TRANSPORT OF THE CLIC MODULES AND ELEMENTS

CLIC Workshop 14 – 17 Oct 2008

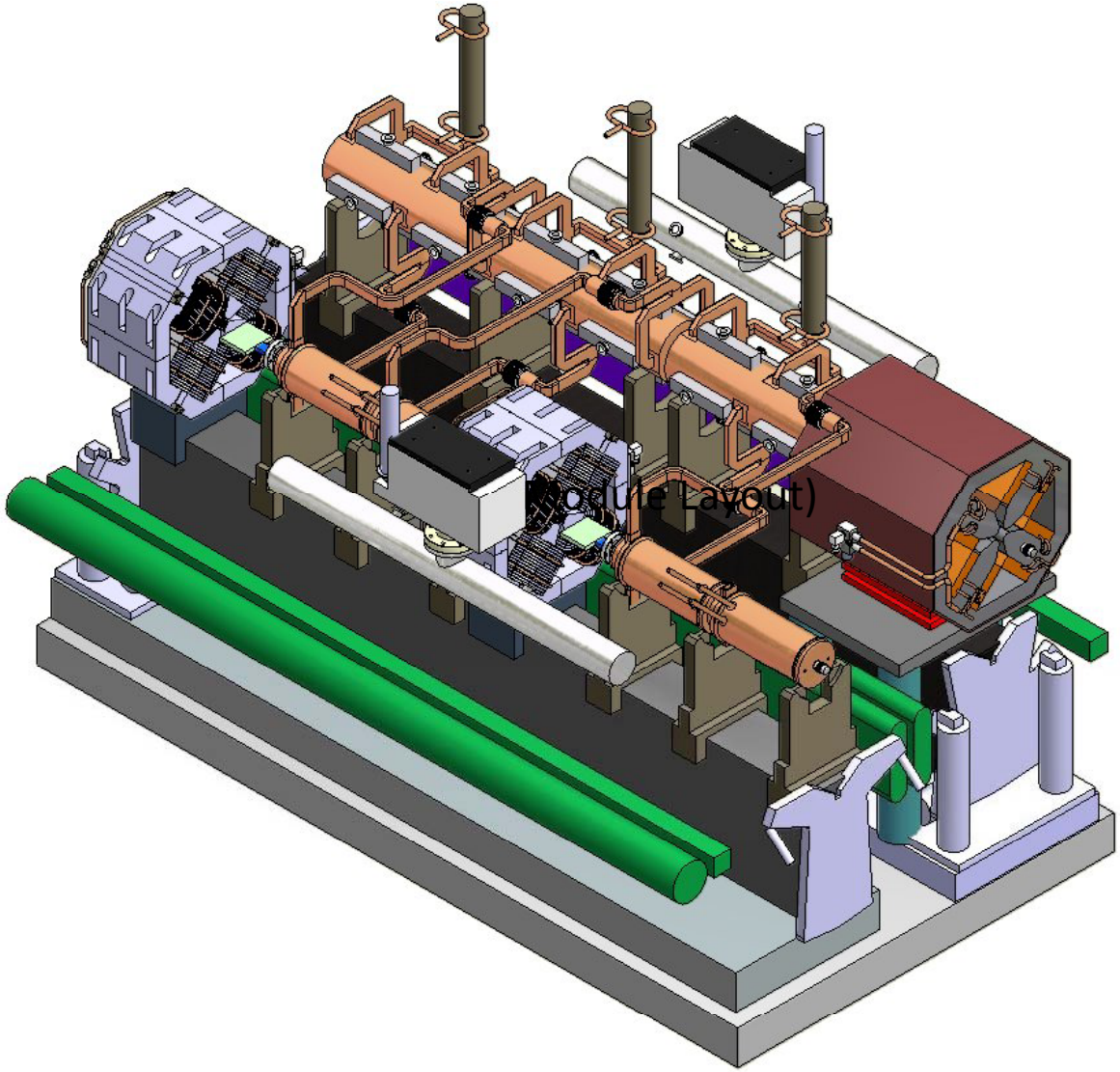
Working Group Technical Issues, Integration and Cost

Keith Kershaw, TS Dept, CERN

AIMS

- Review requirements and propose conceptual solution for lowering, underground transport and installation of CLIC modules.
- This conceptual design will be an input into the tunnel integration studies
- Bear in mind transport of other elements

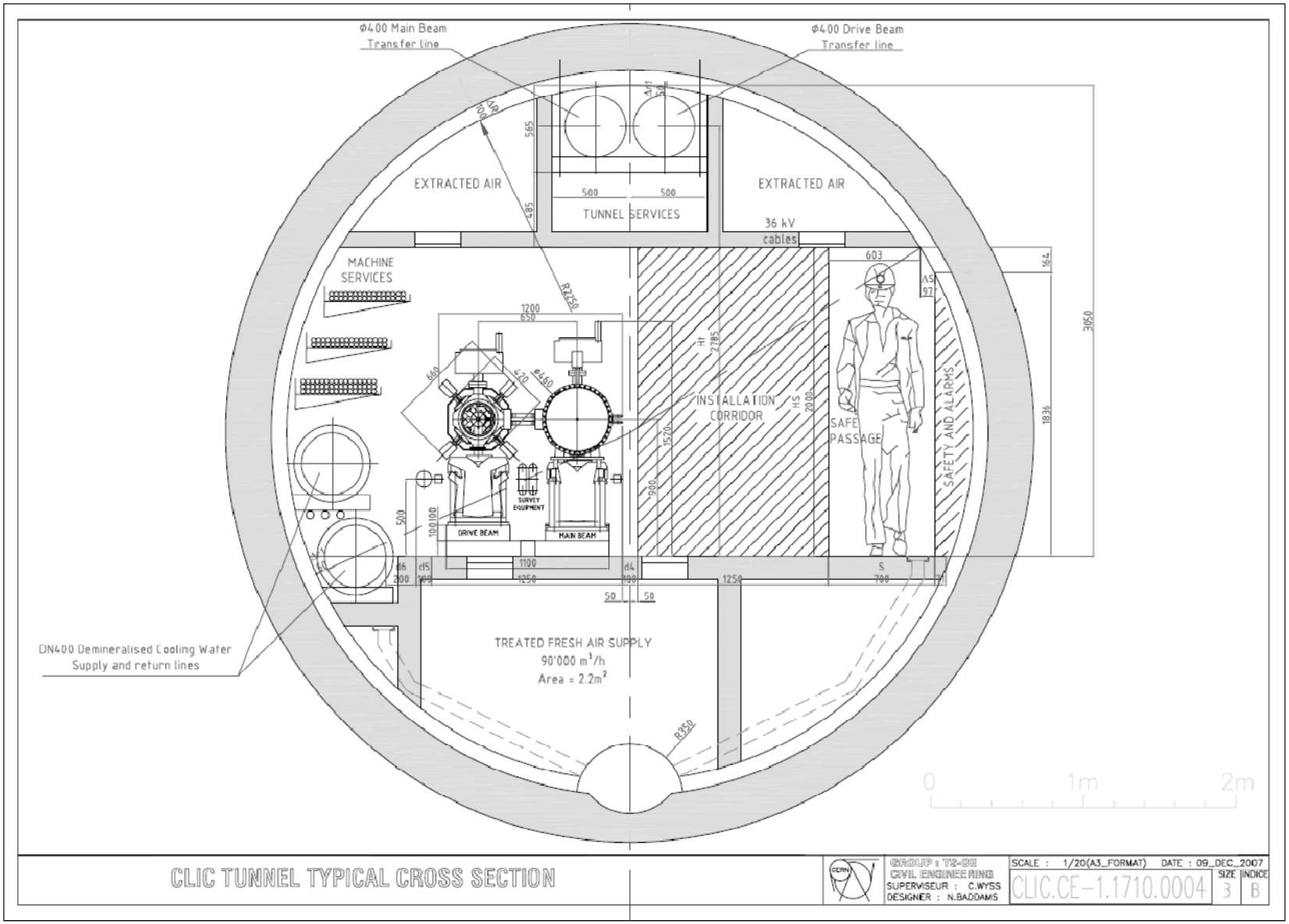
Module Layout



Module Layout №2, status (June 2008)

Alexandre.Samochkine @ cern.ch

Tunnel cross section – with CV ducts (12/07)



NEED TO CONSIDER

- Lowering from surface and entry into tunnel
- Transport along tunnel
- Transfer and installation on supports
- Over 20,000 modules so need to be fast
- Allow individual module exchange (between two installed modules)

TRANSPORT AND TRANSFER

The following slides illustrate transport and installation solutions used elsewhere

a) with separate transport and transfer

b) with combined transport and transfer

CERN LEP Monorail Train

CERN LEP Installation “Lobster”

