Rendering Radiance Animations on the GRID

Vibhor Aggarwal, Kurt Debattista, Gavin Ellis and Alan Chalmers

University of Bristol

University of Delhi

High-Fidelity Rendering

- Physically-based rendering
  - Physically based quantities/materials
  - Global illumination
  - Animations

Motivation

- Speedup Rendering
  - Shared computational resources
  - Radiance animations can take a long time to render
- Distributed method
  - GRID- like systems

Example: Mine Tunnel Ride

- 2964 * 768 HQ
- 2 hours per frame
- 2,310 frames

Computing on GRID-like systems

- Distributively-owned multi-programmed computing resources
- Large pool of potentially unutilised computational resources
  - Many unused at certain times
    - Offices
    - Labs
    - Clusters
    - Screen-saver time
- Workload management systems
  - Condor
    - Job queuing and monitoring

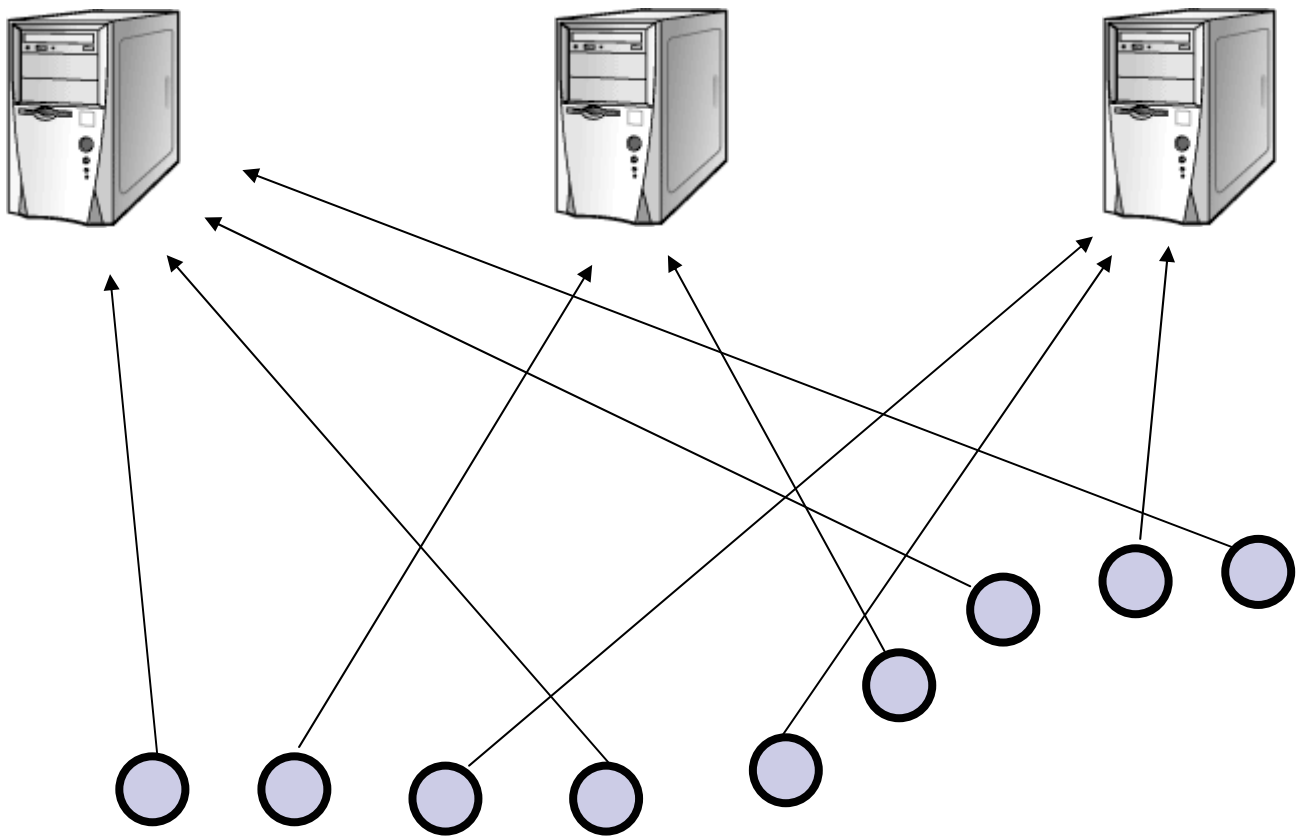
Computing on GRID-like systems

- GRID computing is a different animal from distributed computing on a cluster
- Issues
  - Dynamic change of resources
    - Multi-programmed/multi-user environments
  - Minimise (no) control/data communication
    - Deadlock is easy
  - Fault Tolerance

A first approach

- A queue of frames as jobs
  - Simple approach
  - Little implementation
    - Simple script

