

FEM Electrode Refinement for Electrical Impedance Tomography

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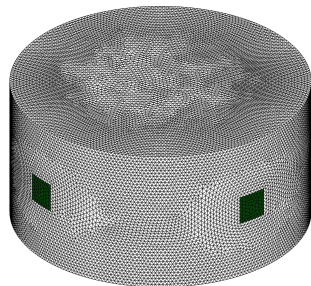
Unterstützt von / Supported by



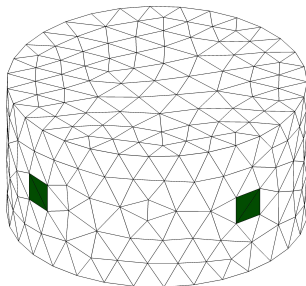
Alexander von Humboldt
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Outline

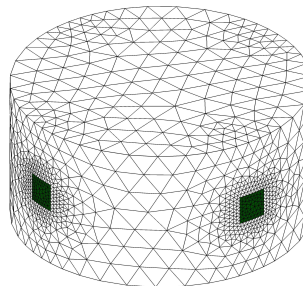
Effects of electrode refinement in EIT



(a) C0



(b) C7



(c) R7

Figure: Examples of (a) fine, (b) coarse and (c) refined meshes.

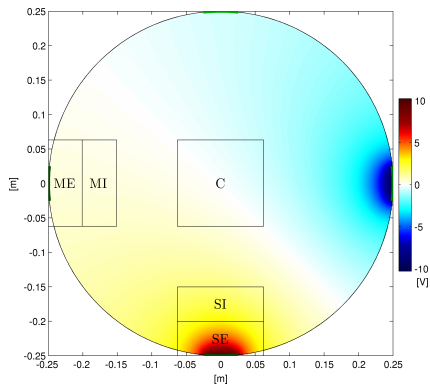
Models overview

Table: Mesh characteristics

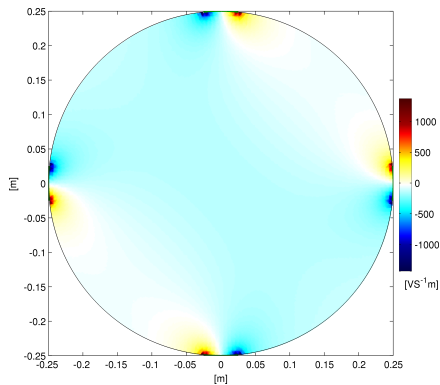
Model	C0	C1	C2	C3	C4	C5	C6	C7	R1	R2	R3	R4	R5	R6	R7
global maxh [mm]	6.25	7.14	8.33	10	12.5	16.7	25	50	50	50	50	50	50	50	50
elec. maxh [mm]	6.25	7.14	8.33	10	12.5	16.7	25	50	25	16.7	12.5	10	8.33	7.14	6.25
# elem. per elec. edge	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8
# elements	1291473	1254681	633324	230947	160323	79787	19033	1983	3705	7893	14538	17778	23423	31188	38244
# nodes	233640	224963	114363	43941	30642	15290	4047	524	874	1712	2956	3601	4692	6098	7436
# elec. elem.	138	110	74	56	36	22	6	2	6	22	28	50	72	86	104
minEL ^a [mm]	3.37	3.55	3.95	5.53	6.7	9.1	13.9	35.4	17.9	11.9	8.2	6.76	5.34	4.94	4.25
maxEL ^b [mm]	15.4	15	19.1	25.2	30.9	41.4	52.3	103	96.1	84.2	85.5	82.7	75.3	73.5	74.4
minEV ^c [cm ³]	0.00825	0.00888	0.0146	0.0407	0.0565	0.139	0.514	8.03	1.55	0.303	0.123	0.0814	0.034	0.0234	0.0131
maxEV ^d [cm ³]	0.159	0.159	0.405	0.739	1.14	3.62	8.67	71.2	59.7	46.1	28.3	31	25.4	26.5	25.2

^a length of the shortest edge; ^b length of the longest edge; ^c volume of the smallest element; ^d volume of the largest element.

Simulation



(a) Potential distribution



(b) Sensitivity distribution

Figure: Reference results obtained on model C0.

