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# European Hyperloop Center

## Specification

European Hyperloop Week 2026

14 November 2026 - Version 2.0

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EUROPEAN  
HYPERLOOP  
WEEK

## Introduction

This document provides information and specifications of the European Hyperloop Center to the teams such that they can effectively design and develop a prototype to operate within the infrastructure.

This document also includes some additional requirements that teams must comply with in addition to the rules and regulations of the competition (in line with T.2.4. of the Rules and Regulations). These are listed in section EHC.R .

If teams seek additional information or wish clarification regarding the information in this document they can submit questions according to A.8.27 – A.8.29. If teams require, 3D CAD files can be shared with teams if needed.

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## Test Facility Overview

The European Hyperloop Center (EHC) is a hyperloop test facility with a length of approximately 420 meter. It consists of a lane switch that splits a single tube into two tubes.



Figure 1: Image of the European Hyperloop Center.

For the purpose of the European Hyperloop Week, the first 112 meters (first 7 pipes) of the EHC infrastructure will be made available for teams to perform tests. Due to time constraints, all tests will be performed under atmospheric pressure.

## Facility Specifications

Below is an overview of the main characteristics of the European Hyperloop Center Infrastructure:

- Total Length: 420 meter.
- Number of Pipes (segments): 21 Linear Pipes and 13 Switch Pipes.
- Pipe Material: Steel S355
- Pipe Diameter: 2.5 meter.
- Pipe Length (segment): 16 meter.
- Thermal Expansion: Expansion Joint every 4 pipe segments.
- Supports: Concrete (every 16 meter).

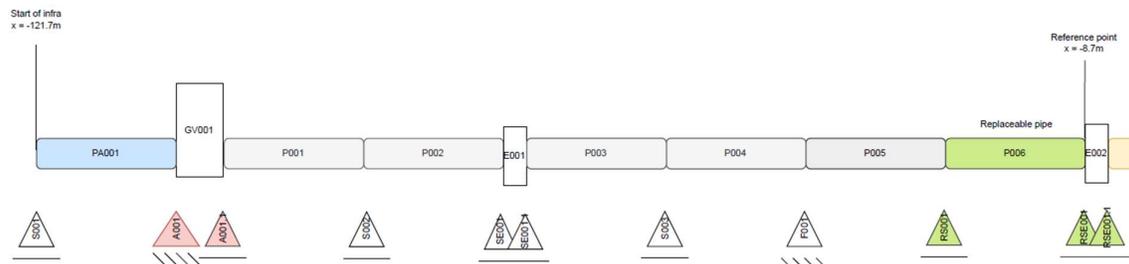


Figure 2: Schematic Overview First 7 Pipes.

## Infrastructure Track Specifications

Within the European Hyperloop Center several tracks are placed at the top of the infrastructure for the following functions:

- Levitation (blue, detail X).
- Guidance (green, detail Z).
- Propulsion (linear synchronous reluctance motor) (red, detail Y).
- Safety (braking and back-up support) (orange, detail AA).

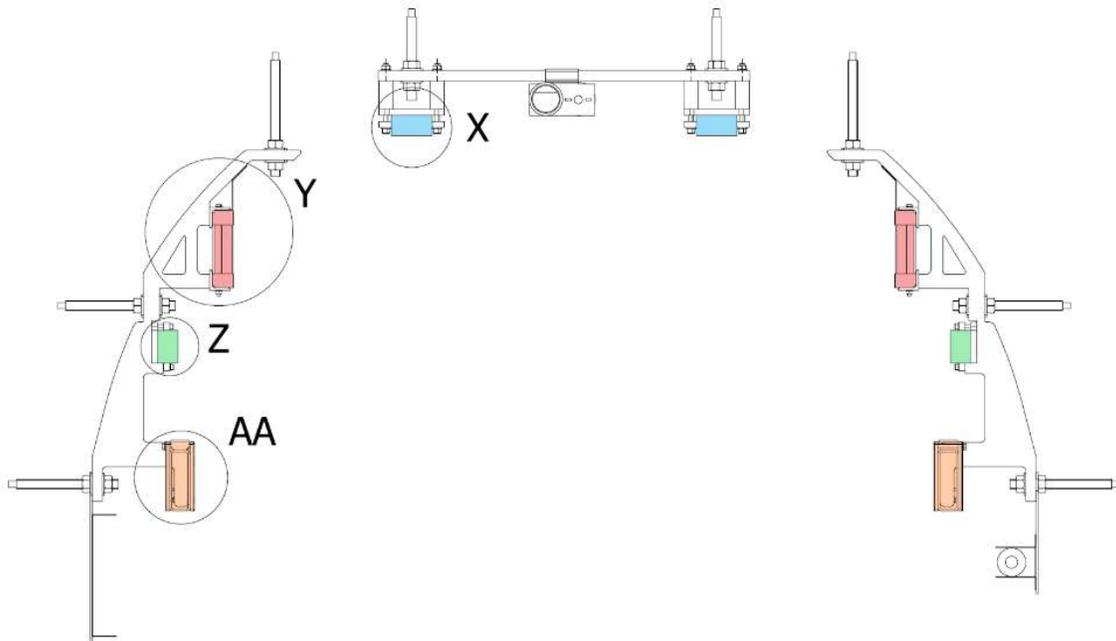


Figure 3: Overview of European Hyperloop Center Tracks.

## Track Position & Tolerances

The position and tolerances of the placement of the tracks within the European Hyperloop Center can be found below.

