

2016. 09. 16, ISWA at ITO Hall, U Tokyo

Technical Development for MST Radar; Pulse Coding, Signal Processing and Spectrum Estimation

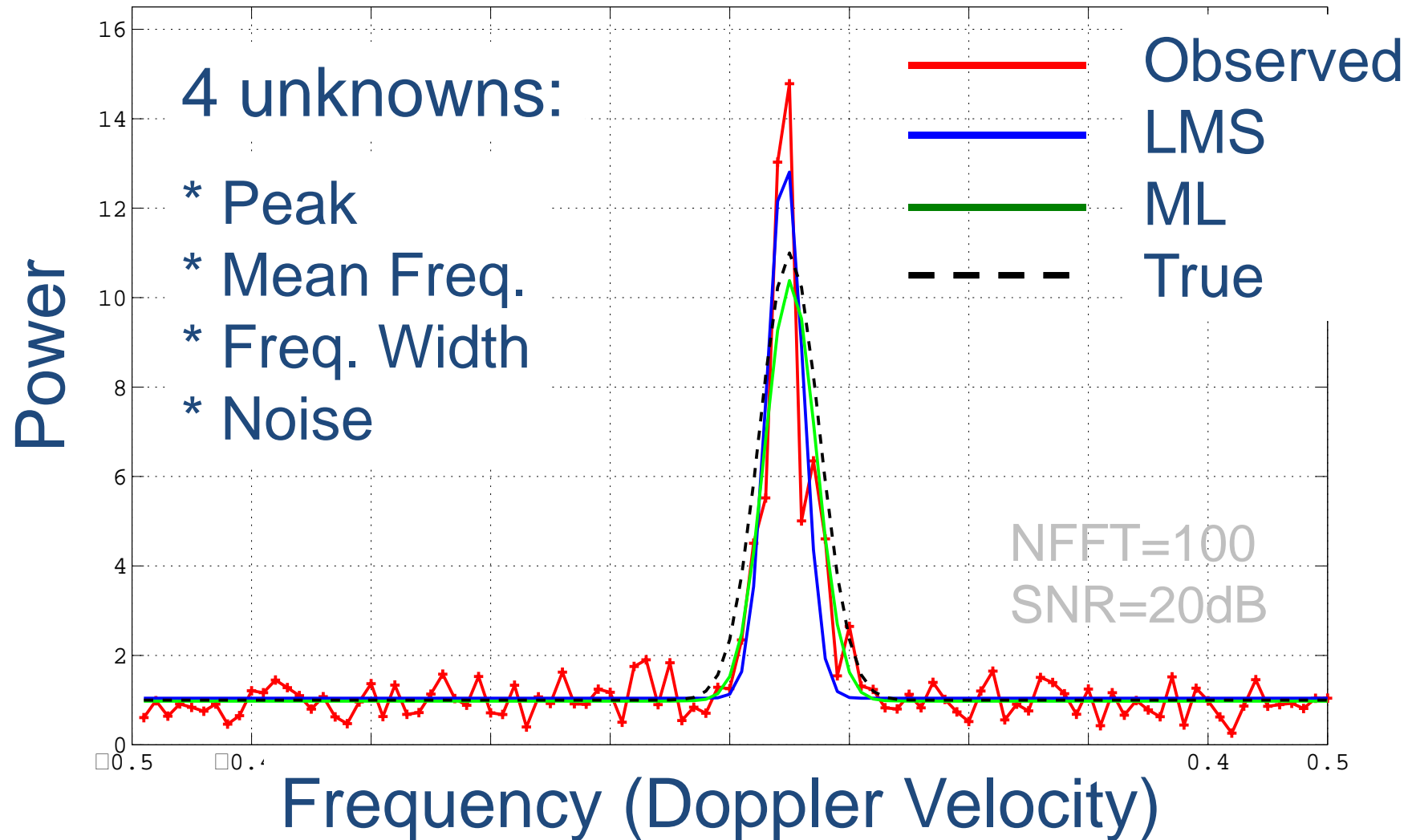
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- (2) Kyoto University
- (3) The University of Tokyo

