

# E301 & E333 Plans for FY26

July 25, 2025

**Valentina Lee**

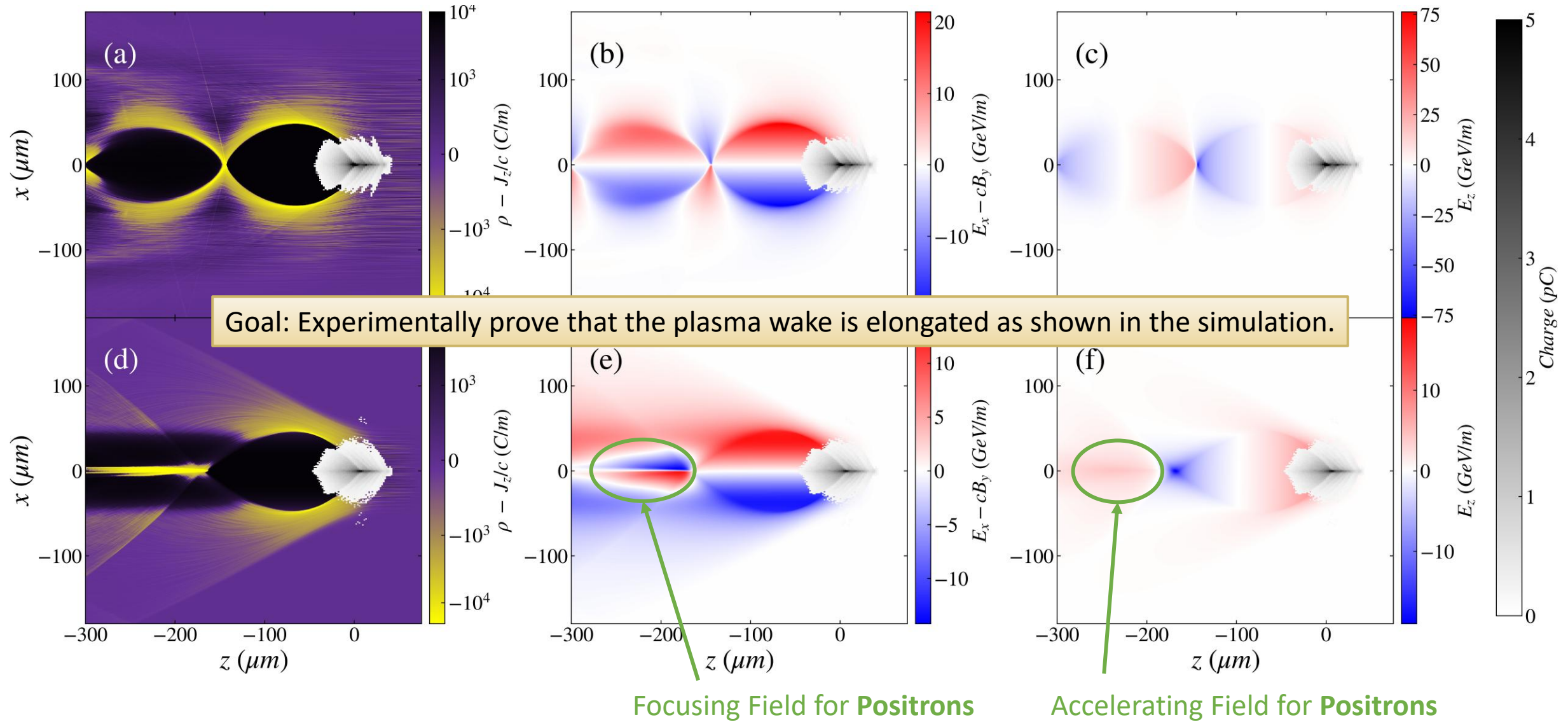
**on behalf of the E301 Collaboration**

University of Colorado, Boulder

- Achieving high performance PWFA in a **laser ionized plasma source**
  - To achieve collider required energy deposited -> Oven has suffered overheating and lithium loss when trying to increase the drive-to-wake energy transfer.
  - Controllable plasma geometry -> Emittance preservation, plasma shaping for positron acceleration (E333)
- High efficiency PWFA
  - Drive to wake efficiency
  - Wake to witness efficiency
  - Charge preservation
  - Energy spread preservation
  - Emittance preservation

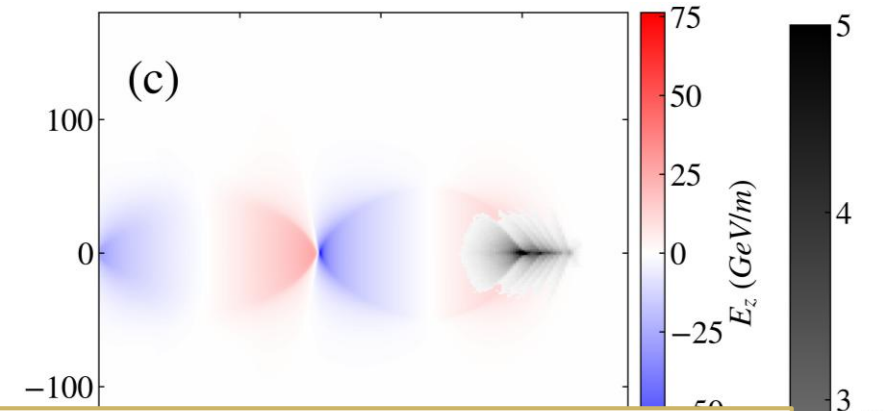
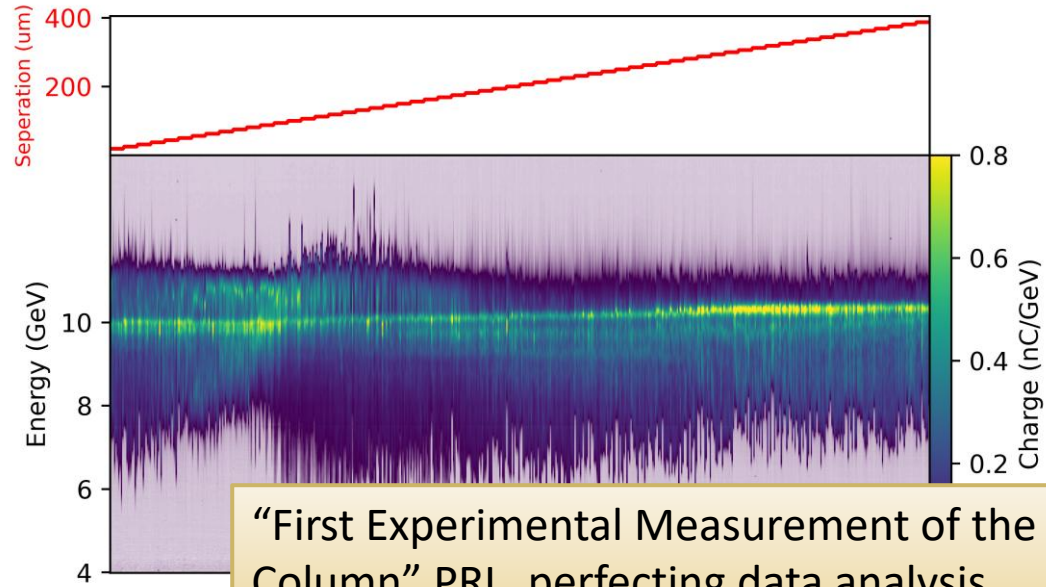
Experimentally demonstrate high performance PWFA in a laser ionized plasma source