Sensitivity

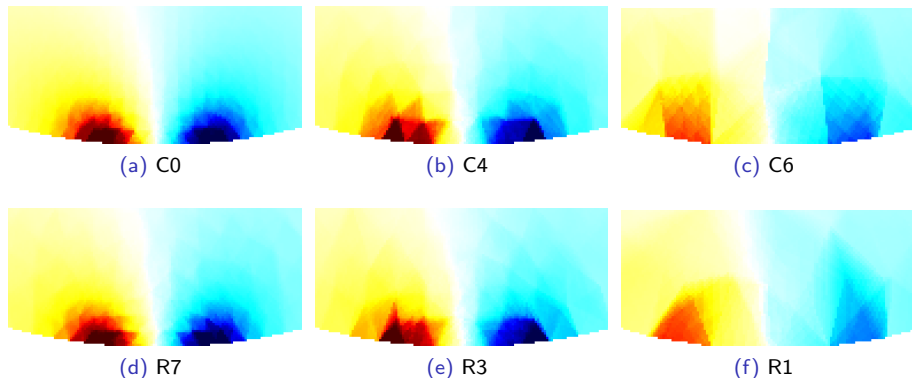


Figure: Average sensitivity in the electrode plane in the vicinity of an electrode (ROIs SE and SI). All images use the same color scale.

