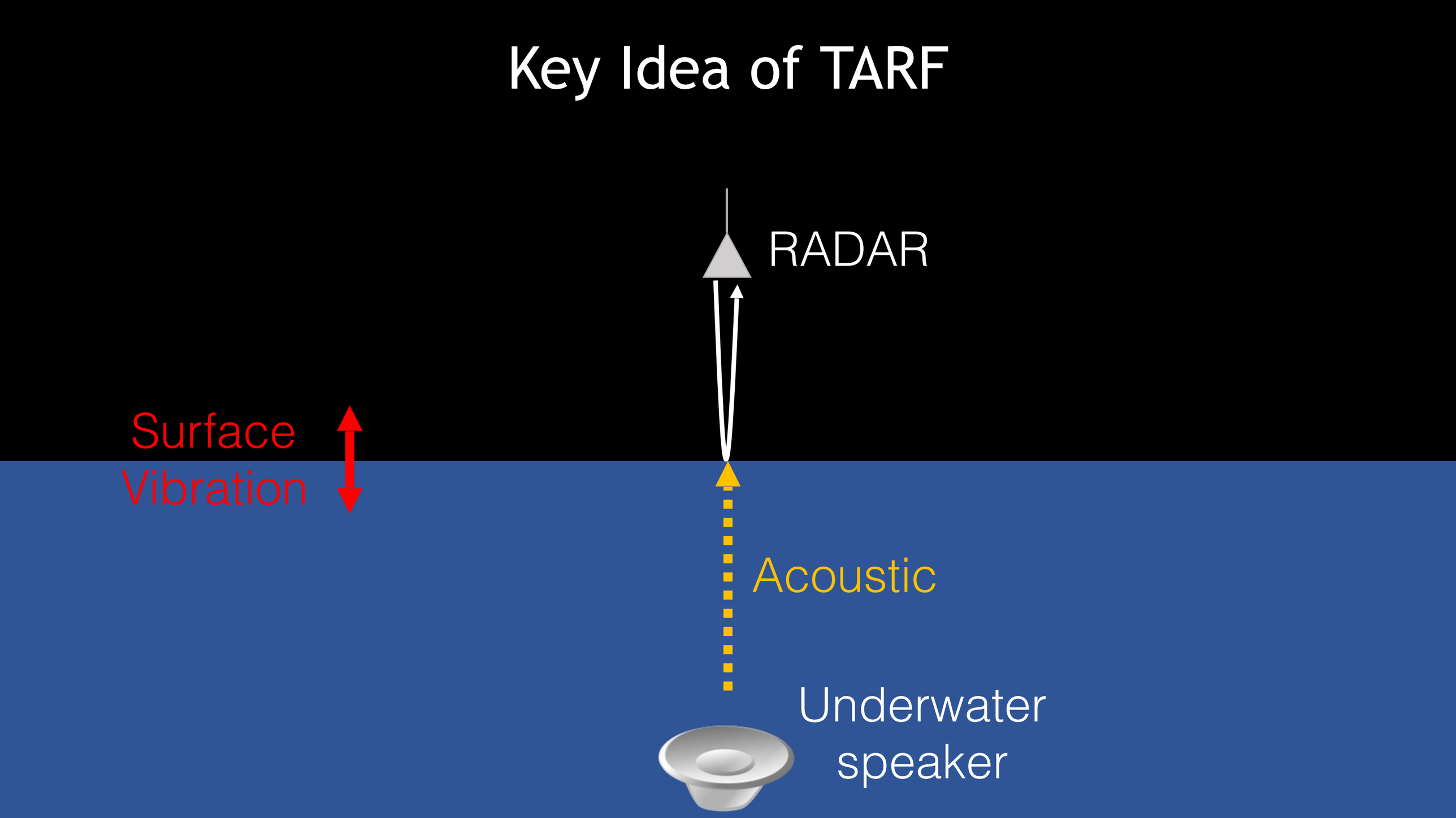
MAS.S66
Computational Wireless Sensing

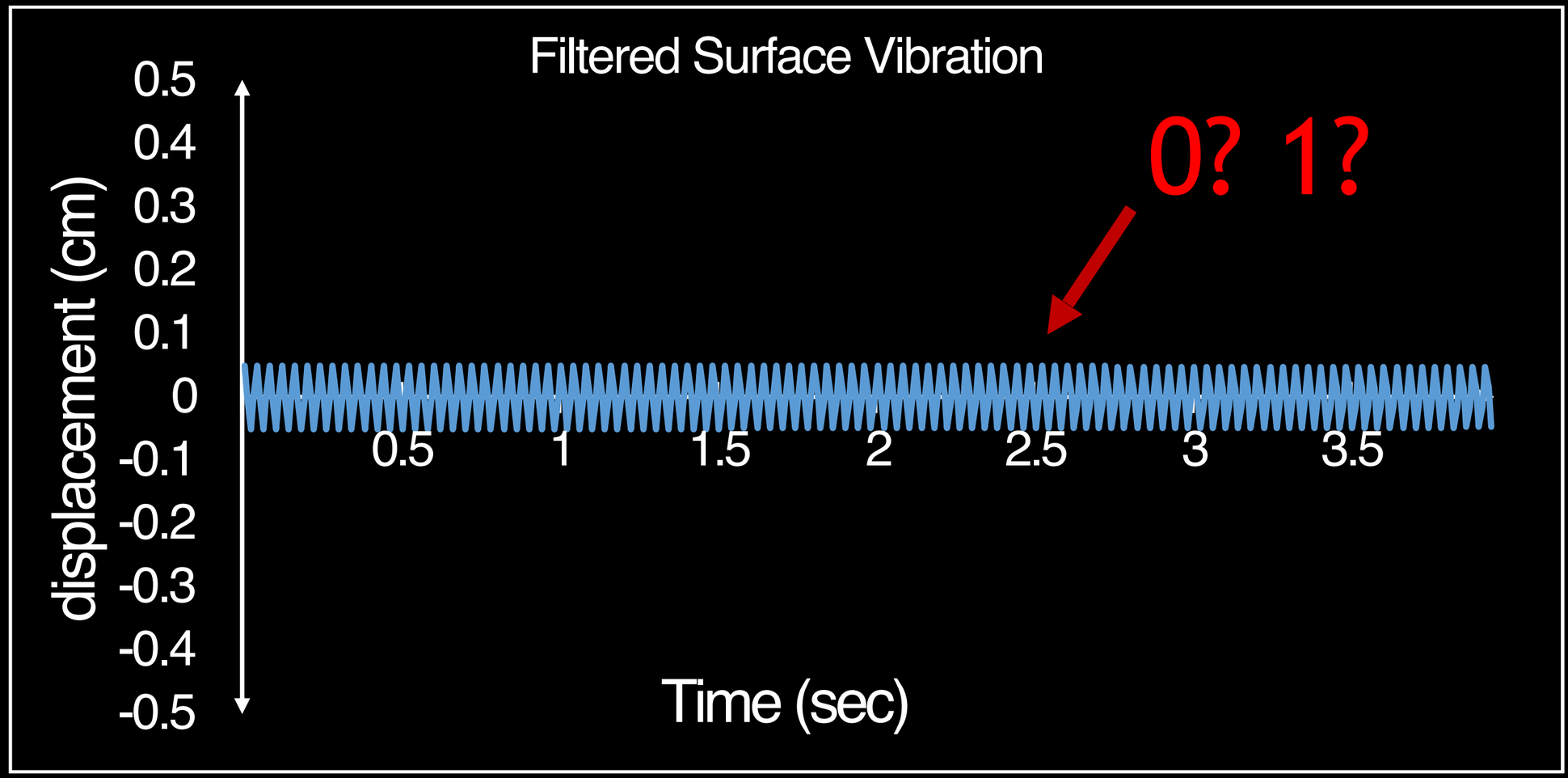
Lecture 6 (part 1):
Wireless Communication Systems

