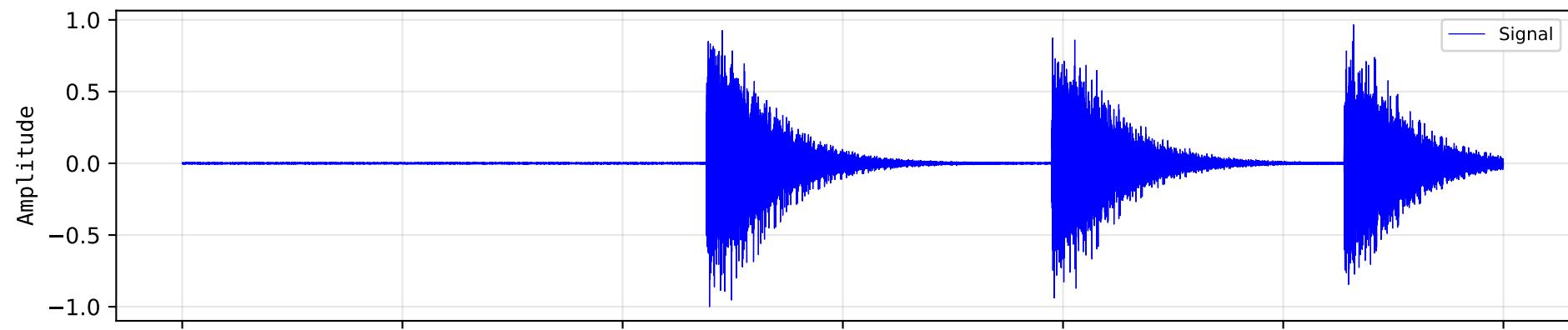
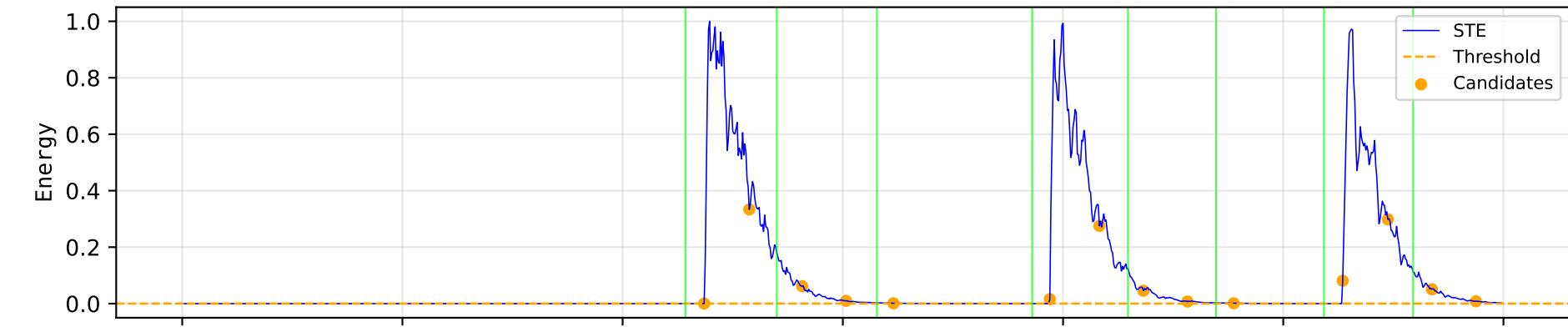