Sensitivity

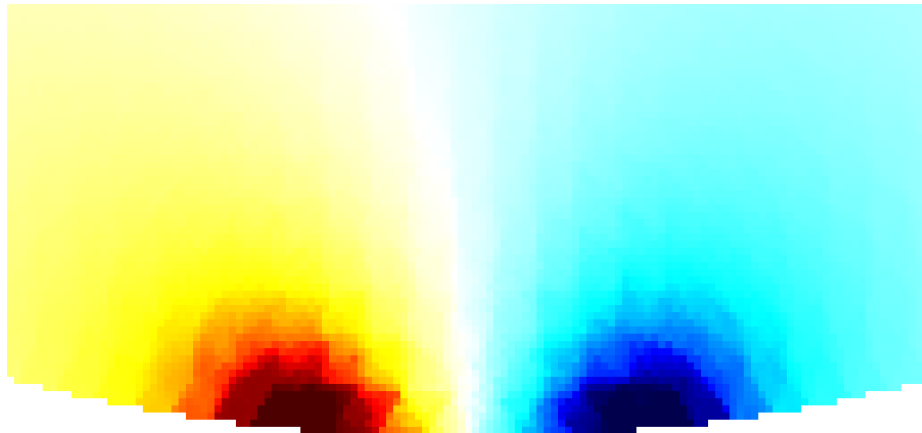


Figure: C0

Sensitivity

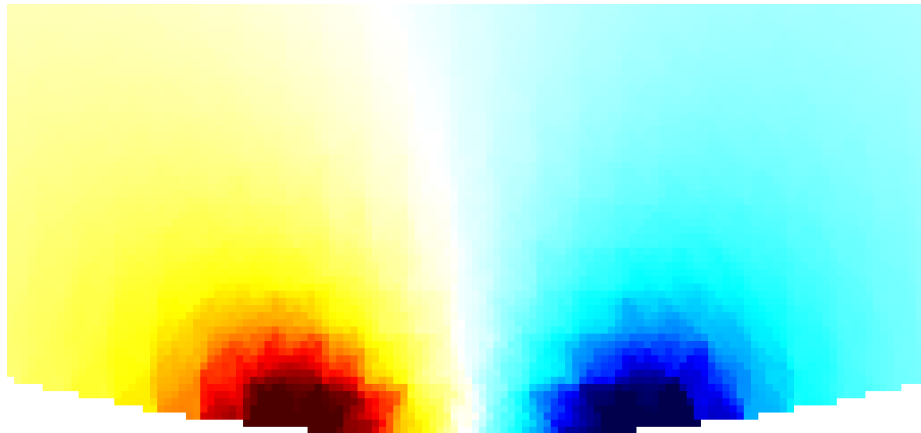


Figure: C1

Sensitivity

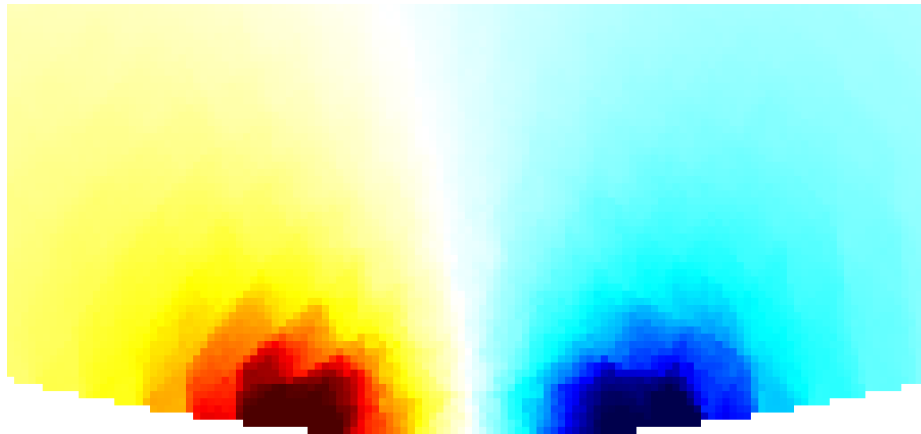


Figure: C2

Sensitivity

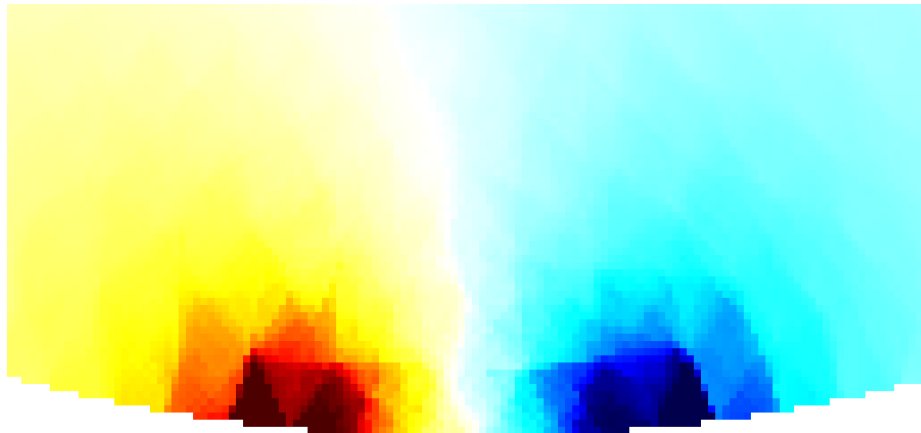


Figure: C3

Sensitivity

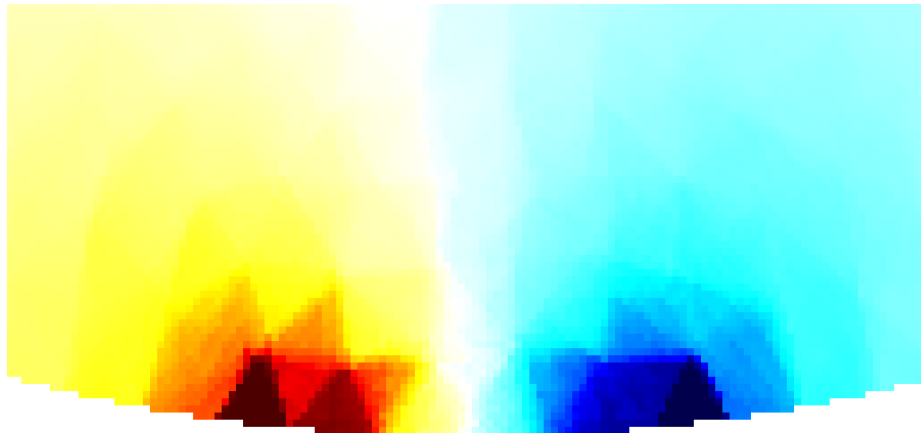


