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# Tracking Closely Spaced Targets Under Ambiguity

(Modified for scenario-dependent tuning using enableDegradation)

```
clc; clear; close all;
```

## ----- Scenario Toggle -----

```
enableDegradation = false; % false = IDEAL, true = RAINY  
% -----  
  
fprintf("\n=====\\n");  
fprintf(" RUN START | Scenario = %s\\n",  
ternary(enableDegradation, "RAINY", "IDEAL"));  
fprintf("=====\\n\\n");  
  
=====
```

## Create scenario + detections

```
scenario = helperCreateScenario;  
dataLog = helperRunDetections(scenario, enableDegradation);  
  
% Quick stats  
nPerScan = cellfun(@numel, dataLog.Detections);  
fprintf("Detections/scan stats: min=%g, mean=% .2f, max=%g\\n", ...  
min(nPerScan), mean(nPerScan), max(nPerScan));
```

---

```
plotScenarioAndDetections(dataLog);

enableDegradation = 0
Please wait. Generating detections for scenario .....
Scan buffer time span (pre-snap) = 0.060000 s
t=0.26: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.060000 s
t=0.52: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.060000 s
t=0.78: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.060000 s
t=1.04: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.060000 s
t=1.30: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.060000 s
t=1.56: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=1.82: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=2.08: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=2.34: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=2.60: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=2.86: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=3.12: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=3.38: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=3.64: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=3.90: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.130000 s
t=4.16: dets=2 (before=3, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=4.42: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=4.68: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=4.94: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=5.20: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
t=5.46: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
t=5.72: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
t=5.98: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
t=6.24: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
```

---

---

```
t=6.50: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
t=6.76: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
t=7.02: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
t=7.28: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
t=7.54: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
t=7.80: dets=2 (before=3, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=8.06: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=8.32: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=8.58: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=8.84: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=9.10: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=9.36: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=9.62: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=9.88: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=10.14: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=10.40: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=10.66: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=10.92: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=11.18: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=11.44: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.020000 s
t=11.70: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.020000 s
t=11.96: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.020000 s
t=12.22: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.020000 s
t=12.48: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.020000 s
t=12.74: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.020000 s
t=13.00: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.020000 s
t=13.26: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.020000 s
```

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---

```
t=13.52: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.020000 s
t=13.78: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.020000 s
t=14.04: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=14.30: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=14.56: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=14.82: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=15.08: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=15.34: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=15.60: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=15.86: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=16.12: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=16.38: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=16.64: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=16.90: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=17.16: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=17.42: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=17.68: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=17.94: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=18.20: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=18.46: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=18.72: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=18.98: dets=3 (before=3, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=19.24: dets=3 (before=3, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.000000 s
t=19.50: dets=1 (before=1, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.000000 s
t=19.76: dets=1 (before=1, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.000000 s
t=20.02: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.000000 s
t=20.28: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.000000 s
```

---

---

```
t=20.54: dets=1 (before=1, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=20.80: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=21.06: dets=3 (before=4, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=21.32: dets=3 (before=3, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=21.58: dets=3 (before=3, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=21.84: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=22.10: dets=3 (before=3, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=22.36: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=22.62: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=22.88: dets=3 (before=3, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=23.14: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=23.40: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=23.66: dets=3 (before=3, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=23.92: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=24.18: dets=3 (before=3, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=24.44: dets=3 (before=3, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=24.70: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=24.96: dets=3 (before=3, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=25.22: dets=3 (before=3, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=25.48: dets=3 (before=3, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=25.74: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.120000 s
t=26.00: dets=2 (before=3, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=26.26: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=26.52: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=26.78: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=27.04: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=27.30: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
```

---

---

```
t=27.56: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=27.82: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=28.08: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=28.34: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=28.60: dets=2 (before=3, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=28.86: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=29.12: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=29.38: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=29.64: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=29.90: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=30.16: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=30.42: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=30.68: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=30.94: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=31.20: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=31.46: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=31.72: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=31.98: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=32.24: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=32.50: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=32.76: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=33.02: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=33.28: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=33.54: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=33.80: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=34.06: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=34.32: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
```

