

Pre-processing for AngLoc Indoor Location Fingerprinting using Wi-Fi CSI

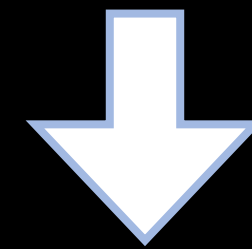
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2021.06.24

INTRODUCTION

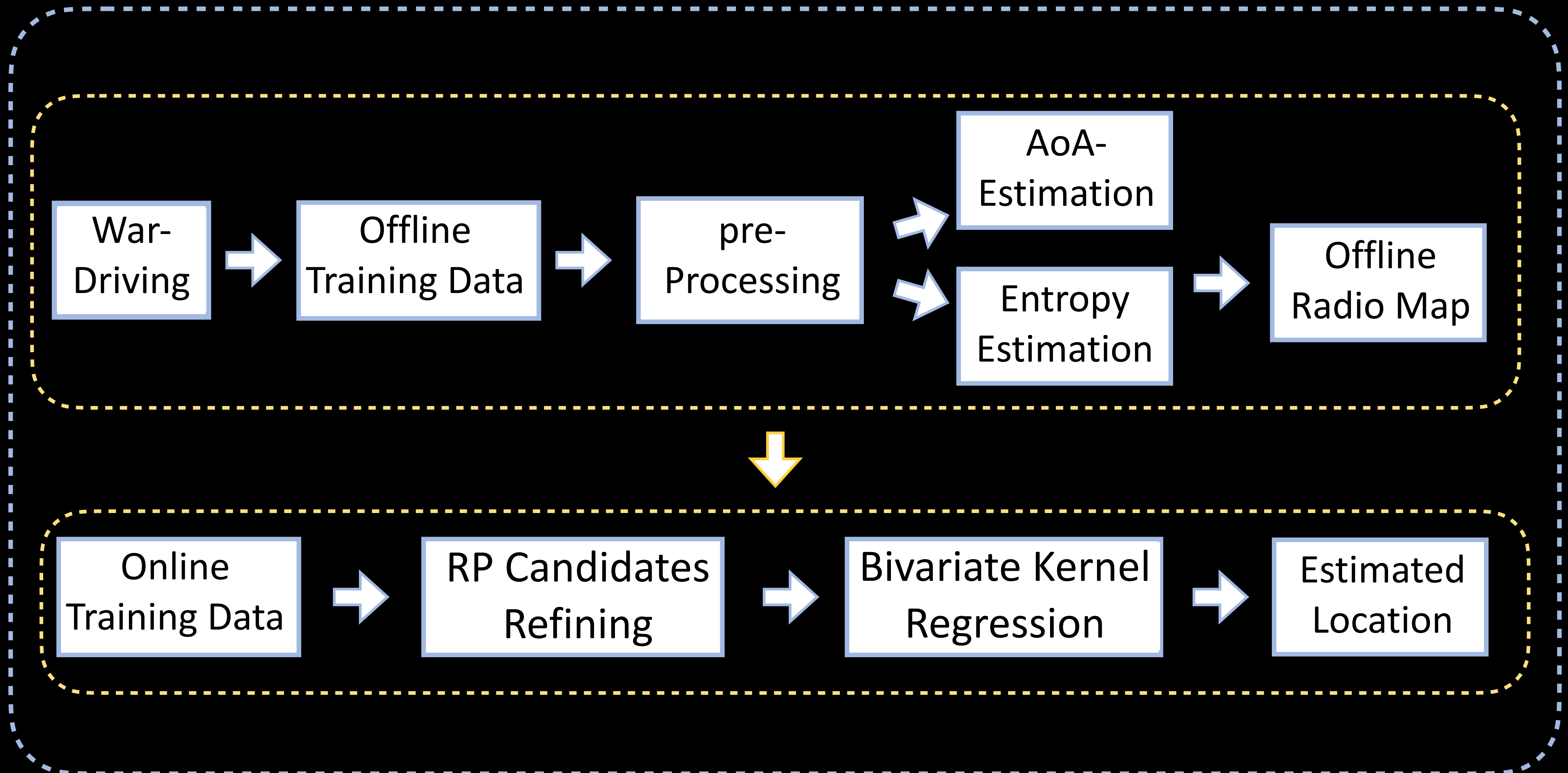
Based on this paper

AoA-aware Probabilistic Indoor Location
Fingerprinting using Channel State Information

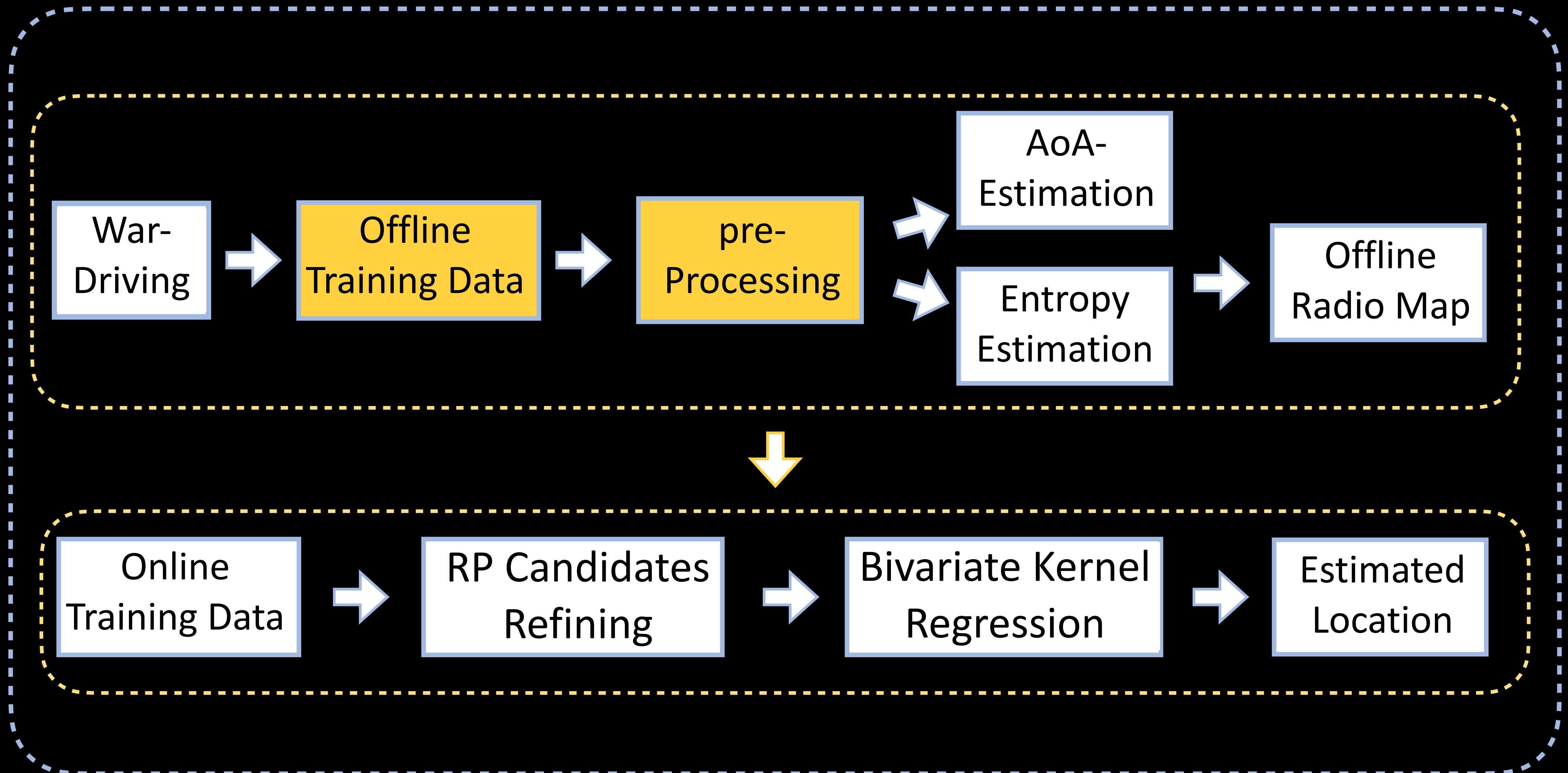


AngLoc system

Introduction—AngLoc system



Introduction—AngLoc system



Data Setup

end-to-end **MIMO-OFDM** wireless transceiver for IEEE 802.11 n/ac

4

Reference points

3000

CSI packets

2

RX antennas

2

TX antennas

56

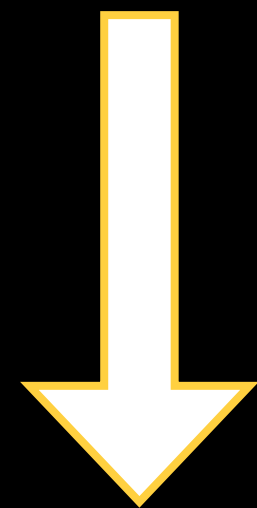
subcarriers

Data Setup — CSI

CFR(channel frequency response)

$$H(f) = |H(f)| e^{j\angle H(f)}$$

IFFT

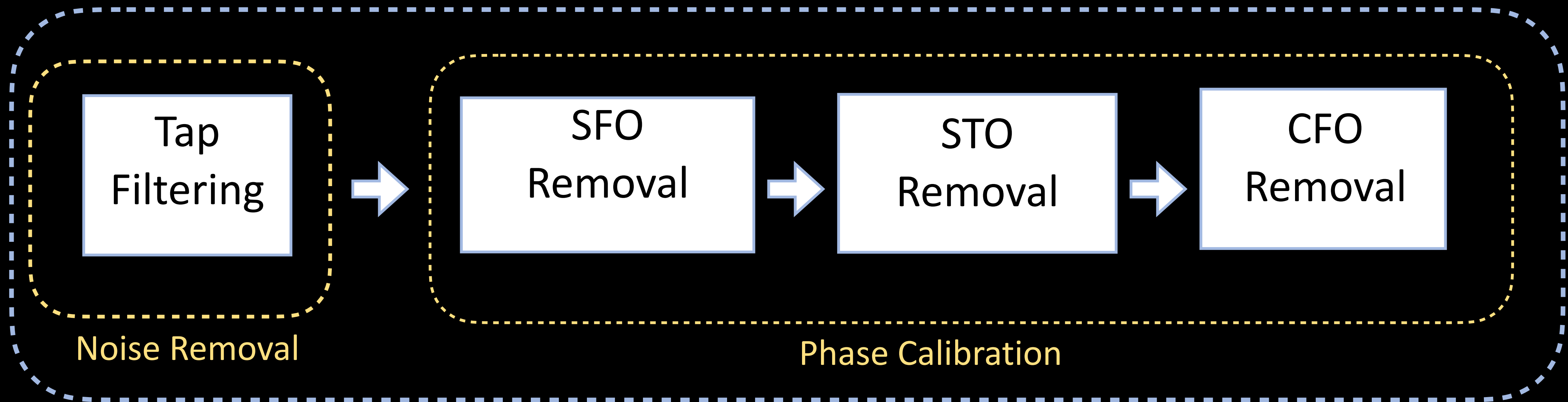


FFT

CIR(channel impulse response)

