



# Merging Conventional and Plasma Accelerators

Overview of the external injection project at REGAE

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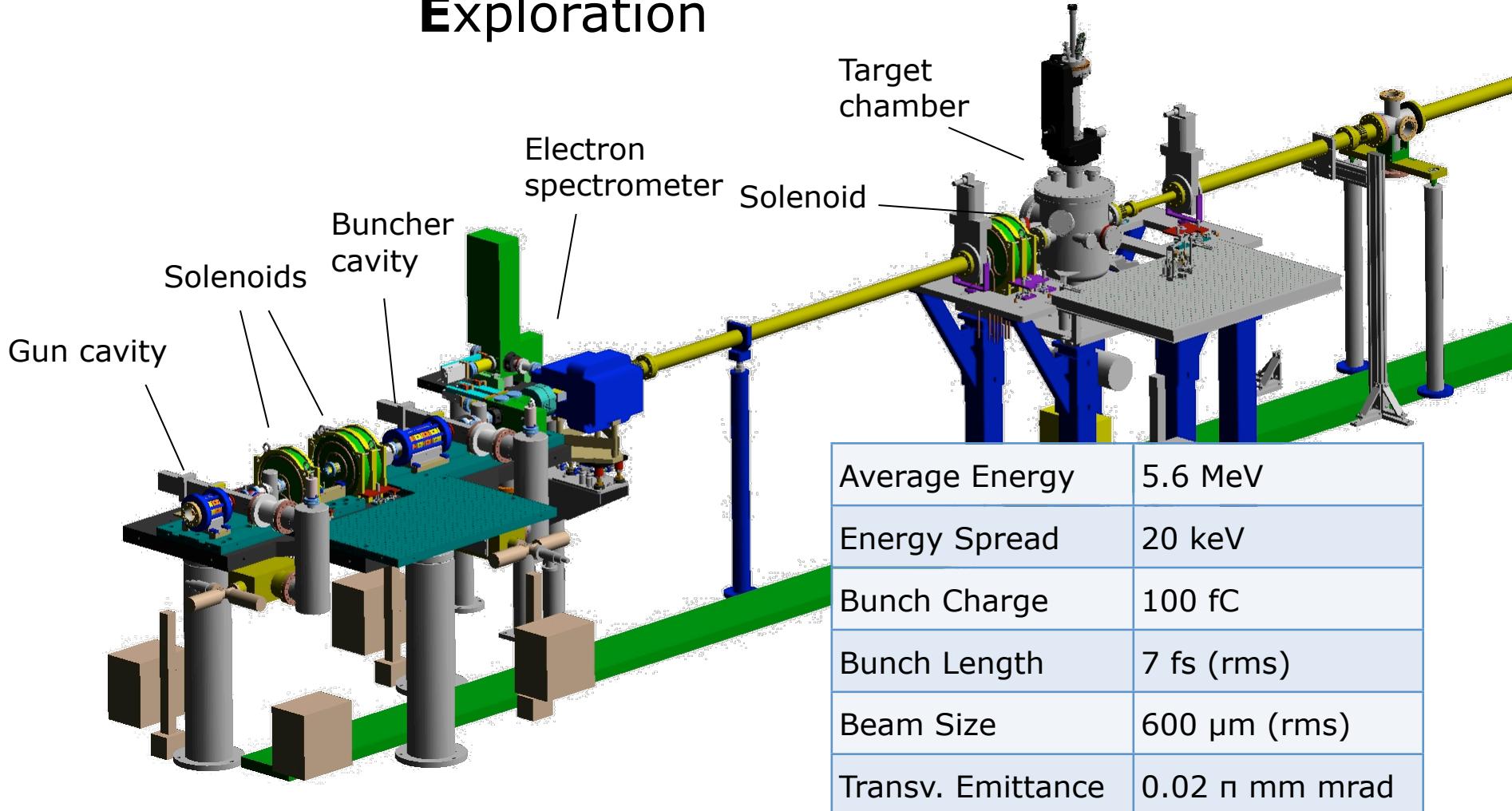
## Outline

