

Reference Data Set for Performance Evaluation of MEMS-based Integrated Navigation Solutions

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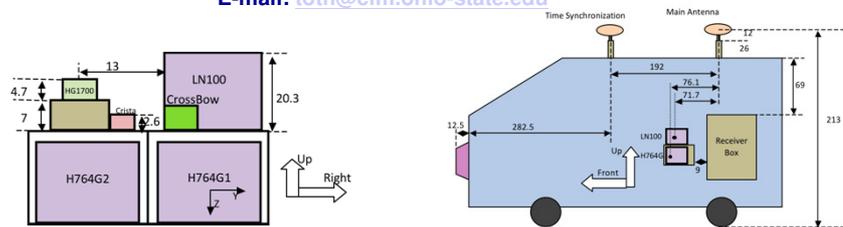
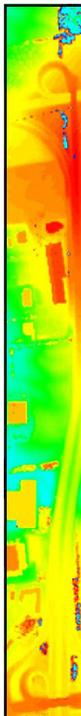


FIG Working Week, Marrakech, Morocco ♦ 18-22 May, 2011

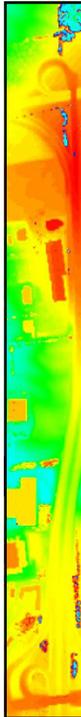


Motivation

- ❖ IMUs are core navigation sensors in indoors/outdoors and other GPS-challenged environments
- ❖ MEMS IMU technology is steadily advancing
- ❖ Algorithmic research is strong in alternative navigation filter design and implementation (EnKF, UKF, PF, machine-learning based varieties, etc.)
- ❖ The need for comparative performance evaluation is increasing
 - Ground truth (reference) availability
 - Use of identical measurement(s)

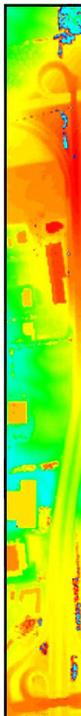


- ❖ IAG/FIG collaborative working group was formed in 2009
- ❖ Major field tests were carried out at OSU in 2010, using IMUs from OSU, UoM and UNSW



Objectives of 2010 OSU field tests

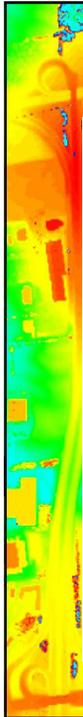
- ❖ Acquire reference data for MEMS performance validation using high-end IMU's
- ❖ Acquire reference data for algorithmic research (typical trajectories)
- ❖ Validate time synchronization performance of different implementations (embedded GPS, timer-board based and software-only PC data acquisition systems)
- ❖ Acquire data in various sensor configurations in highly dynamic environment
- ❖ Acquire data in a group of sensor nodes equipped with GPS/IMU of various grades