Lecturer: Fadel Adib (fadel@mit.edu)

Key Idea of TARF

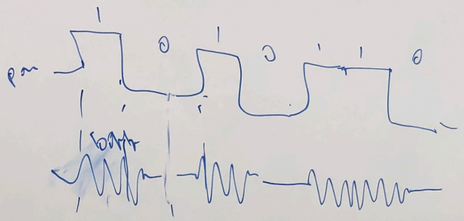


How Can We Decode?

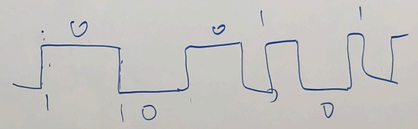


Comm

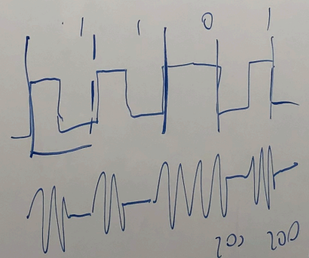
- On-Off

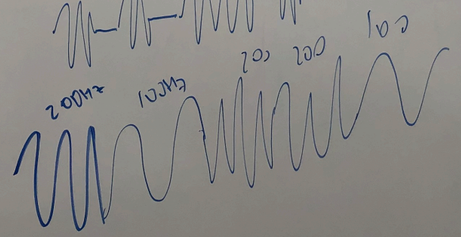


- FMD (Manchester encoding)



* 1 bit in middle is same to other

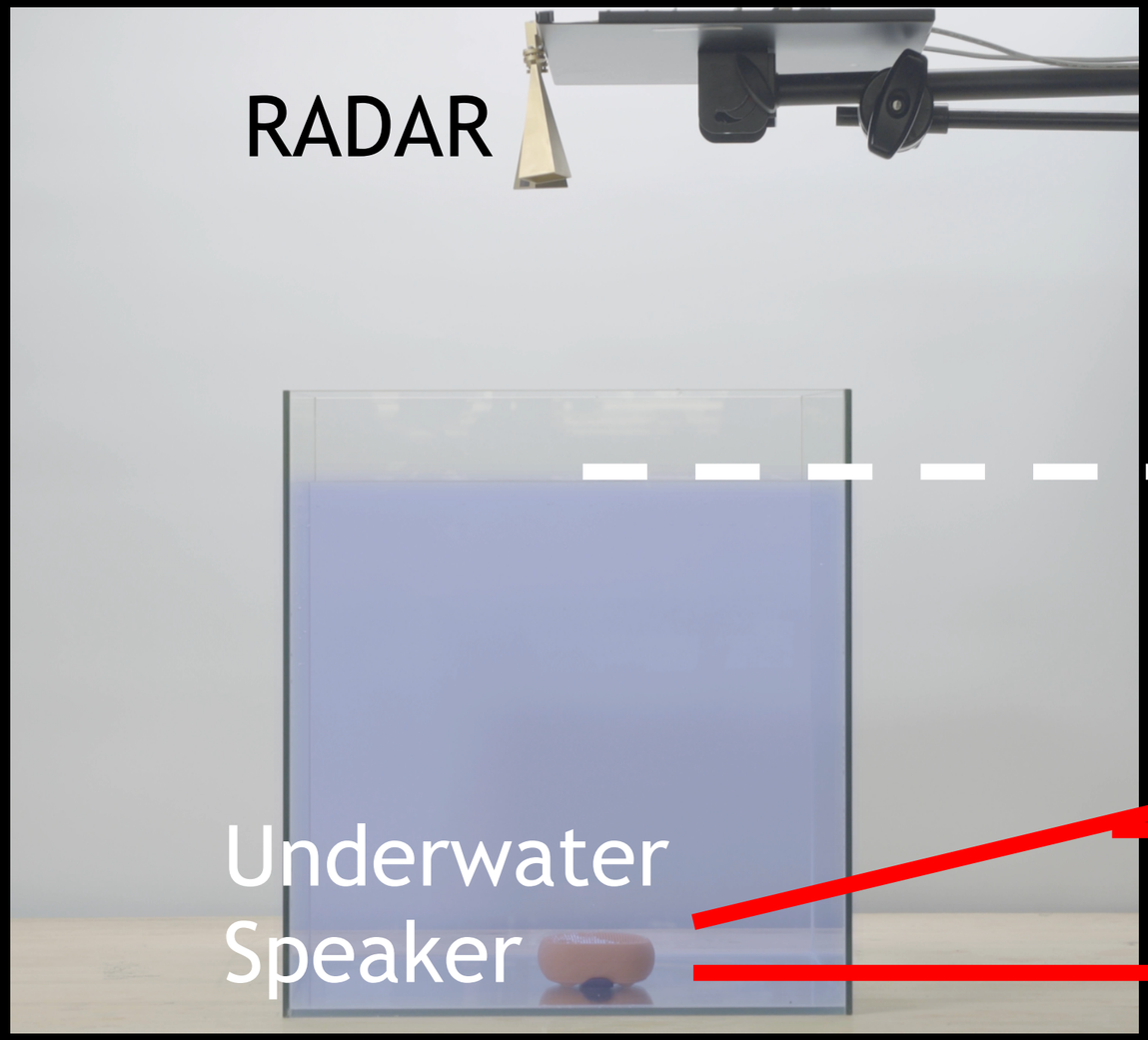




more Signal power
-> SNR
-> better (lower BER)

