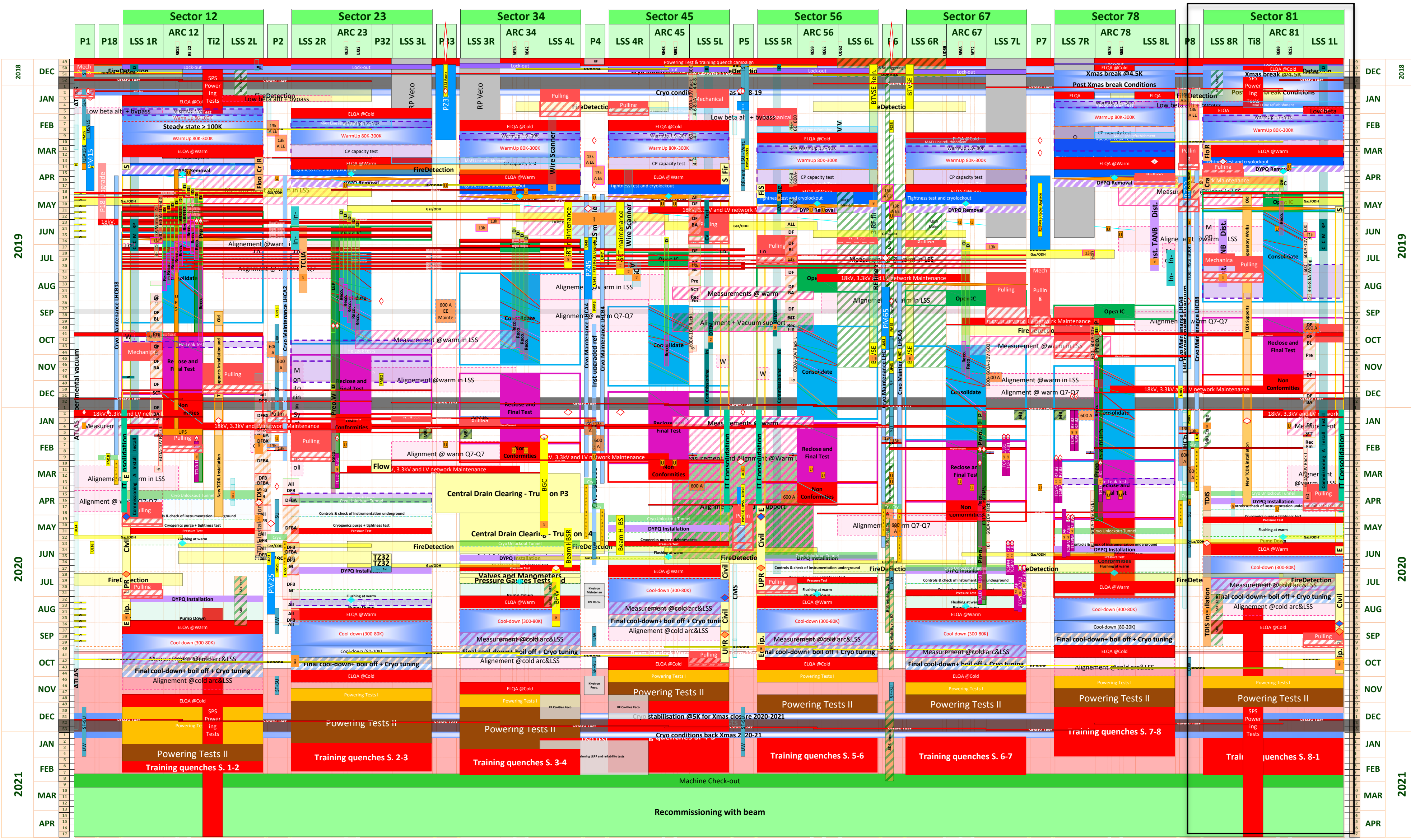
# LHCC referees discussion

26/11/2018

# Update on FASER work scheduling in LS2

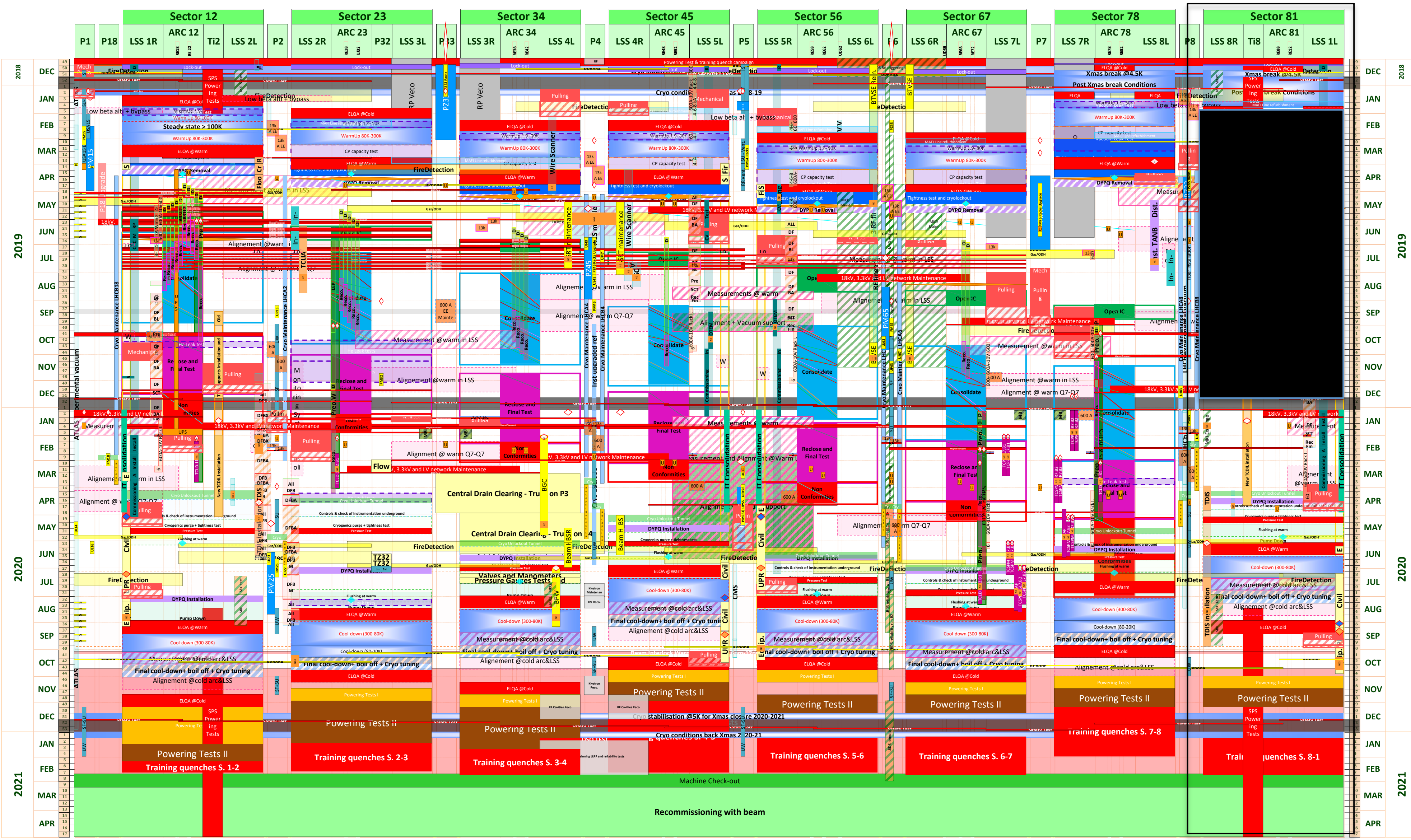
# LHC-LS2 planning - Inwork




Main work since draft TP submitted, was trying to integrate FASER work into LS2 schedule

# Constraints on FASER Civil Engineering works

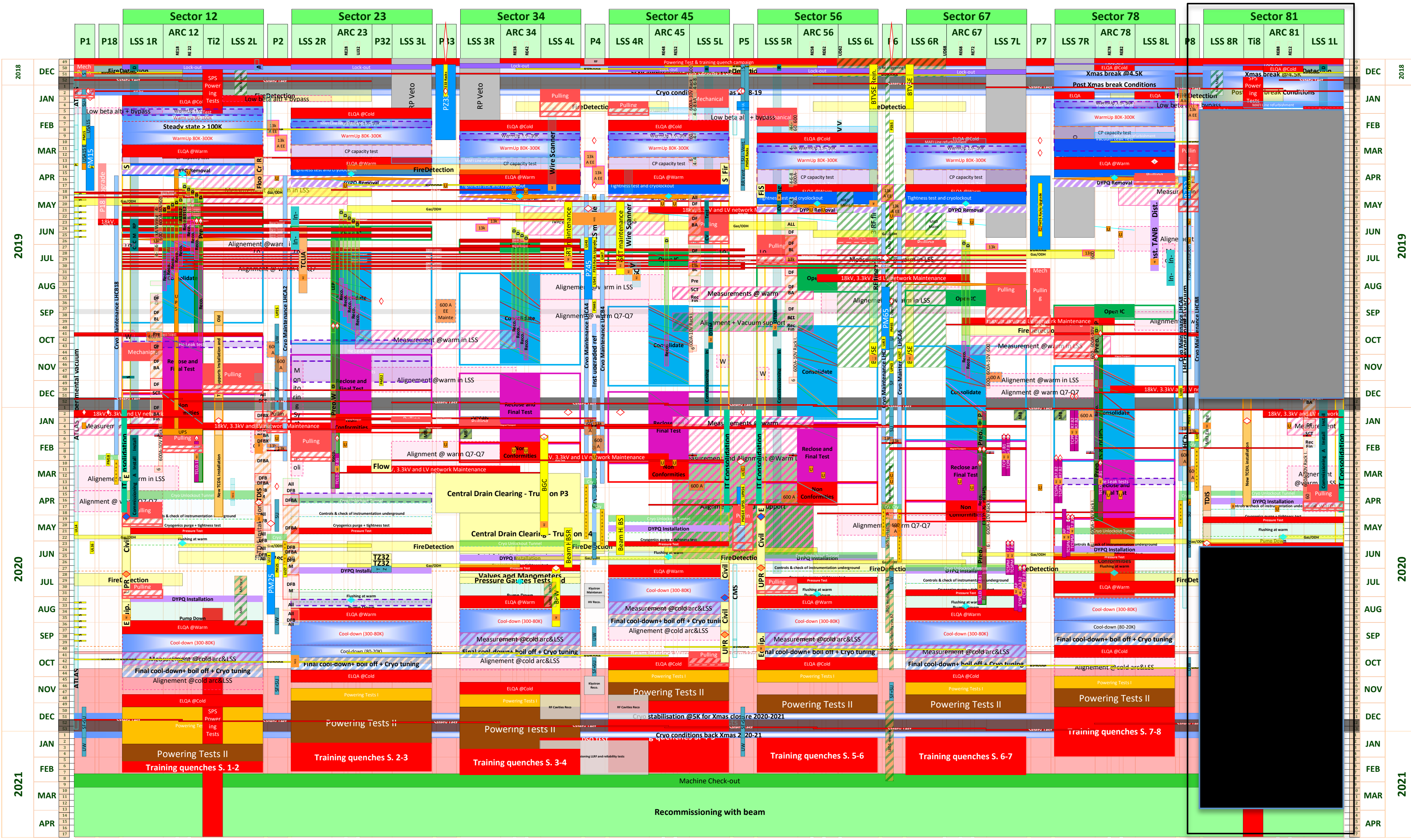
**LHC-LS2 planning - Inwork**




Diode cleaning work in LHC magnet interconnects – No civil engineering work allowed in tunnel

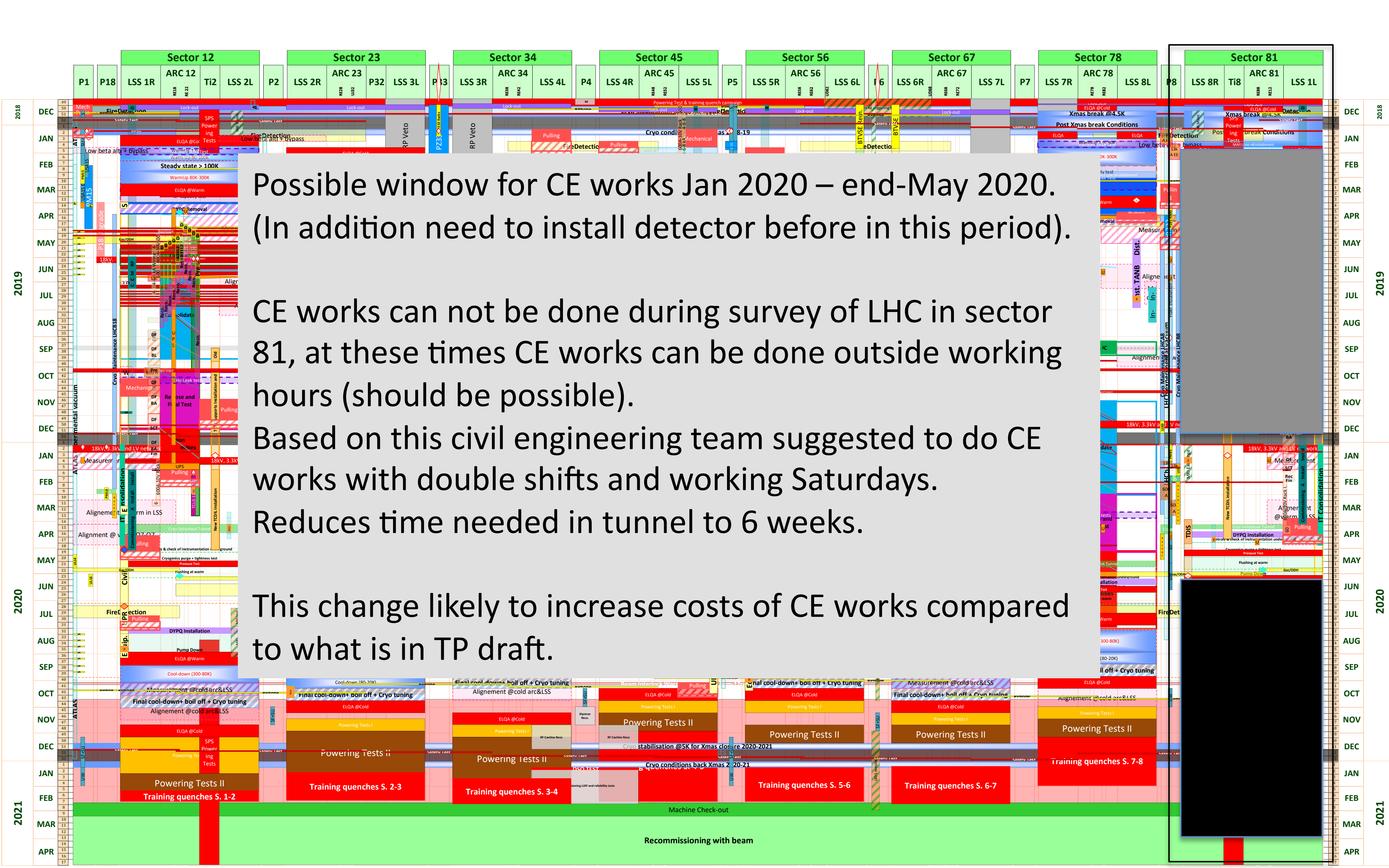
# Constraints on FASER Civil Engineering works

LHC-LS2 planning - Inwork




Machine cold – no civil engineering work allowed in TI12

# Constraints on FASER Civil Engineering works




Possible window for CE works Jan 2020 – end-May 2020. (In addition need to install detector before in this period).

CE works can not be done during survey of LHC in sector 81, at these times CE works can be done outside working hours (should be possible).

Based on this civil engineering team suggested to do CE works with double shifts and working Saturdays.

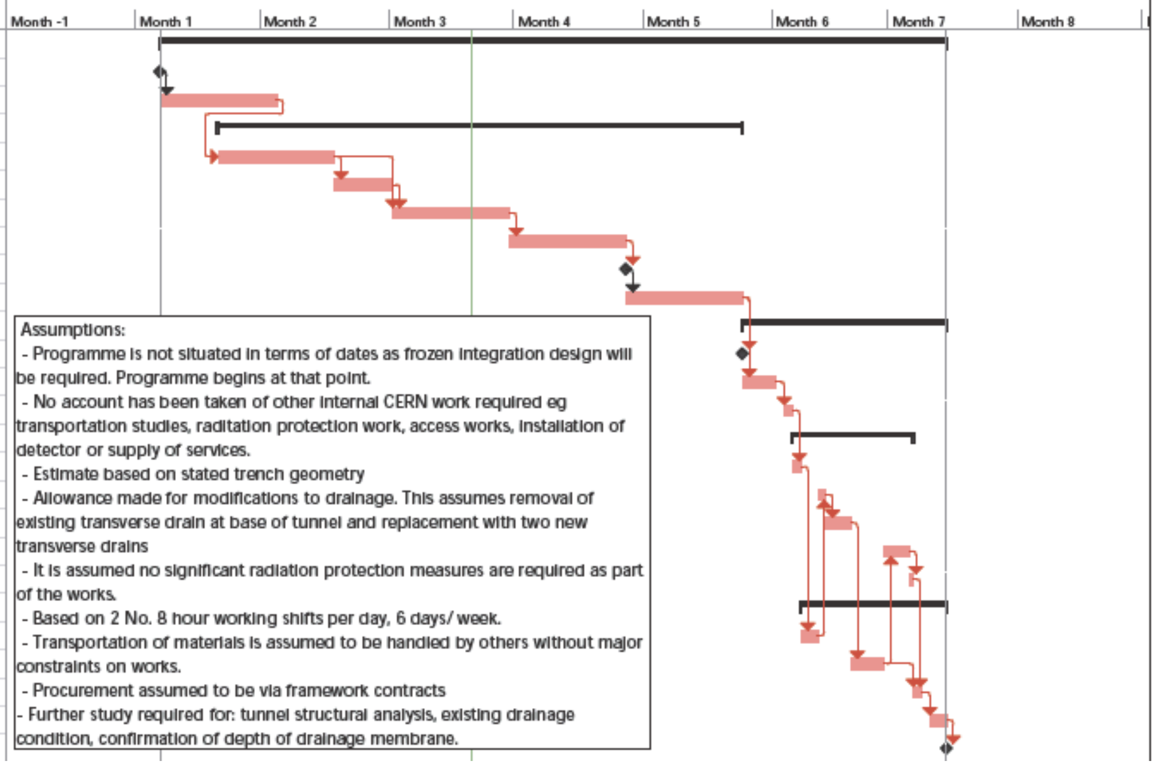
Reduces time needed in tunnel to 6 weeks.

This change likely to increase costs of CE works compared to what is in TP draft.