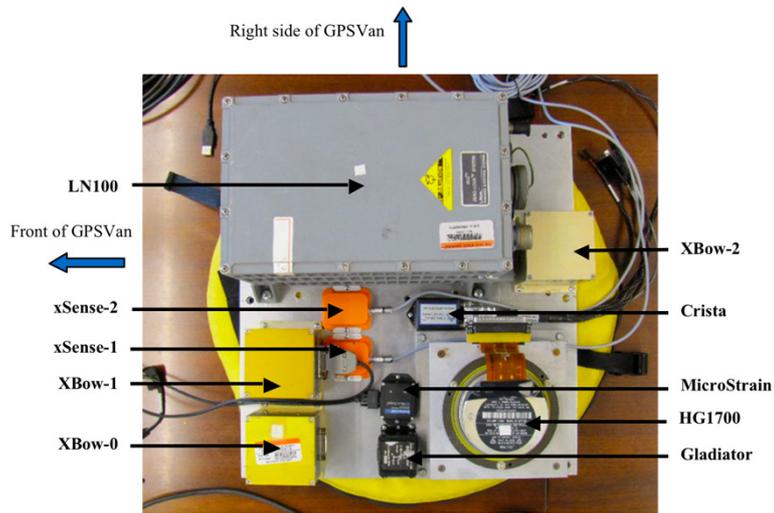
IMU sensors used in the experiments

IMU	Owner	Interface	Timing	Lever arm with respect to rear GPS antenna		
				Right [cm]	Front [cm]	Up [cm]
H764G-1	OSU	1553B	Built-in GPS	26.6	-76.1	123.6
H764G-2	OSU	1553B	Built-in GPS	48.2	-76.1	123.6
LN100	OSU	1553B	External(hw)	26.6	-71.7	102.8
HG1700	OSU	H/SDLC	External(hw)	48.5	-53.4	101.8
XBOW-0	OSU	Serial	External(hw)	53.5	-78.1	107.2
XBOW-1	UoM	Serial	External(sw)	43.8	-78.1	107.2
XBOW-2	UoM	Serial	External(sw)	30.4	-60.2	107.2
XSENS-1	UoM	USB	External(hw)	43.4	-71.4	109.8
XSENS-2	UNSW	USB	External(sw)	37.6	-71.4	109.8
Gladiator Landmark	UoM	Serial	External(sw)	53.9	-64.6	109.7
MicroStrain, INERTIA LINK	UoM	USB	External(sw)	47.6	-64.4	108.9
Crista IMU	UoM	Serial	External(sw)	37.9	-59.5	109.9

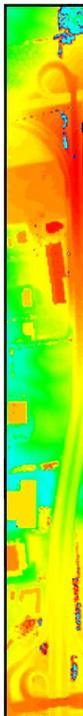
Vehicle axes	LN100	H764G	HG1700	XBOW	XSENS	Gladiator	MStrain	Crista
Right	Y	Y	Y	Y	-Y	Y	Y	Y
Front	X	X	Z	X	X	X	X	X
Up	-Z	-Z	X	-Z	Z	-Z	-Z	-Z



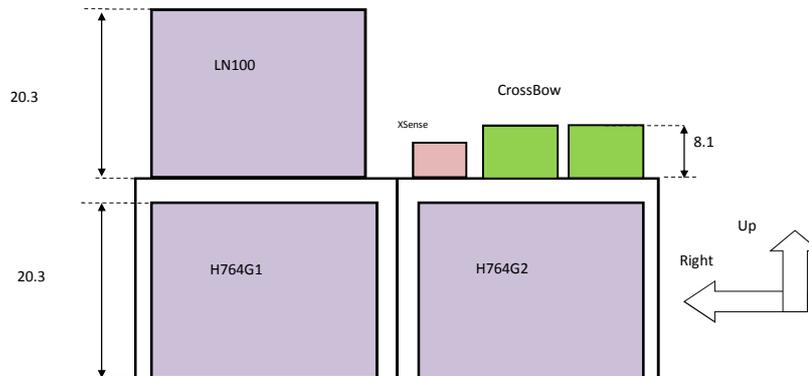
IMU sensors installation

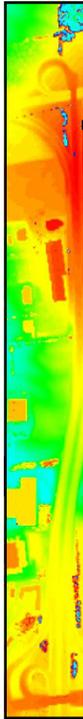


GPS receivers: Novatel OEM4, Topcon Legacy, Trimble 5700 (base: Topcon Legacy, COLB CORS)



