IC3D 2016

Towards an Interactive Navigation in Large Virtual Microscopy Images on 3D Displays

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Outline

Context

3D NeuroSecure

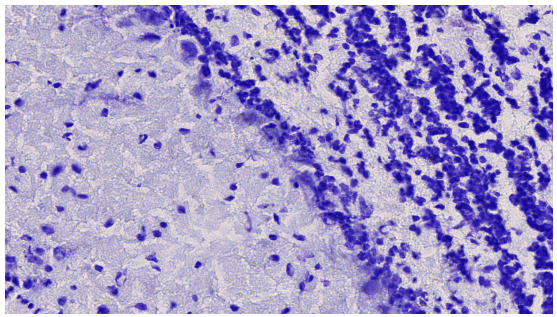
Collaborative solution for therapeutic innovation by high dimension complex data processing.

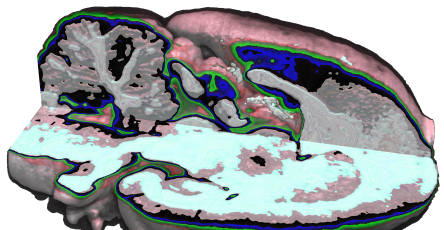
- Scientific visualization
- High performance computing
- Big Data Imaging
- Alzheimer disease

Motivations

Virtual microscopy:

- Modern biomedical acquisition: ultra-high resolution images
  $\Rightarrow$ **huge volumetric data** (several Tera-bytes)
  - Electron microscopy
  - Histological slides scanner
- **Visualize** these data and **interactively navigate** inside is crucial to the spatial understanding

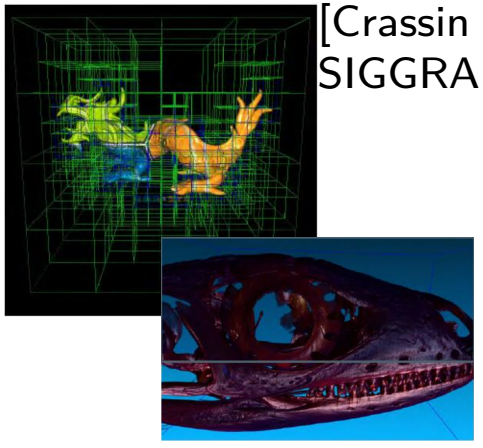




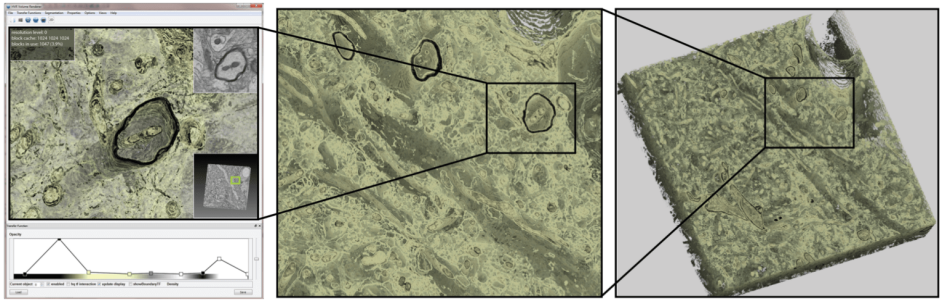
Previous work and contributions

Previous works:

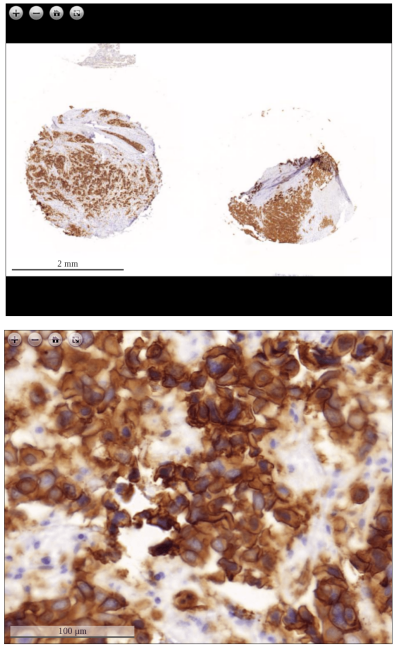
- Multi-resolution pyramidal navigation into a large image.
- Out-of-core GPU volume rendering on large datasets.



[Crassin et al., ACM SIGGRAPH i3D, 2009]



[Hadwiger et al., IEEE SciVis 2012]



[Openseadragon]

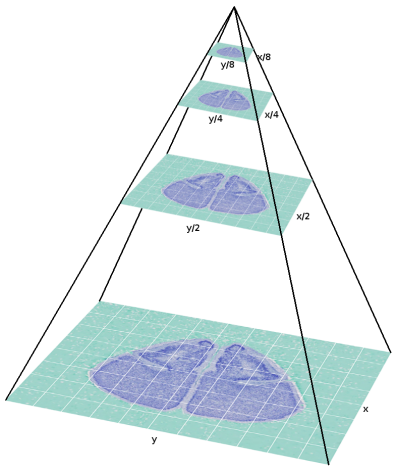
Contributions:

- Improve perception: 3D displays on multi-view auto-stereoscopic screens
- Interactively navigate into a whole volume

Volume data representation

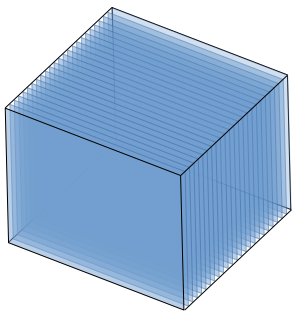
The whole large volume is stocked in a large space device.

- **Multi-resolution**: choose the adapted level to the current screen resolution or desired level of detail.
  $\Rightarrow$ Reduce the amount of data
- **Bricking**: Subdivides the volume into small bricks (e.g 16^3 32^3).
  $\Rightarrow$ Allow out-of-core approaches.

