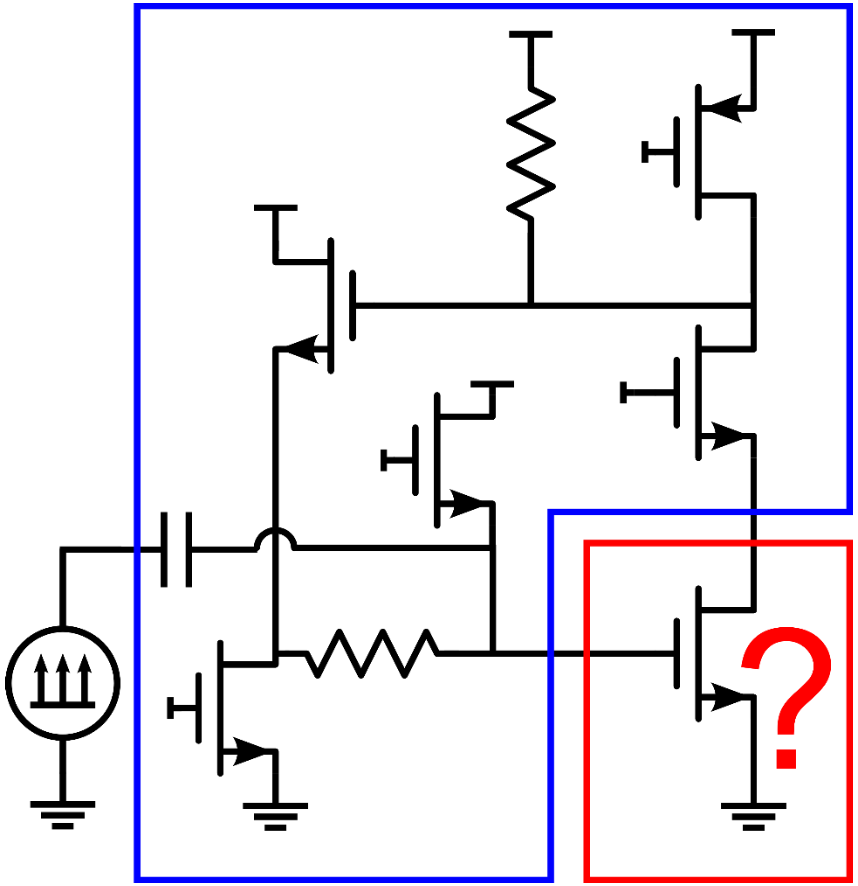
Estimating the BLA of MIMO sub-networks in simulations

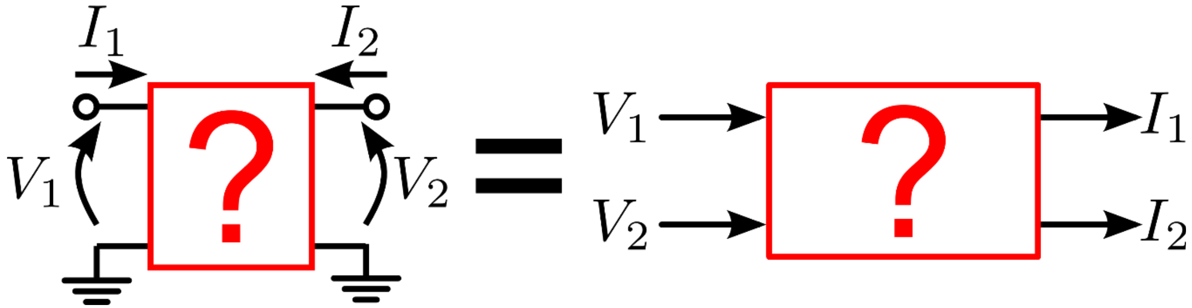
Adam Cooman, Ebrahim Louarroudi & Gerd Vandersteen