- What is REGAE?
  - *Short introduction*
- Wakefield Probing
  - *What do we want to do?*
- Summary & Outlook



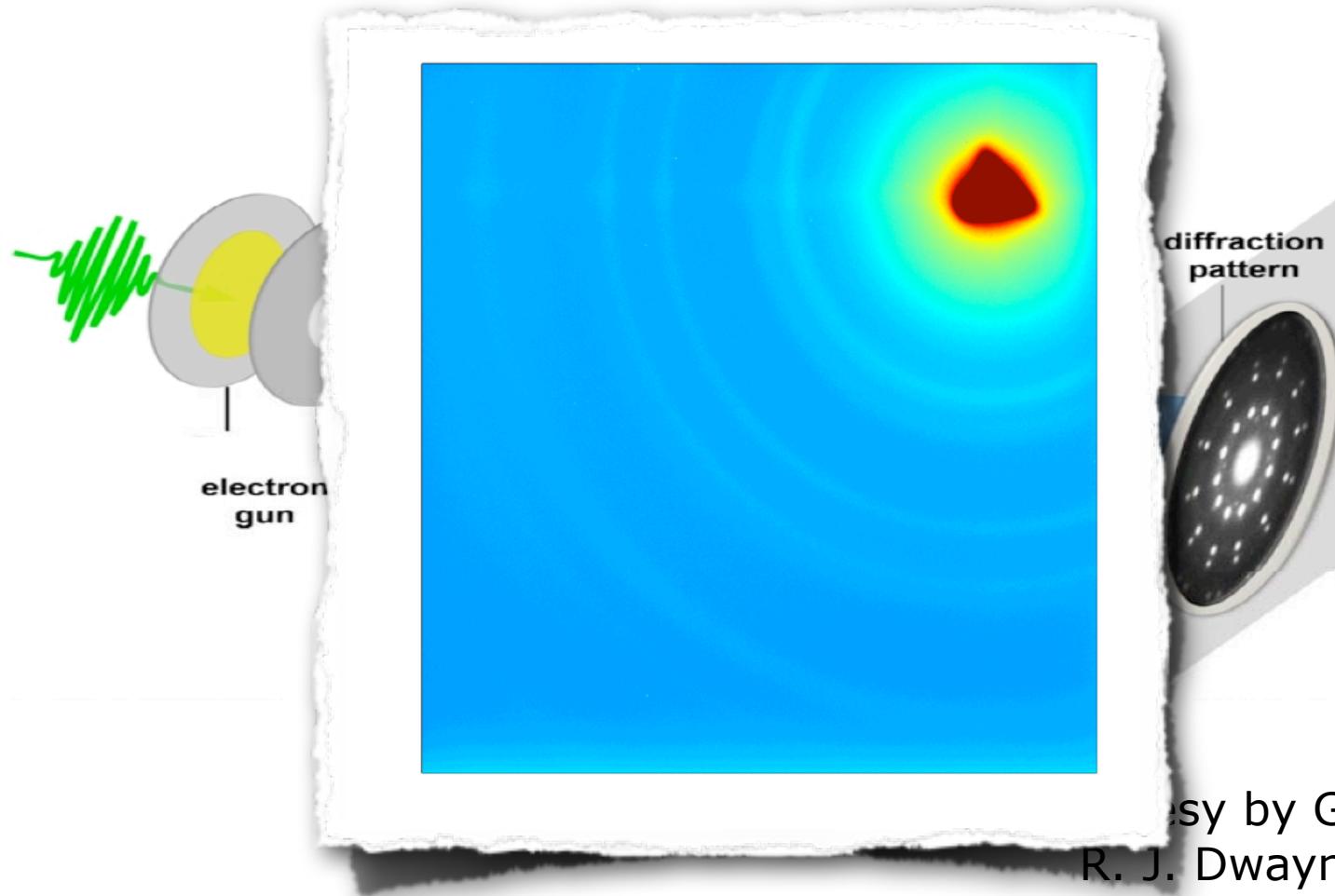
REGAE

# Relativistic Electron Gun for Atomic Exploration



**REGAE**

# Time-resolved Electron Diffraction

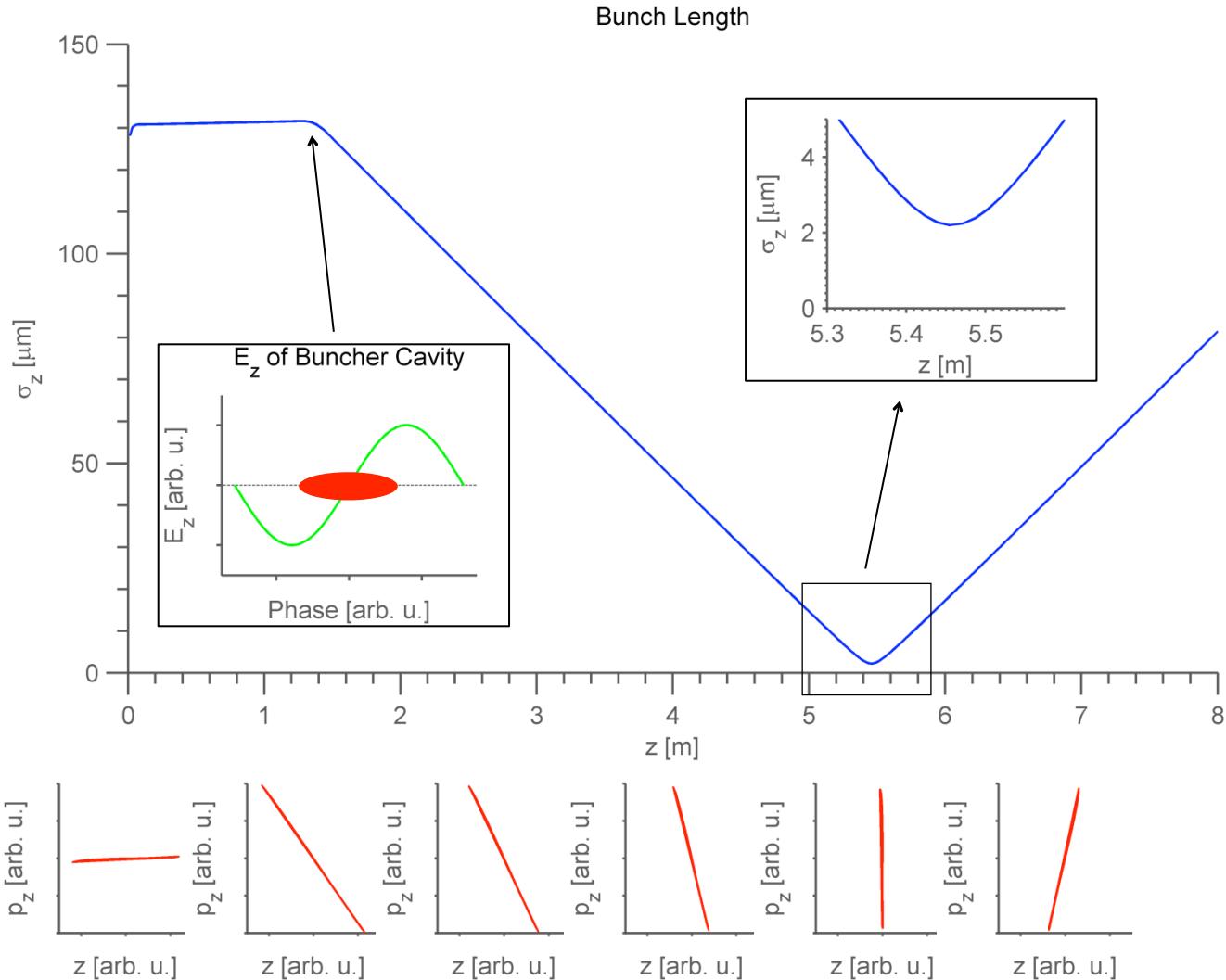


Courtesy by Group of  
R. J. Dwayne Miller



## REGAE

## Ballistic Bunching





## Wakefield Probing

### Basic Idea

- Initial state of electrons *unknown*
  - Statistic process
- Parameters of wakefield *unknown*
  - No „antenna“

