Multichannel Communication based on Adaptive Equalization in Very Shallow Water Acoustic Channels

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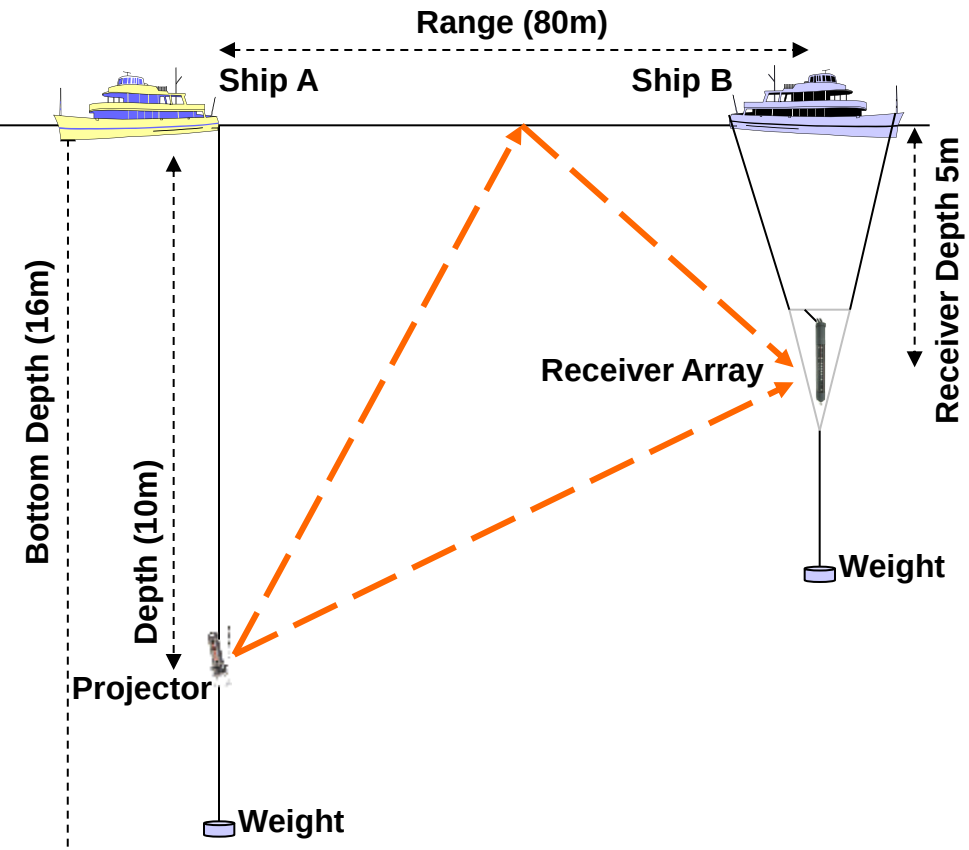
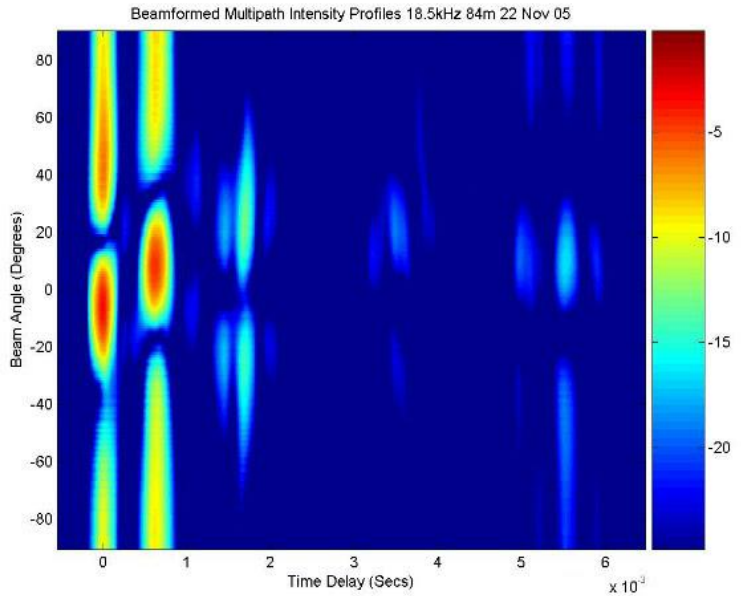
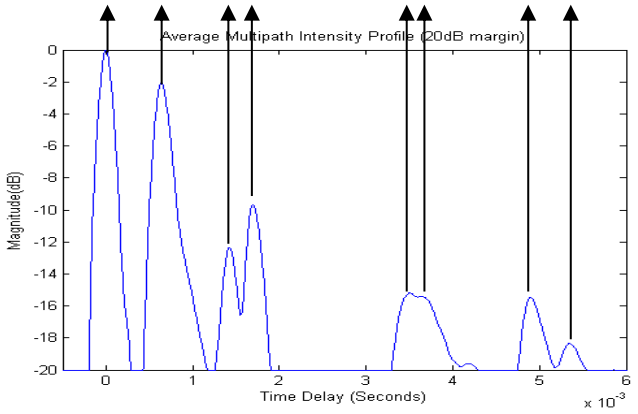
INTRODUCTION