agency for Innovation by Science and Technology

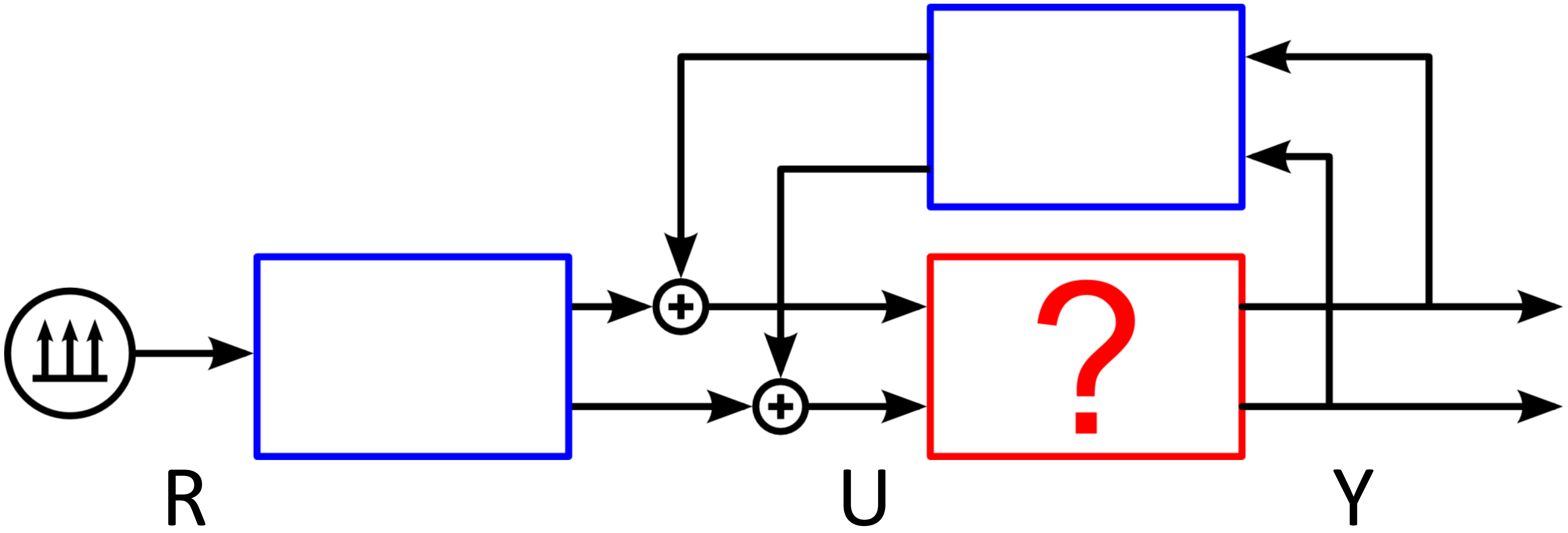
Vrije Universiteit Brussel

Electronic Circuits = MIMO network…



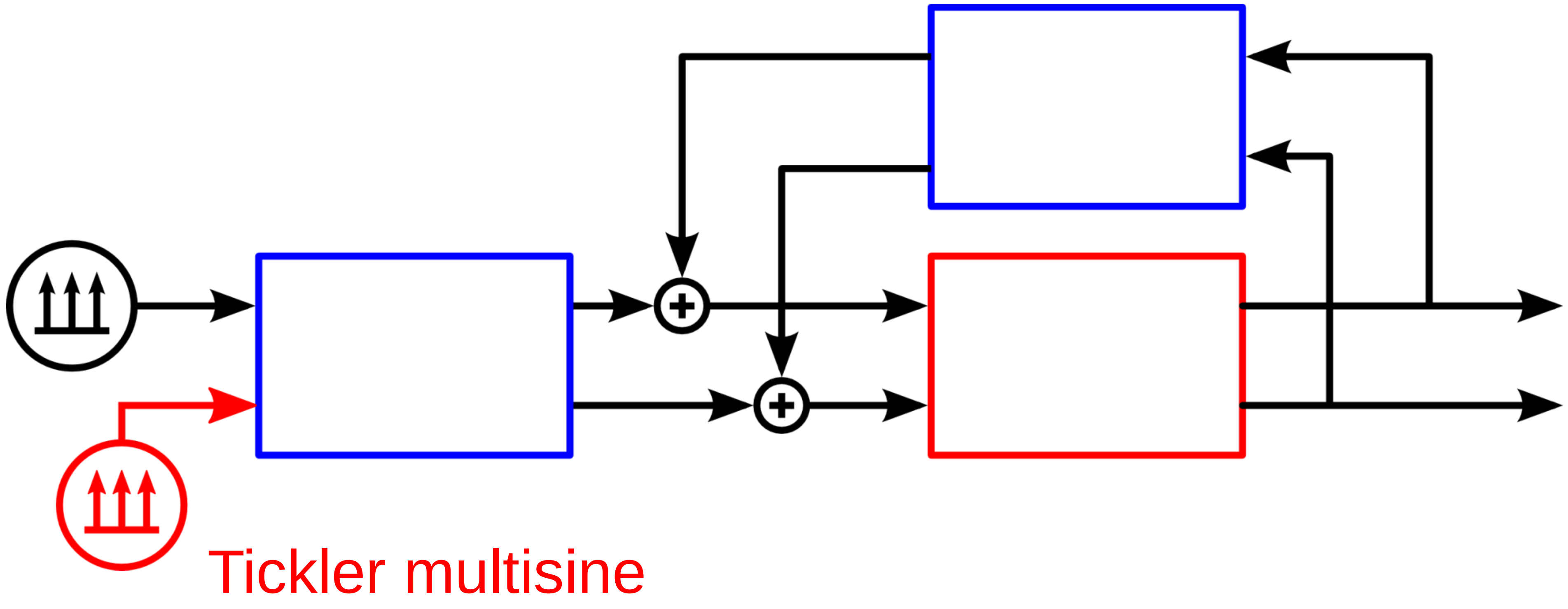


Excited by a single multisine



$$BLA_{?} = \frac{BLA_{R \to Y}}{BLA_{R \to U}}$$

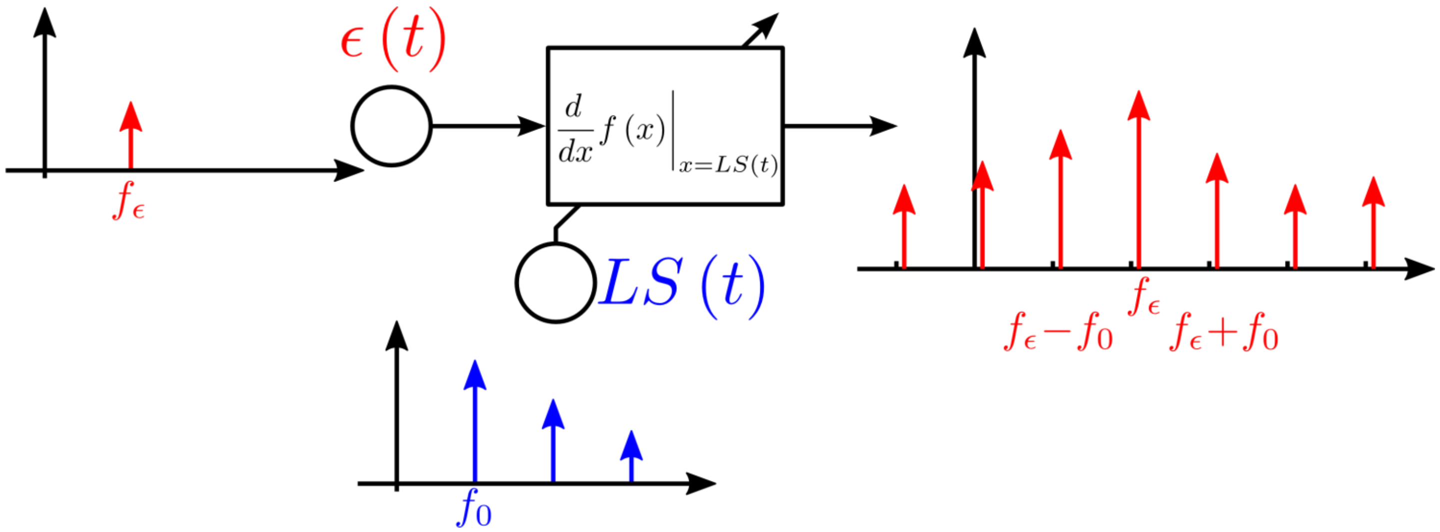
