RemoteVis:

An Efficient Library for remote visualization of large volumes using Nvidia IndeX

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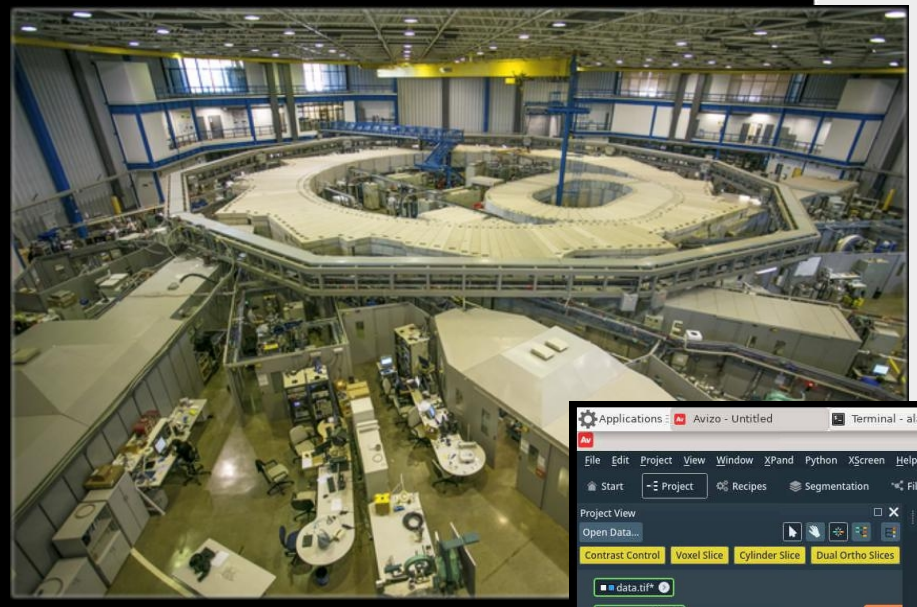
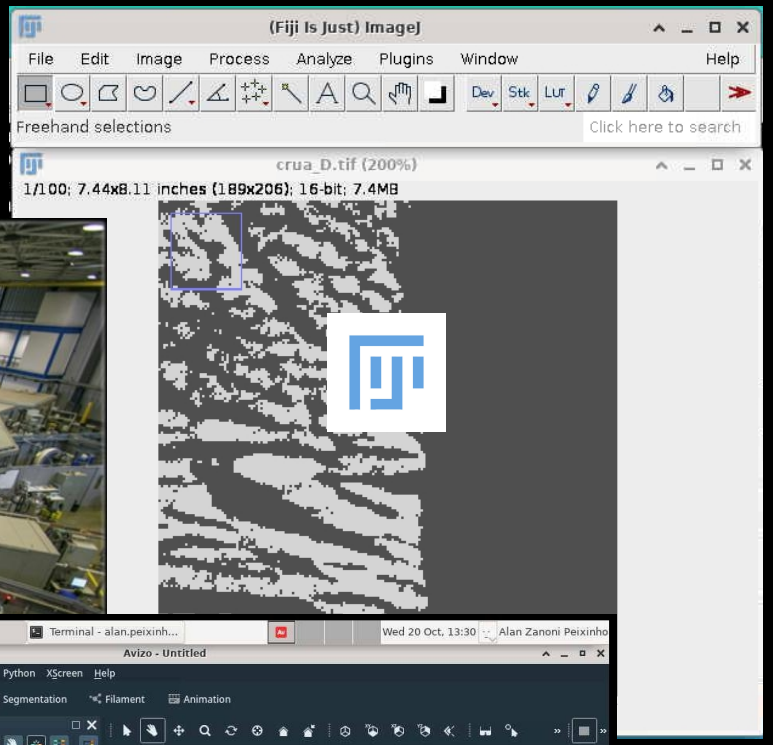
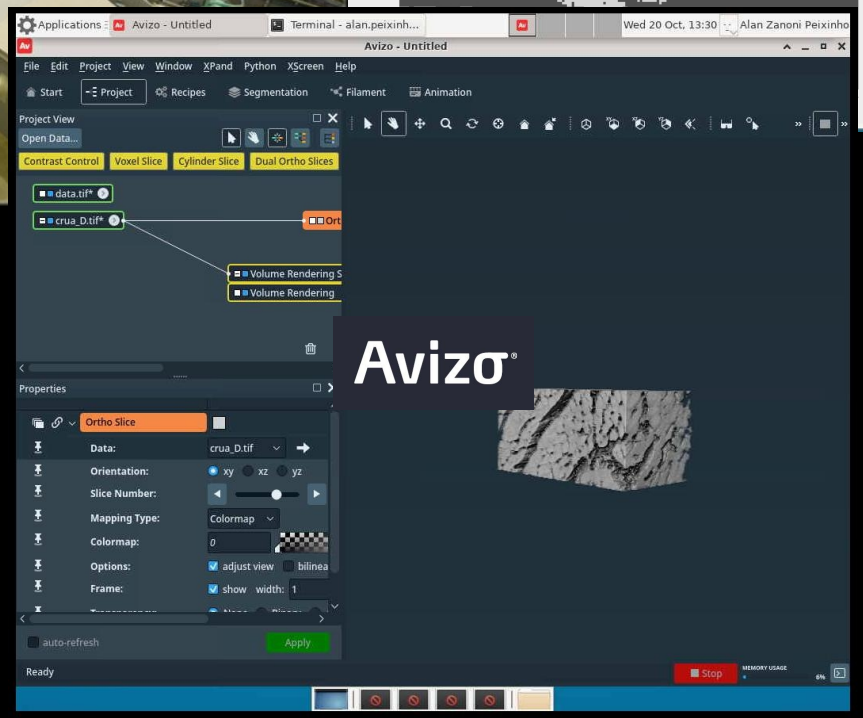
MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATIONS

PÁTRIA AMADA BRASIL BRAZILIAN GOVERNMENT

UVX (<2020)



