

Pressure signal processing

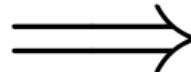
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Thanks to DARPA for funding this work.

Going from raw data to clean spectra

Raw measurements from pinhole (PH) mic.  Cleaned pressure spectra.

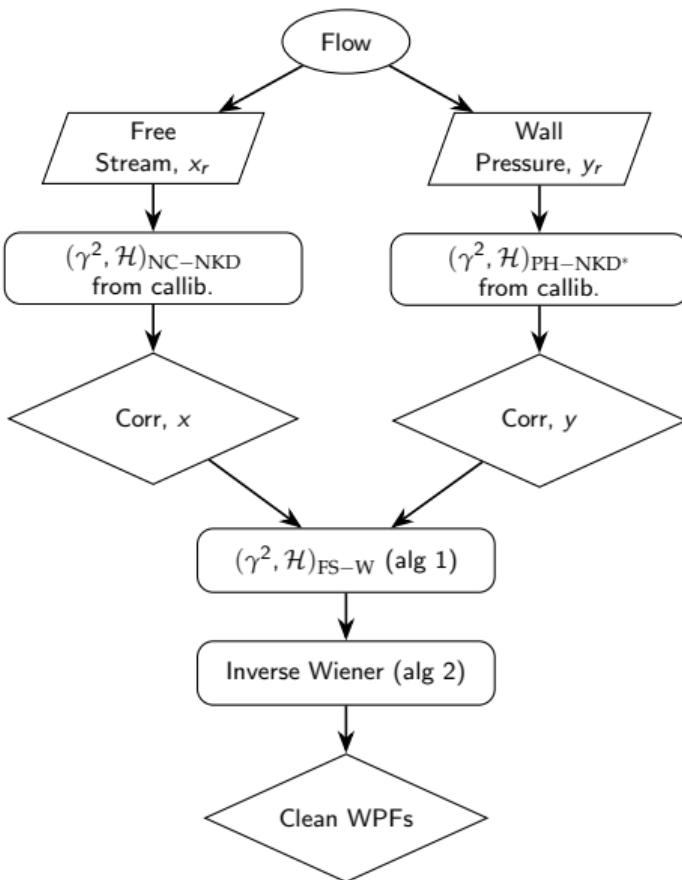
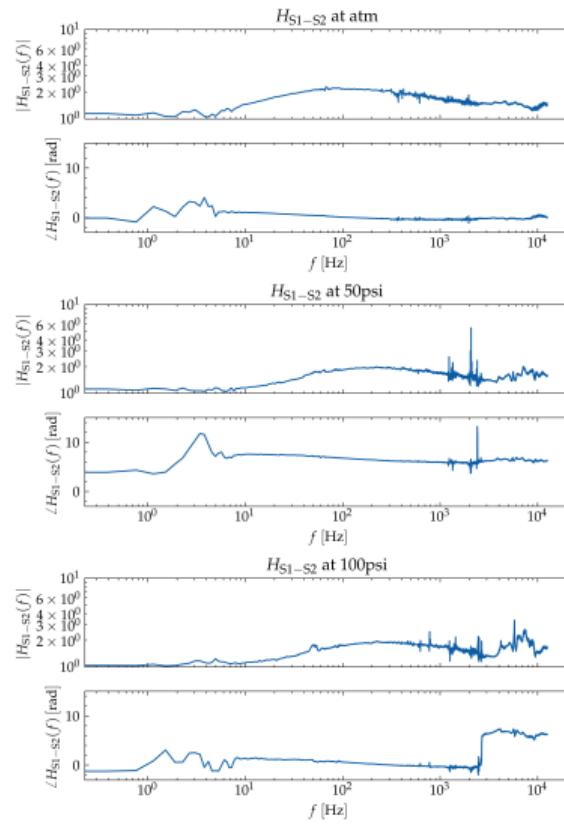
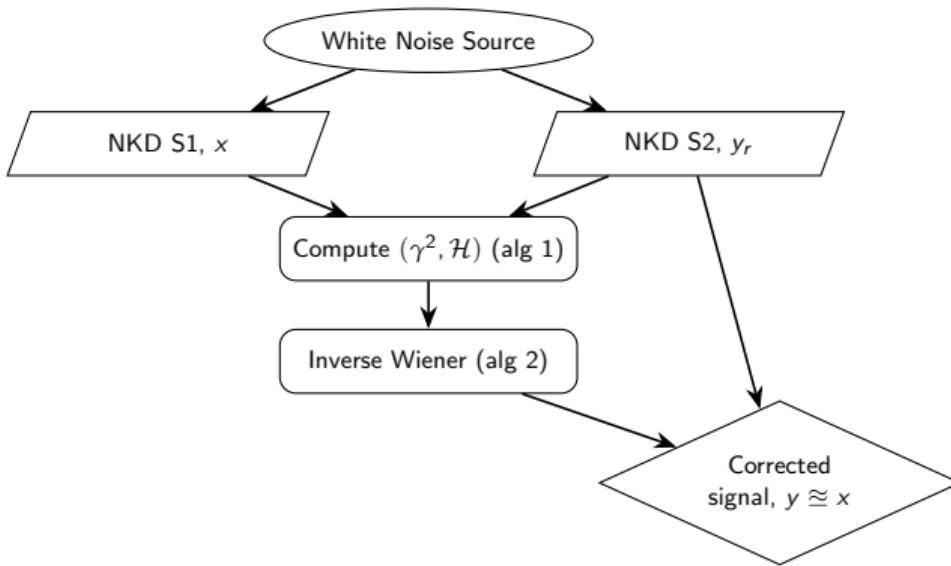
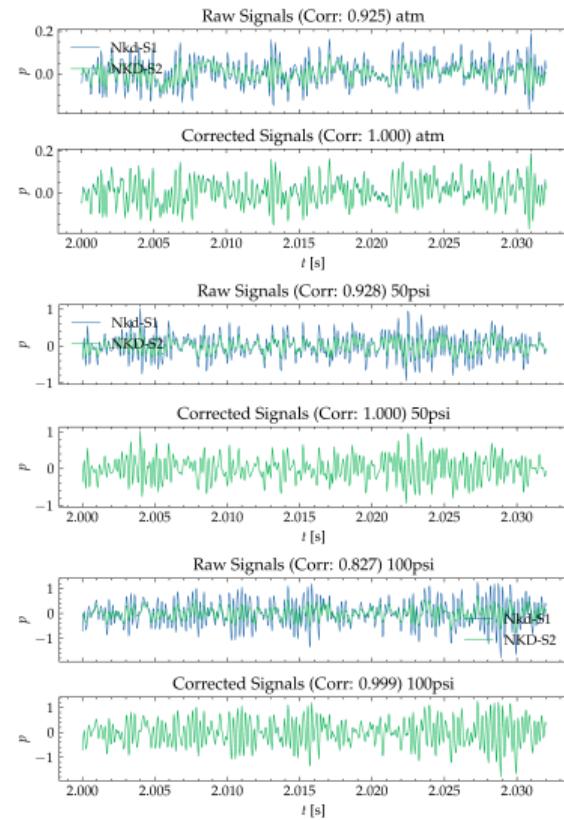
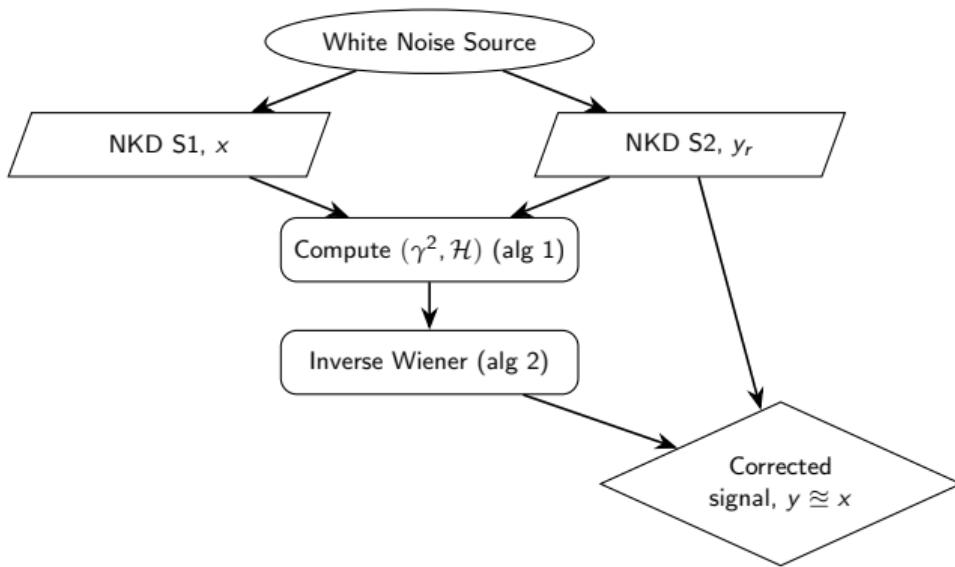


