First Dielectric Wakefield Experiments at ASTA

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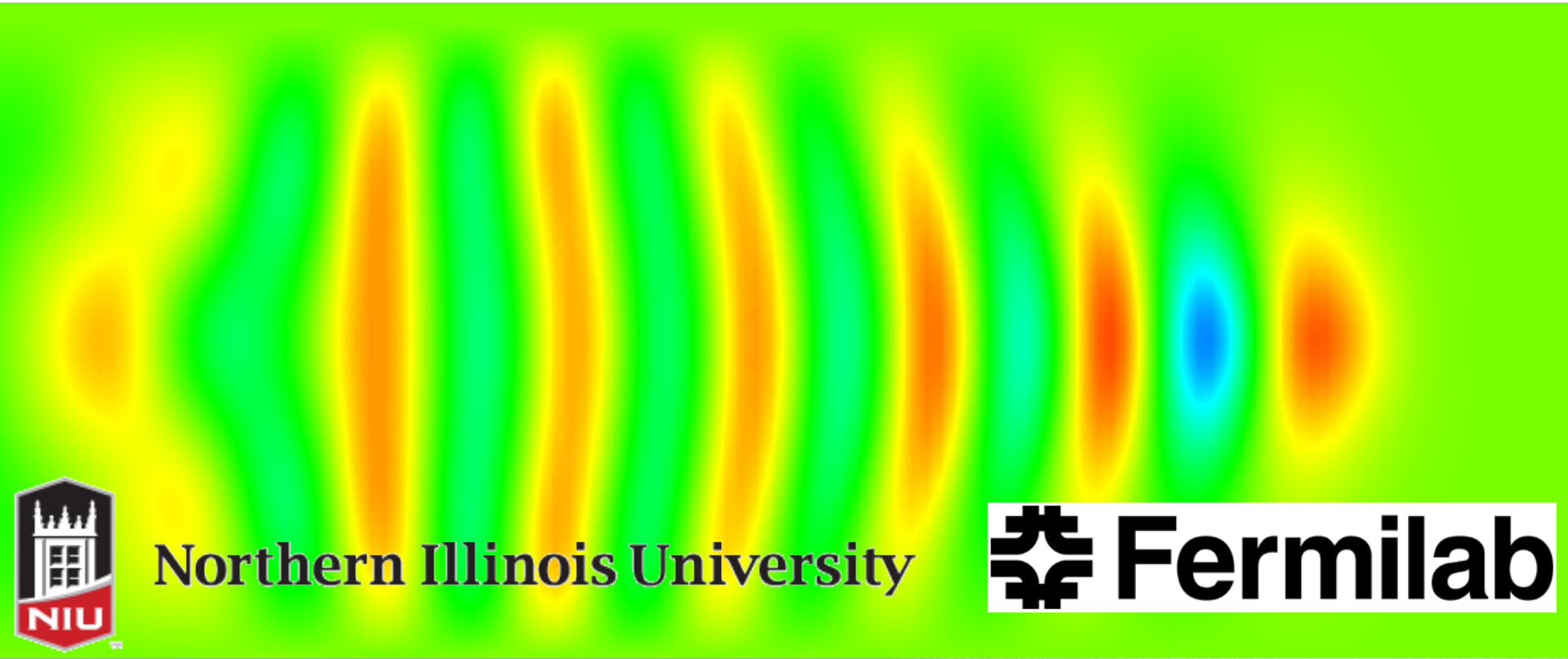
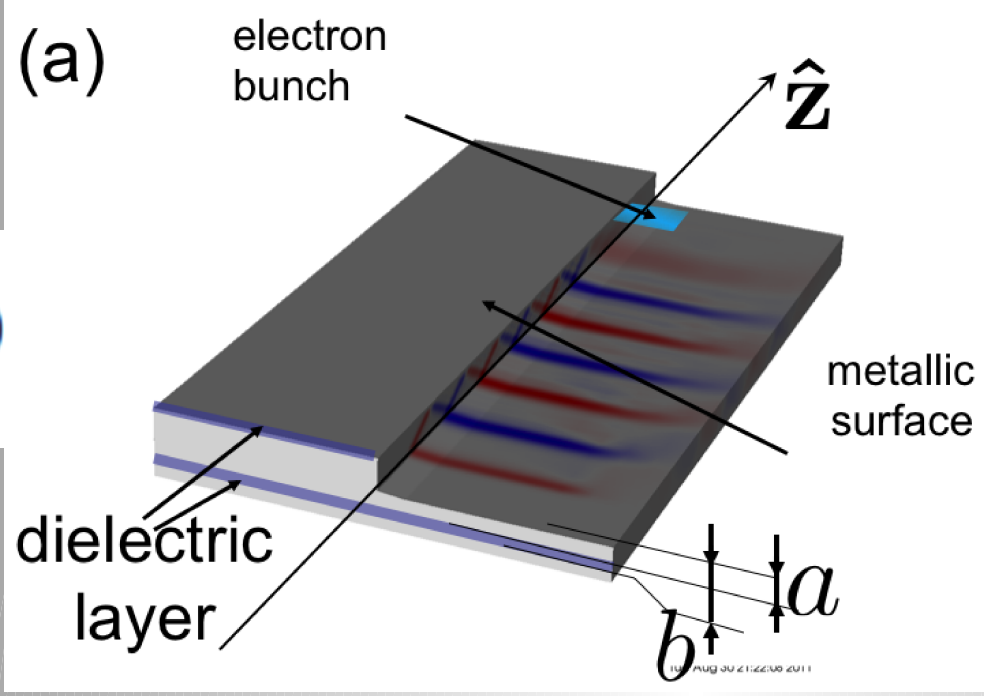