# E333 High-level Scientific Goals



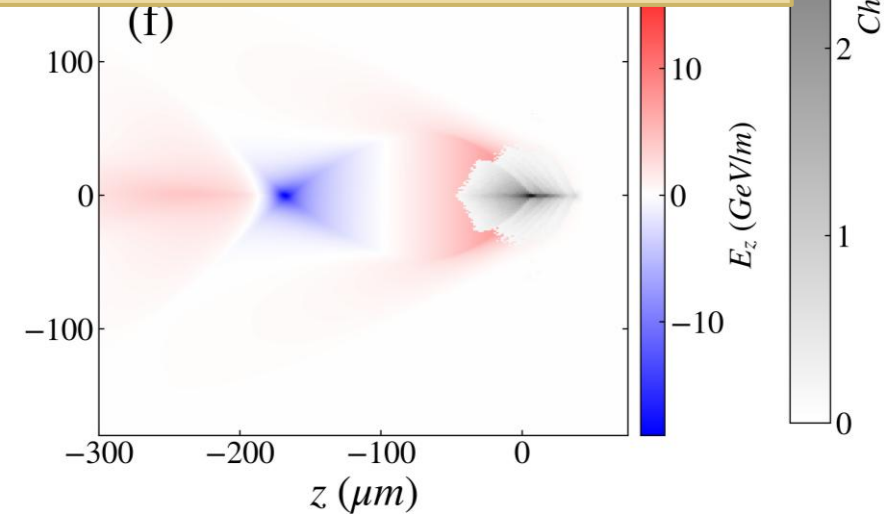
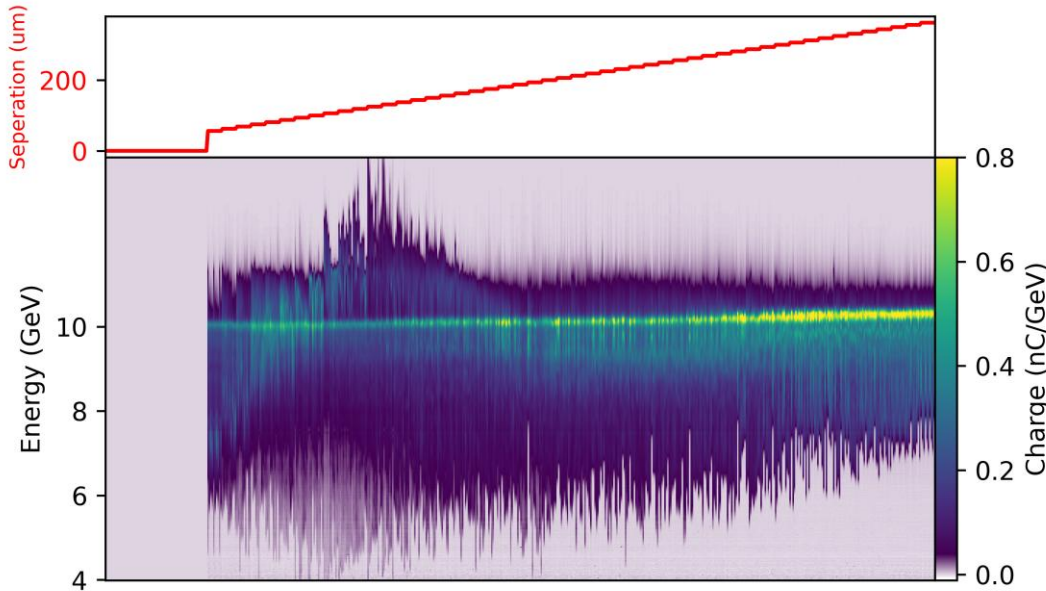
# FY25 Results – Elongated Wake

Wide

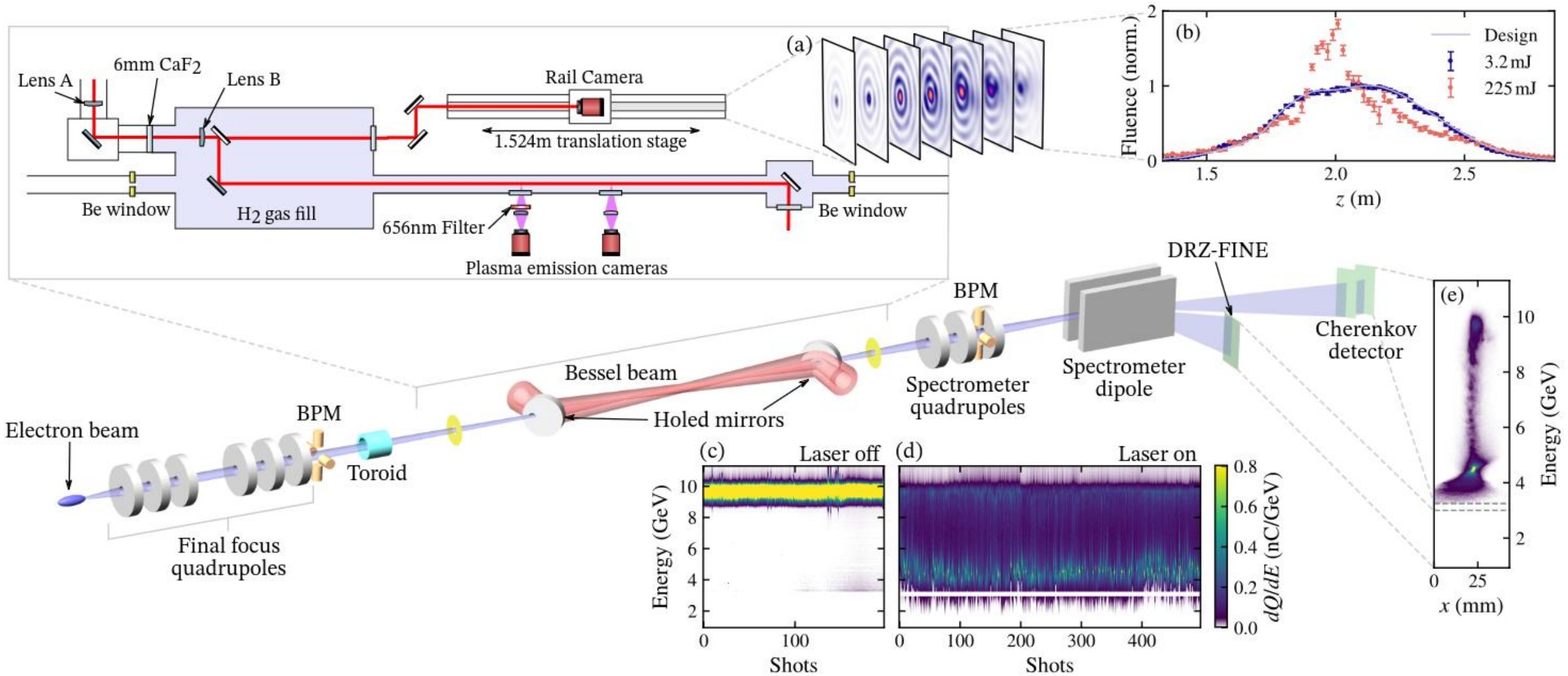


“First Experimental Measurement of the Plasma Wake Structure in a Narrow Plasma Column” PRL, perfecting data analysis