$$h(\tau) = \sum \alpha_i e^{-j\phi_i} \delta(\tau - \tau_i)$$

SYSTEM DESIGN

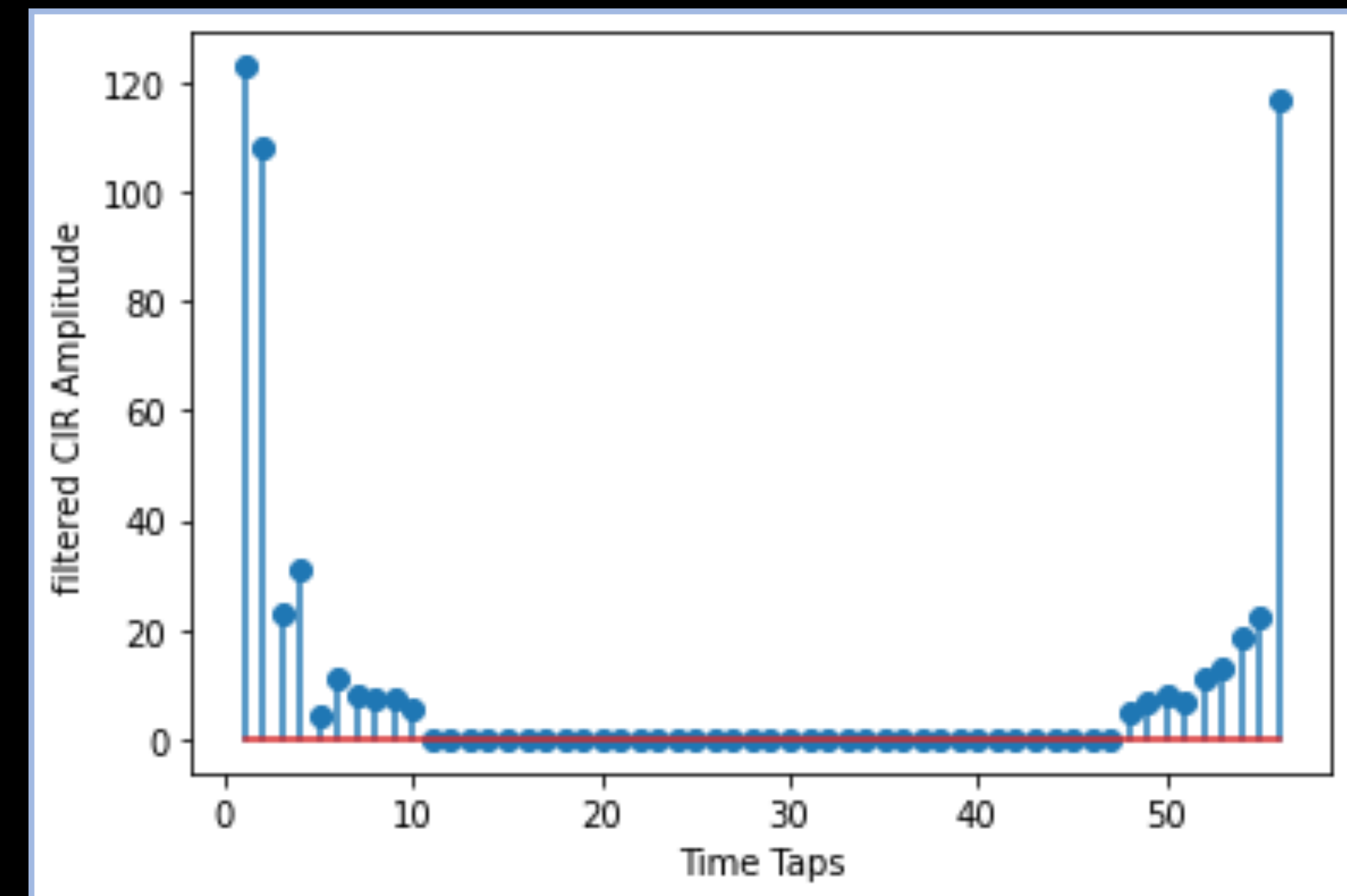
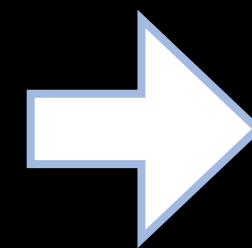
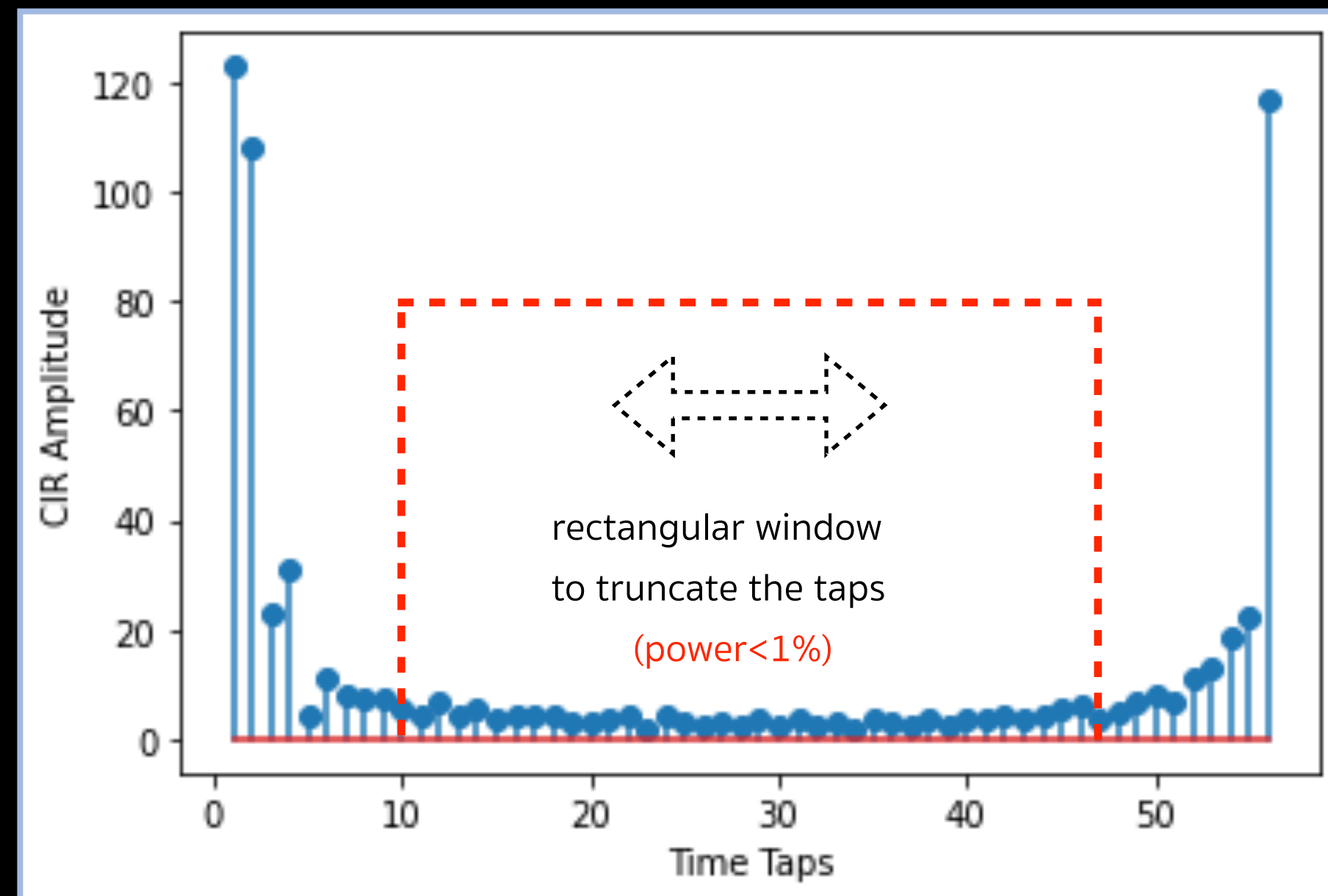


SYSTEM DESIGN — Tap Filtering

an individual raw CFR signature as $H \in \mathbb{C}^{1 \times 56}$

convert H into the same dimensional CIR vector h

the power of each tap : $U = (u_1, \dots, u_k, \dots, u_K)$, $k \in [1, 56]$, where $u_k = |h_k|^2$



SYSTEM DESIGN — SFO Removal

In OFDM transceiver system
when the receiver's ADC sampling rate differs from the transmitter's
synthesization rate
—> SFO occurs

for the k^{th} subcarrier from n_t^{th} TX to n_r^{th} RX :
estimated $\xi\text{sfo} = \underset{\rho}{\operatorname{argmin}} \sum (\varphi_{n_t, n_r}^k + 2\pi f_\delta k \rho + \omega)^2$
(ρ and ω are curve fitting variables, f_δ is subcarrier spacing)
—> the SFO removed $\angle \hat{H}(f_k) = \angle H(f_k) - 2\pi f_\delta k \xi\text{sfo}$

SYSTEM DESIGN — STO Removal

The receiver utilizes the auto/crosscorrelator to detect the presence of the OFDM symbol header, which starts with STFs. The length limitation of these STFs brings great uncertainty to determine the symbol boundary.

—> STO occurs

for each packets :

$$N_{sto} = \operatorname{argmax} |h_k|^2, 1 < k \leq 56$$

$$\text{estimated } \varphi_{sto} = -2\pi k N_{sto} / 56$$

$$\text{—> the STO removed } \angle \hat{H}(f_k) = \angle H(f_k) - \varphi_{sto}$$

SYSTEM DESIGN — CFO Removal

when the receiver's carrier frequency for down-conversion mismatches with the transmitted frequency
—> CFO occurs

