

# MICRO-FLOW CYTOMETRY IN SPACE

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**INTRODUCTION** / INO is a world-class R&D centre specialising in optics and photonics solutions for Canadian industry. INO's expertise covers the full spectrum of optics and photonics technologies including lasers, fibre optic sensors, microfabrication, specialty fibre optics, LIDAR and biophotonics. These have been developed into components, subsystems and systems for space applications, for example, micromachined infrared detectors for earth and planetary observation, a radiation-hardened optical fibre and a fibre amplifier for integration into an OISL. This poster focuses on our development of a miniaturised flow cytometer combining a fibre-based flow cytometer and micro-optics for long-term missions in space.

**APPLICATION** / Immune dysfunction during long flight missions can result in the appearance of opportunistic infections or a decrease in the immunosurveillance mechanisms that eradicate cancer cells. Further, the microbial environment surrounding the astronaut can be responsible for the appearance of infectious diseases in space. Therefore, both aspects must be monitored continuously during long space missions.<sup>1</sup>

**CONCEPT** / Standard laboratories widely use flow cytometry to determine immune function and response. Flow cytometry is a technique for counting, examining and sorting microscopic particles suspended in a stream of fluid, the sheath fluid. A beam of light is directed onto a hydrodynamically focused stream of fluid and each suspended particle passing through the beam scatters light and, if tagged, fluoresces. The scattered and fluorescent light provides physical and chemical information about each individual particle. Their drawback is that flow cytometers are, typically, large instruments that demand constant maintenance, high electrical power consumption and often a highly trained operator.

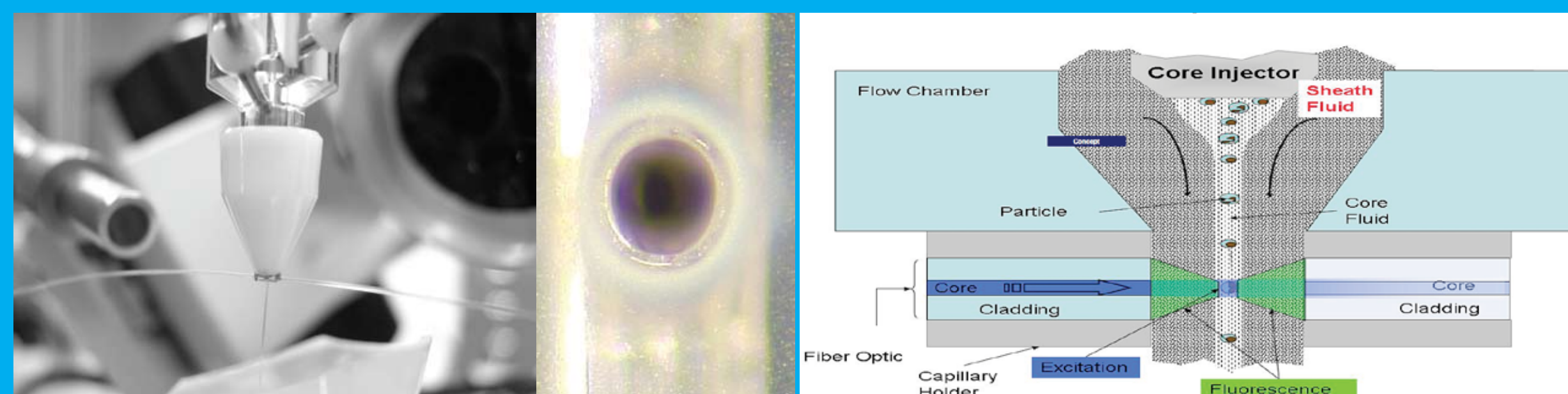
INO's fibre optic flow cytometer consists of a specialty optical fibre through which a hole is transversally bored by laser micromachining. The analyte solution is injected into the hole of the fibre and the particles of interest are detected and counted. The advantage with respect to classic free space flow cytometry is that alignment occurs in the fabrication process only and complex excitation and collection optics are replaced by fibre optics. Further, we take full advantage of the special "counting" fibre by removing the hydrodynamic focusing effect thus removing the sheath fluid. This represents a significant advancement because, although hydrodynamic focusing is highly effective at particle positioning, the use of a sheath fluid increases assay cost, produces excess biohazard material and reduces instrument utility for field and autonomous remote operations. The platform has been demonstrated to be sensitive enough for detection of bacillus anthracis surrogates in spore form, which are less than one micrometer in diameter.<sup>2</sup>

