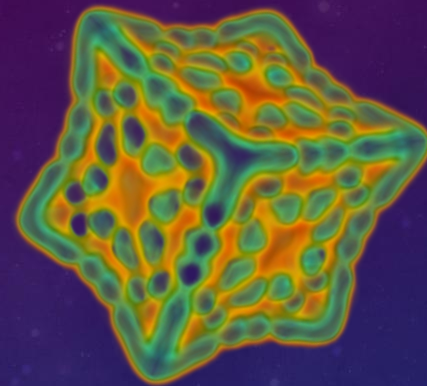
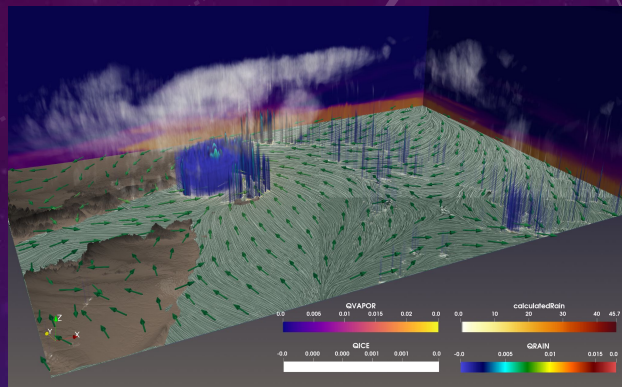
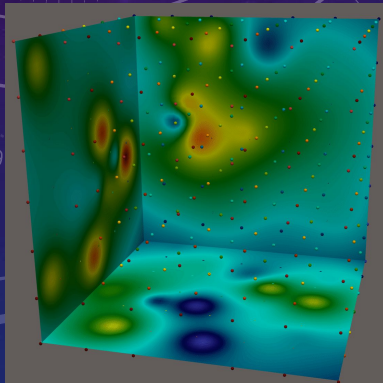
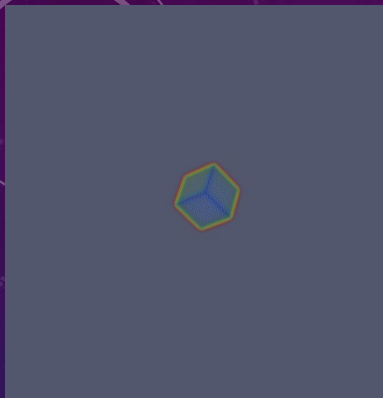




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King Abdullah University of  
Science and Technology



# Scientific Visualization 101

## *ParaView for HPC*

KAUST Visualization Core Lab

Dr. James Kress

April 15, 2026



KAUST  
VISUALIZATION  
CORE LAB

Dr. James Kress

Scientific Visualization 101: ParaView for HPC



# Disclaimer

- Only KAUST students, faculty, staff, and those with existing projects on Ibex will be able to try the Ibex examples
- Everyone will be able to try the scripting workflows locally, which you can then translate for use on your own cluster/system

# Workshop Setup

- Never logged in to Ibex before?
  - Do so now so that your scratch/user directory will have time to get setup
    - `ssh -X <username>@login.ibex.kaust.edu.sa`
  - Go to your scratch/user directory and download this example data:
    - <https://download.vis.kaust.edu.sa/pub/workshops/2026/scivis101-paraviewForHPC/noise.silo.zip>
- Clone example repo on local machine
  - `git clone https://github.com/jameskress/Visualization_Vignettes.git`
    - ex00 - This script shows how to load a data set and then query information about the mesh, variables, and more
    - ex01 - This script shows how to create a screenshot and save it to disk
    - ex02 - This script shows how to take a series of screenshots while moving the camera and creating a movie
    - ex03 - This script shows how to animate the visualization of multiple iso surface values, showing different segments of a static data set
    - ex04 - This script shows how to animate the progress of streamlines in a flow field
    - ex05 - This script shows how to load and step through a multi time step file and take a screenshot per step
    - ex06 - This script shows the value of distributed computation, using a large data set to create a series of interesting visualizations of a cyclone simulation