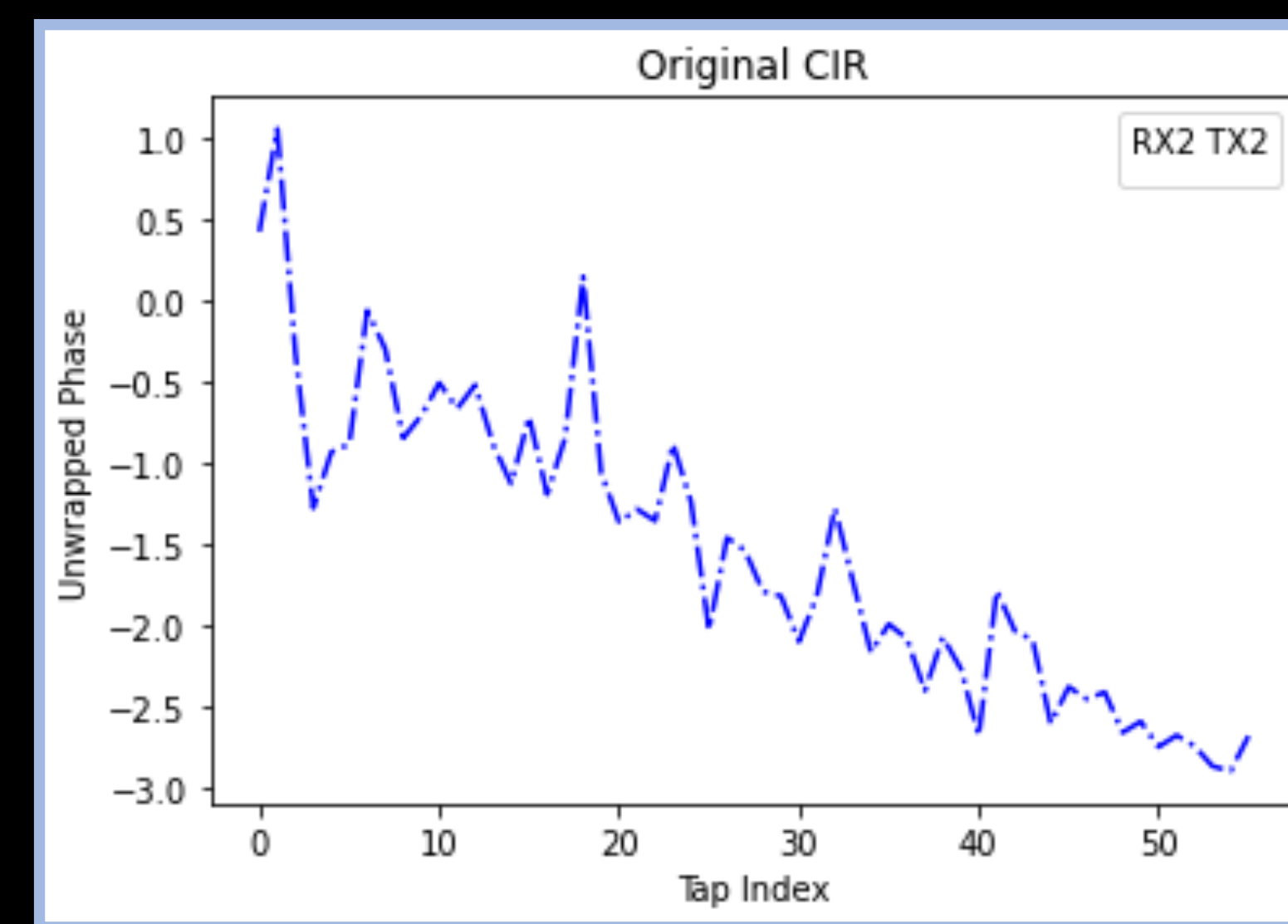
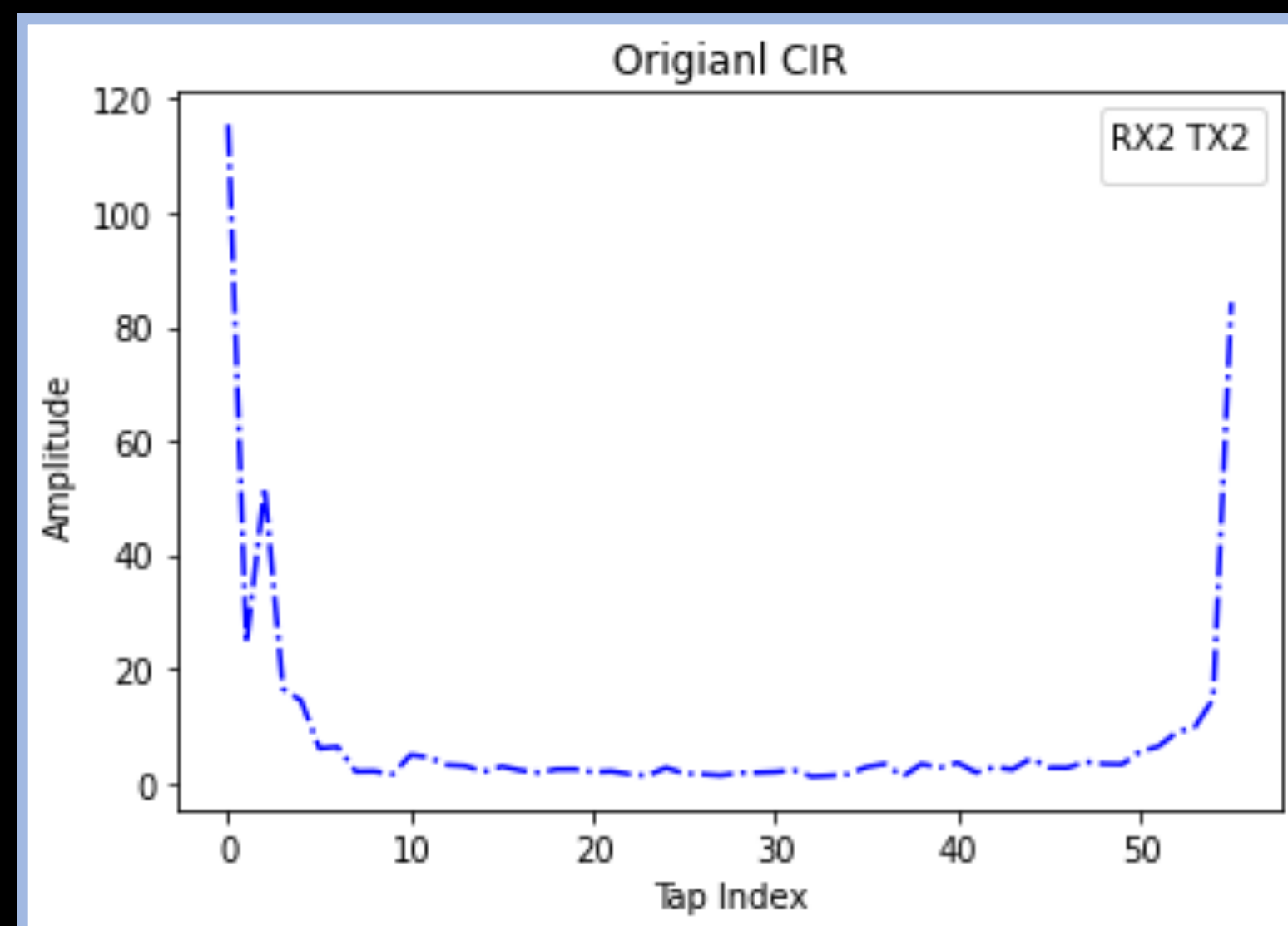
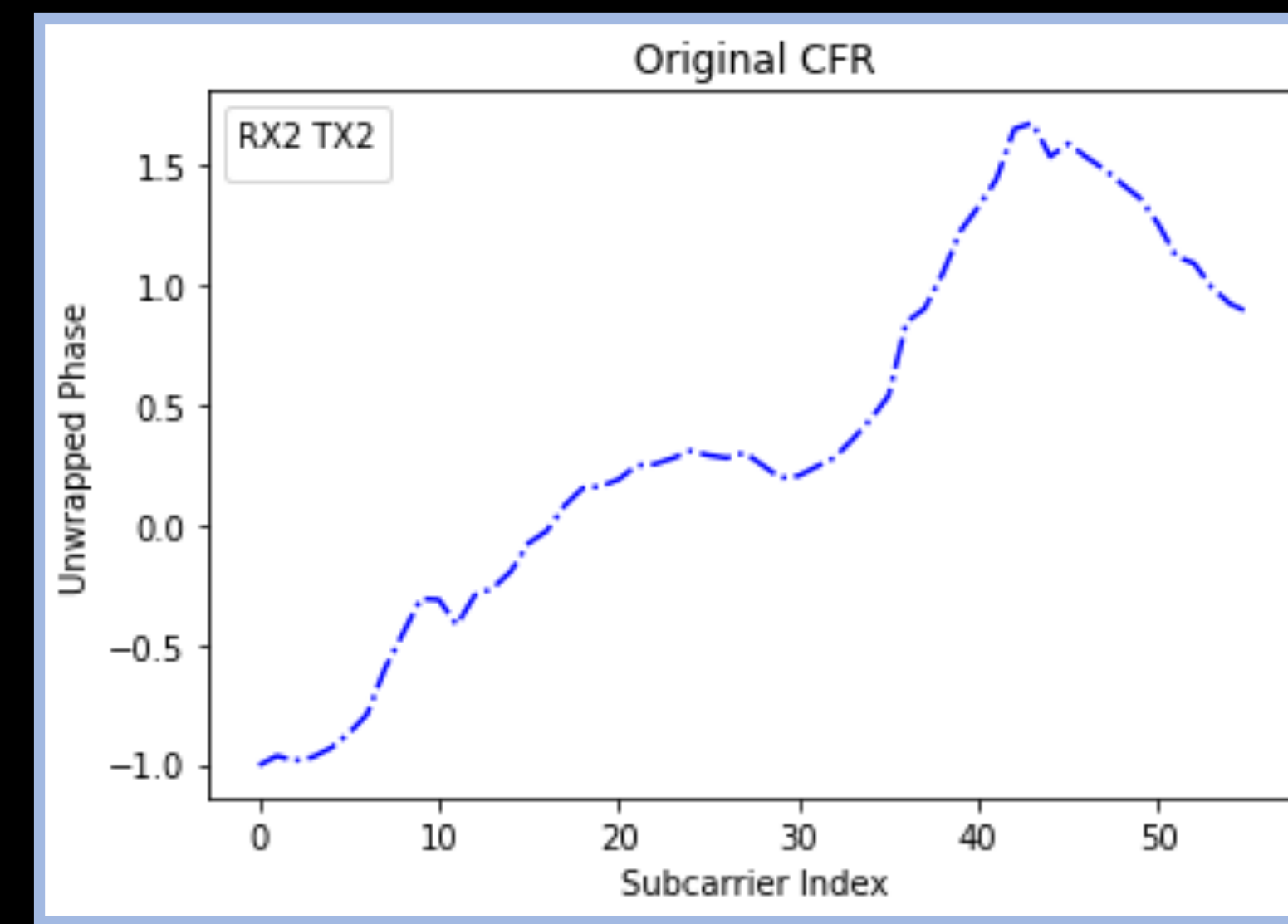
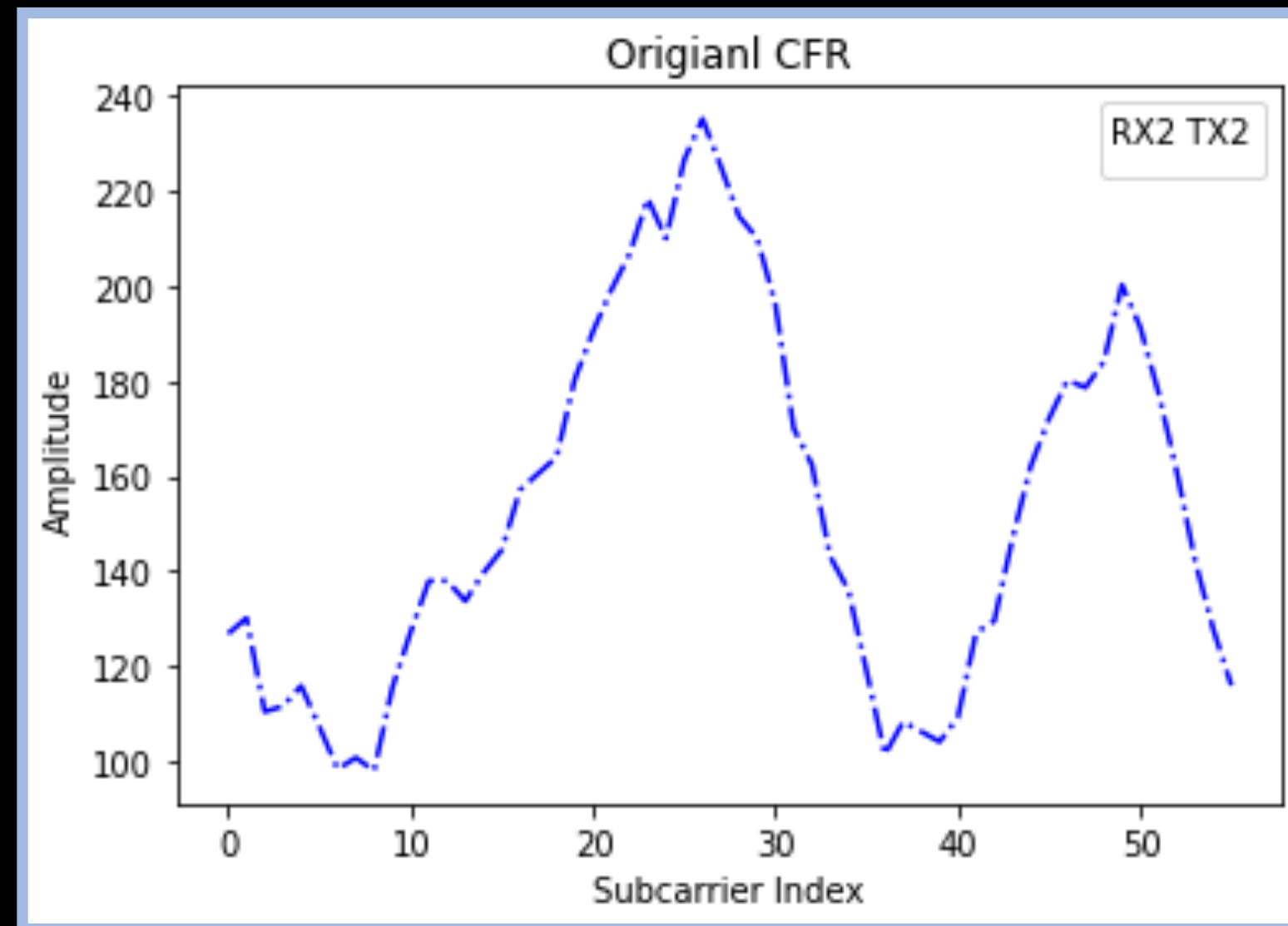
employ a non-overlapping moving window with length $N_p = 30$ for geometric averaging to further smooth out CFO :

