TENDER No. TL56 2017 03001401

Expression of Interest (EOI) for design, development, realisation and supply of Laser Induced Fluorescence (LIF) set up for characterization of Hall-Effect Thruster (HET)

1.Introduction

Liquid Propulsion Systems Centre (LPSC), Valiamala, Thiruvananthapuram, India is established under the Indian Space Research Organisation (ISRO) for the design and development of different types of rocket engines and stages for its launch vehicles and spacecraft. LPSC developed Hall-effect Thrusters at different thrust levels for use in spacecraft propulsion systems. An advanced state of the art Laser Induced Fluorescence (LIF) set up is planned to be setup at LPSC to characterise the Hall-effect thrusters.

Attention of reputed companies, organisations/research laboratories either individually or as a consortium is drawn for submitting the EOI for the design, development, realisation and supply of Doppler effect based Laser Induced Fluorescence set up, in a timely manner to meet the above purpose. In the case of consortium, there should be a prime contractor who will be responsible for the execution of the system.

2.0 Scope of the work

The scope of work covers

2.1 Design of the LIF system to meet the specifications which will be reviewed and subsequently approved by LPSC.

2.2 Procurement of components and equipment as per the design specifications.

2.3 Integration of the system and demonstration of adequate system performance as per the requirement in different phases.

2.4 Training to LPSC personnel for system operation and maintenance.

2.5 Maintenance of the system as per mutual agreement.

3.0 Technical details of the proposal

Hall-effect Thruster (HET) is an electromagnetically controlled plasma device. The fundamental operating principle of HET is to create localized and confined plasma followed by a careful and controlled conversion of the large ionic population of the plasma into an ion beam, by means of directional acceleration which eventually provides the thrust.

Doppler-effect based LIF diagnostics system is required primarily for measuring the ion velocity distribution and in situ magnetic field using hyperfine splitting of spectra at several points inside and outside the discharge channel of the HET. Other derived physical parameters like electron temperature, ion temperature and ion concentration are also need to be determined. The system must utilise advanced techniques in the field of high frequency locked diode lasers, electro- optics components and hyperfine resolution spectrometers to enhance the reliability and accuracy of the system.

4.0 Development Phases

LIF system is proposed to be developed in two phases.

Phase-I: Design and demonstration of a single channel system. Single laser source module and detector shall be developed for demonstration of the system in a bench top Xenon (Xe) plasma lamp including provision for variable external magnetic field.

Phase-II: Demonstrated system in Phase-I for single module has to be extended to a multichannel system for observing several locations in the plasma volume simultaneously with the actual plasma thruster in vacuum facility which is the final configuration envisaged under the EOI.

Details of Phase-I and Phase-II activities are described in the annexure.

5.0 Commercial details of the proposal

Vendor shall have previous experience in design and development of Laser based diagnostics systems. Documentary evidence of the same shall be submitted along with the EOI. The company shall be financially strong to execute the work under this expression of interest and must have experience of at least three years in this field.

The following commercial details of the company and proposal shall be submitted along with the Expression of interest.

5.1 Annual turnover for the last three years

5.2 Proof of experience in the field for 3 years

5.3 List of customers in Aerospace or Scientific area

5.4 Details of similar systems realised

5.5 Company website

The call for EOI does not carry with it any guarantee for allotment of work.

6.0 Delivery period

Timely delivery is the essence of the contract.

Phase-I shall be demonstrated within 6 months of receipt of the purchase order.

Phase-II activities shall be carried out within 4 months after Phase-I or on a date as mutually finalized by the party and LPSC at our premises.

7.0Mode of operation of tender

7.1. In the first stage, companies have to respond to this Expression of Interest (EOI) explaining their capabilities and expertise to execute the proposed work. **No price is to be quoted.**

7.2 Companies who fulfil the commercial and technical terms may be called for a technical presentation within 3 weeks of last date for submission of Expression of Interest.

7.3 Based on the discussions so held, detailed technical specification shall be firmed up.

7.4 In the second stage, techno-commercial and price bid will be invited from short listed vendors on two part bid basis.

7.5 Final selection will be based on techno- commercial evaluation and price bid.

8.0 Payment terms: Payment terms will be finalized based on mutual discussion between the party and the department.

9.0Date of submission of EOI:

Interested vendors may submit their Expression of Interest in a sealed envelope superscribing the " **Reference number of this advertisement and EOI No. TL56 2016030014 due on 26.09.2017, 1600 hrs** " so as to reach LPSC on or before **26.09.2017, 1600 hrs** to the following address:

The Sr.Head, Purchase & Stores
Liquid Propulsion Systems Centre
Valiamala, Thiruvananthapuram – 695 547
Kerala, India

The cover should indicate " **SENDER'S** " address. For any clarification you may contact us at following phone/Fax Nos.

Telephone : 0471 2567813

Fax : 0472 2800712/0471 2567305

EOI received after due date and time will not be considered.

