

Paper one pager:

## Modeling microwave propagation in natural caves using LiDAR and ray tracing

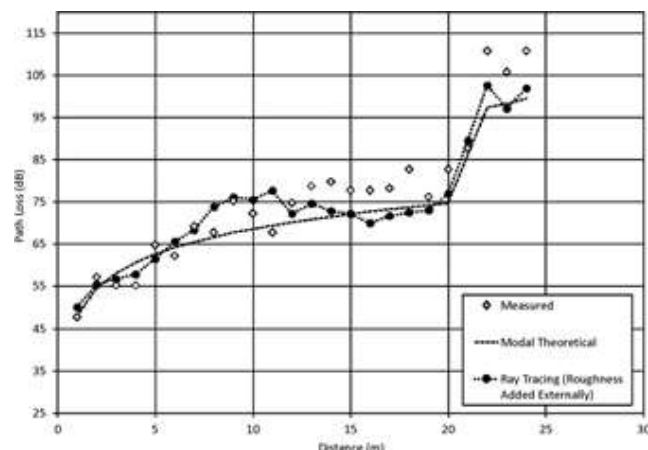
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LiDAR Survey Exercise in Skirwith Cave using ZEB1 and 3D Model of cave

Radio propagation in natural caves attract little attention. Lately, modal analyses have given acceptable results in some cave passages while multiple bends and highly irregular passages remained problematic. Recently introduced rapid capture laser scanners enables creating accurate 3D models of cave passages which permits, for the first time, ray tracing to be applied to a such geometrically complicated environments. The primary aim of this work was to further knowledge into cave communication and the applicability of ray tracing in this unique environment. In addition, it is also intended that the results will be of practical value to those with a requirement for communication in natural cave passages in general. In the paper an evaluation of a ray tracing approach was therefore undertaken in three selected cave passages. In particular, the issues of cave model simplification and handling of roughness, have been studied and results were compared to modal analyses results at three different frequencies. Acceptable correlation was demonstrated despite the difficulty in accurately measuring or estimating average roughness. In particular ray tracing results were more accurate in eight out of the nine combinations of location and frequency compared to modal approach.



Results in KMC Milky Way Inlet at 5.8 GHz with roughness added externally