3nd year MEng Engineering and Architectural Design

Making Buildings – BARC0151

Academic Year 2021 – 2022

Making Here East – scanning & modelling

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Aim

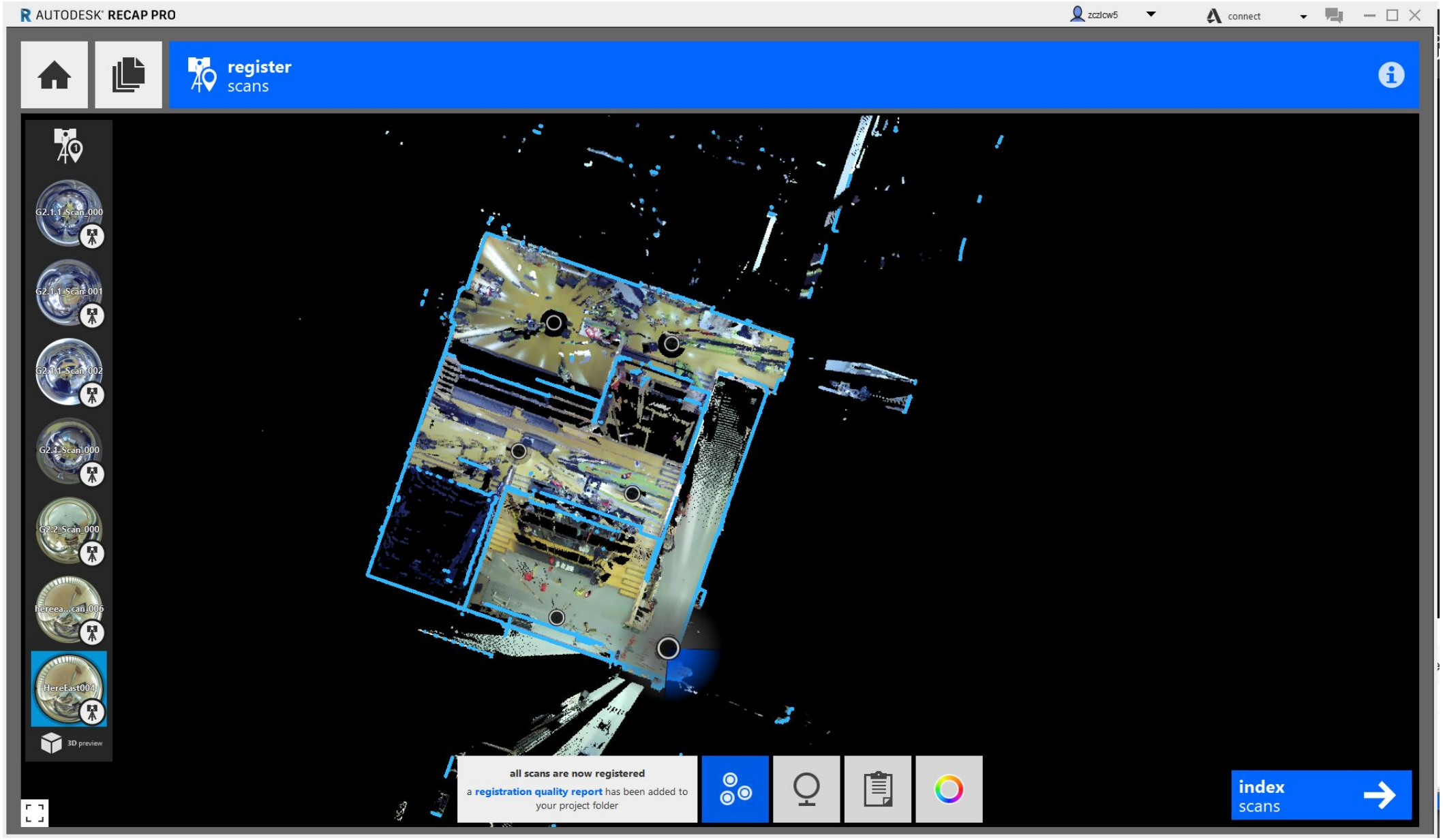
Method & workflow

- **Point cloud registration**
  - Autodesk Recap
  - Target Coordinates
  - Registration report
- **Modelling**
- **Analysis**
  - Detailing levels
  - Difficulties
  - Thermal imaging

Point cloud registration – Autodesk Recap

- Import 7 scanned files
- Register & merge the point clouds using automatic registration
- Use target coordinates to manually register
- Check registration report
- Enter the model, clip unnecessary points
- Use limit boxes to estimate point cloud density
- Export model

Point cloud registration – Autodesk Recap



Point cloud registration – Autodesk Recap

- Target coordinates

POINT	N	E	H
STN01	1036.584	1000	1.529
T1	1035.313	999.0766	1.78
T2	1035.159	1003.635	2.187
T3	1044.953	1003.953	3.29
T4	1049.536	997.7882	5.214
T5	1058.757	998.0686	8.171
T6	1051.131	987.3422	7.022

Figure 30: Final N, E, H coordinates.

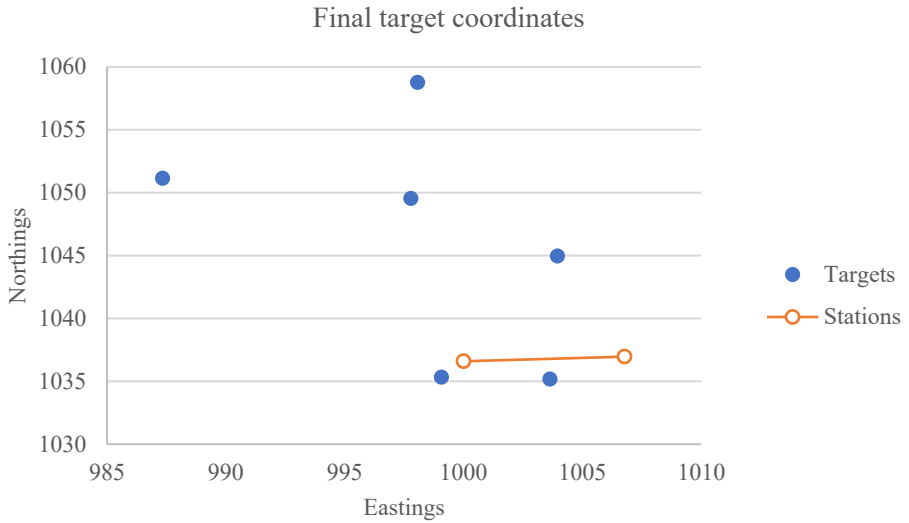


Figure 31: Target coordinate plot, with stations 1 and 2 coordinates.

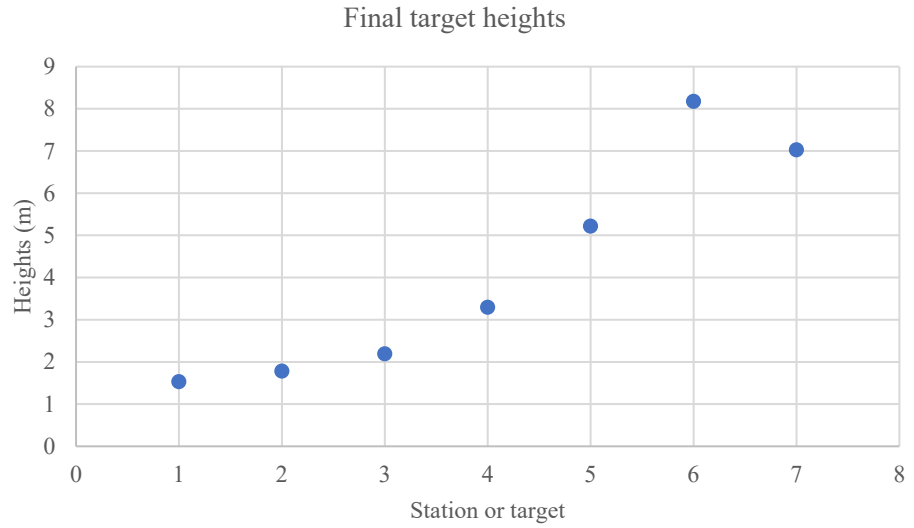
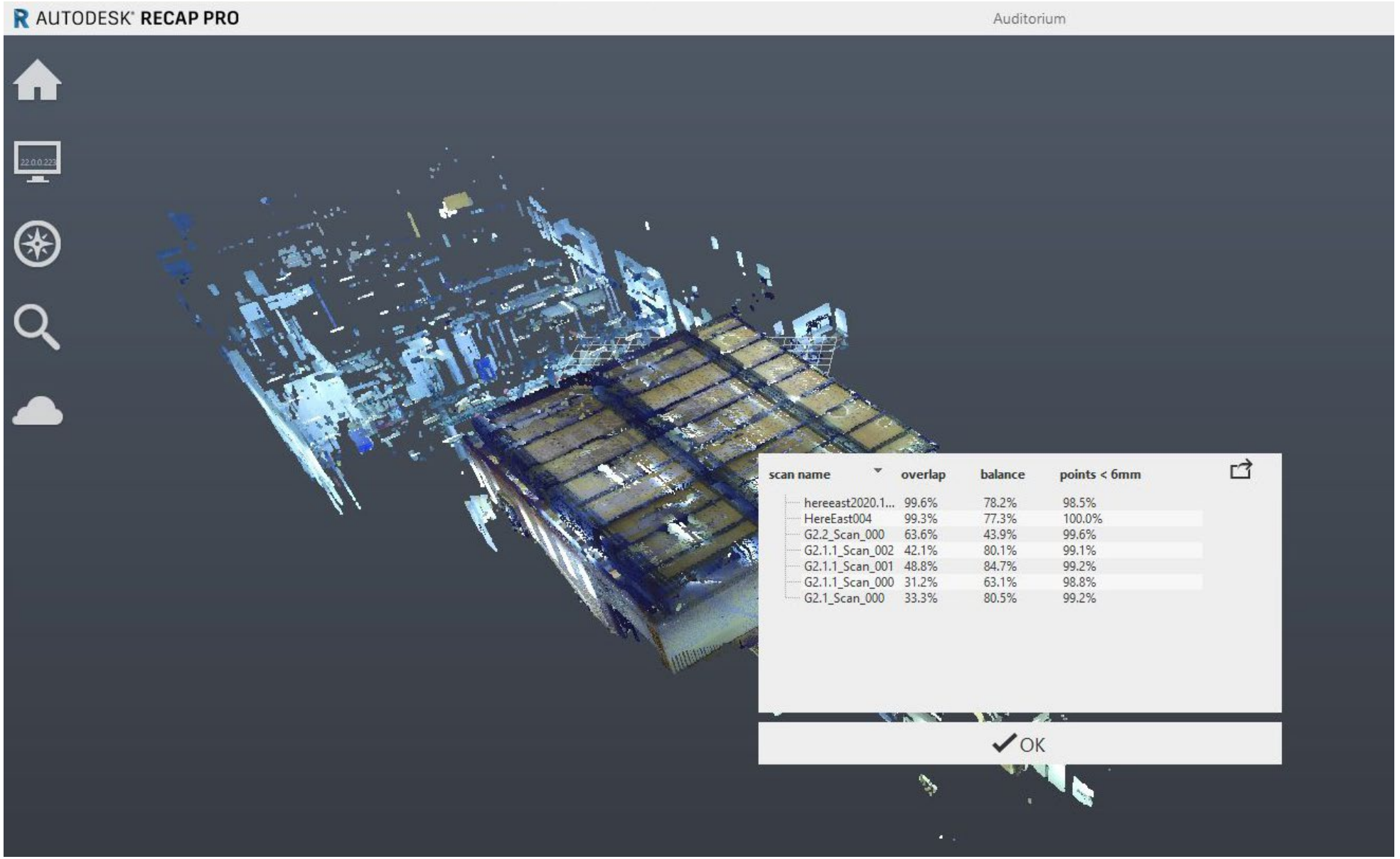


Figure 32: Target heights plot, according to the numbered stations in Figure 33.