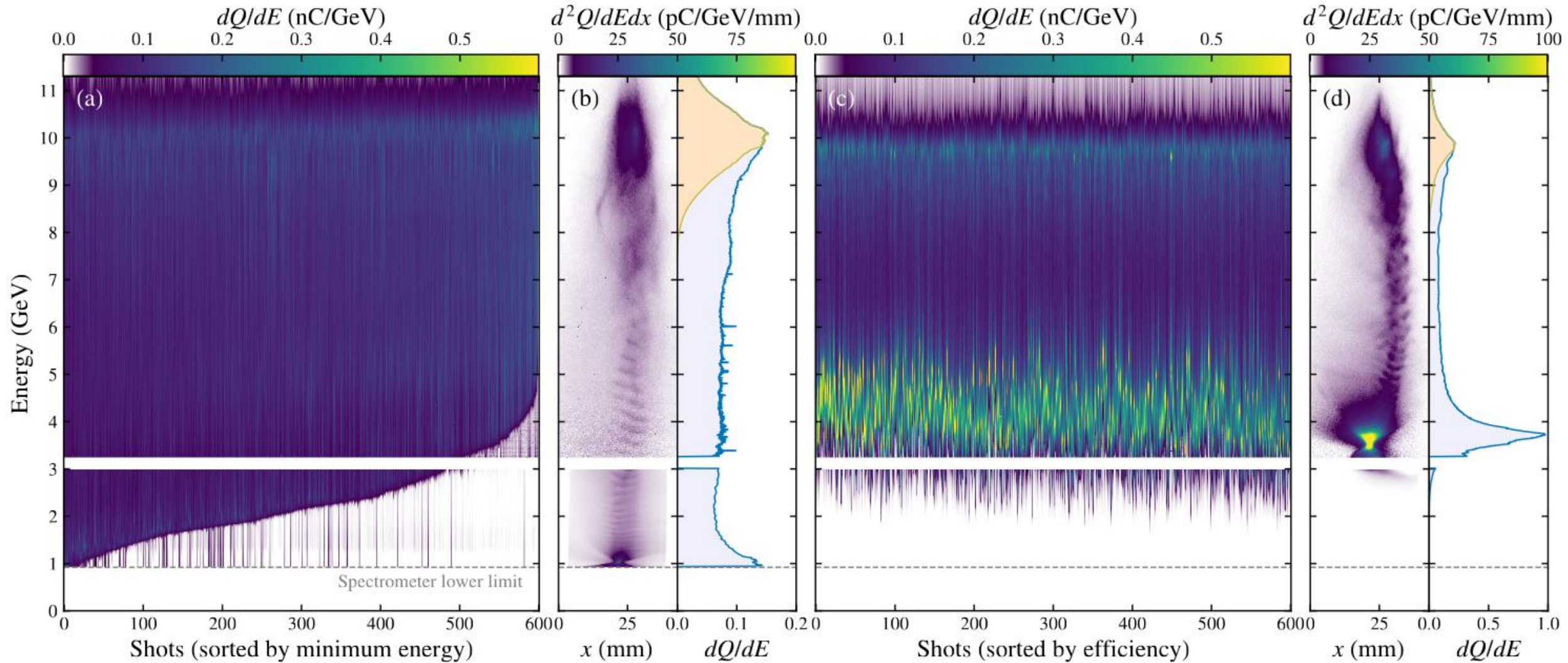
Narrow



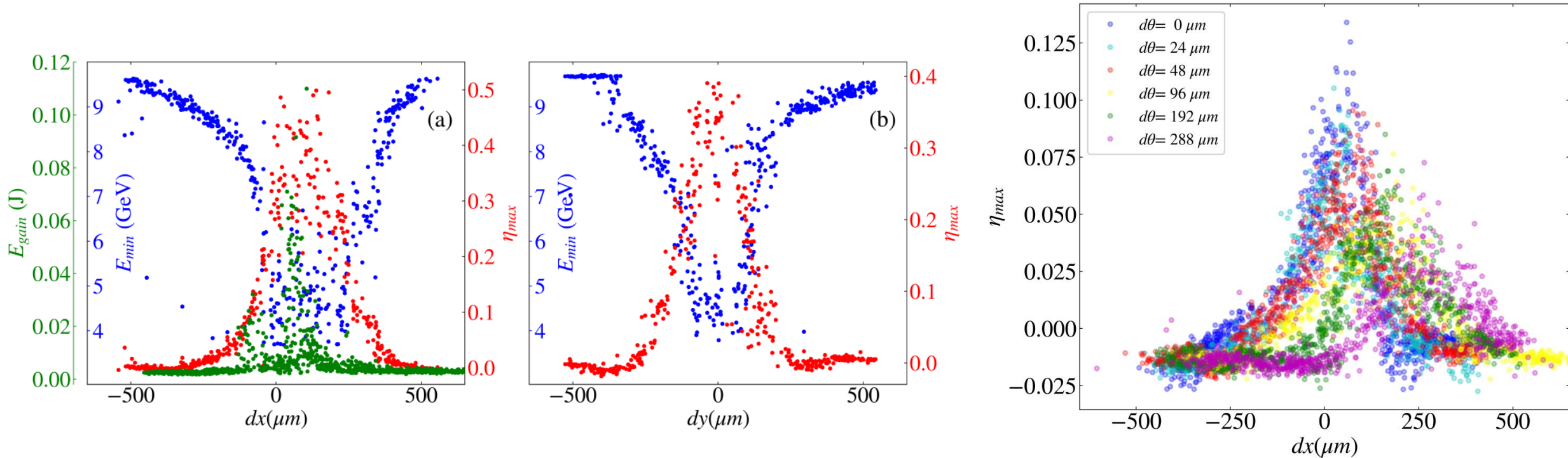
# E301 Experimental Setup



# FY24 Results – Energy depletion, High Drive-to-wake energy transfer efficiency



“Drive beam depletion with multi-Joule energy transfer in a plasma wakefield accelerator” target: PRAB, final editing stage



