From Visualization Research to Public Presentation – Design and Realization of a Scientific Exhibition

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Abstract
In this paper, we present the design considerations of a scientific exhibition we recently realized. The exhibition presented the work of two large research projects related to computer simulations, which include scientific visualization as an essential part of the involved research. Consequently, visualization was also of central importance for our exhibition. It was not only used to illustrate the complex simulation data to convey information about the results from the application domains, but we also wanted to teach visitors about visualization itself. Therefore, explaining the purpose and the challenges of visualization research was a significant part of the exhibition. We describe how we developed an engaging experience of a highly theoretic topic using the same visualization tools we developed for the application scientists and how we integrated the venue into our design. Finally, we discuss our insights from the project as well as visitor feedback.

Categories and Subject Descriptors (according to ACM CCS): K.3.2 [Computers and Education]: Computer and Information Science Education—Literacy I.3.8 [Computer Graphics]: Applications—Public Dissemination

1. Introduction

Research, especially basic research conducted at universities, is usually funded by government agencies, at least in Germany, where many large-scale research projects are paid for by the German Research Foundation (DFG). However, the results of such basic research are normally only published in scientific journals not targeting the general public, mainly for two reasons: On the one hand, specialized scientific findings are often too complex to be explained to laymen. On the other hand, scientist are often only interested in informing their peers about new results, since this is much more important for their individual careers than public dissemination. A promising strategy to make a broader audience aware of science, research and their relevance to society are science exhibitions in the public space – or premises that are at least easily accessible by the public. However, physical accessibility alone is not sufficient. The exhibition also has to convey scientific approaches and basic research findings in an understandable and engaging manner. This way, it can additionally show the visitors that a publicly funded research project is not throwing the taxpayers' money out of

the window, but rather produces significant results that might already influence everyday life, or at least will some day.

We report about the science exhibition "Im digitalen Labor – Durch Computersimulationen die Welt entdecken" ("In the Digital Laboratory – Understanding the world through computer simulations"), which is part of the public relations activities of the two research projects *Cluster of Excellence Simulation Technology* (SimTech) and *Collaborative Research Center 716* (SFB 716) of the University of Stuttgart. We want to illustrate the design considerations behind our exhibition and explain the difficulties involved in a public presentation of basic research to non-experts. Since both projects make heavy use of computer simulations, visualization of the results is a central part of their research agenda. The scientists develop new visualization techniques not only for use by their colleagues in the application domain, but also for public dissemination. Therefore, our paper is not limited to show how results from an application domain can be conveyed by visualization, but we also report how we explain visualization research to the visitors.

While science museums often convey basic scientific knowledge in their exhibitions, our exhibition posed the

above-mentioned design challenge to present recent research activities to the public. Psychological evaluations of scientific exhibitions are rather common, but their design is not really covered by scientific literature. Only few works address the difficulties of this phase of the exhibitions. Allen and Gutwill [AG09], for example, present the concept for a set of game-like exhibits that are designed to deepen the scientific inquiry skills of the audience while maintaining their interest at all times. Roche et al. [RCB16] and Bell [Bel00] examined the influence of science shows that were given during exhibitions like the one presented here. Maintaining the interest of the audience was regarded as easy, but at the cost of scientific profoundness. The design of single exhibits with certain intents was, for example, covered by Nim et al. [NWZ*16], who presented a virtual reality station communicating the dangers of coral bleaching in the Great Barrier Reef, or by the public presentation framework for molecular data by Nickels et al. [NSM*13].

2. Exhibition Concept

Our exhibition tries to convey a holistic view on the state of the art in computer simulations. Such simulations are, besides experiments and theories, an essential part of today's research and development processes. Scientific progress in a wide area of applications from bio-sciences, medicine, mechanical engineering, physics, chemistry to materials sciences is hardly imaginable without them. They are used to design models, to verify processes in nature and technology or to explore possible scenarios of the future. Thus, they have become highly relevant to our modern society as an essential part in the development processes of many everyday products like microchips in computers and mobile phones, but also as a tool to find the right therapies in medicine. This ubiquity of computer simulations in natural sciences stands in contrast to public knowledge about them, which was the reason for us to design a science exhibition explaining the imperative nature of computer simulations to the public.

