Gerbil Aural World Access

Final Presentation, BE768
30 April 2013

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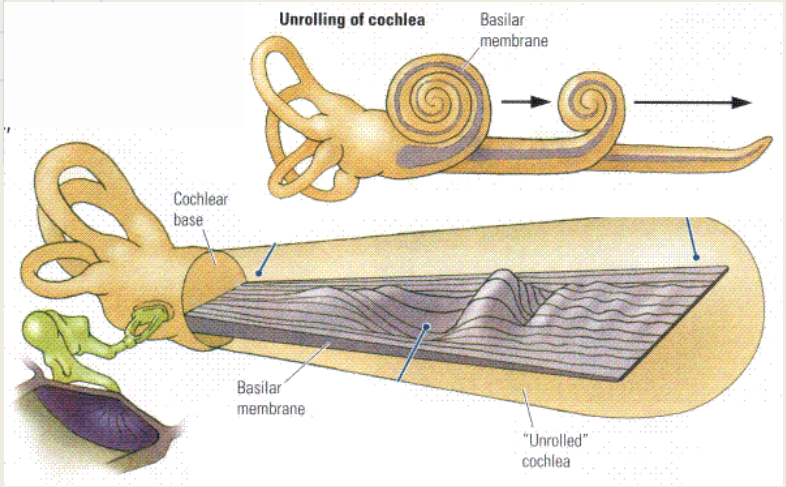
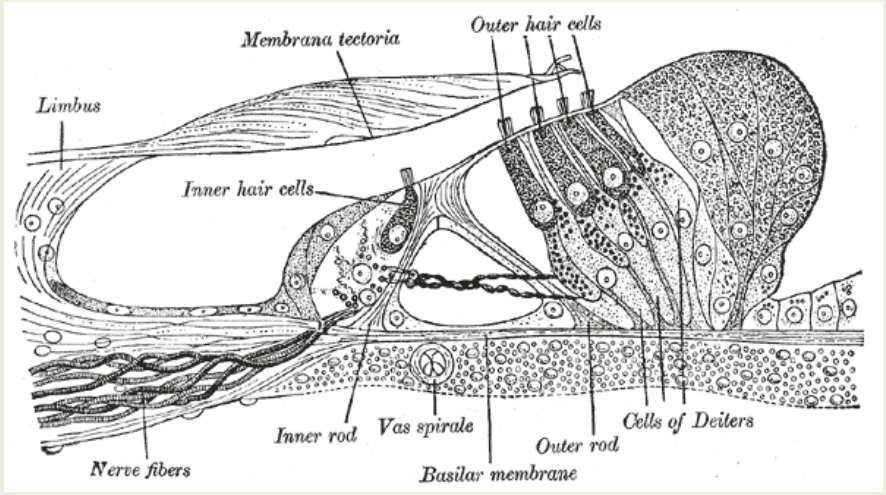
Research Motivation

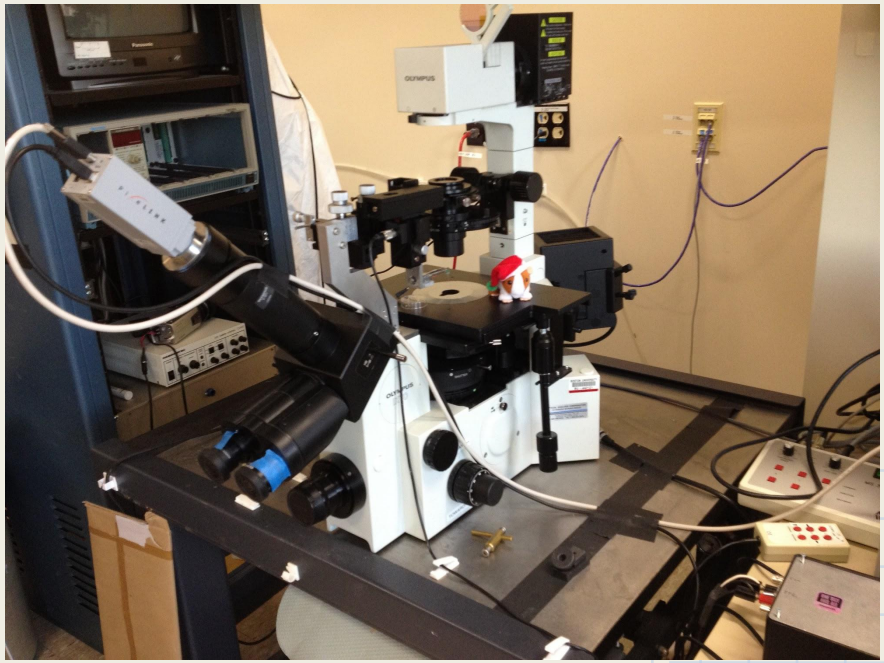




- "Experimental data on the mechanical properties of the tissues of the mammalian cochlea are essential for understanding the frequency- and location-dependent motion patterns that result in response to incoming sound waves."
- Sound from Outer Ear --> Vibration of the Basilar Membrane --> Movement of the Organ of Corti --> Firings on the Auditory Nerve --> "Hello, World!"

Research Motivation

- Gerbils are a good model animal
- The relative contributions to transverse and longitudinal motion to IHC activity (and thus AN spike rates) is a matter of great contention.
- To characterize the BM, a mechanical transducer was used to actuate it at multiple forcing frequencies inside its physiological range, and sets of stroboscopic images were taken during stimulation at a variety of focal depths.
- Image sets are further analyzed to track relative position of major physiological features during stim



Project Goals

1. Make the existing experimental data more broadly useful
   a. Currently, one expert user knows how the file structure works
   b. Collation of images for analysis and figure generation is done by hand
2. Make the existing data searchable
   a. What biomedical questions could be answered by looking at the data differently?
   b. What metadata is missing?
   c. **Quickly narrow down the correct images for post-analysis**
   d. See which images have already been used
3. Update selected metadata that went unrecorded during experimentation.
   a. Add a quality heuristic to each experiment
   b. Fill in relevant data that was hand-recorded
4. Meet NIH requirements for open access
   a. Provide data for other interested research groups

Data Sources

Microscope Data in "PAR" Parameter Files

107,306 Files

In A Directory Tree

Image Metadata

Matlab M Files

ROI Data

84,000 Files

Animal Data

Experiment subjective Data - redundant & inconsistent

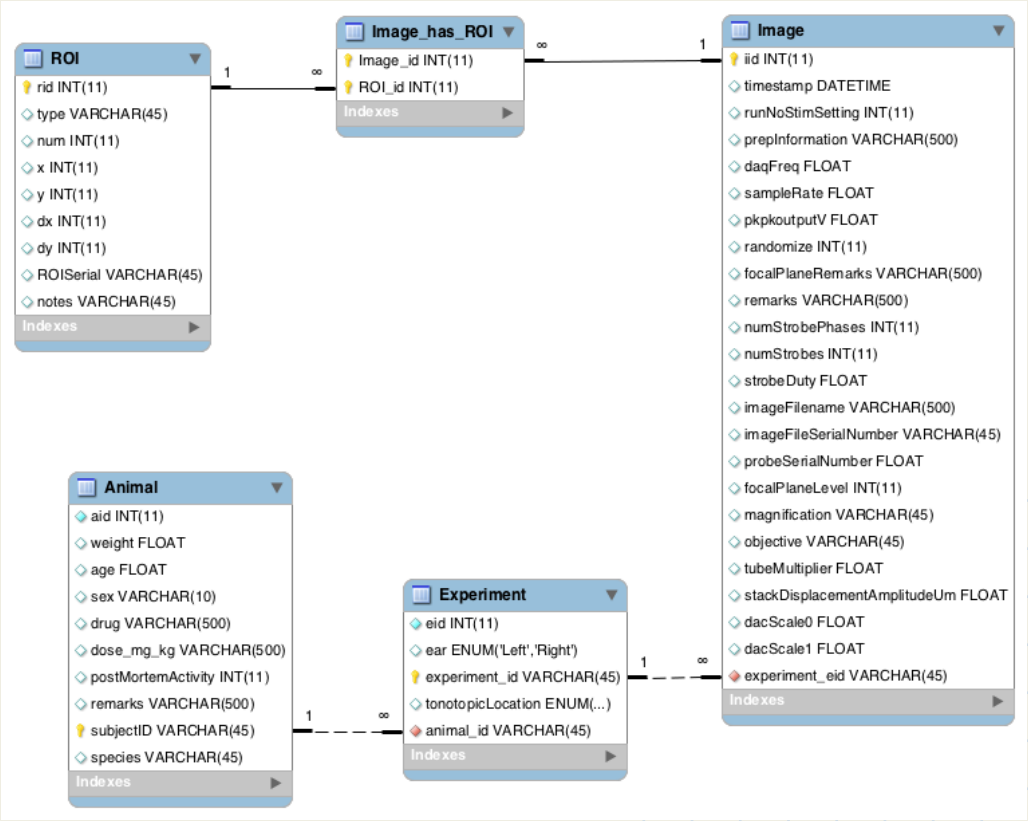
Broken into a directory structure

File name and location has parseable semantic meaning.

