Efficient Automotive Grid Maps Using A Sensor Ray Based Refinement Process

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Occupancy Grid Mapping

- model for static environment
- evidential grid map based on Dempster Shafer Theory
- how to store and manage free space in a map efficiently?

Adaptive Map

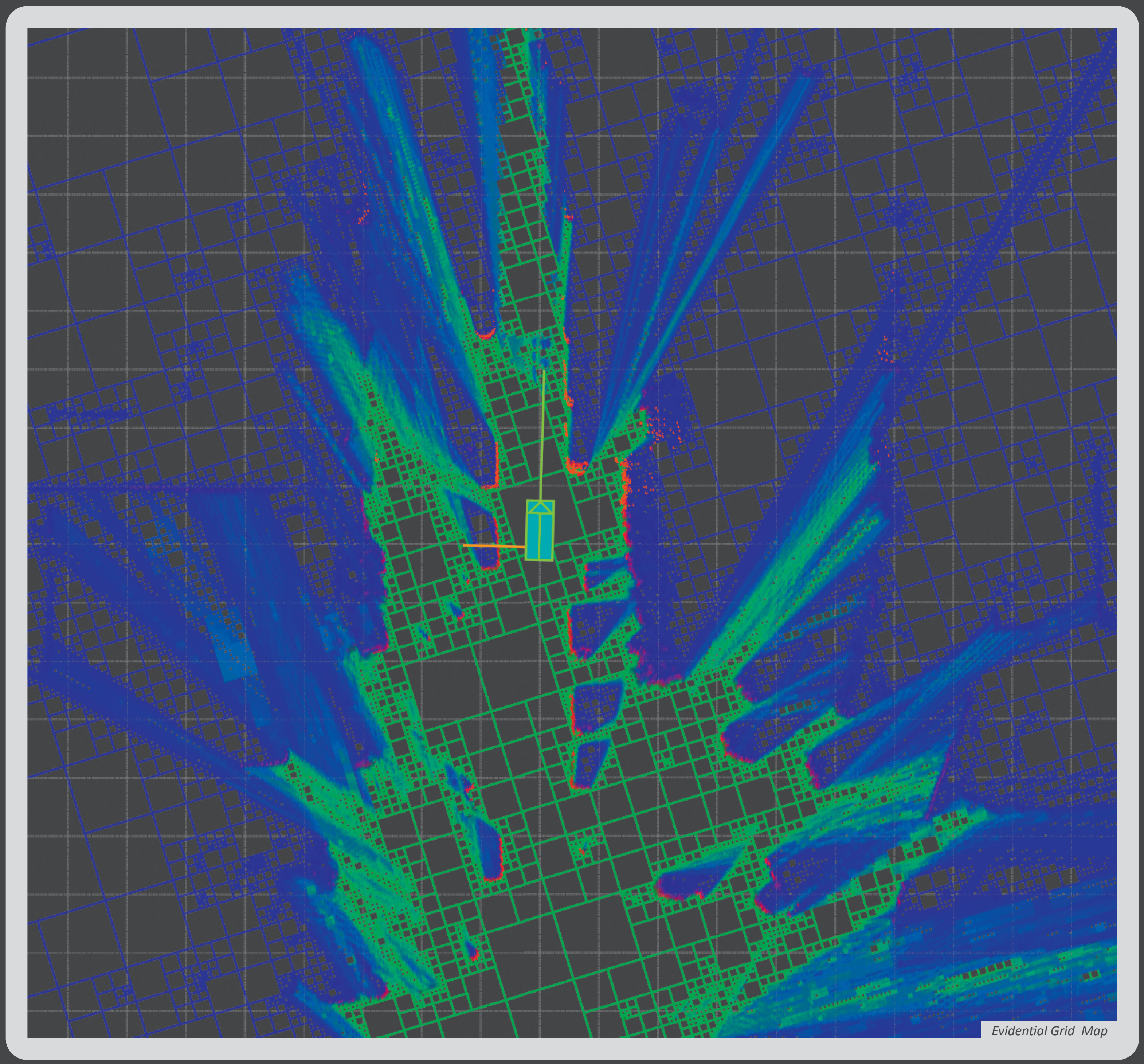
- quadtree or ND-tree architecture
- choose the correct cell size
- define a split and merge algorithm

