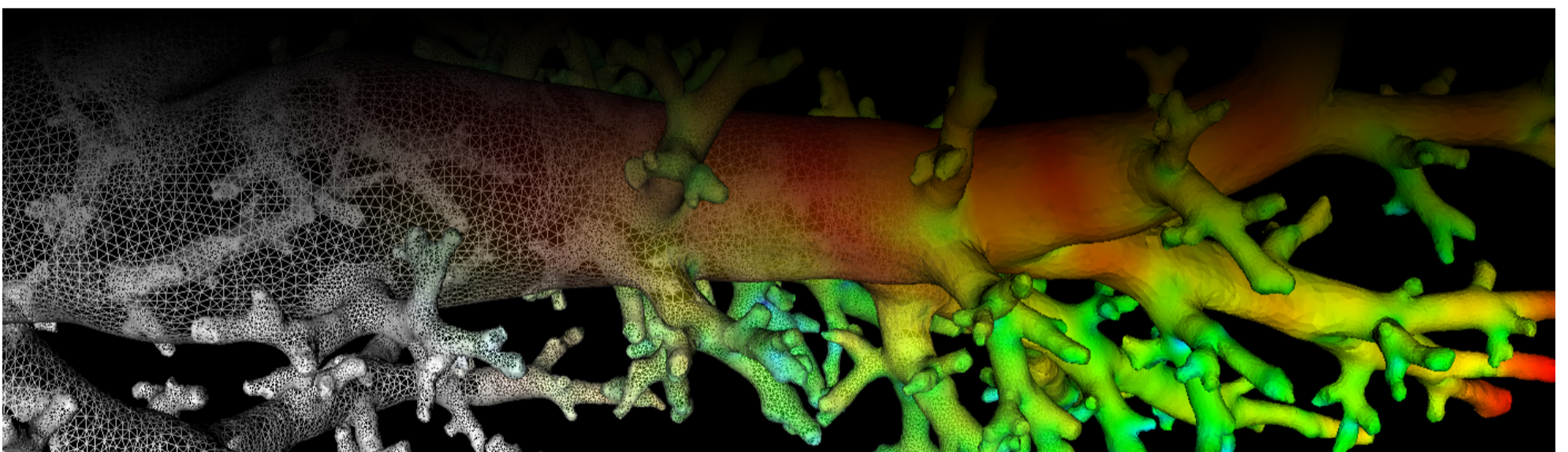# Lung Anatomy + Particle Deposition (lapd) Mouse Archive

for Modeling and Computational Toxicology

lapdMouseBrowser

lapdMouseBrowser is an extension for [3D Slicer](#) to download and visualize files from the lapdMouse data archive (Fig. 1). It allows the user to browse through the datasets in the lapdMouse archive, download them to the local drive, and load them in 3D Slicer. Advantages include:

- GUI for users with no software development skills.
- Visualize lapdMouse files not natively supported by 3D Slicer:
    - airway tree structure with branch labeling
    - aerosol deposition measurements
- Download and visualize a set of commonly used files ("standard file selection") with a single click.
- Pre-configured with suitable visualization parameters and color lookup tables for:
    - Volumetric images (aerosol and autofluorescent image data)
    - Labelmaps (lungs, lobes, near acini, airway segments)
    - Mesh models (airway segments, airway wall deposition)

Included modules:

- **lapdMouseDBBrowser:** downloads files from our archive containing 34 sets of aerosol deposition and lung geometry information. It also keeps track of previously downloaded data.
- **lapdMouseVisualizer:** creates Slicer models from our airway tree and aerosol deposition files.

Installation

lapdMouseBrowser is an extension for 3D Slicer, an open-source medical image processing and visualization system available for all major operating systems.

Prerequisite - 3D Slicer: If 3D Slicer has not yet been installed on your system, go to http://download.slicer.org, download and install a version suitable for your operating system. We recommend the use of the latest stable release of 3D Slicer. lapdMouseBrowser has been developed for **Slicer 5.6.1**.

Slicer Extension Manager: Start 3D Slicer and select from the menu `View` the `Extension Manager` and `Install Extensions`. Then search for the `lapdMouseBrowser`. Select it for installation and restart 3D Slicer.

From Downloaded ZIP File: You may prefer to install the code directly from a downloaded [zip file.](#) Unzip the downloaded file. Open Slicer. Drag the top-level directory (`Slicer-lapdMouseBrowser-master`) onto the Slicer application. Click OK when prompted to Add Python scripted modules to the application. In the second pop-up, make sure both `lapdMouseDBBrowser` and `lapdMouseDBVisualizer` are checked and click Yes.

