

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

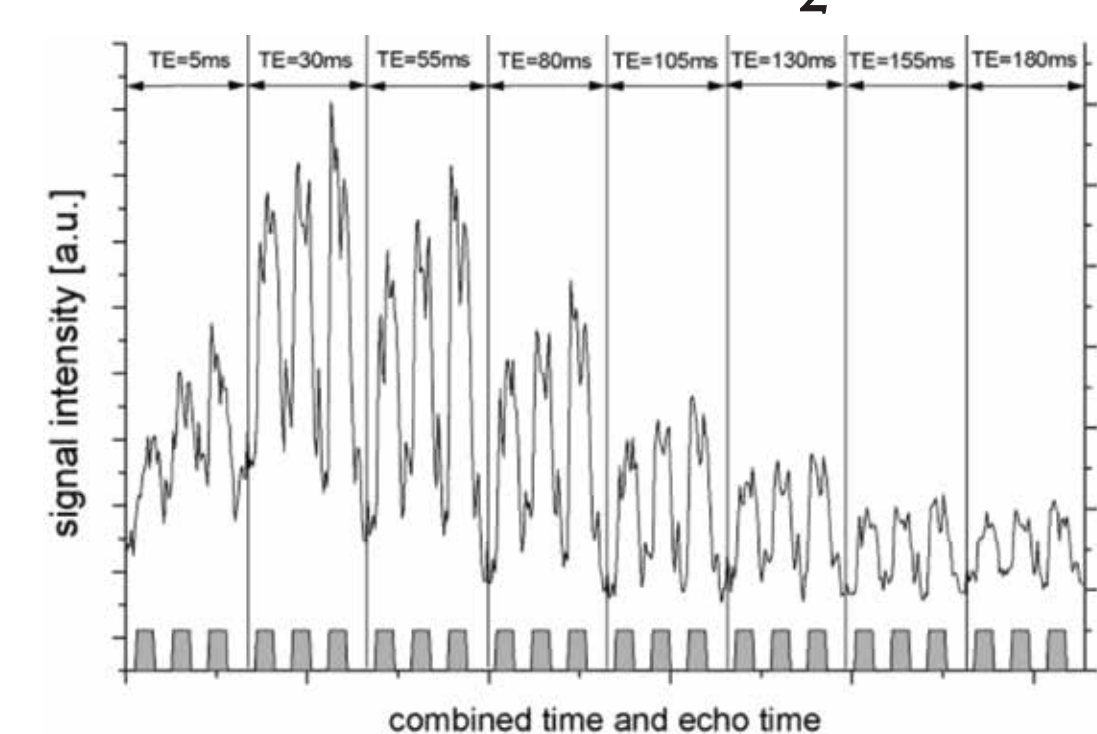
The tedana community: Daniel Handwerker<sup>1</sup>, Eneko Uruñuela<sup>2</sup>, David Abbott<sup>3</sup>, Peter Bandettini<sup>1</sup>, Logan Dowdle<sup>4</sup>, Marta Gómez<sup>5</sup>, Javier Gonzalez-Castillo<sup>1</sup>, Sarah Goodale<sup>6</sup>, Kathryn Lamar-Bruno<sup>7</sup>, Neha Reddy<sup>8</sup>, Marly Rubin<sup>1</sup>, Robert Smith<sup>3</sup>, Bahman Tahayori<sup>3</sup>, Taylor Salo<sup>9</sup>

## tedana.readthedocs.io

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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>

