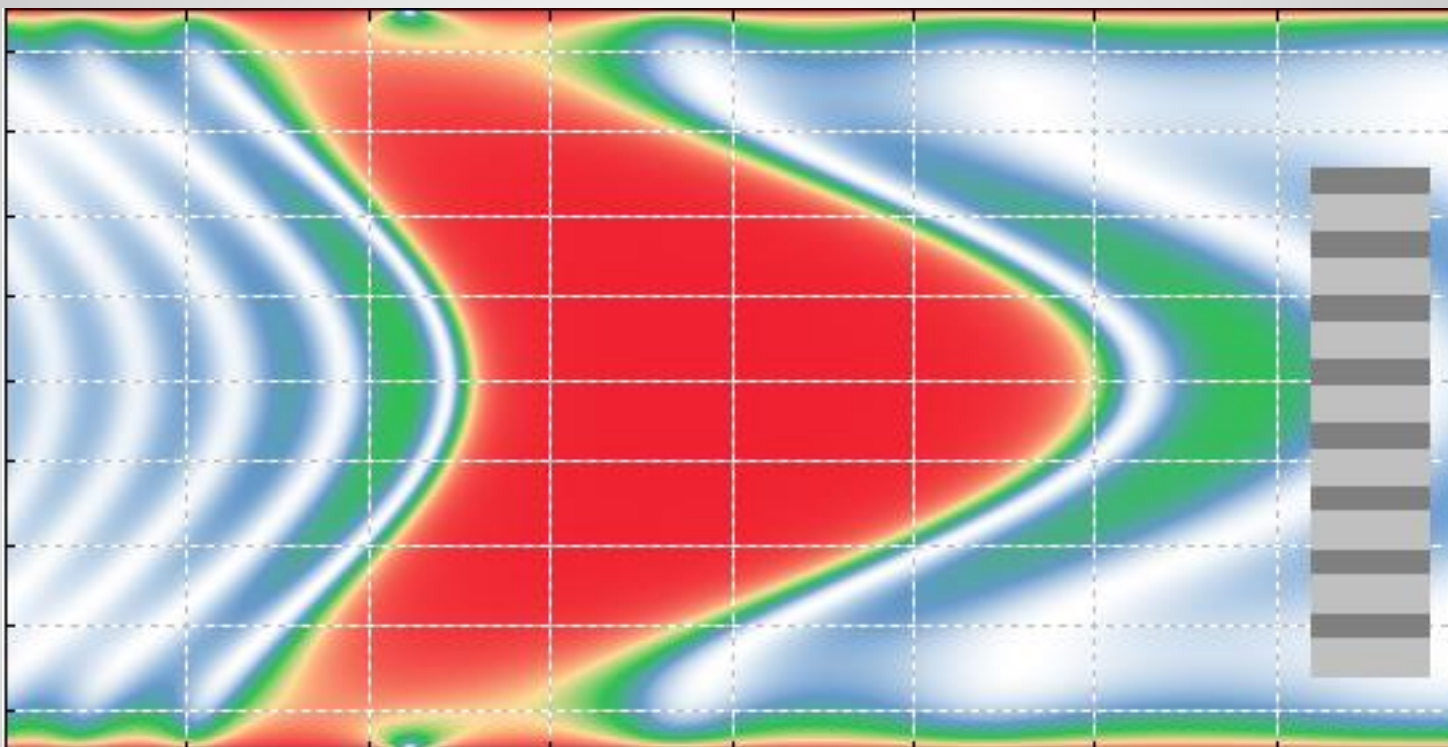


RP Coating V4



a software product of
RP Photonics Consulting GmbH
www.rp-photonics.com/coating.html

Why is a Powerful Multilayer Design Software so Important?

- ▶ Multilayer designs are used to produce structures on **expensive machinery** and possibly in **large volumes**.
- ▶ It is therefore highly desirable
 - ▶ to find the **best possible designs** (for maximum performance, without excessive growth error sensitivities, etc.)
 - ▶ to **do that efficiently**, not leaving expensive infrastructure unused over longer times than necessary

It would be stupid to save a little money on software while wasting not only time, but also expensive resources.

