



OFFICE OF RESEARCH & DEVELOPMENT

**2012** **R&D**  
**REVIEW**

# Autonomous Track Geometry Measurement System (ATGMS)



U.S. Department  
of Transportation  
**Federal Railroad  
Administration**

**CAMERON STUART**  
**PROGRAM MANAGER**

Office of Research and Development  
Office of Railroad Policy and Development



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# Program Area & Risk Matrix

## Autonomous Track Geometry Measurement System (ATGMS)

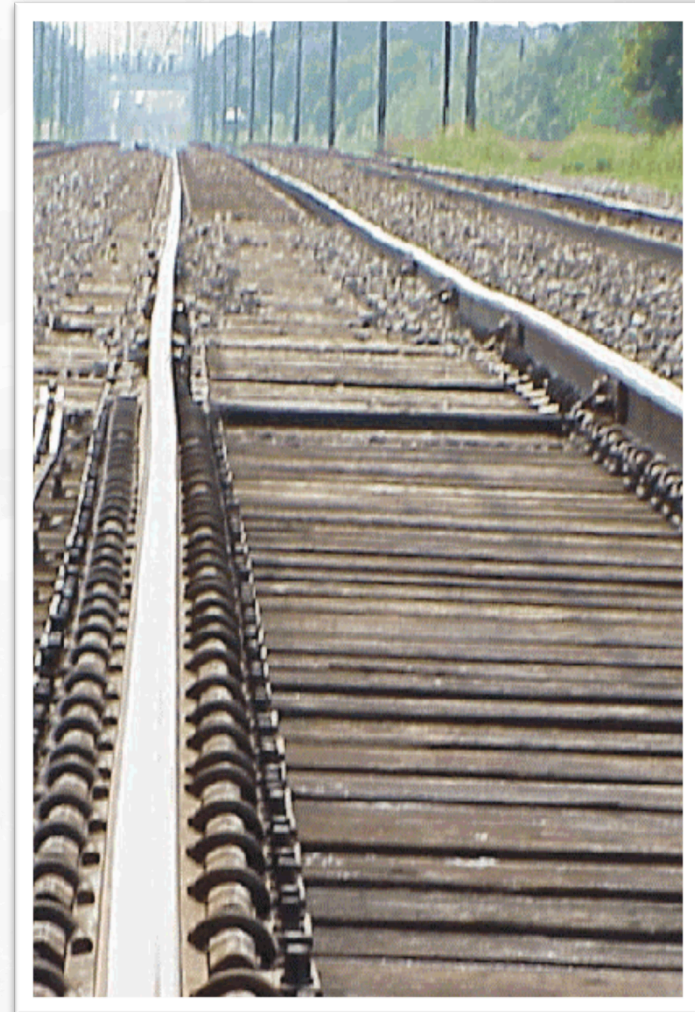
Program Areas	Risk Factors	Trespass	Grade Crossing	Derailment	Train Collision	All Other Safety Hazards
Railroad Systems Issues						
Human Factors						
Track & Structures				X		
Track & Train Interaction				X		
Facilities & Equipment						
Rolling Stock & Components						
Hazardous Materials						
Train Occupant Protection						
Train Control & Communications						
Grade Crossings & Trespass						

# Topics

- What is Autonomous Track Inspection?
- Overview of the FRA's Research & Development (R&D) ATGMS Research Program
- Stages of Development Status
- Areas for Continued Development
- Conclusions and Acknowledgements

# What is Autonomous Track Inspection?

- FRA's vision is to improve track safety and maintenance practices by enhancing conditional awareness through the use of *autonomous* inspection systems.
- **Automated Inspection:** Technique by which key track measurements are collected by specialized trained operators.
- **Autonomous Inspection:** Process of inspecting the track from revenue service trains using *unattended instrumentation* with minimal direct involvement.

