VELaSSCo

***V**isual Analysis for **E**xtremely **La**rge-**S**cale*
***S**cientific **Co**mputing*

Evaluation Event

USE CASE 2: Discrete Element Simulation (DEM)

Simulation Tool & Discrete2Continuum (D2C): GiD

Table of Contents

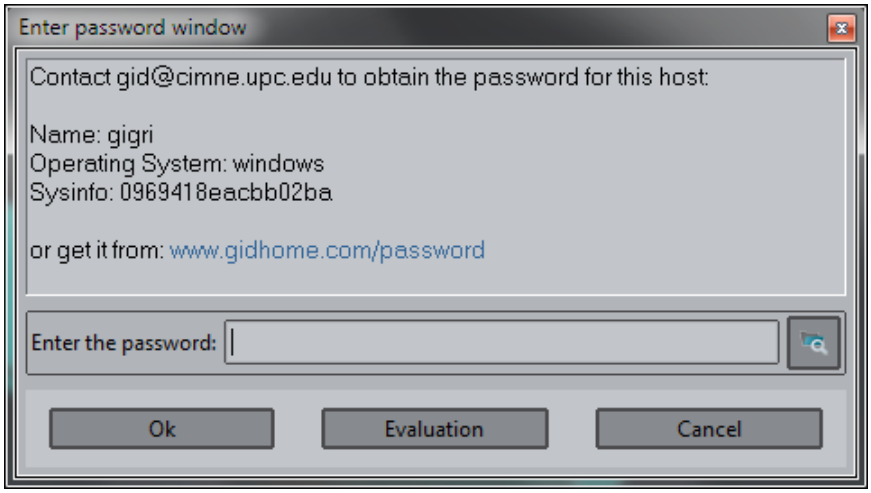
1 GiD Installation Guide

1.1 Download and installation of GiD

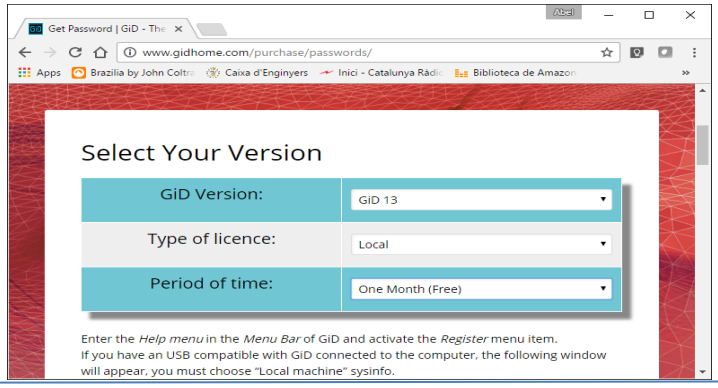
- Enter to www.gidhome.com/download/developer-versions
- Download the **13.1.1d** (developer version) for your operating system
- Install it in your computer.

1.2 Get a password of GiD 13

- The first time you open GiD, the Help->Register GiD window will appear:



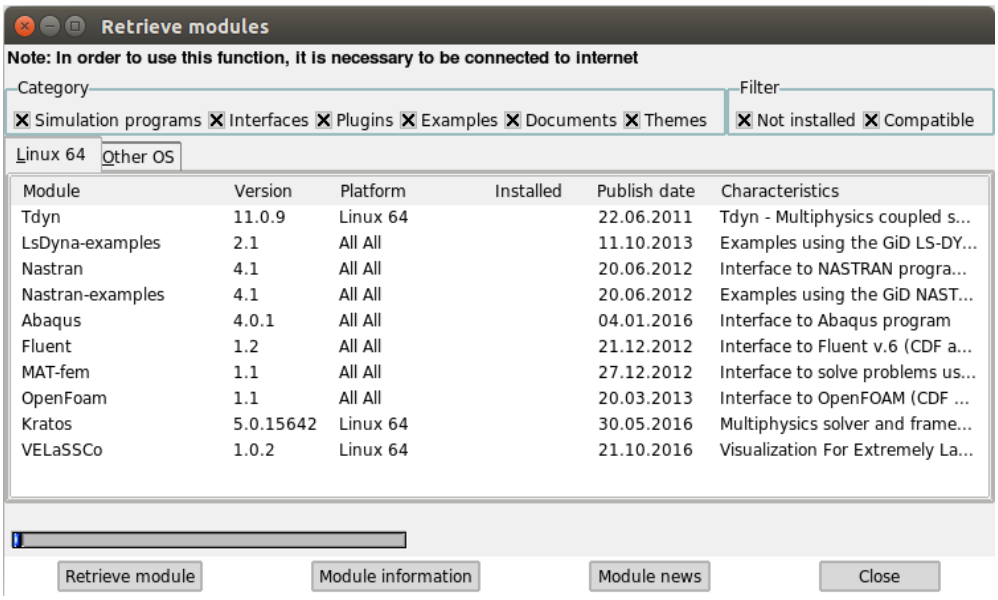
- **In case you already have a password for a GiD v13** installed in your computer, you can get the password from it by clicking the button in the lower right part of the window (icon with a folder) and selecting the path where the other GiD is installed.
- **In case you don't have a password for GiD v13**, you should ask for a free temporary password:
  - Go to:



- Select 'Local' type of license, and 'One month (free)' period of time
- Follow the instructions and click 'Send'
- A free password for one month of duration will be given to you in the web site, and you should put in the 'Register GiD window' and click ok.
- In the upper right part of GiD window, the icon indicating if GiD has password or not should be changed from red to green.

1.3 Installation of VELaSSCo plug-in

- Select the option '*Problem type -> Internet Retrieve…*' from the '*Data*' menu.
- In the appearing window (see Figure below), select the module '*VELaSSCo*' and click '*Retrieve module*'. Note that you need internet connection for retrieving it.