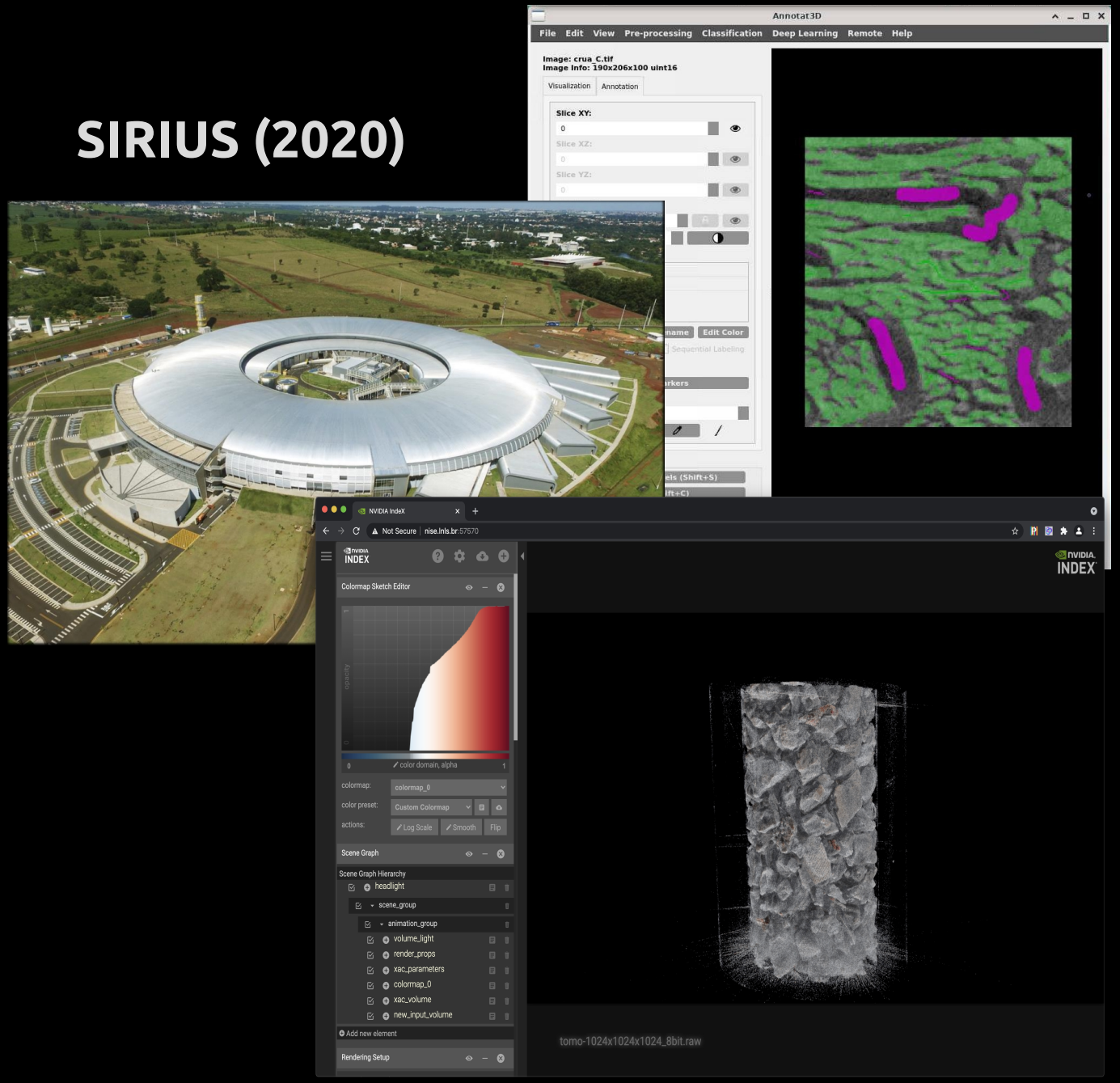




Synchrotron Light Source
2nd Generation
Experiments: up to hours/days
18 beamlines

Image Size: $(2048^3/8bit)\ 8GB$

SIRIUS (2020)

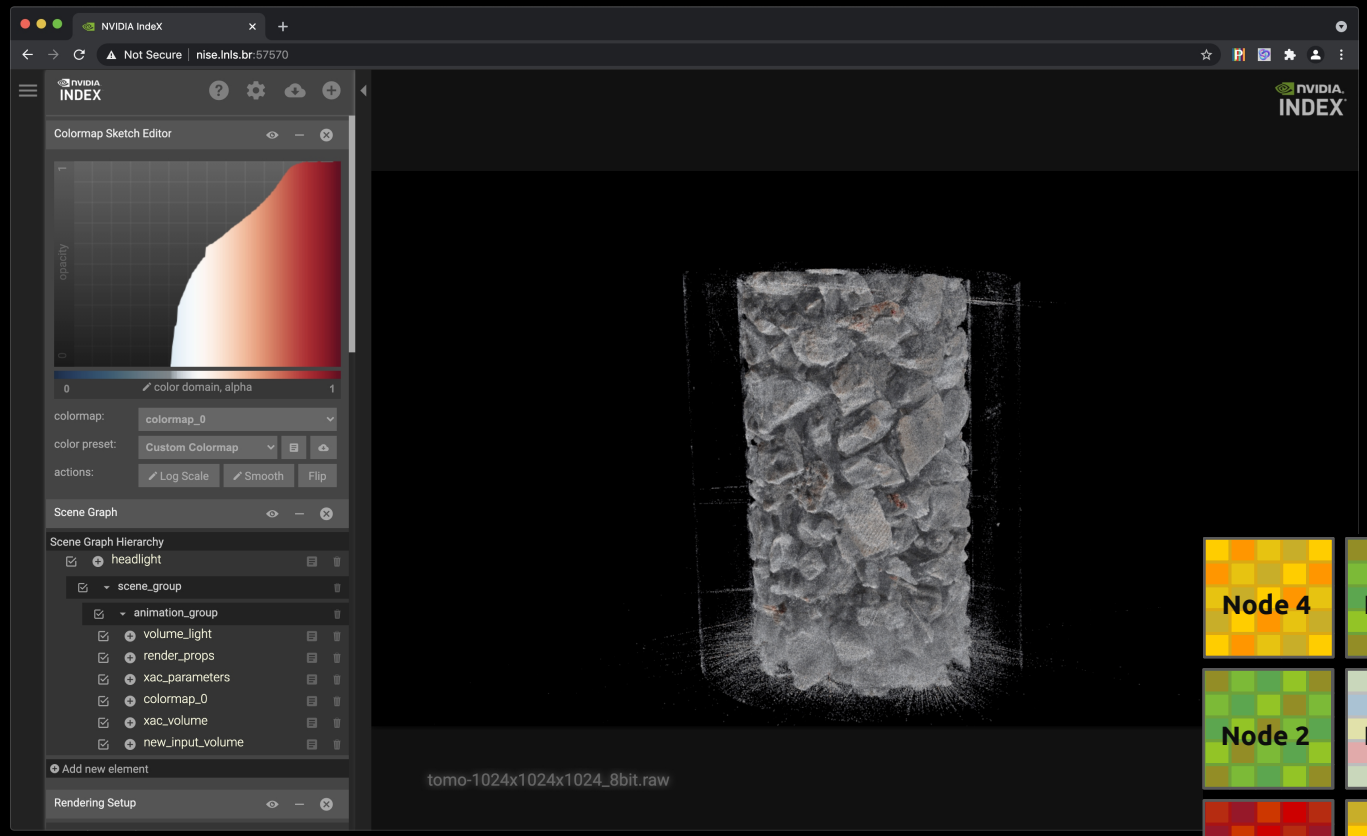


4th Generation Light Source
Experiments: minutes/seconds
- Tomography
- CDI
- Ptychography

