

# Revisiting interference-free power spectral representations of periodic signals

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# Take home message

- Two new procedures provide interference-free representations of power spectra of periodic signals
  - One-stage procedure using a pair of trigonometric series
  - Two-stage procedure using convolution of a trigonometric function and B-splines and fo-adaptive spectral smoothing
- They can replace the infrastructure of STRAIGHT and TANDEM-STRAIGHT

# One-stage procedure

- A pair of trigonometric series

$$w_r(t) = \sum_{k=0}^K a_k \cos(\pi kt)$$

$$w_i(t) = \sum_{k=1}^K b_k \sin(\pi kt),$$

$$\{a_k\}_{k=0}^4 = \{1, 1.8471, 1.3718, 0.6023, 0.0828\}$$

$$\{b_k\}_{k=1}^4 = \{0.7333, 1.0822, 0.7639, 0.2077\}$$

# Two-stage procedure

- convolution of a trigonometric function and B-splines and adaptive spectral smoothing

$$v^{(0)}(x) = \begin{cases} \cos(\pi x) & -\frac{1}{2} \leq x \leq \frac{1}{2} \\ 0, & |x| > \frac{1}{2} \end{cases}$$

$$v^{(n)}(x) = v^{(0)}(x) * \underbrace{\beta^{(0)} * \beta^{(0)} * \dots * \beta^{(0)}}_{n \text{ times}}(x)$$

$$\begin{aligned} P_{\text{TIF}}^{(n)}(\omega) &= \frac{1}{\omega_0} \int_{-\omega_0/2}^{\omega_0/2} P_{\text{TIF}}^{(n)}(\omega + \nu) d\nu \\ &= \frac{1}{\omega_0} \left( U_{\text{TIF}}^{(n)}(\omega + \omega_0/2) - U_{\text{TIF}}^{(n)}(\omega - \omega_0/2) \right) \end{aligned}$$

$$U_{\text{TIF}}^{(n)}(\omega) \equiv \int_{-\omega_0}^{\omega} P_{\text{TIF}}^{(n)}(\nu) d\nu$$

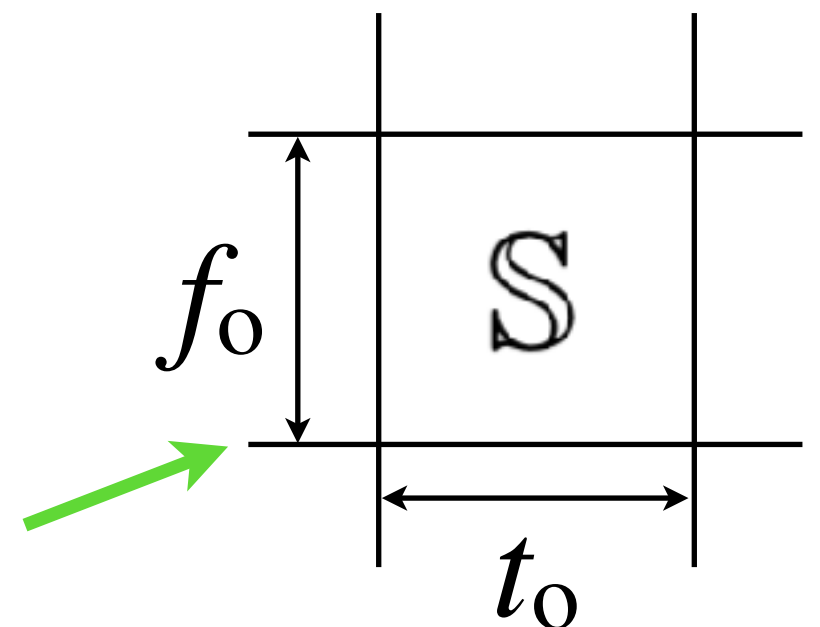
# Performance measure

$$L^2(\Theta) = \int_{(t,f) \in \mathcal{S}} |P(f, t; \Theta) - \overline{P(f, t; \Theta)}|^2 df dt,$$

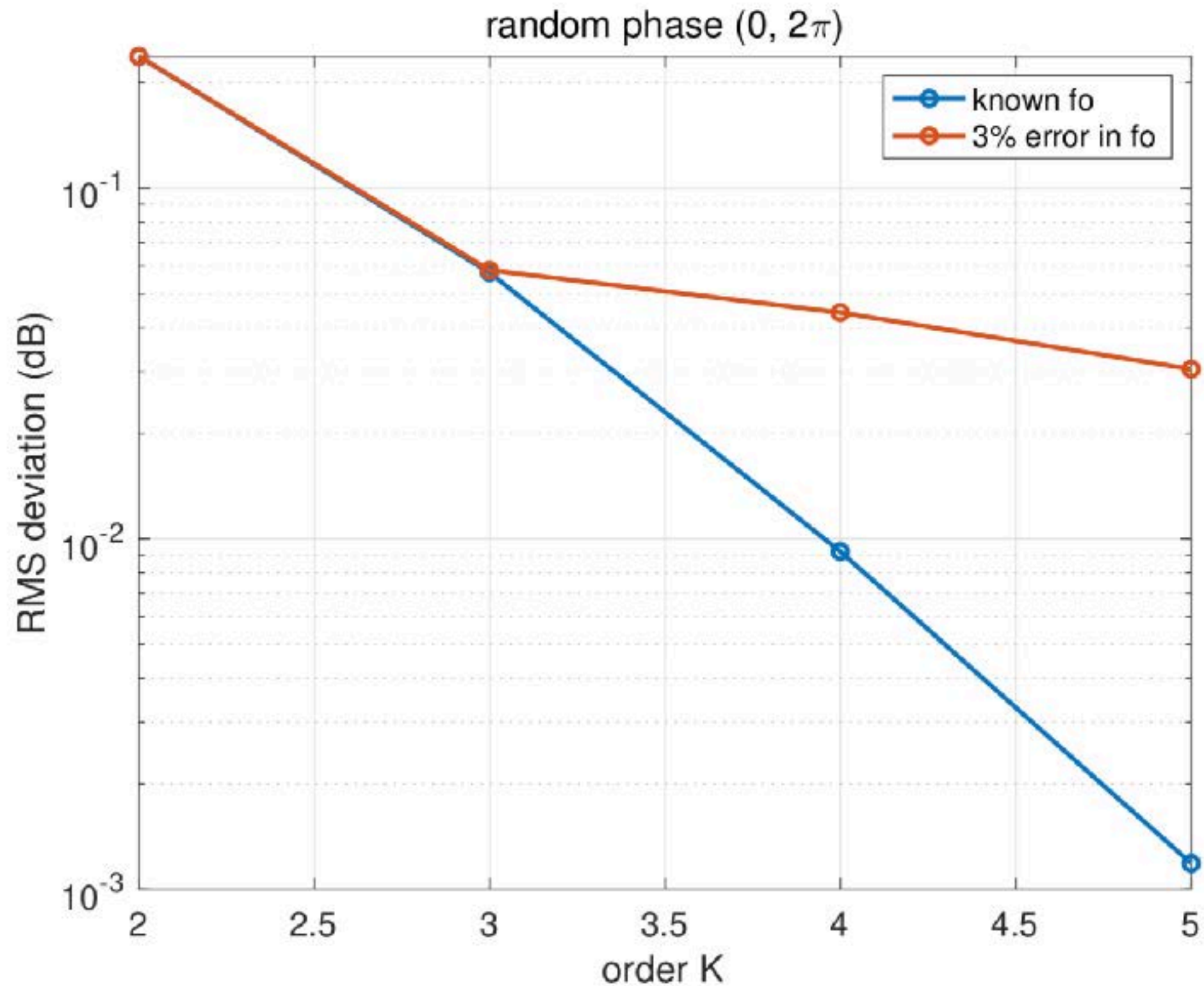
$$\Theta = \left\{ \left\{ a_k \right\}_{k=1}^K, \left\{ b_k \right\}_{k=1}^K, f_0, f_c, \left\{ \varphi_n \right\}_{n=-N}^{N-1} \right\}$$