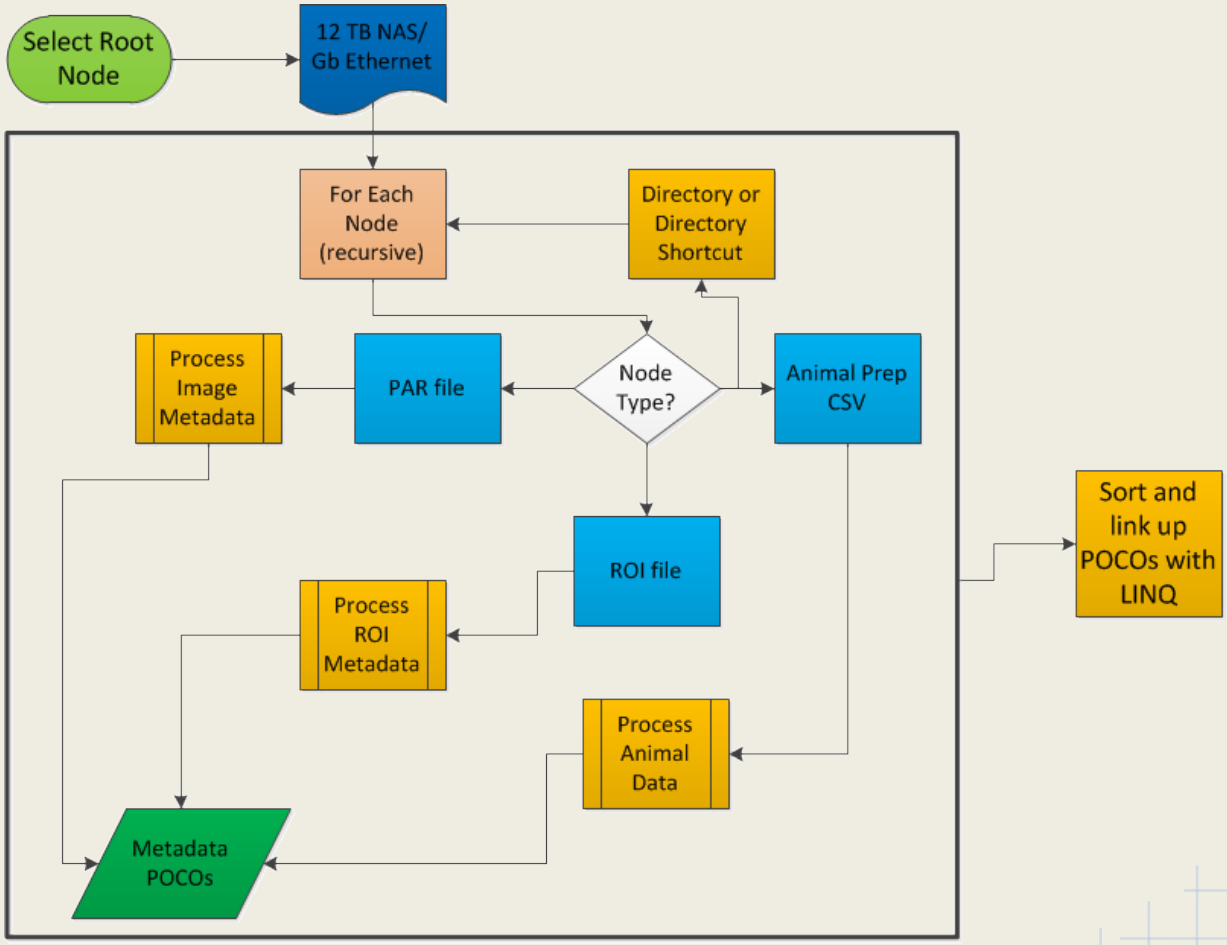
Each image corresponds to exactly one PAR file.

ER Diagram

1. 5 Tables: 4 Entities, 1 Relationship
2. An Animal has one or more associated Experiments
3. An Experiment has many Images
4. A given Image may or may not have one or more Regions of Interest (ROI)
5. Primary Indexes chosen for fast queries.
   a. secondary indexes chosen to meet FK uniqueness constraints

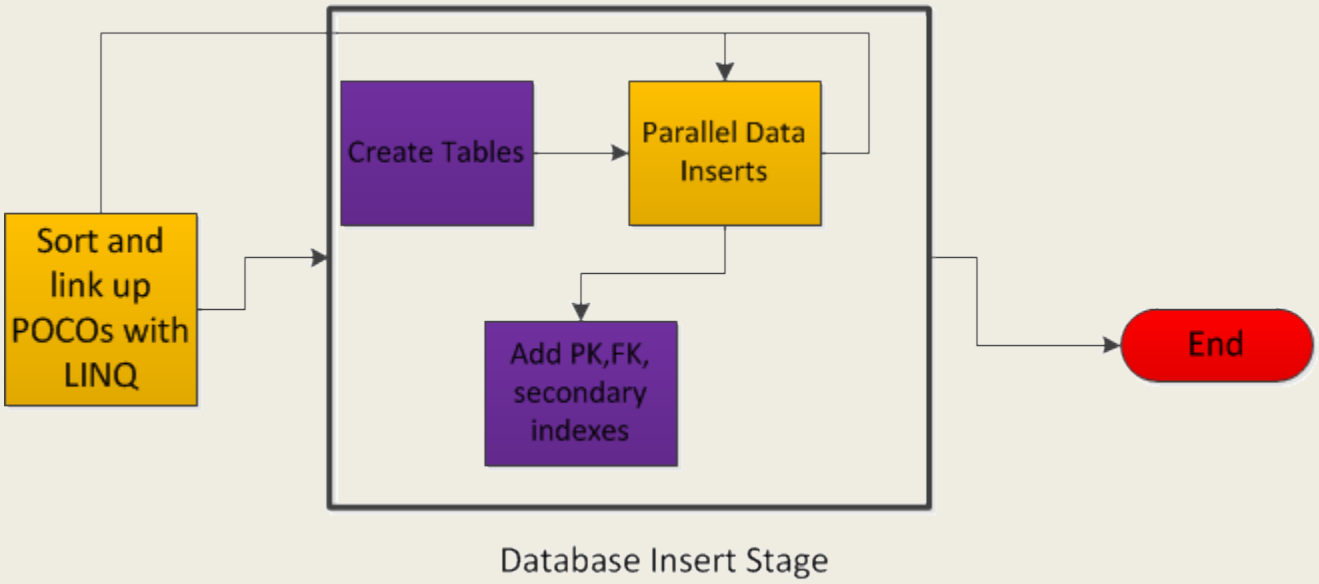


Data Import Process



Processing Stage

Data Import Process

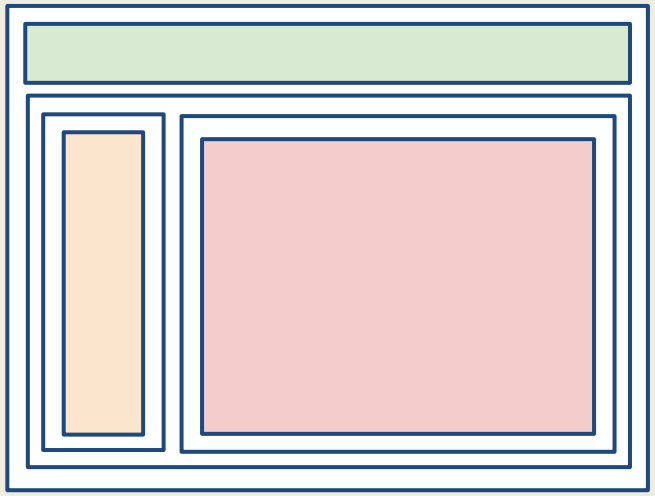


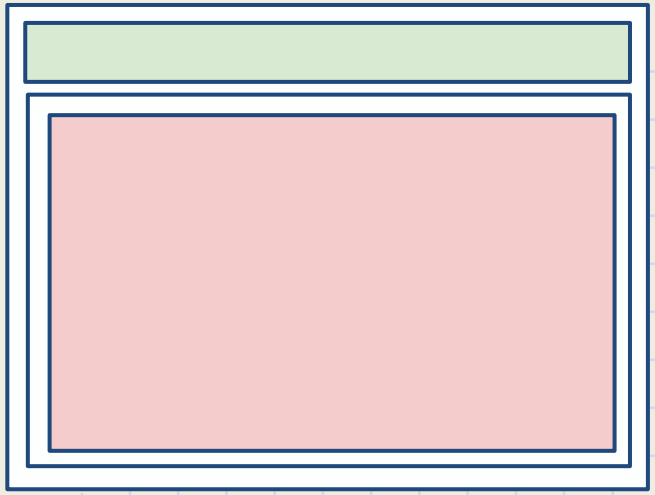
Import Complete!

