

Swift Navigation  
Piksi Multi and Duro Inertial  
with SBAS and Skylark  
Locomotive Testing  
in Niles Canyon, CA

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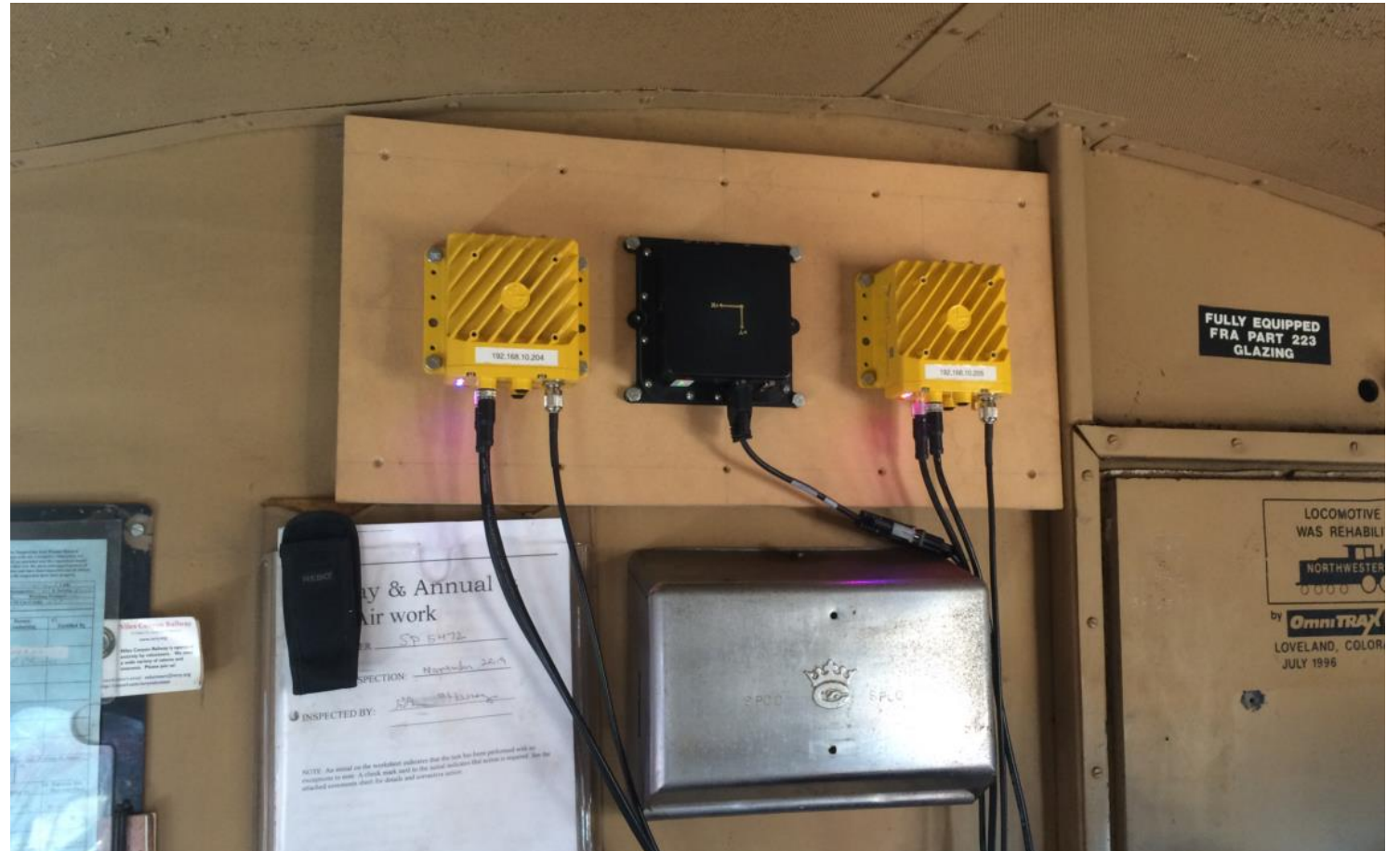
# Test Setup

Locomotive



# Test Setup

Duro Inertial 1, Novatel IMU and Duro Inertial 2



# Test Setup

Antennas: Harxon GPS1000 and Antcom 1G1215A4



# Test Setup

Locomotive: Southern Pacific 5472, GM EMD SD9 (Diesel - Electric), 180 tons

## Receivers:

- Piksi Multi: v2.3.0-2020020705, 5 Hz, Skylark OSR
- Duro Inertial 1: v2.3.0-2020020705, INS, 5 Hz, Skylark OSR
- Duro Inertial 2: v2.3.19-3, INS, 5Hz, GPS and GAL, SBAS
- Novatel FlexPak6 with IMU as a real-time truth reference. RTK base in Fremont about 13 km (8 miles) away over NTRIP (via Verizon cell network)