$$x(t) = \sum_{n=-N}^N c_n \cos(2\pi(n + m)f_0 t + \varphi_n)$$

$m$ -th harmonic

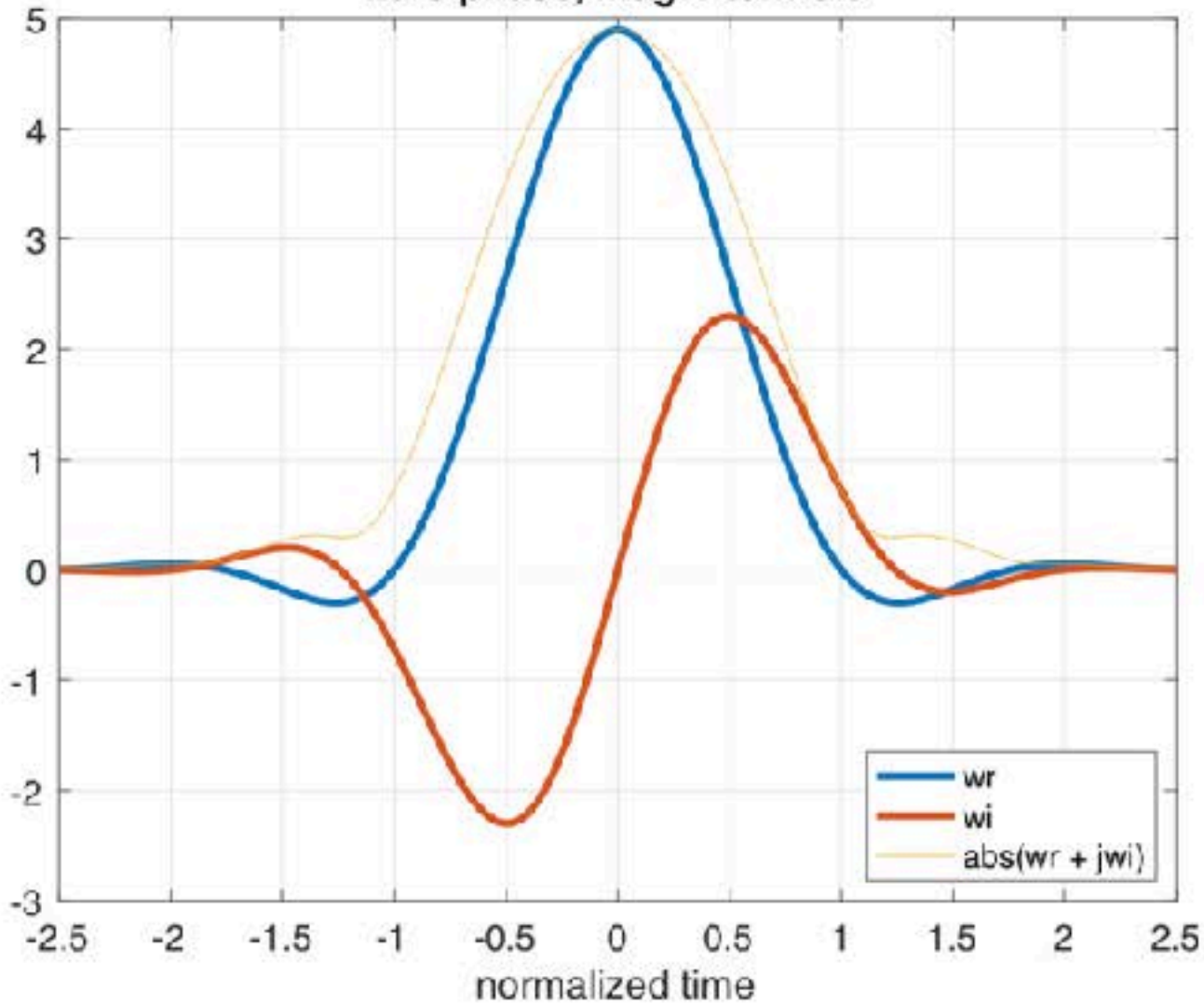


