

Realization of plasma photocathode injection in a compact plasma accelerator powered by laser-accelerated electron beams

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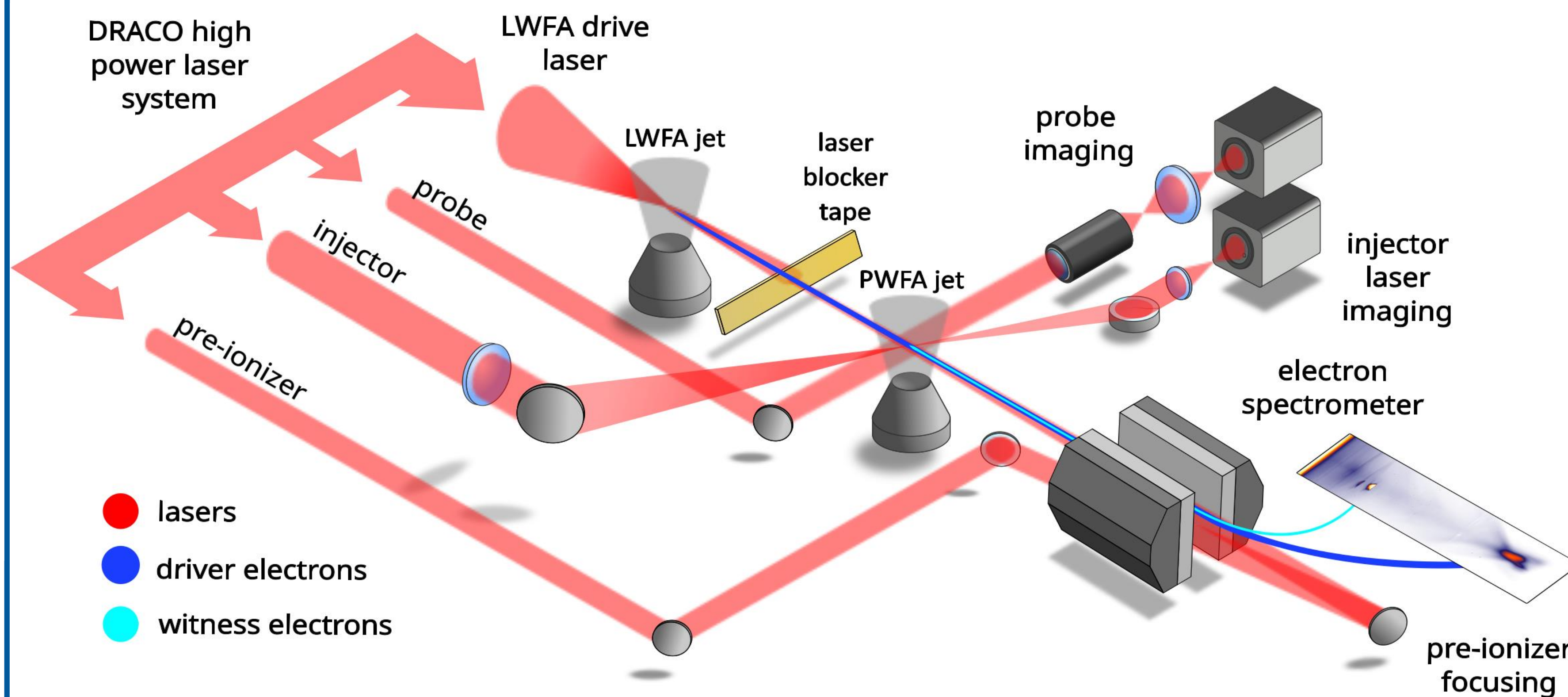
On behalf of the hybrid collaboration:

Related Poster: April 15th, „Synthetic Optical Imaging for Investigating Injection Radiation in Hybrid LPWFAs”



Motivation and Setup

- **LWFA:** tabletop accelerators for high current electron beams with (>10 kA)
- **PWFA:** promising acceleration method for high quality electron beams

