the City College of New York

Targeted stimulation of active brain sources using electromagnetic reciprocity

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Paradigm shift

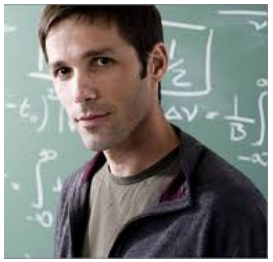
Conventional tDCS

- Large pads or sponges
- Diffuse electric fields
- Optimization requires exhaustive search

HD-tDCS

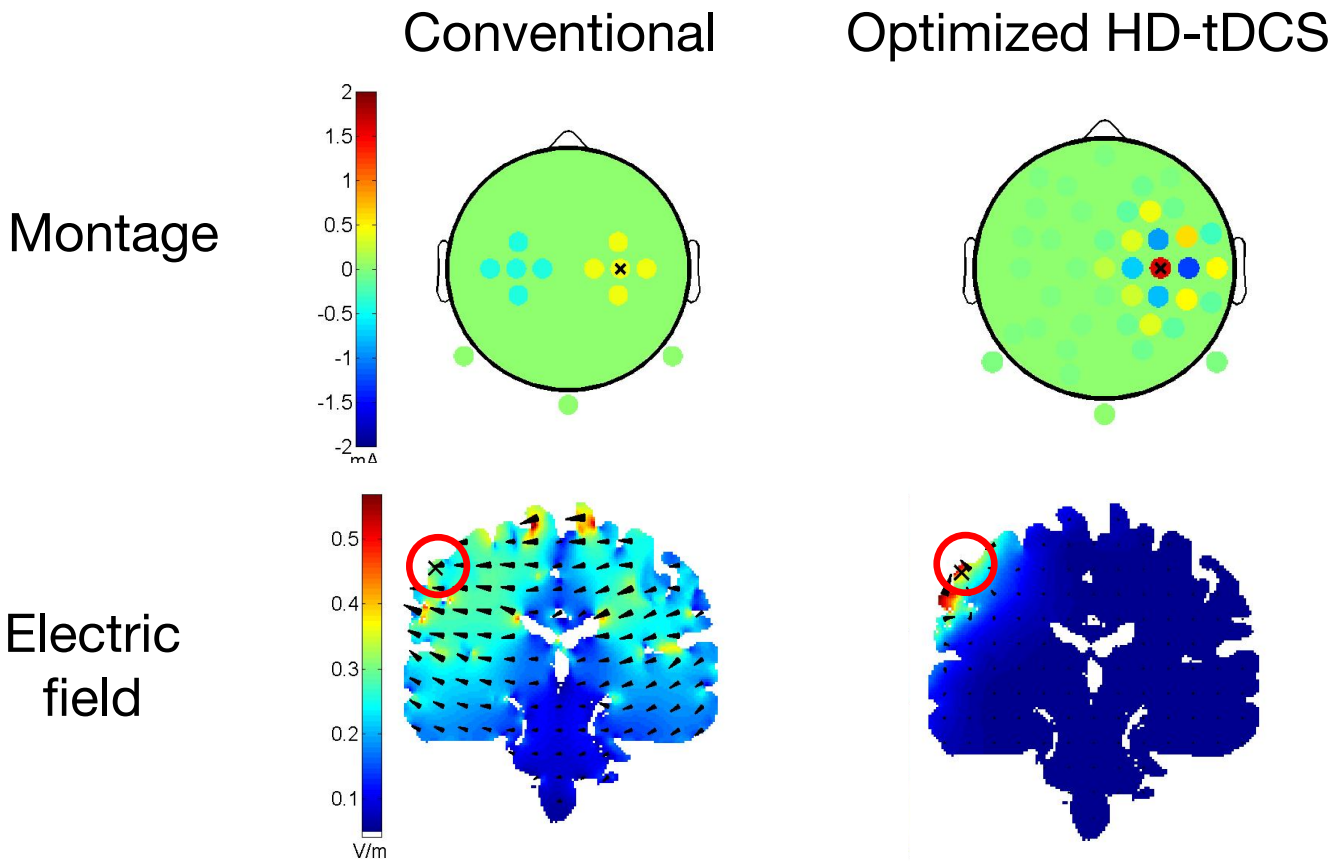
- Multiple small electrodes
- Electric field can be made focal
- Fast convex optimization steers current to target

