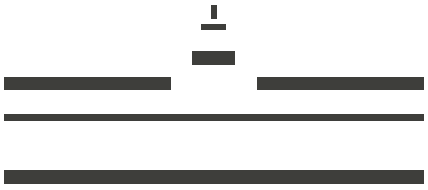
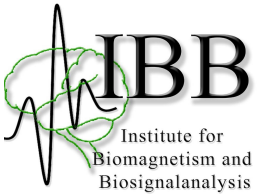


Westfälische Wilhelms-Universität Münster



Westfälische Hochschule

Unfitted Discontinuous Galerkin in Brain Research and the Topology Preserving Marching Cubes

DUNE User Meeting 2015

living.knowledge
WWU Münster

Andreas Nüßing

September 28th, 2015

EEG forward problem

- inhomogeneous Poisson equation
- homogeneous Neumann boundary condition
- strongly irregular right hand side
- domain of complex shape
- discontinuous, anisotropic conductivity tensor

UDG = Unfitted Discontinous Galerkin

- domain given by piecewise multilinear level set
- separate computational grid from domain geometry
- use DG on structured grid and restrict basis functions to domain geometry

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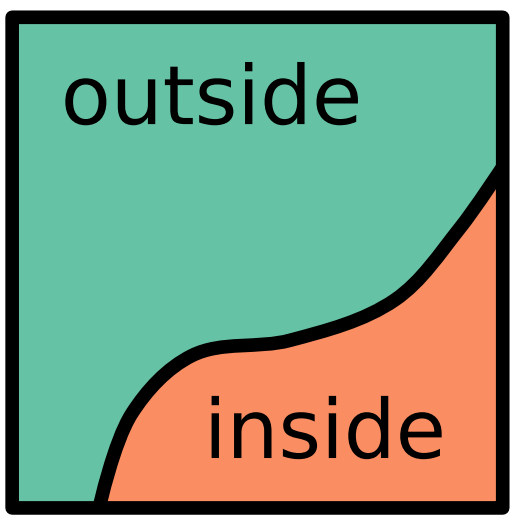
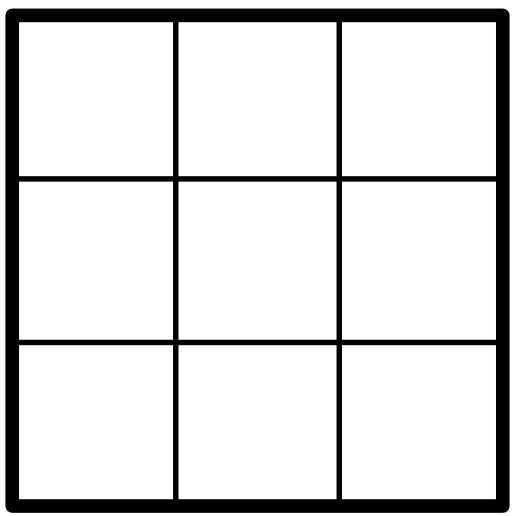
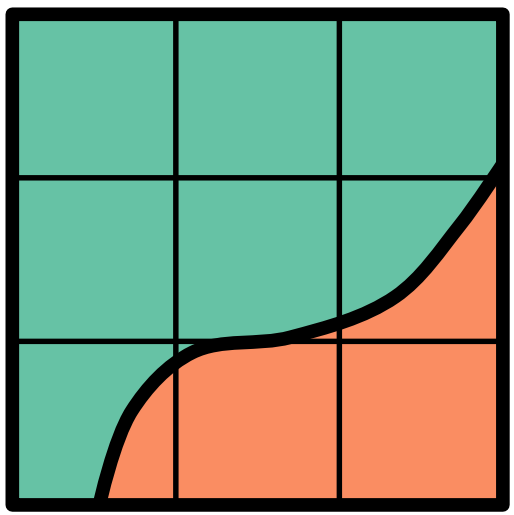


Level set



grid



combined

TPMC = Topology Preserving Marching Cubes

- method for evaluating volume and surface integral over implicitely defined domains
- based on *marching cubes* algorithm from computer graphics
- construct element wise reconstruction of level set
- keep guarantees on topology of the reconstruction

