# Track4 : Foot-mounted IMU

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TEAM GEOLOC

Université Gustave Eiffel

IPIN 2023

THIRTEENTH INTERNATIONAL CONFERENCE ON INDOOR POSITIONING AND INDOOR NAVIGATION

25th-28th Sep. 2023, Nuremberg Germany

NUREMBERG

# Overall description

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THIRTEENTH INTERNATIONAL CONFERENCE ON
INDOOR POSITIONING
AND INDOOR NAVIGATION
25th-28th Sep. 2023, Nuremberg Germany

- **Nuremberg**
- **Museum of Industrial Culture**
- **~1.3 km walk / ~25 min**
- **95% Indoor**
- **5% Outdoor (raw data GNSS)**
- **Active walk almost 100%**
- **Only 1 lift at the end**
- **Several breaks of few seconds (<10s)**
- **3 floors : -2 -1 0**
- ***Quasi RealTime condition !***

# Competitors

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**5 teams**

| Team Name | country | Institute |
|---|---|---|
| ININ624 | China | School of Automation, Beijing Institute of Technology |
| CETC-CePNT | China | The 54th Research Institute of China Electronics Technology Group Corporation |
| SmartLoc | Republic of Singapore | Nanyang Technological University |
| VINF | China | Institute for Sensing and Navigation, Shanghai Jiao Tong University |
| X-lab | China | Navigation Research Center (NRC) in Nanjing University of Aeronautics and Astronautics, College of Automation |

# Objective of Track4 - Foot-mounted IMU

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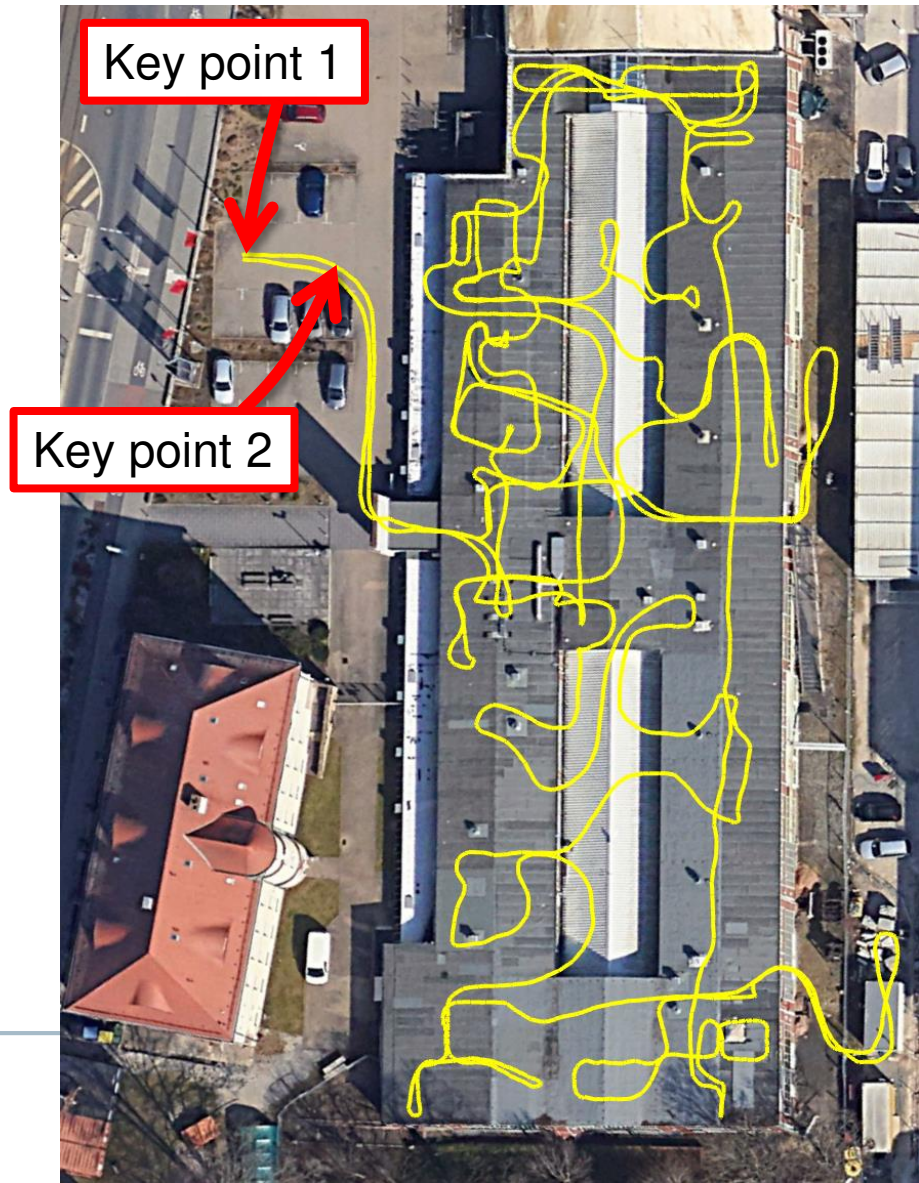
- Re-build the trajectory realized in June 2023
- With ULISS sensor mounted on foot
- Starting from a known point
- And with the help of a second given point
- 2Hz output were evaluated:
  - More than 3000 key points
  - All points for 2D component
  - All points except floor transition for Height



# Sensor description



- **Inputs from ULISS :**

- accelerometer / gyroscope / magnetometer from a Xsens Mti-7

- GNSS rawdata and NMEA (GGA/ZDA) from a Ublox ZED-F9P dual freq. receiver

- barometer from BMP280 sensor
- temperature sensor

nav4you

# Objective

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From: IMU (Acc,Gyro), MAG, GNSS, BARO sensors

```
ROTA,296505.186001000,-0.302074,-0.0711932,-0.156042
ACCE,296505.190147000,-0.705489,-3.4839,9.10367
ROTA,296505.191081000,-0.339169,-0.0550549,-0.152722
MAGN,296505.193585000,0.163107,0.453265,-0.598098
ACCE,296505.195114000,-0.820321,-3.37438,9.02803
ROTA,296505.196161000,-0.387938,-0.0593302,-0.144966
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ROTA,296505.201241000,-0.439892,-0.0571591,-0.138292
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GOBS,296505.202000000,E30  24581760.548 9                9     -1613.038         26.000
GOBS,296505.202000000,C30  22290706.903 8 116073559.62938     -1147.722         27.000
GOBS,296505.202000000,G16  21480546.343 9                9     -1933.039         30.000
GOBS,296505.202000000,E34  23764048.752 9                9      -367.766         24.000
```

Compute:

-Latitude
-Longitude
-Floor level

***In quasi Realtime condition through the Evaal web API***

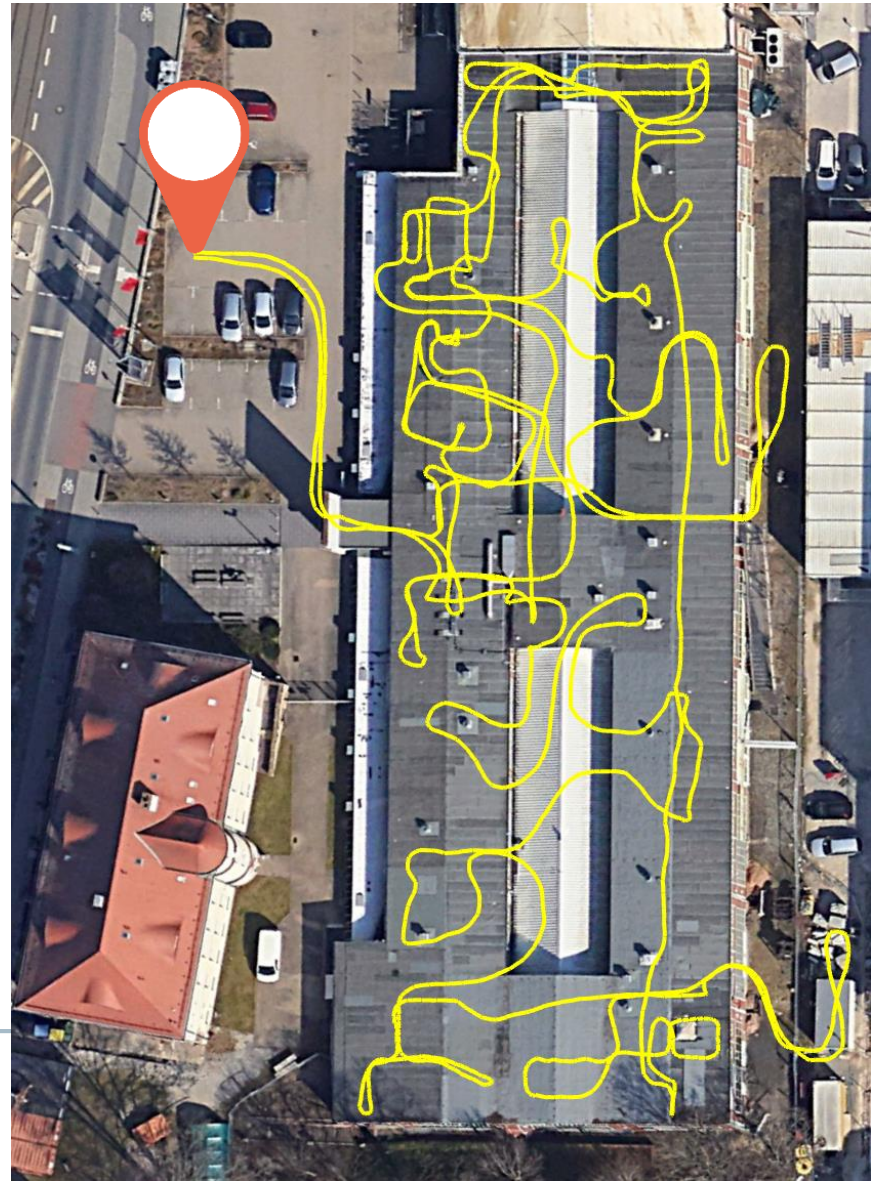
**Track4 Call For Competition**

https://evaal.aaloa.org/files/2023/Track-4_TA-2023-v2.2.pdf

# Track description

Starting point
(outdoor Floor 0)