Classic solution: Add extra multisine



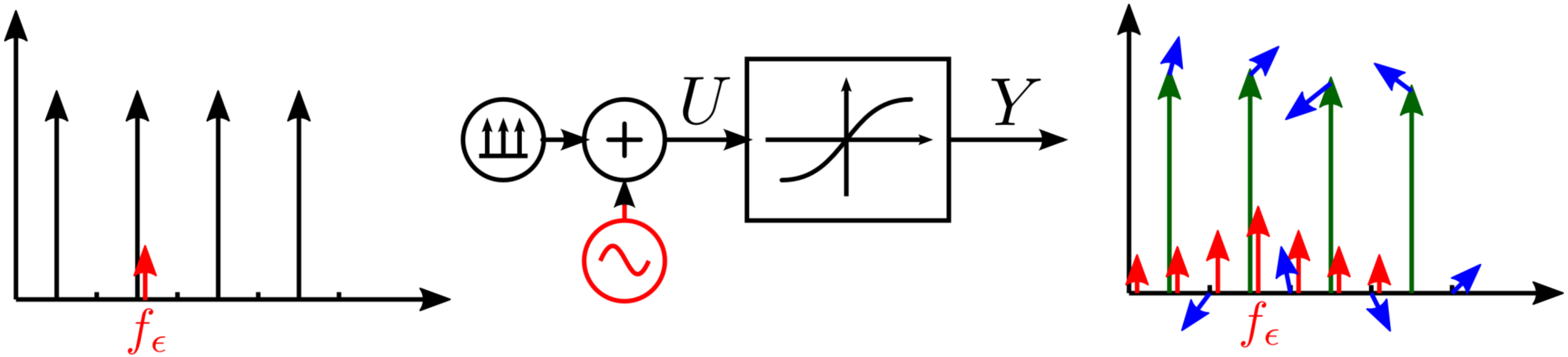
LSSS Analysis offers a solution

$$f\left(DC + \epsilon(t)\right) = f\left(DC\right) + \epsilon(t) \cdot \left.\frac{d}{dx} f(x)\right|_{x=DC}$$

$$f\left(LS(t) + \epsilon(t)\right) = f\left(LS(t)\right) + \epsilon(t) \cdot \left.\frac{d}{dx} f(x)\right|_{x=LS(t)}$$