Simulation technologies are an important research area at the University of Stuttgart and core interests of the two projects involved in the exhibition: The focus of SFB 716 is the development of dynamic simulation methods for systems with large numbers of particles. Scientists use numerical simulations to answer questions about material properties, processes in biochemistry and chemical engineering. The amount and complexity of the data involved mandates the development of efficient algorithms, coarsening and acceleration mechanisms, improved hardware and special visualization techniques. Simulation sciences as a whole are the research are of the second partner, the interdisciplinary SimTech research association. More than 200 scientists from virtually all faculties of the University are working together to reach a common goal: developing simulation technology into an integrative systems science. Both, SFB 716 and

Figure 1: *Overview of the exhibition space. In the foreground, one of the four pedestrals can be seen. In the background, the room with the interactive stations is visible.*

SimTech, could therefore contribute their expertise, technical infrastructure and staff to the exhibition.

We chose Carl-Zeiss-Planetarium Stuttgart as the location for the exhibition, for a planetarium being a place of nonformal education and knowledge transfer. As an interface between science and entertainment it offers the perfect environment for our purposes. The exhibition was shown for three months in the public area of the planetarium. It gave a profound insight into the world of computer simulations, their development, methodical backgrounds, and how they work. A special focus was on the presentation of visualizations from various research areas, ranging from still images over moving images to interactive software applications. The target audience was the general public, not necessarily with an academic background, with a focus on people with a general interest in science, high-school and university students.

The exhibition is structured into several stations. Fig. 1 shows an overview of the exhibitions space. One of them shows the history of simulations beginning with Navier and Stokes and ending with today's tasks and challenges. Each of the others is dealing with an individual aspect of simulations. Four of the exhibits are pedestals combined with an information panel. We use their front and rear side:

Pedestal I: Idea of Simulation
- Front: "What is a Simulation?" – reasons for simulations, like cost or risks of experiments
  Interaction: six rotatable panels, *exhibit:* natural gas injector in simulation and prototype
- Back: "This is how it works" – simulation process
  Interaction: tablet PC with simulation of human gait

Pedestal II: Background
- Front: "From Reality to Model" – first steps, formulation of a scientific question
  Interaction: turntable explaining different approaches to formulate a scientific issue
- Back: "Reality in Equations": particle model/mesh model
  Interaction: hands-on atomic model and mesh model

Pedestal III: Technology

- Front: "Simulation Equipment" – simulation on personal computers and high performance compute clusters
  Exhibit: decommissioned blade of *Hermit* supercomputer at HLRS Stuttgart
- Back: "Smart Computing" – efficient computing with streaming, parallelization, coarsening etc.
  Interaction: puzzle game with assignments

Pedestal IV: Visualization

- Front: "What is Visualization?" – reasons for visualization of scientific data
  Interaction: find the match – cards with visualizations and questions have to be assigned to the correct answer
- Back: "From Data to Images" – visualization pipeline
  Interaction: tablet PC with HTML slider explaining the steps for the visualization of a virus

The last station at the center of the exhibition is a small room having information panels at its outside and exhibits of interactive visualization inside. While the previous exhibits provide background information, this one shows what is at the end of the simulation process: the results of simulation research and specific applications in practical use in science and industry, illustrated by aesthetically pleasing scientific images and visualizations from various research areas.

