Università degli Studi di Padova

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Comparing DOT reconstructed image obtained with and without SS channel regression

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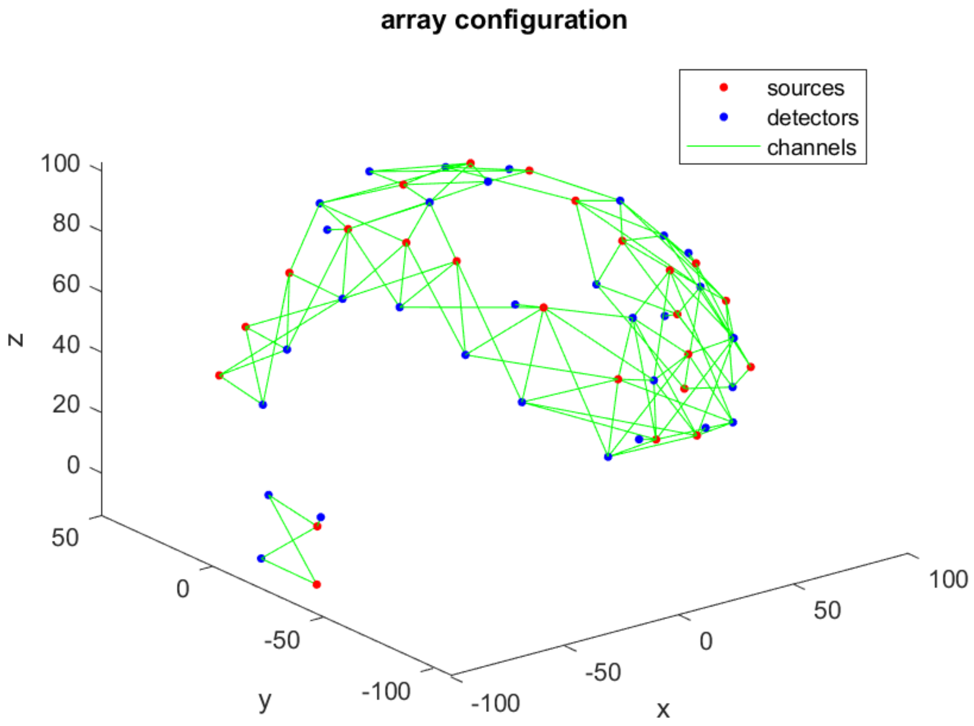
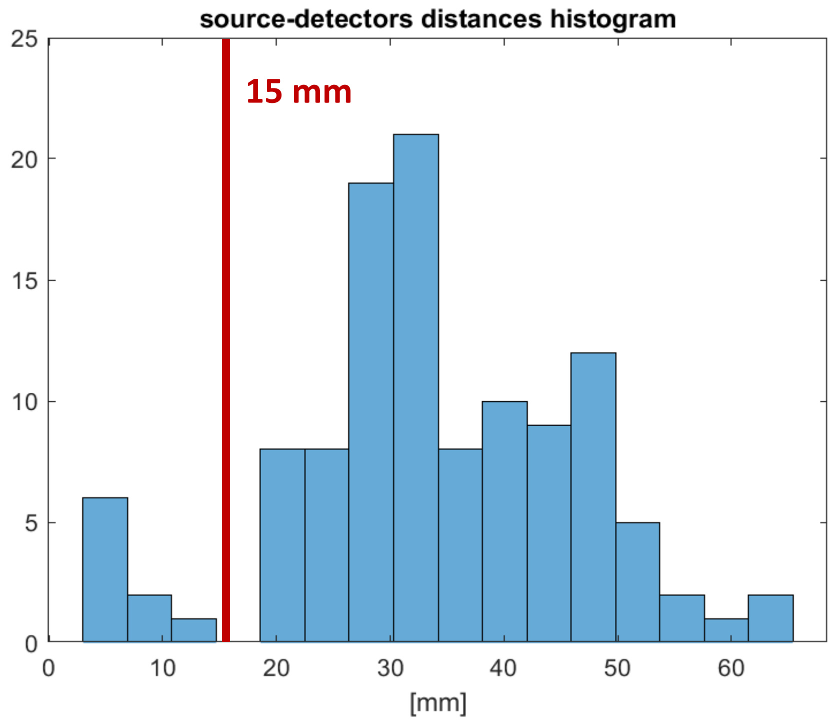
Outline

