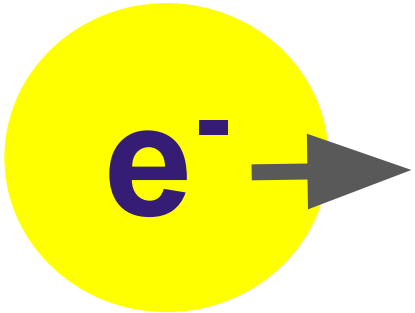
WG 1 Summary Talk



beams from plasma

Sebastien Corde, **Arie Irman** and **Marlene Turner**

Towards high quality witness beams

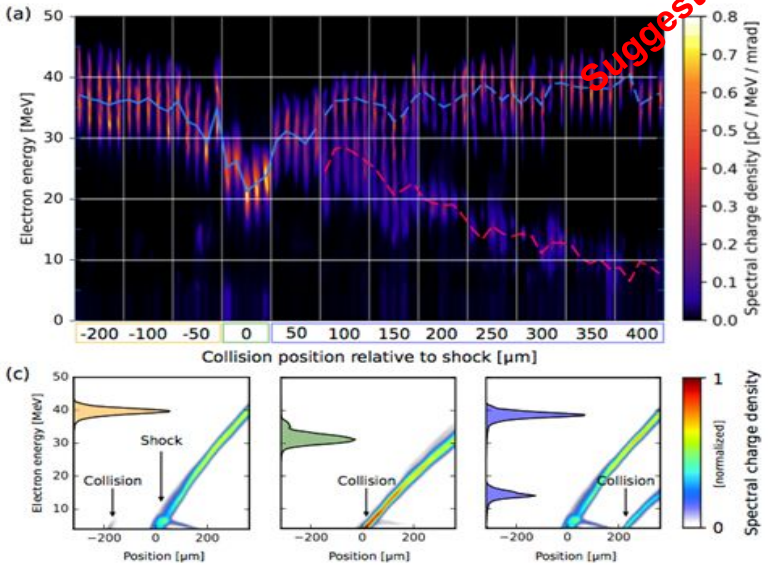
- Electron injection
- Acceleration
- Control
- High average power & brightness
- FEL Quality Beams
- Instability mitigation
- Hybrid LWFA-PWFA staging

Electron Injection

S. Karsch (LMU,MPQ)

Dual-energy beams

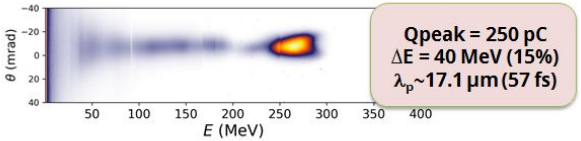
Suggested talk



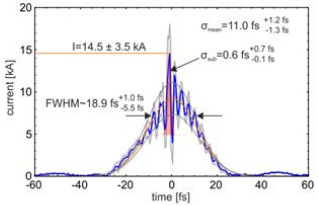
O. Zarini (HZDR)

Reconstructed temporal profile

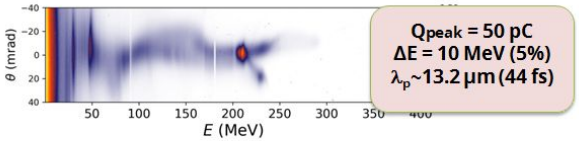
Ionization injection (99% He+1% N_2)



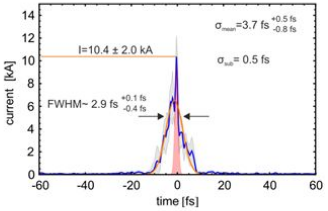
Qpeak = 250 pC
ΔE = 40 MeV (15%)
λ_p~17.1 μm (57 fs)



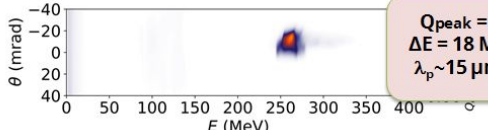
Self injection (100% He)



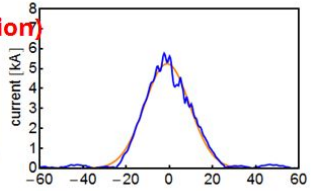
Qpeak = 50 pC
ΔE = 10 MeV (5%)
λ_p~13.2 μm (44 fs)



Shock front injection (100% He + density modulation)



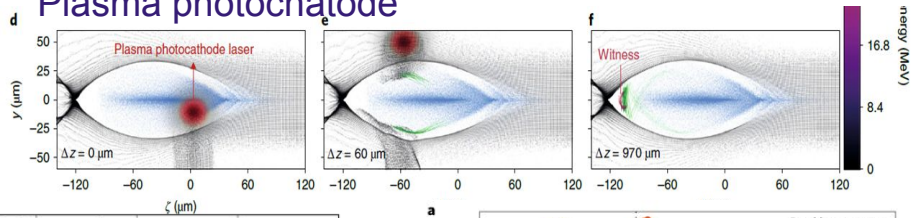
Qpeak = 130 pC
ΔE = 18 MeV (7%)
λ_p~15 μm (50 fs)



Electron Injection

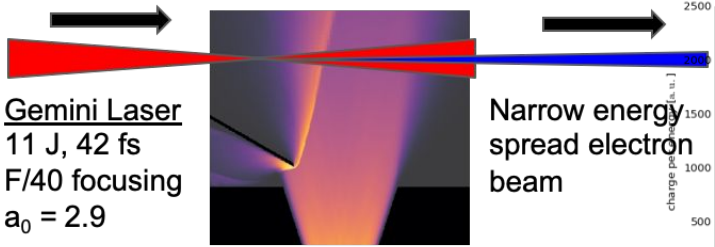
F. Habib (Uni Stratchlyde)

Plasma photocathode



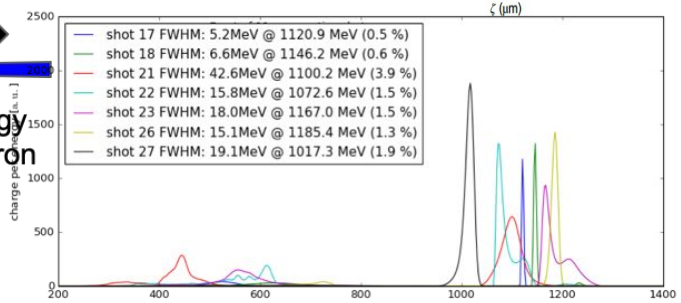
M. Streeter (Imperial College)

