Self-Modulation in a Magnetic Wiggler

James MacArthur

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U.S. DEPARTMENT OF ENERGY
Office of Science

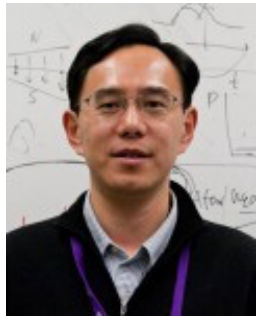
SLAC NATIONAL ACCELERATOR LABORATORY

Thank You


A. Marinelli


J. Duris


A. Lutman


Z. Huang

- Z. Zhang, S. Li, X. Xu, J. Krzywinski, A. Zholents, J. Cryan, M. Glownia, A. Miahanari, G. Stupakov H.-D. Nuhn, Y. Ding, G. Marcus, & many others

Background: Making sub-fs Pulses

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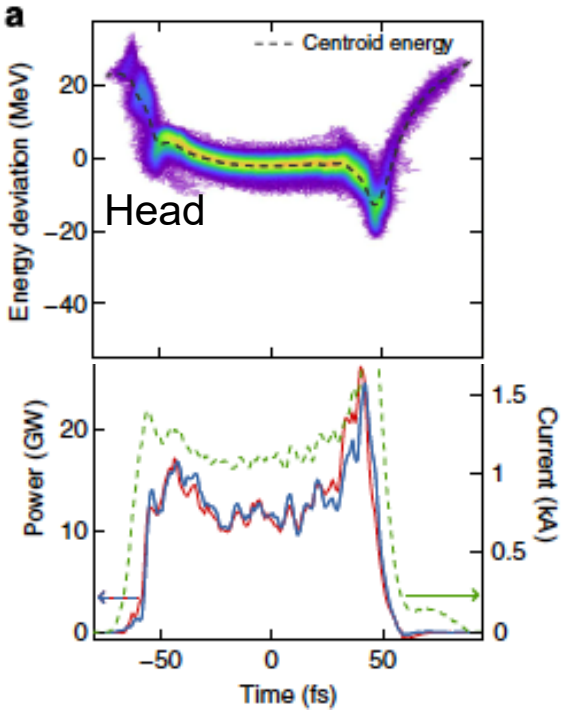
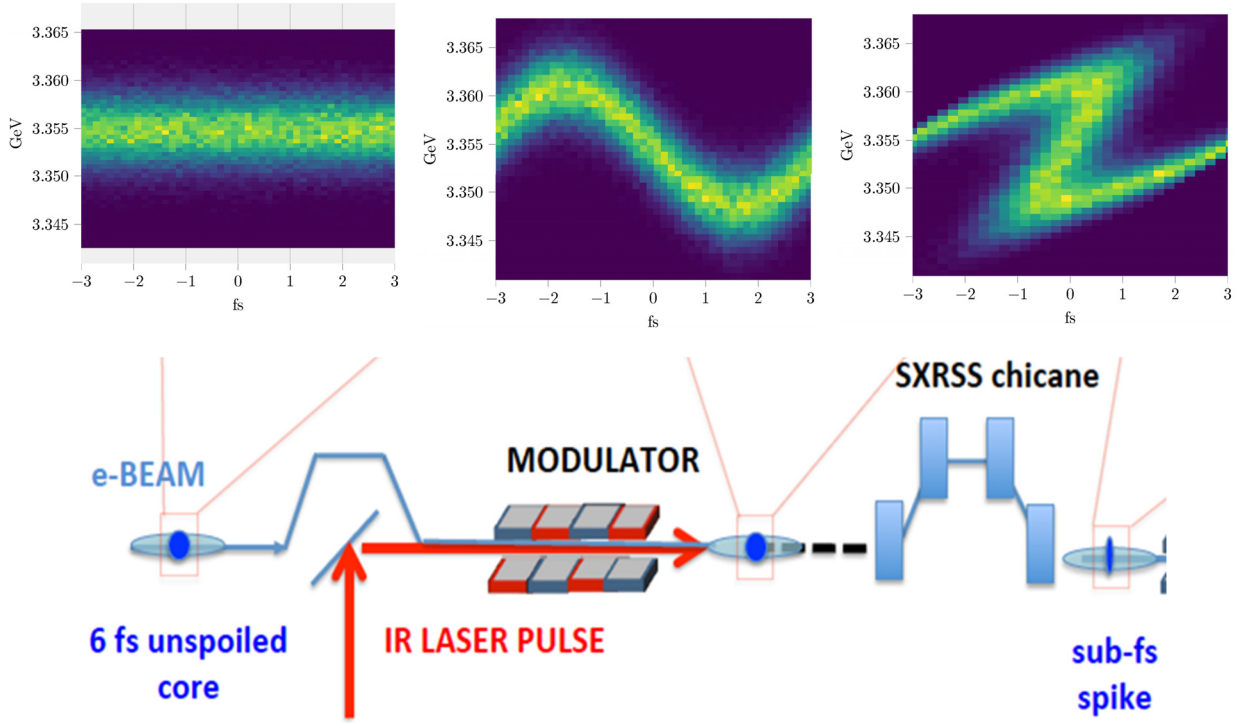
Current = X-Rays