$$H = H(1) \circ \dots \circ H(n_p) \circ \dots \circ H(N_p), 1 < n_p \leq N_p$$

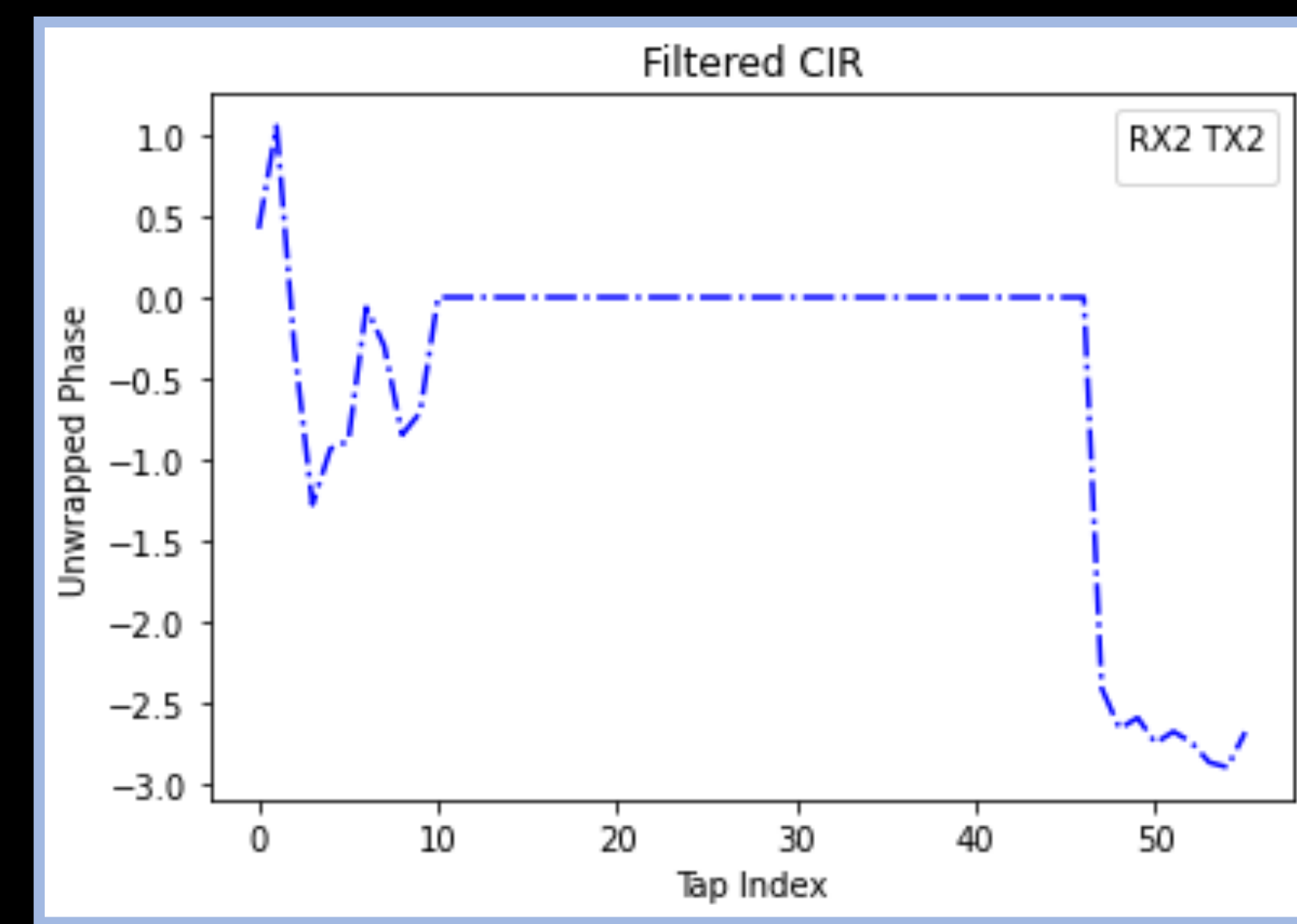
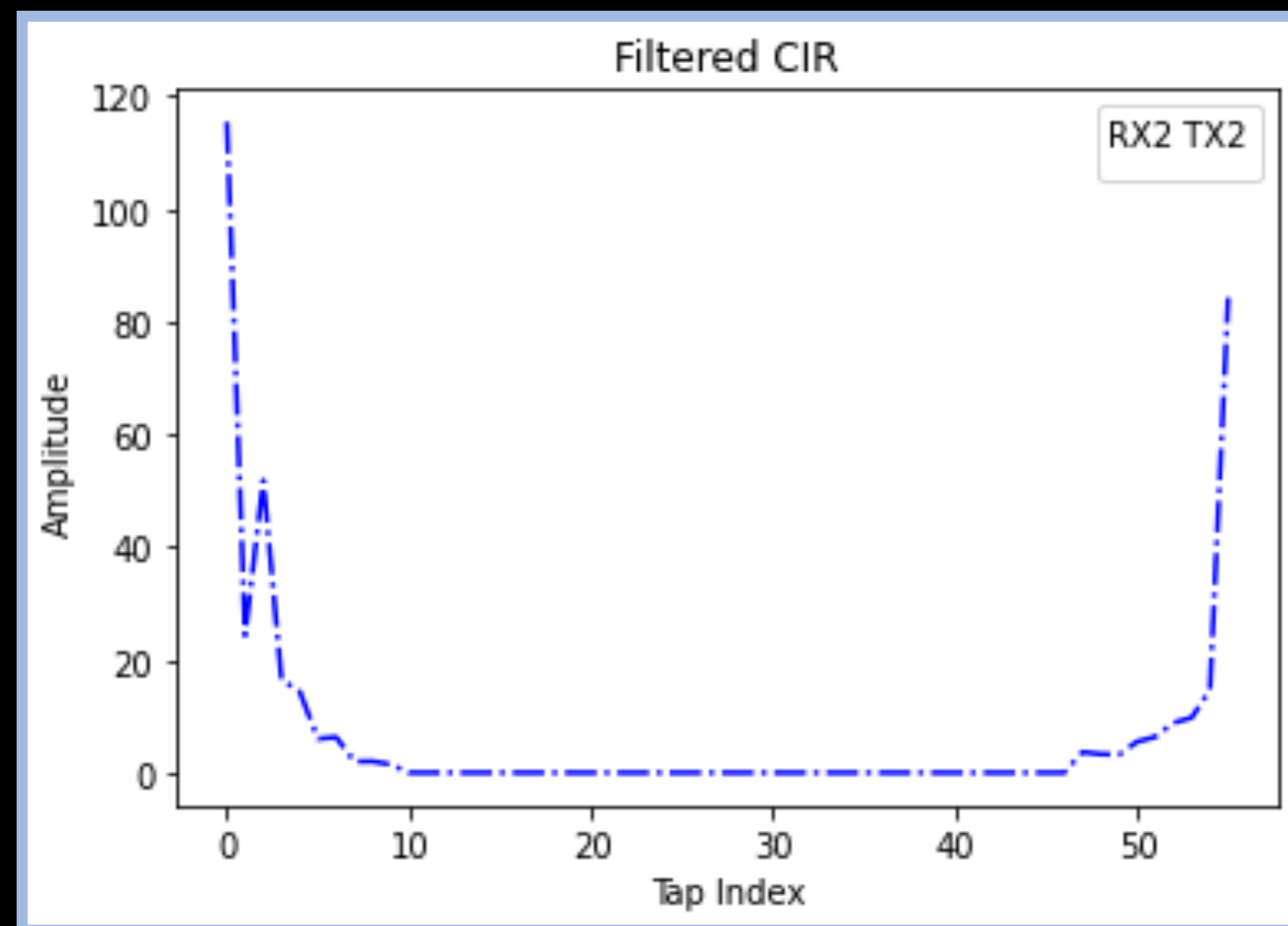
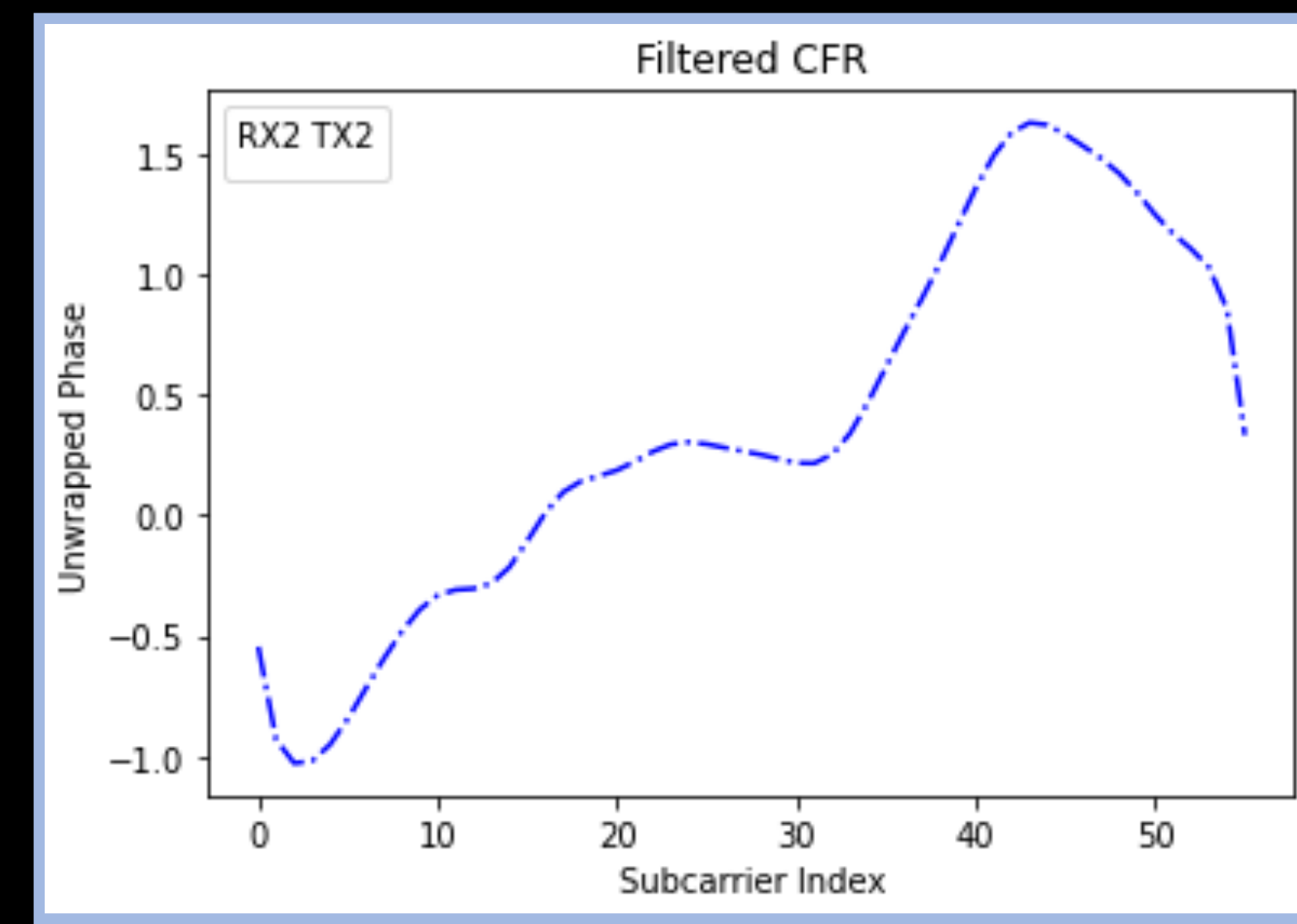
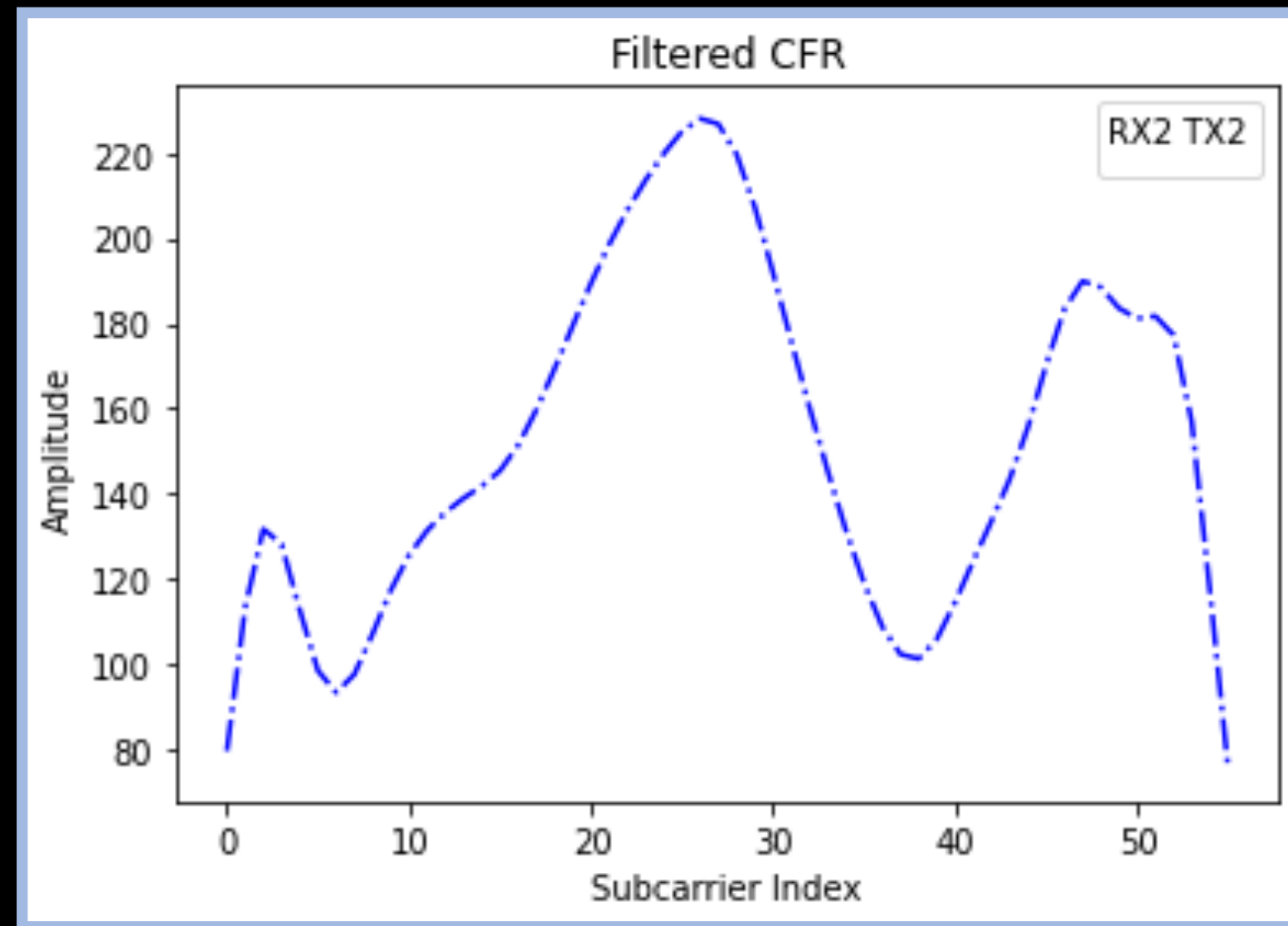
—> the CFO removed $\hat{H} = \{(H_k)^{1/N_p}\}, 1 < k \leq K$

