



Prof Thomas Jarrett
Dr. Michelle Cluver.
Cape Town

29 May 2018

The First Year of the Iziko Digital Dome



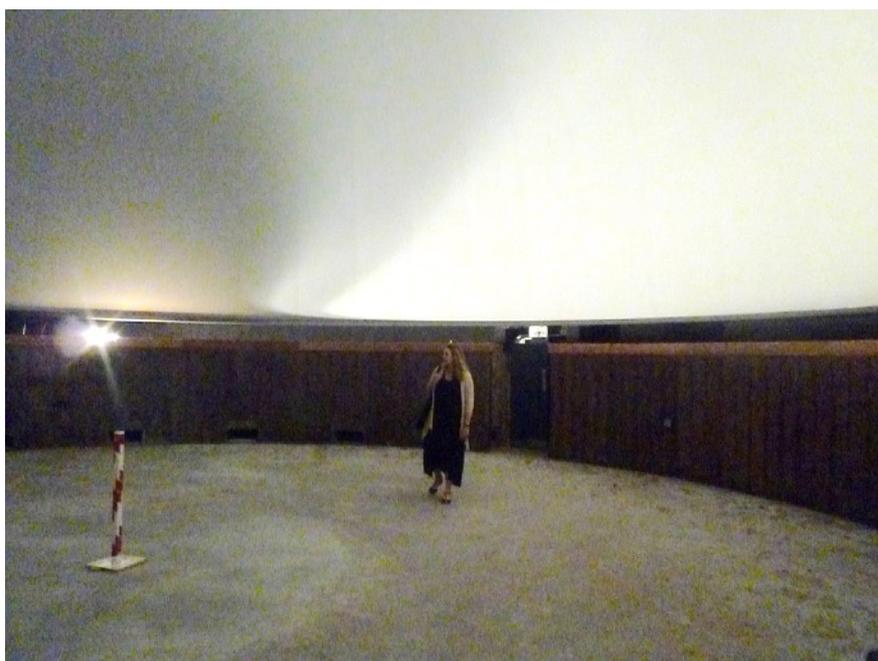
Planned and conceived as both a conventional planetarium — edutainment — and a research facility for visualisation and computing, the Iziko Planetarium 8K Digital Dome upgrade has been an unabridged success in both measures. Since its opening in May of 2017, with operations now reaching the one year stage, the Cape Town public has been dazzled with high-quality production shows, and the Research Consortium, led by the University's of Cape Town and the Western Cape, has carried out unique and significant research that demonstrates both the power and potential of the facility. The past year has not been without its challenges: the projection hardware, computers, network communications and software are exceptionally complex, and the planetarium staff (as well as researchers) have diligently troubleshooted and learned the intricacies of the system. This report will highlight the activities of the memorable first year of the Digital Full-dome facility, focusing for the most part on the research side. The authors of this report are the original founders and lead researchers of the new facility.

Planning and Build-up: 2014-2016

For context and the historical record, we briefly summarise the considerable upgrade efforts. It had become clear for many years that the Planetarium was in dire need of an upgrade with modern technology (read: digital projection), yet funding was not forthcoming. The break through came with the fateful 2014 meeting between Dr. M. Cluver (UWC), T. Jarrett (UCT), T. Ferreira & S. Glanville (Iziko) and T. van der Heyde (DST) in which the concept of a University Research Consortium was hatched. Jarrett had created a document that made the case for scientific research with full-dome facilities, and the game

was on. Pooling resources and marshalling energy, the consortium of the University of Cape Town (lead by Deputy Vice Chancellor for Research, D. Visser), University of the Western Cape, and the Cape University of Technology (and Stellenbosch sitting on the fence). Between the DST and the University Consortium buy-in, it was now possible to forge ahead with an upgrade. Further major fund-raising was carried out under the skilful hands of S. Glanville (Iziko), which then fully provided for a first-rate facility to be built.

A technical committee was then formed, including planetarium experts from the USA (Dr. Mark Subbarao) and Netherlands (Shawn Laatsch), chaired by T. Jarrett (UCT), that designed the digital upgrade. One year later construction began, led and carefully overseen by Theo Ferreira (Iziko Museum) refurbishing the theatre (newly raised floor, and newly-skinned dome), and the projector system under the direction of Sky-Skan, who were the general contractors and primary vendor for the Digital system.



Michelle Cluver walking on the newly designed floor foundation of the theatre. Three different levels will be created using wood construction, with the seats mounted to the structure, thus providing a 'slope' to the seating arrangement (design, brainchild of Theo Ferreira).

Equally important, the 'dome' has been re-skinned to provide optimal reflectance (coating) with the Sony laser projectors.

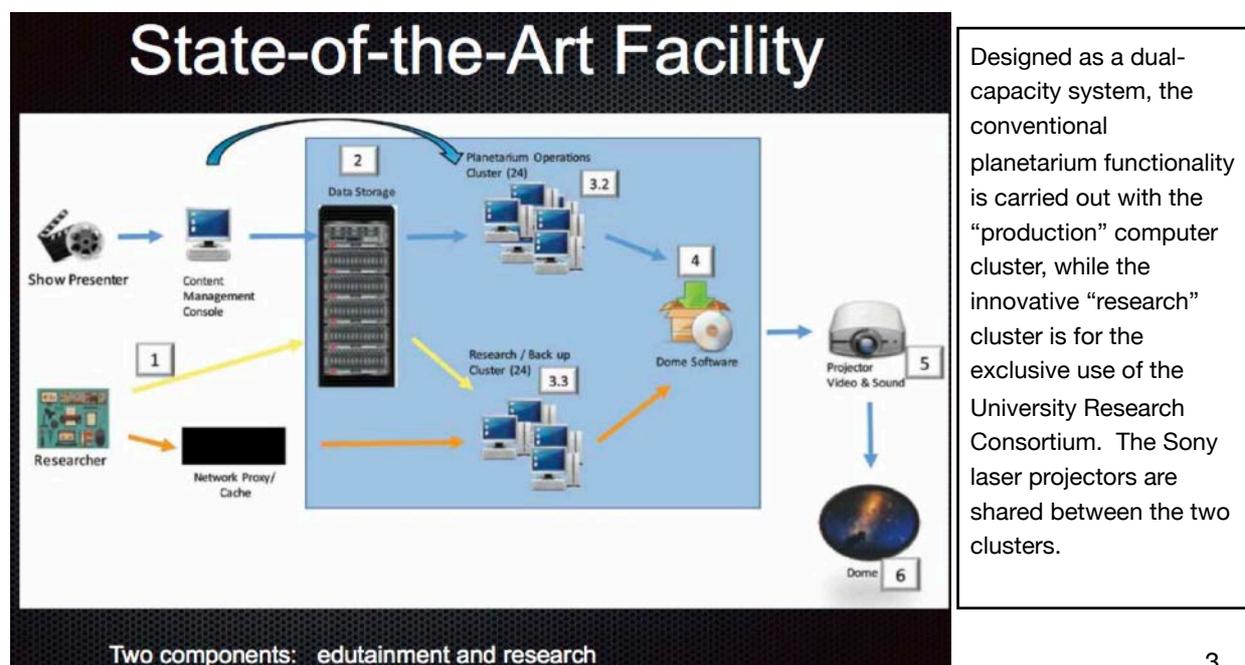
The hardware (projectors and computer cluster) were the main focus of the technical planning team, but it became apparent early on the control software would take front and centre (which is most clearly the case today). After the tender was selected (SkySKAN), a series of workshops were conducted (lead by Sky-Skan astronomer, Martin Ratcliff).



2016 Sky-Skan workshop to learn the dark arts of the system: Digital Sky — Dark Matter (DS-DM)

Projection System Construction: early-2017

Equipment from the USA began to arrive through customs in the first part of the year in 2017. Sky-Skan technicians began the long process of installing the computers and projection system. The system was designed to have two computer clusters, one for shows and production, and the other for research purposes. It turns out that switching between clusters is non-trivial, considering both the visual projection and the sound/audio. To this day, one year later, the switching system is still not stable, notably the audio.



System: The R30M digital upgrade, full dome theatre has the following key features: six Sony 4K Laser projectors (creating a total of 8K pixel projection), two computer clusters -- one for production and show, and the other for research - 5.1 Surround Sound, optimal reflecting dome, raised floor and new control center. The projectors can be driven by either cluster. Each cluster has 12 client computers and one master computer, as well as a sound computer. Each computer has a NVIDIA P6000 GPU, which provides more than enough power to render our large data sets on the fly.

