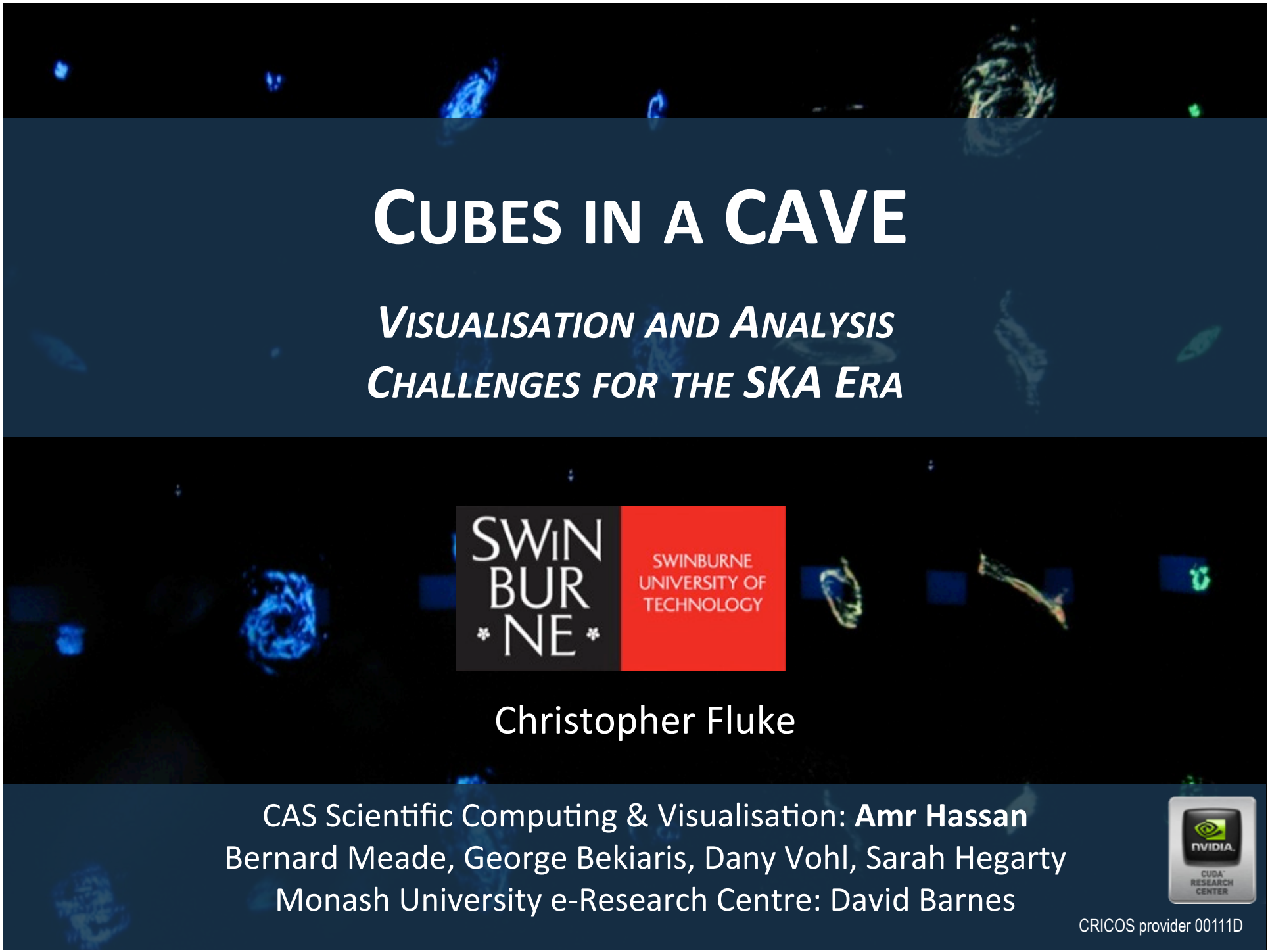


CUBES IN A CAVE

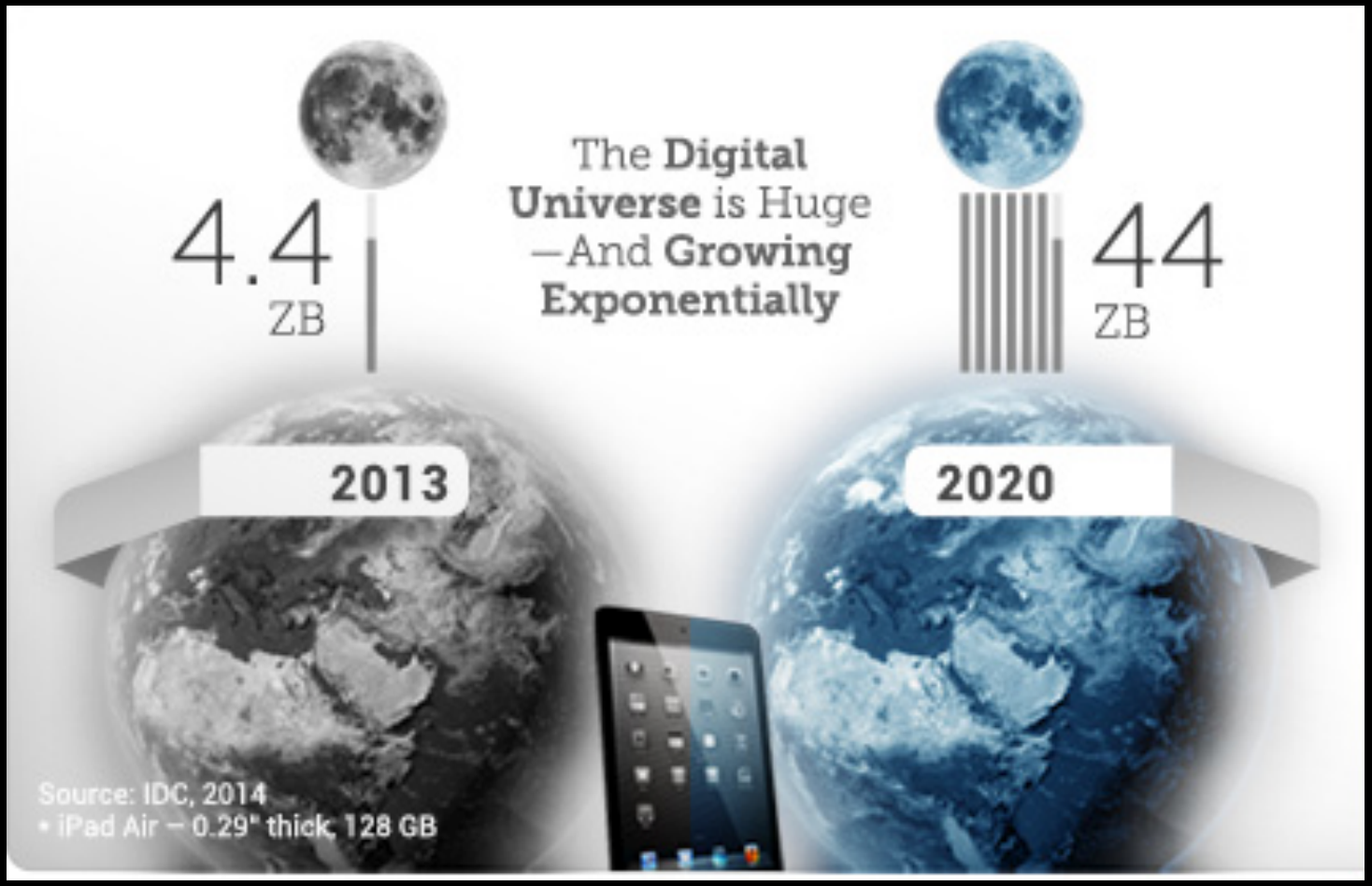
VISUALISATION AND ANALYSIS CHALLENGES FOR THE SKA ERA

SWINBURNE UNIVERSITY OF TECHNOLOGY

Christopher Fluke

CAS Scientific Computing & Visualisation: **Amr Hassan**
Bernard Meade, George Bekiaris, Dany Vohl, Sarah Hegarty
Monash University e-Research Centre: David Barnes

NVIDIA CUDA RESEARCH CENTER



From Turner et al. (2014) - EMC Digital Universe with Research & Analysis by IDC
http://www.emc.com/leadership/digital-universe/2014iview/executive-summary.htm

Business, Public (images/videos), Internet of Things, Metadata and Science projects

The vast majority will be collected…and then thrown away
Never analysed, explored or understood

Data-Rich Astronomy Era (c. 2000)

