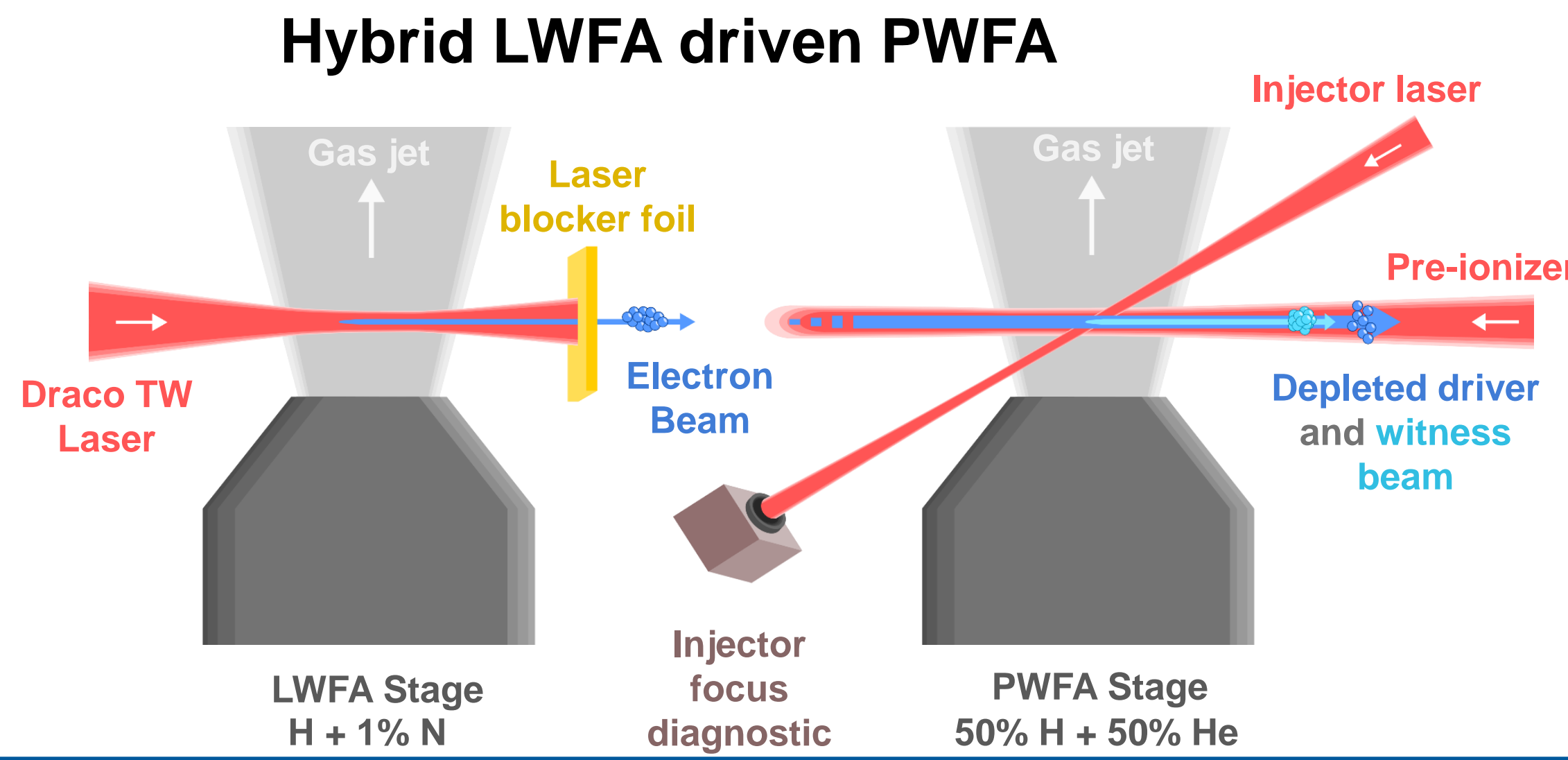


## Motivation and Setup

- LWFA are tabletop accelerators that can produce electron beams with high peak currents (>10 kA)
- PWFA: promising acceleration method for the generation and acceleration of high quality electron beams



