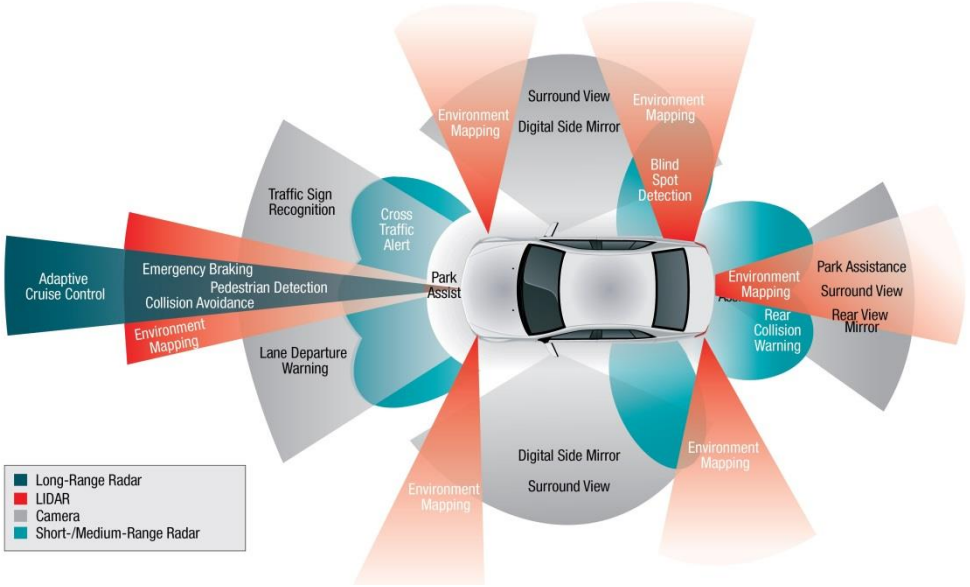
NEW RELEASE

Components for Automated Driving Interferometric Fiber Optic Gyroscope and MEMS combined IMU

Multi Sensor TAG350 Series

TAMAGAWA SEIKI CO., LTD.
TAMAGAWA TRADING CO., LTD.

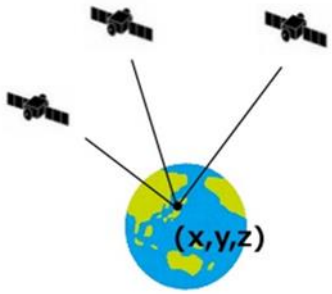
Sensor Fusion for Autonomous Driving



Sensor Fusion

Devise	Purpose	Bottle-neck
GNSS	Localization	GPS denied environment such as tunnels, buildings
Camera	Recognition of Image	Snow, Bad Weather
Rader & Laser Scanner	Recognition of Obstacles	Bad Weather, Limited Detection Range
Wireless Communication	V2V, V2P, V2X	Communication Cut-off
INS（Inertial Navigation System)）	**Autonomous Navigation (Dead Reckoning)**	**Accuracy depends on sensor. High accuracy sensor is needed.**

Product Development Background

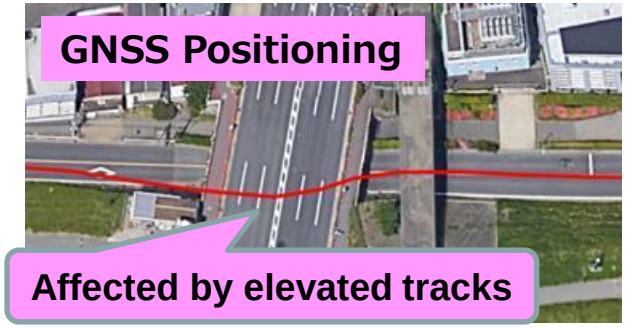


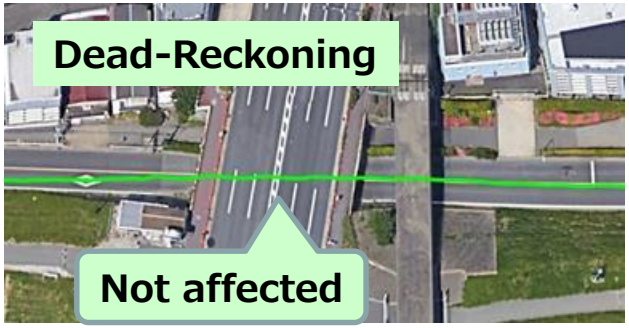
The position accuracy of GNSS (Global Navigation Satellite Systems) has been improved by Satellite Based Augmentation Systems (SBAS) or Real-time kinematic (RTK) positioning.