- Dataset
- fNIRS data pre-processing
  - Poor channels identification
  - Spline intepolation
  - Band-pass filtering
  - HRF recovery: GLM with and without SS regression
- DOT image reconstruction

Dataset

- **fNIRS data** were acquired in an **adult human** performing two hand movements: **grasping and squeezing**
- The array has already been **registered** to the atlas head model
- We retrieved the **source-detector distances histogram** and we saw that it is possible to distinguish between short separation (SS) and standard channels based on a 15 mm threshold.
- The **photon migration simulation** has already been performed and so the **Jacobian sensitivity matrix** was available





fNIRS data pre-processing

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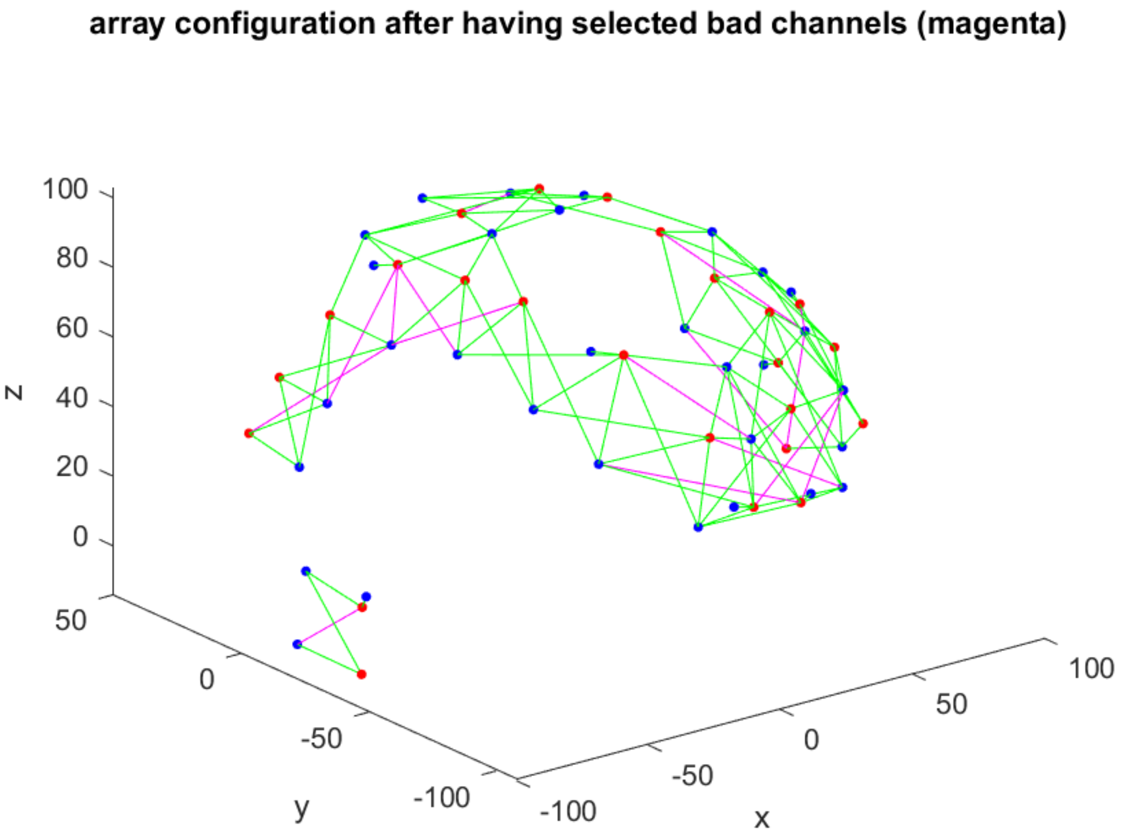
Poor channels identification

