FUTURE
CIRCULAR
COLLIDER

TRANSPORT CONCEPTS (PERSONAL AND MATERIAL)

gratefully acknowledging the contributions of the FCC Infrastructure and Operation WG and sub-WGs, all FCC study teams and the Fraunhofer Institute for Material Flow and Logistics IML

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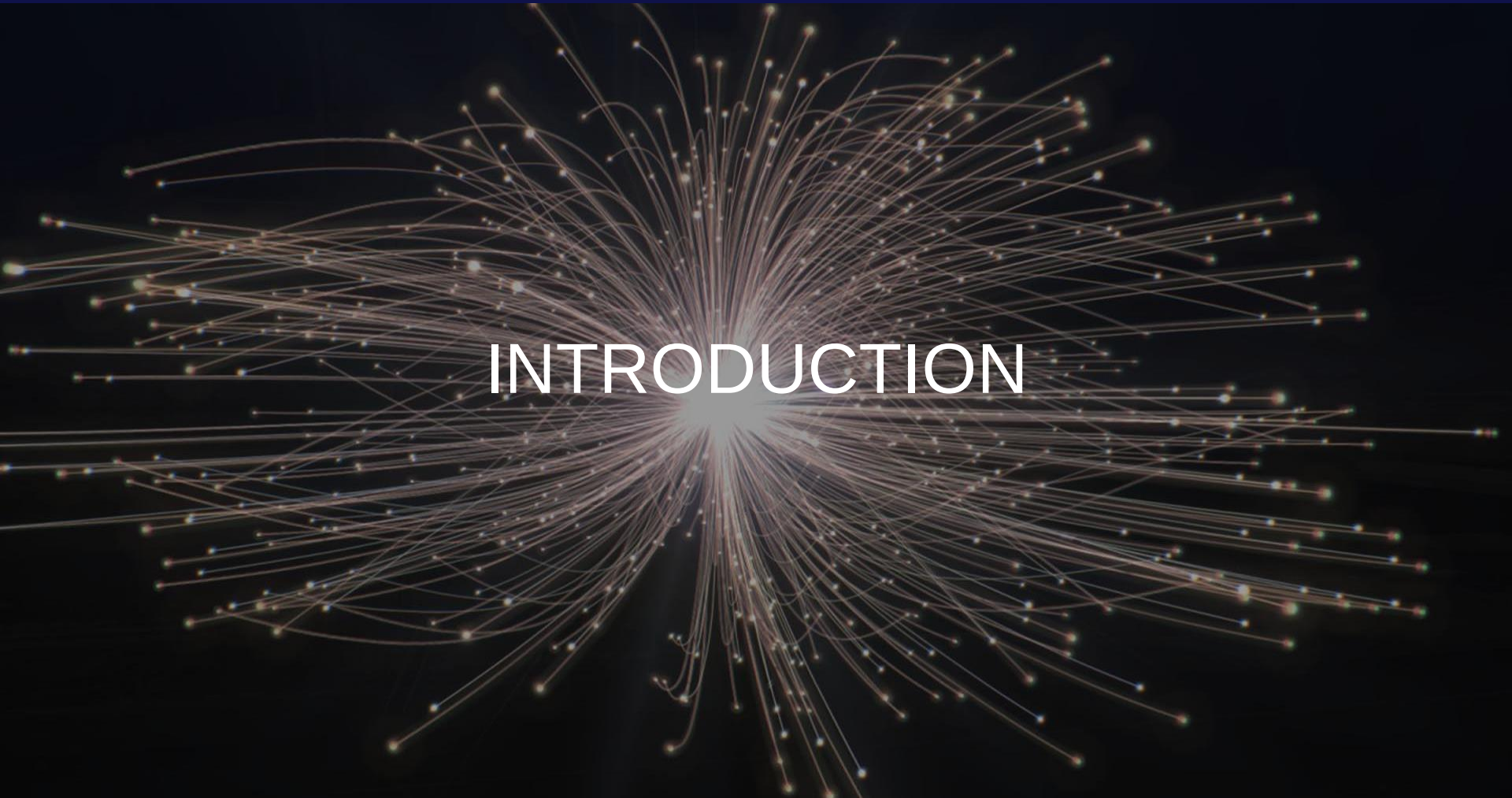


