

Spatio-Temporal Map for Time-Series Data Visualization

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We propose the spatio-temporal map to detect a spatio-temporal feature area from a three-dimensional time-evolving simulation.

Recently, because of the improvement of supercomputers, numerical simulations have been larger and more complex. In the atomic energy field, also, various large-scale and complex simulations, a virtual plant vibration simulator, a reactor core plasma simulator, and so on, has been carried out. Increase in the size and complexity of simulations makes it difficult to understand physical and engineering phenomena from simulation results. So far, in order to understand such phenomena, users have used traditional volume visualization techniques, and have observed a visualized object from various directions. However, the traditional techniques may cause overlooks of interested phenomena and exertion of researchers.

The spatio-temporal map is a two-dimensional diagram with spatial and temporal information in each dimension. The map is created with the following two-steps:

Step1. Creating a hierarchical structure by using voxel subdivision.

Step2. Creating a two dimensional color table (spatio-temporal map).

In step1, to condense a three-dimensional information into a one dimensional information, we create a hierarchical structure of the target three-dimensional model by using voxel subdivision. The rectangle which encloses the model is subdivided on the basis of a parameter that represents characteristics of the area. Candidates for this parameter are the distribution of physical data, the number of vertices, etc. Then, the subdivided voxel is represented by the hierarchical structure with a tree graph. By plotting a tree graph, the vertices of a three-dimensional model can be represented in one dimension. In step2, a two-dimensional color table is created. In this table, the horizontal axis represents the one-dimensionally represented vertices, the vertical axis denotes a time step, and the color indicates the magnitude of the physical value in each voxel. In this way, both spatial and temporal changes in the physical value can be represented as a single diagram. By applying image analysis techniques to the two-dimensional color table, the spatio-temporal feature area can be detected.

By applying the spatio-temporal map to the three-dimensional virtual plant vibration simulator (Fig. 1), we confirmed that the spatio-temporal map was helpful to detect higher stress areas as the spatio-temporal feature area.

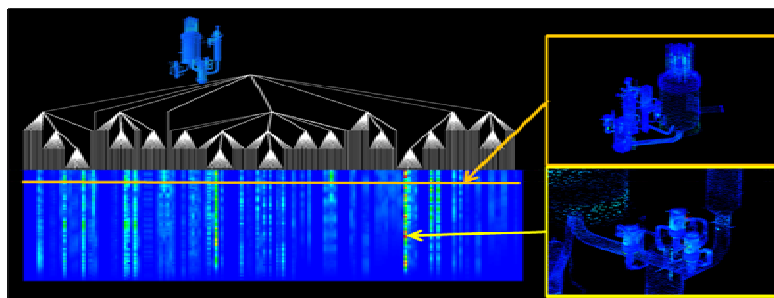


Fig1. Application of the spatio-temporal map to the virtual plant vibration simulator.

Spatio-Temporal Map for Large Scale Time-series Data



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Nuclear Facilities

Safety evaluation of nuclear facilities
ex.) large earthquakes

The necessity of detailed analysis
under the real-world environments is growing more and more.

Such experiments are impossible for most cases.

