pst-optexp
A PSTricks package to draw optical experimental setups

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1 Introduction

The package `pst-optexp` is a collection of optical components that facilitate easy sketching of optical experimental setups. Mechanisms for proper alignment of different components are

provided internally. This way the user does not have to care for proper orientation of the elements. Macros for convenient definition of new user-defined components are also provided.

2 Concept and General Options

2.1 Concept

There are two different categories of optical components that are provided by the package: free-ray and fiber-optical components.

The free-ray components are subdivided in two different kinds: the components which require two reference points and do not alter the direction of the passing light beam (e.g. lenses and retardation plates) and those which work in reflection and require three reference points (mirrors, gratings, beamsplitters etc.).

For free-ray setups one usually has few straight light paths in which several different components are arranged. Therefore, it is more convenient if one has to define only two nodes for each light path. The components then are placed on this light path using the different positioning parameters of the package and at the end the beam itself is drawn. This concept is different from the one used for the fiber-optical components or the way `pst-circ` treats its objects. They directly connect the components with the reference nodes.

The fiber-optical components can be subdivided in dipoles, tripoles and quadrupoles which have a corresponding number of fiber connections. The handling of these components differs in some aspects from the free-ray objects. The fiber optics are directly connected with the reference nodes. The psstyles used for each fiber connections can be flexibly changed for every components (see sec. 4.8).

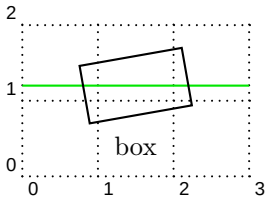
Some hybrid components (laser, optbox, detector etc.) can be used both as fiber-optical or free-ray elements. By default they are treated as free-ray objects, i.e. they are not connected to their reference points. Setting the parameter `fiber` to `true` they are treated as fiber-optical object and connected with the reference points using the appropriate psstyles.

2.2 General Options

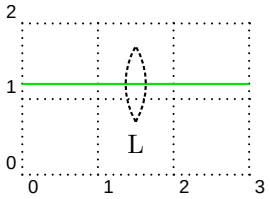
angle: `<value>` (*default:* `0`)
optional: `<boolean>` (*default:* `false`)
position: `<value>` (*default:* `\@empty`)
abspos: `<value>` (*default:* `\@empty`)
showoptdots: `<boolean>` (*default:* `false`)
fiber: `<boolean>`
extnode: `<ref string>` (*default:* `\@empty`)
extnodename: `<string>` (*default:* `Ext`)

The parameter `angle` is available for the macros `\optbox` and `\crystal` only, as for the most other cases it would make no sense. `optional` can be used with every component and marks it as optional and can be configured by changing the psstyle `OptionalStyle`. `position` is equivalent to the `npos` parameter of `\ncput`, but is used only for the 'dipole'-macros to position the component between the two given points. In addition, there is a parameter `abspos`

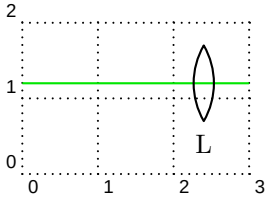
that allows absolute positioning between the two line points. `showoptdots` shows in black the two points calculated for the positioning of the component, and in red the reference points for the label.



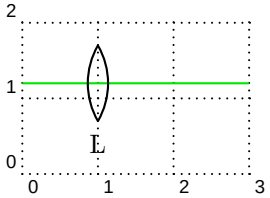

```
\begin{pspicture}(3,2)\psgrid
  \pnode(0,1.2){A}
  \pnode(3,1.2){B}
  \psline[style=Beam](A)(B)
  \optbox[angle=10](A)(B){box}
\end{pspicture}
```



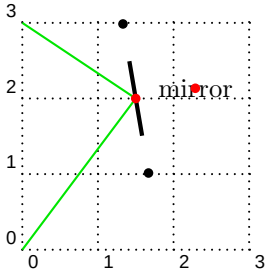

```
\begin{pspicture}(3,2)\psgrid
  \pnode(0,1.2){A}
  \pnode(3,1.2){B}
  \psline[style=Beam](A)(B)
  \lens[optional](A)(B){L}
\end{pspicture}
```




```
\begin{pspicture}(3,2)\psgrid
  \pnode(0,1.2){A}
  \pnode(3,1.2){B}
  \psline[style=Beam](A)(B)
  \lens[position=0.8](A)(B){L}
\end{pspicture}
```




```
\begin{pspicture}(3,2)\psgrid
  \pnode(0,1.2){A}
  \pnode(3,1.2){B}
  \psline[style=Beam](A)(B)
  \lens[abspos=1](A)(B){L}
\end{pspicture}
```




```
\begin{pspicture}(3,3)\psgrid
  \pnode(0,0){A}
  \pnode(1.5,2){G}
  \pnode(0,3){B}
  \psline[style=Beam](A)(G)(B)
  \mirror[showoptdots](A)(G)(B){mirror}
\end{pspicture}
```

3 Free-Ray Components

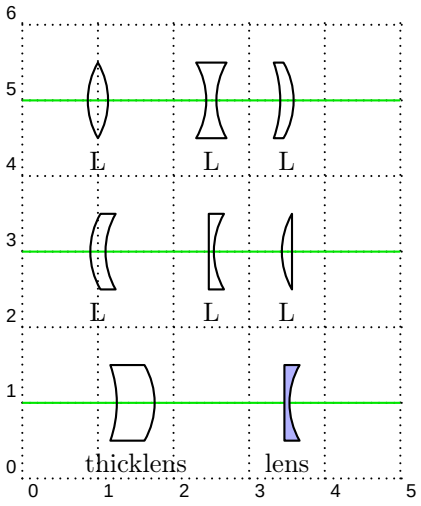
In the sections 3.1–3.12 the available free-ray components with their parameters are described.

In section 2 general parameters are described that are not proprietary to a specific unit but can be used for several different components. Finally, in section 5 the options for the positioning of labels are explained.

The appearence of all components can be changed with the corresponding standard PSTricks parameters such as `fillstyle` or `linestyle`. For some components changing only parts of the layout is possible (e.g. the extended part of mirrors). For those cases psstyles are provided that influence only the corresponing part of the components and can be redefined using `\newpsstyle`.

