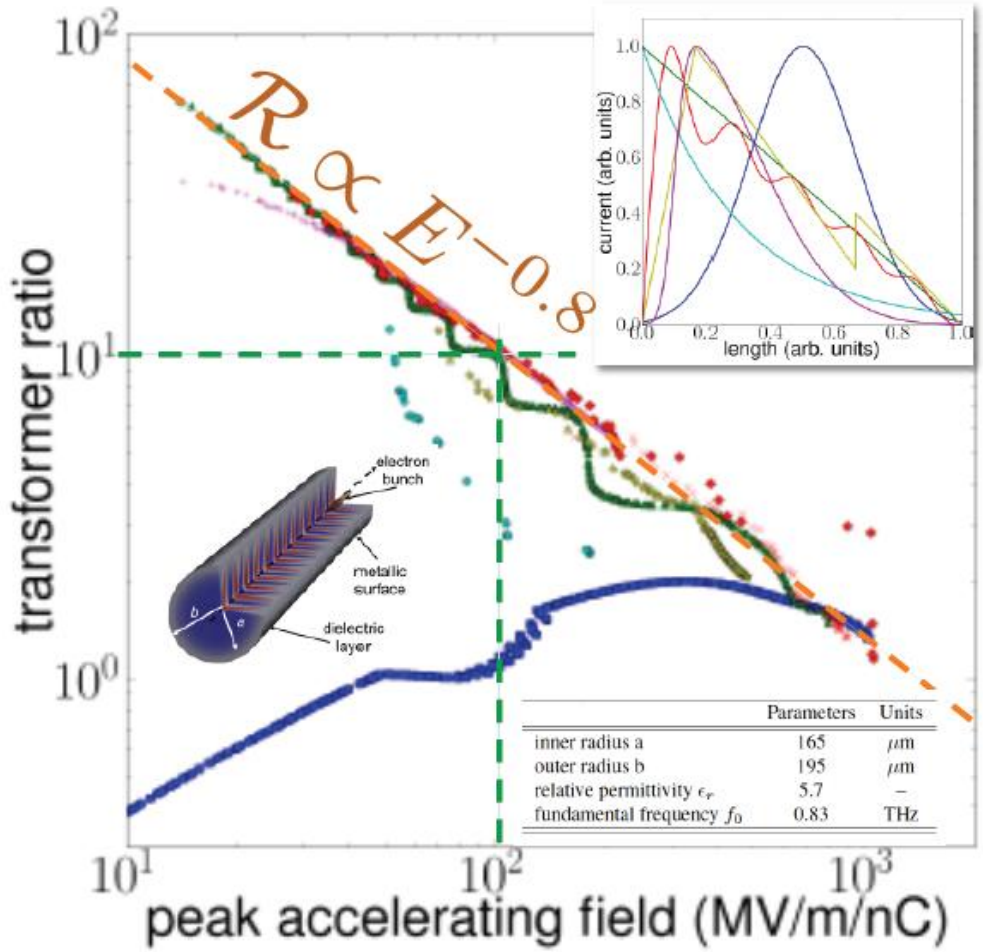
- Transformer Ratio (R = Abs(E+/E-))
  - Fundamental Wakefield Theorem (Sym. Bunch: R < 2)
- Energy modulation (bad).
- Witness bunch must fit in bucket!





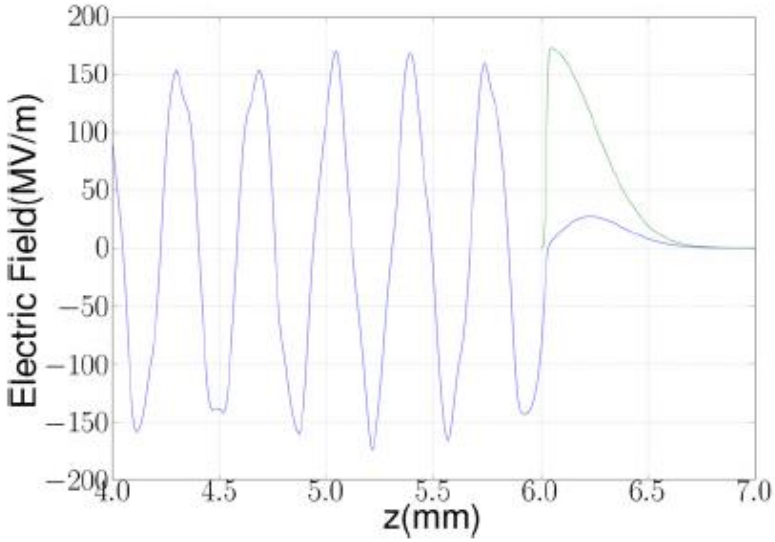
Pulse Shaping

- Very important!
- Maximize both E+ and R.
- Reduce energy spread.

