Clustering of ICA components

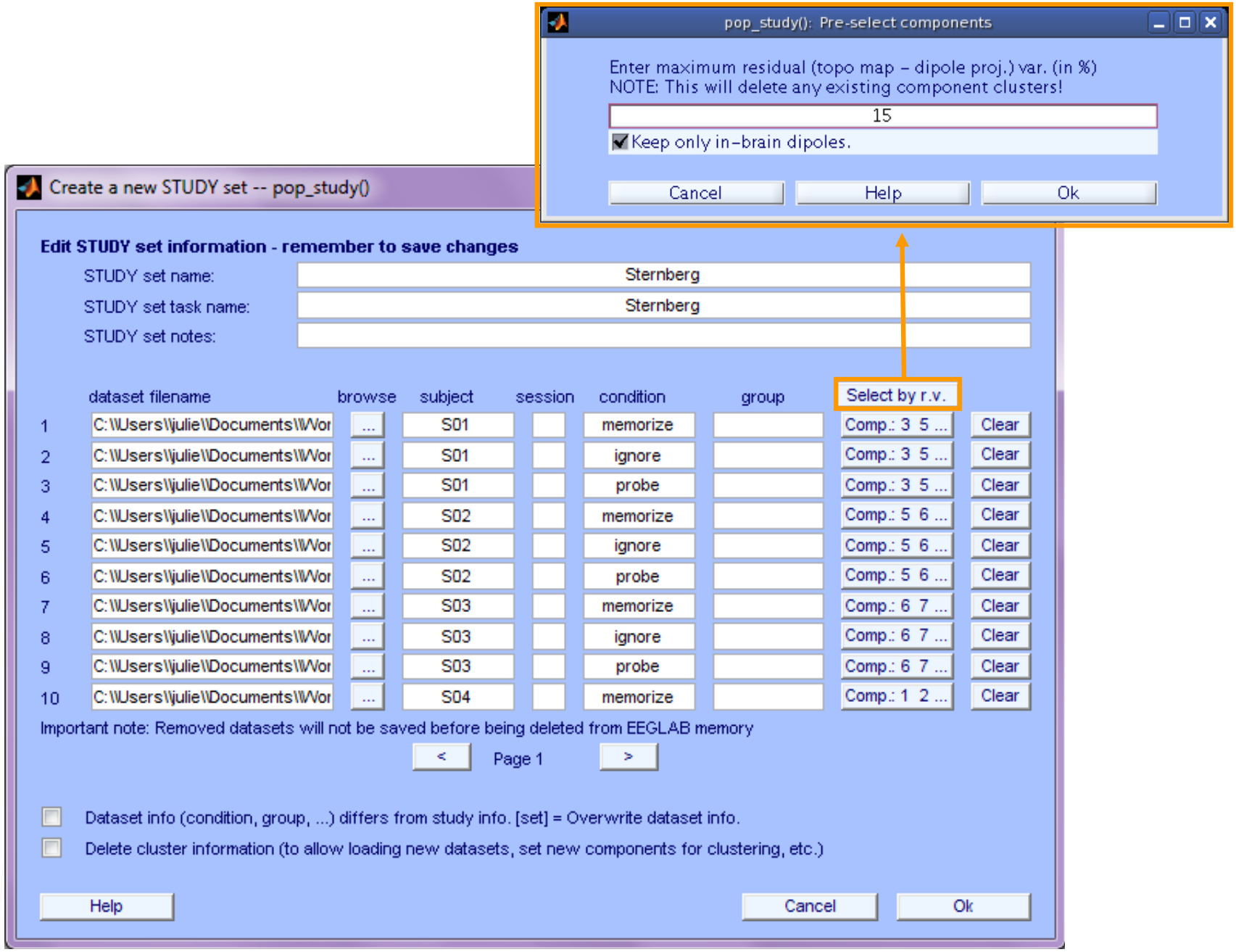
Arnaud Delorme

(with Julie Onton, Romain Grandchamp, Nima Bigdely Shamlo, Scott Makeig)

Steps of clustering

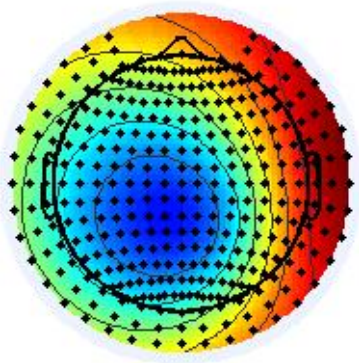
- Select ICA components for clustering
- Precompute measures of interest
- Cluster measures
- Plot clusters and edit them if necessary

Edit dataset info

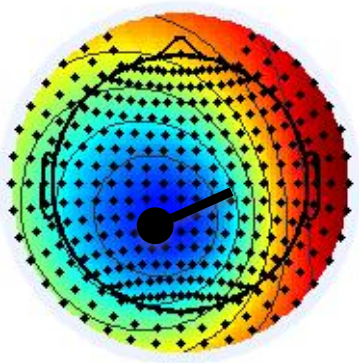


Computing residual variance (%)

Actual

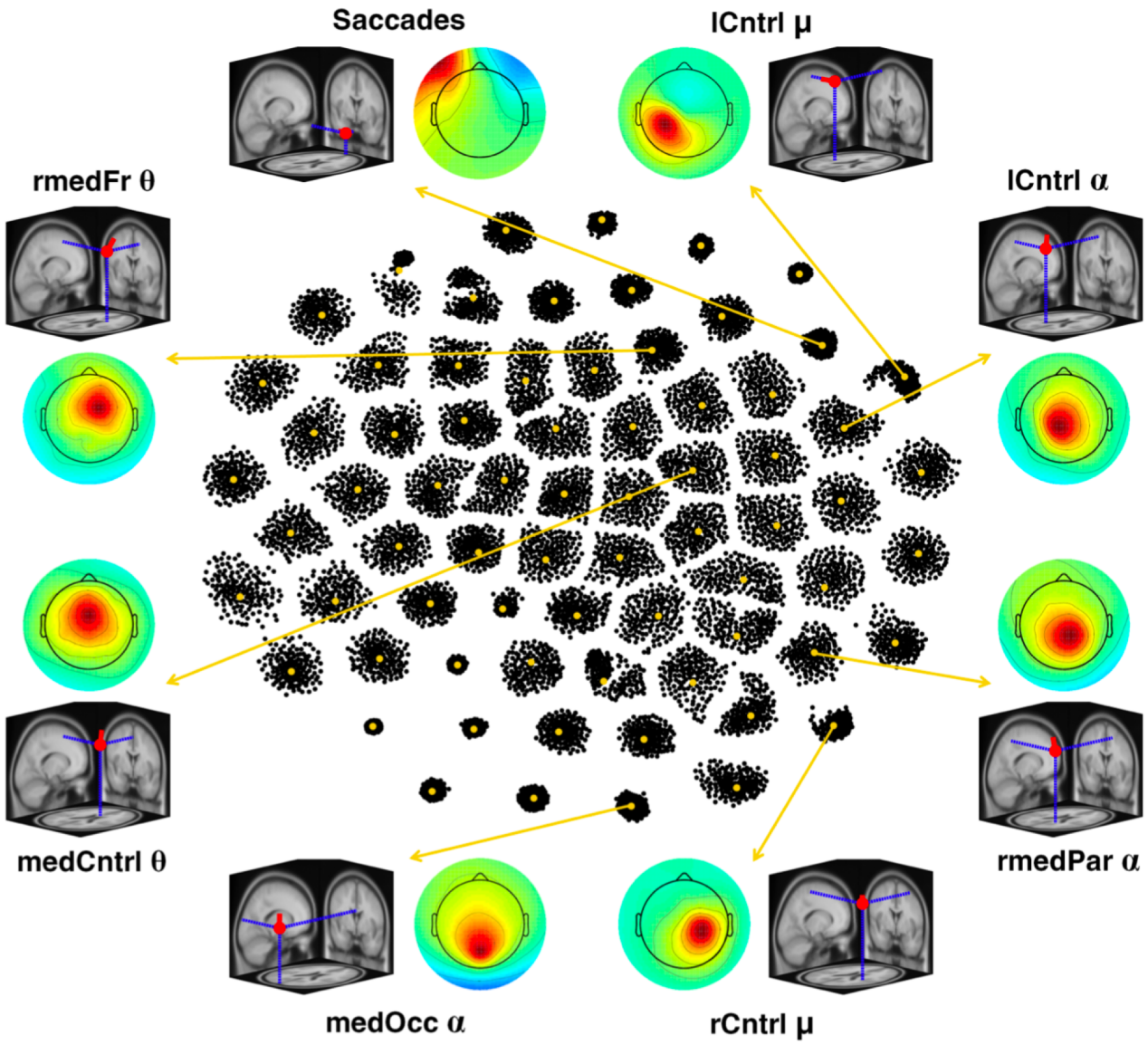


Dipole projection



$$r = \Sigma(x_i - \tilde{x}_i)^2 / \Sigma x_i^2$$

Clustering results example

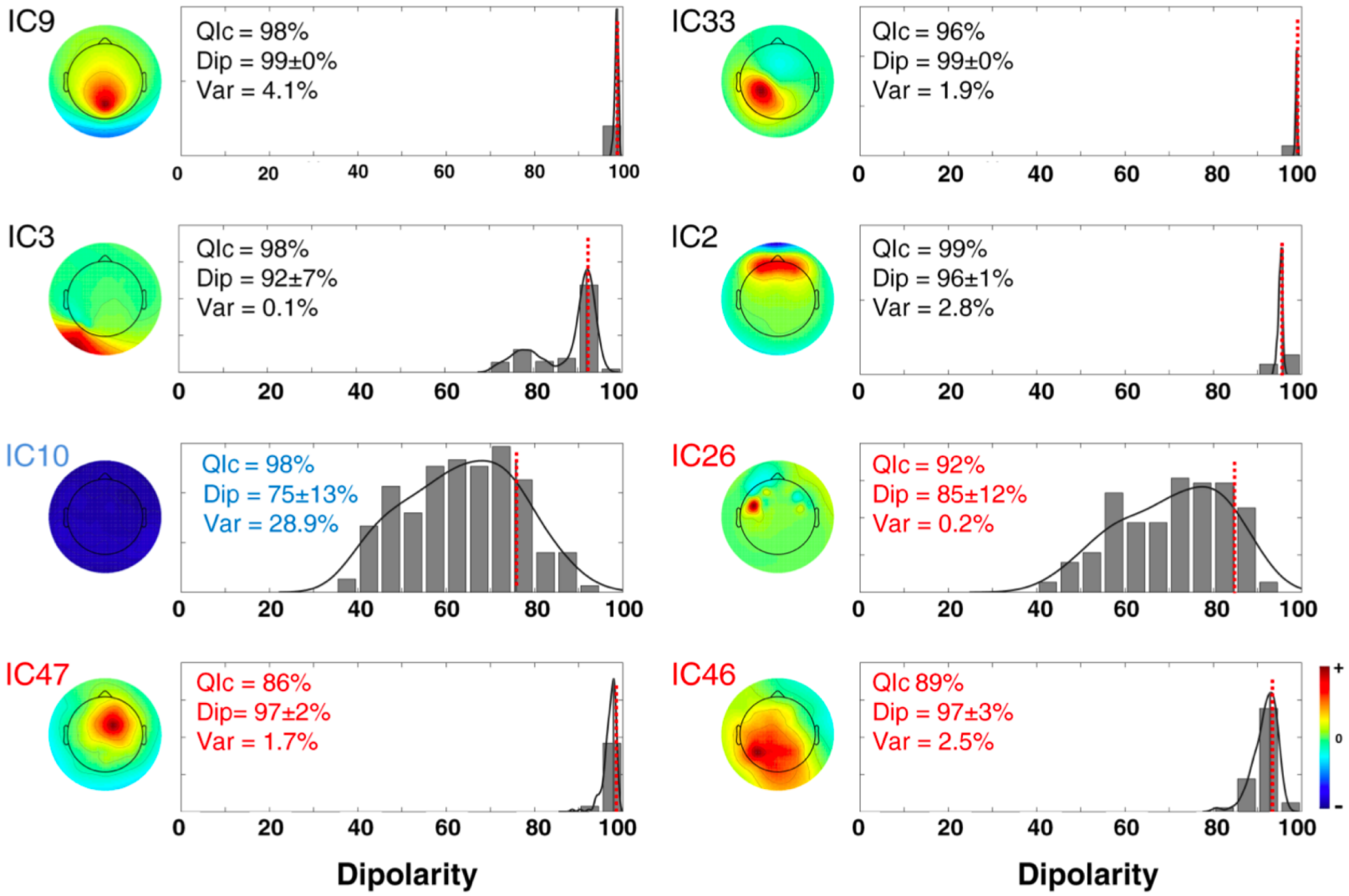


RELICA: A method for estimating the reliability of independent components

Fiorenzo Artoni [a,*], Danilo Menicucci [b], Arnaud Delorme [c,e,f], Scott Makeig [c], Silvestro Micera [a,d]

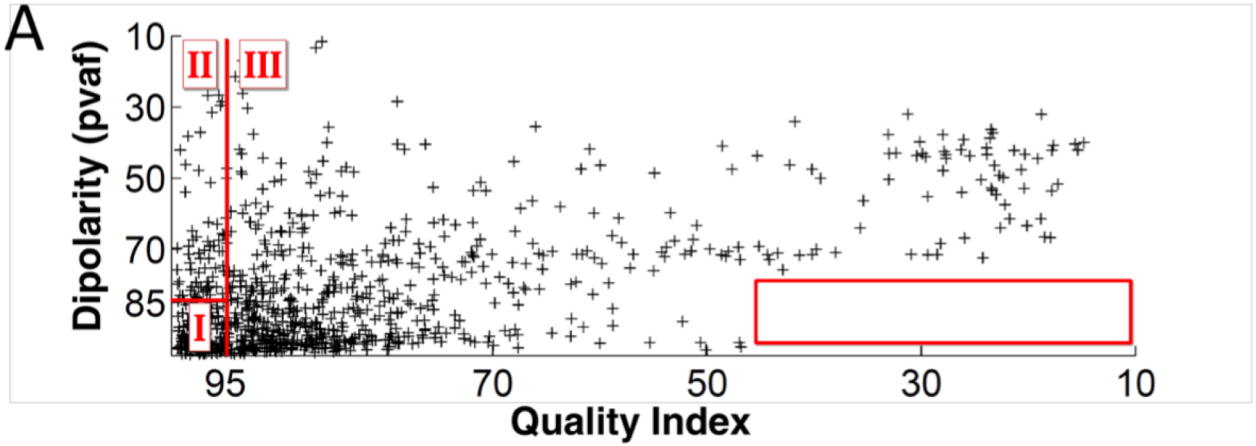
Within-cluster reliability

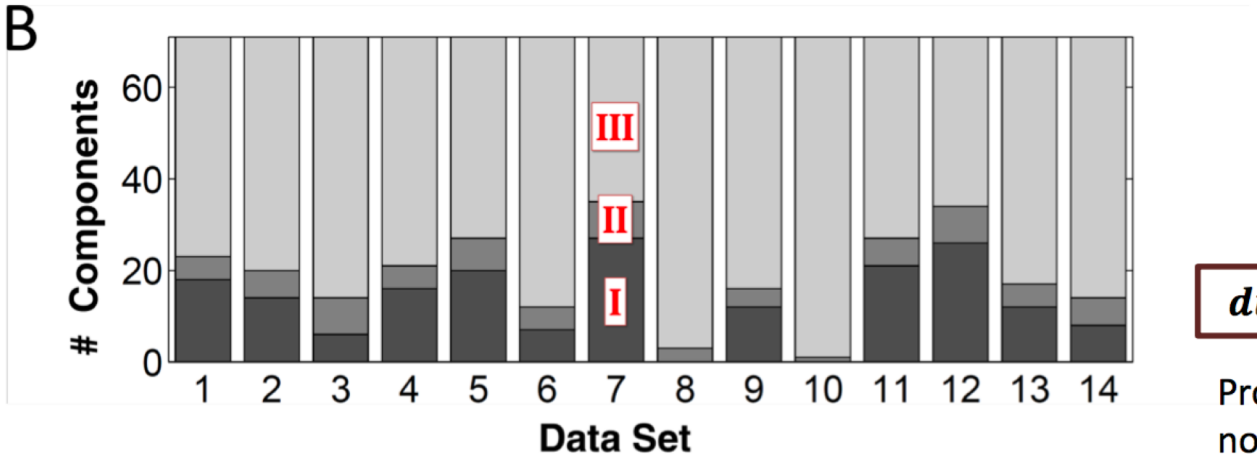
The distribution of dipolarity within the cluster helps assessing the **quality** and characteristics of Independent Components



Reliability criteria and the rv<15%

First justification why we should select an **r.v <15%** for components to include in further analyses: there is a forbidden region underlined in red, that indicates the absence of





CLASS I

Quality Index and Dipolarity above Retention threshold: **Good**

CLASS II

Quality Index above threshold, dipolarity below: **artifact** or mixing of multiple processes