Small-signal sees the BLA as well



Coherent

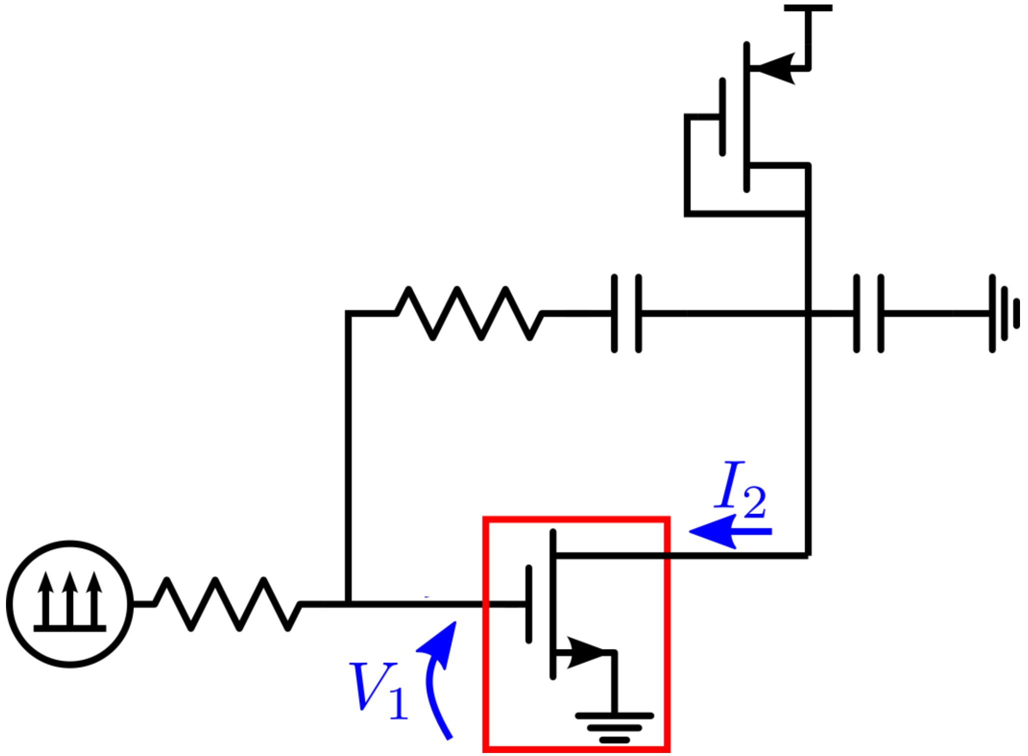
Non-Coherent

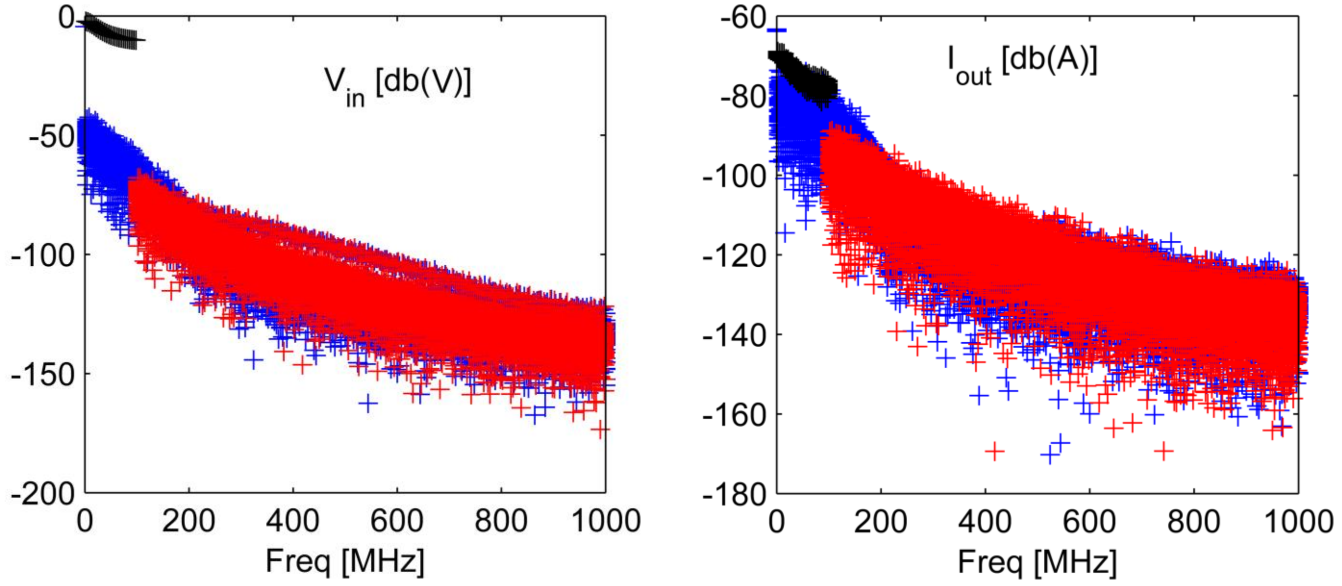
$$Y(f_k) = U(f_k) \cdot \left(\underbrace{G^{[1]}(f_k) + \sum_{i=-N}^{N} G^{[3]}(f_i, -f_i, f_k) \cdot |U(f_i)|^2}_{\text{Coherent}} + \underbrace{\sum_{i=-N}^{N} \sum_{j=-N}^{N} G^{[3]}(f_i, f_j, f_k) \cdot U(f_i) U(f_j)}_{\text{Non-Coherent}} \right)$$