# Workshop Setup

## *Mac Machines*

- Install ParaView --- 6.0.1
  - <https://www.paraview.org/download/>
  - Install XQuartz (X11)
    - <https://www.xquartz.org/>
- Extra info
  - If you want to view ibex files locally without 'scp'
    - Download and install fuse and sshfs: <https://osxfuse.github.io/>
      - Install instructions: <https://sbgrid.org/corewiki/faq-sshfs.md>

# Workshop Setup

## *Windows Machines*

- Install ParaView
  - <https://www.paraview.org/download/>
  - Install PuTTY
    - <https://www.putty.org/>
- Extra info
  - I suggest running all the terminal examples in:
    - Ubuntu for Windows
    - or
    - Visual Studio Code
  - If you want to view ibex files locally without 'scp'
    - Download and install SFTP Drive
      - <https://www.nsoftware.com/sftp/drive/>

# Workshop Setup

## *Linux Machines*

- Install ParaView
  - <https://www.paraview.org/download/>

# Workshop Notes

- Examples have been tested on the following:
  - Mac Silicon
    - Everything runs
  - Mac Intel
    - Everything runs
  - Linux Ubuntu 20
    - Everything runs
  - Windows
    - Everything runs
  - Ibex & Shaheen
    - Everything runs



# Introducing the KVL

*Who we are and what services we offer*

# The KVL Team



**Dr. Sohaib Ghani**  
(LEAD STAFF SCIENTIST)

- VISUAL ANALYTICS
- INFORMATION VIS
- STATISTICAL ANALYSIS



**Dr. James Kress**  
HPC SCIVIS

- VISUALIZATION SOFTWARE
- HPC INSITU VISUALIZATION
- DISTRIBUTED VISUALIZATION



**Dr. Ronell Sicut**  
SCIVIS, AR/VR

- SCIENTIFIC VISUALIZATION
- SEGMENTATION & 3D ANALYSIS
- AR/VR DEVELOPMENT



**Dr. Didier Barradas**  
Data Scientist

- DATA SCIENCE
- MACHINE LEARNING
- DEEP LEARNING



**Dr. Abdelghafour Halimi**  
Data Scientist

- DATA SCIENCE
- MACHINE LEARNING
- DEEP LEARNING

## Core Services

Training and  
Workshops

Data Visualization & Data  
Science Workflows

Facilities  
Support

Scientific  
Visualization  
Workshop  
Series

Data  
Science  
Workshop  
Series

AI Tools  
and  
Techniques  
Workshop  
Series

HPC  
Visualization

Image  
Segmentation &  
3D Analysis

AR/VR

Large Scale  
AI & Data  
Science

AR/VR Hub

Tiled  
Display  
Walls



Visualization Laboratory Wiki

Docs • start

### Welcome to the KAUST Visualization Core Lab (KVL)

**Who We Are**

The KAUST Visualization Core Laboratory is a state-of-the-art facility within the Core Labs that offers students, faculty, researchers, and university collaborators a unique opportunity to utilize one-of-a-kind visualization, interaction, and computational resources for the exploration and analysis of scientific data.

**Contact Us**

- help@vis.kaust.edu.sa
- KVL YouTube Channel
- KVL Twitter
- Core Labs Website
- KVL Core Labs Main Website

**Core Services**

Our mission is to support the data visualization and data science needs of KAUST researchers and In-Kingdom entities. To that end we have a varied range of expertise across the team. Contact us with your questions, project requests, or collaboration requests that fall within our service areas:

- 2D/3D Visualization Facilities**
  - We provide a unique set of visualization and meeting facilities on campus.
  - Contact us for inquiries or use your KAUST credentials to create a booking.
- Data Visualization and Data Science Workflows**
  - We support KAUST users with visualization workflows, VR workflows, and data science/machine learning.
  - Contact us for additional information, to submit a general request, or request a collaboration.
- Training and Workshops**
  - We have a wide variety of trainings available on our YouTube Channel as well as select trainings performed in-person each semester.

