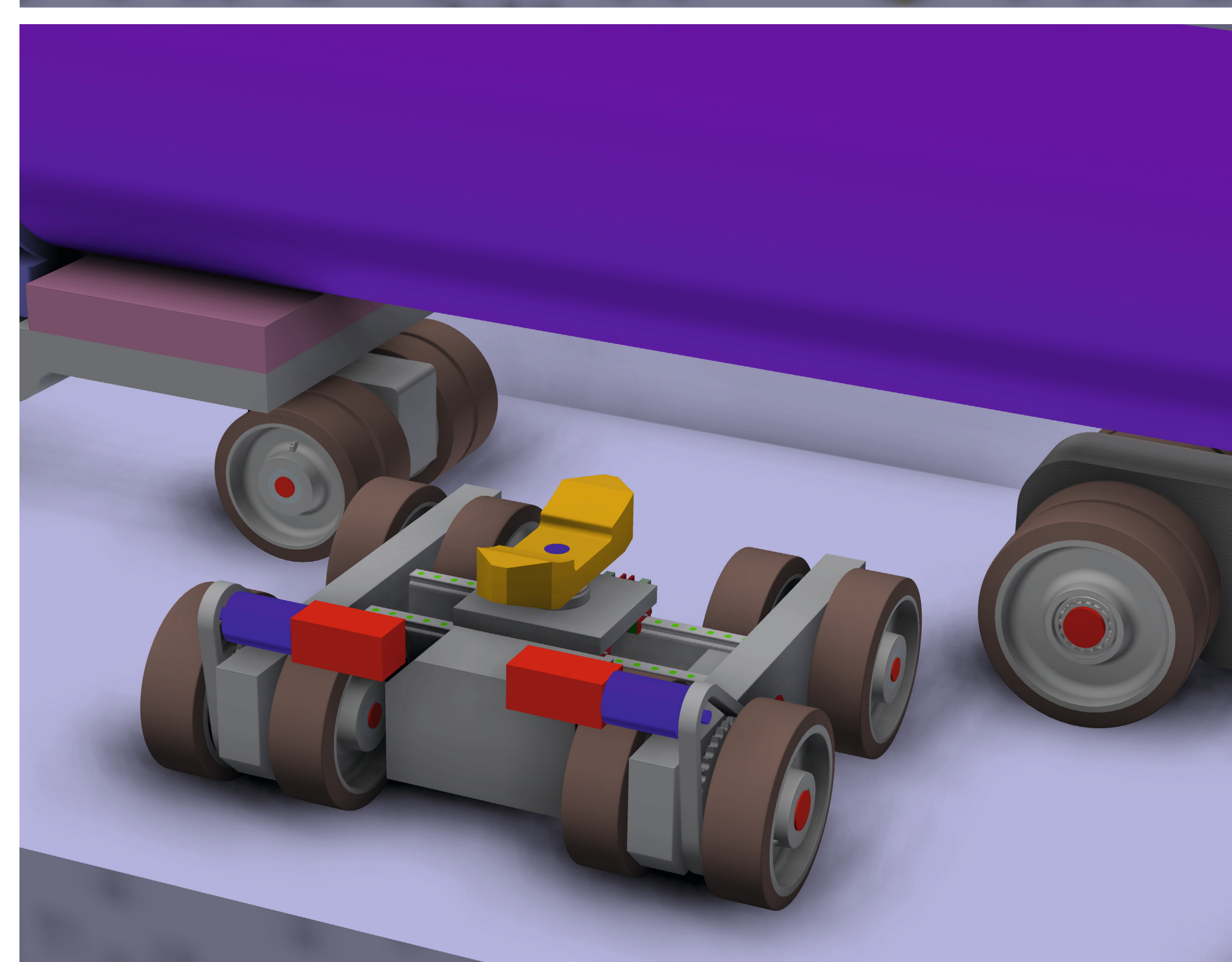
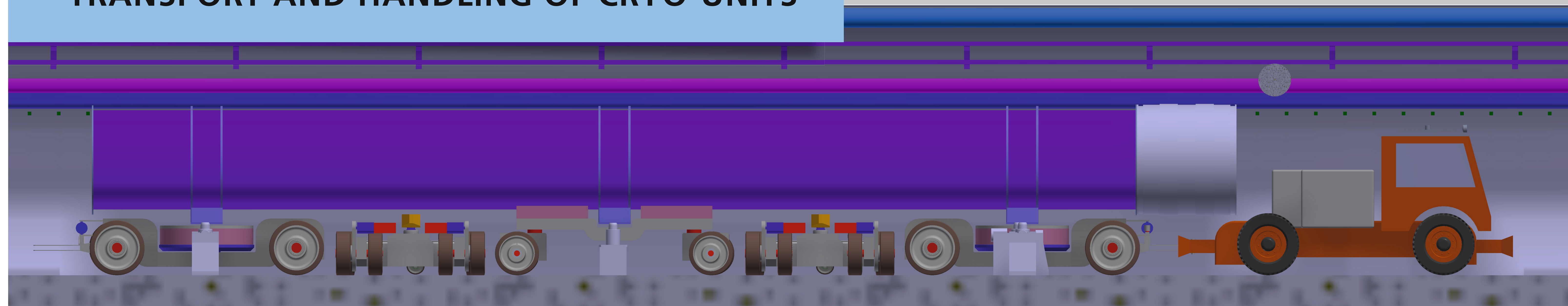


