Deliverable

Deliverable name
D5.1 – Report on Immersive Content Production Part 1

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Abstract
The subject of deliverable 5.1 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 shortly summarizes work done in *"Task 5.1 Content Production"* and partially 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 set of immersive content material created using different production methods for the Immersify project. The document is iterative and will be extended by project results after first reporting period in M24.

REVISION HISTORY

Revision	Date	Authors (Entity)	Description of changes
0.1	1 Sep 2018	Maciej Glowiak Maciej Strozyk Eryk Skotarczak	Initial content of the document, integration of PSNC content descriptions
0.2	17 Sep 2018	Christian Södergren Erik Sunden	Content/immersive production
0.3	18 Sep 2018	Anna Kuthan Sergio Sanz-Rodriguez	Content + review of document
0.4	21 Sep 2018	Maciej Glowiak Maciej Strozyk	Adding missing sections, first complete draft for review
1.0	28 Sep 2018	Maciej Glowiak	Final review

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LIST OF ACRONYMS

Acronym	Description
HMD	Head Mounted Display
Mxx	Month xx
CGI	Computer Generated Imagery
VR	Virtual Reality
UHD	Ultra High Definition (4K or 8K)

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 will be created. The prototypes may target different VR systems (dome, deep space, VR glasses), target 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 will be evaluated in T5.3 and integrated in T5.4.

2 Results

2.1 Addressing objectives

The 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.**

During the first reporting period (until M12) we created several video clips and gained some from other sources (as part of subcontracting). The full list is enlisted in Section 2.2. As the Task 5.1 is not finished yet, some clips are there in production phase or in planning and will be reported in D5.2.

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.**

We started work on interactive non-linear storytelling, however this work is still in progress and will be a subject of Deliverable 5.2.

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 movies, we document the whole process, equipment used. The making-of photos and video clips will be provided on www.immersify.eu webpage and will be a contribution to best practice guidelines in the future.

2.2 Movie clips

2.2.1 Summary

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

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

Results: Partially done
So far PSNC produced several 8K 360° video clips using Orah 4i and Insta360 Pro camera, all recorded in Poznan. Although Insta360 Pro is one of most advanced 360° integrated camera, the quality of panoramas are not sufficient for advanced use with high-end visualisation infrastructures. Partners of the project try different methods of obtaining better content: timelapse 360°, collaboration with external vendors such as Arri (which provided 12K content for the project) and renting 360° rig.
Content finished:
- Cathedral 8K 360° (PSNC)
- Poznan 8K 360° (PSNC)
- Arri demonstration reel 12K (SD)

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

Results: <u>Partially done</u>

There is currently no available 360° 3D 8K camera on the market. We have already made 3D laser scans of Cathedral church and the 8K 3D clips will be generated soon (October 2018).

Point cloud renderings of the Great Pyramid in Cairo (BBC /Scanlab) are in progress (3 clips in 12K).

Content finished:
- *in progress*

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

Results: <u>Partially done</u>

16K animation using point cloud rendering was provided from PSNC in order to present for IBC fairs. The 3D version will be available soon (October 2018). Next laser scans are planned for upcoming months.

The stereoscopic piece Prima Materia from Istanbul based studio Nohlab was rendered in 8K x 8K in 3D.

Content finished:
- Cathedral scans in 16K, 12K and 8K (PSNC) - 2D version
- Prima Materia 8K (AE)

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

Results: <u>Done</u>

PSNC already recorded 12 video clips in 8K 60p using its modified F65 camera in different conditions. Work will be extended in the future in order to have wider portfolio of movie clips, as there is big interest from stakeholders.

Content finished:
- 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

Moreover, PSNC started to create content for Immersify project purposes even before official starting date, which gave us the possibility to test tools and promote Immersify at the very beginning of the project. These 4 clips were:
- Clock 8K https://www.youtube.com/watch?v=IB25yQtsA9g
- Fish 8K https://www.youtube.com/watch?v=wOecjp5GolU
- Magda 8K (PSNC) https://www.youtube.com/watch?v=vi4tTu5EEjg
- Palm House 8K (PSNC) https://www.youtube.com/watch?v=cRgLlVDgosg

2 clips	8K	3D	SONY F65 + 3D rig	1 minute or longer

		60-120 fps		
Results: <u>Partially done</u> PSNC recorded one 3D 8K video clip in Kornik Castle. This video content is still in post-production, which is more demanding and requires more time for preparation and display. **Content finished:** ● *in progress*				
2 clips	8K or more	2D	Timelapse	1 minute or longer