Result

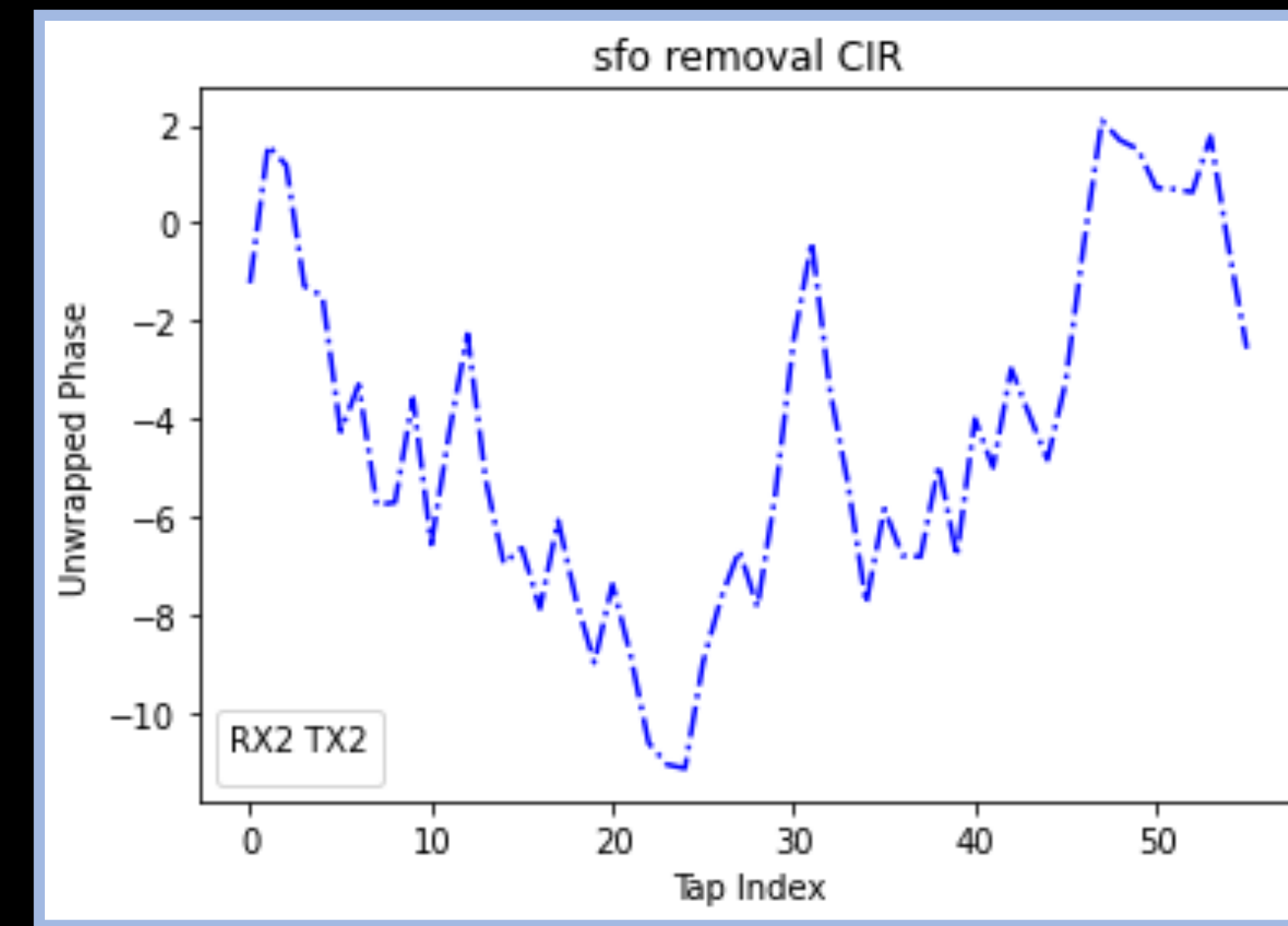
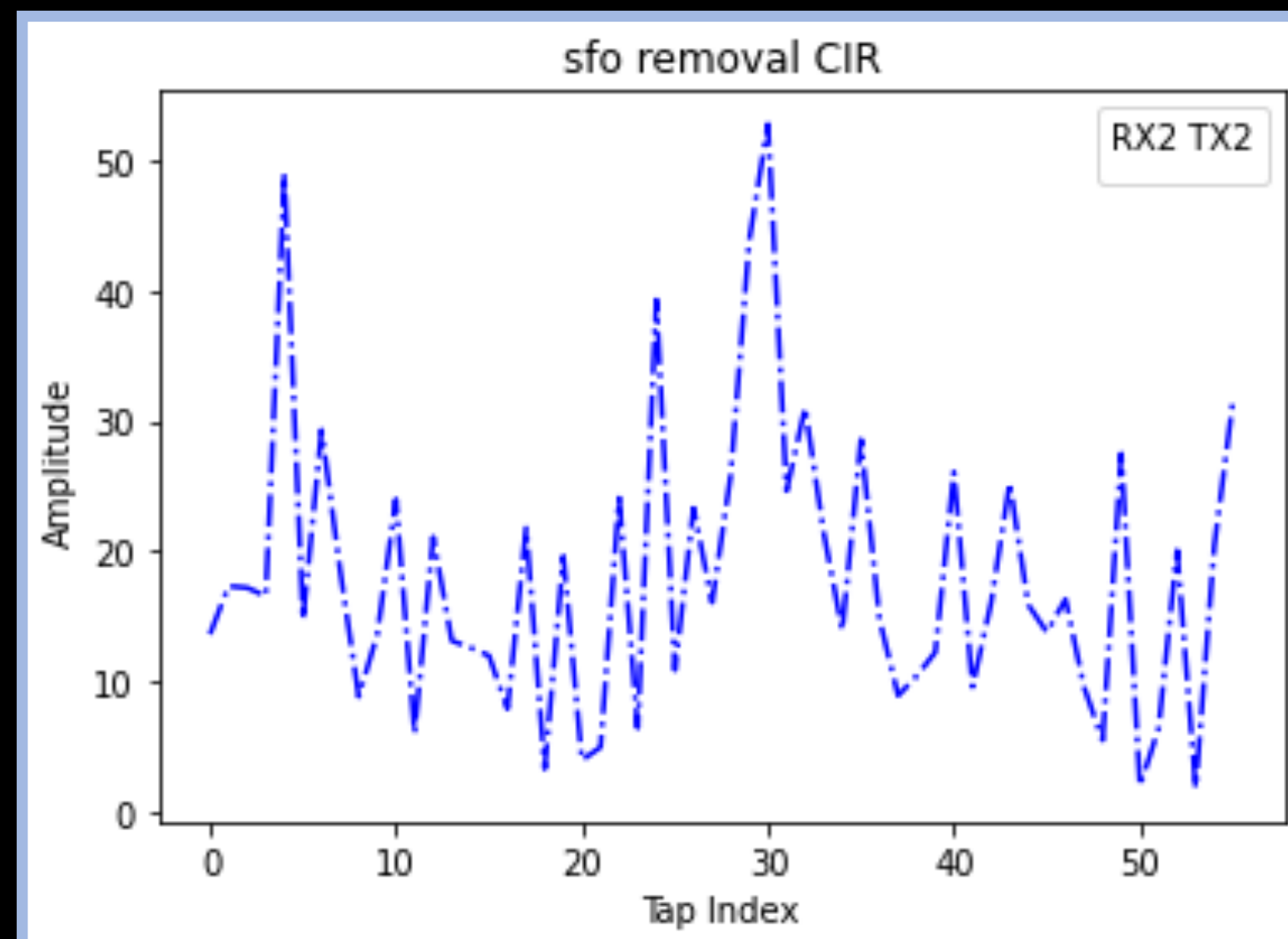
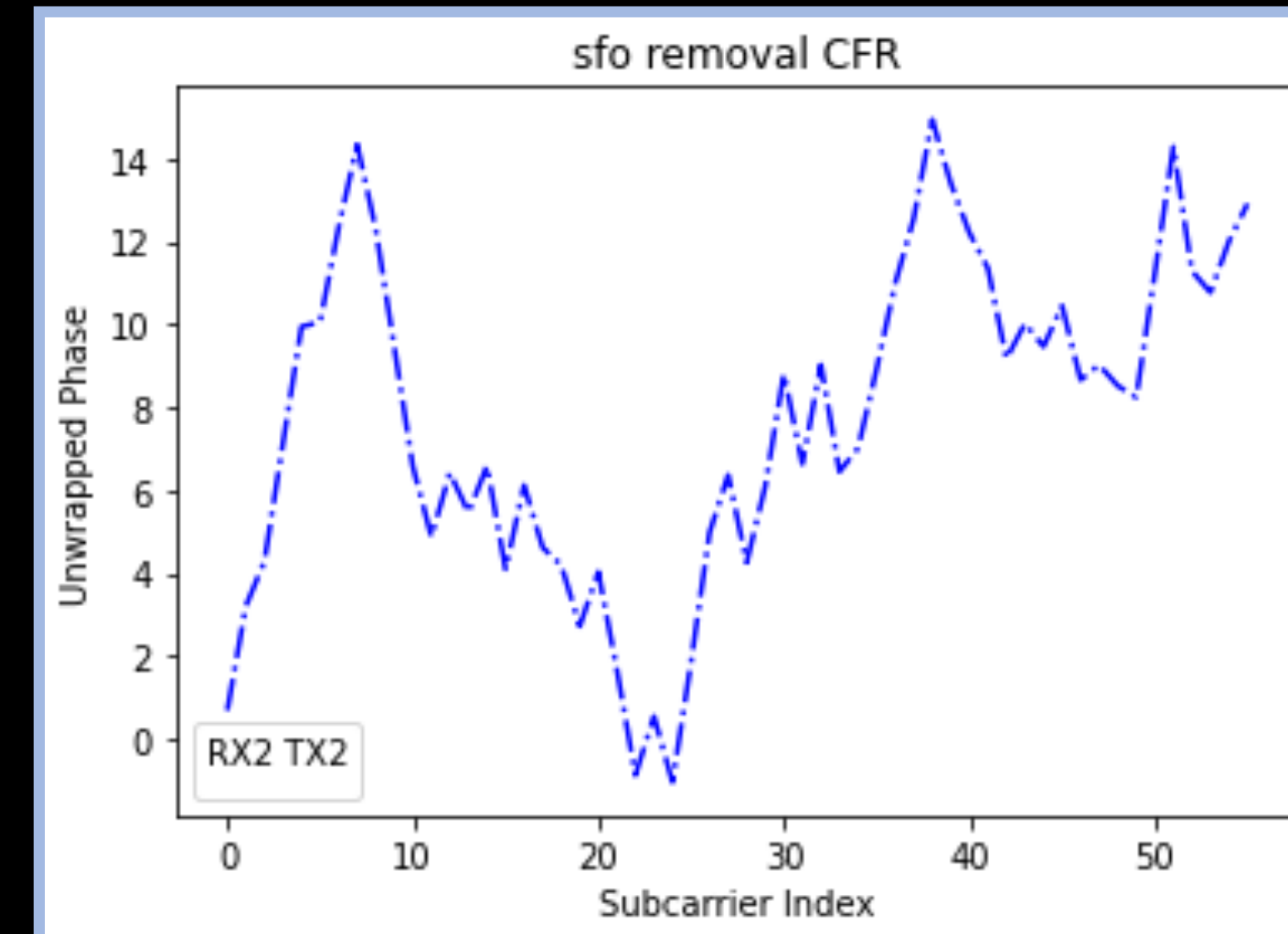
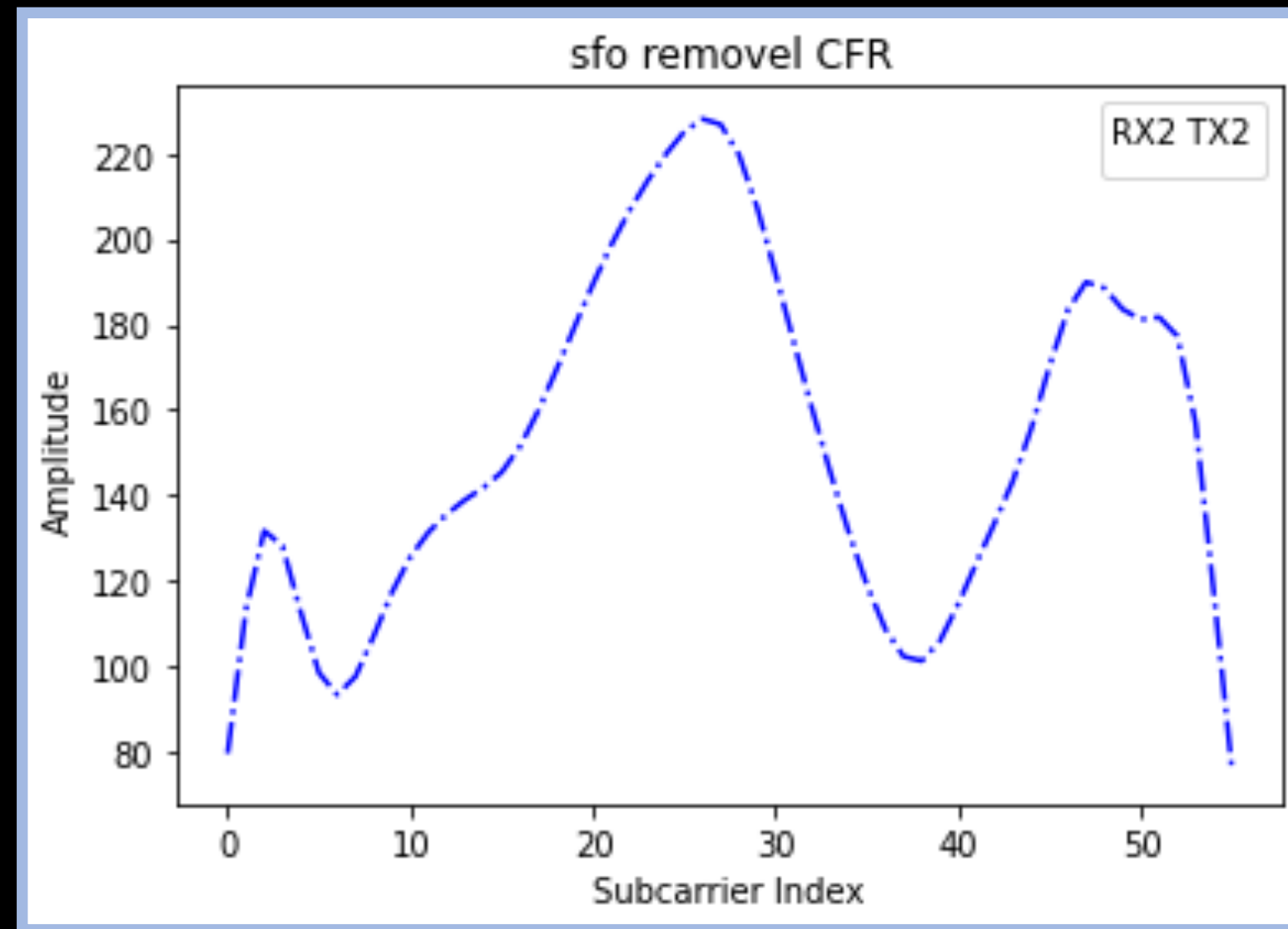
Result—Original