---

---

```
t=34.58: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=34.84: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=35.10: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=35.36: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=35.62: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=35.88: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=36.14: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=36.40: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=36.66: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=36.92: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=37.18: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=37.44: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=37.70: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=38.22: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=38.48: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=38.74: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=39.00: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=39.26: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.010000 s
t=39.52: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.020000 s
t=39.78: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.020000 s
t=40.04: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
t=40.30: dets=2 (before=4, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.020000 s
t=40.56: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.020000 s
t=40.82: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.080000 s
t=41.08: dets=2 (before=3, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.020000 s
t=41.34: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.020000 s
```

---

---

```
t=41.60: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=41.86: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=42.12: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=42.38: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=42.64: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=42.90: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=43.16: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=43.42: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=43.68: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=43.94: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=44.20: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=44.46: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.130000 s
t=44.72: dets=2 (before=3, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=44.98: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.030000 s
t=45.24: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
t=45.50: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
t=45.76: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
t=46.02: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
t=46.28: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
t=46.54: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
t=46.80: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
t=47.06: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.040000 s
t=47.32: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=47.58: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=47.84: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=48.10: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=48.36: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
```

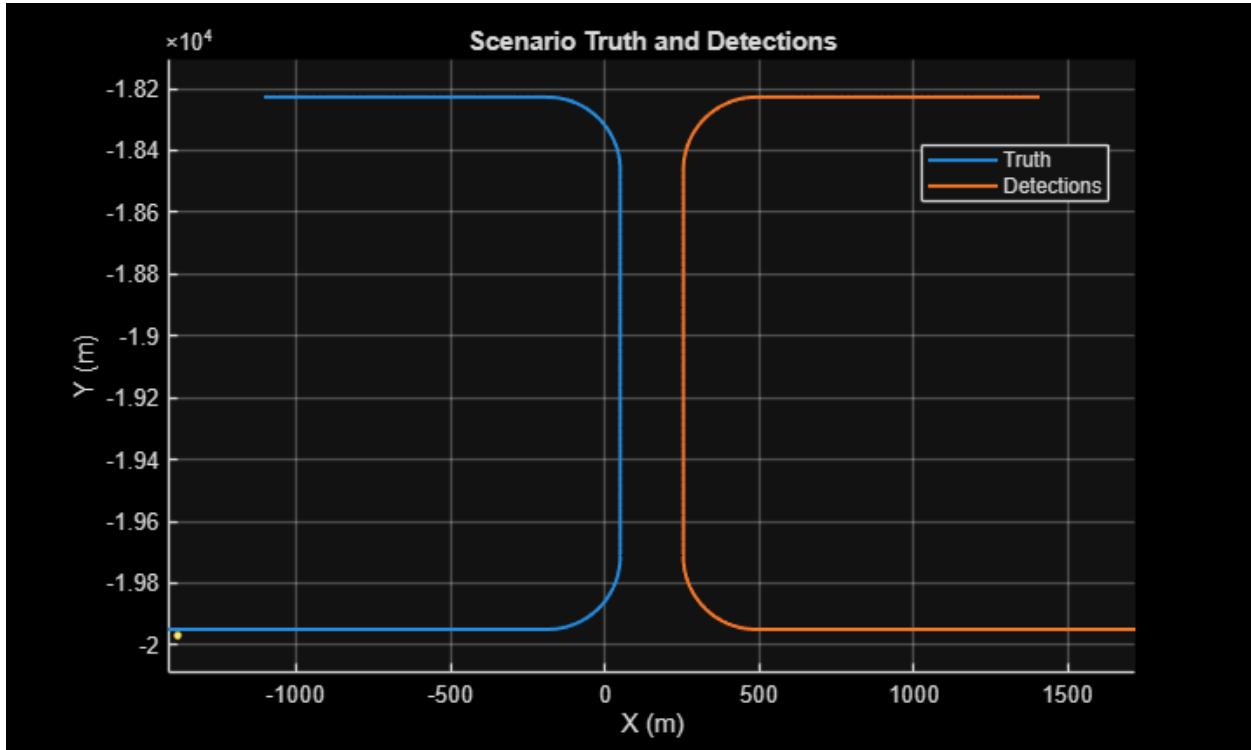
---

---

```

t=48.62: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=48.88: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=49.14: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=49.40: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=49.66: dets=2 (before=2, clutterAdded=0)
Scan buffer time span (pre-snap) = 0.050000 s
t=49.92: dets=2 (before=2, clutterAdded=0)
Detections generation complete.
Detections/scan stats: min=1, mean=2.05, max=3

```



## Global tracker knobs

```

numTracks = 500;
vol   = 1e9;
beta  = 1e-14;
pd    = 0.8;

```

## Scenario-dependent knobs

```

if enableDegradation
    gate = 35;

    % Different trackers tolerate "assumed clutter" differently
    farGNN = 1e-2;

```

---

```

farMHT  = 1e-3;
farJPDA = 1e-3;
else
    gate = 45;

    farGNN  = 1e-6;
    farMHT  = 1e-6;
    farJPDA = 1e-6;
end

fprintf("Scenario: %s | gate=% .2f | farGNN=% .3g | farMHT=% .3g | farJPDA=% .3g
| pd=% .2f | vol=% .3g | beta=% .3g\n\n", ...
    ternary(enableDegradation,"RAINY","IDEAL"), gate, farGNN, farMHT,
    farJPDA, pd, vol, beta);

Scenario: IDEAL | gate=45.00 | farGNN=1e-06 | farMHT=1e-06 | farJPDA=1e-06 |
pd=0.80 | vol=1e+09 | beta=1e-14

```

## TOMHT-only thresholds (score-based → OK)

```

confirmThresh = 20;
deleteThresh  = -5;

```

## TOMHT scenario-dependent knobs

```

if enableDegradation
    tomhtThresh = [0.2, 1, 1] * gate;
    maxBranches = 3;
else
    tomhtThresh = [0.2, 1, 1] * gate;
    maxBranches = 5;
end

```

## JPDA scenario-dependent knobs (initiation + anti-spam)

```

if enableDegradation
    % JPDA MUST have enough new-target density to initiate anything.
    % We'll limit spam with MaxNumTracks instead of starving initiation.
    betaJPDA      = 1e-11;           % encourage initiation (tune 1e-12..1e-10)
    gateJPDA     = gate + 10;        % looser gate helps association under clutter
    timeTolJPDA = 0.05;            % times already snapped in detections

    numTracksJPDA = 200;           % cap so it doesn't explode
else
    betaJPDA      = beta;
    gateJPDA     = gate;
    timeTolJPDA = 0.05;

```

---

```

    numTracksJPDA = numTracks;
end

```

## ===== GNN + CV =====

```

fprintf("\n===== GNN + CV =====\n");
tracker = trackerGNN( ...
    'FilterInitializationFcn', @initCVFilter, ...
    'MaxNumTracks', numTracks, ...
    'MaxNumSensors', 1, ...
    'AssignmentThreshold', gate, ...
    'TrackLogic', 'Score', ...
    'DetectionProbability', pd, ...
    'FalseAlarmRate', farGNN, ...
    'Volume', vol, ...
    'Beta', beta);

[trackSummary, truthSummary, trackMetrics, truthMetrics, timeGNNCV] =
helperRunTracker(dataLog, tracker, false);
disp(trackSummary); disp(truthSummary);
disp(trackMetrics); disp(truthMetrics);