First pass



Example

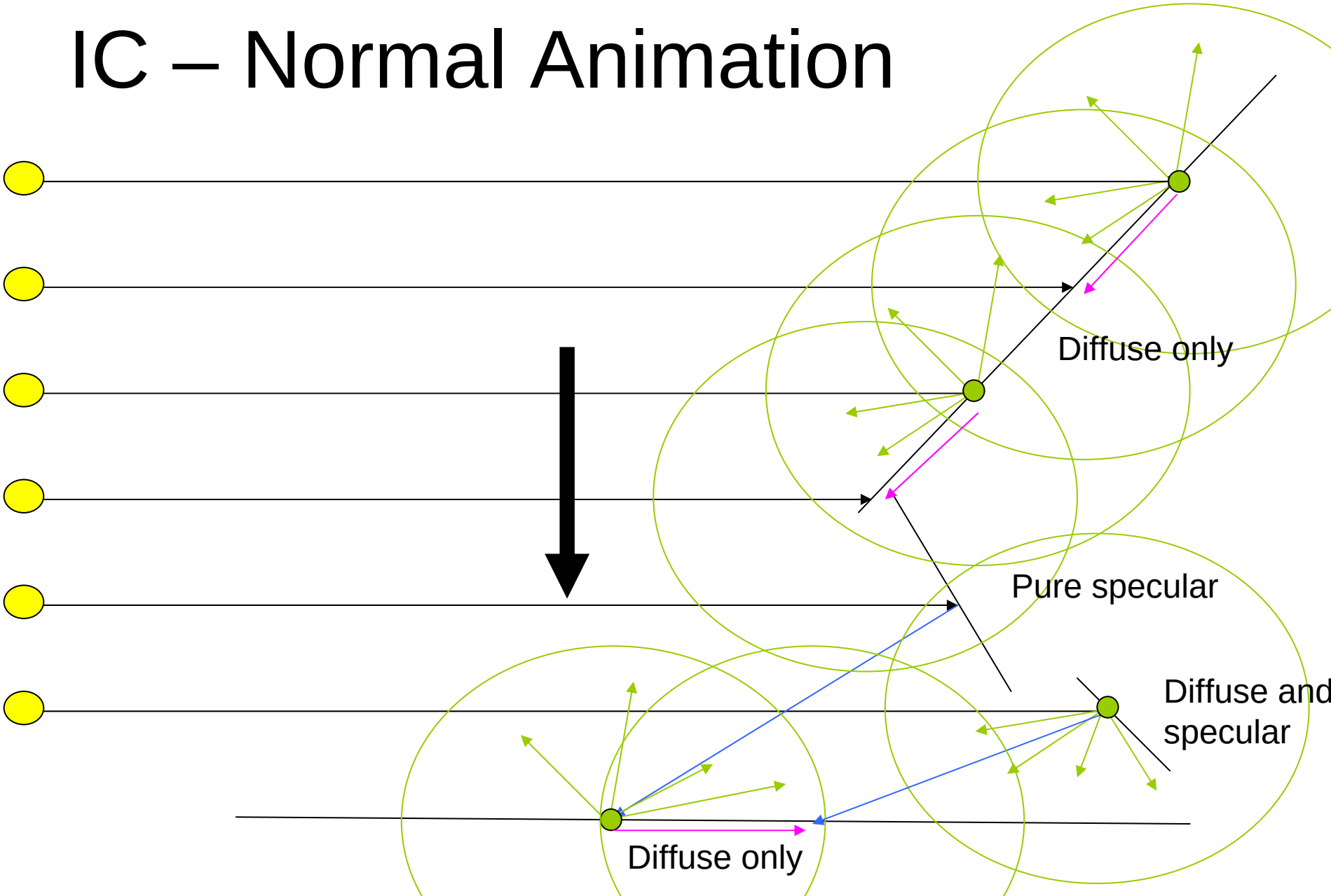
Problems

- Issues
  - Artefacts produced from different IC samples
  - Does not take advantage of coherence

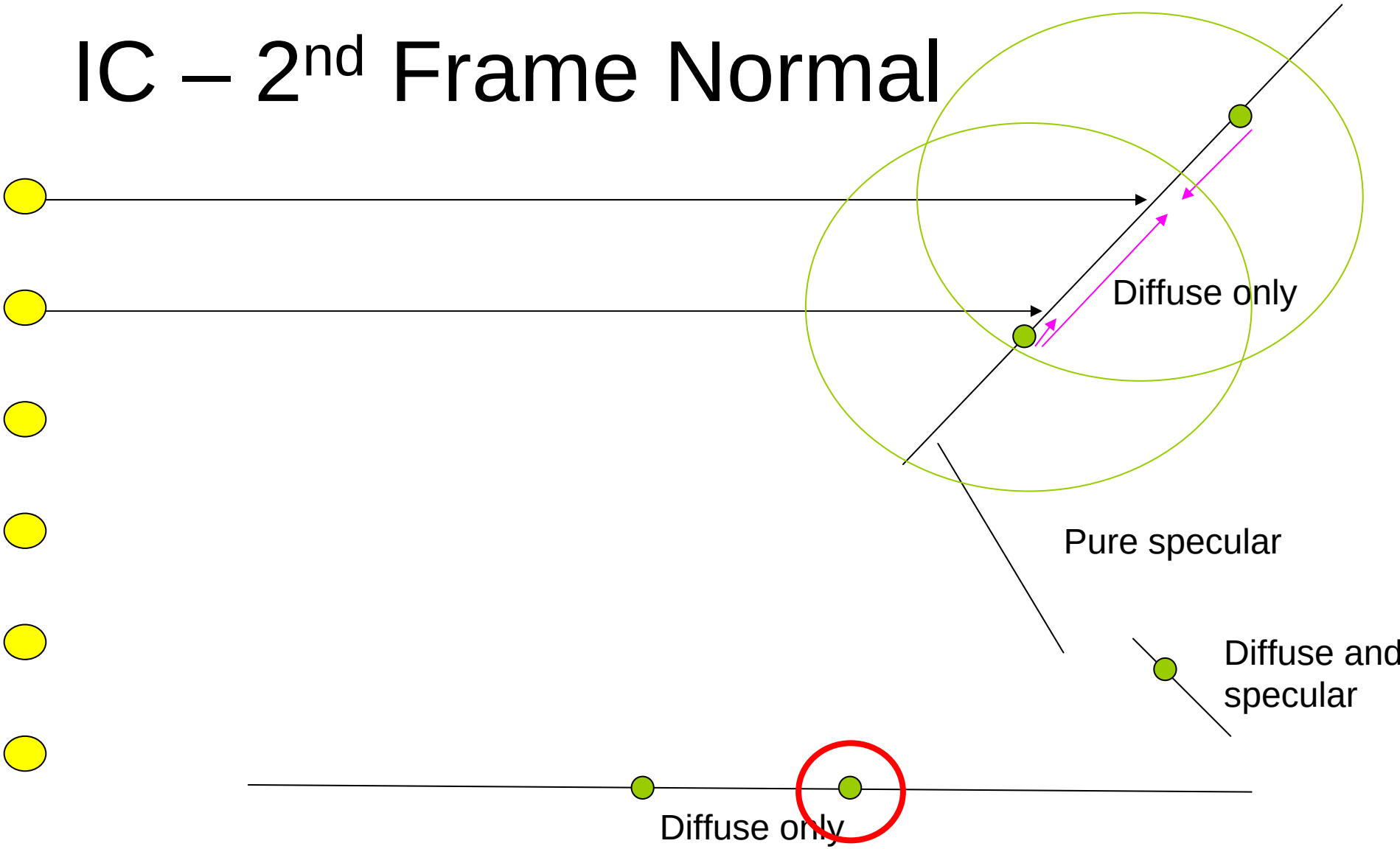
Irradiance Cache

- Acceleration data structure [Ward et al. 88]
  - Distributed ray tracing
  - Accelerates rendering by an order of magnitude
- Algorithm
  - Caches indirect diffuse samples
  - Interpolates/extrapolates from previous samples within radius

