The AMT Team:
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The 3rd AMT Workshop

Turin, 8.9.2023

The AMT Workshop: Structure and Goals

- What is the AMT and how can it be useful for you?
  - General AMT structure
  - The core functionality
  - *Basic*: Using AMT models
  - *Advanced*: Make your own model
  - Hands-on in two groups (*Basic, Advanced*)
- Goals:
  - Do you know what is the AMT and its components?
  - Do you have a basic idea of what you can do with the AMT?
  - *Basic*: Are you able to install the AMT and run its models?
  - *Advanced*: Are you able to implement your own model?

The AMT

- An open-source and open-access toolbox for auditory modeling
  - A tool for reproducing scientific experiments with auditory models
  - A framework for developing new models
- Environment:
  - Core: Matlab/Octave
  - Models: (nearly) any programming language
- Software license:
  - Core: GPL version 3
  - Models: Multi licensing; (nearly) any GPL3-compatible license
- Link of a large amount of data and complex code
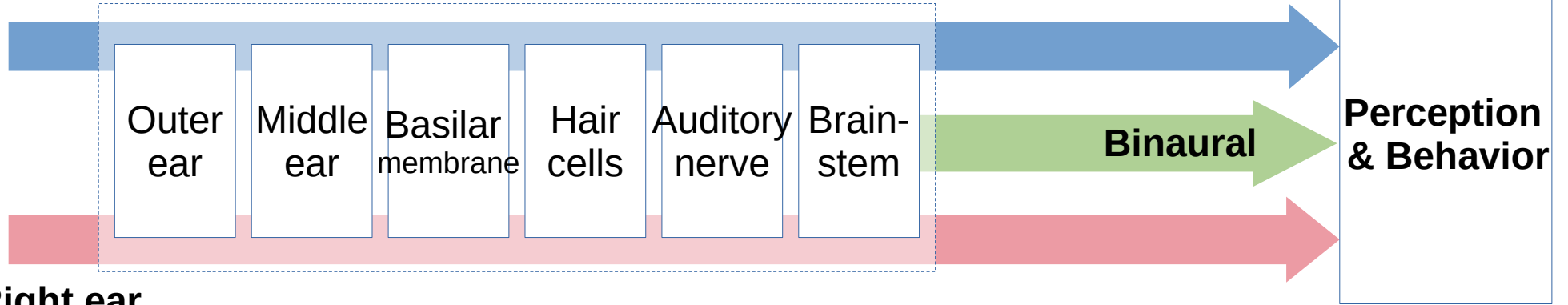- Integration of other toolboxes useful in auditory research

The AMT

- 2009: Development initiated by Peter Søndergaard
- 2012: Development moved to ÖAW
- 2021: AMT 1.0 released
- Now: Over 60 auditory models, 40 GB of auditory data
- Two releases per year, with a focus on sustainability

- Community work: Most of the models "donated" to the AMT
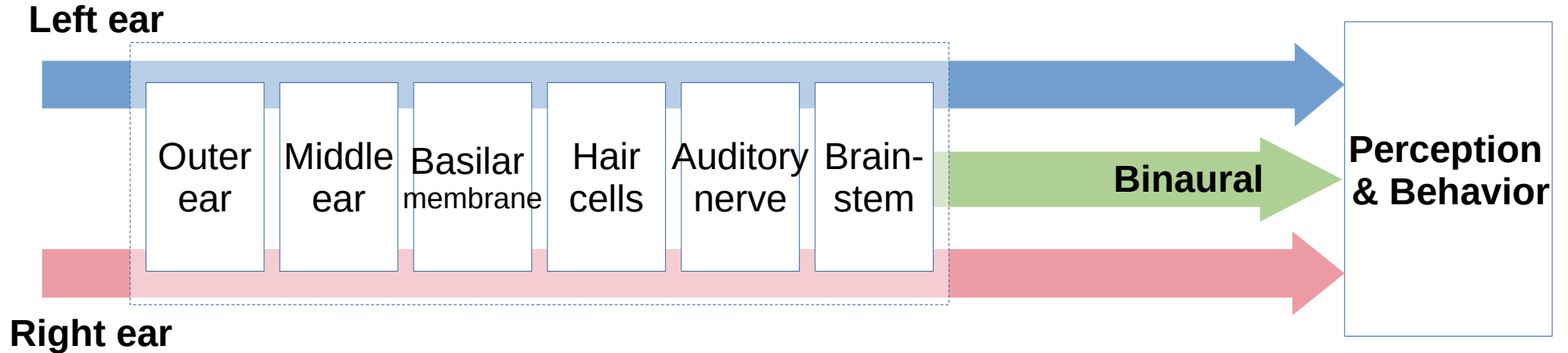- Increase the authors' visibility and add citations

Typical stages of auditory models

Typical stages of auditory models

Left ear

Outer ear | Middle ear | Basilar membrane | Hair cells | Auditory nerve | Brain-stem

Binaural

Perception & Behavior

Right ear

- Model ≠ Model implementation
- Models need data
- Model implementations often rely on toolboxes
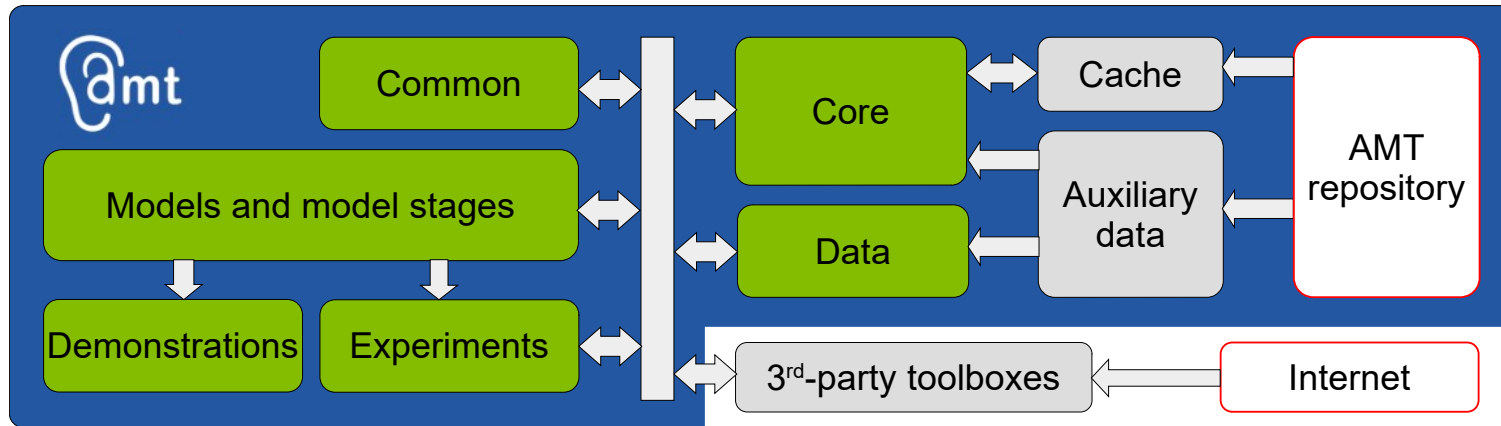- Some models use common functionality, some are stand-alone concepts