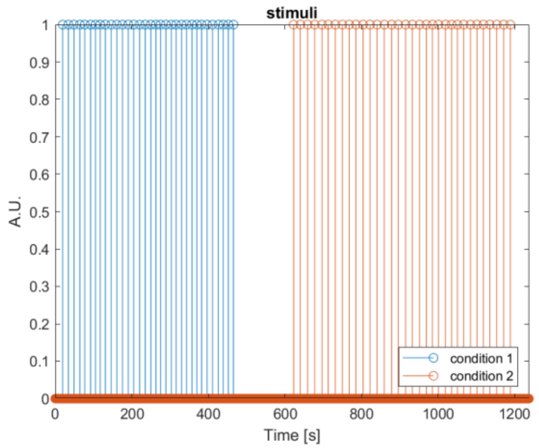
The poor channels have been identified as the ones with

- average intensity **lower** than 0.03 or **higher** than 3
- SNR **lower** than 15

Time points where **no stimuli** were presented has been removed: we discarded the data points

- before the first stimulus
- ~15 seconds after the last stimulus
- between ~15 seconds after the last stimulus of the first block of the experiment and the first stimulus of the second block

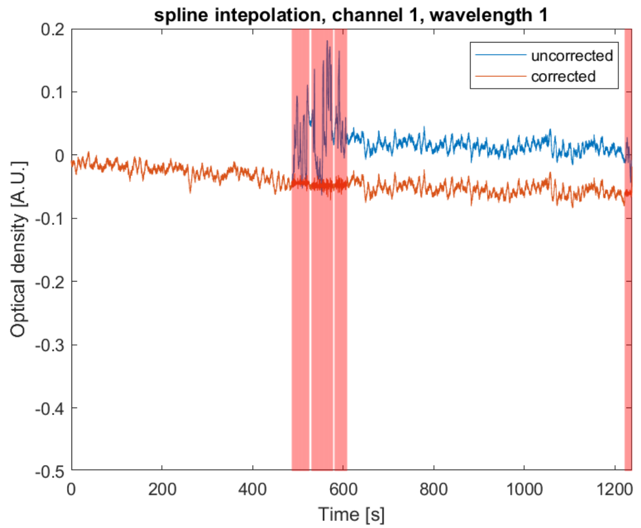




fNIRS data pre-processing

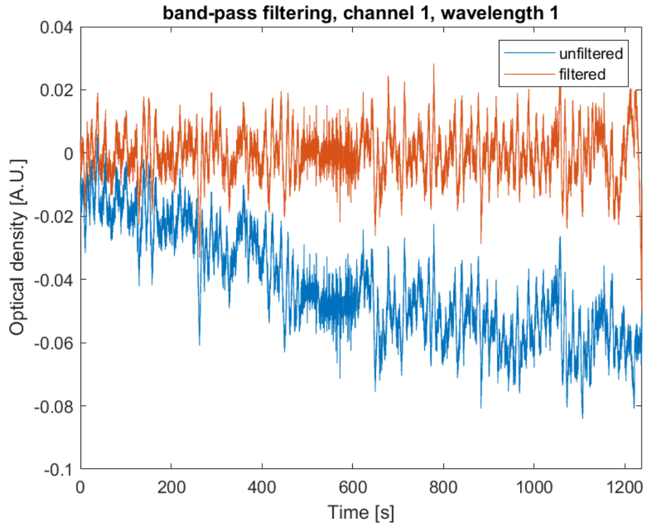
Spline interpolation

- After the **convesion** of intensity data **in optical density changes**, motion correction has been performed with spline intepolation
- Before the correction, motion artifacts have been identified setting **thresholds on amplitude of 0.5 and on standard deviation of 5**
- This step has been able to correct for both motion artifacts and changes in baseline



