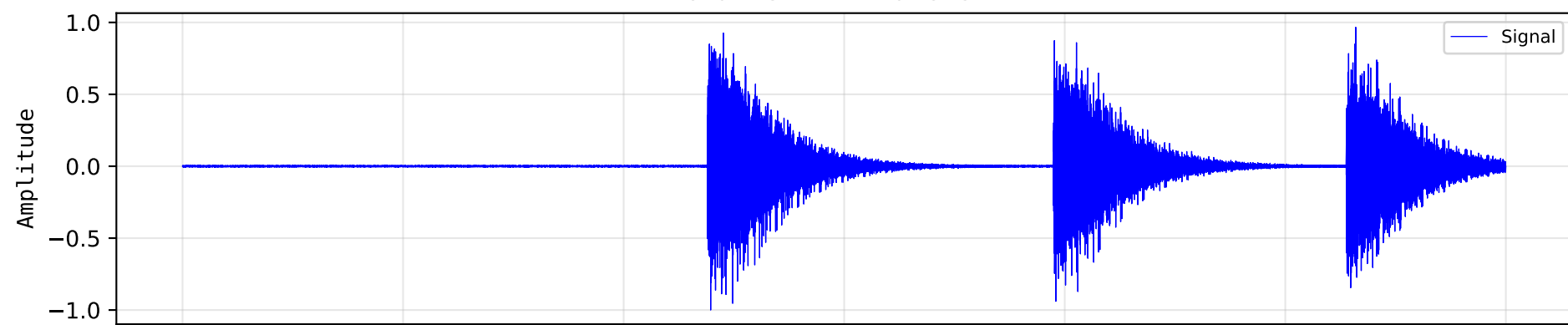
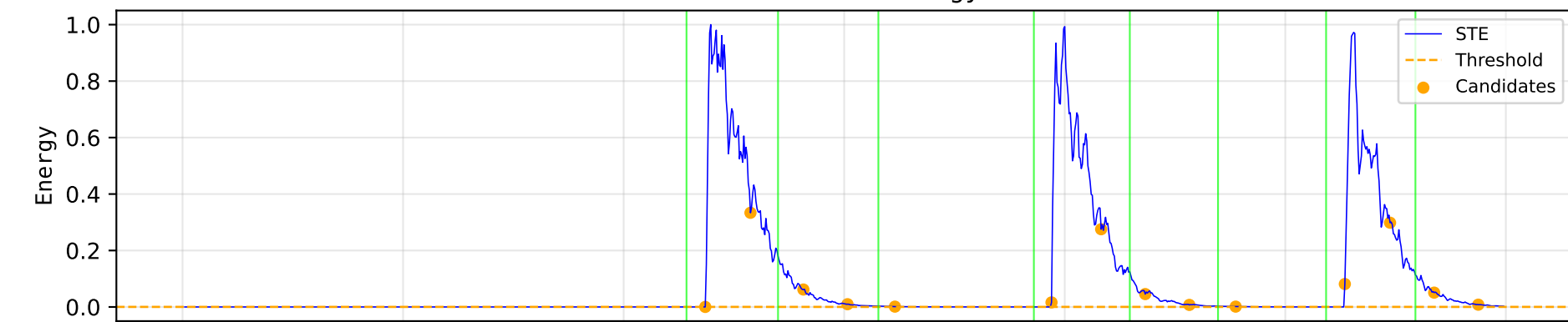