The Auditory Modeling Toolbox (AMT)
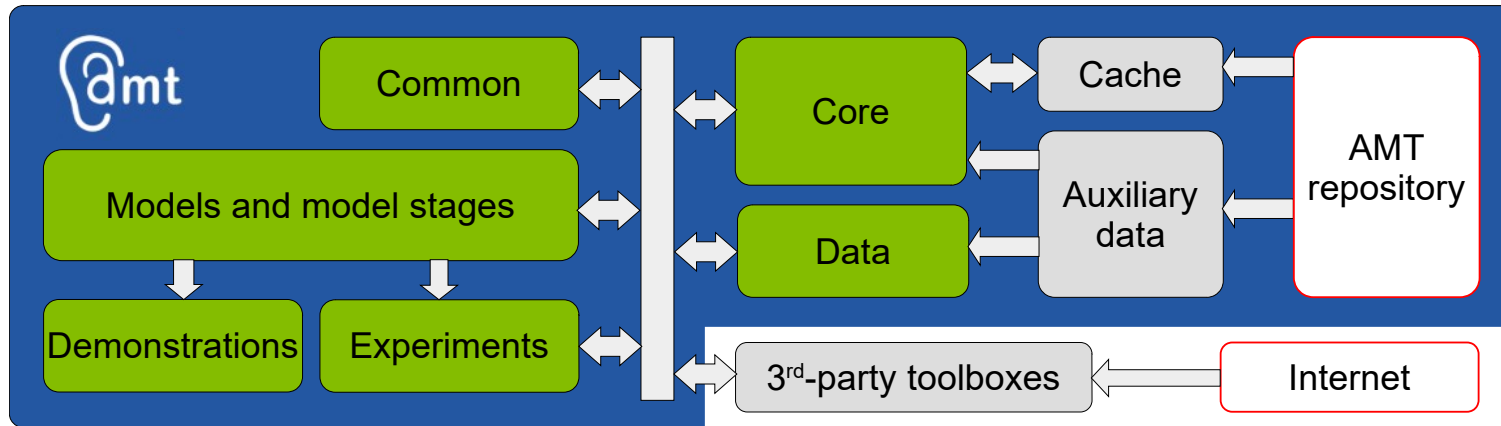
- Model ≠ Model implementation

- Models need data

- Model implementations often rely on toolboxes

- Some models use common functionality, some are stand-alone concepts

The Auditory Modeling Toolbox (AMT)
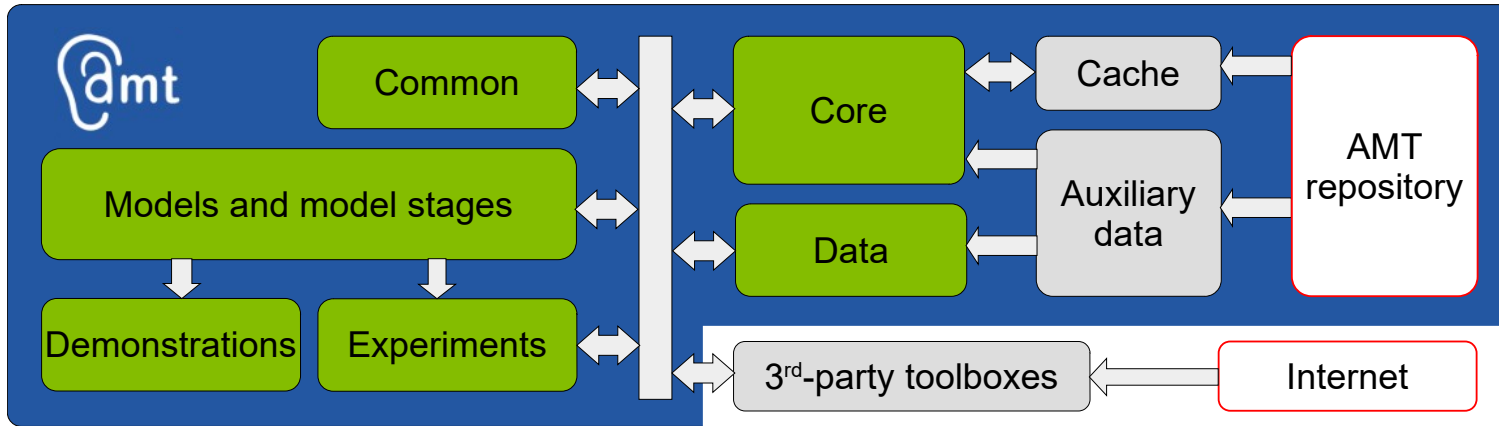
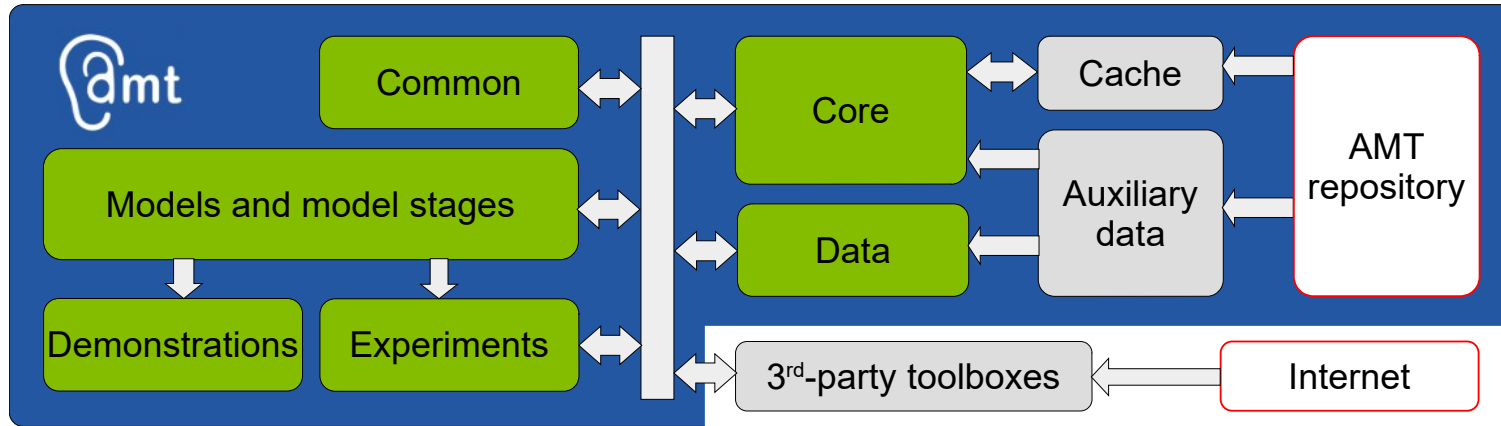- Model ≠ Model implementation: Smith et al. (2022) → `smith2022`
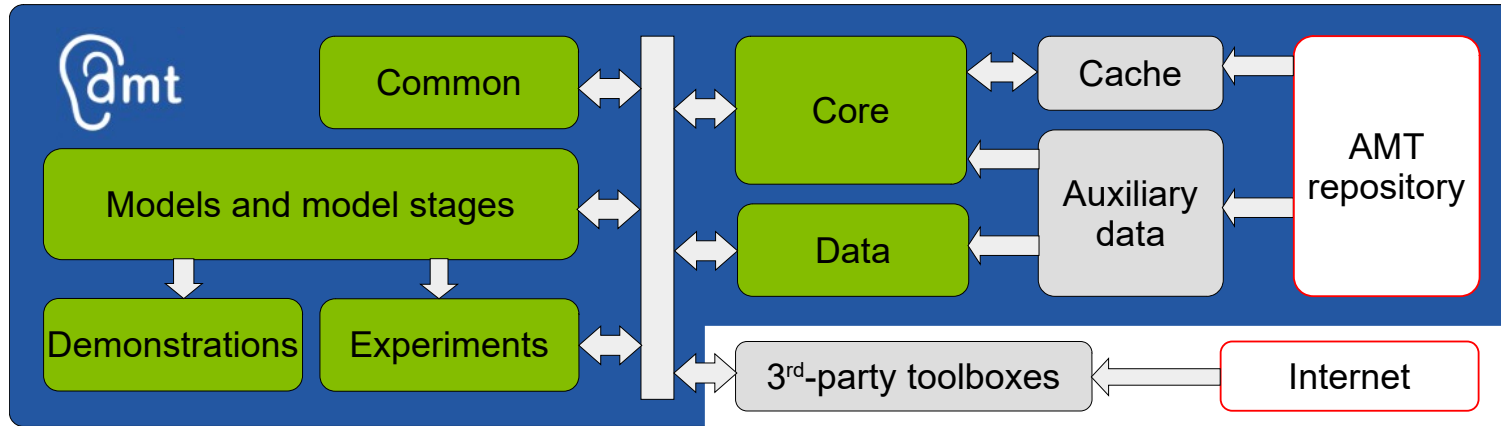
The Auditory Modeling Toolbox (AMT)