Results: <u>Done</u>
AE has subcontracted two timelapse videos in 8K and 10K.
Content finished:
    ● Atacama Desert (8K) - Martin Heck / Timestorm Films (AE)
    ● Pano LA 10K - Joe Capra / Scientifantastic (AE)				

The task T5.1 has been not finished in M12, so it means not all the content is already completed. Some video clips need to be processed in post-production and color-grading, and some need more work related to software development in other tasks (e.g. point cloud). We also intend to produce new clips for whole duration of the project depending on particular needs of the dissemination activities.

Production of new clips in novel technologies require a lot of technology testing, integration and researching new ways of filmmaking (e.g. how to expose small details for ultra high resolution, how to make good 360° content, etc).

2.2.2 Clips produced by Immersify project

2.2.2.1 Dziekanowice Ethnographic Park

General description	
Title	Dziekanowice Ethnographic Park
Date	Autumn 2017
Place	Dziekanowice, Poland
Number of clips	3
Content Summary	
Video clip for folk music in the open-air museum	
Technology	
8K 60p 12bpp - 8K camera	
Introduction	
The idea of the movie is to show a typical cultural place in form of a music clip. Near Poznan there	

is *Wielkopolski Ethnographic Park Dziekanowice* which presents the reconstruction of historical Wielkopolska village architectures from the 17th to early 20th centuries. This place in combination with an invited local folk band performing on contrabass, hurdy gurdy and singing ethno songs created scenic background for the three extraordinary 8K video clips.

Reference to the content
https://www.youtube.com/watch?v=wc_gyf4H68I&feature=youtu.be https://www.youtube.com/watch?v=Tzl7hDktr50&feature=youtu.be https://www.youtube.com/watch?v=Kc1mDEv5dIM&feature=youtu.be

2.2.2.2   Baltic Legend Opera

General description	
Title	Baltic Legend Opera
Date	Winter 2017
Place	Poznań, Poland
Number of clips	1
Content Summary	
8K clips from the Opera	
Technology	
8K 60p 12bpp - 8K camera	
Introduction and story	
December 2017 PSNC was contracted to produce live TV content and streaming from premiere of "Baltic Legend" an opera of Feliks Nowowiejski performed in Poznań Opera House. During rehearsals of the spectacle, there were opportunities to shoot some additional 8K footage together with immersive 360° videos. By this, we created demonstration content for two H2020 projects: Immersia TV (synchronized 4K TV content and 360° 4K movie clips) and Immersify (8K content). Some parts of 8K clips were made behind the stage showing the work that is not visible to the audience, making the final content more interesting.	

Reference to the content
https://www.youtube.com/watch?v=SwGmPmTbldM&feature=youtu.be

2.2.2.3 60 years of Polish Television in Poznań Anniversary Gala

General description	
Title	60 years of Polish Television in Poznań Anniversary Gala
Date	Winter 2017
Place	Poznan, Poland
Number of clips	1
Content Summary	
8K event and news documentation	
Technology	
8K 60p 12bpp - 8K camera	
Introduction and story	
PSNC and Polish Television (TVP) are long-term partners. In 2017 TVP had its 60th Anniversary of operating in Poznań. PSNC as an organisation researching new media technology was invited to document this very special moment using the most up to date video techniques. The outcome is a detail-rich content with vivid colors and wide dynamics.	
Reference to the content	
https://www.youtube.com/watch?v=UqvaL_pfs5Y&feature=youtu.be	