CLASS III

Quality Index below retention threshold

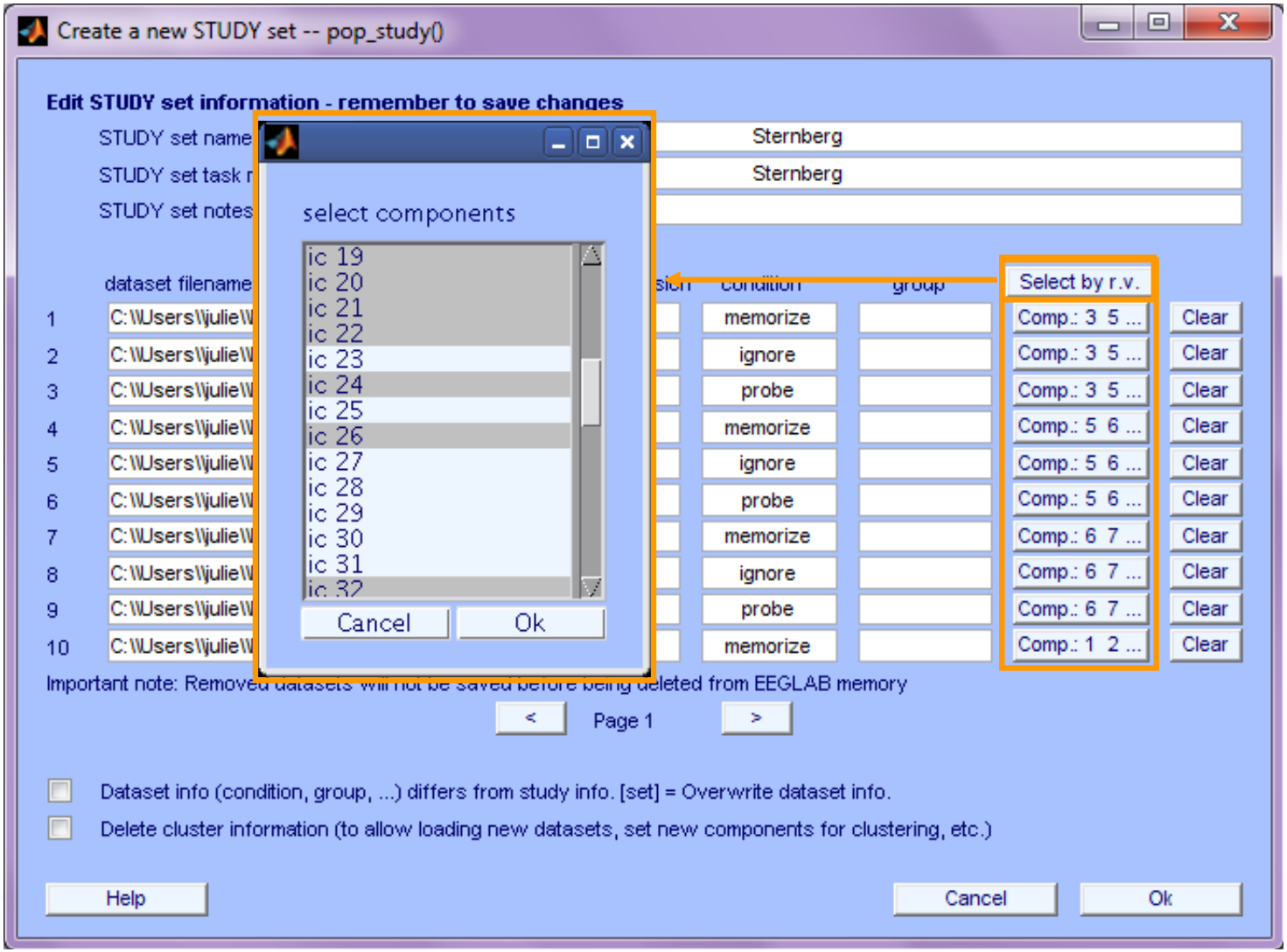
$dip \pm std > th$

Probable Inseparable noise: variance explained useful or **multiple subject confirmation**