Next: Website Development

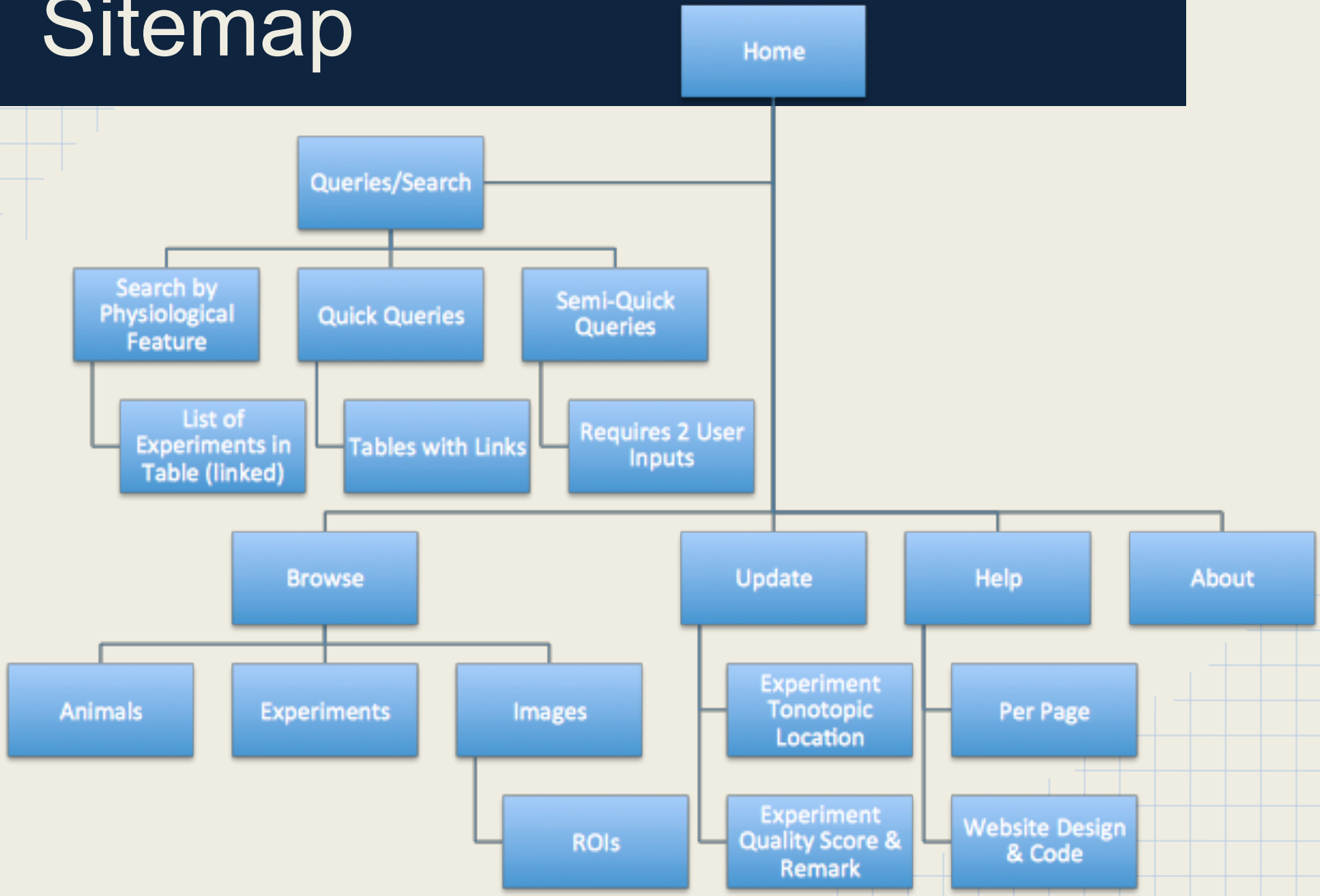
Website Development

- CSS2/3, XHTML 1.0 Strict Compliant
  - Box Model - Independent Scrolling
  - Images sparingly used
- Tested to work in Standards compliant browsers used in the lab and by the group members:
  - Current versions of Opera, Safari, Chrome & Firefox
- Real time generation, no static HTML file
  - One file = one theme = single update
  - Modular HTML functions
- Authenticated users with elevated privileges:
  - Data update functions
  - Additional information about site design and program code
  - Not required for general usage





Sitemap


Home
Queries/Search
Search by Physiological Feature
Quick Queries
Semi-Quick Queries
List of Experiments in Table (linked)
Tables with Links
Requires 2 User Inputs
Browse
Update
Help
About
Animals
Experiments
Images
ROIs
Experiment Tonotopic Location
Experiment Quality Score & Remark
Per Page
Website Design & Code

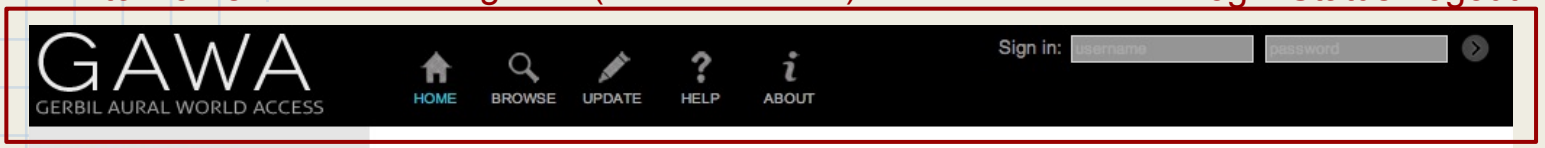
Home Page

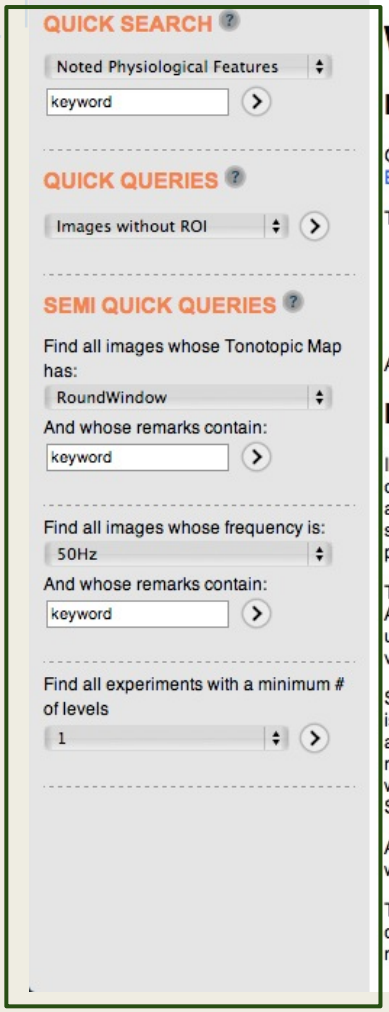
Link to Home

Navigation (location aware)

Login/Status/Logout

Standard Header Bar





Basic Search Options

Quick Queries

Semi-Quick-Queries

On Items for help

Welcome to GAWA: Gerbile Aural World Access

Project Information

GAWA was developed at Boston University as part of the coursework for BE768 in the spring semester of 2013. Professor Gary Benson was the course instructor.

Team members:

- Graham Voysey
- Ali Jiwani
- Amauche Erwani
- Will Chapin

Advisor: Professor David Mountain

Project Description

In the mammalian auditory system, the cochlea transforms sound, a pressure wave in a medium, into a series of action potentials on the auditory nerve that are ultimately processed in cortex. The precise mechanisms by which this is accomplished continue to be a matter of great research interest. Airborne sound pressure waves are first modulated and amplified in the middle ear. The resulting signal propagates in the fluid-filled cochlea, and interacts with the basilar membrane (BM) and the Organ of Corti to result in action potentials propagating to the auditory nerve (AN).

The mechanical properties, structure, and response of the BM are the focus of a series of experiments on gerbils done in the Auditory Biophysics and Simulation Lab, in the College of Engineering's Hearing Research Center. A mechanical transducer was used to actuate the BM at frequencies inside its physiological range, and stroboscopic images were taken during stimulation at a variety of focal depths.

