



LUMOS™

OPTICAL STIMULATION SYSTEM FOR MULTIWELL PLATES

Incorporate cutting-edge optical techniques into your *in vitro* research using Axion BioSystems' Lumos. Previous *in vitro* optical stimulation devices provided low throughputs or limited control of light delivery, hindering the adoption of optogenetic techniques in research and development.

Lumos is the first commercial multiwell optical stimulation system to offer precise control over intensity and duration to four stimulation wavelengths in each well. Designed to pair with the Maestro Pro and Edge recording platforms, the Lumos allows researchers to simultaneously direct and record functional network activity.

THE LUMOS ADVANTAGE

- **High-throughput** – Control light delivery to each well of a standard 24- or 48-well microplate
- **Fully configurable** – Control intensity from each of 94 (24-well) or 192 (48-well) LEDs (four wavelengths per well) with microsecond precision
- **Optimized light delivery** – Market-leading light intensities are evenly distributed across each well
- **User friendly software** – Design optical stimulation patterns quickly with intuitive “drag-and-drop” style building blocks
- **Environmental control compatible** – Regulate temperature, CO₂, and humidity for extended benchtop work
- **Pairs with Axion's Maestro Pro and Edge MEA systems** – Optically control cell activity during real-time recordings of functional responses



LUMOS OPTICAL STIMULATION SYSTEM

The Lumos system can be used in two general ways:

- **Control of cell biology** – Deliver light to Axion’s Lumos OptiClear plates (24- and 48-well formats), standard-format SLAS-compatible microplates with optical specializations and clear bottom.
- **Control of cell activity** – Pair Lumos with Axion’s Maestro microelectrode array (MEA) platform and deliver light to Axion’s Lumos MEA plates for measurement of network activity.



Lumos OptiClear 48 plate (OPT-48) in the ECbase

USE LUMOS TO CONTROL CELL BIOLOGY

Control of cellular biology on a high-throughput scale

Light-mediated control of biochemical, genetic, and cellular functions is an emerging tool in many research fields:

- **Control intracellular signaling pathways** – e.g. Kennedy *et al.* 2010
- **Direct gene expression with light** – e.g. Konermann *et al.* 2013
- **Edit genes with light-induced CRISPR/Cas9** – e.g. Polstein & Gersbach 2015
- **Influence growth and regeneration** – e.g. Park *et al.* 2015

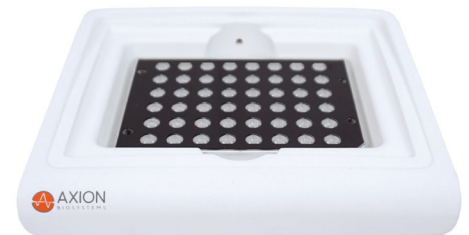


Lumos on the ECbase

ENVIRONMENTAL CONTROL WITH ECBASE

Perform extended light delivery experiments on the bench

- **Temperature** – Compatible with standard lab warming plates
- **CO₂** – Gas delivery port enables a controlled CO₂ environment
- **Humidity** – Lumos plate humidity reservoirs reduce evaporation from wells

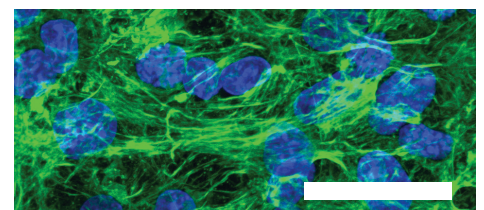


Lumos ECbase for benchtop experimentation

LUMOS OPTICLEAR PLATE

Optimal light delivery and imaging

Lumos OptiClear 24 (OPT-24) and 48 (OPT-48) are Axion’s first microplates without electrodes. These plates have a high clarity bottom culture surface for microscopy and high content imaging. The specially formulated reflective white walls and lensed lid facilitate optimal light delivery within each well.



63x view of a neural culture (scale = 25µm). Courtesy Santangelo lab (Georgia Institute of Technology)

MAESTRO™ PRO AND EDGE MEA SYSTEMS

Decode life's circuitry with MEA

The Maestro™ systems are the industry's first high-throughput microelectrode array (MEA) systems. Record networks of electrically active cells (e.g. neurons, cardiomyocytes, and muscle cells) in a multiwell plate in real-time. Over minutes or months, gain unprecedented access to electrical network function from cultured cell populations. Perfect for characterizing newly created iPS cells, researching the behavior of diseased cells, screening for drugs to treat that disease, or examining potential toxic effects of drug candidates, the Pro and Edge systems deliver an easy-to-use, compact cellular analysis system suitable for any lab.



Lumos is compatible with the Maestro Pro and Edge MEA systems

USE LUMOS TO CONTROL CELL ACTIVITY

Control cell activity with light

Optogenetics techniques use genetic targeting to express light-sensitive ion channels called opsins (e.g. ChR2) in targeted cell populations. Upon stimulation by a specific wavelength of light, these opsins can be activated to shift the cell membrane potential. Light of specific wavelengths can thus be used to activate or silence cell activity in targeted cell populations.