FSK

Decoding Information



Angle
Variation

100Hz

200Hz

Rx

Rx

Surface
Vibration

100Hz

200Hz

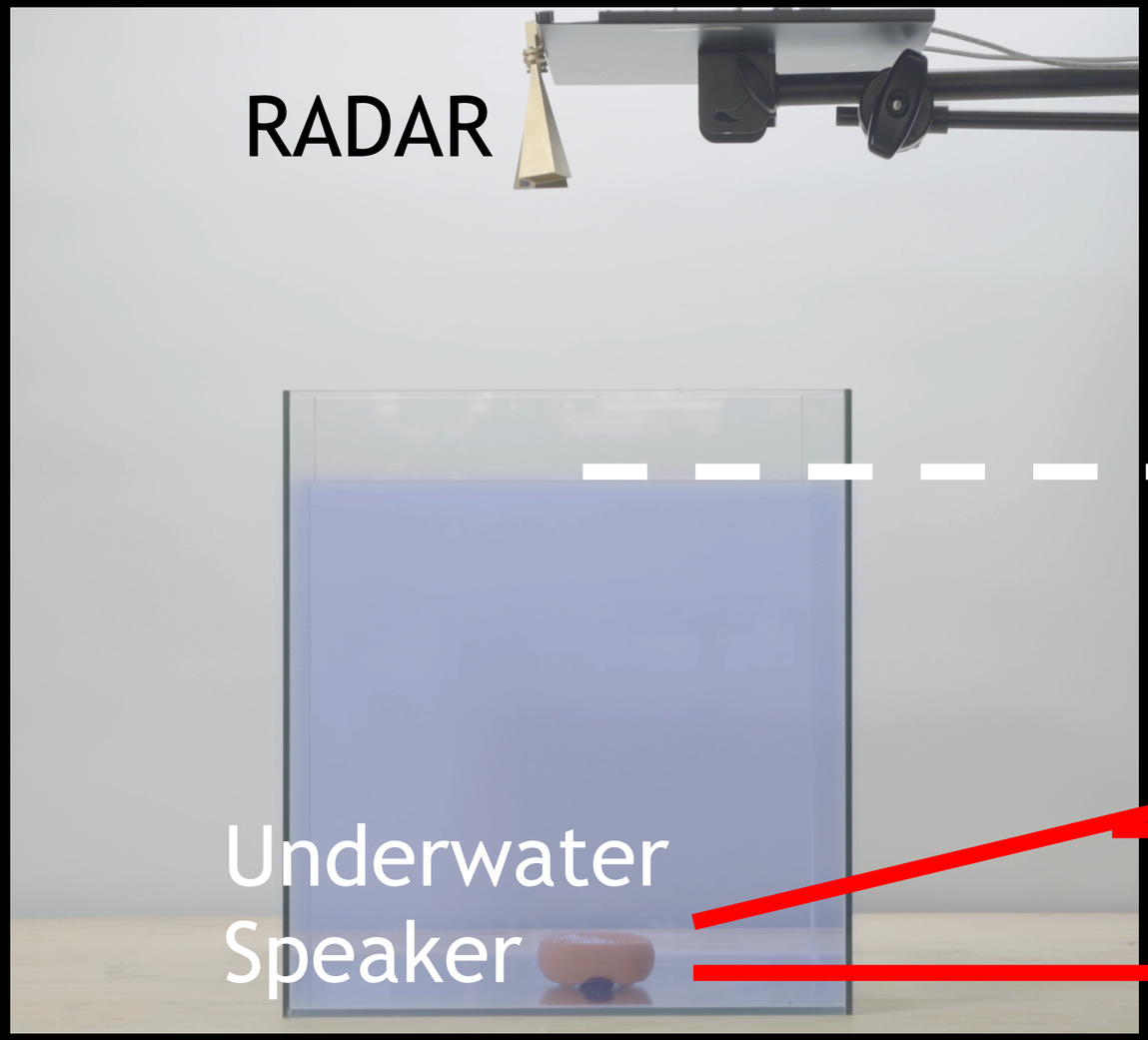
Tx: 100Hz

Bit 0

Tx: 200Hz

Bit 1

Decoding Information



Angle
Variation

100Hz

200Hz

Rx

Rx

Surface
Vibration

100Hz

200Hz

Tx: 100Hz

Bit 0

Tx: 200Hz

Bit 1

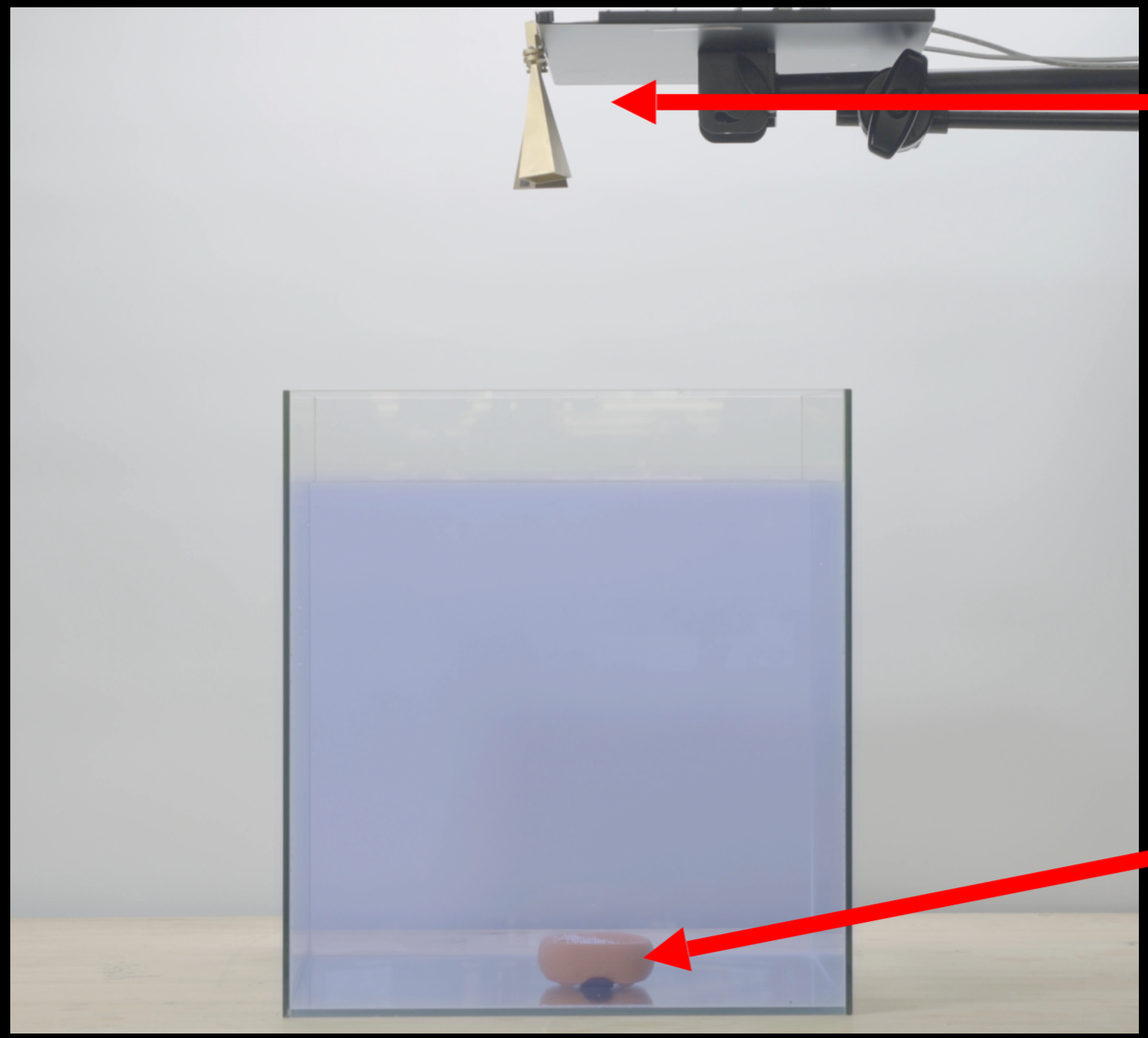
Standard Modulation Schemes?