INTRODUCTION

Introduction

In the scope of work of the WP10 “Transport & Handling, Logistics”, this presentation summarizes transport concepts for personnel and materials as well as the roadmap during the Pre-TdR phase in each of the following domains:

- Vertical access (lifts and lifting platforms) and horizontal access (vehicles) for personnel;
- Concepts of transport and installation for magnets;
- Concepts of installation for specific large equipment (e.g. dumps);
- Concepts of transport for standard equipment;
- Logistics studies.

TRANSPORT OF PERSONNEL

Vertical access and horizontal transport

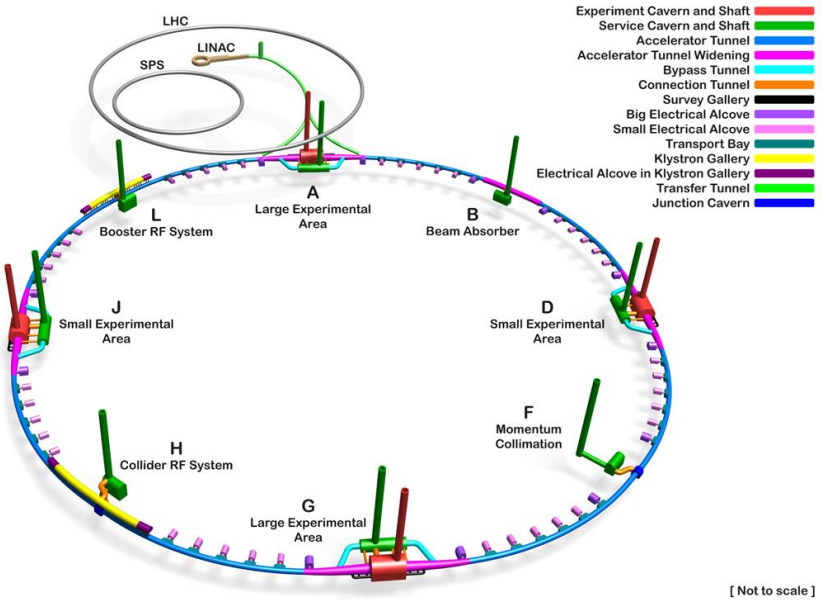
Transport of Personnel

Vertical access : lifts and lifting platforms

The vertical access to the FCC tunnels covers the access to the underground areas themselves through lifts in service shafts, and the vertical access to the equipment to be installed in the shafts (250 m high in average and up to 400 m).

The FCC vertical access concept for the personnel is based on a fleet of 24 lifts in the 8 access shafts around the tunnel (green shafts), plus 4 lifts located at the end of the strait sections in points H and L (connection between yellow galleries and regular arcs in blue).

The vertical access to the equipment concerns all 12 shafts (green and red) where equipment have to be installed (mainly pipes and cables with their supports).