2.2.2.4   Follow Car

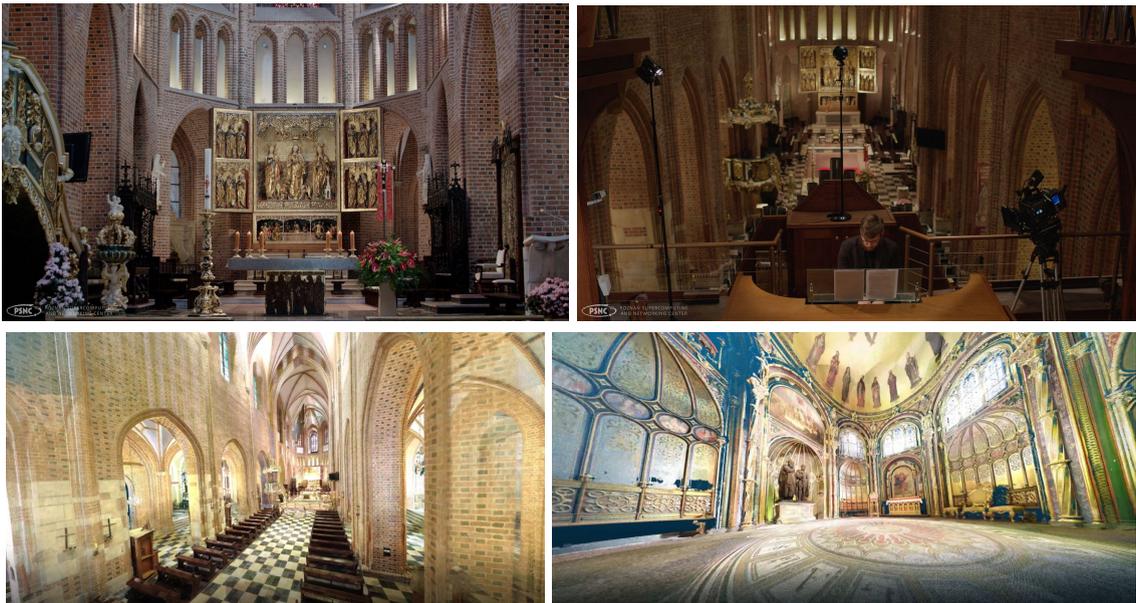| General description	
Title	Follow Car
Date	Autumn 2017
Place	Poznan and Bednary, Poland
Number of clips	1
Content summary	
Race cars in action on the track with 8K camera stabilisation and smooth moving shots.	
Technology	
8K 60p 12bpp - 8K camera mounted on car	
Introduction	
PSNC film crew in cooperation with two other companies did an 8K experimental shooting on Racetrack Poznan and old military airport in Bednary. The choice was made on racetrack, mainly because one of our Polish broadcasters was shooting "*Automaniak*", a Polish version of well known TV show "*Top Gear*" and they brought a few nice cars which we could use for our experimental 8K shooting with big gimbal installed on the follow car. During two day shooting session mainly sports car were filmed, but also professional cyclists were caught "on tape" during their training.	
Reference to the content	
https://www.youtube.com/watch?v=SCw9j3T8Ff4&feature=youtu.be	

2.2.2.5 Karkonosze

General description	
Title	Karkonosze Mountains
Date	March 2018
Place	Szklarska Poręba, Poland
Number of clips	5
Content summary	
Winter shooting of 8K in mountain area and negative temperatures	
Technology	
8K 60p 12bpp - 8K camera	
Introduction	
Due to the fact that this year winter in Poland was quite cold and snowy we had a chance to try 8K real winter shootings in Polish mountains. Our choice was Szklarska Poręba, a beautiful small town located at the foot of the mountain range of Karkonosze. Particularly, five nice places were selected, three in the mountains and two just close to town: ● Szklarka Waterfall ● Kamieńczyk Waterfall ● Szrenica Peak ● Wang Temple in Karpacz ● Glassworks in Szklarska Poręba Frozen waterfalls and winter mountain panoramas from the Szrenica peak (1362m above sea level) were the main goal, but additionally we recorded the Wang Temple, built originally from pine logs in Norway at the turn of the 12th and 13th centuries. The building was transported in 1842 to Karpacz (Poland) and is now considered the oldest surviving wooden church in Poland. Another place that was visited and filmed was a glassworks called "Leśna Huta", where our film crew was very warmly welcomed and the glass-specialists showed our camera their work.	
Reference to the content	
https://www.youtube.com/watch?v=Jo0BdHwy7xY&feature=youtu.be https://www.youtube.com/watch?v=rCeau4OrH3w&feature=youtu.be	

https://www.youtube.com/watch?v=O0iTjZvOvcQ&feature=youtu.be
https://www.youtube.com/watch?v=4t4Ol6WIGPw&feature=youtu.be
https://www.youtube.com/watch?v=YiMZKS1TLr4&feature=youtu.be

