SPECIFICATION FOR

THE PROVISION OF HIGH ENERGY GREEN PUMP LASER

UK SBS PR19082

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Specification Document – Supplies

Title of Request:	**UK SBS PR19082 HIGH ENERGY GREEN PUMP LASER**
Required Delivery Date:	**Must be before March 31th , 2020**

1. Introduction

The STFC is seeking to purchase a high energy green laser; this laser will be used to pump an existing Ti:Sapphire amplifier (Legend, Coherent) and facilitate future laser upgrades. The Legend amplifier consists of a (first-stage) regenerative amplifier (2.8 mJ, 1 kHz target nominal performance) and (second-stage) multi-pass amplifier (800 mJ, 10 Hz, following compression). The pump laser as specified herein is for the regenerative amplifier stage. The age of the Legend system, including the existing pump laser, is now approaching 12 years old and a new pump laser is required due to performance degradation over this period.

The Legend system is a critical component of the CLARA accelerator facility; a £20 M project led by ASTeC, STFC, to construct an electron accelerator delivering 250 MeV electron bunches with femtosecond duration to a variety of target points. The laser light is used to facilitate combined laser-electron beam interactions, as performed by user groups attending the facility during prescribed beam periods of up to six months in duration. As such, the laser system, and therefore the pump laser as delivered, must be exceedingly robust as to delvier consistent performance over the accelerator operational cycle (24/7, 5 days a week).

The parameters outlined herein are based on the original specifications of the pump laser and associated pump laser transport, which are required to deliver the nominal performance of the laser amplifier. These form the essential criteria of the proposal. As we expect the technology to have evolved following the original system purchase, we have extended the performance criteria in a number of areas under ‘desirable’ headings. This will allow greater flexibility in how the system can be used, and extend the lifetime of the system by increasing the performance headroom.

2. Aims & Objectives

Aim: Procurement of a suitable high energy green laser, for use as a pump in an existing Ti:Sapphire regenerative amplifier at 1 kHz.

For specific objectives, see the list of requirements in section 5.

3. Background to the Requirement

This is the first attempt to fully replace the Legend system pump laser. The existing system was refurbished in 2015 following a critical failure in the cooling water, which led to significant thermal damage to the diode bar modules. As of 2019, the system is currently not able to deliver the same output parameters as following the refurbishment without a significant increase in the pump current above accepted 'safe' (as deemed by the installing engineer) levels.

The system is required to facilitate user exploitation of the CLARA facility during 2020 and future years. User exploitation has evolved to become a primary deliverable of the CLARA project and therefore a critical component of ASTeC business delivery. Approximately 50 % of all interest in user exploitation of CLARA is related to combined electron-laser beam interactions; the performance and reliability of the laser system is therefore of significant importance. To reflect the increased importance of laser exploitation as established in recent years, funds for a new laser system have been secured. These funds are dependent on taking receipt of the system prior to March 31st, 2020.

The system will be installed in the Lasers, Terahertz and Terawatt Experiments (LATTE) Laboratory, at STFC Daresbury Laboratory. The LATTE Laboratory is operated and maintained by experts in femtosecond laser systems and applications from the Femtosecond Lasers and Timing Group, ASTeC. The LATTE Laboratory is a environementally controlled, designated laser area, situated adjacent to the CLARA accelerator. It contains a variety of laser systems (including the aforementioned Legend amplifier), specialist laser equipment and diagnostics, in support of a variety of research and development activities.

Users of the laser systems include members of the STFC, academics from university partners from the Cockcroft Institute (hosted at Daresbury Laboratory), and external national and international visitors using the CLARA facility. Servicing of the LATTE laser systems is performed, within reason, by skilled members of the FLT group; in cases in which this is not possible, on-site servicing from company engineers is sought. It is vital to minimise the downtime associated with any system failure, as to minimise the reptutational and business impact due to loss of the laser delivery.