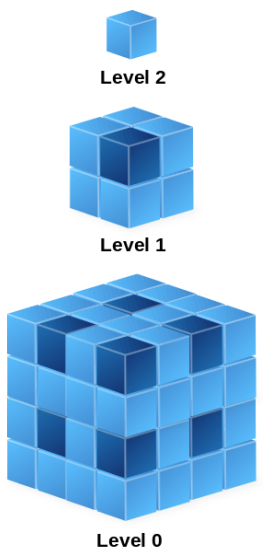


3D Mipmap

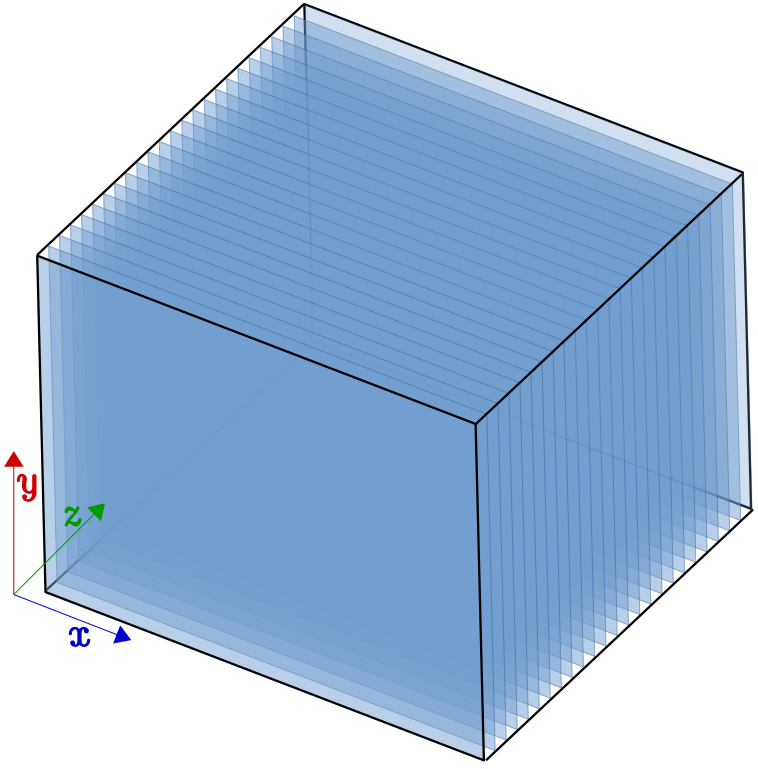
- Extension of 2D tiled pyramidal multi-resolution representation
  $\Rightarrow$ 3D bricked multi-resolution pyramid



