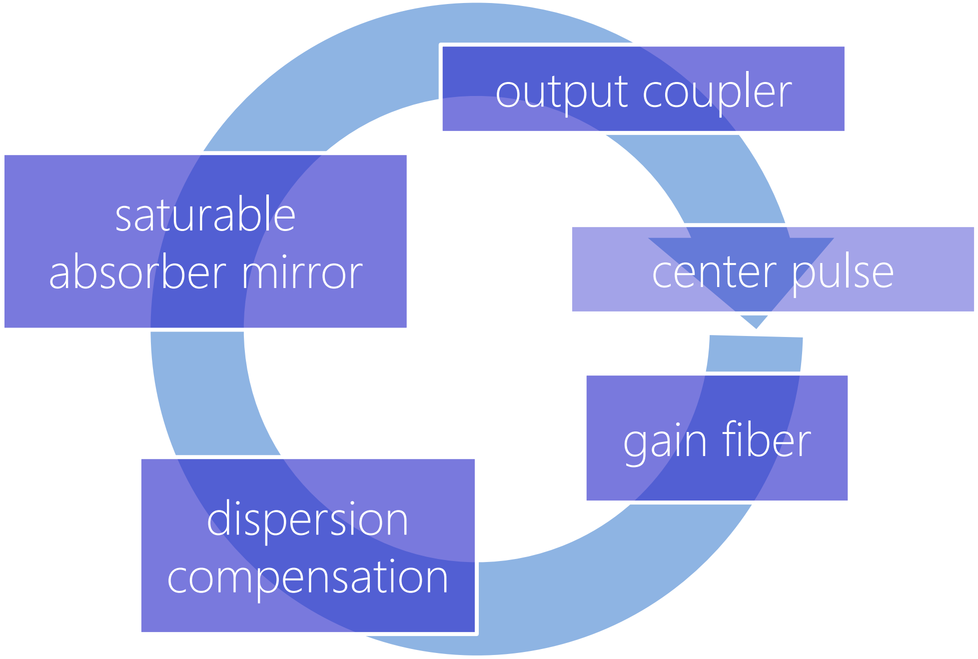
lecture 5

Multi-Element Propagation

lecture 5



Multi-Element Propagation:

Example: Short Pulse Fiber Lasers

- fiber laser cavity:

ring cavity
Fast saturable absorber modelled by reflectivity R

$$R = R_{unsat} + R_{sat} \cdot \left(1 - \frac{1}{1 + P / P_{sat}}\right)$$

- modelling of each part by the NLSE

$$iA_z + \frac{g}{2}A + i\beta_2 A_{tt} = i\gamma |A|^2 A$$

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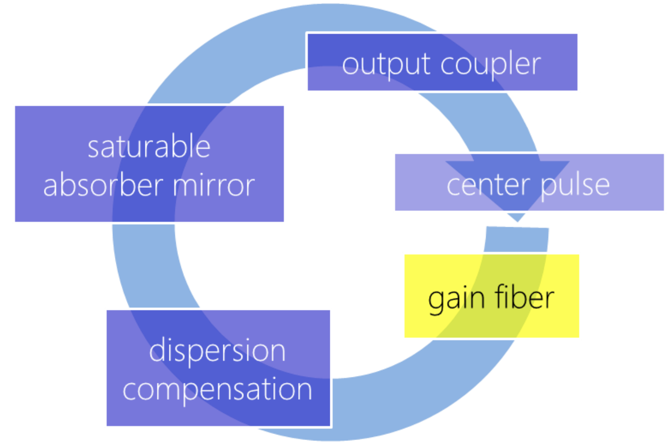
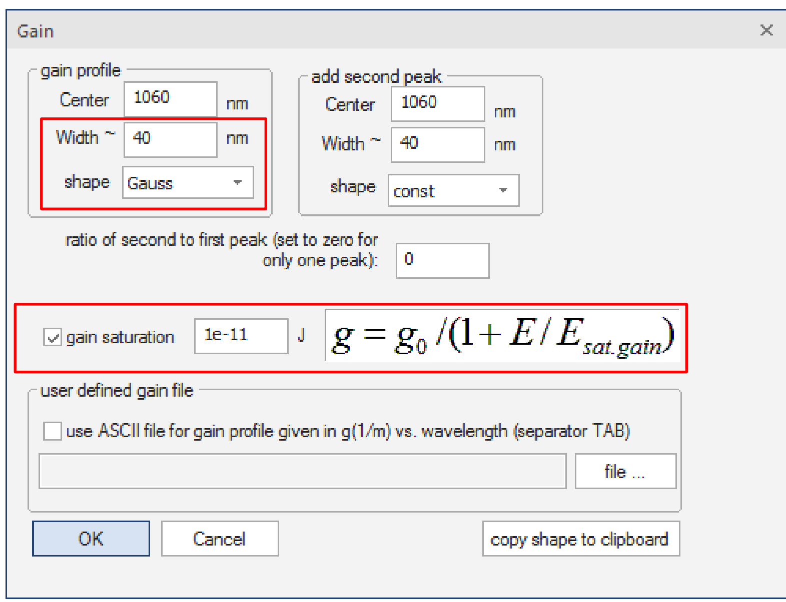
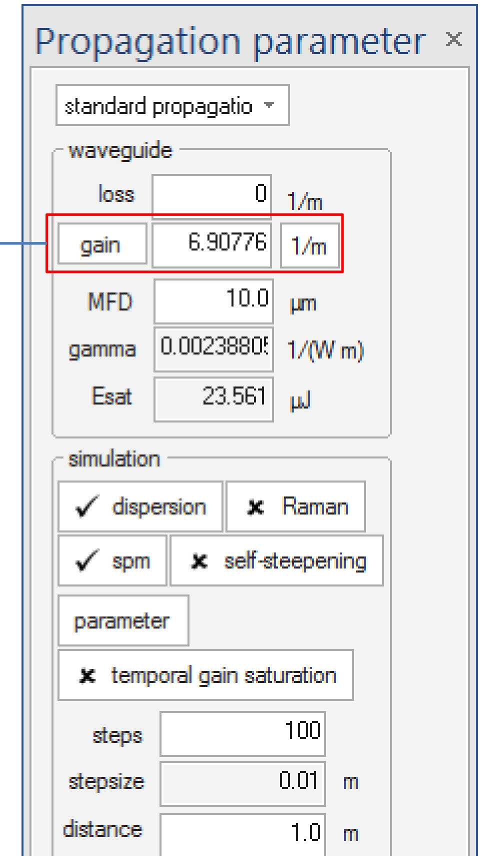


Multi-Element Propagation:

Example: Short Pulse Fiber Lasers

Set up the gain fiber as a standard propagation with saturable gain





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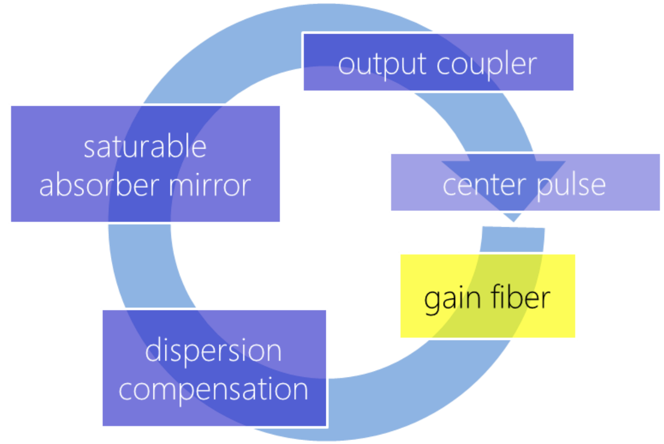
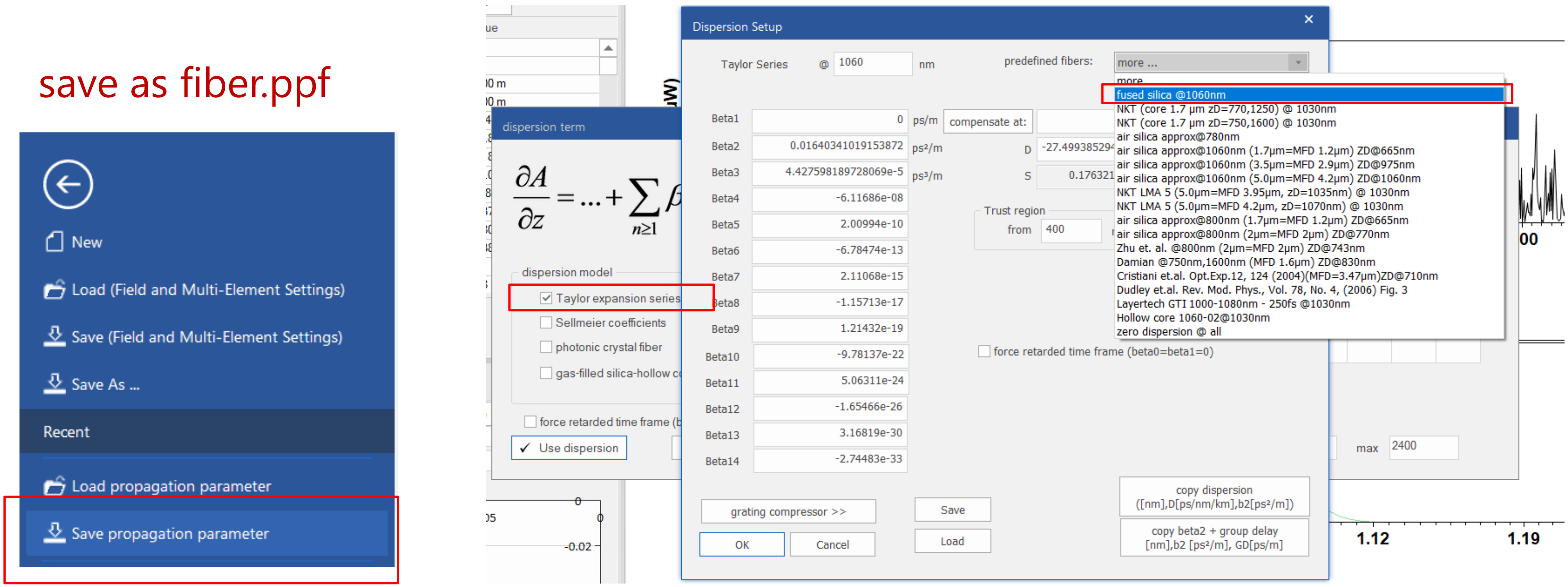