# Part I: Gunshot Detection (energy+GusUM, per-event chunk extraction)

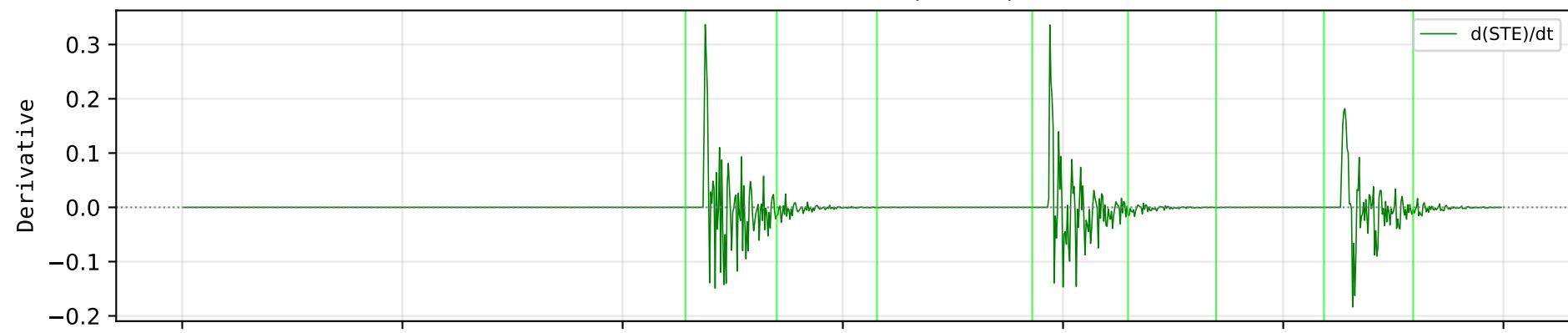
Channel 1 - Waveform



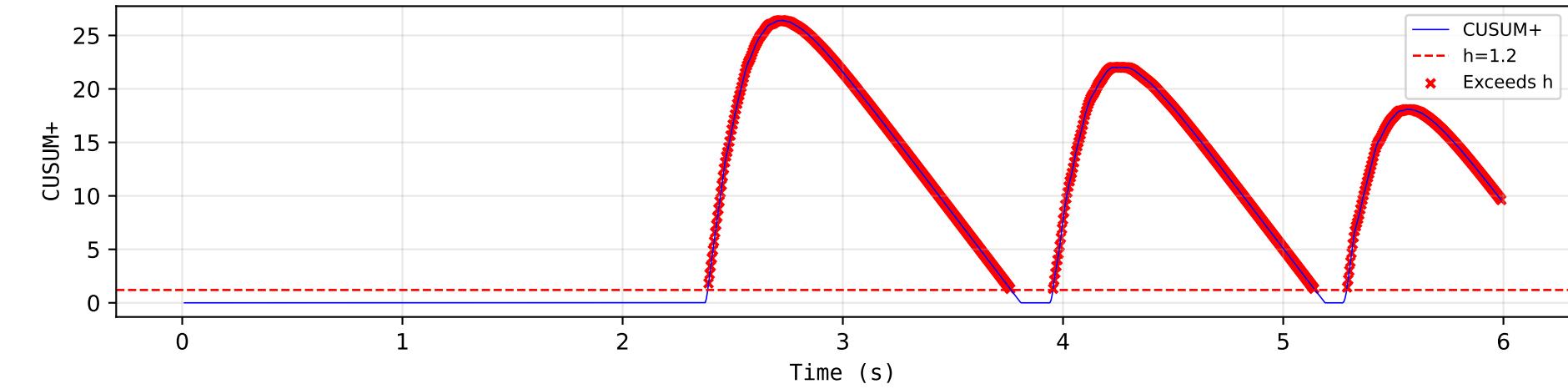
Short-Time Energy



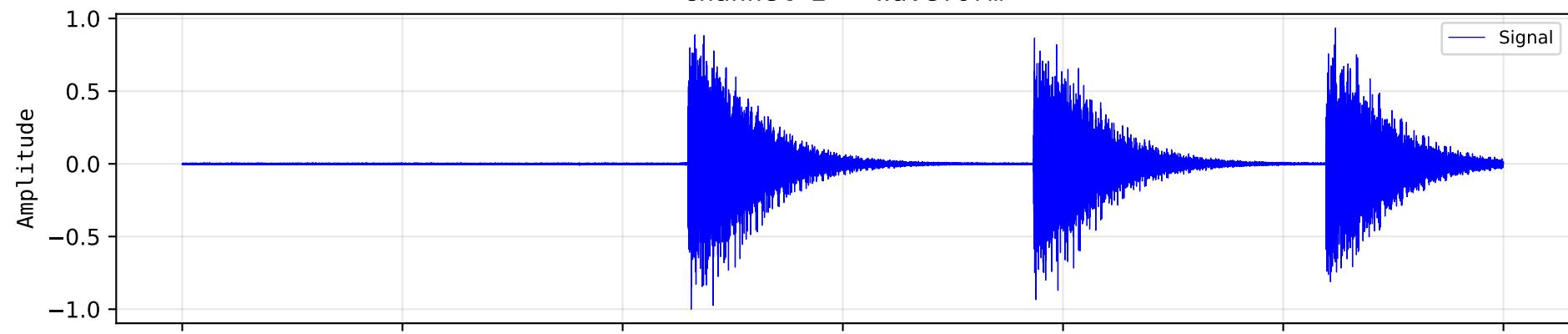
STE Derivative (onset)



