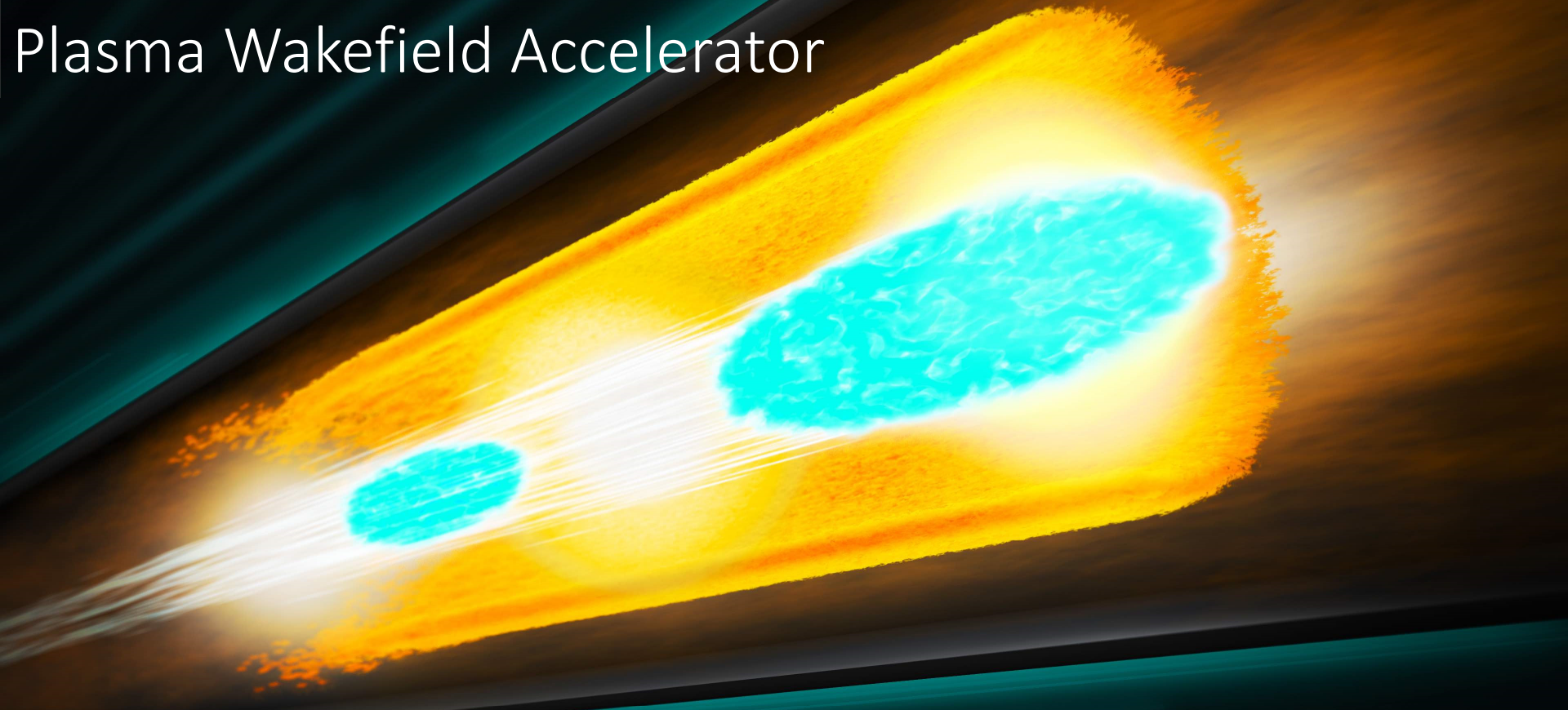


Demonstration of the Hollow Channel Plasma Wakefield Accelerator

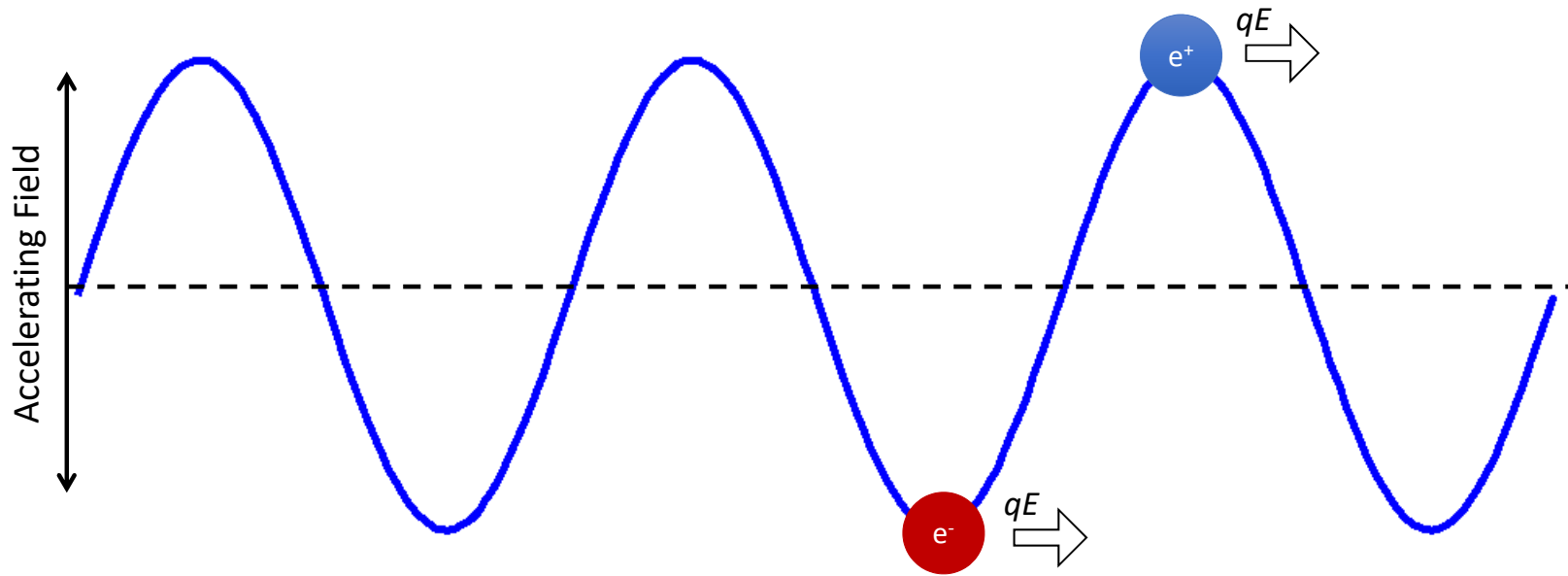


Why Plasma?

- Plasmas support enormous electric fields that can be used to accelerate particles to high energies in short distances.
- Plasma wakefield accelerators can be operated efficiently: we are