



Track4 "Foot-Mounted IMU (online)" special features

Organizational aspects:

Database/dataset access

- Track4 is an “online” track. That means, we ask competitors to process data **as if they were in real time**. To do so, an interface based on a web API has been developed: EvaalAPI. This API will be used by competitors for sending position estimates and reading the sensor values:
<https://evaal.aaloo.org/evaalapi/>
- Participating to Track4 competition means:
 - playing with datasets recorded by track chairs with their own equipment (here ULISS for Track4)
 - computing the best estimates (position) of the equipment by applying their own algorithm on the shared dataset
 - submitting the estimated results through EvaalAPI in quasi-real time condition; meaning a position estimate is required before requesting new data from the next 0.5s window
 - competitors cannot obtain the whole dataset at once in order to apply global optimization
- In the context of this EvaalAPI framework, **one** “scoring trial” will be proposed to competitors. **This scoring trial will be usable only once –excepted on justified reasons approved by track chairs.**
- In order to help competitors to be well prepared for the evaluation, a “testing trial” is proposed. This **“testing trial” is fully accessible and reloadable** (i.e. not restricted to a single usage as scoring trials). GroundTruth positions are included in the “testing trial” under the POSI ¹label, for validation purpose.

Competitor admission process / Application:

- Admission process: <https://competition.ipin-conference.org/current-competition/call-for-competition>
- Application page: <https://competition.ipin-conference.org/current-competition/application>

Submission of the processed results

- As mentioned earlier, results have to be submitted via a web API. See above.

Important deadlines:



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|---|---|
| • Technical annexes published | April, 2026 |
| • “testing trial” is accessible through web API | April, 2026 |
| • Video tutorial accessible online | April 30, 2026 |
| • Application deadlines | <u>April TBD^{1st} – Sept. 21st</u> |
| • 2026 | |
| • “scoring trial” will be accessible for competition | <u>Sept. 28-30TBD</u>, 2026 |
| • Proclamation of winners | Oct. 8th, 2026 |

¹ See hereafter in the document, for details



Scope

Many indoor navigation systems have been developed for pedestrians and assessing their performances is a real challenge. Benefiting from a reference solution that is accurate enough to evaluate other indoor navigation systems and assist novel research is of prime interest. According to ISO18305:2016 two different ways can be used for assessing indoor localization system: “Off-line surveyed test point” that is commonly used, or “reference system” with an accuracy at least one order of magnitude better the system you want to test. The scope of this track4 is clearly focused on the second way of assessing.

For 2026 edition:



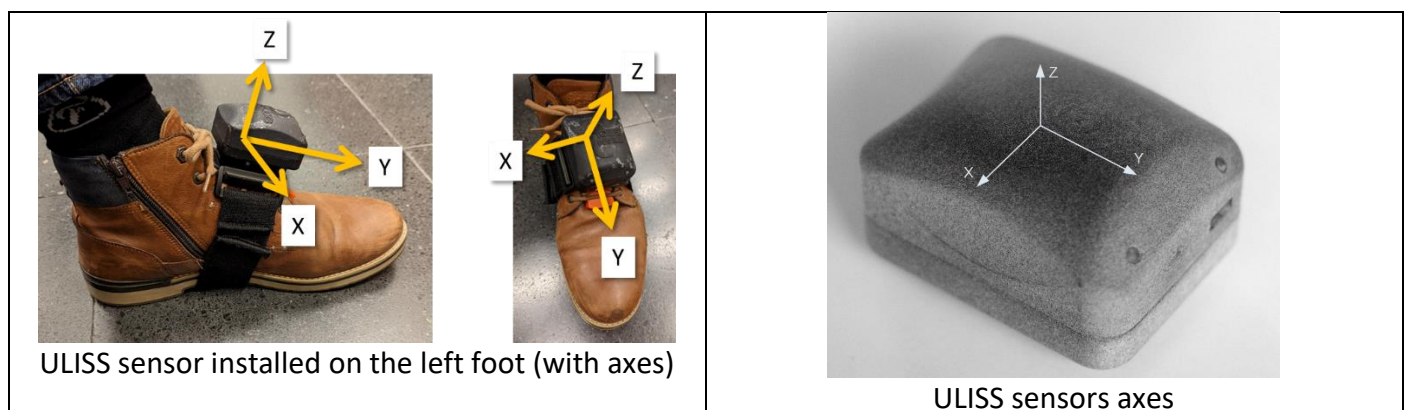
-absolute position of the embedded GNSS receiver is provided; a nice way to correct inertial drift if used smartly!

