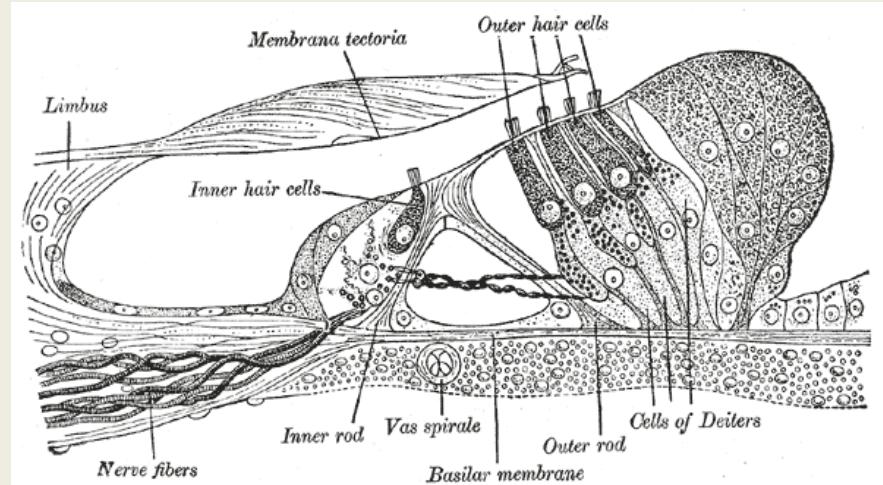
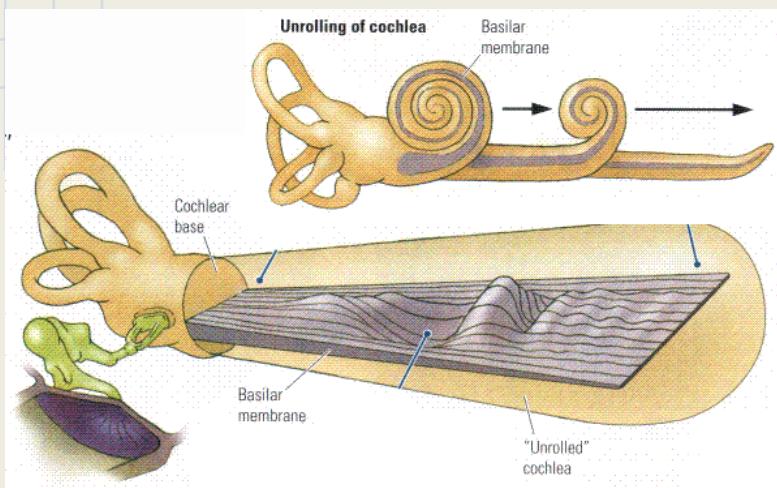


