LSI Project

LASTSUPPER

INTERACTIVE

AI/XR IMMERSIVE INTERACTIVE STORYTELLING …

VR + 8K stereoscopic 3D DIGITAL ANIMATION that combines experimental digital narrative and virtual storytelling based on the *Leonardo da Vinci's Last Supper painting.*

LSI

8K 3D Stereo VR Storytelling

[FF]

Leonardo's Last Supper

THE LAST SUPPER INTERACTIVE - Art and Mathematics in the Renaissance (LSI Project)

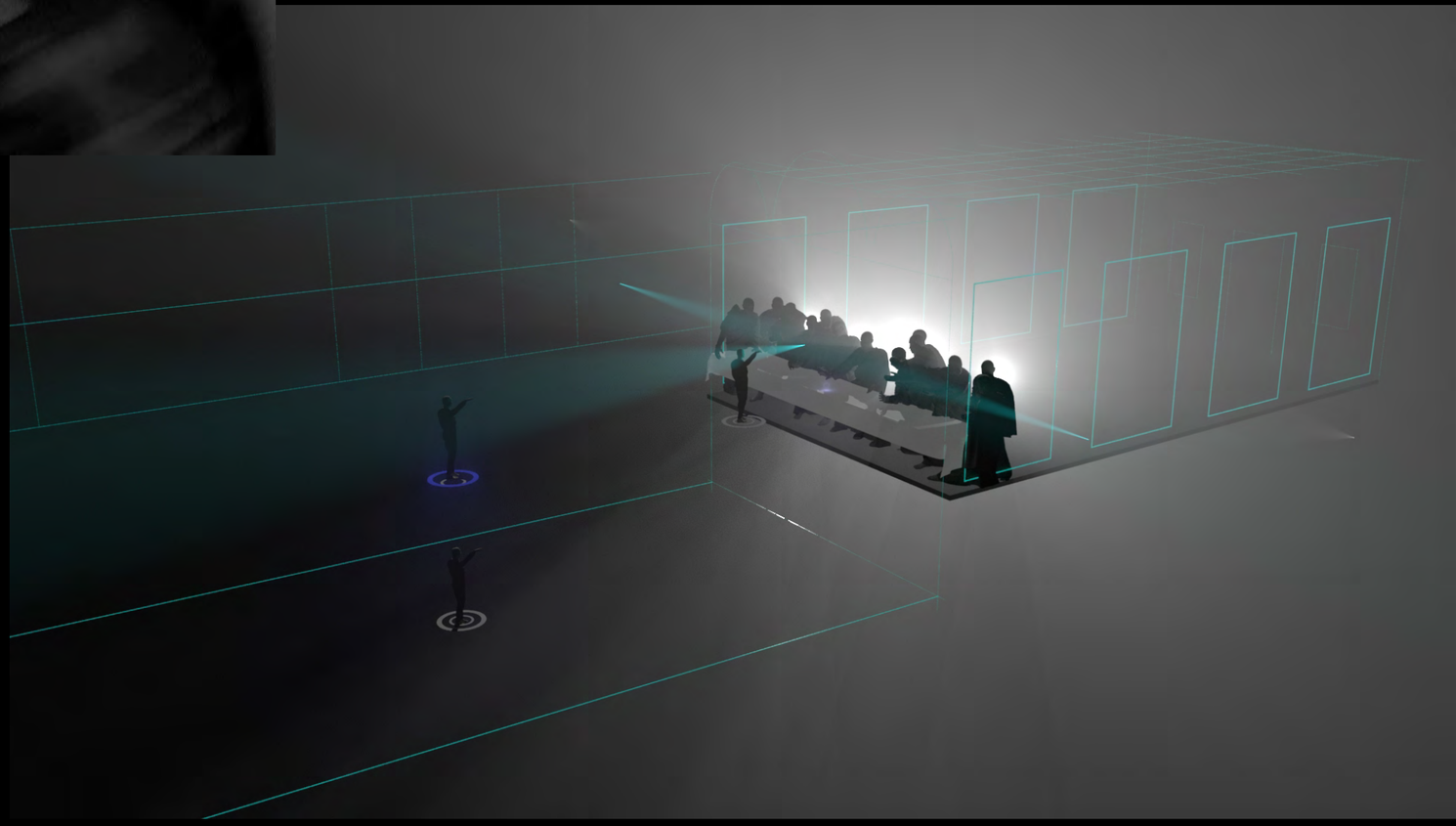
LSI is an immersive experimental digital narrative and virtual storytelling in 8K,articulated in eight scenes based on The Last Supper, a late 15th century mural painting by Leonardo da Vinci located in the refectory of the Convent of Santa Maria delle Grazie in Milan.

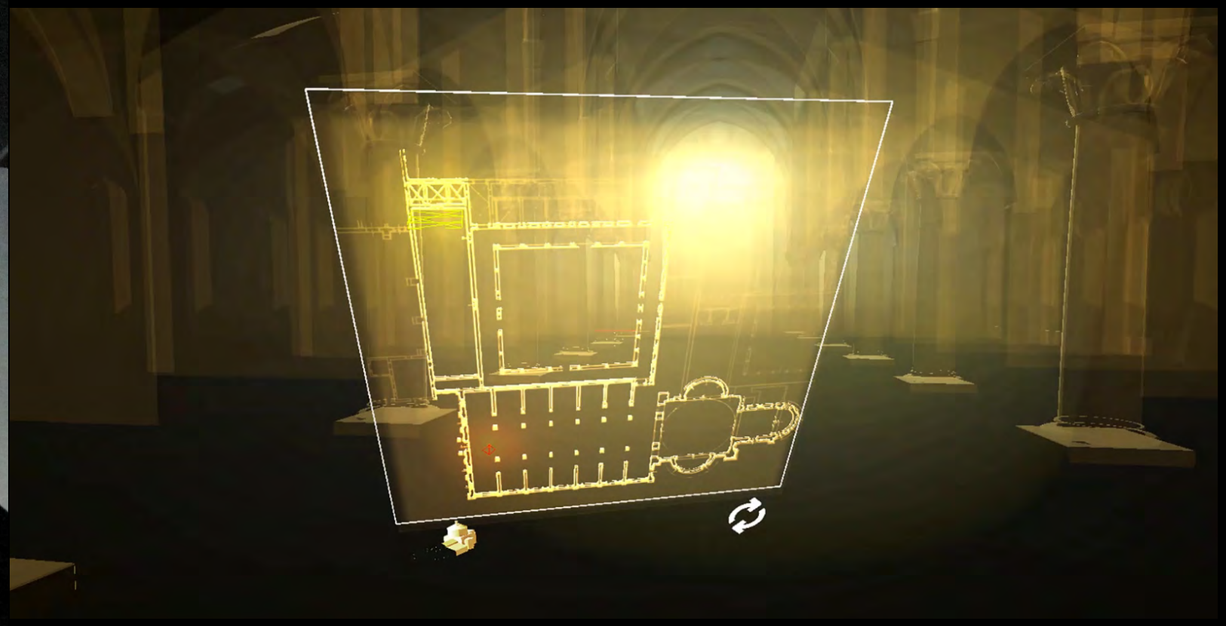
It enables the audience to visit the painting from multiple viewpoints and perspectives and explore its details in high-resolution. Likewise, visitors can penetrate the dimensional layer of the fresco and be virtually transferred “inside.”

Author: Franz Fischnaller.
Project Parters and Teams: INSA Rennes, Institut National des sciences appliquées de Rennes, France; Université de Rennes, France; INRIA, institut national de recherche en sciences du numérique, France;IRISA, Institut de Recherche en Informatique et Systèmes Aléatoire; UMR CNRS; Cineca InterUniversity Consortium, High Performance SuperComputing Applications and Innovation, Bologna, Italy; Polytechnic University of Milan, Department of Mechanics Computer Vision and Reverse Engineering Lab.

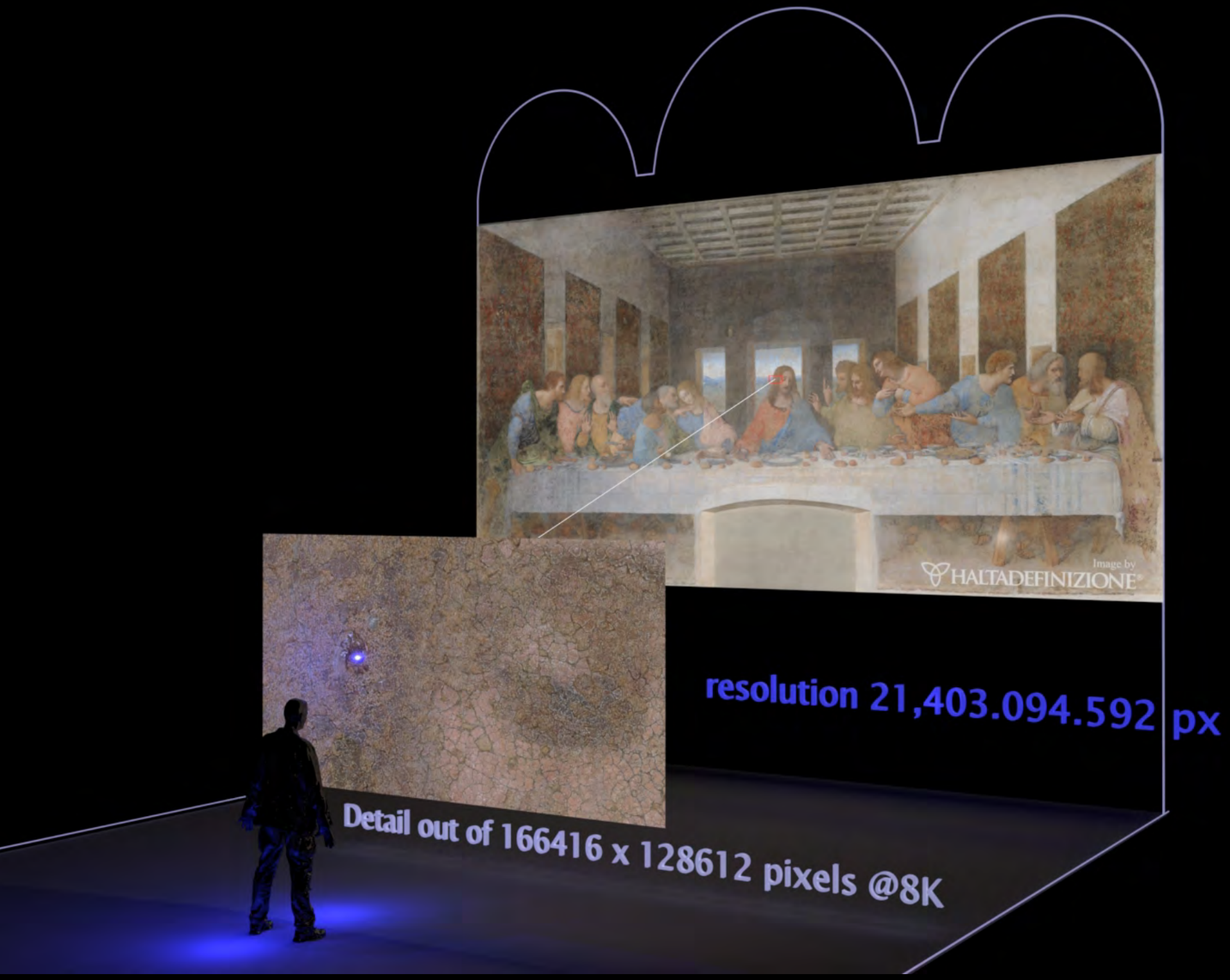
LSI project use the highest-ever definition of Leonardo’s Last Supper (16 billion pixels), that’s 1,600 times larger than images taken with a 10-megapixel camera, done by HALTADEFINIZIONE, leading company in photographic acquisition of works of art in Gigapixel and 3D, a brand of Franco Cosimo Panini Editore S.p.A. 41124 Modena, Modena, Italy

