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APPLICATIONS

EuPRAXIA
Preparatory Phase

Beam Driven Acceleration Scheme to 5 GeV Energy for EuPRAXIA@SPARC_LAB

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EuPRAXIA@SPARC_LAB WP1 leader – Accelerator Physics
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Outline

- EuPRAXIA@SPARC_LAB Performances
- High transformer ratio resonant PWFA ideal working point design for EuPRAXIA@SPARC_LAB
  - Two bunches
  - Train of bunches
- Tailoring beam shaping and further accelerating schemes
- Summary

EuPRAXIA@SPARC_LAB Performances

Funded by the European Union

Radiation Parameter	Unit	PWFA	Full X-band
Radiation Wavelength	nm	**3-4**	4
Photons per Pulse	$\times 10^{12}$	**0.1- 0.25**	1
Photon Bandwith	%	**0.1**	0.5
Undulator Area Length	m	30	
ρ(1D/3D)	$\times 10^{-3}$	**2**	2
Photon Brilliance per shot	$\left(\frac{s\, mm^2 mrad^2}{bw(0.1\%)}\right)$	$\mathbf{1{-}2 \times 10^{28}}$	1×10^{27}

Electron Beam Parameter	Unit	PWFA	Full X-band
Electron Energy	GeV	**1-*1.2***	1.2
Bunch Charge	pC	**30-50**	200-*500*
Peak Current	kA	**1-2**	1-2
RMS Energy Spread	%	**0.1**	0.1
RMS Bunch Length	μm	**6-3**	24-20
RMS norm. Emittance	μm	**1**	1
Slice Energy Spread	%	**≤0.05**	≤0.05
Slice norm Emittance	mm-mrad	**0.5**	0.5

Courtesy C. Vaccarezza

EuPRAXIA@SPARC_LAB Performances

Funded by the European Union

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RMS norm. Emittance	μm	**1**	1
Slice Energy Spread	%	**≤0.05**	≤0.05
Slice norm Emittance	mm-mrad	**0.5**	0.5

We need to increase the energy of the trailing beam up to more than a factor 4 with respect to the reference WP

Courtesy C. Vaccarezza

High transformer ratio PWFA for EuPRAXIA@SPARC_LAB

Funded by the European Union

In perspective of the draft of EuPRAXIA@SPARC LAB technical design report, we have explored through numerical simulations two ideal scenario suitable for the 5 GeV case trying to maximize the

$$R_T = \frac{|E^{+}_{max}|}{|E^{-}_{max}|}$$

- Quasi non-linear regime to exceed $R_T = 2$ and preserve beam quality

$$\tilde{Q} = \frac{N_b k_p^3}{n_p} \leq 2 \qquad n_b/n_p \gg 1$$

→

- Two bunches operation
- Resonant scheme

- The simulations have been performed in 2D by means of the Hybrid Fluid Kinetic code Architect [2]

- Plasma accelerating module → 2.4 m long flat top plasma profile with a background density n_p = 2.5 10^{16} cm^{-3}, preceded by a 1 cm long injection ramp
  → beam energy at injection 1.2 GeV

[1] S. Romeo et al - High transformer ratio resonant PWFA ideal working point design for EuPRAXIA@SPARC_LAB - 2020 J. Phys.: Conf. Ser. 1596 012061
[2] F Massimo, S. Atzeni and A. Marocchino 2016 Journal of Computational Physics 327 841–850

High transformer ratio PWFA for EuPRAXIA@SPARC_LAB

Two scenarios have been explored consisting in

a) Two bunches: 150 pC + 30 pC

b) Train of bunches → 40 – 140 – 270 pC + 30 pC

→ Same results in terms of final beam energy

Table 1. Driver(s) and witness parameters at the injection

	Driver(s)	Witness
Q [pC]	150/40-140-270	30
γ	2348	2348
ϵ_n [mm mrad]	1	0.7
σ_E [%]	0.1	0.1
$\beta_{x,y}$ [mm]	22	22
$\alpha_{x,y}$ [mm]	1	1
σ_z [µm]	33	16 (3.8 rms)

- Driver-driver separation of around $\lambda_p/2$ (105.6 µm)
- Driver-witness separation of around $\lambda_p/2$ (97 µm)

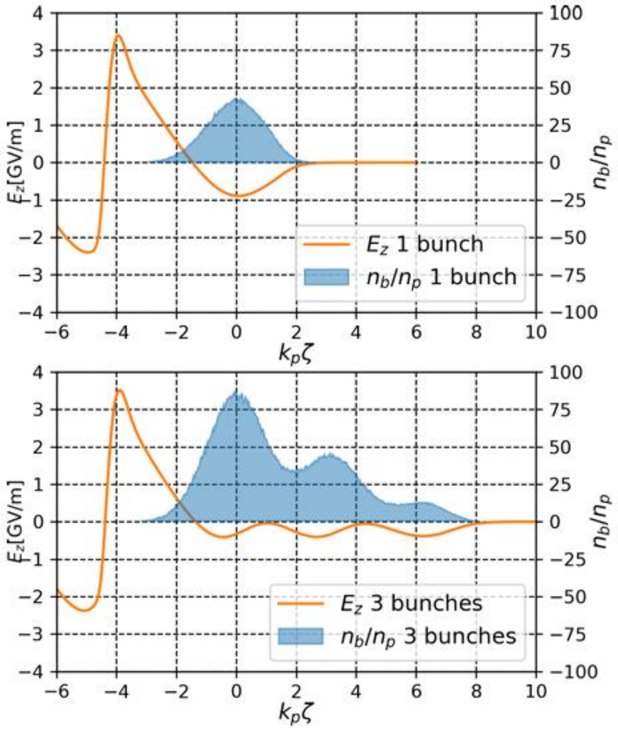
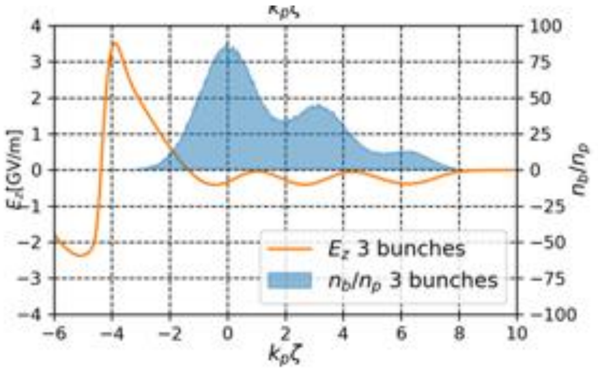


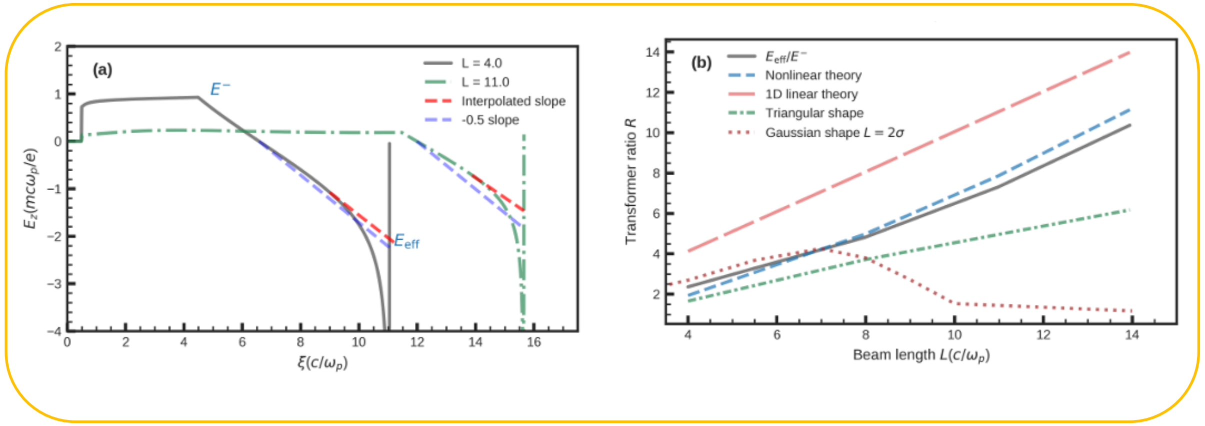
Figure 1. Longitudinal field on axis and longitudinal current profile for single bunch scheme (top) and 3 bunch train scheme (bottom) at $z = 0$.

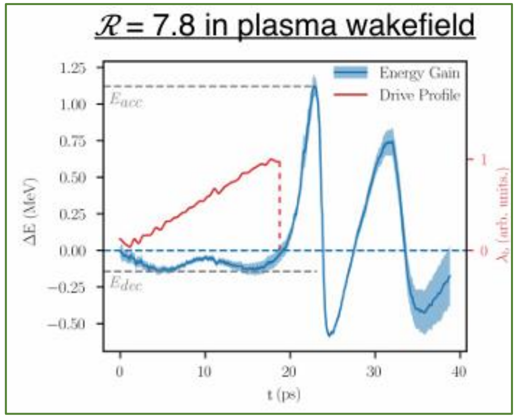
High transformer ratio PWFA for EuPRAXIA@SPARC_LAB: beam tailoring

- Driver:
    - train of three bunches with the same shape
    - final design that is in between a single bunch with ***triangular shape*** and a train of bunches
- *Witness:*
    - *Triangular current shape in order to minimize the energy spread growth* [3]



- Moderate beam quality
    - Higher accelerating gradients in the non-linear blow-out regime → smaller footprint
    - Hybrid LWFA + PWFA
- Further optimisation methods also suggest that customised tailoring exists to produce much higher R_T (for example up to 10 in [4,5])





[3] M. Tzoufras, W. Lu, F. Tsung, C. Huang, W. Mori, T. Katsouleas, J. Vieira, R. Fonseca and L. Silva 2008 Physical Review Letters 101 145002
[4] Q. Su et al. Optimization of transformer ratio and beam loading in a plasma wakefield accelerator with a structure-exploiting algorithm (2023)
[5] Roussel, R., et al. PRL 124 (2020): 044802 - Gao, Q., et al. PRL 120 (2018): 114801 - Loisch, G., et al. PRL 121 (2018): 064801

High transformer ratio PWFA for EuPRAXIA@SPARC_LAB: results

- The average accelerating gradient is E_z = 1.6 GV/m and the effective transformer ratio is R_T = 3.2 → 5 GeV in 2.4 meter long plasma channel

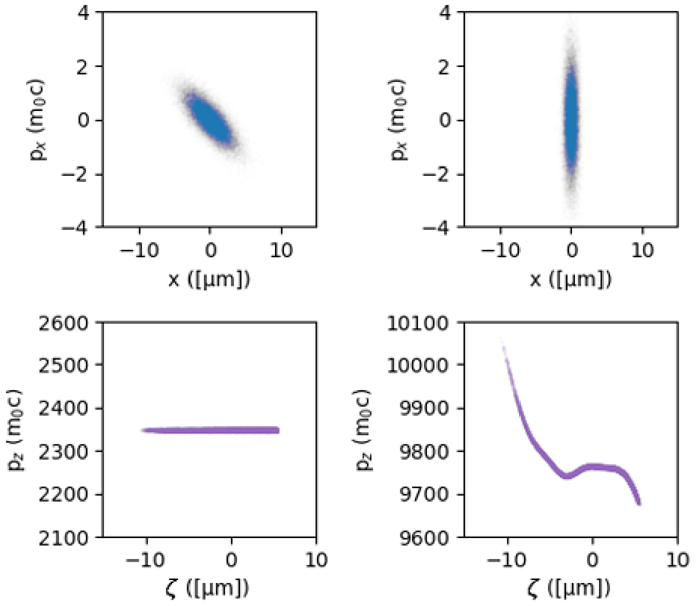


Figure 3. Witness phase space at the initialization (left) and at the end of the simulation (right). The transverse phase space is perfectly matched while the longitudinal phase space presents an energy spread growth mostly located on bunch tail.

