

# Tutorial 1 - Overview

- Graphical User Interface
- Parameter Access
- Setting up a propagation
- Setting up a view
- Loading / Saving field, projects, components



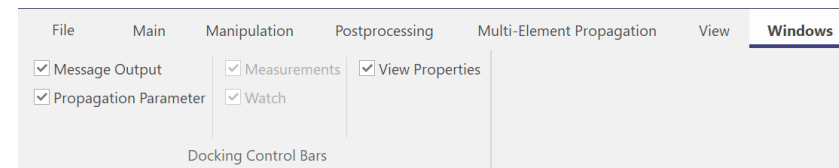
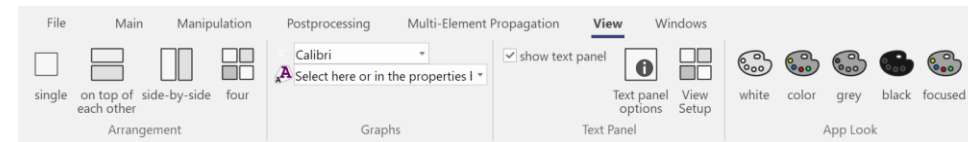
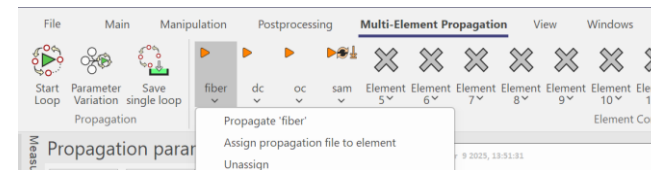
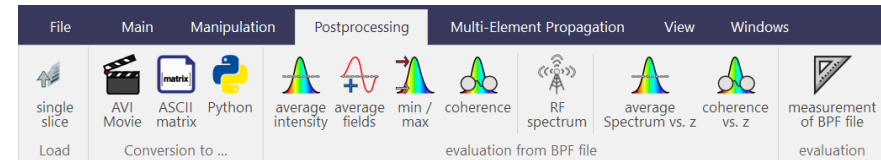
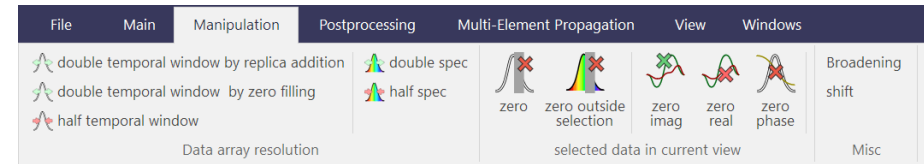
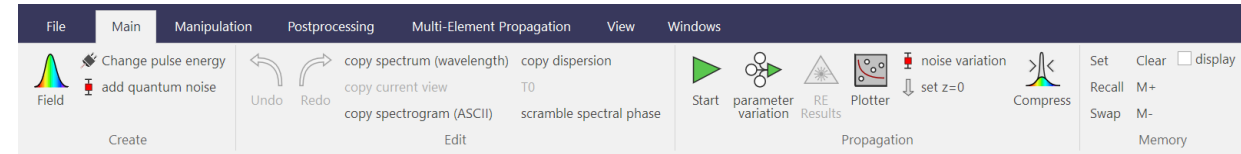
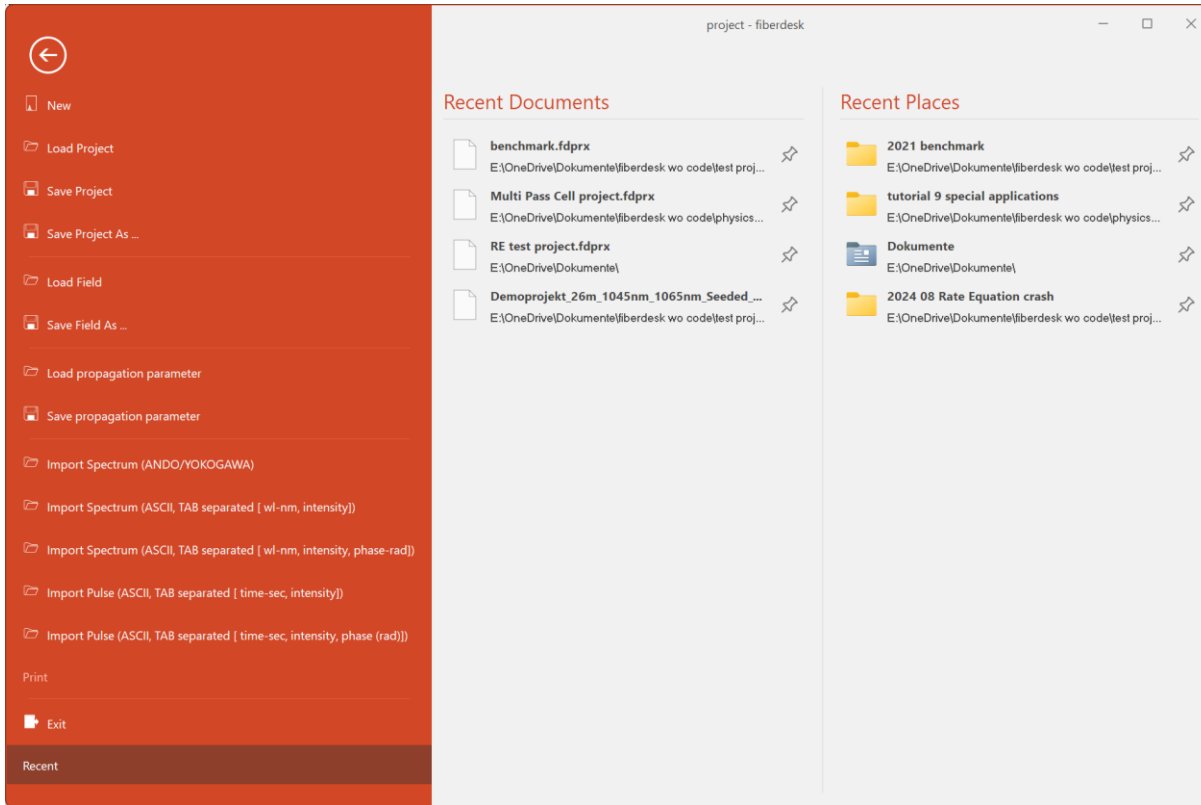
# fiberdesk – graphical user interface (GUI)

