

# ML Feedback for HI Jena Laser plasma accelerators

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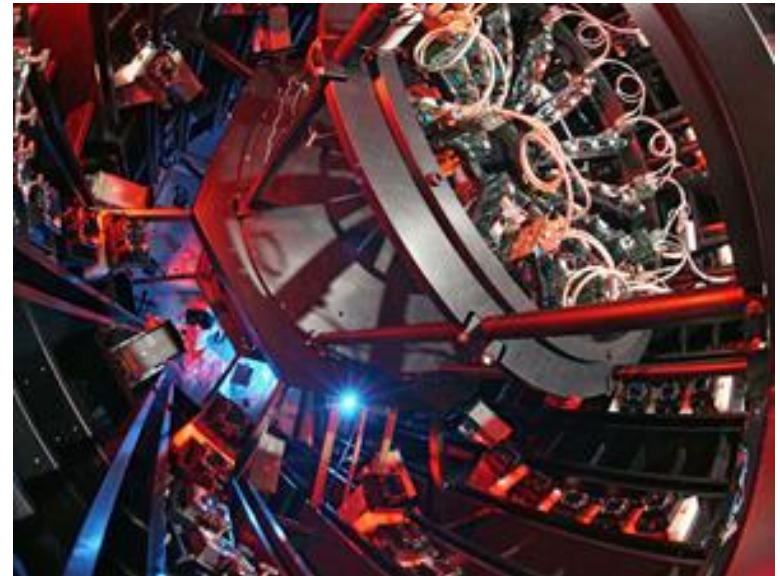
# High Energy Lasers

## JETi200



Wavelength: 800 nm  
Medium: Ti:Sapphire  
Energy on target: up to 5 J (4 J typical)  
Pulse duration: 17 fs (20 fs typical)  
Peak power: 300 TW  
Repetition rate: 5 Hz  
Probe beam: 5 fs

## POLARIS



Wavelength: 1030 nm  
Medium: Yb:CaF<sub>2</sub>, Yb:Glass  
Energy on target: up to 20 J (Comp. limited)  
Energy uncompressed: 54 J  
Pulse duration: >90 fs  
Peak power: >200 TW  
Repetition rate: 1/40 Hz

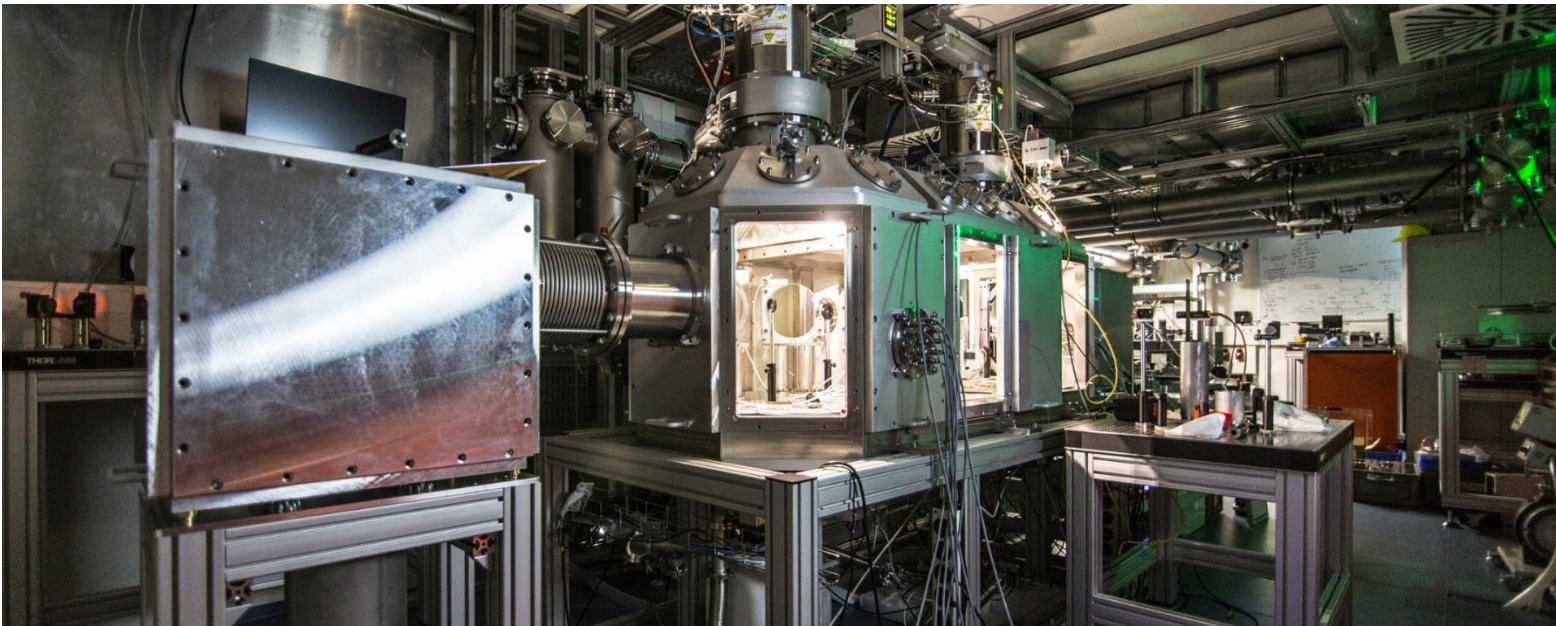
**HI JENA**  
Helmholtz Institute Jena

[www.hi-jena.de](http://www.hi-jena.de)