Data holdings crossed 100 TB barrier (Brunner et al. 2002)

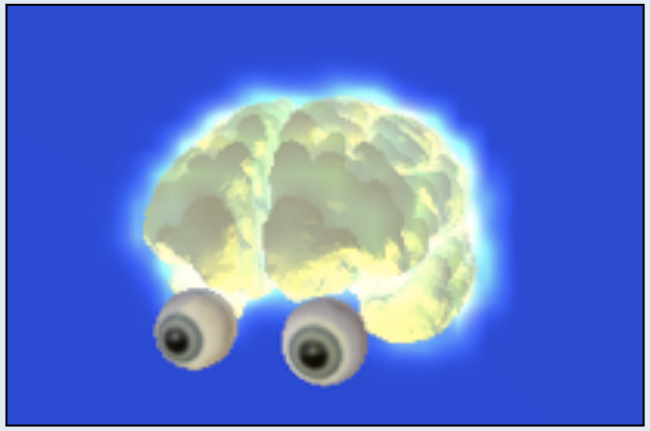
Emergence of…

Virtual Observatory concept (e.g. Szalay & Gray 2001)

"**Data intensive scientific discovery**" paradigm emphasizing *Automated data mining* (Ball & Brunner 2010, Ivezic et al. 2013)

Taken to the extreme: computers making discoveries…not people

Visualisation for Knowledge Discovery



The human visual system is extremely powerful for discovering, exploring and understanding *"interesting things"*

How much of the data collected by SKA will ever be looked at?

What role will visualisation actually play in supporting the scientific goals of the SKA?

What can emerging technologies teach us about how visualisation *might* support knowledge discovery in the SKA era?