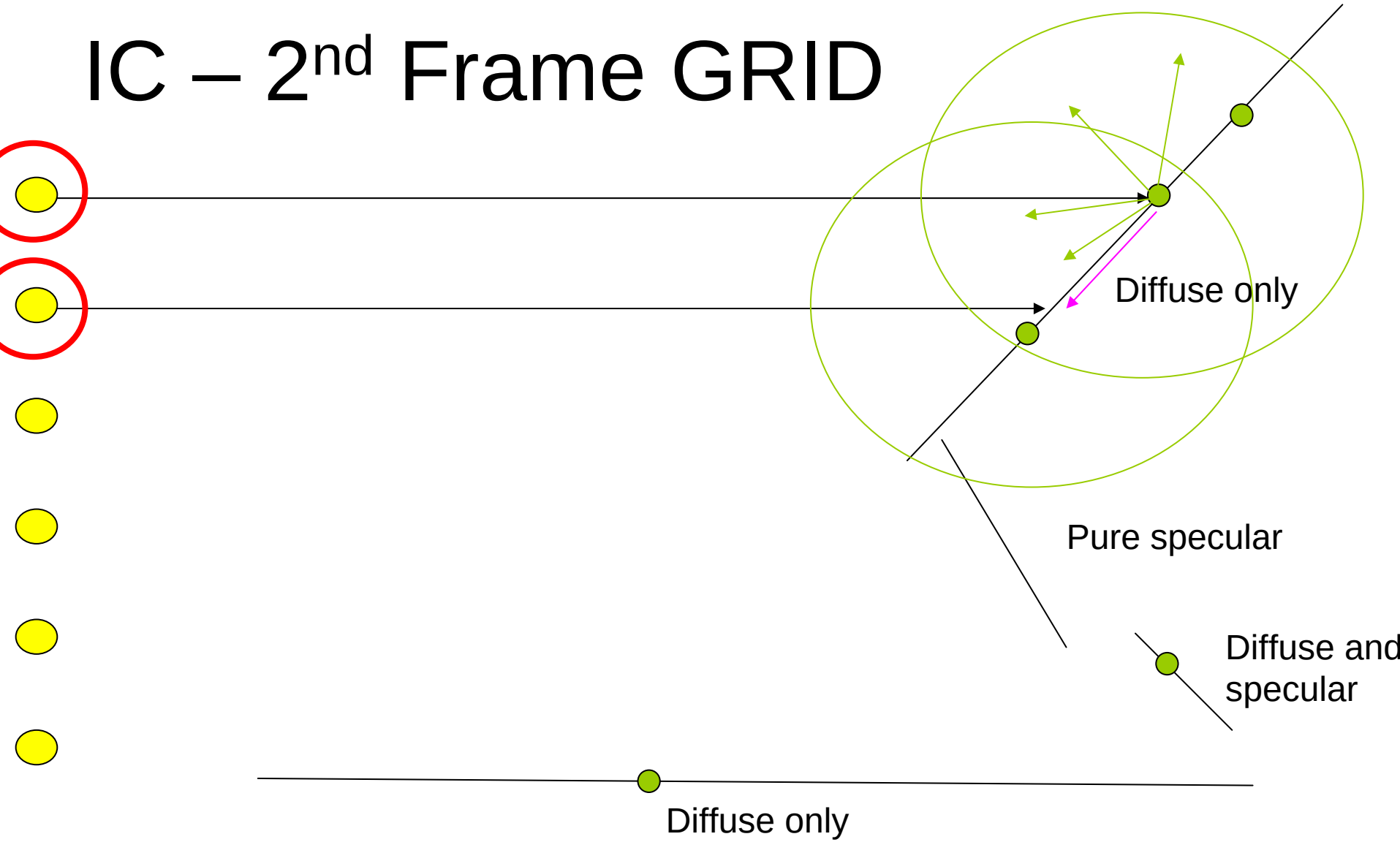
IC – Normal Animation



IC – 2nd Frame Normal



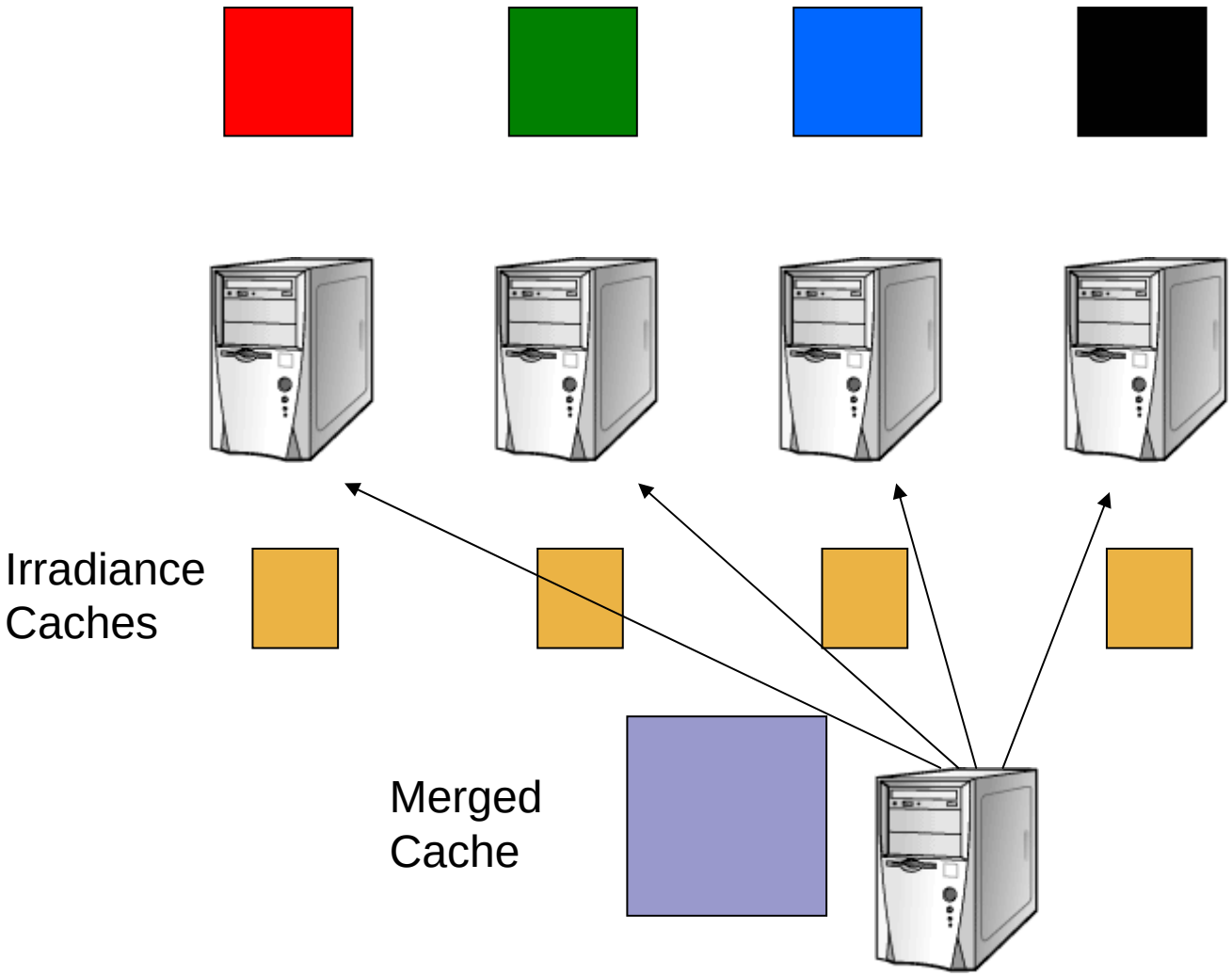
IC – 2nd Frame GRID



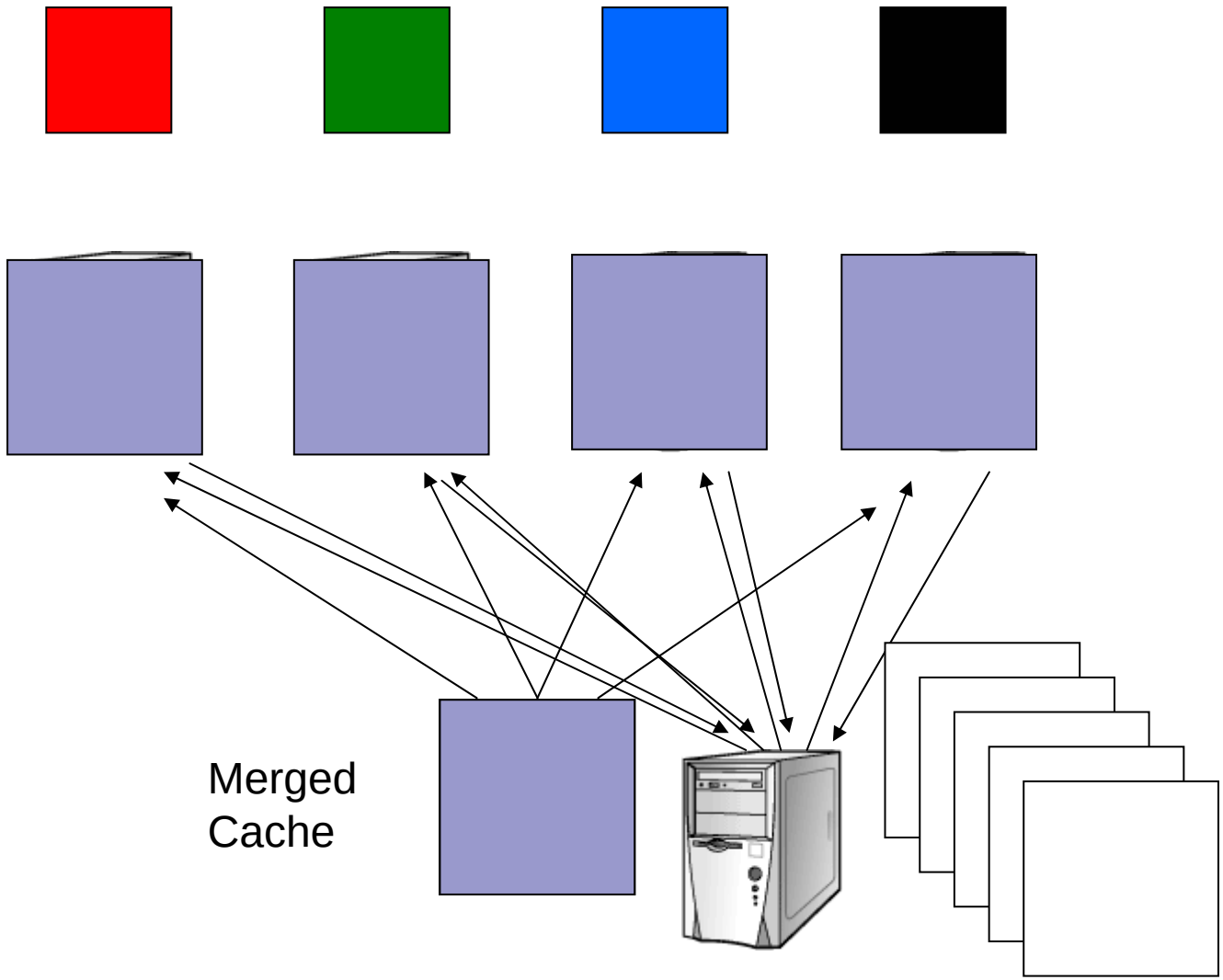
Our solution

- Two pass approach
  - First pass
    - Shoot random rays
    - Many caches
    - Merge cache
  - Second pass
    - Distribute merged cache
    - Render animation frames

First Pass & Merging



Second Pass



First Pass