Lucas Parra



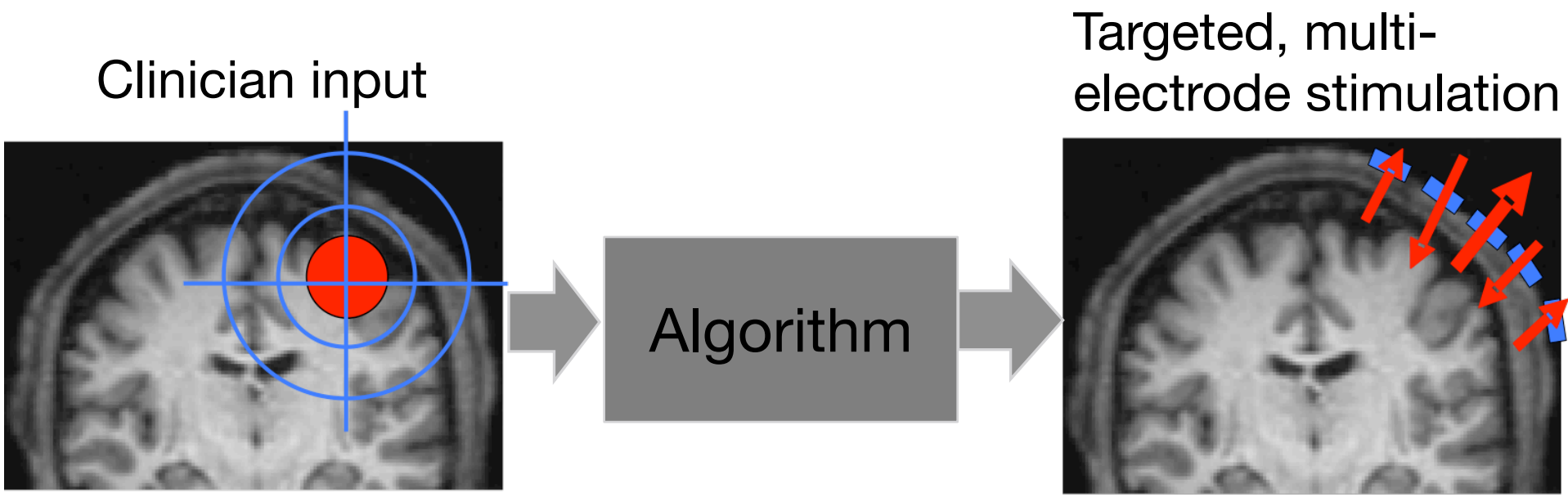
Marom Bikson

Shaping the electric field



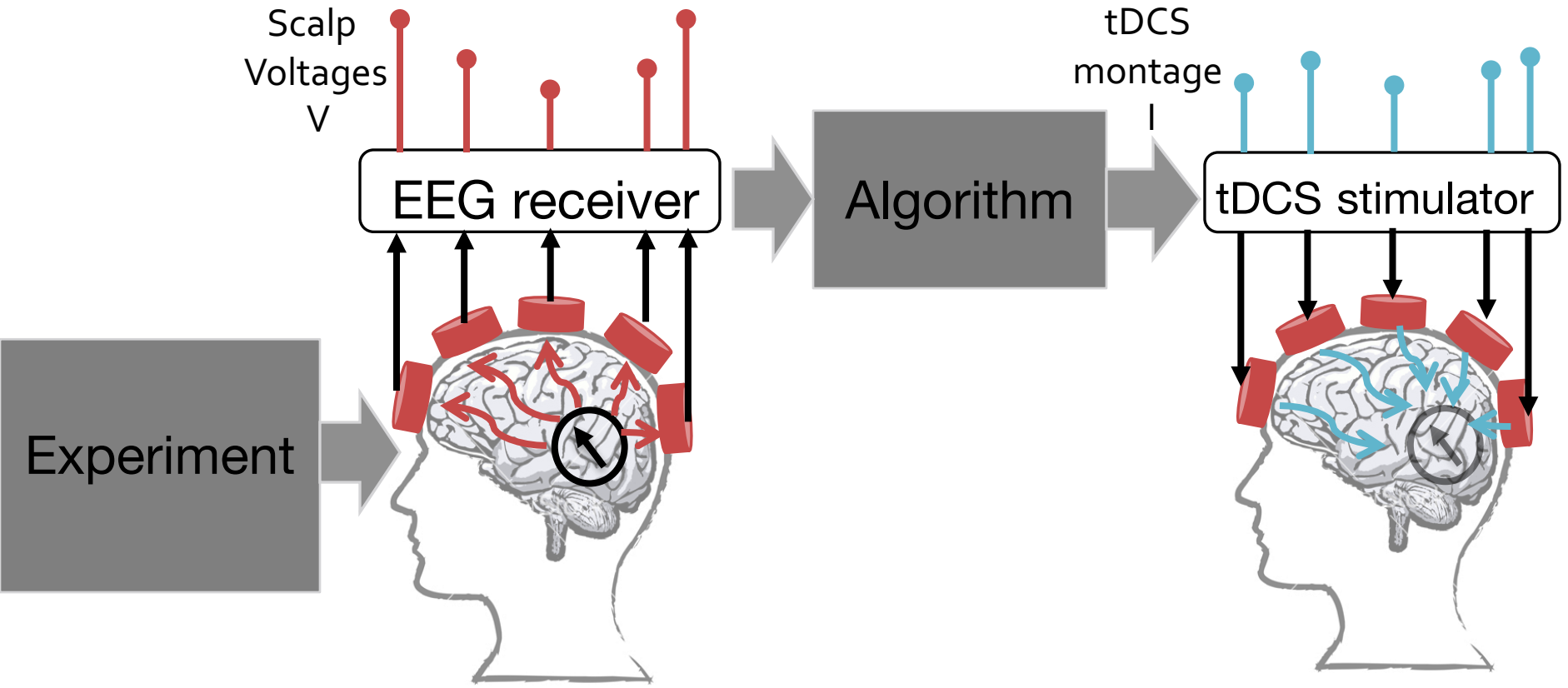
Dmochowski et al. (2011) *J Neural Eng*

Anatomical targeting



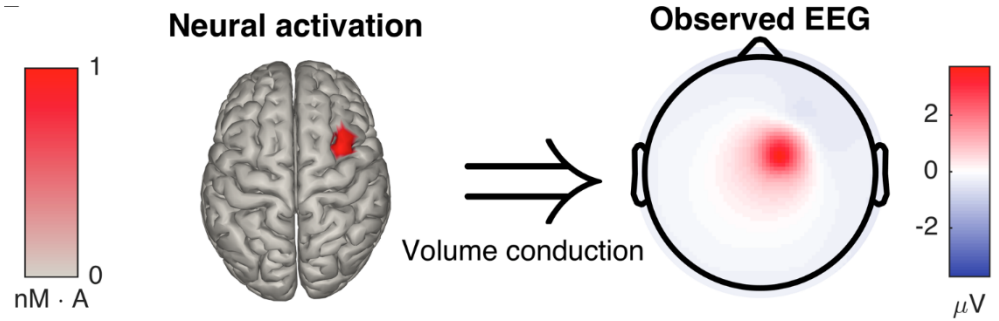
Anatomical targeting requires a “hard decision” on the required target.