CAVE2@Monash University

Ring diameter ~8m; ~320 degrees FOV

Image: Monash University

CAVE2 is a hybrid environment for Visualisation Experiments

Immersive Stereoscopic 3D (CAVE)
84 Mpix for details + context (TDW)
80 TFLOP/s GPU Supercomputer

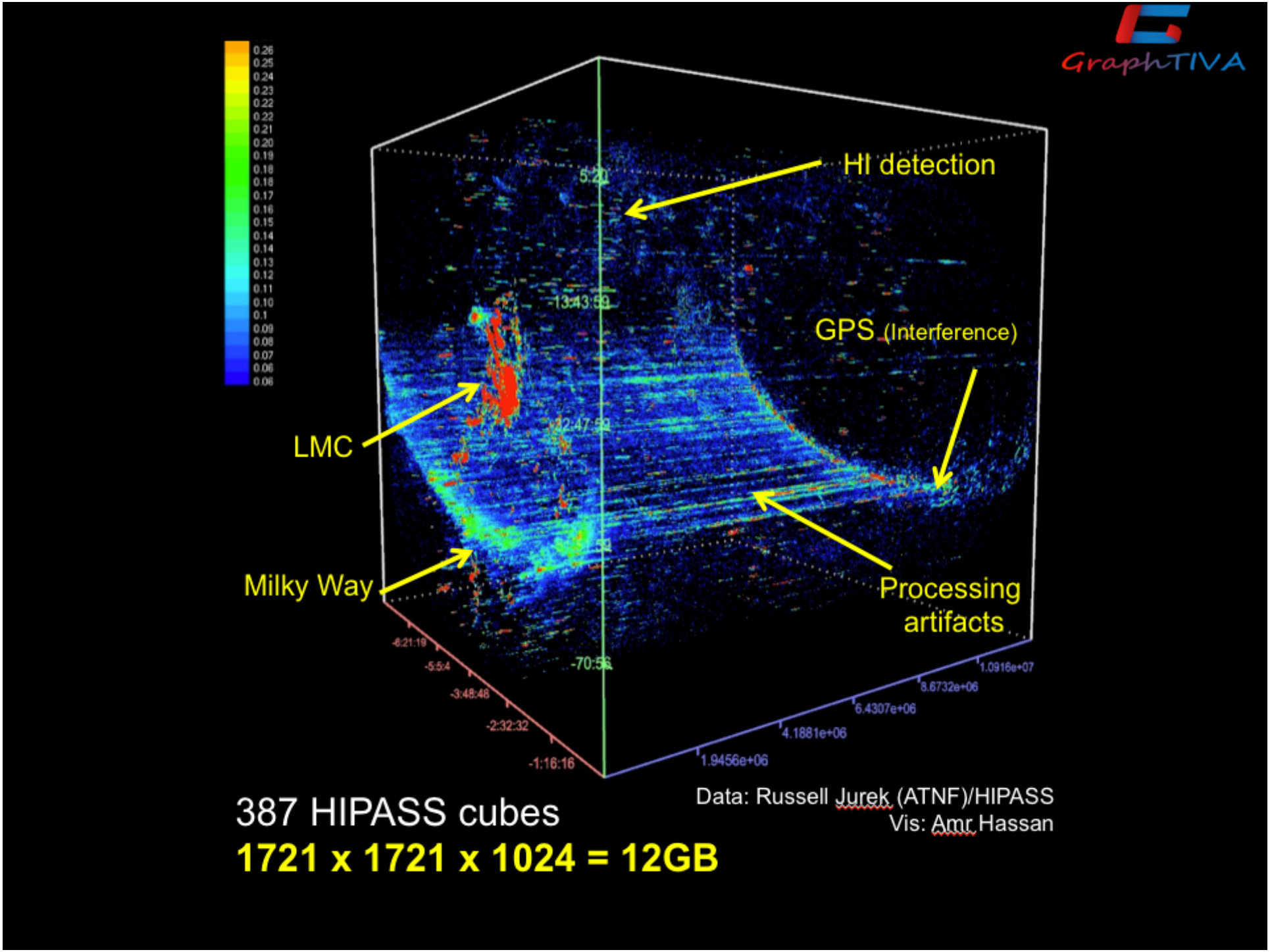
Collaboration + Physical navigation

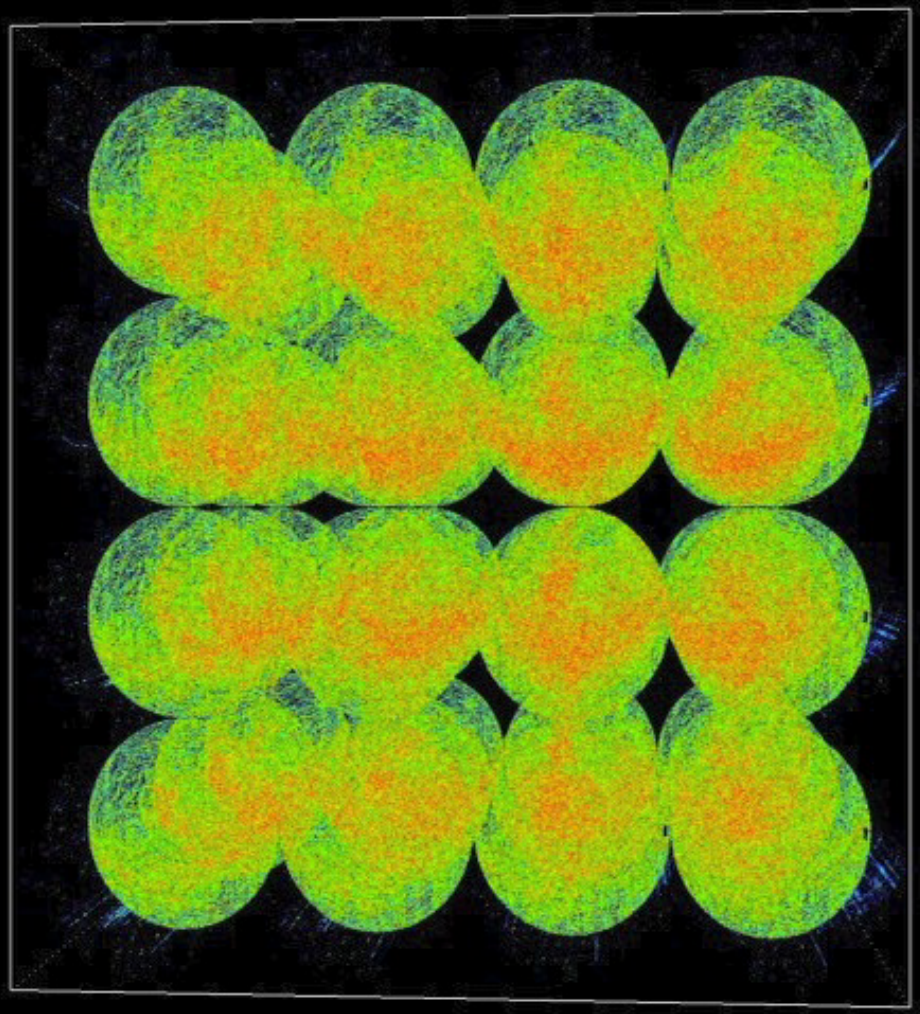
Credits: EVL, B.Meade, G.Tan
Are tiled display walls needed for astronomy? Meade et al. (2014)