Gerbil Aural World Access

Final Presentation, BE768
30 April 2013

Will Chapin, Amauche Emenari, Ali Jiwani, Graham Voysey

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



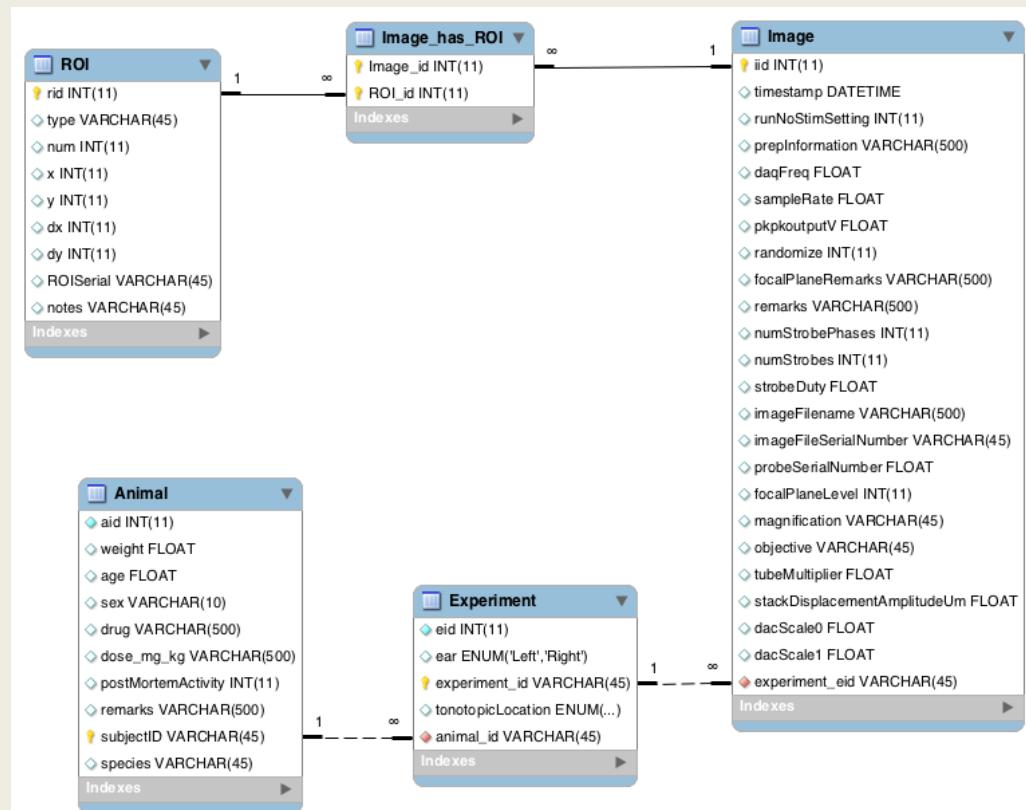
Broken into a directory
structure

File name and location
has parseable semantic
meaning.

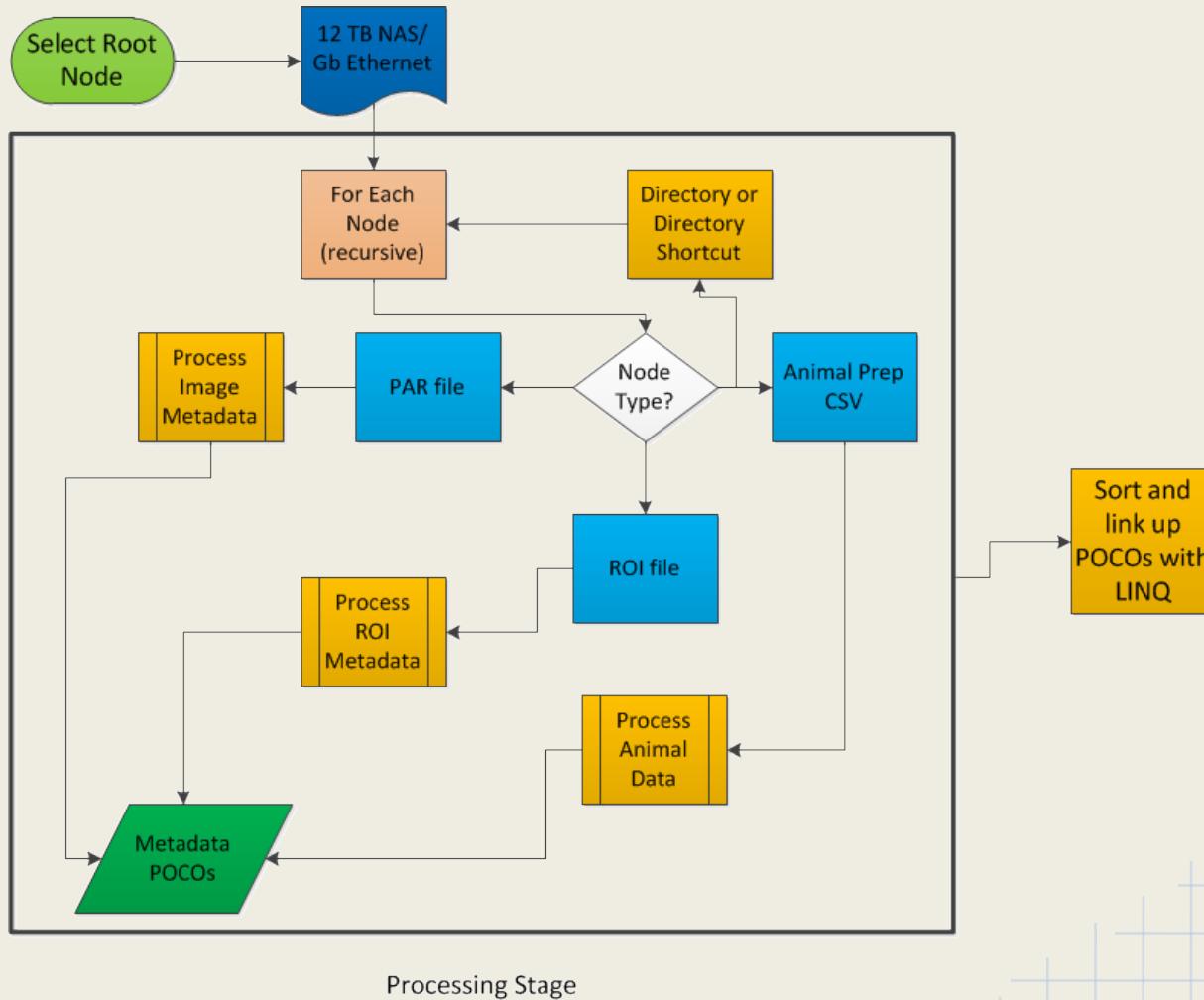
Each image corresponds
to exactly one PAR file.