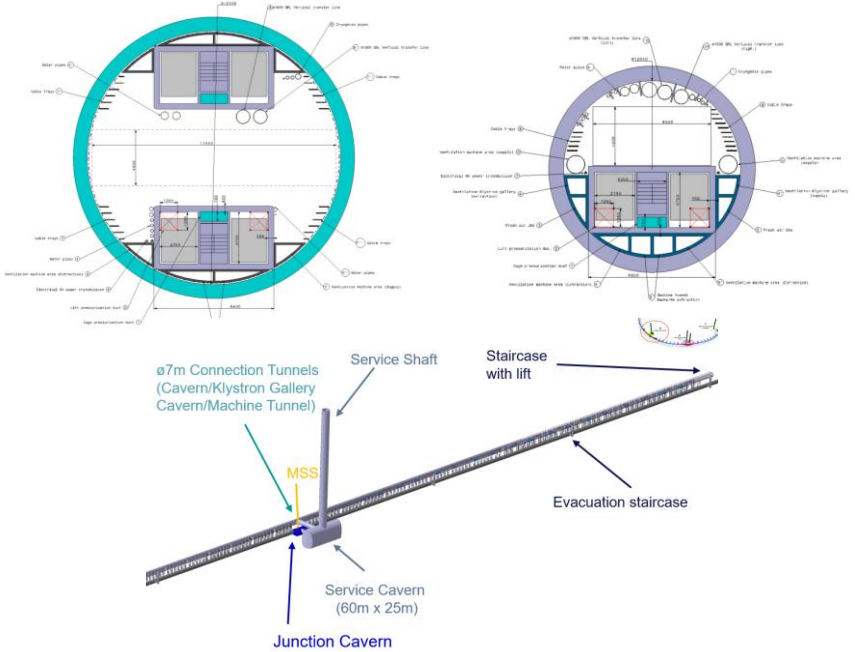
Transport of Personnel

Lifts

The main characteristics of lifts in service shafts are:
- Speed : 4 m/s (travel time ~2mins);
- Capacity : 3000 kg/38 persons.

The main characteristics of the lifts in points H and L are (preliminary):
- Speed : 1 m/s;
- Capacity : 1000 kg/12 persons.

Next step : lifts being rather standard equipment, their design is quite well known, and no significant evolution is foreseen on that topic in the coming years before the final design phase.



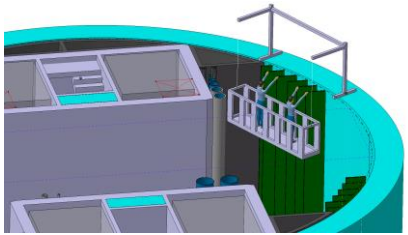
Transport of Personnel

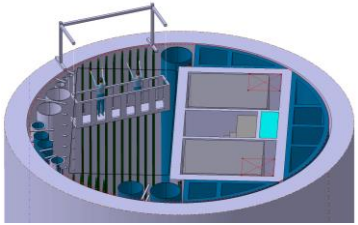
Lifting platforms

Access is needed vertically all along the shafts to install mainly cables and pipes routed from surface buildings to the underground.

The installation concept for FCC relies on lifting platforms to ease and fasten the vertical access to the workplace, therefore optimize the installation of cables and pipes.

Next step : define operational constraints and mitigation measures to use these platforms while handling equipment to be installed with the Safety WP





Transport of Personnel

Horizontal transport – vehicles for personnel

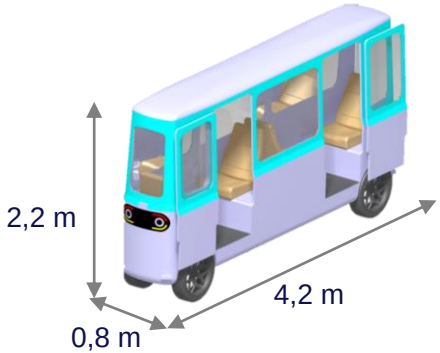
Vehicles for personnel have been designed considering the following constraints:

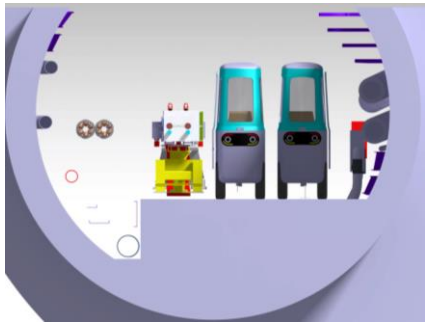
- crossing within the transport zone (2,2m wide)
- maximize the number of persons transported at once
- autonomous driving capability required to allow management of traffic and charging of batteries.

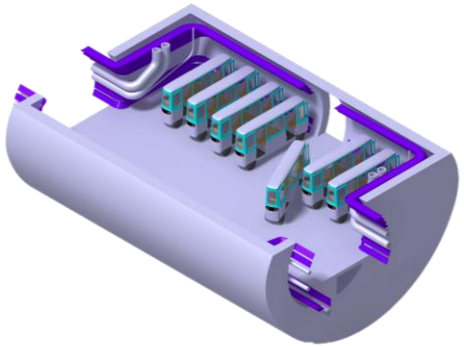
They allow transport of small equipment and tooling.

