



lumencor

light engines for a
BRIGHTER. GREENER. PLANET.

Claudia B. Jaffe, Ph.D. Cofounder, E.V.P.
NIE Rome Sales Meeting, January 2017

APPLICATIONS

- + FLUORESCENCE MICROSCOPY
- + OPTOGENETICS
- + HIGH THROUGH-PUT ANALYSIS
- + CLINICAL PATHOLOGY
- + GENE EXPRESSION ANALYSIS
- + HIGH CONTENT SCREENING
- + PHENOTYPING

PERFORMANCE

- + INTENSE
- + SPECTRALLY PURE
- + SOLID STATE STABILITY
- + FAST SWITCHING
- + LONG LIFETIME
- + ENERGY EFFICIENT
- + MERCURY-FREE



Colored light outputs



AURA & SPECTRA light engines



SPECTRA X light engine



MIRA light engine



LIDA light engine

White light outputs



ASTRA light engine



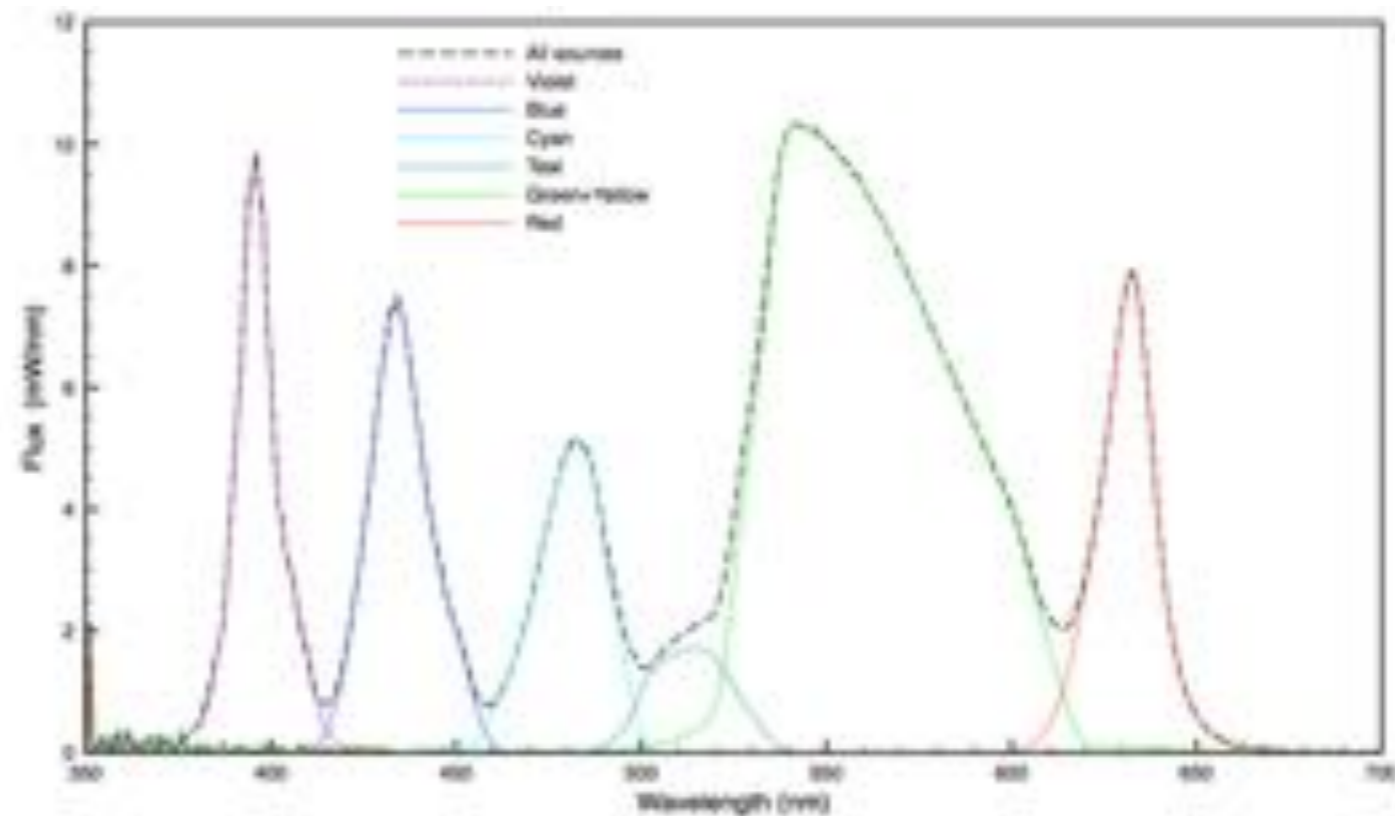
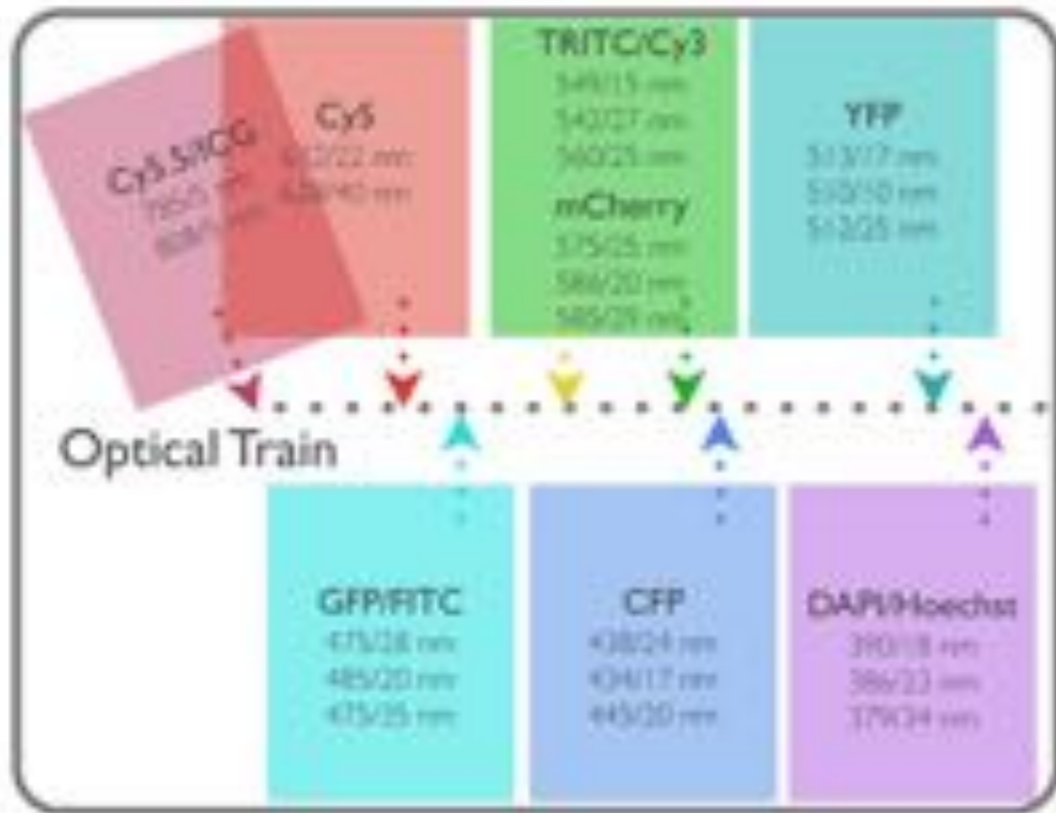
SOLA & SOLA 365 light engine
Manual and Electronic Configurations