Key point 1
(given)



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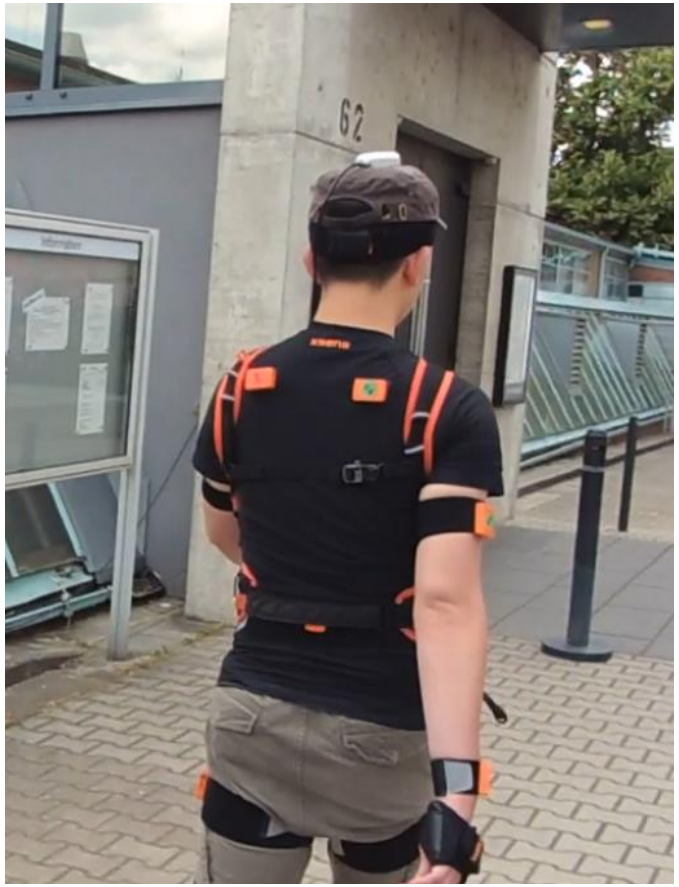
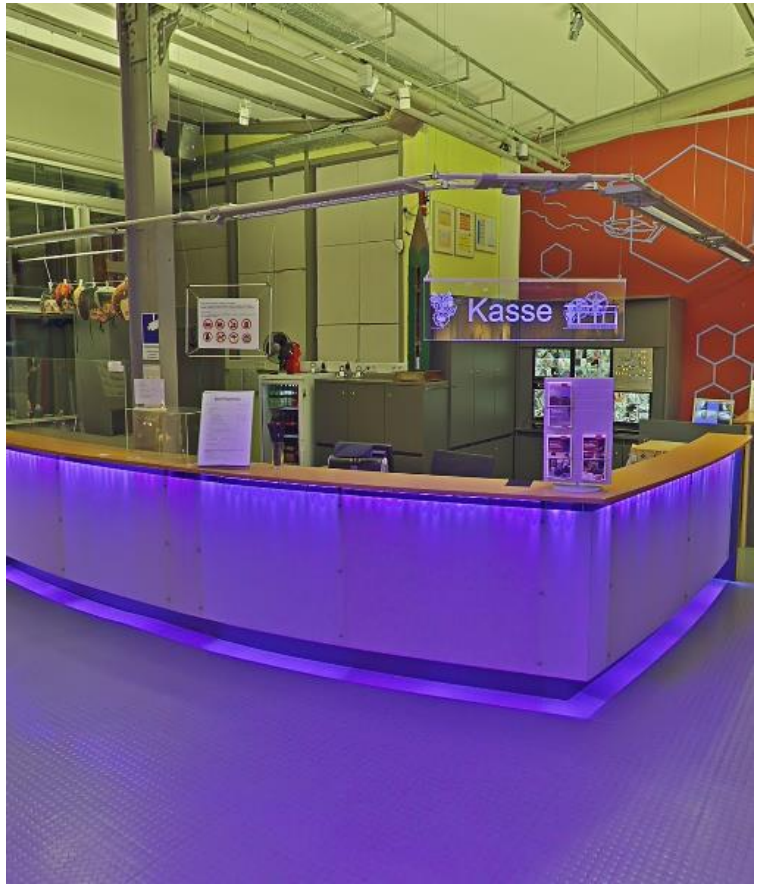
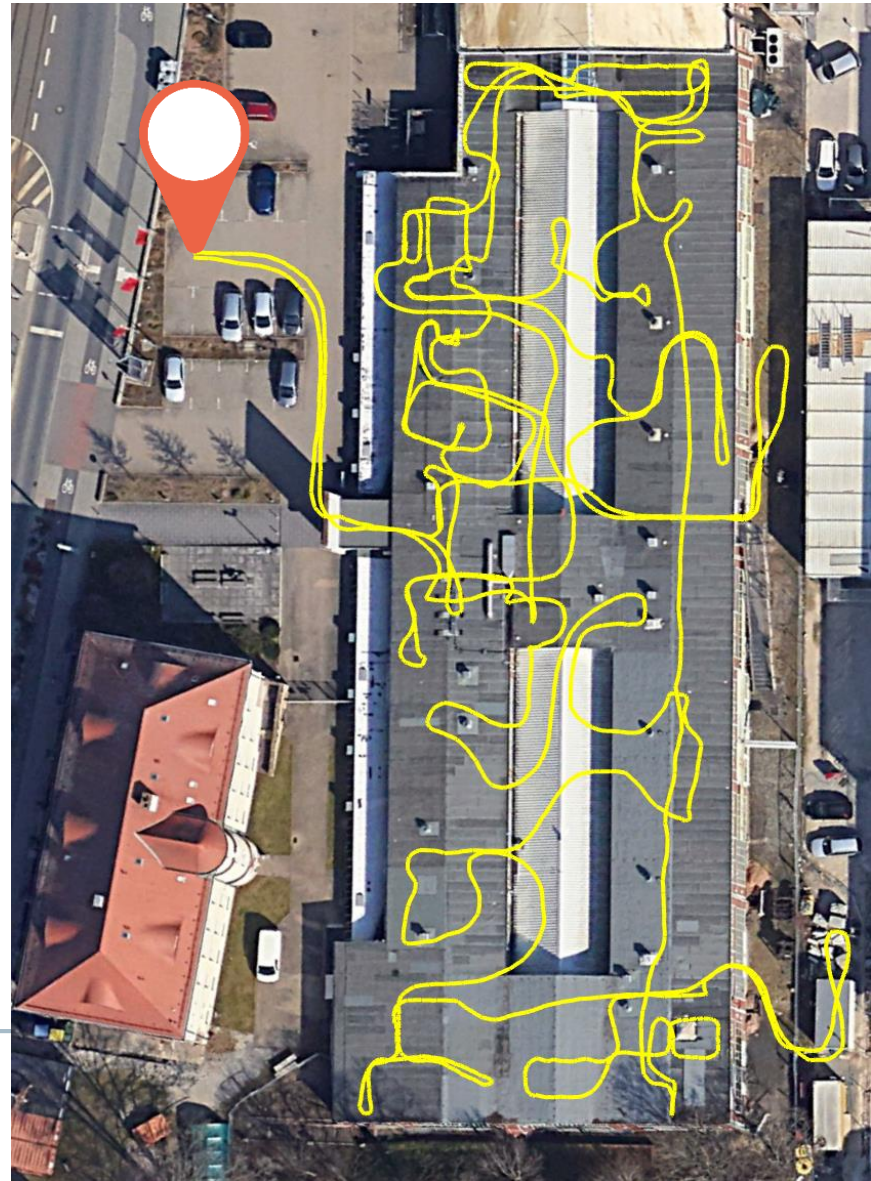
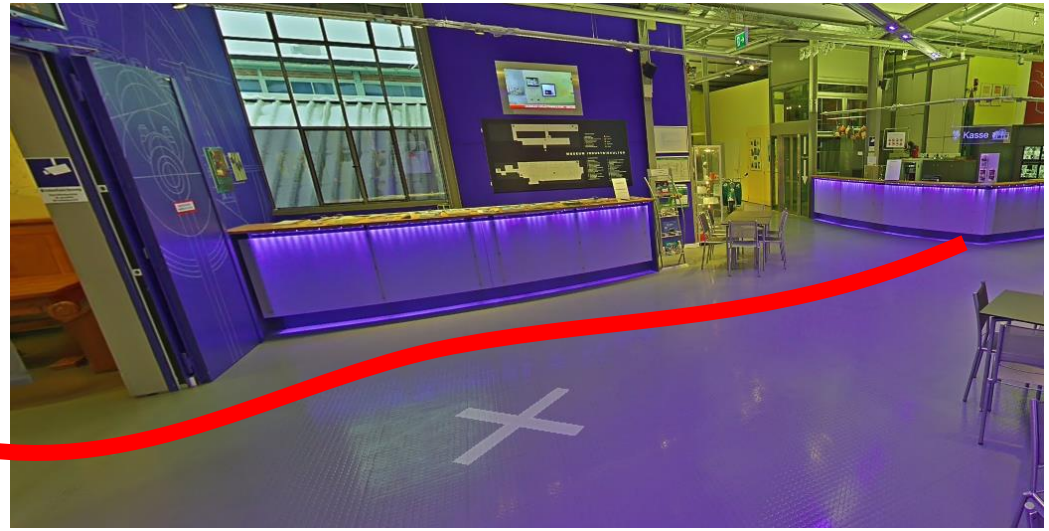


