Problem: Estimate c_1

$G(t, c_1, T_{21}, T_{22}) := c_1 \exp(-t/T_{21}) + (1 - c_2) \exp(-t/T_{22})$

$s := \sqrt{(G + \xi)^2 + \eta^2}$ (Rician noise)

Time (s)

Approach: Use ILR with $\lambda-$estimation

ILR

Input-Layer Regularized Input Vector

Noisy Signal

Regularized Signal

Noise
RNLLS

$H_1 \in \mathbb{R}^{32}$ $H_3 \in \mathbb{R}^{256}$

Input $\in \mathbb{R}^{64}$ **Output** $\in \mathbb{R}^3$

$T_{2,1}$

$T_{2,2}$

c_1

$H_2 \in \mathbb{R}^{256}$ $H_4 \in \mathbb{R}^{32}$

$\lambda_{GCV} = \text{argmin} \dfrac{\|R(\lambda)\|^2}{\text{Tr}(I - C(\lambda))^2}$

Noisy measurement

Input Layer Regularized Vector

$(c_1^{est}, T_{21}^{est}, T_{22}^{est})$

Input Layer Regularization (ILR) Network

(ND, Reg)

λ_{NN}

λ-estimation

Results

−0.5 −0.4 −0.3 −0.2 −0.1 0.0 0.1 0.2 0.3 0.4 0.5

(ND, ND) Superior   (ND, Reg), λ_{GCV} Superior

SNR	5.0	50.0	100.0
$(\text{ND, Reg})_{NN}$ RMSE$_{c_1}$	0.1652	0.0931*	0.0796*
$(\text{ND, Reg})_{GCV}$ RMSE$_{c_1}$	0.1643*	0.0945	0.0817
(ND, ND) RMSE$_{c_1}$	0.1671	0.1079	0.0935
TR-NLLS RMSE$_{c_1}$, λ_{oracle}	0.2328	0.2092	0.2078
TR-NLLS RMSE$_{c_1}$, λ_{GCV}	0.3687	0.3487	0.3347
NLLS RMSE$_{c_1}$	0.3844	0.3471	0.3453