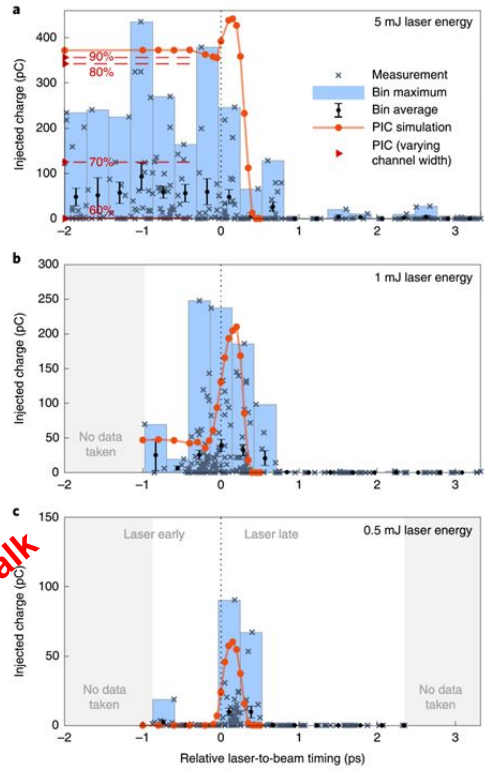
Shock injection for GeV beams



Gemini Laser
11 J, 42 fs
F/40 focusing
a_0 = 2.9

Narrow energy spread electron beam





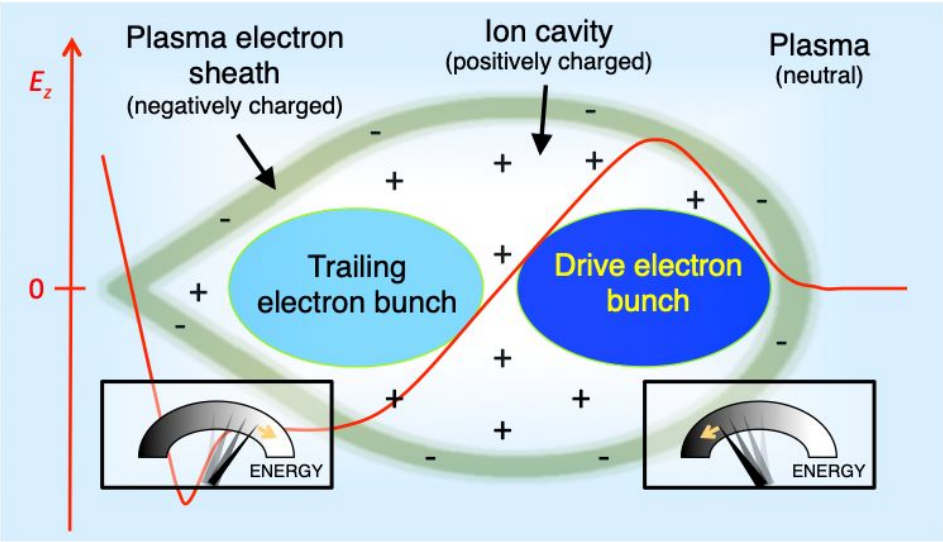
M. Kirchen (Uni Hamburg)