**OBJECTIVE** / To develop a technology platform for the detection of bacteria and other small particles, based on the following design drivers:

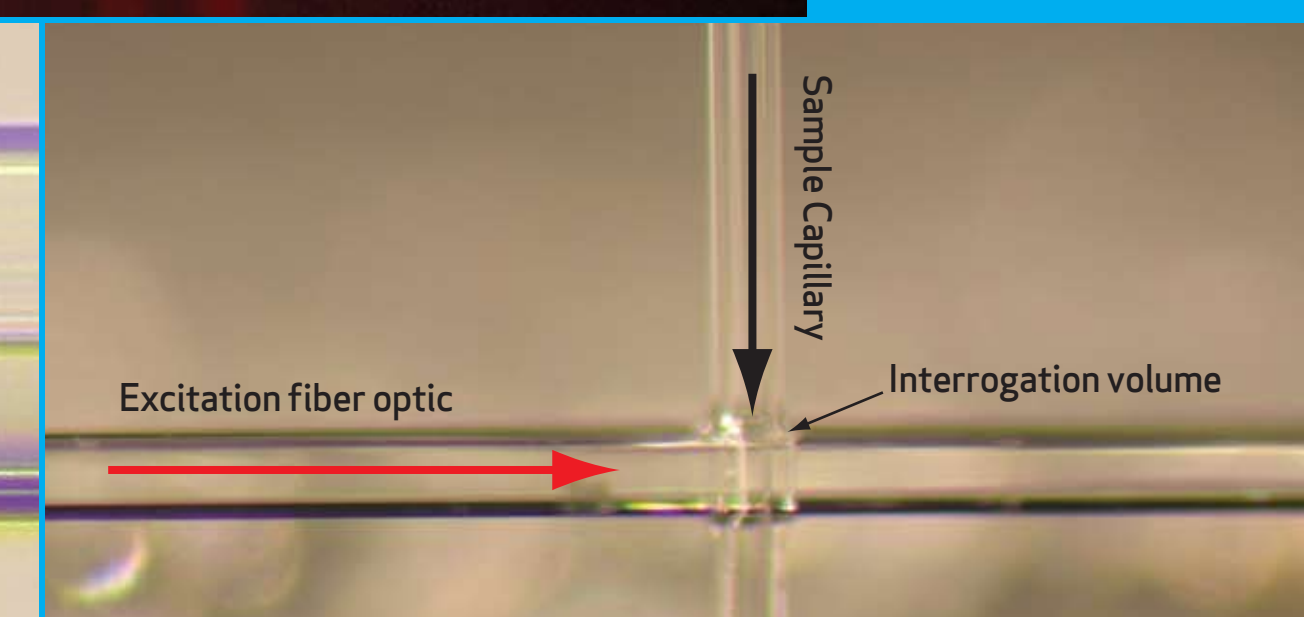
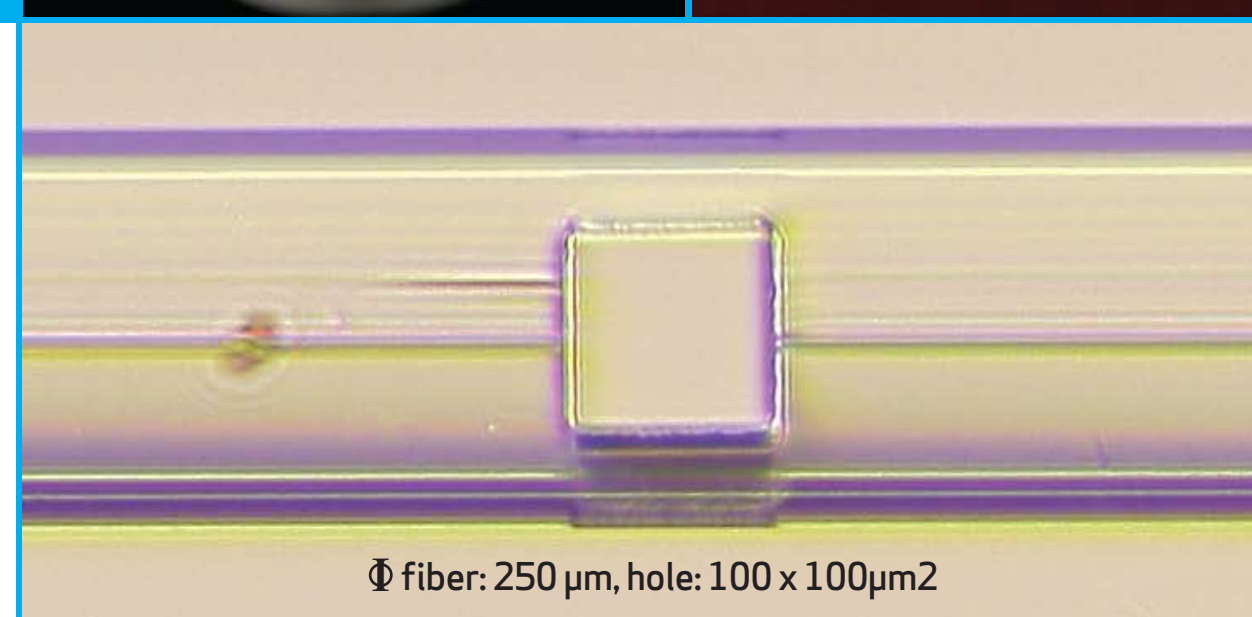