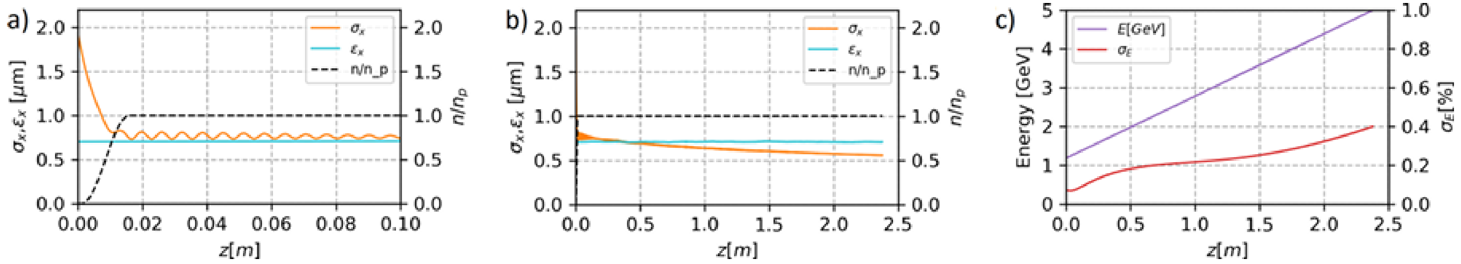
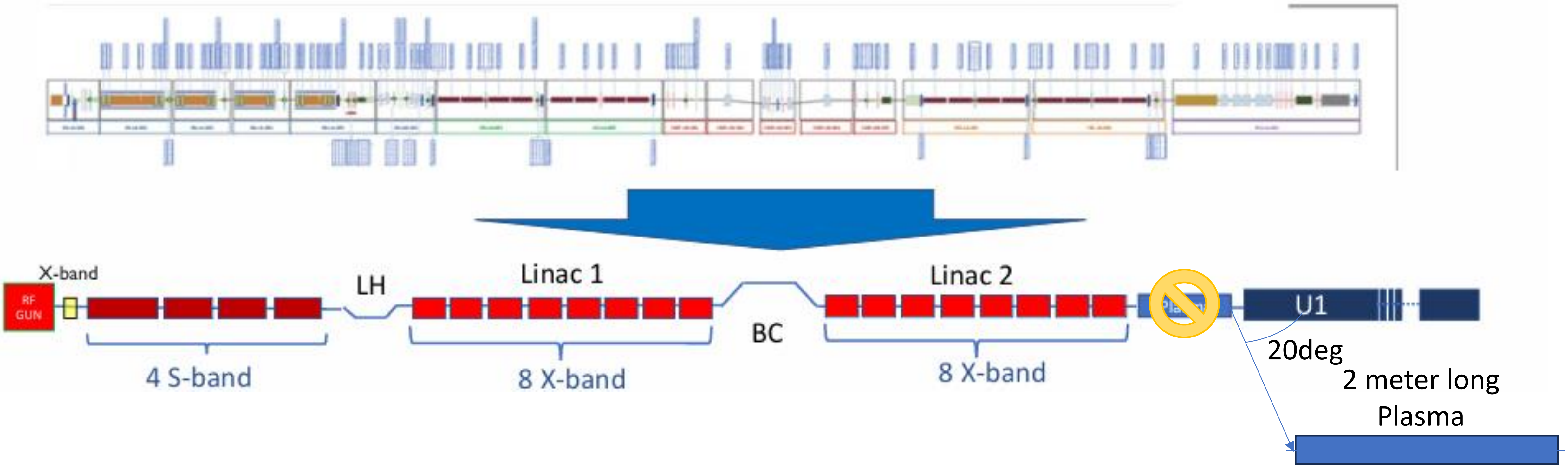


Figure 2. Integrated parameters evolution of Witness bunch. We report the evolution of the transverse spot size and emittance in a) (for the first 10 cm) and in b) (for the entire channel) along with the density of the plasma channel. We report in c) the evolution of energy and energy spread.

The emittance of the witness is preserved along the entire plasma channel and the energy spread grows up to 04%

Integration in the 'basic layout'

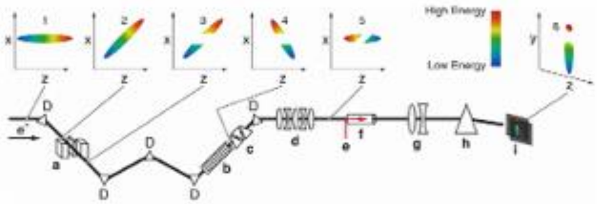


Tentative layout in Andrea Renato Rossi's talk

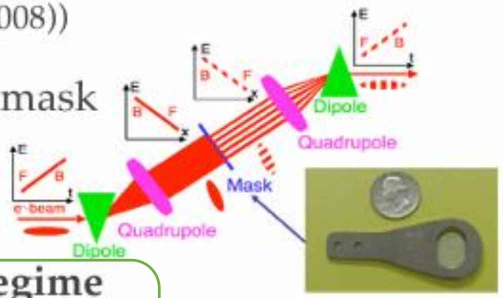
Tailoring Beam Shape

SPARC_LAB

FACET



- Notching device in a dispersing section
  - *High-efficiency acceleration of an electron beam in a plasma wakefield accelerator*, M. Litos et al., Nature **515**, 6 (2014)
- Emittance Exchange (EEX) beam line and transverse mask
  - Double triangular current profile (G. Ha et al., AIP Conf. Proc. **1507**, 693 (2012))
- Anisochronous dogleg beam line
  - ramped bunch trains (R. J. England et al., PRL 100, 214802 (2008))
- Multi-bunch via collimation: dogleg and multi-wire mask
  - P. Muggli et al, PRL 101, 054801 (2008)
- Beam shaping via **photo-emission**
  - **Laser comb generation and velocity bunching regime**
    - Ramped bunch trains (NIM A 637, S43–S46 (2011))
      - **The SPARC_LAB Experience**

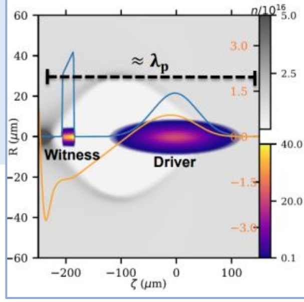


enrica.chiadroni@lnf.infn.it

[6] Beam manipulation for resonant PWFA - Enrica Chiadroni Physics and Applications of High Brightness Beams, Havana, Cuba March 28-April 1, 2016

Applied scheme for the reference WP for EuPRAXIA@SPARC

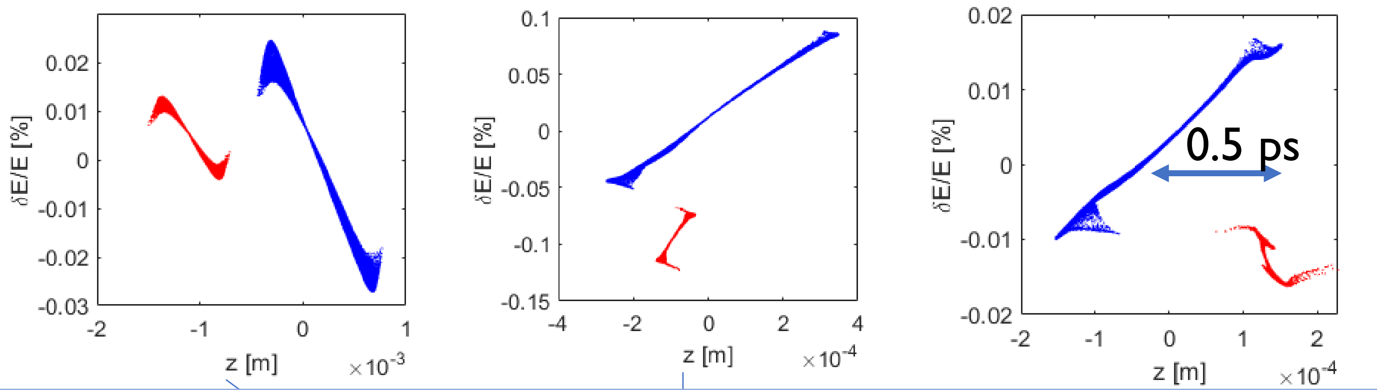
Comb beam generation at EuPRAXIA@SPARC_LAB



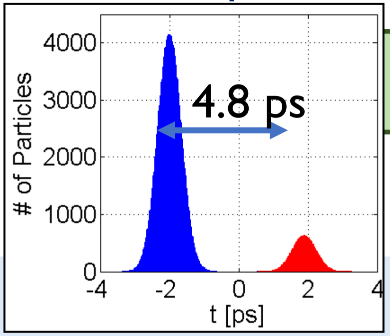
- The **reference working point** is determined by the FEL performances and the plasma module
  - Accelerating gradient of GV/m scale (at least 500 MeV in 1 meter)
  - Weakly non-linear regime (bubble with resonant behavior)

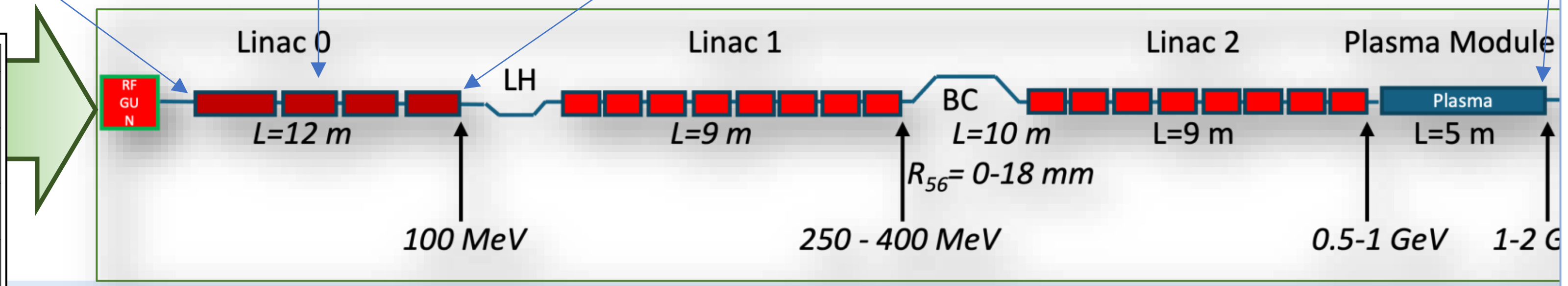
1. 200 (500) pC driver + 30 (50) pC witness
2. plasma density of the order of $10^{16}\ cm^{-3}$ (λ_p = 334 μm)
3. Driver-witness separation of around $\lambda_p/2$ → 0.5 ps (1 ps)
4. Driver and witness bunches of 50 (24) and 6 μm rms
5. Driver and witness spot size of 4 and 1 μm with α=1

