



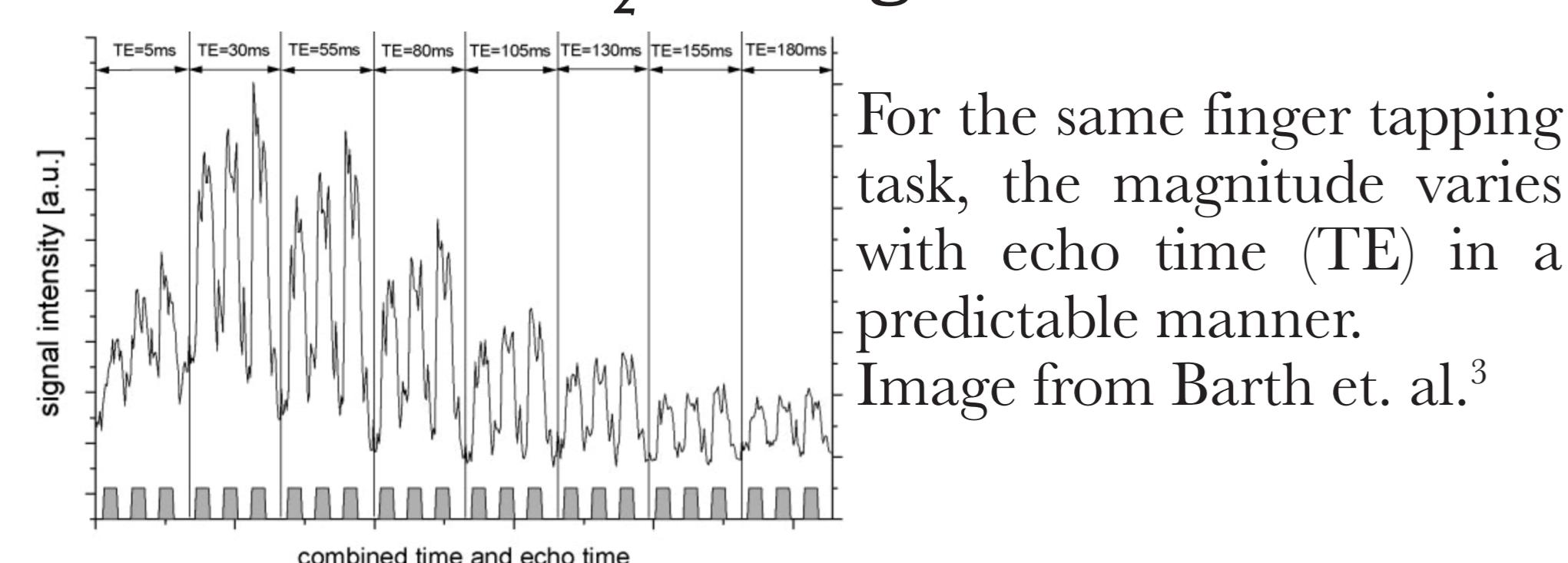
# tedana expanding flexibility for multi-echo fMRI noise removal methods

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## MULTI-ECHO FMRI

Multi-echo fMRI includes collecting and reconstructing data at several echo times.  $T_2^*$  signal, including the fMRI BOLD response, scales across echoes. Multi-echo information can be used to better isolate  $T_2^*$  changes.<sup>1,2</sup>



For the same finger tapping task, the magnitude varies with echo time (TE) in a predictable manner.  
Image from Barth et. al.<sup>3</sup>

## tedana is

1. Open software to test and improve multi-echo methods with an emphasis on an ICA-based denoising method<sup>4-6</sup>. Currently used in AFNI & fMRIprep.