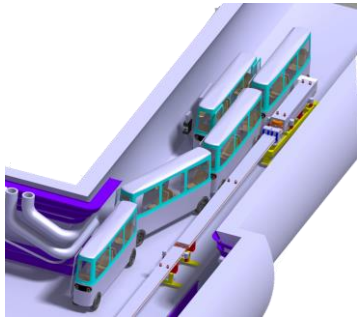
Next steps :

- integrate the feedback from the Safety WP following Feasibility Study and define usage of vehicles in case of evacuation scenarios (2025-2026),
- define usage in normal operation scenario (2027-2028)









TRANSPORT OF MATERIALS

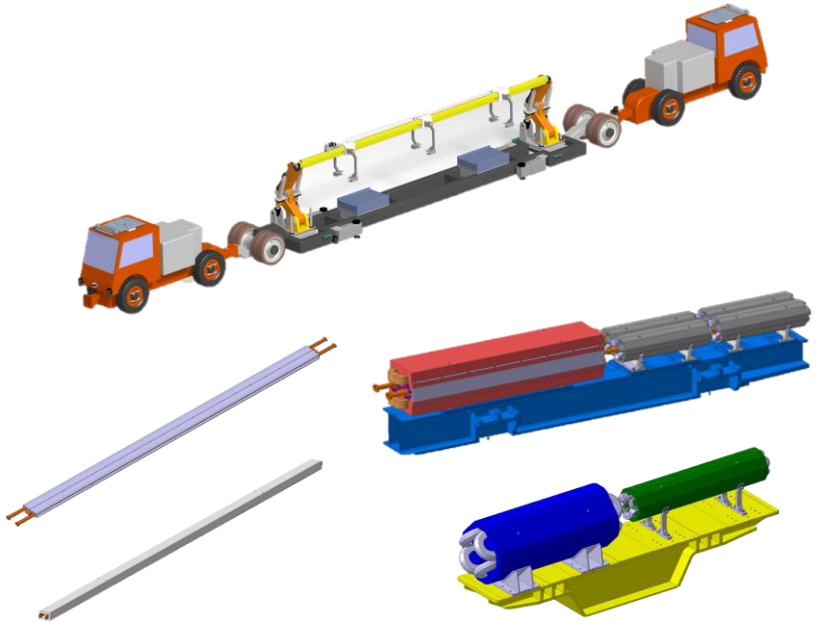
Magnets

Transport of Materials

FCC-ee Magnets

Due to the large quantities of magnets to be installed (several thousands) a specific machine has been studied to optimize their transport and installation.
It will be composed of 2 tractors and 1 trailer, with autonomous driving and installation capabilities (lifting arms).

There are 2 main families of magnets to be handled and installed, both for the collider and the booster : long dipoles and heavy «QSS girders» (assemblies of quadrupoles and sextupoles on a girder), each with specific characteristics leading to the design of 2 trailers.

