Novel presentation of visualisation results

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- Collaborative visualisation.
  - Exploring/evaluating SecondLife over the next few months.

- Questions and invitation to explore the topics above in more detail at the WASP.

Novel hardcopy technologies

- Three options have been explored by which researchers can create 3D "prints" of datasets.
  - Rapid prototyping: generating physical models from datasets.
  - Crystal engraving: supports disjointed datasets not suited to rapid prototyping.
  - Holograms: glasses free 3D prints, called "i-Luminograms'.

- Applications
  - Tactile visualisation, "feel you data".
  - Engaging exhibits for public outreach and education.
  - New ways of presenting research to peers, for example conference posters.

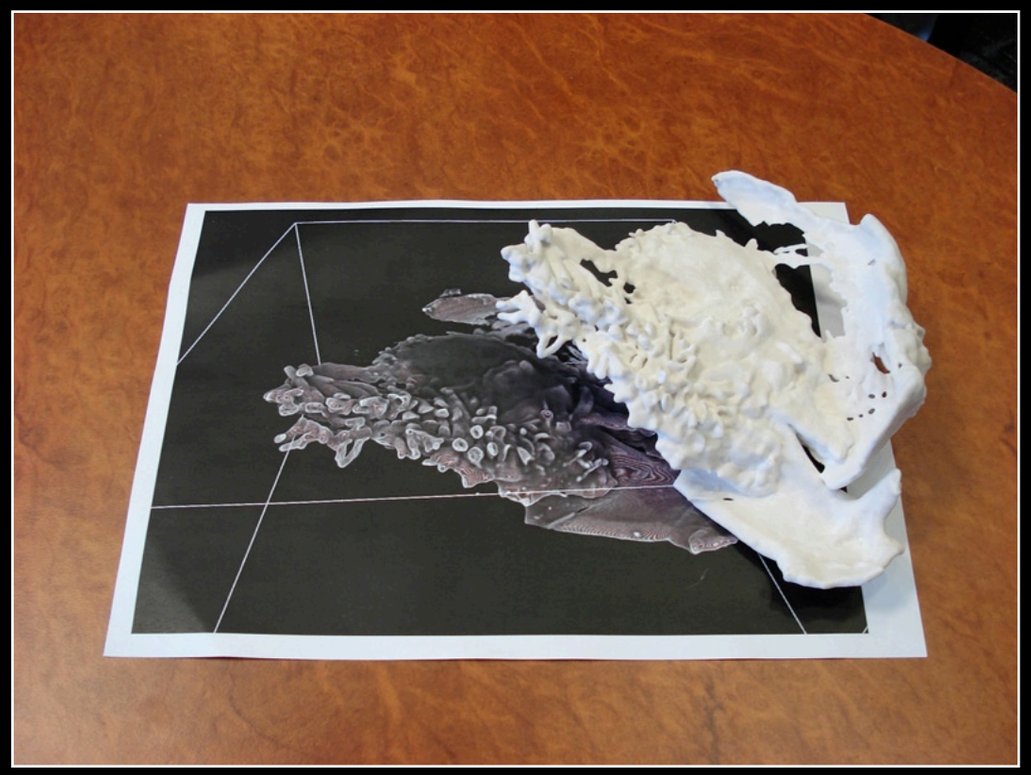
- Software tools have been developed to create these prints from datasets of various types and formats.

- You are invited to contact me if you would like to explore the application of any of these with your own datasets.

Rapid prototyping

- There a number of technologies for automatically creating physical models.
- We have access to a ZCorp 3D printer, unique in that can print in colour.
- Models are limited to maximum dimensions of about 25cm, there are limits on the resolution of fine detail .... these limits are structural, the spatial resolution is about 0.2mm.
- Currently no cost to local researchers, consumables have been funded by iVEC for data visualisation applications.