2. Tools to make ICA-based denoising methods adaptable & understandable.

3. A community and resources for people interested in multi-echo fMRI whether or not they use tedana software

## WAYS TO CONNECT

Multi-echo questions: <https://neurostars.org> with 'multi-echo' or 'tedana' tags

Subscribe to the tedana newsletter:

<https://groups.google.com/g/tedana-newsletter>

Join the conversation:

[mattermost.brainhack.org/brainhack/channels/tedana](https://mattermost.brainhack.org/brainhack/channels/tedana)

Recordings of multi-echo users meetings:

<https://www.youtube.com/@tedana-devs>

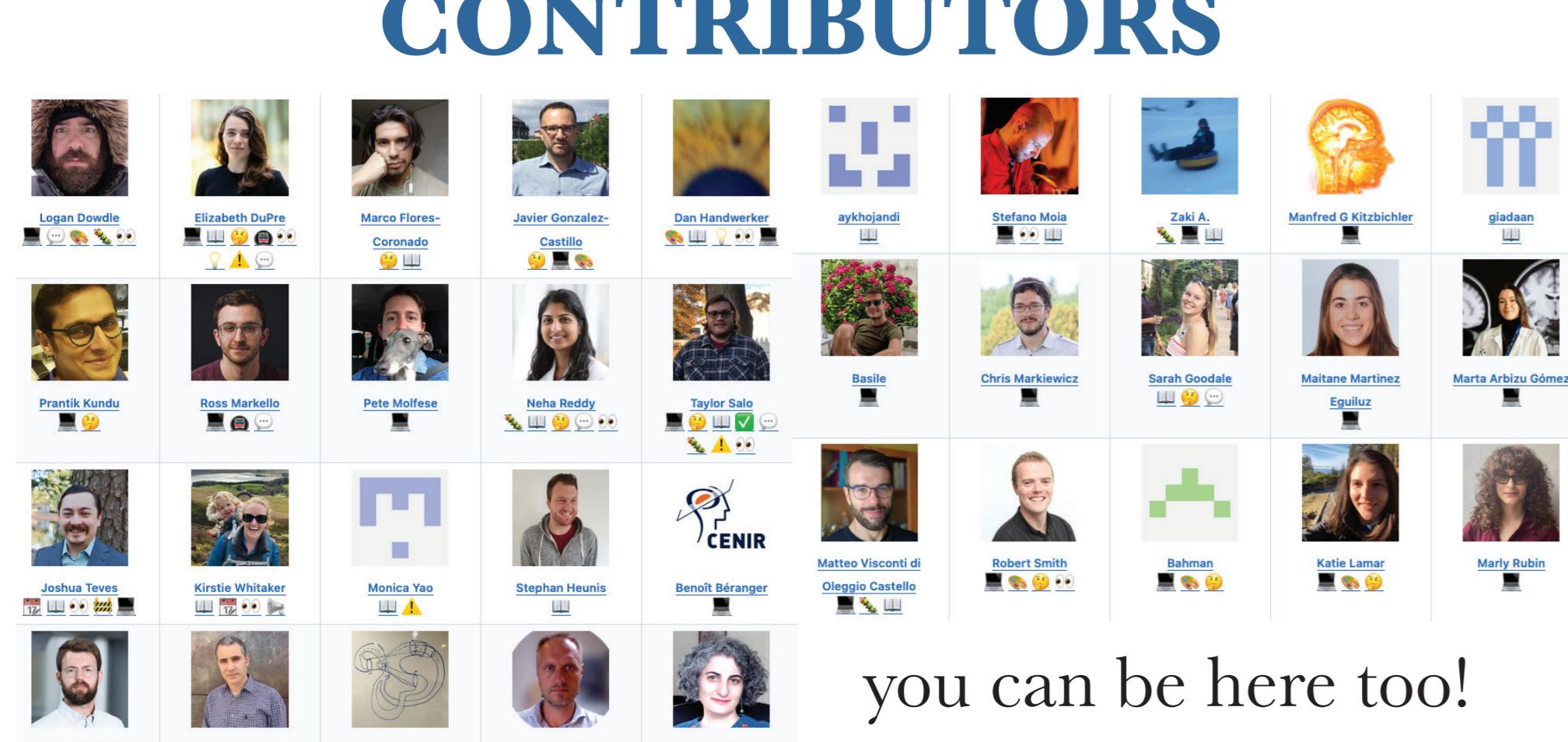
Code and resources are open source.

