Development and Status of H-field Antenna and DSP-Loran Receiver for FAA Loran Program

by
Jim Schliem, Linn Roth, Ph.D., Paul Schick, Chad Schweitzer,
Jim Jacoby, Dean Gervasi, and Jim Weikert
Locus, Inc.

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Phase I Tasks

- Develop dual-loop H-field prototype antenna to receive off-air signals and provide representative data for receiver hardware evaluation
- Match electronic characteristics of receiver hardware with prototype H-field antenna
- Determine if a single ADC can be used to sample separate analog inputs from each loop of an H-field antenna.
- Results reported at ILA29

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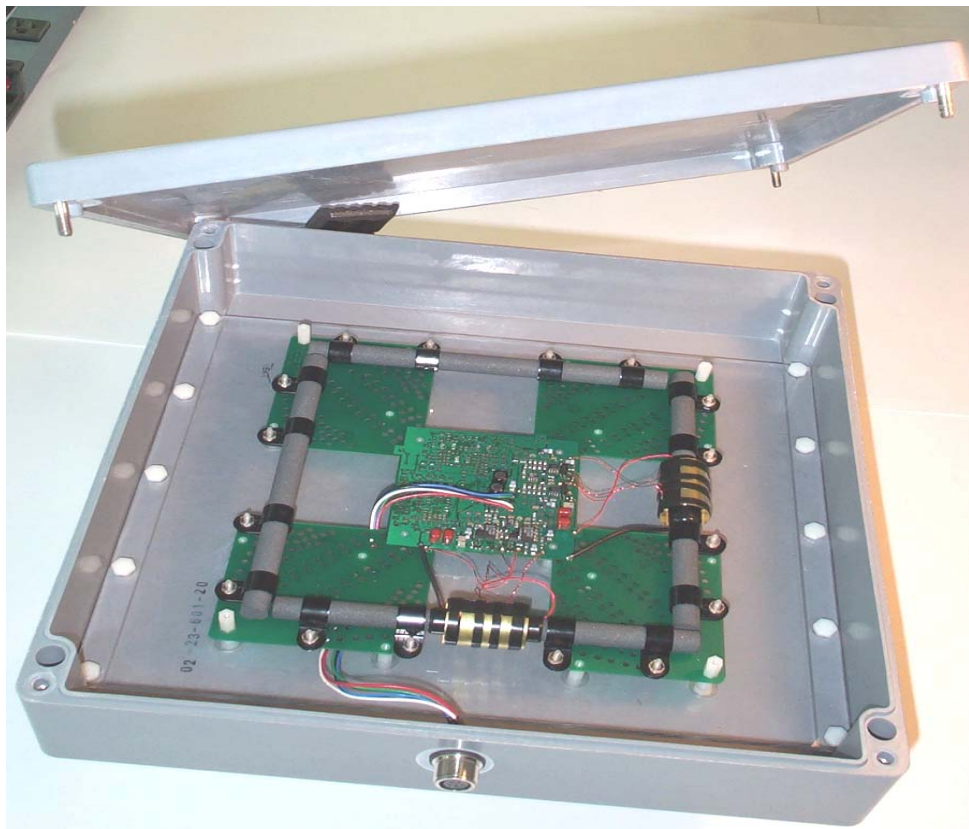
Phase I Results