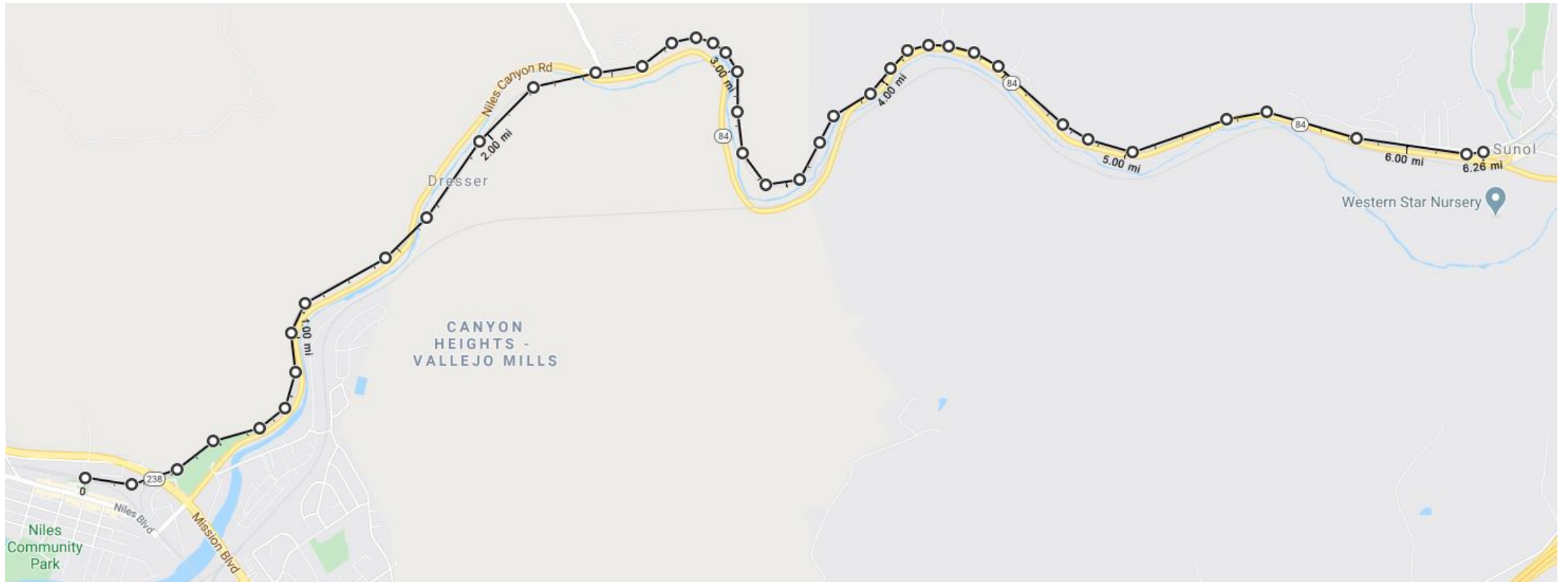
## Antennas:

- Harxon GPS1000 (in tests 1 and 2)
- Antcom 1G1215A4 (in tests 3 and 4)

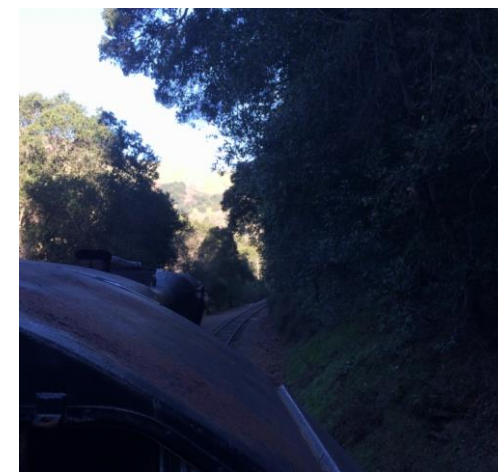
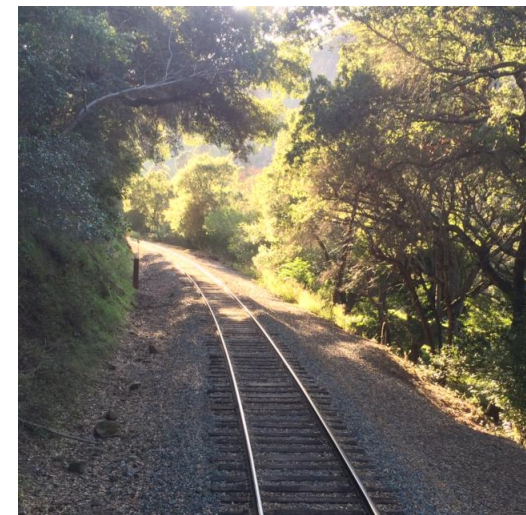
The same antenna was connected to all receivers via RF splitter in each test.