The screenshot displays the fiberdesk GUI with several callout boxes highlighting key features:

- Ribbon control:** Located at the top of the window, containing various tool icons for simulation and analysis.
- Measured values:** A box pointing to the 'Measurements' panel on the left, which lists parameters such as (M0) index = 100, (M1) current position = 0.000 m, and (M2) accumulated distance = 0.000 m.
- Propagation parameter:** A box pointing to the 'Propagation parameter' panel on the left, showing settings for waveguide loss, gain, mode diameter, and effects like dispersion and SPM/TPA.
- Main View:** A central box pointing to the four main plots: 'Temporal Field' (Power / kW vs Time / ps), 'Temporal Propagation' (Distance / a.u. vs Time / ps), 'Spectrum' (Power / W ps<sup>2</sup> vs Wavelength / μm), and 'Spectral Propagation' (Distance / a.u. vs Wavelength / μm).
- Measured graphs:** A box pointing to the 'Measured Graphs' panel on the left, which shows a plot of 'Temporal Field energy / J' vs 'Position.index'.
- view setup:** A box pointing to the 'View Properties' panel on the right, which allows for customizing the display of project information, view content, and data scaling.
- Output:** A box pointing to the 'Message Output' panel at the bottom, which shows system messages like 'Welcome to fiberdesk 8.00'.

# fiberdesk – graphical user interface (GUI)

## File menu



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# fiberdesk – NLSE parameter setup

Parameter access in detail:

The parameters of the underlying equations are shown for the nonlinear Schrödinger equation as an example:

$$\frac{\partial A}{\partial z} = -\frac{\alpha}{2} A + \int_{-\infty}^{\infty} \frac{g(\omega)}{2} \tilde{A}(\omega) e^{-i\omega T} d\omega + \sum_{n \geq 1} \beta_n \frac{i^{n+1}}{n!} \frac{\partial^n}{\partial T^n} A + i\gamma \cdot \left( 1 + i\tau_{shock} \frac{\partial}{\partial T} \right) \left( A(T) \int_{-\infty}^{\infty} R(\tau) |A(T-\tau)|^2 d\tau \right)$$

The screenshot displays the 'Propagation parameter' window in fiberdesk. The 'Gain' tab is active, showing various configuration options. The 'gain' parameter in the 'waveguide' section is highlighted with a yellow box. The 'Gain' window itself is outlined in red and contains the following details:

- steady state gain (long pulses to cw):** Includes a checkbox for 'saturate gain with Esat = 1e-9 J' and the formula  $g = g_0 / (1 + \frac{E}{E_{sat}})$ .
- profile:** Contains two 'gain profile' sections, each with 'Center' (1060 nm) and 'Width' (40 nm) fields, and a 'shape' dropdown set to 'const'.
- temporal gain saturation (pulses shorter than population relaxation time):** Includes a checkbox for 'use temporal gain saturation instead of steady state gain and profiles, with' and the formula  $g(T) = g_0 \exp\left(-\frac{1}{E_{sat}} \int_{-\infty}^T |A(t)|^2 dt\right)$  with  $E_{sat} = F \cdot A_{eff}$ .

# fiberdesk – NLSE parameter setup

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**Propagation parameter**

Load Save

standard propagation Setup >

general

define free parameters

measure and parse 100 >

write file

waveguide

loss 0.0 1/m

gain 0 1/m

mode diameter 3 μm

gamma 0.035555555 1/(W m)

effects

dispersion

SPM / TPA

Raman

self-steepening

LLE

**dispersion term**

$$\frac{\partial A}{\partial z} = \dots + \sum_{n \geq 1} \beta_n \frac{i^{n+1}}{n!} \frac{\partial^n}{\partial T^n} A$$

beta 0  
 beta 1  
 beta 2  
 D

dispersion model

Taylor expansion series **Setup >>**

Sellmeier coefficients

photonic crystal fiber

gas-filled silica-hollow core fiber

force retarded time frame (beta0=beta1=0)  
 @ data array center wavelength

Use dispersion  do not use dispersion

auto y min -100 max 100 auto x min 350 max 2400

D (ps/nm/km)

Wavelength (nm)

**Dispersion Setup**

Taylor Series @ 1060 nm predefined more ...

Beta1	0	ps/m	compensate at: 800 nm
Beta2	-0.01185	ps <sup>2</sup> /m	D 19.8658517912 ps/(nm*km)
Beta3	7.995e-5	ps <sup>3</sup> /m	S 0.187213 ps/(nm <sup>2</sup> *km)
Beta4	0.0		
Beta5	1.21005e-10		
Beta6	4.0347e-14		
Beta7	0		
Beta8	0		
Beta9	0		
Beta10	0		
Beta11	0		
Beta12	0		
Beta13	0		
Beta14	0		

Trust region  
 from 0 nm to 20000 nm

force retarded time frame (beta0=beta1=0)  
 @ data array center wavelength

grating compressor >>

Save

OK Cancel Load

copy dispersion  
 [(nm),D[ps/nm/km],b2[ps<sup>2</sup>/m]]

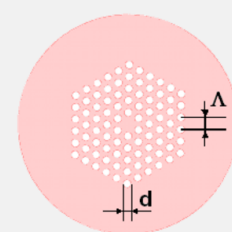
copy beta2 + group delay  
 [nm],b2 [ps<sup>2</sup>/m], GD[ps/m]

# fiberdesk – NLSE parameter setup

Parameter access in detail:

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PCF Parameter



pitch 5.0 μm  
 hole diameter d 0.5 μm  
 d/Λ 2.9209714

Material dispersion

$$n = \sqrt{A + \frac{B_1 \lambda^2}{\lambda^2 - C_1} + \frac{B_2 \lambda^2}{\lambda^2 - C_2} + \frac{B_3 \lambda^2}{\lambda^2 - C_3}}$$

Copy values to clipboard  
 lambda = pitch/10 .. pitch \* 2.0  
 V and W parameter n\_eff  
 dispersion D[ps/nm/km]

predefined more...