**Mission**

To support the needs of KAUST researchers and In-Kingdom entities by:

- Developing and maintaining an effective and efficient environment for data exploration and analysis
- Providing advanced visualization and data analysis services
- Providing training on state-of-the-art visualization hardware and software for scientific discovery
- Developing new capabilities to remain at the cutting edge of visualization and data science

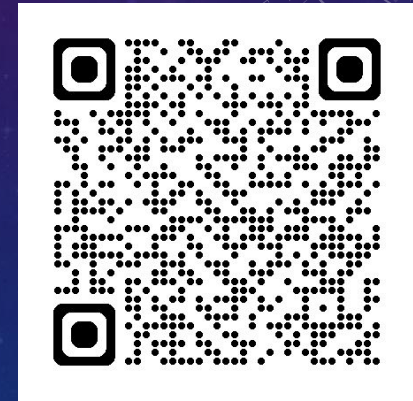
**Location**

Our main showcase facility is located @:  
Building 1 (seaside), Level 2, Showcase

**Community Map**

KAUST Visualization Core Lab

Zoom to | Email Map | Direction

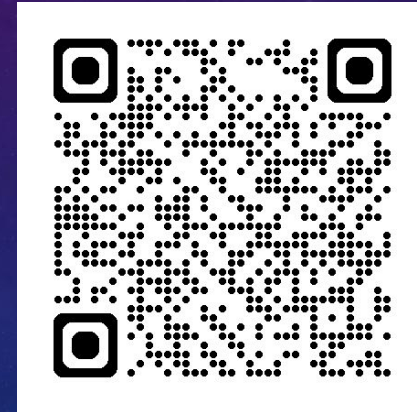


<https://wiki.vis.kaust.edu.sa>

# KVL Training Events

--- Available In-Person and Online ---

- Scientific Visualization Workshop Series
  - ParaView, VisIt, Avizo/Amira
- Data Science Workshop Series
  - Shell, Conda, Python, Git, and more
- Hands-on AI Tools and Techniques Workshop Series
  - Intro to Machine Learning/Deep Learning, Visualization for Data Science



<https://www.youtube.com/@kaustvislab>

# Data Visualization and Science Workflows

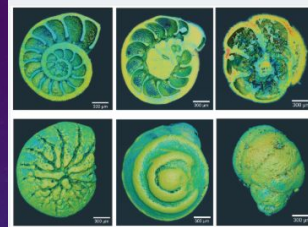


## KVL Collaborates in areas such as:

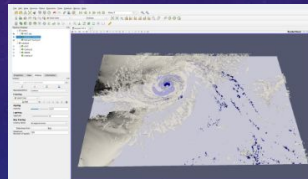
- HPC Visualization
- Scientific and Information Visualization
- AR/VR
- Image Segmentation and 3D Analysis
- Large-scale AI and Data Science

Send us an email if you have a collaborative project that can benefit from our expertise:

[help@vis.kaust.edu.sa](mailto:help@vis.kaust.edu.sa)



**Micro-CT and Holographic Visualization of Late Cretaceous Benthic Foraminifera in Saudi Arabia**



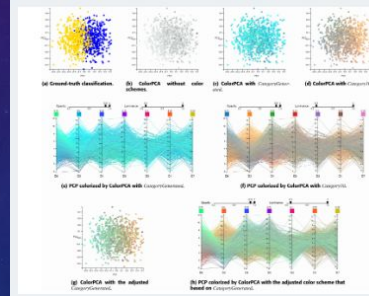
**KVL and Kitware Blog Collaboration**



**KVL Releases Open Source Software to Visualize Supercomputing Simulations**



**Mobile AR Visualization of Giant Red Sea Coral**



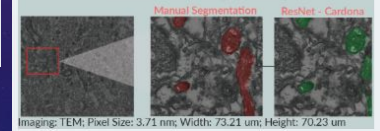
**ColorPCA: Scalable Colored Dimensionality Reduction for Unlabeled High-Dimensional Data**



**KVL Co-Organized Visualization Workshop**

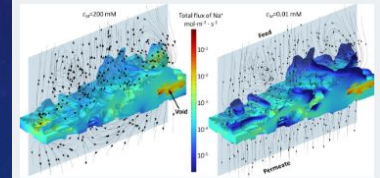


Imaging: TFM; Pixel Size: 3.71 nm; Width: 73.21  $\mu$ m; Height: 70.23  $\mu$ m  
Microwave Irradiation (s/kW, 600ms)

