# Spatially Resolved Rhizosphere Function for Elucidating Key Controls on Below-ground Nutrient Interactions

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We are testing the central hypothesis that spatially focused regions within the rhizosphere funnel a disproportionately high amount of nutrients to a plant root. Further, we hypothesize that the location of these resulting nutrient exchange hotspots are controlled by micro-environmental conditions resulting from host soil geochemistry in conjunction with local microbiological communities. We are using a three-pronged, spatially-resolved analysis of switchgrass microcosms constructed with natural soil (Kellogg Biological Station, Hickory Corners, Michigan). 1) We adapted laser ablation isotope ratio mass spectrometry (LA-IRMS) for analysis of rhizosphere samples and used the approach coupled with a $^{13}C$ tracer to track carbon flow through plant roots and into the rhizosphere. We observed variable carbon flow through different roots and the localization of recent photosynthate/exudate into the rhizosphere. 2) We developed a laser-induced breakdown spectroscopy (LIBS) technique to enable mapping of macro- and micro-nutrients in the soil surrounding the plant roots and demonstrate its ability to identify specific elemental foci that may support hotspots of microbial activity. We developed a quantitative image analysis package to identify the decrease (e.g., carbon) or increase (e.g., calcium, potassium, phosphorous, and iron) of nutrients within increasing distance from a plant root. 3) We are developing a spatially-resolved proteomics technique to evaluate microbial taxonomic diversity within different sections of the rhizosphere, targeting areas with high nutrient availability and root exudation. Overall, our developments allow us to spatially track photosynthate from leaves, through roots, and into the rhizosphere and surrounding soil, and subsequently characterize the elemental and microbial composition of specific locations that show enhanced carbon deposition.