3.1 Lens

lensheight: `<value>` (*default:* `1`)
lenswidth: `<value>` (*default:* `0.3`)
lensradius: `<value> [<value>]` (*default:* `\@empty`)
lensradiusleft: `<value>` (*default:* `1`)
lensradiusright: `<value>` (*default:* `1`)
lens: `<value> [<value> [<value> [<value>]]]` (*default:* `\@empty`)
thicklens: `<boolean>`(*default:* `false`)




```
\begin{pspicture}(5,6)\psgrid
  % concave lenses
  \pnode(0,5){A}\pnode(5,5){B}
  \psline[style=Beam](A)(B)
  \lens[position=0.2](A)(B){L}
  \lens[lensradius=-1,position=0.5](A)(B){L}
  \lens[lens=-1.5 1,position=0.7](A)(B){L}
  % convex lenses
  \pnode(0,3){A}\pnode(5,3){B}
  \psline[style=Beam](A)(B)
  \lens[position=0.2,lens=1 -1](A)(B){L}
  \lens[lens=0 -1](A)(B){L}
  \lens[lens=1 0,position=0.7](A)(B){L}
  % thick lenses
  \pnode(0,1){A}\pnode(5,1){B}
  \psline[style=Beam](A)(B)
  \lens[position=0.3,lens=-1.5 1 1
    0.5,thicklens](A)(B){thicklens}
  \lens[lens=0 -1, position=0.7, fillstyle=solid,
    fillcolor=blue!30!white](A)(B){lens}
\end{pspicture}
```

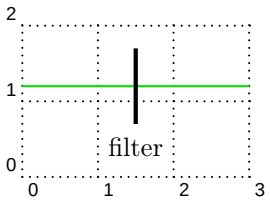
The shape of a lens is defined by its two surface radii. A negative radius gives a concave, a positive radius a convex and a radius of `0` a plain surface. The parameters `lensradiusleft` and `lensradiusright` allow to define independent values for both surfaces. `lensradius` sets both curvatures to the same value. Usually only `lensheight` and the two radii are used to construct the lens. The thickness (or width) is determined automatically. Manually controlling

the thickness of the lens can be achived by setting `thicklens` to `true`. Then `lenswidth` is used as width of the lens at its waist. Finally, the parameter `lens` allows the definition of all relevant lens parameters at once. It consists of one up to four space-separated numbers. The first one gives the left radius. If no further value is set, the right radius will be set to the same value and all other parameters are left unchanged. Using two numbers defines two different radii. The third optional value defines the `lensheight` and the fourth one the `lenswidth`

Compatibility: The whole implementation of the lens was changed in version 1.2. It allows a much more flexible definition of different lens types. However, I could not get full compatibility with the older way to define lens using only `lensheight` and `lenswidth`. To use this old behaviour, you have to set the `lenstype` explicitly, but then you have no access to the new features! All users are encouraged to adapt their code to use the new parameters, as the old code will be removed in future versions.

3.2 Optical Plate

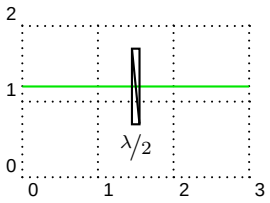
plateheight: `<value>` (*default:* `1`)
platelinewidth: `<value>` (*default:* `2\pslinewidth`)




```
\begin{pspicture}(3,2)\psgrid
  \pnode(0,1.2){A}
  \pnode(3,1.2){B}
  \psline[style=Beam](A)(B)
  \optplate(A)(B){filter}
\end{pspicture}
```

3.3 Retardation Plate

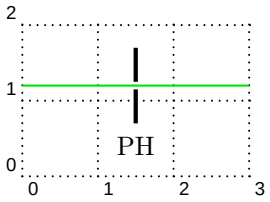
plateheight: `<value>` (*default:* `1`)
platewidth: `<value>` (*default:* `0.1`)




```
\begin{pspicture}(3,2)\psgrid
  \pnode(0,1.2){A}
  \pnode(3,1.2){B}
  \psline[style=Beam](A)(B)
  \optretplate(A)(B){$\nicefrac{\lambda}{2}$}
\end{pspicture}
```

3.4 Pinhole

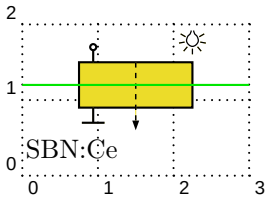
outerheight: `<value>` (*default:* `1`)
innerheight: `<value>` (*default:* `0.1`)
phlinewidth: `<value>` (*default:* `2\pslinewidth`)




```
\begin{pspicture}(3,2)\psgrid
  \pnode(0,1.2){A}
  \pnode(3,1.2){B}
  \psline[style=Beam](A)(B)
  \pinhole(A)(B){PH}
\end{pspicture}
```

3.5 Crystal

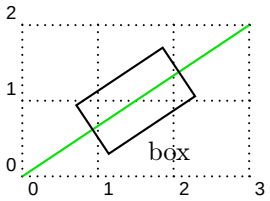
crystalwidth: <value> (*default:* 2)
crystalheight: <value> (*default:* 0.8)
caxislength: <value> (*default:* 0.6)
caxisinv: <boolean> (*default:* false)
voltage: <boolean> (*default:* false)
lamp: <boolean> (*default:* false)
lampscale: <value> (*default:* 0.3)



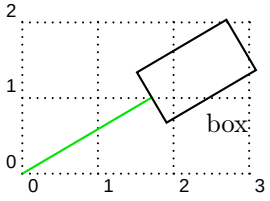

```
\begin{pspicture}(3,2)\psgrid
  \pnode(0,1.2){A}
  \pnode(3,1.2){B}
  \crystal[crystalwidth=1.5, crystalheight=0.6, fillstyle=solid,
    fillcolor=yellow!90!black, labelangle=-45, labeloffset=1.2,
    voltage, lamp](A)(B){SBN:Ce}
  \psline[style=Beam](A)(B)
\end{pspicture}
```

3.6 Box

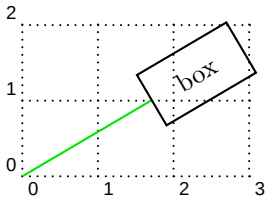
optboxheight: <value> (*default:* 0.5)
optboxwidth: <value> (*default:* 1)
endbox: <boolean> (*default:* false)




```
\begin{pspicture}(3,2)\psgrid
  \pnode(0,0){A}
  \pnode(3,2){B}
  \psline[style=Beam](A)(B)
  \optbox(A)(B){box}
\end{pspicture}
```



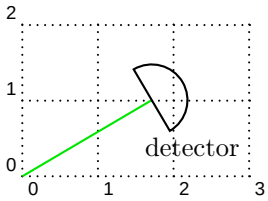

```
\begin{pspicture}(3,2)\psgrid
  \pnode(0,0){A}
  \pnode(1.7,1){B}
  \psline[style=Beam](A)(B)
  \optbox[endbox](A)(B){box}
\end{pspicture}
```




```
\begin{pspicture}(3,2)\psgrid
  \pnode(0,0){A}
  \pnode(1.7,1){B}
  \psline[style=Beam](A)(B)
  \optbox[endbox,labelref=relative,labeloffset=0](A)(B){box}
\end{pspicture}
```

3.7 Detector

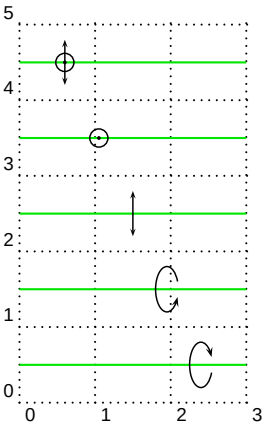
detsize: <value> (*default:* 0.5)




```
\begin{pspicture}(3,2)\psgrid
  \pnode(0,0){A}
  \pnode(1.7,1){B}
  \psline[style=Beam](A)(B)
  \optdetector(A)(B){detector}
\end{pspicture}
```

