Deliverable 2.1

3D model of the Konzerthaus Berlin

AURA

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3D Model of the Konzerthaus Berlin

The development of the 3D NURBS model of the Konzerthaus of Berlin based on the digital surveys, within the project "AURA - Auralisation of Acoustic Heritage Sites Using Augmented and Virtual Reality" (AURA - project no. 101008547), has been fully completed.

This model will be used to develop the auralisation of the Konzerthaus of Berlin (WP2).

Digital Survey

The activity included laser scanning surveys of the exterior of the Konzerthaus Berlin building and its surrounding in Gendarmenmarkt Square, the foyer and the main hall of the theater, and was carried out during the Berlin mission on August 28 - September 3 2021 by the working team of the Department of Architecture of Florence (UNIFI-DIDA) under the scientific guidance of Prof. Stefano Bertocci.

The laser scanner survey has provided highly reliable metric data, which, mainly coloured point clouds, have been subsequently processed by specific software, thus constituting a three-dimensional database that will serve as a support base for the development of the 3D model.

Coloured point cloud of the external areas of the Konzerthaus Berlin and Gendarmenmarkt Square
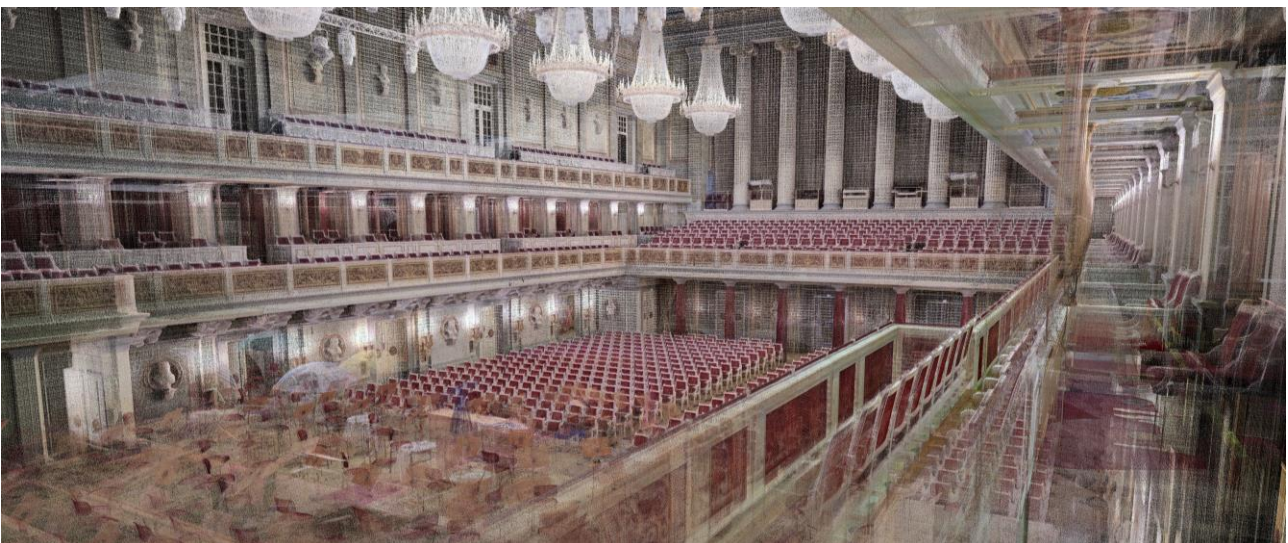
Coloured point cloud of the main hall of the Konzerthaus Berlin

Acquisition and Processing of Laser-Scanner Survey Data

For the laser-scanner survey of the Konzerthaus Berlin, two different instruments were used, a Z+F Imager 5016H and a Faro Focus M70, both with phase difference technology, through which about 300 scans were made: 160 for the B/W acquisition and 160 for the colored one.

