Motorcycle Research by the Virginia Tech Transportation Institute

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Motorcycle Research Group
VTTI
SMSA 2015

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State of Research

~1976 Honda CB750

Until recently the last large scale investigation of issues facing motorcyclists was conducted over 30 years ago (Hurt et al, 1981).

A lot has changed since then

- Motorcycle capabilities
- Roadway environment and traffic
- Research methods

2013 Honda CBR1000RR

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Research Methods

Experimental

Controlled experiments
Lab, Test Track, Simulator
Manipulate an independent variable
Measure a dependent variable

Naturalistic

Some of both

Epidemiological

Passive collection
Naturally occurring events
Sampling strategies
Health sciences

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The Equipment

- GPS
- Machine vision lane tracker
- Accelerometers (3 axes)
- Gyro (3 axes)
- Forward radar
- Turn Signals
- Brake lever inputs
- Continuous collection
- 8-12 mo capacity
- Cellular communication from bikes back to VTTI

- Five color cameras
  - forward
  - rear
  - left
  - right
  - rider

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Video

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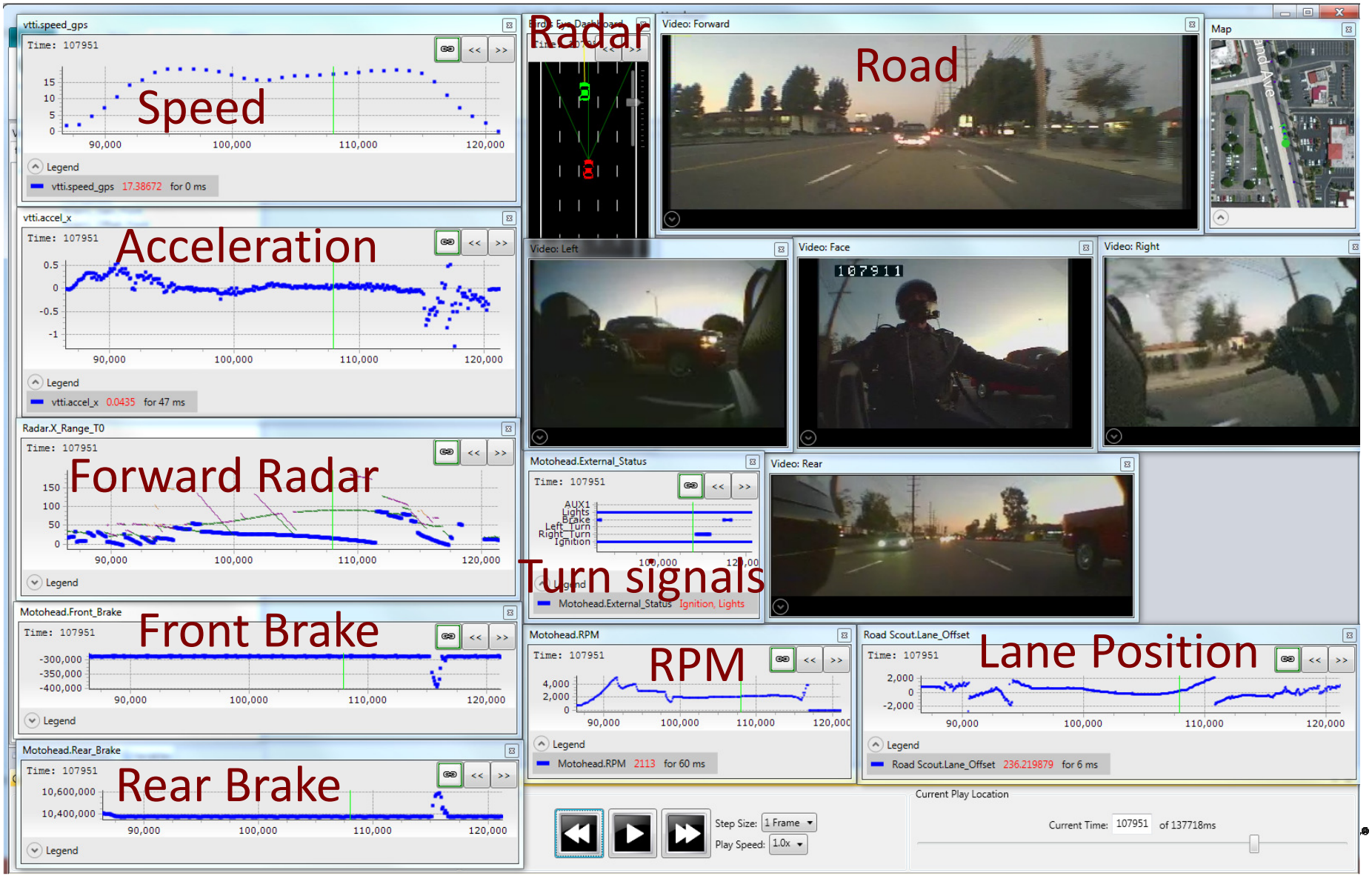
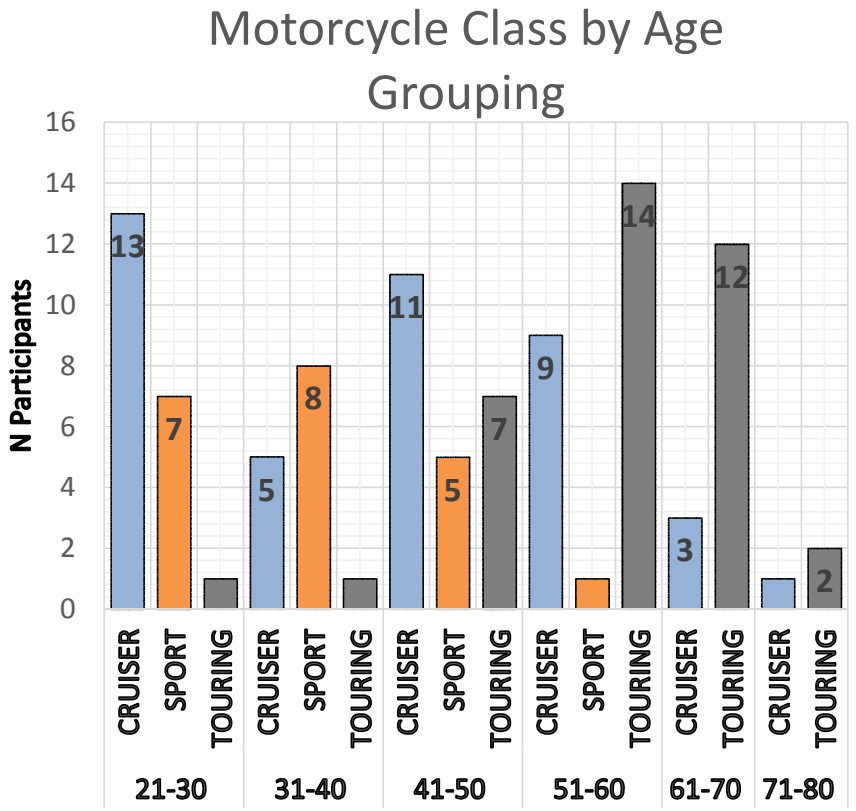