- Model ≠ Model implementation: Smith et al. (2022) → `smith2022`

- Models need data: Auxiliary data

  – Dedicated function: → `data_smith2022`

  – Direct: → `amt_load('smith2022',..)`

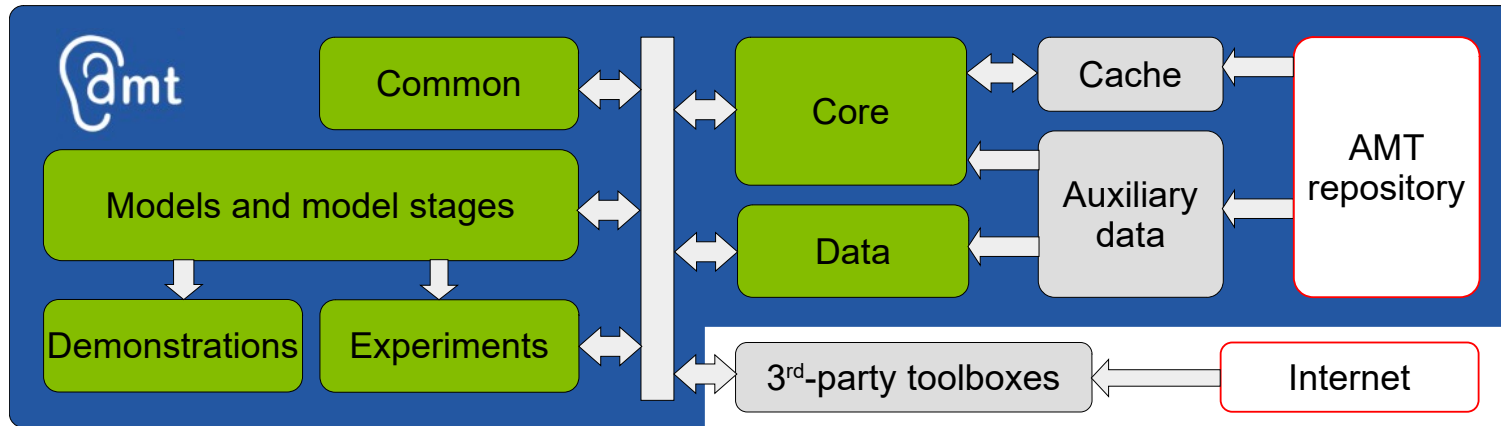# The Auditory Modeling Toolbox (AMT)