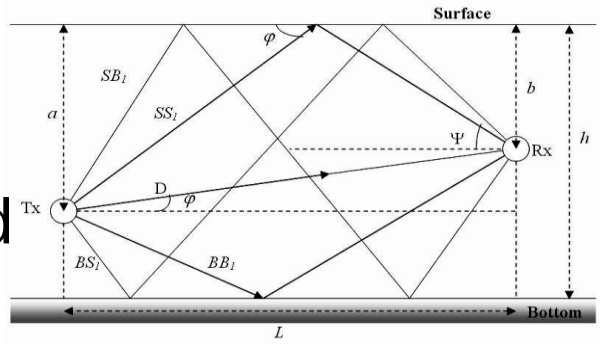


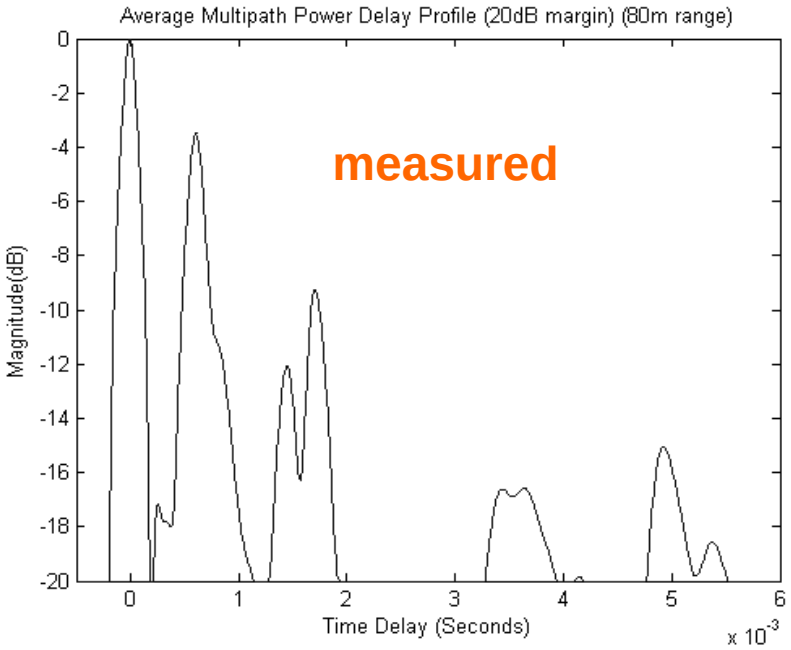


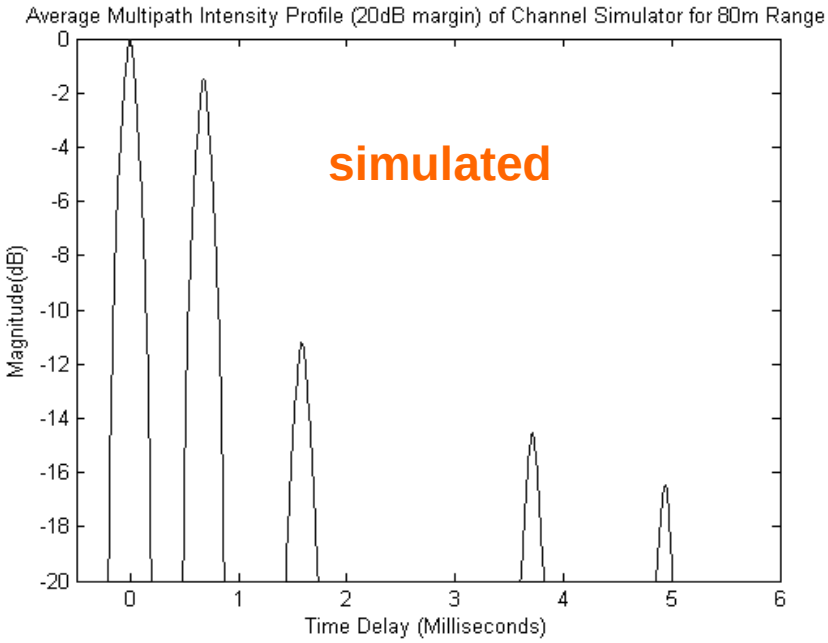
TIME VARYING MULTIPATH FADING

CHANNEL MODEL

- Ray Model
- Rayleigh Fading on individual arrivals
- Fading is time correlated, Doppler spread
- Alpha-Stable noise

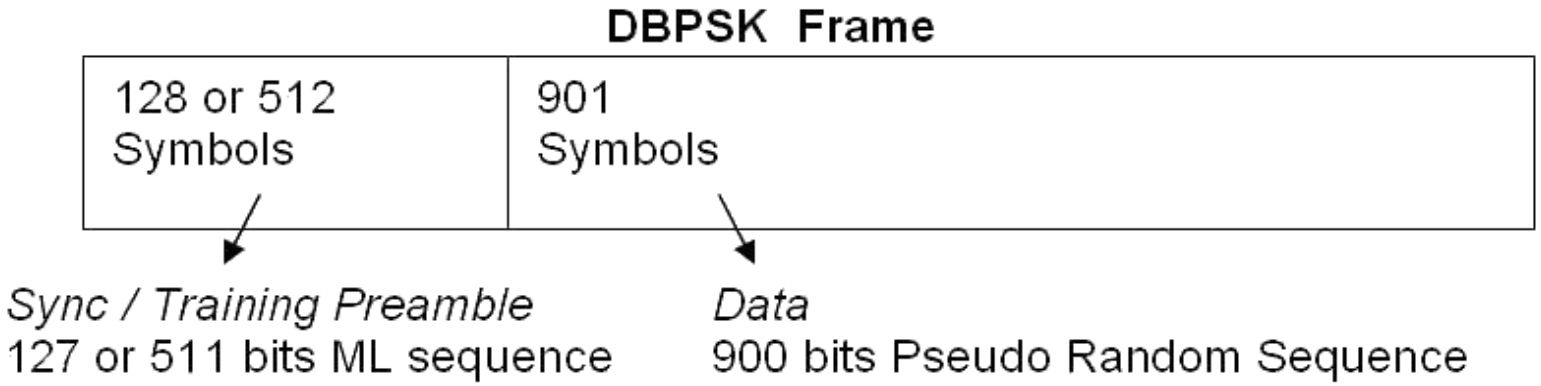






SIMULATION

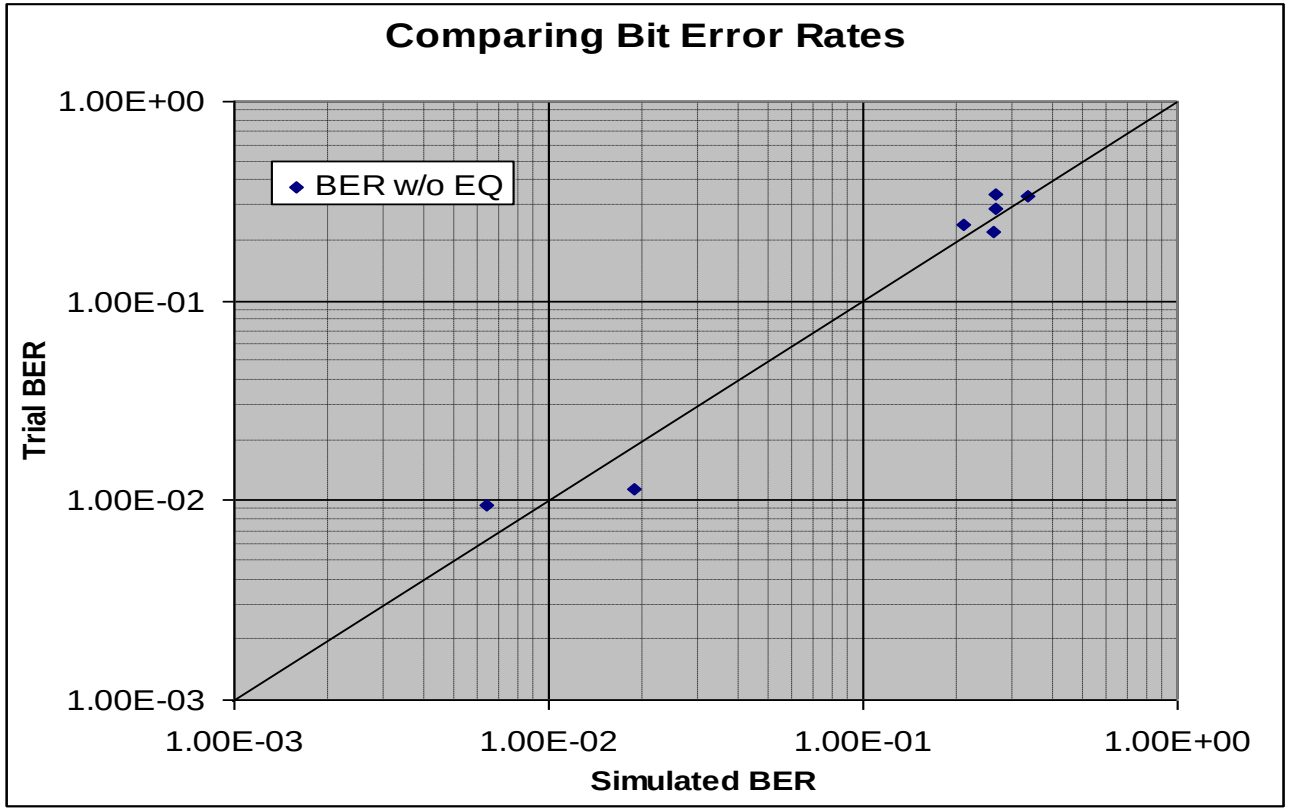
- Single Carrier Differential Phase Shift Keying