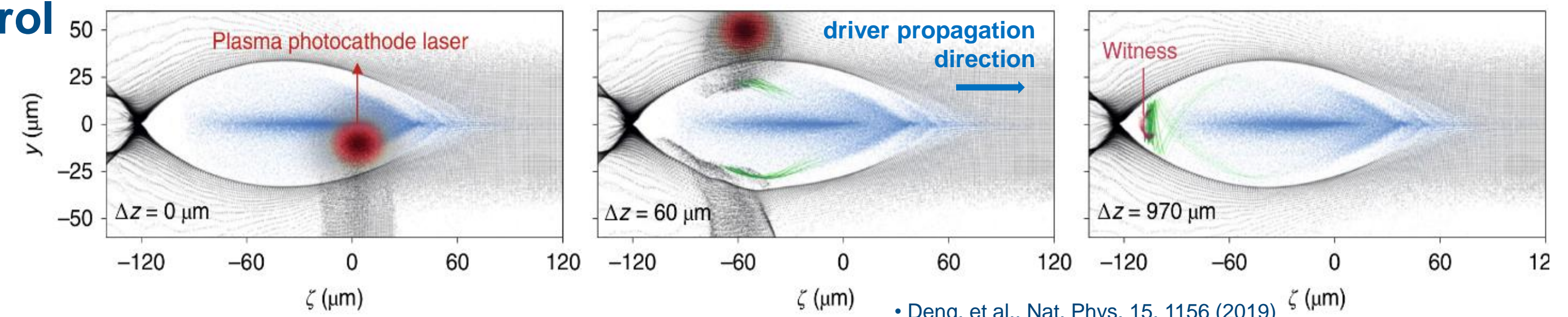
- Combination of LWFA and PWFA to provide high quality electron beams from a tabletop accelerator
- Concept could meet high demands of electron beams for secondary light sources such as free electron lasers

• Hidding et al. B. Phys. Rev. Lett. 104, 195002 (2010)  
 • de la Ossa et al. Phil. Trans. R. Soc. A, 0175 (2019)  
 • Hidding et al. Appl. Sci., 9(13), 2826 (2019)  
 • J.P. Couperus Cabadağ, et al., Phys. Rev. Research 3, L042005 (2021)  
 • T. Kurz, T. Heinemann, et al., Nat. Comm. 12, 2895 (2021)

## Trojan Horse Injection

- Additional gas species in target medium with higher ionization threshold (He II) which is not ionized by the pre-ionizer
- Injector laser, with Intensity above this threshold, intercepts the first cavity of the wakefield (different geometries possible)
- Electrons released in the center of the wakefield → full acceleration distance can be harnessed
- low residual momentum of released electrons allows for the generation of very low emittance beams
- Injector laser properties give enhanced injection control
- High quality witness beams → potential candidate for FEL driver