[Engwer & Nüßing, *In preparation for submission*]

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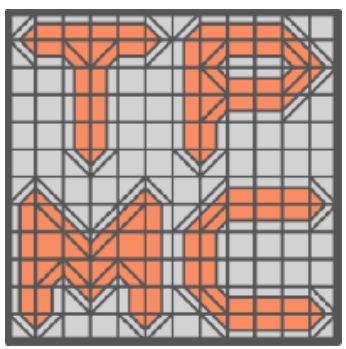

- library available on GitHub: *http://www.github.com/tpmc*
- DUNE wrapper *dune-mc*

[Engwer & Nüßing, *In preparation for submission*]

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- multilinear level set defined by corner values
- each set of corner values can be reduced to a base case
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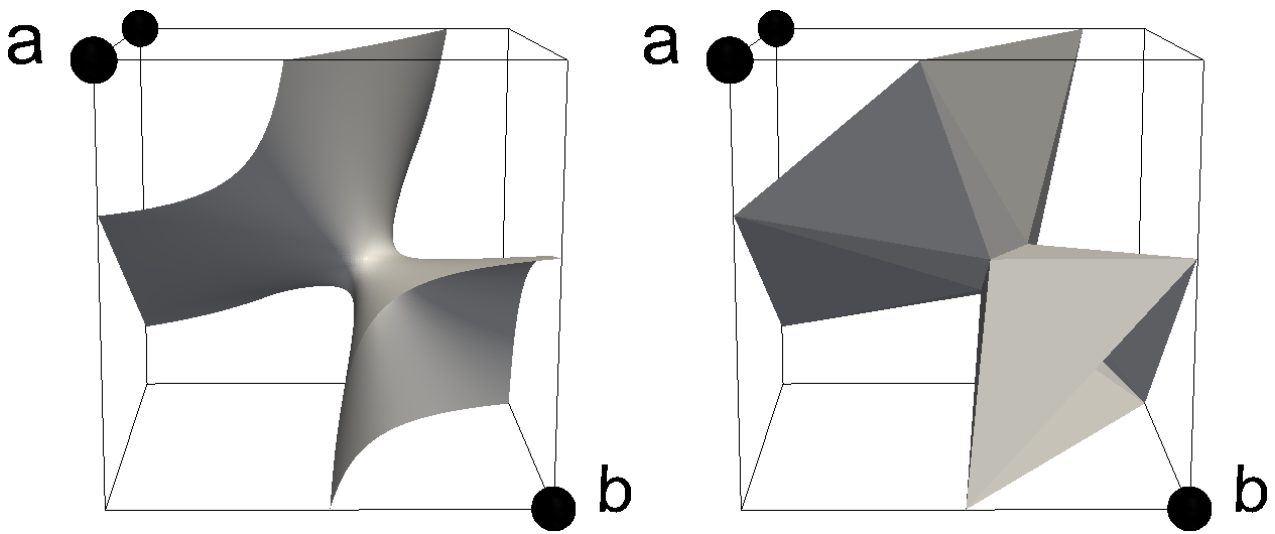

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Results

- Evaluation in a multi layer sphere model
- Discontinuous tissue conductivities:

Radius (mm)	92	86	80	78
Conductivity (S/m)	0.33	0.0042	1.79	0.33

[Nüßing, Wolters, Brinck & Engwer, *In preparation for submission*]