# Performance: one-stage

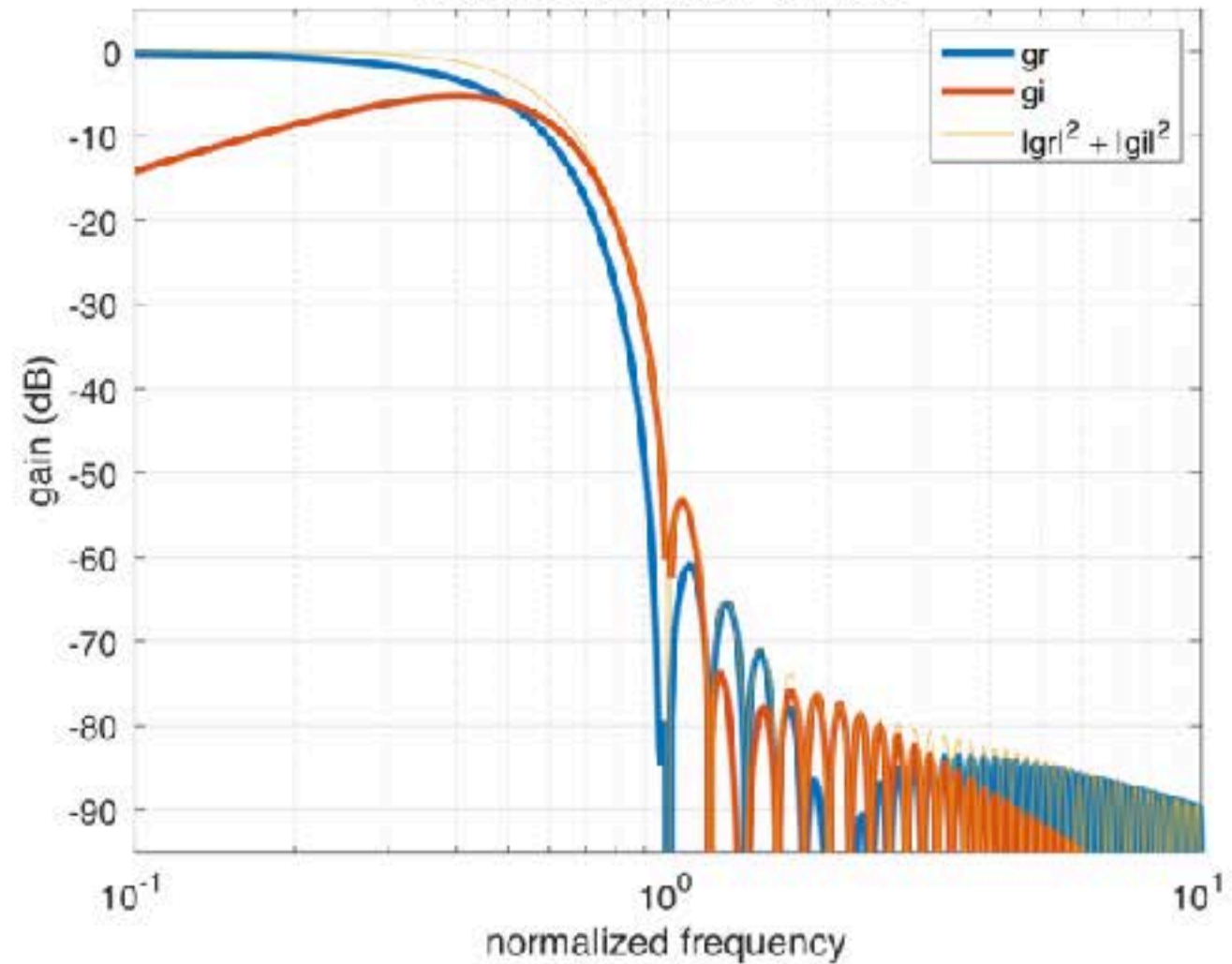


# Shape and gain

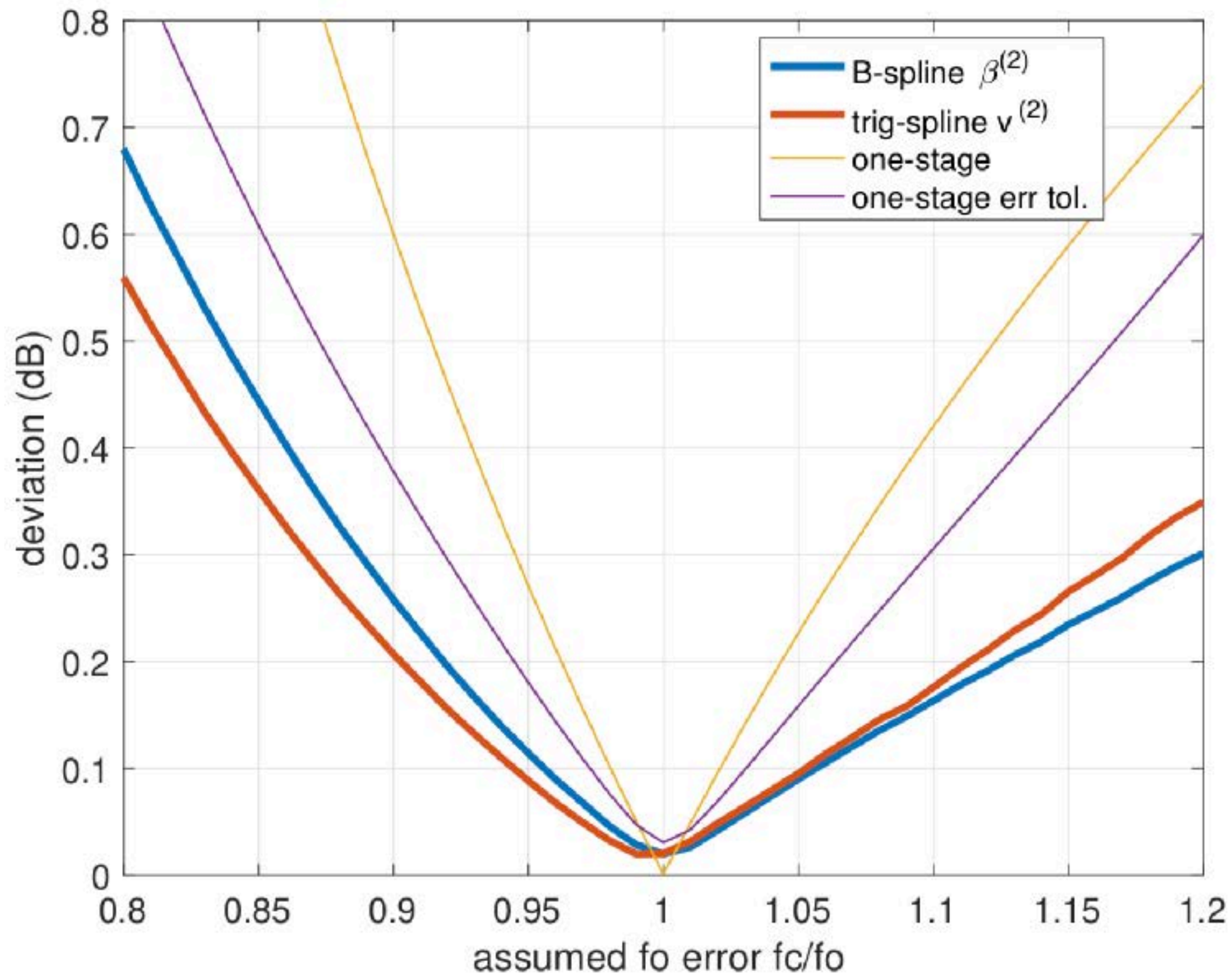
zero phase, mag:1 terms:5