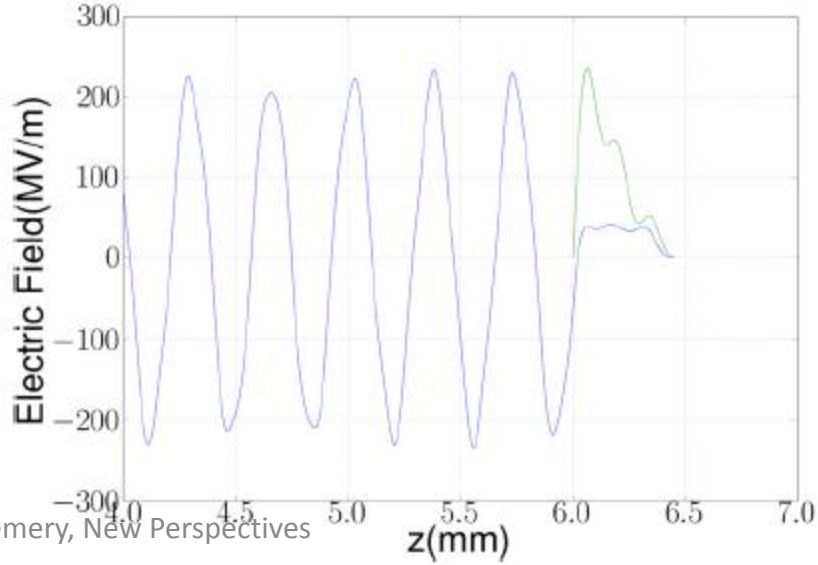


Pulse Shaping Continued

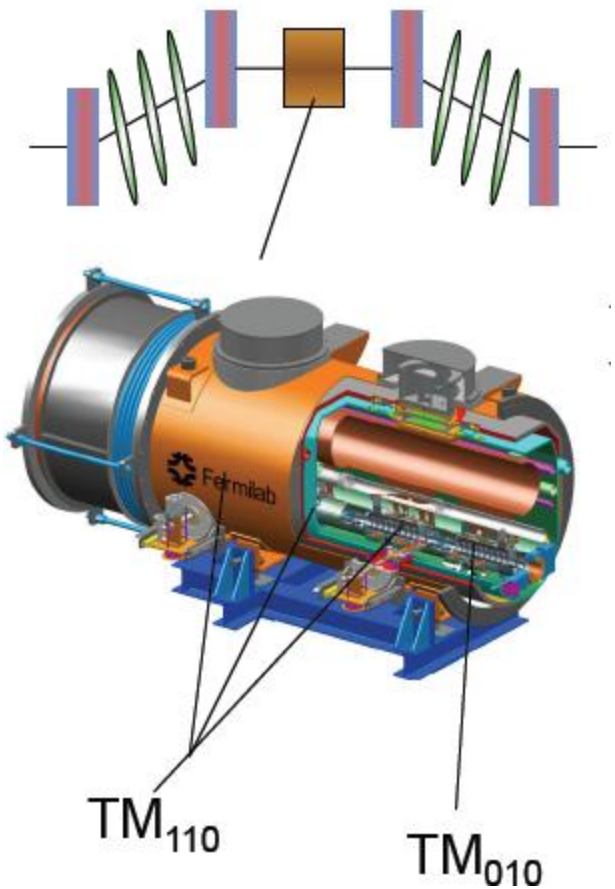
- Skewed Gaussian



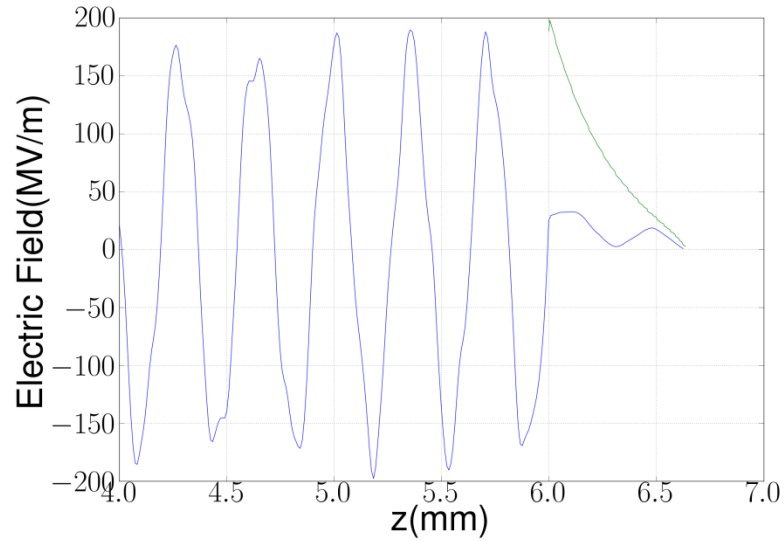
- Fourier Ramp



Pulse Shaping Continued