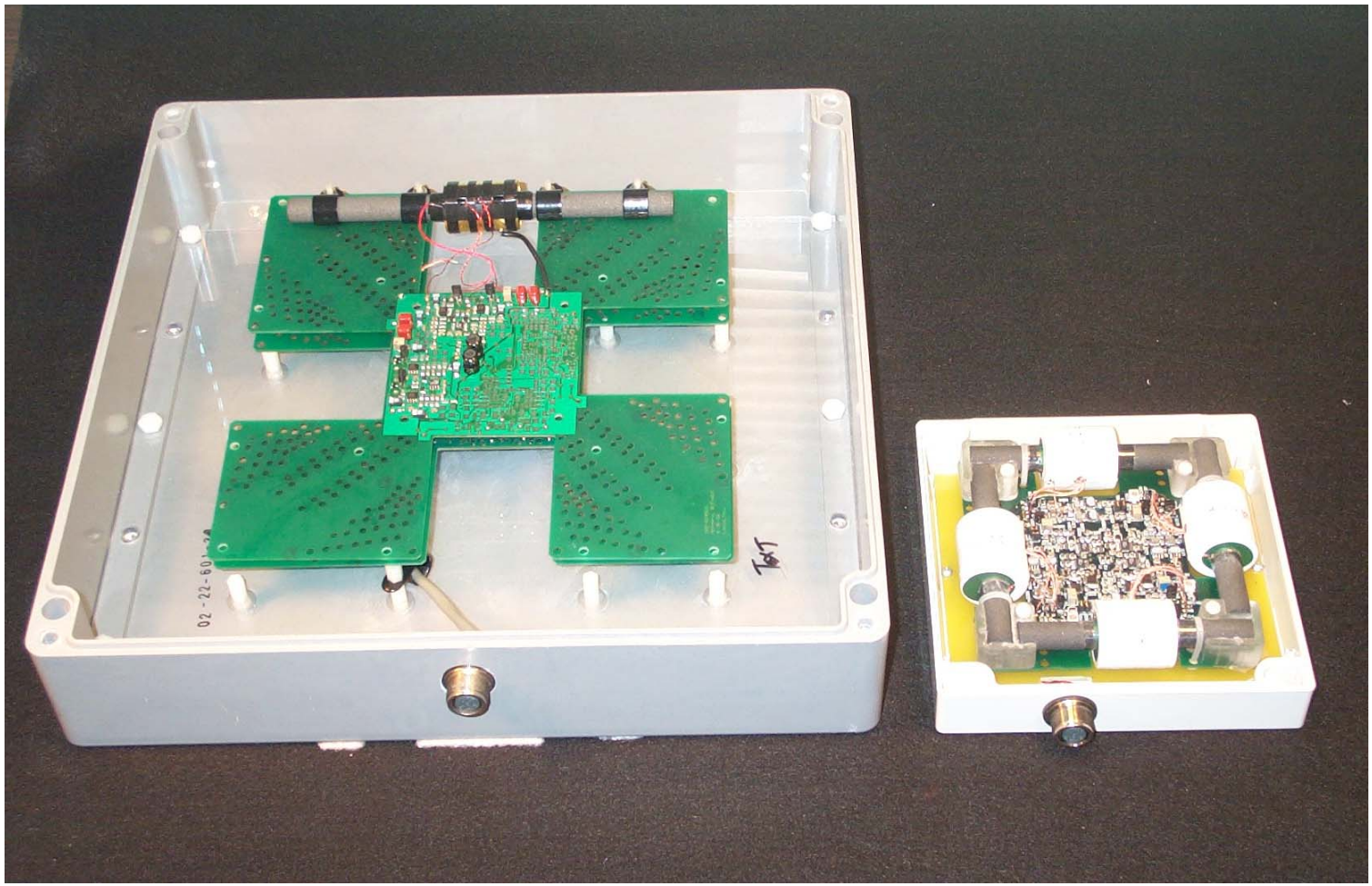
- 7 1/2” ferrite rods
- Signal levels comparable to E-field
- Single channel
- No provisions for mounting on aircraft
- No high-speed dynamic software