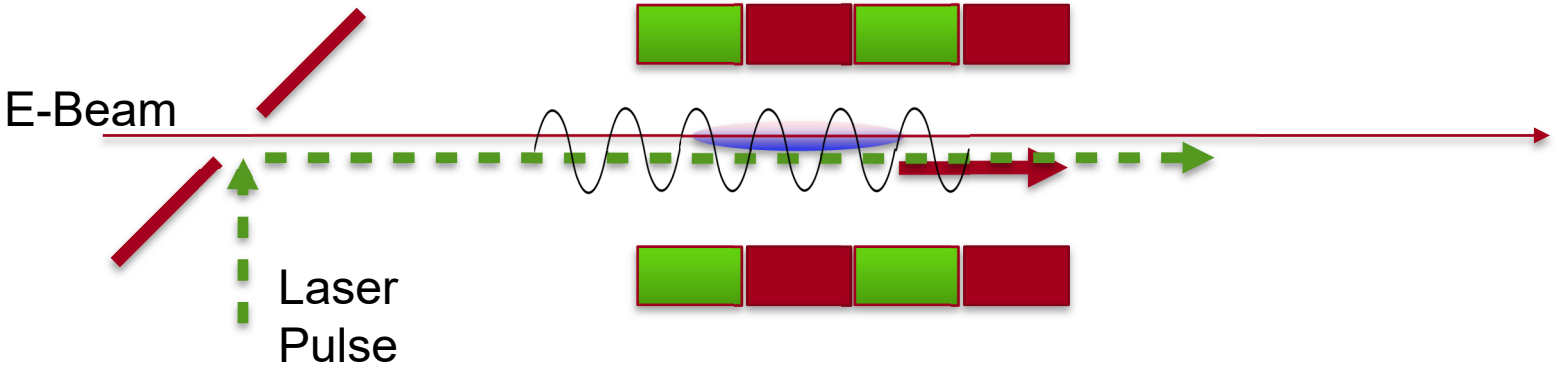
[C. Behrens et al., Nat. Comm. 5, 3762 (2014)]

Current Spike (enhanced SASE)

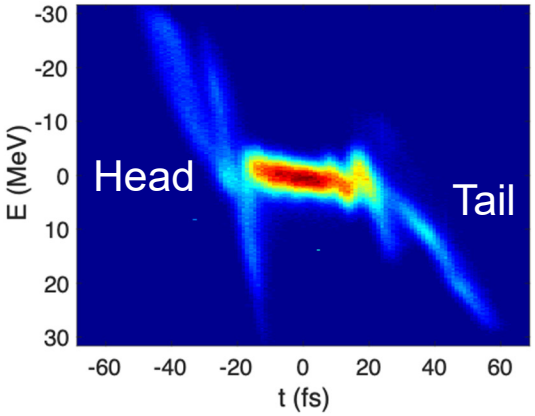


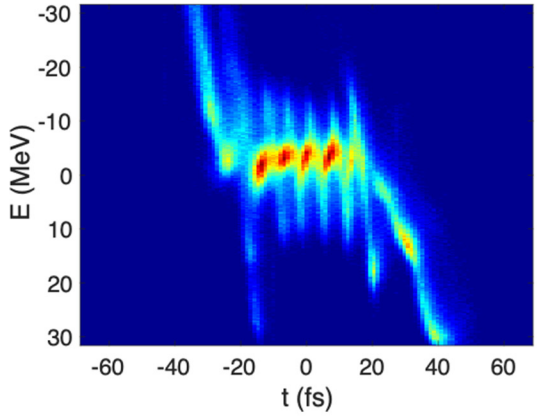
[J. Duris et al., TUPRB087]

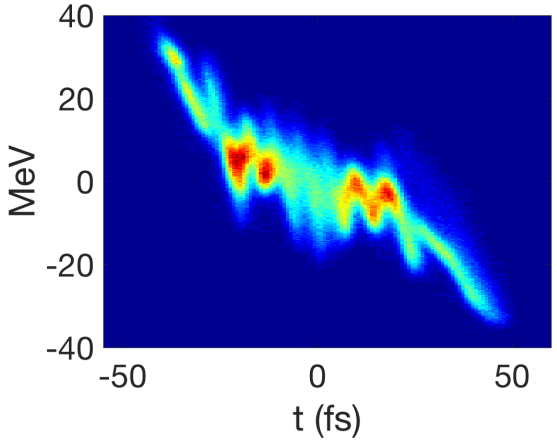
Background: Laser Modulation Data



Streak Camera (TCAV) Images







[Using dechirper, see e.g. A. Lutman WEXPLM1]