PEKA light engine



Lumencor Light Engine Portfolio



Light Engine = many sources

Spectral Output = color bands

This design strategy provides a wide range of benefits to the end user

Performance

- power • speed • stability

Control

- spectral • spatial • temporal

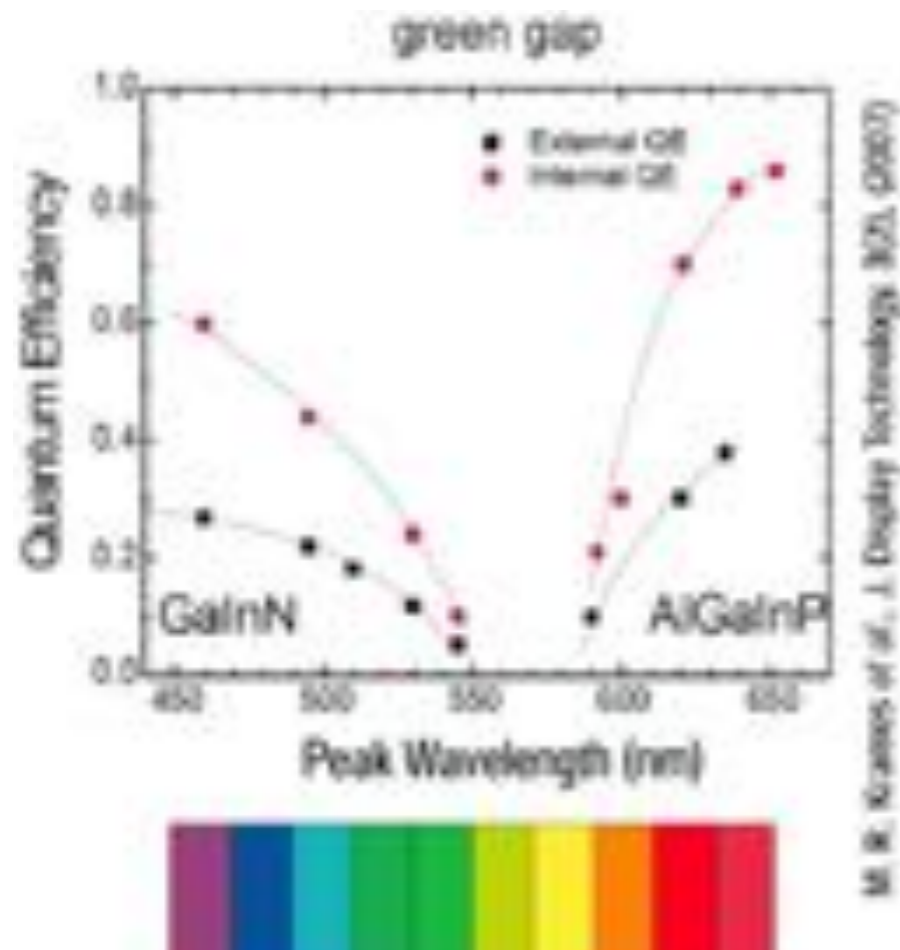
Customization

- additive not subtractive

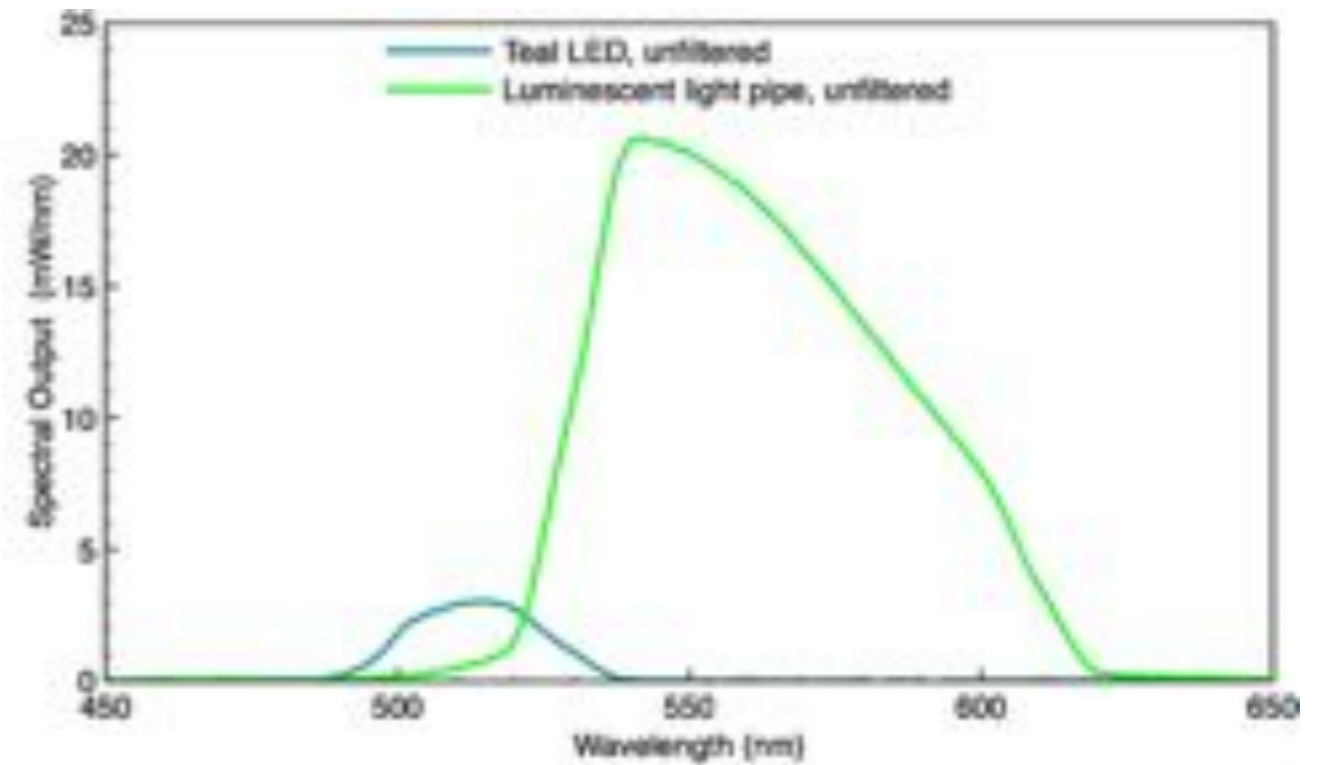


A **Light Engine** is an array of solid state light sources integrated for individual or combined operation according to application requirements

“Green gap” in LED output



Proprietary solid-state light source

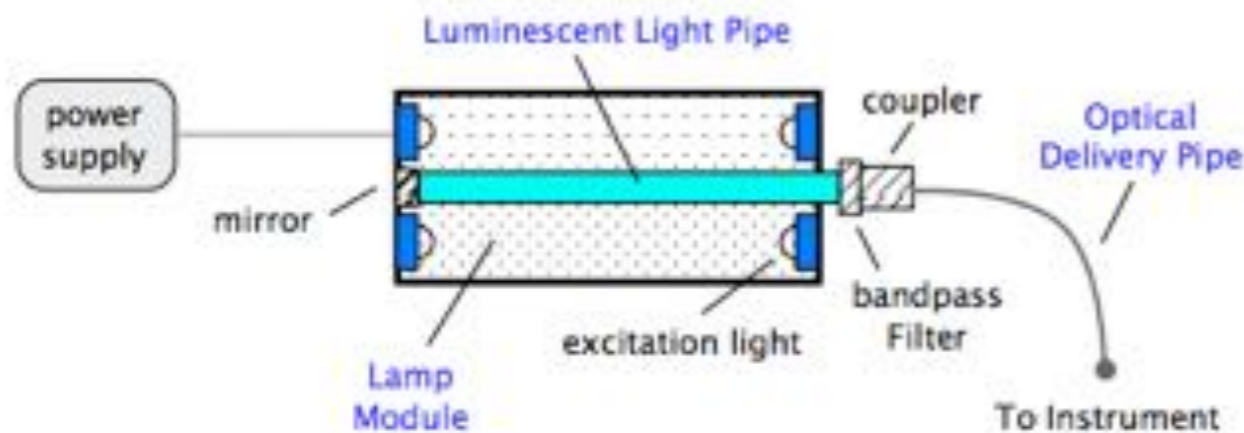


Advantages include:

- fast on/off switching (μs – ms)
- output stability
- electronically attenuate output (intensity control)

Unique to Lumencor:

- Intense output ($>1\text{ W}$) 500–600 nm
- Spectral bandwidth
 - ~ 60 nm FWHM for luminescent light pipe
 - ~20 nm FWHM for LEDs



Luminescent Light Pipe

Performance

Power: Photon attrition in fluorescence microscopy
~billions photons in >> thousands photons out.

Speed: Biology moves quickly. 10 seconds is a long time.

Stability: Frame-to-frame consistency throughout 24-hour time lapse.

Control

Spectral Content: Wavelengths match fluorophore excitation spectra

Spatial: Widefield and confocal (big picture and close-up).

Electronic Attenuation: Minimize phototoxicity and photobleaching
i.e. in applications like live-cell microscopy.

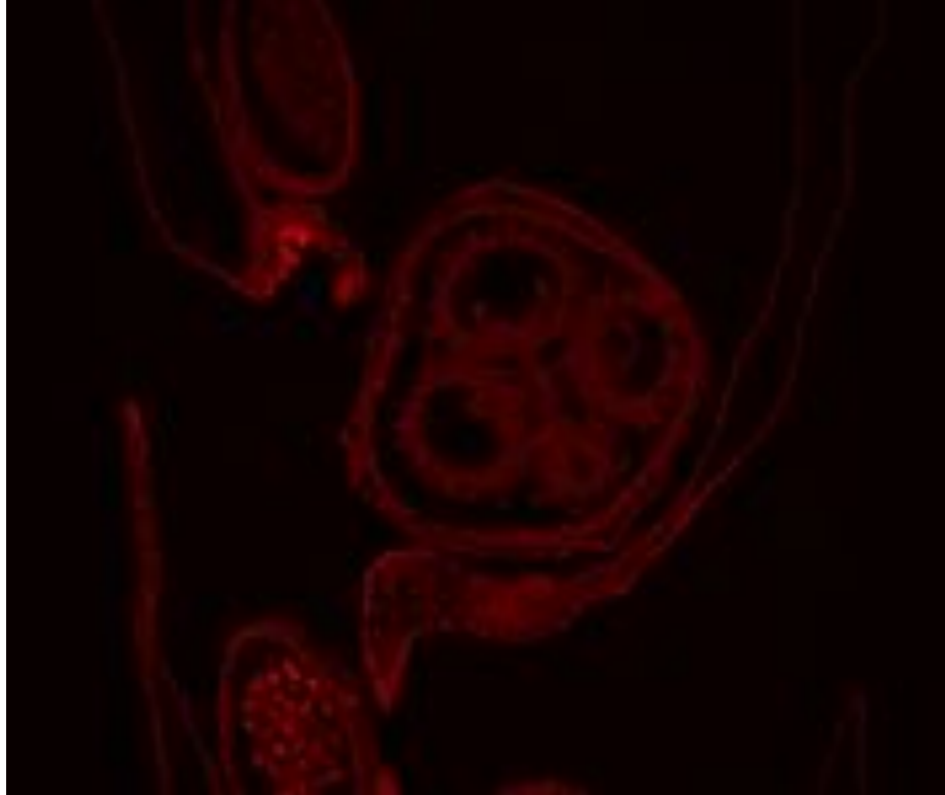
Customization

Source selection: Multicolor mapping of 2,3,4,5 component interactions. Sequential detection to avoid mistaken identity (channel crosstalk).