Emittance Exchanger (EEX) for very flexible shaping

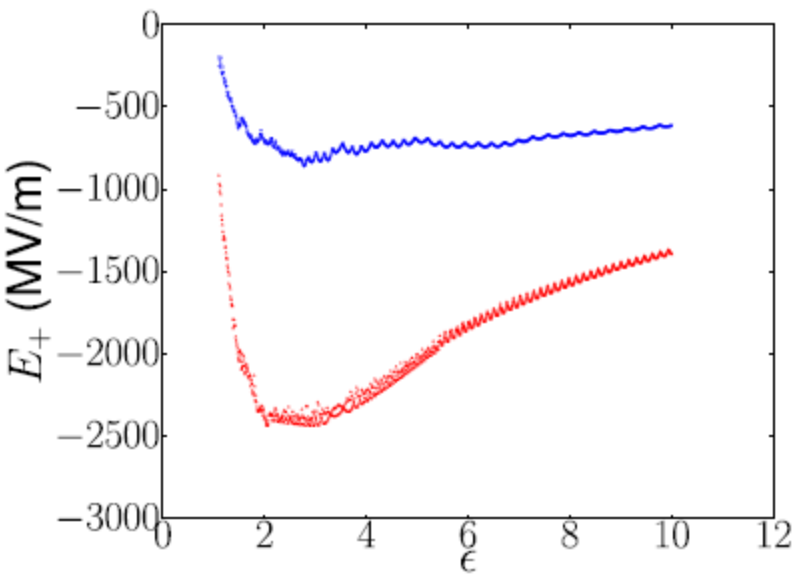


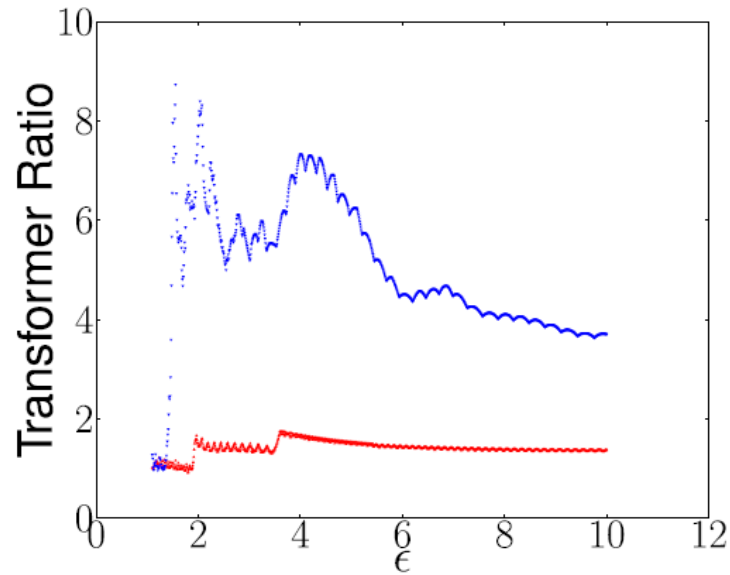
Achievable using multi frequency RF booster

*Both will be available at ASTA!