IMU sensors installation

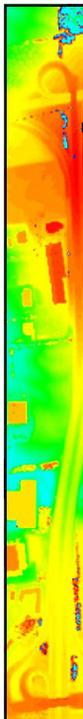




GPSVan in field tests at OSU



Two GPS antennae with two four-way splitters



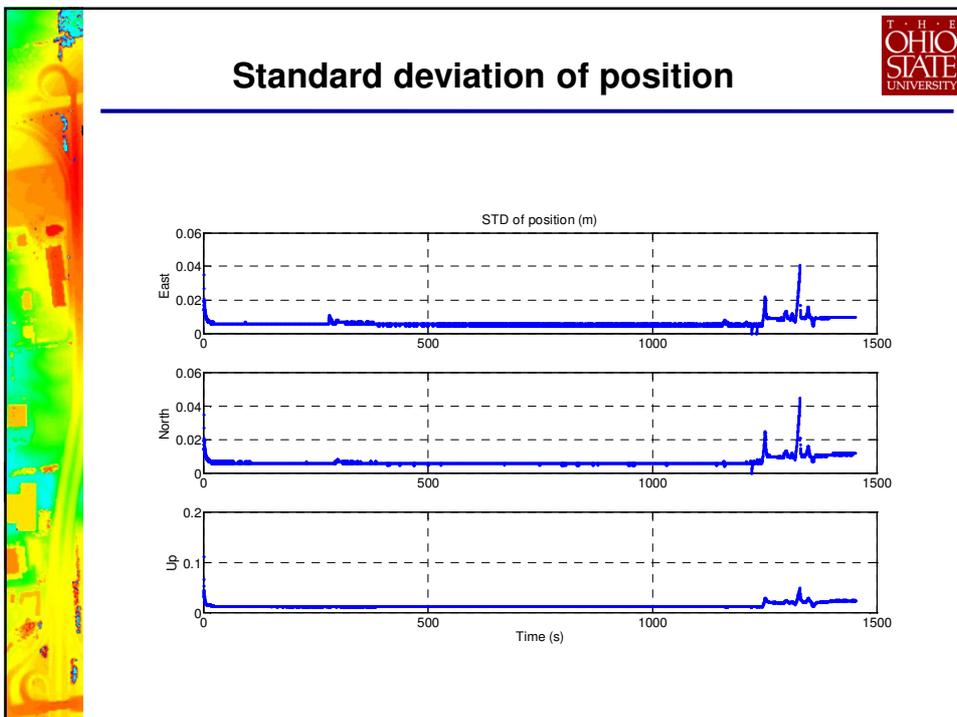
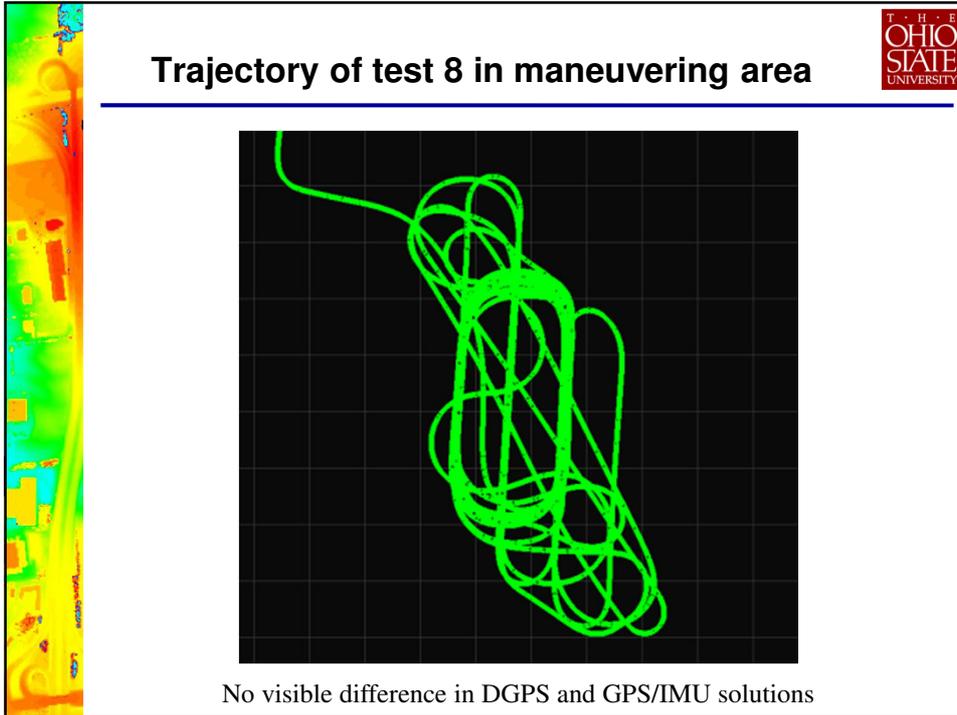
Trajectory of test 8 (parking lot)