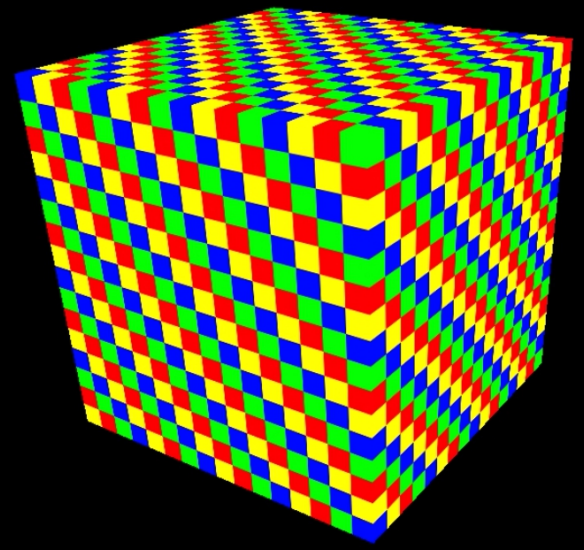
13 beamlines under construction

Expected Image Size: $(2072^3/32bit)\ 108GB$

Visualizing Large Datasets with IndeX



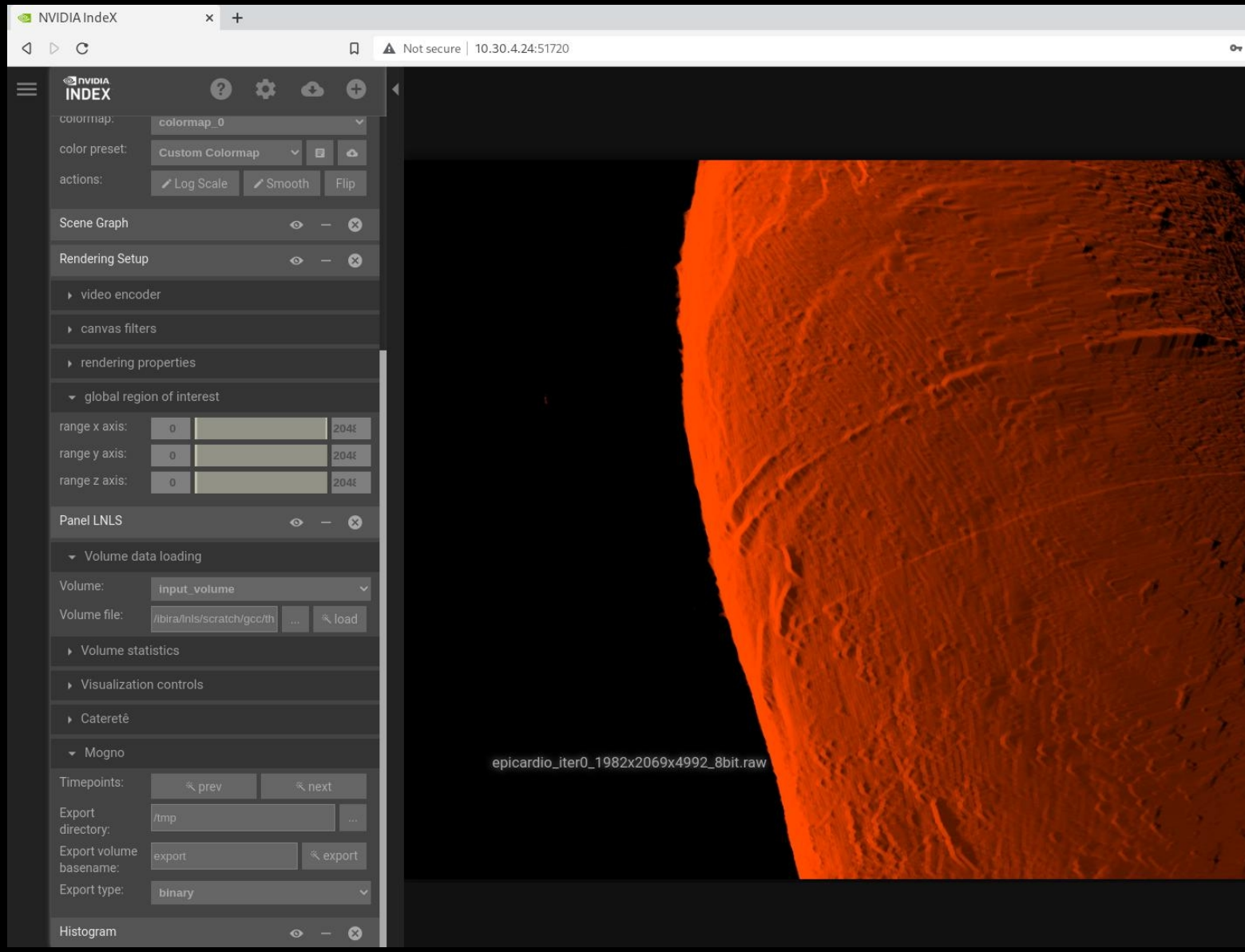
- Fast rendering of large volumes
- Multi GPU/Multi Node support
- Customizable rendering shaders (XAC)
- Web based viewer



Nvidia IndeX - LNLS Plugin

C++ Plugin extensions

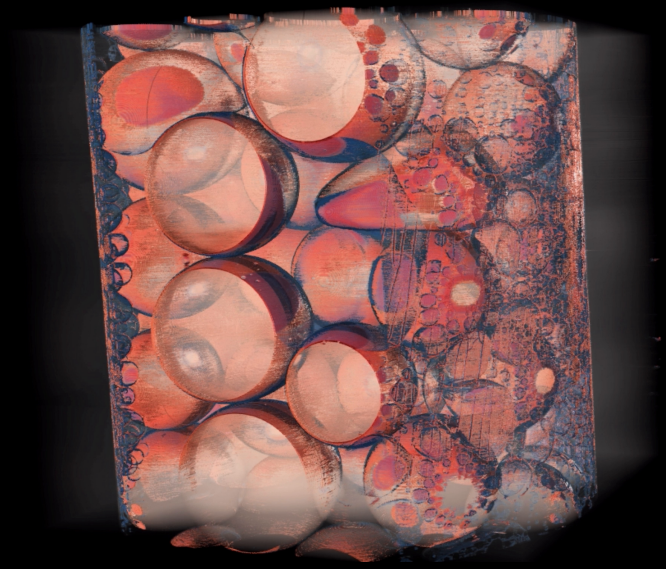
Accommodating needs of beamlines



Visualizing Large Datasets with IndeX

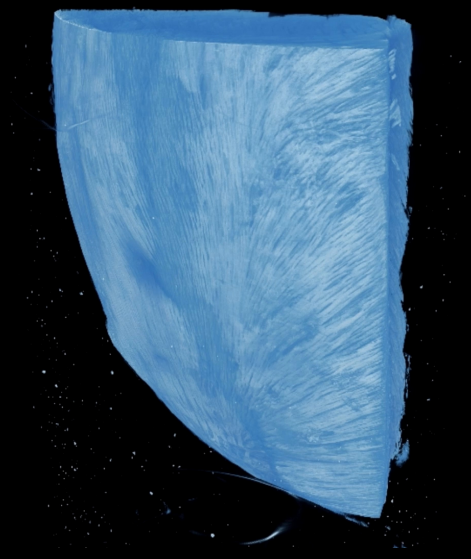
3D Reciprocal Space Mapping

Visualizing Large Datasets with IndeX



Silica bead pore space (fluid flow experiment)