Band-pass filtering

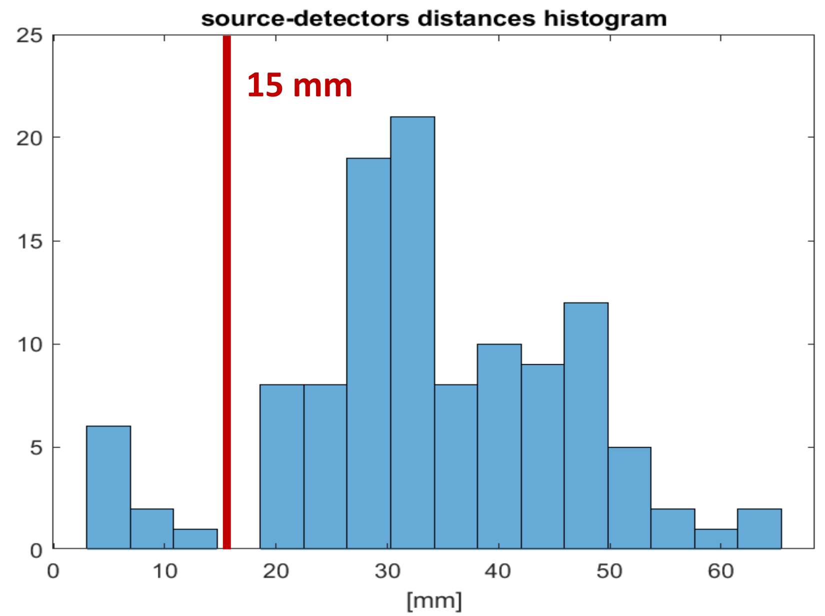
- A band-pass filter with **cut-off frequencies of 0.01 and 2.5 Hz** has been applied to the data
- These cut-off frequencies were **able to remove the instrumental drift from the signal but not the physiology**, but this what we want since we will apply the GLM to correct for serial correlation and so it is better to leave the entire serial correlation (and so the physiology) in the signal



fNIRS data pre-processing

HRF recovery: GLM with and without SS regression

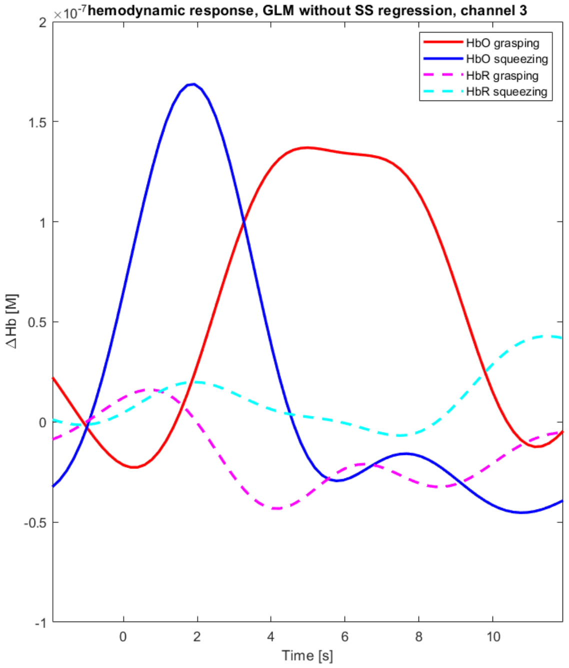
- After the **conversion of optical density changes in concentration changes**, we recovered the average HbO and HbR hemodynamic response across trials for each condition using **GLM approach** with correction of serially correlated error **with and without simultaneous regression of SS channels**
- Looking at the source-detector distances histogram, we saw that a threshold of **15 mm** to distinguish between SS and standard channels would has been suitable

