IMPACT ON TUNNEL INTEGRATION, TRANSPORT STUDIES

CLIC Two-Beam Module Review
15-16 September 2009
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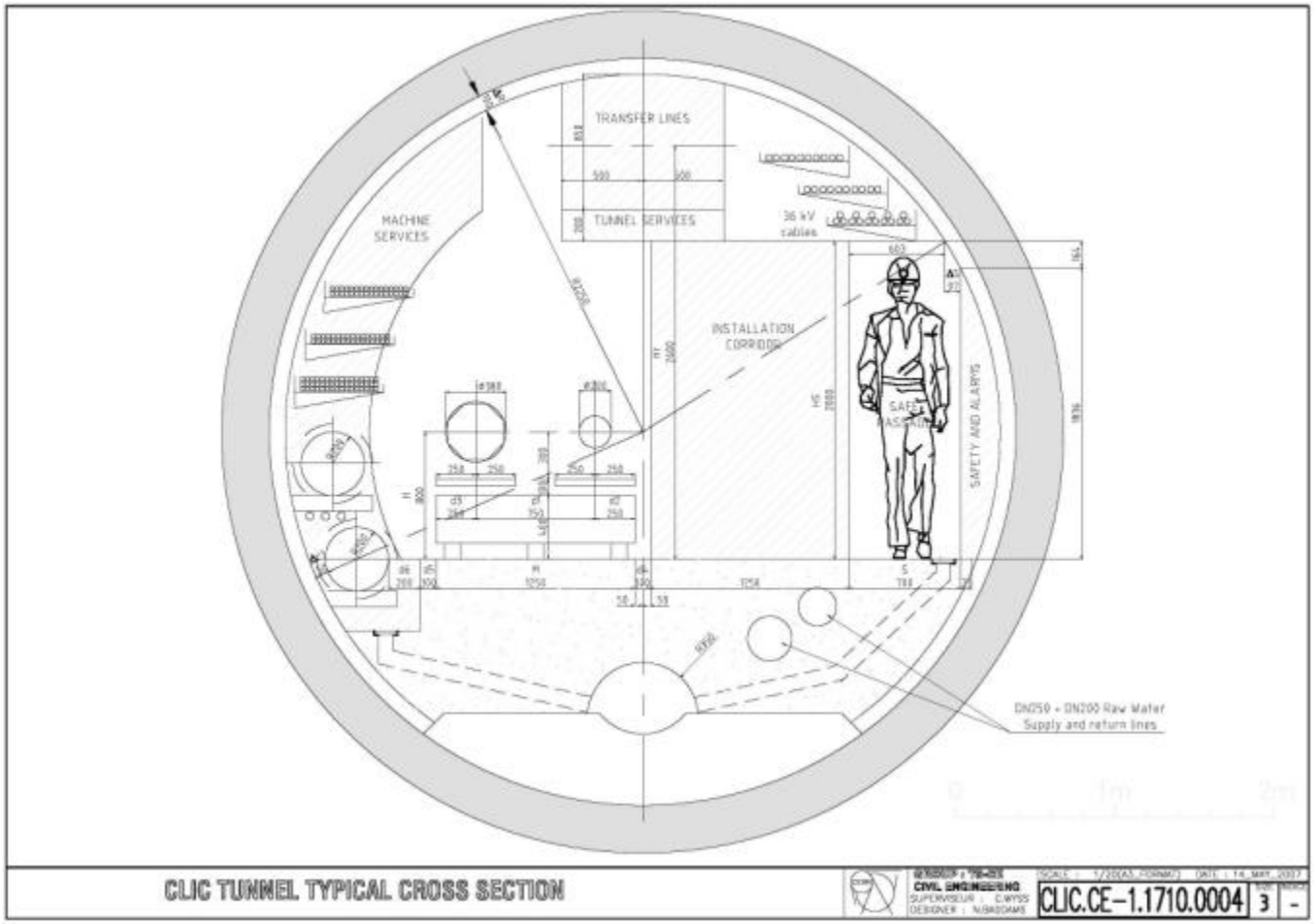
CONTENTS

- Aims of study
- Inputs and requirements
- Proposed solution
- Work to reduce tunnel section
- Implications for module design
- Open questions
- Module mock-ups
- Conclusions

REMINDER - AIMS OF TRANSPORT STUDIES

- Propose conceptual solution for lowering, underground transport and installation of CLIC modules.
- This conceptual solution will provide input into the tunnel integration studies and module integration work

TUNNEL CROSS SECTION 2007



EXPLANATION OF REQUIREMENTS

- Lower modules to underground area
- Transport along tunnel to installation site
- Transfer onto supports

- Minimise work underground
- Be quick (OVER 20,000 modules)
- Allow exchange of individual modules

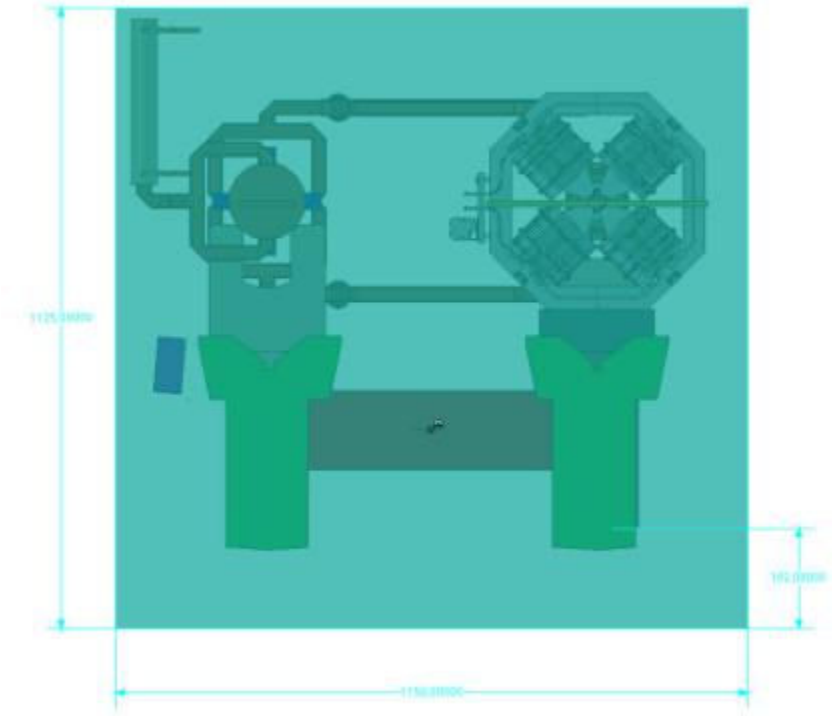
MODULE CONDITIONING FOR TRANSPORT

- Dimensions (see later slides)
- Weight - 1500kg

- Unit of transport - one module at a time
- Support points – under girders
- Lift points - from above

MODULE DIMENSIONS FOR TRANSPORT (2008)