Selection of the Frames for the first pass:

- Selecting every n^{th} frame
  - Total number of frames corresponds to total number of processors
- Selecting frames after parsing the view file
  - Weigh according to change in position and direction

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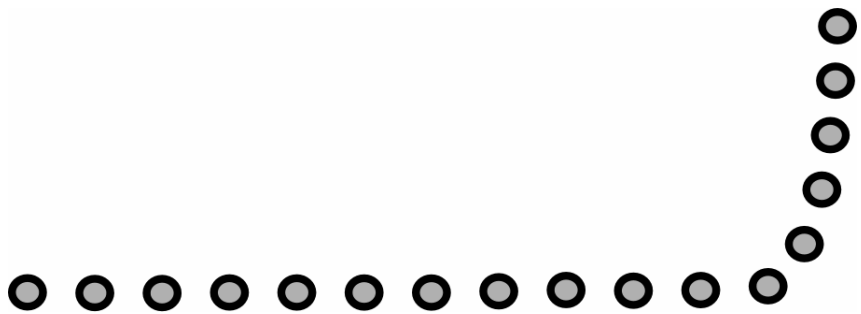

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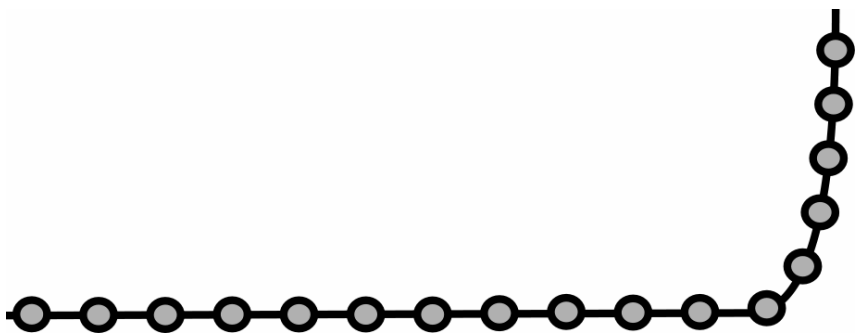