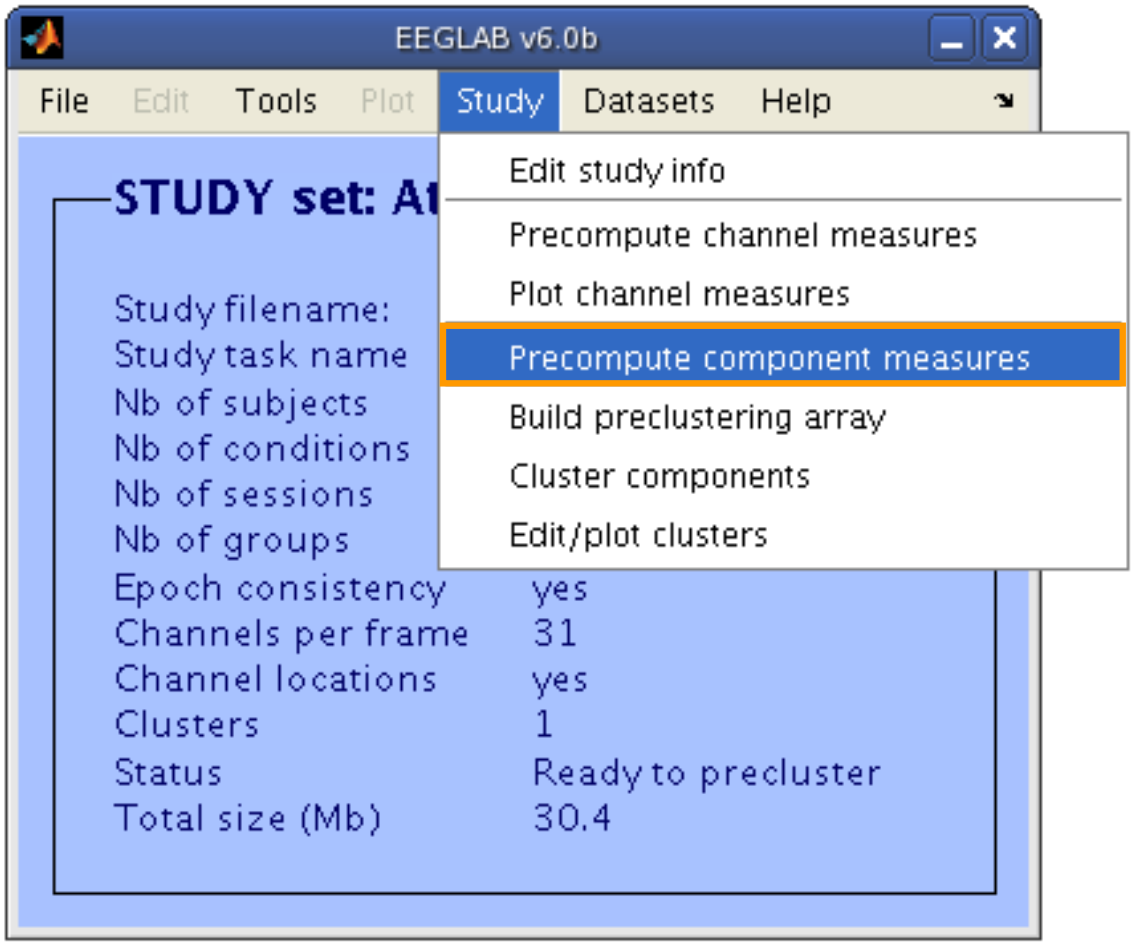
$dip \pm std < th$

Discard

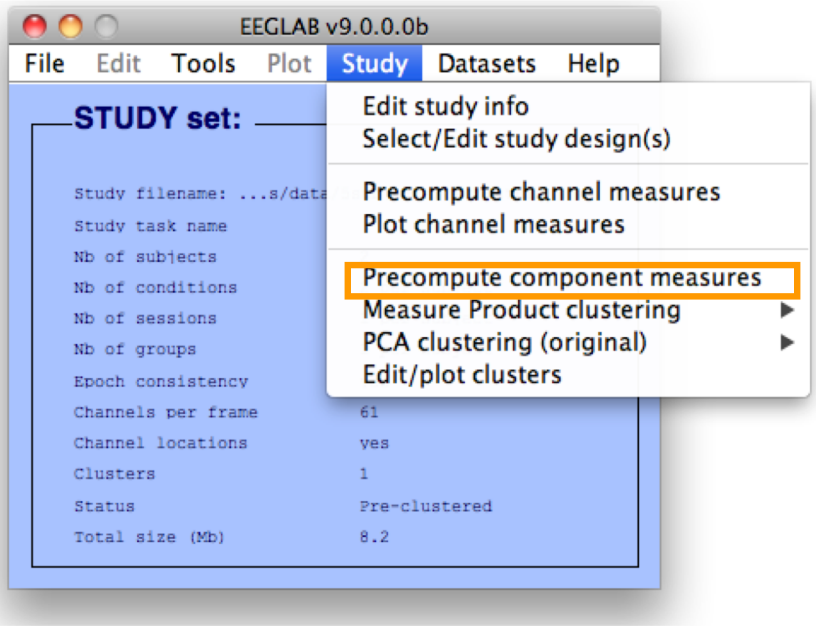
ICs to cluster

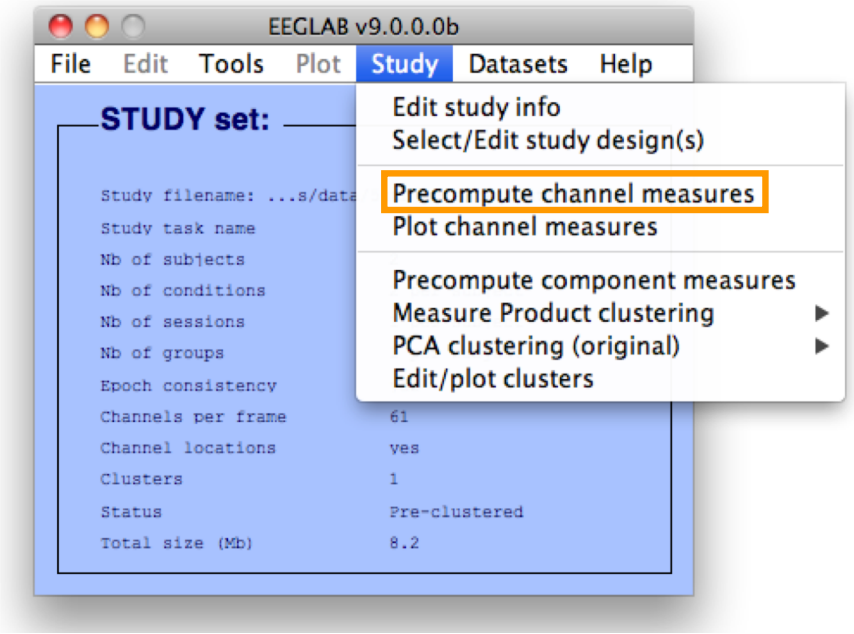


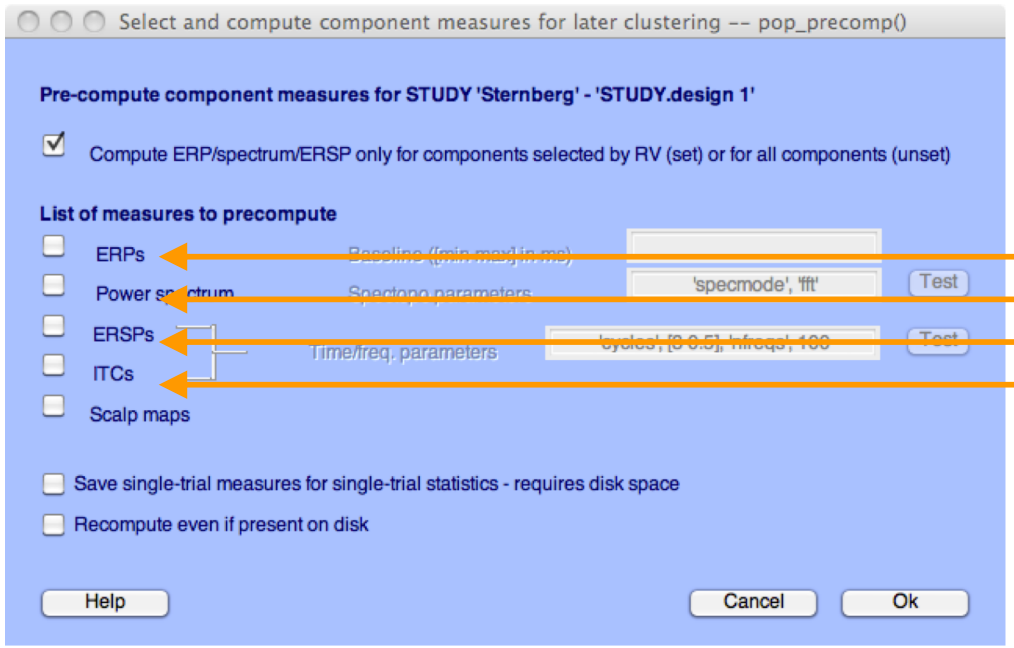
Precompute data measures

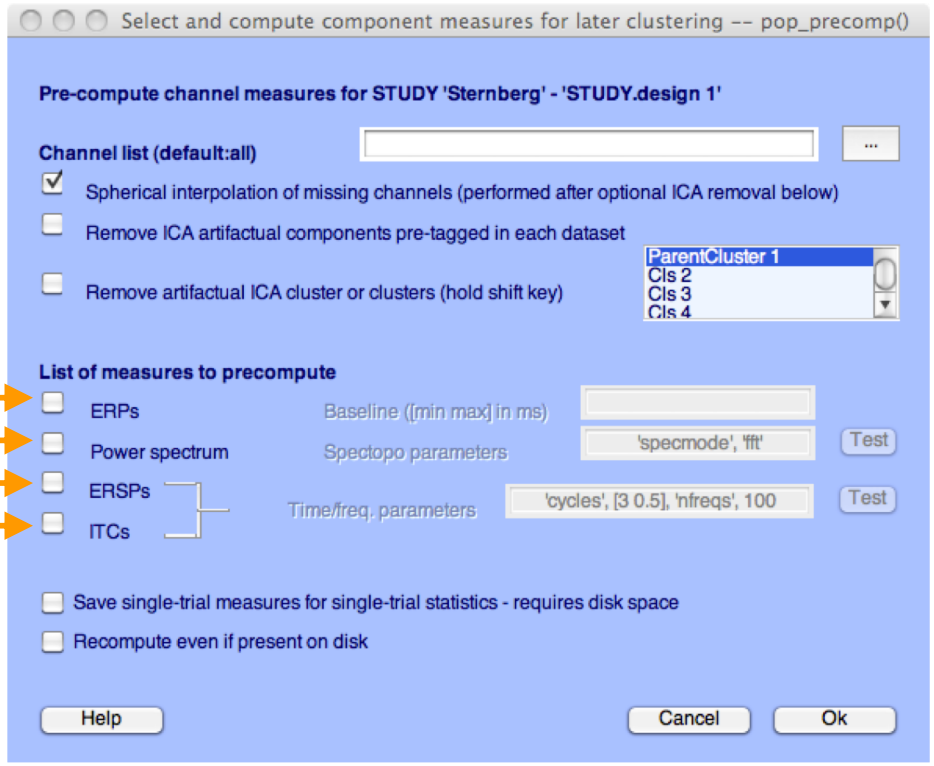


Pre-compute measures



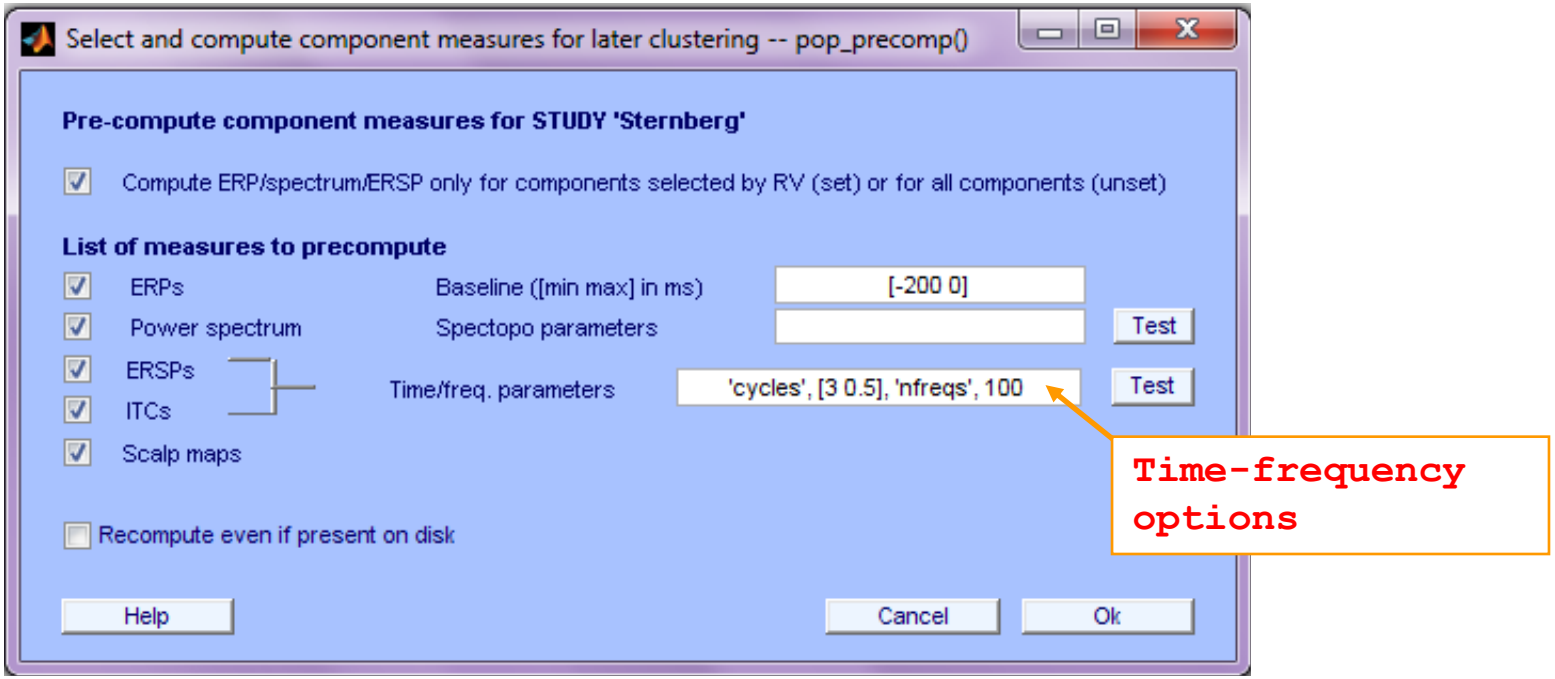




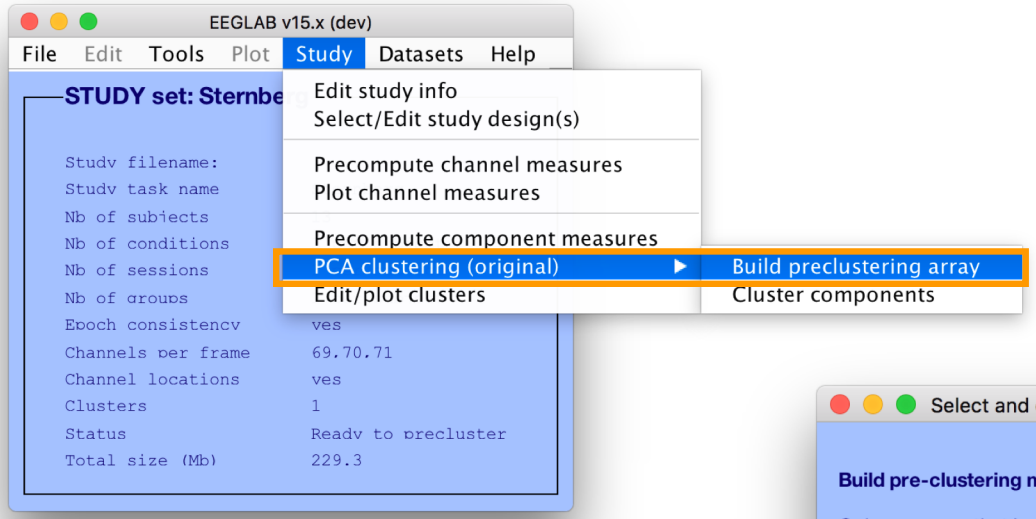


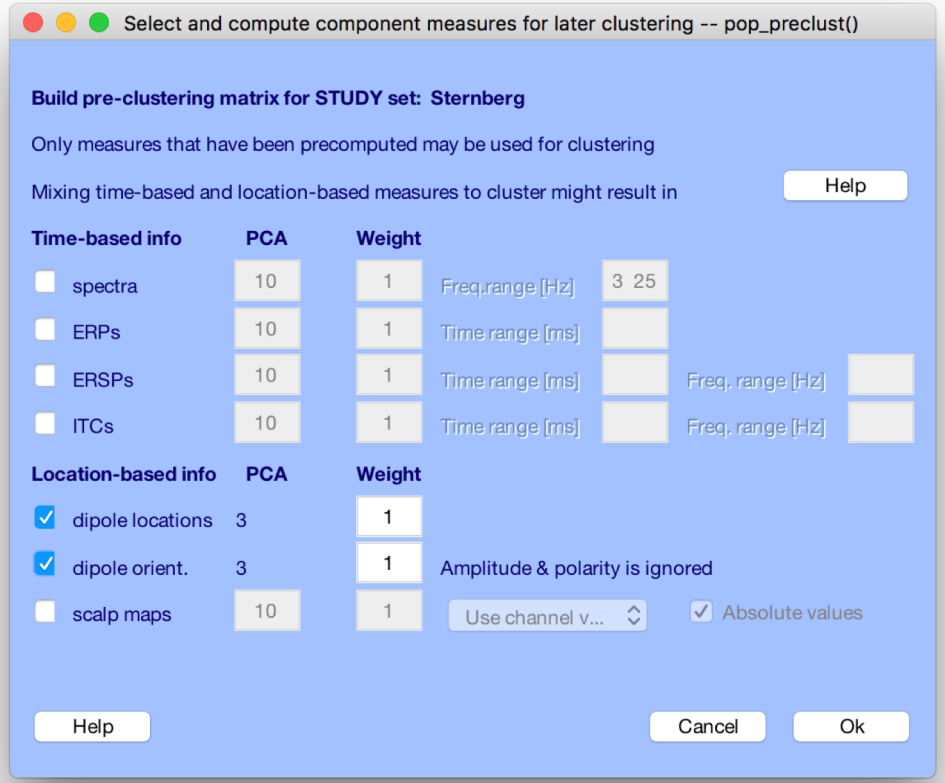
Precompute data measures

TIP: Compute all measures so you can test different combinations for clustering

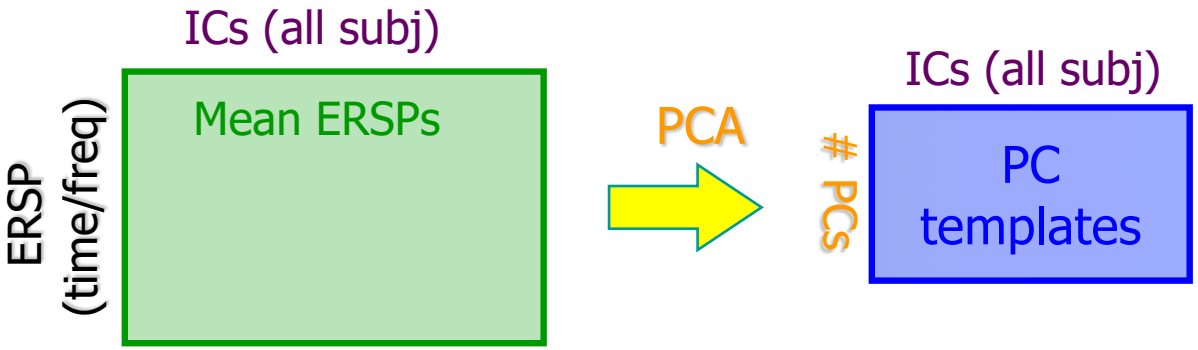


Cluster components

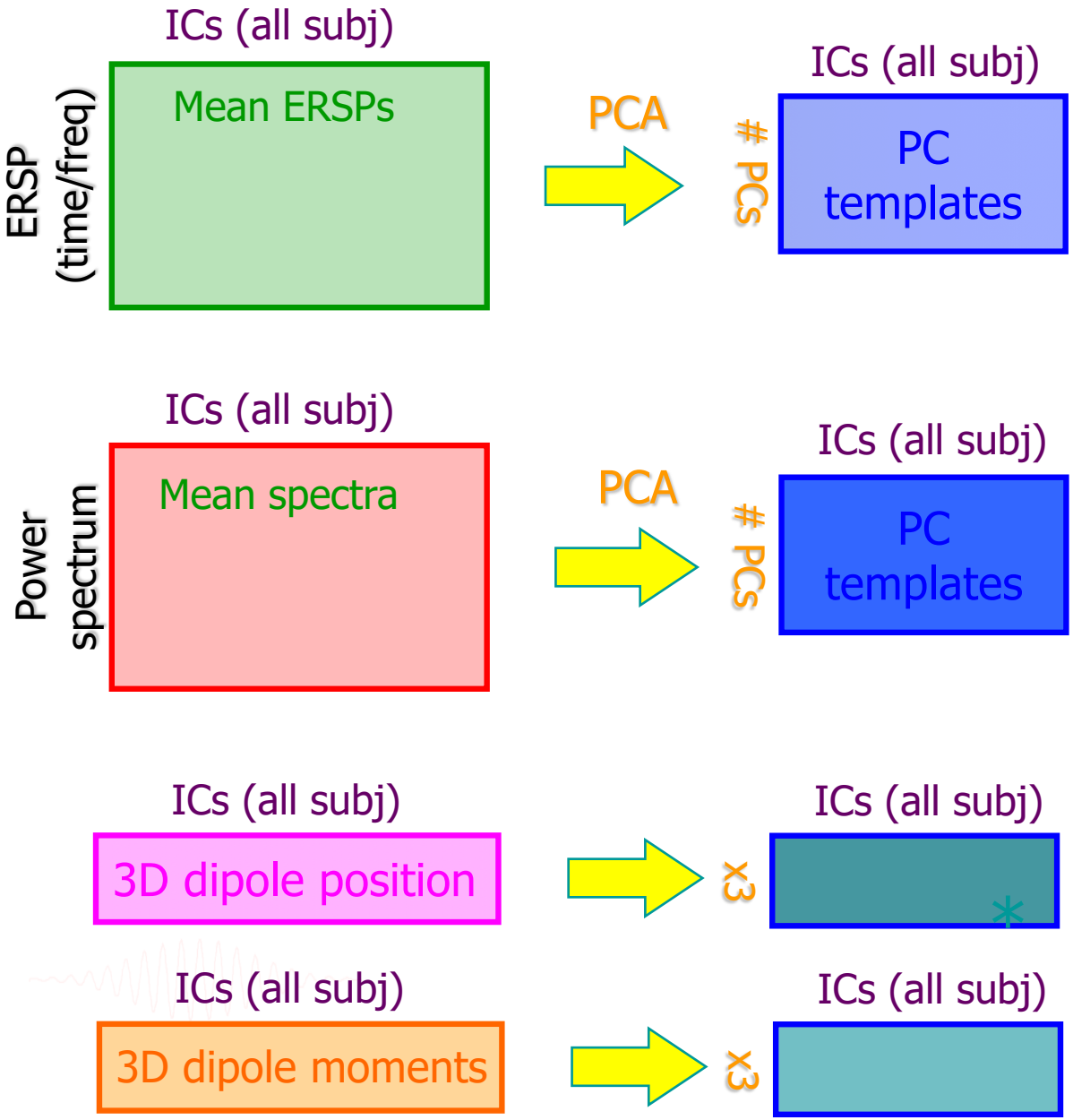




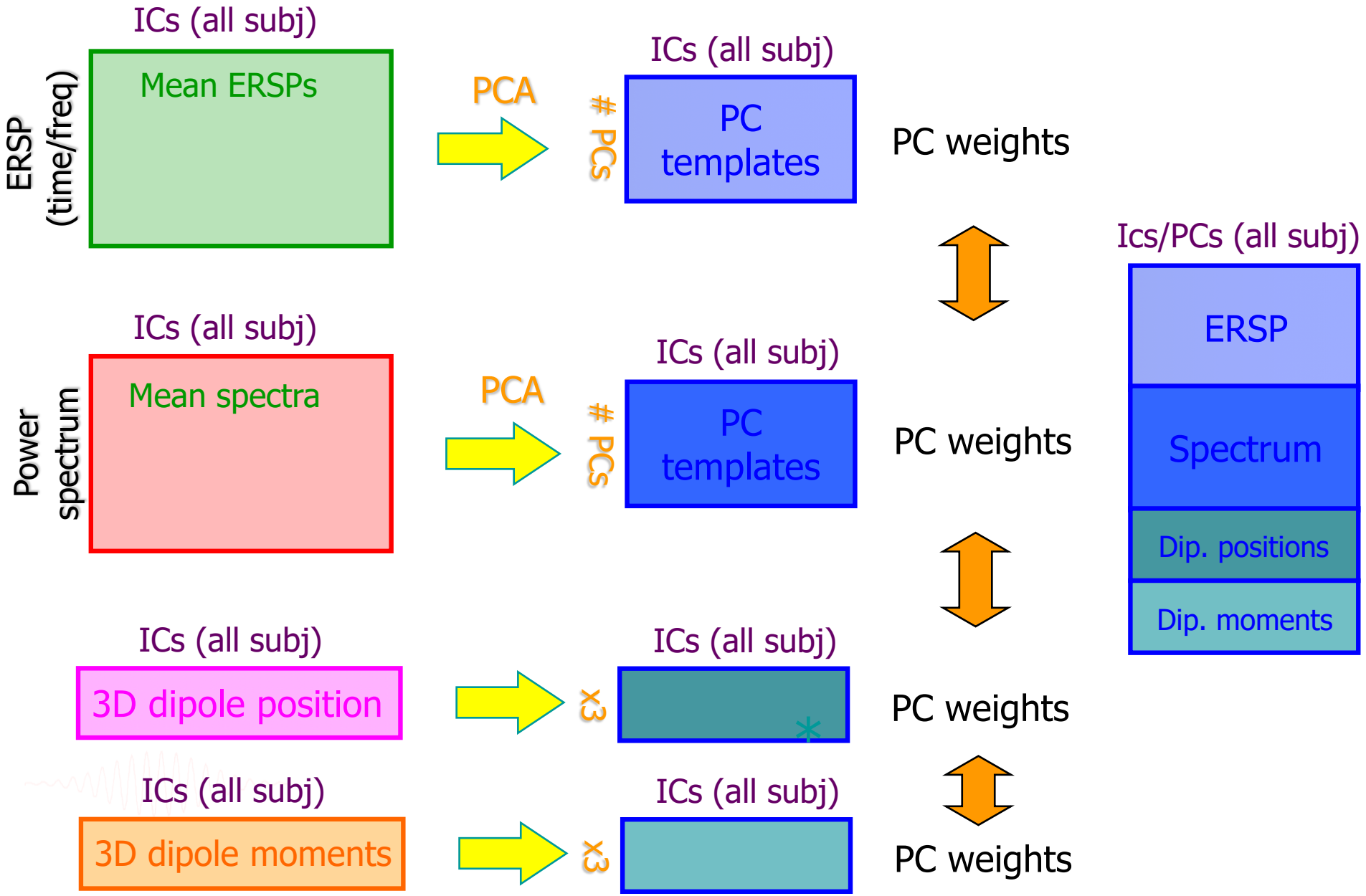
Precluster schematic



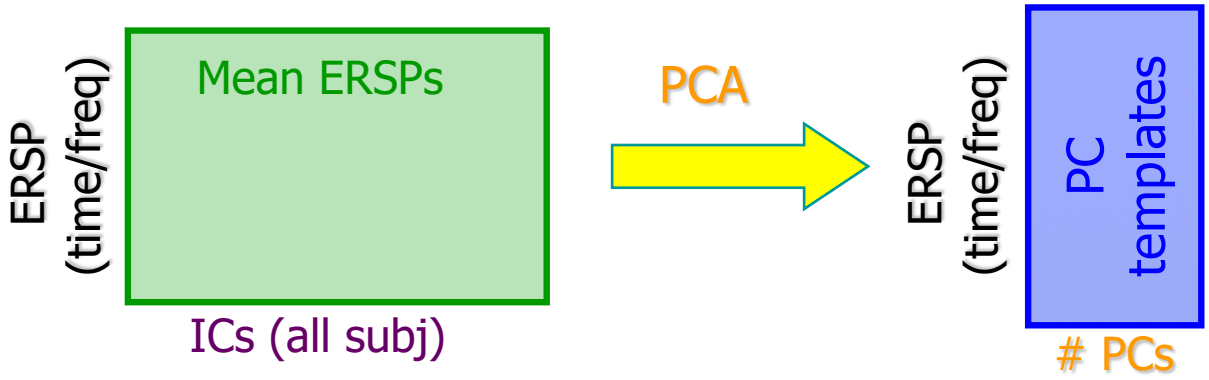
Precluster schematic

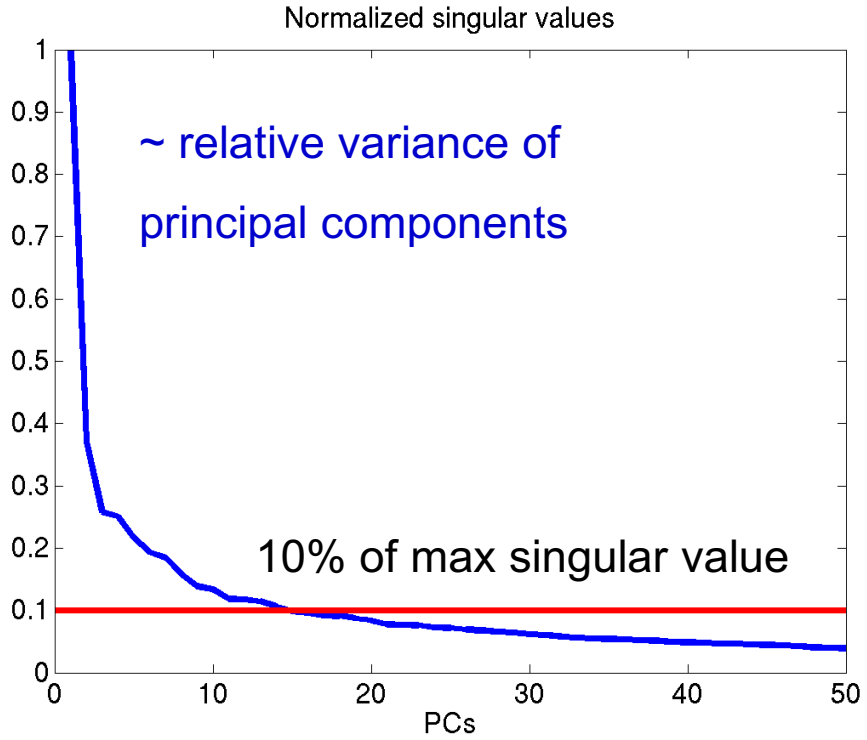


Precluster schematic



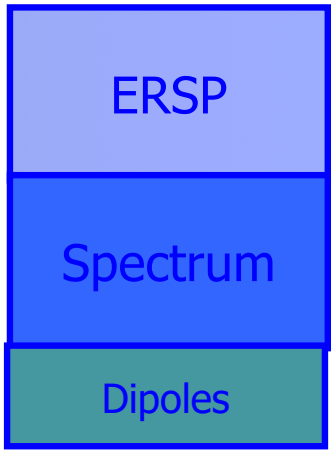
Precluster: Use singular values from PCA



