SECTION - C

TECHNICAL SPECIFICATIONS OF STORES AND DRAWINGS.

Scope of tender :

Supply, installation, and commissioning of Hybrid Ti:Sapphire Femtosecond Laser System based on Chirped Pulse Amplification technique which include suitable femtosecond oscillator, regenerative and multi-pass amplifiers and their pump lasers, pulse compressor and other required equipments for the basic operation and measurements as per following specifications:

A. Typical Laser performance

Central wavelength	800±10 nm
Repetition rate	1 kHz and 10 Hz *10 Hz beam should also compatible with*: 10/N Hz (N integer between 1 and 5) operation and Single-shot operation *Note: Energy stability and beam profile for all mode of operation should be same as specified below..*
Pulse duration	100 -130 fs
Pulse duration stability	≤ 5 fs RMS
Pulse energy	≥ 4 mJ @ 1 kHz 100±15 mJ @ 10 Hz
Beam diameter ($1/e^2$)	12-18 mm @ 1 kHz 35-50 mm @ 10 Hz
Spatial Mode	TEM_{00}
Beam quality (M^2)	≤ 1.5
Pointing Stability	< ±100 µrad RMS
Temporal contrast (ASE)	≥ 10^3 @ 1 KHz (pre pulse) ≥ 10^5 @ 10 Hz (pre pulse)
Short term energy stability (up to 15 min.)	≤ 2.0 % RMS

Long term energy stability (up to 3 hour)	≤ 2.5 % RMS
Polarization	Linear, ~ 1:100

Note :

1. The vender should submit the detailed technical design report of the laser system to IPR for review after the order acknowledgment. Architecture layout of the laser system and detailed technical description of different sub-systems of the quoted laser must be included in this report.
   IPR will review this report and issue a clearance to initiate the laser assembly.

2. Following test measurements should be performed at the vendor site:

Central Wave Length	:	Measured with a spectrometer
Repetition rate	:	Measured on Oscilloscope
Beam Profile:	:	Measured with beam profiler
Beam diameter	:	Measured with beam profiler
Pulse energy:	:	Measured with energy meter
Pulse duration:	:	Measured with single shot auto-correlator
Temporal contrast	:	Measured with suitable high dynamic range device
Short term energy stability	:	Measured with data log over 15 min.
Long term energy stability	:	Measured with data log over 3 hour
Pointing stability	:	Measured with CCD camera
Polarization	:	Measured by suitable optical arrangement

3. Vendor should provide the detailed test report of the above specified laser parameters on completion of the laser assembly such that IPR can review the report and depute IPR staff for the inspection.

4. Test measurements related to Central Wavelength, Repetition Rate, Pulse Energy, Pulse Duration, Beam Profile and Energy Stability should also be performed at the time of final installation and commissioning in IPR.

5. The hybrid laser system will be accepted only after the final installation and successful operation in IPR.

B. Component wise descriptions of the laser system

Above laser system shall be equipped with following sub-components to meet the requirements.

1. Hybrid laser system :

(i) ***Femtosecond oscillator***

Mode locked femtosecond oscillator with compatible diode CW pump laser which is suitable to generate 100-130 fs pulse at 800±10 nm.

(ii) ***Pulse Stretcher***

Pulse stretcher should be based on diffraction gratings.

(iii) ***Ti:Sapphire regenerative amplifier (RGA)***

Ti:Sapphire regenerative amplifier (RGA @ 800±10 nm, 1 KHz), pumped with Nd-YLF laser pulse having suitable pulse energy @ 1 KHz.

(iv) ***Nd:YLF pump laser***

Diode pumped, highly Stable Nd-YLF laser for pump the RGA @ 1 KHz as per following specifications

Wave length	527 nm
Pulse energy	as per requirement
Repetition rate	1 kHz
Divergence	< 10 mrad
Pointing Stability	< ± 30 µrad
Energy stability	< 0.5 % RMS

(v) ***Multi-Pass amplifier for 1 KHz beam line***

Ti:Sapphire Multi-pass amplifier pumped by highly Stable Nd-YLF laser pulse @ 1 kHz.

Both RGA and MPA@ 1 kHz should have the common Nd-YLF pump laser. This stage shall be avoided if the RGA itself can meet the required energy at 1 kHz

(vi) ***Pulse Compressor for 1 KHz beam line***

Pulse compressor based on diffraction grating which is compatible for compressed energy >/= 4 mJ @ 1 kHz.

(vii) ***High energy Multi-Pass amplifier for 10 Hz beam line***

High energy Ti:Sapphire Multi-Pass amplifier pumped by highly Stable Nd-YAG laser pulse @ 10 Hz. The uncompressed output energy of MPA should be >120 mJ.

