MANUAL

femtoPulse Master™
(version 1.1)

BioPhotonic Solutions Inc. Laboratories
1401 East Lansing Dr., Suite 112, East Lansing, Michigan 48823 USA
(Voice) 517-580-4075 info@biophotonicsolutions.com

General Information

femtoPulse Master™ is a software package, developed and distributed by Biophotonic Solutions Inc., which allows simulating time domain profiles of a scalar optical field as well as a variety of nonlinear outputs based on the input spectrum and phase. The program features manipulation controls for the phase and amplitude of the field. The full version of the software also allows loading user-defined spectrum and phase.

Software Outputs:

- Time-domain profile of the linearly-polarized electric field, normalized on the maximum for the unshaped, transform-limited (TL) pulse
- Time-domain profile of electric field intensity, normalized on the maximum for the unshaped, TL pulse.
- Second-harmonic generation (SHG) spectrum, normalized on the SHG maximum for the unshaped, TL pulse.
- Raman excitation efficiency spectrum, normalized on the excitation efficiency at zero wavenumber for the unshaped, TL pulse.
- MIIPS® trace
- MIIPS II™ trace
- FROG/XFROG trace
- Interferometric and Background-free Autocorrelation

The full version of the software allows saving all program outputs as well as inputs. The demo version retains all outputs but does not allow saving those. The ability to load user-defined spectrum and/or phase is also not available in the demo mode.

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Installation

If you have Labview 7.1 Run-Time Engine installed on the computer, you can simply copy the program and supporting files to a convenient location and run ‘femtoPulse_Master_v1.1.exe’. The content of the program folder with the installer is show in Fig. 1.

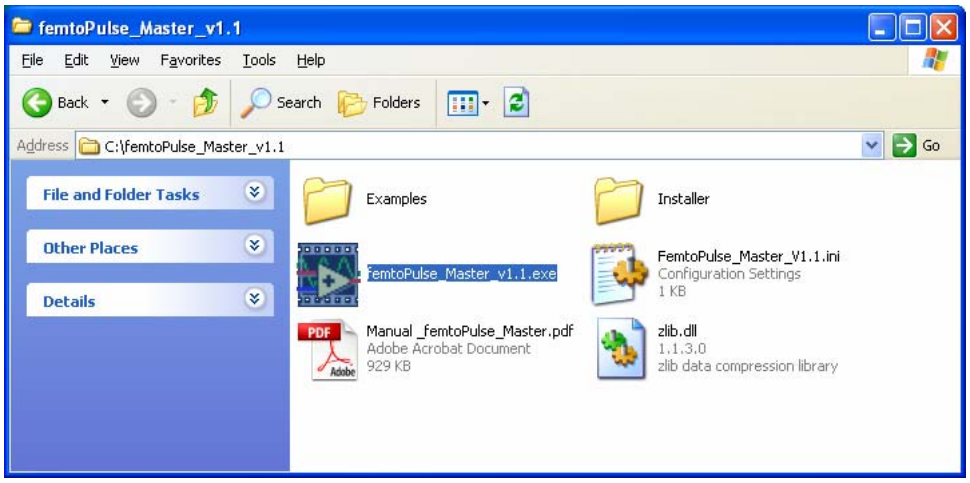

Fig. 1. Program folder.

If you try to run ‘femtoPulse_Master_v1.1.exe’ and get an error message similar to the one shown in Fig. 2, you need to go through the complete installation that includes setting up Labview Run-Time Engine. It also adds *femtoPulse Master*™ into the Program Menu.

Fig. 2 Error message indicating that the computer does not have a proper Labview Run-Time Engine installed.

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For the complete installation, please go to "…\Installer\" folder and run 'setup.exe' as shown in Fig. 2.