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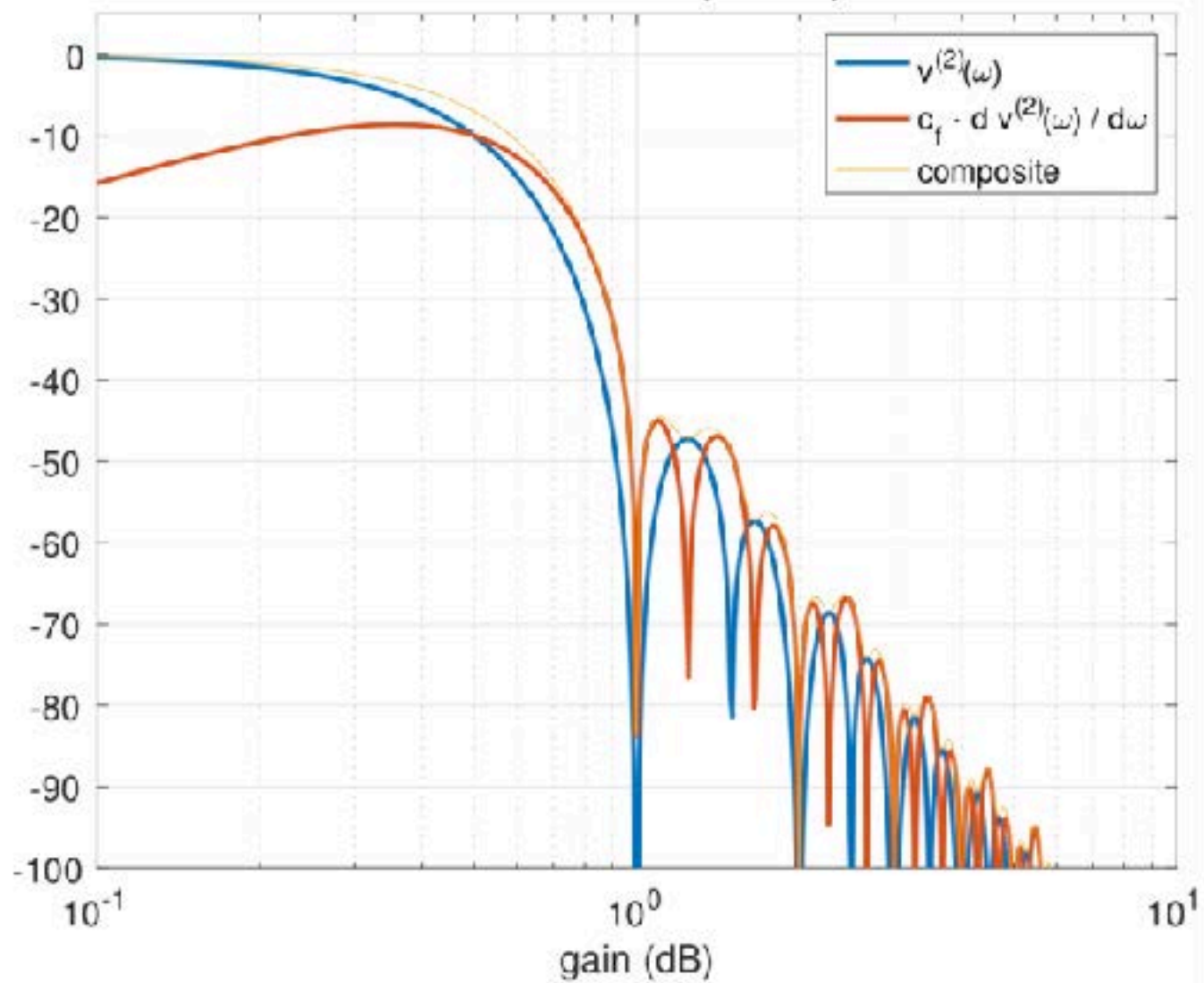
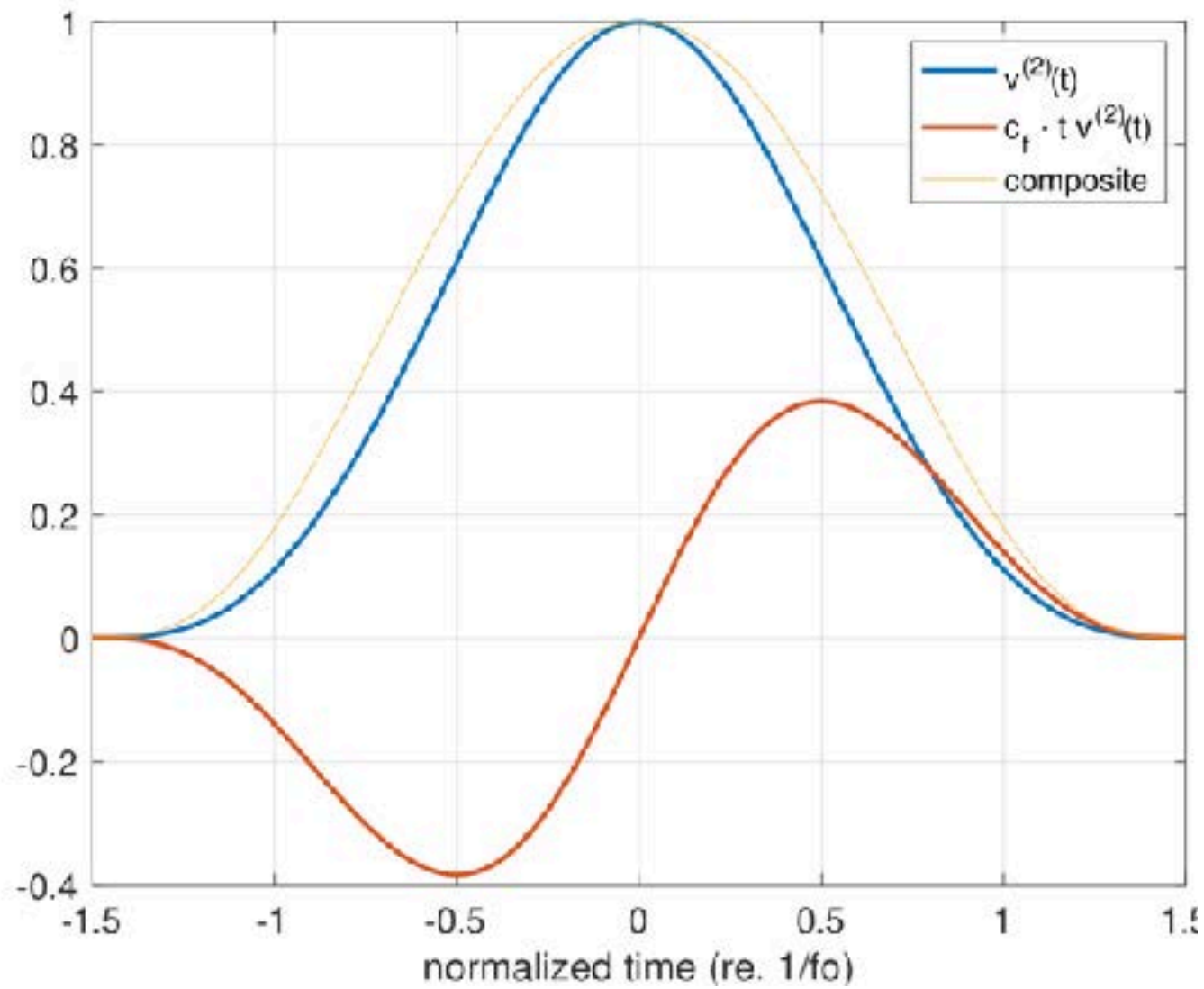