3.8 Polarization

poltype: parallel|perp|misc|lcirc|rcirc (*default:* parallel)
polsize: <value> (*default:* 0.6)
pollinewidth: <value> (*default:* 0.7\pslinewidth)



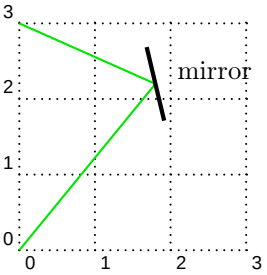

```
\begin{pspicture}(3,5)\psgrid
  \pnode(0,0.5){A1}\pnode(3,0.5){B1}\pnode(0,1.5){A2}
  \pnode(3,1.5){B2}\pnode(0,2.5){A3}\pnode(3,2.5){B3}
  \pnode(0,3.5){A4}\pnode(3,3.5){B4}\pnode(0,4.5){A5}
  \pnode(3,4.5){B5}\psset{style=Beam}
  \multido{\i=1+1}{5}{\psline(A\i)(B\i)}
  \psset{linecolor=black}
  \polarization[poltype=misc,position=0.2](A5)(B5)
  \polarization[poltype=perp,position=0.35](A4)(B4)
  \polarization[poltype=parallel,position=0.5](A3)(B3)
  \polarization[poltype=rcirc,position=0.65](A2)(B2)
  \polarization[poltype=lcirc,position=0.8](A1)(B1)
\end{pspicture}
```

3.9 Mirror

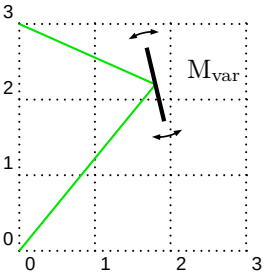
mirrorwidth: <value> (*default:* 1)
mirrorradius: <value> (*default:* 0)
mirrorlinewidth: <value> (*default:* 2\pslinewidth)
mirrortype: normal|piezo|extended (*default:* normal)
mirrordepth: <value> (*default:* 0.08)

variable: `<value>` (*default:* `false`)

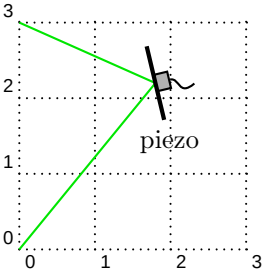
The parameter `mirrorradius` defines the curvature of the mirror. A value of `0` is for a plain mirror, a negative radius is for a concave mirror and a positive radius gives you a convex mirror. The style of the extended mirror is defined as a psstyle `ExtendedMirror` and can be changed using `\newpsstyle`. The appearence of the piezo mirror likewise can be changed by adapting the psstyle `PiezoMirror`.



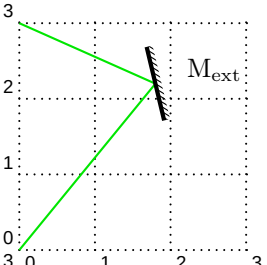

```
\begin{pspicture}(3,3)\psgrid
  \pnode(0,0){A}
  \pnode(1.8,2.2){G}
  \pnode(0,3){B}
  \psline[style=Beam](A)(G)(B)
  \mirror(A)(G)(B){mirror}
\end{pspicture}
```



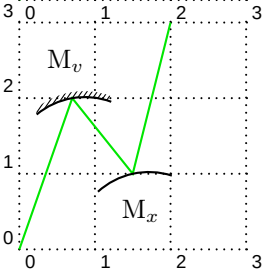

```
\begin{pspicture}(3,3)\psgrid
  \pnode(0,0){A}
  \pnode(1.8,2.2){G}
  \pnode(0,3){B}
  \psline[style=Beam](A)(G)(B)
  \mirror[variable](A)(G)(B){M$_\mathrm{var}$}
\end{pspicture}
```




```
\begin{pspicture}(3,3)\psgrid
  \pnode(0,0){A}
  \pnode(1.8,2.2){G}
  \pnode(0,3){B}
  \psline[style=Beam](A)(G)(B)
  \mirror[mirrortype=piezo,labelangle=-90](A)(G)(B){piezo}
\end{pspicture}
```



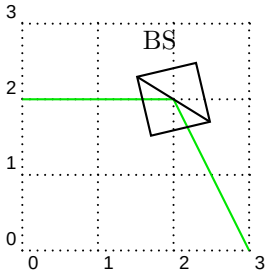

```
\begin{pspicture}(3,3)\psgrid
  \pnode(0,0){A}
  \pnode(1.8,2.2){G}
  \pnode(0,3){B}
  \psline[style=Beam](A)(G)(B)
  \mirror[mirrortype=extended](A)(G)(B){M$_\mathrm{ext}$}
\end{pspicture}
```




```
\begin{pspicture}(3,3)\psgrid
  \pnode(0,0){A}\pnode(0.7,2){G1}
  \pnode(1.5,1){G2}\pnode(2,3){B}
  \psset{labeloffset=0.5}
  \psline[style=Beam](A)(G1)(G2)(B)
  \mirror[mirrortype=extended, mirrorradius=1](A)(G1)(G2){M$_v$}
  \mirror[mirrorradius=-1](G1)(G2)(B){M$_x$}
\end{pspicture}
```

3.10 Beamsplitter

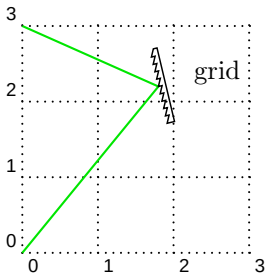
bssize: <value> (*default:* 0.8)



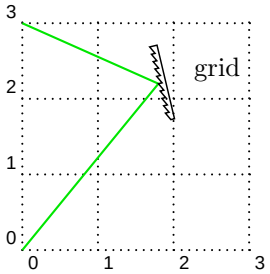

```
\begin{pspicture}(3,3)\psgrid
  \pnode(0,2){A}
  \pnode(2,2){G}
  \pnode(3,0){B}
  \psline[style=Beam](A)(G)(B)
  \beamsplitter(A)(G)(B){BS}
\end{pspicture}
```

3.11 Optical Grid

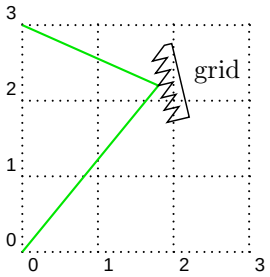
optgridcount: <integer> (*default:* 10)
optgridwidth: <value> (*default:* 1)
optgridheight: <value> (*default:* 0.1)
optgriddepth: <value> (*default:* 0.05)
optgridtype: blazed|binary (*default:* blazed)
optgridlinewidth: <value> (*default:* 0.7\pslinewidth)
reverse: <boolean> (*default:* false)



