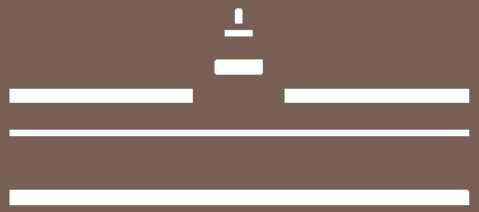
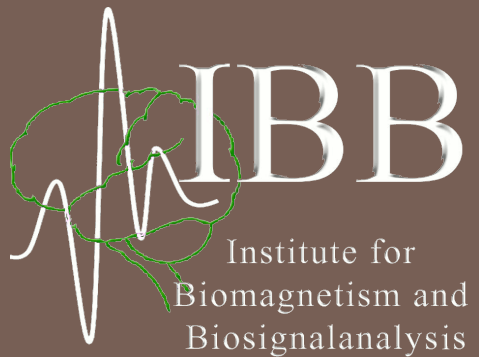


Westfälische Wilhelms-Universität Münster



EEG AND MEG SOURCE ANALYSIS IN FOCAL EPILEPSY

May 20, 2025

Carsten H. Wolters

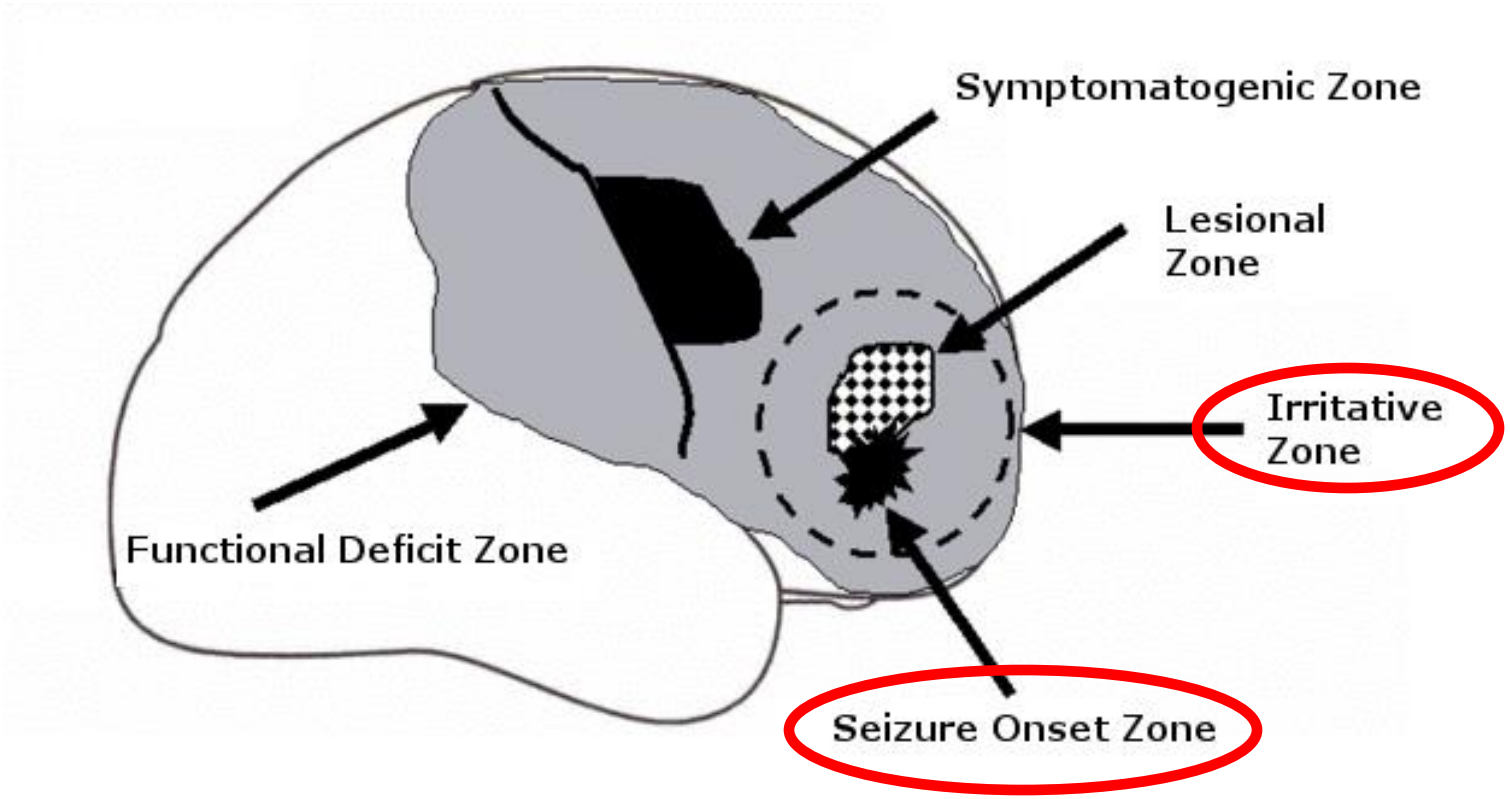
Structure

- Complementarity of EEG and MEG
- How to exploit this complementarity in combined EEG/MEG source analysis
- Focal epilepsy patient case studies
- Summary

Introduction

- 0.5%-1% of world population suffers from epilepsy and 70-80% of patients successfully treated with drugs
- For those who are still pharma-resistent after 2-3 drugs
  - Probability of success of a further different drug: 6% (Wiebe et al 2001)
  - Probability of success of a surgical treatment: 50% (Wiebe et al 2001)
- Indispensable prerequisite for surgery: Focal epilepsy->Localization
  - Gold standard: Video-monitoring and visual inspection of the EEG (Wilson 1996)
  - MRI: Identification of an underlying lesion
  - PET and Neuropsychology: Localization of a functional deficit
  - Source analysis of
    - EEG seizure (ictal) activity (Plummer et al., 2008; Rullmann et al., 2009)
    - EEG/MEG interictal activity: “irritative zone” (Stefan et. al., 2003; Aydin et al., 2015,2017)

Zone-concept in epilepsy diagnosis

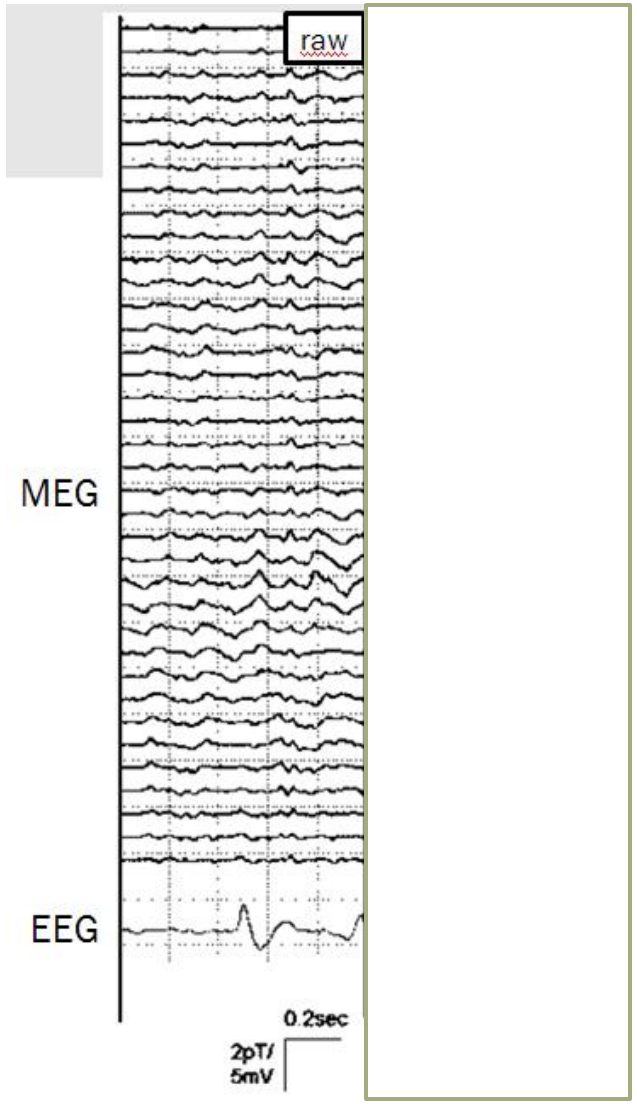


EEG(/MEG) registration during a seizure (ictal)