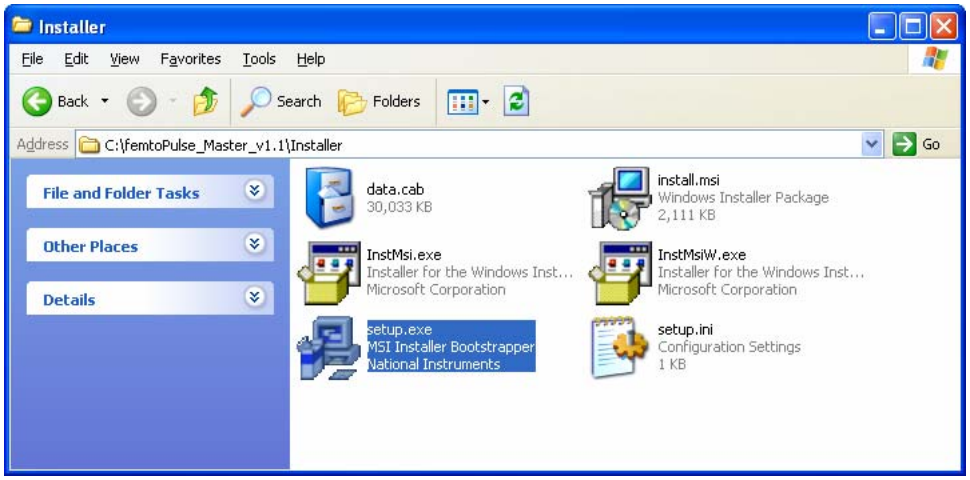
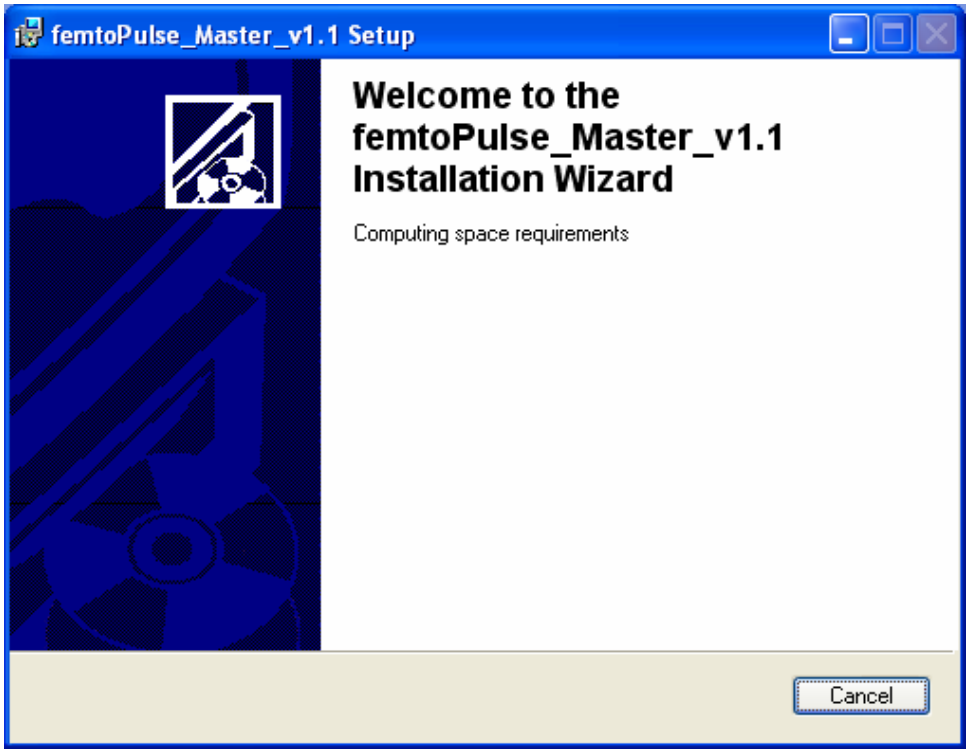


Fig. 3. Installation file for *femtoPulse Master*™ program.

Follow the pop-up instructions to complete the installation. The screen-shots are shown below.



Click 'Next" to continue …

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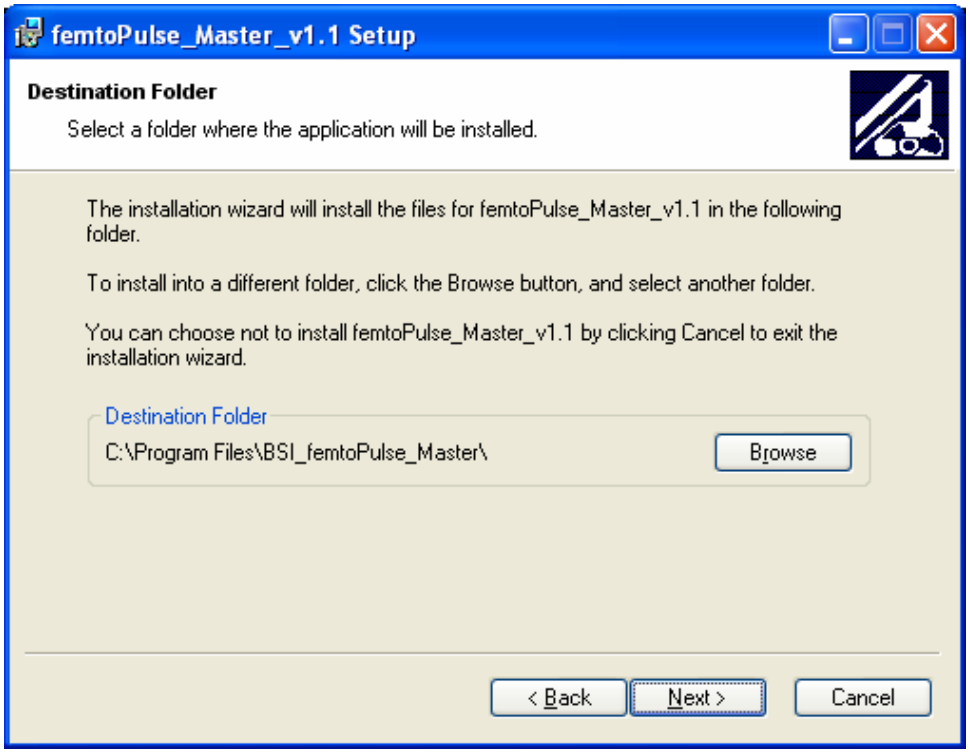
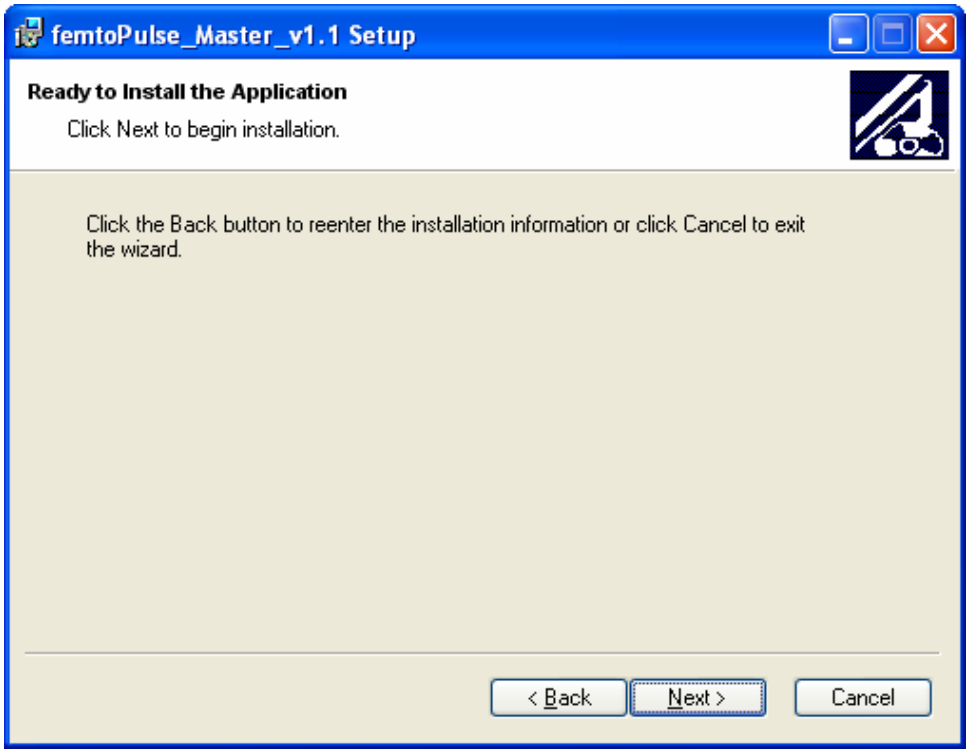