# Route

Niles Canyon, about 10 km (6.4 miles), about 30 minutes one-way ride



# Route



# Test Rides

- Test 1: from Sunol to Niles, GPS1000 antenna
- Test 2: from Niles to Sunol, GPS1000 antenna
- Test 3: from Sunol to Niles, Antcom antenna
- Test 4: from Niles to Sunol, Antcom antenna, several stops on the way



# Piksi Multi GNSS-only with Skylark Results

## Availability

### Test 1:

All Fixes:	6932	(100.00 %)
RTK Fixes:	6932	(100.00 %)
No fix:	0	( 0.00 %)
SPS:	0	( 0.00 %)
SBAS:	0	( 0.00 %)
DGPS:	0	( 0.00 %)
RTK Float:	2819	( 40.67 %)
RTK Fixed:	4113	( 59.33 %)

### Test 3:

All Fixes:	6895	( 99.93 %)
RTK Fixes:	6884	( 99.77 %)
No fix:	5	( 0.07 %)
SPS:	0	( 0.00 %)
SBAS:	0	( 0.00 %)
DGPS:	11	( 0.16 %)
RTK Float:	4923	( 71.35 %)
RTK Fixed:	1961	( 28.42 %)

### Test 2:

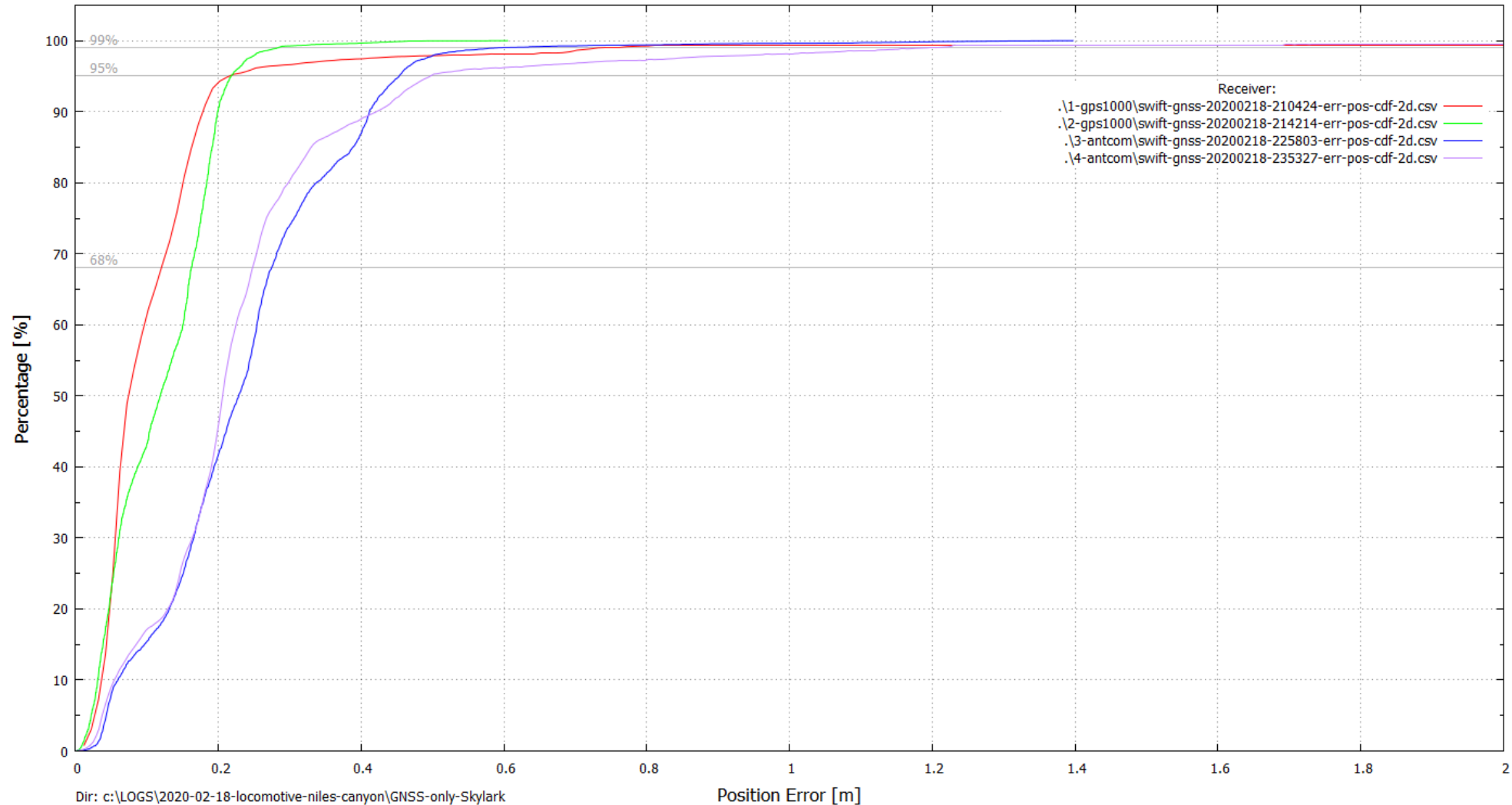
All Fixes:	7424	(100.00 %)
RTK Fixes:	7424	(100.00 %)
No fix:	0	( 0.00 %)
SPS:	0	( 0.00 %)
SBAS:	0	( 0.00 %)
DGPS:	0	( 0.00 %)
RTK Float:	5294	( 71.31 %)
RTK Fixed:	2130	( 28.69 %)