Visualizing Large Datasets with IndeX



Mouse heart sample tomography

SSC-REMOTEVIS

Annotat3D

Detector

CLI

HTTP

Notebook

Start/Shutdown Server

JSON RPC

Middleware

Infer model
Retrieve subvolume

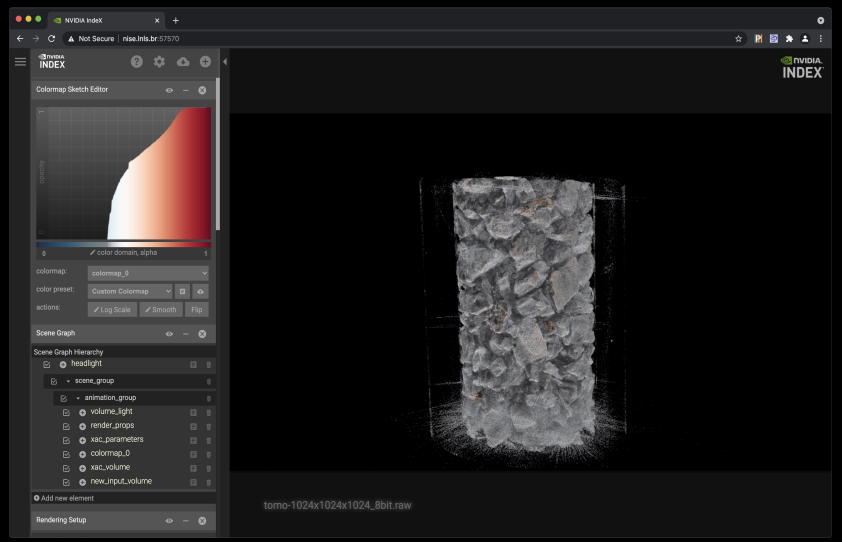
RDMA

Render data/file

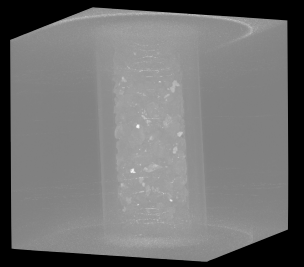
JSON RPC

Start/Shutdown Server

JSON RPC



RDMA



SSC-RDMA

Shared memory volume

Lustre filesystem

SSC-IO

MPI HDF5/TIFF/RAW reader

IndeX

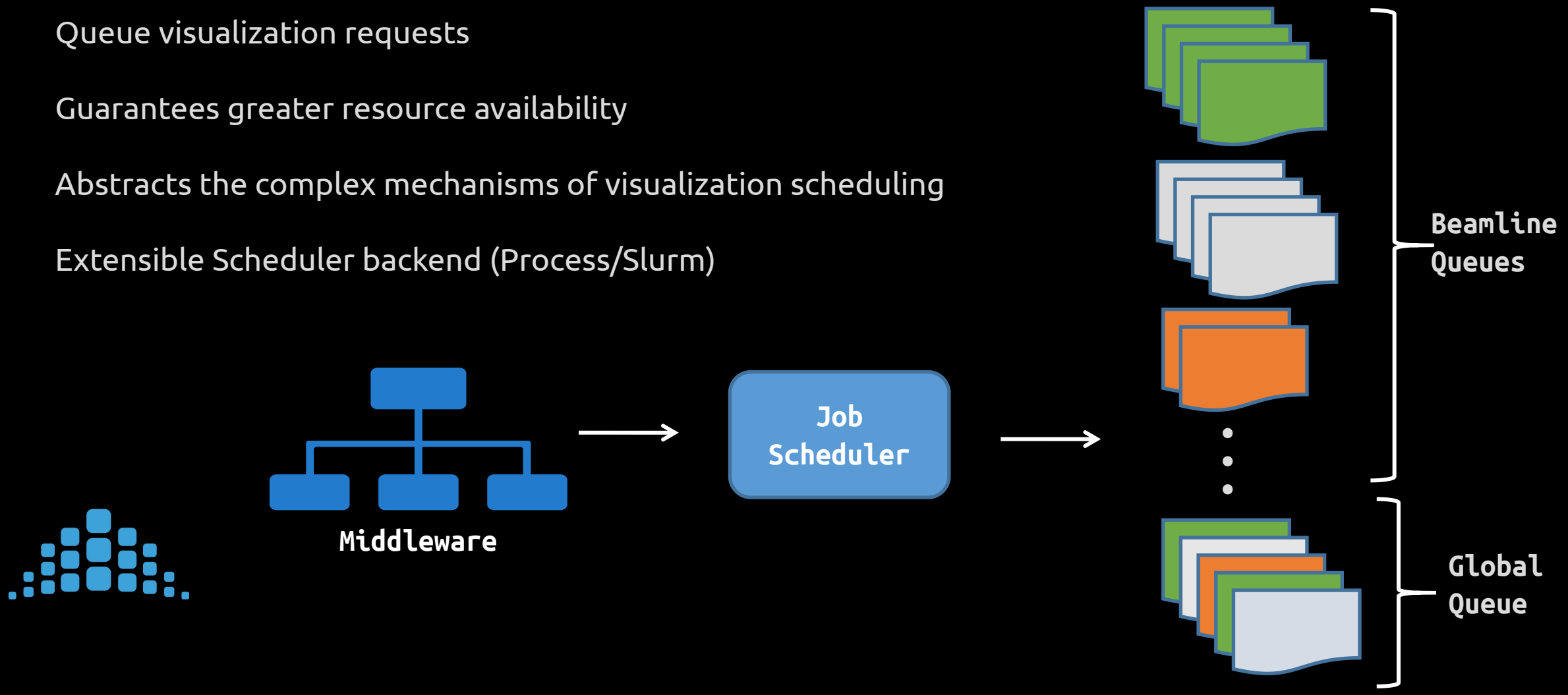
RemoteVis Scheduler

Queue visualization requests

Guarantees greater resource availability

Abstracts the complex mechanisms of visualization scheduling

Extensible Scheduler backend (Process/Slurm)



Jupyter Notebook

- Simple API for RemoteVis
- Allow quick data analysis
- Integration with Python ecosystem

Request a remote visualization server instance from middleware

In [3]:
```
fying if an instance already exists for my user
ce = rv.query_visualization_server(middleware_host, middleware_port)

o instance is found (i.e., instance is None), we request a new one from the middleware
tance is None:
stance = rv.initialize_visualization_server(middleware_host, middleware_port, shape=(2048, 2048, 2048), dtype='uint16')
```

Render volume remotely on IndeX using RDMA-based data transfer (no disk involved)

In [5]:
```
print(instance.visualization_server_url)
```

```
http://harriet.lnls.br:54680
```

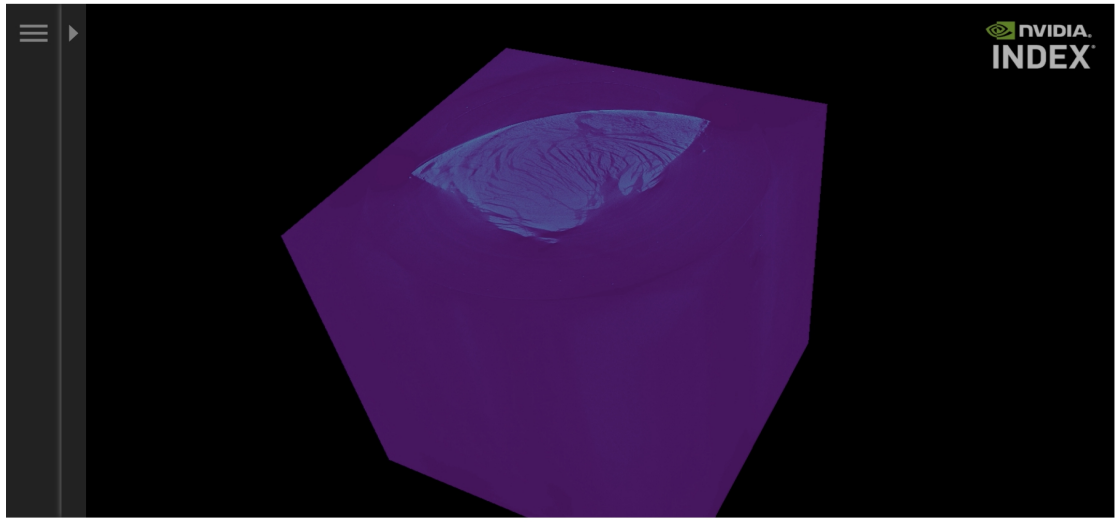
In [6]:
```
rv.render_volume(volume, instance)
```

