

STATISTICAL ERROR

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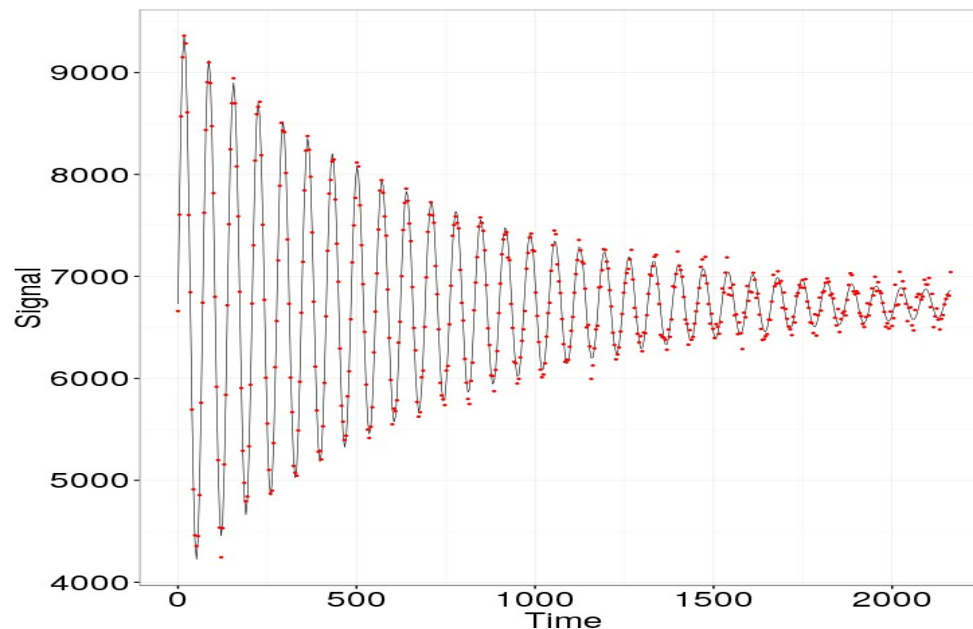
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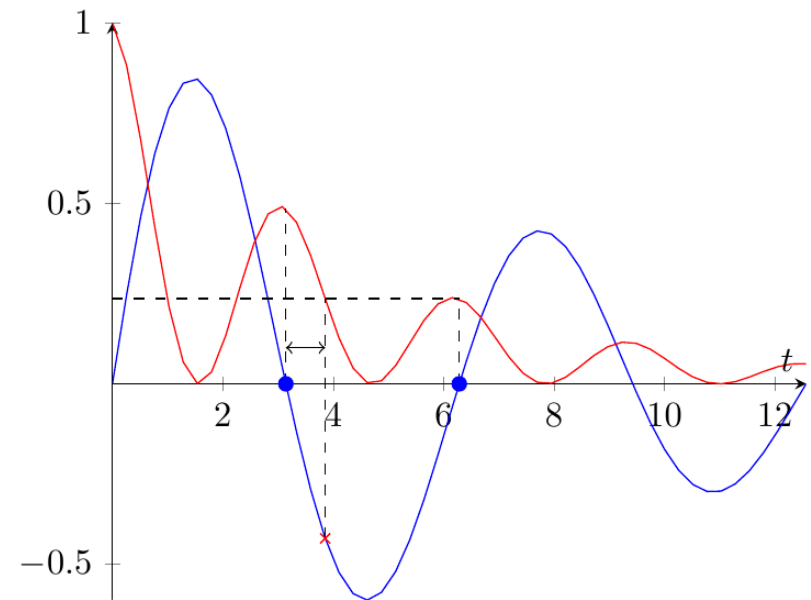
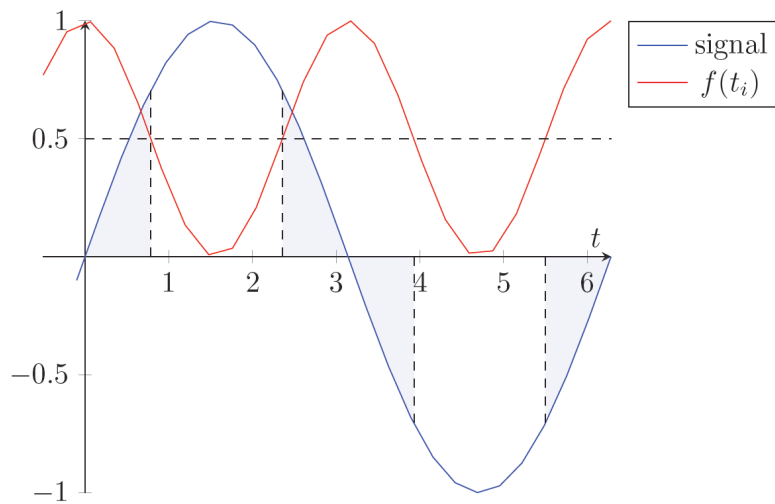
Problem statement