### Test 4:

All Fixes:	9618	( 99.92 %)
RTK Fixes:	9610	( 99.83 %)
No fix:	8	( 0.08 %)
SPS:	0	( 0.00 %)
SBAS:	8	( 0.08 %)
DGPS:	0	( 0.00 %)
RTK Float:	8299	( 86.21 %)
RTK Fixed:	1311	( 13.62 %)

# Piksi Multi GNSS-only with Skylark Results

GNSS Only with Skylark - 2D Position Errors CDF



# Duro Inertial with Skylark Results

## Availability

### Test 1:

All Fixes:	6887	(100.00 %)
RTK Fixes:	6887	(100.00 %)
No fix:	0	( 0.00 %)
SPS:	0	( 0.00 %)
SBAS:	0	( 0.00 %)
DGPS:	0	( 0.00 %)
RTK Float:	3855	( 55.98 %)
RTK Fixed:	3032	( 44.02 %)
DR:	0	( 0.00 %)

### Test 2:

All Fixes:	7393	(100.00 %)
RTK Fixes:	7393	(100.00 %)
No fix:	0	( 0.00 %)
SPS:	0	( 0.00 %)
SBAS:	0	( 0.00 %)
DGPS:	0	( 0.00 %)
RTK Float:	5772	( 78.07 %)
RTK Fixed:	1621	( 21.93 %)
DR:	0	( 0.00 %)

