# Unveiling Fundamental Transport Phenomena in Fuel Cells

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**Keywords**
Fuel Cell; Catalyst Layer Utilization; Oxygen Imaging

**Impact statement**
The results highlight the need to carefully consider non-convenctional variables when developing fuel cells, and that a compromise between performance and durability might be needed. The coupling of thoroughly established techniques with a new and versatile tool displayed in this work, can pave the way to minimize such trade backs in the quest for efficient and durable practical PEFC devices.

**Highlights**
In situ and ex situ spatially-resolved techniques; Reactant distribution impacts in a polymer electrolyte fuel cell; Contribution of convection in heat as well as reactant distribution; Water build-up from neutron tomography is linked to component degradation; Local current densities might shape degradation patterns in fuel cells;

**Abstract**
In situ and ex situ spatially-resolved techniques are employed to investigate reactant distribution and its impacts in a polymer electrolyte fuel cell. Temperature distribution data provides further evidence for secondary flows inferred from reactant imaging data, highlighting the contribution of convection in heat as well as reactant distribution. Water build-up from neutron tomography is linked to component degradation, matching the pattern seen in the reactant distribution and thus suggesting that high, non-uniform local current densities shape degradation patterns in fuel cells. The correlations shown between different techniques confirm the use of the versatile reactant imaging technique, which is used to compare commonly used flow field designs. Among serpentine-type designs, the single serpentine is superior in both equivalent current density and reactant distribution, showing large contributions from convective flow. On the other hand, the interdigitated design is shown to produce larger equivalent current densities, while showing a somewhat poorer reactant distribution. Considering the correlations drawn between the techniques, this suggests that the interdigitated design compromises durability in favour of power output. The results highlight how established techniques provide a robust background for the use of a new and flexible imaging technique toward designing advanced flow fields for practical fuel cell applications.