Multi-Element Propagation:

Example: Short Pulse Fiber Lasers

Set the dispersion of that amplifier fiber to fused silica (e.g. predefined with its Taylor series at 1060 nm)

save as fiber.ppf



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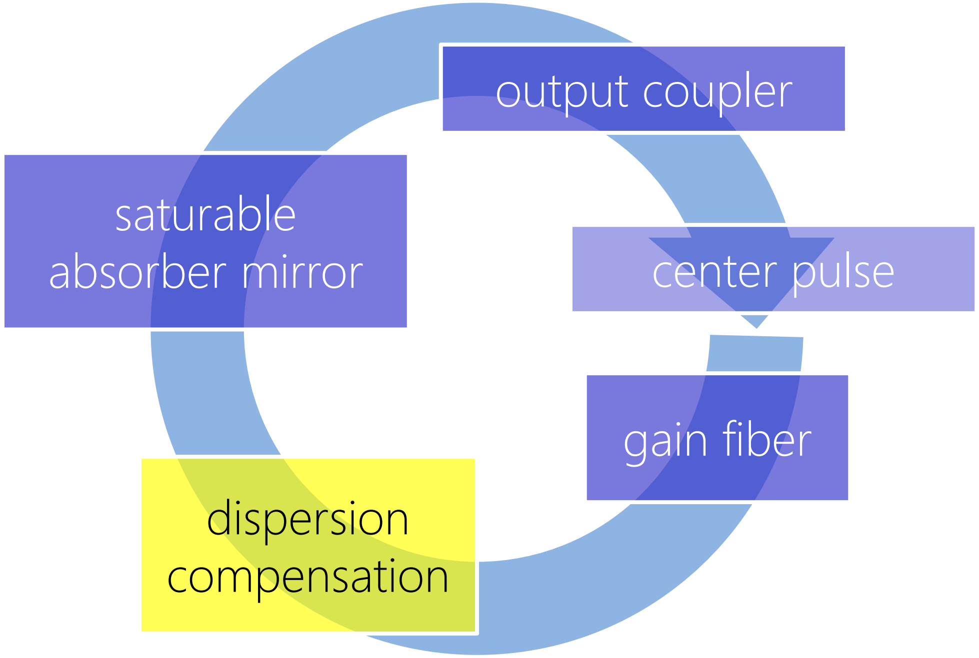

Multi-Element Propagation:

Example: Short Pulse Fiber Lasers

For the dispersion compensation, we only set second order dispersion.

Before, set the gain to zero, switch off SPM etc. Only dispersion need to be set.

As it is a linear step, a single step is enough, see next slide.

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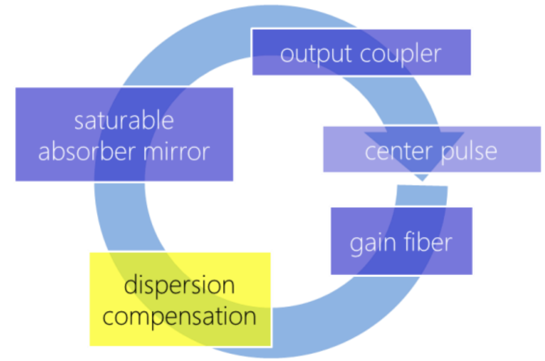
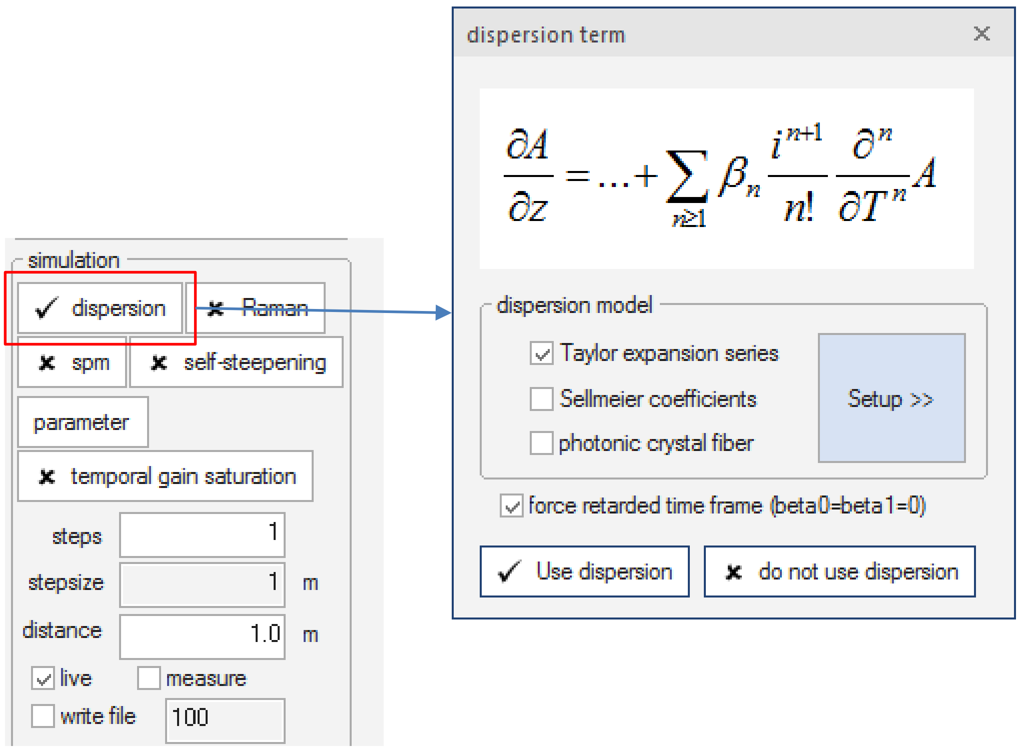
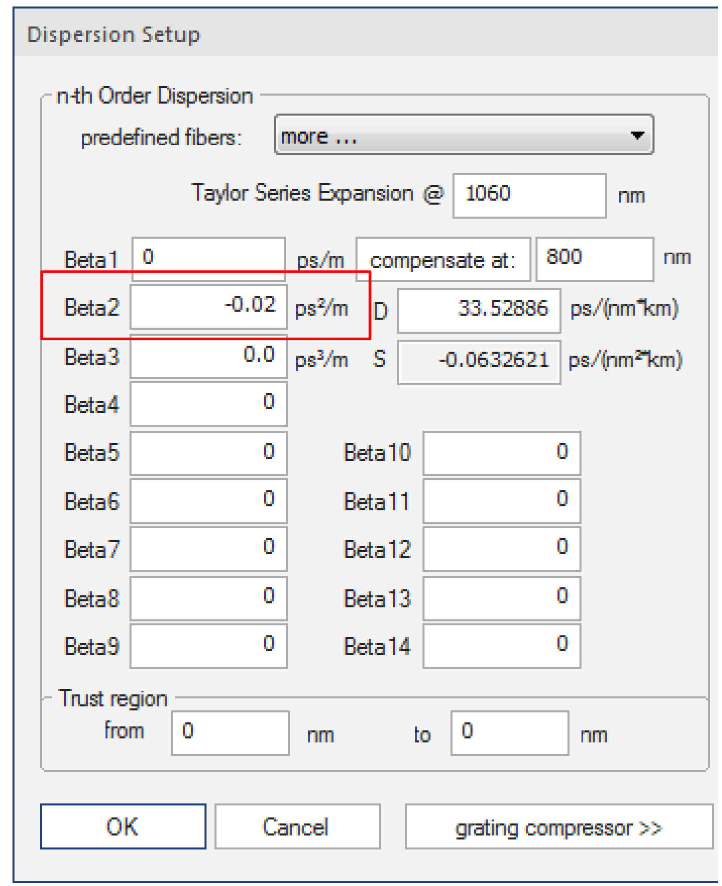


Multi-Element Propagation:

Example: Short Pulse Fiber Lasers





save as dc.ppf

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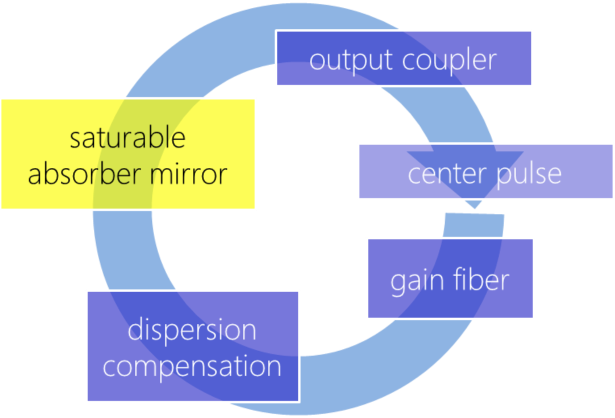
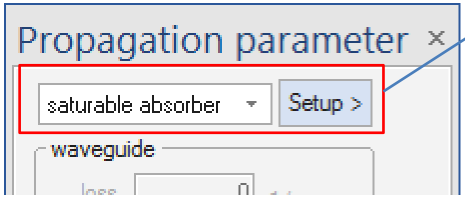


