Deliverable

Deliverable name
D5.2 – Report on Immersive Content Production – Part 2 and Interactive Media Authoring

Project Acronym:	IMMERSIFY
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Abstract

The subject of deliverable 5.2 is to deliver video clips for project needs (type is "DEC: Websites, patents filing, press & media actions, videos, etc."). This report focuses on Immersive Content Production and summarizes work done in *"Task 5.1 Content Production"* and in *"Task 5.2 Interactive Media Authoring"*. The document describes how T5.1 and T5.2 addressed objectives defined for "WP5 Creative Development and Demonstrations" and describes a set of immersive content material created using different production methods for the Immersify project.

This report is the second iteration of immersive content after D5.1 (M12). It includes additional information on content produced in the second reporting period as well as describes the technical aspects and methodology used for creating interactive media content.

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REVISION HISTORY

Revision	Date	Authors (Entity)	Description of changes
0.1	1 Sep 2018	Maciej Glowiak Maciej Strozyk Eryk Skotarczak	D5.1: Initial content of the document, integration of PSNC content descriptions
0.2	17 Sep 2018	Christian Södergren Erik Sunden	D5.1: Content/immersive production
0.3	18 Sep 2018	Anna Kuthan Sergio Sanz-Rodriguez	D5.1: Content + review of document
0.4	21 Sep 2018	Maciej Glowiak Maciej Strozyk	D5.1: Adding missing sections, first complete draft for review
1.0	**28 Sep 2018**	**Maciej Glowiak**	**D5.1: Final review, final version**
1.1	24 Sept 2019	Anna Kuthan (AEF)	D5.2: Initial content of the document basing on information from D5.1
1.2	6 Mar 2020	Clemens Scharfen, Roland Haring, Anna Kuthan	D5.2: Content produced in T5.2
1.3	16 Mar 2020	Maciej Strozyk, Maciej Glowiak, Maciej Jaskiewicz	D5.2: Content produced in T5.1
1.4	30 Mar 2020	Maciej Glowiak	D5.2: Review
2.0	**31 Mar 2020**	**Anna Kuthan**	**D5.2: Final version**

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LIST OF ACRONYMS

Acronym	Description
HMD	Head Mounted Display
CGI	Computer Generated Imagery
360°	360° video

1 Introduction

This report focuses on Immersive Content Production and involves tasks “Task 5.1 Content Production” and “Task 5.2 Interactive Media Authoring”.

Task 5.1 is dedicated to the creation of new immersive content that can be used to demonstrate the creative and immersive capabilities of the new formats. It also determines how to improve and assess the tools to be developed in the project. We assumed that the content for the project could be acquired and produced in several ways: by using existing content; by producing new immersive video content using the infrastructure and equipment from the project partners or by partnerships with external partners.

Content for the project was to be produced using different techniques in order to explore and compare different production methods: time-lapse photography, 3D laser scan based renderings, CGI and animation, 360° panoramic high-resolution video, and real-life 8K footage. It was also assumed that a part of the content creation and production will be subcontracted to leading content producers. The new test content was also needed to validate the codec technologies developed in the project and optimize the media creation workflows with regard to different content genres in collaboration with the content producers.

Task 5.2 focuses on the creation process of interactive media for VR environments and VR applications. Using the playback infrastructures created in WP3 (mostly T3.5 Unity3D integration) and the content from T5.1 several prototypes for interactive non-linear narratives were created. The prototypes target different VR systems (dome, deep space, VR glasses), audiences (children - adult, single user - multi user groups), interaction forms (gesture based, positional tracking, head tracking, direct and indirect manipulation), presentation forms (guided, unguided), media forms (video, audio, real-time CGI) and rendering techniques (monoscopic - stereoscopic, augmented virtuality). The results are evaluated in T5.3 and integrated in T5.4.

2 Results

2.1 Addressing Objectives

WP5 defines 7 major objectives, but only some of them are related to T5.1 and T5.2

Objective 1: Create new 360° content that is able to demonstrate the capabilities of the project’s outcomes on different environments: Head-mounted-display, multi-screen, multi-projection. We created several video clips and gained some from other sources, as part of subcontracting. The video clips created during the first reporting period were reported in D5.1 Report on Immersive Content Production Part 1. The list of video clips created after the first reporting period (from M13-M30) is enlisted in Section 2.2.

Objective 2: Explore different methods for producing and presenting beyond UHD-4K content including time-lapse photography, 3D laser scanning, CGI and animation, panoramic video, and real-life 8K footage.

A number of video clips were produced in various technologies and different conditions: indoor and outdoor, fast movement, negative temperatures, stereoscopic, timelapse, laser scanning, CGI etc.

Objective 3: Experiment and prototype on new forms of interactive, non-linear storytelling building on the technologies created in WP3 and WP4 and unique high-resolution content. Using the playback infrastructures created in WP3 (mostly T3.5 Unity3D integration) and the content from T5.1 several prototypes for interactive non-linear narratives were created.

Objective 4: Encode the immersive content using the HEVC encoder developed in WP4, and find the appropriate quality-rate points for target applications and demonstrations. and **Objective 5: Find optimal configurations of the encoder for high-quality 8K delivery and playback.** and **Objective 6: Perform an informal subjective test on target display environments to validate the quality enhancements developed in the encoder, and give feedback for potential encoder improvements.** All video contents are accessible for all the partners using common repository. Each movie is encoded by Spin Digital HEVC encoder in several ways and optimal parameters are set. Parameters are selected based on experience gained so far, as well as after screening on different devices and subjective quality assessment (e.g. 8K video wall, 8K monitors, Deep Space and CAVE projection).

Objective 7: Establish and document best practice guidelines for media production workflows
During production of each movie, we documented the whole process incl. equipment used. The making-of photos and video clips are provided on www.immersify.eu webpage and were a contribution to best practice guidelines that are published on webpage.

2.2 Video Clips

2.2.1 Summary

In the project proposal, we planned production (or gaining from external sources) of several video clips in various technologies, as follows:

Count	Resolution	Video	Technique	Duration
2 clips	8K or higher	Immersive 360°, 2D	360° Time lapse or 360° camera	1 minute or longer

Results: Done
Total number of clips: 6
PSNC produced several 360° video clips in ultra-high resolution (8K up to 16K) using Orah 4i (4K), Insta360 Pro camera (8K) and custom 360° composed of 8 Blackmagic cameras (16K). Partners of the project tried different methods of obtaining high resolution and high quality omnidirectional content with using various techniques and obtained some content from external companies such as Arri (which provided 12K content for the project).

Content finished:
Part I
- Cathedral 8K 360° (PSNC)
- Poznan 8K 360° (PSNC)
- Arri demonstration reel 12K (SD) - Pandarama

Part II

- Anomalia Jazz Band 8K (PSNC)
- Noise and Structure 14K (PSNC)
- LuxFest 8K (PSNC)
- Krambabula 16K (PSNC)

2 clips	8K or higher	Stereo 3D	360° camera 3D scan CGI	1 minute or longer

Results: Done
Total number of clips: 10
PSNC has made 3D laser scans of Poznan Cathedral church and generated a number of high-resolution clips, ranging from 8K to beyond 16K. AEF released several clips in 12K-30K (point cloud renderings of the Great Pyramid and St. Stephen's Cathedral, body scans and CGI in Virtual Anatomy) and NVAB produced 2 interactive clips.

Content finished:
Part I
- From the inside - Poznan Cathedral (PSNC)
- Adventure Dome (NVAB)
- Open Space (NVAB)
- Great Pyramid (AEF) - 3 clips
- Virtual Anatomy (AEF)

Part II
- tx-reverse 360°(AEF)
- Fallout shelter 16K (PSNC)
- The translucent St. Stephen's Cathedral (AEF)

2 clips	8k or higher	Stereo 3D	3D animated rendered content	1 minute or longer

Results: Done
Total number of clips: 8
PSNC produced several video clips in various formats for 3D displays available in the project (PSNC 8K wall, Deep Space at Ars Electronica, Dome Theater in NVAB). Two productions in this category (however only in 2D) were created by Theresa Schubert during her STARTS Vertigo residency at PSNC: Always dead or alive, Supercomputers. The stereoscopic piece Prima Materia from Istanbul based studio Nohlab was rendered in 8K x 8K in 3D. Singing Sand 2.0, a 3D stereoscopic audiovisual work in 8K resolution was developed especially for Deep Space 8K.