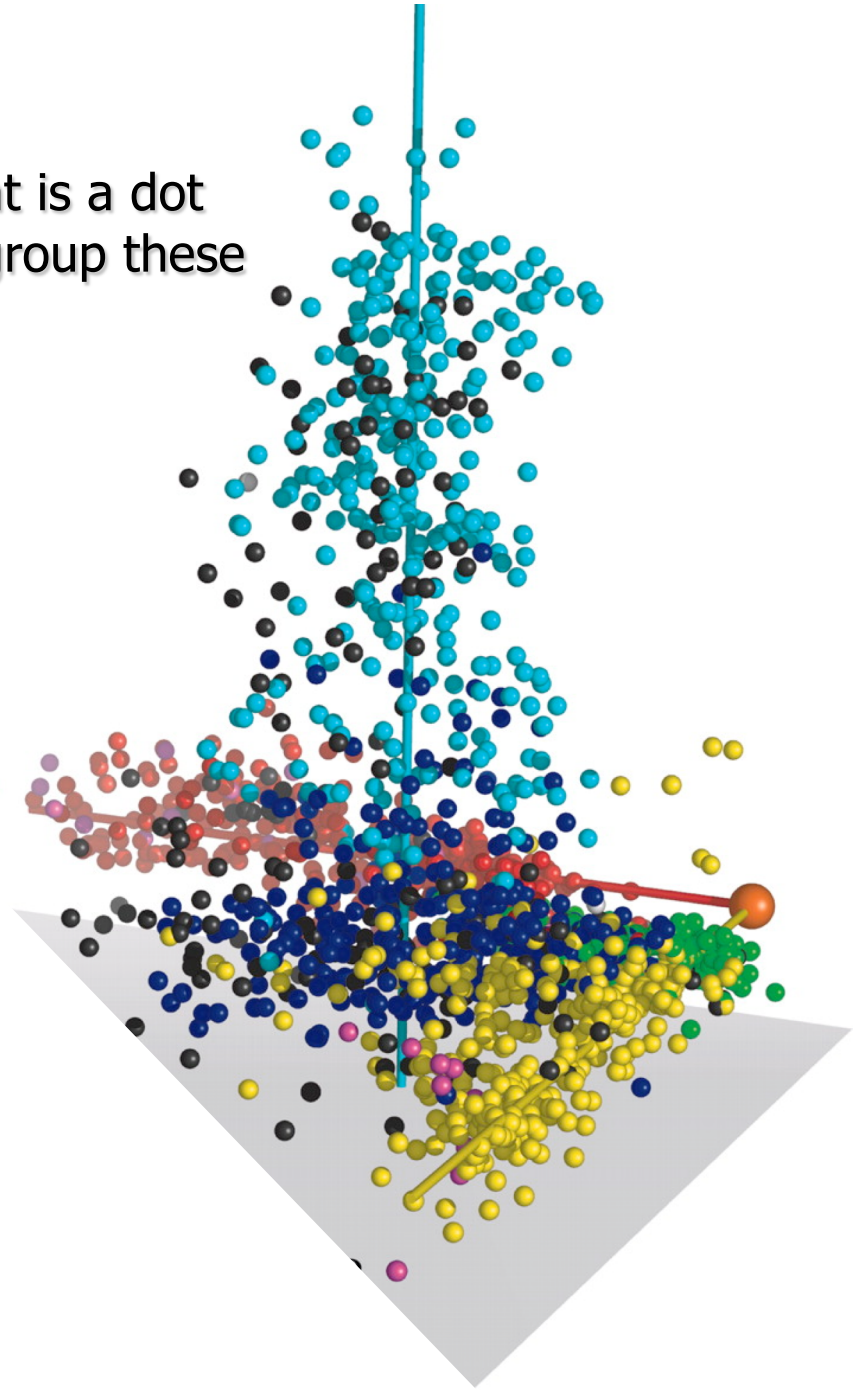


Precluster schematic

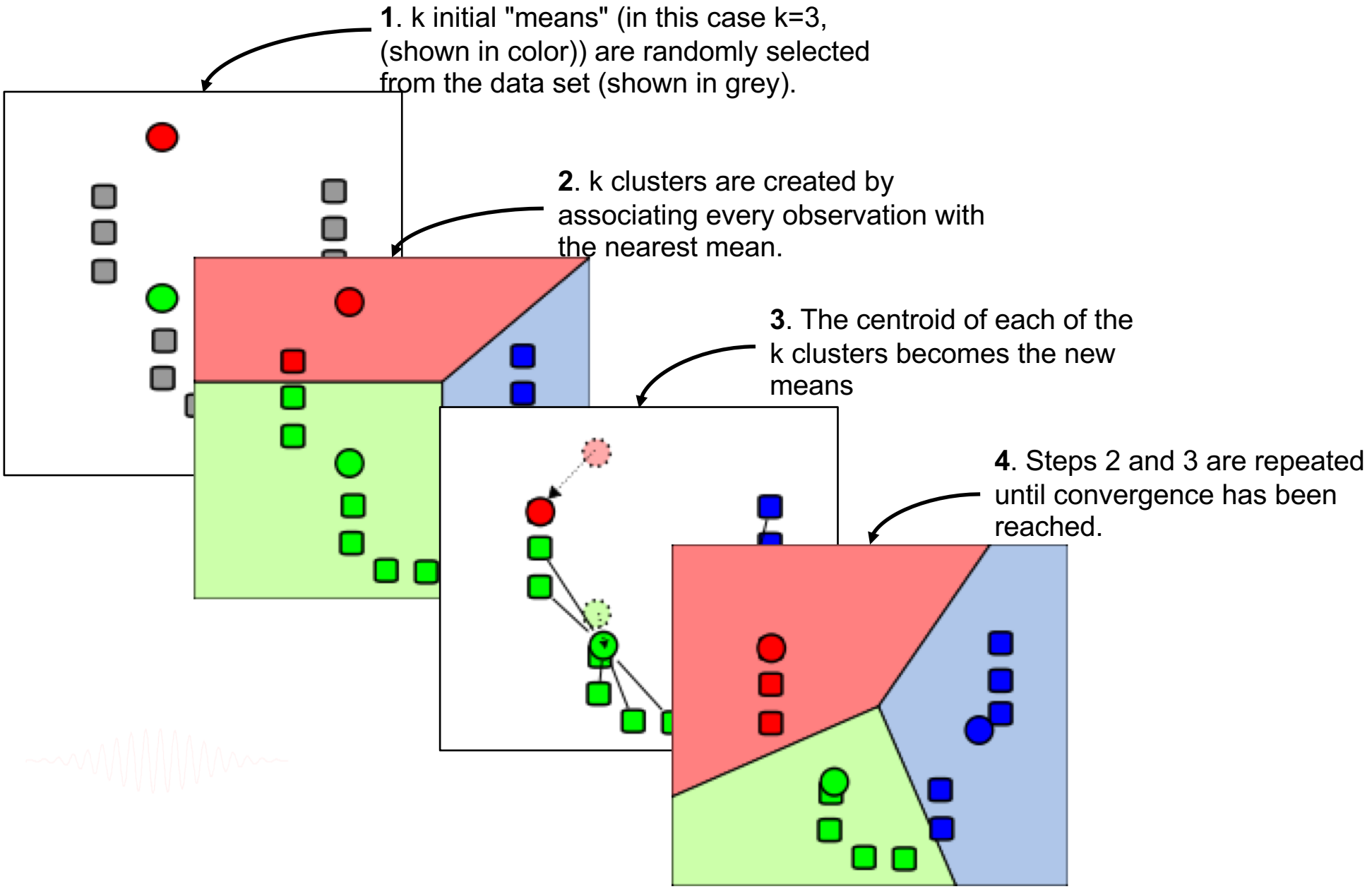
ICs (all subj)



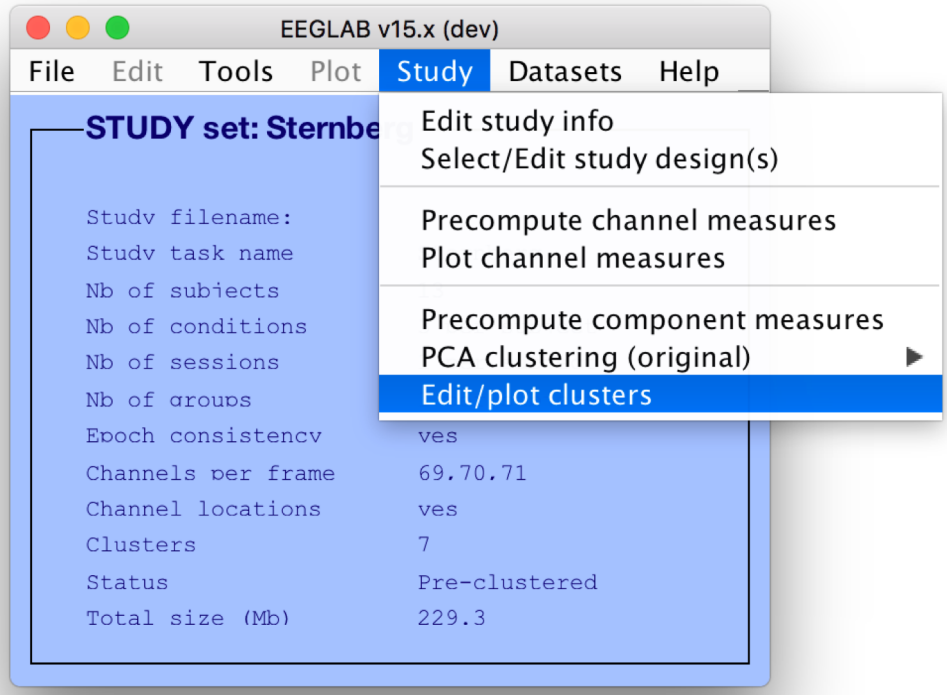
Each component is a dot
Clustering will group these dots

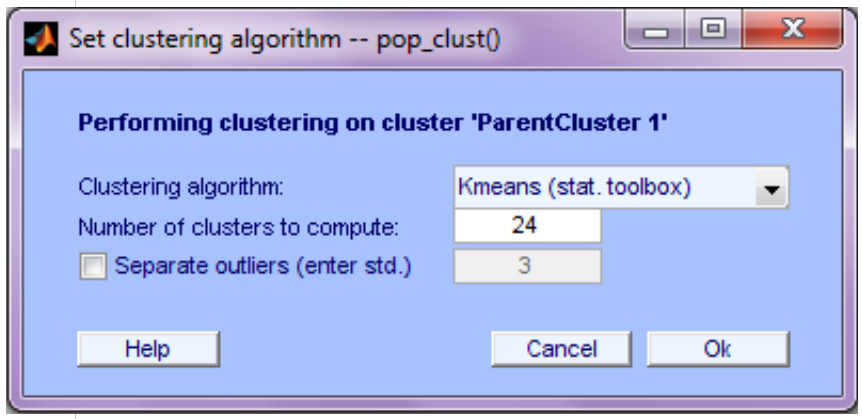


Classical KMean



Cluster components





Choosing data measures

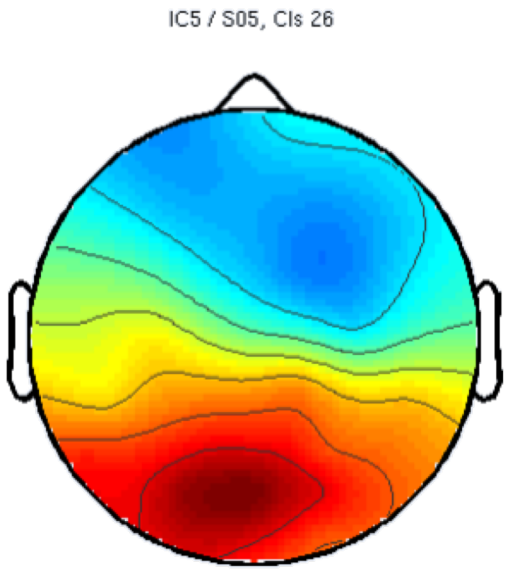
What measure(s) should you use?

It depends on your final cluster criteria…

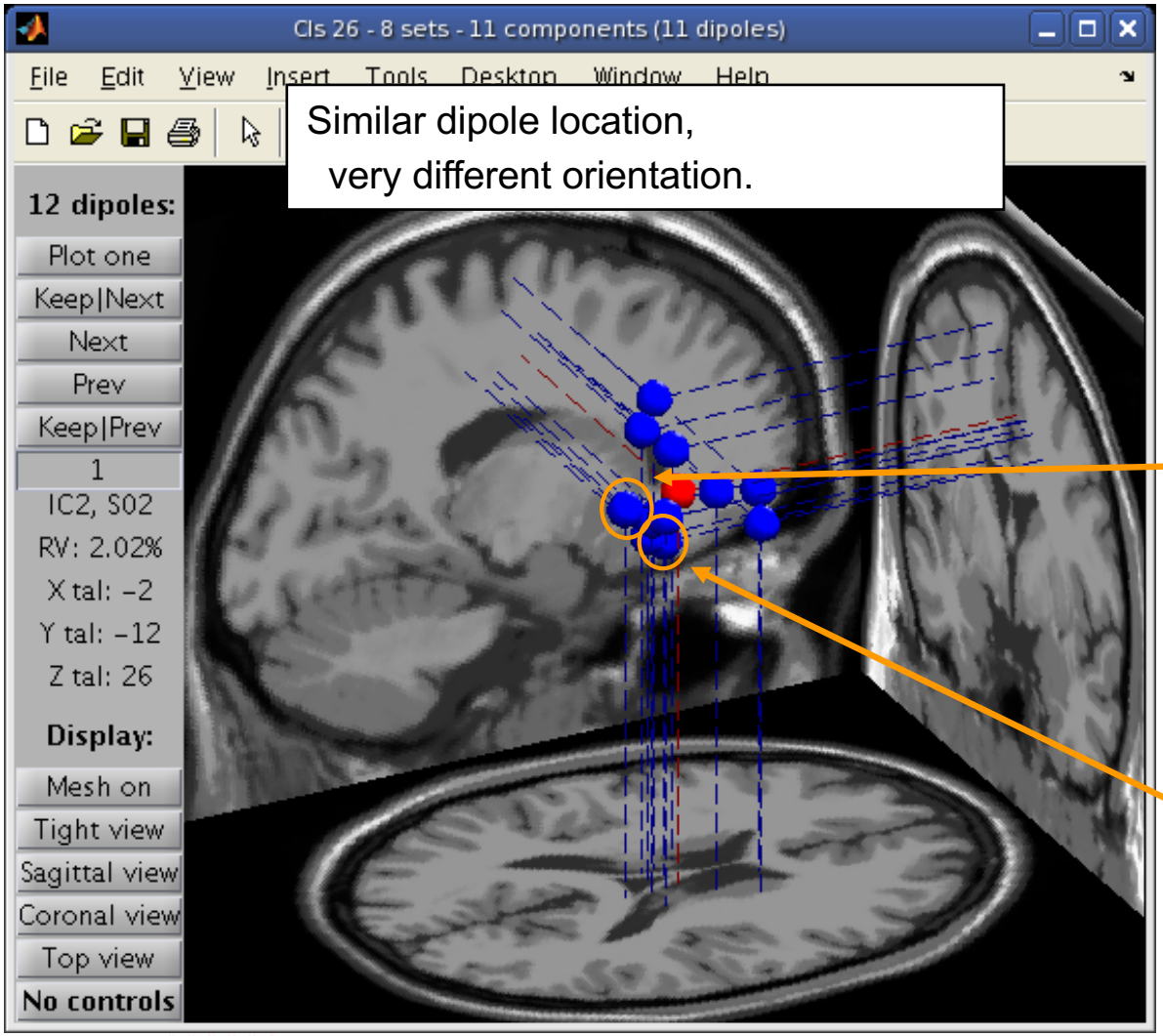
- If for example, your priority is dipole location, then cluster only based on dipole location…

But consider:

- What is the difference between these two components?

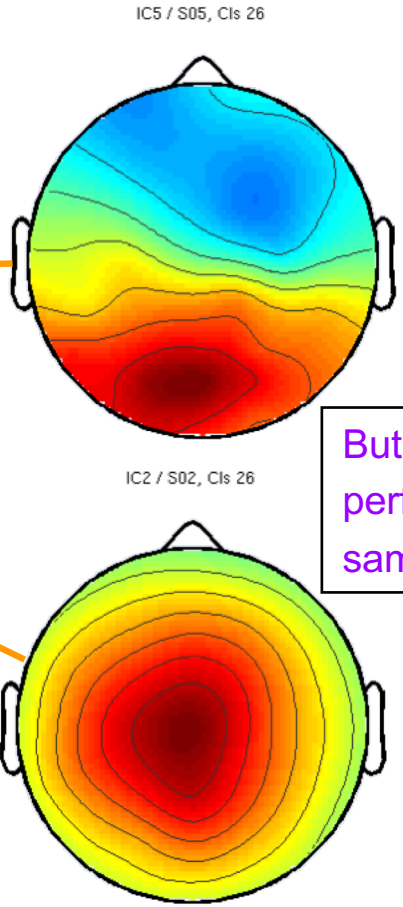


Choosing data measures



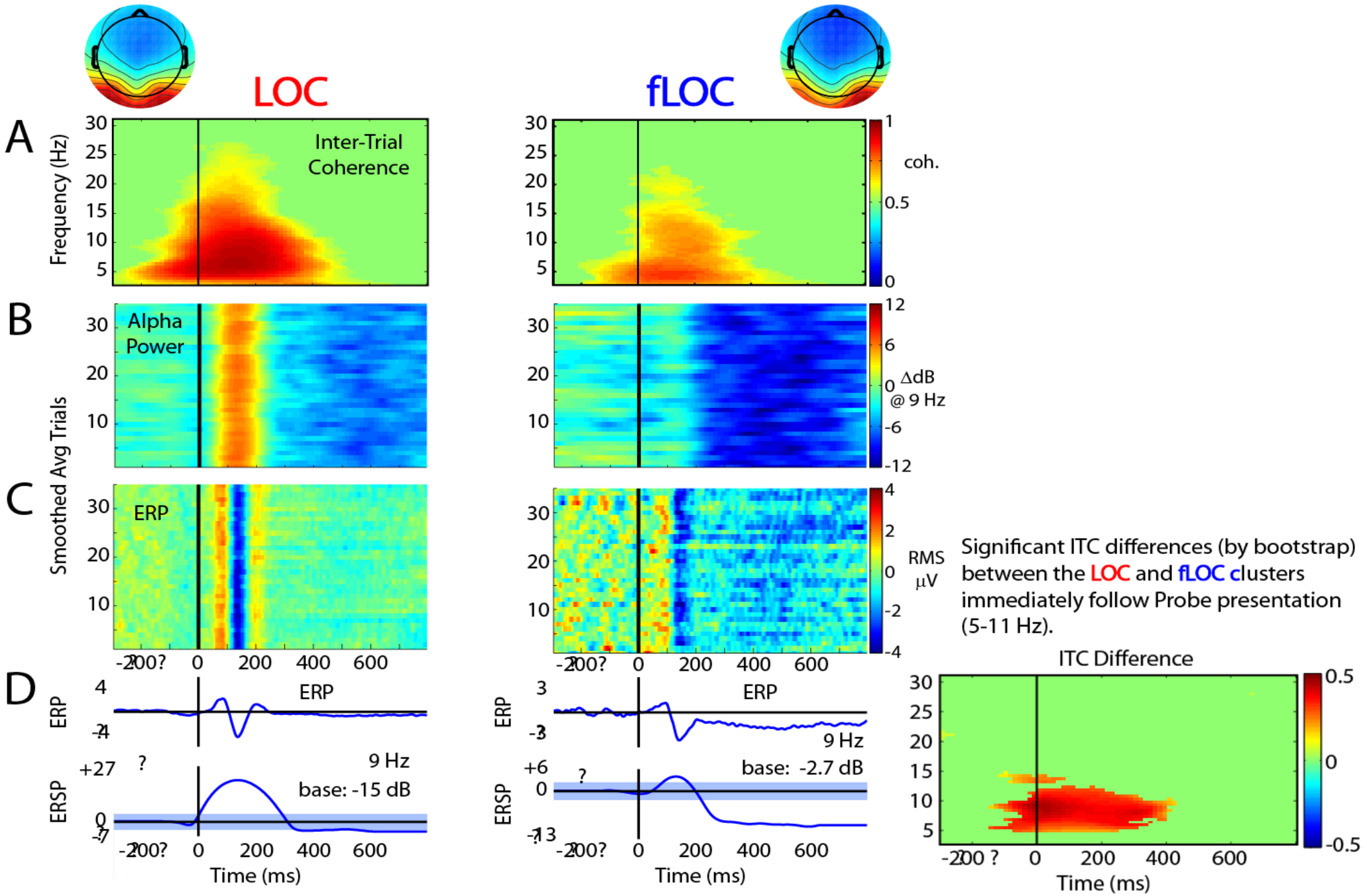
Similar dipole location,
very different orientation.

