ParaView-ANARI : How to Visualize Scientific Datasets with First Class Rendering Engines

Lucas Givord, Mathurin Lemarié, François Mazen

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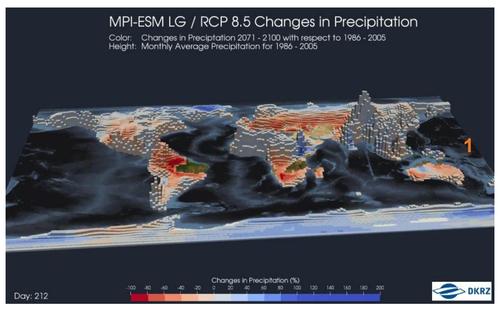
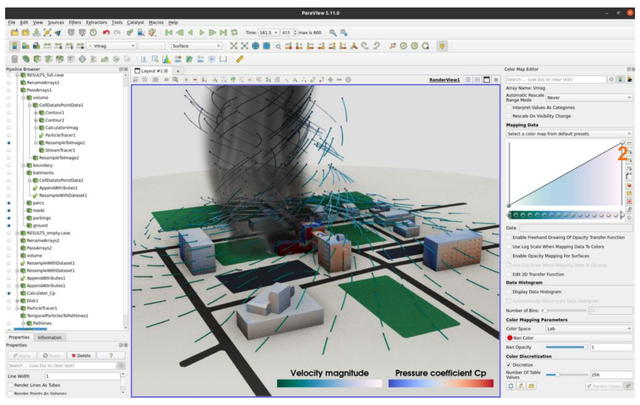
ParaView

- De facto **open-source** application for **scientific visualization** used in several domains such as Computational Physics, Geoscience, Mechanical Engineering…
- More than 200 post processing filters
- Deployed on most **HPC** environment due to is **client server architecture** enabling support for **massive dataset**

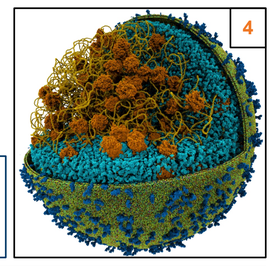


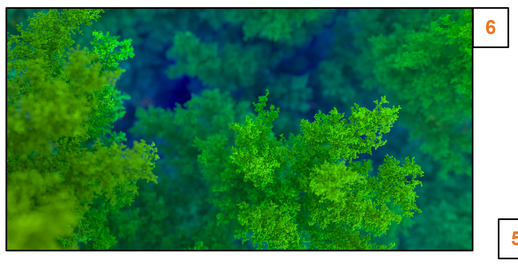


ParaView

ANARI [3]

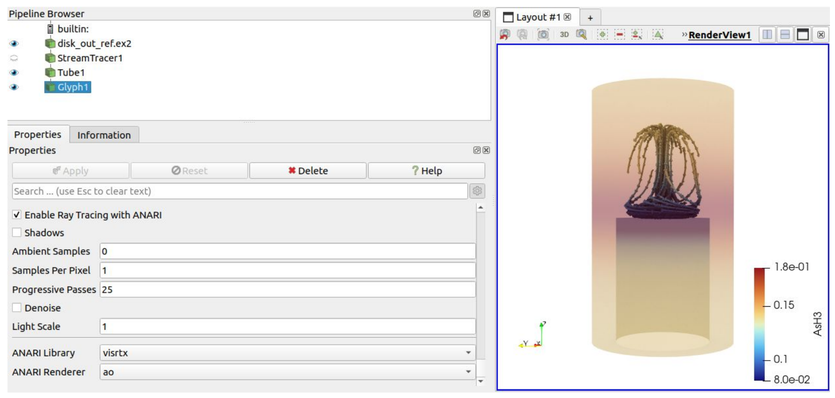
- The industry's first **open standard** 3D Rendering API maintained by the Khronos Consortium
- Allows users to support major rendering engines:
  - **OSPRay (Intel)**
  - **VisRTX (NVidia)**
  - **Cycles (Blender)**
- Support **distributed** rendering : **BANARI** [6]
- Custom backend can be implemented by overriding a few ANARI classes





ANARI in ParaView

- **Simplify** scientist workflow by providing a **single interface** for **data analysis** and **visualization**
- Allow scientists to switch easily between available rendering engines