Example Use Cases: HI Spectral Data Cubes

One very large file

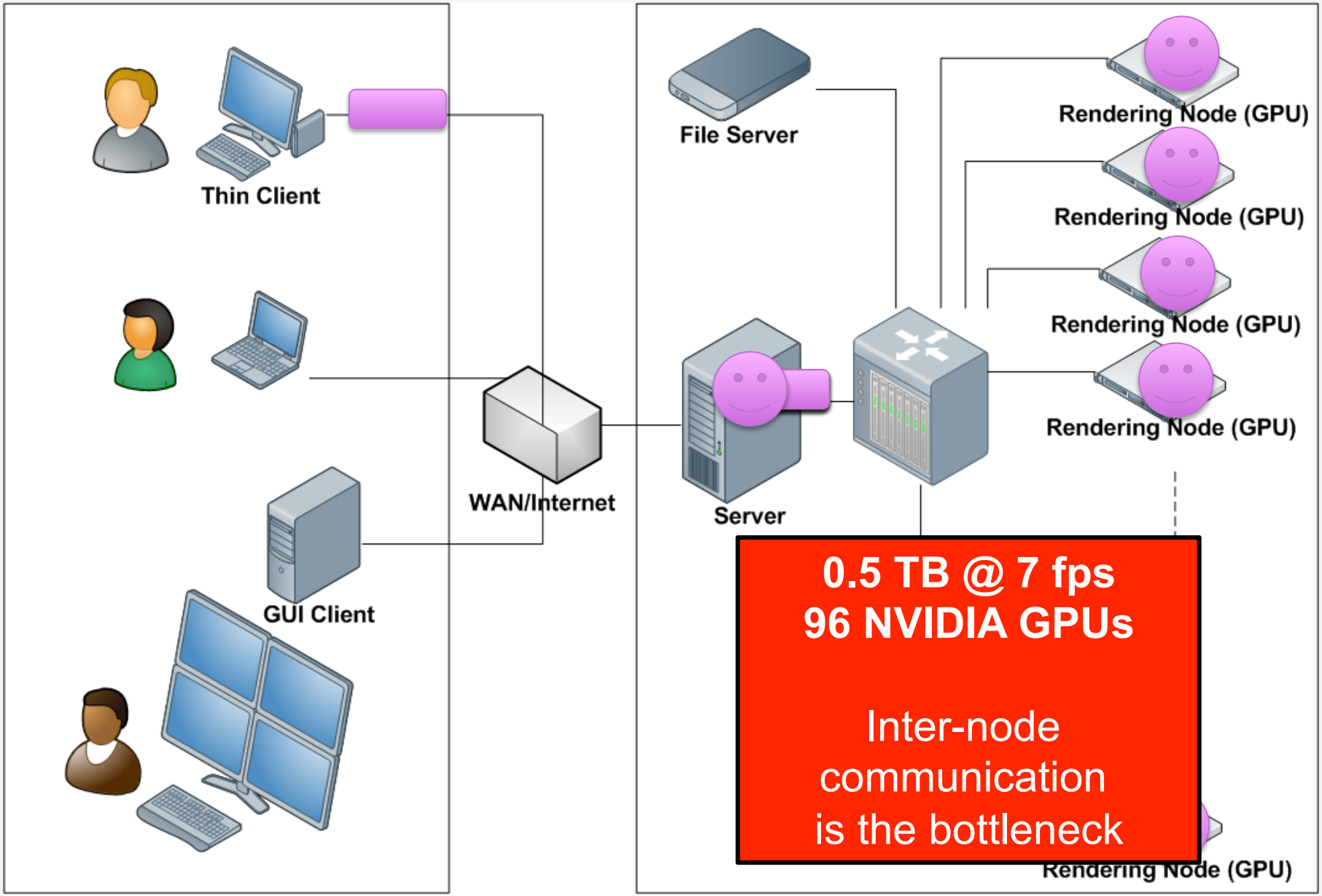
Many individual small files


GraphTIVA
HI detection
GPS (Interference)
LMC
Milky Way
Processing artifacts
387 HIPASS cubes
1721 x 1721 x 1024 = 12GB
Data: Russell Jurek (ATNF)/HIPASS
Vis: Amr Hassan