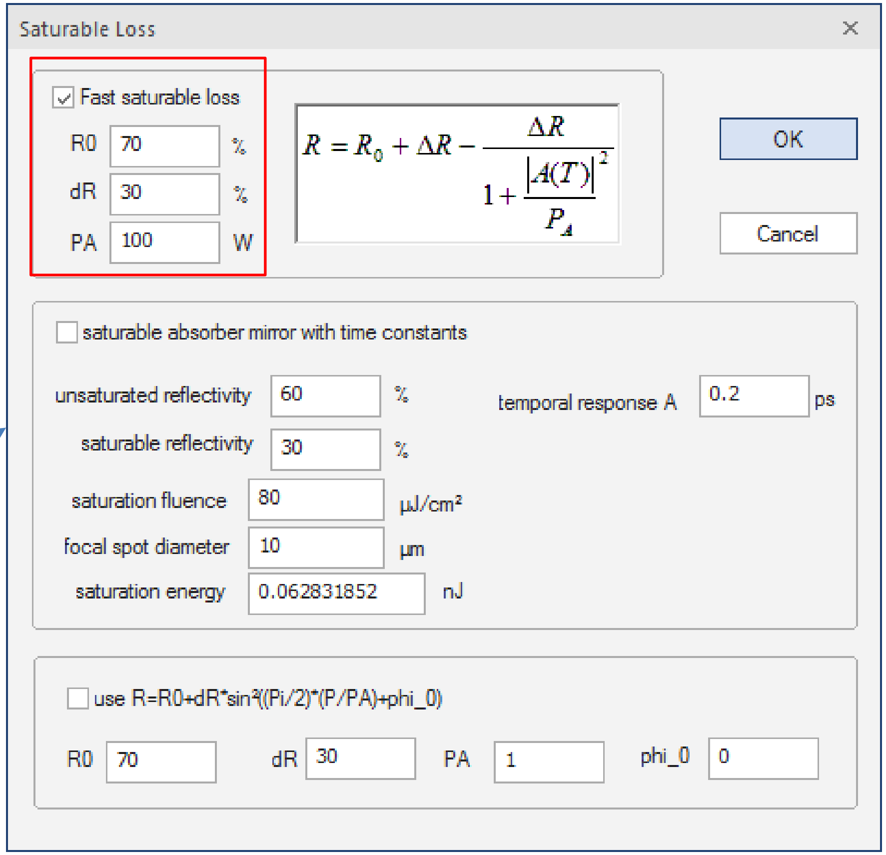
Multi-Element Propagation:

Example: Short Pulse Fiber Lasers

The saturable absorber is a different model, select „saturable absorber“ on top of the propagation parameter dialog.

Then, set it up with the parameters on the right.





save as SA.ppf

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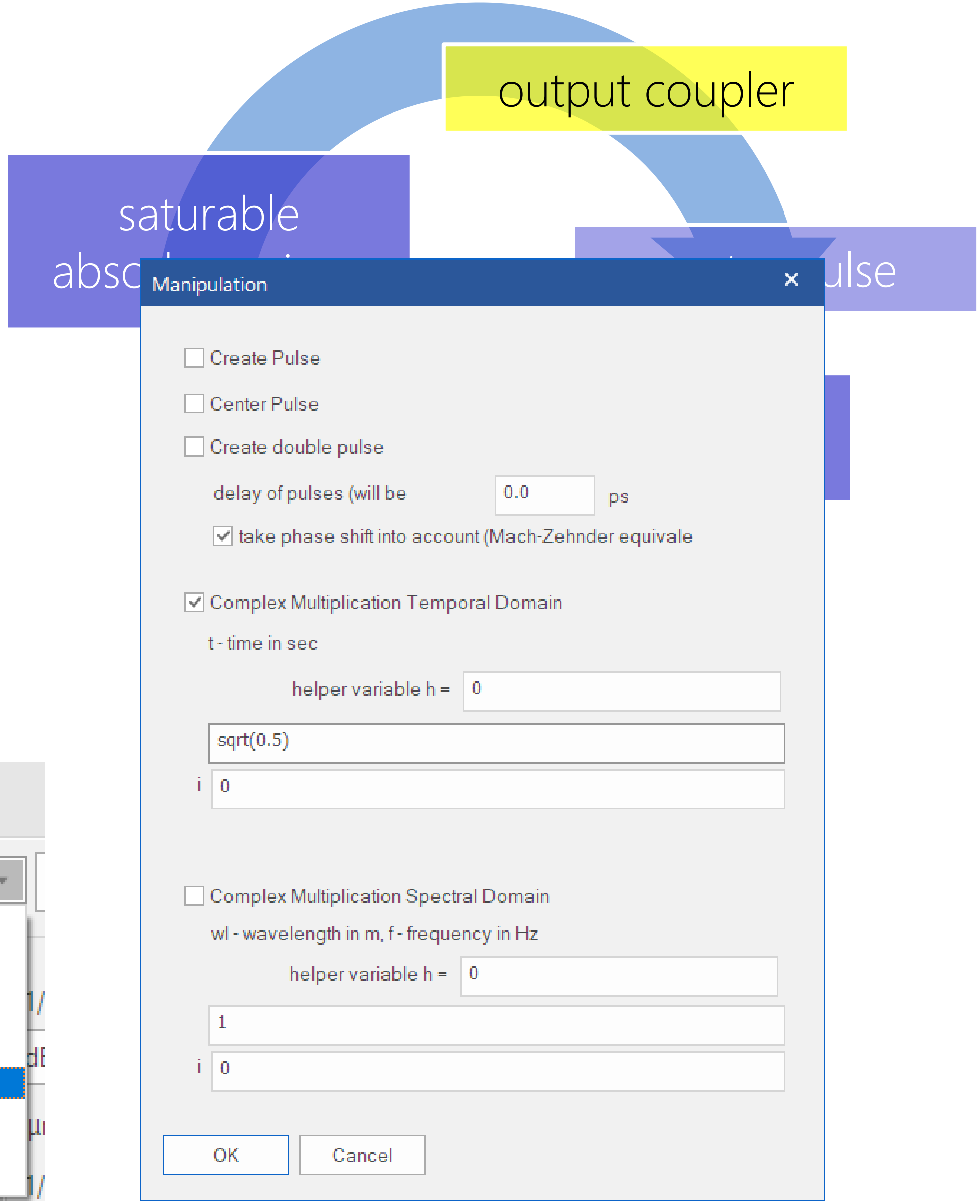
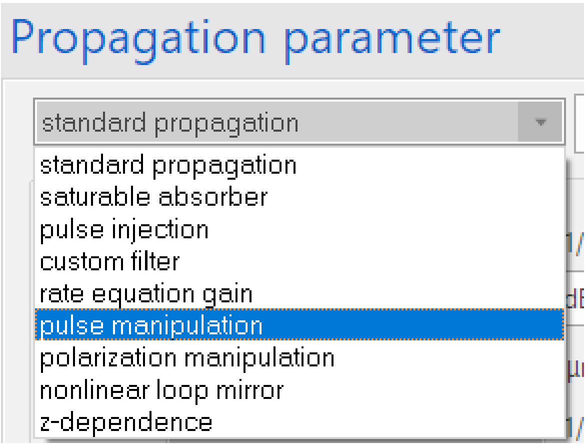
Multi-Element Propagation:

Example: Short Pulse Fiber Lasers

Outcoupling:

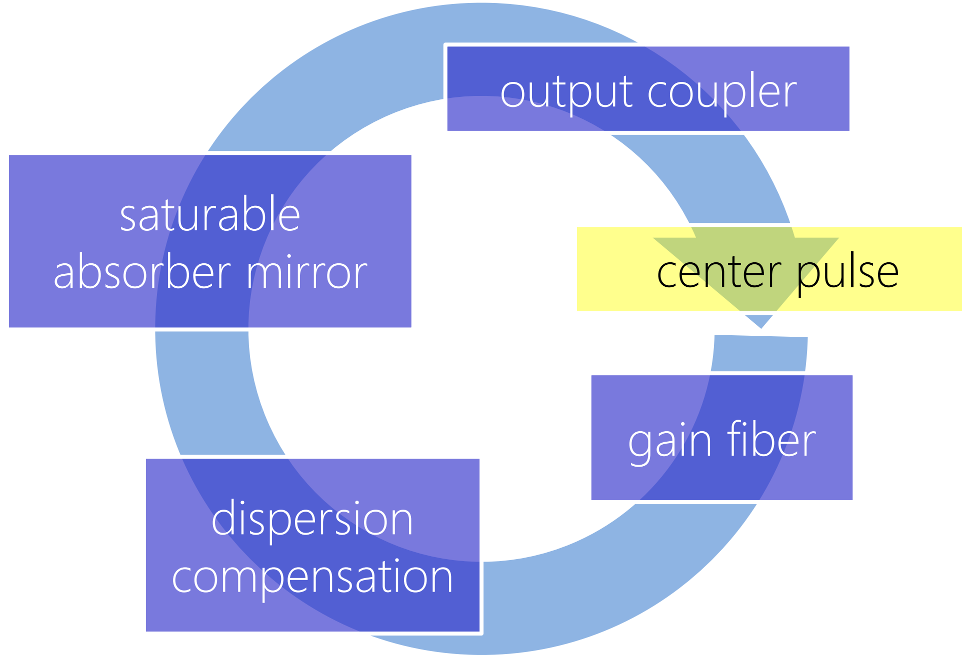
50% means complex multiplication with sqrt(0.5)