# Part 1: Gunshot Detection (energy + CUSUM, per-event chunk extraction)

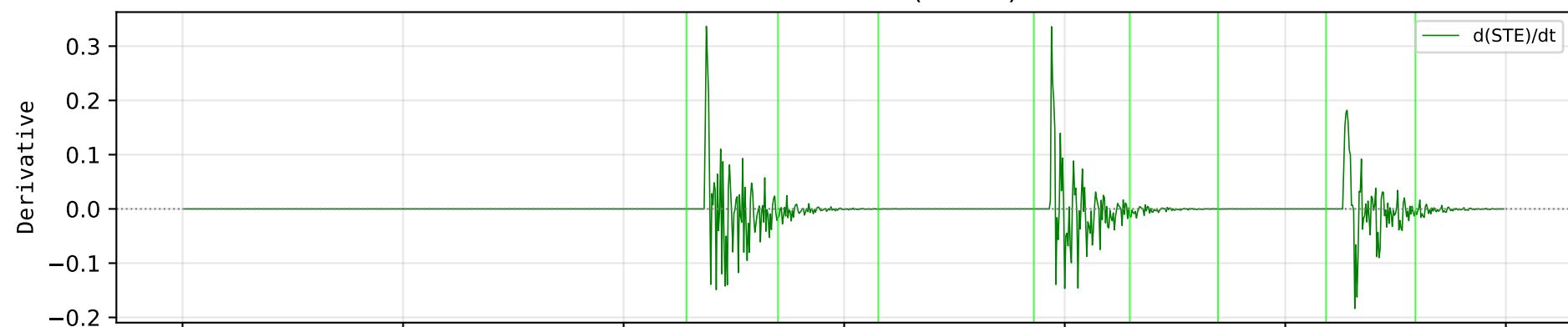
Channel 1 - Waveform



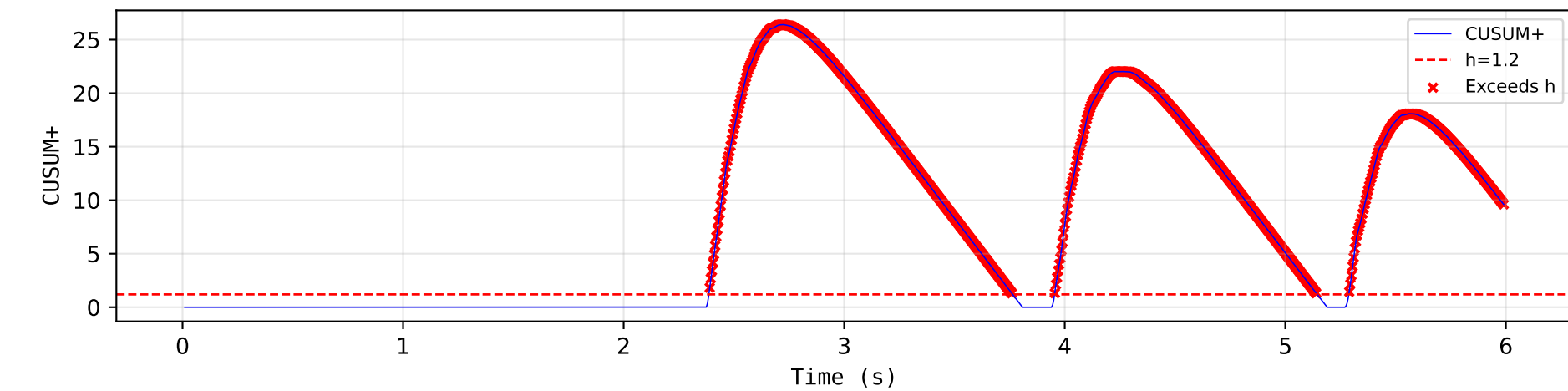
Short-Time Energy



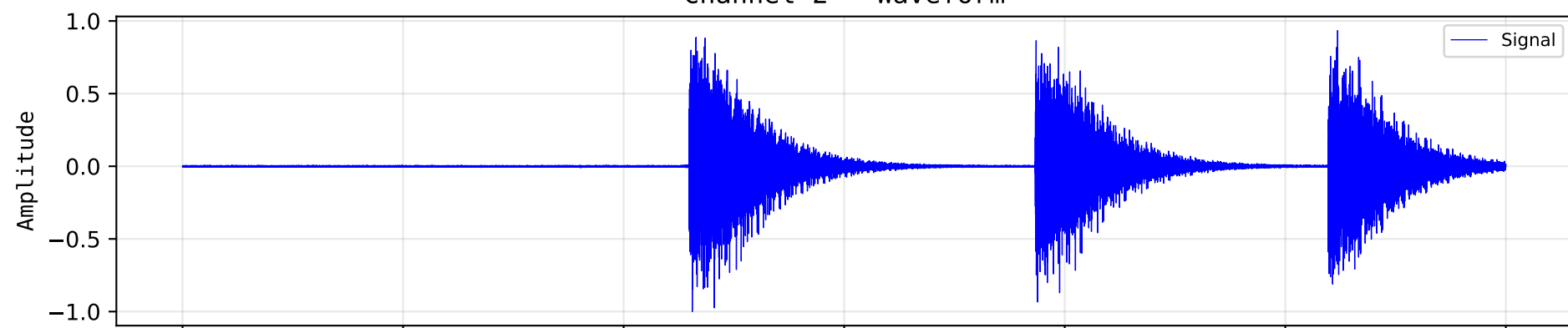
STE Derivative (onset)