Interictal spikes in EEG/MEG

Introduction: Epileptic spikes in EEG and MEG

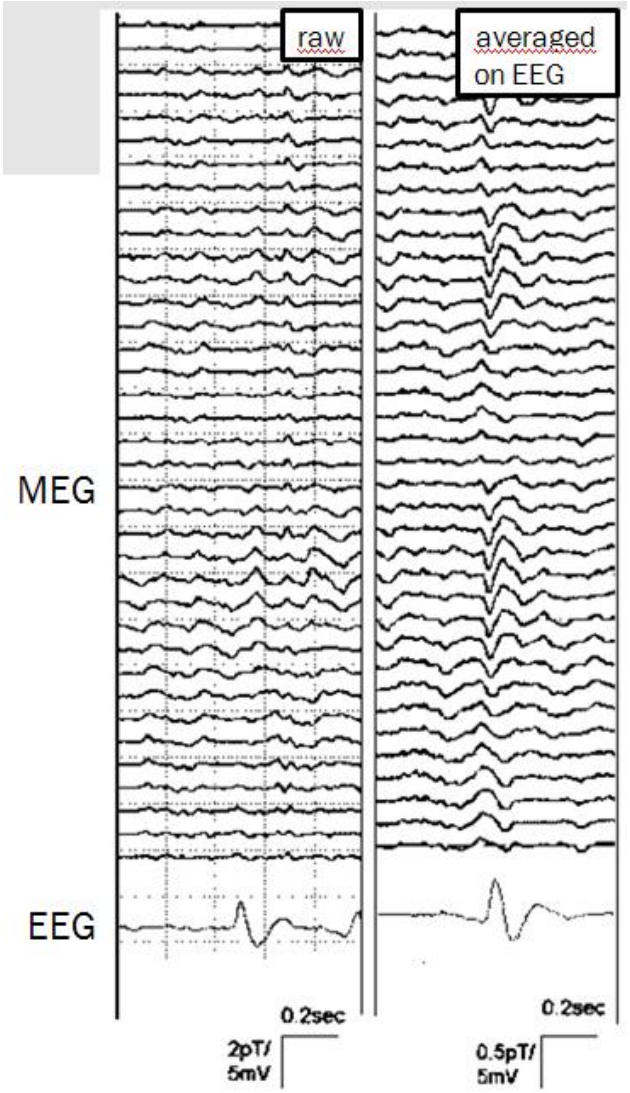
Clear spike in EEG
Nearly no/no signal in MEG



[Courtesy of Stefan Rampp]

Introduction: Epileptic spikes in EEG and MEG

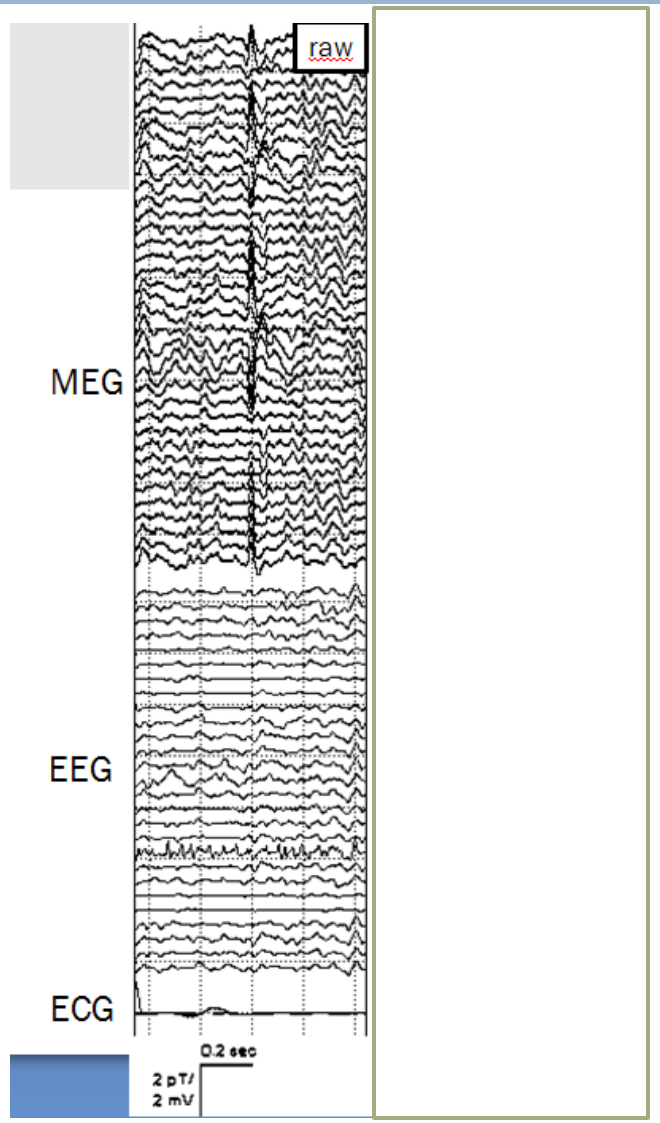
Clear spike in EEG
Nearly no/no signal in MEG
⇒ radially oriented or deep source



[Courtesy of Stefan Rampp]

Introduction: Epileptic spikes in EEG and MEG

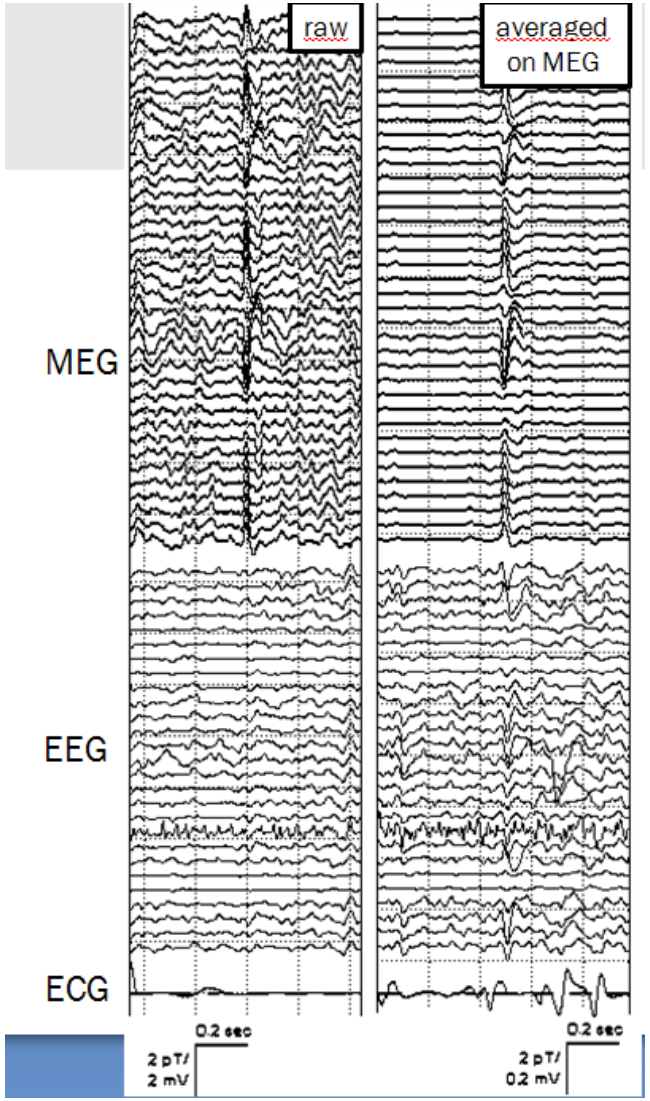
Clear signal in MEG,
poor signal in EEG



[Courtesy of Stefan Rampp]