$$N(t) = N_0 \cdot (1 + P \cdot e^{-t/\tau_d} \cdot \sin(\omega \cdot t + \varphi))$$

$$\sigma^2[\hat{\omega}] = \frac{\sigma^2[\varepsilon]}{\sum_i f(t_i) \cdot \sigma_w^2[t]}$$



Two aspects



Goals

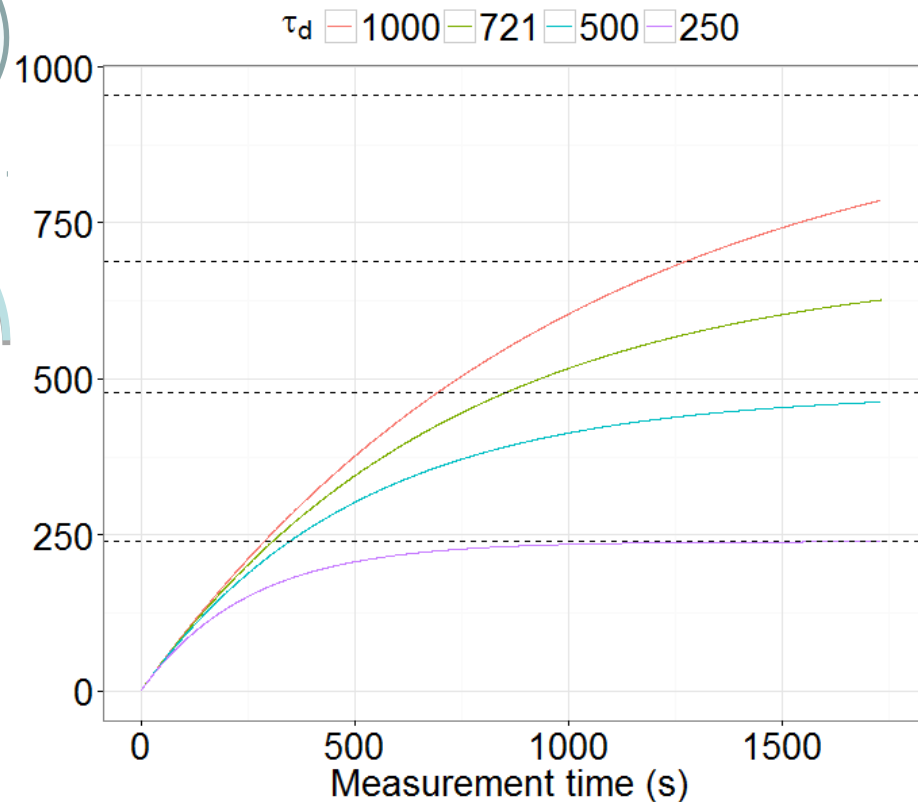
- Under what conditions sampling modulation is beneficial
- How much modulation makes sense
- At what point measurement is no longer reasonable