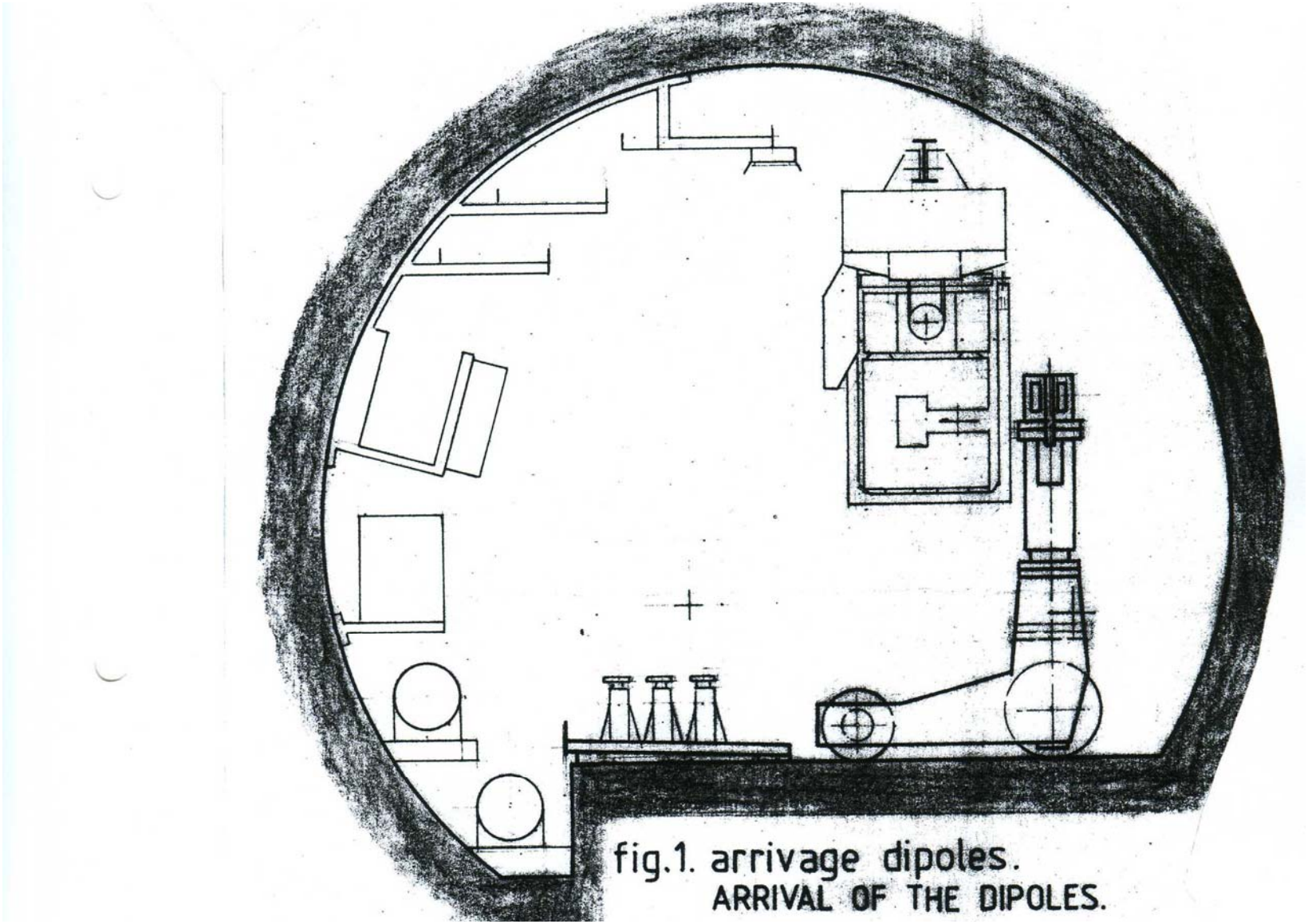
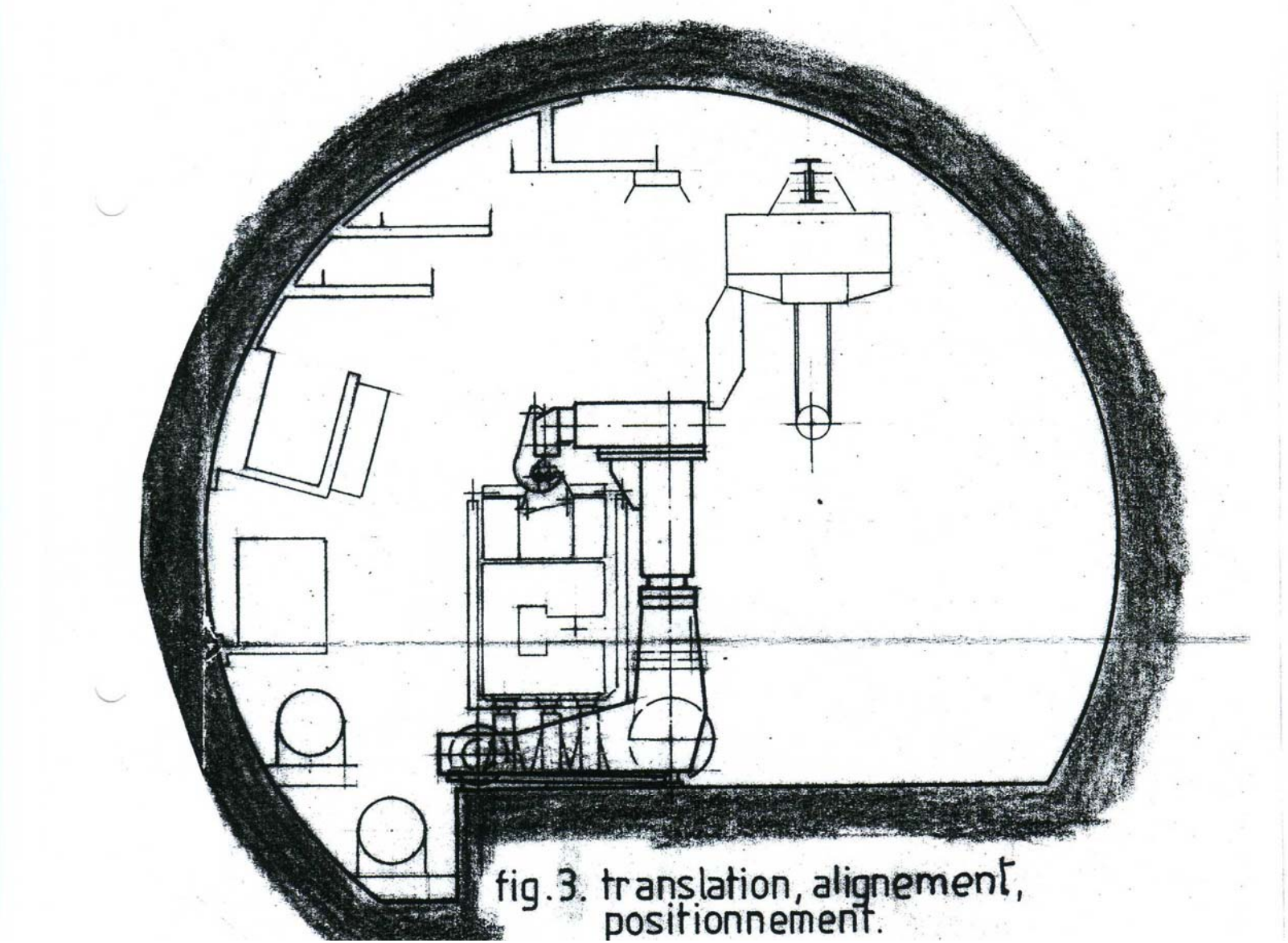


fig.1. arrivage dipoles.
ARRIVAL OF THE DIPOLES.

CERN LEP installation “Lobster” 2



CERN LHC dipole installation with transfer tables

CERN LHC cryodipole installation with transfer table -2

CERN SPS magnet installation

CERN SPS magnet installation (2)

DESY HERA Tram (dipole installation)

CERN LHC Collimator installation with trailer mounted crane

Transport questions + answers (CMWG)

MODULE CONDITIONING FOR TRANSPORT

- What is the unit of transport? -one module –see later slides
- Dimensions in transport configuration - see later slide
- Weights in transport configurations -1500kg
- Potential lifting points (e.g. for transfer) –consider lifting points above module – allow space for spreader beam
- Potential support points – support under girders during transport

TRANSFER TRAJECTORY RESTRICTIONS

- What supports etc will already be installed on the floor? – see later slides
- How much clearance space between adjacent modules during transfer/installation- 30mm allowed for interconnections – space available during installation to be defined

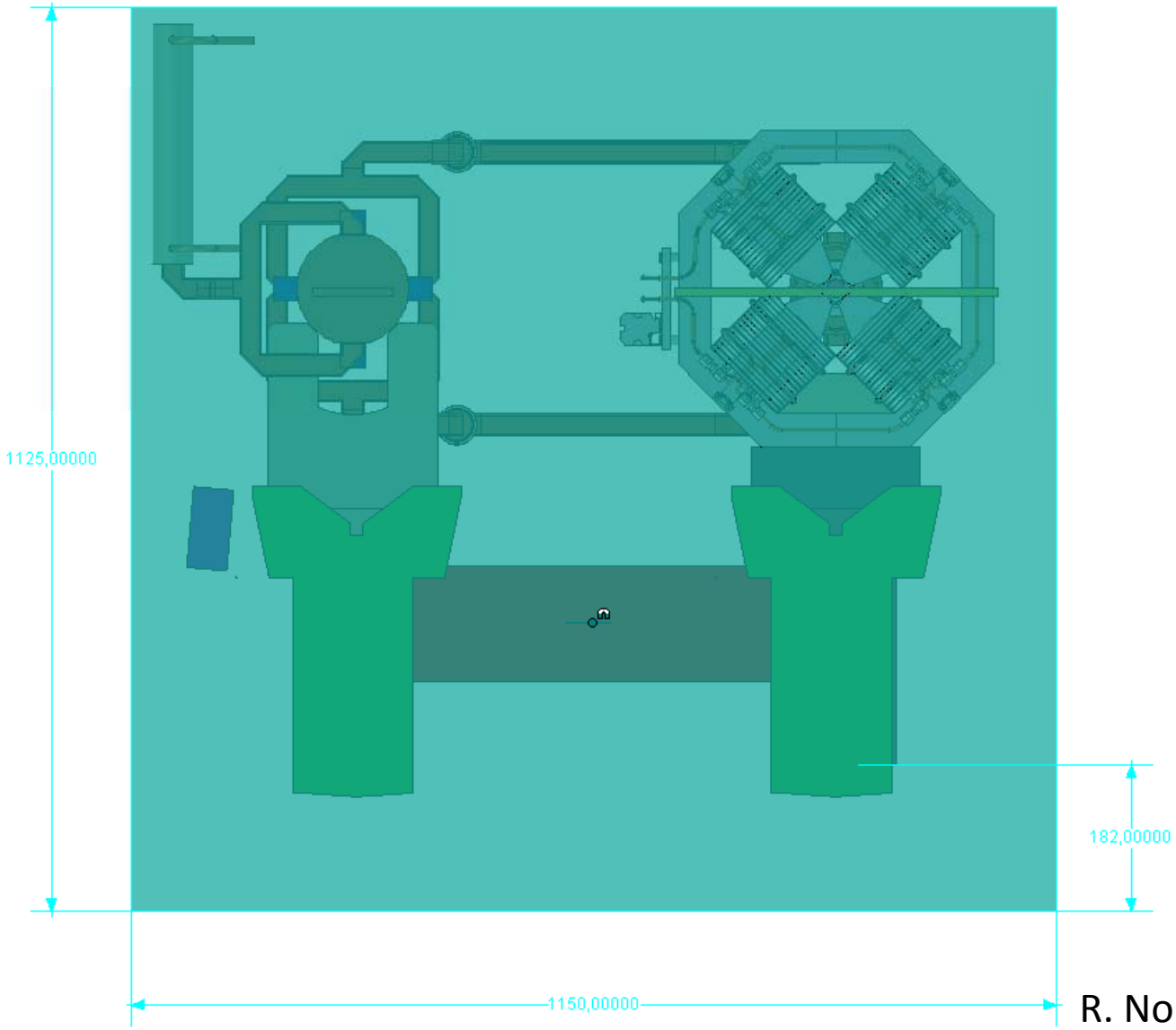
POSSIBLE SIMULTANEOUS TRANSPORT/INSTALLATION OF SEVERAL INTERCONNECTED MODULES

- What if several modules are interconnected on the surface and transported / installed at same time? – support and survey concepts based on module installation one at a time

VIBRATIONS / ACCELERATIONS

- Indicative values for permissible accelerations during transport and handling - 1*g* acceleration used as basis (i.e. normal handling techniques) note: need to avoid overloading supports during installation.

Transport envelope in cyan – 1125 x 1150 x 2100
Lifting points according to the worst case, i.e. on top of the transport envelope.
Intergirder support acceptable assumption for the moment.