The wireless channel

- Mathematics & Physical Interpretation
- Upconversion & Downconversion

Modulation & Demodulation

Implementation



Receiver

Custom made FMCW Millimeter-Wave RADAR

- Center Frequency: 60GHz
- Bandwidth: 3GHz
- Antennas: 23dBi Gain Horn Antennas

Radar acts as daughterboard to a USRP(N210) software radio

Transmitter (low power)

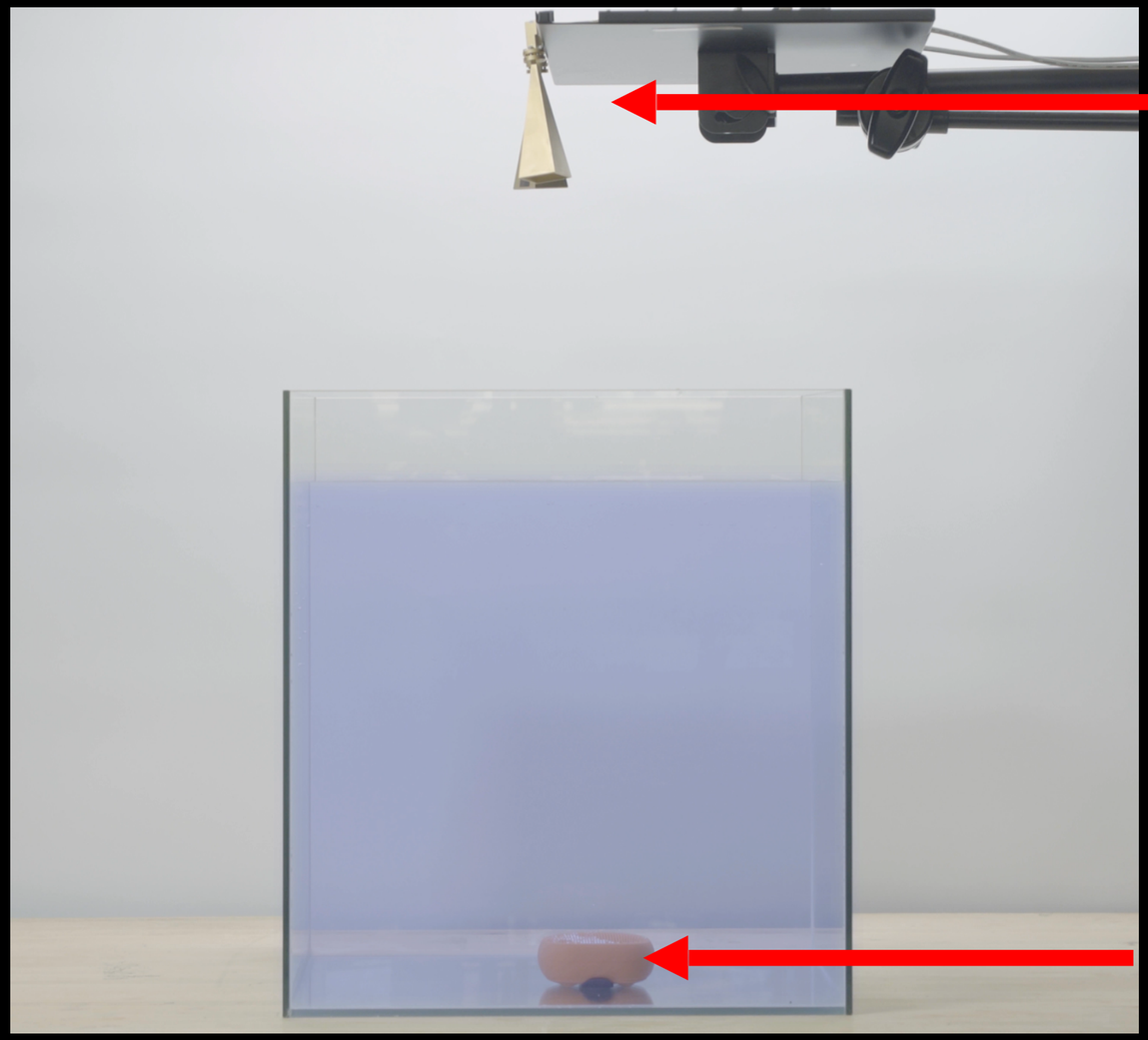
Electro-Voice UW30 Underwater Loudspeaker

- Center Frequency: 150Hz
- Bandwidth: 100Hz

Pre-amplifiers

- OSD 75W Compact Subwoofer Amplifier
- Pyle 300W Stereo Receiver

Implementation



Receiver

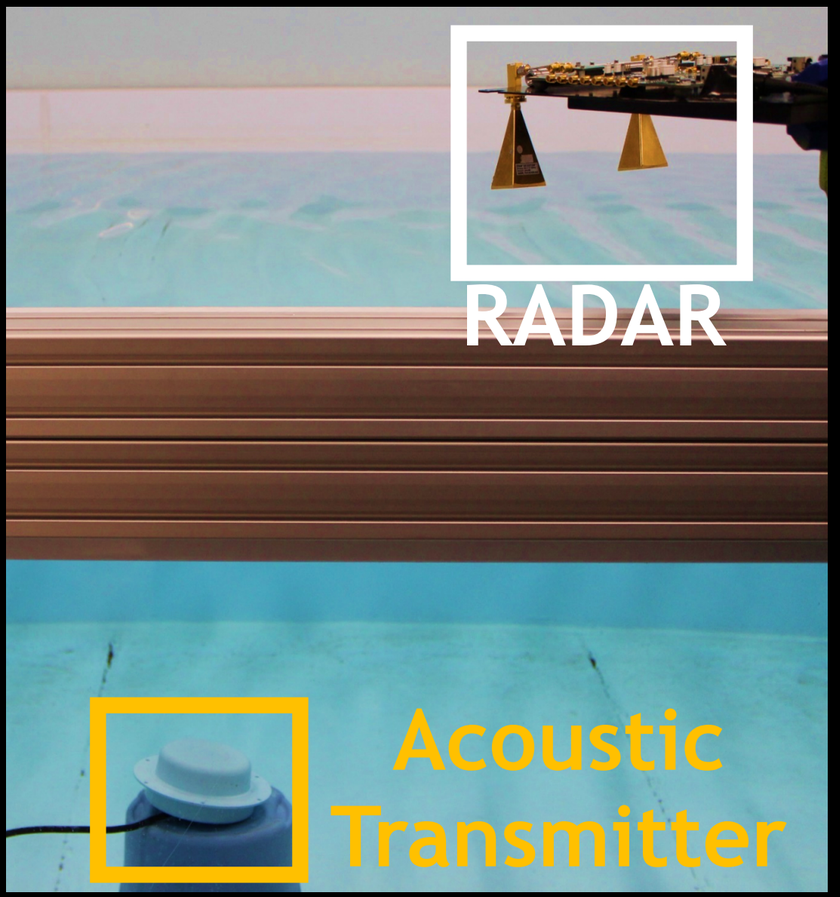
Custom made FMCW Millimeter-Wave RADAR

Transmitter (low power)