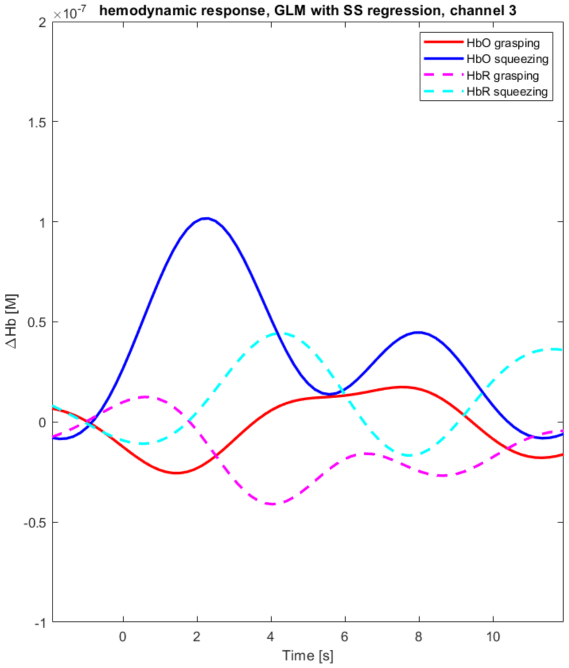


fNIRS data pre-processing

HRF recovery: GLM with and without SS regression

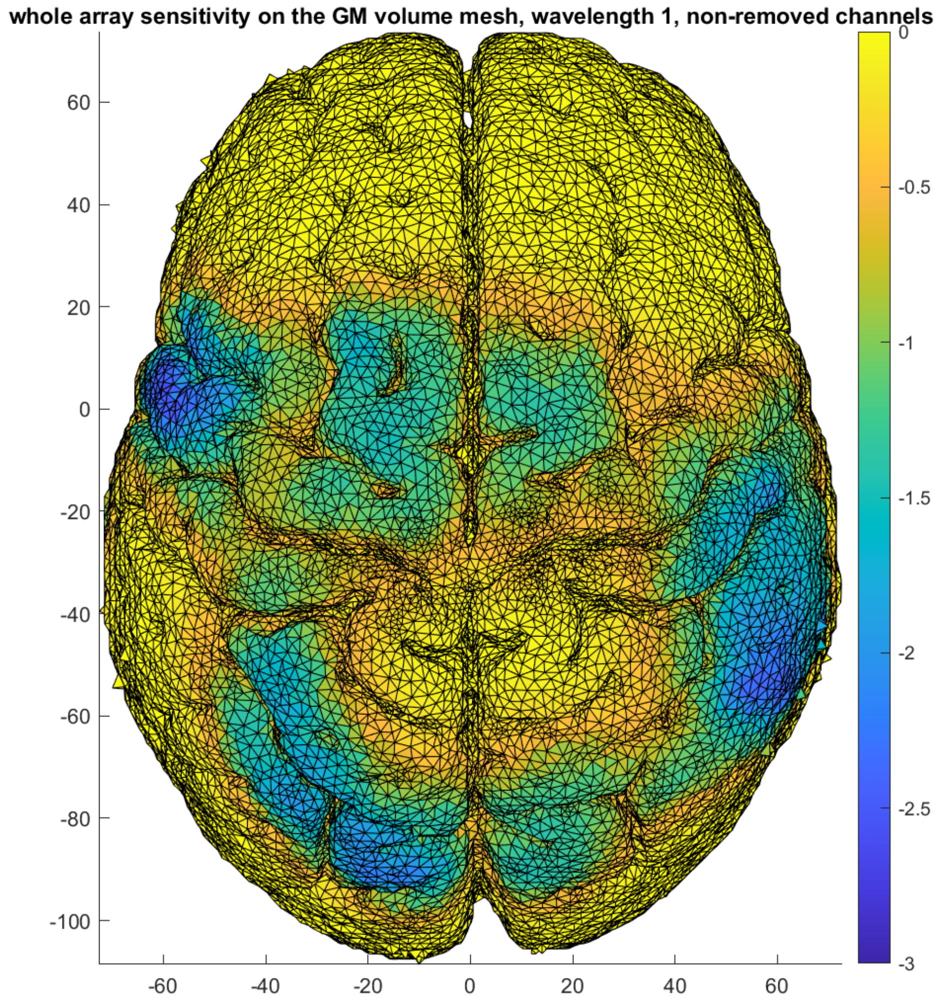
- SS regression is useful to **remove the systemic evoked physiological noise**, which could cause, for example, false positive (mimicking a brain hemodynamic response)
- For example, in **channel 3**, without SS regression we can see activation for grasping, while with SS regression we cannot see it anymore
- This might imply that processing the data without SS regression we end up with a systemic hemodynamic response and not with the desired brain one
- It is possible to notice that generally results for HbR doesn't change a lot with and without SS regression and this is because HbR usually is less affected by physiological confounds