Centre Frequency	18.5kHz
Symbol Rate	9250sym/s
Raised Cosine Filter Alpha	0.25
Over sampling	16
Arbitrary Start Bit	‘1’

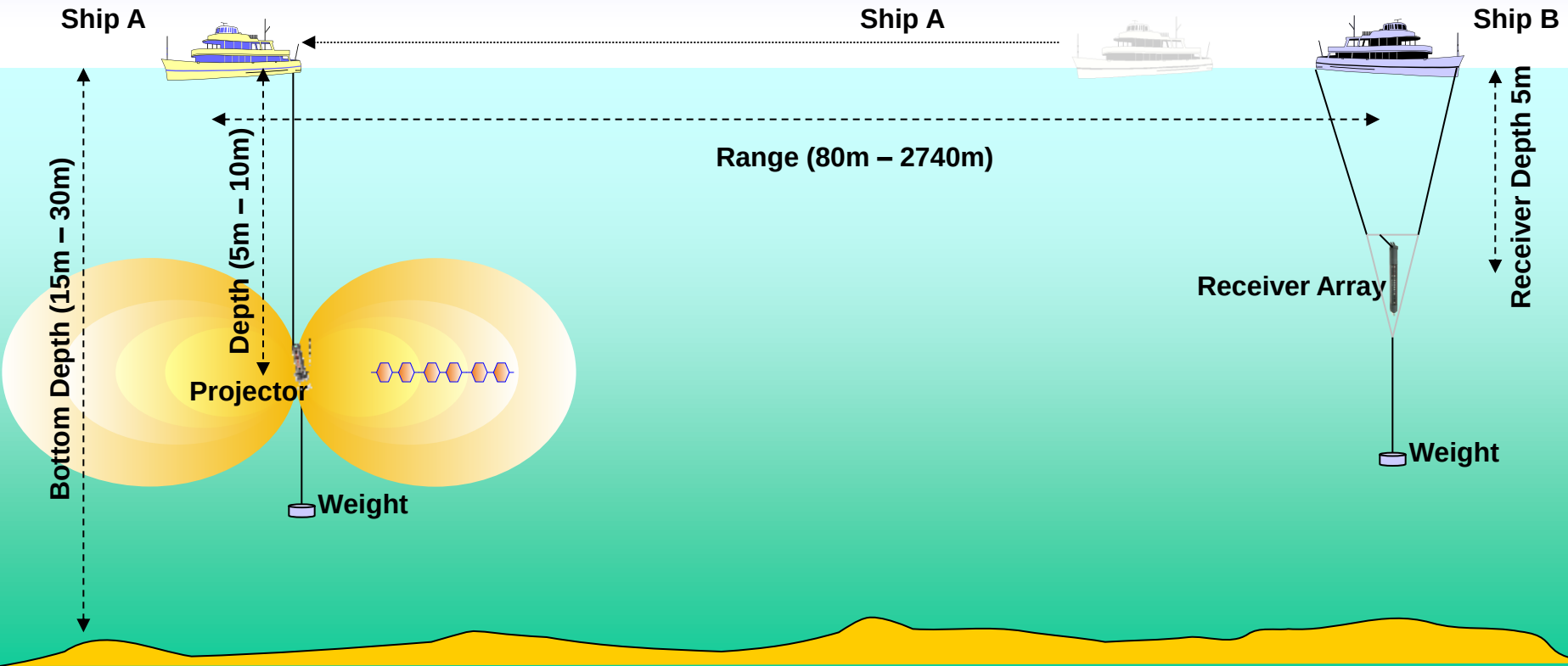
SIMULATION

- Comparing BERs for same channel parameters (80m to 2740m)



EXPERIMENTAL DESCRIPTION

SEA TRIAL SETUP

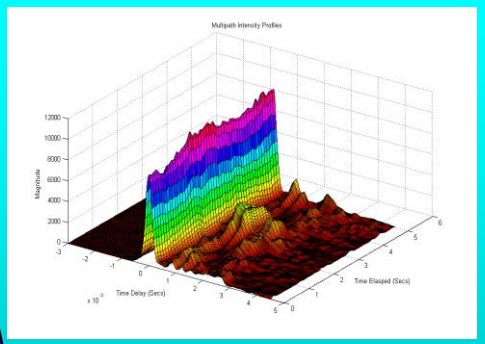


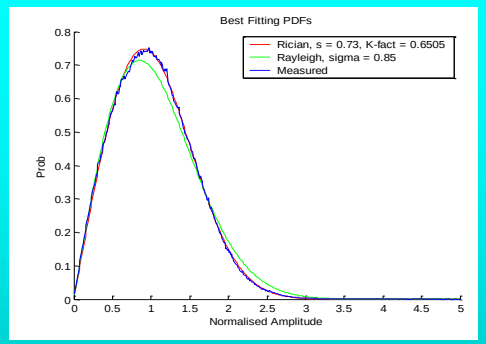
EXPERIMENTAL DESCRIPTION

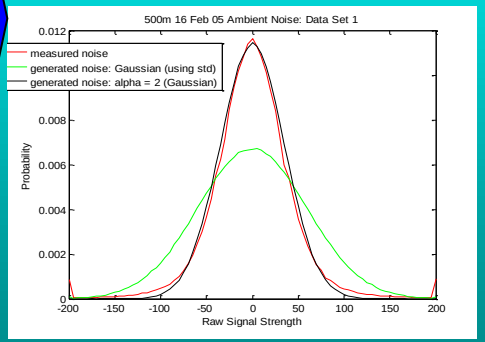
Projector

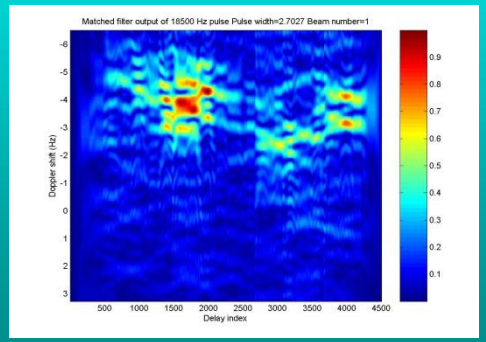
Frequency Band
12.7 kHz – 24.3 kHz

SHALLOW WATER CHANNEL









Sea trial analysis results to set channel model and modem simulation

Front-end Receiver

Nested Hydrophone Array

Signal Conditioning Boards

EXPERIMENTAL DESCRIPTION

PC with PCI NI DAQ (Transmitter/Receiver)