A	1		
B1	0.696166	C1	0.00467915 μm <sup>2</sup>
B2	0.407943	C2	0.0135121 μm <sup>2</sup>
B3	0.897479	C3	97.934 μm <sup>2</sup>

OK

Propagation parameter

Load Save

standard propagation Setup >

general

define free parameters

measure and parse 100 >

write file

waveguide

loss 0.0 1/m

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SPM / TPA

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LLE

dispersion term

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beta 0  
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dispersion model

Taylor expansion series

Sellmeier coefficients

photonic crystal fiber

gas-filled silica-hollow core fiber

force retarded time frame (beta0=beta1=0) @ data array center wavelength

Use dispersion  do not use dispersion auto y

Setup >>

Gas filled silica hollow core fiber (fundamental mode)

predefined more...

$$n = \sqrt{A + \frac{B_1 \lambda^2}{\lambda^2 - C_1} + \frac{B_2 \lambda^2}{\lambda^2 - C_2} + \frac{B_3 \lambda^2}{\lambda^2 - C_3}}$$

T0 0 K p0 0 Pa

B1 0 C1 0

B2 0 C2 0

B3 0 C3 0

actual

T 273.15 K p 101325 Pa

fiber

inner structure thickness 100 nm

core diameter 2\*R 80 μm

OK

Dielectric dispersive medium

$$n = \sqrt{A + \frac{B_1 \lambda^2}{\lambda^2 - C_1} + \frac{B_2 \lambda^2}{\lambda^2 - C_2} + \frac{B_3 \lambda^2}{\lambda^2 - C_3}}$$

predefined more...

A	1		
B1	0.696166	C1	0.00467915 μm <sup>2</sup>
B2	0.407943	C2	0.0135121 μm <sup>2</sup>
B3	0.897479	C3	97.934 μm <sup>2</sup>

OK

# fiberdesk – NLSE parameter setup

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LLE

self phase modulation / two photon absorption term

$$\frac{\partial A}{\partial z} = \dots + i\gamma(1 - f_R)|A(T)|^2 A(T)$$

$$\gamma = \frac{\omega_0}{c} \frac{n_2}{A_{\text{eff}}} \text{ and } A_{\text{eff}} = \frac{\pi}{4} MFD^2$$

n2 3.2e-20 m<sup>2</sup>/W

f R 0.18

TPA 0.0 m/W

TPA is experimental so far

saturate SPM

saturation power 1.0 GW/cm<sup>2</sup>

use SPM and TPA

exclude SPM



# fiberdesk – NLSE parameter setup

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**Propagation parameter**

Load Save

standard propagation Setup >

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write file

waveguide

loss 0.0 1/m

gain 0 1/m

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effects

dispersion

SPM / TPA

Raman

self-steepening

LLE

term delayed Raman response

$\frac{\partial A}{\partial z} = \dots + i\gamma \left( 1 + i\tau_{shock} \frac{\partial}{\partial T} \right) \left( A(T) \int_{-\infty}^{\infty} R(\tau) |A(T-\tau)|^2 d\tau \right)$  with  $R(\tau) = (1 - f_R)\delta(\tau) + f_R h_R(\tau)$

f R 0.18 hR(t) = StepT(t)\*((12.2^2+32.0^2)/12.2/32.0^2\*exp(-t/32.0)\*sin(t/12.2)) 1/fs

n2 3.2e-20 m/W select

use term  exclude term  convolute with current spectr...

# fiberdesk – NLSE parameter setup

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Propagation parameter

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standard propagation Setup >

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waveguide

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gamma 0.035555555 1/(W m)

effects

dispersion

SPM / TPA

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self-steepening

LLE

term self steepening

$$\frac{\partial A}{\partial z} = \dots + i\gamma \left( 1 + i\tau_{shock} \frac{\partial}{\partial T} \right) \left( A(T) \int_{-\infty}^{\infty} R(\tau) |A(T-\tau)|^2 d\tau \right)$$

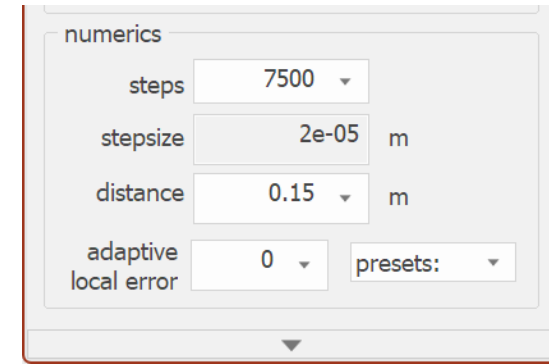
$$\tau_{shock} = \tau_0 + \tau_A = \frac{1}{\omega_0} - \left[ \frac{1}{n_{eff}} \frac{dn_{eff}(\omega)}{d\omega} \right]_{\omega_0} - \left[ \frac{1}{A_{eff}} \frac{dA_{eff}(\omega)}{d\omega} \right]_{\omega_0}$$