$\Longrightarrow$



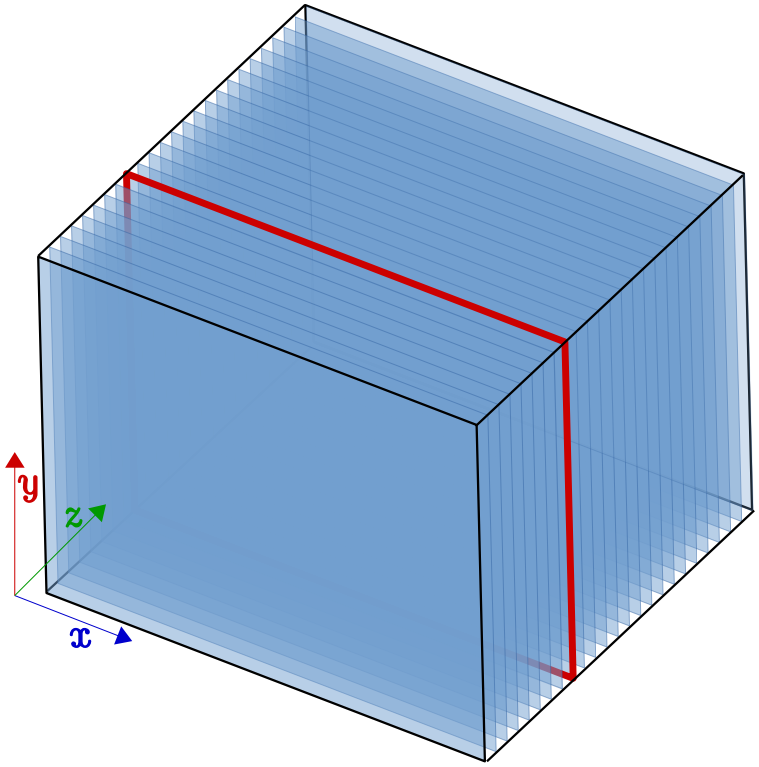
Virtual navigation



Area of interest

- Volume of data

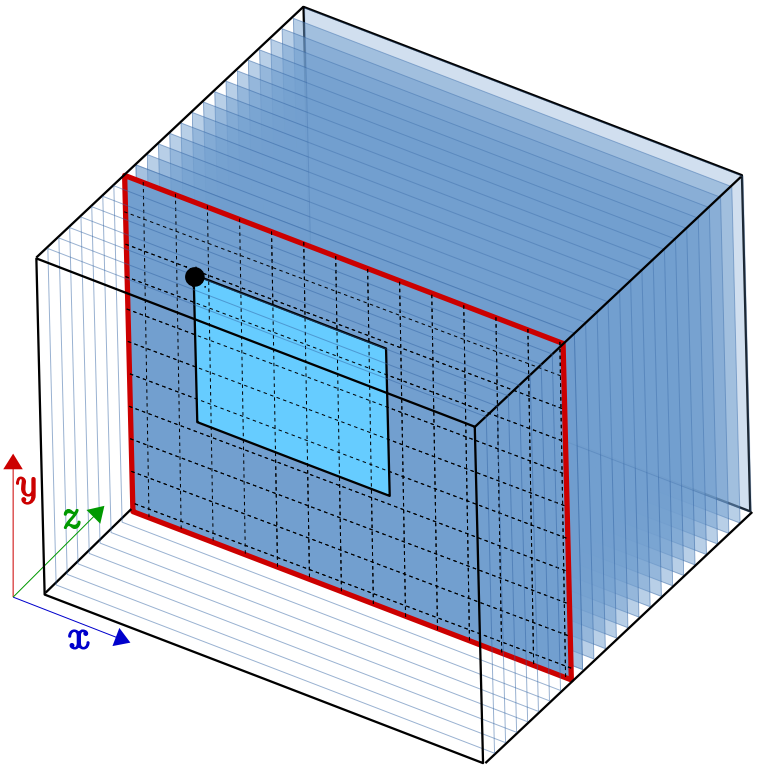
Virtual navigation



Area of interest

- Volume of data
- Depth navigation

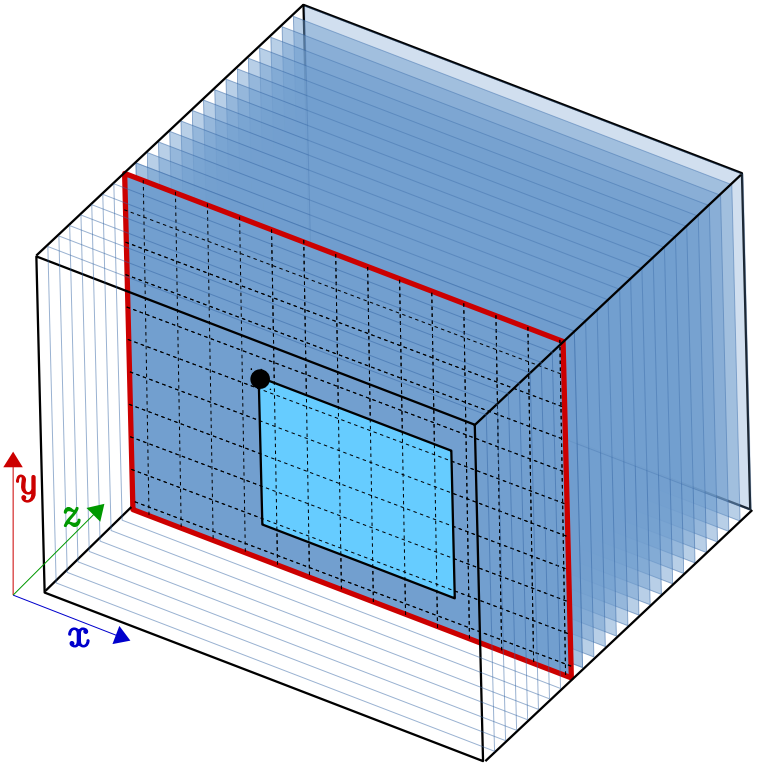
Virtual navigation



Area of interest

- Volume of data
- Depth navigation

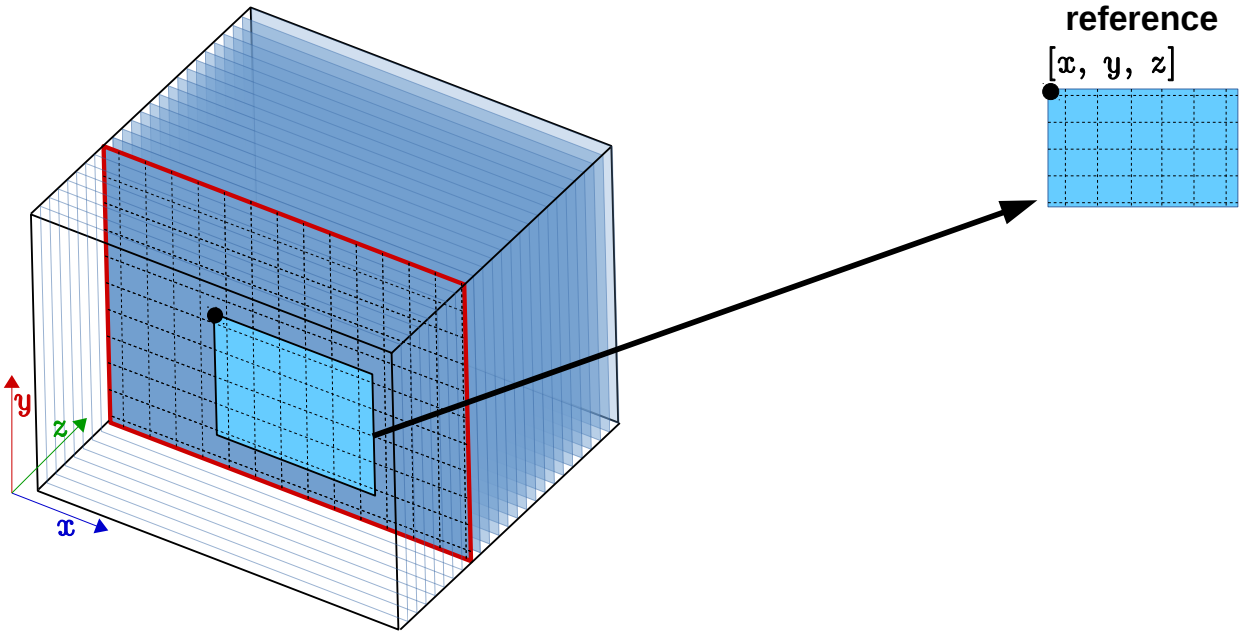
Virtual navigation



Area of interest

- Volume of data
- Depth navigation
- Pan navigation

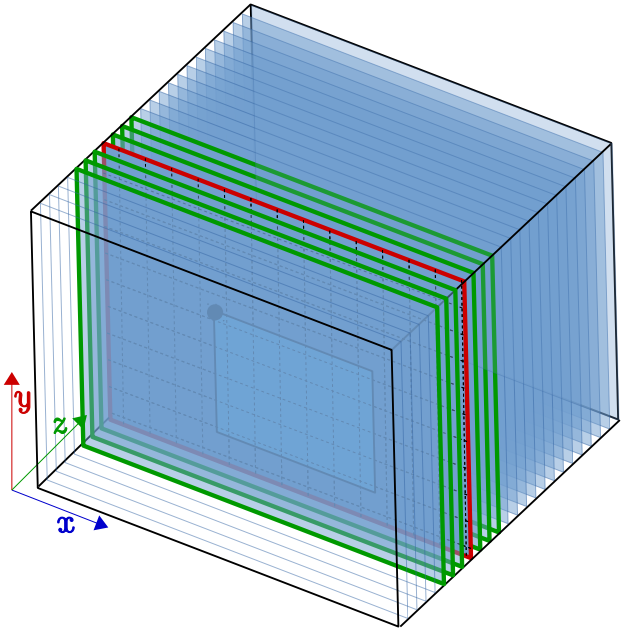
Views selection

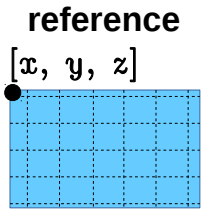