able to extract a significant amount of energy from the plasma wave.
- There is steady progress in our ability to control the acceleration process, as demonstrated in recent publications.



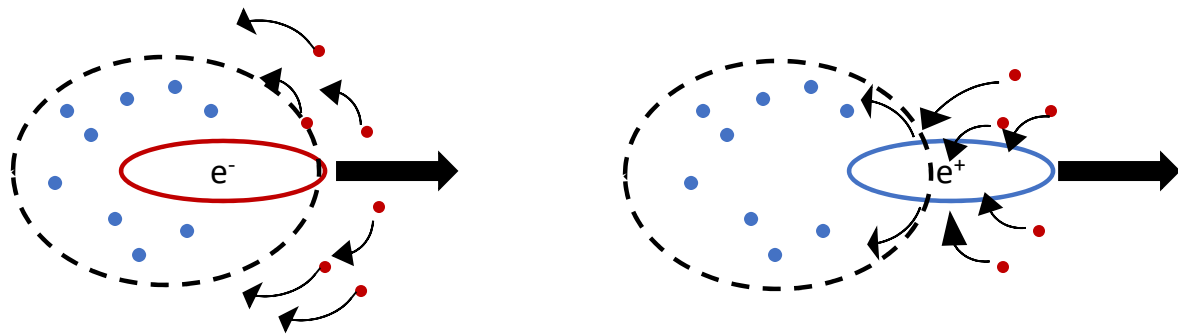
RF Accelerators



RF accelerators are equally good at accelerating electrons and positrons.

Just change the phase by 180° !