# Tolerance to $f_0$ error

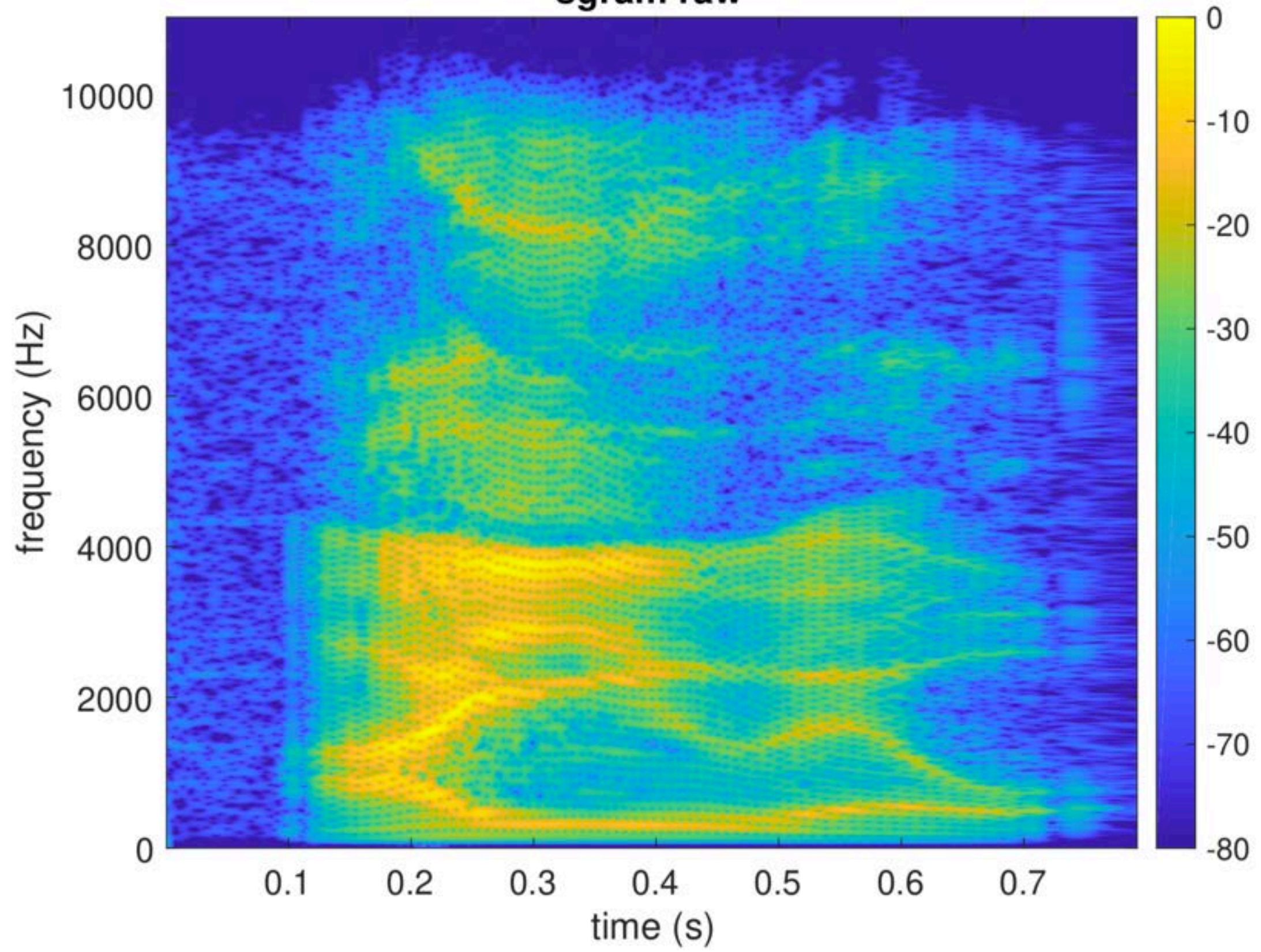




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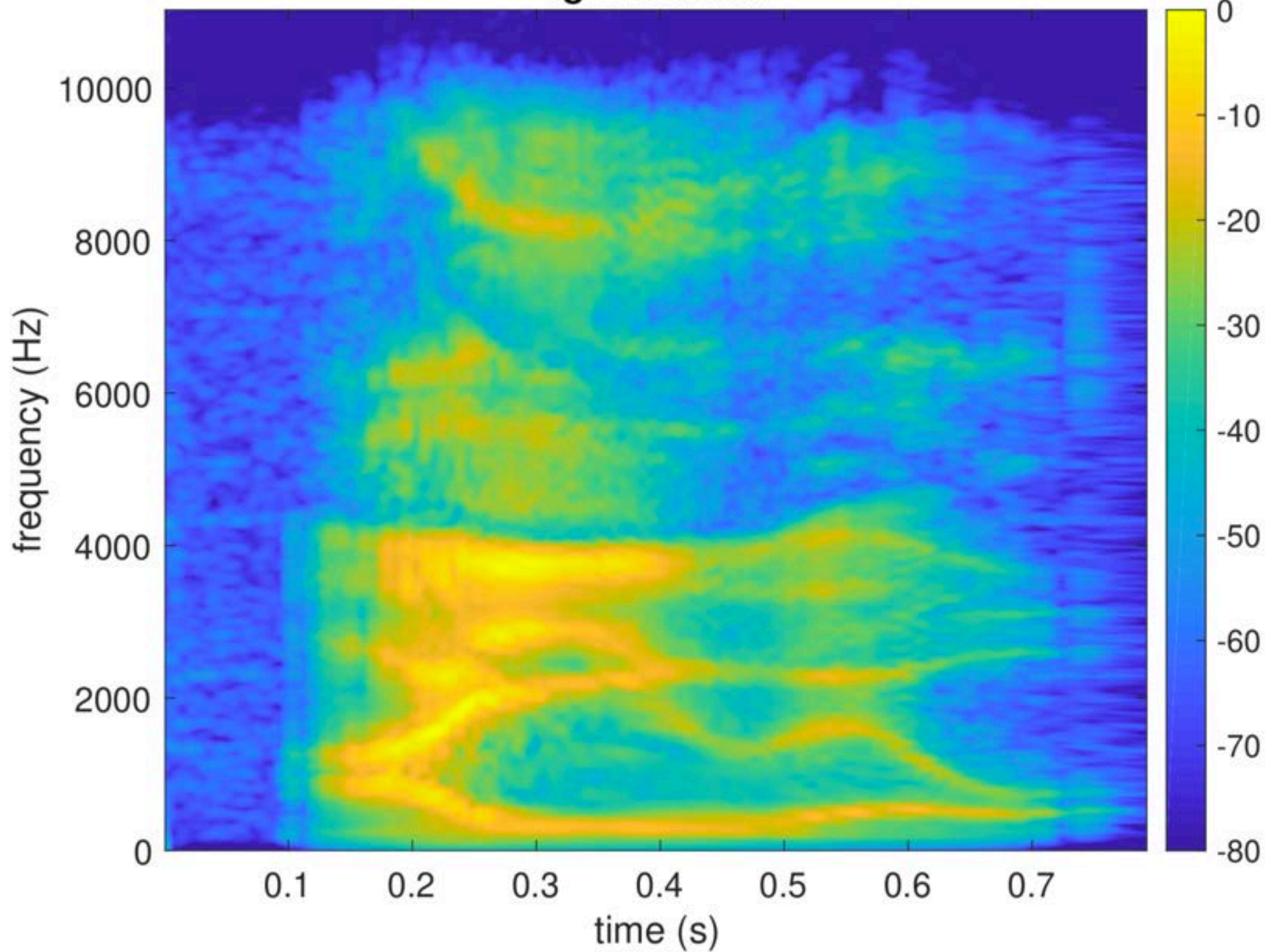