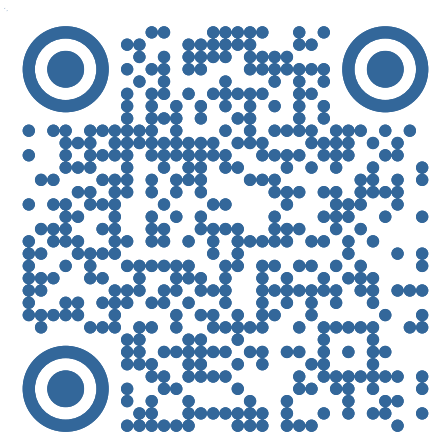
Multi-echo content at OHBM

including a link to this poster

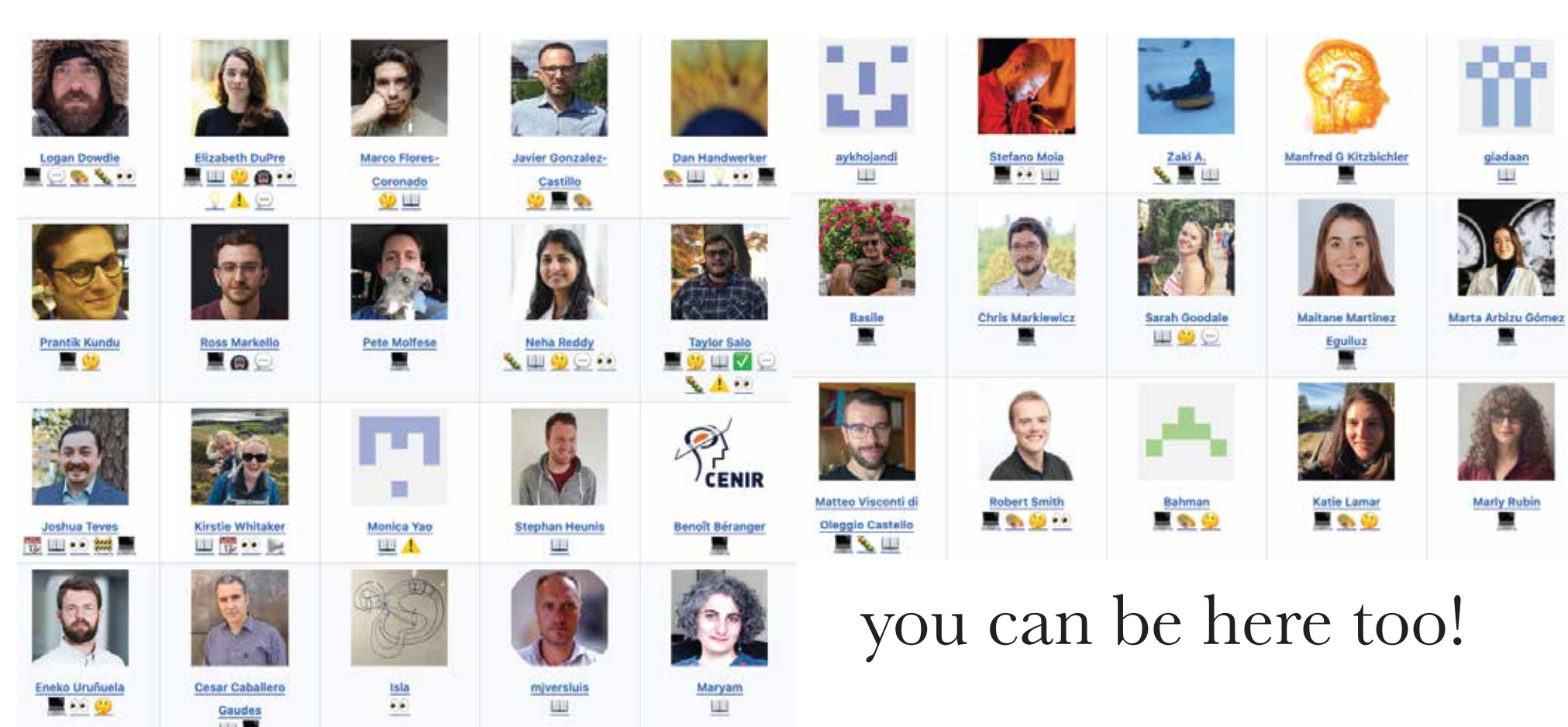
& a form to add info to list of

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!