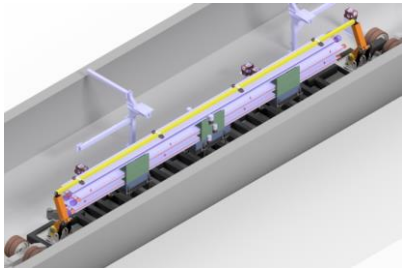


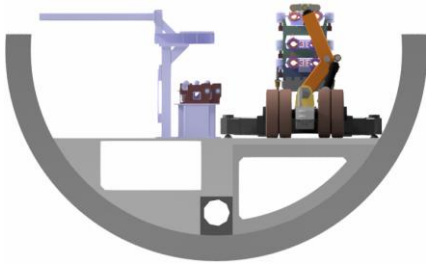
Transport of Materials

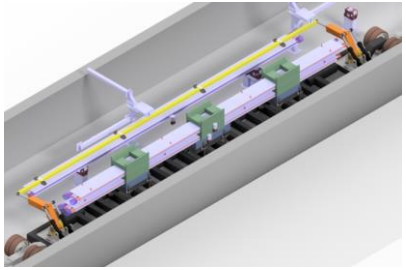
Dipole magnets convoys

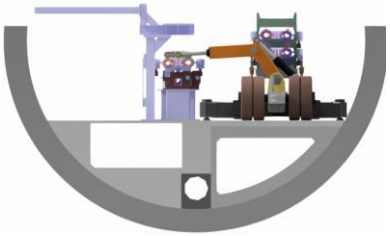
The dipoles of the booster and of the collider are “long and thin” objects relatively sensitive to bending during handling, their weight has significantly evolved since the design of the trailers, from 2,7t in 2023 to 5,5t in 2025, due to the addition of lead shielding.
Theses characteristics (size and weight) allow to design a trailer able to transport several magnets at a time, saving horizontal transport time.
These magnets have to be transported from the experimental service caverns only due to their length, not compatible with the size of the handling shafts in the technical points.

Next step : review the mechanical design of the convoys to consider their final weight (2027)









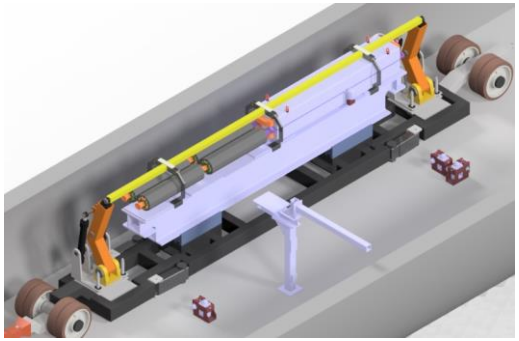
Transport of Materials

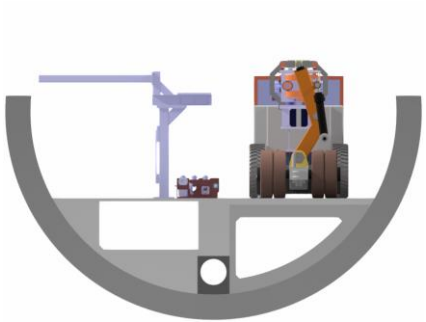
Girders (Quadrupole + Sextupole) convoys

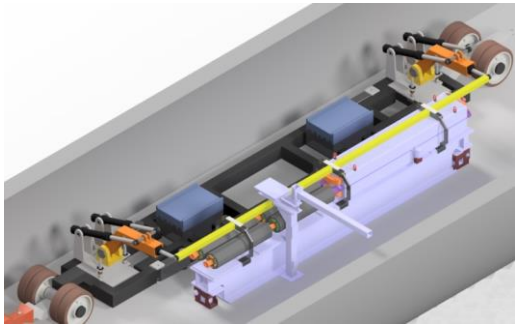
The girders of the booster and of the collider are “short and heavy” objects (last estimates are around 14,5t), probably sensitive to vibrations.
Their volume and weight do not allow to transport several items at a time.
These magnets can be transported from all the service caverns. Due to the workload of the service shaft cranes, they will be handled from technical points.

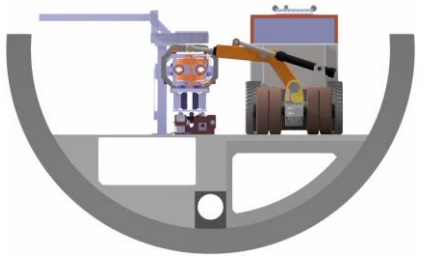
Next steps :

- after the release of a technical design of the magnets, review the design of the convoys (2027)
- review how to install the collider girders due to conflicts with the supporting structure of the booster (2026)