Obvious dramatic effect on scalp map topography:



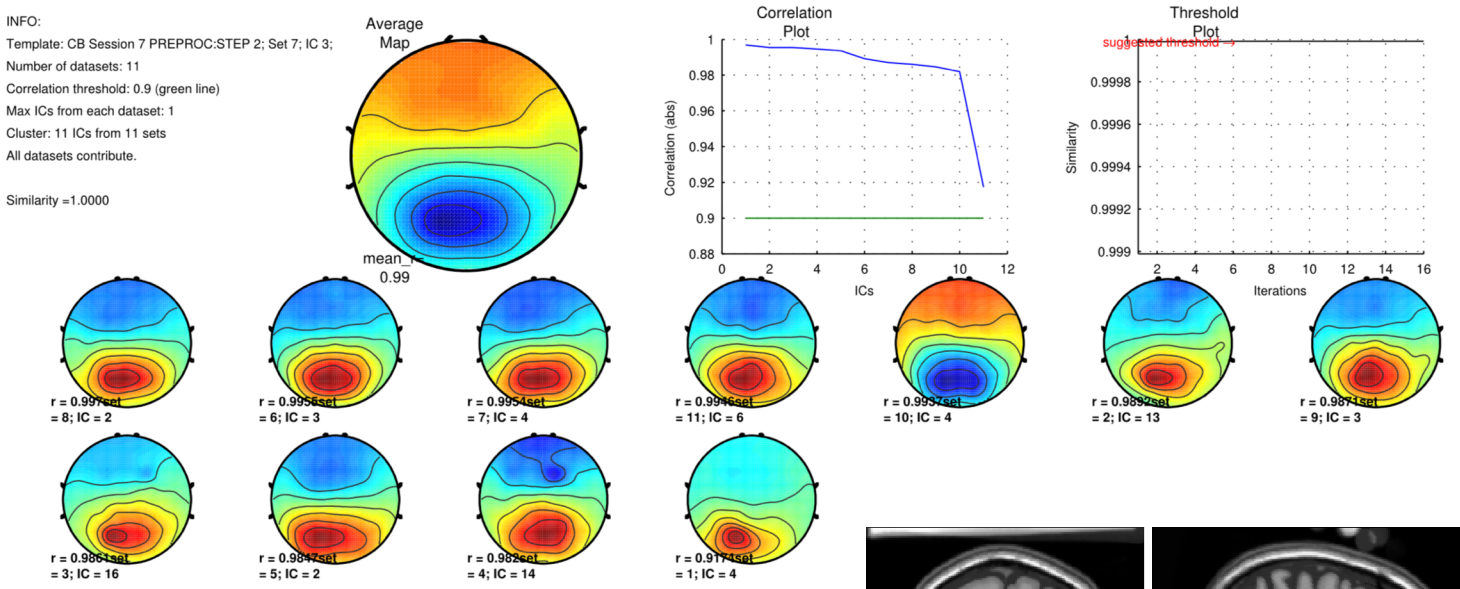
But, do they perform the same functions?

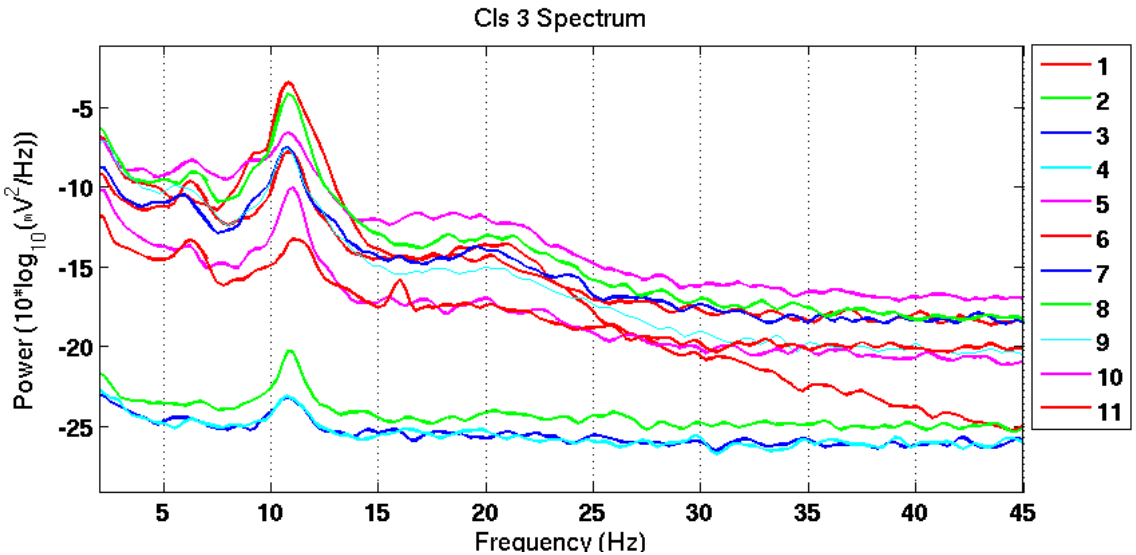
Subject differences?

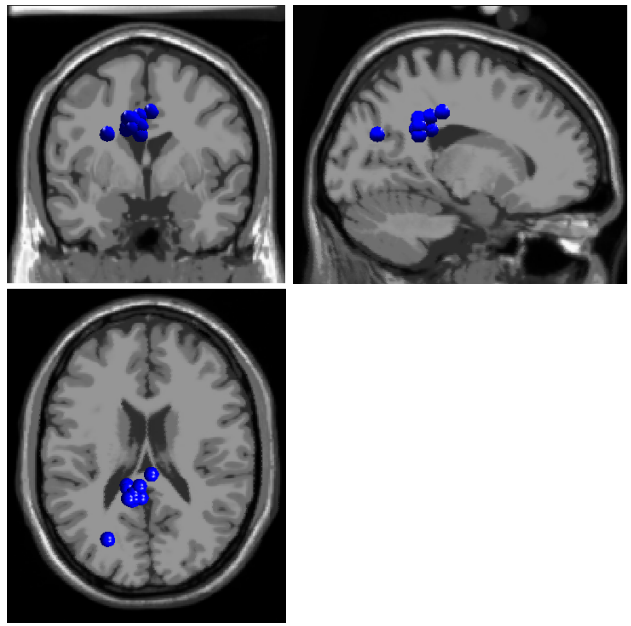


Results (Cluster 1 within subject)

100 % Sessions contribute

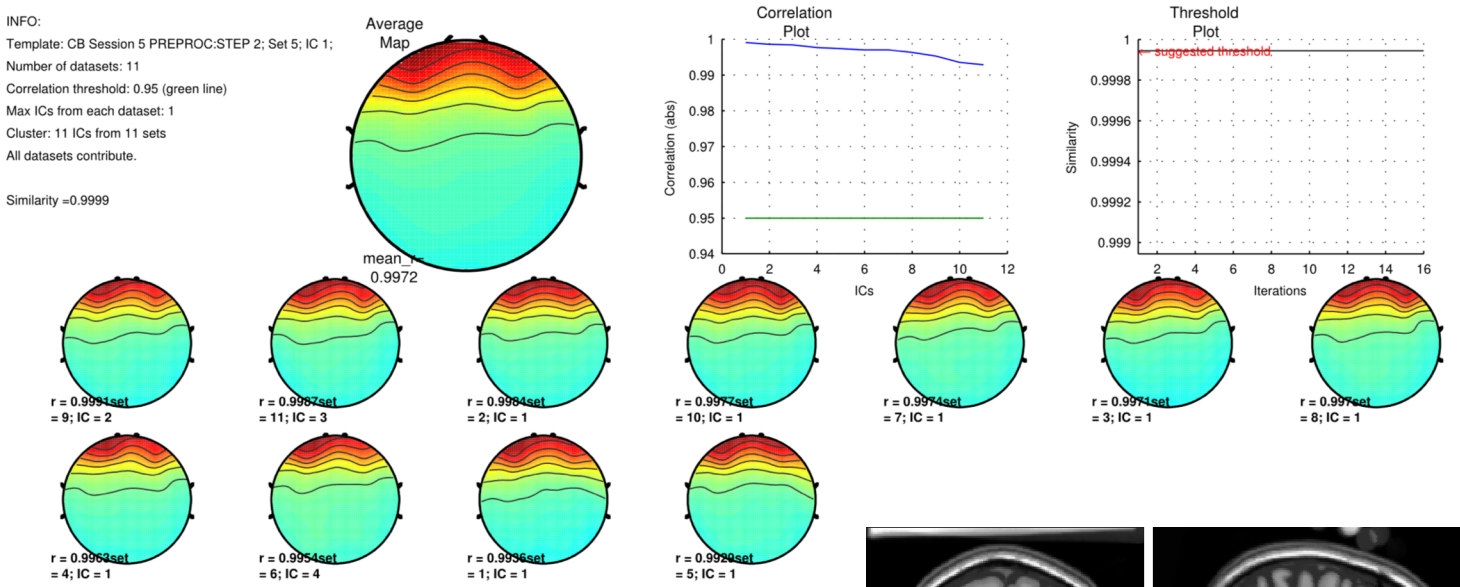


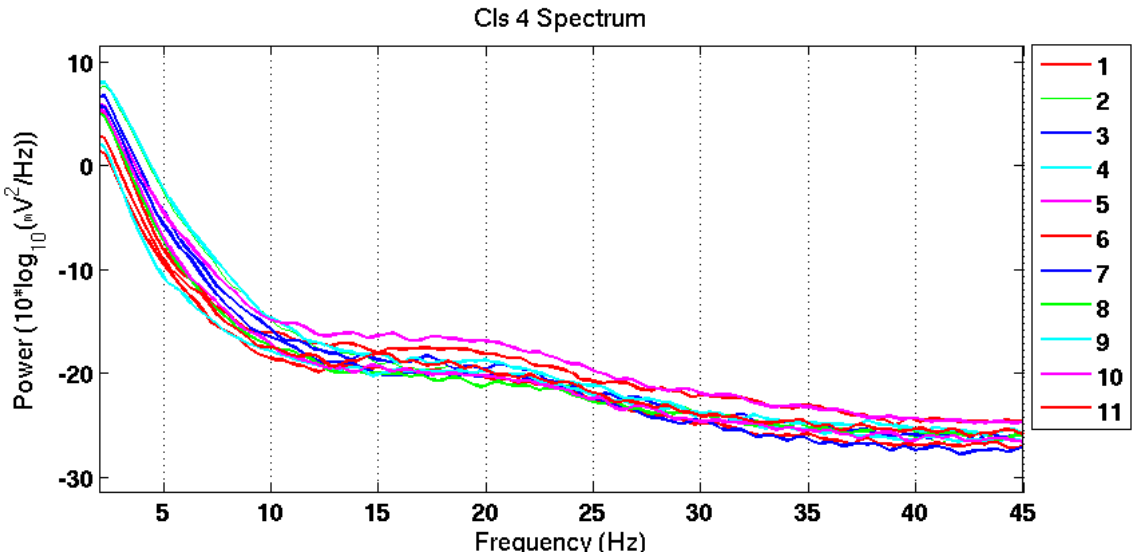


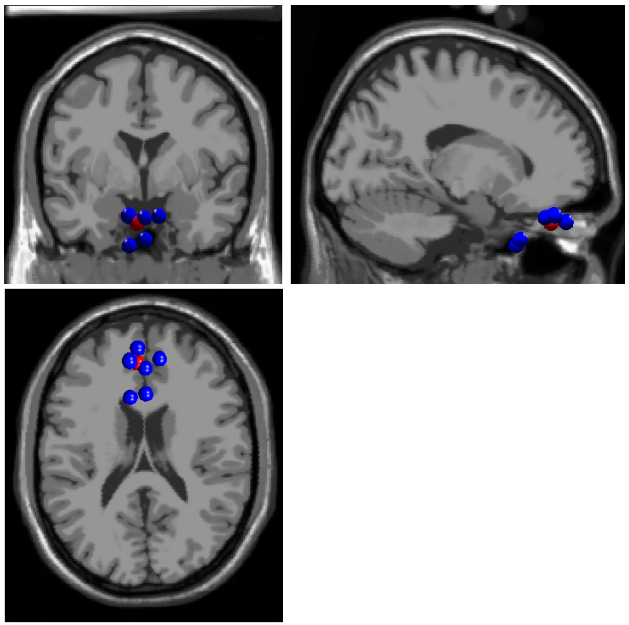


Results (Cluster 2 within subject)

100 % Sessions contribute

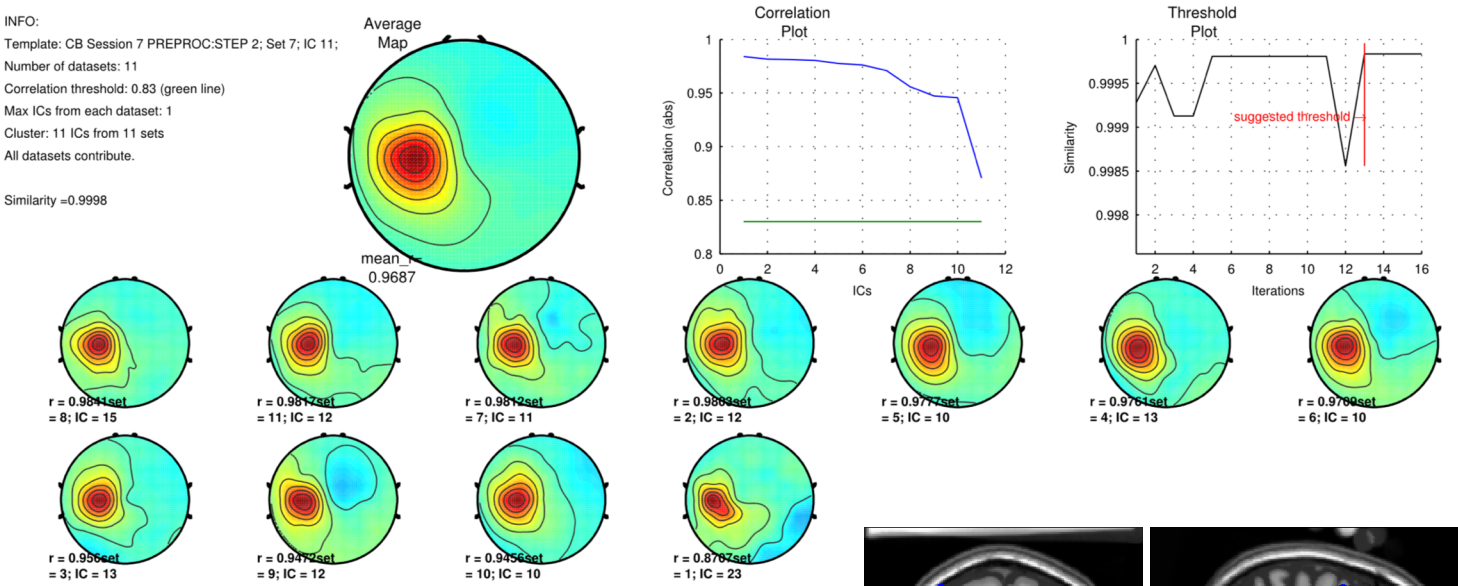


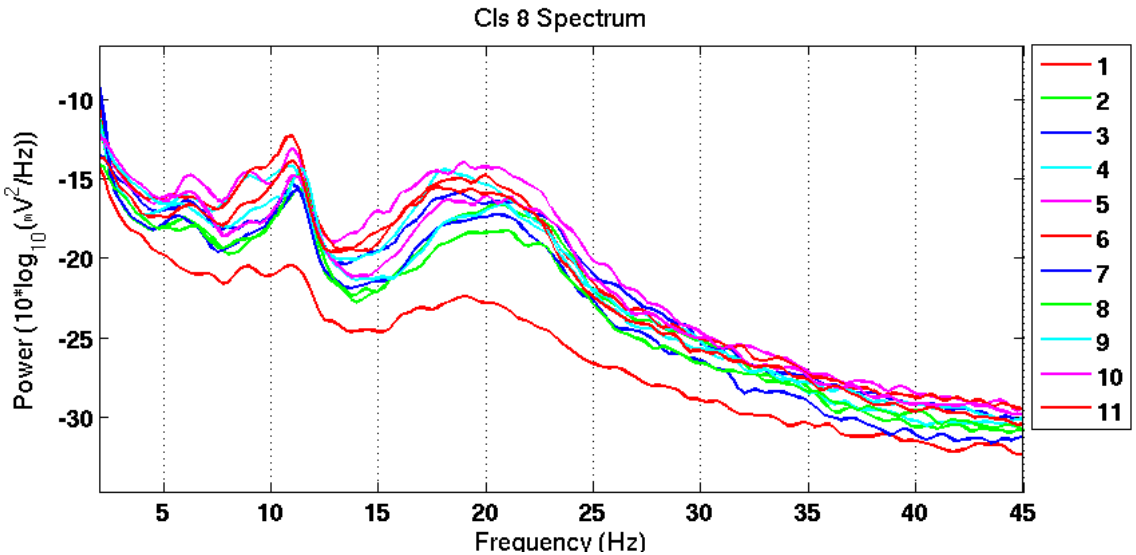


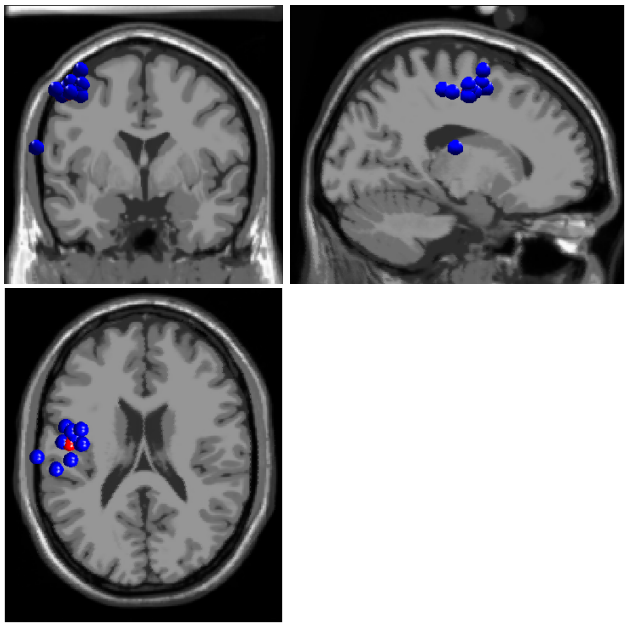


Results (Cluster 8 within subject)