```

===== GNN + CV =====

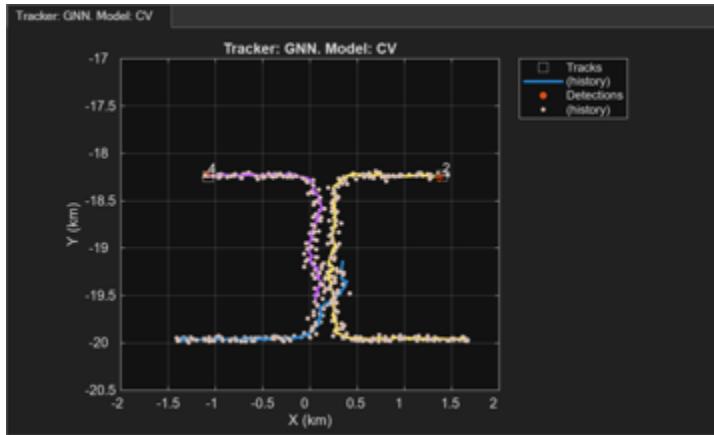
<i>TrackID</i>	<i>AssignedTruthID</i>	<i>Surviving</i>	<i>TotalLength</i>
<i>UnreportedStatus</i>	<i>MeanTimeBetweenReports</i>		<i>MaxTimeBetweenReports</i>
<i>DivergenceStatus</i>			

1	NaN	false	100
true	0.26		0.26
false			
2	2	true	190
false	0.26		0.26
false			
4	1	true	110
false	0.26		0.26
true			

<i>TruthID</i>	<i>AssociatedTrackID</i>	<i>TotalLength</i>	<i>UnreportedStatus</i>
<i>MeanTimeBetweenReports</i>	<i>MaxTimeBetweenReports</i>		<i>BreakCount</i>
<i>EstablishmentLength</i>			

1	4	192	
false	0.26		0.26
1	15		
2	2	192	
false	0.26		0.26
0	2		
<i>TrackID</i>	<i>posRMS</i>	<i>velRMS</i>	<i>posANEES</i>
			<i>velANEES</i>

<i>TruthID</i>	<i>posRMS</i>	<i>velRMS</i>	<i>posANEEs</i>	<i>velANEEs</i>
1	64.311	91.248	10.911	32.803
2	31.508	82.007	8.3299	30.712
4	31.262	80.702	3.7784	20.542
1	45.786	85.465	6.8628	25.129
2	40.722	83.681	9.0993	32.235



## ===== GNN + IMM =====

```

fprintf("\n===== GNN + IMM =====\n");
tracker = trackerGNN( ...
    'FilterInitializationFcn', @initIMMFilter, ...
    'MaxNumTracks', numTracks, ...
    'MaxNumSensors', 1, ...
    'AssignmentThreshold', gate, ...
    'TrackLogic', 'Score', ...
    'DetectionProbability', pd, ...
    'FalseAlarmRate', farGNN, ...
    'Volume', vol, ...
    'Beta', beta);

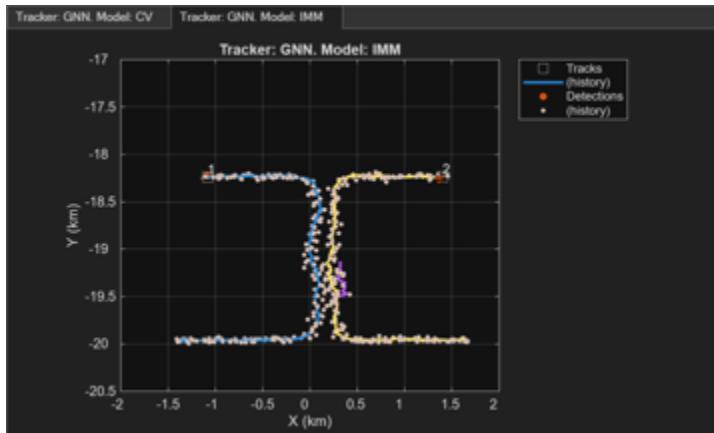
[trackSummary, truthSummary, trackMetrics, truthMetrics, timeGNNIMM] =
helperRunTracker(dataLog, tracker, false);
disp(trackSummary); disp(truthSummary);
disp(trackMetrics); disp(truthMetrics);

