Institute for Mathematical Innovation

UNIVERSITY OF BATH

# Improving oil extraction processes

Modern oil extraction is highly simulation-driven. Decisions on where to search for oil and where to place oil wells depend on accurate and efficient simulations of the physical processes of oil flow underground. The industry partner for this project, the Institut Français du Petrole Energies Nouvelles (IFPEN), was faced with a changing environment in which its competitors were investing in large efficiency improvements in their simulators. Through making improvements to the numerical simulation algorithms used by IFPEN's software packages, our researchers created a ten-fold increase in simulation speed, creating more efficient and robust algorithms.

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## The challenge

IFPEN needed to maintain its market position as a leader in the provision of software for oil and gas reservoir simulations. IFPEN develops software for the optimal exploitation of existing sites and for simulations of sedimentary basins in order to identify potential new sites. IFPEN's simulator products TEMIS3D and ATHOS were at the time the market leader in basin simulation, and the second most widely used product in the reservoir simulator market, respectively. IFPEN collaborated with mathematicians at Bath to explore new ways to increase the speed of simulation across both products, ensuring that it maintained its position in the market.

## The solution

In collaboration with colleagues at IFPEN, our researchers focused on improving the iterative solution algorithms for the linear systems of equations within the simulation process, designing and implementing powerful multilevel preconditioners to increase efficiency and to reduce significantly the time required for the simulations. Since around 90% of the total computational time was taken up by this part of the simulation algorithm, the impact of the improving the iterative solution algorithms was significant.

## The benefits

The work carried out in this project resulted in a ten-fold increase in the speed of the algorithms used in IFPEN simulations. This has resulted in improvements to the robustness and efficiency of IFPEN's simulations, and in the years following the research, this was reflected in the company's financial results.

*"This was a very rewarding project, where cutting edge mathematical research led to a significant increase in efficiency in industrial software that is used on a daily basis."*

Prof Rob Scheichl,
Professor of Scientific Computing, University of Bath