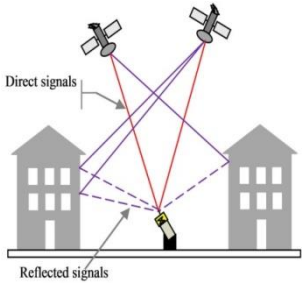
However, GNSS signal is interrupted in tunnel, under elevated tracks or multipath propagation. The accuracy is deteriorated.

In tunnel
(NO GPS Signal)

By using gyro sensors, the deterioration of position accuracy can be suppressed.







Multipath Propagation.
(Lower Accuracy)

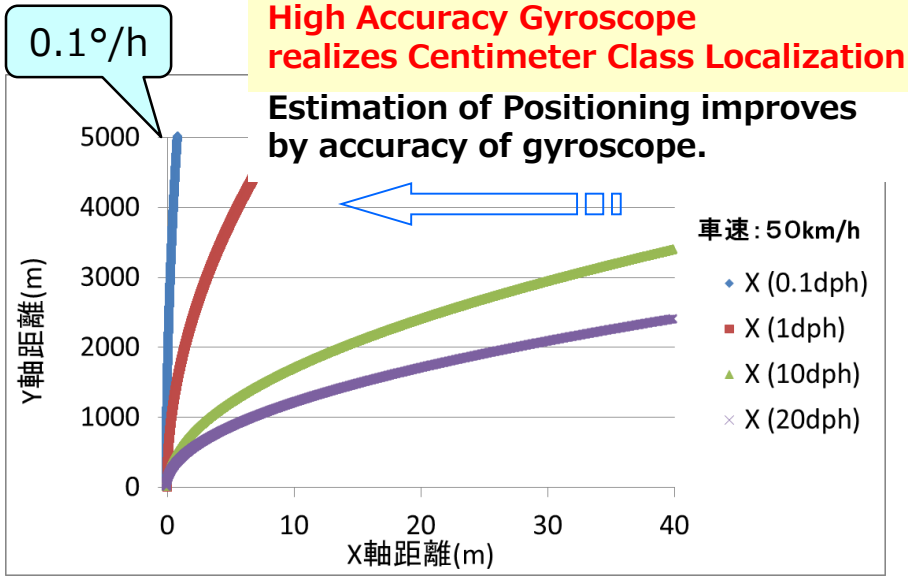
Accuracy of Localization

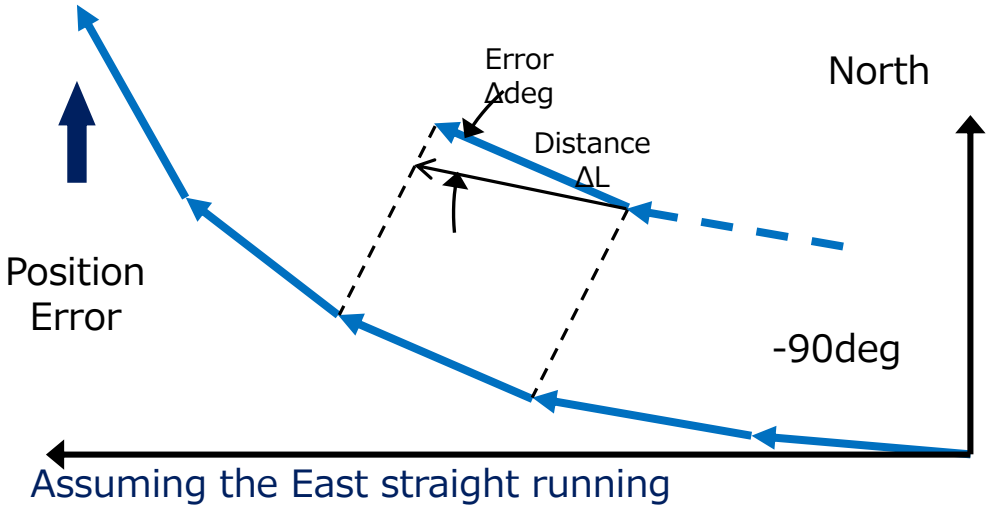
Centimeter Class Localization

- RTK-GPS enables to detect the position on centimeter basis.
- Even in GNSS-denied environment, localization should be kept at same quality.
- FOG or RLG is useful, but the prices are too high to be used for commercial use.