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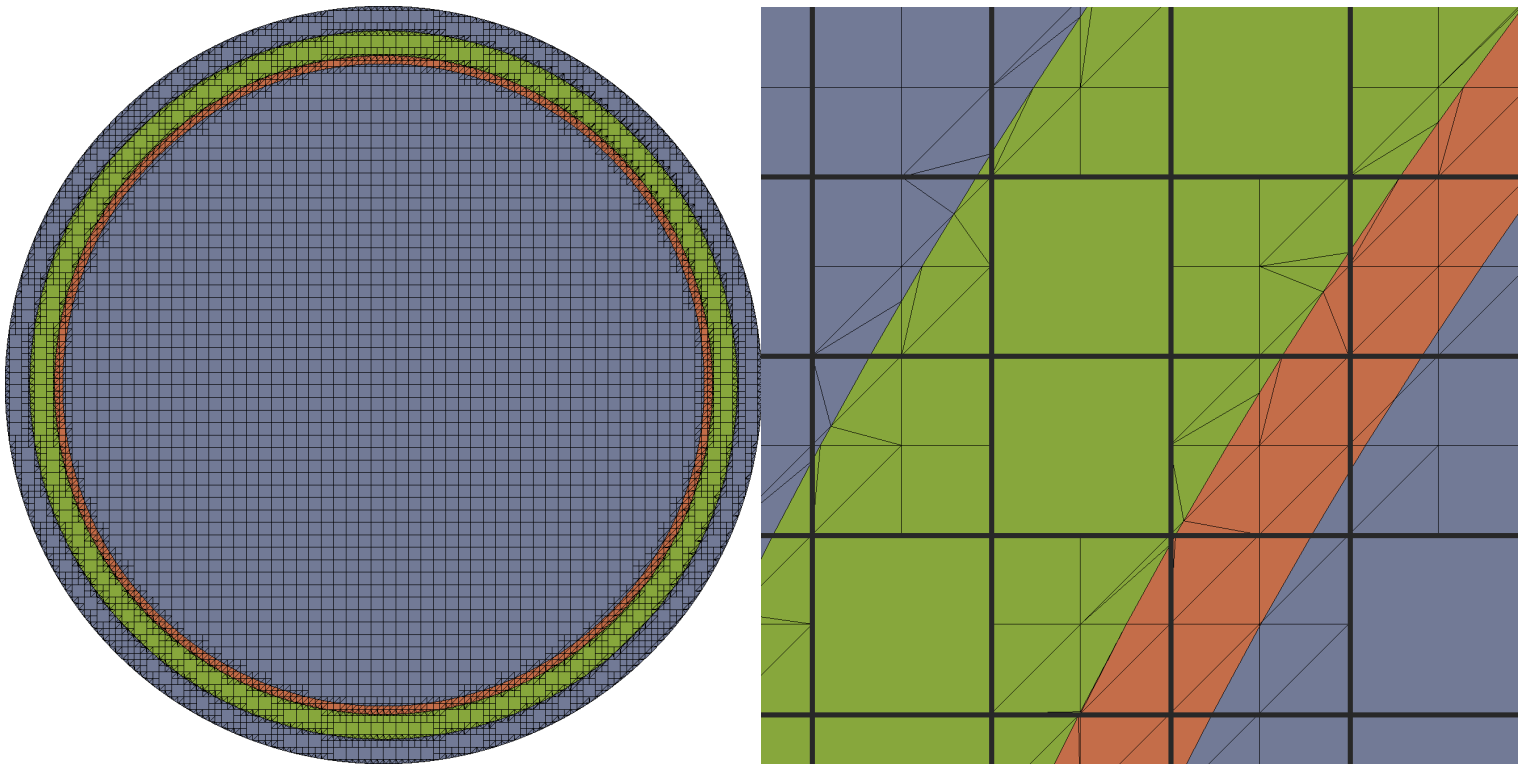
- sample over different dipoles
  - **500** unit dipoles with random direction on each of
  - **15** eccentricities in the inner compartment

[Nüßing, Wolters, Brinck & Engwer, *In preparation for submission*]