Miscellaneous models courtesy Andrew Squelch



Isosurface of vertebrae fossil courtesy Kate Trinajstic

Crystal engraving

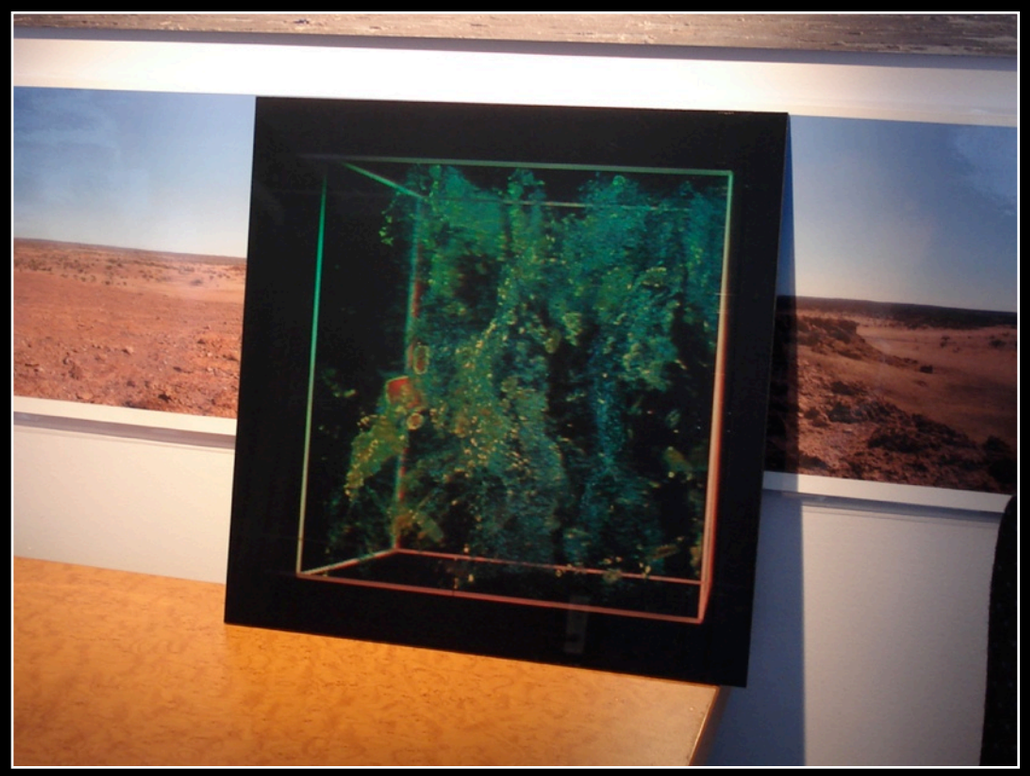
- Disjoint models cannot reasonably be created using rapid prototype machines.
- Small bubbles in the crystal are formed by focussing a laser beam.
- These bubbles subsequently scatter impinging light, making them visible.
- Interesting side effect: refraction allows one to see two views of the model simultaneously.
- Current examples include many volumetric datasets, some from geology.

Isosurface from MRI volumetric dataset.

Holograms (i-Luminograms)

- Holograms are traditionally of physical objects. The interference pattern between light reflected off the object and a reference beam is recorded onto film. Upon illumination by a reference beam the virtual image is reconstructed by the process of diffraction.
- The light reflected off the object can be considered to be a large number of points sources, these can be captured across a range of directions with a large number of renderings.
- Unlike real holograms where faithful colour is difficult, i-Luminograms have good colour reproduction. They do however have lower spatial resolution than holograms.
- I have remaining iVEC funding to experiment with this technology with your datasets.

