Lecture 9: Multi-Pass Cell

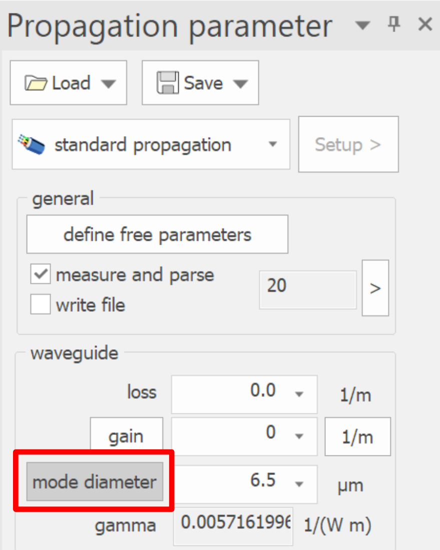
Multi-Pass Cell

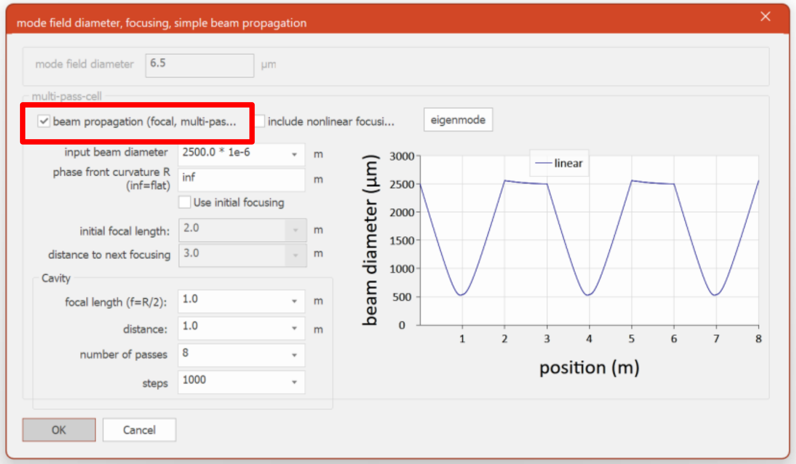
The theory follows the hybrid and 1D modell from the publication:

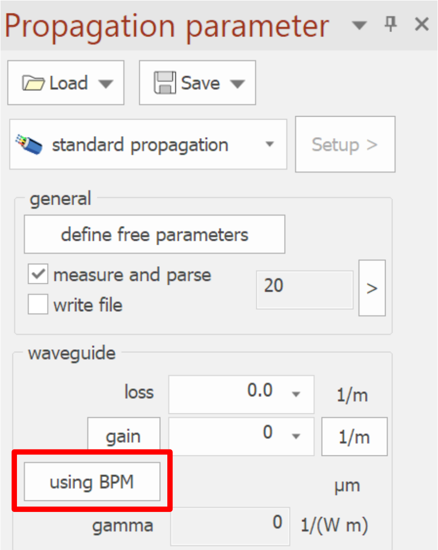
- *Marc Hanna, Nour Daher, Florent Guichard, Xavier Délen, and Patrick Georges, "Hybrid pulse propagation model and quasi-phase-matched four-wave mixing in multipass cells," J. Opt. Soc. Am. B 37, 2982-2988 (2020)*
- *Nour Daher, Florent Guichard, Spencer W. Jolly, Xavier Délen, Fabien Quéré, Marc Hanna, and Patrick Georges, "Multipass cells: 1D numerical model and investigation of spatio-spectral couplings at high nonlinearity," J. Opt. Soc. Am. B 37, 993-999 (2020)*

The beam with a certain size (= mode field diameter) is propagated by Gauss Optics (ABCD formalism) and at each step, the linear and nonlinear effects are considered according to the current beam size. This is a simple form of beam propagation (BPM).