Split

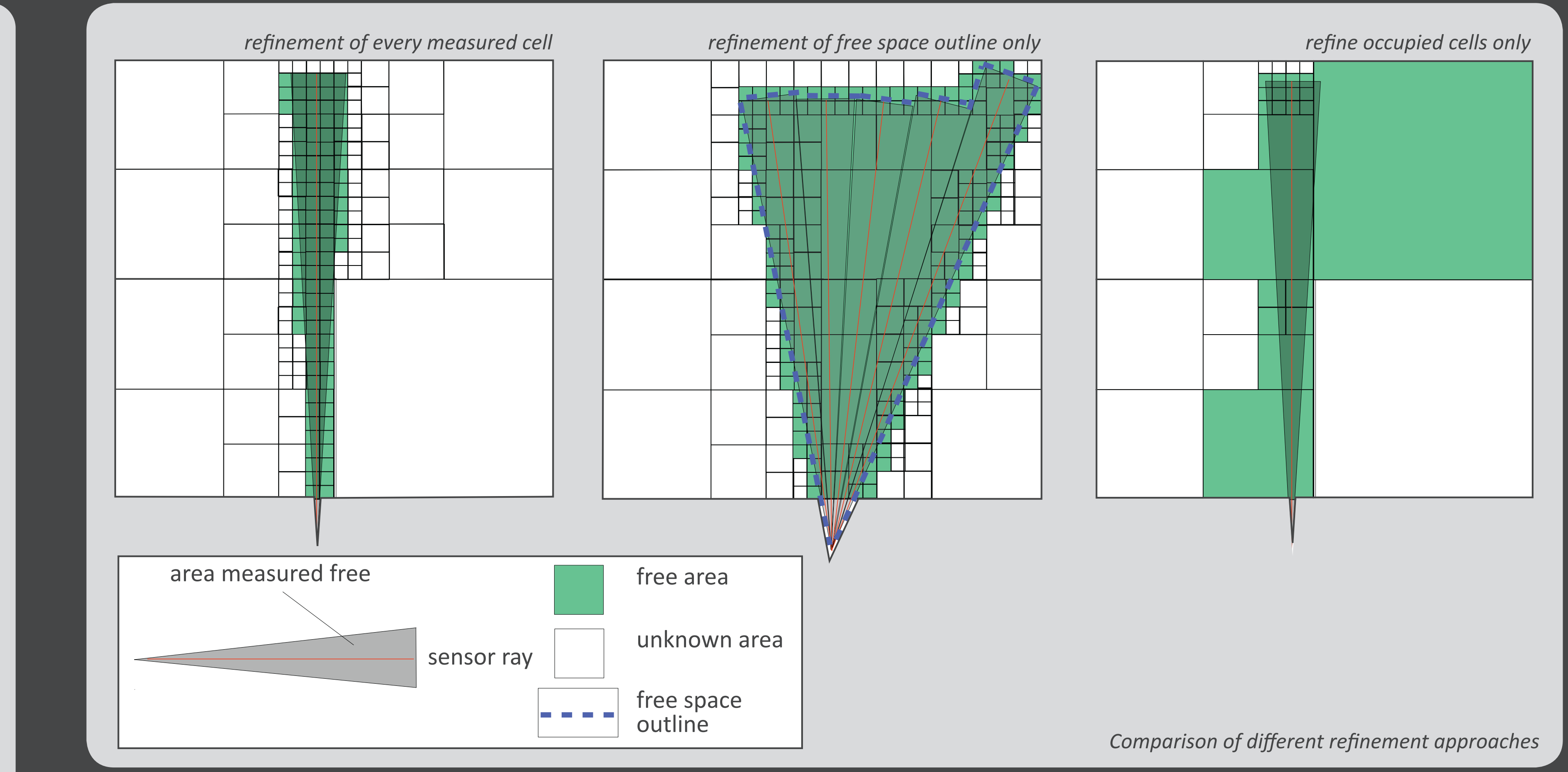
- split every cell hit by a sensor ray (not efficient)
- ray based refinement as tradeoff
- split occupied cells only (not accurate)

Ray Based Refinement

- employ a clustering algorithm for sensor rays
- calculate free space polygon using clustered rays
- split cells at outline of free space polygon