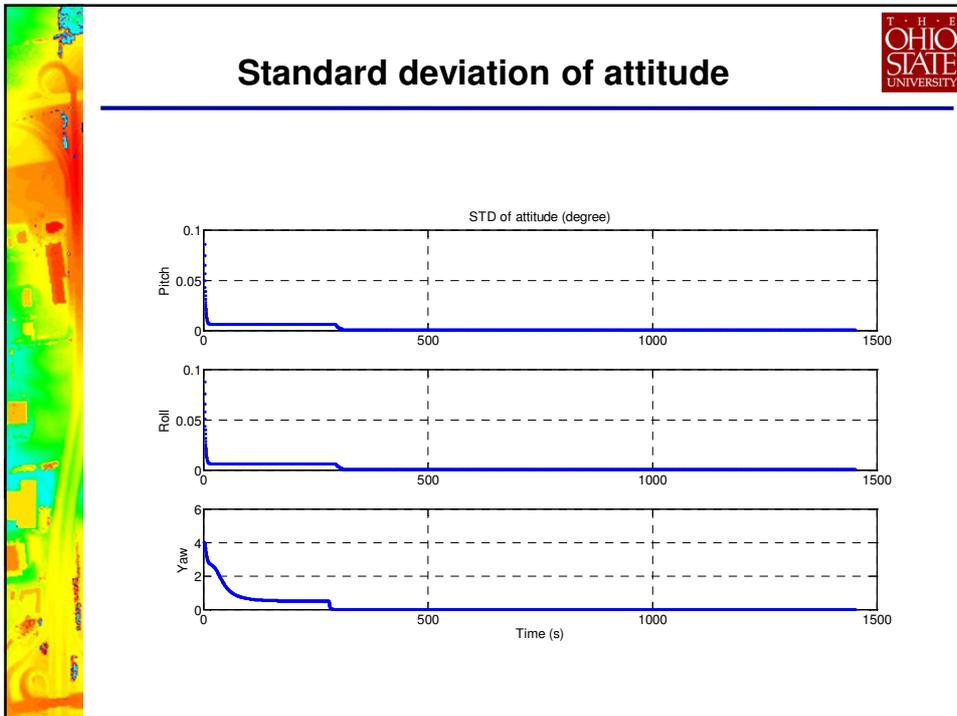
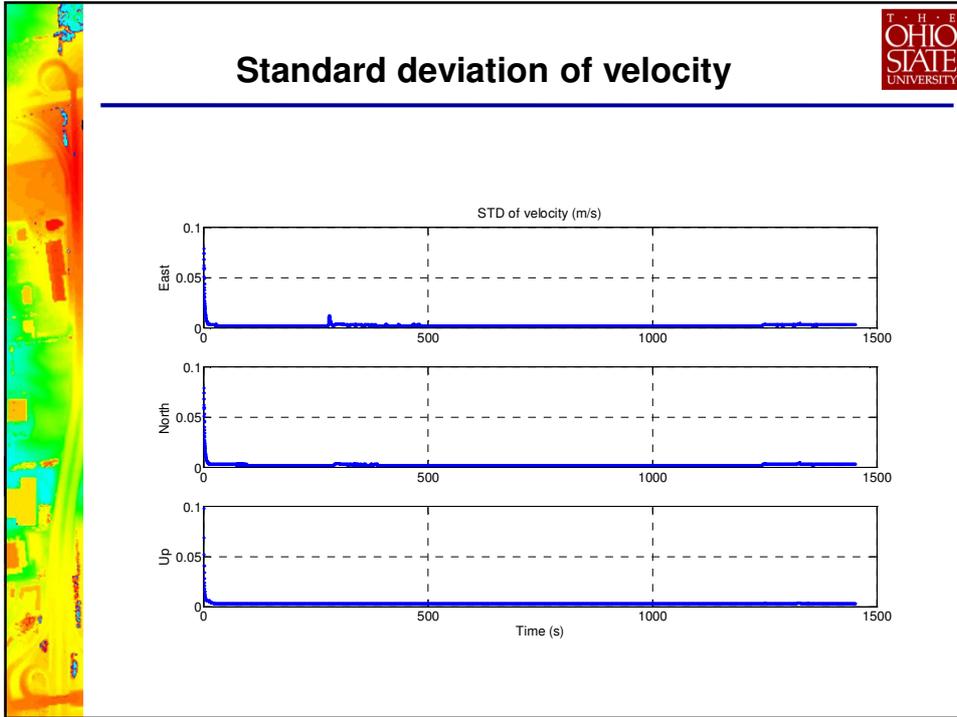