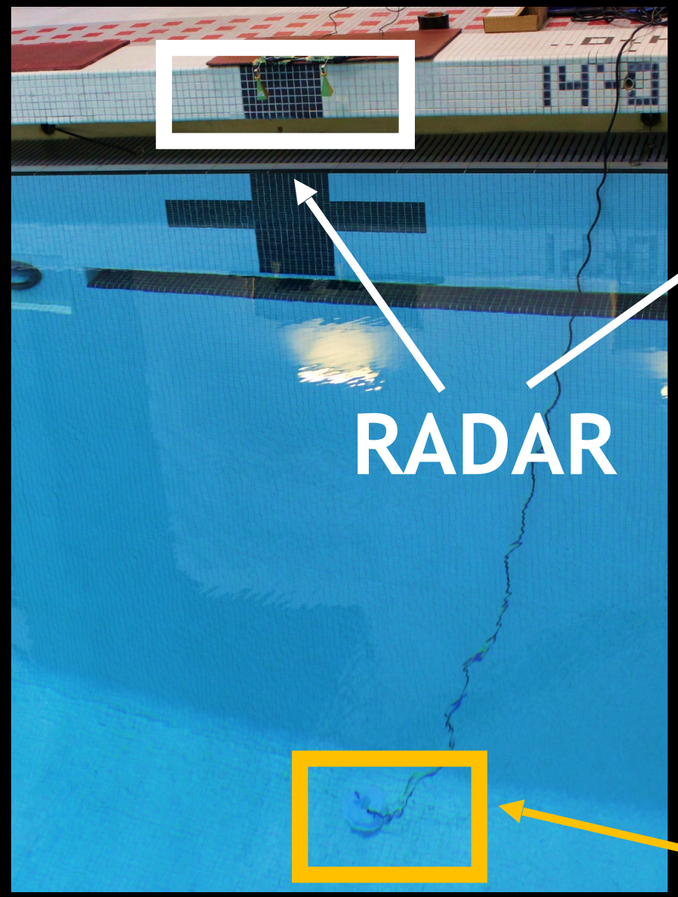
Underwater Loudspeaker

Different Evaluations

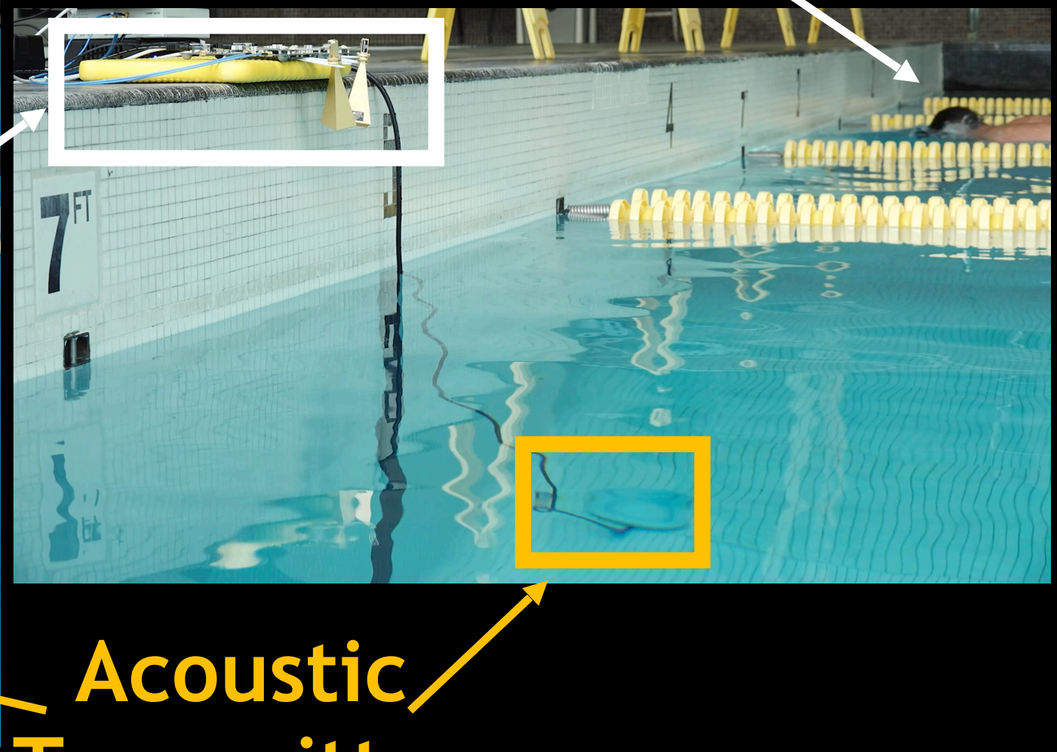
Water Tank



Swimming Pool

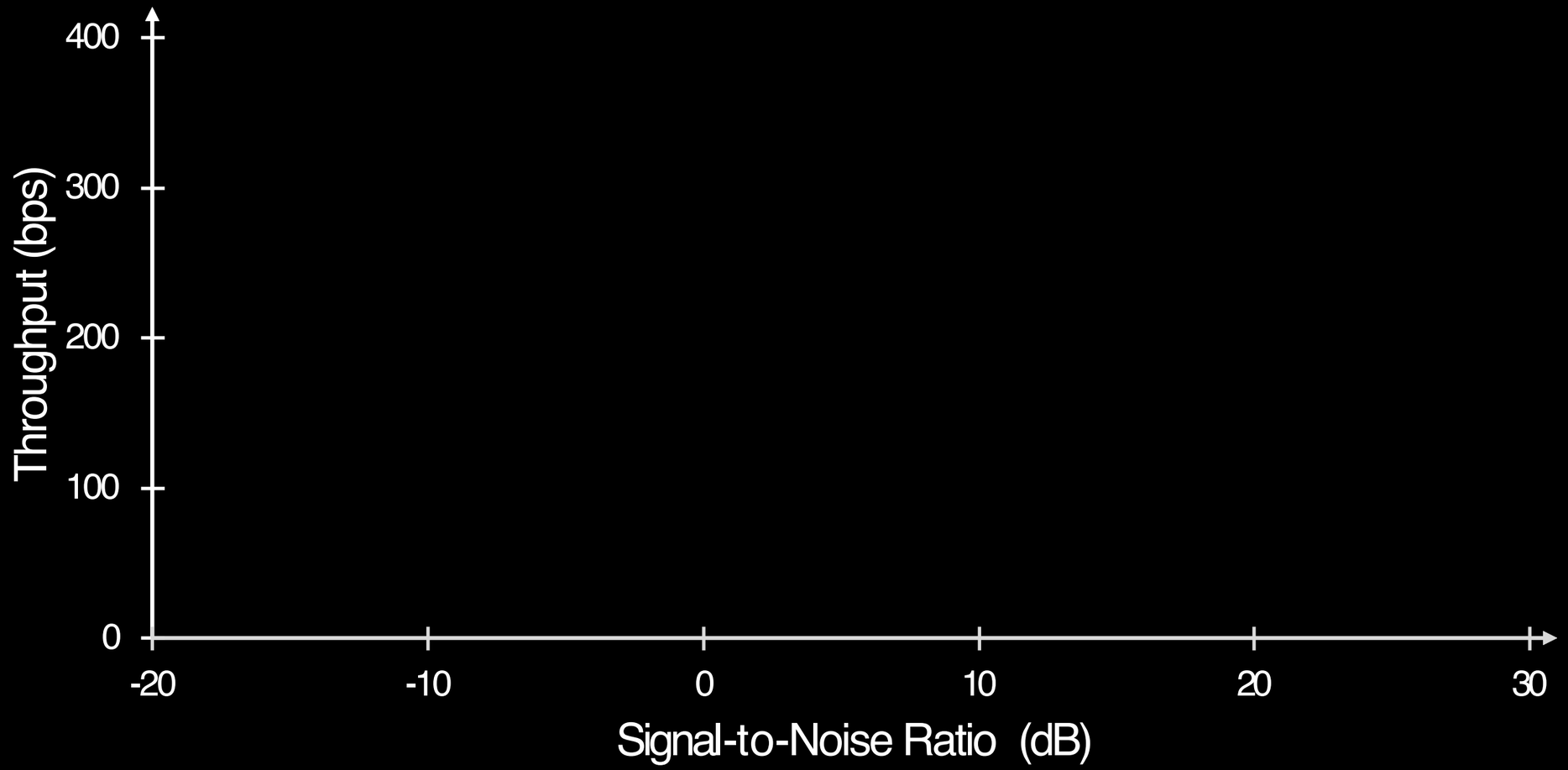


Swimming Pool