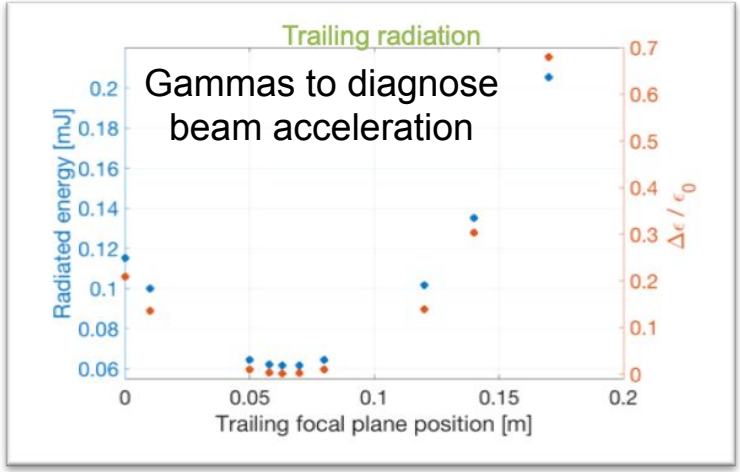
I ♥ WG1

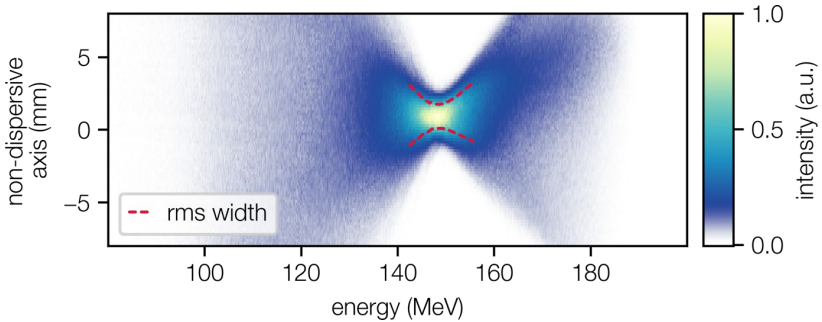
Suggested talk

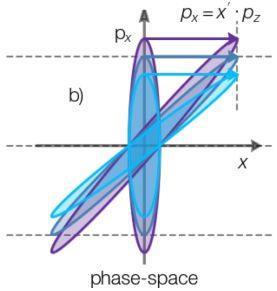
Acceleration

S. Corde (LOA)





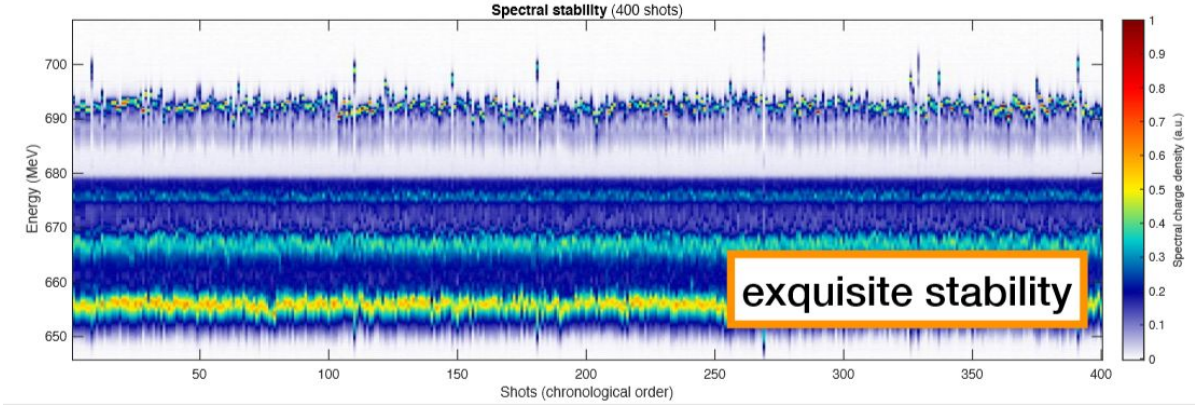


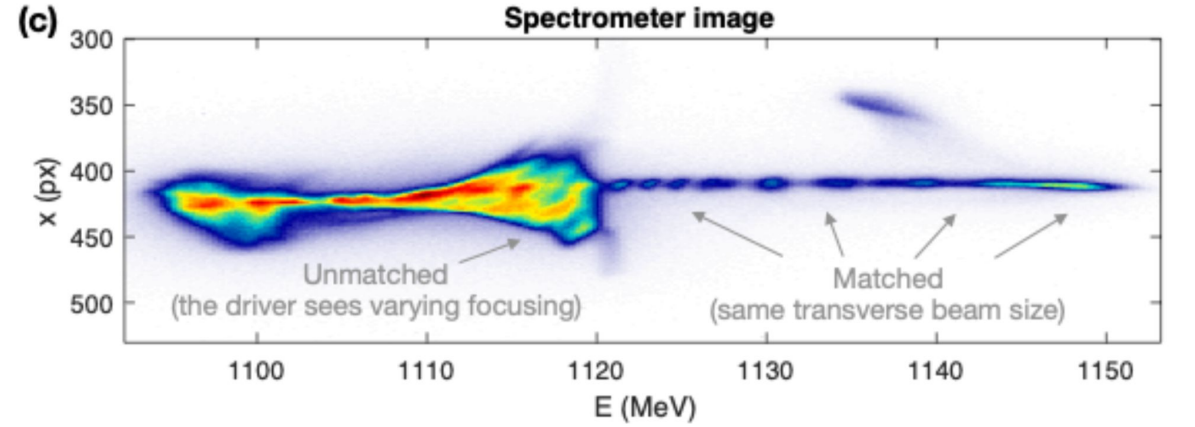


Chromatic emittance measurements

P. Winkler (CFEL)

Acceleration



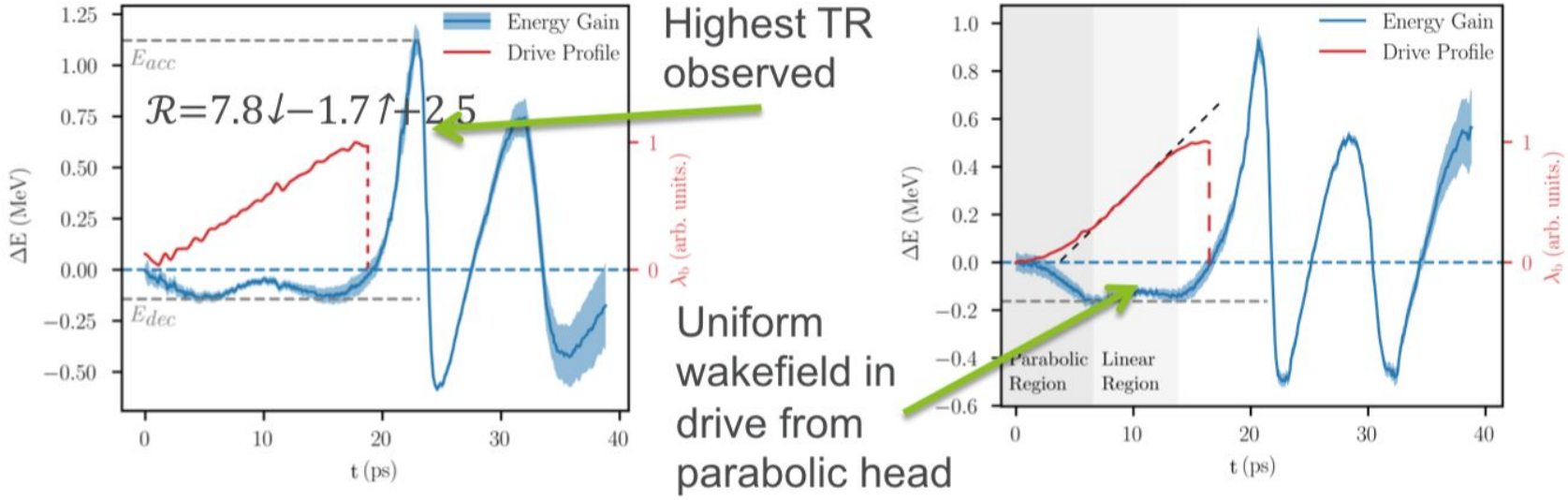


Stable acceleration of a witness beam in a PWFA

K. Poder (DESY - FLASHForward)

Acceleration

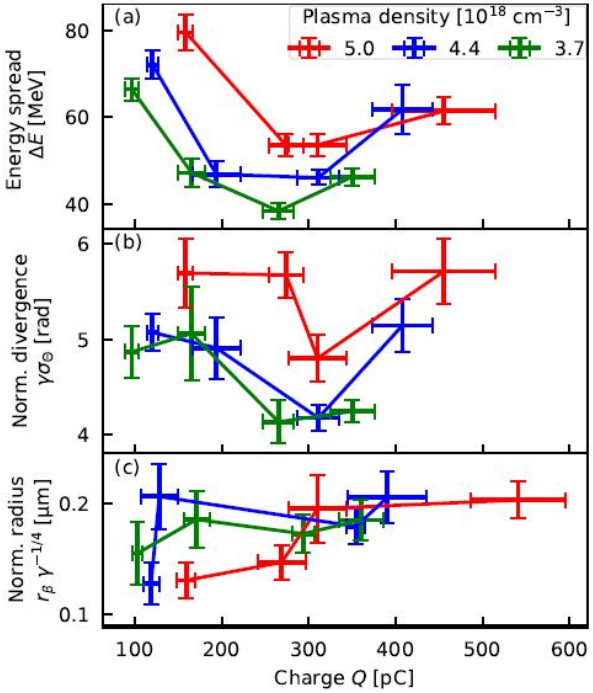
Experimental demonstration of beam shaping and high transformer ratio, G. Andonian (UCLA)