Northern Illinois University

Fermilab

Basic Concepts

$$E(z) = \sum_n \int_{-\infty}^{z} I(z-\tilde{z}) W_n(\tilde{z})$$



- Drive bunch excites wake
- Short Bunch -> High Field
- Long Asymmetric bunch -> High Transformer Ratio

Longitudinal Shaping for better Wake

- Transformer Ratio (R = Abs(E+/E-))
  - Fundamental Wakefield Theorem (Sym. Bunch: R < 2)
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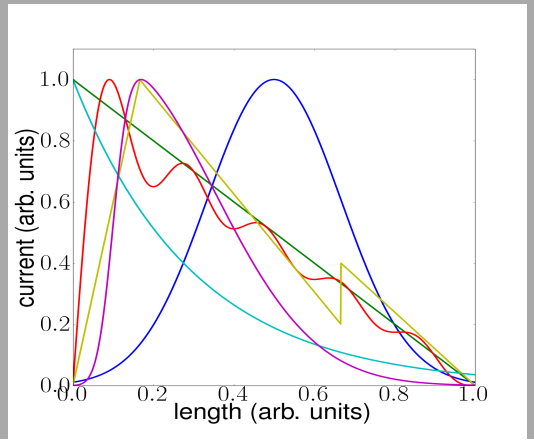
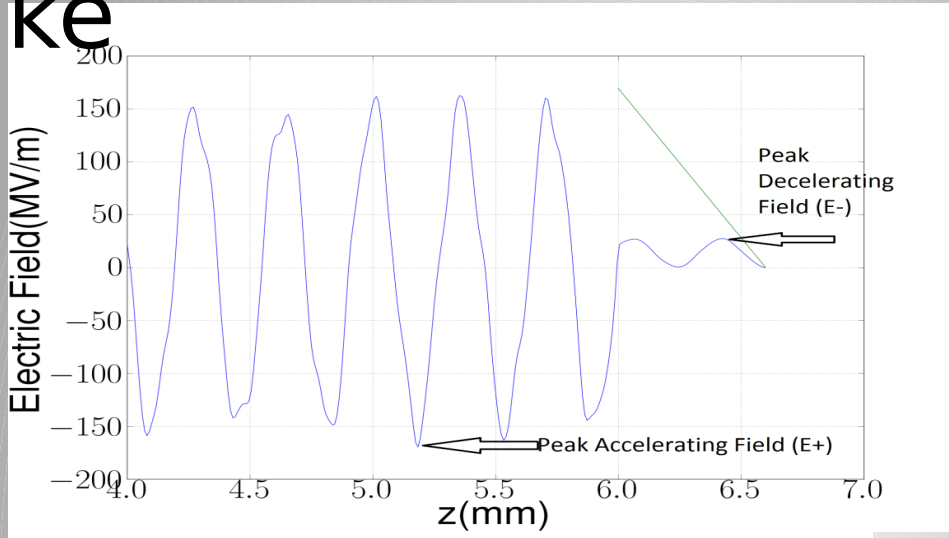
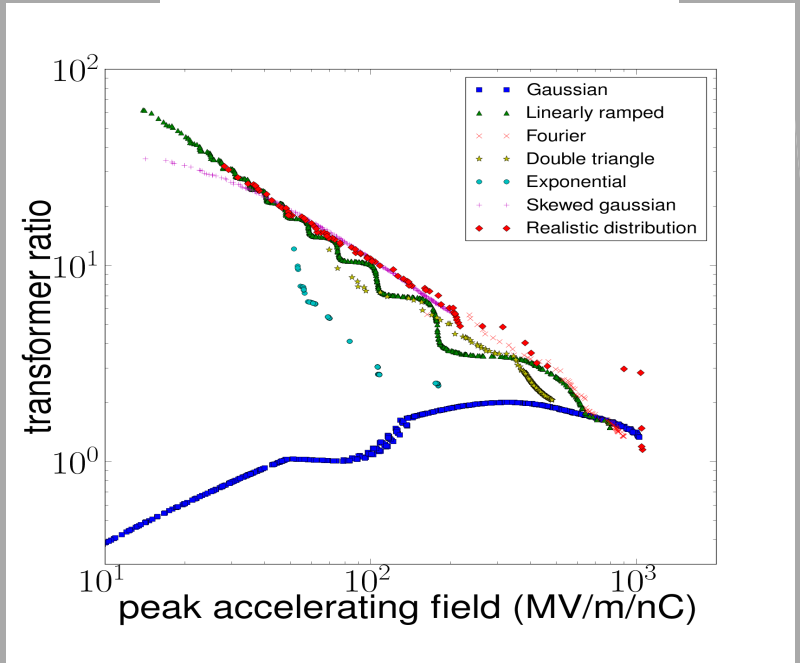
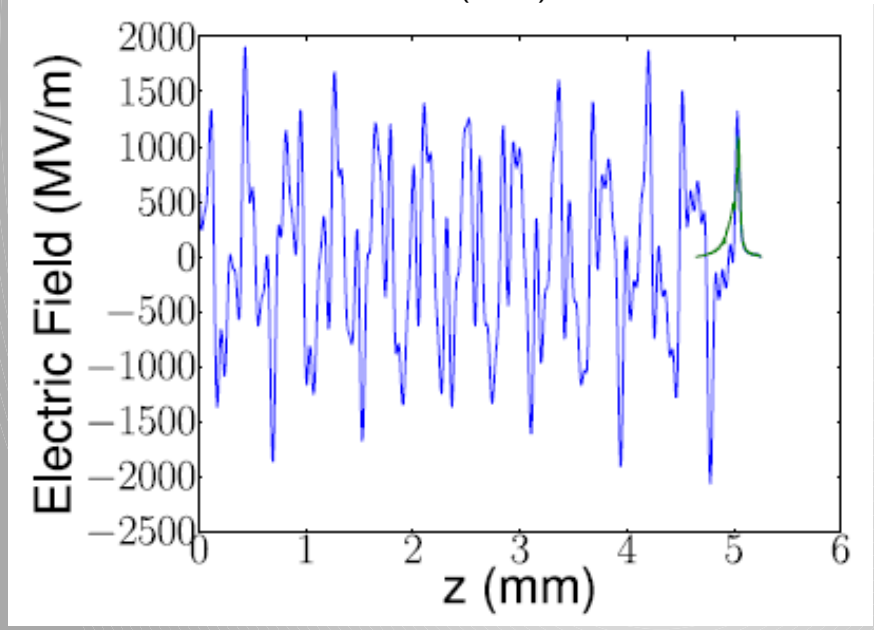