Figure: C4

Sensitivity

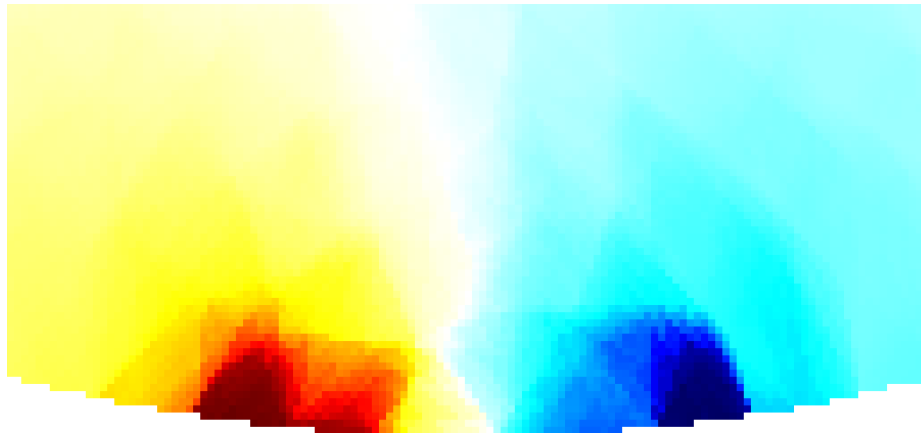


Figure: C5

Sensitivity

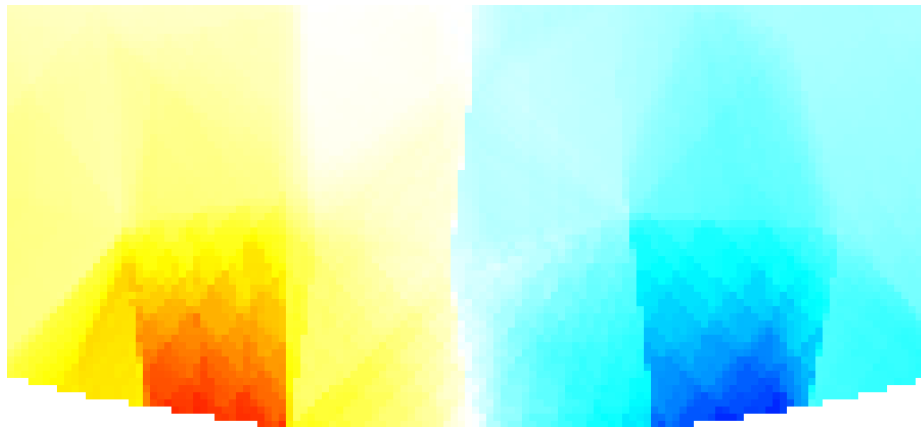


Figure: C6

Sensitivity



Figure: C7

Sensitivity

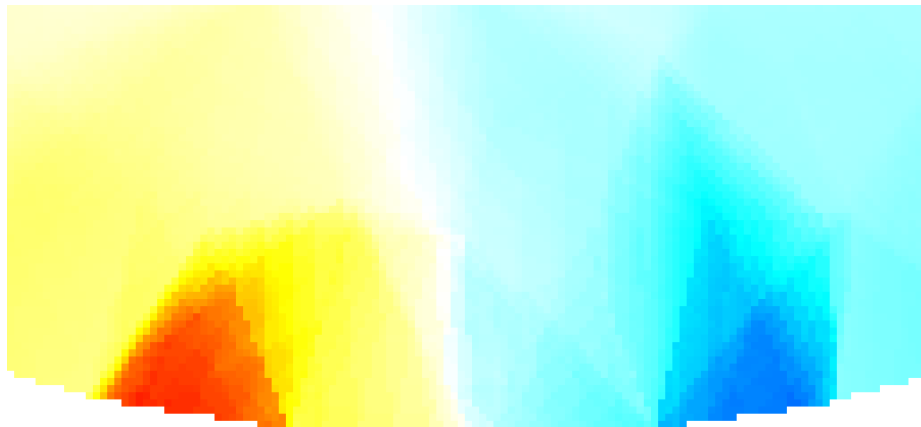


Figure: R2

Sensitivity

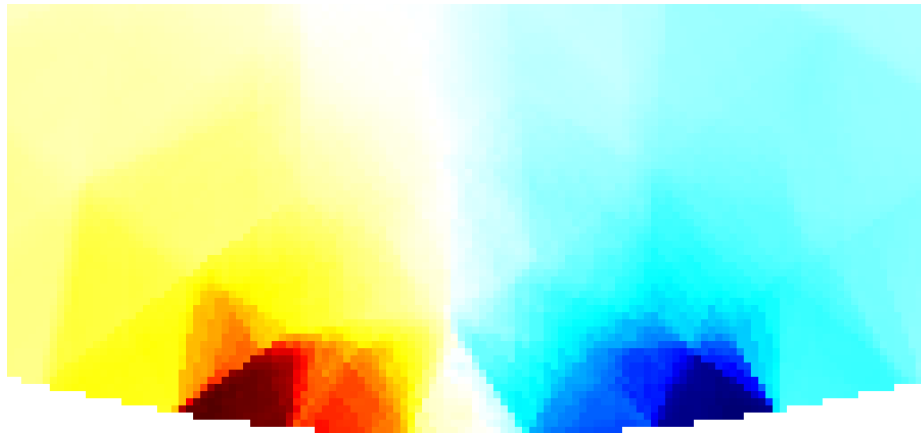


Figure: R3

