INTRODUCTION: Quantitative magnetization transfer (qMT) imaging requires several additional measurements to correct for instrumental biases (B0, B1) and to constrain parameters in the fitting model (T1). These three extra measurements are typically independent of each other, but certain T1 mapping techniques also require B1 maps (e.g., variable flip angle – VFA). In this case, B1 is used twice before fitting the qMT parameters: to correct the flip angles for T1 mapping, and to scale the nominal MT saturation powers. Inaccuracies in B1 would propagate to the fitting of the qMT parameters through two pathways – through errors induced in T1, and errors in MT saturation powers. This work demonstrates that for the Sled and Pike qMT model, certain qMT parameters (F – pool ratio, and T2r) are insensitive to a large range of B1 inaccuracies when using VFA for T1 mapping.

METHODS: Three healthy adults were scanned with a 3T Siemens Tim Trio MRI using a 32-channel receive-only head coil. Single slices (2x2x5 mm3) were acquired parallel to the AC-PC line, superior to the corpus callosum. Whole-brain T1w MPRAGE images (1x1x1 mm3) were acquired for image registration and skull stripping. T1 maps: VFA T1 maps were acquired using an optimally spoiled 3D gradient echo sequence (TE/TR = 2.89/15 ms, α = 3°/20°, AG = 280 ms/m/m, η = 169°), and the flip angles were scaled voxel-wise with each B1 map prior to fitting for T1. Inversion recovery (IR) T1 data was collected from a four inversion time spin echo sequence (TE/TR = 11/1550 ms, TI = 30, 530, 1030, 1530 ms), using an open source robust inversion recovery fitting methodology. qMT maps: MT data was acquired using the spoiled gradient echo two-TR (25/60 ms) optimal 10-point protocol for 3T using Gaussian-Hanning MT pulses (the full protocol including the 10 off-resonance frequency and MT saturation power pairs can be found in Levesque et al 2011). qMT parameter maps were fitted using the Sled and Pike model. B1 was mapped using a two-point phase-difference gradient echo method (TE1/TE2/TR = 4/8/48/25 ms). B1 maps: A double angle (DA) B1 map was acquired using a turbo spin echo readout (TE/TR/Δ = 7/12/1550 ms, u = 60°/120°). To simulate a wide range of B1 inaccuracies, flat (homogenous) B1 maps were simulated for a range of values (B1 Flat = 0.5, 0.75, 0.9, 1, 1.1, 1.25, 1.5, 2 n.u.). VFA T1 maps and qMT/T1/B1 flat maps were acquired for analysis.

RESULTS: Figure 1 shows a comparison between B1 maps (measured DA and simulated B1 flat = 1, the latter being equivalent to assuming true nominal angles) for a single subject; VFA T1 maps calculated using each B1 map; and fitted qMT F maps. Figure 2 shows the pooled whole brain Pearson correlation coefficients (a) and linear regression slopes (b) for qMT F values between the measured DA B1 maps and simulated flat B1, maps, VFA and IR T1 maps. Table 1 lists the correlation and linear regression slope for all fitted qMT parameters and both T1 methods (VFA, IR) between DA and B1 flat = 1.

CONCLUSION: We have demonstrated that qMT F maps fitted using VFA T1 can be insensitive to B1 inaccuracies. Thus, faster and lower resolution B1 maps can be used without sacrificing qMT F accuracy or precision when VFA T1 maps are used. More work in simulating the effects of B1 and VFA T1 inaccuracies on qMT parameter estimation is needed to have a clearer understanding of the limitations of this observation.