convergence of UDG



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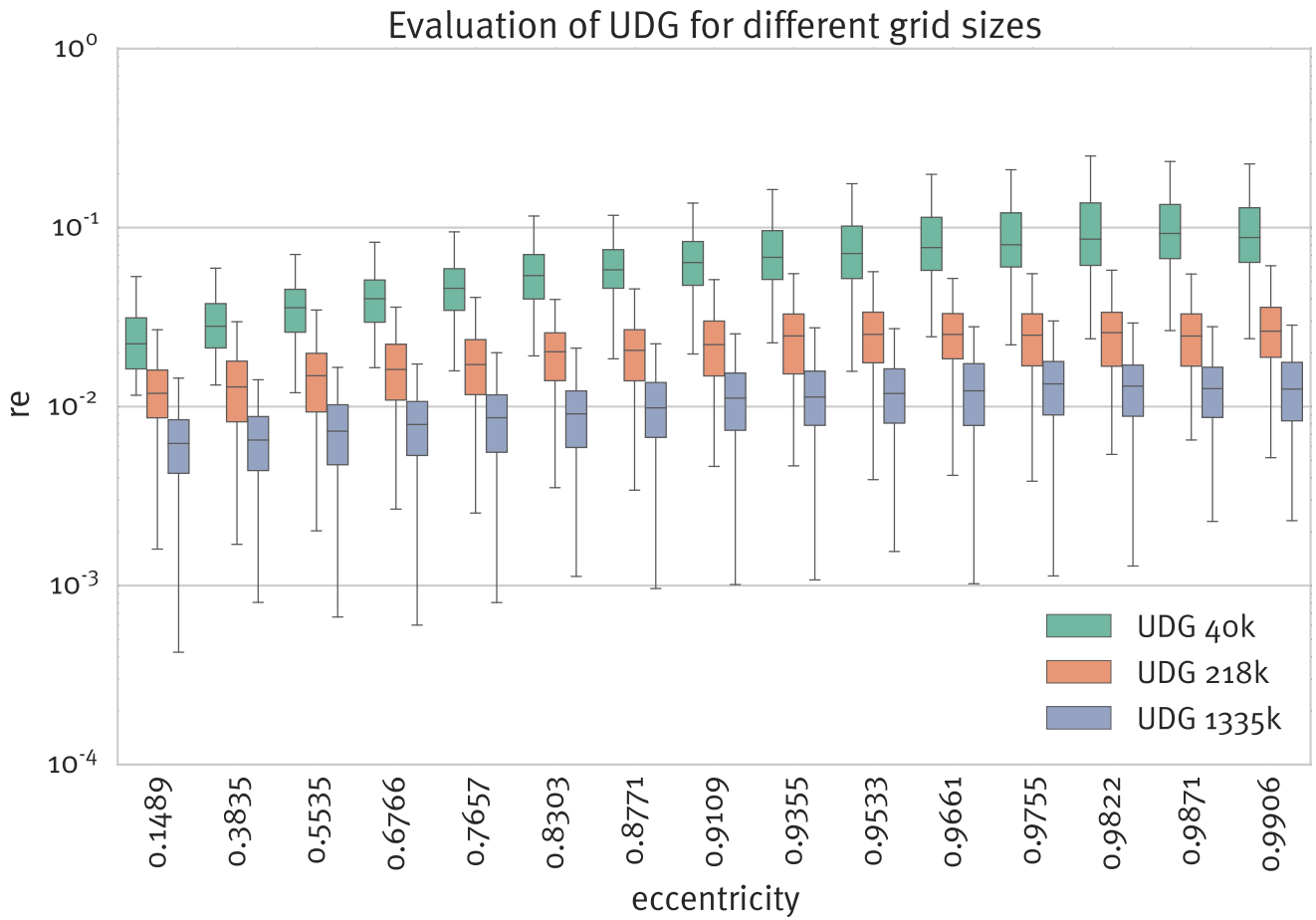