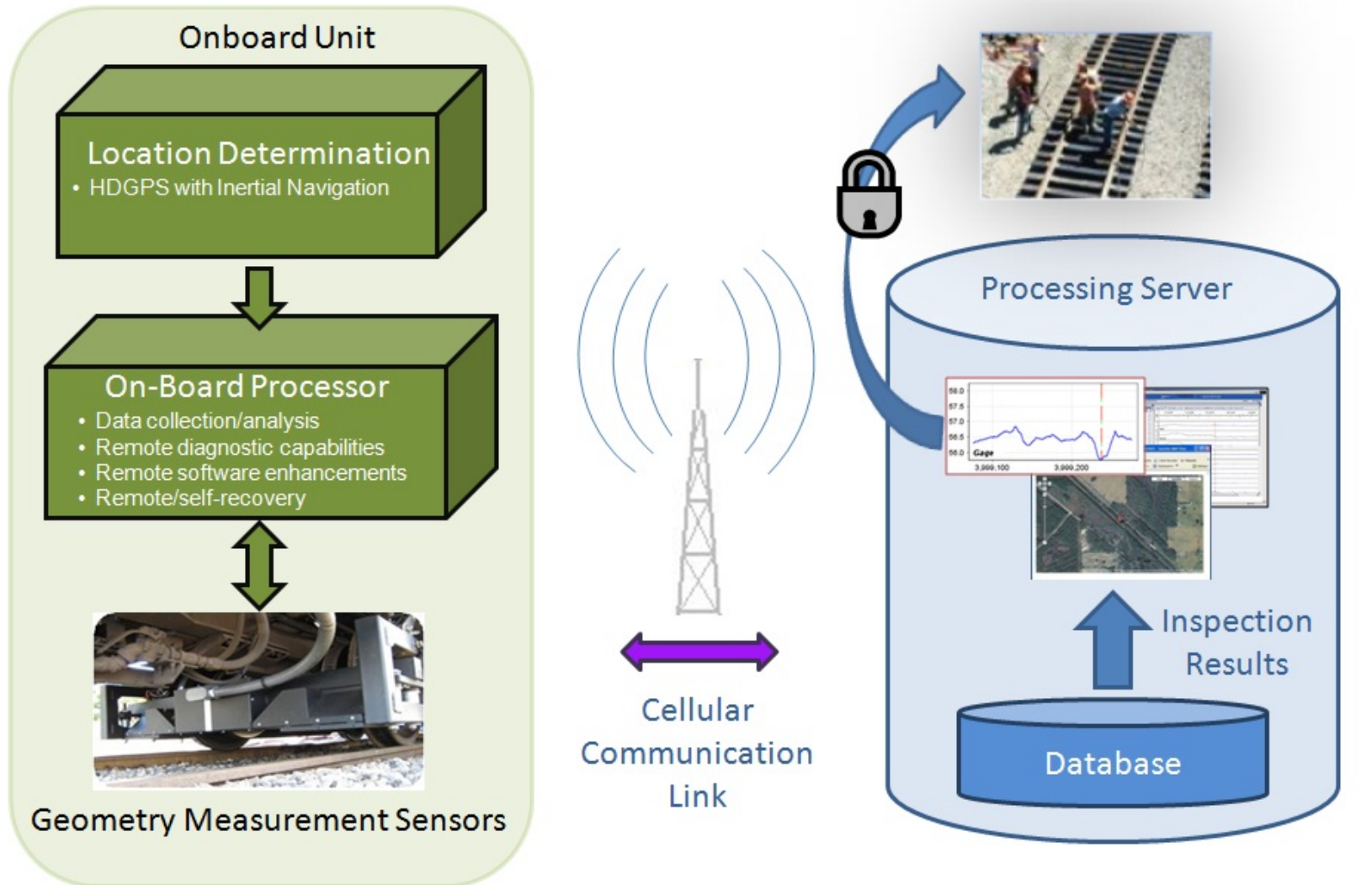


# The FRA's R&D Vision for Autonomous Track Geometry Measurement System (ATGMS)

- Relatively low capital cost
- Able to collect/disseminate accurate track geometry data while installed on a standard revenue train
- Self-powered
- Deployable on wide range of equipment, including standard freight cars

***ATGMS technology is designed to enhance, rather than replace, traditional inspection methods.***

# ATGMS Technical Arrangement



# FRA ATGMS Development Plan

- ✓ ***Stage 1: Long-Term Pilot with Standard Inspection Technology to Establish Baseline Performance***
- ✓ ***Stage 2: Revenue Operations Simulation Test (partner – FRA’s Automated Track Inspection Program (ATIP))***
- ***Stage 3: Develop Advanced Measurement Technology (partner – Amtrak)***
- ***Stage 4: Develop Energy Harvesting Technology***
- ***Stage 5: Demonstrate in Freight Service***