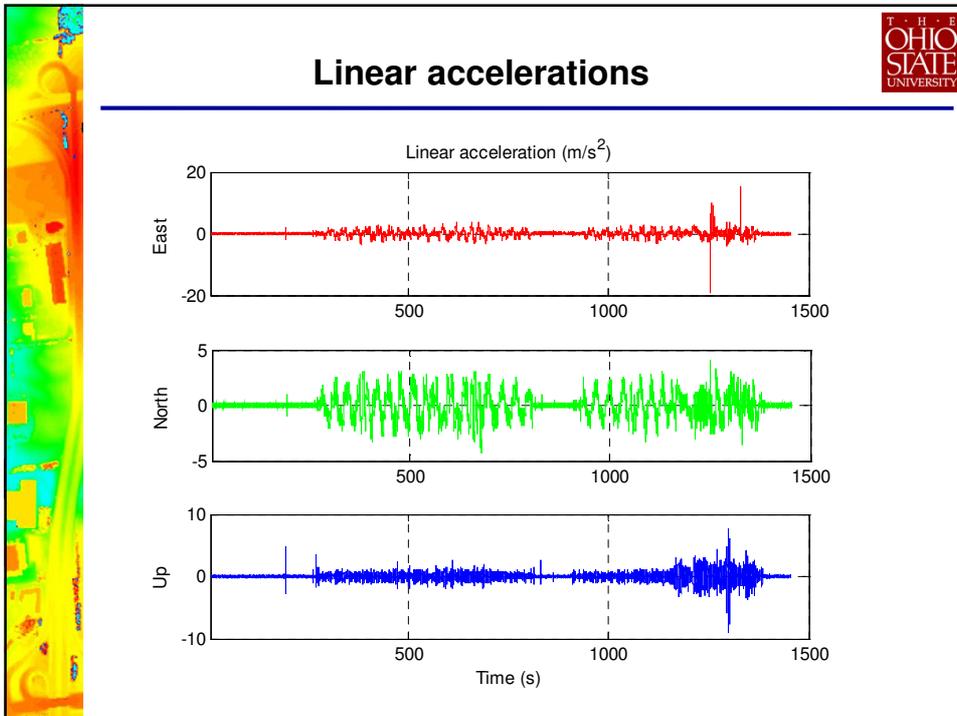
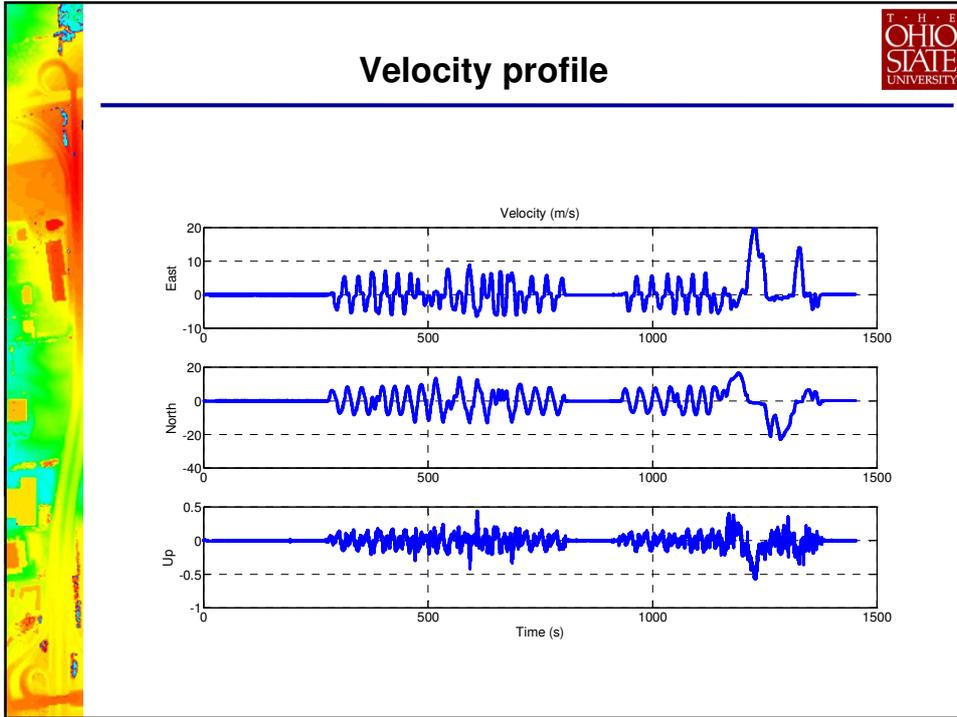
DGPS solution