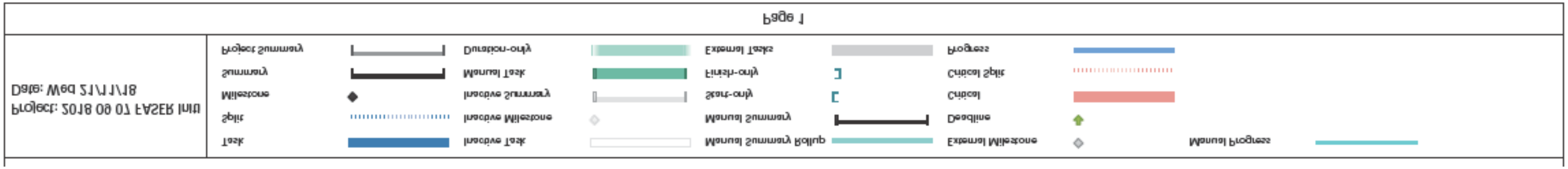
Machine cold – no civil engineering work allowed in TI12

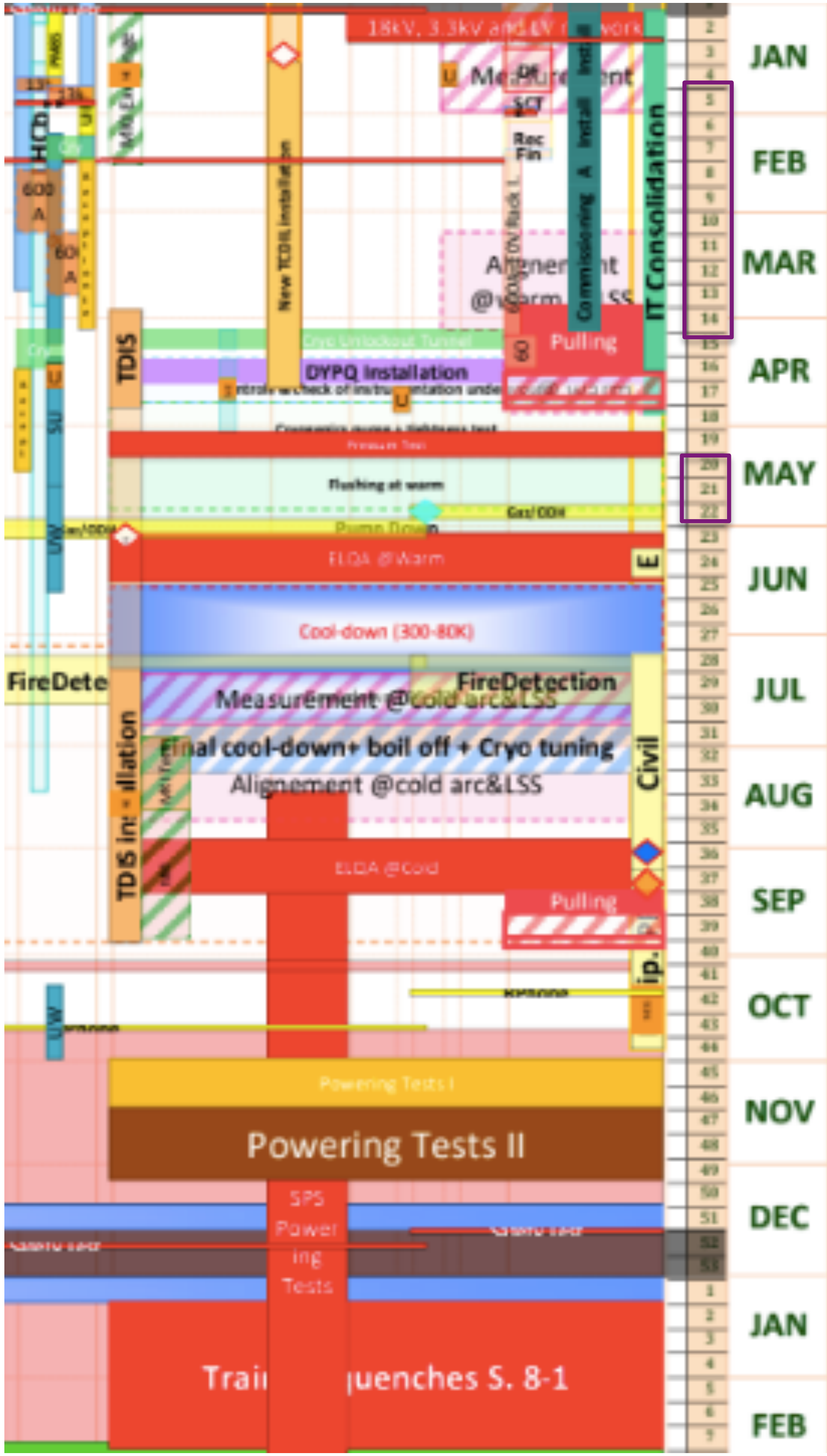
# Updated CE works schedule:

| ID | Task Mode | Task Name | Duration | Days after start] |
|---|---|---|---|---|
| 1 | | **FASER Civil Engineering** | **135 days** | **0 days** |
| 2 | | To Start after frozen integration design - timescales TBC | 0 days | 0 days |
| 3 | | Civil Engineering Design | 4 wks | 0 days |
| 4 | | **Procurement** | **90 days** | **0 days** |
| 5 | | Produce Specification for works | 4 wks | 10 days |
| 6 | | Procurement request with Framework lead | 2 wks | 30 days |
| 7 | | Tender Period | 4 wks | 40 days |
| 8 | | Tender Evaluation | 4 wks | 60 days |
| 9 | | Tender award | 0 days | 80 days |
| 10 | | Exchange contracts and mobilisation | 4 wks | 80 days |
| 11 | | **Construction Works** | **35 days** | **0 days** |
| 12 | | Works Start | 0 days | 100 days |
| 13 | | Set up site and isolate works area | 1.2 wks | 100 days |
| 14 | | Drilling and installation of transport fixtures | 0.4 wks | 106 days |
| 15 | | **Modifications to existing drainage** | **21 days** | **0 days** |
| 16 | | Saw cutting | 0.4 wks | 108 days |
| 17 | | Remove existing drainage and make good | 0.4 wks | 112 days |
| 18 | | Core out concrete | 0.8 wks | 114 days |
| 19 | | Install drainage | 0.8 wks | 124 days |
| 20 | | Pour concrete | 1 day | 128 days |
| 21 | | **Detector Enabling Works** | **25 days** | **0 days** |
| 22 | | Saw cutting | 0.4 wks | 110 days |
| 23 | | Core out concrete | 1.2 wks | 118 days |
| 24 | | Making good/ concrete base | 0.4 wks | 129 days |
| 25 | | Clear site and demobilise | 0.8 wks | 131 days |
| 26 | | Completion | 0 days | 135 days |




Assumptions:
- Programme is not situated in terms of dates as frozen integration design will be required. Programme begins at that point.
- No account has been taken of other internal CERN work required eg transportation studies, raditation protection work, access works, installation of detector or supply of services.
- Estimate based on stated trench geometry
- Allowance made for modifications to drainage. This assumes removal of existing transverse drain at base of tunnel and replacement with two new transverse drains
- It is assumed no significant radiation protection measures are required as part of the works.
- Based on 2 No. 8 hour working shifts per day, 6 days/ week.
- Transportation of materials is assumed to be handled by others without major constraints on works.
- Procurement assumed to be via framework contracts
- Further study required for: tunnel structural analysis, existing drainage condition, confirmation of depth of drainage membrane.






Taking into account schedule constraints from previous slides and other smaller constraints.

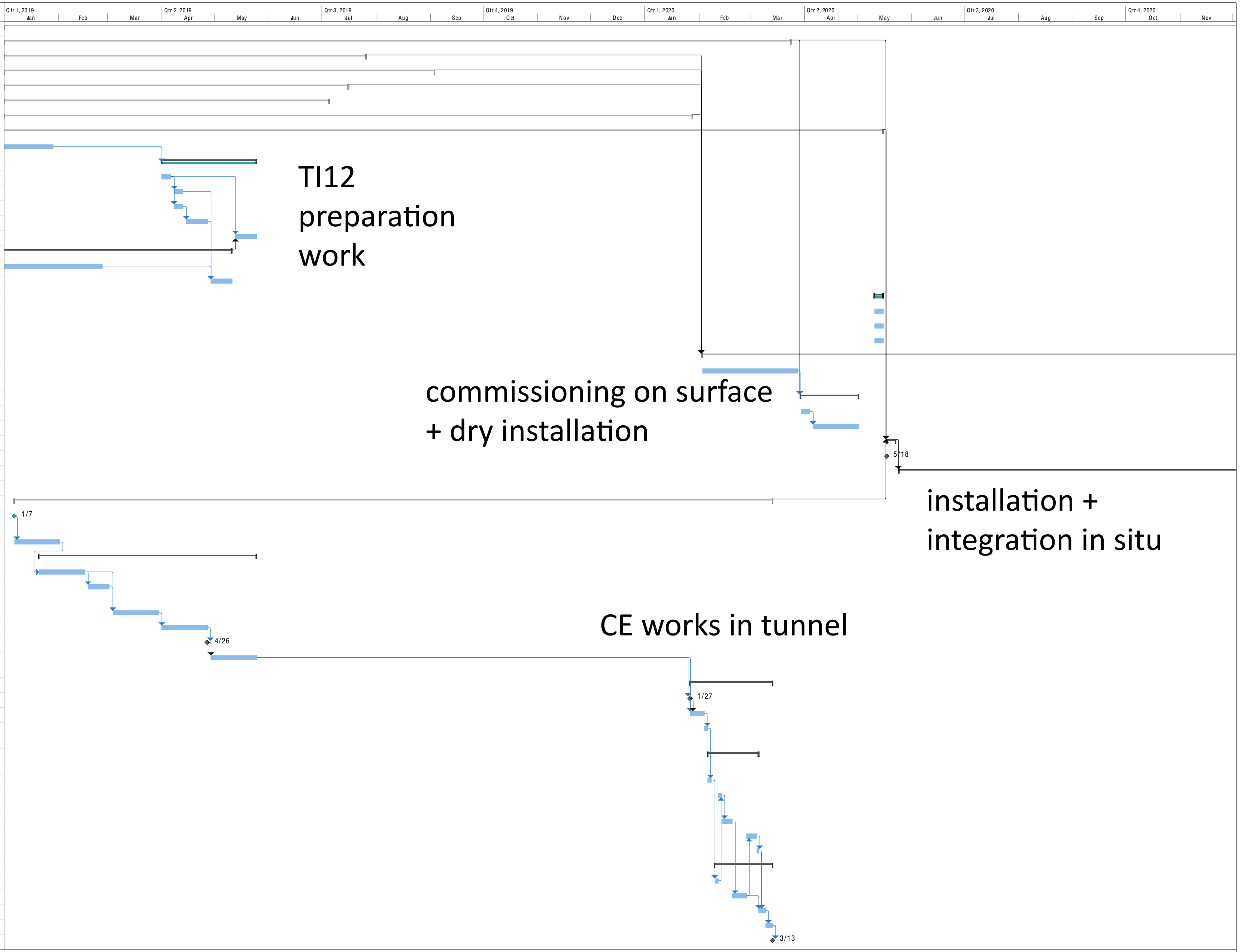
BASELINE SCHEDULE:

- CE work w5-w10, and outside working hours w11-w14
- Installation of heavy components w20/21/22
- Integration and commissioning in situ after cool down (w28), with some weeks excluded for various tests

Discussed with LS2 planning responsible, and fits in current LS2 schedule.

# Master schedule (Jan 2019 – Nov 2020)

| ID | Task Name | Duration | Start |
|---|---|---|---|
| 0 | **FASER** | **626.88 days** | **Tue 1/1/19** |
| 2 | **Magnet System** | **320 days** | **Tue 1/1/19** |
| 3 | **Tracker System** | **148 days?** | **Tue 1/1/19** |
| 4 | **Scintillator System** | **175 days** | **Tue 1/1/19** |
| 5 | **Calorimeter System** | **140 days** | **Tue 1/1/19** |
| 6 | **Detector Support** | **133 days?** | **Tue 1/1/19** |
| 7 | **TDAQ System** | **280 days** | **Tue 1/1/19** |
| 8 | **Infrastructure** | **359 days?** | **Tue 1/1/19** |
| 1 | Final Specification | 4 wks | Tue 1/1/19 |
| 2 | **Worksite Preparation** | **40 days?** | **Mon 4/1/19** |
| 3 | Light installation | 1 wk | Mon 4/1/19 |
| 4 | UJ12 Cable displacement | 1 wk? | Mon 4/8/19 |
| 5 | Removal of TI12 ventilation | 1 wk | Mon 4/8/19 |
| 6 | Removal of TI12 cable trays | 2 wks? | Mon 4/15/19 |
| 7 | Electrical installation | 2 wks? | Mon 5/13/19 |
| 8 | **Transport Preparation** | **94 days?** | **Tue 1/1/19** |
| 9 | Preparation of tools | 8 wks? | Tue 1/1/19 |
| 10 | Installation of tooling | 2 wks | Mon 4/29/19 |
| 11 | **Services** | **5 days?** | **Mon 5/11/20** |
| 12 | Dry air lines | 1 wk | Mon 5/11/20 |
| 13 | Fiber optics | 1 wk? | Mon 5/11/20 |
| 14 | Rack and network on surface | 1 wk? | Mon 5/11/20 |
| 10 | **Commissioning and installation** | **343 days?** | **Mon 2/3/20** |
| 1 | Cosmic and contingency (no magnets) | 2 mons | Mon 2/3/20 |
| 3 | **Surface Test** | **25 days** | **Mon 3/30/20** |
| 4 | Dry installation | 1 wk | Mon 3/30/20 |
| 5 | System testing | 4 wks | Mon 4/6/20 |
| 8 | **Installation** | **5 days** | **Mon 5/18/20** |
| 9 | Installation | 0 days | Mon 5/18/20 |
| 10 | **Comissioning in TI12** | **243 days** | **Mon 5/25/20** |
| 13 | **Data taking starts** | **20 days?** | **Thu 4/29/21** |
| 11 | **Civil Engineering** | **310 days** | **Mon 1/7/19** |
| 1 | To Start after frozen integration design - timescales TBC | 0 days | Mon 1/7/19 |
| 2 | Civil Engineering Design | 4 wks | Mon 1/7/19 |
| 3 | **Procurement** | **90 days** | **Mon 1/21/19** |
| 4 | Produce Specification for works | 4 wks | Mon 1/21/19 |
| 5 | Procurement request with Framework lead | 2 wks | Mon 2/18/19 |
| 6 | Tender Period | 4 wks | Mon 3/4/19 |
| 7 | Tender Evaluation | 4 wks | Mon 4/1/19 |
| 8 | Tender award | 0 days | Fri 4/26/19 |
| 9 | Exchange contracts and mobilisation | 4 wks | Mon 4/29/19 |
| 10 | **Construction Works** | **35 days** | **Mon 1/27/20** |
| 11 | Works Start | 0 days | Mon 1/27/20 |
| 12 | Set up site and isolate works area | 1.2 wks | Mon 1/27/20 |
| 13 | Drilling and installation of transport fixtures | 0.4 wks | Tue 2/4/20 |
| 14 | **Modifications to existing drainage** | **21 days** | **Thu 2/6/20** |
| 15 | Saw cutting | 0.4 wks | Thu 2/6/20 |
| 16 | Remove existing drainage and make good | 0.4 wks | Wed 2/12/20 |
| 17 | Core out concrete | 0.8 wks | Fri 2/14/20 |
| 18 | Install drainage | 0.8 wks | Fri 2/28/20 |
| 19 | Pour concrete | 1 day | Thu 3/5/20 |
| 20 | **Detector Enabling Works** | **25 days** | **Mon 2/10/20** |
| 21 | Saw cutting | 0.4 wks | Mon 2/10/20 |
| 22 | Core out concrete | 1.2 wks | Thu 2/20/20 |
| 23 | Making good/ concrete base | 0.4 wks | Fri 3/6/20 |
| 24 | Clear site and demobilise | 0.8 wks | Tue 3/10/20 |
| 25 | Completion | 0 days | Fri 3/13/20 |




Project: FASER
Date: Fri 11/23/18

Task · Split · Milestone · Summary · Project Summary · Inactive Task · Inactive Milestone · Inactive Summary · Manual Task · Duration-only · Manual Summary Rollup · Manual Summary · Start-only · Finish-only · External Tasks · External Milestone · Deadline · Progress · Manual Progress

# Next steps in planning

- Integration into formal LS2 plans and sign off by all relevant groups
  - Transport
  - EN-EL (power, lights, readout fibers…)
  - EN-CV (compressed air, removal of ventilation ducts)
  - Safety
- We have had discussions with all relevant groups and these indicate that the work we need is minimal and can be done
- Formal integration of FASER work with the LS2 schedule would follow LHCC approval

# Since draft TP submitted to LHCC

- Discussion with CERN Networking group
  - Viable networking solution identified and costed (~6kCHF)
- Discussion with CERN computing resources management
  - Computing resources considered to be very minimal and costed (see next slide)
- Progress on QA of spare SCT modules
  - Using Cambridge/Chimaera readout system, have been able to communicate with SCT module and read out first data for QA analysis
- Continuing to work on background measurements
  - Emulsion detectors from TI18 developed in Bern last week
  - Will be used to measure flux of high energy EM objects, and possibly see first neutrino events from LHC collisions
  - Updated FLUKA study (conclusions unchanged)

## Computing update:

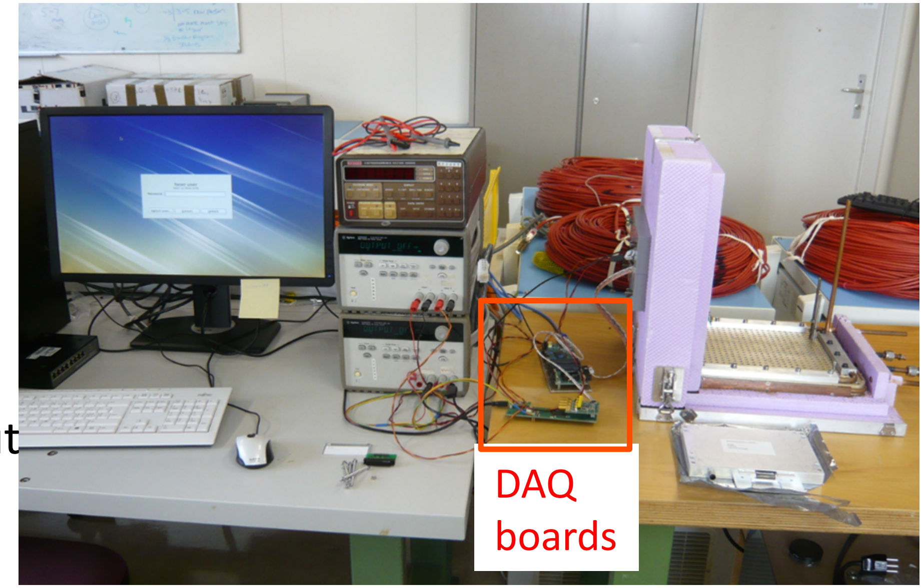
CERN's IT Department estimates the cost of FASER's computing and data storage needs at 160 kCHF total over the lifetime of the experiment (2020 – 2024) based on the following assumptions:

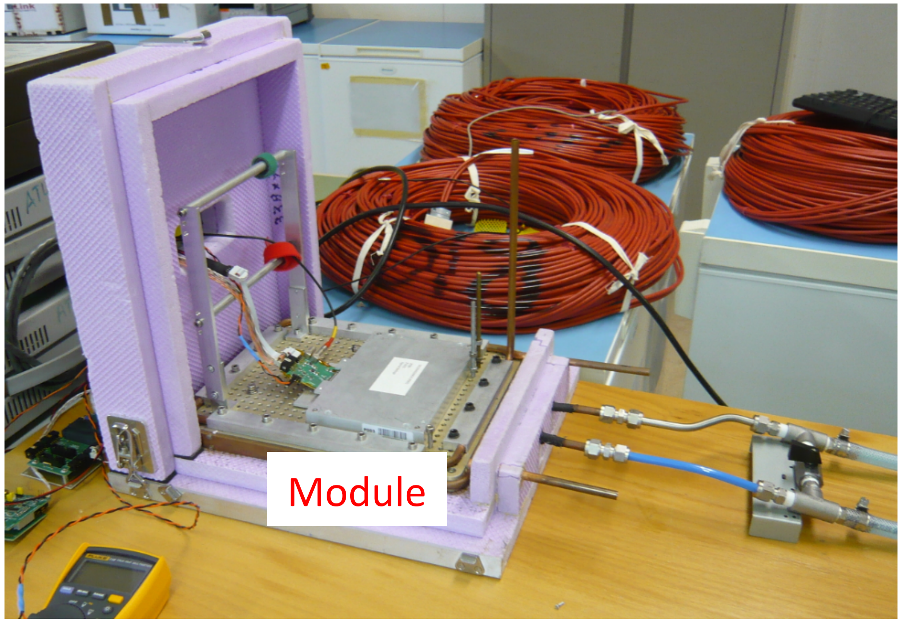
- Collecting 1 petabyte (PB) of real and simulated data per year onto tape media;
- 1 PB of disk space for raw data, Monte Carlo, derived datasets and tape staging;
- 1000 CPU cores available for processing, simulation and analysis (equivalent to 1000 concurrent running jobs);
- Home directories for users;
- Project space for central datasets (ntuples);
- On-demand databases for bookkeeping and metadata;
- 20% available in 2020, full capacity in 2021 – 2024 (three years of running and one year post-analysis).

In addition, we expect at least one FASER institution (to be determined) will provide off-site computing infrastructure, for example by sharing resources with an existing ATLAS Tier-3 grid facility.