```

<i>TrackID</i>	<i>AssignedTruthID</i>	<i>Surviving UnreportedStatus</i>	<i>TotalLength MaxTimeBetweenReports</i>
<i>DivergenceStatus</i>			
1	1	true	190
<i>false</i>		0.26	0.26
<i>true</i>			
2	2	true	190

---

<i>false</i>	0.26	0.26		
<i>false</i>				
4	NaN	<i>false</i>	21	
<i>true</i>	0.26		0.26	
<i>false</i>				
<i>TruthID</i>	<i>AssociatedTrackID</i>	<i>TotalLength</i>	<i>UnreportedStatus</i>	
<i>MeanTimeBetweenReports</i>		<i>MaxTimeBetweenReports</i>	<i>BreakCount</i>	
<i>EstablishmentLength</i>				
—	—	—	—	—
1	1	192		
<i>false</i>	0.26		0.26	
0	26			
2	2	192		0.26
<i>false</i>	0.26			
0	2			
<i>TrackID</i>	<i>posRMS</i>	<i>velRMS</i>	<i>posANEES</i>	<i>velANEES</i>
1	37.653	84.797	12.095	158.19
2	32.65	81.981	10.953	140.19
4	83.991	90.651	18.159	127.21
<i>TruthID</i>	<i>posRMS</i>	<i>velRMS</i>	<i>posANEES</i>	<i>velANEES</i>
1	37.653	84.797	12.095	158.19
2	40.768	82.885	11.67	138.9



## ===== TOMHT + CV =====

```
fprintf("\n===== TOMHT + CV =====\n");
tracker = trackerTOMHT( ...
    'FilterInitializationFcn', @initCVFilter, ...
    'MaxNumTracks', numTracks, ...
    'MaxNumSensors', 1, ...
    'AssignmentThreshold', tomhtThresh, ...
    'DetectionProbability', pd, ...
    'FalseAlarmRate', farMHT, ...
    'Volume', vol, ...
    'Beta', beta, ...
```

---

```

'ConfirmationThreshold', confirmThresh, ...
'DeletionThreshold', deleteThresh, ...
'MaxNumHistoryScans', 10, ...
'MaxNumTrackBranches', maxBranches, ...
'NScanPruning', 'Hypothesis', ...
'OutputRepresentation', 'Tracks');

[trackSummary, truthSummary, trackMetrics, truthMetrics, timeTOMHTCV] =
helperRunTracker(dataLog, tracker, false);
disp(trackSummary); disp(truthSummary);
disp(trackMetrics); disp(truthMetrics);

```

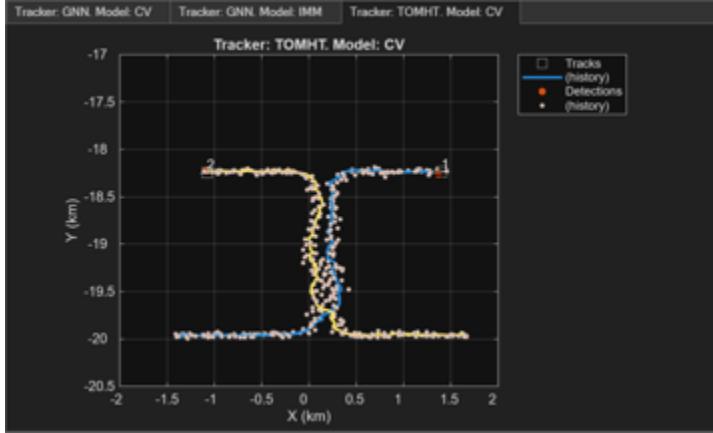
===== TOMHT + CV =====

<i>TrackID</i>	<i>AssignedTruthID</i>	<i>Surviving</i>	<i>TotalLength</i>
<i>UnreportedStatus</i>		<i>MeanTimeBetweenReports</i>	<i>MaxTimeBetweenReports</i>
<i>DivergenceStatus</i>			