R. Nousiainen 04092008

Assembly, Transport and Installation Sequence

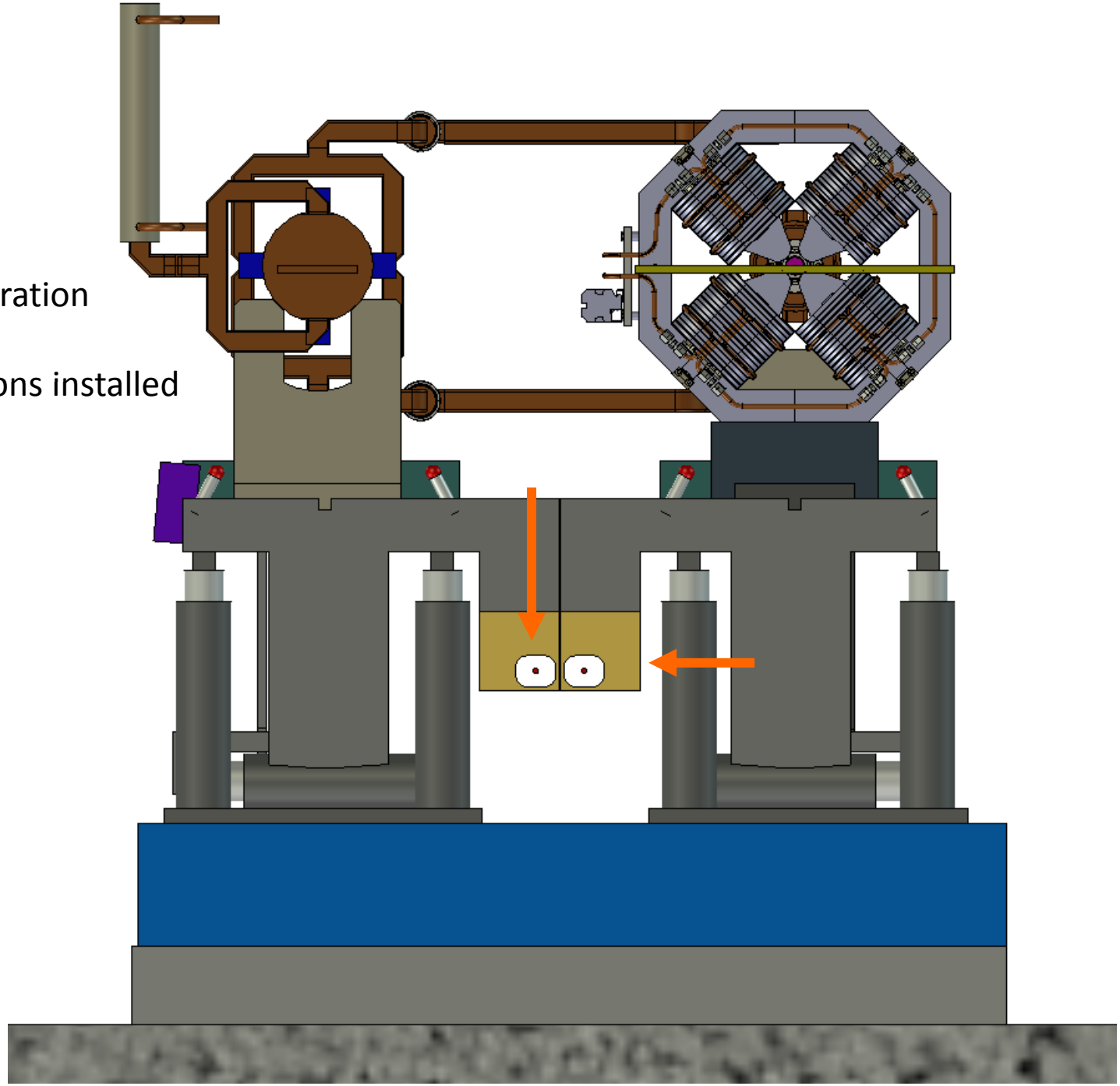
Continuation of the meeting held on 28th of August 2008

K. Kershaw, H. Mainaud Durand, R. Nousiainen, G. Riddone, T. Touze

(R. Nousiainen slides)

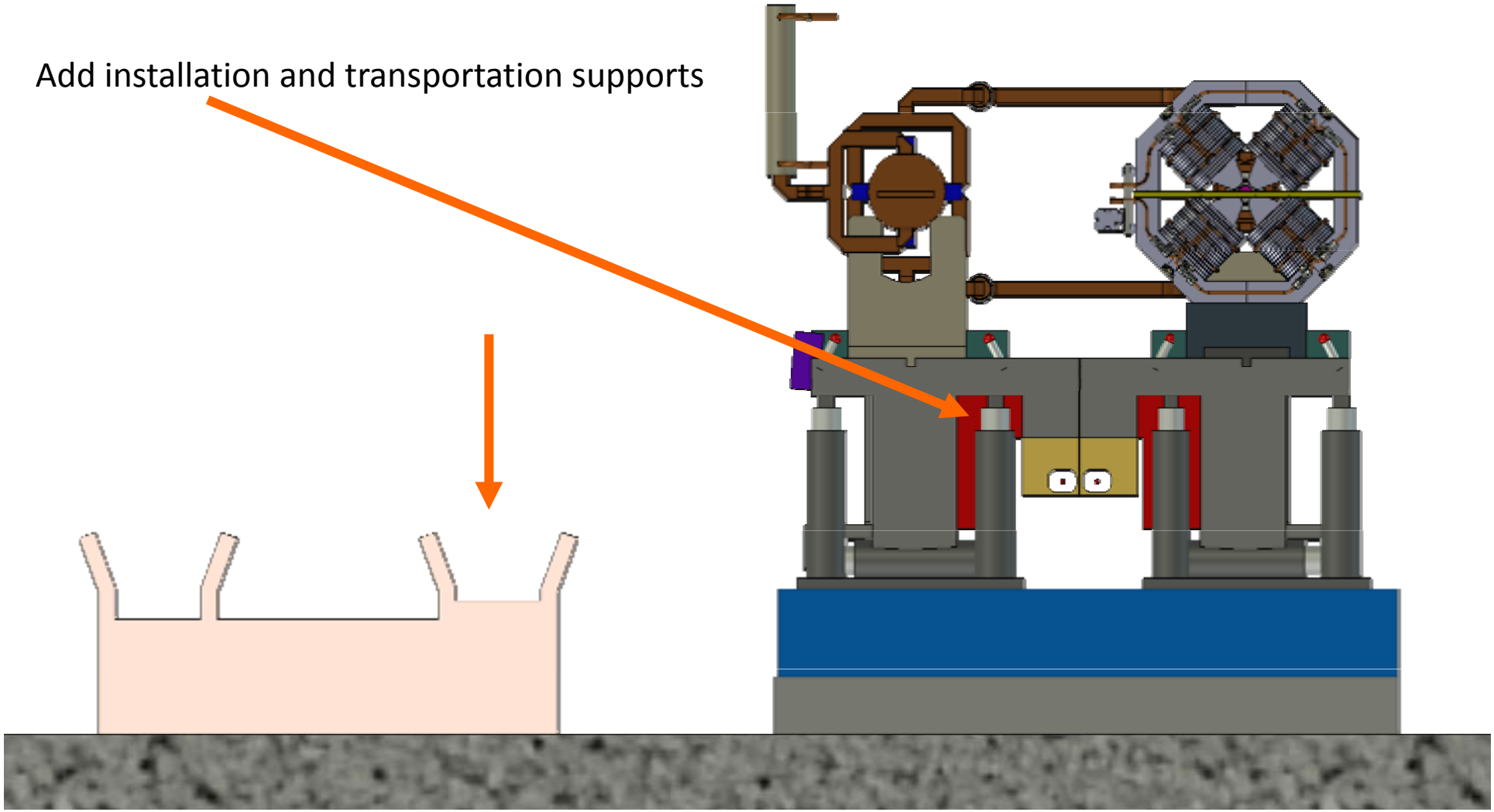
STEP 1

Assembly at surface
- Use the same configuration
  as in the tunnel
- MB-DB interconnections installed
- Fiducialisation done