# SCT module QA Status

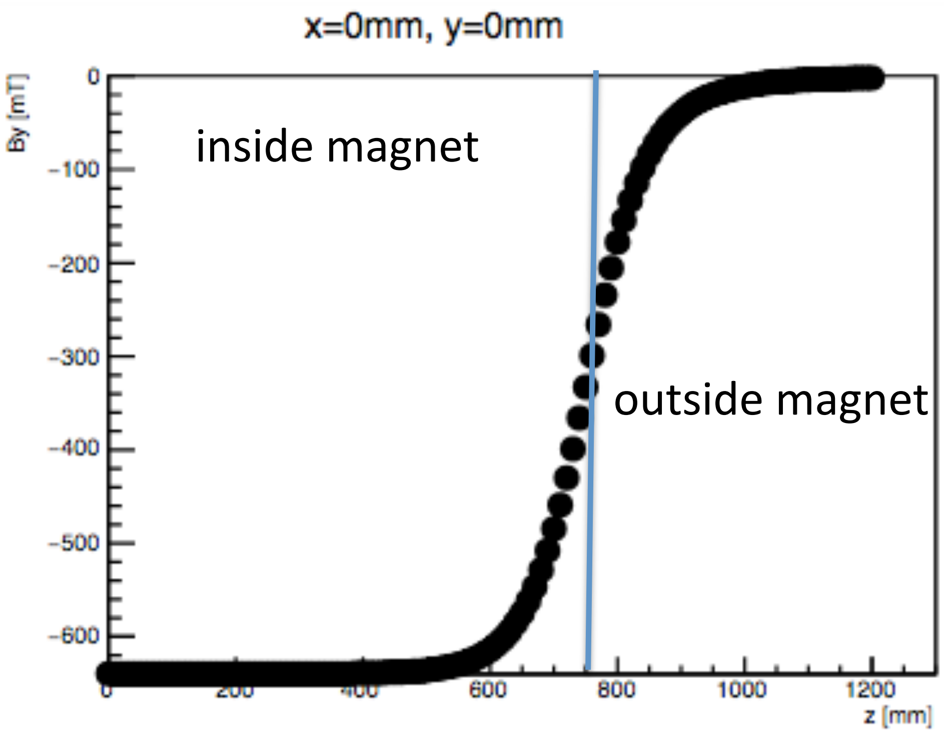
- The system for SCT module QA was setup at CERN.
- DAQ system developed by Cambridge group is used for the module readout.
- The module is operated at room temperature (~15 degree) with water cooling system.
- The configuration of the module and data readout were succeeded.
- The test menu is under preparation.
- The module QA for ~80 modules will start from the beginning of 2019.



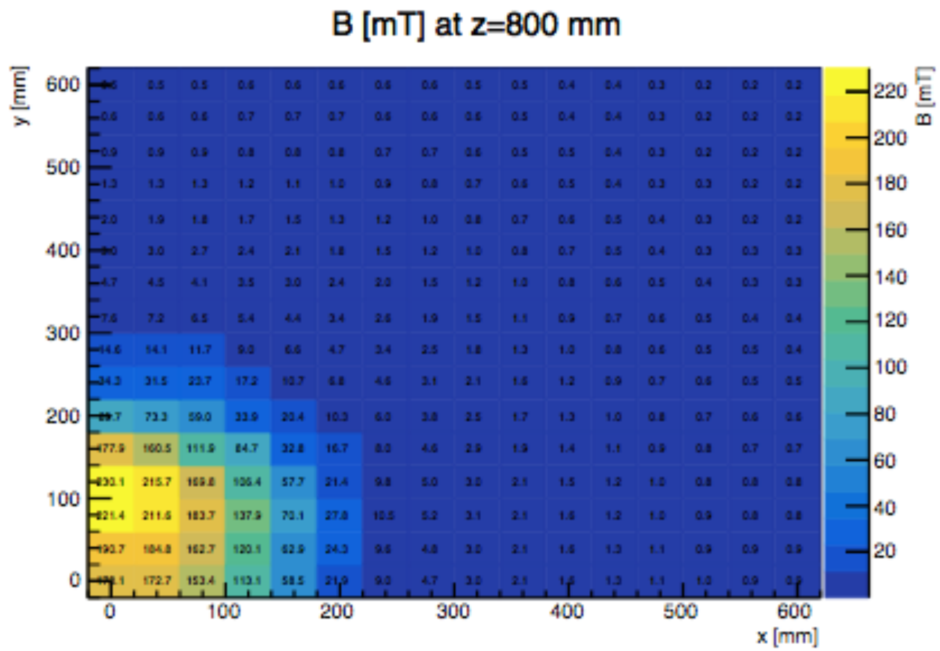



# Stray magnetic field

- More detailed calculation of stray field, also going to larger distance
  - 3mT limit (for signage at CERN) always within 50cm of magnet centre (so enclosed in trench, does not impact access)




5cm outside magnet opening




1mT field 50cm from magnet centre

# Funding Status

- Since the last LHCC discussion, the Simons Foundation has agreed to join the Heising-Simons Foundation in funding FASER for a total of 2 MCHF
  - We expect that 450 KCHF will be available in January 2019 for magnet construction
  - The remaining 1550 KCHF will be available starting in March 2019
- We foresee this funding will include support for 3 full-time graduate students.
  - This could be more than 3 people if some are partially supported by other funds or work partly on other experiments
- In addition, we have submitted proposals for additional funding from national funding agencies for graduate student and postdoc support. Additional proposals are planned, and we expect that LHCC approval will significantly improve the prospects for success

# Collaboration: Structure and Status

- Spokespersons: J. Feng (UCI), J. Boyd (CERN)
- Senior Engineer: F. Cadoux (Geneva)
- Main responsibilities shown on a following slide
- Plan to form a collaboration board with one representative per institute
- CERN legal team drafting MoU for FASER
  - based on other small experiment MoU, although updated due to unique funding of FASER
- Current collaboration:
  - 27 people, 16 institutes, 8 countries
- We believe that we have a core collaboration that will be able to deliver the FASER experiment as detailed in the TP
  - We may try to recruit additional groups if additional specific expertise is needed, but are not looking to add a large number of additional groups
  - We do need some motivated and hardworking graduate students, and possible a couple of postdocs to help complete the work needed
  - In our funding request we foresee funding for three full FASER graduate students
    - This could be more than three people if working partly on FASER and partly on other experiments
  - Intend to apply for additional funding from national funding agencies for graduate student and postdoc funding on FASER

# The current collaboration author list:

(TP author list also includes CERN personnel who have made important technical contributions to the TP)

Akitaki Ariga,[1] Tomoko Ariga,[1,2] Jamie Boyd,[3] Franck Cadoux,[4] David W. Casper,[5] Yannick Favre,[4] Jonathan L. Feng,[5] Didier Ferrere,[4] Iftah Galon,[6] Sergio Gonzalez-Sevilla,[4] Shih-Chieh Hsu,[7] Giuseppe Iacobucci,[4] Enrique Kajomovitz,[8] Felix Kling,[5] Susanne Kuehn,[3] Lorne Levinson,[9] Hidetoshi Otono,[2] Brian Petersen,[3] Osamu Sato,[10] Matthias Schott,[11] Anna Sfyrla,[4] Jordan Smolinsky,[5] Aaron M. Soffa,[5] Yosuke Takubo,[12] Eric Torrence,[13] Sebastian Trojanowski,[14,15] and Gang Zhang[16]

[1] *Universität Bern, Sidlerstrasse 5, CH-3012 Bern, Switzerland*

[2] *Kyushu University, Nishi-ku, 819-0395 Fukuoka, Japan*

[3] *CERN, CH-1211 Geneva 23, Switzerland*

[4] *Département de Physique Nucléaire et Corpusculaire, University of Geneva, CH-1211 Geneva 4, Switzerland*

[5] *Department of Physics and Astronomy, University of California, Irvine, CA 92697-4575, USA*

[6] *New High Energy Theory Center, Rutgers, The State University of New Jersey, Piscataway, New Jersey 08854-8019, USA*

[7] *Department of Physics, University of Washington, PO Box 351560, Seattle, WA 98195-1560, USA*

[8] *Technion – Israel Institute of Technology, Haifa 32000, Israel*

[9] *Weizmann Institute of Science, Rehovot 761001, Israel*

[10] *Nagoya University, Furo-cho, Chikusa-ku, Nagoya-shi 464-8602, Japan*

[11] *Institut für Physik, Universität Mainz, Mainz, Germany*

[12] *Institute of Particle and Nuclear Study, KEK, Oho 1-1, Tsukuba, Ibaraki 305-0801, Japan*

[13] *University of Oregon, Eugene, OR 97403, USA*

[14] *National Centre for Nuclear Research, Hoża 69, 00-681 Warsaw, Poland*

[15] *Consortium for Fundamental Physics, School of Mathematics and Statistics, University of Sheffield, Hounsfield Road, Sheffield, S3 7RH, UK*

[16] *Tsinghua University, Beijing, China*

# Breakdown of responsibilities

| System | Responsible | Groups involved |
|---|---|---|
| | | |
| **Tracker** | | |
| Tracker Mechanics (including cooling) | F. Cadoux (Geneva) | Geneva |
| Tracker Readout | Y. Favre (Geneva) | Geneva, CERN, KEK, Kyushu |
| Tracker Powering (including DCS/interlock) | H. Otono (Kyushu) | Geneva, CERN, KEK, Kyushu |
| Tracker Module QA | Y. Takubo (KEK) | Kyushu, KEK, Geneva, Mainz |
| | | |
| **Calo/Scintillator system** | B. Petersen (CERN) | CERN, Mainz |
| | | |
| **Detector support structure** | F. Cadoux (Geneva) | Geneva, Washington, Mainz, CERN |
| | | |
| **TDAQ** | | |
| Trigger | A. Sfyrla (Geneva) | Geneva, CERN, Technion, Weizmann |
| DAQ | B. Petersen (CERN) | Geneva, CERN, Technion, Weizmann, Oregon, UCI |
| DCS | E. Kajomovitz (Techion) | Geneva, CERN, Technion, Weizmann |
| | | |
| **Detector Integration** | S. Kuhn (CERN) | All |
| | | |
| **Offline** | | |
| Simulation | D. Casper (UCI) | UCI, Washington, Oregon |
| Reconstruction | S-C. Hsu (Washington) | Washington, UCI, Oregon |
| Calibration | E. Torrence (Oregon) | Oregon, UCI, Washington |
| Physics analysis | F. Kling (UCI) | All |
| | | |
| **Background measurements** | A. Ariga (Bern) | Bern, Nagoya |
| | | |
| **Magnet** | CERN | |
| | | |
| **Civil engineering work** | CERN | |
| | | |
| **Installation of services** | CERN | |

# Magnet construction

ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE
EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Laboratoire Européen pour la Physique des Particules
European Laboratory for Particle Physics

GENEVE, SUISSE
GENEVA, SWITZERLAND

Geneva, October 24, 2018

**From :** D.Tommasini, TE
**To :** J.Boyd, EP
**cc :** L.Bottura, TE

**Design and manufacture of 3 magnets for the Faser Project**

Dear Jamie,

I confirm that we are available to design and manufacture the three magnets needed for the Faser project, one magnet 1.5 m long, the other two magnets each 1.0 meter long. All three magnets will be based on permanent magnet technology.

The material cost, including maching of parts, is evaluated to be 350 kCHF for the three units.

To this cost, we need to add 100 kCHF for personnel.

This makes a total cost estimate of 450 kCHF for the three units.

From the approval of the project we need eleven months to complete the assembly of the first magnet. The next two units can be assembled with a rate of one unit per month, then followed by magnetic measurements within two months.

The completion of the three magnets, including magnetic measurements, can be thus performed within 15 months from the validation of the project.

Sincerely

Davide Tommasini
Head of Normal Conducting Magnets Section

Confirmation from CERN magnet group that they can construct the FASER magnets in a time line and cost that meets our needs.

# Formal approval to use SCT and LHCb ECAL spares

From: **Trevor Vickey** <Trevor.Vickey@cern.ch>
Date: 2018年10月16日(火) 18:09
Subject: RE: Vote: Proposal to use spare SCT modules in the FASER experiment
To: atlas-sct-reps (SCT Semiconductor tracking detector Representatives only) <atlas-sct-reps@cern.ch>
Cc: Dave Robinson <dave.robinson@cern.ch>, Hidetoshi Otono <hidetoshi.otono@cern.ch>

Dear Colleagues,

Many thanks for submitting your recent vote on a proposal to use spare SCT modules in the FASER experiment.

I am very pleased to let you know that this proposal passes with 25 institutes voting YES, 0 institutes voting NO and 17 institutes abstaining (total of 42 SCT institutes).

Congratulations to Hide and his colleagues on the FASER experiment.

Best regards,

Trevor (SCT IB Chair)

**Giovanni Passaleva** 18 Oct 2018 16:56
To: Jamie Boyd FASER
Re: Possibility to use spare LHCb ECAL modules for FASER experiment

GP

Dear Jamie,
yes, apologies for the delayed answer. I was about to answer you indeed.

We discussed this issue within the management.
T
he short answer to your question is: yes no problem!

The longer one is that to get around some possible ownership issues, we will probably "lend" you the modules (forever of for how long you need them...)
I asked Andreas to prepare some lightweight agreement, but he is out until the end of the month, so this will come later.

However, as far as your TP is concerned, you can surely go ahead!

Also, it would be nice maybe early next year if you can come to LHCb weekly plenary meeting to present FASER!

Best wishes
Giovanni

# Physics Benchmark Paper

In the next days we will submit a paper to arxiv detailing the physics potential of FASER and FASER-2 in a number of relevant benchmark models. This serves as input to the Physics Beyond Colliders effort.


### Abstract

FASER, the ForwArd Search ExpeRiment, is a proposed experiment dedicated to searching for light, extremely weakly-interacting particles at the LHC. Such particles may be produced in the LHC's high-energy collisions and travel long distances through concrete and rock without interacting. They may then decay to visible particles in FASER, which is placed 480 m downstream of the ATLAS interaction point. In this work we briefly describe the FASER detector layout and the status of potential backgrounds. We then present the sensitivity reach for FASER for a large number of long-lived particle models, updating previous results to a uniform set of detector assumptions, and analyzing new models. In particular, we consider all of the renormalizable portal interactions, leading to dark photons, dark Higgs bosons, and heavy neutral leptons (HNLs); light $B-L$ and $L_\mu - L_\tau$ gauge bosons; and axion-like particles (ALPs) that are coupled dominantly to photons, fermions, and gluons through non-renormalizable operators. We find that FASER and its follow-up, FASER 2, have a full physics program, with discovery sensitivity in all of these models and potentially far-reaching implications for particle physics and cosmology.

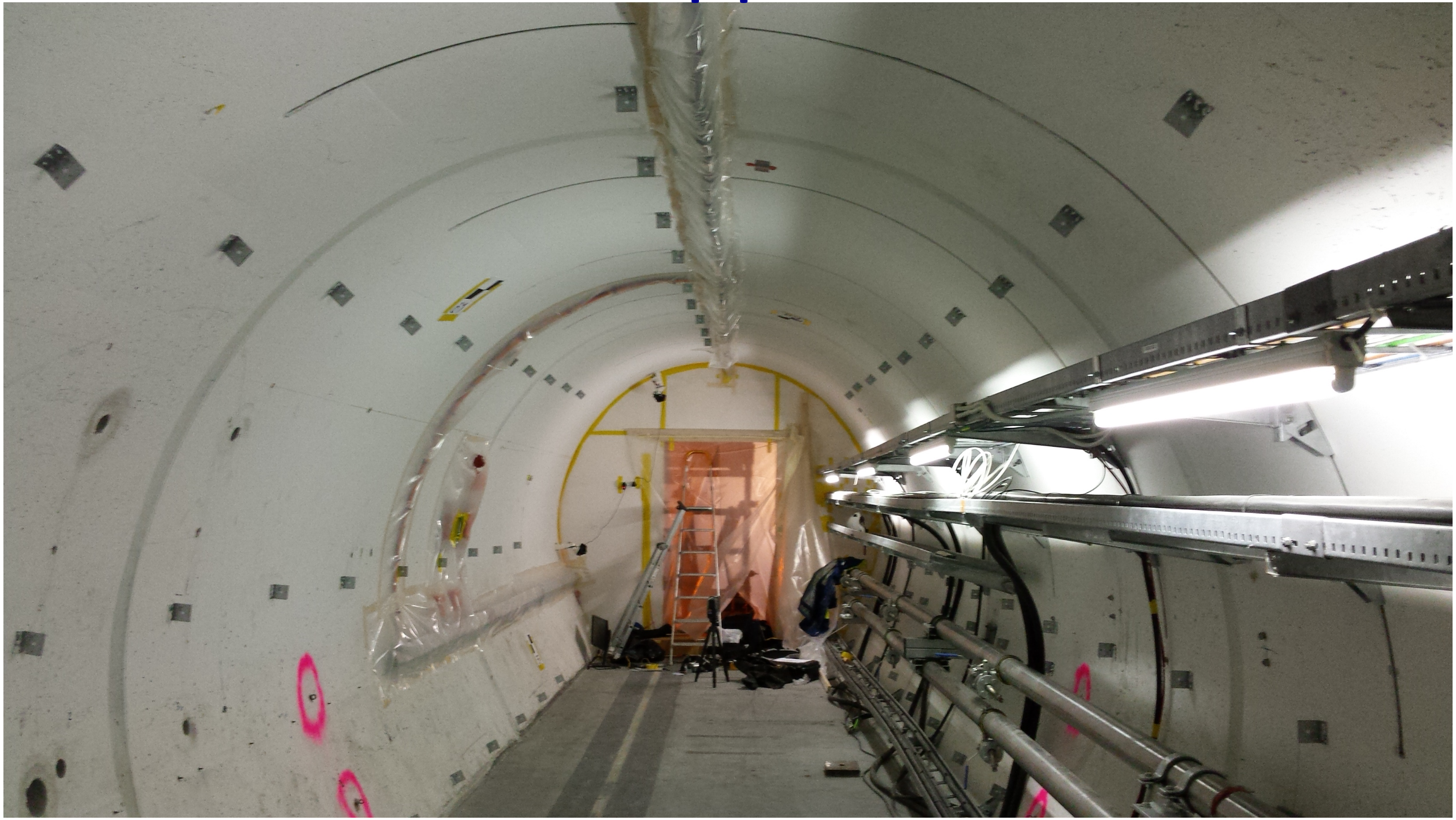

We decided to also submit the LOI to arxiv, in part to allow theorists to study FASER sensitivity for new models.

We would like to acknowledge the **huge** work from many CERN teams and others, in helping us to get to the current stage. For the biggest contributions the CERN technical personnel are included in the author list of the TP. Other contributions are acknowledged below:

We are grateful to the ATLAS SCT project and the LHCb Calorimeter project for letting us use spare modules as part of the FASER experiment. In addition, FASER gratefully acknowledges invaluable assistance from many people, including the CERN Physics Beyond Colliders study group; the LHC Tunnel Region Experiment (TREX) working group; Rhodri Jones, James Storey, Swann Levasseur, Christos Zamantzas, Tom Levens, Enrico Bravin (beam instrumentation); Dominique Missiaen, Pierre Valentin, Tobias Dobers (survey); Caterina Bertone, Serge Pelletier, Frederic Delsaux (transport); Andrea Tsinganis (FLUKA simulation and background characterization); Attilio Milanese, Davide Tommasini, Luca Bottura (magnets); Burkhard Schmitt, Christian Joram, Raphael Dumps, Sune Jacobsen (scintillators); Dave Robinson, Steve McMahon (ATLAS SCT); Yuri Guz (LHCb calorimeters); Stephane Fartoukh, Jorg Wenninger (LHC optics), Michaela Schaumann (LHC vibrations); Marzia Bernardini, Anne-Laure Perrot, Katy Foraz, Thomas Otto, Markus Brugger (LHC access and schedule); Simon Marsh, Marco Andreini, Olga Beltramello (safety); Stephen Wotton, Floris Keizer (SCT QA system and SCT readout); Yannic Body, Olivier Crespo-Lopez (cooling/ventilation); Yann Maurer (power); Marc Collignon, Mohssen Souayah (networking); Gianluca Canale, Jeremy Blanc, Maria Papamichali (readout signals); Bernd Panzer-Steindel (computing infrastructure); and Fido Dittus, Andreas Hoecker, Andy Lankford, Ludovico Pontecorvo, Michel Raymond, Christoph Rembser, Stefan Schlenker (useful discussions).