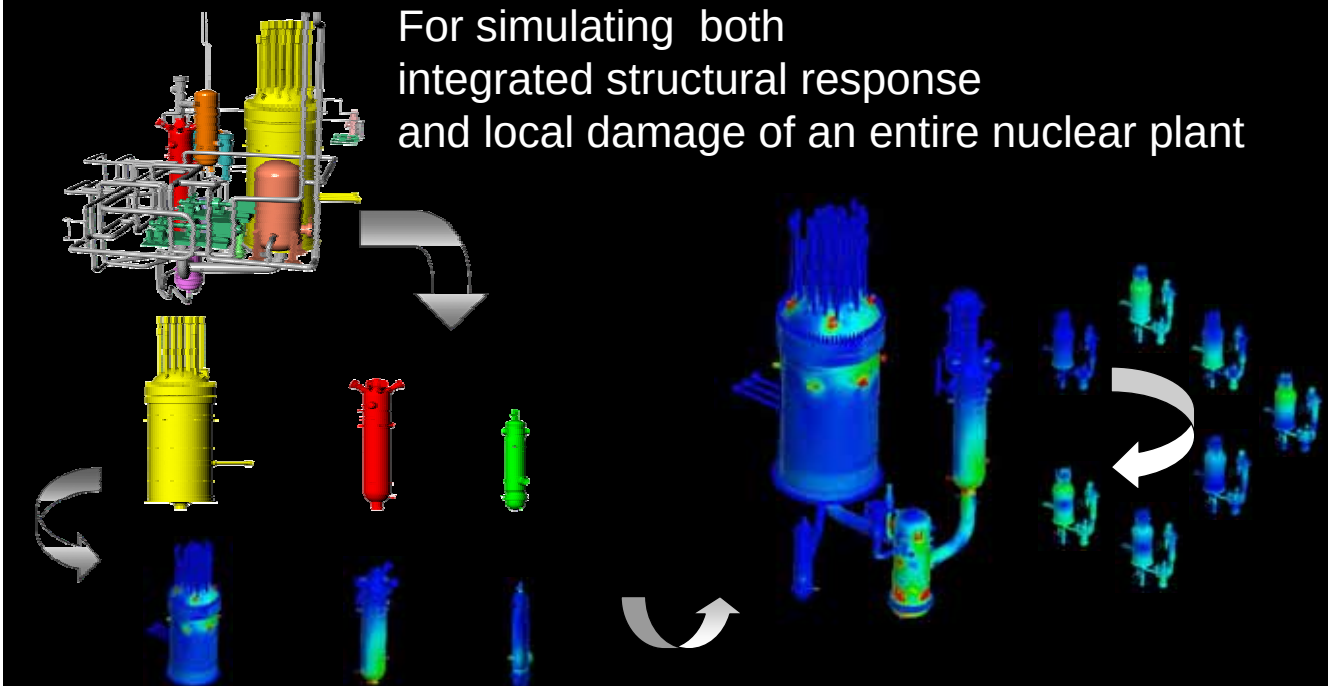
Development of simulation technologies.

Virtual Plant Vibration Simulator

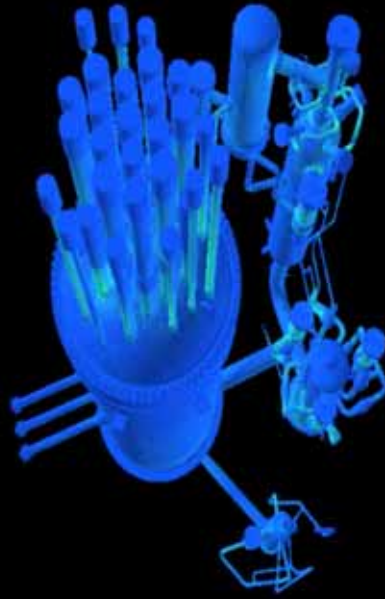


Virtual Plant Vibration Simulator

Coupling model:
For simulating both
integrated structural response
and local damage of an entire nuclear plant