Unbiased Spectrum Estimation

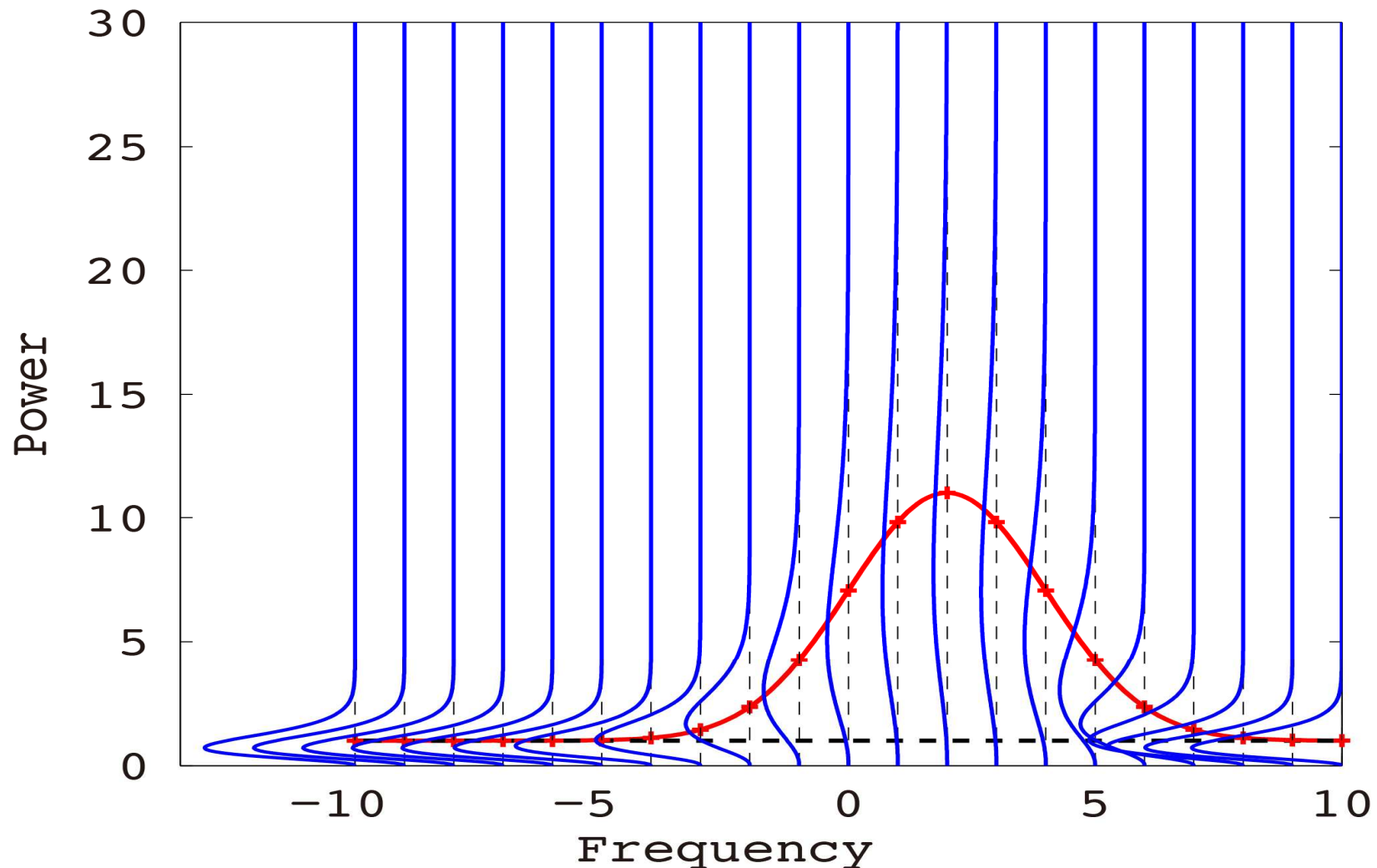
Spectrum Estimation for Gaussian+Noise

A simulated typical radar echo spectrum



Probability Distribution for Power Spectra

- Each frequency point has statistical uncertainty that *approximately* follows the χ^2 distribution.



Problem in using LMS-Fit for Gaussian

- Statistical fluctuation of each frequency component *approximately* obeys Chi^2 distribution.
- But LMS assumes the data obeys the Gaussian distribution and it ignores asymmetry of the Chi^2 distribution.
- When the number of incoherent integration is not sufficient, LMS has a strong tendency to drag the spectrum upward at the peak,
- it under-estimates the spectral width.