Content finished:
Part I
- From the Inside in 16K, 12K and 8K (PSNC) - 3D version, 2 clips
- Prima Materia 8K (AEF)

Part II
- Singing Sand 2.0 (AEF)
- Fallout shelter 8K 3D (PSNC)
- Always dead or alive (PSNC, Theresa Schubert) - 2D, 2 clips
- Supercomputers (PSNC, Theresa Schubert) - 2D (in postproduction)

2 clips	8K	2D 60-120 fps	SONY F65	1 minute or longer

Results: Done
Total number of clips: 18
Since PSNC has SONY F65 cameras recording 8K images, this category is represented by the largest number of video clips. In total, 18 of them have been recorded. Additionally, PSNC provided several 8K videos recorded before official start of the project:

Content finished:
Pre-project content:
- Clock 8K [link]
- Fish 8K [link]
- Magda 8K (PSNC) [link]
- Palm House 8K (PSNC) [link]

Part I
- Dziekanowice Ethnographic Park (PSNC) - 3 clips
- Poznan Race Track (Followcar) (PSNC)
- Karkonosze - Szklarka Waterfall (PSNC)
- Karkonosze - Kamieńczyk Waterfall (PSNC)
- Karkonosze - Szrenica Peak (PSNC)
- Karkonosze - Wang Temple in Karpacz (PSNC)
- Karkonosze - Glassworks in Szklarska Poręba (PSNC)
- Cathedral (PSNC)
- Baltic Legend Opera (PSNC)
- 60th TVP Anniversary Gala

Part II
- HighFrameRate 120p (PSNC), 2 clips
- Anomalia 8K (PSNC)
- Hel Peninsula 8K (PSNC)
- InterBee 8K streaming (PSNC, SD)
- ArsElectronica 8K streaming (PSNC, AEF)

2 clips	8K	3D 60-120 fps	SONY F65 + 3D rig	1 minute or longer

Results: Done
Total number of clips: 5
During the project 5 3D clips were made with different techniques (rig with two SONY F65 cameras, rig with two Phantom Flex 4K slowmo cameras, 3D timelapse).

Content finished:
Part I
- one in postproduction (Kornik Castle Garden 8K 3D)

Part II
- Kornik Castle Garden 8K 3D (PSNC)
- Slowmotion 4K 3D (PSNC)
- Poznan Drive 8K 3D (PSNC)
- Ice festival 8K 3D (PSNC)

2 clips	8K or more	2D	Timelapse	1 minute or longer

Results: Done
Total number of clips: 5
AEF has subcontracted three timelapse videos in 8K and 10K and PSNC recorded 2 in 8K and 16K.

Content finished:
Part I
- Atacama Desert (8K) - Martin Heck / Timestorm Films (AE)
- Pano LA 10K - Joe Capra / Scientifantastic (AE)

Part II
- Poznan Timelapse (PSNC)
- Island in the Sky II (8K) - Timestorm Films (AE)
- Hel Peninsula 16K (PSNC)

2.2.2 Clips produced by Immersify project in (Part I: M1-M12)

Clips produced in reporting period 1 (until M12) have been already described in D5.1 and are as following:

2.2.2.1 Kornik Castle Garden 3D

General description	
Title	Kornik Castle Garden 3D
Date	May, 2018
Place	Kornik, Poland
Number of clips	1 (8K 3D)
Content Summary	
8K 3D photos taken in the arboretum of the castle in Kórnik near Poznań	
Technology	
Two 8K SONY F65 cameras placed on Stereotec 3D rig	

Introduction
Kórnik Castle is a castle in Poland, which was constructed in the 14th century. The current neogothic design and remodeling was done in 1855. The current look of the castle resembles Gothic Revival architecture, one of popular historicising styles in the 19th century. The castle is surrounded by Kórnik Arboretum founded by Count Tytus Działyński in the first half of the 19th century - the oldest and largest one in Poland as well as the fourth largest arboretum in Europe covering around 40 hectares and containing more than 3300 taxa of trees and shrubs. In this idyllic scenery, in May 2018, the PSNC team recorded footages of flowering plants in the arboretum using two 8K cameras and a 3D rig, due to lack of power in the park, battery supply of the cameras and all equipment was used. The editing process took quite a long time because of the large volume of 8K 3D raw data and time-consuming post-production but thanks to the use of 8K technology it was possible to capture the richness of colours and details of the filmed plants, and the stereoscopic technology further expanded and strengthened the final effect.
Reference to the content
 https://www.youtube.com/watch?v=rh-jYfemleo

2.2.2.2 Slowmotion 4K 3D

General description	
Title	Slowmotion 4K 3D
Date	2019
Place	Poznan, Poland
Number of clips	1 (4K 3D 60p)
Content Summary	

3D recordings in PSNC studio made using slowmotion technology with two Phantom Flex 4K cameras and 3D rig
Technology
Ultra High-speed cameras Phantom Flex 4K, 3D rig from Stereotec Liquid Nitrogen for freezing objects
Introduction
The PSNC used two ultra high-speed cameras capable of recording 4K video at about 1000 frames per second to record the falling objects frozen in the Liquid Nitrogen. This speed allows us to record and see phenomena that are invisible at normal speed. Using 60 fps recording with 1000fps camera, we can achieve slow motion effect and can see every detail of the processes. Additionally, an innovative approach was to synchronize two independent HFR cameras and make a 3D recording using a special 3D Stereotec rig. On the recordings you can see, among other things, watering of light bulbs, frozen jelly and tulips crashing on the sheet of plexiglass and a flying mini-drone.
Reference to the content
 https://www.youtube.com/watch?v=Y461szKsgK4

2.2.2.3 HighFrameRate 120p

General description	
Title	HighFrameRate 120p
Date	2019
Place	Poznan, Poland
Number of clips	2 (4K 120fps)

Content Summary
4K recordings from Poznan recorded at 120 frames per second
Technology
RED EPIC camera
Introduction
In order to validate 120fps playback feature implemented in the the Spin Player, the PSNC team recorded several shots from Poznan using a RED EPIC camera. These shots were specially selected to take advantage of the HFR effect, so the shots show objects that move very fast. The recordings were made in two totally different places, the first place was the surroundings of the park and the Poznań opera house, and the second was the workshop and it documents the work of the welder.
Reference to the content

https://www.youtube.com/watch?v=KwYDfvGtbRc

https://www.youtube.com/watch?v=WMMLFSJlhrE

2.2.2.4 Anomalia

General description	
Title	Anomalia
Date	2019
Place	Poznan, Poland
Number of clips	2 (360° 8K with ambisonics sound and 8K music video clip)
Content Summary	
Recording of ambisonic sound from the studio concert of Anomalia jazz band and video in 360° and 8K technologies	
Technology	
DPA 4099 microphones (wind instruments), condenser SE2200a microphone (tenor saxophone), dynamic Shure SM57 and condenser Audio Technica AT 2050 (guitar), Ambeo VR Mic from Sennheiser (ambient), Insta360 Pro camera, SONY F65 cameras, audio equipment including Midas Pro's microphone preamps and KlarkTeknik DN9650, Reaper DAW.	
Introduction	
In 2019 PSNC started experiments with ambisonic recordings and multi-channel sound projection. A jazz band called Anomalia (members of which are students of the Ignacy Jan Paderewski Academy of Music in Poznań) was invited to take part in the project. The audio content recorded by the band was mixed in a spherical ambisonic space created by 24 loudspeakers in the New Media Laboratory of PSNC. In addition to the sound recordings, 8K and 360° videos were produced to show Anomalia's performance. The audio material was eventually encoded as an ambisonic sound of the third and fifth order, then decoded binaurally and finally combined with a 360° video. All of that required a proper workflow for the production and mixing of surround sound for the Immersify project. Anomalia band is jazz septet with musicians playing: drums, double bass, guitar, tenor saxophone, soprano saxophone, trombone and trumpet. All recordings were taken in a sound-adapted event room located in the PSNC. The place was illuminated in an atmospheric way using some historic stage lamps. We placed the members of the band in a circle, although we did not try to separate each of the instruments. We wanted to achieve the most spatial and natural recording possible, so different types of microphones were used. Two video clips were produced - one traditional using SONY F65 camera, and second one as an addition to ambisonics sound was recorded by Insta360 Pro camera.	