Self-Modulation in a Wiggler

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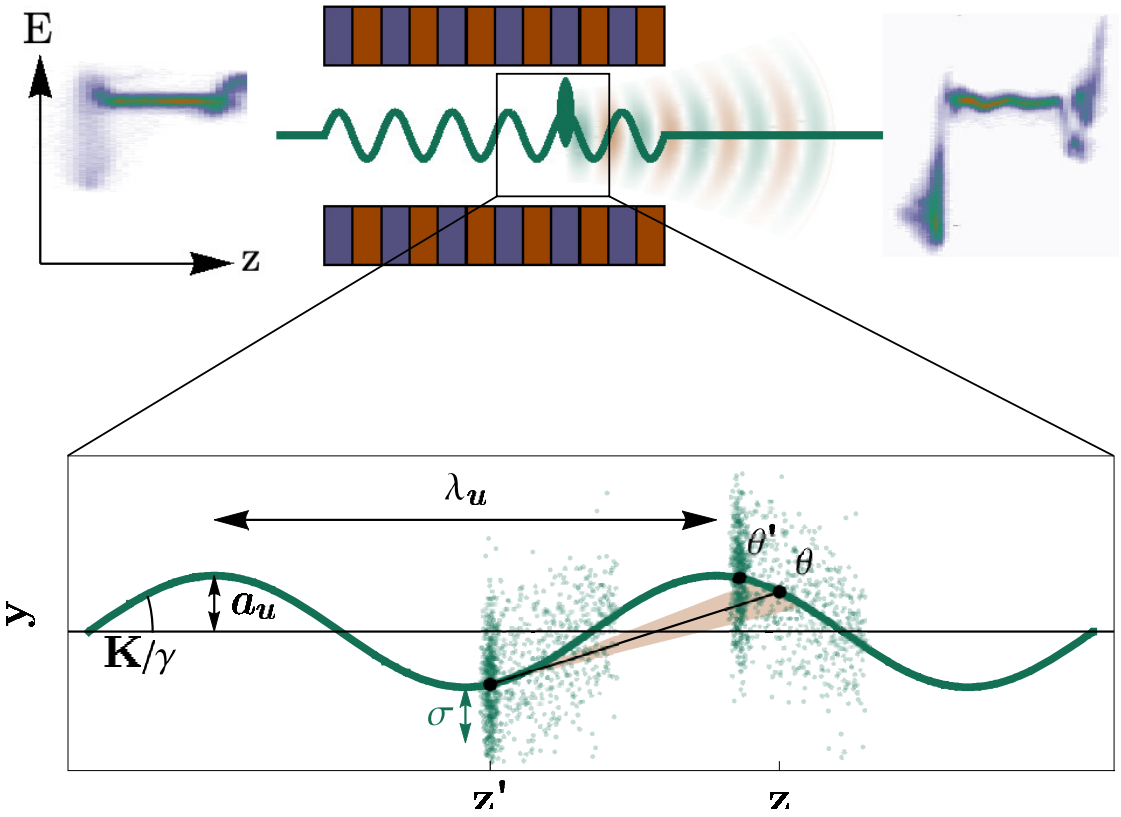
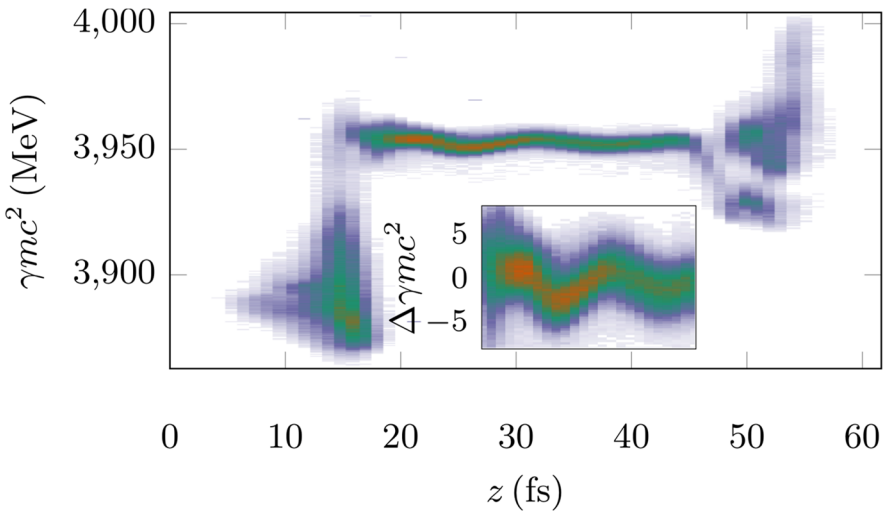
Tail current spike emits coherently at resonant wavelength

