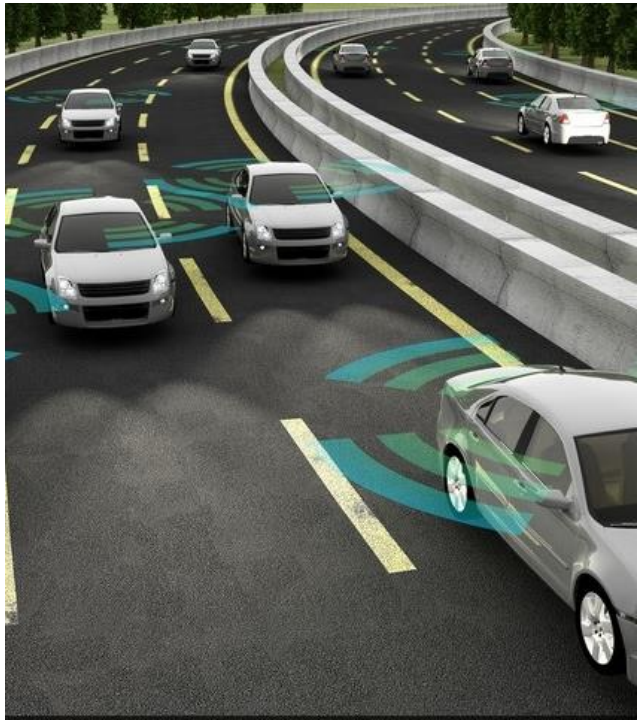
European Global Navigation Satellite Systems Agency

PRoPART
Precise and Robust Positioning for Automated Road Transports

European Global Navigation Satellite Systems Agency

HORIZON 2020

PROPART
FINAL DEMONSTRATION



UWB Ranging Concept

Leader: Ainhoa Cortés (Ceit-IK4)

Astazero, Boras, 2019-11-21

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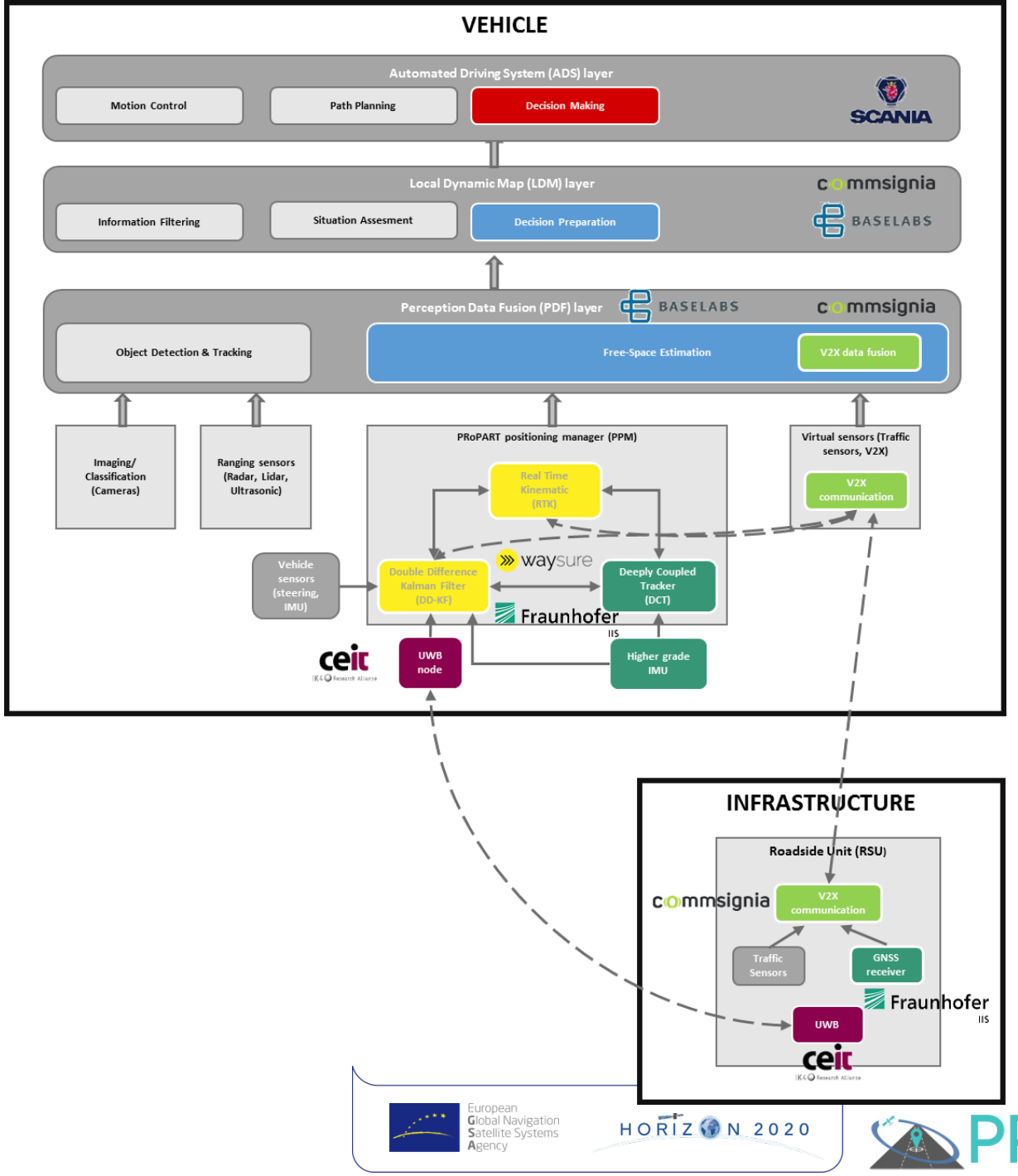
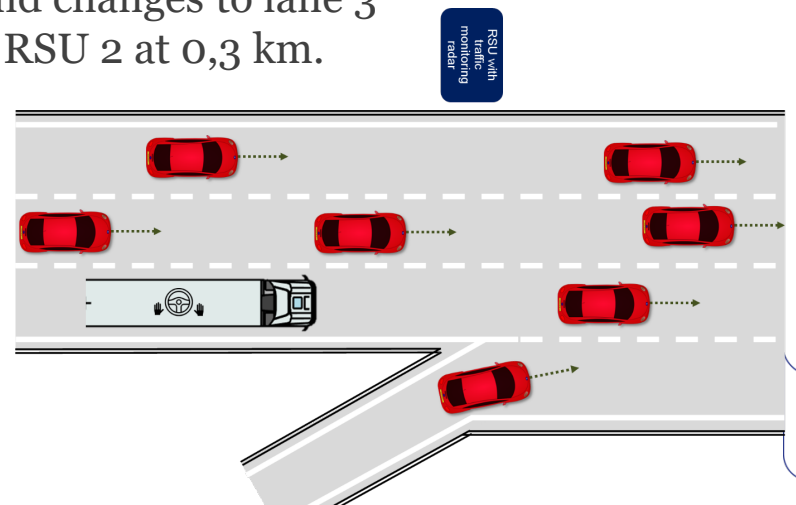
PRoPART Concept