-this is the last time that ULISS is used in track4.

From 2027, a new equipment will be used: Pulsar!!



Competition Goal

The goal of this competition is to evaluate how good up-to-date INS algorithm is. Each competitor will have access to a dataset logged with ULISS (Ubiquitous Localization with Inertial Sensors and Satellites), a state-of-the-art Inertial Navigation System producing IMU data, MAG data, PRESSURE data & GNSS data, without the help of any maps.

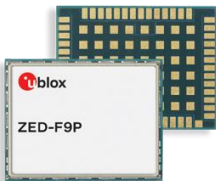


Description of Datasets

Data is recorded from 3 different sensors:

<p>Xsens Mti-7</p> 	<p>IMU-Mag sensor: -3D accelerometer -3D gyrometer -3D magnetometer</p> <p>https://www.xsens.com/mti-7</p>
<p>BMP280 sensor</p> 	<p>Operation range: Pressure: 300...1100 hPa Absolute accuracy : ~ ±1 hPa Relative accuracy : ± 0.12 hPa (typical)</p> <p>https://www.bosch-sensortec.com/products/environmental-sensors/pressure-sensors/bmp280/</p>



<p>Ublox ZED-F9P dual freq. receiver</p> 	<p>Multi GNSS Receiver : BeiDou, Galileo, GLONASS, GPS / QZSS Number of concurrent GNSS 4 Dual GNSS Bands : L1C/A, L2C, L1OF, L2OF, E1B/C, E5b, B1I, B2I</p> <p>https://www.u-blox.com/en/product/zed-f9p-module</p>
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Unit and meaning of the sensors outputs of ULISS are the following ones:

Column	Xsens MTi-1 (accelerometer)	Comments
1	"ACCE"	Acceleration label
2	GPS Time of Week (ToW) in second	
3	Acc X (m/s ²)	Acceleration on X axis
4	Acc Y (m/s ²)	Acceleration on Y axis
5	Acc Z (m/s ²)	Acceleration on Z axis

Sample strings for accelerometer data

ACCE,314410.003952000,-1.25709,-4.34142,8.75831
ACCE,314410.008947000,-1.23771,-4.28408,8.72497
ACCE,314410.013942000,-1.26714,-4.3795,8.72491
ACCE,314410.018937000,-1.26167,-4.29823,8.71566
ACCE,314410.023932000,-1.25662,-4.26479,8.71095

Column	Xsens MTi-1 (gyrometer)	Comments
1	"ROTA"	Gyrometer label
2	GPS Time of Week (ToW) in second	
3	Gyro X (rad/s)	Angular velocity around X axis
4	Gyro Y (rad/s)	Angular velocity around Y axis
5	Gyro Z (rad/s)	Angular velocity around Z axis

Sample strings for gyrometer data

ROTA,314410.004573000,0.00275338,-0.000805736,0.006387
ROTA,314410.009578000,-0.00576329,-0.00401807,0.00535798
ROTA,314410.014582000,0.00813067,0.00989926,0.00747764
ROTA,314410.019587000,0.00594413,-0.00079453,0.00529695
ROTA,314410.024591000,0.00488472,0.00237882,0.0117271

Column	Xsens MTi-1 (magnetometer)	Comments
1	"MAGN"	Magnetometer label
2	GPS Time of Week (ToW) in second	
3	Mag X (a.u.)	a.u. = arbitrary unit according to Xsens.
4	Mag Y (a.u.)	Tips : multiply by 0.49*1000,
5	Mag Z (a.u.)	In order to get milliGauss (mG)