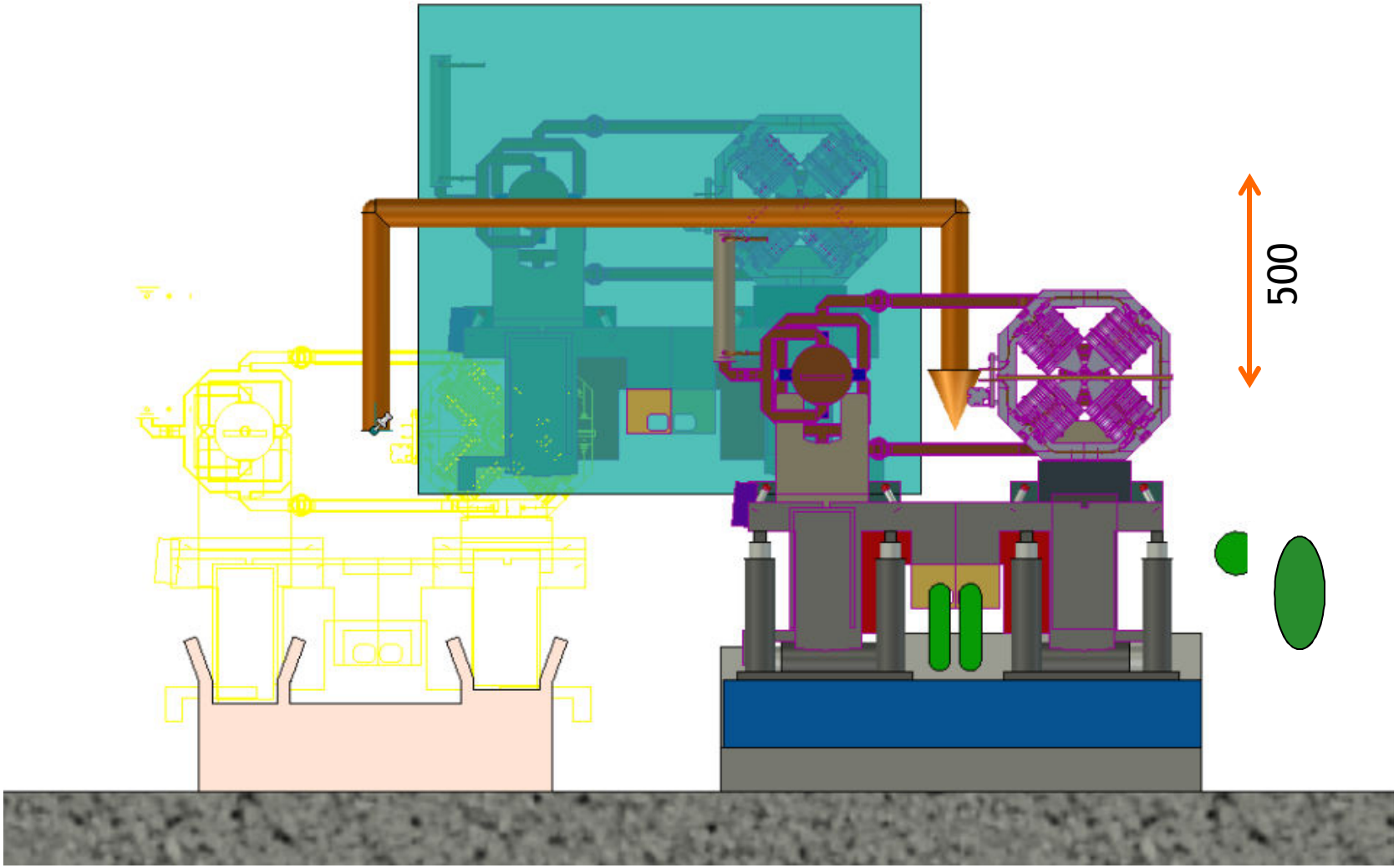
- Transport envelope in cyan – 1125 x 1150 x 2100
- Lifting points on top of the transport envelope.
- Intergirder support acceptable assumption for the moment.



TRANSFER TRAJECTORY RESTRICTIONS

- **Laterally** - depends on what supports etc will already be installed on the floor – see later slides
- **Longitudinally** – depends on clearance space between adjacent modules during transfer/installation
  - 30mm allowed for interconnections
  - space available during installation to be defined

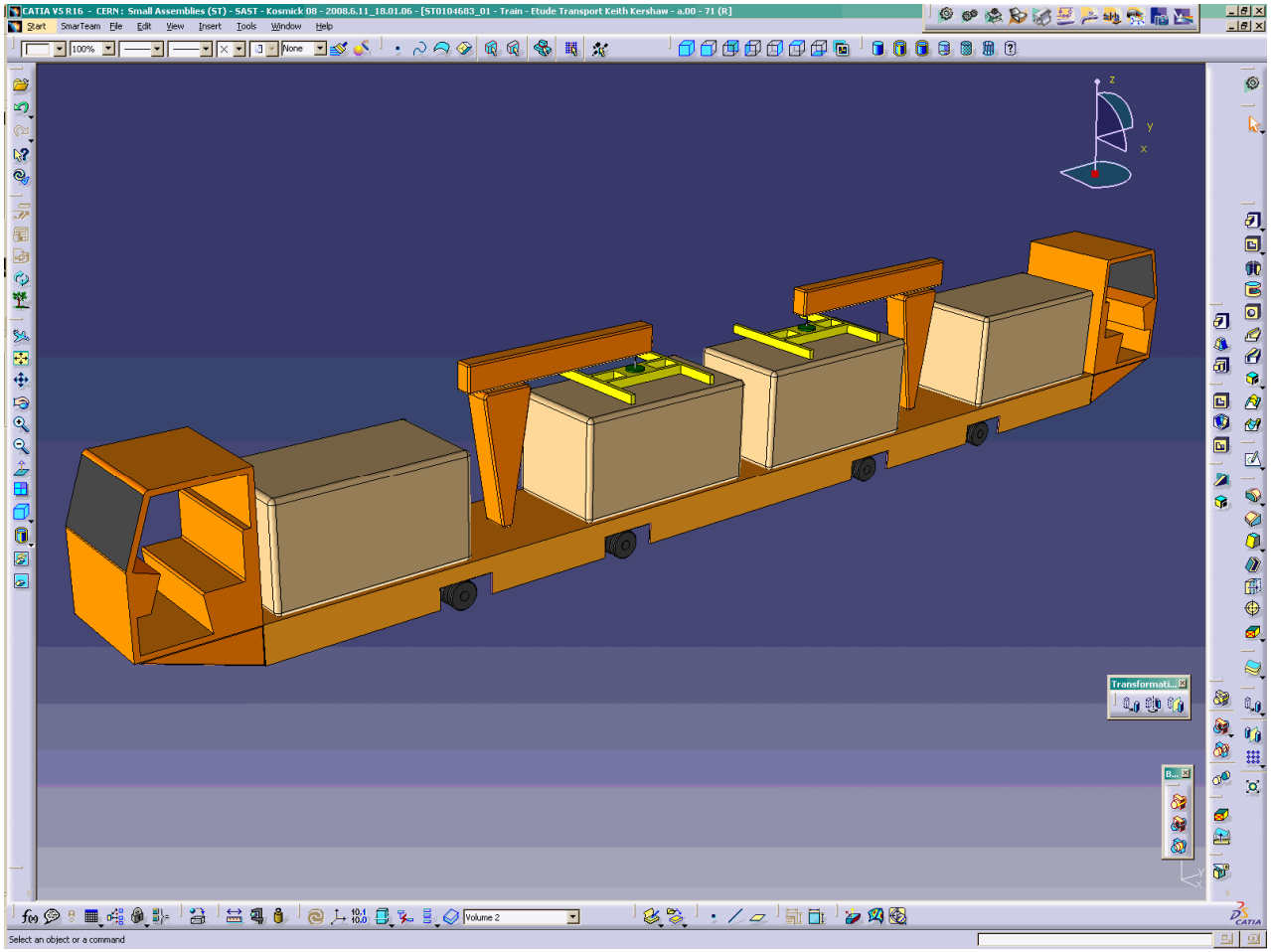
MODULE INSTALLATION TRAJECTORY (2008)