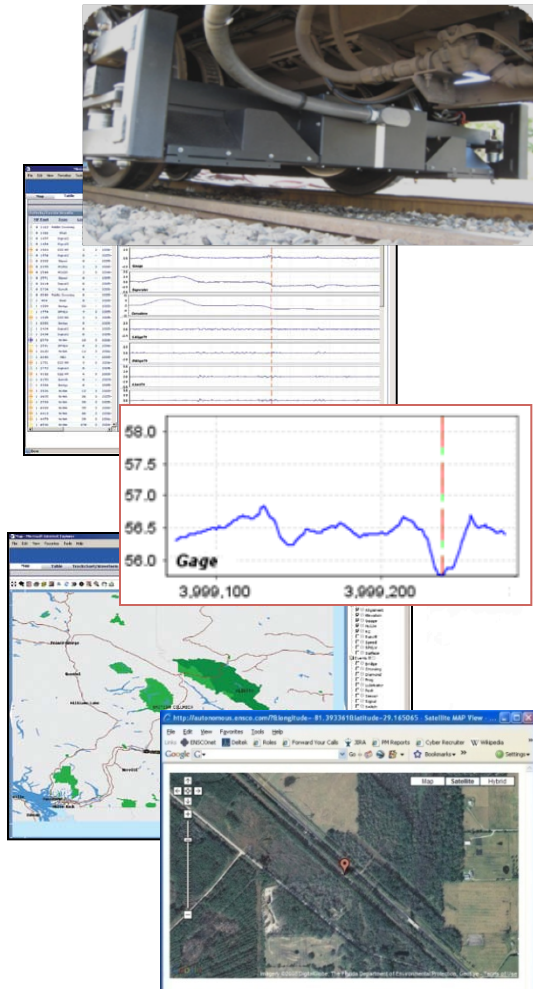
***Partnerships with railroads and equipment owners are a critical aspect to the success of the Development Plan.***

# Stage 1: Accomplishments-to-Date

FRA deployed its pilot ATGMS in early 2008 on Amtrak's Auto Train running on CSX track:

- Remote assessment of track geometry conditions
- Alert/alarm message with location, time and exception description when specific thresholds are exceeded
- Periodic status reports and vehicle location information available through secure Web access
- Advance exception filtering and data correlation and trend analysis

*Through March 2011, the pilot system surveyed over **460,000** track miles.*





# Current Activities

## Targeted improvements building upon Stage 1 success:

- Transfer of foot-by-foot geometry data, in addition to distinct track geometry exceptions
- Implementation of track degradation tools to analyze repeated surveys
- Improvements to film-based optical protection system
- Enhanced diagnostic health monitoring to improve knowledge of system operational status and potential data quality issues

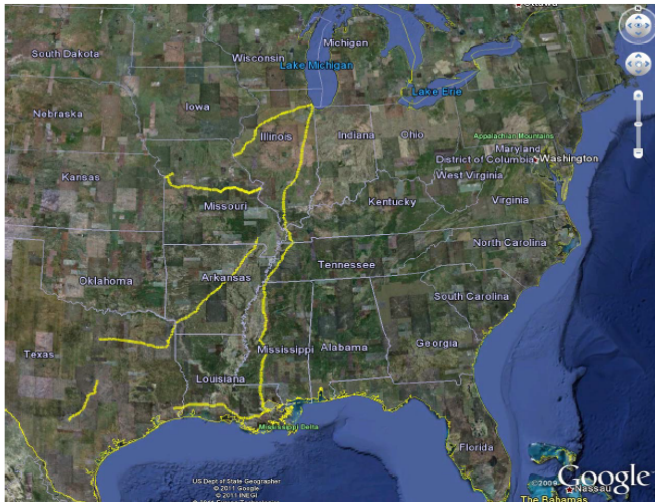
# Stage 2: Accomplishments-to-Date

In August 2011, FRA deployed its pilot ATGMS on DOTX 221 for evaluation around the country in revenue service

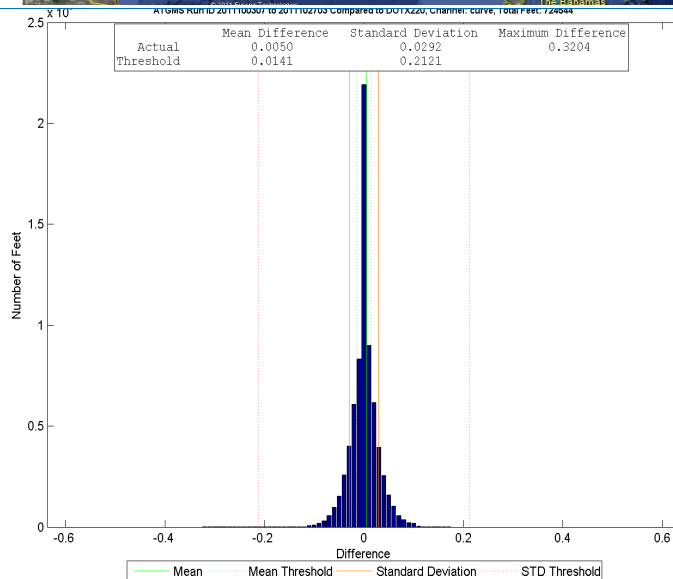
- Comparison of geometry data collected with the autonomous system to geometry data collected with a typical manned vehicle system over a wide range of track conditions
- Regular transfer of foot-by-foot track geometry through cellular transmission
- Equipment reliability