Reference to the content
 https://www.youtube.com/watch?v=B75AKthg2mY  https://www.youtube.com/watch?v=sYALEBPa01E

2.2.2.5 The Noise and The Structure (rooftop)

General description	
Title	The Noise and The Structure (rooftop)

Date	Summer, 2019
Place	Poznan, Poland
Number of clips	1 (360° 16K + ambisonics)

Content Summary

Outdoor recording of ambisonics sound and the 360° video on the roof of the PSNC building using own 360° rig

Technology

Custom 360 rig composed of 8 Blackmagic cameras
Various types of microphones

Introduction

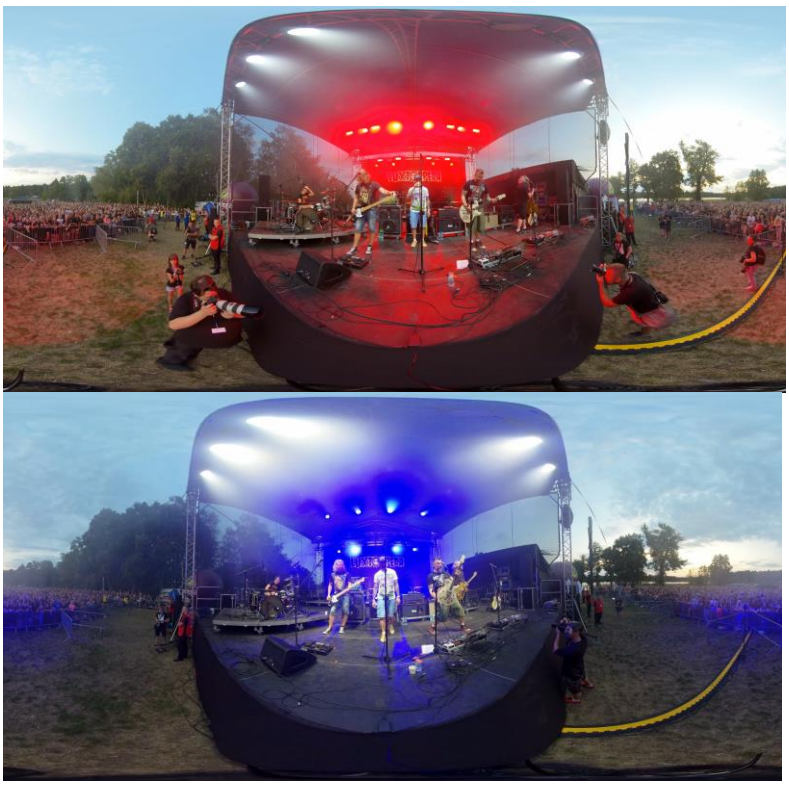
The idea of this footage was to record ambisonic sound and 360°/VR video content in outdoor conditions and to obtain both interesting background sound and 360° image in higher resolution with the help of a custom constructed 360° rig consisting of 8 BlackMagic cameras. Due to the 360° video recording, we wanted to choose a place to be visually attractive. For this purpose, we decided to use the roof of the PSNC building , which allowed us to get amazing scenery and a lot of details. From the musical point of view, we recorded Jan Skorupa's original contemporary composition entitled: „The Noise and The Structure". This composition is written for string quintet (double bass, cello, viola, violin, violin), five crystal bowls and an electronic layer performed live in an eight-channel octagonal system. All the musicians, as before, were placed in a circle, in the middle of which an ambisonics microphone and a camera rig allowing for 360° recording at 16K resolution was set up.

Reference to the content

https://www.youtube.com/watch?v=jIFuI3zb9Xc

2.2.2.6 LuxFest 360

General description	
Title	LuxFest 360
Date	August, 2019
Place	Poznan, Poland
Number of clips	1 (360° 8K + ambisonics)
Content Summary	
360 and ambisonics recording during Luxfest rock festival in Poznan	
Technology	
Insta360 Pro video camera Ambisonic microphone - Ambeo VR Mic from Sennheiser	
Introduction	
Luxtorpeda band was founded in Poznan in 2010 by a charismatic leader Robert 'Litza' Friedrich and now is one of the most popular Polish rock bands. In 2011 they released their debut album; since that time they've released another 3 albums and the band has been awarded many times in Poland and abroad. Luxtorpeda is also interested in new means of expression through technology. The opportunity for collaboration was Luxfest concert in July 2019, where VR and ambisonics audio session was recorded by PSNC. In this case, due to the lack of possibility to build our own microphone setup, we had to base the recording only on the ambisonics microphone and sums from the mixer of the sound engineer of the concert. In this case we wanted to recreate the full stage atmosphere where, combined with a 360° video shootings, the recipient would have the impression of finding themselves live between the band and the audience. We placed the ambience microphone together with the 360° camera at the edge of the stage. This setting made it possible to avoid placing the microphone within the array of the main speaker system. The most interesting effects of spatial sound were achieved during the singing of songs by the audience. Due to the commercial limitations of the rights, the content may be shown only for the Immersify project dissemination and can't be published in Internet or other public broadcasting channels.	
Reference to the content	



2.2.2.7 Poznan Drive 3D 8K

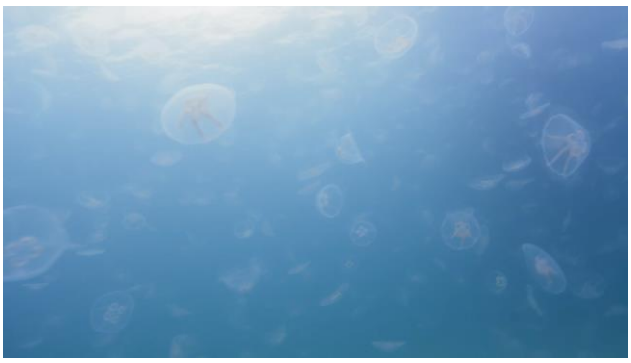
General description	
Title	Poznan Drive 3D 8K
Date	Summer, 2019
Place	Poznan, Poland
Number of clips	1 (timelapse 8K 3D)
Content Summary	
Timelapse in 3D from the car drive through streets of Poznan	
Technology	

Two photo cameras Canon 5DSr + rig + car mount
Introduction
PSNC produced a short 8K 3D time-lapse by mounting two photo cameras on the car roof. The content was recorded during the driving through the most interesting places in the city of Poznan. It is certainly a different view of the city, where even traffic jams are not so terrible. The final clip has been produced in 8K 3D.
Reference to the content
 https://www.youtube.com/watch?v=nuM6JDElj9M

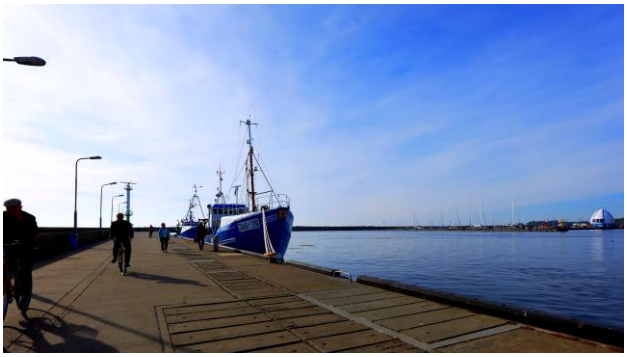
2.2.2.8 Hel Peninsula

General description	
Title	Hel Peninsula
Date	September, 2019
Place	Poznan, Poland
Number of clips	3 (6K underwater, 8K 3D timelapse, 16K panoramic)
Content Summary	
Underwater and aerial video clips from Hel Peninsula.	