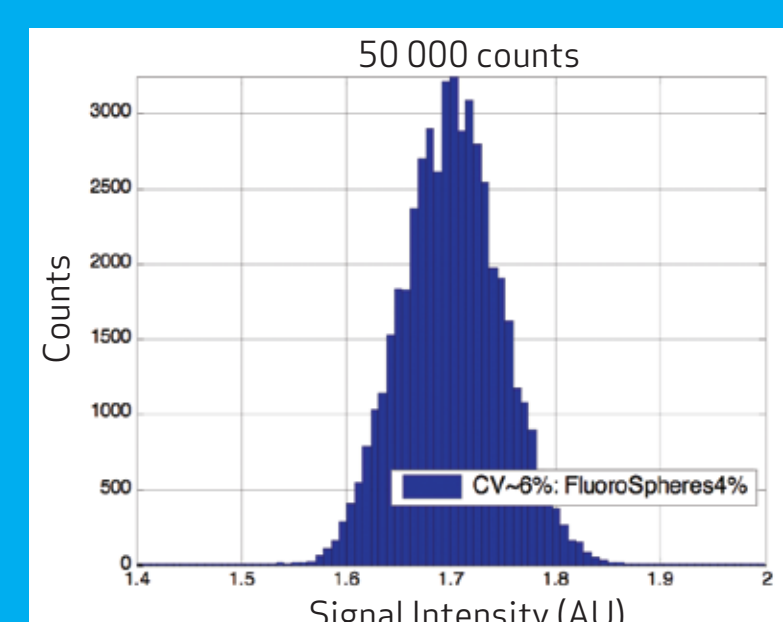
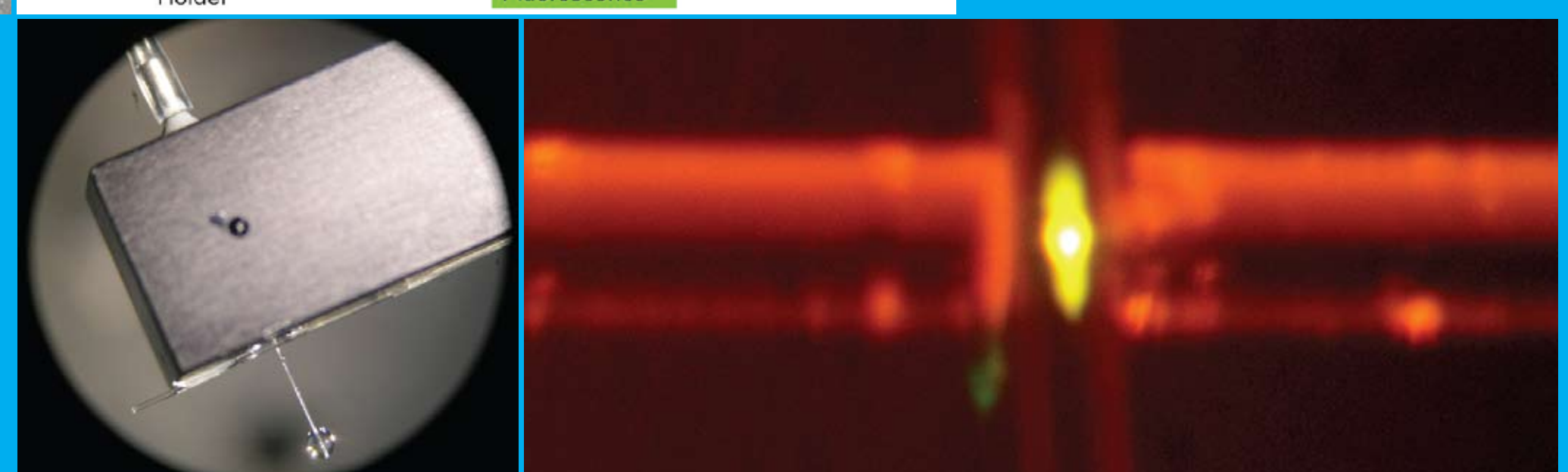
- . Low Cost
- . Reduced number of optical components
- . No need for alignment
- . Ease-of-use
- . Miniaturization and portability