8K 3D stereo VR immersive experimental interactive storytelling that enables to re-visit like never before Leonardo's Last Supper.

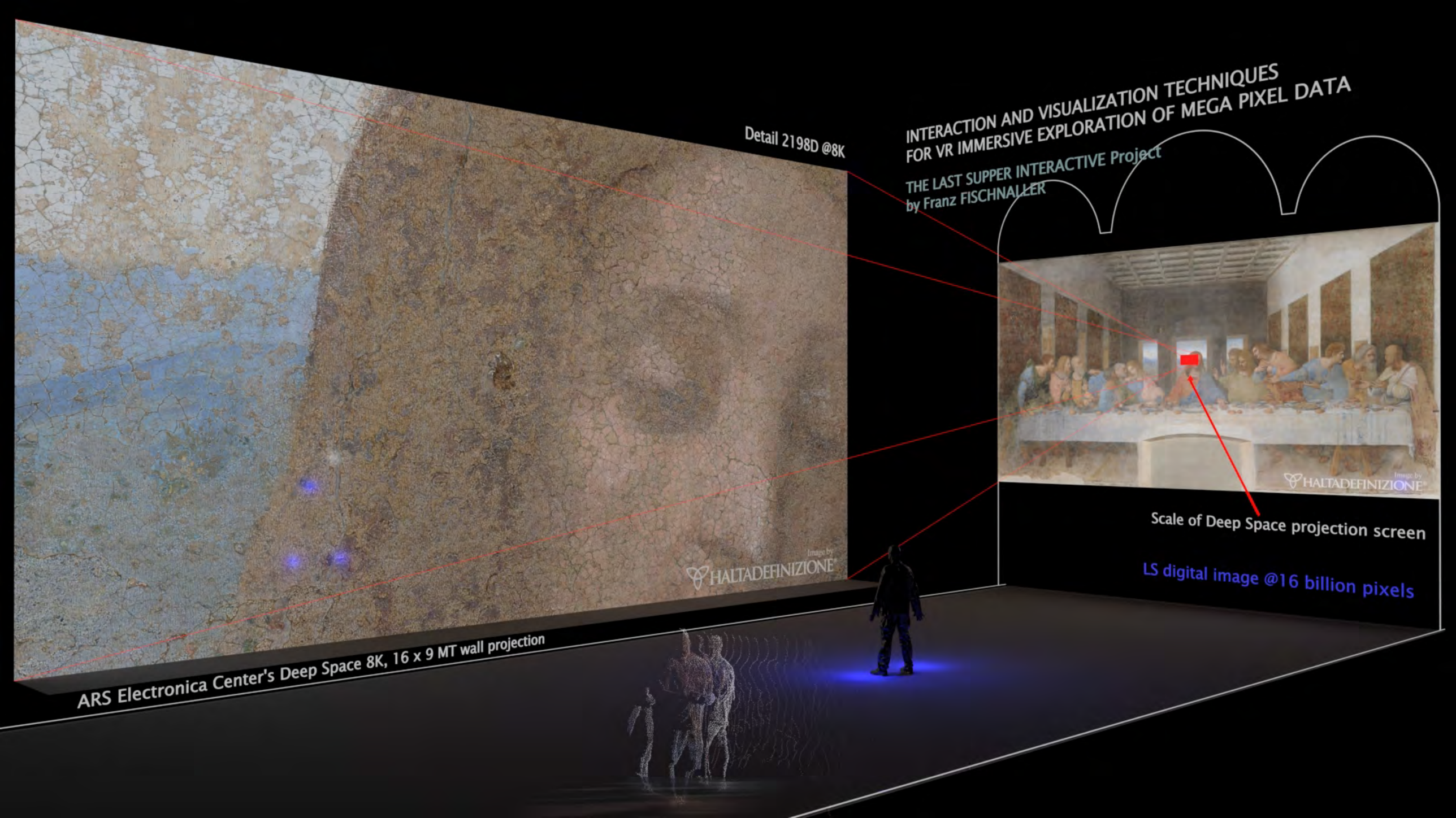


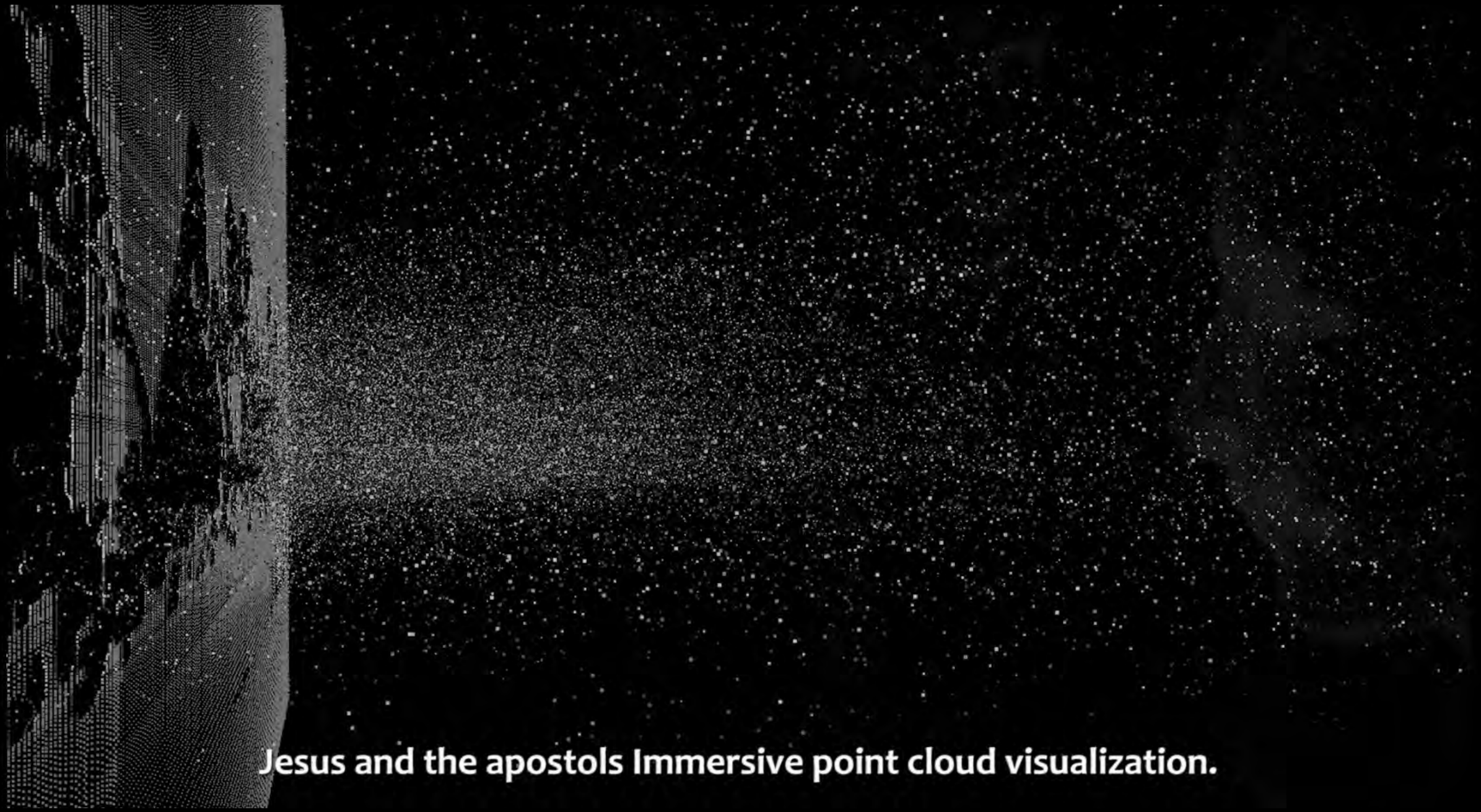


LSI uses the Last Supper world's highest-resolution photo. A 21-billion-pixel Image stitched together with 1042 panoramic images of the 460×880 cm mural painting