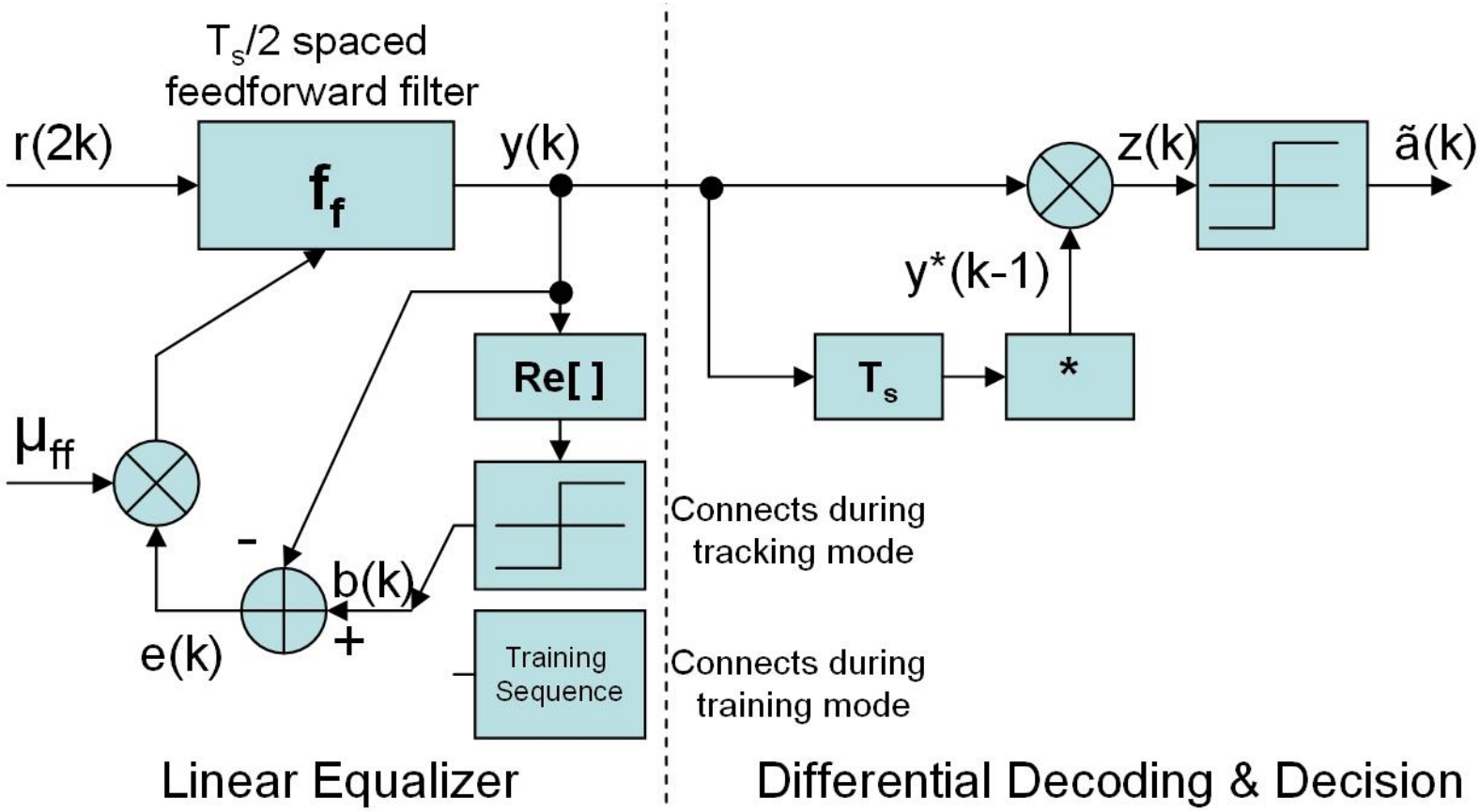
National Instruments Multi-function DAQ Card

CHANNEL MEASUREMENTS

Range (m)	Root Mean Square (RMS) Delay Spread (ms)	Doppler Spread, W_d (Hz)	Doppler Shift (Hz)
80	1.2	9	-1,+2
130	1.9	8	-1
600	0.85	4	-2
1030	0.85	3	0
1510	0.38	2	-1
1740	0.13	2	+1
2740	0.10	3	+2