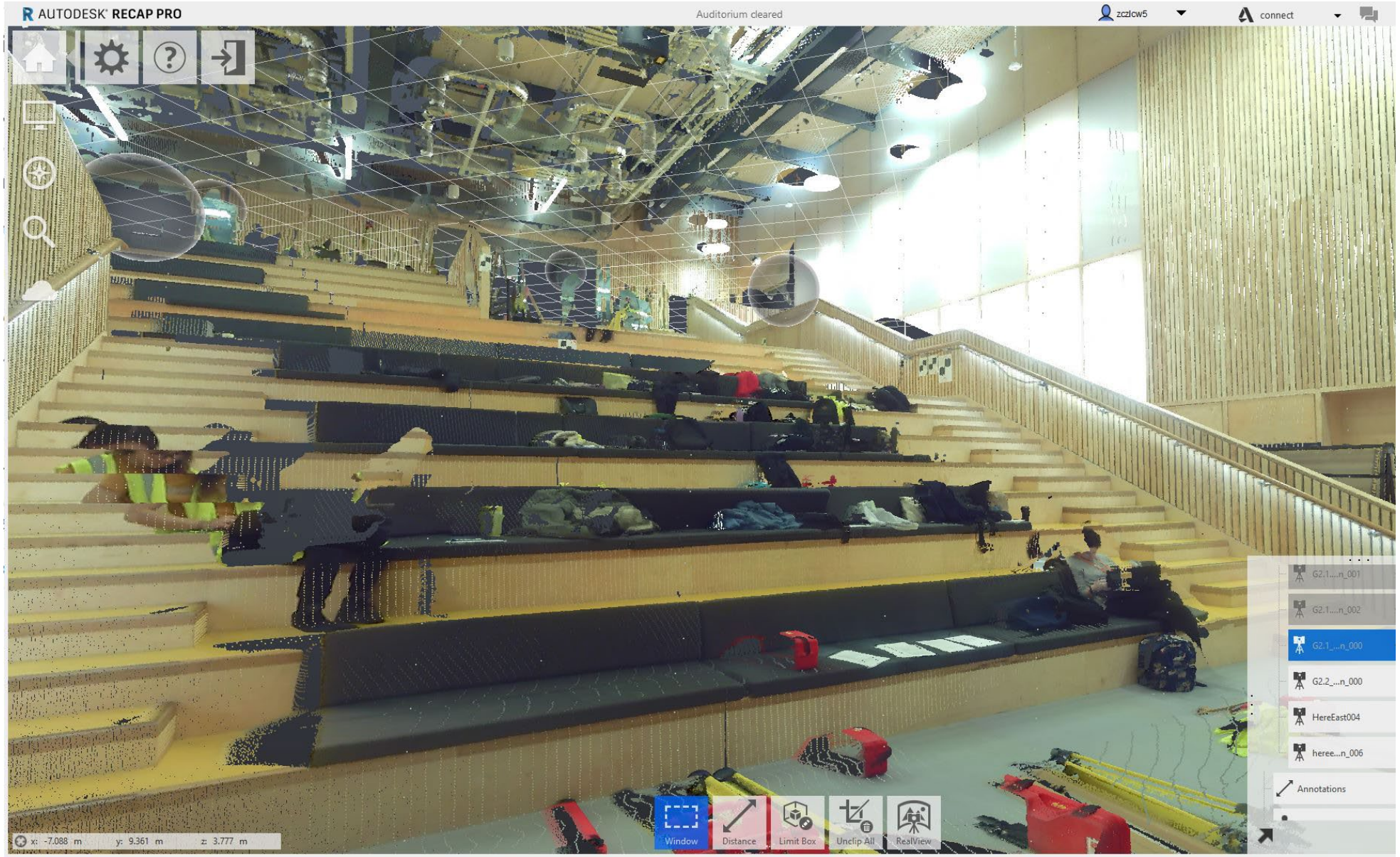
NUMBER	POINT
1	STN01
2	T1
3	T2
4	T3
5	T4
6	T5
7	T6

Figure 33: Numbered stations for plot.

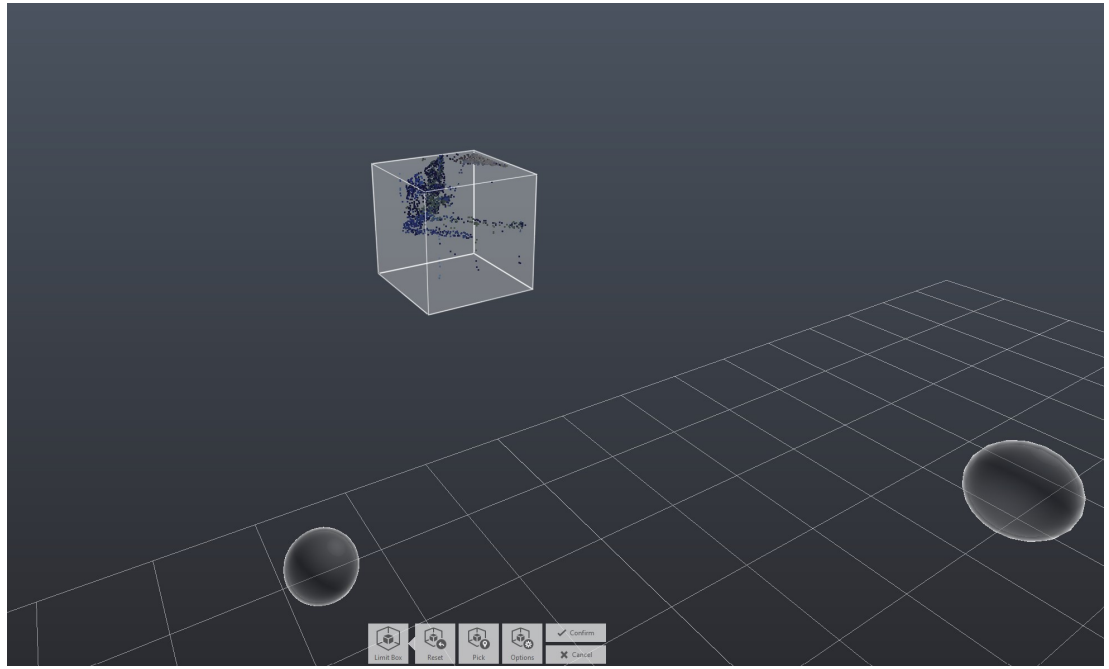
Point cloud registration – Autodesk Recap