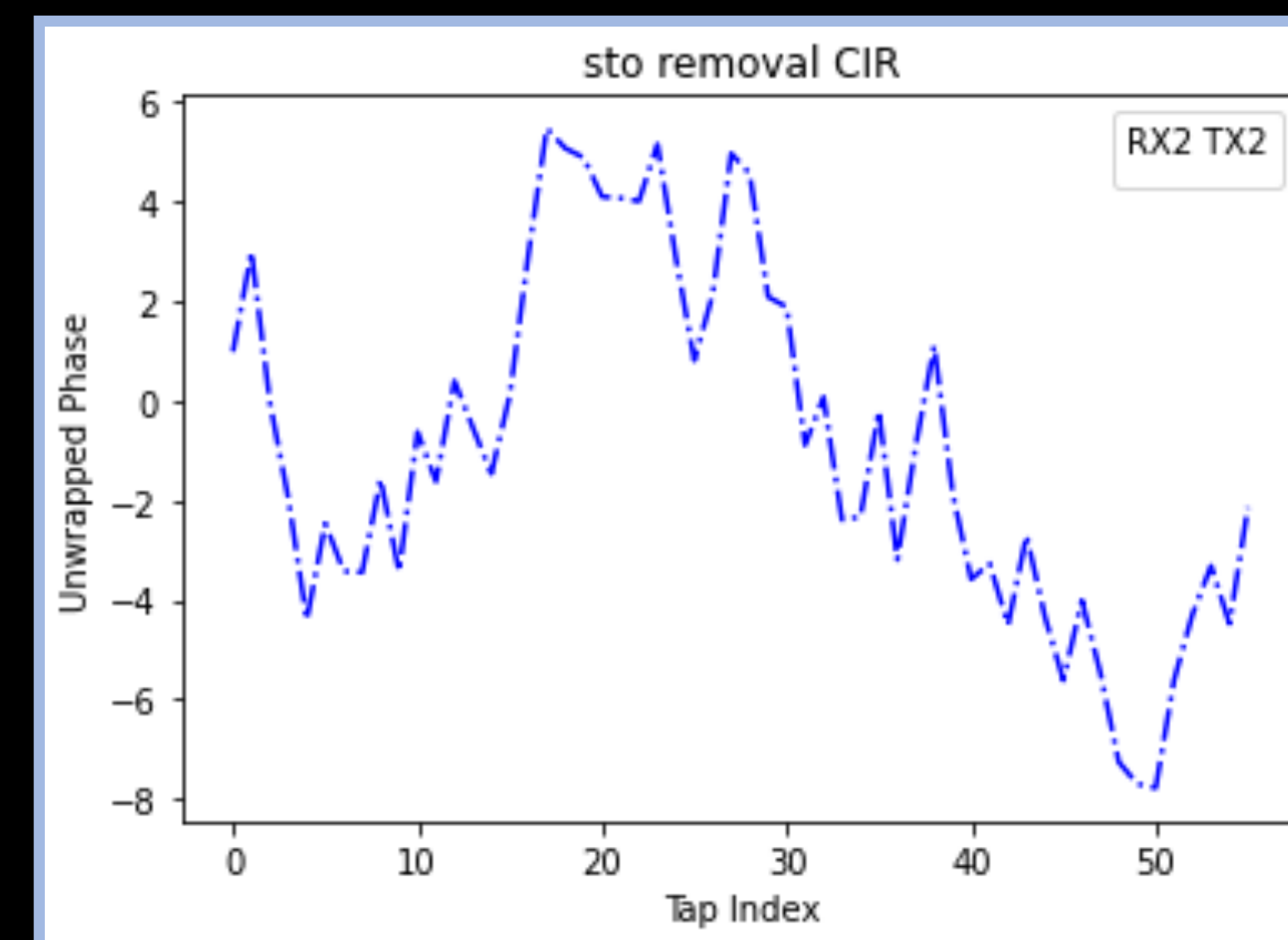
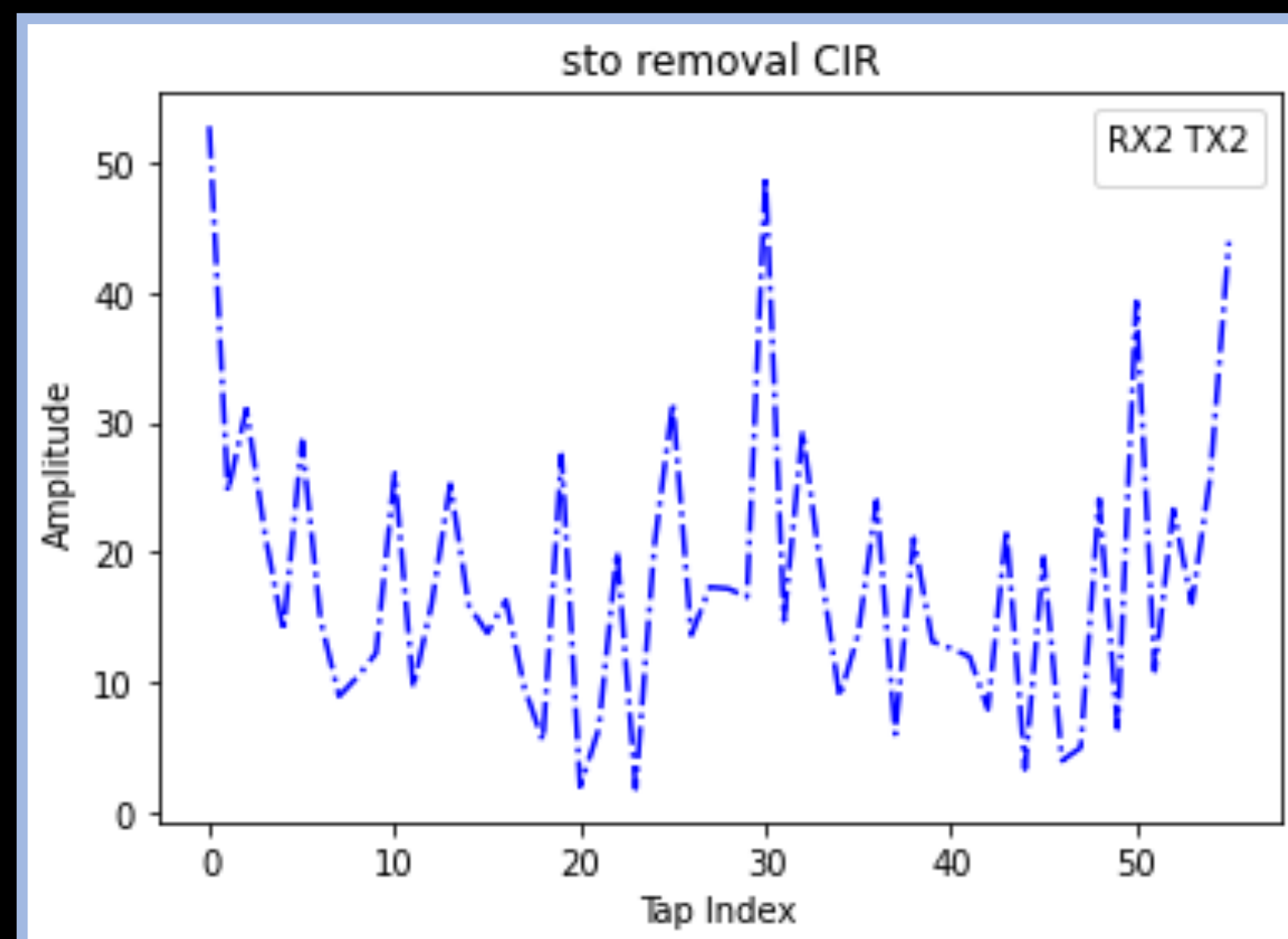
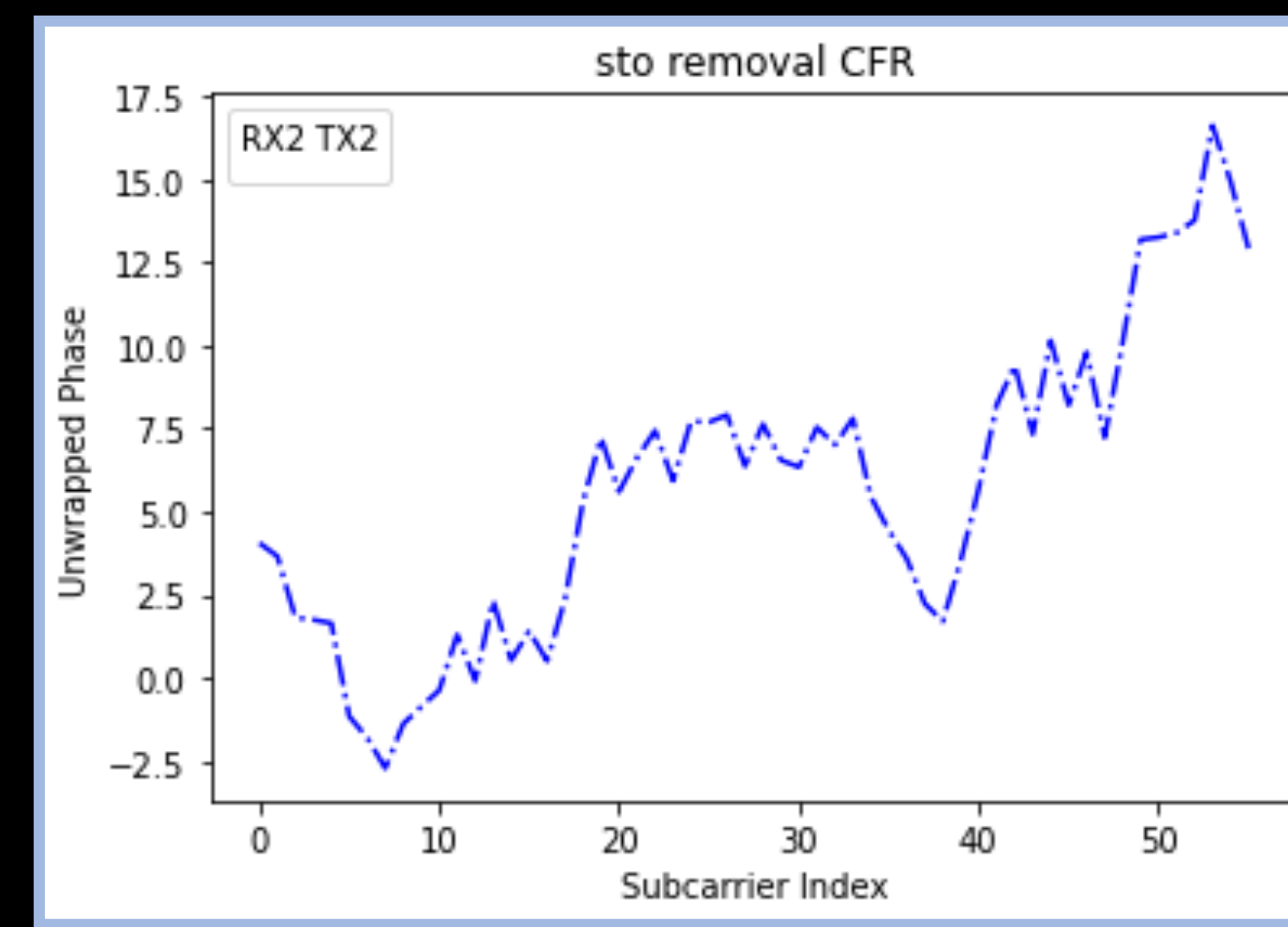
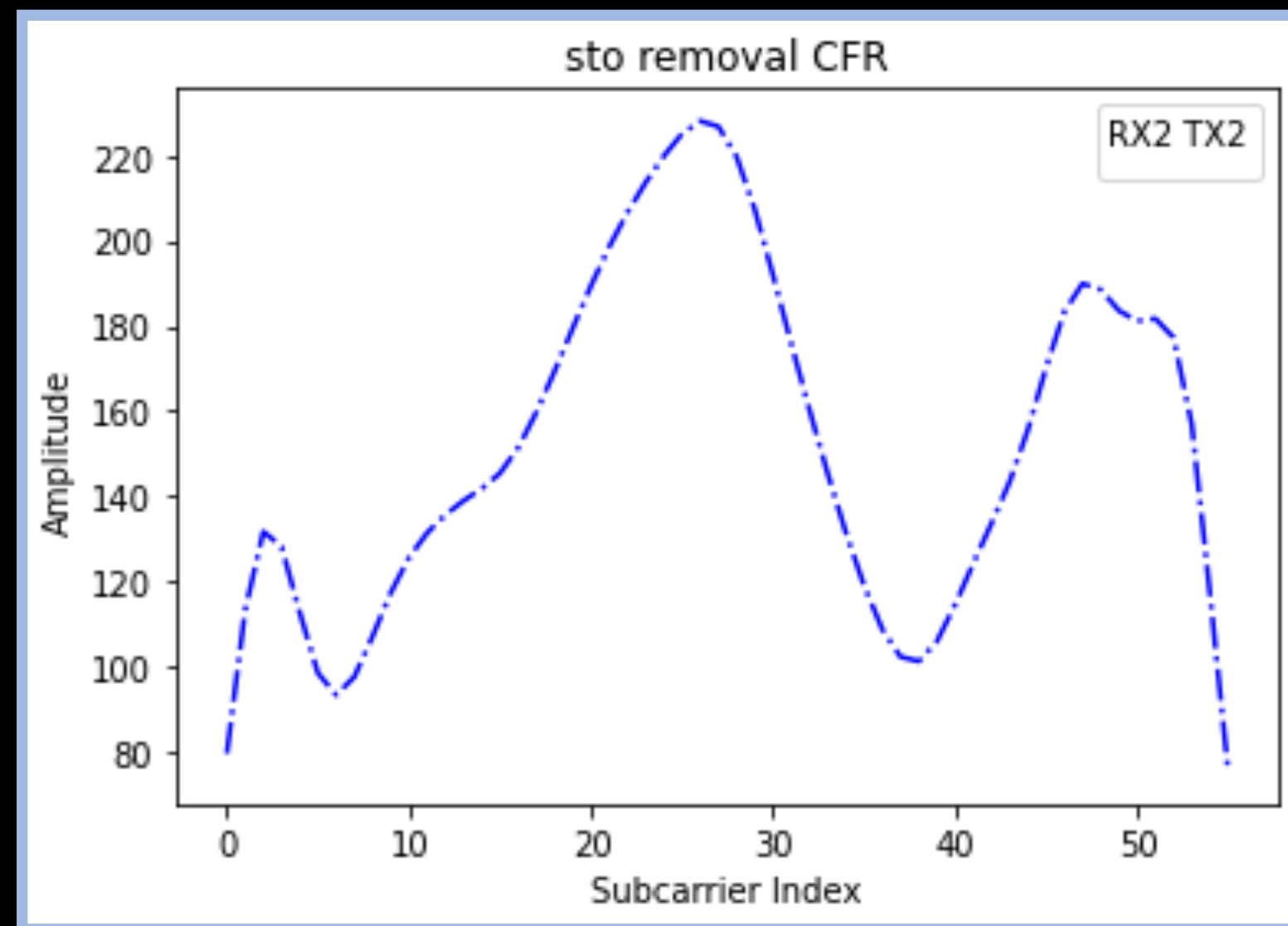
Result— After tap filtering