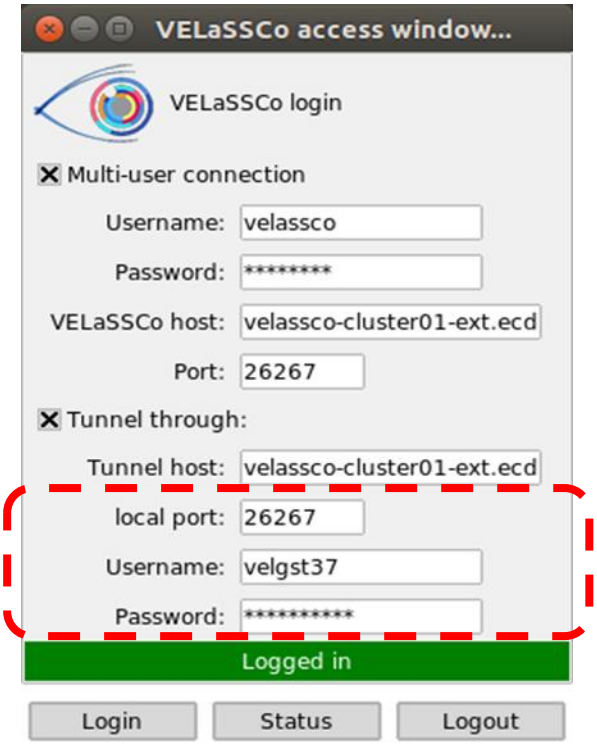


1.4 Connect to EDDIE Cluster

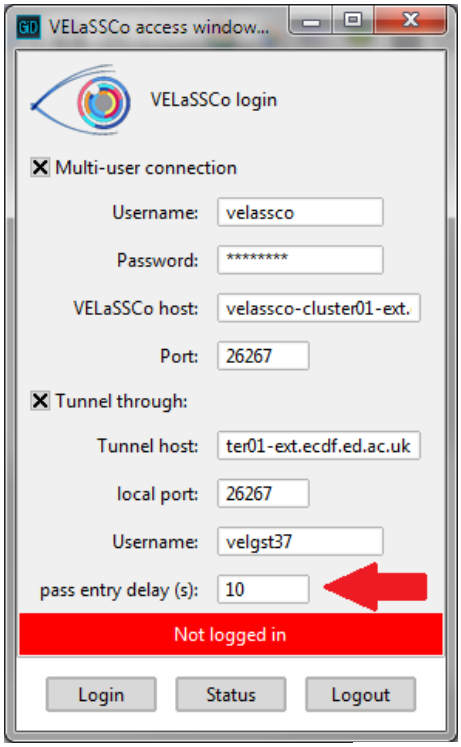
- The usernames created for the Evaluation Event to connect to the VPN network are **velgst2** to **velgst50** (the first 9 have only 7 characters).
- Each one has an initial/registration EASE password set to **"VELaSSCo"**. This will have to be changed through the EASE webpage (https://www.ease.ed.ac.uk/).
- Setup VPN connection to EDDIE cluster following the instructions provided in the URL: http://www.ed.ac.uk/information-services/computing/desktop-personal/vpn/vpn-service-using
- Once connected to VPN, to login in into VELaSCCo will be need provided the following info into the GiD access window:

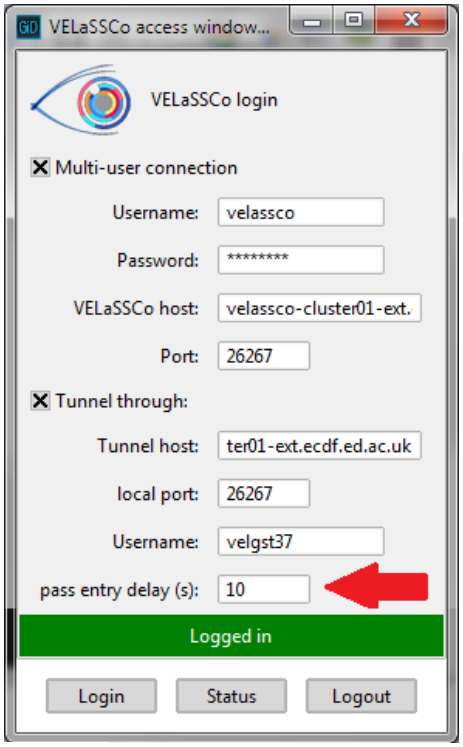
- Multi-user connection:
  - Username: velassco (default)
  - Password: --- (default)
  - VELaSSCo host: velassco-cluster01-ext.ecdf.ed.ac.uk
  - Port: **provided individually by mail. Please check the invitation mail.**
- Tunnel through:
  - Tunnel host: velassco-cluster01-ext.ecdf.ed.ac.uk
  - Local Port: same value that Port.
  - Username: **provided individually by mail. Please check the invitation mail.**
  - Password: **provided individually by mail. Please check the invitation mail.**

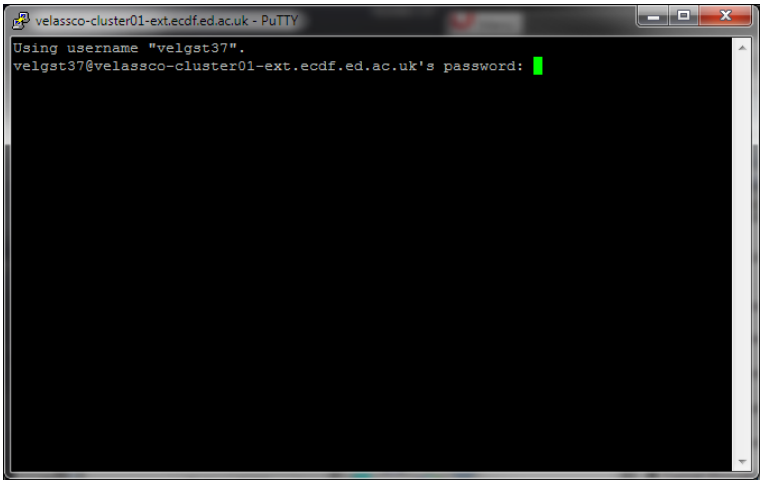
Next, it is provided an example of an instantiation of GiD access windows for the user "velgst37" in Linux:



In MS Windows the connection window is slightly different because you need to enter the password on a separate window:







2 User instructions and brief tasks description

Thank you for your participation in this study. You will carry out the tasks on your own in the presence of a facilitator. The facilitator will be giving hints, asking questions, observing your responses to the exercises and supporting you during the whole process. The study will comprise a series of tasks, to be completed one at a time; i.e. once the facilitator, who would be observing your interactions, agrees that you have concluded one task, you will be presented another one.