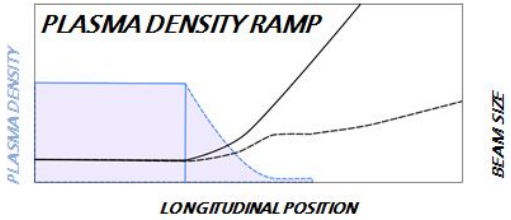
Controls

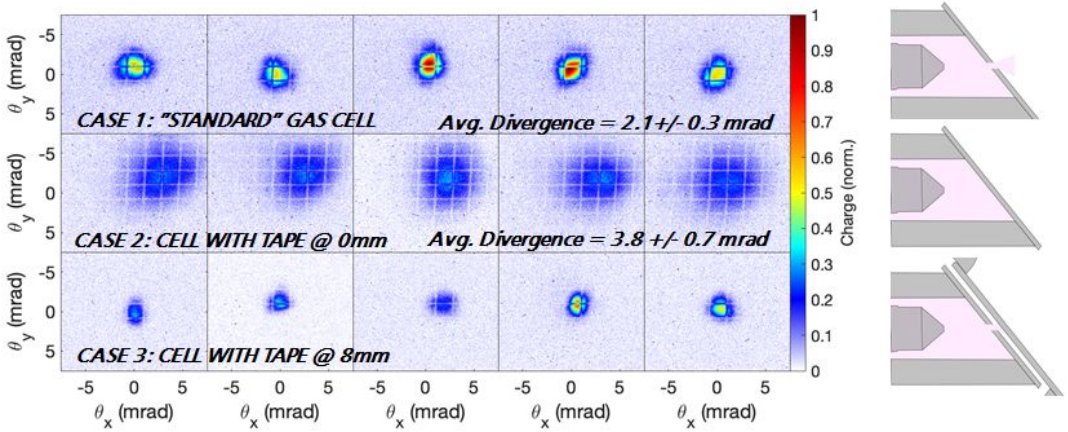
A. Köhler (HZDR)

Energy spread-divergence coupling



R. Shalloo (Imperial College)

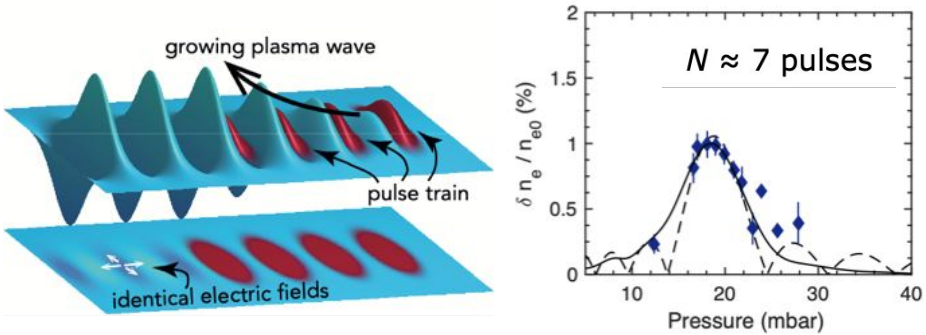




High average power and brightness

Multi-pulse LWFA

Route to high rep rate & high energy efficiency

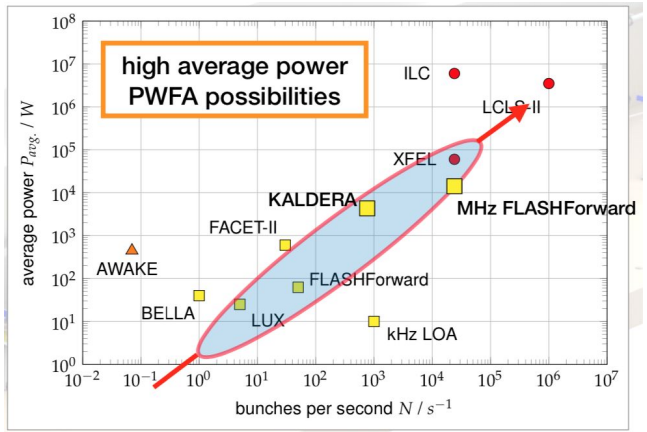


S. Hooker (University of Oxford)

J. Cowley et al., PRL 119, 044802 (2017)

MHz PWFA

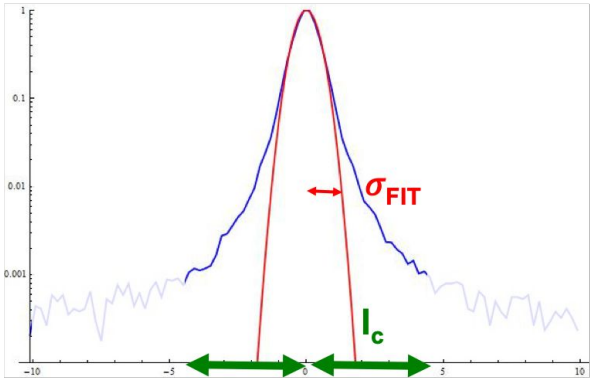
≤ 800 bunches (at ≥ 1 MHz spacing) at 10 Hz rate, a few 10 kW average power



