Derivation of the SR-VFA method (with T2\* correction)

Michael Malmberg – redone with T2\* correction included – Feb 2024

Start with the definition of signals in steady-state GRE from a baseline (Sr) and dynamic (Sd) time point with flip angles . This uses the steady-state fully-spoiled GRE signal equation.   
In the SR-VFA method, we apply the VFA calculation of T1 twice – once on a pair of baseline images, and once on a dynamic time point’s image paired with the low flip angle baseline image

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If E1d == E1 and E2d == E2 (the normal VFA method’s assumptions for calculation of T1), then E1est = E1, and T1 for the pair of images may be calculated directly as T1 = -TR/ln(E1)

Now inputting the first two equations into the last:

Now recognize the similarity between the top and bottom parts of the fraction, and do the following mathematical manipulation:

Now dividing them gets rid of the nasty denominator, and some other terms cancel

, and then rearrange and form a new variable :

Now do the similar trick from before, but include the ratio E2d/E2, which I will call

Thus you now have E1d (E­1 at dynamic time point, and thus T1 at the dynamic time point) if you can get the following:

**E1** (from pair of baseline images), **E1est** (1 dynamic time point image and the low flip angle baseline image), and (make each acquisition multi-echo and then get T2\* for baseline and dynamic time points and thus E2 and E2d from that)