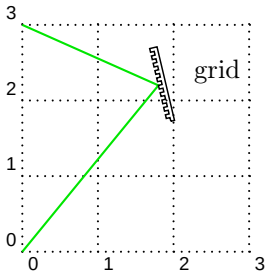

```
\begin{pspicture}(3,3)\psgrid
  \pnode(0,3){A}
  \pnode(1.8,2.2){G}
  \pnode(0,0){B}
  \psline[style=Beam](A)(G)(B)
  \optgrid(A)(G)(B){grid}
\end{pspicture}
```




```
\begin{pspicture}(3,3)\psgrid
  \pnode(0,3){A}
  \pnode(1.8,2.2){G}
  \pnode(0,0){B}
  \psline[style=Beam](A)(G)(B)
  \optgrid[reverse](A)(G)(B){grid}
\end{pspicture}
```



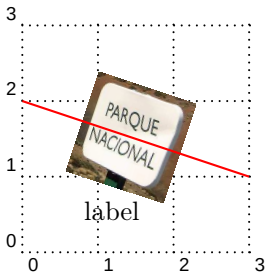

```
\begin{pspicture}(3,3)\psgrid
  \pnode(0,3){A}
  \pnode(1.8,2.2){G}
  \pnode(0,0){B}
  \psline[style=Beam](A)(G)(B)
  \optgrid[optgridcount=6,%
           optgriddepth=0.2,%
           optgridheight=0.3](A)(G)(B){grid}
\end{pspicture}
```



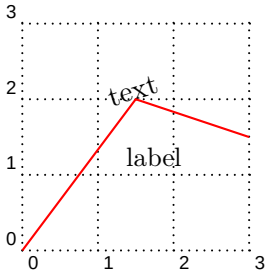

```
\begin{pspicture}(3,3)\psgrid
  \pnode(0,3){A}
  \pnode(1.8,2.2){G}
  \pnode(0,0){B}
  \psline[style=Beam](A)(G)(B)
  \optgrid[optgridtype=binary](A)(G)(B){grid}
\end{pspicture}
```

3.12 Custom Components

The macros \optdipole and \opttripole allow using everything as optical component. If you want to use a certain component several times, you should define it as a new component. For details see sec. 6.2.




```
\begin{pspicture}(3,3)\psgrid
  \pnode(0,2){A}
  \pnode(3,1){B}
  \optdipole[labeloffset=1](A)(B){%
    \rput(0,0){%
      \includegraphics[scale=0.25]{parque-nacional}
    }
  }{label}
  \psline[linecolor=red](A)(B)
\end{pspicture}
```

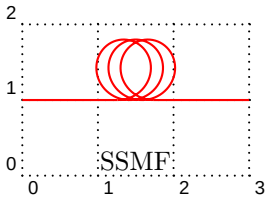



```
\begin{pspicture}(3,3)\psgrid
  \pnode(0,0){A}
  \pnode(1.5,2){G}
  \pnode(3,1.5){B}
  \opttripole(B)(G)(A){\rput[b](0,0){text}}{label}
  \psline[linecolor=red](A)(G)(B)
\end{pspicture}
```

4 Fiber-Optical Components

4.1 Fiber

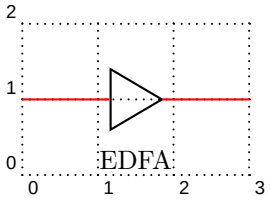
fiberloops: `<integer>` (*default:* `3`)
fiberloopradius: `<value>` (*default:* `0.3`)
fiberloopsep: `<value>` (*default:* `0.3`)




```
\begin{pspicture}(3,2)\psgrid
  \optfiber(0,1)(3,1){SSMF}
\end{pspicture}
```

4.2 Amplifier

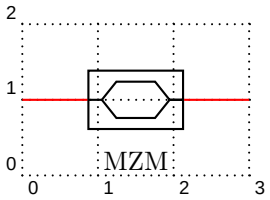
optampsize: `<value>` (*default:* `0.8`)




```
\begin{pspicture}(3,2)\psgrid
  \optamp(0,1)(3,1){EDFA}
\end{pspicture}
```

4.3 Mach-Zehnder Modulator

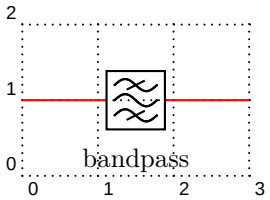
optmzmsize: `<value>` (*default:* `0.8`)



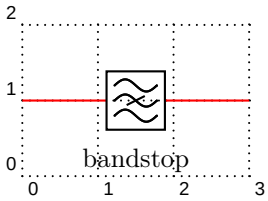

```
\begin{pspicture}(3,2)\psgrid
  \optmzm(0,1)(3,1){MZM}
\end{pspicture}
```

4.4 Filter

filtertype: `bandpass|bandstop` (*default:* `bandpass`)



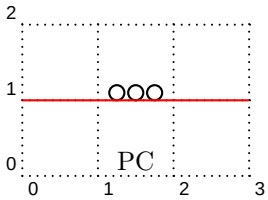

```
\begin{pspicture}(3,2)\psgrid
  \optfilter(0,1)(3,1){bandpass}
\end{pspicture}
```




```
\begin{pspicture}(3,2)\psgrid
  \optfilter[filtertype=bandstop](0,1)(3,1){bandstop}
\end{pspicture}
```

4.5 Polarization Controller

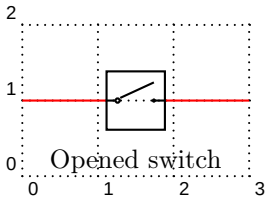
polcontrolsize: `<value>` (*default:* `0.1`)



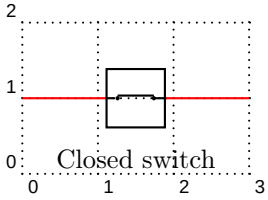

```
\begin{pspicture}(3,2)\psgrid
  \polcontrol(0,1)(3,1){PC}
\end{pspicture}
```

4.6 Optical Switch

switchsize: `<value>` (*default:* `0.8`)
switchstyle: `opened|closed` (*default:* `opened`)




```
\begin{pspicture}(3,2)\psgrid
  \optswitch(0,1)(3,1){Opened switch}
\end{pspicture}
```

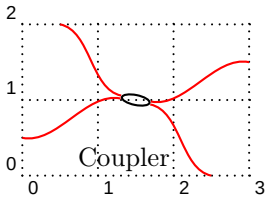



```
\begin{pspicture}(3,2)\psgrid
  \optswitch[switchstyle=closed](0,1)(3,1){Closed switch}
\end{pspicture}
```

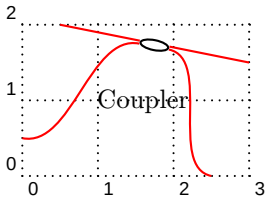
4.7 Coupler

couplersize: `<value>` (*default:* `0.1`)
couplersep: `<value>` (*default:* `0.1`)
couplertype: `none|elliptic` (*default:* `elliptic`)

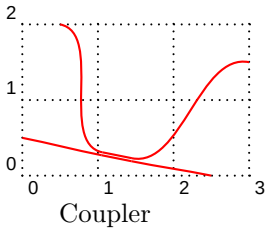
4.7.1 2×2 Coupler




```
\begin{pspicture}(3,2)\psgrid
  \optcoupler(0.5,2)(0,0.5)(3,1.5)(2.5,0){Coupler}
\end{pspicture}
```