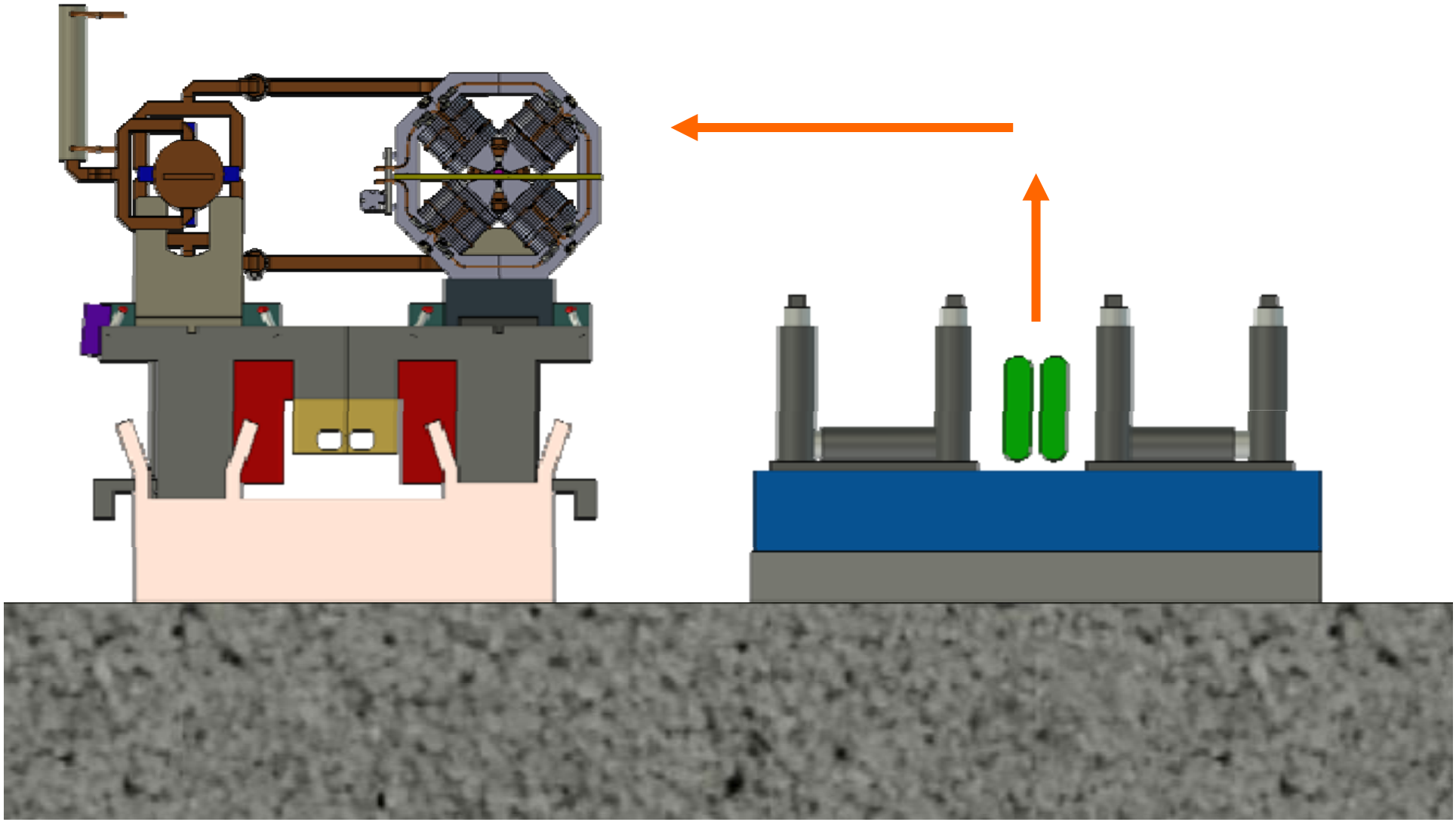
STEP 2

Add installation and transportation supports



STEP 3

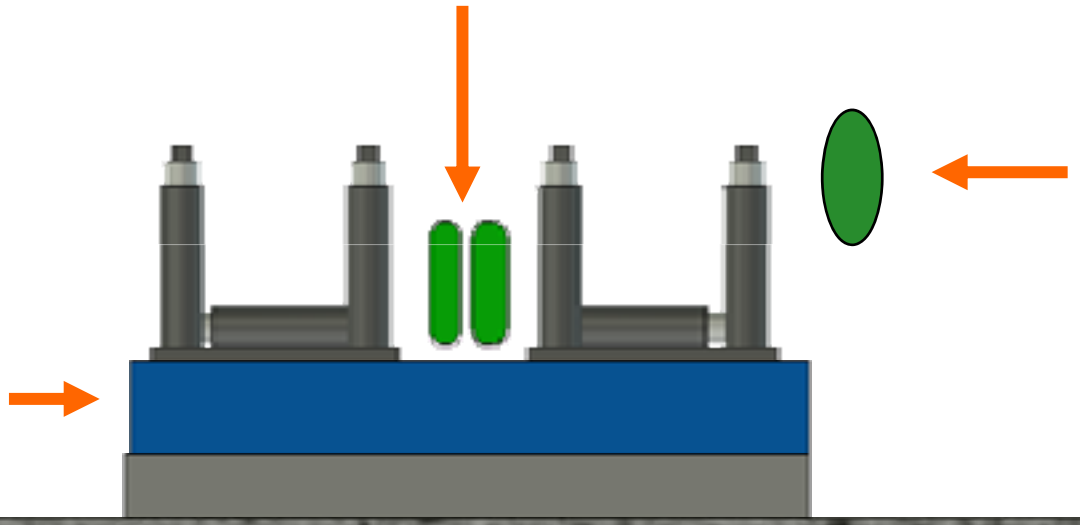
Move module to a transportation support



STEP 4

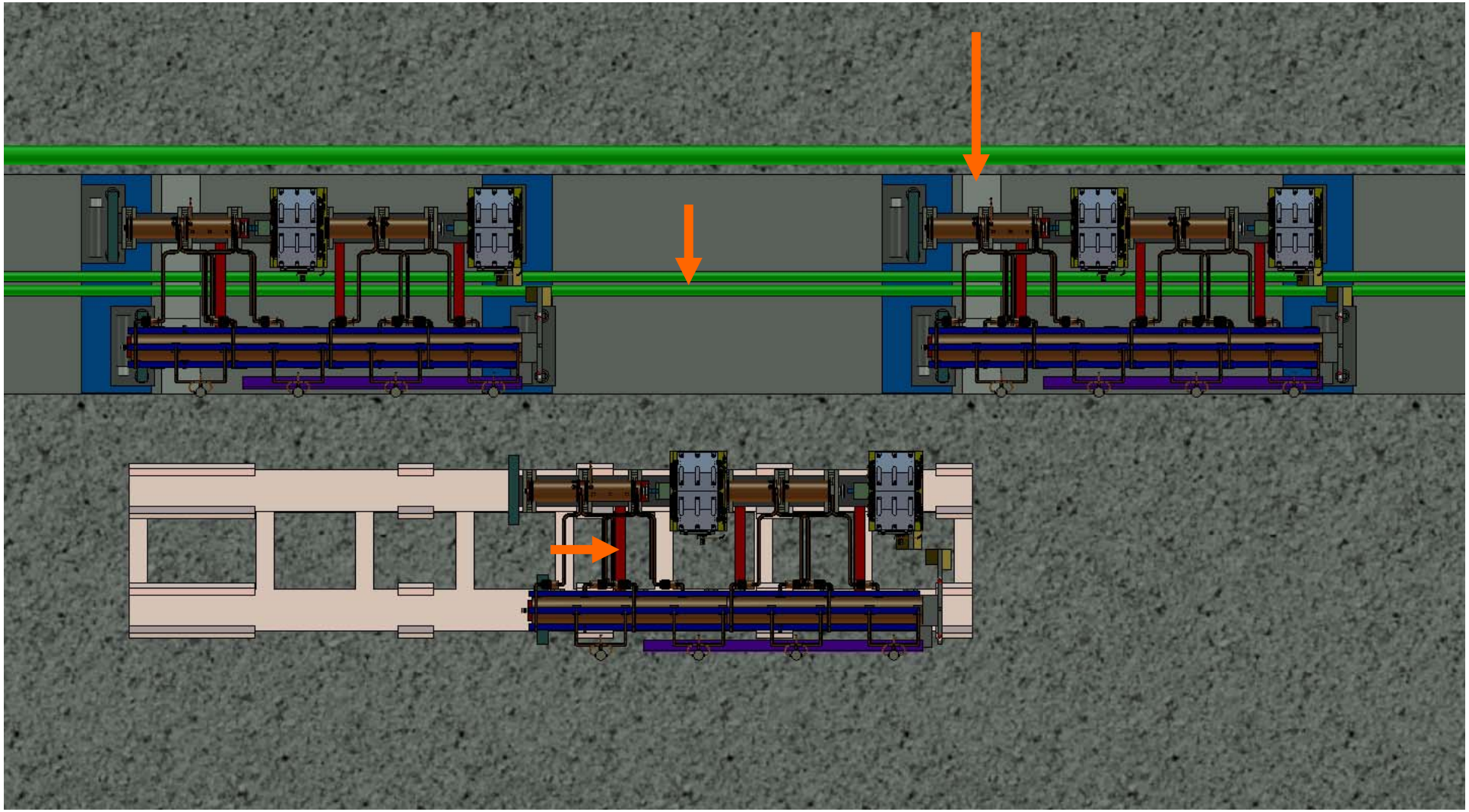
Tunnel before module installation

- Prepare propagation network reference and pre-align supports



STEP 5

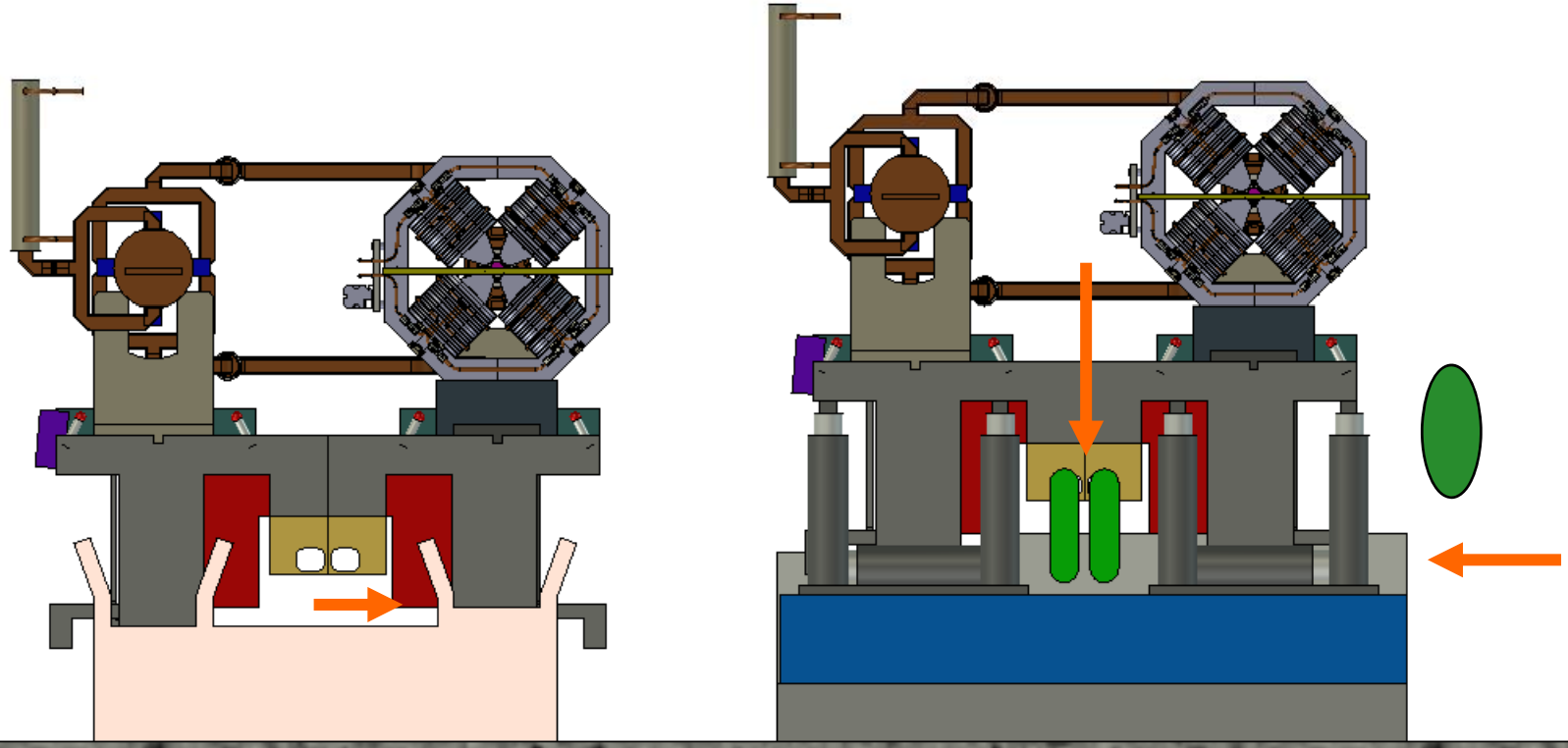
Module at the installation point.
- Use temporary supports for installation.



STEP 5B

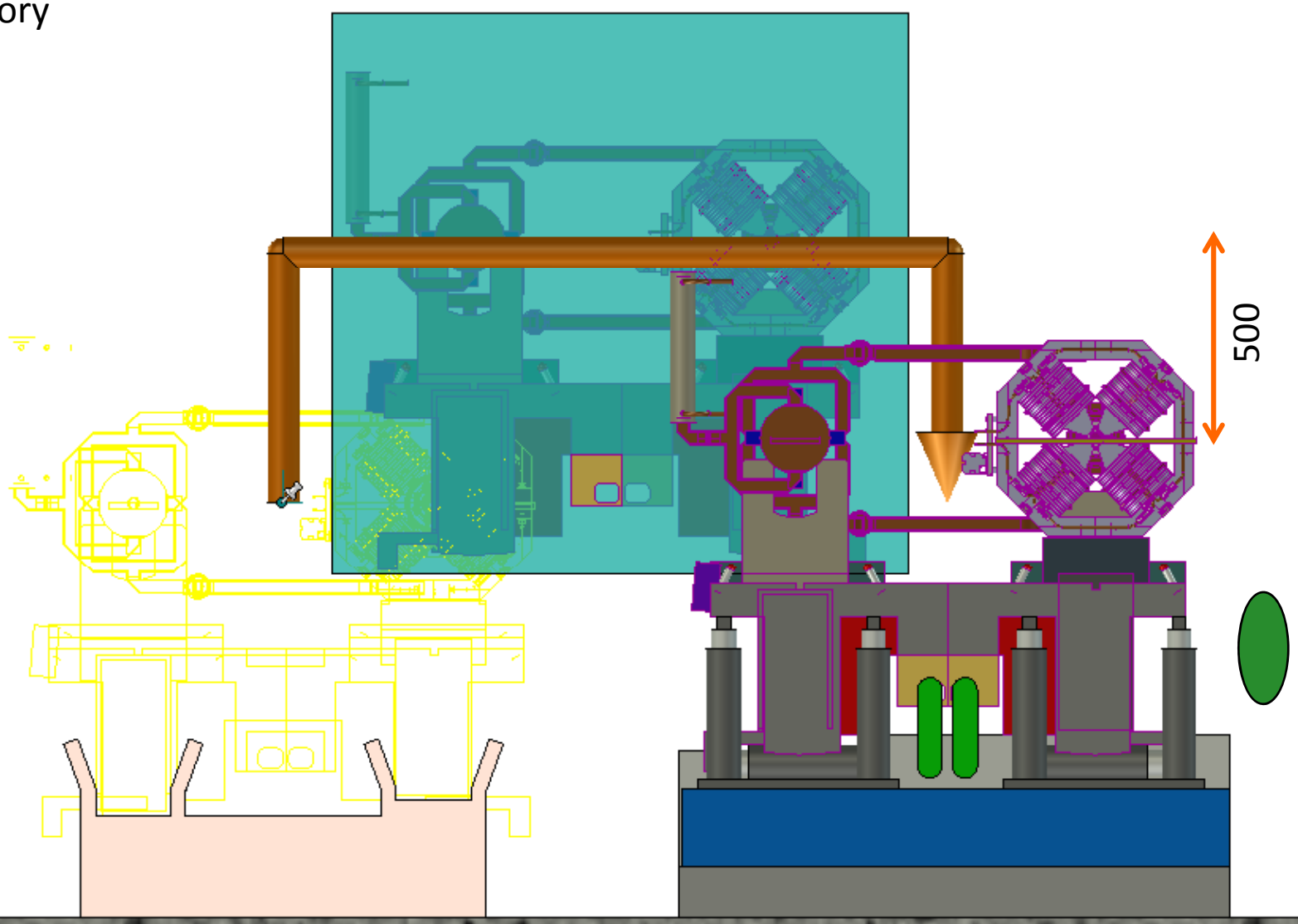
Module at the installation point.