Central station

- Lockable room within the exhibition hall (3×3 m)
- Exterior walls show vivid examples: text and visualizations of applications, examples, results
- The four exterior walls offer the possibility to group images into four thematic areas: material design; machine engineering, process engineering & technology; biotechnology & medicine; nature & environment
- Interior: two screens showing interactive visualizations steered by motion control systems (*Microsoft Kinect, Leap Motion*) via the visitors' hands

For creating the exhibition's concept, we followed three principles: to show what a simulation is and how it works; to make a complex and abstract scientific topic comprehensible for everyone; and to present research from the perspective of the scientists themselves. The practical implementation of the concept posed several important challenges:

- Every station should deal with an individual topic and stand for itself, i.e. it should be usable without the context of the whole exhibition.
- The stations should work without guided exhibition tours.
- The stations' interactions should literally be touchable and invite to playfully discover the topic in order to create a better learning effect.
- The stations and in particular the analog and digital interactions and exhibits should be theft-proof and indestructible – at least by involuntary or casual vandalism.

Figure 2: *The interactive visualization exhibit. The visualization on the left screen is steered using a Microsoft Kinect, the right one via Leap Motion.*

## 3. Visualization and Interaction Concepts

Explaining the results of simulation research to a broader non-academic audience poses several challenges. The main task is to enable even high-school students to understand key concepts of the ongoing research. This can only be achieved by the use of visualization techniques, since the real-world counterparts of the visualized phenomena may be to big or too small to be examined and most of the resulting data may be too abstract to be understandable right away. Thus, nearly all exhibition pedestals offer some kind of visualization. In fact, the interactive visualization of the simulation results is the centerpiece of the exhibition (Fig. 2).

A second challenge is to maintain the interest of the audience during the whole visit. Since purely static exhibits may be considered boring, especially by a younger audience, we decided to add interactive as well as tactile exhibits. This includes gesture-controlled interactive visualization as shown in Fig. 2 as well as 3D-printed representations of previously visualized objects.

3.1. Interactive Stations

The above-mentioned centerpiece of the exhibition is a small room of approximately 3×3 meters that features two interactive stations where visitors can interact with visualizations. Two high-resolution $32''$ LCD displays are mounted on the rear wall of the room (see Fig. 2). Each display is driven by a dedicated visualization workstation, which is hidden from the visitors inside a double wall of the room. The space within the double wall (approximately 40 cm) is open to the top and accessible via a small lockable hatch to allow for sufficient air flow and maintenance.

Our visualization framework MegaMol [GKM*15] served as a basis for the interactive stations. MegaMol is the rapid prototyping tool for visualization of particle-based simulation data within SFB 716. It offers all the interactive scientific visualization methods for molecular data like
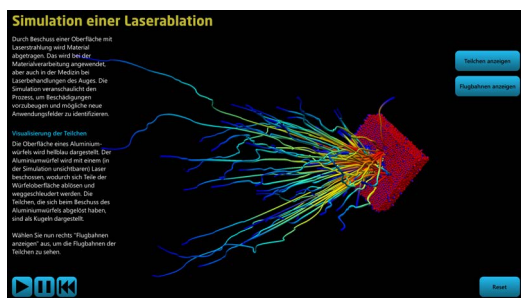
Figure 3: *Screenshot of the laser ablation simulation used in the interactive station that is steered via Microsoft Kinect.*

Figure 4: *Screenshot of the lipase simulation used in the interactive station that is steered via Leap Motion.*
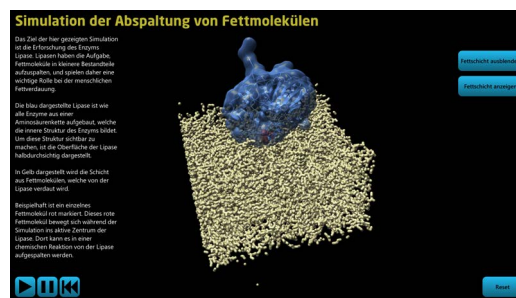
molecular surfaces, ball-and-stick models, or particle trajectories, which have been developed by the visualization researchers of the project. That is, the visual representations developed in the collaborative research project were already available for use in the exhibition context.

Selection of the Examples: Each station allows the visitors to explore one simulation data set. The choice of the data to present was driven by the idea that it should show a sufficiently interesting scientific phenomenon and that the visual representation should also look interesting.