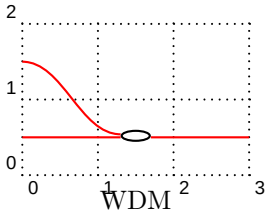



```
\begin{pspicture}(3,2)\psgrid
  \optcoupler[align=top](0.5,2)(0,0.5)(3,1.5)(2.5,0){Coupler}
\end{pspicture}
```



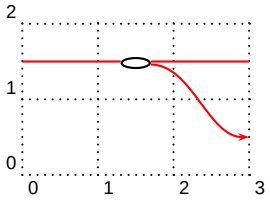

```
\begin{pspicture}(3,2)\psgrid
  \optcoupler[align=bottom,
    couplertype=none](0.5,2)(0,0.5)(3,1.5)(2.5,0){Coupler}
\end{pspicture}
```

4.7.2 WDM Coupler




```
\begin{pspicture}(3,2)\psgrid
  \wdmcoupler[align=bottom](0,1.5)(0,0.5)(3,0.5){WDM}
\end{pspicture}
```

4.7.3 WDM Splitter



```
\begin{pspicture}(3,2)\psgrid
  \newpsstyle{FiberOut2}{style=Fiber, arrows=->}
  \wdmsplitter[align=top](0,1.5)(3,1.5)(3,0.5){}
\end{pspicture}
```

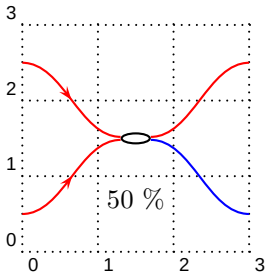
4.8 Fiber Styles

usefiberstyle: <boolean> (*default:* true)
Fiber: <psstyle> (*default:* linecolor=red)
FiberIn: <psstyle> (*default:* style=Fiber)
FiberIn1: <psstyle> (*default:* style=FiberIn)
FiberIn2: <psstyle> (*default:* style=FiberIn)
FiberOut: <psstyle> (*default:* style=Fiber)
FiberOut1: <psstyle> (*default:* style=FiberOut)
FiberOut2: <psstyle> (*default:* style=FiberOut)

All these psstyles control the appearence of the fiber parts before and after each components. The styles can be redefined with \newpsstyle or changed with \addtopsstyle. For optical systems it is not possible to define a unique input and a unique output as most components can be used bidirectionally. Therefore, I refer to the input as the part from the first node to the component and to the output as the part from the component to the second node.

The basic style is Fiber which is the parent of all other styles. FiberIn inherits from Fiber and defines the style of the input fiber. Analogously FiberOut controls the style of the output fiber. If you want to change the input and output fiber styles you should use \addtopsstyle as then the inheritance from the parent style Fiber remains.

The other styles are used by the fiber couplers (\optcoupler, \wdmcoupler and \wdmsplitter). FiberIn1 affects the upper input fiber, FiberIn2 the lower input fiber, FiberOut1 the upper output fiber and FiberOut2 the lower output fiber. If the object has only one input (e.g. \wdmsplitter), FiberIn is used.




```
\begin{pspicture}(3,3)\psgrid
   \addtopsstyle{FiberIn}{ArrowInside=->, arrowscale=1.2}
   \addtopsstyle{FiberOut2}{linecolor=blue}
   \optcoupler(0,2.5)(0,0.5)(3,2.5)(3,0.5){50~\%}
\end{pspicture}
```

In addition to the psstyles there exist corresponding new... and addto... parameter keys for each of them.

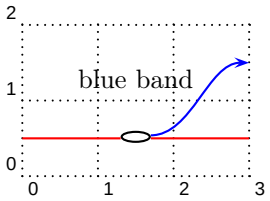
```
\psset{addtoFiberIn={arrows=->, arrowscale=1.3}}
```

is equivalent to

```
\addtopsstyle{FiberIn}{arrows=->, arrowscale=1.3}
```

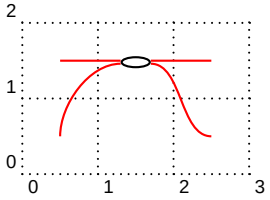
Accordingly newFiberIn corresponds to \newpsstyle{FiberIn}{...}.

At first glance these keys make no sense. The reason why I introduced them was to be able to define special couplers with \newpsobject. This is only possible if all modifications can be expressed as parameter keys. Consider for example a WDM splitter which only couples out a certain spectral range of the input and you want to mark the output with an arrow:




```
\begin{pspicture}(3,2)\psgrid
   \newpsobject{mywdmsplitter}{wdmsplitter}{addtoFiberOut1={arrows=->,
     arrowscale=1.3, linecolor=blue}, labelangle=180, align=bottom}
   \mywdmsplitter(0,0.5)(3,1.5)(3,0.5){blue band}
\end{pspicture}
```

Or if you need a coupler with a particular input angle you can do it be extending the appropriate fiber style:

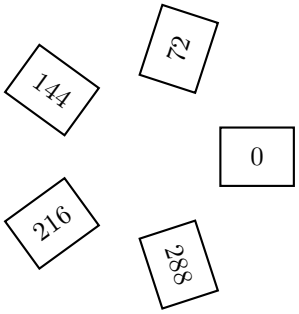



```
\begin{pspicture}(3,2)\psgrid
   \newpsobject{mycoupler}{optcoupler}{addtoFiberIn2={angleA=90},
     align=top}
   \mycoupler(0.5,1.5)(0.5,0.5)(2.5,1.5)(2.5,0.5){}
\end{pspicture}
```

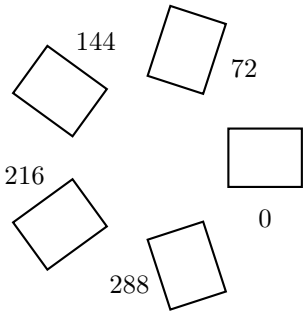
5 Labels

labeloffset: `<value>` (*default:* `1`)
labelangle: `<value>` (*default:* `0`)
labelstyle: `<macro>` (*default:* `\small`)
labelalign: `<\rput ref string>` (*default:* `c`)
labelref: `relative|relgrav|global` (*default:* `relgrav`)

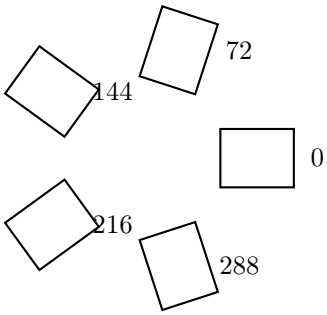
`labeloffset` specifies the offset from the center of the component, `labelstyle` defines the textstyle that is used to typeset the label and `labelalign` corresponds to the refpoint of `\rput`. The parameter `labelref` sets the reference coordinate system for the `labelangle` and the orientation of the label text. The detailed behaviour is best illustrated looking at the following three examples.




```
\begin{pspicture}(-2,-2)(2.5,2)
   \multido{\i=0+72}{5}{%
      \optbox[endbox,
              labelref=relative,
              labeloffset=0,
              optboxwidth=1](0,0)(1;\i){\i}
   }
\end{pspicture}
```




```
\begin{pspicture}(-2,-2)(2.5,2)
   \multido{\i=0+72}{5}{%
      \optbox[endbox,
              labelref=relgrav,
              optboxwidth=1](0,0)(1;\i){\i}
   }
\end{pspicture}
```