DESIGN CONCEPT FOR UNDERGROUND TRANSPORT AND HANDLING OF CRYO-UNITS



THE FOLLOWING ASSUMPTIONS WERE TAKEN INTO CONSIDERATION:

- Maximum shock for cryo-units: 0.1 g
- Maximum tilt angle for cryo-units: 5%
- Amount of cryo-units to be transported: 5,400
- Weight of the cryo-units: 60t (Dipole Magnets)
- Focus on cryo-units, but transport convoy can be adapted for other transport needs such as QRLs, pipes etc.

COMPONENTS FOR THE PROCESSES OF TRANSPORT AND HANDLING

- Separate trailers pulled by tractor to transport the FCC cryo-unit
- Two transfer tables are used for unloading the cryo-units from the transport vehicle
- When the cryo-units arrive at their designated position, two transfer tables drive below the cryo-unit
- The two transfer tables lift the cryo-unit and move it laterally to the assembling position
- After assembling the cryo-unit, the two transfer tables will be moved manually to the next assembling position



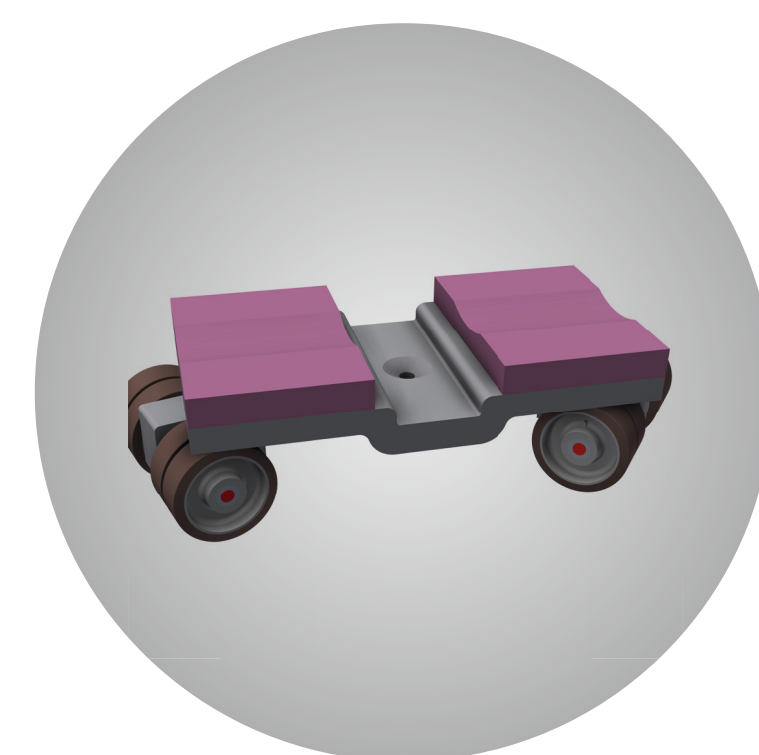
TRACTOR

- The tractor is equipped with two trailer hitches (in both the front and the rear area)
- The tractor is equipped with an electric and emission-free drive
- An intelligent navigation and control system allows autonomous driving in the tunnel