**sgram raw**

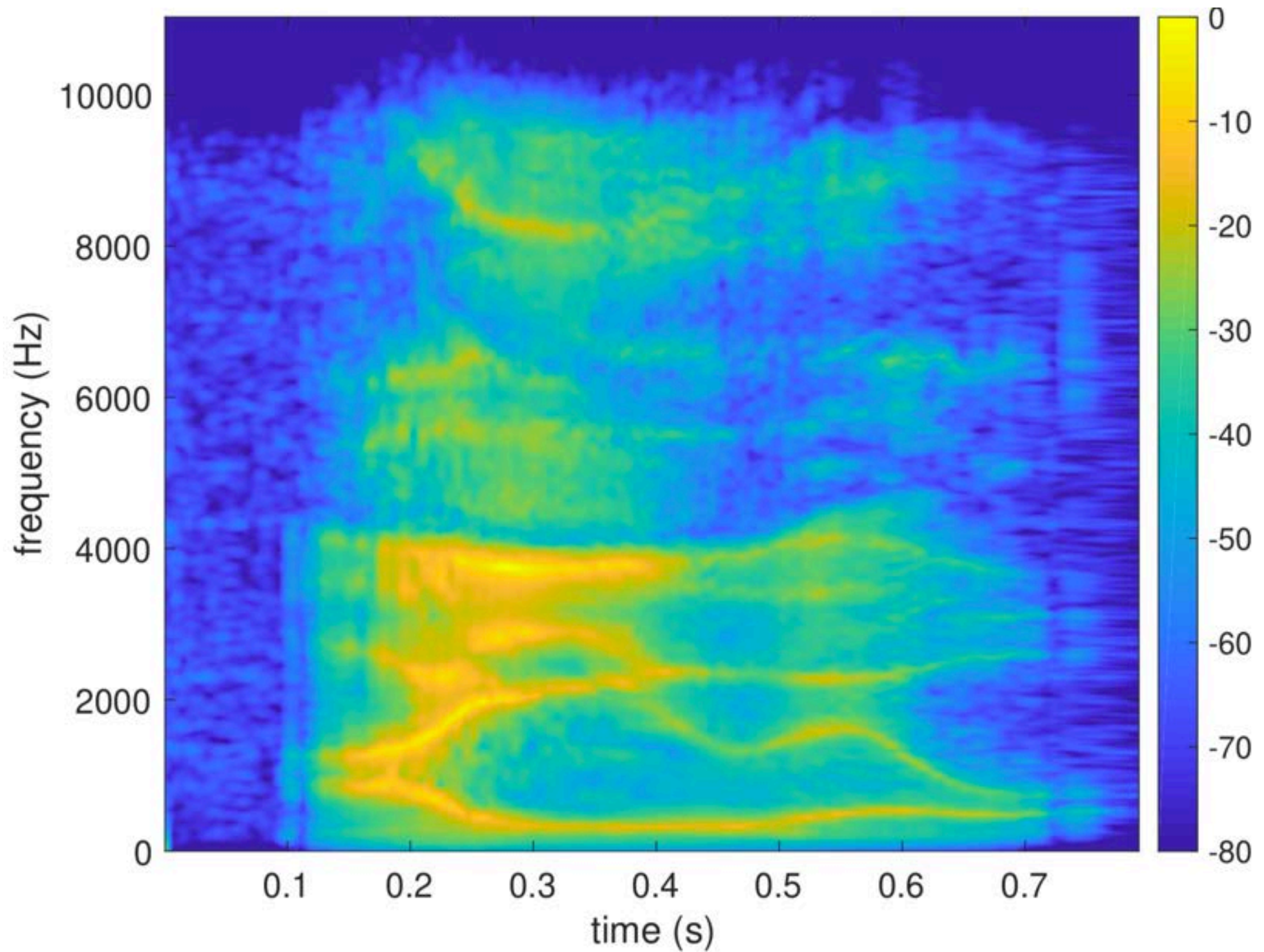




**sgramTFstat**

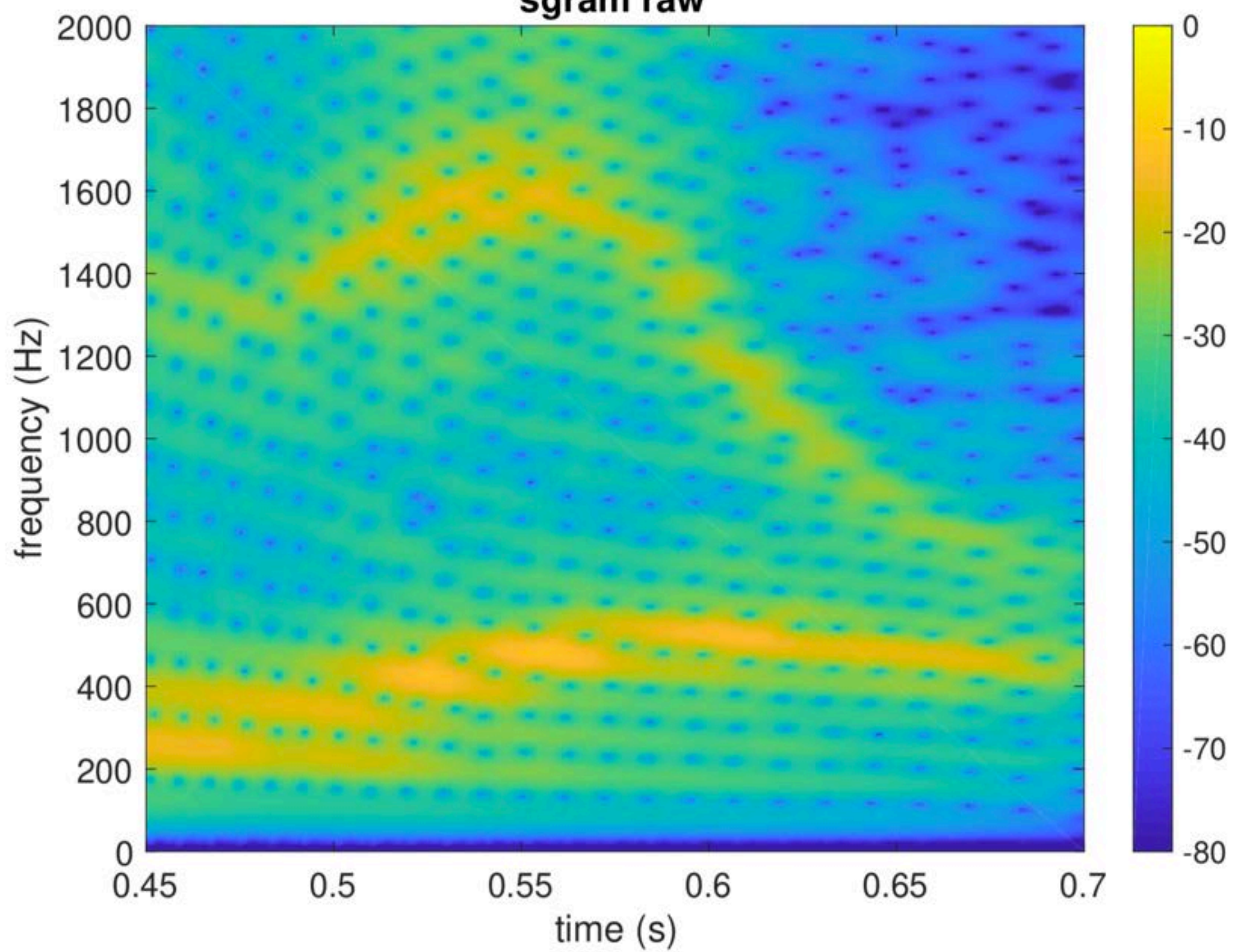


