RCloud Tasking Form – Part B: Statement of Requirement (SoR)

Title of Requirement	**Provision of Access to Facilities and Support to Enable Filamentation Experiment**
Requisition No.	**1000164651**
SoR Version	**0.1**

1.	**Statement of Requirements**
1.1	**Summary and Background Information**
	To conduct research into laser-plasma filaments generated by laser pulses focused into air both at multiple times the critical power for air (for the creation of laser-plasma multiple filaments simultaneously) and also at or slightly above the critical power for air (for single laser-plasma filament creation). This activity requires a unique combination of the following aspects: • Sufficient available distance (>15m) within a controlled indoor environment in which to meaningfully study filamentation propagation over (*note initial tests likely to be at least over several meters with the aspiration of longer ranges*) • Available distance (>15m) within a controlled indoor environment in which to investigate filament properties of interest both along and at the end of the filament following propagation. (*note initial tests likely to be over several meters with the aspiration of longer ranges*) • Sufficiently high repetition rate (ideally of the order 1 Hz) to allow the collection of sufficiently large data sets over experiment duration. • Ability to focus laser pulses into air at the required critical power for air and many times the critical power in air for both single and multiple filament characterisation. • Availability of suitable optical components and diagnostics to produce and confirm the generation of laser-plasma filaments in air. Until recently no UK ultra intense laser facility is believed to have attempted the investigation of laser-plasma filamentation over significant distance in air before. A BAE Systems funded experiment that included LumOptica is believed to be the first attempt to investigate such laser filamentation at a UK national facility. This was conducted at the SCAPA facility, StrathClyde. While the achievement of the intended aims of the BAE/LumOptica/SCAPA experiment were limited, the attempt demonstrated in air filamentation in a UK facility and many lessons were learnt in the approaches, techniques and equipment used in regards to conducting a future filamentation experiment.
1.2	**Requirement**
	Dstl's FY 21/22 Filamentation Experimental Requirement **Mandatory Requirements** 1. Dstl require laser beam time at a suitable facility to propagate and characterise a repeatable laser-plasma filament over several meters in air initially (>15m as a longer term aspiration) and also to study associated effects of interest with test targets supplied and instrumented by Dstl. 2. Technical, science and engineering resourcing support as required to operate the laser to create laser-plasma filaments, set up the overall experiment (set up to be defined/agreed with Dstl) and data from relevant facility diagnostics are to be provided by the supplier. Note that a joint Dstl/industry team will be participating in the experiment. 3. All the diagnostics and equipment required to operate the facility in a safe and efficient manner for conducting an in air laser-plasma filamentation experiment will be provided by the supplier.