- Model implementations often rely on toolboxes: Third-party toolboxes
  - Large Time Frequency Analysis Toolbox (LTFAT)
  - *Optional*: Spatially Oriented Format for Acoustics (SOFA) Toolbox, Sound Field Synthesis (SFS) Toolbox, Circular Statistics (CircStat) Toolbox, Binaural Spherical Harmonics (BinSH) Toolbox
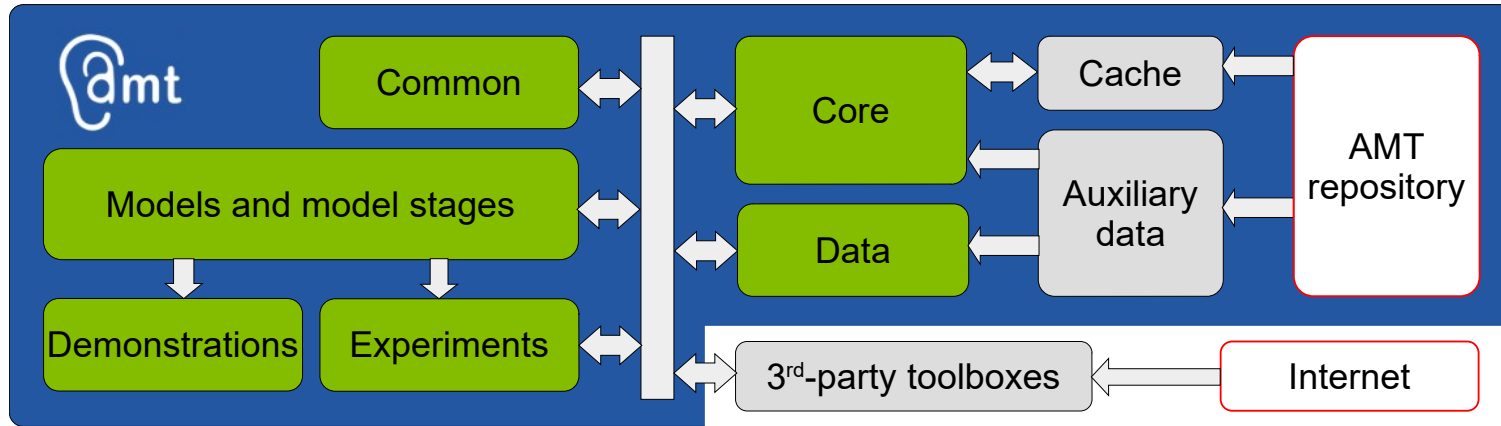
The Auditory Modeling Toolbox (AMT)

- Core functions: the main power of the AMT
  - Storing pre-calculated data: Cache → `amt_cache`
  - Data handling: Auxiliary data → `amt_load`
  - Simulation of experiments: → `amt_emuexp`
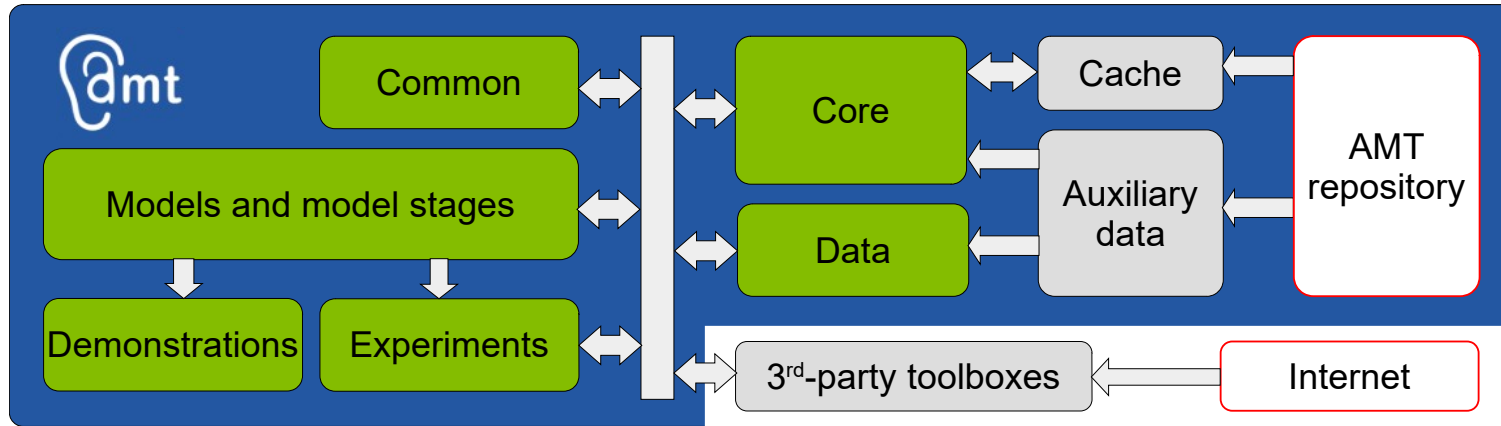
The Auditory Modeling Toolbox (AMT)

- Models
  - → `breebaart2011`

- Model stages:
  - → `breebaart2011_outmiddlefilter`
  - → `breebaart2011_eicell`
  - → `breebaart2011_centralproc`

The Auditory Modeling Toolbox (AMT)

- Common functions:
    - → `scaletodbspl`
    - → `erb2fc`
    - → `middleearfilter`
    - → `gammatone`
    - → `itdestimator`
    - → `adaptloop`

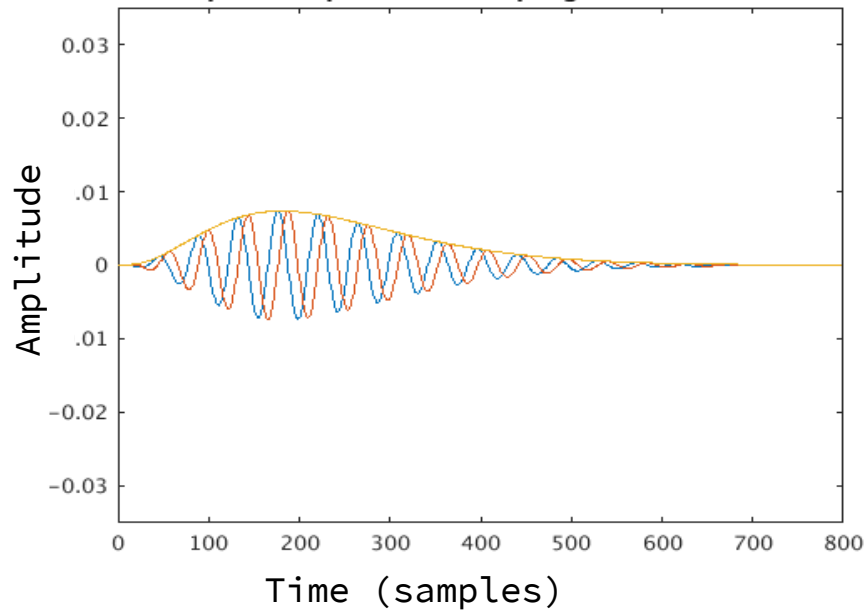# The Auditory Modeling Toolbox (AMT)