100 % Sessions contribute

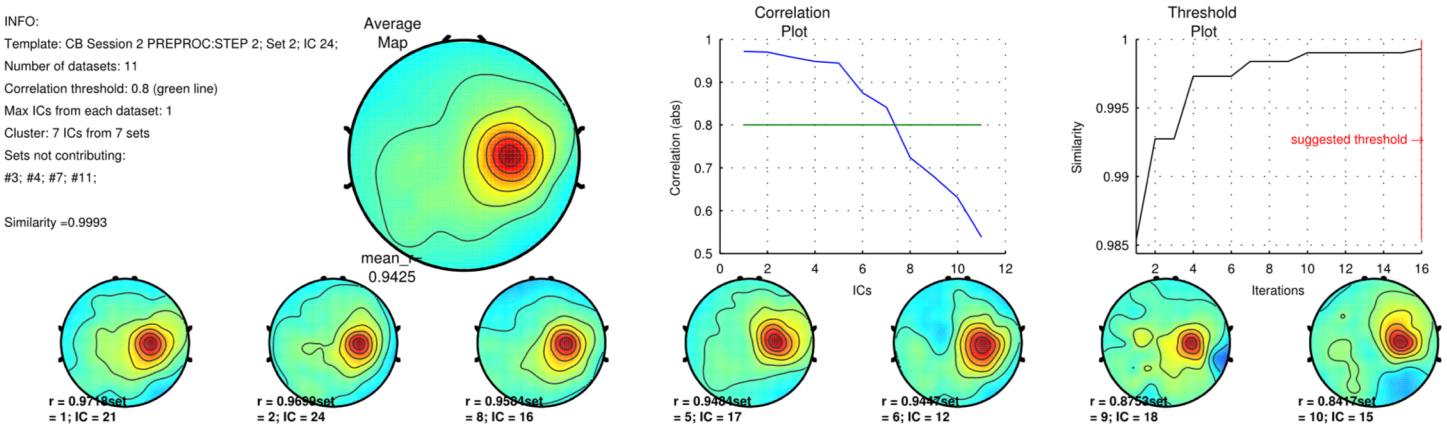


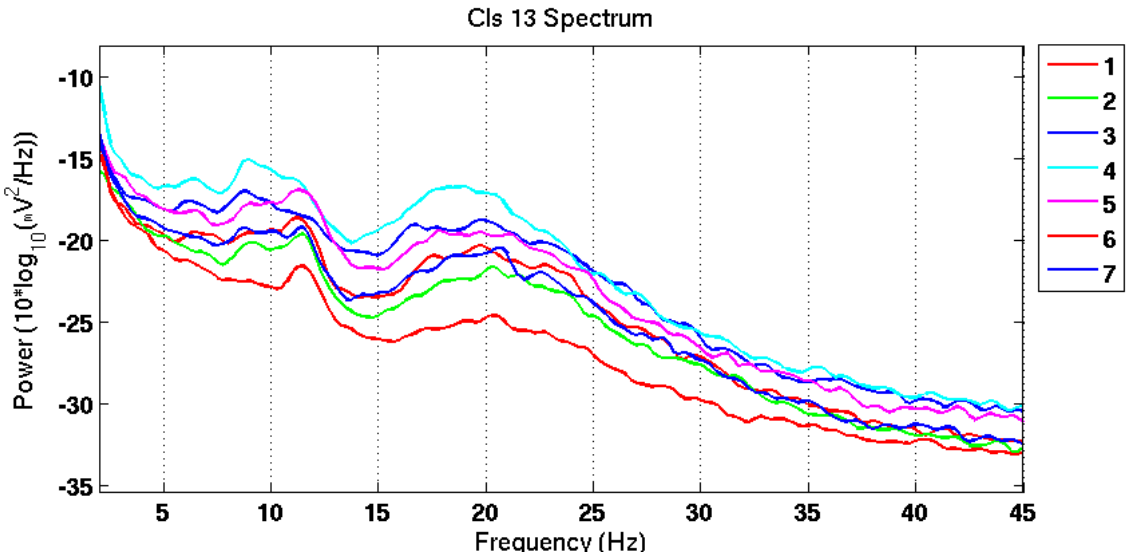


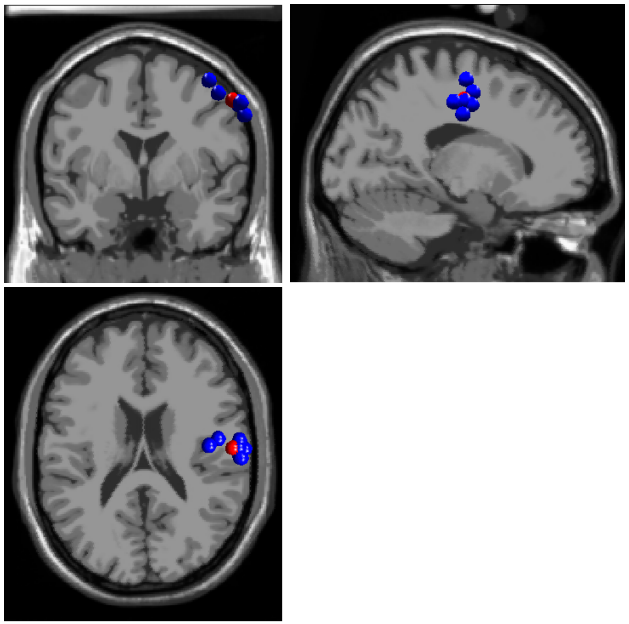


Results (Cluster 13 within subject)

63.64% Sessions contribute

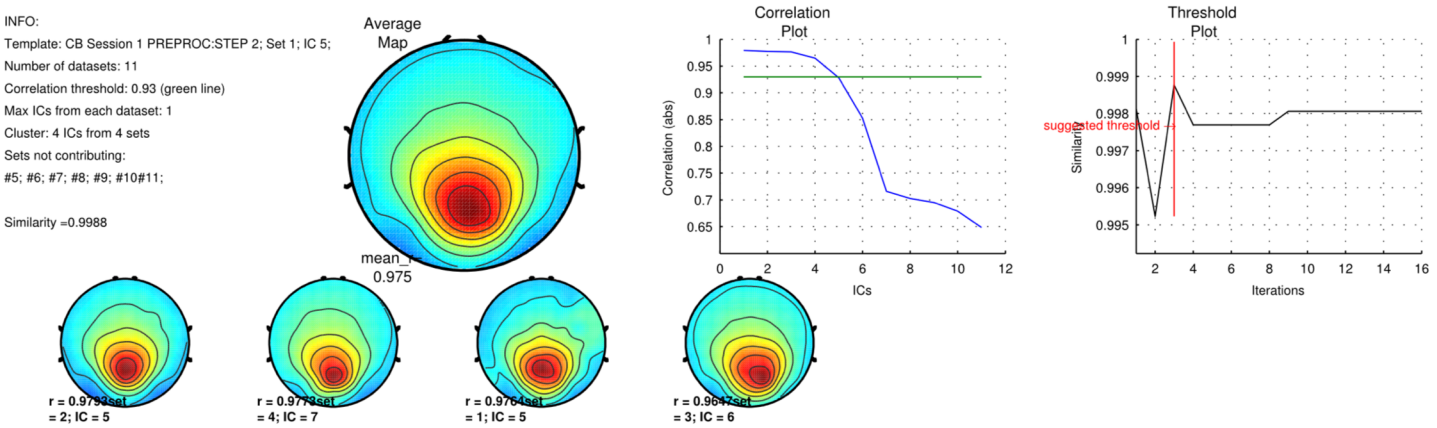


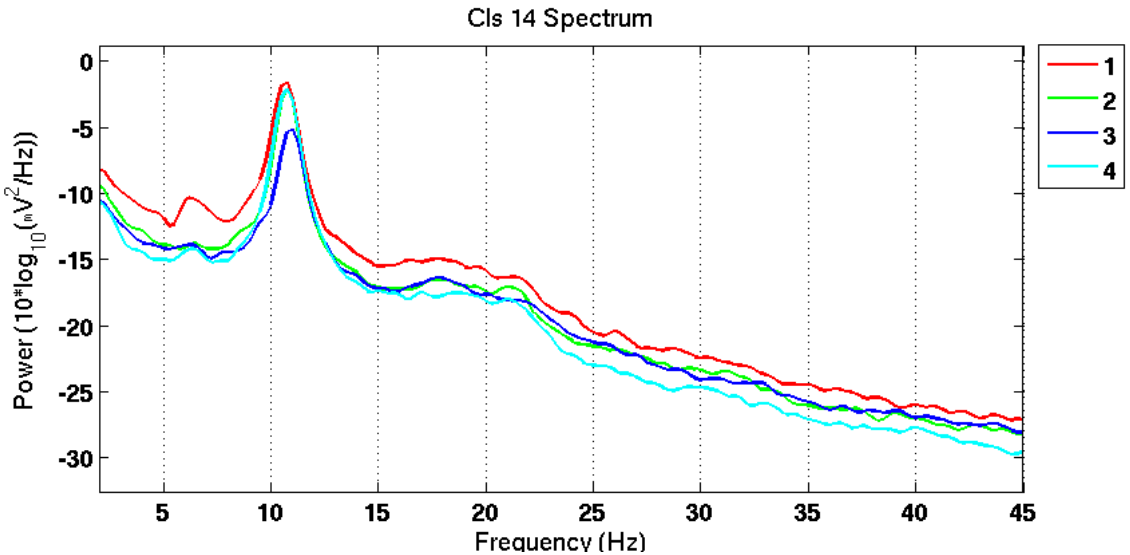


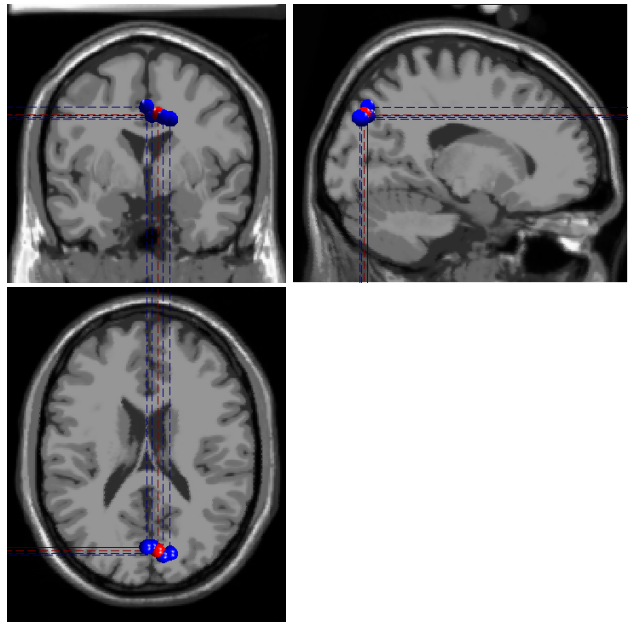


Results (Cluster 14 within subject)