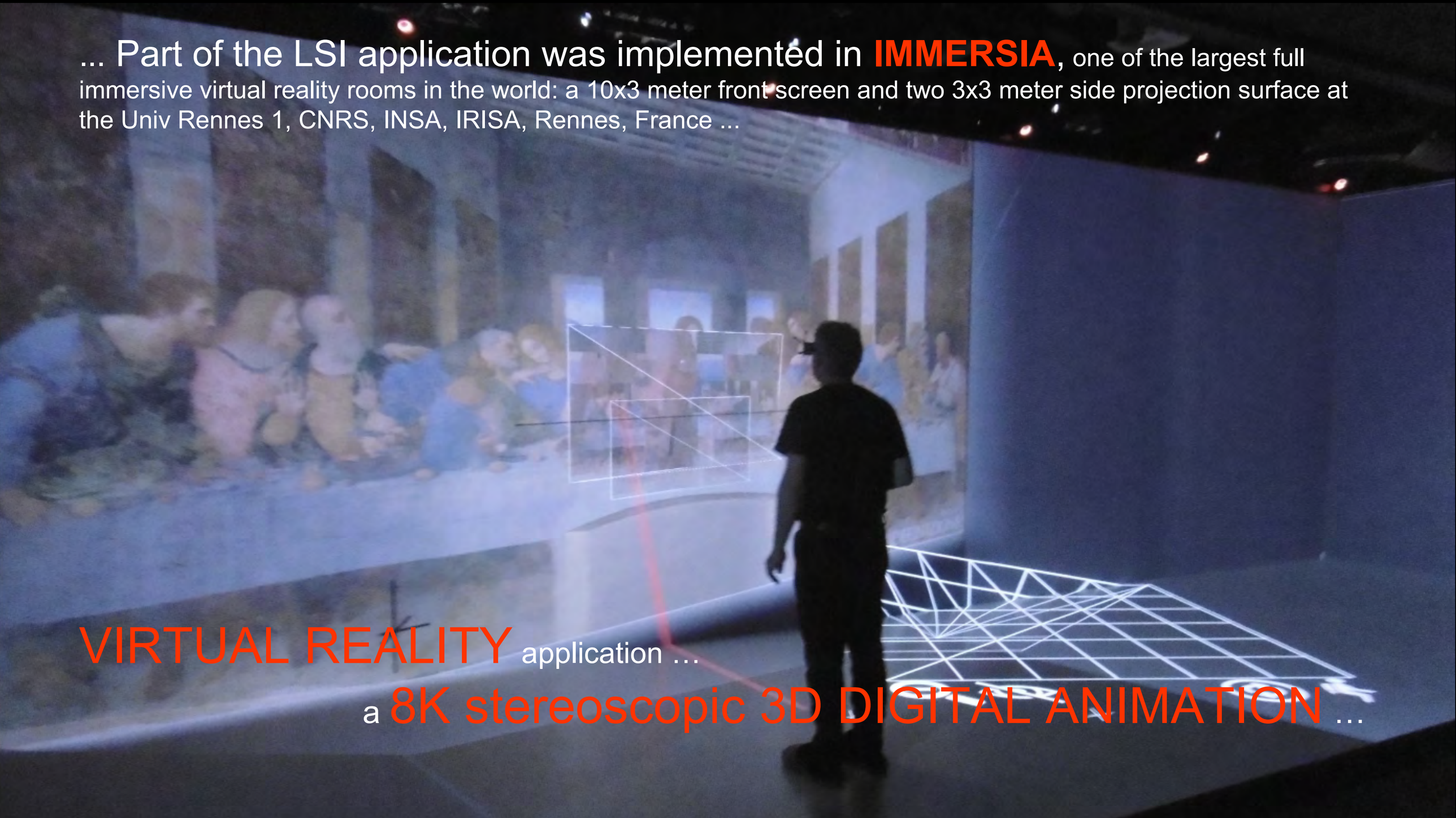
The LSI VR application has been implemented in **IMMERSIA**, one of the largest full immersive virtual reality rooms in the world at the University Rennes 1, CNRS, INSA, IRISA in France;
the **Laser scanned Pointcloud** of the architectural complex of the Dominican monastery of Santa Maria delle Grazie, ever done before, that was carried out by the **Politecnico di Milano** for the LSI, the **8K stereo animation** that has been rendered by **CINECA** – Super Computing Center in Bologna.


INTERACTION AND VISUALIZATION TECHNIQUES
FOR VR IMMERSIVE EXPLORATION OF MEGA PIXEL DATA
THE LAST SUPPER INTERACTIVE Project
by Franz FISCHNALLER
Detail 2198D @8K
Image by
HALTADEFINIZIONE
Image by
HALTADEFINIZIONE
Scale of Deep Space projection screen
LS digital image @16 billion pixels
ARS Electronica Center's Deep Space 8K, 16 x 9 MT wall projection



Jesus and the apostols Immersive point cloud visualization.

... Laser scanning (in/out) of the architectural complex of the Dominican monastery of Santa Maria delle Grazie, ever done before, was carried out by the Politecnico di Milano for the LSI Project, and the 8K stereo animation was rendered by CINECA - SuperComputing in Bologna ...

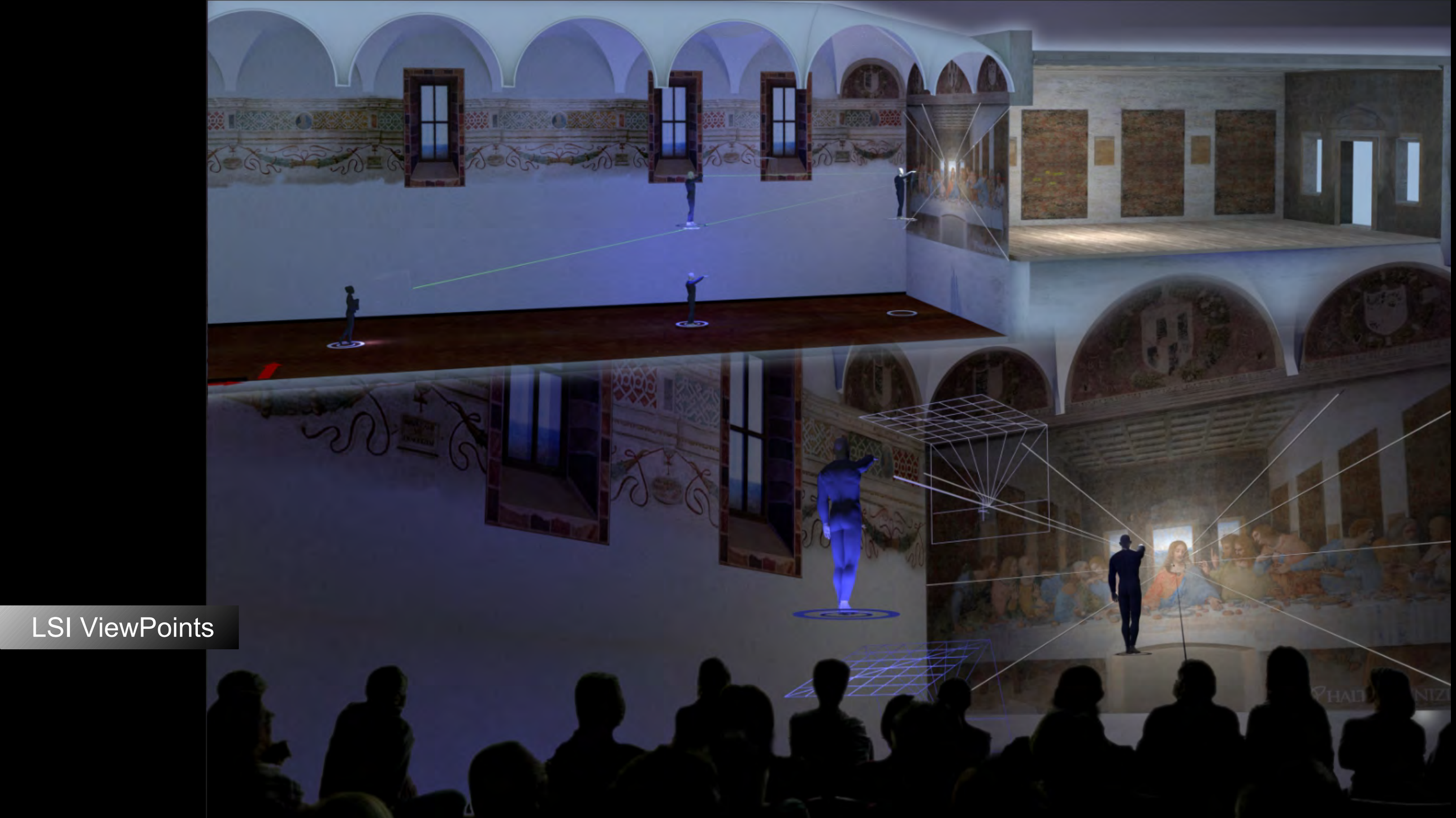

... Part of the LSI application was implemented in IMMERSIA, one of the largest full immersive virtual reality rooms in the world: a 10x3 meter front screen and two 3x3 meter side projection surface at the Univ Rennes 1, CNRS, INSA, IRISA, Rennes, France ...
VIRTUAL REALITY application …
a 8K stereoscopic 3D DIGITAL ANIMATION …

