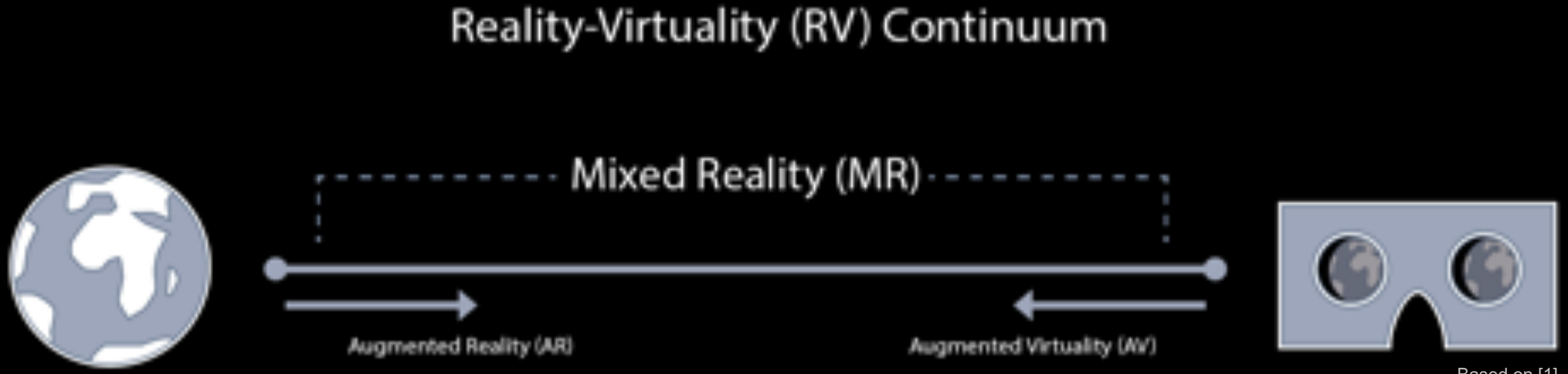
Leibniz Supercomputing Centre

of the Bavarian Academy of Sciences and Humanities

Improved Data Analysis with Virtual and Augmented Reality

27.09.2019 | Thomas Odaker

Definition – VR/AR



Based on [1]

Illustration: Mayer, Weil, LRZ

Definition - VR

Dataset: Bunge, LMU
Foto: Podo, LRZ

Any sense may be addressed (sight, hearing, smell, touch, taste, …)