additional shock time 0.0 fs

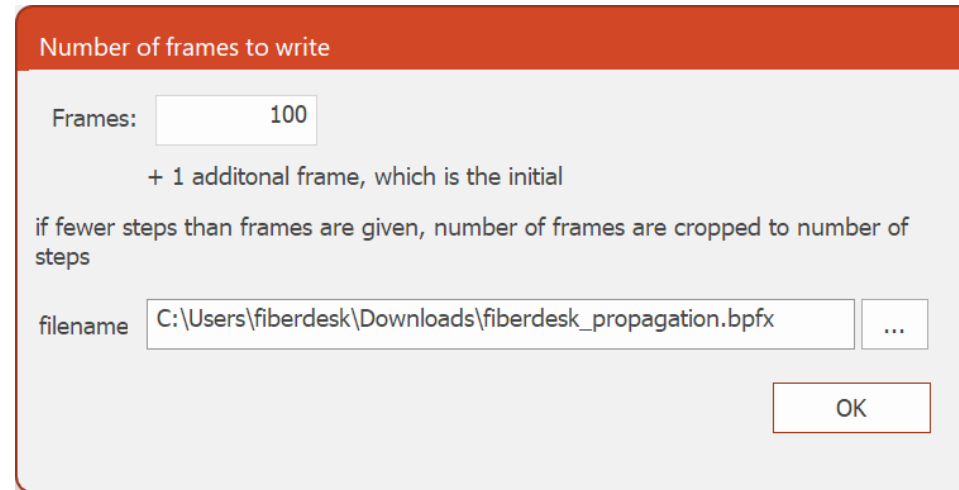
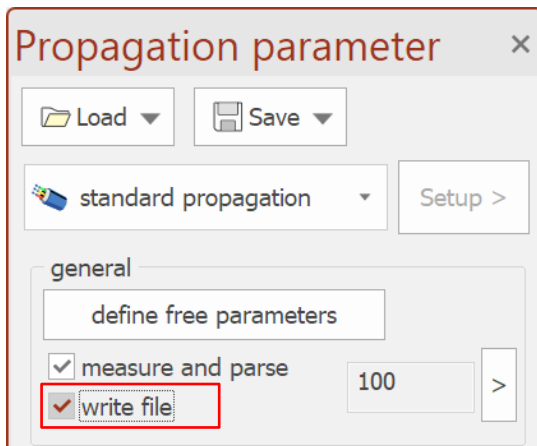
use self steepening term  exclude self steepening

# fiberdesk – NLSE parameter setup

Propagation setup: distance, stepsize, numerical accuracy etc.



$$\frac{\partial A}{\partial z} = -\frac{\alpha}{2} A + \int_{-\infty}^{\infty} \frac{g(\omega)}{2} \tilde{A}(\omega) e^{-i\omega T} d\omega + \sum_{n \geq 1} \beta_n \frac{i^{n+1}}{n!} \frac{\partial^n}{\partial T^n} A + i\gamma \cdot \left( 1 + i\tau_{shock} \frac{\partial}{\partial T} \right) \left( A(T) \int_{-\infty}^{\infty} R(\tau) |A(T-\tau)|^2 d\tau \right)$$



file contains the initial field plus 100 fields from the calculated propagation for later analysis

file extension: **\*.bpfx**

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# Setting up a propagation

Learn the most simple workflow

(1) Create the initial field

(2) Setup propagation parameter

(3) Start the simulation

The screenshot shows the fiberdesk software interface with the following components:

- Menu Bar:** File, Main, Manipulation, Postprocessing, Multi-Element Propagation, View.
- Toolbar:** Includes buttons for 'Field' (1), 'Start' (3), 'Copy spectrum (wavelength)', 'Copy dispersion', 'Copy current view', 'Copy spectrogram (ASCII)', 'Undo', 'Redo', 'Copy current view', 'Copy spectrogram (ASCII)', 'scramble spectral phase', 'Start' (3), 'parameter variation', 'RE', 'PLOTTER', 'noise variation', 'set z=0', 'Compress', 'Set', 'Clear', 'display', 'Recall', 'M+', 'Swap', 'M-', 'Memory'.
- Propagation parameter panel (2):** Contains settings for standard propagation, waveguide, simulation, and steps. The 'simulation' section has checkboxes for 'dispersion', 'Raman', 'spm / TPA', 'self-steepening', and 'temporal gain saturation' (unchecked). The 'steps' section has 'steps' set to 100, 'stepsize' to 0.002 m, and 'distance' to 0.2 m.
- Measurement panel:** Shows a plot of Power (kW) vs. time (ps) with a peak at approximately -0.70 ps. The plot title is 'pulse.width=1.134 ps, ac.width=50.947 fs'.
- Watch panel:** Displays user defined measurements for 'pulse 1'. The table below shows the values for various measurements:

data	value
M0 - index	100
M1 - position	0.200 m
M2 - distance	0.200 m
M3 - datapoints	2048
M4 - pulse energy	927.201 pJ
M5 - pulse.avg_power	231.800 W
M6 - pulse.rep_rate	250.000 GHz
M7 - pulse.shift	-482.714 fs
M8 - pulse.width	1.134 ps
M9 - pulse.RMS	752.218 fs
M10 - pulse.skewness	0.342
M11 - pulse.kurtosis	-0.864
M12 - pulse.max.phase	13.7 rad
M13 - pulse.peakpower1	817.472 W
M14 - pulse.peakpower2	767.964 W