Contribute at:

<https://github.com/ME-ICA/tedana>

Multi-echo content at OHBM including a link to this poster & a form to add info to list of multi-echo fMRI studies: [github.com/ME-ICA/ohbm-2025-multiecho](https://github.com/ME-ICA/ohbm-2025-multiecho)

## CONTRIBUTORS



you can be here too!

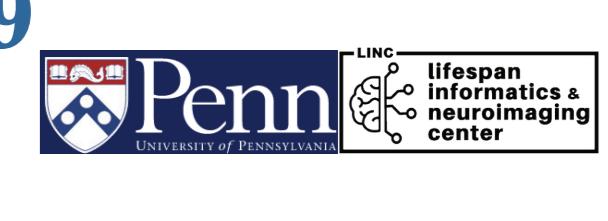
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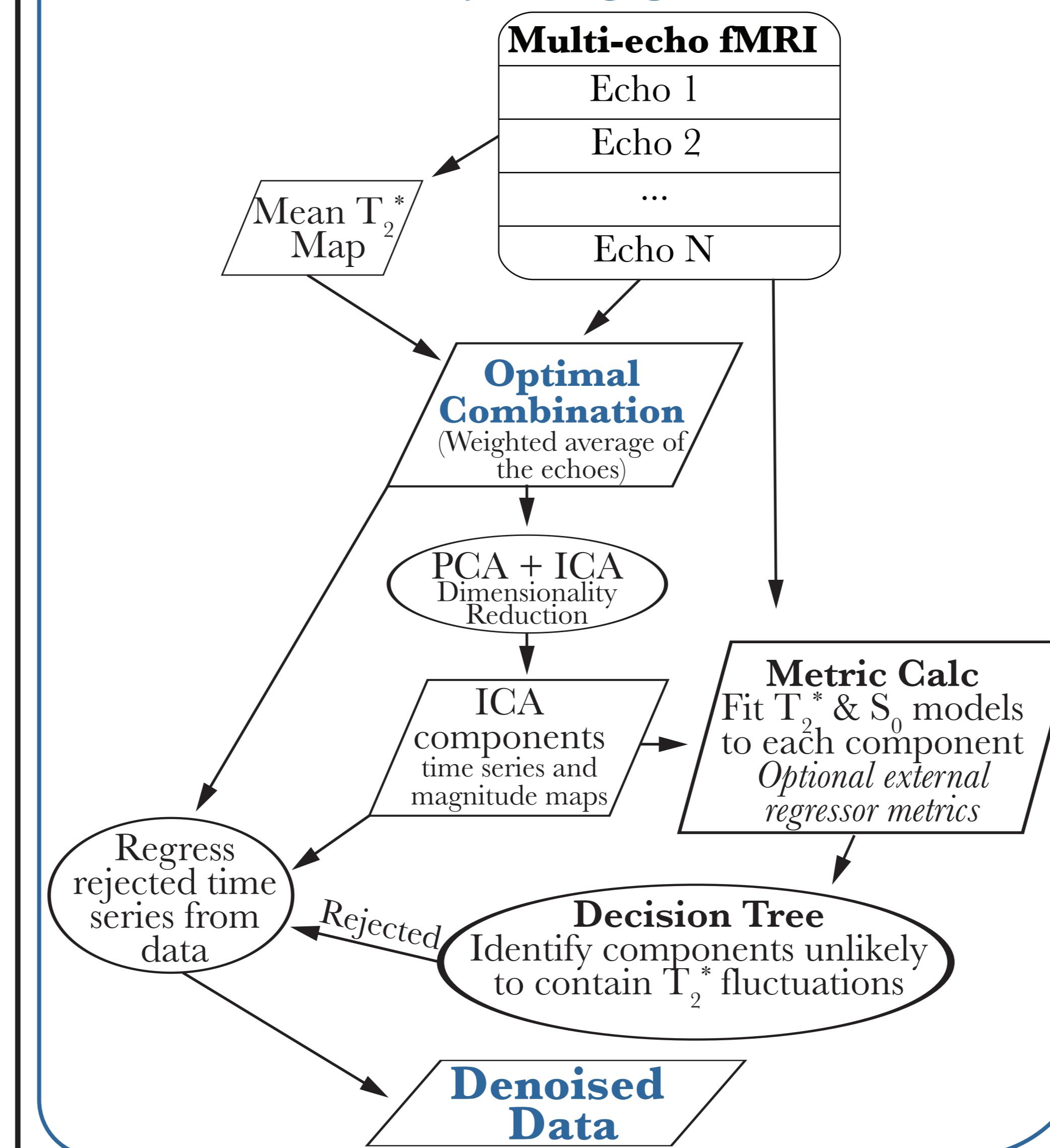
## ACKNOWLEDGEMENTS