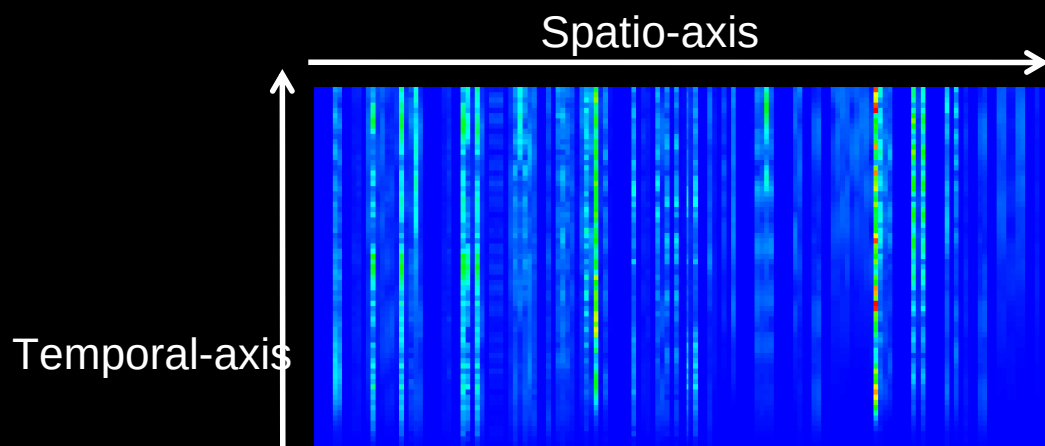


Motivation



Our goal:
To facilitate the examination of large-scale complex datasets.

Spatio-temporal Map



Spatio-temporal map:
The target is 3D models having temporal-varying physical data.
The purpose is assist the users in visualizing and analyzing.

Processing Procedure

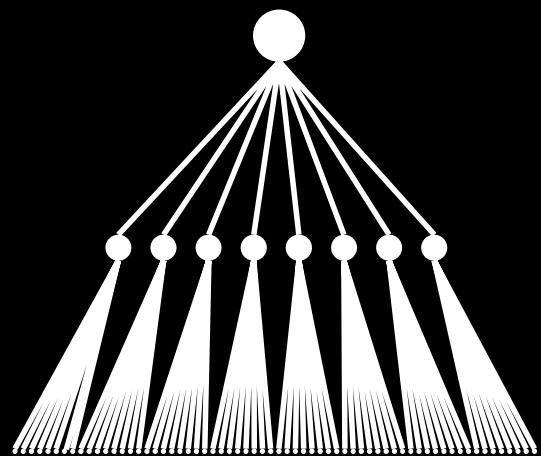
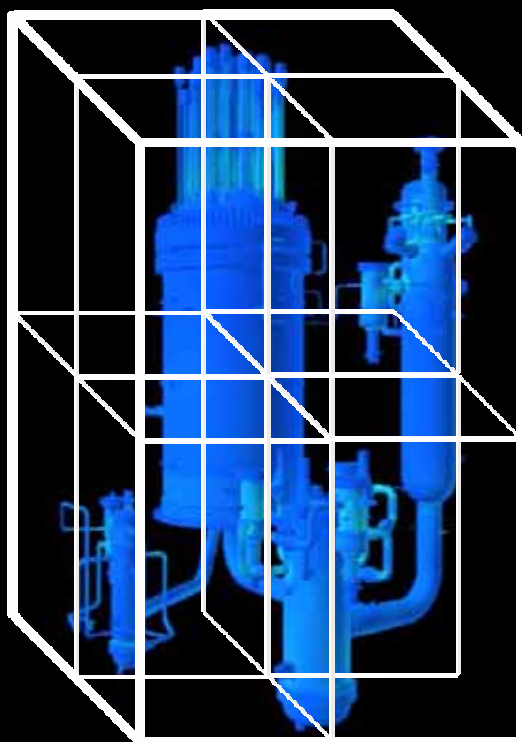
Step1.