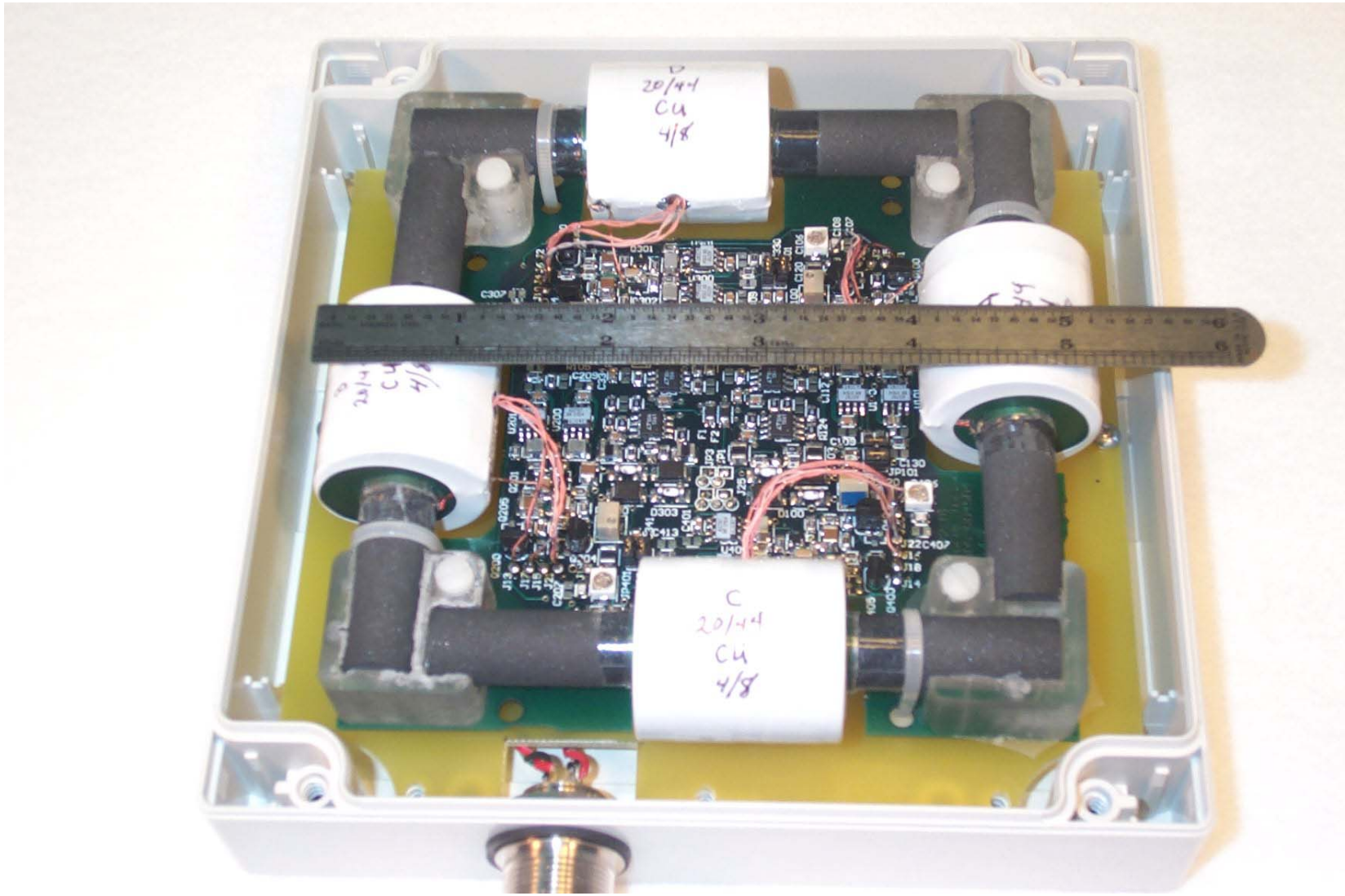
Phase II Project Tasks

- Develop prototype H-field antenna and associated electronics
- Modify SatMate receiver electronics to work with new H-field antenna
- Develop SatMate software to work with H-field antenna, e.g. steering and improved filtering
- Develop SatMate software to operate in high-speed aviation environment

Phase I & Phase II Antennas



Phase II H-field Antenna



Antenna (without enclosure) ~ 12.5 cm x 12.5 cm x 3.8 cm

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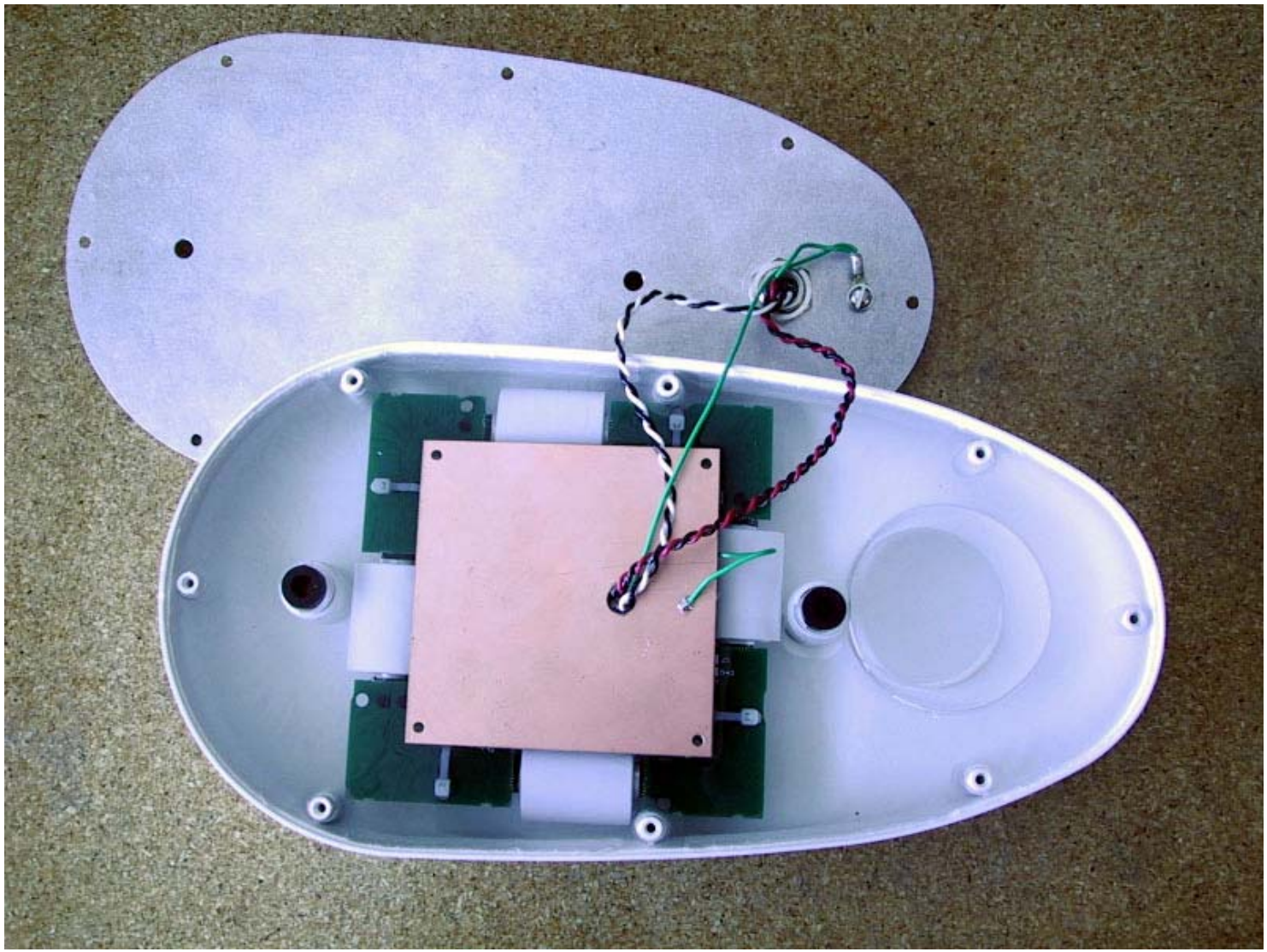
Phase II Antenna/Preamp Design Changes