Choose 'Destination Folder' or use default settings. Click 'Next" to continue …



Click 'Next" to continue …

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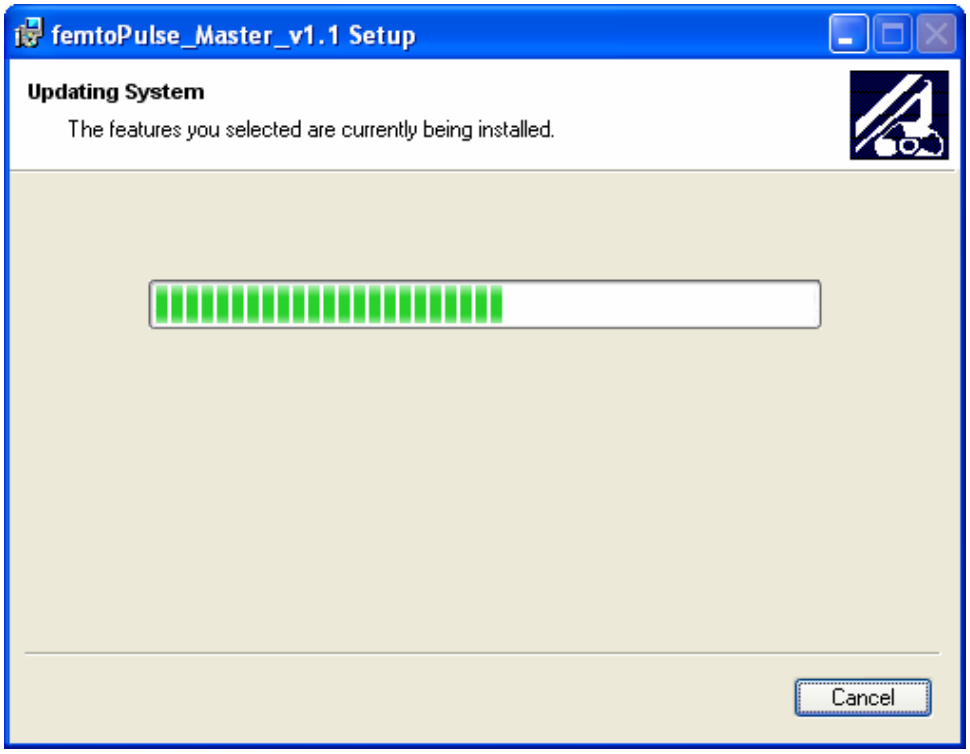
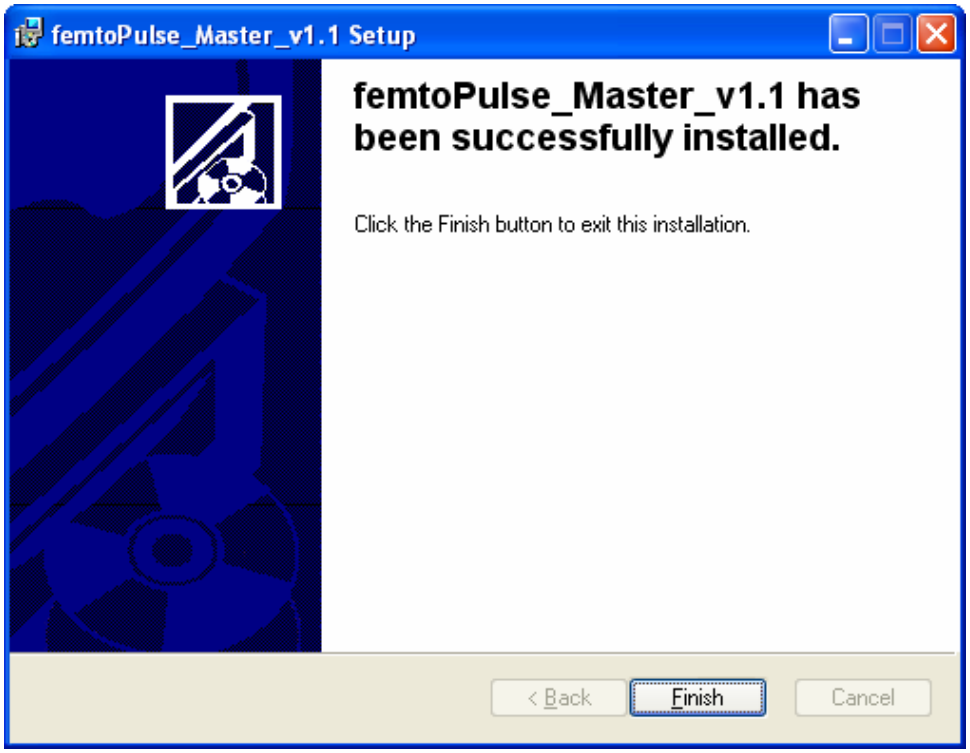


Wait until the installation is completed.