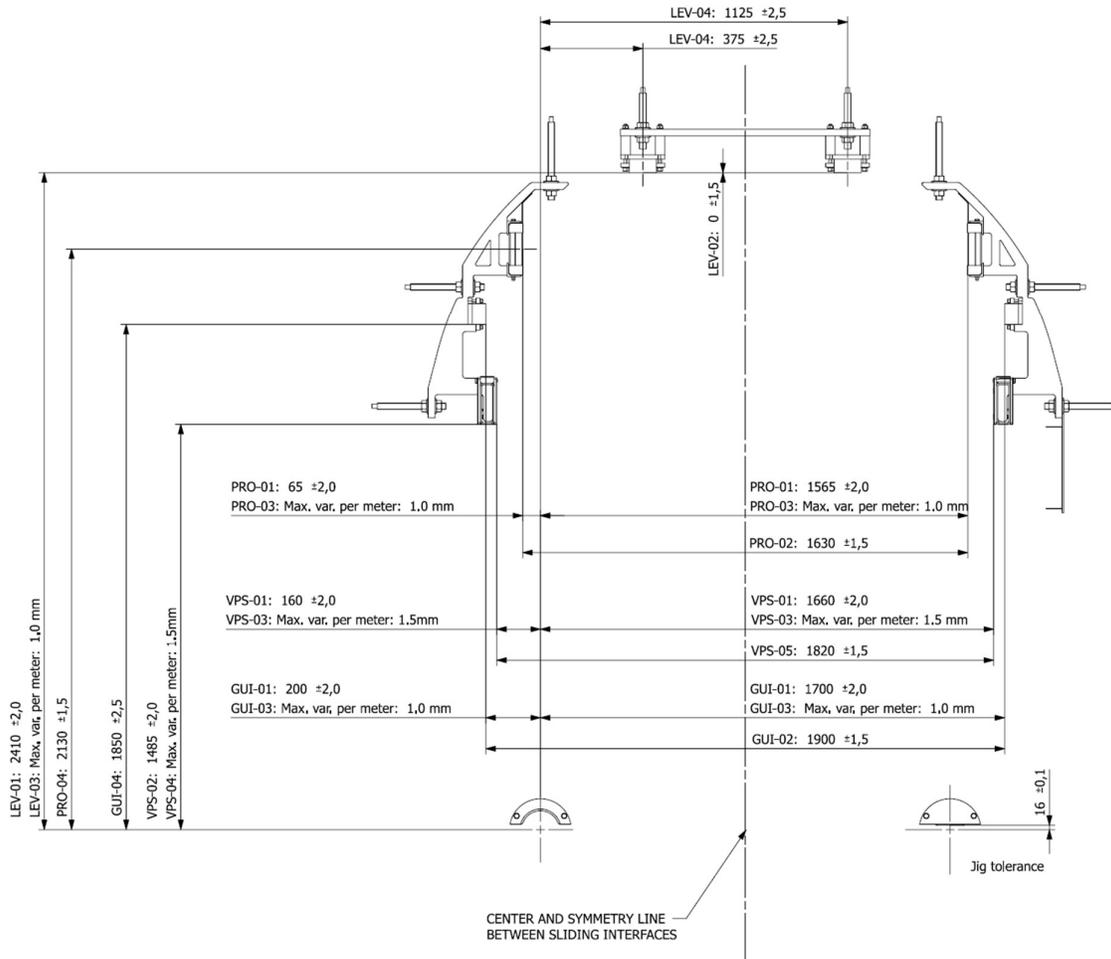


Figure 4: Track locations and tolerances.

The tolerances specified (e.g. LEV-01) are the tolerance within a single pipe section of 16 meter. Often another tolerance for the maximum variation per meter is provided (e.g. LEV-03).

Teams should take note that due long-term effects, on-site placement, and other effects these tolerances have not always been met exactly. Teams are advised to take this into account during their design.

## Infrastructure Keep-Out Zone

Teams need to ensure that their vehicle fits within the permitted envelope specified below to prevent unwanted contact between their prototype and the infrastructure.