The study is about the use of VELaSCCo Platform by means of GiD or IFX visualizations clients to operate with a FEM or DEM simulation previously calculated and injected into the Platform. You will be asked to carry out tasks that involve simple simulations actions on the client side.

During the session you have the following tools at your disposal:

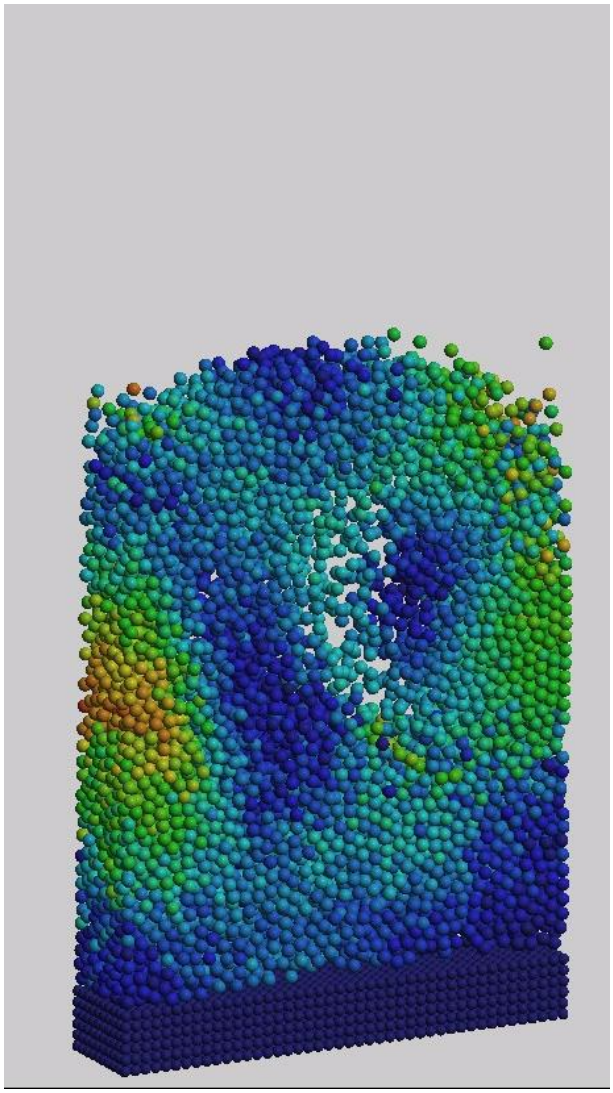
- **VELaSSCo Open Platform**
- **GiD Client V.13.1.1d** (Visualization Tool)
- Text editor and viewer (e.g. Notepad, Word,…)
- Web browser

Your work may be monitored and at the end you will be asked to fill in a simple questionnaire. This will help us understand how people use VELaSCCo Platform and Visualization Clients, how efficient and effective is the VELaSCCo Platform, etc.

2.1 Fluidized Bed Model Description

Fluidized bed processes are very common in pharmaceutical and chemical industries. The Fluidized Bed model selected has the following settings:

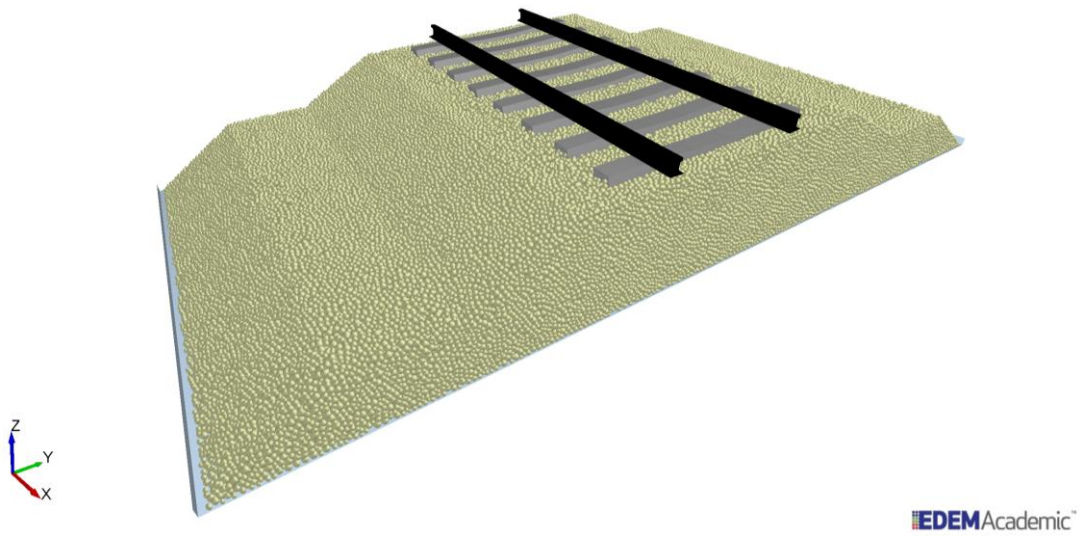
- ~ 12,000 particles per time-step
- ~ 3,000 contacts (p2p and p2w) per time-step.
- 48,000 time-steps.
- Particle results: mass, volume, velocity vector
- Contact results: Force vector.



2.2 Rail Embankment Model Description

Simulations with a high frequency output that cover long time durations are difficult to deal with on a desktop machine due to the large quantity of data generated. The rail embankment model selected has the following settings:

- 207,440 particles per time-step
- ~ 560,000 contacts (p2p and p2w) per time-step.
- 9,102 time-steps – 100Hz output.
- Particle results: mass, volume, velocity vector, angular velocity vector
- Contact results: Force vector.



This results in a total data file size of approximately 540 GB generated by the DEM solver.