Neighboring areas selection

- Area of interest coordinate position

Views selection

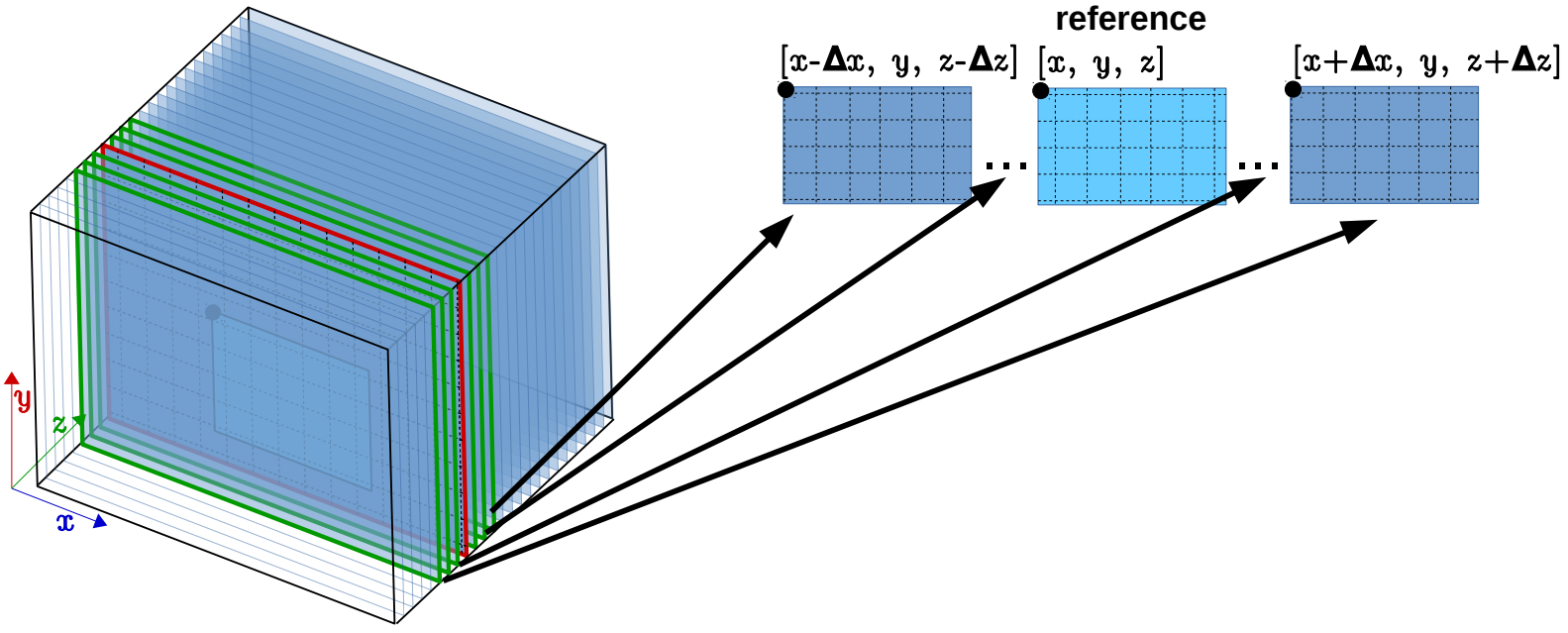




Neighboring areas selection

- Area of interest coordinate position
- Neighboring images selection

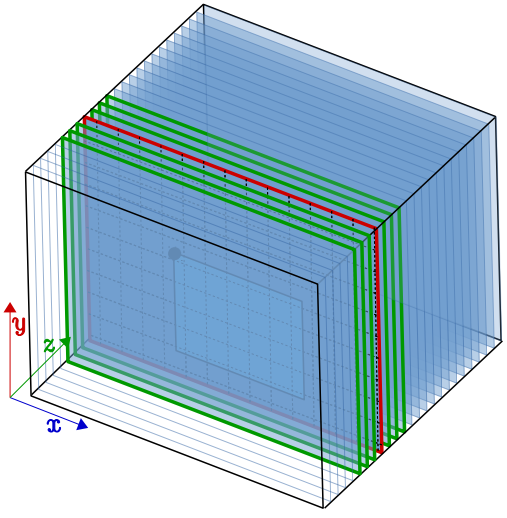
Views selection

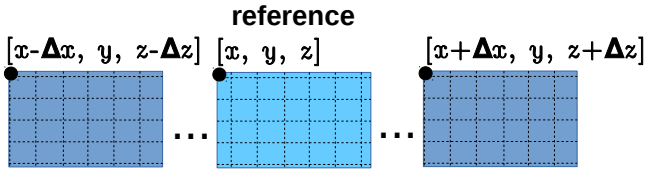


Neighboring areas selection

- Area of interest coordinate position
- Neighboring images selection
- Δ_x for the horizontal disparity
- Δ_z for the depth perception

Out-of-Core Data Management





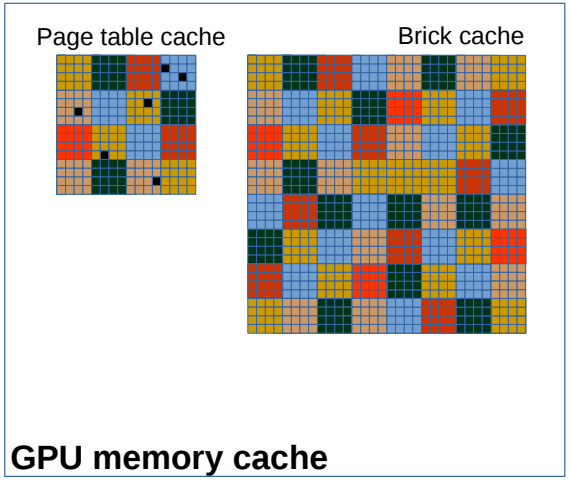
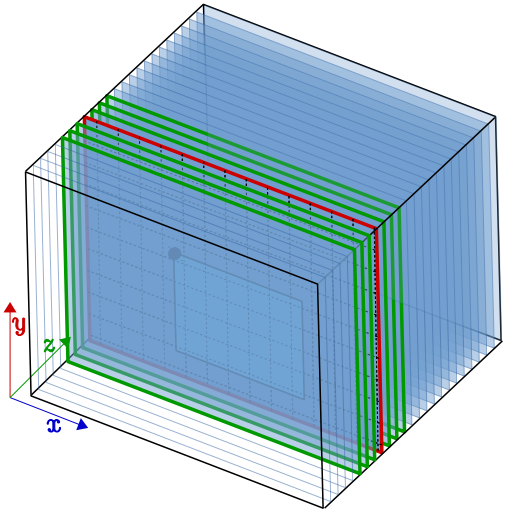