Technology
RED EPIC-M DRAGON (6K camera) with underwater case SONY F65 (8K) 2 photo cameras Canon 5DSr with Canon CN-E30-300mm T2.95-3.7 L SP zoom lens + special rig
Introduction
In September 2019 the PSNC film crew took advantage to dive on the Hel Peninsula in the north of Poland. Hel is the most sea-going part of the Polish coast, hence the surrounding waters were a strategic crossing between the Baltic Sea and the Gulf of Gdansk. Many boats, ships and other equipment are sunk there, so these waters are the target of diving expeditions not only from Poland but also from the world. When it turned out that one of the PSNC employees is a professional diver and organizes diving expedition, it was a great opportunity to shoot the underwater world of the Baltic Sea. For this purpose, the underwater housing had to be adapted to the camera, for which the electronics team constructed dedicated additional focus control. The housing was also equipped with lighting lamps. The film team together with the diver first made tests of the immersion and operation of the camera on a 5m deep pool in Poznan. The tests were successful and the parameters for underwater shooting were selected and tuned. After such training and preparations, it was possible to rent a boat and go underwater near Hel town, at the very end of the peninsula. The 6K camera from RED was inserted into the housing due to its compact dimensions. The diver managed to descend to a depth of about 40 meters, but the best shots were taken at a depth of 25 meters. In the underwater view recorded by camera there are sunken shipwrecks, fish and jellyfish, and even... a bicycle. By the way, it was possible to record 8K clips from the boat deck and from the port. The port has a wonderful view of the Puck Bay and the Gulf of Gdansk, behind which you can see the ports of Gdynia and Gdansk, about 25 km away. A drone with a 4K camera was also used in the port, thanks to which films and making-of could be enriched with aerial shots. In the port, two Canon 4DSr timelapse 3D cameras were also recorded, and on the beach, using the same setup, also 12K panoramic shots were taken. In the latter case, in post-production, the images from both cameras were combined into panoramas using PTGui software.
Reference to the content
 https://www.youtube.com/watch?v=d-kTux84xco



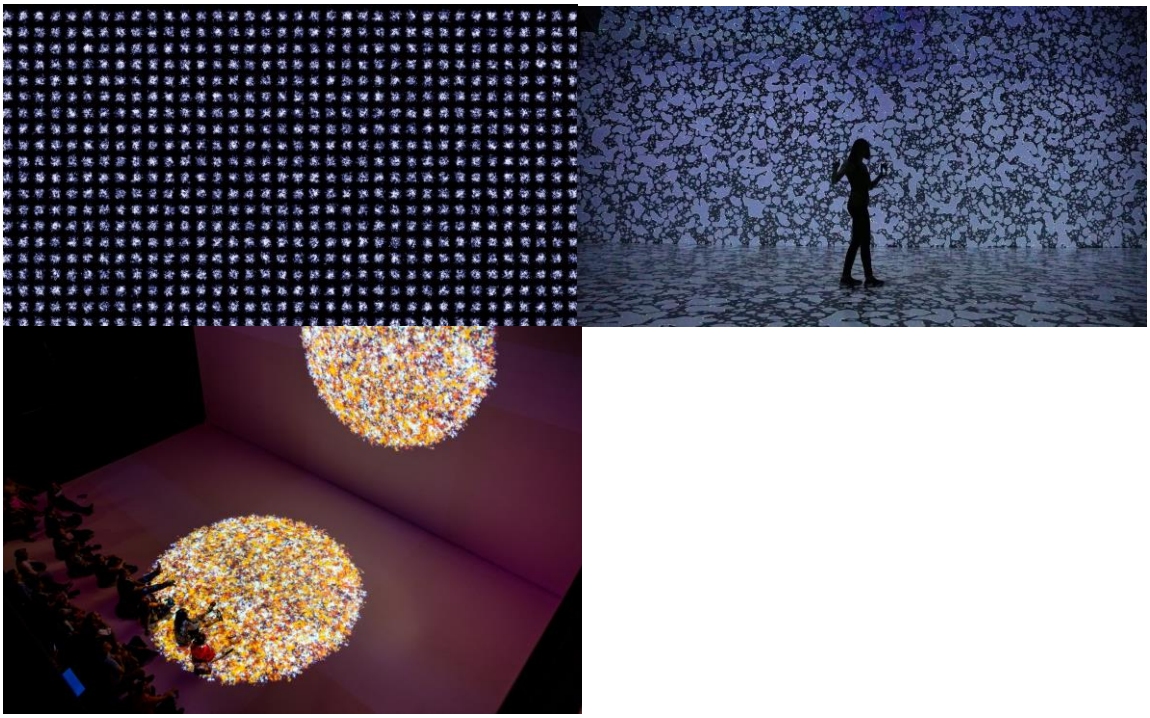
https://www.youtube.com/watch?v=tvwzvDaMsxg



https://www.youtube.com/watch?v=-5JJs_X9iXI

2.2.2.9 Always dead and alive (Immersive Minimalism)

General description	
Title	Always dead and alive (Immersive Minimalism) by Theresa Schubert
Date	Summer, 2019
Place	Poznan, Poland
Number of clips	2 (full time clip and excerpt)
Content Summary	
The CGI graphics in 8K based on Cellular Automata produced as a part of STARTS residency	
Technology	

Computer generated graphics based on Cellular Automata
Introduction
Theresa Schubert's Always Dead and Alive (2019) is an 8K video environment working with cellular automata (CA). In a coded architecture of abstract geometries, a sequence of self-generative patterns plays out, completed and enhanced by an abstract soundscape. It is an immersive and sensorial work intended to make a digital space experienceable in an organic audiovisual flow of light, color and sound, based on the mathematics of nature. In Always Dead and Alive, organic processes unfold within a digital structure. Aspects of living matter (the cell) are applied to hitherto lifeless code (the pixel). The work is an artistic exploration of the interface between life and technology. It applies processual powers of biologic self-organization to intangible mathematical code, describable in zeros and ones, demonstrating the similarities and the possible interconnectedness of the organic and the digital. The work was created as part of a VERTIGO STARTS residency called “Immersive Minimalism“ at PSNC by German Artist Theresa Schubert. Dedicated sound was composed by Jan Skorupa from PSNC.
Reference to the content
 *Source: http://theresaschubert.com/artworks/art/always-dead-and-alive/#images-videos*

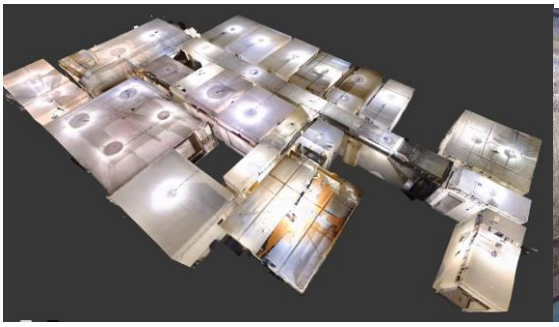
2.2.2.10 Supercomputers (Theresa Schubert)

General description

Title	Supercomputers (Theresa Schubert)
Date	2020
Place	Poznan, Poland
Number of clips	1 (in progress)
Content Summary	
The CGI graphics in 8K	
Technology	
Laser scanner, 8K camera, CGI	
Introduction	
After several visits to PSNC and also after having seen their infrastructure, Theresa Schubert started to be fascinated by large server rooms. The huge concrete halls with server racks, blinking LEDs and deafening noise create a very specific atmosphere. The concept for 25-min. film is to juxtapose images of real Server Spaces, that hold the Supercomputer, but also obsolete server technology. The story unfolds based on visual metaphors of computer networks discussed via a real supercomputer server space and the forest as a superorganism. The film is told from a female first-person perspective via different text-to-speech programs. Produced by the PSNC-team in native 8K and 4K respectively it uses newest film technologies in combination with 3D laser scans and computer-generated visuals. This film is currently (Mar 2020) in the final stage of postproduction and will be an additional outcome of the residency.	
Reference to the content	

2.2.2.11 Fallout Shelter

General description

Title	Fallout Shelter
Date	2019
Place	Poznan, Poland
Number of clips	2 (8K 3D + voiceover, 360 14K ambisonics)
Content Summary	
Point cloud rendering of the fallout shelter from 1950s.	
Technology	
FARO Focus 3D X330	
Introduction	
Under a small house on the outskirts of Poznań there is an fallout shelter built in the 1950s prepared for the Mayor of the city. During the communist times, only few people knew about the shelter and its location was a state secret. After the fall of communism, in 1989, the shelter remained unused and, preserving its original equipment, it was transformed into a museum. The PSNC team had the opportunity to go down to the shelter and go back in time to a moment when a nuclear war seemed inevitable. Using a laser scanner, several dozen scans were made and a complex model of the shelter was obtained in the form of a point cloud. Using Blender software, two versions of video clips were prepared - 8K 3D and 360 in 16K.	
Reference to the content	
 	