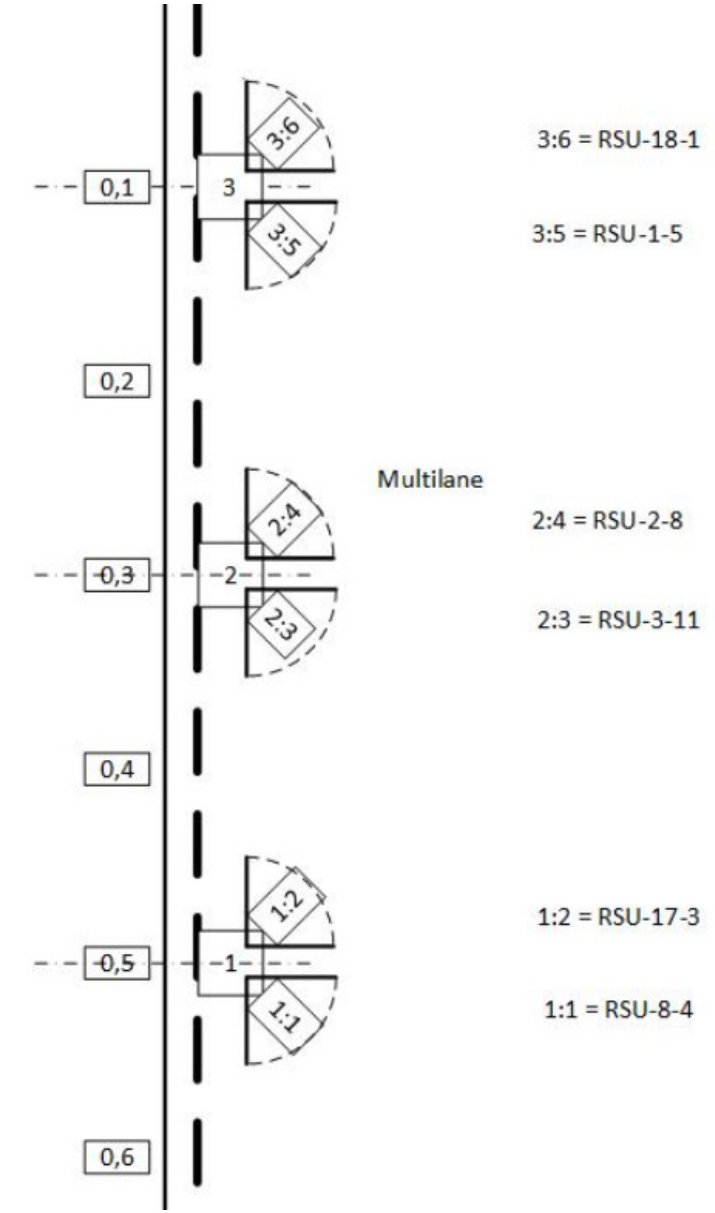
- **UWB**: **indoor positioning technology** applies to **outdoors** positioning.
  - PRoPART challenges:
    - High-accuracy in the cm level.
    - High range (hundreds of meters).
    - At high speed.
- A **redundant system** to get a robust, precise and safer solution when the GNSS has any problem e.g. **no coverage in tunnels or urban canyons** or system drops.
- **Low-cost UWB nodes** are needed **in both sides** to provide to PPM the relative distances between infrastructure and vehicle.



PRoPART use case and scenario

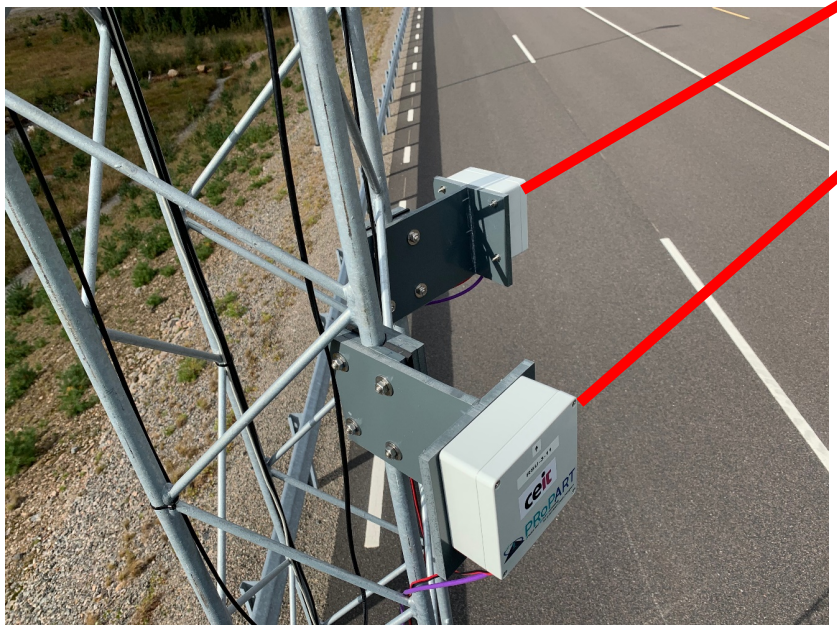
- Use case: **automated lane change to the left**. So, **RSUs at one side**. But, the solution can be adapted to another use cases.
- **Demonstration at Astazero**: around 600 meters.
  - Three RSUs each 200 meters.
  - Truck:
    - Average truck speed: 40 km/h.
    - Starts on lane 2 and changes to lane 3 when reaches the RSU 2 at 0,3 km.