Figure: Complete pressure processing pipeline for measurement of the WPFs through a pinhole microphone.

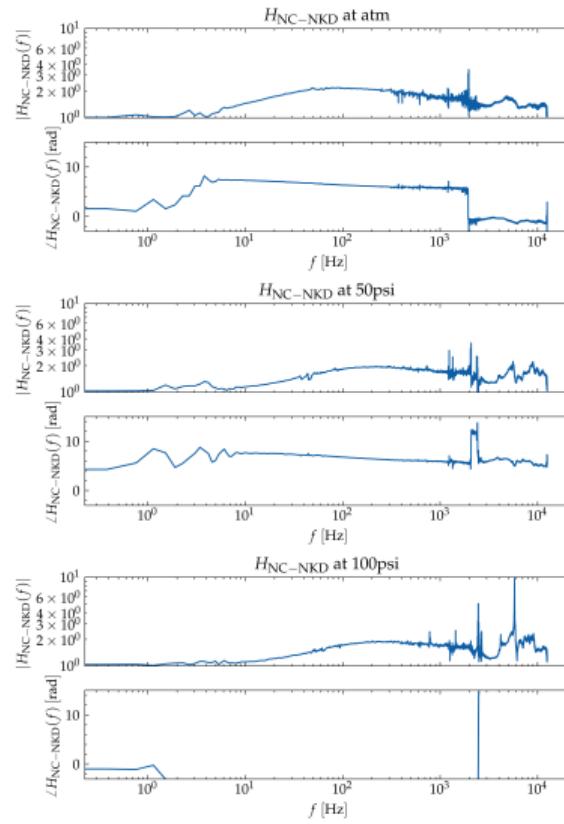
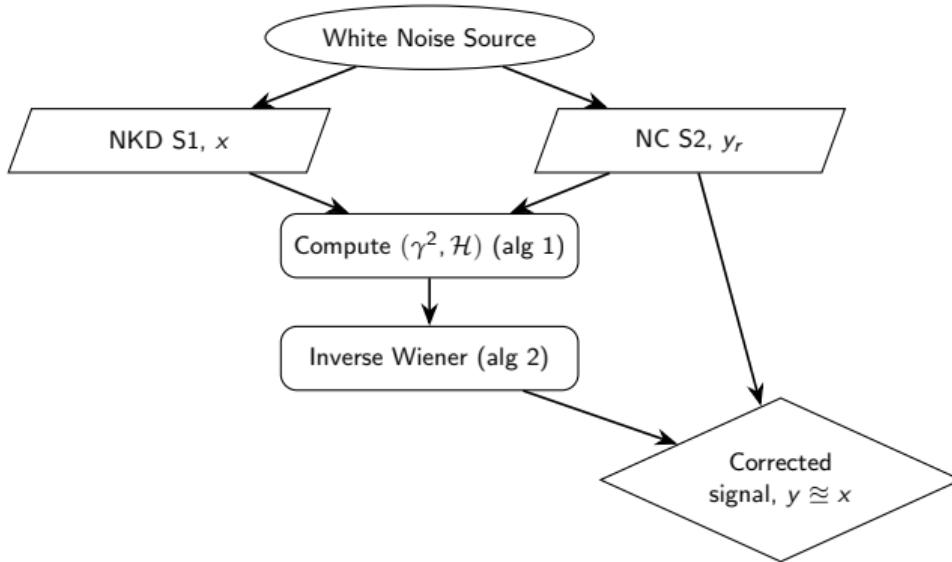
Microphone calibration: Naked (NKD)



