SUPERCONTINUUM GENERATION KIT

► **Spectrally Broaden Femtosecond Pulses Centered Around 800 nm**

► **Broadband Output Spectrum from Visible to NIR**

► **Version for Coherent Anti-Stokes Raman Scattering (CARS) Available**

Dispersed Supercontinuum Output
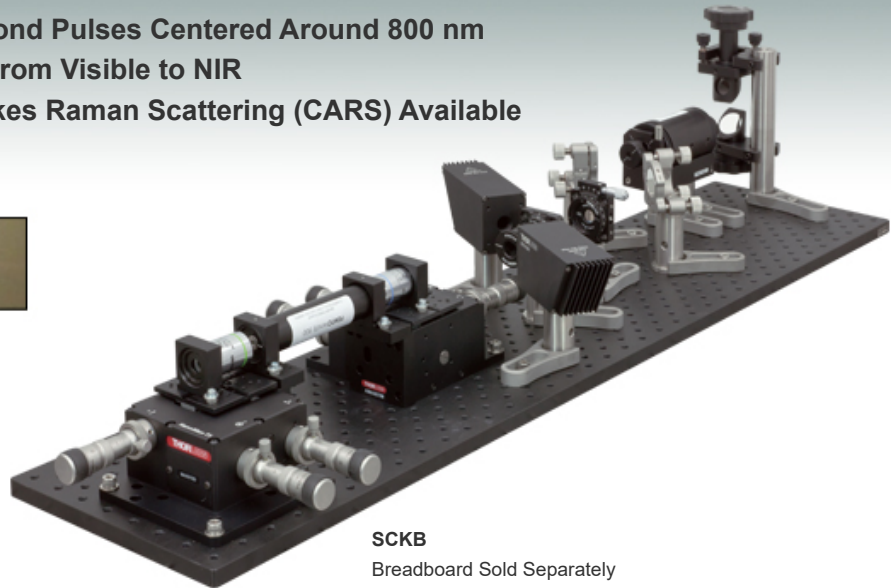
SCKB
Breadboard Sold Separately

OVERVIEW

Thorlabs' Supercontinuum Generation Kits use femtoWHITE highly nonlinear fibers from NKT Photonics to spectrally broaden femtosecond pulses near 800 nm. We offer two versions of these kits. The first version, Item # SCKB(/M), produces an output beam that combines the high power and spatial coherence of a laser with the broad visible-to-NIR spectrum of an incandescent source. The second version, Item # SCKB-CARS(/M), is optimized for Coherent Anti-Stokes Raman Spectroscopy (CARS) and provides a stable beam with peaks at two separate center wavelengths: one in the visible and the other in the NIR.

The supercontinuum generation kits consist of preselected, proven parts that allow the user to quickly build a setup and create a supercontinuum spectrum. The kit components are shipped unassembled. Due to this modular nature, the supercontinuum kits may be easily customized to a particular application by replacing components. For an example, please see the *Kit Customization* tab above. Additionally, the periscope assembly allows the beam height of the pump source to be matched to the height of the kit's optical axis; custom spacers for popular lasers, such as Coherent's Chameleon, are available by contacting techsupport@thorlabs.com.

SCKB(/M): Broad Supercontinuum, Tuned by Input Laser Parameters
When pumped with Thorlabs' Tiberius Ti:Sapphire laser, Menlo Systems' C-Fiber lasers, or Menlo Systems' OEM femtosecond erbium lasers, the SCKB(/M) produces a smooth, stable output and even intensity from at least 500 - 1200 nm. Performance plots using the C-Fiber lasers are shown in the *Graphs* tab above. If a tunable Ti:Sapphire laser is used, the shape and intensity of the spectral output can be tweaked as a function of the peak power, pulse width, and center wavelength of the pump. This enables the production of qualitatively different spectra. For advice on the choice of pump laser, we invite you to contact us at Tech Support.

Depending on the relative distance from the zero-dispersion wavelength of the fiber, a variety of nonlinear effects are responsible for the creation of the spectrum. These effects include self-phase modulation, Raman scattering, soliton fission, and four-wave mixing. Please refer to J.M. Dudley, G. Genty, S. Coen. "Supercontinuum generation in photonic crystal fiber" *Rev. Mod. Phys.* **78,** 1135 (2006) for a review of these effects in photonic crystal fibers.

### SCKB-CARS(/M): Optimized for Coherent Anti-Stokes Raman Scattering (CARS)
The SCKB-CARS(/M) contains a fiber with two zero-dispersion wavelengths for generation of an output with two distinct peaks, suitable for Coherent Anti-Stokes Raman Scattering applications. When pumped at a wavelength between the two zero-dispersion wavelengths, more than 99% of the light is converted into two spectral peaks.

The peak wavelengths result from the choice of the two zero-dispersion wavelengths, which are determined solely by the design of the nonlinear PCF fiber. Due to this, the output wavelength is insensitive to changes in the center wavelength of the pump, pulse energy, pulse width, and spectral bandwidth. However, the relative intensity of the two peaks can be adjusted by varying the pump wavelength.

