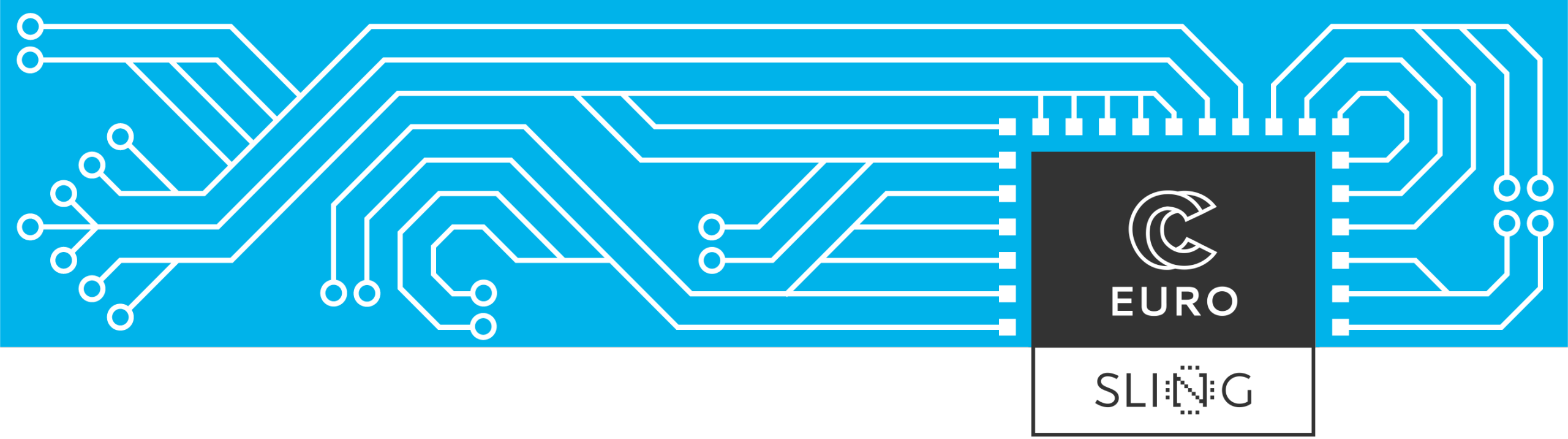

Session 4 – Integration of PlasmaPEPSC into Excellerat

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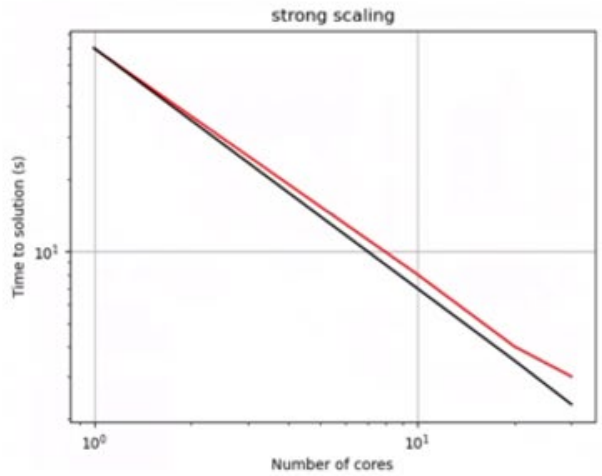
26 September 2024

Raysect code scalability

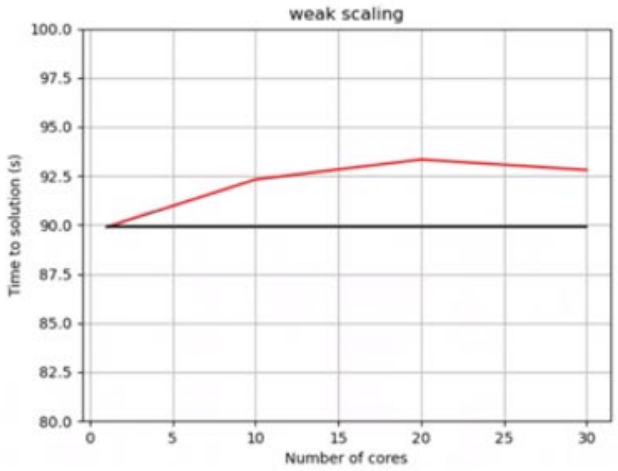
- In Raysect, backwards ray-tracing is employed, meaning that rays are generated on the object of interest and projected into computational domain where their parameters are assessed.
- The case for both strong and weak scaling contains ~26k triangles. From each triangle 40 rays were launched randomly into space and checked for intersection with objects in the scene (in total ~1.41 million triangles). For weak scaling number of triangles is the same but number of rays on each triangle is reduced accordingly.

