Characterization of the Streak Camera for use as a Plasma Spectroscopy Diagnostic in the Magnetically Insulated Line Oscillator

A. Kuskov, G. Shipley, L. Lehr, Jorge Romero and S. Portillo

Department of Electrical and Computer Engineering University of New Mexico, Albuquerque, NM

Abstract

The MILO (Magnetically Insulated Line Oscillator) is a cross-field co-axial device capable of generating high power microwaves. MILO was designed to operate at 1.1 GHz at 500 kV, with an operating current of 45 kA and a design pulse length of 100-300ns was built by the Electrical and Computer Engineering Department at the University of New Mexico, to study plasma beam interactions. High voltage and the low impedance of the device produce a high current that self-insulates and propagates between the coaxial cylinders. The outer conductor includes a slow wave structure to couple the energy of the electrons to RF (radio frequency). During the experiment atoms desorb from the surface of the cathode forming impurities, that make an impact of the working process of MILO. Due to these impurities around the cathode, high energy electrons ionize molecules around the cathode producing plasma. In order to detect and study the behavior of this plasma we need to characterize a streak camera, that will be used to detect light from 200 nm to 850 nm. The characterization of the streak camera will be done using a comb generator which will divide the laser beam into 5 sectors, in order to characterize the total span of the camera’s tube. The temporal and spatial response and resolution of the streak camera will be given. This characterization will aid in the reduction of spectroscopic plasma data and in the analysis of the results. This poster presents the results of the characterization of the streak camera in the time and frequency domains as well as the procedure used.

Introduction

The goal of this experiments was to completely characterize a streak camera for future MILO spectroscopy diagnostics in optical and time domains.

Approach

The outline for the characterization of the streak camera had the following procedure.
1. Set the comb generator to output the train of pulses
   - The comb generator needs to be triggered multiple times in order to create the constant signal of light
2. Align the beam with the lens of the camera
3. Acquire the image from the comb generator
4. Analyze the image using MATLAB/IDL software
   - Calculate/measure the light beam width
   - Integrate the light intensity with beam width boundaries (See Results section)
   - Repeat the experiment with natural density filter

Results

Graphs on the left show the light intensity at different locations. The white light has higher amplitude because the streak camera has a better frequency response to the white light (a sum of multiple frequencies) and a monochromatic laser.

Equipment used

Hamamatsu Streak Camera - Model C5680
Units used: M5676, M5677
Temporal resolution: 2ps (For M5676) and 5ns (For M5677)
Sweep time:
   For M5676: 0.2, 0.5, 1, 2, 5, 10, 20, 50 ns/ full screen
   For M5677: 5ns-1ms/ full screen
Input optics: A1976 spectral transmission 400-1600 nm
Streak tube: N5716 spectral response 300-1600 nm
CCD camera: 8bit

Comb Generator EG&G streak camera cal sources
Aluminum Gallium Arsenide Laser 50mW
Wavelength range 750-850 nm
Class IIb Laser
Trigger: +5V TTL
Comb train of pulses with pulse width 2ns DC 50%

BNC Delay Generator 725 Multi-Trigger Delay Generator
Trigger-pulse: delay 50ns-1370ns
Trigger-pulse duration: 7.7us-1370s
Max output +5V or -5V

Optical equipment
Single mode fiber optical cable with 5um diameter.
Operating wavelength 750-990 nm
Natural density filter OD 0+2

Software
HPD-TA version 9.1
Matlab R2012b (8.0.0.783)
IDL v. 6.3

Conclusion and Future work

The future work will include complete characterization of a streak camera, in a wide range of sweeps and special resolution. Not all the goal were achieved yet, due to some technical difficulties, however a finalized characterization will be performed. Some changes will be made, such as a purchase of a new CCD camera with a lower noise level and higher resolution. Also a MATLAB program will be completed to perform powerful and easy-to-use commands. After completing the process of characterization and image processing, we can start using software/equipment to perform analysis on MILO produces plasma.

References