Dielectric Considerations

- E+ and R highly dependent on electric permittivity of dielectric.

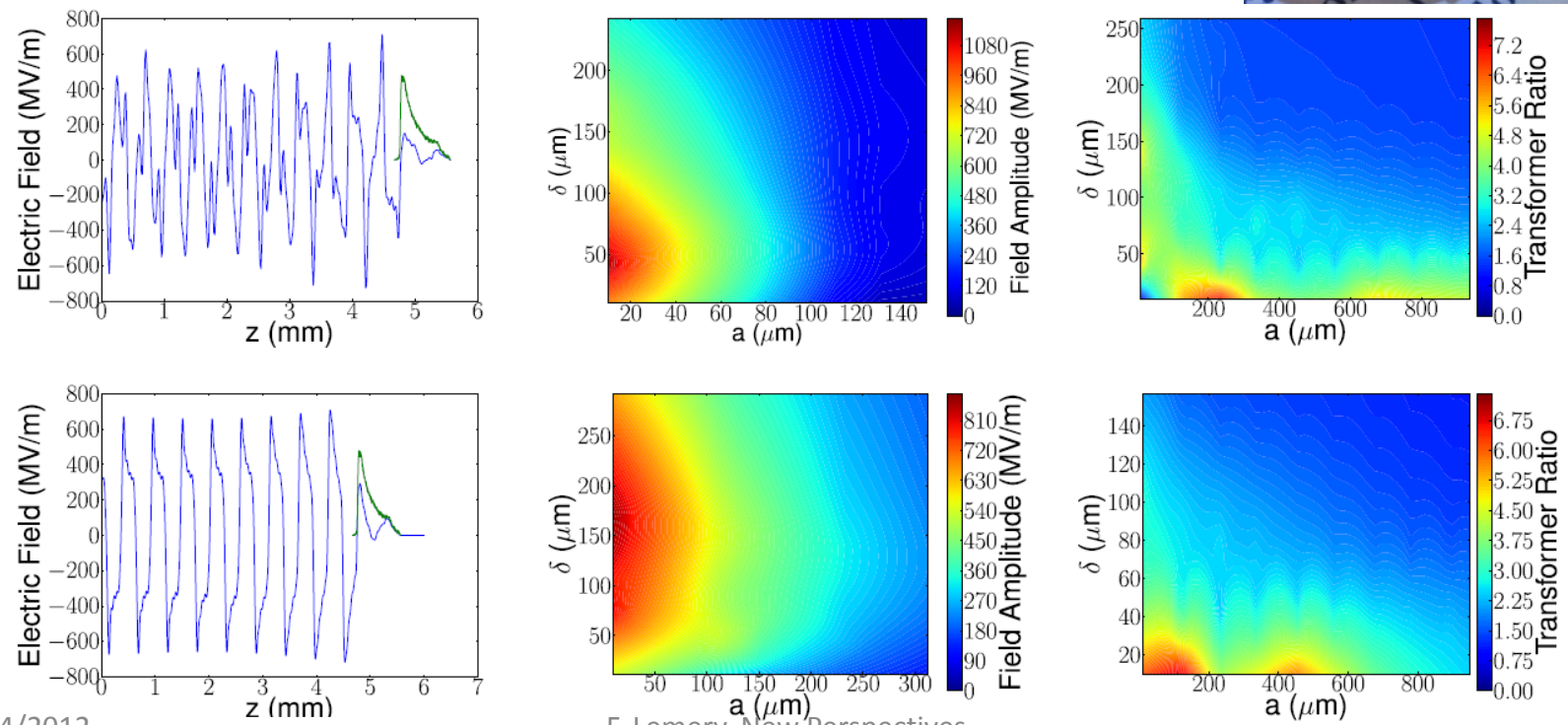




Short Gaussian bunch(red), Linearly ramped bunch (blue)