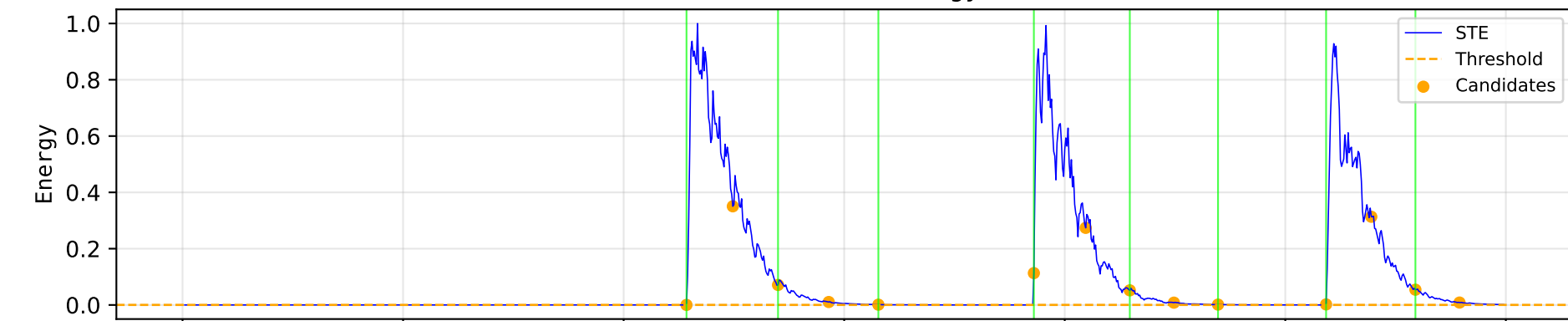
CUSUM Curve



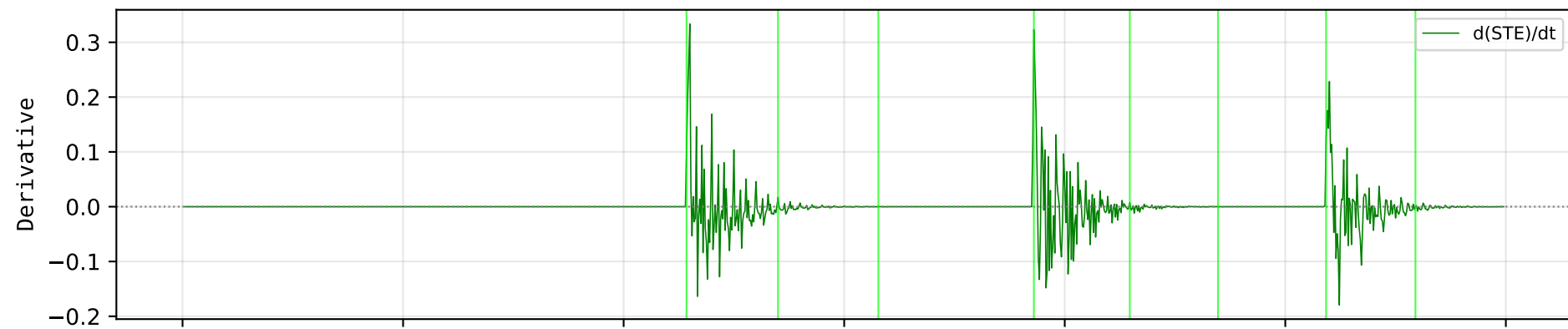
Channel 2 - Waveform



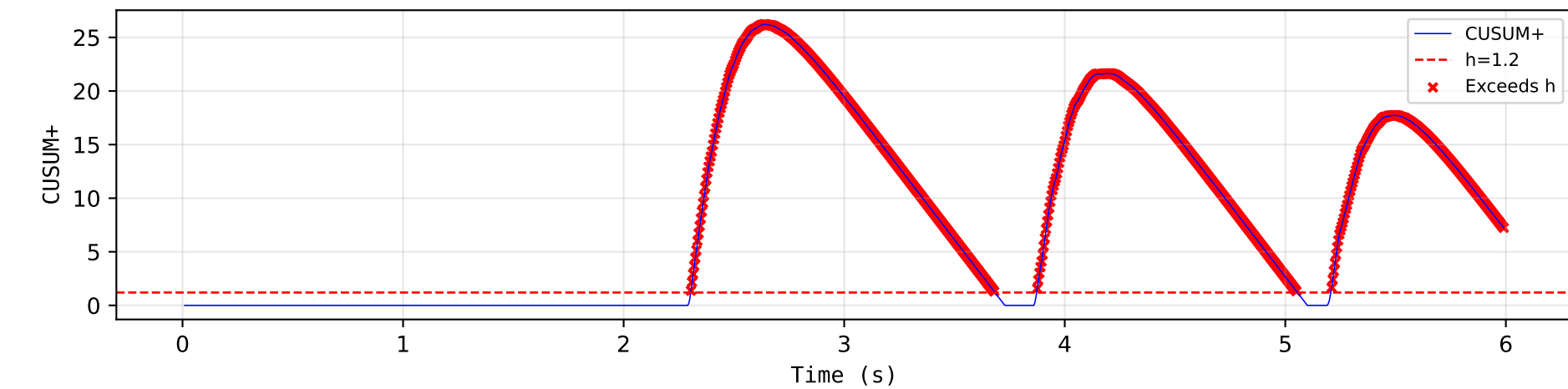
Short-Time Energy



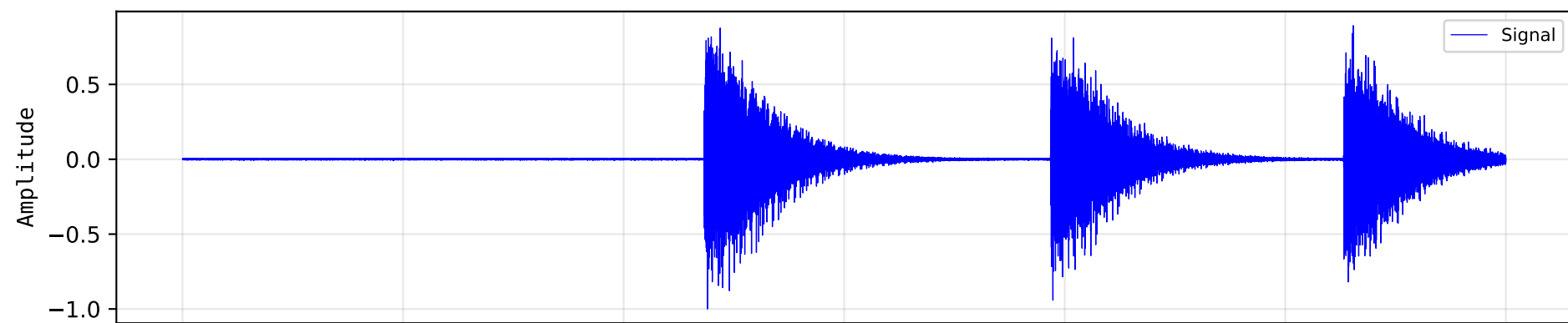
STE Derivative (onset)