- Reduced ferrite rod size from 19 to 10.1 cm
- Improved coil design and shielding to reduce noise
- Changed from 2 to 4-layer PC board for better isolation
- Implemented electronic feedback design to reduce circuit noise
- Encapsulated antenna/preamp in Bendix-King KA-42B ADF radome

Bendix-King KA-42B ADF Radome

H-field Encapsulted in ADF Radome



Phase II
Update SatMate 1000 to SatMate 1020

- Added second channel to accommodate H-field signal
- Developed firmware to process two channels simultaneously
- Developed steering software to account for antenna rotation
- Developed high-speed dynamic software for use in aviation applications

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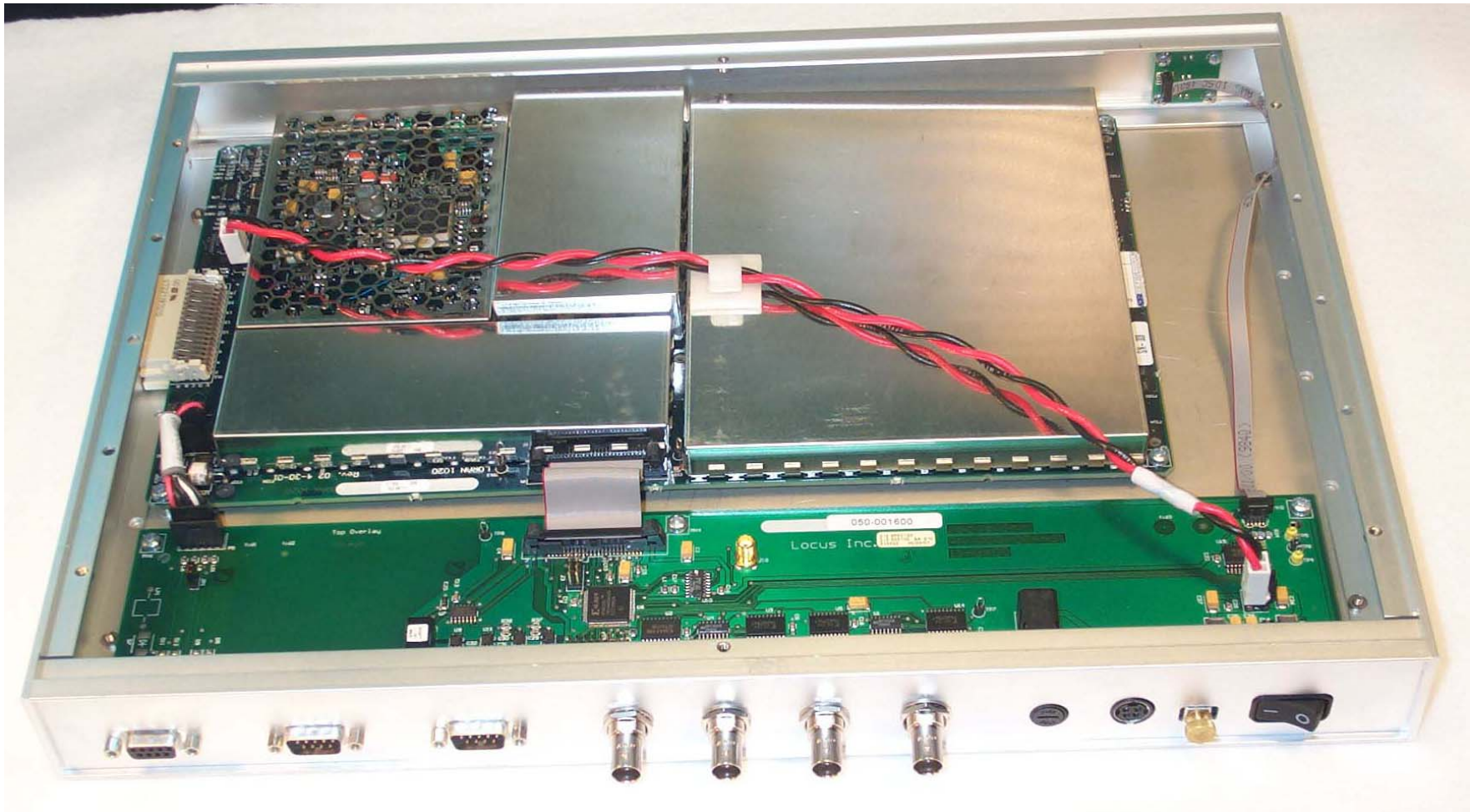
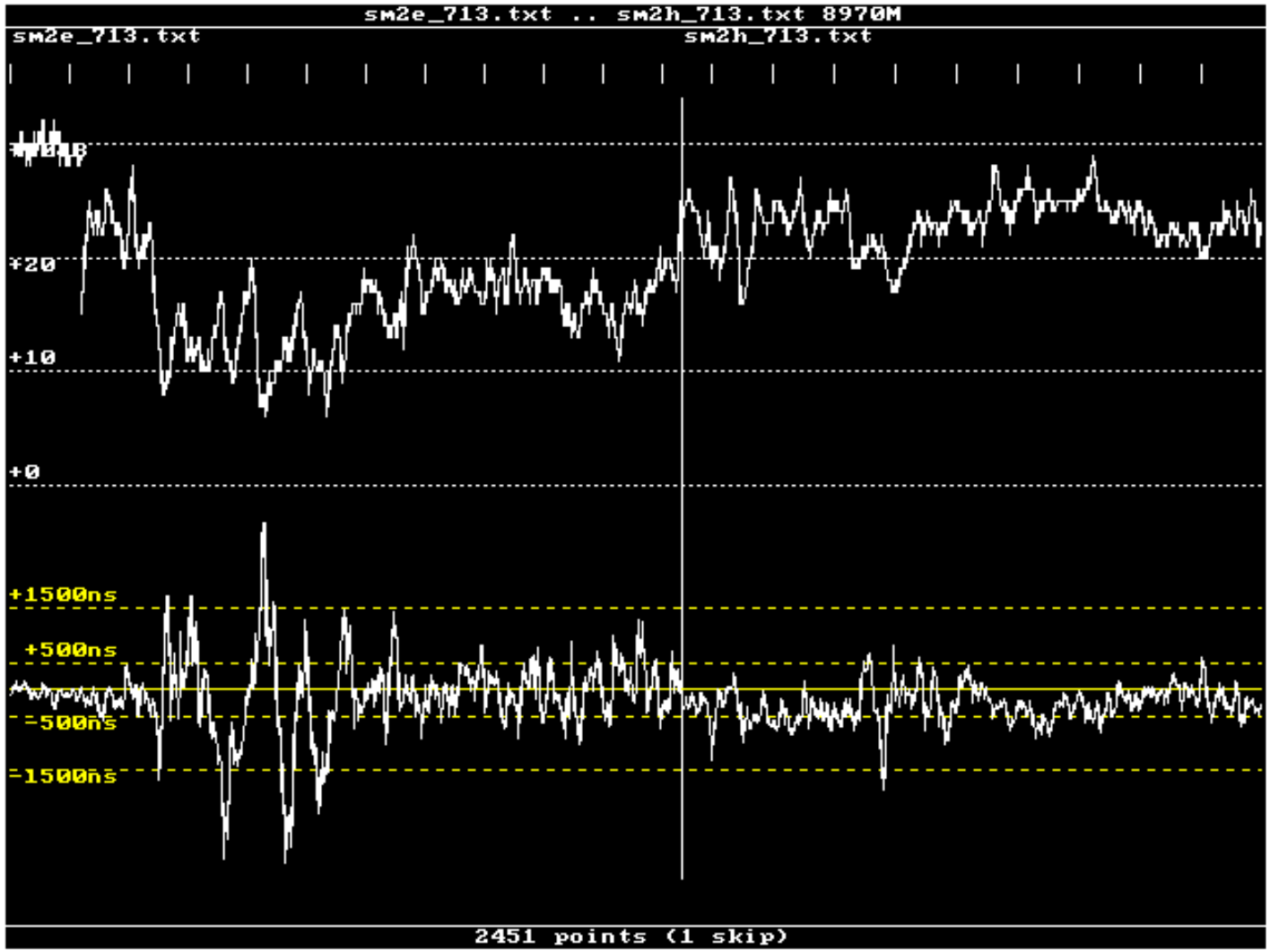
SatMate 1020 Receiver