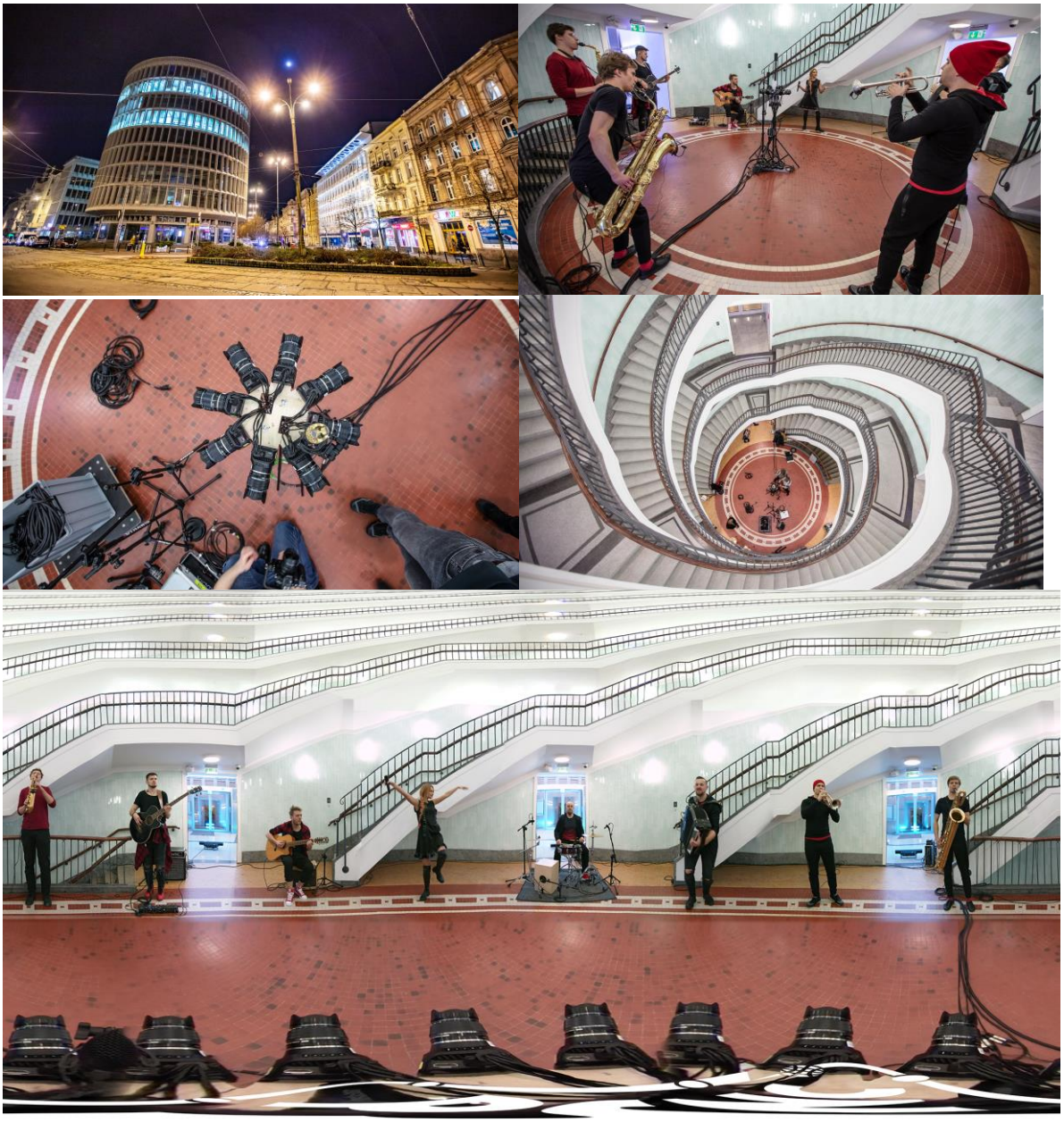
2.2.2.12 Poznan Ice Festival 8K 3D

General description	
Title	Poznan Ice Festival 8K 3D
Date	December, 2019
Place	Poznan, Poland
Number of clips	1
Content Summary	
Timelapse in 3D showing the long process of ice carving during Poznan Ice Festival	
Technology	
2 Canon 5DSr + rig	
Introduction	
Since 2006, every year the Poznan Ice Festival has been attracting crowds becoming one of the greatest points of wintertime in Poznań. It's an international competition hosting guests from all over the world. Some of them come from places familiar with ice like Canada, USA or Poland but also from countries you wouldn't even suspect: Philippines, Malaysia, Spain. For the PSNC film crew the festival was an opportunity to test the 3D timelapse. A few hours of ice carving process was a perfect scenery for this. Two Canon 5DSr photo cameras placed on a special ring and situated on a pedestal were taking a 8K 3D timelapse for about 8 hours at a temperature close to 0 degrees Celsius. By the way, we managed to get a record of the amazing ice spider sculpture that won the competition.	
Reference to the content	

https://www.youtube.com/watch?v=0oPjSFPxqCo

2.2.2.13 Krambabula 360

General description	
Title	Krambabula 360
Date	2020
Place	Poznan, Poland
Number of clips	1 (16K 360 25fps + ambisonics)
Content Summary	
Recording of ambition sound and video 360 in the modernist building Okraglak in Poznań	
Technology	
8x Blackmagic Micro Studio Camera 4K + rig Ambisonic microphone - Ambeo VR Mic from Sennheiser	
Introduction	
Krambabula is a folk-rock band from Poznań, which plays an energetic mixture of Slavic folk music with a touch of rock. The lyrics of the performed songs are in Lemko, Ukrainian and Polish. Many of them are songs from traditional music, sung in a so-called white voice and filtered by various musical passions of the group members. The PSNC crew invited the members of the band to record an	

ambisonic sound of several songs. The whole recording was made in Okrąglak building in Poznan. In order to record 360 in 16K resolution, the 360 rig built by PSNC was used. This content was specially prepared for new ambisonics and immersive installation for Cannes XR event.
Reference to the content


2.2.2.14 InterBee 2019 8K

General description

Title	InterBee 2019 8K
Date	November 18-20 2019
Place	Poznan-Tokyo
Number of clips	1 (8Kp60)
Content Summary	
Recording from the realization of the 8Kp60 live streaming demonstration during InterBee	
Technology	
4 x 8K Sony cameras 3 x IP Live devices Advantech's VEGA real-time HEVC encoder Spin Live Streaming software (HLS, AWS) Spin Player as HEVC decoder and media player	
Introduction	
For the InterBEE 2019 (Tokyo) Immersify partners – PSNC and Spin Digital – have been collaborating with NHK Technologies to present a special live streaming event from Poznan to Tokyo. At the New Media Laboratory in Poznan, PSNC hosted a unique artistic performance (live painting) that was captured and transmitted in 8Kp60 via public Internet. At the NHK Technologies booth in Tokyo the content was presented on a large 8K screen and was open for all visitors. The audience was able to watch the process of painting in an unusual technological scenery consisting of four 8K cameras and a robot. In addition, an 8K live video signal produced by NHK Technologies in Tokyo was transmitted to Poznan and presented inside the scene of the artistic performance, creating a special sense of remote participation.	
Reference to the content	

https://www.youtube.com/watch?v=KCqtynuu4B8

2.2.2.15 Ars Electronica Festival 2019

General description	
Title	Ars Electronica Festival 2019
Date	September 5-9, 2020
Place	Poznan-Linz
Number of clips	1 (8Kp60)
Content Summary	
Recording from the realization of the 8Kp60 live streaming demonstration during AEF 2019	
Technology	