Estimation Errors in Spectrum Width by LMS Methods

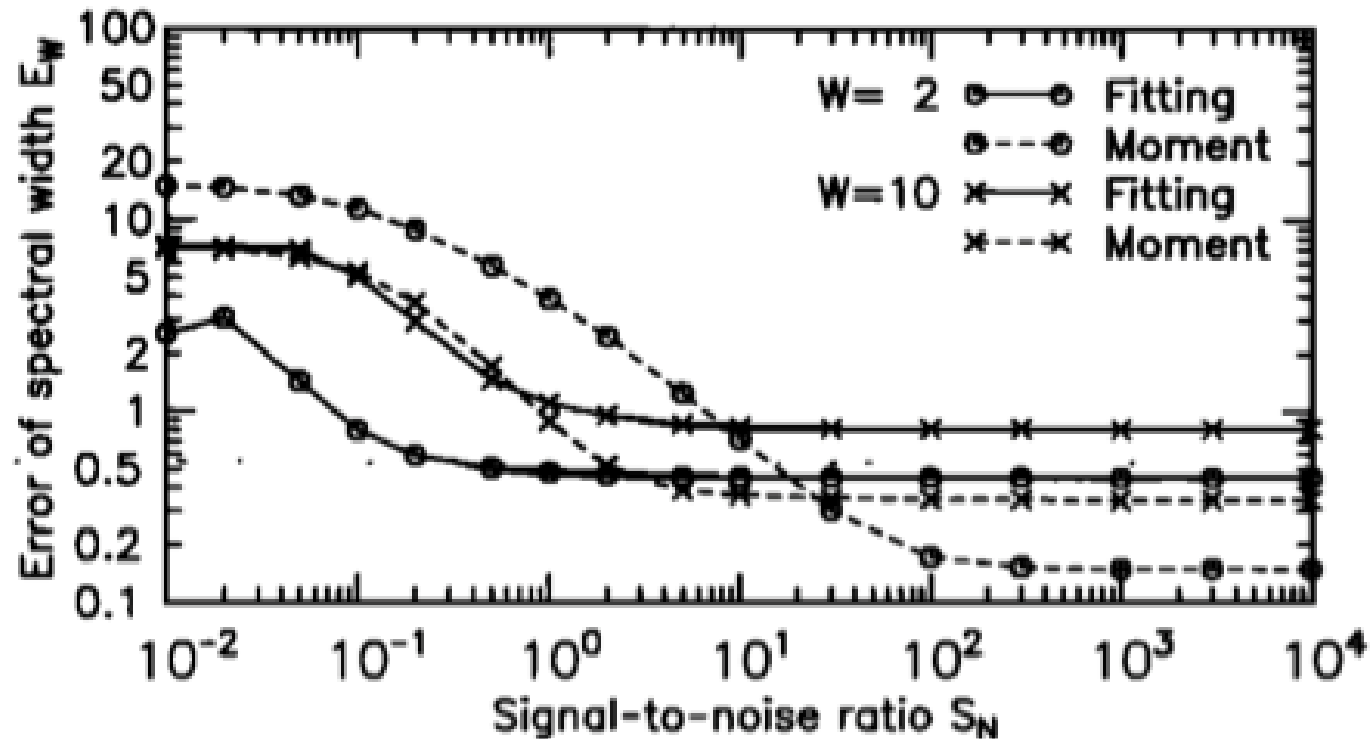
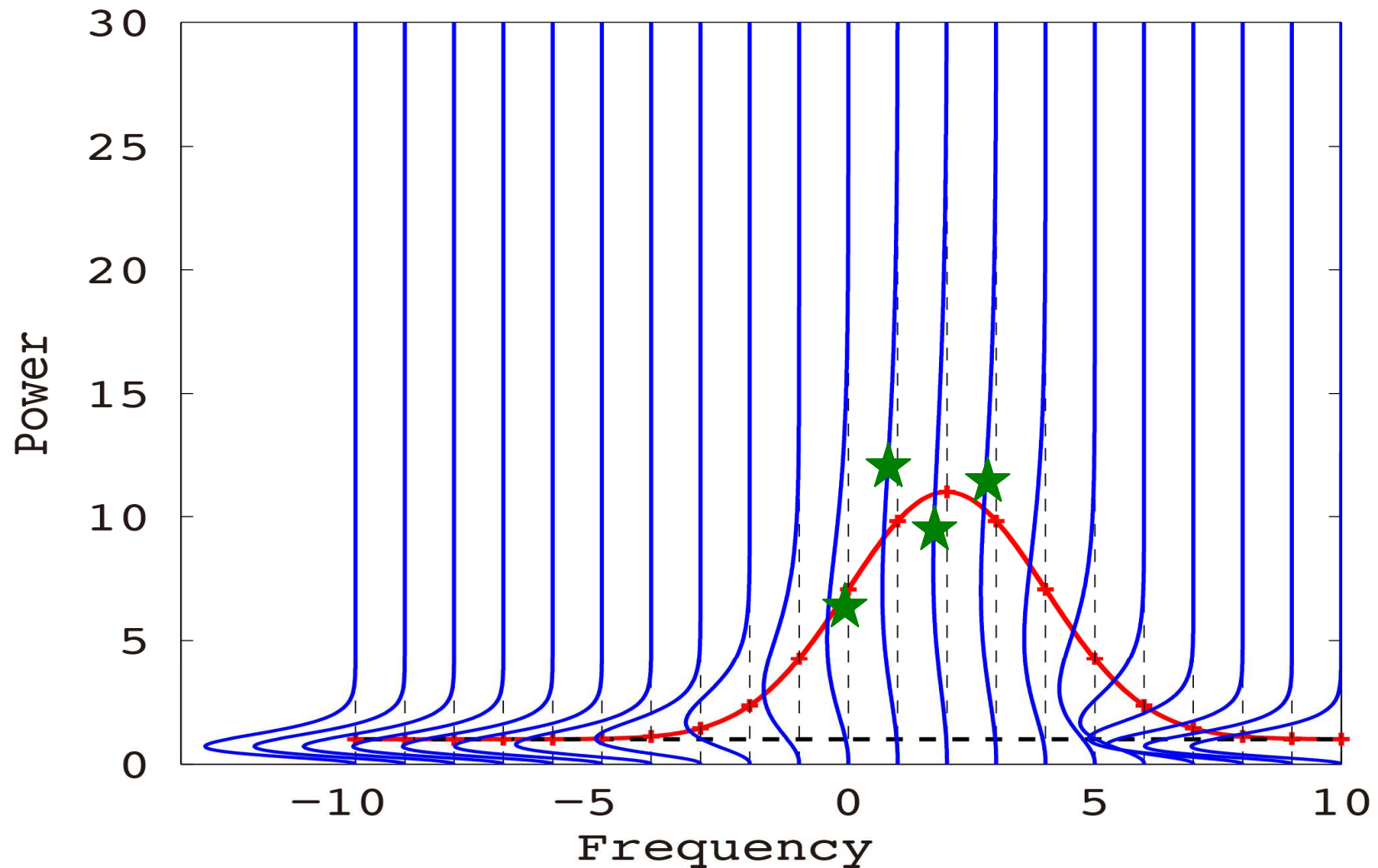


Fig. 4. The same as Figure 3, except for the estimation error of the spectral width.

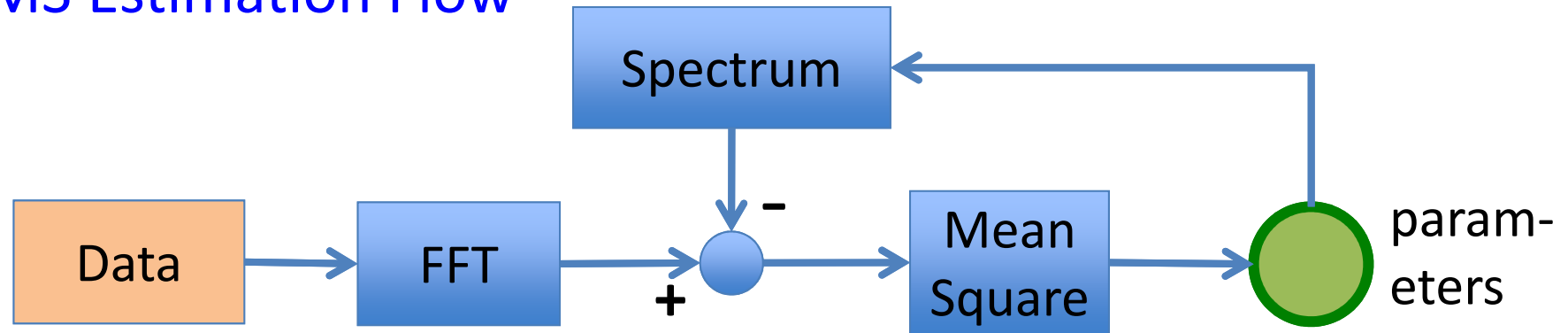
Maximum Likelihood Estimation of PSD

- Likelihood is calculated by putting the observed value into the pdfs and sum.