R. D'Arcy (DESY)

FEL quality beams

Emittance evaluation: use fit&cut



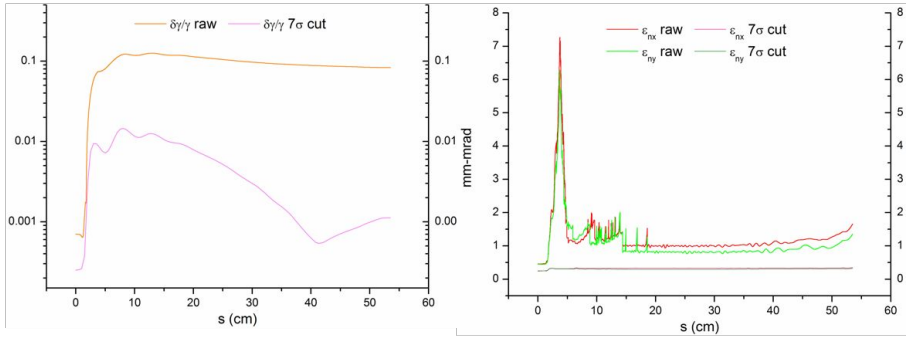
1. Produce a (reasonable) binning of quantity.

2. Fit with a Gaussian and evaluate width σ_{FIT}

3. Set the cut length $I_c = n\ \sigma_{FIT}$

4. Recalculate beam parameters with cut and evaluate charge

Application to EuPRAXIA@SPARC_LAB/EuPRAXIA 5 GeV beam from external injection in LPA



Raw: r.m.s.

Laser settings	
$\sigma_{tr}[\mu m]$	70
$\tau_{FWHM}[fs]$	112
E [J]	24.5
a_0	1.15

Plasma settings	
n_0 [cm^{-3}]	10^{17}
L [cm]	50

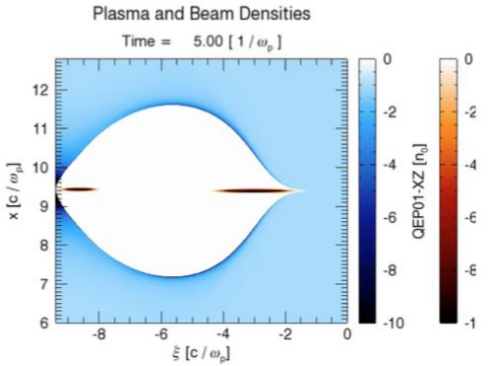
Beam parameters	
E [MeV]	5290
Q [pC]	29.5
dE/E*	1.1×10^{-3}
dE/E$_{slice}$**	3.6×10^{-4}
$\epsilon_n[\mu m]$	0.35
$\epsilon_n[\mu m]^{*slice}$	0.35
L_c [m]	15.5
L_c [m] **	91