2.2.2.6   Cathedral of Poznan

General description	
Title	Cathedral
Date	May 2018
Place	Poznań (Ostrów Tumski), Poland
Number of clips	3
Technology	
1) 8K 60p 12bpp - 8K camera, Aerial photos, 360° camera, binaural audio, ambisonics audio 2) 16K 60p 8bpp - laser scanning 3) Insta360 Pro - 360 content	
Introduction	
In May 2018, thanks to the courtesy of the Poznan Archdiocese, the PSNC team was able to shoot 8K clips in the Poznan Cathedral. A few photographing days were preceded by making laser scans, thanks to which the main nave and the Golden Chapel were accurately mapped. We recorded the surroundings of the cathedral, the church interior, aerial photos (these in 6K due to limitation of drone load capacity – 8K camera was too heavy) and 360° video clips. Also binaural and ambisonics audio during a special organ concert were recorded. The source material will be used to contribute several tasks of the Immersify project related to high quality content, interactive content, immersive sound as well as encoding 16K and VR. By scanning point clouds, we will be able to render movies up to a resolution of 8K (i.e. 16K) and stereoscopic films. So far, two film clips have been produced: 8K from SONY cameras and 8K + 16K from point clouds.	
Reference to the content	
https://www.youtube.com/watch?v=zdoKocv5cek&feature=youtu.be	

2.2.2.7 Cathedral of Poznan

General description	
Title	Poznan 360
Date	August 2018
Place	Poznań - different places
Number of clips	1
Technology	
Insta360 Pro	
Introduction	
In order to create 360 content, we have used Insta360 Pro camera and recorded several clips from Poznan city center in good light conditions. The final clip is in 8K resolution.	
Reference to the content	
https://www.youtube.com/watch?v=n6Ks-Ks_HnI&feature=youtu.be	

2.2.2.8   Adventure Dome

General description	
Title	Adventure Dome
Date	2018-2019
Place	Norrköping, Sweden
Number of clips	Work in progress
Content summary	
Animated interactive prototype for children	
Technology	
Offline movie / real time Unity application, fulldome format	
Introduction	

The planetarium industry is craving new types of immersive content and there are great demands for new interactive non-linear content.

NVAB's idea is to develop an interactive movie prototype telling a non-linear story where the audience is able to participate and interact simultaneously in real time.

We lacked references from previous productions of this type. Our solution was to work with an iterative process of a prototype. We tested our way through with the help of audiences to gain knowledge about how we could create the right feel and interactivity.

The real-time version had problems with load times between scenes which was solved by putting up a code framework that avoided large amounts of data to load simultaneously.

The FPS was another issue where the goal was to never fall below 30 fps in 4K resolution.

Optimization of the scenes was the solution. E.g. reducing number of objects in the scene, terrain with fewer polygons, downscaling of textures and changing texture format from PNG to JPEG,

reducing the number of objects that were controlled by code by grouping them and then control them by code.

NVAB has a small team of 3 people, AD, programmer and 3D-artist working together with script, planning and concept.

The interactive prototype is created in Unity3D as a real-time application to be converted to offline video for playback on media players developed from the Immersify project. The prototype can be converted and made available for other types of screens and platforms in 8K resolution.

2.2.2.9   OpenSpace

General description	
Title	OpenSpace
Date	2018-2019
Place	Norrköping, Sweden
Number of clips	Work in progress
Content summary	
Platform for interactive rendering of scientific space data	
Technology	
Real-time application with offline rendering support and various immersive camera models	
Introduction	
Theme "Data evolution in space". We will create an interactive production which primarily will be	

a visit to Mars (optionally also Pluto), where we discover how much data of the planet we have gathered over the years, and how it was gathered. While the final production can be run interactively, it should also be possible to make an offline version for a specific immersive space (with multiple projectors/screens) such that any site can run it through their video playback system and that it will fill the whole immersive space with content. The production is scheduled to be started in October 2018 (planning is now complete), with an initial two month production phase to implement functionality needed to support offline rendering to any immersive setup. Within this project one key task is measuring rendering and distribution time, i.e. how long it takes to deploy it to the various immersive environments (online and/or offline), with various parameters such a camera/output resolution and number of camera views, which often depend on the setup in the actual immersive theatre/space.