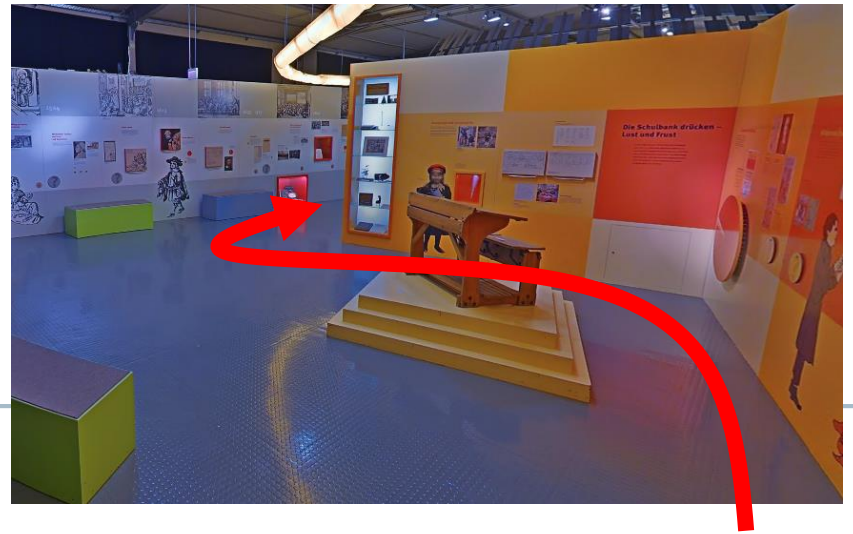



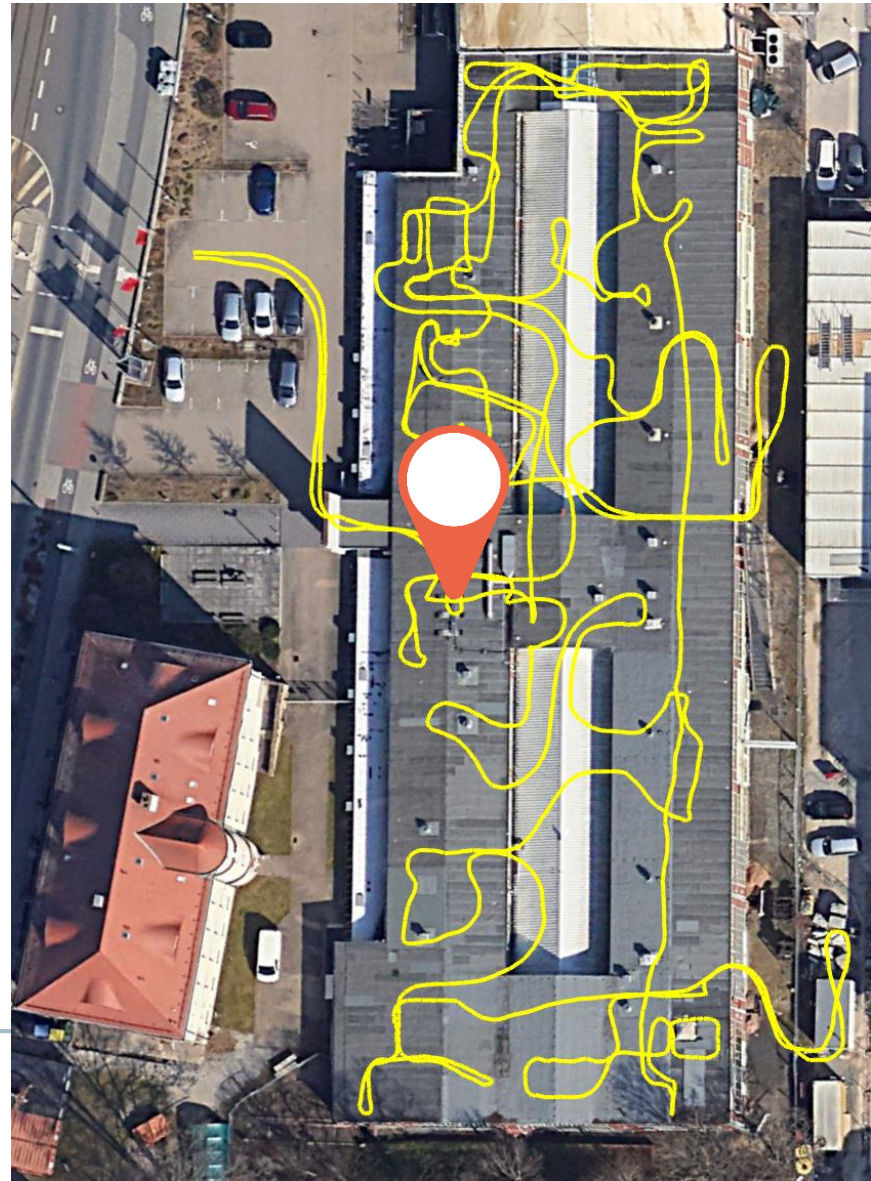
# Track description





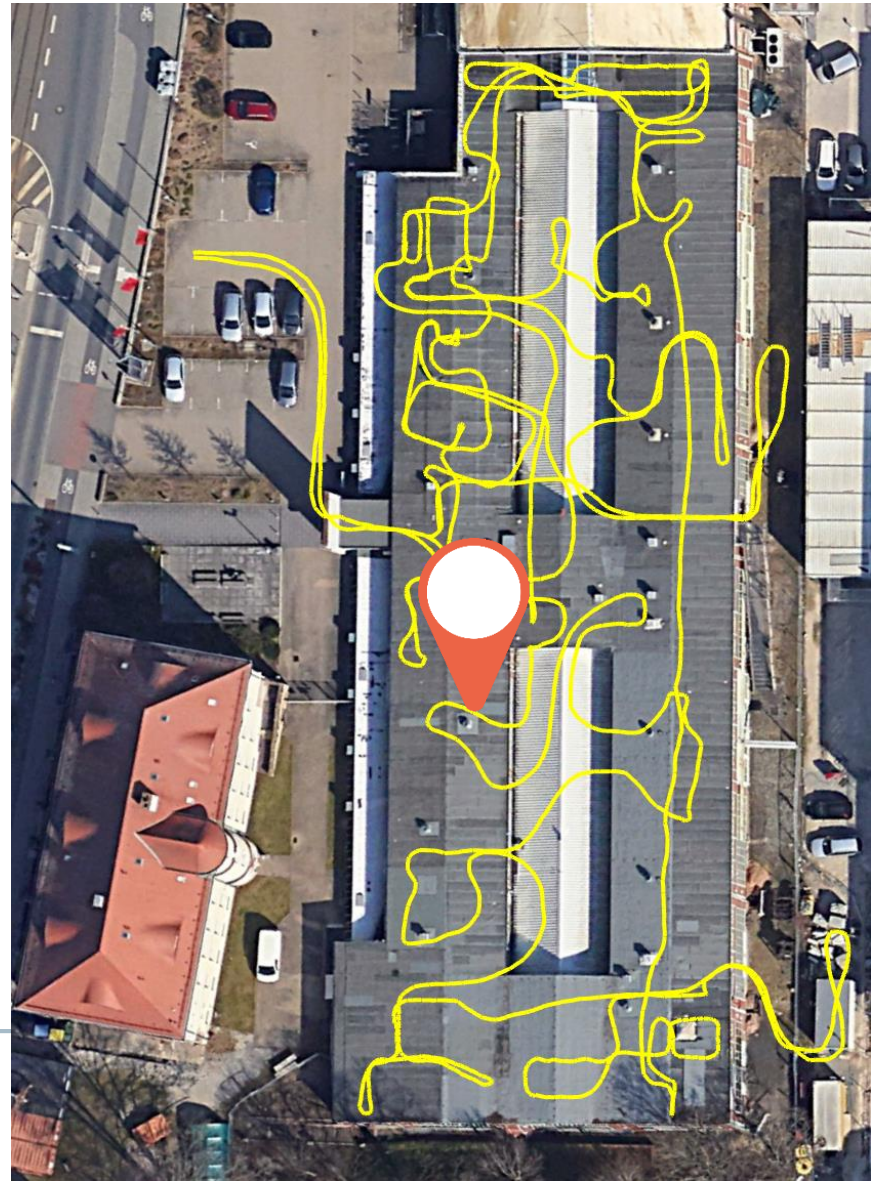


indoor Floor 0
indoor Floor -1



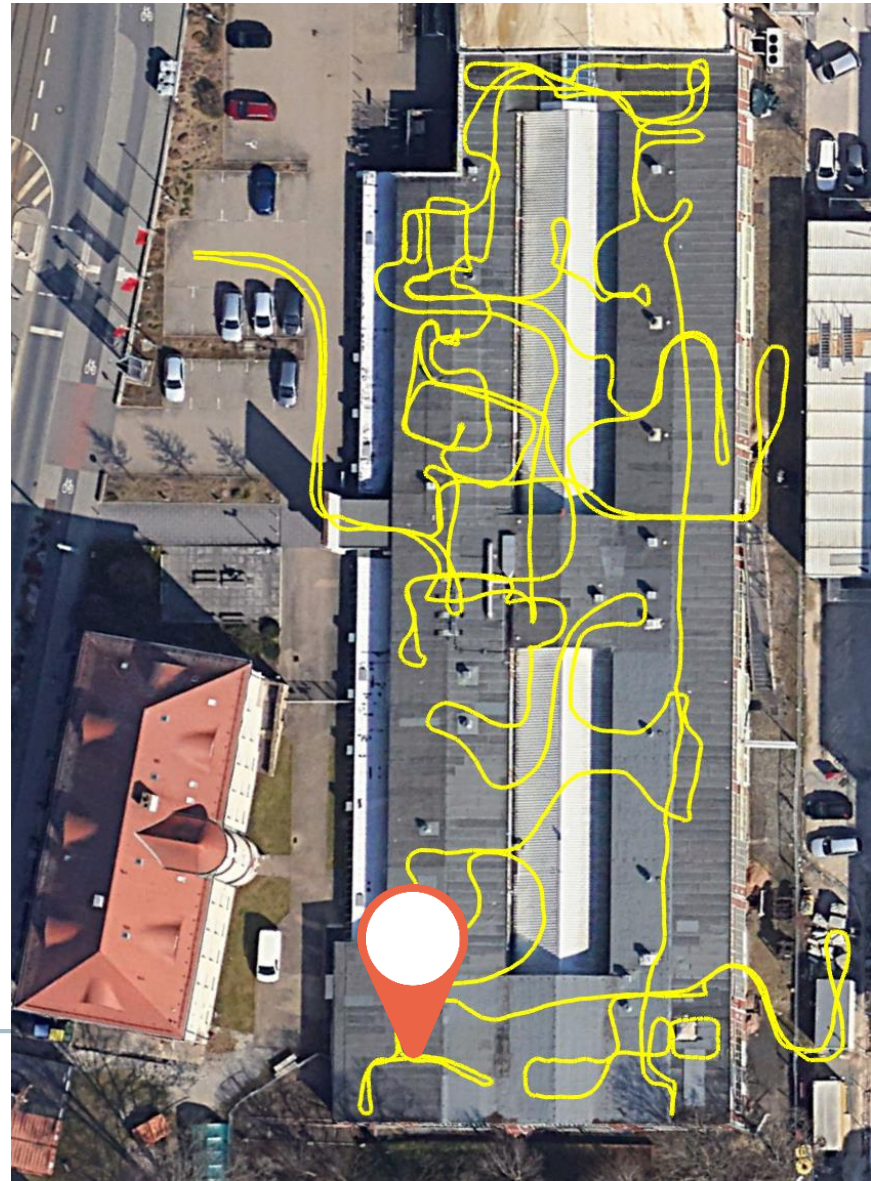
# Track description

indoor Floor -2



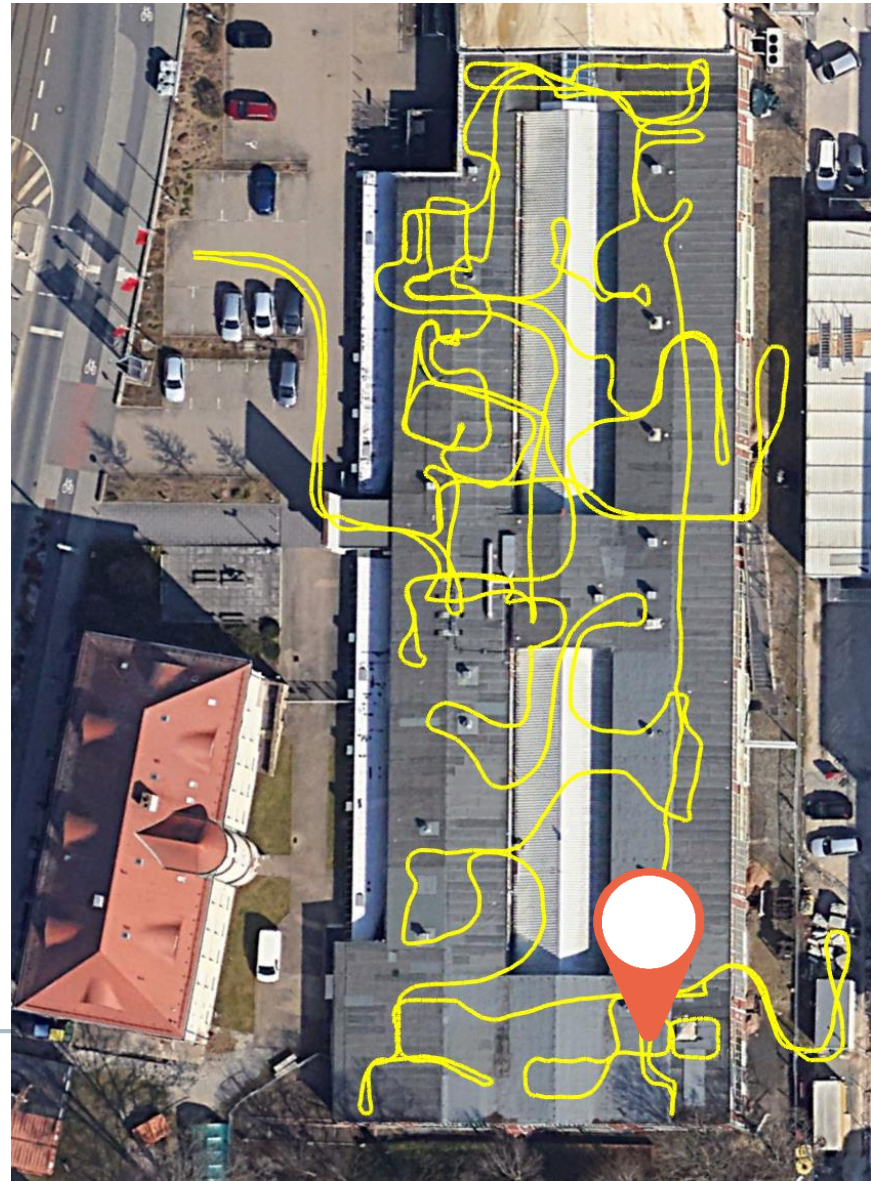
# Track description

indoor Floor -1



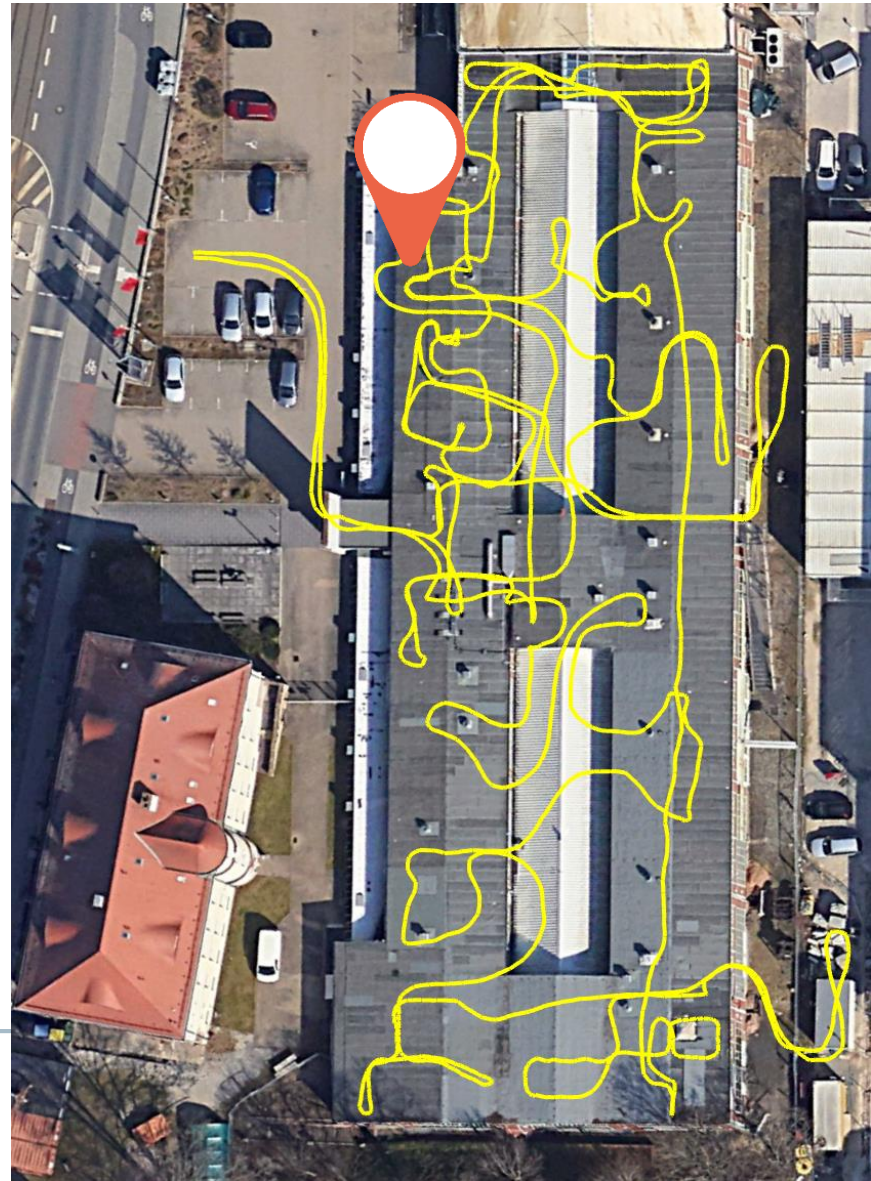
# Track description

indoor Floor 0



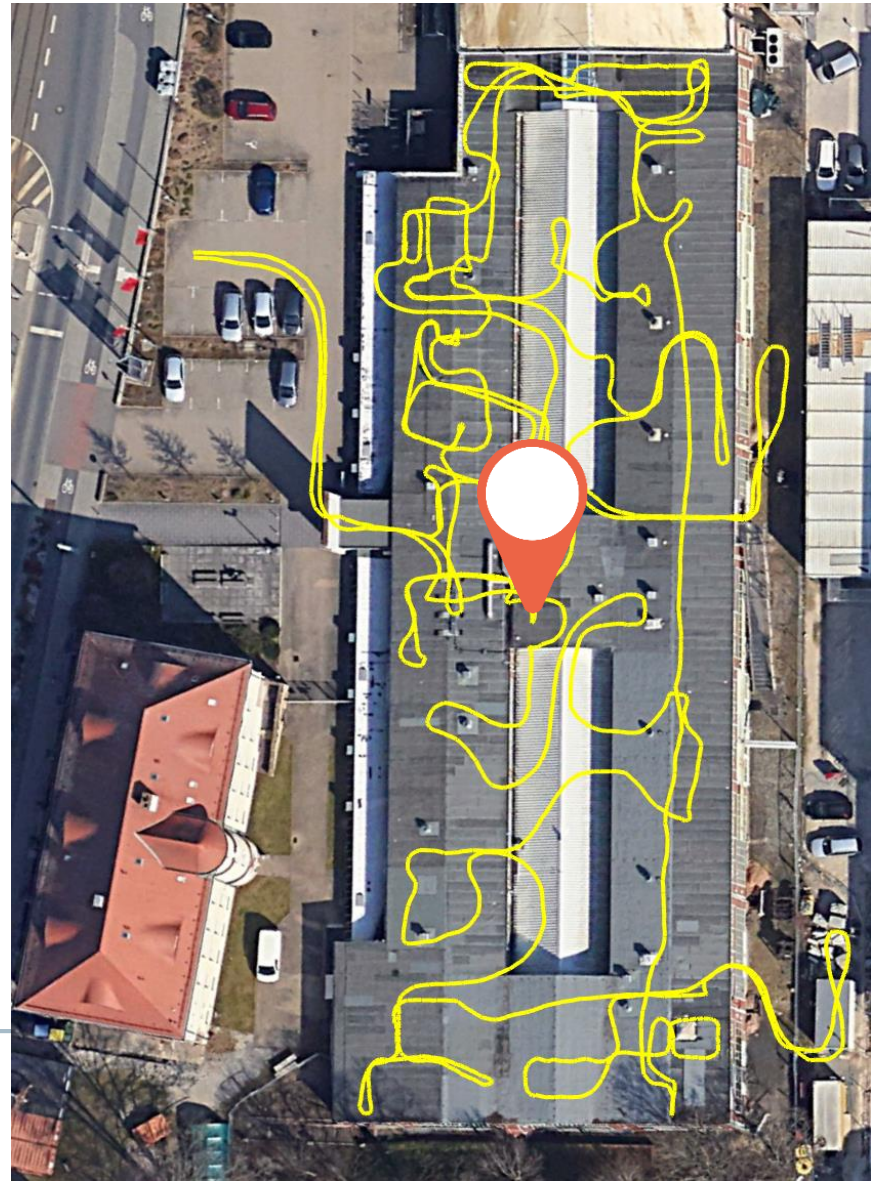
# Track description

indoor Floor -2
Lift



# Track description

outdoor Floor 0