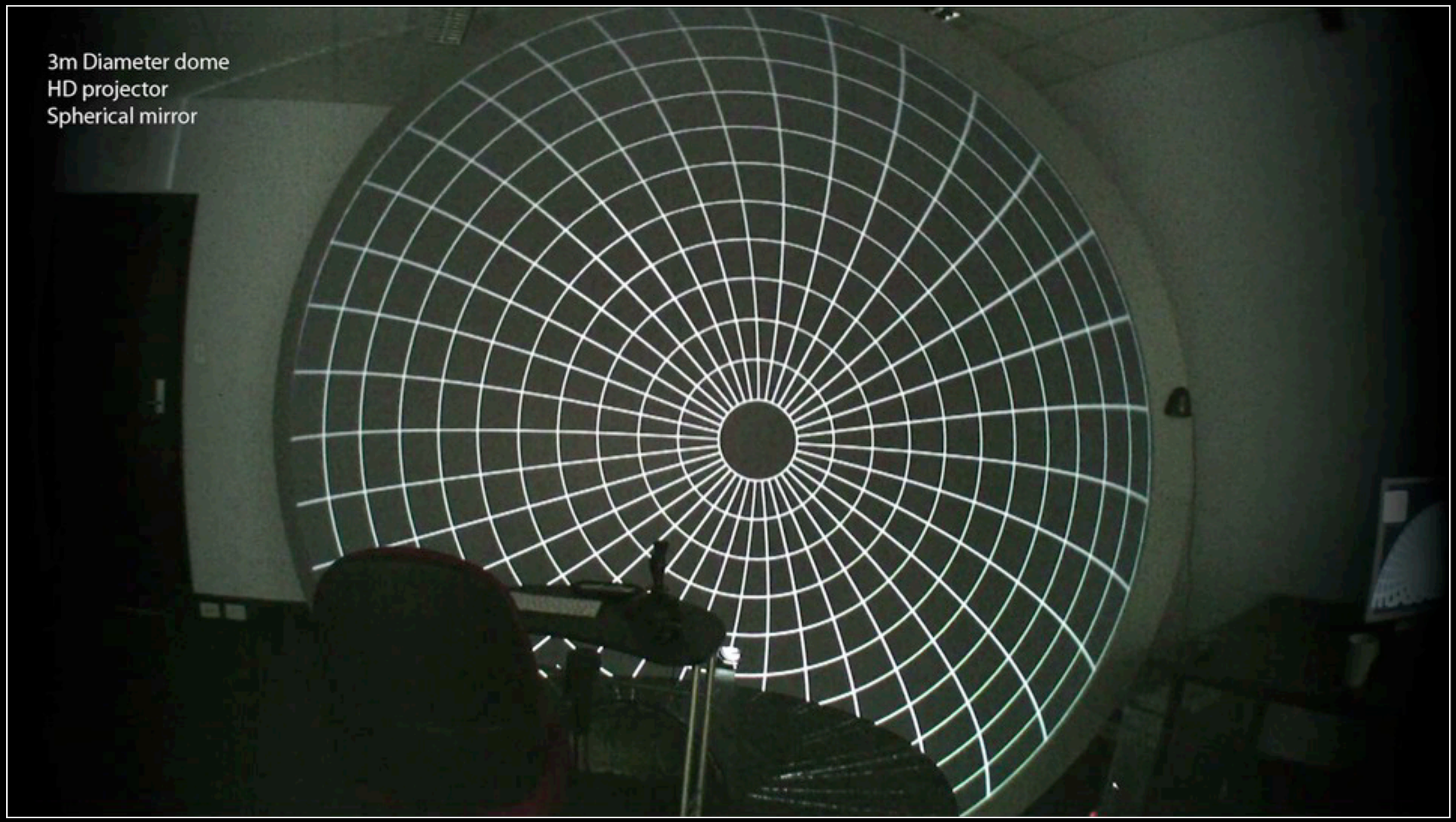
Volumetric dataset courtesy Florian Fusseis



iDome: An immersive environment

- We are all familiar with the use of stereoscopic projection to enhance the visualisation process.
- Filling our peripheral vision gives a strong sense of being in the virtual world, in the context here, being inside the data.
- In the case where one is on the inside of a dataset it allows one to appreciate a full hemisphere of information without continually panning left/right/up/down.
- The iDome is a 3m diameter hemisphere. When suitably geometry corrected images are projected onto the interior the visualisation fills ones entire field of view, horizontally and vertically.
- Hemispherical displays such as the iDome and planetariums often gives a strong sense of depth even though glasses are not being worn and stereoscopic imagery is not being projected.

- Shameless self promotion: Encourage you to visit the "late show" at the Horizon planetarium where they are showing my "Volume Visualisation Under the Dome". This is based upon 6 volumetric datasets sourced from the microCT scanner at the ANU.
- Video showing interaction with volumetric datasets in the iDome.


3m Diameter dome
HD projector
Spherical mirror

The 4K challenge!

- Modern volumetric scanning devices are providing researchers with higher resolution volumes. 4K cubed is soon going to be readily available from a range of devices.

- Current approaches to visualising this data include:
  - Subsampling: Filtering the data down to a resolution where it can be handed in real time.
  - Subsectioning: Choosing smaller sections of the data and visualising those one at a time.
  - Offline rendering: Creating visualisations offline on multiple CPU/GPU machines.

- While some of these approaches are acceptable, and others are forced on the researcher, increasingly realtime visualisation of 4K volume is being requested.