Coherent

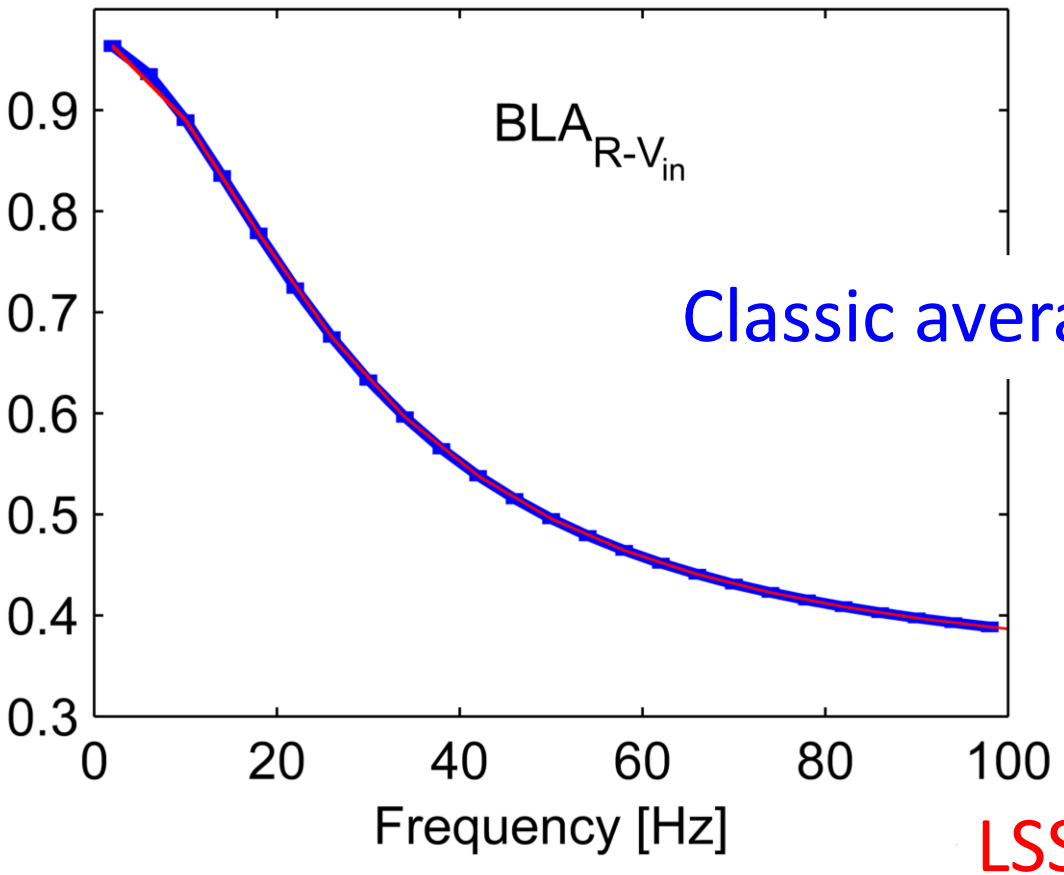
$$Y(f_\epsilon) = U(f_\epsilon) \cdot \left(\underbrace{G^{[1]}(f_\epsilon) + \sum_{i=-N}^{N} G^{[3]}(f_i, -f_i, f_\epsilon) \cdot |U(f_i)|^2}_{\text{Coherent}} \right)$$