2.3 Introduction to necessary VELaSSCo Functionality

The following figure highlights the necessary tools used in this uses and the user should familiarise themselves with the layout with the GiD visualization client:

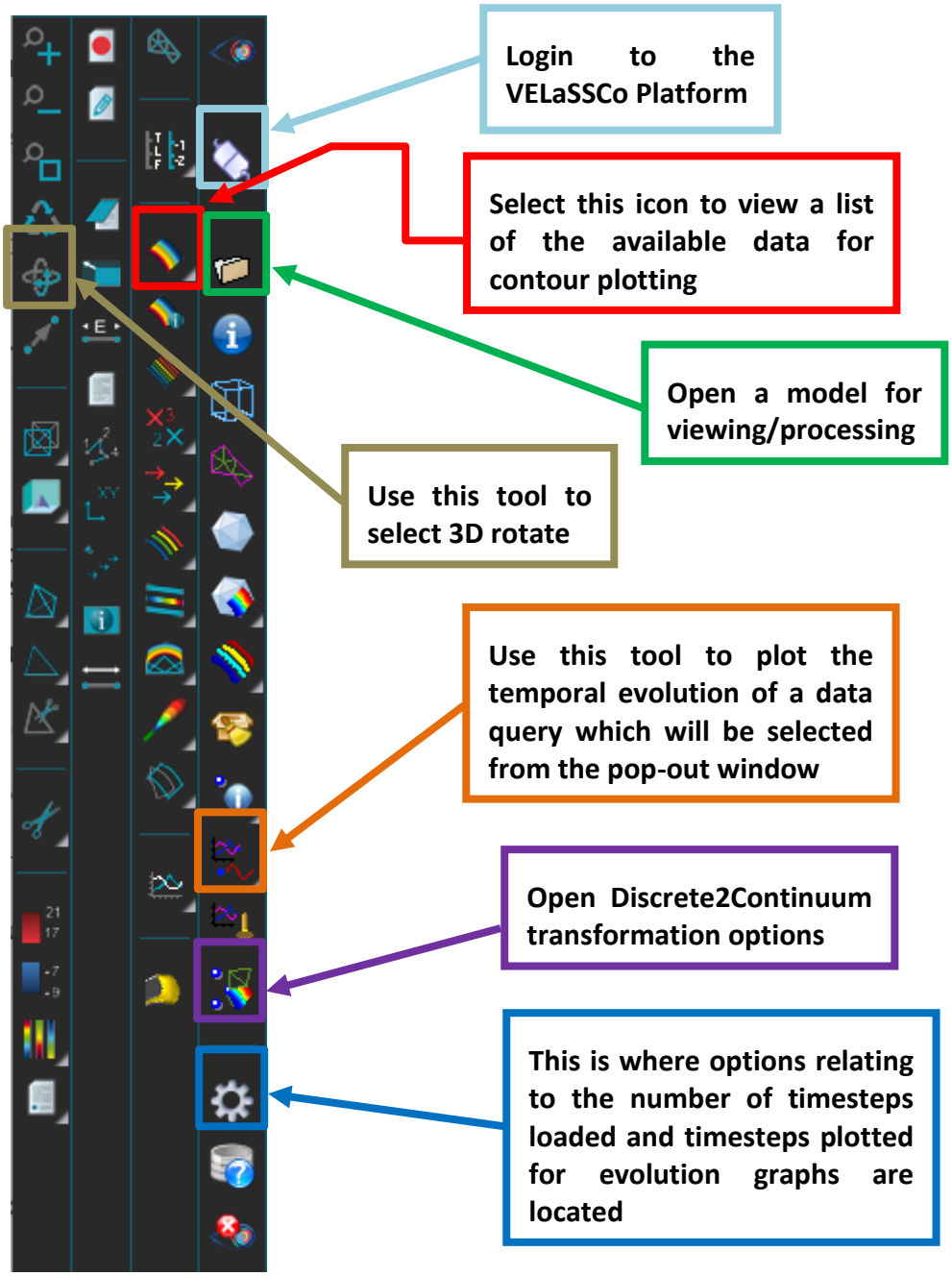


Figure 1 - GID & Velassco toolbar – Navigating the options

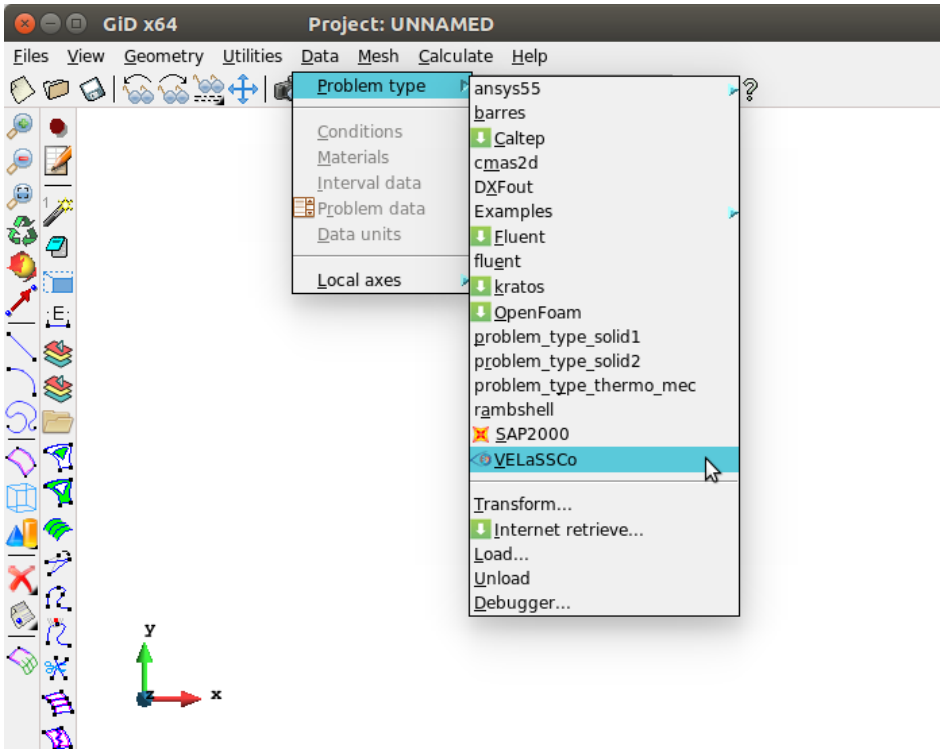
2.4 Task 1: Use Case DEM.M1-01 & M1-02

2.4.1 Motivation

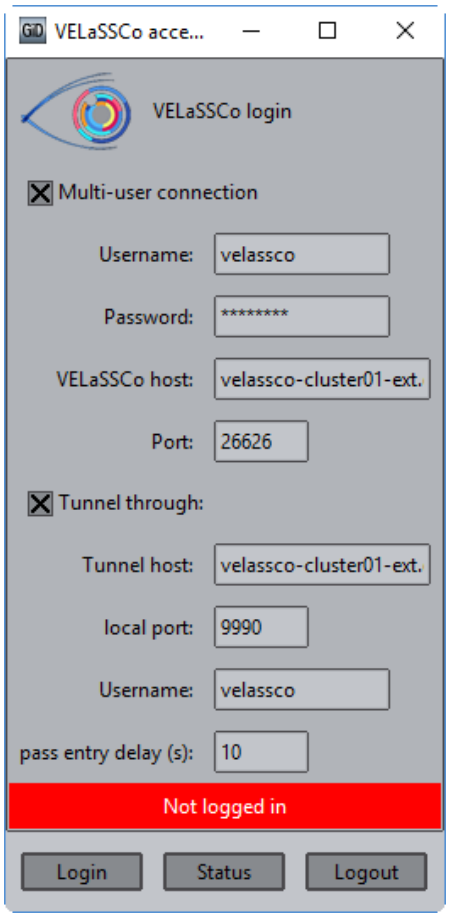
Connect to the VELaSSCo platform and visualise the particle assembly in the visualisation client. Get a result on a particle; concretely get the velocity value specifying a concrete particle id and time-step.

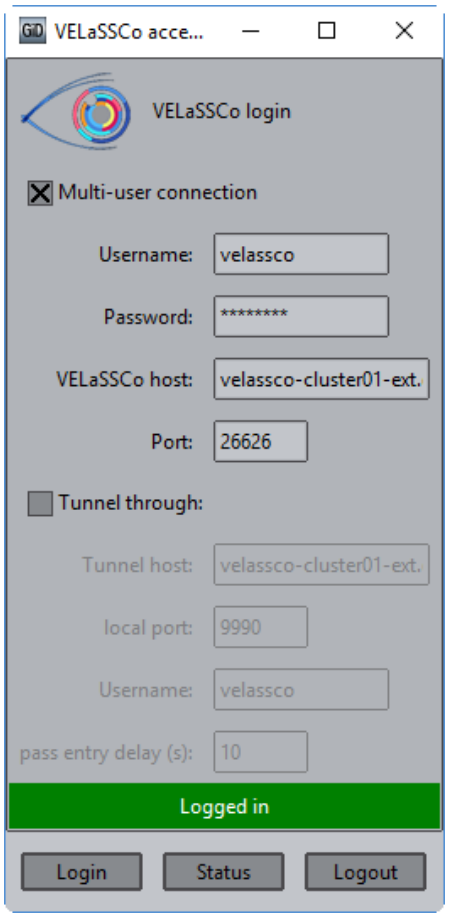
2.4.2 Specification

- Load VELaSSCo module:

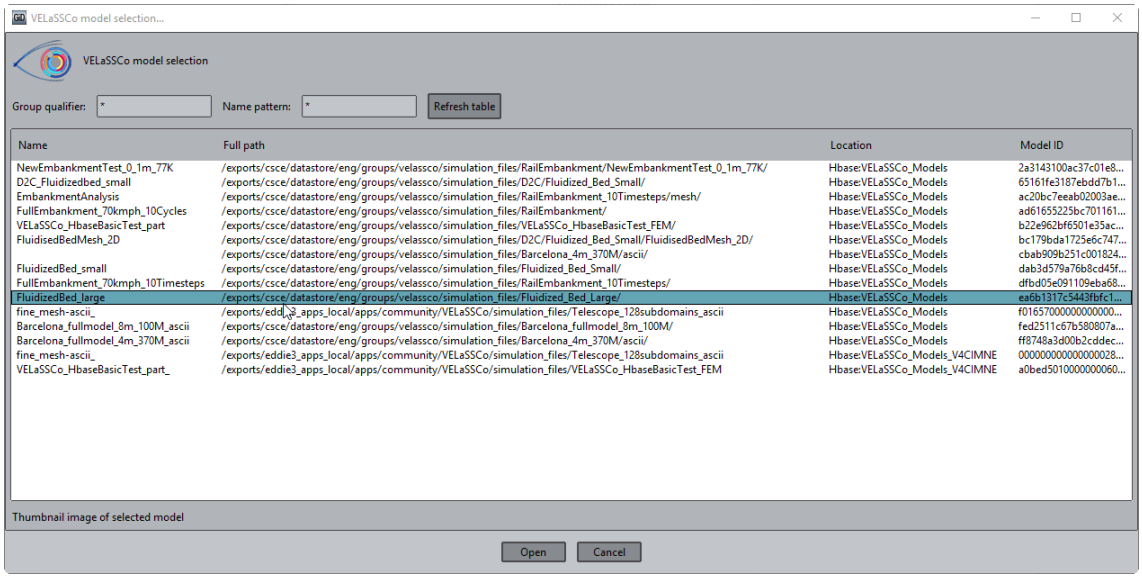


- Connect to VELaSSCo Server using GiD (You will have received separate instruction about user-names and ports to use):





- Open a simulation model from the 'open a model' tool option
  - Select **Fluidized Bed Large** model (FluidizedBed_large)



- Visualize a contour fill of a particle result.
    - Visualize the velocity-Y in the skin of the particles in time step 2939000 (the view results window can be opened via the GiD menu or ctrl+d and the required step selected from the drop-down list)
    - Rotate the model

2.5 Task 2: Use case DEM.M1-03

2.5.1 Motivation

Get the evolution of a result on a particle over time; for instance, get the velocity y-component value for all simulation time-steps of specific particle id.