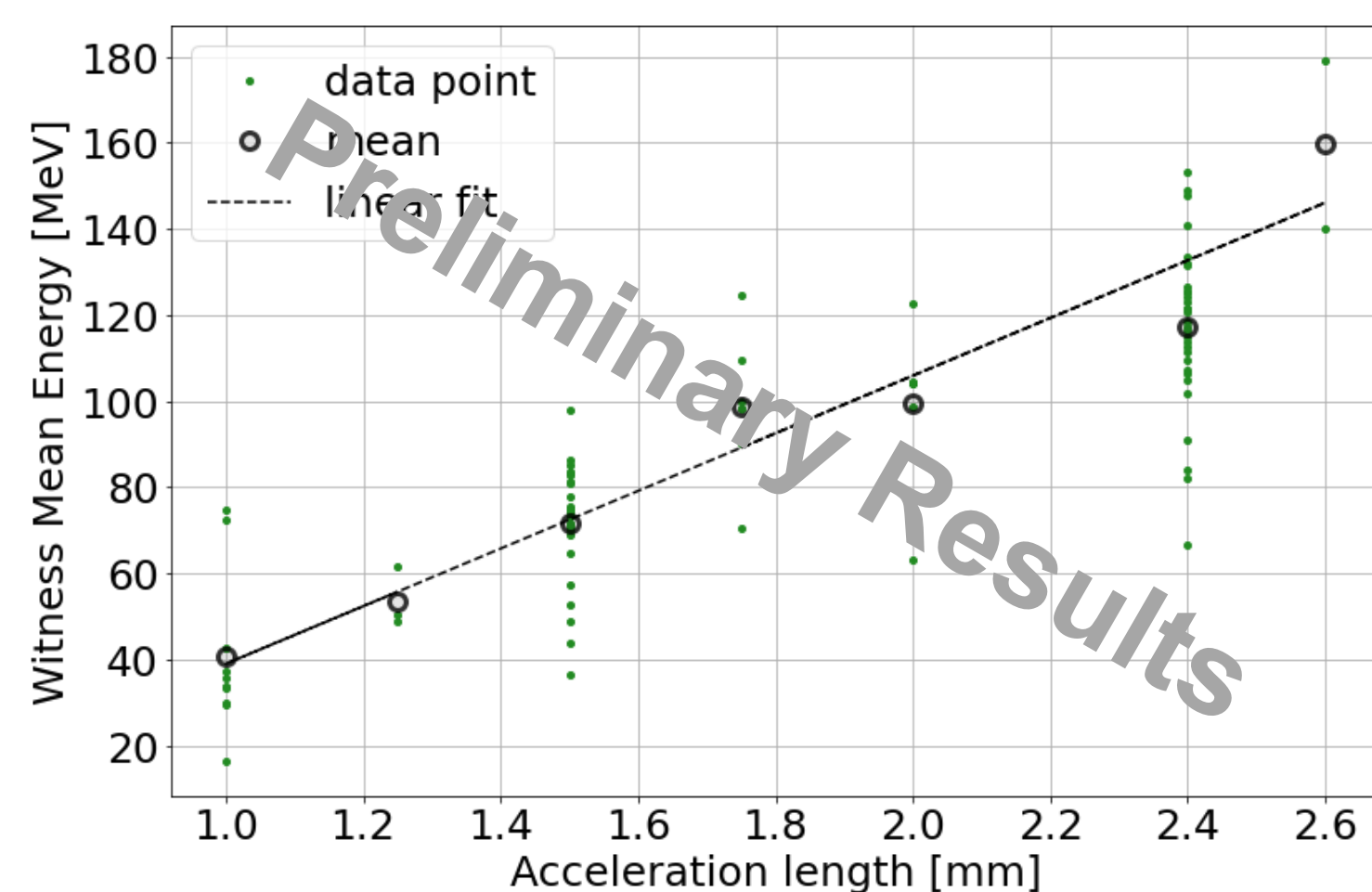
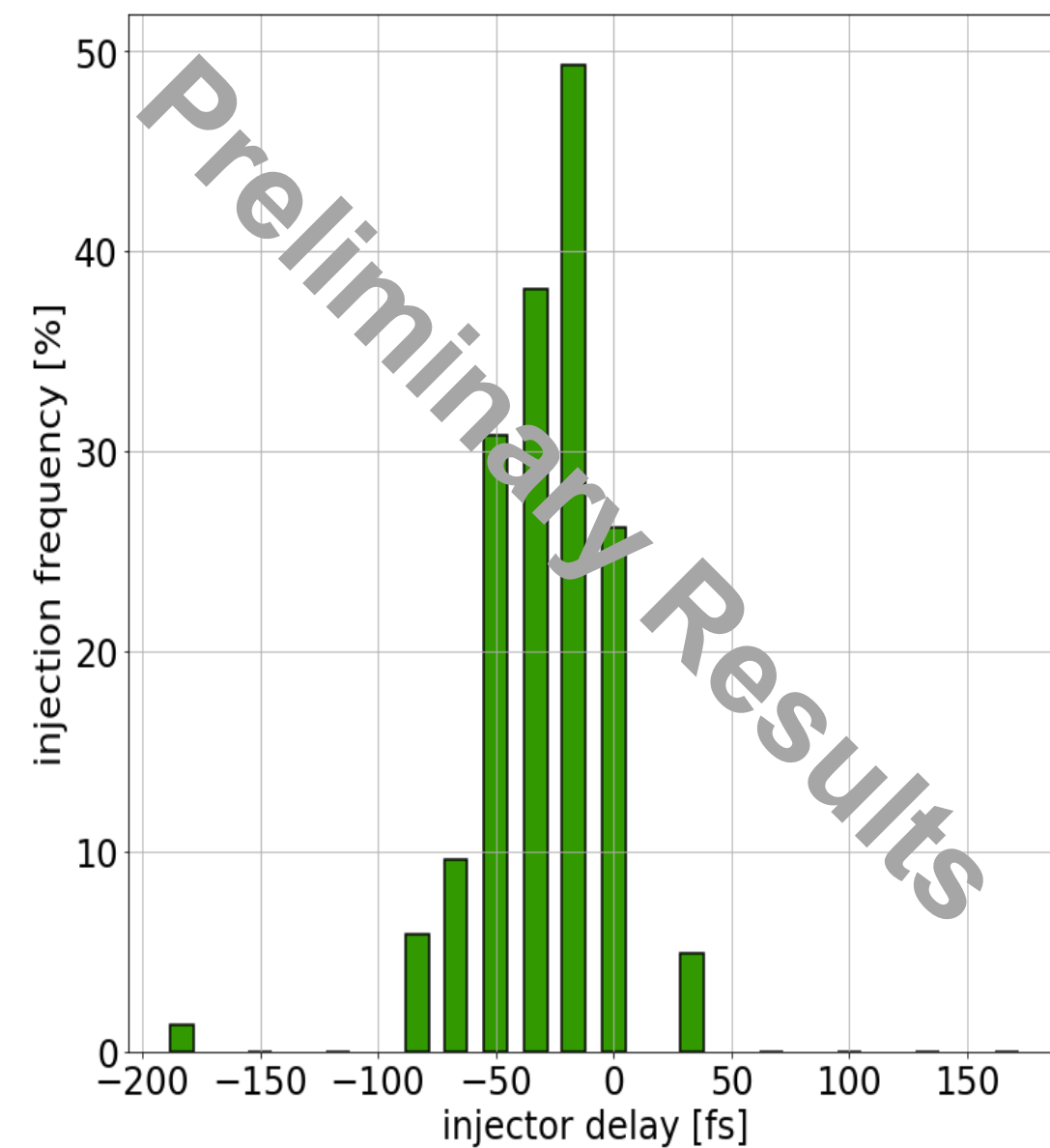