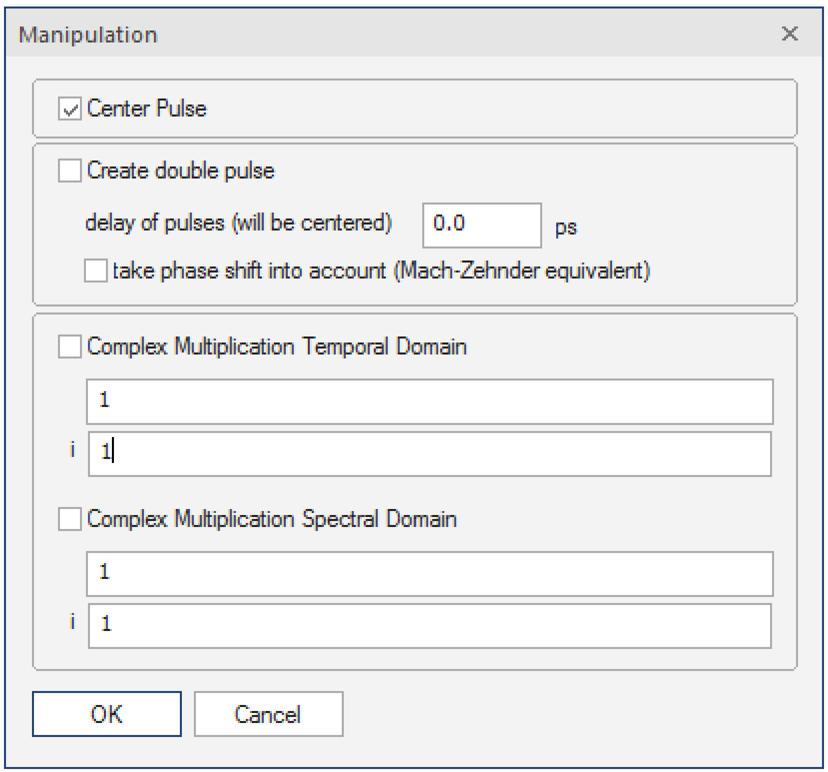
save as OC.ppf

lecture 5

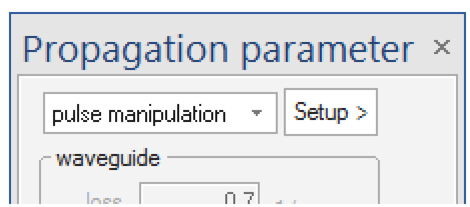


Multi-Element Propagation:

Example: Short Pulse Fiber Lasers



- Center pulse in the time domain, helps to converge the pulse, as changes are measured in the time domain
- Can be combined with OC.ppf in a single element



save as center.ppf

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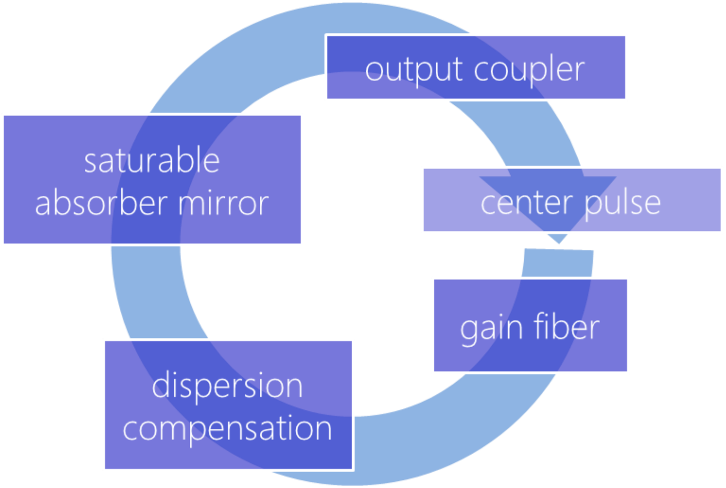
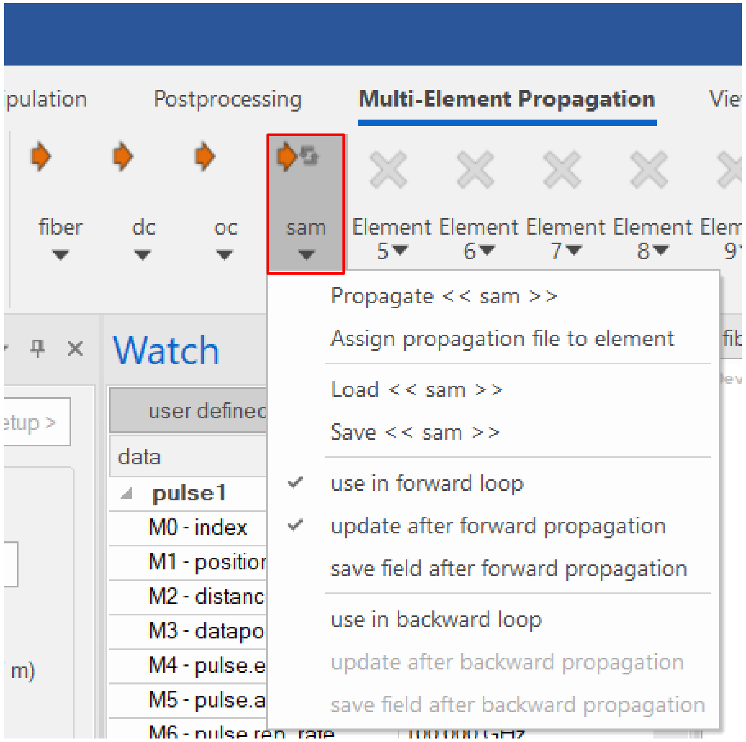
Multi-Element Propagation:

Example: Short Pulse Fiber Lasers

- assign all files to elements in the right order of the cavity
- Select „use in forward loop“ for all elements
- Select the last one to be updated after each loop to see convergence live during simulation
- Icons on top change according to selected status





fiberdesk
nonlinear pulse propagation

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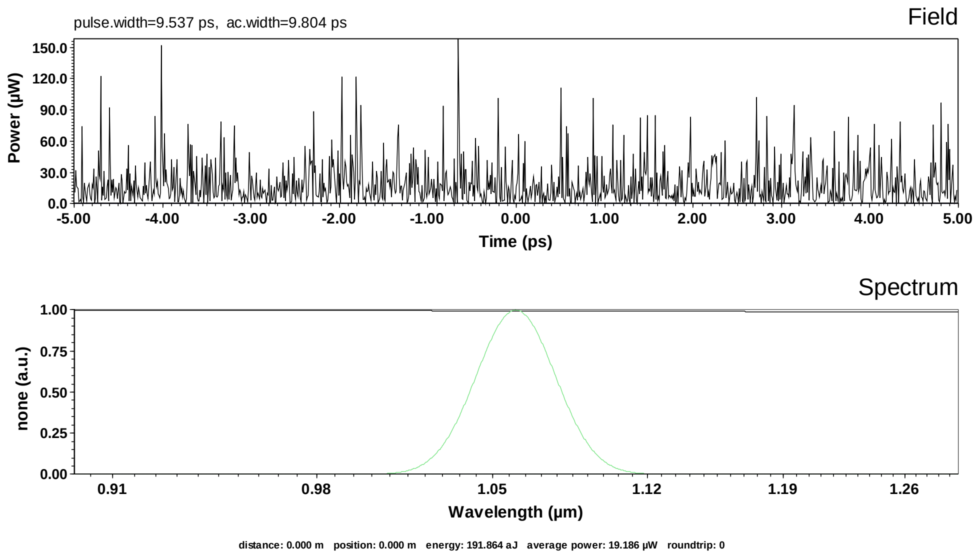
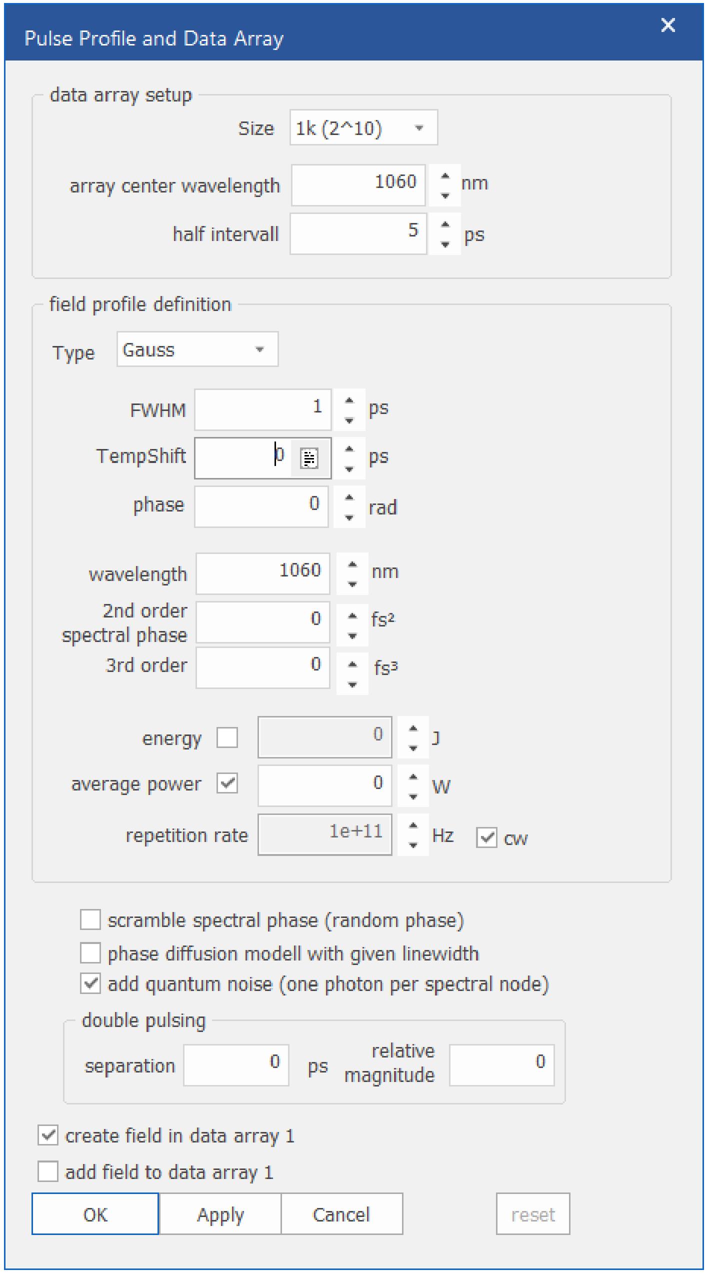
Multi-Element Propagation:

Example: Short Pulse Fiber Lasers

(1) create initial pulse, e.g. quantum noise

(green spectrum is the gain spectrum from „fiber.ppf“





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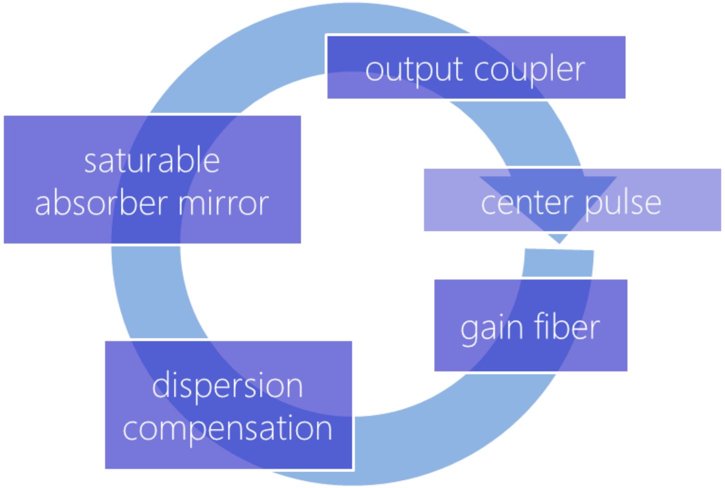
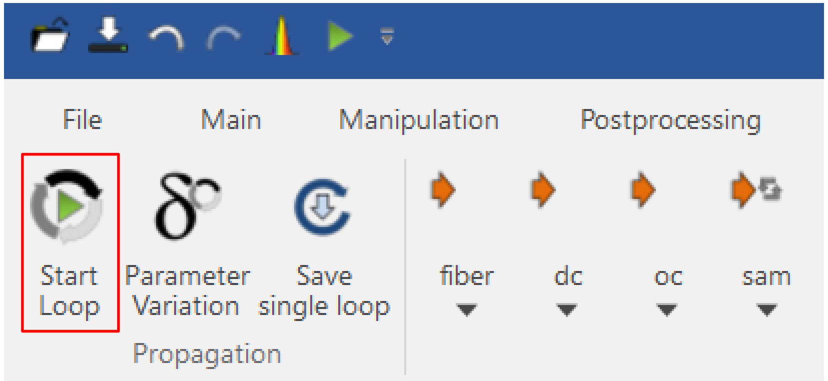
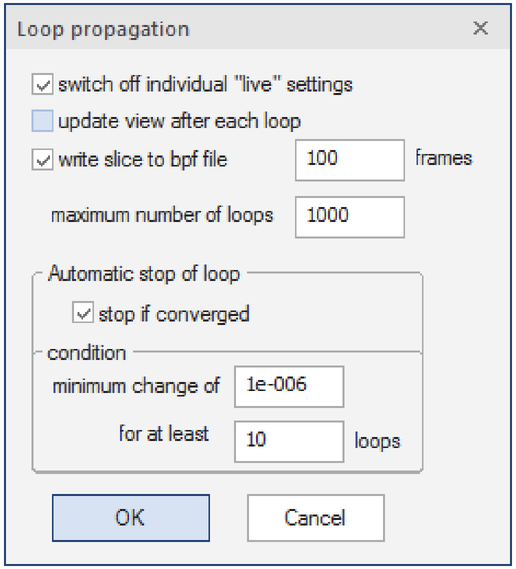


Multi-Element Propagation:

Example: Short Pulse Fiber Lasers

(1) start loop (switch on „write slice … „ for later postprocessing)





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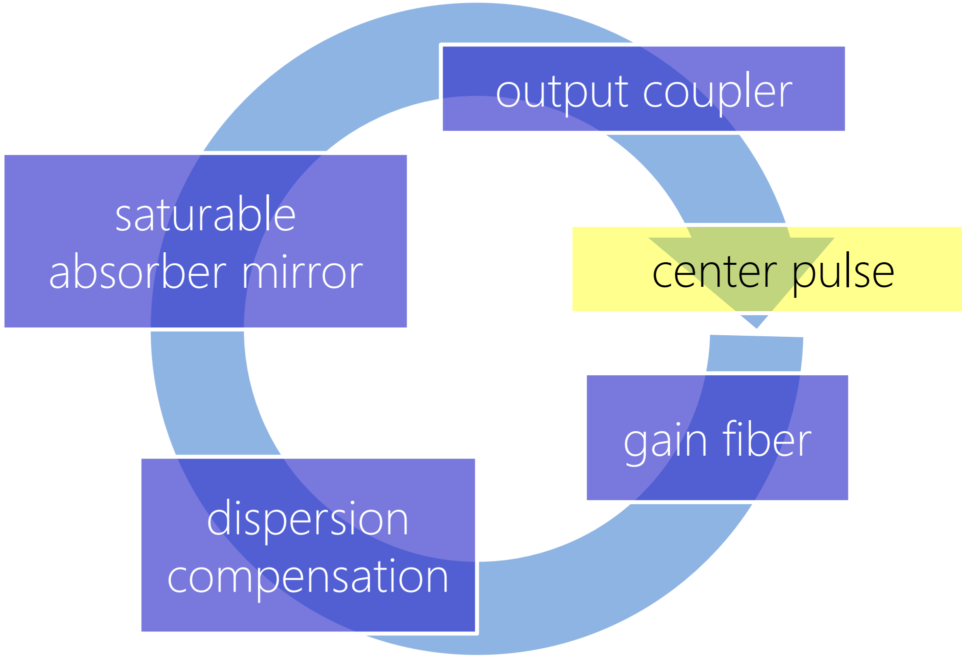
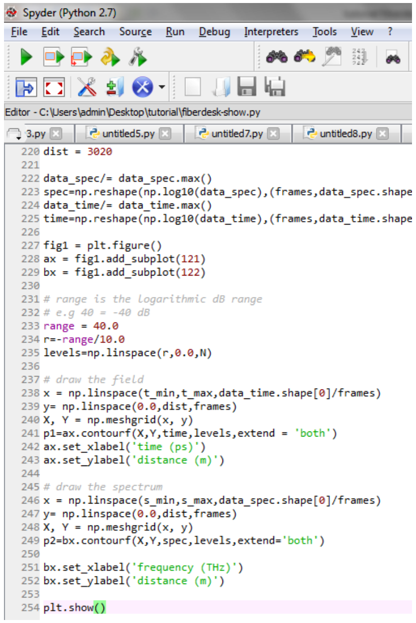
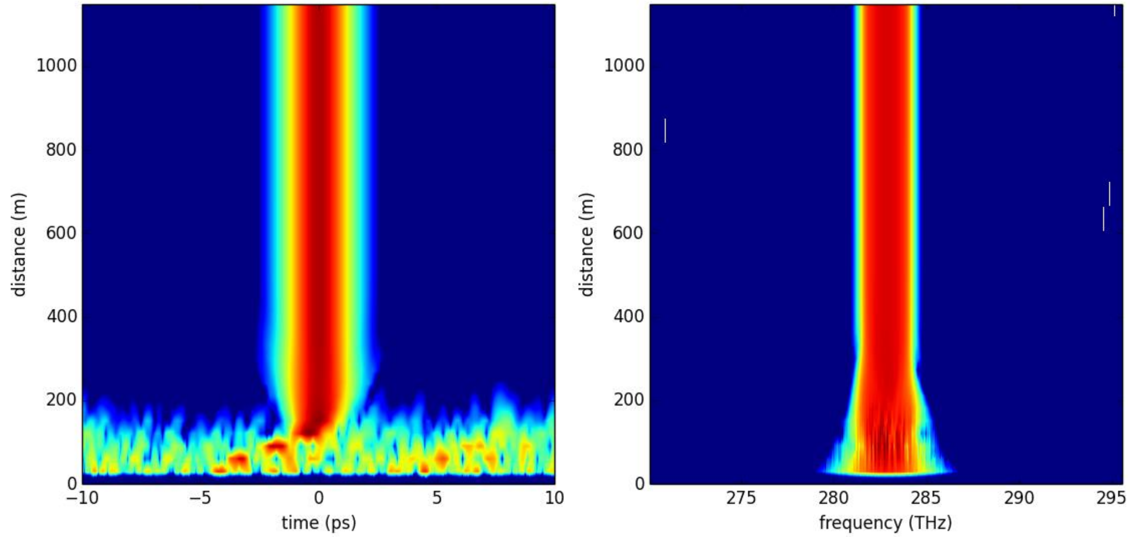


Multi-Element Propagation:

Example: Short Pulse Fiber Lasers

Download the python script from the homepage to process BPF files.