For more information, please see K. M. Hilligsøe, T. V. Andersen, H. N. Paulsen, C. K. Nielsen, K. Mølmer, S. Keiding, R. E. Kristiansen, K. P. Hansen, and J. J. Larsen, "Supercontinuum generation a photonic crystal fiber with two zero dispersion wavelengths" *Opt. Express* **12,** 1045 (2004).

Applications

- Fluorescence Microscopy
- Coherence Tomography
- Flow Cytometry
- Optical Device Characterization
- Coherent Anti-Stokes Raman Scattering (-CARS Version)
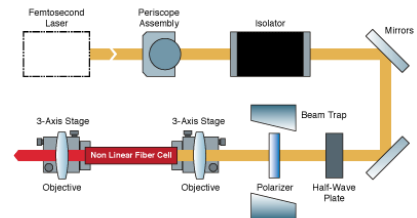
Click to Enlarge
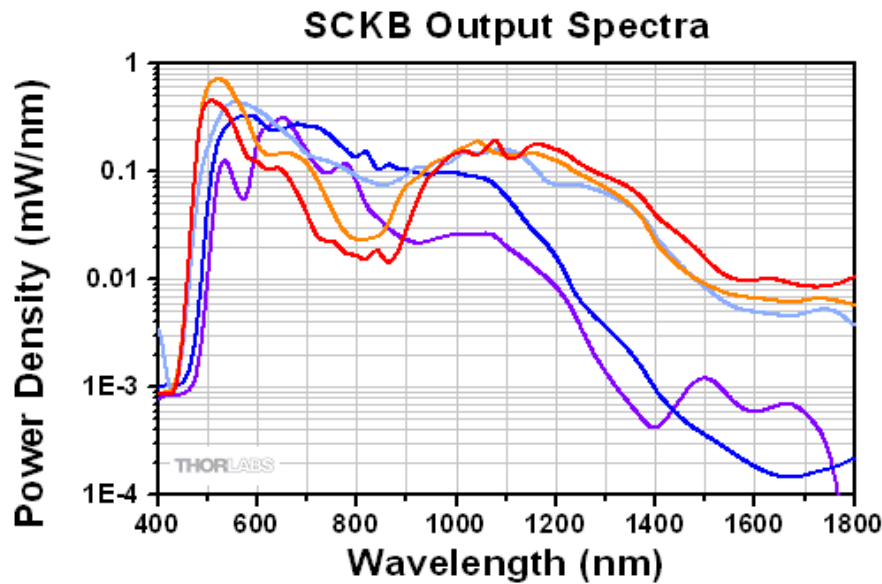Schematic of Supercontinuum Generation Kit

Supercontinuum Generation with Tunable Lasers

The spectral output of the Supercontinuum Generation Kit (Item # SCKB) can be tuned by changing the wavelength of the input light. The zero-dispersion wavelength (ZDW) of the kit's fiber module is
750 nm, which allows Ti:Sapphire lasers to pump above and below the ZDW, accessing qualitatively different spectra.

The following spectra were taken using our Supercontinuum Generation Kit with a Coherent Chameleon Ultra II laser as the pump source. The results were collected by dispersing the light with a prism and then translating a slit and calibrated detector across the dispersed beam to measure the intensity across the spectrum. The data shows how the supercontinuum spectrum varies with input wavelength.

We thank Rupert Oulton and his group at Imperial College London for providing us with these results.


Plot Key

Input Laser Wavelength	Line Color[a]
700 nm	
750 nm	
800 nm	
850 nm	
900 nm	

a. Click on the line for an individual spectrum plot.

Supercontinuum Generation with Fixed-Wavelength Lasers

The graphs below show results obtained by pumping the Supercontinuum Generation Kit (Item # SCKB) with the high-power, 780 nm C-Fiber laser from Menlo Systems. Generally speaking, the output spectrum depends upon the peak power, pulse width, and the center wavelength of the pump. The laser parameters used are given in the tables below each plot.
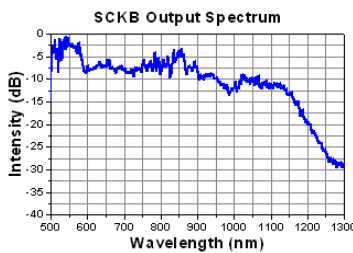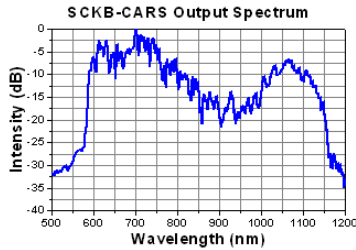

Click to Enlarge

Menlo Systems Laser Item #	C-FIBER-780-HIGH-POWER
Center Wavelength	780 nm ± 10 nm
Repetition Rate	100 MHz
Pulse Length	60 fs[a]
Power After Polarizer	140 mW[a]
Power After Fiber Cell	65 mW[a]

a. Measured Experimental Values

Dual-Wavelength Spectrum for Coherent Anti-Stokes Raman Scattering (CARS)

The graph below shows results obtained by pumping the CARS version of the Supercontinuum Generation Kit (Item # SCKB-CARS) with the high-power, 780 nm C-Fiber laser laser from Menlo Systems. The laser parameters used are given in the table on the right.