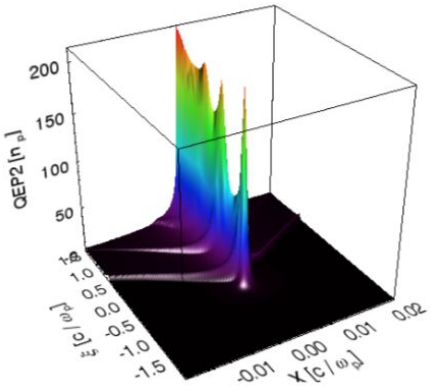
* MAD/Median

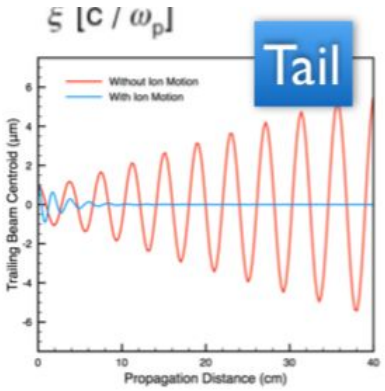
** r.m.s., no charge cut

A. Rossi (INFN Milano)

Instability mitigation: ion motion can suppress hosing

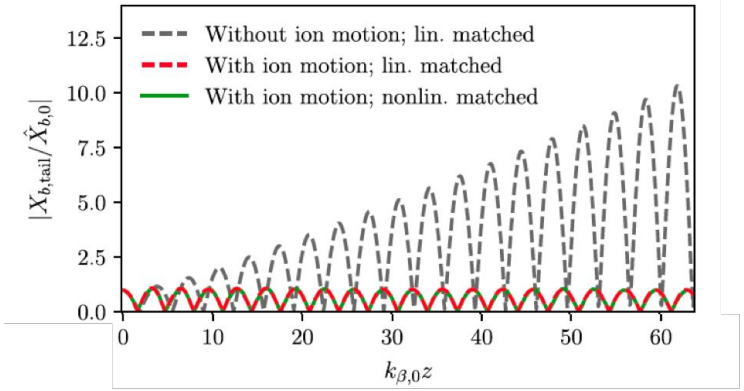




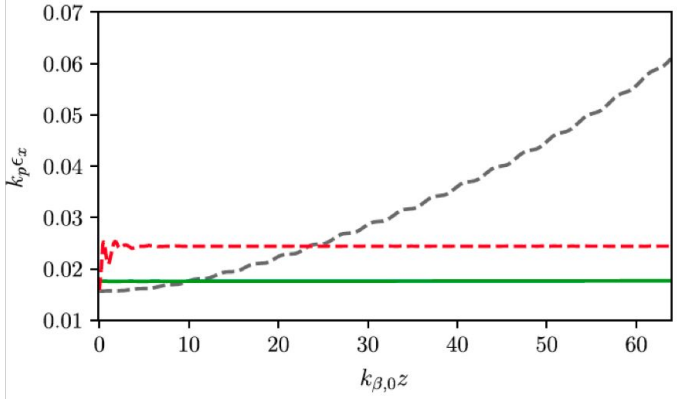


W. An
(Beijing Normal University)

Beam centroid

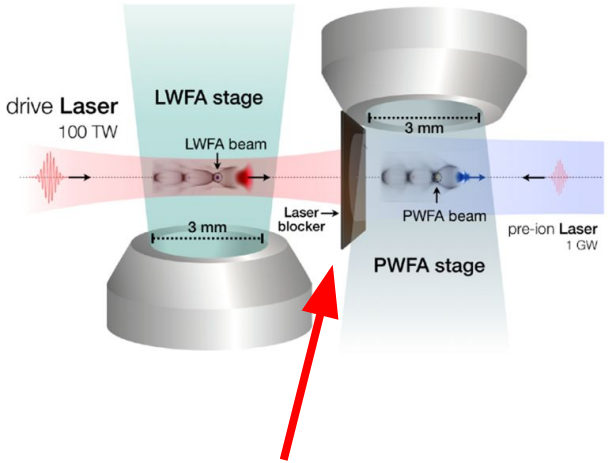


Emittance



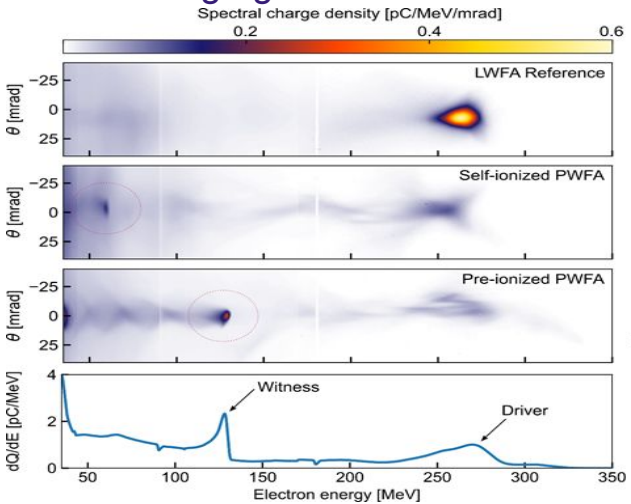
C. Benedetti
(LBNL)

Hybrid LWFA-PWFA staging



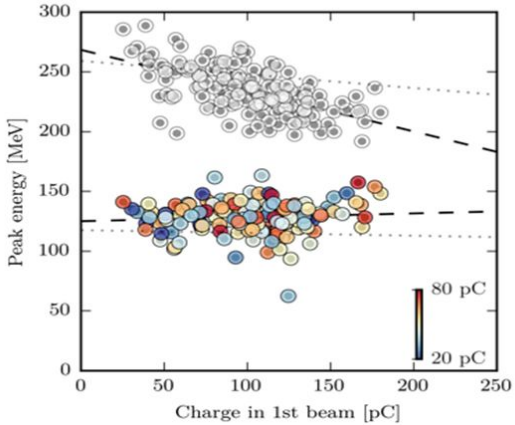
T. Heinemann (DESY, Strathclyde)

High gradient PWFA



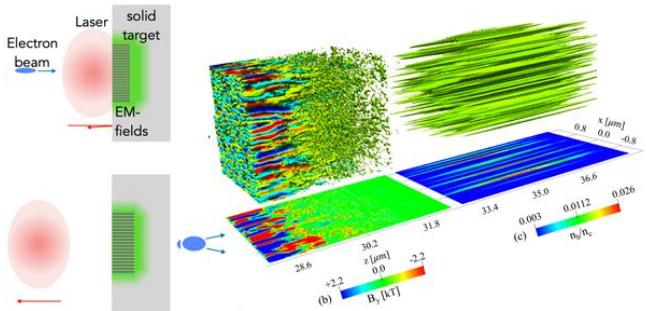
A. Döpp (LMU, MPQ)

Drive-witness bunch pair



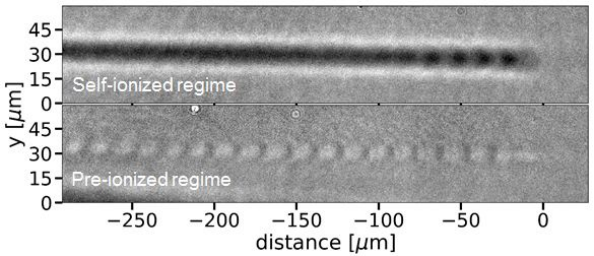
O. Kononenko (LOA)

High-intensity laser-foil interaction



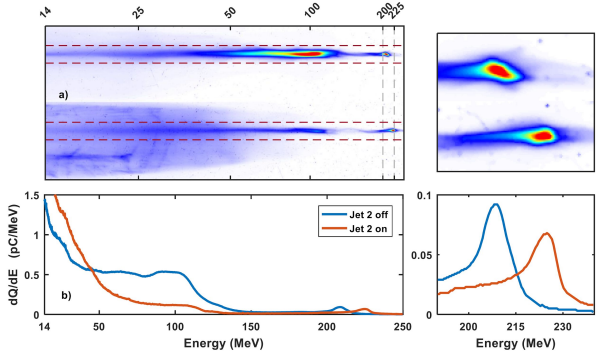
S. Schöbel (HZDR)