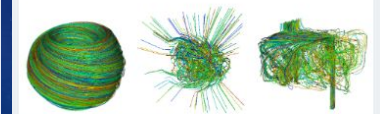


Imaging: TEM; Pixel Size: 3.71 nm; Width: 73.21  $\mu$ m; Height: 70.23  $\mu$ m

**Segmentation and 3D Reconstruction of Glycogen and Mitochondria in Microwave-fixed Brain EM**



**3D Modeling of Composite Membranes from TEM**



**Analyzing Particle Advection Performance**



# Hands–On Session 1

*Ibex Interactive Visualization with ParaView*

# Why use ParaView on Ibex?

- Access to data generated w/out copying
- Can use distributed computation and rendering for very large data
- Ability to run scripted batch visualization
- Ability to run client-server mode
  - GUI runs locally, all computation is done remotely
  - Allows for fast GUI interactions and distributed computation
- Same principle applies to Shaheen or your own cluster, but we'll focus on one system today for brevity.

# Initially Accessing ParaView on Ibex

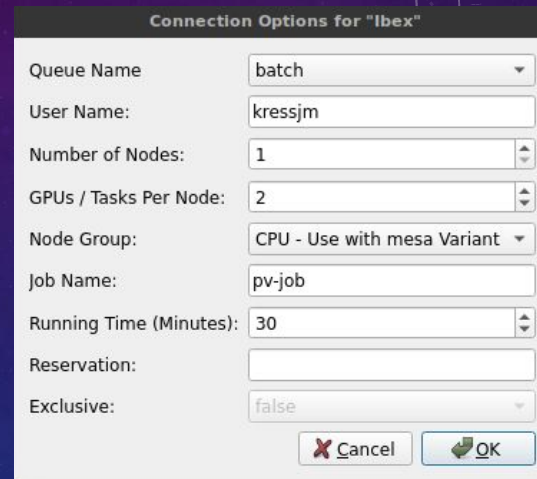
1. Check available ParaView versions on Ibex (use glogin)

```
----- /sw/rl9g/modulefiles/applications -----  
paraview/6.0.1-gnu-egl  paraview/6.0.1-gnu-mesa
```

2. Download/use the latest ParaView version that matches Ibex
3. If first time using ParaView on Ibex, load the KAUST profile
  1. Save the following servers.pvsc file to your local computer: [ibex\\_server](#)
  2. Start ParaView: select <File/Connect> to begin
  3. Import Servers: Click <Load Servers> button and find the servers.pvsc file

# Using ParaView Interactively on Ibex

- Open ParaView on your local computer
- Go to: <File/Connect> or click the <Connect> button on the GUI
- Click the <Ibex> configuration and click connect
- Set connection options:
  - Enter <User Name>
  - Ensure <Node Group> is set to “CPU”
  - Click “OK”
- This will prompt you for your Ibex password, unless you have passwordless ssh setup
- Once specified, the server side of ParaView will be launched, and you can interact with your data (after the job launches and reaches to top of the Ibex queue)



Connection Options for "Ibex"

Queue Name	batch
User Name:	kressjm
Number of Nodes:	1
GPUs / Tasks Per Node:	2
Node Group:	CPU - Use with mesa Variant
Job Name:	pv-job
Running Time (Minutes):	30
Reservation:	
Exclusive:	false