Fluorescence microscopy needs

- SOLA SE Light Engine, 50% maximum output

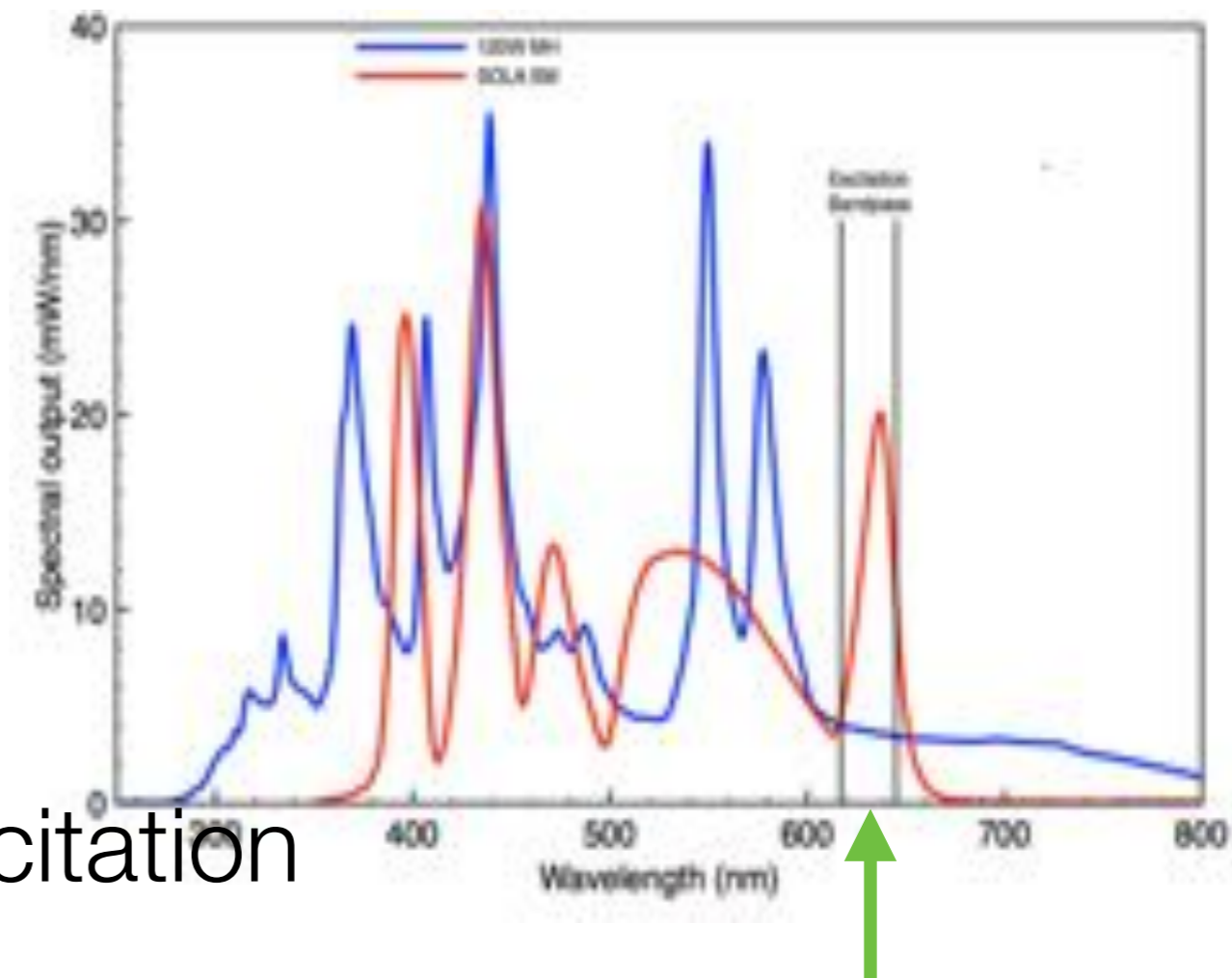


- 120 W Metal Halide, 100% maximum output

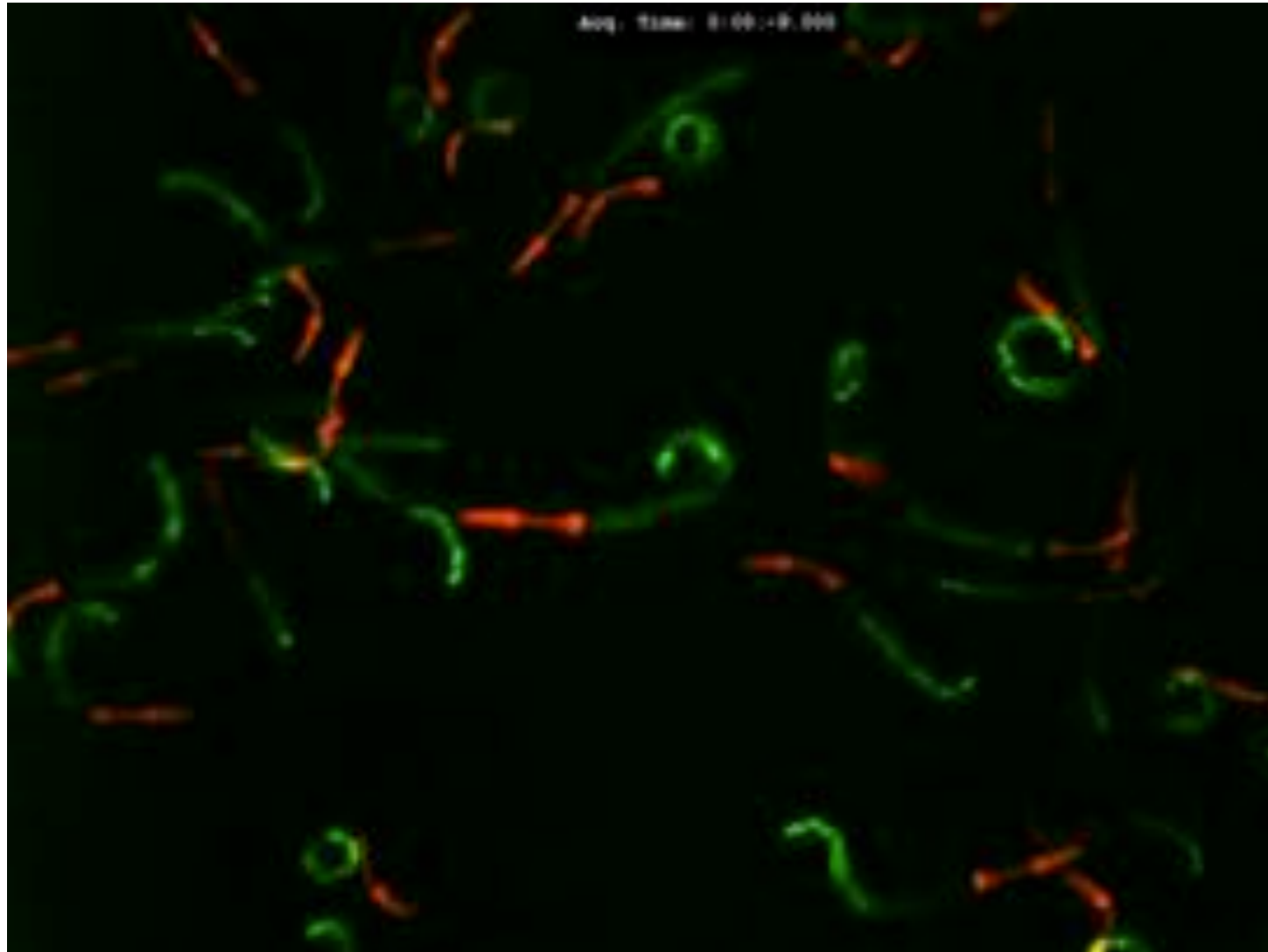


Sample: Autofluorescent longitudinal section of a strobilus from selaginella (heterosporous clubmoss).

- Exciter 631/28 (CWL/FWHM); Semrock FF660-Di02 dichroic; FF01-692/40 emitter.
- Nikon Ti microscope, 10X, 0.5 NA objective, Andor Zyla 5.5 camera, 50 ms exposures.
- Power output at sample plane:
 SOLA SE light engine (50%) = 94 mW.
 120 W metal halide (100 %) = 27 mW.