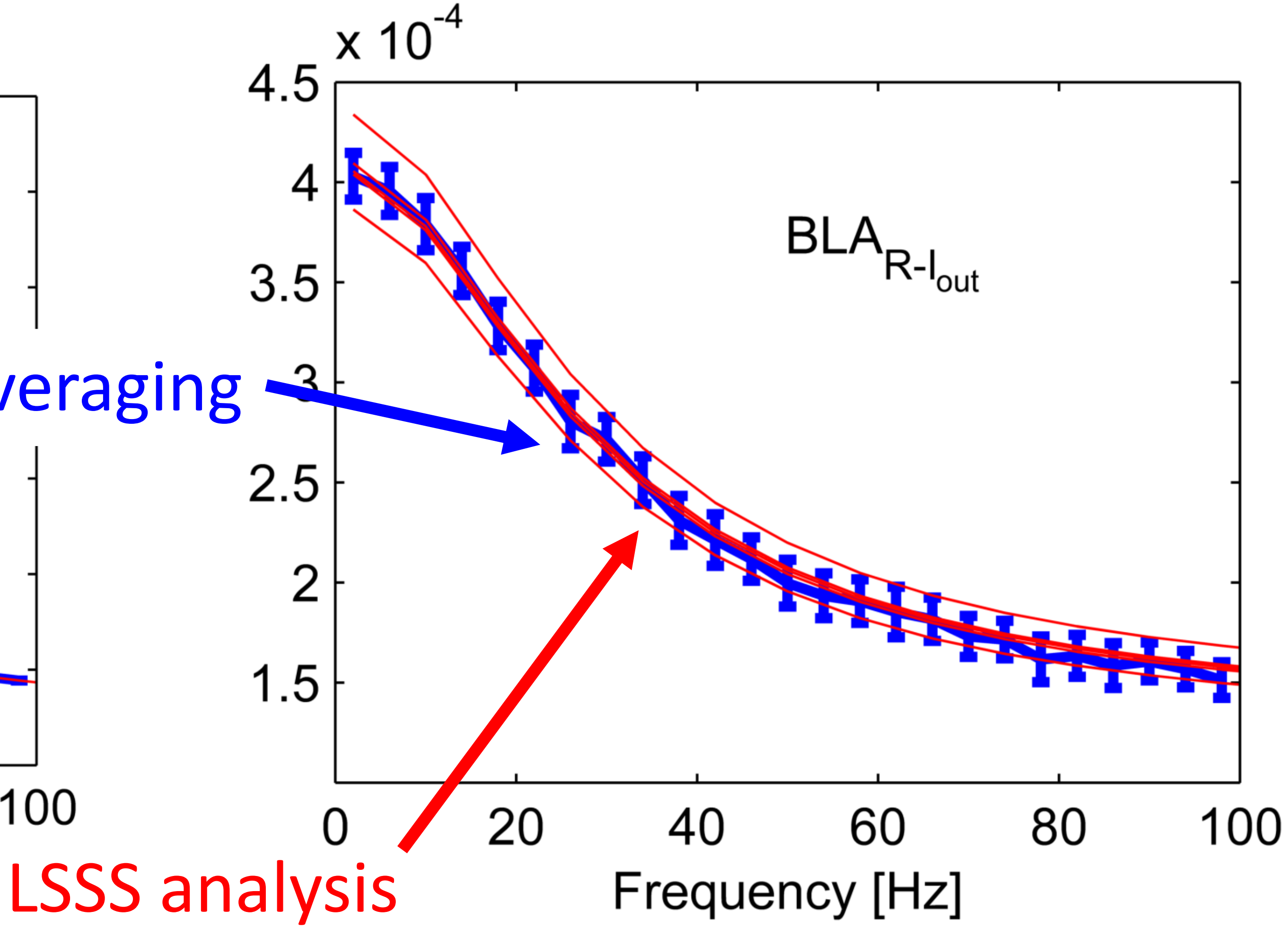
Example: CMOS amplifier





As expected, both techniques match





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