Working Group 2

Topics in Mid-IR Laser Research

Leader: Stuart Mangles (ICL)

Advisor: Jean-Pierre Delahaye (CERN)

User Community Representatives: Navid Vafaei Najafabadi (SUNY-SB), Aakash Sahai (ICL)

70 YEARS OF DISCOVERY

A CENTURY OF SERVICE

U.S. DEPARTMENT OF ENERGY

BROOKHAVEN NATIONAL LABORATORY

Thrust 2: Topics in Laser-Plasma Interactions and Laser Wakefield Acceleration

Focus on research needs involving laser-plasma interactions with mid-IR laser systems, looking primarily at experimental requirements as opposed to laser R&D issues. Major consideration should be given to significant milestones in laser plasma interactions and in developing particle acceleration applications utilizing mid-IR (9-11 μm) laser Systems. Where possible specify the experimental conditions that are needed to achieve these milestones and describe how well they match up with current and planned facilities. In the case of laser wakefield acceleration schemes, where external beam injection may be desirable, the relevant electron beam requirements should also be described.

Active ATF Experiments

- Modification of Gas Jet Density Profile with Hydrodynamic Shocks for CO2 Laser Ion Acceleration Experiment

  PI: A. Ting/Z. Najmudin, NRL/Imperial College

- Key physics study of LPI with NCD plasma using laser machined plasma structure

  PI: Wei Lu, Tsinghua Univ., China

- CO_2-laser-driven GeV wakefield accelerators with external injection / Key Physics Study of Laser Wakefield Acceleration Utilizing Ultrafast CO_2 Laser and Electron Beam

  PI: V. Litvinenko/W. Lu, SUNY SB/Tsinghua Univ.

What are we Looking for?

- Preferred upgrade path from the point of view of laser-plasma interaction research
- Current lasers suitability/availability
- Identify major milestones in laser-plasma interaction and how these relate to laser parameters
- Identify prioritizations in laser development
- How can present facilities complement each other. Should R&D be in multiple directions at different facilities
- Collaboration from the community

Survey Highlights - Landscape

- Plasma Ion-Channel Undulator (PICU) - towards a plasma-based x-ray laser
- Advancing soft-tissue imaging using PICU x-rays
- Laser Ion Acceleration - gas-density targets
- Controlled Transparency based Laser Ion Acceleration - RITA in mixed gasses
- Lab-based astrophysics
- Laser Wakefield Acceleration in the Bubble/Blowout regime

Survey Highlights - Needs

- Longer Wavelength
  - Larger bubble for LWFA external injection, staging etc.
  - Ion acceleration
- Higher Power
  - LWFA - nonlinear regime ($a_0 \sim 1$) - blowout regime ($a_0 \sim 2$) – bubble regime ($a_0 \sim 4$)
  - Ion Acceleration – a_0^2 proportional to power (push to medical range)
- Shorter Pulse
  - LWFA – closed bubble
- Polarization
  - Linear
  - Circular
- Shot-Shot Stability
  - Particle beams acceleration/generation
- Electron beam
  - Source for external injection
  - Diagnostic probe
- Secondary lasers
  - Diagnostics
  - Ionization injection