Performance -
Power: Cy5 Excitation



Video shows two color (DsRed and GFP) time lapse image of C.Elegans on a Nikon Ti microscope with 10x 0.5NA plan fluor objective.

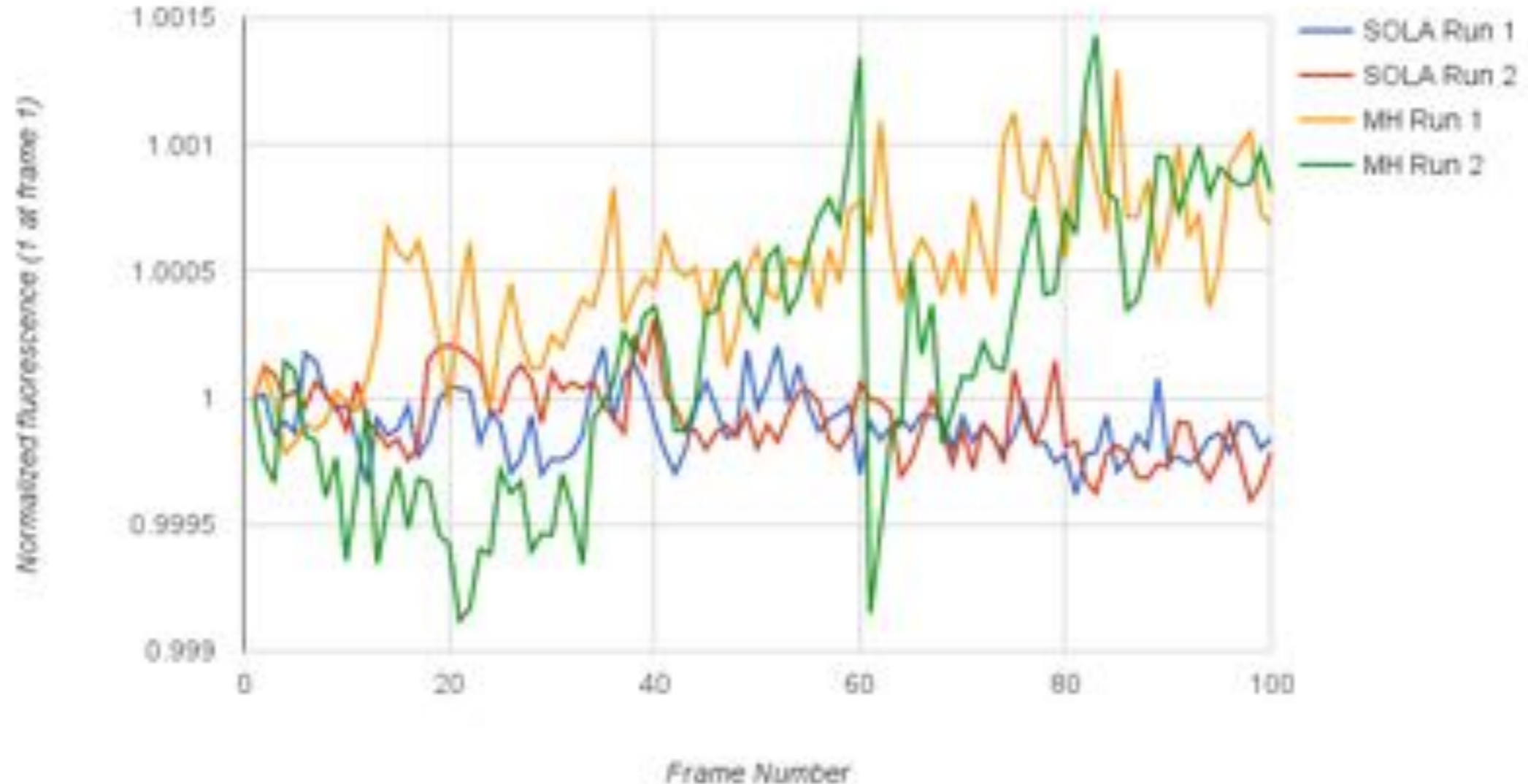
- GFP highlights the worm gut.
- DsRed is a neuronal marker.
- Images were collected using a Photometrics HQ2 camera.
- Exposure time was 5mS, 30 2-color frames collected / second.

- $5\text{ms (GFP)} + 20\mu\text{s (switch time)} + 5\text{ms (DsRed)} + 20\mu\text{s (switch time)} = 10.04\text{ ms / image pair}$
- $1 / 0.01004\text{ s / image pair} \approx 100\text{ image pairs per second or } 200\text{ images per second}$



Performance - Speed: *C. Elegans* Video
Simon Watkins, Univ. of Pittsburgh

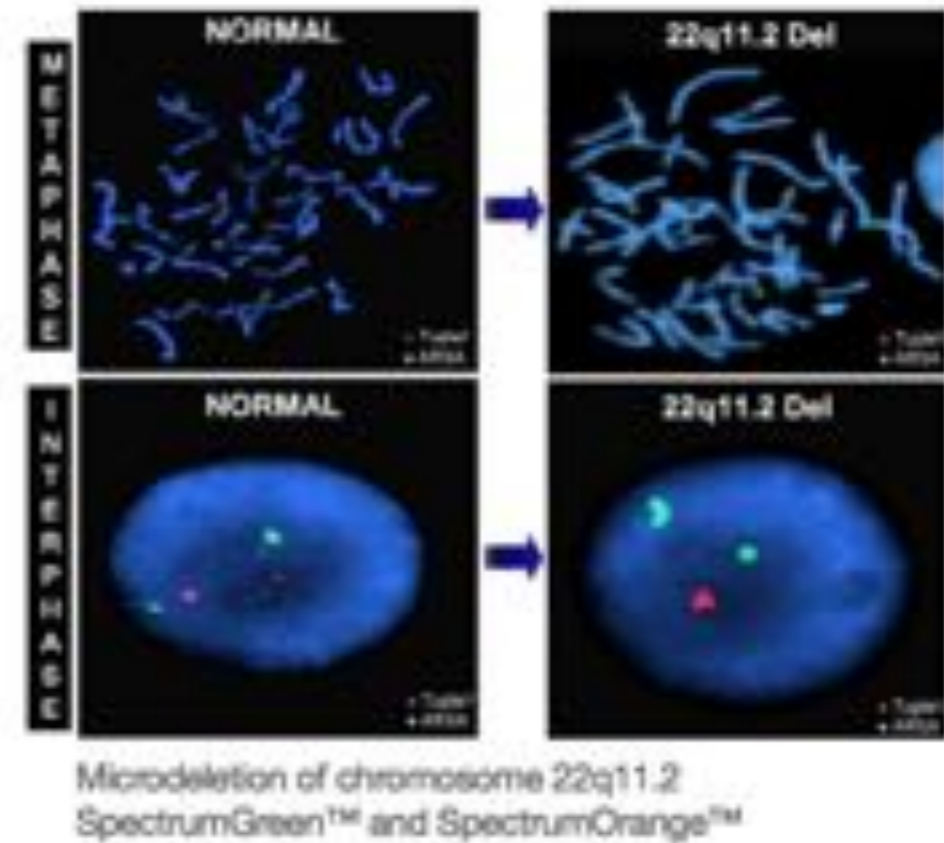
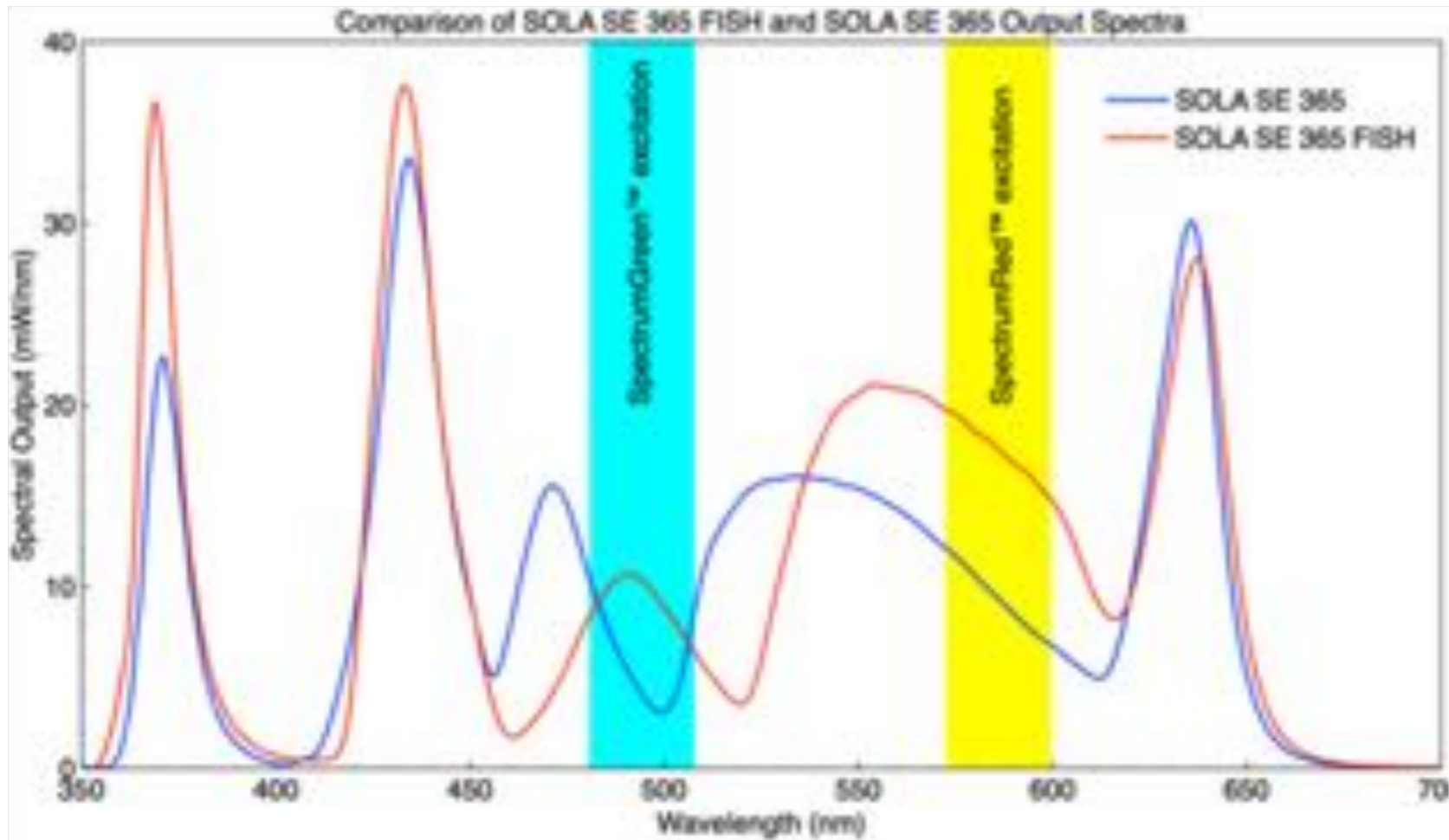
Sola 365 light engine v. Metal halide lamp stability