2.5.2 Specification

- Get the evolution of a result on a particle over time.
    - *Get the velocity y-component value for:*
        - *Analysis = **DEM***
        - *Coordinates = **Particles***
        - *Time-steps: **ALL***
        - *Result = **Velocity-Y***
        - *Node number **2724***

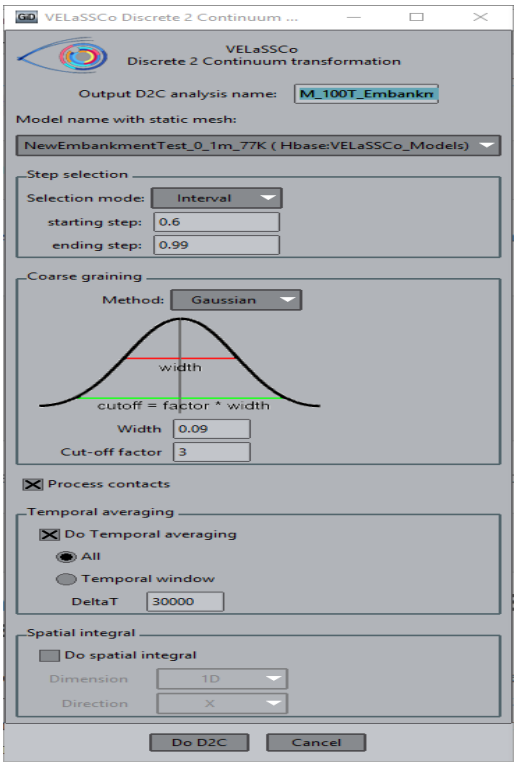
2.6 Task 4: Use case DEM.M1-05 and DEM.M1-07

2.6.1 Motivation

Compute Discrete to Continuum (d2c) values of the model, get the result in a specific node of the d2c Mesh, do a cut plane and visualize the contour fill of a discrete2continuum result.

2.6.2 Specification

- Compute d2c of the model by opening Discrete2Cointinuum transformation window in VELaSSCo toolbar:



- Compute discrete to continuum with the following parameters:
  - **Static mesh** = D2C_Fluidizedbed_small
  - Output D2C analysis name = user initials (can be any unique string) + "_D2C_FB"
  - Time-step options = INTERVAL
  - Starting and Ending time-steps = 2799000,6799001
  - Coarse-graining method = Gaussian
  - Coarse-graining options:
    - Width = 0.0024
    - Cut-off factor = 3
  - Process contacts = True
  - Do temporal averaging = True
    - Temporal averaging options = ALL

- User: Open D2C_Mesh model from the 'open a model' tool option and open the static mesh used for the D2C query ("D2C_Fluidizedbed_small")
- Use "getBoundaryOfAMesh" option to load results and select **Bulk Density** as contour fill option.

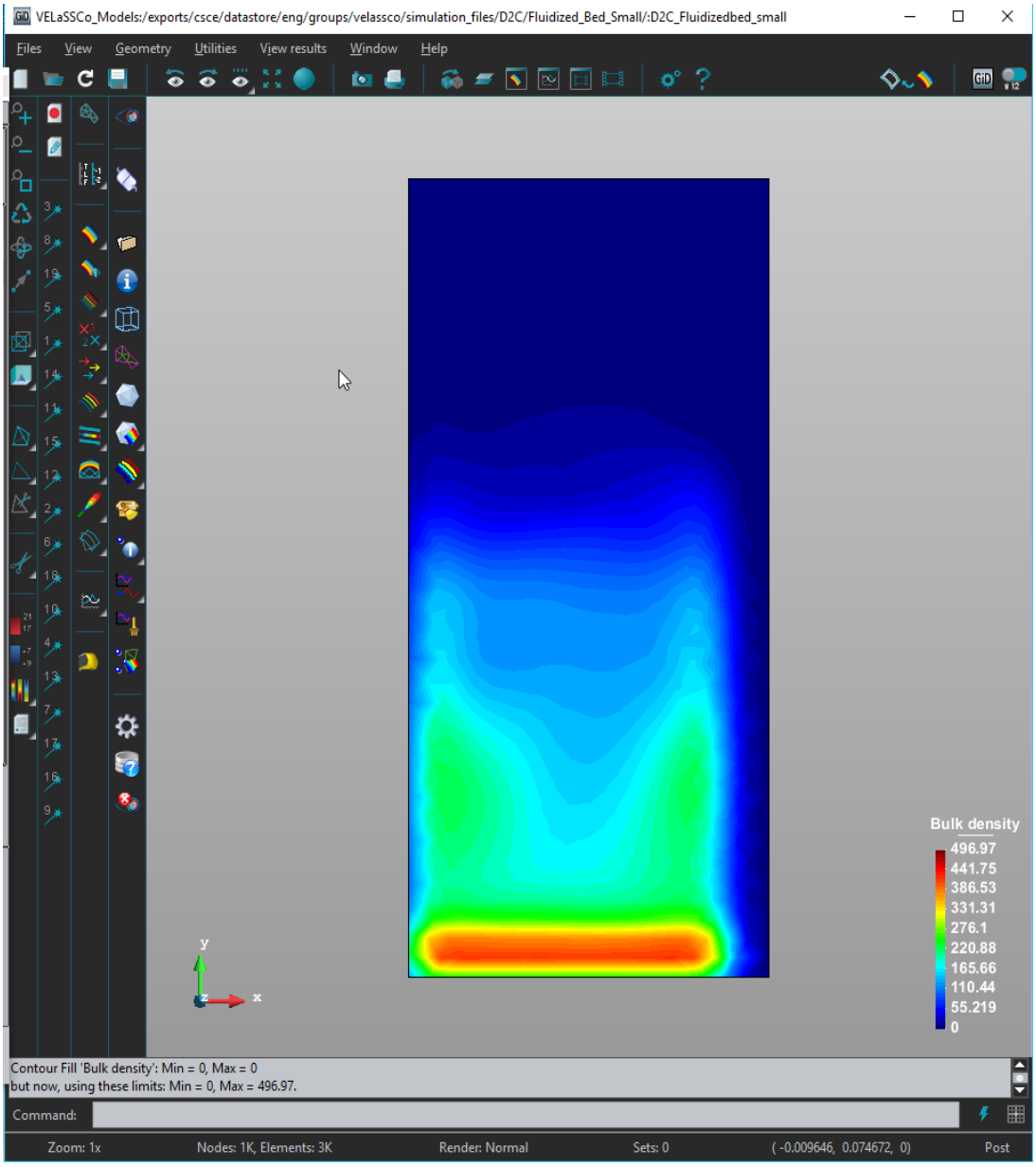


Figure 2 - Bulk Density

- Query the result of the d2c mesh:
  - User: Open D2C_Mesh model
  - User: Get the **density** value for:
    - Analysis = user initials + "_D2C_FB"
    - Time-step **# 4799000.5**
    - Result = **Density**
    - Node number **300**
    - Node number **1000**
- Visualize a contour fill of a velocity result
  - User: Visualize the contour fill of **velocity-Y** in the skin of the volume mesh of the computed d2c result for **time step 4799000.5**

- Use "*GetSimplifiedMeshWithResult*" option to load contour data
- Set view plane to XZ

- Do a cut plane (menu: "*Geometry -> Cut Plane -> 2 Points*" or shortcut) in the d2c mesh, parallel to Y direction, and passing through (0, 0, 0) coordinates (can also be drawn freehand).
- Remember to switch off outer mesh to view cut results (can be accessed from view styles

2.7 Task 4: Use case DEM.M2-01 and DEM.M2-02

2.7.1 Motivation

Compute temporally averaged Discrete to Continuum (d2c) values of the model, get the result in a specific node of the d2c Mesh and visualize the contour fill of a discrete2continuum result.