1	2	true	190
false			0.26
false			
2	1	true	190
false			0.26
true			

<i>TruthID</i>	<i>AssociatedTrackID</i>	<i>TotalLength</i>	<i>UnreportedStatus</i>
<i>MeanTimeBetweenReports</i>		<i>MaxTimeBetweenReports</i>	<i>BreakCount</i>
<i>EstablishmentLength</i>			

1	2	192		
false			0.26	
1	2			
2	1	192		
false			0.26	
1	2			
<i>TrackID</i>	<i>posRMS</i>	<i>velRMS</i>	<i>posANEES</i>	<i>velANEES</i>
1	128.77	85.374	26.956	31.037
2	39.517	84.329	7.7179	30.379
<i>TruthID</i>	<i>posRMS</i>	<i>velRMS</i>	<i>posANEES</i>	<i>velANEES</i>
1	114.26	86.199	23.715	36.457
2	36.354	82.173	4.9272	19.521



## ===== TOMHT + IMM =====

```

fprintf("\n===== TOMHT + IMM =====\n");
tracker = trackerTOMHT( ...
    'FilterInitializationFcn', @initIMMFilter, ...
    'MaxNumTracks', numTracks, ...
    'MaxNumSensors', 1, ...
    'AssignmentThreshold', tomhtThresh, ...
    'DetectionProbability', pd, ...
    'FalseAlarmRate', farMHT, ...
    'Volume', vol, ...
    'Beta', beta, ...
    'ConfirmationThreshold', confirmThresh, ...
    'DeletionThreshold', deleteThresh, ...
    'MaxNumHistoryScans', 10, ...
    'MaxNumTrackBranches', maxBranches, ...
    'NScanPruning', 'Hypothesis', ...
    'OutputRepresentation', 'Tracks');

[trackSummary, truthSummary, trackMetrics, truthMetrics, timeTOMHTIMM] =
helperRunTracker(dataLog, tracker, true);
disp(trackSummary); disp(truthSummary);
disp(trackMetrics); disp(truthMetrics);

```

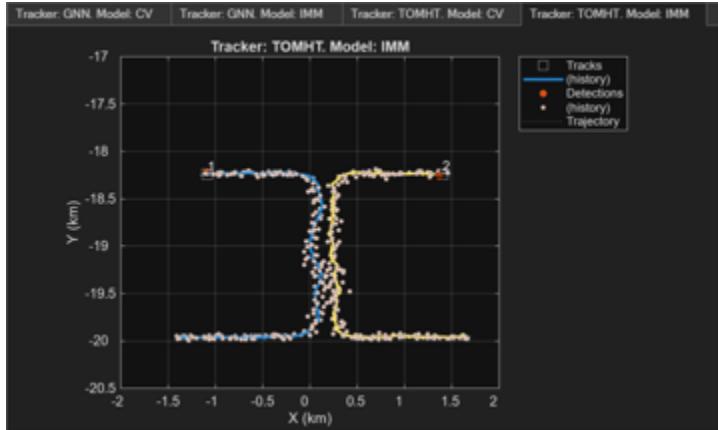
```

===== TOMHT + IMM =====

```

<i>TrackID</i>	<i>AssignedTruthID</i>	<i>Surviving</i>	<i>TotalLength</i>
<i>UnreportedStatus</i>	<i>MeanTimeBetweenReports</i>		<i>MaxTimeBetweenReports</i>
<i>DivergenceStatus</i>			
1 <i>false</i> <i>true</i>	1 0.26	<i>true</i>	190 0.26
2 <i>false</i> <i>false</i>	2 0.26	<i>true</i>	190 0.26
<i>TruthID</i>	<i>AssociatedTrackID</i>	<i>TotalLength</i>	<i>UnreportedStatus</i>