Out[6]:
```
True
```

Load IndeX HTML viewer as IFrame

In [11]:
```
IFrame(instance.visualization_server_url, width=900, height=450)
```

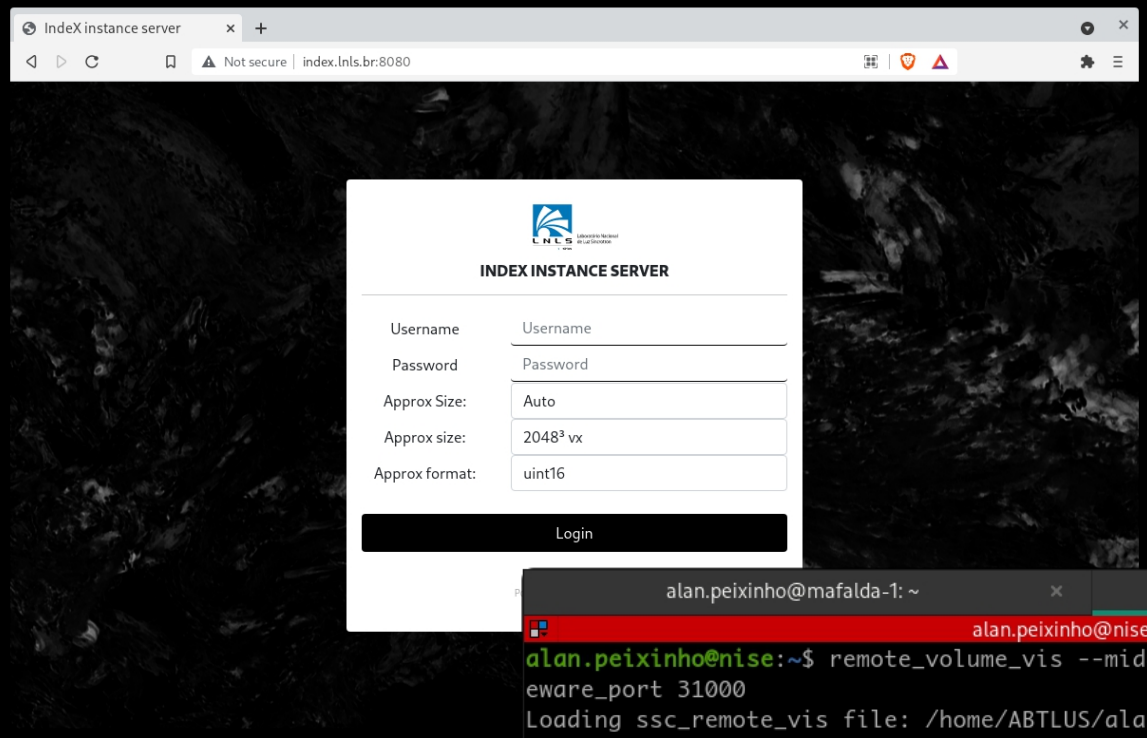
Out[11]:

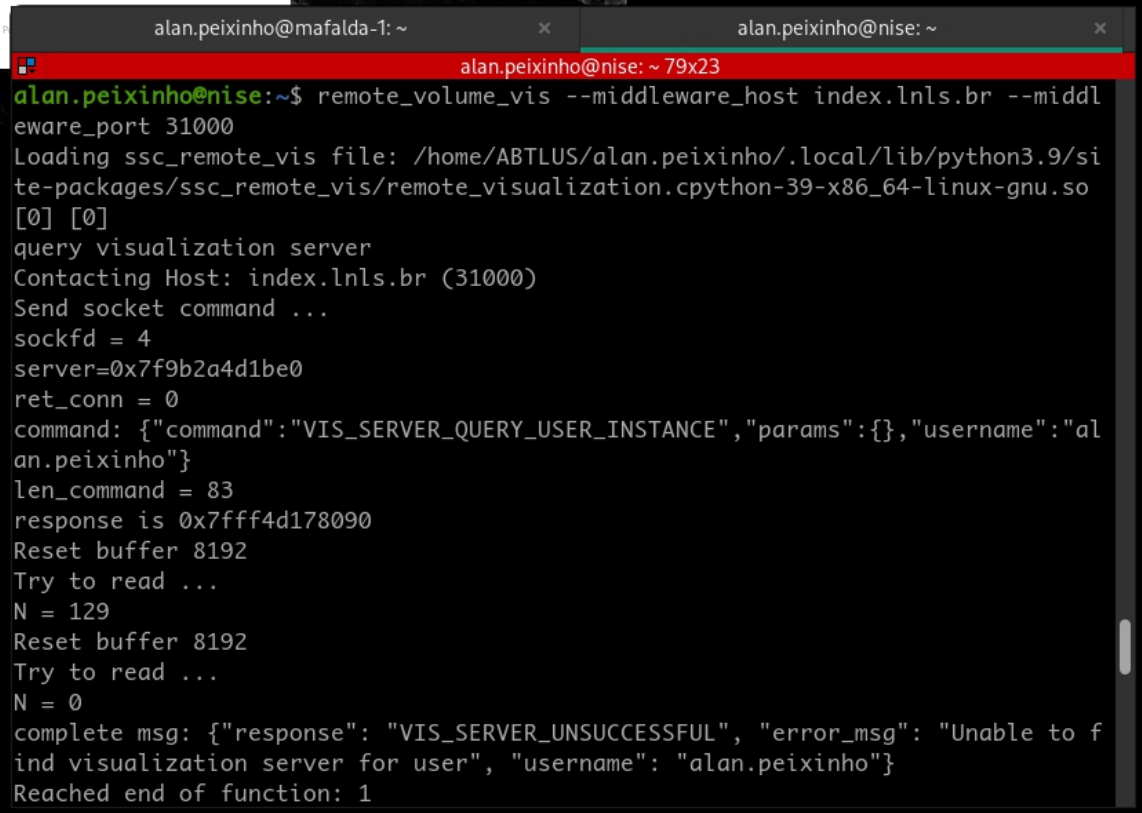


Web Interface/CLI

Simpler interface

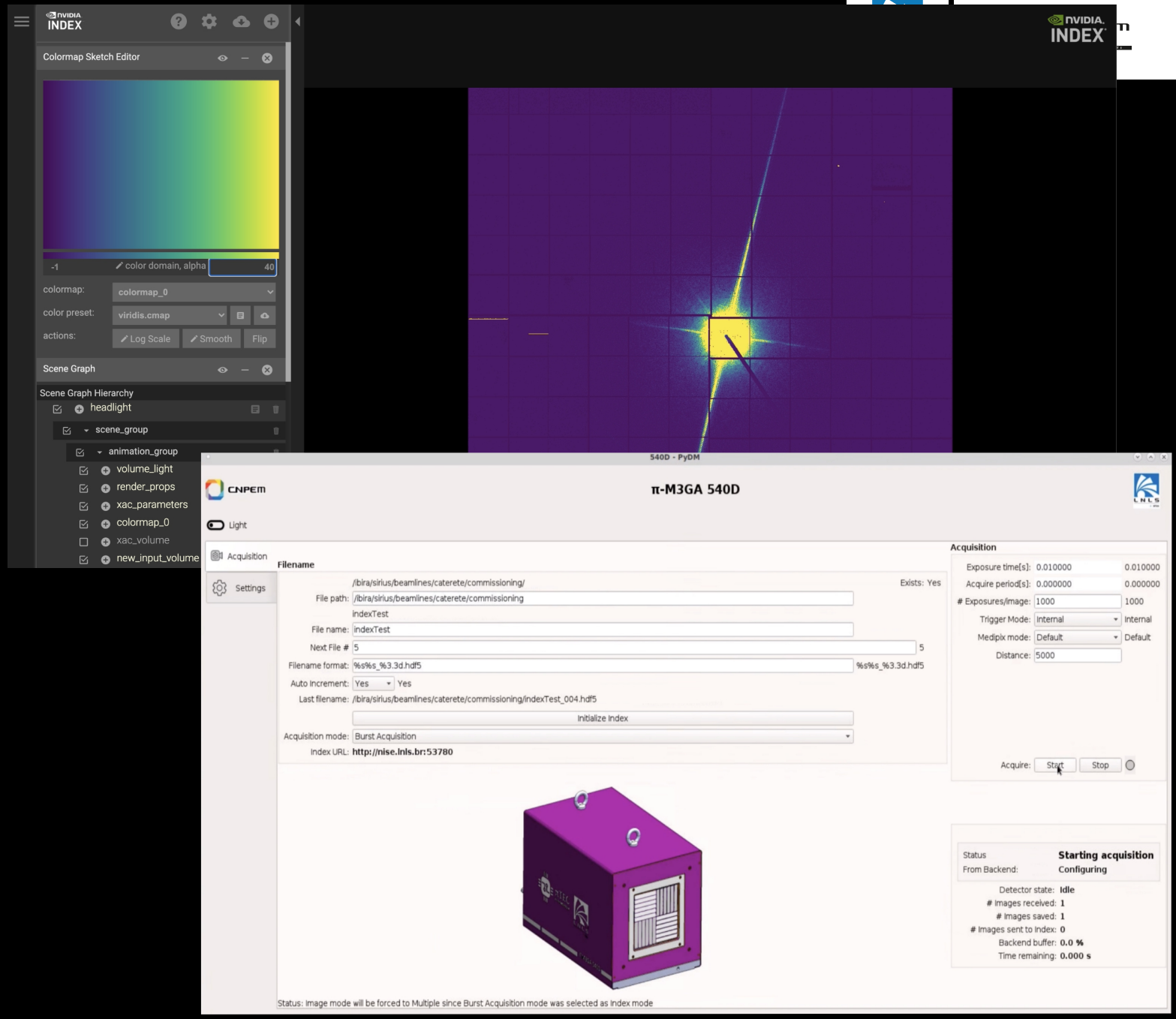
Volumes load from disk





Detector

- On site visualization of reconstructed images
- Facilitates parameters fine adjustments
- Allow users to preprocess data during visualization
-

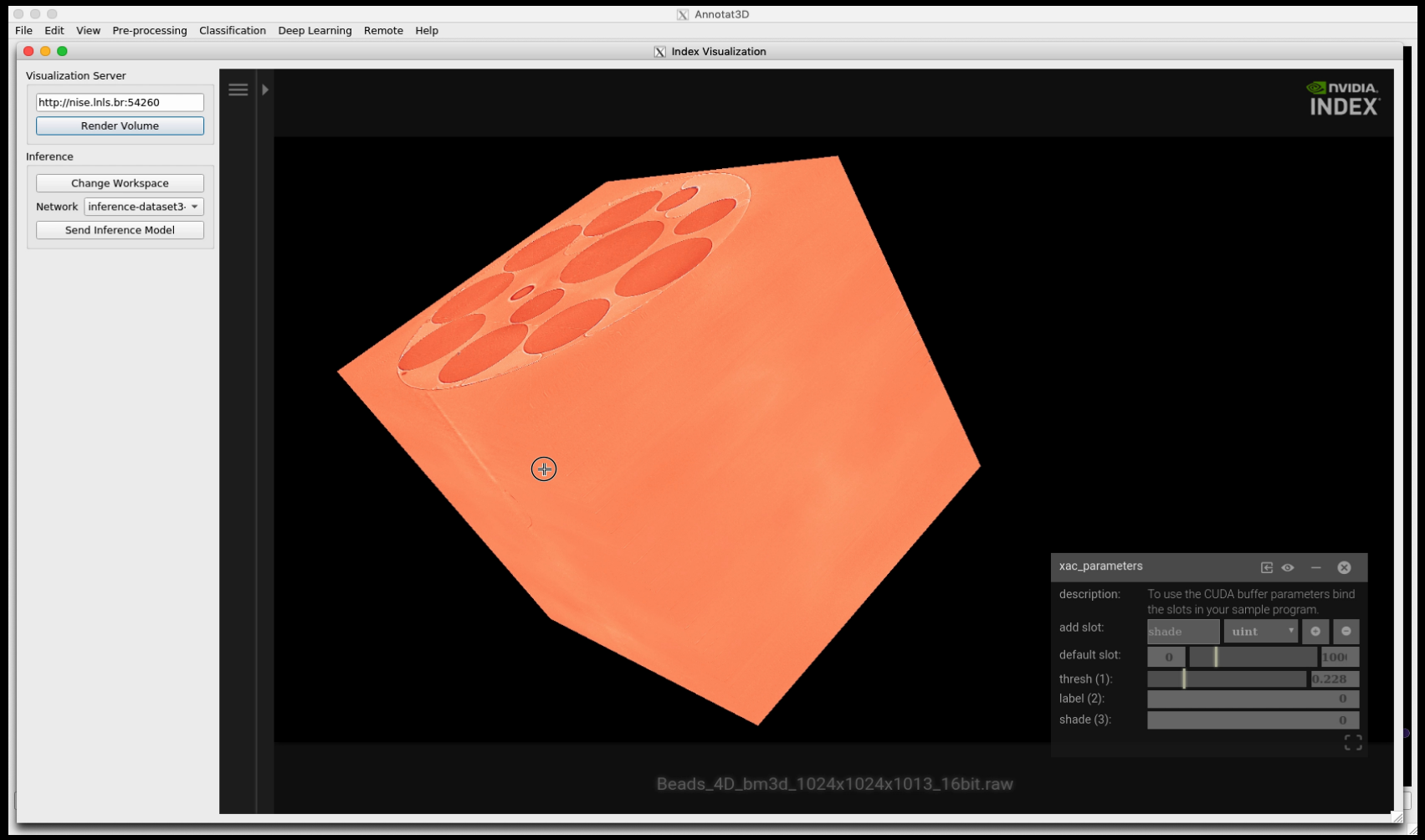


Annotat3D

Bidirectional communication

Analyze regions of interest on big volumes

Annotate/train models and sent back to IndeX



thank you all!

Thanks for scientific examples provided: Ema and Mogno beamlines, LNBio.