Speed
Radar
Road
Acceleration
Forward Radar
Turn signals
Front Brake
RPM
Lane Position
Rear Brake
vtti.speed_gps
Video: Forward
Map
vtti.accel_x
Video: Left
Video: Face
Video: Right
Radar.X_Range_T0
Motohead.External_Status
Video: Rear
Motohead.Front_Brake
Motohead.RPM
Road Scout.Lane_Offset
Motohead.Rear_Brake
Legend
Current Play Location
Step Size: 1 Frame
Play Speed: 1.0x
Current Time: 107951 of 137718ms

MSF 100

- 100 Participants (72 male)
- 38,000 trips, 350,000 mi
- Personal Motorcycles instrumented for between two months and two years.
- August 2011 through December 2013
- Personal motorcycles fell into one of three classes
- Participants ranged in age from 21 – 79 years old at time of install



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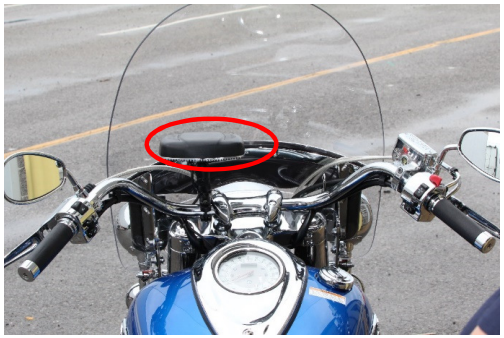
MSF 100 Analysis

- Various exploratory analyses have been performed including
  - Identifying high and low frequency riders
  - Weather and riding
  - Early crash Identifications
  - Speeds and accelerations of the sample
  - Early analysis of risk and personality survey data
- Crash and near-crash investigation currently underway.

NHTSA 160

- All 160 Motorcycles have been instrumented in Southern California



- 60 Full Size DAS
- 100 MiniDas Units
- Recruiting emphasis on sport and cruiser type motorcycles
- Increased variety of makes and models represented
- Partial data in-house for 140 motorcycles so far

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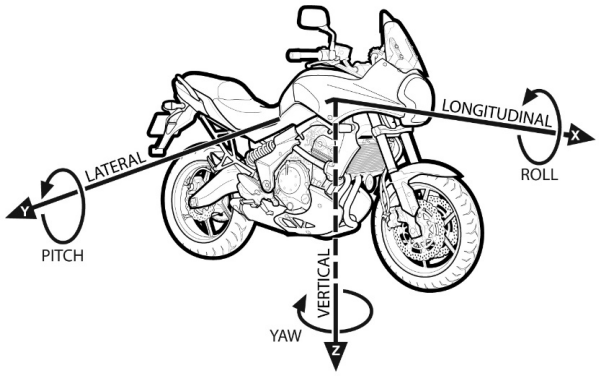
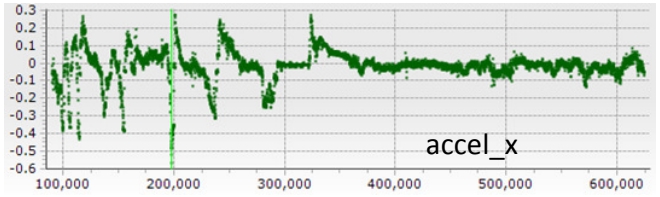
MiniDAS Instrumentation

- Accelerometers (3 axes)
- Gyro (3 axes)s
- GPS
- Two color cameras
  - forward
  - Rider face
- Continuous collection
- 4-6 mo capacity
- Cellular communication
- Rapid install process





Sample of MiniDas IMU Data

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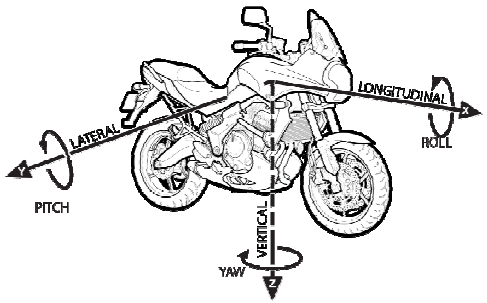
Motorcycle Research Group

Connected and Advanced Vehicle Systems Group



CONNECTED MOTORCYCLE WORK AT VTTI

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VTTI approaching connected vehicles from two directions

- Leading the charge for the involvement of motorcycles in the connected vehicle network
- Human Factors of connected motorcycle interfaces.

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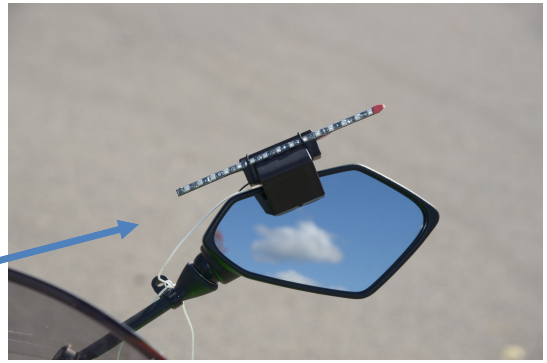
Motorcycle Crash Warning System Prototype Interfaces

Prototype Interfaces

- Auditory – Helmet Speakers
- Visual – Visor/Mirror LEDs
- Haptic – Wristbands

*Tested individually and as a combination of four.