Sample strings for magnetometer data

MAGN,314410.005162000,0.224368,0.435266,-1.14962
MAGN,314410.015162000,0.22387,0.434764,-1.14766
MAGN,314410.025162000,0.222876,0.438141,-1.1481
MAGN,314410.035162000,0.223393,0.433828,-1.14817



MAGN, 314410.045162000, 0.224333, 0.431291, -1.1413

Column	BMP280 (pressure)	Comments
1	"PRES"	Pressure sensor label
2	GPS Time of Week (ToW) in second	
3	Pressure (Pa)	

Sample strings for pressure data

```
PRES, 314410.005162000, 101144
PRES, 314410.025162000, 101152
PRES, 314410.045162000, 101138
PRES, 314410.065162000, 101151
PRES, 314410.085162000, 101151
```

Column	Temperature (temperarure)	Comments
1	"TEMP"	Temperature sensor label
2	GPS Time of Week (ToW) in second	
3	Temperature (Degree Celsius)	

Sample strings for temperature data

```
TEMP, 314410.025162000, 44.1914
TEMP, 314411.025162000, 44.1758
TEMP, 314412.025162000, 44.1758
```



Column	Ublox F9P GNSS receiver (PVT)	Comments
1	"GPVT"	GNSS Position information label
2	GPS Time of Week (ToW) in second	
3	ASCII NMEA GGA Message	Corresponds to GGA NMEA Message*

*: https://fr.wikipedia.org/wiki/NMEA_0183

Sample strings for GPVT (SBAS – EGNOS) data

```
GPVT, 137598.800000000, $GNGGA, 141318.80, 6129.67752, N, 02346.80402, E, 1, 12, 0.57, 106.7, M, 19.1, M, , *4C
GPVT, 137599.800000000, $GNGGA, 141319.80, 6129.67750, N, 02346.80403, E, 1, 12, 0.60, 106.7, M, 19.1, M, , *4A
GPVT, 137600.800000000, $GNGGA, 141320.80, 6129.67749, N, 02346.80404, E, 1, 12, 0.57, 106.7, M, 19.1, M, , *4B
```

Column	Ublox F9P GNSS receiver (SBS)	Comments
1	"GSBS"	GNSS SBAS information label
2	GPS Time of Week (ToW) in second	
3	Hexadecimal WORD	Corresponds to EGNOS SBAS Message Format*

*: https://gssc.esa.int/navipedia/index.php/The_EGNOS_SBAS_Message_Format_Explained

Sample strings for SBS (SBAS – EGNOS) data

```
GSBS, 315499, 9A494C00000000000000400001F00003F80003FC0003FE0001FF0001FF80
GSBS, 315618, 5363FBFFDC000000000000197BBBAA01848160A0580B185BFDFF980900
GSBS, 315619, 9A0A8003FE4027FFBFC7FEFFD4003FEC000003FB8003959559797BA380
```



Column	Ublox F9P GNSS receiver (OBS)	Comments
1	“GOBS”	GNSS Observation label
2	GPS Time of Week (ToW) in second	
3	Observation data	Observation file based on RINEX 3.04 format http://rtcm.info/RINEX_3.04.IGS.RTCM_Final.pdf Only data after header* is used in the context of Track4.

*Header of “OBSERVATION DATA” file under Rinex 3.04 format are given later in each session specific parts (headers are slightly different).