4. Scope

4.1. We require a high energy green laser to be used to pump an existing Ti:Sapphire regenerative amplifier (Legend, Coherent) and facilitate future Ti:Sapphire laser amplifier upgrades.

4.2. The pump laser must be externally triggered to allow synchronous operation of regenerative amplifier output with the CLARA particle accelerator.

4.3. The pump laser must be stable and robust, capable of 24/7 operation over extended periods of time. It is also crucial that any necessary intervention to the laser in case of unexpected failure can be performed with as short a response time as possible, to minimise the impact on user delivery

4.4. The High Energy Green Pump Laser must be delivered by no later than 31st March 2020 .

5. Requirement

The specifications below are the minimum requirements to deliver the experimental programme as currently planned. The specification 'desirable' is used to indicate where improved performance – defined generally as that which facilitates additional programme development – is preferable.

Failure to address the points below or supply requested information may prevent STFC from carrying out an adequate assessment of the tender. In such cases this may result in the tender being excluded from consideration.

Please note that all correspondence with the STFC as part of the bidding process will be made available to all bidders. The tenders should include performance specifications against each of the above parameters. The performance specified in the successful tender will form the basis of any contract.

5.1 Centre wavelength

The centre wavelength **must be 527 nm.**

5.2 Pulse duration

The pulse duration **must be <250 ns.**

5.3 Pulse repetition rate

The nominal repetition rate **must be 1 kHz.**

5.4 Pulse Energy

5.4.1 The pulse energy at laser output window **must be a minimum 20 mJ** at installation.

5.4.2 It is desirable that the pulse energy at laser output window to be a minimum 30 mJ at installation.

5.4.3 It is desirable that the pulse energy at laser output window to be a minimum 40 mJ at installation.

5.4.4 The pulse-to-pulse energy stability **must be <1.0 % rms**.

5.4.5 It is desirable that the pulse-to-pulse energy stability is <0.5 % rms.

5.4.6 It is desirable that the pulse-to-pulse energy stability is <0.25 % rms.

5.5 Beam mode

5.5.1 The beam mode polarization **must be horizontal.**

5.5.2 The beam mode polarization ratio **must be >100:1.**

5.5.3 The beam divergence **must be <10 mrad.**

5.5.4 The nominal output beam diameter at laser output window **must be 3 mm (1/e^2, average of x and y).**

5.5.5 The beam output mode **must be appropriate** for pumping a regenerative amplifier

5.5.6 The beam output **must be circular**, with a min over max ratio better than 80 %.

5.6 Triggering

5.6.1 The laser **must be operated** with user-supplied external 1 kHz TTL trigger, generated from the electrical mains signal at ~50 Hz.

5.6.2 The laser **must be able** to operate continuously in the presence of timing flucations trigger due to mains fluctuations, in which the last pulse (999^{th}) in the 1 kHz train is allowed to be either early or late up to 100 µs.

5.7 Environmental stability

5.7.1 All system optical elements **must be housed in an optically sealed, stable environment.**

5.7.2 It is desirable that above achieved with temperature control and feedback of the sealed environment.

5.7.3 The system **must be able to provide** all stated 'essential' specifications in the presence of room temperature fluctuations of ±1.5°C about 21.5°C and room temperature relative humidity<40 %.

5.8 Routine operation and reliability

5.8.1 As part of the tender, suppliers **must provide evidence** including performance data relevant for the STFC to assess 24/7 facility operation of the laser system; this evidence should include at least one of the following:

- routine warm-up time needed to meet specifications (sections 5.1-5.5);
- expected length of time for which the laser system will operate continuously to performance specifications without intervention;
- power stability of the system over a period of >168 hours continuous operation;
- power stability of the system over a period of >672 hours continuous operation;
- available evidence supporting the reliability of the proposed solution, including contact details of other customers who are willing to provide details of their experience.