(viii) ***Nd:YAG pump laser***

Flash lamp pumped, highly Stable Nd-YAG laser for pumping the specified high energy Multi-Pass amplifier as per following specifications,

Wavelength	532 nm
Pulse energy	as per requirement
Repetition rate	10 Hz
Pulse width	< 8 ns
Divergence	</= 0.5 mrad
Pointing Stability	< ± 50 µrad
Energy stability	< 1.3 % RMS
Jitter	< ± 1 ns

Note:

Both Nd-YAG and Nd-YLF pump lasers should be the regular product and catalogue item of reputed manufacturer (e.g. M/S Coherent Inc., M/S Continuum, M/S Amplitude Technologies**,** M/S Quantel Laser, M/S Spectra Physics, M/S Innolas Laser)

(ix) ***High energy Pulse Compressor for 10 Hz beam line***

High energy pulse compressor based on diffraction grating which is compatible for the compressed energy >/= 100 mJ @ 10 Hz.

(x) ***Pockels cells***

Pockels cells based (pulse picker/pulse slicer) for selecting the laser pulse at desired repetition rate. Also additional pulse slicer for improving the contrast ratio of high energy beam line@10 Hz.

(xi) ***Synchronization module***

Highly precise inbuilt device for the timing synchronization of the different components, e.g, Pockels cells, pump lasers etc. The synchronization unit should be linked with the supervision software for real time control of the laser. A variable +/- 100 ns (pre-trigger and delayed) pulse with respect to laser pulse is also required for synchronize the different diagnostic systems. Ultra low jitter (< 1 ns), pre-trigger pulse, at least 10-20 ns and amplitude >200 mV from the fs pulse (it may be a fast photodiode pulse at an early stage of the laser system) for synchronization of fast detector is also required.

2. Supervision and control system :

The Laser system should be equipped with multiple CCD cameras/detectors (both far field and near field) and fast photodiode for the real time supervision, control and optimization of pump as well fs laser beam position, beam profile, etc at the critical stages of the laser system. Fast photodiode detector to monitor the mode lock pulse train would be preferred.

3. Computer interfacing software :

Windows based computer interface hardware/software along with the compatible Laptop/desktop computer for remote operation of the laser system.

4. Accessories required along with the above laser system :

The vendor should also quote the following items along with the laser system seperately.

(i) Energy meter /Power meter

(ii) Single shot auto-correlator module (wavelength range 700-1000 nm, pulse width 30-180 fs, 1-10 Hz repetition rate in single shot mode) for laser pulse width measurement.

(iii) Vibration isolation table compatible to quoted laser system (Horizontal Isolation@5 Hz ~85% and Vertical Isolation@5 Hz ~94%, Vertical and horizontal amplification at resonance ~9 dB).

(iv) Frequency doubler , compatible for amplified out put @10 Hz line.

(v) Required water-cooling units.

(vi) IR Viewer, IR Card and compatible laser safety goggles.

(vii) A list of consumable spare parts for smooth operation of laser system.

(viii) Other recommended measurement tools and diagnostic tools necessary for the smooth laser operation.

Note:

These entire items should be quoted separately. Also all the above accessories must be compatible to the quoted laser system.

C. Laboratory environment information

Vendor should specify in advance, standard laboratory environment required for smooth laser operation. Permisible range of following parameters shall be clearly mentioned in the quotations -

a) Temperature.
b) Humidity.
c) Cleanliness.
d) Foot print of the laser system. Also foot print of associated unit, eg. Power supply, chiller etc.
e) Required space and heat load of different sub-system of laser, like power supplies pump lasers, etc.
f) Power requirement, 230±10V @ 50 Hz (single or three phase).
g) Cooled water (Normal or de-ionised) requirement with pressure and flow rate.
h) Any other requirements.

D. INSPECTION

On completion of the laser assembly a factory test report, consisting of all measured data should be submitted to IPR so that IPR will depute officials for the pre despatch inspection. The performance of the laser system should be validated before the shipment of laser at the vendor's site. IPR staff will be present at the vendor site for inspection, where all the critical specifications mentioned in Sr.No 3 of Section- A have to be demonstrated. The parameters have to be monitored over duration of 8 hours with an interval of 1-2 hour. This detailed test report will be further evaluated in IPR and a shipment clearance will be issued to the Vendor. *Shipment of the laser to IPR will be subject to the shipment clearance issued by IPR after the successful demonstration of all the laser parameters to IPR representative at the vendor's site.*

E. INSTALLATION AND COMMISSIONING at IPR

The laser system will be installed and commissioned at IPR site by the engineers from the principal company. The Laser system will be accepted only after successful installation and operation in IPR. An installation and commissioning report, which includes all the measured data at the time of final commissioning, should be submitted to IPR.

F. TRAINING

Vender should separately organise a complete training program in IPR for IPR user team related to the overall laser system operation and maintenance of the whole laser system. The training shall be inclussive such that the IPR staff should able to perform all the required alignments of lasers system for the day-to-day operation of and also able to assess the health of laser system based on the specific procedure. The duration of the required training should be mentioned in the offer. Duration of dedicated training program must be three to four days after completion of installation of the laser system.

G. After-sales supports

Vendor should also specify the after sales support condition on the following line, which shall be come in to effect after the warranty period.