- Demonstrations: Simple scripts demonstrating the functionality
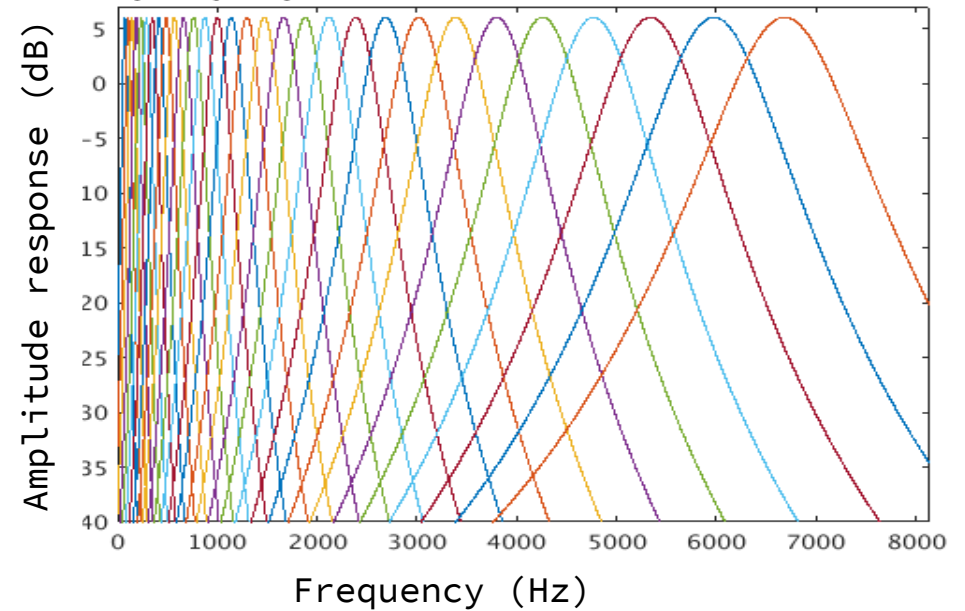 → `demo_smith2022`

Demonstrations

`demo_hohmann2002;`

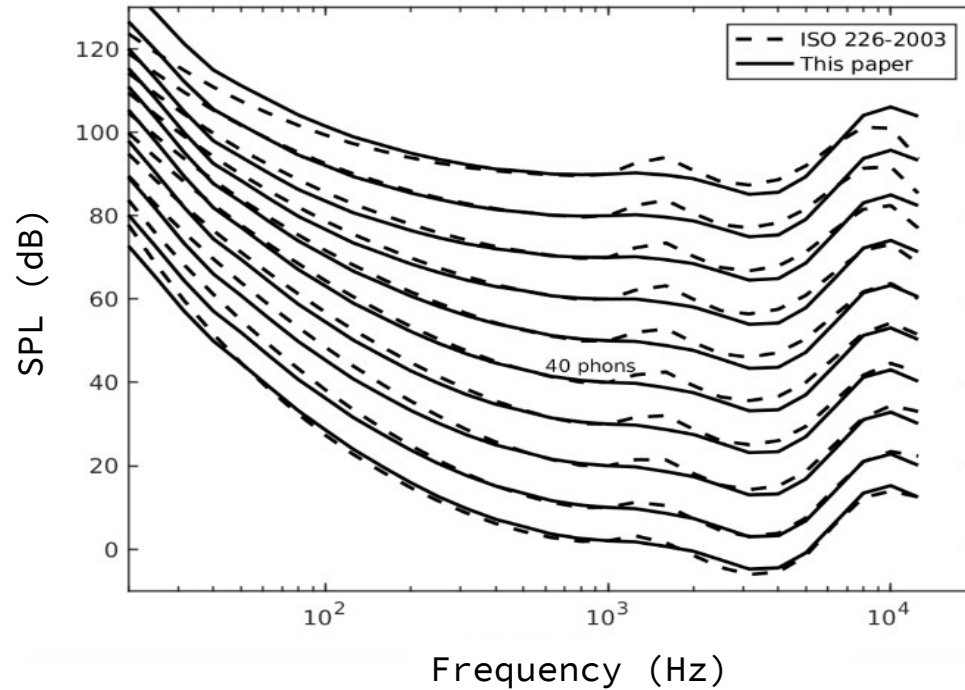impulse response of example gammatone filter

frequency response of the individual filters in this filterbank
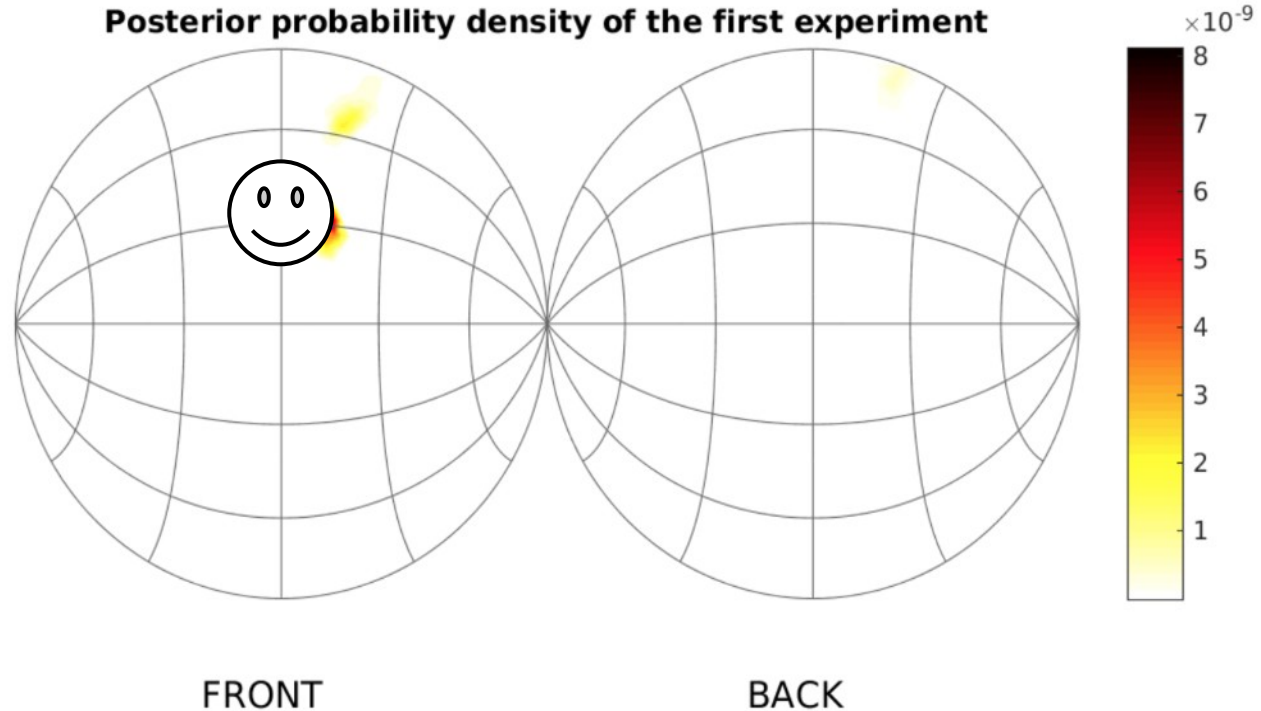
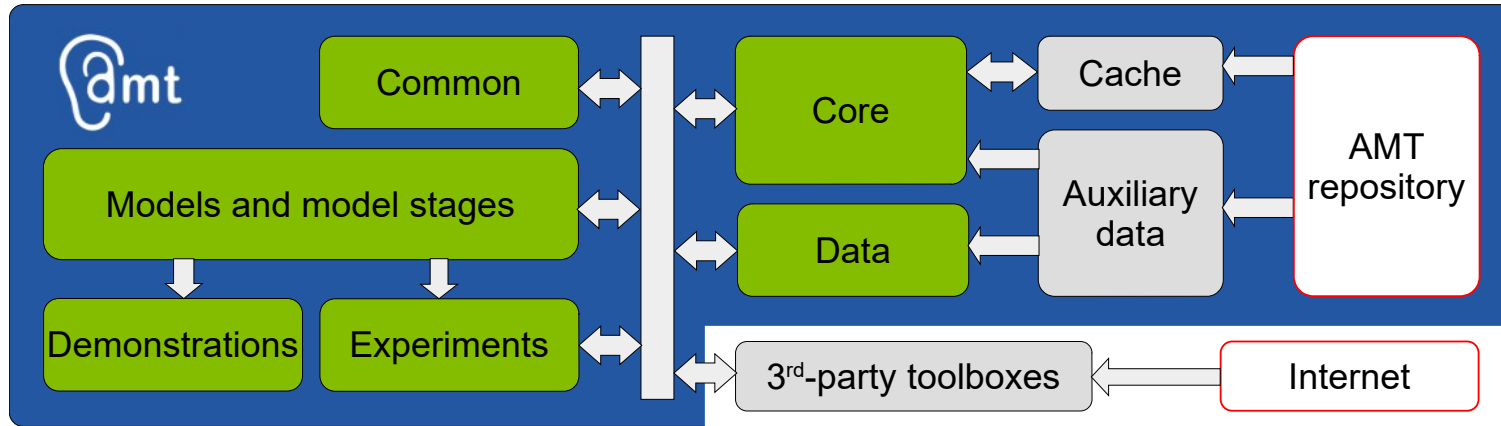# Demonstrations