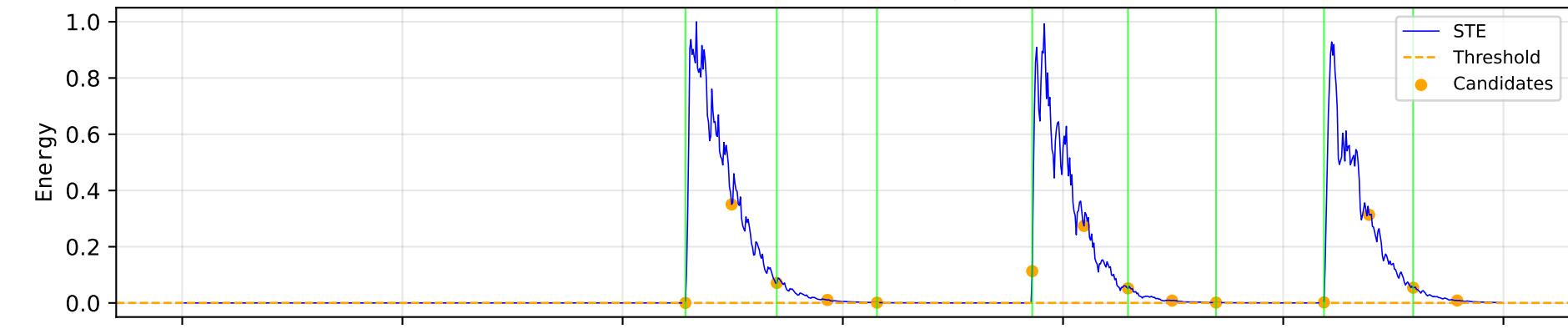
CUSUM Curve



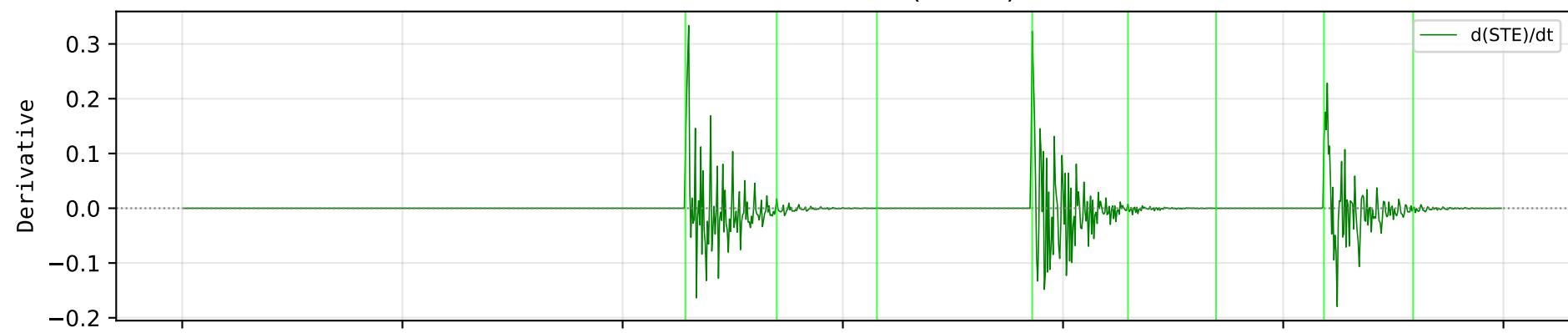
## Channel 2 - Waveform



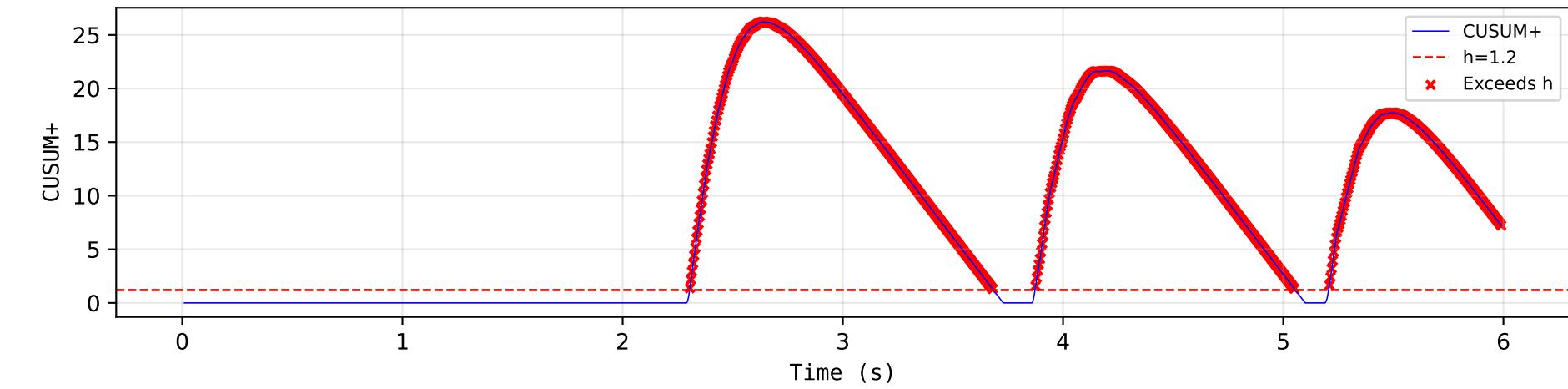
## Short-Time Energy



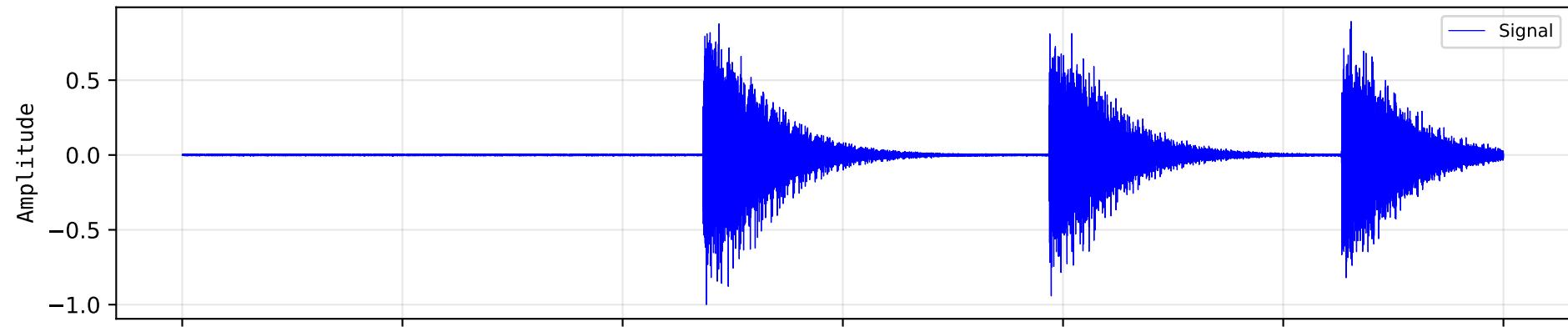
## STE Derivative (onset)