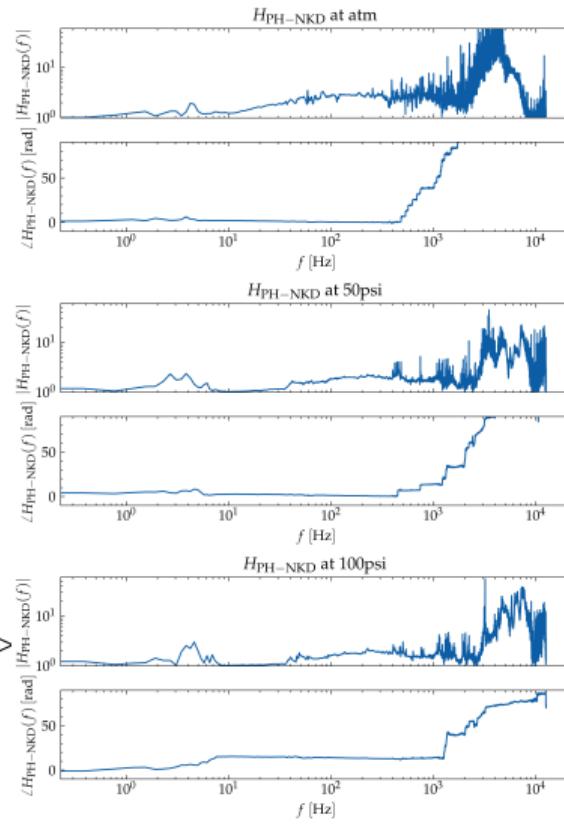
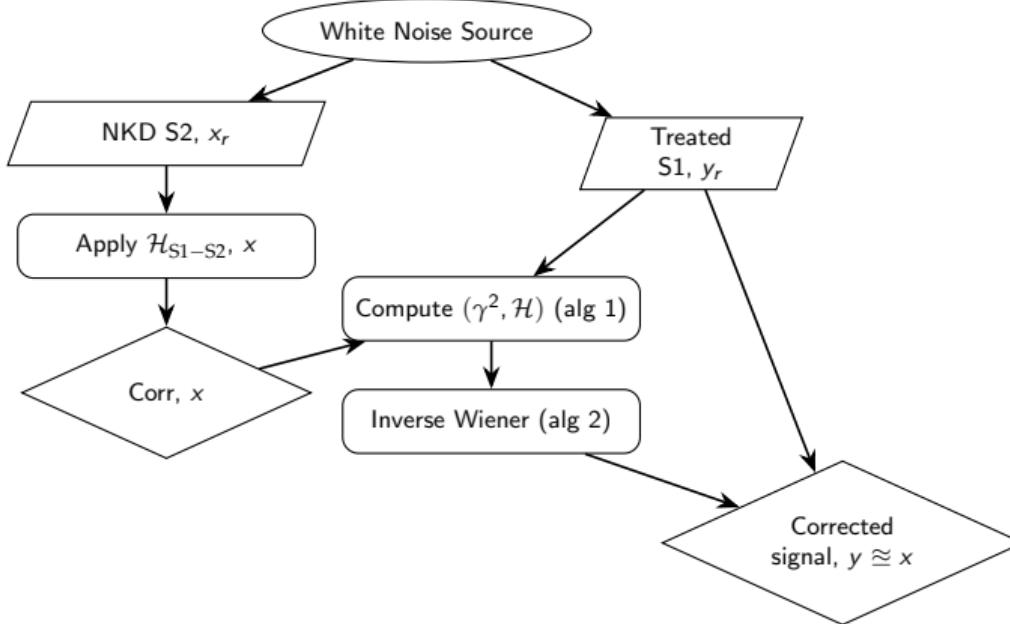
Microphone calibration: Naked (NKD)



Microphone calibration: Nose Cone (NC)