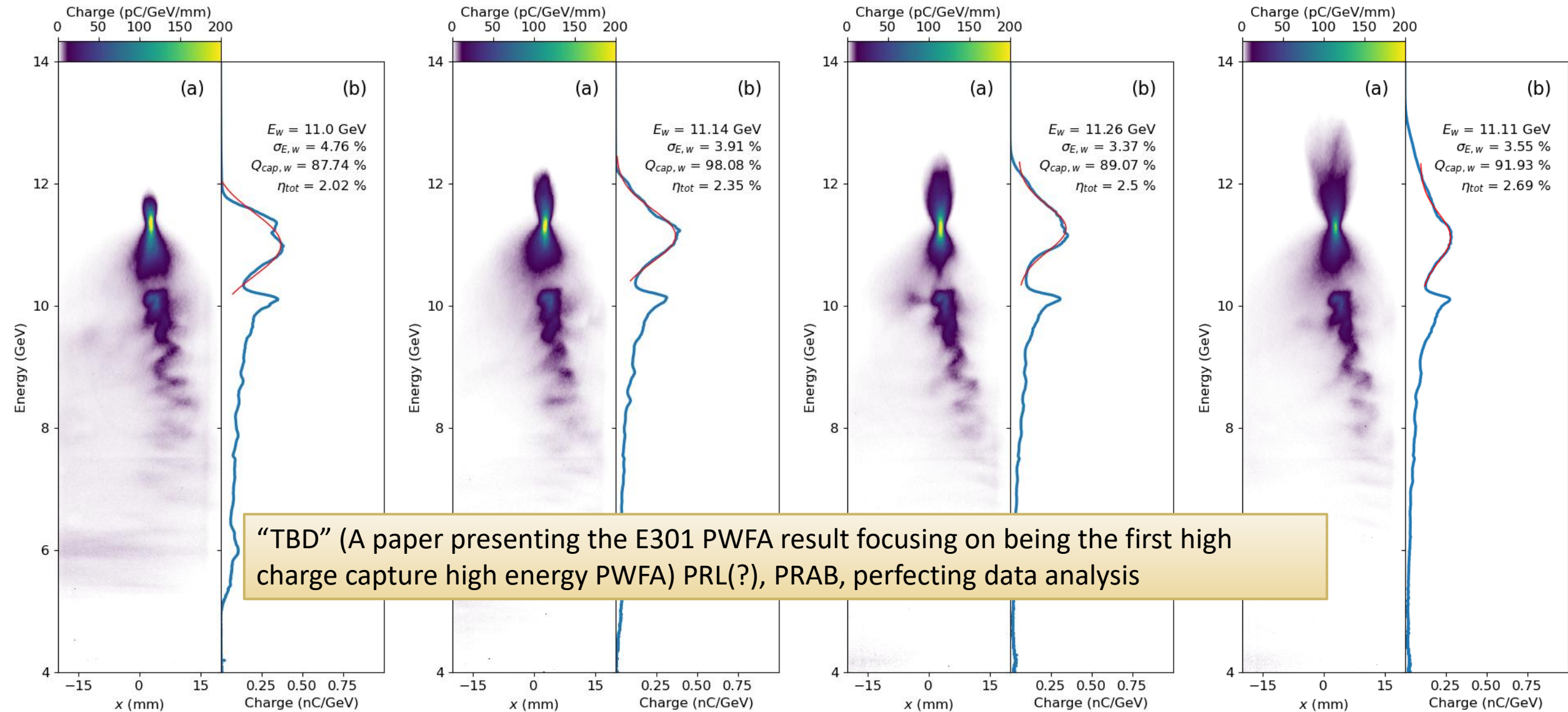
- The geometric tolerance of a PWFA in a laser-ionized plasma source can be easily estimated as:

$$dr + L \sin(d\theta) \leq 2(R_p - r_b)$$

- Previous studies have shown that a mis-aligned drive beam can be attracted into the plasma column, which suggests that the alignment tolerance may be greater than that predicted by the simple geometric argument.

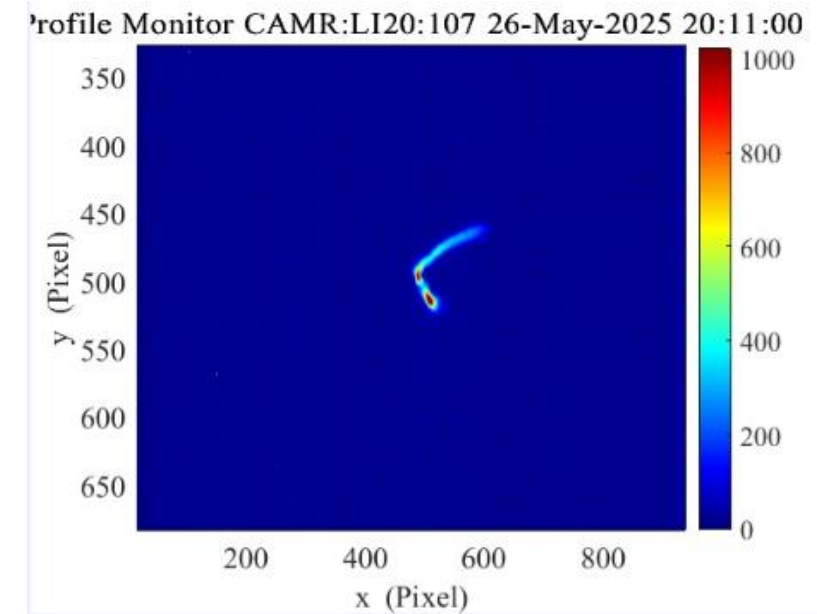
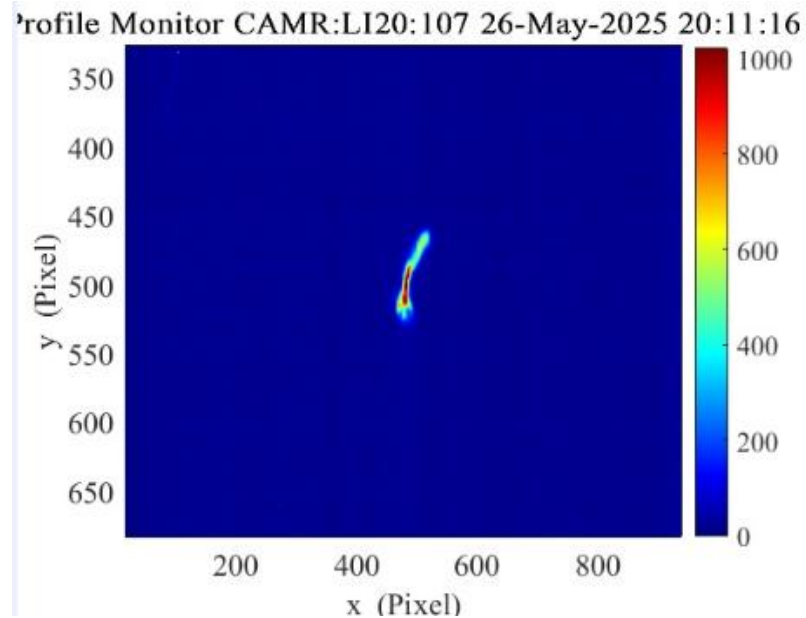
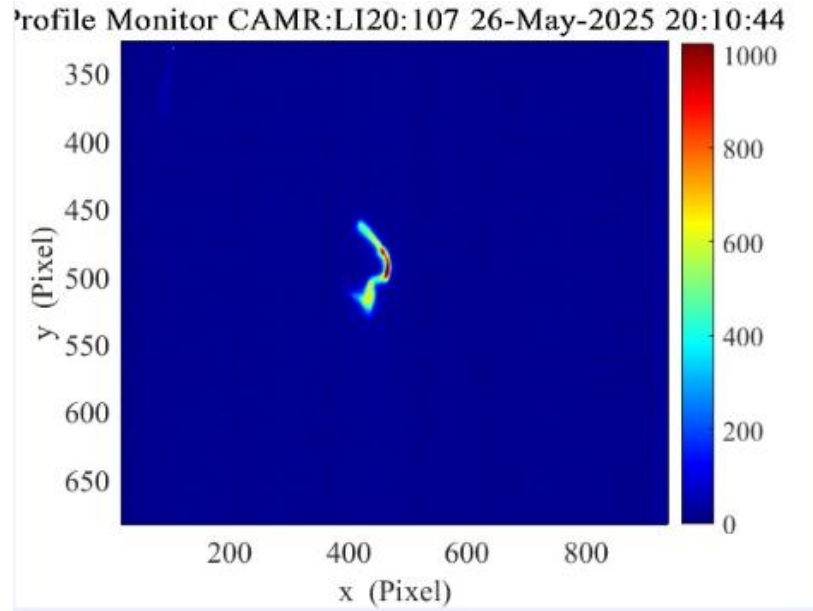
“Alignment Method and Tolerance of a Plasma Wakefield Accelerator in a Laser-ionized Plasma Source” target: PRAB, final editing stage