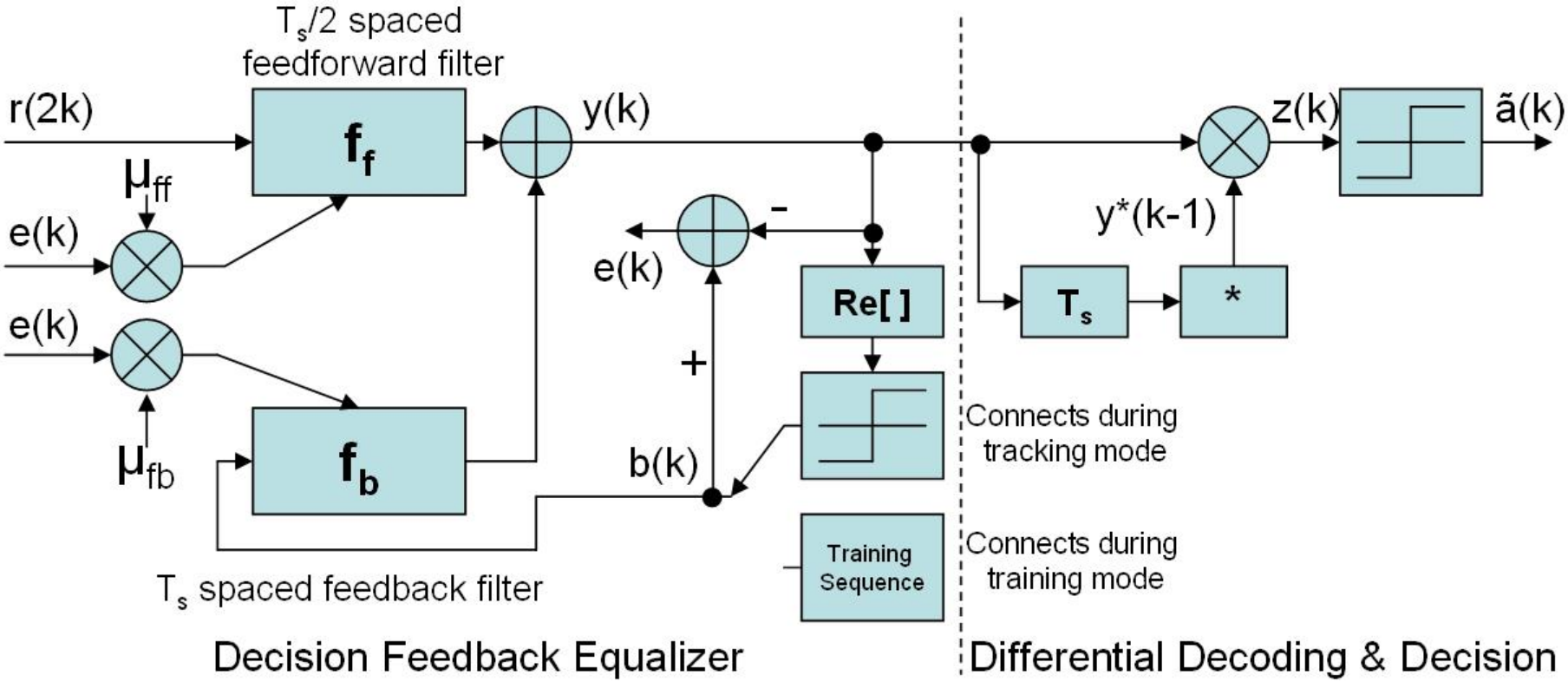
ADAPTIVE EQUALIZATION

- LINEAR EQUALIZER



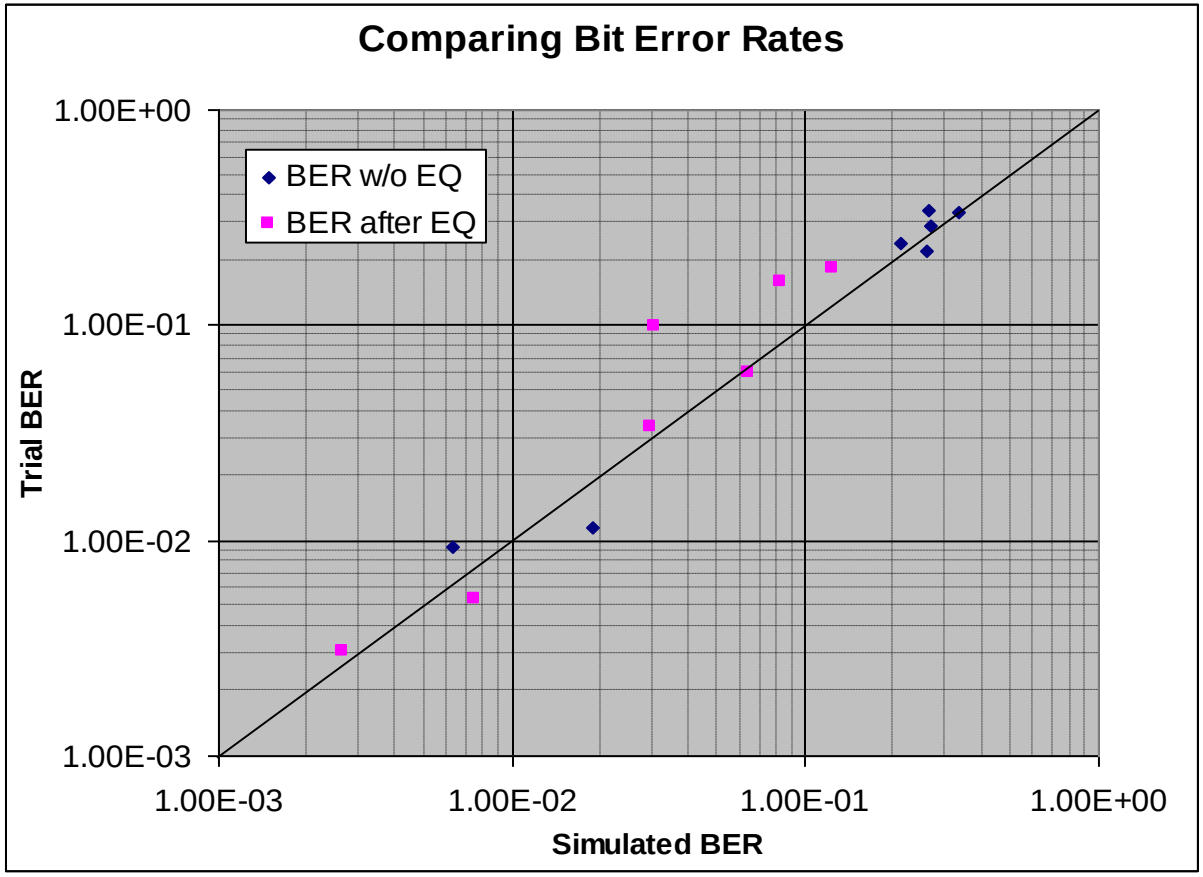
ADAPTIVE EQUALIZATION

- DECISION FEEDBACK EQUALIZER



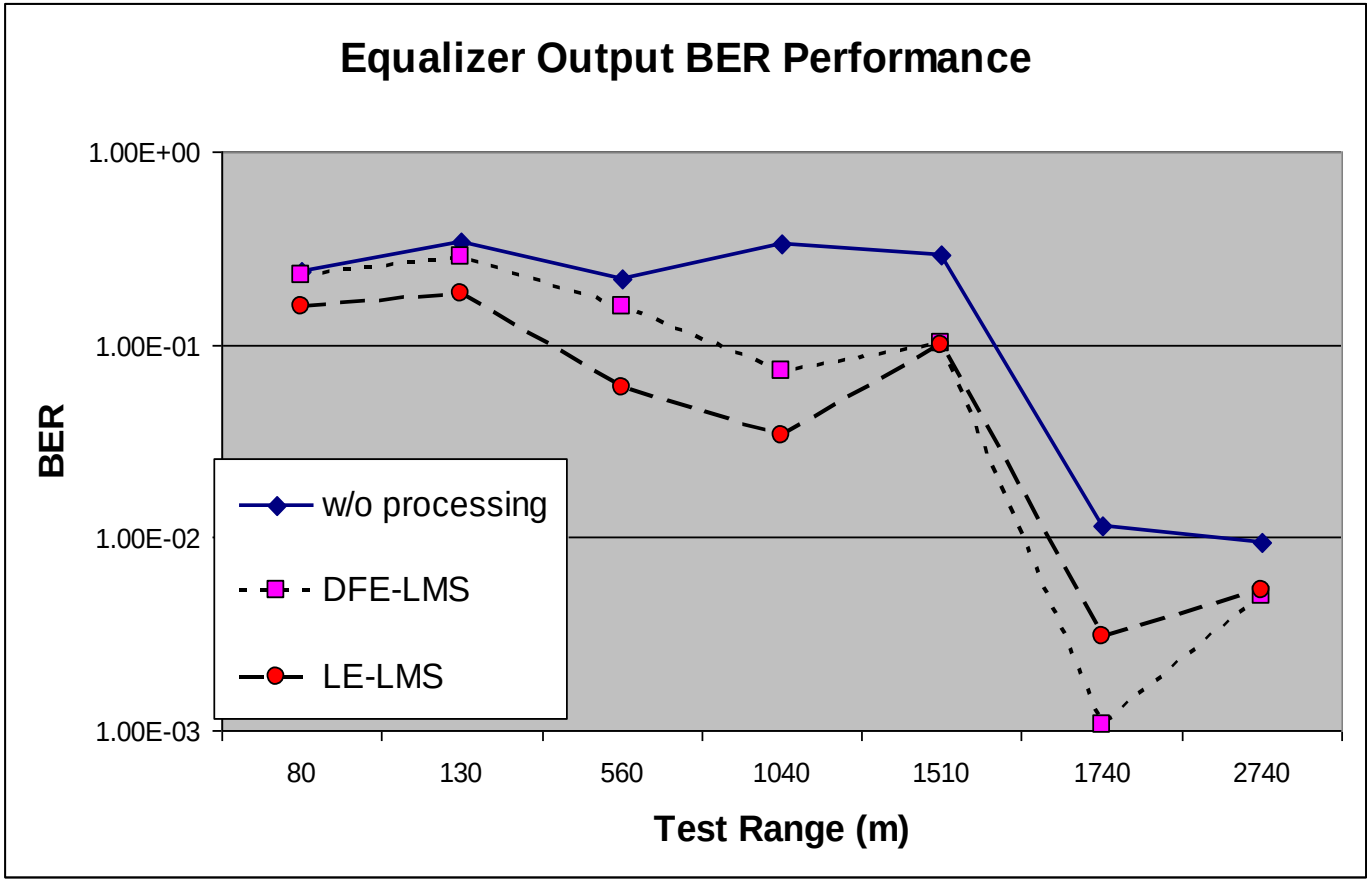
ADAPTIVE EQUALIZATION

- Comparing LE in simulation and trial
- Least Mean Square (LMS) Adaptation