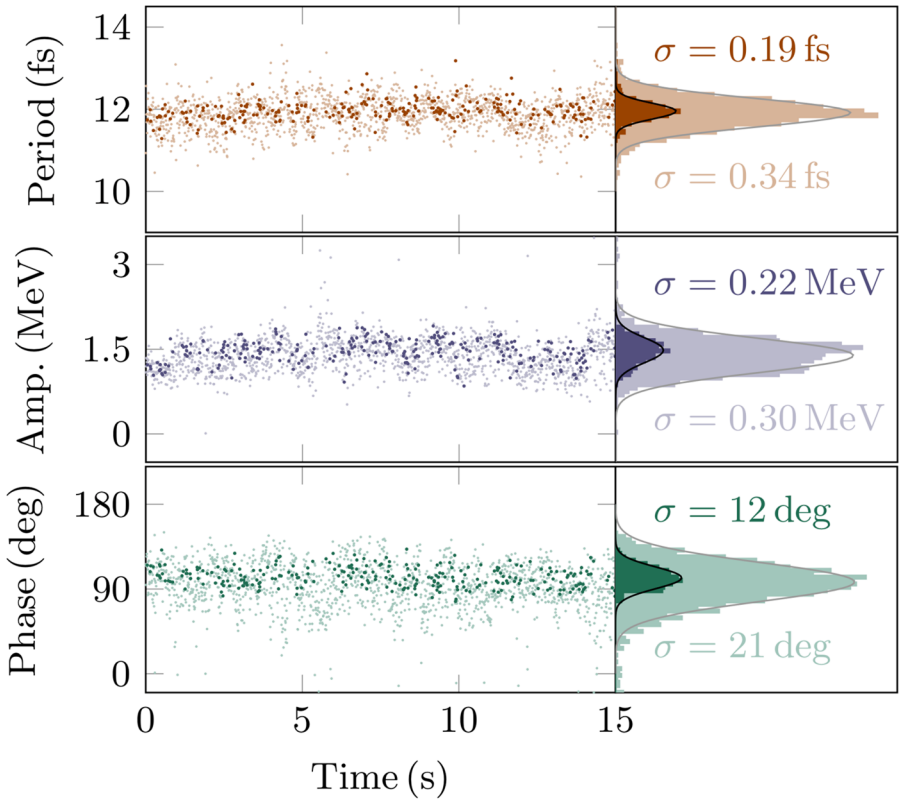


[current spikes also discussed in IPAC19, see e.g.
T. Charles et al., WEYYPLS2]

Stability

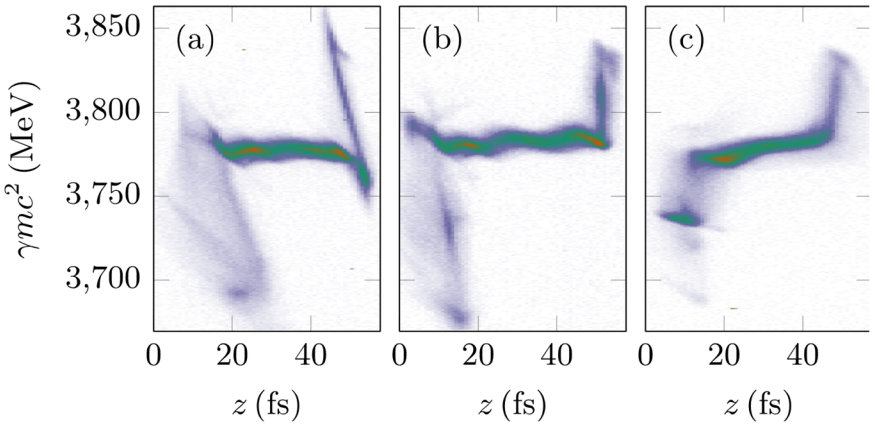
- The modulation is stable in wavelength, amplitude, and phase (right)
- Useful for enhanced-SASE