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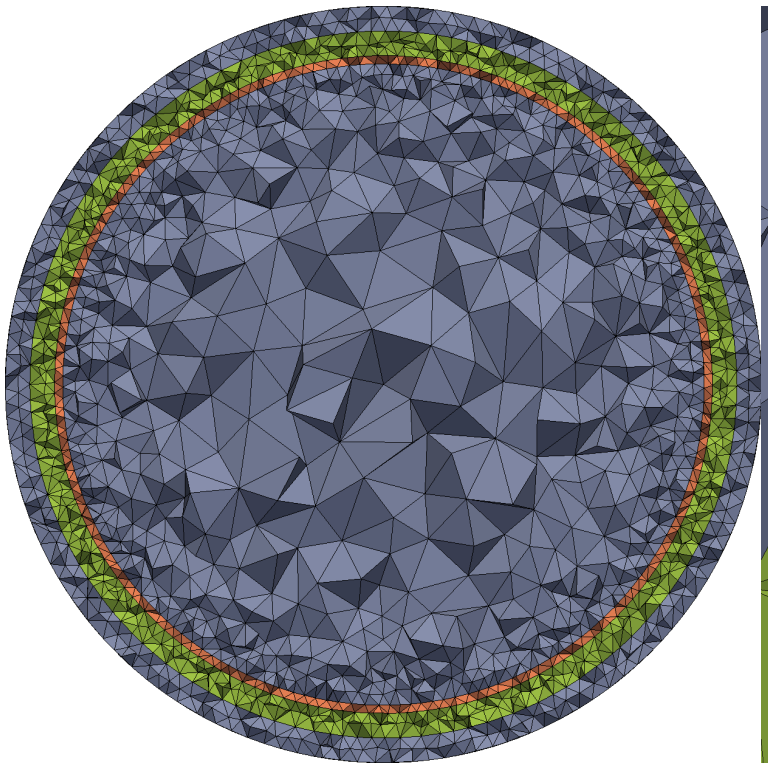
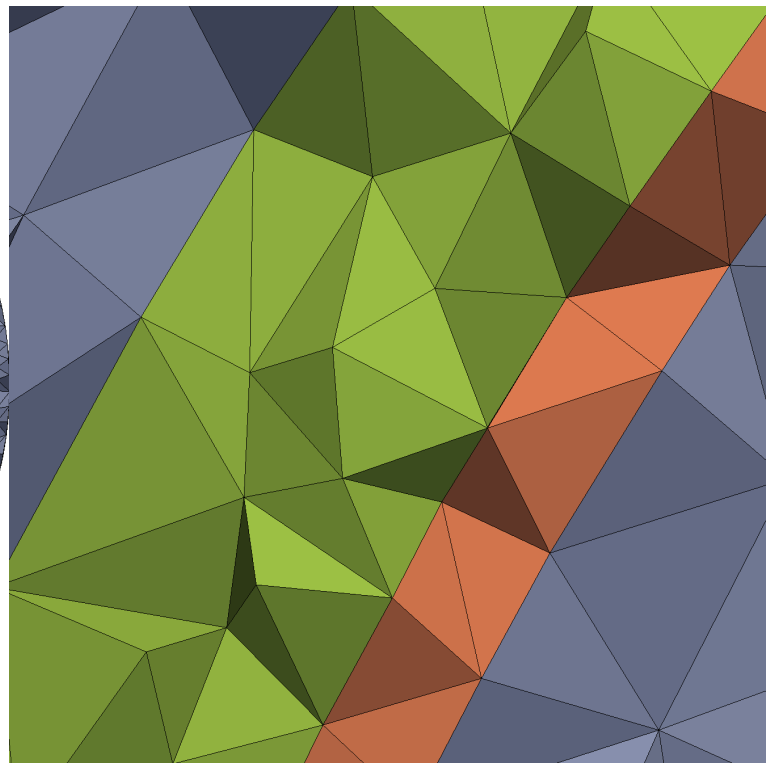
comparison to DG on conforming mesh