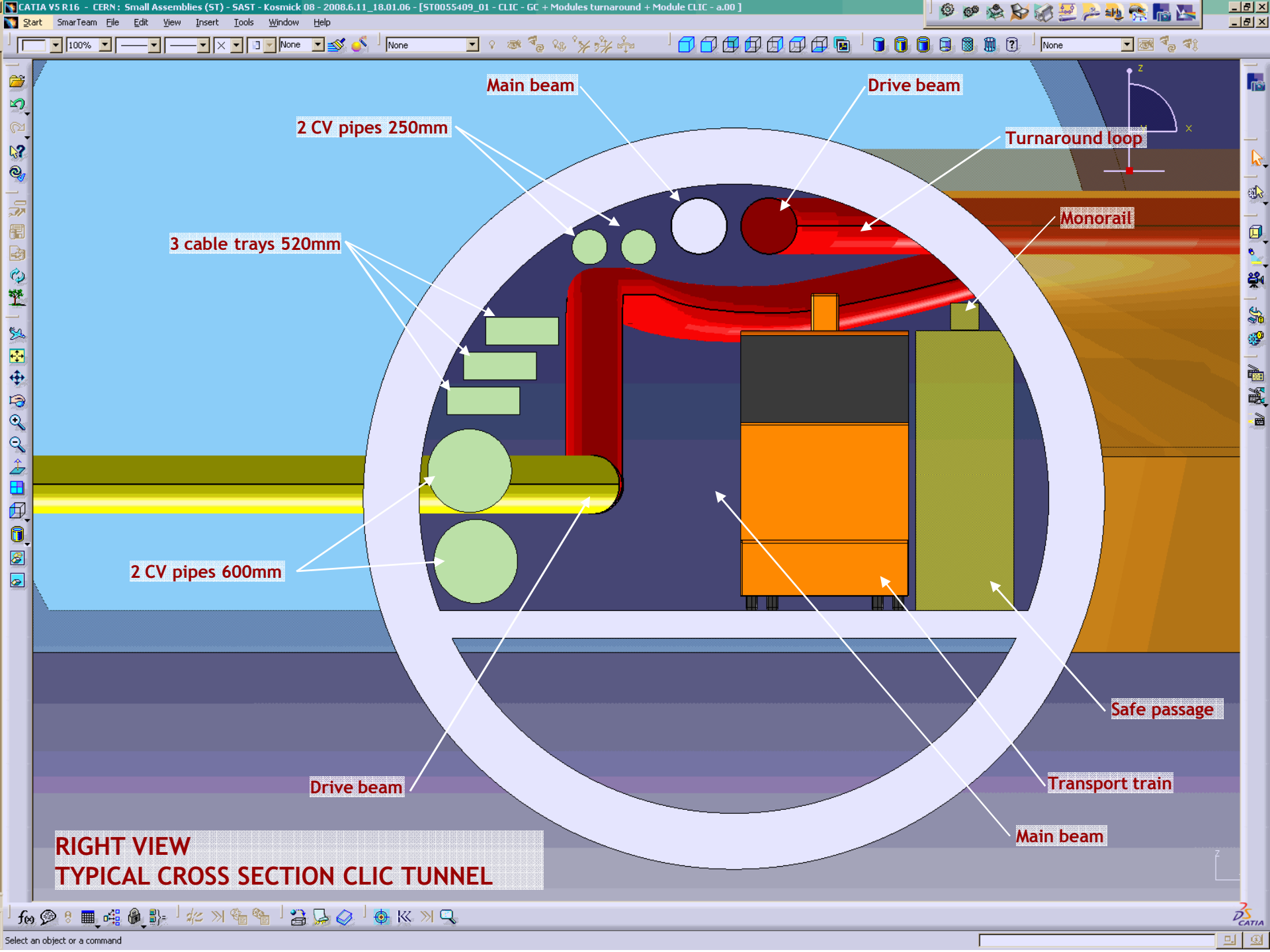


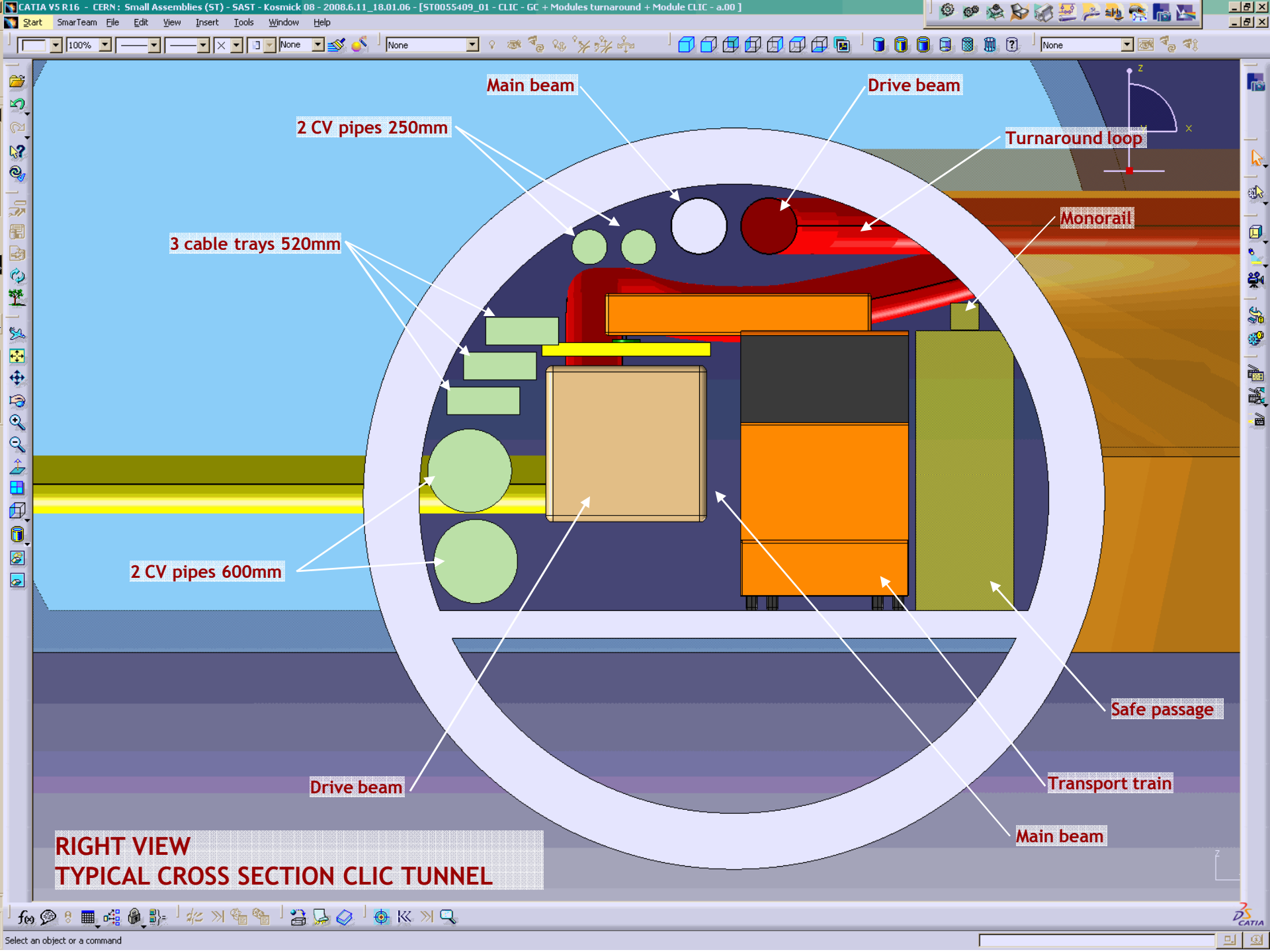
VIBRATIONS / ACCELERATIONS

- 1g acceleration used as basis (i.e. normal handling techniques)
- Need to avoid overloading supports during installation.

