

Technical specifications

HyperScope Launch Optics	
External beam expander	<p>Lens type: Achromatic</p> <p>Input clear aperture: 14 mm</p> <p>Output clear aperture: 24 mm</p> <p>Expansion Ratio: 2.5x</p> <p>Wavelength range: 750 to 1550 nm</p> <p>Coating: Optical average reflectivity per surface <1% average (750 to 1550nm)</p>
Achromatic wave plates	<p>Clear aperture: 12 mm</p> <p>Wavelength range: 700-1100 nm or 900-1300 nm</p> <p>Coating: Optical reflectivity per surface <0.7% average</p> <p>AOI: Normal</p> <p>Surface flatness: $\lambda/4$ @ 633 nm (over the clear aperture)</p>
45° Folding mirror(s)	<p>Dimensions: 1"</p> <p>Substrate: Fused Silica</p> <p>Coating: Protected Silver (average reflectivity ~ 96% from 700 nm to 1400 nm @ 45° AOI)</p> <p>Clear aperture: 90% of the diameter</p> <p>Surface flatness: $\lambda/10$ @ 633 nm</p>
Electro optic modulators (optional)	<p>Classification: Transverse field type Pockels cells</p> <p>Aperture diameter: 2.7 mm</p> <p>Extinction ratio: 200:1 or 500:1 @ 633 nm (with 1mm beam @ 1% point)</p> <p>Standard wavelength range: 680-1300 nm or 680-1100 nm*</p> <p>Beam blocker: Built-in</p> <p>*Wavelength range modification is possible</p>
Electro optic modulator driver (302RM)	<p>Bandwidth: DC-to-250 KHz</p> <p>Rise/fall times: 1 μs</p> <p>Typical drive configuration: Lumped capacitance</p> <p>Output: Linear</p>
HyperScope Scan Head Optics	
Scan axes	<p>Resonant X-axis: Cambridge Technologies CRS8K (8KHz) clear aperture is 5.0 x 7.2 mm ellipse</p> <p>Galvanometer: X-axis Cambridge Technologies 8315KL clear aperture 6 mm</p> <p>Galvanometer: Y-axis Cambridge Technologies 8315KL clear aperture 6 mm</p>
Galvanometer driver	<p>Cambridge Technologies MicroMax 671 (High Power option)</p> <p>Voltage/optical degree: ~ 0.5 V</p> <p>Maximum scan angle: $\pm 20^\circ$</p> <p>Small angle step response: ~ 130μs</p>
Resonant driver	<p>Cambridge Technologies CRS (711-80159)</p> <p>Angle control: External analogue reference 0 to 5V (zoom function)</p> <p>Max scan angle: ~ $\pm 13^\circ$</p> <p>Typical step and settle: 6.0 ms</p>
1:1 Relay lens	<p>Input beam diameter: up to 3 mm</p> <p>Maximum scan angle: $\pm 15^\circ$</p> <p>Wavelength range: 700 to 1400 nm</p> <p>Coating: Optical reflectivity per surface <0.7% average ~ 700nm to 1400nm</p>

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Scan lens	Wavelength range: 700-1400 nm Coating: Optical average reflectivity per surface <0.7% average ~ 700nm to 1400nm
Beam combining cube	Dimensions: 25.4 x 25.4 x 25.4 mm Clear aperture: >85% of central dimension Wavelength Range: 400-1300 nm Average Transmission TP: > 90% Average Reflection RS: > 97.5% Transmitted Beam Deviation: < 5 arc min Reflected Beam Deviation: 90° ± 20 arcmin
45° Folding Mirror	Dimensions 45 x 64 x 6 mm Substrate: Fused Silica Coating: Protected Silver (average reflectivity ~ 96% from 700nm to 1400 nm @ 45° AOI) Clear aperture: 90% of the specified dimensions Surface flatness: $\lambda/10$ @ 633 nm
Beam diameter at Objective Back Aperture	Scan head beam expansion ratio: 6.85x Beam size at the microscope objective back aperture: ~ laser output size x table beam expander (usually 2.5x) x scan head beam expansion
Average scan-head transmission*	~30 ± 0.8 % (700 to 1050 nm) *using a Nikon 16x 0.8 NA objective lens
Resonant/Galvanometer field of view	Galvo: ~ 1 mm Resonant: ~ 0.7 mm Measured centre field (on-axis) resolution @ 860nm*: X/Y~ 0.59± 0.022 μ m and Z~ 3.24 ± 0.114 μ m Measured edge field (off-axis) resolution @ 860nm*: Average X/Y~ 0.67± 0.028 μ m and Z~ 4.12 ± 0.210 μ m *using a Nikon 16x 0.8 NA objective lens
Acquisition & Control	
Sample rates from 5 MHz - 120 MHz depending on software and hardware configuration chosen	
Amplifiers	
Fixed gain current amplifier (HCA-20M-100K-C) - Resonant only	Gain[V/A]: 105 3dB Bandwidth [MHz]: 20 Equivalent input noise [pA/\sqrtHz]: 3.5 Rise/fall time (10% - 90%) [nS]: 18 Maximum source capacitance [pF]: up to 50
Variable Gain High Speed Current Amplifier (DHPCA-100) - Switchable systems	Gain[V/A]: 102-108 Bandwidth [MHz]: up to 200 Equivalent input noise [pA/\sqrtHz]: 0.051-220* Rise/fall time (10% - 90%) [nS]: 1.8-1.6 μ s* Maximum source capacitance [pF]: up to 108* *dependant on bandwidth/noise setting

