Measuring Noise Figure inside the Stability Circle

It has been claimed, recently, that a legacy electronic tuner measuring system (NP5) and an electromechanical tuner system are capable of identifying the optimum noise reflection coefficient inside the instability area of the Smith chart. This organization believes that this is physically impossible and claims of the opposite are false!

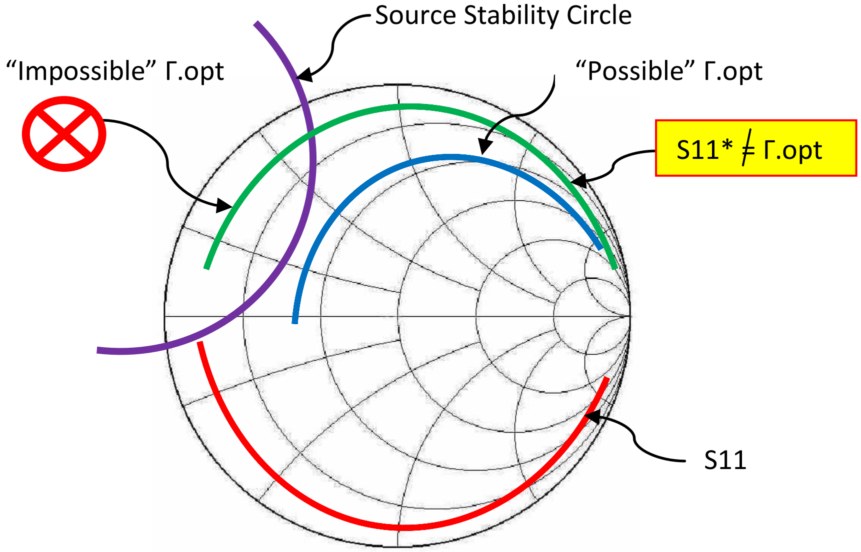
This organization suspects that said measurement systems falsely declare approximate values of S11* of the DUT as being the optimum noise reflection coefficient, Γ.opt.

The reason is simple: The source stability circle defines the area for which the output reflection factor of the DUT $|\Gamma.out| \geq 1$ ($|\Gamma.out|=1$ or Re(Y.out)=0 is the locus of the stability circle itself).

For the noise receiver this means NF.rec = ∞ , based on the well known equation (1)

$$NF.rec = NF.rec.min + Rn.rec/Re(Y.out)^{*} \; |Y.out - Y.opt.rec|^2 \qquad (1)$$

Or, the overall noise figure, including DUT and receiver NF.tot = ∞.



When the source impedance (tuner) tunes inside the ⊗ area, the output impedance of the DUT has a negative real part. This means power will flow from the noise receiver to the DUT and not vice versa. This contradicts to the definition of Noise Figure. In particular when tuning "on" the stability circle, then Re(Z.out)=0, in which case the available power from the DUT $P.dut.av=|V.out|^2/4Re(Z.out) = \infty$; because P.dut.av cannot be ∞, this means V.out=0, in which case we have a 0/0 indefinite relation. Associate experiments in fact always show NF.tot ->∞.

All this simply means that measuring Noise Figure (and designing LNA's) inside the instability area of a transistor does not make physical sense.