DOT image reconstruction

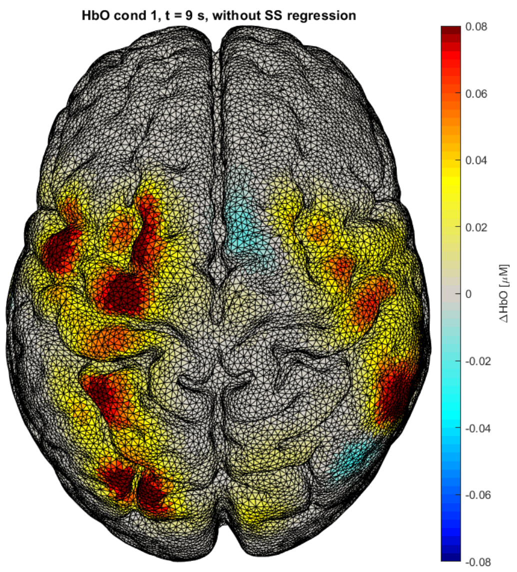
- After the conversion of the average HbO and HbR hemodynamic responses in **average optical density hemodynamic responses**, we reconstructed **HbO and HbR images mapped on the surface GM mesh** for both conditions and for both GLM with and without SS regression
- To solve the image reconstruction problem, we removed from the **Jacobian sensitivity matrix** the bad channels (identified as already described)
- The **array sensitivity** has been obtained summing the rows of the Jacobian sensitivity matrix, which corresponds to the Photon Measurement Density Function (PMDF) of the channels