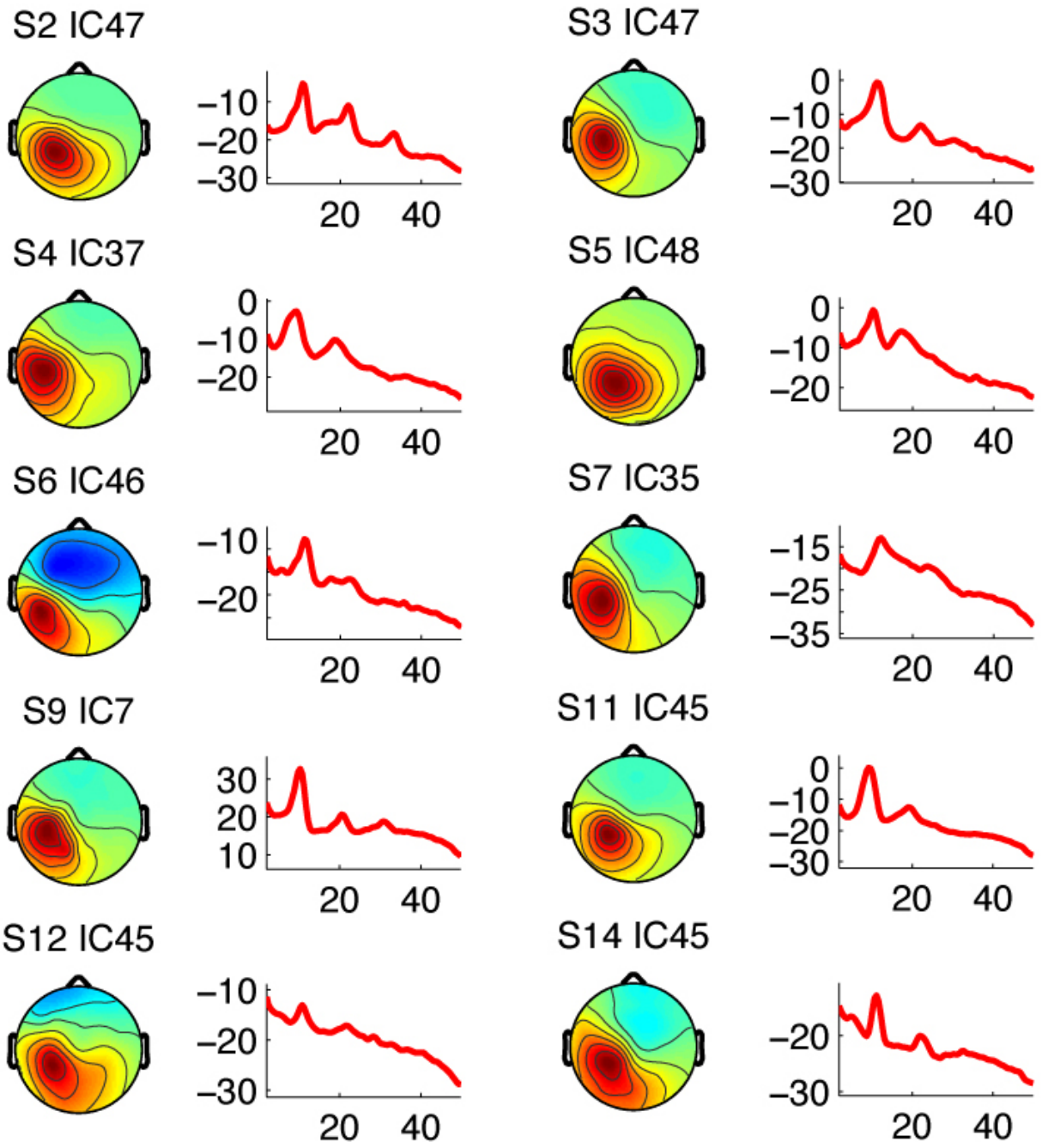
36.36% Sessions contribute



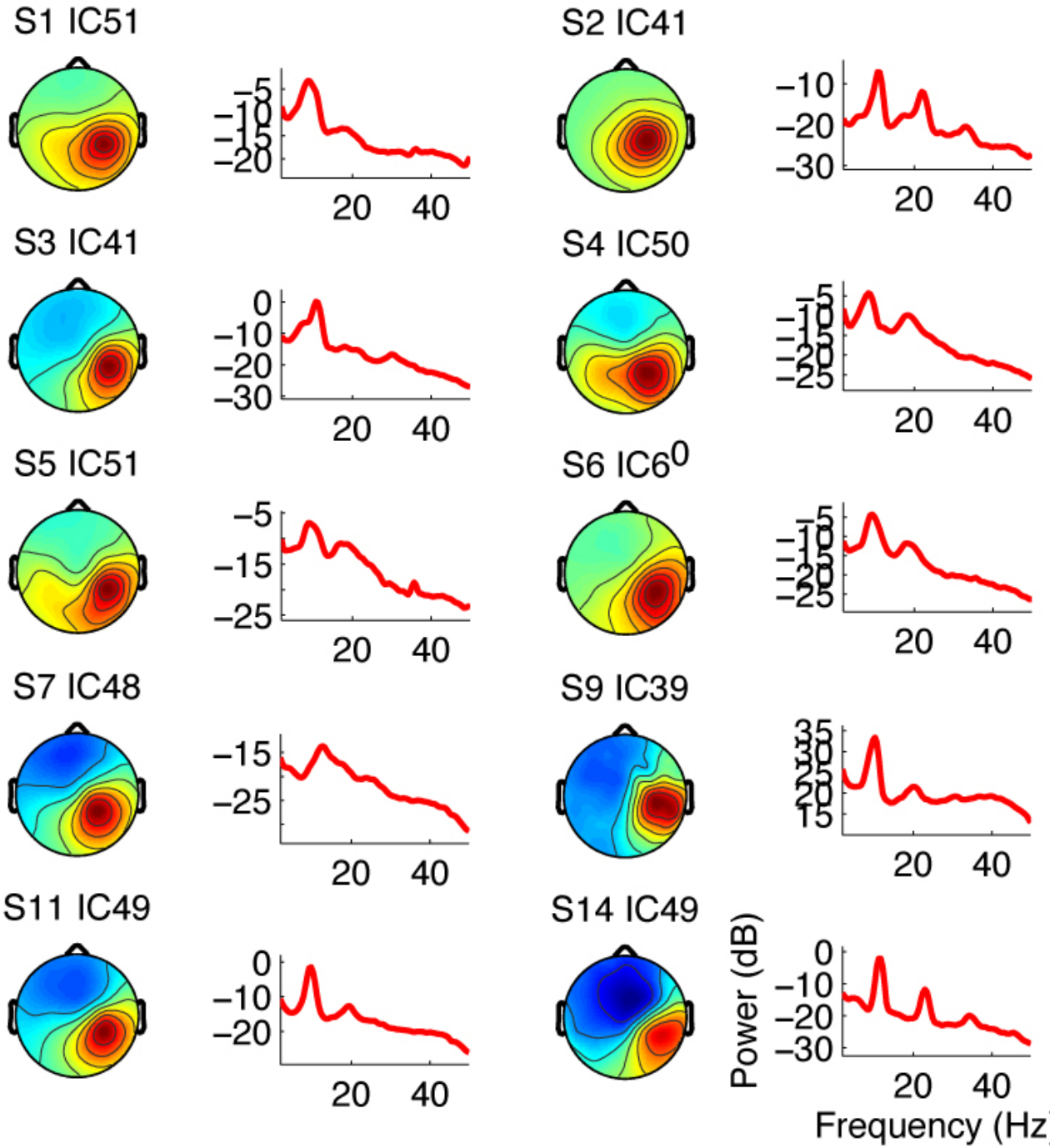




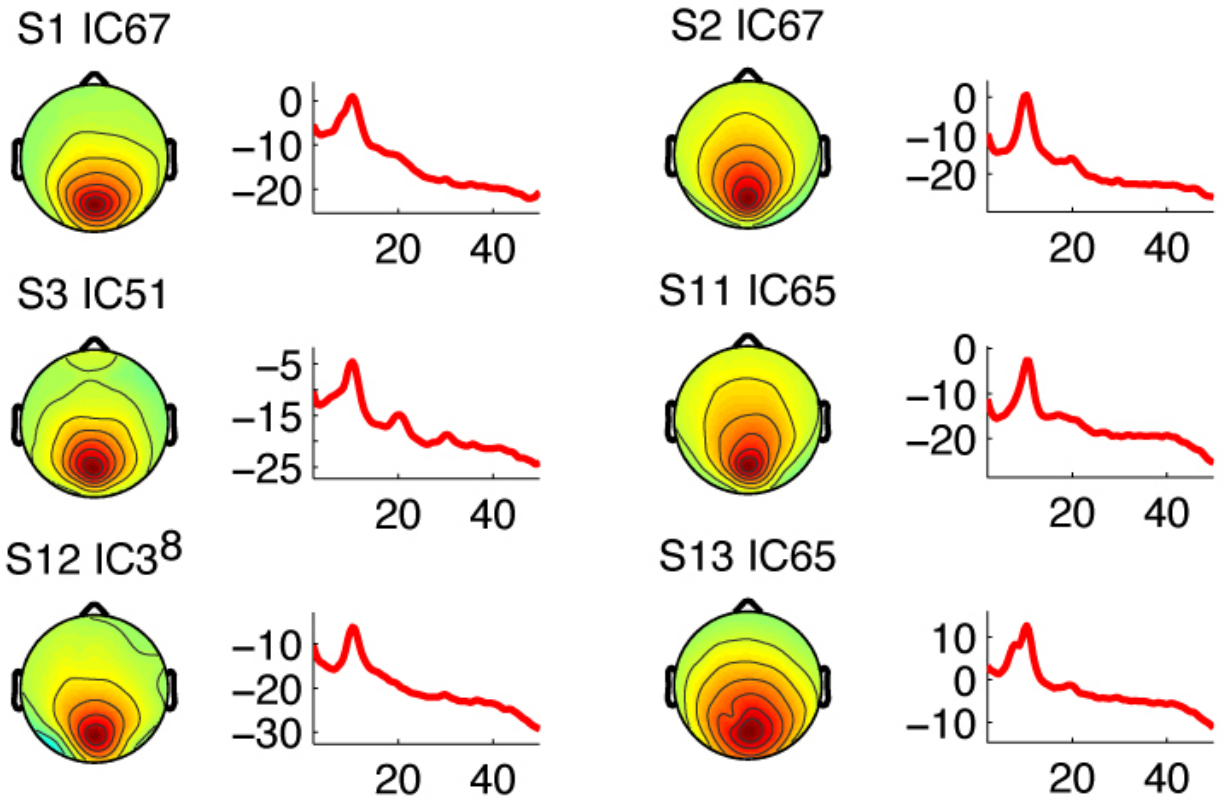
Left μ cluster (across subjects)