- Chroma uniform FITC slide on Nikon Ti, 10X/0.3 NA objective
- SOLA SE 365 @10%, 120W MH @12.5%, exciter Semrock 474/27*
- 100 frames, 50 ms exposure, 50 ms intervals (10 fps) ORCA-Flash4.0 sCMOS
- Fluorescence intensity = average gray level per frame



Performance - Stability: Source stability minimizes variance of fluorescence signal



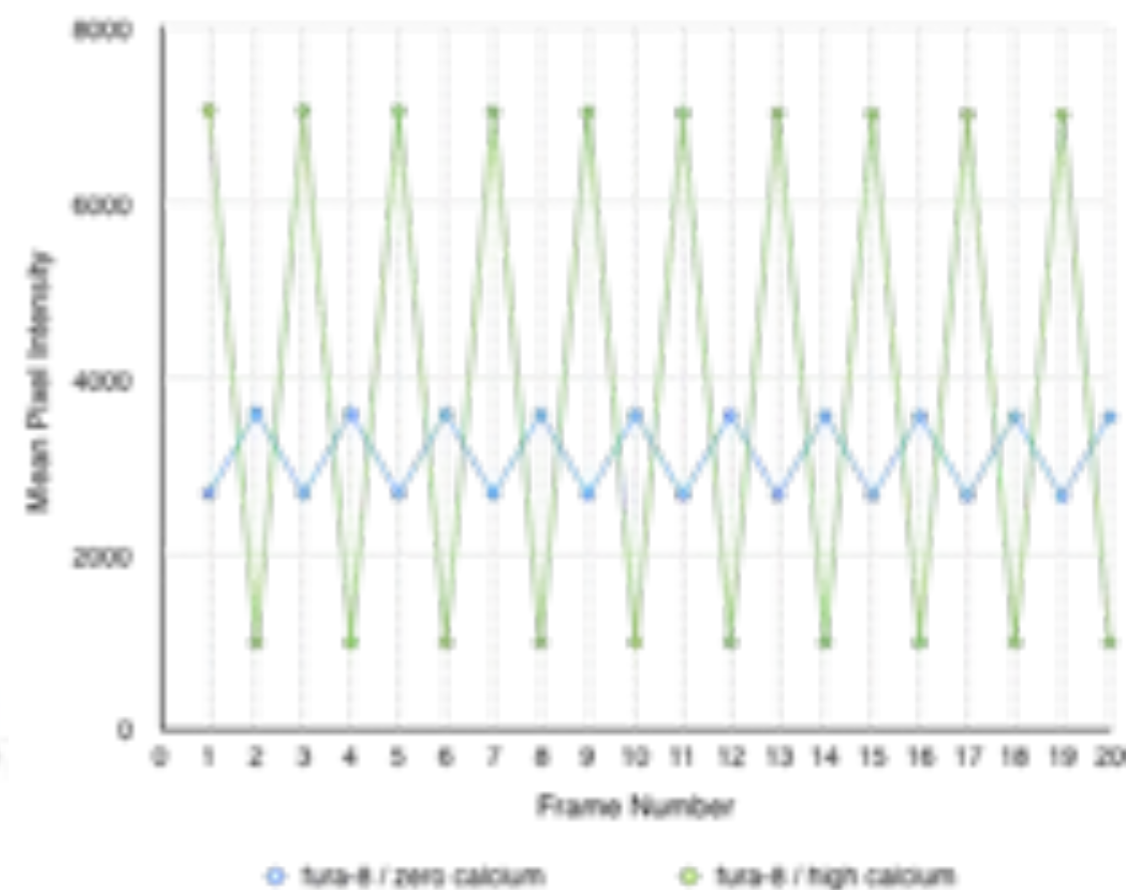
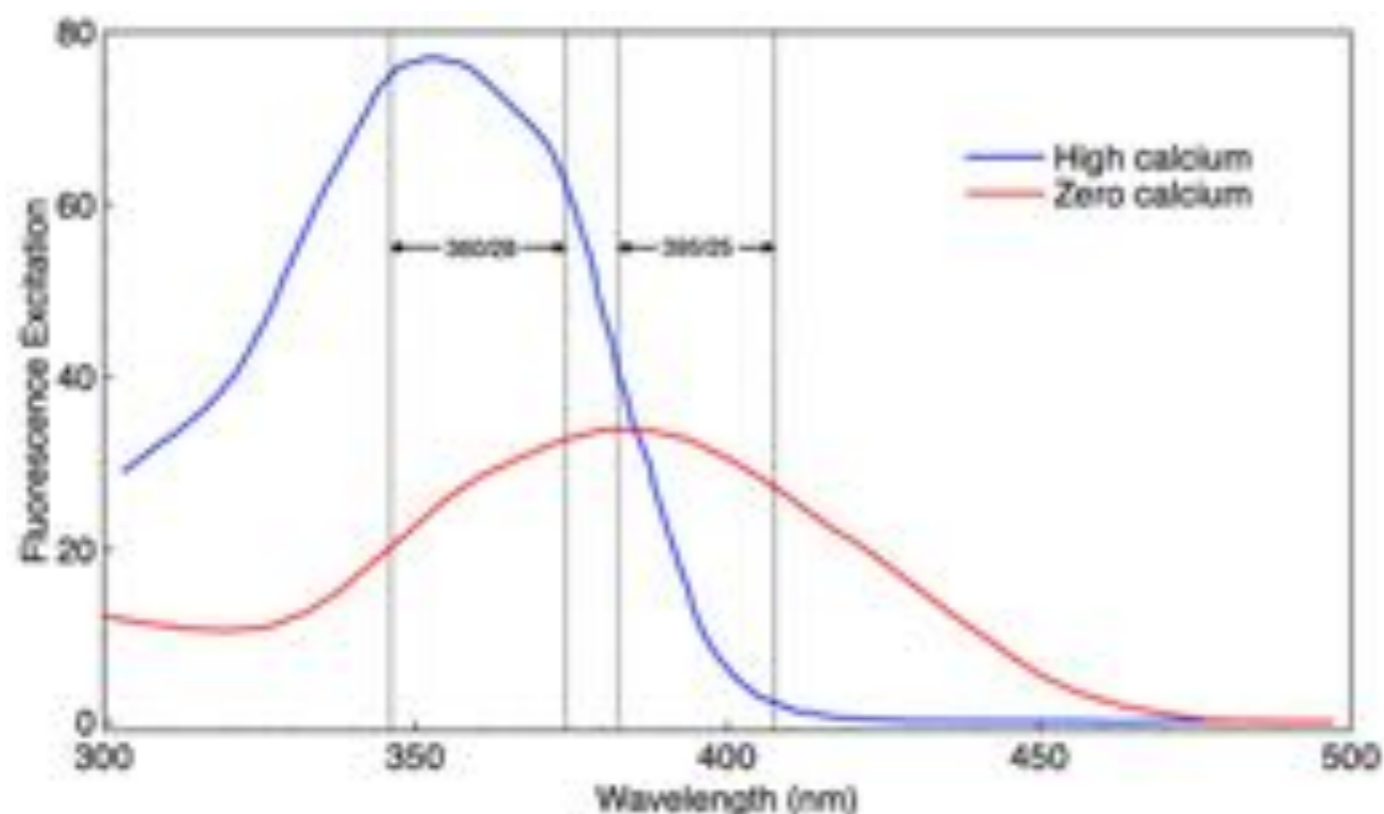
- Hybrid source: LED + luminescent light pipe
- High power: >4W visible light
- White light for compatibility with existing assay protocols