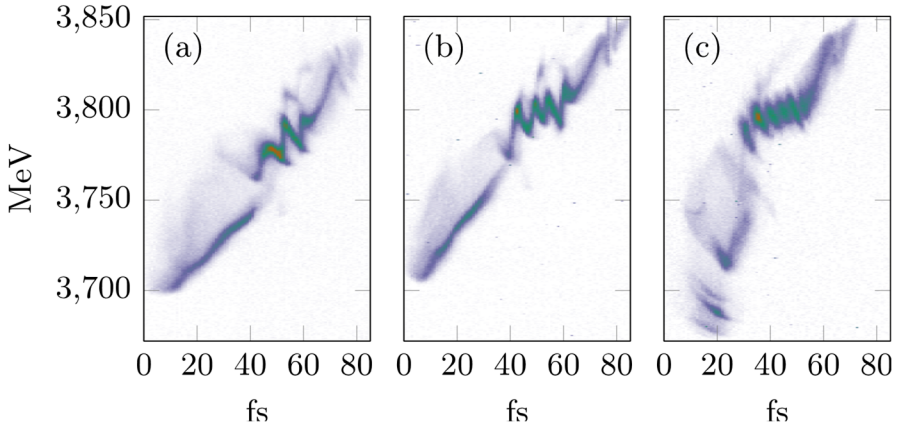


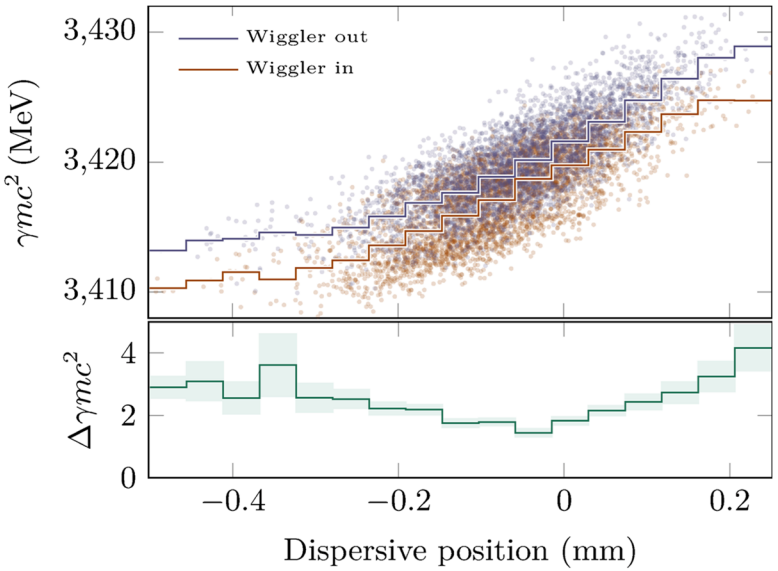
Other Details

Dog-Leg-2 Tail-Wag



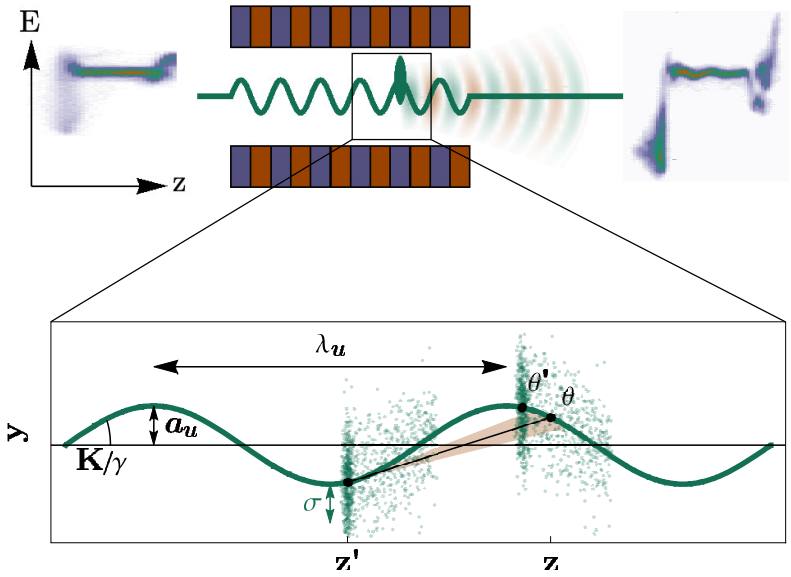
Gap-Tunable





~280 uJ per IR Pulse

Modeling Self-Modulation: The Radiative Model

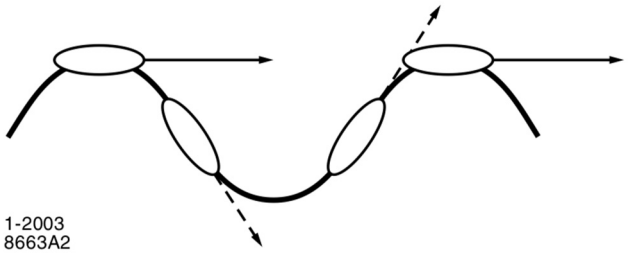


$$\left[\frac{\partial}{\partial z} + k_u \frac{\partial}{\partial \theta} - i\frac{\nabla_\perp^2}{2k_1}\right]\mathcal{E}(\mathbf{x},\theta;z) = -\kappa_1 k_1 \sum_{j=1}^{N_e} e^{-i\theta_j(z)}\delta(\mathbf{x}-\mathbf{x}_j)$$