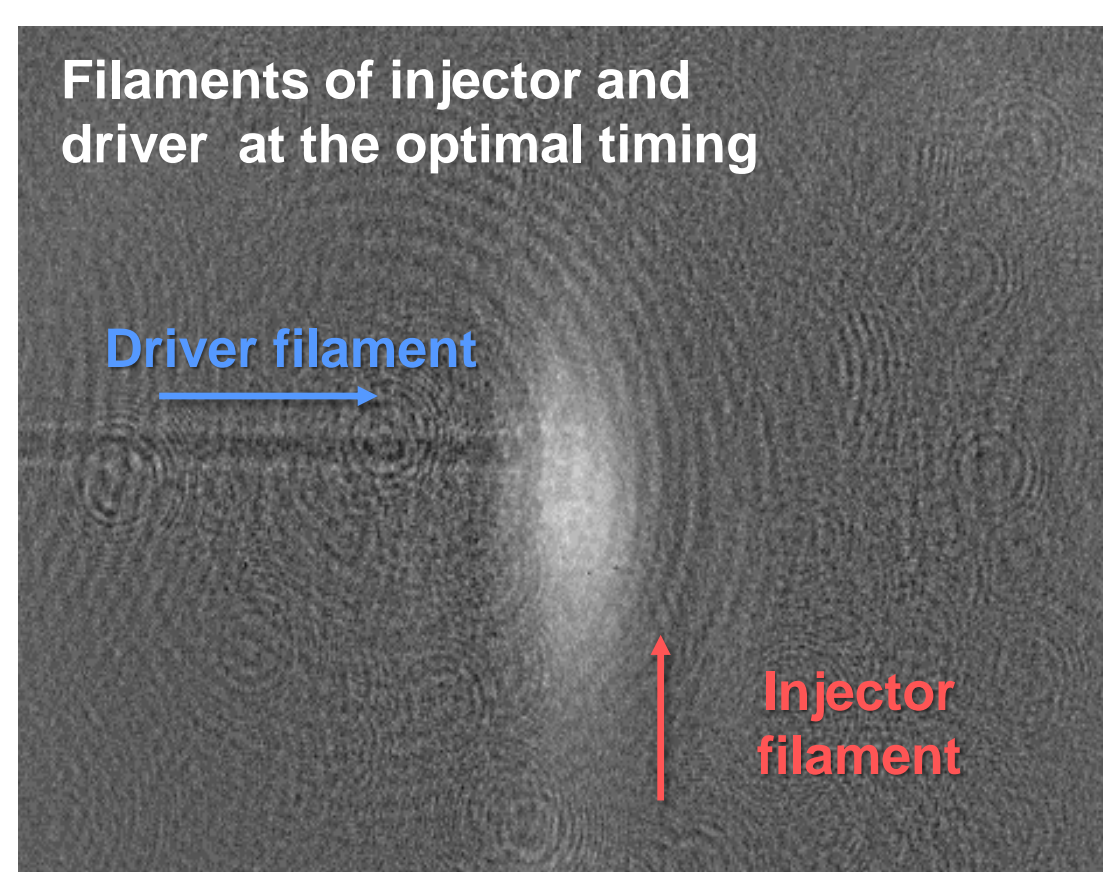
In Hybrid LPWFA: inherent synchronization between laser and electron beams