# FY25 Results – Good Performance PWFA



“TBD” (A paper presenting the E301 PWFA result focusing on being the first high charge capture high energy PWFA) PRL(?), PRAB, perfecting data analysis

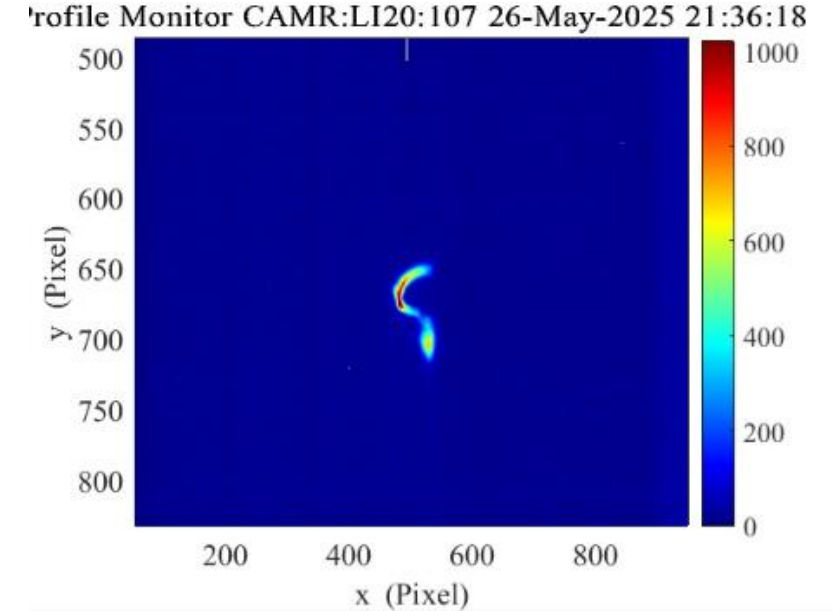
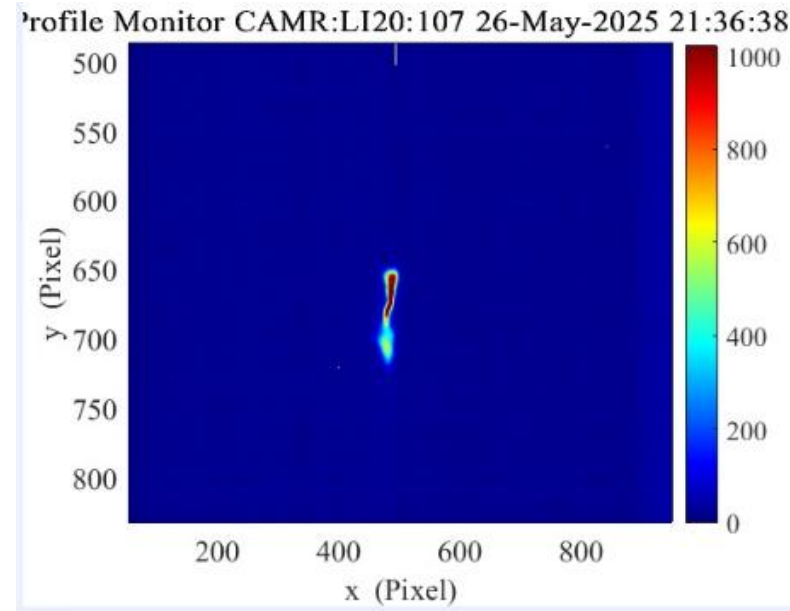
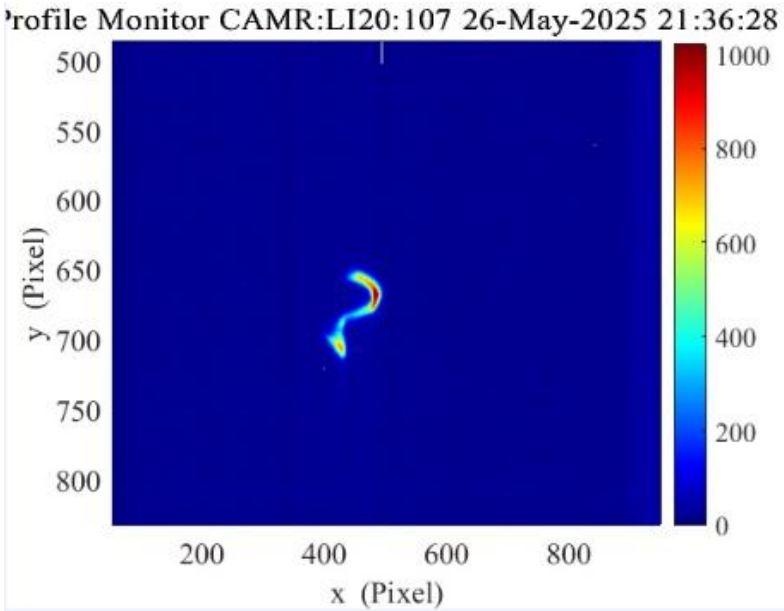
- High energy part of the drive was aligned with witness in time