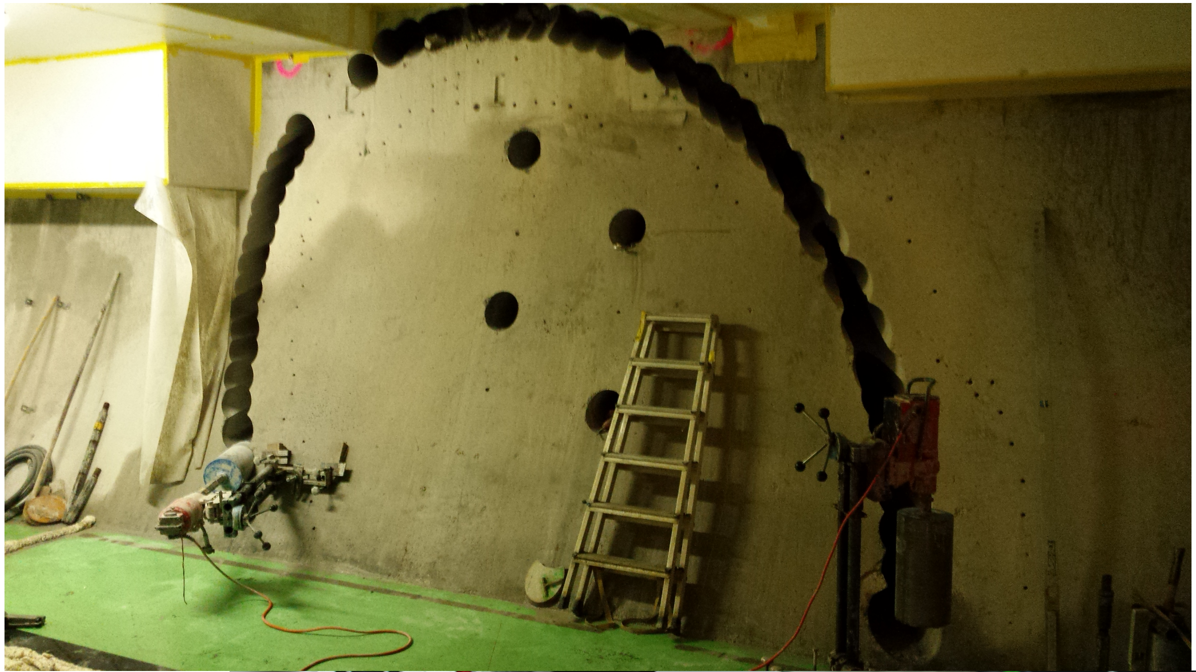
# Backup

# Dust suppression



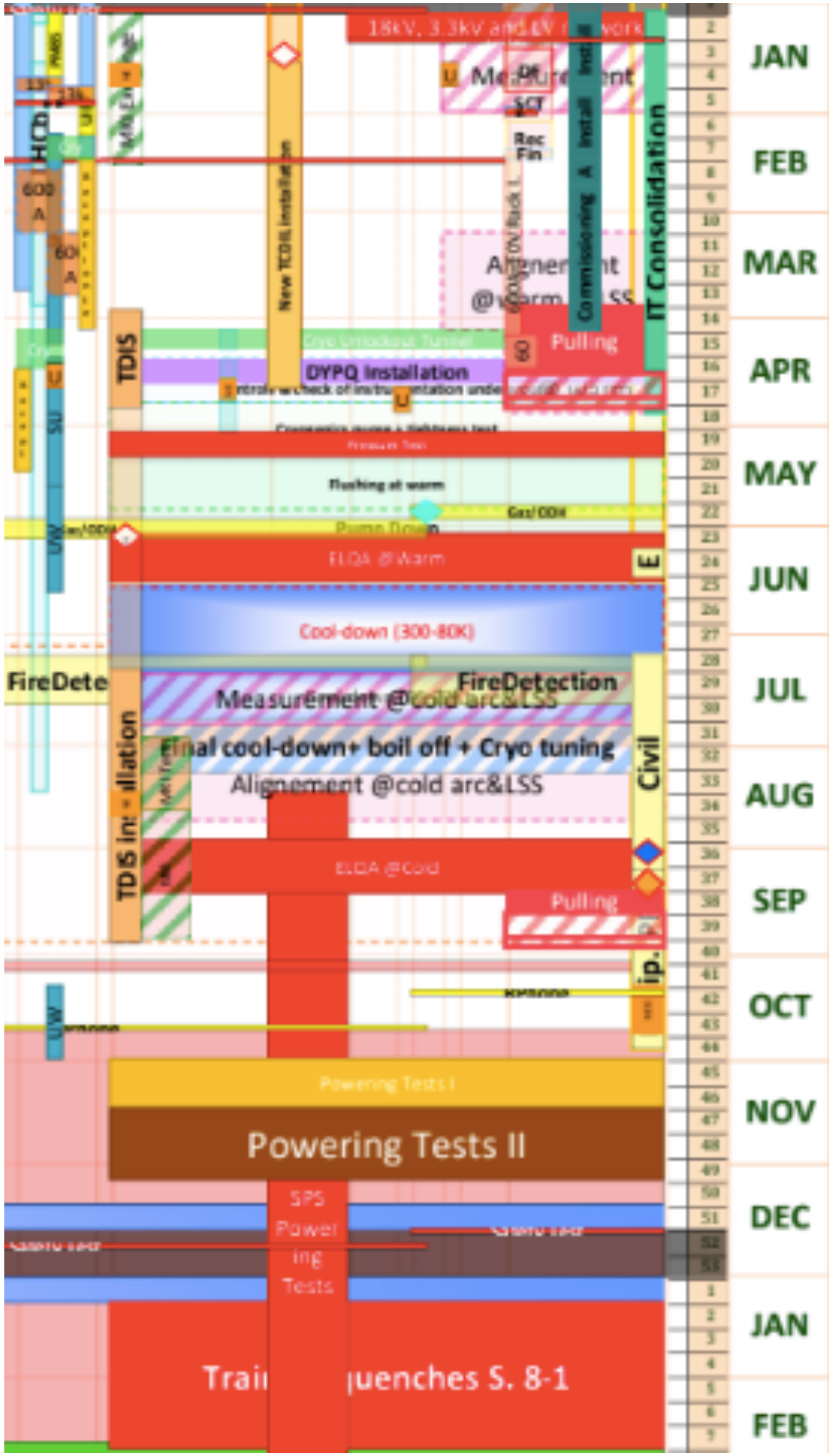
Picture of SAS used for CE work in AWAKE

# Dust suppression



# Dust suppression

Example of tools to be used for CE work – designed for maximum dust suppression…

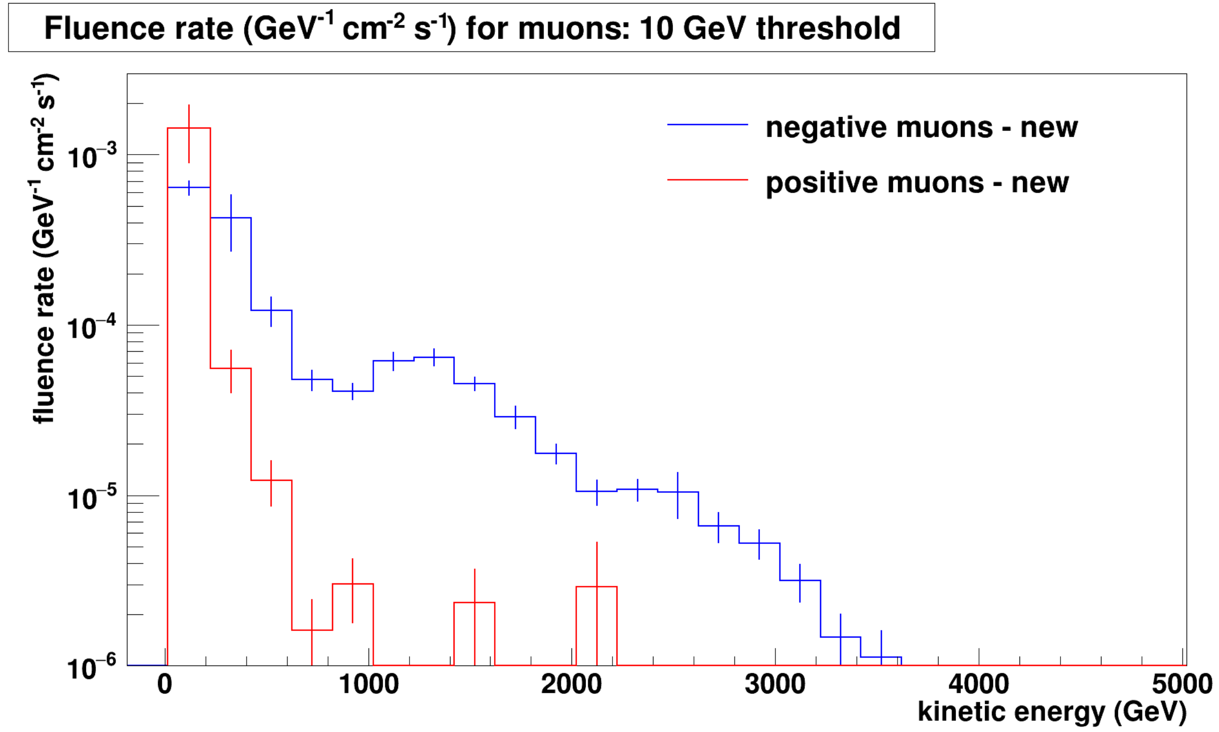


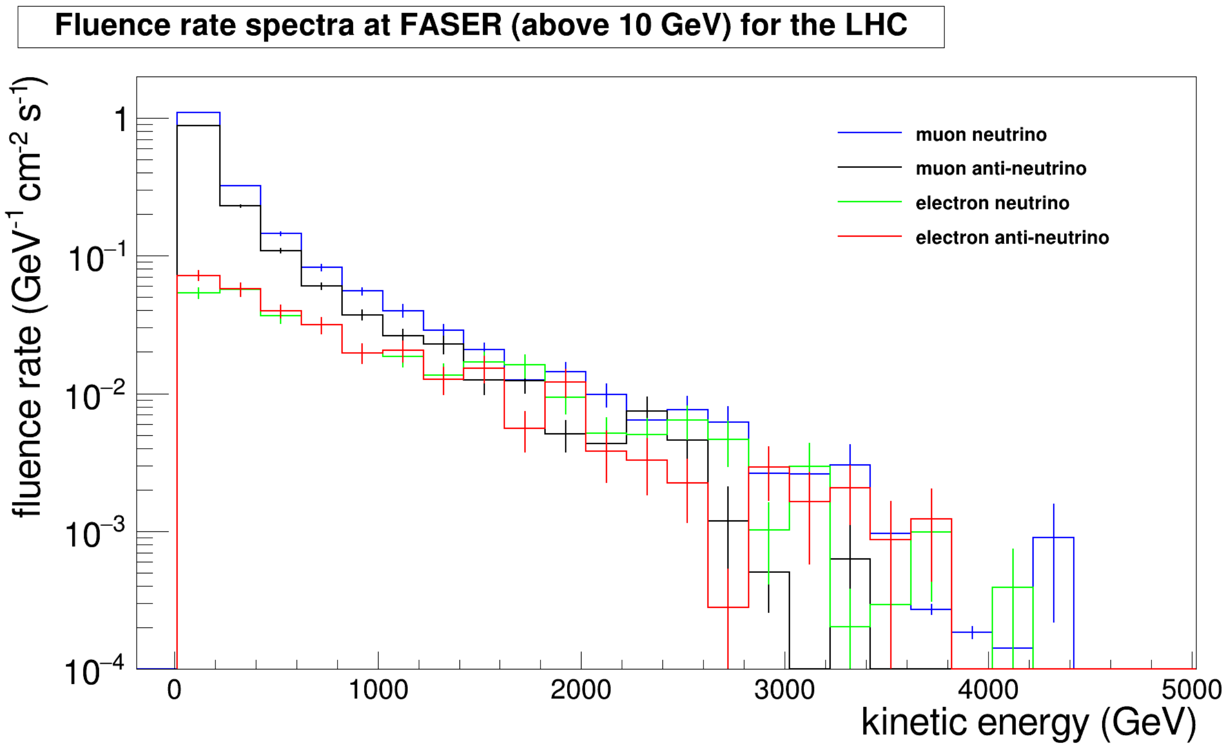

CONSTRAINTS:
- No CE works in 2019 (diode cleaning campaign)
- Sector 81 cool down end-May (w25) – after this no CE works, no transport of heavy loads over QRL
- CE work only outside working hours when survey work ongoing in s81
- Water cooled cabling using TI12 in Jan 2020
- Various weeks with no access due to electrical/pressure tests etc…

BASELINE SCHEDULE:
- CE work w5-w10, and outside working hours w11-w14 (first week preparation of TI12 area)
- Installation of heavy components w20/21/22 (flushing stopped during day of heavy lifting)
- Integration and commissioning in situ during some weeks after cool down

POSSIBLE ISSUES:
- AFP dust issue in Feb/March 2020
- little contingency for CE works
- little contingency for magnet delivered late

CONTINGENCY:
- possibly transport heavy items over machine when cold IF adequate protection available and redundant procedures
- last resort finish installation in YETS 21/22




# Updated FLUKA simulations

Updated plots with much improved statistical accuracy.

These studies show:
neutrinos come mostly from p-p collision products direct decay, while two thirds of the muons are produced through further interactions.

# Costs

| Detector component | Cost [kCHF] | Detailed Table |
|---|---|---|
| Magnet | 420 | Table V |
| Tracker Mechanics | 66 | Table VI |
| Tracker Services | 105 | Table VII |
| Scintillator Trigger & Veto | 52 | Table VIII |
| Calorimeter | 13 | Table IX |
| Support structure | 60 | Table X |
| Trigger & Data Acquisition | 52 | Table XIV |
| **Total** | **768** | - |
| Spares | 55 | - |

TABLE XVI. Overall budget for FASER experiment hardware. The TDAQ system includes the readout for all detectors (including the Tracker).

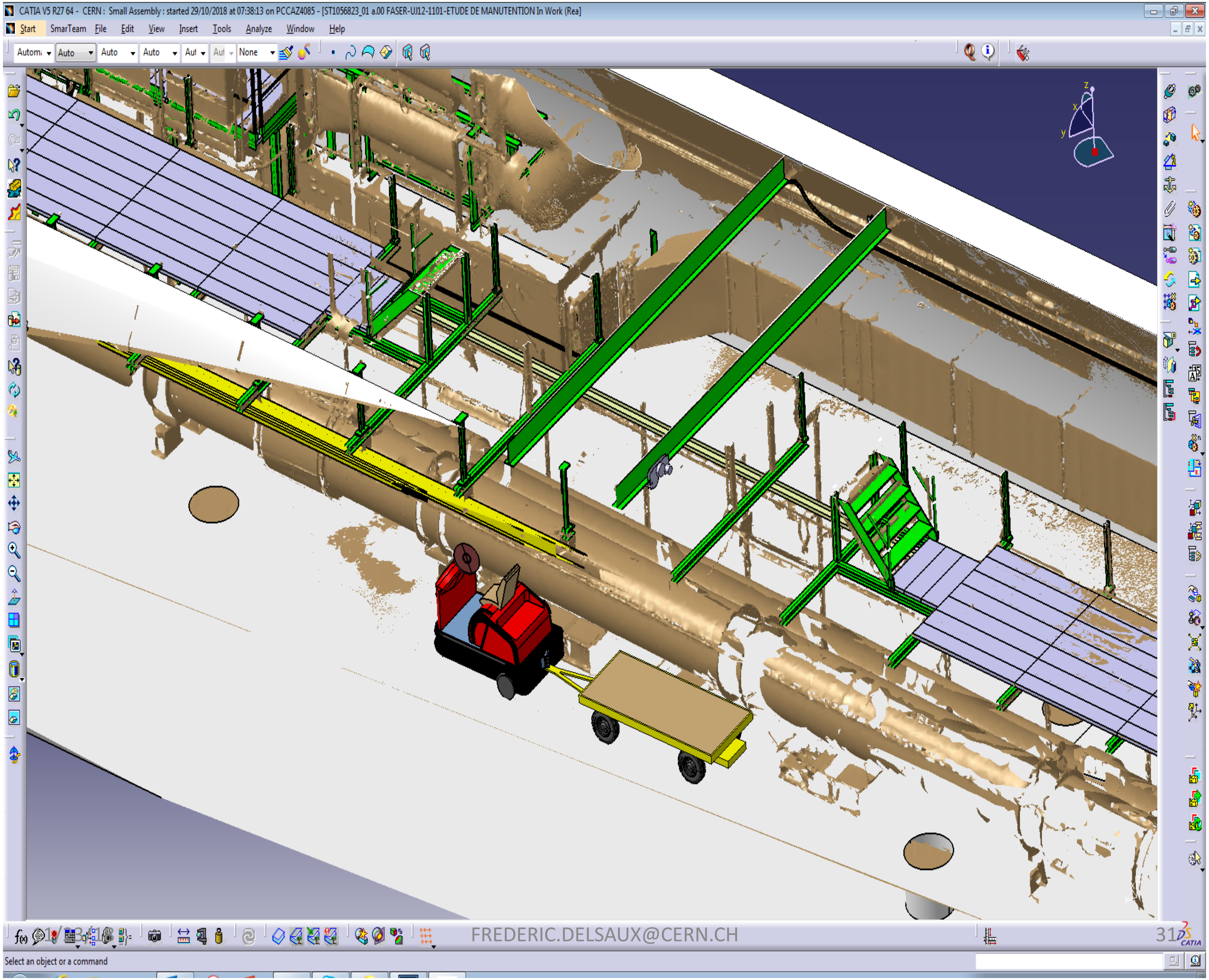
Included 20% contingency for funding request

| Work | Cost [kCHF] |
|---|---|
| Civil Engineering | 83 |
| Transport | 55 |
| Optical Fiber & Network Connection | TBD |
| Power Connection | 10 |
| Compressed Air Connection | 6 |
| Preparation of TI12 | TBD |
| **Total** | $> 160$ |

TABLE XVII. Budget for infrastructure work whose cost is assumed to be borne by CERN. Preparation of TI12 includes removal of ventilation tubes and cable trays, installation of lighting and installation of temporary ventilation and water. The cost for most of these are in the process of being determined.

