

Cancer Killers in 3D

Project Leader: Dr Maja Divjak

 Partner Institutions:
 Peter MacCallum Cancer Centre

 System:
 Nebula

 Areas of science:
 3D Imaging and Reconstructing, Data Science, Medical Data Analytics, Visualisation

The Challenge

Million

t-cells per patient

p resolution

times render

speed

terabyte of

data

CAR-T cell therapy is a new cancer treatment which modifies the body's T-cells to better recognise cancer. These cells play a vital role in the immune system by recognising foreign agents. CAR-T cell therapy has proven so effective against some advanced blood cancers that it is now publicly-funded in Australia. Adults with Diffuse Large B-cell Lymphoma and children with Acute Lymphoblastic Leukaemia are eligible for treatment.

"The Peter McCallum Centre is licensed to engineer these T-cells onsite for treatment of patients in Australia. Previously we had to send a patient's T-cells to Asia to have them engineered," said Maja.

Maja's animation explains how this treatment works. Doctors gather the patient's T-cells, then tailor them to identify cancer cells. They then release the Tcells back into the body to fight the cancer. Maja's animation informs patients about their treatment options. It also promotes this revolutionary new treatment to the public. But molecular animation is a unique challenge and requires powerful graphics processing.

The Solution

Maja used Pawsey's Nebula cluster to render her animation. Maja's animations are in 1080p resolution. This means her computer must generate millions of pixels for each animation frame.



Chimeric Antigen Receptors (CARs, purple) on the surface of a killer T cell (blue)



Killer T cell receptors (teal) binding to an abnormal cell (brown)

"That rendering process is labour-intensive, depending on the complexity of your scene, and takes a long time. It represents a real bottleneck in the animation pipeline," said Maja.

"I was able to speed up the rendering process between two and four times. It was a significant time-saver... It pushed the production through the rendering bottleneck to the compositing stage much faster." Dr Maja Divjak, Project Leader.



To overcome this bottleneck, Maja approached Pawsey staff. This was possible because Pawsey partners with Australian public research institutes like the Peter MacCallum Cancer Centre.

Pawsey partners have access to high-performance computation and graphics solutions for their research. This includes the Nebula cluster for Windows and Topaz for Linux graphical user interface systems. The Pawsey visualisation team helped Maja to connect to its Nebula advanced GPU cluster.

"I was able to speed up the rendering process between two and four times. It was a significant time-saver. I log on to the Nebula cluster itself and work within a virtual Windows environment. I worked with Ali Zamani on Pawsey's visualisation team; he was always available for technical support. I couldn't believe how helpful he was."

Maja has flexible access to Nebula, meaning she could render her animations when she needed them. Pawsey's client-side requirements were also minimal. All Maja needed to complete her work was access to this state-of-the-art graphics workstation via a web browser.

The Outcome

Maja's work integrates art and science to create understanding. Scientists have long used 3D structures to comprehend the complex inner workings of bodies and molecules. The Protein Databank is a repository of the 3D shapes of proteins and nucleic acids that aids scientists in understanding how they work. But only recently have researchers simulated or animated molecular movement in 3D. Maja's work accomplishes this by combining digital storytelling, animation and scientific knowledge.

It breaks down the complex science to inform patients of their choices. It also helps train students and boosts public awareness.

The production also shows Peter MacCallum researchers in action in the lab. These world-leading experts have generated time lapse microscopy video of CAR-T cells killing cancer cells. Nebula's improved rendering time meant Maja was able to output her animated scenes in less than half the usual time.

"It pushed the production through the rendering bottleneck to the compositing stage much faster."

Maja's CAR-T cell animation is providing important research outreach for the Peter MacCallum Cancer Centre. Maja is developing it into exhibition images and submitting it to film festivals, including the Raw Science film festival. Pawsey is projecting Maja's work at its newlycommissioned visualisation space.