Therefore, the setup is done via the dialog of „mode field diameter“ in the standard propagation options, and once you select „beam propagation“, the button outside the dialog changes to „using BPM“.





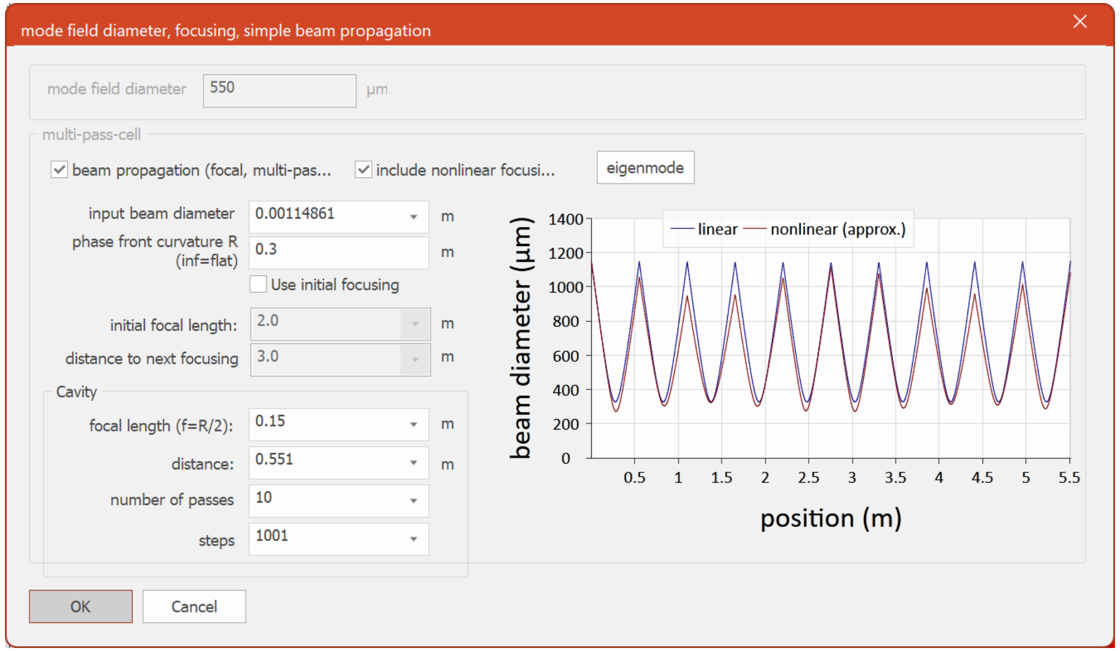


Multi-Pass Cell

We follow the parameter of the publiation, which come from: *L. Lavenu, M. Natile, F. Guichard, Y. Zaouter, X. Delen, M. Hanna, E. Mottay, and P. Georges, “Nonlinear pulse compression based on a gas-filled multipass cell,” Opt. Lett. 43, 2252–2255 (2018).*

- Setup the multi pass cell
- No inital focuing is required
- Include nonlinear focusing, of the actual peak power shall be included in the beam propagation. In the dialog, this is shown approximately for the current peak power in the field
- Once the cavity data is given, the eigenmode can be calculated togive the input beam and phase front
- Leave the dialog