# One more trick: will be open on 17 July

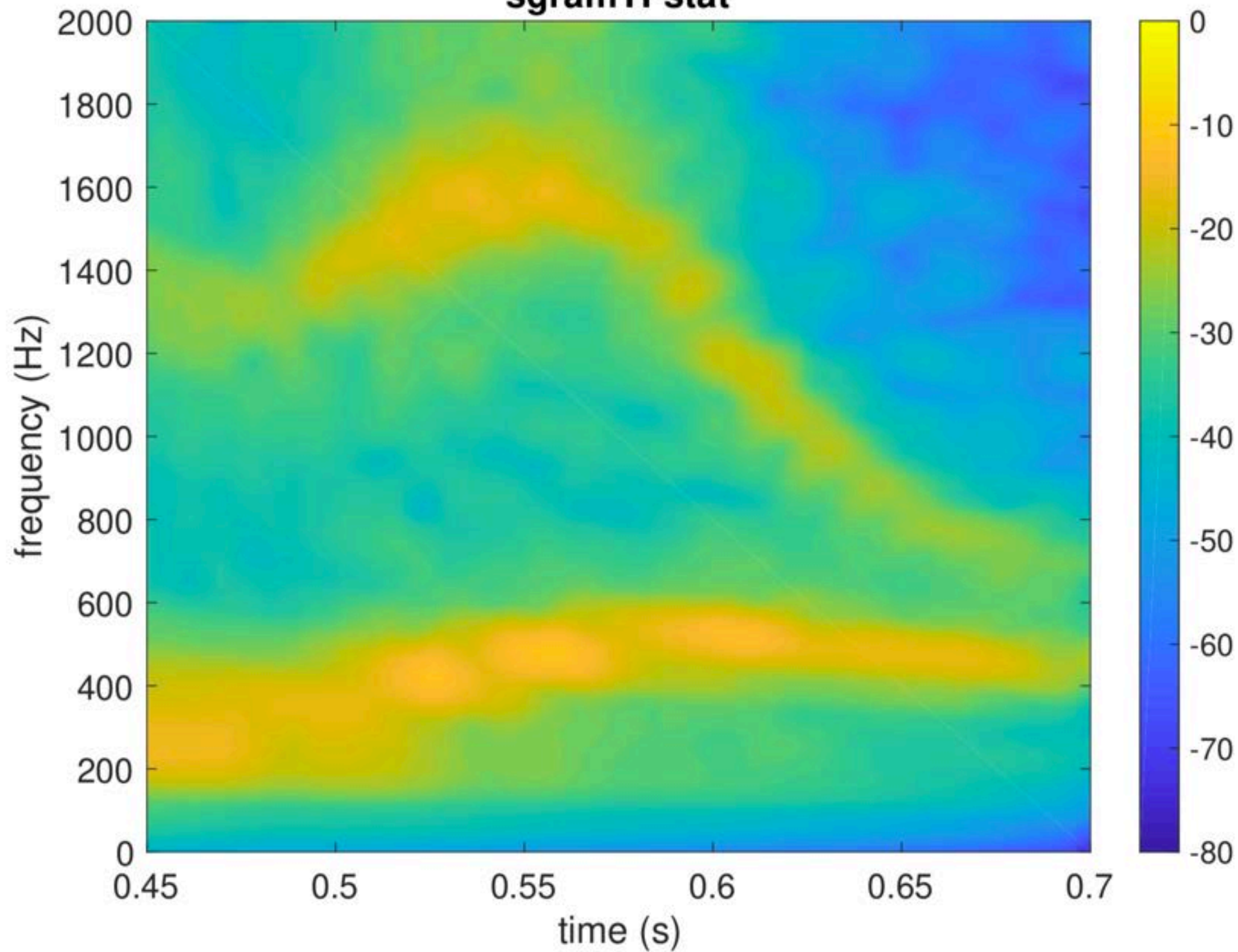




**sgram raw**