- Use temporary supports for installation.



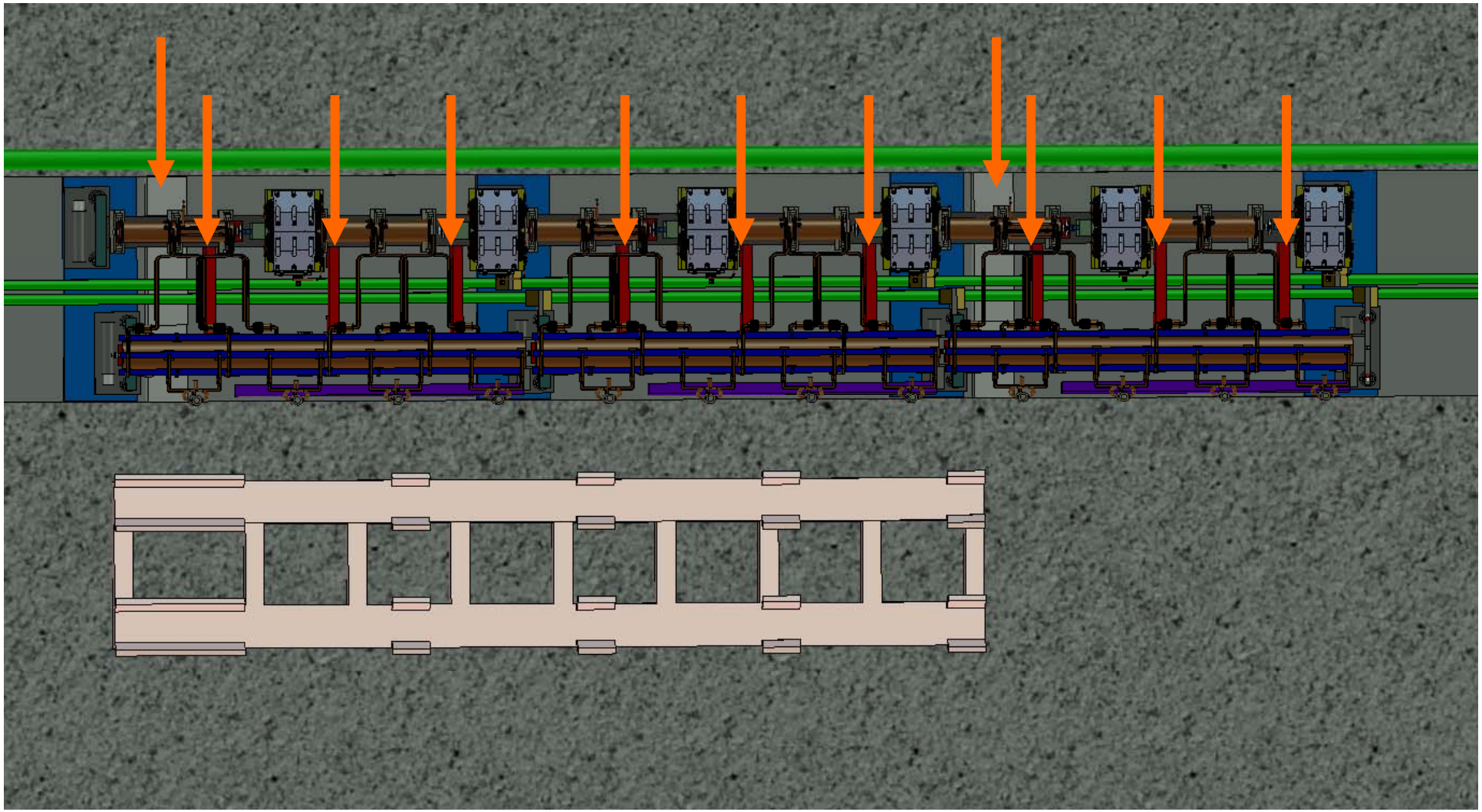
STEP 6

Module installation trajectory



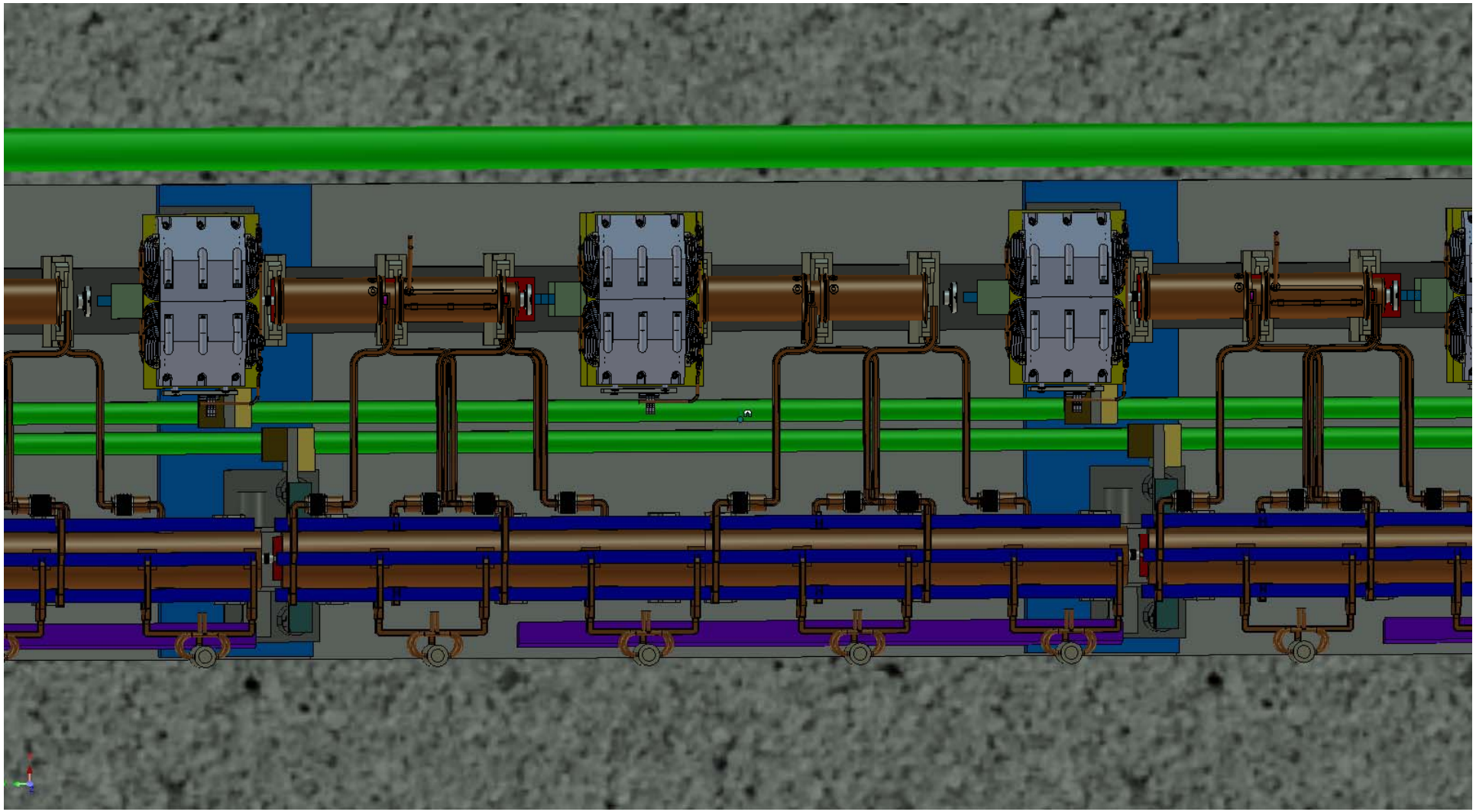
STEP 7

Installed module with temporary supports



STEP 7B

Installed module
- Temporary supports removed

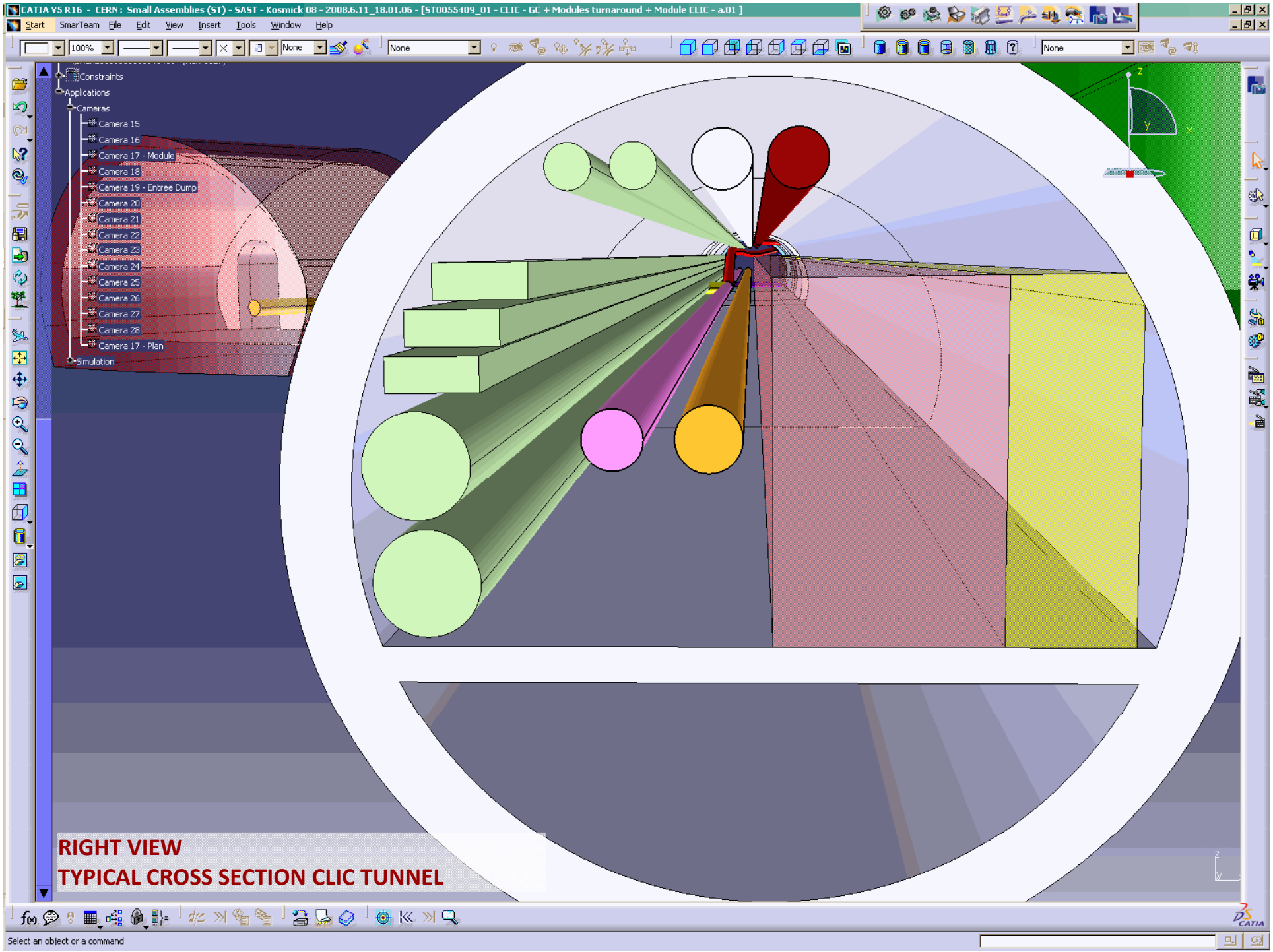


Vehicle conceptual design

- Floor – running vehicles with on-board (un)loading cranes.
- Transport several modules at a time
- Avoid requirement for reserved space below beams / girders