- Raysect code scalability
  - On 1 node



N proc	Actual time (s)	Ideal time (s)
1	70.7	70.7
10	8.4	7
20	4.7	3.5
30	3.9	2.33

Strong scaling for Raysect



N proc	Actual time (s)	Ideal time (s)
1	89.89	89.89
10	92.32	89.89
20	93.34	89.89
30	92.8	89.89

Weak scaling for Raysect

Optimisation techniques

- Sampling techniques:
  - Adaptive sampling (Markov-Chain Monte Carlo, Metropolis-Hastings algorithm)
  - Uniform sampling
  - Cosine sampling
  - Light source sampling

Optimisation techniques

- Space partition:

  Bounding volume hierarchy: typically found for non-scientific rendering, in animations and video games

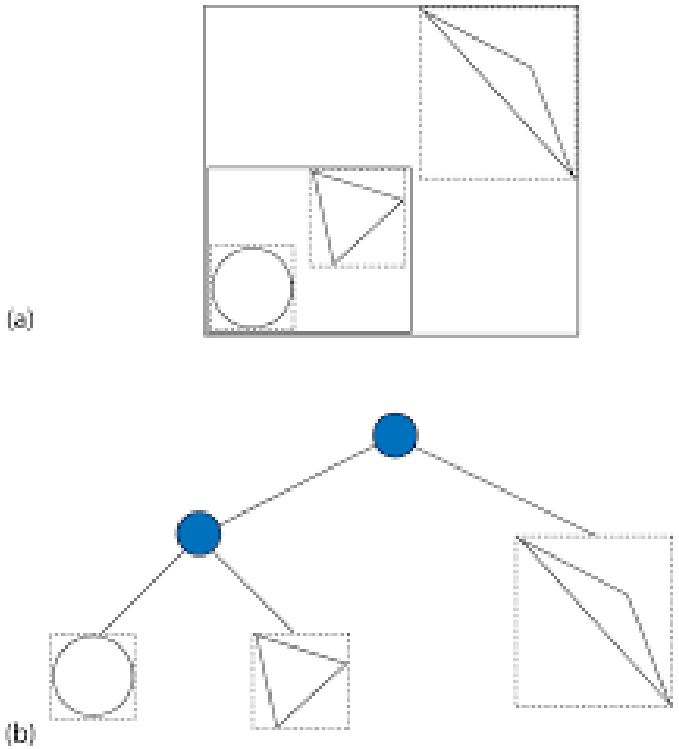


Figure taken from:
M.Pharr, J. Wenzel; Physically based rendering

Optimisation techniques

- Space partition:

OCTREE partition:

Division of computational domain into boxes. Bigger boxes are further divided into 8 sub-boxes etc.

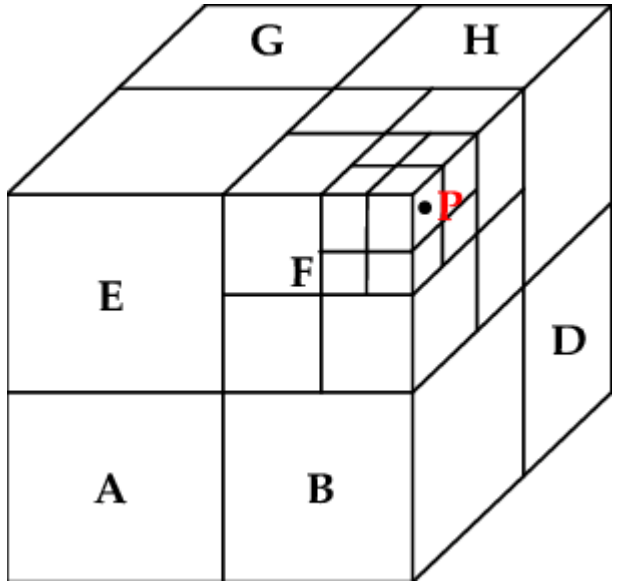


Figure taken from:
Gao, Zhizhou & Wan, Lujun & Cai, Ming & Xu, Xinyu. (2022). Research on Lazy Theta* Route Planning Algorithm Based on Grid Point Optimization. Applied Sciences. 12. 10601. 10.3390/app122010601.