4. Preliminary activities to ensure suitable setup of the laser for reliable production of suitable filaments noting that this will likely require some considerable time and effort prior to the experiment to implement. Provide evidence that these activities have been completed in advance of the experiment for de-risking and planning. Specifically, this is to include:
   - Obtain a Gaussian beam intensity profile at the outset prior to artificial /self-focusing in air.
   - Also have available the option to focus a flat top beam intensity profile when operating in the self-focusing regime.
   - Optimisation and control of the beam focal spot and astigmatism for controlled filament onset and sustainment (which may involve a variety of suitable techniques to achieve).
   - Setup of a probe beam suitable for conducting both plasma density and plasma lifetime (with an associated time window of the order of ns) measurements of produced filaments. This should involve a frequency shifted and time synchronised pick off from the main laser.
5. The supplier shall deliver a minimum of 20,000 laser shots focused in air to obtain laser pulses at multiple times the critical power for air (for the creation of laser-plasma multiple filaments simultaneously) and also at around the critical power for air (for single laser-plasma filament creation) and a full width at half maximum pulse duration no greater than 50 fsec. A sufficiently high repetition rate (of the order of 1Hz) is required to allow the collection of sufficiently large data sets over experiment duration.
6. 1 week of laser and diagnostics setup time prior to the actual experiment to conduct characterisation tests and for the opportunity to observe and understand the laser system configuration and optics required for filamentation. Supplier is to provide Dstl team with assurance/confirmation (i.e. initial measurements verifying filament formation) that the laser is reliably producing laser-plasma filaments in air.
7. A total of 4 weeks consecutive weeks of beam time to be completed by 31 October 2021. It has been assumed 5 day weeks will be worked.
8. Dstl shall set the overall objectives for the experiment and provide a team who will lead in conducting the experiment during this period of facility access. The Dstl team will adhere to a plan for the experiment known as a "Dstl Trial Plan". Dstl will field selected complementary diagnostics for filamentation characterisation, conducting initial data analysis and measuring/observing filament effects on test targets of particular interest. Dstl will also use the opportunity to better understand laser setup and optimisation required for creating in air laser filamentation. It is acknowledged that the supplier may also contribute/ formulate a supplementary experimental plan to deliver the experimental requirements, this could include engineering drawings of the experiment target area specifying the placement of optics, targets, diagnostics, etc.
9. Regular experiment planning meetings are required, at least every month. A formal record of actions and decisions will be produced and agreed following each meeting.
10. Supplier to provide details of facility safety considerations required for informing the Dstl Trial Plan and Dstl Risk Assessment to ensure Dstl staff are able to work safely at the facility. This is to include:
    a. safe systems of work (e.g. Interlocks, warning systems, PPE etc),
    b. relevant risk assessments,
    c. emergency procedures (e.g. emergency access routes, fire points, alarms, emergency circuit breakers etc)
    d. any required specialist/mandatory training
    e. local work instructions for applicable systems/equipment and any required sign off/authorisation
    f. procedures for bringing external equipment and potentially COSHH materials (e.g. scintillators) into the facility
11. The supplier is to provide Dstl with dedicated expertise/support for the setup and operation of:
    a. The laser system and associate optics,
    b. setup and operation of key diagnostics for fundamental laser parameters
    c. Setup and operation of diagnostic(s) to provide confirmation of the successful generation of laser-plasma filaments
    d. Support to Dstl diagnostic setup and assistance in linking diagnostics up to required time trigger signals and IT networks for data acquisition/data backup as may be required.
12. A complete list of confirmed diagnostics (including both facility staff and industrial/academic collaborators as well as Dstl diagnostics) and relative priorities agreed with Dstl at least 2 months prior to the experiment.

13. Provision of suitable work spaces to Dstl and industry staff during the experiment for general computer/office based tasks (access to networks etc) and for setting up and testing diagnostics for the experiment.
14. Provision of key information and data from relevant laser system parameters and facility diagnostics in electronic format within 2 weeks of the end of the access period, or by 30/11/21 at the latest.

Desirable requirements

The following requirements are not essential but are requested should the supplier be able to provide them:

15. An agreed list of critical systems (i.e. External optics, Triggering system, attenuators etc) needed to deliver a laser pulse suitable for delivering single or multiple laser-plasma filaments in air together with confirmed status (from testing) and who is responsible for ensuring each critical system and diagnostics operates correctly in the experiment and a summary of the intended key laser parameters and configuration to be used for generating filaments. The initial draft list is to be identified and further developed at planning meetings, and a finalised list provided (preferably in the form of a technical report) and agreed at least 2 month prior to the experiment.
16. Provision of supporting numerical simulations to inform on suitable beam parameters and conditions for the fliamentation experiment.
17. An engineering drawing of the agreed experiment layout including positions of diagnostics to be provided at least 1 month prior to the experiment.
18. Provision of chirp control for varying filament(s) onset distance (i.e. negative chirp control).
19. Analysis and results write-up in a formal technical report of specific facility measurements/diagnostics key for filamentation creation and confirmation.
20. Proposed high level break down of general activities for experiment (Subject to change):

Timescale

Week 0 – Setup week (pre-experiment tests at a suitable time prior to the experiment).
Setup and configuration of laser system for in air filamentation. Installation and testing of diagnostics.

Week 1 – Initial single filament confirmation and characterisation
Confirmation of reliable single filament production. Optimising and troubleshooting of various diagnostics. Data collection and analysis to obtain statistically meaningful measurements on key filament characteristics of interest including loss measurements.

