

**SOLEIL after its upgrade will lead to a paradigm shift in the field of biomedical research by making it possible to combine, on the one hand, investigation techniques and, on the other hand, the analysis of the results obtained, all in perfect complementarity with other 4th generation synchrotrons facilities in Europe.**

**Implemented by multidisciplinary teams, this multimodal approach will provide information on a wide range of dimensions (from the nanometer to the centimeter), in order to study, in their globality, biological problems such as those listed below.**

## NEW PATHOGENS

Ebola, H1N1, SARS-CoV-2... There are many emerging viruses that weigh heavily and risk further weighing on global health and economy in the future. These potentially recurring situations require great reactivity, in particular by reducing the development time for new screening methods, drugs and vaccines. So many challenges that science must meet.

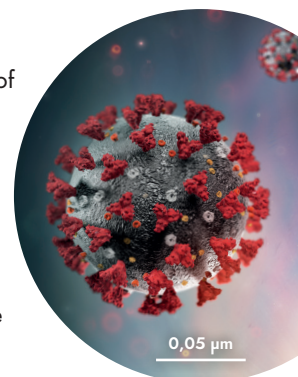
SOLEIL UPGRADE

Increased the brightness and coherence of synchrotron radiation =

Routine use of microbeams of radiation, for serial crystallography combined with micro-fluidics & more powerful imaging techniques.

→ **Better understanding of drug/ pathogen interactions.**

→ **Study of the effects of infection at the cellular and tissue levels.**



## MEDICAL DIAGNOSIS

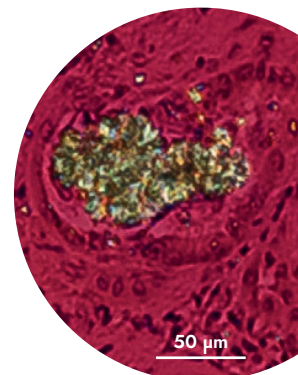
To refine and accelerate their diagnosis, clinicians can use imaging techniques available only at facilities like SOLEIL, for example to identify micro-calcifications linked to pathologies affecting different organs (kidney, thyroid, breast, etc.). Rapid and automated access to these cutting-edge techniques, combined with intelligent data analysis processes, provides the additional information needed to refine the choice of appropriate treatment.

SOLEIL UPGRADE

Increased brightness and coherence of synchrotron radiation =

Qualitative improvement of the performance of various and complementary characterization methods. These methods are based on imaging, diffraction and light scattering techniques.

→ **New multi-scale information: from the atomic level to the scale of an organ.**



## ANTIBIOTIC RESISTANCE

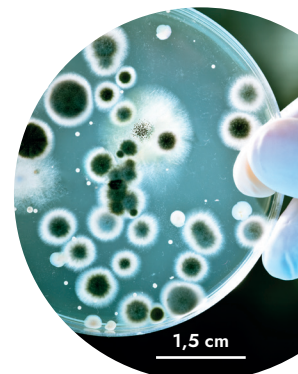
Multi-antibiotic resistant bacteria kill around 700,000 people a year worldwide. Understanding the mechanisms of entry and expulsion of antibiotics by these bacteria are key points in the fight to save lives.

SOLEIL UPGRADE

Increased photon flux on the samples = Gain in quality of measurements.

→ **Coupling of analytical techniques to elucidate the mechanisms of interactions between antibiotics and bacteria.**

More information on back page 



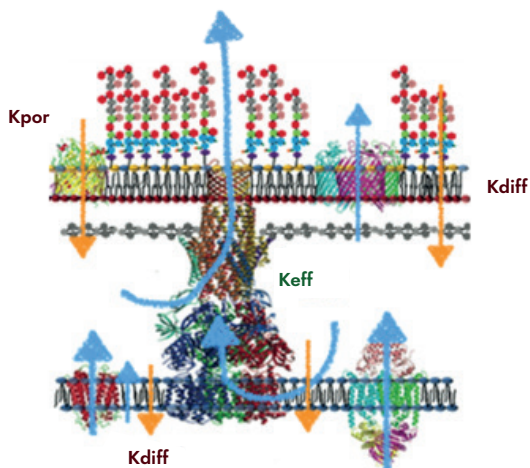


# ONE HEALTH CRISIS CAN HIDE ANOTHER: THE RESISTANCE OF BACTERIA TO ANTIBIOTICS

Masi et al., Nature Microbiology, 2, 17001 (2017)

Vergalli et al., Nature Protocols, 13, 1348–1361 (2018)

The development of bacterial strains that are multi-resistant to antibiotics is constantly increasing worldwide. The massive consumption of antibiotics by farm animals and the lack of new antibiotics (no new class of antibiotics on the market since the late 1980s) result in a growing number of induced problems whose cost is estimated at 1.5 billion Euros in the EU.



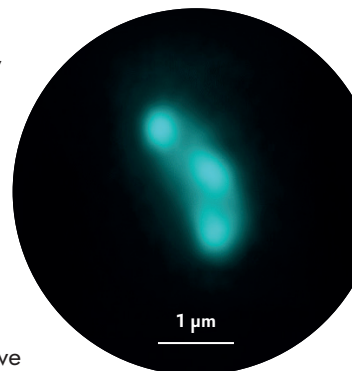
Schematic representing the outflow (blue arrows) and inflow (yellow arrows) of small antibiotics through the two membranes of a gram-negative bacterium.

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## Current responses from SOLEIL:

Within the framework of the European consortium Innovative Medicine Initiatives\*, new synchrotron techniques have been developed to track antibiotics in individual bacteria in real time and elucidate the mechanisms of bacterial responses. Public laboratories and the pharmaceutical industry are using these results to design new antibiotics capable of evading the resistance mechanisms set up by bacteria.

\* <https://www.imi.europa.eu/>



In this E.coli bacterium, antibiotics fluoresce under the effects of UV synchrotron radiation and 3 zones of antibiotic accumulation can be seen.

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& J.-M. Pagès

## UPGRADE OF SOLEIL

- Improvement of the quality of the measurements in terms of:
- spatial and temporal resolution
  - signal to noise ratio



Enhanced coupling of imaging and chemical characterization techniques, over a unique wavelength range



**A state-of-the-art instrument for  
biomedical research**

The SOLEIL upgrade will pave the way for the study of the dynamic localization of antibiotics between the two membranes of gram-negative bacteria. The coupling with structural methods - serial crystallography or cryo-electron microscopy - particularly well adapted to the study of membrane proteins, will allow a detailed understanding of the molecular mechanisms of antibiotic transport within bacteria, and the development of new drug strategies to combat their resistance to antibiotics.



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