Sensitivity

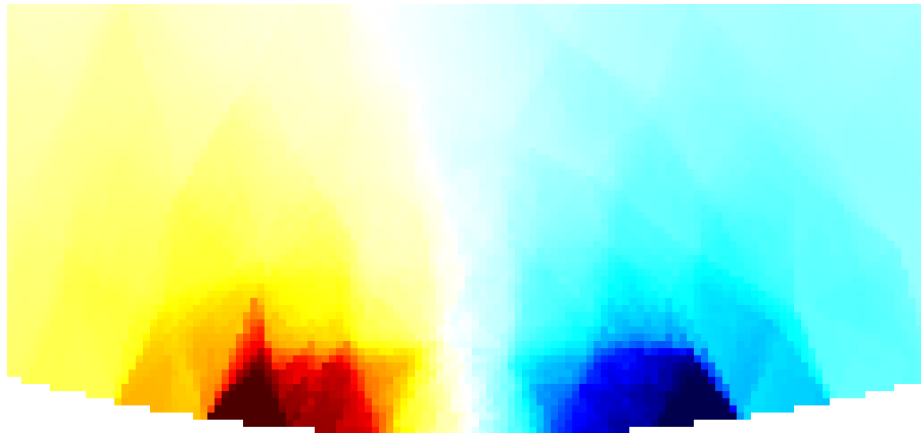


Figure: R4

Sensitivity

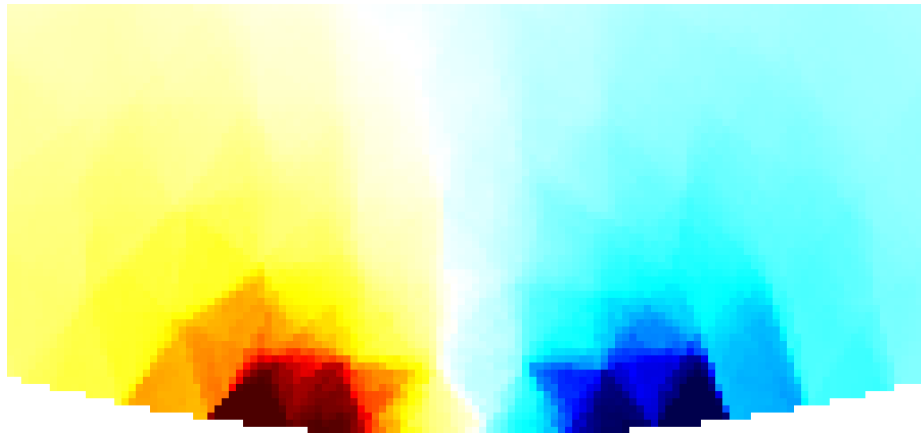


Figure: R5

Sensitivity

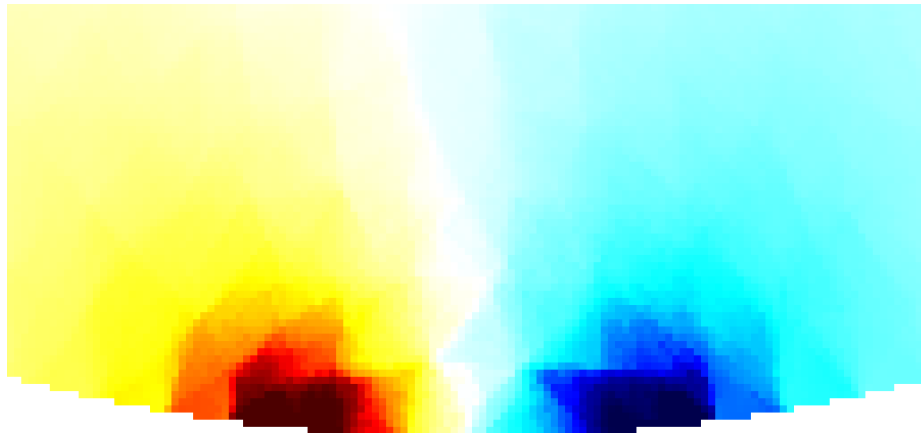


Figure: R6

Sensitivity

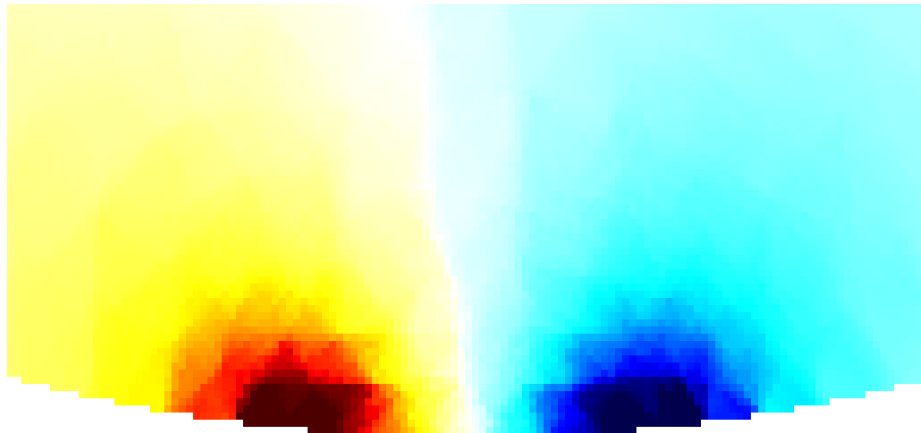


Figure: R7

Sensitivity

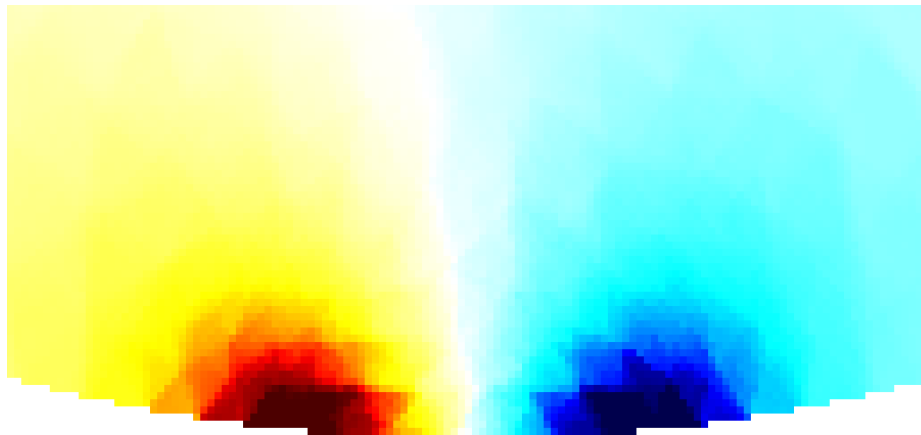