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## tedana.readthedocs.io



## TEDANA ALGORITHM



## IMPROVEMENTS DURING THE PAST YEAR

Added RobustICA<sup>8-9</sup>, a method to find more stable ICA components across multiple iterations of ICA

ICA components can be fit to external regressors, like motion or respiration. That info can be used to accept or reject components

Custom labelling for component classifications changed outside of tedana to support and document integration with other tools, like AROMA<sup>10</sup>

Options added to use tedana with EPTI sequences with many reconstructed echoes<sup>11</sup>

New quality check metric for % variance of accepted components explained by rejected components

Started online multi-echo users meetings. Join newsletter to hear about future meetings

Improvements in quality report visualization, information logging, & educational docs

Under-the-hood improvements & bug fixes

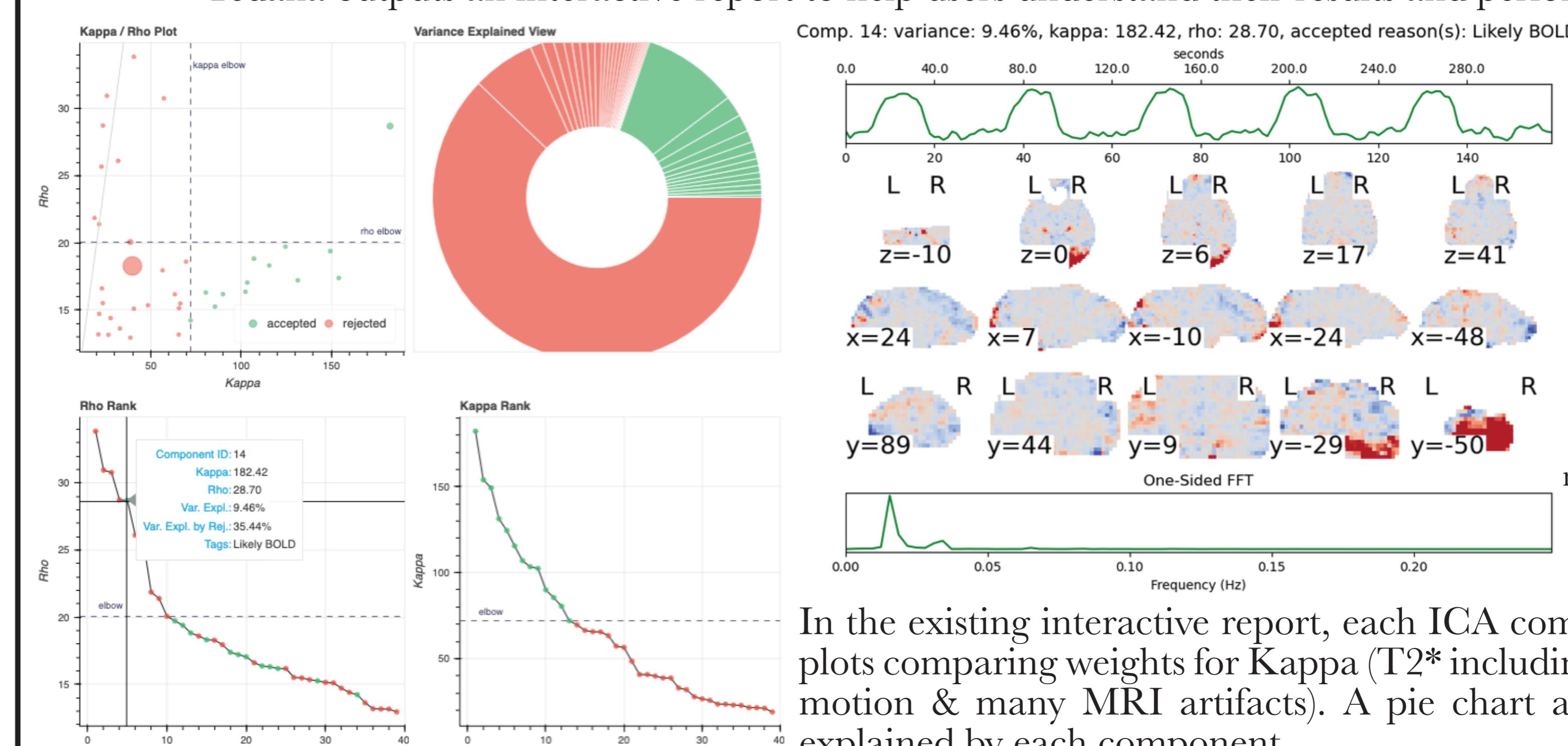
## MULTI-ECHO FMRI IS GROWING IN POPULARITY