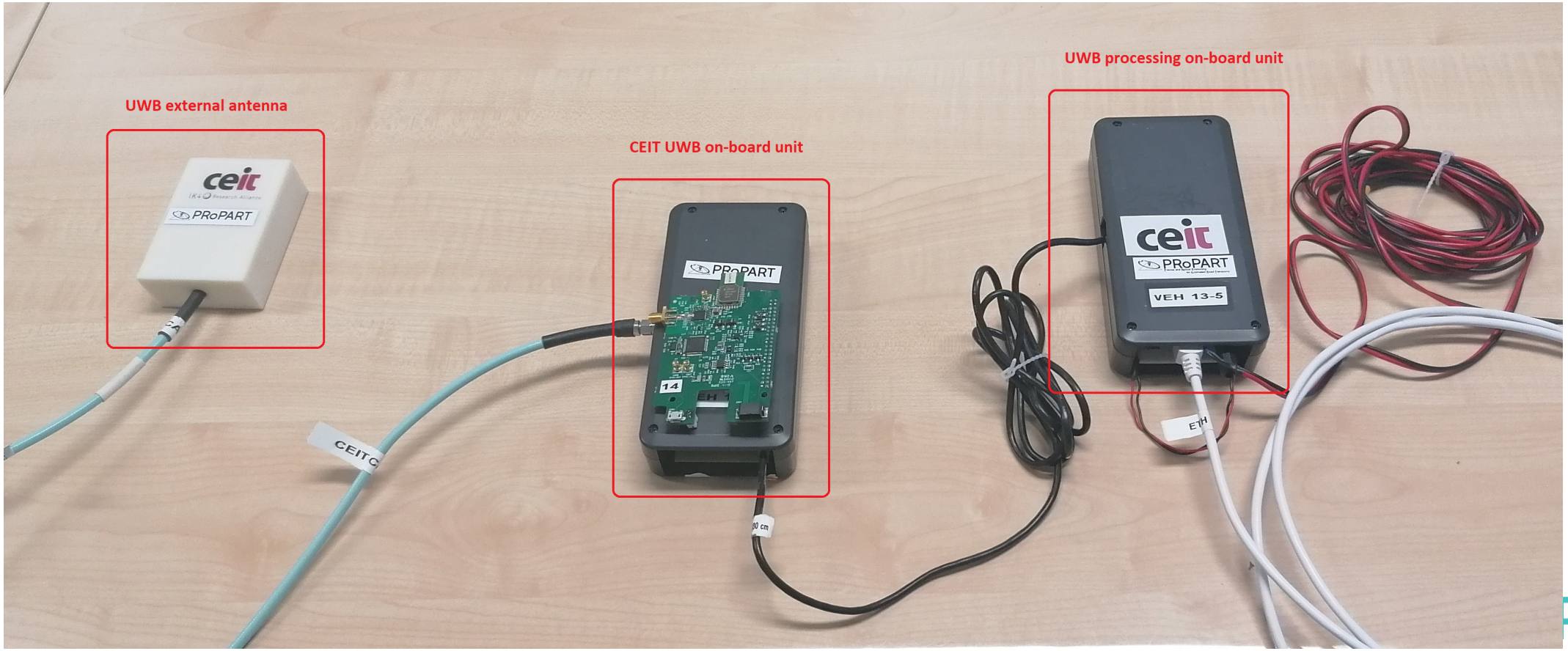
UWB elements at the RSU side

- **Own and customized low cost electronics** for the UWB nodes **designed by CEIT**.
- Ad-hoc calibration procedure to use external or integrated antenna. In the **fixed nodes**, we can use the **integrated antennas** enough to **comply with the PRoPART requirements in terms of range and accuracy**.
- IP housing to protect the electronics from humidity, rain…



