Measurement of Stokes Parameters

File name: `Stokes_parameters.apc`

Reference: R. M. A. Azzam and N. M. Bashara, *Ellipsometry and Polarized Light*, North-Holland, 1977.

The four Stokes parameters describe the state of polarization of an electromagnetic wave. Said E_{TE} (E_{TM}) and φ_{TE} (φ_{TM}) the amplitude and the phase of the TE (TM) component of the wave, the Stokes parameters are defined as

$$S_0 = E_{TE}^2 + E_{TM}^2$$

$$S_1 = E_{TE}^2 - E_{TM}^2$$

$$S_2 = 2E_{TE}E_{TM}\cos(\varphi_{TM} - \varphi_{TE})$$

$$S_3 = 2E_{TE}E_{TM}\sin(\varphi_{TM} - \varphi_{TE})$$

with

$$S_0^2 = S_1^2 + S_2^2 + S_3^2.$$

The classical circuit for the experimental measurement of the Stokes parameter is a combination of beam splitters, waveplates and polarizers and has been implemented in Aspic with the Free Space Library as shown in Fig. 1. The incoming light is split in four beams and the intensity measured through polarizers with transmission axis set to 0°, 90°, 45° and 45° again but after a quarter wavelength rotating plate with axis set at 45°.

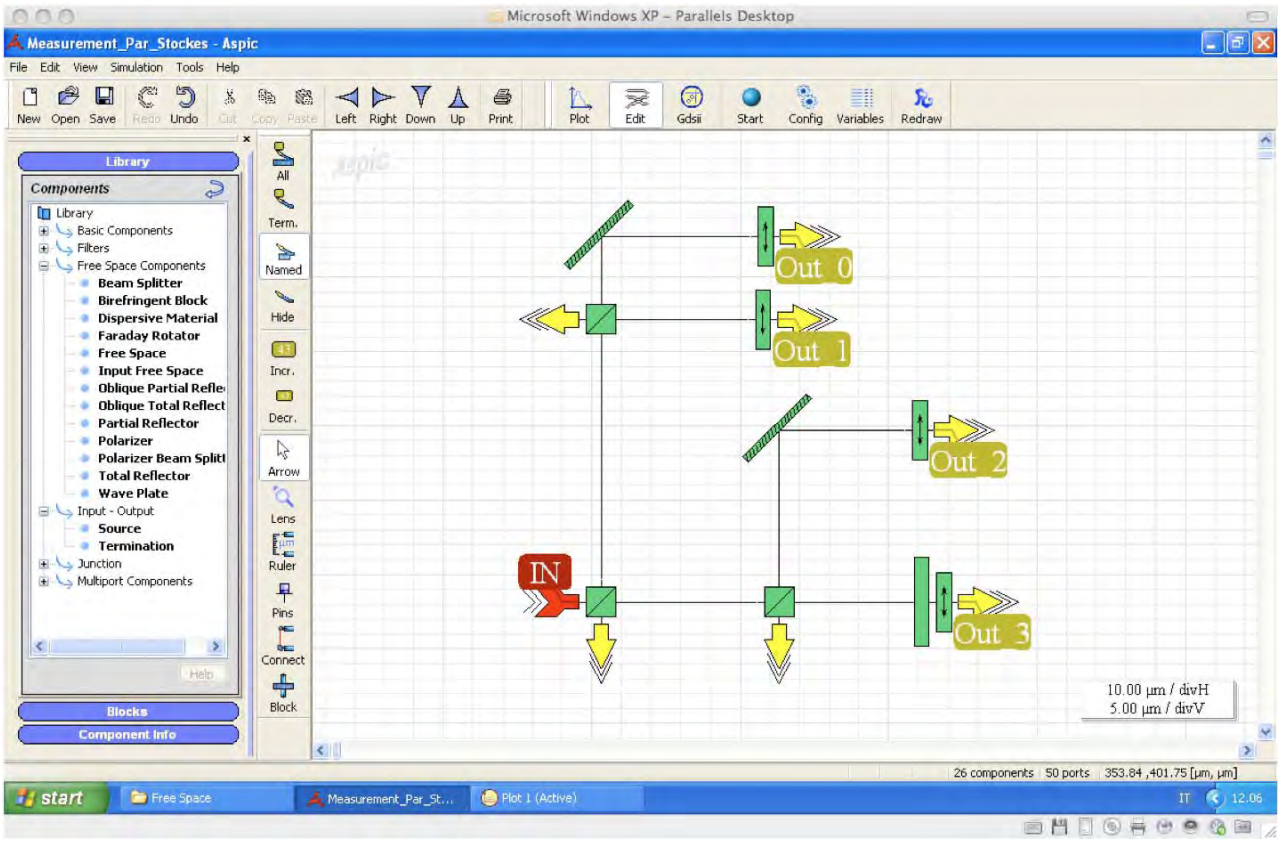

Fig. 1 – Circuit for the measurements of Stokes parameters.

