Nanosecond electric pulses for manipulation of cytoskeletal systems: *in silico, in vitro, in vivo*

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Ultrashort duration intense pulsed electric field (PEF) represents a unique tool to modulate the function of biological systems with potential applications in bionanotechnology and biomedical therapies. However, an integrative understanding of PEF effect from atoms to cells and beyond is missing for the rational development of any potential biomedical/bionanotechnological method based on PEF.

We present our bottom-up approach for the understanding of PEF effects on biomolecular building blocks of cytoskeleton from *in silico*, through in *vitro* and up to *in vivo* approaches. At first, we show our insights into the nanosecond PEF effect on tubulin in molecular dynamics simulations[1]. We leveraged these insights in interpreting our findings on nanosecond PEF ability to modulate tubulin conformation to control the self-assembly of tubulin into microtubules in vitro[2]. Then we demonstrate how the marriage between advanced microfabrication technology and super-resolution technology brought us tools to observe in vivo effects of nanosecond PEF on cytoskeleton network in vivo (in cells) [4], see also Figure 1 [3].

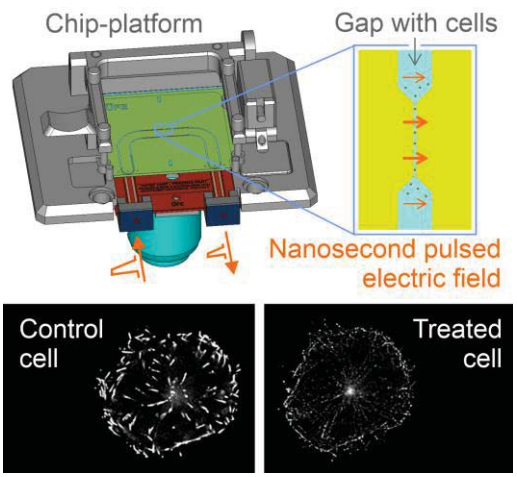

Figure 1 The nanosecond chip platform integrated into a microscope. The chip platform enables real-time observation of live cells with super-resolution microscopy while delivering an intense nanosecond pulsed electric field. We demonstrated that nsPEF remodels the cytoskeleton via observation of fluorescently labeled microtubule end-binding proteins in rat basophilic cell line. The figure is adapted from reference [4].

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References

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