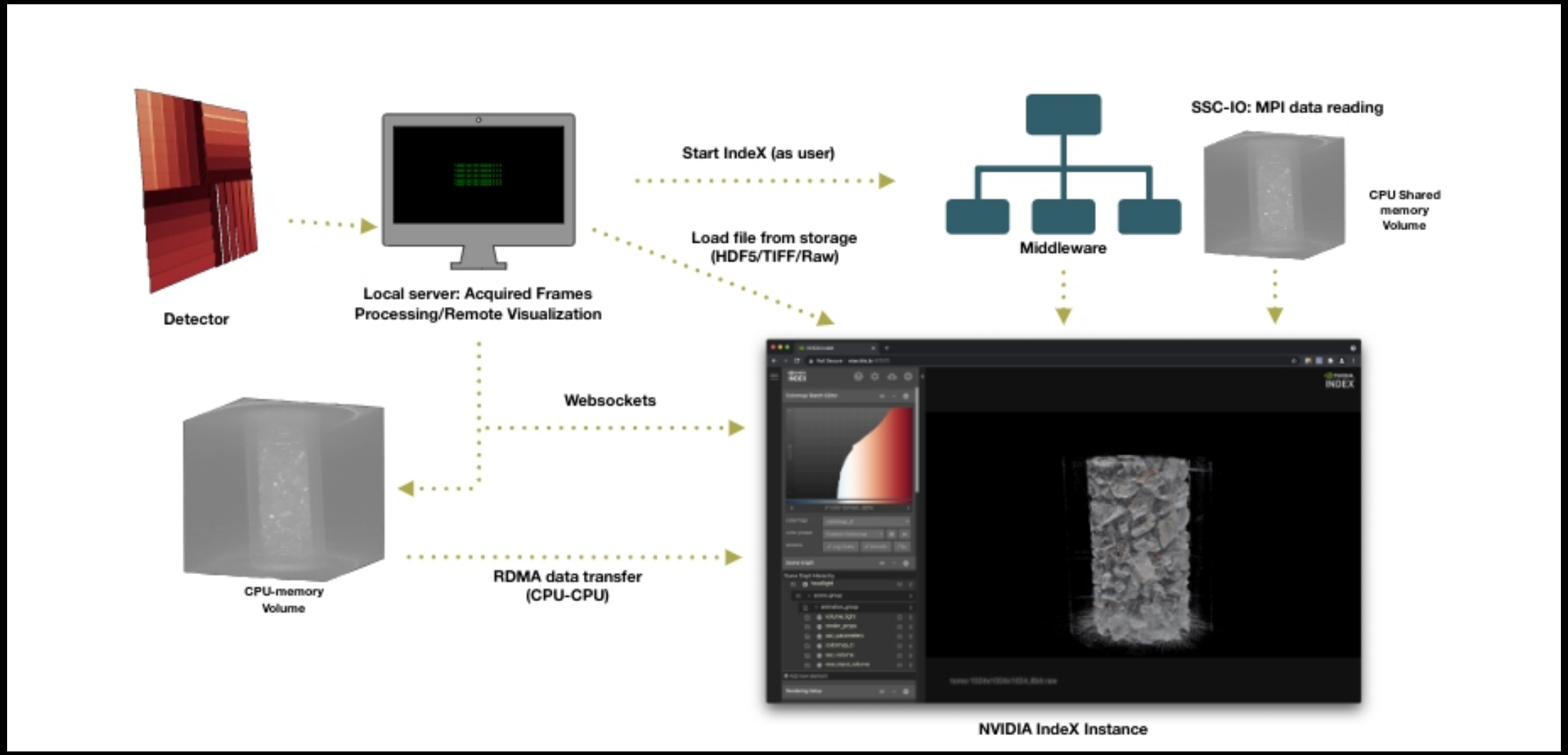


Figure 1: The proposed remote visualization workflow using the RemoteVis library to send volumes into NVIDIA IndeXfor visualization, via RDMA data transfer.

# vx	$P9_{50}$ to DGX	DGX to $P9_{50}$	DGX to DGX
1024^3	0.87 ± 0.01	1.13 ± 0.20	0.86 ± 1.48
1536^3	2.58 ± 0.09	3.00 ± 0.65	2.53 ± 0.47
2048^3	5.99 ± 0.09	7.17 ± 1.47	5.98 ± 1.12
3072^3	20.30 ± 0.26	21.89 ± 4.90	19.16 ± 3.66

Table 1: RDMA-based data transfer times using SSC-RDMA. Three settings were tested between three differentservers, one IBM Power 9 and two NVIDIA DGX-A100.The IBM Power 9 (P950) is connected at 50 Gb/s to theNVIDIA DGX-A100 while the connection between the DGXservers is at 100 Gb/s. The selected volumes are of typefloat 32 bits (4 bytes per voxel) and vary in number of voxels.All times are in seconds. For DGX to DGX, the destinationserver was the same as P950 to DGX.

Figure 2: Soil sample renditions using IndeX XAC operators. (a) The original volume with basic rendering and no shading.(b) The volume rendered with XAC local shading (S1). (c) The more advanced XAC shading scheme with ambient occlusion(S3). Data courtesy: MOGNO beamline/Sirius, LNLS/CNPEM.

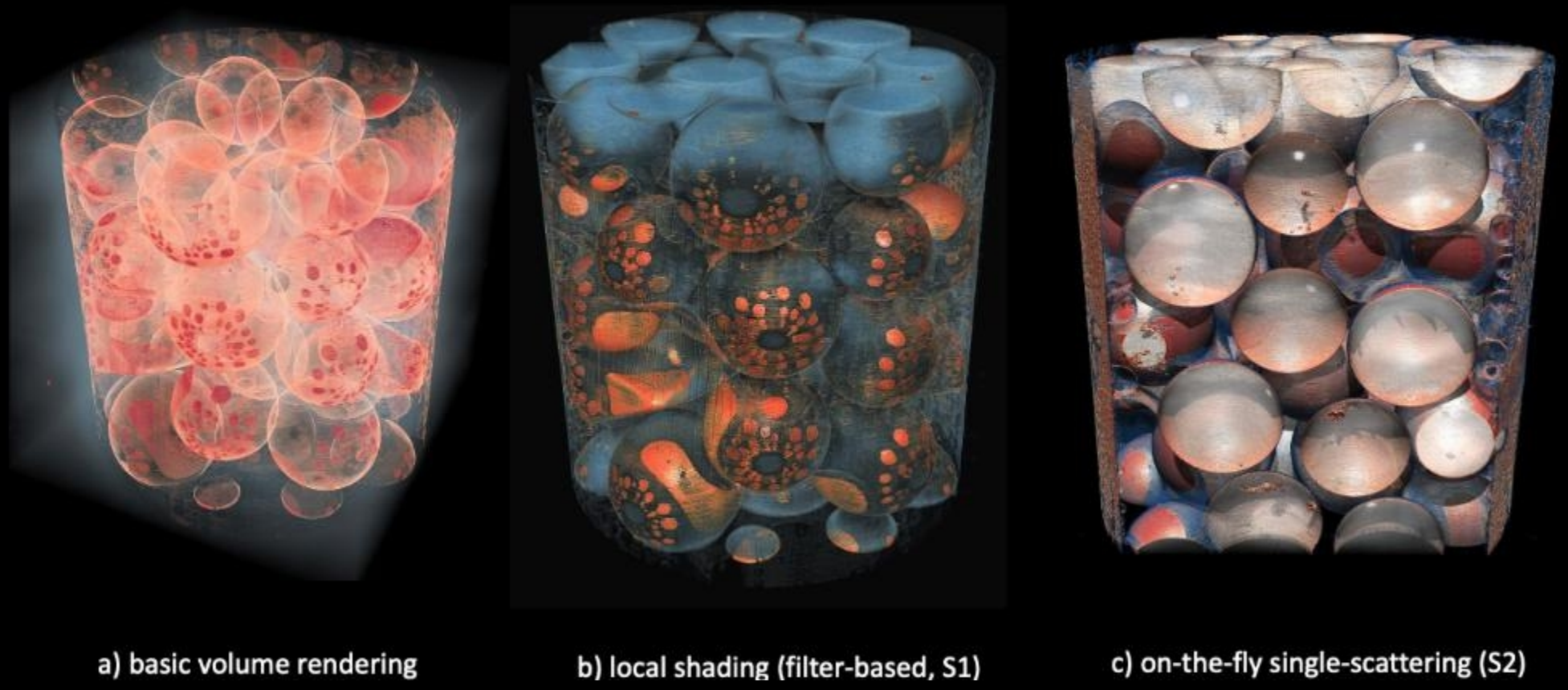


Figure 3: Silica bead fluid flow experiment renditions using IndeX XAC operators. The original image with segmentationof the gas phase is depicted in Figure 4 (left). Data courtesy: MOGNO beamline/Sirius, LNLS/CNPEM.