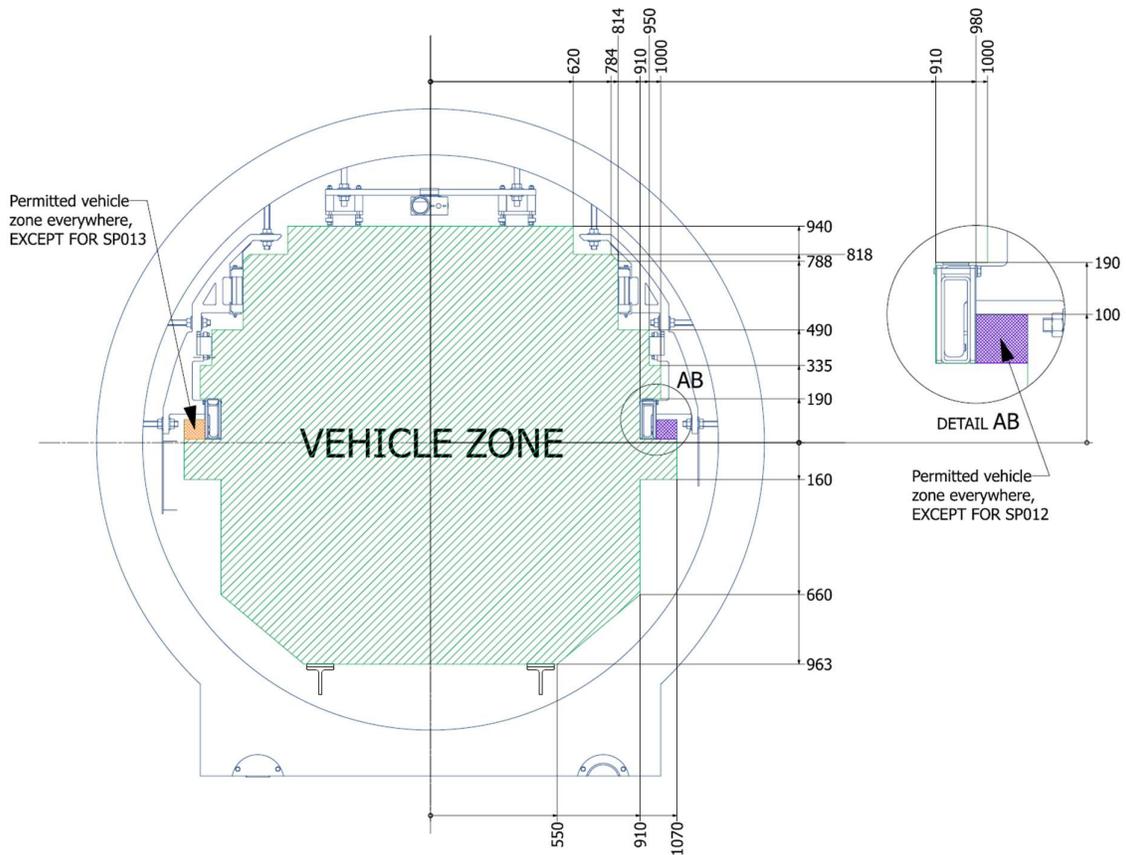


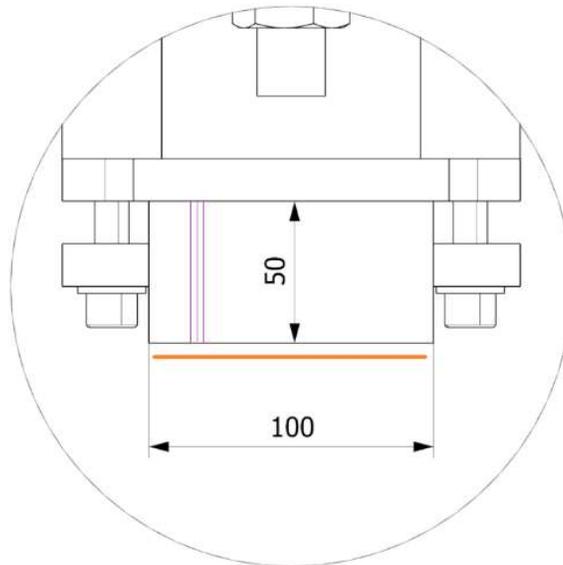
Figure 5: Permitted zone for prototypes.

## Description of Tracks

### Levitation Track

Figure 6 provides a closeup of the levitation track. Characteristics and requirements include:

- Track segment length: 1 m.
- Topology & materials: rectangular track made of M470-50A, laminated as indicated in purple.
- Point of possible contact (orange):
  - The material hardness on the prototype shall be no greater than 121 HB / 70 HRB.
  - A shallow chamfer shall be present on the prototype's feature in the directions of travel, with the chamfer angle being no greater than 20 degrees.
  - The material shall prevent forming any permanent bond with the track as a result of sustained contact.
  - Abrasion of the on-board material shall not lead to any significant fire or respiratory hazard.



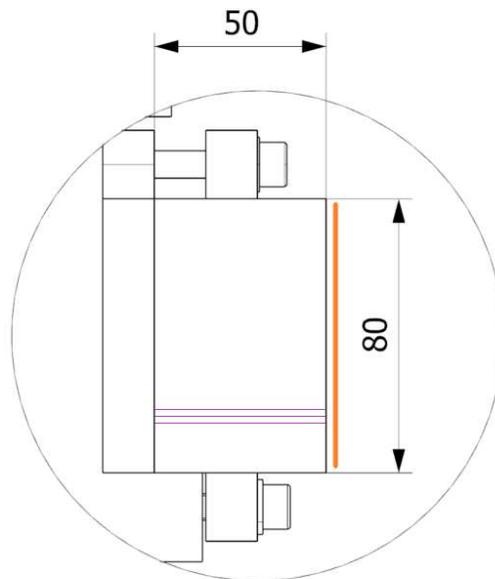
DETAIL X

Figure 6: Detail of levitation track.

## Guidance Track

Figure 7 provides a closeup of the guidance track. Characteristics and requirements include:

- Track segment length: 1 m.
- Topology & materials: rectangular track made of M470-50A, laminated as indicated in purple.
- Point of possible contact (orange): needs to be avoided as much as possible. When contacting:
  - The material hardness on the prototype shall be no greater than 121 HB / 70 HRB.
  - A shallow chamfer shall be present on the prototype's feature in the directions of travel, with the chamfer angle being no greater than 20 degrees.
  - The material shall prevent forming any permanent bond with the track as a result of sustained contact.
  - Abrasion of the on-board material shall not lead to any significant fire or respiratory hazard.



DETAIL Z

*Figure 7: Detail of guidance track.*

## Propulsion Track

Figure 8 provides an isometric view of a propulsion track segment, which is comprised of various components that are shown in a closeup in Figure 9. Characteristics and requirements include:

- Track segment length: 4 m.
- Topology & materials:
  - Magnetically separated track blocks made of M470-50A, whose individual dimensions are presented in Figure 10. The blocks are placed at a 200 mm pitch, as shown in Figure 11.
  - A 35 mm wide layer of HMPE that sits on either side of the track blocks and protrudes 1 mm from the surrounding components.
  - The track is accompanied by a 2 mm thick flange on the top made of stainless steel 304L. Barcode stickers with encoder marks are present on the blue surface across the entire track, which can be used for position measurements (see section about positioning system).
  - The collective is supported by two stainless steel L-brackets which are located behind the layers of HMPE.
- Points of possible contact (green): contact is permitted exclusively with the layers of HMPE. Direct contact with the electrical steel track blocks is not allowed. Requirements for any prototype features that may come in contact with the HMPE include:
  - A shallow chamfer shall be present on the prototype's feature in the directions of travel, with the chamfer angle being no greater than 20 degrees.
  - The prototype's feature shall have a surface roughness of no greater than 3.2  $\mu\text{m Ra}$ .
  - The temperature at the contact patch shall never exceed 80 degrees Celsius, given a temperature of 30 degrees Celsius as initial condition.
  - Abrasion of an on-board material shall not lead to any significant fire or respiratory hazards.

