Innovative Solutions Canada: Stabilization of quantum measurements

Sponsor

National Research Council

Program

Innovative Solutions Canada [1]

For More Information

For more information, see the funder's website here [2].

Description

Problem statement

Quantum correlation present among the particles of light promises improved metrological measurements with precision beyond what is achievable by classical resources. National Research Council [3] (NRC) has recently established the source of entangled photons at Metrology Research Centre (METRO) [4] in order to push the measurement precision limit in Optical Metrology to what is guaranteed by quantum physics. In measuring quantum entanglement between spatially distributed photons, it is critical to ensure synchronizing a readout-phase between local interferometers as quantum state analyzers (QSAs) and stabilizing their interconnecting optical links against thermal and/or mechanical fluctuations, within the coherence of participating photons. NRC is hence seeking innovators who could build active feedback system(s) for quantum channel stabilization and analyzer synchronization. Together, the resulting system, will enable robust and faithful observation of space-separated quantum states, and will eventually be integrated into quantum network prototype based on three-photon entanglement that NRC is currently developing as a fundamental building block for a scalable quantum Internet. Anticipated applications of the prototype include quantum secret sharing between three users and networked quantum information processing with multiple quantum sensors distributed over a distance.

Desired outcomes and considerations

Essential (mandatory) outcomes (the proposed solution must):

- Consist of a minimum of four interferometers (three optimized for quantum signals centered at 1550.00 +/- 0.05 nm, and one optimized for a pump signal centered at 775.00 +/- 0.01 nm).
- Be able to actively stabilize and control an optical phase within 0.001 radians.
- Have negligible crosstalk noise (greater than 80 dB isolation) from phase-locking laser on quantum signals.
- Yield a high throughput (each interferometer must have a transmission of greater than 80%).
- Have the ability to tune path-length difference of each interferometer at least 10 millimeters with 1 micrometer precision.
- Be able to stabilize relative temporal fluctuation of photon between two spatially separated interferometers on the order of picoseconds.
- Be able to stabilize relative temporal fluctuation of photon among all interferometers on the order of picoseconds.
- Be scalable with additional interferometers.

Additional outcomes (the proposed solution should):

- Be capable of monitoring phase of interlocked interferometers using Labview or Python.
- Be capable of monitoring temperature of all individual interferometers.
- Be capable of monitoring relative arrival time of photons at each interferometer using Labview or Python.

Background and context

Optical channel stabilization is essential for the realization of quantum networks as local quantum nodes are interconnected by interfering independent photons travelled from each network node. This photonic interference measurements require all participating photons indistinguishable in their degrees of freedom (DOFs), i.e. frequency, polarization, space and time. Compared to other DOFs, stabilizing the arrival time of photons, within their typical coherence of O (1 – 10 ps), is nontrivial due to sudden and large thermal and/or mechanical fluctuations throughout the entire system. Such a high-precision time-stabilization system could be expensive and labour intensive as separate hardware (lasers and photon detectors) and feedback mechanism are needed to be integrated into the main quantum system. Therefore, the development of an innovative solution to this problem through the IRAP-ISC challenge program would be time- and cost-effective, and would further support the quantum industry in Canada. Until now, no commercial solution has been provided by enterprises.

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% 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% or more of its FTE employees have Canada as their ordinary place of work*
- 50% 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.

Funding Availability

Multiple contracts could result from this challenge.

This disclosure is made in good faith and does not commit Canada to award any grant for the total approximate funding. Final decisions on the number of Phase 1 and Phase 2 awards will be made by Canada on the basis of factors such as evaluation results, departmental priorities and availability of funds. Canada reserves the right to make partial awards and to negotiate project scope changes.

Maximum Project Value

Phase 1:

The maximum funding available for any Phase 1 contract resulting from this challenge is : **$150,000 CAD**

Phase 2:

The maximum funding available for any Phase 2 contract resulting from this challenge is : **$1,000,000 CAD**

Note: Only eligible businesses that have completed Phase 1 could be considered for Phase 2.

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

Project Duration

Phase 1:
The maximum duration for any Phase 1 project funded by a contract resulting from this challenge is up to **6 months**

Phase 2:
The maximum duration for any Phase 2 project funded by a contract resulting from this

challenge is up to **18 months**

Deadlines

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

Type	Date
External Deadline	Friday, November 4, 2022 - 2:00pm

For Questions, please contact
All incoming questions regarding this specific challenge should be addressed to SIC-ISC@pwgsc.gc.ca [5].

Alert Classifications**Category:**
Funding Opportunities and Sponsor News

Disciplines:
Information and Communications Technology

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Links
[1] https://ised-isde.canada.ca/site/innovative-solutions-canada/en
[2] https://ised-isde.canada.ca/site/innovative-solutions-canada/en/stabilization-quantum-measurements
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