### Test 3:

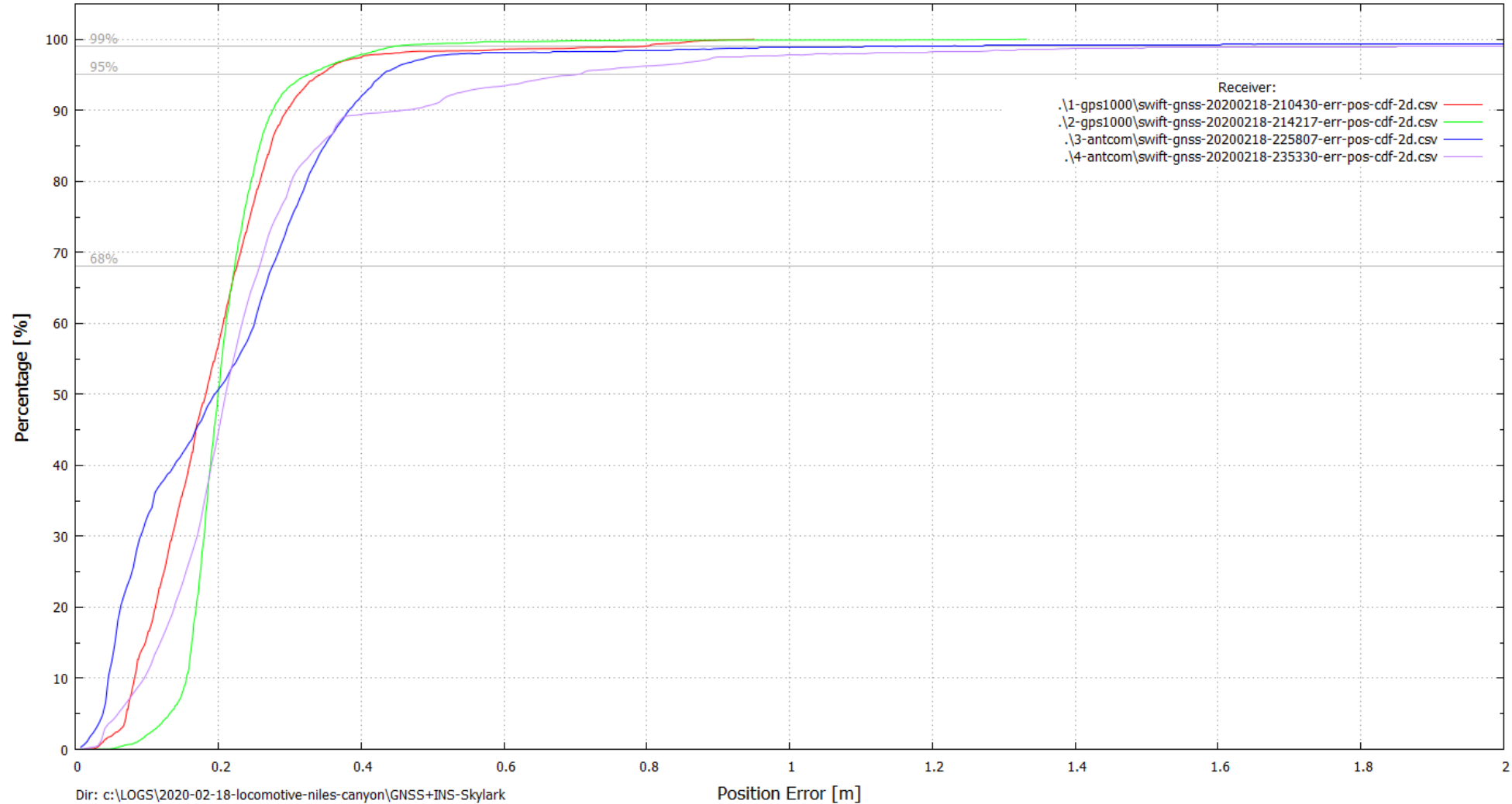
All Fixes:	6863	(100.00 %)
RTK Fixes:	6848	( 99.78 %)
No fix:	0	( 0.00 %)
SPS:	0	( 0.00 %)
SBAS:	0	( 0.00 %)
DGPS:	0	( 0.00 %)
RTK Float:	4180	( 60.91 %)
RTK Fixed:	2668	( 38.88 %)
DR:	15	( 0.22 %)

### Test 4:

All Fixes:	9591	(100.00 %)
RTK Fixes:	9563	( 99.71 %)
No fix:	0	( 0.00 %)
SPS:	0	( 0.00 %)
SBAS:	16	( 0.17 %)
DGPS:	0	( 0.00 %)
RTK Float:	8382	( 87.39 %)
RTK Fixed:	1181	( 12.31 %)
DR:	12	( 0.13 %)

# Duro Inertial with Skylark Results

GNSS + INS with Skylark - 2D Position Errors CDF



# Duro Inertial with SBAS Results

## Availability

### Test 1:

All Fixes:	6859	(100.00 %)
RTK Fixes:	0	( 0.00 %)
No fix:	0	( 0.00 %)
SPS:	0	( 0.00 %)
SBAS:	6842	( 99.75 %)
DGPS:	0	( 0.00 %)
RTK Float:	0	( 0.00 %)
RTK Fixed:	0	( 0.00 %)
DR:	17	( 0.25 %)

### Test 3:

All Fixes:	6541	( 95.81 %)
RTK Fixes:	0	( 0.00 %)
No fix:	286	( 4.19 %)
SPS:	464	( 6.80 %)
SBAS:	6022	( 88.21 %)
DGPS:	0	( 0.00 %)
RTK Float:	0	( 0.00 %)
RTK Fixed:	0	( 0.00 %)
DR:	55	( 0.81 %)

### Test 2:

All Fixes:	7085	( 96.55 %)
RTK Fixes:	0	( 0.00 %)
No fix:	253	( 3.45 %)
SPS:	156	( 2.13 %)
SBAS:	6918	( 94.28 %)
DGPS:	0	( 0.00 %)
RTK Float:	0	( 0.00 %)
RTK Fixed:	0	( 0.00 %)
DR:	11	( 0.15 %)

# Duro Inertial with SBAS Results

GNSS + INS with SBAS - 2D Position Errors CDF