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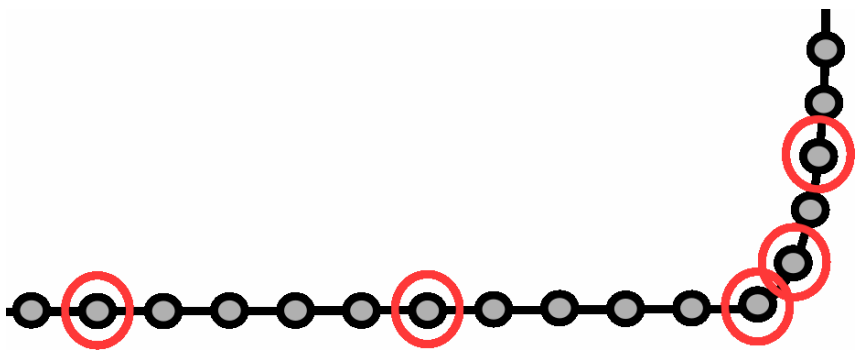
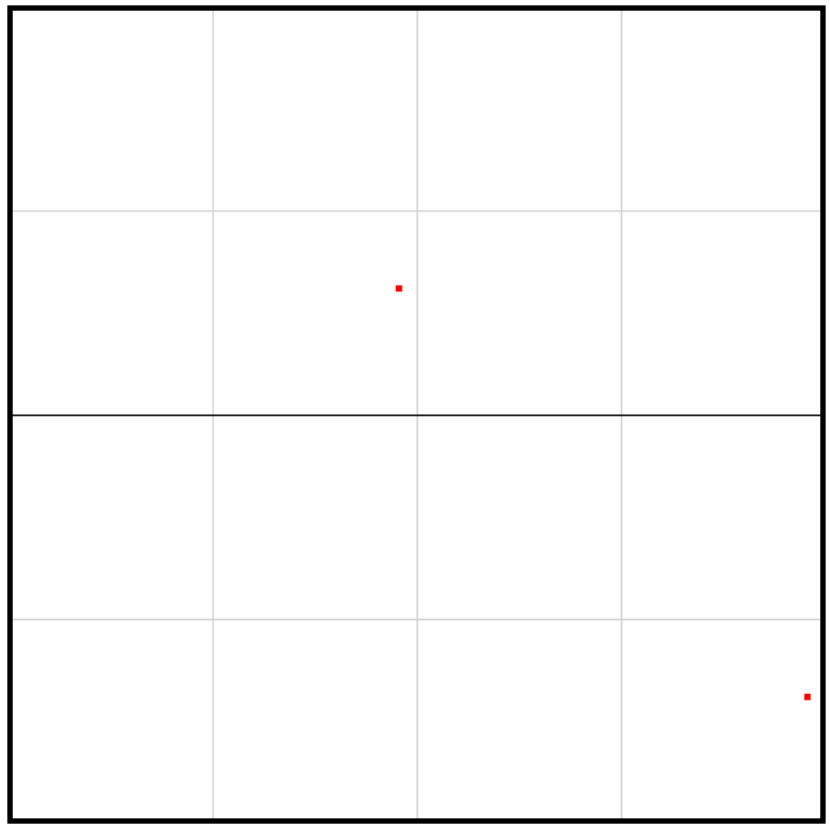


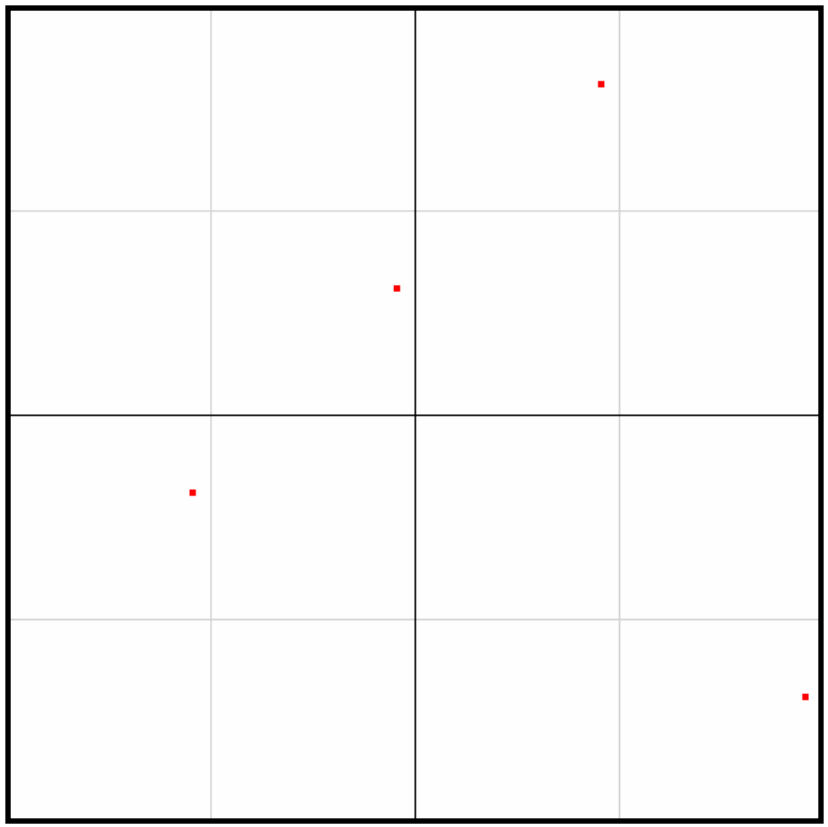
First Pass: Sampling

- Render using pseudo random sampling
  - Good hierarchy
  - Progression
  - Distribution
  - (0,2) quasi- random sequence
- Render until
  - Time runs out
  - IC hit/miss ratio threshold
  - Progressive aspect ensures we can stop whenever we want