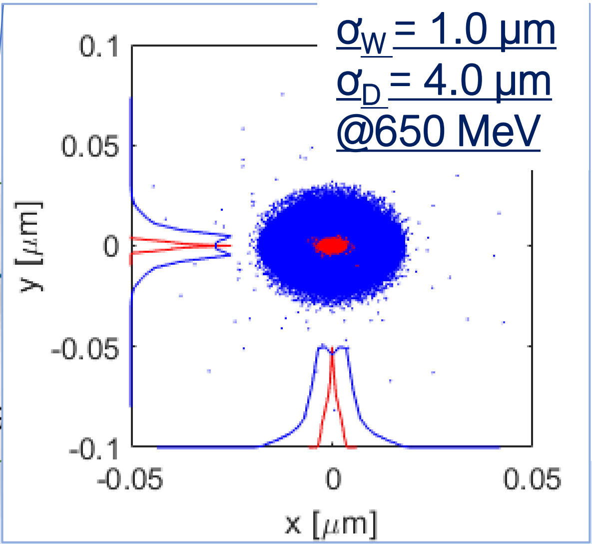
Velocity bunching technique



Laser comb technique

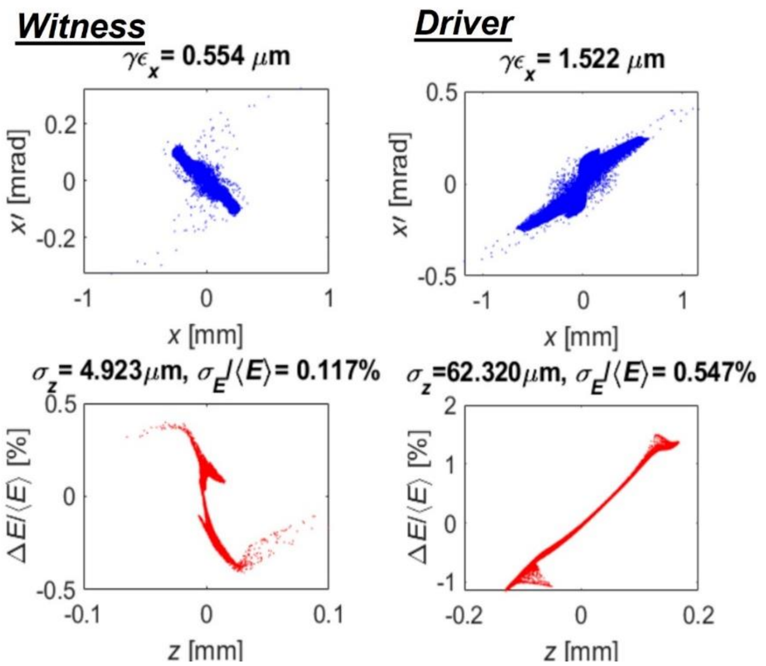


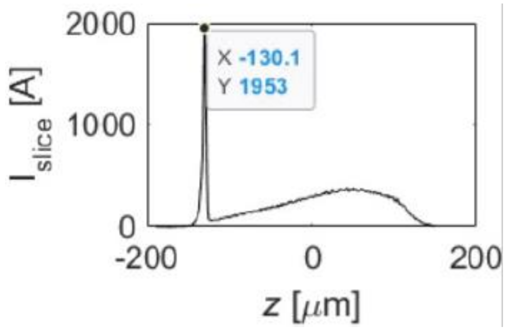




The Photo-injector

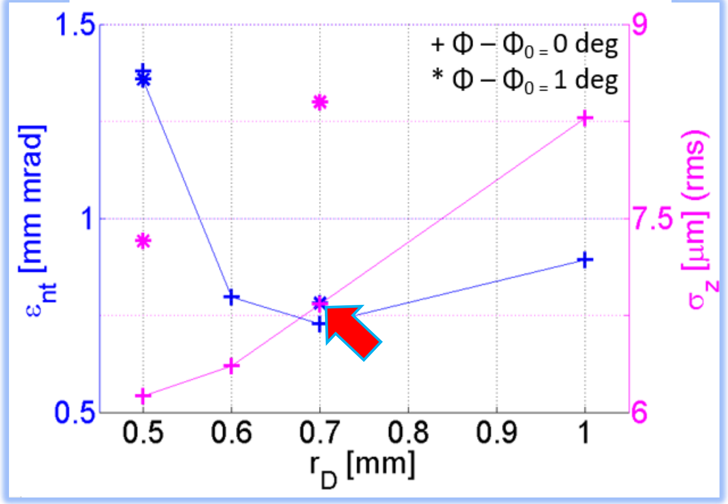
- **The beam dynamics has been studied by means of simulations with the TStep *(and ASTRA)* code**
  - The photoinjector sets the beam separation, emittance and current
  - The photoinjector is operated in the double hybrid RF compression scheme → this scheme ensures at same time up to 2 kA peak current and separation lower than 0.6 ps [8,9] and good flexibility
  - The witness and driver distribution on the cathode has been chosen looking at the witness quality that depends on the density of the beams at the overlapping point [7]

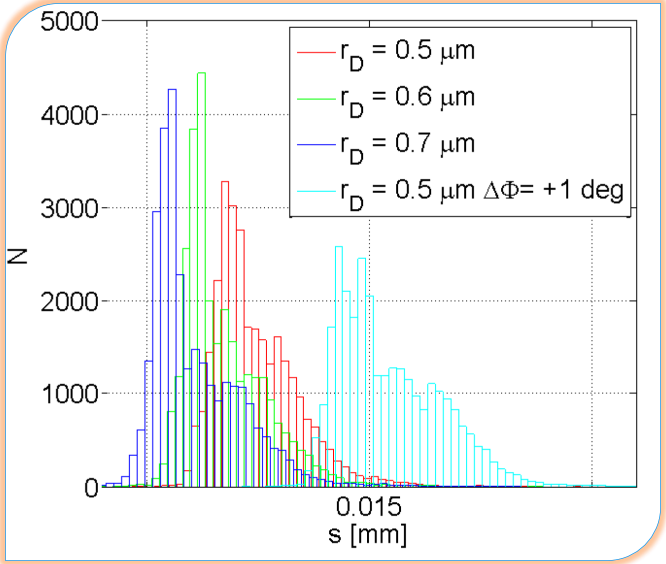




[8] A. Giribono et al., 'Electron beam analysis and sensitivity studies for the EuPRAXIA@SPARC_LAB RF injector IPAC23 , TUPL130, IoP proceedings
[9] G.J. Silvi et al. "Beam dynamics optimization of Eu-PRAXIA@SPARC_LAB RF injector" presented at the IPAC'23, Venezia, Italy, May. 2023, paper WEPA040

Optimised Working point



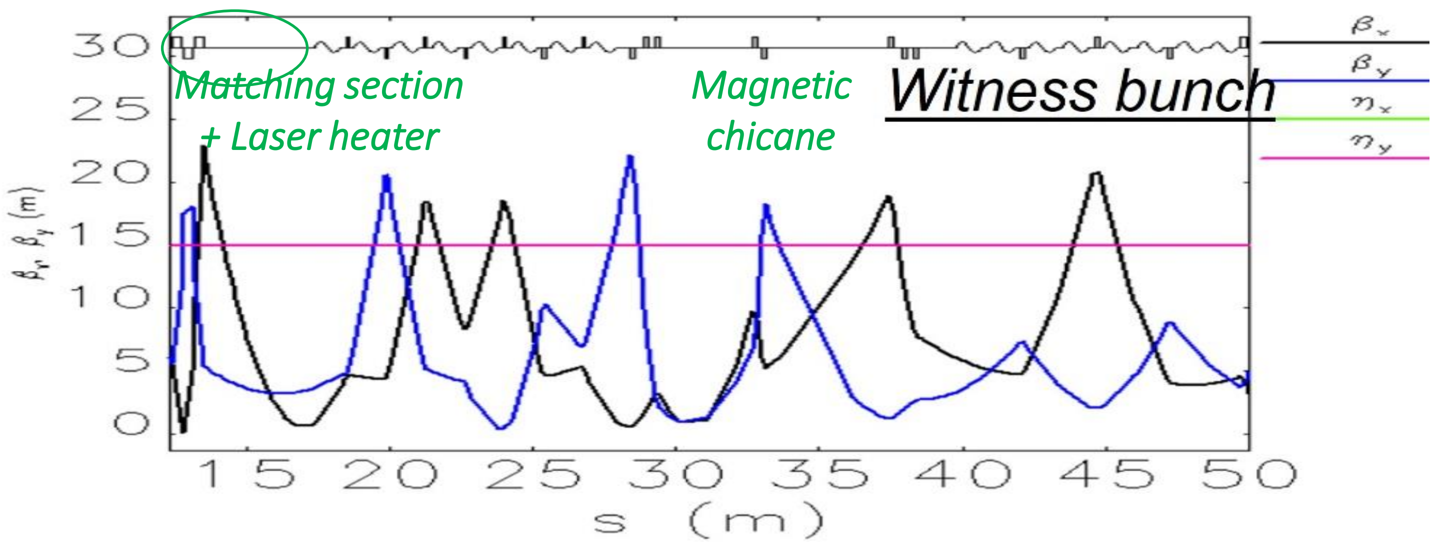


[7] A. Giribono et al. EuPRAXIA@SPARC_LAB: The high-brightness RF photo-injector layout proposal, https://doi.org/10.1016/j.nima.2018.03.0

The X-band Linac

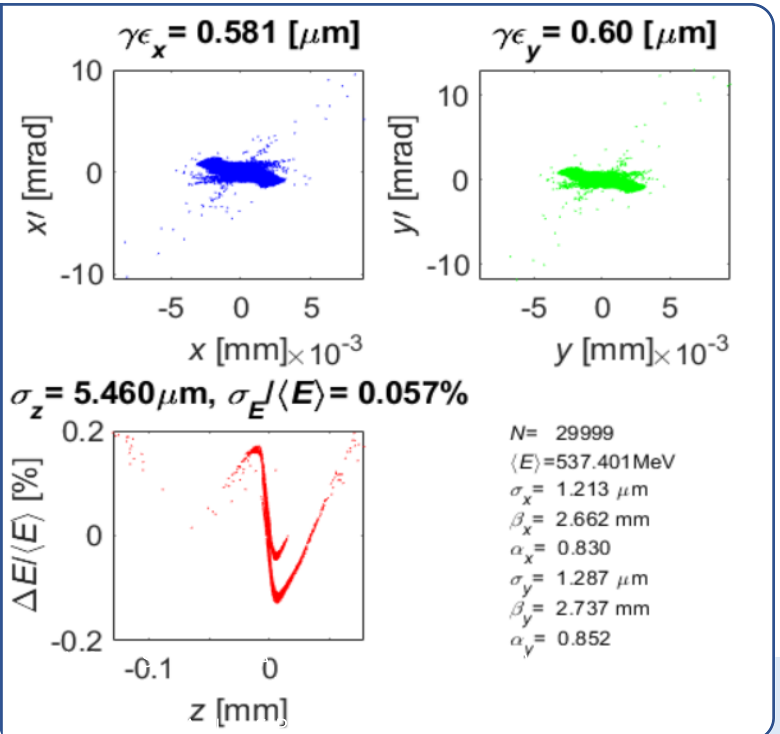
- The beam dynamics in the X-band linac and in the final focusing system has been studied by means of simulations with the Elegant and TStep code respectively.
    - The X-band linac sets the beam energy (up to 1.0 GeV) and Twiss parameters at the plasma entrance → α = 1.0, β = 1.0 – 3.0 mm @0.5 GeV
- It is operated off-crest as
    - manipulation of the beam current profile, a ‘second order effect’ that is amplified by the coupling of two systems, the photoinjector and the linac, operating at different RF frequencies