Plasmas are Asymmetric Accelerators



$$m_i \gg m_e$$

The plasma electrons are mobile but the ions are not.

The symmetry of the accelerating mechanism is broken!



PHYSICAL REVIEW SPECIAL TOPICS - ACCELERATORS AND BEAMS 14, 041301 (2011)

Hollow plasma channel for positron plasma wakefield acceleration

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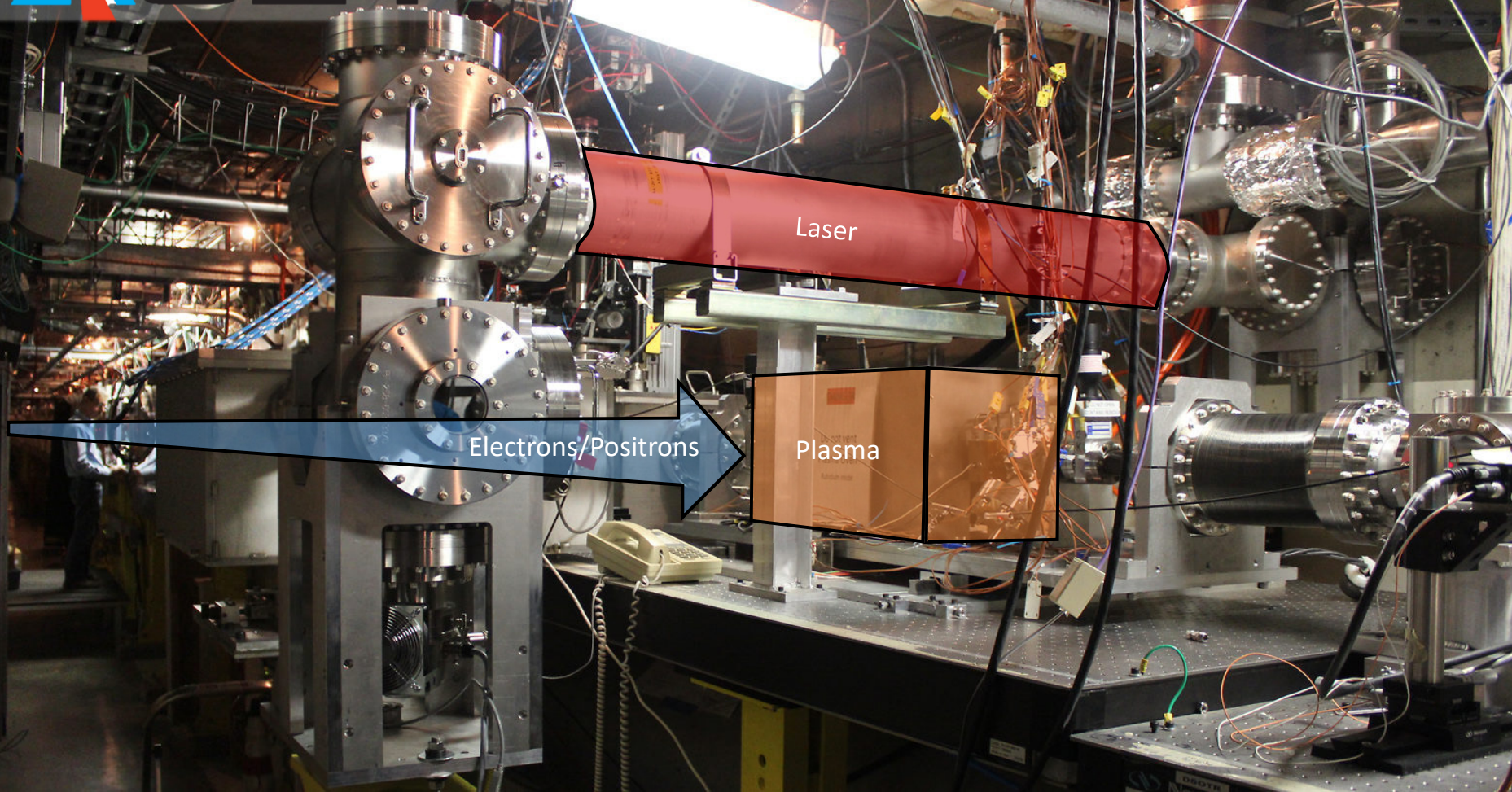
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(Received 9 September 2010; published 18 April 2011)