The first data set is a simulation of a laser ablation, a process used in many industrial applications. Here, a laser beam hits a block of aluminium, causing a small portion of the metal at the surface to heat up and explode outwards, thereby creating a small crater. In the simulation, the aluminum block consists of approximately 560 k particles. The user can switch between a visualization of the raw particles and an abstract visualization where only the trajectories of larger particle clusters are shown [FSG*11] (see Fig. 3).

The second data set is a simulation of a lipase protein, which is part of the fat metabolism. In the simulation, the lipase sits atop a layer of fat molecules, while one fat molecule moves towards the active site of the protein where the fat would be split (see Fig. 4). To show the complexity of the protein and to allow the user to see the fat moving into a tunnel within the protein, we chose a semitransparent molecular surface visualization computed using QuickSurf [KSES12]. The complex structure of the lipase is shown using the Cartoon representation within the surface [KBE08]. Both protein representations are rendered in a medium blue color, to show that both geometries visualize the same molecule. Fat molecules in the layer are colored light yellow and displayed as Stick representation. Only the specific fat molecule that moves into the protein is rendered in red to visually stick out.

User Interaction: One major challenge when designing the interactive stations was to come up with a interaction concept that is both easy to use and engaging for the visitors. Users should be able to grasp the interaction possibilities ei-

ther intuitively or with very little explanation provided on a small poster next to the interactive station. Another consideration was that the users should not be able to exit the visualization by accident or on purpose. One obvious choice would be to use a touch screen as a replacement for the typical mouse interaction. However, we saw several problems with this concept. First, large touch screens are still quite expensive compared to standard non-touch displays. Second, a user interacting with the visualization would occlude parts of the screen from other visitors since he/she would have to stand close in order to touch the screen. Third, extra measures have to be taken to prevent users from exiting the application, since the touch screen would effectively act as a mouse. Therefore, we decided to implement a gesture-based system that uses either *Microsoft Kinect* or *Leap Motion* as input device. While the *Kinect* can be placed on top of the display using a commercial mounting kit, the *Leap* requires a table that places the device about 30 cm underneath the hand of a standing adult person. According to the DIN 33402 standard, the average elbow height in Germany is 106.75 cm, therefore, a table height of 75 cm was chosen. We fabricated a special mount for the *Leap* using 3D-printing that was screwed to the table to prevent theft. The cables of both devices are also mostly hidden from visitors to prevent casual vandalism or accidental unplugging. Both devices are provided with software development kits that allow for a relatively simple usage. Due to the modular concept of MegaMol, adding support for these devices into the existing interaction concept required no changes of the software architecture.

Camera Adjustment via Gestures: The basic interaction with the visualization is the manipulation of the camera. Users should be able to turn the data around and to zoom in an out. Modifying the camera uses the same gestures on both devices: A simple "grab" gesture (i.e., making a fist) activates the camera adjustment. If the fist is moved left and right or up and down, the camera orbits the data sets (i.e., the data set is turned around). Moving the fist towards or away from the screen zooms in and out. To exit the camera adjustment mode, the user simply has to open the fist again.
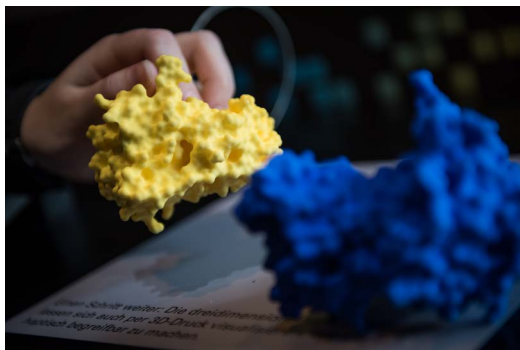
Figure 5: *3D printed molecular surface of two proteins.*

Graphical User Interface: Since the desired interactions also include parameter changes, a simple graphical user interface (GUI) that can be steered via gestures was also needed. The standard GUI of MegaMol is too complex for this application case and warrants a mouse and keyboard.