PROPOSED TRANSPORT / INSTALLATION SYSTEM




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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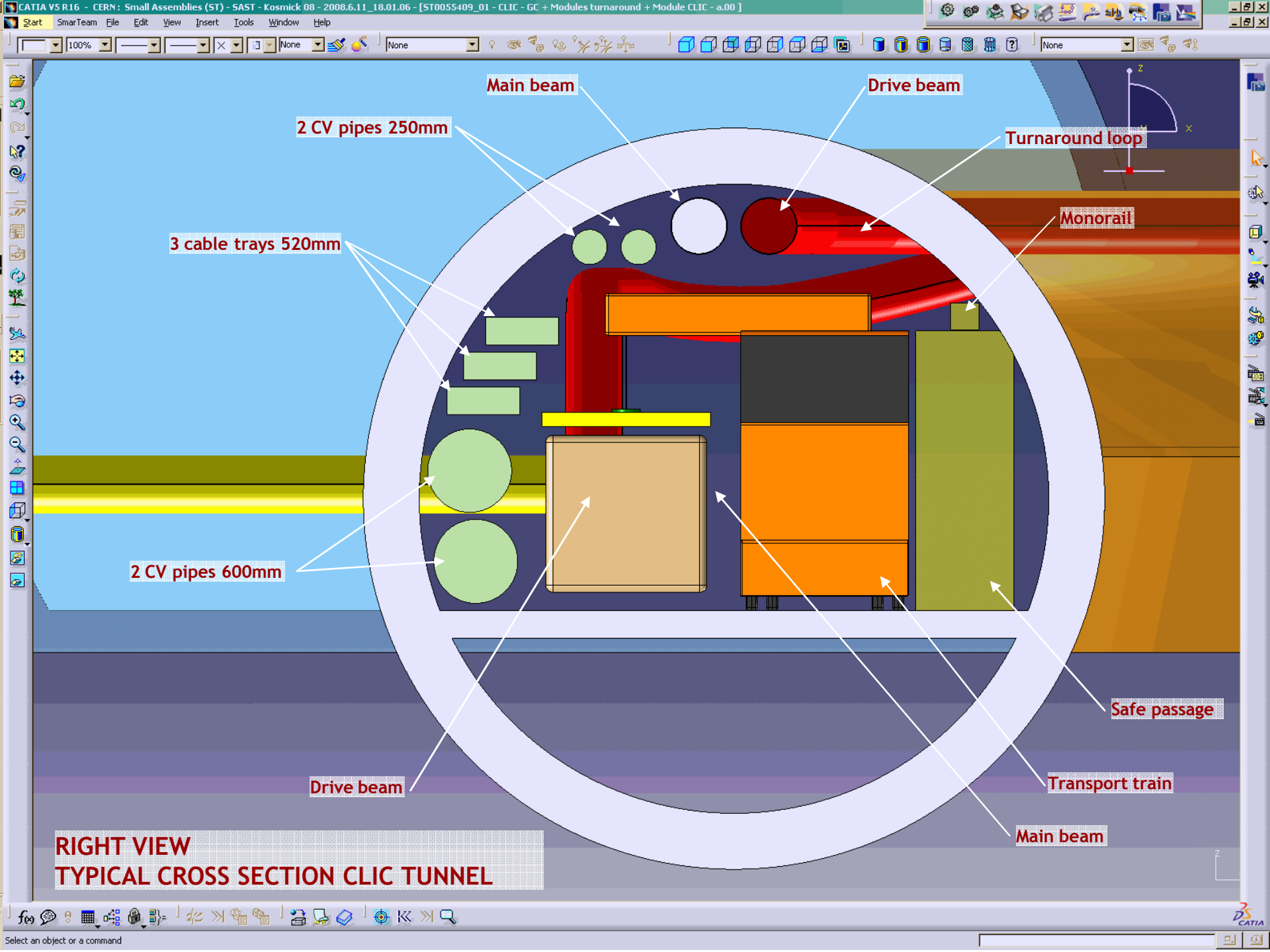
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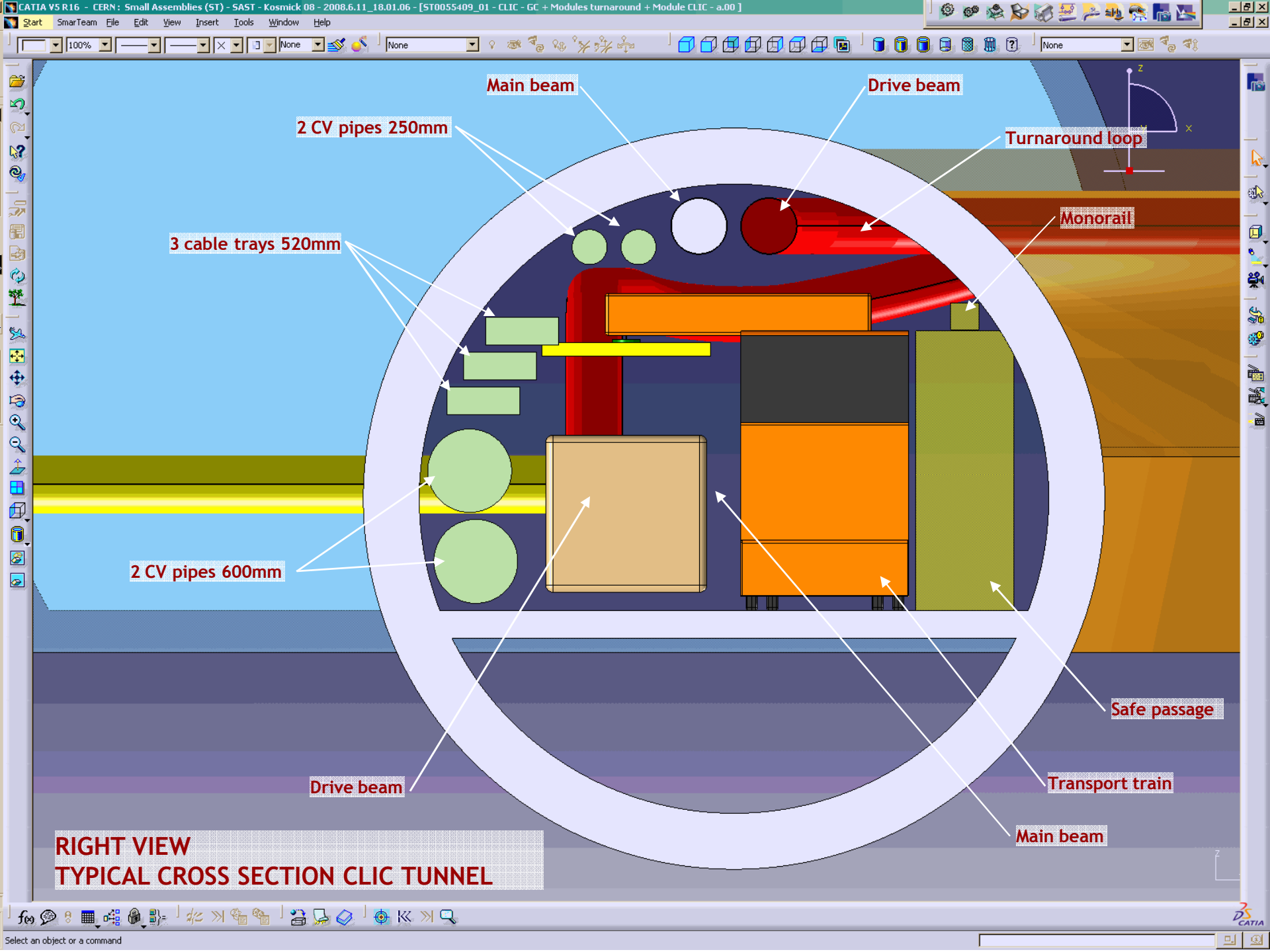