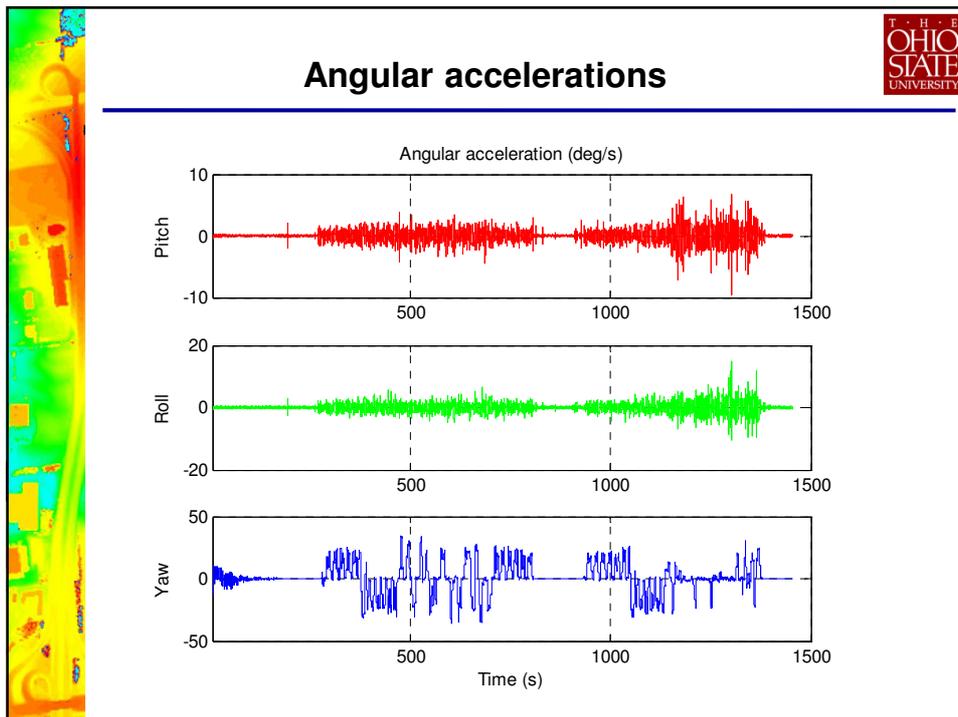


GPS/IMU solution
(high-end IMU)

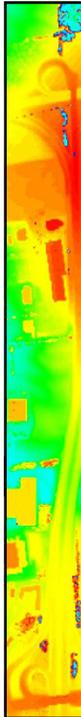








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- ## Navigation solutions
- T · H · E
OHIO STATE
UNIVERSITY
- ❖ Reference solution is produced by AIMS PRO (OSU EKF-based software)
 - ❖ MEMS IMU solutions are created/investigated by
 - SPIN Lab at The Ohio State University
 - University of Melbourne, Australia
 - University of New South Wales, Sydney, Australia
 - National Technical University of Athens, Greece
 - Budapest University of Technology and Economics, Hungary
 - Vienna University of Technology, Austria



Summary



- ❖ IAG/FIG Working Group, formed in 2009 to support research in using MEMS IMUs, conducted a successful data acquisition campaign at the Campus of The Ohio State University in May 2010
- ❖ Eight MEMS and four navigation/tactical-grade IMU sensors were used in the field tests
- ❖ All the IMU data sets are GPS time-tagged and reference solution based on a H764G GPS/IMU solution was created by OSU
- ❖ Ongoing activities of the WG are:
 - Continue with MEMS IMU processing
 - Research/publications at large
 - Data portal/web-site developments (University of Melbourne)
 - Standardizing data formats, including metadata and measurement data stream in various formats, such as ASCII (CSV), Matlab, XML, etc., (OSU)