<i>MeanTimeBetweenReports</i>	<i>MaxTimeBetweenReports</i>	<i>BreakCount</i>		
<i>EstablishmentLength</i>				
1	1	192		
<i>false</i>	0.26	0.26		
0	2			
<i>false</i>	0.26	0.26		
0	2			
<i>TrackID</i>	<i>posRMS</i>	<i>velRMS</i>	<i>posANEES</i>	<i>velANEES</i>
1	43.327	82.849	10.438	136.3
2	32.23	81.866	9.6267	134.8
<i>TruthID</i>	<i>posRMS</i>	<i>velRMS</i>	<i>posANEES</i>	<i>velANEES</i>
1	43.327	82.849	10.438	136.3
2	32.23	81.866	9.6267	134.8



## JPDA + CV (storm-friendly initiation)

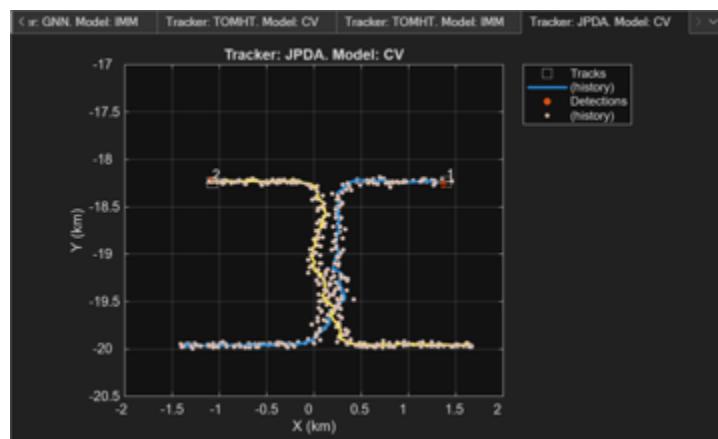
```
fprintf("\n=====JPDA + CV=====\\n");
tracker = trackerJPDA( ...
    'FilterInitializationFcn', @initCVFilter, ...
    'MaxNumTracks', numTracksJPDA, ...
    'MaxNumSensors', 1, ...
    'AssignmentThreshold', gateJPDA, ...
    'TrackLogic', 'Integrated', ...
    'DetectionProbability', pd, ...
    'ClutterDensity', farJPDA/vol, ...
    'NewTargetDensity', betaJPDA, ...
    'TimeTolerance', timeTolJPDA);

[trackSummary, truthSummary, trackMetrics, truthMetrics, timeJPDACV] =
helperRunTracker(dataLog, tracker, false);
disp(trackSummary); disp(truthSummary);
disp(trackMetrics); disp(truthMetrics);
```

---

=====JPDA + CV=====

<i>TrackID</i>	<i>AssignedTruthID</i>	<i>Surviving</i>	<i>TotalLength</i>	
<i>UnreportedStatus</i>	<i>MeanTimeBetweenReports</i>		<i>MaxTimeBetweenReports</i>	
<i>DivergenceStatus</i>				
1 <i>false</i> <i>false</i>	2 0.26	true	191 0.26	
2 <i>false</i> <i>true</i>	1 0.26	true	191 0.26	
<i>TruthID</i>	<i>AssociatedTrackID</i>	<i>TotalLength</i>	<i>UnreportedStatus</i>	
<i>MeanTimeBetweenReports</i>		<i>MaxTimeBetweenReports</i>	<i>BreakCount</i>	
<i>EstablishmentLength</i>				
1 <i>false</i> 1	2 0.26	192	0.26	
2 <i>false</i> 1	1 0.26	192	0.26	
<i>TrackID</i>	<i>posRMS</i>	<i>velRMS</i>	<i>posANEES</i>	<i>velANEES</i>
1	127.16	84.707	28.235	31.57
2	112.33	83.455	24.12	30.944
<i>TruthID</i>	<i>posRMS</i>	<i>velRMS</i>	<i>posANEES</i>	<i>velANEES</i>
1	126.62	84.63	27.96	31.615
2	112.85	83.527	24.378	30.894