VR/AR for scientific visualisation

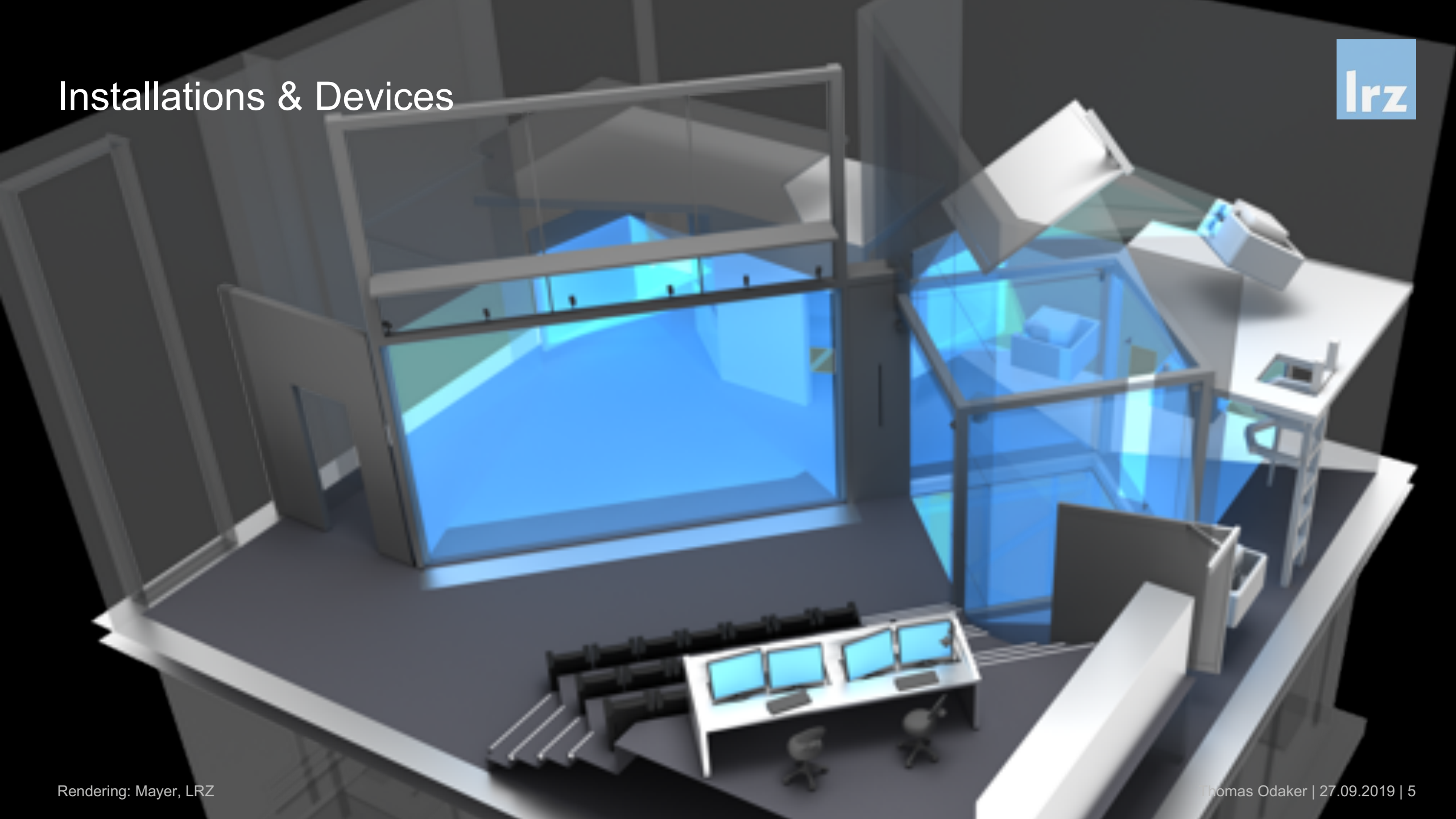
Stereoscopic view

- Different perspective for left and right eye provides 3-dimensional views

Interactivity

- Tracking position of head, input devices, hands, …
- Input devices are important, 6-dof head tracking useful

Installations & Devices



Rendering: Mayer, LRZ

Advantages & Problems

Advantages

- No 2D projection
- Natural interaction
- Visual analytics

Limitations

- Bound to real-time visualisation
- Not viable for all types of data
- Requires additional hardware and know-how

VR is a tool suitable for a certain set of problems, not a universal solution

Simulation/Visualisation: [2]

Use-Case

Visualising Bloodflow

Dataset: Coveney, UCL
Rendering: Mayer, LRZ

Dataset

- 166 mio data sites/time step
- 26 time steps

Use-Case

- High-quality renderings for “Virtual Humans” cinematic movie
- Real-time VR visualisation for setting up shots

Implementation

Organize data sites in an octree

Each leaf stores cluster of fluid sites for all time steps

For each particle

- Find corresponding data site in tree
- Animate based on stored data

Use-Case

Visualising Bloodflow (2019)

Dataset: Coveney, UCL
Rendering: Mayer, LRZ

Dataset

- Several billion data sites/time step
- Thousands of time steps
- Simulation of coupled arterial and venuous trees