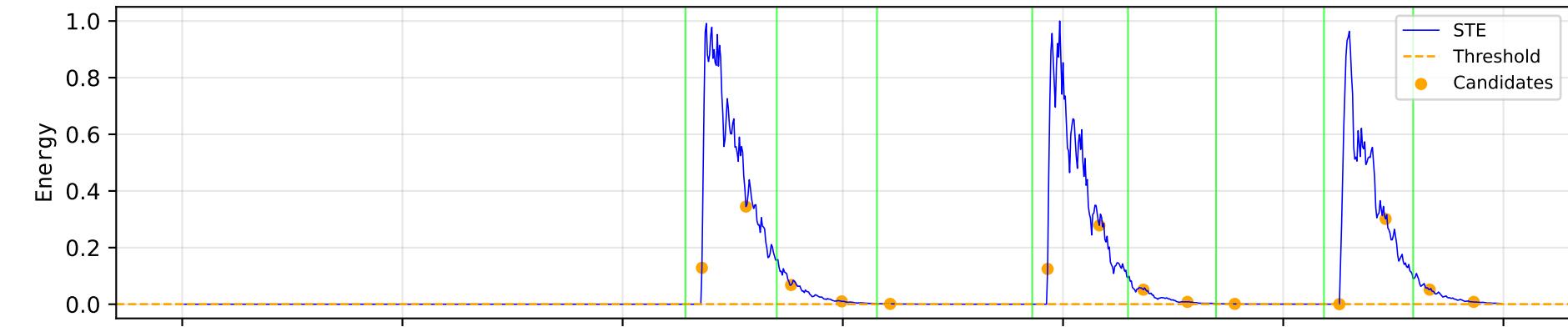
## CUSUM Curve



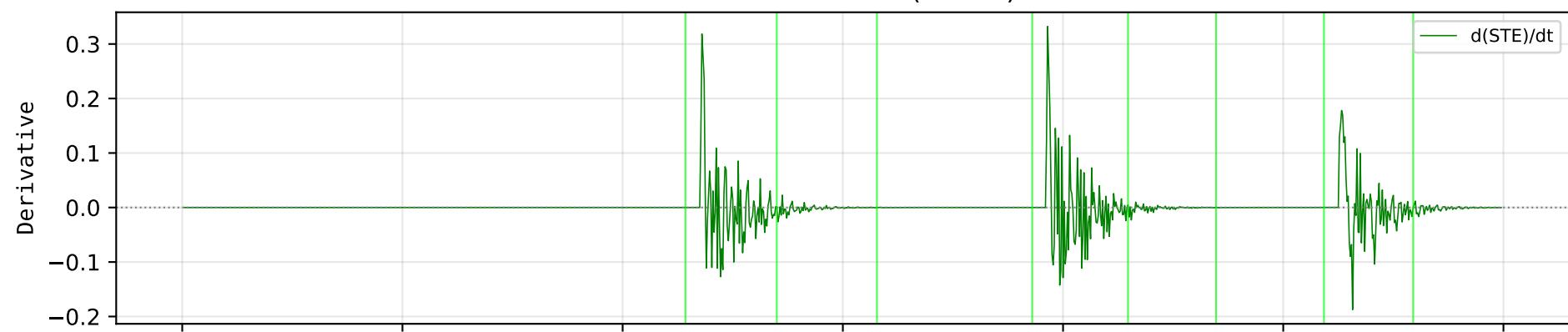
Channel 3 - Waveform



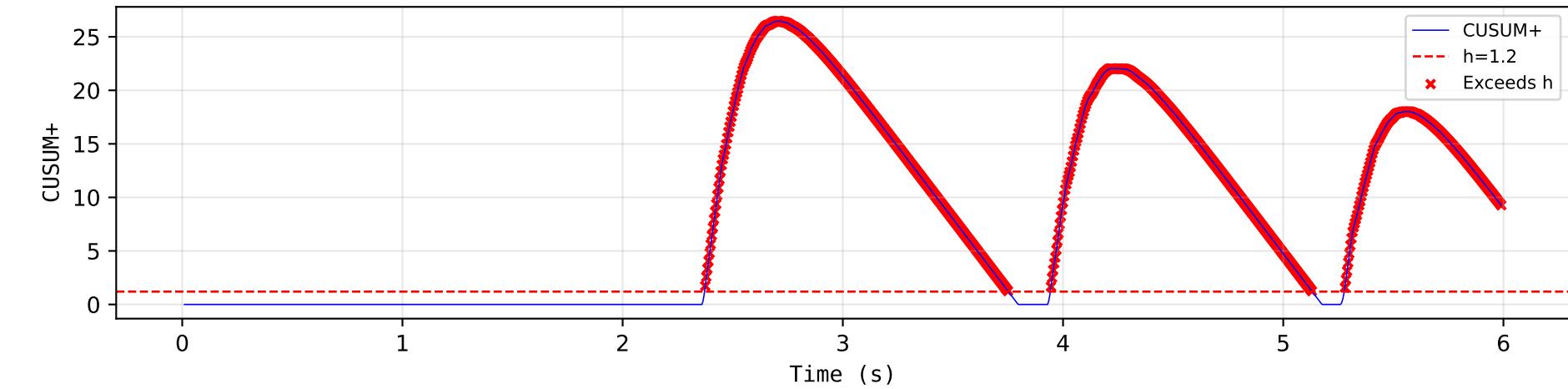
Short-Time Energy



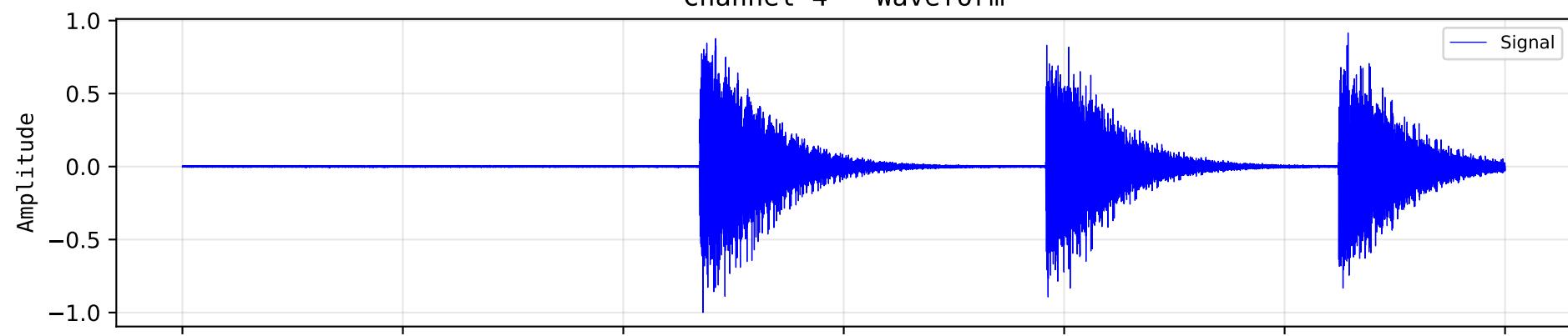
STE Derivative (onset)