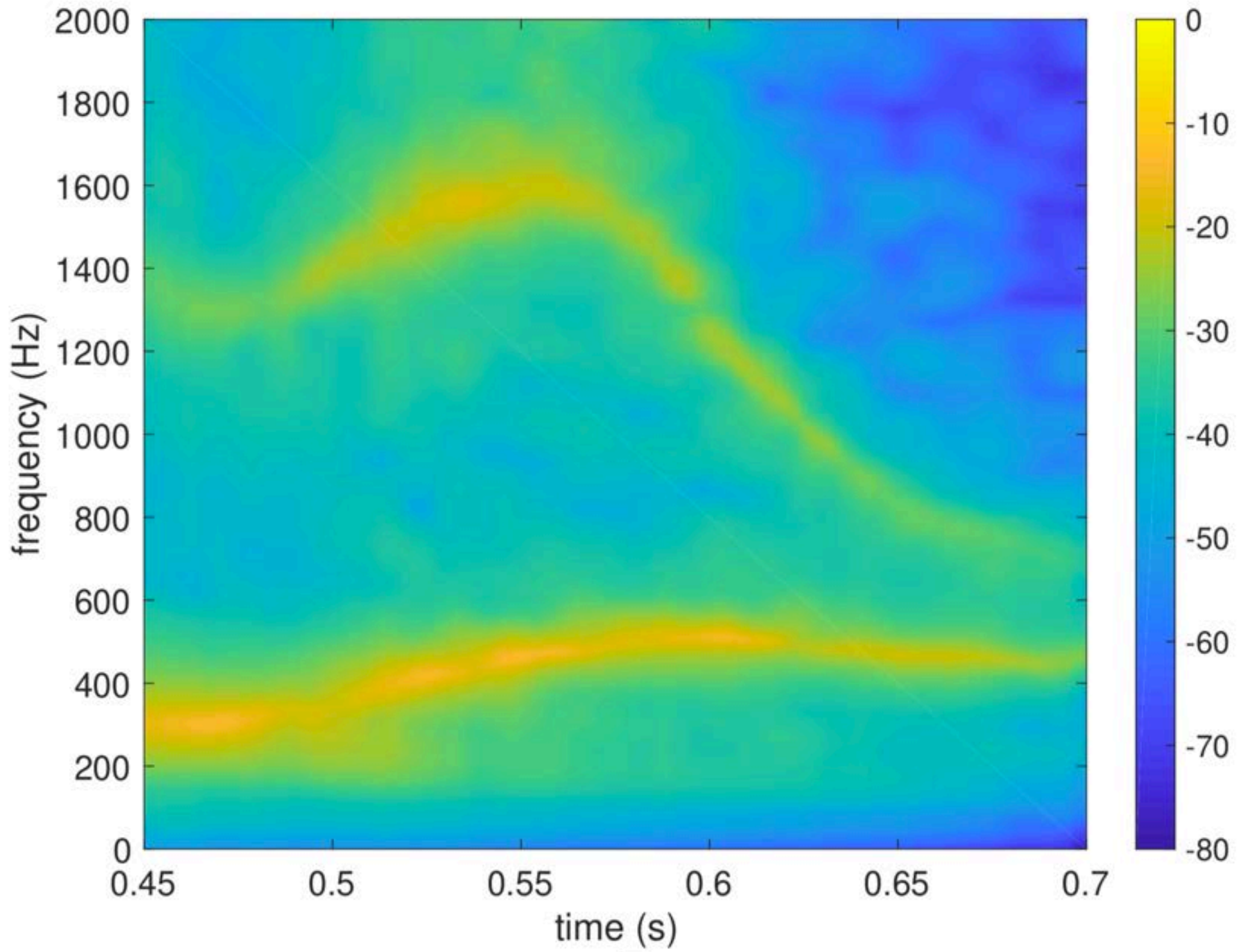


**sgramTFstat**





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