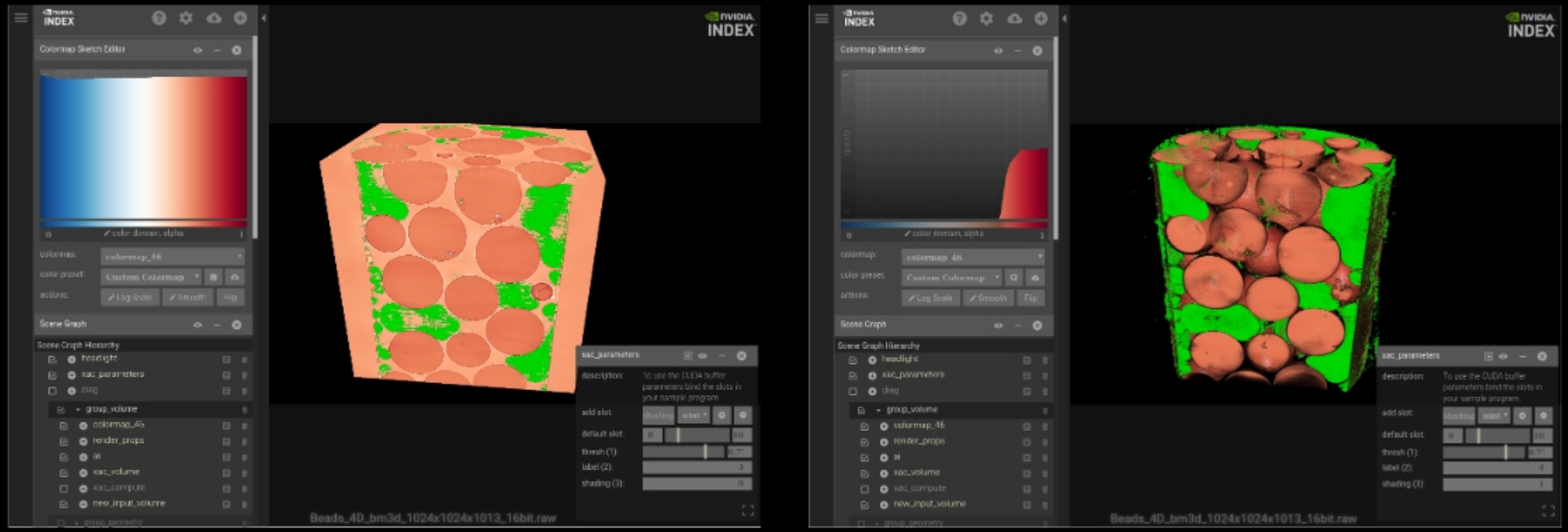


Figure 4: Integration between a pre-trained U-net segmentation model, optimized with NVIDIA TensorRT, and IndeXfor visualization. The TensorRT inference engine is called to segment the gas phase of the sample (left) and the result isimmediately used in the 3D rendering (right). Data courtesy: MOGNO beamline/Sirius, LNLS/CNPEM.

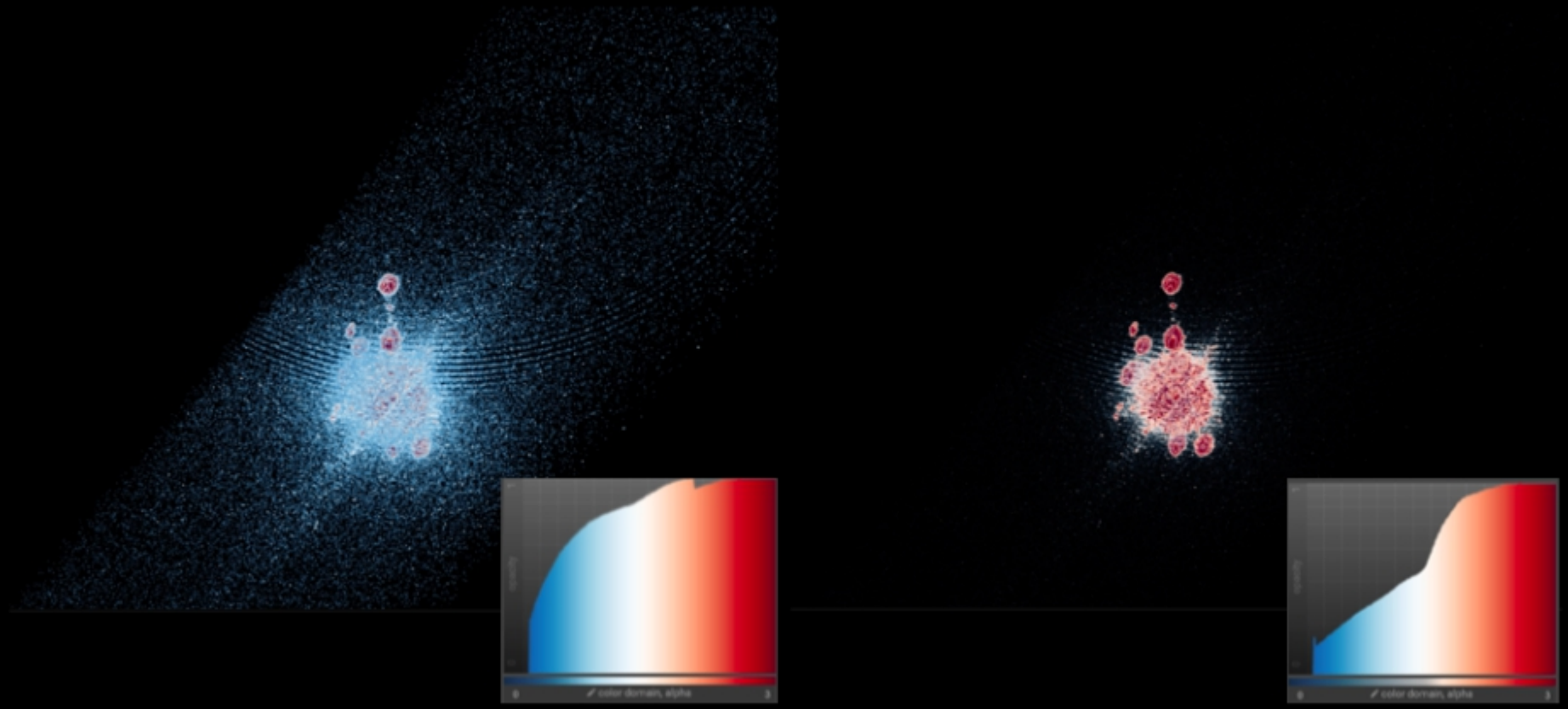


Figure 5: Point cloud renditions by NVIDIA IndeX as a particle volume. The XYZ and point value data are transferredby RemoteVis using SSC-RDMA and the points are rendered as spheres with radii proportional to their values. The usercan then select which points to view based on their radii (left) by simply altering the considered colormap (right). Datacourtesy: EMA beamline/Sirius, LNLS/CNPEM.