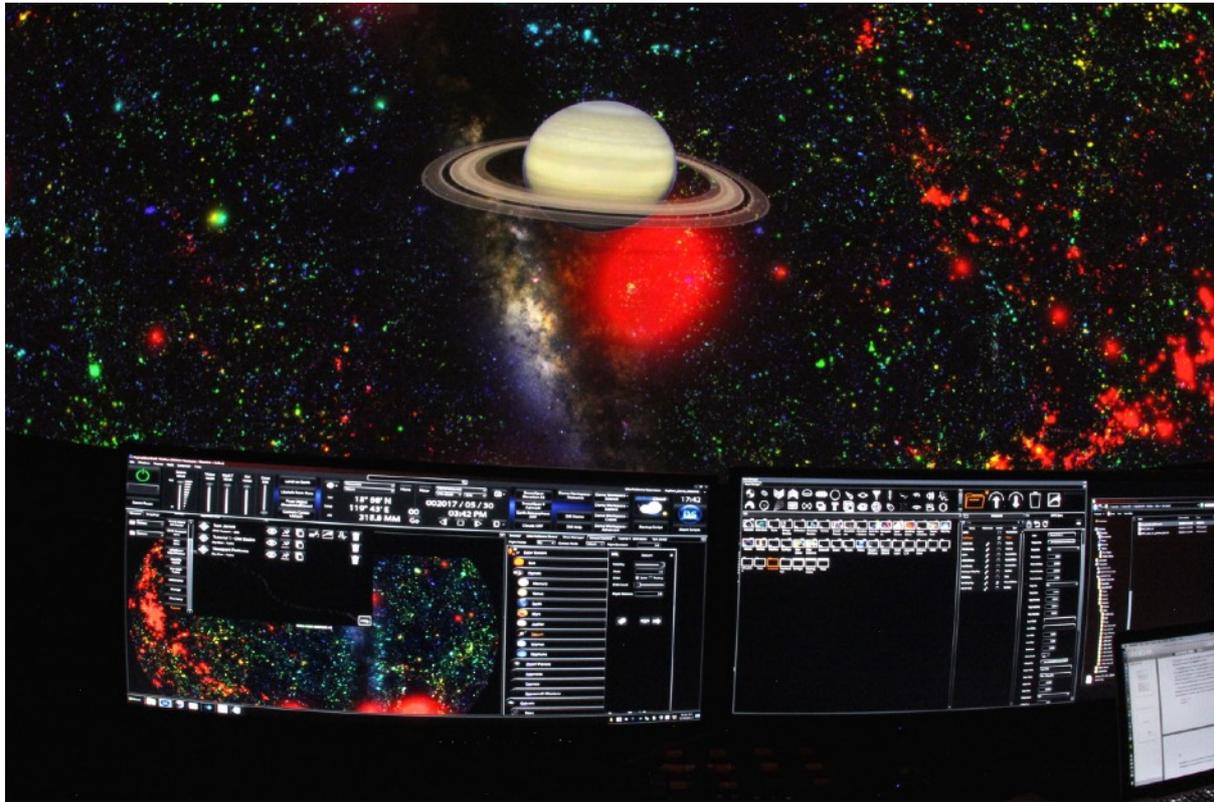


Theo Ferreira admiring the brand new rack of computers. (inset) Two clusters, each with fourteen computers consisting of a master, 12 clients and sound micro-computers, each with its own NVIDIA P6000 GPU.



One (of six total) Sony 4K laser projectors, state of the art technology. They are arranged along the circumference of the theatre (right panel), each producing a spherical 'slice' of the image, which is then blended together in-real-time to form the final, seamless full-dome image.

The primary software that is used to ingest data and drive the projectors is SkySKAN's Digital Sky: Dark Matter (DS-DM), which is capable of traditional planetarium functionality as well as modern data exploration. Researchers use their own cluster, allowing them to optimize setups and saved work areas without disrupting the production/show computers. The cluster is so powerful that may also be used for running cosmological evolution simulations (one of the original design drivers for the system). Although not yet in place, there will be a fully automated backup system to ensure secure backup of the data sets.



A colorful cosmic projection appearing on the full-dome (more details on the actual data are given below). In the foreground the control-centre monitors display the DS-DM software control panels.

“Planetariums are, for the first time, able to give back to the scientific world.”

Planetarium capacity is growing. A US\$2-million digital upgrade of the Iziko Planetarium in Cape Town is being funded by the museum and local universities with the expectation that it will also serve as a facility for researchers. The European Southern Observatory Supernova Planetarium, scheduled to open near Munich, Germany, next year, is charged with supporting both research and education. Already, software originally written for educational planetarium shows is being used by NASA to review space missions and to aid forecasts of 'space weather', such as solar flares that can disrupt radio communications.

International recognition of what Cape Town Astronomers and the Iziko Museum are trying to do in this unique endeavour.

Excitement builds as the opening of the new upgrade approaches.

Opening Launch Week: May 23-26, 2017

After a long period of being down for construction, the new planetarium is now ready for prime time. The big week arrives, VIPs are invited and catering is set, people arrive and (many) speeches are given. The highlight is the fulldome projection, as the new system demonstrates the exciting powerful graphics and sound that delight the senses (it has been described as sensory overload for some).

INVITATION PREVIEW

IZIKO PLANETARIUM AND DIGITAL DOME

Ambassador Dikgang Moopeloa, IZIKO Museums of South Africa Chairman of Council, and Ms Rooksana Omar, Chief Executive Officer, invite you to attend an exclusive preview.

This viewing is specifically aimed at introducing this new facility to investing partners, as well as scientists and researchers from the academic community, to showcase the potential of this cutting-edge technology for big data visualisation, collaborative research and the development of novel teaching methods. The event and Q&A session will be hosted by Associate Professor Michelle Cluver (UWC), IZIKO Planetarium and Digital Dome Associate Astronomer, and Professor Thomas Jarrett (UCT), NRF SARCHI in Astrophysics and Space Science.

Date: Tuesday, 23 May 2017 **Time:** 18:00 for 18:30
Venue: IZIKO South African Museum, 25 Queen Victoria Street, Cape Town (Parking is available at the African Pride 15 on Orange Hotel)
RSVP: Ahmien van der Walt: +27 (0) 21 481 3852; +27 (0) 79 133 2815 or email avanderwalt@iziko.org.za www.iziko.org.za

Logos for: Arts and Culture Science and Technology, NRF National Research Foundation, NLC NATIONAL LETTERS COMMISSION LETS FANSE, iziko museums of South Africa, an agency of the Department of Arts and Culture, University of Western Cape, University of Cape Town, Cape Peninsula University of Technology.

IZIKO PLANETARIUM AND DIGITAL DOME

An exciting digital era is dawning at IZIKO Museums of South Africa...

Experience perspective-3D edu-tainment, and be inspired by this digital, immersive, fulldome theatre and revolutionary eResearch facility.

www.iziko.org.za

IZIKO gratefully acknowledges the significant, ongoing support of our partners in the digitisation of the IZIKO Planetarium and Digital Dome.

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Theo Ferreira proudly showing off his new system to the diverse array of VIPs, politicians, artists, scientists, press and journalists, and planetarium enthusiasts who have shown up for the Launch Week. For the most part, all goes well !



Launch Week consisted of four successive nights, each with its own theme, including and most importantly, the **scientific research** (helmed by Dr. Cluver) due to the unique dual-purpose nature of the facility,

Left: Astronomers Mark Subbarao (Adler Planetarium) and Tom Jarrett (UCT) are in fine form (at least their ties are looking good). Both were instrumental with the design of the system.

Operations: 2017-2018

Normal operations began following the Launch Week. Shows and real-time sky presentations were conducted by Theo's staff, initially every day during normal operations. Later, a proper schedule that parsed time for the researchers (University Consortium) was agreed upon, as follows: Every Monday (entire day) is set aside for the exclusive use of the researchers, as well as select hours during weekdays (3 to 5 pm), and 9-11am on the weekends. This is how the planetarium was operated during the 2017-2018 season.

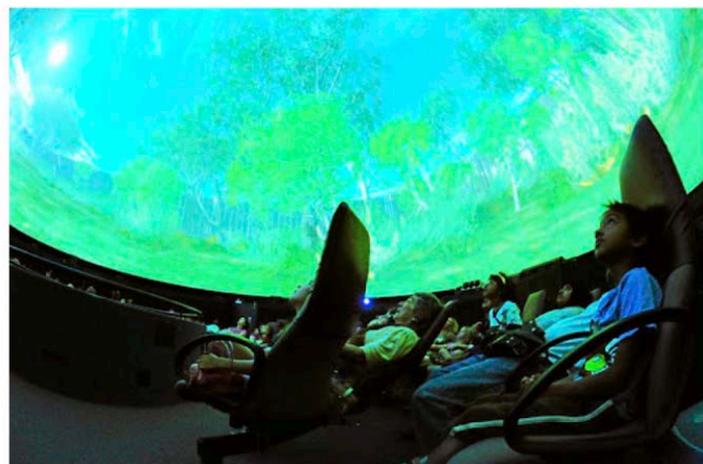
“The planetarium is one of only six fully fledged planetaria in Africa and its new digital visualisation technology promises “immersive multisensory edutainment” for young and old.”