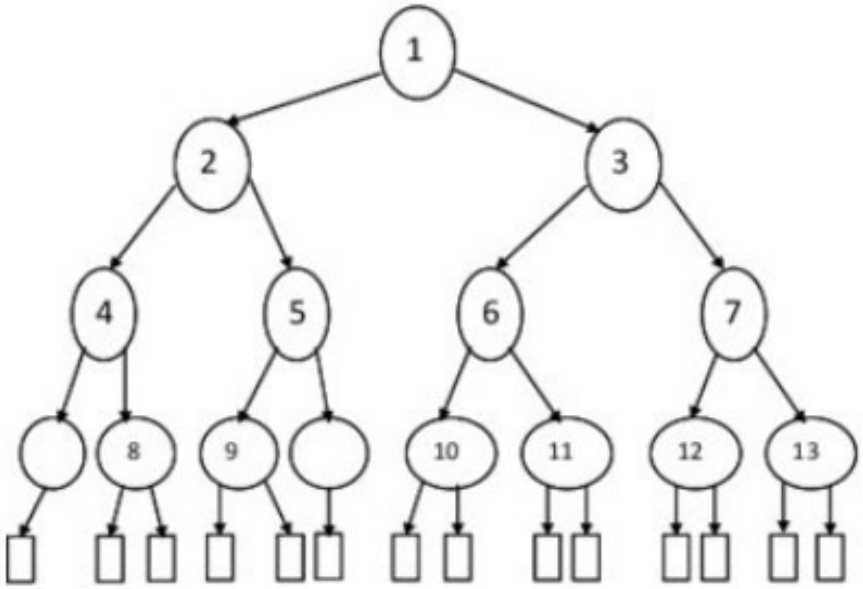
Optimisation techniques

- Space partition:

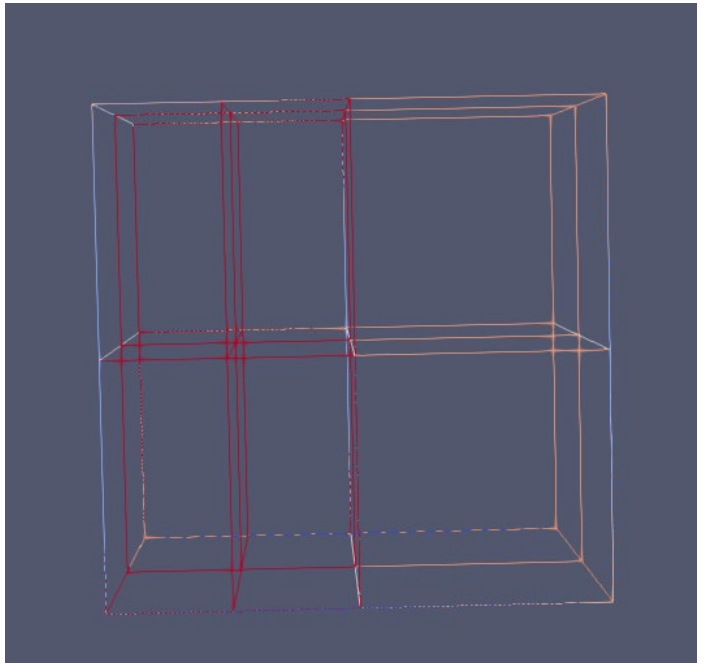
KD-Tree partition:

KD-tree partition is used to separate computational mesh into boxes that contain multiple sub-boxes (tree structure with multiple levels). The intersection of ray with computational mesh is done only for the box, thus speeding up the process.