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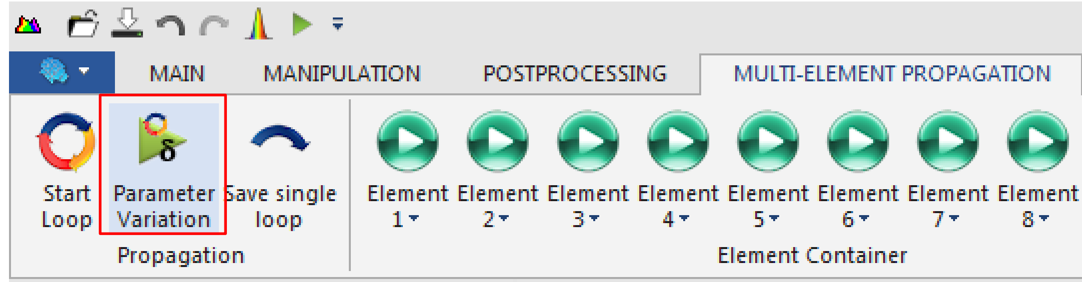
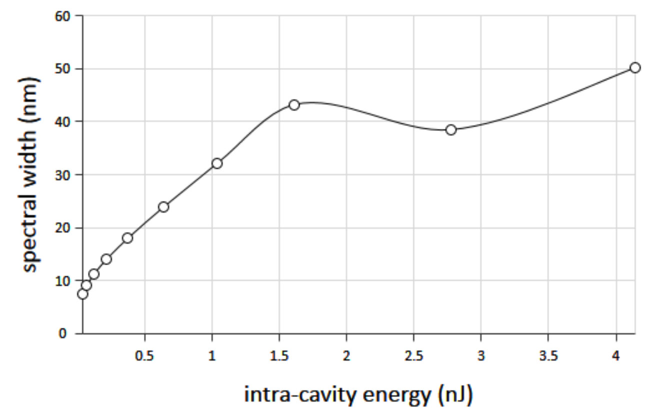


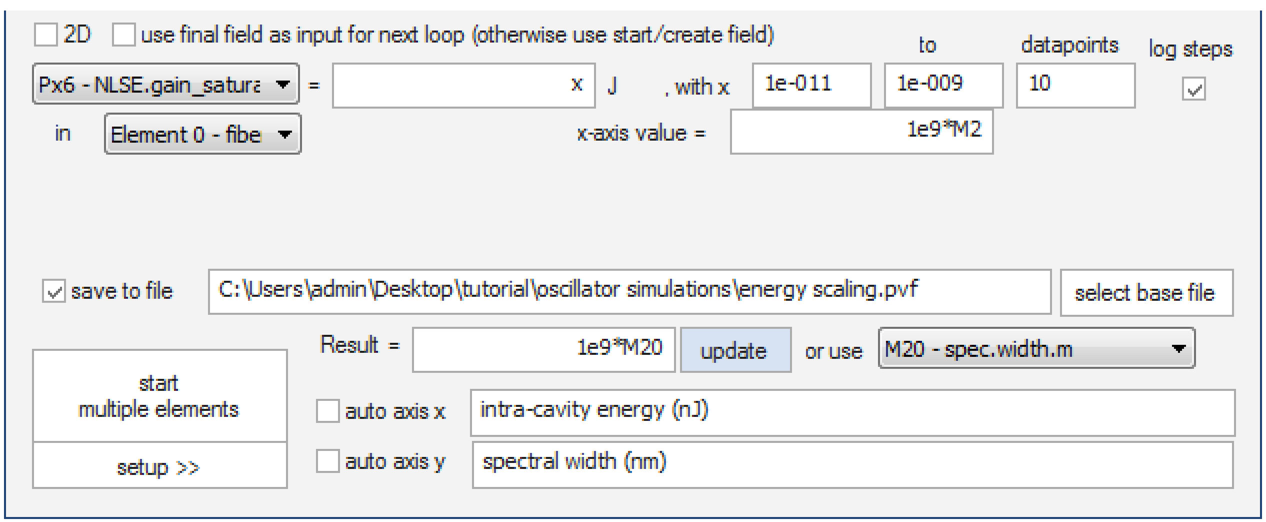
Multi-Element Propagation:

Example: Short Pulse Fiber Lasers



Multi-element > Parameter variation

we change the gain saturation to increase the energy (remark: intracavity energy!)



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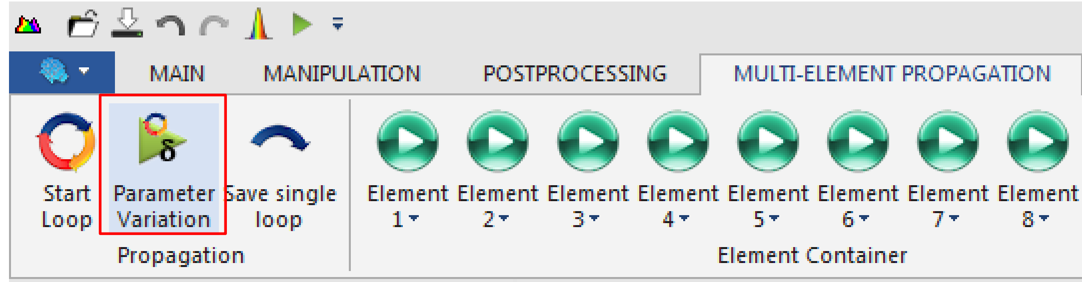
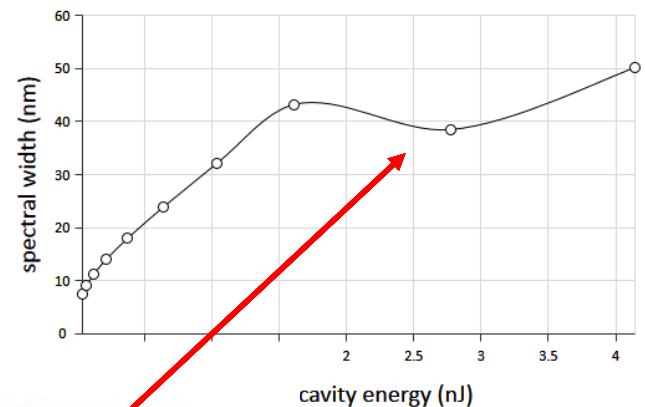


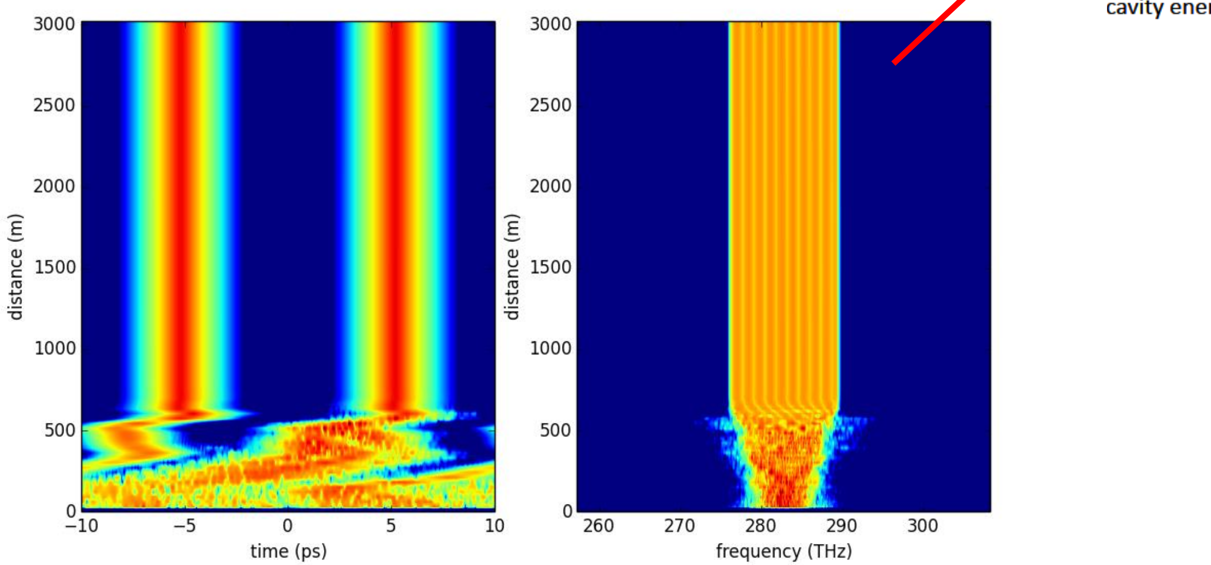
Multi-Element Propagation:

Example: Short Pulse Fiber Lasers

Multi-element > Parameter variation

we change the gain saturation to increase the energy (remark: intracavity energy!)