- Start the propagation with „measure and parse“ switched on



Multi-Pass Cell

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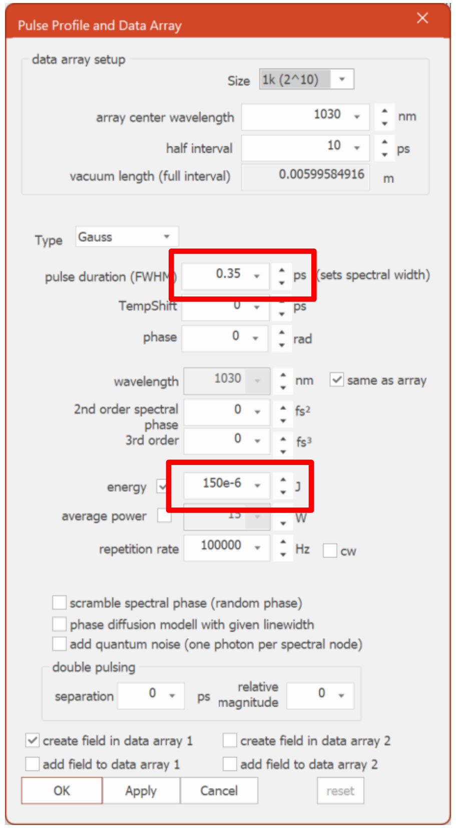
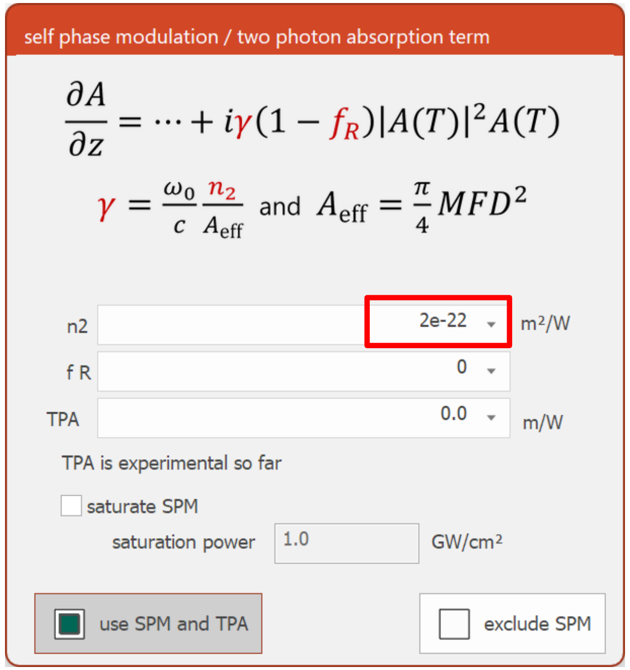
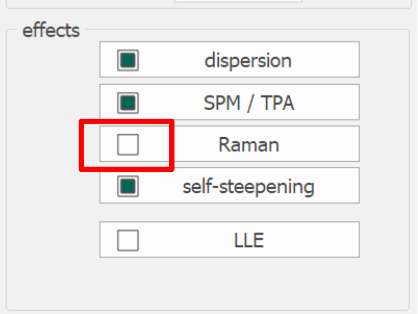
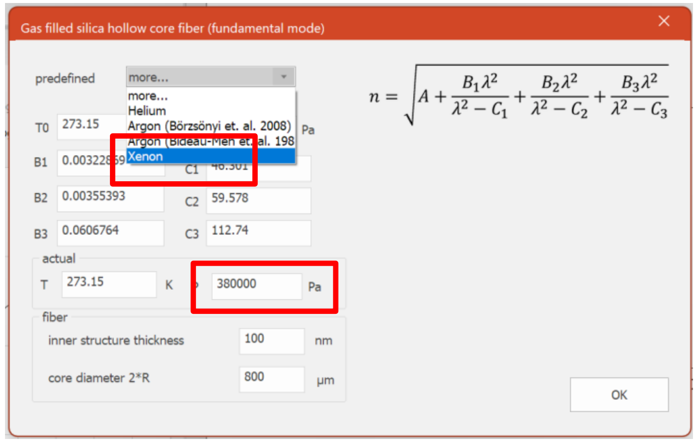
- Define the pulse as Gaussian with 300 fs and 150 µJ
- Set the dispersion to „gas filled hollow core fiber“ and use the dispersion for xenon and a pressur of ~3.8 bar. Also the core diameter is made large as it is not a waveguide, so no resonances appear.
- The nonlinearity n2 is set to 2 e-22 m^2/W (at 3.8 bar)
- Raman can be switched off (or fR=0.0)