Evidential Grid Map


refinement of every measured cell
refinement of free space outline only
refine occupied cells only
area measured free
sensor ray
🟩 free area
□ unknown area
free space outline

Comparison of different refinement approaches

RESULTS

In Adaptive Grid Mapping, splitting and merging algorithms control computational and memory ressources.
To store free space efficiently, be aware of partially free cells.
Look at the outline of the free space area and refine cells at the outline only.
Split cells:

- **measured occupied**
- **measured on the free space outline**
- **where the measurement resolution is higher than the cell resolution**

Merge cells, where all leafs show the same occupancy/free state.
This procedure saves memory and CPU ressources in contrast to conflict based cell refinement algorithms.

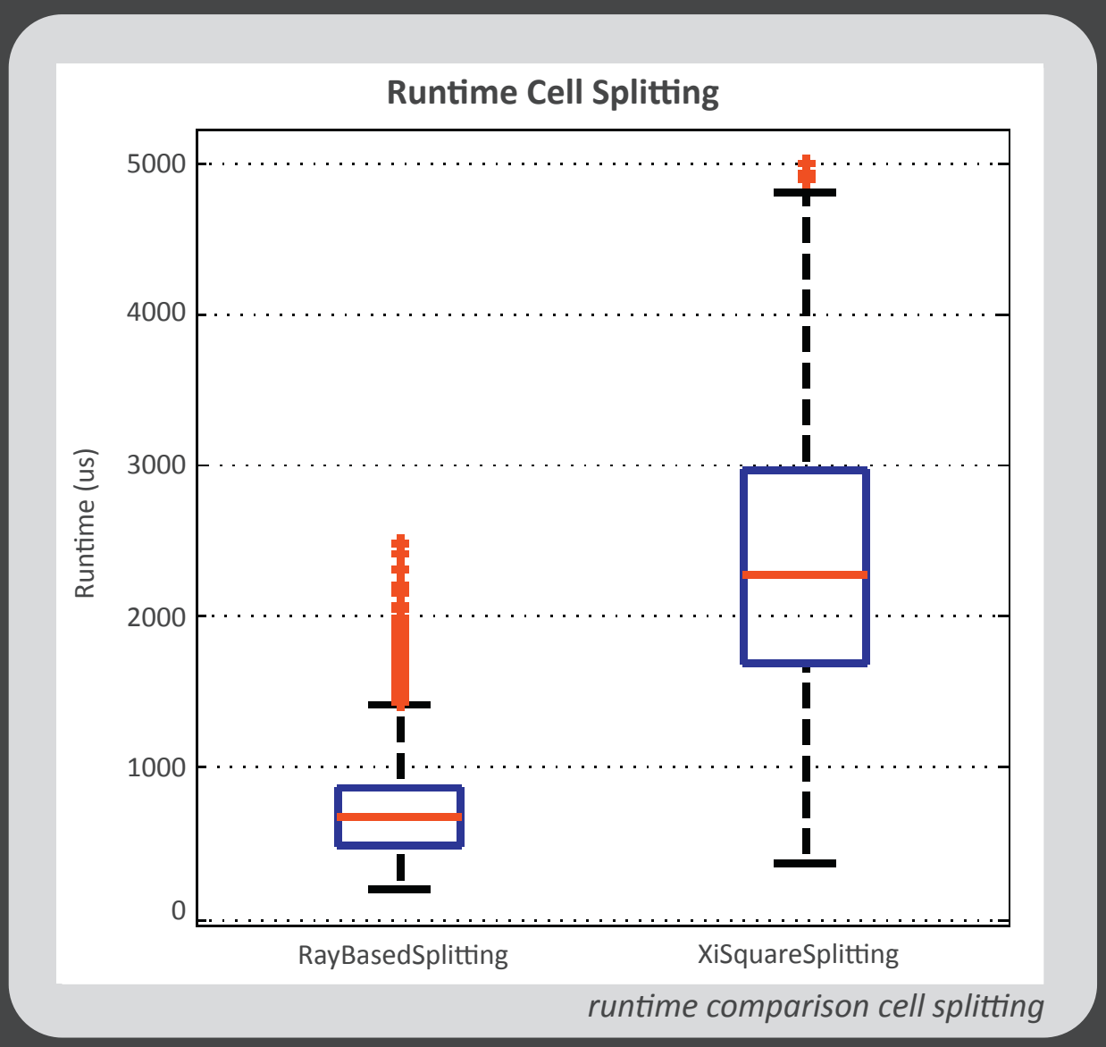
reference video view

Evaluation

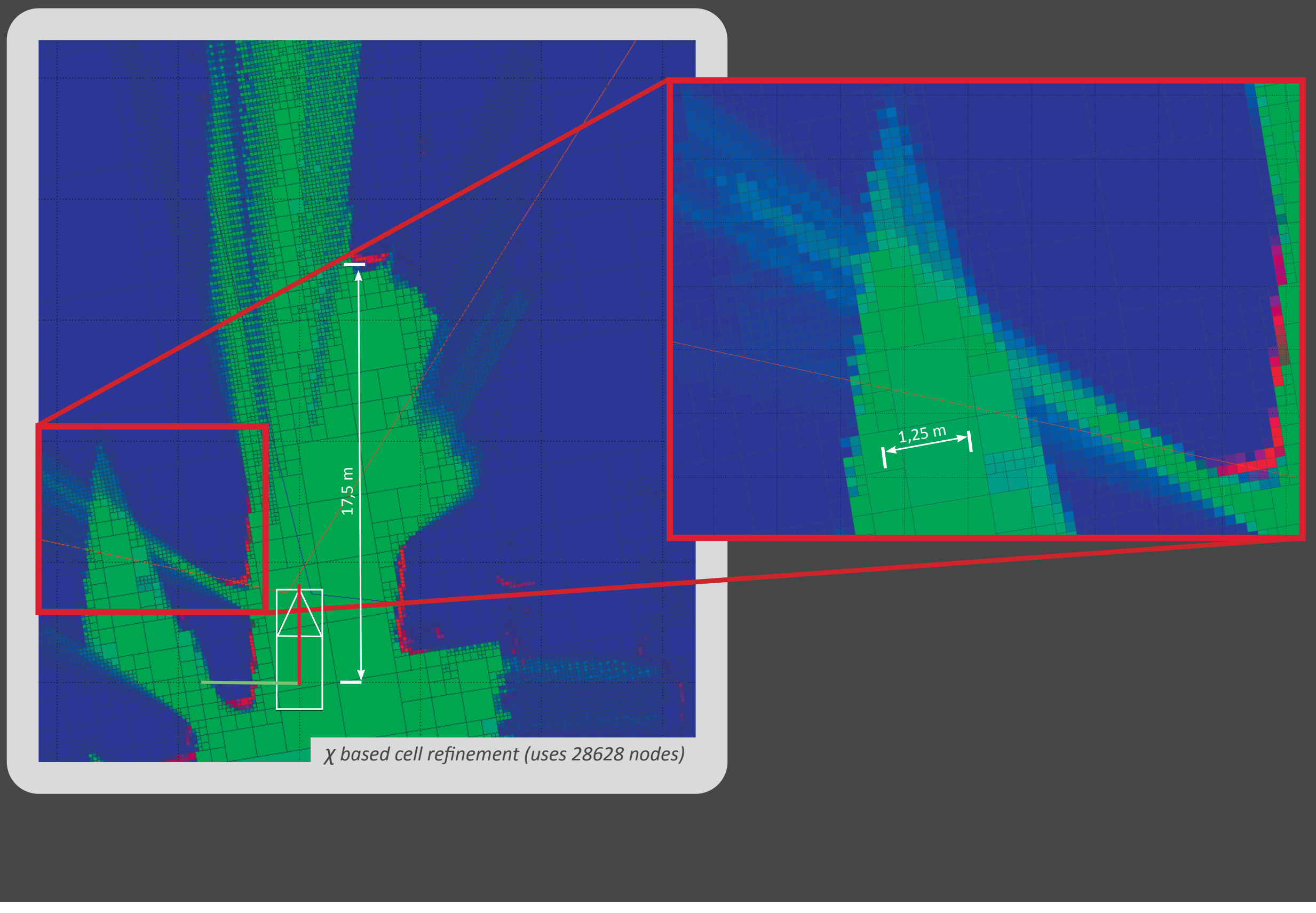
- compare against conflict based splitting approach »X based refinement«
- ray based refinement choose coarser resolution
- ray based approach memory and runtime efficient