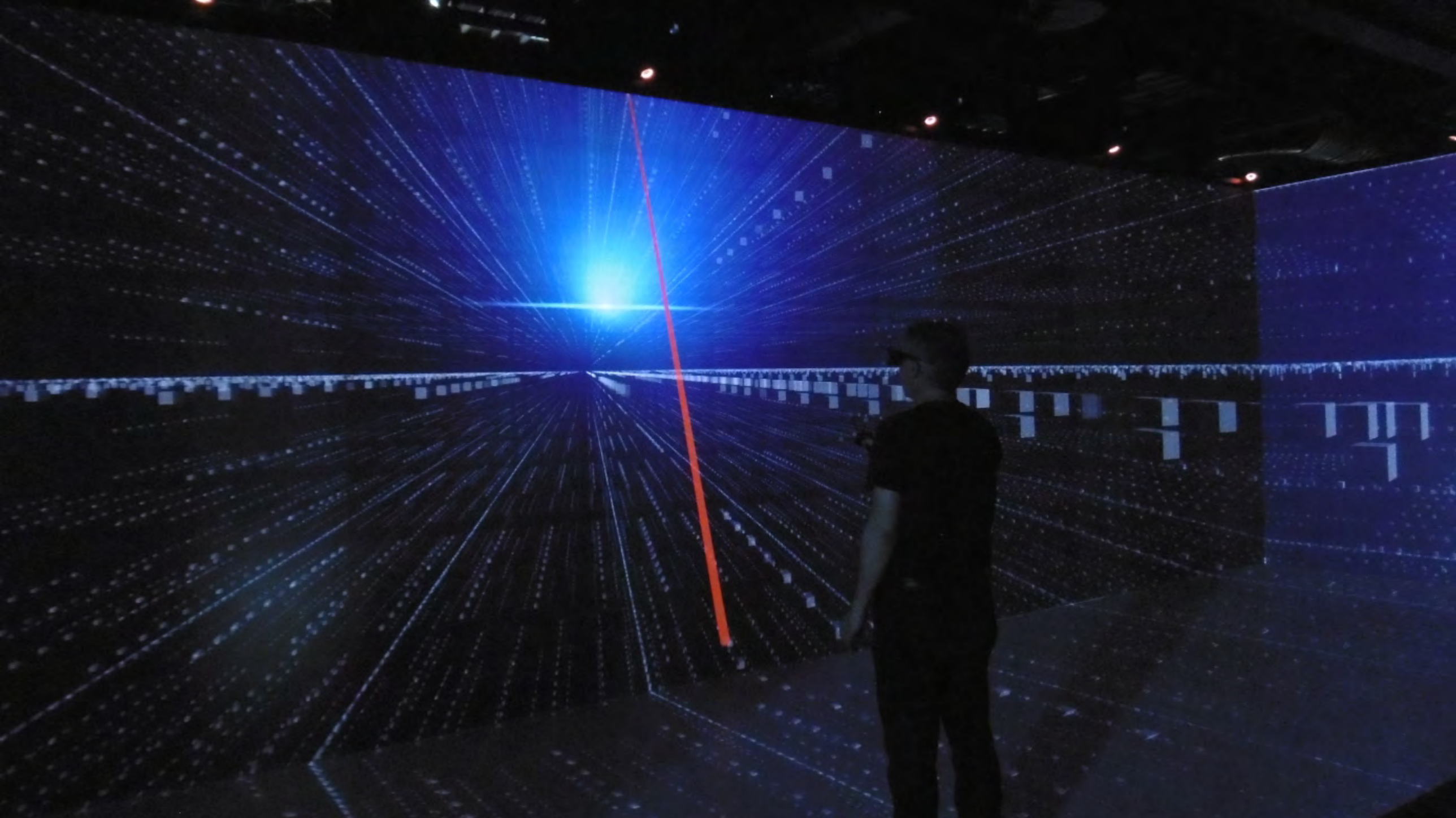
LSI went on display
in ARS Electronica Center 's
DEEP SPACE 8K, an exhibit space of 16 x 9 meter wall and 16 x 9 meters of floor projection, with laser tracking and 3D-8K resolution images.

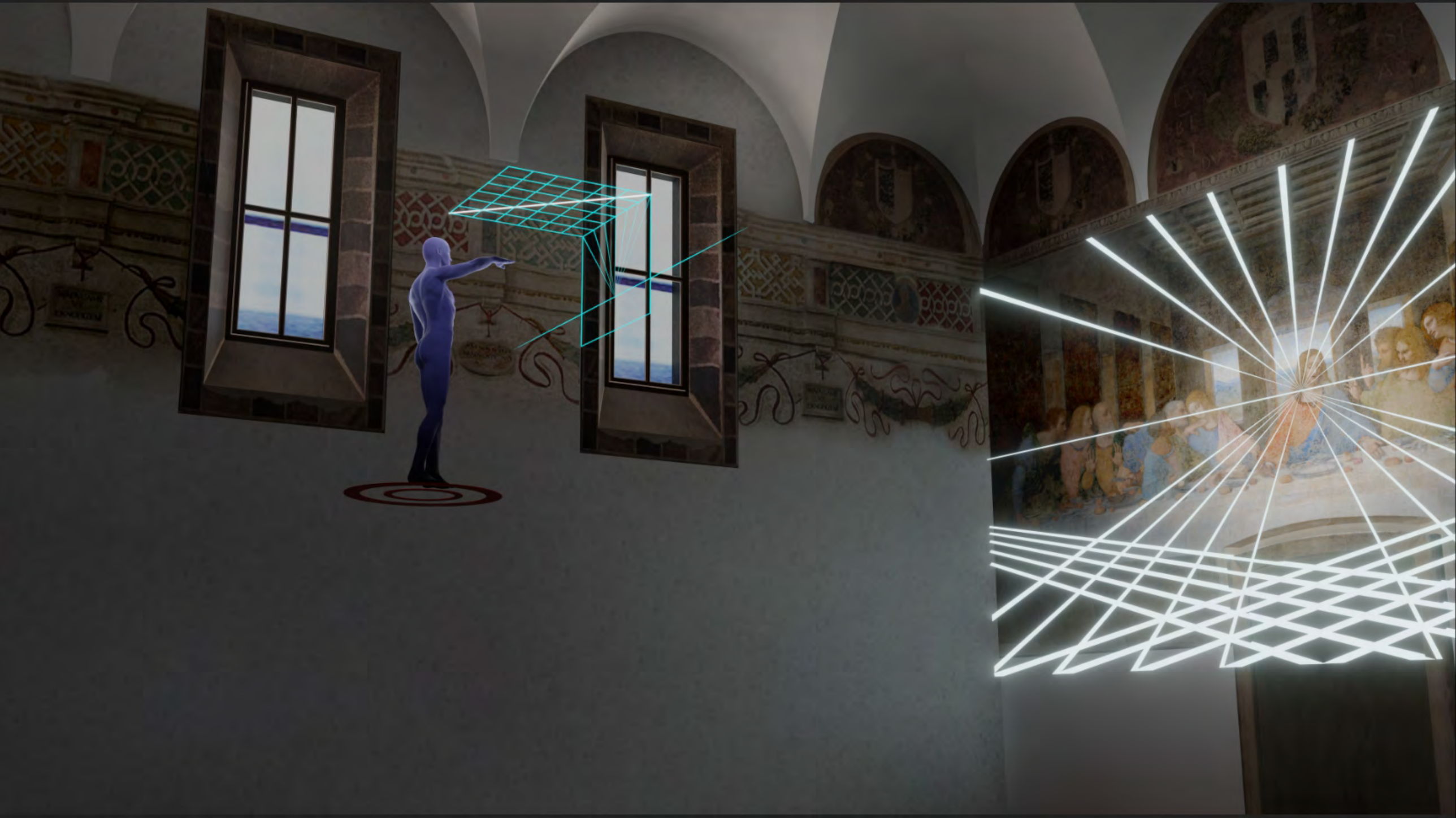
LSI is designed to run on different visualization & display Systems (i.e. Immersive Room visualization for multiple users, Virtual Reality Headset).

Available Formats: Full Immersive LSI -Virtual Reality application in 8K; 8K3D Video (Stereo) and 3D 360 Video.

16x9 mt projection on Deep Space in ARS ELECTRONICA


LSI ViewPoints



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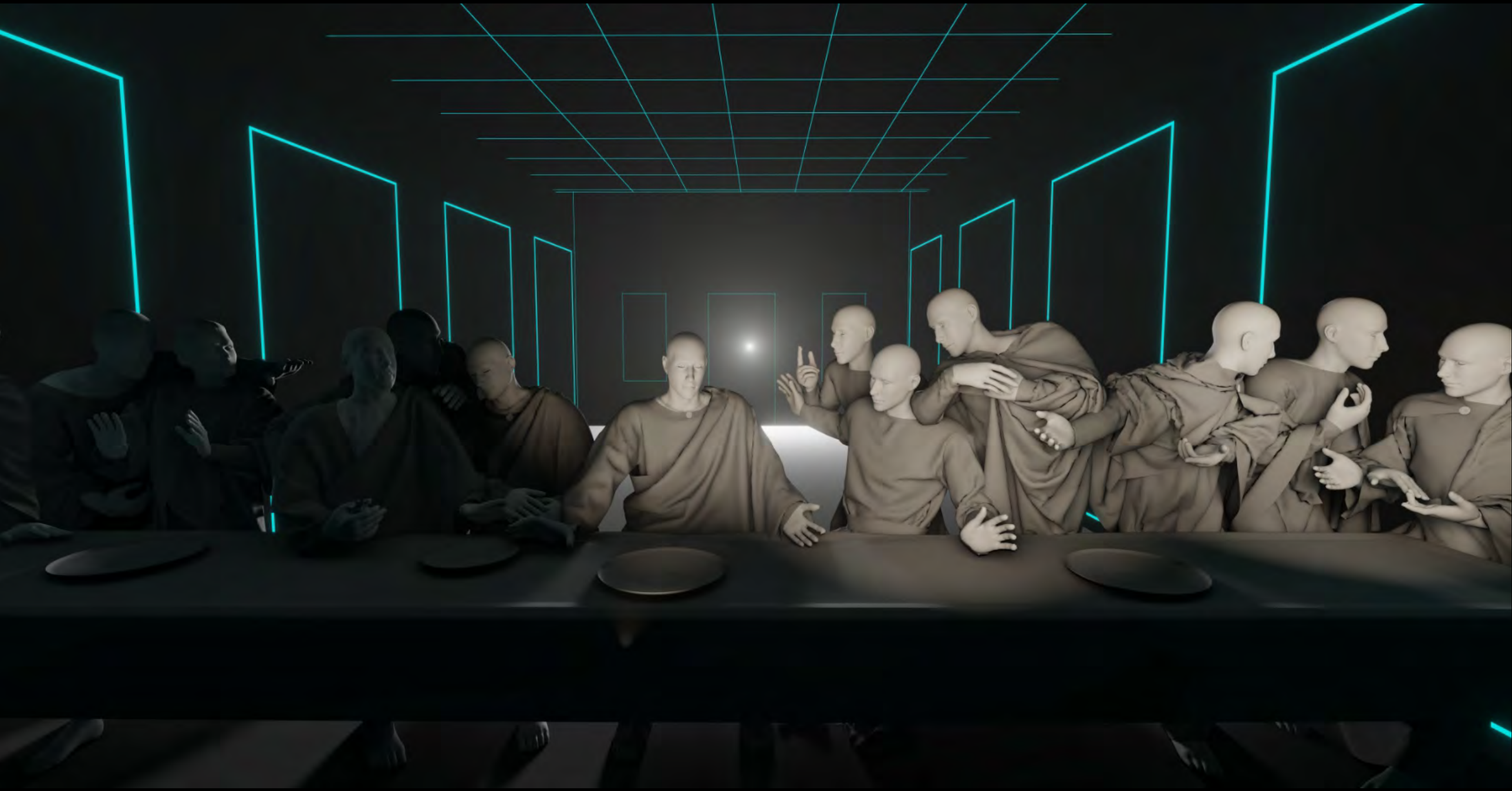