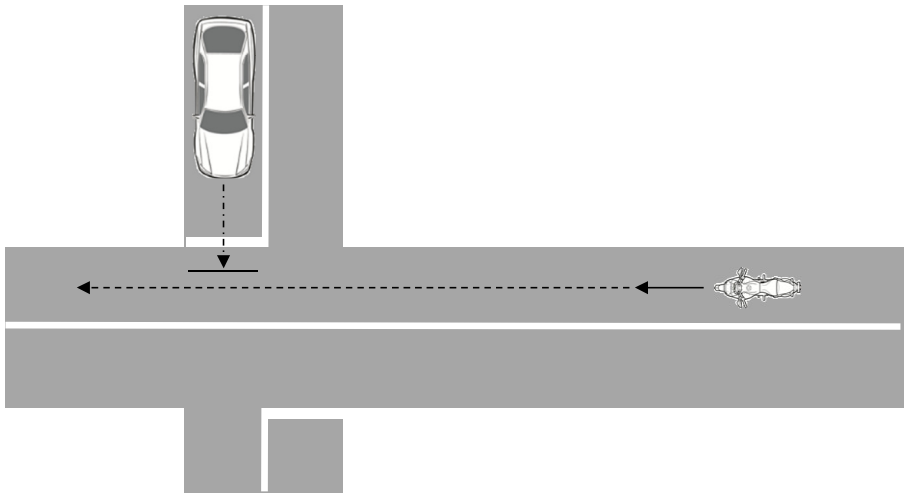


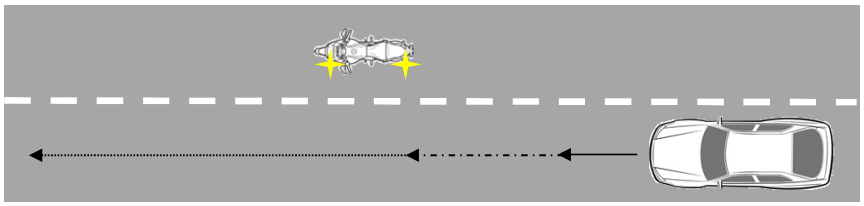
Alerts

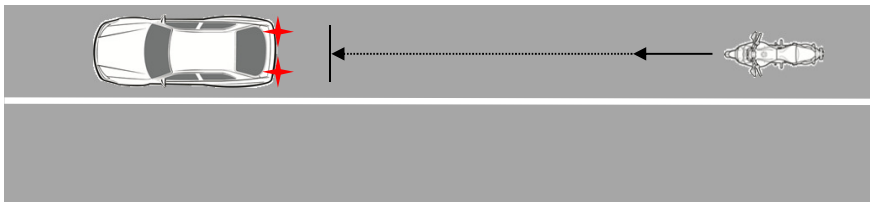
- Caution alert/Warning

Motorcycle Crash Warning System Test Scenarios

- Closed Track Testing - Smart Road
  - Intersection Movement Assist
  - Lane Change Warning
  - Forward Collision Warning