ER Diagram

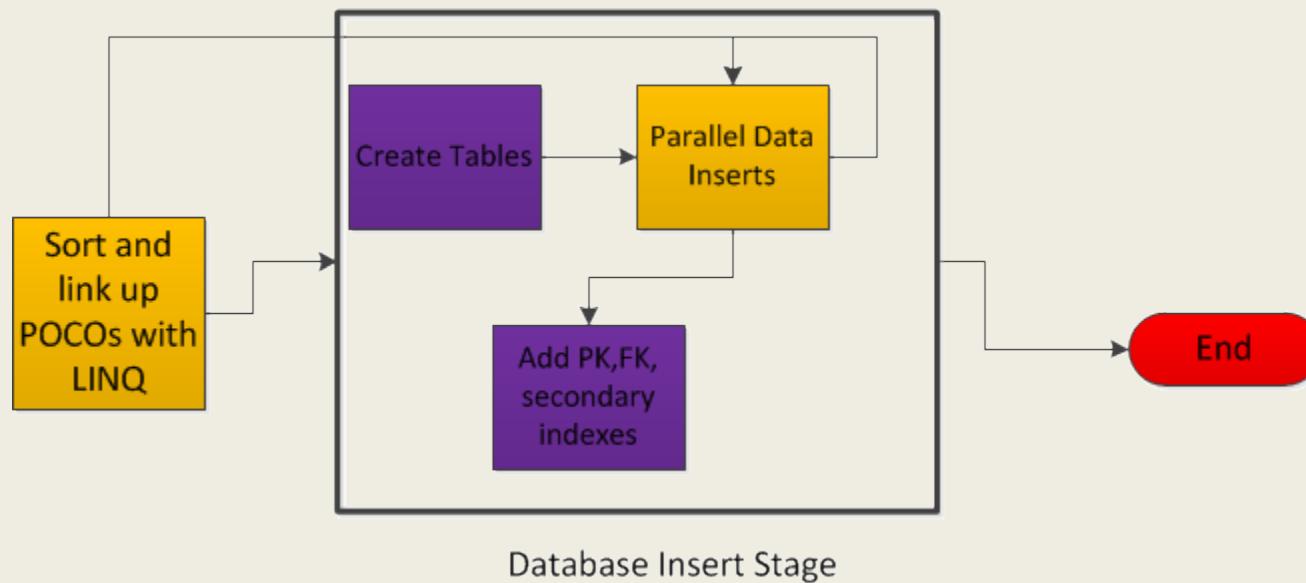
1. 5 Tables: 4 Entities, 1 Relationship
2. An Animal has one or more associated Experiments
3. An Experiment has many Images
4. A given Image may or may not have one or more Regions of Interest (ROI)
5. Primary Indexes chosen for fast queries.
 - a. secondary indexes chosen to meet FK uniqueness constraints



Data Import Process



Data Import Process

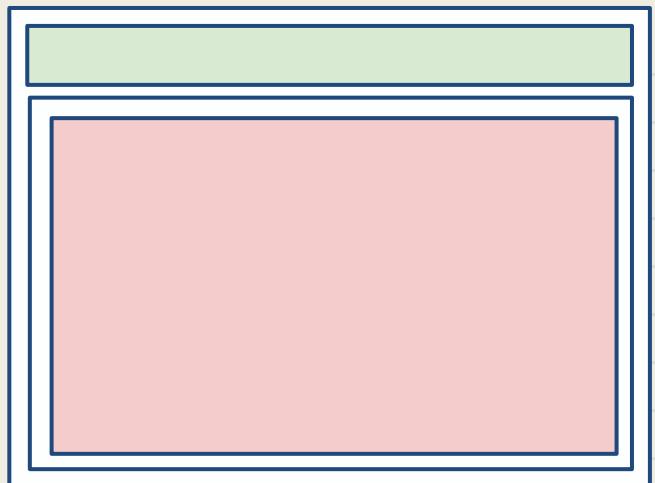
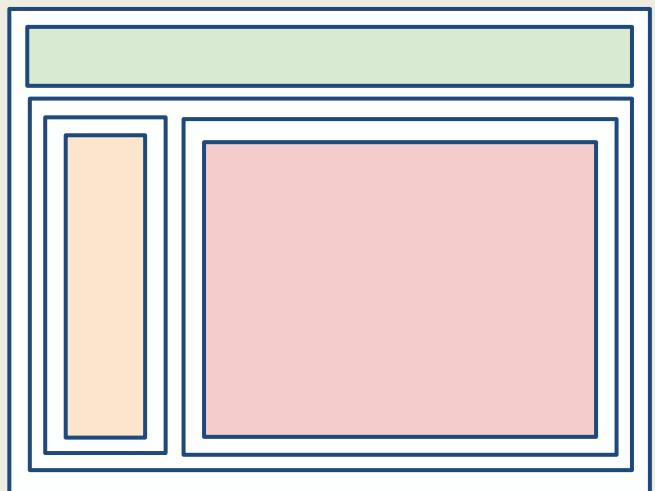