with swimmers



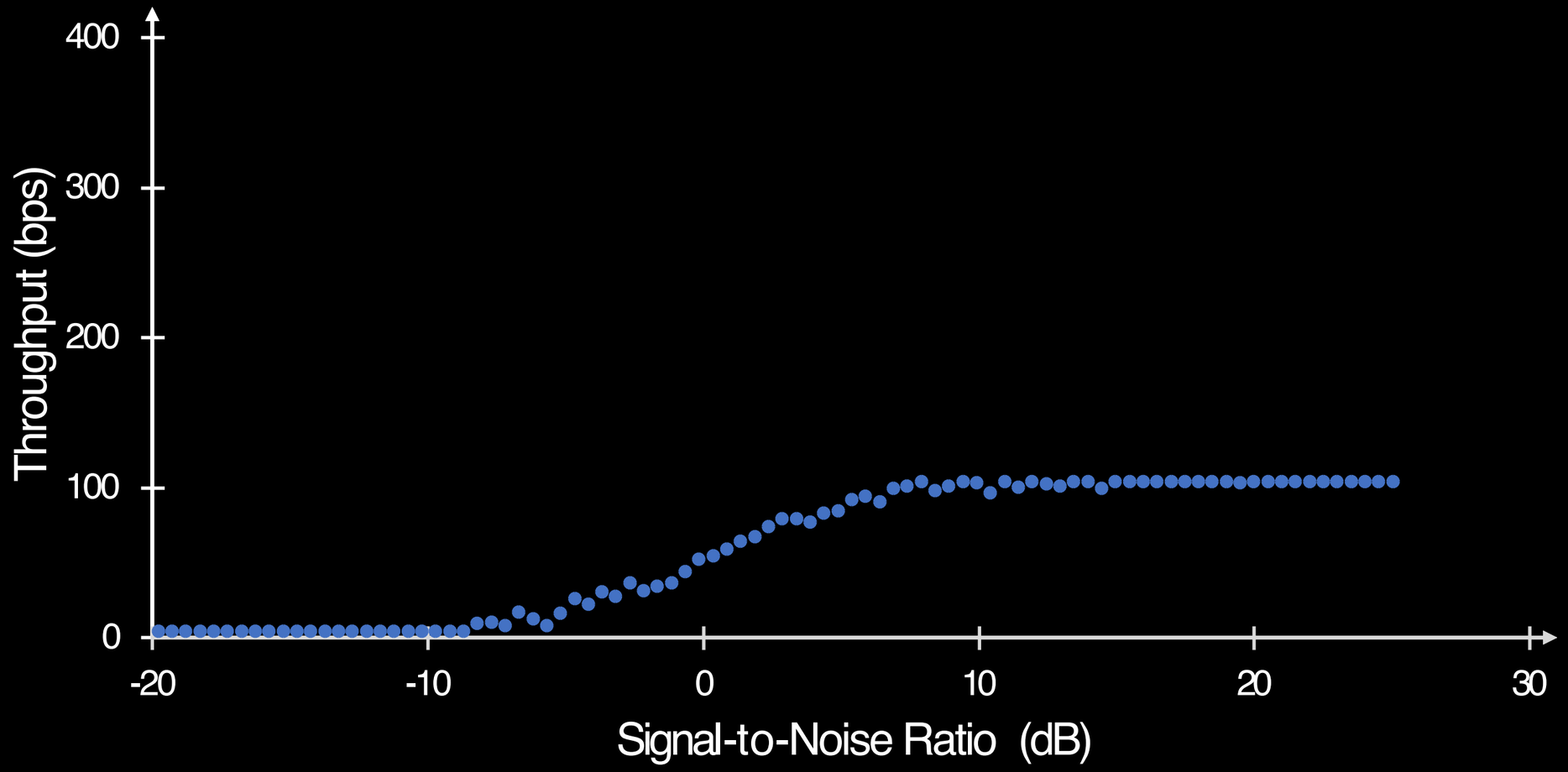
Throughput Results

Experiment: Vary the Power and Depth of Underwater Transmission



Throughput Results

Experiment: Vary the Power and Depth of Underwater Transmission