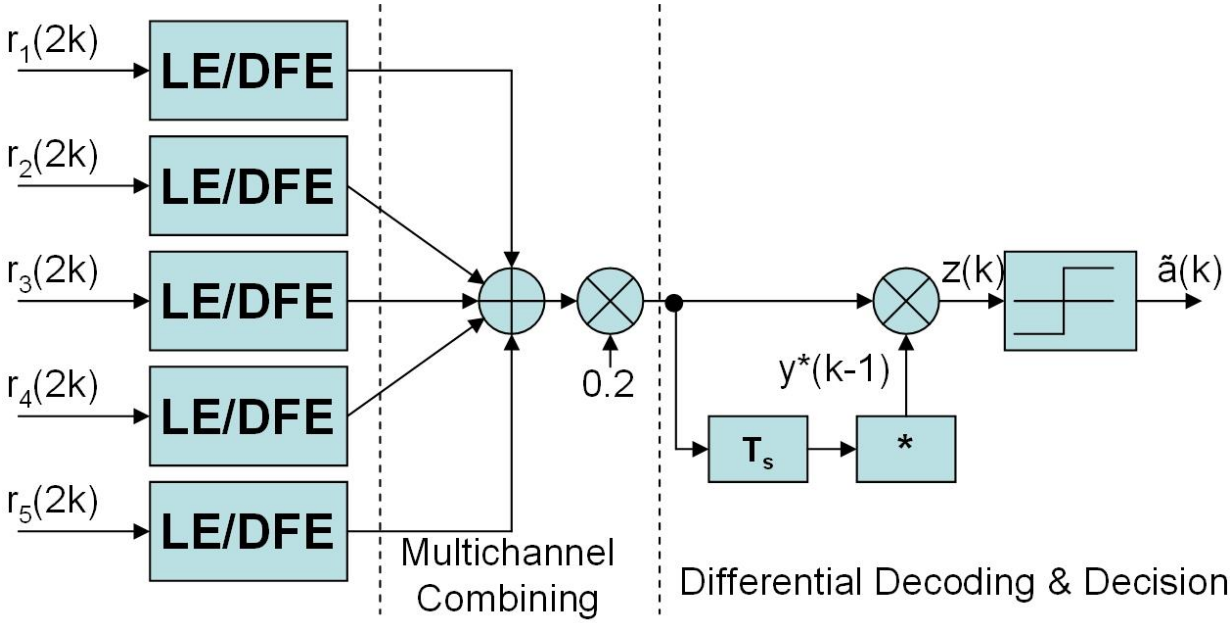
ADAPTIVE EQUALIZATION

- Comparing LE-LMS and DFE-LMS from trial data



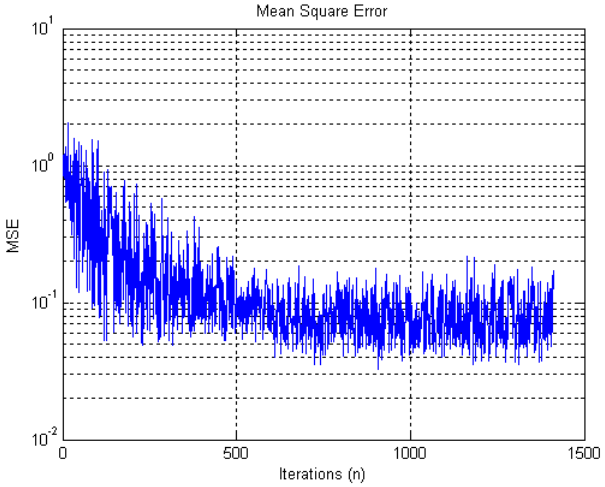
MULTICHANNEL COMBINING

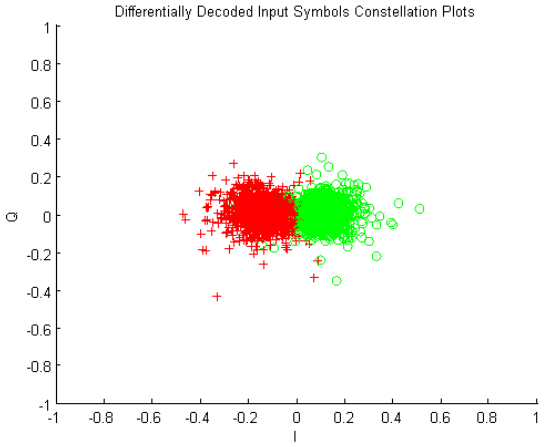
- Multichannel Combining
  - Short Range: Main improvement from automatic beamforming.
  - Long Range: Main improvement from increased SNR.