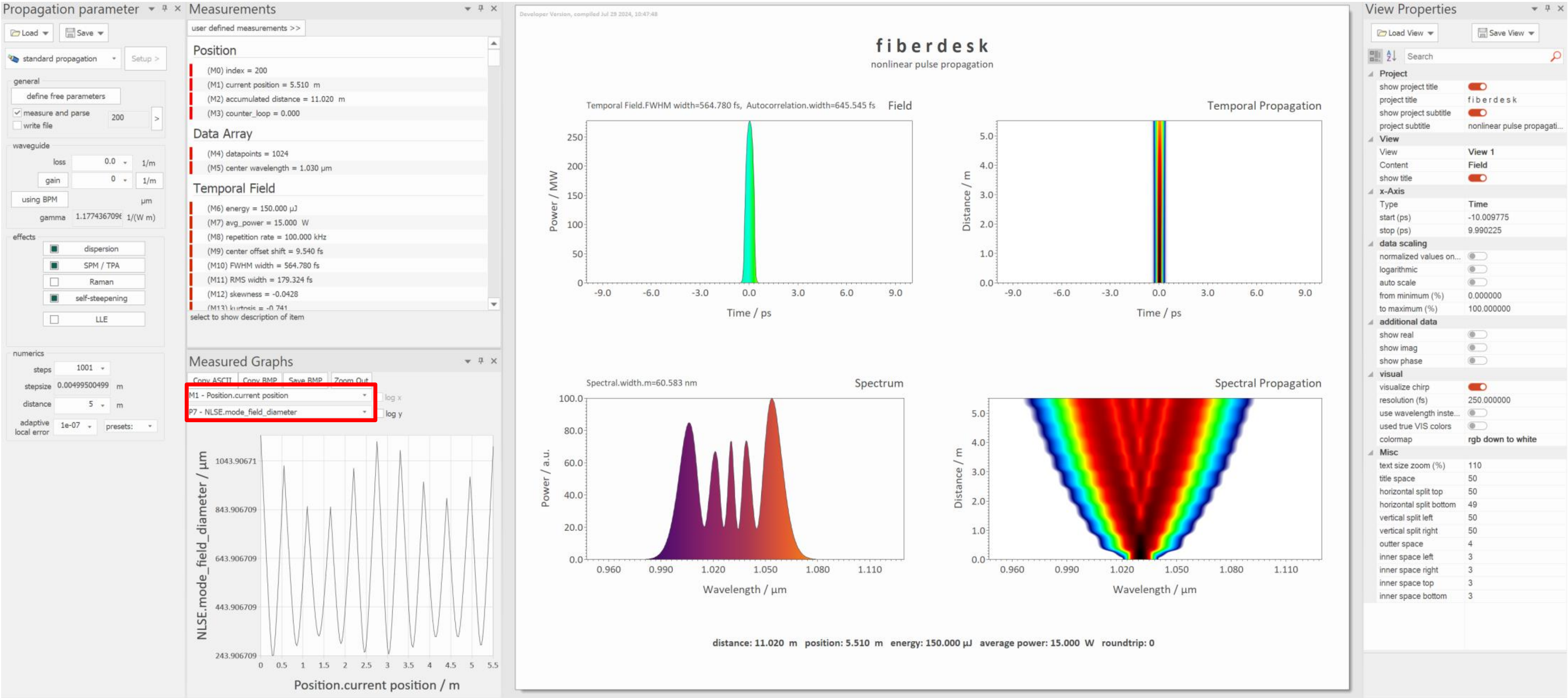




fiberdesk
nonlinear pulse propagation

Multi-Pass Cell

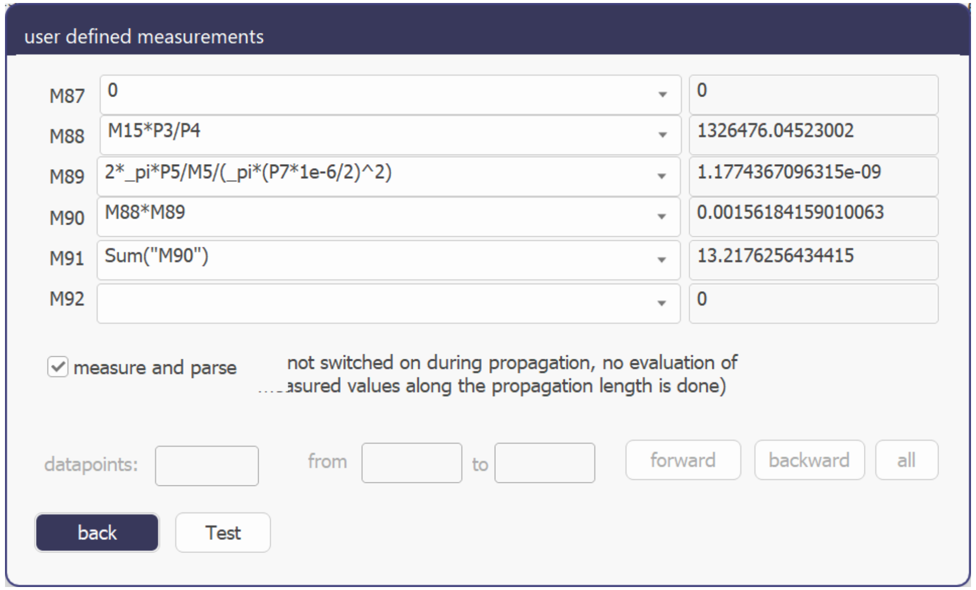
After propagation, the result looks like this, including the beam propagation in the measured graph.



Multi-Pass Cell

You can add the measurement of the B-Integral.

Please keep in mind that in comparison to the demonstration in lecture 1, in the