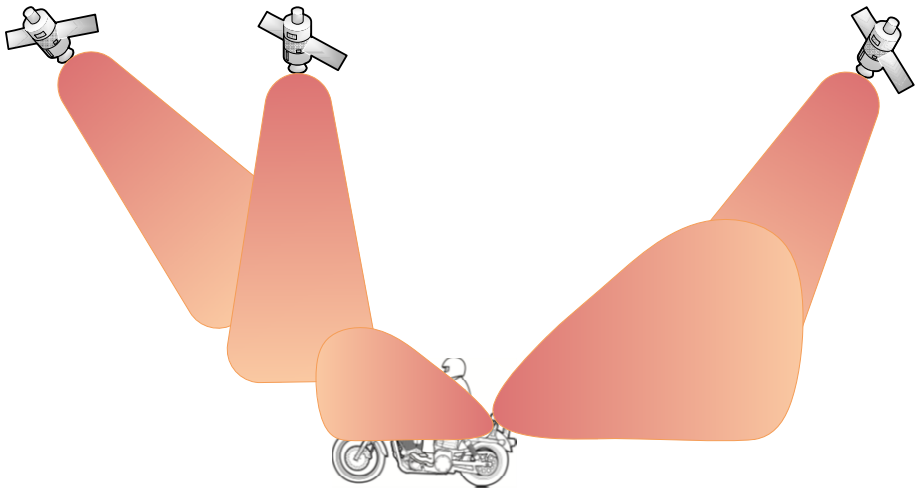


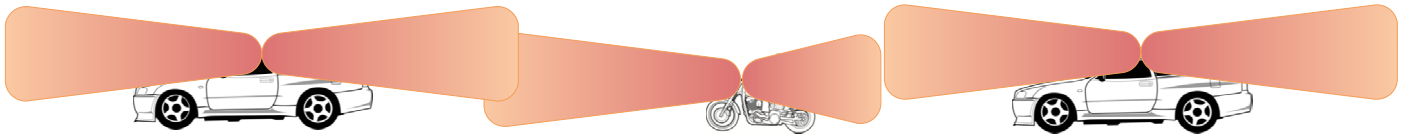
Sorry about the teaser…

- Results by Dr. Miao Song of VTTI expected to be part of TRB 2016

Motorcycle System Performance Background

- Ability of CVS to detect and classify vehicles are based on:
  - Wireless Communication Robustness
  - GPS Position Accuracy
- Unlike Light Vehicles, the CVS antenna is blocked by the Motorcycle Rider and other components on the MC
- Rider occlusion may degrade signal levels, therefore negatively impact CVS alert applications
- Certain roadway environments may exasperate this degradation (e.g. frequent curves requiring considerable lean angle)





Motorcycle Systems Performance Objectives

- Characterize communications (DSRC) and positioning performance (GPS) based on:
  - Antenna Configuration
  - Terrain and Roadway Geometries
  - Roadway Environments
- Compare motorcycle vs. automobile performance
- Report observations and provide recommendations

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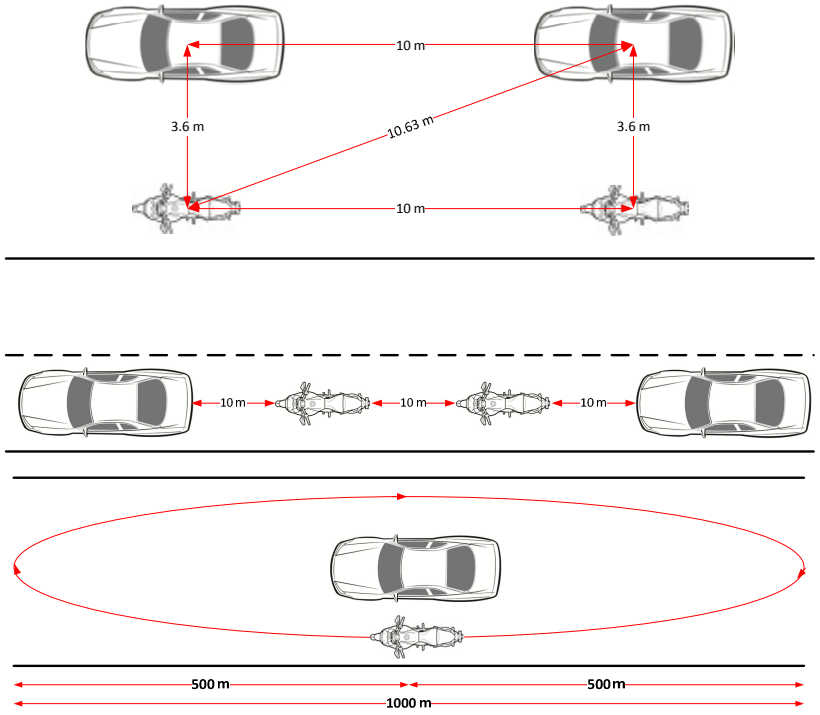
Motorcycle System Performance Test Scenarios

- Closed Track - Smart Road Testing
  - Static Dwell Tests
  - Dynamic Ranging
  - Dynamic Platooning
- Real World Testing – Platooned Performance Drives
  - 2-Hour Platooned drives across diverse roadway environments (i.e. Interstates, Local Roads, Urban Thruways)
  - Locations
    - New River Valley, VA
    - Charleston, SC to Savannah, GA (Planned)



