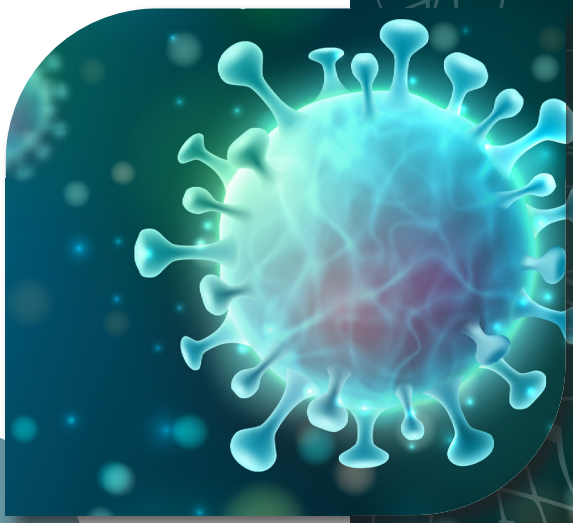
NATO OTAN

Science for Peace and Security (SPS) Programme

NATO SPS Multi-Year Project

SARS-CoV-2 Multi-Messenger Monitoring for Occupational Health & Safety (SARS 3M)



Virtual Launch

Thursday, 27 May 2021

11:15-13:00 (CEST)

Emerging Security Challenges Division

Project Overview

Context

The SARS-CoV-2 pandemic has created many new challenges to society. One of them is how to guarantee safety and occupational health, maintaining a high environmental security.

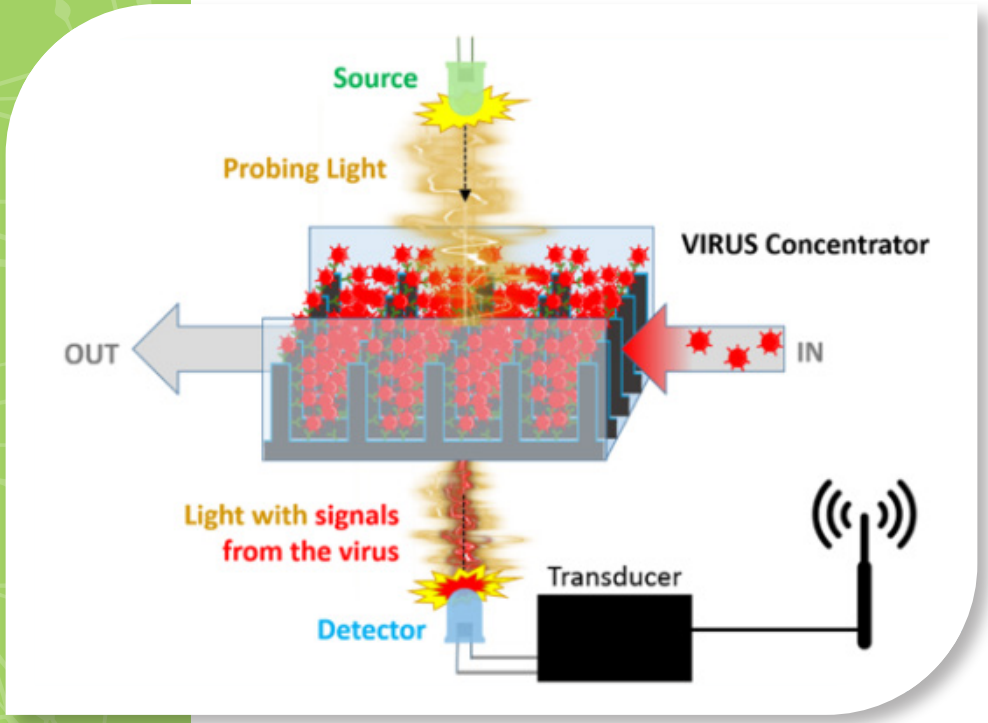
This project proposes an innovative nanotechnology-based platform to monitor the SARS-CoV-2 virus and other toxic bio-agents in the workplace. The project will design new plasmonic nanoporous materials capable of selecting and efficiently adsorb the virus, providing its identification and quantitative evaluation by multi-messenger (infrared and terahertz) vibrational spectroscopy. The combination of nanotechnology and high-sensitivity vibrational spectroscopy will open the way to a cost-effective alternative to existing monitoring techniques.