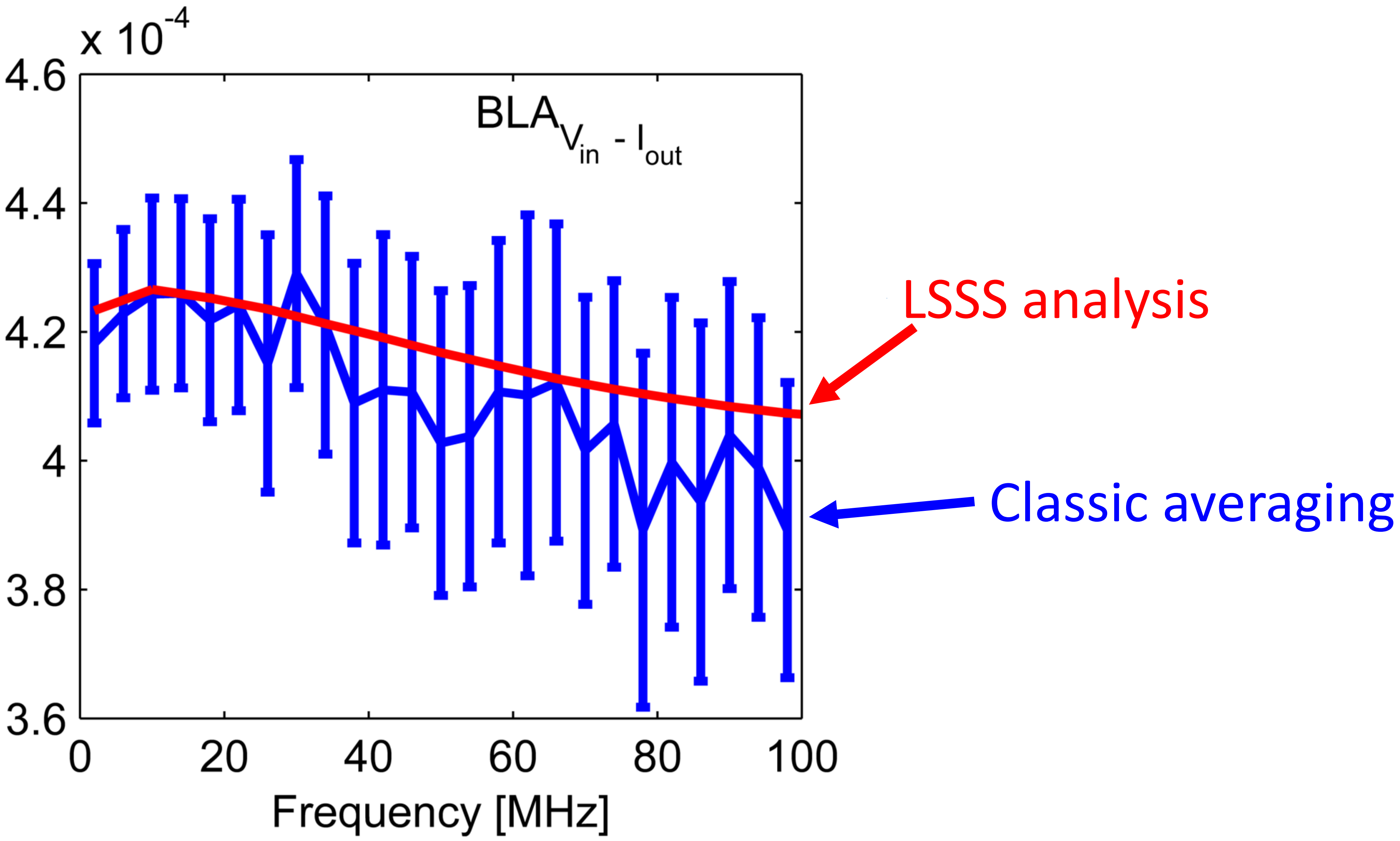
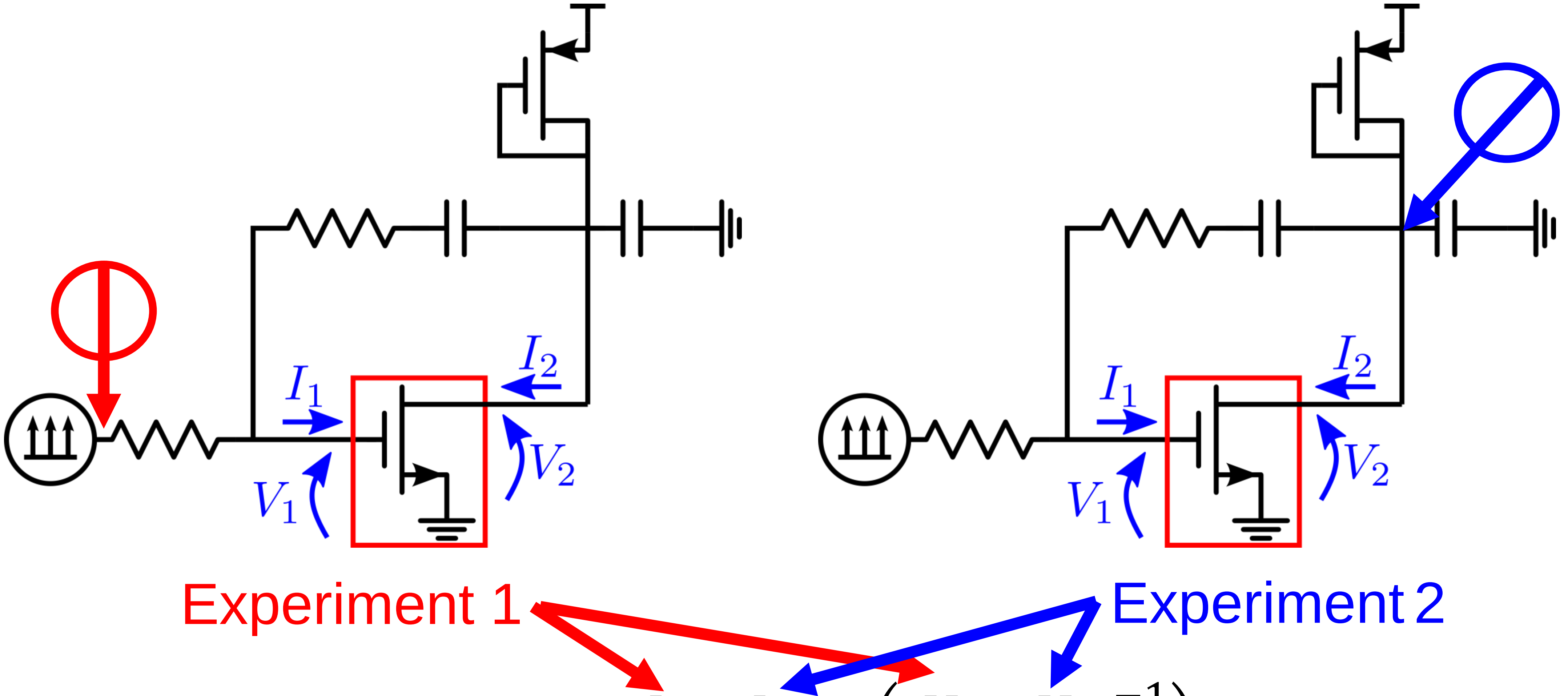
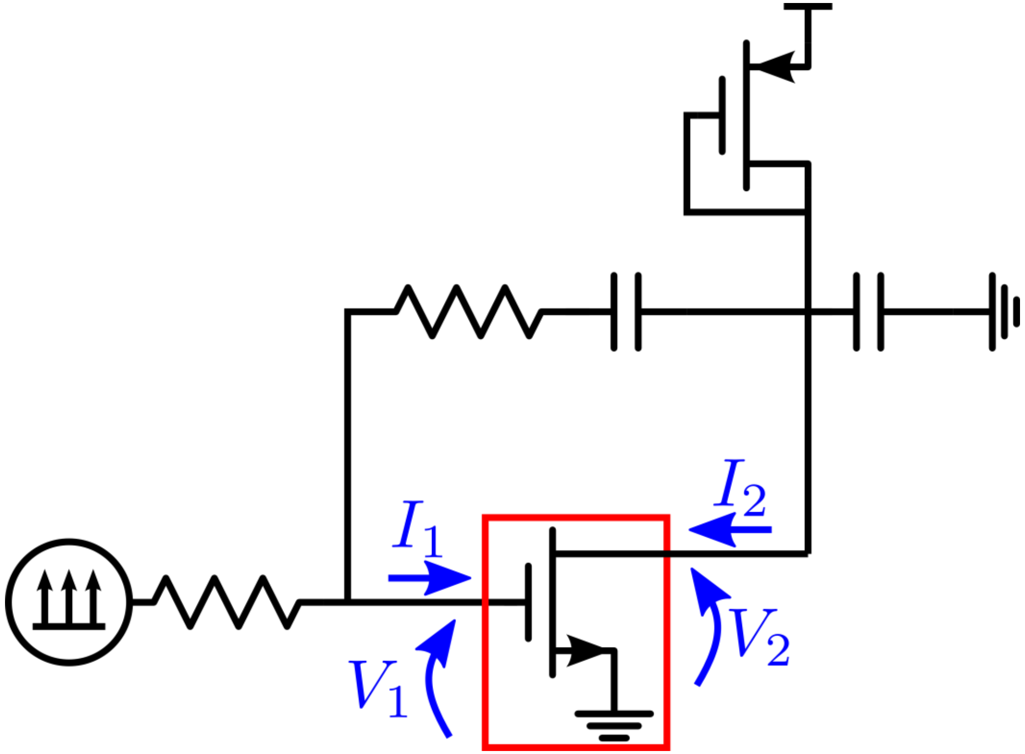