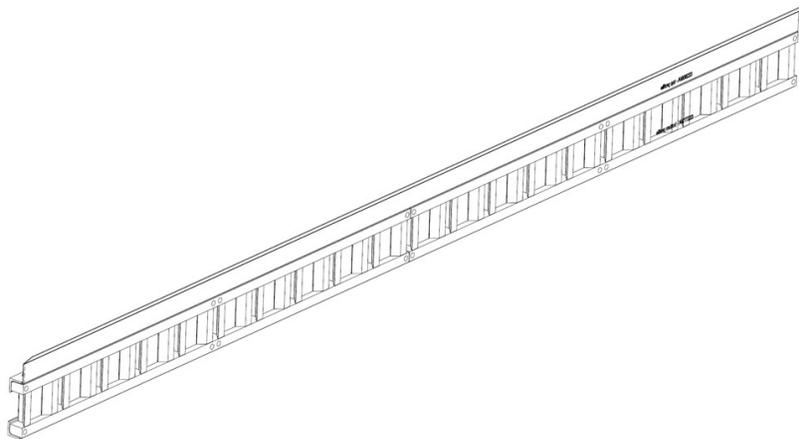


Figure 8: Propulsion track segment.

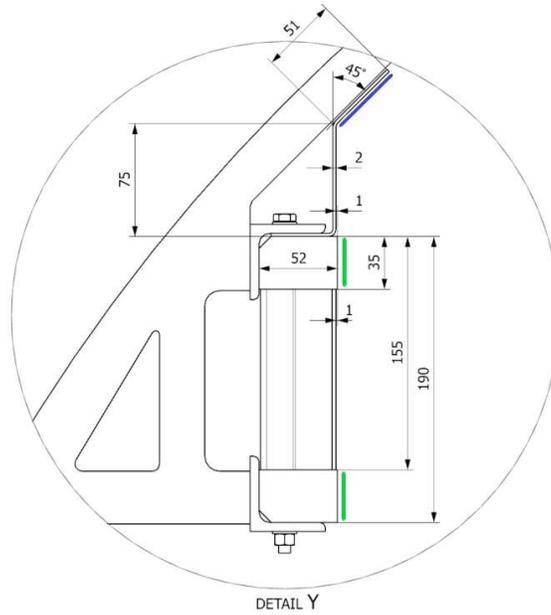


Figure 9: Propulsion track detail.

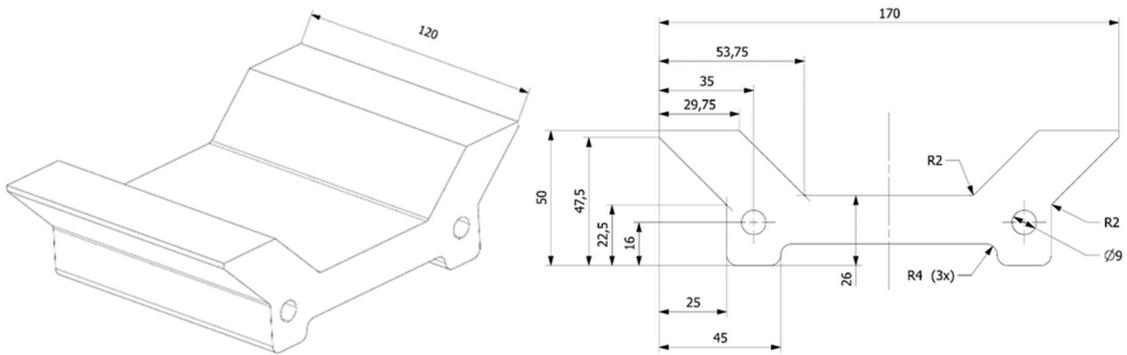


Figure 10: Propulsion track block dimensions.

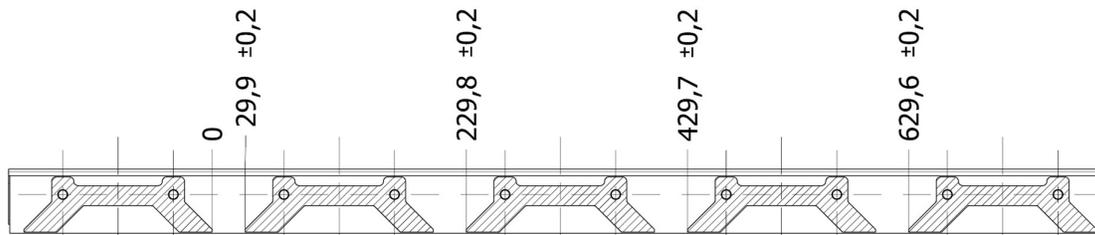


Figure 11: Layout of propulsion track blocks.

## Safety Track

Figure 13 provides a closeup of the safety track. Characteristics and requirements include:

- Track segment length: 3.0 - 3.5 m.
- Topology & materials:
  - Gray: Steel track attachment.
  - Orange: Hollow section made of SS 304L.
  - Blue: plates made of SS 304L.
  - Green: 45 mm wide layer of HMPE that protrudes 5 mm from the stainless-steel plates.
- For contact on the top face, contact is permitted exclusively with the HMPE. For this contact area, requirements are identical to those stated for the propulsion track, namely:
  - A shallow chamfer shall be present on the prototype's feature in the directions of travel, with the chamfer angle being no greater than 20 degrees.
  - The prototype's feature shall have a surface roughness of no greater than  $3.2 \mu\text{m Ra}$ .
  - The temperature at the contact patch shall never exceed 80 degrees Celsius, given a temperature of 30 degrees Celsius as initial condition.
  - Abrasion of an on-board material shall not lead to any significant fire or respiratory hazards.
  - Every 1000 mm there is gap between the HMPE parts of approximately 100 mm to accommodate the steel track attachment as shown in Figure 12.
- For contact on the remaining faces, contact is permitted with the stainless-steel components with a few remarks:
  - On the bottom face momentary contact is permitted, however continuous contact is not.
  - Contact with the outboard face (left) is permitted but not preferred.
- Requirements for prototype features that make contact with the stainless-steel track components include:
  - The material hardness shall be no greater than 170 HB / 87 HRB.
  - A shallow chamfer shall be present on the prototype's feature in the directions of travel, with the chamfer angle being no greater than 20 degrees.
  - The material shall prevent forming any permanent bond with the track as a result of sustained contact (galling of particular relevance here).
  - Abrasion of the on-board material shall not lead to any significant fire or respiratory hazard.