Image construction

- Multi-resolution page table hierarchy

Out-of-Core Data Management



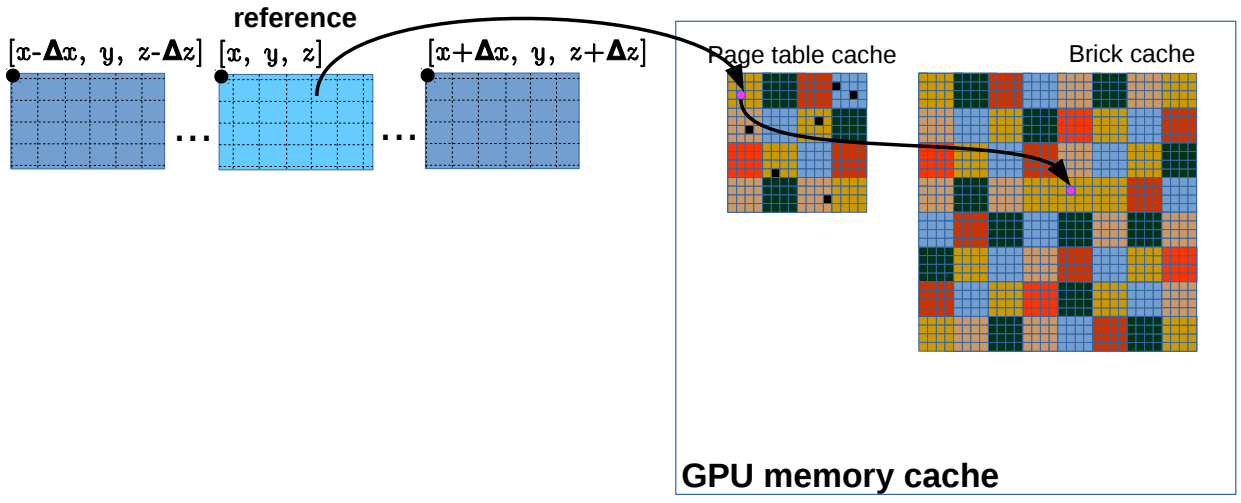
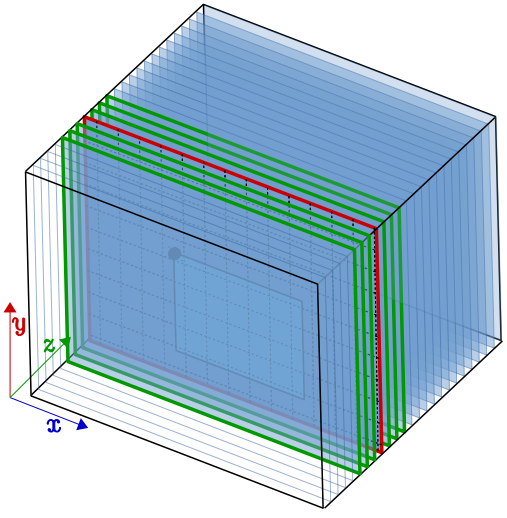


Image construction

- Multi-resolution page table hierarchy
- Cache hit

Out-of-Core Data Management



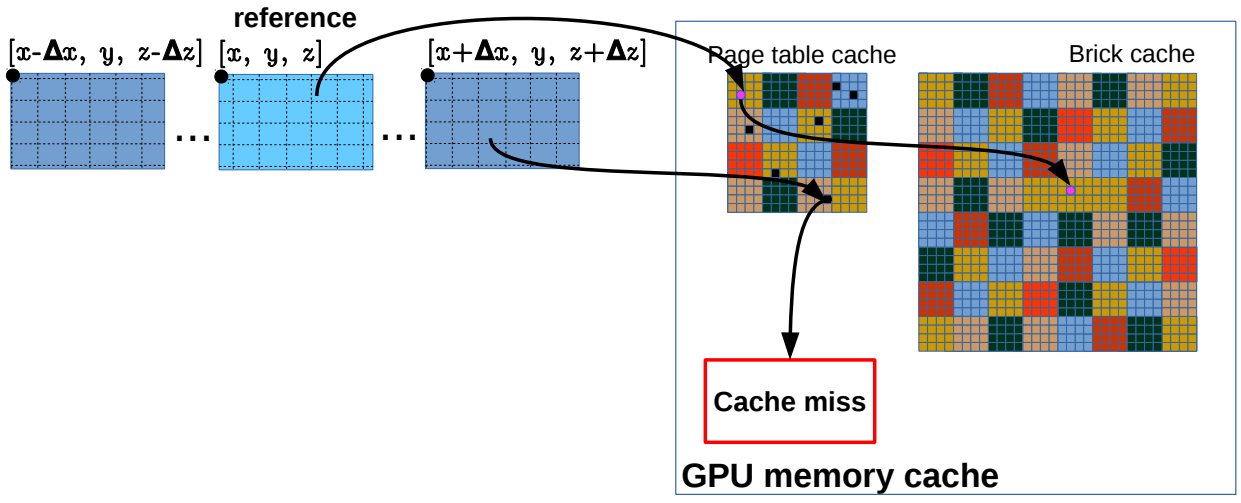
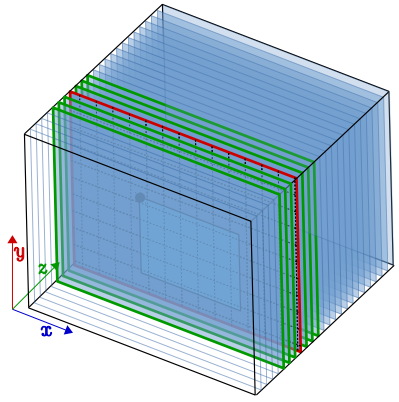