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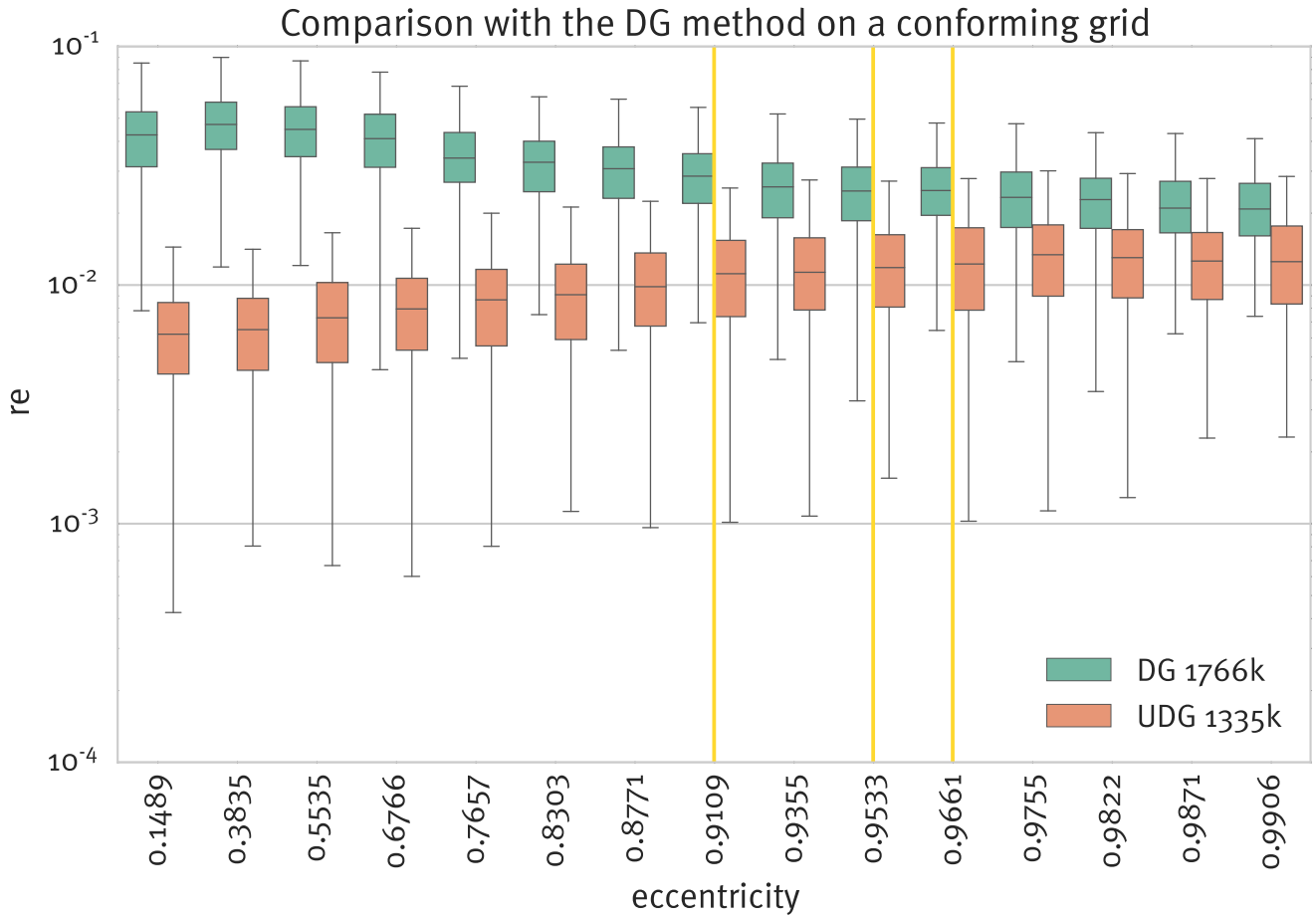
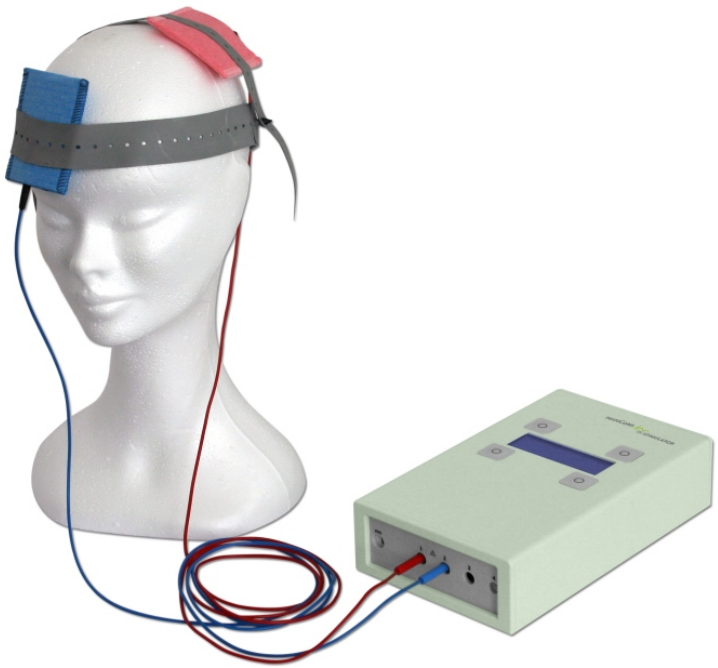
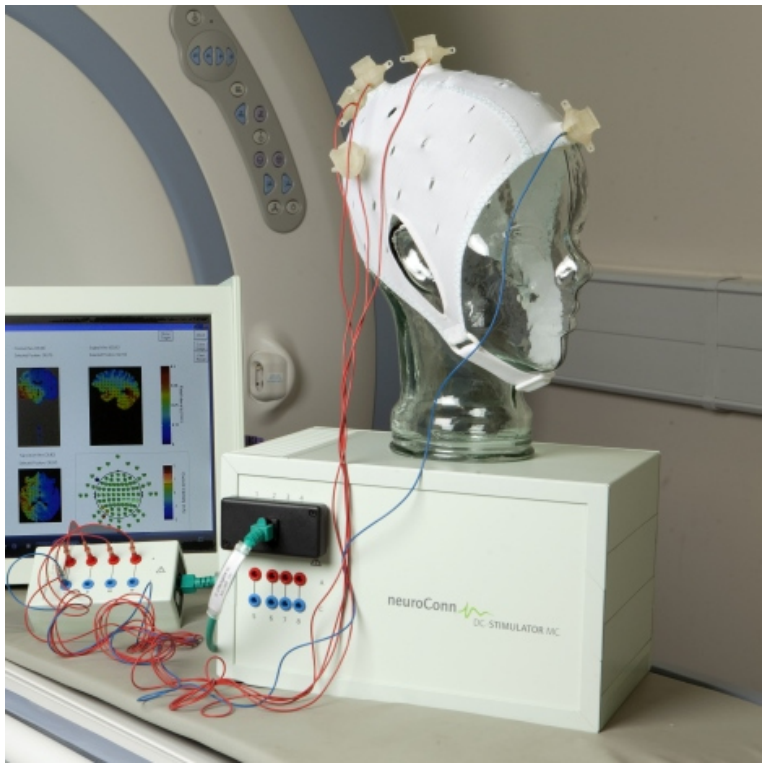