FRIB

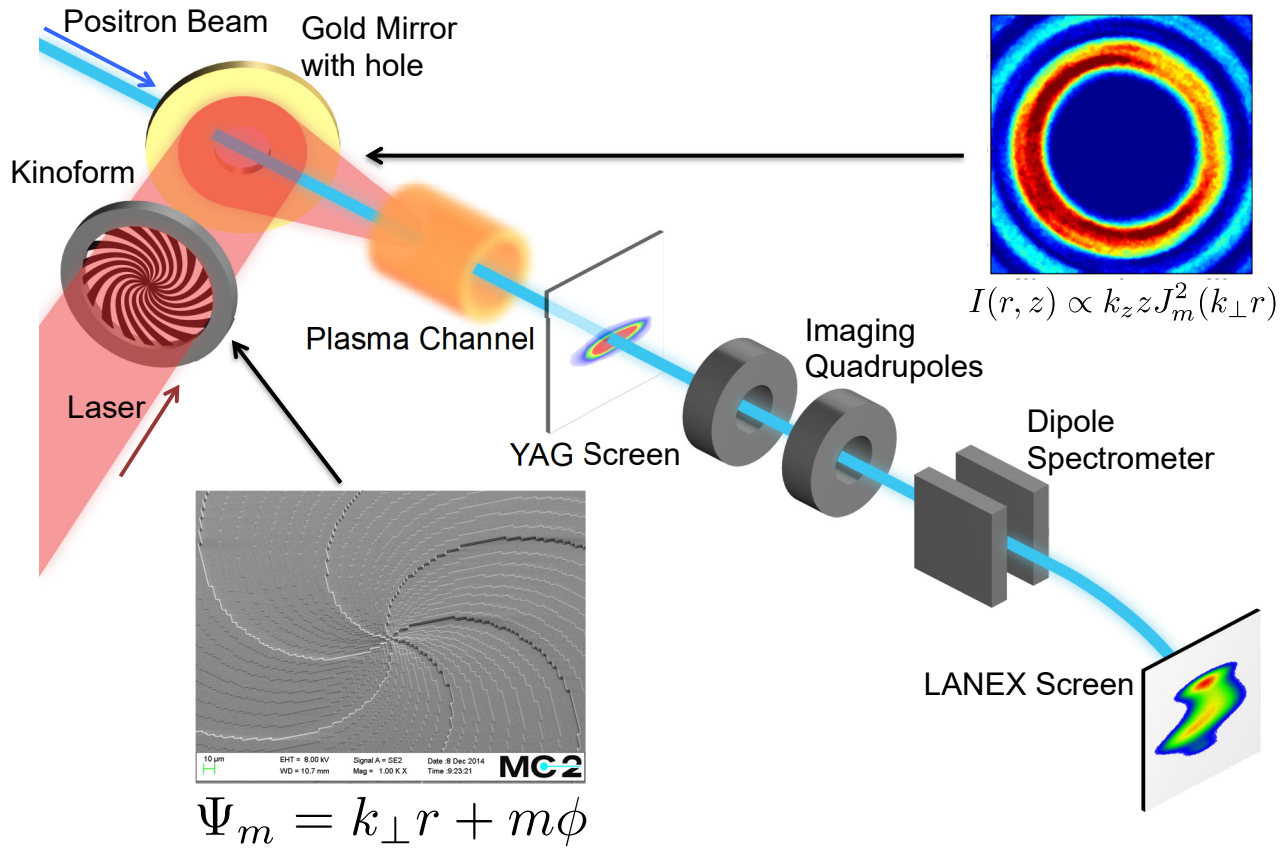


Laser

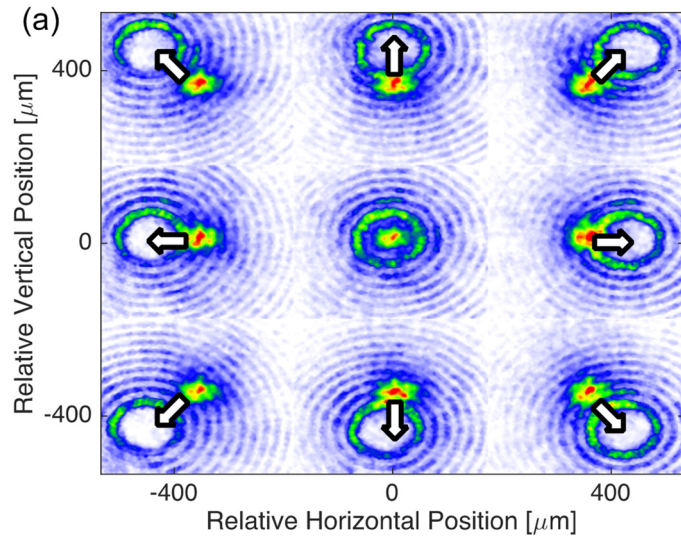
Electrons/Positrons

Plasma

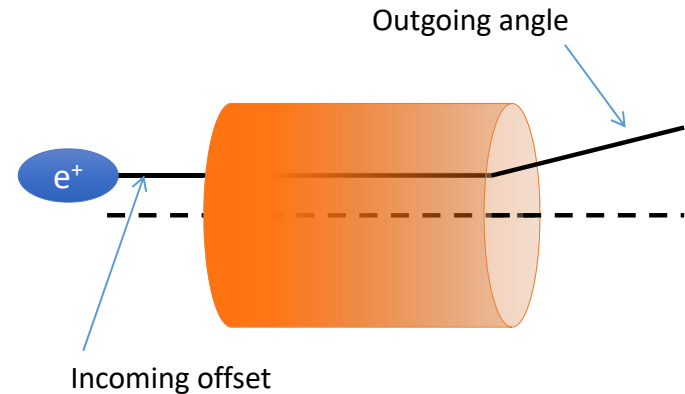