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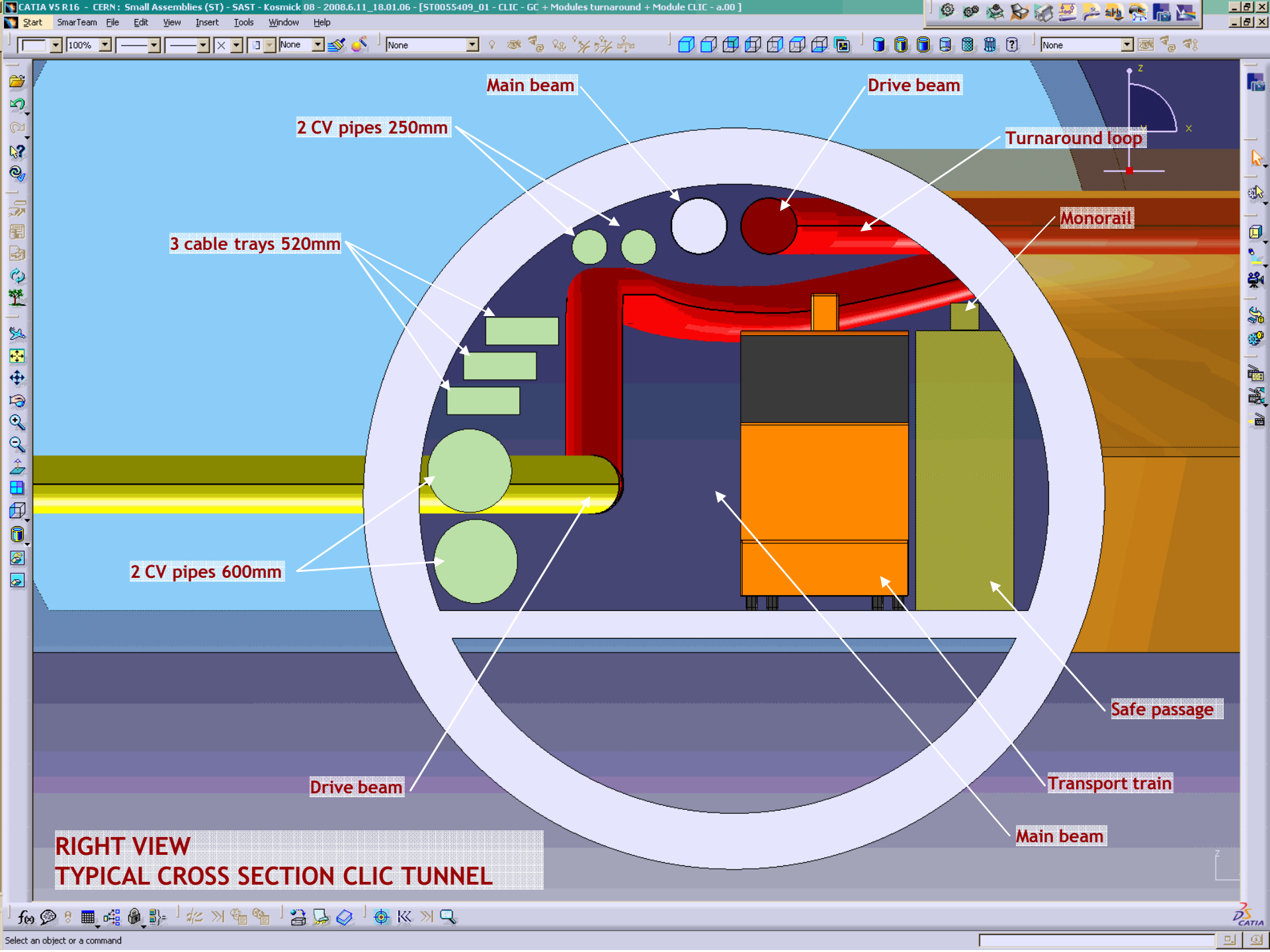
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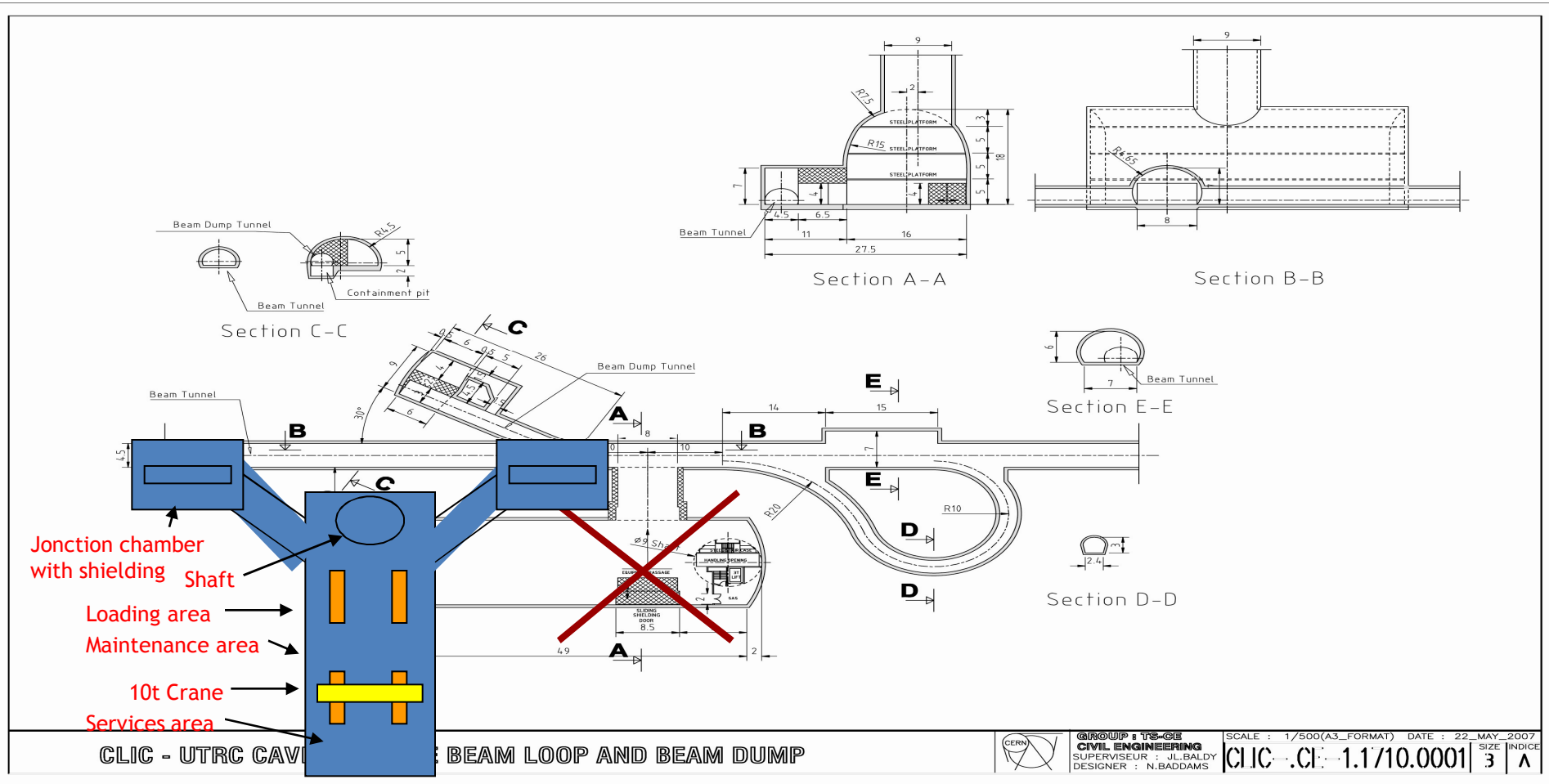
BOTTOM OF SHAFT INTEGRATION