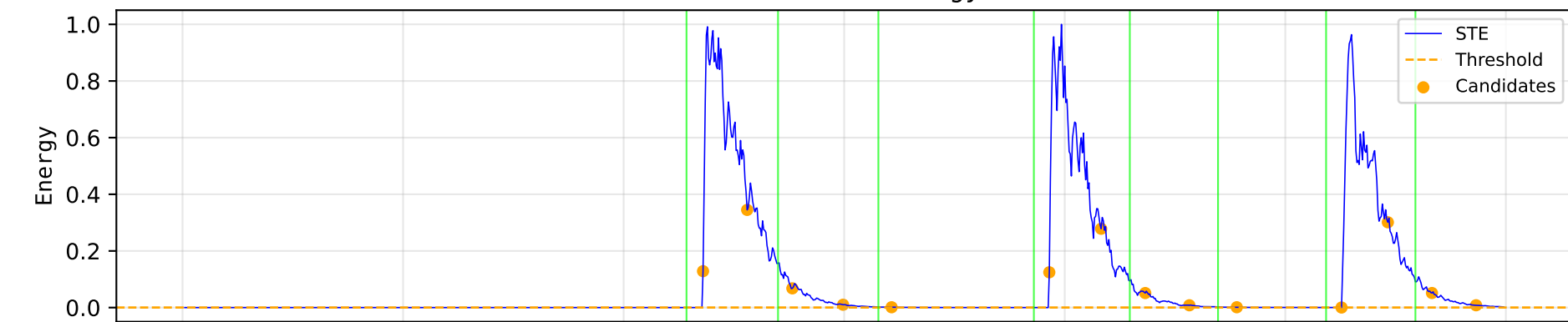
CUSUM Curve



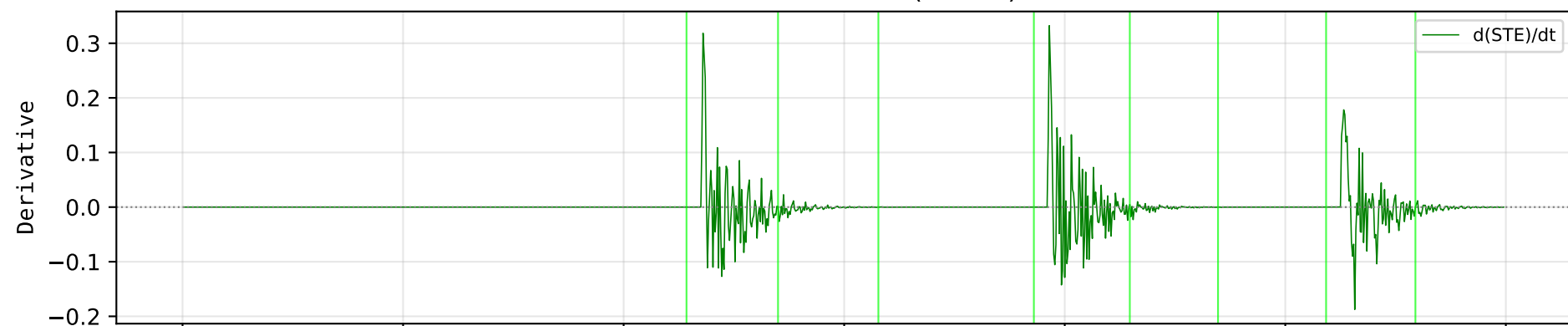
Channel 3 - Waveform



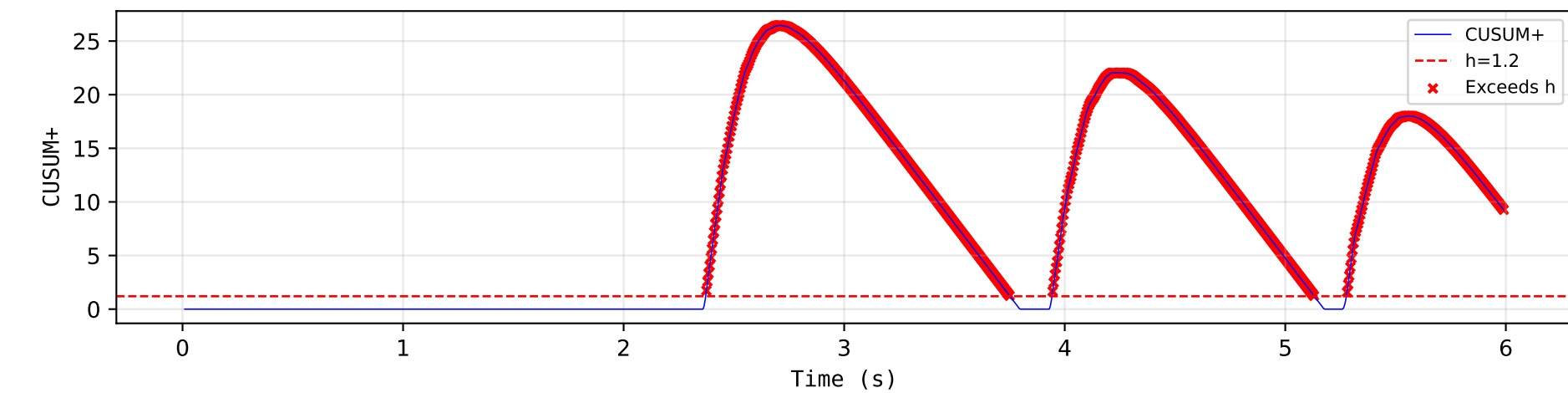
Short-Time Energy



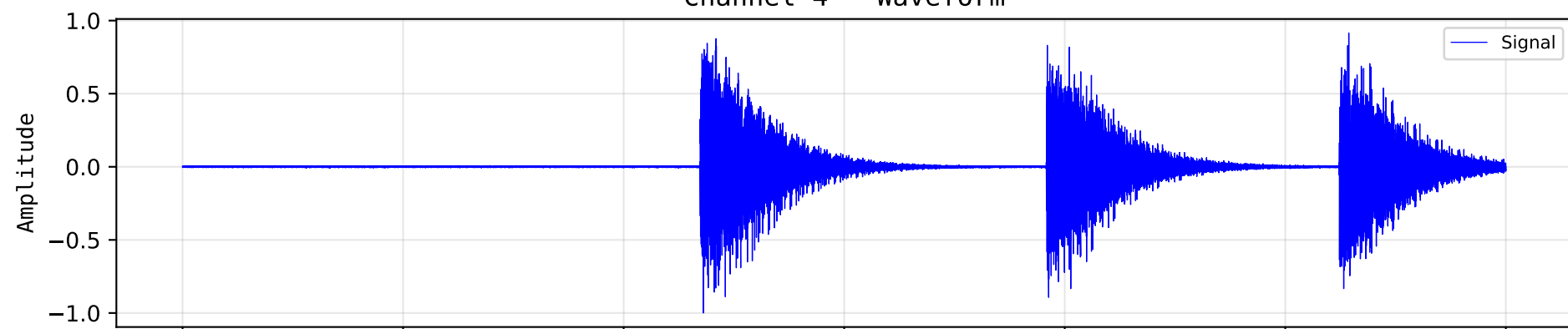
STE Derivative (onset)