Use-Case

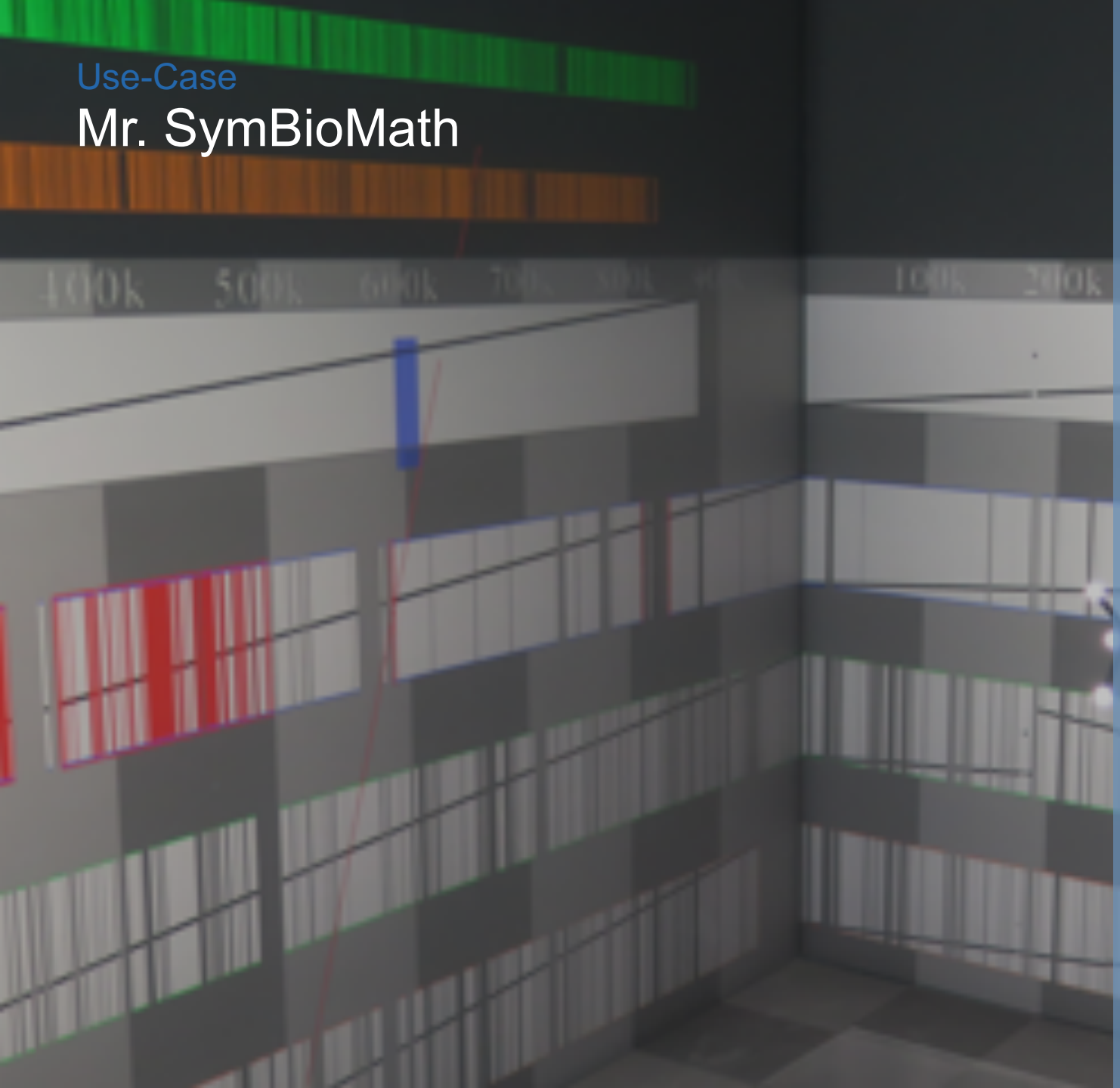
- Cinematic renderings
- Scientific visualisation

Different Approach

- Preprocess data for visualisation (3D models, flow paths, …)
- Provide real-time capable visualisation for analysis, data exploration and (if necessary) cinematic renderings