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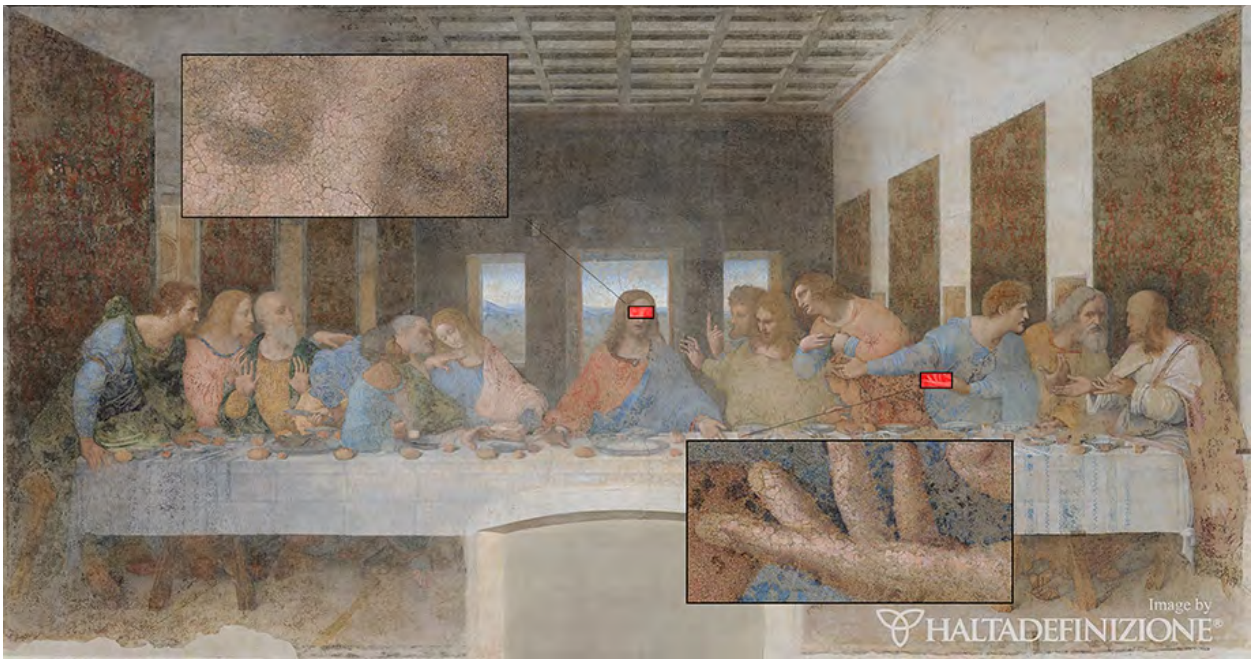

Figure 1. The Last Supper (Italian: L'Ultima Cena), Artist: Leonardo da Vinci, Year: 1495-1498 - Type: tempera on plaster, pitch and mastic - Dimensions: 460 cm × 880 cm (181 x346 in) - Location: Refectory of the Convent of Santa Maria della Grazie, Milan, Italy - Photographic reproduction from the original painting. © F.Fischnaller. Photo:©Haltadefinizione® Image Bank

Gigapixel VR Storytelling [GVRS]

The Last Supper Interactive Project (LSI)

Immersive VR, Storytelling, Leonardo da Vinci, Geometry, Mathematics, Renaissance Arts, Humanities, Digital Heritage

Artpl_129

Abstract

The LSI Project is a high resolution immersive VR storytelling that enables a 360 degree virtual access to Leonardo's Last Supper and transports visitors in the architectural environment where Leonardo created the artwork. Additionally, LSI transfers users “inside” the painting. Conceived for different type of viewing format/experiences, LSI provides an 8K UHD Immersive Virtual Reality Interactive application and a 3D Digital Stereo Animation in addition to a 4K UHD3D-VR 360-degree video. The application runs on different platforms and display systems such as:

Immersive virtual reality rooms, large scale multi viewer immersive spaces, immersive visualization environment and VR Head-Mounted Displays.

Introduction

<1> Research Framework

The LSI is one of the results of author N.N. multidisciplinary applied research: Technology in the Arts , Humanities and Cultural Heritage [1], that concentrates on novel approaches in developing a language of storytelling for immersive VR (based on emotional involvement and driven engagement). LSI embraces a trans-disciplinary fertilization and knowledge creation [2] based methodology through interdisciplinary teams bridging and building strengths across art, design, science, technology, cultural heritage, humanities, social sciences and management; providing emphasis on the use and combination of leading technologies and advanced media tools and techniques, that can provide context for empowering experimental approaches in the design and creation of novel forms of storytelling in VR and immersive narrative in the field of the arts and digital heritage[3] .

This paper presents an overview of the LSI project [4] current state and the most recent goals and outcomes scheduled for the first stages of phase 7. It describes the latest improvements, upgrading and optimization, software migration and new technological features implementations for the visual content and storytelling: the vision, the story, scenes, narrative techniques, music composition and user type of viewing experience, platforms and visualization display system on which the project can run and be displayed; insights into the "making of", the development and implementation process, along with the fundamentals of production, methodological framework, hard- and software technologies; tools and techniques used to carry out the LSI concept and design; the project history, its artistic, scientific, historic and cultural heritage significance, aims and implications, conclusive notes and forthcoming deliveries.

<2> Project overview and history

LSI is conceived as a several-phase development, planned over a number of years. Presently, six phases were completed [5]. Initial stages of Phase 7 (currently in progress), were delivered in summer of 2019. The premiere presentation took place in ARS Electronica Festival 2019 [6], on

the occasion of the quincentenary of Leonardo da Vinci's death in concomitance with the celebration of AEC Festival' 40th anniversary [7].

Figure 2. Scene 5 “Betraying the Master”. LSI VR Experience in the Deep Space 8K, in ARS Electronica Festival 2019. © F.Fischnaller. Photo:Magdalena Sick-Leitner. LS Photo: ©Haltadefinizione® Image Bank

The 8K UHD Immersive Stereo VR Interactive application was showcased in the Deep Space 8K [8] , an interactive exhibit space of 16 x 9 meter wall and 16 x 9 meters floor projection, with laser tracking and 3D 8K resolution. Outcomes of further implementations will be delivered in june 2020.

The Last Supper

The geometry of the arts and mathematics in the Renaissance

Artistic, scientific and cultural heritage significance and implication.

Leonardo da Vinci's Last Supper [9], the late 15th century mural painting on the north-wall of the dining hall (the refectory) of the Convent of Santa Maria delle Grazie in Milan [10], that depicts

the scene of the Last Supper, the final days of Jesus, as recounted in the Gospel of John 13:21 [11] when Jesus announces that one of his twelve apostles would betray *him*.
The Last Supper (LS) is one of the results of Leonardo's research, studies and visions in art geometry and mathematics. He has applied the method of linear perspective [12] in the LS. A mathematical system and technique to achieve the accurate illusion of three-dimensional space on a flat surface [13] used by artists in the early part of the Renaissance [14]

that marked the end of the Middle Ages [15], in terms of artistic technique and pointed the way to the modern era [16]. Leonardo was a pioneer of the single point perspective in painting, which he used to create more realistic paintings.