- **48 x HIPASS**
- 6884 x 6884 x 3072
- **542.33 GB**
- **5-10 frames/second**

Courtesy A.Hassan



For details see: Hassan et al. (2011), Hassan et al. (2012), Hassan et al. (2013)

GraphTIVA

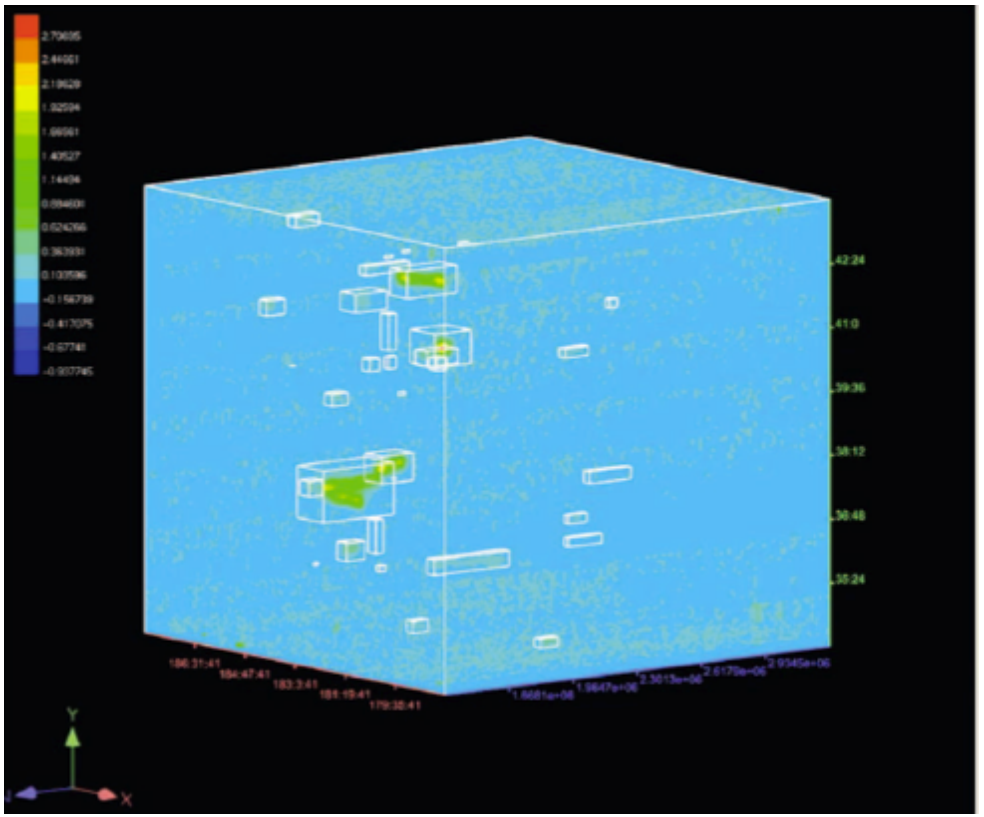
A framework for **Terascale Interactive Visualisation and Analysis** of data

Task	Description	Time
Histogram	Visit each data point once	~4 sec
Global mean and standard deviation	Summarizing whole dataset into single value(s)	~2 sec
Global median	Multiple iterations to convergence (Torben's method)	~45 sec

96 GPUs

48X HIPASS Cube = 6884 x 6884 x 3072 = 145 Gigavoxels
cf. CHILES (A.Popping talk) = 2048 x 2048 x 31000 = 130 Gigavoxels

Details + Context for Terascale data: new mode for CAVE2



Duchamp source-finder catalogue overlaid on volume rendering.
Data: Ursa Major galaxy cluster at 21cm (V.Kilborn)
Image: Hassan, et al, 2011, ADASS XX

Existing CUDA/C++ code

omegalib

A next generation framework for virtual reality and cluster-driven display systems