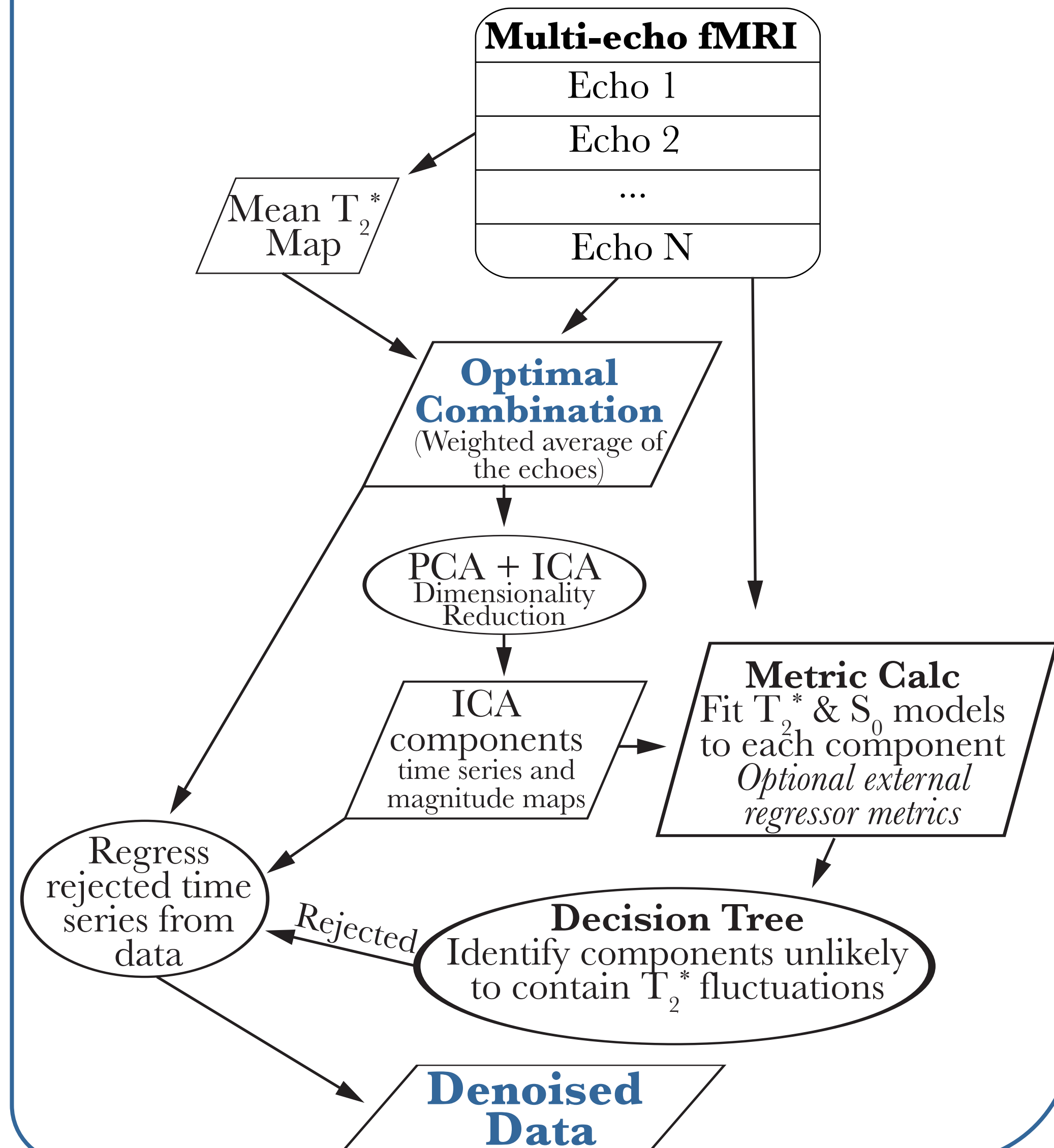
## REFERENCES

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## ACKNOWLEDGEMENTS

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## TEDANA ALGORITHM