Control - Spectral Content:

Assay specific SOLA *FISH* Light Engine

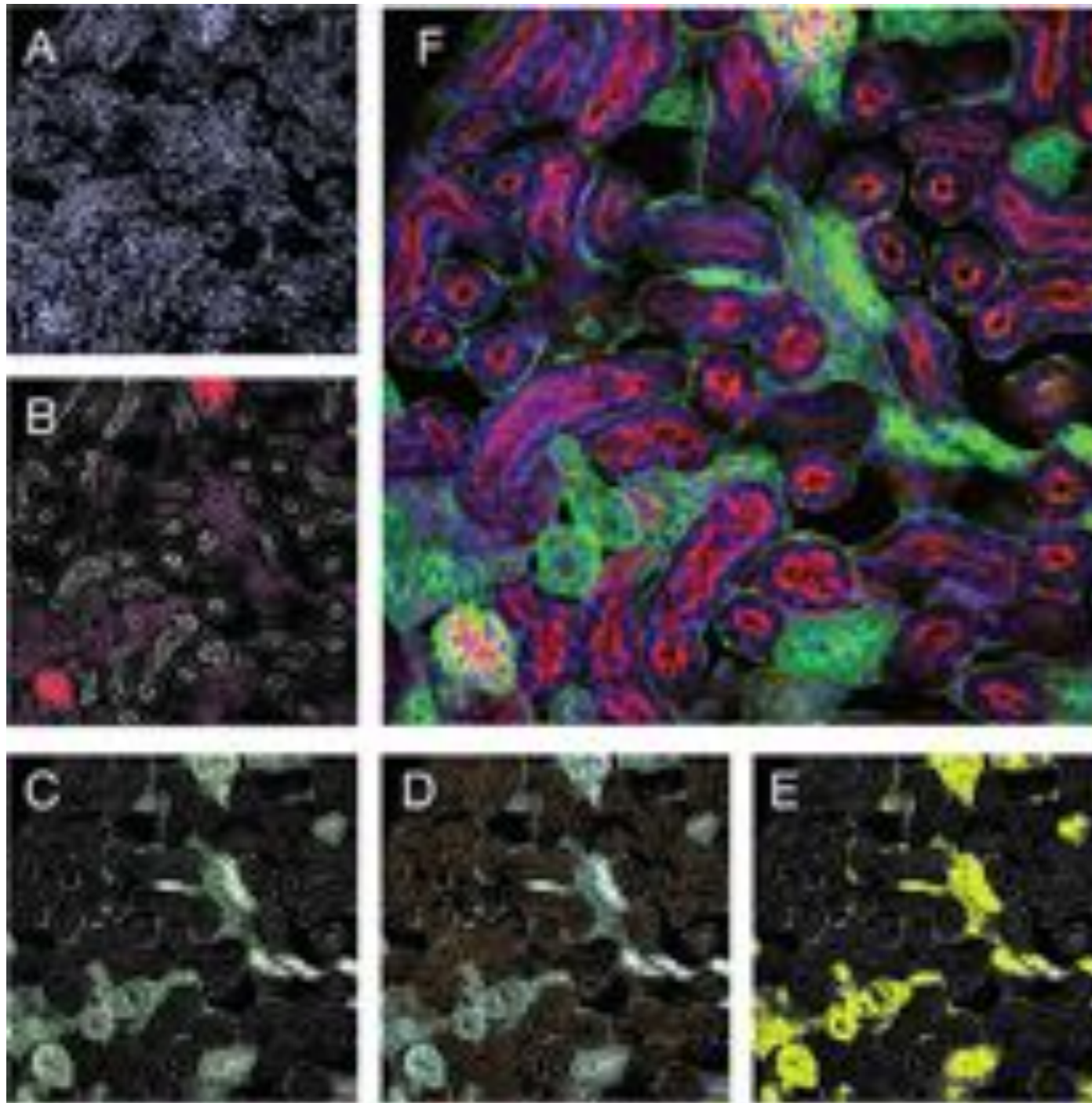
AURA Light Engine® for Ca₂₊ Ratio Imaging



- A solid-state light engine with 360 and 395 nm sources
- Images of fura-8 calcium indicator in solutions containing no calcium (10 mM EGTA) or 40 μ M.
- Excitation alternates between 360 nm (odd-numbered frames) and 395 nm (even-numbered frames).
- Data acquisition rate is 6 image pairs per second (30 ms exposures interleaved with 50 ms intervals).



Control - Spectral Content:
Assay specific AURA Light Engine



Confocal image analysis of a fluorescently stained mouse kidney.

A 16 μm cryostat section of mouse kidney was stained with

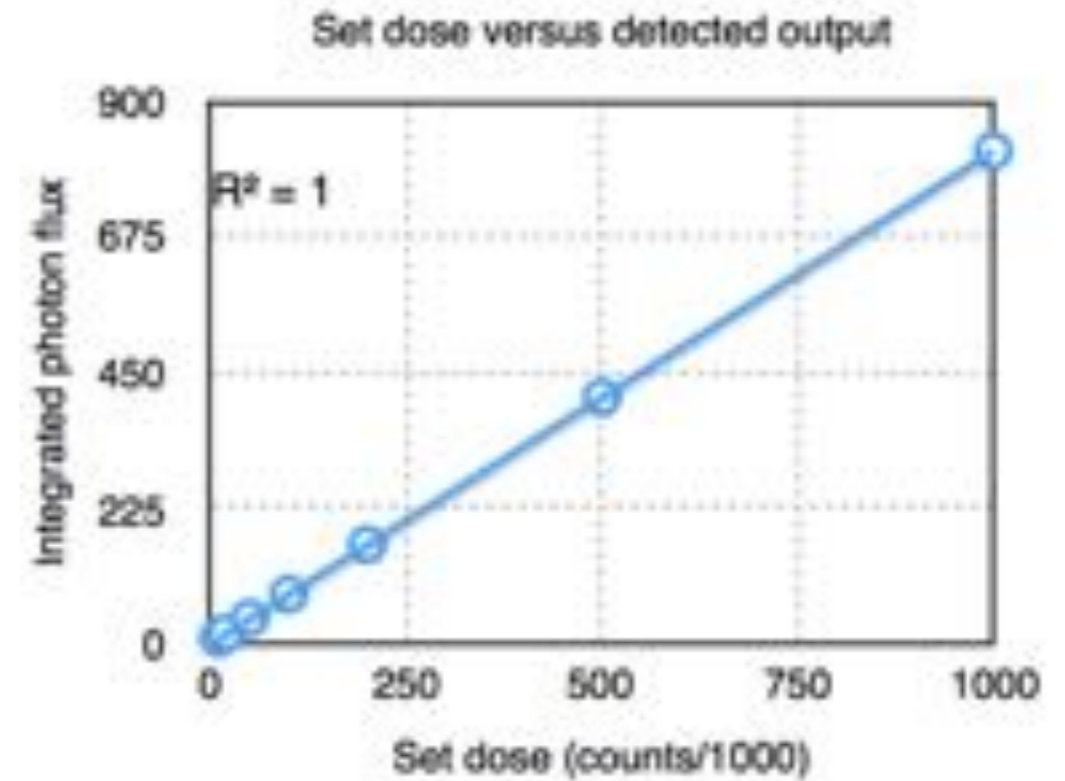
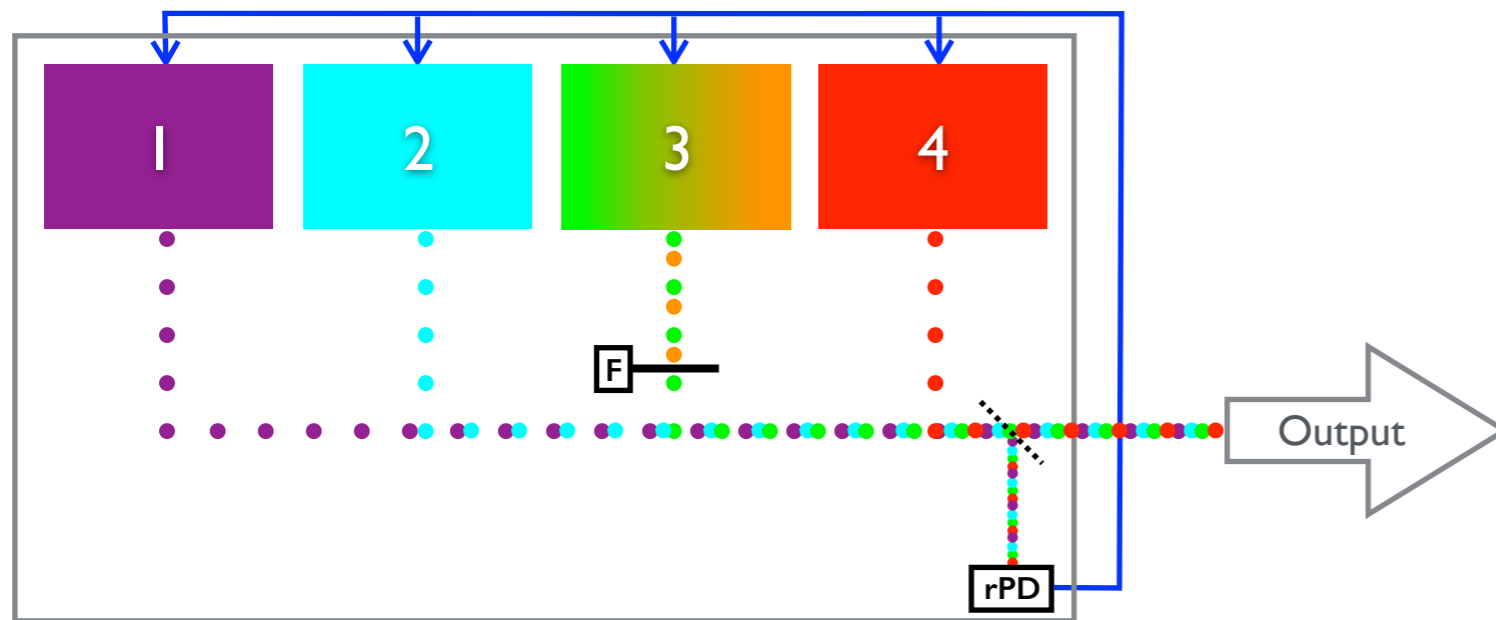
- Alexa Fluor™ 488 Wheat Germ Agglutinin (green),
- Alexa Fluor 568 Phalloidin (red),
- DAPI (blue).