Week 2 – Single filament parameter scans
Conduct parameter scans at slightly greater than the critical power in the single filament regime. Systematically scan through key parameters of interest and measure effects on key filament characteristics of interest including loss measurements.

Week 3 – Multiple filaments confirmation and characterisation
Confirmation of reliable multiple filaments production. Optimising and troubleshooting of various diagnostics. Data collection and analysis to obtain statistically meaningful measurements on key filament characteristics of interest including loss measurements.

Week 4 – Multiple filaments parameter scans + pack up
Conduct parameter scans at multiple times the critical power to perform initial data collection and analysis/characterisation in the multiple filaments regime. Systematically scan through key parameters of interest and measure effects on key filament characteristics of interest including loss measurements. Industry/Dstl dismantling and pack up of equipment and clear out.

	The Approach **Monitoring progress and main key steps in for delivery of experiment** 21. Agreed list of critical systems and equipment required for conducting filamentation experiment together with identified responsibilities. 22. A complete list of confirmed/agreed diagnostics and relative priorities to be provided. 23. A diagram of the agreed experiment layout including positions of diagnostics to be provided 24. Assurance of the reliable production of laser-plasma filamentation in the week prior to Dstl characterisation tests. 25. Delivery of required training and documentation for Dstl team to safely participate in the experiment 26. Delivery of a minimum of 20,000 laser shots focused in air to obtain repeatable laser pulses at the critical power for air (suitable for single laser-plasma filament creation) and/or repeatable laser pulses at several times the critical power for air (suitable for the creation of multiple laser-plasma filaments simultaneously) and a full width at half maximum pulse duration no greater than 50 fsec. 27. Information and data on laser parameters and relevant facility diagnostics to be provided during/following the experiment. 28. Processing and analysis of specific facility measurements/diagnostics key for filamentation creation and confirmation (specific parameters/measurements for this task to be agreed with Dstl). **Required Supplier Skill Sets for supporting the experiment** 29. The supplier is to provide Dstl with dedicated expertise/support for the setup and operation of: a. The laser system and associate optics, b. setup and operation of key diagnostics for fundamental laser parameters c. Setup and operation of diagnostic(s) to provide confirmation of the successful generation of laser-plasma filaments d. Support to Dstl diagnostic setup and assistance in linking diagnostics up to required time trigger signals and IT networks for data acquisition/data backup (during the experiment) as may be required. e. Expertise to provide processing and analysis of specific facility measurements/diagnostics key for filamentation creation and confirmation (specific parameters/measurements for this task to be agreed with Dstl). 30. Supplier is to confirm how these requirements will be best fulfilled with their available resources. **Methodologies used in the past** *31.* The above outlined approach includes the lessons learnt by Dstl in contracting/conducting Ultra Intense Laser Experiments.
1.3	**Options or follow on work**
	Not Applicable
1.4	**Health & Safety, Environmental, Social, Ethical, Regulatory or Legislative aspects of the requirement**
	• This work requires Dstl, contractor and facility staff to work in a class IV laser facility. The external laser facility is responsible for facility users' health and safety and is responsibility for ensuring that the necessary health and safety courses for user participation have been taken and successfully completed. • The laser system and facility is required to be maintained and the facility providers are responsible for this maintenance. • Dstl trial staff will complete any Dstl laser safety training course and relevant trials related training courses (e.g. manual handling etc) deemed appropriate for this trial by their line management.

	• The external laser facility providers are to provide details of facility safety considerations required for informing the Dstl Trial Plan and Dstl Risk Assessment to ensure both Dstl and contractor staff are able to work safely at the facility. This is to include: a. safe systems of work (e.g. Interlocks, warning systems, PPE etc), b. relevant risk assessments, c. emergency procedures (e.g. emergency access routes, fire points, alarms, emergency circuit breakers etc) d. any required specialist/mandatory training e. local work instructions for applicable systems/equipment and any required sign off/authorisation f. procedures for bringing external equipment and potentially COSHH materials (e.g. scintillators) into the facility