The program has been successfully installed! You can now start it from the 'Start' menu.

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Getting a License

If you haven't got the license file from Biophotonic Solutions, Inc., the program will start in the 'Demo' mode and will display a 'Demo Mode' warning as shown in Fig. 4.

Fig. 4. 'Demo Mode' pop-up dialog notifying that *femtoPulse Master*™ will be executed in the demo mode.

Click 'OK' to continue. The program will switch to the 'Demo Mode' and some of the functions will be disabled, i.e. not available to the user.

Below is the list of constraints of the 'Demo Mode':

- Input spectrum and phase are limited to those provided by the program controls. User-defined spectrum and phase inputs are disabled.
- Program version is limited to '16-bit'.
- 'Load P-mask' and 'Load T-mask' controls are disabled.
- All 'Save' buttons are disabled.
- '# of φ″ points' control in 'MIIPS II' pallet is disabled.
- 'Step Size' in 'FROG/XFROG' pallet is disabled.

If you would like to take advantage of these features, you will need to generate an 'activation key' (to be sent with your request) and purchase a license from Biophotonic Solutions, Inc.. **Note that the activation key is hardware-bound, i.e. the license file that you will receive is valid only for the PC, where the activation key has been generated.**

Biophotonic Solutions offers various packages for the installation and licensing of the full version of *femtoPulse Master*™ on several PCs. However, the license files are issued per activation key provided. Therefore, you need to generate activation keys on each of the machines to be used.

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To generate the activation key, please select ‘Activation’ menu in the top left corner of the program window; see Fig. 5.

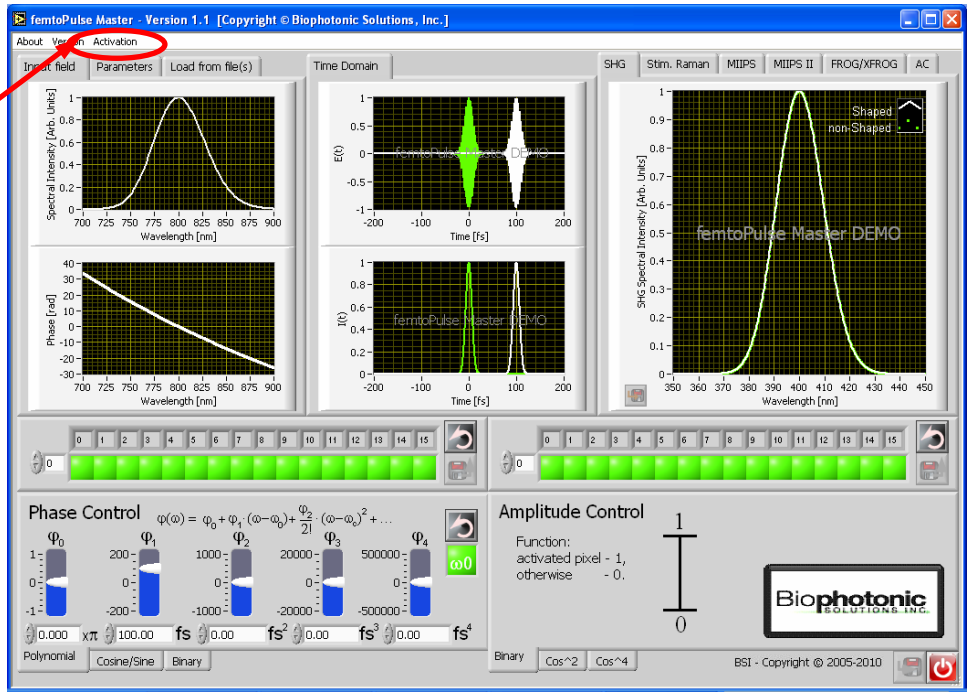

Fig. 5 ‘Activation’ menu of *femtoPulse Master*™

A pop-up window, shown in Fig. 6, will follow.

Fig. 6. ‘Activation’ dialog

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Click ‘Generate Activation Key’ and save file ‘BSI_femtoPulseMaster_ActivationKey.dat’ in a convenient location.