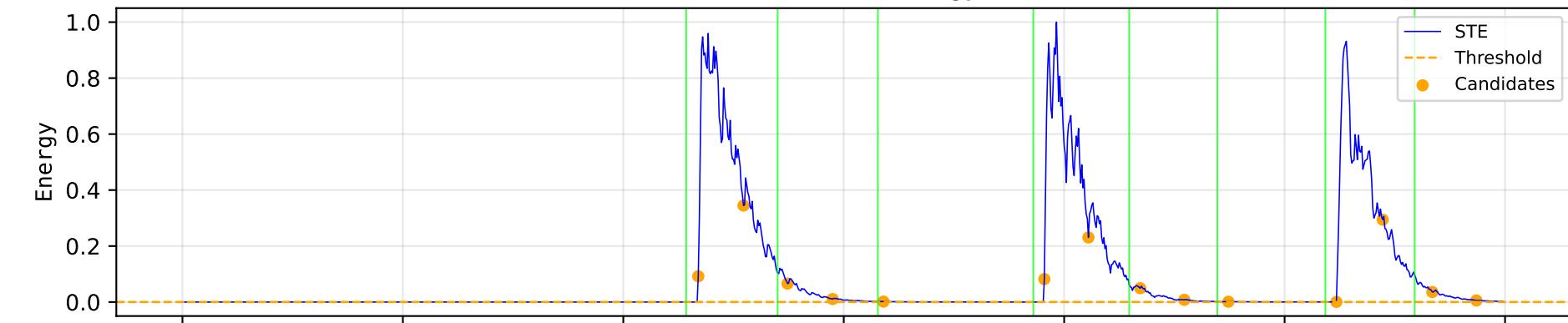
CUSUM Curve



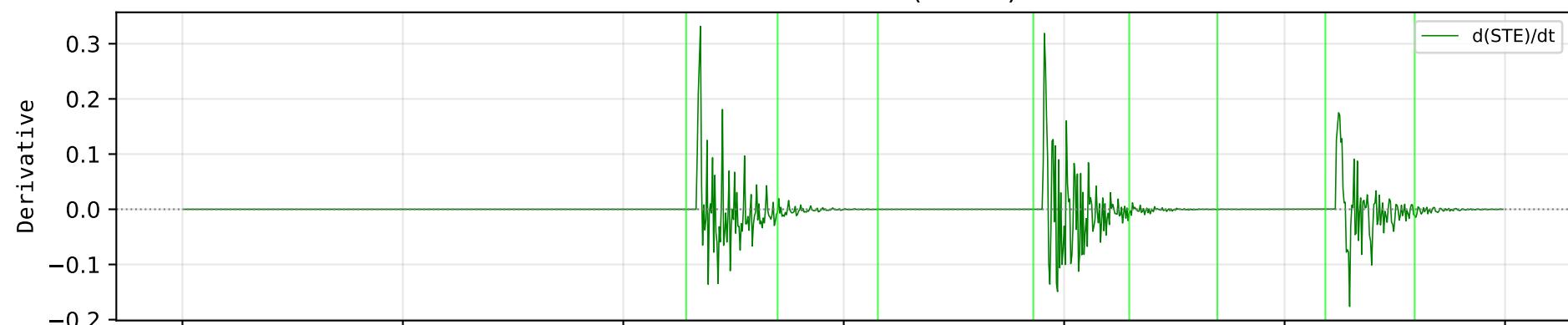
### Channel 4 - Waveform



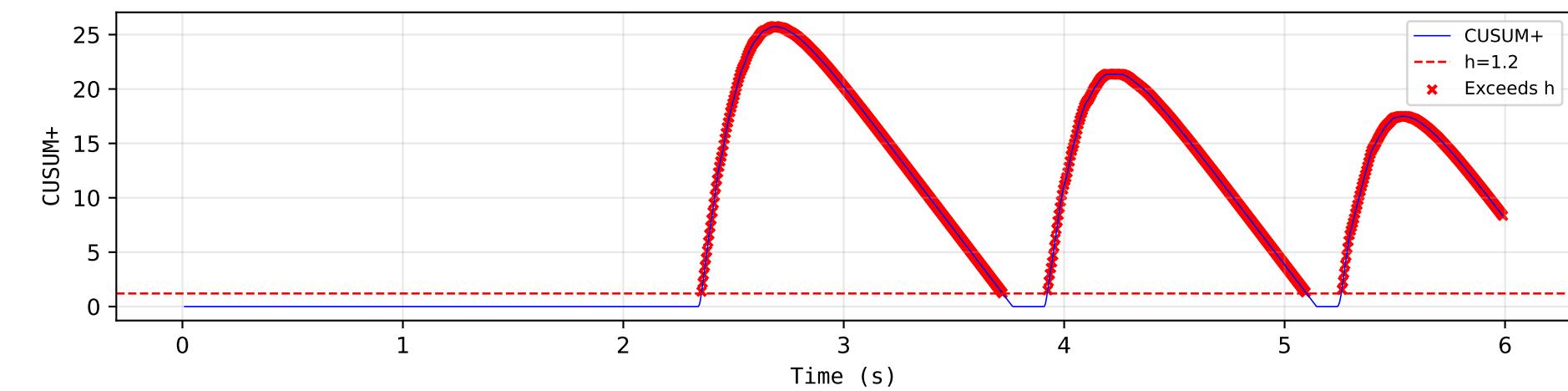
### Short-Time Energy



### STE Derivative (onset)



### CUSUM Curve

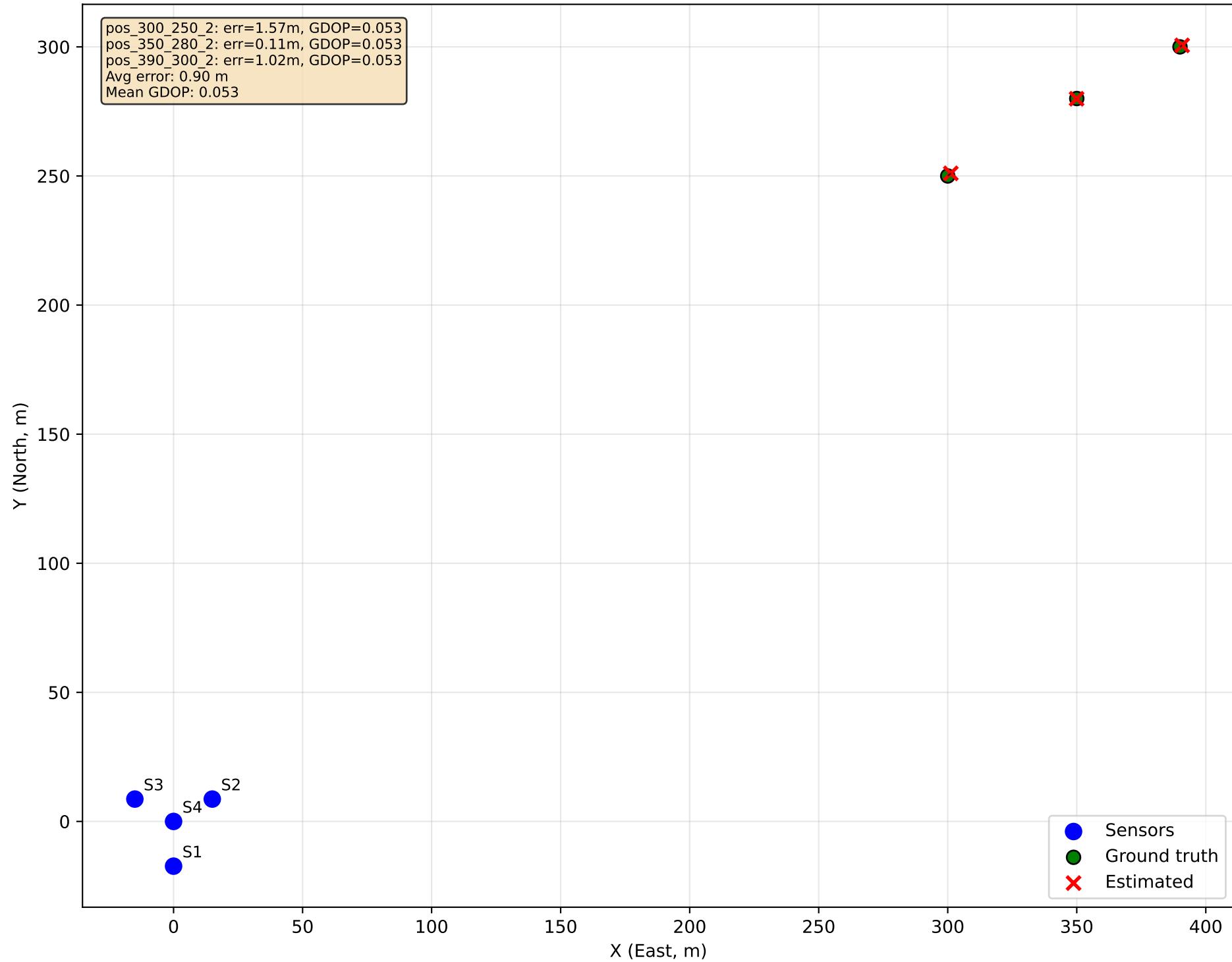


# Part 2: TDOA Localization (GCC-PHAT on per-event chunks, no TOA)

## 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: 0.05		Mean conf: 