The interaction with the GUI mainly involves selecting buttons. Due to the different accuracies of the two devices, we chose to use slightly different gestures here. For the *Leap Motion*, the user has to extend his/her index finger and point at the screen. While the index finger points at the screen, a ring-shaped cursor is shown on the screen at the position the user points at. Since *Kinect* was not able to reliably detect the extended index finger, we decided to use an extended flat hand to activate the cursor mode. If the user moves the cursor over a button, the cursor ring starts to fill. Once the whole ring is full, the button is activated. We decided to use this technique since it is routinely used by *Kinect* games, therefore, we reckoned that it would be familiar to users knowing this gaming console. The animation of the ring that is filled up also makes the method intuitive and easy to explain, as it provides clear graphical feedback. As mentioned above, the GUI itself consists of buttons that can be selected by the user. Buttons can have a text label and an icon. As observable in Figures 3 and 4, we also added a short text that explains the visualized simulation.

Since users are typically much less accurate when using mid-air gestures than when using a mouse [VMM14], the buttons are relatively large in relation to the screen size to make it easy to keep the cursor on them. Additional buttons known from AV devices (play, pause, rewind), which feature no text but only the well-known media control symbols (see Fig. 3) can be used to control the playback of the time-dependent simulation data.

3.2. Tangible Visualization

On-screen visualization can only approximate the appearance of objects as they would look in the real world. It can be beneficial to complement the visual representations with tangible ones, which has become possible and afford-able through 3D printing. This enables visitors to get a more complete impression. We, therefore, included a 3D printed object in the pedestal targeting molecular surface visualization. While the visualization technique is explained in textual form, the actual result is displayed as 3D printed model.

Creating such models requires several steps: First, the surface of the model has to be computed. This is done using our visualization framework MegaMol, which is able to compute the Solvent Excluded Surface [Ric77] via the MSMS algorithm [SOS96]. The result of this computation is a triangle mesh that can be used as input for the 3D printing.

In 3D printing, the choice of the material and printing technology is crucial for a suitable result. In our case, the material had to be stable enough to survive several months of skin-contact and potentially rough handling, the printing technology has to be able to cope with the complex structures of a molecule as well as a large number of overhangs. Depending on the printing technique, these overhangs may need support structures to be printed correctly. We opted for laser-sintering, since it does not need support structures. As material, we chose a polyamide that is sufficiently robust. To reduce production costs, the models have been printed hollow. The polyamide only allows for a single color. While multi-colored 3D printing is possible in principle, the resulting objects would have been too fragile for our purpose. The 3D printed molecules shown in Fig. 5 are fixed to the visualization pedestal using thin wire ropes to prevent theft.

3.3. Explaining Scientific Visualization to Laymen

The two interactive stations explained in Section 3.1 only use visualization as a vehicle to show simulation data to the user. Besides using visualization to convey simulation results, one goal of the exhibition was to explain the process of visualization and the research involved in this field of research to the visitors. However, most scientific visualization algorithms are too complex to be explained to laymen in the context of a self-guided exhibition, with visitors only getting information from reading the text provided on the pedestals. We therefore decided to explain the process and challenges involved in scientific visualization research in two simple ways. First, the pedestal dedicated to visualization (IV, see Section 2) briefly summarizes the visualization pipeline using the example of molecular surface visualization. The textual explanations are backed by graphical depictions of the individual stages (raw input data, filtering, mapping, renderable representation). Second, we designed an exhibit showing the complexity of scientific visualization and computer graphics at the example of lighting calculations.