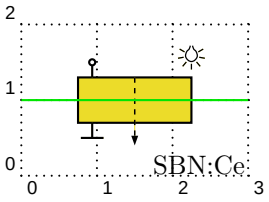



```
\begin{pspicture}(-2,-2)(2.5,2)
   \multido{\i=0+72}{5}{%
      \optbox[endbox,
              labelref=global,
              optboxwidth=1](0,0)(1;\i){\i}
   }
\end{pspicture}
```

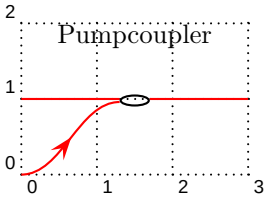
6 Defining New Components

6.1 Customized Versions of Existing Macros

The easiest way to define your own components is to use the `\newpsobject` macro. With this you can define a new component using predefined objects with a set of options. These options serve only as default values and can be overridden. The following examples defines a new object `\sbn` for the special crystal used in Sec. 3.5.

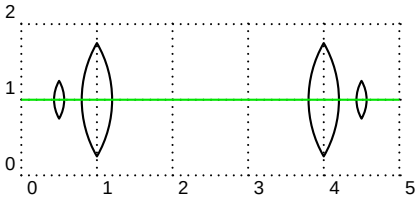



```
\newpsobject{sbn}{crystal}{crystalwidth=1.5, crystalheight=0.6,
  voltage, lamp, labelangle=45, labeloffset=1.2, fillstyle=solid,
  fillcolor=yellow!90!black}
\begin{pspicture}(3,2)\psgrid
   \sbn(0,1)(3,1){SBN:Ce}
   \psline[style=Beam](0,1)(3,1)
\end{pspicture}
```




```
\newpsobject{pumpcoupler}{wdmcoupler}{align=top, labelangle=180,
  addtoFiberIn2={ArrowInside=->, arrowscale=2}}
\begin{pspicture}(3,2)\psgrid
   \pumpcoupler(0,1)(0,0)(3,1){Pumpcoupler}
\end{pspicture}
```

If you need more than one type of lenses in your setup it is very cumbersome to specify all parameters every time.



```
\newpsobject{MOLensIn}{lens}{lens=0.5 0.5 0.5}
\newpsobject{MOLensOut}{lens}{lens=1.5 1.5 1.5}
\begin{pspicture}(5,2)\psgrid
   \pnode(0,1){A}\pnode(5,1){B}
   \MOLensIn[abspos=0.5](A)(B){}
   \MOLensOut[abspos=1](A)(B){}
   \MOLensOut[abspos=4](A)(B){}
   \MOLensIn[abspos=4.5](A)(B){}
   \psline[style=Beam](A)(B)
\end{pspicture}
```

6.2 Defining New Objects

Since version 1.2 `pst-optexp` provides some high-level macros to allow very convenient definition of completely new components. The macro `\newOptexpDipole` generates all organizing code for a new free-ray component. All you have to do is to define a new "'drawing"' macro `\mycomponent@iii` which contains all drawing code. Analogously `\newOptexpDipoleNolabel` defines a new free-ray object which takes no label (like `\polarization`) and `\newOptexpTripole` defines a new reflective component.

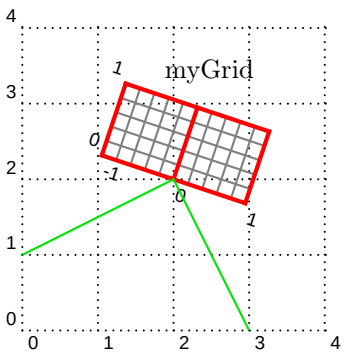
New fiber-optical components can be defined using `\newOptexpFiberDipole`. This macro differs from its free-ray analogous only in that it presets `fiber` and hence directly connects the component with the nodes. The first node in the parameter list gets connected with a node `tempNode@A@`, the second node with a node `tempNode@B@`. These two internal nodes are preset to `(0,0)` and can be overwritten within the drawing macro.

The syntax of the macros is

```
\newOptexpDipole[fixed options]{name}{default options}
\newOptexpDipoleNolabel[fixed options]{name}{default options}
\newOptexpTripole[fixed options]{name}{default options}
\newOptexpFiberDipole[fixed options]{name}{default options}
```

The `default options` are simply a list of PSTricks parameters which are taken as defaults for the new component. The optional argument allows setting of parameters which cannot be overridden later.

This is illustrate a bit more in the next code snippet, which also shows how the coordinate system is handled withing the `\mycomponent@iii` macro.

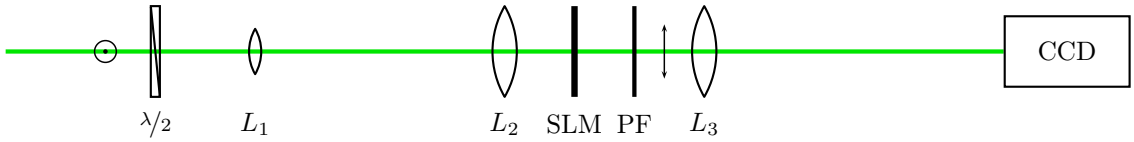



```
\newOptexpTripole{mygrid}{subgriddiv=5, griddots=0,
  subgridwidth=\pslinewidth, gridwidth=2\pslinewidth}
\makeatletter
\def\mygrid@iii{% put here all PSTricks drawing code
  \psgrid(-1,0)(1,1)
}%
\makeatother
\begin{pspicture}(4,4)\psgrid
   \pnode(0,1){A}\pnode(2,2){G}\pnode(3,0){B}
   \mygrid[gridcolor=red,labeloffset=1.5](A)(G)(B){myGrid}
   \psline[style=Beam](A)(G)(B)
\end{pspicture}
```

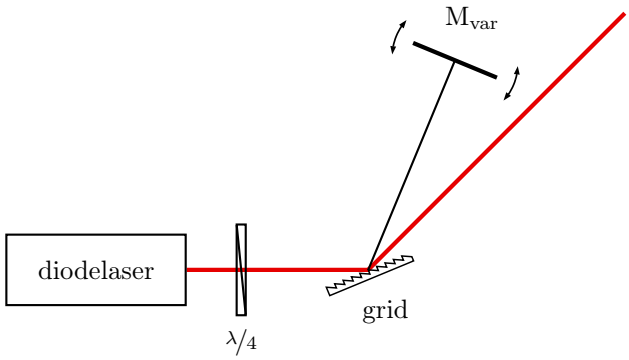
The default position of the label reference point is (0,0). If you want to change this, you have to define a new pnode named `tempNode@Label` in the `\mycomponent@iii` macro.