□ NATIONAL / SCIENCE & ENVIRONMENT

New view of stars baffles the senses

Cape Town's revamped Iziko Planetarium and Digital Dome offers immersive multisensory edutainment

03 JULY 2017 - 06:22 by JANINE STEPHEN



Close-up of the stars: The astronomy shows are convincingly 3-D and one of the projectors will be devoted purely to research. Picture: SUPPLIED

There were a few occasions, notably holidays, however where Iziko Planetarium (read: Theo Ferreira) requested that dedicated research time be used for shows due to the maximal public interest and financial gain during the holidays. Negotiating with Prof Tom Jarrett (representing the researchers), acceptable agreements were managed (e.g., trading hours), and both parties were suitably satisfied with the arrangement. This informal way of bargaining was successful because Ferreira and Jarrett see eye-to-eye with operations and the importance of the planetarium as a public outreach facility; however, in the future this negotiation process may require more care and thought (as these two gentlemen will not be around forever).

For the remainder of this report, we will discuss the research that has been carried out with the full-dome facility.

Research/Academic Digital Dome Demos

This list indicates the academic usage of the Digital Dome to showcase capabilities relevant to the use of the dome for academic visualisation (after the launch in 26 May 2017). This excludes academic time on the system used for learning the software, uploading data sets, training etc., which occurs predominately on Mondays.

- June 12, National Astrophysics and Space Science Students (+/- 35 people)
- September 11, UWC Dome Day attending by representatives from the departments of Bioinformatics, Earth Sciences, Biodiversity studies (10 people)
- October 2, UCT Astronomy (+/- 30 people)
- October 28, UWC/CPUT Space Association (+/- 20 people)
- November 13, Data to Dome event for .astronomy conference (+/- 25 people)
- November 16, .astronomy Hack Day — working on original planetarium storyboard for an indigenous astronomy show (10 people)
- December 2, Southern Star Party Demo (+/- 50 people)
- December 11, Data to Dome (public event, ticketed)
- December 11, UCT Dept of Neuroscience Demo (5 people)
- December 18, Data to Dome event (public event, ticketed)
- January 8, 2018, Data to Dome event (public event, ticketed)
- January 14, Dept of Neuroscience Demo (1 person)
- January 15, Data to Dome event (public event, ticketed)

Should further information be required, please contact me on michelle.cluver@gmail.com.

Data to Dome: One of the most important concepts that is part of using the full-dome as a research tool for visualizing Big Data is the *Data to Dome* paradigm — smoothly and easily transferring data from computers, clouds, research facilities to the full dome. To demonstrate the capabilities of the Iziko Planetarium toward this end, it was the brainchild of Prof Cluver to do a series of Data to Dome (D2D) events, open to the public (in general) and specifically pitched to the science community. And so Profs Cluver and Jarrett prepared the data, planned the shows, did the marketing (with some help from Iziko, although rather paltry in that regard), rocked up and did the events. Huge success !

“Data to Dome” Public Showings

Prof. Tom Jarrett (UCT) & Associate Prof. Michelle Cluver (UWC) invite you on a tour of the universe! See real astronomy data visualised on the dome, and hear about the research being done by astronomers in Cape Town. See planets, stars, nebulae, galaxies and even the Cosmic Web!

Dates: 11 December 2017 at 14:00
 18 December 2017 at 15:00
 8 January 2018 at 14:00
 15 January 2018 at 14:00

Venue: Iziko Planetarium and Digital Dome
 25 Queen Victoria Street, Cape Town
 Cost: Adults R60

Enquiries: Kim Lindeboom: Tel. 021 481 3874;
 or email klindeboom@iziko.org.za

UNIVERSITY of the WESTERN CAPE
 UNIVERSITY of Cape Town
 IDIA Inter-University Institute for Data Intensive Astronomy
 from big data to big ideas
 www.iziko.org.za
 iziko museums of South Africa



Highlights from a Data to Dome presentation. To the left, Michelle Cluver guiding the audience through a tour of the Universe with real data of stars & galaxies.

In addition to the Data-to-Dome public events, promotion of the facility as a scientific facility was carried out by Jarrett & Cluver through a series of academic talks (colloquia for the most part) and other formal public gatherings (e.g., the Famelab, see below).



Visualizing Big Data
"a picture is worth a thousand words."
T.H. Jarrett (UCT)

Fame Lab
TALKING SCIENCE

Come watch UCT's young scientists compete and present a scientific topic, in just 3 minutes!!!

Date: 29 August 2017
Time: 4:30pm for 5pm
Venue: Hlanganani Junction
Invited speaker: Prof Thomas Jarrett (Astronomy)

Please RSVP to Judith.Rivart-Lara@uct.ac.za by 21 August as space is limited and for catering purposes.

NEURO DOME

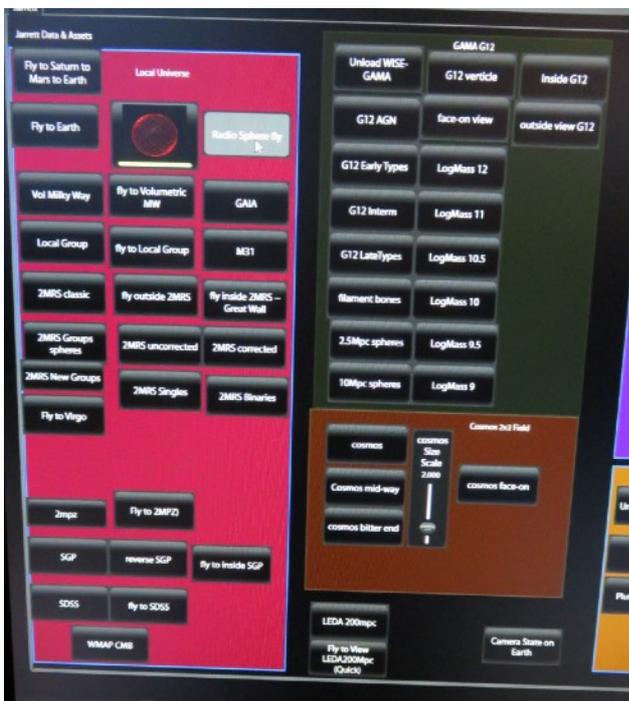


Will astronomers lead the big data charge...

But not in visualisation?

Dr Michelle Cluver, UWC

Researchers and Data Sets Prof Jarrett has been using the facility to visualise data that is derived from his research on galaxies. Starting from the Opening Launch Week, which used his data and results as a showcase, and continuing throughout the 2017 and 2018 period, he has been compiling and loading data, consisting of tables (and meta-data), images, videos, simulations and volume renderings. Both he and Prof Cluver have been meeting with researchers from the University Consortium (and not just astronomers), demonstrating the system and forging partnerships. Jarrett has been carrying this mantle during the 2018 period, actively working with Stellenbosch University cellular and molecular biologists (notably, Dr. Ben Loos and his students), and with the UCT neuroscientists. An impressive array of data is now loaded on the research cluster, ready to be analysed and interrogated uniquely with the 8K fulldome projection. Examples are to follow ...