Introduction: Epileptic spikes in EEG and MEG

Clear signal in MEG,
poor signal in EEG
=>tangentially oriented source

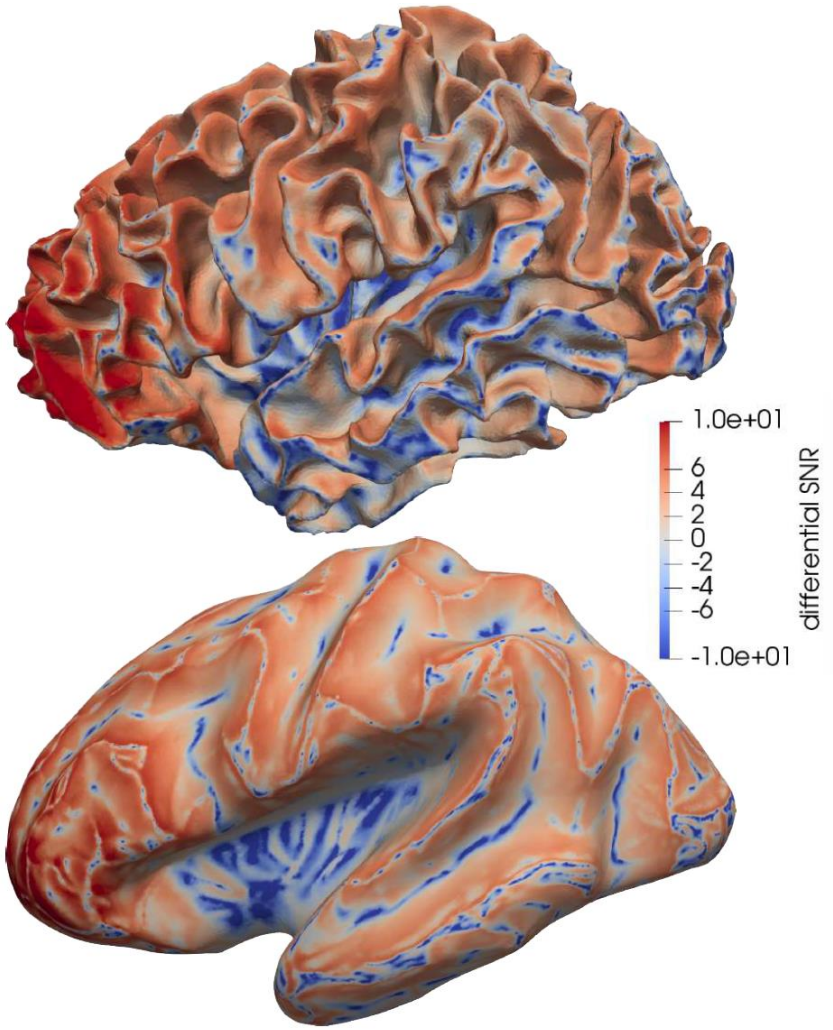


[Courtesy of Stefan Rampp]

[Piastra, Nüßing, Vorwerk, Clerc, Engwer & Wolters, *Human Brain Mapping,* 2021]

Introduction: Sensitivity of EEG and MEG

- Blue: Sensitivity EEG > MEG for radial and deep sources
- Red: Sensitivity MEG > EEG in sulcal wall areas



Introduction: Complementarity of EEG and MEG

- Iwasaki et al 2005:
  - EEG/MEG: 72% (31/43 pat)
  - Only EEG: 2% (1/43 pat)
  - Only MEG: 19% (8/43 pat)
  - None: 7% (3/43 pat)

- Knake et al 2006:
  - EEG/MEG: 75% (50/67 pat)
  - Only EEG: 3% (2/67 pat)
  - Only MEG: 13% (9/67 pat)
  - None: 25% (17/67 pat)

What should we use?
MEG instead of EEG?
Only EEG?

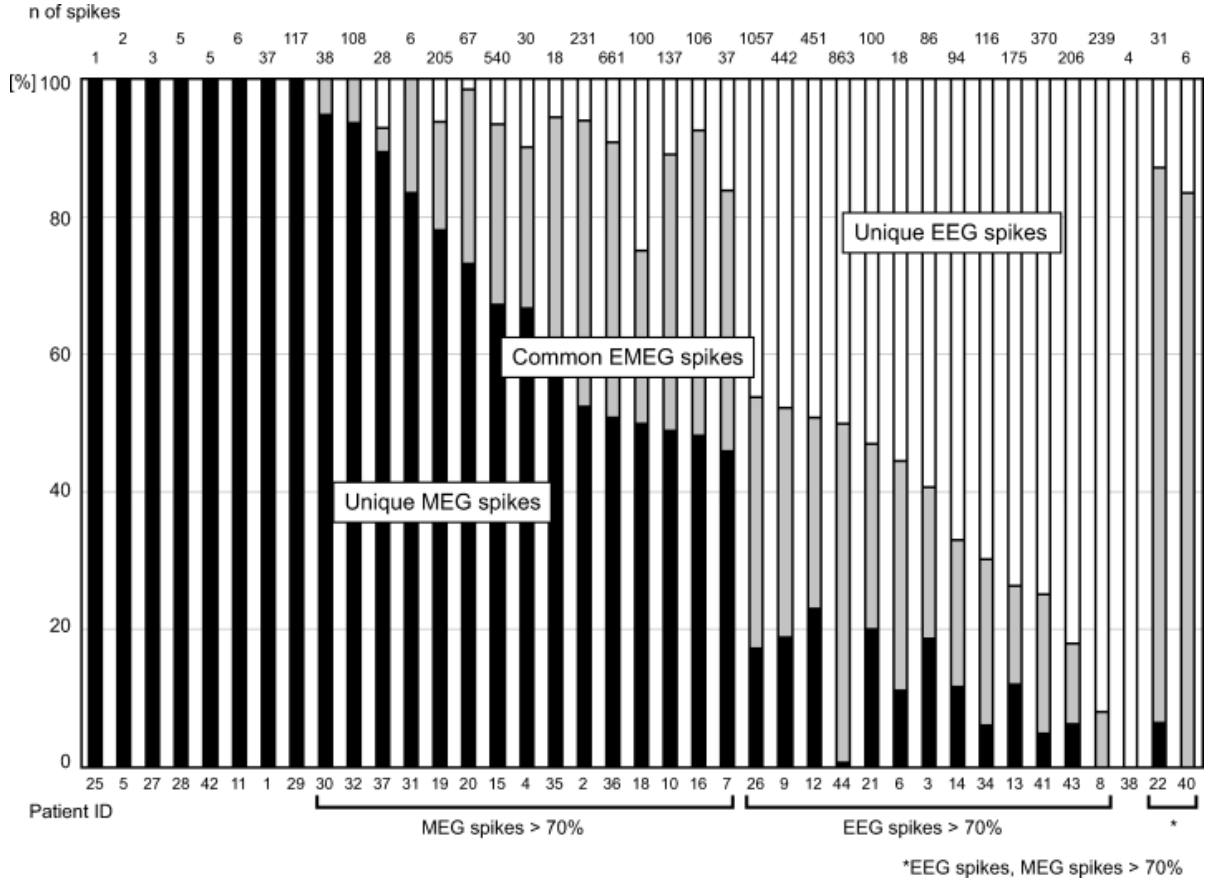


Fig. 3. Populations of spikes that were detected only in magnetoencephalography (MEG) (unique MEG spikes in *black*), only in EEG (unique EEG spikes in *white*), and commonly in both EEG and MEG [same spike detected in both modalities (EMEG) spikes in *gray*] are shown on a percentage scale for 39 patients who had at least one spike. Common EMEG spikes account for a relatively small proportion of the total spikes (median, 25.7%). The patients are roughly divided into those with a large number of EEG spikes (n = 13), those with a large number of MEG spikes (n = 15), and those with no dominancy (n = 2).

Introduction: Combined measurement of EEG and MEG

275 channel axial gradiometer whole-cortex MEG
128 channel EEG

Structure

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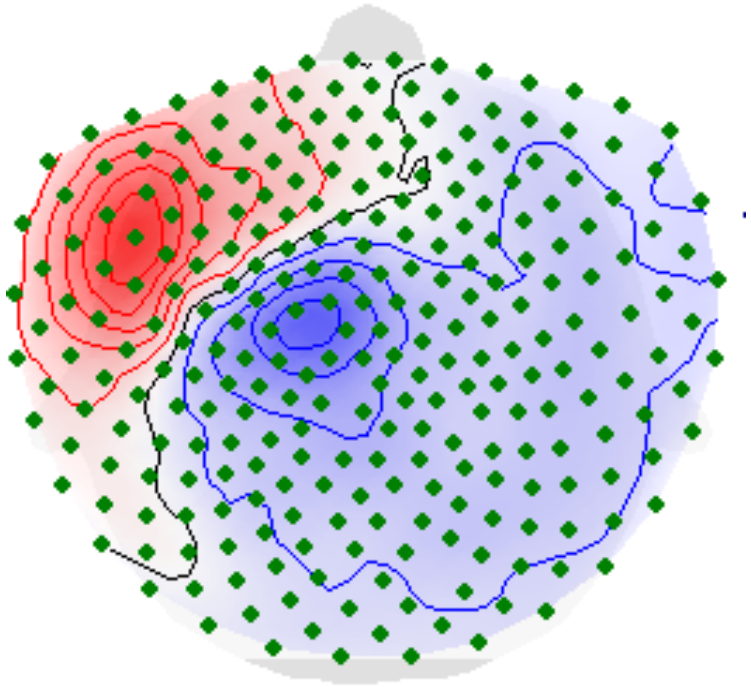
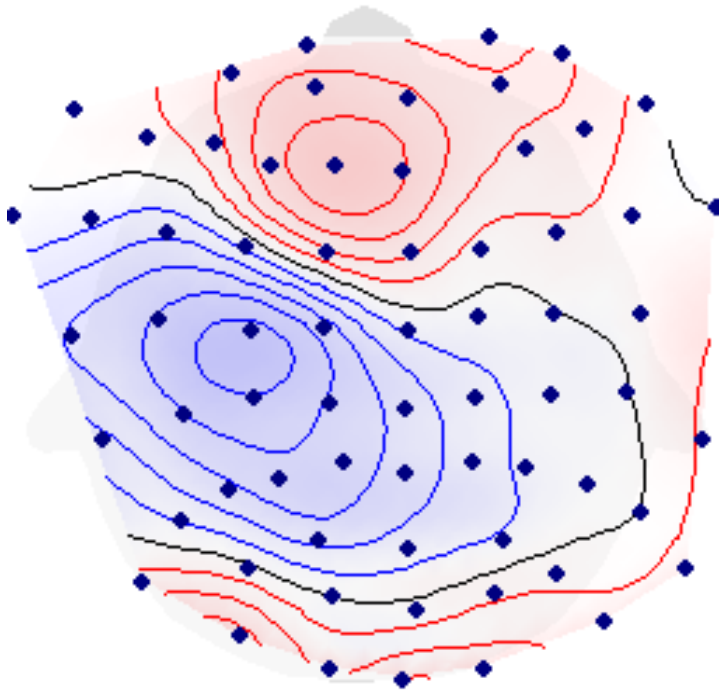
[Aydin, Vorwerk, Küpper, Heers, Kugel, Galka, Hamid, Wellmer, Kellinghaus, Rampp & Wolters, *Plos One*, 2014]