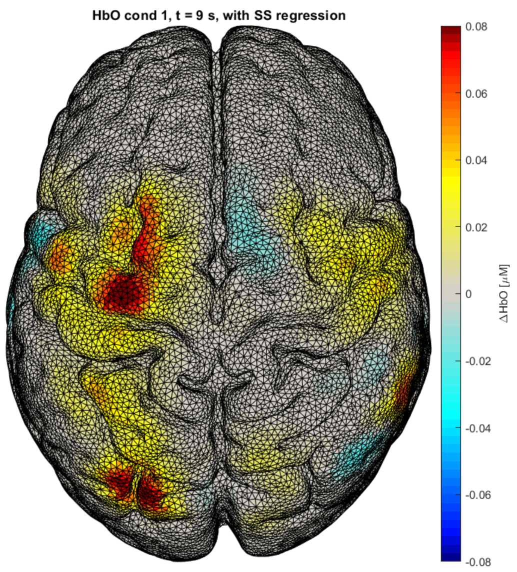


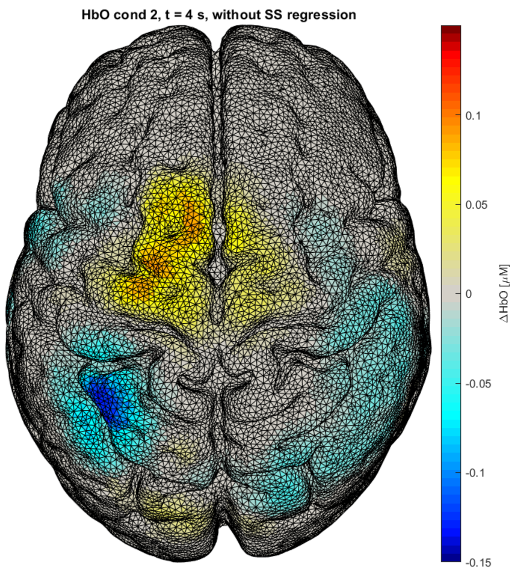
DOT image reconstruction

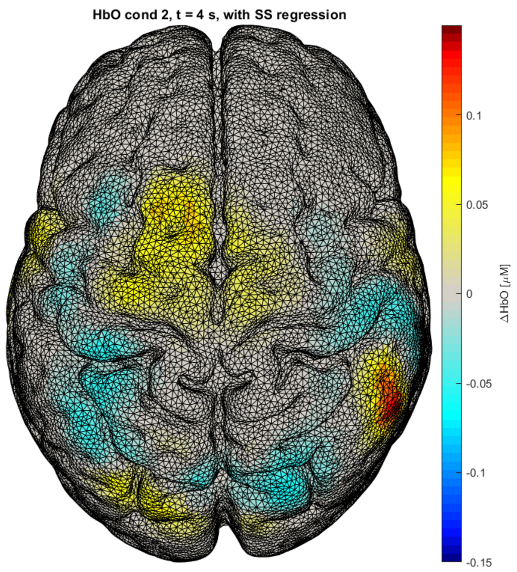
SS regression seems to **reduce the systemic evoked physiological noise**, which can cause both

- **false positive**, mimicking a brain hemodynamic response: **Hb0, condition1, t = 9s**
- **false negative**, masking the actual brain hemodynamic response: **Hb0, condition 2, t = 4s**



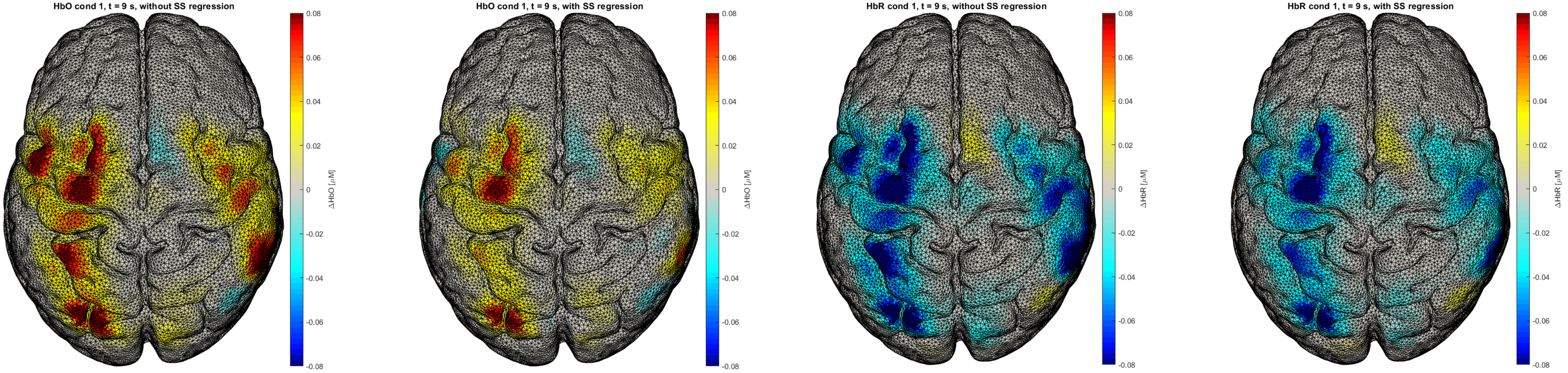






DOT image reconstruction

Again it is possible to notice that generally results for **HbR** doesn't change a lot with and without SS regression because HbR usually is less affected by physiological confounds.



Thanks for your attention!