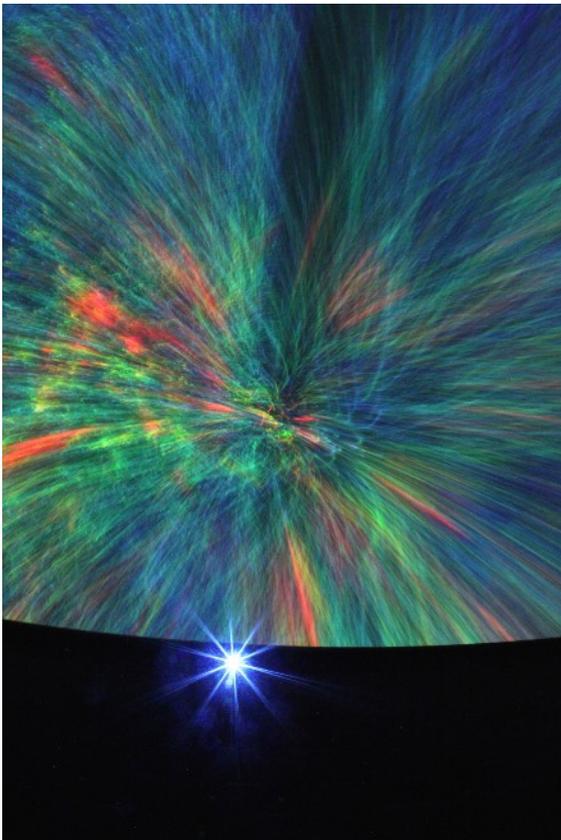
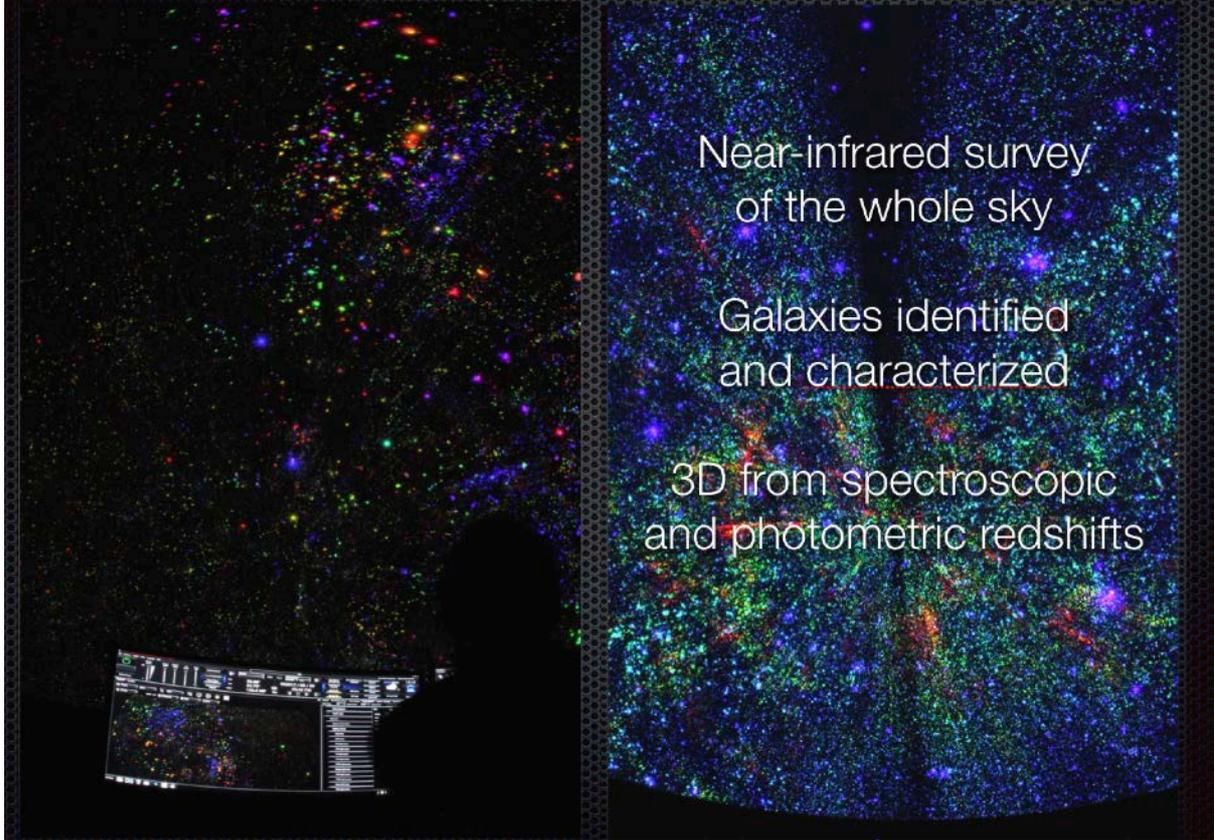
Data Set	Researcher	Type	Notes/Published
GAMA-WISE G12	Jarrett (UCT) & Cluver (UWC)	galaxies; catalogue;	Jarrett, Cluver et al. 2017
2MPZ	Bilicki (Leiden) Jarrett (UCT)	galaxies catalogue	Bilicki et al. 2015; Jarrett 2004
Cosmos	Marchetti (UCT/UWC)	photo-z galaxies	high-redshift, pencil beam
2MRS	Lambert & Jarrett (UCT)	galaxies and groups; LSS	redshift-bias corrected
GAIA DR1	C. Cater	Milky Way stars	precise 3D positions
CLUES	Subbarao (Adler)	3D cosmological simulation	https://arxiv.org/abs/1005.2687
Cell death	B. Loos (SU)	volume rendering	Alzheimer's Disease research
Mouse Cerebellum	A. Du Toit (SU)	volume rendering	heat mapping in 3D
Olefaction	A. Du Toit (SU)	volume rendering	Olefactory bulb 3D mapping
Brain scan	U. Rohlwick (UCT)	volume rendering	Neurological research

The DS-DM “work space” page of T. Jarrett



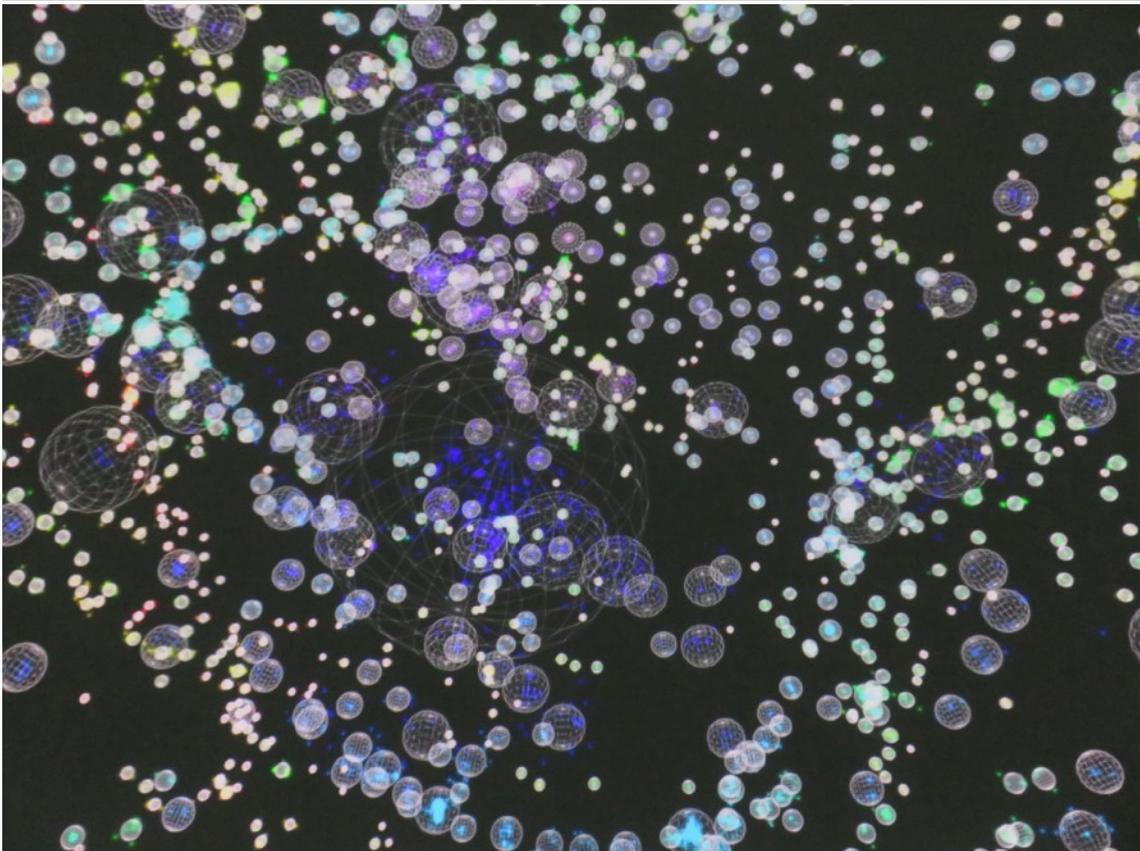
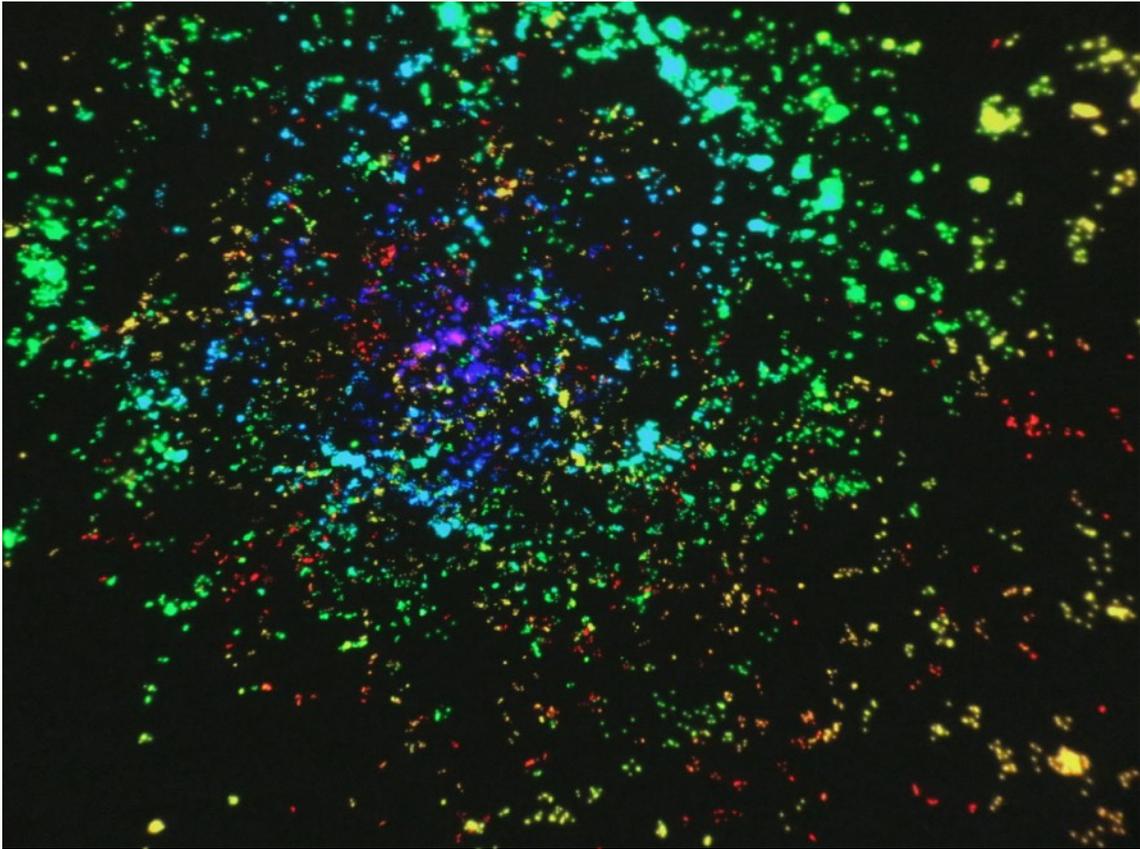
The workspace is comprised of “buttons” that control scripts, that in turn control the data (known as “assets”) and how it is visualised onto the full dome.

