Tunable components and reconfigurable architectures for integrated systems that require increase levels of functionality can be relatively easily implemented at microwave and millimetre-wave frequencies. However, for THz applications this is not the case, due to the limited availability of solid-state switches and tight tolerances needed for implementing passive structures. A paradigm shift in the way to deal with the above problem is the use of the photoconductive effect. Recently, a new class of substrate integrated waveguide (SIW) technology – RETINA (Reconfigurable Terahertz Integrated Architecture) – has been reported [1]. With RETINA, the photo-induced plasma is extended from the top surface downwards towards the bottom surface of the semiconductor. Thus, by the photo-generation of free charged carriers, regions in the substrate become highly conducting; by changing the projected light pattern on the surface of the substrate, in real time, tunable components and reconfigurable architectures can be created.

At THz frequencies, traditional metal-pipe rectangular waveguides (MPRWGs) provide relatively low loss and high cross-talk isolation and, for these reasons, is an important guided-wave structure. This paper presents a novel design for an optically-controlled THz switch with high on-off ratio. The switch operates at 500 GHz and consists of a partially-filled MPRWG (i.e., standard WR-1.9) that is selectively illuminated by a continuous wave (CW) laser source. A rectangular high resistivity silicon (HRS) slab with tapered ends is centered in the cross-section of the waveguide and placed in parallel to the large wall of the waveguide. The angle and the corresponding length of the tapered ends have been chosen to provide good impedance matching between the dielectric-filled and air-filled MPRWG. The HRS slab is illuminated in three spots through circular “windows” on the top and bottom surface of the MPRWG. Here, the worst case scenario is investigated, where the penetration depth inside the HRS slab is less that the height of the slab, thus a region in the HRS is not illuminated. The increase in the carrier density due to a CW optical source has been calculated using Silvaco™ TCAD [1].

In order to model this structure with a full-wave simulator, the photo-induced plasma regions have been divided into several sub-regions. When there is no laser excitation, the proposed structure operates as a typical MPRWG and thus the THz propagating wave is not affected. In the case though that the waveguide is illuminated, highly conducting plasma regions are created which cut off the propagation resulting in a high on-off ratio switch. In the final paper the photoconductivity profile of the plasma regions inside the dielectric slab will be described in detail and the results characterizing the performance of the switch will be presented.