TRANSPORT REQUIREMENTS

gratefully acknowledging the contributions of J. Bauche, J. Osborne, T. Otto and FIML

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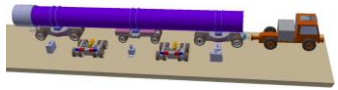
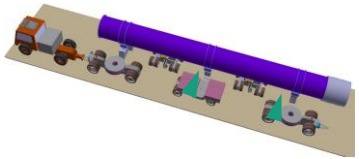
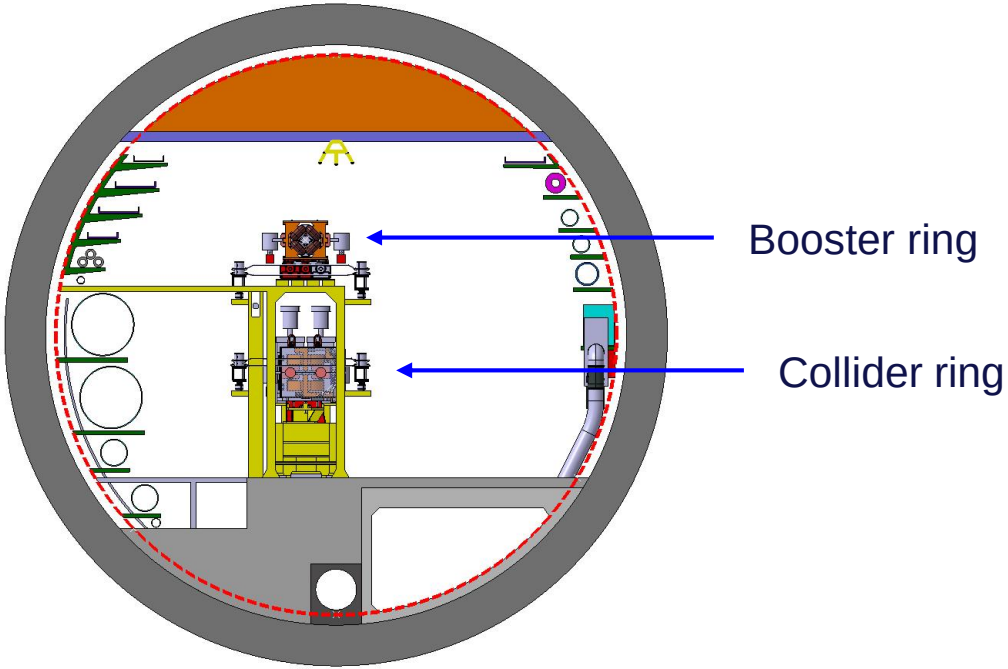


Unloading



[1] FCC-ee magnets only are considered at this stage

Requirements for underground transport and handling of magnets



Requirements for underground transport and handling of magnets

Collider ring

Type	Dipoles	Quadrupoles	Sextupoles
Number	5800	2900	3560
Length [cm]	**1200**	340	170
Width [cm]	45	**60**	30
Height [cm]	30	**70**	50
Weight [kg]	3700	**5500**	600

Requirements for underground transport and handling of magnets

Collider ring

Unit	Q-S	Q-S-S
Length [cm]	520	**700**
Width [cm]	60	**60**
Height [cm]	100	**100**
Weight [kg]	6620	**7400**

Magnets will be installed as follows:

- **5800** single dipoles
- **492** single quadrupoles
- **1256** units made up of quadrupole-sextupole and supporting girder (Q-S)
- **1152** units made up of quadrupole-sextupole-sextupole and supporting girder (Q-S-S)

Requirements for underground transport and handling of magnets

Booster ring

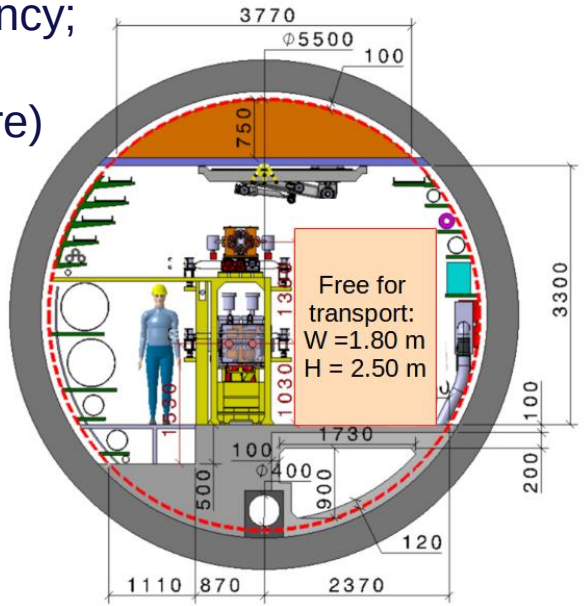
Type	Dipoles	Quadrupoles	Sextupoles
Number	5888	2944	Unknown
Length [cm]	**1140**	170	70
Width [cm]	30	**50**	30
Height [cm]	30	**70**	50
Weight [kg]	**2500**	2000	200

Requirements for underground transport and handling of magnets

- Data about collider ring have been defined based on existing design;
- Data about booster ring have been derived by scaling the collider ones;
- No specific requirements concerning the max allowed acceleration and tilt angle;
- Max tunnel slope: 0.5%

Requirements for underground transport of people 1/2

- Vehicle shall be used to transport personnel
  with material and evacuate them in case of emergency;
- Minimum capacity: 6 people - 500 kg (possibly a bit more)
  Materials payload: 1000 kg
  Total capacity: 1500 – 2000 kg
- Max speed: 30 km/h (lower for material);
- Battery powered;