CE cost will increase due to changes discussed. In addition transport costs will increase for protection of QRL (under design)

# Following slides on model of FASER transport/installation

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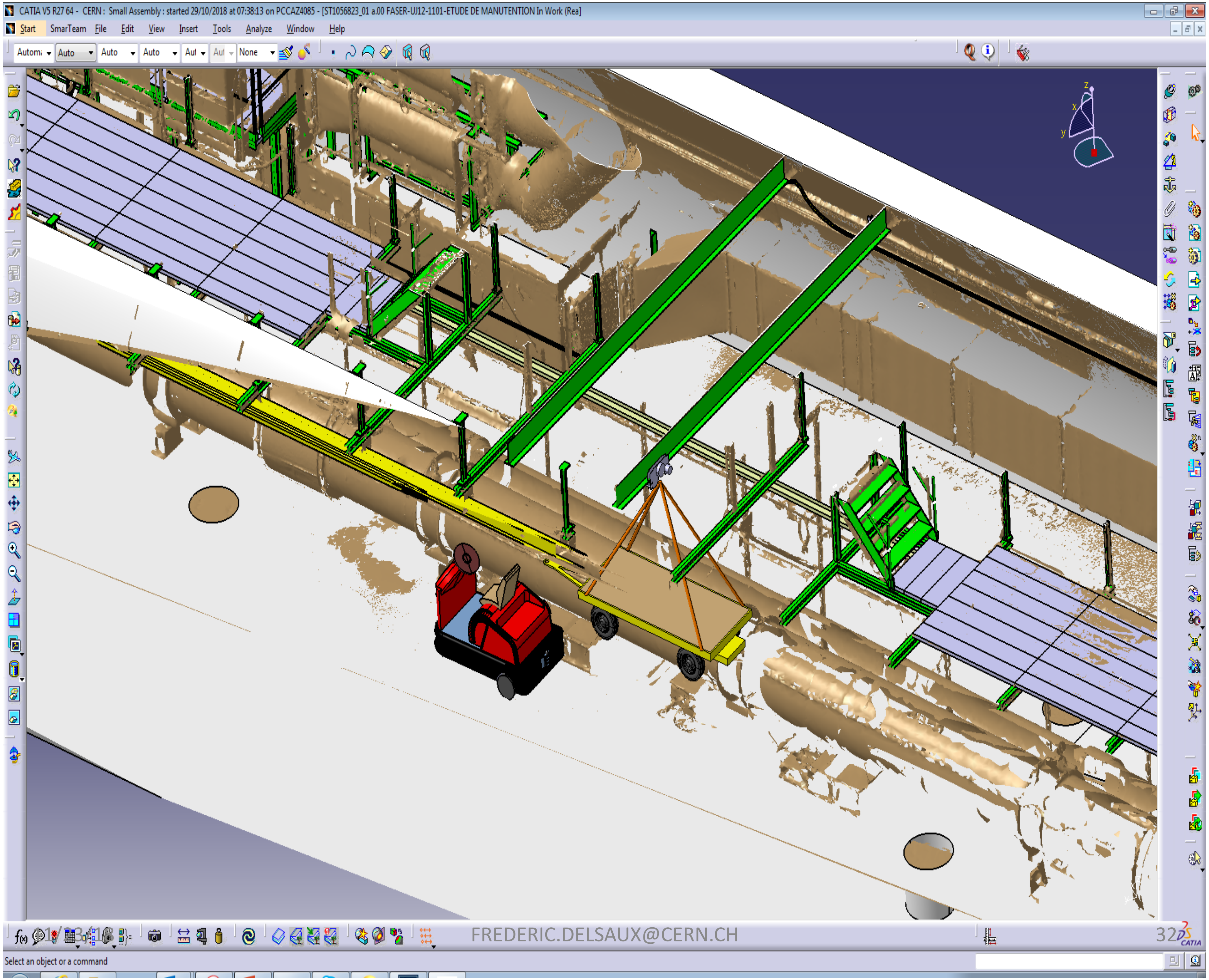
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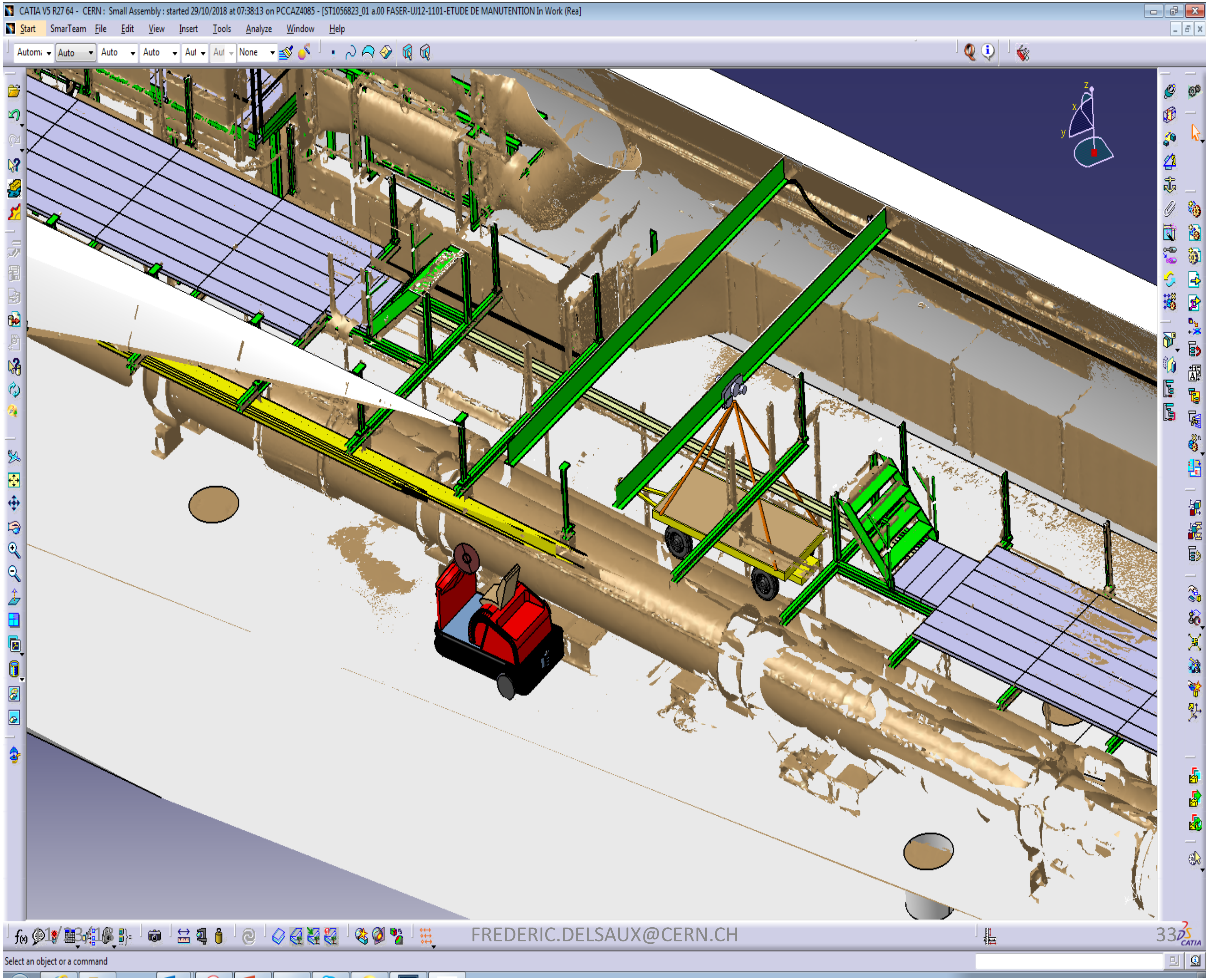
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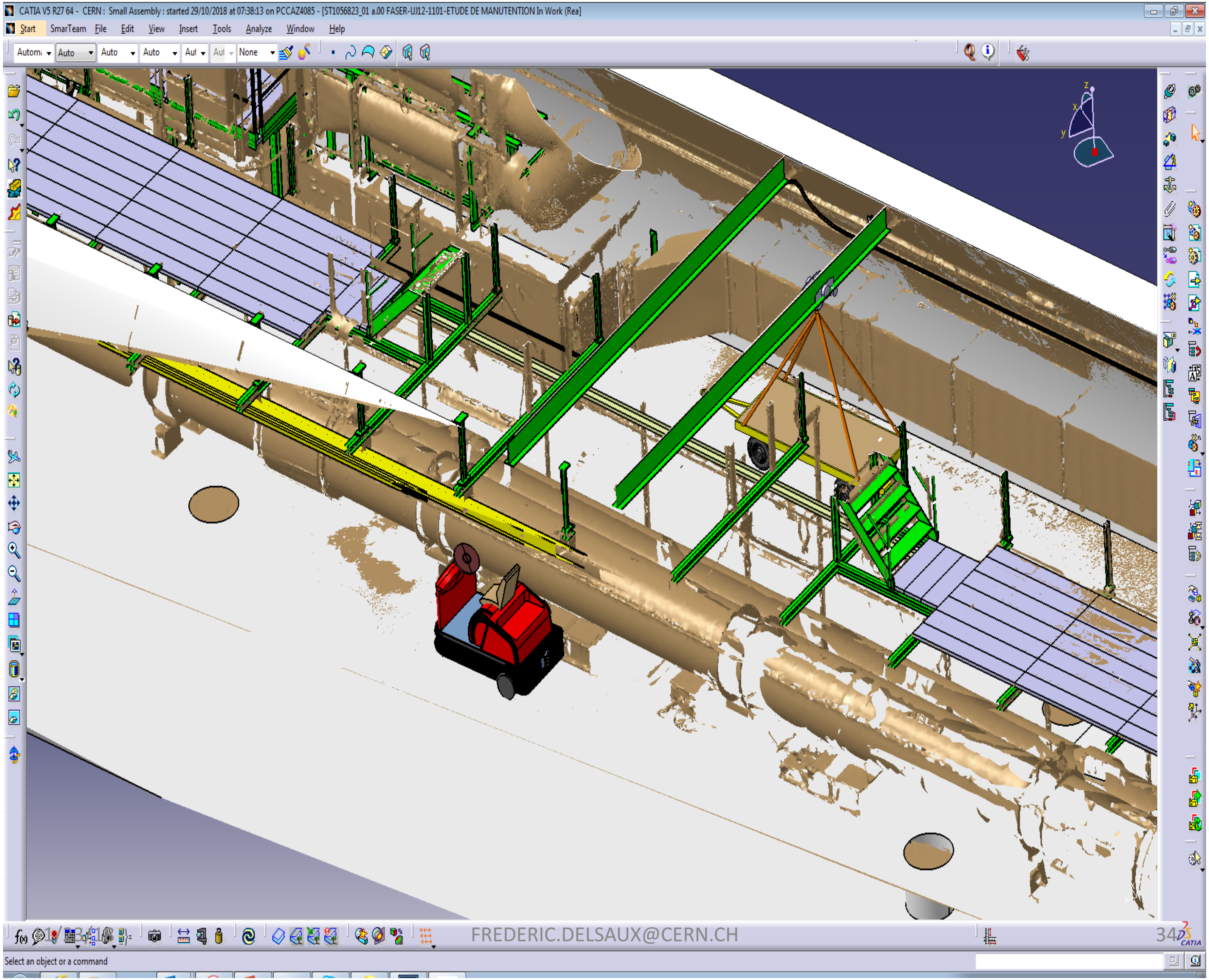
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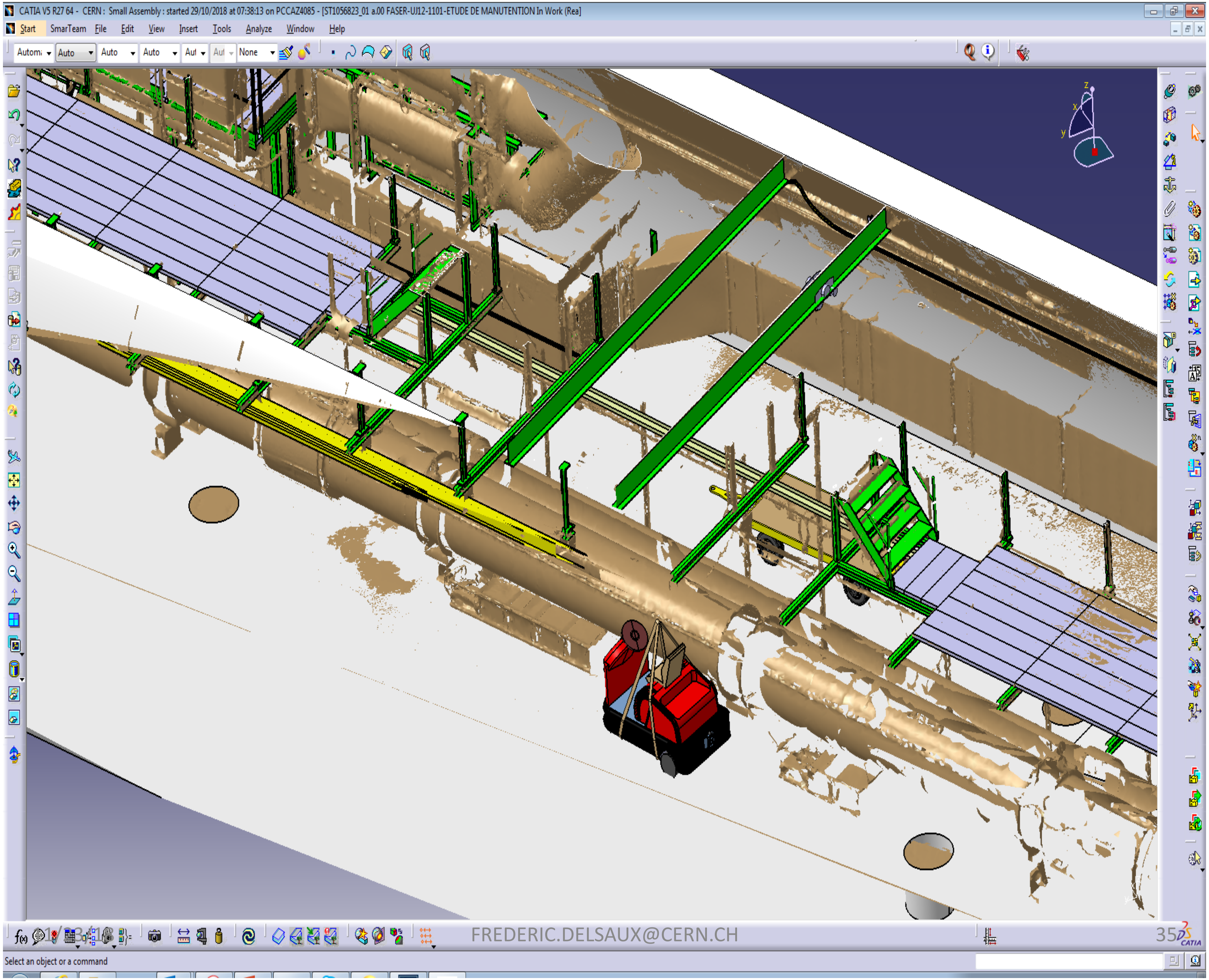
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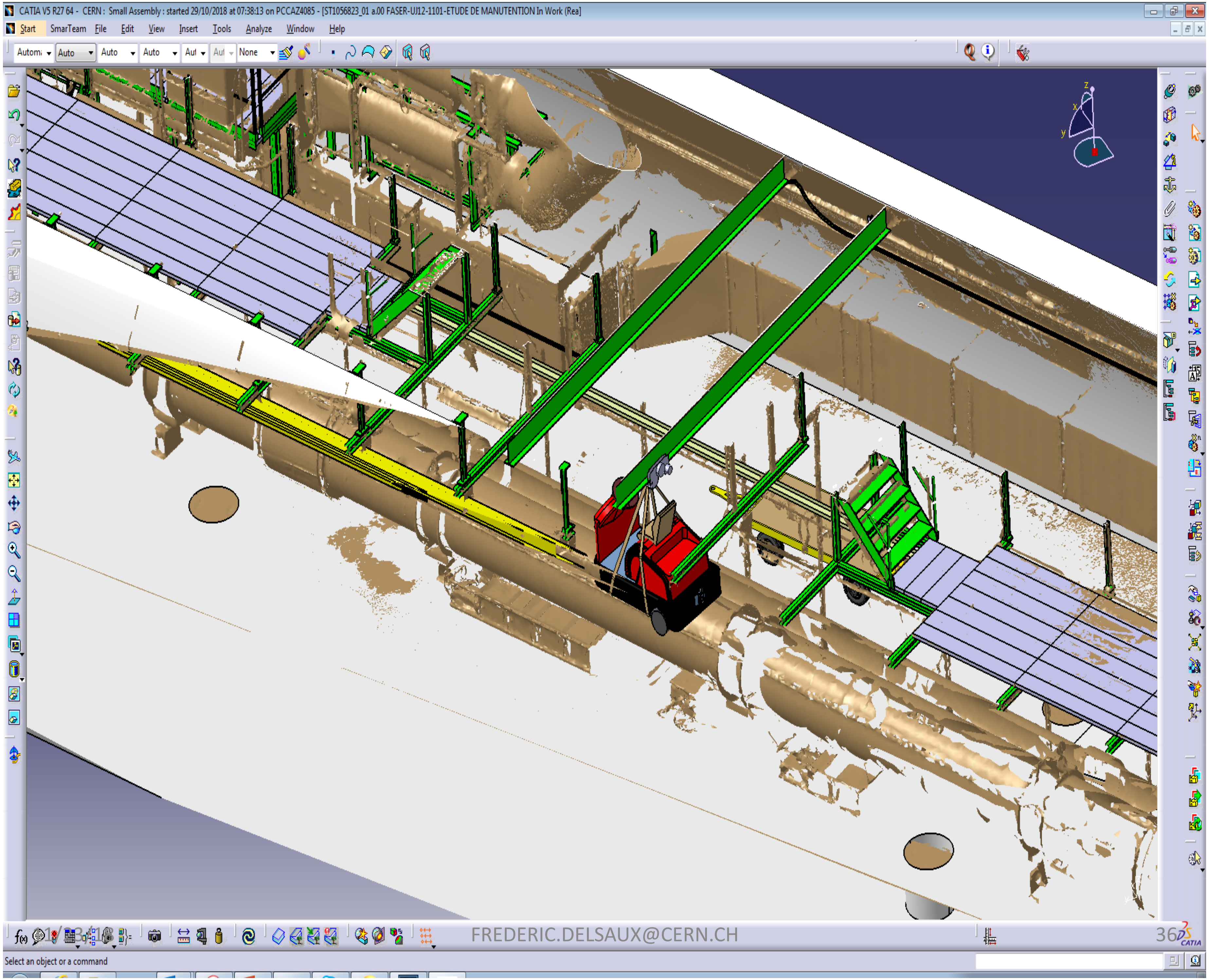