We are maintaining a curated list of openly shared multi-echo fMRI datasets:

<https://me-ica.github.io/open-multi-echo-data/>

## INTERACTIVE RESULTS REPORT

Tedana outputs an interactive report to help users understand their results and perform quality assurance.



Code to generate figures and interactive versions of these reports:

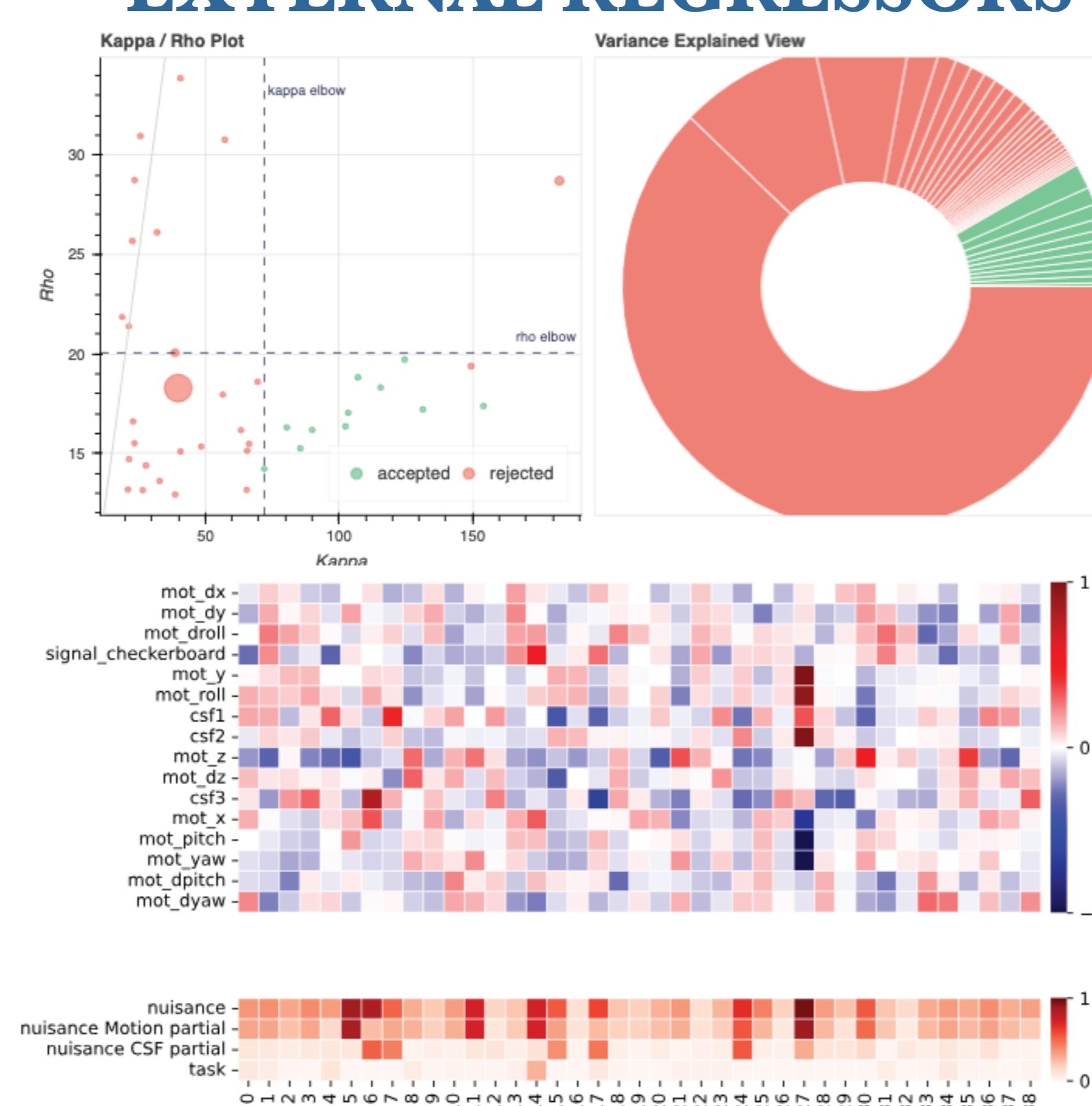


[me-ica.github.io/ohbm-2025-multiecho](https://me-ica.github.io/ohbm-2025-multiecho)

In the existing interactive report, each ICA component is presented as a dot in plots comparing weights for Kappa (T2\* including BOLD), & Rho (S0 including motion & many MRI artifacts). A pie chart and dot size show the variance explained by each component.