Import Complete!

Next: Website Development

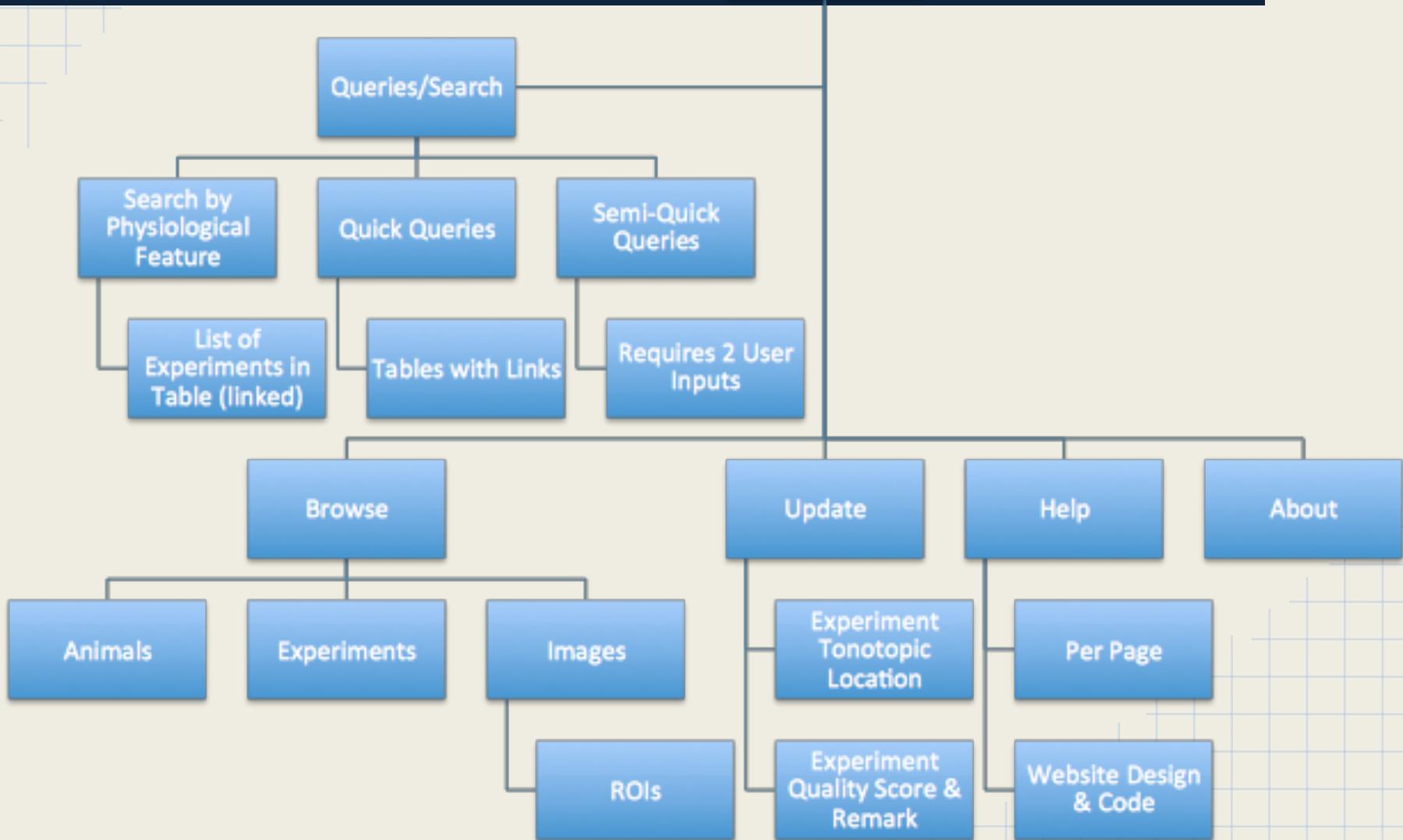
Website Development

- 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



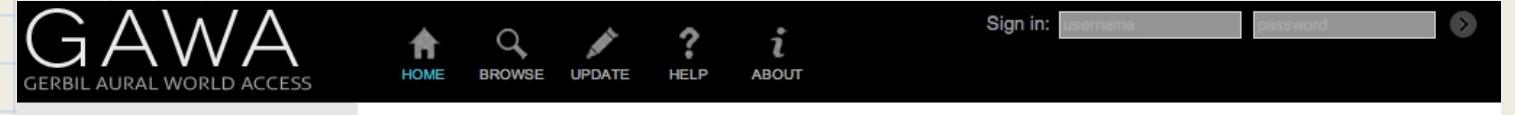
Home Page

Link to Home

Navigation (location aware)

Login/Status/Logout

Standard Header Bar



Basic Search Options

Quick Queries

Semi-Quick-Queries



On Items for help

QUICK SEARCH ?

Noted Physiological Features

keyword

QUICK QUERIES ?

Images without ROI

SEMI QUICK QUERIES ?

Find all images whose Tonotopic Map has:

RoundWindow

And whose remarks contain:

keyword

Find all images whose frequency is:

50Hz

And whose remarks contain:

keyword

Find all experiments with a minimum # of levels

1

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

The screenshot shows the GAWA home page with a sidebar containing search filters and a main content area titled "All Experiments" displaying a table of experiment data.

Search Filters (Sidebar):

- QUICK SEARCH**: Noted Physiological Features, keyword: "RoundWindow".
- QUICK QUERIES**: Images without ROI.
- SEMI QUICK QUERIES**: Find all images whose Tonotopic Map has: RoundWindow; And whose remarks contain: keyword: "RoundWindow".
- Find all images whose frequency is: 50Hz; And whose remarks contain: keyword: "RoundWindow".
- Find all experiments with a minimum # of levels: 1.

Main Content: 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

The image displays three horizontal screenshots of the GAWA (GERBIL AURAL WORLD ACCESS) application interface.

- Top Screenshot:** Shows the main GAWA homepage. The header reads "GAWA GERBIL AURAL WORLD ACCESS". Below the header are navigation links: HOME (with a house icon), BROWSE (with a magnifying glass icon), UPDATE (with a pencil icon, highlighted in blue), HELP (with a question mark icon), and ABOUT (with an information icon). To the right is a "Sign in:" form with fields for "username" and "password" and a "Sign in" button.
