

Towards 3D Cell Behavior Monitoring with Advanced Electrical Impedance Tomography Reconstruction

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Two-dimensional impedance-based cellular assays [1], such as ECIS, have been widely adopted to monitor key aspects of cell behaviour, including viability, adhesion, and differentiation, in a label-free and real-time manner. As cell biology increasingly shifts towards three-dimensional (3D) models that better capture the complexity of in vivo tissues, there is a need for impedance-based methods that can profile the biophysical behaviour of 3D constructs such as tissue engineering scaffolds, organoids, and spheroids.

Electrical impedance tomography (EIT) offers this possibility by reconstructing conductivity maps within living tissues. Our recent studies have shown that miniature EIT sensors [4] can capture viability changes deep inside tumour spheroids [2] and tissue-engineered scaffolds [3], while integration with optical imaging has improved the fidelity of these reconstructions [5, 6, 7]. Together, these advances demonstrate that EIT can sensitively report on cell survival, differentiation, and drug responses in environments where traditional optical or biochemical assays fail.

In this talk, we will describe our progress towards building a new generation of 3D impedance assays, combining compact sensors with advanced reconstruction [8] and dual-mode approaches. Step by step, these developments are extending the power of impedance assays beyond the 2D monolayer, towards comprehensive monitoring of 3D cell behaviour. This paradigm shift will enable richer phenotyping of organoids, engineered tissues, and regenerative therapies, offering real-time, non-destructive insights into cell state across all dimensions.

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