Image construction

- Multi-resolution page table hierarchy
- Cache hit
- Cache miss

Out-of-Core Data Management



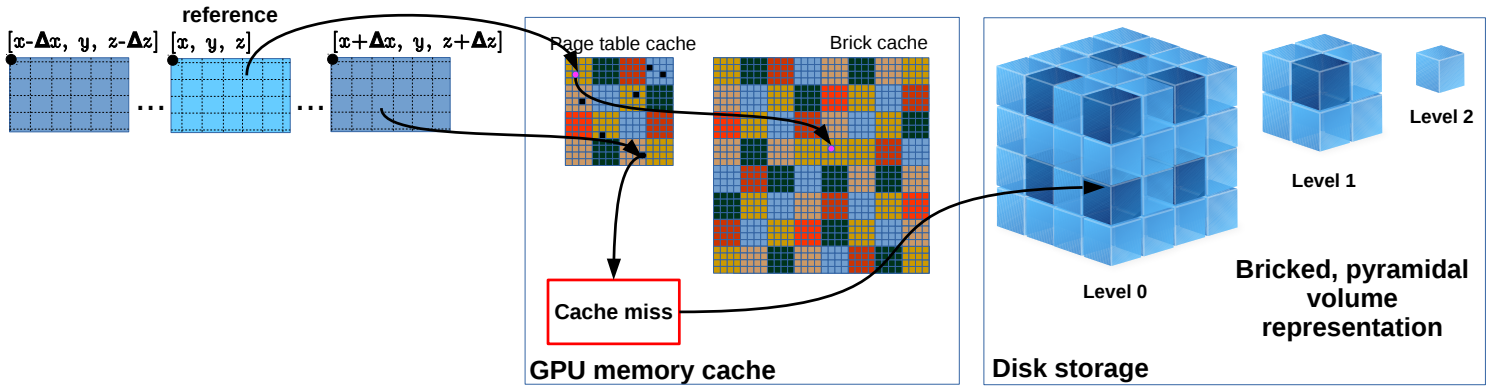
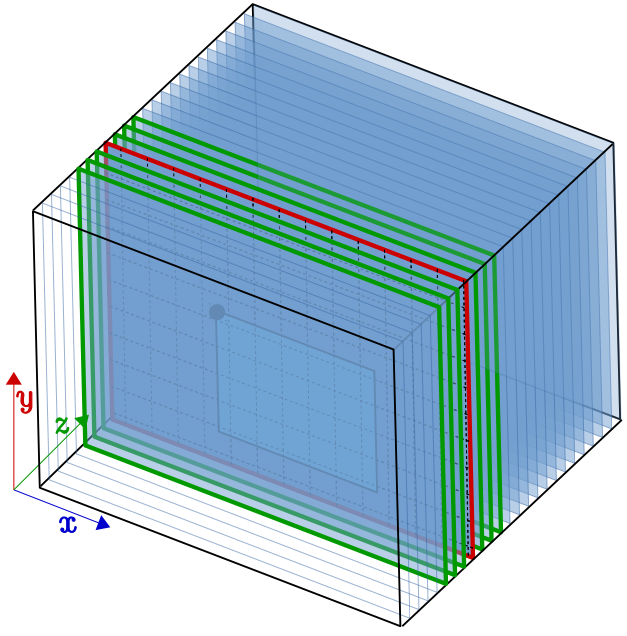
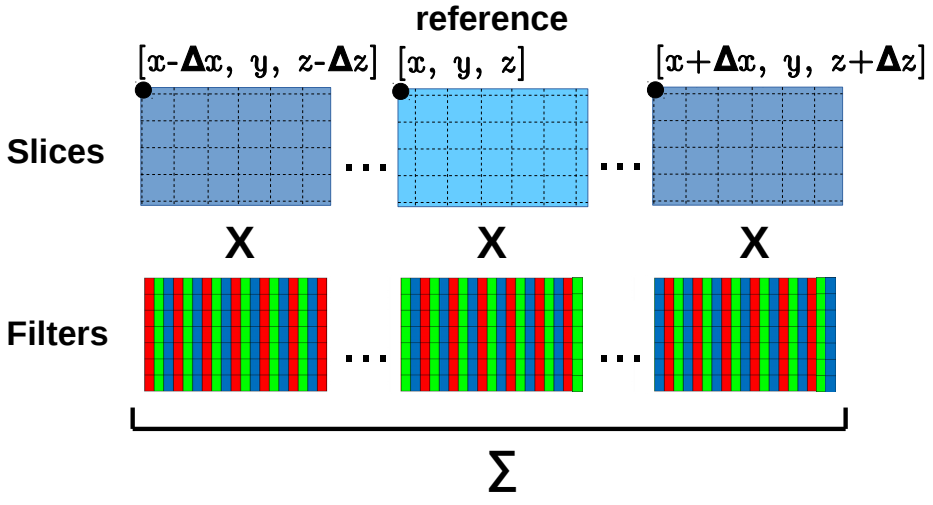


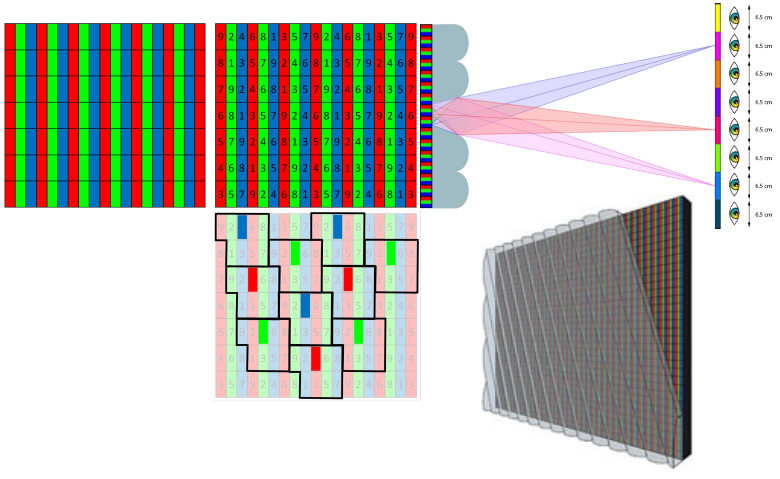
Image construction

- Multi-resolution page table hierarchy
- Cache hit
- Cache miss
- Data fetch in the CPU RAM or HDD