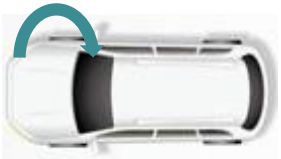
High Accuracy Gyroscope realizes Centimeter Class Localization

Estimation of Positioning improves by accuracy of gyroscope.





In the dead-reckoning, heading angle is quite important. The error of heading angle is accumulated by an error of gyroscope. Therefore, the high-accuracy gyroscope is needed.



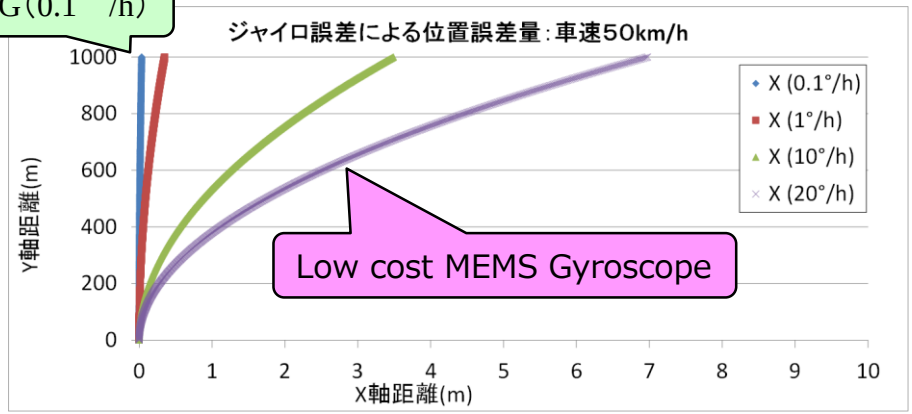
Z-axis Angular Rate

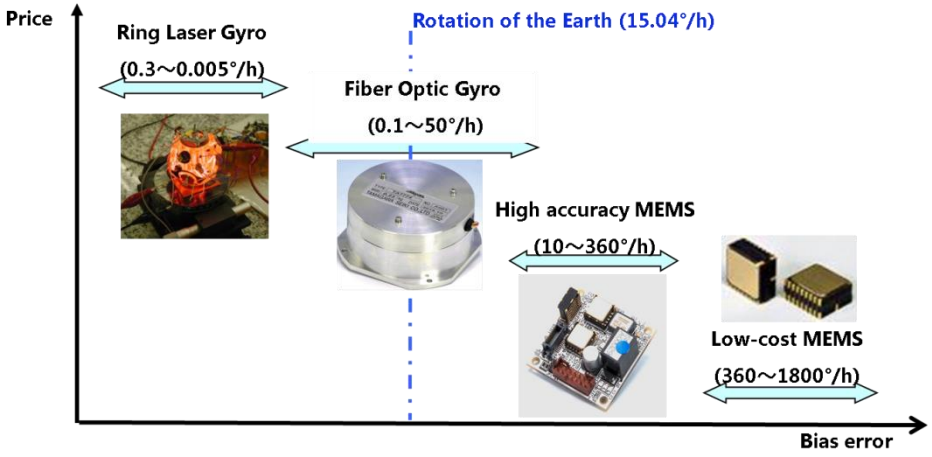
Accuracy of Localization

Position Error by Gyroscope

Vertical: Distance　　Horizontal: Position error

i-FOG（0.1°/h）





The accuracy of MEMS Gyroscope is several to dozens of degrees, so it is difficult to achieve centimeter class localization.

The accuracy of FOG is 0.1 °/h which is possible to keep the accuracy for a certain period of time.

However, the price of FOG is very high, so it was not used for commercial use.

Cost reduction of FOG is needed for fully autonomous driving.

Centimeter Class Localization

Interferometric Fiber Optic Gyroscope(i-FOG)

TA7774

Item	Spec.
Detection Range	±200°/s
Bias Repeatability	0.1°/h 1σ
Bias Instability	<0.1°/h
Angular Random walk	<0.01°/√h
SF Accuracy	100ppm

FEATURES

- Achieved 0.1°/h Bias Repeatability required for Fully Autonomous Driving.
- Core-technology for winding and Fiber Optical IC realizes cost reduction.