- ▶ You want **a high degree of flexibility** of such software in order to
 - ▶ conveniently implement all sorts of design ideas
 - ▶ quickly get a comprehensive characterization of any design
 - ▶ generate any plots which may be helpful in your case

What is Special about the RP Coating software?

- ▶ You can define coating structures, additional calculations or optimizations, graphical diagrams etc. in text form – i.e., as **script code**.
- ▶ This approach is **far more flexible** than working with forms or pop-up menus:
 - ▶ can easily **parametrize designs**: for example, generate chirped-mirror structures with automatically calculated layer thickness values, or produce certain layer sequences automatically
 - ▶ can **freely define detailed optimization goals** in the form of a figure-of-merit function (not just enter parameters of a given function!)
 - ▶ can **define your own diagrams**, containing any curves and additional elements – no limitation to predefined types of diagrams!
- ▶ **Note: flexibility is not just nice to have, but essential for sophisticated design tasks!**

Scripting is Easy!

Example 1: definition of a Bragg mirror:

```
d_units: nm
l_units: nm

l_Bragg := 1000 { Bragg wavelength }
N_Bragg := 8 { number of layer pairs }

beam from superstrate
substrate: BK7
for j := 1 to N_Bragg do
begin
  * SiO2, l/4 at l_Bragg
  * TiO2, l/4 at l_Bragg
end
superstrate: air
```

It's quite obvious what that code does, isn't it? And it is easy to add more layers, introduce a chirp, etc.

Scripting is Easy!

Example 2: get the reflectivity profile plotted:

diagram 1:

```
"Reflectivity Profile"
```

```
x: 600, 1400
```

```
"wavelength (nm)", @x
```

```
y: 0, 100
```

```
"reflectivity (%)", @y
```

```
frame
```

```
hx
```

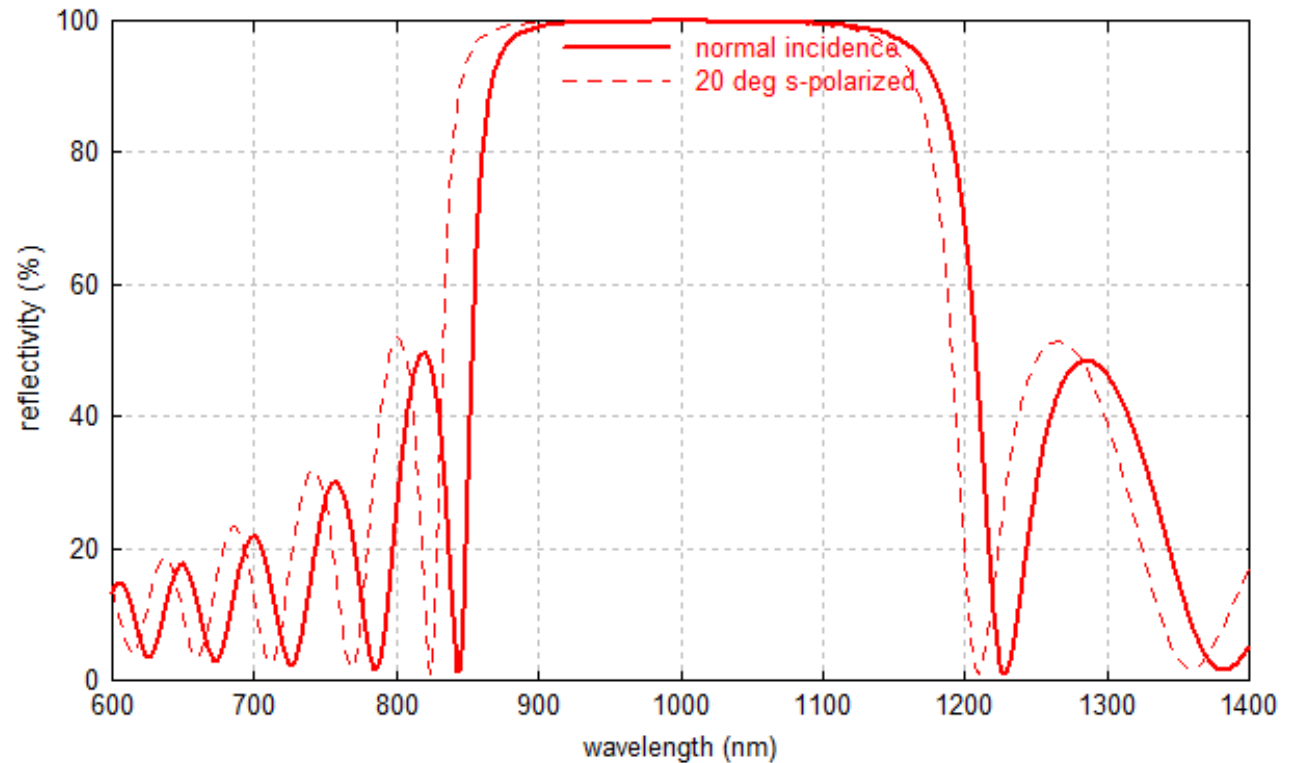
```
hy
```

```
legpos 420, 150
```

```
f: 100 * R(x),  
  "normal incidence",  
  color = red,  
  width = 3
```

```
f: 100 * R_s(x, 20 deg),  
  "20 deg s-polarized",  
  color = red,  
  width = 1,  
  style = dashed
```