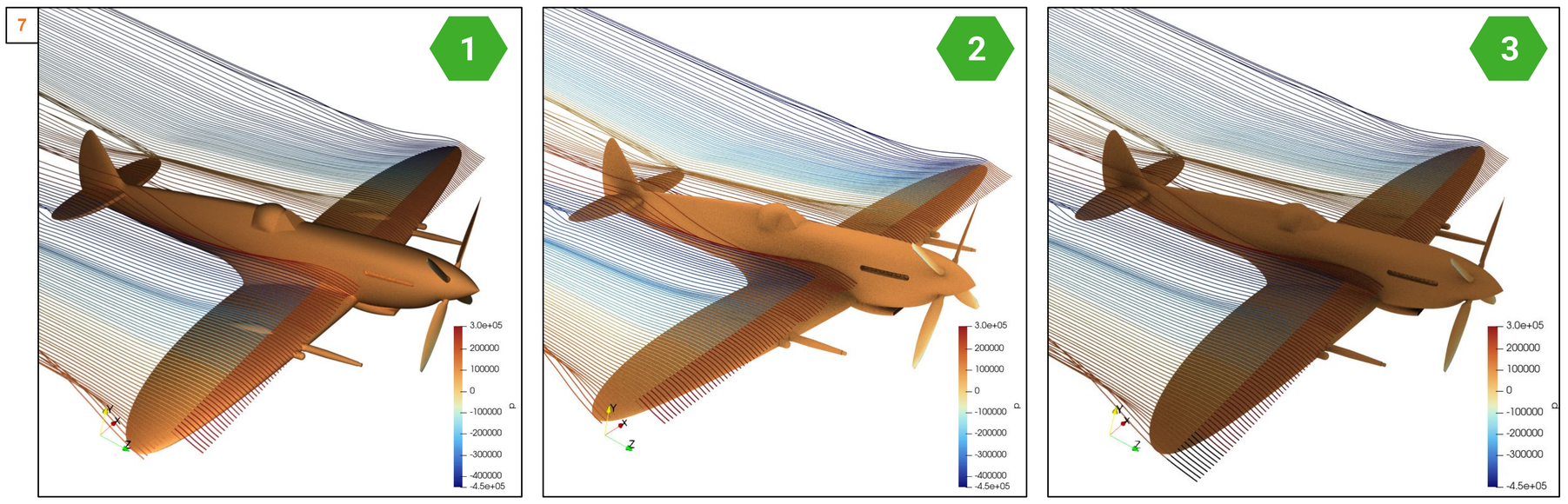


- Expose essential rendering parameters, via a single API:
  - **Denoiser**
  - **Renderer** (such as PathTracer, Raycaster…)
- Render on **CPU**, **GPU**, **multi-GPU**

Use Case 1: Select the best rendering engine depending on your hardware

ANARI-compatible backends can be used without changing the code in ParaView.
User can switch between them at runtime by setting **ANARI_LIBRARY** environment variable to:

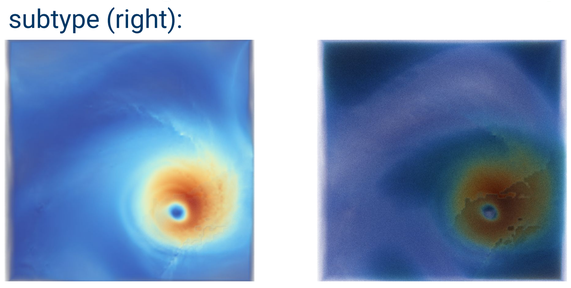
1. `"ospray"` : For CPU rendering (intel)
2. `"visrtx"` : For GPU(CUDA) rendering (NVIDIA)
3. `"barney"` : For MPI environments



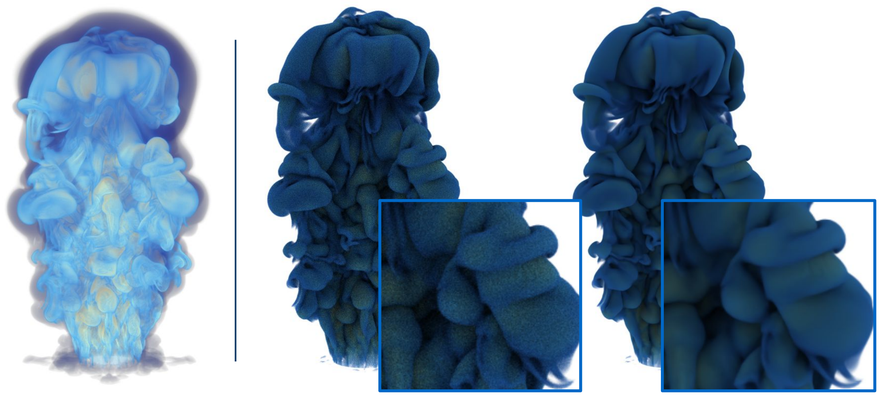
Use Case 2: better volumetric rendering depending on your dataset with VisRTX

*With ANARI, backend specific properties can be exposed to the user. For instance, VisRTX has 2 renderer **subtypes**. Depending on the dataset, one would be preferred than the other.*

The **default** subtype (left) yields to a better understanding of the dataset[8] than the **dpt** subtype (right):



However, the **dpt** (diffuse path tracer) subtype gives a better depth understanding of flow dataset[9] (right) than the **default** subtype (left):



***denoiser** disabled* ***denoiser** enabled*

Conclusion

+ **This work demonstrates qualitative results on the usage of several rendering backends of ANARI in ParaView**
+ **It confirms the promise of effortless integration of several rendering engines**
− **Using ANARI API means relying on the developer community for the backends maintenance**

Future Works

- **Fine grain control** over rendering parameters (like **sampleLimit**,...)
- **Bundle** every feature complete implementation in the **ParaView Release** for users

Acknowledgments

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4 Molecular rendering with ANARI in Visit : https://www.khronos.org/anari/

5 San Miguel scene rendered with ANARI and VisRTX : https://www.khronos.org/anari/

6 250M particle DLA simulation rendered with Barney, I. Wald et al., "Standardized Data-Parallel Rendering Using ANARI," 2024 IEEE 14th Symposium on Large Data Analysis and Visualization (LDAV), St Pete Beach, FL, USA, 2024, pp. 23-32, doi: 10.1109/LDAV64567.2024.00013.

7 Spitfire dataset provided by IT4Innovations

8 Simulation of the 2003 Isabel Hurricane. The authors will like to thank Bill Kuo, Wei Wang, Cindy Bruyere, Tim Scheitlin, and Don Middleton of the U.S. National Center for Atmospheric Research (NCAR), and the U.S. National Science Foundation (NSF) for providing the Weather Research and Forecasting (WRF) Model simulation data of Hurricane Isabel.

9 Finite-Time Lyapunov Exponent of the Jet Dataset - Christoph Garth (Technische Universität Kaiserslautern)