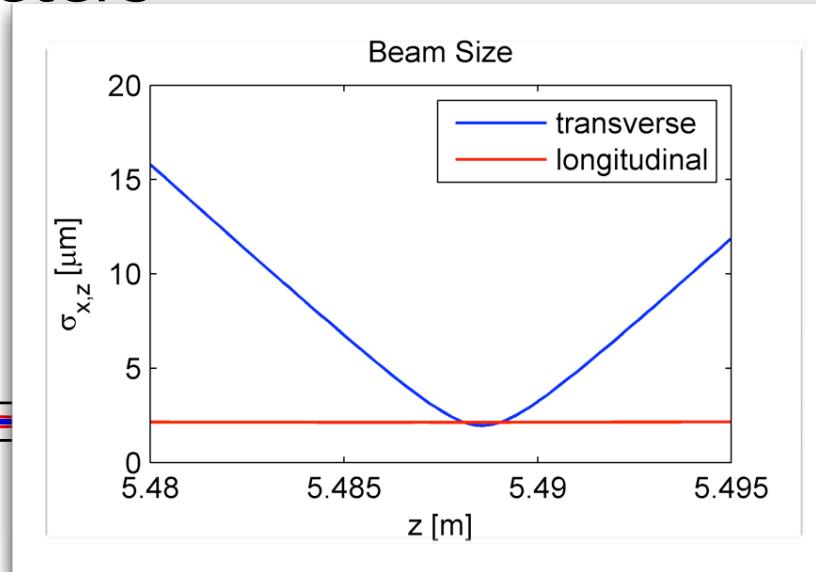
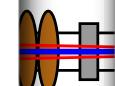
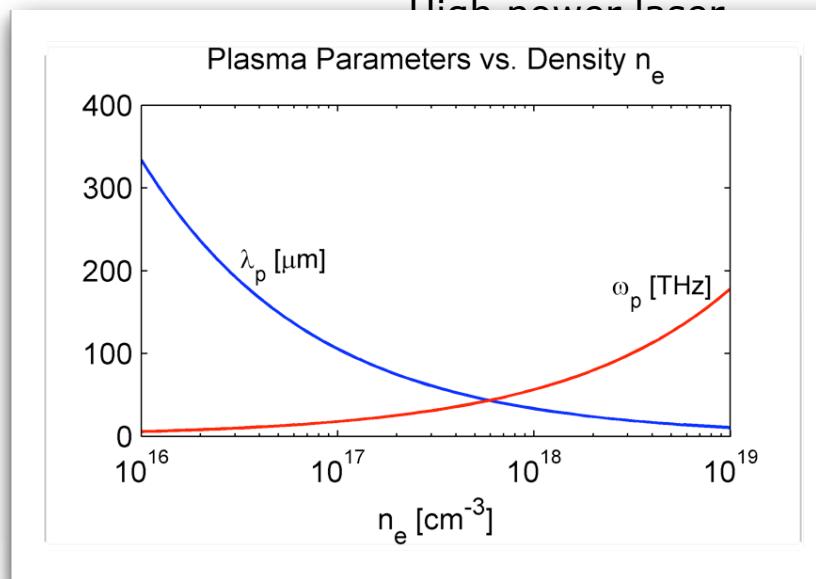
Instabilities & lack of control  
**Lack of knowledge**