SEP/SEF skull conductivity calibration



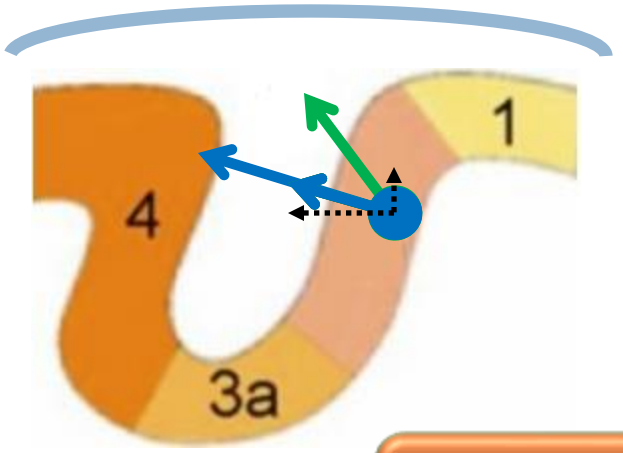
SEF



SEP

[Aydin, Vorwerk, Küpper, Heers, Kugel, Galka, Hamid, Wellmer, Kellinghaus, Rampp & Wolters, *Plos One*, 2014]

SEP/SEF skull conductivity calibration



Define a set of skull conductivity parameters: $\Sigma=\{\sigma_1,\sigma_2,\ldots,\sigma_n\}$

SEF GFS → location x, orientation o_1 and magnitude m_1.

SEP Least Squares (LS); x fixed → orientation o_2 and magnitude m_2.

SEF LS; x and o_2 fixed → m_3

SEP x, o_2 and m_3 → Residual Variance (RV)

Select the conductivity that gives the lowest RV

Repeat for all predefined conductivities $\{\sigma_1,\sigma_2,\ldots,\sigma_n\}$

[Aydin, Vorwerk, Küpper, Heers, Kugel, Galka, Hamid, Wellmer, Kellinghaus, Rampp & Wolters, *Plos One*, 2014]

SEP/SEF skull conductivity calibration

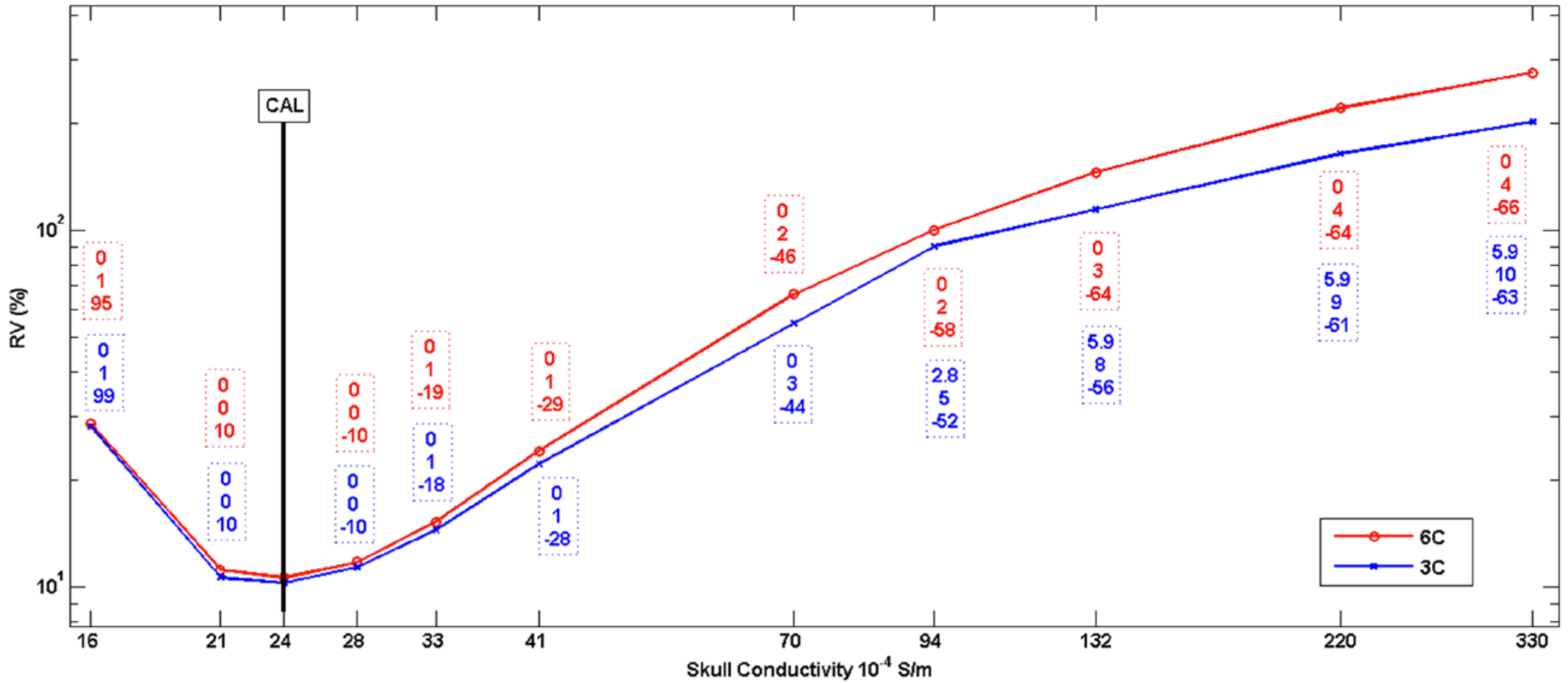


Figure 3. Skull conductivity calibration graph. RV (in %) obtained from Algorithm 2 in step 2.d. for different skull conductivity parameters for 6C (red) and 3C (blue) head models. The differences to the calibrated head models *6C_Cal* and *3C_Cal* (indicated by the black bar, see also Table 1) in source reconstruction are indicated by boxes with dashed frames: Difference in source location x (top row, in mm), orientation o_2 (middle row, in degree) and strength m_2 (bottom row, in %).