- High energy part of the drive was aligned with witness in time



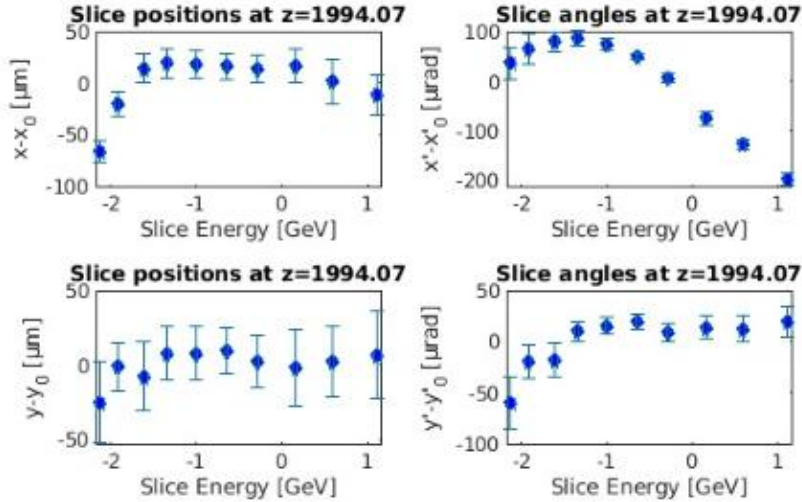
- High energy part of the drive was aligned with witness in time



- Large dispersion and dispersion'

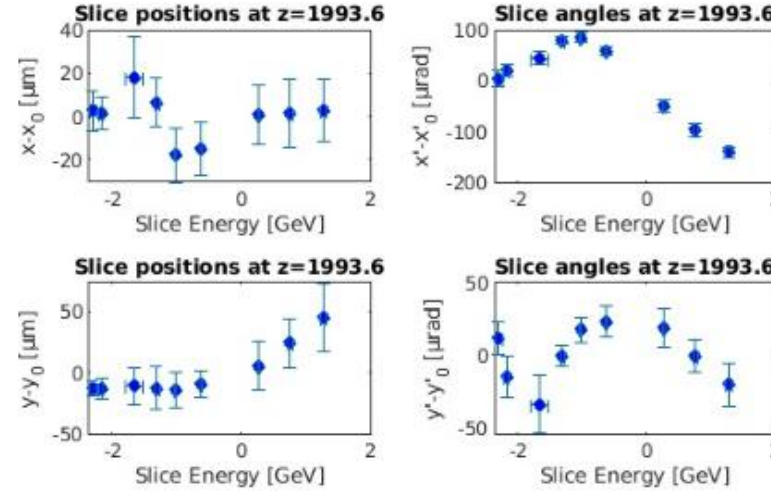
IP BPM Orbit Analysis  
DAQ 13566

Slice BPM after lower density Sext. tuning



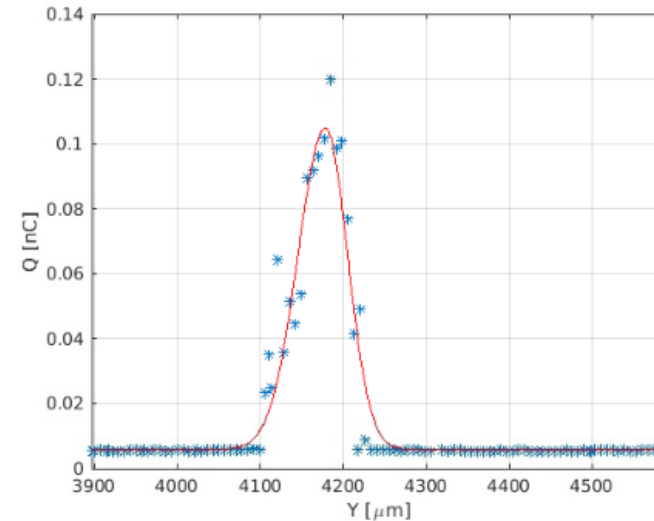
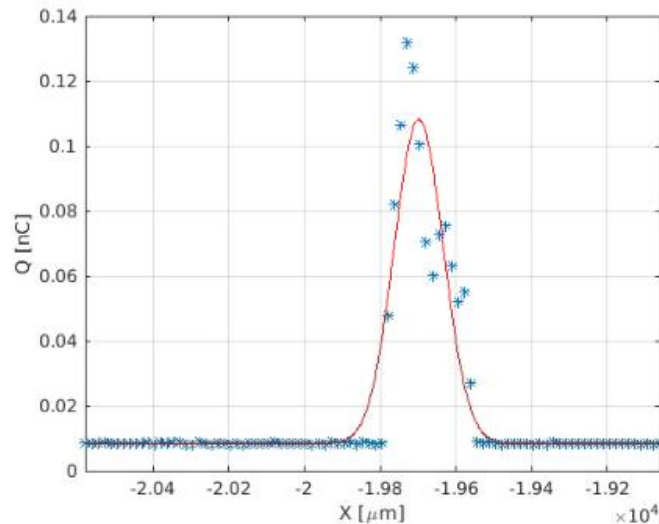
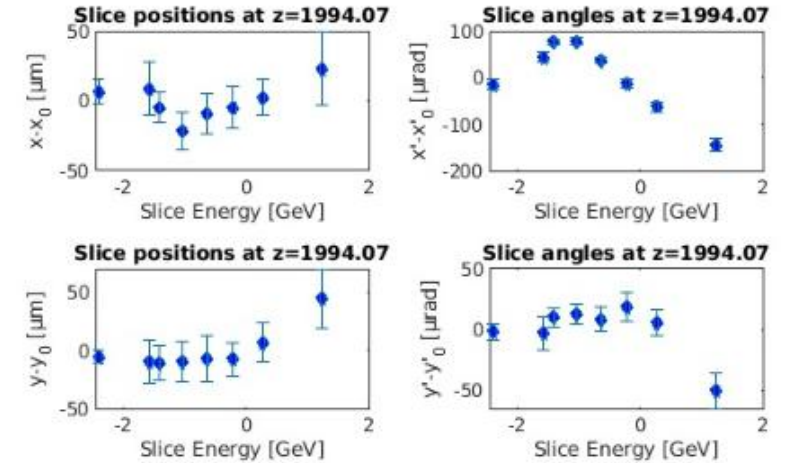
IP BPM Orbit Analysis  
DAQ 13570

Slice BPM after lower density Sext. tuning



IP BPM Orbit Analysis  
DAQ 13572

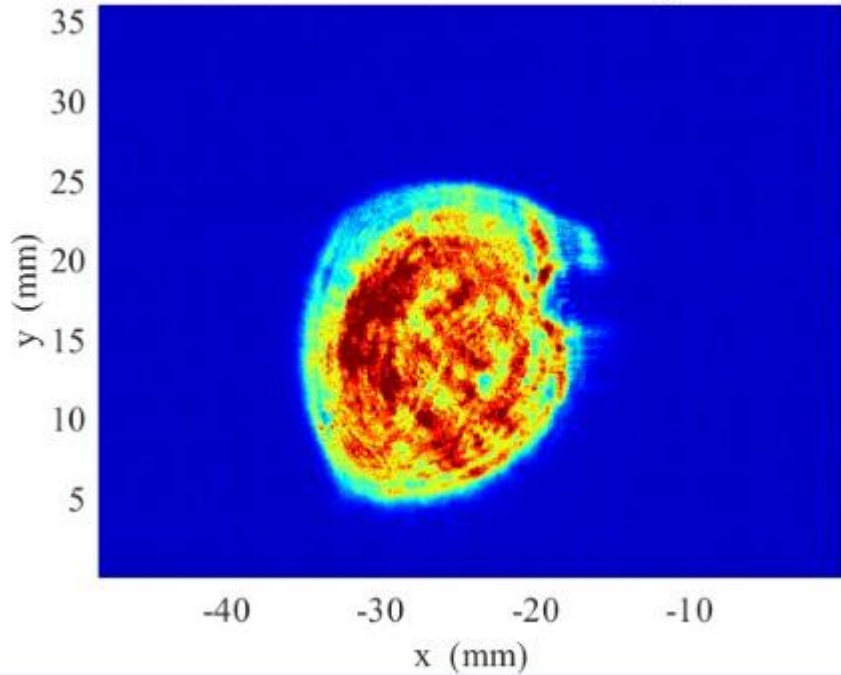
Slice BPM after lower density Sext. tuning, shift the waist 50cm down at PENT+75