Spread

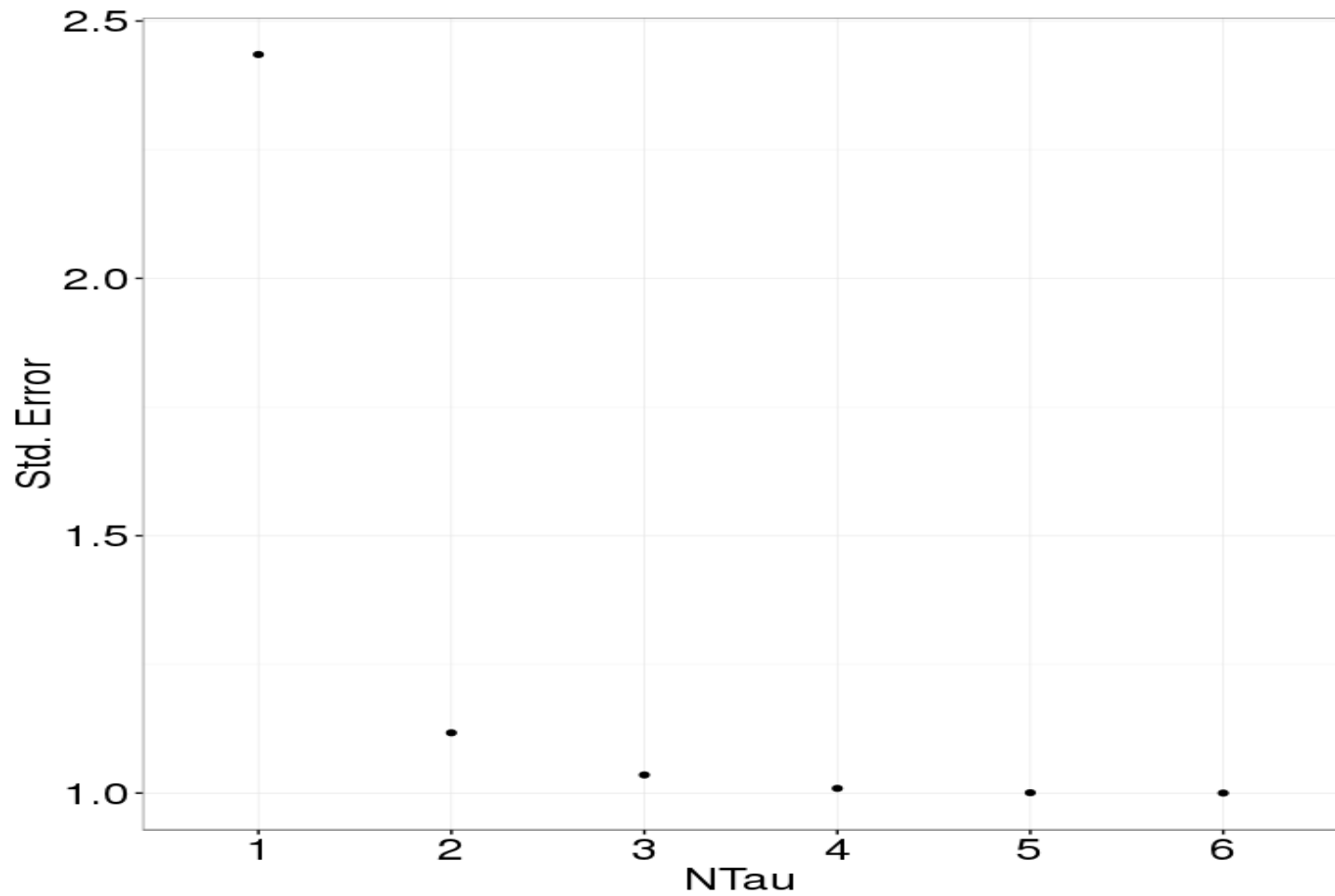
$$\sum f(t_i) = n_{\varepsilon/zc} \cdot x_{01} \cdot \frac{\exp(-\frac{\pi}{\omega\tau_d} n_{zc}) - 1}{\exp(-\frac{\pi}{\omega\tau_d}) - 1}$$