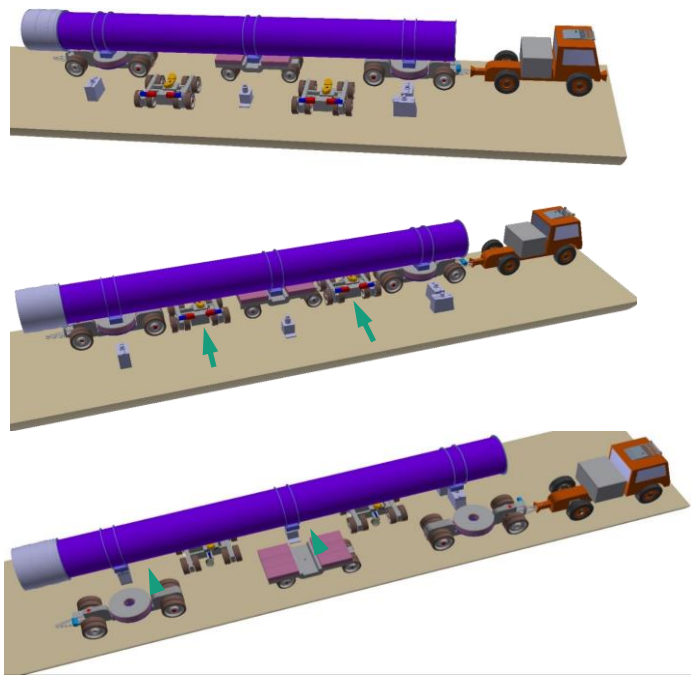
Transport of Materials

FCC-hh Dipole magnets convoys

The FCC-hh cryomagnets are foreseen to be much heavier and bigger than the FCC-ee magnets : 15m long x Ø1,6m @ 60t .

Such magnets can be transported via rivers and public roads in surface (from Rotterdam and Marseille harbors) to the FCC tunnels.
A first concept of convoy has been established to transport the magnets in the tunnel during the previous phases of the FCC studies.

Next step : review the design of the convoys to validate the pressure on the floor of the tunnels and provide this input to Civil Engineering (2025)



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TRANSPORT OF MATERIALS

Specific studies for large equipment, transport of standard materials

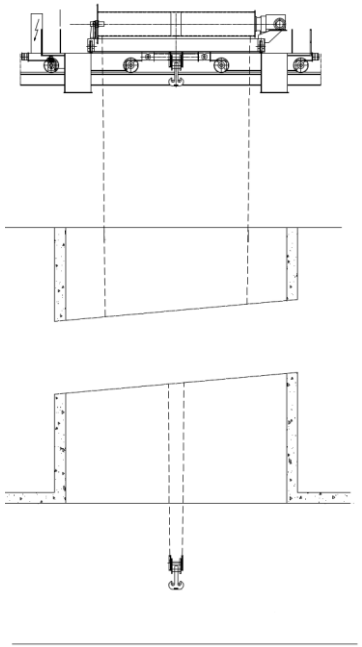
Transport of Materials

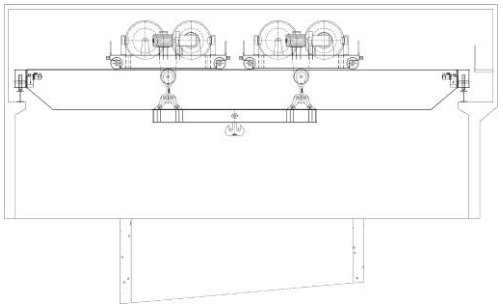
Transport of equipment – overhead cranes

The FCC project includes the installation of 67 overhead cranes in surface buildings and underground areas.
The overhead cranes in head-shaft buildings will be the critical point of logistics to handle to the underground areas all the equipment not fitting inside the lifts. These cranes have been designed integrating redundancy to minimize downtimes.
Some areas require further installation handling studies and might need additional overhead cranes. It's typically the situation in point B due to the density of equipment.

Next steps:

- Identify needs for additional cranes in the tunnel, design it and integrate it;
- Integrate already designed cranes





Transport of Materials

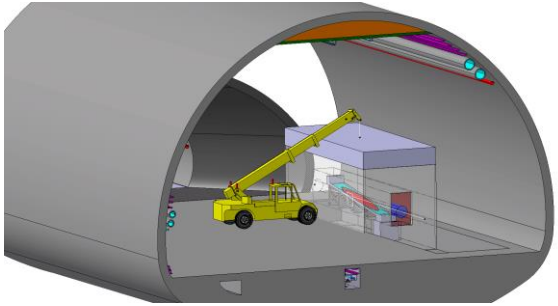
Installation of specific equipment

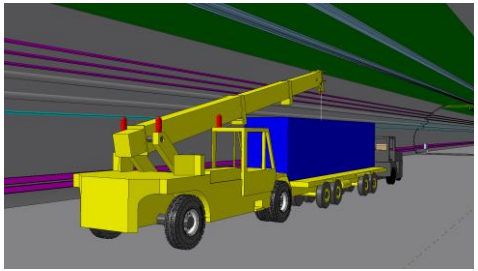
Some specific larger and heavier equipment need specific handling studies; it's typically the case for:

- Cold boxes in points H and L (estimated at 60 t);
- Beamstrahlung dump systems in all experimental points (shielding blocks of up to 15t);
- All equipment in point B (including beam dumps) due to the density of equipment in this zone;
- Areas hosting equipment for injection from injector to booster and from booster to collider in point A.

Next steps:

- Perform the conceptual handling studies for RF cryomodules in points H and L (ongoing, 2025)
- Perform the conceptual handling studies as soon as equipment are conceptually designed, to define constraints to the Civil Engineering (2026-2027)





Transport of Materials

Transport of standard equipment

The majority of equipment to be installed will be transported thanks to the existing lifts, the overhead cranes in the service shafts and standard trailers and electric tractors.

The estimated quantity for the installation is 20 tractors and 30 trailers for the whole machine .

Next steps:

- Study coactivity of tractors for material with vehicles for personnel (2027)

TRANSPORT OF MATERIALS

Surface Logistics

Transport of Materials

Surface Logistics

The installation of a machine such as FCC implies a significant volume of transport on public roads estimated to 13’500 trucks for the construction.
The logistics concept proposed is based on logistic platforms in close vicinity of FCC sites (less than 50 km) to allow:

- Temporary storage to provide contingency during installation;
- Optimisation of the number of trucks reaching each site.

Next steps :

- update the logistics estimates based on latest information, including empty packages to be handled (2026)
- quantify the logistic buffers needed to smoothen installation and allow contingency in schedule (2027 and yearly updates onwards)