SatMate 1020 Dynamic Performance

E-field H-field



SNR

ECD

- these data used in next 3 slides

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SatMate 1020 Dynamic Tests with E-field

- SatMate - White
  GPS - Green
- Simultaneous recording, positions updated 1/sec
- Velocities up to 100 km/hour
- Much of route parallel to or crossing power lines
- SatMate 1020 using no ASF corrections

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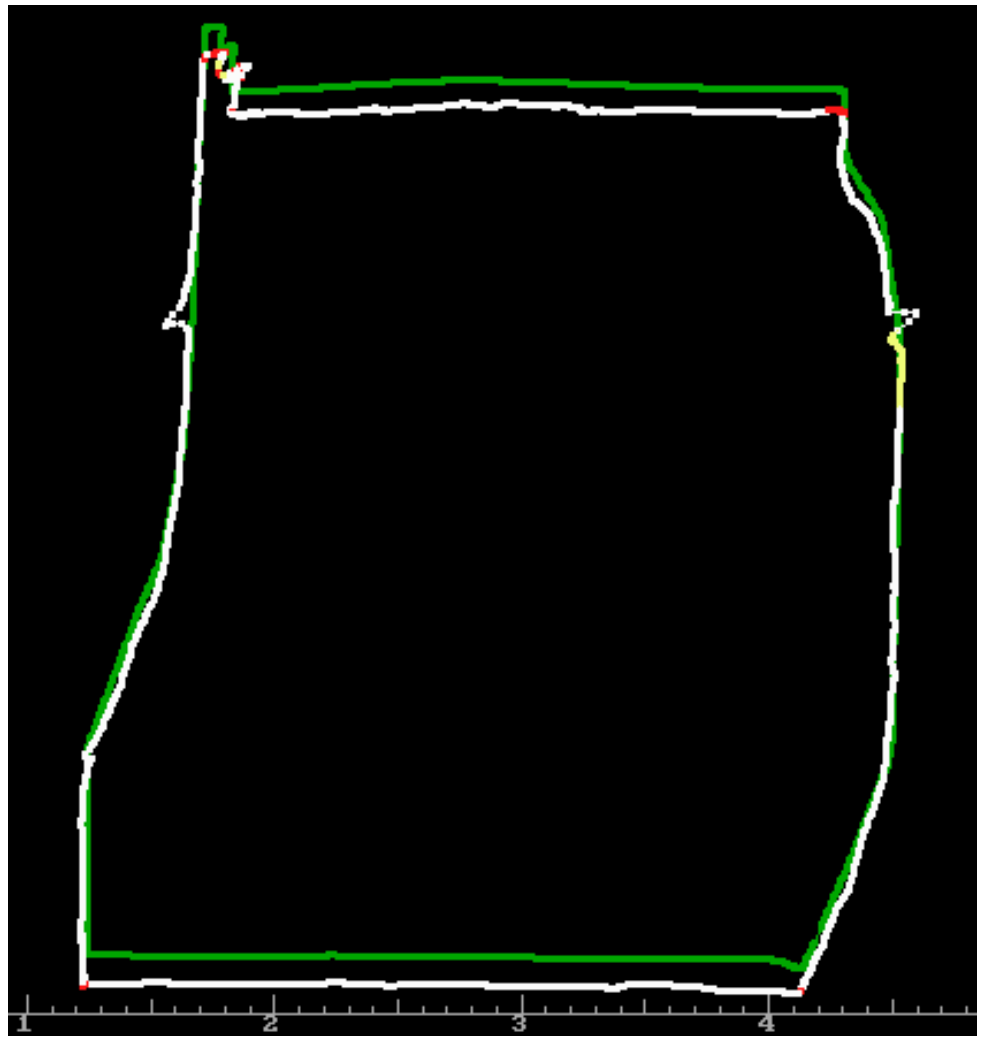
SatMate 1020 Dynamic Tests with H-field