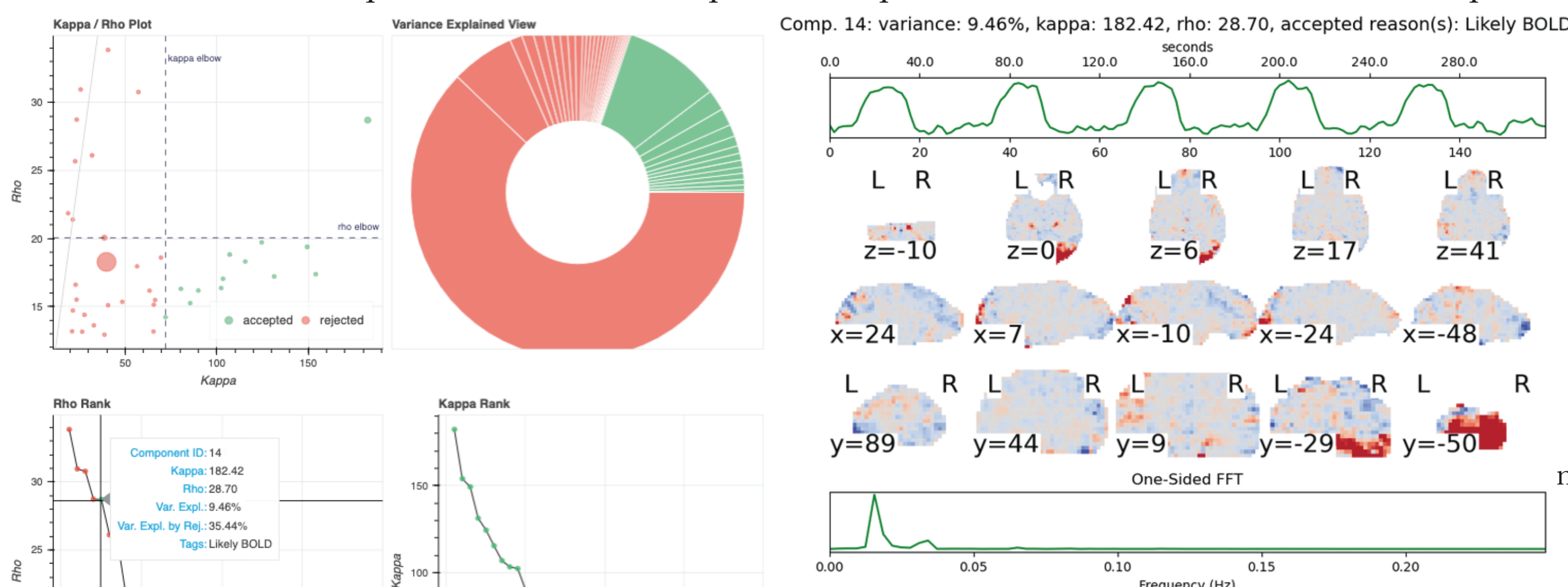
## MULTI-ECHO FMRI IS GROWING IN POPULARITY

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

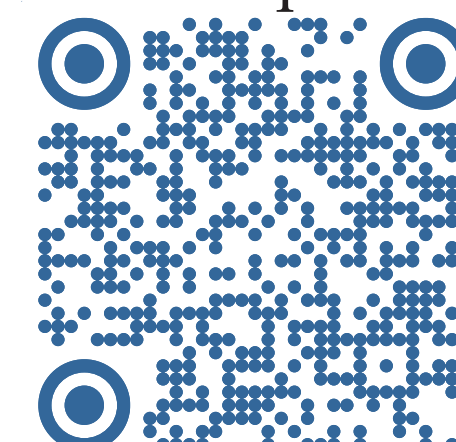
<https://me-ica.github.io/open-multi-echo-data/>