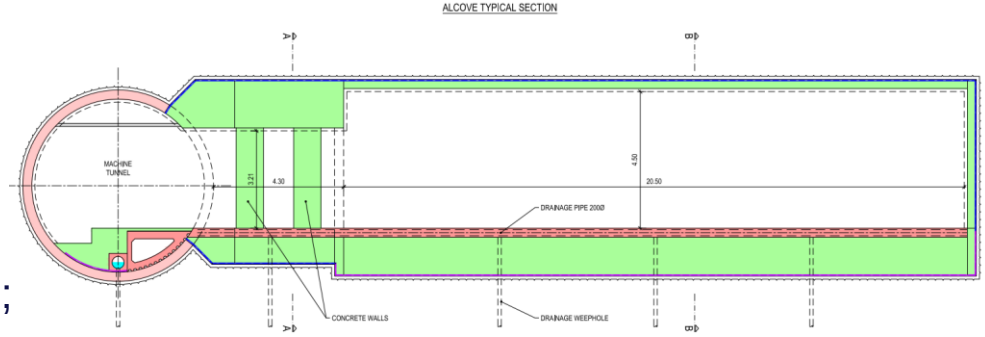
Requirements for underground transport of people 2/2

- Possibility for autonomous drive to be investigated;
- Vehicles connected between them and/or with a centralized system;
- Modular design allowing the mounting of different platforms;
- Hosting equipment for autonomous
  or remote interventions (minimise human access to the tunnel).

Boundary conditions

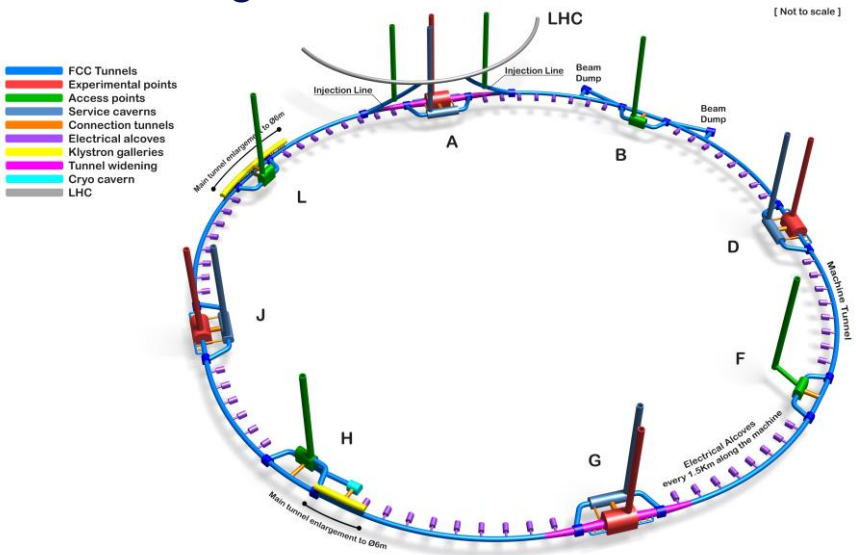
Vehicle design shall take into account the interaction with the surrounding environment, in particular:

- Vehicle-vehicle crossing (especially for people vehicle)
  -> if this shall be possible anywhere, a rail-bound system is not possible;
- Vehicle-people crossing;
- Presence of alcoves;
- Dedicated areas for vehicles parking;
- Passage through fire protection doors in fire partitions.



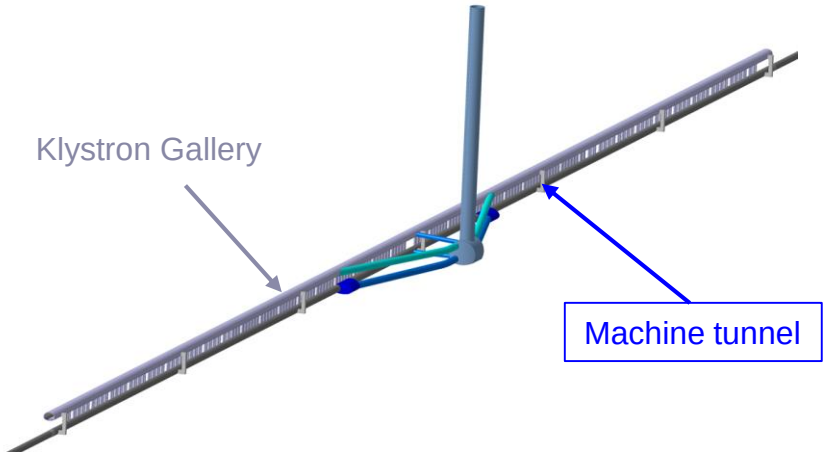
Open points 1/2

- Same vehicle for all types of magnets?
- Number of shafts dedicated to magnets' handling
- Magnets design:
  - Connection design;
  - Installation procedure and time;
  - Number of support points.



Open points 2/2

- Number of people/sector present at each stage (installation of the machine, operation i.e. technical stops, dismantling)
- Installation schedule and sequence of magnets, technical services and fire protection doors
- Information about components
  to be installed in the klystron gallery



Open points per phase

	Installation	Operation (technical stops)	Dismantling
Different types of vehicles	x	x	x
Number of shafts for magnets' handling	x		x
Magnets design: • Connection design • Installation procedure and time • Number of support points	x	x	
Number of people/sector	x	x	x
Installation schedule and sequence of magnets, technical services and fire protection doors	x		x
Information about components to be installed in the klystron gallery	x		x

Thank you for your attention.