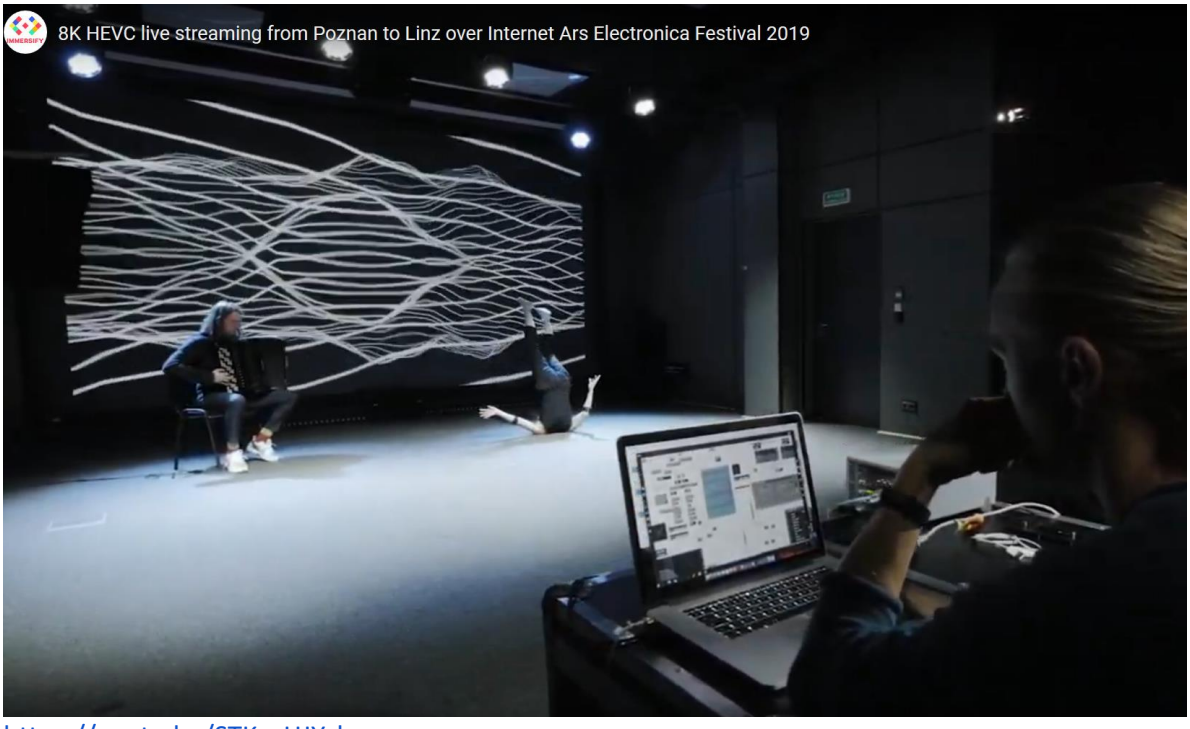
4 x 8K Sony cameras
3 x IP Live devices
PC server equipped with:
- Blackmagic DeckLink 8K Pro
- two nVidia Quadro P5000 cards

MYO Armband
Spin Player as HEVC decoder and media player

Introduction

During this festival, the Immersify consortium was involved in several different activities and one of them was 8K Live Streaming Demo. The demonstration used a number of new interesting solutions – from the artists' performance, through the use of a PC and graphics cards to encode HEVC 8K, transmitting network streams via the traditional Internet instead of a dedicated link, and finally – thanks to a low delay of about 2 seconds – remote interaction with the artists.
The performance was created by the Movement Sonification Lab, a group of artists oriented around artistic, research and affective aspects of feedback loops between the body in motion and sound environment. They apply the technologies that are able to sonificate and visualise kinetic data and shape the relationship between movement and the sound in real time. The "Receive" is an interactive performance based on the sound improvisation between the dancer – Anna Kamińska and the musician – accordionist Przemysław Degórski. It is the short study of the generating sound by the accordion which is mediated by the dance and movement sensors (Myo armband). The sound is processed in various ways with the motion – from becoming another disembodied musician to enhancing the analogue boundaries of the instrument timbre.

Reference to the content



https://youtu.be/STKz_HJYzlc

2.2.3 Clips produced with third parties

A part of the content creation and production was subcontracted to leading content producers. Clips produced in reporting period 1 (until M12) have been described in D5.1. Following is a description of clips produced by/with subcontractors after M12 (M13-M30).

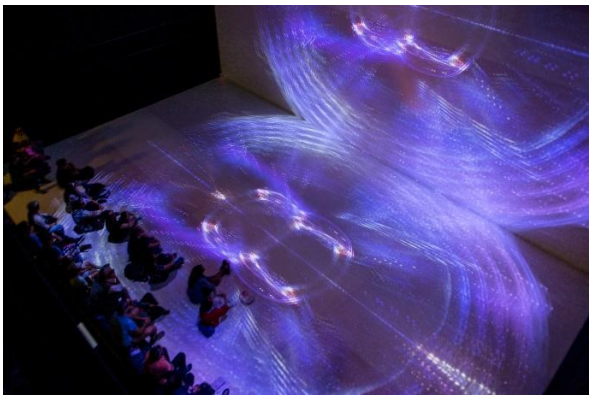
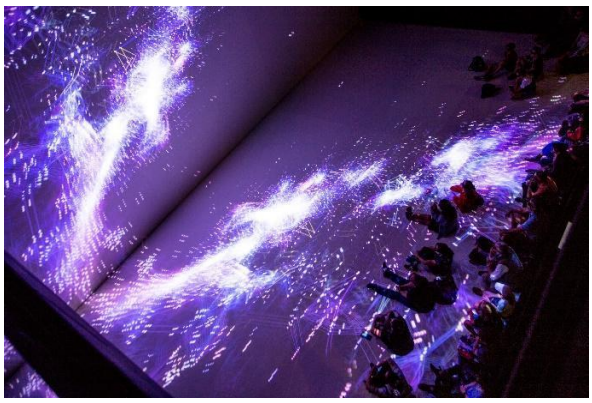
2.2.3.1 Island in the Sky II

General description	
Title	Island in the Sky II
Subcontractor	Timestorm Films
Date	May 2018
Number of clips	1
Content Summary	
Timelapse video of La Palma, Spain	
Technology	
Timelapse with sound 8K@60fps, 4:30 min Camera: Nikon D850, Sony A7RIII, Sony A7RII, RED Epic-W	
Introduction	
Almost seven years after the release of the original “Island in the Sky” timelapse film by Christoph Malin – back then showing timelapse techniques that were revolutionary to say the least – Timestorm Films is back with a state of the art sequel. Shot in native 8K 60fps, this film tries to showcase future display and video technologies.	
Reference to the content	
https://immersify.eu/content-demos/island-in-the-sky-ii/ https://youtu.be/CI8P7gMJbVg	


2.2.3.2 *Singing Sand 2.0*

General description	
Title	Singing Sand 2.0
Subcontractor	Tadej Droljc
Date	Feb 2019
Number of clips	1
Content Summary	
Singing Sand 2.0 is a 3D stereoscopic audiovisual work in 8K resolution that was developed especially for Deep Space 8K in the frame of Immersify.	
Technology	
8K stereoscopic CGI	
Introduction	
Singing Sand was inspired by the sonic potential of abstract 3D computer graphics. The central element of the composition is a physics-based visual material whose movement is sonified in real-time. The piece explores what various particle fluctuations, tensions or shape-morphings sound like, what internal rhythms they create and how that affects our perception of the visuals in return. Grains of sand resembling visual particles are sonified by mapping their individual velocities to various parameters of individual grains inside a custom-made granular synthesizer. At the same	

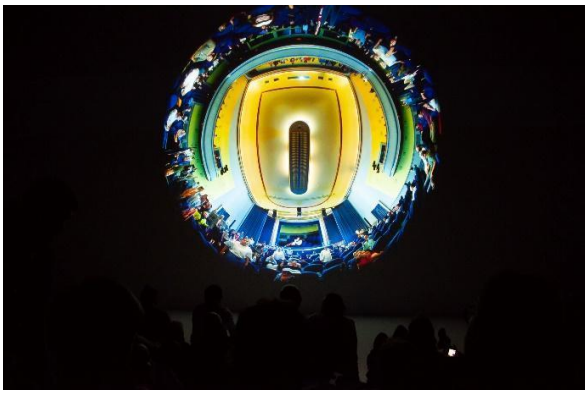
time the velocities determine the colours of the particles which together creates a spectrum of colours and sounds. This results in perceptually tight audiovisual bonds, which is a crucial element of this piece as the composition focuses on the gestural qualities of the audiovisual material. The aim of the composition was to explore how such audiovisual material could function in a free audiovisual paradigm and also how to meaningfully force it onto the grid of harmony and metric rhythm. In the latter case the material created liquid grooves on top of dub-tech influenced fixed rhythmic elements, as well as ever changing spectral swirls that emerged from cross-breeding an originally noisy and non-stable sound source with pitch-based material. The piece represents an attempt to compose from within an audiovisual paradigm where most of the compositional decisions came as a consequence of cross-fertilisation between both modalities.
Reference to the content
https://immersify.eu/content-demos/singing-sand-2-0/ https://youtu.be/n3gSq3nQD-k

2.2.3.3 tx-reverse 360°

General description	
Title	tx-reverse 360°
Subcontractor	Martin Reinhart, Virgil Widrich
Date	2019
Number of clips	1