`demo_chen2011;`

Demonstrations

```
demo_reijniers2014;
```


Posterior probability density of the first experiment
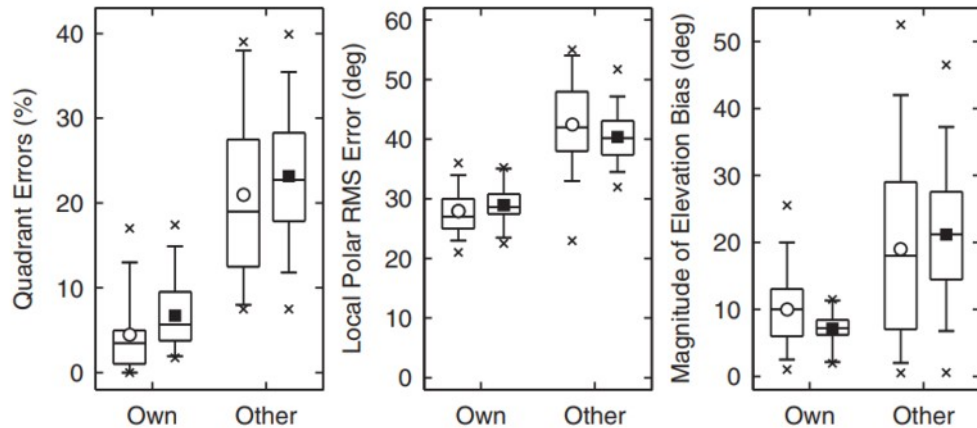
FRONT   BACK

The Auditory Modeling Toolbox (AMT)

- Demonstrations: Simple scripts demonstrating the functionality
  → `demo_smith2022`
- Experiments: Functions reproducing published results
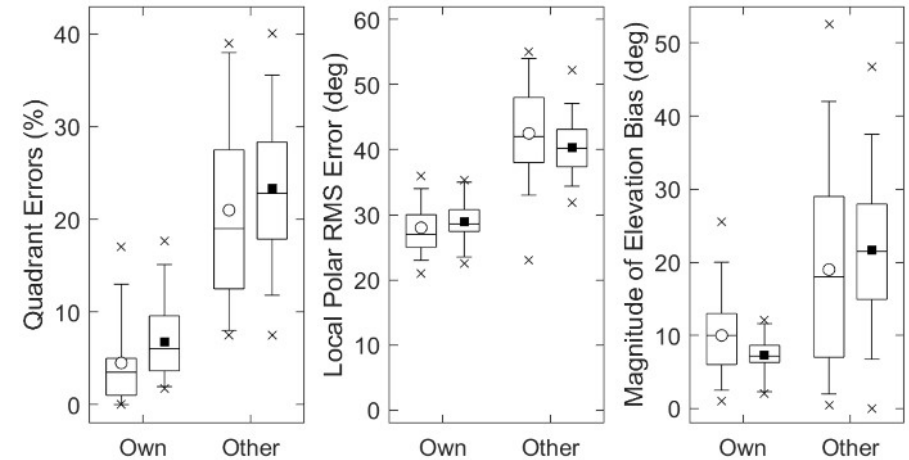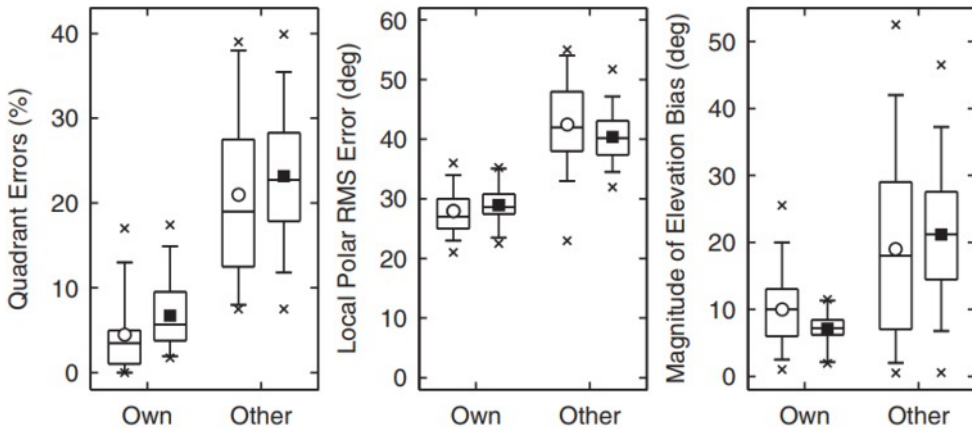 → `exp_smith2022('fig3')`

