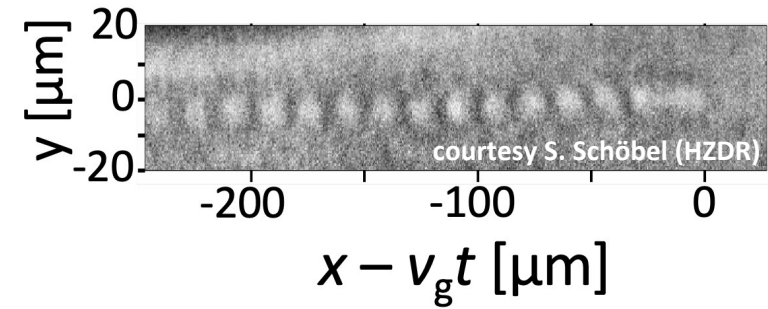


PLASMA STRUCTURES



theory & computer simulation

DIAGNOSTICS

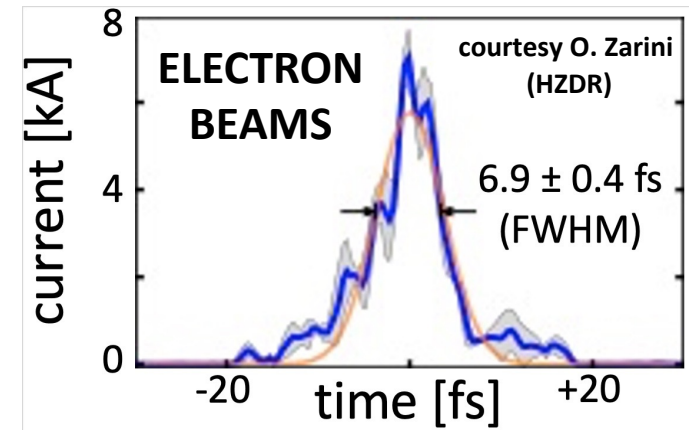
... "eyes" for plasma-based acceleration physics
& performance optimization

Plasma accelerators require **unconventional diagnostics** capable of measuring...

...plasma structures that are:

- small (tens of μm)
- light-speed
- evolving (ps)
- low-contrast ($\Delta\eta \sim 10^{-5}$)

- light emission (*wave-breaking, sheath dynamics*)
- collective Thomson scatter
- freq.-domain holography
- Faraday rotation
- transverse shadowgraphy & electron radiography
- ...



...and e-beams that are:

- small ($\sigma_{\perp} \sim 1 \mu\text{m}$)
- ultrashort (few fs)
- low- $\mathcal{E}_n < 0.1$ mm mrad
- pC- to nC-charged

- CTR spectroscopy, imaging
- β -tron X-ray spectroscopy
- electro- & magneto-optics
- optical & plasma-based transverse deflectors
- inverse Compton scatter
- ...

...employing a **new generation of methods:**

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Diagnostics for plasma-based electron accelerators

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“High-Resolution Diagnostics for Plasma-Based Accelerators”



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- 2004: **PhD in Physics**, Technical University Munich (“*Characterization of laser-accelerated proton beams*”)
- 2004-2005: **Research Associate**, Plasma Physics Group, Imperial College, London
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“Electron Beam Diagnostics”



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- 2006: **PhD in Physics**, University of Rome Tor Vergata (“*Bunch length characterization at the TTF-VUV FEL*”)
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- Since 2021: **Associate Professor**, Sapienza U. Rome, Dept. Basic & Applied Science for Engineering
 - Leader, “Injector” Working Area of EuPRAXIA@SPARC_LAB project
 - PI of FIRB grant to develop a plasma-based test accelerator at SPARC_Lab.
 - Co-Leader, WP Applications in EuPRAXIA – Preparatory Phase



Questions for Discussion

- **What are the 2 or 3 most important new plasma structure diagnostic capabilities to develop?**
 - diagnose shot-to-shot instability due to non-ideal drivers/targets
 - improve spatial resolution of single-shot structural images
 - diagnose temporal evolution of plasma structures: fs \rightarrow ms time scales
 - extend diagnostics to wider range of plasma accelerator parameters:
high \rightarrow low n_e , NIR laser \rightarrow LWIR laser/e⁻/e⁺/p⁺-driven wakes, μm \rightarrow m length scales
 - incorporate diagnostics into simulations
- **What are the 2 or 3 most important improvements to make in plasma-accelerated e-beam diagnostics?**
 - spatial resolution (beam size & overlap diagnosis)
 - time resolution (drive-witness temporal jitter)
 - accurate 3D/6D measurement/reconstruction of individual e-bunch profiles
 - single-shot diagnostics