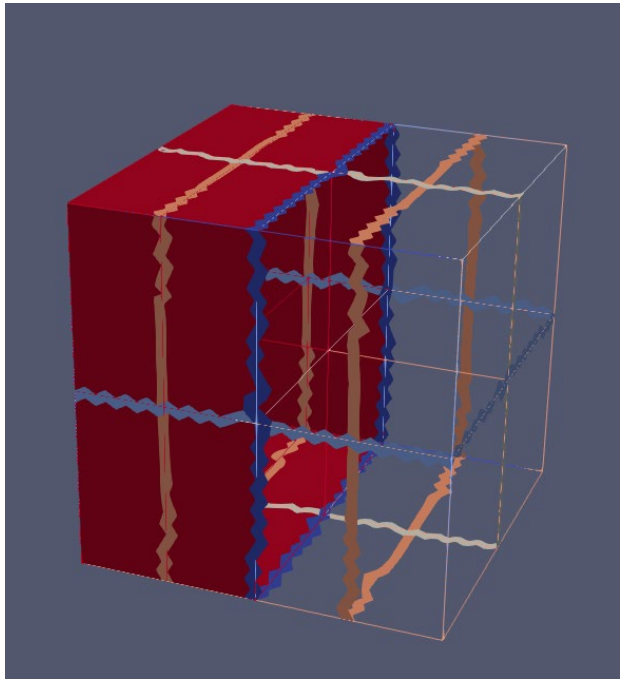
KD-Tree partition



KD-tree structure. Fig. courtesy [4]



Partition into bounding boxes.



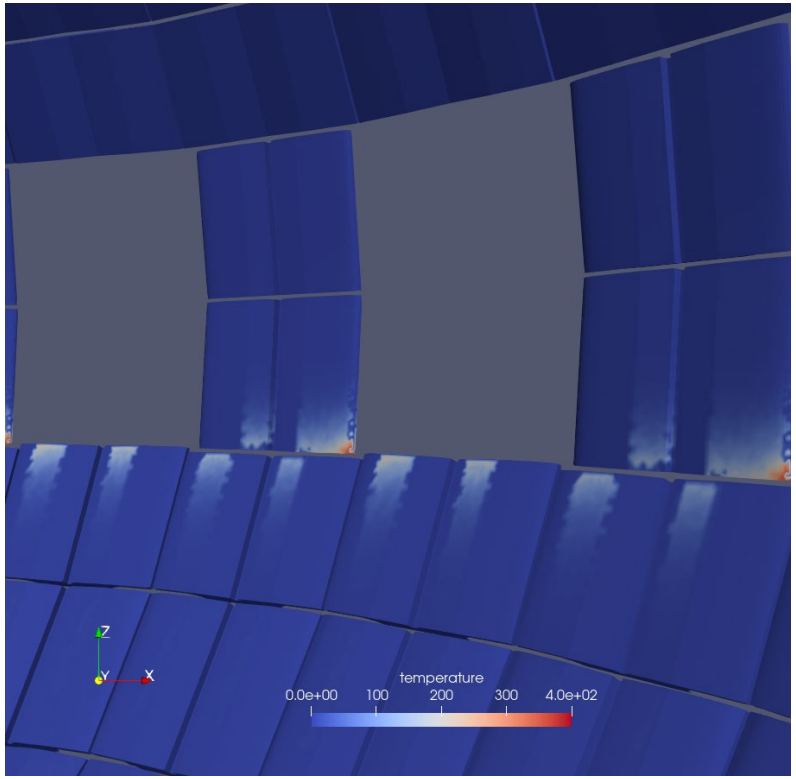
Triangular mesh sorted into boxes.