Annexure

Doppler-effect based Laser Induced Fluorescence setup design for characterization of Hall-effect thruster

1.0 Introduction

Hell-effect thruster is an electric propulsion device suitable for interplanetary missions. They involve the use of a gas that is ionized by the electron cloud created close to the channel exit by the shaping of the magnetic field. As, the ions get accelerated through the potential drop, they are thrown out of the channel. Electrons are released from the cathode kept externally to maintain charge neutrality. Ion velocities that are along the axis contribute to thrust and the normal component causes erosion of thruster wall. LIF system is to be developed for the ion velocity distribution and in-situ magnetic field along with the derived parameters. The proposed system must utilize most advanced techniques in the fields of high precision frequency locked diode lasers, electro-optic components and hyperfine resolution spectrometers in order to make the operation smooth and rapid compared to existing systems. A scheme solicited here should have clear edge over the existing systems in use, in terms of ease of operation, locking, quality and quantity of data acquired, etc. Most important aspects to be addressed while designing the hardware are radical simplification in the method used to lock and detune the laser and the flexibility in the data assimilation and post processing with latest technological advancements in the afore mentioned fields and their commercial availability.

2.0LIF System specifications

In Hall-effect thruster, considering the velocity of ions varying from 0 m/s to 22 km/s, the maximum shift to be detected corresponding to Doppler shift due to 22 km/s velocity is 0.061 nm (26.4 GHz). The resolution in terms of wavelength or frequency of collected photons is determined by the accuracy required in velocity measurement. The shift to be detected is 0.00028 nm (0.12 GHz) over the excitation wavelength of 834 nm (3.6 PHz), for the required 100 m/s accuracy in velocity measurement. As reported by other investigations, for a typical 1 mm^3 volume in near field of SPT-100 (a well-known Hall-effect thruster tested by Fakel Russia) with injection intensities closer to saturation, produces on an average 0.01 fluorescence photon per micro second whereas the plasma environment produces nearly 1 photon per micro second from the background. This keeps stringent requirements on source and detector side equipment.

It is also proposed to use multiplexing for phase-II system, during a single laser scan for observing multiple points at an instant of time. It is required to have a rapid laser scan over +-10 GHz by efficient data assimilation and time correlation. 3-axis translation stage has to be provided for moving the target with a high accuracy for changing the set of observation points.

Table1. System specifications

S. No.	Parameter	Specifications
	I. Source side requirement	
1.	Laser wavelength	830 nm ± 10nm
2.	Laser power	1.5 W minimum
3.	Laser line width	Better than 10 kHz
4.	Laser locking stability	Better than 10 MHz for minimum 2 mins
5.	LIF scan (over a range of 20 GHz) time for one interrogation point	2mins nominal
	II. Detection side requirement	
6.	Rate of sampling	1 MHz.
7.	Minimum number of simultaneous interrogation points (use of multiplexing)	5
8.	Monochromator	high resolution better than 0.01 nm at 540 nm
9.	Photon detector	High quantum efficiency (better than 55%)
	III. Translation stage details	
10.	Full range of x,y,z translation	±25 cm in all the directions
11.	Accuracy of the translation	0.1 mm
12.	Hardware to be loaded	Dimensions: 50 X 50 X 30 cm Weight: 50 kg
	IV. Additional requirements	
13.	DAQ system must be multi-parameter, fast, should also record parameters like breathing mode oscillation along with other data signals to enable time-averaged and time-resolved analysis from same data sets.	
14.	Optical couplings between laser beam preparation and the injection and collection optics must be optical fiber based.	
15.	Mechanical shutters for all the internal optical components as required.	
16.	All operations including translation stage, optics shutters, laser controls and other related components must be remotely operable via suitable interface.	
17.	All the components to be installed inside vacuum chamber must be high vacuum compatible.	

18.	Adequate framework for DAQ system and LAN protocol.
19.	Vendor must provide mechanical fixtures to hold the optical components at desired location with desired vibration tolerances.

3.0 Implementation of the LIF system development

LIF system is proposed to be developed in two phases. The final product required is a multi-channel system for measuring ion velocity distribution function at several points inside a plasma volume existing in a vacuum chamber at an instant. The system is proposed to have a modular design with each module capable for single point observation in space.

Phase-I: First phase of the LIF system development is required to implement a single module of the proposed configuration and demonstrate performance on a plasma volume inside a Xe discharge cell. The phase-I system will be used for system characterization and calibration, creating conditions inside the plasma volume similar to the ones that exist in real Hall thruster firing. The effect of an externally applied magnetic field will be studied in the system to calibrate the Zeeman splitting of the hyperfine spectra with respect to the in-situ magnetic field applied. The phase-I system is proposed to be a test-bed for generating calibration data for phase-II multi-channel system operating on plasma volume inside a vacuum chamber. Design demonstration of a single channel system is to be developed with single point observation capability inside a plasma lamp. Single laser source module with the required (stated later) precision, line width and stability, associated detuning mechanism must be developed. Similarly, one detector side system is to be developed for demonstrating the capability of ion velocity measurement.

Phase-II: The demonstrated system in phase-I for a single module has to be extended to a multi-channel system for observing several points in the plasma volume using time-correlated data analysis. The system has to be integrated with a vacuum chamber. The optical elements to be kept inside vacuum must be placed on a rigid breadboard and the LIF equipment outside the vacuum is needed to be several meters away from the plasma source. Optimum performance of the system has to be demonstrated while the operation of a Hall-Effect thruster.