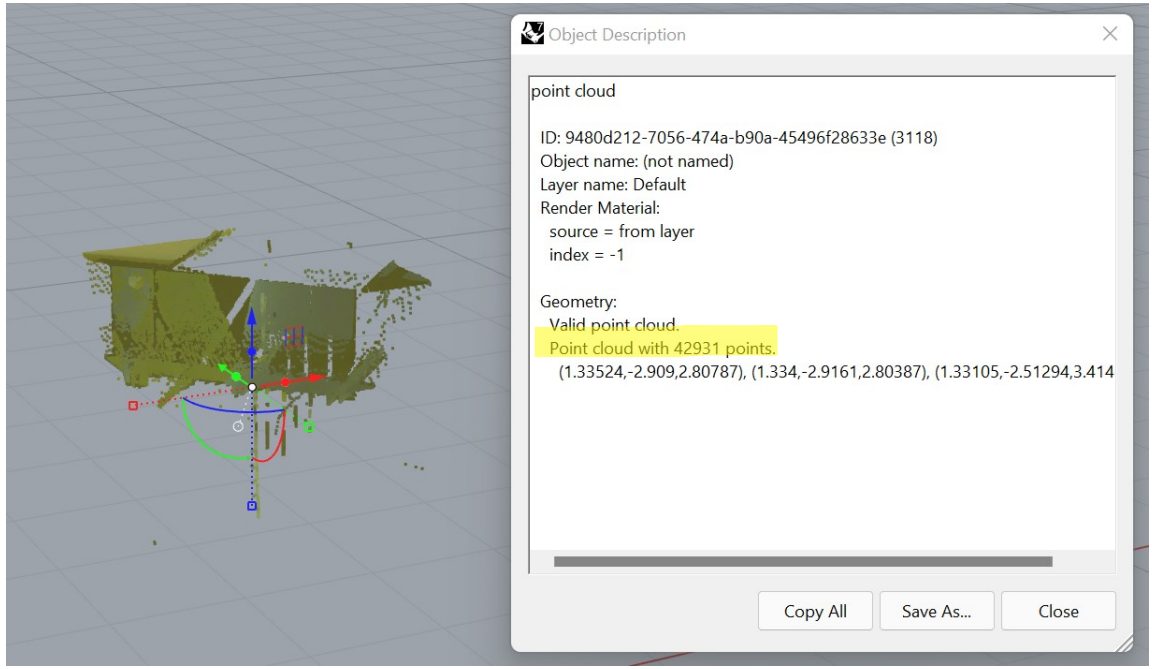


Point cloud registration – Autodesk Recap



Point cloud registration – Autodesk Recap





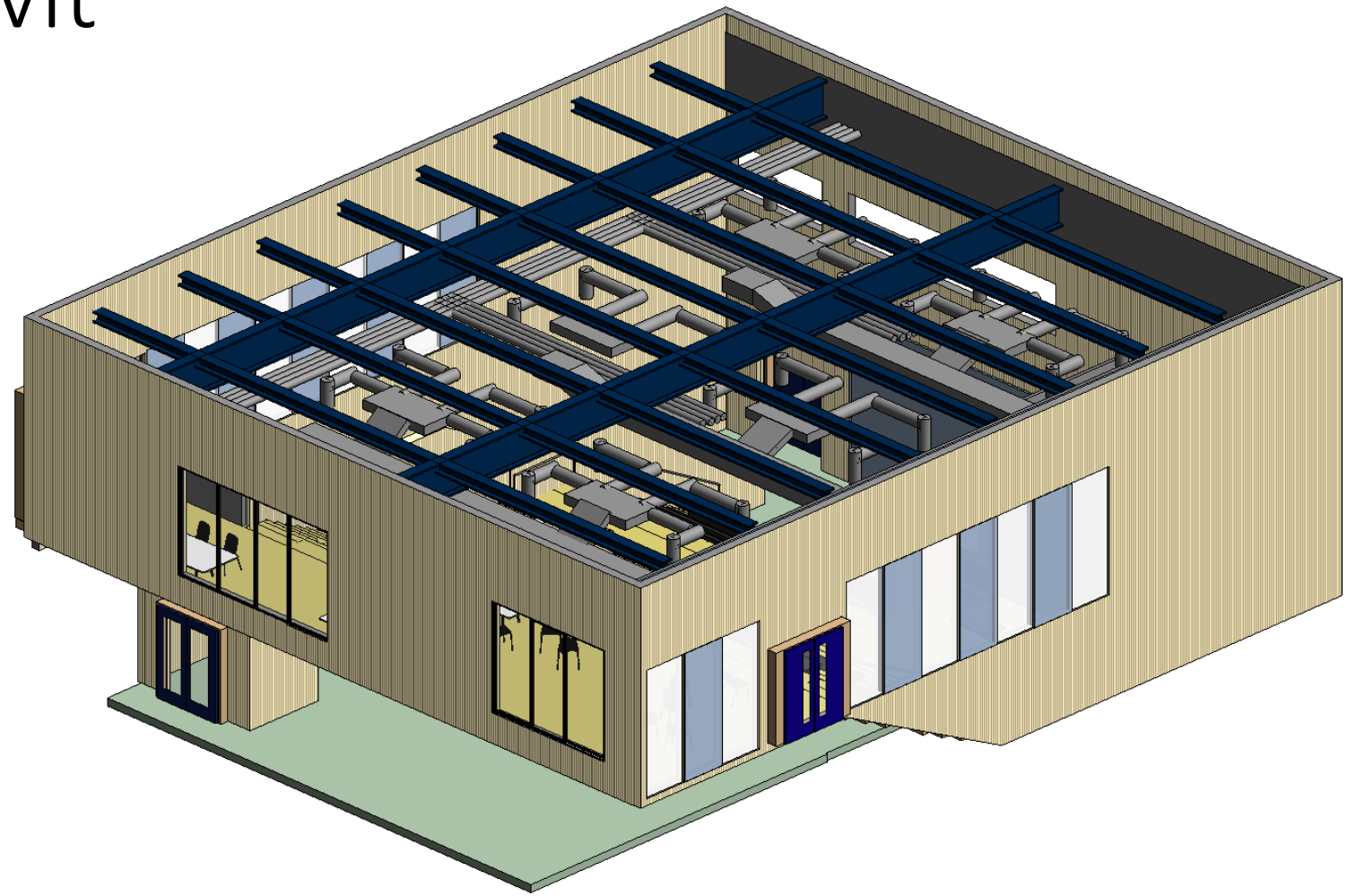
Density of point cloud

- Recap: Using a 1*1*1 limit box and exporting the points as a .pts file.
- Rhino: Import the .pts file and the information of number of points is shown.

Point cloud registration – Autodesk Recap

position	point number / m^3	
ceiling 1	42931	
ceiling 2	23774	
floor 1	119538	
floor 2	36937	
wall 1	85432	
wall 2	96610	
avrg	**67537**	point/m^3

Modelling - Revit



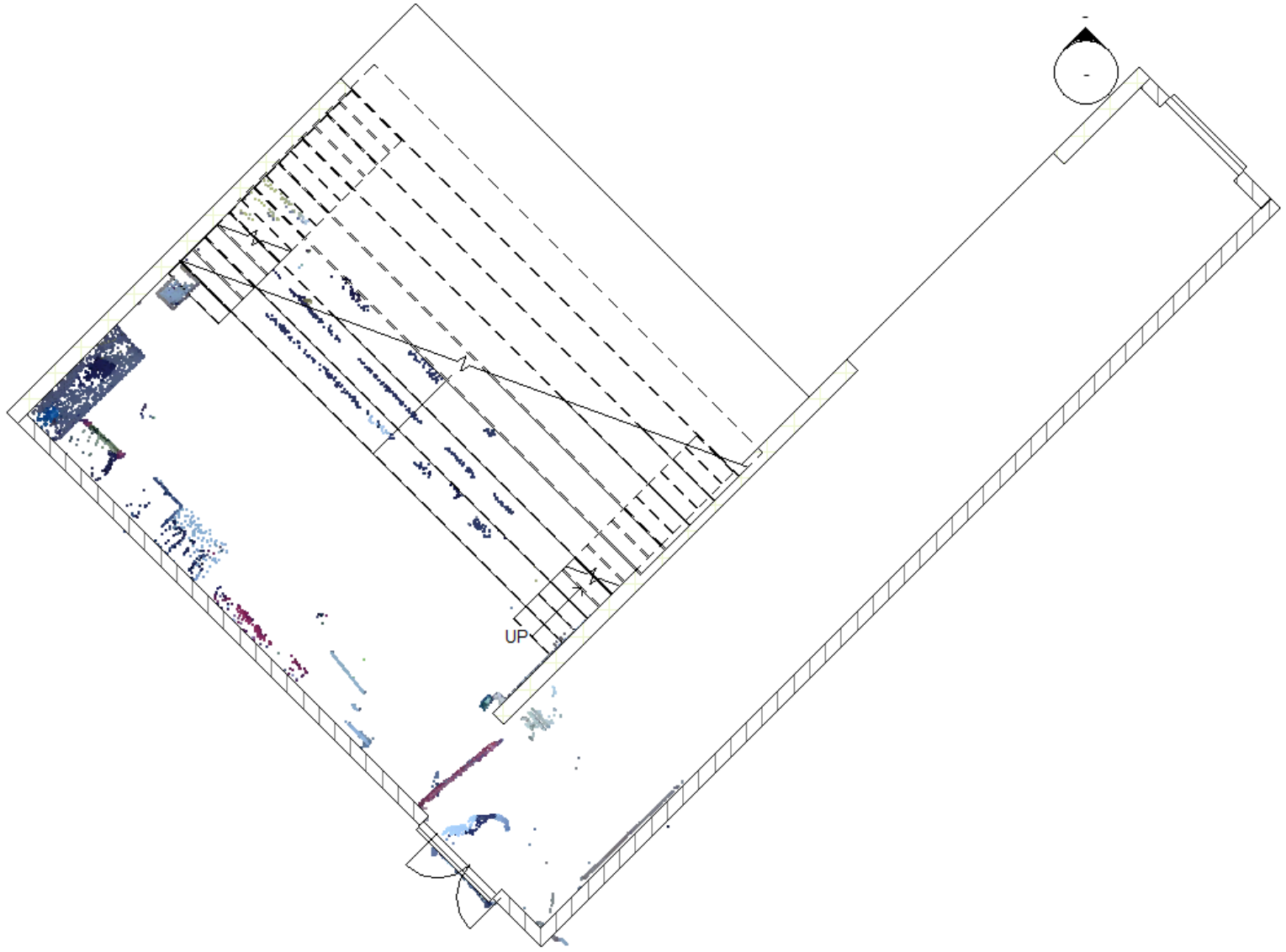
Assumptions:

- Walls are made of 10cm thick wooden boards
- Beams are structural steel
- Floors are wood with gloss finish
- Opaque panels on the walls are modelled as glass with 3% transparency