Creating a **hierarchical structure**
by using voxel subdivision

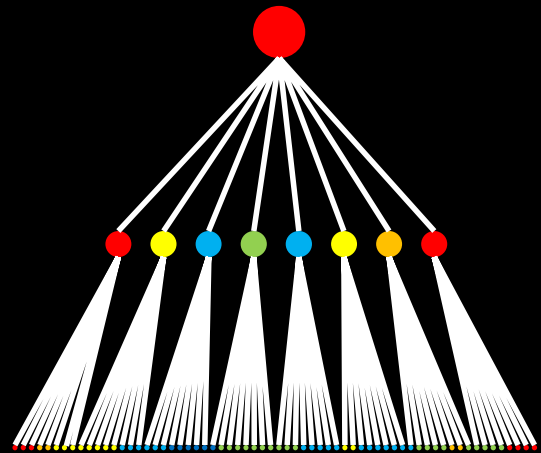
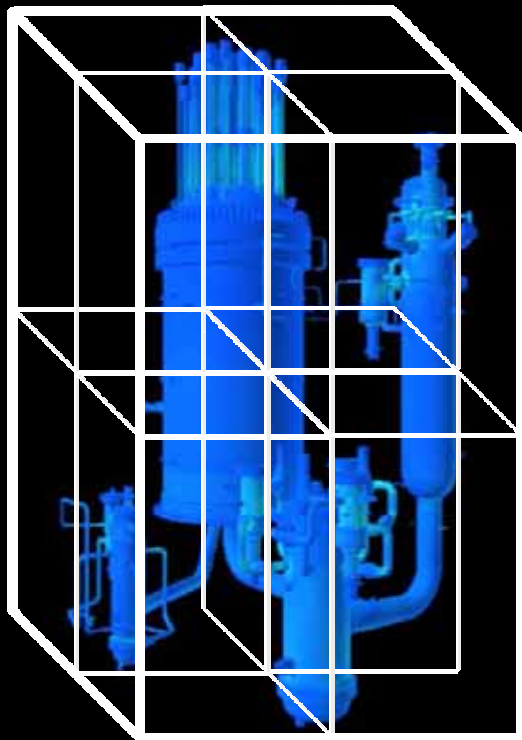
Step2.

Creating a **two dimensional color table**
horizontal axis: spacio-information
vertical axis: time step
color: physical value

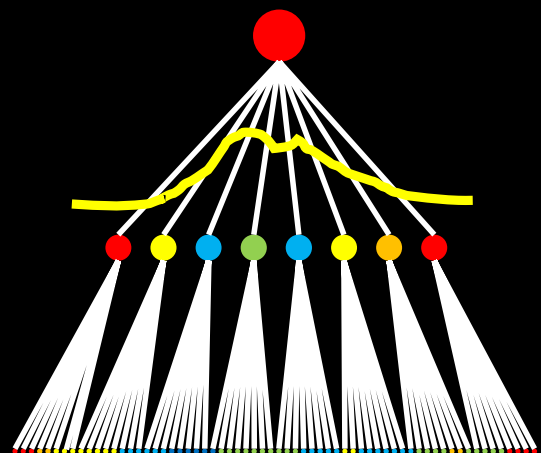
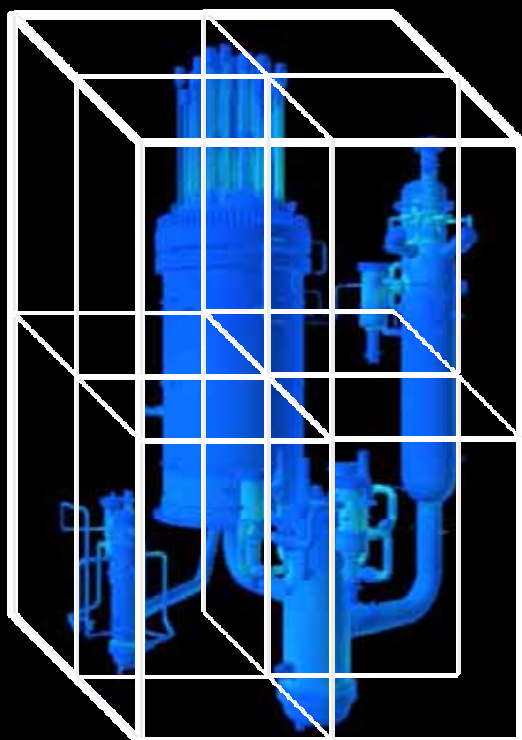
Hierarchical Structure