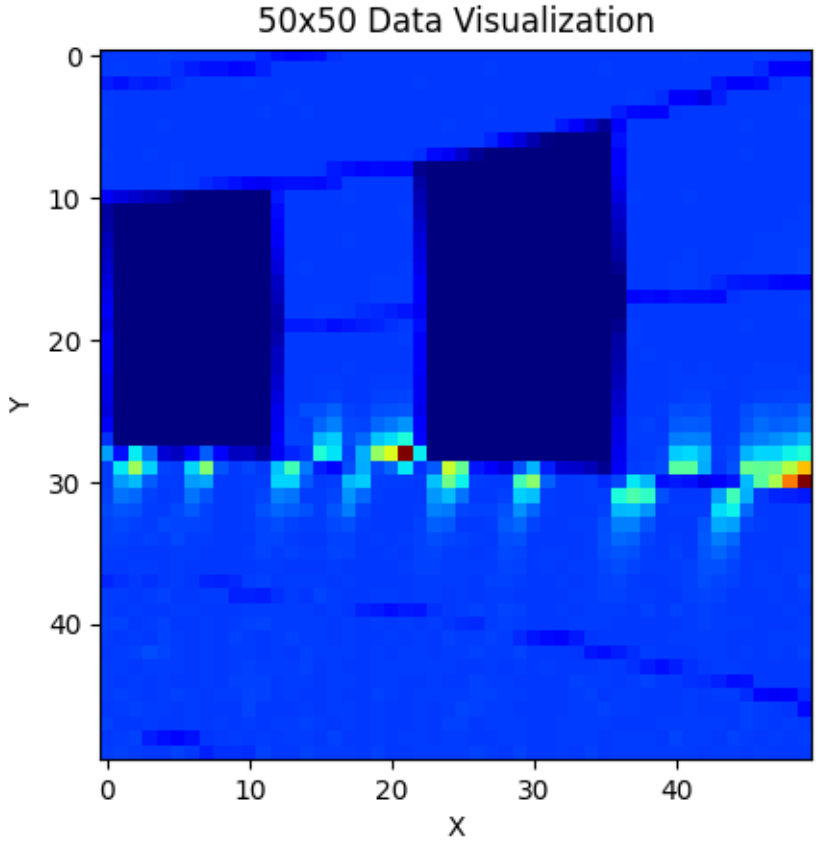
Optimisation techniques

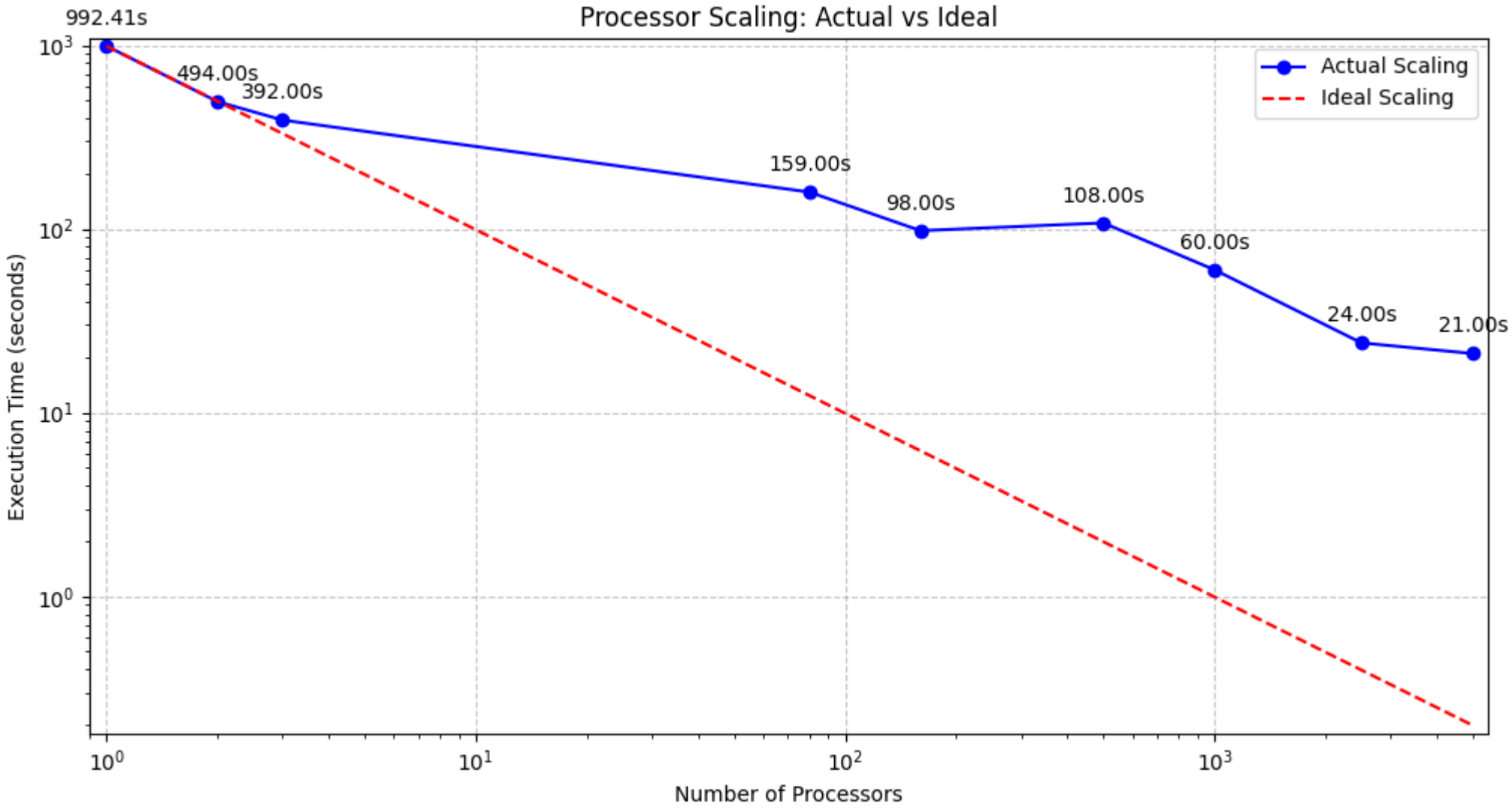
- Parallelisation
  - CPU/GPU
  - An example of hybrid parallelisation using OpenMP and OpenMPI
  - Input Mesh of first wall with temperatures (assessed with OpenFOAM). Then a simple Stefan-Boltzmann wall is solved to arrive at the power
  - Camera 50x50 pixels
  - 100 rays from each pixel