Modelling – Autodesk Revit

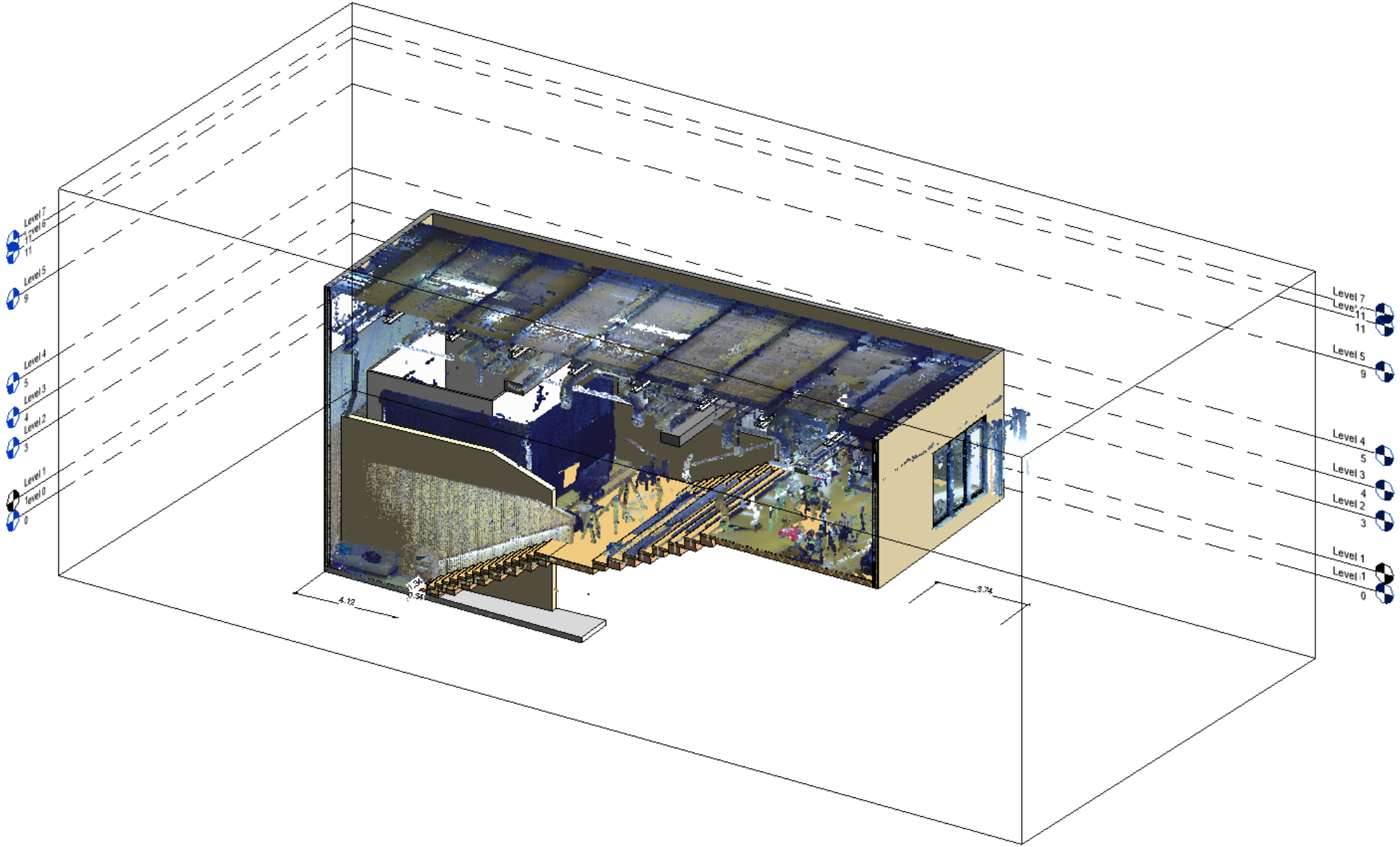
Step 1

Modelling – Autodesk Revit



Step 2

Modelling – Autodesk Revit

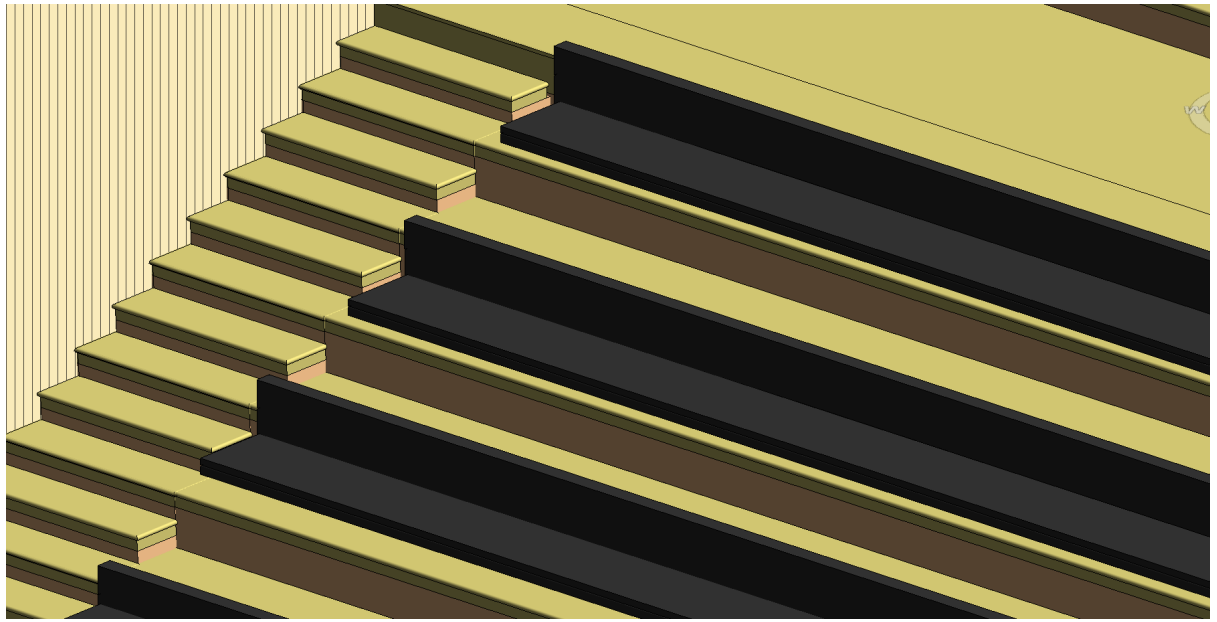


Step 3

Modelling – Autodesk Revit

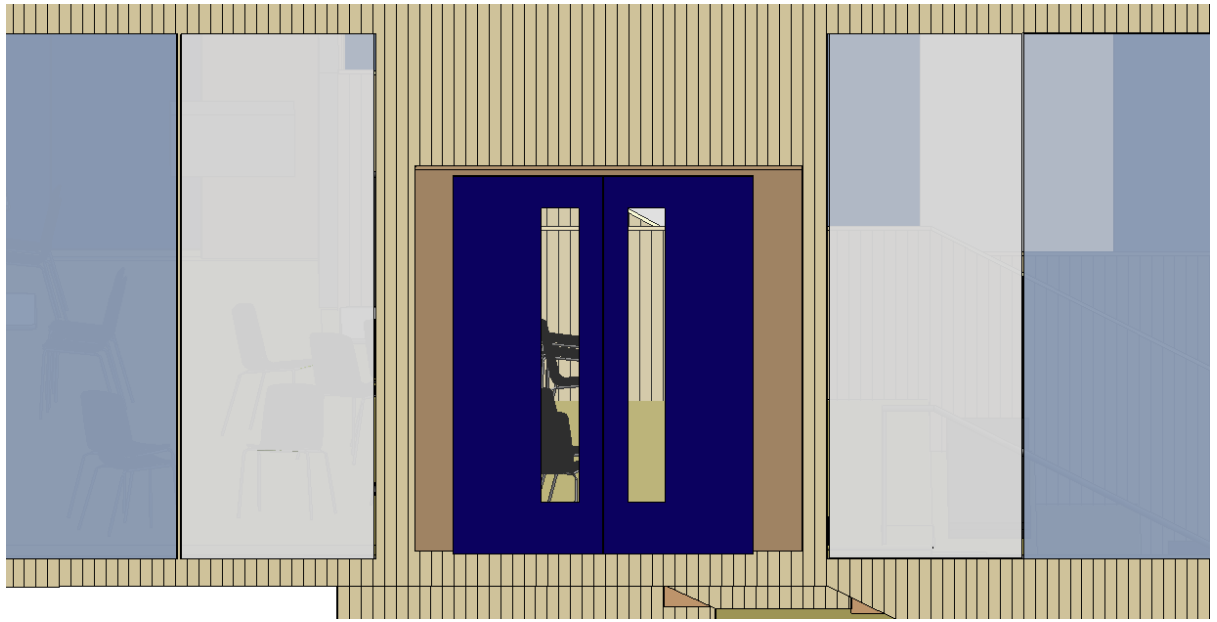
Step 4

Modelling – Autodesk Revit



Details

Modelling – Autodesk Revit



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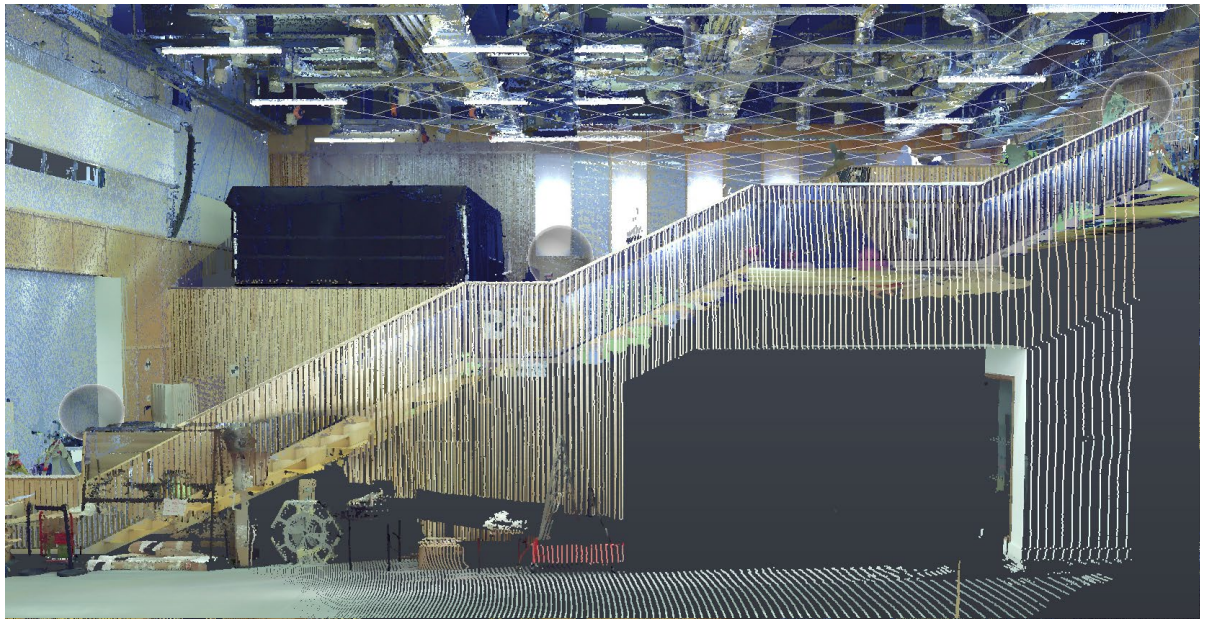