# Ground Truth: based on Motion Capture + GNSS-PPK + optimization

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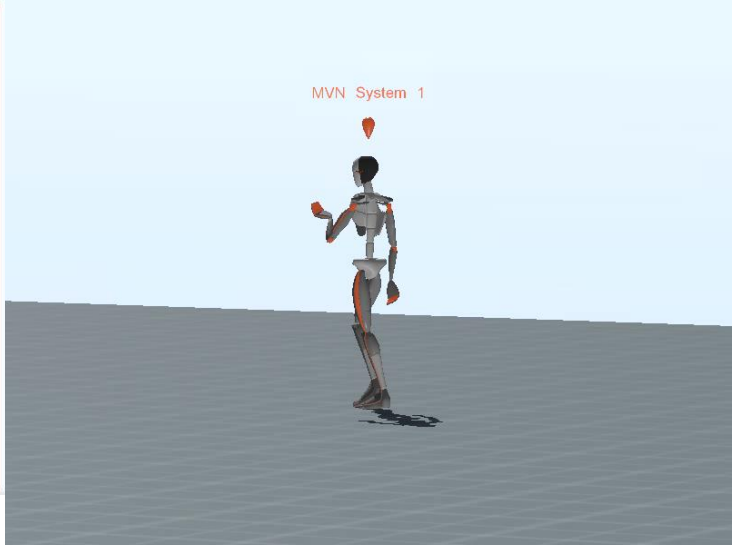

Ground Truth = position of “virtual” right foot of the avatar.

ULISS sensor being mounted on the “real” right foot of Ziyou !

# Evaluation / Assessment

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**Accuracy Score** $=$ $\text{3rdQuartile}\{\text{SampleError}(R_i, E_i)\}$

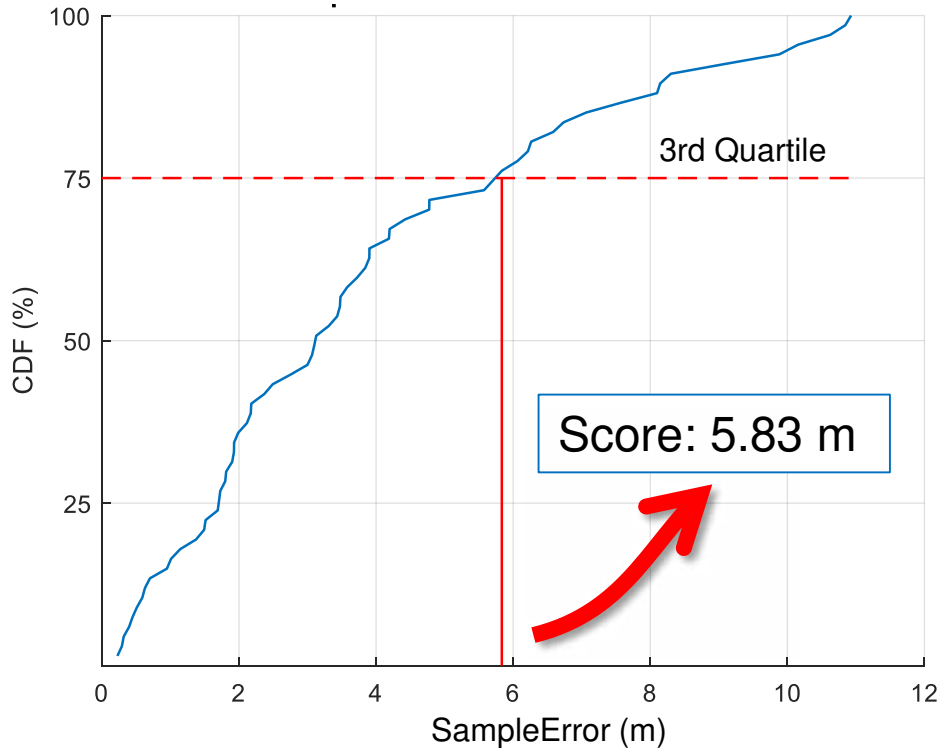
Where :

$\text{SampleError}(R_i, E_i) = \text{Distance}(R_i, E_i) + (\text{penalty} \times \text{floorfail})$

where:

- "3rdQuartile" is the third quartile error, in meters, of a cumulative error distribution function, i.e., the error value that includes 75% of estimations (sample errors) with a lower error.
- $R_i$ is the actual position (ground truth).
- $E_i$ is the predicted position by the method proposed by the contest participant.
- floorfail is the absolute difference between actual floor and the predicted one.
- penalty is used to penalize errors in estimating the floor. penalty is set to ~~15~~ 0 m.
- $\text{Distance}(R_i, E_i)$ calculates the Euclidean distance between coordinates (longitude and latitude) of $R_i$ and $E_i$.