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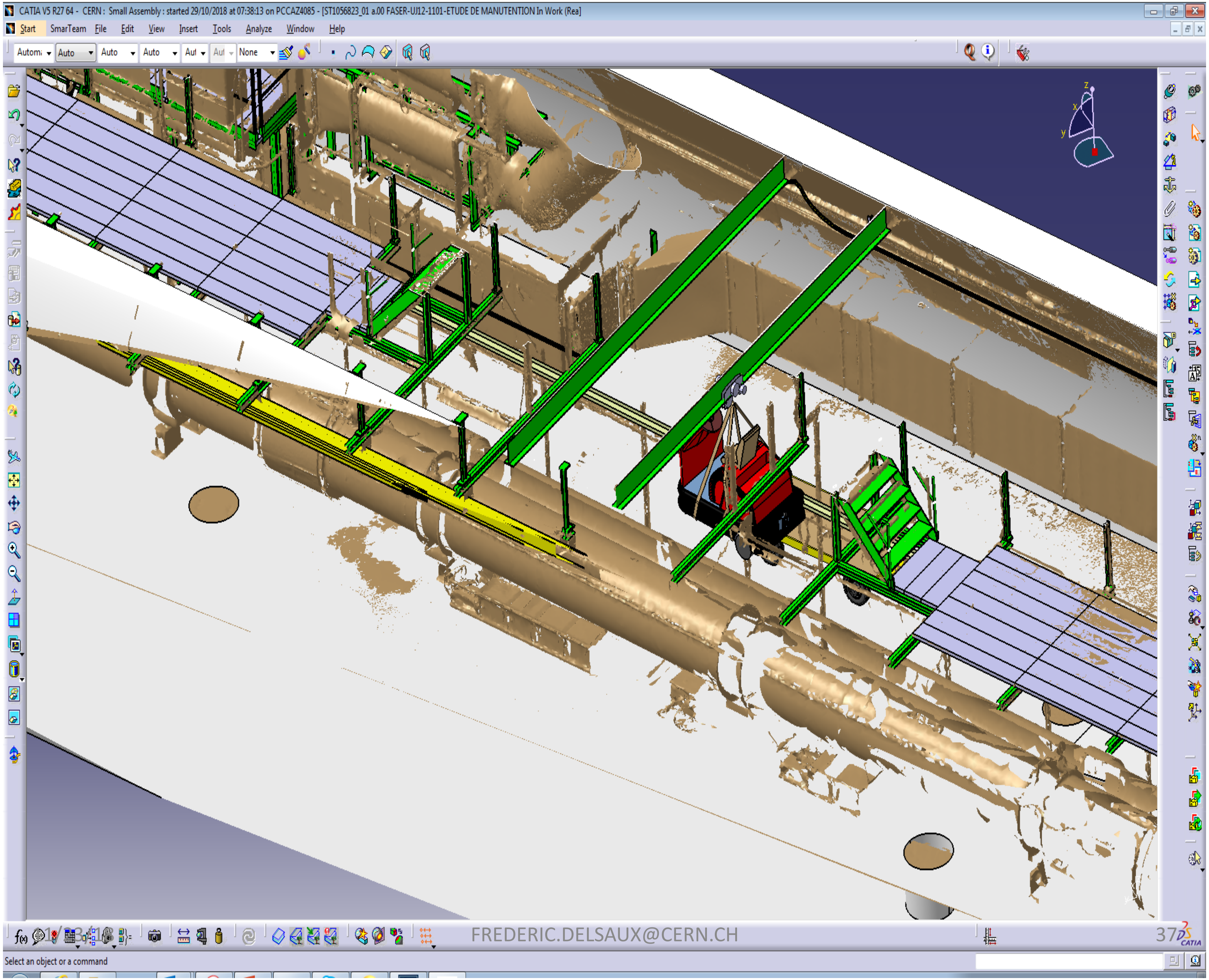
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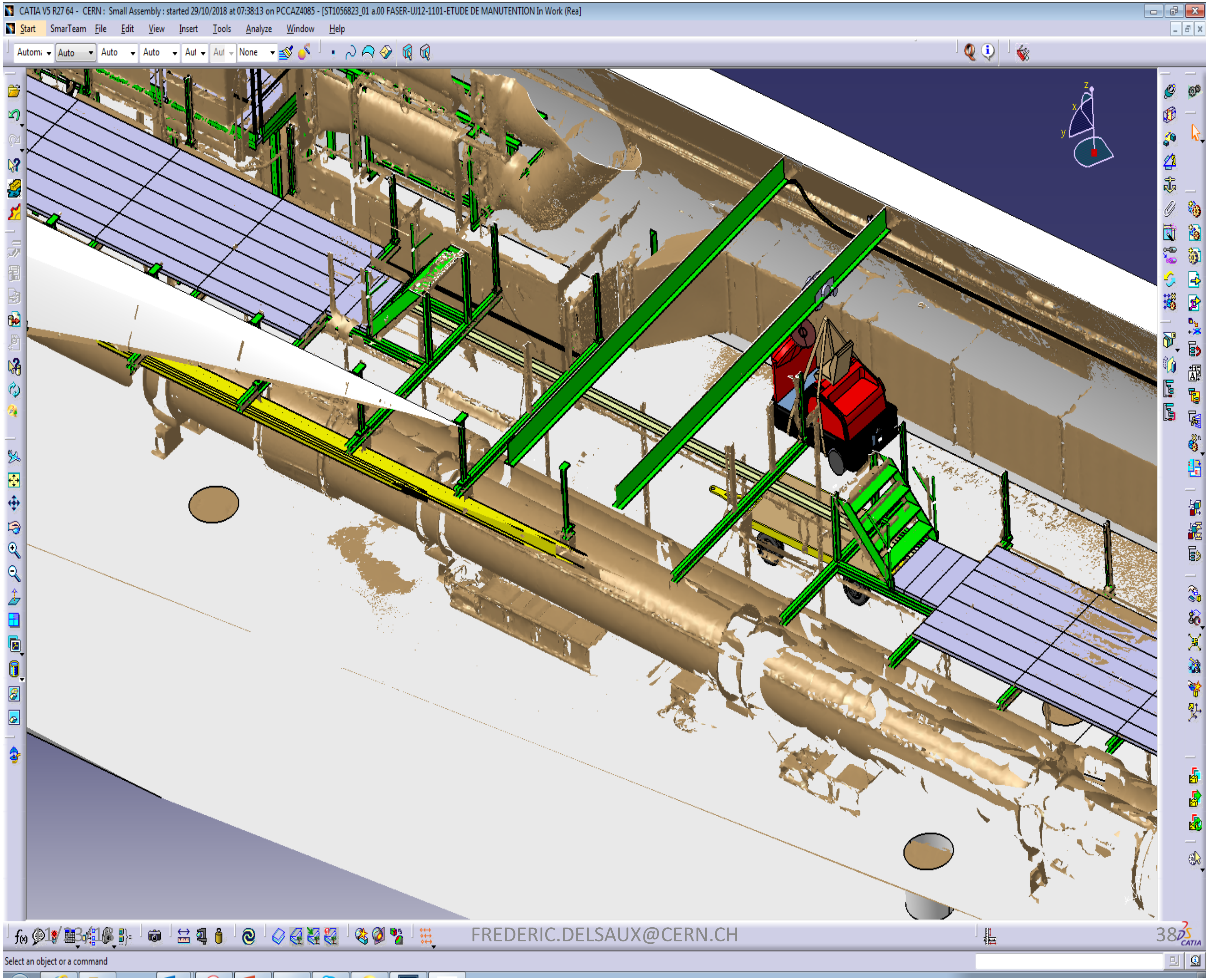
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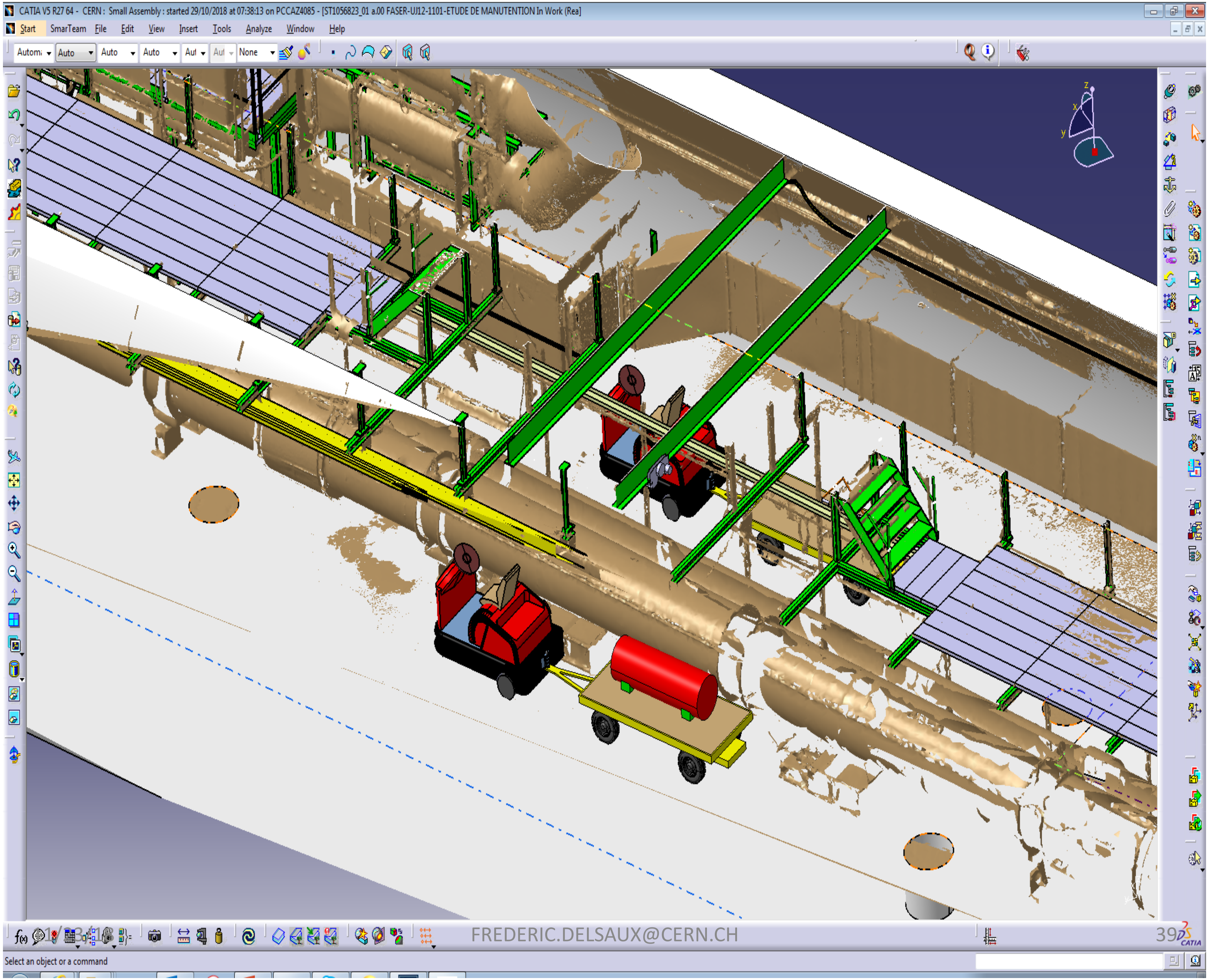
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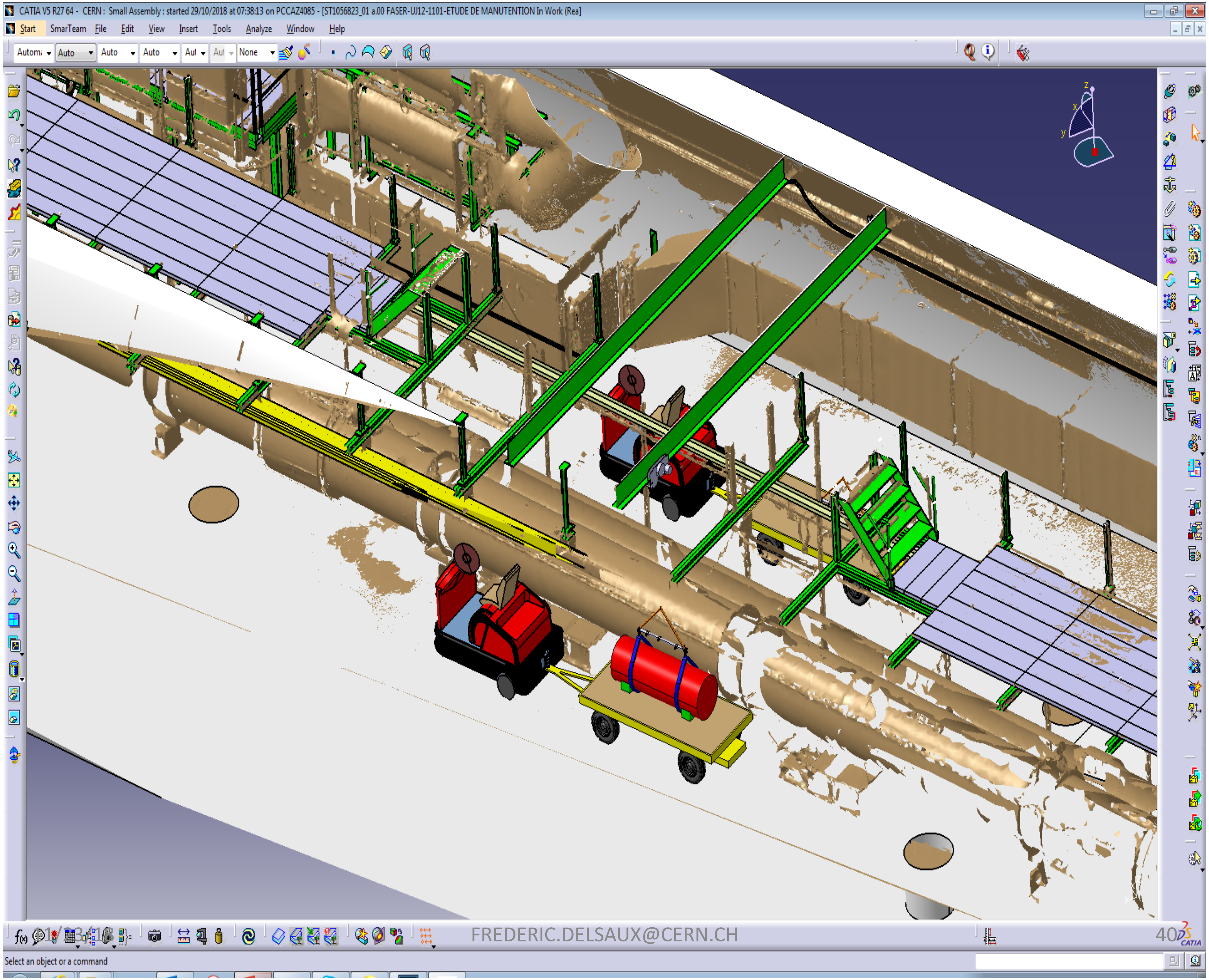
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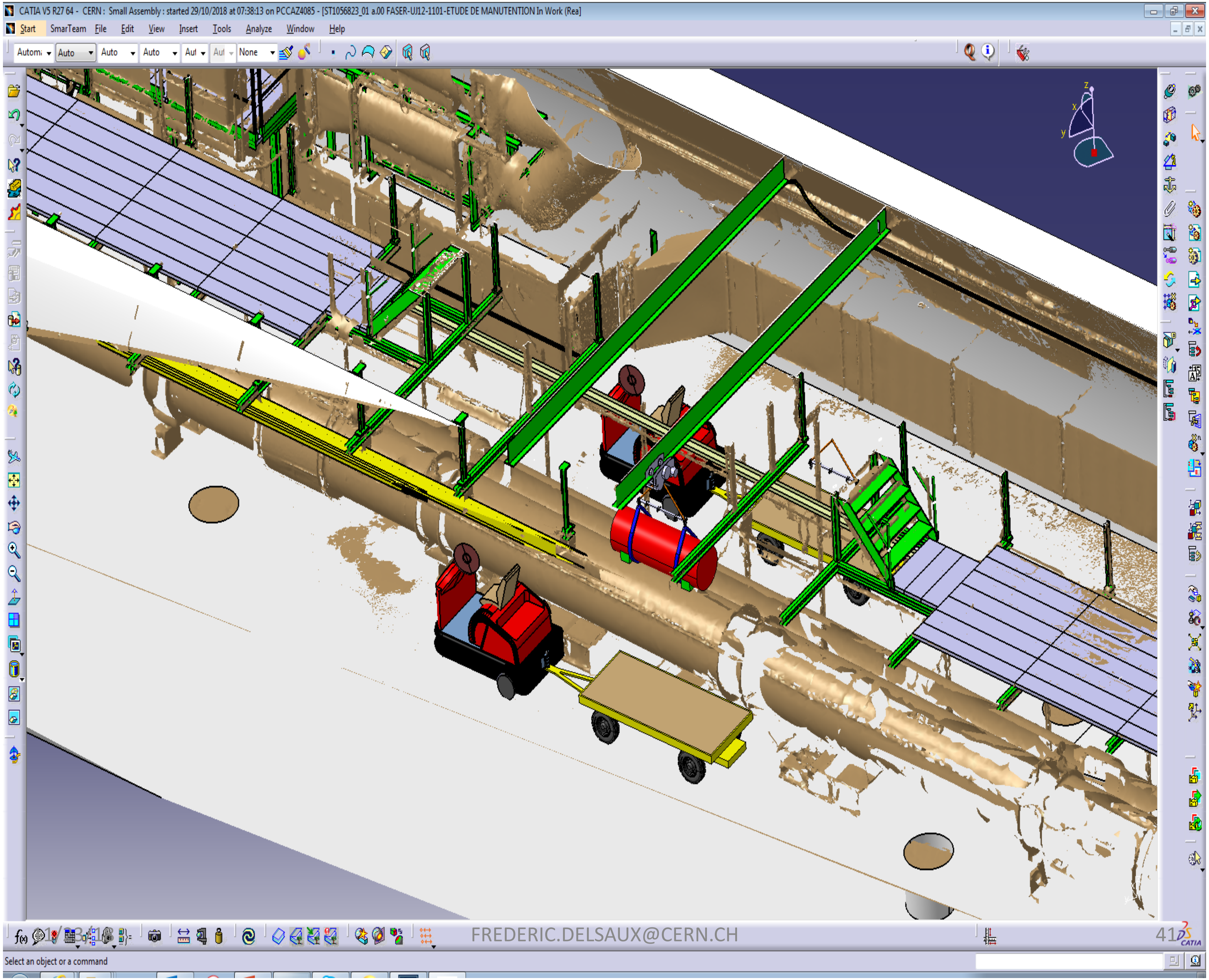
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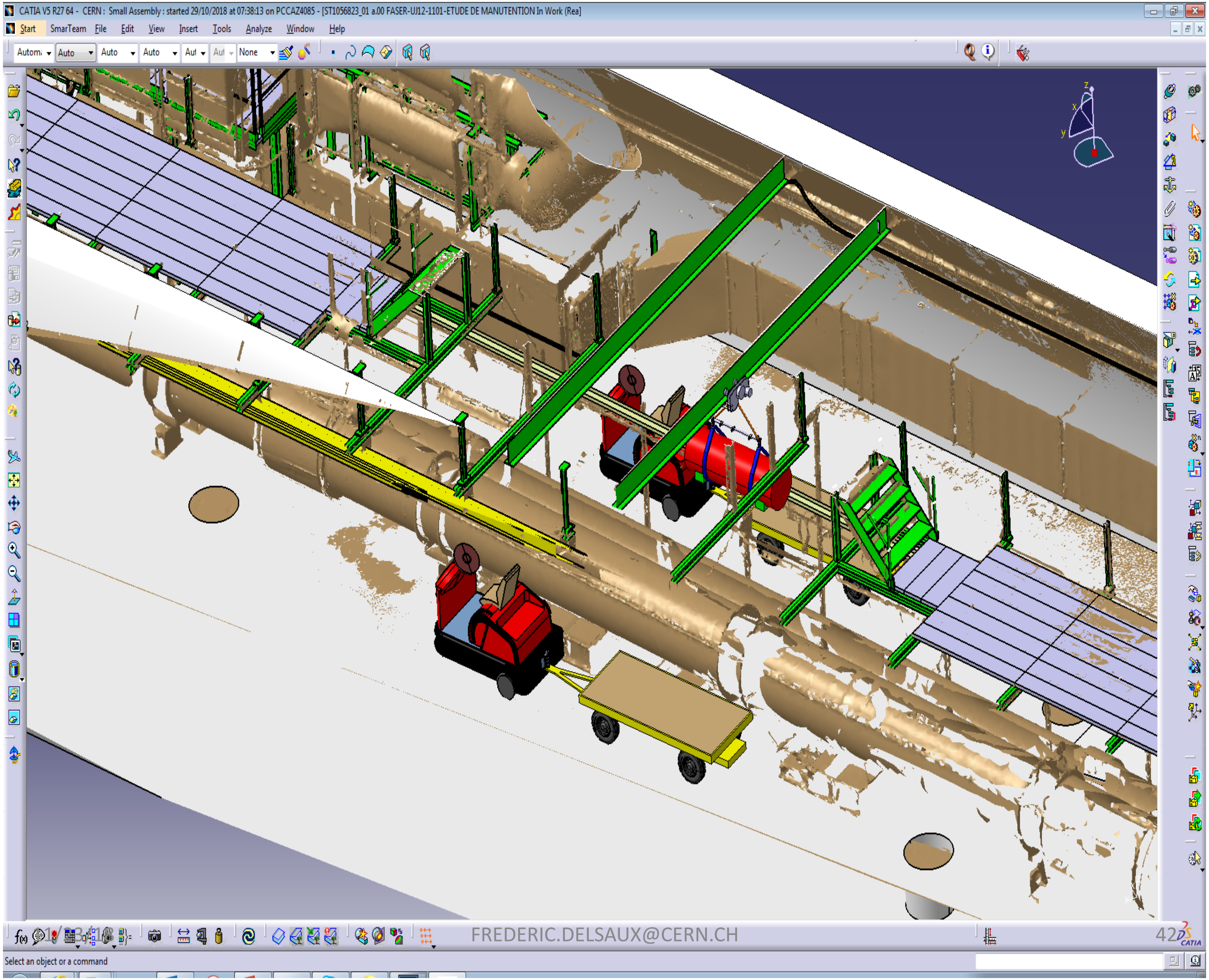