Beam-driven plasma wakefield imaging



J. Björklund (Lund Univ)

Drive-witness bunch pair



Exploring physics and overcoming limitations

Overcoming Limitations

LWFA


Depletion

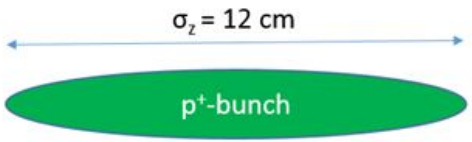

Diffraction

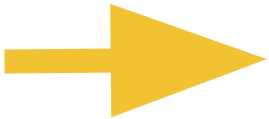

Dephasing

Exploring Physics

Proton Driven PWFA

$$k_{pe}\sigma_z \approx \sqrt{2}$$





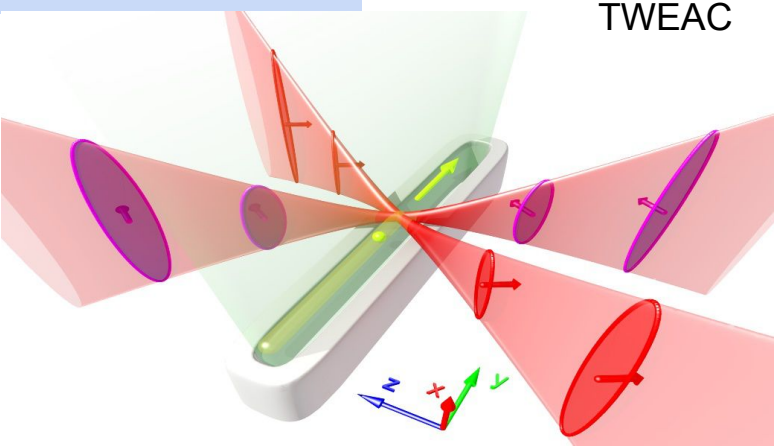
Wakefield amplitudes: ~MV/m

Overcoming the 3Ds

Novel Concepts

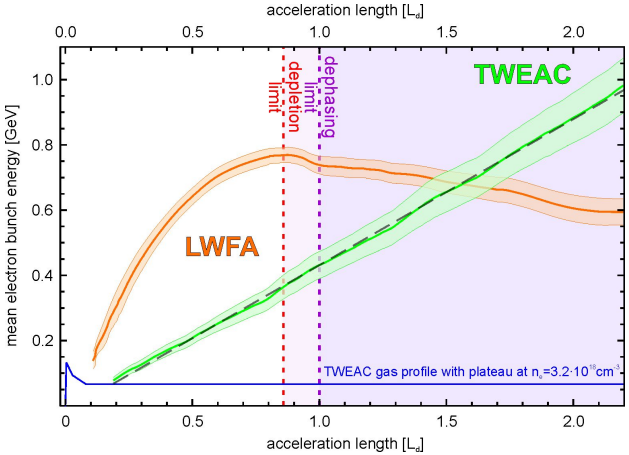
A.Debus (HZDR)

TWEAC

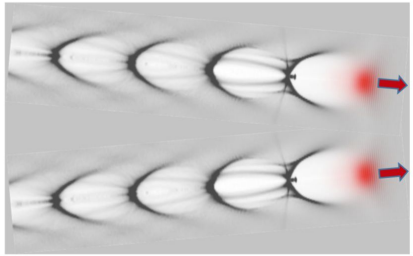


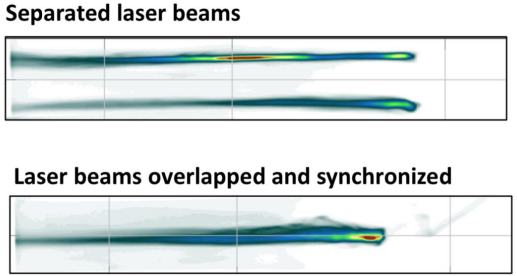
Two pulse-front tilted lasers.

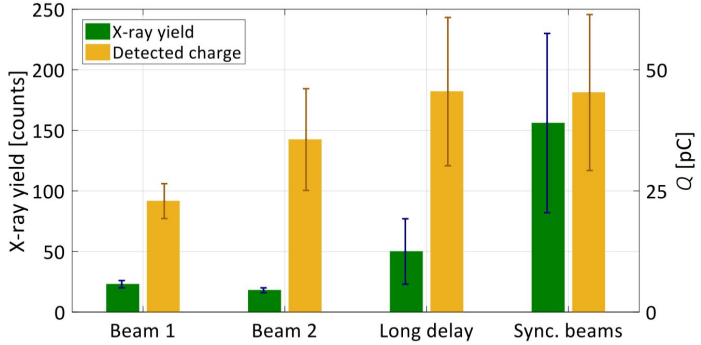
With that configuration the location of the peak intensity of the laser moves at the speed of light.



O. Lundh, (Lund University)





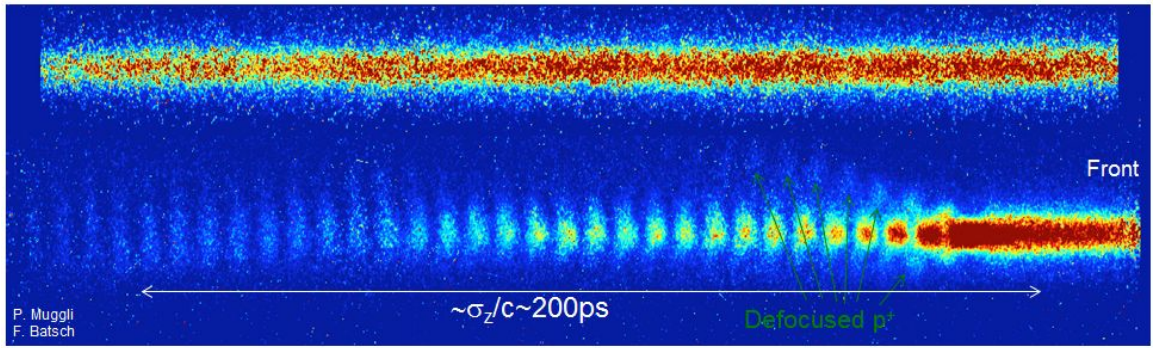


Merging wakefields → electrons oscillate with large radial amplitude

⇒ approx. times 3 enhancement in the forward X-ray yield.

Physics Study: Driver evolution

A.Bachmann,(CERN, MPP).



WG 1 suggested!