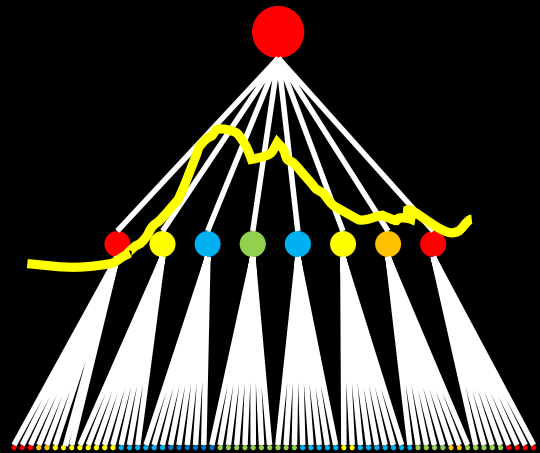
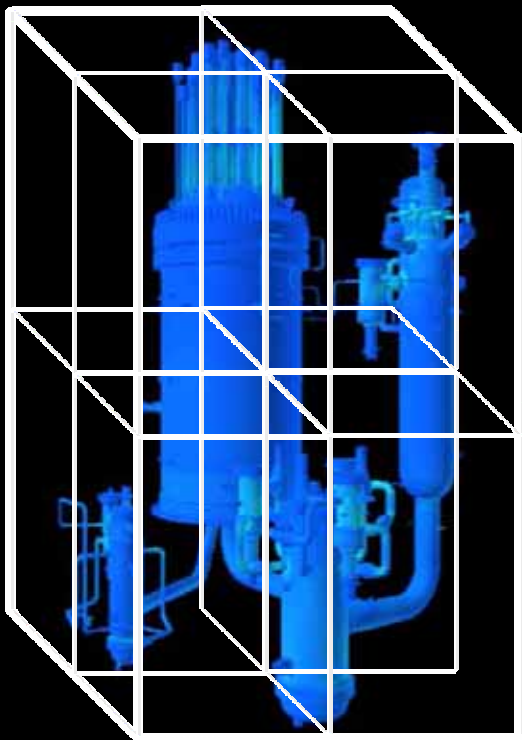
Hierarchical Structure



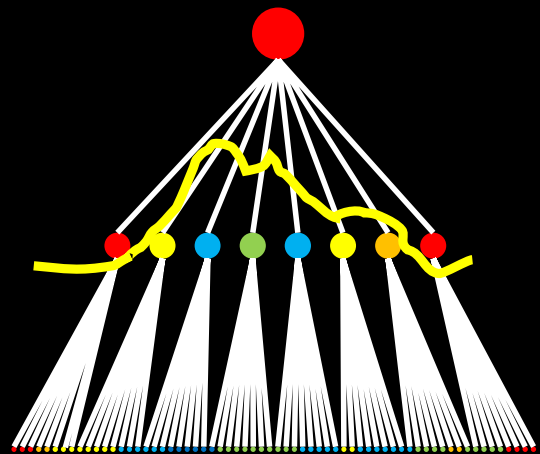
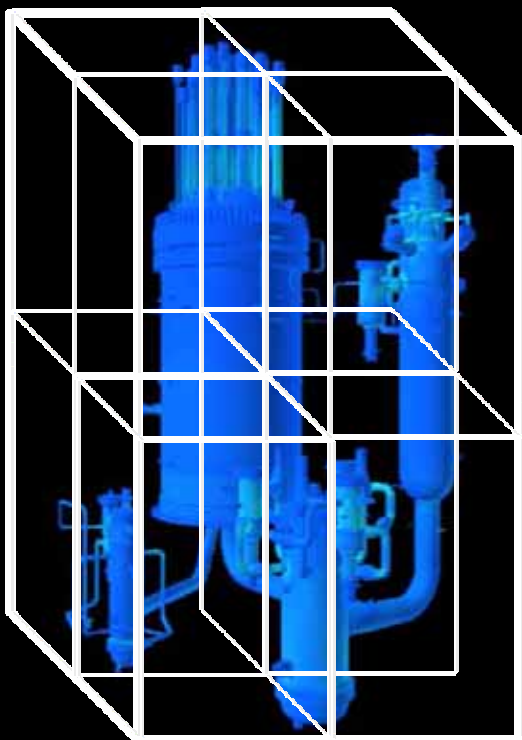
Adaptive Hierarchical Structure