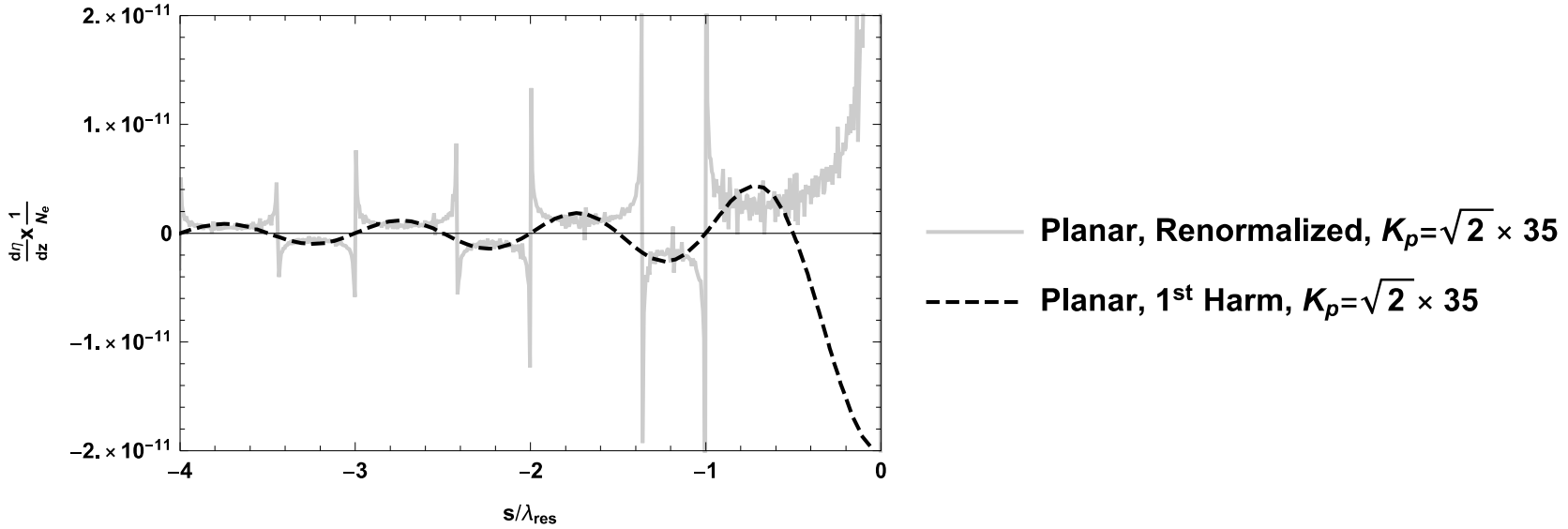
$$\boxed{\langle \eta(\theta;z)\rangle = -\eta_0(k_u z - \theta)\frac{2\hat{\sigma}^2\cos\theta + \theta\sin\theta}{\theta^2 + 4\hat{\sigma}^4}}$$