**Remove one variable:**  
Injection of a well-characterized  
electron bunch into a laser-driven  
plasma wakefield



# Wakefield Probing

## Injection Parameters



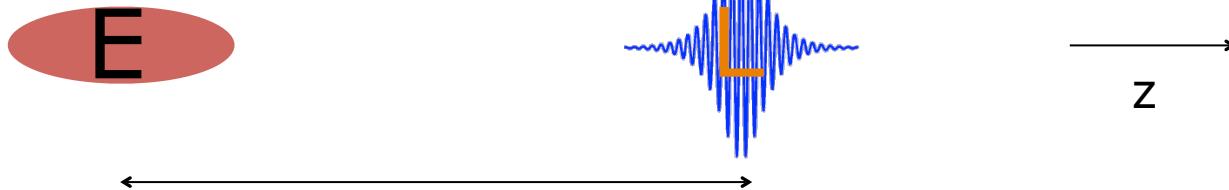
Plasma Density	$10^{17} \text{ cm}^{-3}$
Plasma Wavelength	$100 \text{ } \mu\text{m}$
Norm. Vectorpotential	$0.01 < a_0 < 1.8$
Synchronization/Jitter	$< 20 \text{ fs}$

Average Energy	5.6 MeV
Energy Spread	10 keV
Bunch Charge	100 fC
Bunch Length	<10 fs (rms)
Beam Size	$2.5 \text{ } \mu\text{m} \text{ (rms)}$
Transv. Emittance	$0.03 \text{ } \pi \text{ mm mrad}$

Wakefield  
Probing

## Laser-Bunch Overtaking

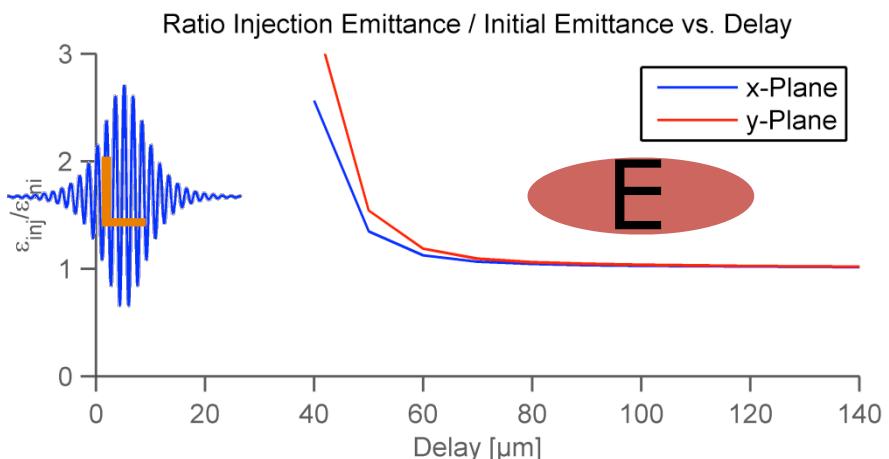
On target:



$$\gamma \approx 12 \rightarrow \beta \approx 0.996$$

$$\Delta z \approx 100 \mu\text{m}$$

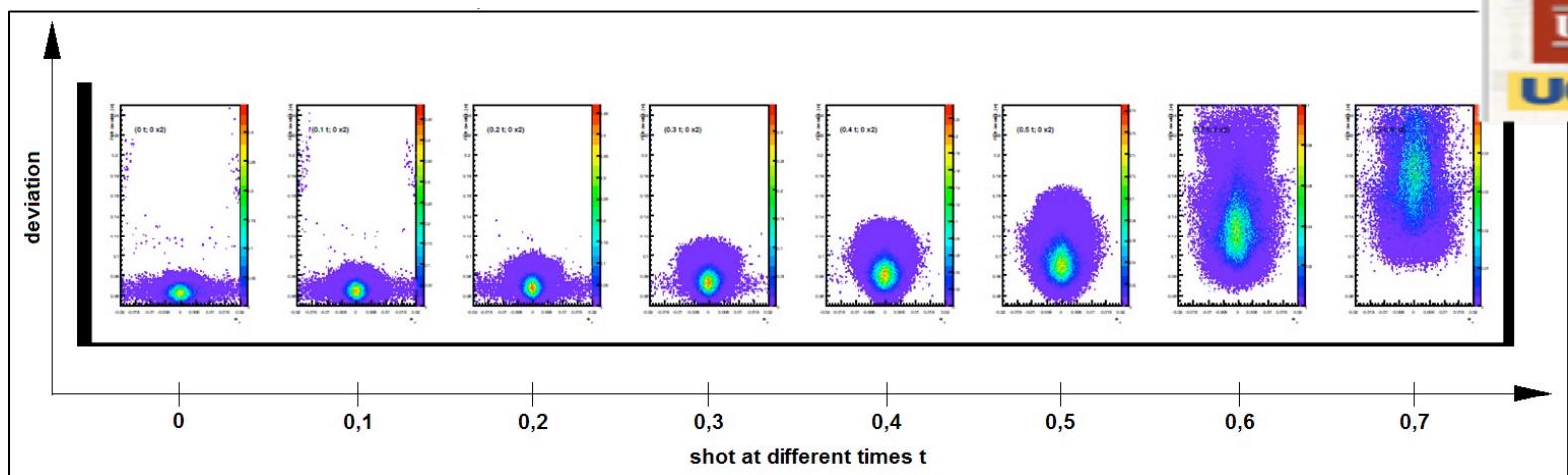
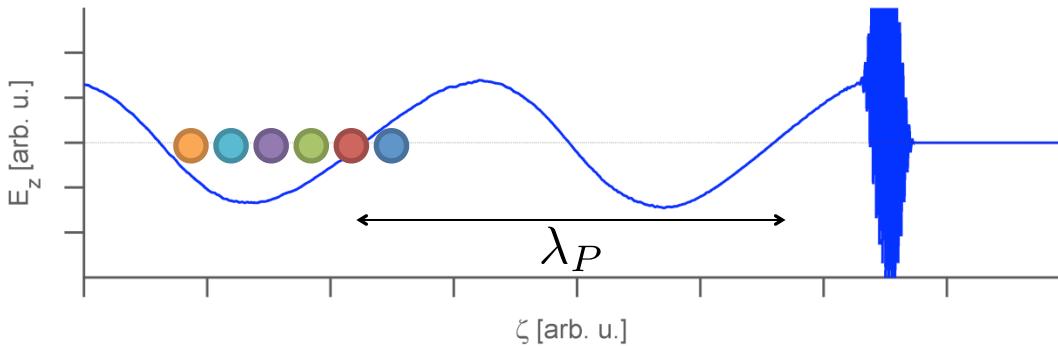
$$\beta = 1$$