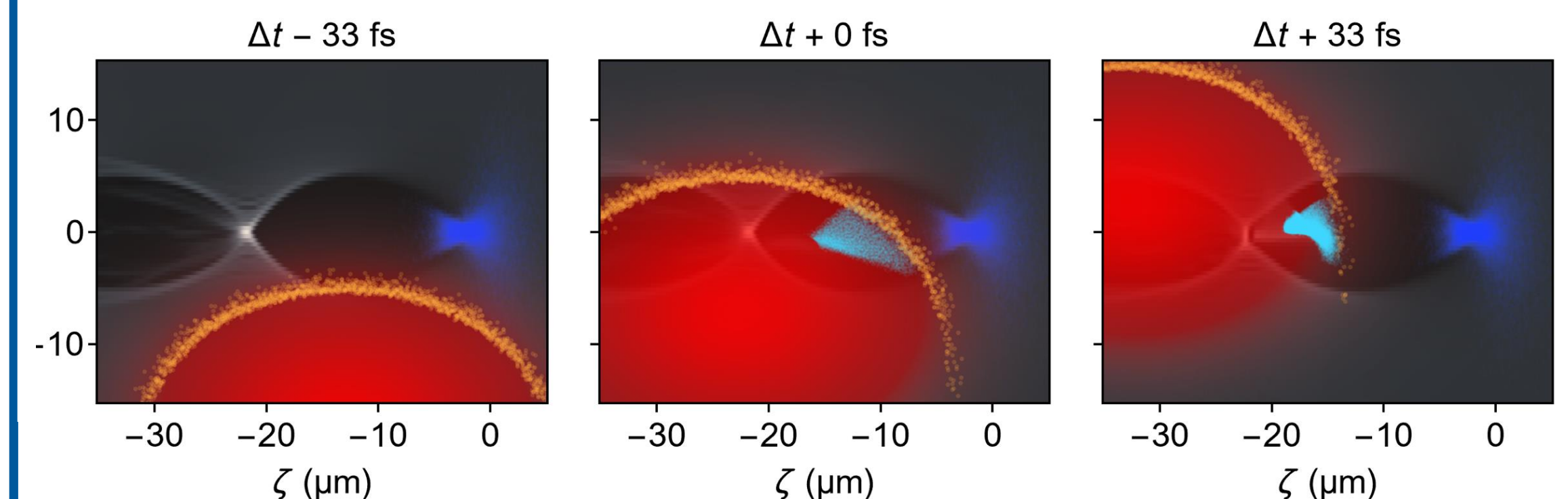


LWFA Driver	2.25 J
Probe	400 μJ
Injector	23 mJ
Pre-Ionizer	22 mJ

- **Combination of LWFA and PWFA** for high quality electron beams from a **tabletop accelerator**
- **Inherent synchronization** between laser beams and the electron beam
- Potential to meet high demands of electron beams for **secondary light sources** such as FEL