Sample strings for OBS (observation file, based on RINEX 3.04 format) data

GOBS,314856.1990000000,G04	24066762.037	8	126471694.10925	-3666.900	39.000
GOBS,314856.1990000000,G09	21204418.682	8		-2579.258	24.000
GOBS,314856.1990000000,G06	21843663.561	9		-3361.335	14.000
GOBS,314856.1990000000,C24	24066200.488	4		-1496.777	42.000
GOBS,314856.1990000000,C09	41038802.886	9	213699815.76337	-1391.943	30.000
GOBS,314856.1990000000,R10	20885796.375	8	111333055.23728	-1125.414	35.000
GOBS,314856.1990000000,R17	21027399.505	9	112521861.85837	1.771	31.000
GOBS,314856.1990000000,G16	24420695.497	9		-607.284	34.000
GOBS,314856.1990000000,E25	26416183.541	9		1623.139	22.000
GOBS,314856.1990000000,R09	23641111.957	9		-3901.952	26.000
GOBS,314856.1990000000,E24	27240945.515	8		-857.287	38.000
GOBS,314856.1990000000,E05	27154158.133	8		-2871.781	35.000
GOBS,314856.3990000000,G04	24066902.088	8	126472426.50726	-3656.825	35.000
GOBS,314856.3990000000,G09	21204516.880	8		-2576.887	25.000
GOBS,314856.3990000000,G06	21843791.401	9		-3361.335	14.000
GOBS,314856.3990000000,C24	24066258.112	4	125319321.10437	-1491.643	44.000
GOBS,314856.3990000000,C09	41038856.136	8	213700093.52228	-1387.629	30.000
GOBS,314856.3990000000,R10	20885839.907	8	111333279.85427	-1119.290	37.000

Important notes on GNSS Receiver data

3 kind of data are now shared to competitors. Track chairs highlight:

- GPVT is the easiest GNSS data to be used. Because it gives directly positions computed by the RxGNSS (F9P) embedded in ULISS system. Take care: position accuracy is much better in outdoor environments compared to indoor environments.
- GOBS is observation data. A specific skill on GNSS signal processing is required in order to be used. If this data is correctly used, then dead-reckoning navigation could be enhanced (thanks to the possibility of few observations (i.e. 1,2 or 3 sat) ; instead of the minimum of 4 sat required to compute a single position.
- GSBS is SBAS data deliver by EGNOS satellite. This data can be used to enhance GOBS data.

In any case, indoor environments disturbed a lot GNSS signals, so a well-balanced choice is required when using GNSS data.



Column	ground truth position	Comments
1	"POSI"	ground truth position label
2	GPS Time of Week (ToW) in second	
3	WGS84 longitude in decimal degrees	
4	WGS84 latitude in decimal degrees	
5	Floor Number in integer	0 : Ground Floor, -X : for downstairs number X Y : for upstairs floor n° Y
6	POSI number index	Incremental counter, starting at "1"

Sample strings for ground truth position data

POSI,137766.000,23.780099827,61.494600019,0,1
POSI,137854.505,23.780363395,61.494526707,0,2

Note1: POSI frame is only used twice in scoring trials. For the first Key Point (n°1) and the second Key Point (n°2).

Note2: POSI frame is used in testing trial to help competitors to tune their algorithm.



Testing Trial: dataset recorded around 17h00 (local time), the 2nd of June 2025 in Tampere (Finland)

Type	Description	URL to download
Testing Trial	CSV file containing all data as described in section "Description of Datasets". GroundTruth is given inside IPIN2025_T4_TestingTrial_v1.txt through POSI frames.	https://data.d4science.net/6aLv
Ground Truth	Ground Truth of TestingTrial given @60Hz for offline evaluation purpose.	matlab file: https://data.d4science.net/mLjD Python file: https://data.d4science.net/qsMH kml file: https://data.d4science.net/ojby
NEW Tutorial	Python script given as an example to play with Your specific TestingTrial name (TT) : run 2026_Track4_EvaalAPI_example_v1.0.py "TT"	Python files: https://data.d4science.net/cByiL
Allan Variance	static logfile of about 14 hours that can be used for sensors bias estimation.	https://data.d4science.net/3Hyg
Magnetometer Calibration	logfile of about 1 minute that can be used to calibrate the magnetometer sensor	https://data.d4science.net/Q7U5
GNSS Navigation file	contains ephemeris data for those who want to use GNSS sensor.(format RINEX 3.04)	https://data.d4science.net/9Sut
GNSS Observation header	<pre> 3.04 OBSERVATION DATA M: Mixed RTKCONV demo5 b34L 20250623 123852 UTC format: u-blox UBX log: D:\IPIN2025\ULISS\2025.06.02_Testing-1_ULISS\uless-1-tr ace-942\gnss.ubx </pre>	<pre> RINEX VERSION / TYPE PGM / RUN BY / DATE COMMENT COMMENT MARKER NAME MARKER NUMBER MARKER TYPE OBSERVER / AGENCY REC # / TYPE / VERS ANT # / TYPE APPROX POSITION XYZ ANTENNA: DELTA H/E/N SYS / # / OBS TYPES SYS / # / OBS TYPES SYS / # / OBS TYPES SYS / # / OBS TYPES SYS / # / OBS TYPES TIME OF FIRST OBS TIME OF LAST OBS SYS / PHASE SHIFT SYS / PHASE SHIFT SYS / PHASE SHIFT SYS / PHASE SHIFT SYS / PHASE SHIFT SYS / PHASE SHIFT SYS / PHASE SHIFT SYS / PHASE SHIFT SYS / PHASE SHIFT SYS / PHASE SHIFT GLONASS SLOT / FRQ # GLONASS SLOT / FRQ # GLONASS COD/PHS/BIS END OF HEADER </pre>
RINEX 3.04 spec	Specification of RINEX format version 3.04	https://data.d4science.net/a3Jn