Creating a Hollow Channel Plasma



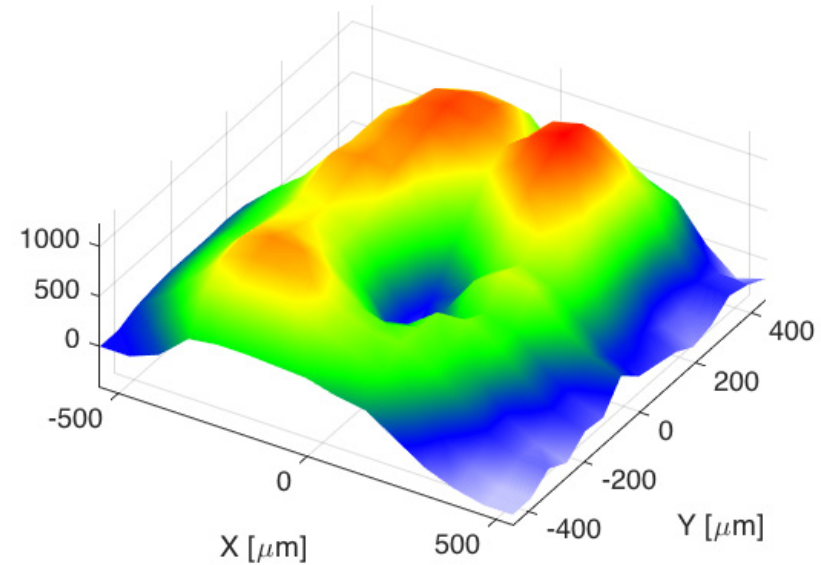
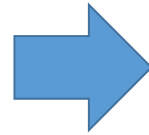
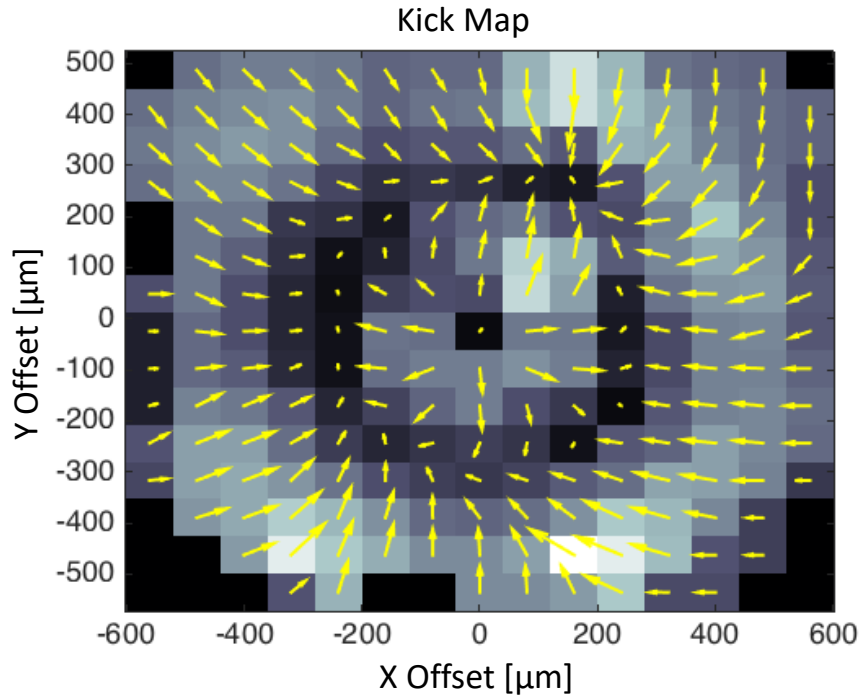
Measuring the Channel Shape