Stroboscopic images were automatically recorded from a camera, attached to a microscope observing the experiment. The camera is controlled with a National Instruments Data Acquisition card, a C# application, and a collection of MATLAB scripts. Computer automation of data collection has resulted in large amounts of data. The bulk of the data are images captured from the stroboscopic microscope and waveform data of stimuli and responses, with associated metadata. To date, on the order of 100,000 images and waveforms have been stored on a network drive, totaling in excess of 2 terabytes of data stored on a 12 TB Network-attached Storage (NAS) device.

Approximately 300 animal experiments were performed during the period December 2009 - July 2012, and a relevant subset of them were determined to be of further research value and were included in the database.

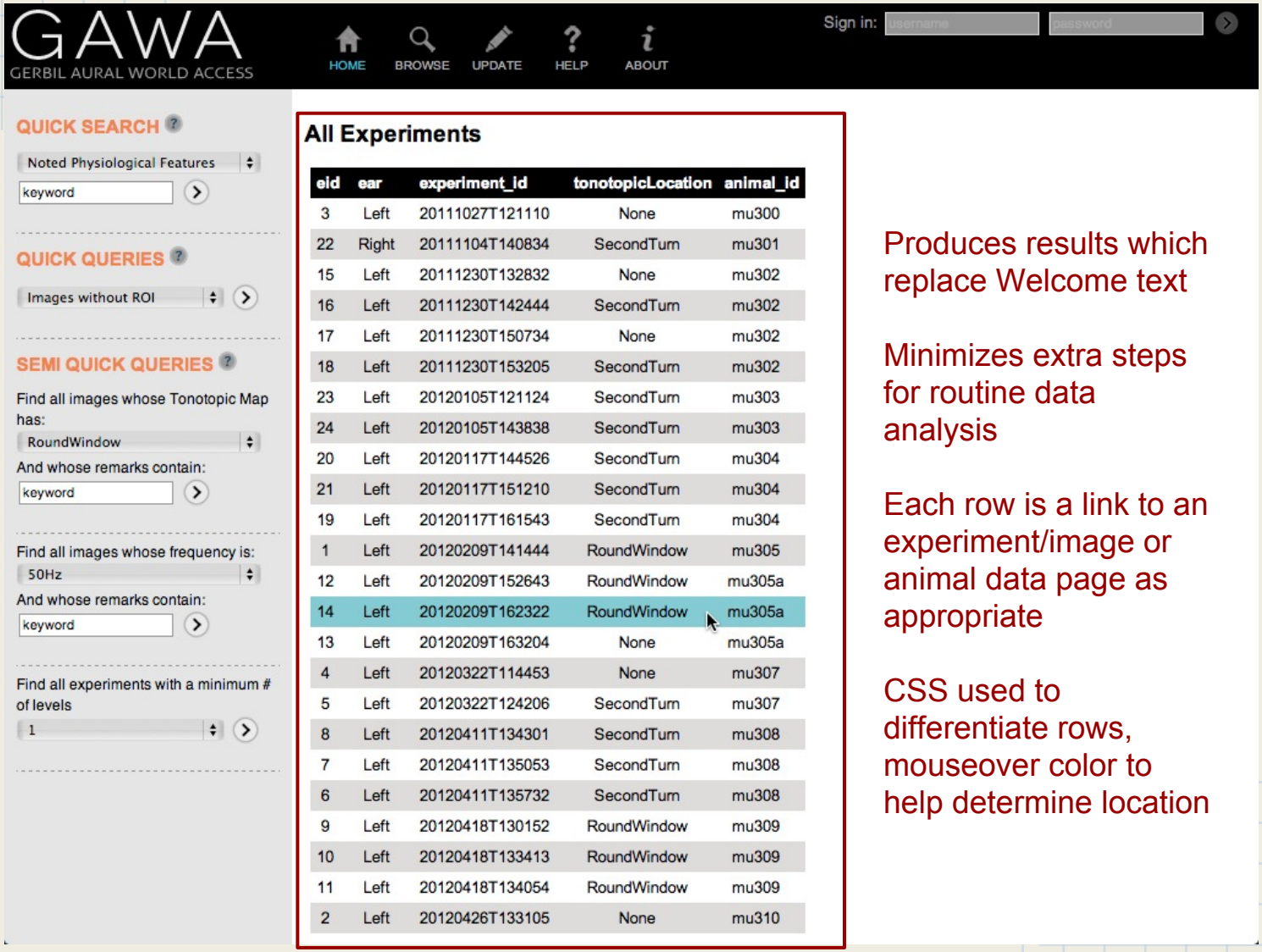
This project created a database to allow the researchers involved with the project to more efficiently sort and qualify prerecorded data for generation of graphics and interpretation of results. Additionally,this provided a mechanism for guests and interested members of the research community to access results for their own analyses.

Home with introductory text, contains links to PubMed and other relevant information

Search

- Quick Search (free text)
  - Free text of physiological feature of an experiment subset encoded in two remarks fields within the Image data
- Quick Queries (No user input needed)
  - View remarks by Experiment & Focal Plane Level
  - Images without associated ROI data
  - Experiments without associated ROI data
  - All Experiments
  - Experiments without a tonotopic location defined
- Semi-Quick Queries (requires selection for a user inputs)
  - Images whose tonotopic map has (drop down of possibilities) and whose remarks contain (free text).
  - Experiments with more than (drop down #) of focal planes
  - Images by frequency (drop down) and whose remarks contain (free text)
- Results as tables whose rows link to Image pages or Experiment Pages
  - Tables can be downloaded as text file

Home Page Contextually Updates: Search Results



All Experiments

eid	ear	experiment_id	tonotopicLocation	animal_id
3	Left	20111027T121110	None	mu300
22	Right	20111104T140834	SecondTurn	mu301
15	Left	20111230T132832	None	mu302
16	Left	20111230T142444	SecondTurn	mu302
17	Left	20111230T150734	None	mu302
18	Left	20111230T153205	SecondTurn	mu302
23	Left	20120105T121124	SecondTurn	mu303
24	Left	20120105T143838	SecondTurn	mu303
20	Left	20120117T144526	SecondTurn	mu304
21	Left	20120117T151210	SecondTurn	mu304
19	Left	20120117T161543	SecondTurn	mu304
1	Left	20120209T141444	RoundWindow	mu305
12	Left	20120209T152643	RoundWindow	mu305a
14	Left	20120209T162322	RoundWindow	mu305a
13	Left	20120209T163204	None	mu305a
4	Left	20120322T114453	None	mu307
5	Left	20120322T124206	SecondTurn	mu307
8	Left	20120411T134301	SecondTurn	mu308
7	Left	20120411T135053	SecondTurn	mu308
6	Left	20120411T135732	SecondTurn	mu308
9	Left	20120418T130152	RoundWindow	mu309
10	Left	20120418T133413	RoundWindow	mu309
11	Left	20120418T134054	RoundWindow	mu309
2	Left	20120426T133105	None	mu310