- Middle Screenshot:** Shows a user profile page for "gvosey". The header is identical to the top screenshot. On the right side, it says "Welcome gvosey." and "Logout: >".
- Bottom Screenshot:** Shows the "Update Experiment Remarks" page for Experiment 10. The header is identical to the top screenshot. The main content area includes a "Select an experiment" dropdown set to "Experiment 10", a search bar with the placeholder "keyword", and a "Search" button.

Select an experiment

Experiment 10

Experiment 10

keyword 

Browsing

Next: A general database browser.

Browse Function: Data via AJAX

GAWA
GERBIL AURAL WORLD ACCESS

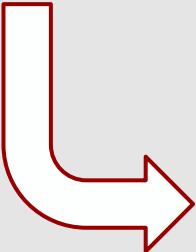
HOME BROWSE UPDATE HELP ABOUT

Sign in: username password >

BROWSE BY:

✓ Select Result Type

Animal
Experiment
Image



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:
any

Animals

aid	weight	age	sex	drug	dose_mg_kg	postMortemActivity	remarks	subjectID	species
3	46.0	40.0	F	Ketamine200mg:xylazine20mg		2		mu300	Mongolian Gerbil
10	48.0	48.0	F	Ketamine200mg:xylazine20mg		0		mu301	Mongolian Gerbil
8	63.0	106.0	F	Ketamine200mg:xylazine20mg		1		mu302	Mongolian Gerbil
11	63.0	112.0	F	Ketamine200mg:xylazine20mg		1		mu303	Mongolian Gerbil
9	64.0	124.0	F	Ketamine200mg:xylazine20mg		1		mu304	Mongolian Gerbil
1	46.0	45.0	F	Ketamine200mg:xylazine20mg		0		mu305	Mongolian Gerbil
7	0.0	0.0						mu305a	
4	54.0	87.0	F	Ketamine200mg:xylazine20mg		4		mu307	Mongolian Gerbil
5	52.0	52.0	F	Ketamine200mg:xylazine20mg		2		mu308	Mongolian Gerbil
6	56.0	59.0	F	Ketamine200mg:xylazine20mg		1		mu309	Mongolian Gerbil
2	60.0	67.0	F	Ketamine200mg:xylazine20mg		2		mu310	Mongolian Gerbil