# Laser Plasma Accelerators (LPA)

## ACCLAIM:

- Enhanced Active Control of Laser Parameters
- Direct feedback to LPA observables



Radiation protection up to 3 GeV for electron beams and 50 MeV for proton beams.

Short focal length (F/1.5) for highest intensity and up to F/21 for long interactions.



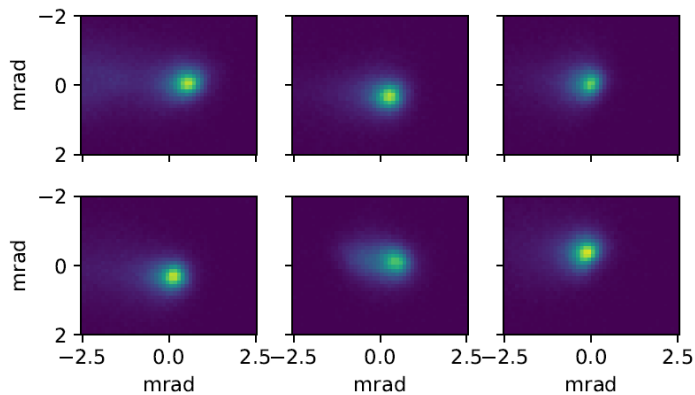
# GeV electron bunches

Using F/25 focusing geometry and variable gas cell length for optimized electron beams.  
Helium + Nitrogen mixture for ionization injection.



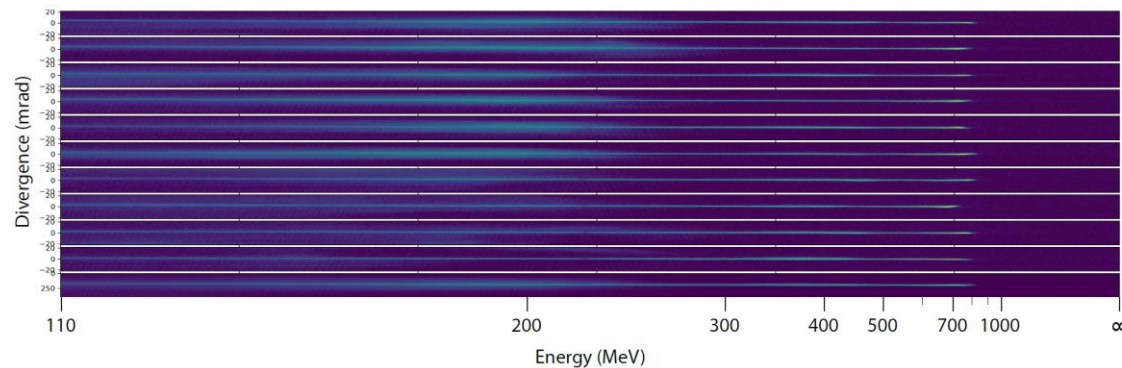
Gas cell (11 mm,  $n_e = 3 \times 10^{18} \text{ cm}^{-3}$ , 23 fs, 2.5 J on target)

Electron bunch profile



pointing fluctuations on  
same order as divergence

Electron bunch spectrum



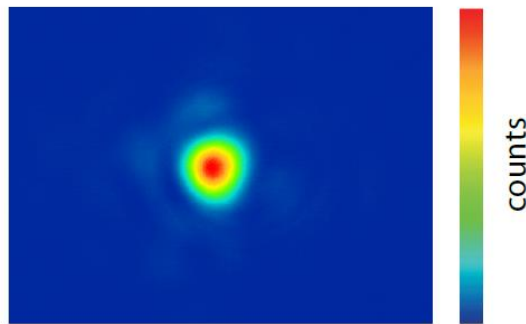
GeV beams with ultra low  
beam divergence  $< 0.5 \text{ mrad}^2$

# Laser Parameters Fluctuations



- Characterize beam parameters
  - Fast online diagnostics
- Implement feedback loops
  - Fast pointing mirror
  - Adaptive optic for spot optimization

F/21 focal spot



full spectrum (FWHM: 80 nm)  
FWHM: 22  $\mu\text{m}$  x 21  $\mu\text{m}$ ,  $q=0.48$