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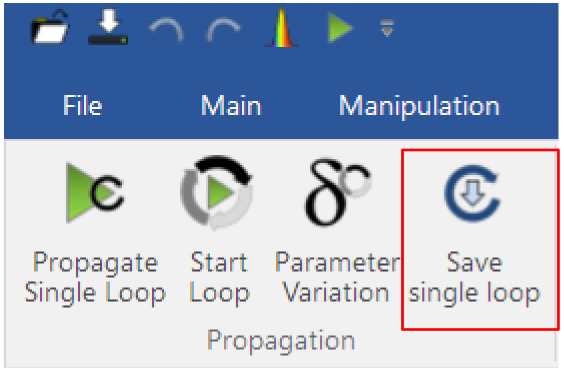
Multi-Element Propagation:

Example: Short Pulse Fiber Lasers

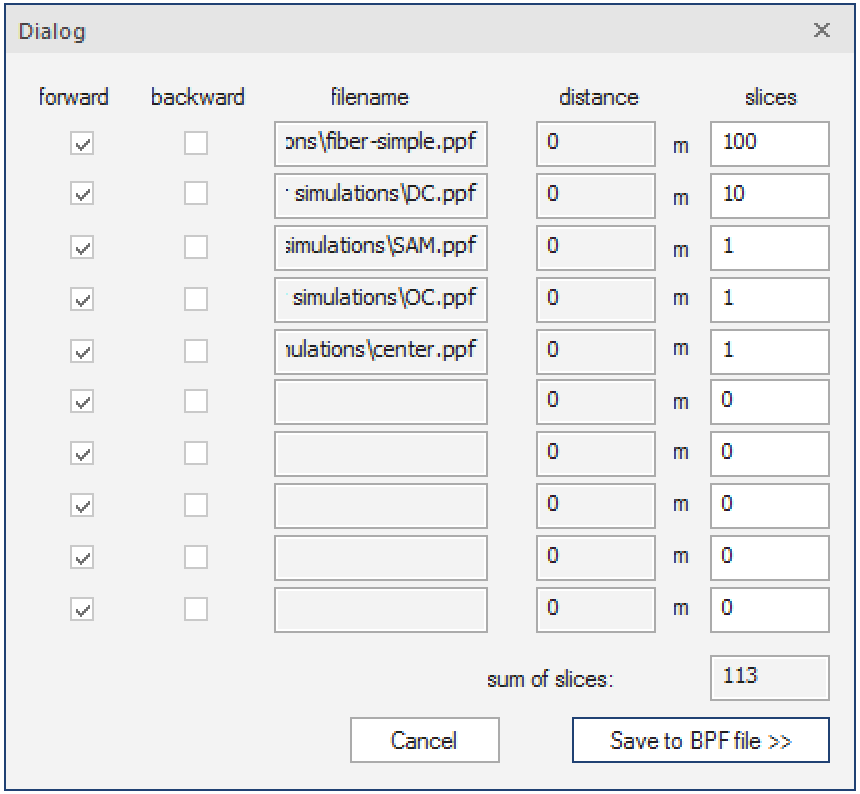


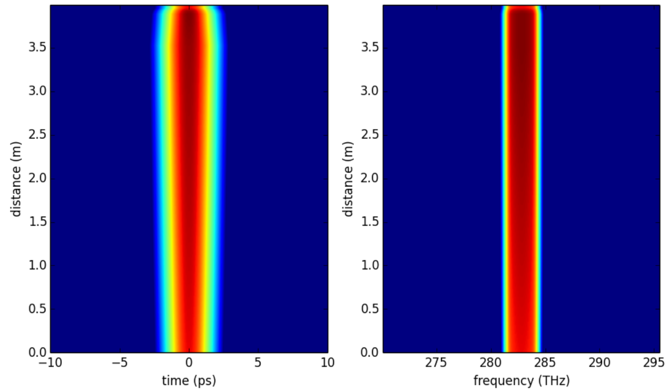
Intracavity evolution

(1) select stable solution from saved file

(2) specify slices to be saved

(3) post-process





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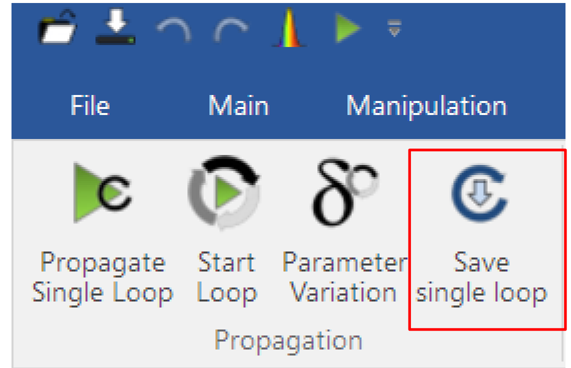
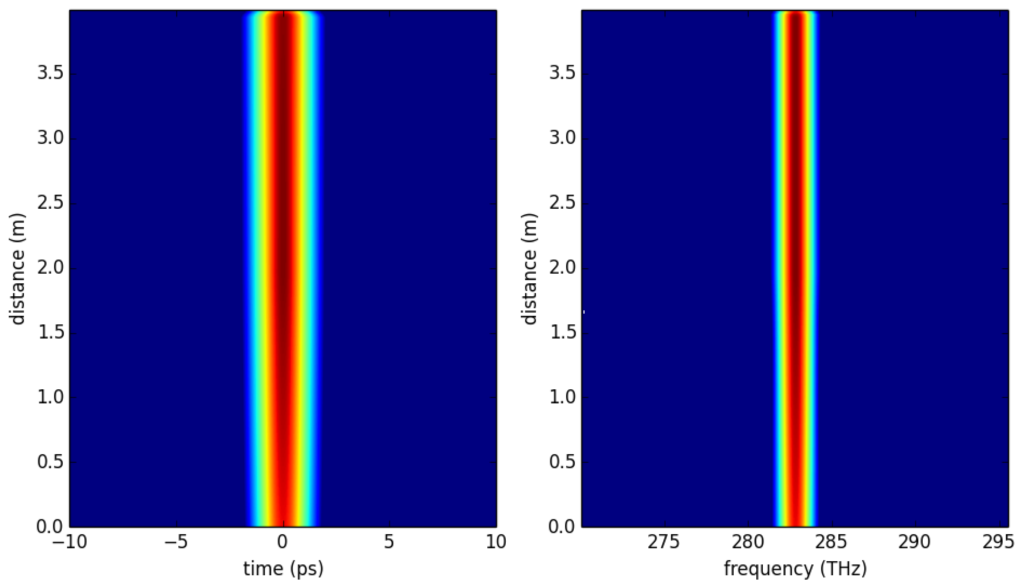
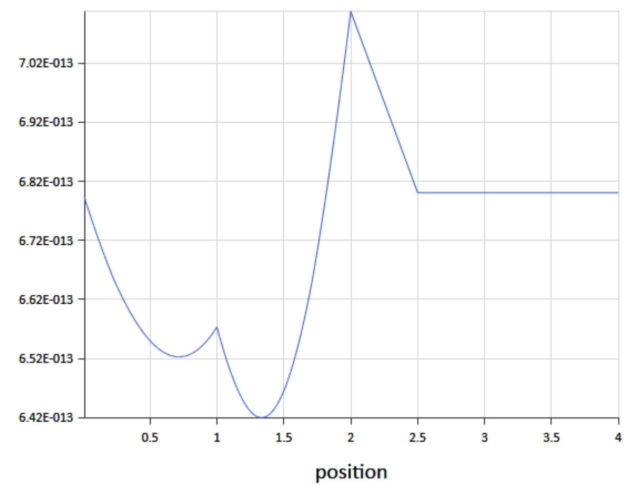


Multi-Element Propagation:

Example: Short Pulse Fiber Lasers

soliton solution: beta2@DC = -0.06 ps^2





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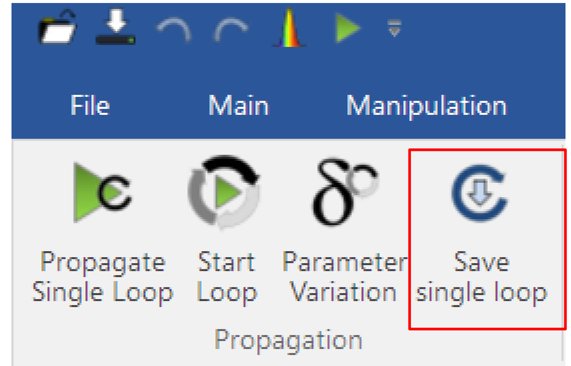
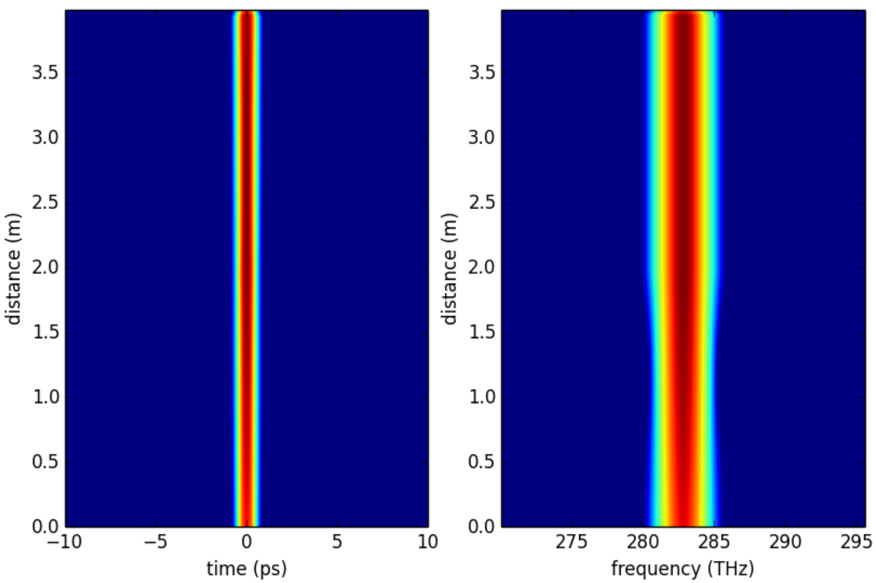
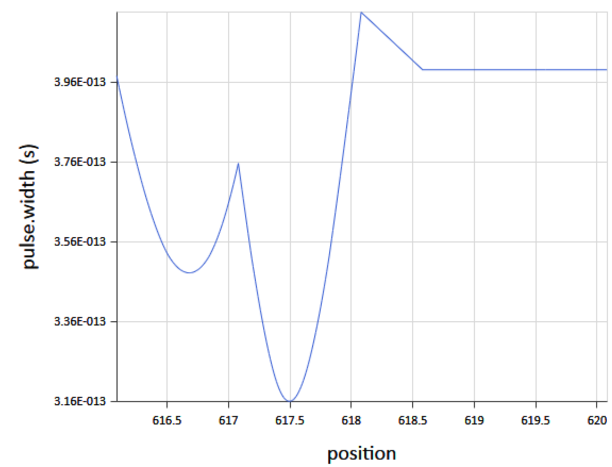