Goals

- New methodological approach to air-quality monitoring, reliant on the combination of advanced nanotechnology-based platforms and high-sensitivity vibrational spectroscopy.
- Development of an appropriate nanostructured plasmonic platform transparent to terahertz (THz)/infrared (IR) radiation to detect the presence of pathogens.
- Investigation of the potential correlation between SARS-CoV-2 proteins' secondary structures and functionality at various environmental conditions.
- Fabrication of a new biosensor, highly flexible and suitable to the early detection also of other pathogens.
- Development of a fast and economic tool with high sensitivity and selectivity to enhance protection from and prevention of viral infection spread.
- Ensuring a portable and user-friendly solution working in real-time, and marketable on a large scale.

How does it work?

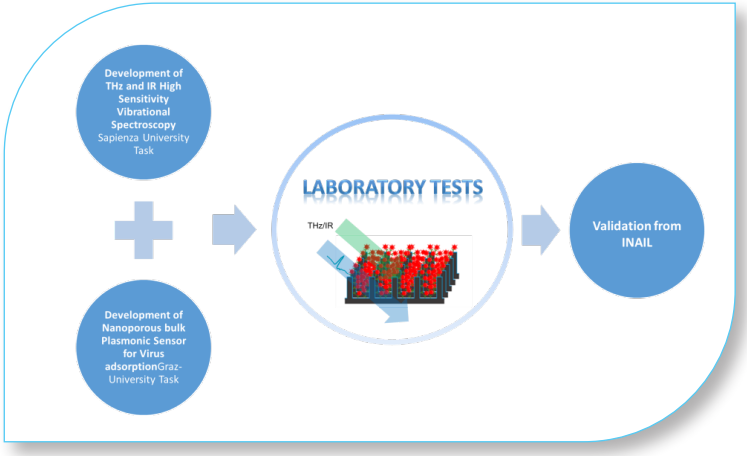
- A nanostructured materials platform is used for active air sampling, like a filter. The sensors are exposed to air-flux, monitoring environmental conditions, such as temperature, humidity, sampling time, flow rate, pressure, etc.
- Air goes through the sensors, and the viral pathogens of interest are trapped thanks to the easy functionalization and/or high adsorption ability.
- THz/IR spectral interrogation techniques are applied on exposed sensors for a highly efficient reading.
- Polychromatic THz/IR radiation source illuminates the sensors and pathogens, and it absorbs the frequencies associated to the roto-vibrational modes of pathogens.



Working principle of SARS-CoV-2 Multi-Messenger Monitoring for occupational health & safety device

Deliverables

1. Design of the biosensor chip and the acquisition, installation and testing of accessories for vibrational THz/IR spectroscopy.
2. First spectroscopic characterization and identification of SARS-CoV, MERS and SARS-CoV-2 spike proteins S and their subunits at various environmental conditions (such as temperature, humidity, pressure, pH, etc...).
3. Realization of 2D Zeolitic Imidazole Framework-8 (ZIF-8) structures by ZnO via CVD on commercially available Silicon/Germanium substrates and their IR/THz spectroscopic characterization, to prevent a loss of the signal in the spectral region of interest.
4. Evaluation of the geometric aspect ratio and density parameters for high pathogen concentration. In particular, 3D pillared biosensors will be realized and optimized, and their performance will be evaluated to gain information about stability, robustness, limit of detection (LOD), signal-to-noise ratio (SNR), sampling effects (such as mechanical stress, sampling time, flow rate, etc).
5. Design of a portable THz/IR spectrometer.
6. The nanostructured chip sensor will be spectroscopically characterized from THz to IR. The reading efficiency of a functionalized microchip will be proven through multi-