Ressources

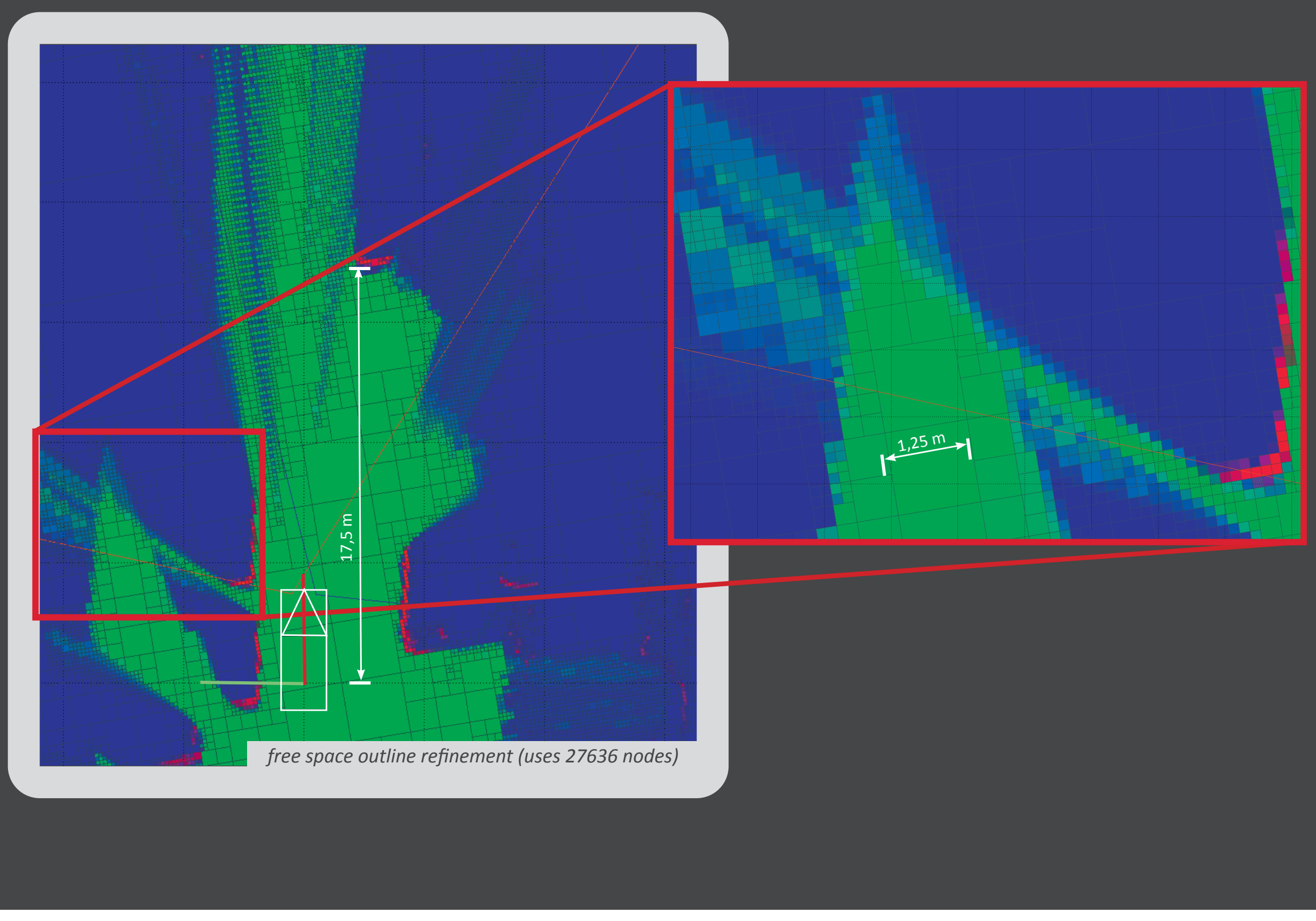
- ten times lower memory consumption than in static grid maps
- ray based refinement is three times faster than »X based refinement«
- memory footprint is about 98 MB for a 3.6 km trip in urban environment



runtime comparison cell splitting



χ based cell refinement (uses 28628 nodes)



free space outline refinement (uses 27636 nodes)

demonstrator vehicle equipped with LIDAR scanners

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