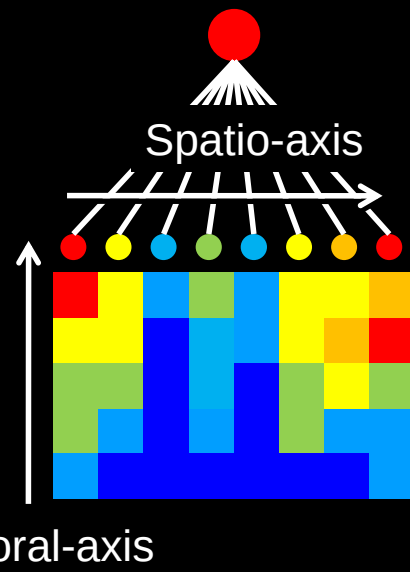
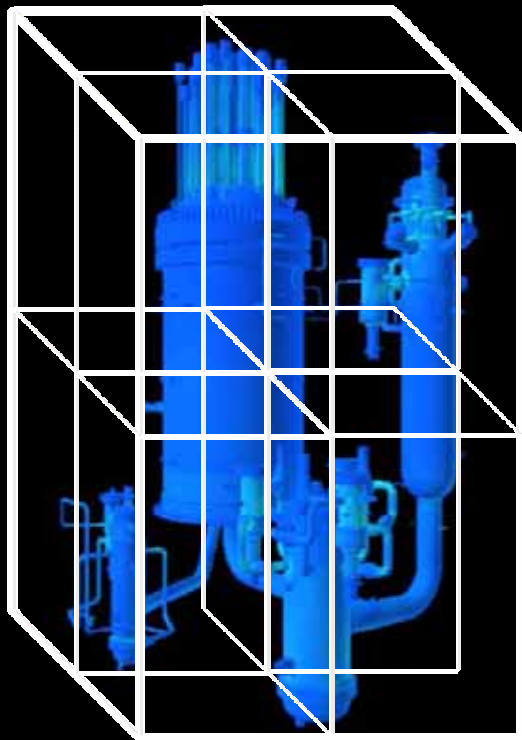
Adaptive Hierarchical Structure