1. Preventive maintenance visit, all costs included.
2. Supply of critical components over a period of 10 years (e.g. amplifier crystal and diffraction gratings) should be assured.
3. Maintenance service contracts options shall be specified in the offer.
4. A price list of common accessories like flash lamps, mirrors, filters, power supply cards etc. shall be quoted for a duration of three years after warrenty so that in case of a damage of any of this components an immediate replacement shall be possible.

Important Note

1. The complete laser system should be offered as a single package with price breakup.
2. All the optical components used in the laser system should be made by reputed manufacture from Europe / USA / India.
3. The system should be supplied with in six months from the date of purchase order. Also, installation and commissioning of the system should be completed within one month (depending on the availability of visa) from the date of received of the system at IPR.
4. Warranty of the system : The vendor should provide a warranty of at least one year from the date of final acceptance of the laser system in IPR .
5. Quoted/Offered laser system should be the regular product of the vendor and it should be appeared in their catalogue.

Note:

During the warranty period if any part of the complete system requires repairing or replacement, it should be free of cost (that is cost of to-and-fro shipment charges including packing between the IPR and the Supplier's site will be bear by the Supplier). However, IPR will be responsible for the custom clearance charges and any other duty in India.

During the warranty period, if there is a system fault and the supplier/Indian agent takes more than 15 days to rectify the problem and make the laser system operational, the down period should be added to the system warranty period.

Compliance sheet

H. Typical Laser performance

Descriptions	IPR specifications	Offered specifications
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I. Component wise descriptions of the laser system

	Description	IPR Specifications	Offered specifications
1	**Hybrid laser system**		
(i)	***Femtosecond oscillator***	Mode locked femtosecond oscillator with compatible diode CW pump laser which is suitable to generate 100-130 fs pulse at 800±10 nm.	
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(iii)	***Ti:Sapphire regenerative amplifier (RGA)***	Ti:Sapphire regenerative amplifier (RGA @ 800±10 nm, 1 KHz), pumped with Nd-YLF laser @ 1 KHz.	

(iv)	***Nd:YLF pump laser*** Diode pumped, Nd-YLF laser for pump the RGA @ 1 KHz	Wave length - 527 nm; Pulse energy - as per requirement; Repetition rate - 1 kHz; Divergence - < 10 mrad; Pointing Stability-< ±30 µrad; Energy stability-< 0.5% RMS	
(v)	***Multi-Pass amplifier for 1 KHz beam line***	Ti:Sapphire Multi-pass amplifier pumped by Nd-YLF laser pulse @ 1 kHz. Both RGA and MPA@ 1 kHz should have the common Nd-YLF pump laser. (This stage shall be avoided if the RGA itself can meet the required energy at 1 kHz).	
(vi)	***Pulse Compressor for 1 KHz beam line***	Pulse compressor based on diffraction grating which is compatible for compressed energy >/= 4 mJ @ 1 kHz.	
(vii)	**i)** ***High energy Multi-Pass amplifier for 10 Hz beam line***	High energy Ti:Sapphire Multi-Pass amplifier pumped by Nd-YAG laser pulse @ 10 Hz. The uncompressed output energy of MPA should be >120 mJ.	
(viii)	***Nd:YAG pump laser*** Flash lamp pumped, Nd-YAG laser for pumping the specified high energy Multi-Pass amplifier	Wavelength - 532 nm; Pulse energy - as per requirement; Repetition rate - 10 Hz; Pulse width - < 8 ns; Divergence - </= 0.5 mrad; Pointing Stability-< ±50 µrad; Energy stability-< 1.3% RMS; Jitter - < ± 1 ns.	
(ix)	***High energy Pulse Compressor for 10 Hz beam line***	High energy pulse compressor based on diffraction grating which is compatible for the compressed energy >/= 100 mJ @ 10 Hz.	
(x)	***Pockels cells***	Pockels cells based (pulse picker/pulse slicer) for selecting the laser pulse at desired repetition rate. Also additional pulse slicer for	

		improving the contrast ratio of high energy beam line@10 Hz.	
(xi)	***Synchronization module***	Highly precise inbuilt device for the timing synchronization of the different components, e.g, Pockels cells, pump lasers etc. The synchronization unit should be linked with the supervision software for real time control of the laser. A variable +/- 100 ns (pre-trigger and delayed) pulse with respect to laser pulse is also required for synchronize the different diagnostic systems. Ultra low jitter (< 1 ns), pre-trigger pulse, at least 10-20 ns and amplitude >200 mV from the fs pulse (it may be a fast photodiode pulse at an early stage of the laser system) for synchronization of fast detector is also required.	
2	**Supervision and control system :**	The Laser system should be equipped with multiple CCD cameras/detectors (both far field and near field) and fast photodiode for the real time supervision, control and optimization of pump as well fs laser beam position, beam profile, etc at the critical stages of the laser system. Fast photodiode detector to monitor the mode lock pulse train would be preferred.	
	Computer interfacing software	Windows based computer interface hardware/software along with the compatible Laptop/desktop computer for remote operation of the laser system.	