LSI Project Concept, aims

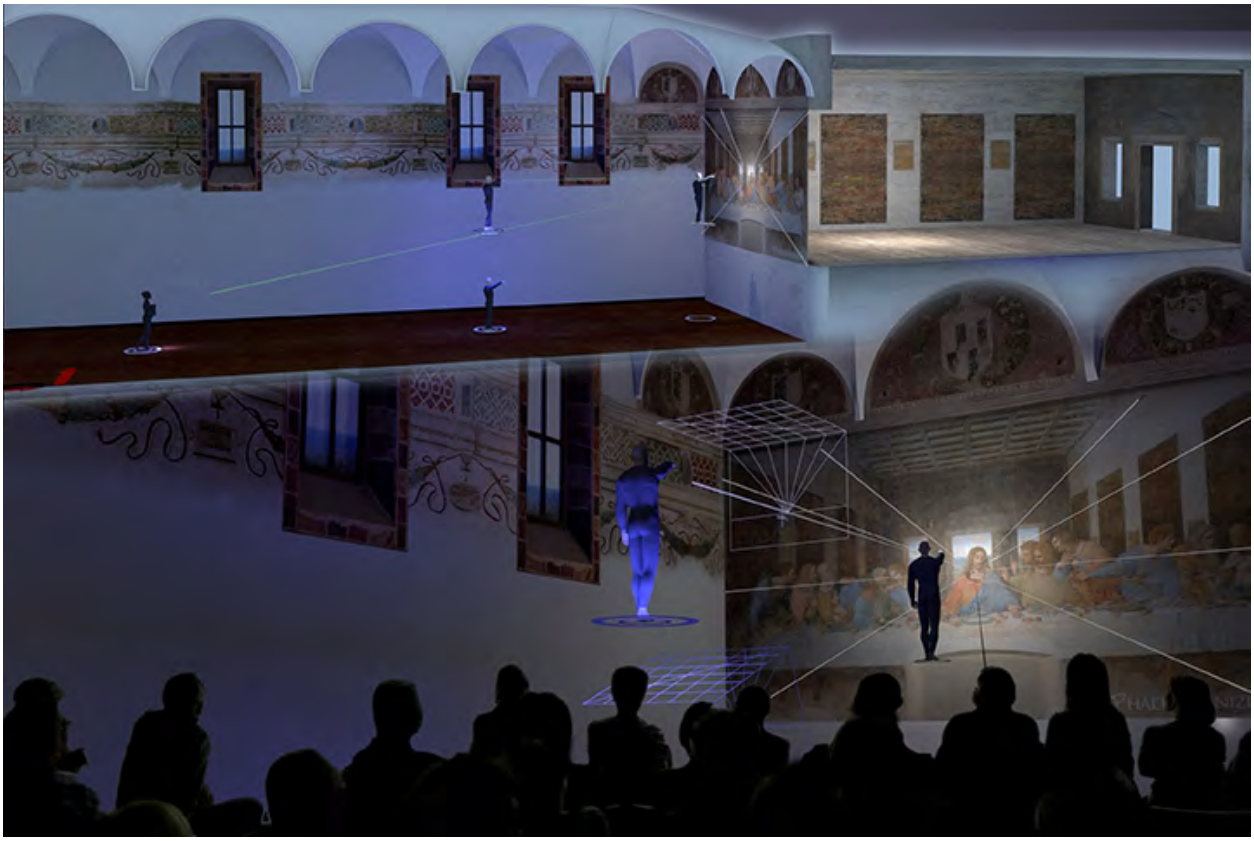

Figure 3. Tracking the Linear Perspective: experiencing a number of alternative virtualized views and interactive navigation allowing visitors to experience the art work from multiple viewpoints, co-location, distance, levels of exploration. VR Experience in the Deep Space 8K, in ARS Electronica Festival 2019. © F. Fischnaller rendering mixed with Photo: Magdalena Sick-Leitner

LSI **is an interdisciplinary project combining traditional humanities disciplines, together with art, design, science, media, technology tools, techniques and computer graphics.** The project's author envisions to create a virtual storytelling, combined with emerging forms of immersive narrative and novel approaches to digital heritage experience, drawing the visitors into the picture to re-visit and enhance visitors' knowledge and appreciation of the masterpiece. To provides deeper ways of sensing and feeling the painting and to gain deeper insights into Leonardo's narrative, symbolism and techniques behind LS. In addition to bring to life the research in art and mathematics and to explore first-hand the use of the geometrical mathematics that underpins the linear perspective applied to two dimensional paintings. Thus, Alberti's Theorem Virtual Tool (ATVT) [17], an augmented virtual interactive device, has been designed ad hoc for the LSI to gain a better comprehension of how Leonardo used the Linear Perspective in his Last Supper painting[18].

Figure 4. Step "inside the painting" and explore the 3D digital reconstruction, the realistically portrayed the room Leonardo depicted in his work of art. VR Experience in Deep Space 8K at ARS Electronica Festival 2019. © F.Fischnaller. Photo: Jessica Roude

In LSI attention is given to location awareness, emotional involvement, immersion and presence and cognitive processes in audio-visual perception, to make visitors feel as if they were there "inside" the painting and within its historical context, hence experiencing the sense of being "immersed" in the scene of the narrated events. There, where the story can be felt, interpreted, experienced, and told, becoming an active part of it [19].

<3> Current stage of the project

Goals and outcomes of Initial Stages in Phase 7

Objectives of the early stages in Phase 7 were delivered as planned. Among which:

- Enrichment of the story and the scenes, content;
- Upgrade LSI in achieving a stereoscopic and ultra-high resolution 8K-3D application;
- Technology improvement and enrichment with new features being implemented and further adaptation to different visualization display systems and platforms;
- Project technological improvement, optimization, upgrading, software migration with new features to be implemented.

At this current stage the project provides for an Immersive Stereo Virtual Reality Interactive Application (8K UHD), content running in tandem with the application adapted for an ultra-high resolution visualization system, a 12 minute 3D Digital Stereo Animation (8K UHD) and a 3D-VR 360-degree video for VR Headset (4K UHD).

Specifically, this stage delivered the enrichment of the first part of the visual content based on Gigapixel - Ultra-High resolution data, and adapted to the updated content based on the scenes and storytelling. LSI uses the world's highest-resolution photo of the Last Supper ever taken. A 21-billion-pixel image, a Gigapixel Image stitched together with 1042 panoramic images of the 460×880 cm mural painting.

The first results of the content development for immersive stereoscopic visualization and interaction for high definition immersive Virtual Storytelling has been delivered and further adapted for testing and experimentation purposes to large scale display systems (up to 8K Stereo) including the VR platform Immersia, the Deep Space 8K and Cineca's Virtual Theater, in addition to Vive head mounted displays.

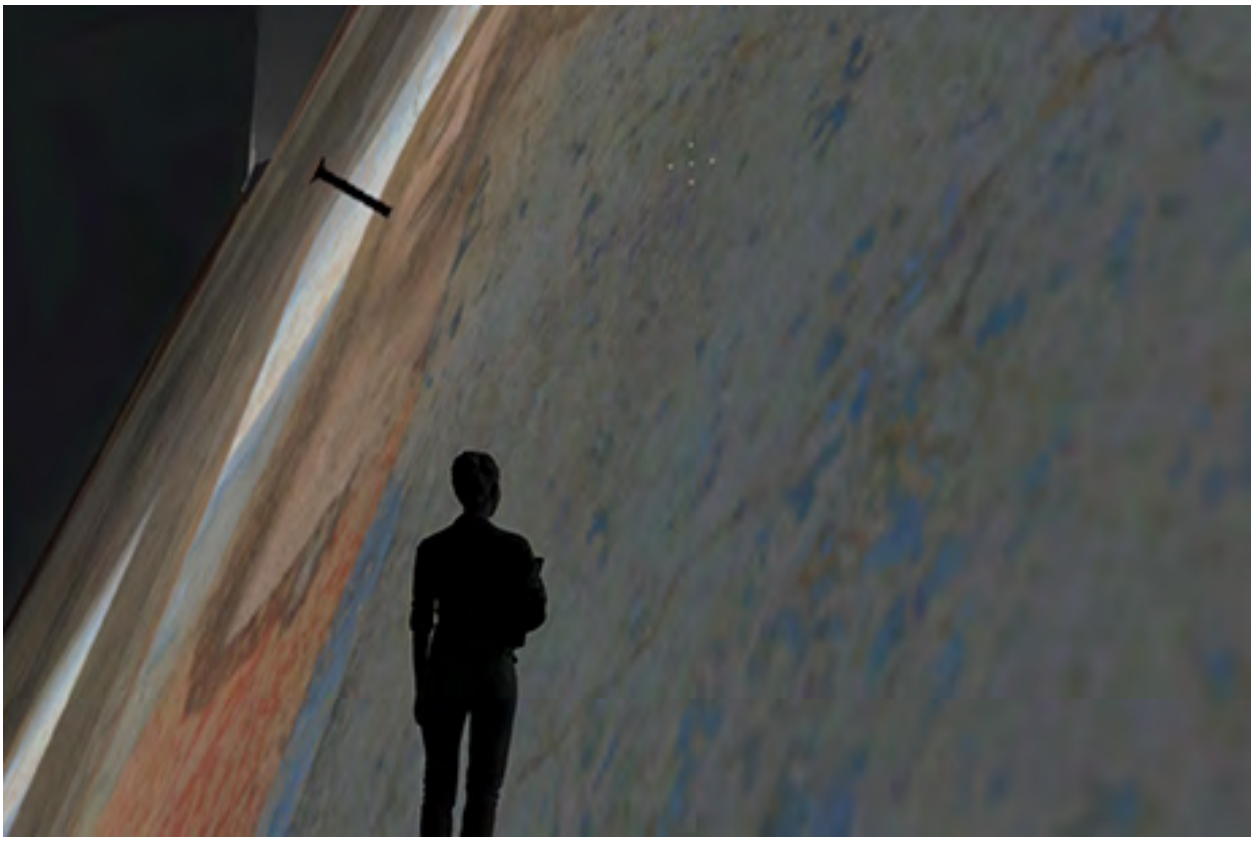

Figure 5. Simulation in VR of the "Close encounter" with the hammered nail at the vanishing point "punto de fuga" of Leonardo's painting. Experience in real time at the Immersia VR space. © F. Fischnaller. LS Photo:©Haltadefinizione® Image Bank

In achieving these goals, it was completed a number of outcomes, some of which are listed here. More detailed explanation of the tasks, process, method systems used to implement the goal described further below in the section the Making-of.

The 3D digitization of Santa Maria delle Grazie - never done before- was carried out ad hoc. An accurate digital model replica of the Santa Maria delle Grazie architectural structure (inside- and outside) was done. Additionally, a 3D model reconstruction, which realistically portrayed the three-dimensional room and its components as depicted in the work of art was done. This includes: the space, composition, components and objects depicted in the interior (on the front wall-less) room, including the figure of Christ and the apostles represented in this painting.

Figure 6. Different internal views of Immersive point cloud visualization in 8K of the Basilica Santa Maria Delle Grazie VR application. © F.Fischnaller.