OpenSpace rendering of Ganges Chasma, a deep canyon on Mars

2.2.3   Clips produced with third parties

2.2.3.1   Atacama Desert

General description	
Title	Atacama Desert
Subcontractor	Martin Heck / Timestorm Films
Date	July 2017
Number of clips	1
Content summary	
8K timelapse video of Atacama Desert in Chile, taken at night (2am) showing stars spreading upon	

the night sky
Technology
Timelapse with sound 8K@29,97fps, 1 min Sony A7RII camera
Introduction
Upon receival of the raw material from the artist at first the material was screened. Then a clip was selected from the total material. A fitting audio was selected that emphasizes the video material and at last the final compound was made.

2.2.3.2   Pano LA 10K

General description	
Title	Pano LA 10K
Subcontractor	Joe Capra / Scientifantastic
Date	shot over 2 years
Number of clips	1
Content summary	
10K timelapse video of Los Angeles, showing panoramic views of the city of Los Angeles	
Technology	
Timelapse with sound 10k@23.967fps, 2 min 30 sec shot over a period of 2 years entirely in true panoramic form using 2 synced DSLR cameras (Canon 5DIII) side by side	
Introduction	
Upon receival of the raw material from the artist at first the material was screened. Then a	

selection of several scenes of 2min 30sec was made from the total material. The final cut was done, as well as final camera movements were rendered in raw material. A fitting audio was selected that emphasizes the video materia. At last the final compound of the material was made as well as video encoding.

2.2.3.3   Prima Materia 8K

General description	
Title	Prima Materia 8K
Subcontractor	Nohlab
Date	2018
Number of clips	1
Content summary	
A stereoscopic piece taking the audience on an audiovisual journey.	
Technology	
Computer generated stereoscopic video with sound Format is side by side stereoscopic 3D Rendered 8K @60 fps for each eye, 7 min 28 sec	
Introduction	

Story: A stereoscopic audiovisual journey of the primitive formless base of all matter Prima Materia. Alchemical authors have compared the "Prima Materia" to everything, to male and female, to the hermaphroditic monster, to heaven and earth, to body and spirit, chaos, microcosm, and the confused mass; it contains in itself all colors and potentially all metals; there is nothing more wonderful in the world, for it begets itself, conceives itself, and gives birth to itself.

Nohlab delivered 4 video files (for wall, floor, left eye, right eye). On the basis of the raw material (delivered as single frame sequences) the final compound was made by AE, rendering material with audio and credits.

2.2.3.4   Ancient Invisible Cities: The Great Pyramid

General description	
Title	Ancient Invisible Cities: The Great Pyramid 3D Immersive Experience
Subcontractor	BBC / Scanlab
Date	June 2018 - March 2019
Number of clips	3 videos embedded within a framework allowing interactive use Work in progress
Content summary	
Point cloud renderings of the Great Pyramid in Cairo	
Technology	
3 clips in 12K@60fps, Stereo 3D, 360° camera based on 3D scan CGI Exploring the millimetre accurate full-colour scans in spectacular VR gives you more freedom of movement and access to this remarkable structure's secrets than a visit to the pyramid itself. This scanning technology creates point-clouds of data that allow us to recreate the Pyramid in the digital world allowing us to move through the space in a way that is impossible in real life.	
Introduction	
The Great Pyramid in 3D: From the BBC series, Ancient Invisible Cities will offer users access to a spectacular VR experience inside the oldest wonder of the ancient world: The Great Pyramid of Giza. With a choice of three starting points users can explore the stunning signature scans featured in the Ancient Invisible Cities series in astonishing 12K. Enhanced by surround sound designs, specially crafted soundtracks, and content-packed commentary, international venues can invite their visitors to embark on their own immersive journey around, under, and above the Great Pyramid of Giza. It can also be experienced using VR headsets.	