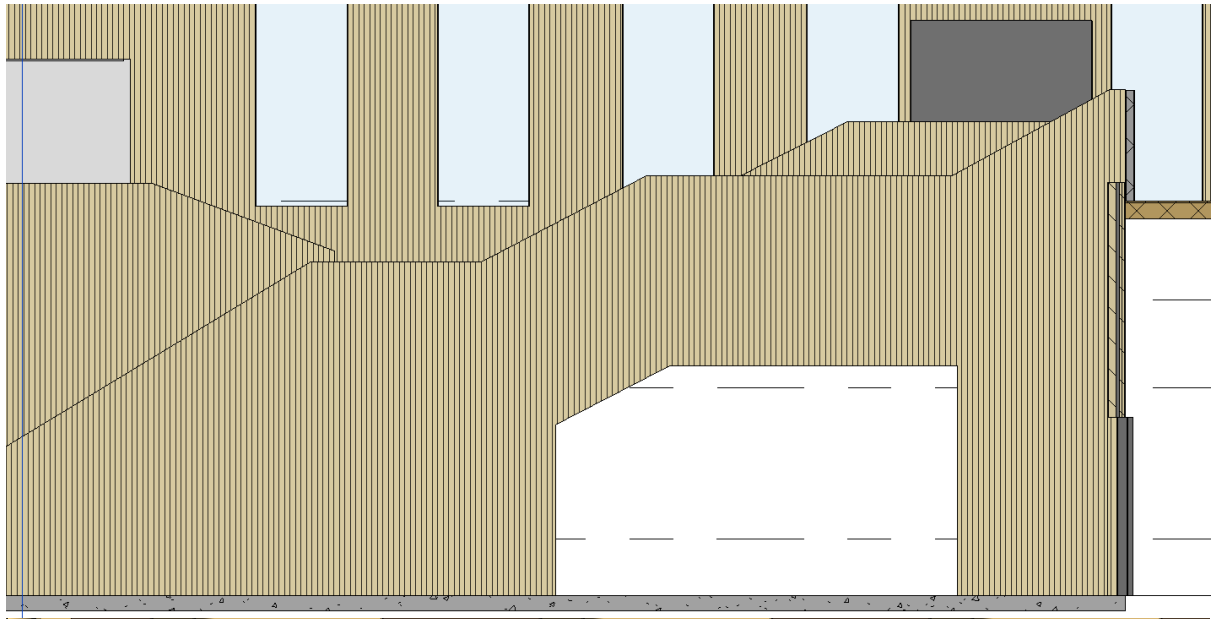

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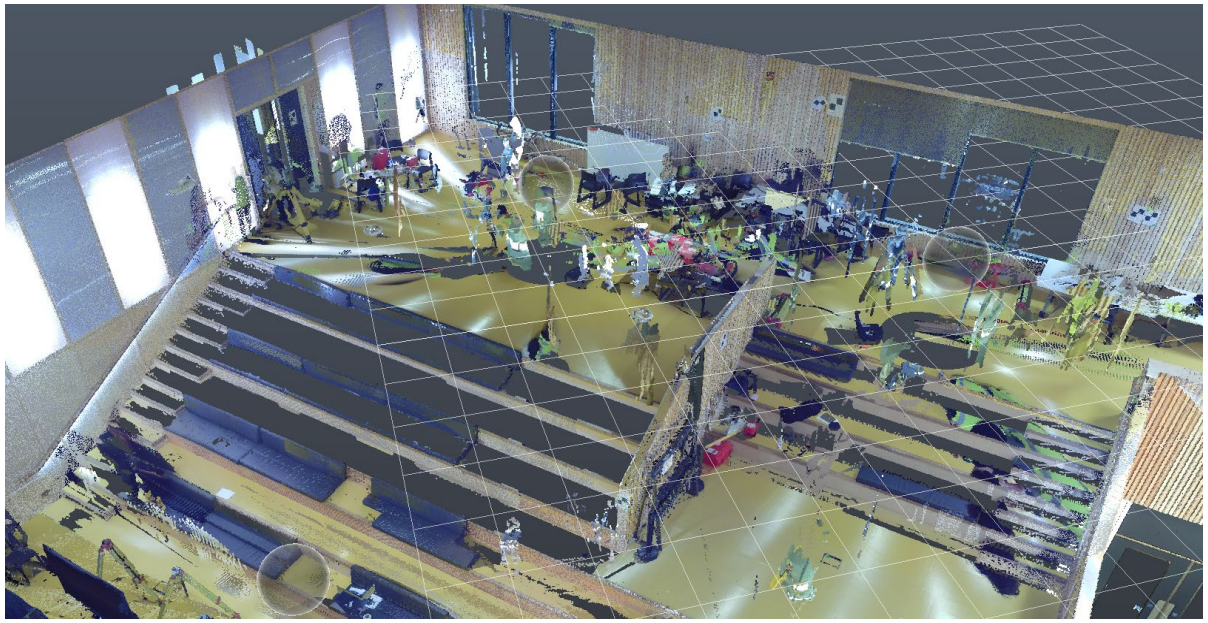
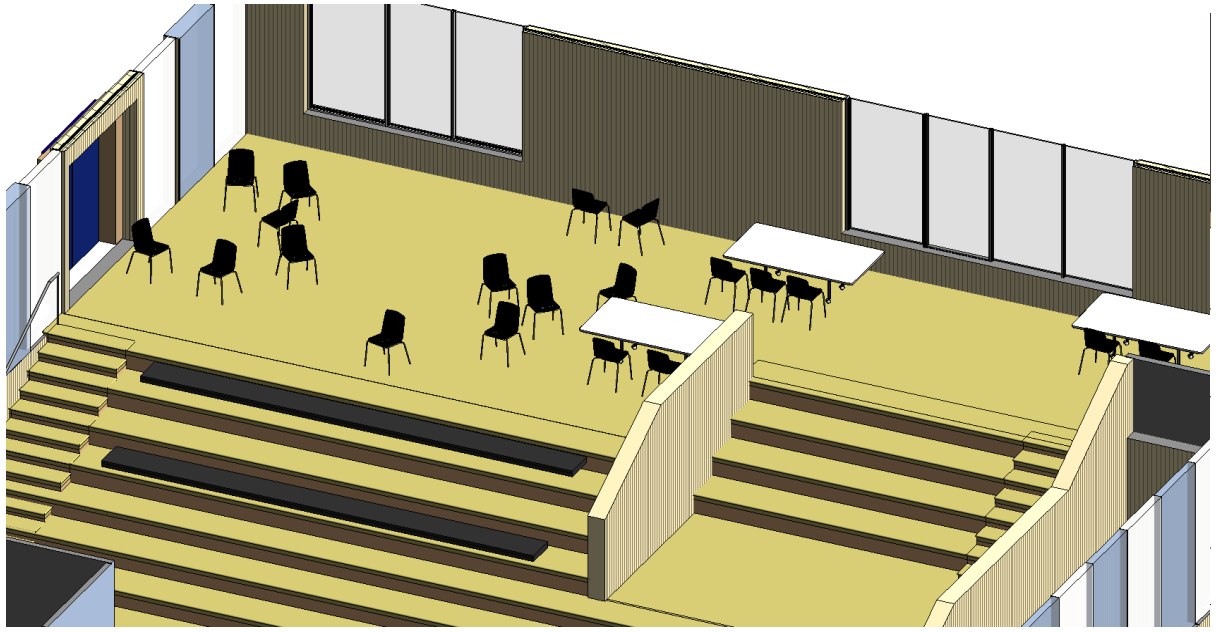
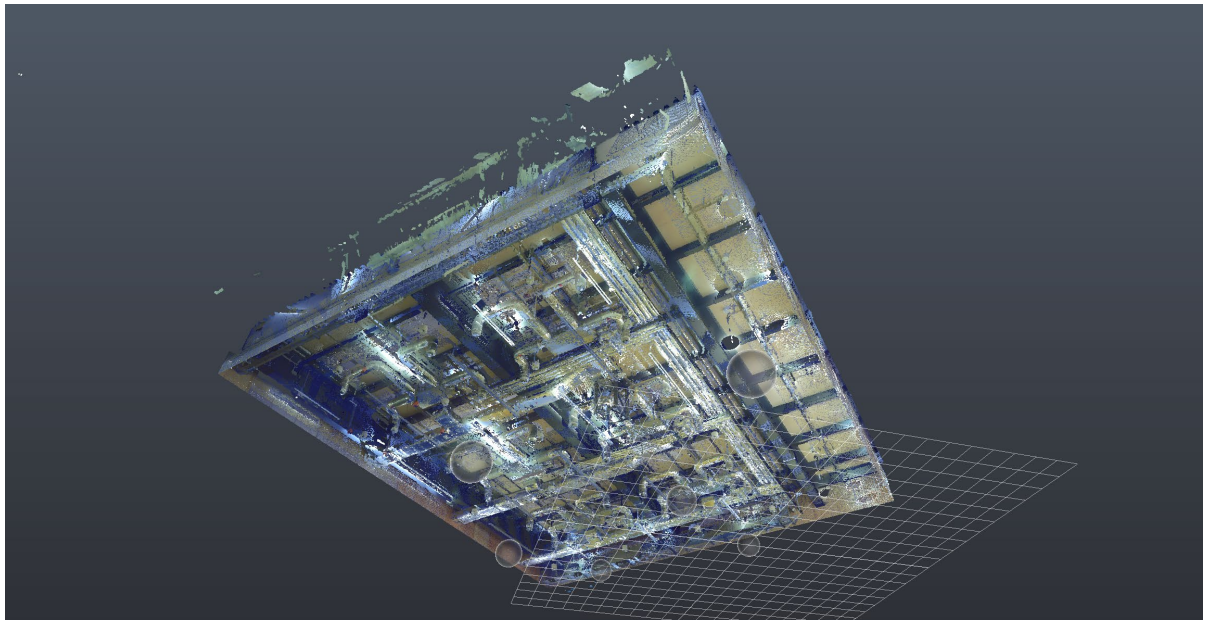
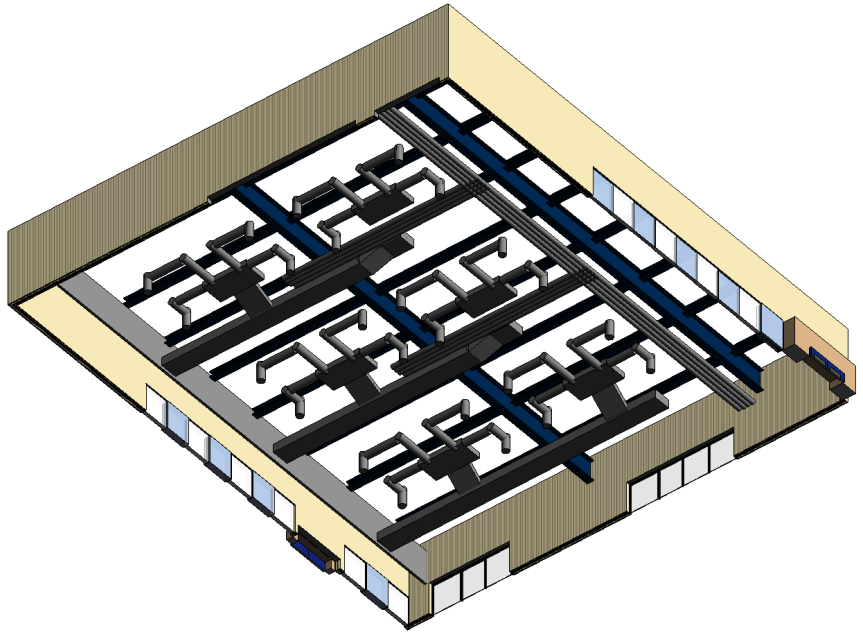