The four outputs Out_1…4 can be combined to obtain the four Stokes parameters as follows:

$$S_0 = O_0 + O_1 \qquad S_2 = 2O_2 - O_0 - O_1$$
$$S_1 = O_0 - O_1 \qquad S_3 = 2O_3 - O_0 + O_1 .$$

Fig. 2 shows the four outputs when the input polarization is set to linear and its orientation is varied from horizontal (TE) to vertical (TM) and back to TE. The angle of the input linear polarization has been defined as variable SOP and varied from 0 to 180. Out_2 and Out_3 are identical.

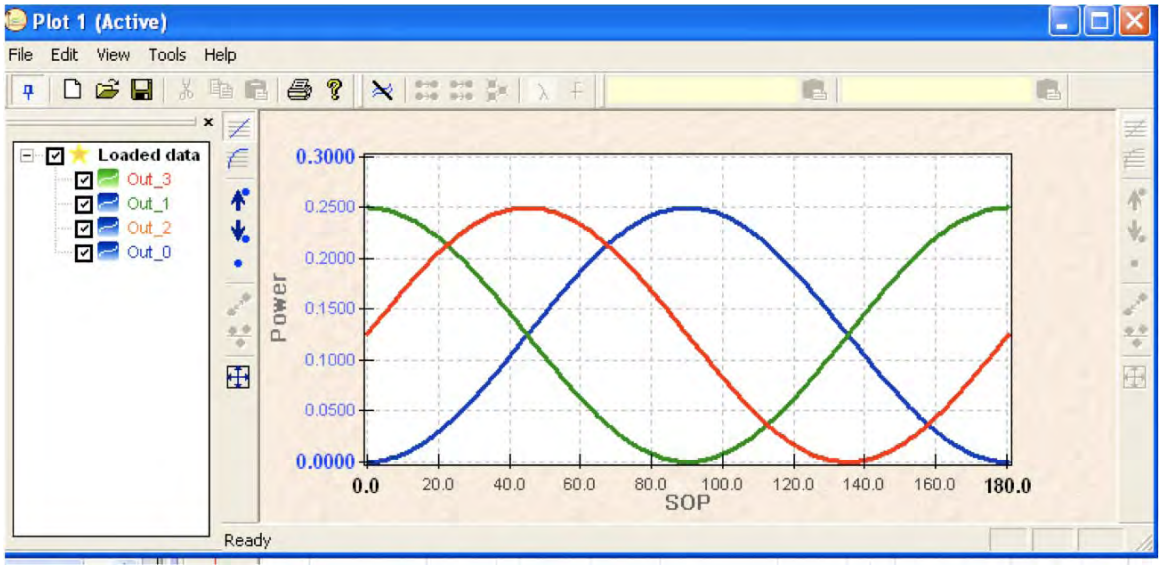

Fig. 2 – Intensities at the four output ports Out_1...4. Out_2 and Out_3 are identical.

The circuit is useful to investigate the polarization behaviour of other circuits such as the "TE-TM conversion" example. The free space Stoke detector can be saved as a Block and used also with integrated optics components, as shown in Fig. 3.

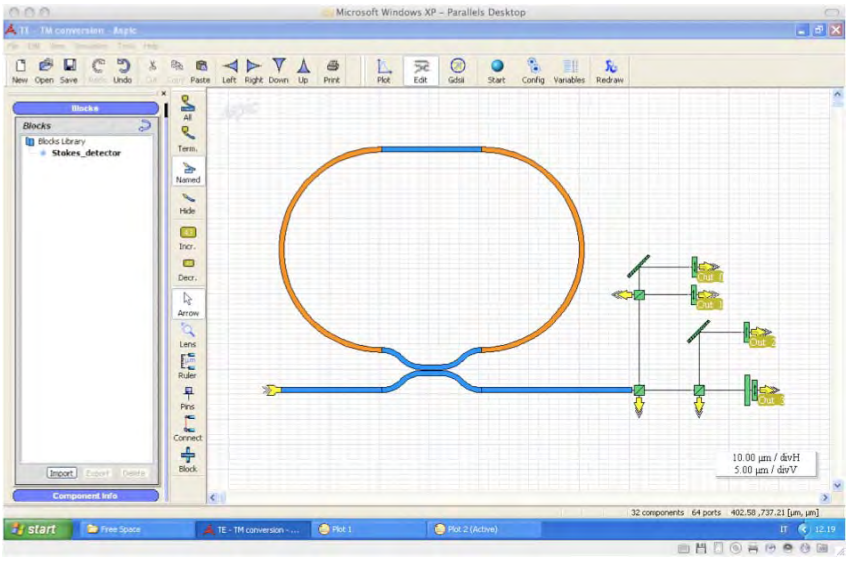

Fig. 3 – Free space components and integrated optic components can be used in the same circuit.