<4> Scenes, immersive storytelling, narrative visualization and sound art

LSI is composed by eight scenes:

- **Scene 1.** Outside scenario: Dominican Convent of Santa Maria Delle Grazia (SMGZ), Construction of the architectonic environment (Corso Magenta, Piazza Santa Maria delle Grazie, Milan), Interactive Square (Point of departure/arrival);
- **Scene 2.** Basilica Santa Maria Delle Grazie (enter/inside) ... fade in of the inner architectonic structure Cloister and Garden;
- **Scene 3.** Inside The Refectory Construction of the Last Supper + Graphic representation of Linear perspective concept + Refectory inner structure;

- **Scene 4**. The LS+Alberti's Theorem Virtual Tool (ATVT) experiencing Viewpoints A, B, C, Tracking the Linear Perspective;
- **Scene 5**. Betraying the Master **-** Viewpoint C;
- **Scene 6**. Zooming-in, the Centre Point, penetrating the Painting, Viewpoint D to E;
- **Scene 7**. Inside the LS ... Immersion and exploring ... inside/out, Viewpoint E;
- **Scene 8**. Deconstructing… from inside/out, Time Shift Effect, Viewpoint E.

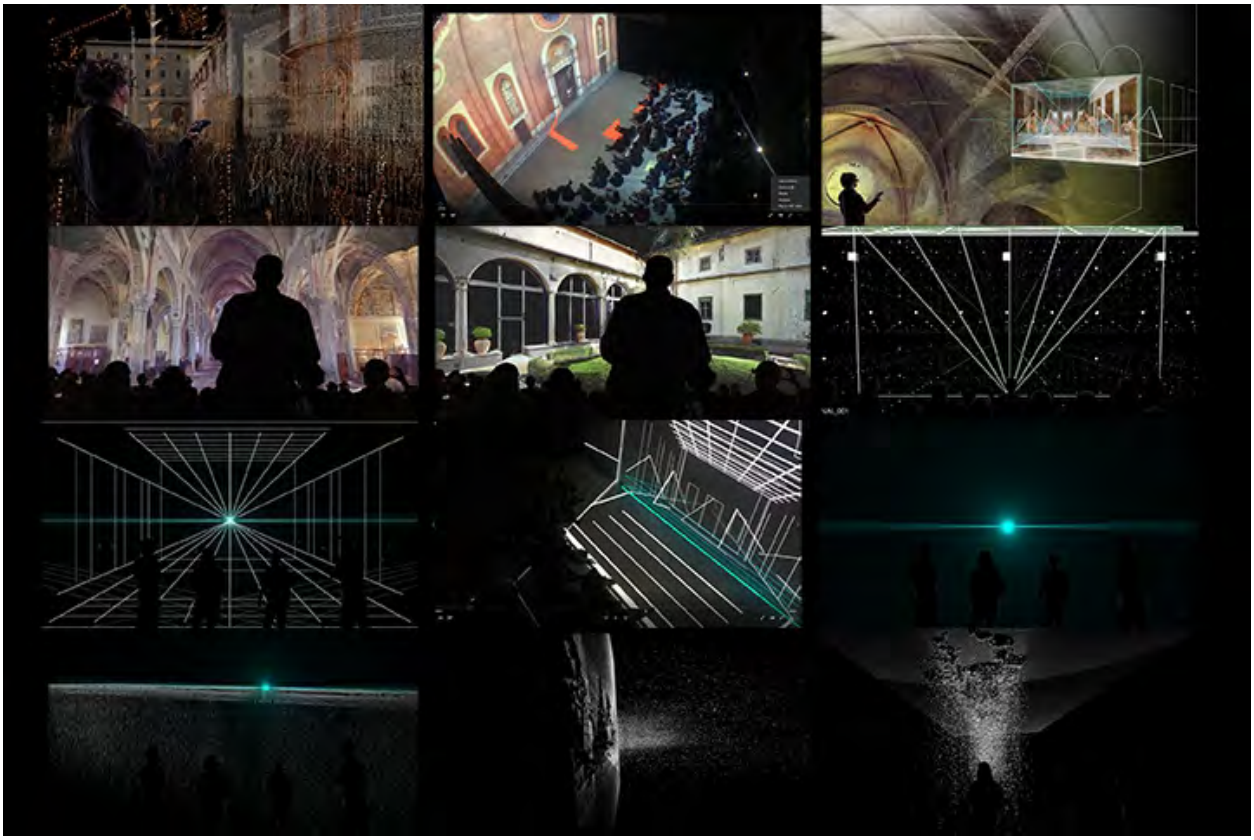

Figure 7. Storytelling, narrative scenes and sequence and (selected) sequences of user interaction in LSI. Part 1.© F.Fischnaller.

Figure 8. Storytelling, narrative scenes and (selected) sequences of user interaction in LSI. Part 2.© F.Fischnaller.

Story, Narrative Highlights

LSI enables the audience to visit and explore the painting with zoom-in capabilities, up to a square millimetre of a 21-billion-Gigapixel Image. Instead of the external observation provided by the two-dimensional view of the painting; from the real viewing height an distance (6 Mt and 4.6 Mt, below the horizon line towards the center of projection), where the observer stands in the real site (the Refectory), LSI provides a number of virtual views and interaction, allowing visitors to experience the artwork from different viewpoints, co-location, distance and through different levels of exploration and contextual information over the full 360º range, through multiple perspective, and height. Furthermore, users can be virtually transported "inside" the painting and explore it first hand from any viewpoint within the multi-perspective pictorial space of the three dimensional environment of the painting's composition, with zoom-level capabilities, getting close to the apostles sitting and standing at the table, experiencing the perspective

from Christ's viewpoint at the height of the horizon and center of projection and looking to the Refectory from the opposite side.

Yet, the LSI not only draws the visitors "between, inside and behind" the painting, but also “transfers” them into the historical context, the physical scenario: the architectural complex of the Dominican monastery of Santa Maria delle Grazie in Milan where Leonardo created the masterpiece on the north wall of the Refectory.

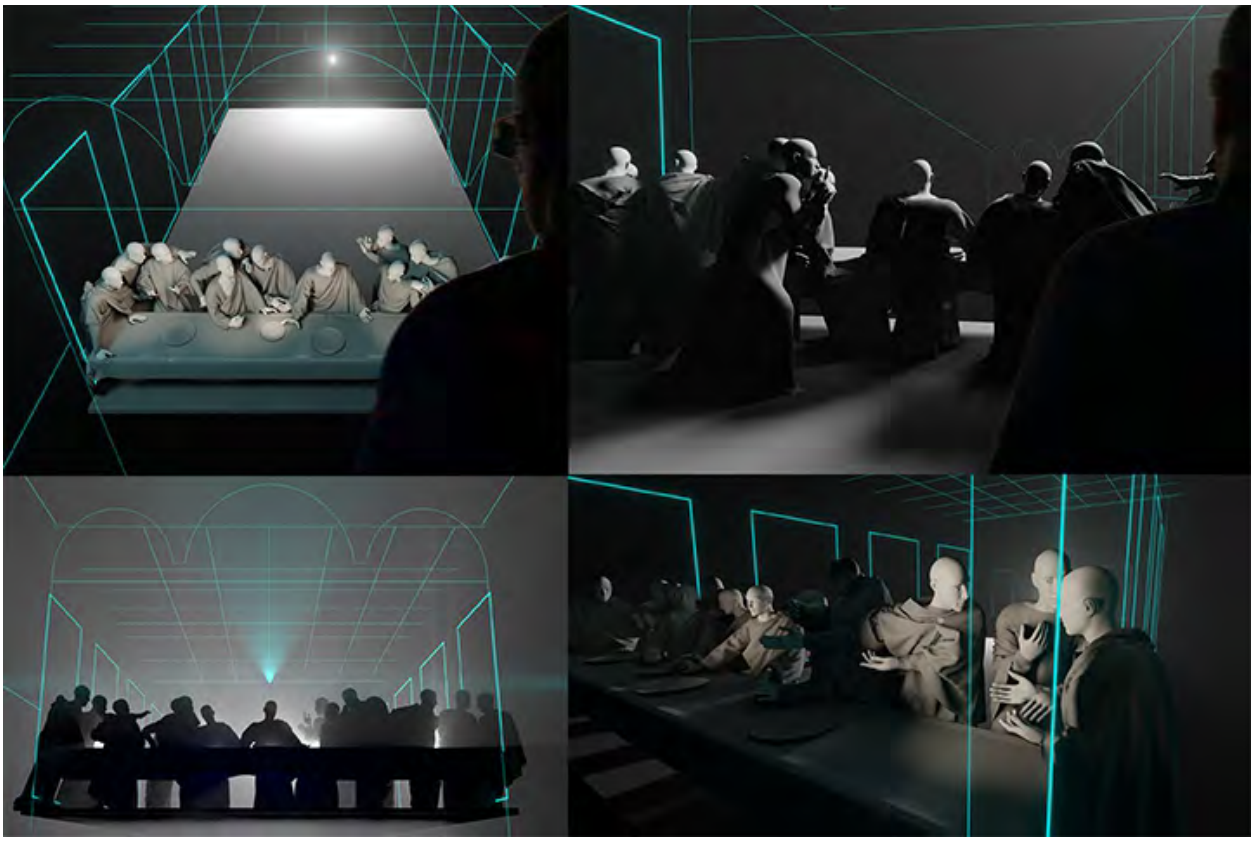

Figure 9. Render images of different viewpoints of the 3D digital simulated figures of Christ and the apostles represented in the LS painting. © F. Fischnaller. Render farm: CINECA

Content visualization approach, iimmersive storytelling and Sound Art

Focus was given the aesthetics to the graphics, the approach of the techniques the digital representation of architectural heritage, the integration and overlays of 3D modeling and textures, merged with the point clouds and photogrammetry of the monastery of Santa Maria delle Grazie, enriched by high resolution 3D realistic architectural simulation, multi-layered texture intersections, overlays and visual effects mixed and combined with music, sounds and

2D/3D information. Music and sound effects are conceived to bring an emotional involvement to increase the user's feeling of immersion, VR dramatization, perspective motion, perception and experience.