Details

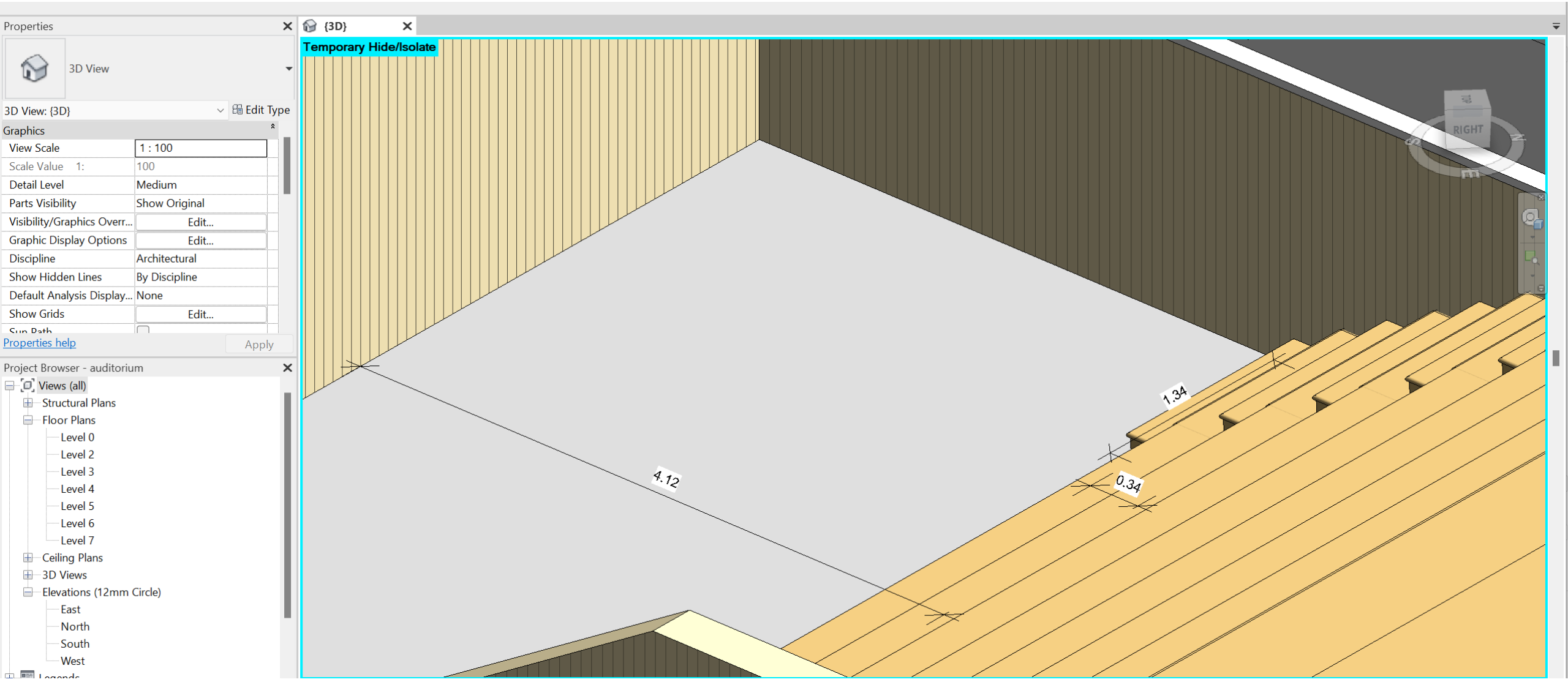
Modelling – Autodesk Revit





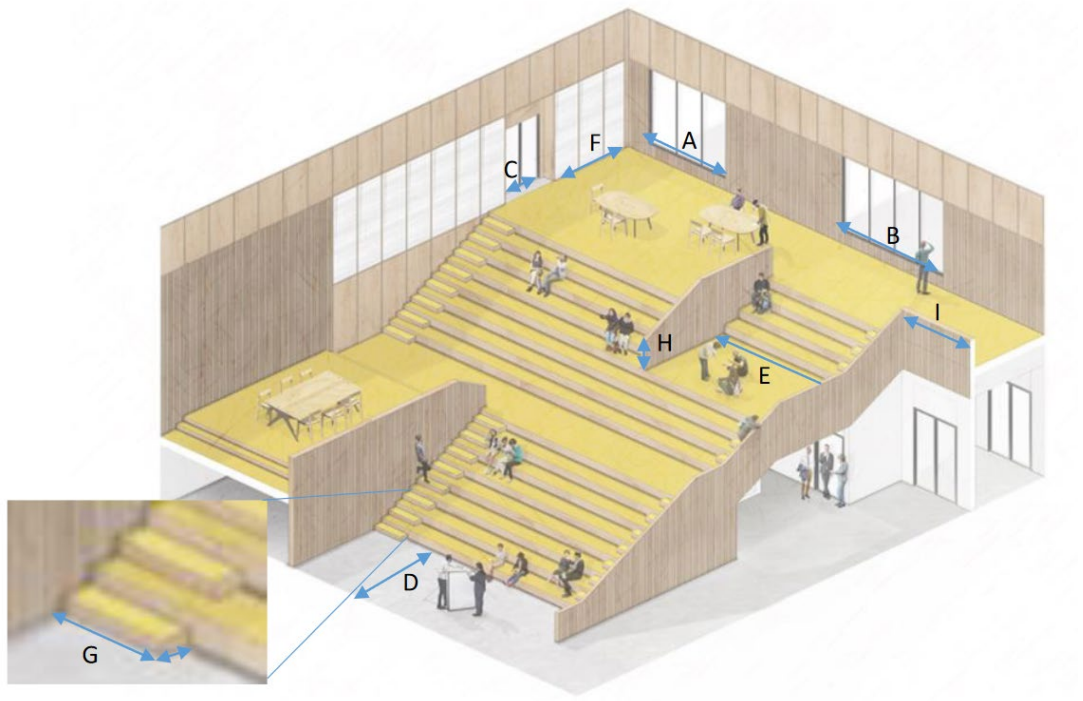
Details

Modelling – Autodesk Revit



Quality check: dimension measurement

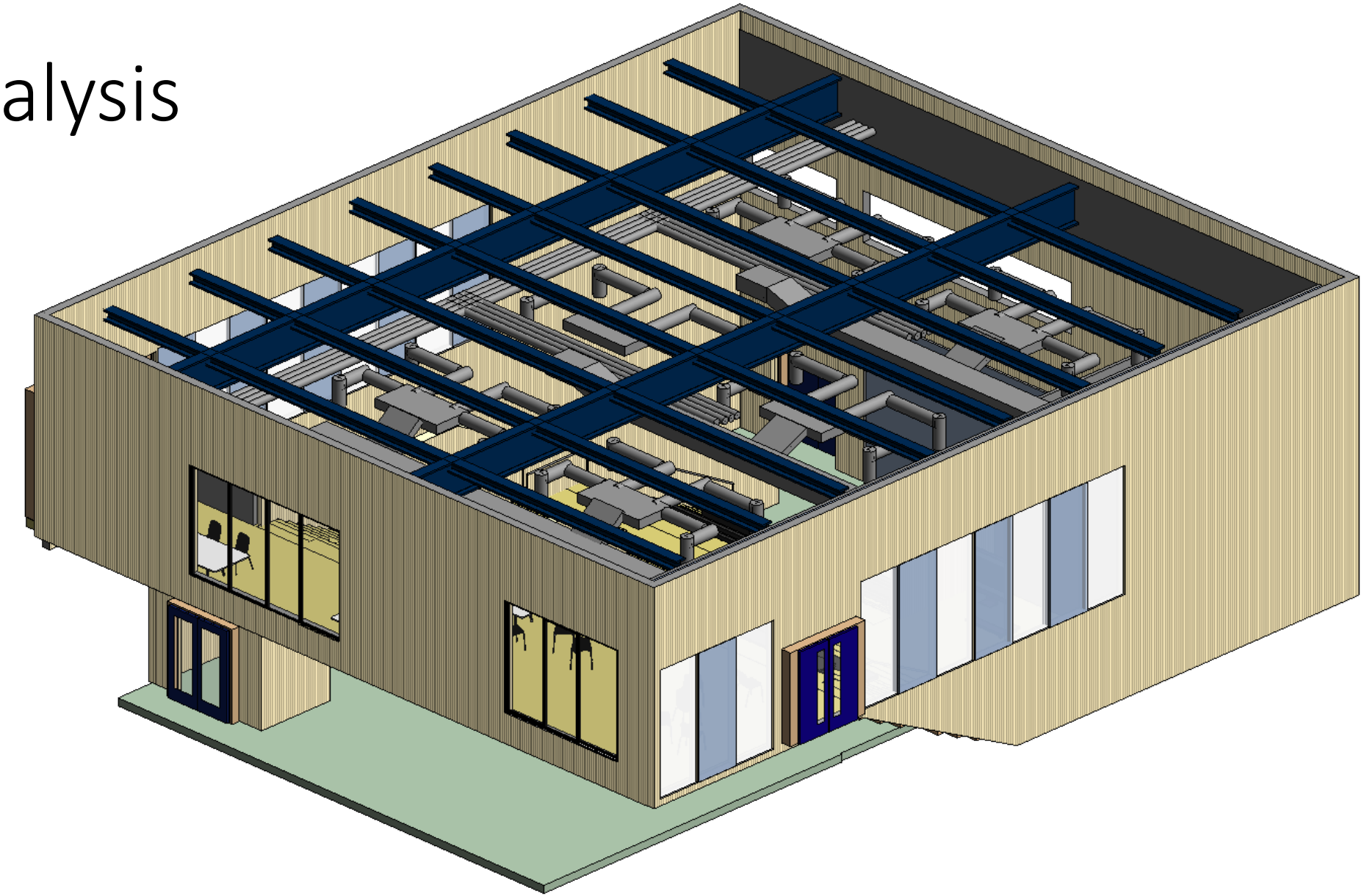
Modelling – Autodesk Revit



		Given data(m)	Model data(m)	Deviation	
A	width	3.632	3.78	0.040748899	
	height	2.7	2.96	0.096296296	
B	width	4.862	5.03	0.034553682	
	height	2.7	2.96	0.096296296	
C	width	1.945	1.978	0.016966581	
	height	2.435	2.478	0.017659138	
D	width	4.651	4.12	0.114168996	11%
E	width	6.369	6.07	0.046946145	
F	width	3.715	3.74	0.006729475	
G	length	1.305	1.34	0.026819923	
	width	0.35	0.34	0.028571429	
	height	0.165	0.178	0.078787879	
H	height	1.392	1.416	0.017241379	
I	length	3.916	3.53	0.098569969	9.9%
			ACRG	0.051454006	
				5.14%	

Quality check: result

Analysis



Final model

Level 3 – Basic Architectural model

Modelling on the Level of Detail 3 is used as a base project excluding the construction documentation. The BIM model (LoD3) generates details in the same way as a 2D documentation in the scale 1:50 or 1:100.

- the model contains all structural elements and basic simplistic architectural details
- external woodwork like doors and windows are marked
- on this level, the inner walls with doors and installation components are presented

Level 4 – Detailed Architectural model

Modelling on the Level of Detail 4 is generally used for creating engineering projects as well as for the finishing projects. What more, the model BIM (LoD4) represents the most geometrically described architectural details.