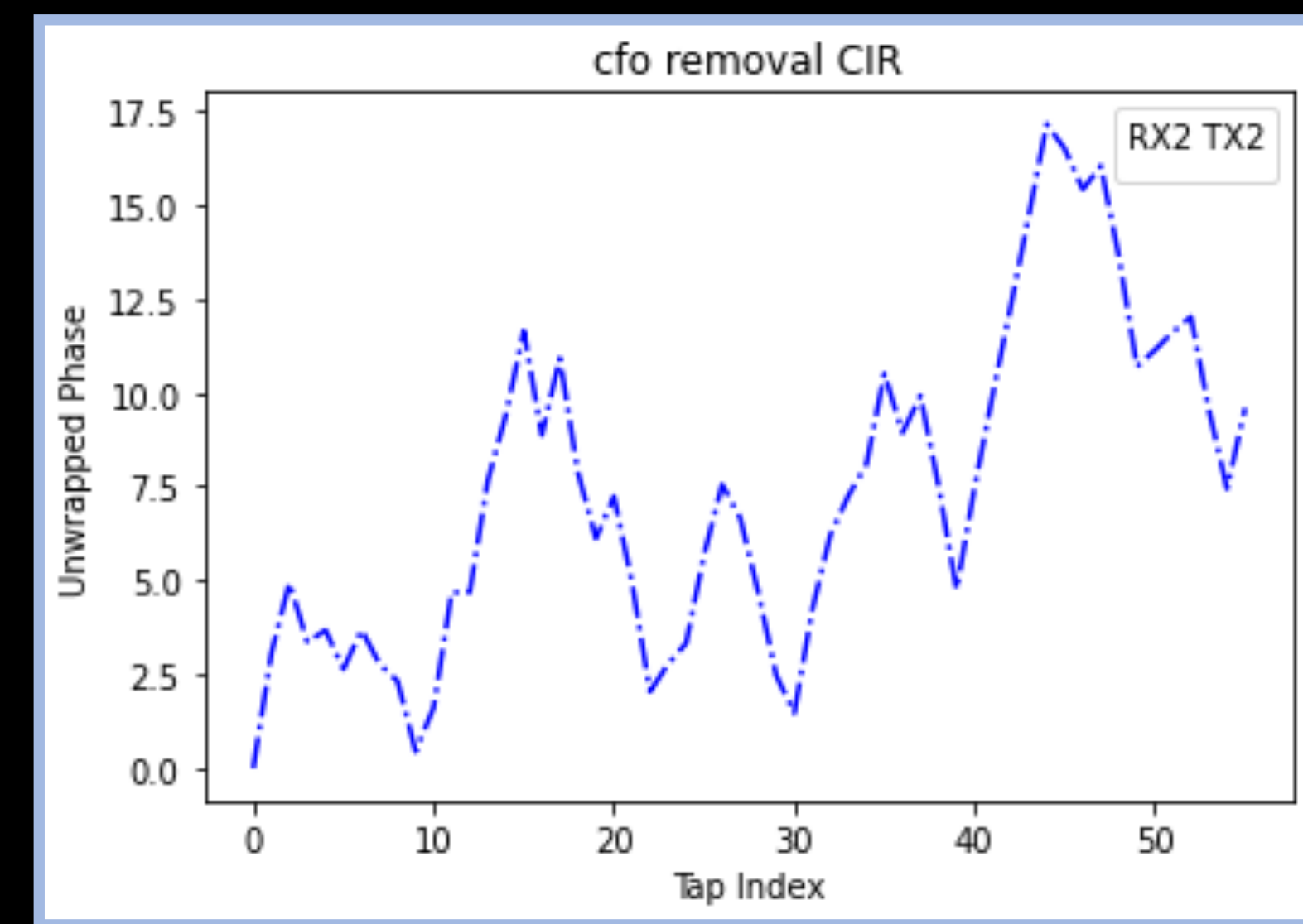
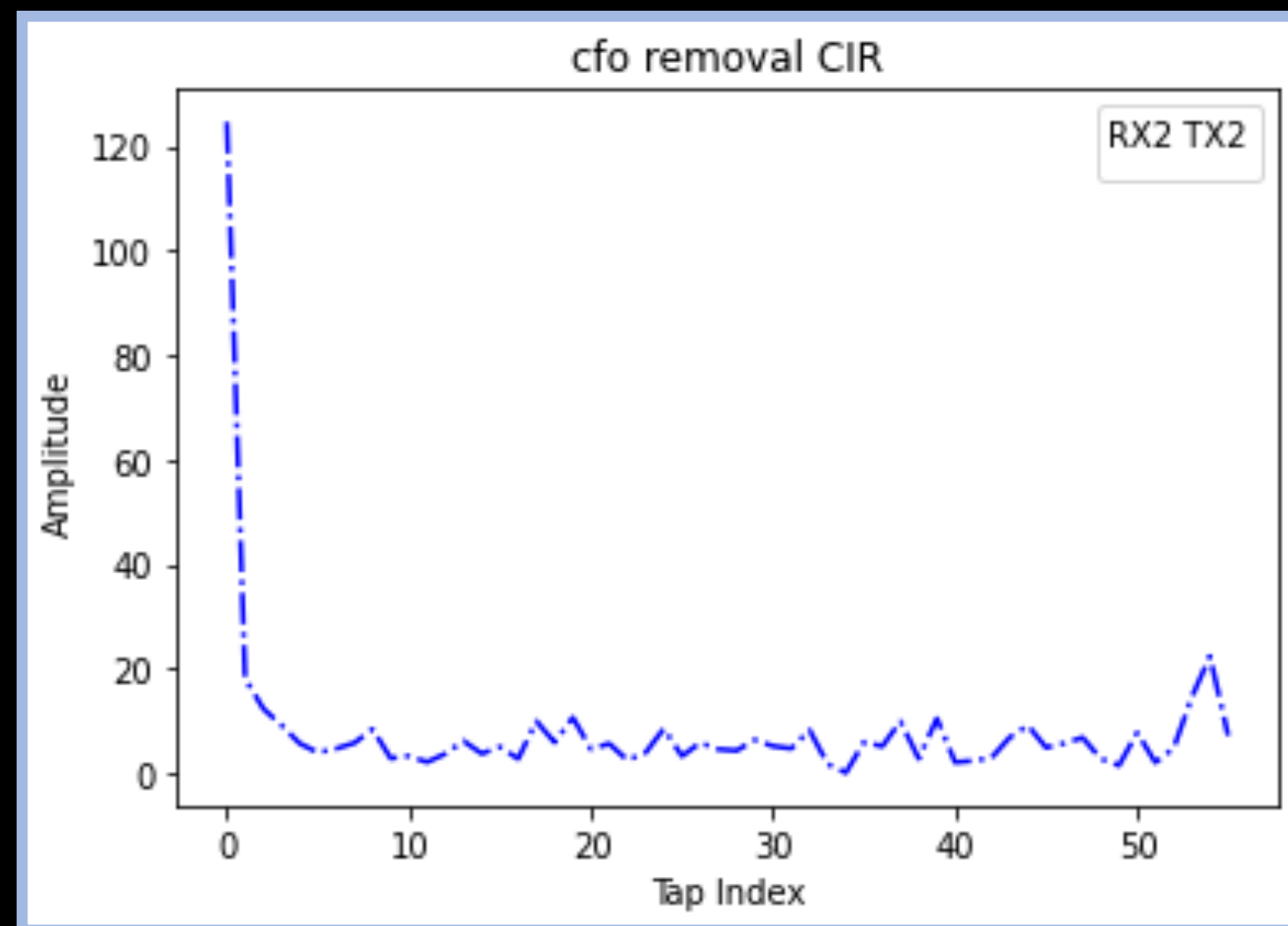
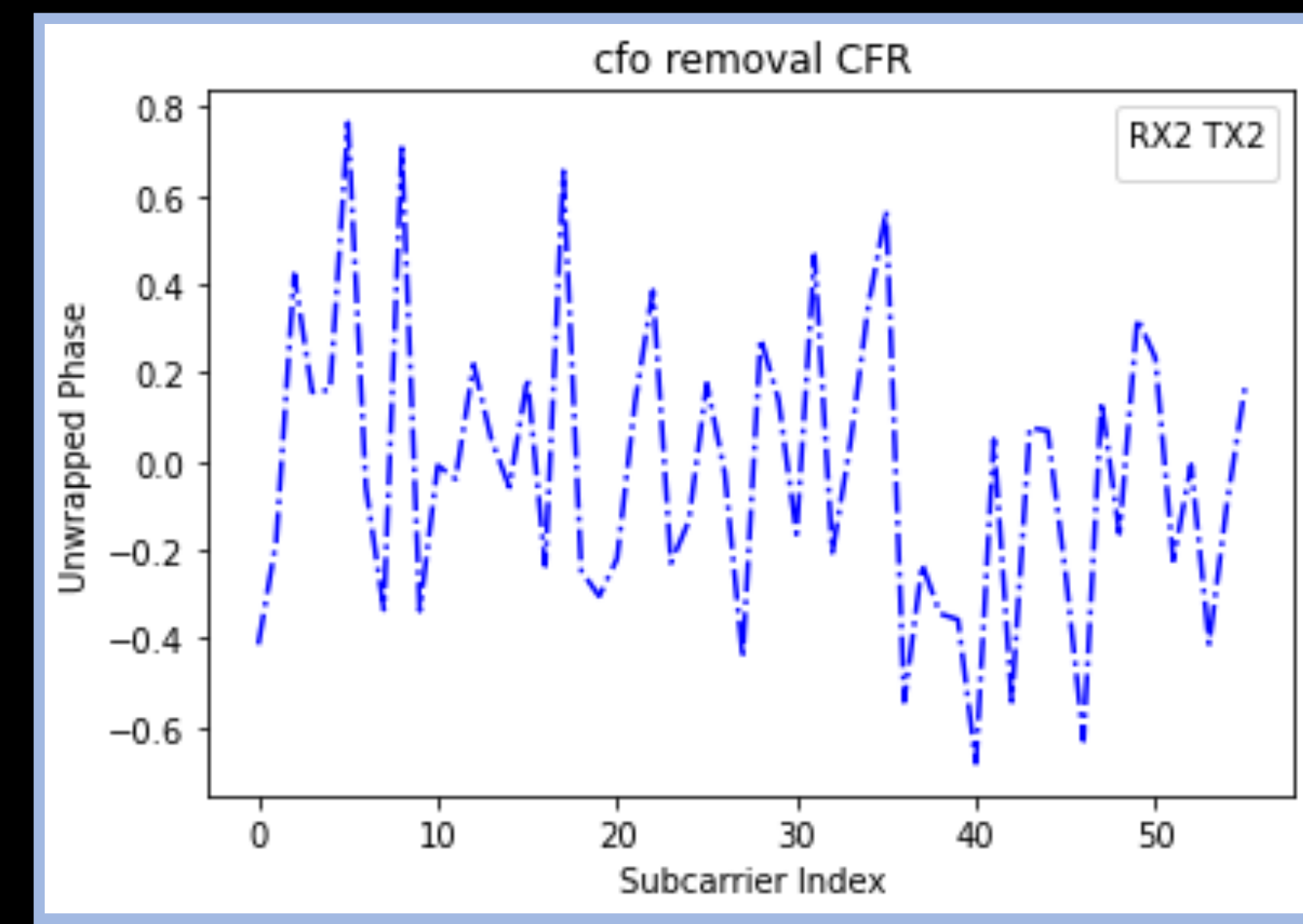
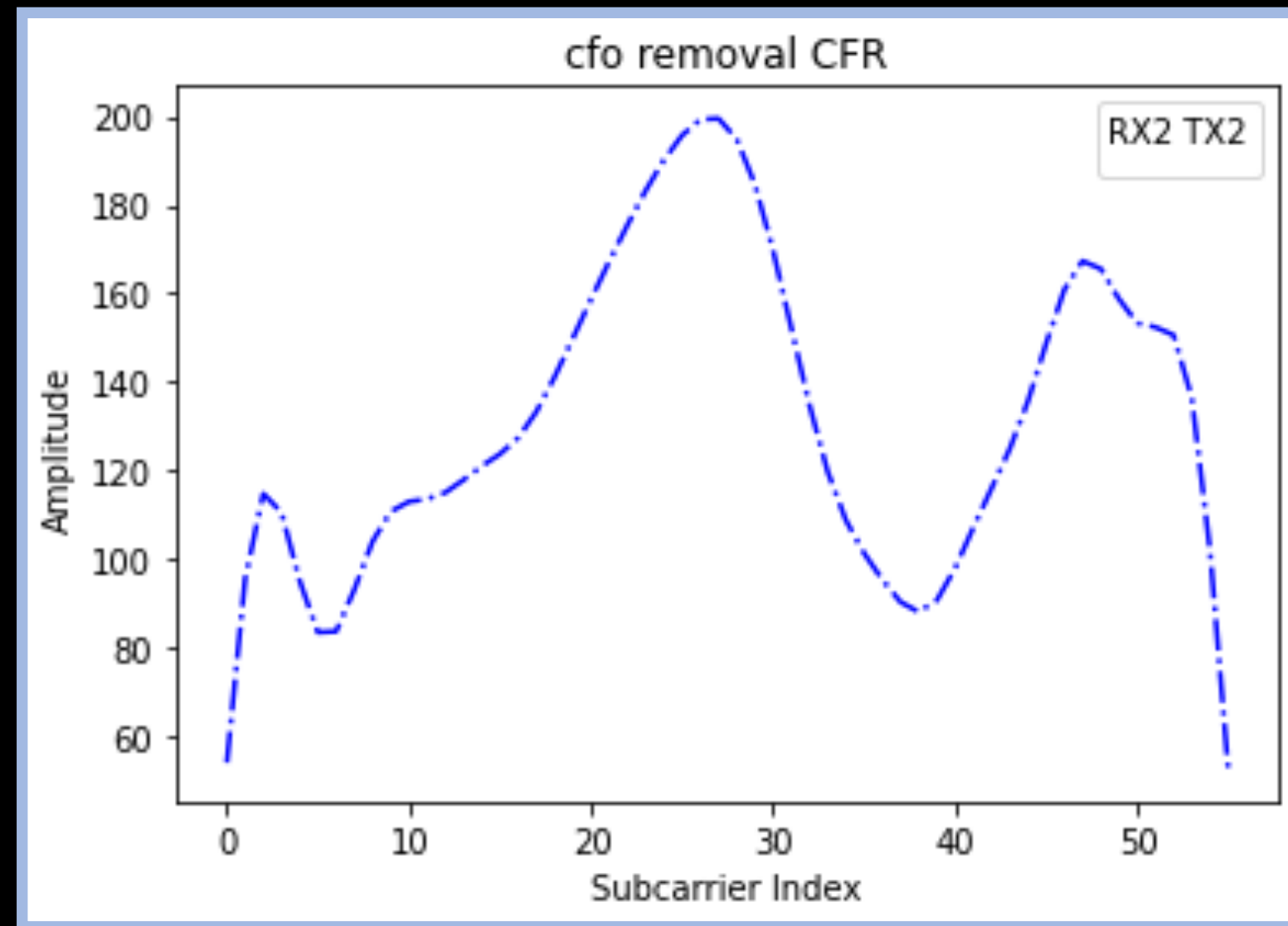
Result— After sfo removal