The combination of FOG and MEMS Gyro realizes low-cost, multi-functional and high-accuracy IMU.

i-FOG & MEMS combined Multi Sensor

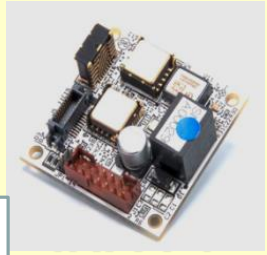
Yaw angle is measured by FOG.

i-FOG

TA7774

GNSS/INS

MEMS-IMU



AU7684

Combine both advantages
To create a synergy

「 Heading 0.1°/h + Attitude 0.1° 」

	i-FOG	MEMS-IMU	i-FOG/MEMS IMU
Attitude Angle	No function	Excellent	Excellent
Heading Angle	Excellent	Good	Excellent
Communication I/F	RS232C	RS232C/CAN	RS232C/CAN
GNSS interface Dead-reckoning	No function	Excellent	Excellent
Odometer interface	No function	Excellent	Excellent
Multi-functioness	No function	Excellent	Excellent
Cost performance	Expensive	Reasonable	Reasonable

TAG350 Configuration Diagram

GNSS

External GNSS Module: Position KGM-810GRB1_PS_917
Other GNSS module (C099-F9P/u-blox) can be customized.

External GNSS Module

RS232,1PPS

RS232, CAN

Upper System
INS data
Vehicle Speed

Vehicle Speed

Power Sorce : +12V (+9~+18V)

12V

J1

J5

DC/DC
DC/DC

±5V
±15V

PCB

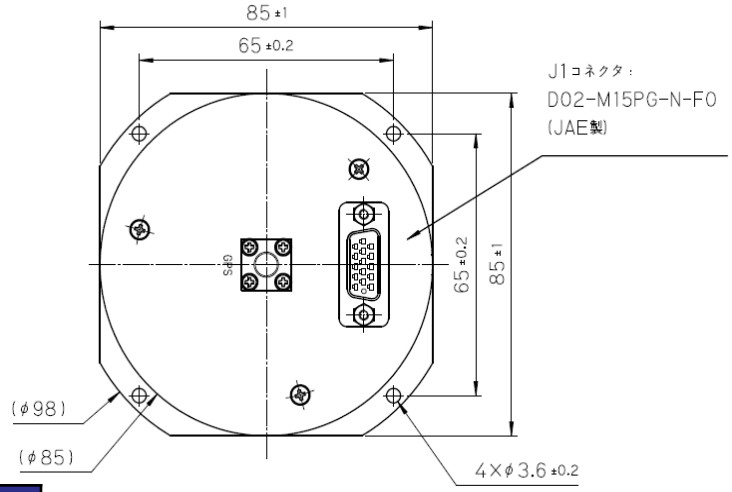
Serial Communication

i-FOG TA7774

MEMS IMU AU7684

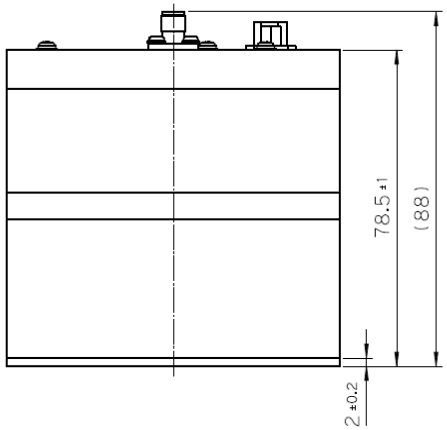
TAG350N2000 (Serial Production)

June 2020
Coming soon!



Specification

Item	Spec	Remark
Dimension	85mm×85mm×78.5mm	Except connector
Weight	600ｇ以下	
Input Voltage	9V～28V　DC	15W max
Interface	RS-232 : 115.2kbps(fixed) CAN : 500kbps（default）	Output:50Hz
Operating temp.	−20℃ ～+60℃	
Gyroscope	±200 deg/sec	
Accelerometer	±29.4 m/s² (±3G) ±58.8 m/s² (±6G)	



i-FOG & MEMS combined Multi Sensor

We are committed to produce a low-cost & high quality sensor by combining FOG, MEMS-IMU, GNSS and our unique algorisms.

Heading 0.1°/h + Attitude 0.1°
GNSS combined Navigation

TAG350N2x00

Multi Sensor meets the need of high-quality localization.