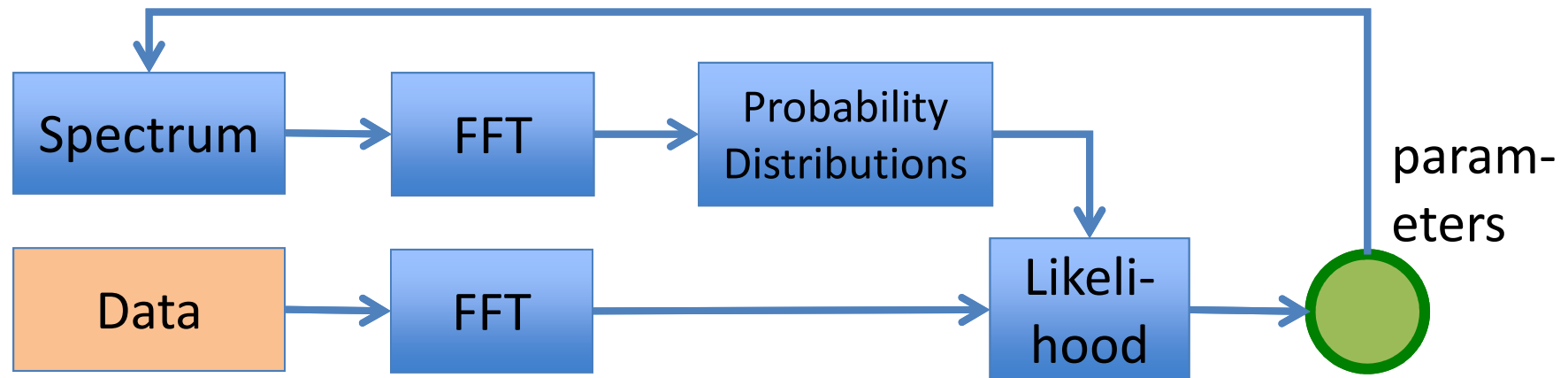


Spectrum Estimation with LMS and ML

LMS Estimation Flow



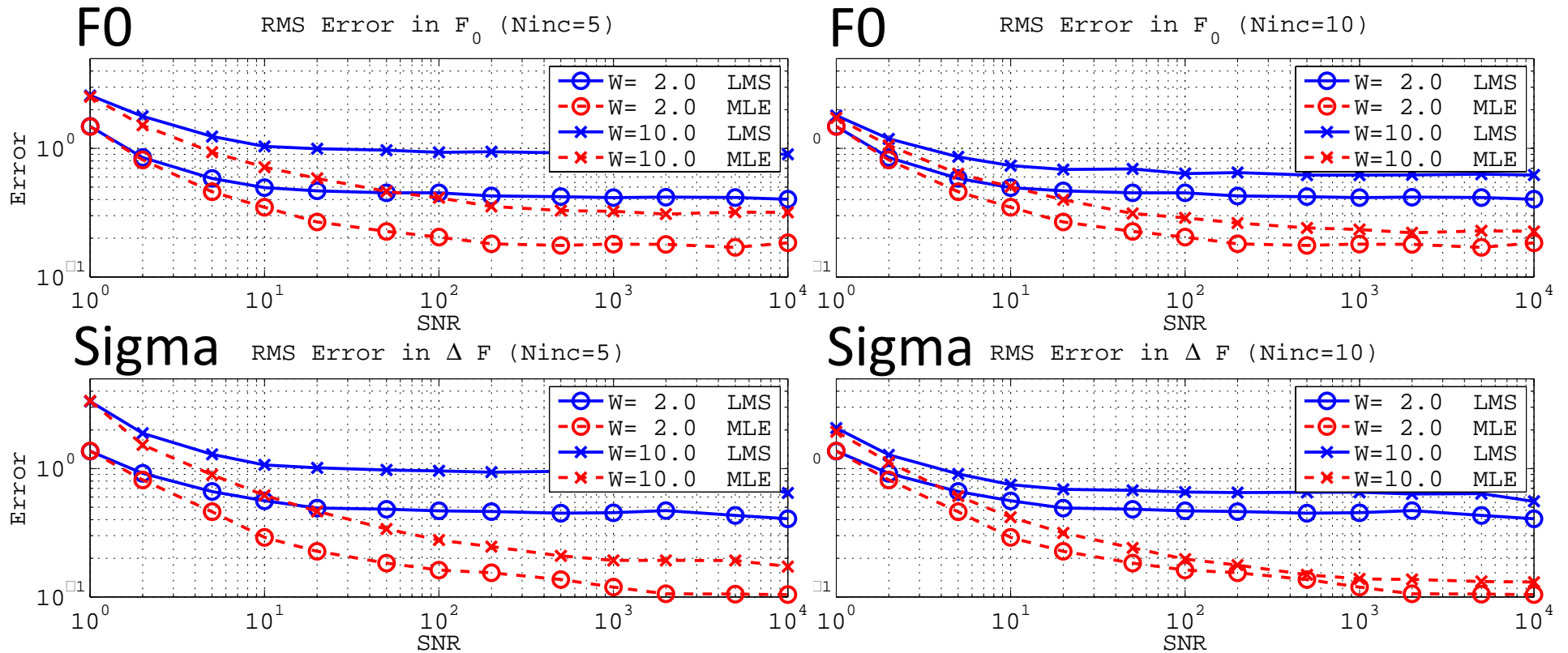
ML Estimation flow



RMS Error for Mean Frequency and Sigma

LMS vs MLE

NFFT=100. Errors are normalized by the interval of FFT bins.