If you create a new component, please send it to me then I can incorporate this in a new released version.

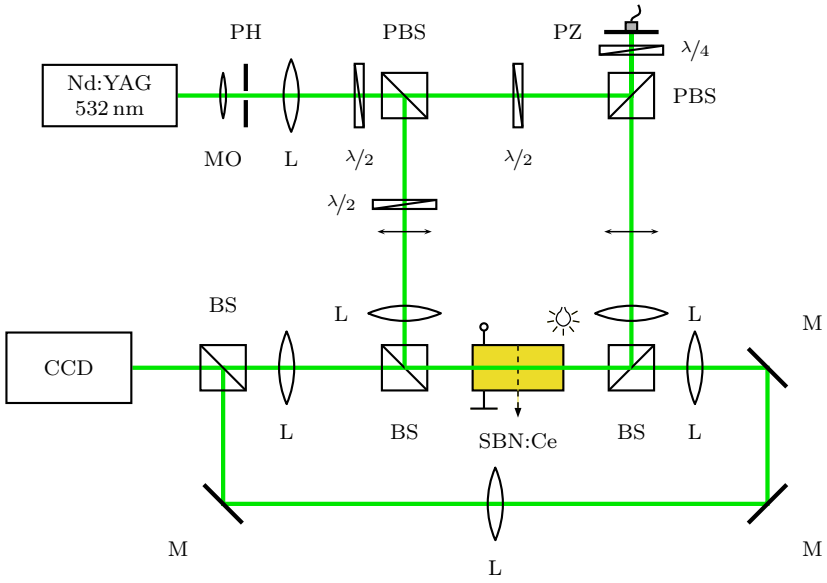
7 Examples




```
\begin{pspicture}(0,0.2)(12,1.8)
\pnode(0,1.2){Start}\pnode(11,1.2){CCD}
\psline[linewidth=2\pslinewidth,style=Beam](Start)(CCD)
\polarization[poltype=perp,position=0.1](Start)(CCD)
\optretplate[position=0.15](Start)(CCD){$\nicefrac{\lambda}{2}$}
\lens[lensheight=0.5,
      lensradius=0.5,
      position=0.25](Start)(CCD){$L_1$}
\lens[position=0.5](Start)(CCD){$L_2$}
\optplate[position=0.57, platelinewidth=3\pslinewidth](Start)(CCD){SLM}
\optplate[position=0.63](Start)(CCD){PF}
\polarization[position=0.66](Start)(CCD)
\lens[position=0.7](Start)(CCD){$L_3$}
\optbox[endbox,labeloffset=0](Start)(CCD){CCD}
\end{pspicture}
```

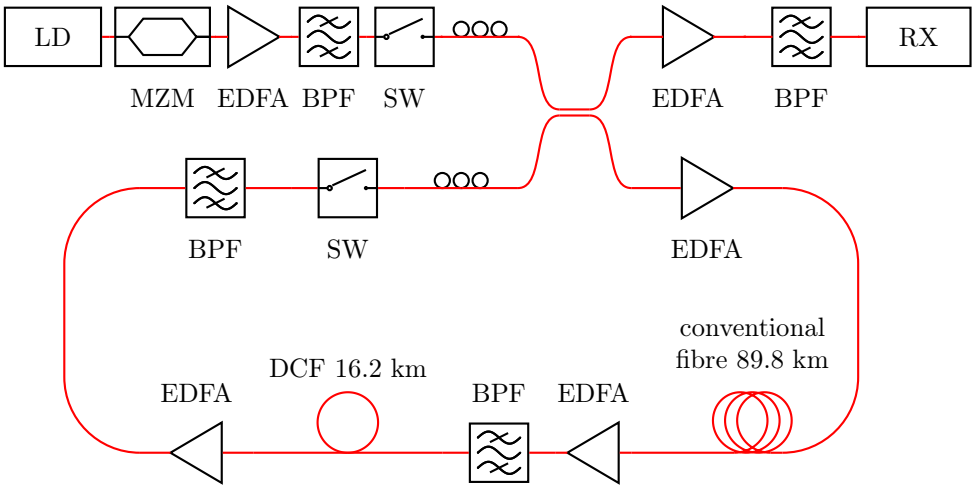



```
\begin{pspicture}(-4,-1)(3,3)
  \psset{labeloffset=0.5}
  \pnode(-2,0){LaserOut}
  \pnode(0,0){Grid}
  \pnode(4;45){Out}
  \pnode(2.5;67.5){Mvar}
  \psline[linewidth=2\pslinewidth,
        linecolor=red!90!black](LaserOut)(Grid)(Out)\psline(Grid)(Mvar)
  \optbox[endbox, optboxwidth=2, labeloffset=0](Grid)(LaserOut){diodelaser}
  \optretplate[position=0.3, labeloffset=0.8](LaserOut)(Grid){$\nicefrac{\lambda}{4}$}
  \optgrid(LaserOut)(Grid)(Out){grid}
  \mirror[variable](Grid)(Mvar)(Grid){M$_\mathrm{var}$}
\end{pspicture}
```




```
\begin{pspicture}(0,-0.4)(9,6)
  \pnode(1.5,5){Laser}\pnode(4,5){PBS}\pnode(6.5,5){PBS2}
  \pnode(6.5,5.7){piezo}\pnode(4,2){BSFwd}\pnode(6.5,2){BSBwd}
  \pnode(2,2){BS4f}\pnode(2,0.5){M4f3}\pnode(8,2){M4f1}
  \pnode(8,0.5){M4f2}\pnode(1,2){CCD}
  \psline[style=Beam,linewidth=2\pslinewidth]%
        (Laser)(PBS2)(piezo)(BSBwd)(M4f1)(M4f2)(M4f3)(BS4f)(CCD)
  \psline[style=Beam,linewidth=2\pslinewidth](PBS)(BSFwd)(BS4f)
  \psset{mirrorwidth=0.6, plateheight=0.7, outerheight=0.7, labeloffset=0.7,
    labelstyle=\scriptsize, lensheight=0.8, lenswidth=0.2, bssize=0.5}
  \optbox[endbox,optboxwidth=1.5, optboxheight=0.7,labeloffset=0]%
     (PBS)(Laser){\parbox{1.5cm}{\centering Nd:YAG\\ 532\,nm}}
  \lens[lensheight=0.5, position=0.2](Laser)(PBS){MO}
  \pinhole[position=0.3,labelangle=180](Laser)(PBS){PH}
  \lens[position=0.5](Laser)(PBS){L}
  \optretplate[position=0.8](Laser)(PBS){$\nicefrac{\lambda}{2}$}
  \beamsplitter(Laser)(PBS)(BSFwd){PBS}
  \optretplate[position=0.4](PBS)(BSFwd){$\nicefrac{\lambda}{2}$}
  \polarization(PBS)(BSFwd)\polarization(PBS2)(BSBwd)
  \lens[position=0.8](PBS)(BSFwd){L}
  \optretplate(PBS)(PBS2){$\nicefrac{\lambda}{2}$}
  \beamsplitter(PBS)(PBS2)(piezo){PBS}
  \optretplate[abspos=0.5](PBS2)(piezo){$\nicefrac{\lambda}{4}$}
  \mirror[mirrortype=piezo,labelangle=90](PBS2)(piezo)(PBS2){PZ}
  \lens[position=0.8,labelangle=180](PBS2)(BSBwd){L}
  \beamsplitter(PBS)(BSFwd)(BSBwd){BS}
  \beamsplitter[labelangle=-90](PBS2)(BSBwd)(BSFwd){BS}
  \crystal[crystalwidth=1, crystalheight=0.5, voltage, lamp, fillstyle=solid,
    fillcolor=yellow!90!black, labeloffset=0.8](BSFwd)(BSBwd){SBN:Ce}
  \mirror(BSBwd)(M4f1)(M4f2){M}\mirror(M4f1)(M4f2)(M4f3){M}
  \lens[labelangle=180](M4f2)(M4f3){L}\mirror(M4f2)(M4f3)(BS4f){M}
  \beamsplitter(M4f3)(BS4f)(CCD){BS}\optbox[endbox,labeloffset=0](BS4f)(CCD){CCD}
  \lens[abspos=0.7](BS4f)(BSFwd){L}\lens[abspos=0.7](BSBwd)(M4f1){L}
  \psline[style=Beam, linewidth=2\pslinewidth](BSFwd)(BSBwd)
\end{pspicture}
```