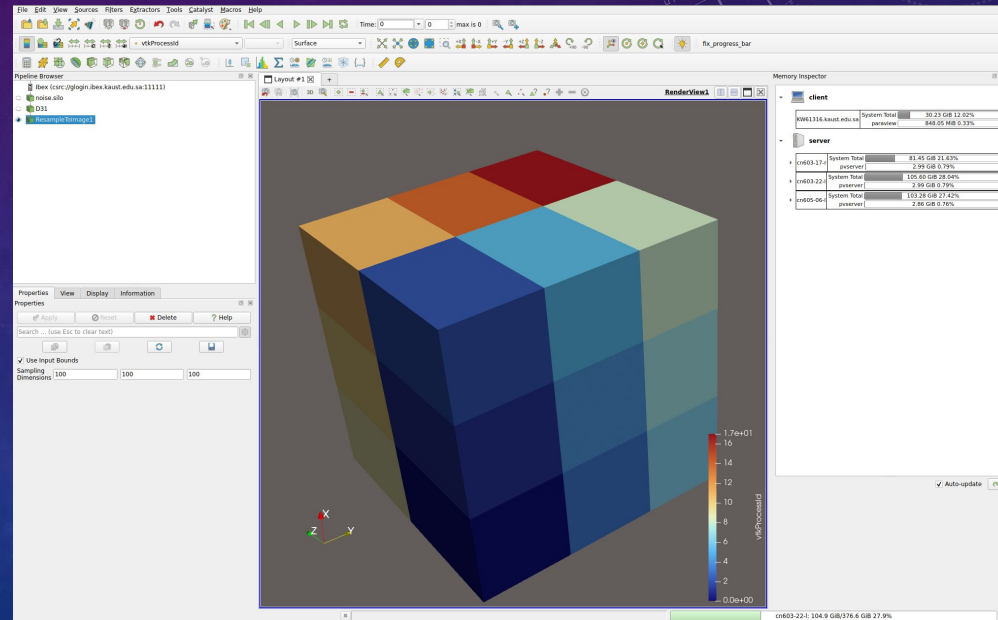
Cancel OK

# ParaView for HPC: Interactive on Ibex

It's just that easy

- You can directly connect and visualize your data
- You can spread the data across as many nodes as you need
  - May need to use 'Redistribute Data' filter on non parallel files
- Can use GPU or CPU based on your rendering needs
  - Stick with CPU until you really need GPU for faster queue times and less waiting

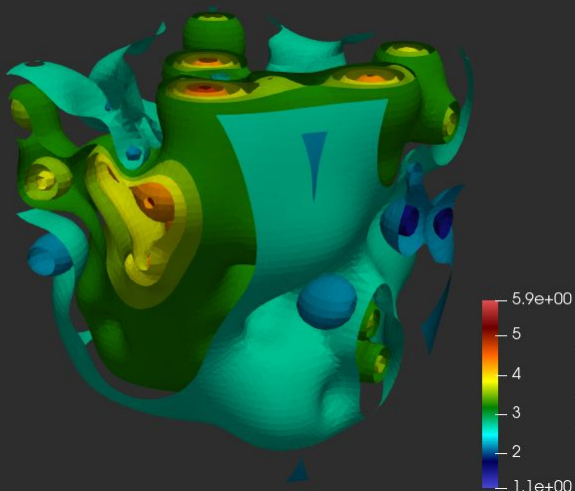
Questions on Interactive ParaView on Ibex?



# Explore Example Repo Data Set

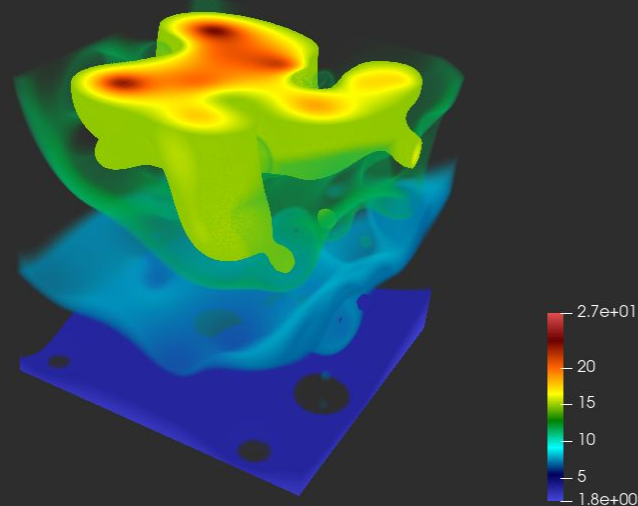
- Load the example data set and try different visualizations
  - `/sw/vis2/ibex-visit/3.4.1/linux-x86_64/data/noise.silo`  
Or  
wget <https://download.vis.kaust.edu.sa/pub/data/visualizationVignettes/noise.silo>

Mode: still  
Level-of-detail: no  
Remote/parallel rendering: no  
Frame rate (approx): 181.91 fps