Adaptive Hierarchical Structure



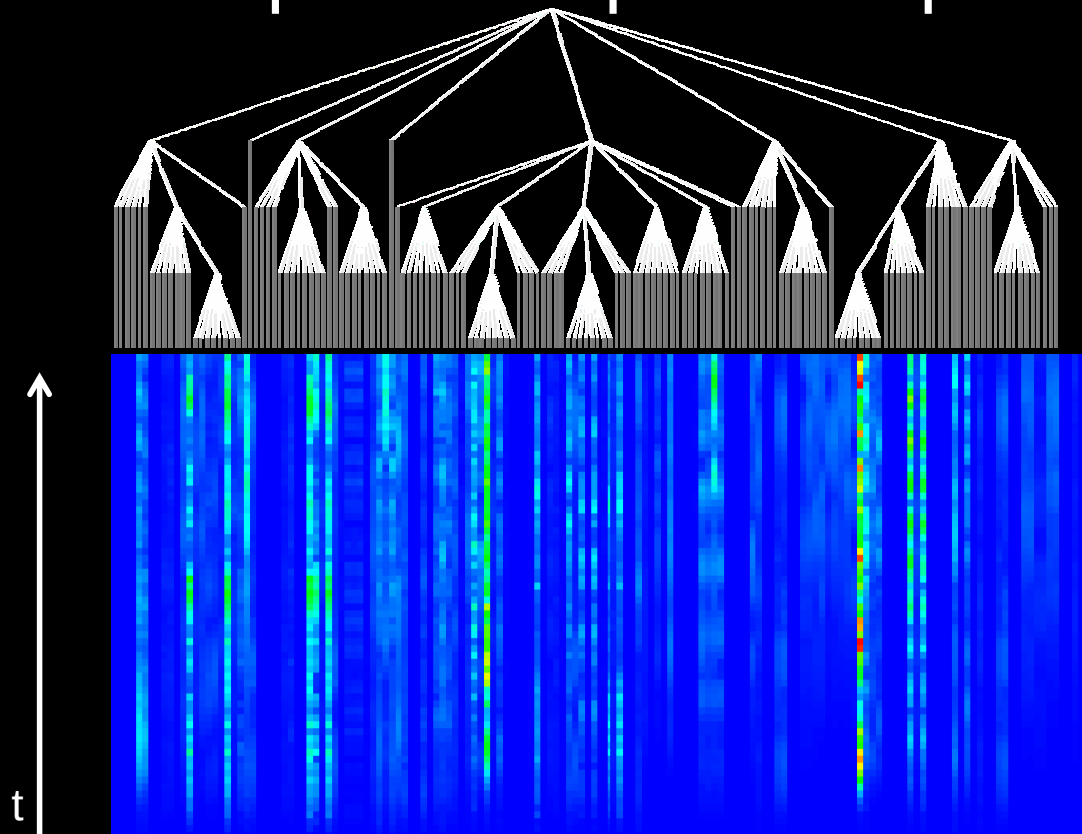
Two Dimensional Color Table



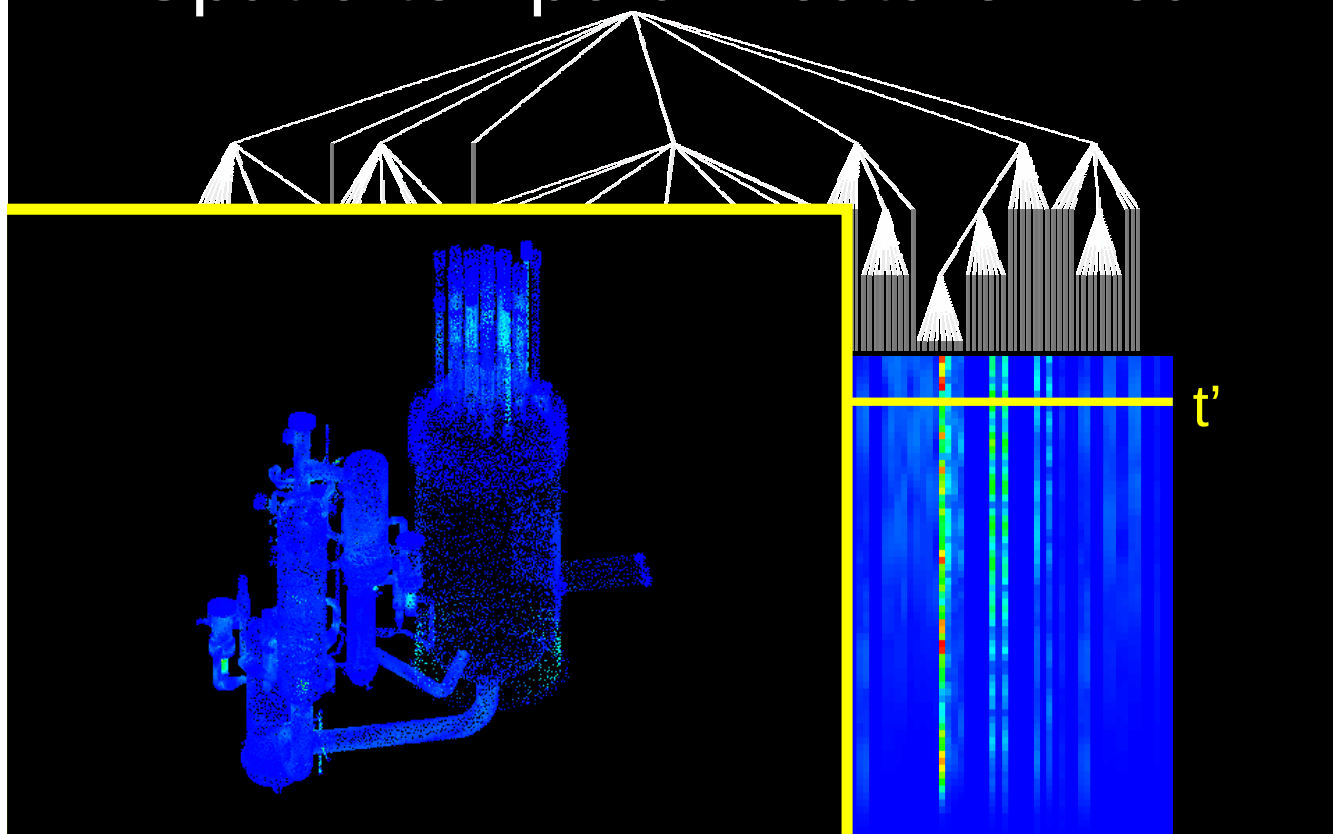
Experiment