- ML sextuple tuning limitations
  - Sextuple tuning can straighten the drive beam but there is still drive/witness offset
  - We compressed them until they are overlapped and use the ML sext. Tuning
  - Cost function: Egain & Eloss -> alignment contribute to cost function more  
-> limit the parameter space.

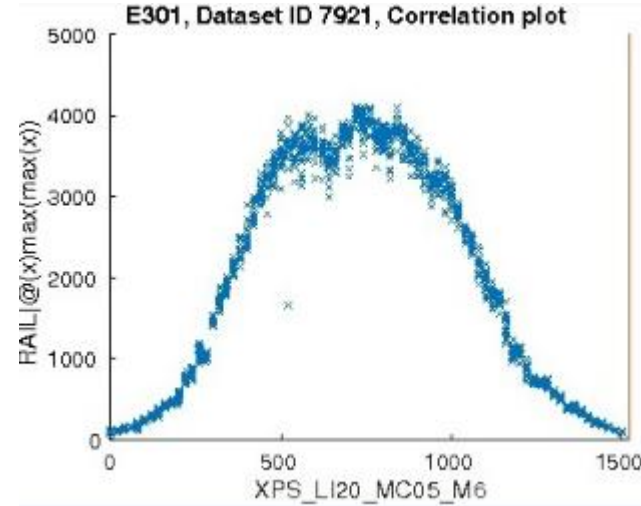
- Laser quality

Profile Monitor CAMR:LI20:201 22-May-2025 22:00:19

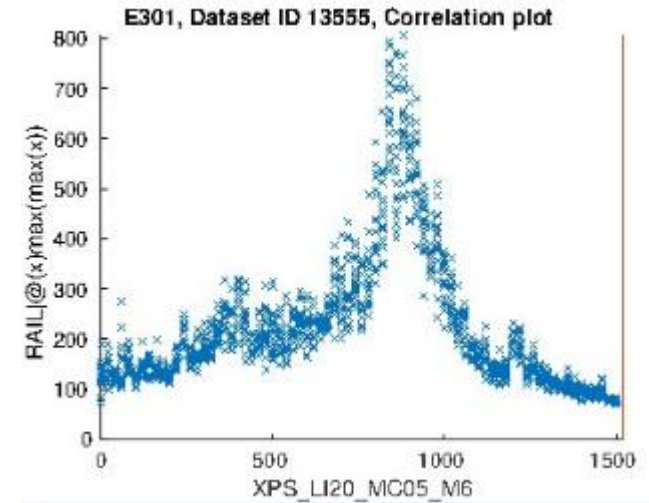


FY24

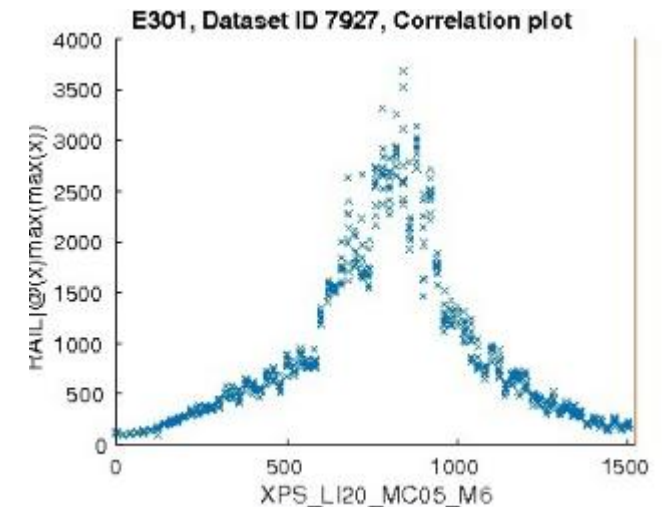
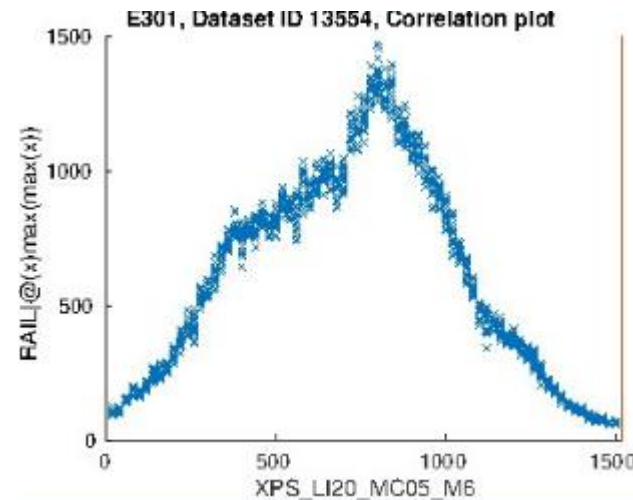
Low power