example, the beam diameter changes and the calculation needs to be adapted like this:



$$B = \boxed{\int_0^L \boxed{\gamma \boxed{P_{Peak}(z) \cdot dz}}} \text{ with } \boxed{\gamma = \frac{2\pi n_2}{\lambda A_{eff}}}$$

M88 = P_{Peak}*L / Steps = M15 * P3/P4

M89 = 2* π *n_2/λ/(π*(MFD_µm*1e-6/2)^2)

M90 = γ * P_{peak} dz = M88*M89

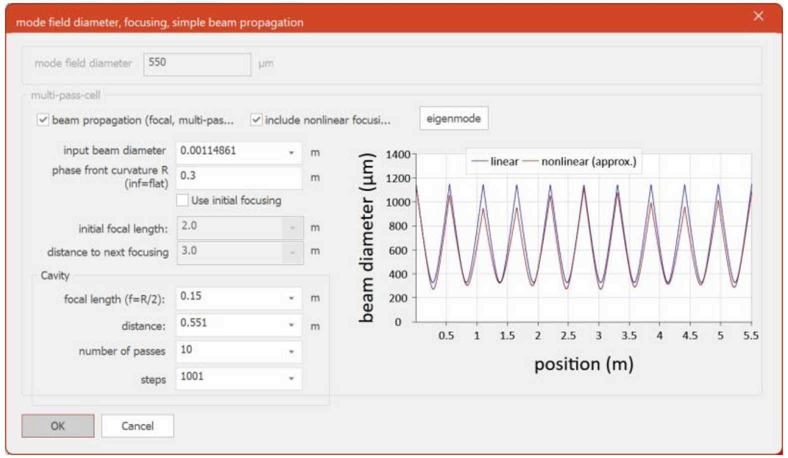
M91 = Sum(„M90“)