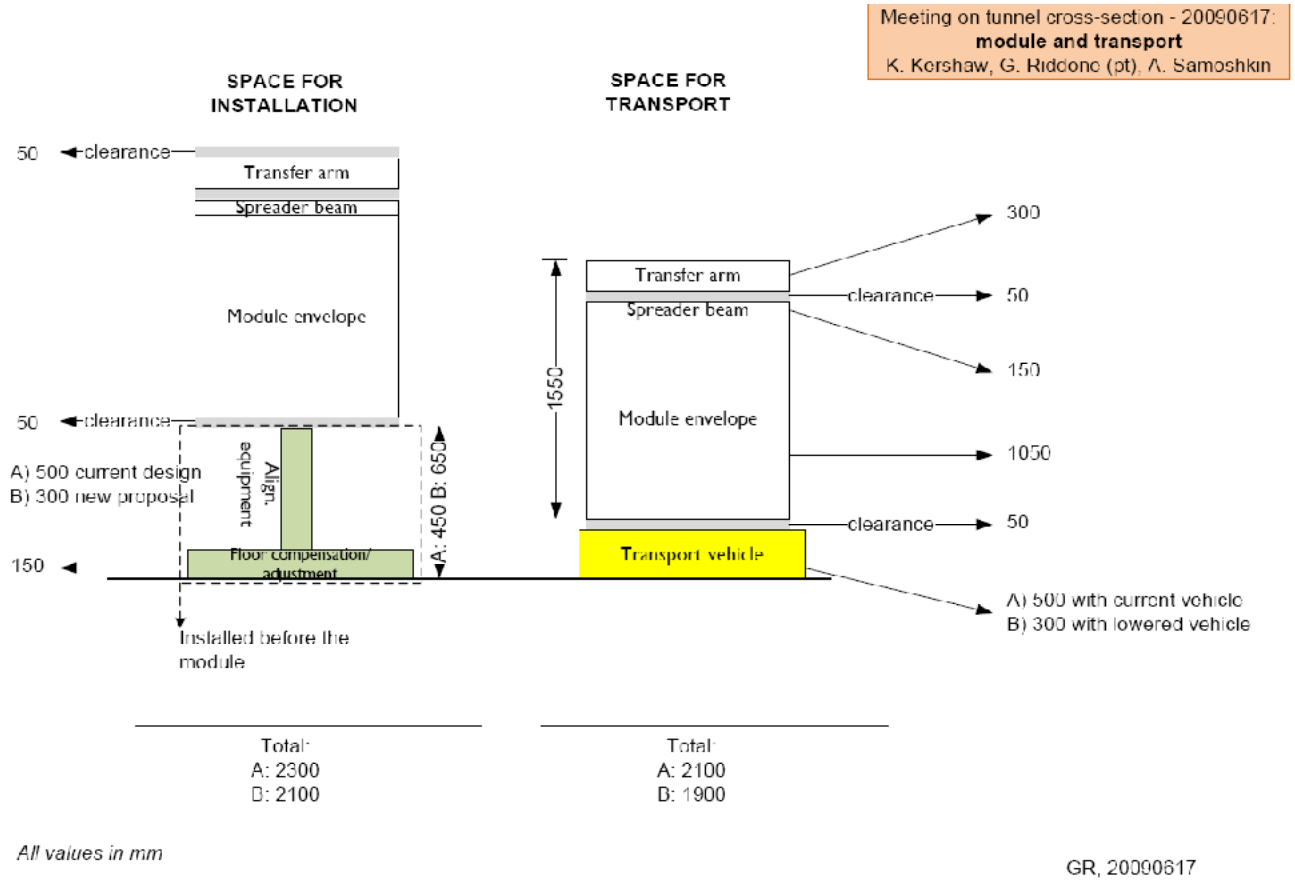


WORK TO REDUCE TUNNEL SECTION

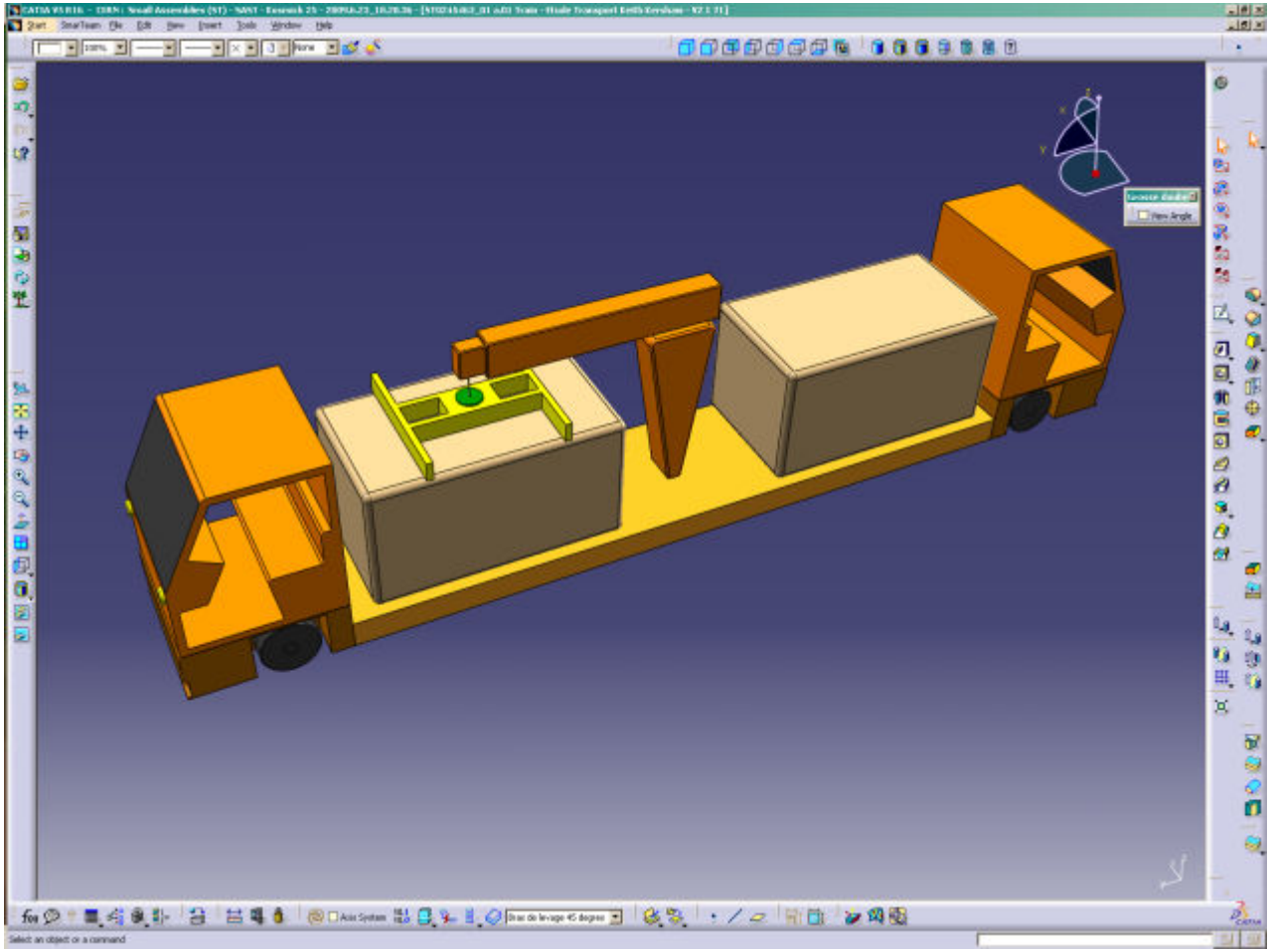
Need to consider space needed

- for transport
- for installation transfer

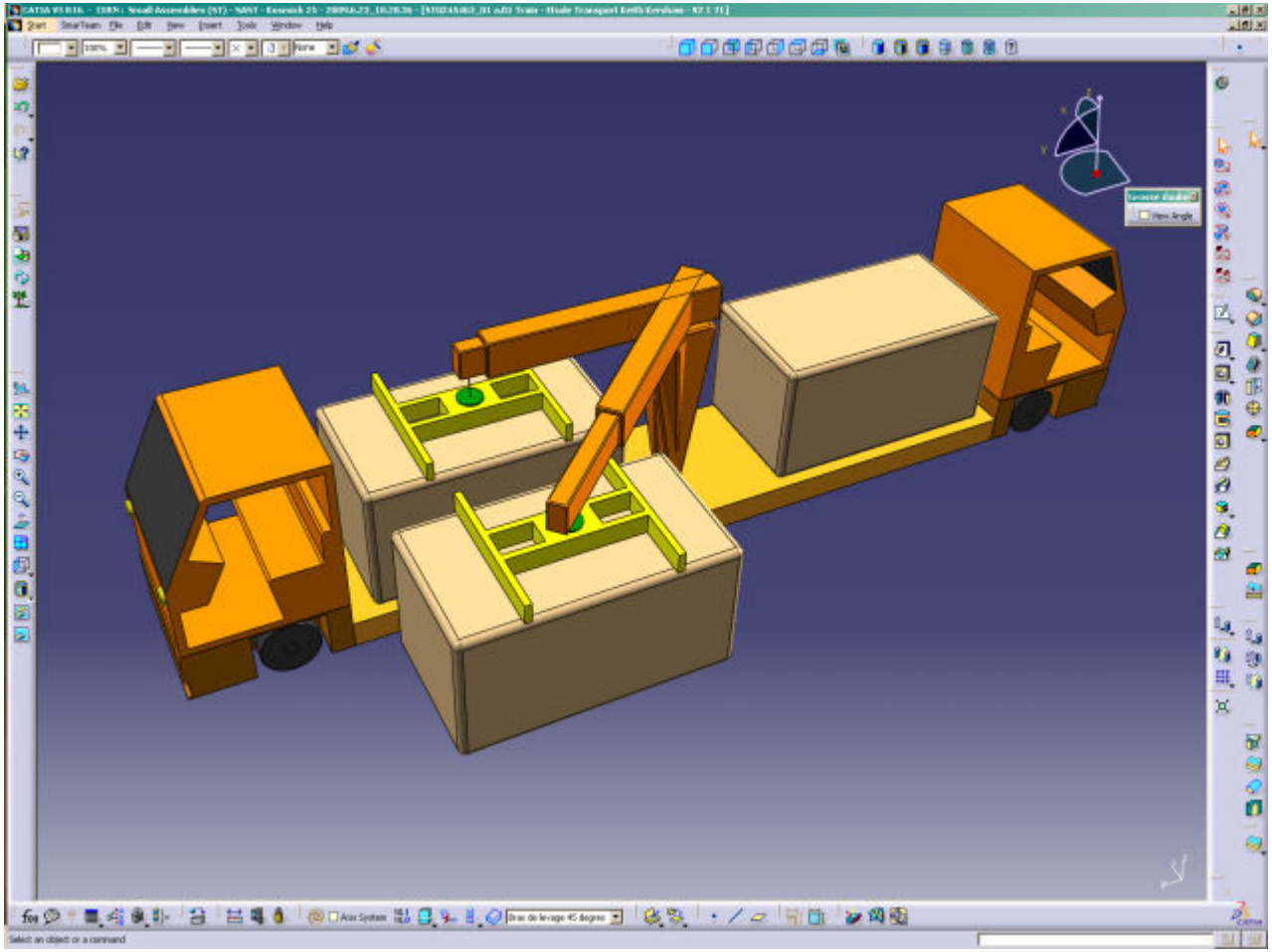
SPACE REQUIREMENTS - TRANSPORT AND INSTALLATION



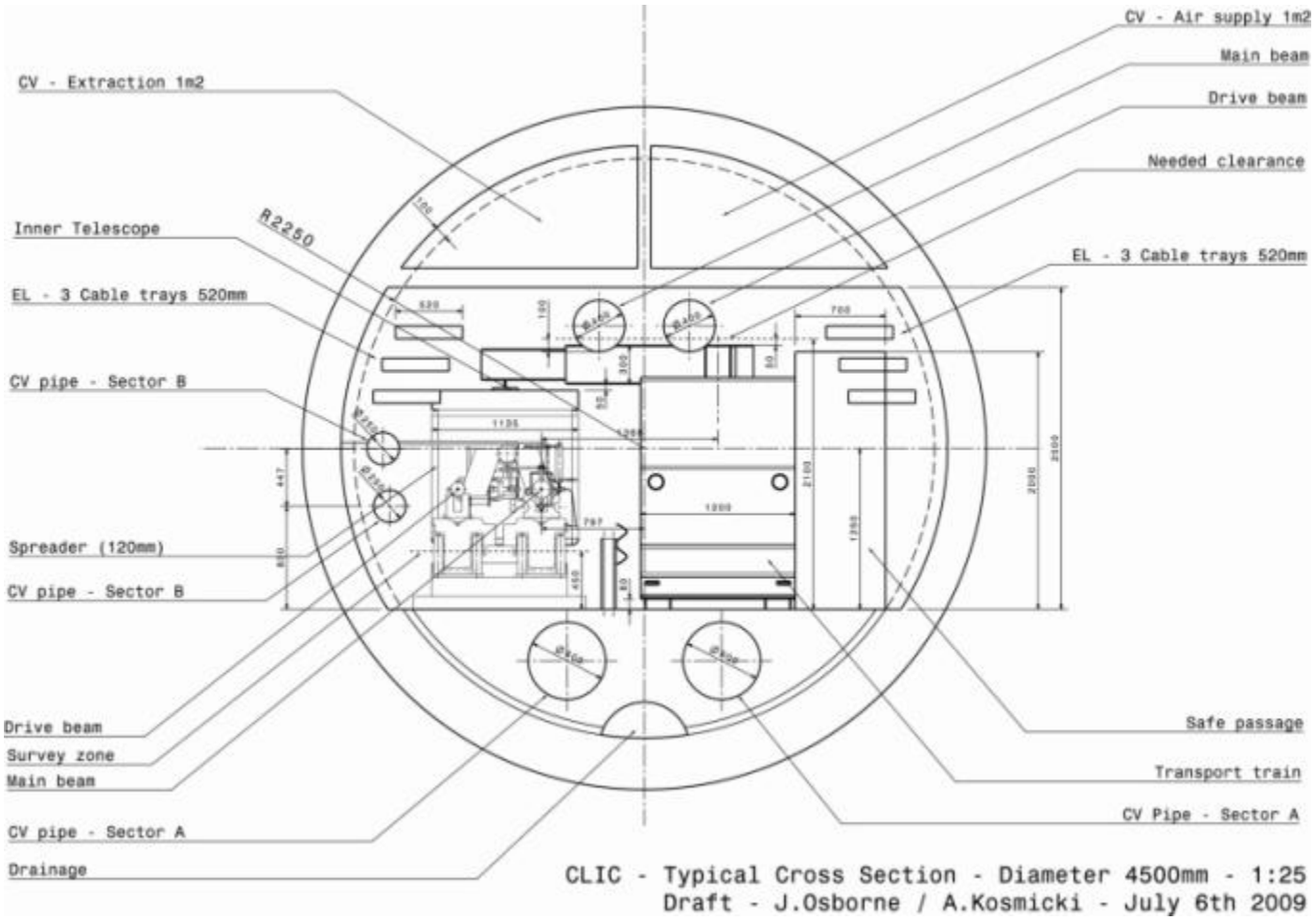
LOWER VEHICLE IN CASE TRANSFER TRAJECTORY IS LOWERED



LATERAL TRANSFER



4.5m SECTION JULY 2009 WITHOUT TURNAROUNDS



