Photonic Technologies for Early Detection of Human Disease

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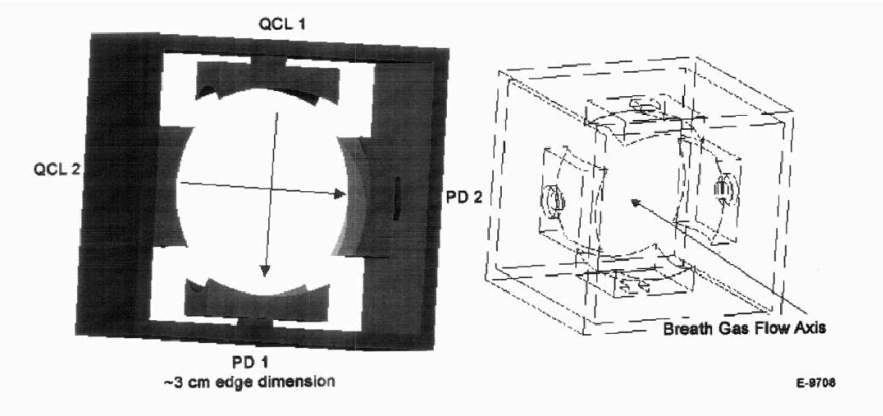

Description

The proposed photonic sensor platform addresses the following:

1. Novel molecular recognition devices suitable for in-vivo use:

The photonic sensor platform directly measures expressed biomolecular processes as revealed through trace gases in exhaled human breath. Through this linkage, it can be at once remote (outside the body) and in-vivo (within the body) in its concept.

2. Novel strategies for in-vivo signal generation and amplification:

The use of resonant optical cavities to enhance the IR absorption signature and recently available, room-temperature quantum cascade lasers in a modular configuration is a novel extension of state-of-the-art photonic technologies.

3. Non-invasive dynamic signal acquisition systems suitable for non-invasive, dynamic signal acquisition from deep tissues and systems of reduced scale suitable for manned space missions:

The photonic sensor platform is ideally suited for long duration space missions, capable of continuous monitoring with near- zero cost per test and no consumption of consumable or hazardous materials. It is completely non-invasive.

4. New tools for feature definition and extraction, including computational and mathematical approaches:

Optimal wavelength selection of the multi-wavelength sensor will allow selected target gas features to be extracted from the high-sensitivity, coarse wavelength spectra.

Innovative Claims/NASA Significance

The proposed photonic platform technology represents an innovative solution to the technical challenges associated with multi-signature analysis and dynamic monitoring of human physiologies for early disease detection. It also uniquely and specifically addresses the limitations on potential technologies that are imposed by the requirements for long-duration manned space missions.

Plans

Year One
1. The proposed list of target gases and relevant concentrations will be refined and ranked according to biophysiological significance.
2. High sensitivity detection of broadband absorbing trace breath gas species will be demonstrated using a conventional multi-pass optical cell configuration.
3. Various cavity-enhanced detection methods will be evaluated according to their suitability for the proposed application based on detection of small molecular weight trace breath gas species.
4. Compact mirror designs will be developed and components purchased for use in the tasks of years two and three.

Year Two
1. High sensitivity detection of broadband absorbing trace breath gas species will be demonstrated using a dual-wavelength optically resonant cavity.
2. Time-resolved measurements of small molecular weight trace breath gas species will be demonstrated using a compact resonant cavity design.
1.1.2.3 Compact, dual-wavelength optical cavities and associated control electronics will be fabricated and tested.

Year Three
1. Time-resolved measurements of broadband absorbing trace breath gas species will be demonstrated using a compact, dual-wavelength resonant cavity design.
2. Time-resolved, multi-species measurements of trace breath gases will be demonstrated using multiple, dual-wavelength resonant cavity modules.
3. An engineering design of a complete prototype breath analyzer for subsequent commercial development will be completed and documented.