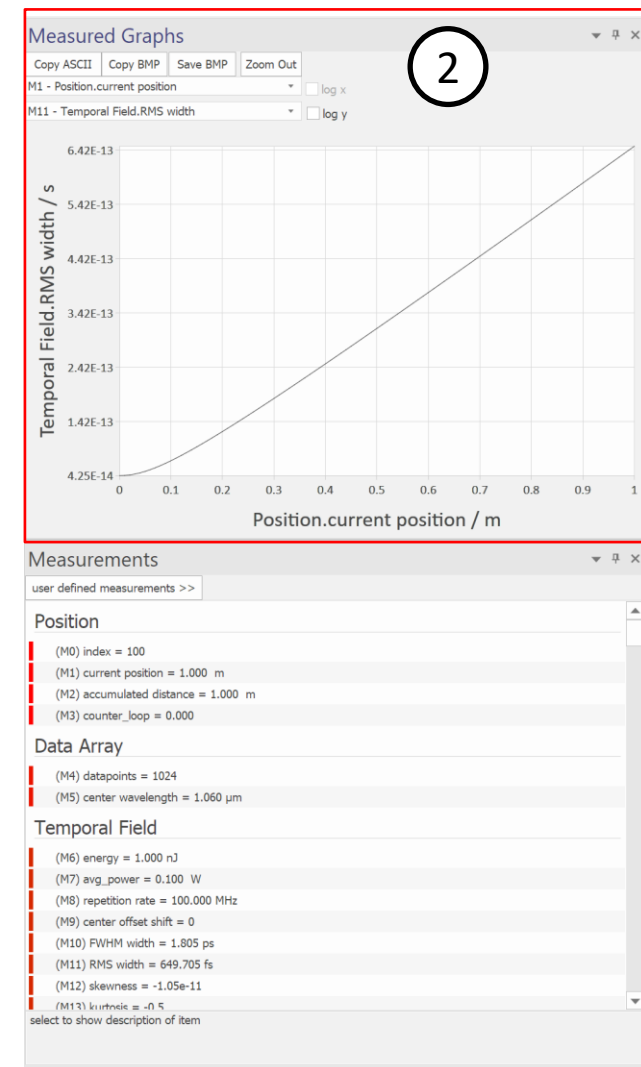
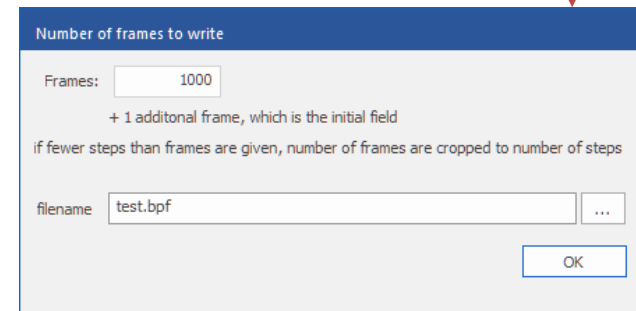
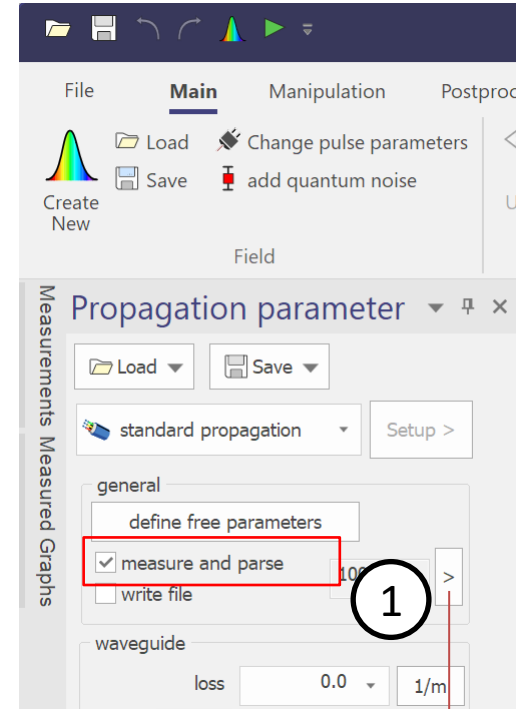
**Output panel:** Shows a plot of Power (W ps<sup>2</sup>) vs. time (ps) with a peak at approximately -0.70 ps. The plot title is 'spec.width.m=300.570 nm'. The x-axis is labeled 'distance: 0.200 m position: 0.200 m'.

# Setting up a propagation

## Measure something along z

To measure different values of the numerical field that fiberdesk is propagating:

1. choose „measure and parse“ and setup the number of measurement points along z, which should be equal or less than the number of steps. (change with setup button to access dialog)
2. After propagation, you will see the measured values as instantaneous values or graphs along the propagation.



# Setting up a propagation

## User defined measures

You can also define your own measurement in addition to the pre-defined options.

You need to:

1. Open the dialog „user defined measurements >>“
2. Script your own function by either using values measured before or math expressions with variables

*M90 = log2(M4) (just an example for M4 = datapoints)*

1

data	value
pulse 1	
M0 - index	100
M1 - position	0.200 m
M2 - distance	0.200 m
M3 - datapoints	2048
M4 - pulse.energy	927.201 pJ

user defined measurements

M87		0
M88		0
M89	M4	1024
M90	log2(M4)	10
M91		0
M92		0

measure and parse not switched on during propagation, no evaluation of ...asured values along the propagation length is done

datapoints:  from  to

# Setting up a propagation

## User defined measures

Real example:

### How to measure the B-Integral?

(shown by several user defined measurements for educational reasons)

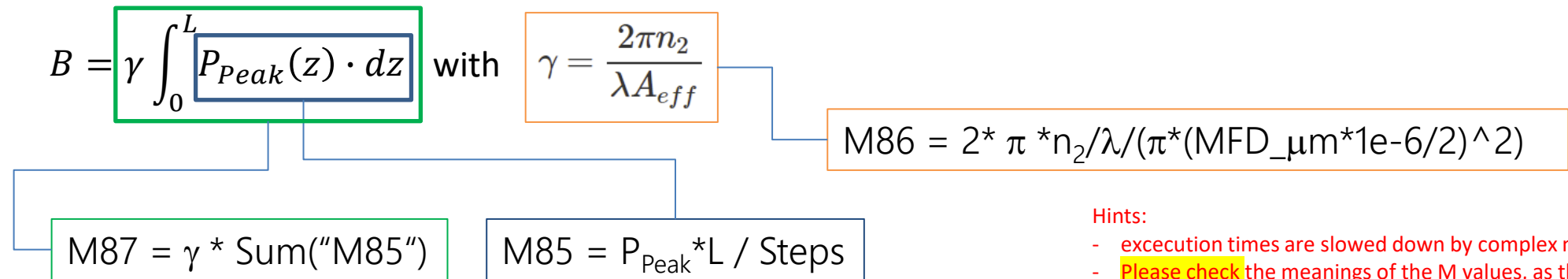
We translate the equation to measured values and a function that integrates (summation) along z.