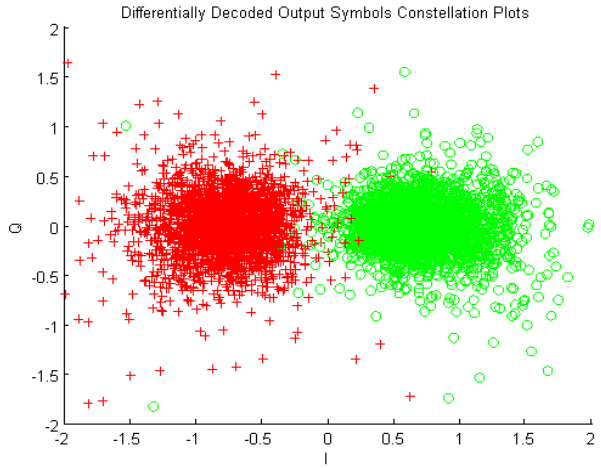


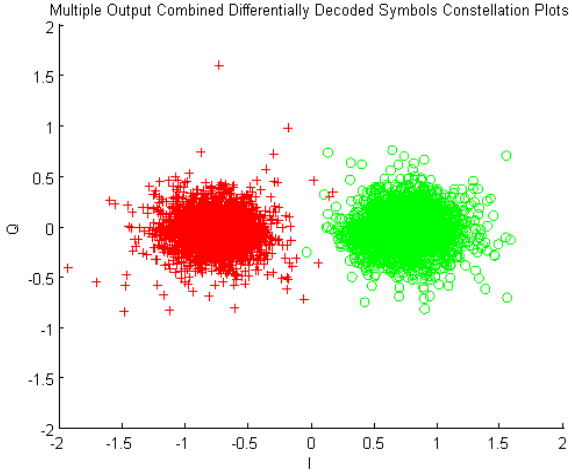
MULTICHANNEL COMBINING

2740m Trial Data



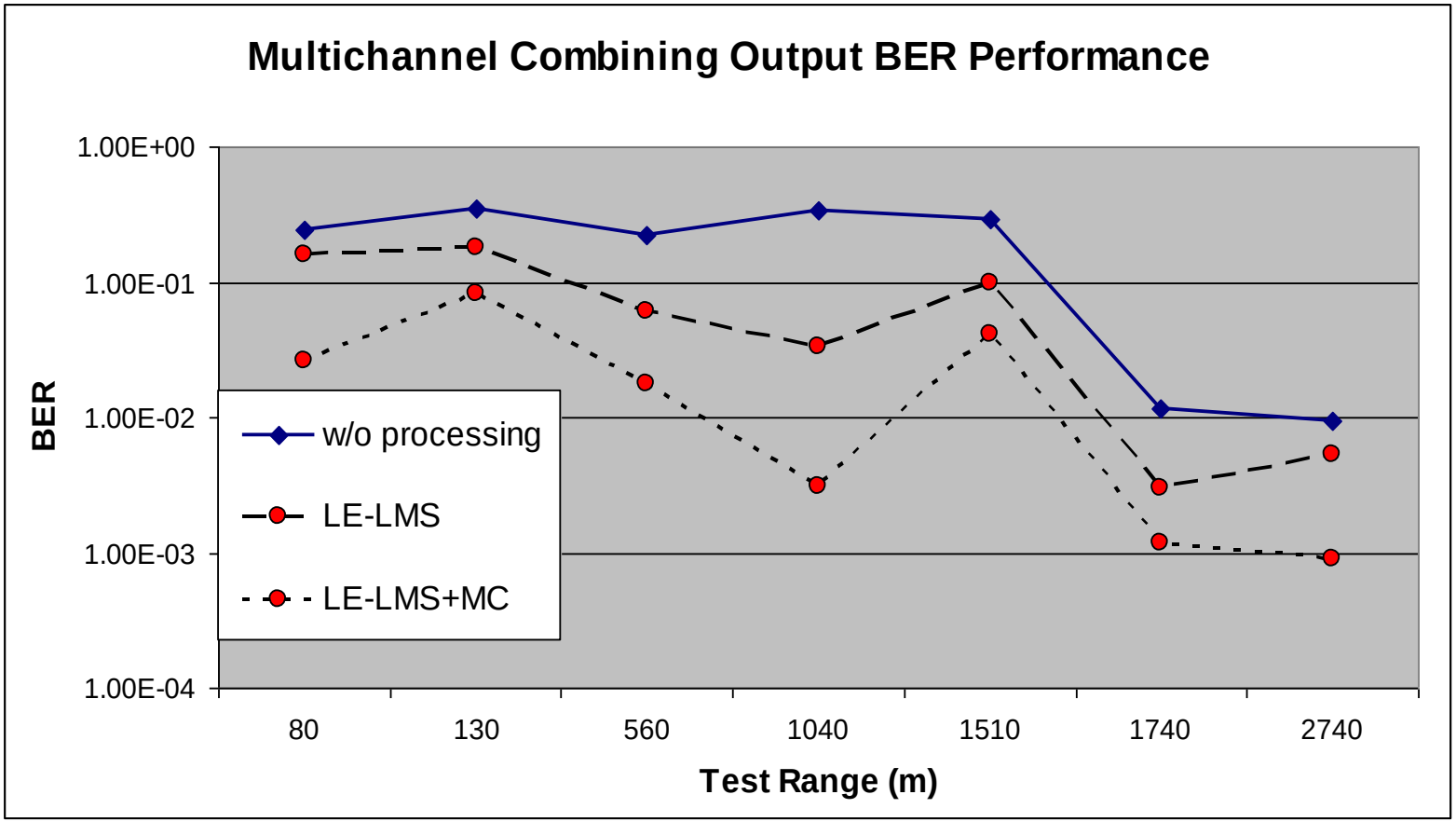






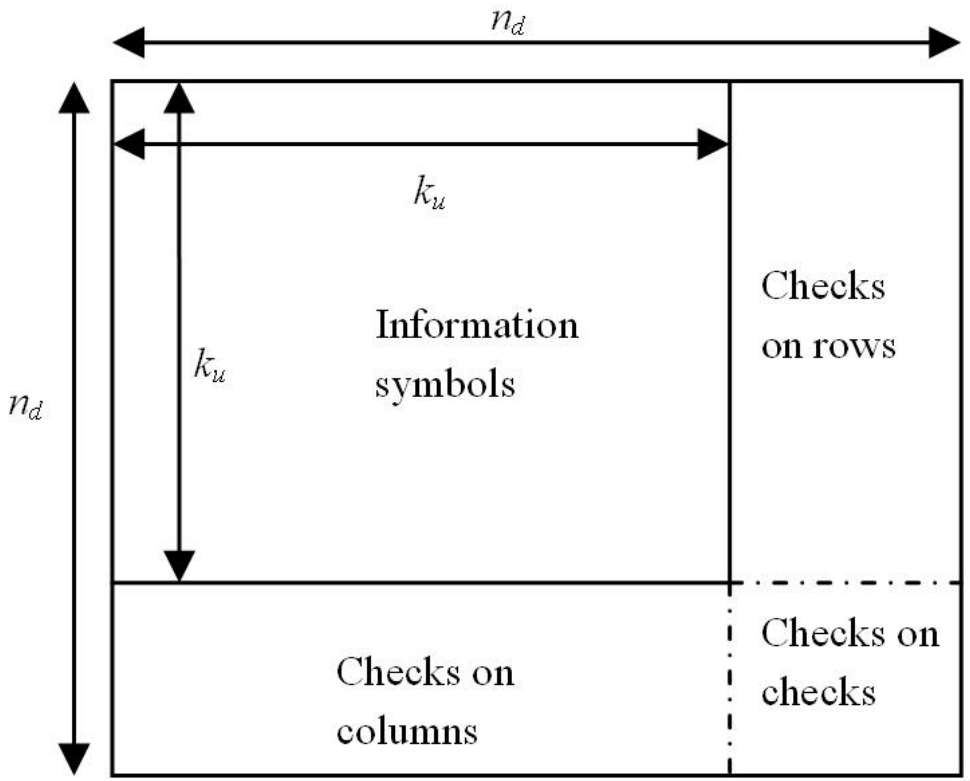
MULTICHANNEL COMBINING

- Performance from trial data



CHANNEL CODING

- Turbo Product Codes
  - Code Rate ~ 0.75



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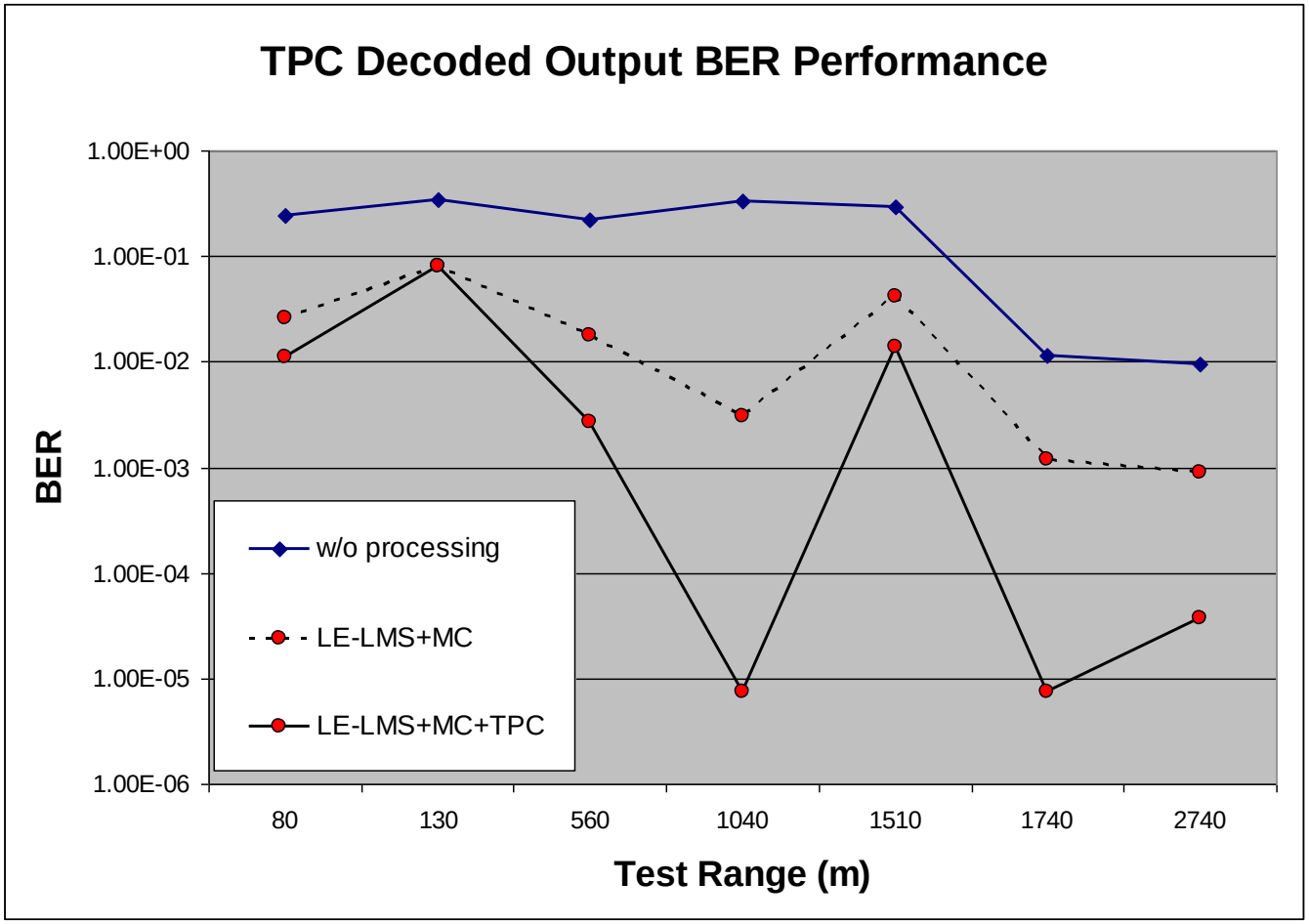

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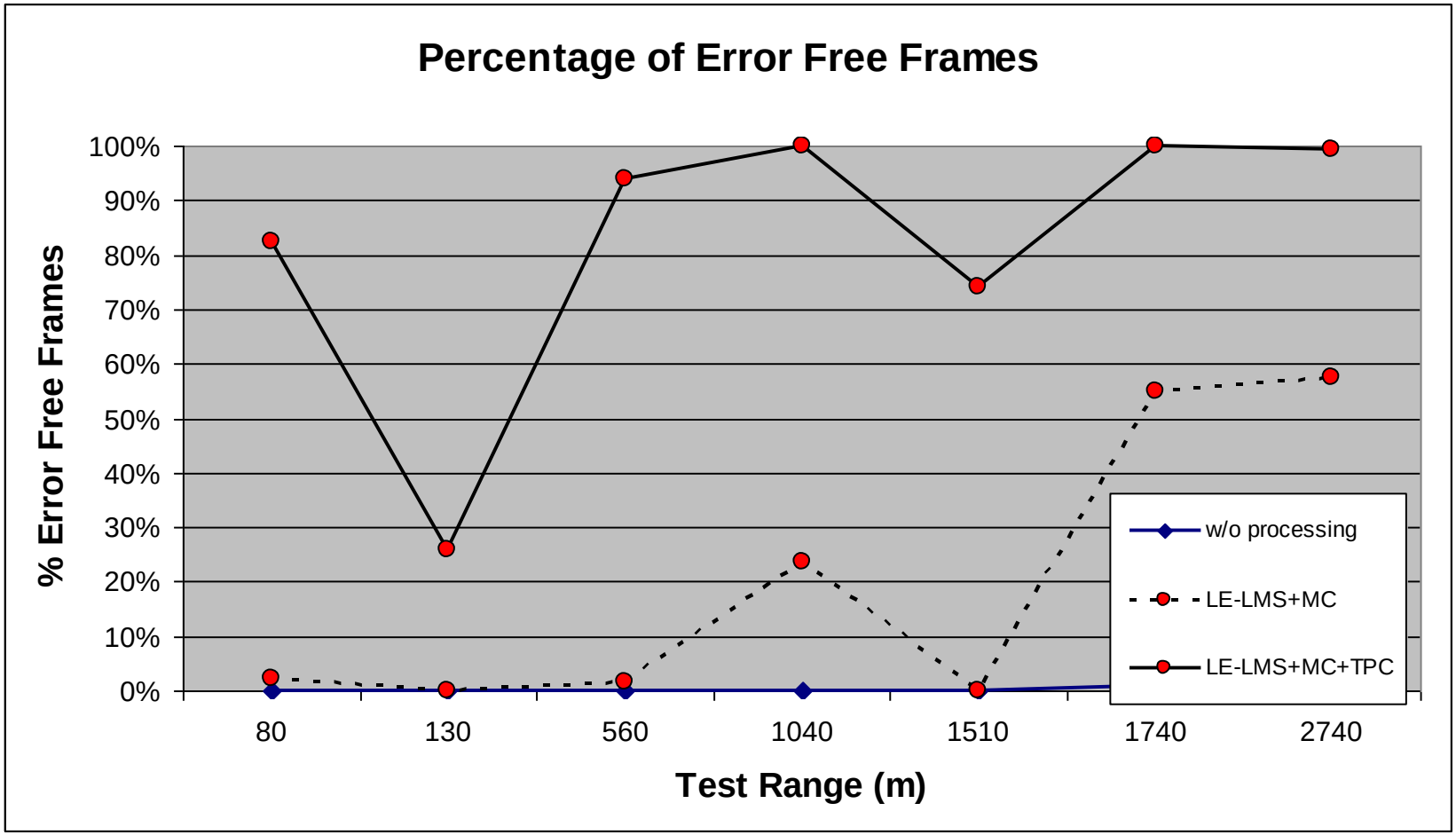

CONCLUSION

- Channel model results are adequately close to real data
- DPSK-LE-LMS is generally better than DPSK-DFE-LMS for shorter distances
- Multichannel combining and TPC improves BER performance
- Overall the packets recovered are over 80% except at 130m and 1510m. The channel is probably varying too fast for the LMS adaptation
- Faster adaptation algorithms will work better but at expense of increased computational complexity.

THAT'S ALL FOLKS!

- Questions and Answers
- Have a pleasant day ahead!

BACK UP SLIDES