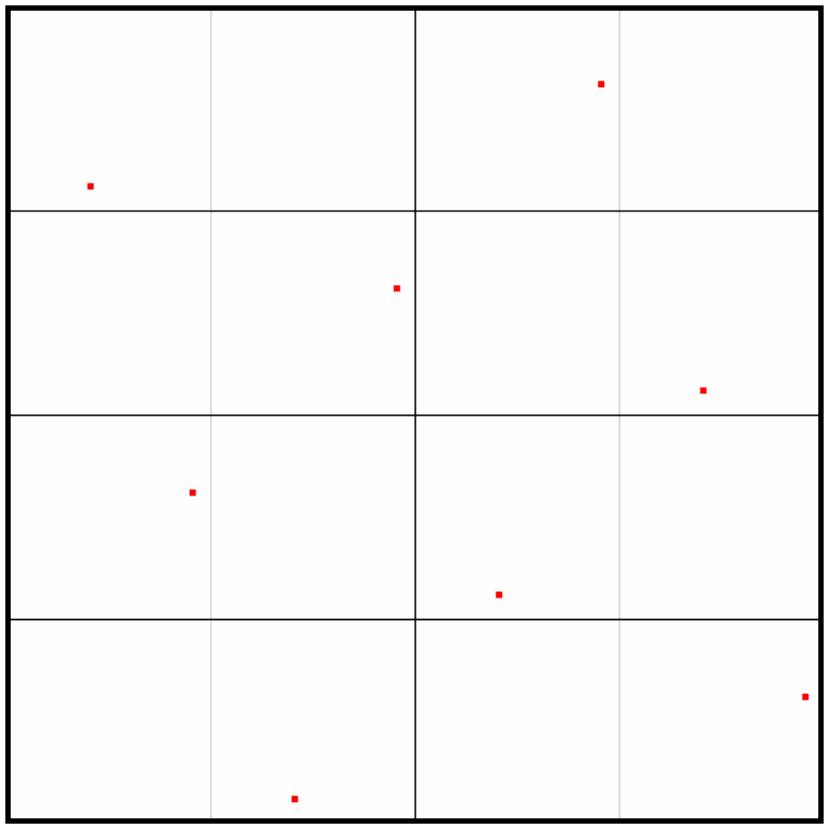
(0,2) sequence hierarchy – 2



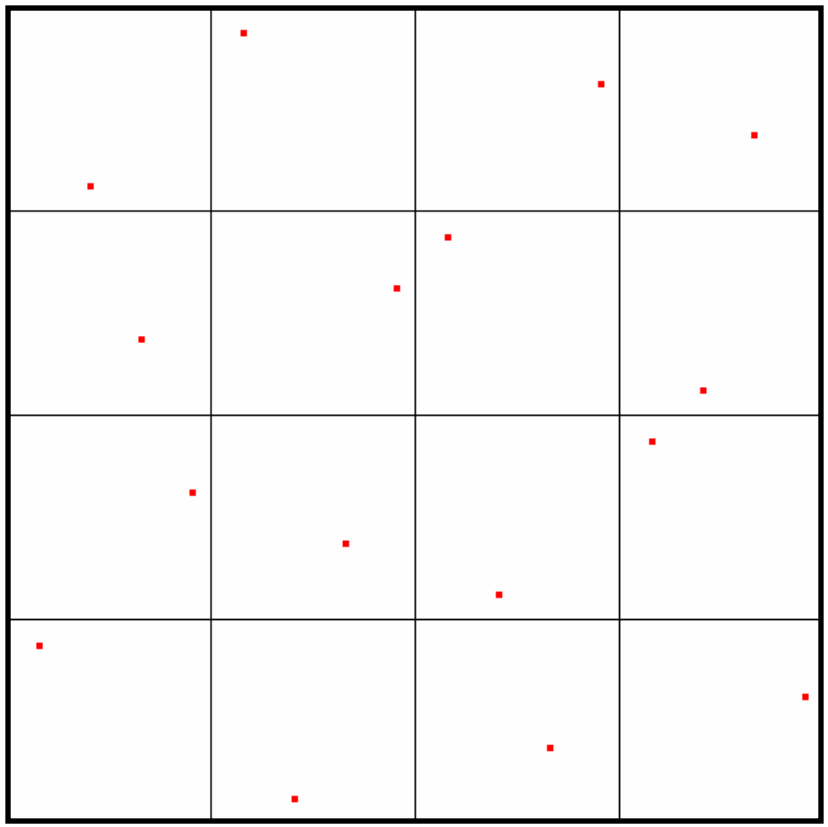
(0,2) sequence hierarchy – 4



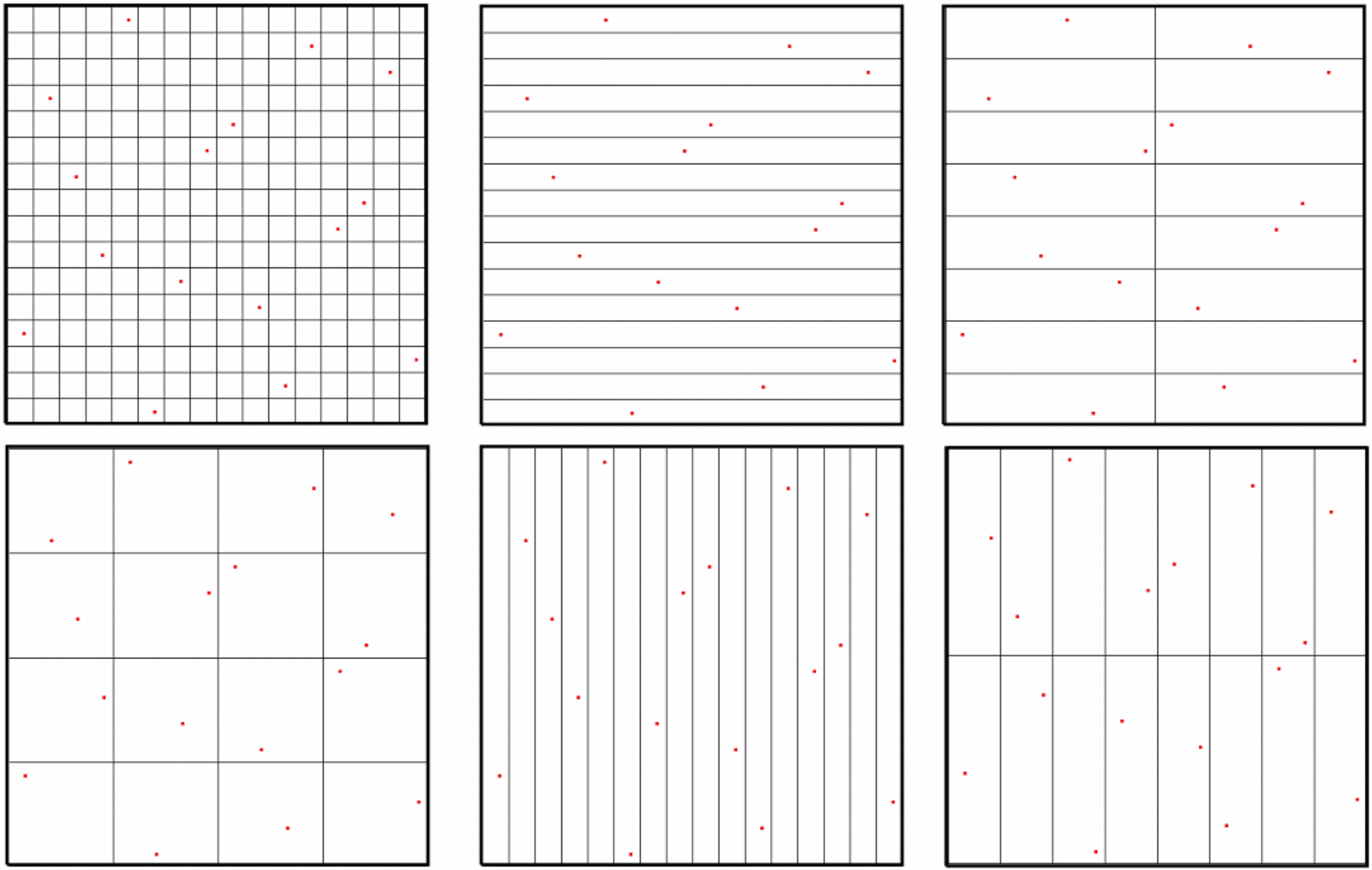
(0,2) sequence hierarchy – 8



(0,2) sequence hierarchy – 16