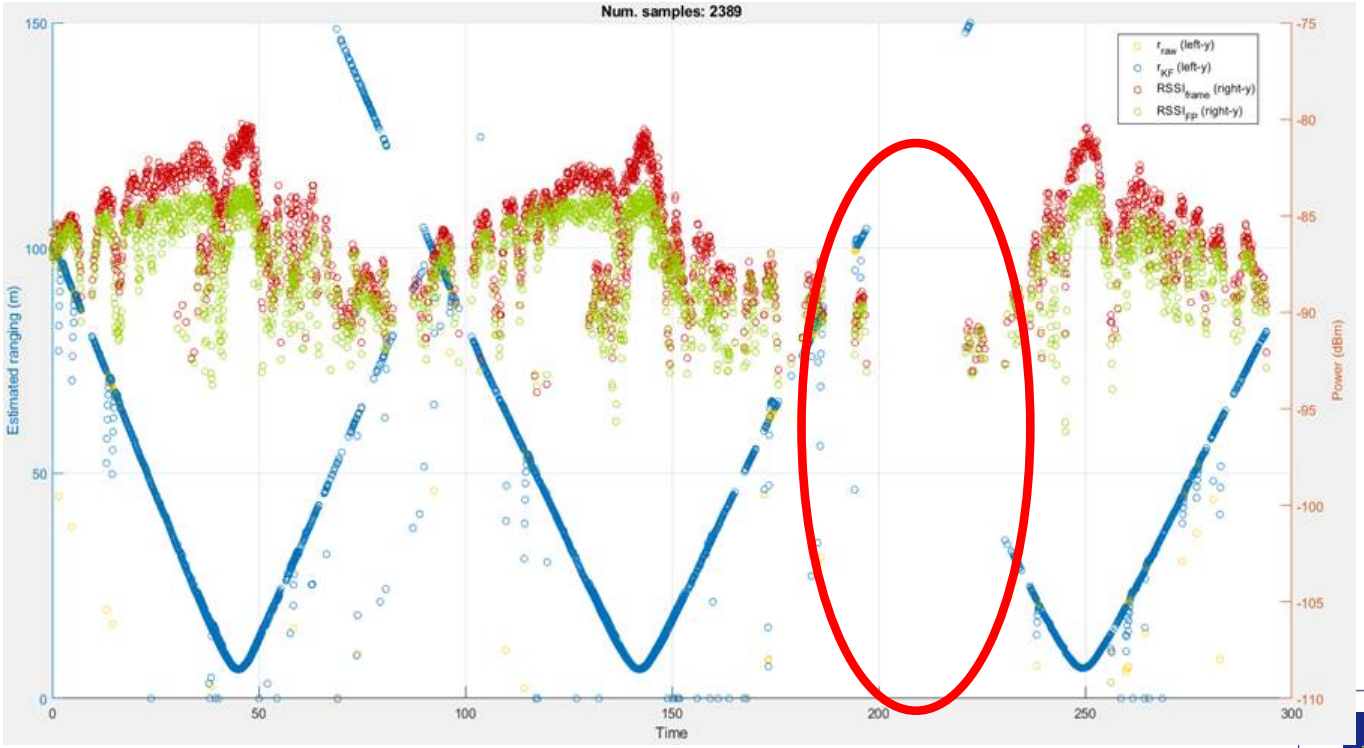
UWB elements on-board

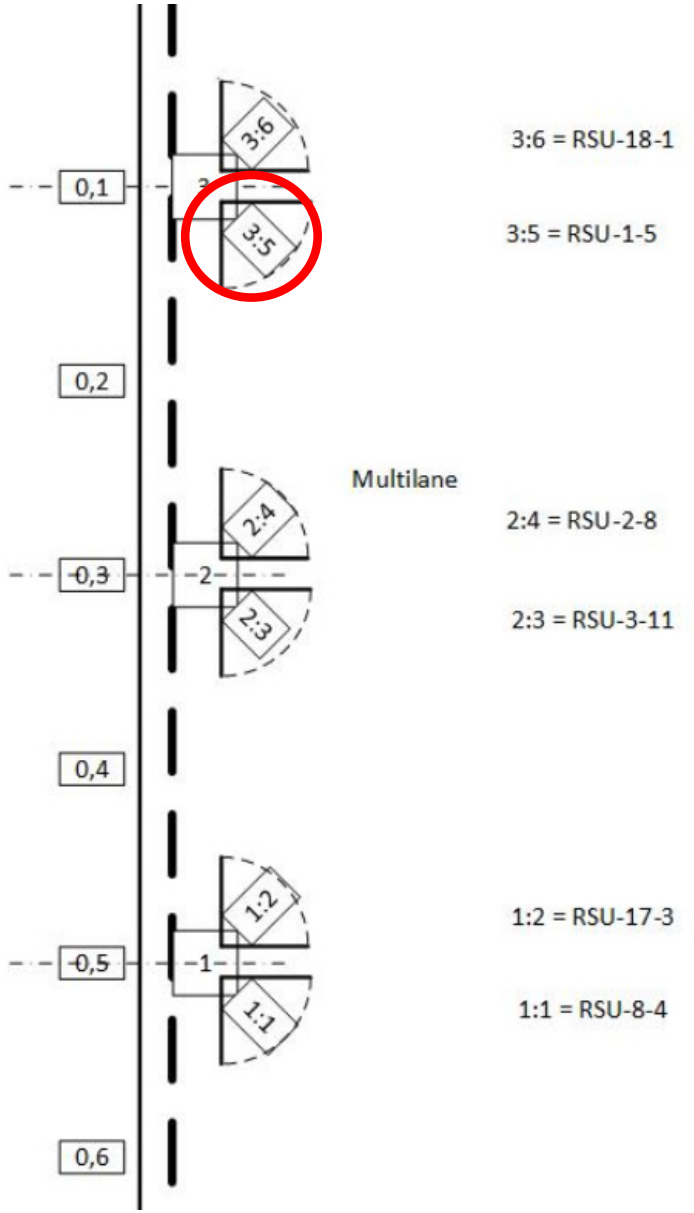
- **Customized prototype for on-board units**:
  - **External antenna** (wind mirror) to **avoid metallic parts of the truck** and keep good performance (range and accuracy).
  - More **flexible design** (without previously knowing the location of the antenna): **separated enclosures**.
  - **Electronics inside the cabin of the truck** to get more robust design.



Test 1: Range of ranging estimations (RSUs)

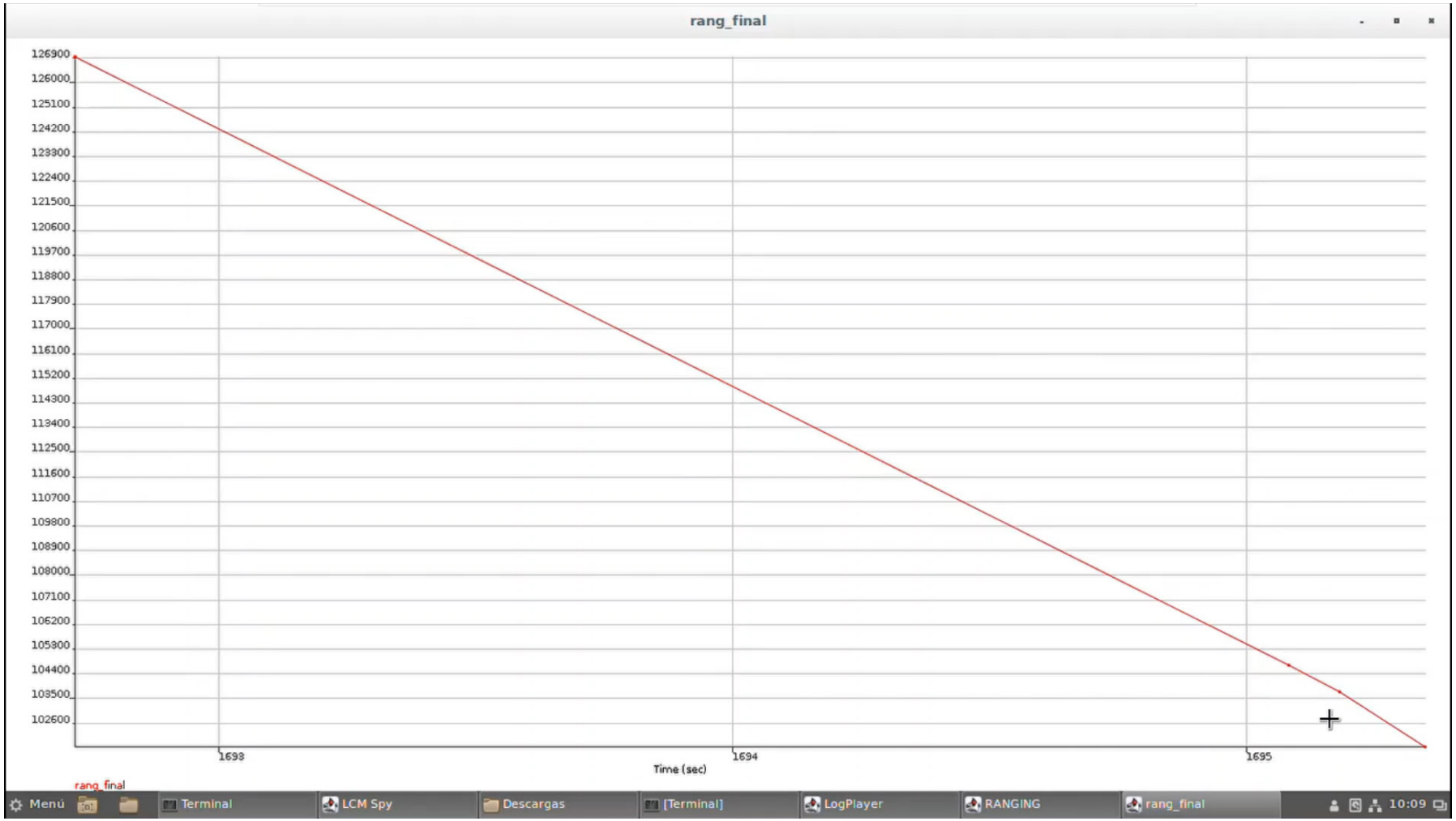
- **6 UWB nodes at RSU** side at **4 meters of height**.
- **A person walking with the mobile node** through lane 2 (at 3 meters of height).
- Average person speed: 5 km/h.
- In this case UWB node RSU 3:5 is switched down (testing different number of fixed nodes)