# Stage 2: Accomplishments-to-Date



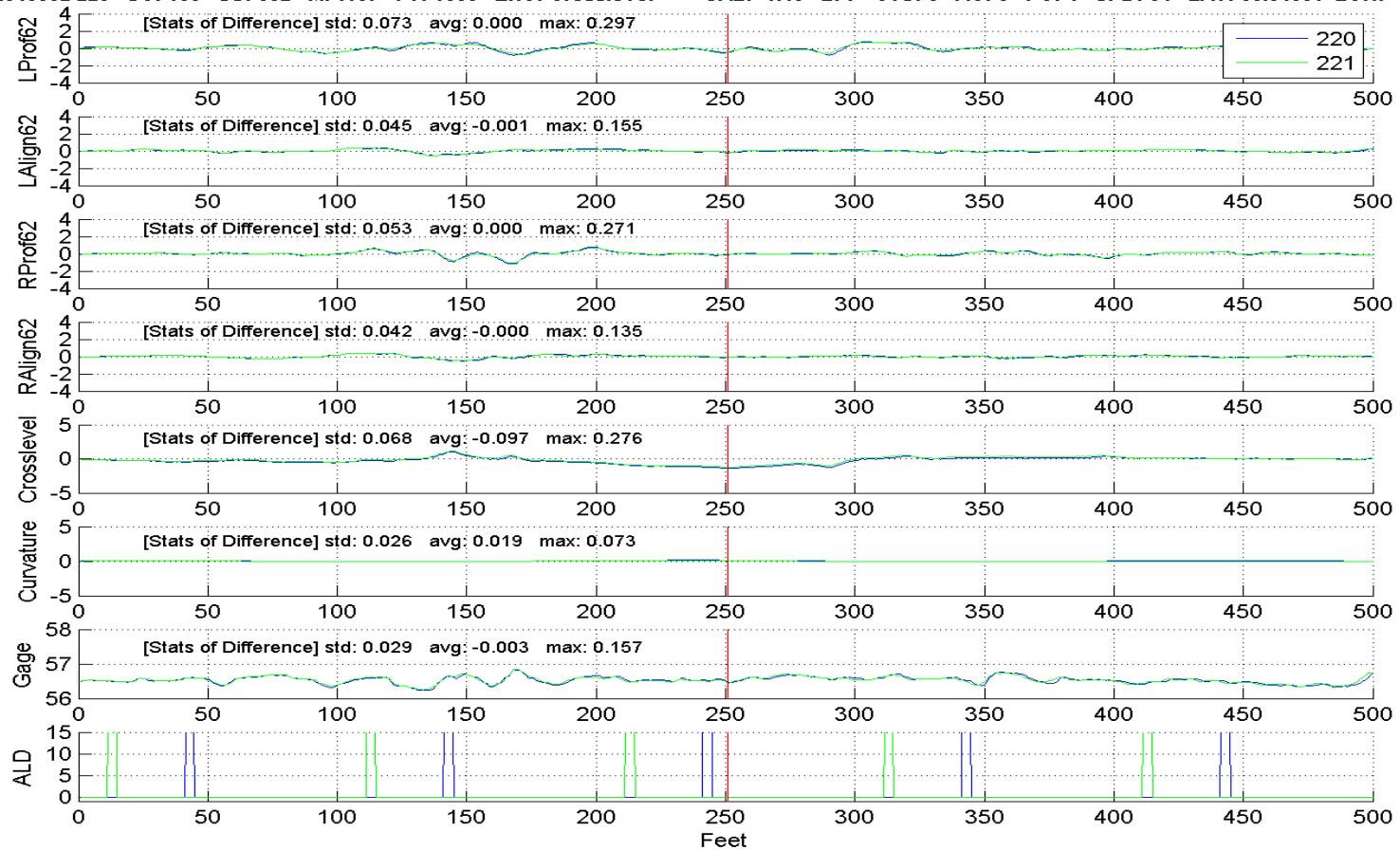
- Joint surveys with DOTX220 (ATIP)
  - Fall 2011: ~ 21,000 miles
  - Spring 2012: ~ 12,000 miles
- Data Analysis shows good agreement between manned and autonomous systems. The differences are within accepted thresholds.
- System overall reliability = good
- Technical development:
  - Exception editing – human vs. machine
  - Track determination
  - 24/7 operational procedures



Parameter	Mean Difference (inches)	Standard Deviation (inches)	Maximum Difference (inches)
Profile (Inches)	0.000	0.060	2.575
Alignment (Inches)	0.000	0.051	1.256
Crosslevel (Inches)	-0.085	0.100	2.673
Curvature (Degrees/100Feet)	0.005	0.029	0.320
Gage (Inches)	0.013	0.030	1.205