The large amount of data obtained from the laser-scanner survey campaign was subsequently processed, starting the phase of the registration of the point clouds. In this way the scans were aligned, and after verifying the correct union, a single global point cloud was developed, both for the B/W and the coloured one.
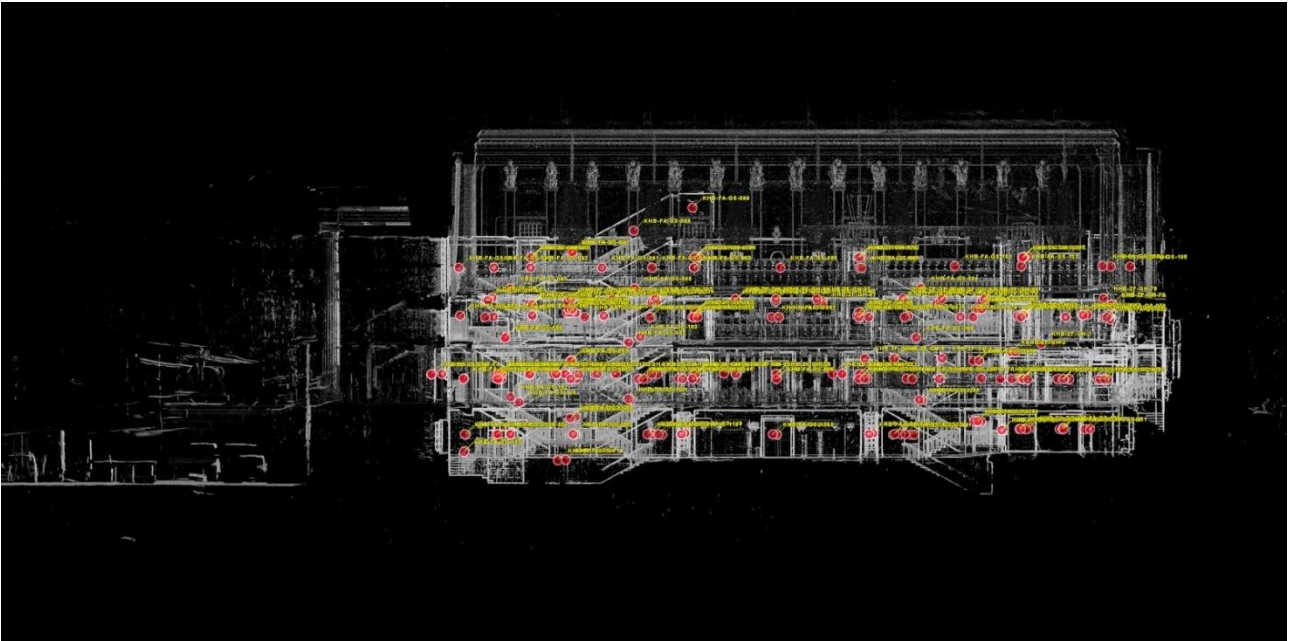
Point clouds alignment phase

From this global point cloud has been exported and decimated the part related only to the main hall, which has become the metric support for the development of the 3D model.

Decimated point cloud of the main hall inserted within the 3D modelling software

3D Model

For the development of the final model of the Konzerthaus Berlin, the existing textured model in the possession of the theater administration was used.