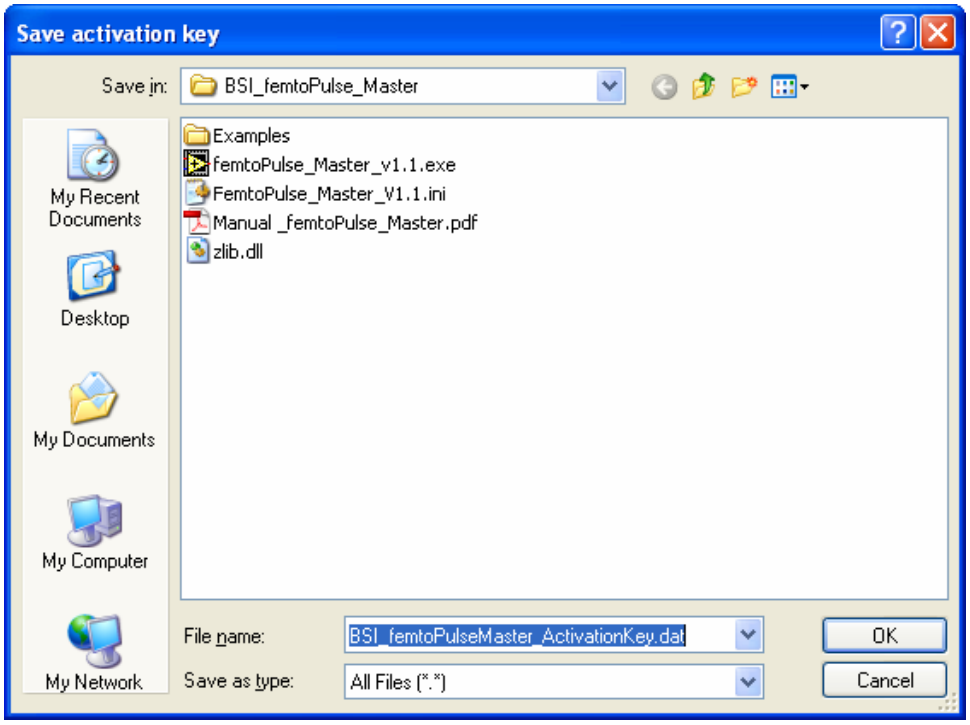

Fig. 7. Save activation key

You will need to e-mail us file ‘BSI_femtoPulseMaster_ActivationKey.dat’ as an attachment to your request for a license. Once the payment has been received, we will send you the license file ‘FemtoPulseMaster.lfl’. Put the license file into the folder that contains the executable ‘femtoPulse_Master_v1.1.exe’ and restart *femtoPulse Master*™. You are ready to go!

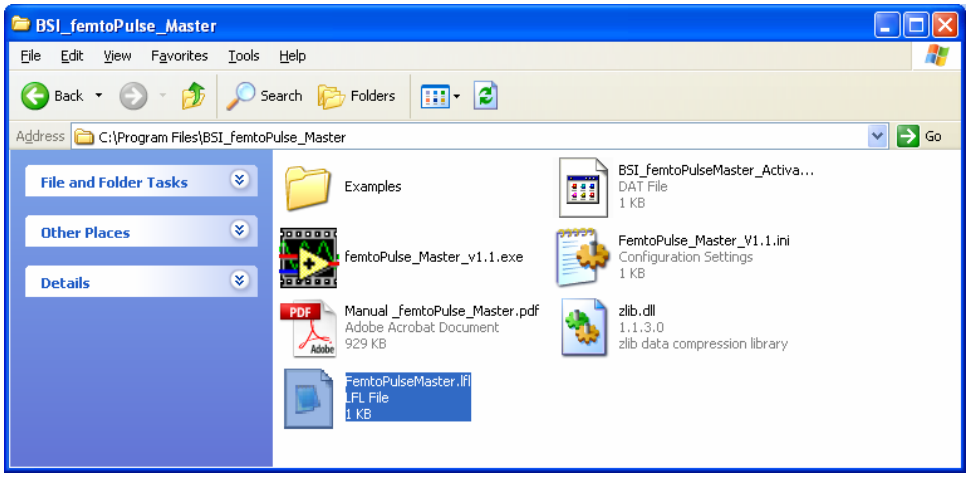

Fig. 8. Save the license file in the *femtoPulse Master*™ folder

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If the license file is correct, *femtoPulse Master*™ will start in the normal mode automatically. All functions should become available to the user, and the 'Activation' menu should become disabled and grayed out.

If the license file is incorrect, the following warning will appear; see Fig. 9.

Fig. 9. 'Invalid License' pop-up dialog

If you are experience difficulties activating the license, please contact us.

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femtoPulse Master™ Main Panels

Below is a brief overview of *femtoPulse Master*™ 's panels.

Input Panel

The input spectrum and phase functions as well as most of the calculation parameters are displayed and manipulated in one of the three panels shown in Fig. 10.

Fig. 10. Input sub-panels

By default, *femtoPulse Master*™ uses a Gaussian function to generate the intensity spectrum within the given 'Wavelength Range'. The other input parameters for the Gaussian are 'Center Wavelength (λ_c)' and 'Pulse Duration (FWHM). Note, however, the spectral intensity is assumed to be zero outside the 'Wavelength Range'. Therefore, proper wavelength range limits need to be chosen to encompass the 'tails' of the Gaussian function. Failure to do so will cause distortion in the actual pulse duration and shape.

'Spectral Resolution' and 'FFT Time Resolution' values are used to generate the frequency-domain mesh (limits, step size, etc.) for the subsequent calculations.

'Time Range' controls define the region displayed in the 'Time domain' plots.

Two presets are available to the user for quick resetting of the input parameters. Upon the start, the program loads 'Preset 1'. One can reset modified values by pressing 'Preset 1' or 'Preset 2' buttons.

The user may choose to load the intensity spectrum and/or phase from a file. The indicators on sub-panel 'Load from files(s)' will show then if the data has been loaded from a file and what kind of processing has been performed upon loading the data (see Load Data section).

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Time Domain Panel (Output)

This panel shows the electric filed and intensity profiles in the time domain. They are normalized on the maxima for a TL pulse (zero phase), corresponding to the input spectrum without any amplitude modulation. The electric filed and intensity profiles of such a pulse are shown by green lines.

The time-domain profiles corresponding to the modulated spectrum and phase are shown by white lines.

The time range in the plots is set by 'Time Range' controls in 'Parameters' sub-panel. The scales can be accessed and modified directly on the plots to zoom-in on features of interest but they will reset to their original values after the next rerun.