Throughput Results

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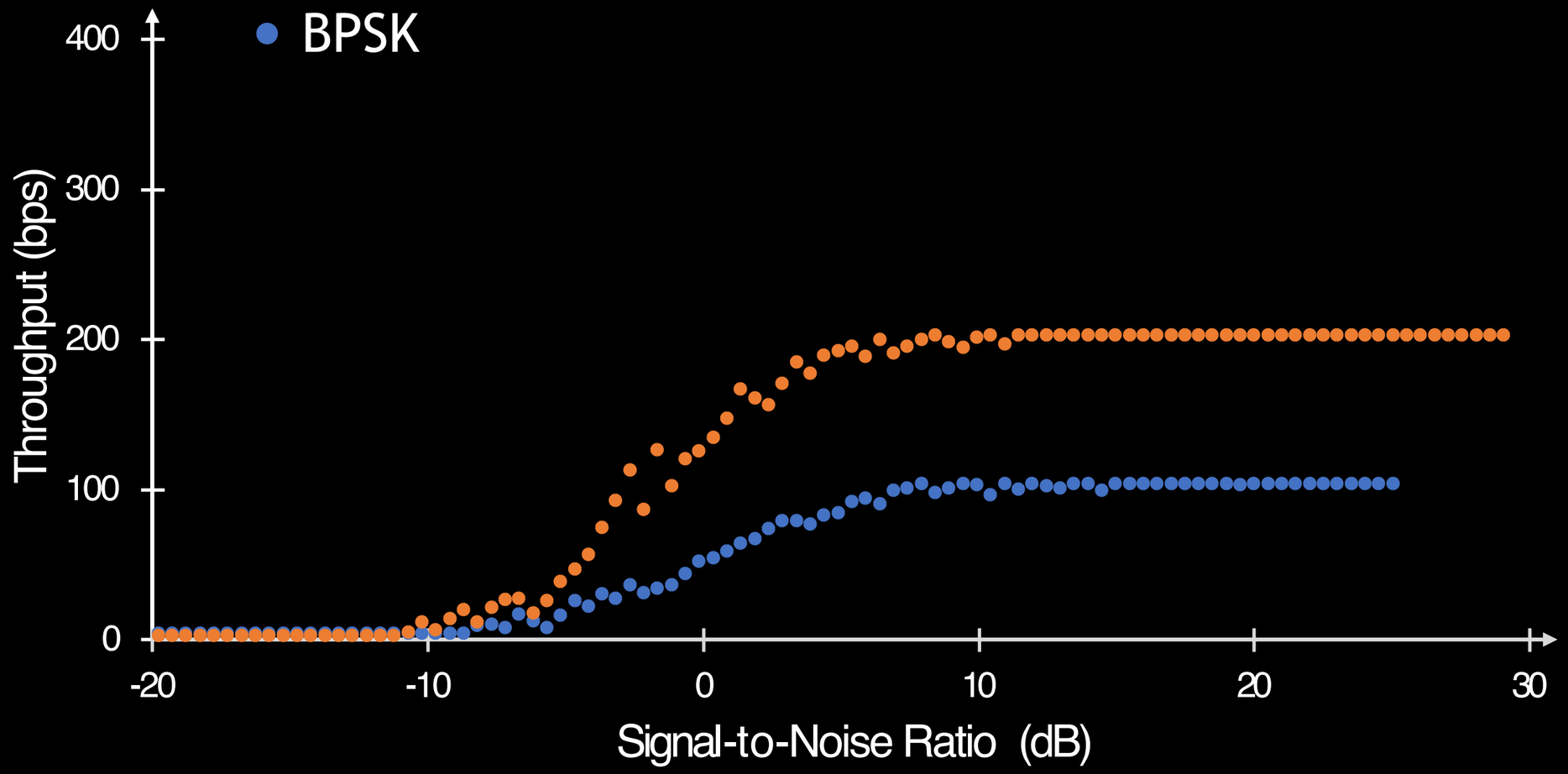
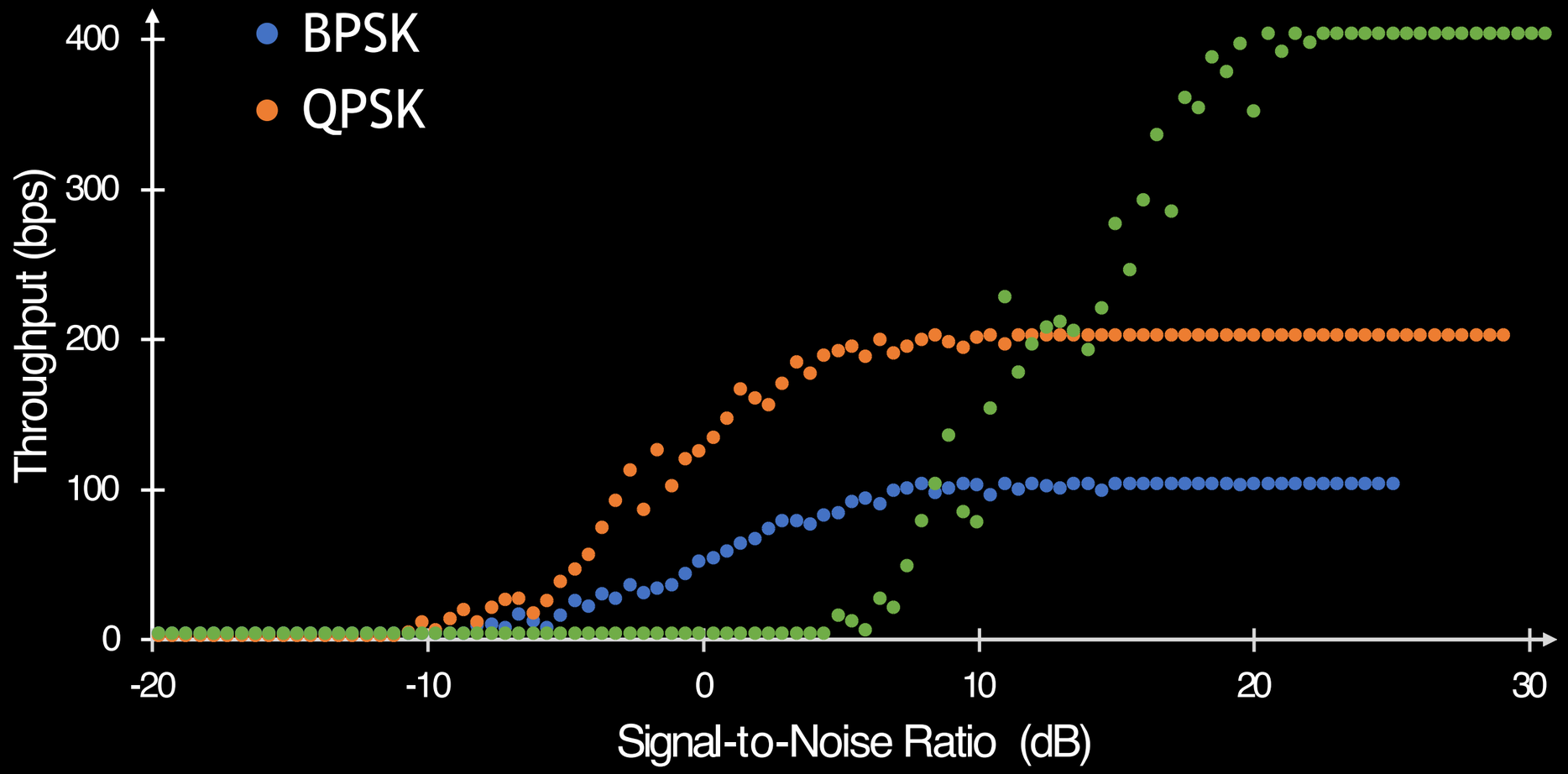
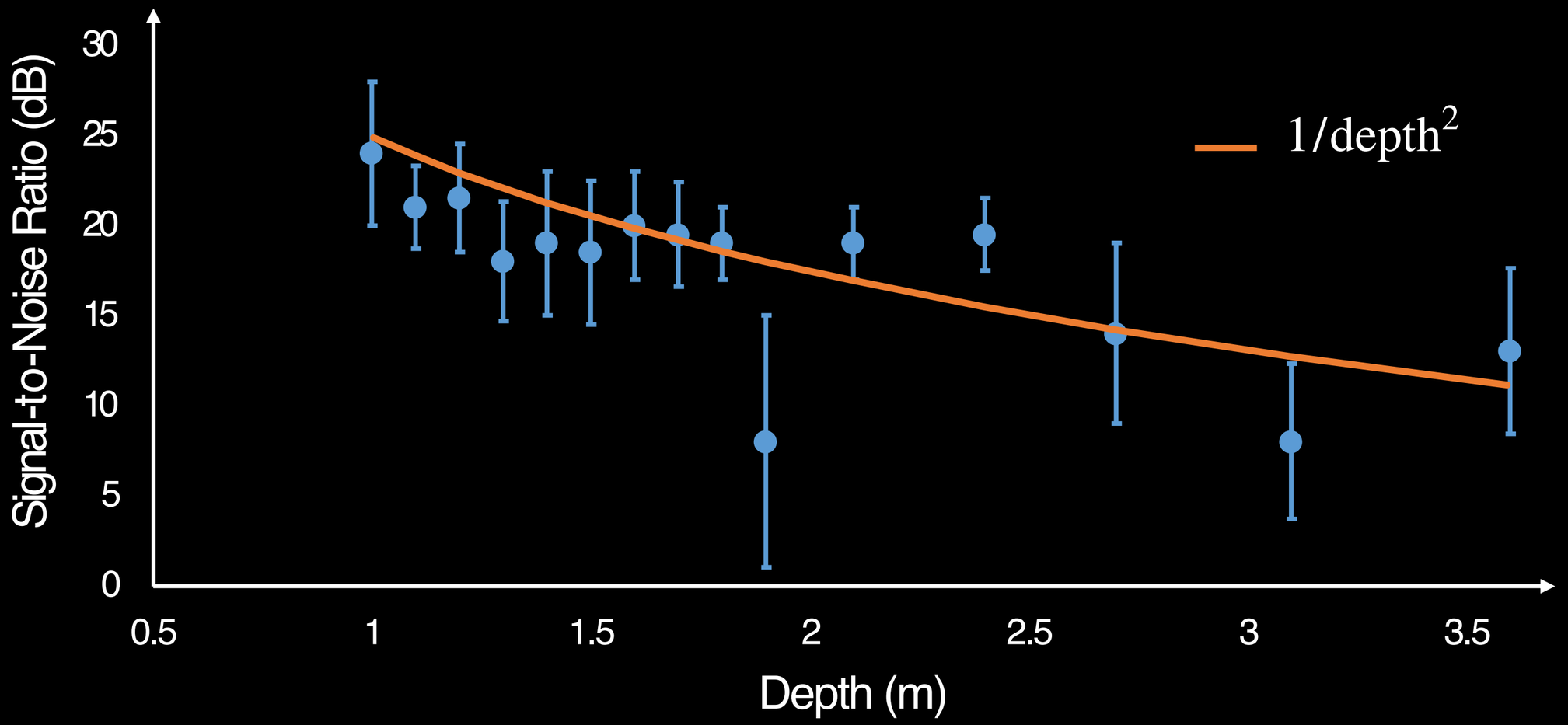