Browse Function: Data via AJAX: Real Time Updates

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:

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

age	sex	dose_mg_kg	postMortemActivity	remarks	subjectID	species
106.0	F	Ketamine200mg:xylazine20mg	1		mu302	Mongolian Gerbil
112.0	F	Ketamine200mg:xylazine20mg	1		mu303	Mongolian Gerbil
124.0	F	Ketamine200mg:xylazine20mg	1		mu304	Mongolian Gerbil
59.0	F	Ketamine200mg:xylazine20mg	1		mu309	Mongolian Gerbil

postMortemActivity:

remarks:

subjectID:

species:



Browse Function: Similar for Experiment & Image

GAWA
GERBIL AURAL WORLD ACCESS

HOME BROWSE UPDATE HELP ABOUT

Sign in: username password >

BROWSE BY:

Experiment

Display Options

- eid
- ear
- experiment_id
- tonotopicLocation
- animal_id

eid:
any
ear:
any
experiment_id:
any
tonotopicLocation:
any
animal_id:
any

GAWA
GERBIL AURAL WORLD ACCESS

HOME BROWSE UPDATE HELP ABOUT

Sign in: username password >

BROWSE BY:

Image

Display Options

- iid
- timestamp
- runNoStimSetting
- preplInformation
- daqFreq
- sampleRate
- pkpkoutputV
- randomize
- focalPlaneRemarks
- remarks
- numStrobePhases
- numStrobes
- strobeDuty
- imageFilename
- imageFileSerialNumber
- probeSerialNumber
- focalPlaneLevel
- magnification
- objective
- tubeMultiplier
- stackDisplacementAmplitudeUm
- dacScale0
- dacScale1
- experiment_eid

iid:
any
timestamp:
any
runNoStimSetting:
any

Image Sets

iid	timestamp	runNoStimSetting	preplInformation	daqFreq	sampleRate	pkpkoutputV	randomize	focalPlaneRemarks
3385	2011-10-27 13:01:49	0	left_ear	10.0	10000.0	0.8	0	IHCSS
3421	2011-10-27 13:02:13	0	left_ear	50.0	400000.0	0.8	0	IHCSS
3365	2011-10-27 13:02:24	0	left_ear	250.0	400000.0	0.8	0	IHCSS
3362	2011-10-27 13:02:36	0	left_ear	500.0	400000.0	0.8	0	IHCSS
3373	2011-10-27 13:02:48	0	left_ear	1000.0	400000.0	0.8	0	IHCSS
3367	2011-10-27 13:02:58	0	left_ear	2000.0	400000.0	0.8	0	IHCSS
3398	2011-10-27 13:03:11	0	left_ear	3000.0	400000.0	0.8	0	IHCSS
3391	2011-10-27 13:03:33	0	left_ear	4000.0	400000.0	0.8	0	IHCSS
3456	2011-10-27 13:03:45	0	left_ear	5000.0	400000.0	0.8	0	IHCSS
3380	2011-10-27 13:04:01	0	left_ear	6000.0	400000.0	0.8	0	IHCSS
3361	2011-10-27 13:04:08	0	left_ear	7000.0	400000.0	0.8	0	IHCSS

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

GERBAL AURAL WORLD ACCESS

HOME BROWSE UPDATE HELP ABOUT

Sign in:

BROWSE BY:

Image

MAKE GIFS AT GIFSOUP.COM

A small video thumbnail showing a gerbil running in a wheel. The gerbil is dark-colored with a light patch on its back. The wheel is blue and silver. The background shows a cage with bedding and a water bottle.

Animal Page

Sign in: username password

GAWA
GERBIL AURAL WORLD ACCESS

HOME BROWSE UPDATE HELP ABOUT

Subject ID: mu300

species: Mongolian Gerbil
age: 40.0
weight: 46.0
sex: F
drug:
dose_mg_kg: Ketamine200mg:xylazine20mg
postMortemActivity: 2
remarks:

Contains full information about Animal found in its table

Experiment ID	ear	Tonotopic Location
20111027T121110	Left	None

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

GAWA
GERBIL AURAL WORLD ACCESS

HOME BROWSE UPDATE

HELP ABOUT

Sign in: username password >

GAWA
GERBIL AURAL WORLD ACCESS

HOME BROWSE UPDATE

HELP ABOUT

Sign in: username password >

Experiment ID: 20111

ear: Left

Tonotopic Location: None

Animal ID: mu300

Available Focal Plane Levels

1
2
3
4
5
6
7

Available Focal Plane Levels

1
2
3
4
5
6
7

Available Frequencies

10.0
50.0
250.0
500.0
1000.0
2000.0
3000.0
4000.0
5000.0
6000.0
7000.0
8000.0
9000.0
10000.0
15000.0
18000.0
20000.0
21000.0
22500.0
25000.0