Courtesy: A.Hassan

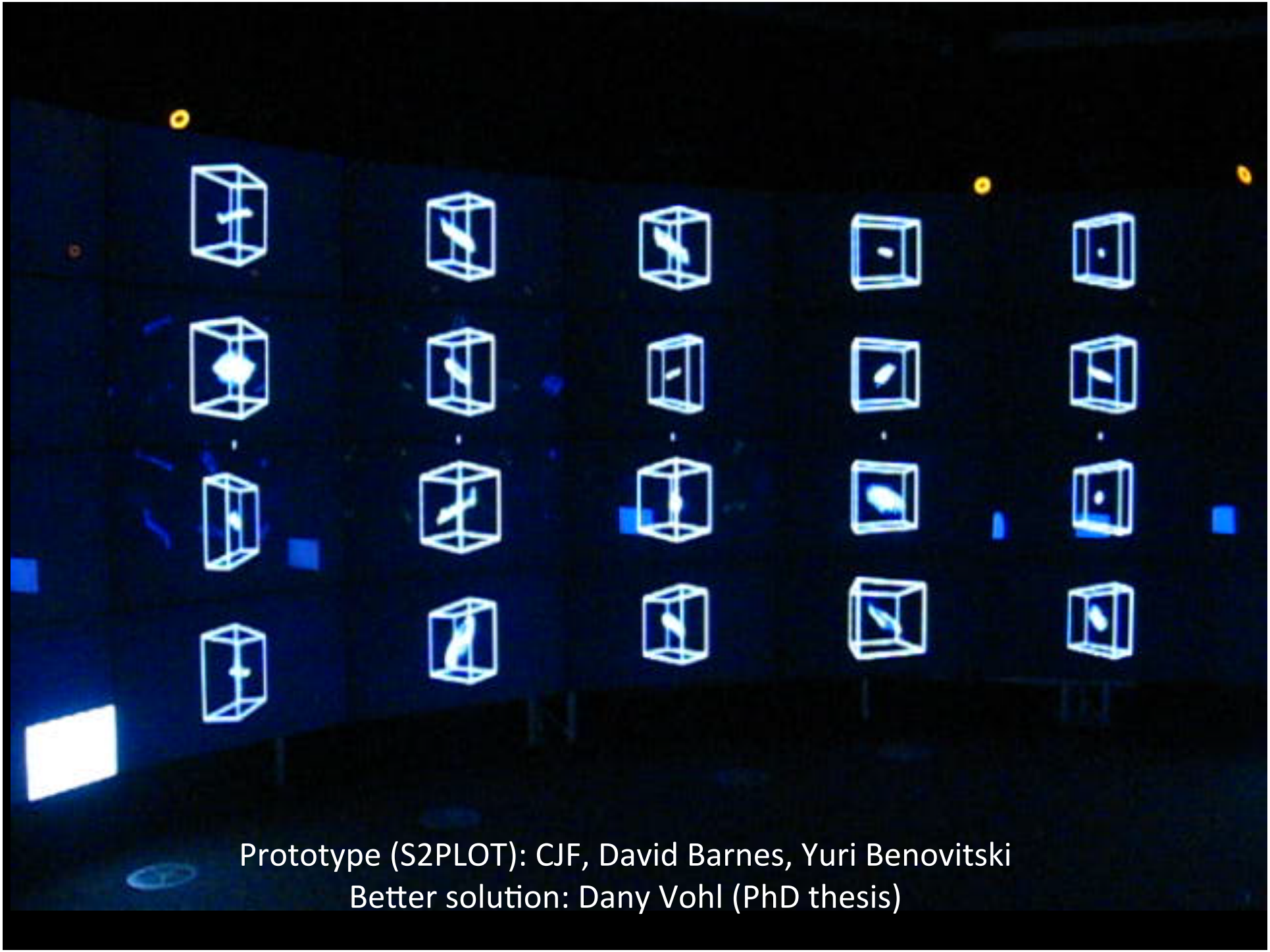
Example Use Cases: HI Spectral Data Cubes

One very large file

Many individual small files

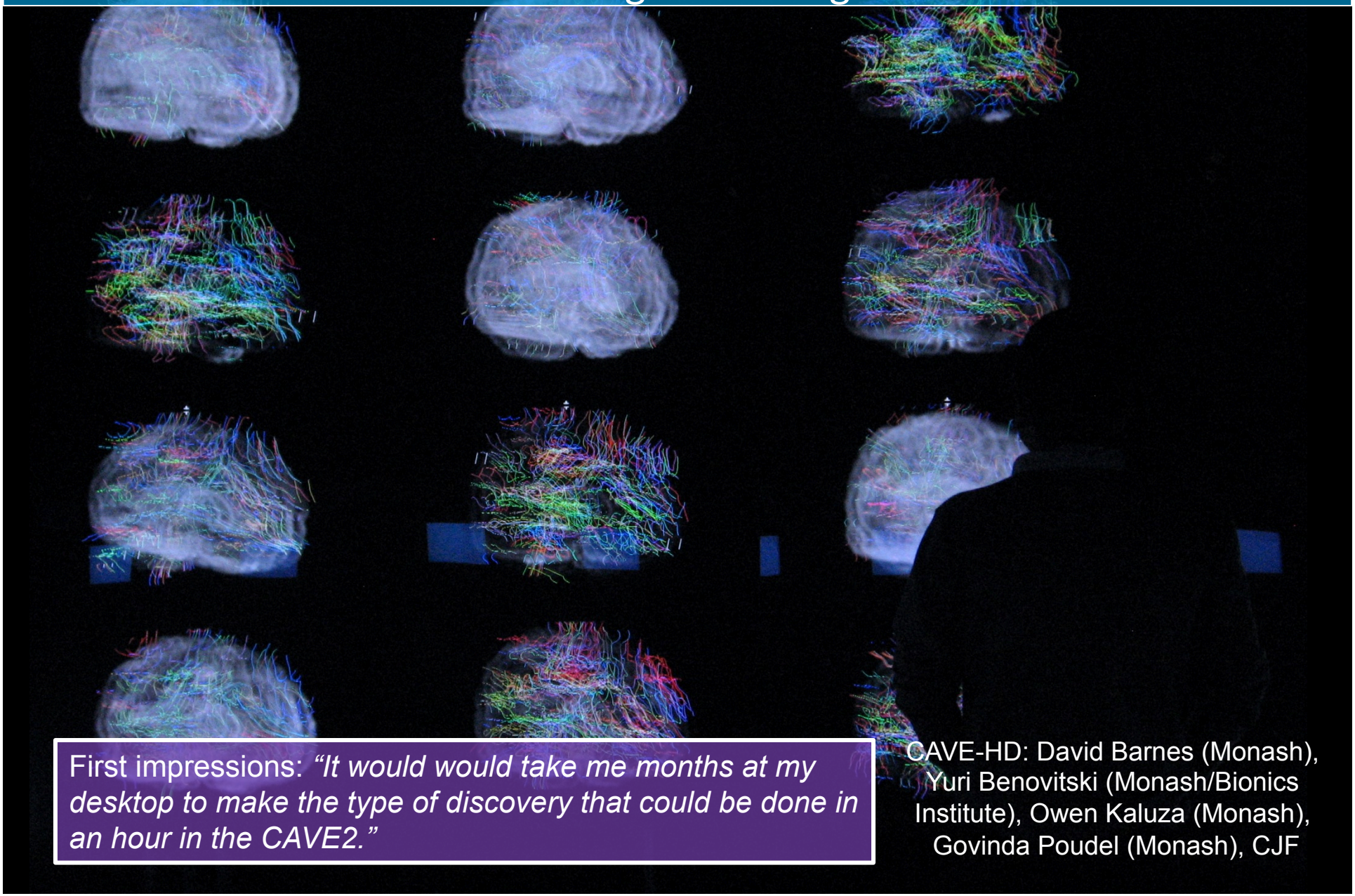
Cubes in a Cave
(CAVE-HD)