EEG-guided tDCS



Reciprocal tDCS in a finite element model

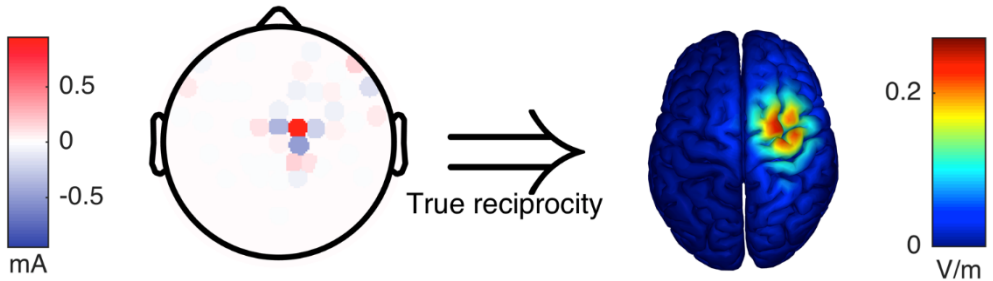
$$D \quad R = V$$



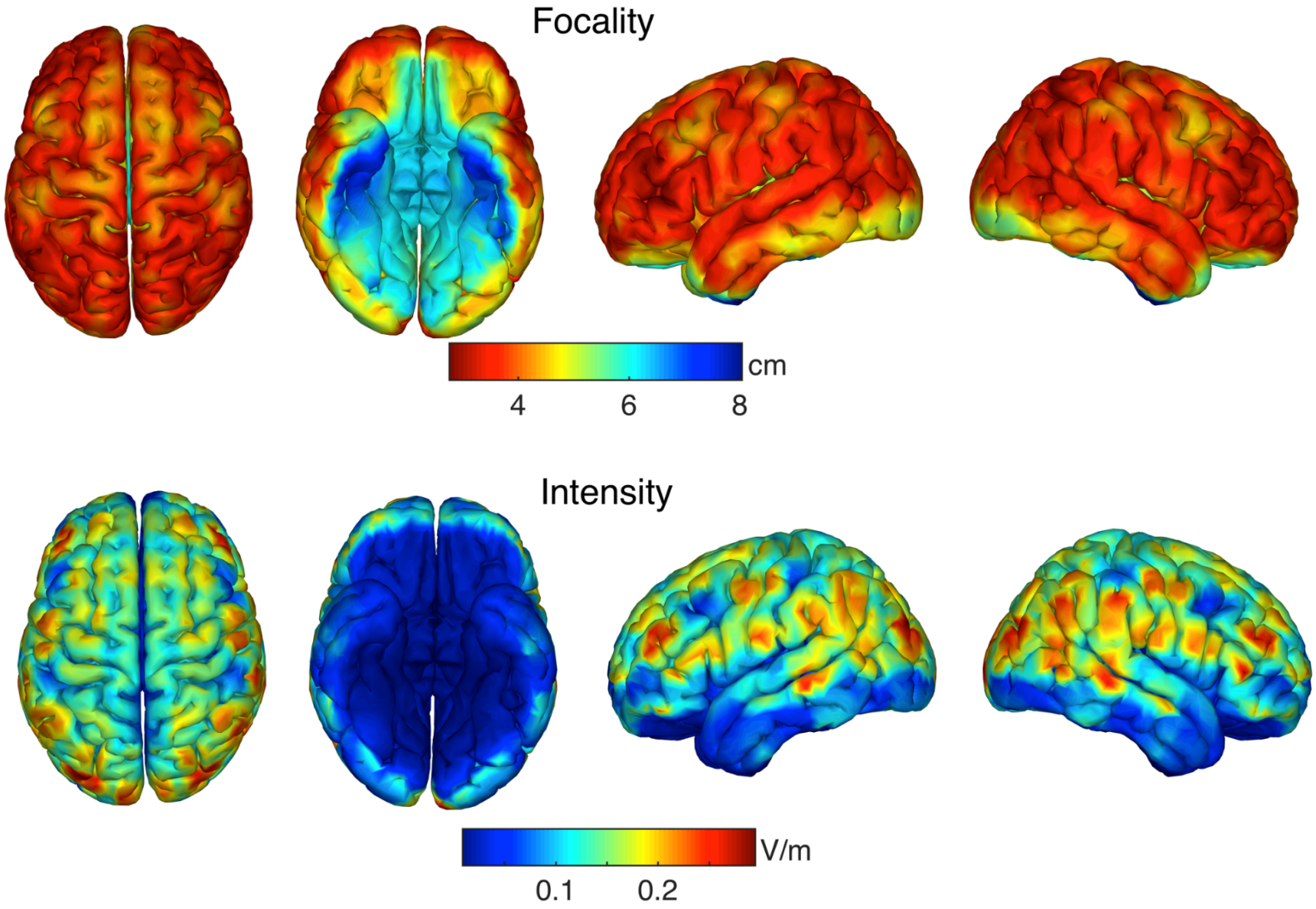
$$I = (RR^T)^{-1} V$$

EEG-tDCS reciprocity solution

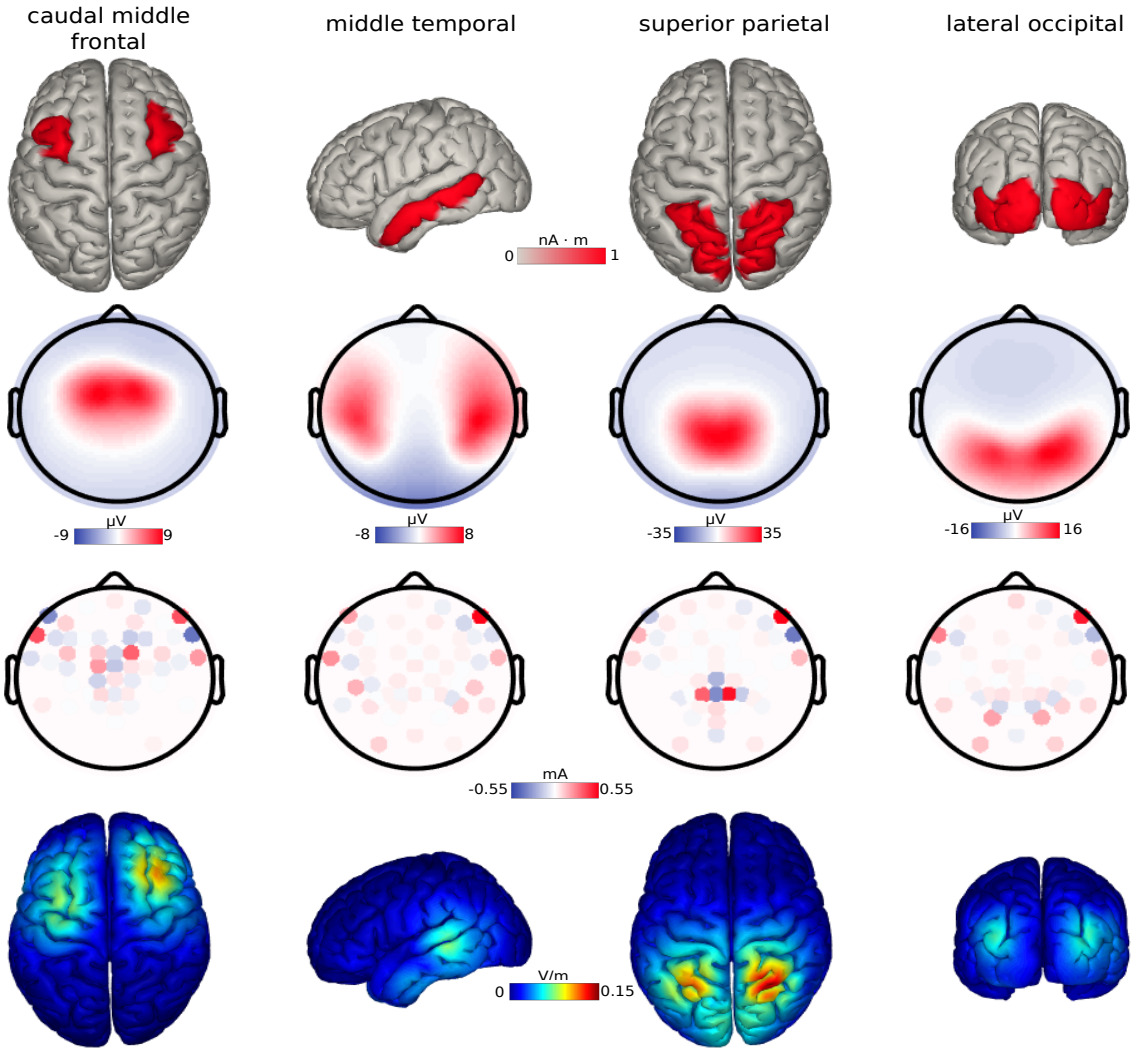
$$I \quad R^T = E$$



Achievable focality & intensity