Multi-Element Propagation:

Example: Short Pulse Fiber Lasers

soliton solution: beta2@DC = -0.04 ps^2





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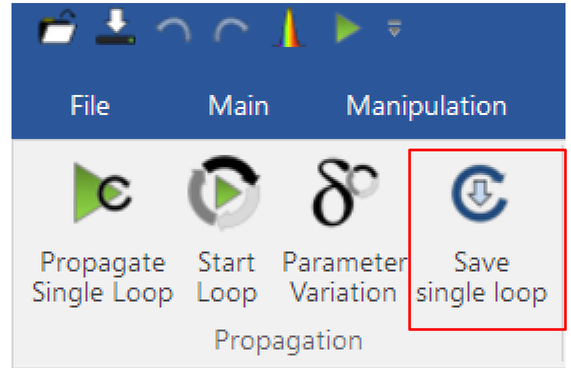
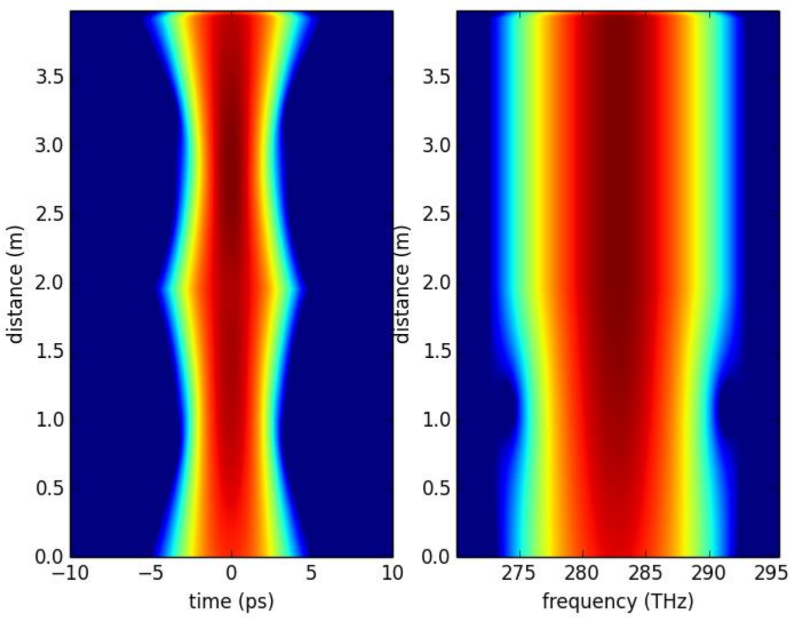
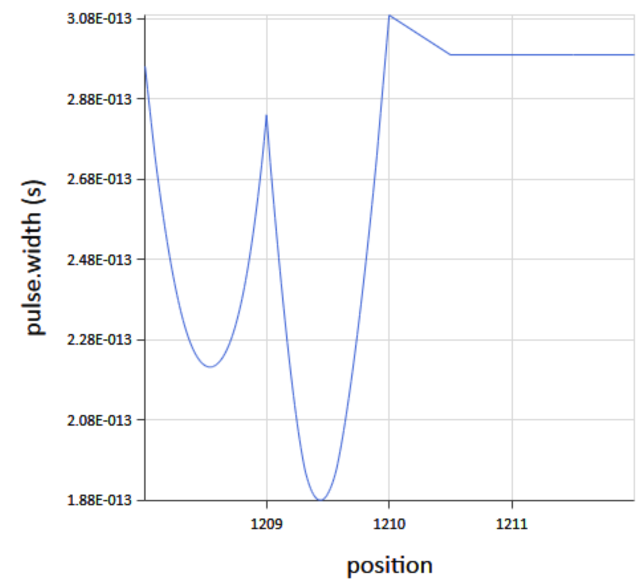


Multi-Element Propagation:

Example: Short Pulse Fiber Lasers

toward stretched pulse: beta2@DC = -0.03 ps^2





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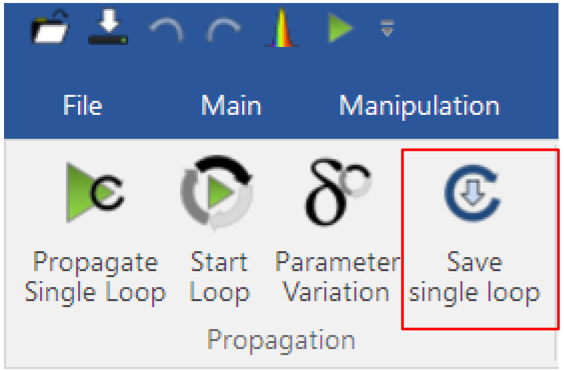
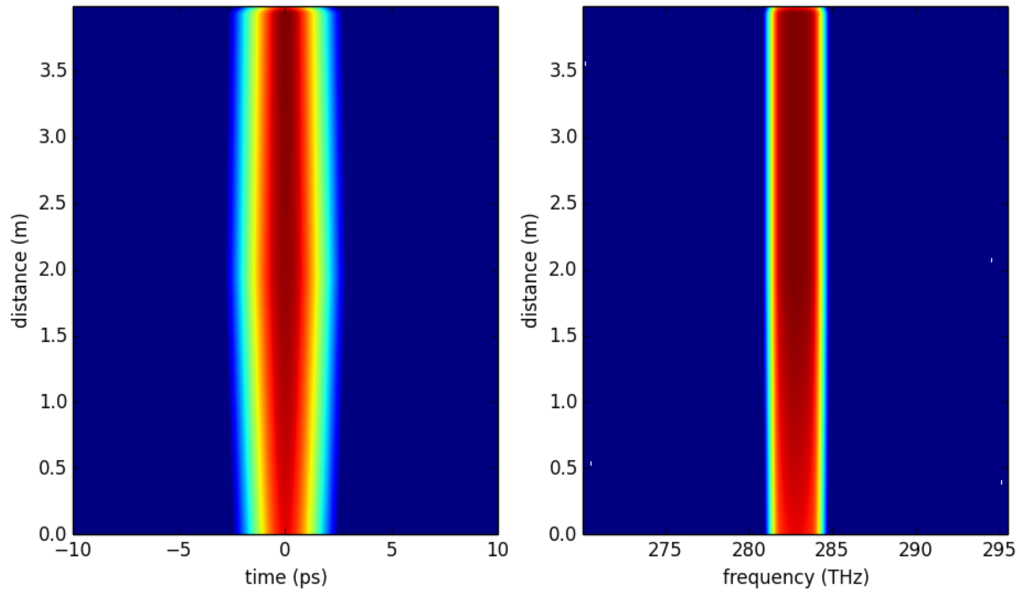
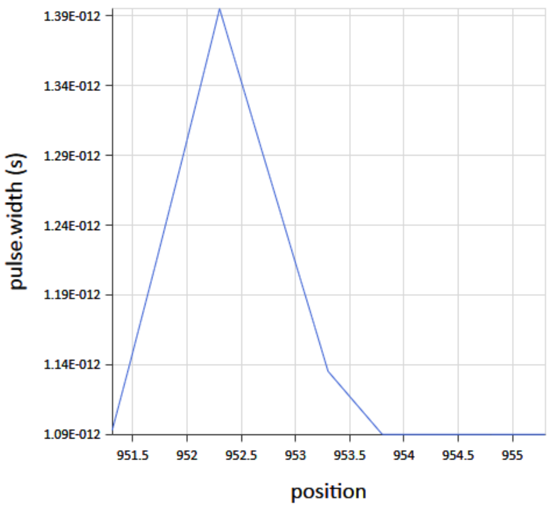


Multi-Element Propagation:

Example: Short Pulse Fiber Lasers

similariton: beta2@DC = -0.02 ps^2





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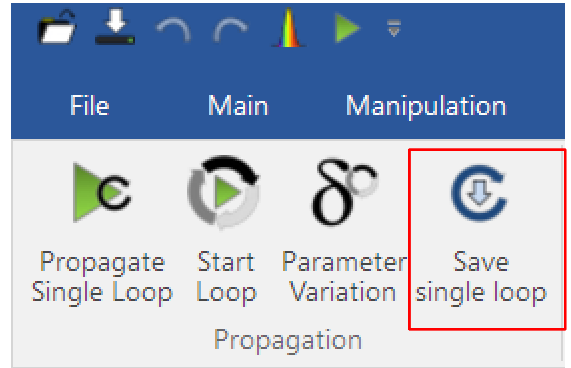

Multi-Element Propagation:

Example: Short Pulse Fiber Lasers

chirped pulse oscillator: beta2@DC = +0.02 ps^2