Nincoh=5

Nincoh=10

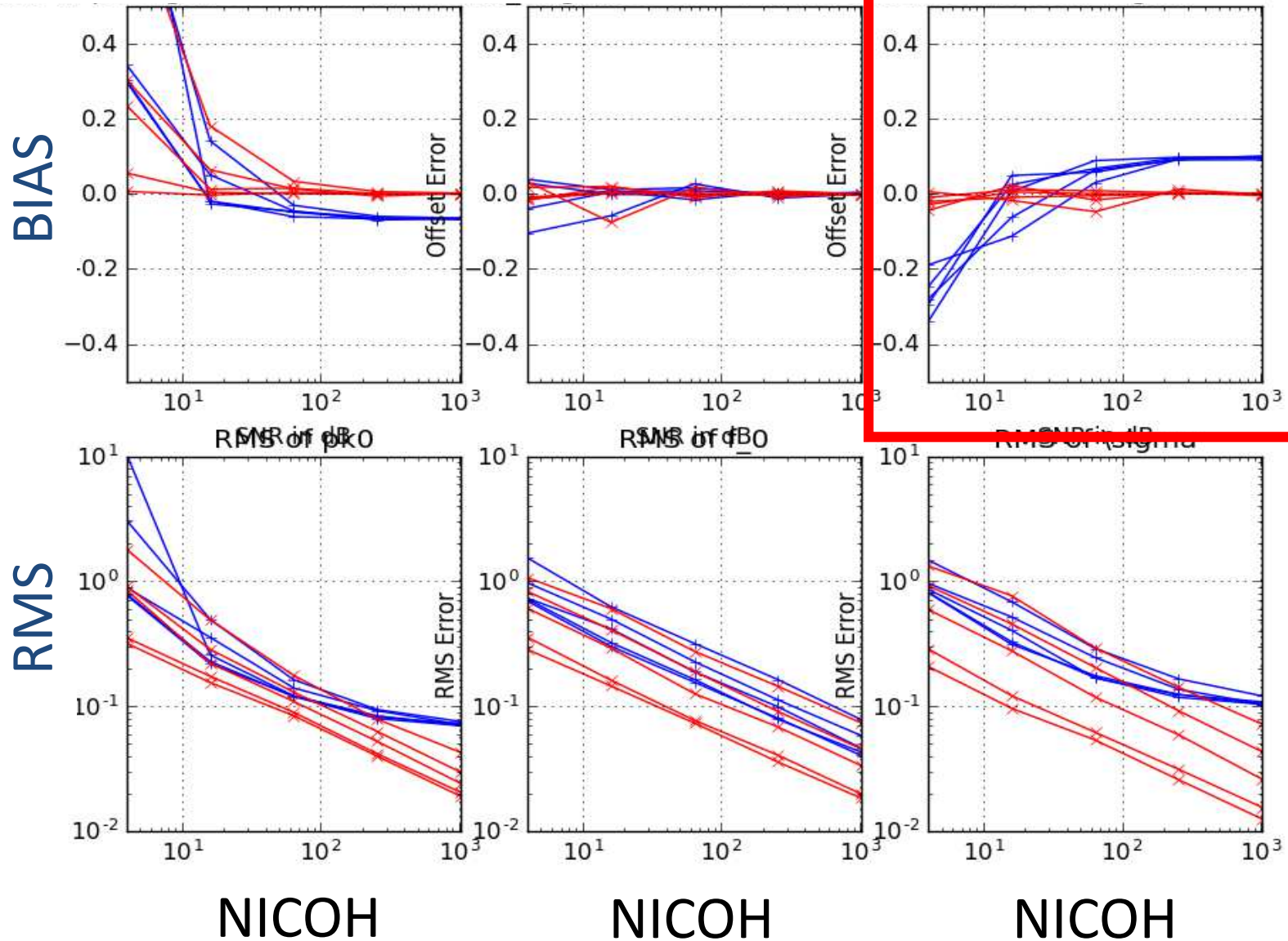
Bias Errors vs NICOH

LMS
MLE

Peak

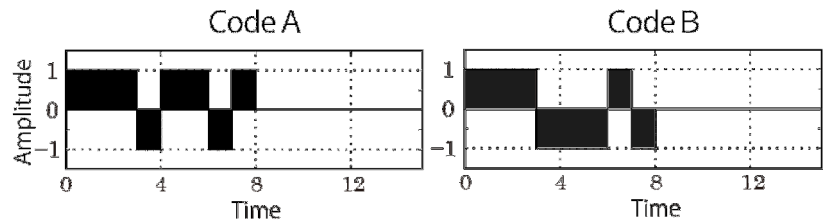
Mean

Sigma



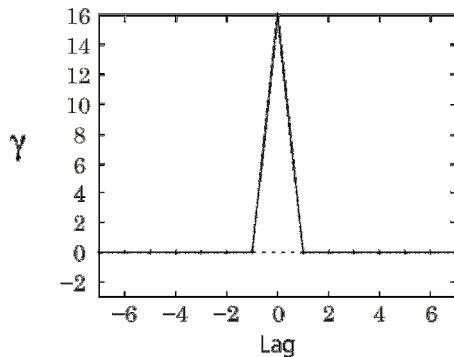
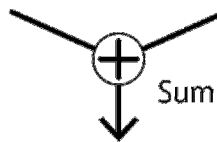
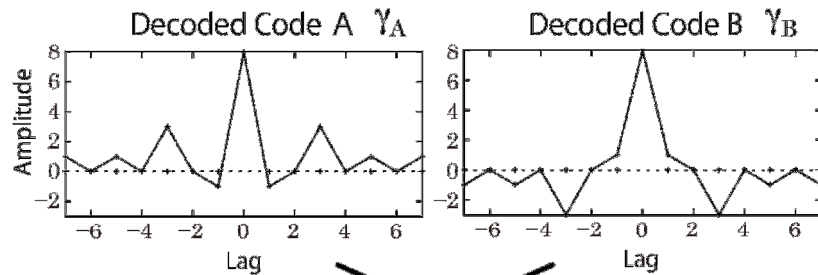
Pulse Compression Technique
Optimal Decoding for Complementary Code