2.7.2 Specification

- Open a simulation model from the 'open a model' tool option
  - Select **Rail Embankment** model (RailEmbankment_100Timesteps)

- Compute d2c of the rail embankment model
  - Compute discrete to continuum for:
    - Static mesh = "NewEmbankmentTest_0_1m_77K"
    - D2C analysis name = user initials + "_D2C_RAIL"
    - Time-step options = INTERVAL
    - List of time-steps = 0.2,1
    - Coarse-graining method = Gaussian
    - Coarse-graining options:
      - Width = 0.09
      - Cut-off factor = 3
    - Process contacts = True
    - Do temporal averaging = True
      - Temporal averaging options = ALL
    - Do Spatial Integral = False
- User: Open D2C_Mesh model from the 'open a model' tool option and open the static mesh used for the D2C query ("NewEmbankmentTest_0_1m_77K")
    - Analysis = user initials + "_d2c_RAIL"
    - Time-step **0.595**
- Use "getBoundaryOfAMesh" option to load results and select **Contact Stress/S-ZZ** as contour fill option. Query the values at the following nodes:
    - *Result* = ***S-ZZ***

- Node number **30000**
- Node number **10120**

- Visualize a contour fill of a result
  - User: Visualize the contour fill of **Bulk Density** in the volume mesh of the computed d2c (model “NewEmbankmentTest_0_1m_77K” and analysis name “user initials + “_D2C_ RAIL””) for **temporally averaged time step 0.595**
  - Use “GetSimplifiedMeshWithResult” option

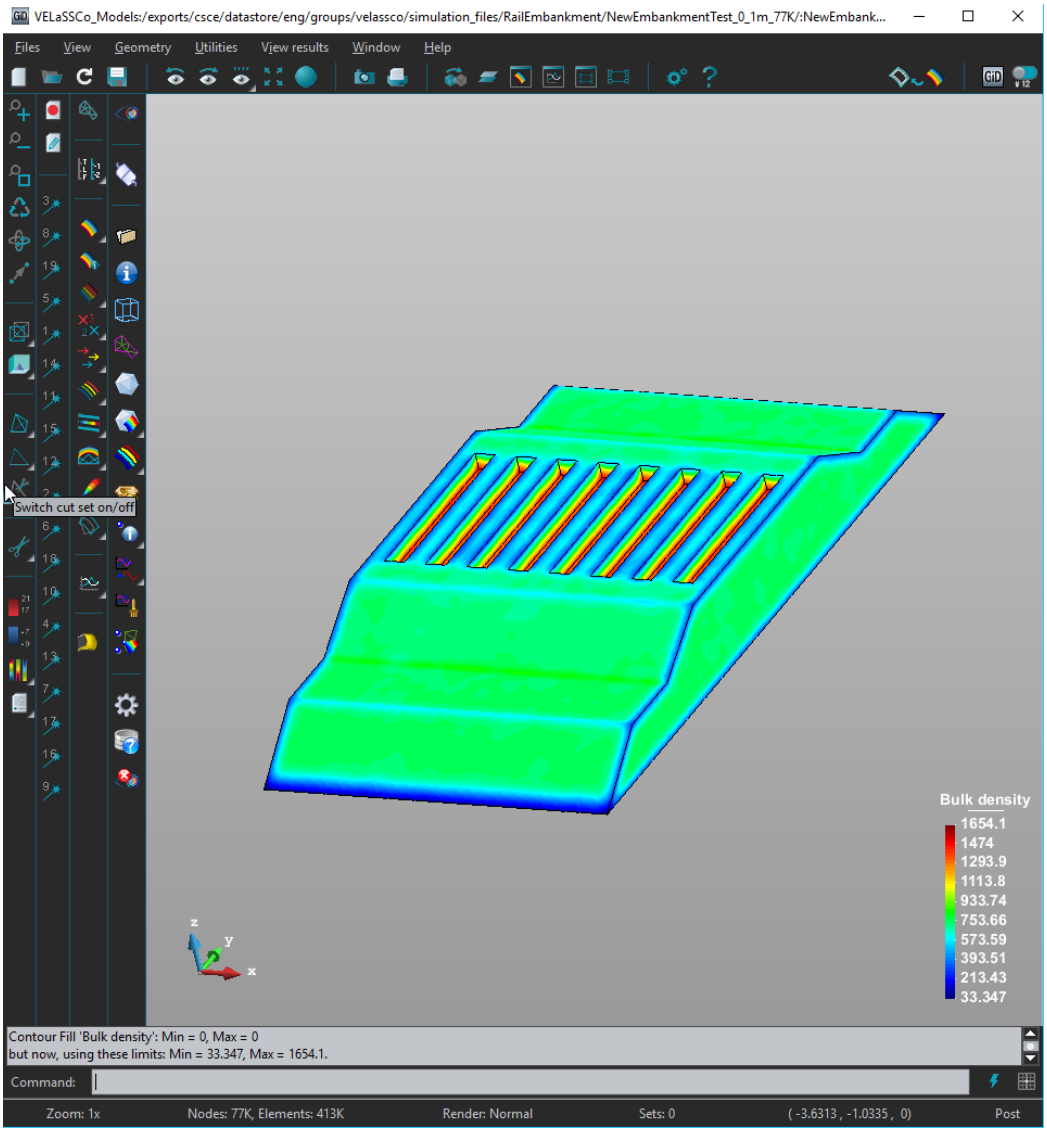


Figure 3 - Simplified Mesh with Bulk Density Result

- Do Cut through Embankment to visualise the density distribution
  - Switch to plan view
  - Draw cut line plane (menu: “Geometry -> Cut Plane -> 2 Points” or shortcut) along centre of embankment