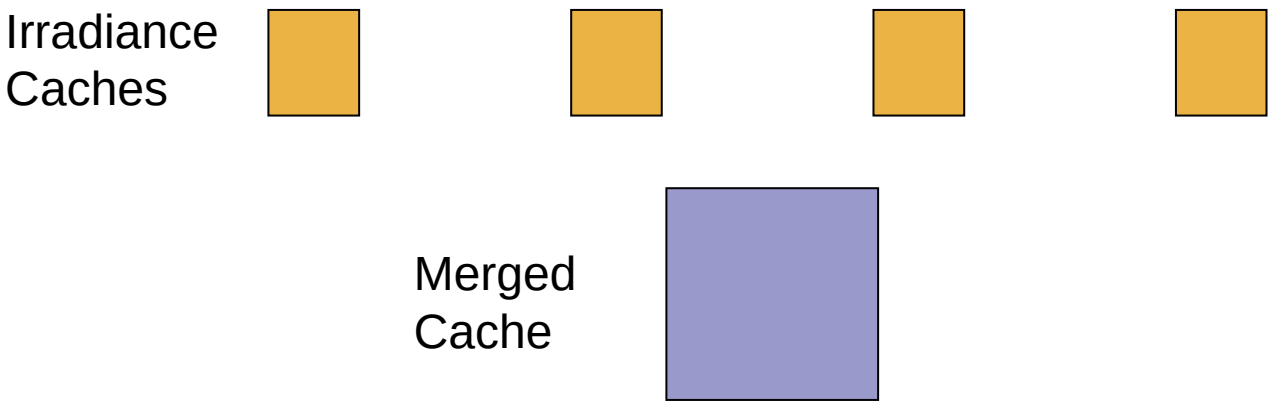


(0,2) sequence - Distribution

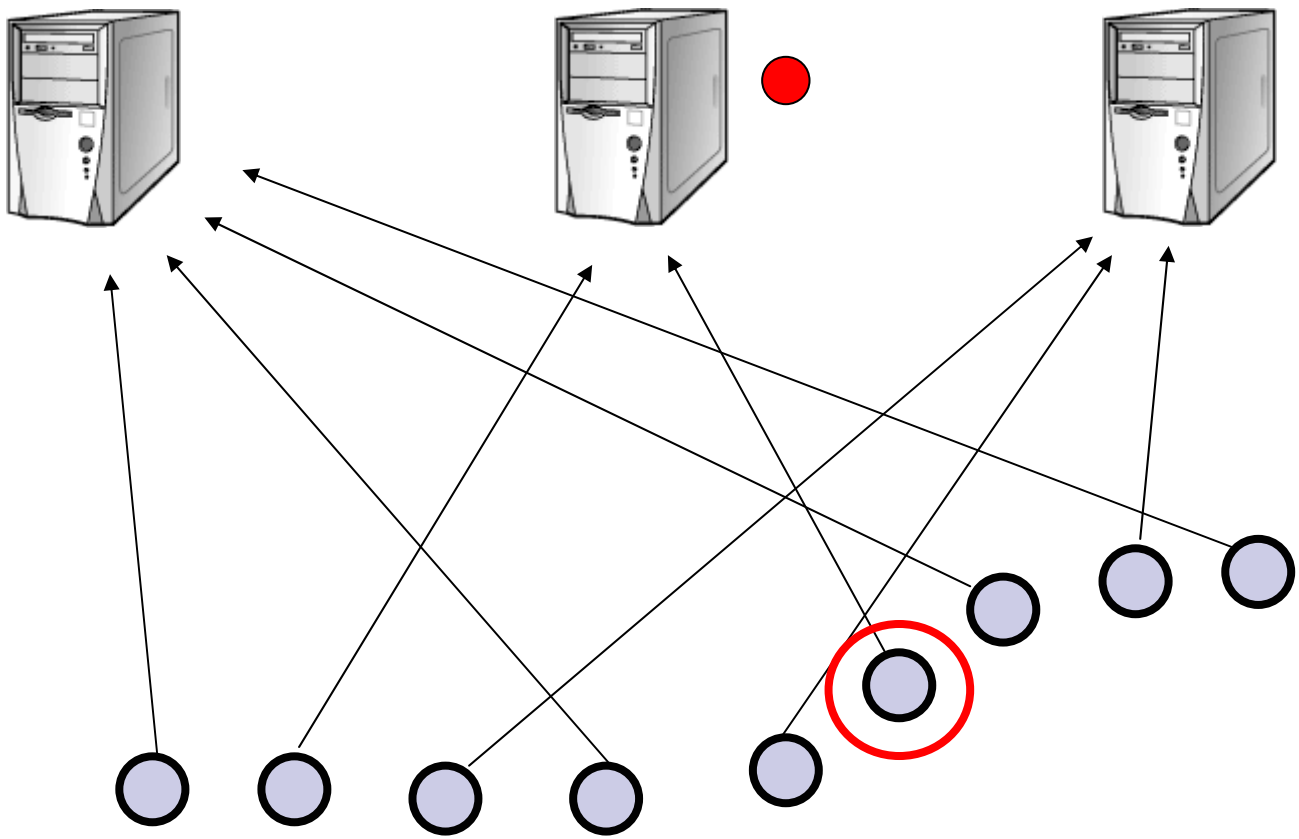


Merging the Cache

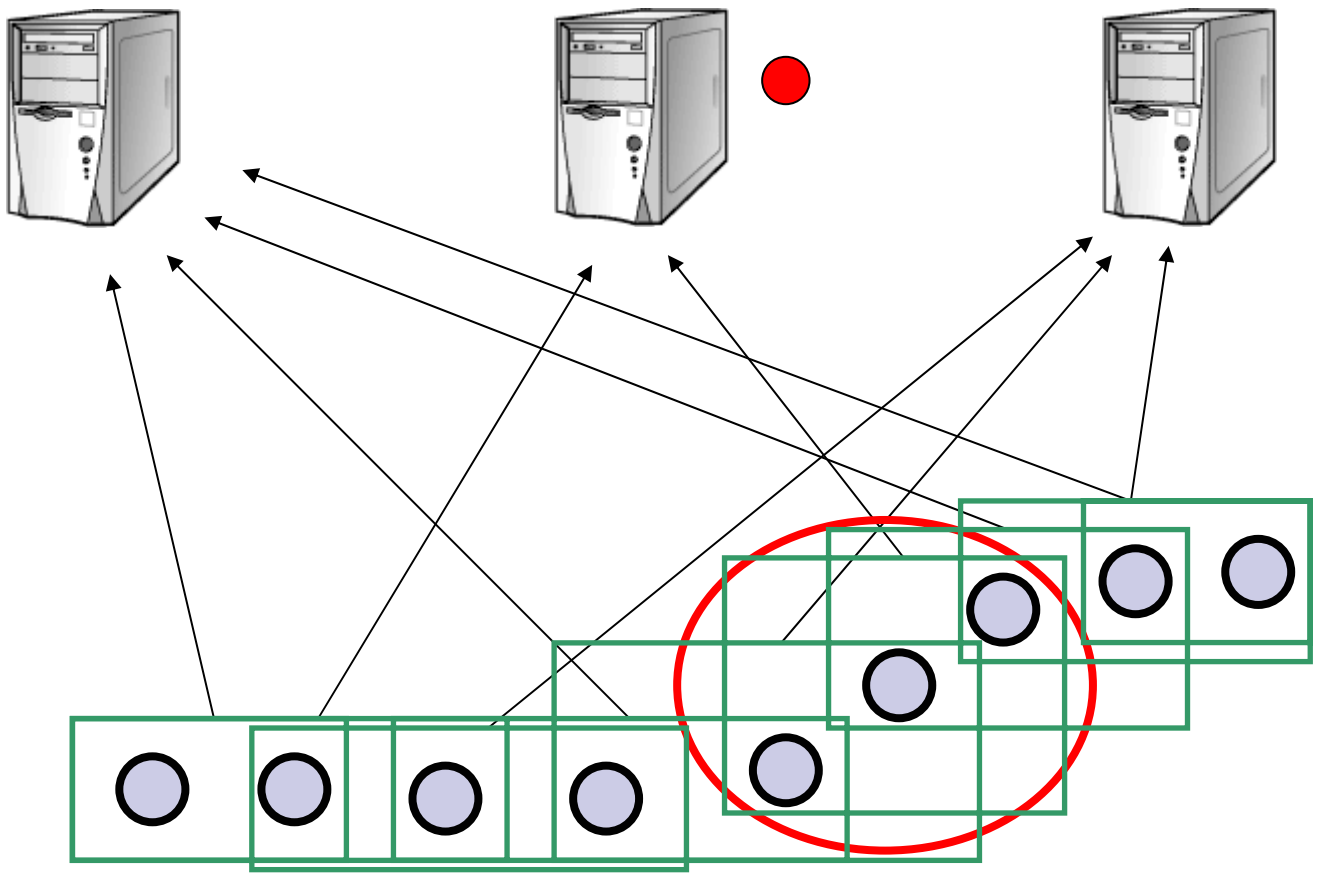
- The Irradiance cache
  - Merged
  - Shared