- **Note about Maps use**

- Usage of maps as an input for the computation of position estimates is **not allowed**. Track chairs, in such a case, could cancel contributions of competitor.
- Algorithms are not supposed to embed or access maps to enhance positioning. However, maps can still be used in the scope of auto-assessment during the preparation phase (Testing Trial).

- **Key Points:**

- All reference points are given at a sampling rate $\sim 60\text{Hz}$, for offline evaluation purpose.
- 34 ground truth key points will be given as POSI frames through EvalAPI.
- Among them the two first are important, because they can be used to compute a good heading like for “Scoring Trial” sessions (see Key Point n°1 and Key Point n°2 below).
- Evaluation is based like other Tracks: i.e. position estimates have to be computed and sent twice a second ($\sim 2\text{Hz}$; i.e. EvalAPI horizon of 0.5s), synchronized with the eval data stream, and thus corresponding to the end of each dataset window of 0.5s.
- The output format is described in the chapter “Description of the Output File” here after.

- **Points given in order to get a good first heading:**

Two reference points are given to competitor in order to help them.

- **Coordinates of Key Point n°1 (starting point):**

- GPS Tow : 137766.000 s
- longitude: 23.780054845 °
- latitude : 61.494621014 °
- Floor Nb : 0
- Corresponding POSI line:
POSI,137766.000,23.780054845,61.494621014,0,1

- **Coordinates of Key Point n°2 (at less than $\sim 10\text{m}$ far from starting point):**