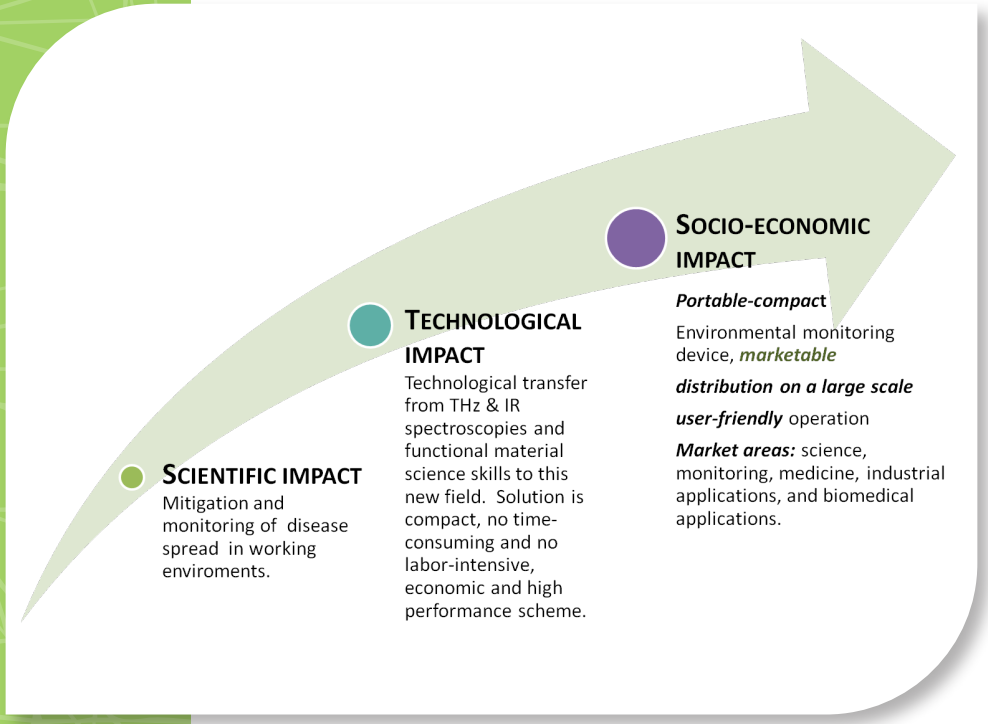
Project flowchart

messenger investigations, starting from the saturated concentration of the analyte on the biosensor towards very low concentrations, in order to reproduce the conditions of a working environment.

Validation of the proposed methodological approach with intercomparison of the results achieved using different methodological approaches for airborne particulate sampling reproducing working environment conditions. A portable spectrometer coupled to 3D nanostructured ZIF-8 sensors will be used in working environments.

Workshops, scientific conferences, scientific publications, and reports on progress.

Impact



Programme

11:15 – 11:45 **Opening Session**

Moderator: Dr. Eyup Turmus, SPS Advisor and Programme Manager, NATO

- **Mr. David Van Weel**, Assistant Secretary General for Emerging Security Challenges, NATO
- **H.E. Mr. Francesco Maria Talò**, Permanent Representative of Italy to NATO
- **H.E. Mrs. Elisabeth Kornfeind**, Ambassador of Austria to NATO and to the Kingdom of Belgium
- **Dr. Deniz Beten**, Senior SPS and Partnership Cooperation Advisor, NATO
- **Prof. Paolo Mataloni**, Director of the Department of Physics, Sapienza University of Rome, Italy
- **Prof. Georg Gescheidt-Demner**, Director of the Institute of Physical and Theoretical Chemistry, Graz University of Technology, Austria

11:50 – 13:00 **Presentation of 'SARS 3M' project**

The project's co-directors will present the project, its objectives, scope and deliverables, including the roles and responsibilities, timelines, communication and meeting plans, and discuss the next steps.

Speakers:

- **Prof. Stefano Lupi**, NATO Project Director (NPD), Sapienza University
- **Prof. Paolo Falcaro**, NATO Partner Country Director (PPD), Graz University of Technology

Introduction of young researchers

Questions and Answers session

13:00 **Meeting Closure**

Participating Institutions

Sapienza University of Rome (Department of Physics), Italy

Founded in 1303, Sapienza is the oldest university in Rome and the largest in Europe. The Department of Physics, is the natural heir of the tradition of Enrico Fermi, Ettore Majorana and Edoardo Amaldi (School of Rome), and is renowned throughout the world for high quality research, in high-energy particles and condensed matter.