## 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:

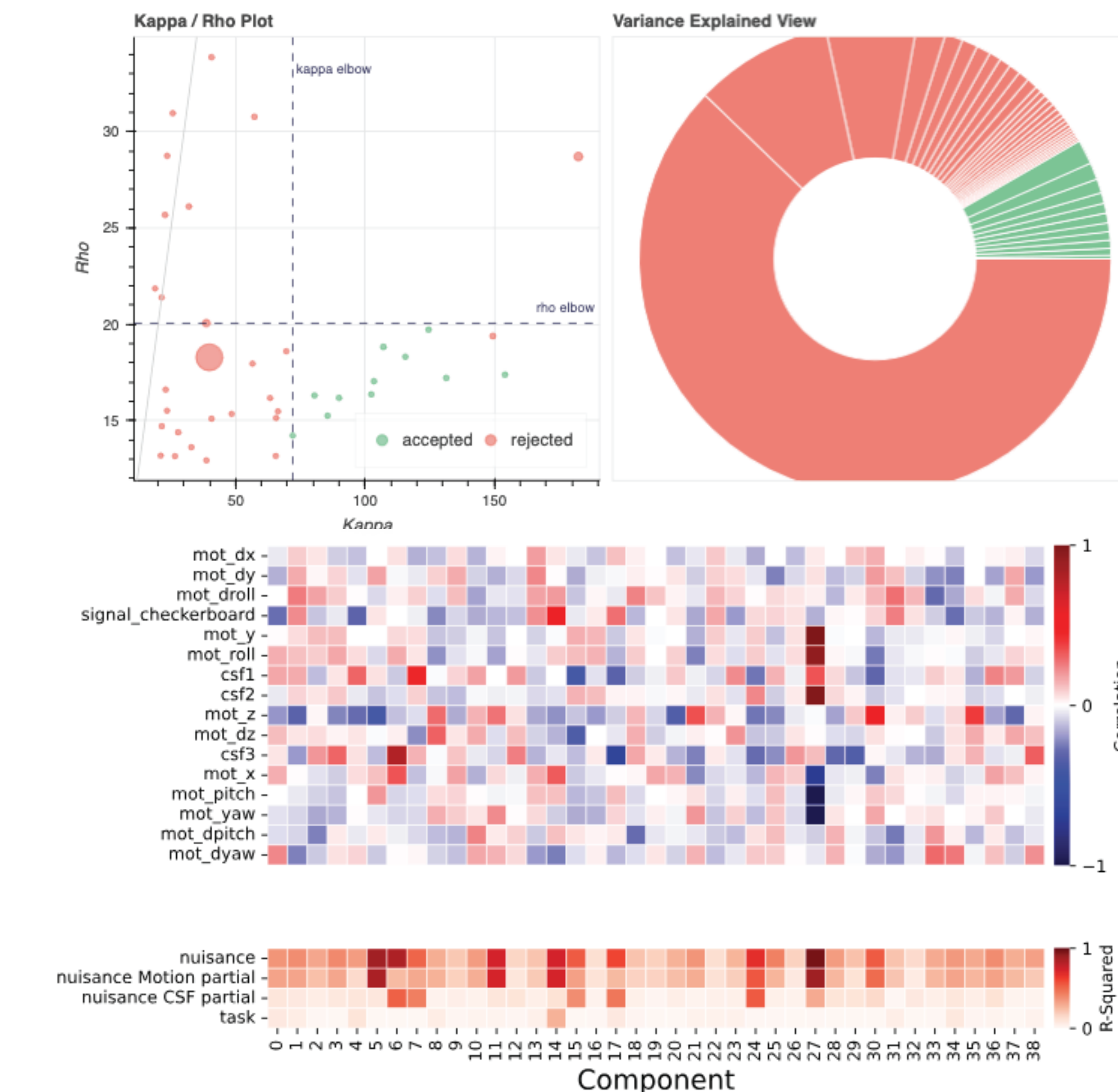


[me-ica.github.io/ohbm-2025-multiecho](https://me-ica.github.io/ohbm-2025-multiecho)

In the existing interactive report, each ICA component is presented as a dot in plots comparing weights for Kappa ( $T_2^*$  including BOLD), & Rho ( $S_0$  including motion & many MRI artifacts). A pie chart and dot size show the variance explained by each component.