CAVE2 = 80 individual stereoscopic panels



Prototype (S2PLOT): CJF, David Barnes, Yuri Benovitski
Better solution: Dany Vohl (PhD thesis)

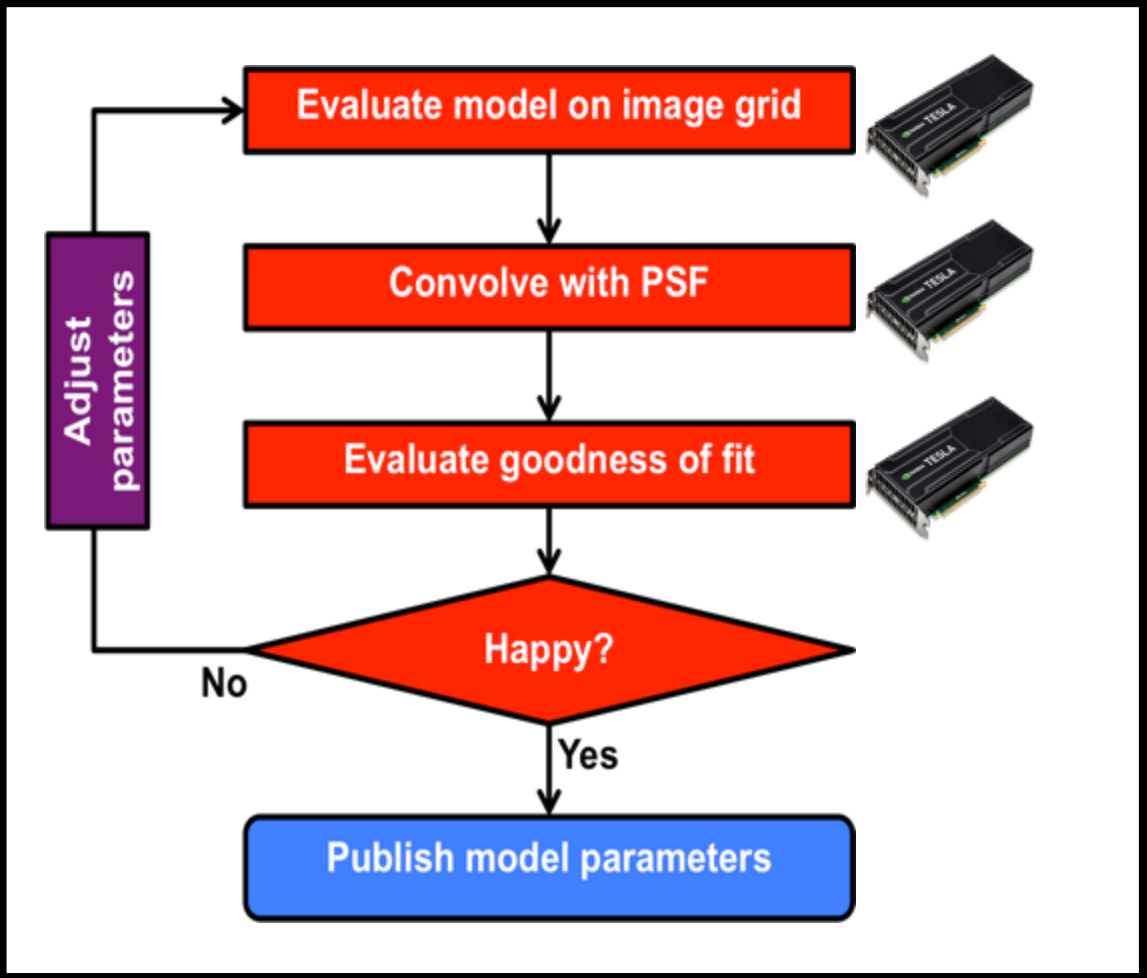
IMAGE-HD: Early Identification of Huntington's Disease
An incurable neurodegenerative genetic disorder

