



The Abdus Salam
International Centre for Theoretical Physics



SMR 1698/6

WORKSHOP ON PLASMA PHYSICS

7 - 11 March 2005

Laser-Plasma Interaction and Application

L. Dhareshwar

BARC, India

These are preliminary lecture notes, intended only for distribution to participants.

Proposal for 'Host Lab experiments'

Area of work :

***Interaction of Intense Laser with matter-
Studies on X-rays and particle emissions from high
temperature, high density plasma***

Proposed by: Shivanand Chaurasia

&

Dr.L.J.Dhareshwar

***Solid State Laser Section , High pressure Physics Division,
Bhabha Atomic Research Centre, Mumbai, India***

Experiment:

" Studies on correlation of ion and X-ray emission with non-linear processes in plasmas produced by intense laser pulses"

Background:

Emission of highly charged ,energetic ions and hard X-rays from laser produced plasmas have been correlated with non-linear processes occurring in the plasma.

Plasmas produced by 10^{16} – 10^{19} W/cm² laser pulses have been able to generate ions with charged state upto 50+, with MeV energy in high Z targets.

Aims and Broad Objectives:

Generation and studies on high temperature high density plasmas created with laser intensity- 10^{13} - 10^{17} W/cm².

Specific studies-

- 1. Ion/X-ray emission in targets of different atomic numbers***
- 2. Effect of laser pulse parameters on ion/X-ray emission.***
- 3. Study of self focusing of laser beam in plasma with Schlieren/optical shadowgraphy***
- 4. Scaling of ion current/X-ray emission with laser intensity***

Diagnostics:

- ***X-ray diagnostics- X-ray pin hole camera***
 - ***X-ray diodes (time and space resolved)***
- ***Particle diagnostics- ion collectors***
 - ***Electrostatic ion energy analyzers***
- ***Optical diagnostics - Shadowgraphy***
 - ***Interferometry***

Relevance of experiments:

Laser based ion/X-ray sources have several applications

Ion source – Ion implantation studies

- highly charged heavy ion source for preinjector for large colliders

- hybrid ion sources- combination of LIS and Electron cyclotron Resonance ion source

X-ray source – emission over a wide range of wavelengths → Studies in Material science

Scientific and Technical Profile of High Pressure Physics Division of Bhabha Atomic Research Centre, India:

- ***More than twenty years experience in science and technology of High Power Nd:glass Laser Development (10J,300ps)***
- ***Experimental programs in Laser-plasma physics***
- ***Numerical simulations of laser plasma, laser driven shock***

1980- 1985 → 50Joule/5ns Nd:glass laser

Plasma Diagnostics → Optical shadowgraphy, Optical interferometry, X-ray K-edge spectrometer, X-ray pin hole camera, ion collectors

1985- 2005 → 10 GW/100ps Nd:glass laser

30 GW/ 300-800 ps Nd:glass laser

1TW/100 fs Nd:glass laser

***Plasma Diagnostics → Optical streak camera
for shock velocity***

VISAR for particle velocity

Ideal as Host Lab

Scientific Collaboration with-

- ***PALS laser-plasma group,
Inst.Physics,Academy of Science, Czech
Republic – 1KJ,400ps,***

1.33 micron

- ***Institute of Plasma Physics and Laser
Microfusion, Warsaw,Poland***

HOST LABS

Proposed mode of operation:

- 1. Total time duration- 3 to 4 weeks for experiments and analysis***
- 2. A group of 10-15 participants along with mentors from host lab***
- 3. New diagnostics can be introduced by participating groups***
- 4. First week- set up plasma diagnostics on-line
second and third week- Experiments
Fourth week – Analysis of results***

Proposed out put:

At the end of four weeks,

- Enough data should be generated which can lead to a journal publication- not just training***
- Hands-on experience on several on-line laser-plasma diagnostics***
- Experimental techniques***
- Theoretical calculations/simulations***
- Some experience on High Power Lasers and Laser diagnostics***

Financial Requirements:

Travel and subsistence

Boarding and Lodging

Scientific Equipments and consumables

Conference expenses