Beam parameters @Plasma inj.		
	Witness	Driver
E [MeV]	537.6	539.5
$\varepsilon_{x,y}$ [μrad]	0.58-0.60	2.9-5.3
$\sigma_{z\text{-rms}}$ [μm]	5.460	59.620
ΔE/E [%]	0.057	0.095
Δt [μm] (ps)	150 (0.503)	
$\sigma_{x\text{-rms}}$ [μm]	**1.2-1.3**	**4.5-6.3**
$\beta_{x,y}$ [mm]	**2.7-2.7**	**7.4-7.8**
$\alpha_{x,y}$	**0.83-0.85**	**3.2-3.2**



Twiss parameters along the linac for the witness bunch. The overall beam transverse size remains always smaller than the X-band irises with maximum spot size in the matching quadrupoles of the order of 0.7 mm.

Witness Phase space @plasma inj



Possible WPs for EuPRAXIA@SPARC_LAB

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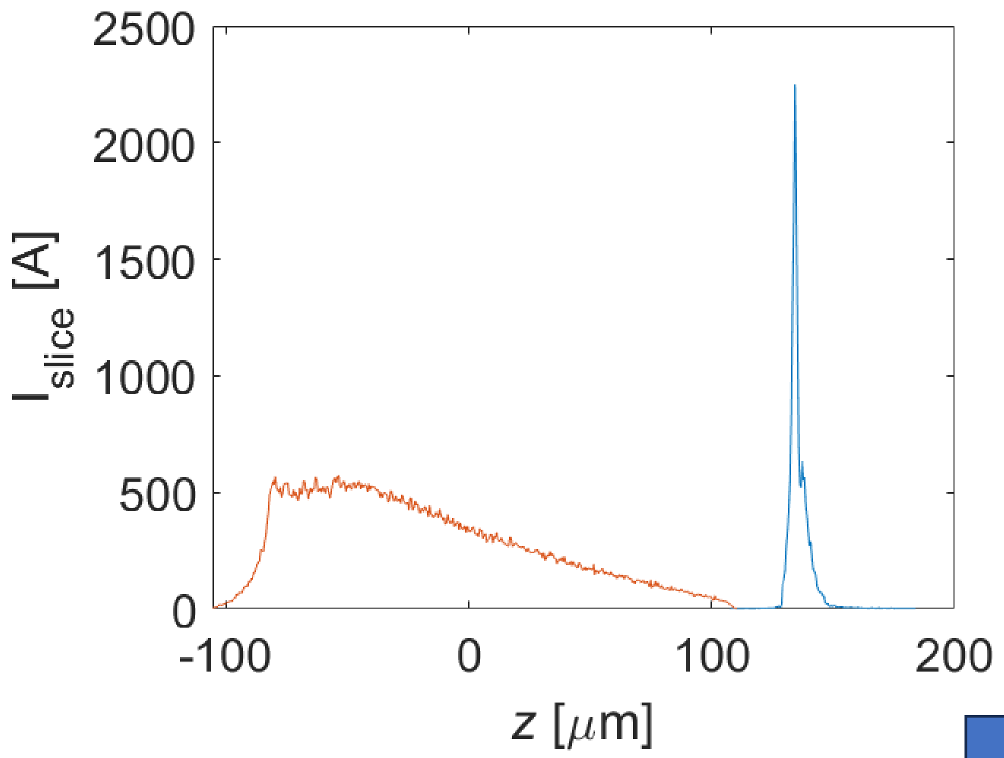
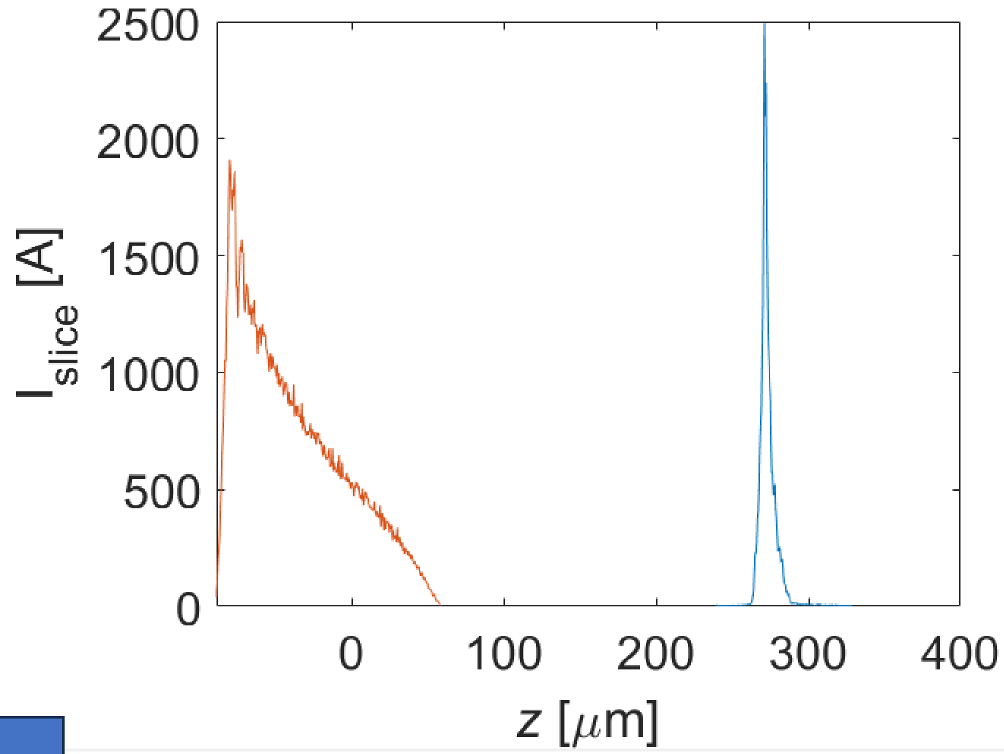
$200 + 30$ pC , $n_e = n \times 10^{16}$ $E_{acc} \approx 1$ GV/m



$400 + 50$ pC , $n_e = n \times 10^{15}$ $E_{acc} \approx 1$ GV/m

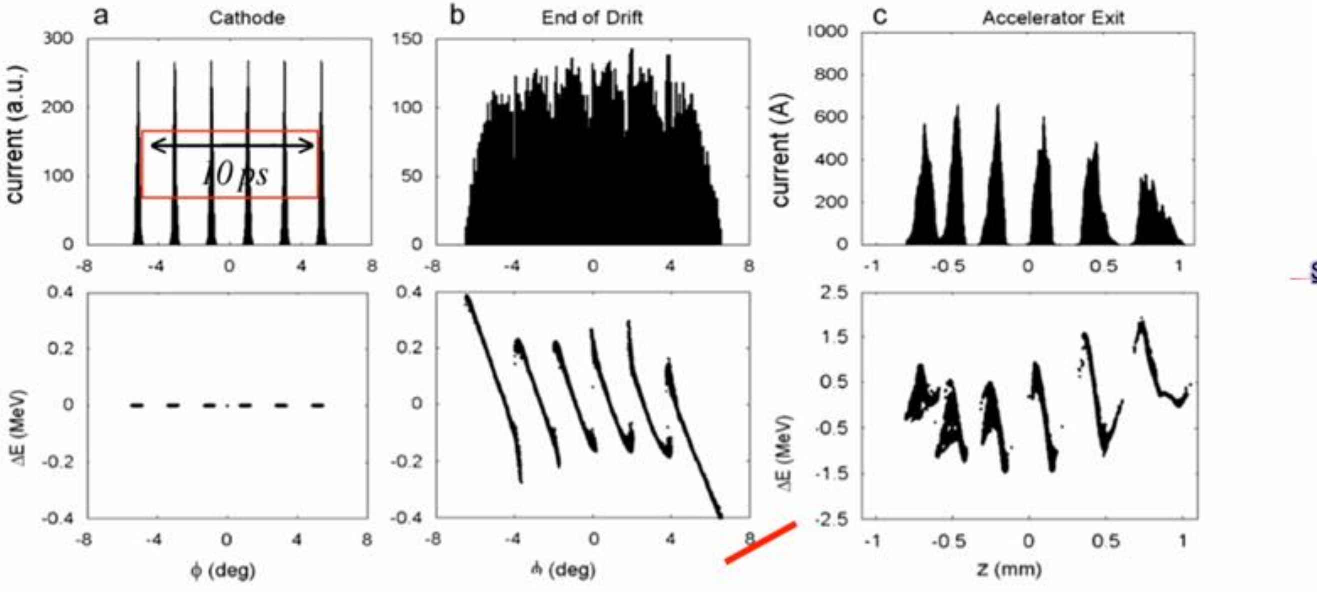


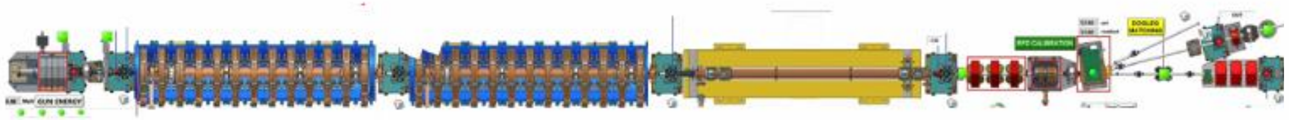
- Driver beam with higher charges and shorter lengths → higher gradients at fixed n_e
- In the next future a new WP with 400+50 pC beam and higher plasma density but still in the quasi non-linear regime to shorten the plasma channel length

Train of bunches: the SPARC_LAB experience

Funded by the European Union

Start2End beam dynamics simulations in the SPARC_LAB photoinjector



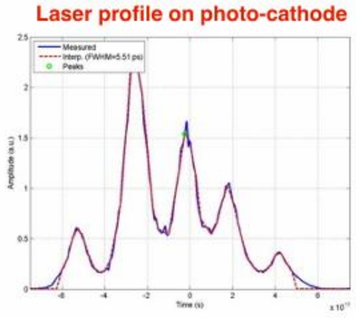


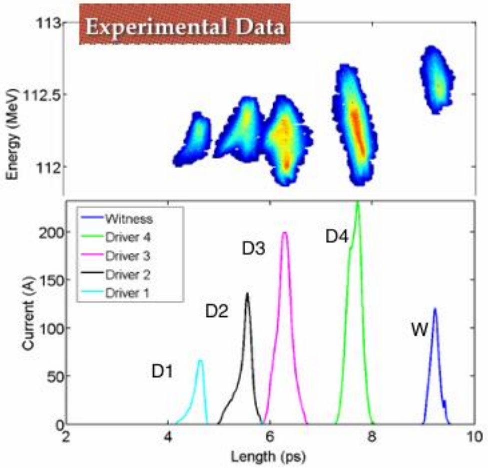
[10] P. O. Shea et al., Proc. of 2001 IEEE PAC, Chicago, USA (2001) p.704.
[11] M. Ferrario et al., Int. J. of Mod. Phys. B, 2006