Images collected on the Cellinsight CX7 HCA Platform using laser autofocus and confocal acquisition at 20x magnification.

- (A) nuclear identification and segmentation (blue);
 (B) phalloidin detection in WGA+ cells (red);
 (C) WGA+ cell selection (green);
 (D) WGA mask modification (green);
 (E) spot detection for quantifying WGA signal;
 (F) composite confocal image.



Control - Spatial: Confocal images with Light Engine not lasers



- Discrete spectral outputs of 4 solid state light sources (1–4) are electronically selected and combined according to application requirements.
- The spectral output of each source may be refined by filtering (F).
- Optionally, light engine output may be monitored by a reference photodiode (rPD) to provide feedback control.



Control - Electronic Attenuation:
Precise photon delivery via **Dosimetry**

Near-infrared fluorescence image of renal hilum vasculature during robotic-assisted minimally invasive partial nephrectomy.
©2015 Intuitive Surgical, Inc.



ASTRA Light Engine®



5 Solid state sources
18 Watts optical output

White light reflectance image of the renal hilum during robotic-assisted minimally invasive partial nephrectomy.
©2015 Intuitive Surgical, Inc.

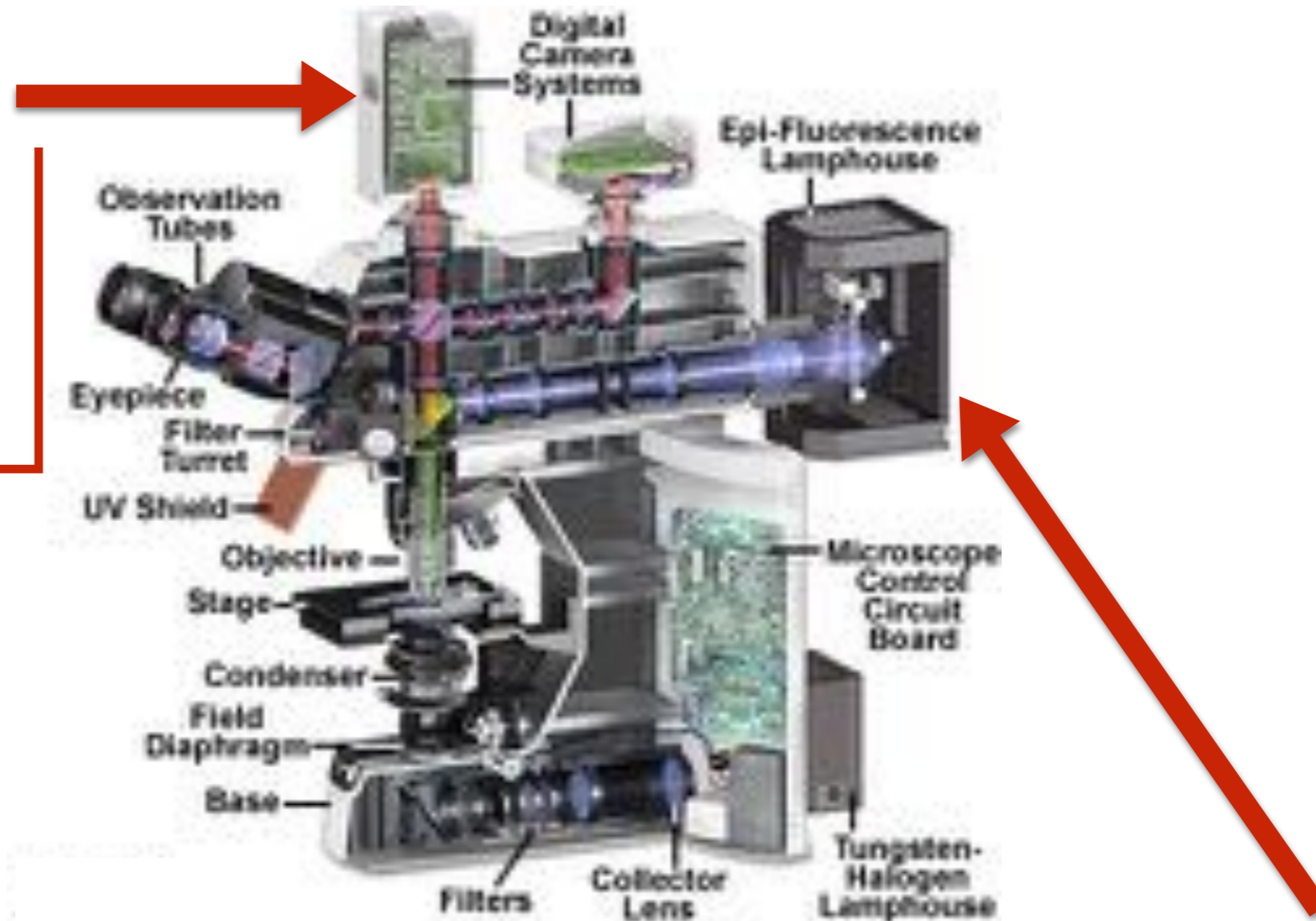


- Hybrid sources: laser + LED + light pipe
- Powerful: 9.5 W visible + 8.5 W nIR
- White light for reflectance endoscopy
- Composite white for optimized color rendition
- nIR fluorescence excitation for vascular tracing
- Stringent control of output angular distribution
- Output stability for critical surgical application



Customization: Light Engines for Multimode Intravital Endoscopy

It's been a long time since you replaced your 35 mm film camera with digital....



.....doesn't your archaic mercury arc light source deserve the same sort of upgrade?



It's about time.....



lumencor® light engines for a
BRIGHTER. GREENER. PLANET.

APPLICATIONS

- FLUORESCENCE MICROSCOPY
- OPTOGENETICS
- HIGH THROUGHPUT ANALYSIS
- DIGITAL PATHOLOGY
- GENE EXPRESSION ANALYSIS
- HIGH CONTENT SCREENING
- ENDOSCOPY