3-D Integration of Module Transport and Installation

Keith Kershaw / John Osborne / A.Kosmicki


CATIA V5 R16 - CERN : Small Assemblies (ST) - SAST - Kosmick 08 - 2008.6.11_18.01.06 - [ST0055409_01 - CLIC - GC + Modules turnaround + Module CLIC - a.01]
Start SmarTeam File Edit View Insert Tools Window Help
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Applications
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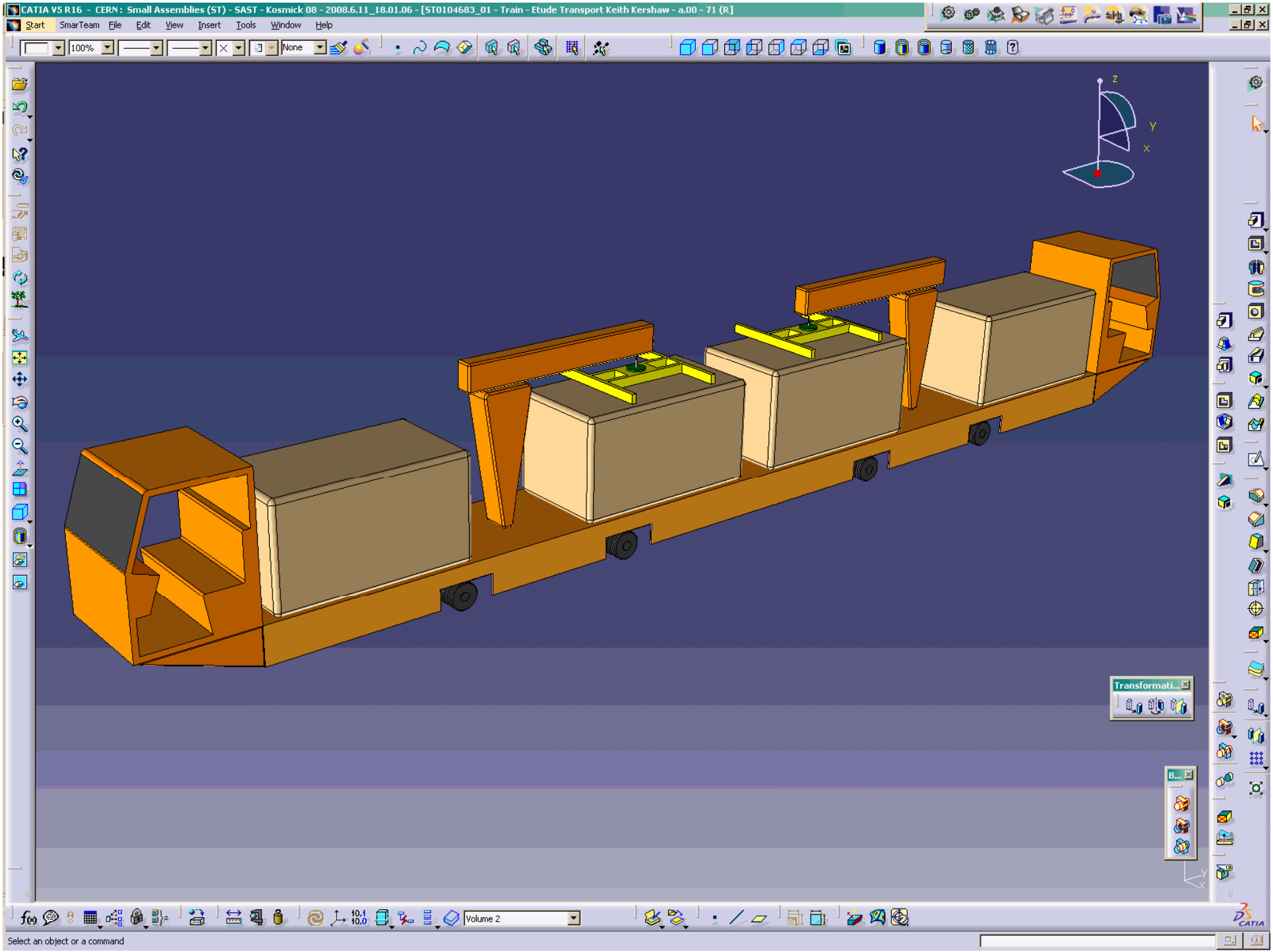
Camera 15
Camera 16
Camera 17 - Module
Camera 18
Camera 19 - Entree Dump
Camera 20
Camera 21
Camera 22
Camera 23
Camera 24
Camera 25
Camera 26
Camera 27
Camera 28
Camera 17 - Plan
Simulation
RIGHT VIEW
TYPICAL CROSS SECTION CLIC TUNNEL
Select an object or a command


