**DESCRIPTION FOR THE GENERAL PUBLIC**

The objective of proposed project is to carry out theoretical and experimental research concerning pump and signal power combiners used in all-fiber power amplifiers. Those combiners are designed in configuration (N+1)x1, which means that on the input they have one singlemode (SM) signal fiber and N number of multimode (MM) fibers for the pump radiation. At the output of the combiner passive double clad (DC) fiber is used, for example with diameters of core/inner cladding: 9/125 µm. In case of conventional power combiner in configuration (6+1)x1, input fiber bundle consist of 6 MM fibers (typical 105/125 µm) surrounding one SM fiber (9/125 µm). Such fiber bundle with total diameter of about 375 µm needs to be tapered down considerably in order to match to the 125 µm diameter of inner cladding of the output passive DC fiber. During this tapering process the core of input signal fiber will be also significantly tapered down, effecting with core diameter less than 3 µm in case of conventional telecomm 9/125 µm input fiber. Since the output DC fiber has a core diameter of 9 µm, splice between this fiber and fiber bundle with very small core diameter of signal fiber at the output causes high signal transmission losses. The proposed research will help to developed new power combiner construction, enabling to increase the singlemode signal coupling efficiency. The research will concern on configuration (5+1)x1, which means 5 MM fiber at the input, and not 6 as usual. Additionally as a signal input port will be used fiber with reduced cladding diameter (9/80 µm). At the output will be used singlemode passive DC fiber with core/clad diameter of 9/125 µm. Such configuration will allow to decrease the diameter of input fiber bundle before tapering, and thus decrease the tapering ratio. This specific configuration of combiner and using core diffusion technique will allow to significantly increase the efficiency of the combiner, and thereby the efficiency of fiber amplifier in which this combiner could be applied will be also increased. Moreover possible application of an inner mode field adapter (MFA) will be investigated. MFA is an equally important component as a power combiner in all-fiber construction technique and its task is to connect two fibers with different mode field diameter with minimal transmission losses. Creating an inner MFA for a signal radiation could allow for matching final mode field diameter of input signal port from the tapered fiber bundle and the mode field diameter of an output DC fiber. Thanks to this construction the coupling efficiency of a signal in the combiner will be considerably increased.

In the planned project both theoretical and experimental research will be carried out. In the most common configuration (6+1)x1 of the combiners, the conventional SM telecomm fiber 8.2/125 µm is used. Because its outer cladding diameter is the same as used MM fibers (105/125 µm), we have symmetrical placement of all fibers at the input of the combiner. In the planned in the project research will be used signal fiber with reduced cladding diameter (9/80 µm) in the (5+1)x1 configuration. Fiber bundle consisting of 5 MM fibers (105/125 µm) and one SM 9/80 µm fiber will guarantee their symmetrical placement in the capillary tube at the input and what is more: a 100% effectiveness of placing signal fiber in the center of the bundle. Using this signal fiber and reducing number of MM ports causes reducing of the taper ratio, and thus increasing transmission efficiency in case of configuration (5+1)x1 in comparison to (6+1)x1configuration. During theoretical part, the model the input signal port of combiner will be elaborate in order to define its optimal length and final diameter. There will be also investigated possibility of application of inner mode field adapter. The model of input port will consist then of an input singlemode fiber and one or more segments of LMA fibers. By tapering such structure mode field adapter will be created – mode fields of subsequent fibers will be gradually tapered down. Simulation will help to define optimal LMA fiber parameters like: numerical aperture, length, diameters, splice position with SM fiber regarding to the total length of taper. Based on the beam propagation method BeamPROP software will be used for the needs of theoretical research. Simulations will allow for comprehensive investigation of singlemode beam propagation in the developed structure and also to define detailed parameters input signal port with and without an inner MFA. Based on the result from theoretical research, experimental part of the project will be performed and carried out in order to fabricate practical power combiner, using the LDS System (Large Diameter System). It is advanced fiber splicer designed for working with fibers/fiber bundles with diameter from 80 µm to 2 mm. It will be essential to elaborate next stages of designed combiner fabrication process in order to preserve all parameters given in theoretical research, which will also be verified in experiments.

The Reason for choosing this topic is fact, that the results achieved in this research field will have great impact on the state of knowledge and achievements on a global scale not only in the research area of passive fiber components, but also on the research area of all-fiber amplifier setups. Currently available commercial combiners with output 9/125 µm DC fiber offer signal transmission efficiency on a 85-90% level. Carried out research will allow to increase signal coupling efficiency to more than 95%, and thus increase efficiency of fiber amplifiers setups, which depending on the spectral range are used in many fields: in telecommunication, industry, medicine, remote sensing technology, and gas sensing. Additionally many scientific teams are still developing this research area and carrying advanced studies, thus planned investigations perfectly suit the current trend in the field of passive fiber components.