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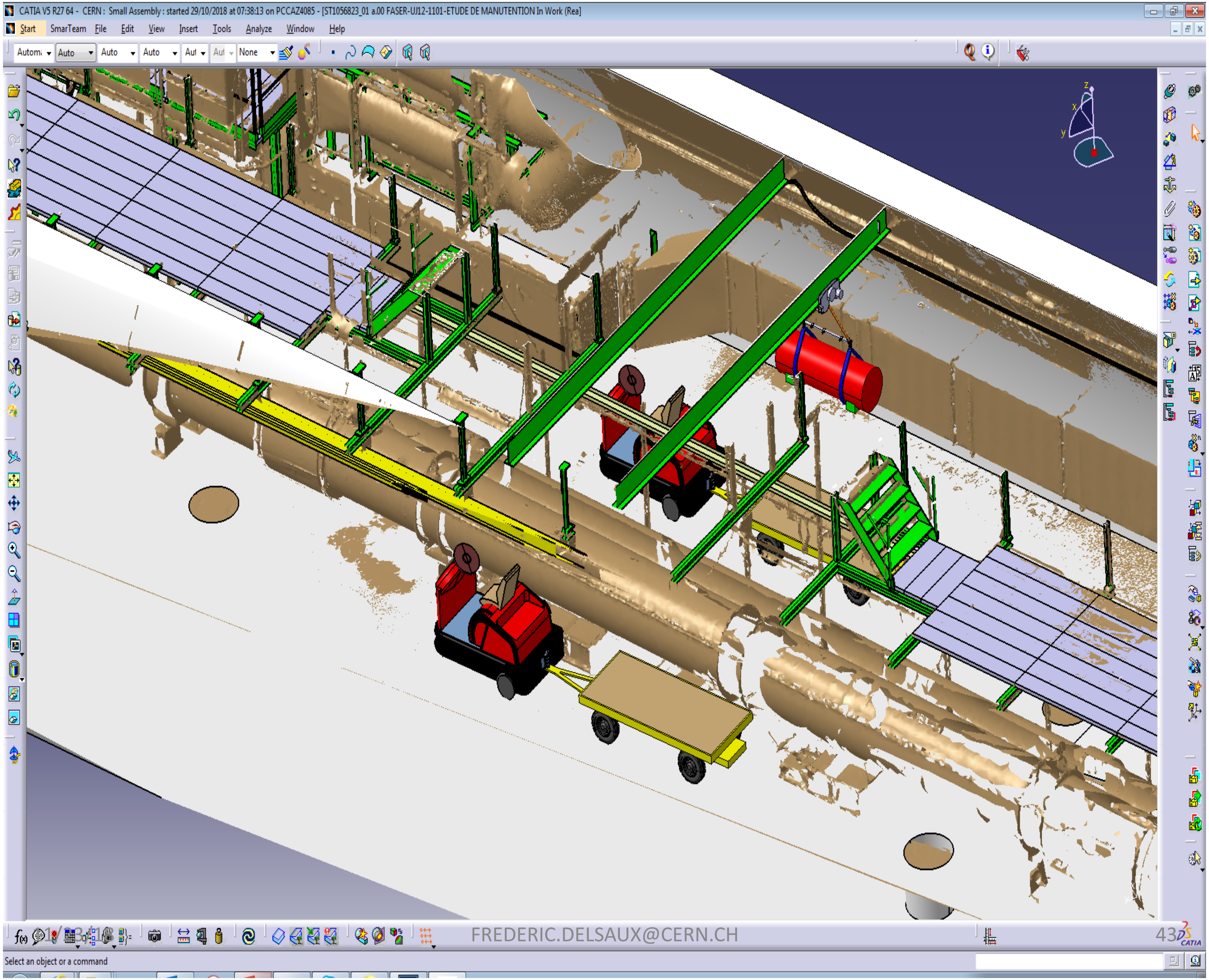
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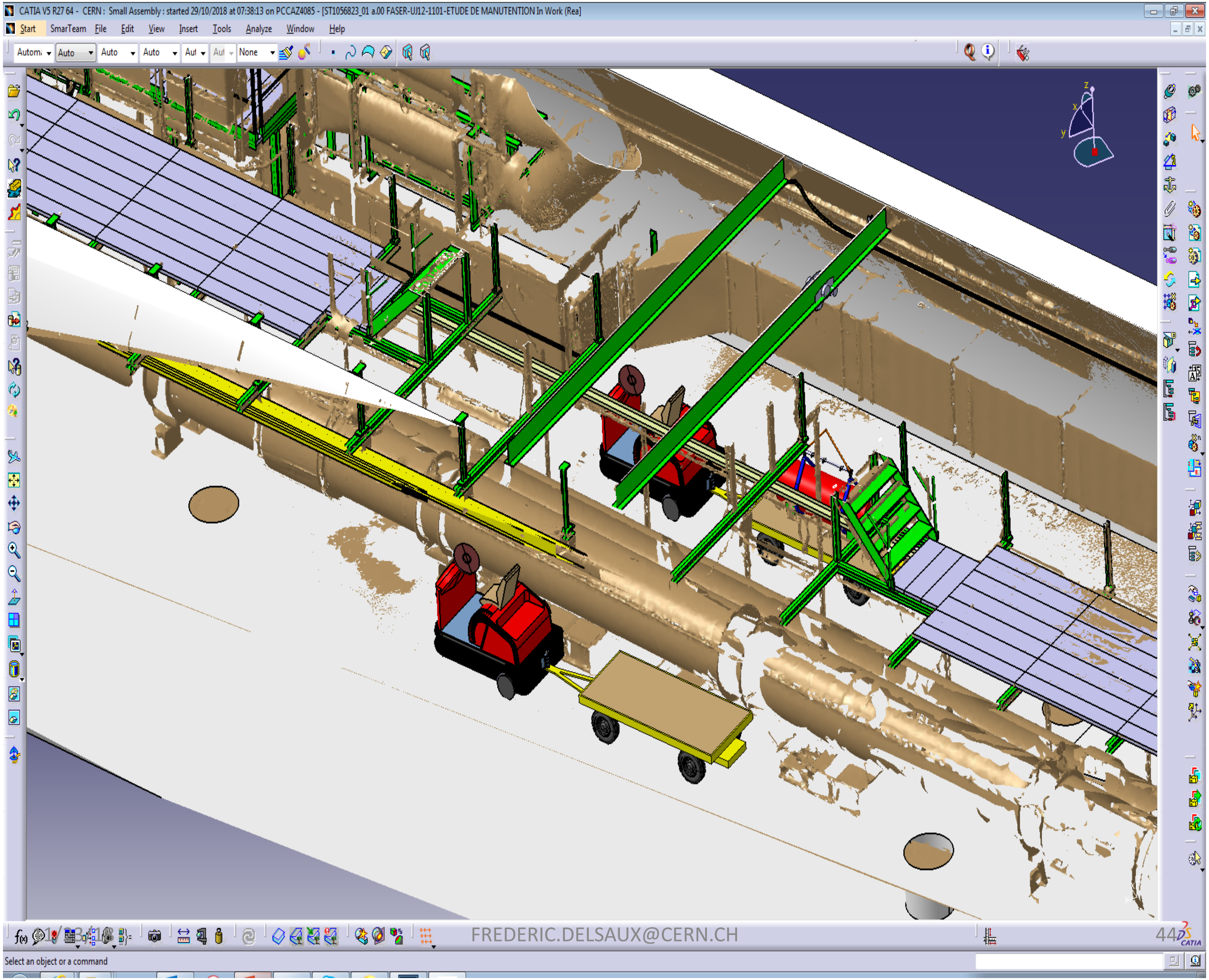
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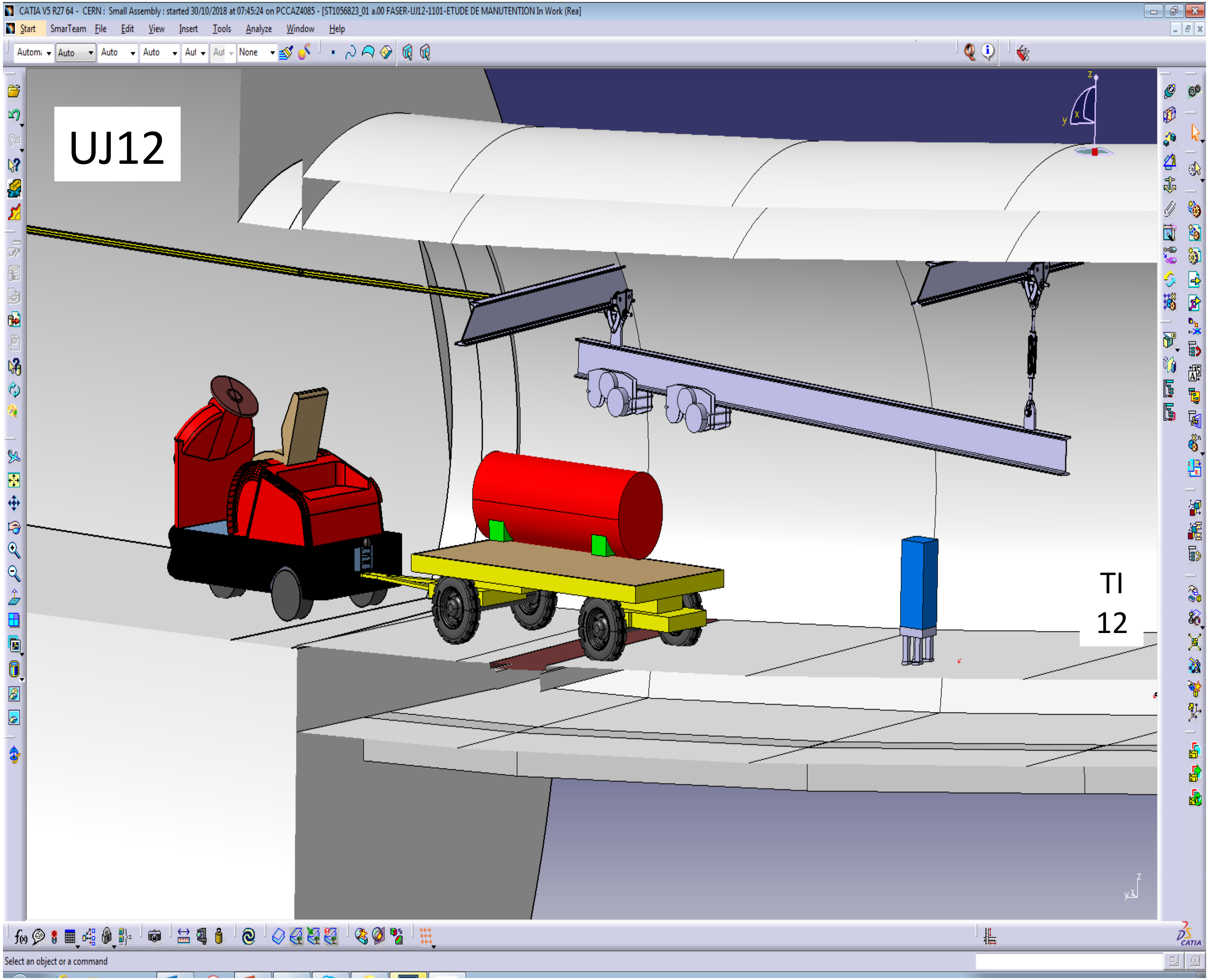
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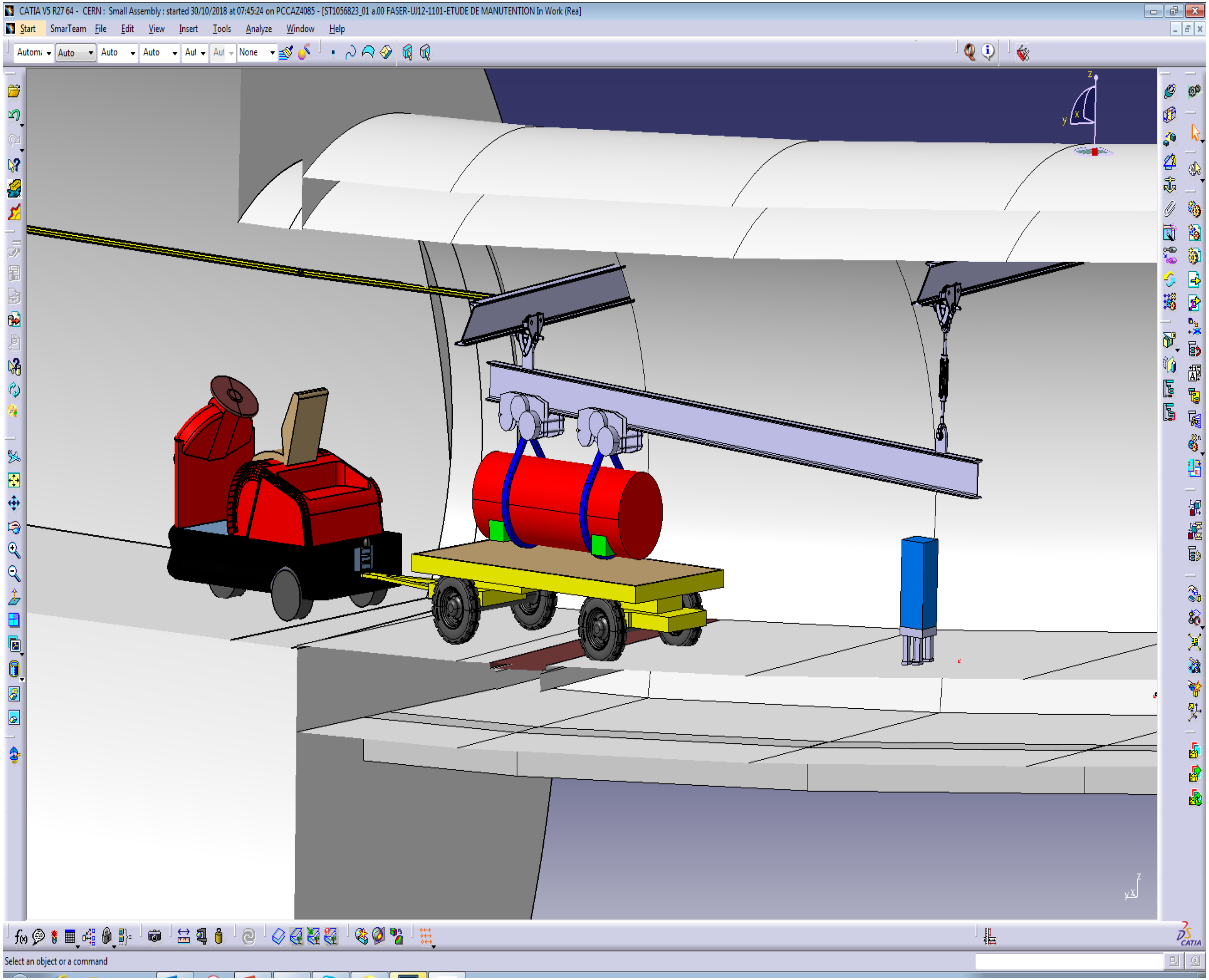
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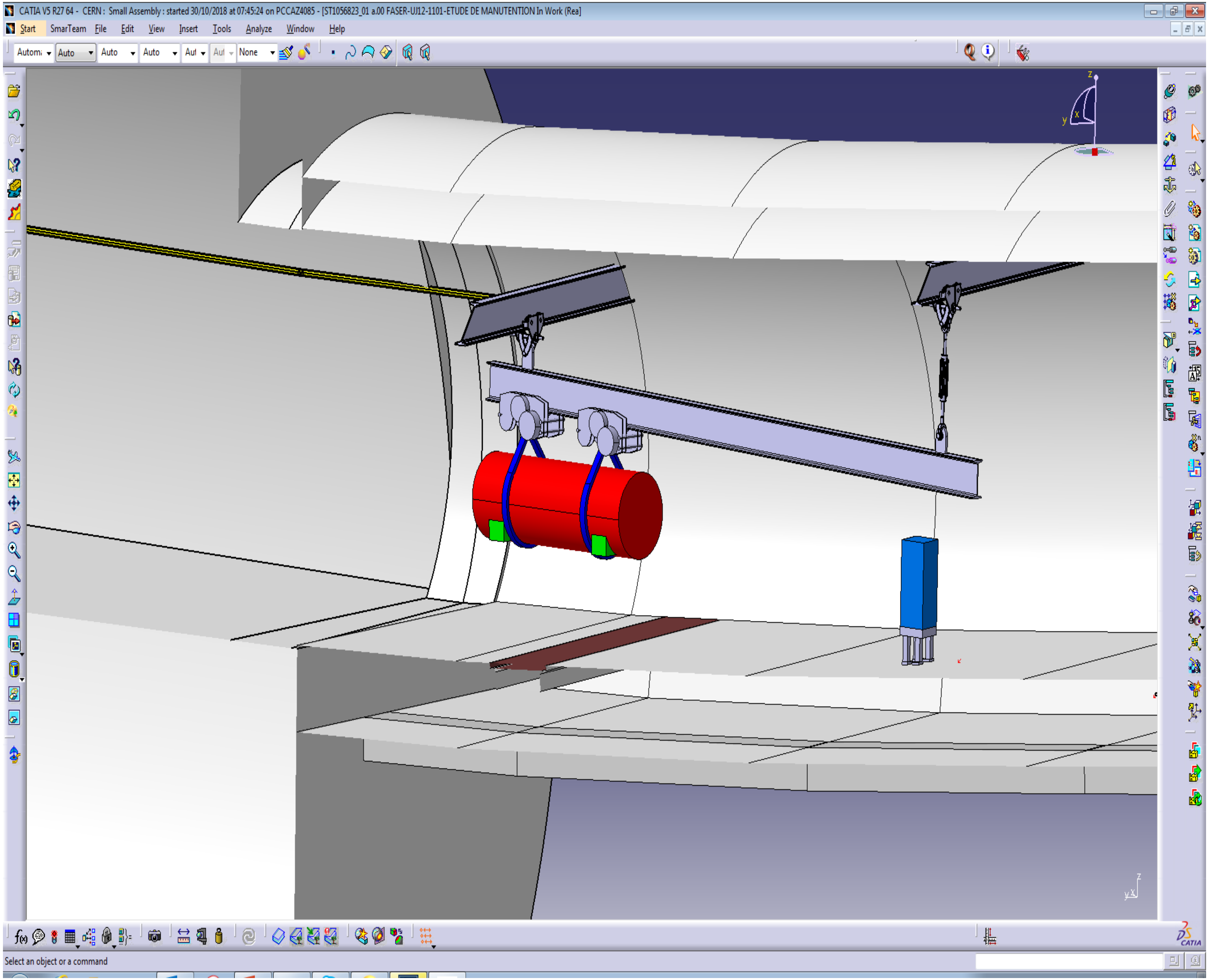
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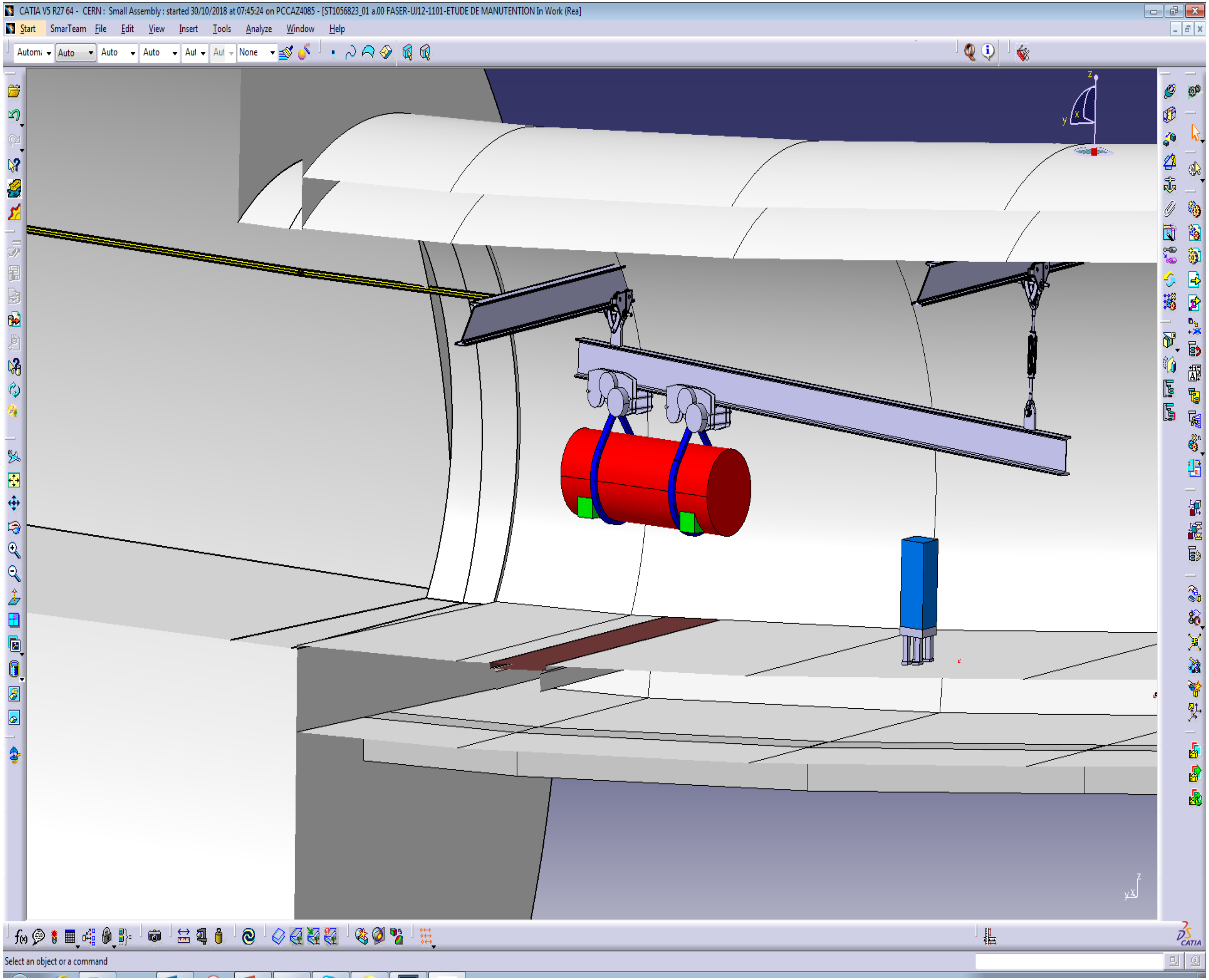
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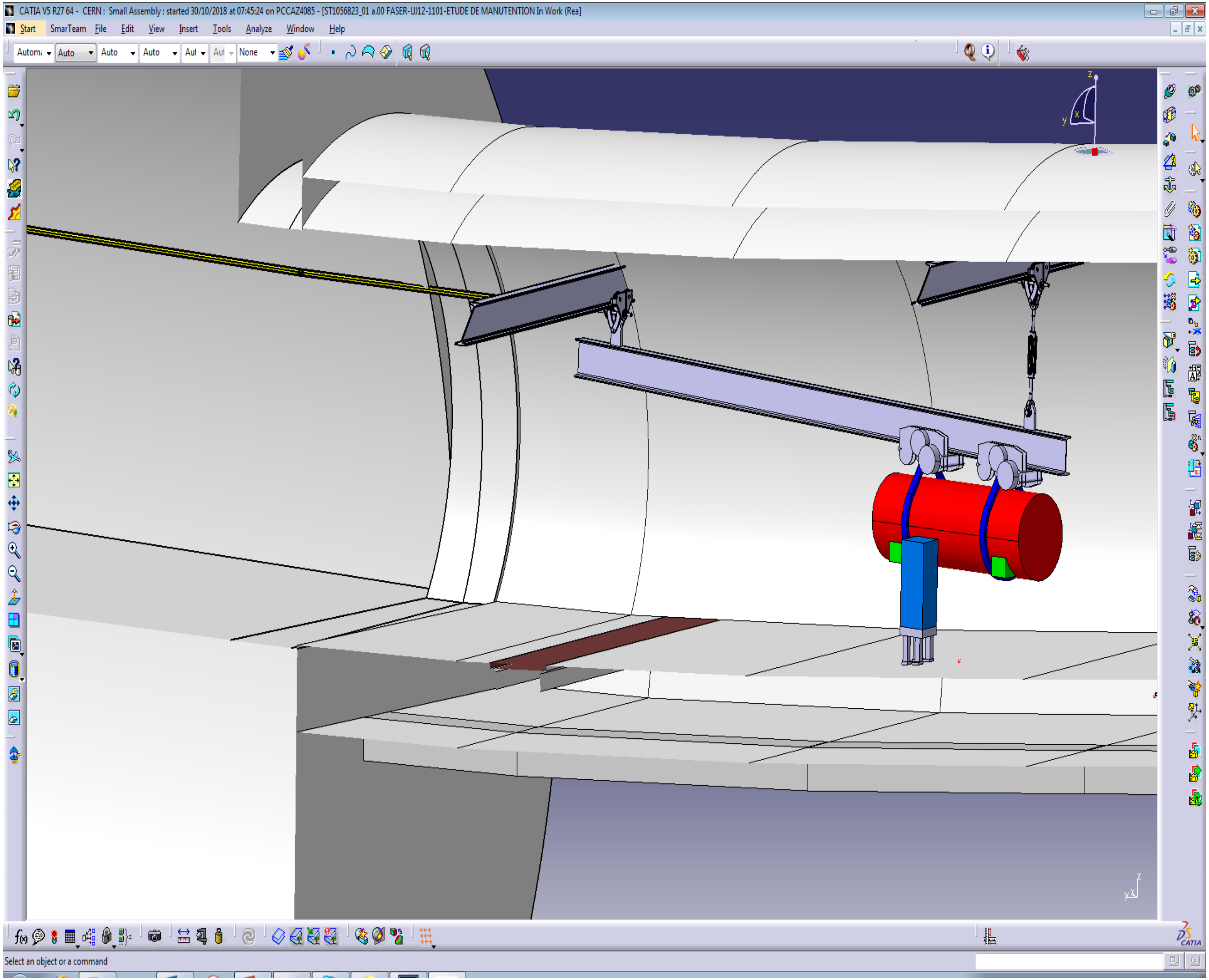
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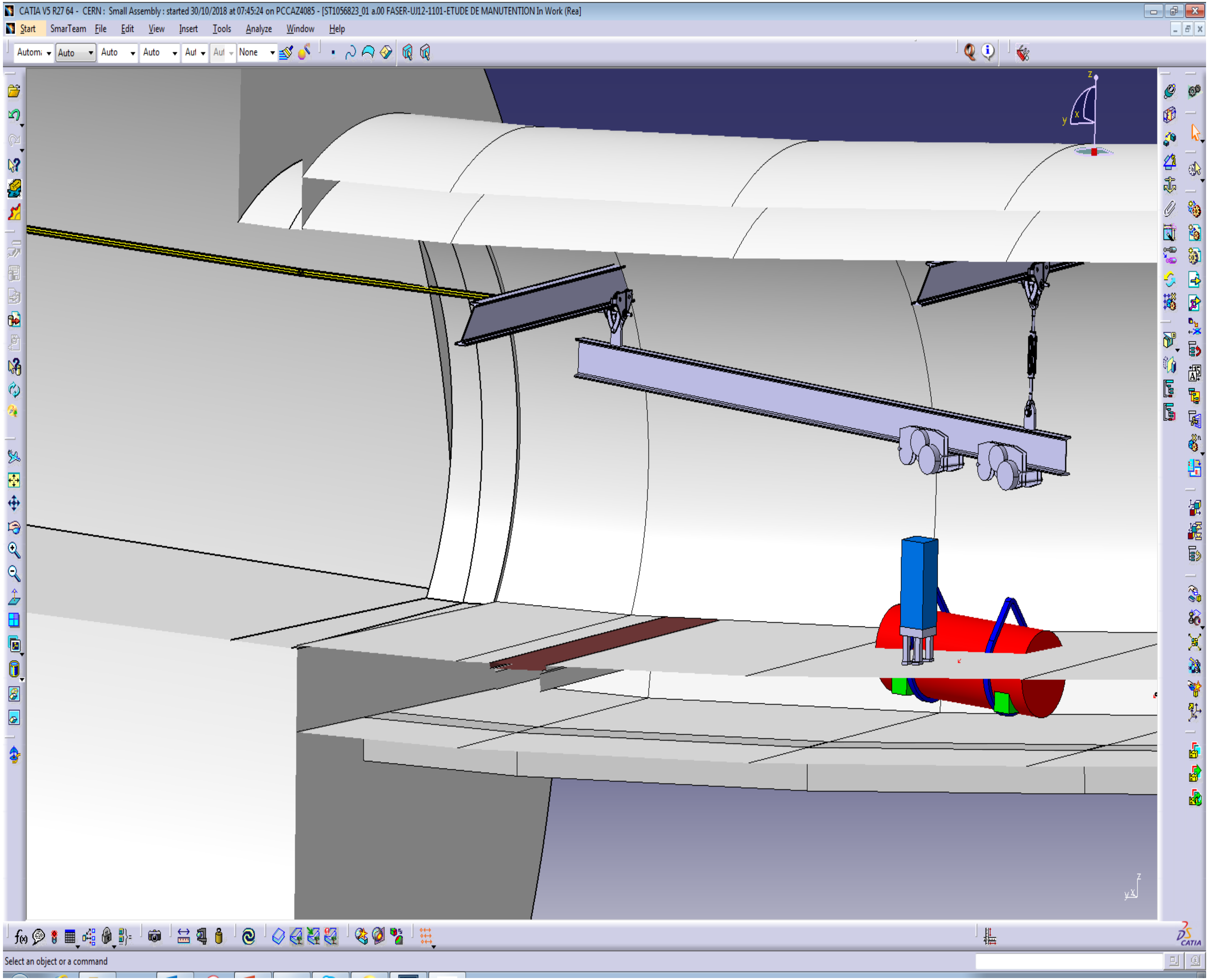
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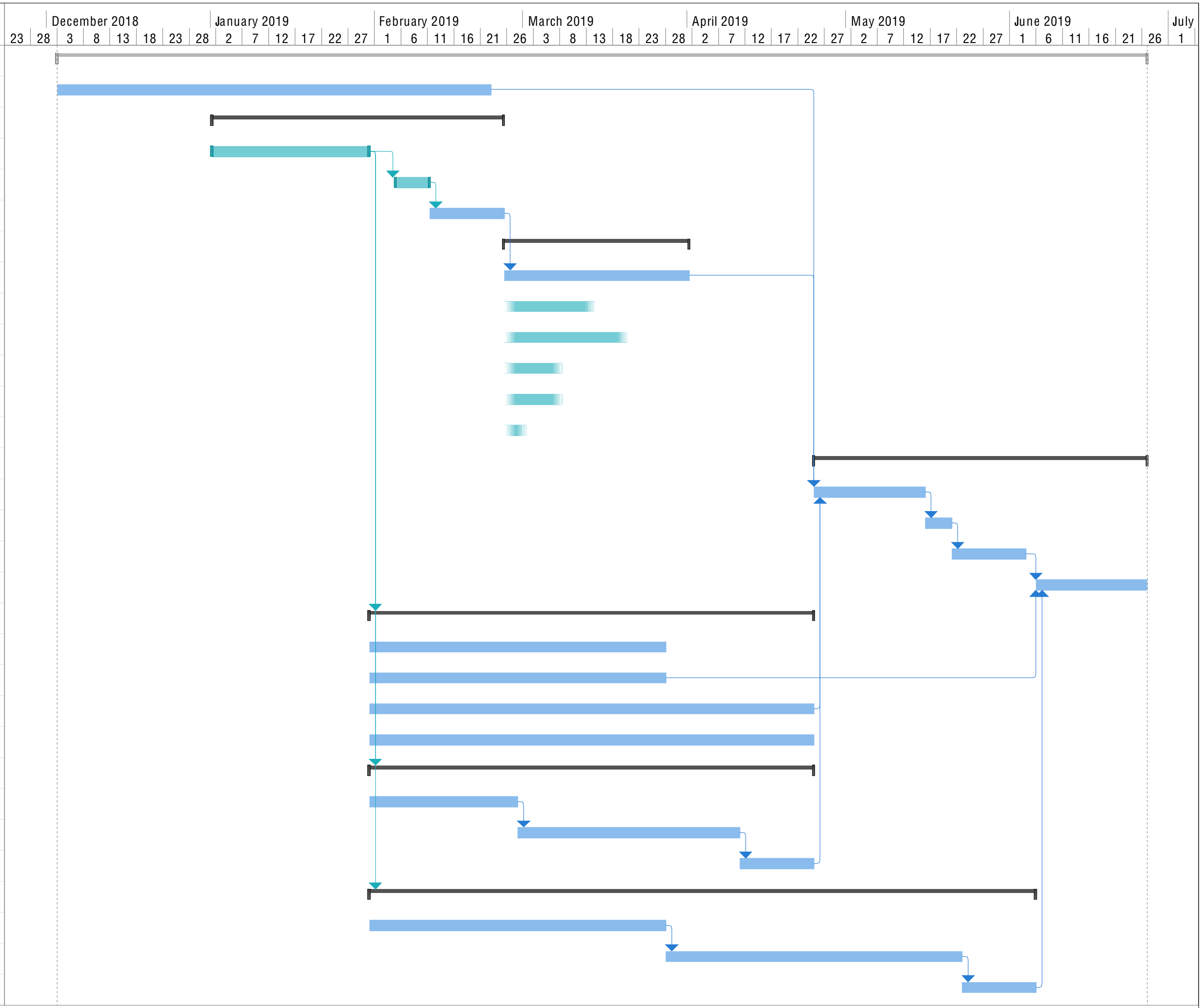
# Updated schedules