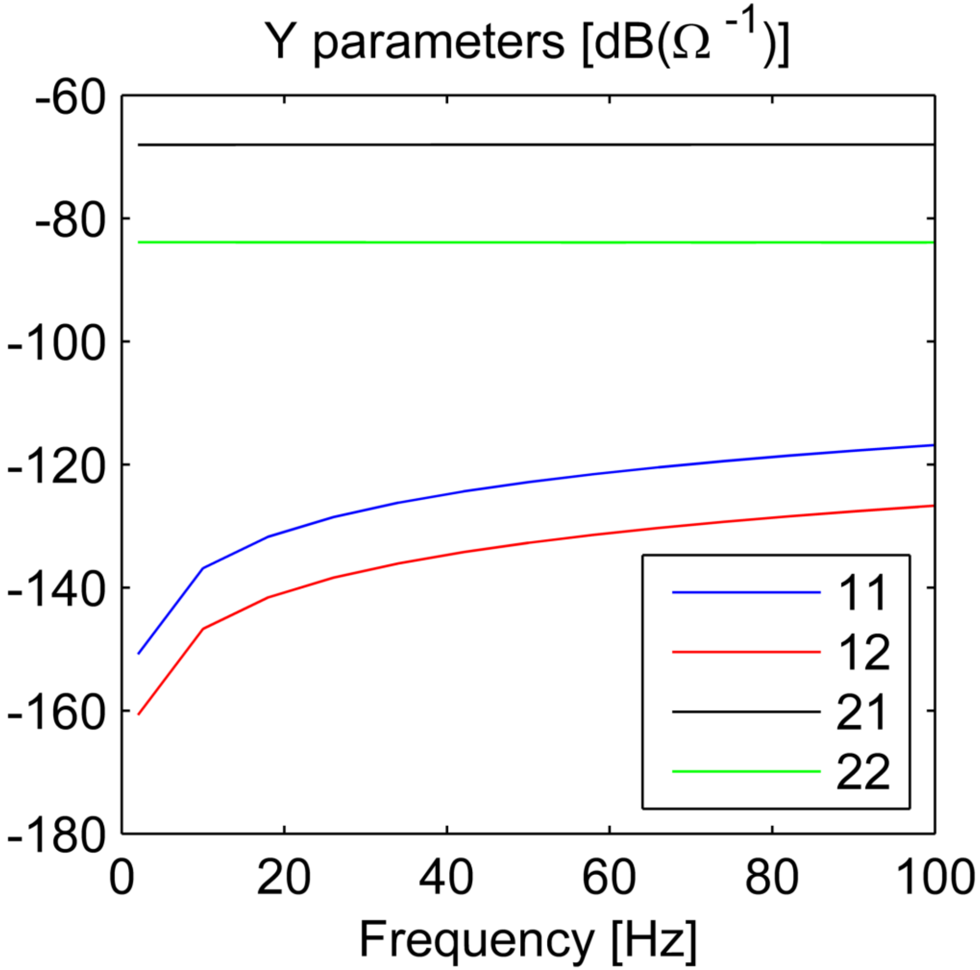
MIMO is just multiple experiments



$$G(f) = \begin{bmatrix} I_1 & I_1 \\ I_2 & I_2 \end{bmatrix} * \left(\begin{bmatrix} V_1 & V_1 \\ V_2 & V_2 \end{bmatrix}^{-1} \right)$$

Back to the example





Conclusions

Linearisation around MS ⇒ tickler issues solved

no danger of disturbing the operating point

Additional benefits

Single-tone excitation ⇒ flexible frequency grid

Contributions are smooth ⇒ less MS phase realisations

But! you need access to Large-Signal Small-Signal simulation