Hyper-Spectral Sensing with Intense Ultrafast Laser Fields

Sponsor

National Research Council of Canada (NRC)

Program

Innovative Solutions Canada

Description

NRC's Security and Disruptive Technologies (SDT) research center hosts research in the field of strong optical interactions with materials and nanostructures, with applications towards improved sensing. High-intensity femtosecond lasers are required to reach the high-field regime of light-solid interaction. Because NRC utilizes materials with widely different properties and with various length scales (nanoscopic to macroscopic), the laser system must efficiently deliver a unique combination of intense and weak fields over a wide spectral range, from deep-ultraviolet to mid-infrared frequencies, at high repetition rate (100 kHz), and with short pulses. The high repetition rate assures the high-field response of small nano- and atomic-scale materials can be adequately measured; the wide spectral coverage enables pumping and probing of material-specific resonances.

In this challenge, NRC is seeking a femtosecond laser system that operates at a repetition rate of 100 kHz and that, starting from a pump laser with a center wavelength of 1.03 ?m and pulse duration of 200 femtoseconds (fs), delivers a minimum of three laser outputs with pulse durations < 100 femtoseconds over wavelengths ranging from the deep-ultraviolet (450 nm) to the far infrared (10 ?m). To ensure a sufficiently high intensity can be reached on the solid target, NRC requires ?J-level pulse energies for wavelengths longer than 1 ?m.

Essential (mandatory) outcomes

Proposed solutions must:

- Be compatible with a femtosecond Yb pump laser (LightConversion Carbide CB3) operating at 100 kHz repetition rate, with a center wavelength of 1.03 ?m, and with pulse duration of 200 femtoseconds and average power of up to 80W.
- Output (O1) mid-infrared femtosecond pulses with a wavelength tunable between 2.5 – 10 µm (potentially with a gap between 4 – 4.3 µm), pulse duration less than 100 femtoseconds, and pulse energy of at least 2 ?J, throughout the wavelength range.

Wavelengths longer than 4 µm must be Carrier-Envelope-Phase (CEP) stable (passive).
- Output (O2) near-infrared femtosecond pulses with 10 femtoseconds duration or shorter, at 1.03 µm wavelength, with at least 3 W of power.
- Output (O3) visible and ultraviolet femtosecond pulses with a wavelength tunable between 450 – 600 nm and pulse duration less than 70 femtoseconds.
- Have all these outputs available simultaneously.
- If cooling is required, water-to-air heat exchangers (chillers) must be provided.
- Operate in laser lab with a temperature of 20°C+/-3°C and 35 per cent humidity.
- Occupy no more than 0.6 m x 4 m of table space.
- Be completely enclosed in appropriate laser-safety containers.

Additional outcomes

Proposed solutions should:

1. Have additional integrated diagnostics, displayed by an integrated software, such as

- near-infrared cameras and photodiodes to monitor alignment and power of the pump beams.
- near-infrared (< 1.2 ?m) spectrometer for monitoring the spectrum of output O2.
- mid-infrared beam profiler covering 2 – 16 µm wavelengths.
- mid-infrared spectrometer, covering at least 2 – 10 µm wavelengths, operating at least at 1 Hz (1spectrum/second).
- Visible-ultraviolet spectrometer to monitor output O3.
- Pulse measurement device (autocorrelator, FROG, …)

2. Allow software selection of the wavelengths of the tunable outputs.
3. Extend the wavelength range of output (O3) to below 450 nm, and between 600 – 850 nm.
4. Provide one additional output (O4) of 35 femtoseconds pulses at a wavelength of 1.03 ?m with more than 70 W of power, not simultaneously available with any other output.
5. Provide one additional output (O5) of 50 femtoseconds pulses at a wavelength of 2 ?m, with at least 4 W of power, simultaneously available with O1, O2 and O3.

Eligibility

Solution proposals can only be submitted by a small business that meets all of the following criteria:

- for profit
- incorporated in Canada (federally or provincially)
- 499 or fewer full-time equivalent (FTE) employees**
- research and development activities that take place in Canada
- 50 per cent or more of its annual wages, salaries and fees are currently paid to employees and contractors who spend the majority of their time working in Canada**
- 50 per cent or more of its FTE employees have Canada as their ordinary place of work**

- 50 per cent or more of its senior executives (Vice President and above) have Canada as their principal residence**

**Calculations must take into account and include affiliated businesses, such as parent companies and subsidiaries, that are either in or outside of Canada.

The program is specifically designed for Canadian small businesses with 499 or fewer employees. Small businesses may partner with individuals or other organizations (e.g., universities, colleges, research organizations, other businesses, etc.) to develop solutions. These partners would effectively be sub-contractors for the eligible small business.

Under Phase 1, the applicant small business must perform at least two-thirds (2/3) of the research and development. The remainder can be sub-contracted to partner organizations.

Under Phase 2, the applicant small business must perform at least half (1/2) of the research and development with the remainder being sub-contracted to another organization.

Funding Availability

Multiple contracts could result from this Challenge.

Phase 1:

The maximum funding available for any Phase 1 contract resulting from this Challenge is: $150,000 CAD excluding applicable taxes, shipping, travel and living expenses, as required.
The maximum duration for any Phase 1 contract resulting from this Challenge is up to 6 months (excluding submission of the final report).
Estimated number of Phase 1 contracts: 2

Phase 2:

Note: Only eligible businesses that have successfully completed Phase 1 will be invited to submit a proposal for Phase 2.

The maximum funding available for any Phase 2 contract resulting from this Challenge is: $1,000,000 CAD excluding applicable taxes, shipping, travel and living expenses, as required.
The maximum duration for any Phase 2 contract resulting from this Challenge is up to 24 months (excluding submission of the final report).
Estimated number of Phase 2 contracts: 1

Note: Selected companies are eligible to receive one contract per phase per challenge.

Maximum Project Value

See Funding Availability

Project Duration

Phase 1

The maximum duration for any Phase 1 contract resulting from this Challenge is up to 6 months (excluding submission of the final report).

Phase 2

The maximum duration for any Phase 2 contract resulting from this Challenge is up to 24 months (excluding submission of the final report).

Special Notes

Please note that research activities carried out in the context of COVID-19 need to adhere to the University of Guelph COVID-19 research principles, policies, guidelines and processes as they may be updated from time to time and communicated on the Office of Research web-page [1].

Deadlines

If College-level review is required, your College will communicate its earlier internal deadlines.

Type	Date	Notes
Internal Deadline	Friday, July 9, 2021 - 4:30pm	Researchers participating in a project where University of Guelph would be a sub-contractor submit all application documents, along with an OR-5 Form, to research.services@uoguelph.ca [2].
External Deadline	Friday, July 23, 2021 - 2:00pm	Once approval is received from University of Guelph for participation as a sub-contractor, eligible Companies submit their application through the Innovation, Science and Economic Development Canada website [3] under "Propose a Solution".

Type	Date	Notes

How to Apply

Researchers participating in a project where the University of Guelph would be a sub-contractor submit all application documents, along with an OR-5 Form, to research.services@uoguelph.ca [2] before 4:30 p.m. EST on July 9, 2021.

Once approval is received from University of Guelph for participation as a sub-contractor, eligible Companies submit their application through the Innovation, Science and Economic Development Canada website [3] under "Propose a Solution" by July 23, 2021 at 2:00pm EST.
For Questions, please contact
All incoming questions regarding this specific challenge should be addressed to SIC-ISC@pwgsc.gc.ca [4].

You can also consult the Frequently asked Questions [5] about the Innovative Solutions Canada Program.

A glossary [6] is also available.

Office of Research

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