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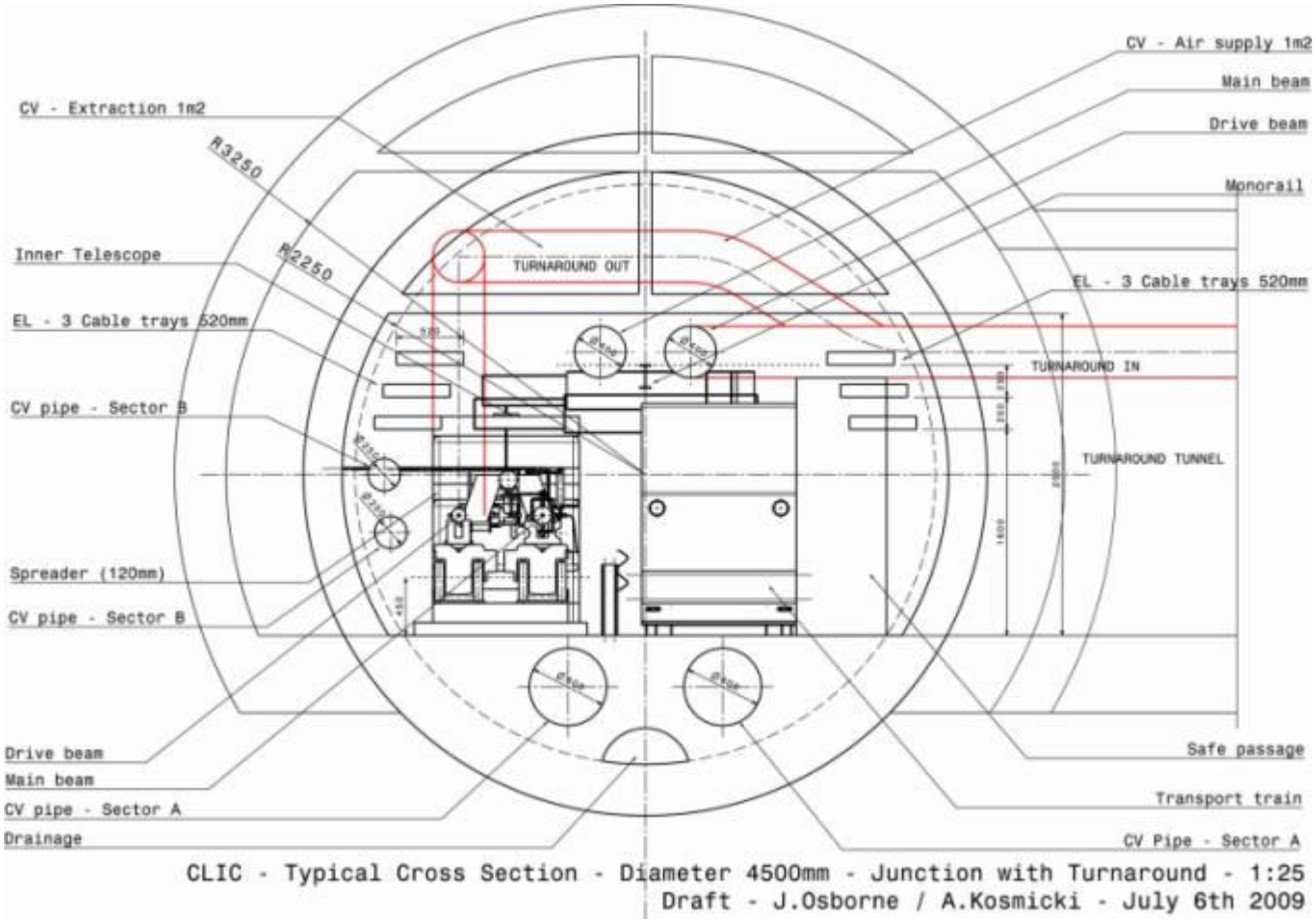


IMPLICATIONS FOR MODULE DESIGN

- Clear interconnection plane (interconnection specification)
- Inter-girder restraints for transport
- Lifting points and lifting beam
- Installation trajectory to be considered during design
- Interfaces between tunnel floor, supports and module to be compatible with module installation as a unit.