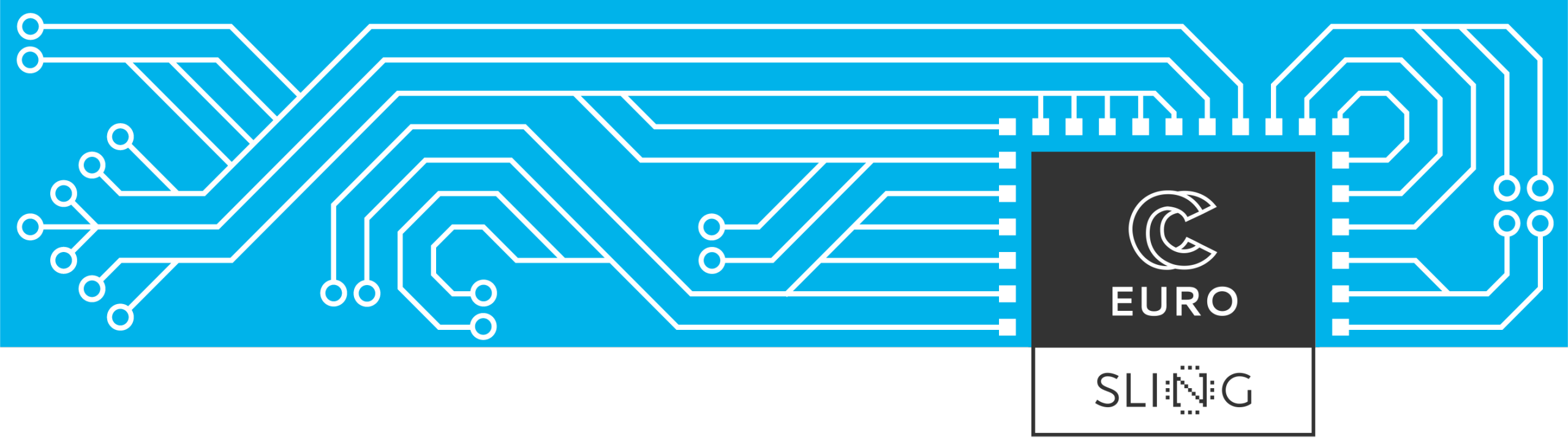
Optimisation techniques

- Parallelisation






Processor Scaling: Actual vs Ideal
992.41s
494.00s
392.00s
159.00s
98.00s
108.00s
60.00s
24.00s
21.00s
Actual Scaling
Ideal Scaling
Execution Time (seconds)
Number of Processors
10^0
10^1
10^2
10^3



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REPUBLIC OF SLOVENIA
MINISTRY OF HIGHER EDUCATION, SCIENCE AND INNOVATION

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