Environment

Understanding and better controlling our environment are increasingly key societal challenges.

The development of analytical methods and instruments will allow us to understand the evolution of our interactions with our environment in all its complexity and diversity. To do this, SOLEIL exhibits many assets.

WHERE DOES THE PLASTIC GO?

More than 400 million tons of non-biodegradable plastic are produced each year, a quantity that grows by 3% per year. Their alteration leads to the formation of micro- and then nano-particles that are very difficult to detect.

To fight against this pollution and mitigate the consequences of human activities, it is necessary to understand, and even predict, how these plastics are transported from the continent (soil and freshwater) to the sea, including those present in trace amounts.

SOLEIL UPGRADE

Significant overall improvement in the performance of techniques using low energy radiation (UV, infrared) =
Refinement of the characterization of all (organic) components of plastic.
→ Better understanding of plastic degradation processes and associated pollution chains.
→ Optimization of innovative recycling processes.

AEROSOLS AND CLIMATE CHANGE

Sea spray, forest fires, deserts, but also human activities (pollution, combustion), are important sources of aerosols. With a size varying from one micrometer to a few nanometers, their interaction with solar radiation and the atmosphere has an impact on the average temperature of the Earth and its climate (greenhouse effect).

The study of the origins and compositions of aerosols is essential to understand their fate and mitigate their effects.

SOLEIL UPGRADE

Improvement of the instrument performances on a wide energy range =
Characterization of the chemical processes involved under real conditions.
→ Detailed information on the chemical properties of gases and nanoparticles, natural or anthropogenic.

PRESERVING PLANTS

We depend on plants to breathe or to feed us. The increase in the world's population, global warming and intensive farming techniques are making plants more vulnerable to drought and the rapid spread of pathogens.

Optimizing plant resistance to drought and their adaptation to the emergence of new pathogens: these are the challenges of tomorrow's agriculture.

SOLEIL UPGRADE

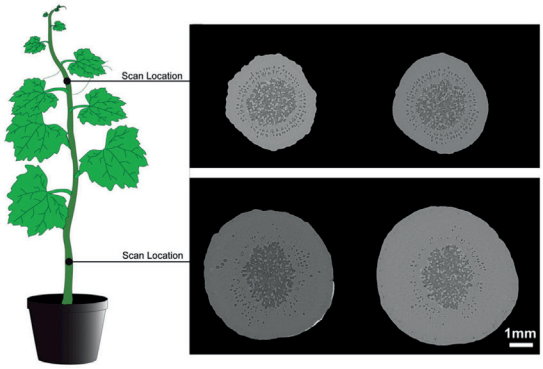
Increased flux, brightness and coherence of synchrotron radiation =
Qualitative improvement of X-ray tomography and scanning microscopy techniques.
→ Non-invasive techniques providing morphological and chemical information (detection of trace elements in plants).

More information on back page

PLANTS
FACING GLOBAL WARMING

Charrier et al., Plant Physiology, 172, 1657-1668 (2016)
Bortolami et al., Journal of Experimental Botany, 72(10), 3914–3928 (2021)

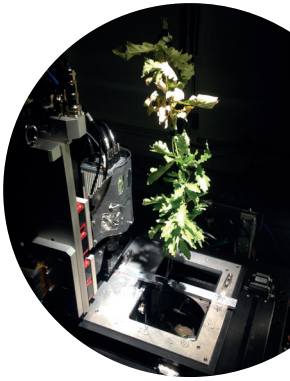
Throughout the world, plants are suffering from global warming. The water they draw from the soil evaporates through transpiration at the level of the leaves and creates a depression in their vessels, which is the real engine of the sap ascent. But if this depression is too high, especially in case of drought, bubbles are formed, which can break the water column: this is embolism. When a majority of vessels are affected, the plant dies.



X-ray tomography images: cross-sections measured at two different heights of a vine before (left) and after (right) its hydration.
©Charrier et al. 2016.

Faced with increasingly intense and frequent droughts, entire forest stands are dying. However, some plants can withstand the lack of water better than others.

What are the most resistant species to select? How do plants and trees adapt? It needs urgent study, from the molecular to the plant tissue scales.



Live oak branch (in a pot) ready to be scanned with SOLEIL X-rays.
©PSICHE Beamline.

Current responses from SOLEIL:
SOLEIL has developed high-resolution, non-invasive 3D imaging instruments that allow direct observation of embolism on intact plants.

UPGRADE OF SOLEIL

Increase in flux and spatial resolution

+

Improvement of contrast

+

Use of beam coherence properties

=

A set of innovative methods for plant biology

The SOLEIL upgrade will allow a dramatic improvement of all 3D imaging techniques, in particular by using different phase contrast methods and by pushing the spatial resolution to limits that are currently unreachable.

These new approaches will thus open the way to multi-scale studies of the vascular system of plants. This knowledge is essential for agronomic and environmental sciences.

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