user defined measurements

M84	$(M10 * M11)^2$	1.54365569478842e-09
M85	$M13 * P3 / P4$	3.9668238857714
M86	$2 * \pi * P5 / M17 / (\pi * (P7 * 1e-6 / 2)^2)$	0.0268343815513627
M87	$M86 * \text{Sum}("M85")$	10.7510217188675
M88		0
M89		0

Extended Syntax:

datapoints:  from  to



#### Hints:

- execution times are slowed down by complex measurements.
- Please check the meanings of the M values, as they might have changed in their number, depending on the actual version of fiberdesk

# Setting up a propagation

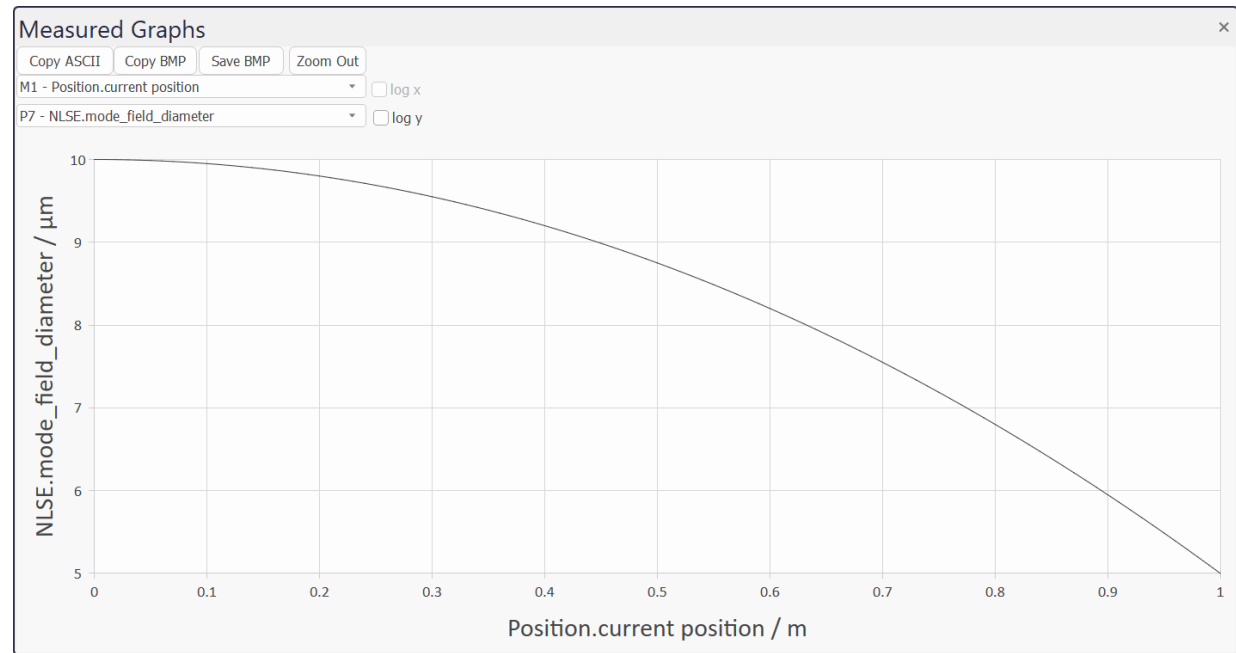
## Change parameters during propagation

For example, if you script the mode field diameter (MFD) like this, the MFD will change quadratically with propagation, because M1 is the current position.

You need to have “measure and parse” switched on!

The screenshot shows two panels from a software interface. The top panel, titled "waveguide", contains several input fields: "loss" with a value of 0.0 and units 1/m; "gain" with a value of 0 and units 1/m; "mode diameter" with a value of  $10^{-5} * M1^2$  and units  $\mu\text{m}$ ; and "gamma" with a value of 0.002415094 and units 1/(W m). The "mode diameter" field is highlighted with a red box. The bottom panel, titled "general", contains a "define free parameters" button, a checked checkbox for "measure and parse", an unchecked checkbox for "write file", and a numerical input field with the value 100 and a right-pointing arrow button. The "measure and parse" checkbox is also highlighted with a red box.

To check the success, the measured parameter is show in the measurement windows:



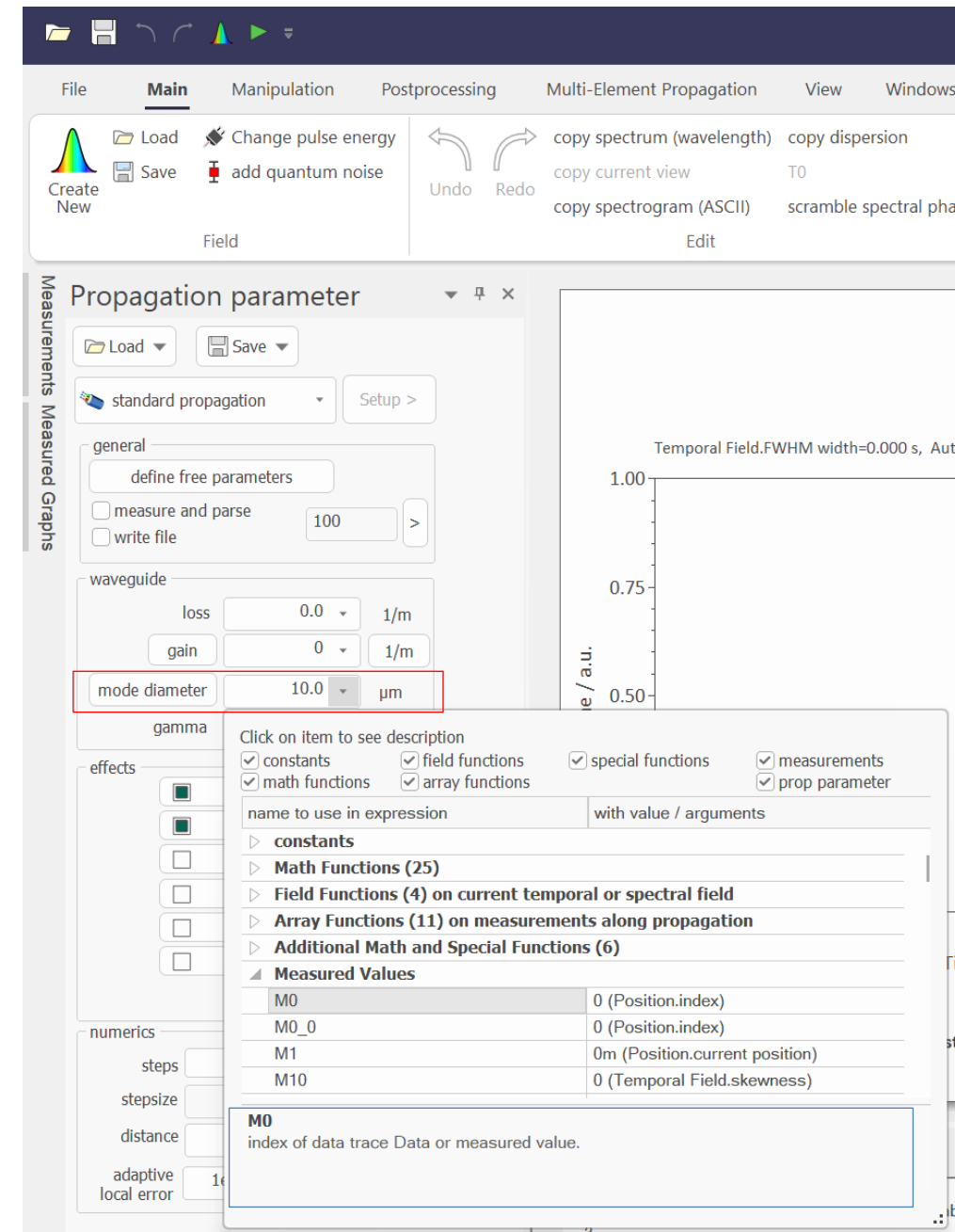
# Setting up a propagation

## Change parameters during propagation

Changing parameters along the propagation can be made for any parameter, where **a symbol (button) appears in the input line**, if in focus, see for instance the mode field diameter prompt.

If you click on the symbol, a dialog appear with **all available variables**, functions etc.

Click on any of the entries, and a **short help** will appear in the lower part of the dialog

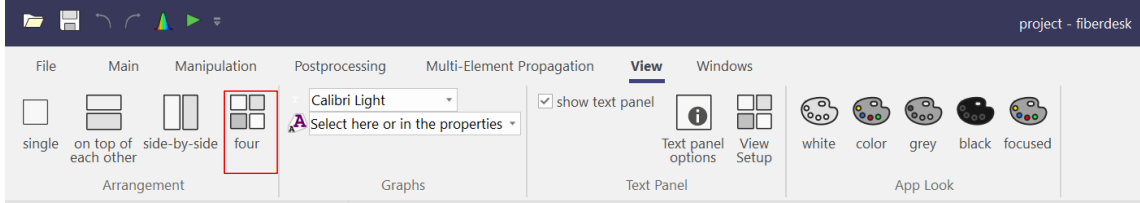


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# Setting up a view



View Properties

- Project
  - show project title
  - project title fiberdesk
  - show project subtitle
  - project subtitle nonlinear pulse propa...
- View
  - View View 1
- Content Field
- show title
- x-Axis
  - Type Time
  - start (ps) -2.007843
  - stop (ps) 1.992157
- data scaling
  - normalized values on...
  - logarithmic
  - auto scale
  - from minimum (%) 0.000000
  - to maximum (%) 100.000000
- additional data
  - show real
  - show imag
  - show phase
- visual
  - visualize chirp
- Misc
  - text size zoom (%) 83
  - title space 15
  - horizontal split top 50
  - horizontal split bottom 50
  - vertical split left 50
  - vertical split right 50
  - outer space 3
  - inner space left 3
  - inner space right 3
  - inner space top 3
  - inner space bottom 3

View  
Select the view, where properties need to be changed.

Click here to select the view to set up

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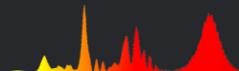
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- Loading / Saving field, projects, components



# Loading / Saving field, **projects**, components

The screenshot shows the fiberdesk application interface. The left sidebar contains a menu with the following items: New, Load Project, Save Project (highlighted), Save Project As ..., Load Field, Save Field As ..., Load propagation parameter, Save propagation parameter, Import Spectrum (ANDO/YOKOGAWA), Import Spectrum (ASCII, TAB separated [ wl-nm, intensity]), Import Spectrum (ASCII, TAB separated [ wl-nm, intensity, phase-rad]), Import Pulse (ASCII, TAB separated [ time-sec, intensity]), Import Pulse (ASCII, TAB separated [ time-sec, intensity, phase (rad)]), Print, and Exit. A tooltip for the 'Save' option is visible, stating 'Save Saves an existing project.' The main window title is 'project - fiberdesk' and it displays a 'Recent Documents' list with four entries: 'tutorial5-short\_pulse\_oscillator.fdprx', 'project\_B integrals test.fdprx', 'project pair induced quenching.fdprx', and 'test project Er short pulse rate equation amplifier.fdprx'. Each entry includes a file icon, the filename, a partial path, and a star icon.

The dialog box is titled 'Select project details to load' and contains a list of options, each with a checked checkbox: field data, view settings, NLSE parameter, create pulse settings, multi-element settings, plotter, parameter variation, and user defined measures. At the bottom, there are three buttons: 'Load', 'Load all', and 'Cancel'.