Reciprocal montages are not trivial



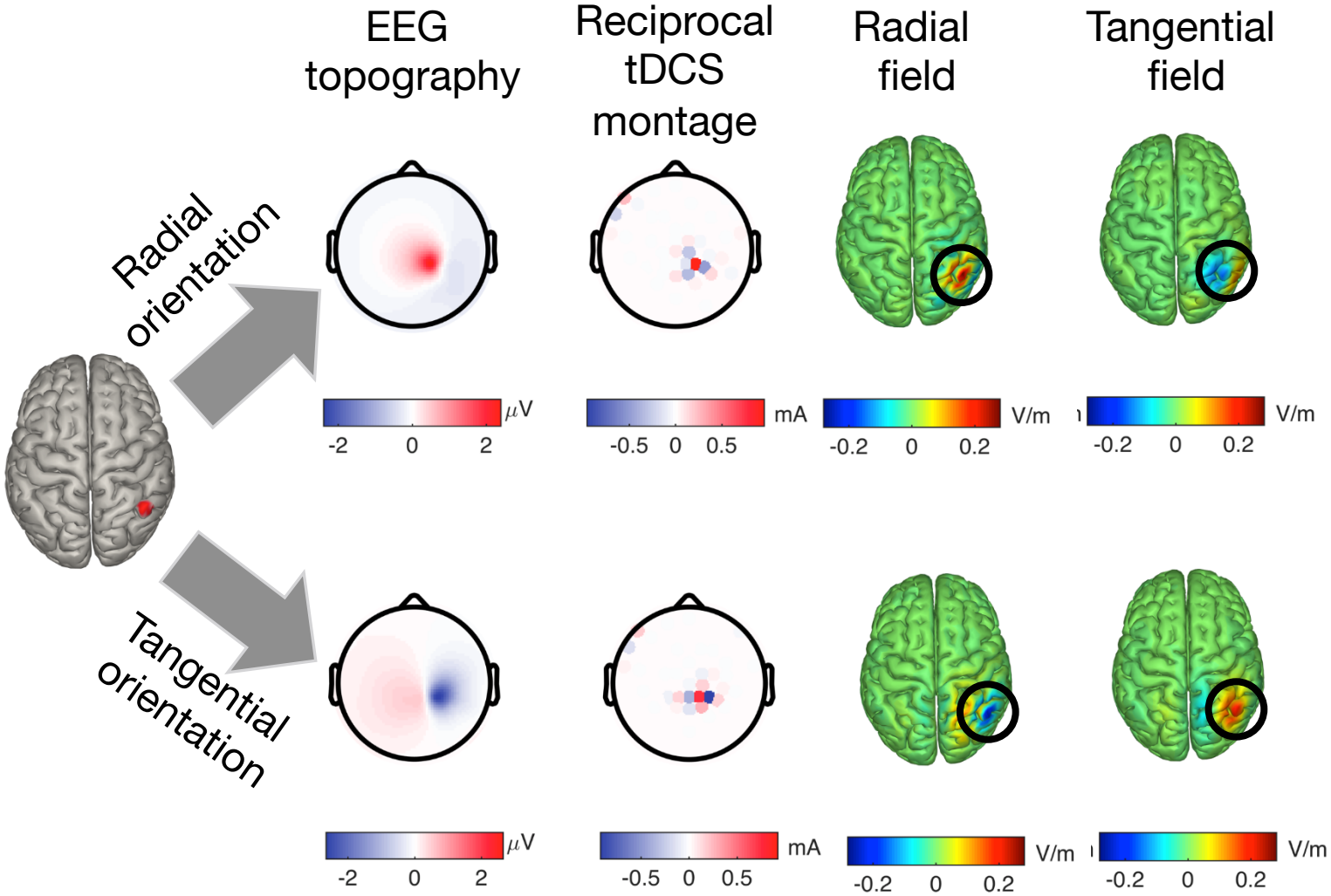
Regions of interest

EEG topographies

Reciprocal tDCS montages

Achieved electric fields

Reciprocity handles varying source orientation



Takeaways

- Advantages of EEG-guided tDCS
  - Data-driven, no assumptions on target
  - Can account for **individual differences**
  - Source localization not required
  - Immediate applicability to disorders with observable EEG correlates
- Many sources of variability in tDCS
  - Electrode placement and montage could be systematized

Acknowledgments

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  - Laurent Koessler (CRAN-Nancy) 
  - Marom Bikson (CCNY)