Micro-transit

Transportation

Robot-taxi

Construction

Patrolling

Logistics

Case Studies of Dead-Reckoning (1)

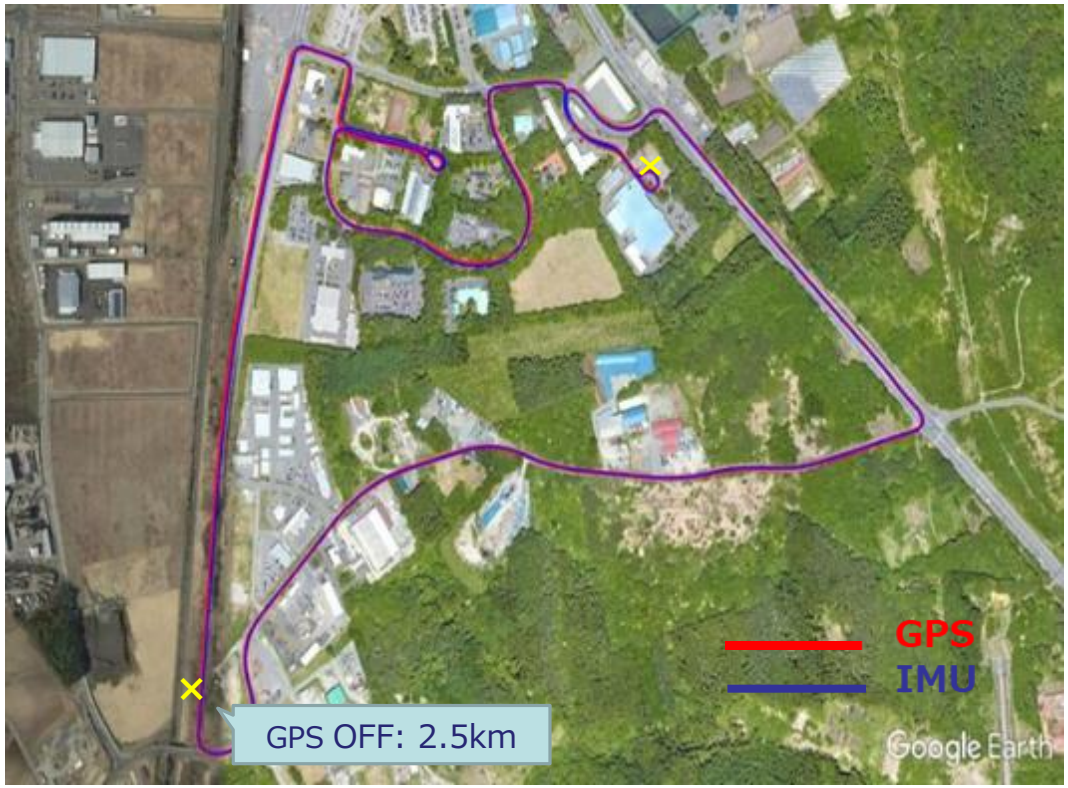
Test Condition:	Straight, Up and Down, Curve
Speed:	34km/h (using speed pulse)
Driving distance:	5.3km
GNSS:	NEO-M8N/u-blox
Dead-reckoning:	2.5km (manually turn GNSS off)
Driving time:	8.8min (GPS OFF: 4.4min)
Map:	Shown as below

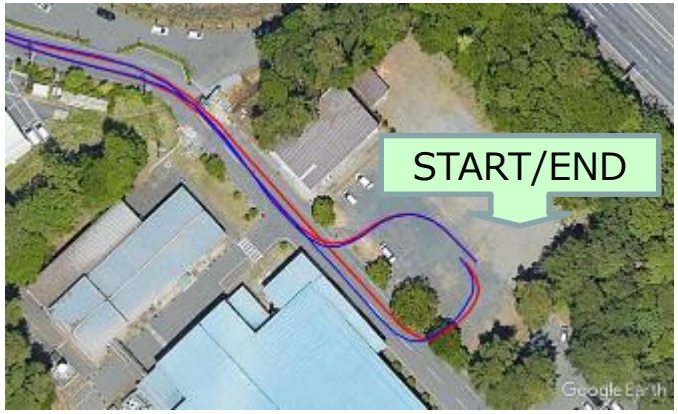
Case Studies of Dead-Reckoning (1)