**Only few centimeters of pathlength  $\Delta z$  needed to cover the delay!**In front of  
target:

Wakefield  
Probing

## Mapping the Wake

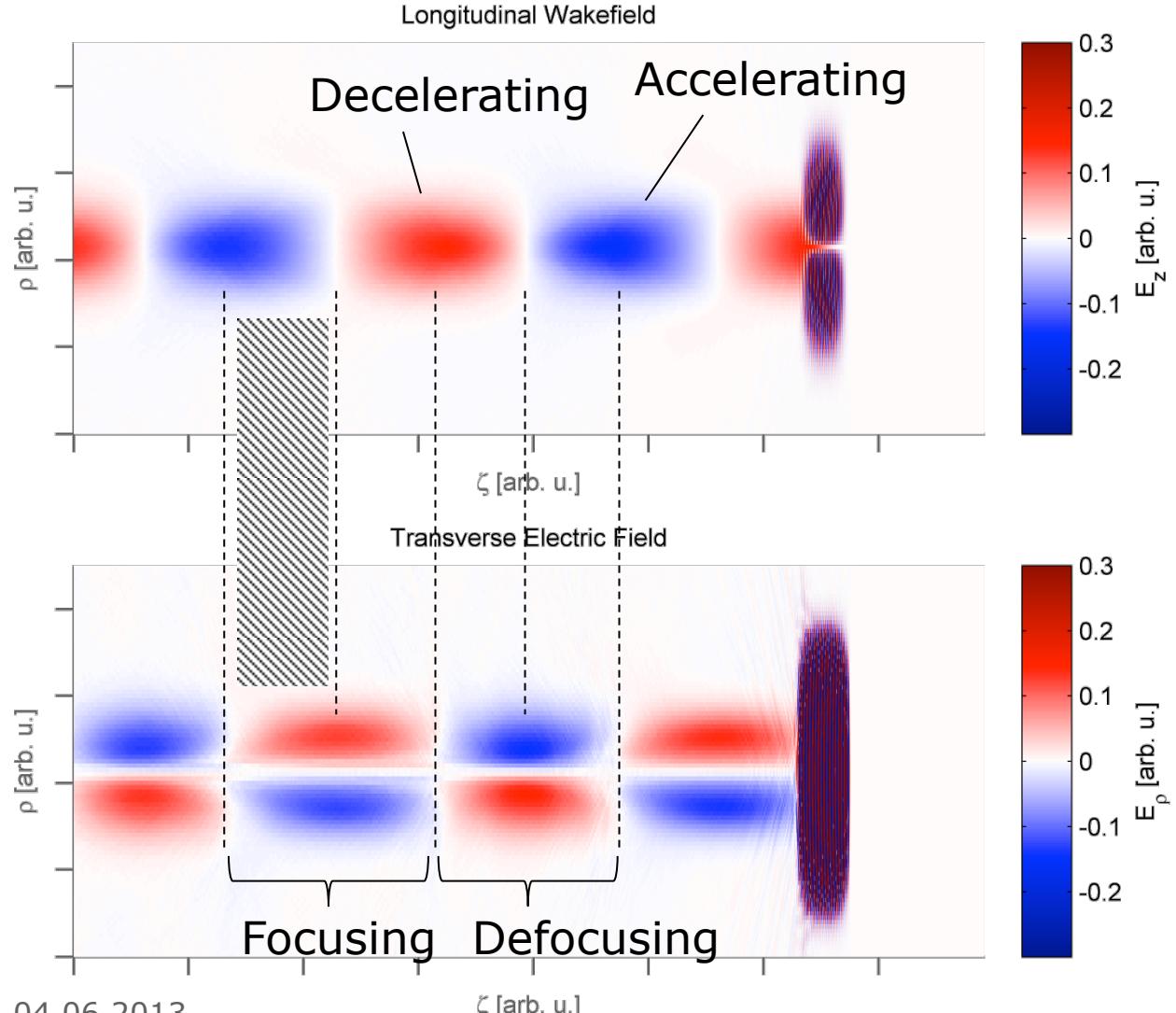
Linear Wakefield



Courtesy by group of J. Osterhoff

Wakefield  
Probing

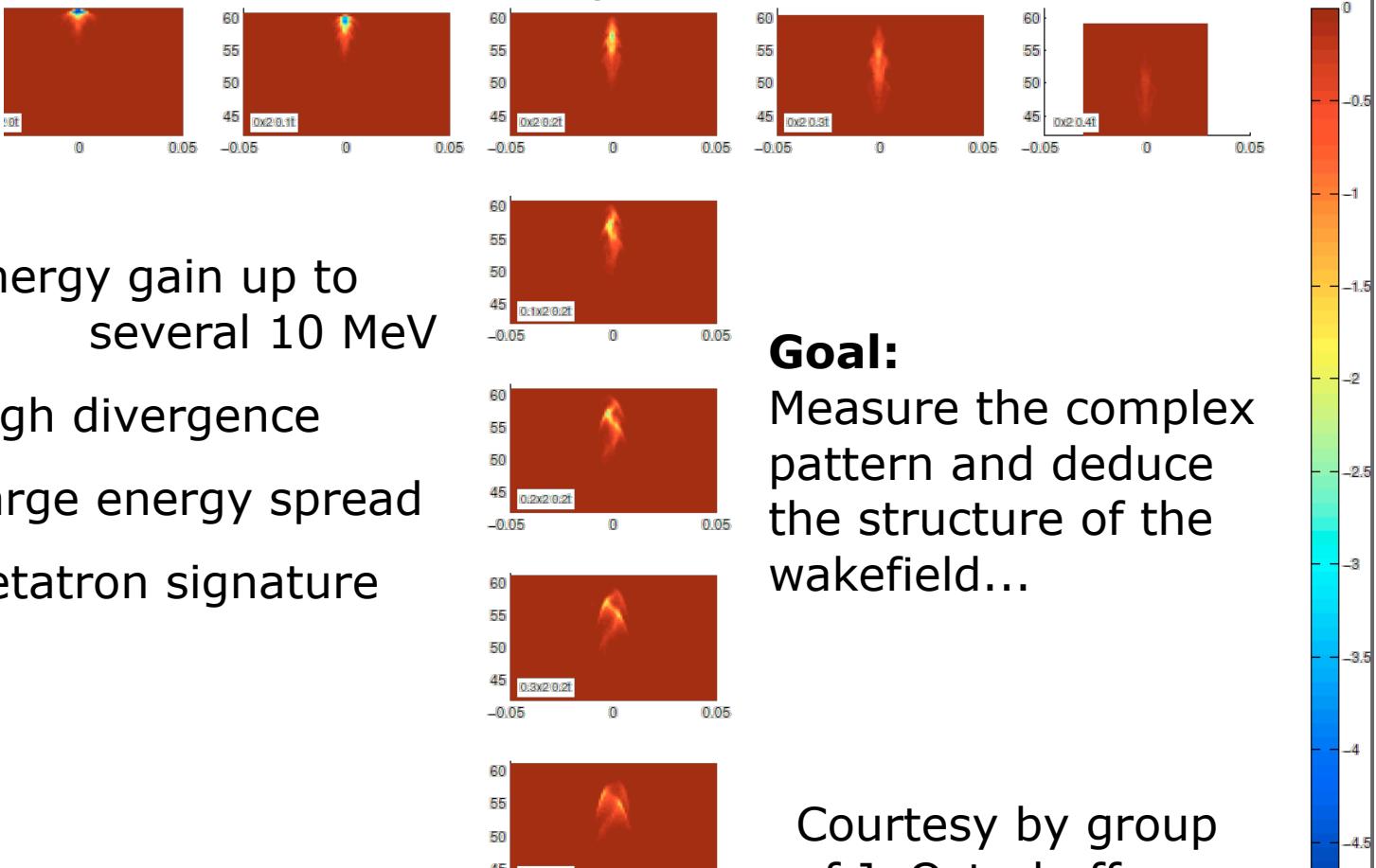
## (Quasi) Linear Wakefields





# Wakefield Probing

## Expected Results (PIC)





## Summary

- Overview of REGAE
- Parameter matching
- Wakefield probing:  
Mapping the wake

## Outlook

- Demonstration of injection at REGAE
- Studies on...
  - Energy distribution dynamics
  - Emittance growth



Thank you... for your attention!

## Acknowledgements

**UHH**

L.-O. Berger  
N. Delbos  
M. Diem  
I. Dornmair  
T. Gehrke  
F. Grüner  
B. Hidding  
A. Maier  
K. Peters  
M. Schnepf  
M. Titberidze  
C. Werle  
P. Winkler

**DESY**

R. Aßmann  
R. Bacher  
S. Bayesteh  
R. Brinkmann  
H. Delsim-Hashemi  
M. Felber  
K. Flöttmann  
J. Grebenyuk  
M. Hachmann  
U. Hahn  
M. Hoffmann  
G. Kube  
S. Lederer

**Univ. Darmstadt**

A. Angelovski  
A. Penirschke

**ELI Beamlines**

T. Lastovicka  
D. Kocon  
L. Pribyl

**AND...**

R.J.D. Miller  
and his group