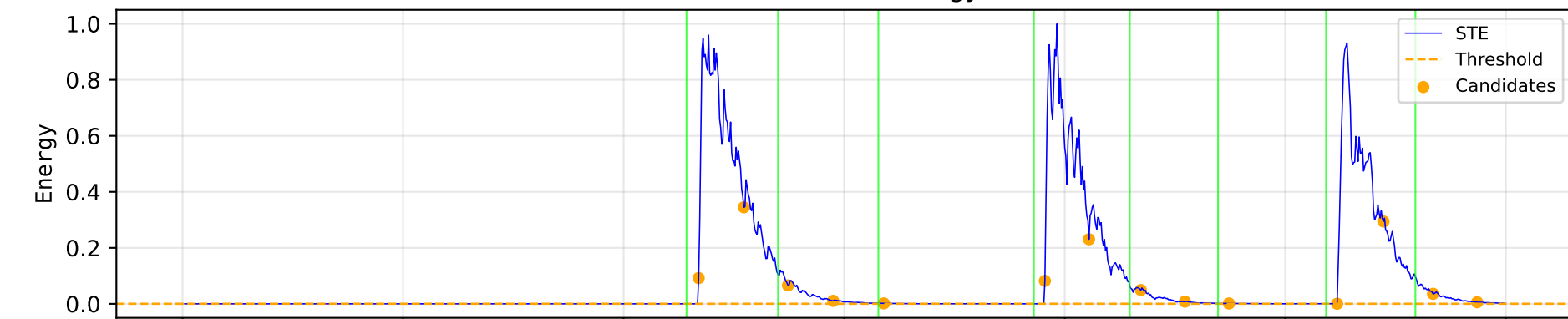
CUSUM Curve



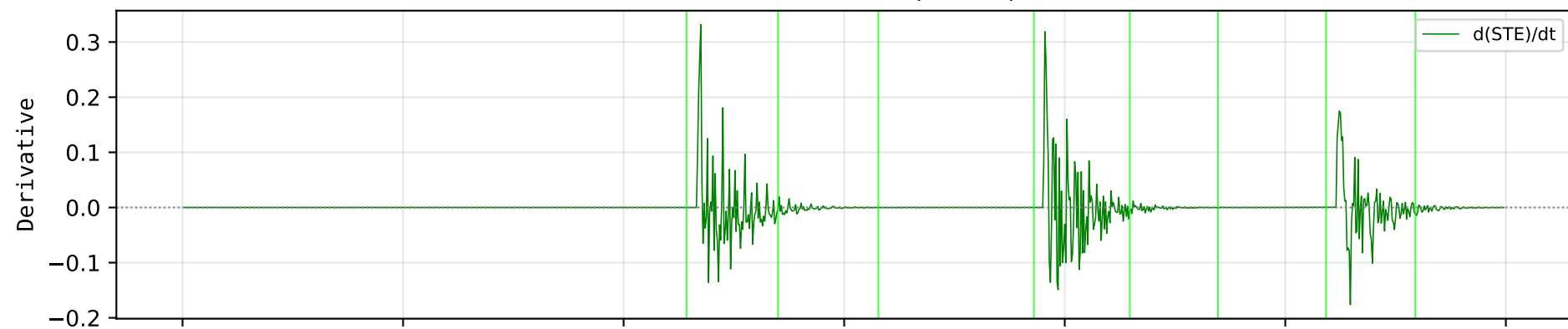
Channel 4 - Waveform



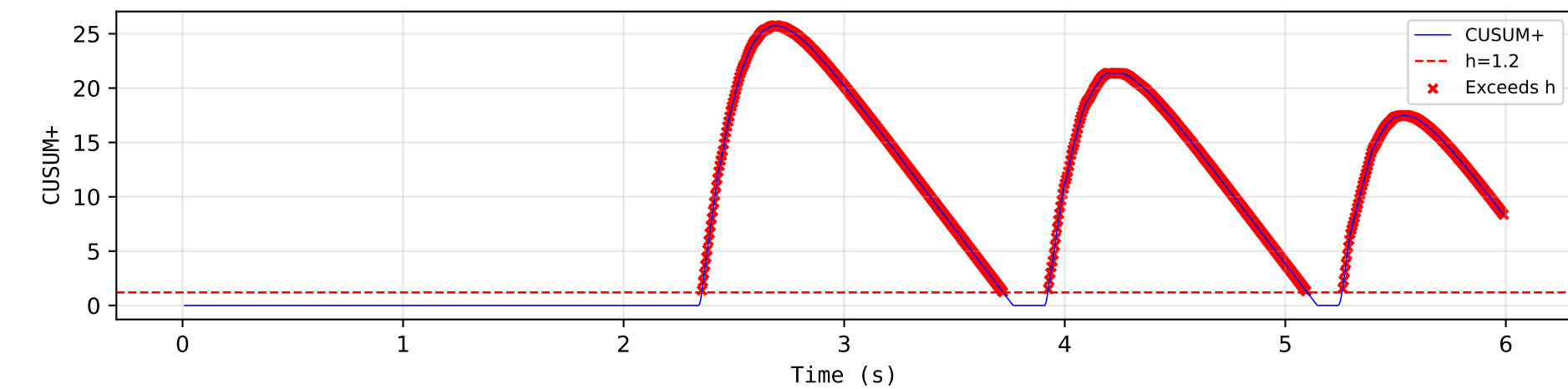
Short-Time Energy



STE Derivative (onset)