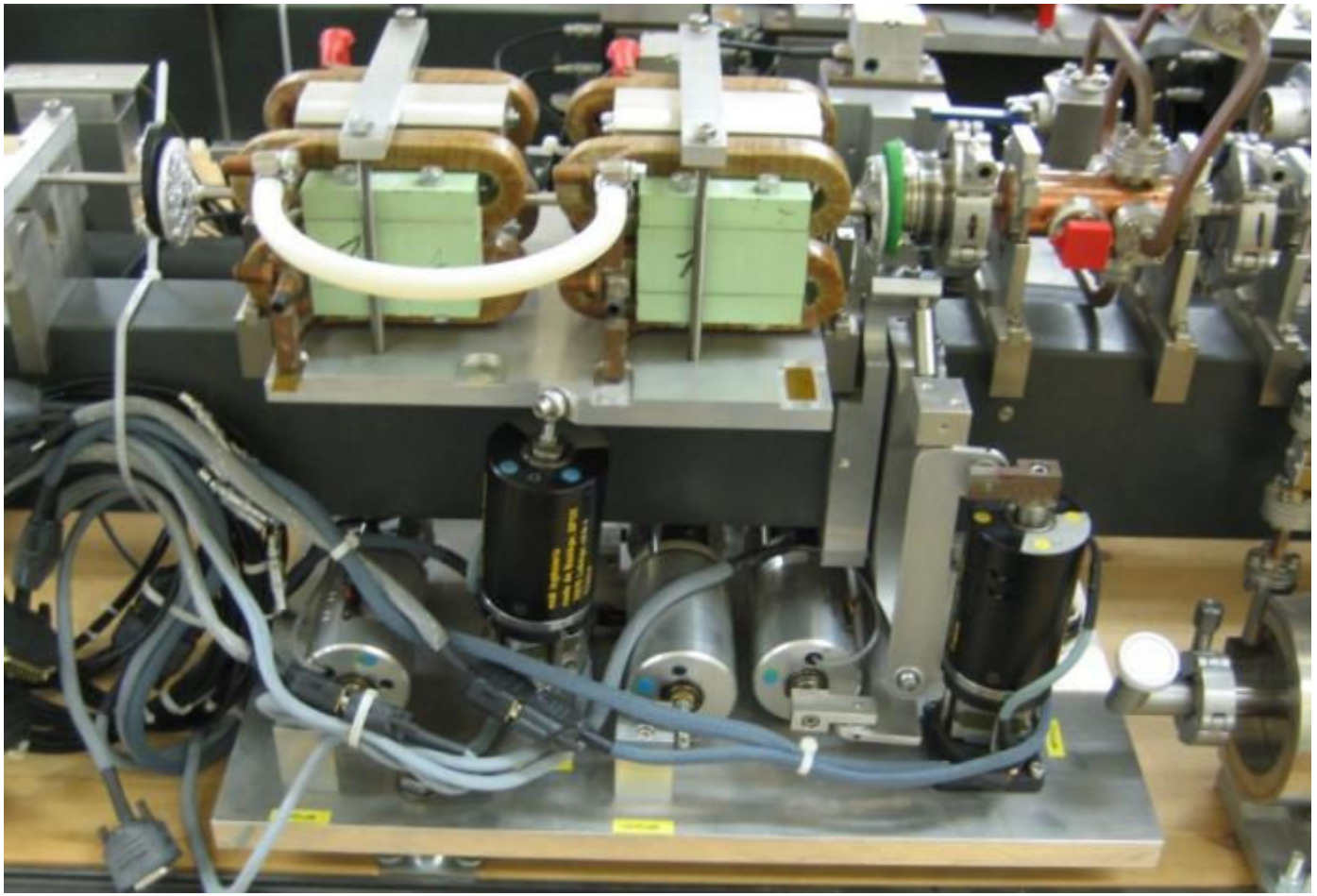
INTERCONNECTION SPECIFICATION TO INCLUDE:

1. A clear interconnection plane, with nothing to prevent vertical or lateral movements during installation
2. Space available between adjacent modules during installation transfer from vehicle onto supports.
3. Requirements for any tooling to hold bellows in position during installation.
4. Protection during transport and installation – eg vacuum protection

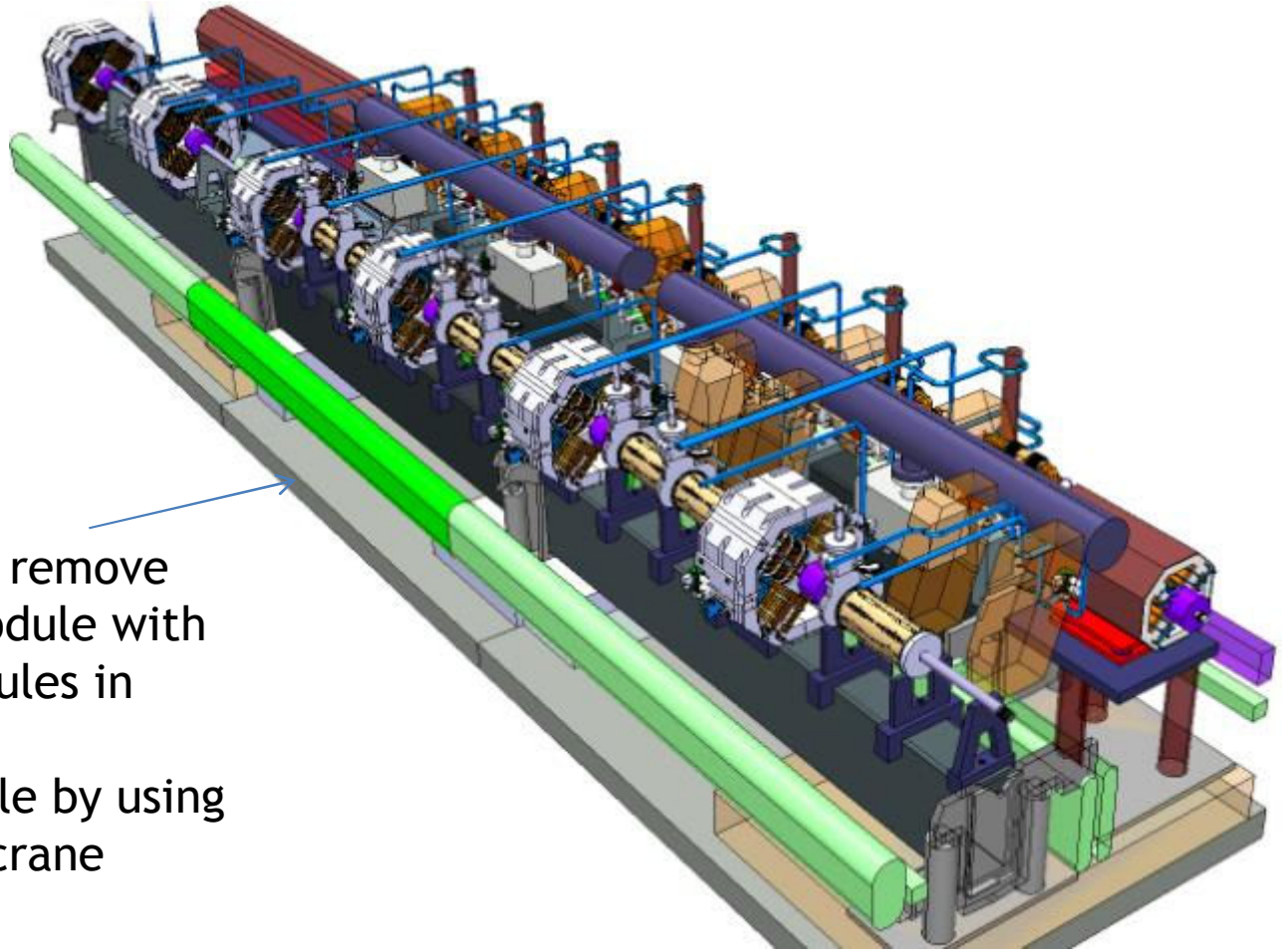
OPEN QUESTIONS

- What is interface between supports and module?
- What is installation trajectory ? (depends on support interface and height of what is installed before module arrives).

WHAT WILL SUPPORTS LOOK LIKE? CTF2 ALIGNMENT SYSTEM



MODULE MOCK -UPS



Install and remove central module with outer modules in position.
For example by using overhead crane

CONCLUSIONS

- Installation principle (lifting from above) compatible with module layout and pre-installation of alignment equipment.
- Provides input to tunnel cross section studies
- Allows input into interconnection specification - clear interconnection plane and clearance needed to allow installation and removal of one module between two others
- Raises questions about lifting points and transport restraints
- Raises questions about whole installation sequence covering supports, alignment equipment and interfaces between girders and their supports
- Module mock ups should be used to test installation issues (this will increase focus on installation problems during design).
- Installation of other items in tunnel still to be considered.