Experimental results obtained at SPARC_LAB

Ramped Bunch Train

SPARC_LAB





	E (MeV)	$\Delta E/E$ (%)	σ_t (fs)	Q (pC)	ε_{nx} (mm mrad)
W	112.6	0.084	80	24	1(0.09)
D4	112.3	0.159	42	75	0.8(0.1)
D3	112.2	0.112	92	69	1.7(0.1)
D2	112.3	0.087	113	36	2.7(0.6)
D1	112.2	0.045	100	36	2.8(0.3)

Bunch Separation (μm)
W-D4 =470 (0.02) ~ $\frac{3}{2}\lambda_p$

D4-D3 =420 (0.03)
D3-D2 =240 (0.03)
D2-D1 =270 (0.05) $\approx \lambda_p$

IPAC18

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INFN LNF

The FACET II WP: laser comb + magnetic chicane

- High transformer ratio thanks to extremely short drive bunch → 1.6 nC – 1 µm rms length at plasma injection
- Bunches modeled as Gaussian bunches
- Plasma source: neutral lithium gas with 40 cm long flattop plasma density of 8×10^{16} cm^{-3}
- PIC simulations using QPAD [28] have been performed to provide insights into the expected performance of PWFA

TABLE I. FACET-II beam parameters for two-bunch PWFA. The two-bunch parameters are listed as drive/trailing.

Electron beam parameter	Current[a]	Design
Bunch configuration	Single	Two-bunch
Delivered beam energy (GeV)	10	10.1/9.9
Normalized emittance (mm mrad)	~20	>50/5
Charge per bunch (nC)	2	1.5/0.5
Peak current (kA)	...	30/15
rms energy spread (%)	~1	0.8/0.3
Repetition rate (Hz)	1–30	1–30
IP β^* (cm)	50	5–50

[a]Parameters achieved at time of preparation of this manuscript.

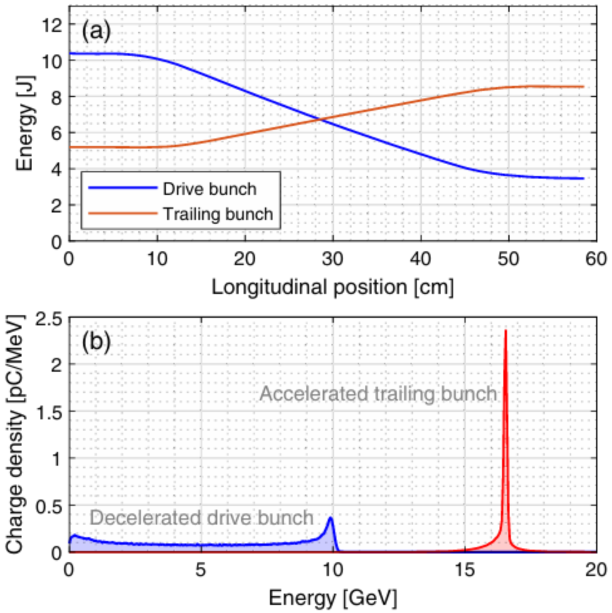


FIG. 1. PIC simulation of PWFA performance with initial FACET-II beam parameters, including incoming beam energy of 10 GeV for both drive and trailing bunches. (a) The evolution of the total energy content of the drive and trailing bunches as they traverse a lithium plasma with 40 cm long flattop profile at a density of 8×10^{16} cm^{-3}, resulting in an overall drive to trailing bunch efficiency of 32%. (b) The final energy spectra of the drive and trailing bunches, showing an acceleration of the trailing bunch by 6.6 GeV with final energy spread of 0.9%.

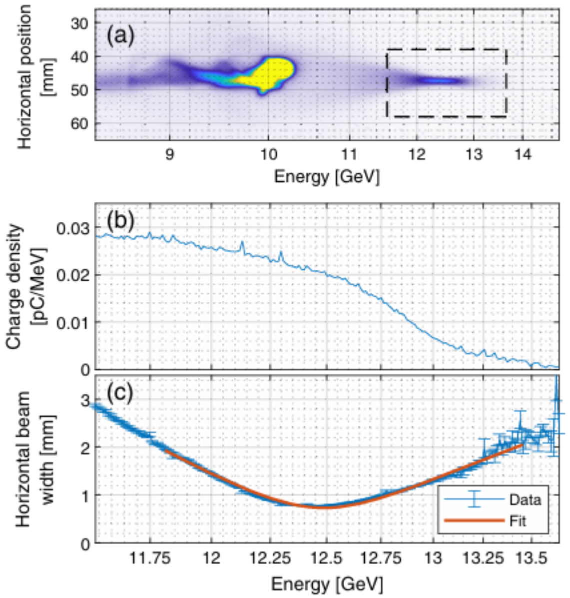


FIG. 8. (a) Electron energy spectrum with the spectrometer set to reimage at an energy of 12.5 GeV. Energy depleted electrons are visible at energies below 10 GeV, while some tens of pC of charge are accelerated up to ~13.5 GeV in this shot. An emittance analysis was performed for the charge indicated by the box, with charge distribution shown in (b). (c) The beamwidth as a function of energy, and the emittance fit function overlaid which provides a normalized emittance of approximately 1500 µm. The Twiss parameters determined from the fit indicate that the beam waist (and hence the exit from the plasma) was located at the location of the Beryllium window.

[12] D. Storey et al. Wakefield generation in hydrogen and lithium plasmas at FACET-II: Diagnostics and first beam-plasma interaction results PHYSICAL REVIEWACCELERATORS AND BEAMS 27, 051302 (2024)

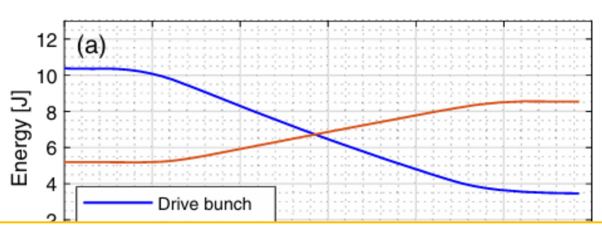
The FACET II WP: laser comb + magnetic chicane

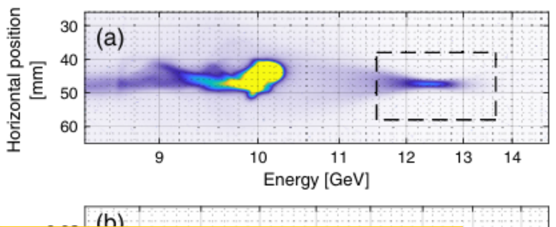
- High transformer ratio thanks to extremely short drive bunch → 1.6 nC – 1 µm rms length at plasma injection
- Bunches modeled as Gaussian bunches
- Plasma source: neutral lithium gas with 40 cm long flattop plasma density of 8×10^{16} cm^{-3}
- PIC simulation ... to provide insi... PWFA

TABLE I. F... The two-bunc...

Electron beam ...		
Bunch configu...		
Delivered bea...		
Normalized en...		
Charge per bu...		
Peak current (...		
rms energy sp...		
Repetition rate (Hz)	1–30	1–30
IP β^* (cm)	50	5–50

[a]Parameters achieved at time of preparation of this manuscript.

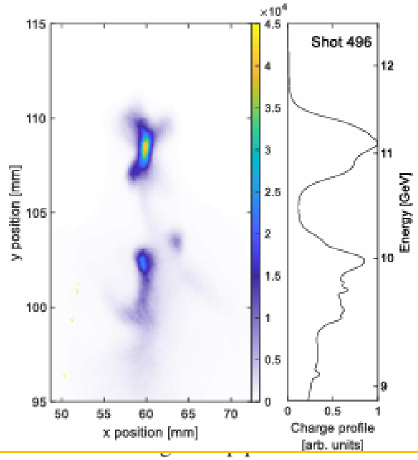


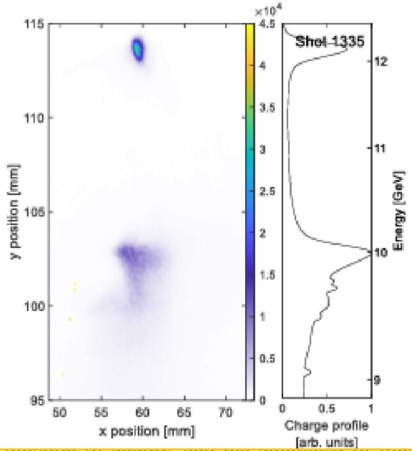


Summary

July 23, 2024 Doug Storey | AAC24 | Two-bunch PWFA at FACET-II

- First demonstration of **both** two-bunch delivery **and** witness bunch acceleration at FACET-II
- Achieved 1-2 GeV witness acceleration
  - Limited by the degraded Lithium plasma source