# Detailed Data Comparison

RunID: 2012043002 220 SC: 168 SS: 652 MP:197 FT: 1009 EXC: Crosslevel VAL: -1.43 L: 7 CTS: 0 AC: 3 PC: 4 SPD: 64 LAT: 30.04661 LON: -97.86163 DEI



# ATGMS E-mail Reporting

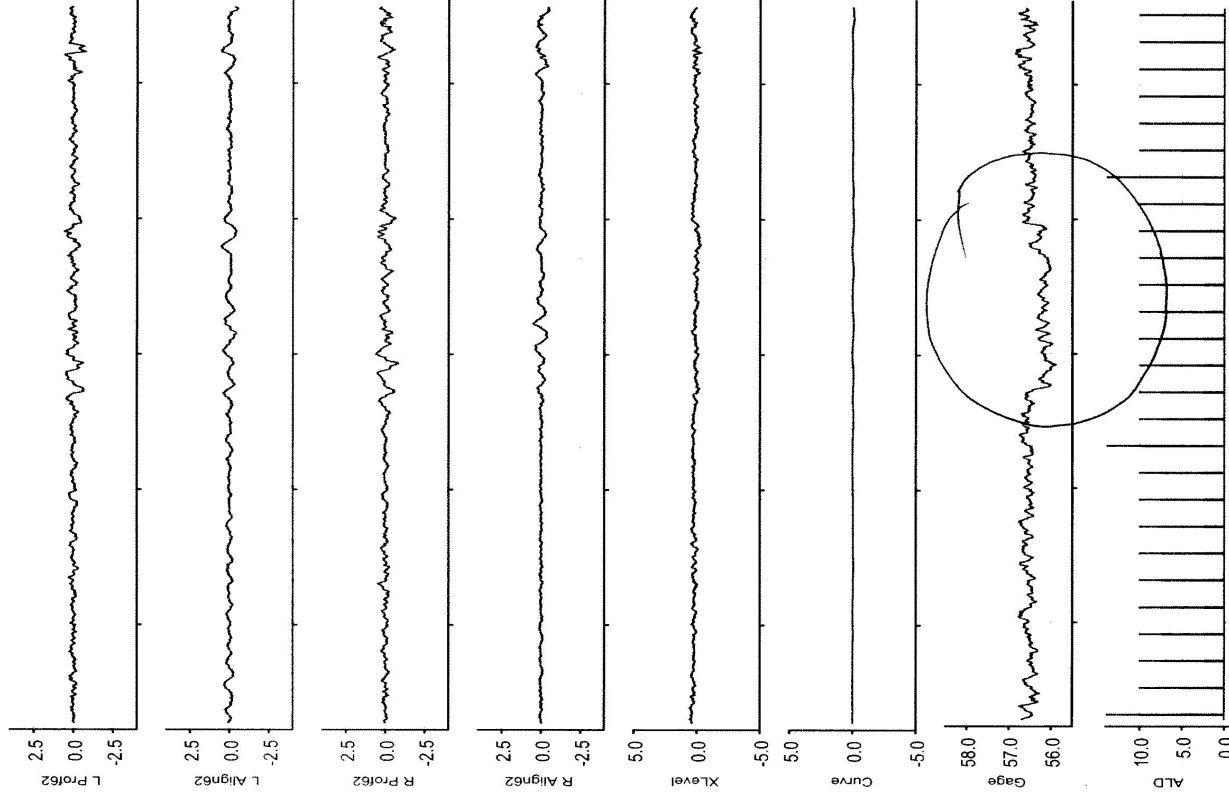
## ATGMS EXCEPTION REPORT

Run Date: 2012-05-10  