Problem in decoding complementary code for Doppler shifting targets

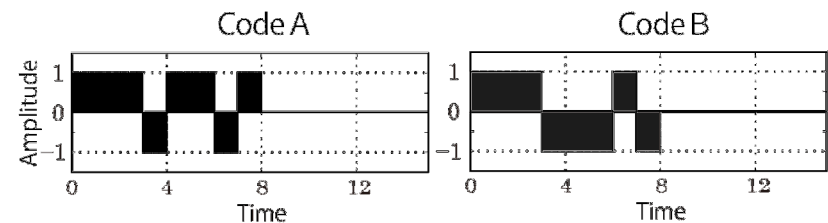


↓ Decoding

↓ Decoding

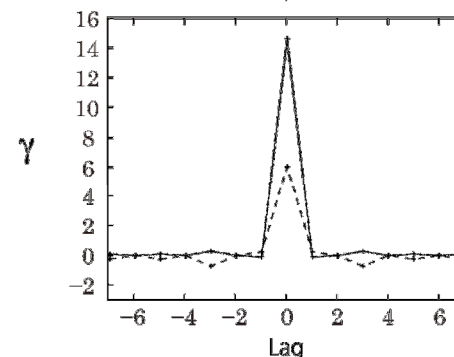
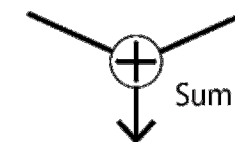
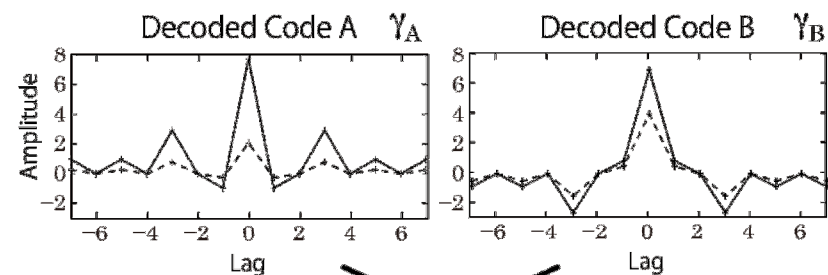