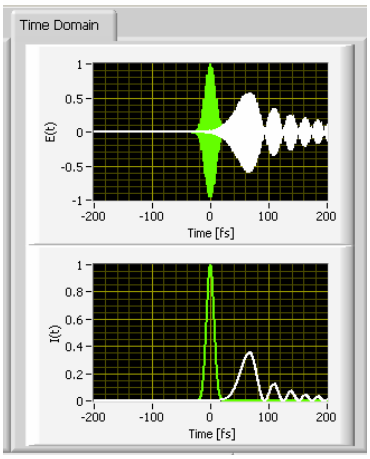

Fig. 11. Time-Domain panel

Nonlinear Output Panel

femtoPulse Master™ offers a variety of outputs. Figure 12 demonstrates the output sub-panels for different control parameters.

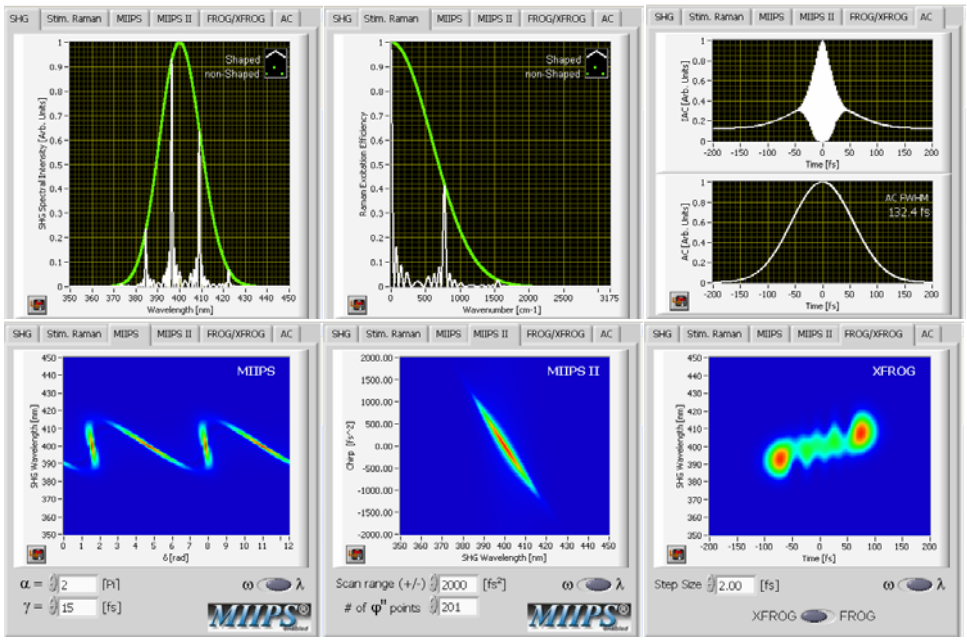

Fig. 12. Output sub-panels

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Phase Control Panel

Phase Control Panel features two distinct sections; see Fig. 13. The upper section defines 'active pixels', and the lower section provides controls for the phase applied. For the case shown, the 'Wavelength Range' is divided into 16 even 'pixels'. If the pixel is ON (light green), the phase across this 'pixel' is defined by the phase function in the lower panel (plus user-loaded phase when applicable). If the 'pixel' is OFF (dark green), the phase across the 'pixel' is equal to zero (plus user-loaded phase when applicable).

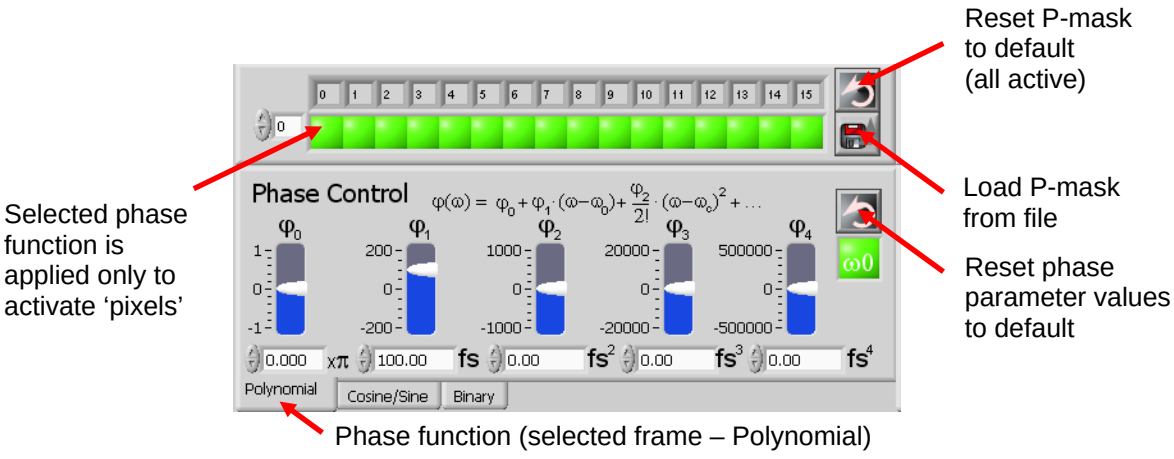

Fig. 13. Phase control panel

'Polynomial' frame allows generating the following phase function:

$$\varphi(\omega) = \varphi_0 + \varphi_1 \cdot (\omega - \omega_0) + \frac{\varphi_2}{2!} \cdot (\omega - \omega_c)^2 + \frac{\varphi_3}{3!} \cdot (\omega - \omega_c)^3 + \frac{\varphi_4}{4!} \cdot (\omega - \omega_c)^4,$$

where $\omega_c \equiv 2\pi c / \lambda_c$ is the center frequency, calculated from the user-defined center wavelength λ_c, and ω_0 is equal to ω_c if ω_0-button is ON and equal to zero if ω_0-button is OFF.