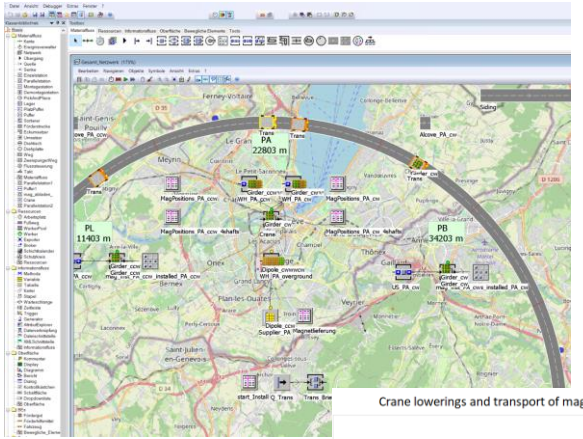
Transport of Materials

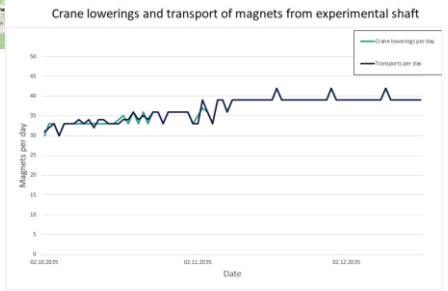
Underground Logistics

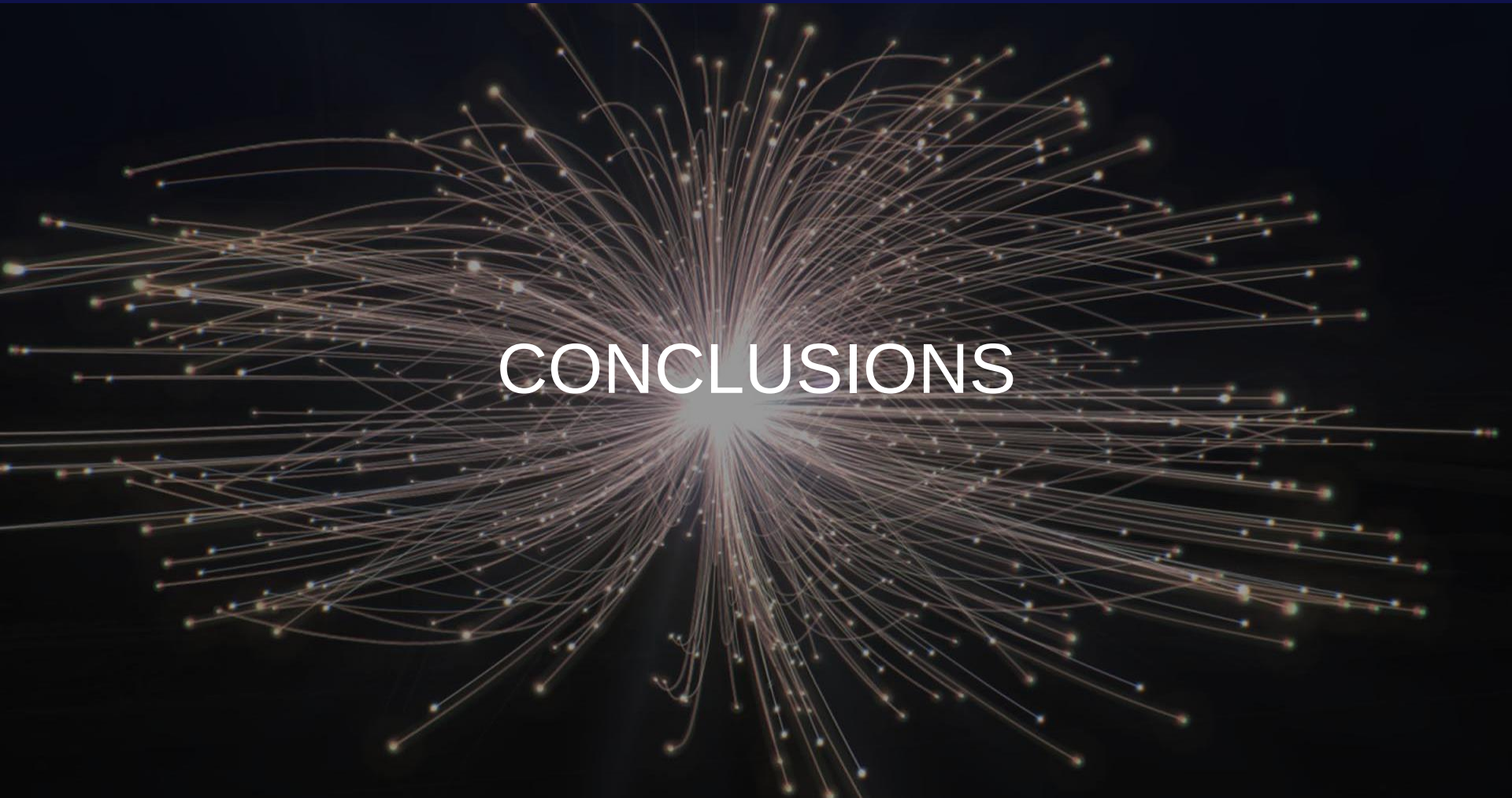
A logistic model has been established to estimate the installation time of magnets.
The overhead cranes in service shafts are the potential bottleneck in the logistic chain. The installation schedule has a significant impact on that parameter.

Next steps :

- update the logistics model based on latest schedule (2025), only considering magnets in arcs;
- Include equipment from point B, H and L if available (2026), define buffers required in surface points and in service caverns, include these requirements to the integration models, update the resource usage of shaft cranes






CONCLUSIONS

Conclusions

Transport is a service

Standard equipment (e.g. lifts, overhead cranes) have been specified already, custom-made equipment need to wait for the machine components to have a technical design before refining their design.
There are still many areas where conceptual design of equipment is missing (strait sections around experiments, points B and F) to perform conceptual handling studies.

Priority will be given in the next years on transport of elements impacting the civil engineering design, due to the transport volumes required for their installation.
Logistics studies will be refined to estimate storage volumes required.

Thank you for your attention.