Use-Case

Mr. SymBioMath



Comparison of genomes in VR

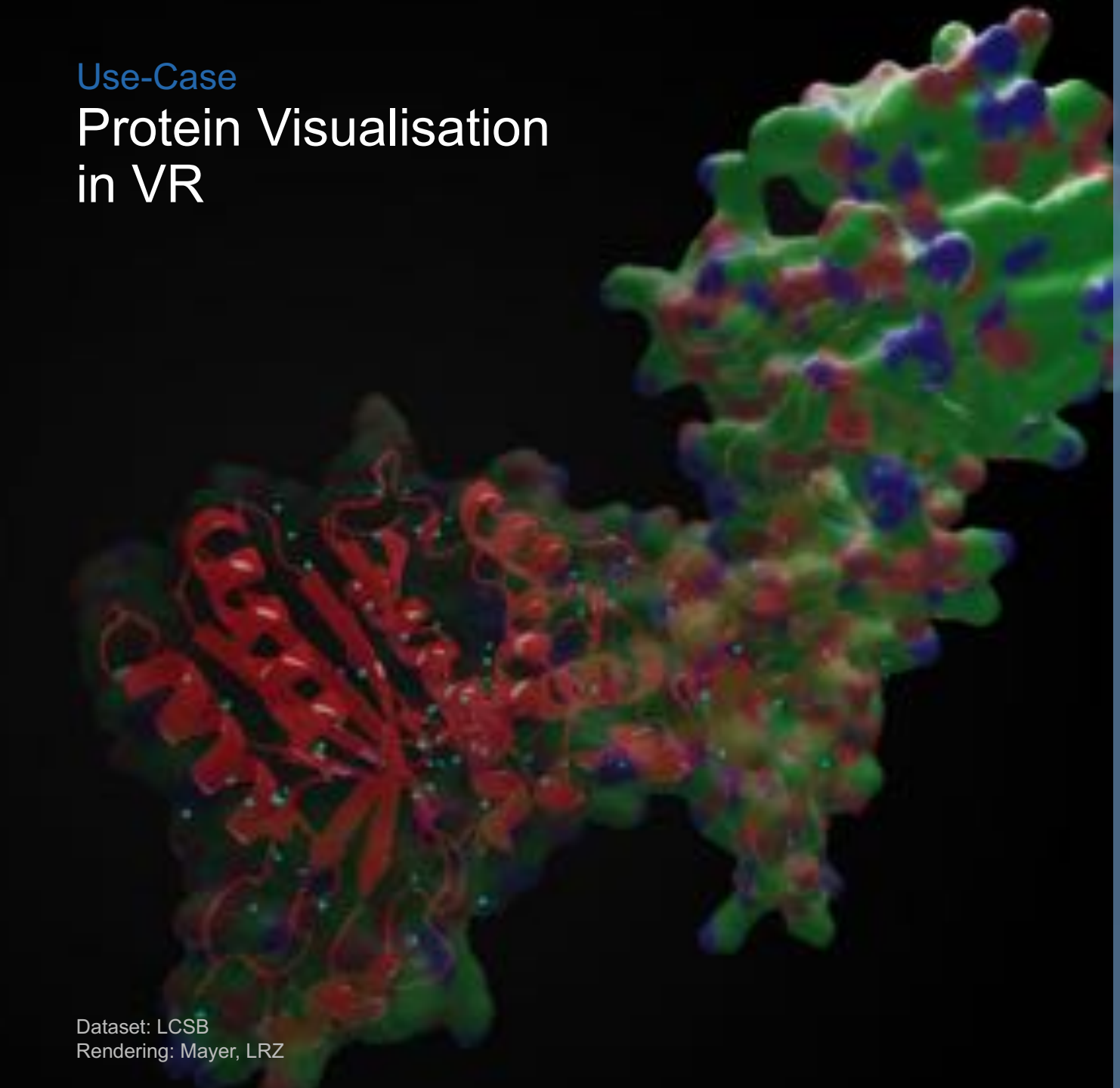
- Information visualisation
- Project Mr. SymBioMath [3]
- Taking 2D visualisations into 3D space

Idea

- Genome visualisation stays in 2D
- Visualisation of a genome is projected onto a plane (multiple planes for multiple genomes)
- Using 3rd dimension for visualisation of comparison (e.g. “diagonally” between two planes)
- UI using a tablet device

Use-Case

Protein Visualisation in VR



Dataset: LCSB
Rendering: Mayer, LRZ

VR visualisation of proteins

- Cooperation with Luxembourg Centre for Systems Biomedicine
- pyMol has support for stereoscopic output, but not HMDs/CAVE
- Provide a workflow from Minerva webinterface [4] to VR

Workflow

- Use pyMol to download data and convert to 3D model
- Load model into running VR environment
- Tablet shows webinterface, user can select a protein and it appears in VR

Conclusion

Pros

- VR can be a useful tool for data analysis
- Natural visualisation of 3D datasets
- Supports interdisciplinary science
- Hardware prices are dropping
- Increasing support thanks to HMDs availability for consumers

Cons

- Bound to real-time visualisation
- Large/complex datasets limit capabilities
- Requires high-end hardware
- HMDs not well-suited for cooperative work

Sources

[1] Paul Milgram; Haruo Takemura; Akira Utsumi & Fumio Kishino, “Augmented Reality: A class of displays on the reality-virtuality continuum“, Presence: Telemanipulator and Telepresence Technologies, 1994, 2351, Pages 282 - 292

[2] Mario Silaci: “Interactive Exploration and Visualisation of Multi-Scale FluidFlow Problems”, Bachelor Thesis, TUM, 2018

[3] Luisa Wurm, Rubén García, Christoph Anthes, Dieter Kranzlmüller and Wolfgang Höhl: “Benefits of Tablet Interfaces for Immersive Visualization in Information Visualization”, WSCG 2016 poster paper proceedings, pp 1-4, WSCG 2016, 2016

[4] Piotr Gawron, Marek Ostaszewski, Venkata Satagopam, Stephan Gebel, Alexander Mazein, Michal Kuzma, Simone Zorzan, Fintan McGee, Benoît Otjacques, Rudi Balling, Reinhard Schneider: “MINERVA—a platform for visualization and curation of molecular interaction networks”, Npj Systems Biology And Applications, https://www.nature.com/articles/npjsba201620#supplementary-information, 2016