We deliberately misalign the beam with respect to the channel in order to understand the shape of the channel.

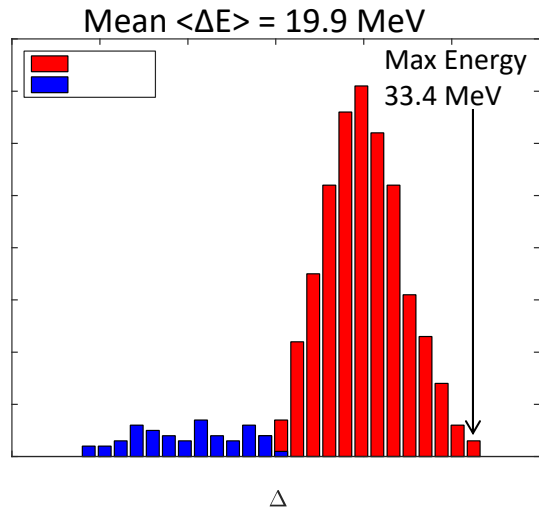


Reconstruction of the Hollow Channel

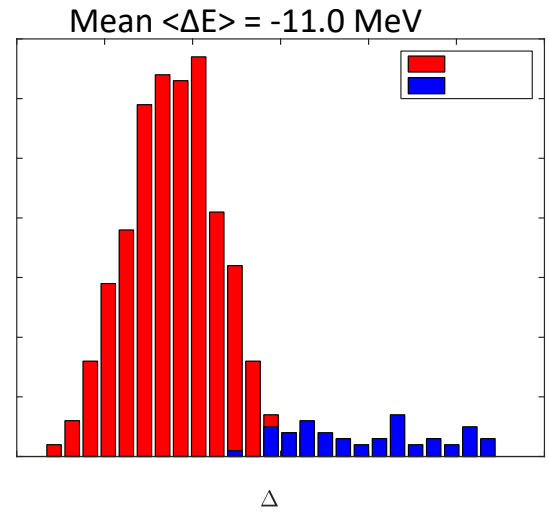
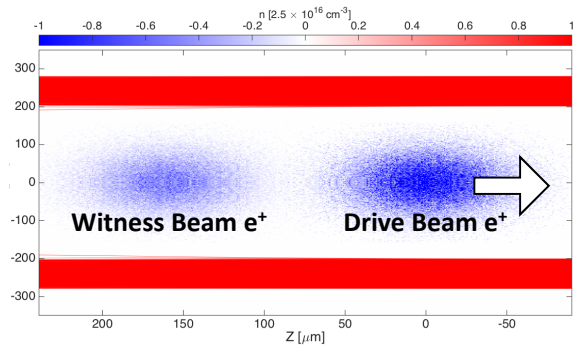


Using the kick data, we can “reconstruct” the shape of the channel.

Positron Acceleration



Witness beam gains energy from the wake.



Drive beam transfers energy to witness beam.