5.8.2 The supplier **must guarantee at least one of the following** *as a first response* to a critical fault (defined as a fault requiring direct cavity intervention, such as significant loss in output power):

- laser cavity can be accessed and realigned (etc.) by trained STFC personnel as required to restore operation, following guidelines outlined by the supplier and supplemented if necessary through on-site training (during commissioning) and online/phone advice;
- a service agreement is provided through which a service engineer can restore the system on-site, within a period of no more than five days from first reporting of the incident. The tender response must include details of the suppliers servicing system including organisational structure, location of service personnel and corresponding transit times from service locations to STFC Daresbury Laboratory.

5.9 Interface

5.9.1 The suppliers **must provide** a control interface to enable day-to-day operation of the laser system, both in the laboratory and remotely (defined as the case in which the laser operator is not present in the laboratory, for example control of the laser system through network access).

5.9.2 It is desirable that all day-to-day laser operation aspects, including start-up and shutdown commands, could be monitored and controlled through remote computer interface using serial (or otherwise appropriate) command elements, with the supplier providing the corresponding command list to enable integration by STFC scientists of laser operation with the STFC EPICS particle accelerator controls system.

5.9.3 It is desirable that the diagnostic elements (pulse energy or average output power) could be monitored and controlled through remote computer interface using serial (or otherwise appropriate) elements, with the supplier providing the corresponding command list to enable integration by STFC scientists of laser operation with the STFC controls structure.

5.9.4 It is desirable that all control elements and power suppliers could be housed in 19" rack mount units.

5.10 Warranty and service agreement

5.10.1 A service agreement **must be provided** covering a minimum 12 month period from installation and acceptance. Tender response should include details of the offered service level and warranty on parts, including details of those parts.

5.10.2 The bidders **must provide details** of service arrangements for the U.K., including at least one of the following:

- availability of service engineers for online / phone advice;
- availability of service engineers for on-site servicing of lasers;
- details regarding any change in arrangements that are active at the end of the warranty period;
- See 5.8.2.

5.11 Installation and delivery

5.11.1 The laser system **must be delivered, installed and commissioned at STFC Daresbury Laboratory** whereupon the agreed performance will need to be demonstrated to the customer's satisfaction. Delivery must be before March 31st, 2020.

5.11.2 The suppliers **must provide** information of diagnostic equipment which will be provided as part of the laser system.

5.11.3 The suppliers **must carry out** on-site acceptance testing on all of the following essential (and if offered in the tender response, desirable) parameters. All parameters are to be 'industry standard', as defined or accepted by the STFC. As part of this acceptance, suppliers will provide information on proposed testing procedures, including details of equipment to be used:

- Section 5.1;
- Section 5.2;
- Section 5.3
- Section 5.4.1, (5.4.2), (5.4.3), 5.4.4, (5.4.5), (5.4.6);
- Section 5.5.4.

5.11.4 The suppliers **must carry out** factory acceptance testing on all of the following essential (and if offered in the tender response, desirable) parameters. All parameters are to be 'industry standard', as defined or accepted by the STFC. As part of this acceptance, suppliers will provide information on proposed testing procedures:

- Section 5.5.1, 5.5.2, 5.5.3, 5.5.6

5.11.5 The suppliers **must provide** written confirmation from the supplier the laser system is fully compliant with EU and UK safety legislation. Details of any safety-critical components must be given.

5.11.6 Written progress reports and continuous cost reduction proposals for performance improvements must be submitted to STFC during the contract by e-mail addressed to the

contract supervising officer regularly. This programme must contain sufficient detail to enable progress of the contract and proposed cost improvements to be monitored accurately.

6. Timetable

6.1. Delivery, Installation and Commissioning :

6.1.1 Delivery must be done before March 31st, 2020.

6.1.2 Delivery of the instrument will be made to:

Science and Technology Facilities Council (STFC)
Daresbury Laboratory
Sci-Tech Daresbury
Daresbury
WA4 4AD

The laser system must be delivered, installed and commissioned at STFC Daresbury Laboratory whereupon the agreed performance will need to be demonstrated to the customer's satisfaction.

6.2. Payment terms are defined as follows:

100% upon acceptance of the equipment