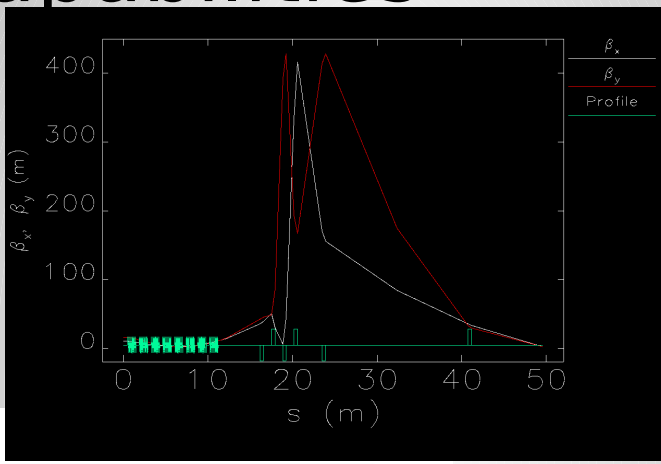


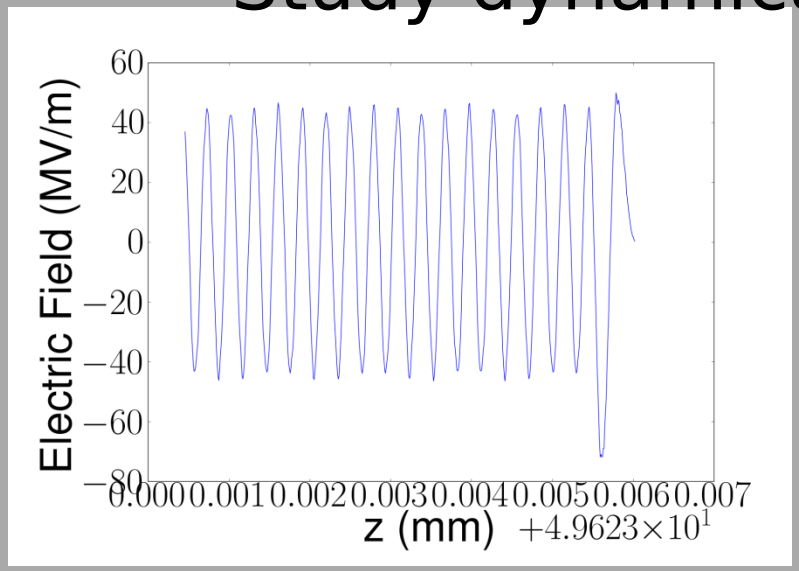


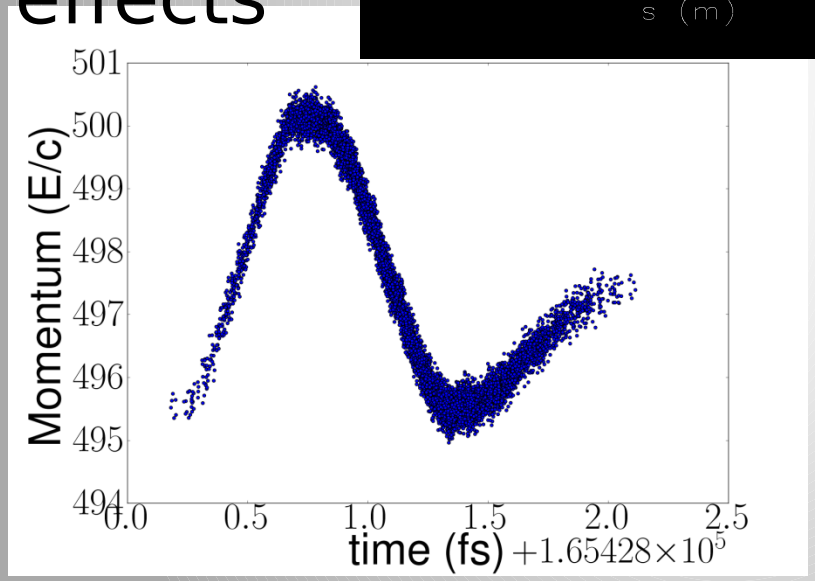


DLW Acceleration at ASTA

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







Difficulties & Requirements

- Cylindrical-symmetric waveguide offer higher with more stringent requirements on beta functions
- Slab-symmetric / flat beam offers 2 main advantages:
  - Easier to fit inside the structure (less scraping)
  - Unprecedented tunability