Run ID: 2012051003  
MP Dir: Up

ATGMS DOTX221

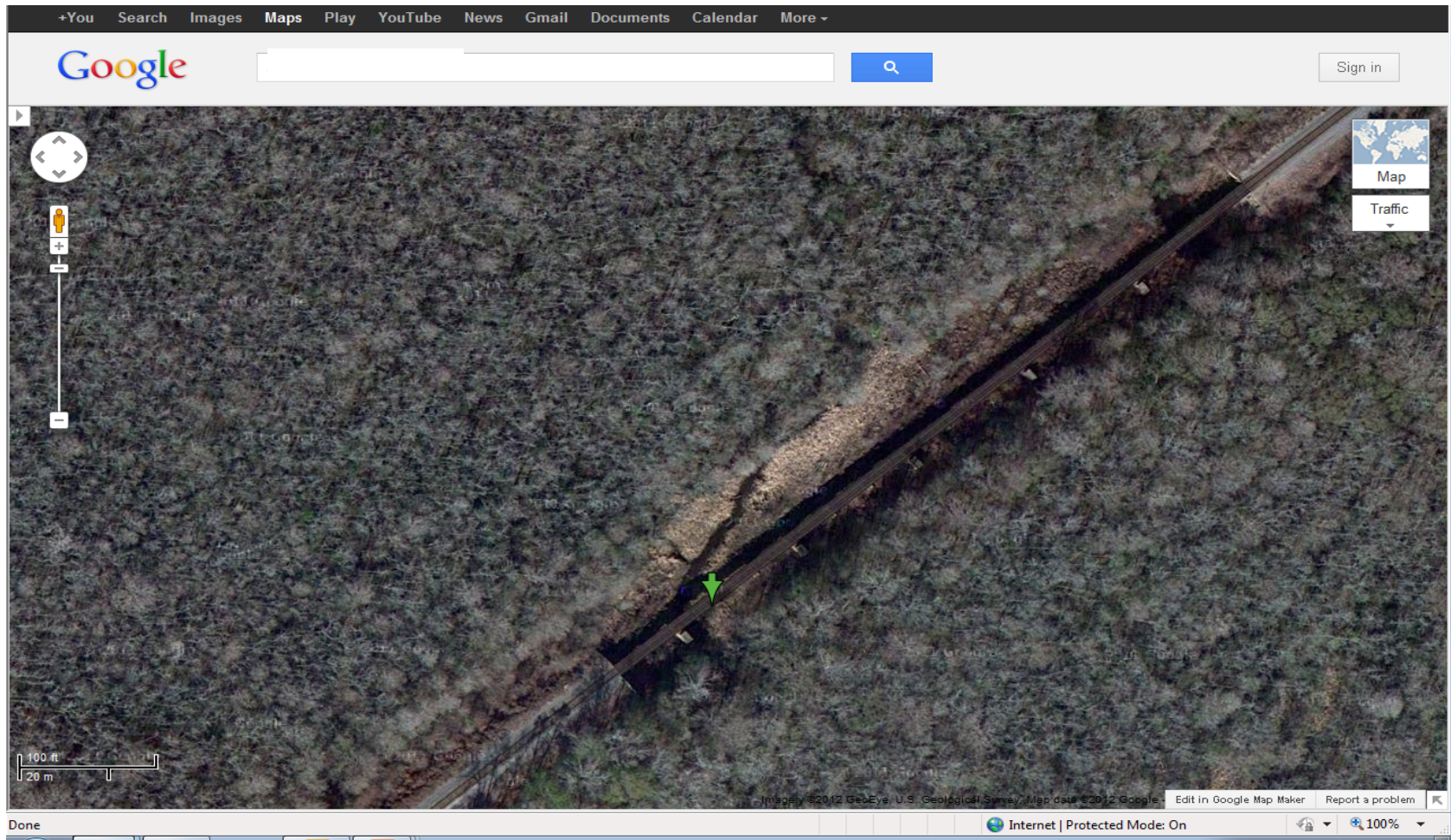
MP	FT	Parameter	Value	Length	TSC	LC	TC	Speed	Latitude	Longitude
477	5052	Gage Narrow	55.89	1	T	0	3	46	32.244035	-81.12874

Railroad: [REDACTED] Subdivision: [REDACTED]