CUSUM Curve

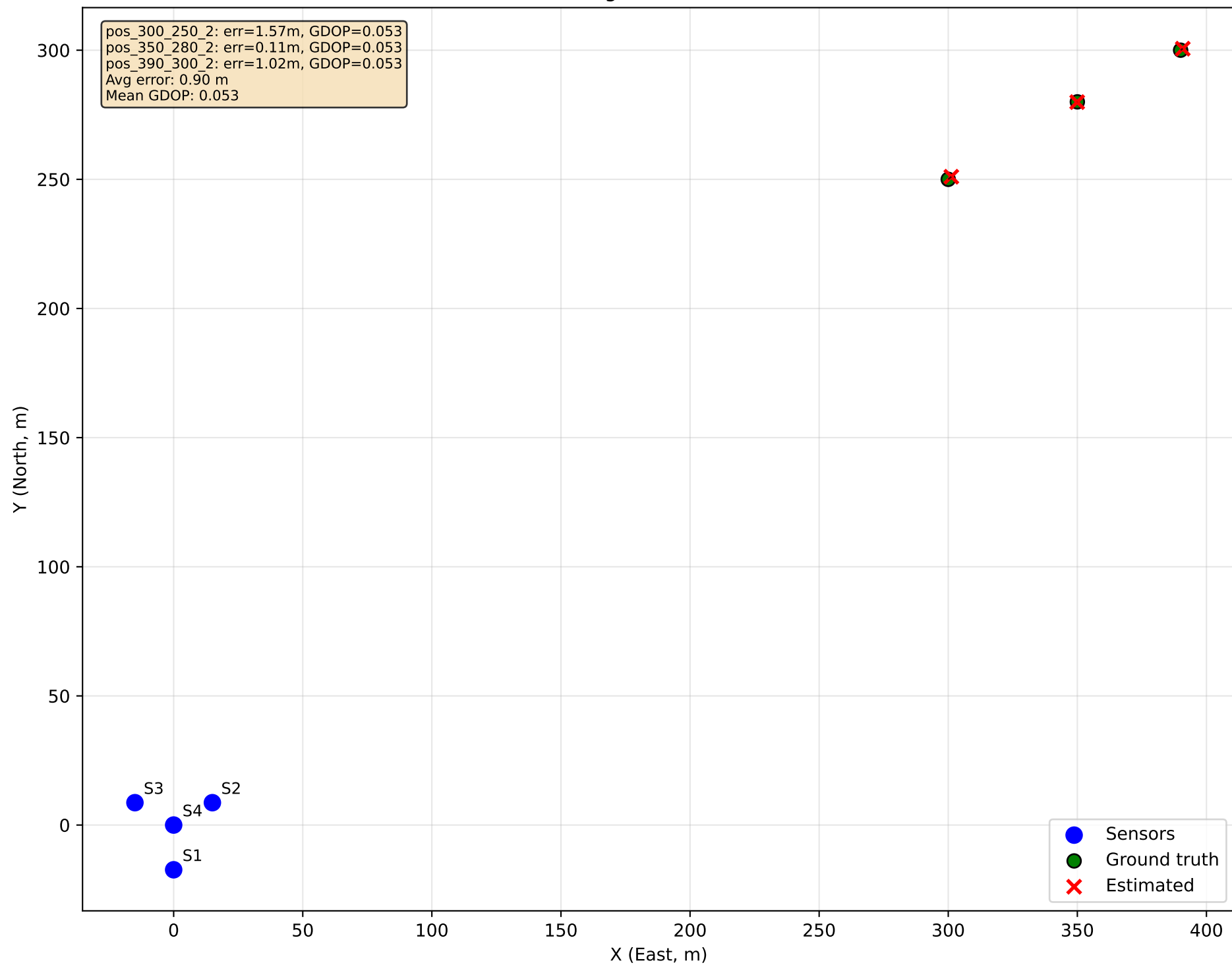


# Part 2: TDQA Localization (GCC-PHAT on per-event chunks, no TOA)

Localization results: error, avg error, GDOP

| Position name | Ground truth (x,y,z) m | Estimated (x,y,z) m    | Error (m)          | GDOP             | Uncertainty (m)  | Confidence       |
|---------------|------------------------|------------------------|--------------------|------------------|------------------|------------------|
| pos_300_250_2 | (300.00, 250.00, 2.00) | (301.19, 251.02, 2.00) | 1.569              | 0.053            | (3.24,1.69,0.00) | 0.950            |
| pos_350_280_2 | (350.00, 280.00, 2.00) | (349.94, 279.91, 2.00) | 0.114              | 0.053            | (3.22,1.68,0.00) | 0.950            |
| pos_390_300_2 | (390.00, 300.00, 2.00) | (390.83, 300.59, 2.00) | 1.019              | 0.053            | (3.17,1.65,0.00) | 0.950            |
| Summary       |                        |                        | Avg error: 0.901 m | Mean GDOP: 0.053 |                  | Mean conf: 0.950 |