Figure: R8

Current near electrode

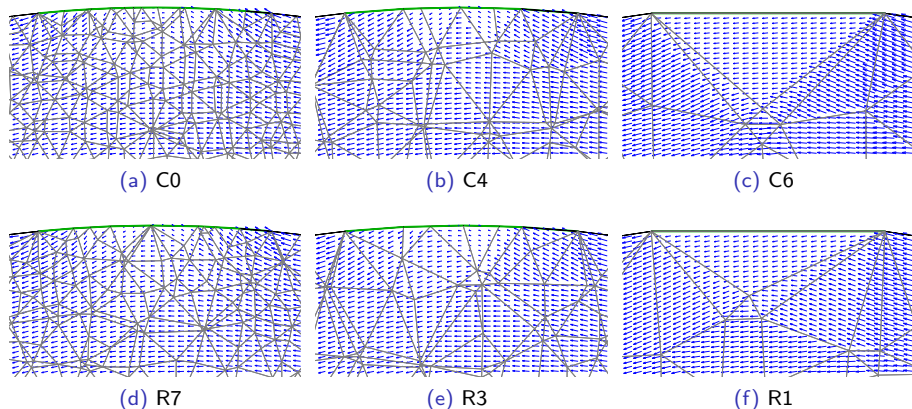


Figure: Current flow in the electrode plane (ROIs ME and MI). Arrows in each image are scaled individually.

Results

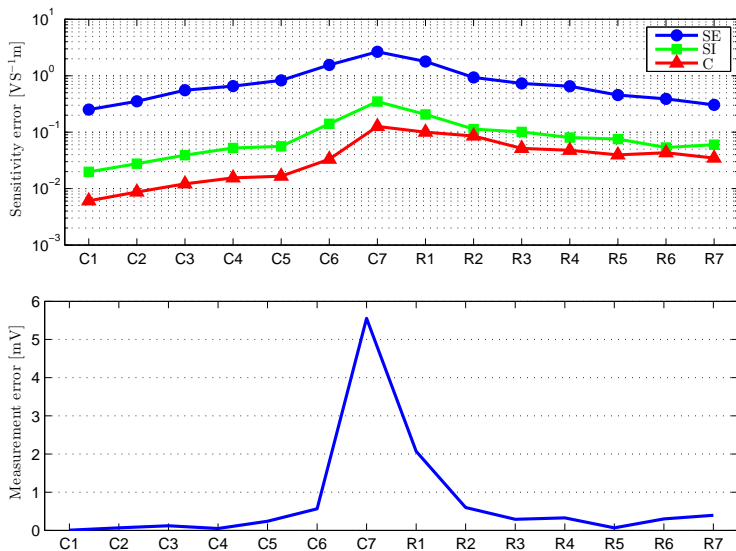
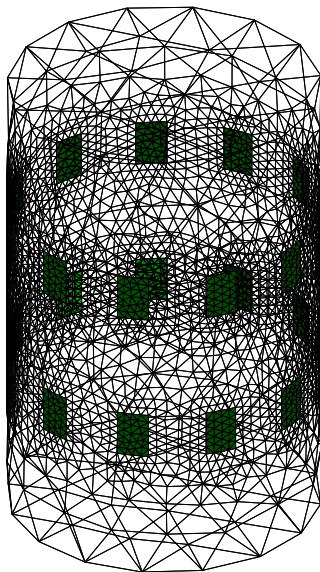


Figure: Errors with respect to model C0.