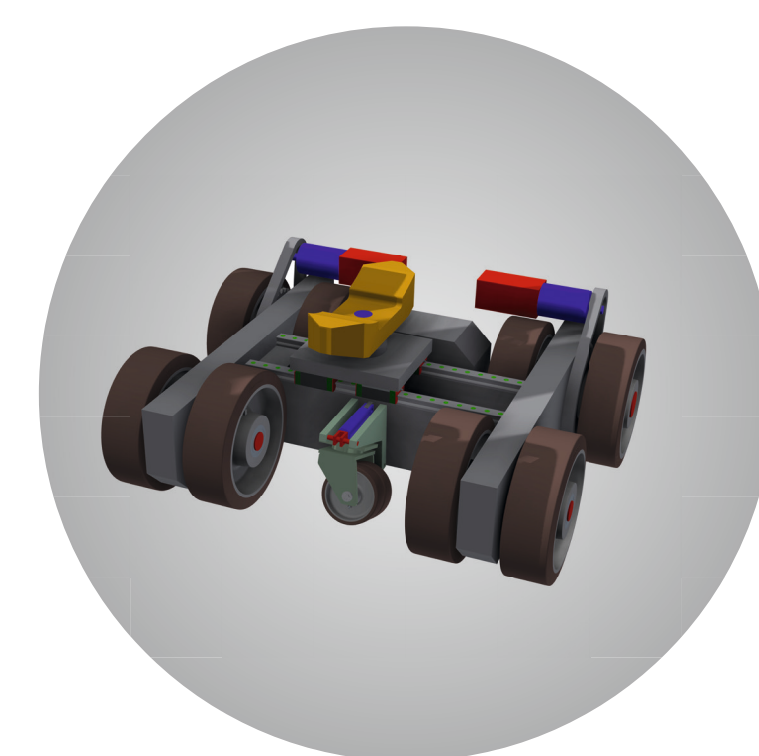
TRANSPORT TRAILER

- The transport trailer has an electronic steering system
- Vibration-dampening support for loading
- The ground contact of the special wheels is secured by using pendulum axles (swing axle)



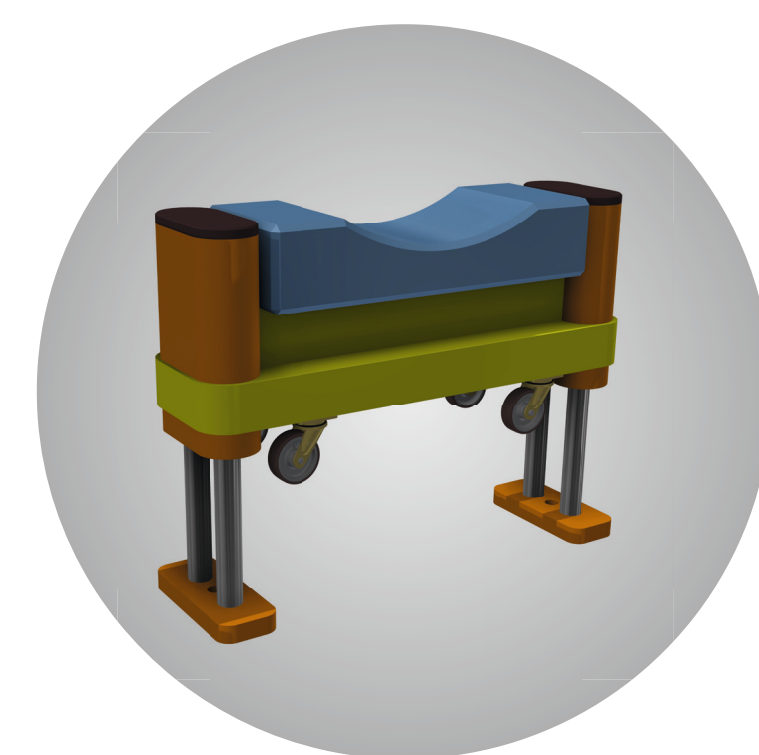
SUPPORT TRAILER

- Because of its two steering axles the support trailer is capable of taking on any steering movement of the cryo-units during transport
- The cryo-unit is securely located on vibration-dampening beds during transport



TRANSFER TABLES

- Two transfer tables equipped with hoists are used for unloading the cryo-units of the transport vehicle
- The adjustable steering roller (by means of linear cylinders) allows a high manoeuvrability of the transfer table
- Compensation of uneven ground by flexible chassis



THE EMERGENCY TRANSFER TABLES

- The emergency transfer tables use non-slippery half beds to hold the cryo-unit in case of a breakdown of the transport convoy
- The cryo-unit is being lifted by hydraulic cylinders
- The individual units of the emergency system are equipped with rollers with which the individual units can be moved and positioned

MAIN FACTS ABOUT VEHICLE CONCEPT:

- Maximum speed: 10km/h – loaded, 20km/h unloaded
- Maximum possible slope: ~3 Degree (ca. 5%)
- Battery technology based on lithium-ion batteries
- Autonomous driving technology based on contour navigation with safety laser scanners and navigation scanners

TWO POSSIBLE SUPPLY SCENARIOS FOR CRYO-UNIT INSTALLATION PHASE NOV. 2035 – NOV. 2039:

- Central supply via shaft A and supply of tunnel segments in two directions and semi-cycles: 5 vehicles, 25 coldmass test benches, 35 assembly facilities, 3 final test facilities
- Decentral supply via two shafts A and E: 4 vehicles, 12 + 12 coldmass test benches and additional storage capacities, 17 + 17 assembly facilities, 2 + 2 final test facilities
- Recommendation: decentral supply with local facilities to avoid long overground transports