0.950

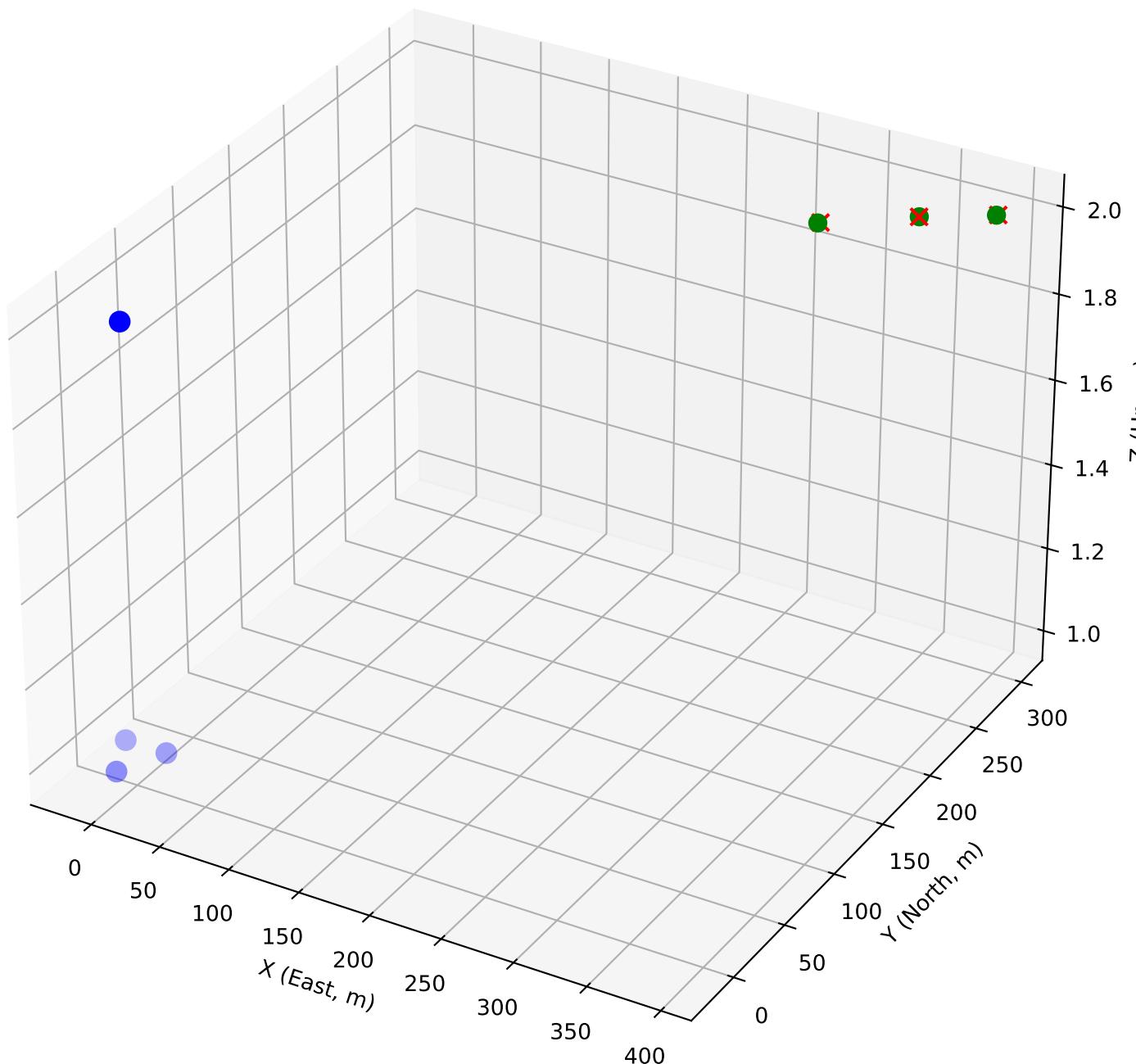
## 2D localization: sensors, ground truth, estimated, error lines



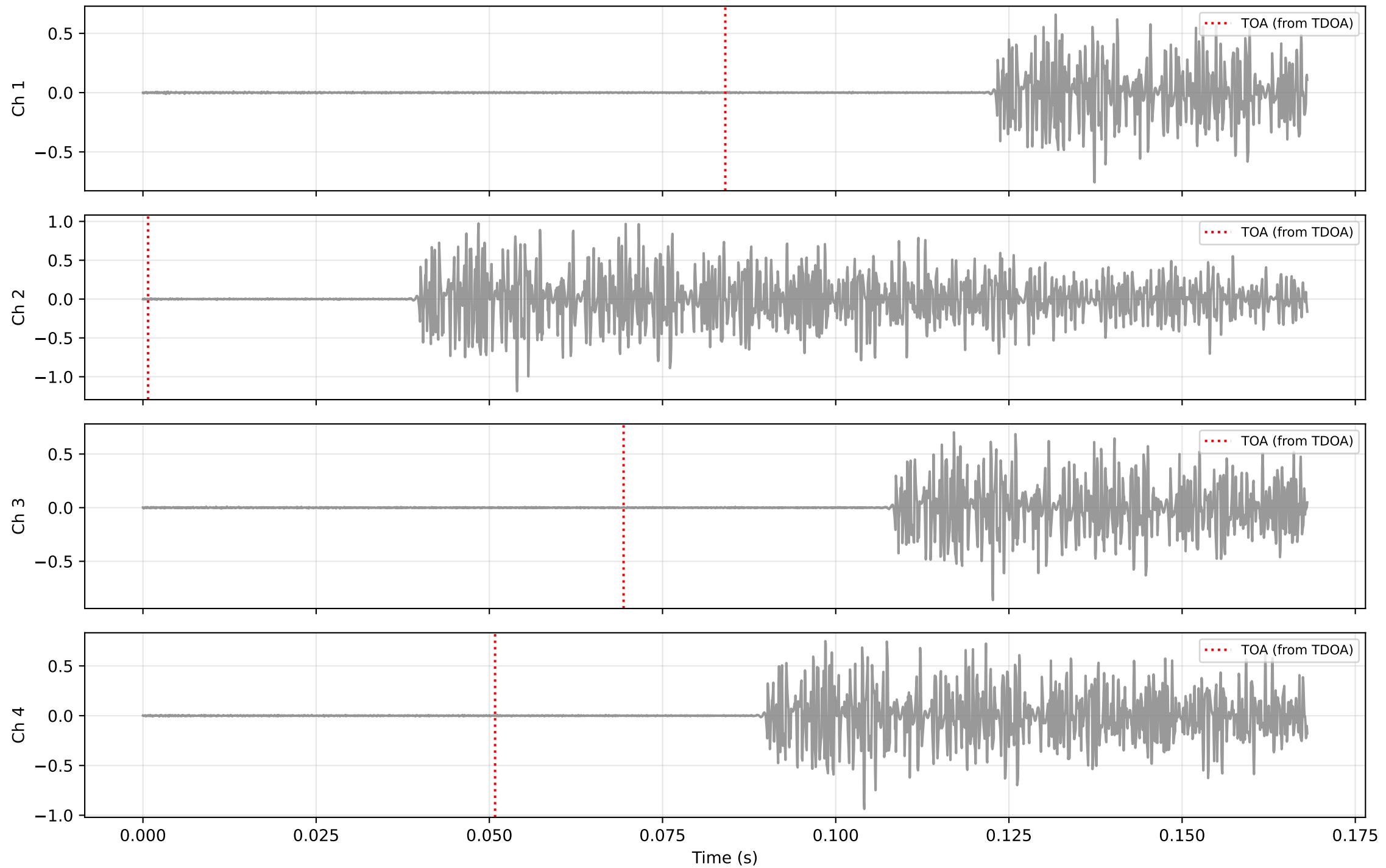
### 3D localization: sensors, ground truth, estimated