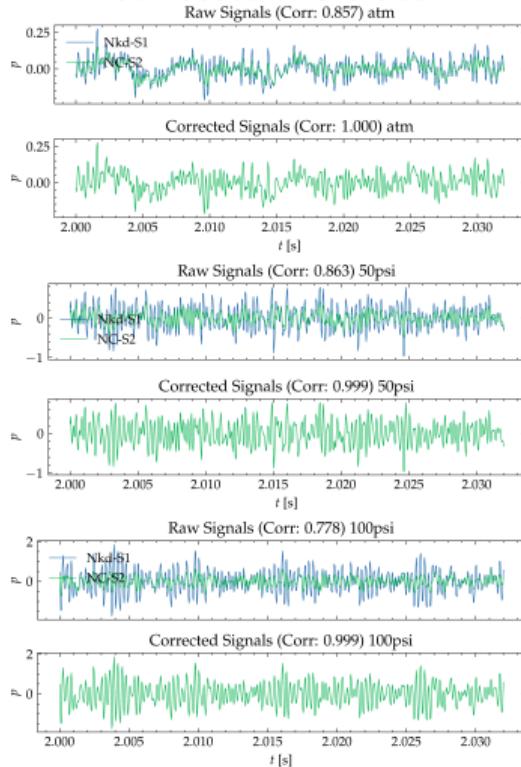


Microphone calibration: Pinhole (PH)