Reflectivity Profile



Scripting is Enormously Flexible!

Many tasks can easily be accomplished with a few lines of script code – for example:

- ▶ Generate tailored **graphical diagrams** for visualizing properties of your coating or whatever else.
- ▶ Define a **figure-of-merit function** as a precise definition of your optimization target, and do a numerical optimization such that the value of that function becomes minimal. The optimization may be applied to a few design parameters only or to all layer thickness values. Where necessary, employ a Monte-Carlo algorithm.
- ▶ Save any calculated data in a **text file or binary file** – essentially any file format can be generated, e.g. for your coating machine.

You don't depend on which details the software developer has anticipated: put together yourself what you need! You can even do full-blown programming for most sophisticated calculations.

How to Get Scripts Developed?

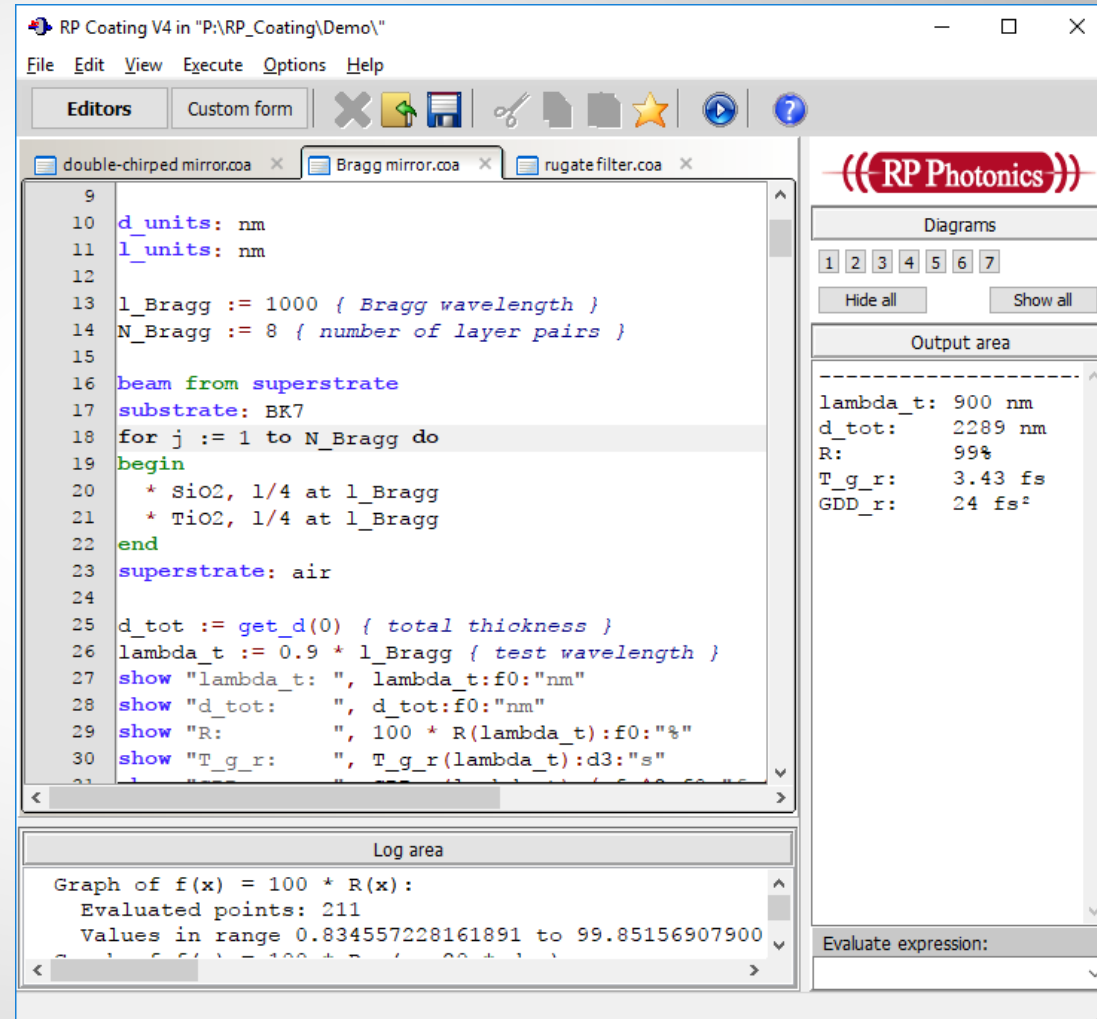
There are different approaches:

- ▶ Copy one of the **demo scripts** and modify it according to your needs.
- ▶ Adapt a **previously developed script** to the new requirements.
- ▶ Use the **code snippets library** for getting frequently used parts of script code. (Also add your own code snippets to that!)
- ▶ Get help within the **technical support**. Describe your needs, and we send you a script as a starting point for your development.

The User Interface (1)

Powerful script editors and editing tools:

- ▶ **Code snippet library** for frequently used parts of code
- ▶ **Parameter hints** for predefined functions
- ▶ **Multilevel undo/redo**
- ▶ **Syntax highlighting** for good readability of code
- ▶ **Integrated syntax checker**
- ▶ **Automatic code formatting** for consistent formats
- ▶ Setting of **breakpoints** for easy debugging



The User Interface (2)

Custom forms: get any tailored forms you need!

- ▶ Such forms **can be made for any simulation!**
- ▶ **Very easy to use:** just fill out the input fields and execute to see the output values as well as created graphical diagrams.
(See the example on the next page.)
- ▶ You can either **make such forms yourself or get them made** within the technical support. (A custom form is defined quite simply in text form within a script.)
- ▶ Ideal combination of flexibility and ease of use!
- ▶ Consequently, **RP Coating** becomes more suitable also for those who need to get certain designs recalculated **without spending much time on technical details.**

The User Interface (3)

Simple example for **custom forms**:

Bragg mirror model, where one can simply enter a few parameters and select some of the offered diagrams.