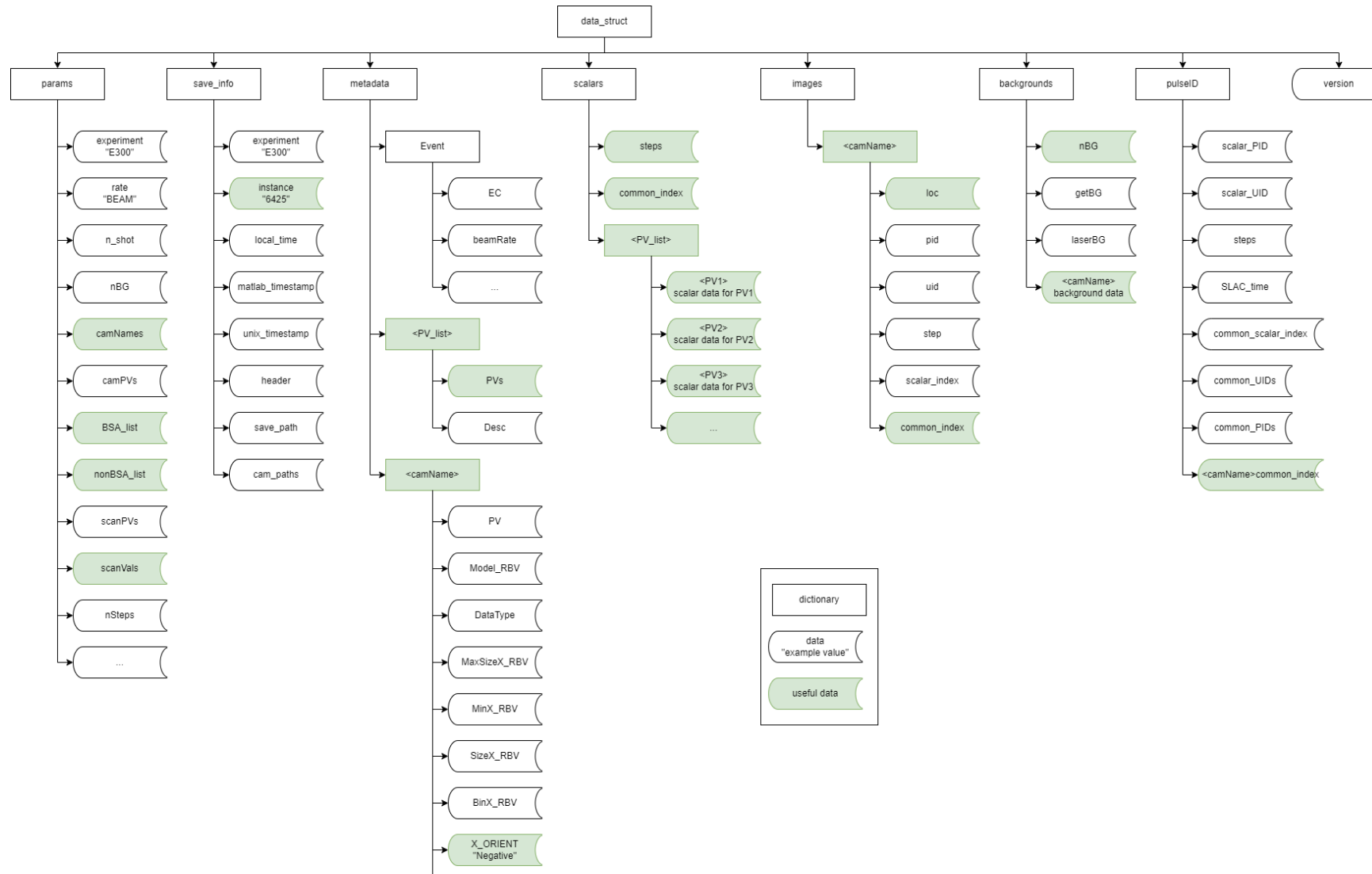
High power



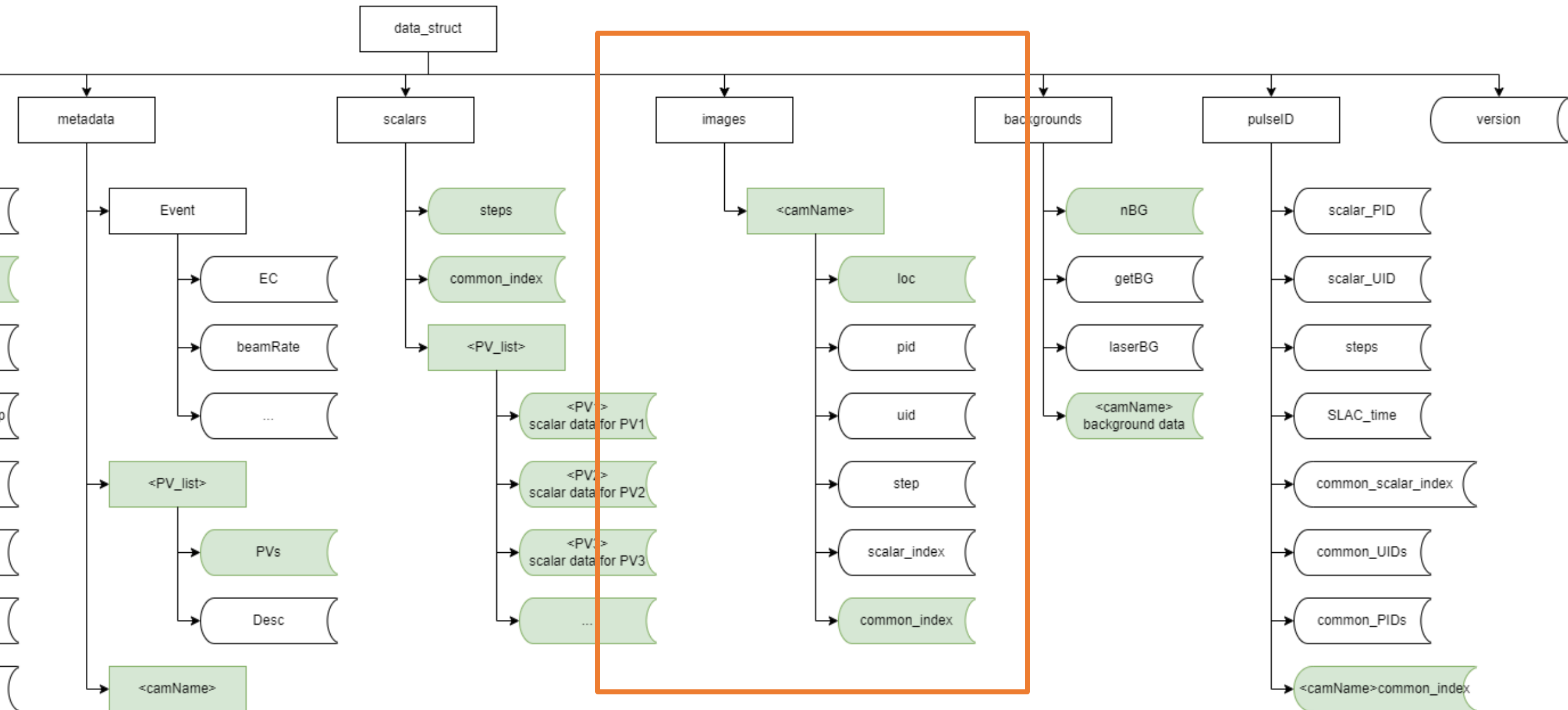
FY25



- Hdf5 DAQ



- Hdf5 DAQ



- Beam tuning
  - C shape beam
  - Dispersion, dispersion'
- Sextuple tuning
  - Tune with beam ionized Ar
  - Remove the alignment effect by shifting the plasma to match the beam orbit
- Laser
  - Profile (realign, get rid of clippings)
  - Compression
  - Replace RAIL/PB Near Far NDs
  - Compressor valve

- Sextuple tuning
  - Tuning with Ar
  - Move the plasma to follow beam orbit
- Decrease witness charge
  - Without loading the wake -> improve energy spread
- Repeat FY25 without the compressor window
  - Better and more well-known plasma source
- Laser/e beam timing delay
- At CU Boulder: Design a new pair of lens for H2 for emittance preservation

- Collaborate with E302 to study hosing instability
- Collaborate with E340 imaging the wake with dark shadowgraphy
- Transverse laser probe (developing at CU)

# Questions?