2MPZ: 950 000 galaxies



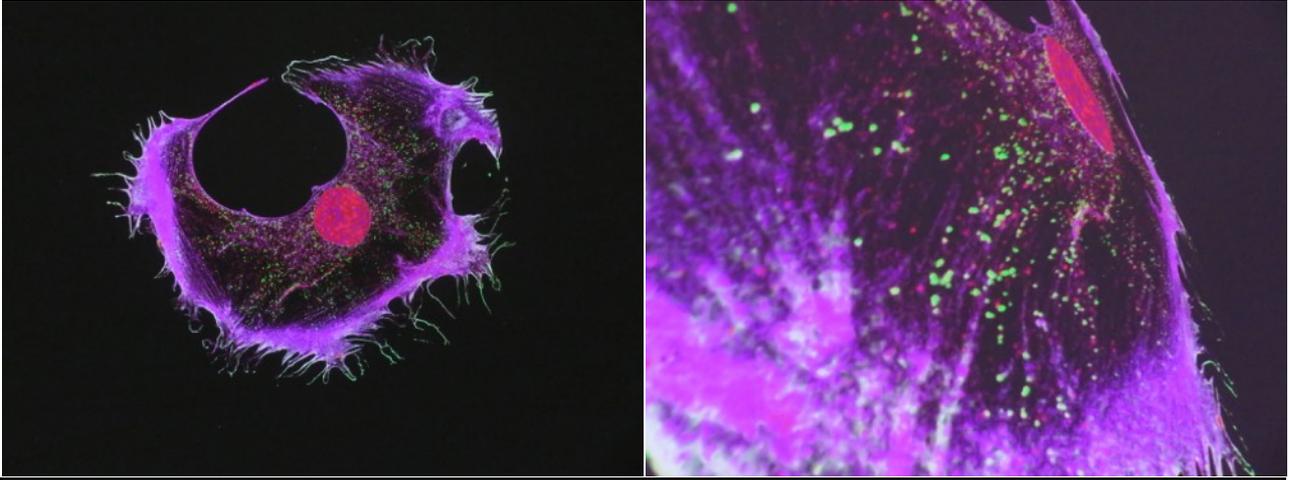
One of the premier data sets visualised with DM and the full dome. Consisting of nearly one million galaxies, 2MPZ is a 3-D catalogue that defines the 'cosmic web' of galaxies in the local universe. Published by Jarrett (2004), and updated by Bilicki et al. (2015). The snapshots here demonstrate the way the galaxies are rendered (see colourful halos), with some flying-motion (left) and foreground planets in the mix for a nice cool planetarium effect.

3D Catalogues — also known as particle tables

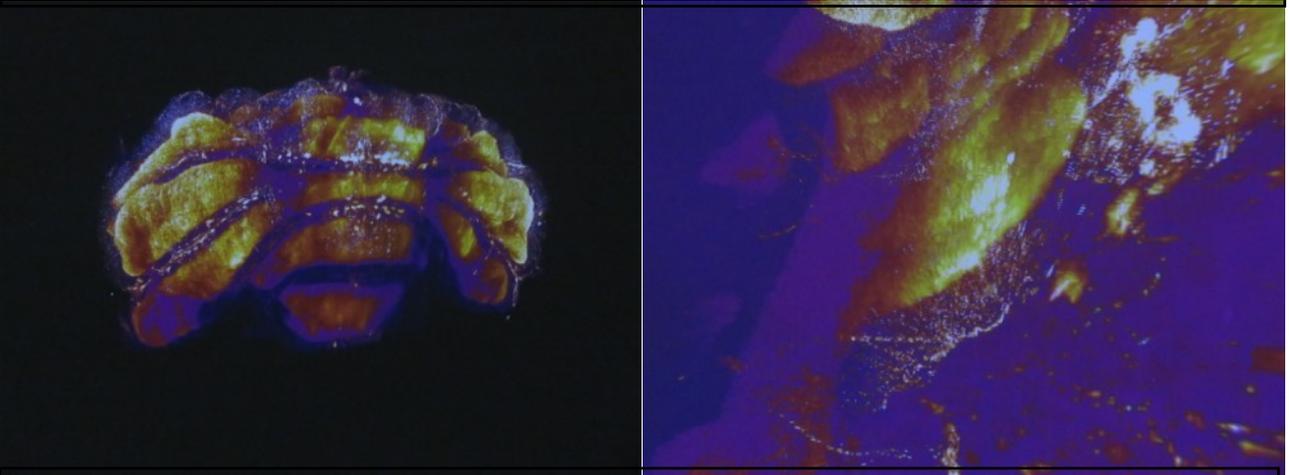


Two Micron Redshift Survey (2MRS), now viewed in a completely different way — namely, the redshift bias “finger of god” artifacts have been removed through identification of all groups and clusters. These physical groupings are indicated with the spherical mesh; note the large one in the center: the Virgo Galaxy Cluster. This project is part of the MSc/PhD of UCT student Trystan Lambert (under the supervision of Jarrett).

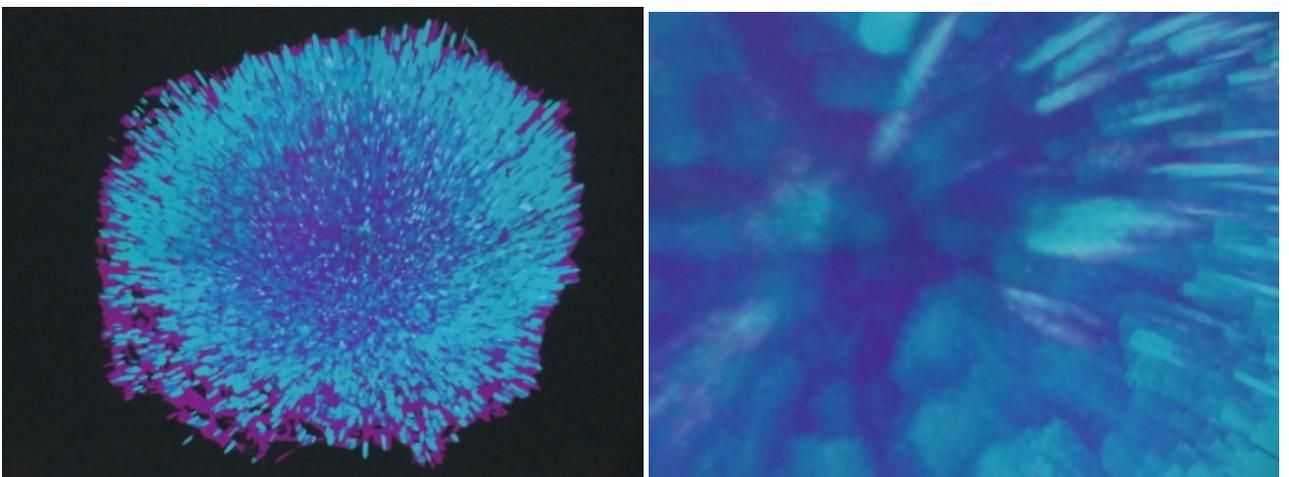
Volume Rendering – GPU-intensive data exploration



Cells in space ! Mouse embryonic fibroblast stained for mitochondrial DNA (red), autophagosomes (green) and actin cytoskeleton (magenta). The process under investigation is associated with neurodegenerative disease, where dysfunctional mitochondria and proteins are aggregating. Normally, these will be captured and removed through the autophagic machinery (green). This is a process that B. Loos research group assess quantitatively, to understand the degree of dysfunction and the level needed to rescue a cell from protein aggregation-induced toxicity. <https://www.neuroresearchgroup.com>