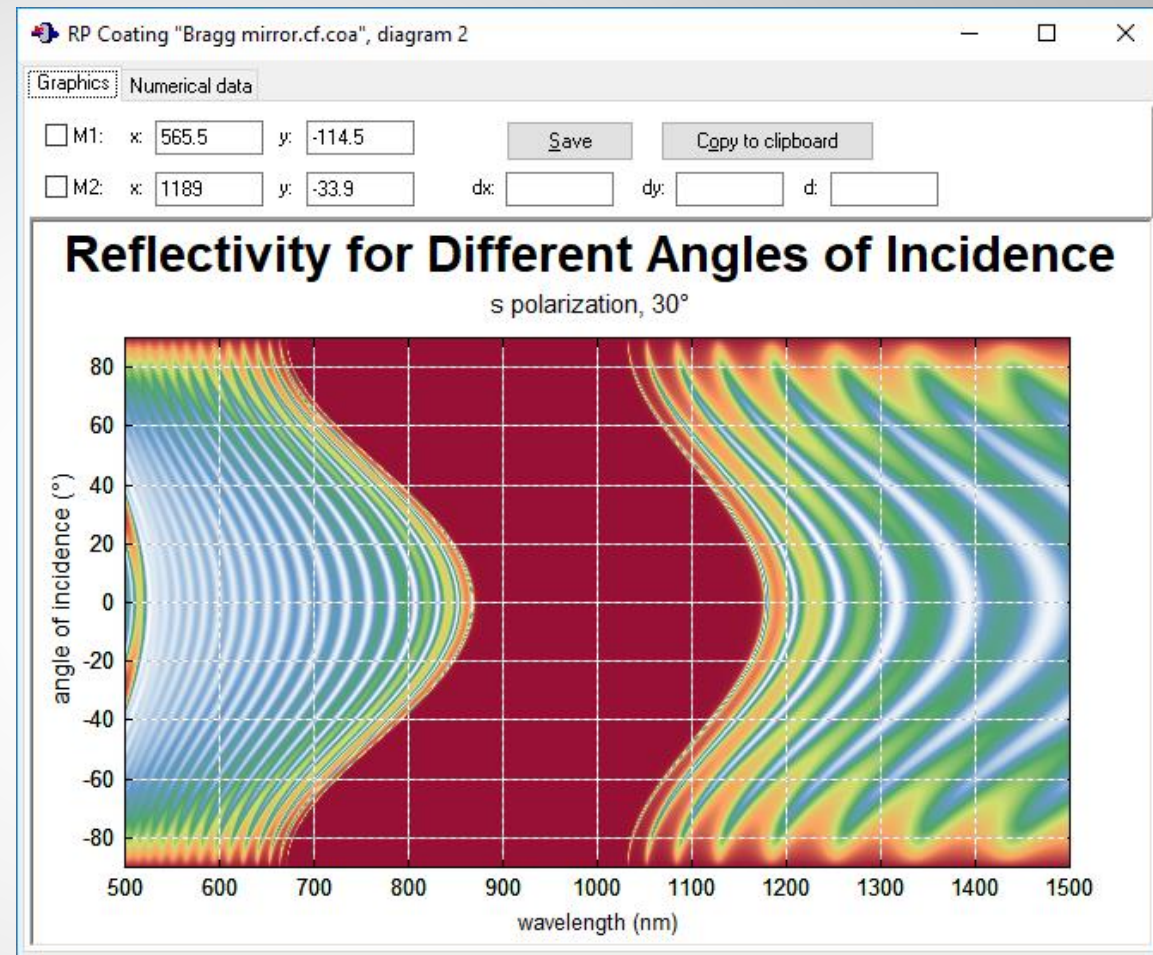
The screenshot displays the RP Coating V4 software interface. The main window is titled "RP Coating V4 in 'P:\RP_Coating\Demo\'". The interface is divided into several sections:

- Editors:** Includes a "Custom form" tab and various icons for file operations and execution.
- Bragg Mirror:** The main configuration area, divided into:
 - Inputs:** Material 1 (SiO2), Material 2 (TiO2), Bragg wavelength (1000 nm), Number of layer payers (20), Test wavelength (1180 nm), Angle of incidence (30°), and Polarization (s).
 - Outputs:** Reflectivity at the test wavelength (10.51%) and Transmittivity (89.49%).
 - Diagrams:** A list of checkboxes for different diagram types: Reflectivity profile (checked), Reflectivity for different angles of incidence (checked), Group delay (unchecked, max. value in fs: 150), Chromatic dispersion (checked, max. value in fs^2: 400), Field strength in the structure (unchecked), Field penetration (unchecked), and Development of reflectivity during fabrication (unchecked). A "Lambda range for diagrams in nm:" field is set from 500 to 1500.
 - Log area:** A text area showing the graph equation $f(x) = 100 * R_s(x, \theta)$, evaluated points (290), and values in range (1.7431099951338 to 99.9999996657537).
- RP Photonics:** A sidebar on the right with a logo, "Diagrams" section (Hide all, Show all), and an "Output area" displaying:
 - l_test: 1180 nm
 - d_tot: 5722 nm
 - R: 11%
 - T_g_r: 95.5 fs
 - GDD_r: -324957 fs^2
- Evaluate expression:** A field at the bottom right for entering and evaluating mathematical expressions.

The User Interface (4)

Graphical output windows

- ▶ high-quality graphics, directly usable for publications:
copy to clipboard or save to file
- ▶ can make animated graphics
- ▶ adjustable resolution
- ▶ markers for doing measurements
- ▶ export numerical data



Also have flexible options for generating output in text form!

Put that into diagrams or files as you like.

Documentation

- ▶ comprehensive **PDF manual**
- ▶ detailed **online help system**
- ▶ comprehensive explanations of the used physical model, details of the script language, etc.
- ▶ various **demo files**, demonstrating many different possibilities

The screenshot shows a web browser window titled "RP Coating". The address bar contains "RP Coating". The browser interface includes "Hide", "Back", "Forward", and "Print" buttons. The main content area is divided into two panes. The left pane, titled "Contents", has a search bar with the text "definition of a coating" and a list of topics. The "definition of a coating" item is highlighted. The right pane, titled "Definition of the Coating", contains the following text:

The following lines given an example for the definition of a coating:

```
beam from superstrate
substrate: BK7
* TiO2, d = 500e-9
* SiO2, d = 1/4 at 1000e-9
* TiO2, d = 1/4 * 0.54 at 1000e-9
* SiO2, d = 1/4 at 1000e-9
* (n = 1.5), d = 30e-9
superstrate: air
```

The first line specifies from which direction the probe beam is coming: from the substrate or the superstrate, the latter being the default value. The command **beam from...** has to be used before the substrate or superstrate command. However, this setting can later be changed by calling the [set_dir\(\)](#) function.

The **substrate** and **superstrate** commands specify the materials around the coating.

Each line beginning with '*' defines one layer of the coating. All these lines must be located between the substrate and superstrate commands.

The available materials (e.g., TiO2) are [defined in a plain text file](#) which can be modified by the user. Instead of a material name, the refractive index can be specified in parenthesis (see the last layer in the example); in this case, chromatic dispersion (wavelength dependence of the refractive index) cannot be taken into account.

Note that the medium of the incident beam may not be absorbing.

The second parameter in the lines beginning with * defines the layer thickness ('d =' can be omitted). In the simplest case, the

Technical Support

Any remaining technical issues can be addressed with the technical support:

The price for a **commercial user license** contains **8 support hours** (non-commercial licenses: 4 hours).

The support is done by Dr. Paschotta himself, who is a distinguished expert in this area and has developed **RP Coating**. He will make sure that you become another very satisfied user of the software!



Dr. Rüdiger Paschotta,
founder and managing director
of RP Photonics,
developer of RP Coating

Note that RP Photonics also offers consultancy on laser technology.

Can I Afford This Software?

Sure, a high-quality software product including competent support from a top expert costs some money.