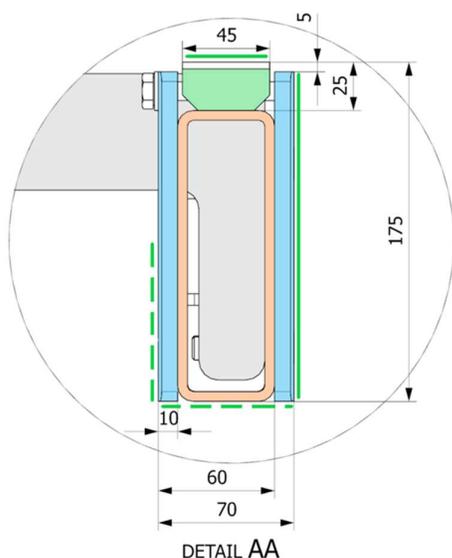


Figure 13: Safety track detail.



Figure 12: HMPE profile gaps.

## Maximum Loads Permitted

To prevent damage to the European Hyperloop infrastructure maximum forces are defined which are not allowed to be exceeded. In addition to a maximum force, an equivalent stiffness is also defined for the track that can be used by teams to support their calculations (e.g. impact calculations). The maximum forces and equivalent stiffness can be found in Table 1.

A prototype may impact a track on several locations at once. In that case, a point load as high as the value presented in Table 1 may be reached on each point of contact, as long as said contact points are spatially separated by at least 1000 mm. For this evaluation objects that apply a force over a surface are simplified to point loads. For example, two magnets may impact with the levitation track, each reaching an impact force of 20 kN as long as they are spaced more than 1000 mm apart in longitudinal direction (center-to-center).

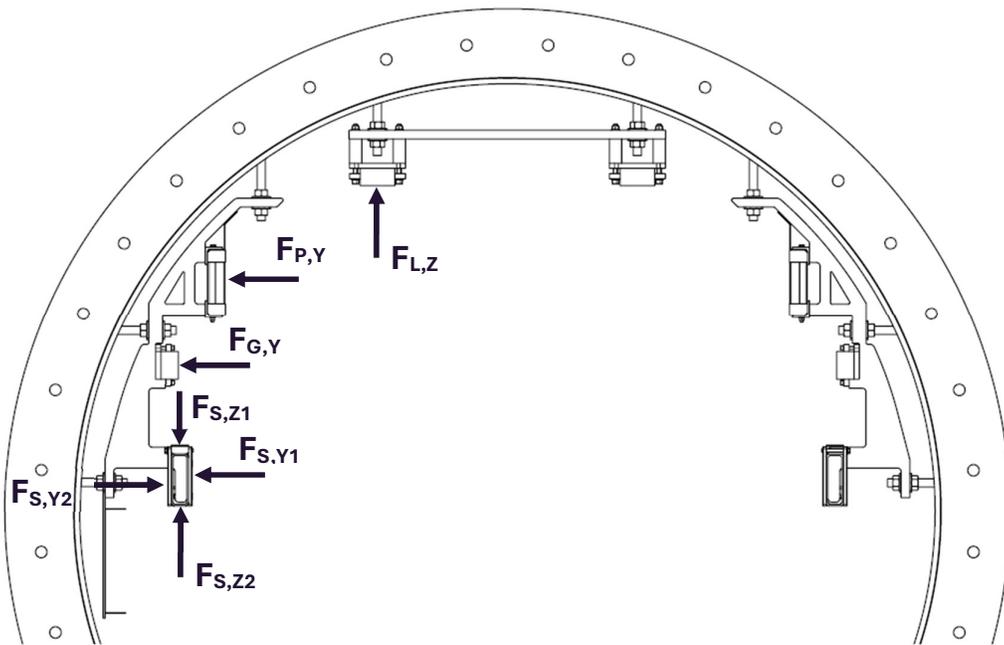


Figure 14: Track force reference locations.

Table 1: Track maximum forces and equivalent stiffness.

Track	Load	Max. Load	Equiv. Stiffness in impact direction	Remarks
Levitation	$F_{L,Z}$	$\pm 25.0$ kN	$6.6 \cdot 10^7$ N/mm	
Levitation	$F_{L,Y}$	$\pm 1.5$ kN	N/A	As a result of friction / magnet offset.
Levitation	$F_{L,X}$	$\pm 5.0$ kN	N/A	As a result of friction.
Propulsion	$F_{P,Z}$	$\pm 5.0$ kN	N/A	As a result of friction.
Propulsion	$F_{P,Y}$	$\pm 25.0$ kN	$5.3 \cdot 10^8$ N/mm	Only on plastic (see track desc.).
Propulsion	$F_{P,X}$	$\pm 5.0$ kN	N/A	As a result of friction.
Guidance	$F_{G,Z}$	$\pm 1.0$ kN	N/A	As a result of friction.
Guidance	$F_{G,Y}$	$\pm 30.0$ kN	$8.3 \cdot 10^8$ N/mm	
Guidance	$F_{G,X}$	$\pm 5.0$ kN	N/A	As a result of friction.
Safety Track	$F_{S,Z1}$	$\pm 25.0$ kN	$2.5 \cdot 10^8$ N/mm	
Safety Track	$F_{S,Z2}$	$\pm 25.0$ kN	$2.5 \cdot 10^8$ N/mm	
Safety Track	$F_{S,X}$	$\pm 5.0$ kN	N/A	Applies to all locations.
Safety Track	$F_{S,Y1}$	$\pm 19.0$ kN	$6.9 \cdot 10^8$ N/mm	
Safety Track	$F_{S,Y2}$	$\pm 19.0$ kN	$6.9 \cdot 10^8$ N/mm	

## Track Transitions at Pipe Connections

This section contains information about the transition from pipe-to-pipe where gaps and other features exist to support with the transition.

### Regular Pipe-to-Pipe Connection

At regular pipe-to-pipe connections a small gap is present between tracks up to approximately 10-20 mm as can be seen in Figure 15 below.



