Purpose:
Maximizing the signal-to-noise ratio (SNR) and/or contrast-to-noise ratio (CNR) is very frequently the primary goal when designing new imaging protocols or when choosing from among several magnetic resonance (MR) imaging methods that give similar physiological measurements. In both cases, minimization of the noise inherent in the reconstructed image becomes the key goal. By optimizing with the Cramer-Rao Lower Bound (CRLB), a best achievable case of variance can be found in the unbiased estimator sense and, ranges can be found were biased estimators improve upon the CRLB.

Methods:
We perform derivations of the MR image channel in order to find the best case of the CRLB. Simulations with a digital brain phantom, using ideal parameters, are then performed and matched with the derivation. In addition, simulations with distortions from the B0 field, B1 field, gradient field and receiver coil sensitivity profiles were also performed to define the CRLB in the presence of machine imperfections.

Results:
From the derivation and simulation, we showed an increase in data variance of greater then 1000× when distortions from common machine imperfections are present. Using the derived CRLB value is not a suitable benchmark to compare biased estimators as the value is much lower then what is achieved practically.

Conclusions:
We have demonstrated in this work that improving upon the best case CRLB is not a reasonable goal, rather we should be focused upon achieving estimates that are 1000× times greater then the derived CRLB. This work allows us to find the bound where we may choose to switch from conventional FFT reconstruction to alternative methods, resulting in lower data variance.