Test 2: Range of ranging estimations (RSUs – TRUCK)

- 6 UWB nodes at RSU side at **4 meters of height**.
- RSU 2:3 is switched down.
- Truck starts on lane 2 and changes to lane 3 when reaches the RSU 2 at 0,3 km.
- Average truck speed: 40 km/h.
- **<u>One UWB node onboard</u>**:
  - Around **2.8 meters of height**.
  - Gap due to RSU 2:3 not active.
  - Seeing RSU 2:4 and RSU 3:5 during some period of time simultaneously.



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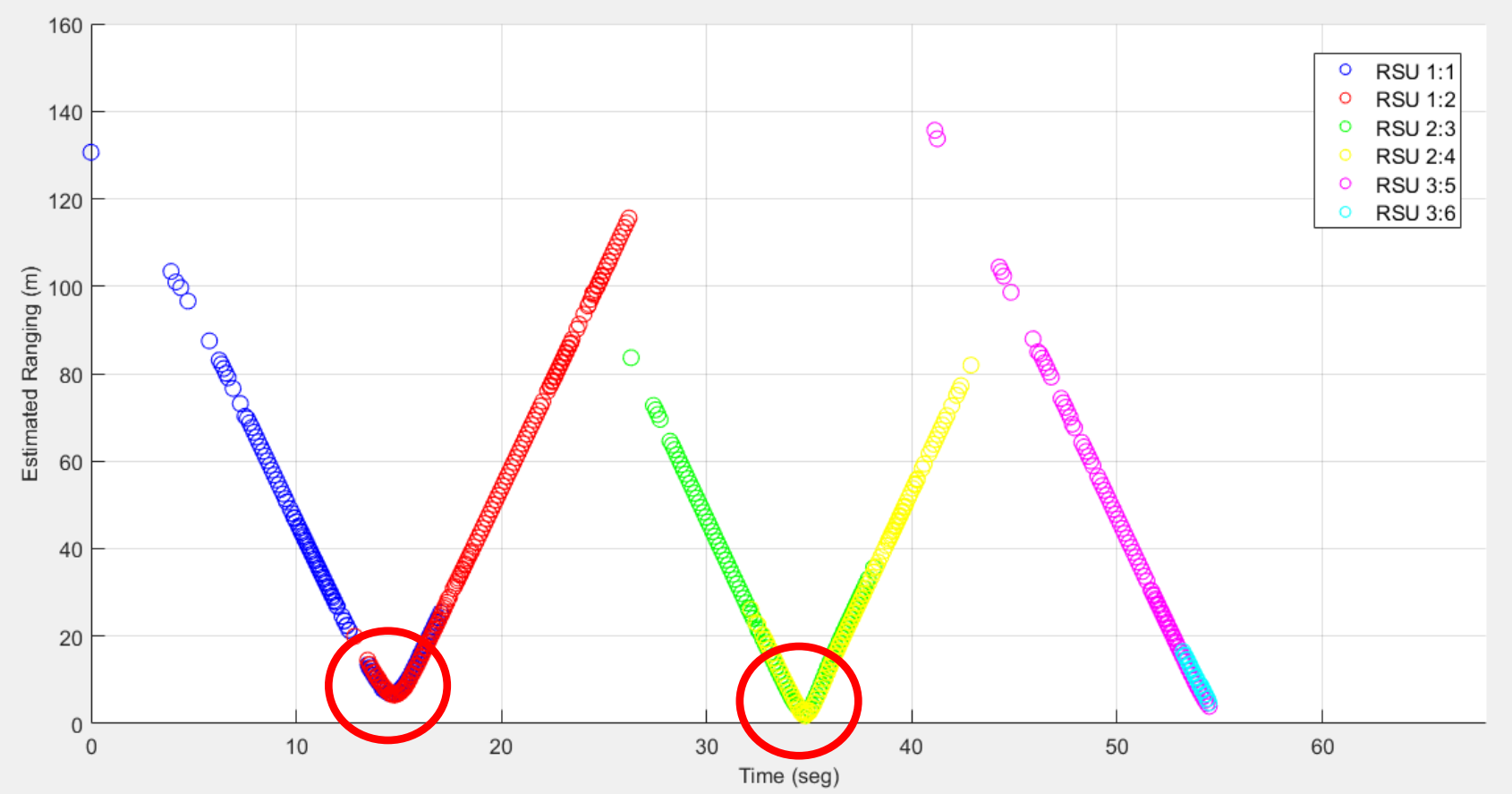
Test 3: Range of ranging estimations (RSUs – TRUCK)

- 6 UWB nodes at RSU side at **4 meters of height**.
- Truck starts on lane 2 and changes to lane 3 when reaches the RSU 2 at 0,3 km.
- Average truck speed: 40 km/h.
- **Two UWB node onboard**:
  - Around **2.8 meters of height** both of them.