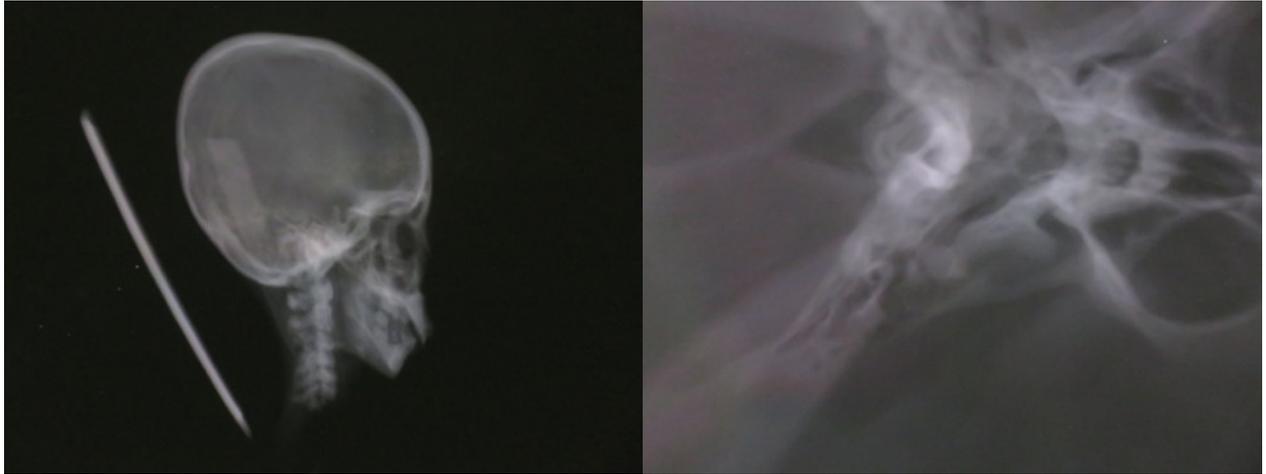


Brains in space ! Mouse cerebellum tissue that forms part of the sensory systems which is involved in the coordination of voluntary movements such as posture and balance, resulting in smooth and balanced muscular activity. Processed using CLARITY, a method that renders tissue transparent by washing out light-scattering lipids and allowing for 3D fluorescent imaging of large tissues. A Carl Zeiss LSM780 confocal microscope was used for tissue imaging. B. Loos & A. Du Toit

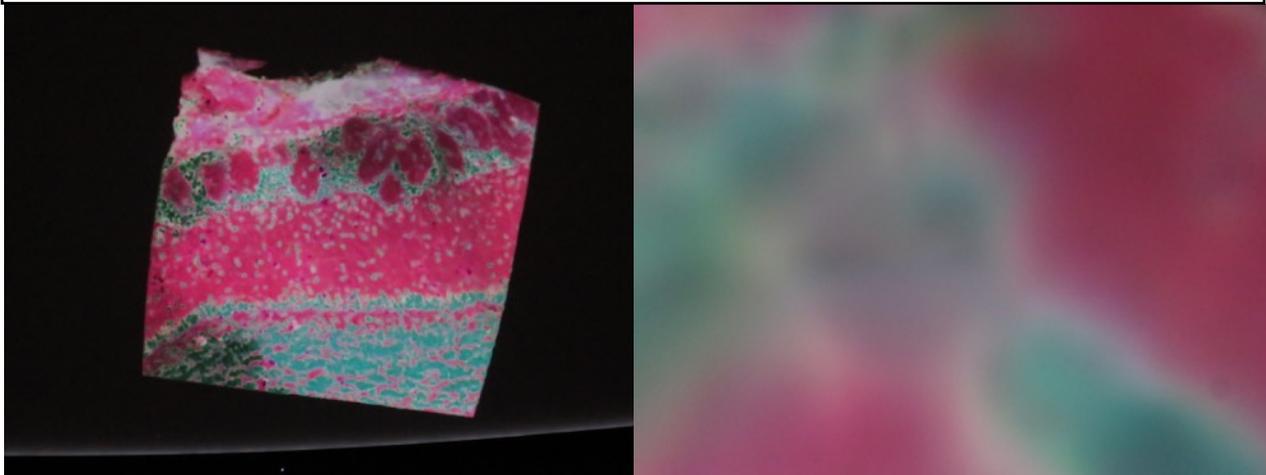


Cancer in space ! Volumetric rendering of a human cancer cell. Right side, flown into the murky void.

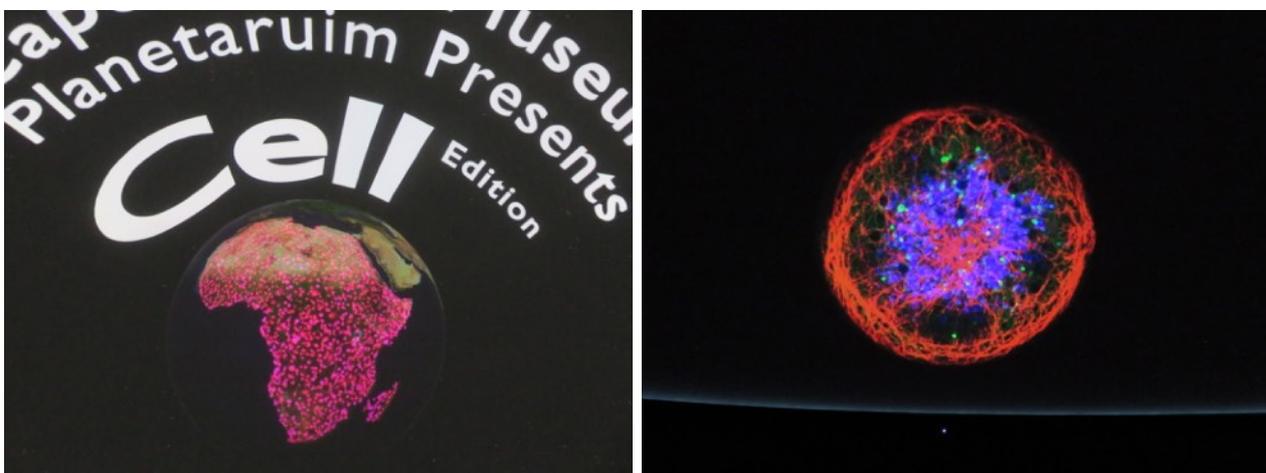
Volume Rendering – GPU-intensive data exploration



Craniums in space ! This is computed tomography (CT) scan of a human skull/spinal column, attempting to find details in the squishy brain matter among the bony bits. Right side: now inside the brain, looking straight down the spinal cavity. U. Rohlwink



Scent in space ! Olfactory bulb, a neural structure of vertebrate fore-brain involved in the sense of smell. Nuclei are shown in blue (Hoechst stain) and tissue density shown in red (auto-fluorescence) Right side: flying into the Olefaction cell proves to be a colourful experience (note the irony). A. Du Toit