Dr. James Kress

Mode: still  
Level-of-detail: no  
Remote/parallel rendering: no  
Frame rate (approx): 23.1118 fps



Scientific Visualization 101: ParaView for HPC

Array Name: temp

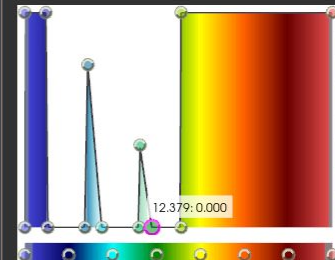
Automatic  
Rescale Range: Grow and update on 'Apply'

Mode

- Interpret Values As Categories
- Rescale On Visibility Change

Mapping Data

Select a color map from default presets



Data: 12.3794

- Enable Freehand Drawing Of Opacity Transfer Function
- Use Log Scale When Mapping Data To Colors
- Enable Opacity Mapping For Surfaces



# Hands–On Session 2

*Scripting Visualization from Command Line*

# Running Scripts from CMD Line

- Navigate to ParaView\_Vignettes repo folder on your local computer
  - Run each of the examples (excluding ex06, data is too large for local use)
    - cd to individual example directory
    - Use pvpython or pvbatch and run the examples
      - pvbatch and pvpython are the same when running a script, except that pvbatch will run in parallel
      - pvbatch ex00\_pvConeStat.py
      - pvpython ex00\_pvConeStat.py --verbosity=OFF (hides warnings we don't need)

```
kressjm@KW61316 ~/Downloads/remove/Visualization_Vignettes/ParaView_Vignettes/ex00_pvQuery $ ~/packages/ParaView-6.0.1-MPI-Linux-Python3.12-x86_64/bin/pvbatch ex00_pvConeStat.py
Running ParaView example script: ex00_pvConeStat.py

Cone Resolution: 6
Cone Height: 1.0
Cone Radius: 0.5
Cone Center: [0.0, 0.0, 0.0]
Cone Direction: [1.0, 0.0, 0.0]

Checking for the currently supported OpenGL Driver
server glx vendor string: NVIDIA Corporation
server glx version string: 1.4
kressjm@KW61316 ~/Downloads/remove/Visualization_Vignettes/ParaView_Vignettes/ex01_pvScreenshot $ ~/packages/ParaView-6.0.1-MPI-Linux-Python3.12-x86_64/bin/pvbatch ex01_pvScreenshot.py
Running ParaView example script: ex01_pvScreenshot.py

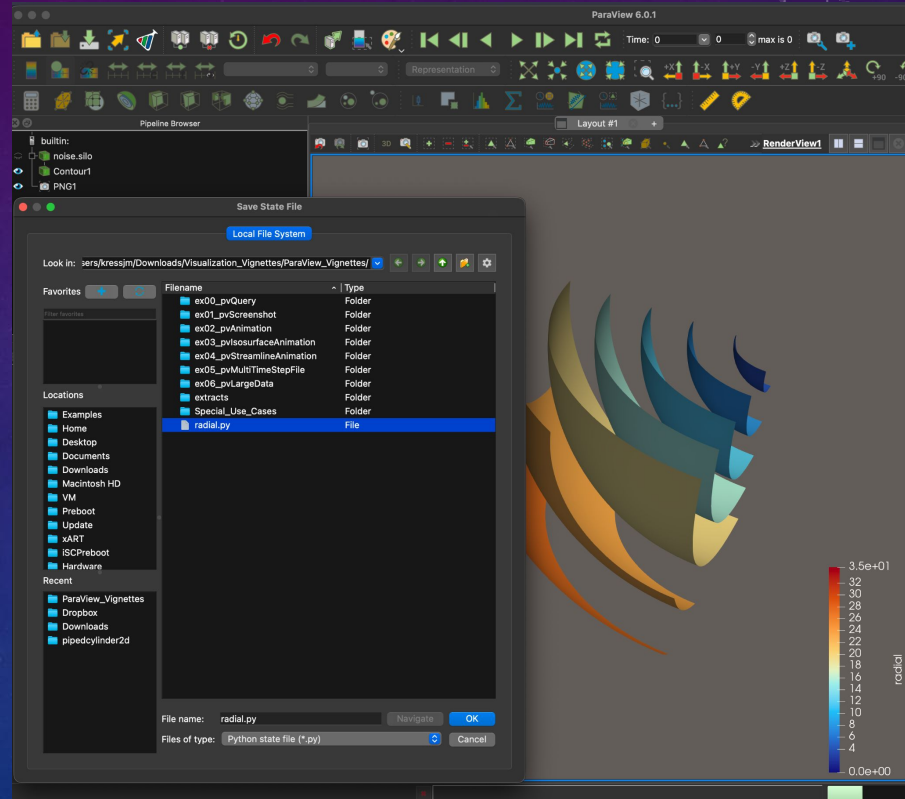
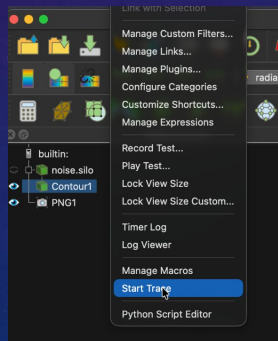
VisRTX 0.1.6, using devices:
0: NVIDIA RTX A5000 (Total: 25.3 GB, Available: 21.5 GB)
1: NVIDIA RTX A5000 (Total: 25.3 GB, Available: 25.0 GB)
2: NVIDIA GeForce RTX 3070 (Total: 8.2 GB, Available: 8.0 GB)

Finished ParaView example script

kressjm@KW61316 ~/Downloads/remove/Visualization_Vignettes/ParaView_Vignettes/ex01_pvScreenshot $ ls
ex01_ibex_runScript.sbat ex01_pvScreenshot.py ex01_shaheen_runScript.sbat output Testing
```