- this level contains in detail all structural elements as well as the architectural ones
- modelled are even the smallest items of installation and furniture
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Source: https://www.3deling.com/bim-lod-specification/

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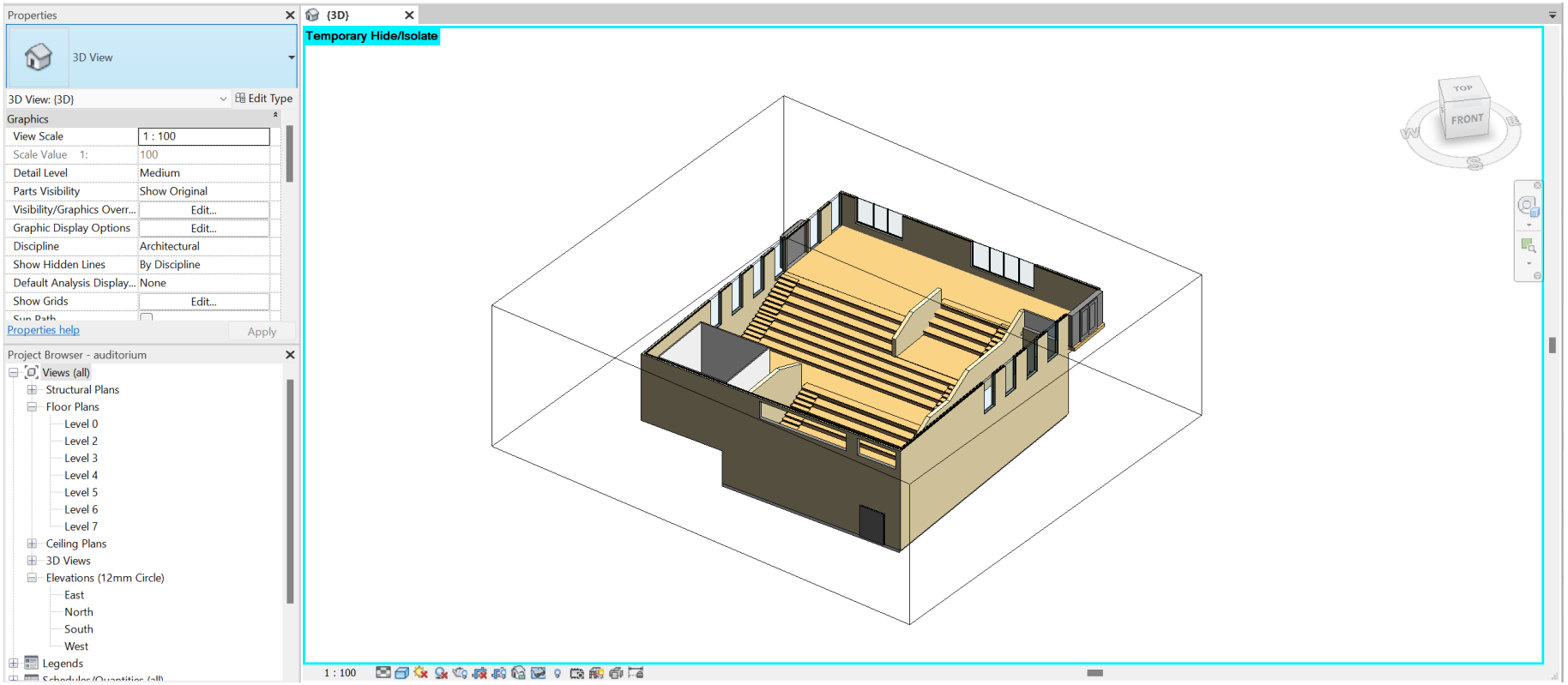

Level 3 – Basic Architectural model

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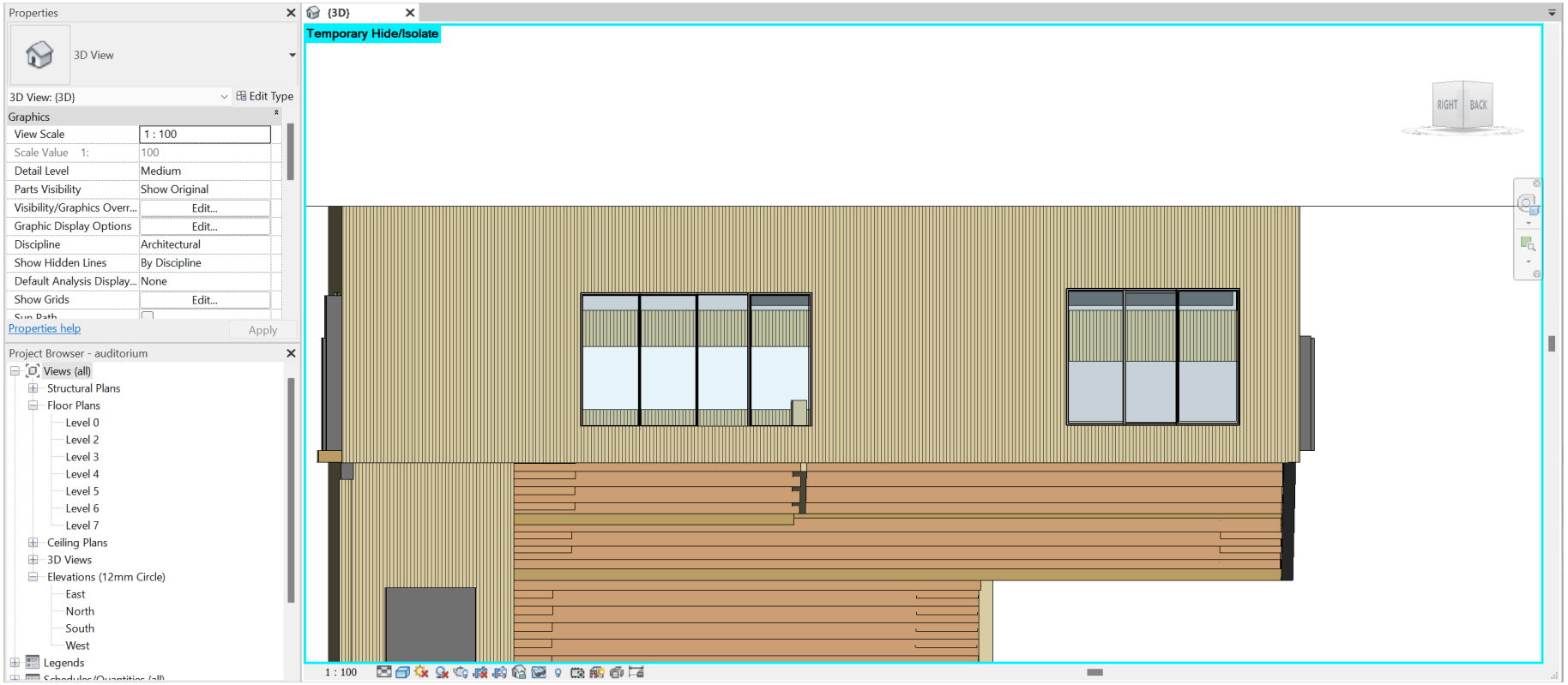
LOD check

Analysis



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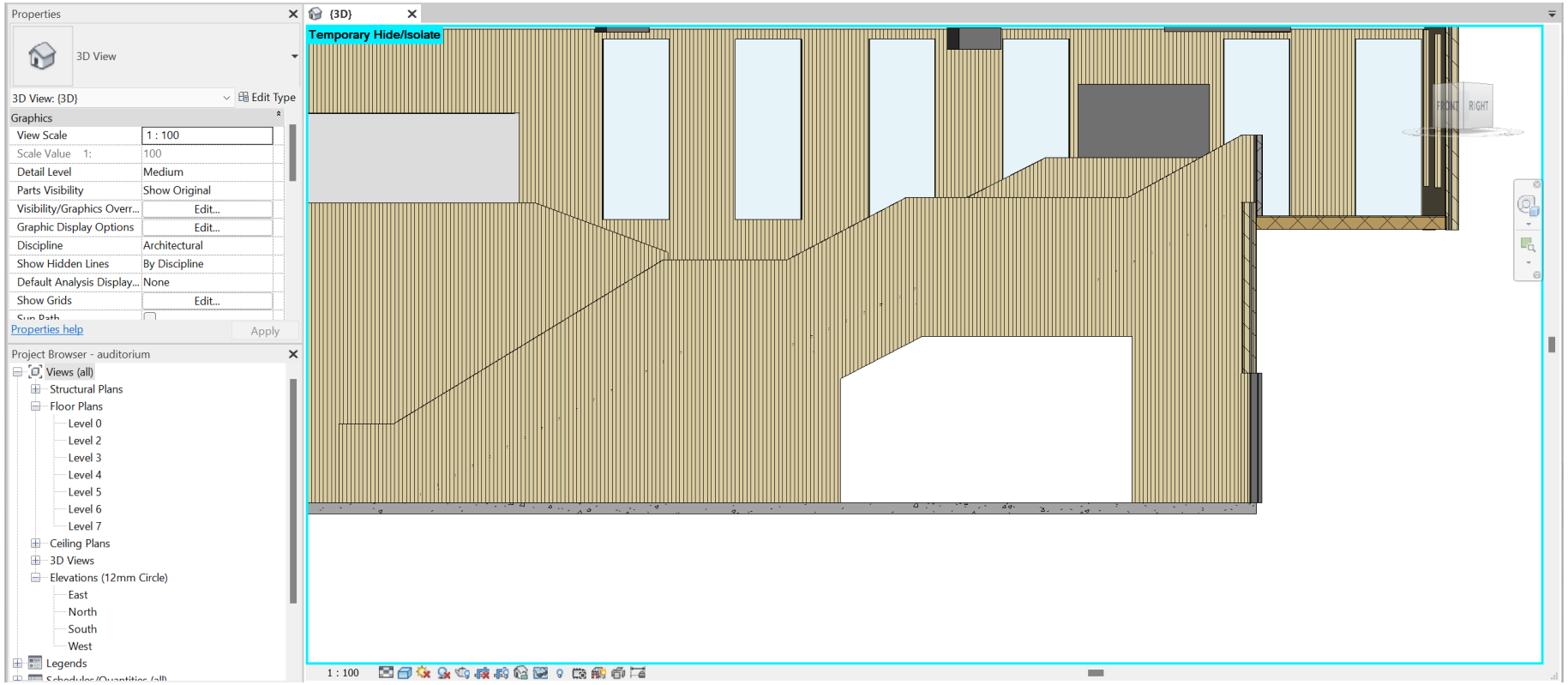

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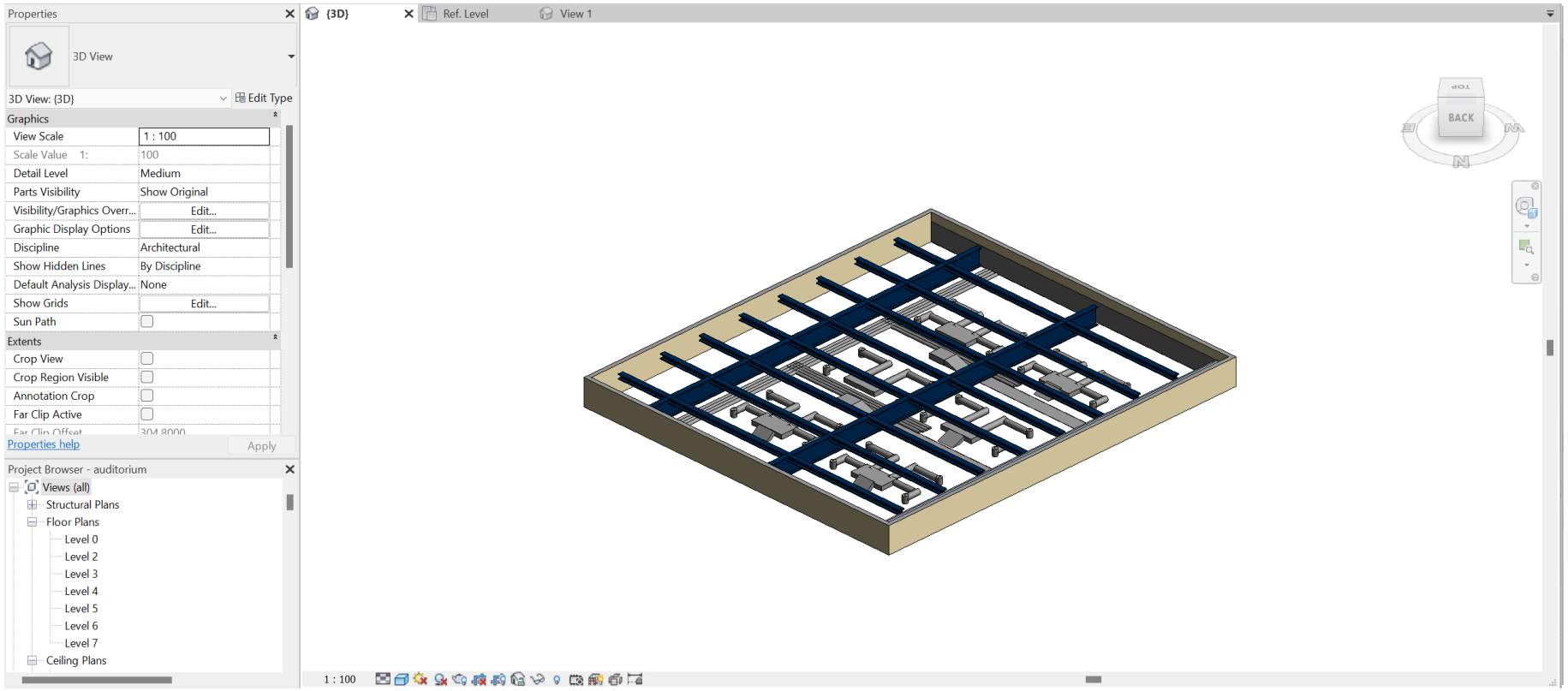