The peak wavelengths result from the choice of the two zero-dispersion wavelengths, which are determined solely by the design of the nonlinear PCF fiber. Due to this, the output wavelength is insensitive to changes in the center wavelength of the pump, pulse energy, pulse width, and spectral bandwidth. However, the relative intensity of the two peaks can be adjusted by varying the pump wavelength.

SCKB-CARS Output Spectrum

Click to Enlarge

Menlo Systems Laser Item #	C-FIBER-780-HIGH-POWER
Center Wavelength	780 nm ± 10 nm
Repetition Rate	100 MHz
Pulse Length	60 fs[a]
Power After Polarizer	140 mW[a]
Power After Fiber Cell	60 mW[a]

a. Measured Experimental Values

KIT CUSTOMIZATION

Kit Customization Example

Because of a modular design that uses items compatible with Thorlabs' stock components, the Supercontinuum Generation Kit may be modified to fit the demands of a particular application. For example, the microscope objectives used in the kit may be easily replaced with appropriate aspheric lenses. This is particularly beneficial if pulse broadening is a concern; the single-element aspheric lenses will broaden the pulses less than the multi-element microscope objectives. With either objectives or aspheric lenses, the fiber coupling efficiencies will be in excess of 60%.

To replace the microscope objectives with aspheres, such as our C610TME-B aspheric lens, you will need Thorlabs' E09RMS RMS to M9 x 0.5 Adapter. Thread the M9 x 0.5-threaded lens housing into the adapter (an SPW301 spanner wrench is useful for this task), and then thread the adapter into the RMS-threaded holder on the 3-axis stage. A detail of the fiber coupling assembly with one objective replaced with an aspheric lens is shown in the photo to the upper right.
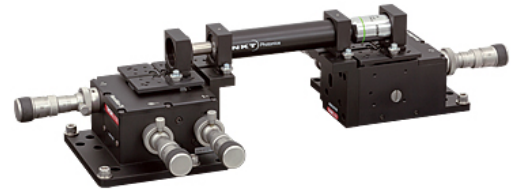
An additional example is shown to the lower right. In this case, the kit's standard fiber cell and mounts have been replaced with one of our photonic crystal fibers and two of our fiber clamps. The HFF001 fiber clamp and HFF003 fiber clamp are both shown, although in practice, one or the other can be used exclusively.

For more information on these and other customization options, please contact us at techsupport@thorlabs.com.

Click to Enlarge
Fiber Assembly Modified with an Aspheric Lens

Click to Enlarge
Fiber Assembly Replaced with Fiber Clamps and Custom Fiber

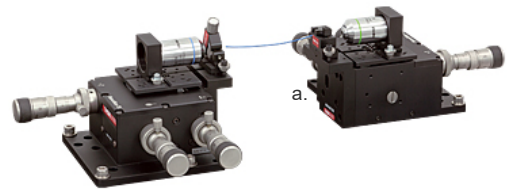## Lasers from Thorlabs and Strategic Partners

The supercontinuum generation kits may also be ordered as a package that includes a femtosecond laser. Options include the Tiberius femtosecond laser, manufactured by Thorlabs, and fiber-laser-based solutions from our strategic partner, Menlo Systems. Selected laser specifications are given in the table below; for full details, please see that laser's full web presentation.

For more details or to receive quotes on a complete supercontinuum system, pre-assembly services, or installation services, please contact us at Tech Support.

Click to Enlarge
Tiberius Femtosecond Laser

Item #	Manufacturer	Output Power	Repetition Rate
TIBERIUS	Thorlabs	>2.3 W at 800 nm	77 MHz (Nominal)
C-FIBER-780-HIGH-POWER	Menlo Systems	>180 mW (Average)	100 MHz
ELMO-780	Menlo Systems	>75 mW (Average)	100 MHz

Supercontinuum Generation Kit

Part Number	Description	Price	Availability
SCKB/M	Customer Inspired! Supercontinuum Generation Kit, Metric	$17,440.50	Lead Time
SCKB	Customer Inspired! Supercontinuum Generation Kit	$17,440.50	Lead Time

Supercontinuum Generation Kit for Coherent Anti-Stokes Raman Scattering

Part Number	Description	Price	Availability
SCKB-CARS/M	Customer Inspired! Supercontinuum Generation Kit with CARS Fiber Cell, Metric	$19,507.95	Lead Time
SCKB-CARS	Customer Inspired! Supercontinuum Generation Kit with CARS Fiber Cell	$19,507.95	Lead Time