$$t(z) = \tau_d \cdot \ln\left(\frac{1}{1-z}\right)$$

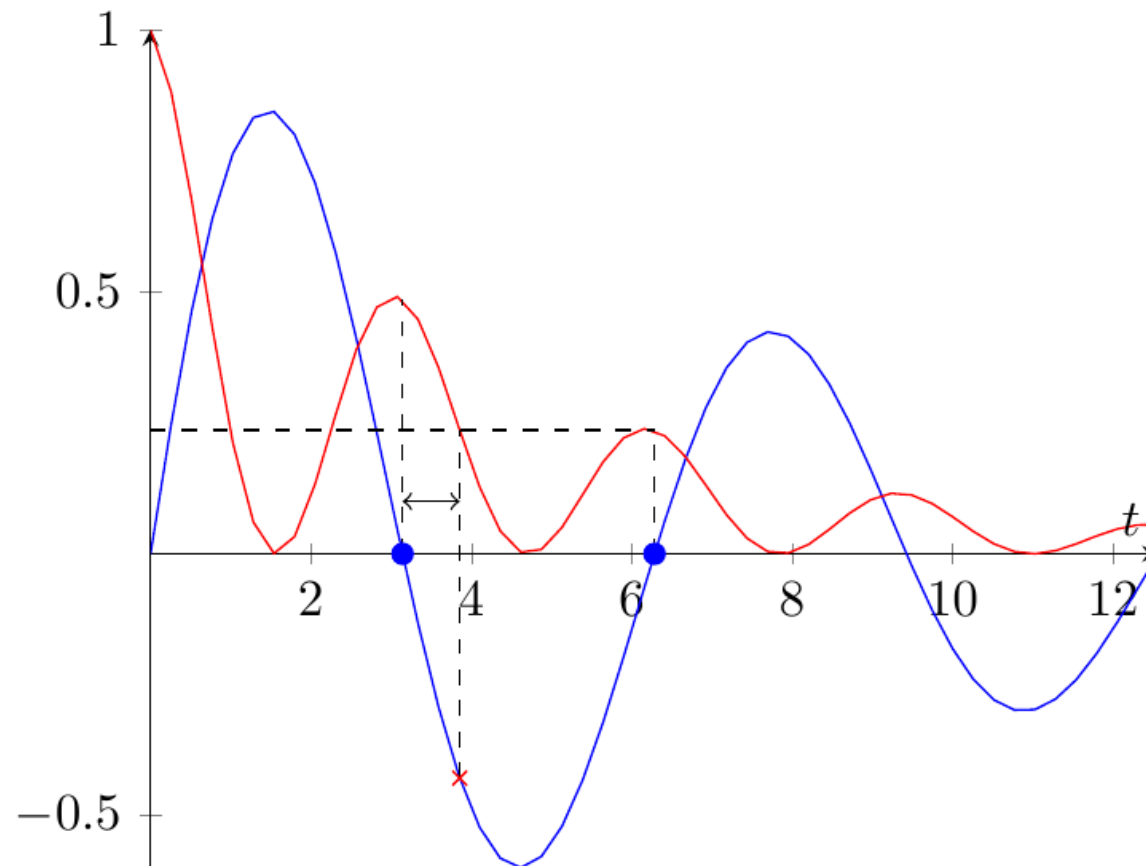
FI limit (%)	Reached ($\times\tau_d$)	SNR@3% error
95	3.0	1.7
90	2.3	3.3
70	1.2	10.0
50	0.7	16.5