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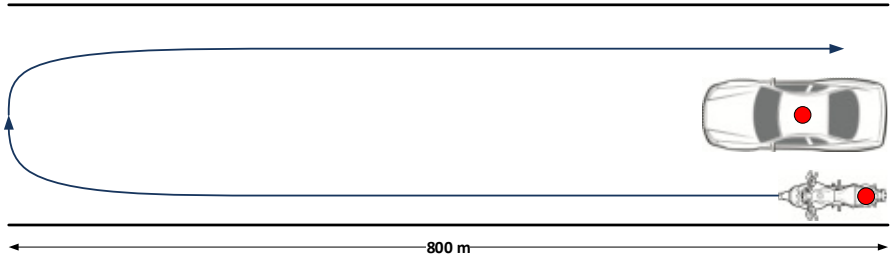
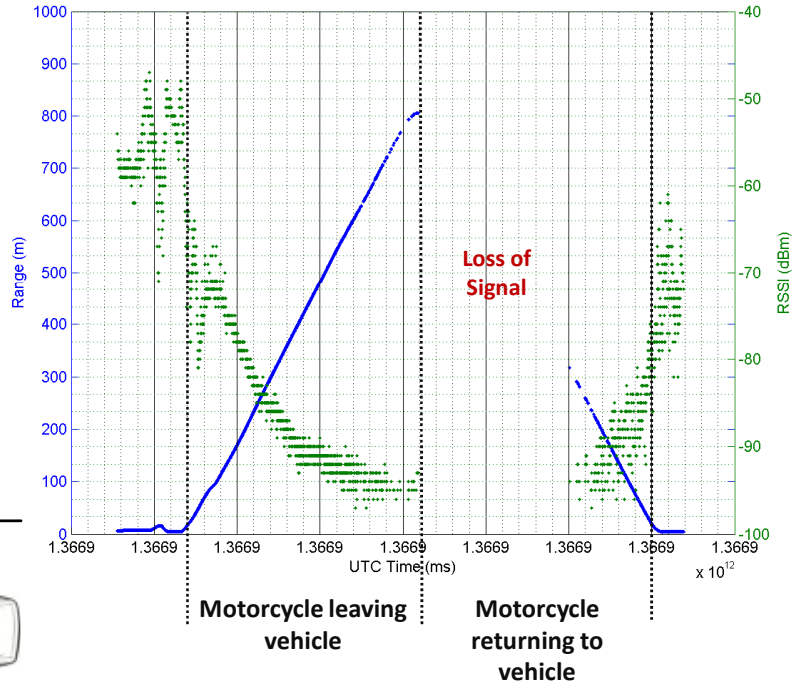
Motorcycle System Performance Assessment

- Utilizing data collected during test scenarios, statistics describing Performance Measures such as:
  - Communications:
    - Received Signal Strength Indicator
    - Packet Error Rate
    - Inter-Packet Gap
  - Position:
    - # of Satellites Used
    - Dilution of Precision
    - Fix Quality