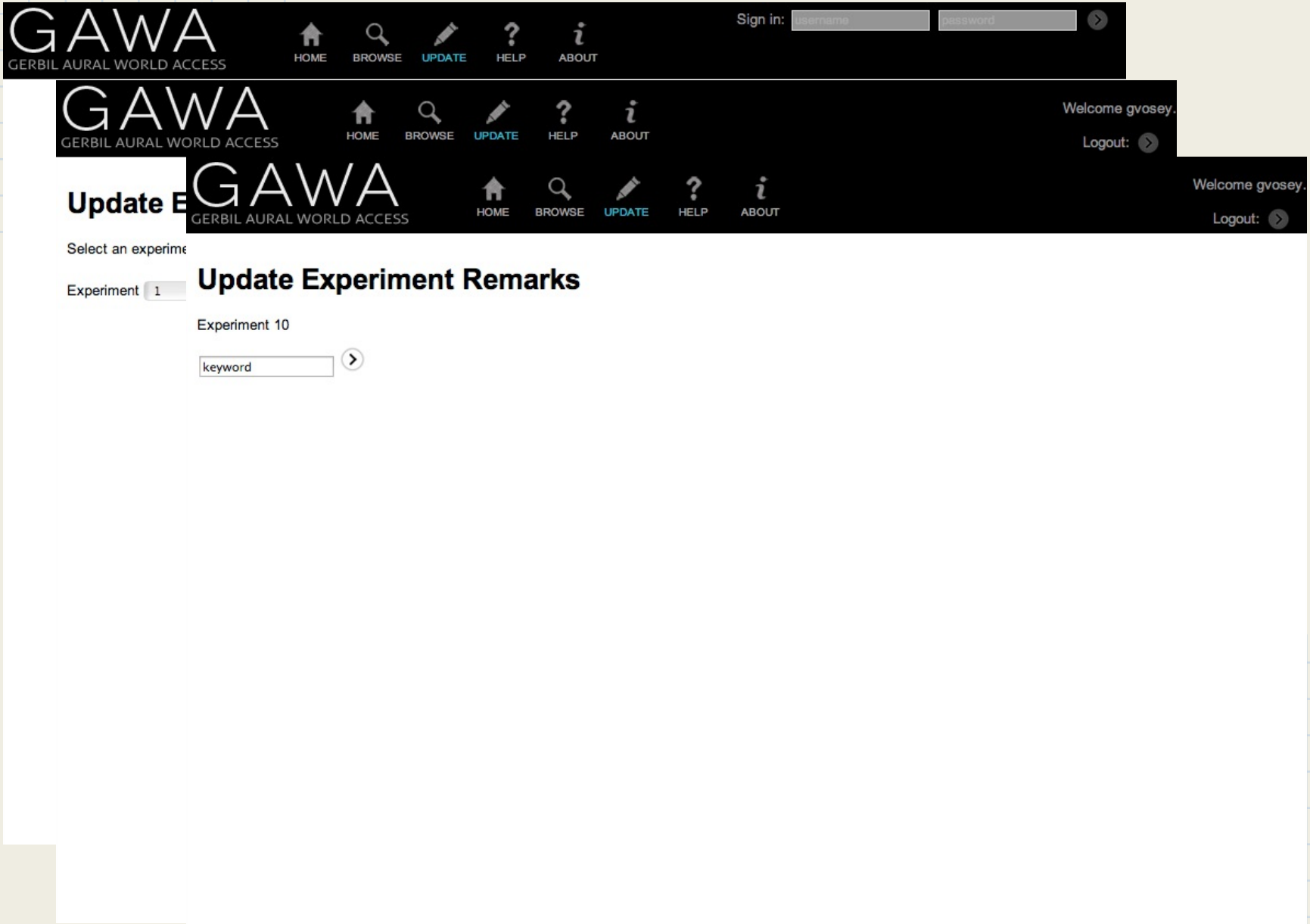
Produces results which replace Welcome text

Minimizes extra steps for routine data analysis

Each row is a link to an experiment/image or animal data page as appropriate

CSS used to differentiate rows, mouseover color to help determine location

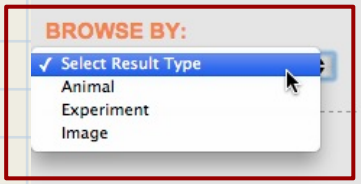
Update Pages



Browsing

Next: A general database browser.

Browse Function: Data via AJAX



Builds Table with Display Options on-the-fly

Real Time Table Updates

Results link deeper as appropriate

GAWA
GERBIL AURAL WORLD ACCESS

HOME BROWSE UPDATE HELP ABOUT

Sign in: username password

BROWSE BY:
Animal

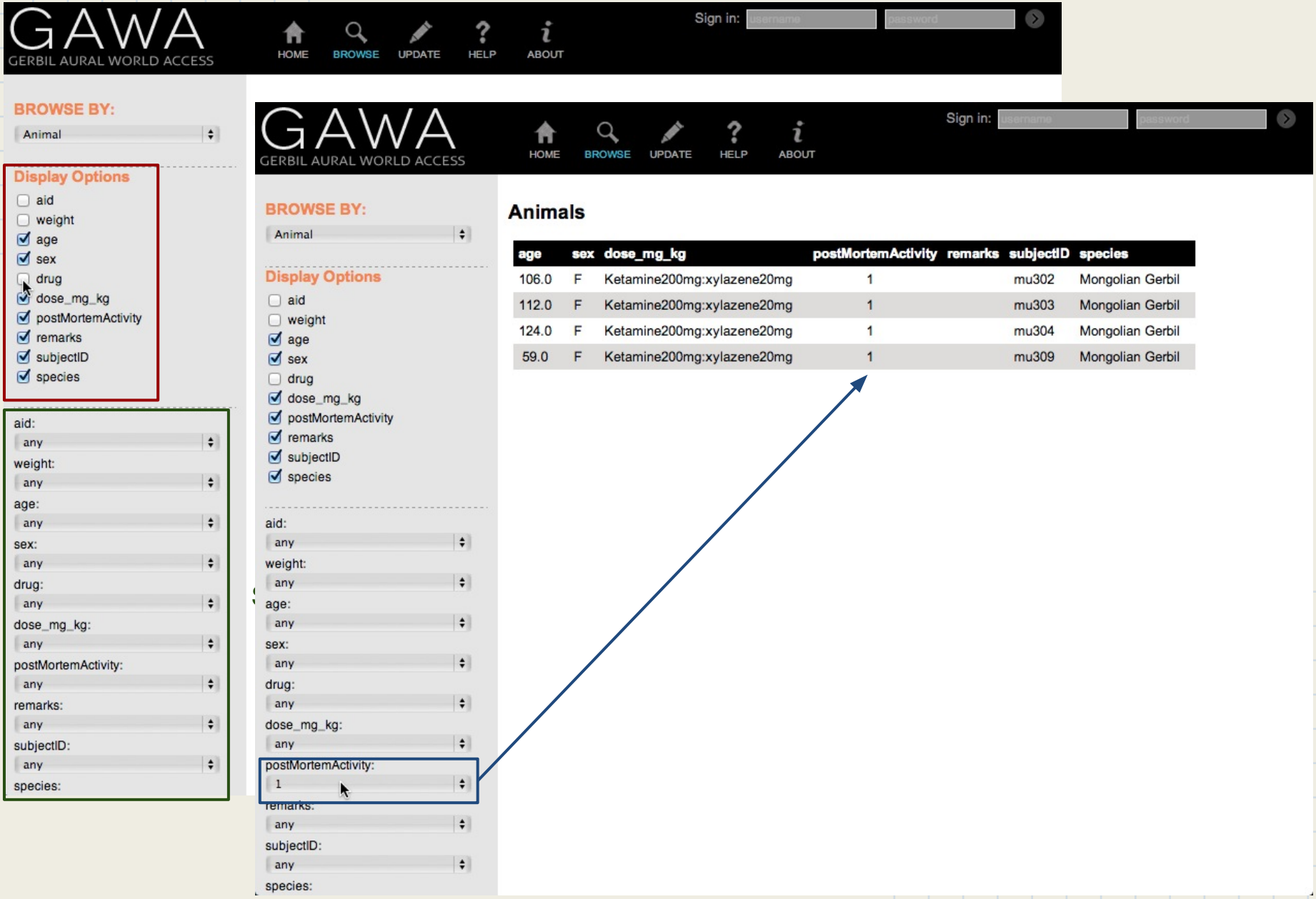
Display Options
- aid
- weight
- age
- sex
- drug
- dose_mg_kg
- postMortemActivity
- remarks
- subjectID
- species

aid: any
weight: any
age: any
sex: any
drug: any
dose_mg_kg: any
postMortemActivity: any
remarks: any
subjectID: any
species:

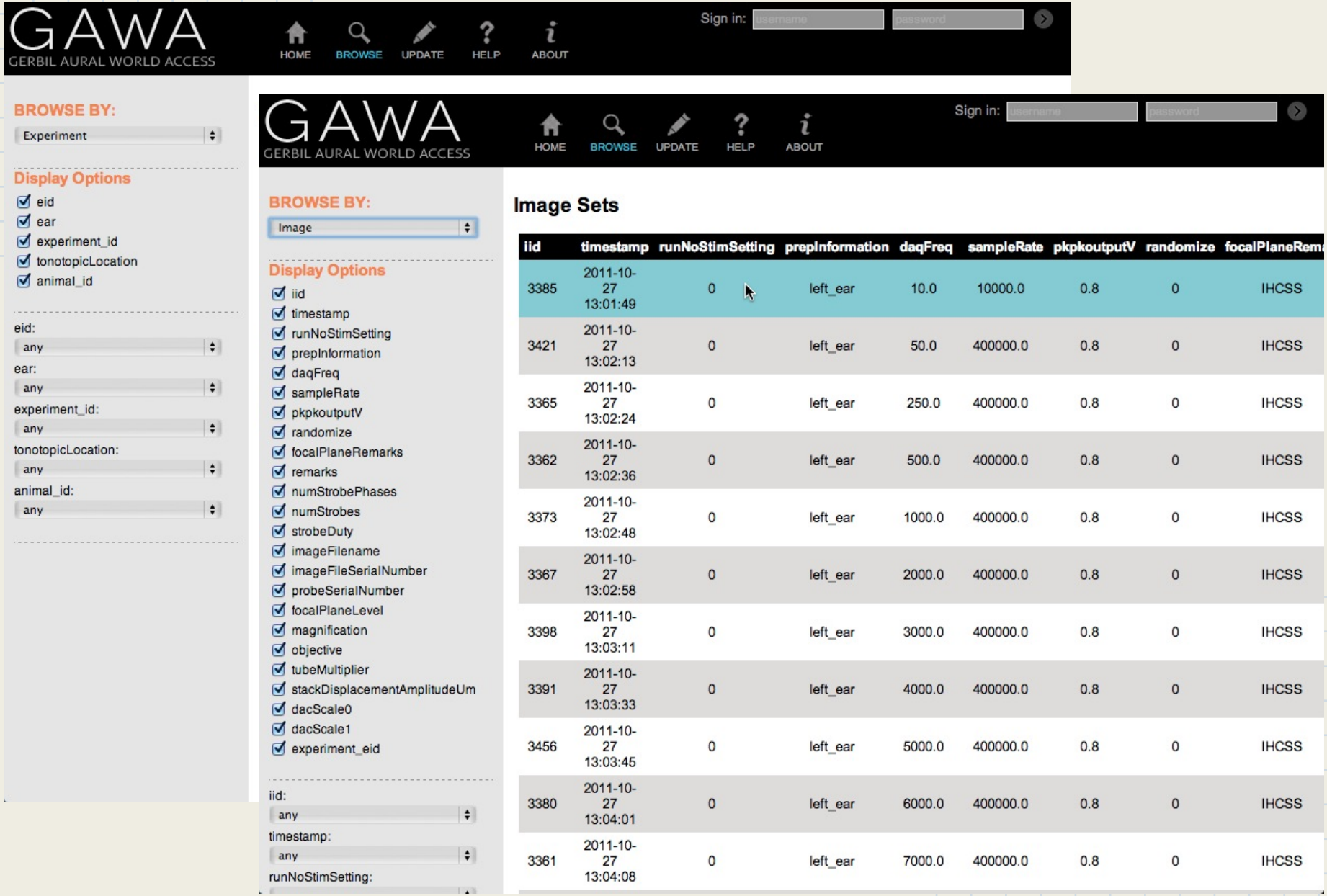
Animals

aid	weight	age	sex	drug	dose_mg_kg	postMortemActivity	remarks	subjectID	species
3	46.0	40.0	F		Ketamine200mg:xylazene20mg	2		mu300	Mongolian Gerbil
10	48.0	48.0	F		Ketamine200mg:xylazene20mg	0		mu301	Mongolian Gerbil
8	63.0	106.0	F		Ketamine200mg:xylazene20mg	1		mu302	Mongolian Gerbil
11	63.0	112.0	F		Ketamine200mg:xylazene20mg	1		mu303	Mongolian Gerbil
9	64.0	124.0	F		Ketamine200mg:xylazene20mg	1		mu304	Mongolian Gerbil
1	46.0	45.0	F		Ketamine200mg:xylazene20mg	0		mu305	Mongolian Gerbil
7	0.0	0.0				0		mu305a	
4	54.0	87.0	F		Ketamine200mg:xylazene20mg	4		mu307	Mongolian Gerbil
5	52.0	52.0	F		Ketamine200mg:xylazene20mg	2		mu308	Mongolian Gerbil
6	56.0	59.0	F		Ketamine200mg:xylazene20mg	1		mu309	Mongolian Gerbil
2	60.0	67.0	F		Ketamine200mg:xylazene20mg	2		mu310	Mongolian Gerbil

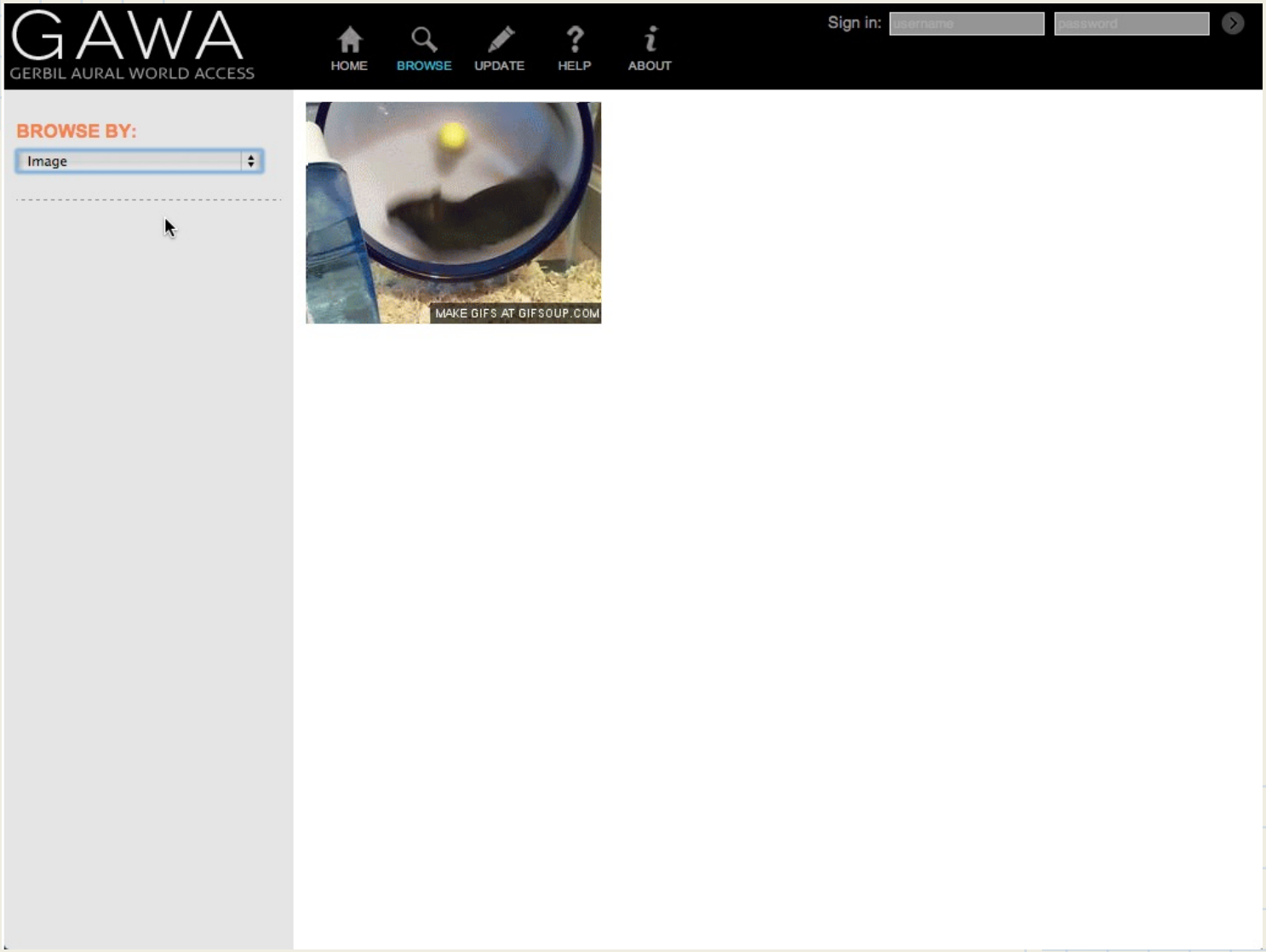
Browse Function: Data via AJAX: Real Time Updates