- SatMate - White

  GPS - Green
- Simultaneous recording, positions updated 1/sec
- Velocities up to 100 km/hour
- Disturbances of north-south routes due to high voltage line over road
- SatMate 1020 using no ASF corrections



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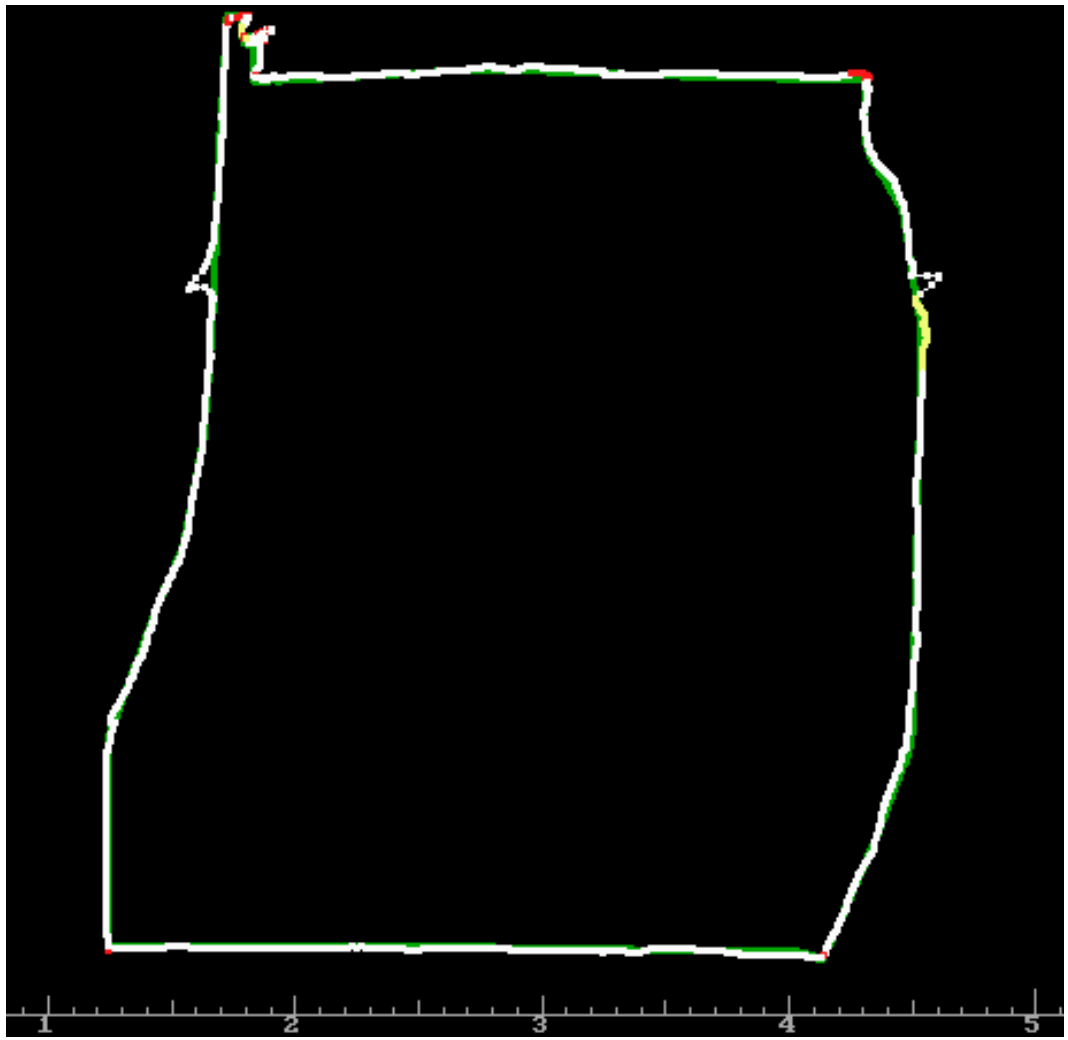
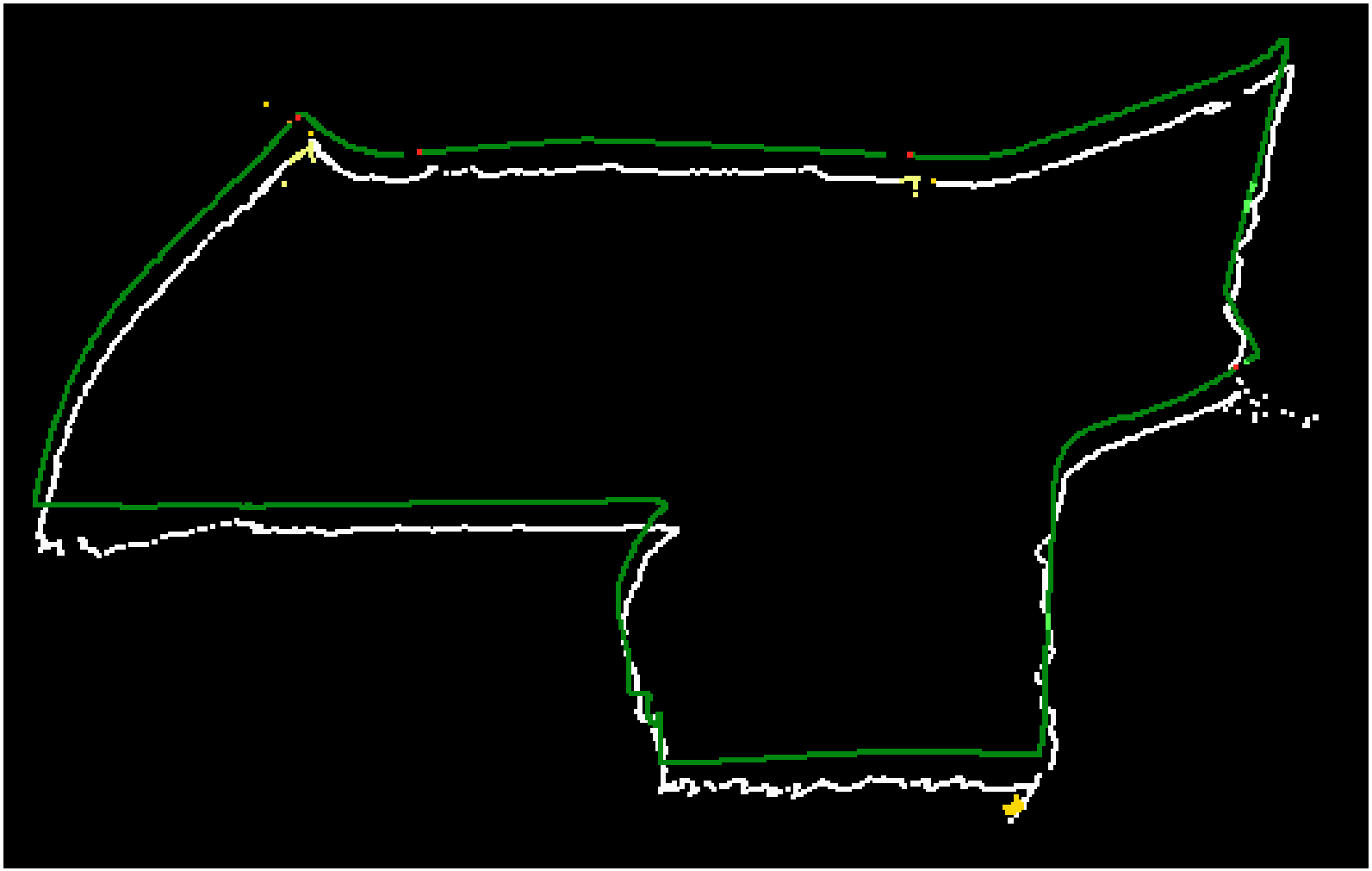
SatMate 1020 Dynamic H-field Test Results with Graphic Offset to Mimic ASF Corrections

- SatMate - White
  GPS - Green



SatMate 1020 Dynamic Tests with E-field



- Loran disturbance in southwest due to large power station next to road
- GPS gaps due to overpasses
- No ASF corrections