## JPDA + IMM (storm-friendly initiation)

```
fprintf("\n=====JPDA + IMM=====\n");
tracker = trackerJPDA( ...
```

---

```

'FilterInitializationFcn', @initIMMFilter, ...
'MaxNumTracks', numTracksJPDA, ...
'MaxNumSensors', 1, ...
'AssignmentThreshold', gateJPDA, ...
'TrackLogic', 'Integrated', ...
'DetectionProbability', pd, ...
'ClutterDensity', farJPDA/vol, ...
'NewTargetDensity', betaJPDA, ...
'TimeTolerance', timeTolJPDA);

[trackSummary, truthSummary, trackMetrics, truthMetrics, timeJPDAIMM] =
helperRunTracker(dataLog, tracker, true);
disp(trackSummary); disp(truthSummary);
disp(trackMetrics); disp(truthMetrics);

% % % % %% Time Performance Comparison (tabbed)
% % % % ax = tabbedAxes('Time Performance Comparison');
% % % % axes(ax);
% % % %
% % % % c1 = categorical({'CV','IMM'});
% % % % timeData = [timeGNNCV timeJPDACP timeTOMHTCV ; timeGNNIMM
timeJPDAIMM timeTOMHTIMM] / timeGNNCV;
% % % % bar(c1, timeData)
% % % % legend('GNN','JPDA','TOMHT','Location','northwest')
% % % % ylabel('Normalized Time (x timeGNN-CV)')
% % % % title('Time Performance Comparison')
% % % % ax.YGrid = 'on';
% % % %

fprintf("\n=====\\n");
fprintf(" RUN END | Scenario = %s\\n",
ternary(enableDegradation,"RAINY","IDEAL"));
fprintf("=====\\n\\n");

```

**=====JPDA + IMM=====**

TrackID	AssignedTruthID	Surviving UnreportedStatus	TotalLength MaxTimeBetweenReports
<i>DivergenceStatus</i>			

1	1	true	191
false			0.26
true			
2	2	true	191
false			0.26
false			

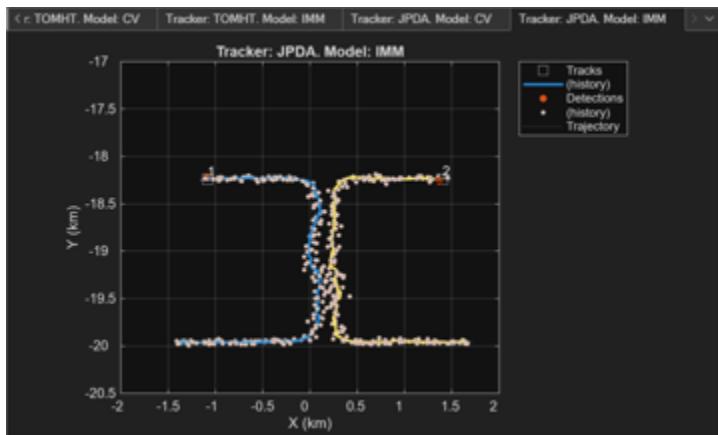
TruthID	AssociatedTrackID	TotalLength	UnreportedStatus
MeanTimeBetweenReports			
EstablishmentLength			BreakCount

1	1	192	
---	---	-----	--

---

<i>false</i>		0.26		0.26
0	1		192	
2	2	0.26		0.26
<i>false</i>				
0	2			
<i>TrackID</i>	<i>posRMS</i>	<i>velRMS</i>	<i>posANEES</i>	<i>velANEES</i>
1	42.029	82.965	11.066	138.26
2	31.41	81.773	10.371	139.16
<i>TruthID</i>	<i>posRMS</i>	<i>velRMS</i>	<i>posANEES</i>	<i>velANEES</i>
1	42.029	82.965	11.066	138.26
2	31.41	81.773	10.371	139.16

=====



## ----- Local helper: ternary -----

```
function out = ternary(cond, a, b)
if cond
    out = a;
else
    out = b;
end
end
```

```
RUN START | Scenario = IDEAL
=====
```

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