Existing textured 3D model of the main hall of the Konzerthaus Berlin

However, this model did not have any metric information and its sizes were dimensionally incorrect.
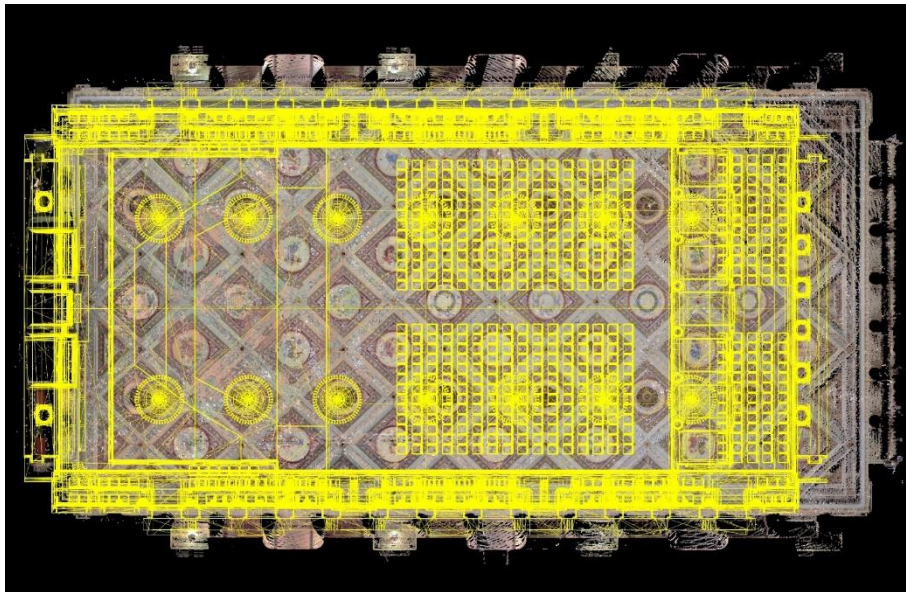
Graphical demonstration of the incorrect proportions and dimensions of the existing 3D model (yellow) and the metrically reliable point cloud processed by the laser-scanner surveys

For this reason, transformations of the model surfaces were carried out on the basis of the metrically reliable point cloud.

By means of specific morphological transformation tools, the original model was scaled to actual dimensions and referenced to the coordinate system present in the global point cloud.