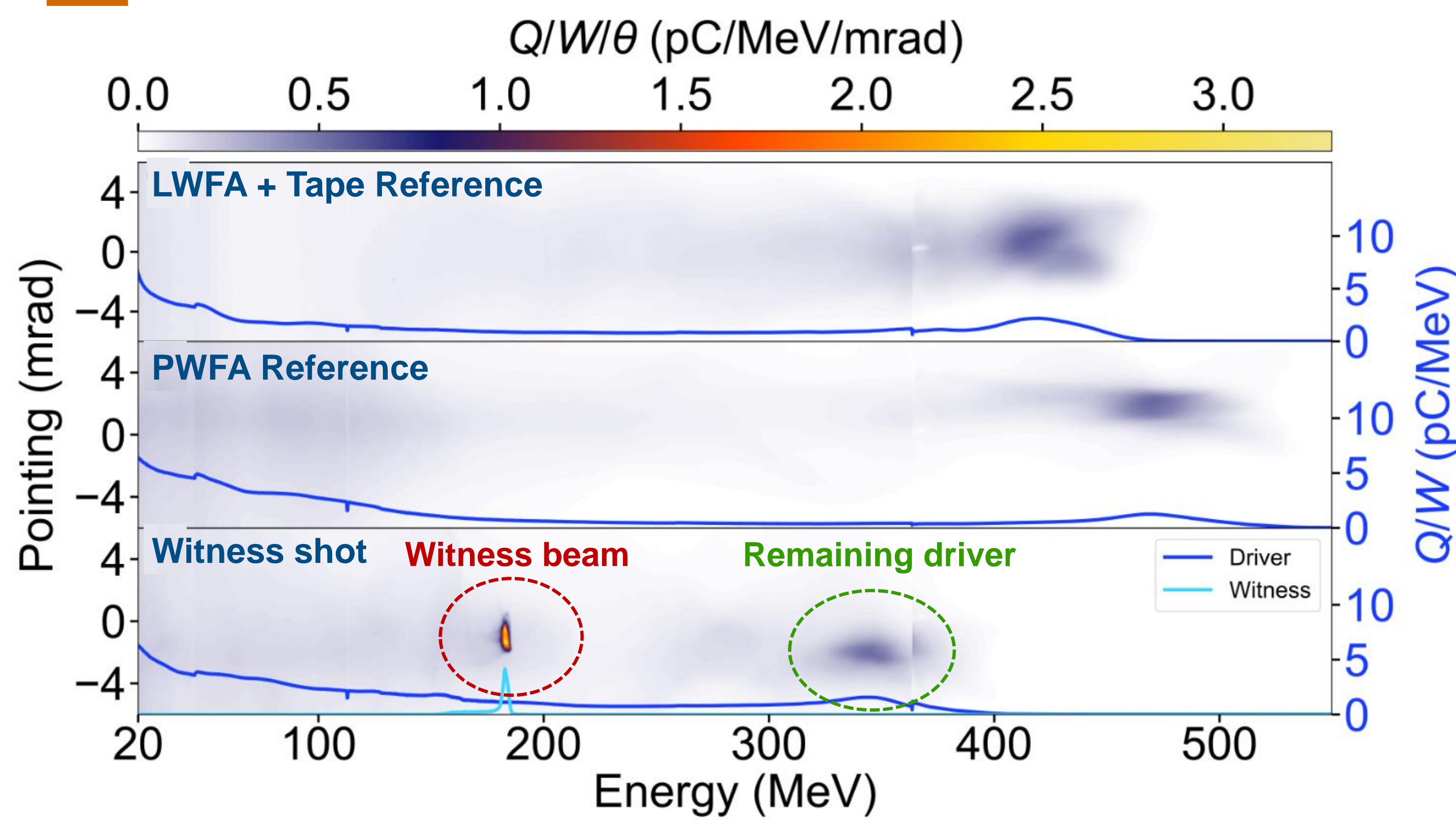
Plasma Photocathode

- **Ionizing additional species** of target medium by a laser (2nd level of helium)
- Electrons **released inside the cavity** can be trapped and accelerated
- Low initial momentum → **very low emittance**
- So far only realized as **proof of concept** at SLAC



- **New high density regime:** ($\sim 2 \times 10^{18} \text{ cm}^{-3}$)
- Releasing electrons in the **whole cavity**
- **Small source volume** due to cavity size
- Advantage due to **high field gradients**
- **Small slice emittance** possible, as shown by simulations (**tens of nm rad**)