Throughput Results

Experiment: Vary the Power and Depth of Underwater Transmission

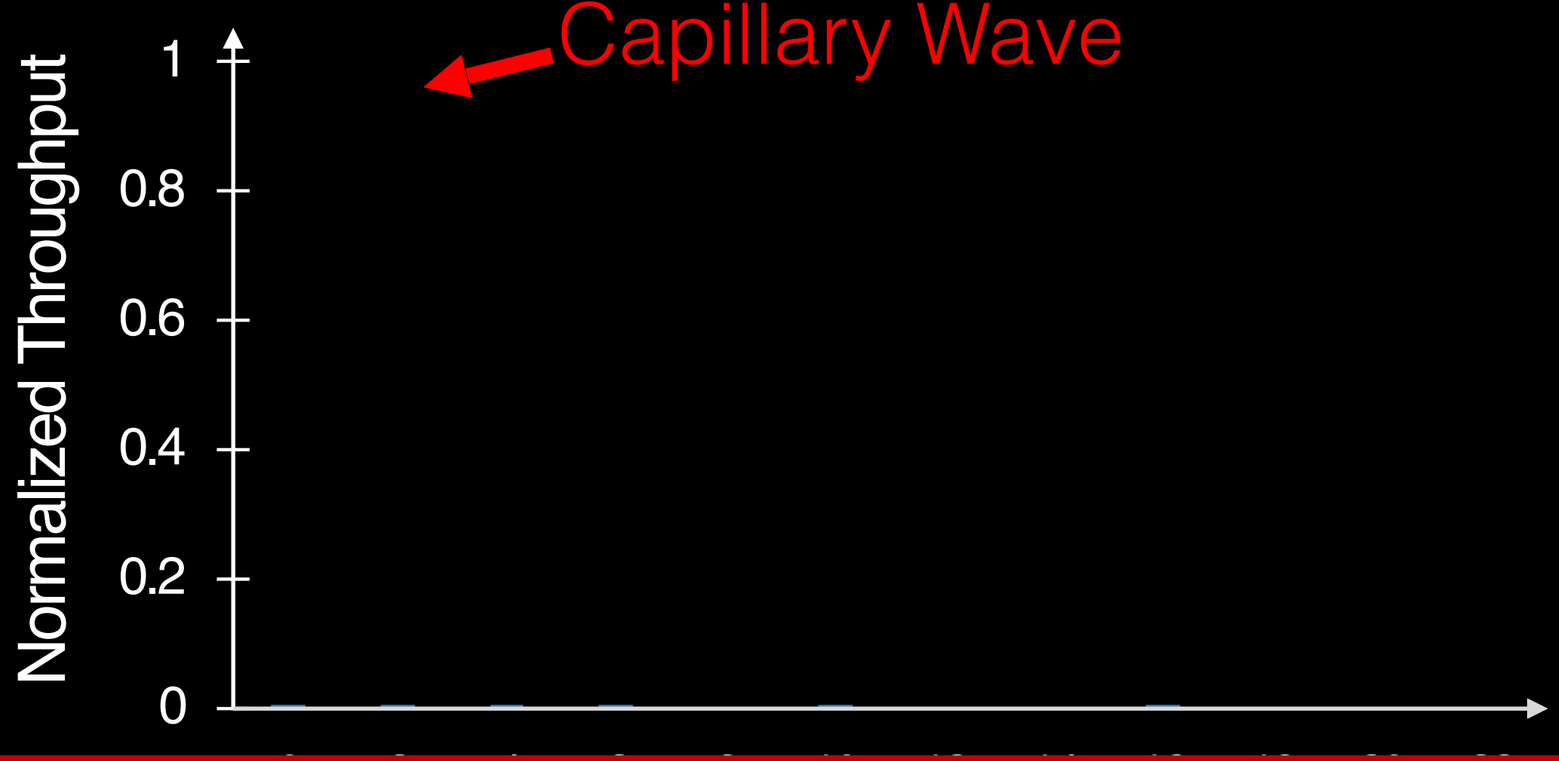


SNR vs Depth


Signal-to-Noise Ratio (dB)
30
25
20
15
10
5
0
0.5
1
1.5
2
2.5
3
3.5
Depth (m)
1/depth^2

Dealing with Waves

Experiment: Generate Waves of Peak-to-Peak Amplitudes



Our technology can communicate even in the presence of natural surface waves that are 1,000x larger than the acoustic vibrations

Receiver Misalignment

Experiment: Vary the Alignment Between the RADAR and the Transmitter