3D display



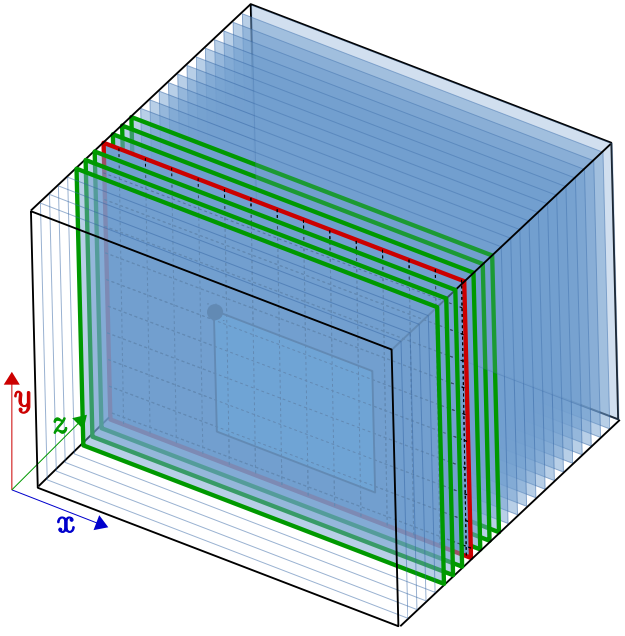


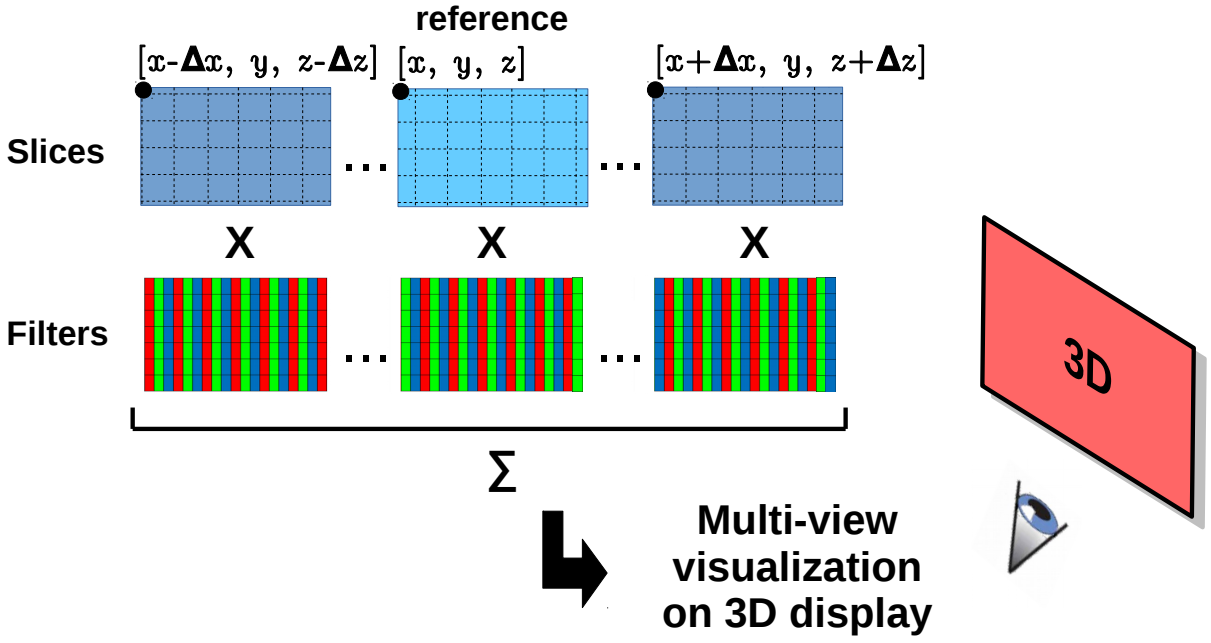


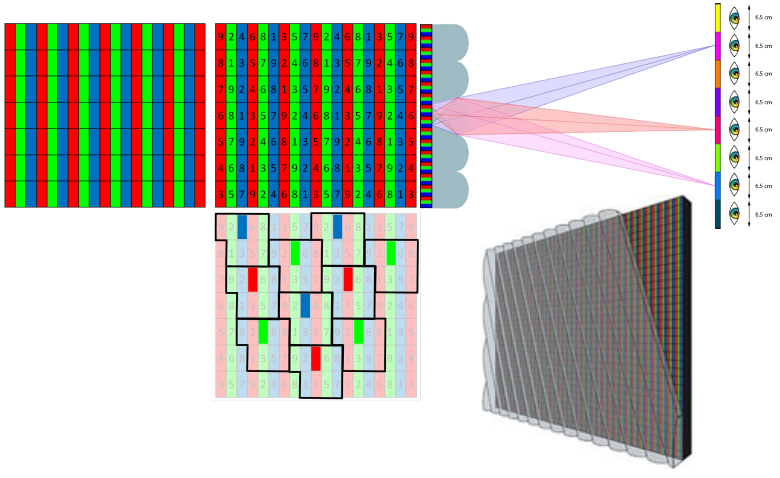
Final frame composition

- Applying multiplexing filters on the images
- Sum all images

3D display



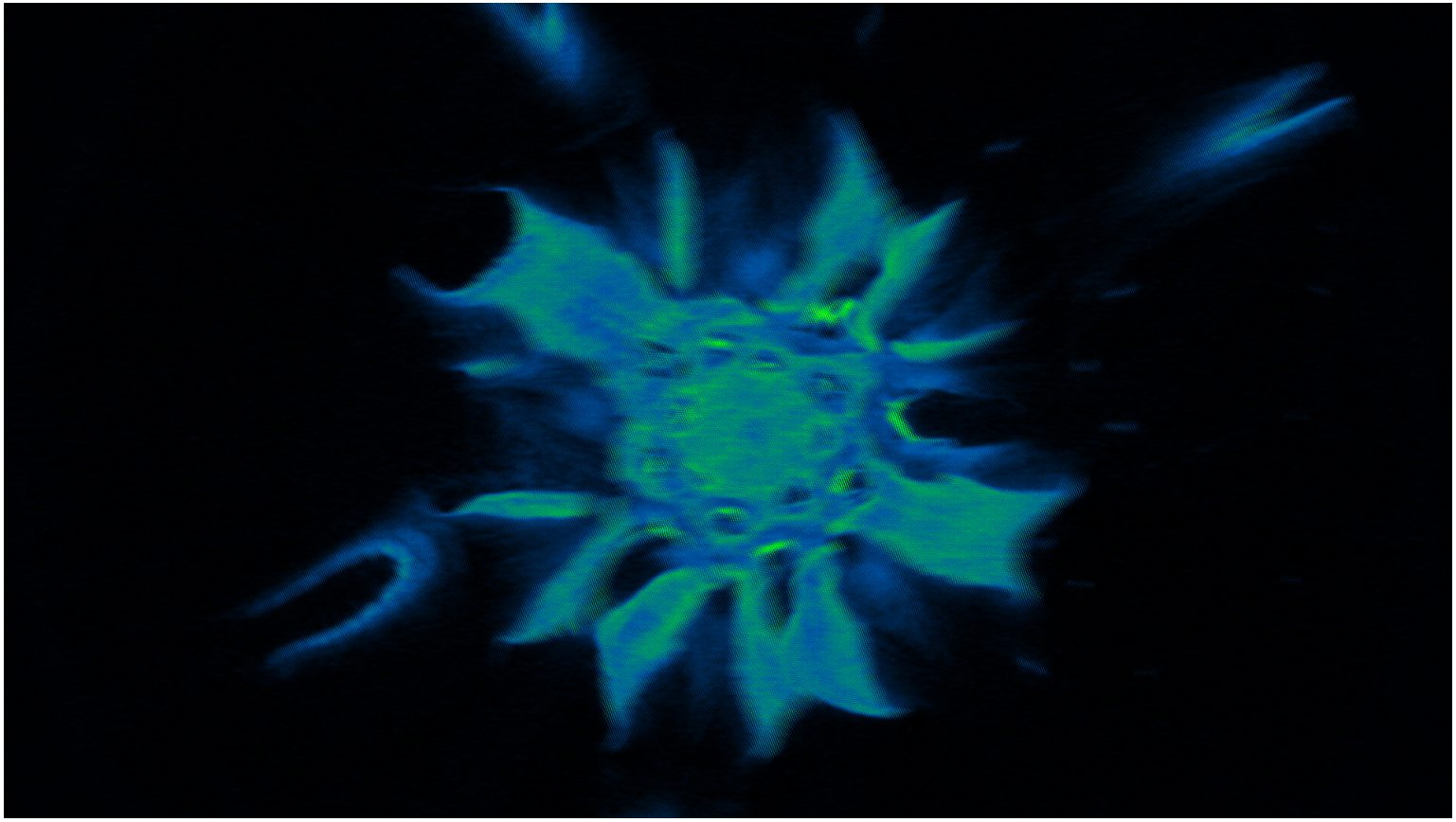




Final frame composition

- Applying multiplexing filters on the images
- Sum all images
- Display it !

Final frame



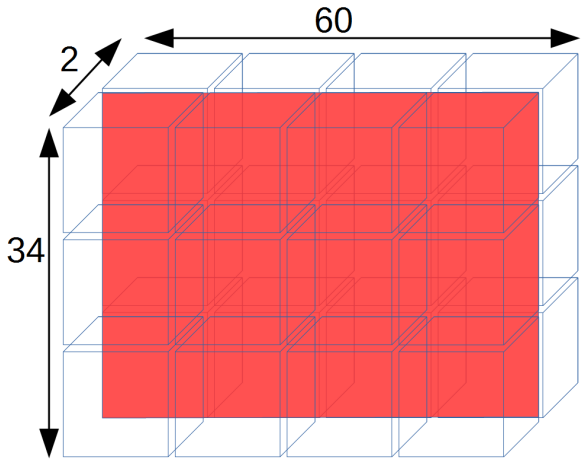
- microCT scan of a dried flower 2048^3
- Display 8-views - 16:10 aspect ratio - 1920×1200