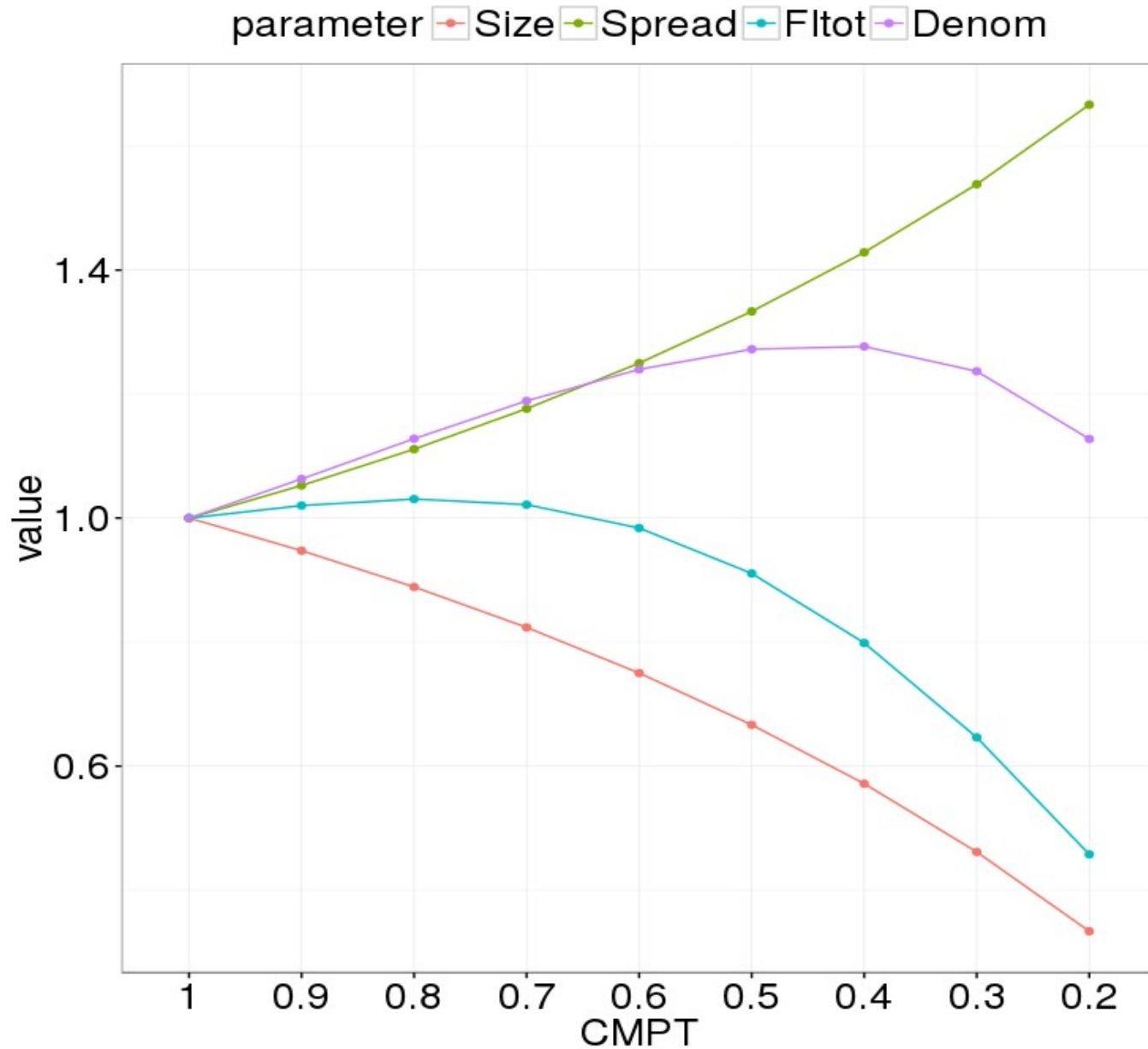
Simulation



Modulation: Beam lifetime doesn't matter



Modulation: beam lifetime matters



Statistical precision