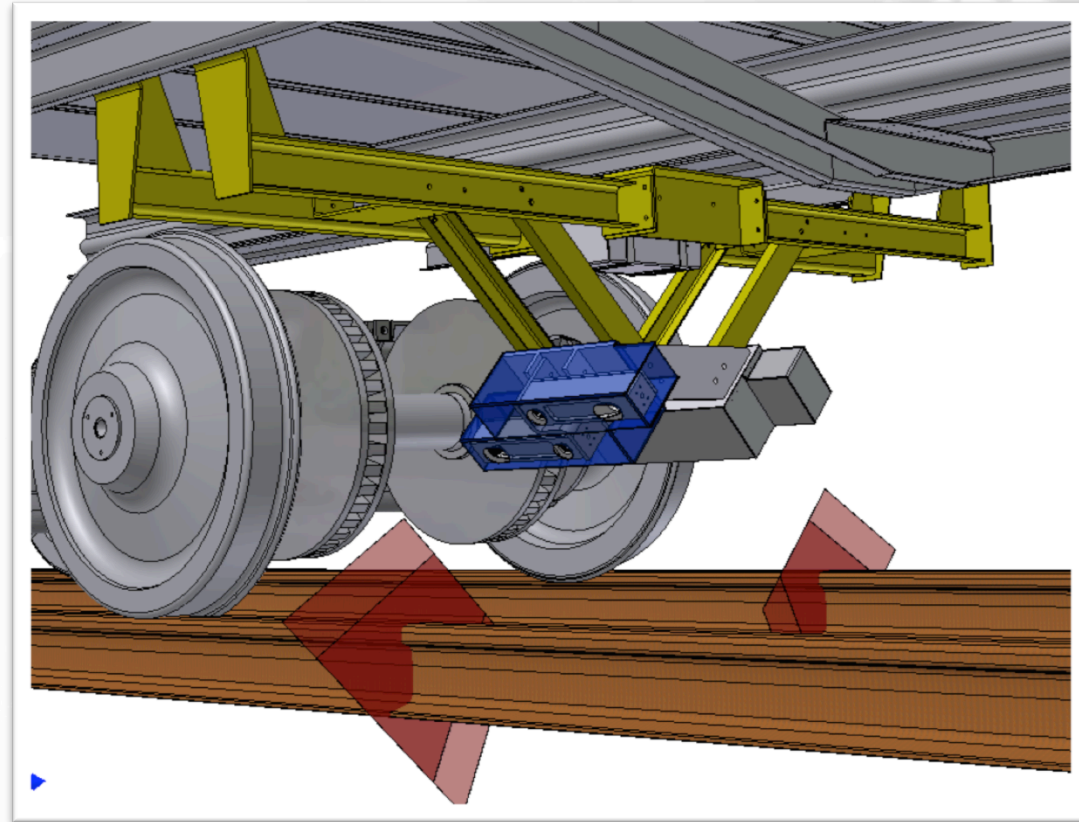
Exception is centered with 1320 feet on either side.

# ATGMS Location Determination



# Stage 3: Carbody ATGMS

- Reduced capital cost of technology
- Minimize truck interfaces
- Easily adapts to different car types (freight and passenger)
- Amtrak: Development partner



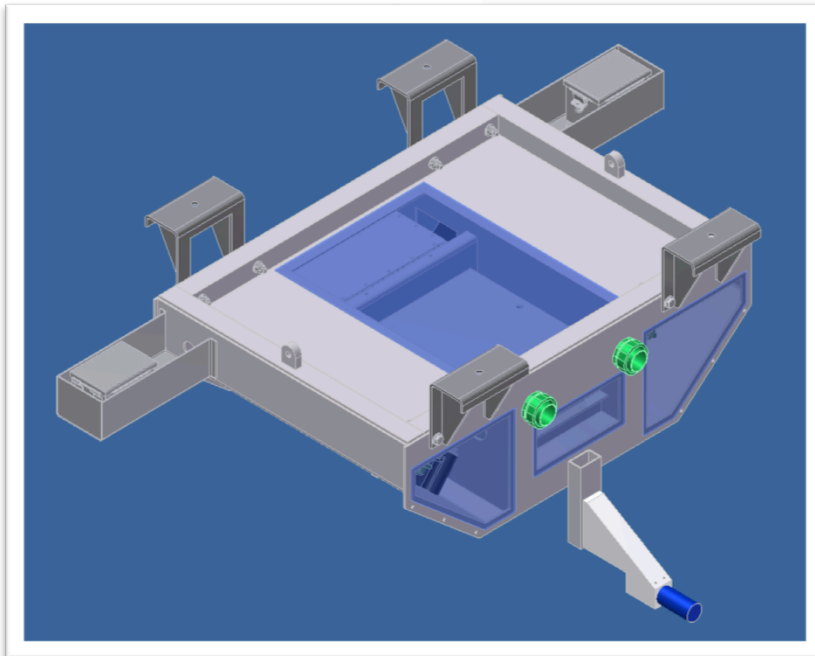
*Conceptual Design*

# Carbody ATGMS Development

- New technology laser/camera assembly which covers a wider field of view
- Bracket mounted to carbody sills