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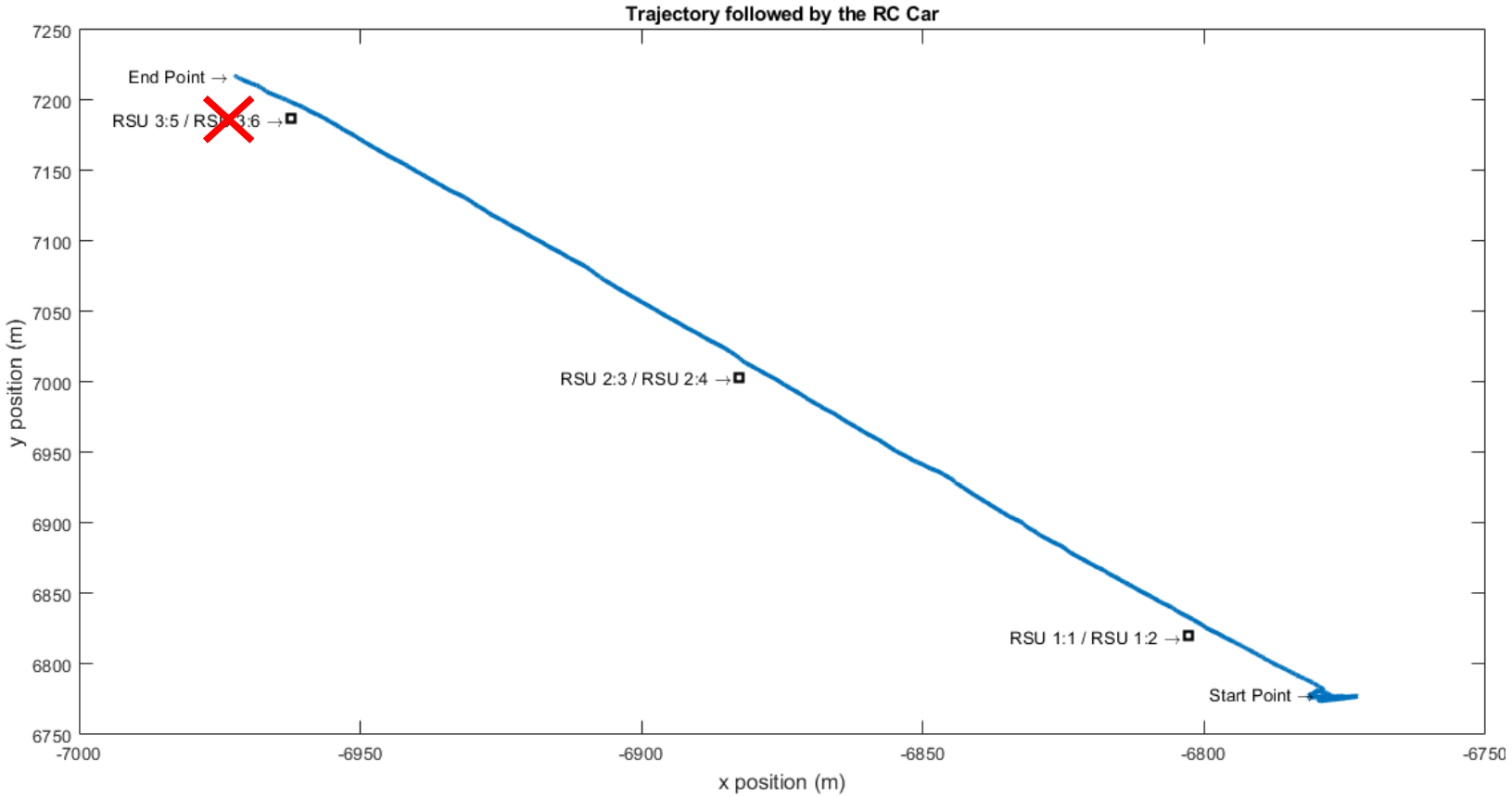
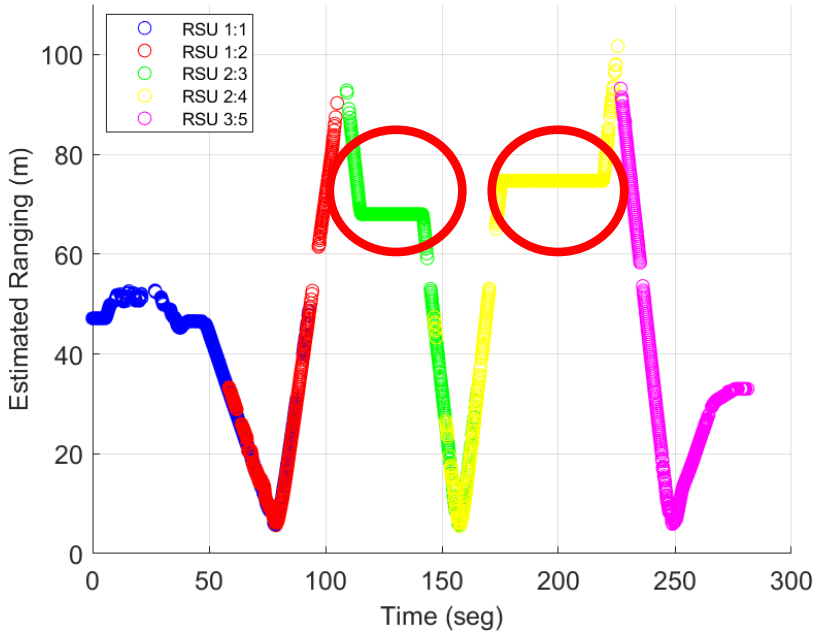
CEIT UWB elements attached to the RC Car

- 6 UWB nodes at RSU side at **4 meters of height**.
- One UWB node attached to the RC Car at **1 meter of height and the antenna is oriented looking forward (at the direction of the movement).**
- Average RC Car speed: 20 km/h.
- Two testing trajectories:
  1. Similar to the **PRoPART use case**: keeps on lane 2 without lane change (RC Car in manual mode).
  2. Closed-loop trajectory (RC Car in automatic mode)