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Scientifica - Galvo only	Gain[V/A]: 105 Bandwidth [MHz]: 1.25
Minimum workstation specification	Sciscan GUI Monitor requirements: Full HD 24" OS: Windows 7 64bit CPU: (Intel Xeon type i.e. E5-1650 v3) Six Cores, base frequency 3.5GHz max turbo frequency 3.8GHz RAM Memory: DDR 4 - 32GB Graphics: GPU memory GDDR6 3 2GB (i.e. NVIDIA® Quadro® K4000620 or better) Required PCI/PCIe Bus Slots: 1x Full Length (30") PCI slot (Galva DAQ card), 2x PCIe (secondary DAQ card and resonant DAQ card)
Multiphoton Detection Unit	
Collection optics	Collection lens diameter: 30 mm* Maximum collection angle: $\sim \pm 5^\circ$ assuming 20mm objective back aperture and $\sim \pm 3.5^\circ$ (optical) assuming a 20 mm objective back aperture* <small>*see J.P. Zinter et. al. OPT EXPRESS (19), 16 15348, 2011.</small>
Dichroic beam splitter	Dimensions: 30x40x1.1 mm Average reflectivity: $\sim 98\%$ 350 nm to 685 nm @45° AOI Average transmission: $\sim 93\%$ 715 nm to 1600 nm @45° AOI Surface flatness: $\lambda/4$ @ 633 nm
Photomultiplier tubes	Ultra bialkali (R9880U-210) Photocathode size: 8mm diameter Spectral response: 230 to 700 nm Quantum efficiency @400 nm: $\sim 40\%$ Multialkali (R9880U-20) Photocathode size: 8mm diameter Spectral response: 230 to 920 nm Quantum efficiency @630 nm: $\sim 16\%$ GaAsP protected photomultiplier tube (H10770PA-40) Photocathode size: 5mm diameter Spectral response: 300 to 720 nm Quantum efficiency: not specified GaAsP photomultiplier tube with gating function (H11706P-40) Photocathode size: 5mm diameter Spectral response: 300 to 720 nm Quantum efficiency @580 nm: 40% Typical shutter rise/fall time: 230nS Shutter width (FWHM): 1 μ s to 10mS* Shutter input low level threshold: min 0 V max to +0.4V Shutter Input high level threshold: min + 2.0 V to Vcc (i.e. +14.5 to +15.5 V) <small>*The shutter remains closed for a maximum period of 10mS.</small>

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ChromoFlex	
Green channel filter	Dimensions: 25mm diameter 1 mm thickness Average Transmission: ~ 97% 502 nm to 546 nm @normal incidence Surface flatness: N/A
Red channel filter	Dimensions: 25mm diameter 1 mm thickness Average Transmission: ~ 97% 590 nm to 648 nm @normal incidence Surface flatness: N/A
Collection optics	Collection lens diameter: 45 mm* Maximum angular Collection angle: ~ $\pm 8^\circ$ assuming 20mm objective back aperture. *see J.P. Zinter et. al. OPT EXPRESS (19), 16 15348, 2011.
Liquid light guide	Core diameter: 5 mm Transmission range: 280 to 650 nm Temperature range: -5°C to 35°C
Dichroic beam splitter	665 nm long-pass dichroic, factory-fitted (60 x 40 x 1 mm) Dimensions: 60x40x1.1 mm Average reflectivity: ~ 98% 350 nm to 685 nm @45° AOI Average transmission: ~ 93% 715 nm to 1600 nm @45° AOI Surface flatness: $\lambda/4$ @ 633 nm
IR Blocking Filter	680nm short-pass filter, factory fitted Dimensions: 30mm diameter 2mm thickness Average Transmission: ~ 98% 350 nm to 650 nm @45° AOI Surface flatness: $\lambda/4$ @ 633 nm
Compatible emission filter dimensions	Excitation/emission filter: 25 mm diameter Dichroic beam splitter: 24x36x1 mm
Tested Ultrafast Laser Oscillators	
Tunable laser oscillators (Ti:S)	Coherent Chameleon family Spectra physics Maitai family
Fixed wavelength laser oscillators (Yb³⁺ or Er³⁺)	ONE FIVE origami 10 Toptica Femto fibre Dichro
System Optical damage threshold	0.5 J/cm ² (1064 nm, 10 ns, 10 Hz, Ø1 mm)