Electrode refinement in EIDORS 3.7

Functions

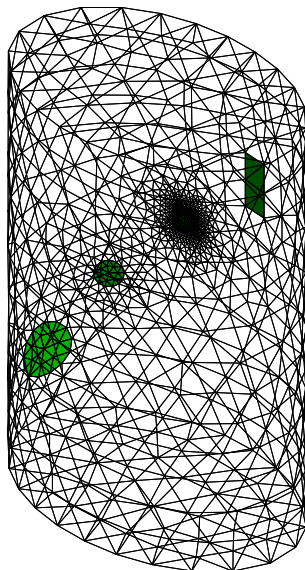
- `ng_mk_cyl_models`



Electrode refinement in EIDORS 3.7

Functions

- `ng_mk_cyl_models`
- `ng_mk_ellip_models`



Electrode refinement in EIDORS 3.7

Functions

- `ng_mk_cyl_models`
- `ng_mk_ellip_models`
- `ng_mk_gen_models`

Electrode refinement in EIDORS 3.7

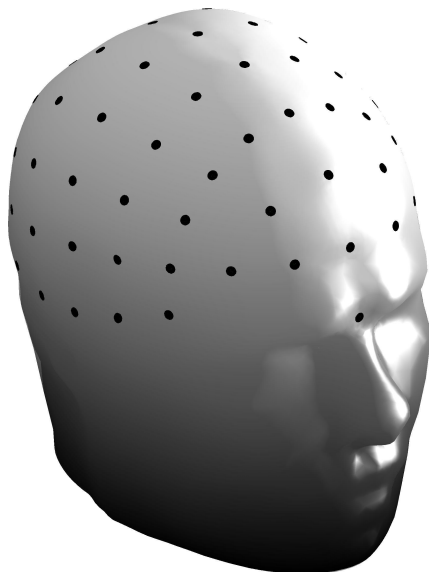
Functions

- `ng_mk_cyl_models`
- `ng_mk_ellip_models`
- `ng_mk_gen_models`
- `ng_mk_extruded_models`

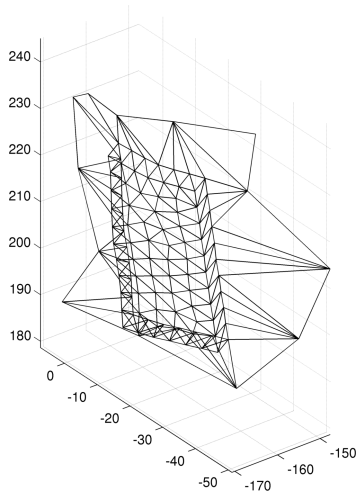
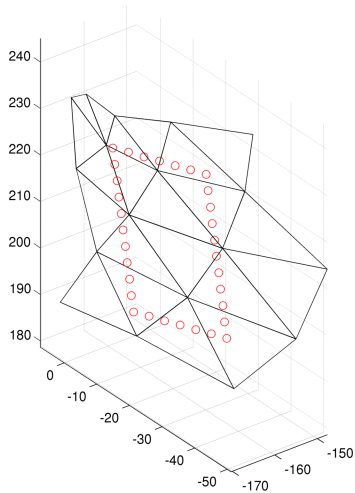
Electrode refinement in EIDORS 3.7

Functions

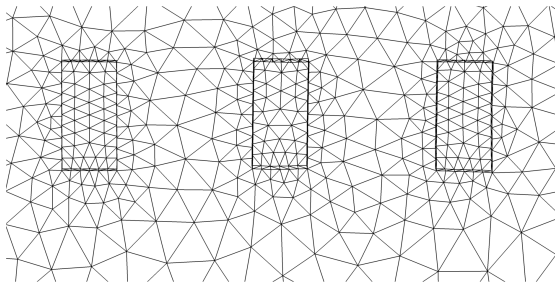
- `ng_mk_cyl_models`
- `ng_mk_ellip_models`
- `ng_mk_gen_models`
- `ng_mk_extruded_models`
- **`place_elec_on_surf`**