*Figure 15: Track transitions at regular pipe-to-pipe connections.*

At these transitions the following needs to be considered:

- The levitation track, guidance track, and propulsion track have no chamfers on the tracks.
- The safety rails at the transition of the stainless steel elements has small gaps with chamfers, making it more suitable to use for mechanical contact.
- The top surface (HMPE) of the safety rail is continuous as if it was in the middle of the pipe.

## Expansion Joint Connections

In the infrastructure multiple expansion joints are placed to manage the thermal expansion of the pipes. At these locations a significant gap is included between the tracks to allow for the thermal expansion. These gaps depend on the temperature but can be as large as 120 mm. Figure 16 below shows the connection in the expansion joints.



Figure 16: Expansion joint track connections.

At these transitions the following needs to be considered:

- The levitation track, guidance track, and propulsion track have no chamfers on the tracks.
- The safety rails at the transition of the stainless steel elements have a continuous surface, making it more suitable to use for mechanical contact.
- The top surface (HMPE) of the safety rail is continuous as if it was in the middle of the pipe. Except that the gap between plastic elements is increased from approx. 100mm to 160mm.
- At the propulsion track, plastic blocks have been added in the open space where normally the HMPE parts would be, the gap between these blocks and the track is generally <100 mm.
- At the propulsion track, 1 full track block is essentially missing.
- At the first expansion joint (directly after the first pipe), the gaps are largest and at this location there is a space larger than 1 full track block missing from the propulsion track, this effectively puts the track after the expansion joint at an offset of 90deg electrical angle. Accelerating through this section is therefore very complicated. Teams are recommended to start their acceleration after the expansion joint or turn-off their propulsion based on position.

## Positioning System

The positioning system can be used both to determine the absolute and relative position of prototypes within the infrastructure.

The positioning system for the European Hyperloop Center consists of two independent systems. For absolute positioning of the vehicle in the tube a barcode positioning system is used. Each barcode uniquely identifies 40 mm in the infrastructure.

Below the barcode sticker a sticker suitable for an incremental encoder is placed. This system comprises of a black and white alternating bars with a pitch of 10 mm. Below an index track is created with 400 mm indices that line up with the propulsion track blocks and thus effectively with the 0 degree electrical angle. A full electrical rotation of the propulsion system coincides with 400 mm of travel along the infrastructure.

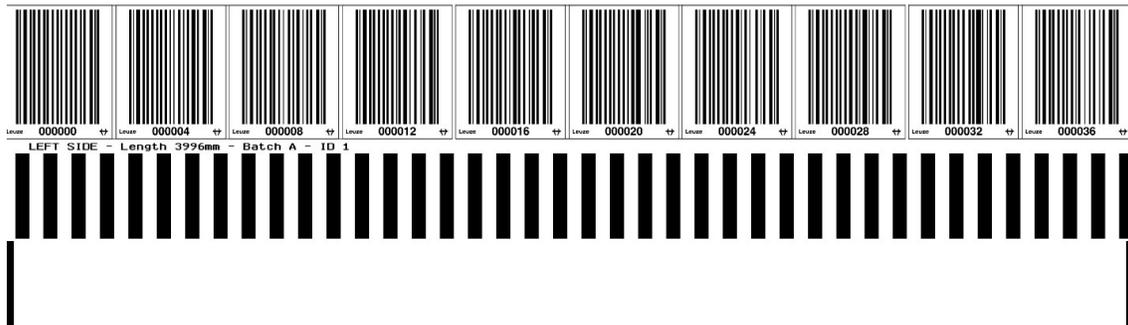


Figure 17: Example of sticker in the infrastructure.

To read the barcode sticker any barcode scanning equipment can be used. The BPS system from Leuze can be used and has been successfully tested before. This system scans four barcodes at a time for a precise measurement and gives a position and velocity values up to 10 m/s.



Figure 18: Leuze BPS338i Barcode Sensor.

For higher speeds the incremental encoder track can be used. For this system a contrast sensor is suitable to output a pulse pattern coinciding with the black and white stripes.

When the incremental track is read by two sensors one can determine whether the vehicle is moving forward or backwards. With the addition of the third sensor also the 0 position relative to the magnetic field of the linear motor can be determined.

These three signals can be interfaced to a Quadrature Encoder Interface (QEI) found on many microcontrollers and industrial systems.

Figure 19 below shows a cross section of the infrastructure where the positioning system is located. There is a positioning system on both the right and left side of the infrastructure.

