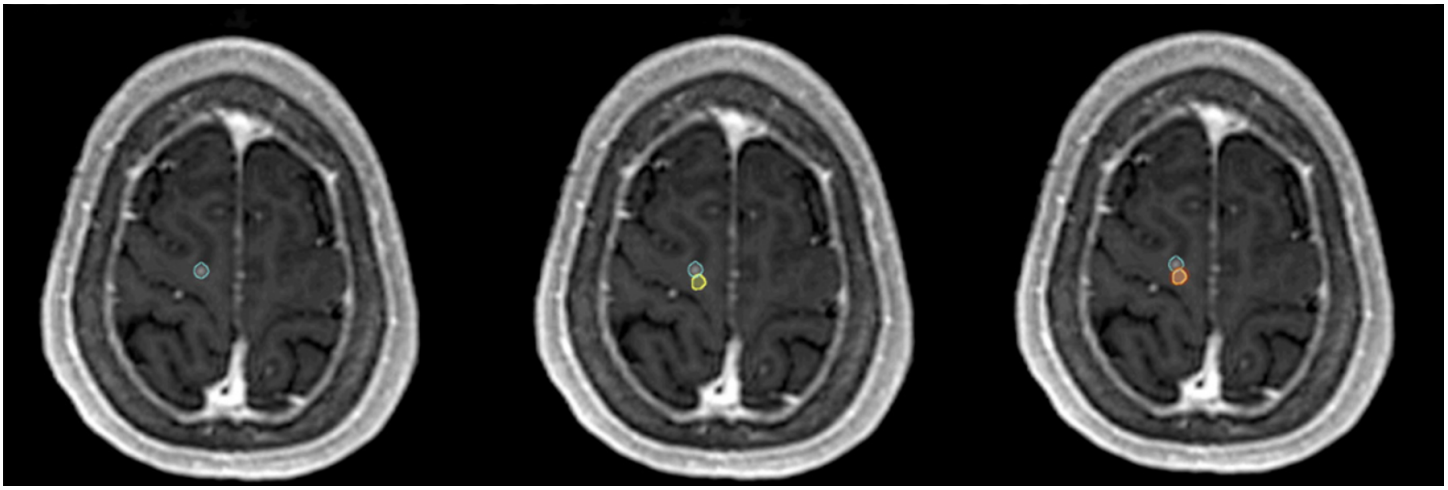
Reducing anatomic distortion in images to improve radiotherapy accuracy

MRI scanners use very strong (but safe for humans) magnetic fields to generate detailed images of the inside of the body. Subtle variations in those magnetic fields, though, can lead to clinically important distortion—stretching and squishing of parts of the image. If those images are used for targeted treatments (e.g., radiation therapy) or to guide procedures (biopsy or surgery), anatomic accuracy can be critical to success. We are developing and implementing methods to minimize and correct that distortion.



T1-weighted post-contrast MRI scan for a patient with a brain metastasis outlined in cyan after correcting distortion of the images. If distortion is not corrected, the whole brain is stretched and distorted subtly such that the tumor would appear to be in the position outlined in yellow. Targeting the incorrect (yellow) location would lead to underdosing of 75% of the true tumor (≥90% of prescription radiation dose is shown as shaded red in the right panel). Adapted from Seibert et al., *PRO* 2016. For diffusion MRI commonly used to detect cancer in much of the body, distortion can be much larger—nearly 2 cm in some cases (see Digma et al., *Sci. Rep.* 2022).

- Selected publications:
  - Digma et al., *Scientific Reports* 2022 https://pubmed.ncbi.nlm.nih.gov/34997164/
  - Seibert et al., *Practical Radiation Oncology* 2016 https://pubmed.ncbi.nlm.nih.gov/27523440/
- Ongoing projects:
  - ReIGNITE dosimetry. We are studying how the variations in radiation oncologists' tumor targeting impacts the dose delivered to the tumor and the probability of cancer recurrence.
  - FLAME proved a focal radiation boost yields better outcomes for patients. ReIGNITE showed oncologists are better at targeting tumors when they have our advanced MRI (RSIrs). We are now improving imaging accuracy even further by comparing MRI cancer detection to what is found in prostates that have been removed surgically (whole-mount histopathology from radical prostatectomy). We aim to optimize tumor targeting for radiation therapy to millimeter-level accuracy.