- $[\Delta_x, \Delta_z] = [4, 1]$

8 views composition

Results

GPU memory usage

- $\sim 400MB$ (RGB)
  - Brick size: 32^3
  - $60 \times 34 \times 2 = 4080$ bricks
- Brick shape



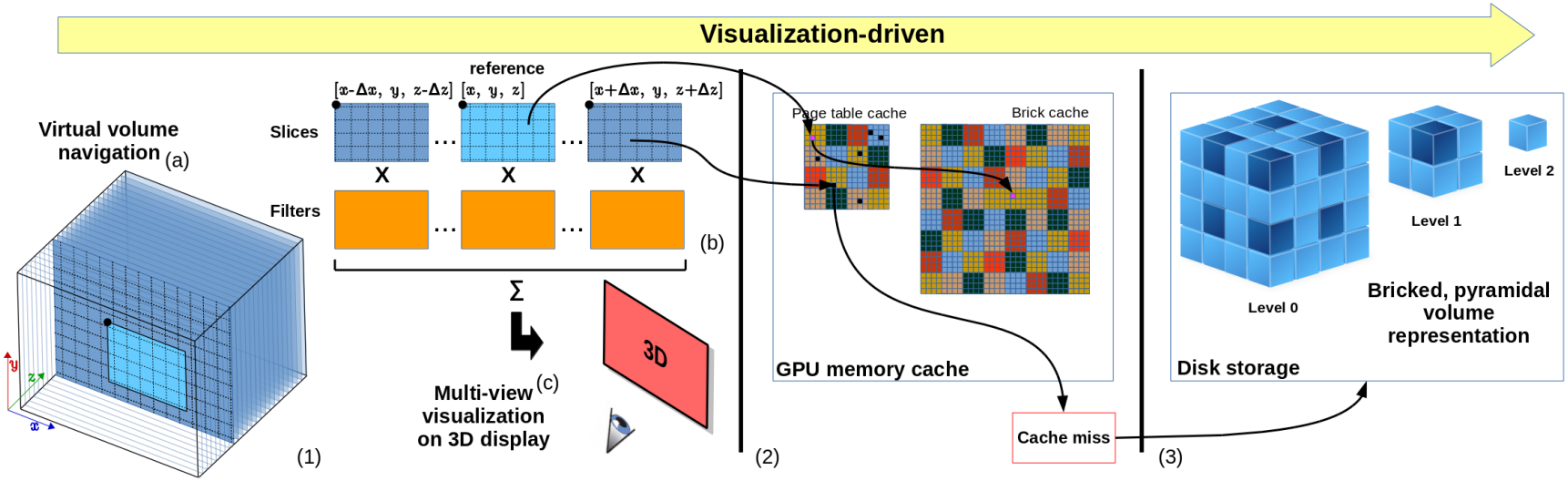
Parameters

- Relation between Δ_z and distance between slices
- Maximum horizontal disparity Δ_x

Validation

- Statistical studies
  - Different displays
  - Different samples
  - Pool of users

Conclusion



Perspectives

- Proof of concept
- Scaling needs to be validated
- Statistical studies

This is the end !

Thanks

Questions ?