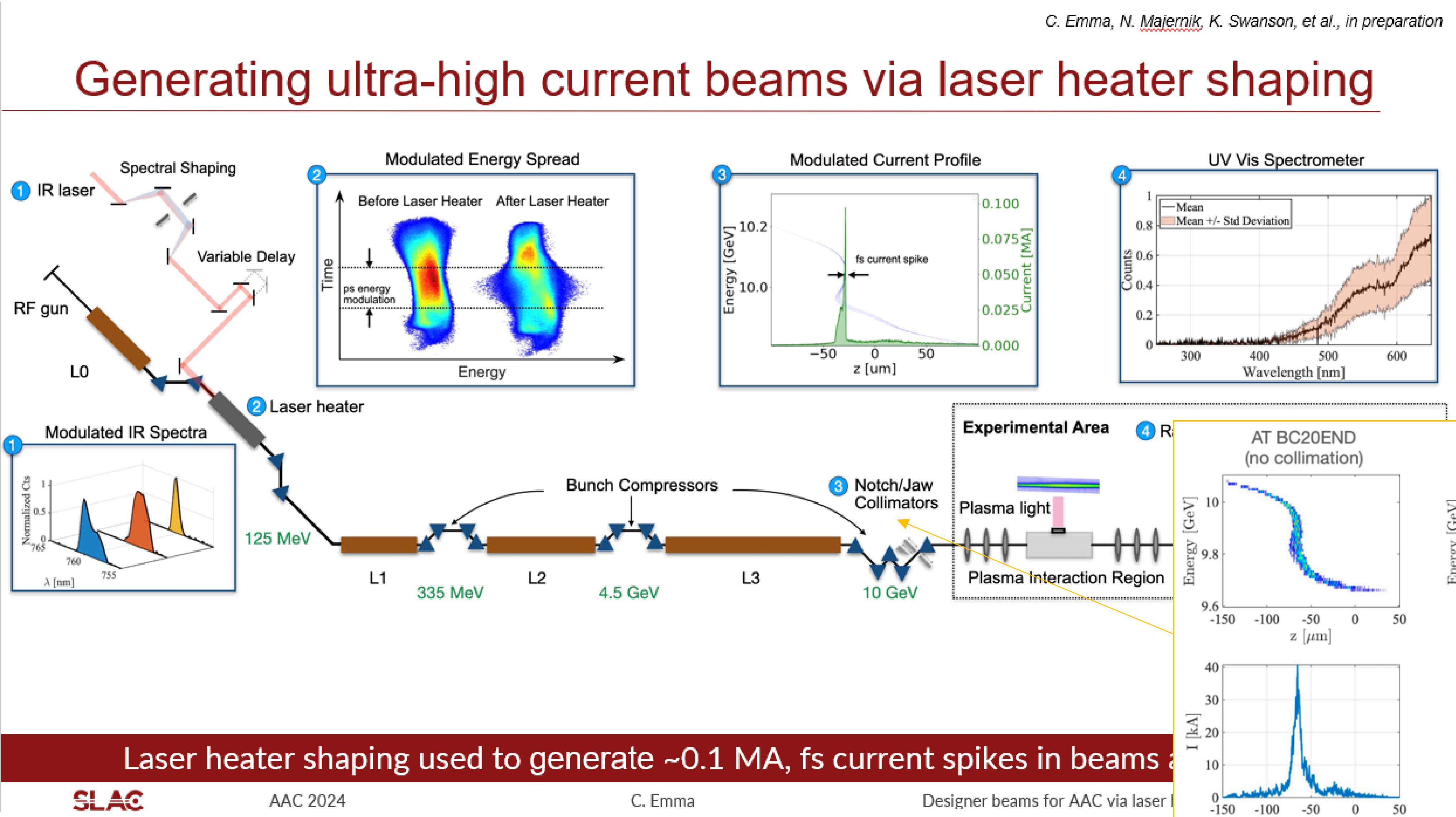


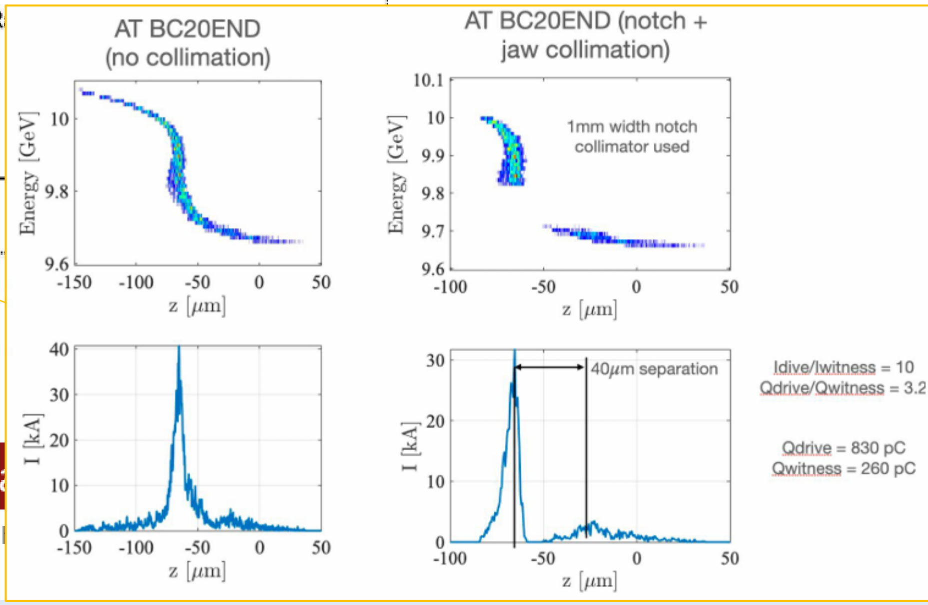
density of 8 × 10^{16} cm^{-3}, resulting in an overall drive to trailing bunch efficiency of 32%. (b) The final energy spectra of the drive and trailing bunches, showing an acceleration of the trailing bunch by 6.6 GeV with final energy spread of 0.9%.

...rometer set ...d electrons ...s of pC of ... shot. An ...ndicated by ...beamwidth as a function of energy, and the emittance fit function overlaid which provides a normalized emittance of approximately 1500 µm. The Twiss parameters determined from the fit indicate that the beam waist (and hence the exit from the plasma) was located at the location of the Beryllium window.

[12] D. Storey et al. Wakefield generation in hydrogen and lithium plasmas at FACET-II: Diagnostics and first beam-plasma interaction results PHYSICAL REVIEWACCELERATORS AND BEAMS 27, 051302 (2024)

The FACET II WP: laser comb + magnetic chicane





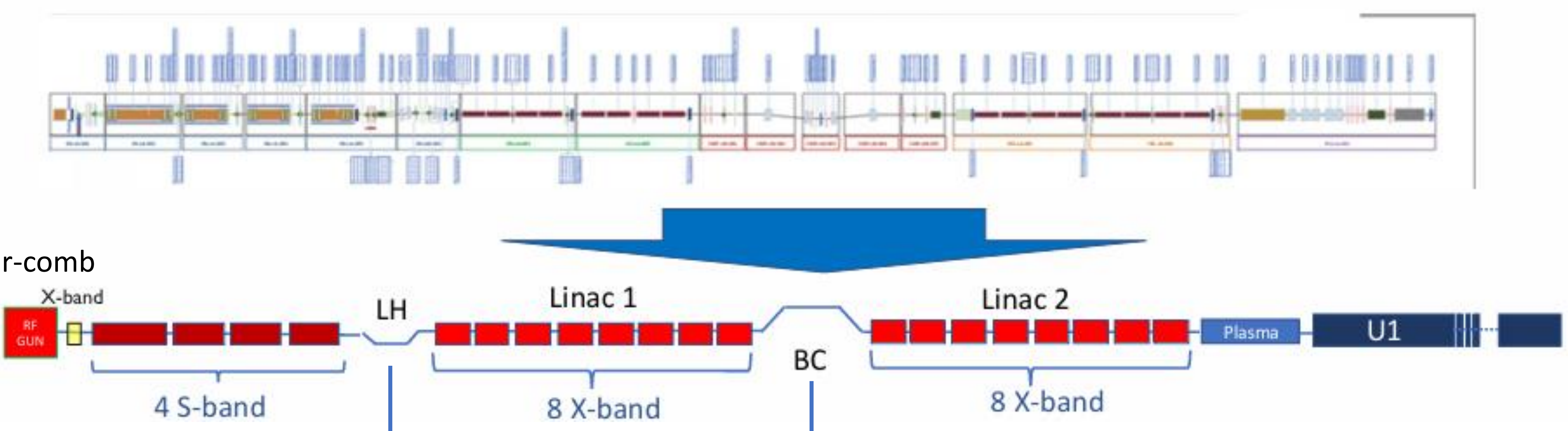
[14] Beam Configurations Claudio Emma et al FACET-II User Meeting October 17th, 2023 SLAC

[13] AAC 2024 Contribution - C. Emma et al - Designer beams for AAC via laser heater shaping

Integration in the ‘basic layout’

Funded by the European Union

Laser-comb



1st RF compressor

Laser Heater that is also suitable to compress the beam

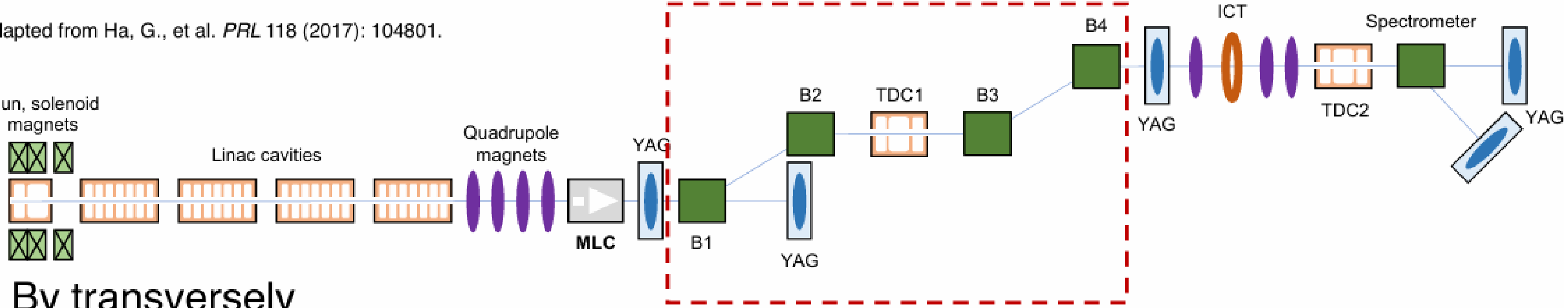
3rd bunch compressor

- X-band technology could limit in terms of bunch charge
- Other available space for further compression if needed

EEX beamline and transverse mask

Emittance exchange for advanced accelerators

Adapted from Ha, G., et al. *PRL* 118 (2017): 104801.



- By transversely masking the beam before the EEX beamline, the final current profile is controlled
- Shaping drive and witness bunches with this approach has yielded record-breaking transformer ratios

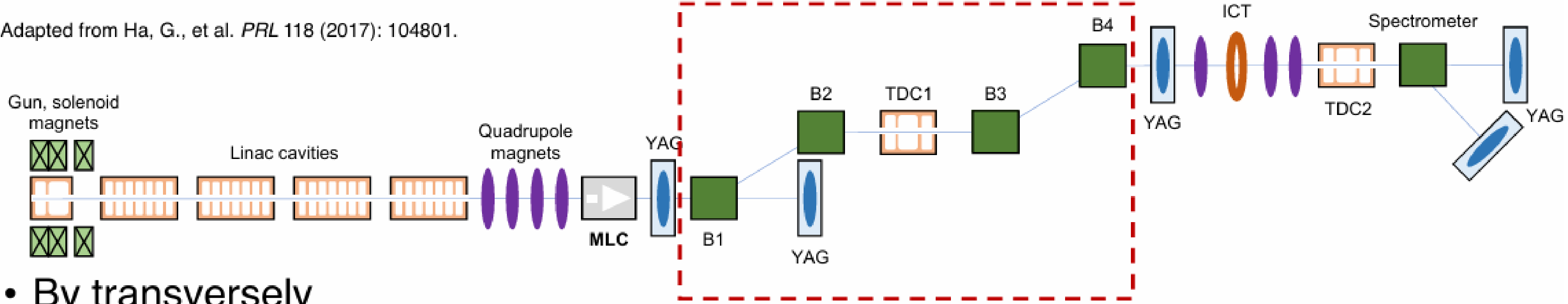
$$\underbrace{\begin{pmatrix} 1 & \frac{L}{2} & 0 & \eta \\ 0 & 1 & 0 & 0 \\ 0 & \eta & 1 & \frac{\xi}{2} \\ 0 & 0 & 0 & 1 \end{pmatrix}}_{\text{Dogleg}} \underbrace{\begin{pmatrix} 1 & Lc & \frac{Lc\,\kappa}{2} & 0 \\ 0 & 1 & \kappa & 0 \\ 0 & 0 & 1 & 0 \\ \kappa & \frac{Lc\,\kappa}{2} & \frac{Lc\,\kappa^2}{4} & 1 \end{pmatrix}}_{\text{Deflecting cavity}} \underbrace{\begin{pmatrix} 1 & \frac{L}{2} & 0 & \eta \\ 0 & 1 & 0 & 0 \\ 0 & \eta & 1 & \frac{\xi}{2} \\ 0 & 0 & 0 & 1 \end{pmatrix}}_{\text{Dogleg}} = \underbrace{\begin{pmatrix} 0 & 0 & -\frac{L}{2\,\eta} & \eta - \frac{L\,\xi}{4\,\eta} \\ 0 & 0 & -\frac{1}{\eta} & -\frac{\xi}{2\,\eta} \\ -\frac{\xi}{2\,\eta} & \eta - \frac{L\,\xi}{4\,\eta} & 0 & 0 \\ -\frac{1}{\eta} & -\frac{L}{2\,\eta} & 0 & 0 \end{pmatrix}}_{\text{EEX}}$$

[15] AAC2024 Contribution - Nathan Majernik et al. 'Generation of arbitrary bunch shapes using a multileaf collimator and emittance exchange'

EEX beamline and transverse mask

Emittance exchange for advanced accelerators

Adapted from Ha, G., et al. *PRL* 118 (2017): 104801.