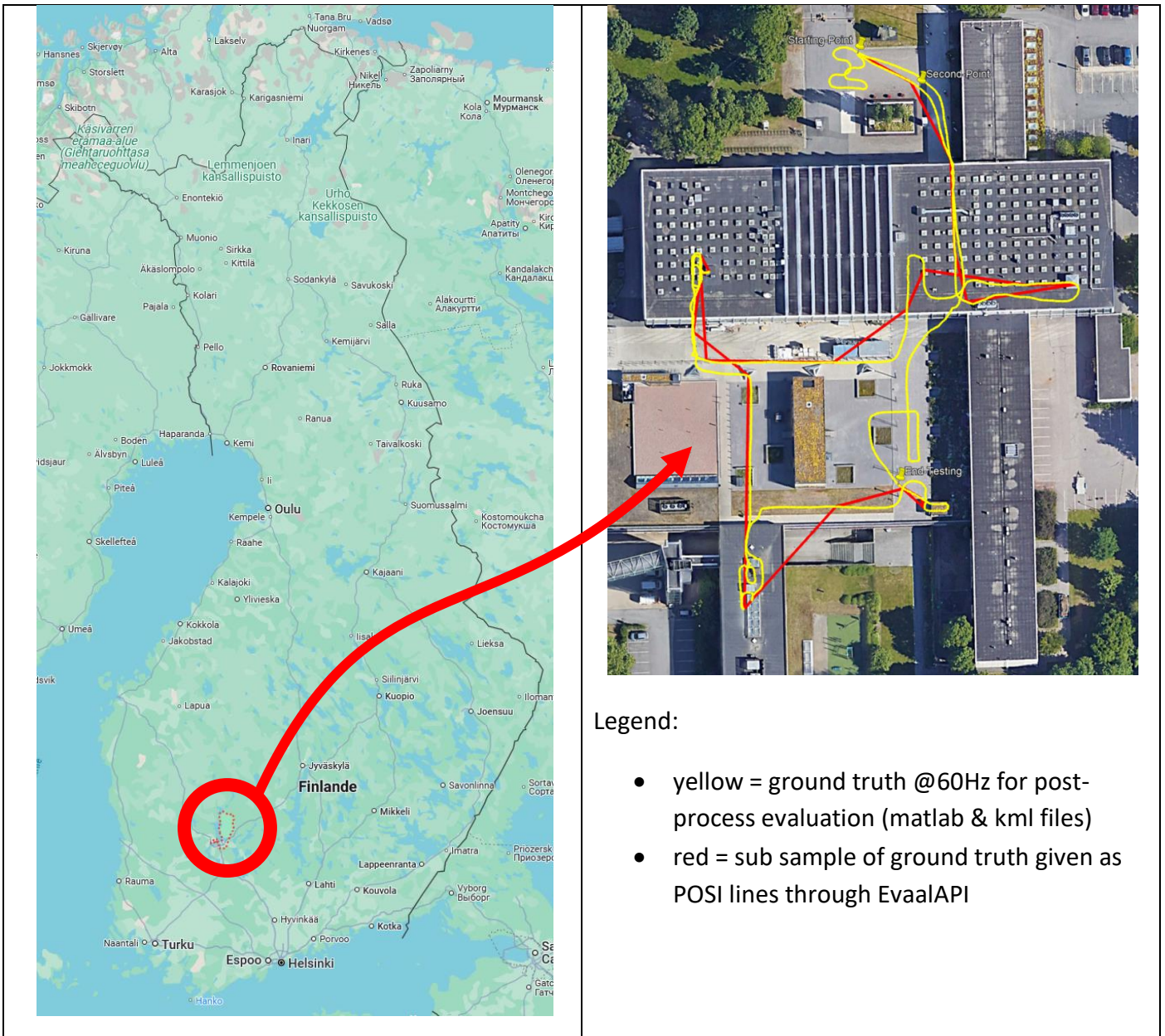
- GPS Tow : 137854.505 s
- longitude: 23.780294812 °
- latitude : 61.494559522 °
- Floor Nb : 0
- Corresponding POSI line:
POSI,137854.505,23.780294812,61.494559522,0,2



○ **Coordinates of Key Point n°34 (ending point):**

- GPS Tow : 138507.533 s
- longitude: 23.780239010 °
- latitude : 61.493687427 °
- Floor Nb : 0
- Corresponding POSI line:
POSI,138507.533,23.780239010,61.493687427,0,34

Bird view:



Legend:

- yellow = ground truth @60Hz for post-process evaluation (matlab & kml files)
- red = sub sample of ground truth given as POSI lines through EvaalAPI



Scoring Trial: dataset recorded around XX h XX (local time), the XX of June 2025 in Tampere

Type	Description	URL to download
Scoring Trial	<u>SCORING TRIAL is only accessible via EvaalAPI</u>	coming later
Allan Variance	static logfile of about 14 hours that can be used for sensors bias estimation.	coming later
Magnetometer Calibration	logfile of about 1 minute that can be used to calibrate the magnetometer sensor	coming later
GNSS Navigation file	contains ephemeris data for those who want to use GNSS sensor.(format RINEX 3.04)	coming later
GNSS Observation header	coming later	
RINEX 3.04 spec	Specification of RINEX format version 3.04	https://data.d4science.net/a3Jn



- **Note about Maps use**

- Even if maps may be allowed in others tracks, for this one, **it is NOT**. Track chairs, in such a case, could cancel contributions of competitor.
- Algorithms are not supposed to embed or access maps to enhance positioning.