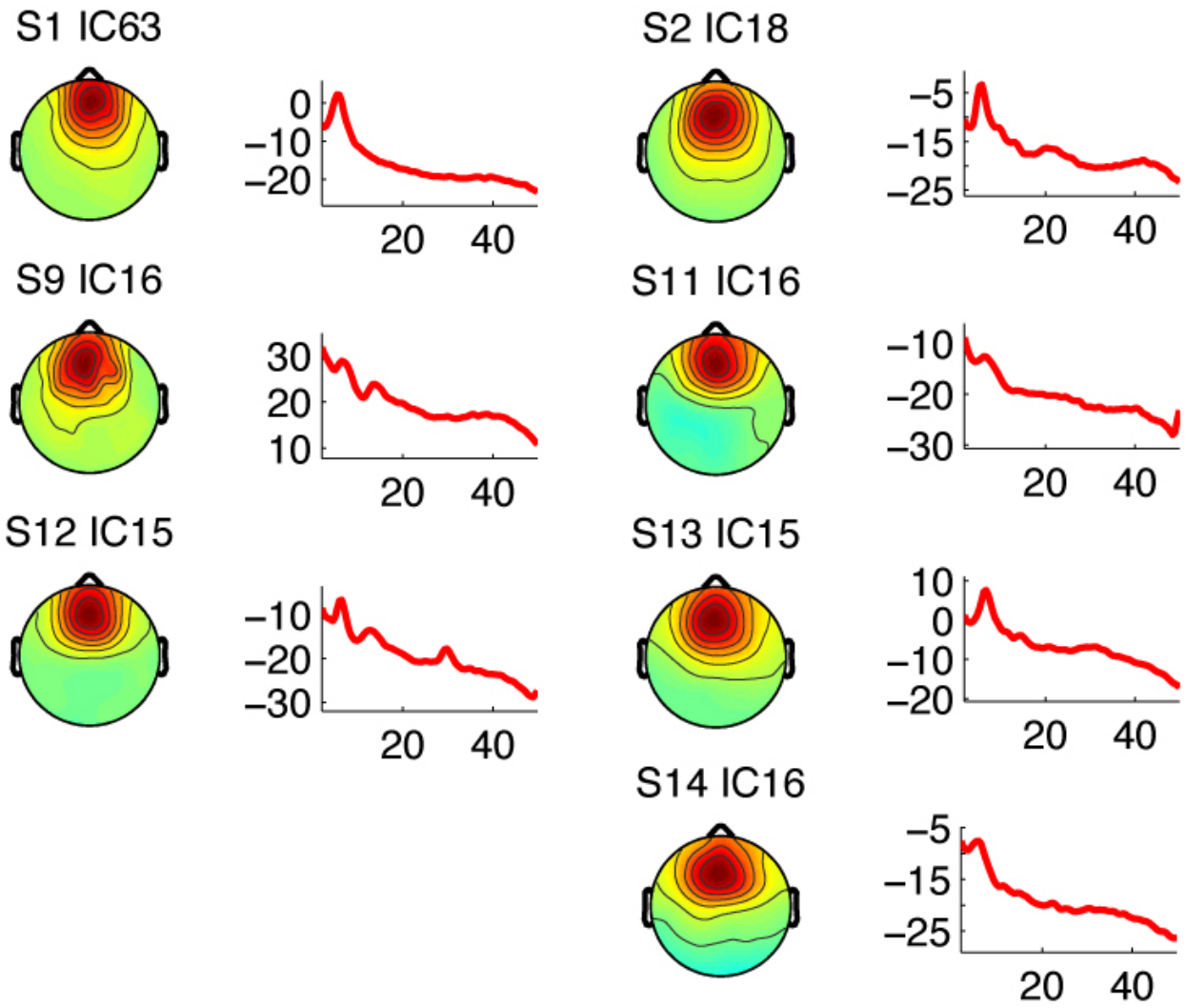
Right μ cluster



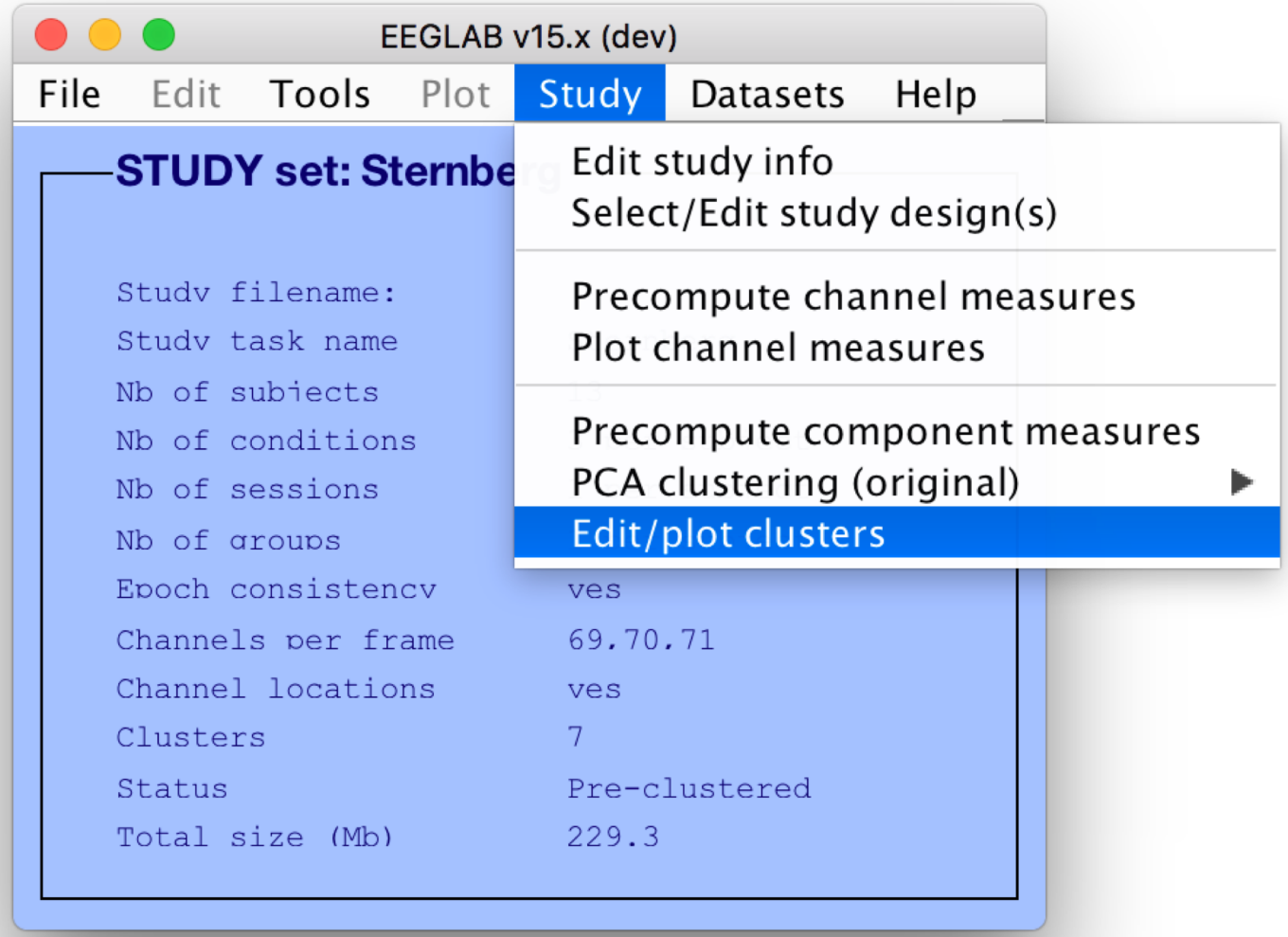
Occipital α cluster



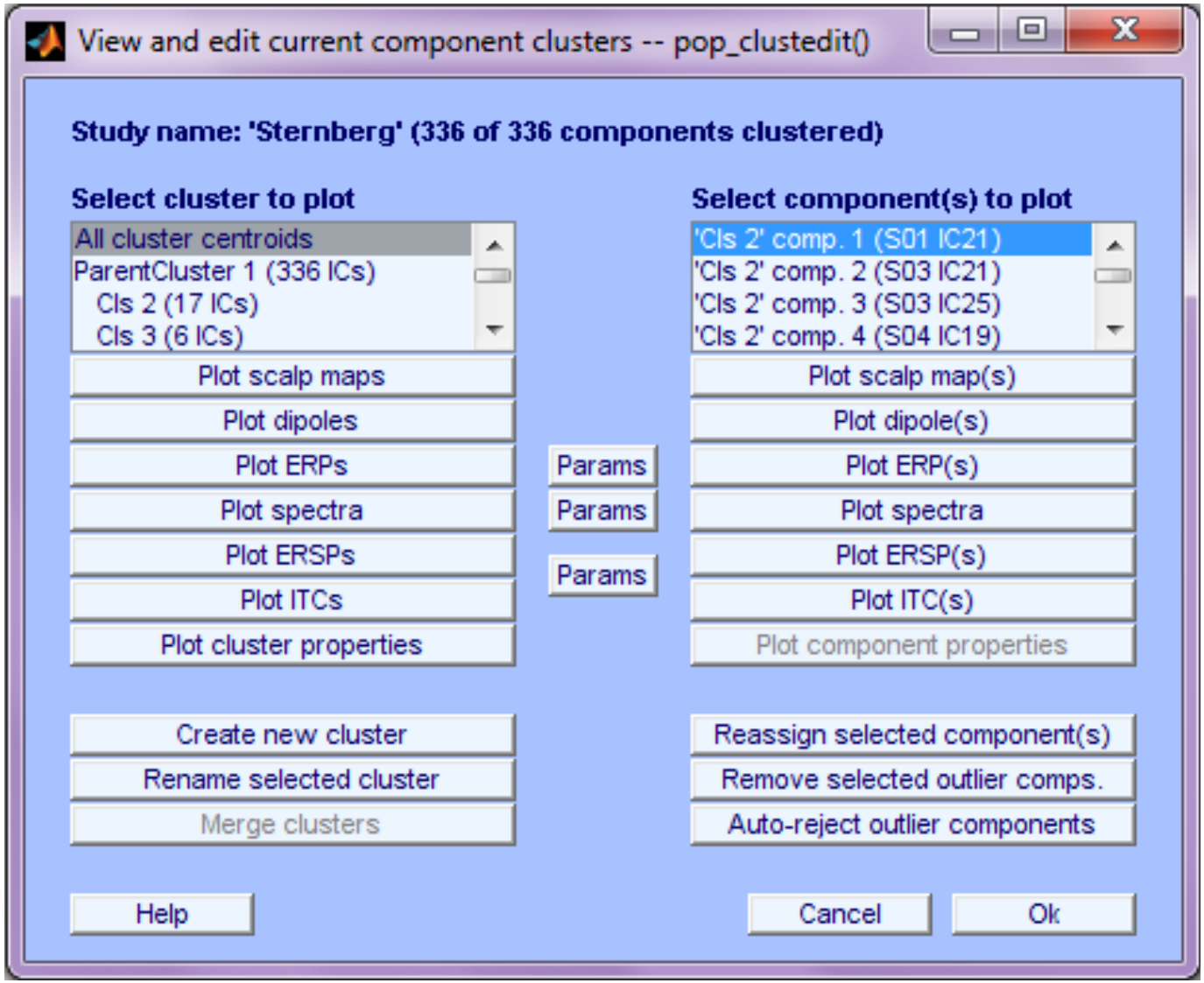
Frontal Midline θ cluster



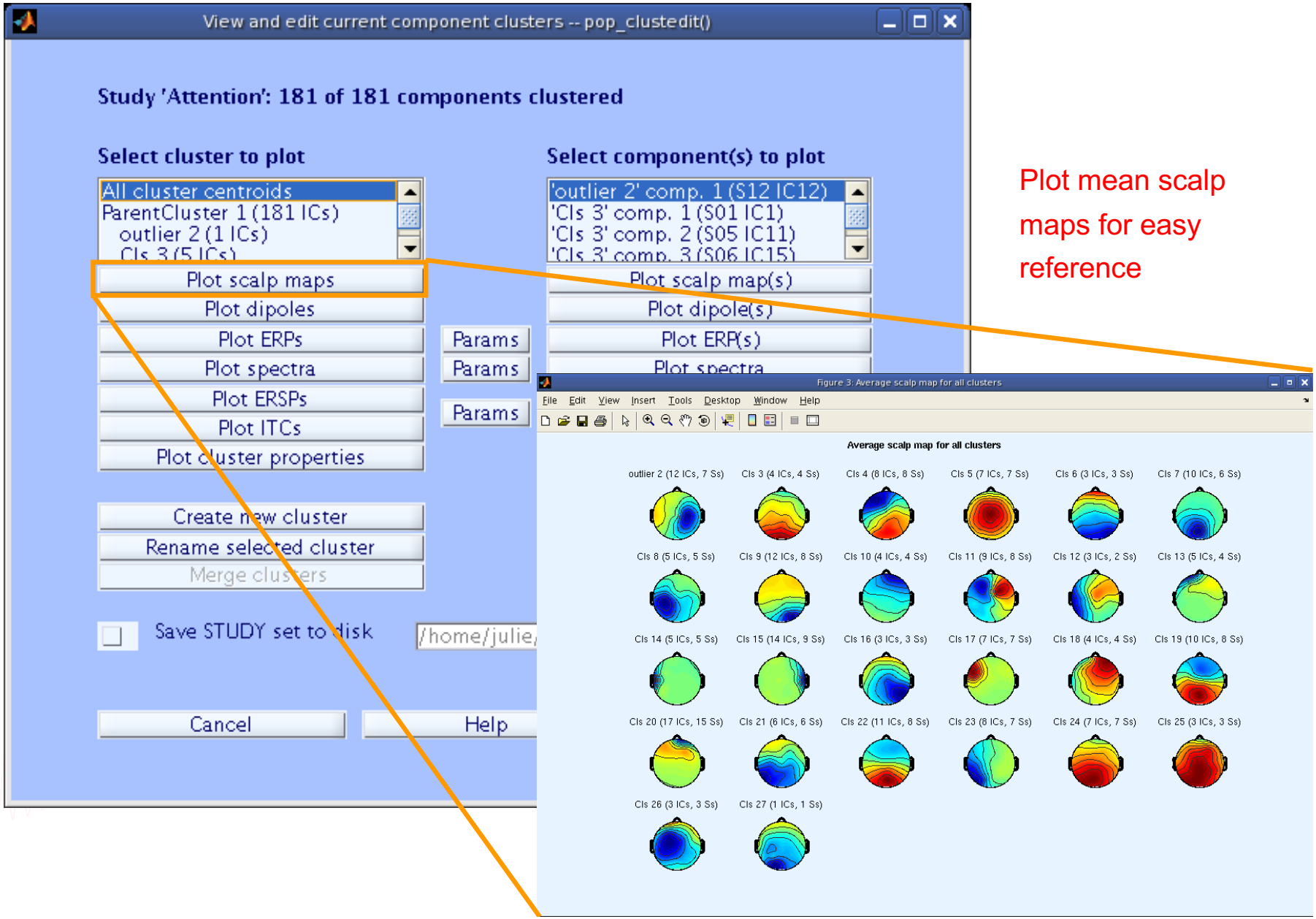
View and edit clusters



Plot/edit clusters

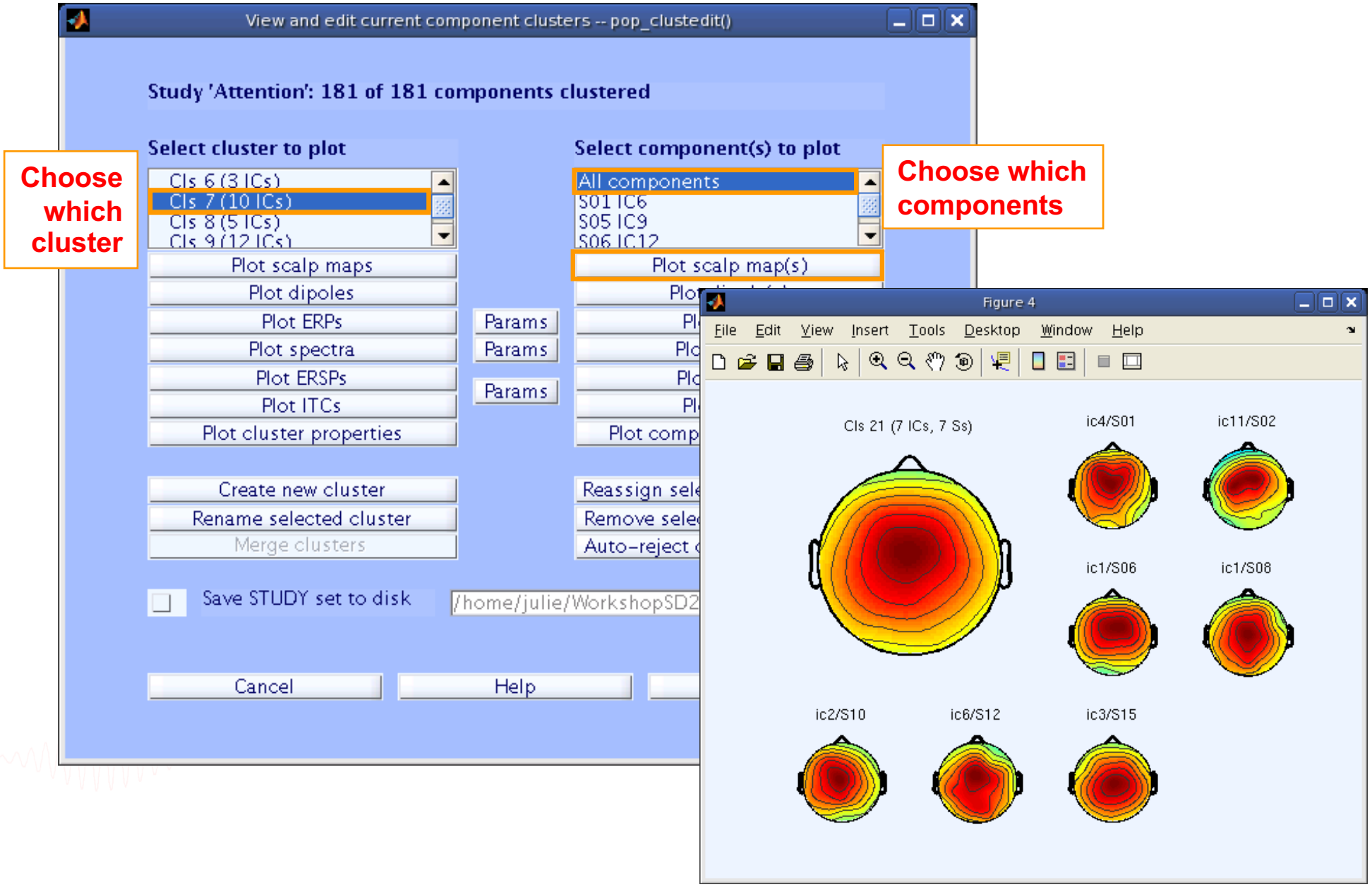


Plot cluster data

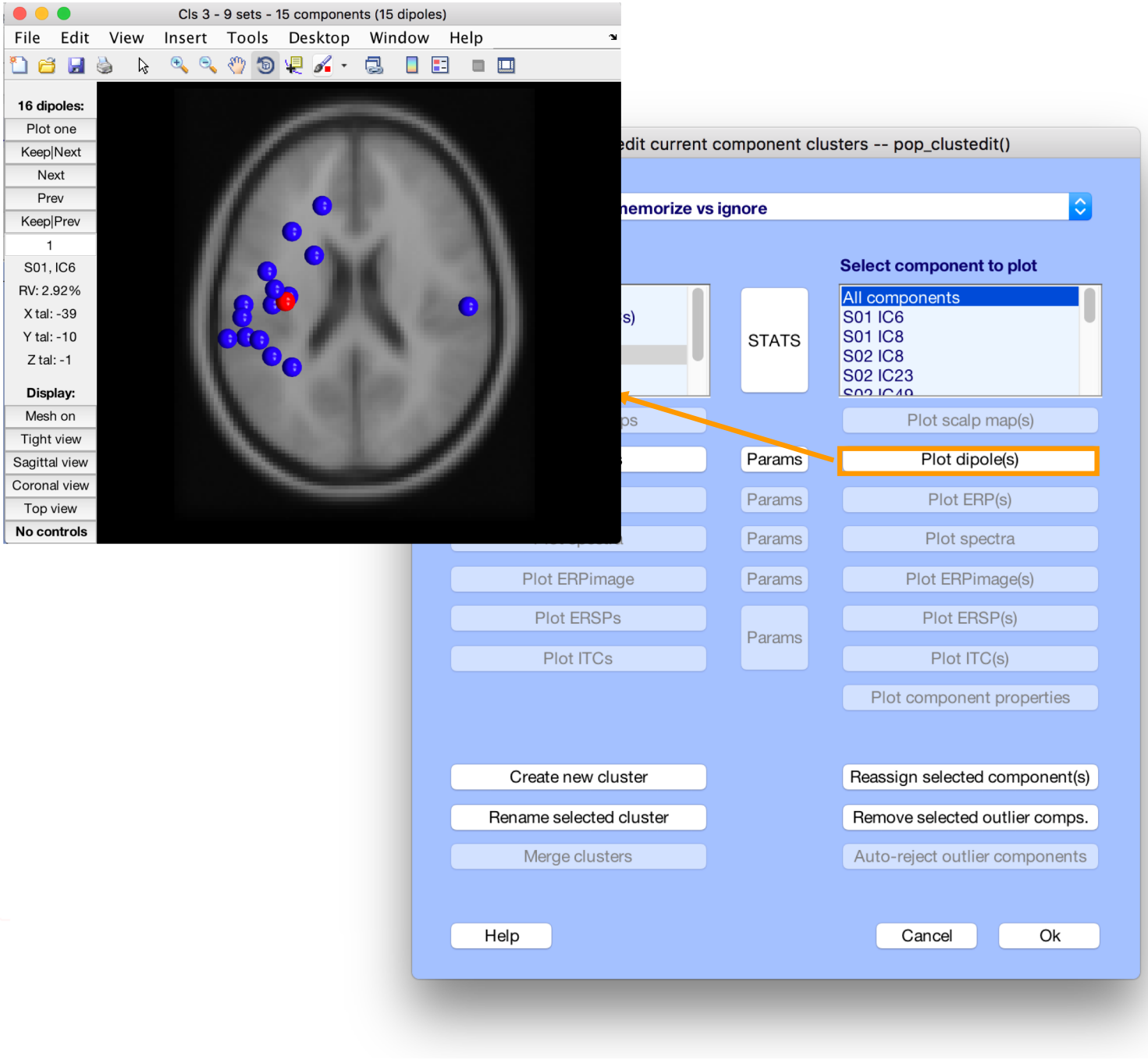


Plot mean scalp maps for easy reference

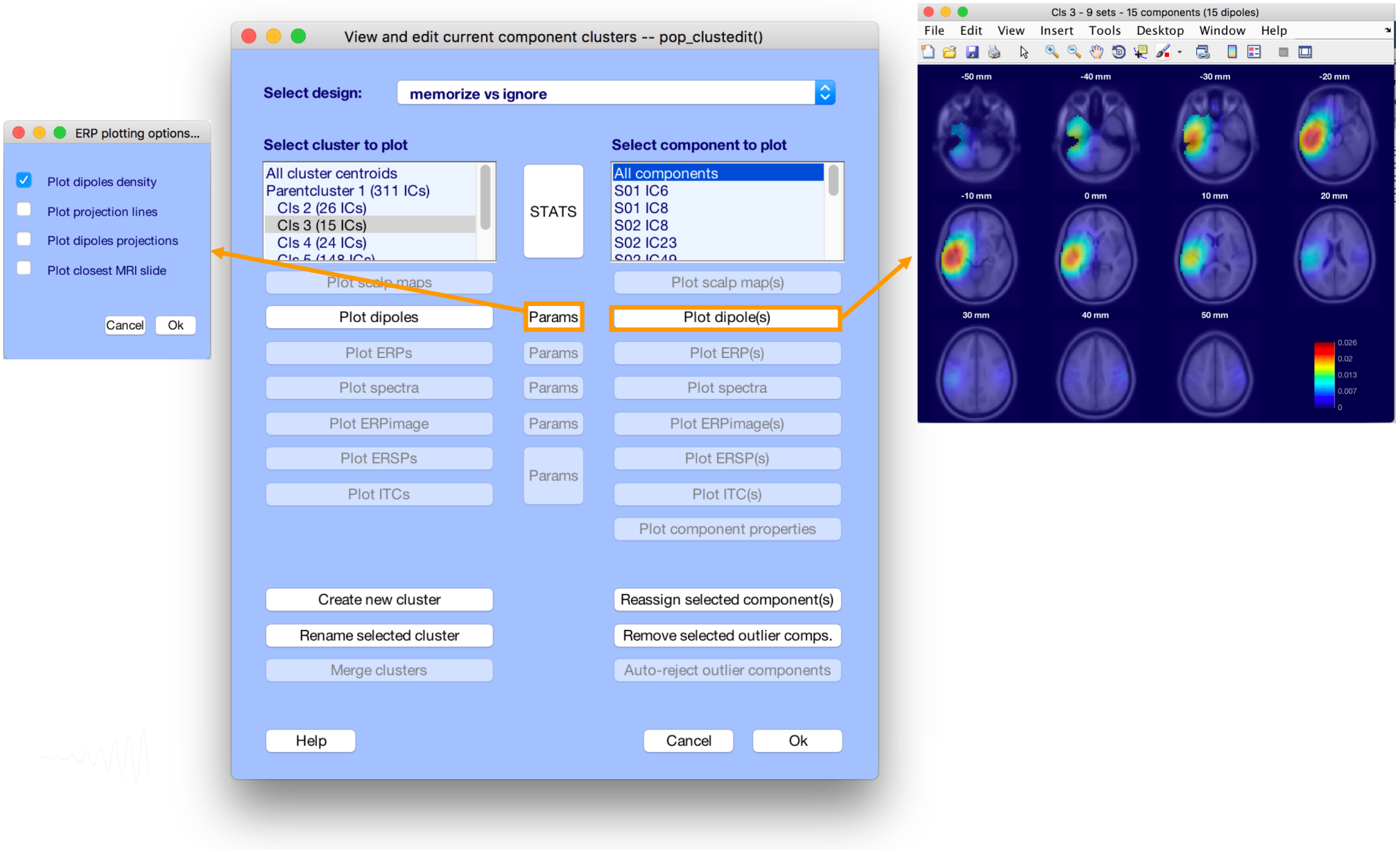
Plot cluster data



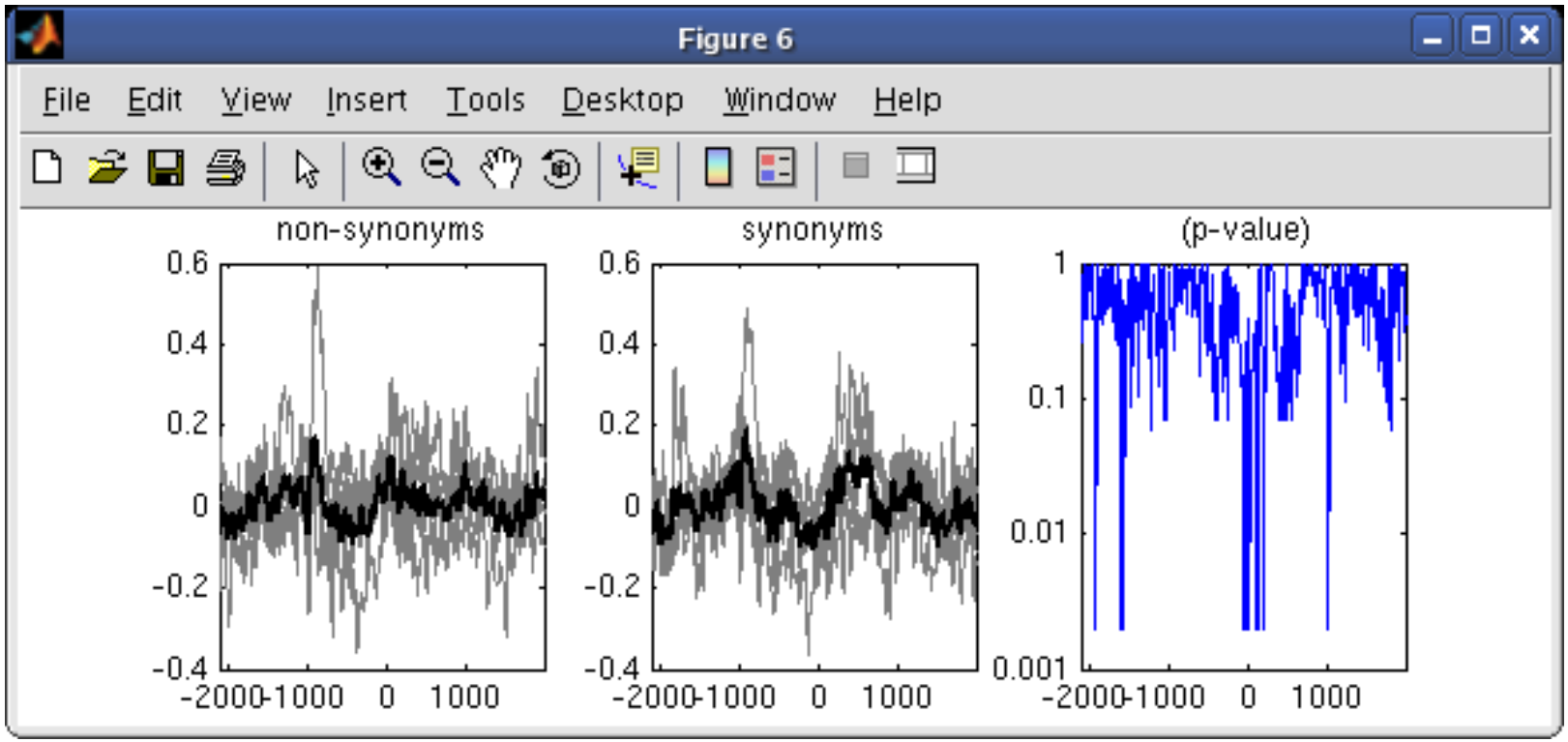
Plot cluster data



Plot cluster data



Plot cluster ERP



Exercise

- Load the STUDY stern.study
- Precompute **spectrum, ERP** and **scalp maps** for components
- Precluster and cluster components using **dipole locations** and **dipole moments** (affinity clustering)
- Look at your cluster. Identify frontal midline theta cluster and occipital alpha cluster
- Remove outliers if any
- Plot significant difference (parametric statistics) for one component cluster spectrum between the two conditions ignore vs memorize