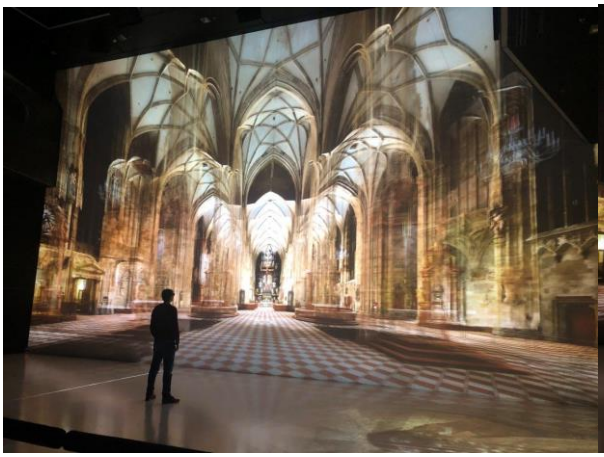
Content Summary
Virgil Widrich Film- und Multimediaproduktions G.m.b.H. provided us with tx-reverse 360°, a space time cut through cinema. 20 years after Martin Reinhart and Virgil Widrich used this film technique for the first time in a short film (“tx-transform”, 1998), they again deal with the question of which previously unseen world arises when space and time are interchanged, aptly in a cinema and at full 360°.
Technology
360° stereoscopic 10k
Introduction
What is behind the cinema screen? It is not surprising that cinema-in-the-cinema scenes are often used in horror films. For they irritate and unsettle by reminding us – the immobile viewers hidden in the cosy darkness – of our own questionable position. What if the forces of unlimited imagination penetrate through the canvas into our reality? What if the auditorium dissolves and with it the familiar laws of cinema itself? In a way never before seen, "tx-reverse" shows this collision of reality and cinema and draws its viewers into a vortex in which the familiar order of space and time seems to be suspended. Back in the 1990s, Martin Reinhart invented a film technique called "tx-transform", which exchanges the time (t) and space axis (x) in a film. Normally, each individual film frame represents the entire space, but only a brief moment of time (1/24 second). In the case of tx-transformed films, however, the opposite is true: each film frame shows the entire time, but only a tiny part of the space – in cuts along the horizontal spatial axis, the left part of the image thus becomes the "before", the right part the "after". 20 years after Martin Reinhart and Virgil Widrich used this film technique for the first time in a short film ("tx-transform", 1998), they again deal with the question of which previously unseen world arises when space and time are interchanged, aptly in a cinema and at full 360°: at the Babylon Kino in Berlin they filmed with the OmniCam-360 about 135 actors and calculated the installation "tx-reverse 360°" for the ZKM from this material.
Reference to the content
https://immersify.eu/content-demos/tx-reverse-360/



2.2.3.4 *The translucent St. Stephen's Cathedral*

General description	
Title	The translucent St. Stephen's Cathedral
Subcontractor	ScanLAB Projects
Date	March 2020
Number of clips	-
Content Summary	
High resolution interactive tour of the St. Stephen's Cathedral in Vienna	
Technology	
Interactive 360° stereoscopic 8K from Point Cloud data	
Introduction	
With more than 20 billion laser points the cathedral church of St. Stephen in Vienna was spatially measured. In this unique level of detail they correspond to a data volume of almost 400 gigabytes and form the basis of the transparent St. Stephen's Cathedral. This innovative approach offers spectators an interactive journey through the transparent sacred building in stereoscopic 8K. The novel insights through the layers of the Cathedral Church were created as a cooperative effort	

between the Ars Electronica Futurelab, ScanLAB Projects, RIEGL Laser Measurement Systems and the Dombauhütte St. Stephan zu Wien.
Reference to the content
https://immersify.eu/content-demos/the-translucent-st-stephens-cathedral/



2.2.4 Preparing the content for final showcase

All the content produced or acquired in this task are master files in very high quality (4:2:2/RGB format, 10/12-bit). In order to show the content at the envisioned events or installations (Trade Fairs, Deep Space 8K, large screen displays, etc.), they must be encoded and played using the Spin Digital HEVC codec. The encoding parameters also have to be carefully selected according to the application or use case. In other words, not all the target applications demand the same level of quality or resolution. In D5.3 Report on QA and Content Preparation Guidelines we specify the encoding options we proposed

for each use case. These options are the result of subjective and objective quality analysis performed by the project partners.

3 Interactive Media Authoring

Following describes best practice examples and findings on interactive media authoring for high resolution VR infrastructures.

3.1 Deep Space 8K DevKit

The Ars Electronica Deep Space 8K Unity Development Kit (short: Deep Space Dev Kit) shall make it possible for developers all over the world to easily create Unity applications for the Deep Space 8K, a large-scale multiuser VR environment.

This is just a very brief overview of the possibilities and features, that are provided by the Deep Space Dev Kit. Please have a look at the documentation for more detailed information: https://docs.google.com/document/d/1DFtmojlEZNq_6QAa1wZN3GKHvegcunNurQoUmE6cAvs/edit

3.1.1 Interaction

The Deep Space introduces several interaction possibilities to control applications or play games. The Dev Kit supports the following interfaces:

- **VR Controller (Guides only)**
  The VRController is an Android application developed at the Ars Electronica Futurelab to start, stop and control Deep Space applications. It shows all available applications in Deep Space as a list where a specific application can be started. Furthermore, it can send predefined control messages (such as button triggers or position and rotation data) to the currently running application. It implements the VRPN protocol and uses the build-in VRPN server at the Deep Space.

- **Mobile Control (Guides only)**
  Each Highlight Guide has access to a mobile device to have basic control over the Deep Space 8K. The Mobile Control is an Android app consisting of generic views to interact with a Deep Space 8K application. Therefore, a Unity Application can tell the Mobile Control, which views and content shall be presented on the screen and the Mobile Control can tell the Unity Application, what option has been chosen on the screen (e.g. button presses or list item selections).

- **Pharus Laser Tracking**
  Six Laser Rangers track movement on the floor. Our own Tracking Software (Pharus) is processing the measured data and provides the results (people moving in the Deep Space 8K in real-time) as UDP Stream. A Unity application can get access to this Tracking Stream and use the Tracks as interaction possibility.

- **Xbox Controller**

A standard controller can be used to control an application.

3.1.2 Features

The Deep Space Dev Kit provides a range of functionalities and features that support to create applications for the Deep Space 8K.

3.1.2.1 Project Settings

Depending on what you want to do in your Unity application, there need to setup some settings to achieve these aims. All suggested settings can be done via an integrated editor window, which can be found in the menu: DeepSpace -> Settings…

You can do all recommended settings by pressing the “Do the magic” button on the very top, or only do selected settings by clicking the available buttons. The descriptions should be self-explaining. Once a button was pressed and the setting was changed, the button vanishes. If there are no buttons left to press, everything is set up as recommended.

3.1.2.2 Command Line Configuration

In general, we are using command line arguments to configure dynamic parameters. For example, where the application runs (on the wall or on the floor), IP addresses and ports (to know how to connect to each other or to any other hardware), or if there shall be shown a debug UI.

You can use your own command line arguments by deriving from the CmdConfigManager class and overriding the ParseArgument Method. If you need a callback, after all parameters have been parsed, you can implement the virtual method FinishedParsingArguments. Have a look at the UdpCmdConfigMgr to learn more about this.

3.1.2.3 Wall-Floor-Camera

An often wanted camera view is a connected Wall-Floor-Camera, which means that a user who stands in the so called sweet spot can look at Wall and Floor without seeing the edge between these two projection planes. This effect is created by an off-axis projection.

This setup can be taken directly from the WallFloorCombinedScene which can be found in Assets/DeepSpace/Demo/Scenes. Alternatively you can use the prepared prefabs and scripts to build the setup yourself. The camera's sweet spot can be adopted to your needs.

3.1.2.4 Pharus Laser Tracking

One of the nicest ways to interact with an application in the Deep Space 8K is by using the Laser Tracking System, because it is a multi-user-input-system that can handle up to 30 users at the same time.

Our in-house developed software "Pharus" receives the data from our laser rangers, calculates current positions of people in the room and sends this information to Unity. Thanks to the Dev Kit, a user does not need to care about the networking that happens in the background, but can just use the positions

as input. To get a first impression of how these recorded data can be used in a Unity application, just open the PharusTUIOScene or PharusTracklinkScene.

3.1.2.5 Xbox Controller

The Deep Space SDK provides a controller input manager that wraps the Unity input system for controllers. All functionality is packed into the ControllerInputManager class. It is a singleton and can be accessed easily from all other script components. To make the wrapper work, the Unity Input Settings have been already set to support all controller keys.