Fault Tolerance - problem



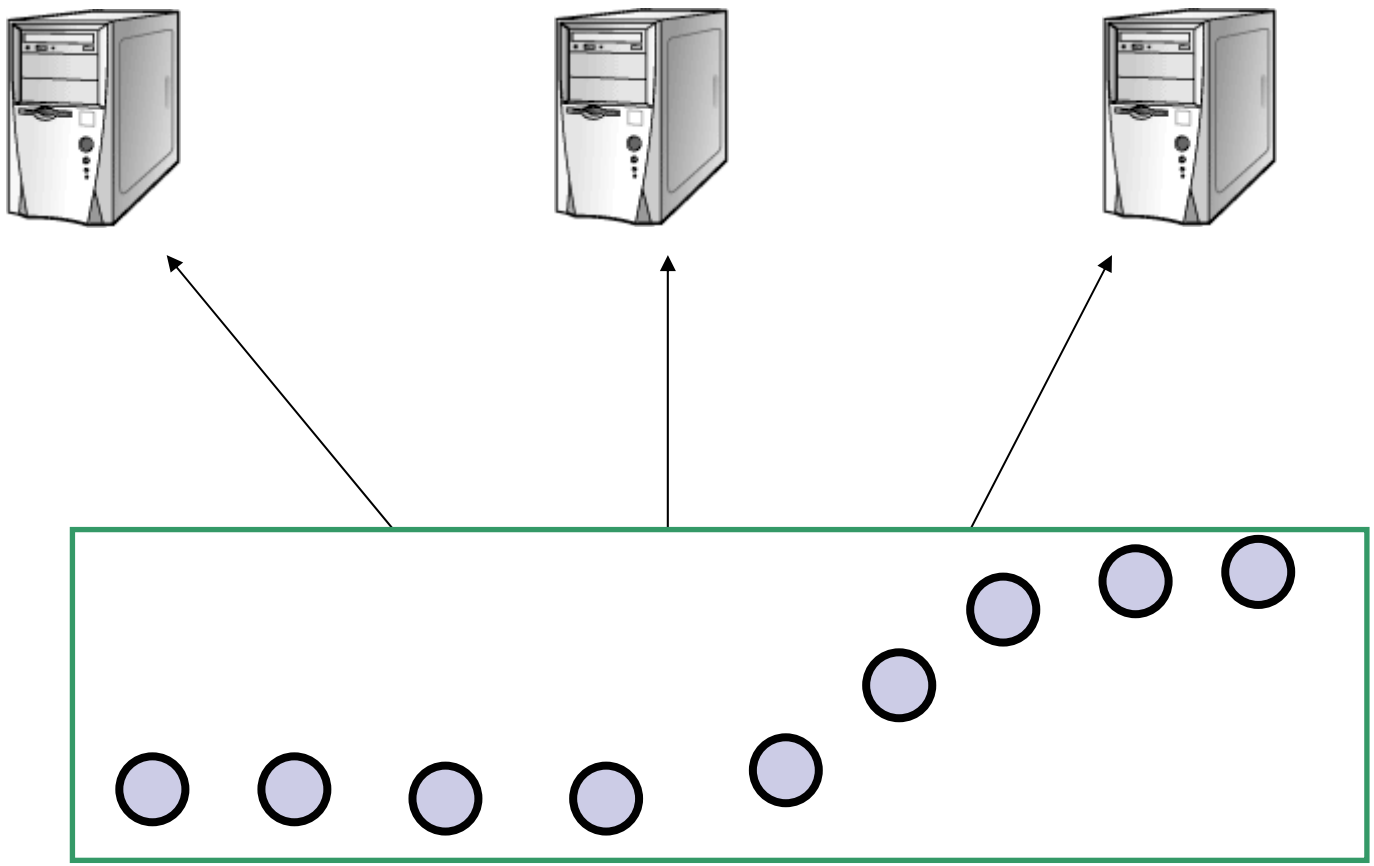
Fault Tolerance (WIP)



Second Pass

- Same as standard method
  - Simplicity
    - Can be used with our various guises of Radiance
    - Potentially newer versions of Radiance
- Issues
  - Redo frame if not done
- Future work
  - Include fault tolerance at this stage
    - Compromise simplicity

Fault Tolerance – Second Pass



Implementation

- First pass
  - Modified version of rpict
    - Could have used rtrace
- Second pass
  - Standard Radiance rpict and variants
- Job distribution and management
  - Condor system
  - Shell scripts
    - Automate process

Examples

- Kalabsha
- Art Gallery (-ab 3)
- Corridor

Kalabsha merged

Art Gallery (-ab 3) unmerged

Art Gallery (-ab 3) merged

Timings – 100 procs

Corridor: ca. 320 frames
Merged Cache - 1hr 12 min
Unmerged Cache - 1hr 40 min

Art Gallery –ab 3: ca. 220 frames
Merged Cache – 4hr 35 min
Unmerged Cache – 5hr 7 min

Kalabsha: ca. 90 frames
Merged Cache - 31 min
Unmerged Cache - 48 min

Conclusions and Future Work

- Underutilised computational resources can be put to good use
  - Radiance for animations
    - Faster
    - Little cost
- Learnt a lot about GRID-like computation
- Future work
  - Design GRID specific parallel rendering algorithms
    - Better fault tolerance
    - Minimum sharing

Thank You!

Contact:
Kurt.Debattista@bristol.ac.uk

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