Experimental Results



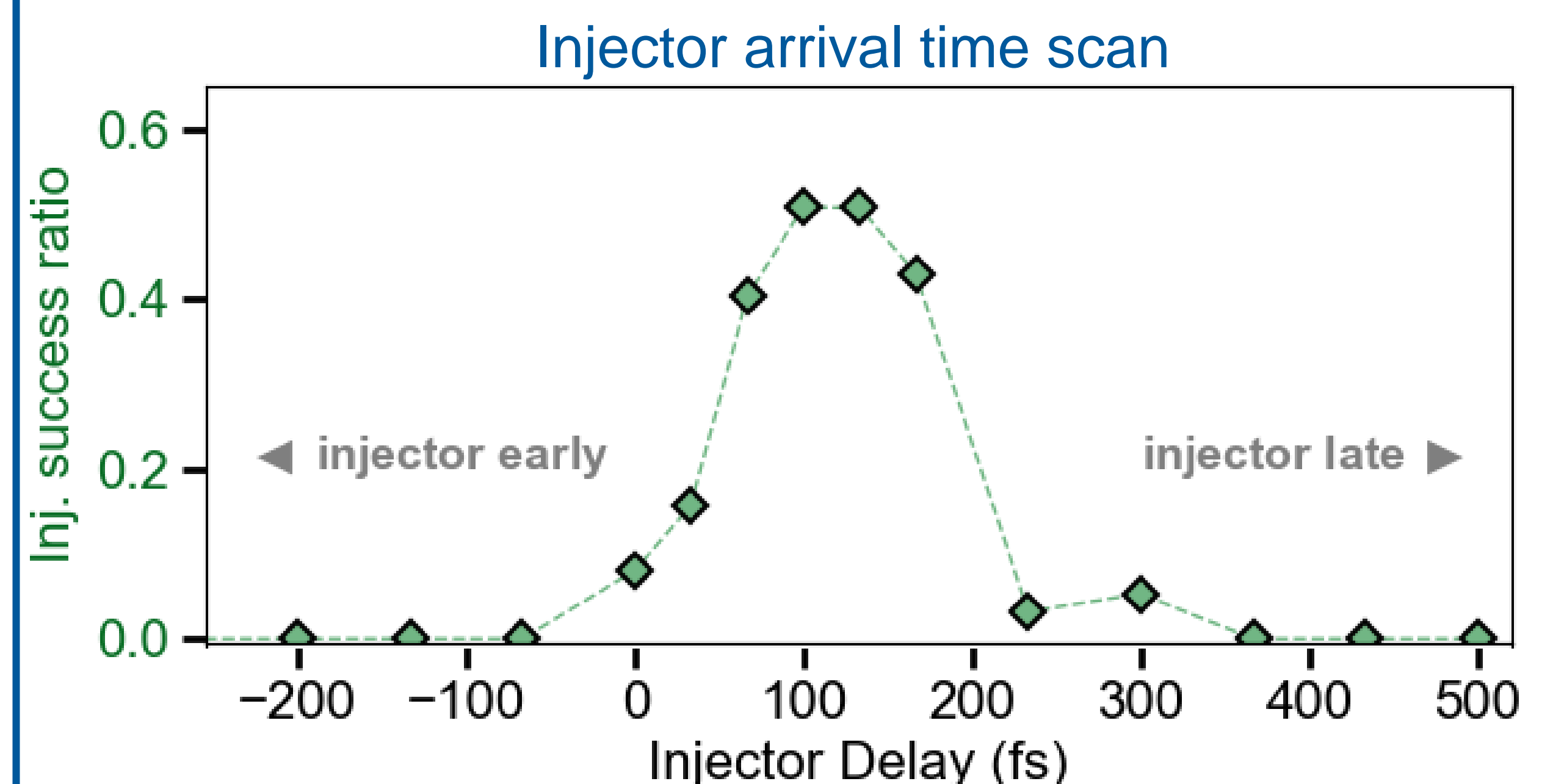
Best witness parameters

FWHM charge: 8.5 pC
 Energy spread (rms): 1.24 MeV
 Divergence (rms): 0.59 mrad
 Mean energy: 183.1 MeV

Confirmation of Plasma Photocathode:

- **No injection** with pure hydrogen (no ionizable gas species present)
- **No injection** without the injector laser

→ Injection based on **laser ionization**



- Injection observed in a **ca. 200 fs timing window**
- **Agrees** with **expected timing window** (from geometrical overlap and simulations)