Lighting is not only a very important factor in data visualization, it is also easy to understand for a general audience without prior knowledge, since it models a natural phenomenon everybody knows. Furthermore, the individual steps involved in the lighting calculation are in general understandable without knowing the calculations involved. To
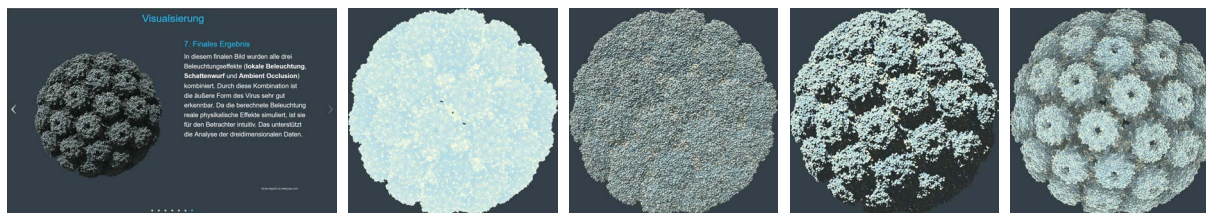
Figure 6: *Screenshot of the HTML page explaining lighting calculations in scientific visualization. The leftmost image shows the full slide layout with an image of the final visualization result and a short description. The rest of the images show example images of the different stages (from left to right: without lighting, local lighting, shadows, ambient occlusion).*

illustrate this, we used a 12.3″ tablet PC (Microsoft Surface Pro 4). We created an HTML application which allows the user to swipe or navigate using buttons through the steps of the computation. For each step, a short textual explanation is displayed in conjunction with an image showing the effect. Our example shows a virus capsid consisting of approximately 200,000 atoms that form a spherical shape. Each atom is depicted as a sphere. The first image shows the virus without any lighting, that is, everything appears flat. In the second image, local Blinn-Phong shading is employed, showing the atoms' spheres as round objects. Images four and five show the effects of shadow mapping [KRZ*17] and ambient occlusion [GKSE12], which help to convey the global spherical shape of the virus. In the last image, all effects are combined to show how each of them contributes to the final appearance. Fig. 6 shows the slide layout and example images. To prevent theft, the tablet PC is locked into a commercial metal mount that is fixed to the pedestal. Furthermore, we disabled all OS-level touch gestures in Windows 10 that would allow a user to interact with the operating system and locked the browser displaying the HTML slides to kiosk mode.

4. Fulldome Movie

Given the planetarium as our location, we decided to use all of the assets available there, namely the fulldome video projection system. Therefore, we produced a ten-minute documentary movie to be shown before the normal program of the planetarium during the exhibition, advertising the exhibition to all visitors of the planetarium. The movie features several of the visualizations for simulations developed within the two research projects. It explains the necessity and usefulness of simulations and their subsequent visualization to the audience. The visualization sequences include results from SFB 716 of laser ablation simulations, protein interactions, DNA transport, and studies of the cracking behavior of aluminum (see Fig. 9). Additionally, we included a visualization of a simulation of underground carbon dioxide storage that covers a period of over one hundred years. All renderings of particle simulations are directly taken from Mega-Mol, our visualization framework for large particle data sets, which is also used by the domain scientists. We also produced a significant amount of cutscenes between the ac-

tual visualization sequences, which has been produced using *Maya* and *Mental Ray* (see Fig. 8).

The key difference between this movie and regular videos is the non-planar projection surface. Planetariums handle this spherical projection by means of a special image format called *dome master*. A dome master is a square image embedding a fish eye projection of the dome's content (Fig. 7). Videos in this format can normally be shown on all fulldome systems, possibly after some post-processing to adapt to the hardware characteristics of the specific planetarium.

There are basically two ways of producing such dome masters from computer-generated imagery: When using ray casting, one could generate rays mimicking the characteristics of a fish eye lens in the first place. Or one could render at least five sides of a sky box an reproject their content to the dome master – an approach which is compatible with any traditional interactive rendering approach. We opted for the second way, because it allows us to use any visualization technique already available in MegaMol, regardless of the rendering technique. We were able to implement this with only minimal changes to our existing code base: Besides adding the option to render the sides of the sky box with fixed 1:1 aspect ratio and aperture angle of $90°$, we had to implement the means for animating the camera. We developed a key frame-based camera path editor to create smooth camera movements for the movie. The camera positions between the key frames, as well as other camera-parameters, are interpolated using Catmull-Rom splines, which ensure that the camera actually passes all key frame positions. We also interpolate the simulation data to produce smooth material in 30 fps. For scientists, the low number of snapshots exported from the simulations is not a problem when interactively exploring their simulation data. However, creating a film directly from those snapshots can result in jumping particles if the positions are not interpolated. Therefore, we had to implement an interpolation of the particle positions that could also handle periodic boundary conditions usually found in particle simulations. These boundary conditions cause particles leaving the simulation domain on one side to re-enter it on the opposite one to conserve the energy.