1.5	Deliverables & Intellectual Property Rights (IPR)						
Ref.	**Title**	**Due by**	**Format**	**TRL***	**Expected classification (subject to change)**	**What information is required in the deliverable**	**IPR DEFCON/ Condition**
1	Experimental Planning Meeting minutes/Notes	1 week after meetings	email	TRL2	OFFICIAL	• Agreed decisions and actions.	*Rcloud standard T&Cs shall apply*
2	Critical systems list, responsibilities, agreed key parameters for experiment	At least 2 months prior to the experiment.	Technical report	TRL2	OFFICIAL	• Agreed list of critical systems and equipment required for conducting filamentation experiment together with identified responsibilities and a summary of the intended key laser parameters and configuration to be used for generating filaments. Preferably this information will be provided in the form of a technical report.	*Rcloud standard T&Cs shall apply*
3	Experiment Preparation Activities	At least 2 months prior to the experiment	Summary report/Presentation Slides	TRL2	OFFICIAL	• Evidence that essential preparation specific to conducting filamentation has been completed in advance of the experiment, including: - Obtain a Gaussian beam intensity profile at the outset prior to artificial /self-focusing in air. - Also have available the option to focus a flat top beam intensity profile when operating in the self-focusing regime (as a fall back plan). - Optimisation and control of the beam focal spot and astigmatism for	*Rcloud standard T&Cs shall apply*

						controlled filament onset and sustainment. - Optimisation and control of the beam focal spot and astigmatism - Setup of a synchronised probe beam, ideally tapped off the main laser, suitable for conducting both plasma density and lifetime measurements (with an associated time window of the order of ns) of produced single and multiple filaments.	
4	Diagnostics list	To be provided at least 2 months prior to the experiment.	email	TRL2	OFFICIAL	• A complete list of confirmed/agreed diagnostics and relative priorities	*Rcloud standard T&Cs shall apply*
5	Experimental layout diagram	1 month prior to the experiment.	Any common format - TBC	TRL2	OFFICIAL	A diagram of the agreed experiment layout showing positions of diagnostics.	*Rcloud standard T&Cs shall apply*
6	Training and documentation	Prior to the start of the experiment		TRL2	OFFICIAL	For the Dstl team to safely participate in the experiment prior to Dstl staff conducting characterisation tests.	*Rcloud standard T&Cs shall apply*
7	Deliver a minimum of 20,000 laser shots	On completion of 4 weeks of beam time access		TRL2	OFFICIAL	Focused in air to obtain repeatable laser pulses at multiple times the critical power for air (for the creation of laser-plasma multiple filaments simultaneously) and also at around the critical power for air (for single laser-plasma filament creation) and a full width at half maximum pulse duration no greater than 50 fsec during experimental access period.	*Rcloud standard T&Cs shall apply*
8	Key information and data	To be provided within 2 weeks from the end of the	TBC	TRL2	OFFICIAL	• Provision of key information and data from relevant laser system parameters and facility diagnostics in an electronic format.	*Rcloud standard T&Cs shall apply*

		access period or by 31/10/21 at the latest					
9	Post experiment results and analysis report	Initial DRAFT to be provided by 30th December 2021, final version provided by 31st January 2022.		TRL2	OFFICIAL	• Analysis and results write-up in a formal technical report of specific facility measurements/diagnostics key for filamentation creation and confirmation (specific parameters/measurements for this task to be agreed with Dstl).	*Rcloud standard T&Cs shall apply*

1.6	**Deliverable Acceptance Criteria**

2	**Evaluation Criteria**
2.2	Technical Evaluation Criteria
	The requirements will be evaluated against the requirements in section 1.2 – 1.5 and if these requirements are not met the proposal may be rejected or asked for clarification. Technical proposal demonstrates: • Understanding of the requirement and technical plan to deliver • Experience in relevant technical areas • Delivery and project management plan
2.3	Commercial Evaluation Criteria

Commercial Mandatory Criteria		**Pass/Fail**
C1	The Contractor must provide a firm price for our requirement.	
C2	The proposal must acknowledge and accept the additional Terms and Conditions included within the Tasking Form.	
C3	The proposal must clearly identify any background intellectual property (IP) that the Tenderer intends to use in the execution of the contract, and the Authorities rights with respect to that IP. If no background IP is to be used then a 'Nil Response' must be provided. There must be no limiting IP issues.	