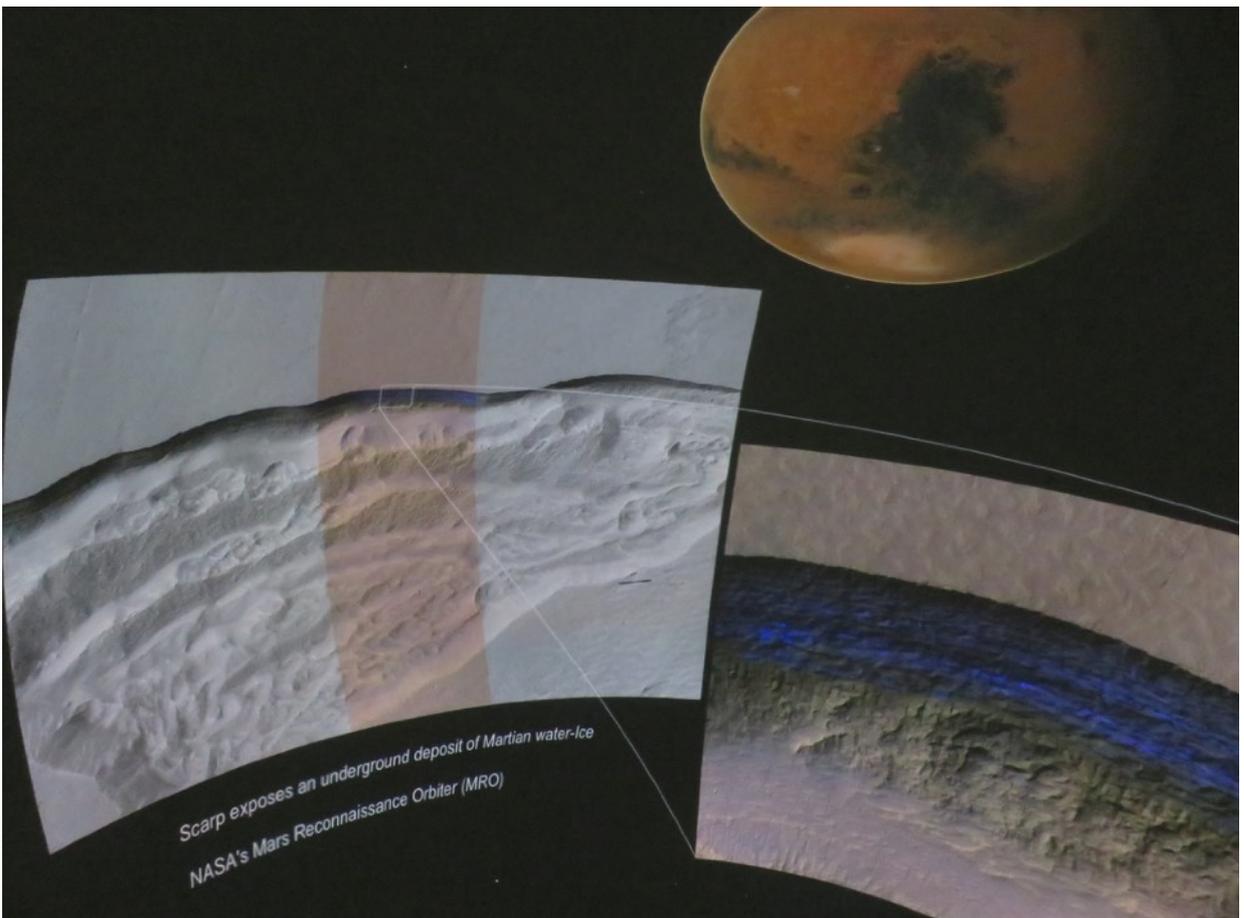


Combining the planetarium tools with a external graphic art tools to create a short animation (show), here highlighting the cells (coerced to group into a shape of Africa), individually shown in detail (right).

Adding images and slides to enhance the 'planetarium' experience



The DS-DM digidome environment is versatile. Here we have flown to the dwarf planet Pluto (left), and then displayed (with a button push) an enhanced image from the New Horizon's flyby (right). This was used in the Cluver & Jarrett Data-to-Dome (D2D) events.



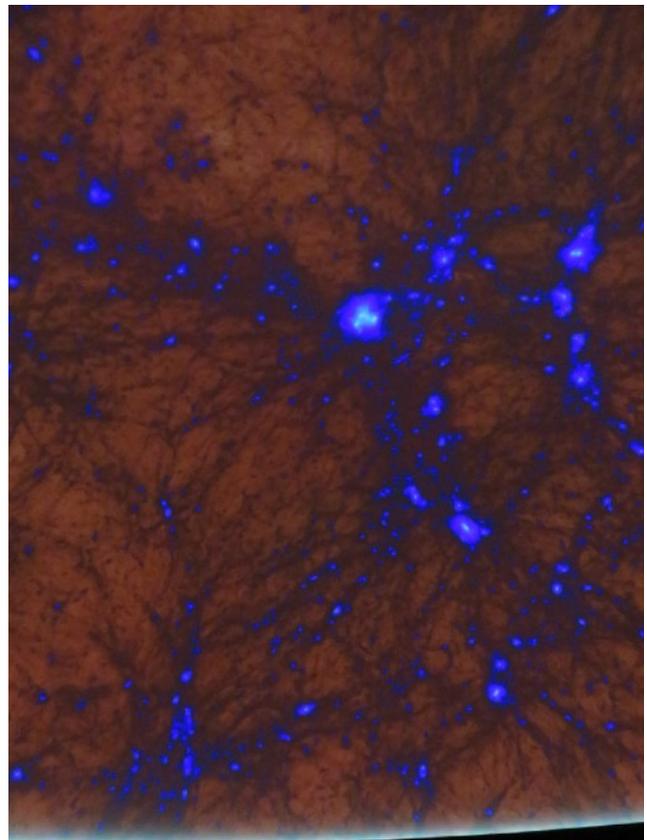
Using slides to supplement Solar System exploration. Here we have flown to Mars, and then displayed a slide to discuss Mars ice. This was used in the Cluver&Jarrett D2D events.

Full-dome imaging and videos

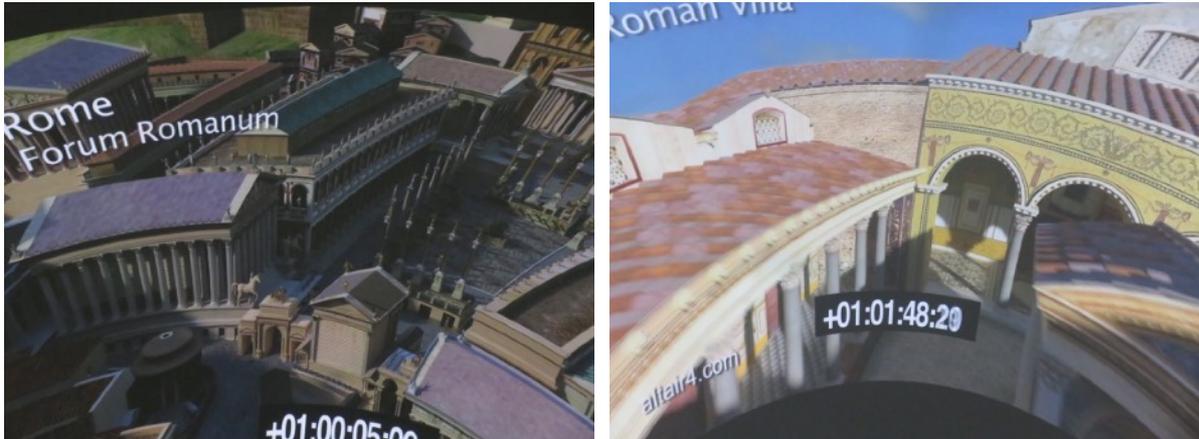


Images that have been transformed to a full-dome format — also known as fish-eye or dome-master — are particularly effective for lecturing and demonstration because of the 360-degree immersion. Here we are showing a beautiful fish-eye image of the VLT in Chile, telescopes and Milky Way in full view. With DM scripting, we can auto-rotate this image to jazz up the immersive experience.

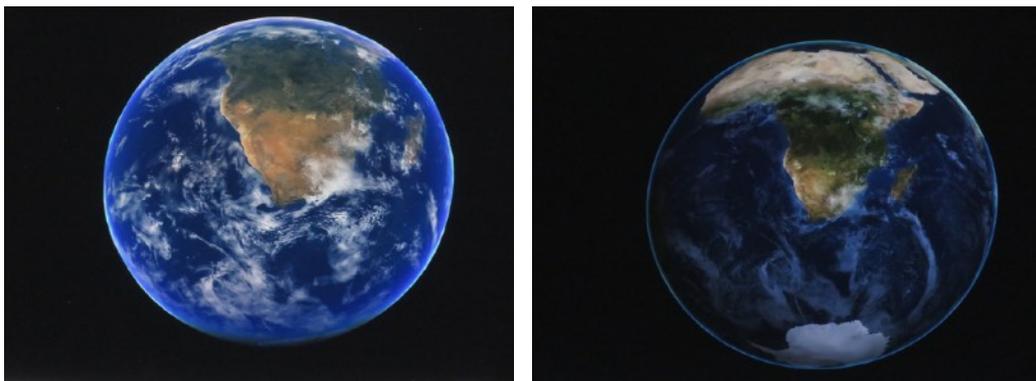
Simulations of the forming and evolving Universe are particularly effective in the full-dome environment because it is the entire universe you are looking at. Here we have the CLUES simulation, which stands for Constrained Simulations of the Local Universe (Gottloeber et al. 2010). This is a full-dome video, which plays over a few minutes of time to depict the 13 Gyr evolution of the Universe. Thanks to Mark Subbarao for obtaining and installing the data.



Standard format videos and hybrid animations



Simple rectangular format movies/vids look great on the dome. Here are some stills of a video being produced by the Italian Consulate of South Africa, showing casing Ancient Rome.