Antenna Mounted @ Rear of Motorcycle



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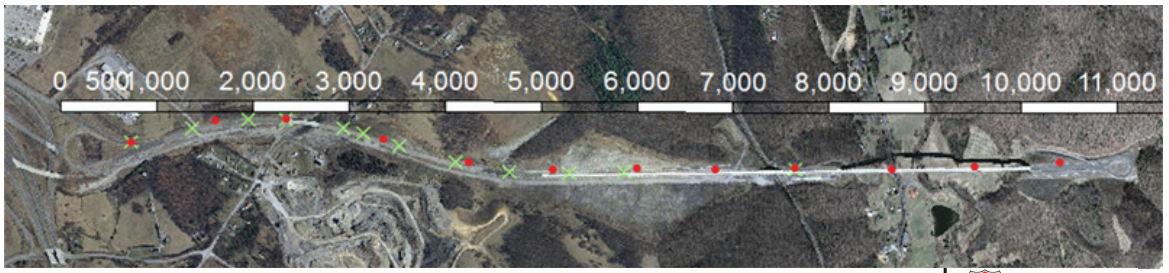
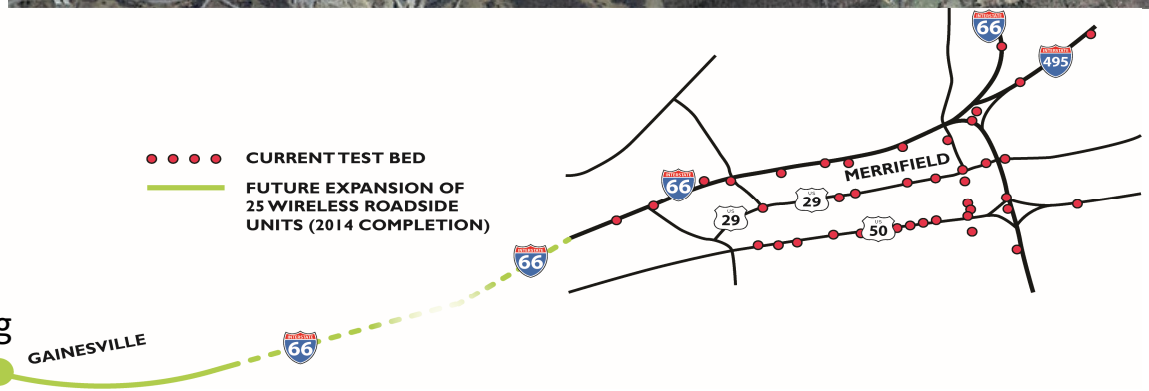
Testing Occurring in the…..

Virginia Connected Corridors

- Two Corridors for Testing
  - Smart Road, Blacksburg VA
    - Controlled access
    - Development
  - Fairfax County, Northern VA
    - Real work challenges
    - Early Deployment
- Array of Infrastructure
  - Connected Vehicle fleet
    - Motorcycle
    - Cars
    - Truck & Buss
  - Roadside equipment
  - Backed network and processing
  - DSRC and cellular capabilities





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As of this week…

- Provides both Visual and Auditory warnings
- 10 hour battery life
- Can take from bike to bike
- Leverages technology already available in helmets (Bluetooth)
- Can readily be miniaturized

- Prototype DSRC Helmet developed by VTTI
- Supports any V2X (or shall we say M2X) protocol
- Basic equipment of our connected vehicles, packaged in a helmet

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X2M Helmet

Dedicated short range radio (DSRC)

Tablet PC

RSE Transmitter

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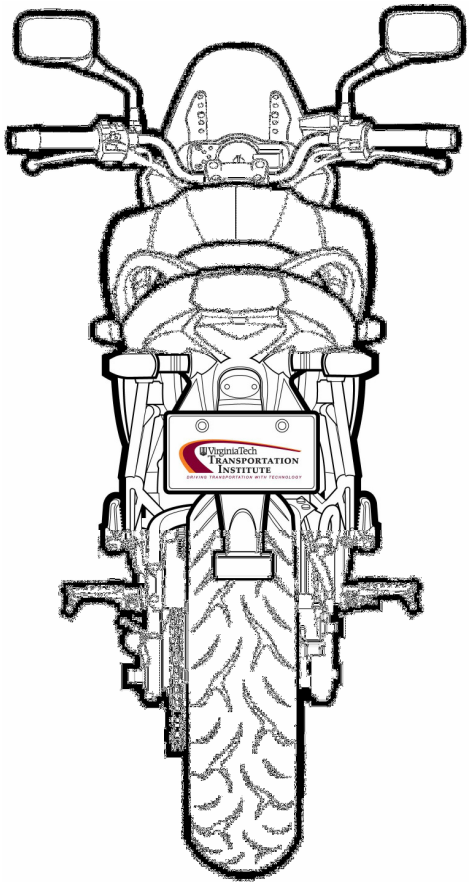
VTTI Motorcycle Program Direction

- Continue to analyze existing and upcoming naturalistic collections in order to understand how exactly riders ride.
- Continue to push the envelope regarding the inclusion of motorcycles in the development of vehicle communication technologies including V2I, I2V, and V2V applications
- Support riders, manufacturers, roadway designers, and policy makers by utilizing data-driven approaches, backed by cutting edge research.



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