3.1.2.6 Mobile Control

The Mobile Control is our own proprietary Android App (client) that can be connected with a server (the Unity application on the wall) via TCP. The basic communication concept is that the server tells the client what view shall be shown and the client tells the server what buttons have been pressed in the currently visible view. You do not need to care about the specific protocol between these two because all messages that can be sent and received are wrapped in the MobileControlMessages namespace classes.

To make the beginning of using the MobileControl easier, the DevKit provides the MobileControlManager. This class handles the communication between server and client. The public interface for this class handles Registering and Unregistering of active and passive views, getting the current or a specified view, and activating a specific or the next or last in order view.

3.1.2.7 VRPN

In addition to the aforementioned ways of communication, it is also possible to use the built-in VRPN server in the Deep Space. The VRPN server is mainly used by VRController. As mentioned before, it is an Android application to start, stop and control Deep Space applications. Using VRController brings additional control possibilities such as interacting with buttons or using its virtual touchpad that sends touch positions to Unity3d applications through VRPN protocol.

3.1.2.8 Networking

The reason why we decided to implement some networking messages ourselves was because of performance and control. Using UDP directly is slightly faster than using UNET. You buy this little performance by a big loss of features and comfort.
Nevertheless, you can extend and use this feature if you prefer a simple byte or JSON packaged based network communication. Furthermore, if you are using an external server application, you can easily communicate between your server and the unity applications via JSON packages.

The UdpManager owns the references to two senders (one sending to the Wall and the other one sending to the Floor) and one receiver. The manager activates the right sender and the receiver based on the configuration (UdpCmdConfigMgr) and disables the not needed sender based on the application type (e.g. the wall does not need to send data to the wall).

3.2 Dome and Interactive Content

The dome and planetarium industry are seeking new forms of immersive content and particularly non-linear interactive content is in great demand.

3.2.1 AdventureDome

AdventureDome is an experimental immersive and interactive full dome prototype created to explore the possibility of conducting interactive shows for a group of people where the audience can interact simultaneously.

Guidelines:
https://docs.google.com/document/d/1gYCm99dplswd5R6lltji8RwE1OgvpTzHftl2vCu5BMg/edit

3.2.1.1 Features

The prototype is intended for children aged 5-8 years and contains a full dome video consisting of multiple scenes, mostly straight forward cutscenes but also scenes where the audience can answer trivia questions and to some extent control the characters and make choices to create alternative paths in real time.

3.2.1.2 Interaction

The interaction is analogue which encourages the audience to move and consists of holding arms up and swaying to steer the characters and clapping to increase characters speed.
When answering cutscenes questions, like trivia, choose paths or decide the fate of the characters, the audience holds up cards over their heads marked by a triangle or circle. The guide who controls the show decides which answer the audience chooses and then controls the video according to the decision.
The audience's movements have been greatly appreciated by the children and have led to collaborations and many laughs.

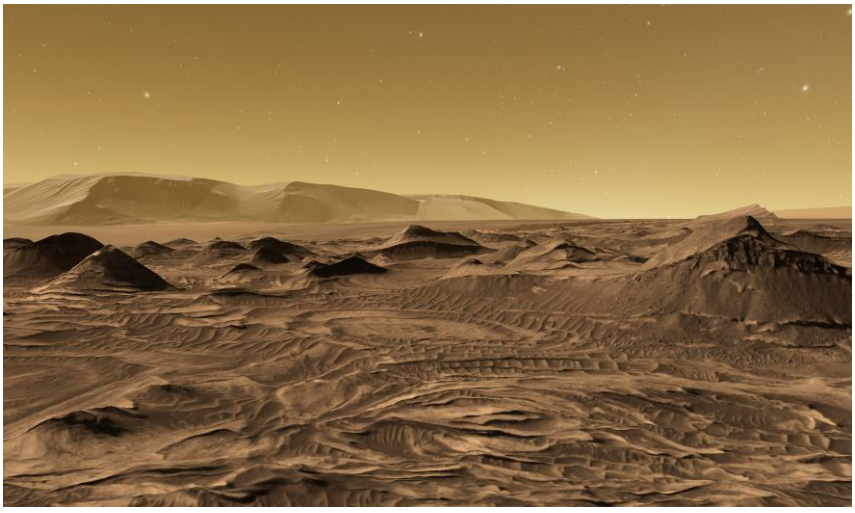
3.2.1.3 Production

AdventureDome was created in Unity, C# and Autodesk Maya and is primarily designed to be displayed in real time. A shorter and simplified offline rendered version is also available for playback in an HMD and as it is developed in Unity it is flexible and can be exported to variable formats like high resolution flat screens.
The real-time version consists of a 360 degrees world in Unity projected to the dome's half a sphere surface. The real-time video is a 4K 30-60 fps fisheye stream divided into 6 slices and sent out to 6 projectors. As the back-end engine does not support real-time synchronization between multiple machines the resolution and frame-rate depends on the capabilities of the single machine running the application, as such, an offline version could potentially have higher resolution then the real-time version.

3.2.2 OpenSpace

Immersive environments can be constructed in various ways, such as a dome, cave, powerwall etc. The environments usually want to achieve a very high resolution, and even today the 8K setups considered state-of-the-art is still considered to not have the desired pixel density in a large display environment. It is then very demanding to produce content for these high-resolution environments, which can have various display setups. A lot of the content produced then is based on more interactive applications in comparison to traditional modelling and offline ray-tracing output. But then to achieve a desired resolution in a multi display/projector scenario such softwares needs to be very flexible and high-performance. OpenSpace was built from the ground up to be a visualization software for showing the findings and research mission conducted in space, both on desktop environments but with clear support for any multi-display/projector with 3D/stereoscopic capabilities and running on a multi-machine/cluster support. As built with these requirements from the beginning, this software has, within this project, been tailored to record and render out very high resolution clips (basically any resolution for any display setup, with proper eye/user positions) in a reasonable amount of time. Currently result from rendering out very high resolution fly-by of the Mars surface in fisheye view, 8Kx8K 3D, where performed on a high performance gaming machine with roughly 1 TB of frames per hour, where the bottleneck where considered to be storage/disk write speed and not CPU/GPU power. These offline rendering capabilities were introduced as there are many immersive environments that still struggle with having the compute power necessary for running OpenSpace within sufficient interactive framerate in the desired resolution, and such only support high-resolution video playback.

Close-fly-by of the Surface of Mars with high-resolution imagery was rendered with OpenSpace for various immersive environments in their native resolution within Immersify. Any resolution (tests with up to 16K) is possible.



4 Conclusions

In the second reporting period (M13-M30) we focused on two main areas related to the content production in various technologies. First set of the created content was dedicated mainly for the verification of the new functionalities provided by the software developed in scope of the project, especially SD encoder and player. PSNC and AE prepared a new set of high resolution laser scans (e.g.

Fallout Shelter or St. Stephen's Cathedral) to check efficiency and quality of the encoder in case of high resolution (16K) CGI images consisting of huge amounts of not connected dots. The next set of clips dedicated for the functional verification of the software processing modules were HFR movies (120fps and above), 8K timelapses and 360° stereoscopic panoramas in high 16K resolution.
Some parts of those materials were also used in the second area which was promotion of the project at several fairs and festivals (the full list of dissemination events is collected in D2.3 Dissemination and Exploitation Report and D2.4 Final Plan for Use and Dissemination of Foreground). Additionally we created a set of 8K (3D) videos using typical 8K cameras and combined it with ambisonic sound to extend immersive user experience. Finally, we invited artists and individual media creators (e.g. Tadej Droljc, Timestorm Films, Theresa Schubert) for cooperation which allowed us to produce or get licenses for several other interesting video clips including a timelapse in 8K and several stereoscopic works in 8K and 10K (e.g Singing Sand 2.0 or The translucent St. Stephen's Cathedral).

Using the playback infrastructures created in WP3 (mostly T3.5 Unity3D integration) and the content from T5.1 several prototypes for interactive non-linear narratives were created. Best practice examples and findings on interactive media authoring for high resolution VR infrastructures were documented. These include a guideline for developers to easily create Unity applications for the Deep Space 8K, a large-scale multiuser VR environment and also a guideline on creating interactive content for a multi-user dome or planetarium environment using real-time game engines.

5 References

Declaration

The information, documentation and figures available in this deliverable, is written by the members of *Immersify (Audiovisual Technologies for Next Generation Immersive Media)* project consortium and does not necessarily reflect the views of the European Commission. The European Commission is not liable for any use that may be made of the information contained herein.

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