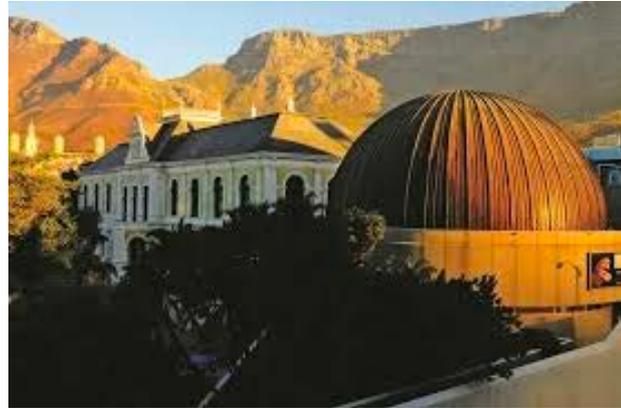
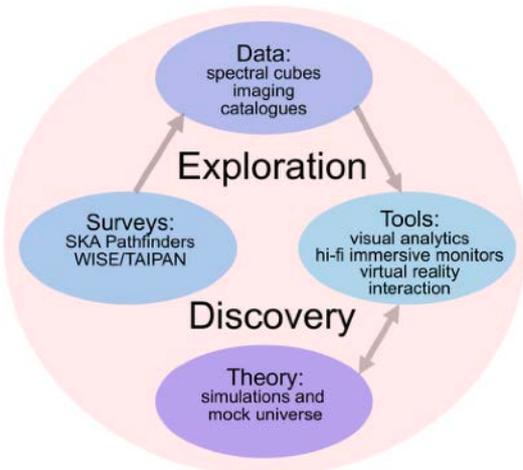
Finally, the most ambitious 'production' from the research side is this 10-min animation/film created for the IDIA/SKA-SA opening of MeerKAT in Winter of 2018. It starts with the planetarium flying to Earth orbit (upper left), hovering over S. Africa, and then (transitioning from the planetarium to a video) flying down to the Karoo where the SKA/MeerKAT dishes are doing their receiving thing. It ends with the IDIA and partner credits.



Designed and created by graphic artist and student astronomer: Charl Cater



UCT/IDIA Visualization Laboratory



Big Data Visual Analytics: As scientific data sets become larger and more complex, it is necessary to migrate to new technologies to facilitate scientific analysis and exploration. With the advent of big data, cloud technologies provide a clean solution for managing and processing data sets that would otherwise be unmanageable. As we shift paradigms to having our scientific data living in the cloud, it is necessary to develop the tools and techniques necessary to enable science on these data large data sets. See more here: <http://www.acgc.uct.ac.za/~jarrett/VisLab/>

EXTRAGALACTIC
UCT ASTRONOMY

IZIKO PLANETARIUM DIGITAL FULLDOME FACILITY

In partnership between UCT Astronomy and IDIA, a laboratory for visual analytics has been created to develop and test hardware and software solutions for interactive visualization of large astronomical data sets. Central to the Visualization Lab is the Iziko Planetarium & Digital Dome, located in the heart of Cape Town. The fulldome facility is optimal for study and investigation of the largest-area data sets, including the Cosmic Web.

8K Digital Upgrade: Planning for the upgrade began in late 2014, spurred on by the creation of the University Research Consortium: University of Cape Town, University of the Western Cape, and the Cape University of Technology (with Stellenbosch Univ. in the wings). The facility is now part of the IDIA Visualization Laboratory.

System: Six Sony 4K Laser projectors (creating a total of 8K pixel projection), two computer clusters: one for production and the other for research, 5.1 Surround Sound, optimal reflecting dome, raised floor and new control center. Each cluster has 12 client computers and one master computer, as well as a sound computer. Each computer has a NVIDIA P6000 GPU, which provides more than enough power to render our large data sets on the fly.

The primary software is SkySKAN's Digital Sky: Dark Matter (DS-DM), which is capable of traditional planetarium functionality as well as modern data exploration. Researchers use their own cluster, allowing them to optimize setups and saved work areas without disrupting the production/show computers.

Full-dome projection creates an immersion 3-D experience, and hence ideal for data sets that are 3-D and volumetric. Prof. Jarrett and PhD student Christina Hall are 'flying' through the ZMASS Galaxy Redshift Catalogue, which is an infrared-based all-sky survey containing over 1 million galaxies. Each point is a galaxy (inhabited by billions of stars) color-coded based on their clustering properties.

Research: The system has 67 megapixels of 360-degree projection real estate that provides a unique perspective for interrogating large data sets. Cosmic web of galaxies – is one of the key science areas that astronomers use the fulldome facility to explore and mine.

Inspecting the local universe, starting from just outside the Milky Way Galaxy (left), flying millions of light years distant (middle) to view the Cosmic Web, and finally flying back to the Solar System (right, with Saturn in the foreground, and the web of galaxies in the background).

Multiple data sets can be viewed at the same time, making for some powerful contrast and comparison analysis. Here we show the Sloan Digital Sky Survey (SDSS) galaxies (note the pink structures) and the 'pencil beam' data from the Cosmics field (note the blue-cyan beam) to the lower right). In the background is the cosmic-microwave-background WMAP view of the early universe, showing the primordial space-time fluctuations (due to mass concentrations) that would later grow into the web of galaxies we see today.

Special Thanks

The authors would like to acknowledge and thank the following individuals, all proved crucial toward the successful design, implementation and operations (and vision!).



Mark Subbarao is the original Data to Dome architect and planetarium astronomer extraordinaire. I guess you could say he is the god-father of the Iziko Planetarium research consortium. He remains active with our group, having visited twice in 2017.



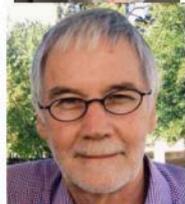
Shawn Laatsch was truly the spiritual leader of the Technical Advisory Committee, having been through the most perilous adventures with planetaria. His experience -- and strong advice ... ahem ... opinions -- was as if we were following Gandalf into Mines of Moria.



Ben Loos was our secret weapon, notably because he is not an astronomer! As a cellular biologist, Ben made sure our digidome design would work for those who like to probe down to the very small and squishy. Today he remains very active with the research, you can see a few of his spectacular volume rendered data, along with his crack PhD student, Andre Du Toit. Ben is also from Stellenbosch Uni, who are a little slow to join the Consortium ! (crack the wip Ben)



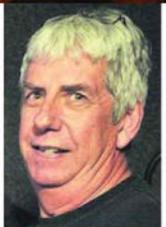
Thomas van der Heyde of the Dept of Science and Technology (DST). If there is one person who is truly the VIP of this entire project, it is this person. Without the backing of the DST, this project would never have seen the light of day. A thousand thank you's.



Similarly, it was Danie Visser's drive and support to bring UCT into the mix that made this project possible. He somehow corralled his fellow DVCs from UWC and CPUT (but no such luck with SUN) to form a Consortium. Remember, without the Consortium there would be no upgrade to the planetarium.



Susan Glanville-Zini kept the ship afloat, that is to say, she found the money (in the many millions), protected it from the forces of evil (no small thing in SA), and we got our system. She is the god-mother of the Iziko Planetarium !



Theo Ferreira, because he keeps the planetarium running. It breaks. A lot. Very complex system, finicky and downright obstinate at times (e.g., the sound system). Dealing with a lot of nonsense, including SkySkan and their lack of good service. Hang in there Theo!



Naledi Pandor, because she is awesome. Without her leadership, courage and honesty (few can claim that) as the Minister of Science, there would be no SKA, no SARChI program, no UCT astronomy, and no planetarium upgrade. So we come to the end, the most important person of all.

Appendix: Technical Advisory & Project Implementation Committees

Architects of the TAC Terms of Reference: A. Beitz and S. Glanville

The technical requirements and specifications to upgrade the Planetarium to meet edutainment requirements have been thoroughly researched. However, the additional requirements and technical specifications, to achieve optimal eResearch (Visualisation) capability, are currently unclear. There are also a number of related issues that require careful consideration, in order to ensure a suitable and sustainable upgrade. Production capacity must also be assessed, in relation to adapting existing analogue content, as well as the capability to produce new content. Must also clearly define skills development and training needs, maintenance and upgrade requirements, and technical support staff and operational guidelines to ensure the integrity of the equipment is not compromised when in use.

The Technical Sub Committee's role is thus to:

- provide a report regarding all technical requirements and considerations pertaining to successful implementation of the Iziko Planetarium Upgrade Project;
- provide ongoing advice on technical issues, for the duration of the implementation phase.

The remainder of the TAC TOR document can be found online (or by request from T. Jarrett or S. Glanville).

The TAC members:

- Prof. T. Jarrett (UCT; chair of TAC)
- Mr. Theo Ferreira (Iziko)
- Mr. Anthony Beitz (UCT)
- Mr. Piet Helm (UCT)
- Dr. Thandi Mgwebi (UWC)
- Mr. Shawn Laatsch (Infoversum)
- Dr. Mark Subbarao (Adler Planetarium)
- Dr. Ben Loos (SUN)

Iziko Planetarium Digital Upgrade Project Implementation Committee (PIC)

Committee Members:

Dr B Ndhlovu	— <i>Chairman</i>	BN	Ms S Glanville-Zini	SGZ	Mr H Maritz	Prof E Cloete
Prof M Phakeng		MP	Mr T Ferreira	TF	Prof R Taylor	Ms R Pedro
Dr M Cluver		CM	Dr W Alexander	WA	Prof R Pellissier	
Prof T Jarret		TJ	Mr A van der Walt	AW	Mr Y Manjoo	
Dr B Loos		BL	Ms K de Leeuw	KL	Prof T Mqwebi	
Mr R Lefebure		RL	Ms N Ngwilikane	NN	Prof Jose Frantz	