The other two available function options, 'Cosine/Sine' and 'Binary', are shown in Fig. 14.

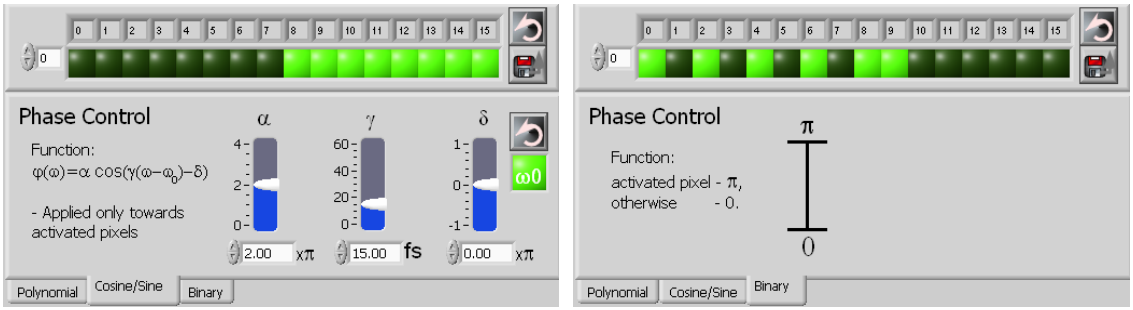

Fig. 14. 'Cosine/Sine' and 'Binary' options in the Phase Control panel

Note that 'Binary' sub-panel gives a quick access to 0-π binary phase shaping. Its functionality can be reproduced in 'Polynomial' sub-panel by setting φ_0 to π.

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Amplitude Control Panel

Amplitude Control panel is similar in functionality to Phase Control panel. Its options and their effect on the default Gaussian spectrum are summarized in Fig. 15.

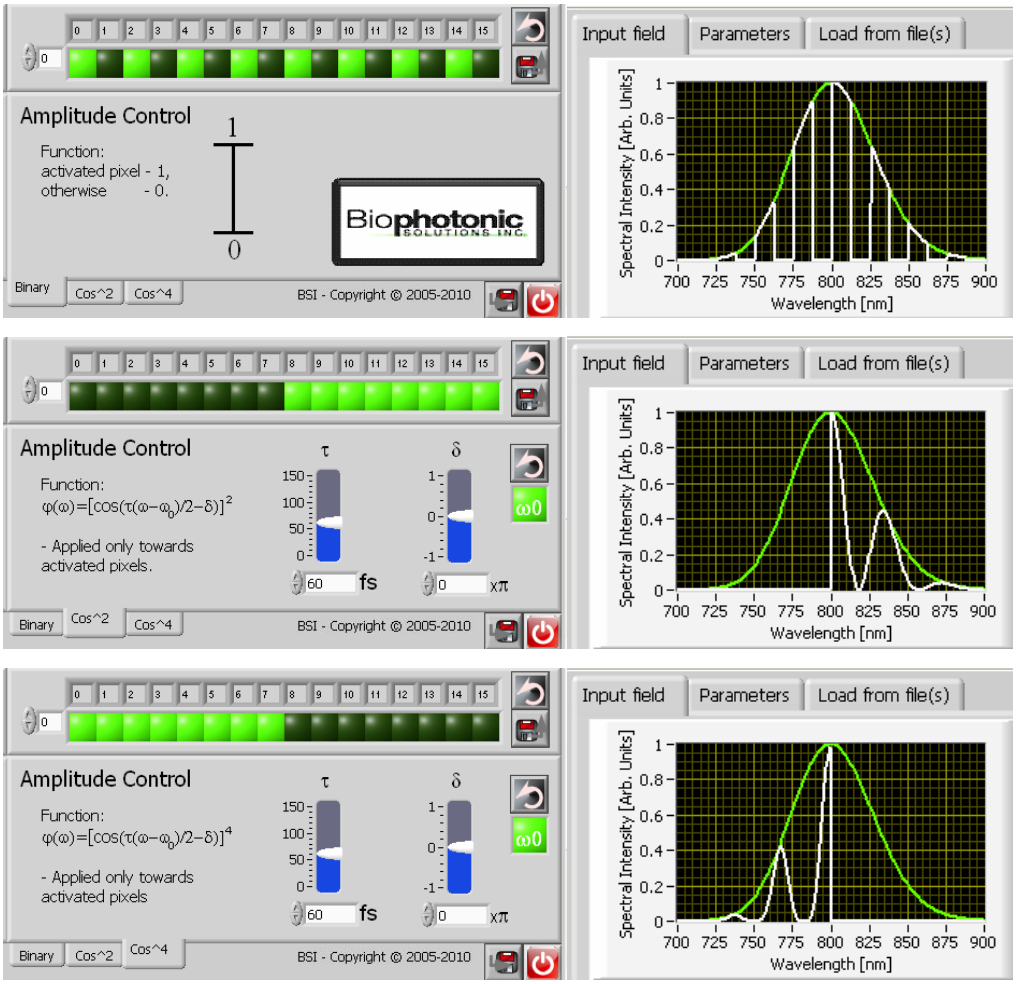

Fig. 15. Amplitude Control panel

Note that the amplitude control functions are applied to the input spectral intensity of the field and are limited to [0,1] interval. To deduce their effect on the field amplitude, one needs to take the square root of the 'Amplitude Control' function.

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Loading User-Defined Spectrum and Phase

The full version of the *femtoPulse Master*™ software allows loading spectrum and/or phase from file through 'Load from file(s)' sub-panel; see Fig. 16.