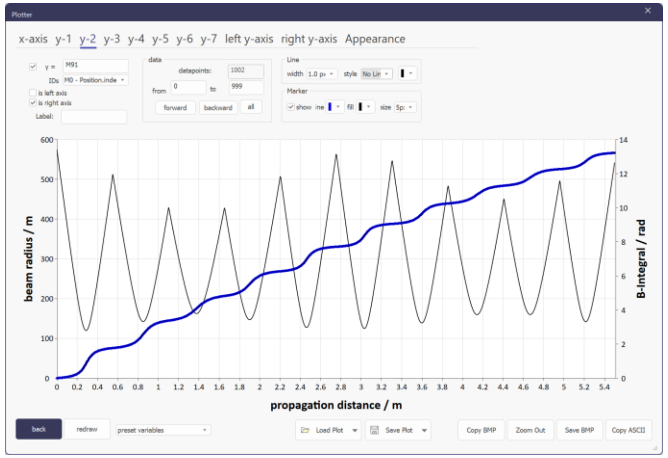
Hints:

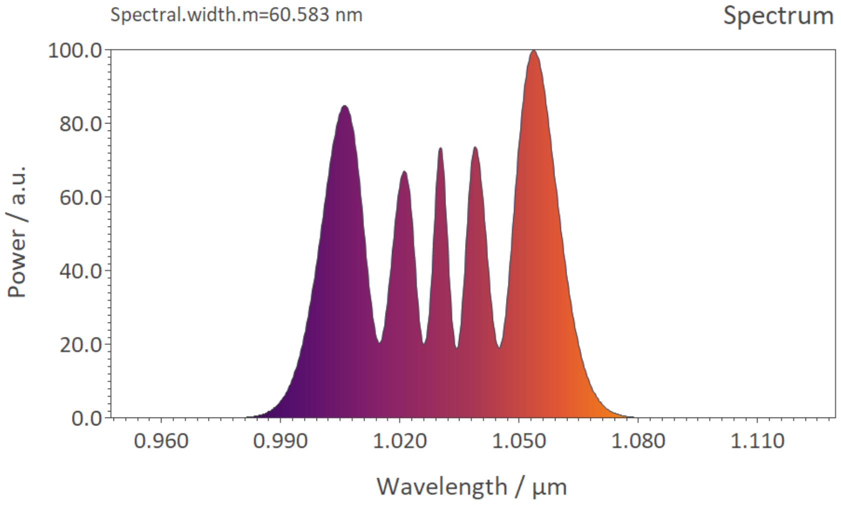
- excecution times are slowed down by complex measurements.
- Please check the meanings of the M values, as they might have changed in their number, depending on the actual version of fiberdesk

Multi-Pass Cell

The result resembles the publication graphs to a very good degree:







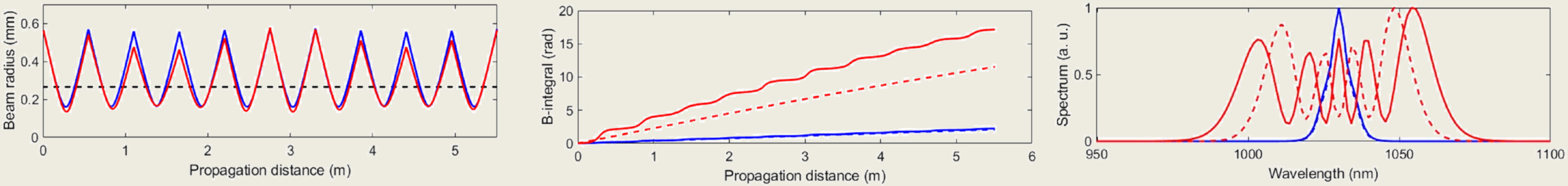


Fig 3 from: *Nour Daher, Florent Guichard, Spencer W. Jolly, Xavier Délen, Fabien Quéré, Marc Hanna, and Patrick Georges, "Multipass cells: 1D numerical model and investigation of spatio-spectral couplings at high nonlinearity," J. Opt. Soc. Am. B 37, 993-999 (2020)*