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A comprehensive feasibility study on the utilisation of the Ion Beam Induced Charge (IBIC) Nuclear Microprobe Technique at the RBI for the LGAD's Characterization including the Interpad-Gap Measurements

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Techniques for silicon detector characterization have predominantly relied on the laser methods such as TCT and quite recently TPA-TCT. We show that the Ion Beam Induced Charge (IBIC) technique has great potential in future LGAD characterizations. The LGAD sensors, 200 um thick and arranged in a 2x2 array configuration with a nominal interpad distance of 50 um were tested. The microprobe system at the Rudjer Boskovic Institute delivered different energies for the proton and carbon ion beams so that the 2D charge collection efficiency maps were obtained for shallow and deep probing. In the vicinity of the interpad region, the two different doses of irradiation were performed with the carbon ions so that a damage of 3.1x1011 ions/cm2 and 6.3x1011 ions/cm2 was introduced. As a consequence of the induced damage, the charge collection efficiency degradation was studied and some regions with extremely high electric fields were notified. The dependence of the interpad measurements on the penetration depths was demonstrated using proton beams with various energies. It was observed that the interpad distance increases with the penetration depth of ions. This result confirms the previously established hypotheses regarding the bending the el. field towards JTE. The results presented here are part of the joint research of the University of Montenegro (UoM), the Jozef Stefan Institute (JSI) and the Rudjer Boskovic Institute (RBI) where the experiment was carried out. This research may also have a significant impact on the future development of the IBIC technique hence it was shown that LGAD is a good tool for further exploitation of the IBIC. Thus, this research also is a good example of how both, the sensor device (LGAD) and the tool used for its characterisation (IBIC technique) can benefit from each other through further improvements of its own imperfections in a well-designed research approach. This will be the subject of the next research.

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