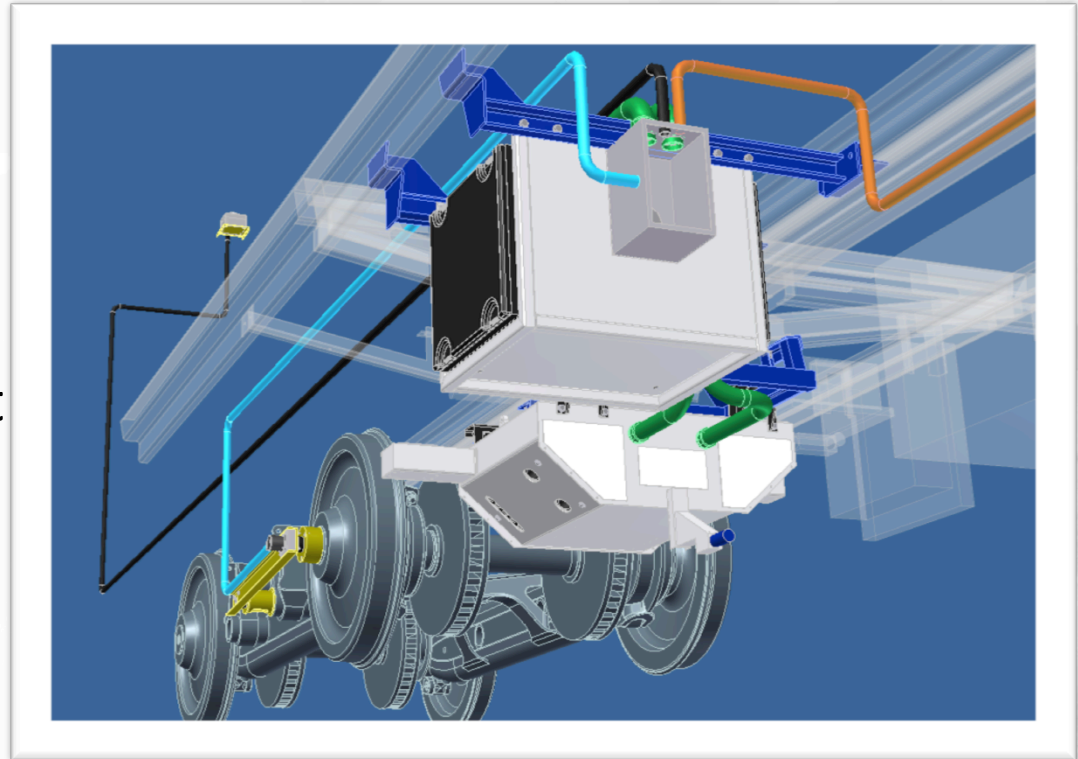
- Wheel-mounted Tachometer
- Upgraded electronics package
- Acceleration and brake pressure signals





# Schedule of the Carbody ATGMS

- **Current:** System installation (Amfleet I) and calibration
- **Summer 2012:** North East Corridor (NEC) demonstration in consist with Amtrak geometry cars
- **Fall 2012:** Complete corridor demonstration testing



# Stage 4: Energy Harvesting

- **Goal:** Autonomous Track Geometry Measurement System (ATGMS) self-powered freight car
- **Current power requirements:** <200 Watts
- **Combined systems approach**
  - Solar: Primary
  - Wind: Experimental
    - Some experience under the BAA program
  - Small scale diesel generator: Back-up
    - Department of Transportation Small Business Innovative Research (SBIR) program initiated

# Stage 5: Freight Demonstration

- Boxcar or DOTX 223 deployment
- Cost sharing opportunity
- Industry demand?



# Areas for Continued Development

- **Automatic Exception Editing**
  - Man vs. Machine
  - Editing station
  
- **Track Location**
  - Track number vs. GPS coordinates
  
- **Using ATGMS as a quality control tool**
  - System calibration and the need for absolute accuracy
  - Degradation role and tools to support:
    - The 1% filter
  - Awareness and reaction – regulatory compliance
  
- **Tachometer development**

# Conclusions

- **The vision of the autonomous track geometry measurement system (ATMGS) is nearly a reality**
  - Truck-mounted system is ready for service
  - Significant milestones in the next year:
    - Carbody system testing
    - Energy harvesting
    - Freight demonstration
- **Technology refinements and regulatory arrangements can be efficiently addressed with direct industry participation in the research**

# Acknowledgements

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- **ENSCO:**
  - Mr. Eric Sherrock
  - Mr. Soheil Saadat
  - Ms. Jacinda Clemenz

# Break | Nearby Food Options

(all within 5-7 minutes walking distance)



- Au Bon Pain: 601 Indiana Ave NW # 1 Washington, DC 20004
- Burger King: 501 G Street NW, Washington, DC 20001
- Chipotle: 601 F Street NW, Washington, DC 20005
- Cosi: 601 Pennsylvania Ave NW # 2 Washington, DC 20004
- Dunkin Donuts: 601 F Street NW, Washington, DC 20004
- Firehook Bakery & Coffee House: 441 4th Street NW, Washington, DC 20001
- Jack's Famous Deli: 501 3rd St NW # 2, Washington, DC 20001
- Quiznos Sandwiches: 772 5th St NW, Washington, DC 20001
- Starbucks: 443 7th St. NW, Washington, DC 20004
- Subway: 501 D Street NW, Washington, DC 20001