[Nüßing, Wolters, Brinck & Engwer, *In preparation for submission*]

trancranial direct current stimulation



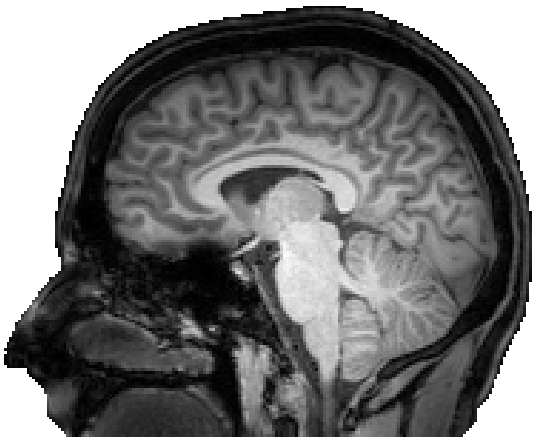


[Neuroconn]

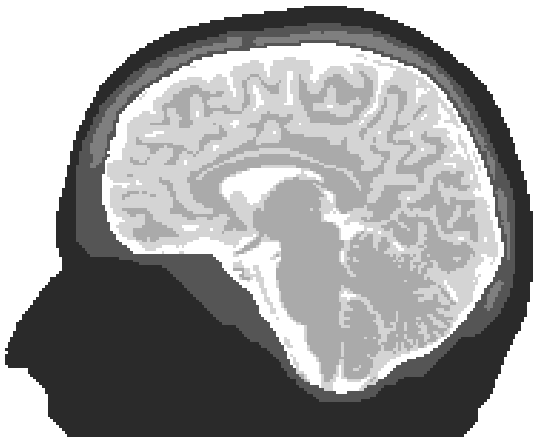
applications:

- understanding current flow
- optimized stimulation protocols

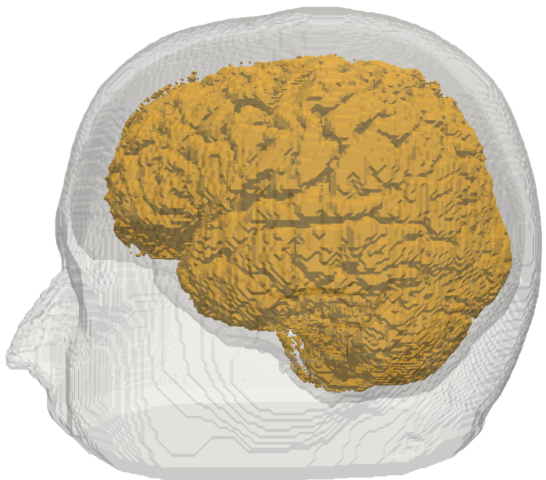
tDCS on realistic data



MRI image

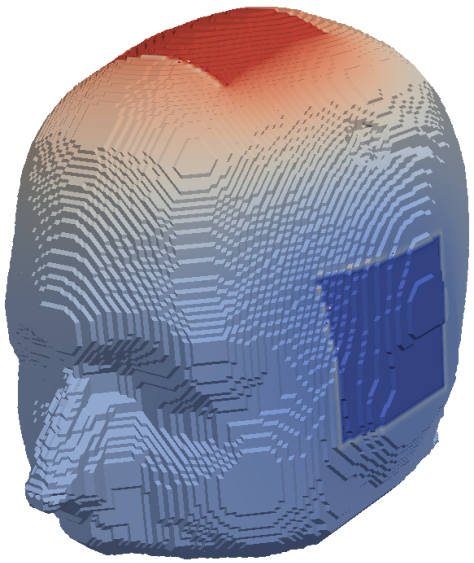


Segmentation



UDG level sets

tDCS on realistic data



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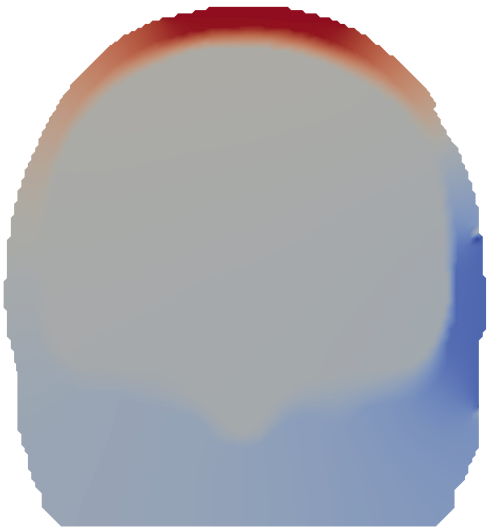

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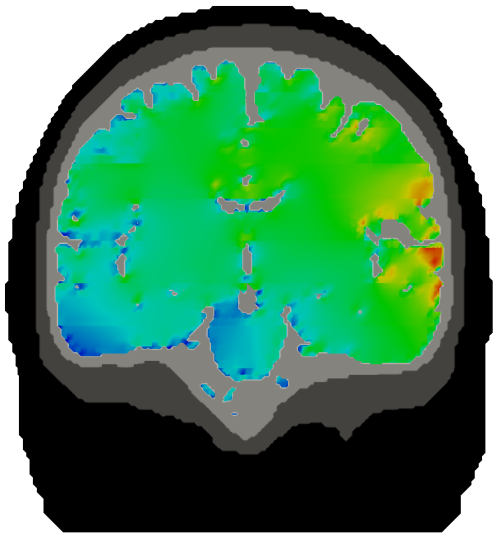

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Outlook

- investigate source model for UDG
- smoothing using constrained mean curvature flow
- integrate DUNE into software for brain research
  e.g. FieldTrip, Besa
- application to data from children

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Thank you for your attention!