# How to Create ParaView Scripts

- Create a ParaView pipeline in the GUI
  - Add an extractor, such as png
  - Save you state as a Python (\*.py) file
  - Edit Python file to enable the extractor
- Trace your actions and make your own python state file
- Run your state file like we did before and see results






# Wrap Up

*Final Thoughts and Q/A*

# Visualization Best Practices



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🏠 > Software ecosystem > Visualization > Visualizatio...

## Visualization Best Practices

- 1. If your data is small/manageable**
  - Do your visualizations on your laptop or desktop
- 2. If your data is medium/large**
  - Do interactive visualization on Ibox
    - Run ParaView or Visit on your local machine and connect directly to Ibox to load/process/visualize
      - [Using ParaView Interactively](#)
      - [Using Visit Interactively](#)
- 3. If your data is large/huge and you have a defined workflow**
  - Do batch visualization on Shaheen
    - [Batch Processing with ParaView](#)
    - [Batch Processing with Visit](#)
- 4. If you have repeatable repetitive tasks**
  - Do scripted or batch visualization

### Reach out

Contact the KAUST Visualization Core Lab for visualization advice, help, collaboration, and consulting:

- [KVL Wiki](#)
- KVL email: [help@vis.kaust.edu.sa](mailto:help@vis.kaust.edu.sa)

Previous [Visualization](#) Next [ParaView @ KAUST](#)



# Thanks!

*Contacts:*

[james.kress@kaust.edu.sa](mailto:james.kress@kaust.edu.sa)

[help@vis.kaust.edu](mailto:help@vis.kaust.edu)

# Remote Connection Issues: ParaView

- MacOS
  - ParaView unable to connect due to port already being in use:
    - Check what is using the port and kill it
      - `lsof -i:11111`
      - `kill -9 PID`
  - No terminal window appears when trying to connect
    - Ensure you have xQuartz installed, restart system
    - If problem persists, try and specify the terminal and ssh ex.
      - In server.pvsc file add:

```
<Option label="SSH Exec:" name="SSH_EXEC" save="true">  
  <File default="/usr/bin/ssh" />  
</Option>  
<Option label="Terminal:" name="TERMINAL" save="true">  
  <File default="/usr/bin/xterm"/>  
</Option>  
<SSHConfig user="$USER$">  
  <Terminal exec="$TERMINAL$"/>  
  <SSH exec="$SSH_EXEC"/>  
</SSHConfig>
```