2D localization: sensors, ground truth, estimated, error lines

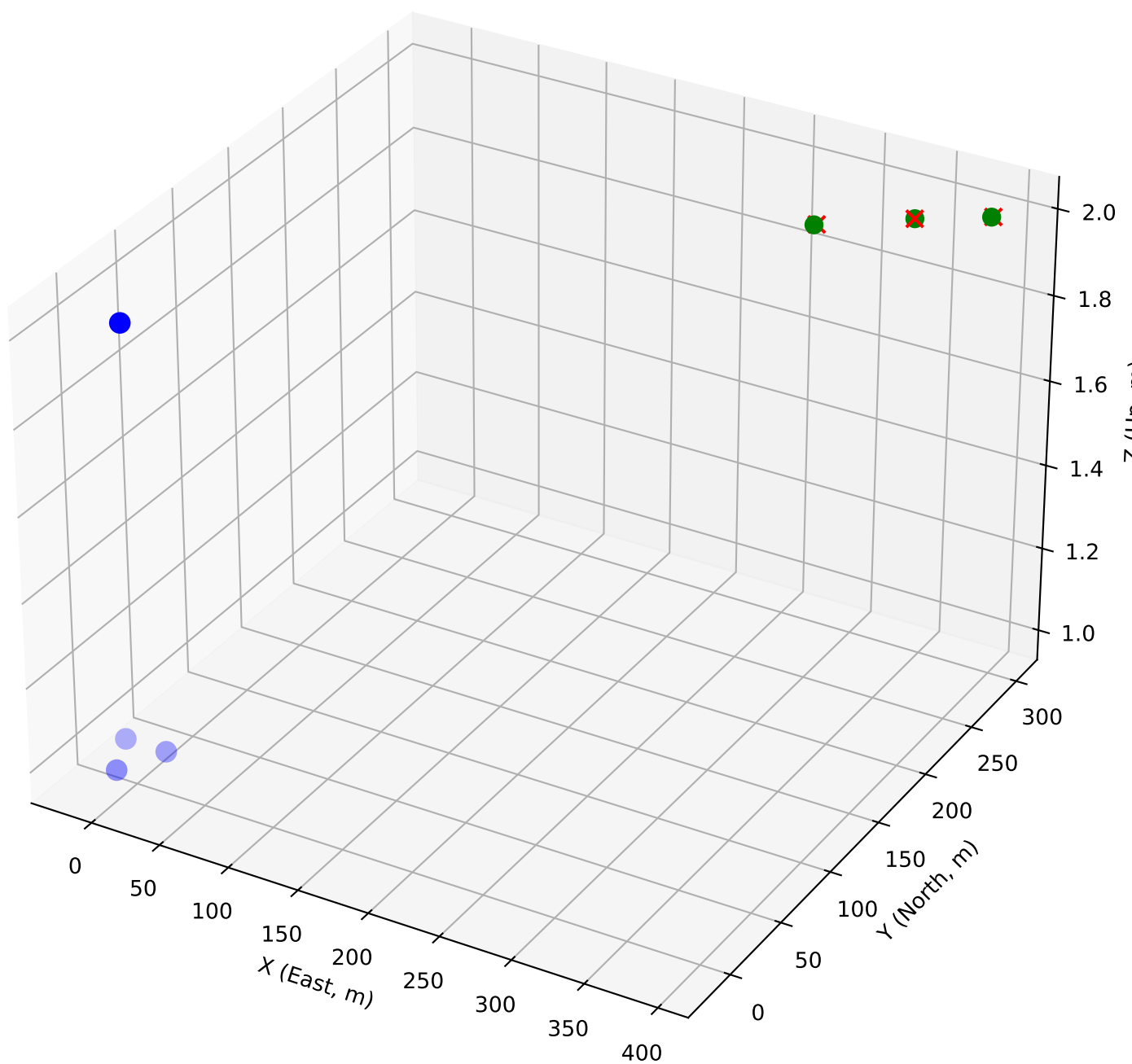




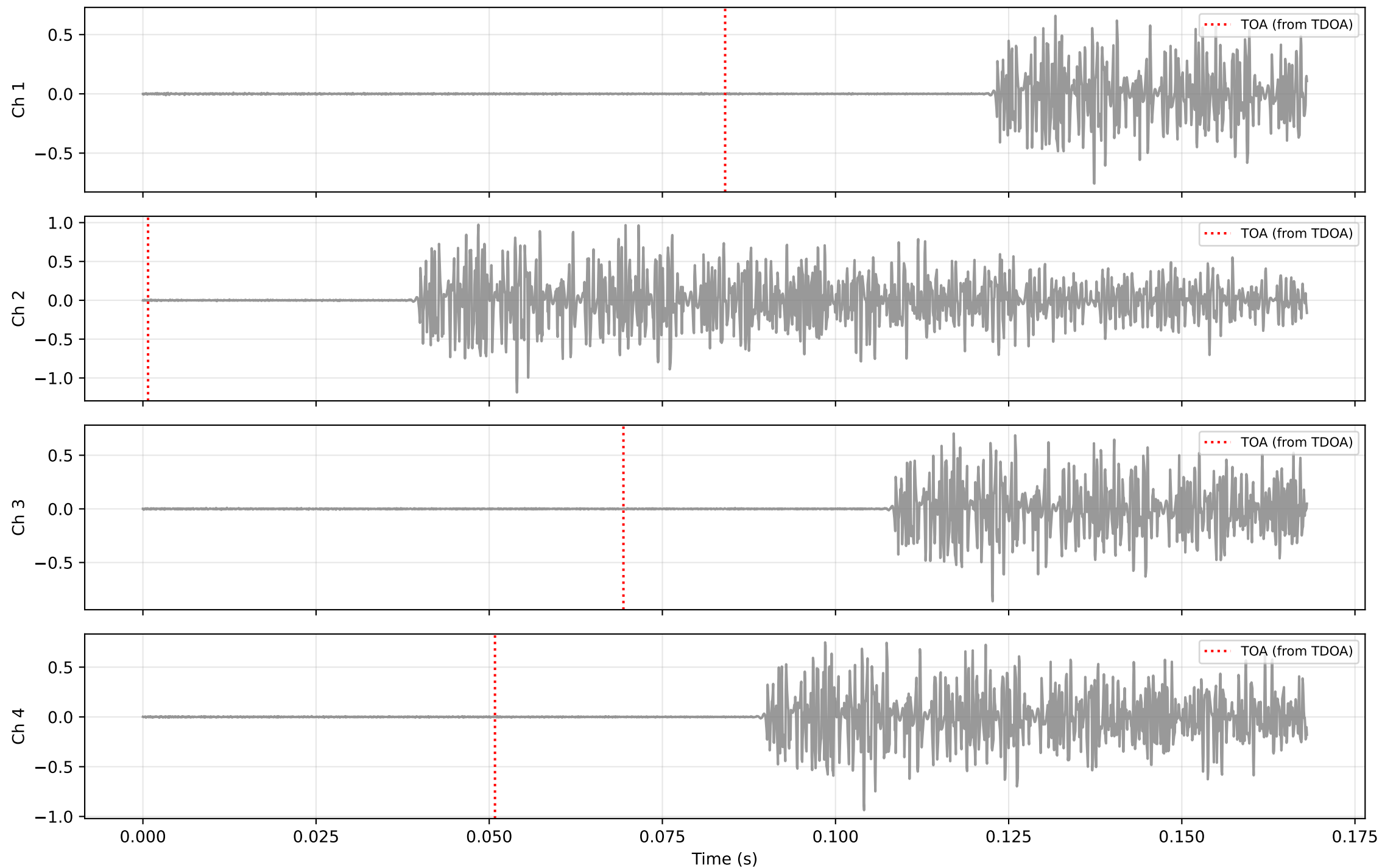
# 3D localization: sensors, ground truth, estimated