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[15] AAC2024 Contribution - Nathan Majernik et al. ‘Generation of arbitrary bunch shapes using a multileaf collimator and emittance exchange’

Multileaf collimator masking

- Replace the laser cut tungsten masks in EEX beamline with a multileaf collimator (MLC)
- MLCs are commonly employed to shape radiotherapy beams
- Real-time, nearly arbitrary drive and witness beam shaping
- Highly synergistic with machine learning
- Extension of UCLA/AWA collaboration to study exotic shaped beams for HTR PWFA

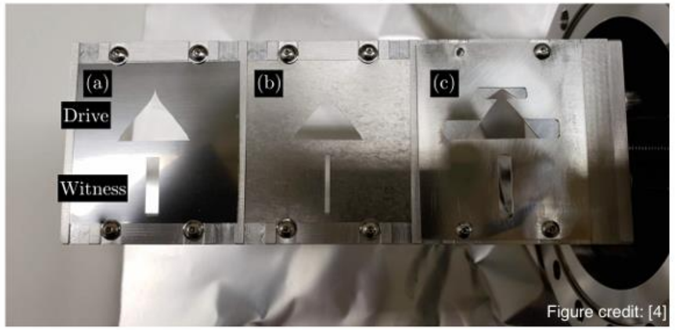


Figure credit: [4]

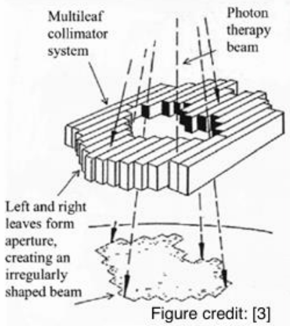


Figure credit: [3]

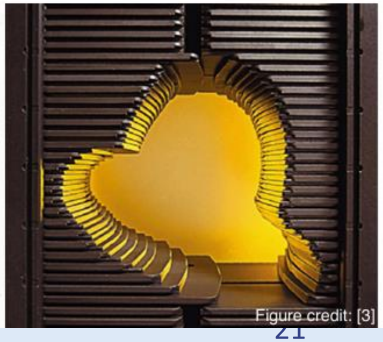
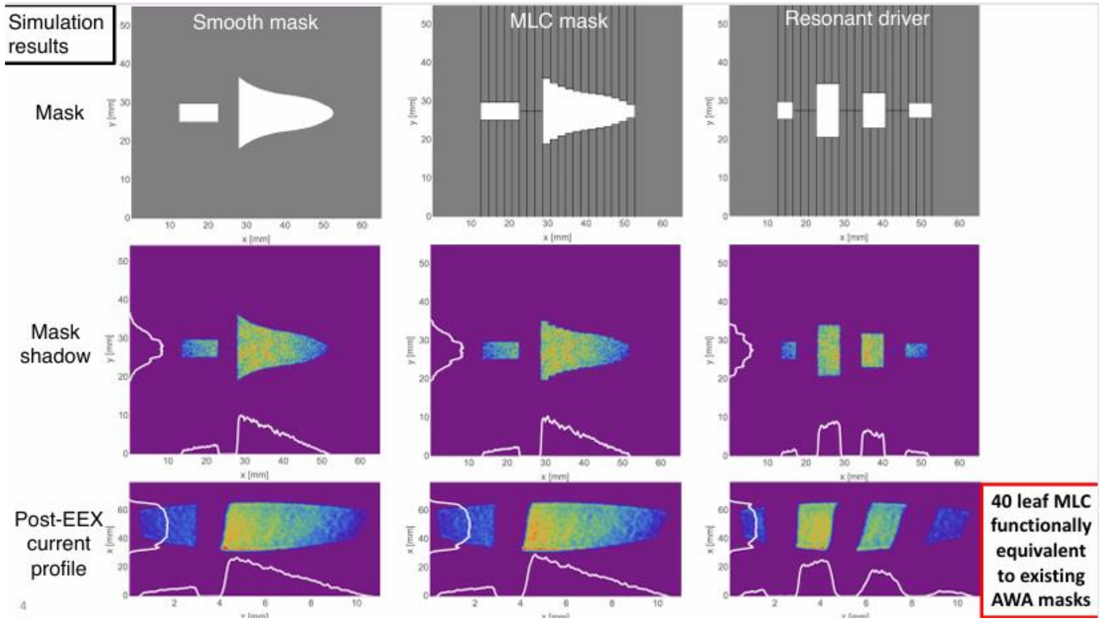
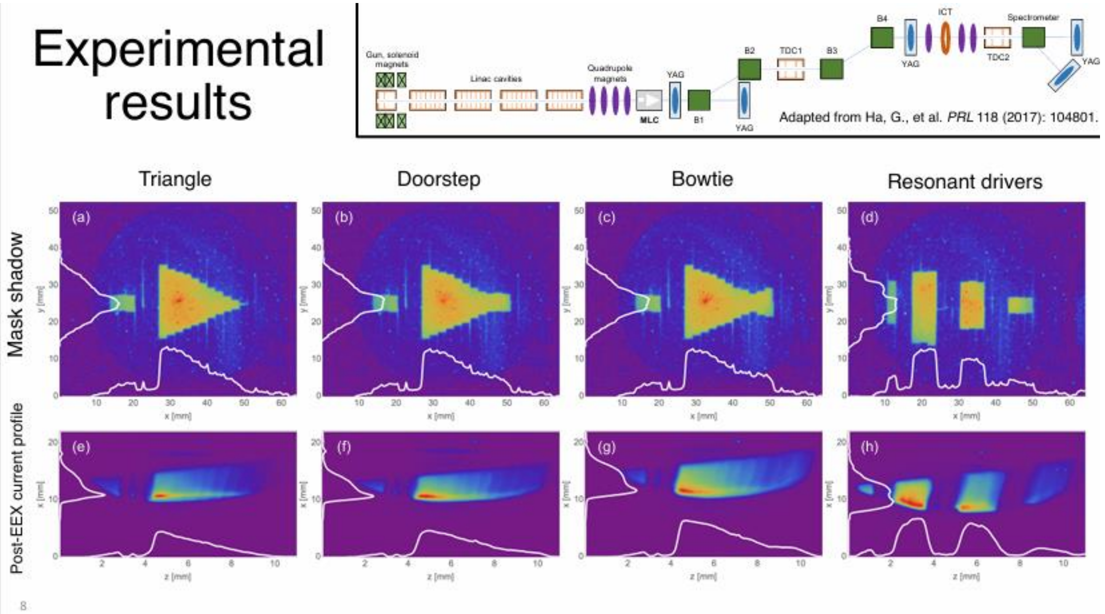


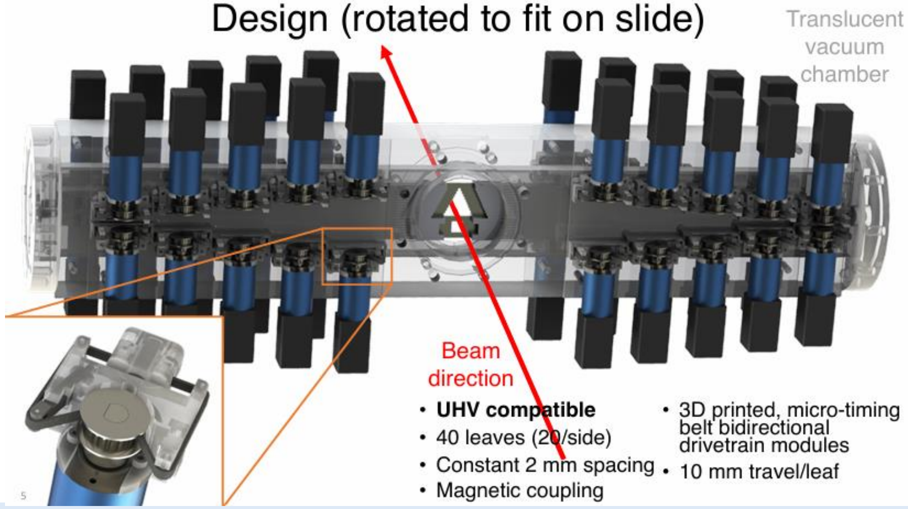
Figure credit: [3]

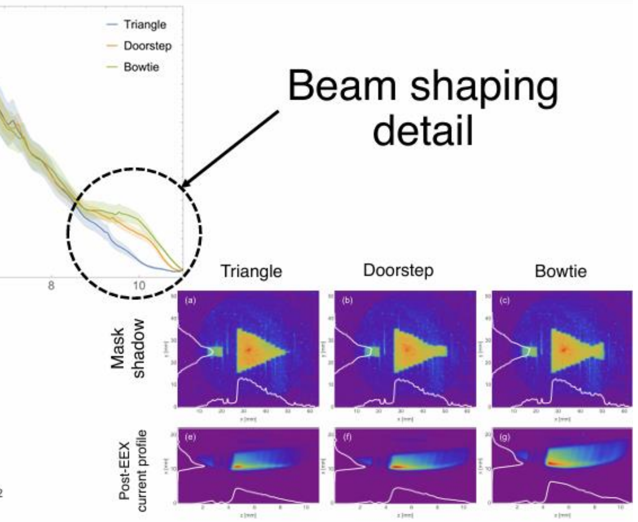
EEX beamline and transverse mask

Funded by the European Union









Majernik, N., et al. "Beam shaping using an ultrahigh vacuum multileaf collimator and emittance exchange beamline." *Physical Review Accelerators and Beams* 26.2 (2023): 022801.