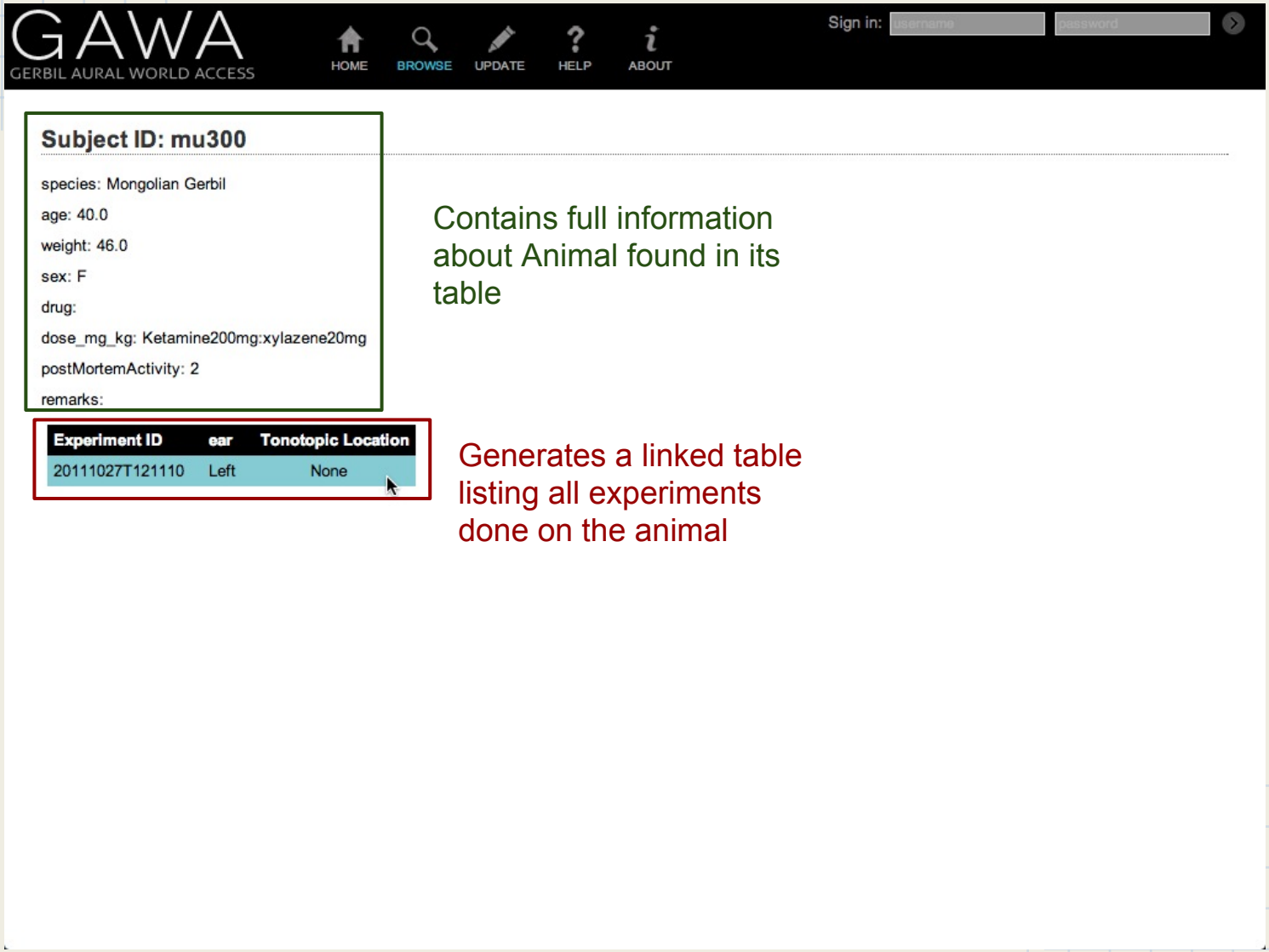
Browse Function: Similar for Experiment & Image



Wait.. is it working? That gerbil is running...



Animal Page



Contains full information about Animal found in its table

Generates a linked table listing all experiments done on the animal

Persistent Links: gawa.py?page=browse&toAnimalPage=true&aid=XXX (XXX=AID)