Anyway, the better question is:

Can I afford *not* to have a powerful software tool, i.e.,

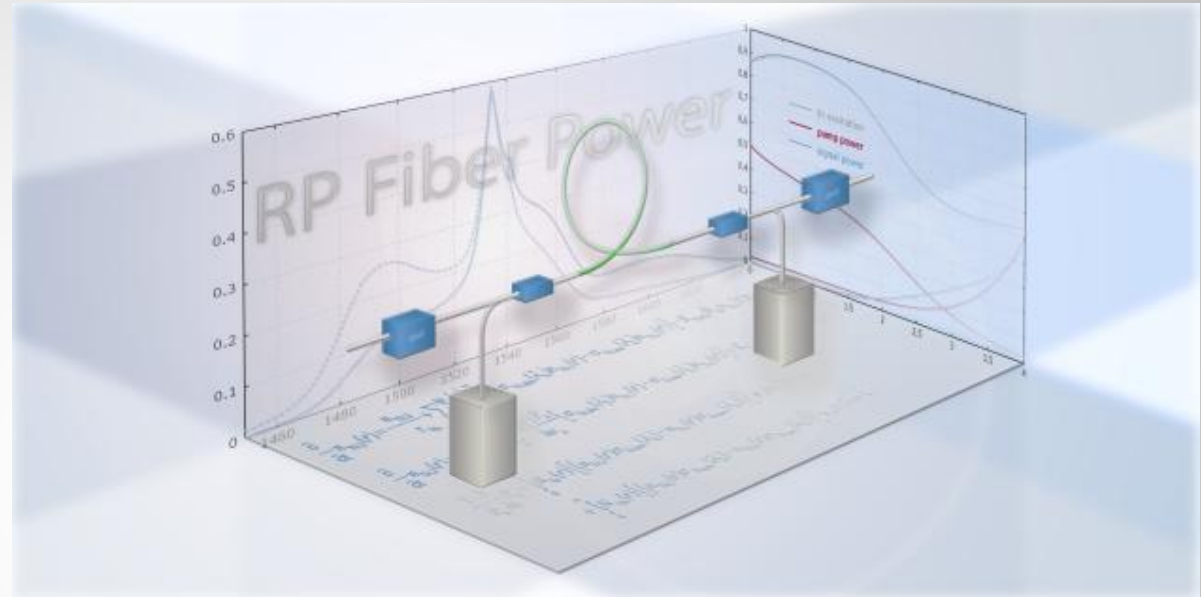
- ▶ to muddle through with insufficient tools?
- ▶ to use trial & error, wasting time and materials?
- ▶ to let customers wait while my competitors sell their products?

The **RP Coating** software will give a boost to your productivity! Also, your employees or students will become productive sooner when they acquire a deep understanding by playing with this software.

Other Software from RP Photonics

RP Fiber Power:

- ▶ design of fiber amplifiers, fiber amplifiers, double-clad fibers, multi-core fibers, fiber couplers, etc.
- ▶ powerful script language for an enormous flexibility
- ▶ can do most sophisticated analysis and optimizations