CATIA V5 R16 - CERN : Small Assemblies (ST) - SAST - Kosmick 08 - 2008.6.11_18.01.06 - [ST0104683_01 - Train - Etude Transport Keith Kershaw - a.00 - 71 (R)]
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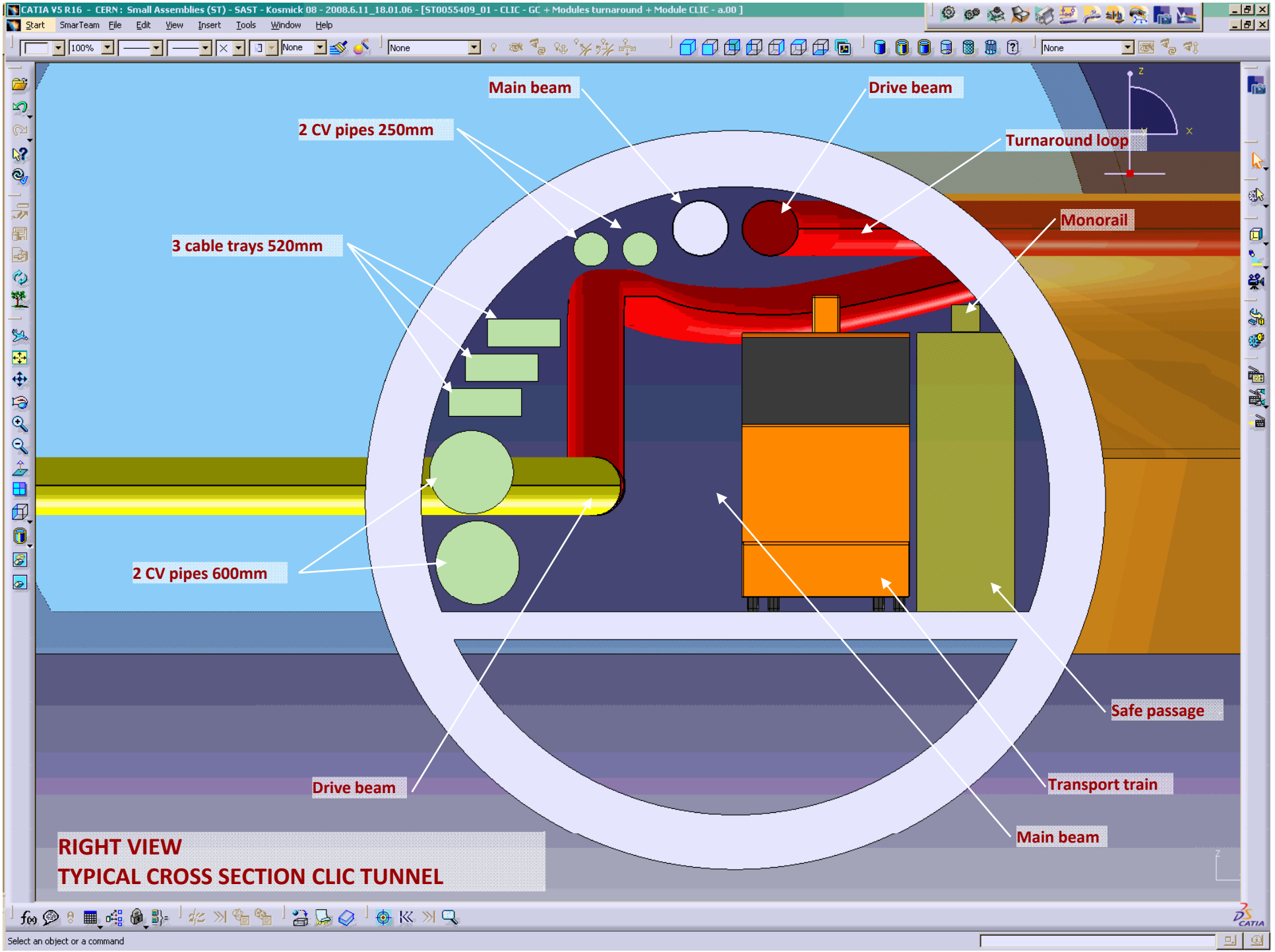
Volume 2
Select an object or a command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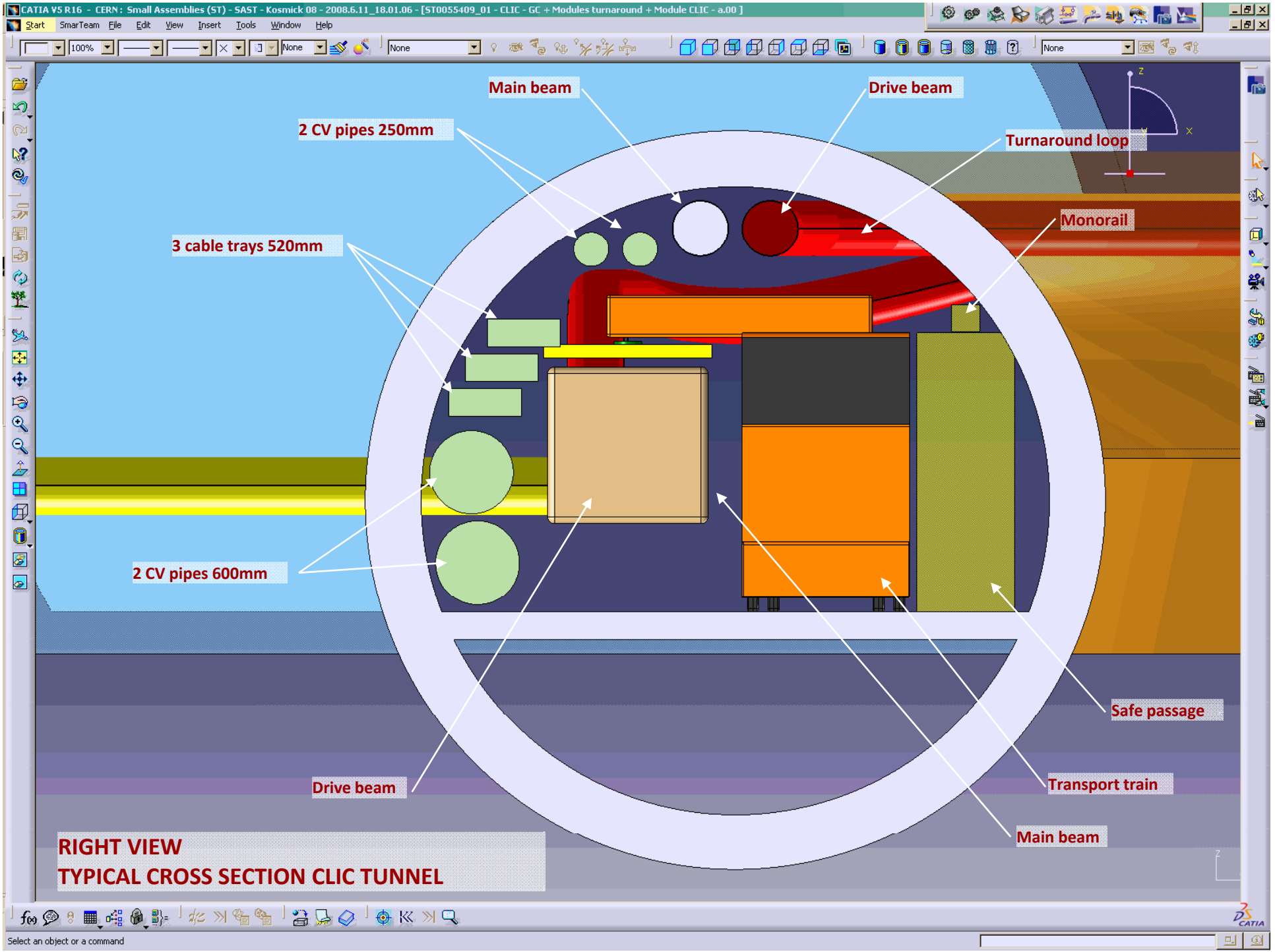
Start SmarTeam File Edit View Insert Tools Window Help
Main beam
Drive beam
2 CV pipes 250mm
Turnaround loop
Monorail
3 cable trays 520mm
2 CV pipes 600mm
Safe passage
Drive beam
Transport train
Main beam
RIGHT VIEW
TYPICAL CROSS SECTION CLIC TUNNEL
Select an object or a command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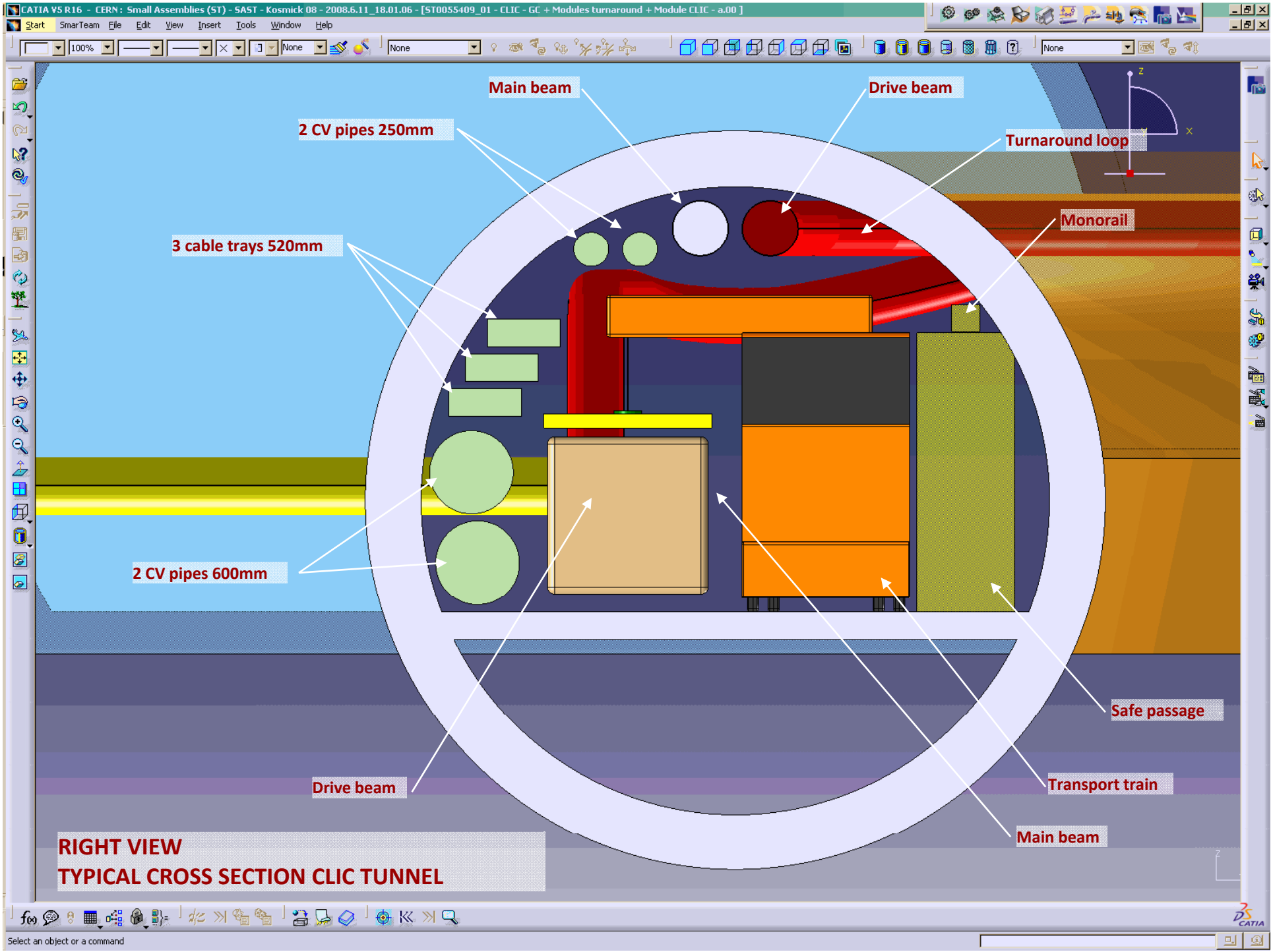
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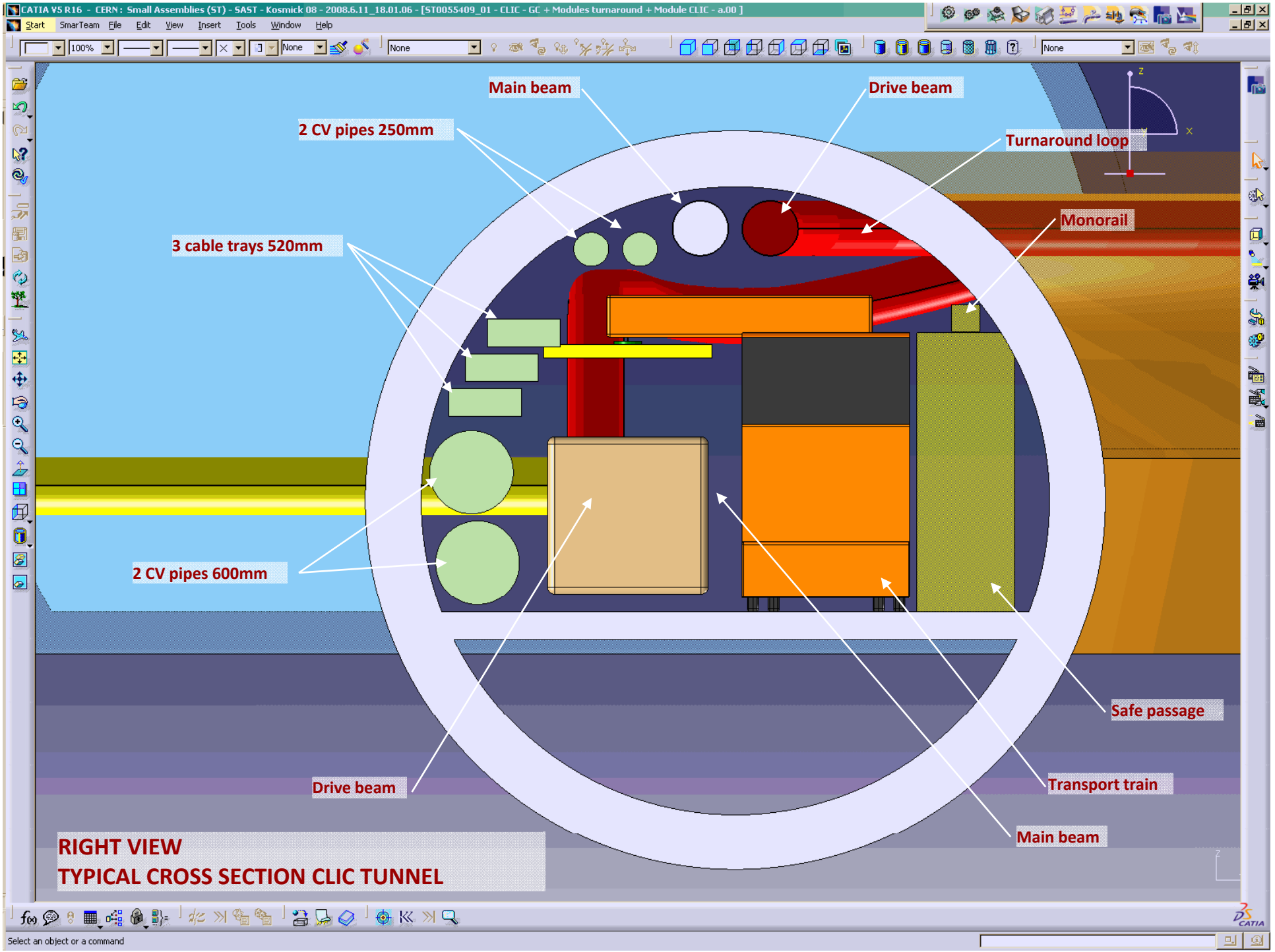
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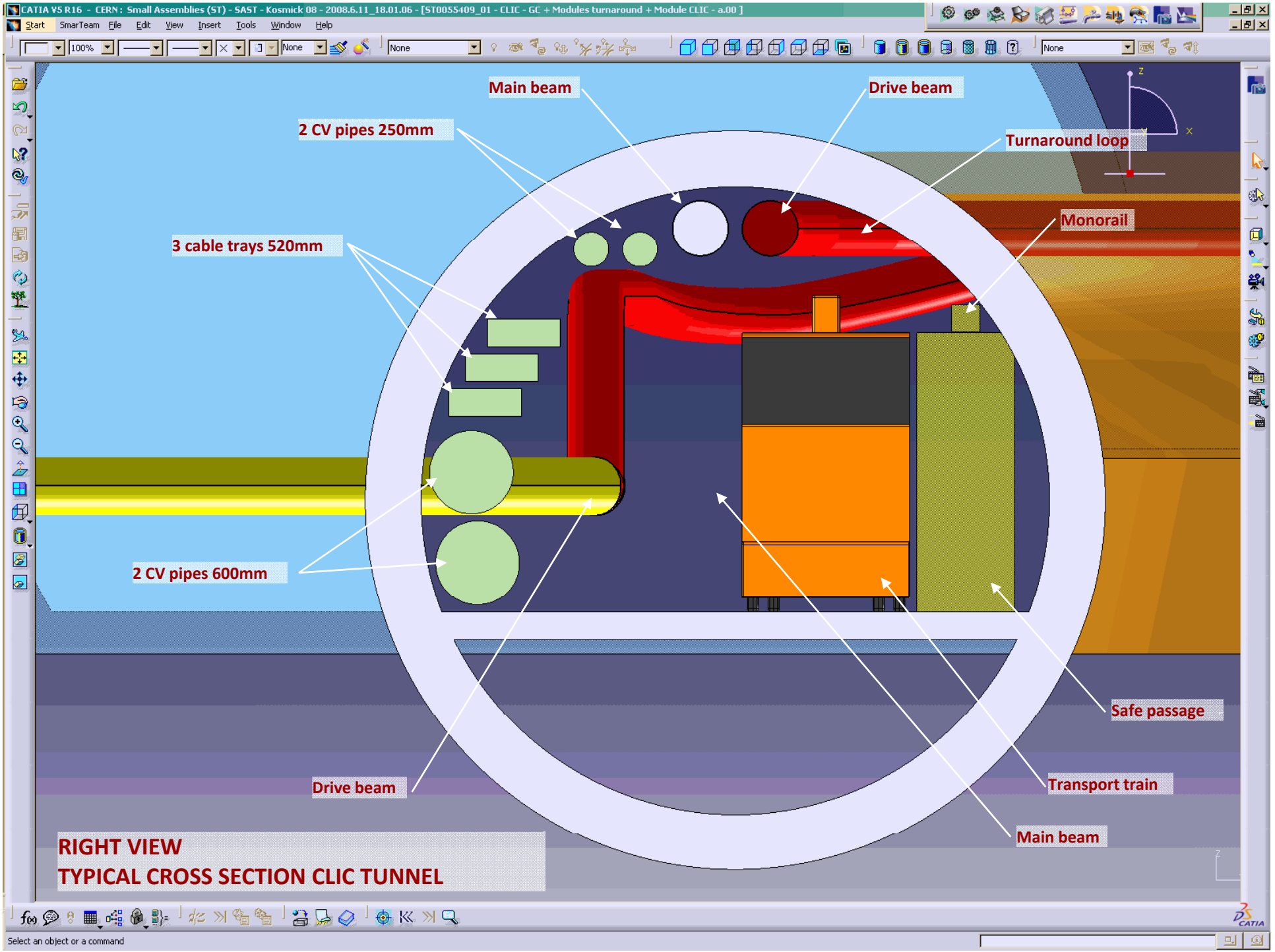
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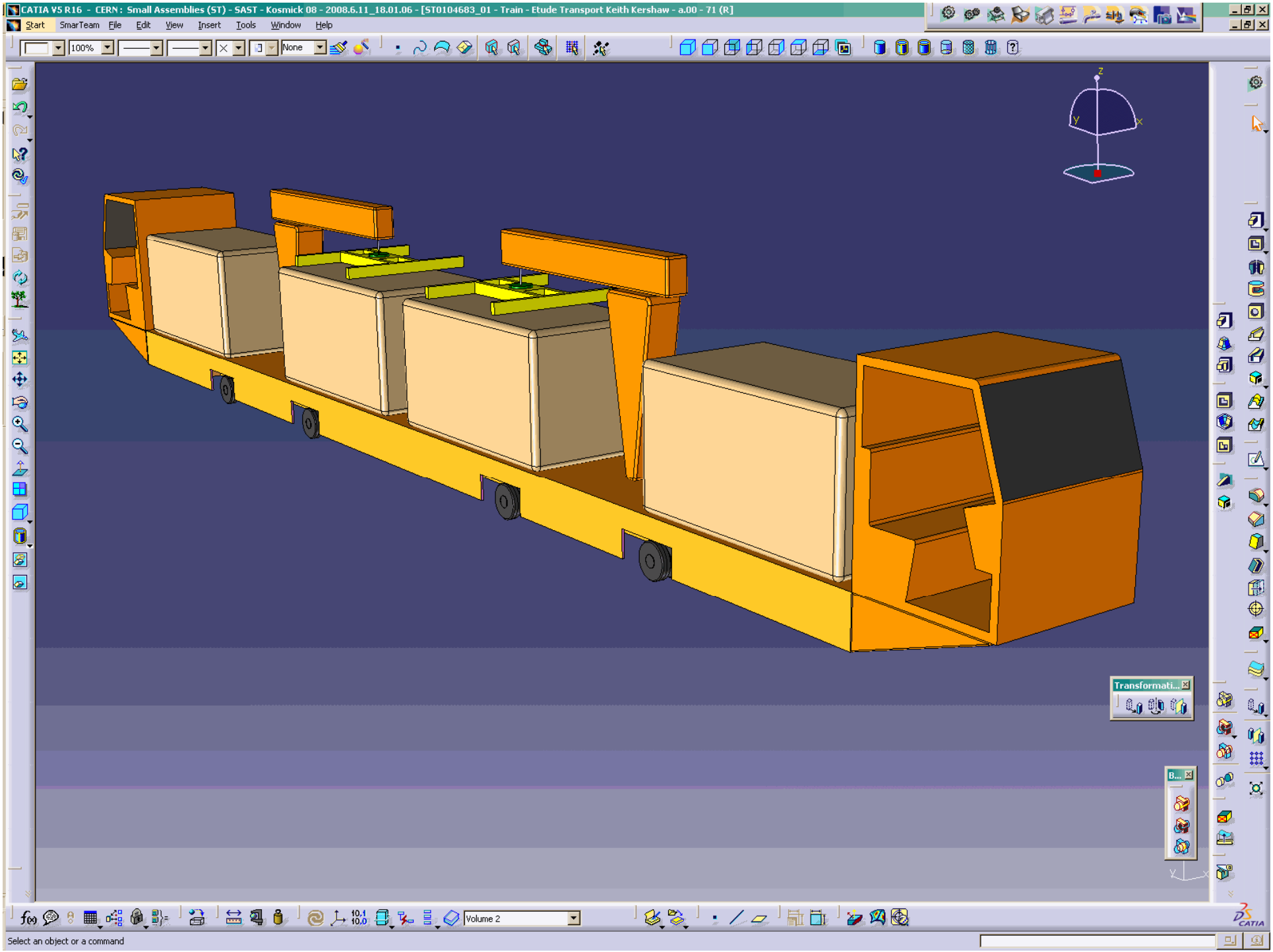
Select an object or a command