Image Group Containing 3421

timestamp: 2011-10-27 13:02:13
experiment id: 20111027T121110
prep information: left_ear
focalPlaneRemarks: IHCSS
daqFrequency: 50.0

Image Group Information Appears for Focal Plane/Frequency Combination

Linked Out

bioed.bu.edu/cgi-bin/students_13/gawa/gawa.py?page=browse&toImagePage=true&iid=3421

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

GAWA
GERBIL AURAL WORLD ACCESS

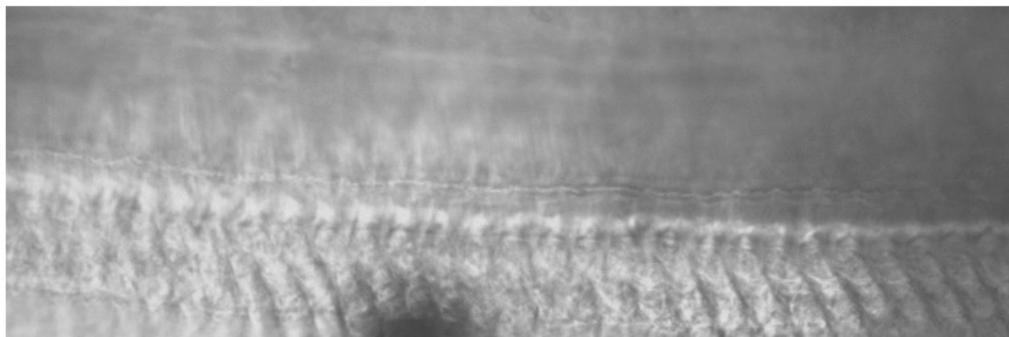
HOME BROWSE UPDATE HELP ABOUT

Sign in: username password >

Image Group File Path: /data/gawa/2011_10_27_mu300/20111027T121110/L1/F50

timestamp: 2011-10-27 13:02:13
experiment id: 20111027T121110
prep information: left_ear
focalPlaneRemarks: IHCSS
daqFrequency: 50.0

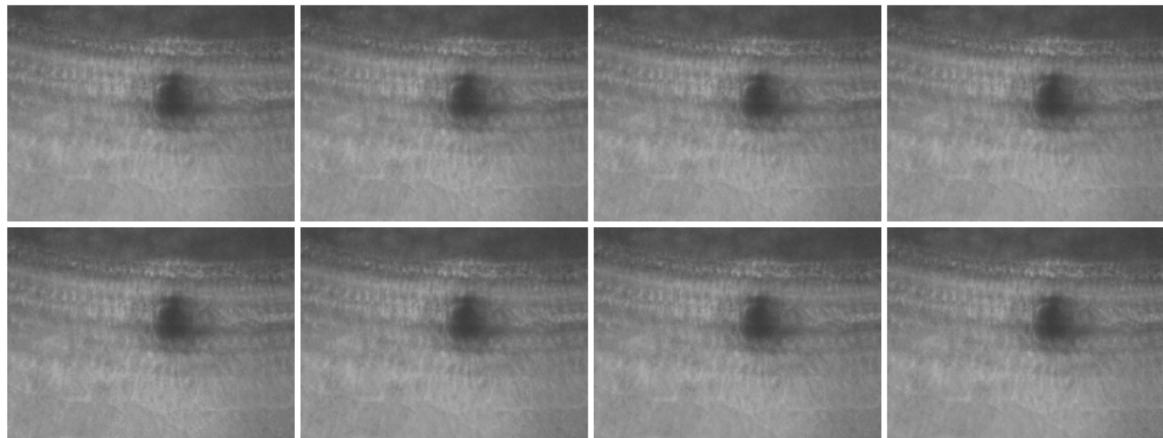
[ROI Information link](#)



Link to ROI

Page

[Download images \(ZIP FILE\)](#)



[Download images](#)

[Download File Paths \(TXT FILE\)](#)

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

Download Option for Images & File Paths

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

ROI Page

Sign in: username password

GAWA
GERBIL AURAL WORLD ACCESS

HOME BROWSE HELP

20120118T153520

Region Name or Image Map Box link to ROI Information

Regions:

- Region 1
- Region 2
- Region 3
- Region 4
- Region 5
- Region 6
- Region 7
- Region 8
- Region 9
- Region 10
- Region 11
- Region 12
- Region 13
- Region 14
- Region 15
- Region 16
- Region 17
- Region 18
- Region 19
- Region 20
- Region 21**
- Region 22
- Region 23

ROI #21 (304,492)

ROI Serial: 20120118T163520
Experiment ID: 20120105T143838
Image ID: 23935

Help Pages



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

If logged in,
Additional
Help Pages

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:

The screenshot shows a search interface with a dropdown menu labeled "QUICK SEARCH ?". The dropdown contains the text "Noted Physiological Features". Below the dropdown is a text input field containing "IHCSS" and a search button represented by a right-pointing arrow.