[Antonakakis, Schrader, Aydin, Khan, Gross, Zervakis, Rampp & Wolters, *NeuroImage, 2020*]

Skull-conductivity calibration: Individual calibration curves in a group study (20 subjects)

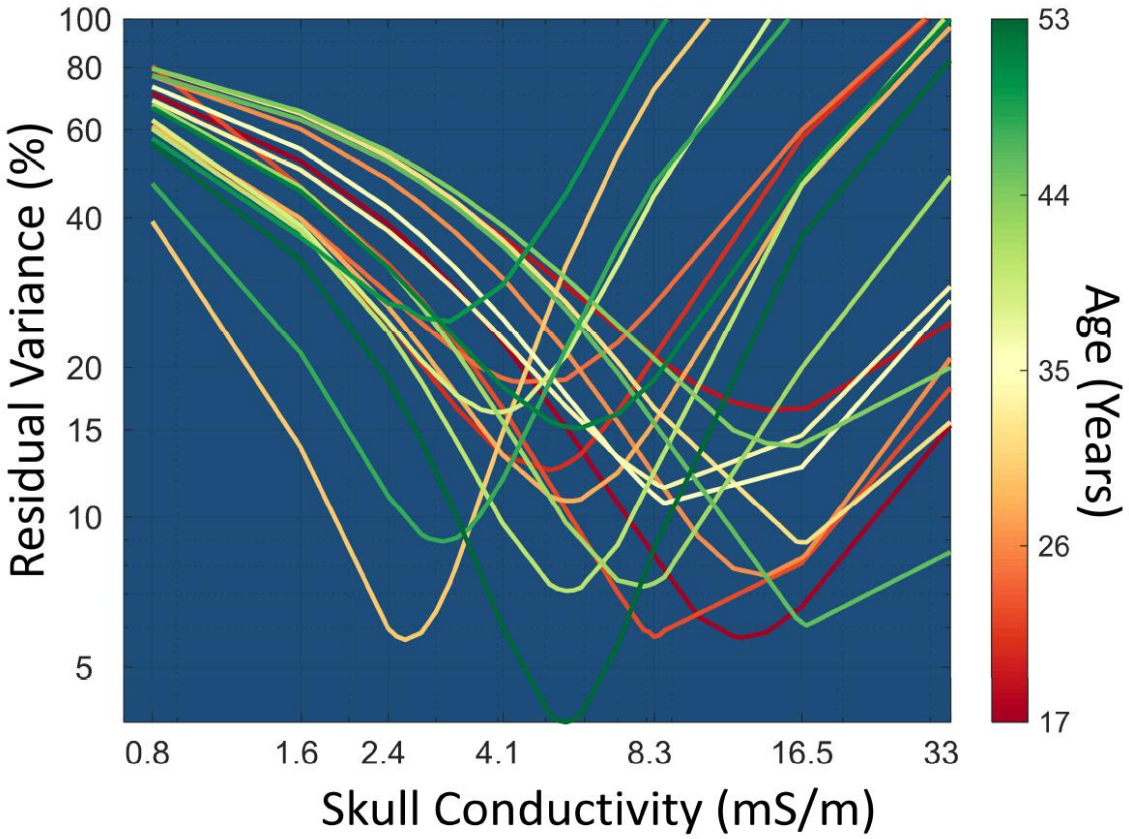
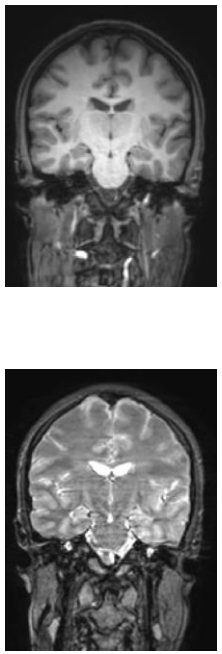


Figure 4. Skull conductivity calibration graph. Residual variance (RV in %) curves as they were estimated by the skull conductivity calibration procedure. The RV curves are presented as a function of the skull compacta conductivity for all the subjects. The horizontal axis is in mS/m and the vertical axis is in %. Each curve is color-coded by the age of the subject.

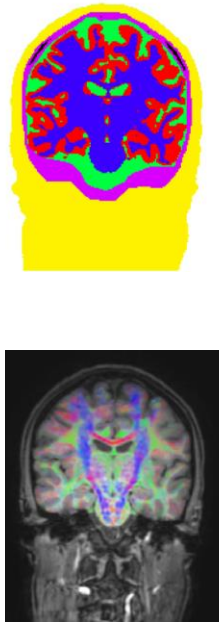
[Aydin, Vorwerk, Küpper, Heers, Kugel,Galka, Hamid, Wellmer, Kellinghaus, Rampp & Wolters, *PLOS ONE,* 2014]
[Antonakakis, Schrader, Aydin, Khan, Gross, Zervakis, Rampp & Wolters, *NeuroImage, 2020*]
[Schrader, Antonakakis, Rampp, Engwer & Wolters, *Phys Med Biol, 2020*]

Combined EEG/MEG source analysis in calibrated head model

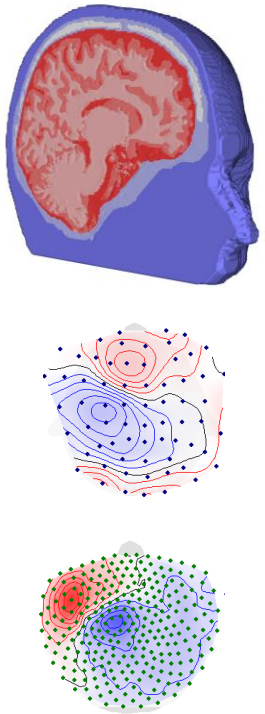
MRI measurement



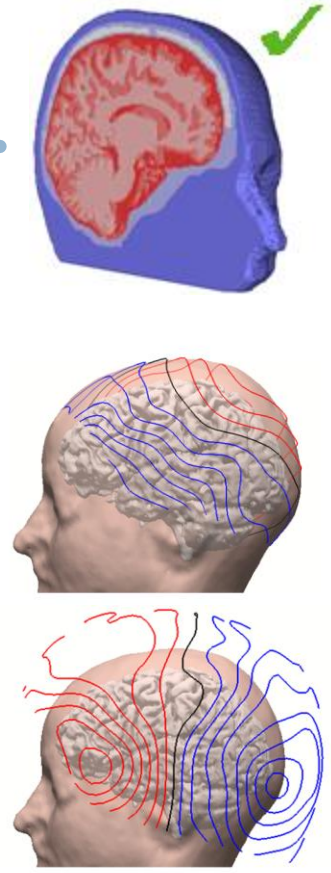
Segmentation



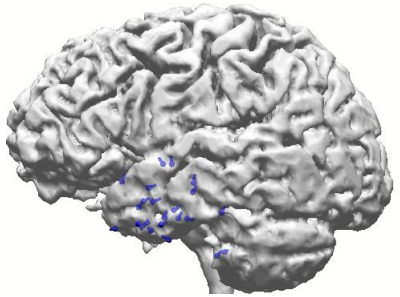
Anisotropic head model



Calibration for skull conductivity



Measurement and reconstruction of epileptic activity



- T1, T2, DTI (27 min)
- Medianus-nerve stimulation (7 min)
- Skull conductivity
  - High interindividual variability
  - EEG very sensitive
  - MEG nearly not influenced

Structure

- Complementarity of EEG and MEG
- How to exploit this complementarity in combined EEG/MEG source analysis
- Focal epilepsy patient case studies
  - EEG reconstruction of ictal activity
  - Reconstruction of propagation pathway
  - Multifocal epilepsy
  - Broca epilepsy
  - Epilepsy and pregnancy
- Summary

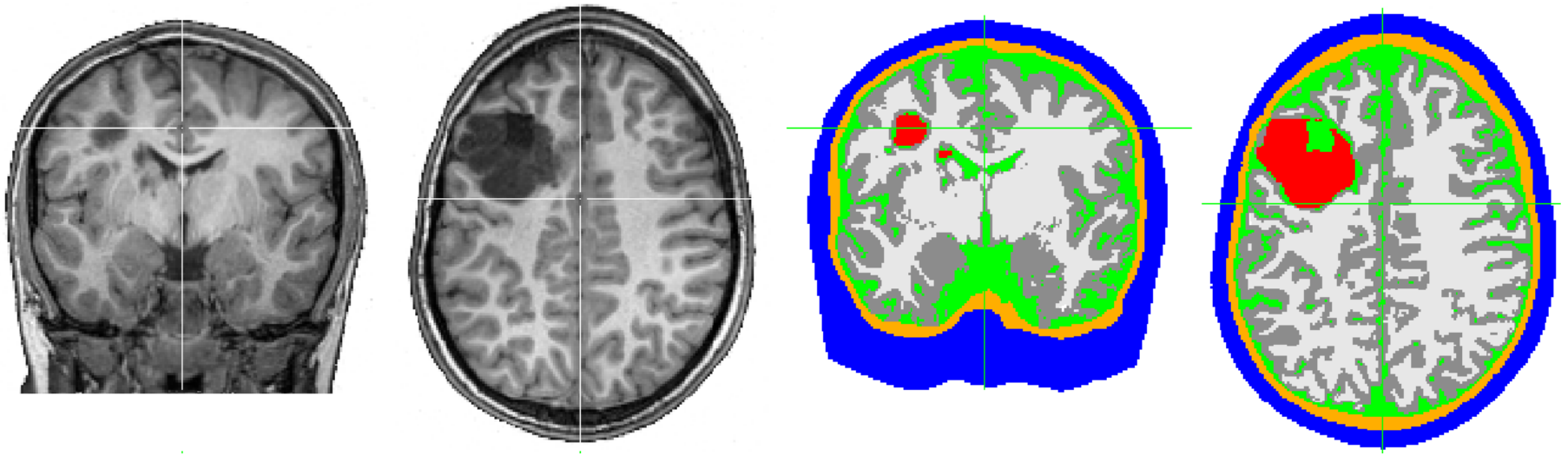
[Rullmann, Anwander, Dannhauer, Warfield, Duffy & Wolters, NeuroImage, 44(2), 2009]