Outcome

GPS OFF: 2.5 k m

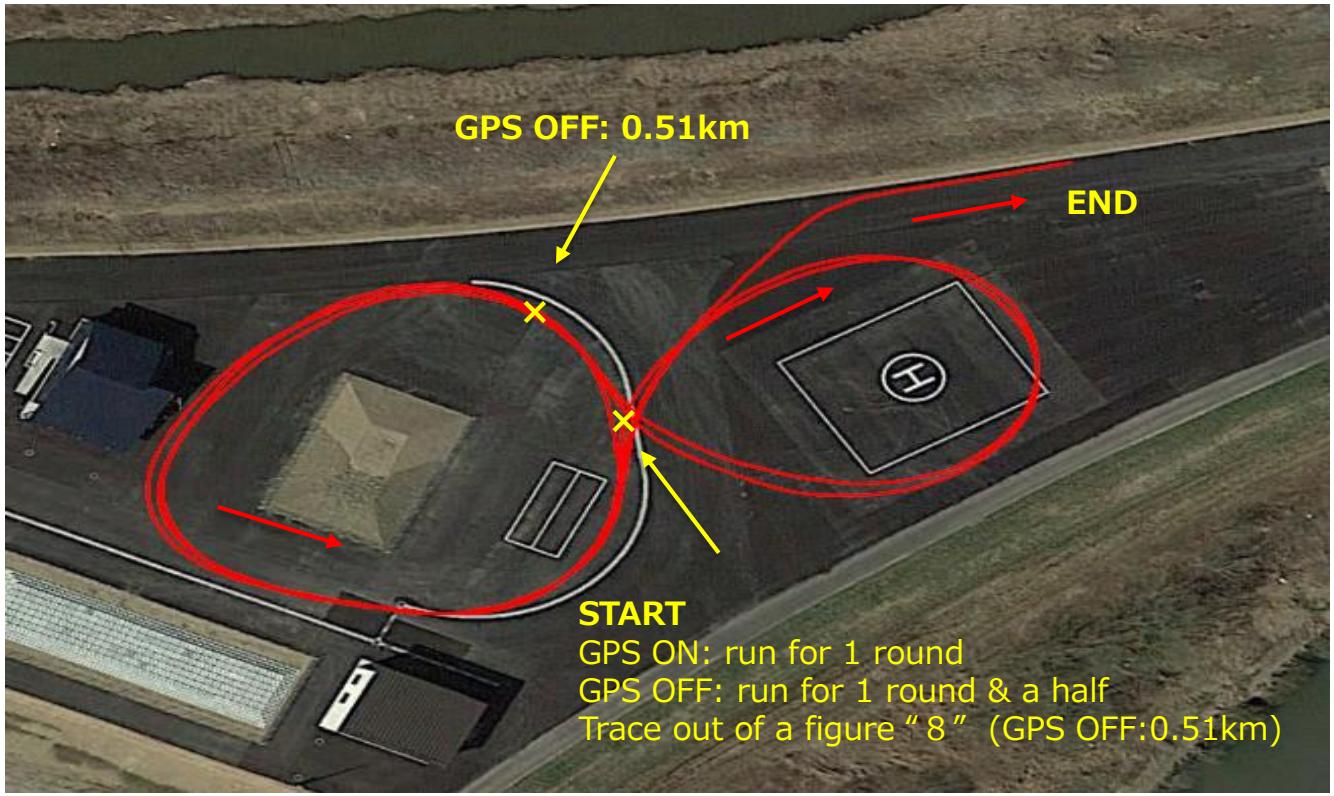
Position error: **1.74m (0.07%)**





Case Studies of Dead-Reckoning (2)

Test Condition:	Heliport (trace out a figure of “8”)
Speed:	6～8km/h (using creep phenomena)
Driving distance:	0.83km
GNSS:	NEO-M8N/u-blox
Dead-reckoning:	0.51km (manually turn GNSS off)
Driving time:	7.5min (GPS OFF: 4.8min)
Map:	Shown as below