Graz University of Technology (TU Graz), Austria

Graz University of Technology (TU Graz) was founded by Archduke Johann in 1811. It is one of the five universities in Styria (Austria) and currently comprises seven Faculties, with more than 13 000 students. TU Graz combines its research into five Fields of Expertise in which researchers work in an interdisciplinary way, both with the regional economy and internationally. This unique ecosystem creates ideal conditions for scientific excellence and technology transfer.

The Science for Peace and Security (SPS) Programme

The Science for Peace and Security (SPS) Programme is an established brand for NATO based on four pillars: science, partnership, security, and unconventional issues (hybrid threats). It has been contributing to the core goals of the Alliance for more than six decades. Today, the SPS Programme continues to be one of the largest and most important partnership programmes addressing 21st century security challenges, particularly cyber defence, counter-terrorism, CBRN defence, energy security and advanced technologies.

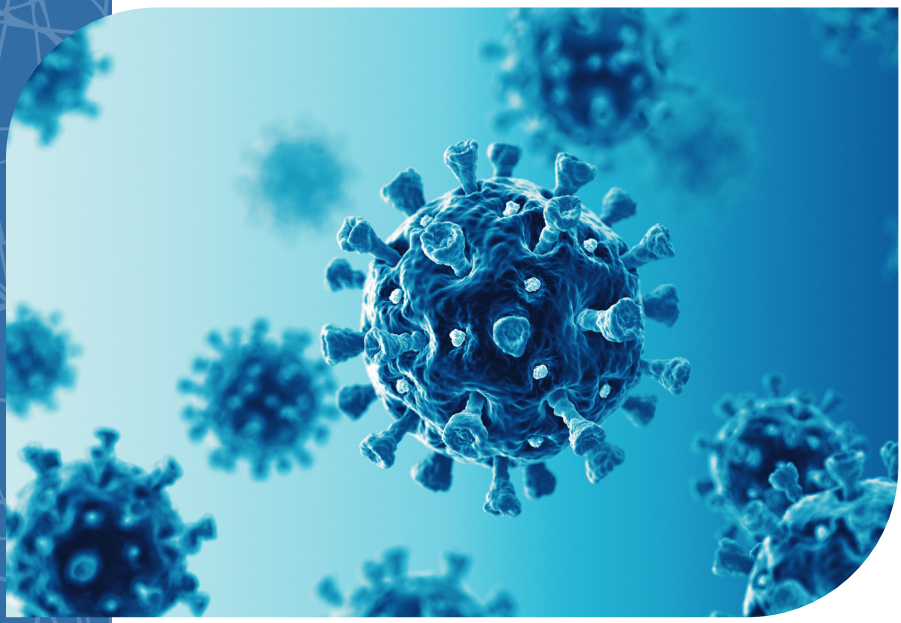
The NATO Science for Peace and Security (SPS) Programme enhances security-related civil science and technology to address emerging security challenges and their impacts on international security. It connects scientists, experts and officials from NATO and Partner countries to work together to address these challenges. The SPS Programme provides funding and expert advice for security-relevant activities in the form of Multi-Year Projects (MYP), Advanced Research Workshops (ARW), Advanced Training Courses (ATC), and Advanced Study Institutes (ASI). SPS activities are always demand-driven, modular, and designed to meet the requirements of the nation(s) and end user(s). The relevance of SPS activities in response to NATO Strategic Objectives and political priorities is reinforced also via special calls, which are issued on an ad hoc basis to draw the attention of the scientific community towards current topics of interest for Allies.

Every year, approximatively 2000 experts participate in SPS activities and help to build capacity in partner nations, and support NATO's security efforts.

More than 20 Nobel Laureates have been involved in the SPS Programme, a testament to the scientific excellence supported by the SPS Programme.

Young scientists are also actively supported through SPS activities, which contribute to broaden their professional network and scientific expertise.

The SPS Programme also has a high public diplomacy value for NATO, providing the Alliance with separate, non-military communication channels by bringing together experts from NATO and Partner countries, often in situations or regions where other forms of dialogue more directly focused on defence and security are difficult to establish. Accordingly, the Programme enables NATO to become actively involved in such regions, often serving as the first concrete link between NATO and a new partner.



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Emerging Security Challenges Division

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