# Loading / Saving field, projects, components

- ←
- New
- Load Project
- Save Project
- Save Project As ...
- Load Field
- Save Field As ...
- Load propagation parameter
- Save propagation parameter
- Import Spectrum (ANDO/YOKOGAWA)
- Import Spectrum (ASCII, TAB separated [ wl-nm, intensity])
- Import Spectrum (ASCII, TAB separated [ wl-nm, intensity, phase-rad])
- Import Pulse (ASCII, TAB separated [ time-sec, intensity])
- Import Pulse (ASCII, TAB separated [ time-sec, intensity, phase (rad)])
- Print
- Exit
- Recent

Propagation parameter ▾ ⚙ ×









Developer Version, compiled Mar 13 2025, 23:23:34

Load ▾ Save ▾

standard pr

double click to save directly

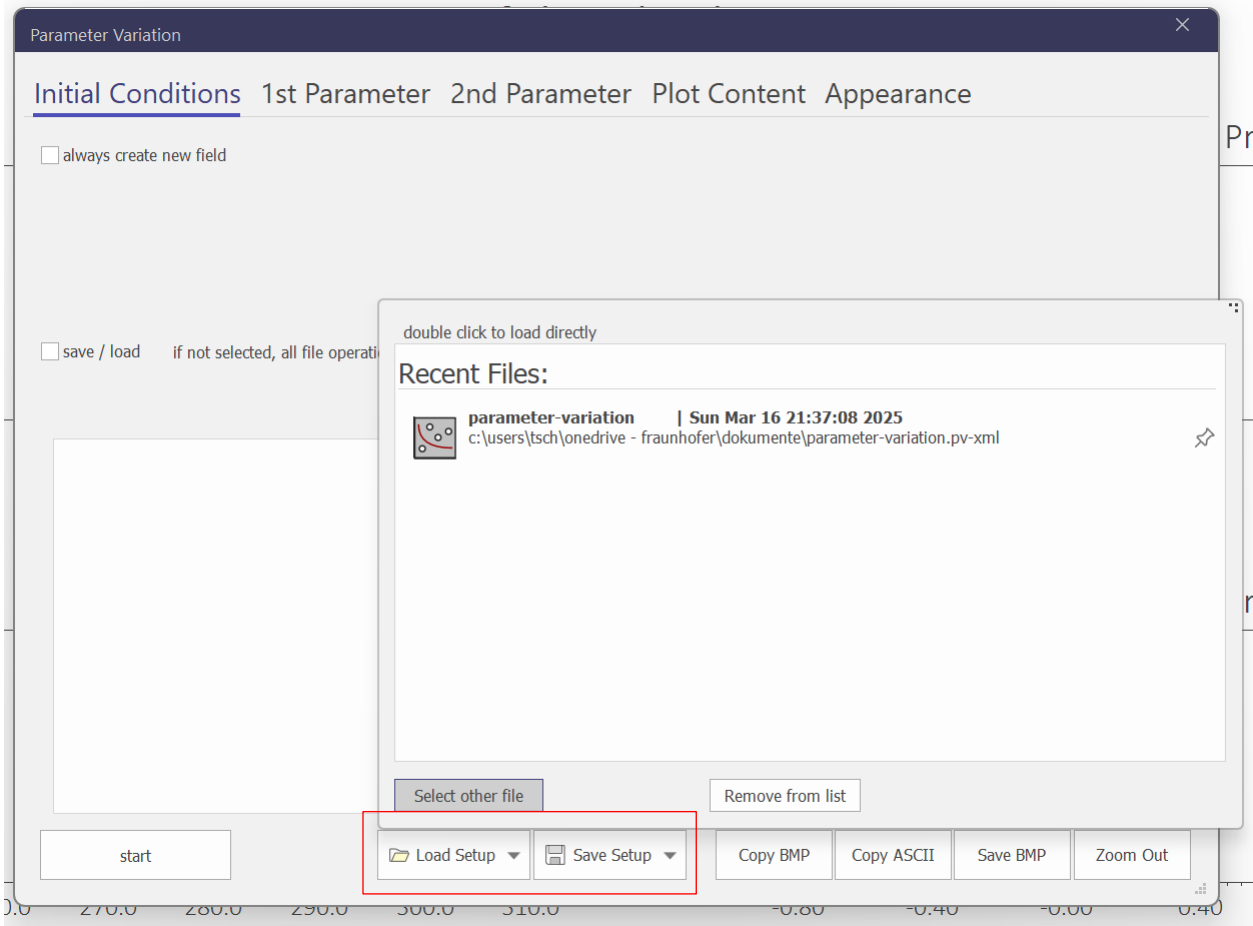
### Recent Files:

	<b>fiber</b>   Sun Sep 1 20:30:35 2024	
c:\users\tsch\onedrive\dokumente\fiberdesk wo code\physics data tutorials\tutorial\tutorial 5 - multi element propagation\part 1 short pulse oscillator\fiber.ppfx		
	<b>oc</b>   Tue Jan 3 10:17:26 2023	
c:\users\tsch\onedrive\dokumente\fiberdesk wo code\physics data tutorials\tutorial\tutorial 5 - multi element propagation\part 1 short pulse oscillator\oc.ppfx		
	<b>sam</b>   Tue Jan 3 10:17:46 2023	
c:\users\tsch\onedrive\dokumente\fiberdesk wo code\physics data tutorials\tutorial\tutorial 5 - multi element propagation\part 1 short pulse oscillator\sam.ppfx		
	<b>dc</b>   Wed Aug 28 19:21:39 2024	
c:\users\tsch\onedrive\dokumente\fiberdesk wo code\physics data tutorials\tutorial\tutorial 5 - multi element propagation\part 1 short pulse oscillator\dc.ppfx		

Select other file Remove from list

# Loading / Saving field, projects, components

Saving dialog content



Saving view content