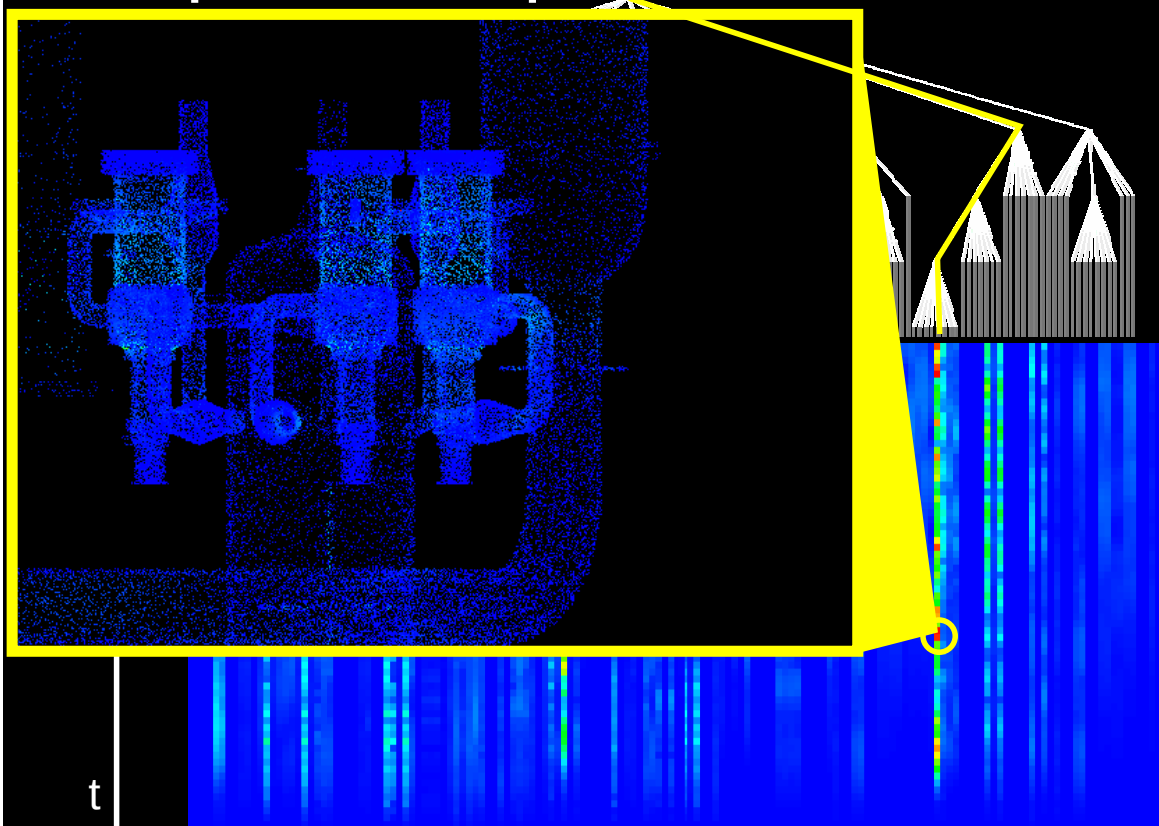
Spatio-temporal Map



Spatio-temporal Feature Area



Spatio-temporal Feature Area



Conclusion

Spatio-Temporal Map