Experiments

Screenshot from Figure 9
(Baumgartner et al., 2014):

Baumgartner, Majdak, Laback (2014) „Modeling sagittal-plane sound localization", J Acoust Soc Am 136: 791-802

Experiments

Screenshot from Figure 9
(Baumgartner et al., 2014):

Output of
`exp_baumgartner2014('fig9');`

Baumgartner, Majdak, Laback (2014) „Modeling sagittal-plane sound localization", J Acoust Soc Am 136: 791-802

Experiments

Output of
`exp_osses2022('fig4');`

a) CF at 502 Hz, on-frequency bin
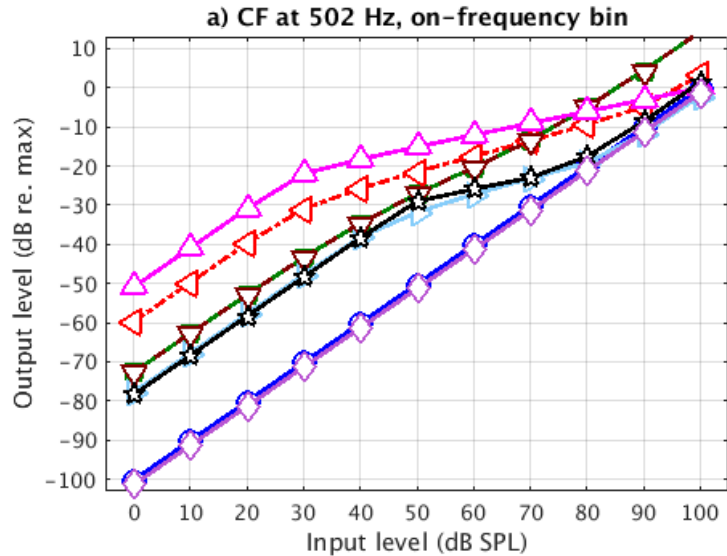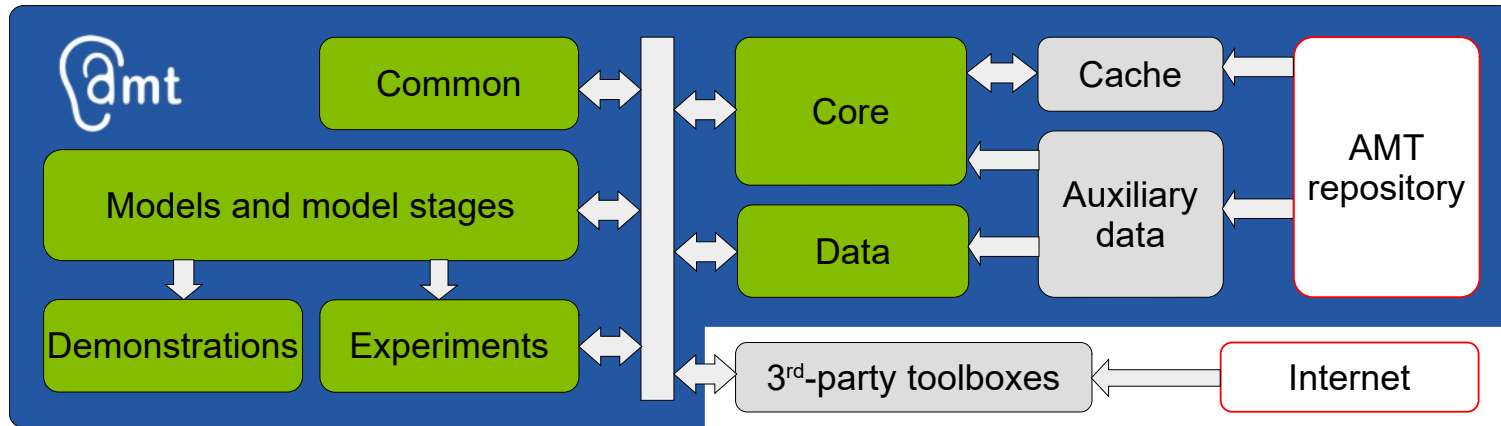
- Blue: Dau et al. (1997)

- Orchid: Osses and Kohlrausch (2021)

- Green: Zilany et al. (2014)

- Maroon: Bruce et al. (2018)

- Red: Verhulst et al. (2015)

- Skyblue: Verhulst et al. (2018)

- Magenta: King et al. (2019)

- Black: Relano-Iborra et al. (2019)

Osses et al. (2022) „A comparative study of eight human auditory models of monaural processing", Acta Acustica, 6: 17.

The Auditory Modeling Toolbox (AMT)

- Code: Files structured in directories
- Special directories:
  - auxdata
  - cache
  - defaults
  - mat2doc

Documentation

- Website: http://amtoolbox.org

Documentation

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Documentation

THE AUDITORY MODELING TOOLBOX

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Applies to version: 1.5.0

Go to function | absolutethreshold

Categories

- Main
- Core functions
- Models
- Model stages
- Demos
- Experiments
- Common functions
- Plot
- Signals
- Data
- Auxdata
- Cache

AMT - Core functions

Installation and session management

- amt_mex - Compile binaries (Mex/Oct interfaces)
- amt_stop - Stop the AMT session and remove all AMT paths

General functions

- amt_cache - Cache variables for later or retrieves variables from cache
- amt_disp - AMT-specific overload of the function 'disp'
- amt_emuexp - Emulate psychoacoustic experiments
- amt_flags - Return the start-up flags of the AMT
- amt_load - Load auxiliary data of a model
- amt_extern - Execute functions in an external environment (e.g., Python)

Paths and configuration

- amt_configuration - Return the configuration of the AMT

Documentation

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Applies to version: 1.5.0

View the code

Go to function amt_configuration

Categories

- Main
- Core functions
- Models
- Model stages
- Demos
- Experiments
- Common functions
- Plot
- Signals
- Data
- Auxdata
- Cache

AMT_CONFIGURATION - Get and set the configuration of the current AMT session

Usage:

```
[flags, kv] = amt_configuration;
[flags, kv] = amt_configuration('cacheURL', cU);
[flags, kv] = amt_configuration('silent');
[flags, kv] = amt_configuration('silent', 'normal');
```

Description:

amt_configuration accepts the following optional parameters:

'cacheURL', cU	Set the download URL of the cache
'auxdatapath', aP	Set the path where the auxdata is stored
'auxdataURL', aU	Set the download URL for the auxdata