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LOD check

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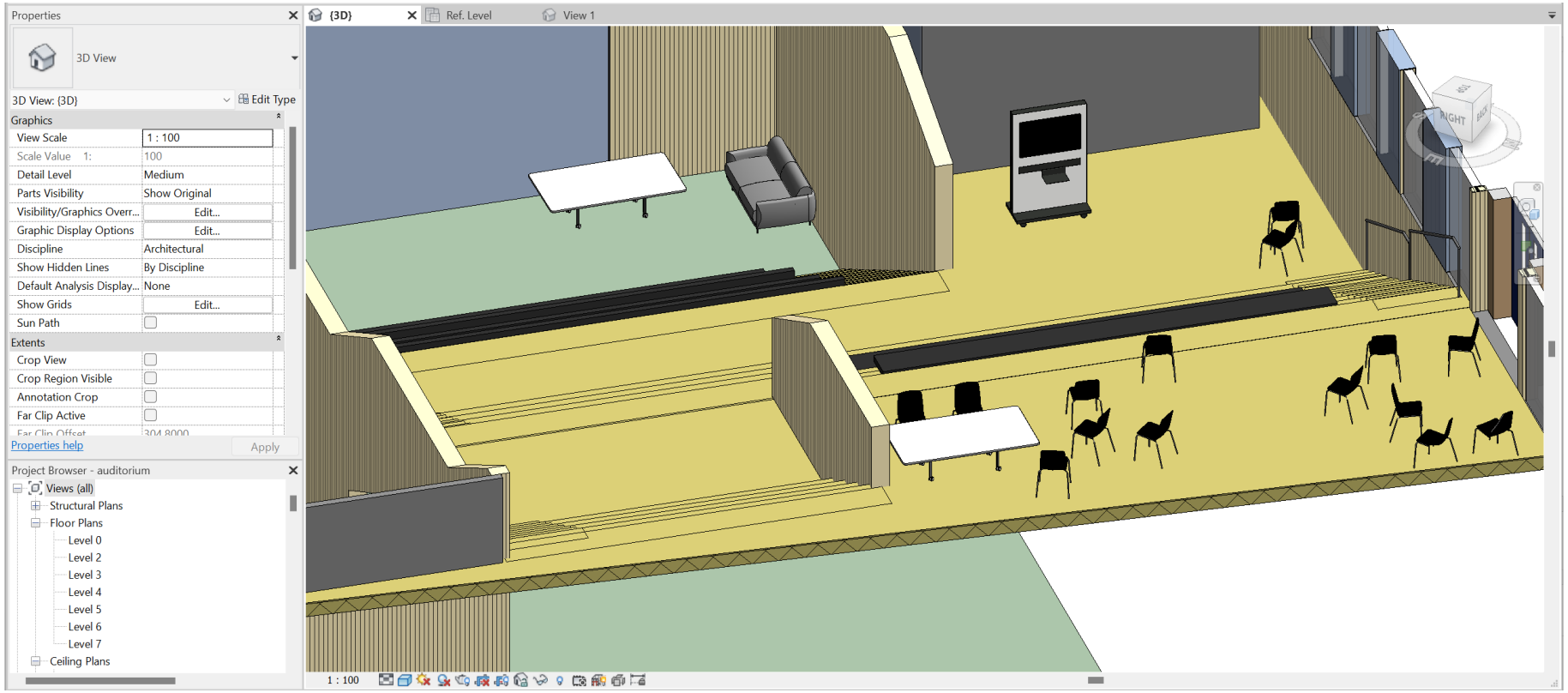
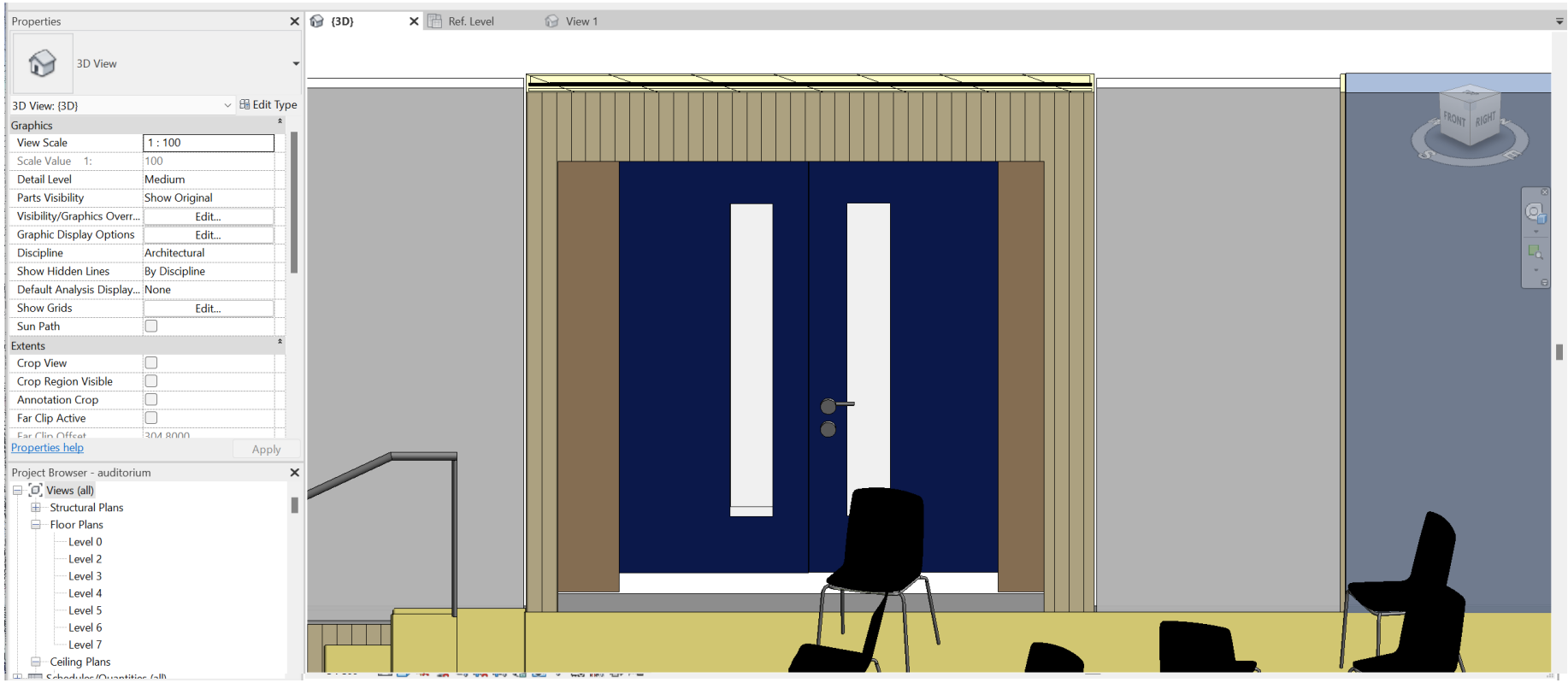


Level 4 – Detailed Architectural model

- this level contains in detail all structural elements as well as the architectural ones ✗
- modelled are even the smallest items of installation and furniture ✓
- external woodwork like doors and windows along with door handles are marked

LOD check

Analysis



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- this level contains in detail all structural elements as well as the architectural ones ✗
- modelled are even the smallest items of installation and furniture ✓
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LOD check

Difficulties & lack of accuracy:

- The imported point cloud in Revit is a large file, which takes a long time for every rotation and pan.
- In Revit it becomes very complex to navigate in the internal spaces, as compared to Recap. Solutions can be using limit boxes and modelling on each level.
- Some edges of the point cloud are very blurred (due to lack of data).
- When modelling on each level, the point clouds are more sparse, making it difficult to trace the accurate geometry.
- There are no default components in Revit with the same dimensions of the point cloud components. We have to model components first and then load them to the model, which can cause large inaccuracy.
- The approach of modelling stairs in Revit is very different from in other software. We have to set up the positions of floors, measure the thread depth and overall height and the number of steps. Then, connect the two floors with the stairs. It can be difficult to measure.
- The point cloud contains a lot of details. Thus, it is difficult to decide where to measure.
- The service system is not clearly defined and, with the data available, modelling it is not entirely accurate.

Infrared camera analysis:

- Energy conservation in buildings is one of the major areas to reduce energy consumption. Objects inside buildings transfer heat by three means: conduction, convection and radiation. Infrared thermography is an efficient method for investigating thermal performance of buildings.

- However, interpretation of the infrared images require significant experience and complex calculations. In order to obtain accurate imagery, it is essential to take several reading on different weather conditions. The readings were taken in a winter month and only on a single date, which means they may not be an accurate indication of Here East's energy efficiency. As such further readings should be taken in summer months to obtain accurate results.

- Furthermore, the process should be repeated several times and data needs to be recorded in other places around Here East to ensure that we obtain better quality results of the energy efficiency of the whole building

- Overall, Here East can be classified as an energy efficient building as it is modern and contains surfaces such as glass and double-glazed windows that are able to successfully insulate the building and thus minimize heat loss, reducing the amount of energy needed for heating. Furthermore, the glass used in windows allows natural light to filter through the building meaning less energy is needed to be spent on electricity especially throughout the day.

Thank you.

3nd year MEng Engineering and Architectural Design

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Academic Year 2021 – 2022

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Model link

https://autode.sk/3nbpADM