This methodology will then allow to integrate the point cloud of the exterior and the foyer with the 3D model of the interior of the main hall.
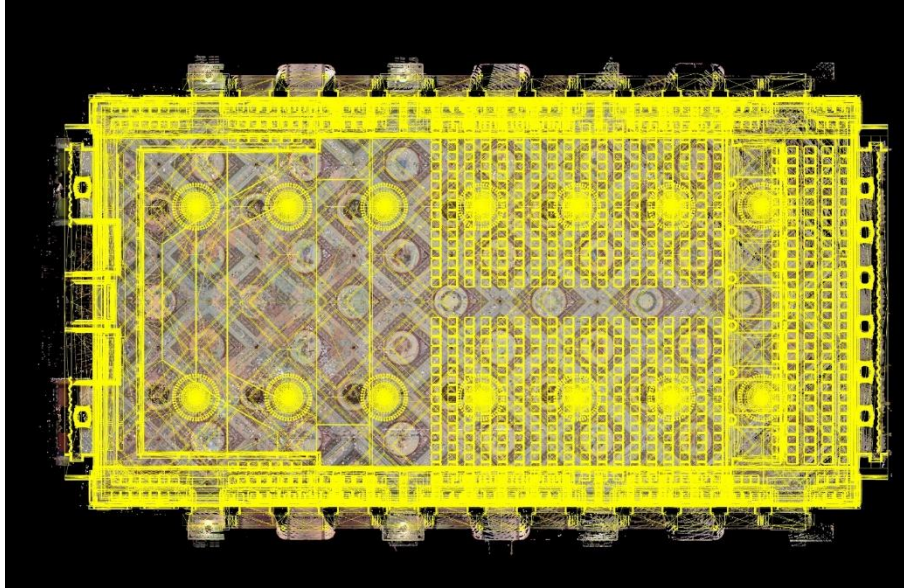
Results of the morphological transformation of the existing model with respect to the point cloud
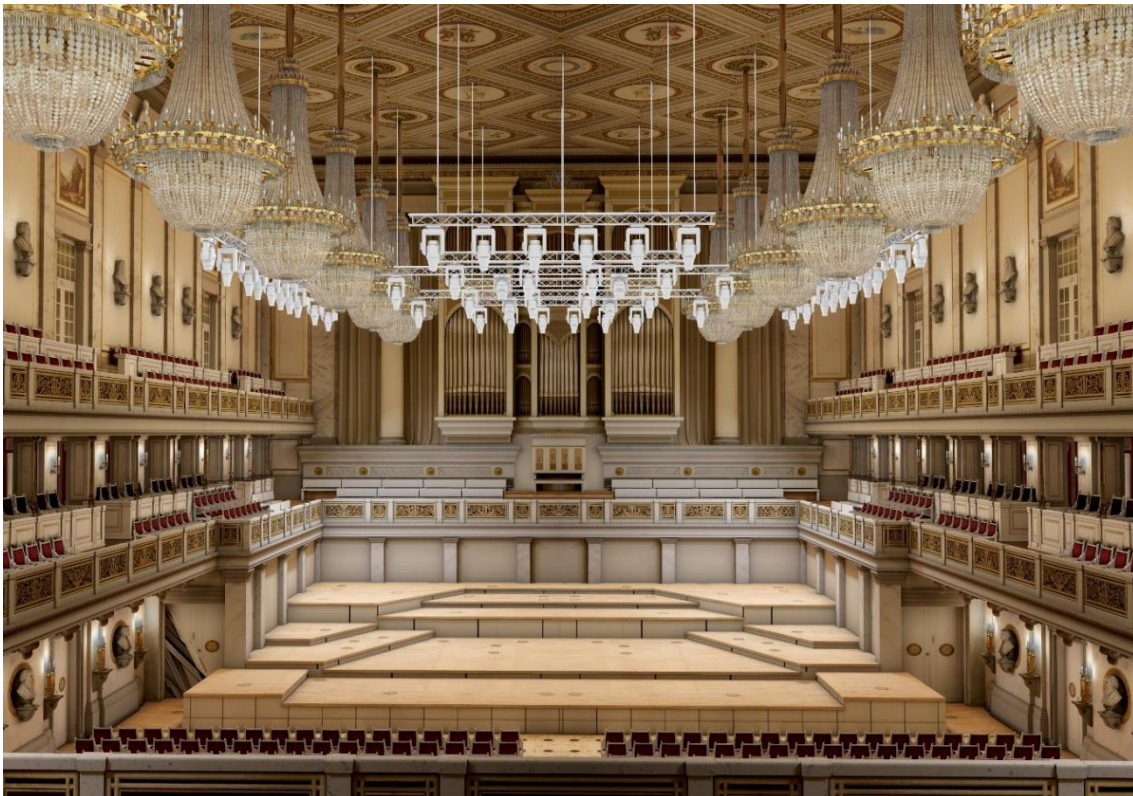
Prospective view of the new main hall 3D model metrically reliable
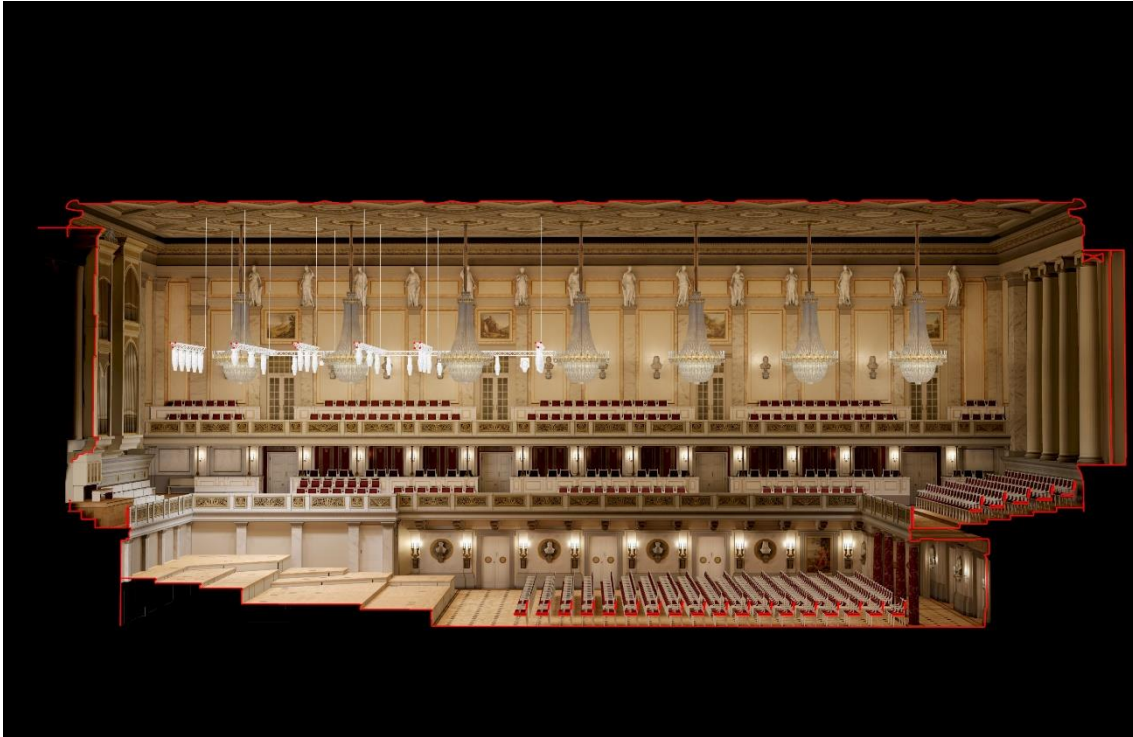
Longitudinal section of the 3D model of the main hall