Usage

Start 3D Slicer with the installed **lapdMouseBrowser** extension. For users not familiar with 3D Slicer, we refer to the [3D Slicer user documentation](#) and its [Getting started](#) section. From 3D Slicer's Module selector (drop down menu `Modules`: in tool bar) select `lapdMouse`, `lapdMouseDBBrowser`. The **lapdMouse Data Archive Browser** window opens. On the left it lists all datasets available in the data archive, on the right it shows a list of files and actions associated with a selected dataset.

The following subsections will explain how to:

- [Specify a local storage folder](#)
- [Download and visualize a standard set of files](#)
- [Download and visualize a custom set of files](#)
- [Visualization of files not natively supported by 3D Slicer](#)

Specify a local storage folder

lapdMouseBrowser stores downloaded files in folder `./lapdMouse` by default. If you want to change the default storage directory, close the lapdMouse Data Archive Browser window, change the `Storage Folder` using the lapdMouseBrowser's 3D Slicer module panel (panel on left side of 3D Slicer main window) and reopen the lapdMouse Data Archive Browse window by clicking `Show browser`.

Download and visualize a standard set of files

In the **lapdMouse Data Archive Browser** window select on the left side the dataset you want to load. Then on the right side click `load standard file selection in Slicer`.
The "standard" file selection includes files commonly used:

- [AerosolSub4.mha](#) (aerosol deposition image volume)
- [AutofluorescentSub4.mha](#) (autofluorescent image volume showing anatomical structures)
- [Lobes.nrrd](#) (Labelmap for lung lobes)
- [AirwayOutlets.vtk](#) (Airway mesh with label assigned to outlets)
- [AirwayWallDeposition.vtk](#) (aerosol deposition measurements near the airway wall)

If the files have not yet been downloaded, **lapdMouseBrowser** will display the total size of the files and ask the user to confirm the download. **Note:** Some files in the data archive such as full resolution volumetric images are several GB in size. Depending on your internet speed, the download might take several minutes. Files that are available on the local hard drive have a different status icon and will not have to be downloaded again.

Once the files are locally available, they will be loaded into 3D Slicer with suitable color lookup tables and default visualization parameters (e.g. gray-value window). After loading the standard files, 3D Slicer displays the aerosol deposition image and the airway wall deposition measurements mesh, and an outline of the lung lobes. The visualization parameters and displayed models can then be modified using 3D Slicer's standard functionality.

Download and visualize a custom set of files

If you want to download additional (or other) files for a dataset, select the file names from the list (use `Ctrl`-key to select multiple at once), and click `download selected files`. **lapdMouseBrowser** will display the total size of the files and ask the user to confirm the download. After download, they can get loaded in 3D Slicer using `load selected files`.

Visualization of files not natively supported by 3D Slicer

lapdMouseBrowser includes **lapdMouseVisualizer**, a 3D Slicer module to create mesh models for visualization of lapdMouse files not natively support by 3D Slicer:

- airway tree structure with branch labeling stored as `*.meta` files
- aerosol deposition measurement tables stored as `*.csv` files

To create visualizations of these files, select from the 3D Slicer's Module selector, `lapdMouse`, `lapdMouseVisualizer`. Then, under Section `Tree Structure` or `Compartment Measurements`, select the the inputfile, an output model, and click `Apply`.
The airway tree structure is rendered as a set of cylinder elements with a color coding of labeled branches. Compartment aerosol deposition measurements are rendered as spheres with a color coding of the measurement value.

Note on 3D Slicer's coordinate systems

One of the issues while dealing with volumetric images and derived models are the differences between the coordinate systems. See https://www.slicer.org/wiki/Coordinate_systems for an explanation.

All lapdMouse data (images, meshes, tree structure, etc.) were generated with Insight Segmentation and Registration Toolkit (ITK) and use an LPS coordinate system.

3D Slicer however, loads raster images assuming an LPS coordinate system and models assuming an RAS coordinate system; see Slicer File Formats. As a result, when loading images and meshes using 3D Slicer's `Add data`, they seem to not match. To fix this manually, one needs to transform either the images or the models. After loading the datasets, go to Slicer's `Transforms` module, and select from `Active Transform Create new Linear Transform`. Specify the Transformation Matrix to flip the data in the first two dimension:

```
-1 0 0 0
0 -1 0 0
0  0 1 0
0  0 0 1
```

Then, in Section `Apply transform` move the models from `Transformable` to `Transformed`. Then loaded images and models are aligned.

lapdMouseDBBrowser takes care of these steps automatically when loading models.

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