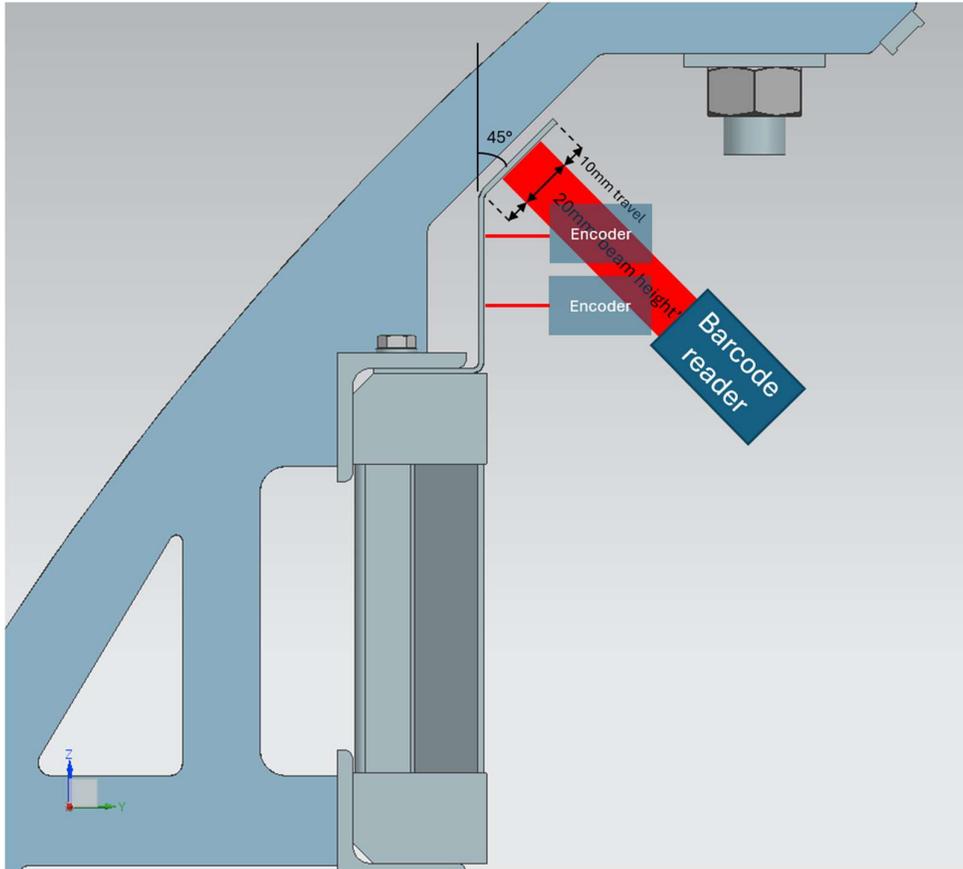


Figure 19: Positioning system location within infrastructure.

## Barcode Encoding

Although each barcode sensor reads a location it does not directly relate to the absolute position inside the infrastructure. This has two main reasons.

1. The same stickers have been used for the left and right side of the pipe. On the left side this means that the barcodes are increasing with the direction of travel. However, on the right side this means that it is decreasing with the direction of travel.
2. For logistical reasons it was impossible to install the 4 meter tracks in correct order, this means that the position that the sensor reads will jump across the valid range every 4 meter.

Additionally, the infrastructure contains expansion joints where the tracks are 4.2m long on either side to cope with the length of the joint.

This means that the absolute position needs to be derived from the measured barcode position. Table 2 (left) and Table 3 (right) describe the relation between barcode and absolute position can be found.

The MATLAB code later in this section uses these tables to determine the absolute position given a barcode measurement. The data from the lookup table should be formatted as follows:

```
track.id = 1;           % Corresponds to the track number
track.start = 640;     % Starting position of the track
track.end = 644;      % Ending position of the track
track.absolute_start = 0; % Absolute starting position in global coordinates
track.absolute_end = 4; % Absolute ending position in global coordinates
```

This code tries to find the track in which the barcode measurement lies and to optimize the runtime performance it only looks at the previous or next track as possible other tracks to transition to. If no valid track is found it uses the vehicle velocity to estimate the position based on the previous position.

It also outputs a valid flag if the measurement was found inside a track range. This can be used if multiple sensors are available to only use sensors with valid measurements.

In case the barcode sensor travels across an expansion gap it will take the velocity of the vehicle to estimate the correct position of the vehicle. This assumes that the vehicle is not accelerating significantly between an execution cycle.

Table 2: Barcode lockup table left side.

track_number	x_position	type	batch	ID	Length [m]	start_value [m]	end_value [m]
1	0	straight	B	61	4	640.0	644.0
2	4	straight	B	58	4	628.0	632.0
3	8	straight	B	60	4	636.0	640.0
4	12	straight	B	24	4.2	304.6	308.8
5	16.4	straight	B	2	4.2	212.2	216.4
6	20.6	straight	B	66	4	660.0	664.0
7	24.6	straight	B	65	4	656.0	660.0
8	28.6	straight	B	55	4	616.0	620.0
9	32.6	straight	B	47	4	584.0	588.0
10	36.6	straight	B	44	4	572.0	576.0
11	40.6	straight	B	178	4	1108.0	1112.0
12	44.6	straight	B	4	4.2	220.6	224.8
13	49	straight	B	9	4.2	241.6	245.8
14	53.2	straight	B	181	4	1120.0	1124.0
15	57.2	straight	B	164	4	1052.0	1056.0
16	61.2	straight	B	74	4	692.0	696.0
17	65.2	straight	B	166	4	1060.0	1064.0
18	69.2	straight	B	32	4	524.0	528.0
19	73.2	straight	B	184	4	1132.0	1136.0
20	77.2	straight	B	187	4	1144.0	1148.0
21	81.2	straight	B	16	4	460.0	464.0
22	85.2	straight	B	14	4	452.0	456.0
23	89.2	straight	B	13	4	448.0	452.0
24	93.2	straight	B	22	4	484.0	488.0
25	97.2	straight	B	158	4	1028.0	1032.0
26	101.2	straight	B	38	4	548.0	552.0
27	105.2	straight	B	120	4	876.0	880.0
28	109.2	straight	B	20	4.2	287.8	292.0

Table 3: Barcode lookup table right side.

track_number	x_position	type	batch	ID	Length [m]	start_value [m]	end_value [m]
1	0	straight	B	52	4	608.0	604.0
2	4	straight	B	87	4	748.0	744.0
3	8	straight	B	86	4	744.0	740.0
4	12	straight	B	1	4.2	212.2	208.0
5	16.4	straight	B	16	4.2	275.2	271.0
6	20.6	straight	B	63	4	652.0	648.0
7	24.6	straight	B	62	4	648.0	644.0
8	28.6	straight	B	59	4	636.0	632.0
9	32.6	straight	B	51	4	604.0	600.0
10	36.6	straight	B	72	4	688.0	684.0
11	40.6	straight	B	69	4	676.0	672.0
12	44.6	straight	B	12	4.2	258.4	254.2
13	49	straight	B	18	4.2	283.6	279.4
14	53.2	straight	B	116	4	864.0	860.0
15	57.2	straight	B	23	4	492.0	488.0
16	61.2	straight	B	49	4	596.0	592.0
17	65.2	straight	B	12	4	448.0	444.0
18	69.2	straight	B	29	4	516.0	512.0
19	73.2	straight	B	33	4	532.0	528.0
20	77.2	straight	B	186	4	1144.0	1140.0
21	81.2	straight	B	17	4	468.0	464.0
22	85.2	straight	B	21	4	484.0	480.0
23	89.2	straight	B	20	4	480.0	476.0
24	93.2	straight	B	15	4	460.0	456.0
25	97.2	straight	B	48	4	592.0	588.0
26	101.2	straight	B	197	4	1188.0	1184.0
27	105.2	straight	B	56	4	624.0	620.0
28	109.2	straight	B	11	4.2	254.2	250.0