→ **Short timing window**

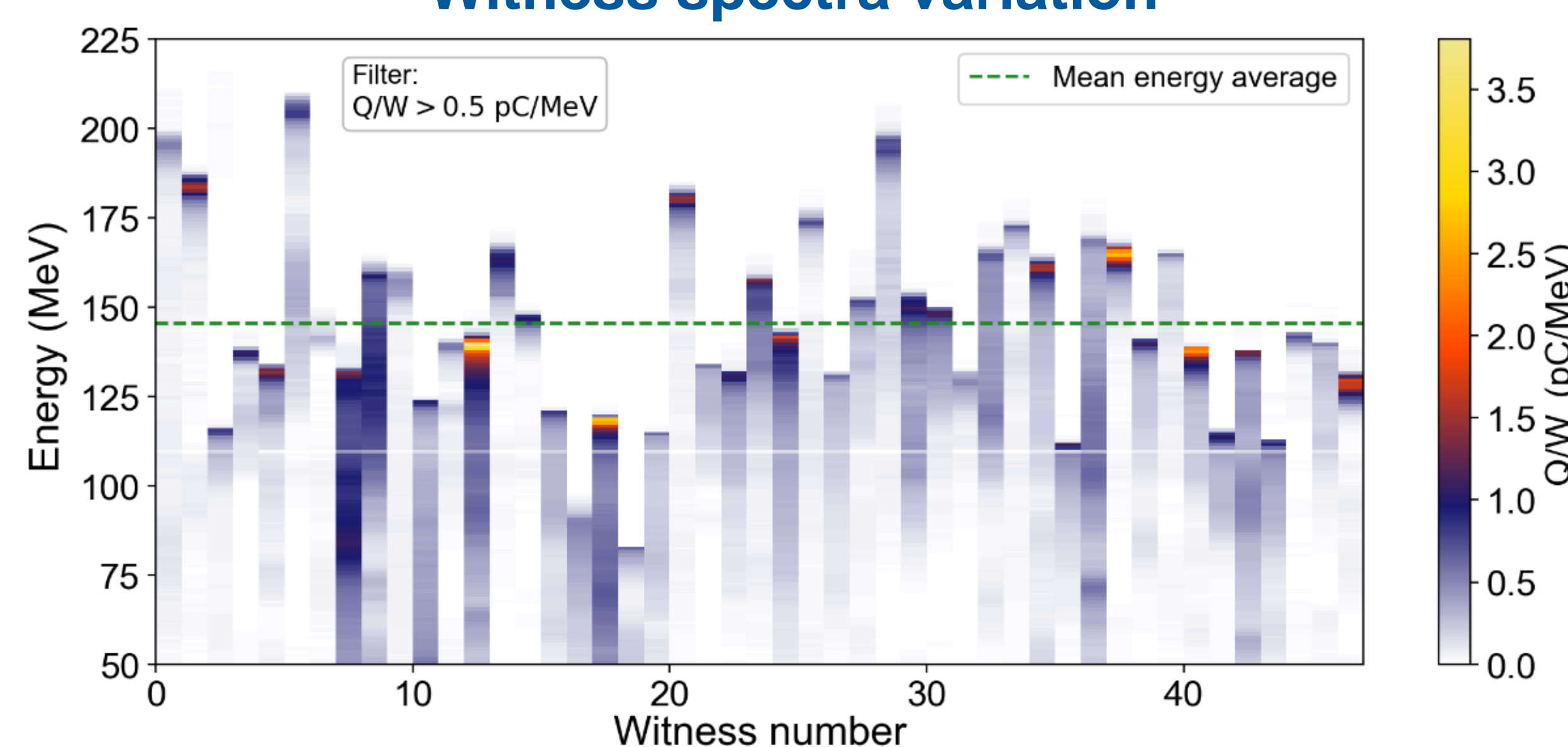
Outlook & Conclusions

- Successful implementation of **plasma photocathode** injection in an LPWFA setup

→ Opening **high level PWFA physics** to many laser facilities

→ Discovering **new plasma photocathode regime**

Witness spectra variation



- **Identification of shortcomings** through the analysis, e.g:
 - **Drive beam ionization** of 2nd level of helium
 - Unusual high driver pointing jitter

→ Potential for **future experimental improvements**