Anchor Links to Sections

The search results will resemble the following example Experiment:

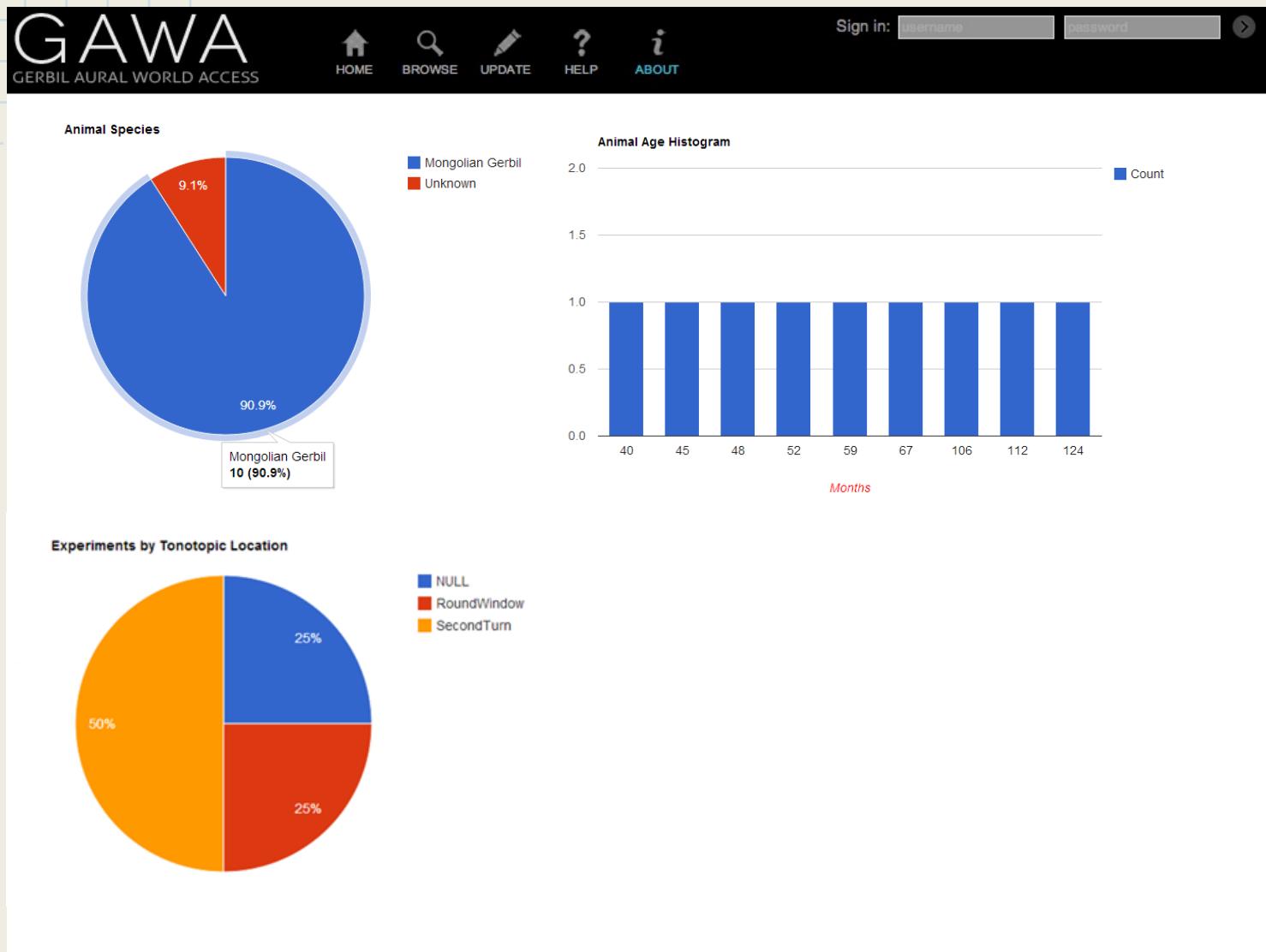
Experiment ID: 20120105T121124

ear: Left

Persistent Links: gawa.py?page=help

Major
Aspects of
the site
have their
own pages

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?