Patient

- In 2009: 11 year old boy
- In 2001: In the age of 3
  - diagnosis of refractory (pharmaco-resistent) focal epilepsy and dysembryoplastic neuroepithelial tumor (DNET)
  - DNET- and focus-resection
- In 2009
  - again epileptic seizures
  - DNET-relapse anterior to the motor-cortex close to resection-area from first surgery

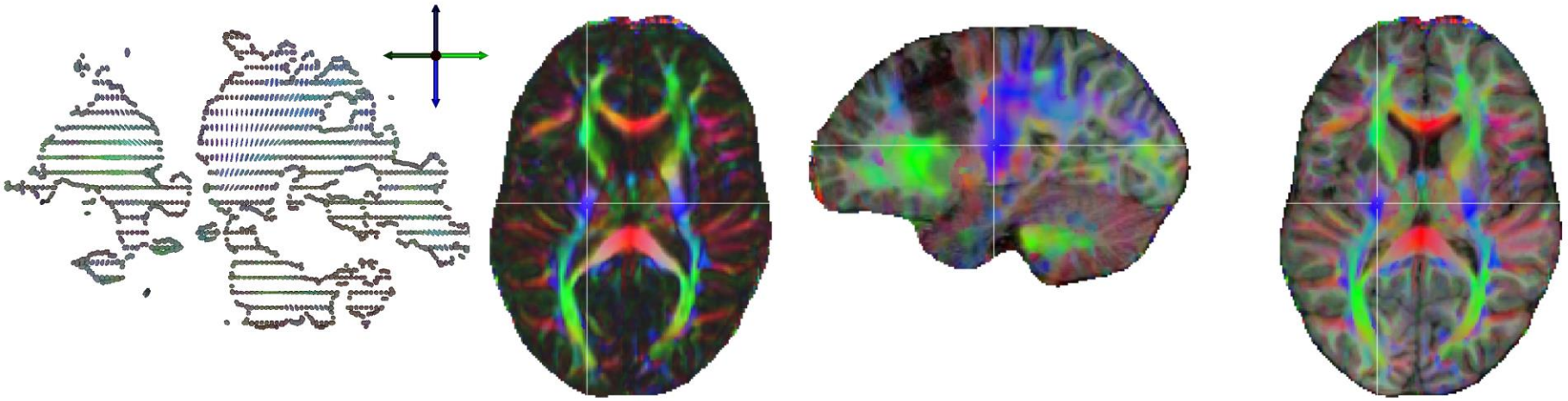
[Rullmann, Anwander, Dannhauer, Warfield, Duffy & Wolters, NeuroImage, 44(2), 2009]

MRI segmentation



[Rullmann, Anwander, Dannhauer, Warfield, Duffy & Wolters, NeuroImage, 44(2), 2009]

Modeling of brain conductivity anisotropy



Original DTI data

FA-map after registration

FA-map on T1-MRI

Effective medium approach model (DTI <-> CTI):

Model DTI<->Conductivity Tensor Image (CTI) [Tuch et al., *Ann. NYAS*, 1999]

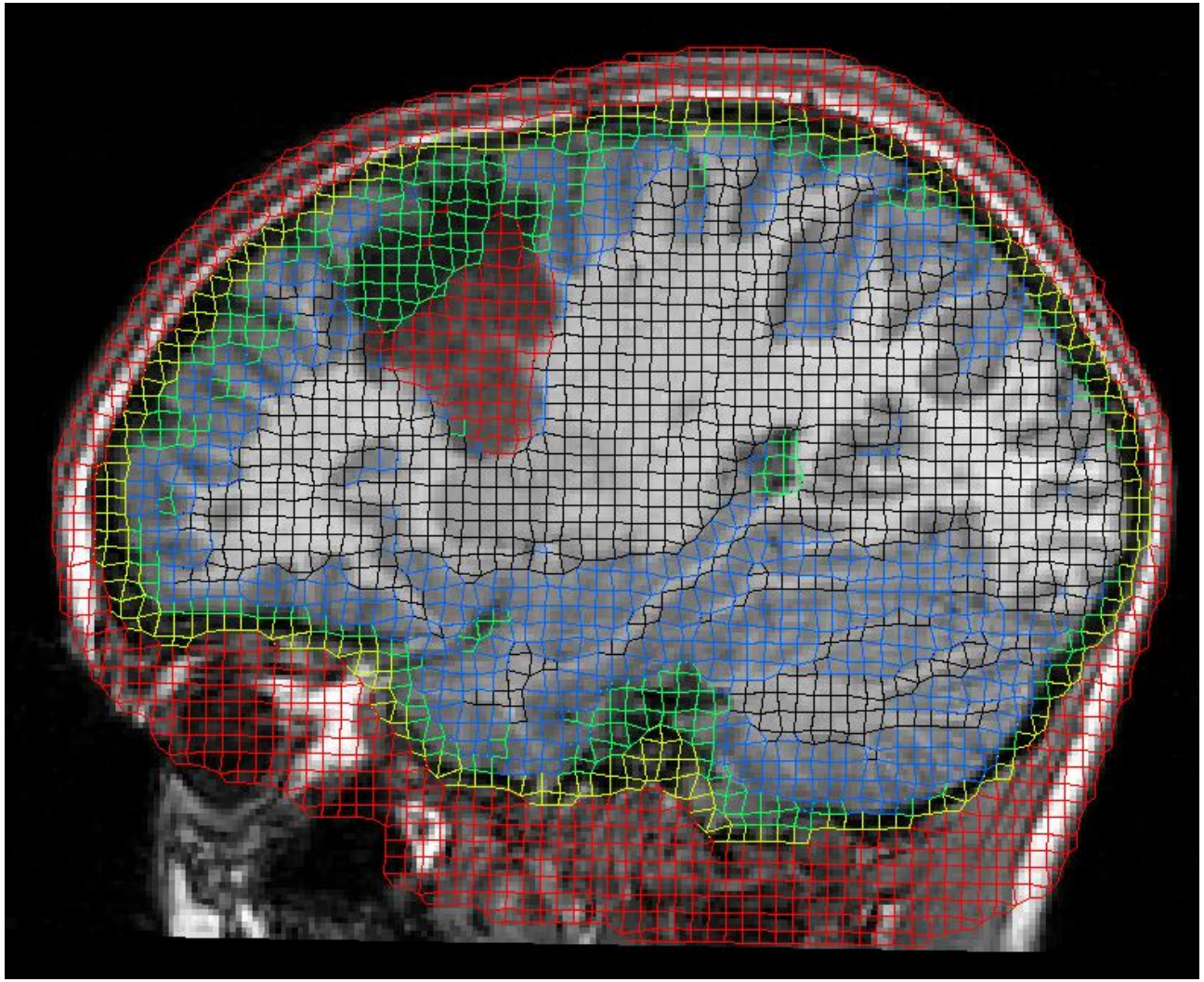
Linear model DTI<->CTI [Tuch et al., PNAS, 2001]

Validation of DTI<->CTI model in silk yarn phantom [Oh et al., ISMRM, 2006]

Improved DTI artifact correction and registration [Ruthotto et al., Phys Med Biol, 2012]