The following schematic configuration of a recirculating loop was adapted from the publication N. Kikuchi, S. Sasaki and K. Sekine, "'10 Gbit/s dispersion-compensated transmission over 2245 km conventional fibres in a recirculating loop"', Electron. Lett. 31 (**5**), 375 (1995).




```
\psset{unit=1cm}
\begin{pspicture}(0.5,4)(13.2,10.5)
  \laser[labeloffset=0](2.1,10)(2,10){LD}
  \optmzm(2.1,10)(3.5,10){MZM}
  \optamp(3.5,10)(4.5,10){EDFA}
  \optfilter(4.5,10)(5.5,10){BPF}
  \optswitch(5.5,10)(6.5,10){SW}
  \polcontrol(6.5,10)(7.5,10){}
  \optcoupler[couplertype=none,couplersep=0.2](7.5,10)(7.5,8)(9,10)(9,8){}
  \optamp(9,10)(10.5,10){EDFA}
  \optfilter(10.5,10)(12,10){BPF}
  \optbox[endbox, labeloffset=0, conn=f-f](12,10)(12.1,10){RX}
  % loop
  \optamp(9,8)(11,8){EDFA}
  \psline[linearc=1,style=Fiber](11,8)(12,8)(12,4.5)(11,4.5)
  \optfiber[labelalign=b, labeloffset=-1,
    position=0.8](9,4.5)(11,4.5){\begin{tabular}{c}conventional\\fibre 89.8~km\end{tabular}}
  \optamp(9,4.5)(8,4.5){EDFA}
  \optfilter(8,4.5)(6.5,4.5){BPF}
  \optfiber[fiberloops=1, labeloffset=-1, labelalign=b](4,4.5)(6.5,4.5){DCF 16.2~km}
  \optamp(4,4.5)(2.5,4.5){EDFA}
  \psline[style=Fiber,linearc=1](2.5,4.5)(1.5,4.5)(1.5,8)(2.5,8)
  \optfilter(2.5,8)(4.5,8){BPF}
  \optswitch(4.5,8)(6,8){SW}
  \polcontrol(6,8)(7.5,8){}
\end{pspicture}
```

8 Complete List of Parameters

parameter	values	default
abspos	<value>	\@empty
angle	<value>	0
bssize	<value>	0.8
caxisinv	<boolean>	false
caxislength	<value>	0.6
couplersep	<value>	0.1
couplersize	<value>	0.1
couplertype	none|elliptic	elliptic
crystalheight	<value>	0.8
crystalwidth	<value>	2
detsize	<value>	0.5
endbox	<boolean>	false
extnode	<ref string>	\@empty
extnodename	<string>	Ext
Fiber	<psstyle>	linecolor=red
FiberIn	<psstyle>	style=Fiber
FiberIn1	<psstyle>	style=FiberIn
FiberIn2	<psstyle>	style=FiberIn
fiberloopradius	<value>	0.3
fiberloops	<integer>	3
fiberloopsep	<value>	0.3
FiberOut	<psstyle>	style=Fiber
FiberOut1	<psstyle>	style=FiberOut
FiberOut2	<psstyle>	style=FiberOut
filtertype	bandpass|bandstop	bandpass
innerheight	<value>	0.1
labelalign	<\rput ref string>	c
labelangle	<value>	0
labeloffset	<value>	1
labelref	relative|relgrav|global	relgrav
labelstyle	<macro>	\small
lamp	<boolean>	false
lampscale	<value>	0.3
lens	<value> [<value> [<value> [<value>]]]	\@empty
lensheight	<value>	1
lensradius	<value> [<value>]	\@empty
lensradiusleft	<value>	1
lensradiusright	<value>	1
lenswidth	<value>	0.3
mirrordepth	<value>	0.08

parameter	values	default
mirrorlinewidth	<value>	2\pslinewidth
mirrorradius	<value>	0
mirrortype	normal|piezo|extended	normal
mirrorwidth	<value>	1
optampsize	<value>	0.8
optboxheight	<value>	0.5
optboxwidth	<value>	1
optgridcount	<integer>	10
optgriddepth	<value>	0.05
optgridheight	<value>	0.1
optgridlinewidth	<value>	0.7\pslinewidth
optgridtype	blazed|binary	blazed
optgridwidth	<value>	1
optional	<boolean>	false
optmzmsize	<value>	0.8
outerheight	<value>	1
phlinewidth	<value>	2\pslinewidth
plateheight	<value>	1
plateheight	<value>	1
platelinewidth	<value>	2\pslinewidth
platewidth	<value>	0.1
polcontrolsize	<value>	0.1
pollinewidth	<value>	0.7\pslinewidth
polsize	<value>	0.6
poltype	parallel|perp|misc|lcirc|rcirc	parallel
position	<value>	\@empty
reverse	<boolean>	false
showoptdots	<boolean>	false
switchsize	<value>	0.8
switchstyle	opened|closed	opened
thicklens	<boolean>	false
usefiberstyle	<boolean>	true
variable	<value>	false
voltage	<boolean>	false

9 Todo

The next thing I will add are components with multiple internal reflections, as right-angle, penta and dove prisms. The code is almost ready, I just need to think a bit more about the best way to provide access to the nodes that are newly defined within the components.

Drawing of extended beams with focusing and so on could be integrated to some extent in future versions. But as the topic is rather difficult if you want to do it properly (components should be placed above the beam, but the new nodes are available only when the component is drawn) it could take very long until this feature will be implemented.

10 Acknowledgements

I thank all the people of the PSTricks mailinglist for the continuous help, especially Herbert Voß.

11 History

For the package history see file Changes that is distributed with the package.