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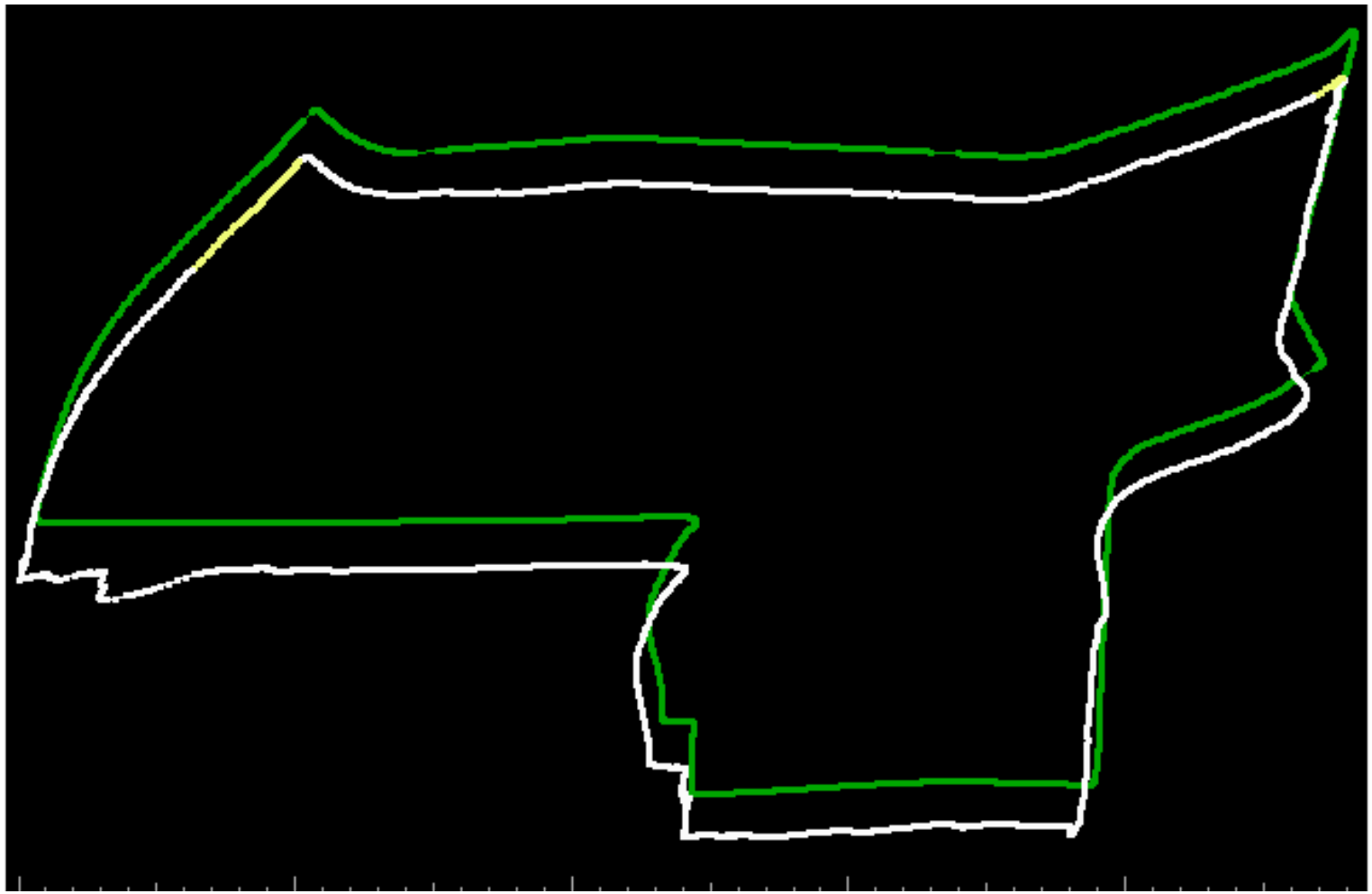
SatMate 1020 Dynamic Tests with H-field



- Loran disturbance in southwest due to large power station next to road
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- No ASF corrections

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SatMate 1020 Dynamic H-field Test Results with Graphic Offset to Mimic ASF Corrections

H-field *vs.* E-field Dynamic Test Results

- H-field - Higher signal levels and SNR
- H-field - Lower ECD
- H-field - Improved interference immunity which provides more accurate tracking
- H-field - Steering software performed well at speeds up to 100 km/h. Current software can track at .2 radians/sec (or 10 degrees/sec)
- Have verified tracking to 300 knots in flight tests and 600 knots with simulator

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Phase II H-field Tasks Completed

- Designed prototype antenna ferrite/coil assemblies and preamp board
- Mechanically adapted antenna to encapsulate antenna/preamp in Bendix-King KA-42B ADF radome for FAA flight tests
- Modified SatMate receiver hardware to accommodate dual loop antenna
- Implemented two-channel processing and tracking software
- Developed prototype SatMate aviation software
- Provided FAA with SatMate 1020 receivers, H-field antennas in radomes, and new software

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Phase II H-field Tasks Remaining

- Optimize high-speed dynamic software for aircraft applications - very promising results to date
- Optimize H-field steering and digital filtering software - very promising results to date
- Improve H-field manufacturability
- Support flight tests as required
- Complete work in December 2001

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H-Field Antenna
Market Advantages and Applications

- *No antenna ground required* - terrestrial, marine, and aviation applications
- *Less local distortions* from fixed objects on ground - terrestrial, plus aviation and marine in terminal and port operations
- *Better penetration into semi-shielded areas* (e.g. underpass and cities) - terrestrial and timing, aviation and marine in terminal and port operations
- *P-static immunity* - marine and aviation
- *Operation at low antenna elevation* - marine, terrestrial and timing
- *Smaller form factor* - marine, aviation, terrestrial and timing
- *Combined GPS/Loran antenna* - a single unit for marine, aviation, terrestrial, and timing
- Multiple market uses invoke *economies of scale* $\rightarrow$ lower user prices

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