Avg error: 0.90 m  
Mean GDOP: 0.053

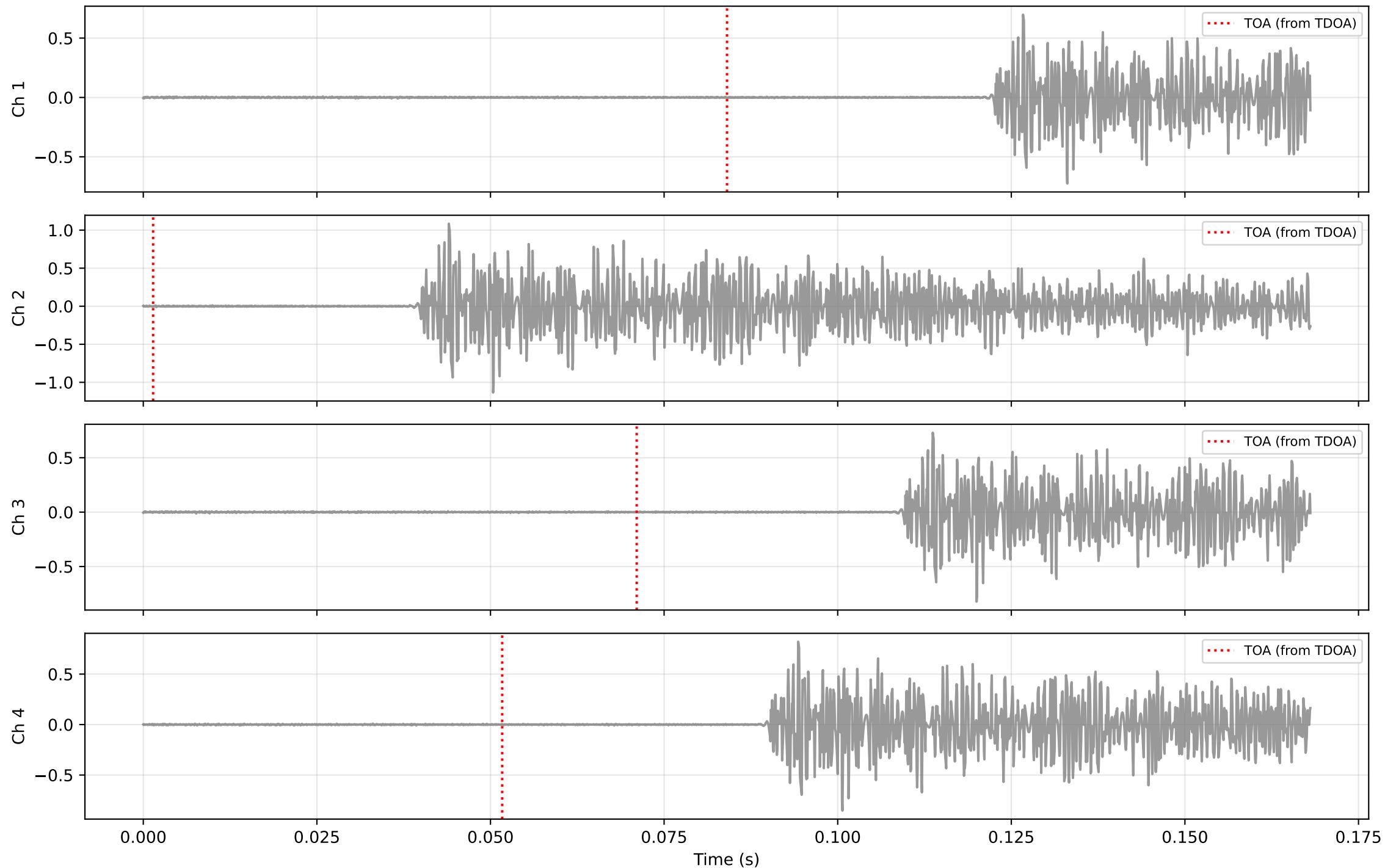
● Sensors



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)