Vehicle conceptual design (continued)

- Modular: vehicle base with separate operator cabins and interchangeable lifting equipment modules
- Monorail for power (+ buffer batteries)
- 1200 wide x 2270 high x 12m long (+ 2.5m for cabs)
- Automatic guidance
- Allows reservation of space in tunnel for transport and transfer of modules (however module beam offset issues may change transfer height)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Volume 2
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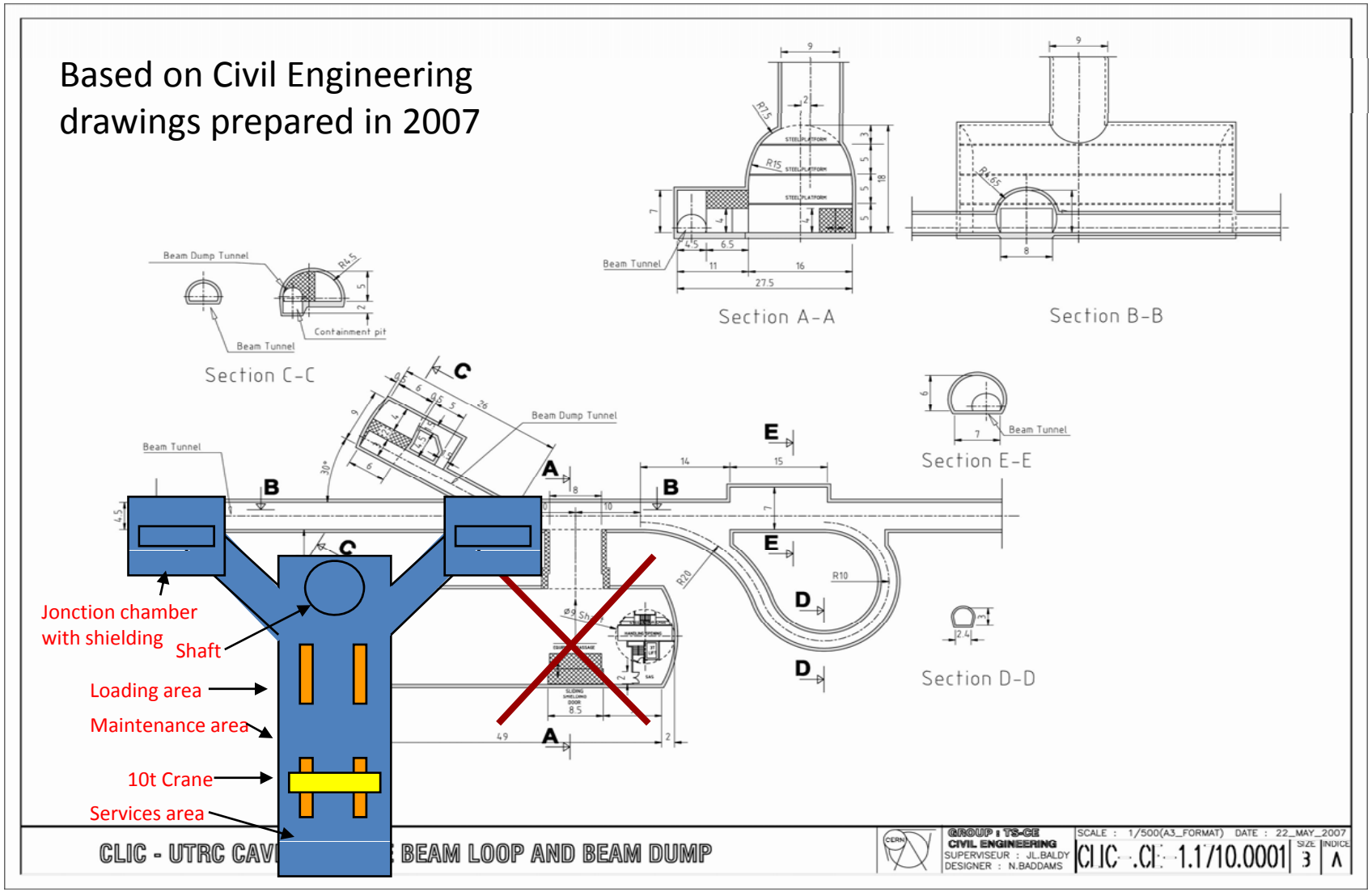
Lowering of modules etc from surface to underground

- Use lifts (elevators) for fast lowering of modules
- Need method of fast loading of modules onto vehicles
- Provide passing places to allow queuing and sorting of vehicles for logistics flexibility
- Provide space for maintenance / repair

Proposal for module lowering and tunnel access

Based on Civil Engineering drawings prepared in 2007



Logistics – indicative figures

- 20,549 modules to install (assume supports already in place)
- Access shafts 5km apart
- Consider 1 vehicle with 4 modules
- Driving speed 4km/h
- Consider mid-sector (2.5km driving each way)
- Ignore loading time (queuing)
- Driving time = 2 x 2.5/4 = 1.25hrs
- Unloading / installation time = say ½ hr x 4 = 2hrs
- 1 shift → 8 modules with one vehicle
- 20549 modules in 2 years (single shift, weekdays) → ~41/day → need min 6 operational vehicles for modules

Next steps

1) Agree concept as basis for further work – feedback from other groups
2) Review and refine as more details of modules, supports and other items and services become available (clarify longitudinal offset issues)
3) As part of tunnel integration process - consider transport and installation of:

- Overhead magnets
- Turnarounds
- Beam dumps
- Services