- **Key Points:**

- Only 2 ground truth key points will be given as POSI lines through EvaalAPI (see Key Point n°1 and Key Point n°2 in the Bird View below).
- Evaluation is based like other Tracks: i.e. position estimates **have to be computed and sent twice a second (~2Hz)**, synchronized with the eval data stream, and thus corresponding to the end of each dataset window of 0.5s.
- Based on previous point, Track4 is now able to assess all estimations computed by competitors. Thus, last editions, for instance, more than 3000 key points were evaluated for each run of competitors.
- The output format is described in the chapter “Description of the Output File” here after.

- **Points given in order to get a good first heading:**

Two reference points are given to competitor in order to help them.

- **Coordinates of Key Point n°1 (starting point):**

- GPS Time of Week in seconds: **coming later**
- WGS84 longitude in decimal degrees: **coming later**
- WGS84 latitude in decimal degrees: **coming later**
- Floor Number in integer: **coming later**
- Corresponding POSI line: **coming later**

- **Coordinates of Key Point n°2 (at less than ~10m far from starting point):**

- GPS Time of Week in seconds: **coming later**
- WGS84 longitude in decimal degrees: **coming later**
- WGS84 latitude in decimal degrees: **coming later**
- Floor Number in integer: **coming later**
- Corresponding POSI line: **coming later**



IPIN2026

SIXTEENTH INTERNATIONAL CONFERENCE ON
INDOOR POSITIONING
AND INDOOR NAVIGATION
05th – 08th October 2026, Rome, Italy

Version 2.0 (March 31st, 2026)



- Bird view: coming later

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Description of the Output stream to return by competitor

For each scoring trial, competitor is asked to give processed data inside the field “position estimates” of the *GET/TRIAL/nextdata* EvaalAPI request. The string “position” has to be composed of the 4 following fields:

- Field 1: WGS84 longitude in decimal degrees with at least 9 decimal digit resolution
- Field 2: WGS84 latitude in decimal degrees with at least 9 decimal digit resolution
- Field 3: Floor Number in integer. 0 for Ground Floor, -X for downstairs number X, Y for upstairs floor n° Y
- Field 4: Incrementing counter starting from 1. 1 being the first point computed by competitor, 2 being the second, and so on...

Comma (“,”) has to be used as data delimiter.

Assessment will take into account the PTS (timestamp relative to the last position) return by *GET/TRIAL/estimates* EvaalAPI request.

Examples of successive string “position estimates” included in *GET/TRIAL/nextdata* requests:

```
-1.542614572,47.217689856,0,1  
-1.542614573,47.217689855,0,2  
-1.542614574,47.217689854,2,3  
...
```

Corresponding example of *GET/TRIAL/estimates* request:

```
pts,c,h,s,pos  
217034.000,0.000,0.000,45.000,-1.542614572,47.217689856,0,1  
217034.500,1662121746.081,0.500,43.762,-1.542614572,47.217689856,0,1  
217035.000,1662121747.877,0.500,45.000,-1.542614573,47.217689855,0,2  
217035.500,1662121749.670,0.500,45.000,-1.542614574,47.217689854,2,3  
...
```



Evaluation criterion

The final metric will be based on the accuracy for the correct floor detection and the horizontal positioning error. In particular, the score for comparing the different location systems will be based on the following equations:

Accuracy Score = 3rdQuartile{SampleError(R_i, E_i)}, \forall groundtruth reference in all final test sets
 $SampleError(R_i, E_i) = Distance(R_i, E_i) + (penalty \times floorfail)$

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 estimate 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 m.
- $Distance(R_i, E_i)$ calculates the Euclidean distance between coordinates (longitude and latitude) of R_i and E_i .

The team with the lower “Accuracy Score” wins.

Contact points and information

For any further question about the database and this competition track, please contact to:

- Miguel Ortiz (miguel.ortiz@univ-eiffel.fr) at the University Gustave Eiffel, France.
- Ni Zhu (ni.zhu@univ-eiffel.fr) at the University Gustave Eiffel, France.

Introduced changes

For any further question about the database and this competition track, please contact to:

Version 1.0	January 27 th , 2026	First version. -Including Testing Trial of previous 2025 edition. - Add of a new kind of data: GPVT that is the position computed by the GNSS receiver embedded inside ULISS.
<u>Version 2.0</u>	<u>March 31st, 2026</u>	<u>Update dates of agenda page1</u>