## RESULTS

- . First results demonstrate CVs below 7% with commercial microspheres
- . Side scattering detection is implemented
- . The project will wrap-up with a series of experiments carried out with Laval Hospital and DRDC-Suffield to demonstrate the detection of antibiotic resistance (AR) genes using rapid detection protocols developed by the two. To date, *Bacillus anthracis* spore simulants have been detected in the compact fiber optic flow chamber and work is now ongoing to detect their AR via gene markers



R. Beaulieu et al. "Flow Cytometry Analysis Across an Optical Fiber" U.S. (2006) and Canadian (2007) Patent Applications, Assignee INO



**CONCLUSION** / The development of inexpensive small flow cytometers will enable applications ranging from analytical platforms in support of space flight and defence&security to disease diagnosis and monitoring. The development of a micro flow cytometer with the characteristics needed for space flight (low power consumption, small footprint, low maintenance and robustness) combined with the low cost of optical fibres and microfabrication will also have great impact in point-of-care diagnostics, diagnostics facilities in remote areas and resource-poor countries and in-situ environmental monitoring and control. No commercial micro-flow cytometer has been produced to date.

## REFERENCES

1. Luchino Y. Cohen<sup>1</sup>, Marcia Vernon<sup>2</sup> and Michel G. Bergeron<sup>3</sup>, **New molecular technologies against infectious diseases during space flight**, Acta Astronautica, volume 63, No 7-10, October-November 2008, Pages 769-775.

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2. M. Fortin<sup>1,\*</sup>, I. Noiseux<sup>1</sup>, M.L. Vernon<sup>1</sup>, C. Laflamme<sup>2</sup>, G. Fillion<sup>2</sup>, C. Duchaine<sup>2</sup>, J. Ho<sup>3</sup> **System for rapid detection of antibiotic resistance of airborne pathogens**, submitted SPIE Defence&Security, 2009.

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