2.2.3.5 Cinematic rendering – Virtual Anatomy

General description	
Title	Cinematic rendering – Virtual Anatomy
Subcontractor	Siemens Healthineers /JKU
Date	Work in progress (production in 2019)
Content summary	
On the basis of physical fundamentals, Siemens has developed an innovative rendering algorithm that provides superbly detailed, photorealistic images. A game controller can be used to operate Cinematic Rendering software so that it can generate interactive real-time depictions of human anatomy on the basis of CT and MR data sets.	
Technology	
8K Stereo with 60/120 fps	
Introduction	
Imaging procedures such as computer tomography (CT) and magnetic resonance (MRI) deliver realistic, extraordinarily detailed pictures of the interior of a patient's body. This opens up new possibilities for medical education and the planning of surgical procedures, and also facilitates communication with referring physicians and patients. On the basis of physical fundamentals, Siemens has developed an innovative rendering algorithm that provides superbly detailed, photorealistic images. Driven forward by progress in the animated film industry, new rendering techniques bring forth results that are increasingly realistic and beautiful.	
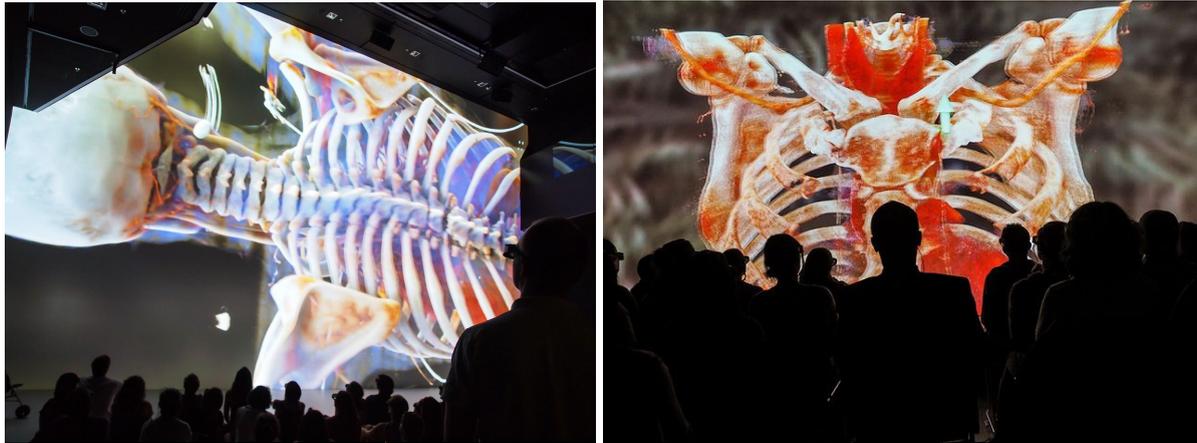
2.2.4 Clips obtained from external sources

In order to have wider range content for testing the codec and for screening purposes at dissemination events, the partners of the consortium obtained several video clips from external partners. These clips are not official Immersify content and may be available for only selected partners due to licence limitations (but were provided free of charge).

- **Devil's Lungs:** This 10-min 360° piece was shooted by the Loikka Dance Film Festival (Finland) with the Ozo camera. This camera produces spherical videos in 4Kx4K (stereo) at 30 frames/s. The content about musicians and dancers moving around the camera and playing accordion.
  - https://www.imdb.com/title/tt8385026/
  - https://www.danceinfo.fi/en/news/finnish-3d-vr-360o-dance-film-in-cannes-devils-lungs-celebrates-the-mystical-power-of-accordion-and-women/

For the purposes of Immersify, this piece has been upscaled to 8K resolution using the Spin Digital high precision pre-processing filters.

- **NHK "Beyond the frame: 8K Future Project"** offers a glimpse into the joint research project between the Ars Electronica Futurelab and NHK, Japan's largest public broadcasting organization. *Tokyo – The Luminescent Megacity* takes the audience on a flight in 8K over the megacity at nighttime, providing spectacular views in astounding resolution. The stop-motion animated *DOMO WORLD* invites viewers to discover a complex, miniature world. For *8K TECHNE* five artists were asked to express themselves artistically in 8K, producing a series of unique high-resolution videos: *1024* by Fuyu Arai, *Cosmos under Foot* by Koki Sone, *The Window* by Haruka Furuya, *88888888•••K* by Koichiro Tsujikawa and *mimesis* by Eiji Tanigawa.
- **Pandarama:** It is a 3-min 360° piece shooted by ARRI using their Alexa Omnicam. The FOV is 360° x 120°, the resolution is 13.7K x 4.8K, and the frame rate is 24 frames/s. More details about this omnicam camera can be see in Deliverable 4.1 on "Report on HEVC Encoder for Immersive Content". This content is about a Chinese town celebrating a dragon boat race.
- **16K clips:** Spin Digital received from Azlab three video clips in 16K resolution at 60 frames/s for showcase at major Trade Fairs including IBC (Amsterdam), ISE (Amsterdam), NAB (Las Vegas), InterBEE (Tokyo).

2.2.5 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 the table below 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.