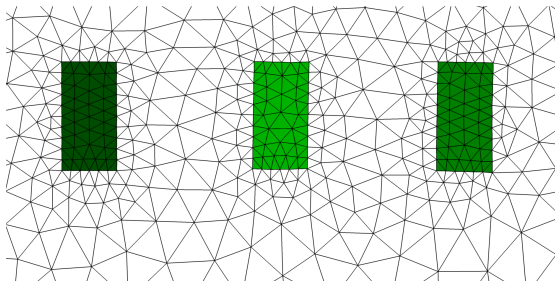
place_elec_on_surf



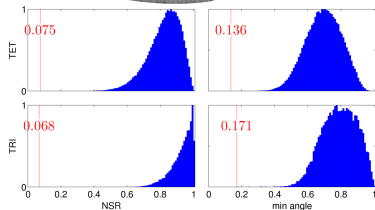
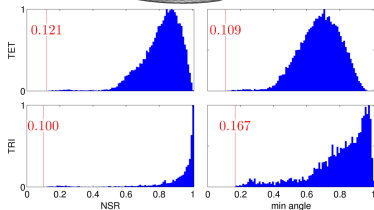
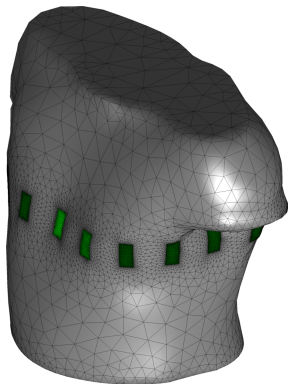
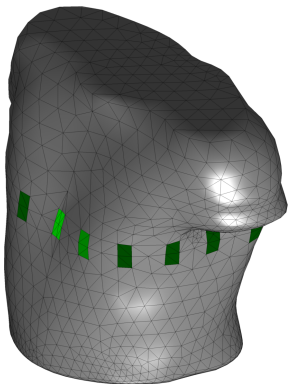
place_elec_on_surf



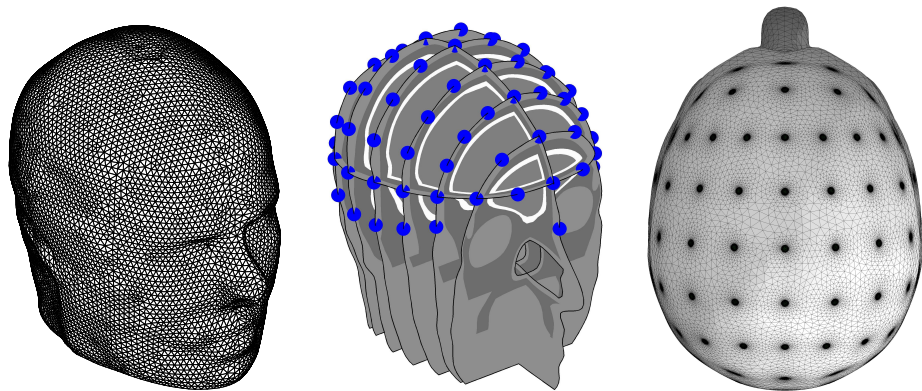
place_elec_on_surf



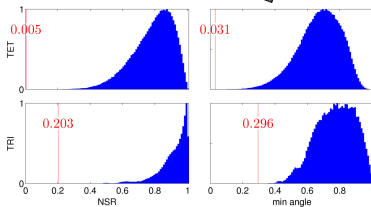
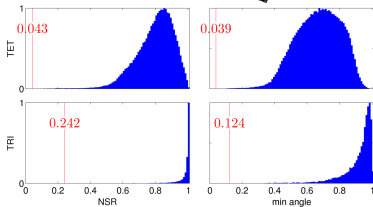
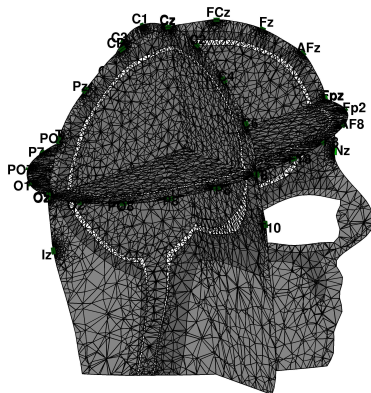
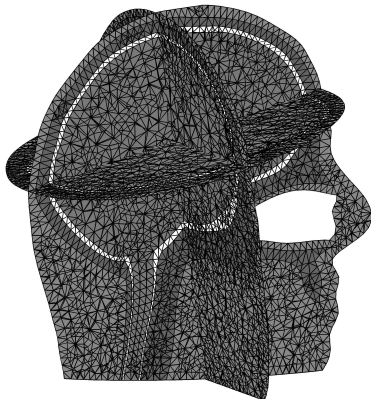
Before & After



Building the head mesh



Before & After



Conclusions

- Electrode refinement improves accuracy
- Electrode refinement decreases computation cost
- But, how much electrode refinement is required?
- EIDORS provides a free tool for electrode refinement on arbitrary shapes

Conclusions

- Electrode refinement improves accuracy
- Electrode refinement decreases computation cost
- But, how much electrode refinement is required?
- EIDORS provides a free tool for electrode refinement on arbitrary shapes
- It's not ideal, but we have a money-back guarantee.