Classification of the 3D Elements and Development of a Materials Database

Subsequently a semantic classification of the elements present in the main hall was elaborated and for each of these a different material was assigned.

This methodology has been followed to facilitate the development of the subsequent auralisation process, which requires the subdivision of the elements of the 3D model, in order to associate them with the acoustic parameters values.
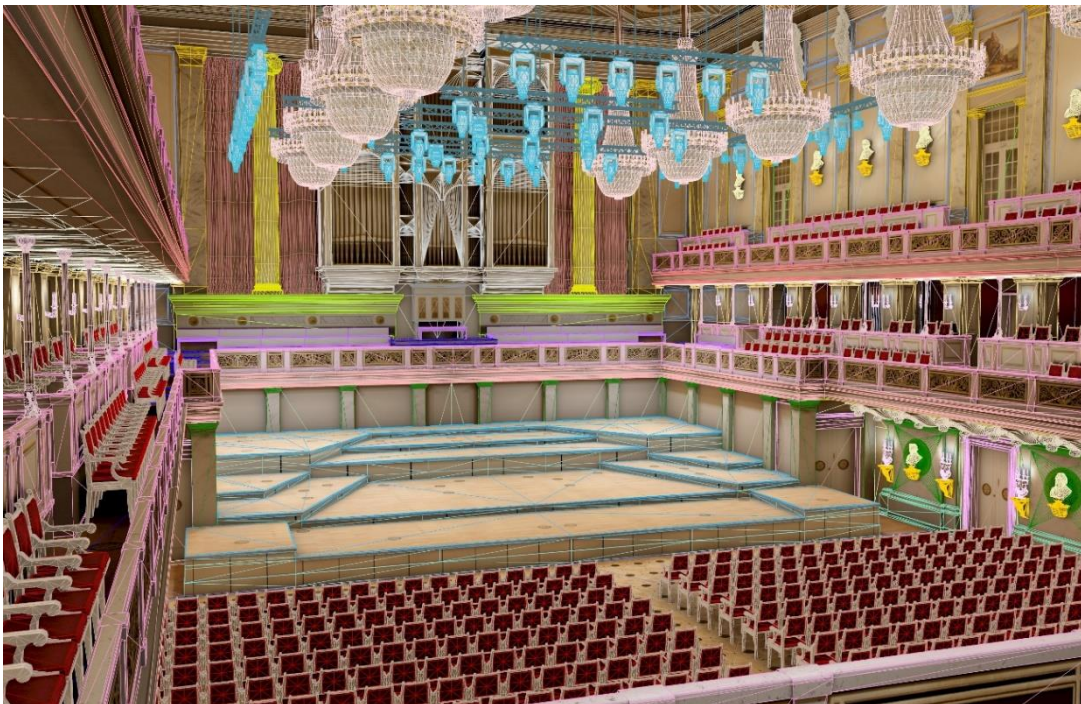
Different visualisations of the 3D model divided into component elements (each represented by a different colour)