# Tracker

| ID | Task Name | Duration |
|---|---|---|
| 0 | **Tracker System** | **148 days?** |
| 1 | SCT module QA | 3 mons |
| 2 | **Tracker Design & fabrication Drawings** | **39.25 days** |
| 3 | 3D design validation | 21.88 days |
| 4 | Fabrication drawings | 4.38 days |
| 5 | Tendering & orders | 10 days |
| 6 | **Fabrication of Tracker parts** | **25 days** |
| 7 | Tracking plane Frame (x9) | 25 days |
| 8 | Spacer frame (x6) | 13.13 days |
| 9 | Tracking station Outer box (x3) | 17.5 days |
| 10 | Cooling piping | 8.75 days |
| 11 | Fixation to BaseFrame (x3) | 8.75 days |
| 12 | Chiller pipe manifolds | 4.38 days |
| 13 | **Assembly of Tracker planes** | **45 days** |
| 14 | SCT Module to Frame & Tests | 15 days |
| 15 | Assembly with spacers & Tests | 3 days |
| 16 | Assembly into Outer Box & servicing | 10 days |
| 17 | Station TESTING (x3) | 15 days |
| 18 | **Procurement** | **60 days?** |
| 19 | Powersupplies and crate | 8 wks |
| 20 | Chiller | 8 wks |
| 21 | Flex cables | 12 wks? |
| 22 | Cables | 12 wks? |
| 23 | **Patch panels** | **60 days** |
| 24 | Design | 4 wks |
| 25 | Production | 6 wks |
| 26 | Validation | 2 wks |
| 27 | **Interlock and monitoring** | **90 days** |
| 28 | Design | 8 wks |
| 29 | Production | 8 wks |
| 30 | Testing | 2 wks |

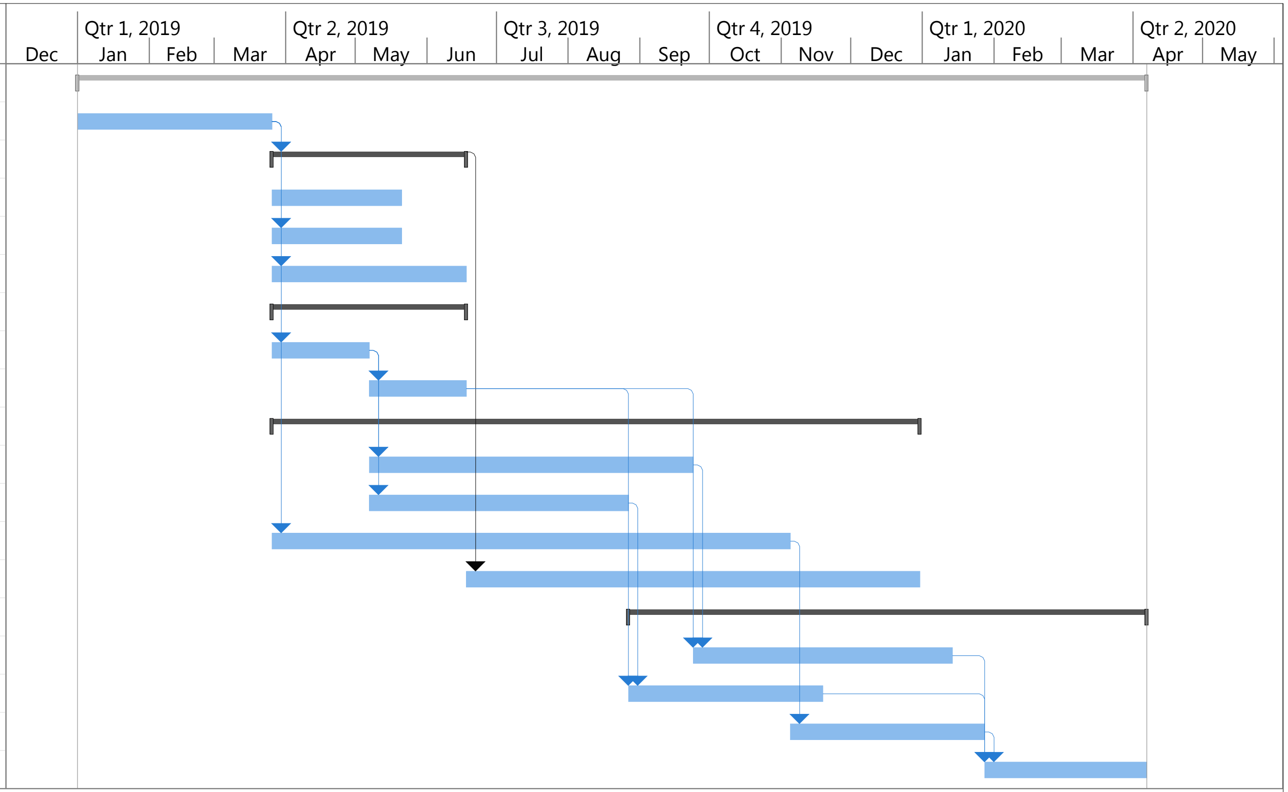



Project: Tracke
Date: Sat 11/17/18

| | | | |
|---|---|---|---|
| Task | Project Summary | Manual Task | Start-only |
| Split | Inactive Task | Duration-only | Finish-only |
| Milestone | Inactive Milestone | Manual Summary Rollup | External Tasks |
| Summary | Inactive Summary | Manual Summary | External Milestone |
| Deadline | Progress | Manual Progress | |

# TDAQ

| ID | Task Name | Duration |
|---|---|---|
| 0 | **TDAQ System** | **330 days** |
| 1 | Final Specification | 12 wks |
| 2 | **Procurement** | **60 days** |
| 3 | Network switches | 8 wks |
| 4 | Readout PCs | 8 wks |
| 5 | Digitizer and crate | 12 wks |
| 6 | **Custom hardware** | **60 days** |
| 7 | Adapter board design | 6 wks |
| 8 | Adapter Board Production | 6 wks |
| 9 | **Firmware production** | **200 days** |
| 10 | Tracker Firmware | 20 wks |
| 11 | TLB Firmware | 16 wks |
| 12 | DAQ Software | 8 mons |
| 13 | DCS software | 7 mons |
| 14 | **Commissioning** | **160 days** |
| 15 | Tracker readout | 16 wks |
| 16 | Trigger readout | 12 wks |
| 17 | DAQ | 12 wks |
| 18 | Integration | 10 wks |

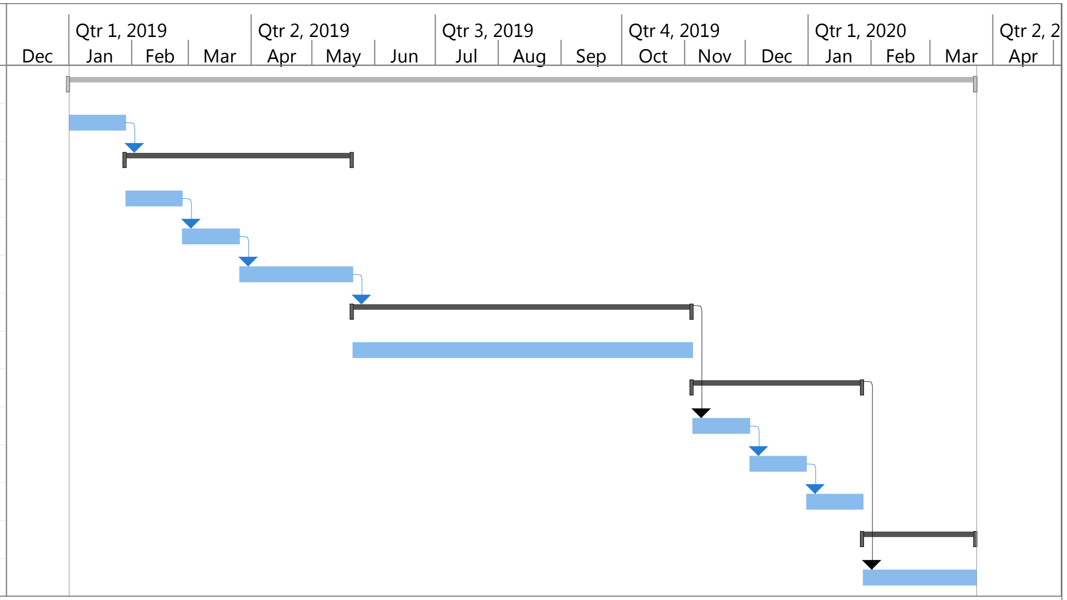



Project: TDAQ
Date: Mon 11/5/18

Task | Split | Milestone | Summary | Project Summary
Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only
Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks
External Milestone | Deadline | Progress | Manual Progress

# Magnet

| ID | Task Mode | Task Name | Duration |
|---|---|---|---|
| 0 | | **Magnet System** | **320 days** |
| 1 | | Project Validation | 1 mon |
| 2 | | **Design** | **80 days** |
| 3 | | Magnet Design | 1 mon |
| 4 | | Design Report | 1 mon |
| 5 | | Mechanical Design | 2 mons |
| 6 | | **Procurement** | **120 days** |
| 7 | | Materials | 6 mons |
| 8 | | **Assembly** | **60 days** |
| 9 | | 1st Magnet | 1 mon |
| 10 | | 2nd Magnet | 1 mon |
| 11 | | 3rd Magnet | 1 mon |
| 12 | | **Field Measurements** | **40 days** |
| 13 | | Measurements | 2 mons |




Project: Magne
Date:
Fri 11/2/18

| | | | |
|---|---|---|---|
| Task | Inactive Task | Manual Summary Rollup | External Milestone |
| Split | Inactive Milestone | Manual Summary | Deadline |
| Milestone | Inactive Summary | Start-only | Progress |
| Summary | Manual Task | Finish-only | Manual Progress |
| Project Summary | Duration-only | External Tasks | |

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