Avg error: 0.90 m  
Mean GDOP: 0.053

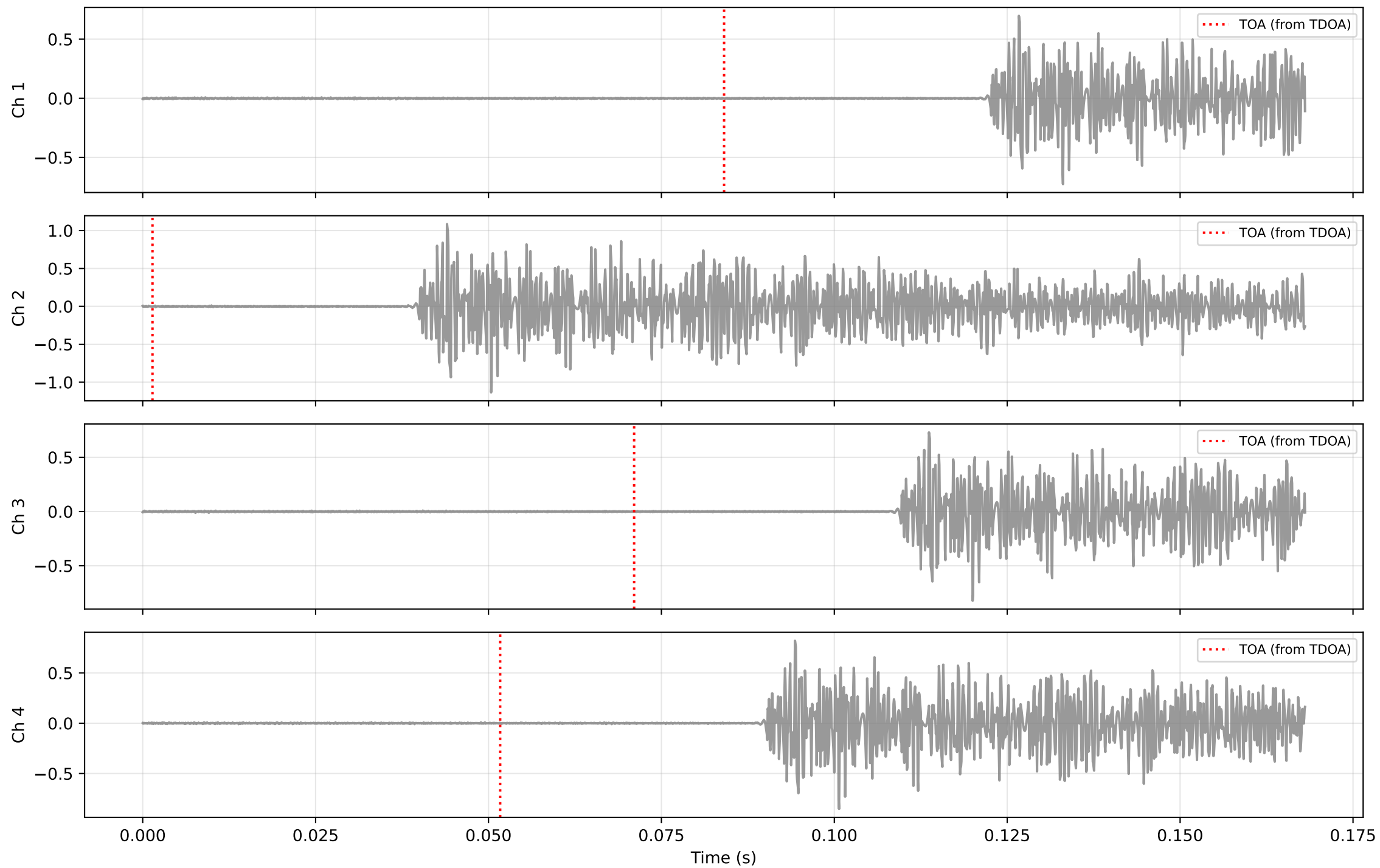
● Sensors



Waveform: pos\_300\_250\_2 — TOA marks (visualization only, not used in localization)



Waveform: pos\_350\_280\_2 — TOA marks (visualization only, not used in localization)



Waveform: pos\_390\_300\_2 — TOA marks (visualization only, not used in localization)