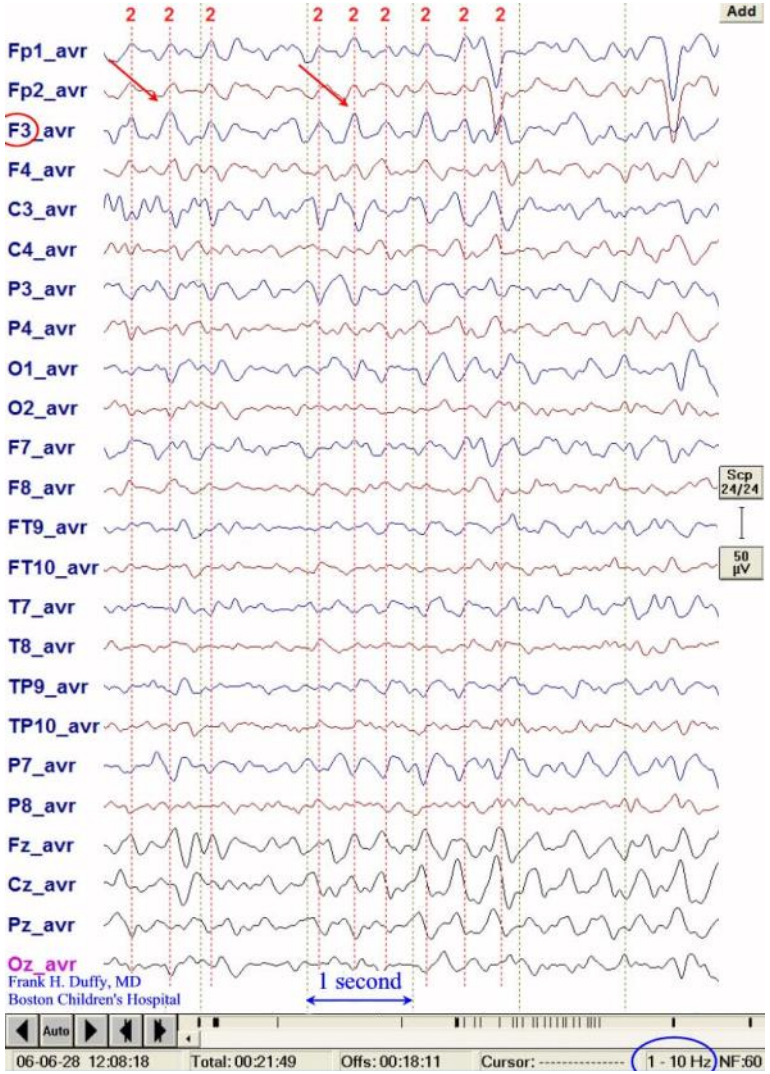
[Rullmann, Anwander, Dannhauer, Warfield, Duffy & Wolters, NeuroImage, 44(2), 2009]

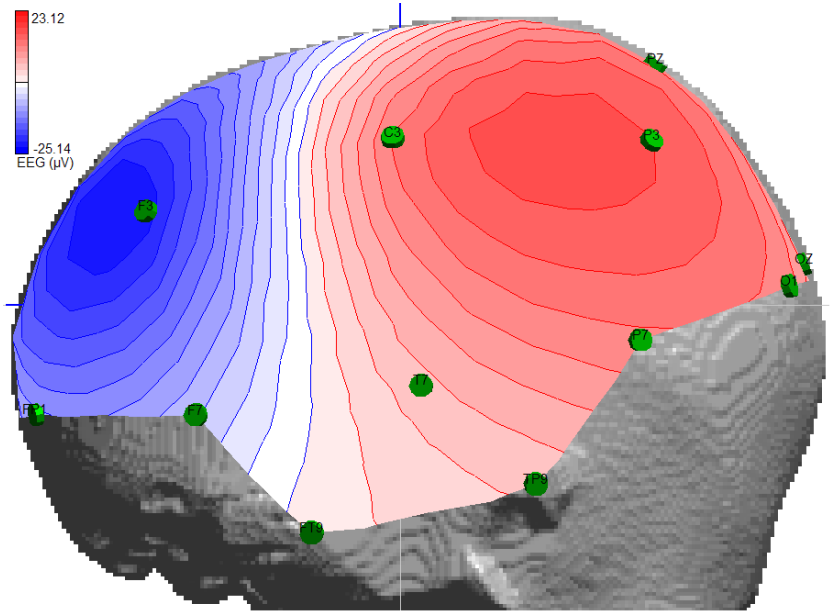
Finite element method (FEM) mesh generation



[Rullmann, Anwander, Dannhauer, Warfield, Duffy & Wolters, NeuroImage, 44(2), 2009]

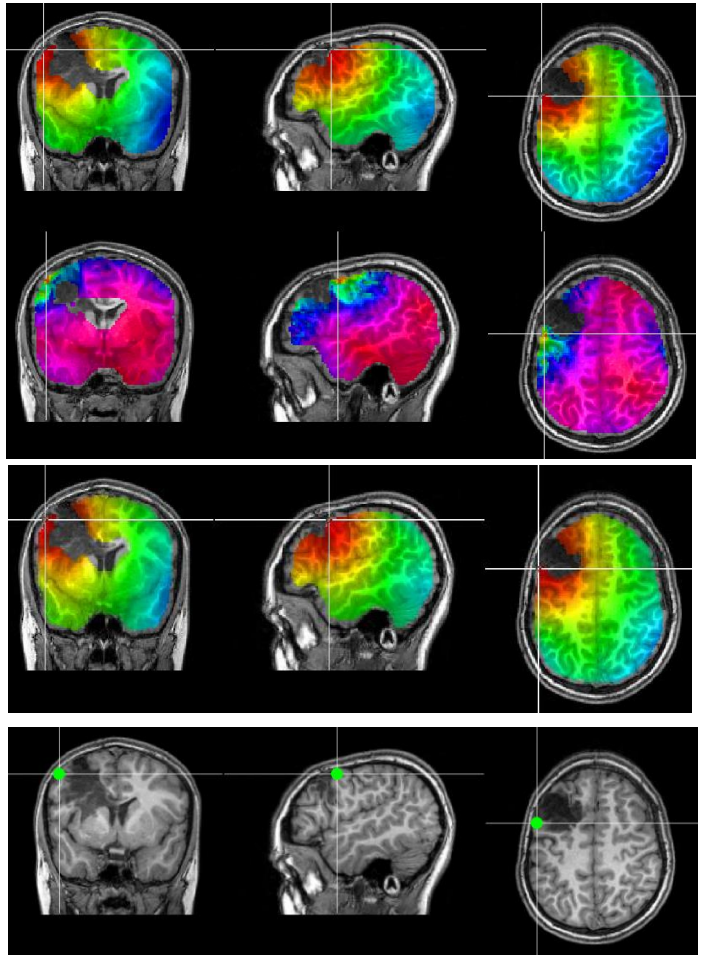
EEG preprocessing





[Rullmann, Anwander, Dannhauer, Warfield, Duffy & Wolters, NeuroImage, 44(2), 2009]

Presurgical EEG source analysis



Goal function scan
(Mosher, 1992; Knösche, 1997)

MNE
(Hämäläinen & Ilmoniemi, 1984)

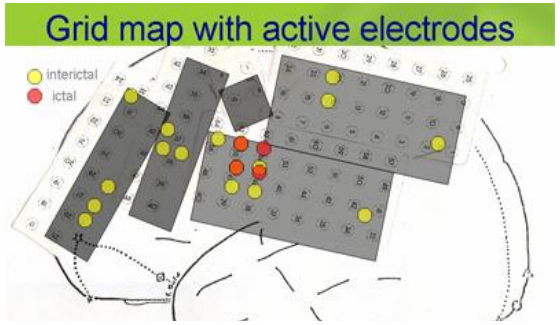
sLORETA
(Pascual-Marqui, 2002)

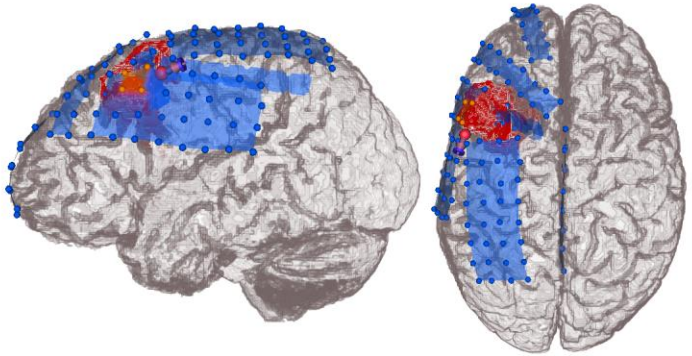
Dipole fit
(Scherg and von Cramon, 1985)

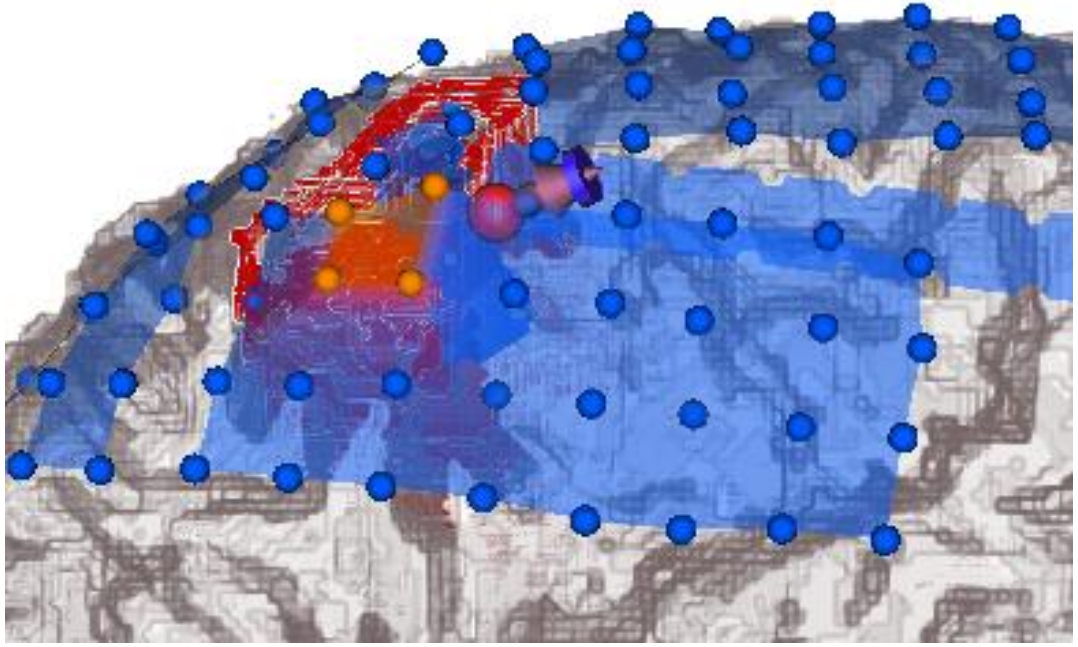
Result: Posterior to the lesion in lateral premotor cortex