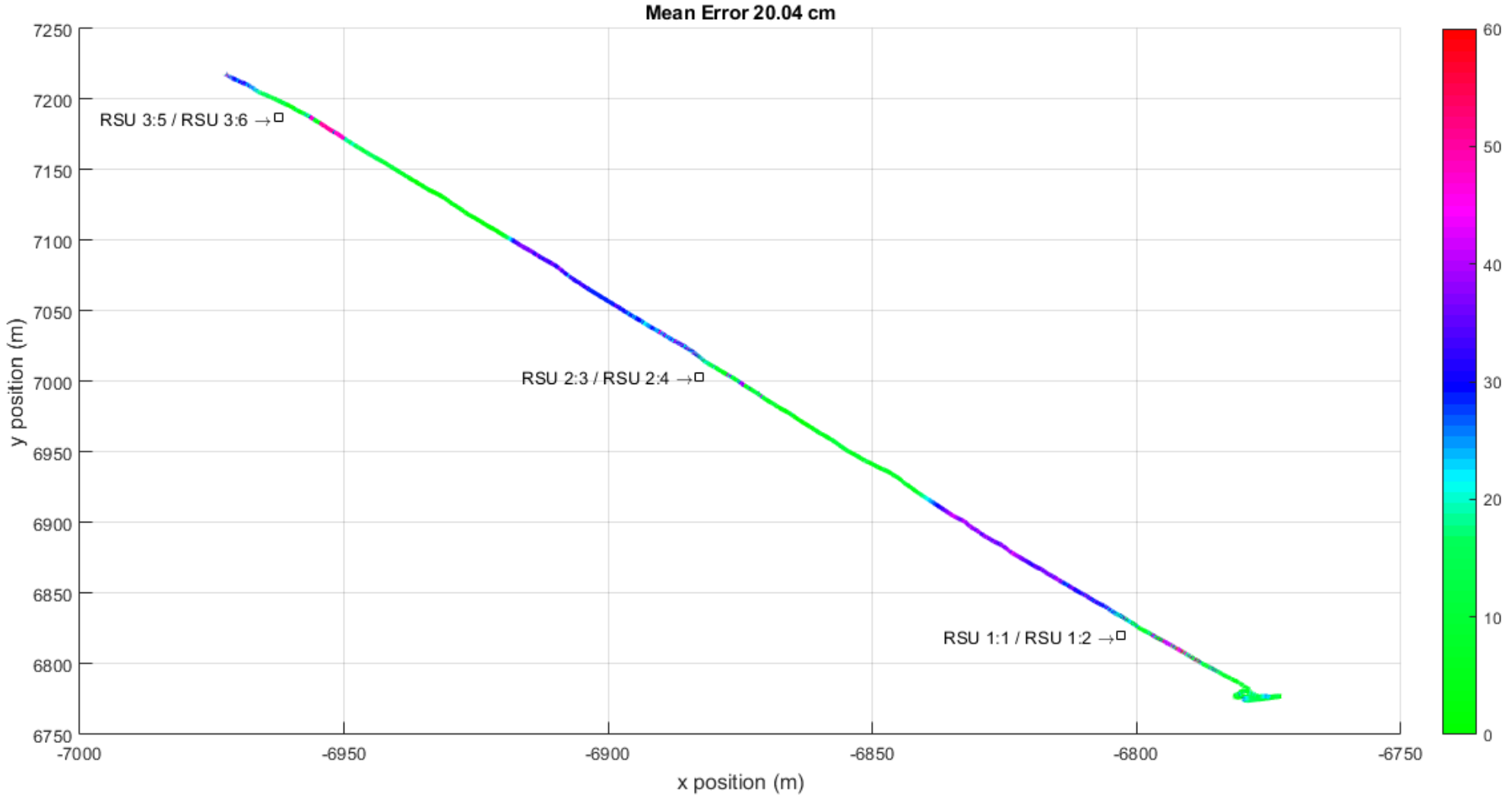
Range of ranging estimations (RSUs – RC Car) Trajectory 1



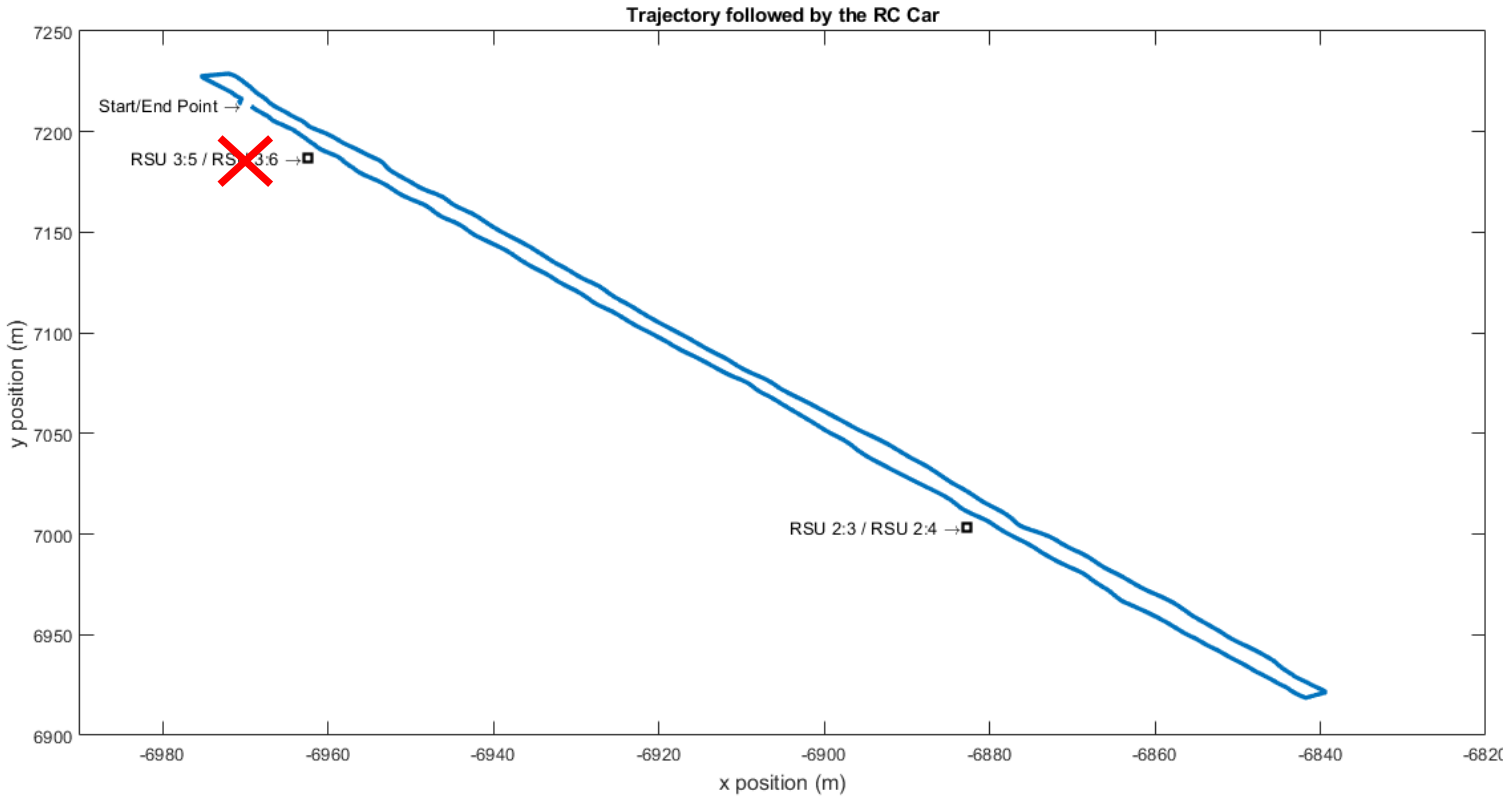
- RC Car due to communication losses with the main controller.