$$\boxed{\hat{\sigma} = 2\sigma/a_u = \sigma\sqrt{k_1 k_u} \ll 1}$$

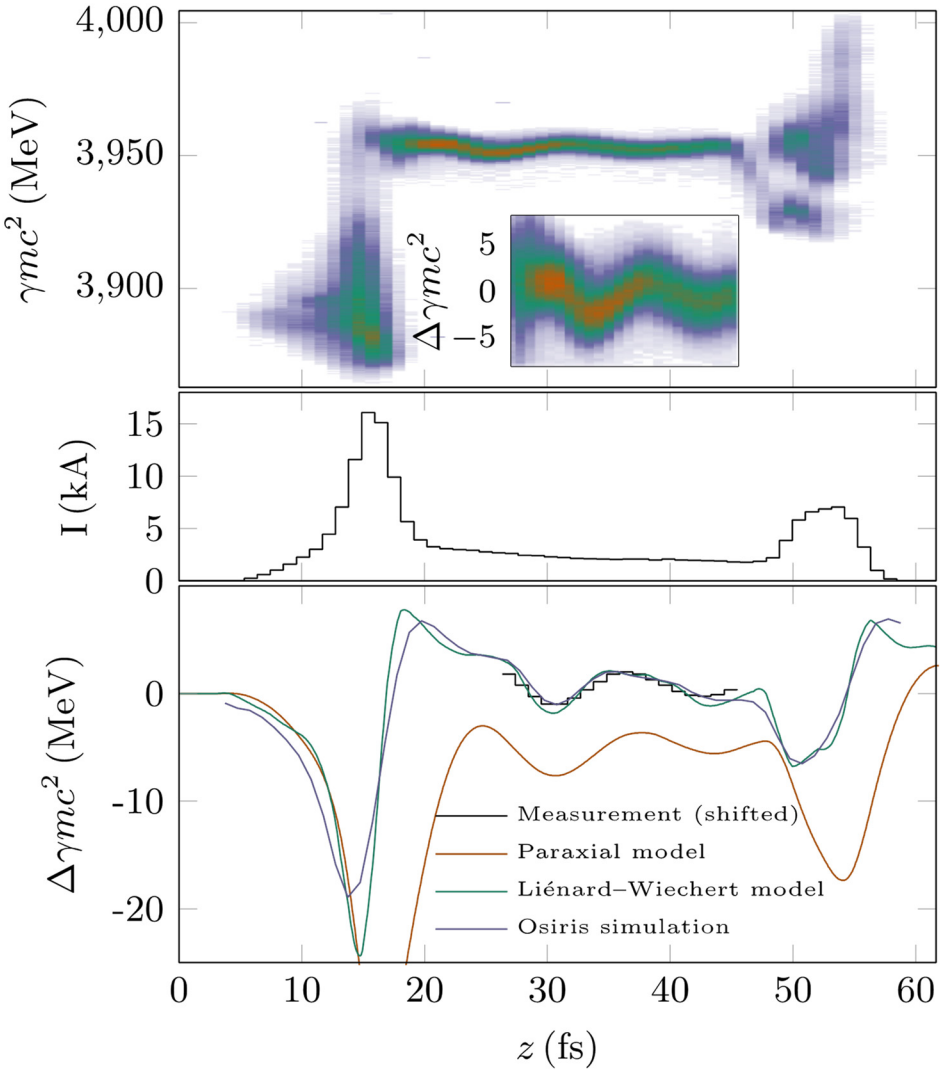
Modeling Self-Modulation: The Line-Charge Model



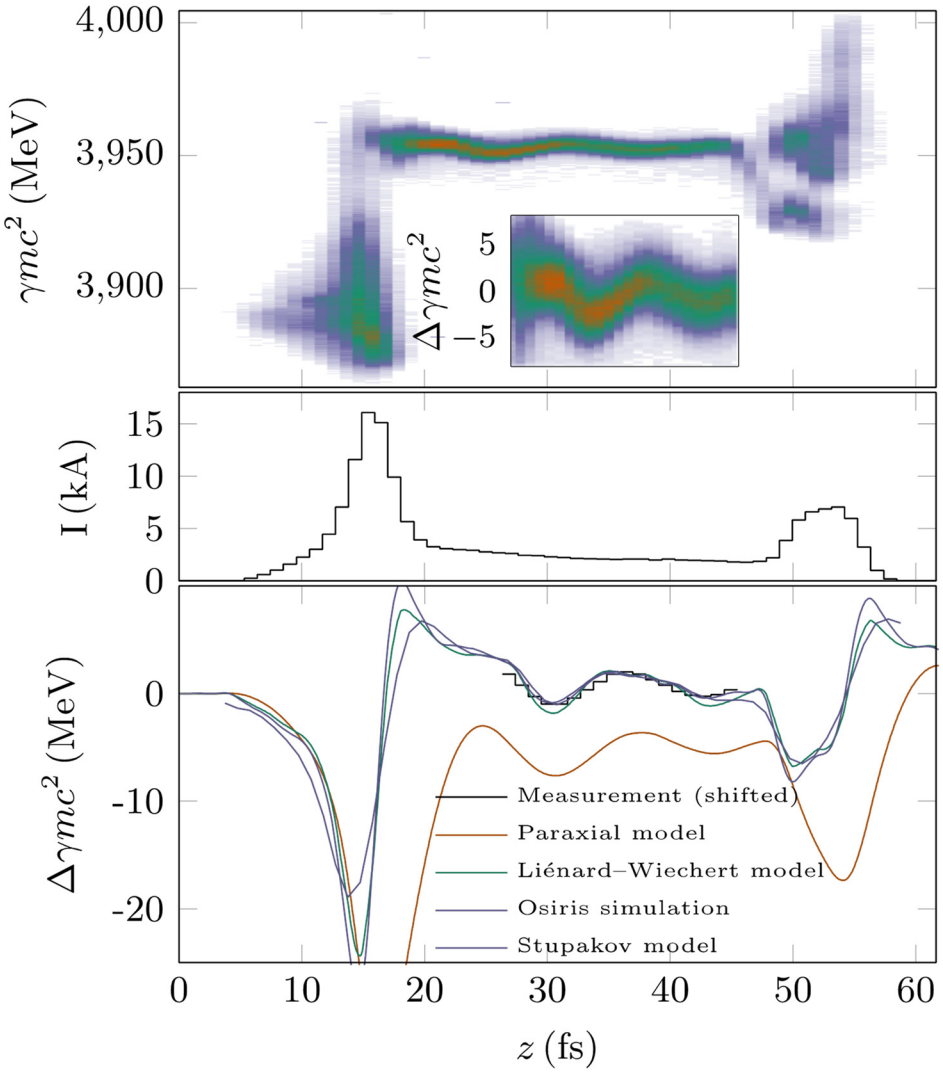
[1] E. Saldin, E. Schneidmiller, M.V. Yurkov, NIMA **417** 158 (1998)
[2] J. Wu, T. Raubenheimer, G. Stupakov, PRSTAB **6**, 040701 (2003)