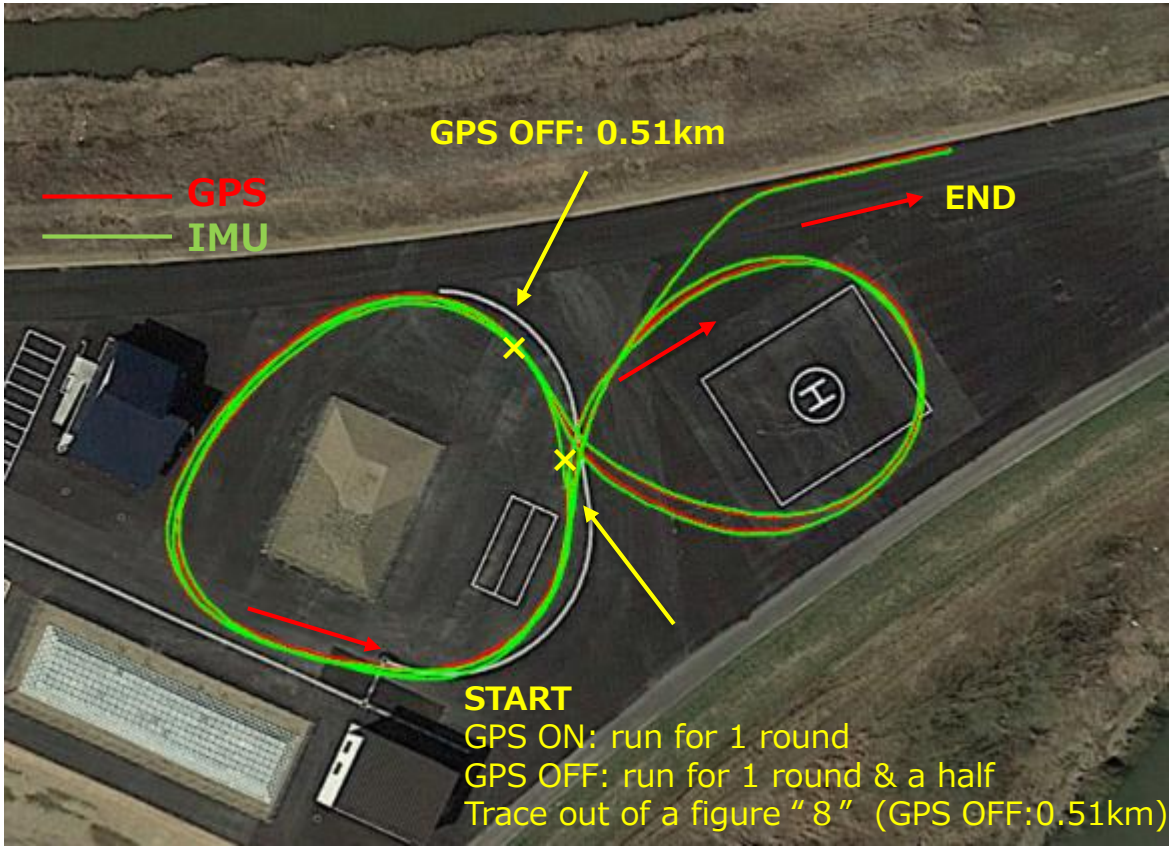


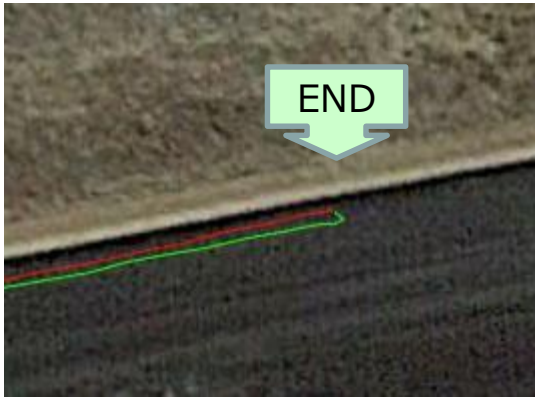
Case Studies of Dead-Reckoning (2)

Outcome

GPS OFF: 0.51 k m

Position error: **0.81m (0.16%)**





Case Studies of Dead-Reckoning (3)

Test Condition:	Highway including tunnel
Speed:	95km/h
Driving distance:	24.4km
GNSS:	NEO-M8N/u-blox
Dead-reckoning:	2.3km, 0.55km (manually turn GNSS off)
Driving time:	15.2min (GPS OFF: 1.6min, 0.35min)
Map:	Shown as below

Case Studies of Dead-Reckoning (3)

Outcome

GPS OFF (Oritsume Tunnel): 2.3km, Position error: **0.80m (0.03%)**

GPS OFF (Ichinohe Tunnel): 0.55km, Position error: **0.34m (0.06%)**