Early detection of high-grade malignancy, such as glioblastoma multiforme (GBM) significantly increases not only the treatment options available, but also the patient survival rate. For this purpose, the local magnetic-field gradient variations due to inhomogeneity of deoxyhemoglobin concentration and vasculature in early GBM are sensitively detected in our work by the selective self-excitation process through active feedback magnetic resonance.

As GBM cells grow rapidly there are usually regions of anemia in the brain tumor. GBM cells also increase the vascular endothelial growth factor secretion and weaken the blood brain barrier junctions, and therefore cause excess accumulation of water. We take advantage of the slightly lower deoxyhemoglobin concentration at GBM and develop new techniques, termed “Active-Feedback MRI”, to sensitively detect the magnetic susceptibility effect from deoxyhemoglobin.

To enhance the contrast, the active-feedback field generated from a home-made electronic device is added to the system. The active feedback field vector is controlled by the averaged transverse magnetization of the system. Moreover, the active-feedback field can be modified based on local field variation.

Simulation results suggest that this new approach provides enhanced and robust contrast under different local environment conditions and makes early tumor detection possible.