Different visualisations of the 3D model divided into component elements (each represented by a different colour)

The following table shows the development of the acoustic database on which to carry out the acoustic analysis necessary for the subsequent auralisation process.

COD	Element Description	TYP	Element Type / Component Description	MAT	Material Description
BE	Bench	A	Wooden bench	ben-01	Bench 01
CE	Ceiling	A	Balcony 01 lower ceiling	cei-01	Ceiling 01
		B	Balcony 02 lower ceiling	cei-02	Ceiling 02
		C	Main hall ceiling	cei-03	Ceiling 03
CN	Cornice	A	Balcony 01 cornice	cor-01	Cornice 01
		B	Balcony 02 cornice	cor-02	Cornice 02
		C	Main hall cornice	cor-03	Cornice 03
		D	Door cornice	cor-04	Cornice 04
CU	Curtain	A	Curtain	cur-01	Curtain 01
DO	Door	A	Wooden door	dor-01	Door 01
		B	French wooden door	dor-02	Door 02
FL	Floor	A	Main stage wooden floor	flo-01	Floor 01
		B	Audience wooden floor	flo-02	Floor 02
		C	Balcony 01 wooden floor	flo-03	Floor 03

		D	Balcony 02 wooden floor	**flo-04**	Floor 04
		E	Perimetric wooden floor	**flo-05**	Floor 05
HR	Handrail	A	Balcony 01 handrail	**hra-01**	Handrail 01
		B	Balcony 02 handrail	**hra-02**	Handrail 02
LA	Lamp	A	Pendant chandelier	**lam-01**	Lamp 01
		B	Side chandelier	**lam-02**	Lamp 02
		C	Spotlight	**lam-03**	Lamp 03
		D	Spotlight rail structure	**lam-04**	Lamp 04
OR	Organ	A	Organ structure	**org-01**	Organ 01
		B	Organ pipe	**org-02**	Organ 02
		C	Organ keyboard instrument	**org-03**	Organ 03
SC	Sculpture	A	Bust sculpture	**scu-01**	Sculpture 01
		B	Full statue	**scu-02**	Sculpture 02
SE	Seat	A	Wooden seat structure	**sea-01**	Seat 01
		B	Seat fabric lining	**sea-02**	Seat 02
ST	Structure	A	Audience culumn	**str-01**	Structure 01
		B	Upper culumn	**str-02**	Structure 02
		C	Balcony 01 structural support	**str-03**	Structure 03
		D	Balcony 01 pillar	**str-04**	Structure 04
		E	Balcony 01 metal pillar	**str-05**	Structure 05
		F	Balcony 02 lesene	**str-06**	Structure 06
		G	Scuplture support	**str-07**	Structure 07
WA	Wall	A	Perimetric basement wall	**wal-01**	Wall 01
		B	Marbled wall	**wal-02**	Wall 02
		C	Audience plastered wall	**wal-03**	Wall 03
		D	Stage plastered wall	**wal-04**	Wall 04
		E	Stage wooden wall	**wal-05**	Wall 05
		F	Organ basement wall	**wal-06**	Wall 06
		G	Rear basement wall	**wal-07**	Wall 07
		H	Balcony 01 red wall	**wal-08**	Wall 08
		I	Balconies plastered wall	**wal-09**	Wall 09

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