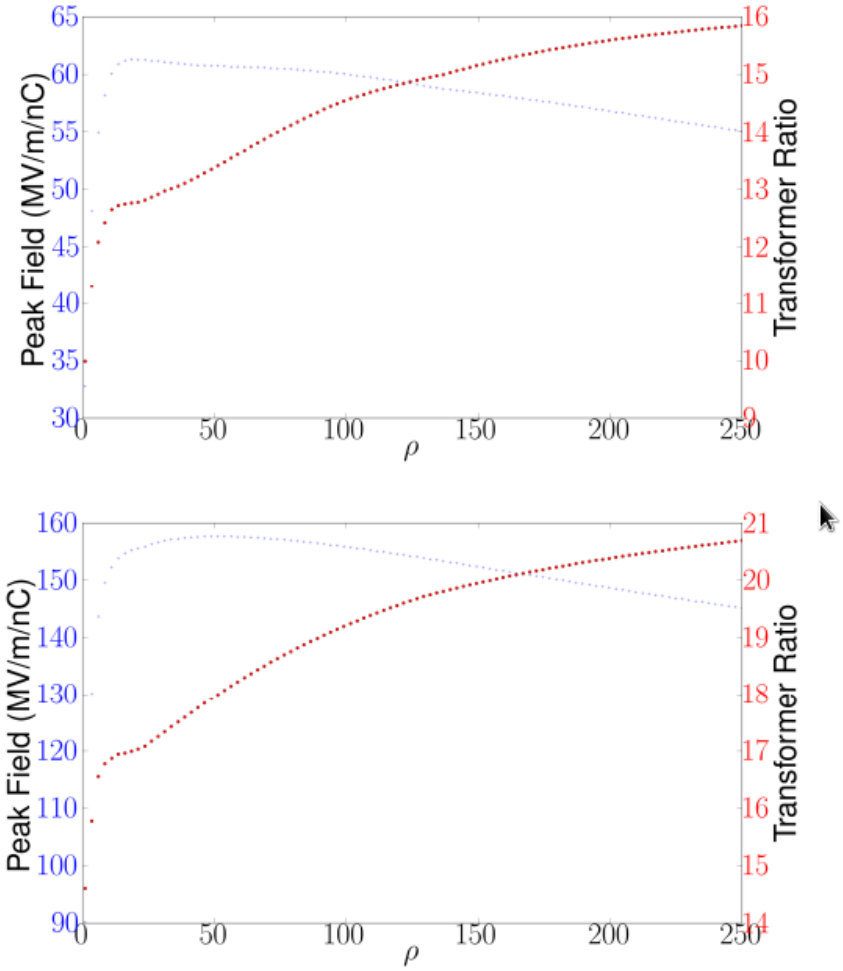
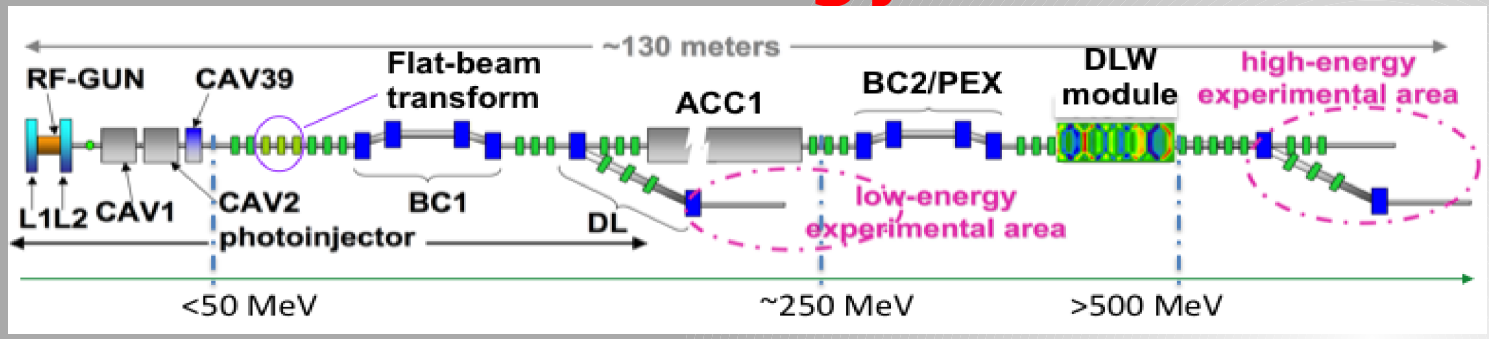
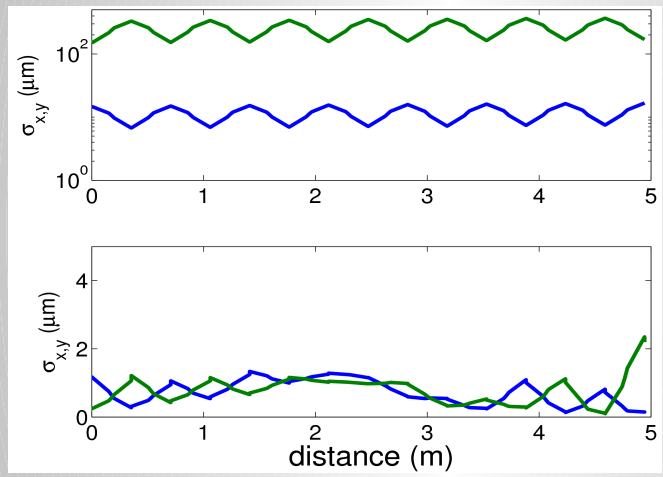


Figure 3: Peak accelerating electric field (blue trace) an
transformer ratio (red trace) as a function of emittance rati
$\rho = \varepsilon_n^+/\varepsilon_n^-$ for a 1 nC electron bunch with 4D emittanc
$\varepsilon_n^u \equiv \varepsilon_n^+\varepsilon_n^- = 5\ mu$m. The structure parameters is a =
165 mu and $b - a = 30\ \mu$m (top) and taken to be variabl
such that $a = 4\sigma_y$ and $b - a = 30\ \mu$m (bottom). The bunc
is taken to be linearly-ramped with total length of 1.2 mm.

Toward an Energy Doubler



- Aim for E+ = 100MV/m; R=10
  PEX <-> Shaping <-> Improvements
  Full S2E in progress



Drive (top) and witness bunches rms transverse beam sizes evolution along a 5-m FODO channel. The two bunches are assumed to have the same initial Courant-Snyder parameters. The drive bunch is accelerated from 250 to 500 MeV while the witness bunch is decelerated from 250 to 225 MeV.