Multigigabit wireless transfer of data for HEP experiments

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The data to be transferred by the several million of channels in the high-granularity LHC detectors is limited by the available bandwidth in the readout links. Furthermore, because of the power and of the mass budget, as well as of the space constraints, the amount of transferred data is limited. Such limitations heavily impacts LHC experiments. One example is the tracking sub-detectors not playing a role in the first level of trigger decision, thus limiting the physics reach of the experiments. In order to exploit the full potential of the detectors one must either increase the available bandwidth, by increasing the number of links and/or the transfer rate, and/or efficiently pre-process the data. The wireless technology, which is constantly in our daily lives (e.g: transferring of uncompressed data for HDTV), can deliver rates in the range of several gigabits per second, thanks to the constant progress being made [1]. Because of that and of the reasons described below, the wireless technology can tackle both the need for more links and for the efficiently pre-processing of the data.

Wireless links consist of antennas and transceivers. In an example design exploiting the 60 GHz band [2], the transceiver is designed in 90 nm CMOS and the size of the chip is of 2.75 mm $\times$ 2.5 mm. The size of a surface integrated waveguide (SIW)-based four-by-four slot array antenna is approximately 1 cm^2. The choice of the antenna is vital to reduce the power consumption and, depending on the antenna directionality, the cross talk. The power consumption of the transceiver are measured to be respectively 170 mW in transmit mode and 135 mW in receiver mode. The measured bit error rate over 1 m distance at 4 Gb/s is 10^{-11}. Performed tests show the the transmission of data with wireless through one or several silicon layers is not possible, thus making the cross talk problem reduced.

A track going through the tracker is sampled many time. Thanks to the wireless communication, the spatial information provided by the tracker modules can be correlated across the layers, thus allowing to derive information on the particle momentum. By making use of the momentum, the data volume can be significantly reduced.

Given the rapid progress in technology, the smaller size of its components and their less sensitivity to mechanical damages, the limited cross talk, and the possibility to introduce on-detector intelligence, the wireless technology offer an alternative high-rate data transfer to what already available in the HEP world. The drawback of the higher frequency is the short data transmission range. However, that should not be a limiting factor, given the short distances involved in the tracker environment. More application examples are reported in [3], [4].

These motivations have led to the formation of the WADAPT (Wireless Allowing Data and Power Transmission) consortium, in charge of identifying specific needs of projects that might

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benefit from wireless technologies, and possibly provide a common platform for research and development [5].

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