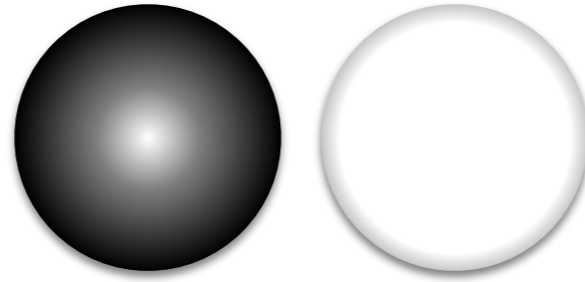
PERFORMANCE

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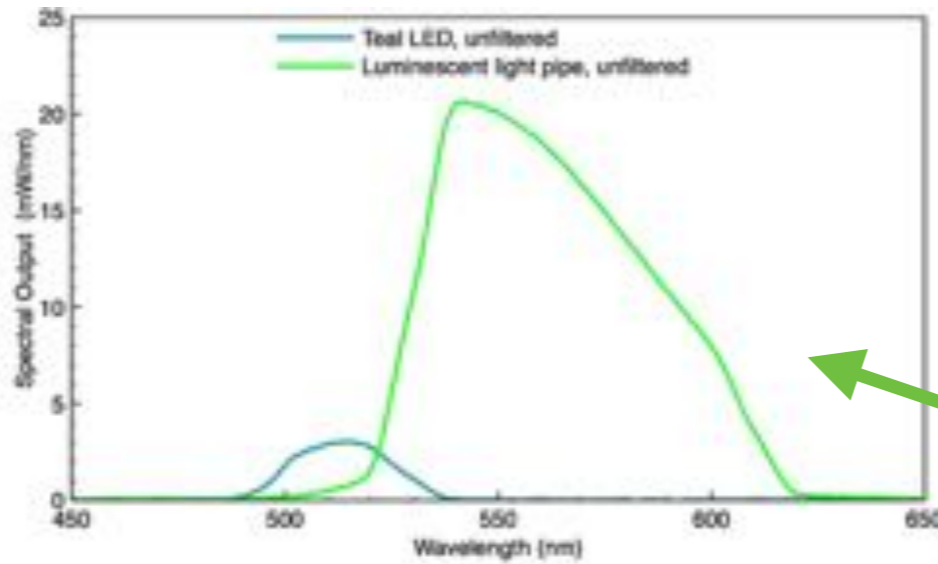
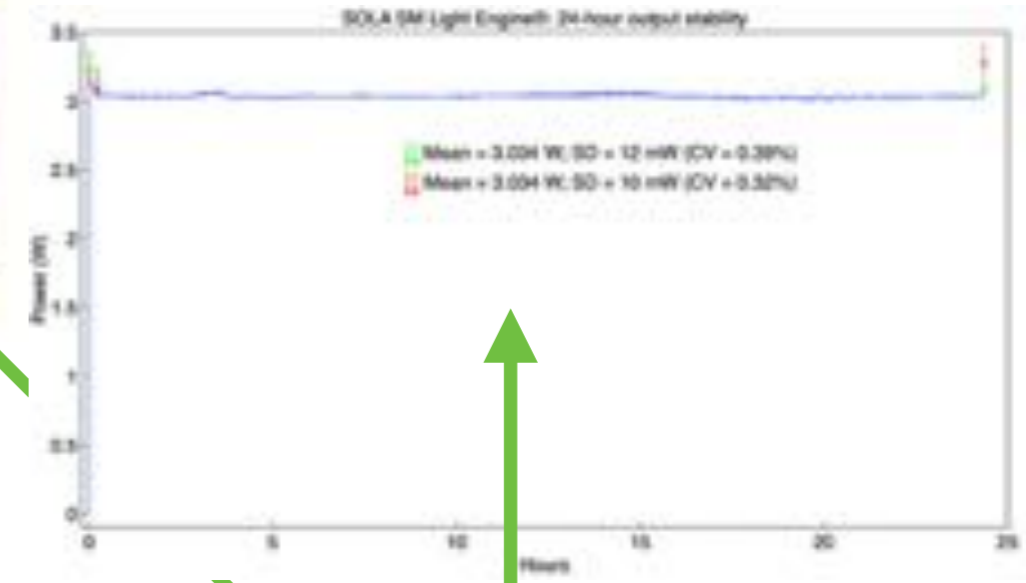
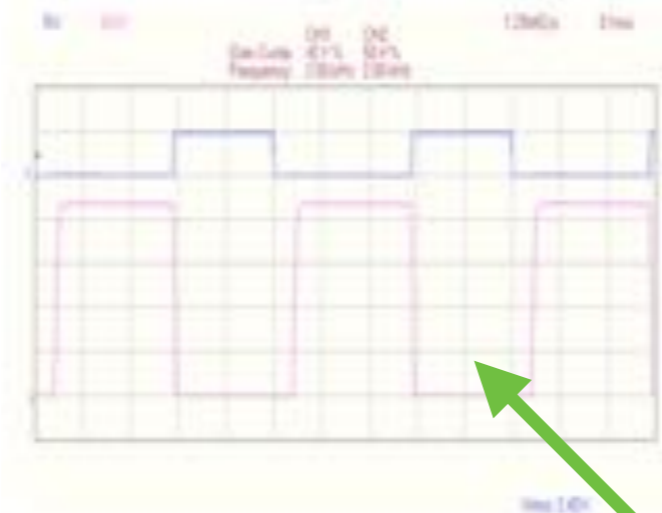
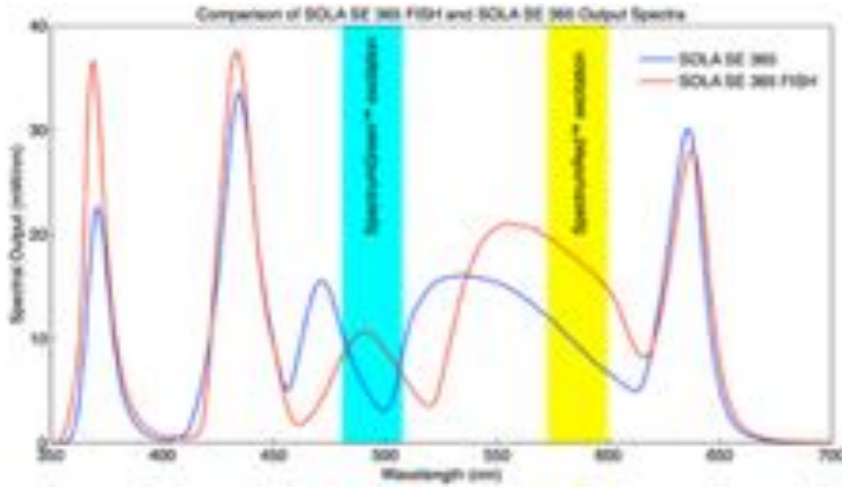


Control

- Channel
- Spatial
- Spectral



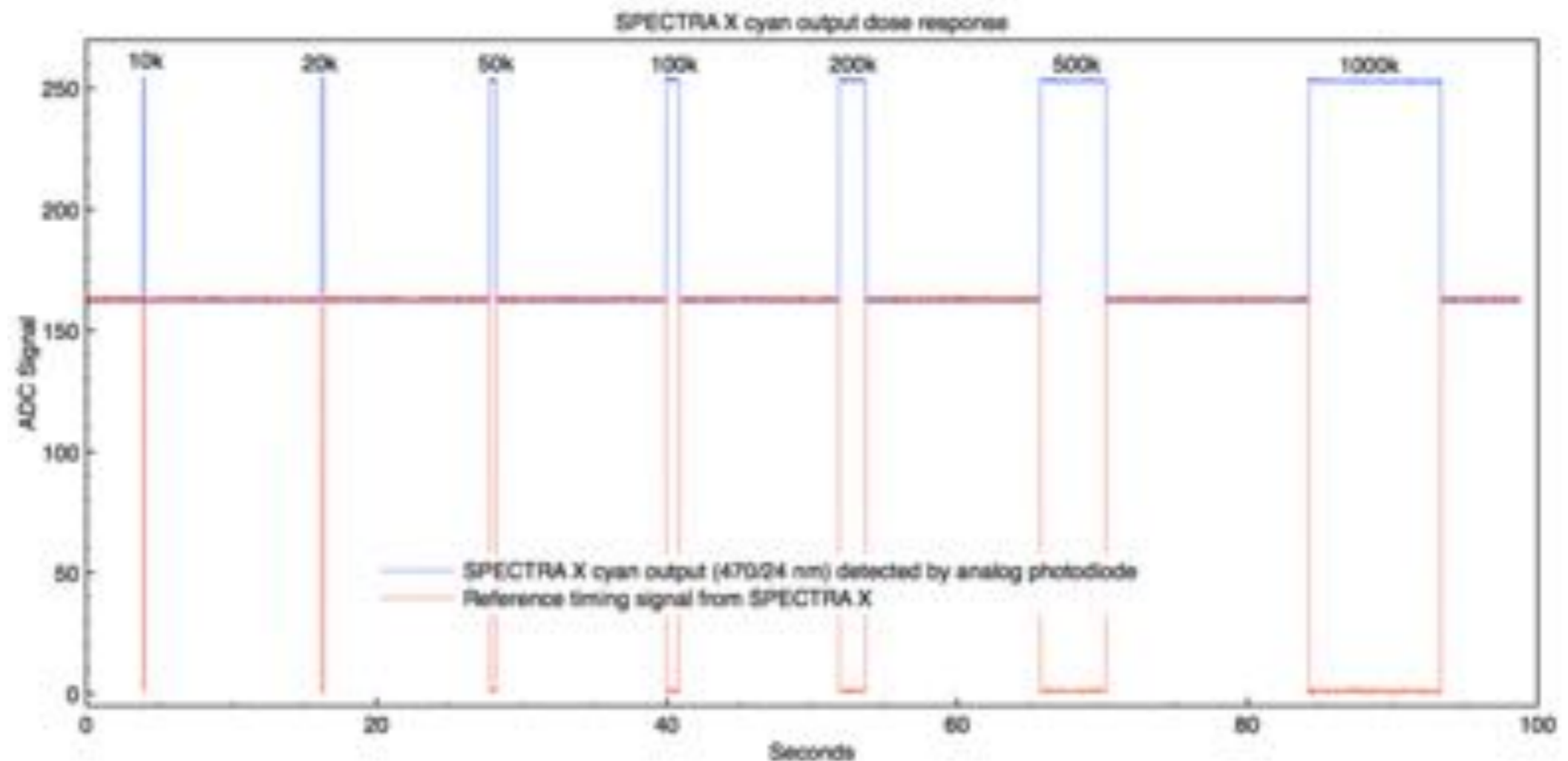
Critical or Koehler
10 μ s 475/575 switch



Control and Performance Met

- Stability
- Speed
- Power

Performance



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Control - Stability: Dosimetry
Detected Photon Flux