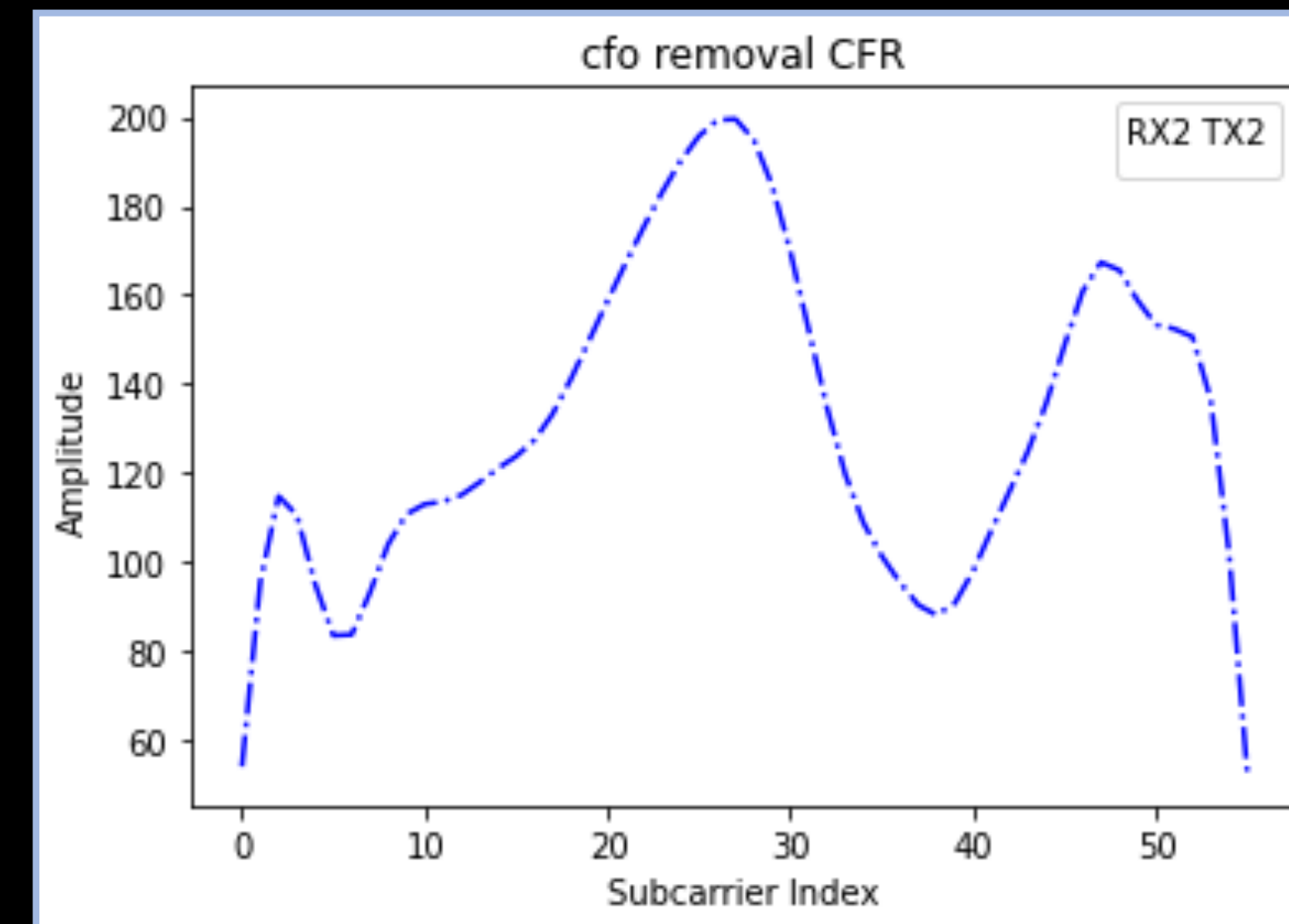
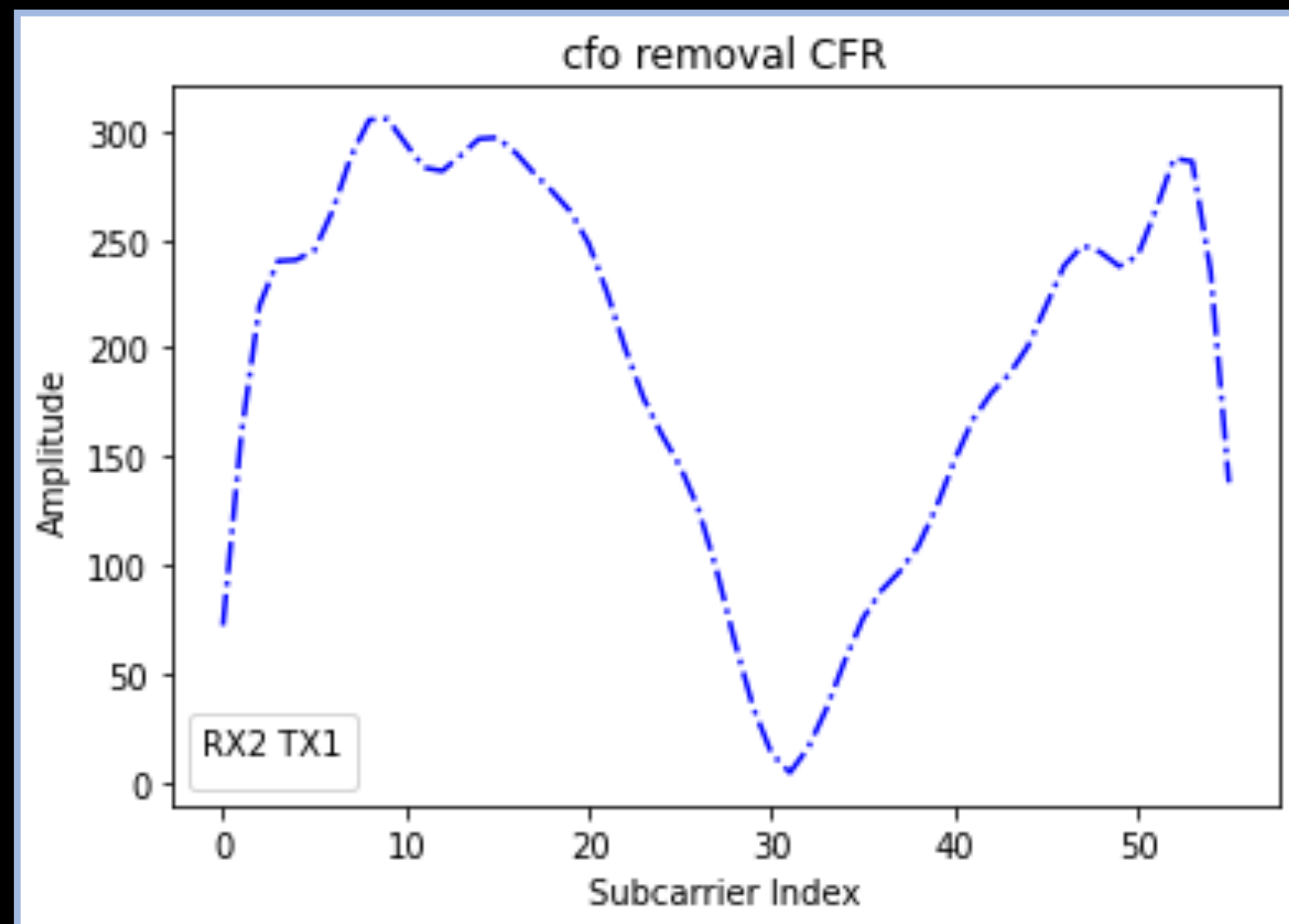
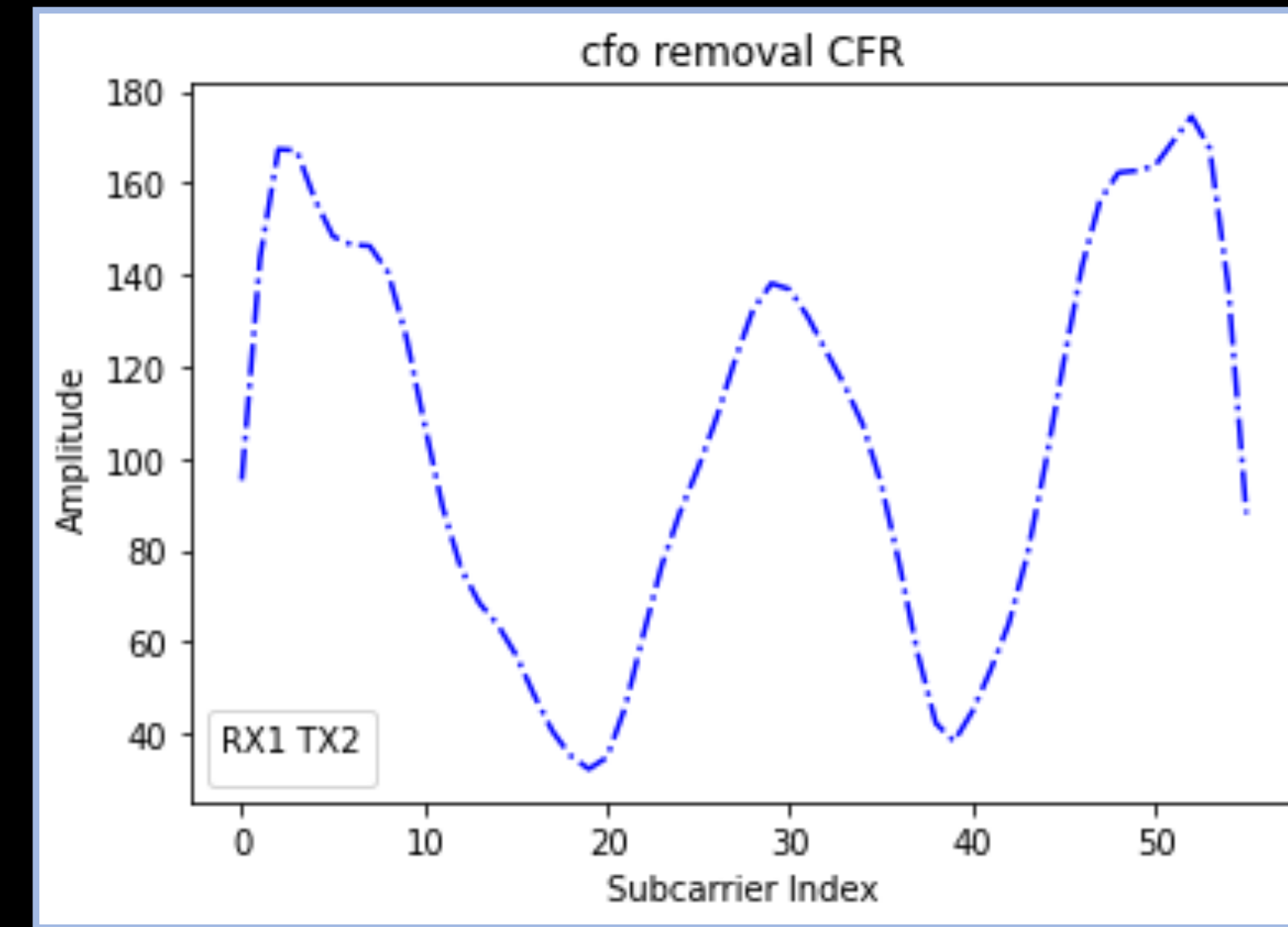
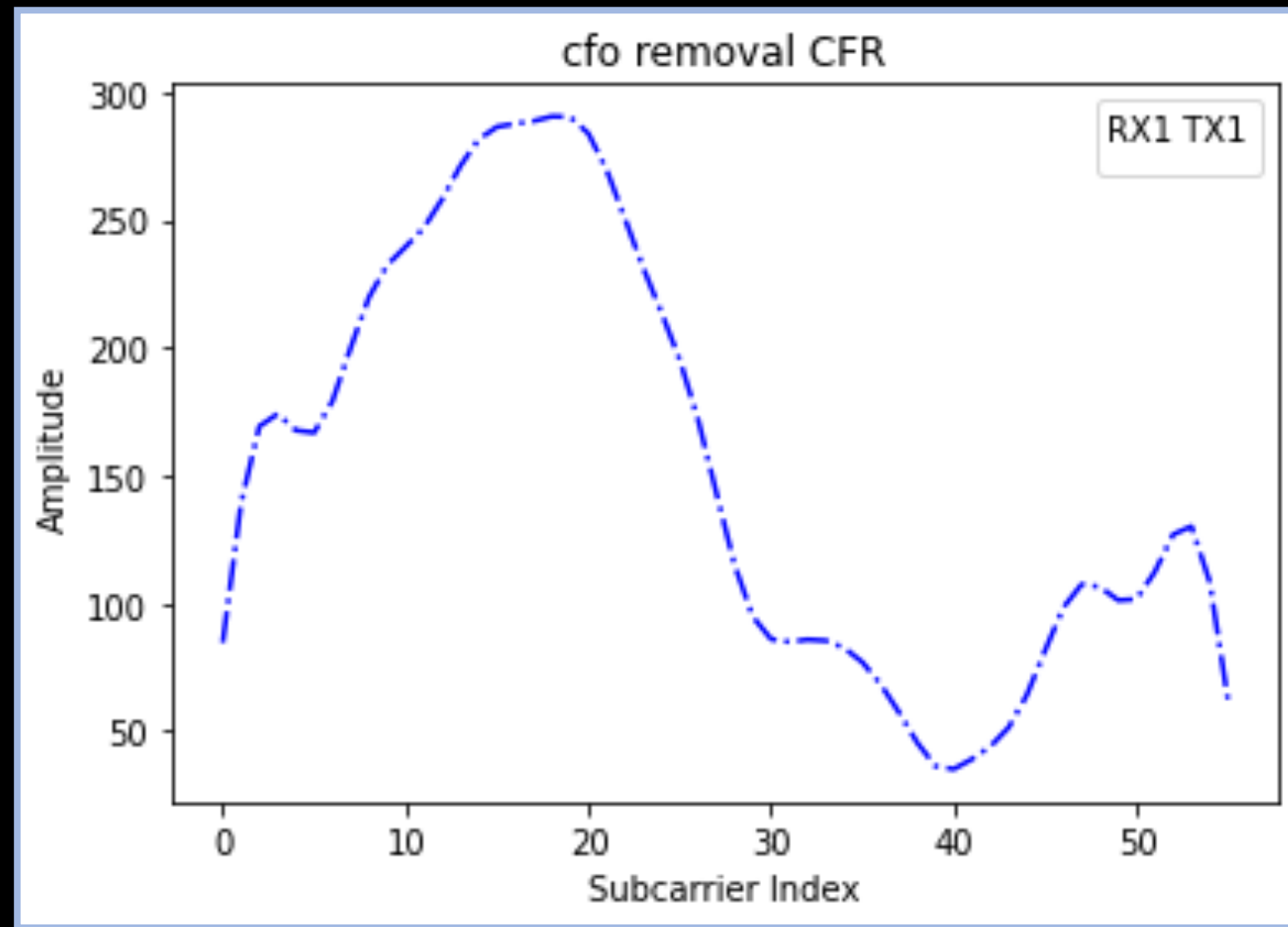
Result— After sto removal



Result— After cfo removal



Result— 4 RX-TX pair after pre-processing



Thanks for listening