The team with the lower "Accuracy Score" wins.




+3000 key points were evaluated for each Scoring Trial

**Important note** : no Floor penalty this year due to an issue in the Technical Annex.

# Lessons learnt this year

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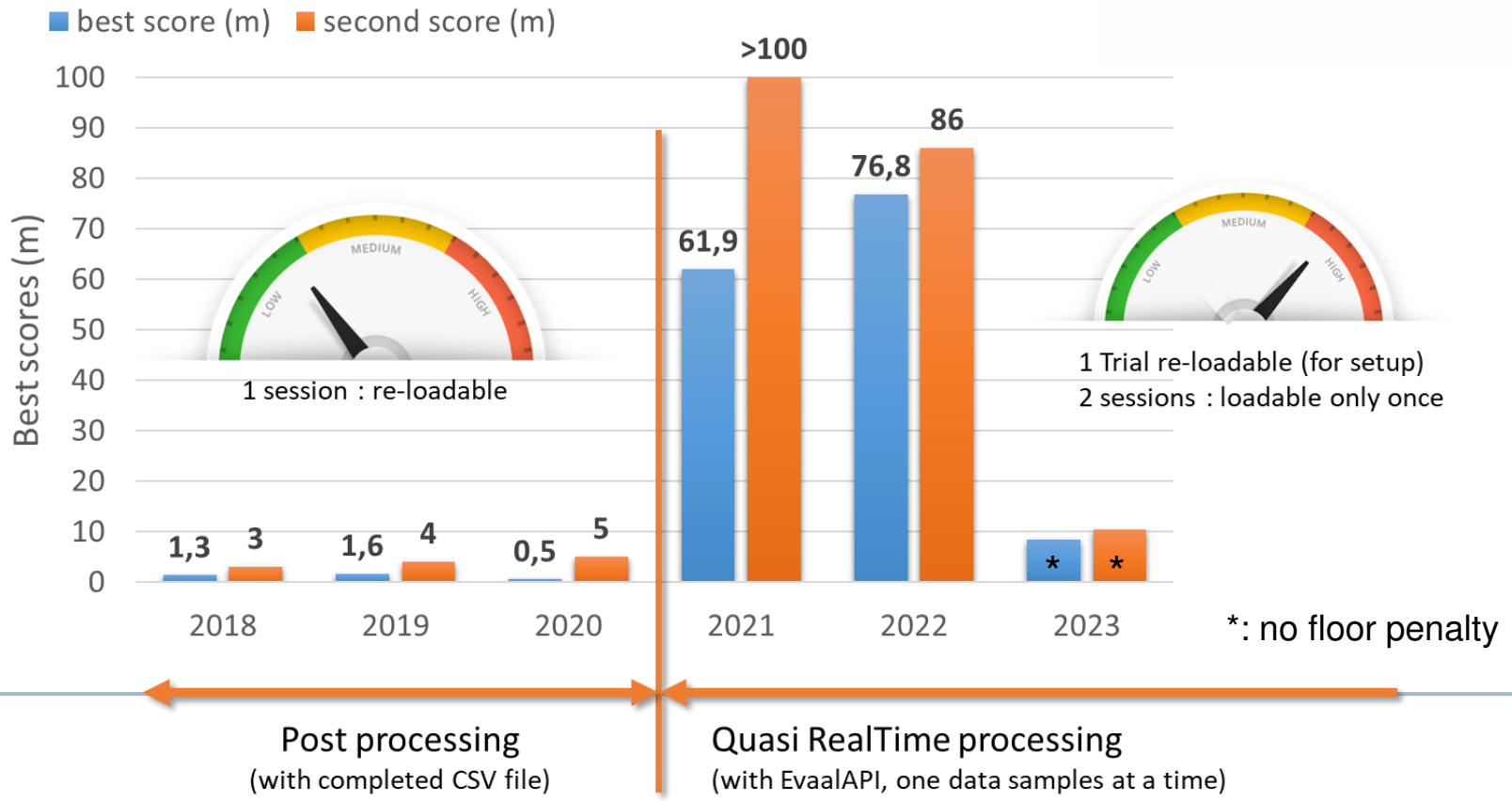
- GNSS raw data is now used by some competitors;
  it is a good opportunity to use GNSS signals in light indoor environment
- Good preparation of the use of EvaalAPI framework leads to better results !



# Results

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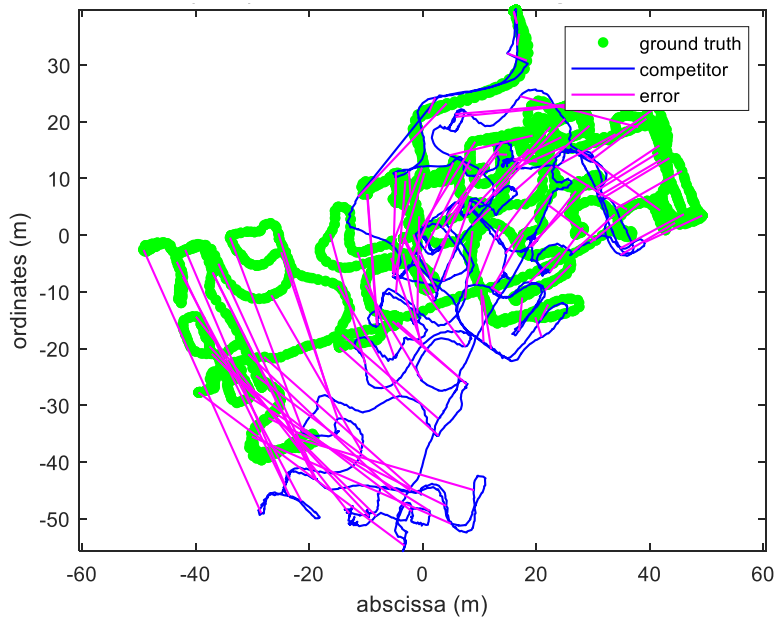
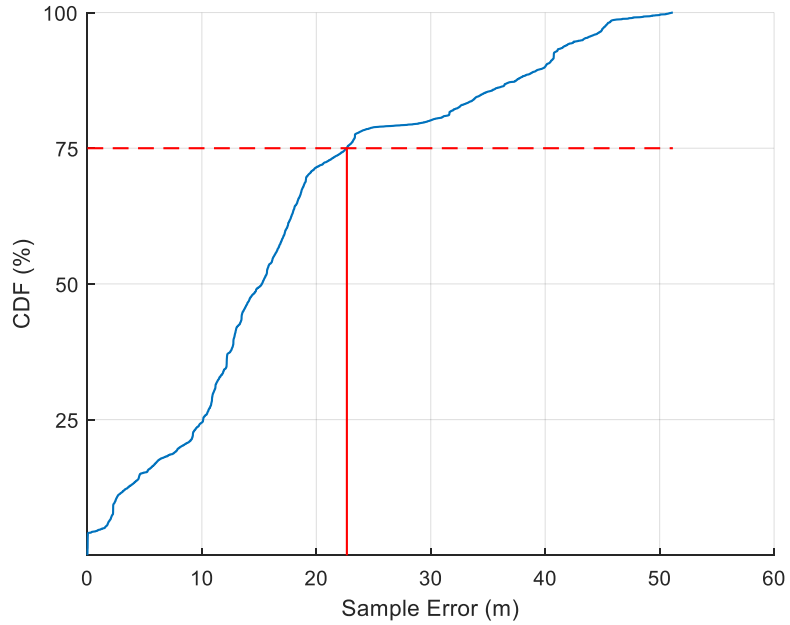
| Rank | Accuracy Score | Team |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