Figure 10. Piazza +Dominican Convent of Santa Maria delle Grazie in Milan. Immersive point cloud visualization. Rendered image of 8K UHD 3D digital stereo animation. © F.Fischnaller. Render farm: CINECA

<5> Key highlights of the "making of" - Design, Development and Implementation

Brief

Phase 7 initial stages were developed in several steps and with different teams up on the type task and objective to fulfill. The author's work from day one together with each team leader, on separate basis via online and on site. The teams were located in different geographies locations. A team manager and coordinator support the activities. Planned outcome was delivered by the

end of August 2019. All the team leaders meet for the first time in October 12th to hold a cross-disciplinary workshop based in the project, that took place in Digital Design Days Milan.

Process to obtain the planned objectives for **the initial stages of Phase 7**.

1. Tasks carried on by the author with his in-house team

Concept, design and content development for VR environment and Digital 3D animation in 8K resolution with the integration of Gigapixel images, Ultra-High resolution and complex point-cloud data; upgrading and additional 3D modelling, 3D animation, video editing and coordination of the different media solutions.

A. Concept, Content Design, Methodological Framework

Research, theories, forms, approach, tech+media tools, experimentation

B. Methodologies, Tools and Technologies used for the development and implementation

Definition: Hard- and software technologies, tools and techniques used for the content creation, development, implementation bringing the LSI concept and design to life.

Initial development and implementation of the LSI VR Project in 8K-3D has required (among others) the following steps to compile:

Integration of the 21-billion GigaPixel photograph of the painting Last Supper. This image of Leonardo da Vinci's Last Supper painting (LS) has been tiled into singular 8K resolution images to facilitate the zooming on the high definition image of the painting in real time; all existing 3D models have been scaled in Autodesk Maya to 1:1 scale with respect to the original size of the painting; new additional 3D models with higher details have been created for the various scenes, including an accurate digital model replica of the Santa Maria delle Grazie architectural structure (in- and outside). The existing textures have been scaled up to 4K and higher, and new ones with higher details and resolution have been added.

A 3D model reconstruction, which realistically portrayed the three-dimensional room and its components as depicted in the work of art: the space structure, composition, components and objects depicted in the interior (on the front wall-less) room, including the figure of Christ and the apostles represented in this painting. In addition to the elements of the structure for the simulation and the effects of the perspective applied to the LS painting.

The 3D models have been made using Autodesk MAYA, Blender, Meshlab and CloudCompare; Adobe Photoshop was used for the fine-tuning of texture maps and Marvellous Designer for creating the apostles clothing.

2. 3D Digital data acquisition/processing, photogrammetry, laser scanning of the architectural complex of the Dominican monastery Santa Maria delle Grazie in Milan.
The focus of this activity was to capture a high-resolution 3D representation of the basilica and monastery "Santa Maria delle Grazie" in Milan, containing Leonardo's painting, including a) interiors and exteriors of the church and b) the great cloister adjacent to the cenacle where the LS is located. For achieving this result, we used integration of 3D laser scanning and digital photogrammetry, aiming at generating a redundancy of 3D data coming from the different technologies given the difficulty for getting access authorizations. A phase-shift laser scanner capable of capturing both 3D information and color at 1 million points (MPoints) per second was used (Faro Focus 3D). For photogrammetry, a 24 Mpixel mirrorless digital camera Sony Alpha 6200 was employed, equipped with an aspherical 12mm Zeiss lens.

The 3D digitization activity was completed in two sessions on the field: in March 2019, the photogrammetry and the laser scanning of the basilica exteriors were made; in July 2019, the laser scanning of the basilica interiors and the laser scanning of the cloister completed the data acquisition phase. The laser scanner was set to provide 6mm sample spacing at 10 m from the device (generating 44 MPoints each full-dome scan) for the acquisitions taken outside and in the center of the basilica. The sample spacing was reduced at 12 mm at 10 m (11 MPoints/scan) inside the small chapels on the sides of the basilica in order to maintain a uniform 3D resolution in the final result. Twenty-two scans were taken at the exteriors, 27 in the interiors, and 10 in the cloister. The 59 point clouds collected on the field were registered in a single reference system with the "Iterative Closest Point" (ICP) algorithm embedded in the software tool "Scene" by Faro. By merging the raw data, a 3D cloud of 963 MPoints was created for the exteriors, 348 MPoints for the interiors. The 193 digital images were instead processed with the tool "Metashape" by Agisoft, generating another dense cloud of 16 Mpoints.The final 3D clouds represent the first 3D digitization ever made of the basilica containing the Last Supper. Such

results were delivered to the project partners for proper integration with the other 3D components of the LSI project before its first preliminary presentation given in August 2019.

3. From Physical to Cloud, Photographic Gigapixel imaging of Leonardo da Vinci's Last Super painting (21 billion pixel image); technology, techniques and performance

LSI project uses the world's highest-resolution photo of Leonardo da Vinci's in the development of selected scenes, a 21-billion-pixel image. The image was realised in 2010, taking 1,042 shoots of the original fresco. Final file dimensions: 21,403 Megapixel, 110 Gigabytes, 166,416px (W) × 128,612px (H).

There have been stitched together 1,042 panoramic images of the 15-foot-by-29-foot painting using advanced AMD Opteron technology with 16 GB of memory and a 2-terabyte hard disk. The image was made available thanks to the software platform Jarvis we developed for the use of Gigapixel images: thanks to its structure, the platform allows to store images absolutely safely and with a very reduced need of memory.

It was used a special automatic panoramic head working on the basis of an in-built movement system formed by a Nikon D3 camera and a lightning system expressly built.

The digitized version, produced using special techniques designed to protect the fragile painting from damaging light exposure. The shooting techniques were validated by the Istituto Superiore per la Conservazione e il Restauro (Central Institute for Conservation and Restoration) as non-invasive and not damaging pieces of art.

4. VR Development and implementation

The development and implementation of part of the LSI VR Project were performed in collaboration with the N.N., a research team that owns the VR infrastructure.The immersive structure is constituted of 4 screens, sizing 10mx3mx3m and displaying more than 45 Mpixels. Images are displayed with 14 laser WQXGA projectors associated with 14 Nvidia P6000 graphic cards. Sound is rendered through a 10.2 spatialized sound system. The structure is equipped with infrared full body motion capture system, active stereoscopy, and full space bi-manual haptics.

Scientific challenges handled by the VR team were the interactions with combinations of heavy point cloud data, 8K images and narrative animated 3D data. Interactions were designed with a particular care in order to support the narrative content, from the navigation to the manipulations of the ATVT and zooming on the high definition image of the painting.

The VR implementation was done in Unity 3D, with MiddleVR for multi-process and multi-view synchronization, and homemade libraries to handle point clouds processing and rendering of the 3D digitized basilica of Santa Maria delle Grazie and adapted for processing and rendering for different visualization systems, such as IMMERSIA, Deep Space 8K at the Ars Electronica Center and VIVE HMD. [The integration of the point cloud in a large immersive structure benefited from recent works of the team. In addition, were integrated animated characters rendered by point clouds destined to guide the visitors in their journey.
For the treatment of the Point clouds has been used: MeshLab, CloudCompare and Blender together with the add-on "point cloud visualizer" to convert each point to a simple polygon.
The VR implementation phase was divided in 3 steps, one week of preparation of data constituted of the point cloud resulting from the scan of the basilica, 3 weeks with the hosting of the artist leading the project where it was focused on the interactions and narration, and 2 additional weeks to integrate the 8K images of the painting and adapt the VR application to the Deep Space 8K of Ars Electronica Center.

5. Production and postproduction of 3D modelling and digital *animation*

Part of the Rendering on High Performance Computing of 8K stereoscopic 3D animation sequences with integration of special effects for the HW/SW processing of complex point cloud data and adaptation for Blender has been implemented in collaboration with CINECA.

For the LSI project The Visit Lab team has designed a new pipeline able to optimize the rendering of 8K stereoscopic 3D animation sequences together with the integration of special effects required by the artistic direction and the processing of massive point cloud data in order

to create a flexible Blender open workflow according to the methodology followed in Cineca since the year 2011.
The pipeline allows to reconfigure easily the workflow according to the requirements of the different output video content to be produced (8K stereo, 4K, VR scenes, etc.).
Rendering of 8K stereoscopic 3D animation sequences created in Autodesk MAYA has been done on High Performance Computing of 8K *stereoscopic* 3D animation sequences with integration of special effects for the HW/SW processing of massive and complex point cloud data and adaptation for Blender has been performed on Galileo, an IBM/Lenovo Nextscale supercomputer configured with 516 nodes, for a total of 19060 frames at 8K resolution: 8192 x 4320 pixels; about 115 MB per frame for a total of 2192 GB (2 TeraBytes), Computing time: 95300 minutes 55600 cores / for the visualization of the interior of Santa Maria delle Grazie and the garden, the scene must manage a cloud of points composed of 95 million vertices. For 8K Stereo (sideby side) 16384 x 4320 pixel | size 191 MB | format PNG; the 8K stereoscopic video was edited in Adobe Premiere Pro 2019, mp4 format, Codec: H265 /mjpeg, Framerate: 25 fps.

6. Implementation of the VR application in the Deep Space 8K platform, at the Ars Electronica Center

The LSI VR application was adapted and setup to run on the wall and floor projection of the DeepSpace Projection System with the wand device in MiddleVRConfiguration and assigned its buttons and axis devices to the ones of the game controller.

<6> Conclusive notes forthcoming delivery

The expected outcome was accomplished. As for the next step, the most important direction for the on-going work would be to complete phase seven, that is to deliver a final immersive VR application, a 3D digital Stereo Animation and a 360° video that can run on the different platforms and display systems, mention above. Forthcoming planned project deliverables are scheduled for the second semester of the 2020. We have scheduled presentations starting from June 2020 onward.