## Barcode Position Estimation Code

```
function [track_id, barcode_position, valid_position] = barcode_estimator(barcode, ...
    track_id_prev, barcode_prev, velocity, vehicle, tracks, reset)

track_id = track_id_prev;
barcode_position = 0;

if reset
    track_id_prev = -1;
end

% First find track_id
if (track_id_prev == -1)
    index = 1;
    track = tracks(index);
    in_range = check_range(barcode, track);

    while(~in_range)
        index = index + 1;
        if (index > length(tracks))
            barcode_position = -1;
            track_id = -1;
            break;
        end
        track = tracks(index);
        in_range = check_range(barcode, track);
    end

    if (in_range)
        track_id = track.id;
        barcode_position = calculate_position(barcode, track);
    end
else
    [track_id, barcode_position] = find_position(barcode, track_id, ...
        barcode_prev, velocity, vehicle, tracks);
end

if(track_id == -1)
    valid_position = false;
else
    valid_position = check_valid(barcode, tracks(track_id));
end
end
```

```

function [track_id, barcode_pos] = find_position(barcode, track_id, ...
    barcode_prev, velocity, vehicle, tracks)

% Check neighbours
if(track_id == 1)
    track_id_prev = track_id;
    track_id_next = track_id + 1;
    track_id_current = track_id;
elseif(track_id == length(tracks))
    track_id_prev = track_id - 1;
    track_id_next = track_id;
    track_id_current = track_id;
else
    track_id_prev = track_id - 1;
    track_id_next = track_id + 1;
    track_id_current = track_id;
end

track_prev = tracks(track_id_prev);
track_next = tracks(track_id_next);
track_current = tracks(track_id_current);

distance_prev = abs(barcode_prev - track_prev.absolute_end);
distance_next = abs(barcode_prev - track_next.absolute_start);

if (track_prev.id == track_current.id)
    distance_prev = 5000;
end

if (track_next.id == track_current.id)
    distance_next = 5000;
end

% previous track closer
if distance_prev <= distance_next
    track_other = track_prev;
% next track closer
else
    track_other = track_next;
end

% in range of previous or next
if check_range(barcode, track_other)
    track_id = track_other.id;
    barcode_pos = calculate_position(barcode, track_other);
% in range of current
elseif check_range(barcode, track_current)
    track_id = track_current.id;
    barcode_pos = calculate_position(barcode, track_current);
% lost sync assume current
else
    track_id = track_current.id;
    barcode_pos = barcode_prev + velocity * (1 / vehicle.software.operating_frequency);
end
end

```

```
function valid = check_valid(barcode, track)
    % left
    if(track.start < track.end)
        valid = barcode >= track.start + 0.2 && barcode <= track.end - 0.2;
    % right
    else
        valid = barcode <= track.start - 0.2 && barcode >= track.end + 0.2;
    end
end

function is_in_range = check_range(barcode, track)
    % left
    if(track.start < track.end)
        is_in_range = barcode >= track.start + 0.05 && barcode <= track.end - 0.05;
    % right
    else
        is_in_range = barcode <= track.start - 0.05 && barcode >= track.end + 0.05;
    end
end

function position = calculate_position(barcode, track)
    % left
    if(track.start < track.end)
        position = track.absolute_start + (barcode - track.start);
    % right
    else
        position = track.absolute_start + (track.start - barcode);
    end
end
```

## Communication System

Teams have several options to set up communications with their prototype while operating within the infrastructure:

1. Teams can set up everything completely independent from the infrastructure. For example by bringing an antenna that is placed at the start of the infrastructure that communicates with their vehicle, similar to how they would do it when testing their prototype outside the infrastructure.
2. Teams can connect an antenna to the PoE network inside the infrastructure, for example at the end of the linear section pointing towards the entrance. Teams can then connect to the control room Wi-Fi network to reach their prototype. For example using Ubiquity Building Bridge to create a connection between the infrastructure and prototype.
3. Teams can also connect directly with the (hidden) Wi-Fi network that is in the infrastructure to connect to the control room network. This however has not been tested extensively with different prototypes.

Teams are recommended to have a back-up solution readily available in case the chosen method does not work as expected.

## EHC.R Requirements for Teams

### EHC.R.1. General Requirements

- EHC.R.1.1 Teams that intent to use the European Hyperloop Center Infrastructure for demonstration and testing shall not enter or interface with the infrastructure without prior consent of the EHW staff.
- EHC.R.1.2 Depending on demand to use the European Hyperloop Center Infrastructure, a schedule will be created during the week with timeslots in which each team can make use of the infrastructure.
- EHC.R.1.3 Teams are required to ensure they have removed their prototype from the infrastructure before their timeslot ends.

### EHC.R.2. Technical Requirements

- EHC.R.2.1 All surfaces that may contact the infrastructure shall have a chamfer on the start and end no greater than 20 degrees.
- EHC.R.2.2 Teams shall ensure no force shall be exerted on the infrastructure greater than the forces specified in Table 1.
- EHC.R.2.3 Teams shall ensure any material contacting the infrastructure shall meet the material requirements as specified in section “Description of Tracks”.
- EHC.R.2.4 The prototype of the team shall fit fully in the “Vehicle Zone” as defined in Figure 5 in all operating conditions.
- EHC.R.2.5 The prototype shall never exceed the 7<sup>th</sup> pipe of the infrastructure (112 meter position).
- EHC.R.2.6 To prevent the prototype from existing the infrastructure, at the start of the first pipe two end-stops will be installed on the safety tracks (see image below). It must not be possible for the prototype to exit the track with these end-stops installed.



- EHC.R.2.7 A safety perimeter will be defined around the infrastructure entrance. No team member may be present inside the safety perimeter while the high-voltage system is active.
- EHC.R.2.8 The maximum speed of the prototype in the direction of the door (moving backwards) must not exceed 2 m/s.