PITZ – the photocathode laser shaping

Funded by the European Union

- Photocathode laser shaping
- Driver bunch charge was 500 pC, the witness bunch charge 10 pC with rms length of about 20 ps and 0.7 ps respectively.
- The delay between the current maxima of the two bunches was 10 ps.
- Gas discharge plasma cell ≈ 100 mm and n_e = n x 10^{13}
- Simulations performed using ASTRA and 3D particle in cell (PIC) code HIPACE

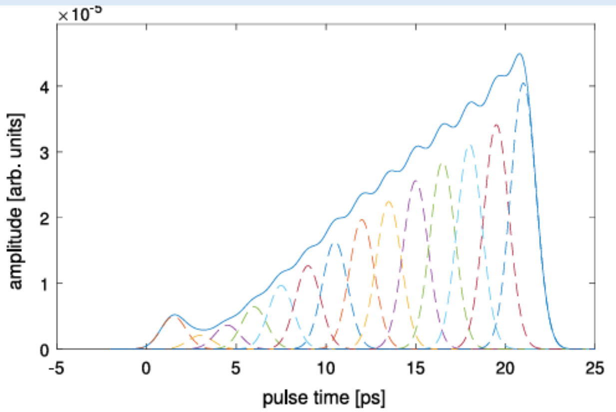


Fig. 1. Simulated output shape of an ideal birefringent fan filter with crystal angles as given in Table 1. The dashed lines show the virtual pulses that are combined to the overall shape.

[17] G. Loisch et al. Photocathode laser based bunch shaping for high transformer ratio plasma wakefield acceleration Nuclear Inst. and Methods in Physics Research, A 909 (2018) 107–110

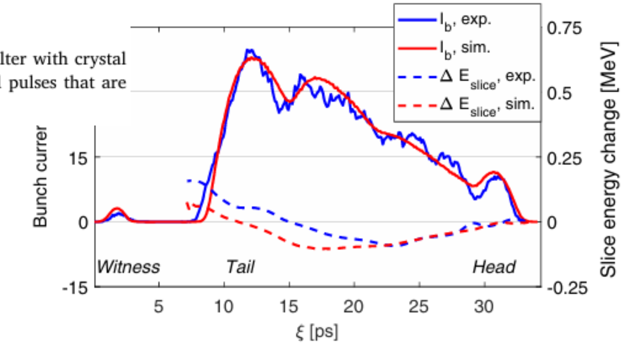


FIG. 2. Experimental and simulated electron bunch currents I_b (solid lines) and slice energy changes ΔE_{slice} (dashed lines) between plasma off and on cases in the comoving coordinate $\xi = z/c$. Blue cross and red circle indicate measured and simulated maximum witness energy gain, respectively. Total charge of ramped driver (right) and short, low charge Gaussian witness bunch (left) is 518 ± 16 pC. The time resolution of the measurement is 0.6 ps.

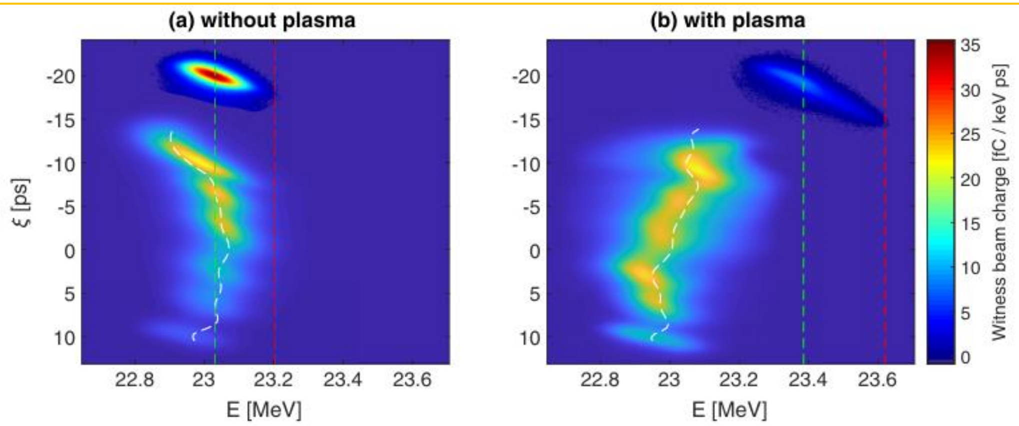


FIG. 4. Longitudinal phase space of driver and witness bunches measured without (a) and with (b) plasma acceleration in a plasma of 2×10^{13} cm^{-3} electron density. Note that the upper (witness) bunch was imaged with a different camera gain than the driver. Dashed lines indicate the witness mean (green) and maximum (red) energy and the driver mean slice energies (white). The bunch current and the measured slice energy changes inside of the driver bunch, corresponding to this measurement, are shown in Fig. 2.

Measured transformer of $4.6^{+2.2}_{-0.7}$

[16] G. Loisch et al. Observation of High Transformer Ratio Plasma Wakefield Acceleration - PHYSICAL REVIEW LETTERS 121, 064801 (2018)

Hybrid schemes: PWFA+LWFA

Funded by the European Union

- This is not meant to be a review → there are many other methods to be explored

[18] A. Martinez de la Ossa - Wakefield-induced ionization injection in beam-driven plasma accelerators *Phys. Plasmas* 22, 093107 (2015)

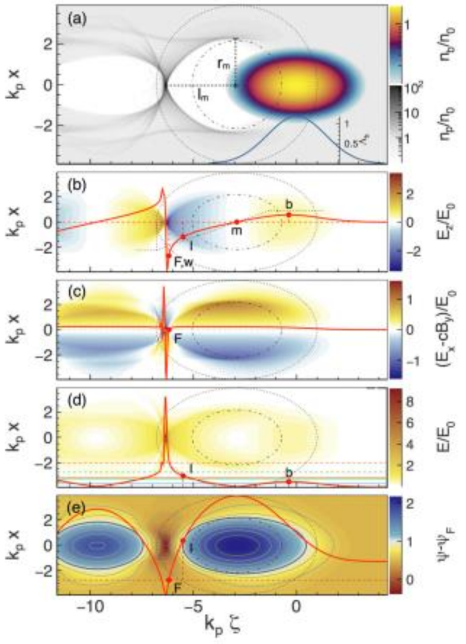


FIG. 1. An OSIRIS 3D simulation of a high-current ($I_b = 10$ kA), moderately wide ($k_p\sigma_r = 0.8$), axially symmetric Gaussian electron beam, going through a plasma at the (linear) resonant length ($k_p\sigma_z = \sqrt{2}$). (a) Spatial particle density, (b) longitudinal electric field, (c) transverse wakefield, (d) electric field magnitude, and (e) wake potential. Red solid lines are the corresponding quantity along the on-axis region, except for (c) and (d), where the profile is taken $0.1\,k_p^{-1}$ off-axis. The outer and inner circles represent the blowout radius estimations through Eqs. (6b) and (9), respectively. The dark dotted lines in (b) indicate the model estimations for the maximum decelerating field in the beam region (right horizontal line, Eq. (6a)), the maximum accelerating field (left horizontal line, Eq. (8a)), and the longitudinal field slope around the center of the cavity (diagonal line, Eq. (7)).

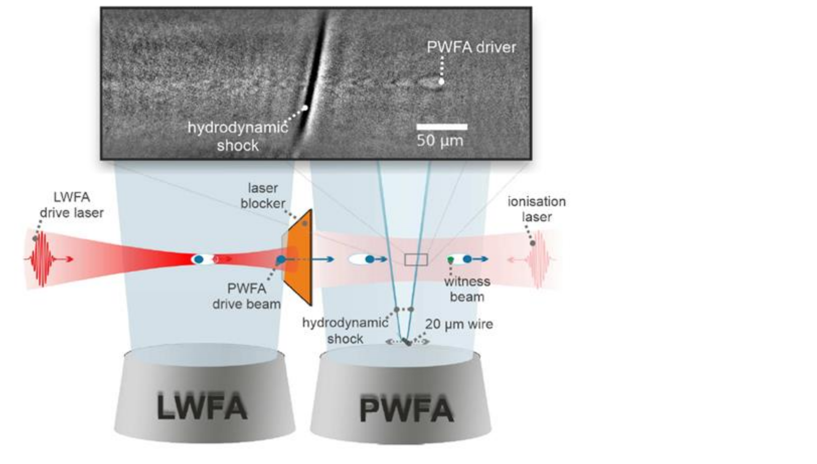
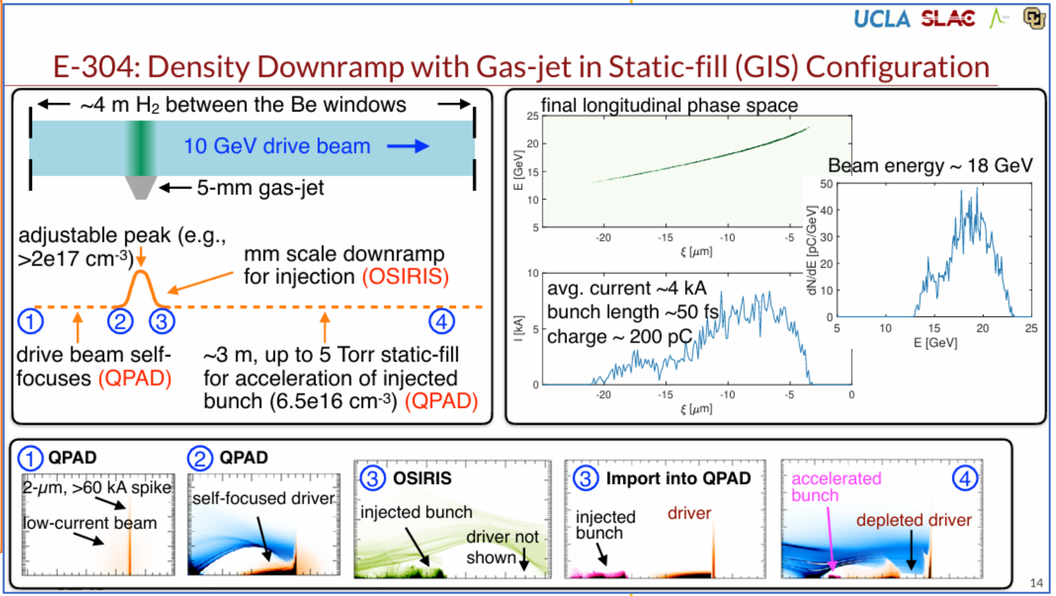


Figure 10. Gas-dynamic density downramp injection, realized by wire-induced shocks in the PWFA gas jet. Shadowgraphy reveals both the PWFA-driven plasma wave and the hydrodynamic shock profile (figure from [50]).

[20] Bernhard Hidding - Progress in Hybrid Plasma Wakefield Acceleration Photonics2023,10,99



[19] FACET-II: Status of the First Experiments and the Road Ahead EAAC2023 Mark J. Hogan

PWFA + LWFA

→ See Andrea Renato Rossi's talk

Summary

- A baseline solution has been studied for the PWFA based 5 GeV case
- The integration in the layout has been addressed → beam dynamics studies to be completed
- Further accelerating schemes and beam shape tailoring are under study versus higher transformer ratio → smaller footprint and room for possible applications and 'save' beam dump
- PWFA+LWFA: a possible solution → more details in the next talk

EuPRAXIA-PP Consortium

Funded by the European Union

Coordinator

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- EuAPS

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THANK YOU FOR YOUR ATTENTION!