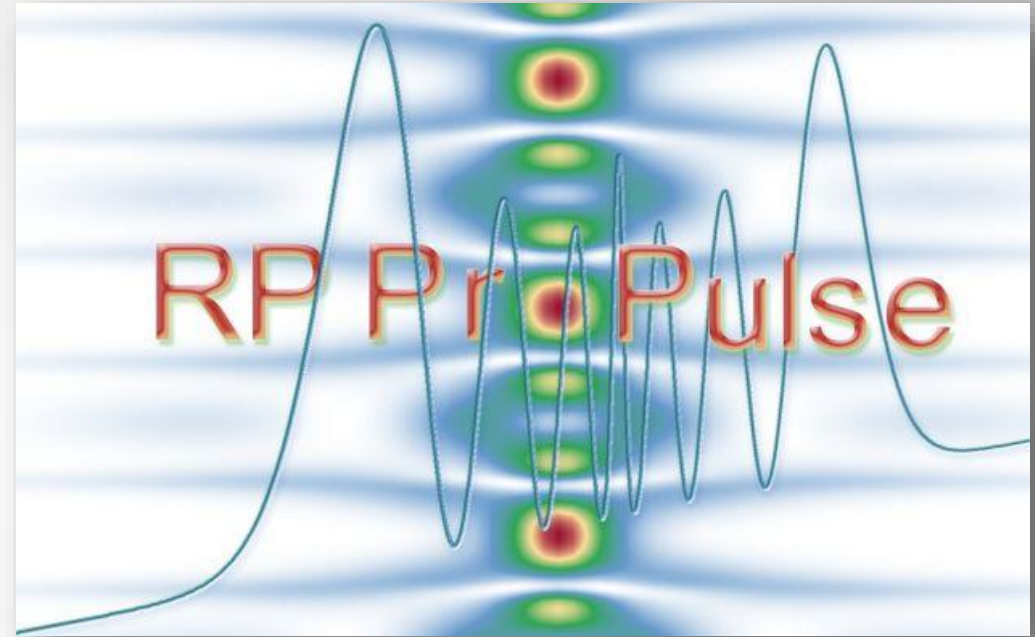


See a detailed description: www.rp-photonics.com/fiberpower.html

Other Software from RP Photonics

RP ProPulse:

- ▶ simulates the propagation of ultrashort pulses e.g. in mode-locked lasers or sync-pumped OPOs
- ▶ can include laser gain, parametric gain, SHG, Kerr and Raman effect, chromatic dispersion, etc.
- ▶ pulse display window
- ▶ can do most sophisticated analysis and optimizations

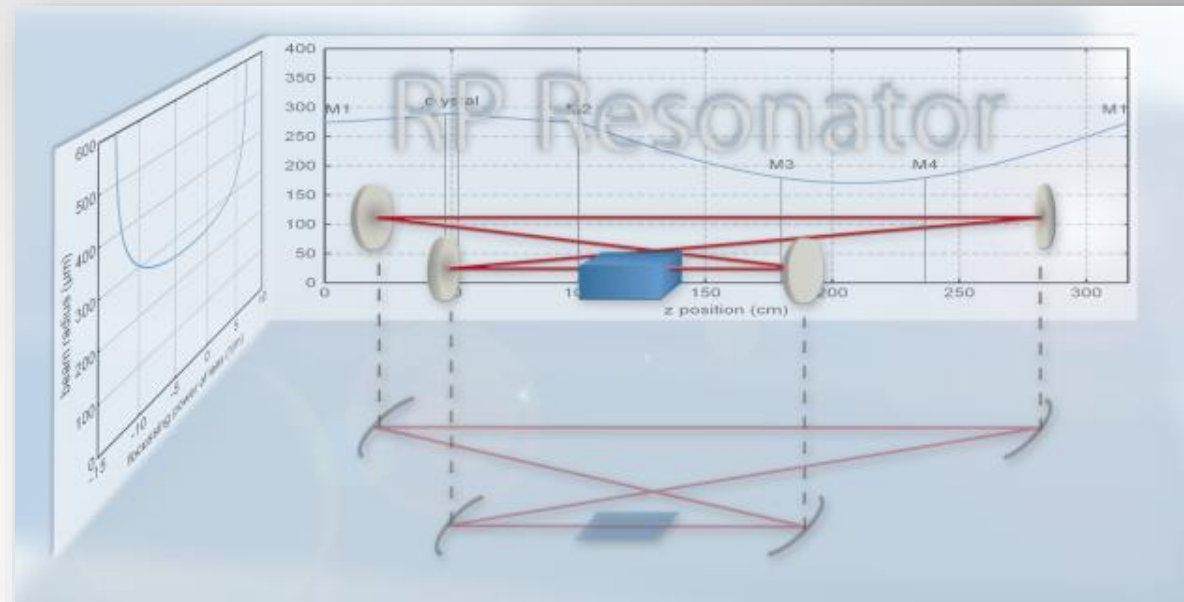


See a detailed description: www.rp-photonics.com/propulse.html

Other Software from RP Photonics

RP Resonator:

- ▶ design of optical resonators for lasers, OPOs, filters, etc.
- ▶ can fully parameterize the designs
- ▶ powerful script language for an enormous flexibility
- ▶ can do most sophisticated analysis and optimizations



See a detailed description: www.rp-photonics.com/resonator.html