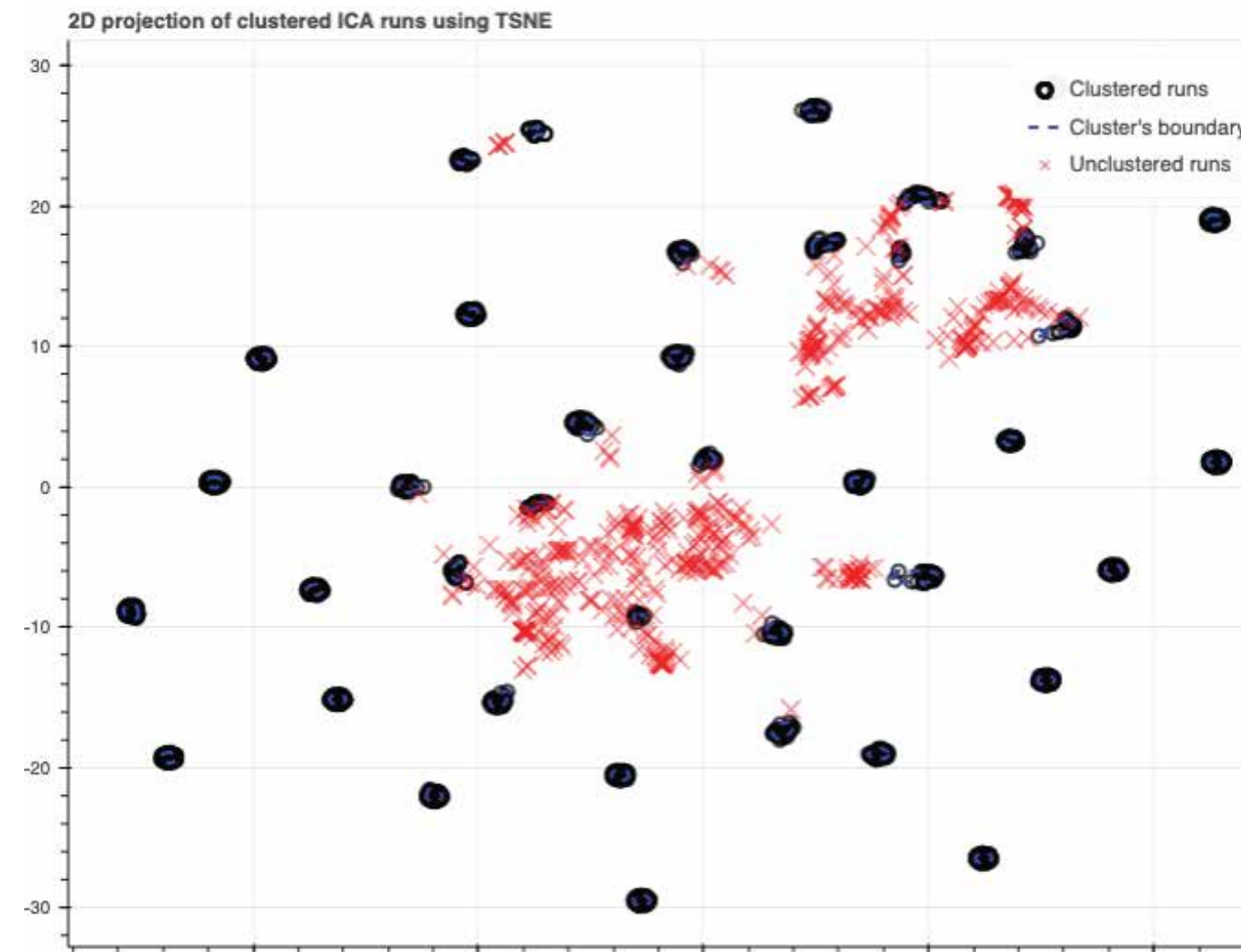
By clicking on a dot or wedge, the time series and spatial map for a component appears. Component 14 is highlighted which shows the occipital cortex response to a block design checkerboard task.

## 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