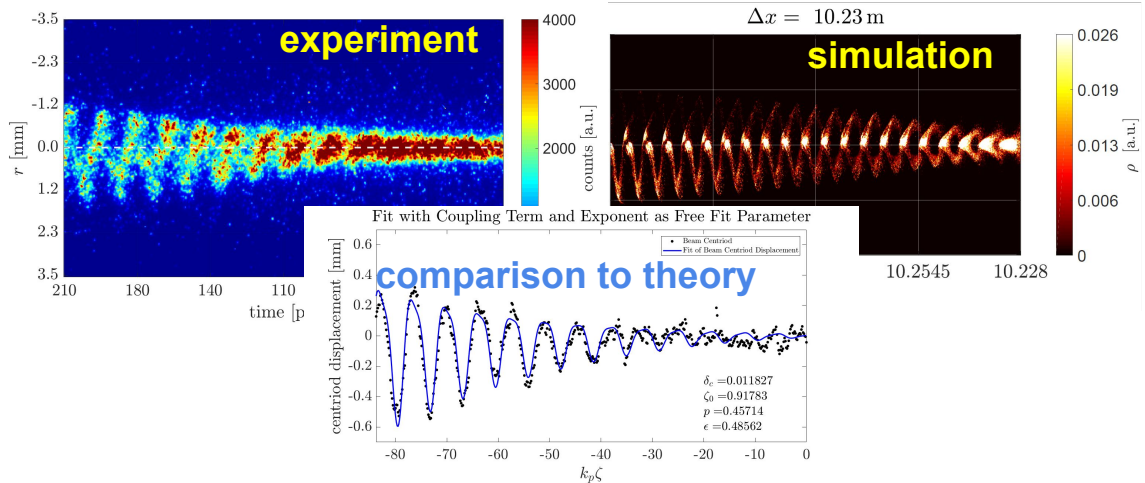
When seeding the axisymmetric mode (wakefield amplitude must exceed the noise):

⇒ phase reproducible wakefields, with high amplitudes.

Important for external injection and acceleration of electrons.

⇒ experimental evidence for electron beam seeding.

M. Hüther, (MPP)



The non-axisymmetric mode ⇒ Hosing

Observed in AWAKE only for very low n_{pe} (<0.7e14/ccm) or with induced misalignment.

Asymmetric oscillation of the bunch centroid consistent with the characteristics of coupled beam hosing.

Fits and simulations show good agreement with experimental data and confirm the expected characteristics for coupled beam hosing.

Whats next?

(Future) Facilities & Proposed Experiments

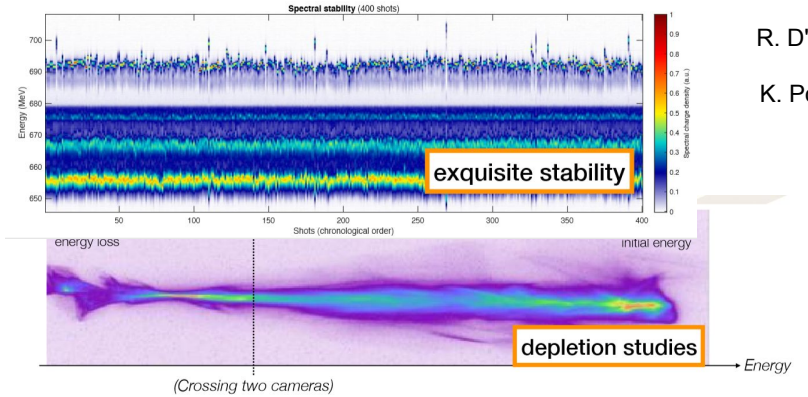
FLASHForward @DESY

- a next-generation experiment for beam-driven plasma wakefield accelerator research.
- extension beam line to FLASH, to be operated simultaneously with FEL beamlines.

Special Features:

- Exquisite stability allows for precision measurements.
- ≤ 800 bunches (at ≥ 1/MHz spacing) at 10 Hz rate, a few 10 kW average power.
- diagnostics,...

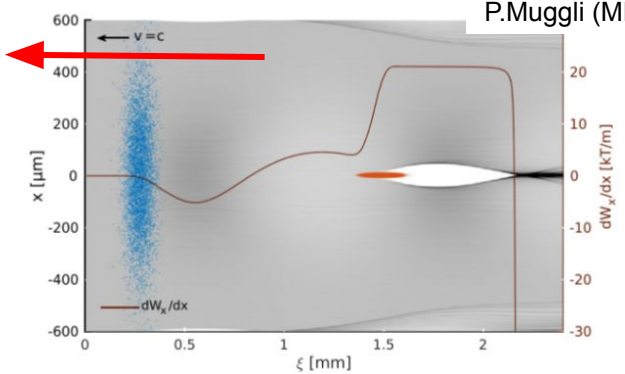
Experiments started...



R. D'Arcy, (DESY).

K. Poder, (DESY).

Physics Plans for AWAKE Run 2 @ CERN



P.Muggli (MPP)

- **"Blow-out"** regime (n_{b0}>>n_{e0}) for focusing force ~r, i.e., focusing free of geometrical aberrations.
- **Loading of wakefields** for narrow energy spread and minimization of chromatic effects on emittance.
- e-beam matching for control of divergence angle and projected **emittance preservation**.
- SM seeded by wakefields driven by **electron bunch**.

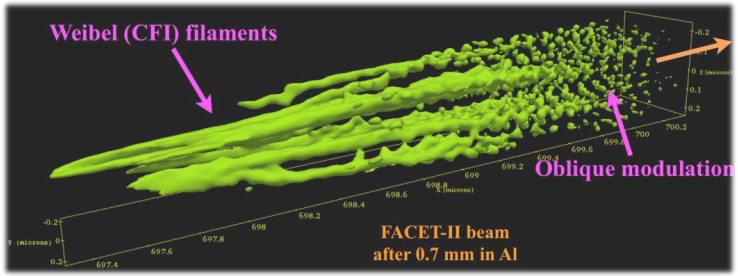
(Future) Facilities & Proposed Experiments

FACET-II@SLAC

FACET-II | Facility for Advanced Accelerator Experimental Tests

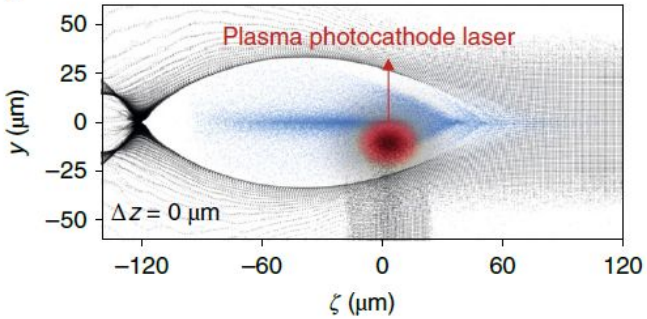
E300: high efficiency and preserved emittance PWFA

E305: beam filamentation



S. Corde (LOA)

E310: Trojan Horse



B. Hidding & F. Habib (Strathclyde)

Thank you for attending and contributing to WG 1!