no Doppler Shift



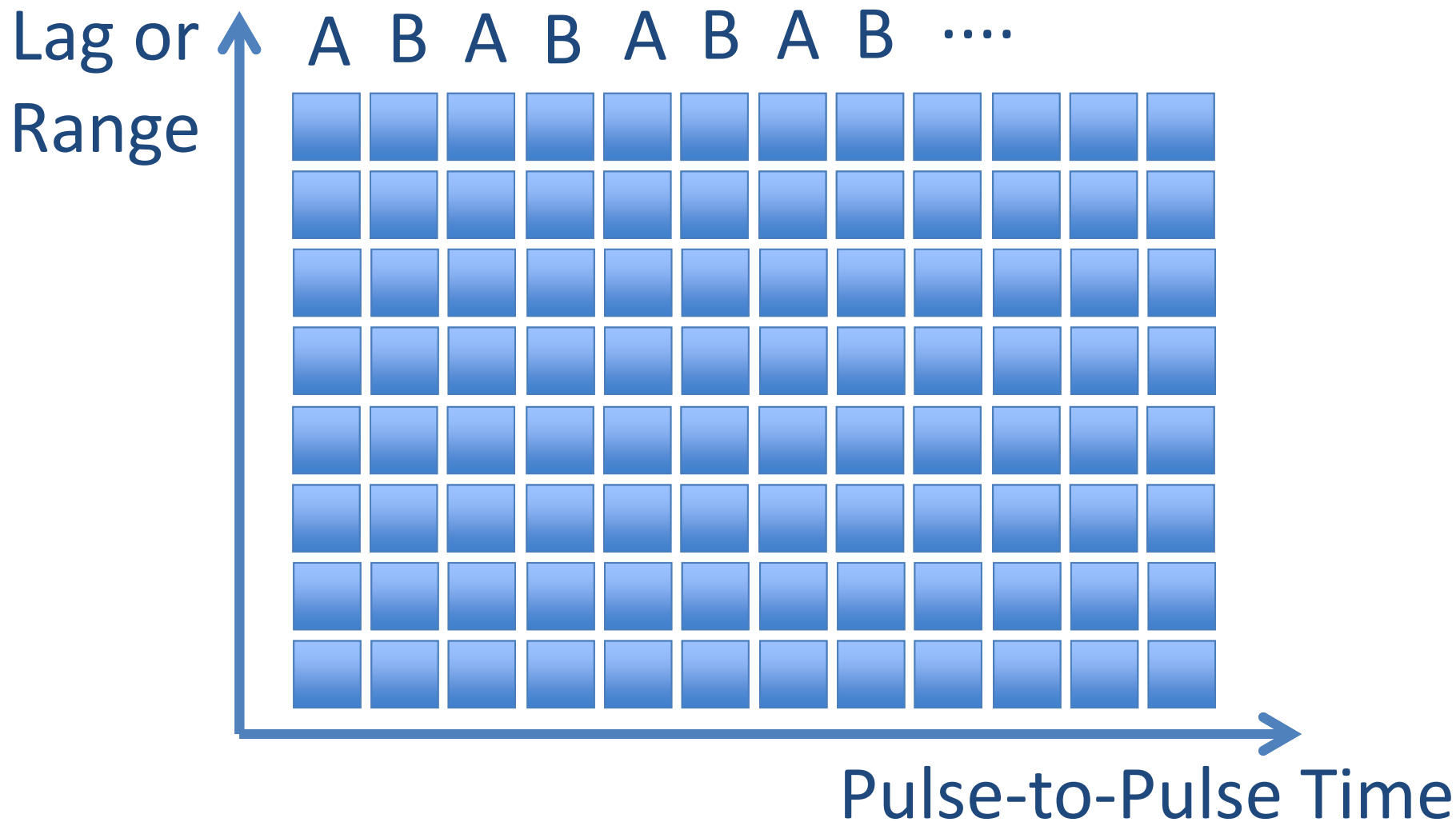
↓ Decoding

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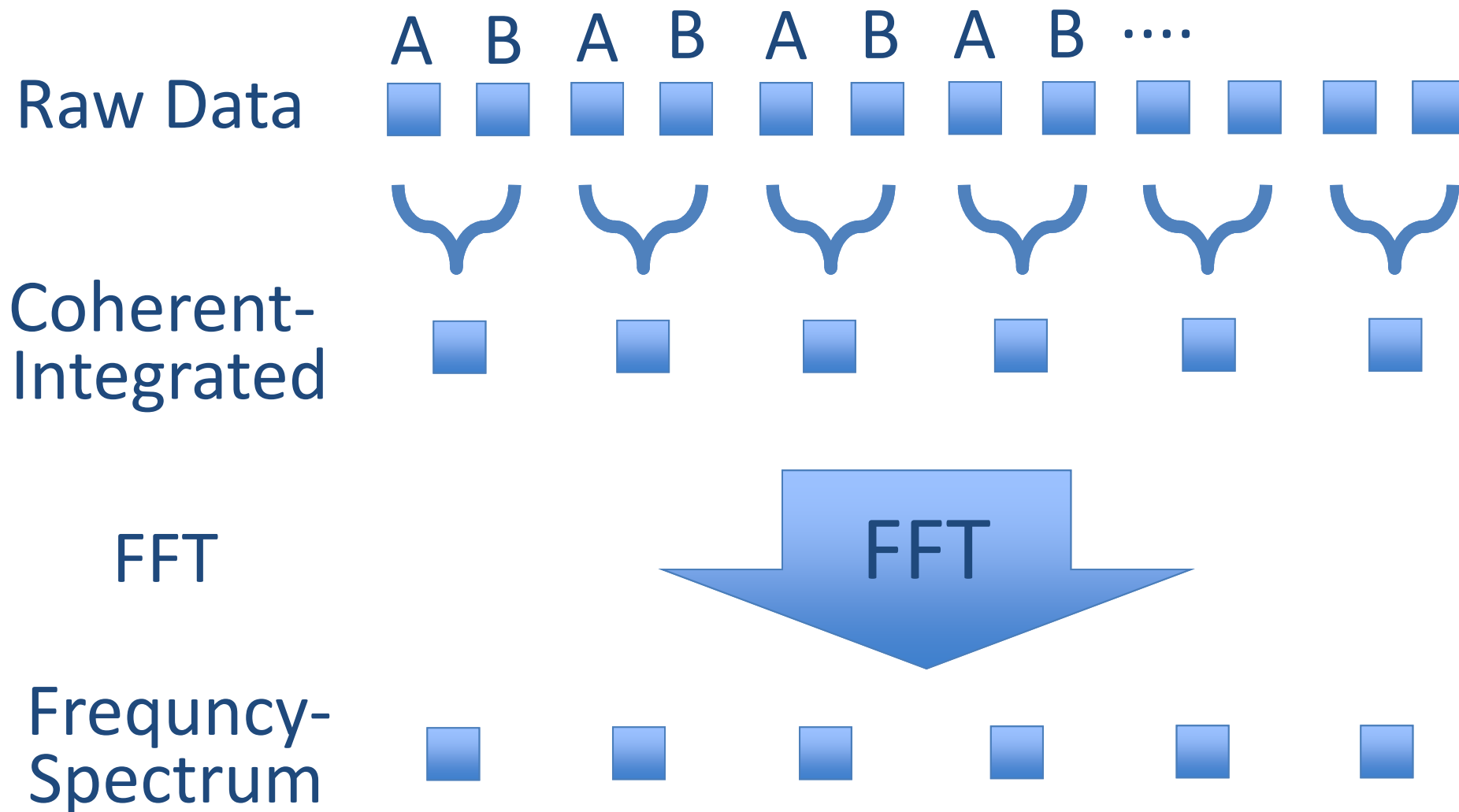


with Doppler Shift

Problem in decoding complementary code for Doppler shifting targets

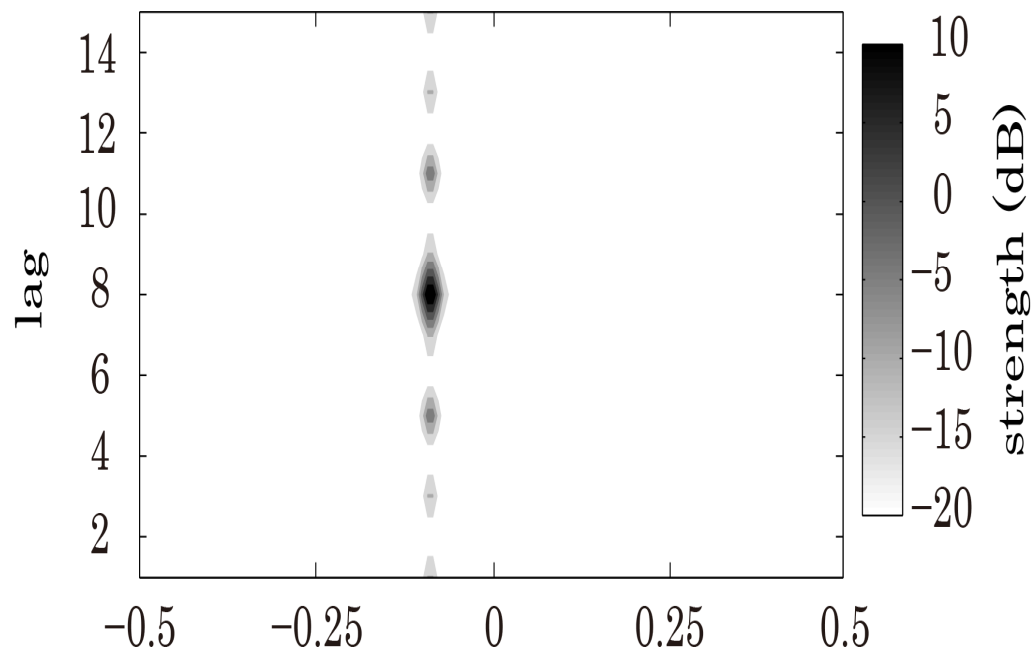
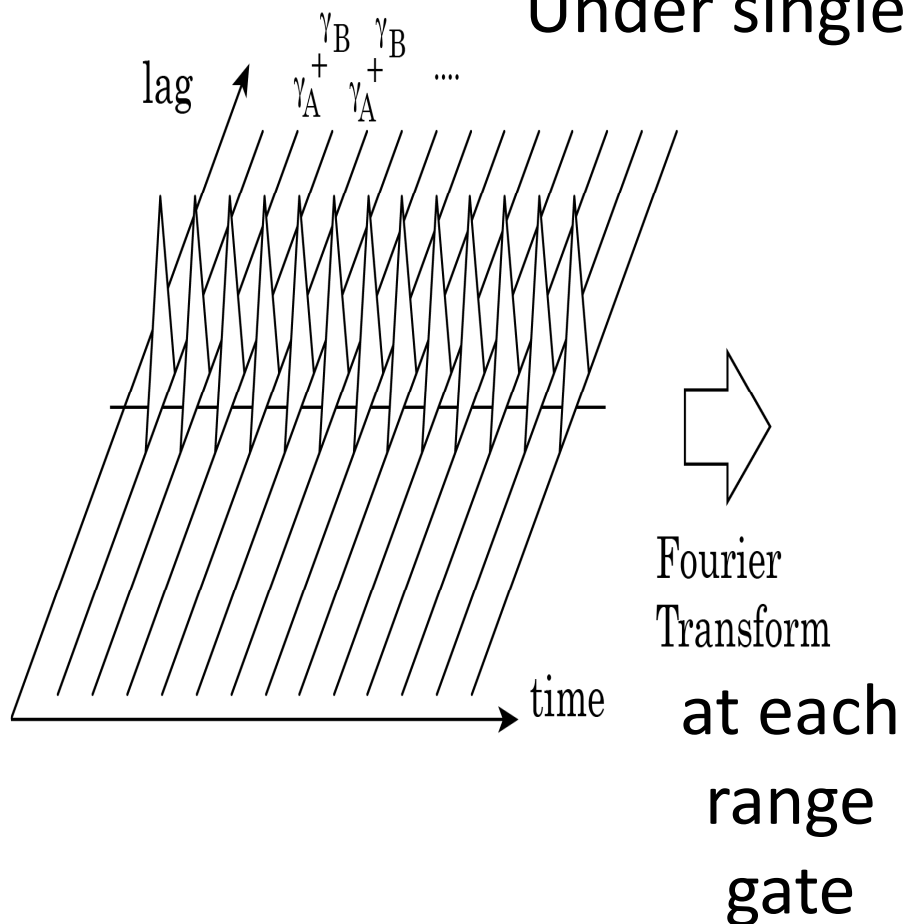