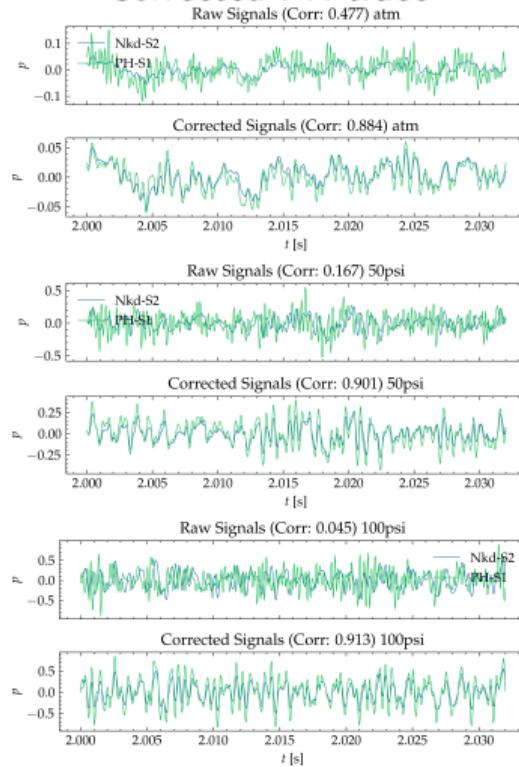


Corrected signals

Corrected NC trace



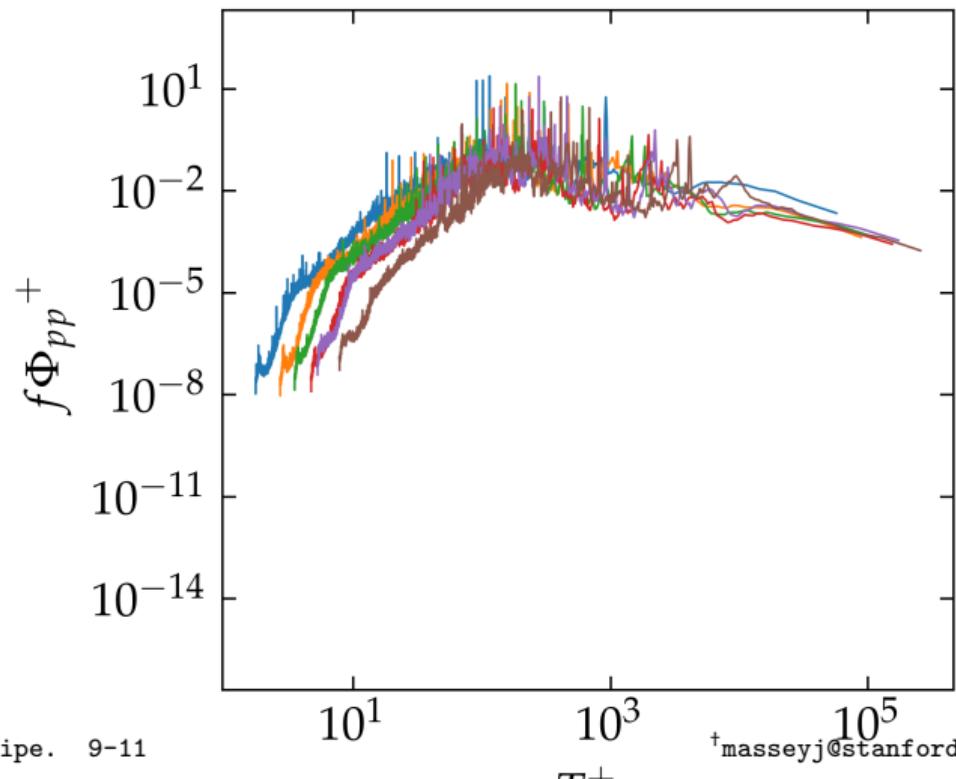
Corrected PH trace



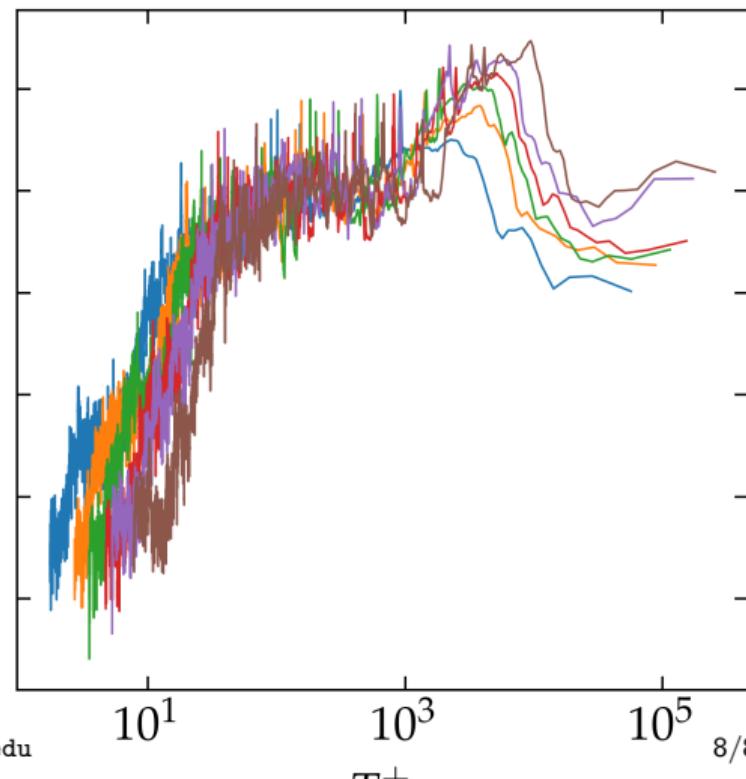
Raw vs corrected

Corrected NC trace

Raw



Corrected



Calibration algos

Algorithm 1 H Transfer-Function Estimation

Require: $x[n]$ (ref), $y[n]$ (treated), f_s , Welch (N_{seg} , N_{ov} , w)

Ensure: $f[k]$, $H[k]$, $\gamma^2[k]$

- 1: Compute $S_{xx}[k]$, $S_{yy}[k]$ (Welch)
 - 2: Compute $S_{xy}[k]$ (same settings)
 - 3: $H[k] \leftarrow S_{xy}[k]/S_{xx}[k]$
 - 4: $\gamma^2[k] \leftarrow |S_{xy}[k]|^2/(S_{xx}[k]S_{yy}[k])$
 - 5: **return** $(f[k], H[k], \gamma^2[k])$
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Algorithm 2 Coherence-weighted Wiener inverse

Require: y_r , f_s , grid f , $H(f)$, $\gamma^2(f)$

Ensure: y

- 1: $y_r \leftarrow y_r - \text{mean}(y_r)$
 - 2: $\hat{y}_r \leftarrow \mathcal{F}(y_r, N_{\text{fft}})$
 - 3: $m \leftarrow |H|$, $\phi \leftarrow \text{unwrap}(\angle H)$
 - 4: Interp m, ϕ, γ^2 to FFT grid $\Rightarrow m_i, \phi_i, \gamma_i^2$
 - 5: $H_i \leftarrow m_i e^{j\phi_i}$; $\varepsilon \leftarrow \text{machine epsilon}$
 - 6: $H_{\text{inv}} \leftarrow \gamma_i^2 H_i^*/\max(m_i^2, \varepsilon)$
 - 7: $H_{\text{inv}}[0] \leftarrow 0$ (& Nyquist if present)
 - 8: $y \leftarrow \Re\{\mathcal{F}^{-1}(\hat{y}_r \cdot H_{\text{inv}})[0:N]\}$
 - 9: **return** y
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