FACET E-215 Status update

High-quality witness bunch generation and acceleration

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FACET User Meeting: Sept 2014
Experimental aims

• Demonstrate controlled down-ramp injection of electrons into a wake driven by the FACET electron beam

• Measure and control the accelerated electron beam properties (energy, energy spread, emittance)

• Investigate the influence of the down-slope shape on the injected beam parameters such as energy spectrum, charge and emittance
planned by FACET

proposed changes for E215

roughly 0.5m

[Diagram]

- Bellow to allow for transverse aperture alignment
- Separation flange including aperture defining gas target. Includes gas jet and outside vacuum transverse positioners (x,y)
- Camera and mirror to look at entrance and exit aperture of the gas cell
- Turbo pump
- Connection Flange pressure gauge and gas distribution system
- Region with hydrogen at a pressure of up to 15mbar
3D Hydrodynamic simulations with OpenFOAM
3D Hydrodynamic simulations with OpenFOAM

50 microseconds

$\frac{n_e \times 10^{16}}{\text{cm}^{-3}}$ against $z$ [mm]
3D Hydrodynamic simulations with OpenFOAM

100 microseconds

$\frac{n_e \times 10^{16}}{\text{cm}^{-3}}$

$z [\text{mm}]$
3D Hydrodynamic simulations with OpenFOAM

150 microseconds

$n_e \times 10^{16}$ [cm$^{-3}$] vs. $z$ [mm]
3D Hydrodynamic simulations with OpenFOAM

200 microseconds
OSIRIS simulations of FACET beam-driven wake

Injection and initial acceleration with OSIRIS[1] (3D PIC)  
Remaining acceleration section with HiPACE[2]  
(3D quasi-static PIC)

OSIRIS simulations of FACET beam-driven wake

Propagation distance = 3.6 mm
OSIRIS simulations of FACET beam-driven wake

Propagation distance = 3.8 mm
OSIRIS simulations of FACET beam-driven wake

Propagation distance = 3.9 mm
OSIRIS simulations of FACET beam-driven wake

Propagation distance = 4.1 mm
OSIRIS simulations of FACET beam-driven wake

Propagation distance = 12.5 mm
OSIRIS simulations of FACET beam-driven wake

Propagation distance = 24.8 mm
OSIRIS simulations of FACET beam-driven wake

Propagation distance = 50.2 mm
HiPACE simulations of FACET beam-driven wake

Propagation distance = 250.3 mm
HiPACE simulations of FACET beam-driven wake

Propagation distance = 506.9 mm
Injected beam spectrum after 50 cm
Driver beam spectrum after 50 cm

[Graph showing the charge per GeV (pC/GeV) as a function of electron energy (GeV).]
Shot plan

- Alignment checks
- Preliminary shots
  - Density scan without gas jet - Electron spectrometer
- Main experimental shots
  - Scan gas cell and gas jet density independently
  - Optimise gas jet timing
  - Main diagnostic electron spectrometer
  - Optimise injected beam and then perform mutli-shot and single shot emittance measurements.
- Secondary diagnostic, x-ray spectrometer to look for betatron emission.
Summary

- New target design completed
- Hydrodynamic simulations show expected density profiles
  - Checked experimentally with replica target at DESY
- PIC simulations ongoing to determine expected experimental performance
- Expected experimental shifts in Feb/March 2015