The original idea was to perform the projection from the sky box to the dome master during post-production using
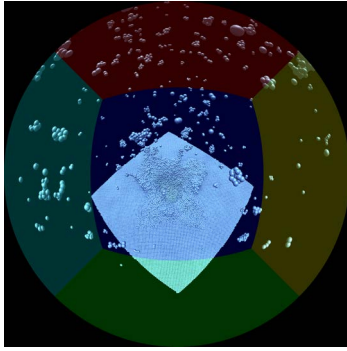
Figure 7: *A dome master frame from the visualization of a laser ablation simulation. The parts from different sides of the sky box are subtly tinted to show the production process.*

Figure 8: *Closing credits of the fulldome movie, photographed from the ground upwards.*

commercial plugins available, e.g., for *Adobe After Effects*. However, we quickly realized that it is difficult to design meaningful sequences filling appropriate parts of the dome without an actual preview rendering. We thus developed an additional tool that allowed us not only to verify the dome master embedding by producing images like Fig. 7, but also to render actual preview videos. The latter allowed us to get a feeling for how fast objects move on the dome's surface and to verify that the camera paths make sense in their entirety.

To guide the audience through the single visualizations and to keep them engaged between the sequences, we used traditionally animated sequences produced in *Autodesk Maya*, which can directly render dome masters by means of an appropriate plugin. As to not distract the viewer from the displayed information, scientific visualization tends to be much more mundane than the computer-generated imagery that we have become used to from cinema. Meeting the expectation of the audience for an animated movie while still matching the tone of our scientific visualizations was the biggest challenge for producing cutscene animations. To have a consistent theme throughout the movie, the cutscenes also feature a particle-based simulation, although a very simple, purely synthetic one. As in our scientific visualizations, particles are rendered as simple spheres but with more sophisticated surface shading. Scene lighting is composed of a single back light to give the scene a more dramatic atmosphere and to generate some contrast to the more evenly lit scientific visualizations. To improve the perception of scale and depth, the scene is located in a volumetric nebula and employs volumetric lighting (see Fig. 8).

To match the resolution of the fulldome system, we produced our movie using $6,122 \times 6,122$ px (6K) dome masters. For the MegaMol scenes, these have been reprojected from 4K sky box sides, except for the laser beam data set (fourth in Fig. 9). The high number of particles in this data set demanded supersampling to reduce aliasing artifacts, wherefore we rendered each side in 6K. We ended up having a 1.1 TB of raw imagery in total, visualization sequences and
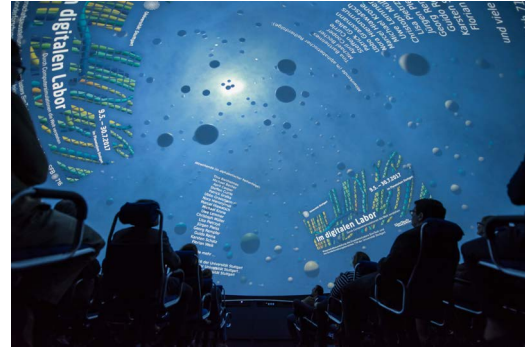
cutscenes combined. Rendering the latter took about nine days in total on a cluster of 20 nodes. The same cluster ran almost 16 days to render the sequences in MegaMol. Note that only a small fraction of this imagery found its way to the final film. The overwhelming majority of the rendering time was consumed for iterating over the sequences until the best camera path and visualization parameters had been found.