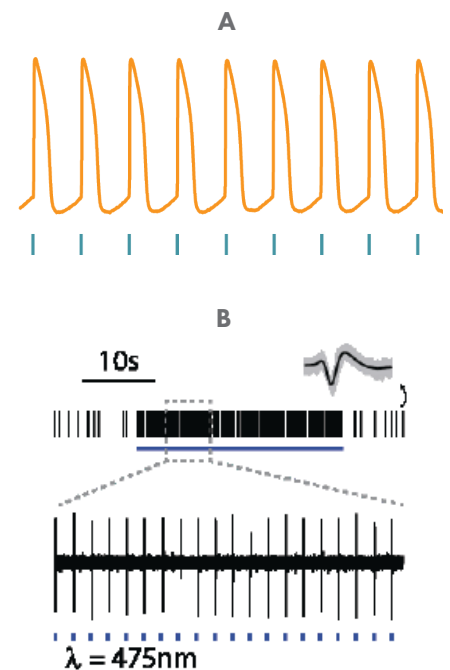
Advantages of optogenetic-mediated control of cell activity include:

- **Artifact-free stimulation** – Light-evoked electroactivity is artifact-free
- **Precise control of cell activity** – Study a range of physiologically relevant states in each well
- **Reduced experimental variability** – Standardize cell activity to reduce variability in well-to-well and batch-to-batch activity
- **Cell specific control** – Enhanced neural disease modeling is possible with cell type specific control in mixed cell cultures

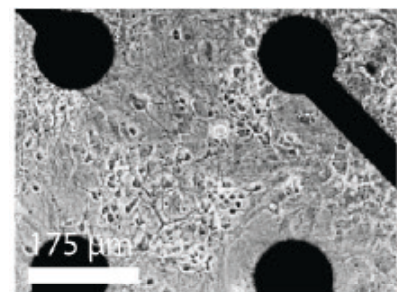
LUMOS MEA PLATES

Designed for optogenetic MEA studies

Lumos MEA 24 (M384-tMEA-24OPT) and 48 plates (M768-tMEA-48OPT) for the Maestro Pro and Edge MEA platforms combine unparalleled access to cellular electrical network information (16 recording electrodes per well) with a thin, transparent plate bottom for culture visualization and assay multiplexing. The specially formulated reflective white walls and lensed lid facilitate optimal light delivery within each well.



ChR2-expressing cardiomyocytes (fig. A) and neurons (fig. B) are activated with pulses of blue light

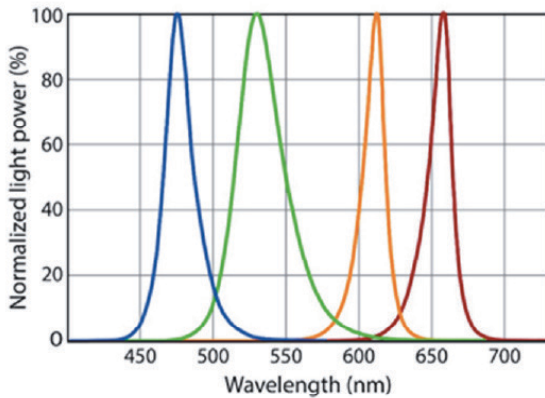


Bright field images of primary rodent cortical neurons at (20x)

REVOLUTIONIZING OPTICAL STIMULATION

The most flexible *in vitro* optical stimulation system

A first-of-its-kind on the market, Lumos revolutionizes *in vitro* optical approaches. Lumos provides 24 or 48 concurrent wells of stimulation and the ability to simultaneously use up to four different wavelengths of light per well at user-specified, precisely defined output patterns.



LED	Target Opsin	Center Wavelength (nm)	Maximum Intensity (mW/mm ²)
Blue	ChR2	475	>3.9
Green	ArchT	530	>1.9
Orange	eNpHR	612	>2.2
Crimson	Jaws	655	>2.4

AXIS NAVIGATION - STIMULATION STUDIO

Fast, flexible set-up

AxIS Navigator provides intuitive, visual stimulation programming in an easily accessible plate map format. Here, each of the LEDs can be independently controlled for both intensity (1-100% max power) and duration (down to 100 microseconds). Additionally, stimulation across the plate can be set up for predefined time courses or regulated via an operator start-stop interface in the software.



Stimulation setup in AxIS Navigator

AWARD WINNING INNOVATION

Axion's pioneering Lumos system



TheScientist
TOP 10
 INNOVATIONS

"The platform . . . now puts unique control in the hands of the researcher. Using high-power LEDs that span several wavelengths increases the customization ability to go with specific light-manipulated protein manipulation."

"This system for high-throughput optical stimulation in multiwell plates is the first large-scale practical implementation in the emerging field of biophotonics."

- The Scientist Top 10 Innovations 2016 judges' comments