Fake



# Results

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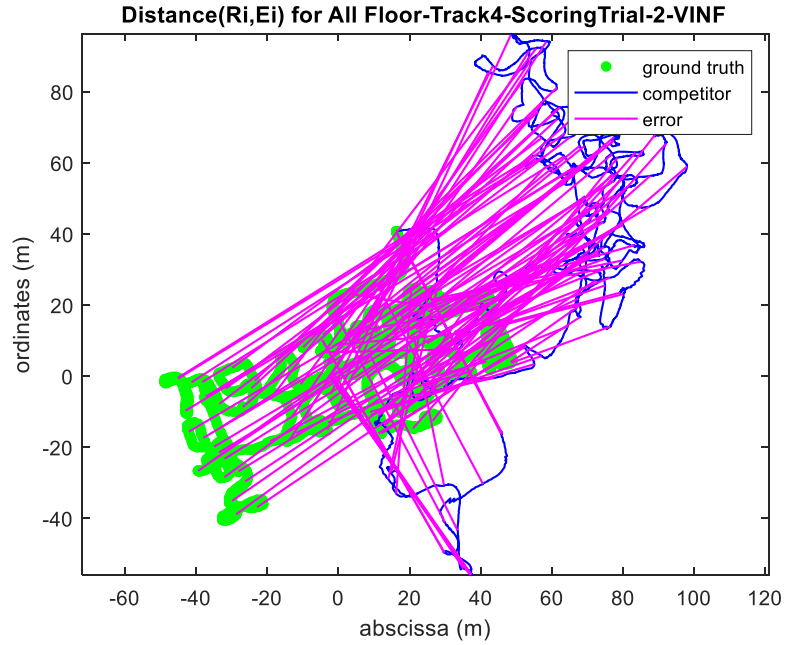
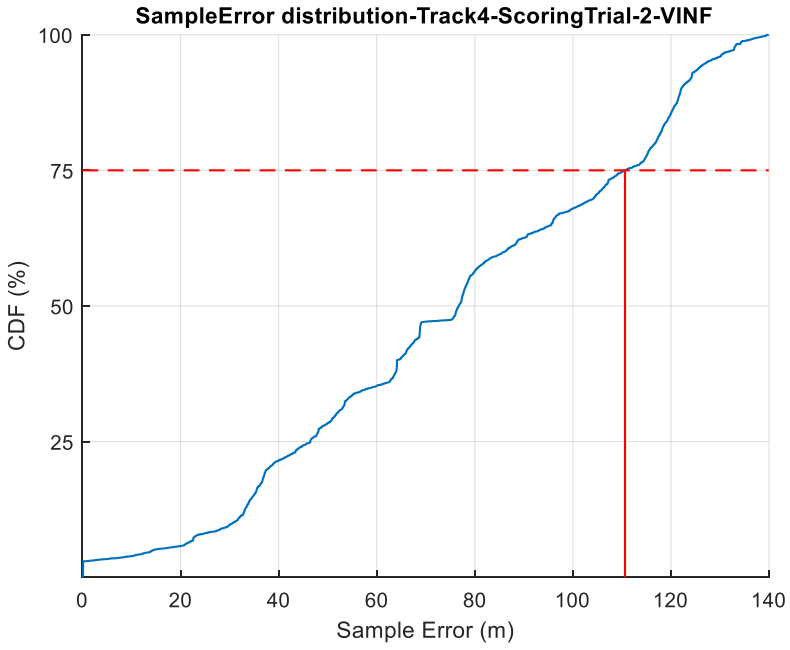
| Rank | Accuracy Score | Team |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | 110.7 m | VINF |



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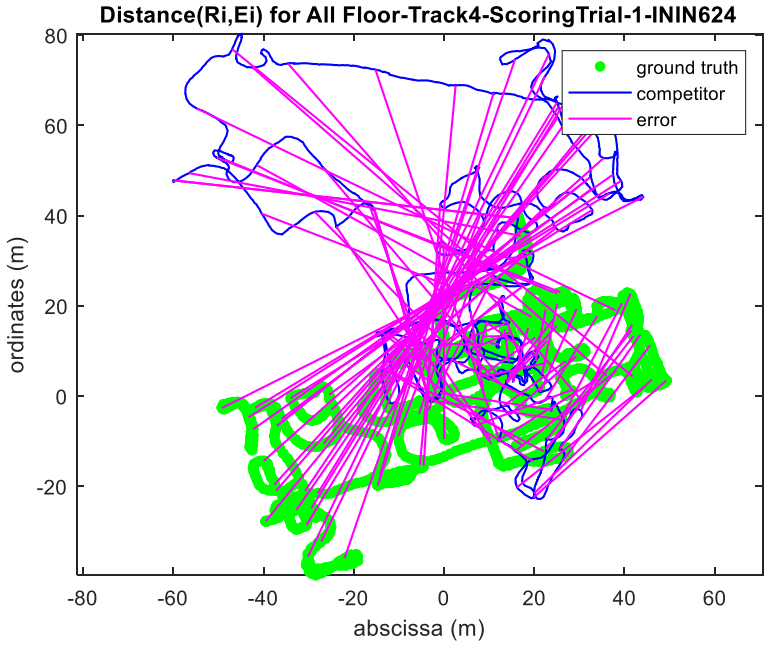
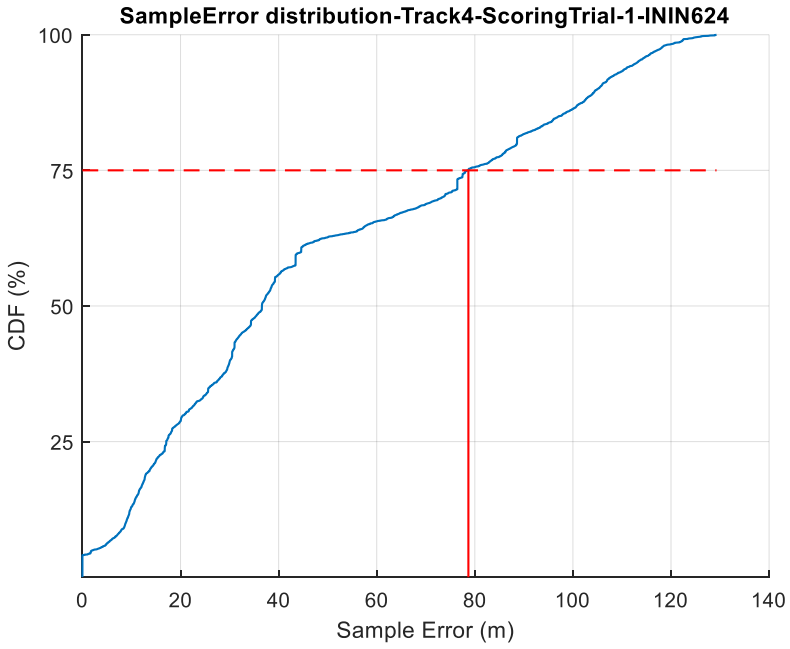
| Rank | Accuracy Score | Team |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | 58.2 m - 78.7 m | ININ624 |
| 5 | 110.7 m | VINF |



# Results

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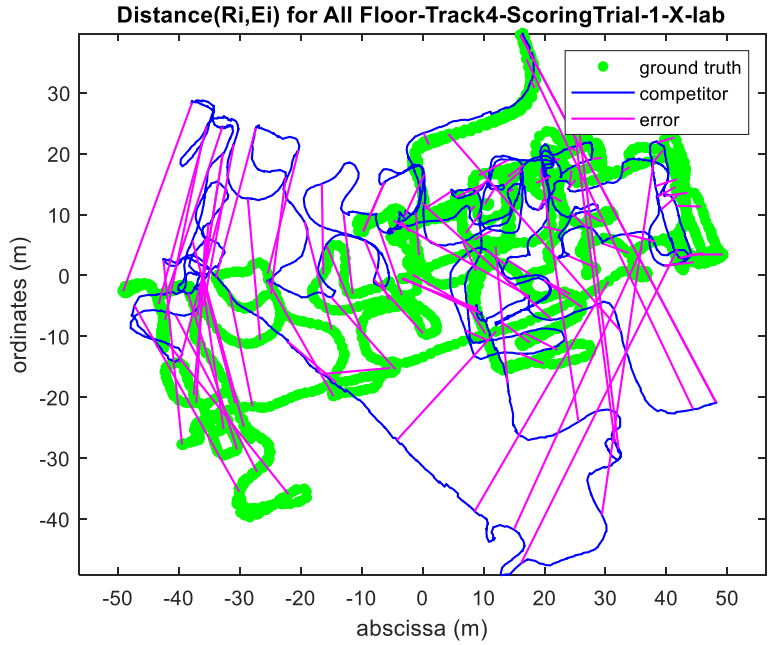
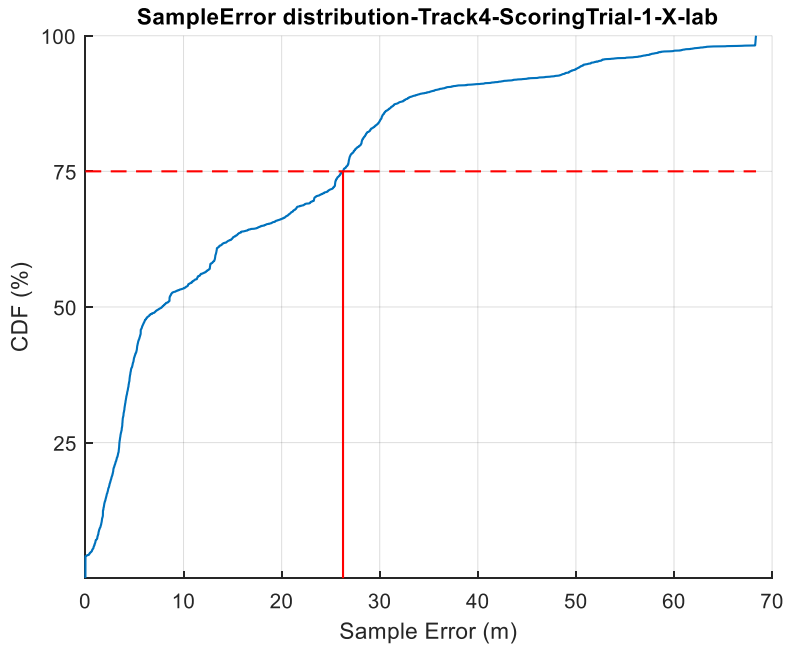
| Rank | Accuracy Score | Team |
|---|---|---|
| 1 | | |
| 2 | | |
| | 26.3 m | X-lab |
| 4 | 58.2 m - 78.7 m | ININ624 |
| 5 | 110.7 m | VINF |