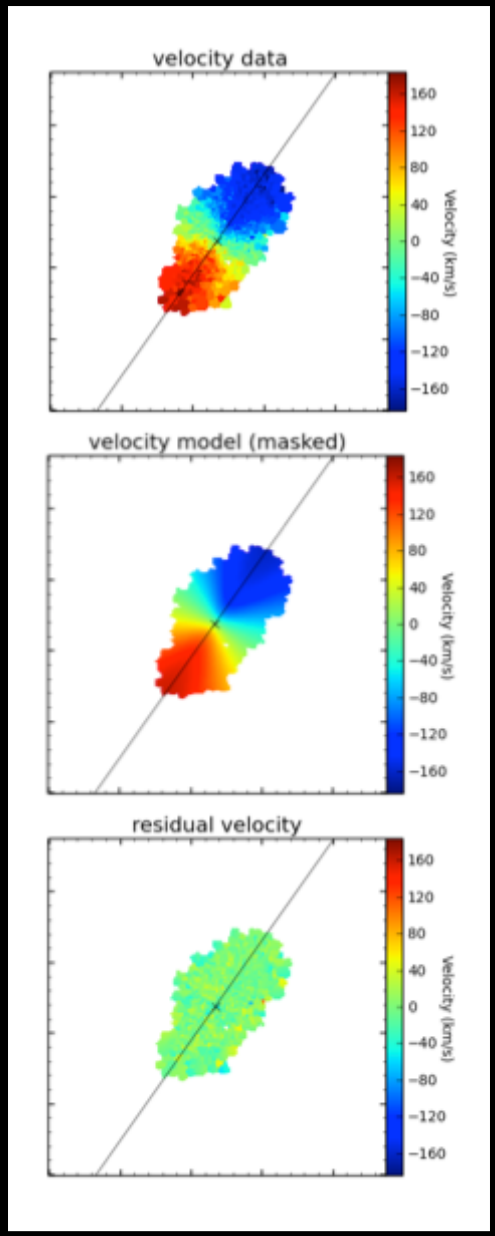


First impressions: *"It would would take me months at my desktop to make the type of discovery that could be done in an hour in the CAVE2."*

CAVE-HD: David Barnes (Monash), Yuri Benovitski (Monash/Bionics Institute), Owen Kaluza (Monash), Govinda Poudel (Monash), CJF

CAVE2 = Visualisation environment + GPU Supercomputer





Kinematic Modeling of Disc Galaxies using GPUs
George Bekiaris et al. (submitted)

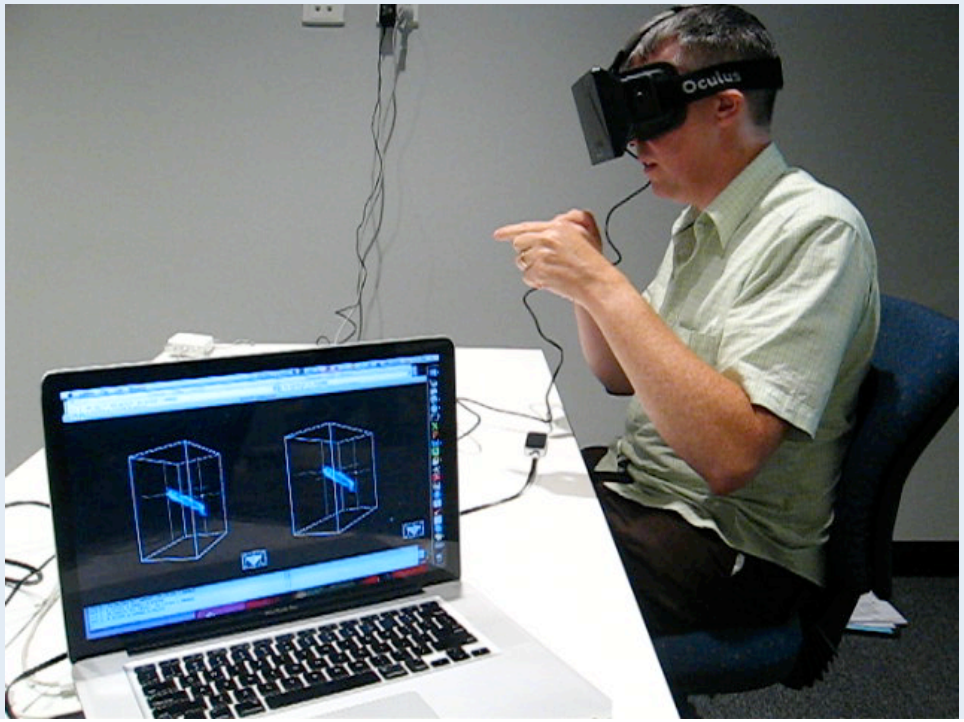
- 100x speed-up compared to single thread on CPU
- 10x speed-up compared to multi-threaded

Visualisation for Knowledge Discovery

What role will visualisation actually play in supporting the science goals of the SKA?

Transformational science might just benefit from ***transformational technologies***…

"Unknown unknowns" may also apply to the emergence of technology



Can't fit a CAVE2 in your office? Try an **Oculus Rift** with a **Leap Motion**

Optional question

That's nice Chris, but does everyone actually need to regularly use the CAVE2 for science?

Of course not!

In fact you might only need to use it once or twice to help ***accelerate discovery*** before returning to more traditional and/or automated techniques.

At this stage, the CAVE2 is so new, that our goal is to understand how/why alternative approaches might work when the data scales beyond what can be achieved at the desktop.