Problem in decoding complementary code for Doppler shifting targets

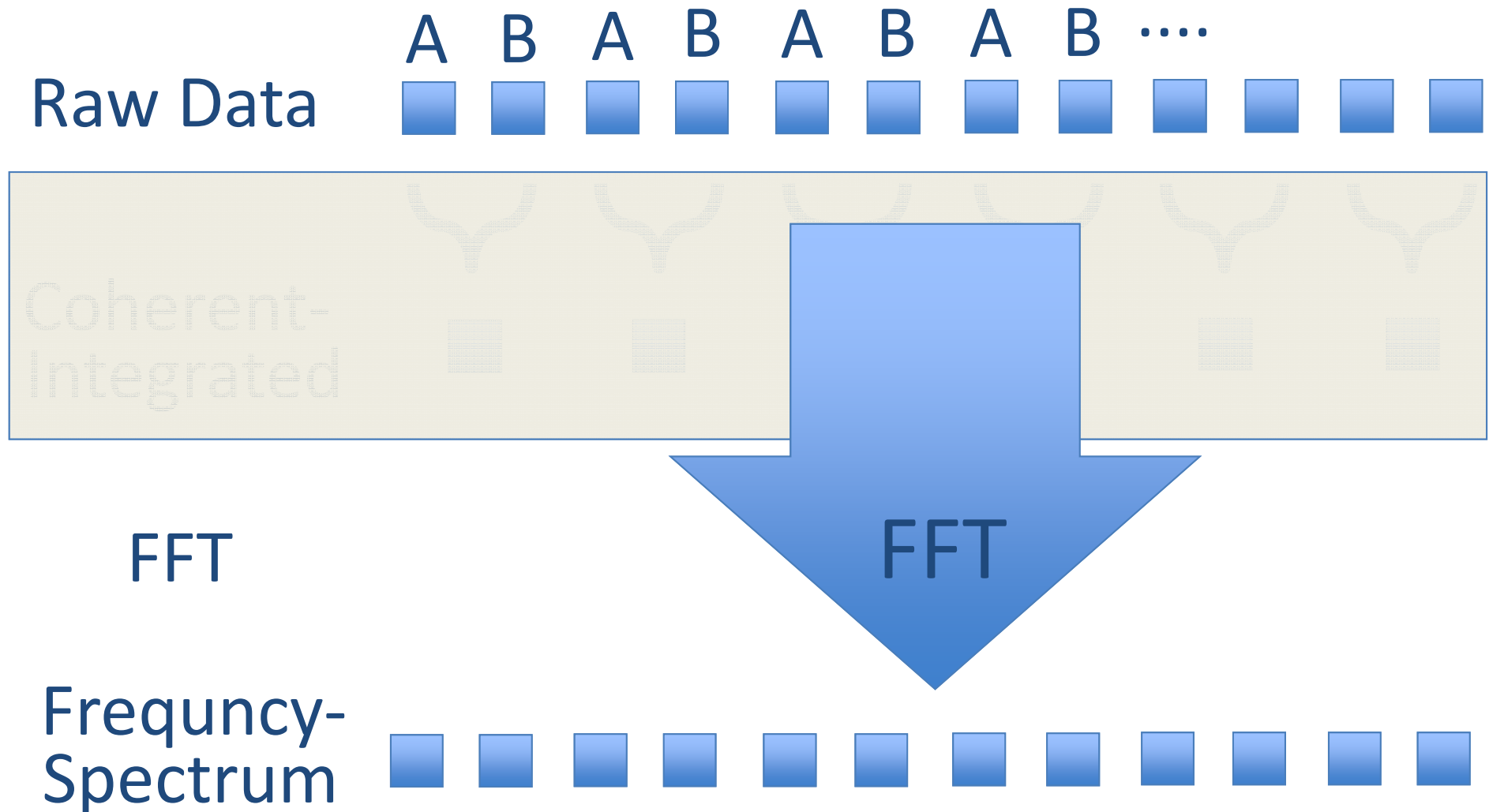


Problem in decoding complementary code for Doppler shifting targets

Under single solid target model.



Proposed Decoding Method for Doppler shifting targets



Proposed Decoding Method for Doppler shifting targets

Under single solid target model.