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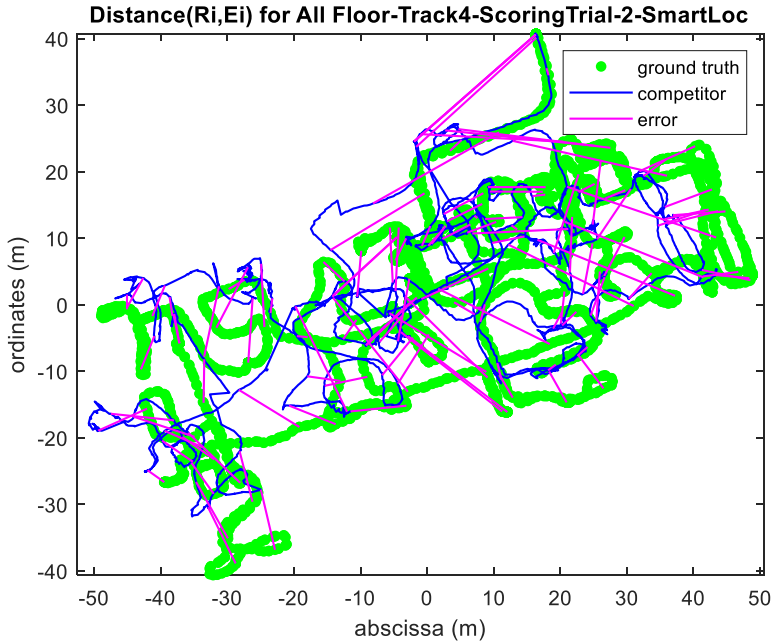
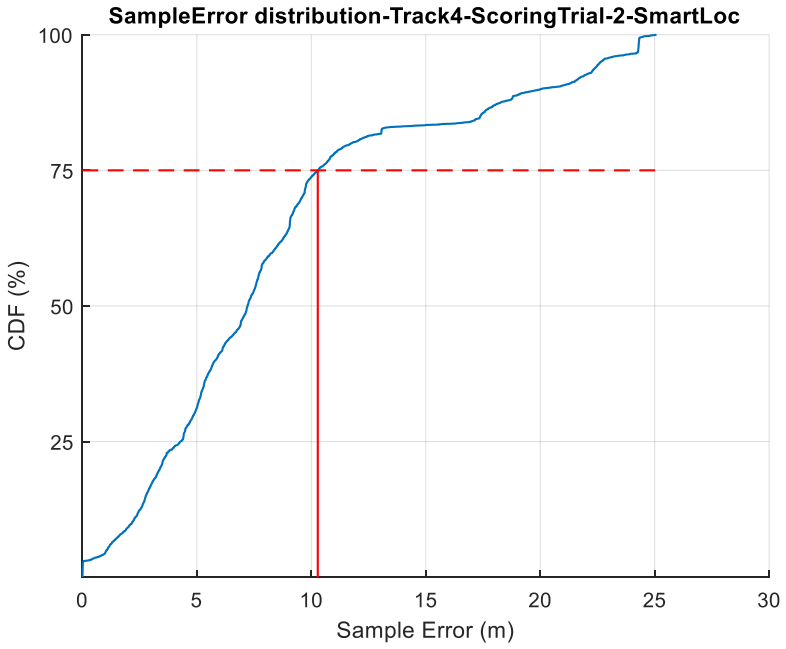
| Rank | Accuracy Score | Team |
|---|---|---|
| 1 | | |
| | 10.3 m | SmartLoc |
| | 26.3 m | X-lab |
| 4 | 58.2 m - 78.7 m | ININ624 |
| 5 | 110.7 m | VINF |



# Results

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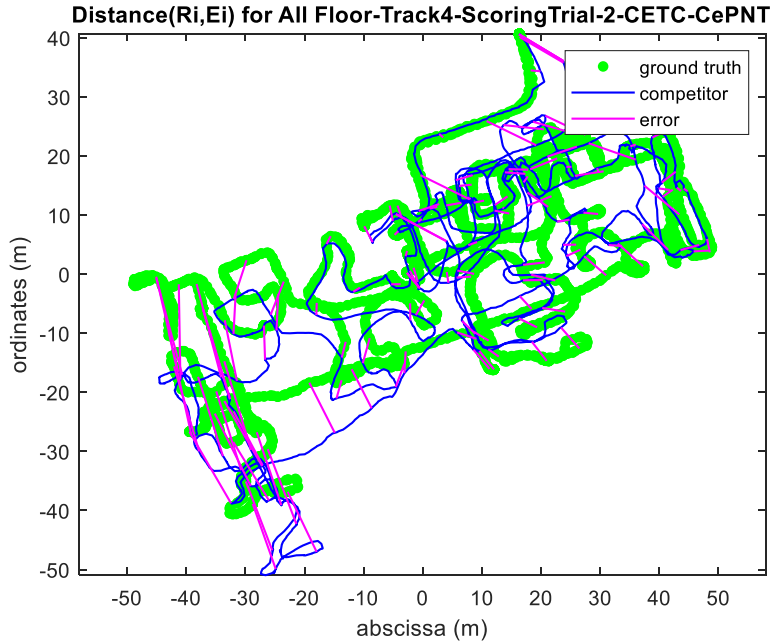
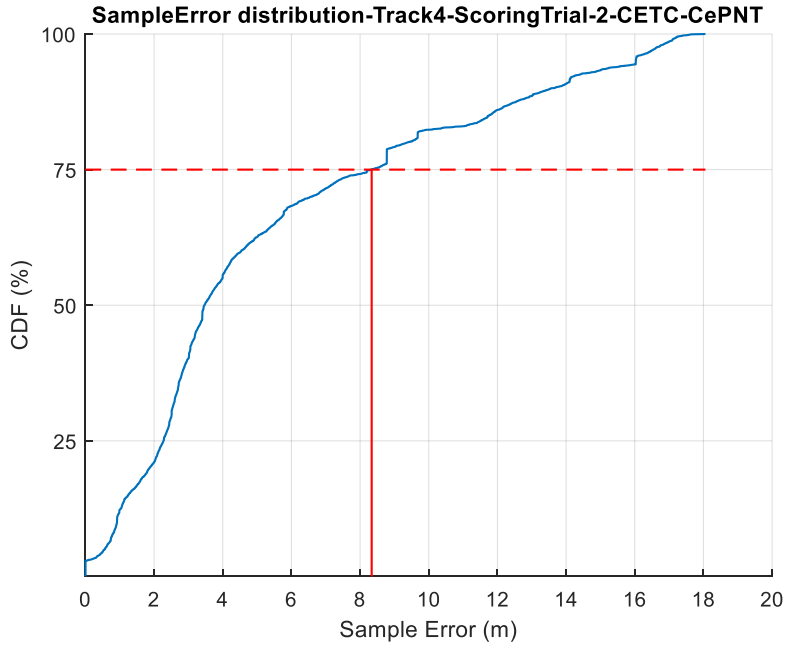
| Rank | Accuracy Score | Team |
|---|---|---|
| 1 | 8.3 m | CETC-CePNT |
| 2 | 10.3 m | SmartLoc |
| 3 | 26.3 m | X-lab |
| 4 | 58.2 m - 78.7 m | ININ624 |
| 5 | 110.7 m | VINF |



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CONGRATULATIONS

# CETC-CePNT

Baoguo Yu, Jun Li,
Xinjian Wang, Yanan Hu,
Haonan Jia, Lu Huang

The 54th Research Institute of China Electronics Technology Group Corporation

# Winner presentation

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## Details in Foot-Mounted IMU

——IPIN2023 TRACK4

Reported by Xinjian Wang

Date: 2023.09

CETC-CePNT

# Thank you for your attention

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