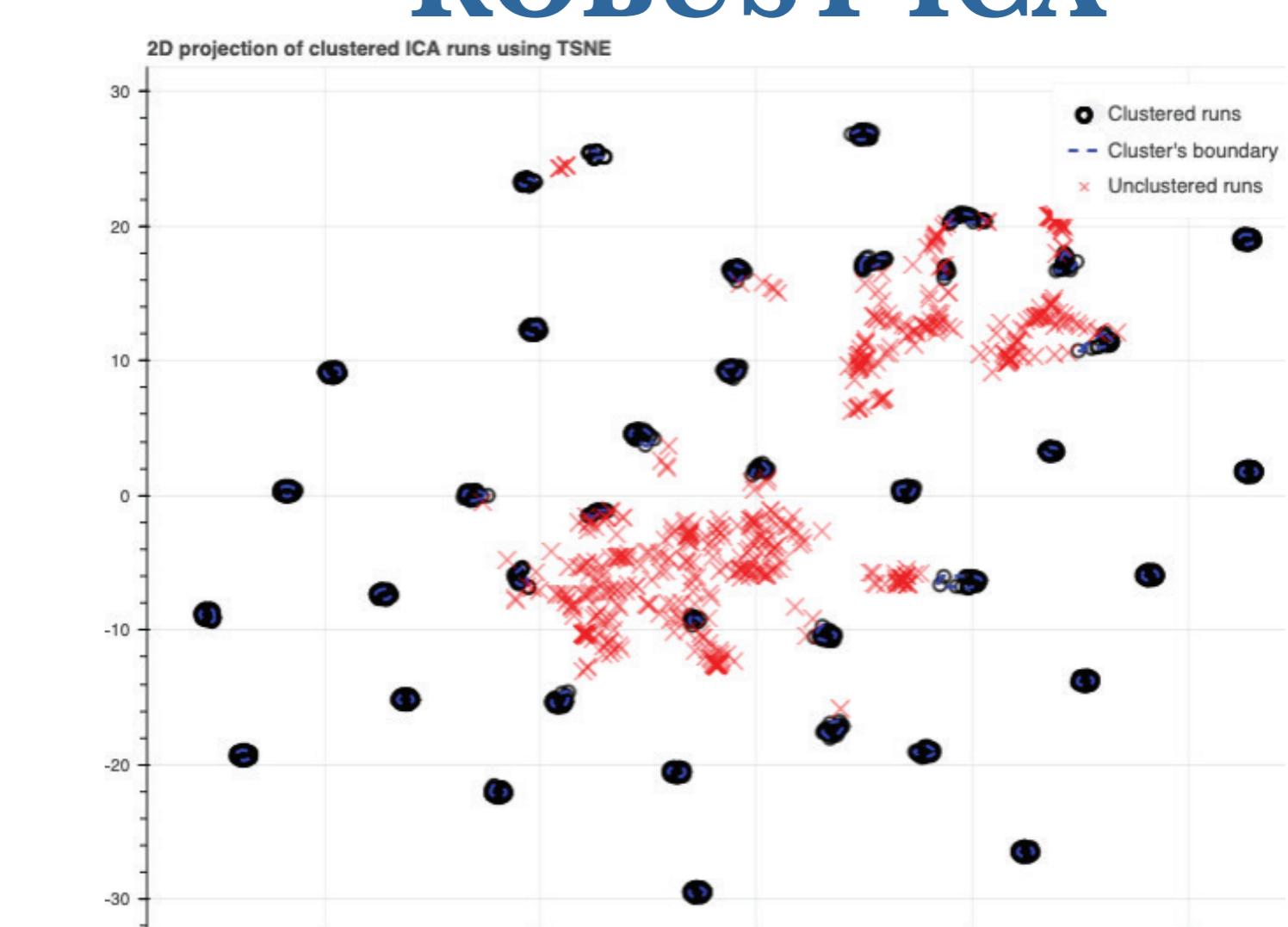
By clicking on a dot or wedge, the time series and spatial map for a component appears. Component 14 is highlighted which shows the occipital cortex response to a block design checkerboard task.

## EXTERNAL REGRESSORS



The new addition of external regressors includes new visualizations. The above figures are from the same data, but use a decision tree that was designed to show how to use external regressors. It rejects components based on fits to motion or CSF regressors. Component 14 is now rejected & heat maps show it is correlated to motion. Even though this component should not have been rejected (& we could easily make decision tree that wouldn't reject it), the new visualizations highlight how this component also has a relatively high rho value and it clearly contains both desired signal and undesired noise. This is vital information for better understanding data quality and improving methods.

## ROBUST ICA



When Robust ICA is used, this plot is added to the report. It uses t-SNE dimensionality reduction to show distances between components from 30 repetitions of ICA on a 2D plot. The black dots show components that were clustered together across iterations and this figure helps users understand the stability of their data and if Robust ICA is performing appropriately.

## FUTURE PLANS

Design and validate decision processes that use external regressors and better integrate with other ICA denoising approaches

Improve component estimation methods

Improve tools for data with >5 echoes, like EPTI

Build multi-echo fMRI community around shared data to improve current practice & future methods

Improve education & collaboration via continued multi-echo fMRI users meetings