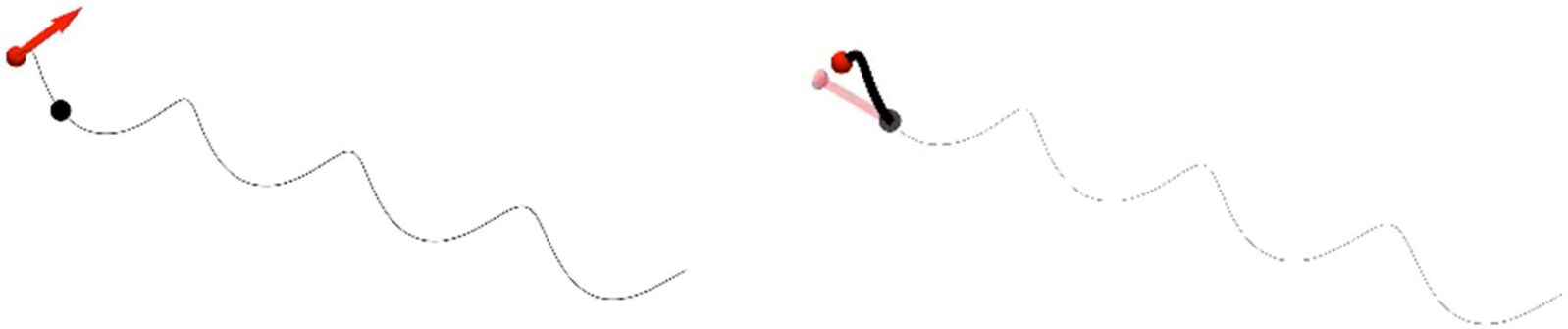
Model, Simulation, Data

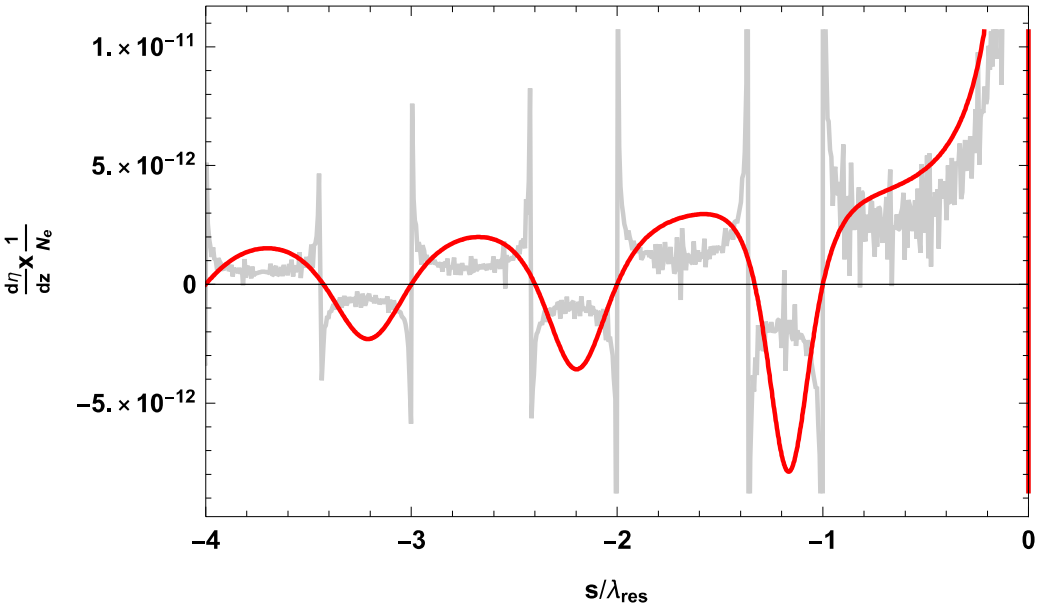


Model, Simulation, Data



Fun Extension: Helical Wake





Planar, Renormalized, $K_p=\sqrt{2} \times 35$

Helical, Renormalized, $K_h=35$

Questions?