- What is the state of play at the moment for interactive volume visualisation?
  - 512 cubed is solved on even relatively commodity hardware (eg: graphics card).
  - 1K cubed is not a problem if one invests in some higher end hardware.
  - 2K cubed is getting hard ... 4K cubed is 8 times harder.

- Aside: Note that visualising a 4K cubed volume implies that you have a display device with "close" to that resolution.

Why is 4K so hard?

- Volume data, assuming 2 bytes per voxel (may be 2 bytes per voxel or 1 byte for scalar and 1 byte for gradient).

512 cubed	256MB
1K cubed	2GB
2K cubed	16GB
4K cubed	128GB

- Most interactive volume visualisation these days is performed on the graphics card.
  The graphics card with the most RAM today has 4GB, approximately 1500 cubed.

- Can sub-cubes be shuffled on and off the card and composited at the end?
  Current PCI Express 2 is 1/2GB/sec per lane.
  So over 16 lanes a 2K cubed requires (at least) 2 seconds just for data transfer.

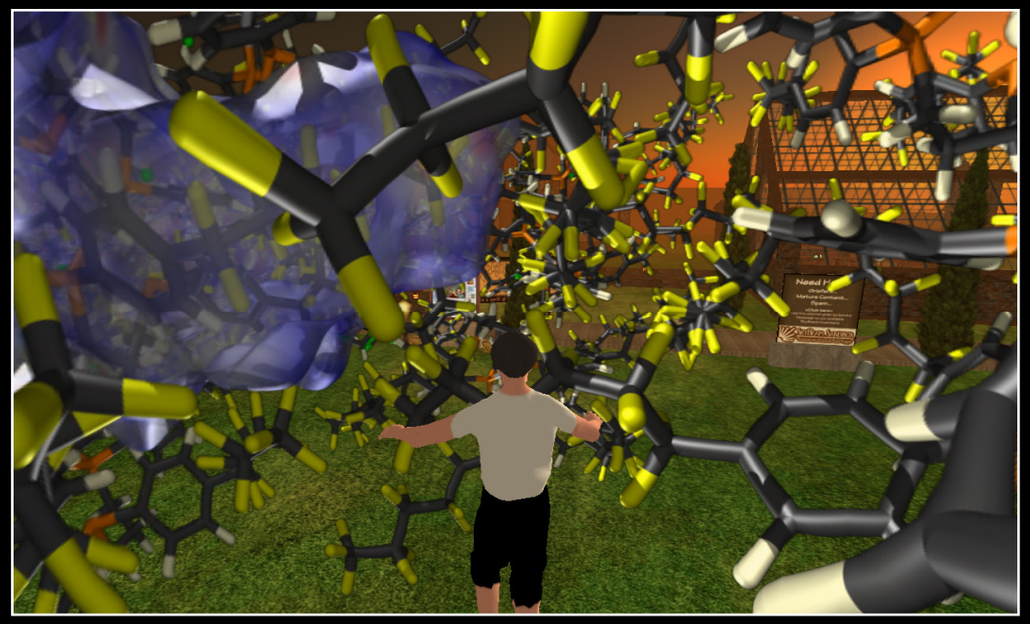
- The likely solution will involve distributing the data over a number of CPUs, GPUs, or combination. Each compute unit will render a sub-cube (stays in memory), the results of which will be composited to present the final image.

- Keep UWA in the loop and contribute to developments along these line at ANU and Monash.

Collaborative Visualisation in SecondLife

- SecondLife provides a virtual world in which (remotely located) participants can interact with each other in various ways: text, voice, gestures, character movement.
- In addition it is possible to represent datasets within the virtual world (Explored in 2008).
- Compare this to traditional forms of remote collaboration (video conferencing) which rarely support data exchange and if they do it isn't in a shared 3D environment.
- Currently UWA is acquiring two regions, one will be mainly dedicated to a campus model, the other half will be available to researchers who would like to explore SL for collaborative visualisation. ps: a region costs money and is required for persistent data/geometry.
- See me afterwards if you are interested in being part of this trial.

Volumetric dataset in SecondLife



Molecular data example

Questions?

Further discussion and viewing of real examples will occur after this meeting.

Meet at the WASP, ground floor Physics building.

Stereoscopic examples from attendees will also be shown.