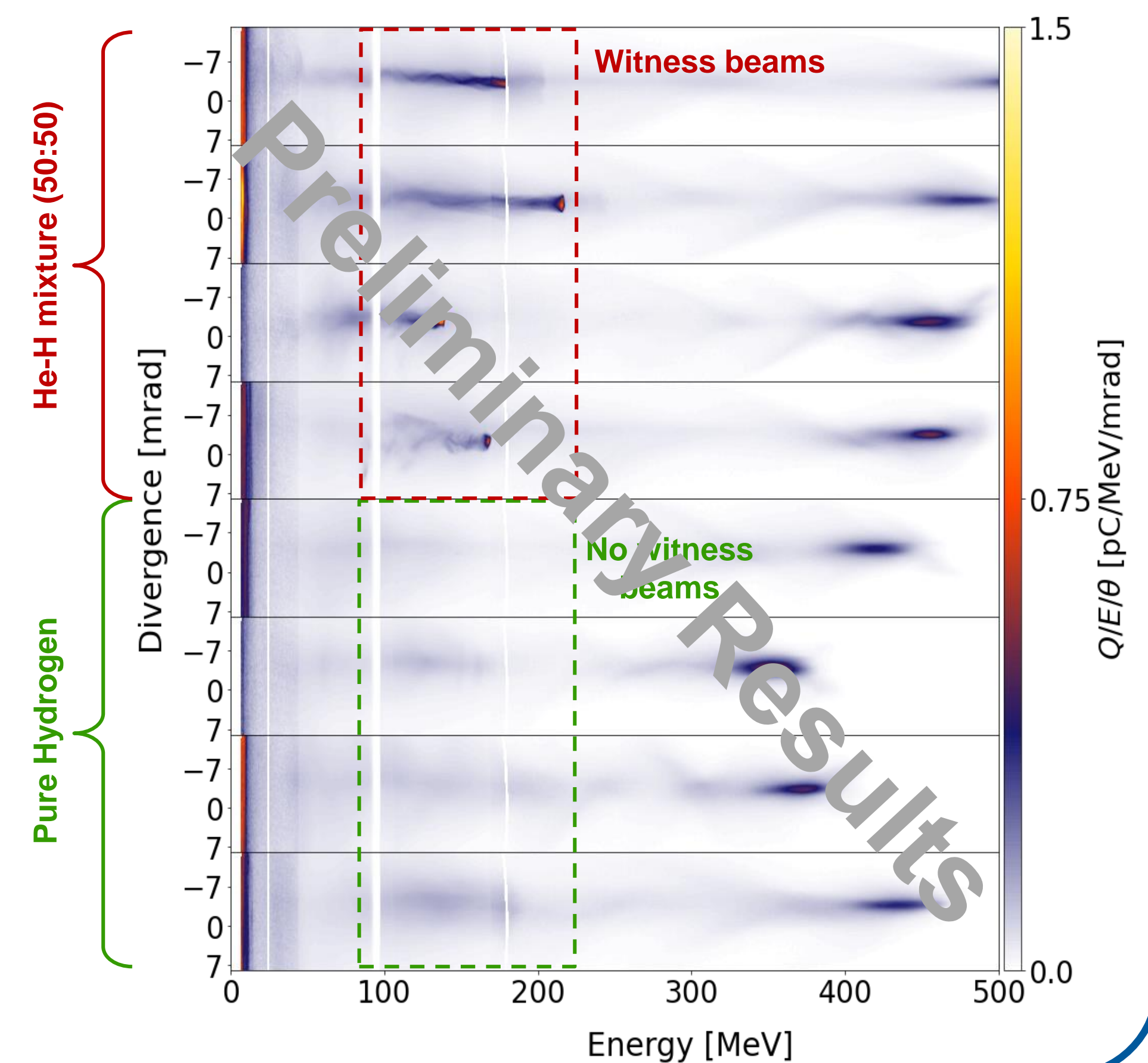
• Deng, et al., Nat. Phys. 15, 1156 (2019)  
 • Wittig et al. Phys. Rev. ST Accel. Beams 18, 081304 (2015)

## Experimental Results

- Injection of witness beams in the PWFA stage in a 100fs window of injector laser timing
- Timing window size corresponds to an overlap of injector laser and first cavity of the wakefield
- Overlap of injector laser and cavity confirmed with imaging of the filaments with a probe beam
- Scaling shown between acceleration length and witness energy



- No injection observed when only hydrogen (low ion. thresh.) was used, proving that the injection is based on ionization



## Conclusions

- First experimental results of Trojan Horse injection in a hybrid LPWFA accelerator
- Witness beam quality promising for future usage of the LPWFA concept in applications like free electron lasers
- Next step: improving the control and stability of the witness parameters (energy, charge, etc.)