Use Case	Encoding parameters	Comments
8K HLS streaming (distribution)	- Format: 8Kp60, 4:2:0, 10-bit - IP[1]: 64 frames (1 second) - GOP[2]: 16 frames - Bitrate: 70 Mbps	HLS streaming for distribution to end users. The bitrate must be as low as possible.
8K RTP streaming (contribution)	- Format: 8Kp60, 4:2:2, 10-bit - IP: 64 frames (1 second) - GOP: 16 frames - Bitrate: 160 Mbps	RTP streaming for real-time contribution links from the live event to the broadcast studio. High bitrate is required.
Master file quality playback	- Format: 8Kp60, RGB, 12-bit - IP: 64 (1 second) - GOP: 16 frames - Bitrate: 600 Mbps	Visually lossless / original quality distribution format (same quality level as the original).
Ultra-high resolution playback on large screen displays	- Format: 16Kp60, 4:2:0, 10-bit - IP: 64 (1 second) - GOP: 16 frames - Bitrate: 400 Mbps	As coding artefacts (blocking, ringing, etc.) can be very visible on large screen displays, high bitrate is required in this application scenario.
Point cloud	8K - Format: 8Kp60, 4:2:0, 10-bit - IP: 64 frames (1 second) - GOP: 4 frames - Bitrate: 1600 Mbps 12K - Format: 12Kp60, 4:2:0, 10-bit - IP: 64 frames (1 second) - GOP: 4 frames - Bitrate: 1000 Mbps 16K - Format: 16Kp60, 4:2:0, 10-bit	A point cloud is a set of data points in space. The pictures generated by 3D scanners are the most difficult and challenging for any video encoder including HEVC, as they present very high frequency components (the points). As a result, the content must be encoded at the maximum bitrate that the workstation can process.

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[1] IP refers to Intra Period: the distance between two consecutive Intra frames. The longer the intra period, the fewer seeking points in the bitstream.
[2] GOP refers to Group of Pictures: The GOP defines the length of the coding structure (see Section 4.5 of Deliverable 4.1 for more details).

	- IP: 64 frames (1 second) - GOP: 4 frames - Bitrate: 400 Mbps	
Deep Space 8K	6K - Format: 6Kp60, 4:2:2, 10-bit - IP: 128 frames (2 seconds) - GOP: 16 frames - Bitrate: 100 Mbps 8K Format: 8Kp60, 4:2:2, 10-bit - IP: 128 frames (2 seconds) - GOP: 16 frames - Bitrate: 160 Mbps 12K stereoscopic side-by-side - Format: 12Kp60, 4:2:2, 10-bit per view (wall, floor) - IP: 128 frames (2 seconds) - GOP: 16 frames - Bitrate: 30 Mbps	A Windows 10 machine with Spin Player was used to play 8K videos. Since the AE playback system is still under development to enable 8K and beyond playback, downscaled versions of the content in 6K were created for the AE Festival 2018 to ensure stable performance. Because of its spatio-temporal characteristics, Prima Materia in 12K stereoscopic side-by-side was compressed at a relative low bitrate (30 Mbps), which is a good trade-off between quality and decoding performance.
High-res 360° video playback on screen	8K - Format: 8Kp30, 4:2:0, 10-bit - IP: 128 frames (2 seconds) - GOP: 16 frames - Spherical format: Cubemap - Bitrate: 70 Mbps 12K - Format: 12Kp24, 4:2:0, 10-bit - IP: 128 frames (2 seconds) - GOP: 16 frames - Spherical format: Cubemap - Bitrate: 50 Mbps	In the case of the Pandarama 12Kx8K sequence, there was no need to encode it at high bitrate. A bitrate of 50 Mbps was sufficient to ensure high quality playback.

3   Conclusions

In the first reporting period (until M12) we focused on delivery of nice 8K videos using 8K cameras for presentation and dissemination purposes. In this time we promoted the project at several fairs and

festivals and some 8K clips were required (the full list of dissemination events is collected in D2.3 Dissemination and Exploitation Report). We started also laser scanning, which enables rendering 16K resolution images as well as 360° panoramas in high resolution or 8K/16K stereoscopic content. We will go on with laser scanning, stereoscopic recording and timelapse technologies in next months.

The cooperation with other companies such as NHK or studios and individual media creators allows us to produce or get licences for several other interesting video clips.

Declaration

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