Transverse Wakefields

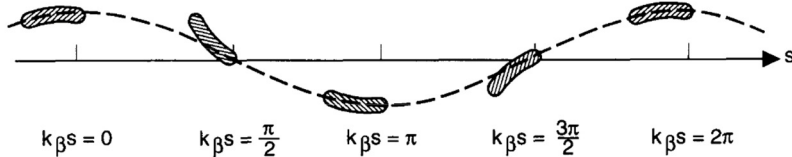
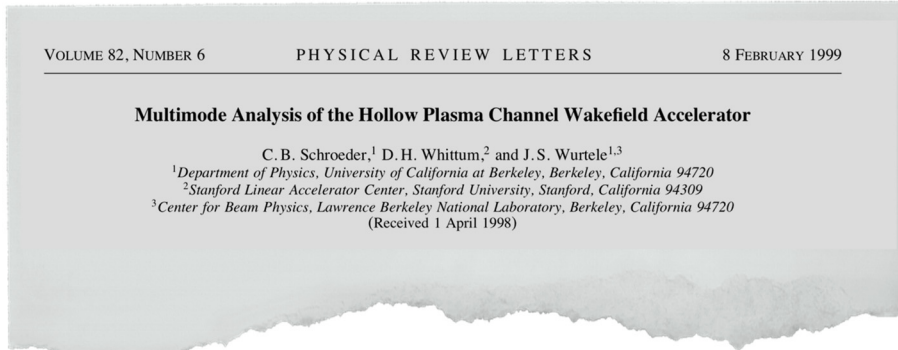
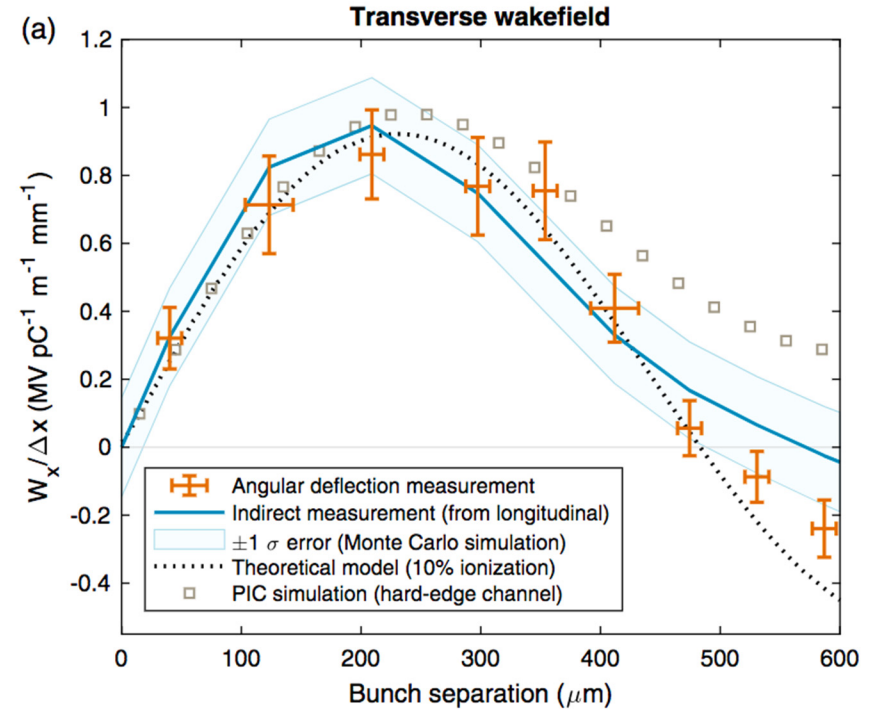


Figure 3.3. Sequence of snapshots of a beam undergoing dipole beam breakup instability in a linac. Values of $k_{\beta}s$ indicated are modulo 2π . The dashed curves indicate the trajectory of the bunch head.

Physics of Collective Beam Instabilities in High Energy Accelerators.
A. Chao, Wiley 1992



The Team



My Mentors



Tor Raubenheimer



Mark Hogan



Vitaly Yakimenko

My Family



Conclusion

- Hollow channel PWFA is a promising approach for accelerating positrons in plasma.
- However, transverse wakefields are a fundamental challenge. New techniques must be developed to suppress the beam break-up instability.
- This work demonstrates a big step forward in our ability to engineer plasmas and particle beams on the micron/femtosecond scale.



Thank You!

E200/E225 Collaboration



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