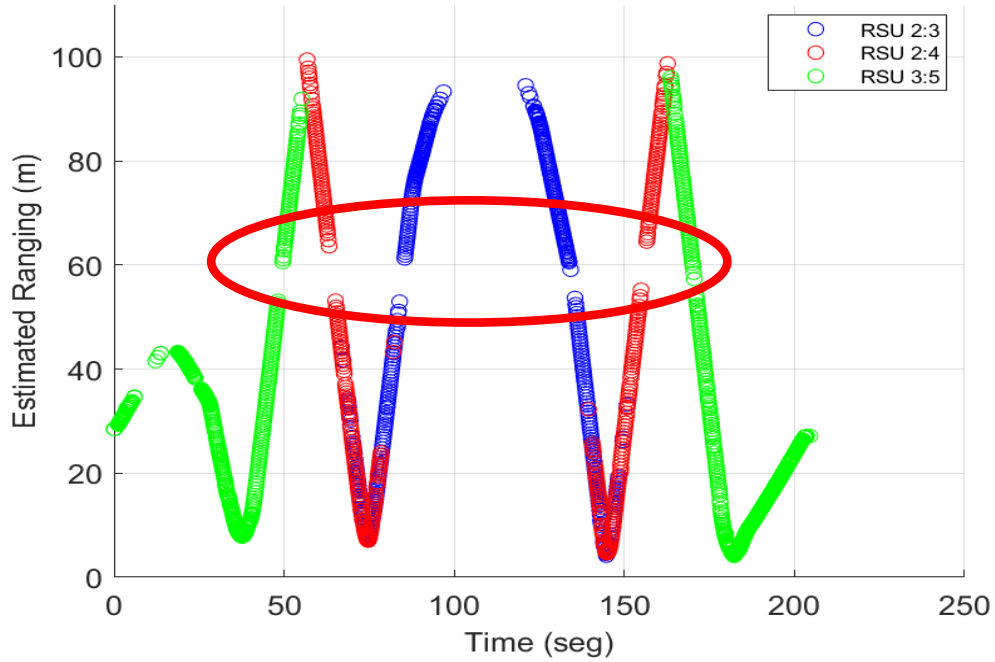
Accuracy of ranging estimations (RSUs – RC Car) Trajectory 1



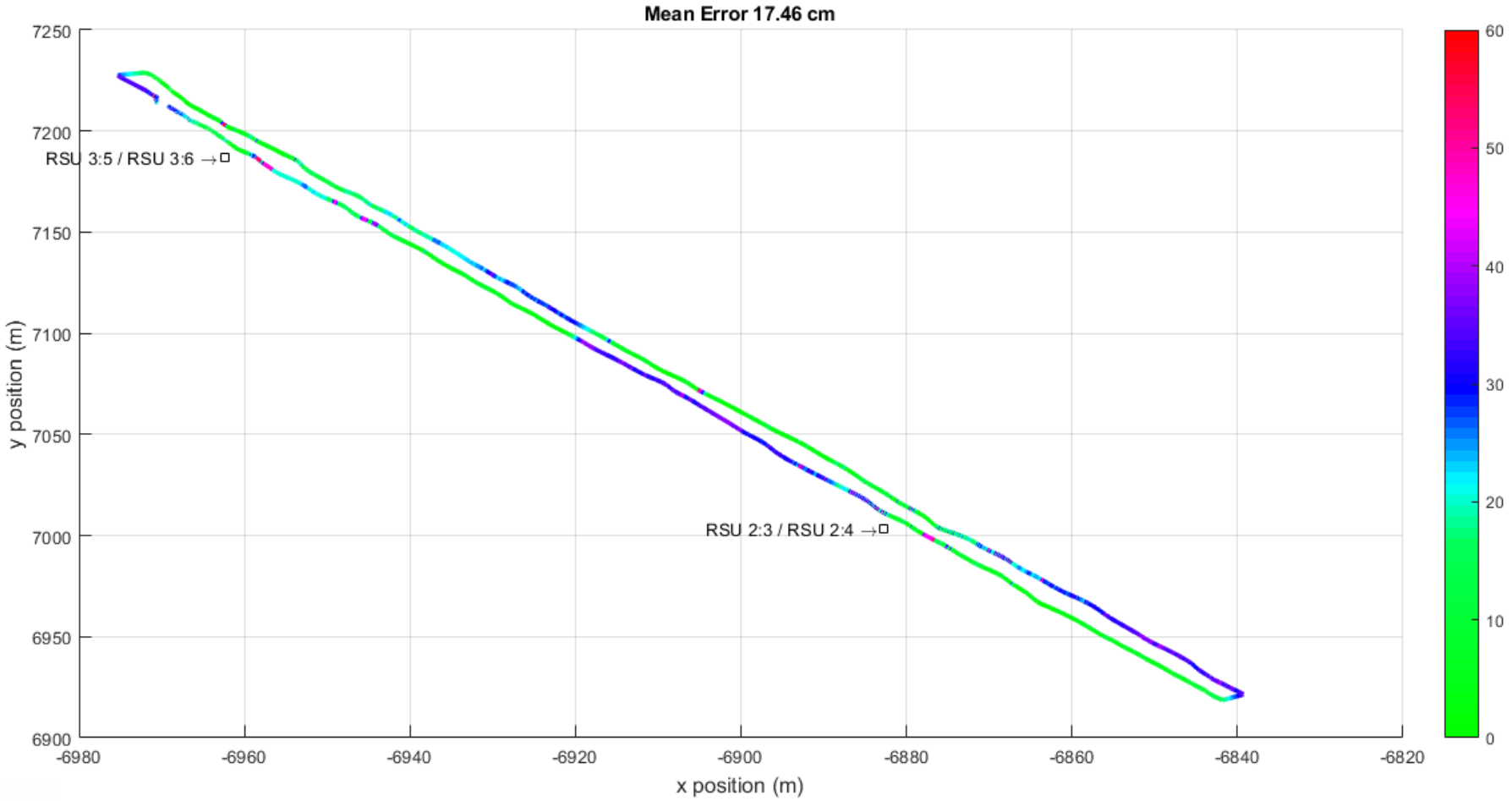
Range of ranging estimations (RSUs – RC Car) Trajectory 2



- Some signal power losses at 60 meters but during few seconds -> **No problem**, it continue being able to correct the trajectory since the error accumulated by the IMU will be low.



Accuracy of ranging estimations (RSUs – RC Car) Trajectory 2



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THANK YOU

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