Experiment Page

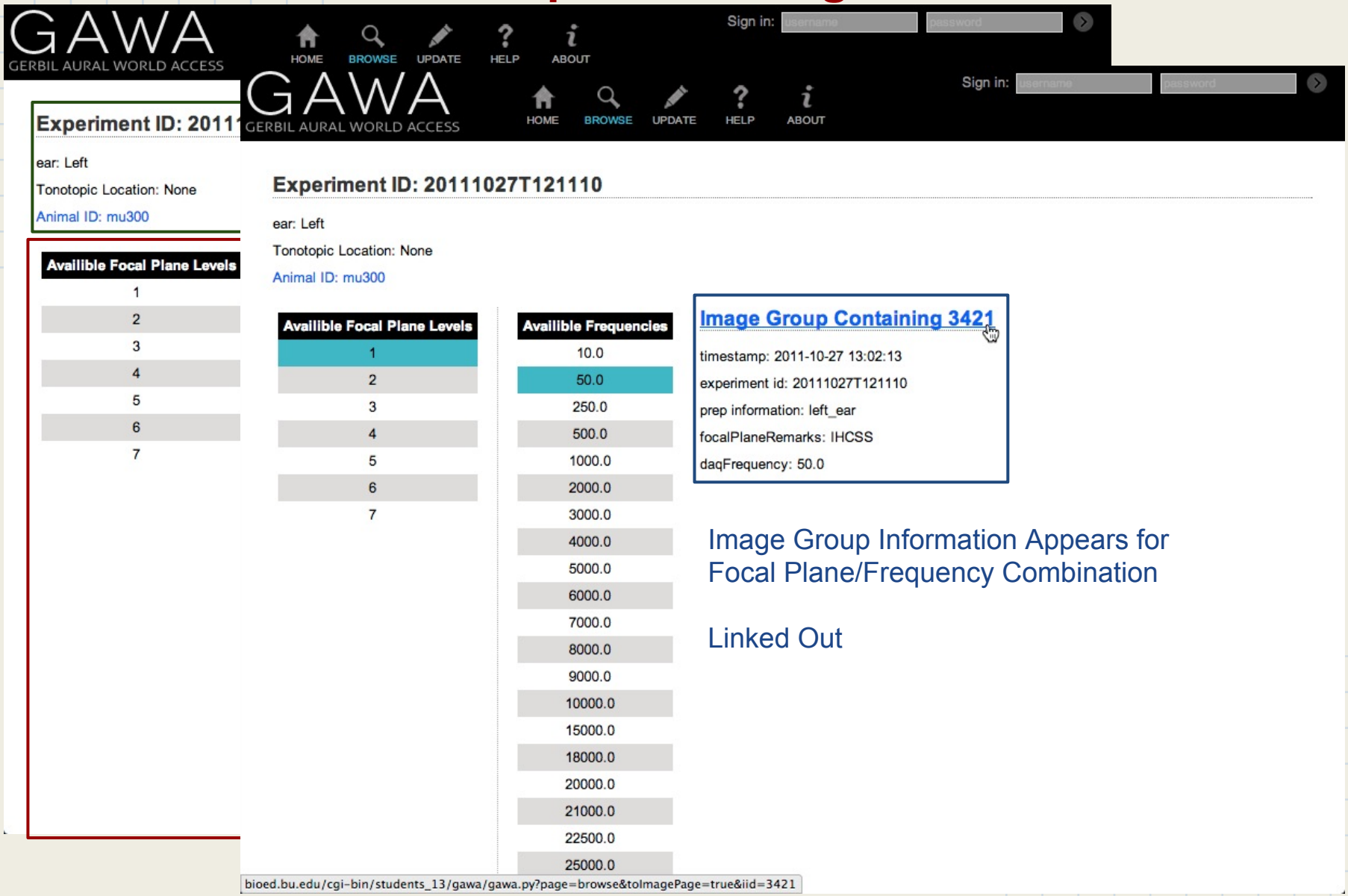


Image Group Information Appears for Focal Plane/Frequency Combination

Linked Out

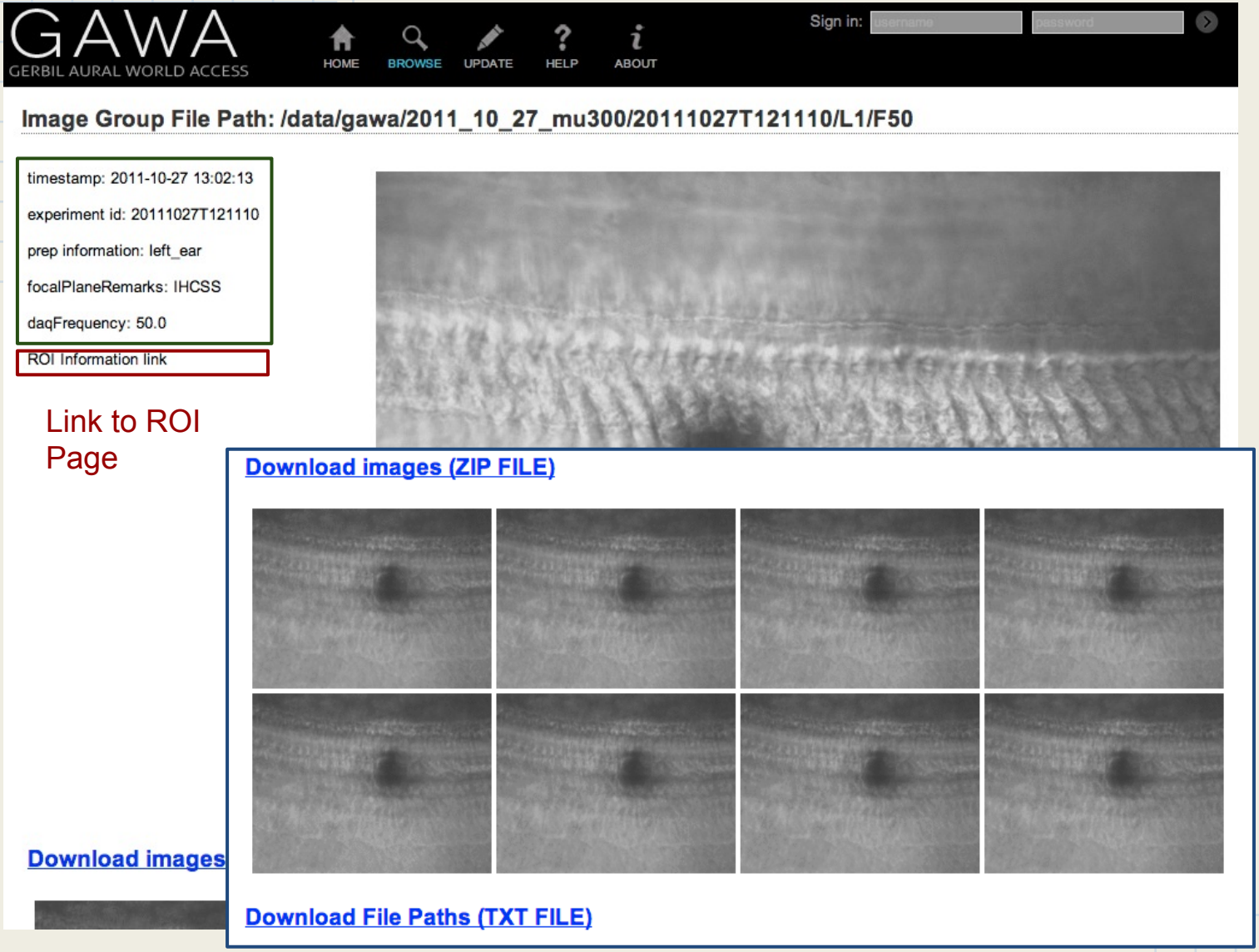
Persistent Links: gawa.py?page=browse&toExperimentPage=true&eid=XXX (XXX=EID)

Images

All queries ultimately result in generating a page that shows the selected Images, and their ROI analyses.

Quick access to these images, and the ability to download them, drive further research.

Image Set Page



Contains full information about an Image Set as found in its table

Link to ROI Page

Download Option for Images & File Paths

Persistent Links: gawa.py?page=browse&toImagePage=true&aid=XXX (XXX=IID)

ROI Page

Region Name or Image Map Box link to ROI Information

ROI Info

Help Pages

Major Aspects of the site have their own pages

If logged in, Additional Help Pages

GAWA
GERBIL AURAL WORLD ACCESS

HOME BROWSE UPDATE HELP ABOUT

Welcome gvosey.
Logout:

Help Pages

Select from the list below to learn more about how each works

- Search & Queries
- Browse Functions
- Update Functions
- HTML/CSS Design
- Python Code

Overview

This page is intended to provide relevant information on the use and function of the different features of the GAWA database.

Getting Started

GAWA provides several main features:

- There are a number of pre-built common tasks present on a persistent sidebar to quickly navigate to commonly used features.
- There is a data browsing function, so the full scope of the database can be seen and navigated by the user.
- There is the ability to update and correct existing data, if you have appropriate access. To request database access with these abilities, please contact the GAWA maintainer.
- There is the ability to download collections of images, animations of images, and post-processor data. These data are assembled on the fly for further analysis.

Quick Search

Quick searches are a dropdown list of common queries where *one* parameter in the search query is a user-entered string.

Example: This will return a result of Experiments that were noted to have contained Inner Hair Cell/Sterocilia:

Anchor Links to Sections

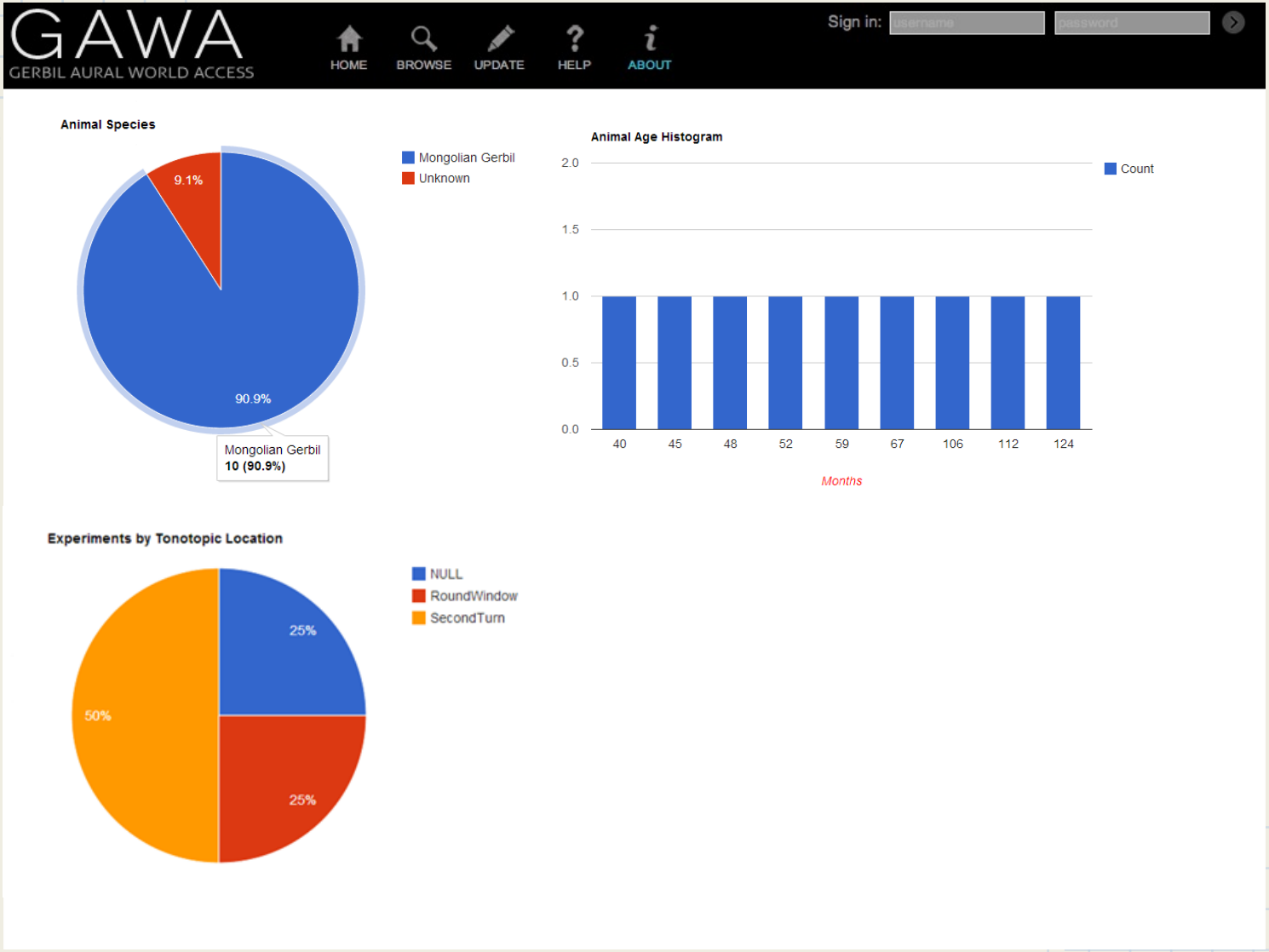
The search results will resemble the following example Experiment:

Experiment ID: 20120105T121124

ear: Left

Persistent Links: gawa.py?page=help

About Page: DB Data



Future Directions

- Break Out Focal Planes and Frequencies as Entity Tables
  - Assign combinations of (FP & Experiments) and (Frequency, FP, & Experiment) Quality Scores and Remarks as the data is reanalyzed
- Normalize the ROI table by storing ROI blobs, not individual (x,y) records.
  - This will speed up queries and reduce the size of the Image_has_ROI table.
  - A serializer/deserializer will need to be written in C# and python
- Port the database from bioed to a server managed by the Auditory Biophysics lab
- Modify existing experimental setup to automatically insert records into the database during active research
  - C# DAQ interface
  - MATLAB post-processor
  - MATLAB ROI processor

Questions?