Documentation

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Applies to version: 1.5.0

View the help

Go to function   amt_configuration

Categories

Main	>
Core functions	**>**
Models	>
Model stages	>
Demos	>
Experiments	>
Common functions	>
Plot	>
Signals	>
Data	>
Auxdata	>
Cache	>

AMT_CONFIGURATION - Get and set the configuration of the current AMT session

Program code:

```
function [flags,kv]=amt_configuration(varargin)
%AMT_CONFIGURATION Get and set the configuration of the current AMT session
%
%   Usage:
%     [flags, kv] = amt_configuration;
%     [flags, kv] = amt_configuration('cacheURL', cU);
%     [flags, kv] = amt_configuration('silent');
%     [flags, kv] = amt_configuration('silent', 'normal');
%
%   AMT_CONFIGURATION accepts the following optional parameters:
%
%     'cacheURL',cU        Set the download URL of the cache
```

Documentation

Documentation

- Website: http://amtoolbox.org
  - Compiled version: the website
  - Code version

- In-code documentation
  - Syntax: Similar to reStructuredText
  - Compiler: Based on mat2doc
  - Automatic creation of figures and results
  - Links to the publications

EXP_TABUCHI2016 - Results from Tabuchi et al. (2016)

Usage:

```
data = exp_tabuchi2016(flag)
```

Description:

`exp_tabuchi2016(flag)` reproduces figures of the study from Tabuchi et al. (2016).
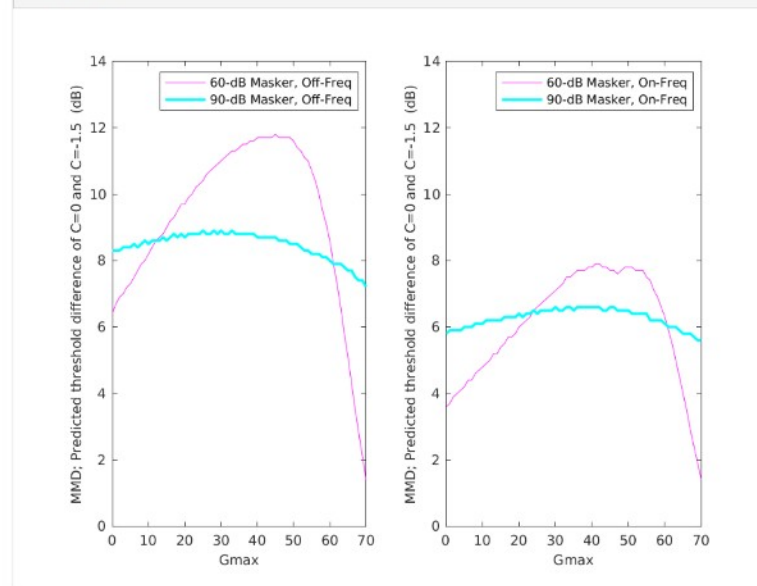
The following flags can be specified

`'fig6'`   Reproduces the lower panel of Figure 6

Examples:

To display Fig.6 use :

```
exp_tabuchi2016('fig6');
```


References:

H. Tabuchi, B. Laback, T. Necciari, and P. Majdak. The role of compression in the simultaneous masker phase effect. *The Journal of the Acoustical Society of America*, 140(4), 2016. [DOI]

EXP_TABUCHI2016 - Results from Tabuchi et al. (2016)

Program code:

```matlab
function varargout = exp_tabuchi2016(varargin)
%EXP_TABUCHI2016 Results from Tabuchi et al. (2016)
%   Usage: data = exp_tabuchi2016(flag)
%
%   EXP_TABUCHI2016(flag) reproduces figures of the study from
%   Tabuchi et al. (2016).
%
%   The following flags can be specified
%
%     'fig6'    Reproduces the lower panel of Figure 6
%
%   Examples:
%   ---------
%
%   To display Fig.6 use :
%
%     exp_tabuchi2016('fig6');
%
%   See also: tabuchi2016
%
%   References:
%     H. Tabuchi, B. Laback, T. Necciari, and P. Majdak. The role of
%     compression in the simultaneous masker phase effect. The Journal of the
%     Acoustical Society of America, 140(4), 2016.
%
%
%   Url: http://amtoolbox.org/amt-1.5.0/doc/experiments/exp_tabuchi2016.php


%   #Author: Hisaaki Tabuchi (2022)
%   #Author: Clara Hollomey (2023): adaptations for AMT
%   #Author: Joonas Guevara (2023): implemented ploting


definput.import = {'amt_cache'};
definput.flags.type = {'missingflag','fig6'};

[flags,~]  = ltfatarghelper({},definput,varargin);
```

Documentation

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  - Compiled version: the website
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- In-code documentation
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- Model list and ratings

Documentation

THE AUDITORY MODELING TOOLBOX

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Models included in the AMT (latest release, 1.5.0)

In order to describe the quality of the models available in the AMT, we rate the implementation of every model by considering its **source code** and **documentation**. We also rate the models in terms of their **verification**, i.e., we rate the results of the implementation versus the results shown in the corresponding publication. The comparison is done within the experiments implemented in the exp_ functions. In the best case, the experiments produce the same results as in the publication - up to some minor layout issues in the graphical representations.

The following table provides an overview of the available models, their documentation, code, and verification status.

Peripheral models	Function	Doc	Code	Verification
Gammatone filterbank	gammatone	✔	✔	✔
Linear filtering for monaural masking (basic)	dau1996	◯	✔	?
Linear filtering for monaural masking (improved)	dau1997	◯	✔	?
Invertible Gammatone filterbank	hohmann2002	✔	✔	✔
Dual-resonance nonlinear filterbank (DRNL)	lopezpoveda2001	✔	✔	✔
Fast acting compression (CARFAC) model	lyon2011	✔	✔	?

Documentation

- Website: http://amtoolbox.org
  - Compiled version: the website
  - Code version
- In-code documentation
  - Based on mat2doc
  - Syntax: Similar to reStructuredText
  - Automatic creation of figures and results
  - Links to the publications
- Model list and ratings
- Other resources

| DOCUMENTATION | DEVELOPMENT | RESOURCES |

Getting started

- The release package:
  - For **working** with the AMT only
  - Download the **full** release package from Sourceforge
- Starting the AMT:
  - Go to the AMT directory
  - Start the AMT: `amt_start;`
  - Compile the environments: `amt_mex;`
- Testing the environment:
  - Simple test: `demo_absolutethreshold`
  - SOFA/auxdata/internet test: `demo_baumgartner2014`
  - C-compiler test: `demo_zilany2014`
  - Python test: `demo_verhulst2012`
- Stopping the AMT: `amt_stop;`
- Cheat sheet: http://amtoolbox.org