5. Summary and Conclusion

In the first month, over 3,500 visitors attended the exhibition and its associated events (vernissage, scientific lectures for the public). During this time, we collected visitor feedback using anonymous questionnaires that allowed visitors to rate and comment on different aspects of the exhibition. As expected, only a small fraction of the visitors provided feedback (25 completed questionnaires; 52 % female visitors, 36 % male, 12 % unknown; 80 % over 13 years old, i.e., fitting the intended audience). Even though the number is quite low, this initial feedback already provides us with valuable insights. The explanations about the simulation and visualization techniques were overall regarded as good and comprehensible, while not being too simple. Especially the interactive exhibits that allowed visitors to explore scientific visualizations were consistently rated as very good and engaging. The dome movie also received very positive marks and comments, which is a very pleasing result, since it was intended to catch the interest of visitors that originally only planned to watch a planetarium show. Even younger visitors (<13 years) rated the exhibition as interesting and comprehensible, which we did not expect. We guess that these younger kids were accompanied by adults who guided them. One person actually commented that the exhibition was too small. Although this is only one individual sentiment, we infer from the overall positive feedback that our exhibition concept was engaging and did not overwhelm the visitors.

We of course also encountered some issues that could be improved in the future. Although we designed all exhibits to be as sturdy as possible, we encountered a few cases that we did not expect to fail. As mentioned in Section 3.2, we
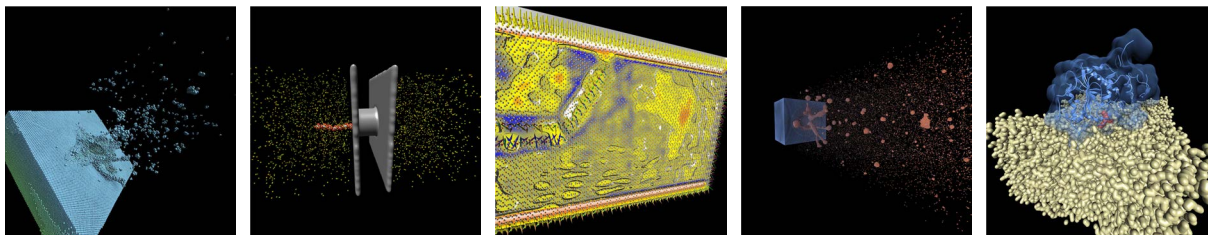
Figure 9: *Several scenes shown in the fulldome movie. From left to right: Laser ablation with the two moving lasers forming a cross on the surface. DNA strand tunneling through a nanopore. Crack propagation through aluminium. Laser ablation with one static laser. Lipase trying to detach fat from a larger structure. All pictures were rendered using MegaMol.*

chose a polyamide material for the 3D printed molecules due to its robustness, however, since this material is dyed after printing, the color slightly wears off after some time. Using a colored material would circumvent this issue. Regarding the fulldome movie, the circular seating necessitates that the movie has no orientation – that is, no "up" and "down". While this is no issue for most planetary movies, it is a bit harder to create such a movie for particle simulations. Although we paid attention to this fact, at least one visitor comment was that this could be improved. For the interactive stations, the Leap Motion proved to be better suited than the Microsoft Kinect. Kinect is not only less accurate in our setting – which might be due to lighting conditions – but also has the issue that users need to stay away a certain distance from the device. Although we marked the optimal distance on the floor, visitors tend to stand too close. Another issue is that the Kinect sometimes switches to another person if the room is crowded. This could be fixed by implementing a more stable tracking.

In summary, we have presented our concept for a scientific exhibition for the general public that makes heavy use of scientific visualization. We have discussed our design choices and explained that we not only used visualizations to convey simulation research, but also presented visualization as an area of research to the visitors. As mentioned above, we are aware that the evaluation of the questionnaires has to be taken with a grain of salt due to the low number of completed questionnaires. However, we still think that the very positive feedback shows us that the design of our exhibition was overall successful.

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