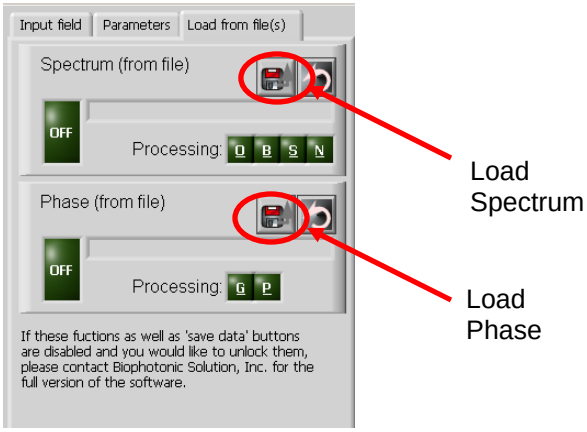

Fig. 16. Loading spectrum and phase from file

A pop-up 'Load Spectrum' window will appear. Click 'Upload (from file)' button and select an ASCI file with two columns (Wavelength [nm], Intensity) you would like to load. Choose from the available option to reduce the wavelength range, offset the spectrum vertically (to avoid cutting negative values), subtract background (fit and subtract a linear line), or normalize to unity as shown in Fig. 17.

'SpecScale Correction' can be used to convert $I(\lambda)$ into $I(\omega)$, used in calculations. Here, $I(\lambda)$ is the spectral density per unit of wavelength, as one usually observes in a spectrometer, and $I(\omega)$ is the spectral density per unit of frequency.

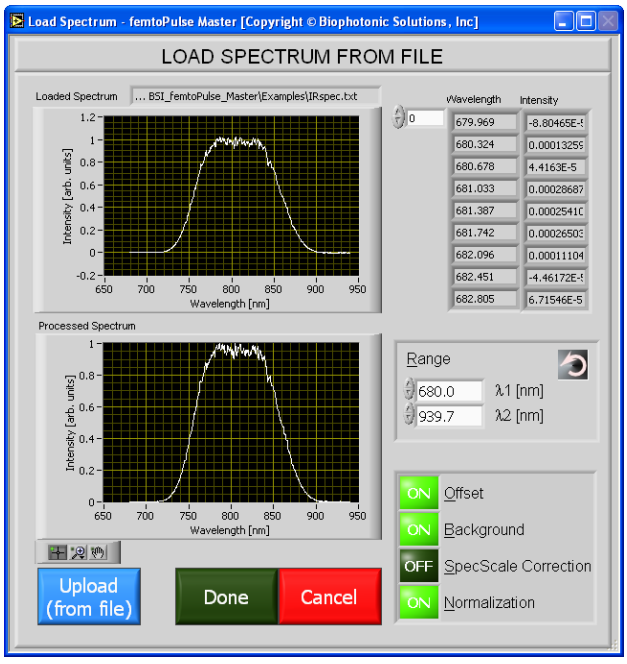

Fig. 17. Pop-up window for loading and processing spectrum

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The fact that the spectrum is loaded is reflected in 'Load from file(s)' sub-panel; see Fig. 18. The indicators show processing options chosen by a user in 'Load Spectrum' window.

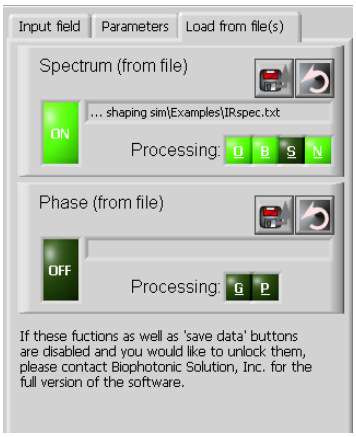

Fig. 18. Indication of user-loaded spectrum in 'Load from file(s)' panel of *femtoPulse Master*™

Similar interface but with different processing options is used to load phase functions; see Fig. 19. The user can load phase as a function of wavelength (in nanometers) or as a function of pixel. In the later case, a geometry file in the format used by *BSI's MIIPS® Box* software.

'Pixelation' option should be used for inhomogeneous phase functions (like, binary phase) to prevent *femtoPulse Master*™ algorithms from spline interpolation in-between the points.

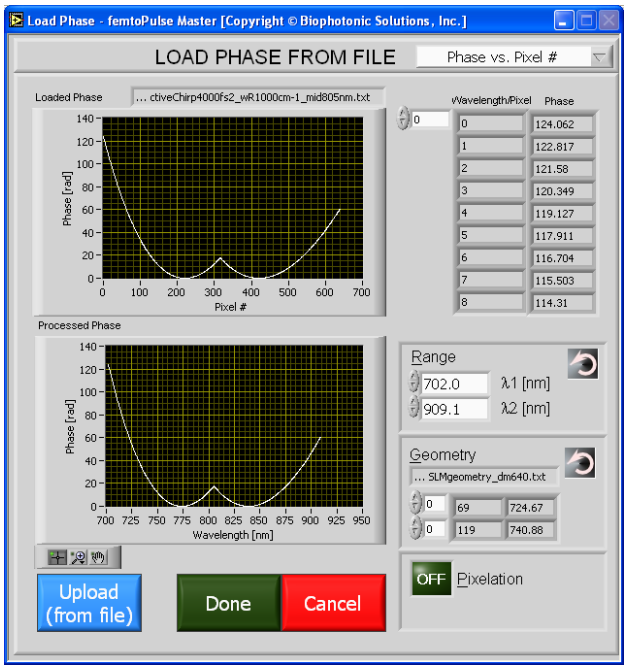

Fig. 19. Pop-up window for loading and processing phase

Again, the fact that the phase is loaded and options used are reflected in 'Load from file(s)' sub-panel.

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