- Draw a cut line transversely through the embankment under sleeper 4
- Using the layer manager, switch off the outer mesh to view the new cuts
- The bulk density can be further clarified by applying limit filters for the upper and lower bounds (1500-1650 kg/m^3 used in the following example figures)

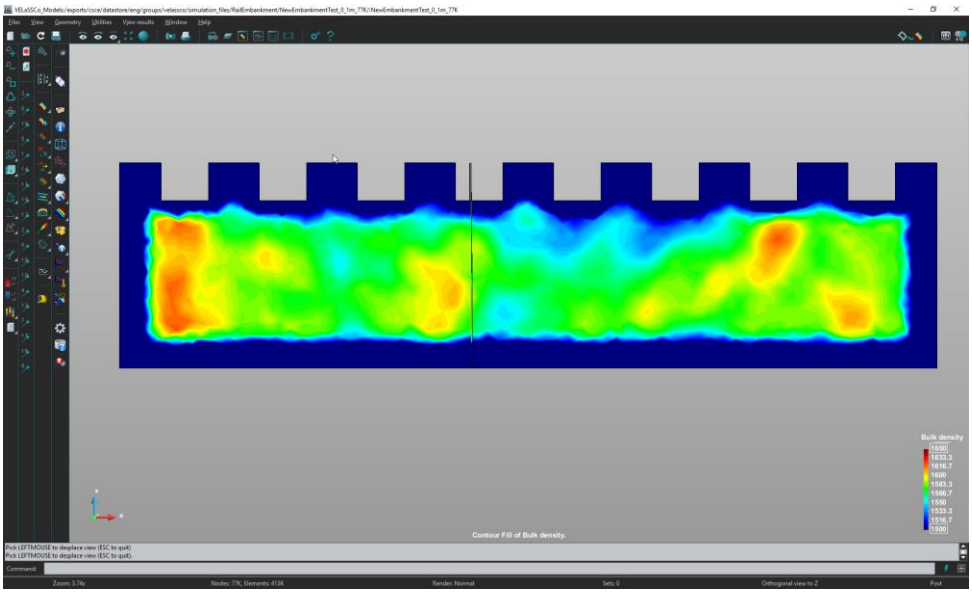


Figure 4 – Long-section through Embankment

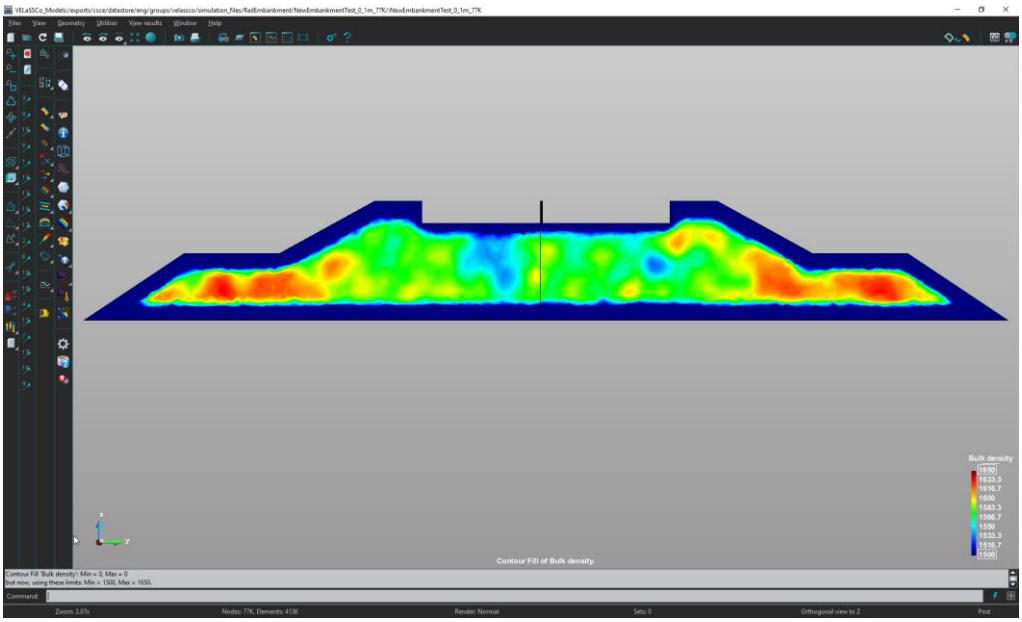


Figure 5 - Cross-section Under Sleeper 4

- User can repeat for other queries such as Contact stress if they wish to explore further
- Logout

3 Questionnaire for participants

Measuring the quality of a service can be a very difficult exercise. Unlike product where there are specific specifications such as length, depth, width, weight, colour etc. a service can have numerous intangible or qualitative specifications. In addition, there is there expectation of the customer with regards the service, which can vary considerably based on a range of factors such as prior experience, personal needs and what other people may have told them.

The questionnaire below is in three sections. On the one hand the first section asks you to rank all software tools for pre and post processing of numerical simulations in science and engineering according to your expectations i.e. what you expect all these tools to provide. On the otherhand the second section asks you to rank the VELaSSCo Plugin for GiD according to your experiences and perceptions. The third section asks you about the overall satisfaction of VELaSSCo Plugin for GiD.

Expectations deals with your opinions of software tools for pre and post processing of numerical simulations. What we are interested in here is a number that best shows you expectations about software tools for pre and post processing of numerical simulations offering services.

Perceptions relate to your feelings about the VELaSSCo Plugin for GiD. Please show the extent to which you believe this tool has the feature described in the statement. Here, we are interested in a number from 1 to 7 that shows your perceptions about the VELaSSCo Plugin for GiD.

You should rank each statement following a seven-point Likert-style scale from 1=very unimportant to 7=very important

The questionnaire is available in the following URL to be filled:

https://docs.google.com/forms/d/e/1FAIpQLSdnbKEbF7703zyOU0S6Kg9lLCLXfiyDJEZNkJsrHU2qXJcRgg/viewform#responses

In summary, our purpose is to get your valuable feedback about your experience with the VELASSCO Platform and its usability against expectations.

We would also appreciate your impressions on practical issues and any other comment or criticisms that you may find interesting.

Please send your completed questionnaires telematics using the URL indicated above.

Thanks for your time.

The VELASSCO project.