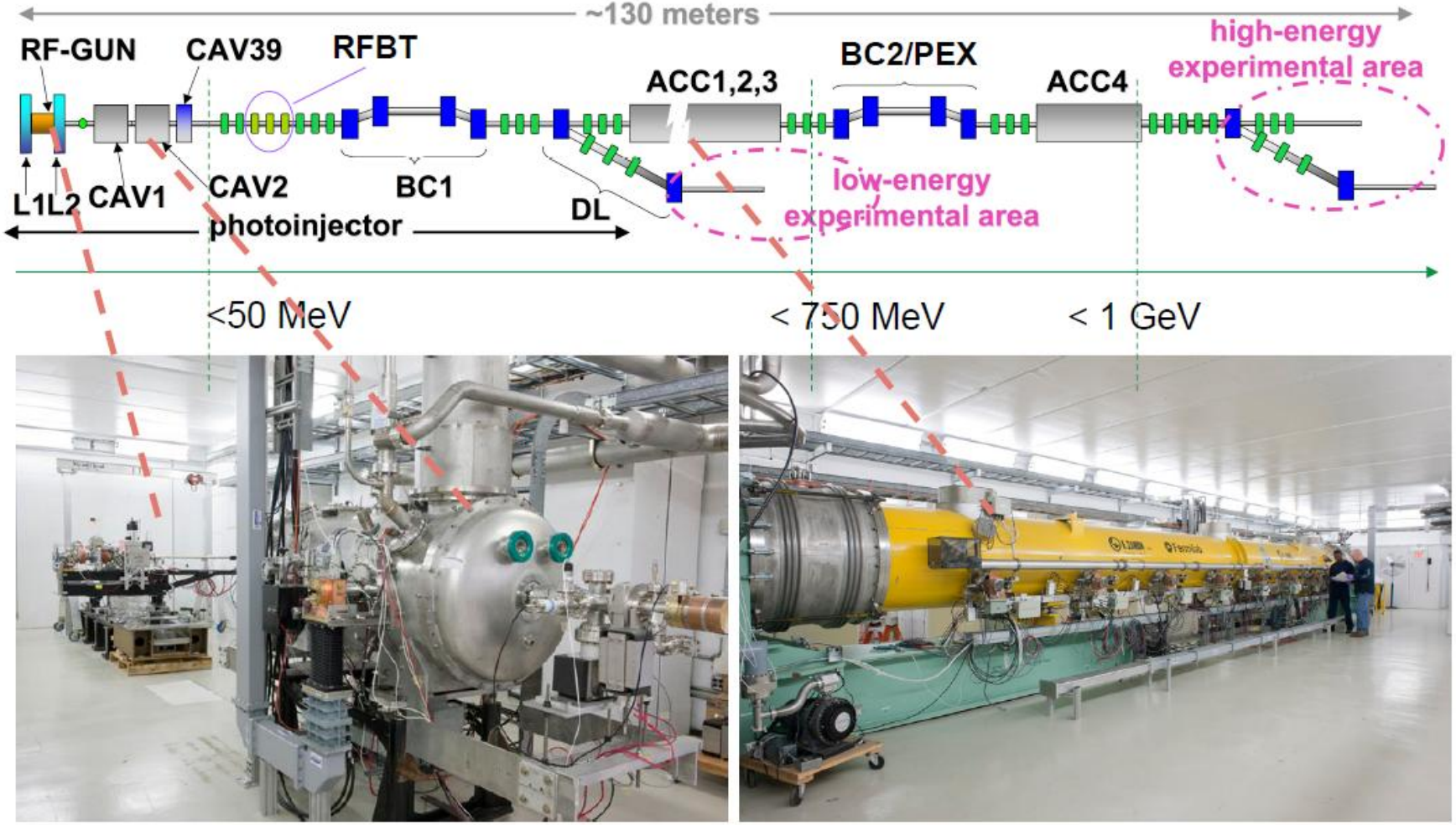
Round vs Flat Beam

- Round beams have more stringent requirement on betatron functions



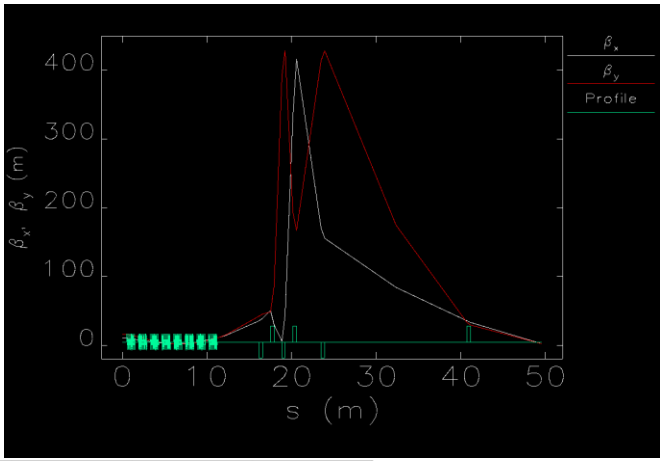
$(a, \delta) = (20, 60)\ \mu\text{m}.$

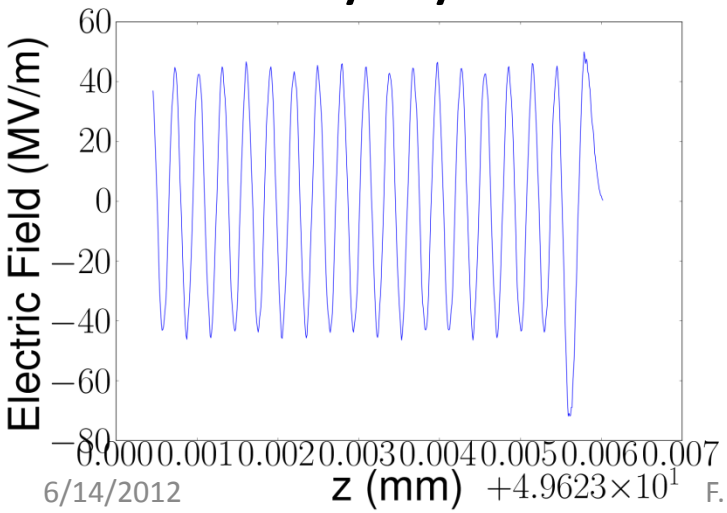
Advanced Superconducting Test Accelerator (ASTA)

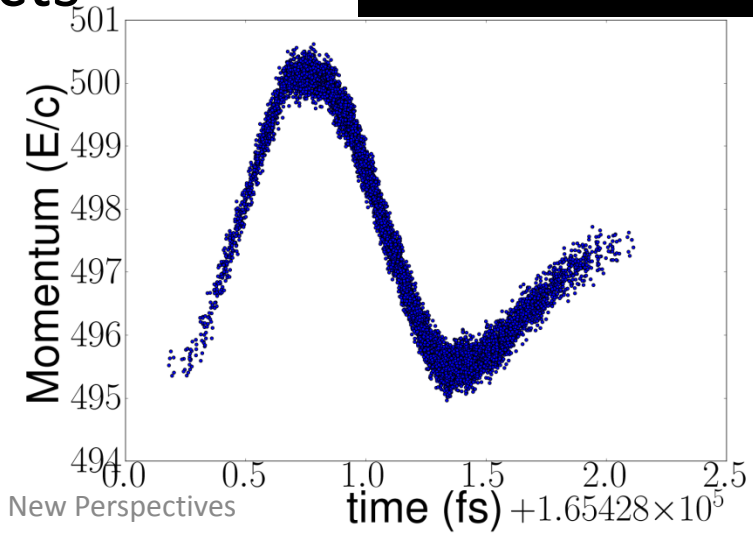


DLW Acceleration at ASTA

- Flexible bunch shaping capabilities
  - Round, flat,
  - longitudinally tailored(p2)
- High repetition rate
  - Study dynamical effects

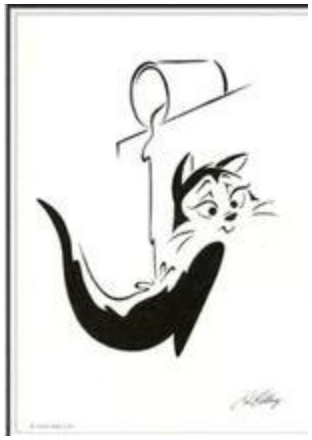






Conclusions

- What's beyond the standard model?
  - Let's make a PeV machine!
- Light sources have long waiting lines!
- "Recycle"



SUSY