[Rullmann, Anwander, Dannhauer, Warfield, Duffy & Wolters, NeuroImage, 44(2), 2009]

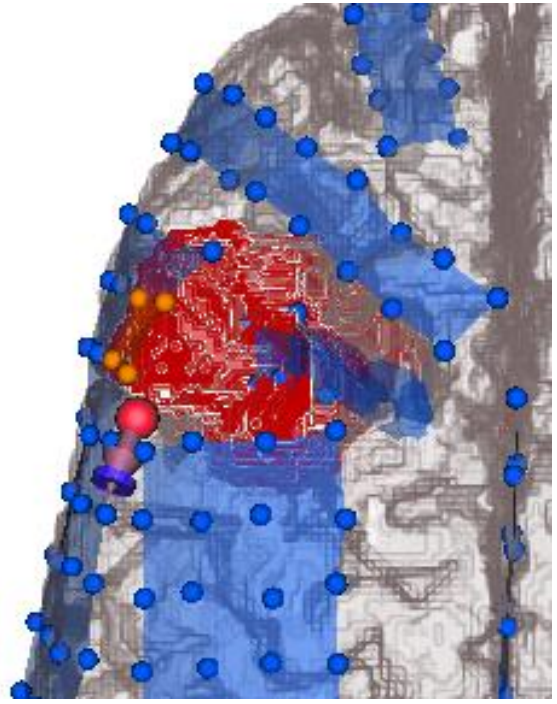
Validation using intracranial EEG







ECoG peaking electrodes



EEG dipole fit result

[Rullmann, Anwander, Dannhauer, Warfield, Duffy & Wolters, NeuroImage, 44(2), 2009]

Comparison with more homogenized head models

Table 4
Differences of dipole fit results in the volume conductor models of FE conductivity labeling section and the result using model 6CompAnisoBrain

Model	Loc. diff. (in mm)	Orient. diff. (in degree)	Rel. Mag. diff. (in percent)	GOF (in %)
6IsoComp	0.21	4	2.2	97.05
3IsoComp	8.97	18	19.7	96.59

Summary

- First study in highly-resolved (1mm) 6-compartment anisotropic head model plus tumor modeling using accurate and fast FEM-methods
- Significant localization and orientation differences to standard 3-compartment head model
- Recommendation to use different inverse approaches (“converging evidence”) for a more reliable detection of the epileptogenic focus
- Presurgical source localization was evaluated with post-surgical intracranial EEG: Only small differences, most probably due to craniotomy and resulting post-surgical brain shift
- Source orientation in posterior direction, i.e., in direction of the epileptogenic tissue, in agreement with (Salayev et al., 2006), who postulated this for central and interhemispheric epileptic activity

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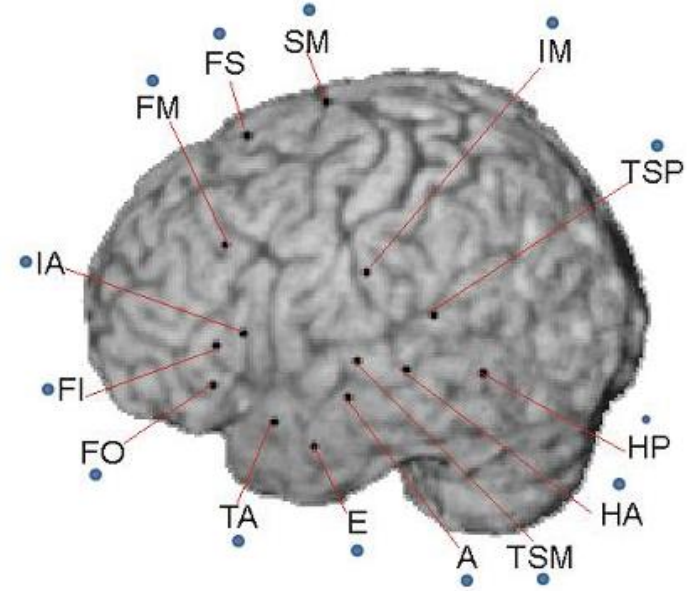
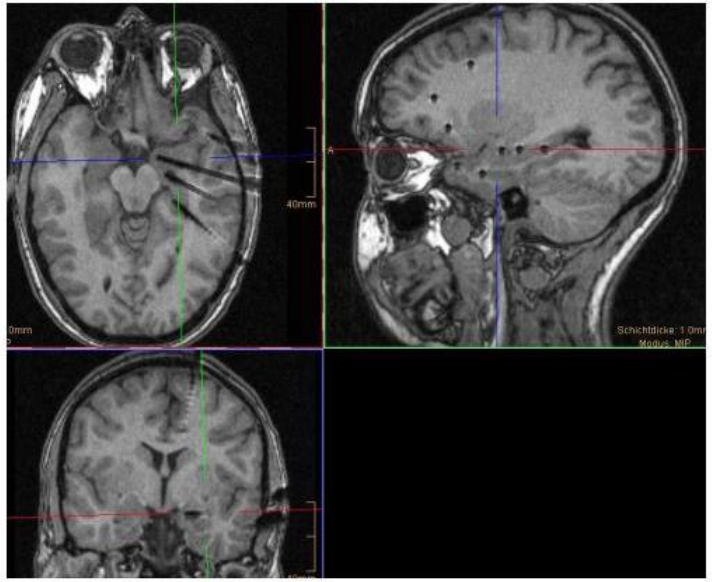
[Aydin, Vorwerk, Dümpelmann, Küpper, Kugel, Heers, Wellmer, Kellinghaus, Haueisen, Rampp, Stefan & Wolters, *PLOS ONE,* 2015]
[Aydin, Vorwerk, Küpper, Heers, Kugel, Galka, Hamid, Wellmer, Kellinghaus, Rampp & Wolters, *PLOS ONE,* 2014]

Patient history

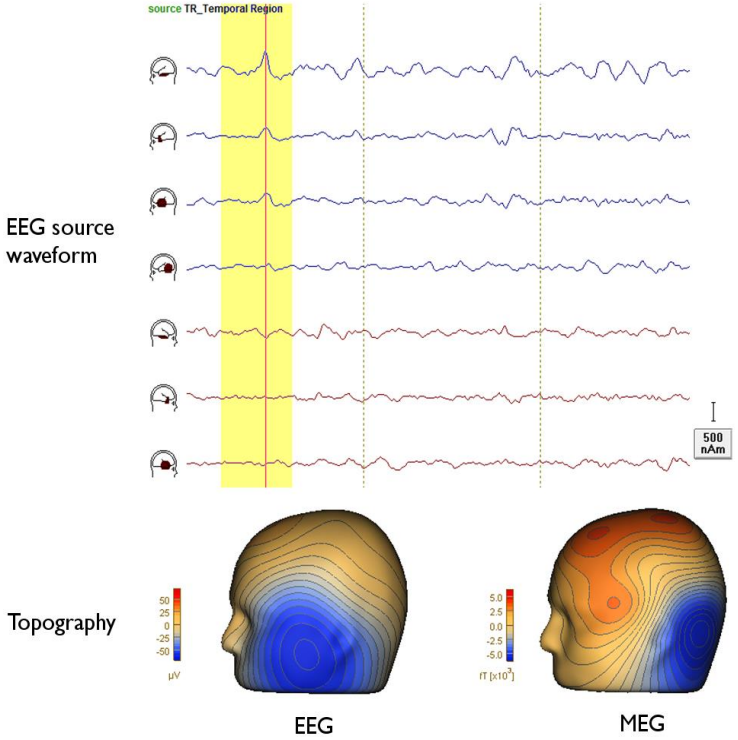


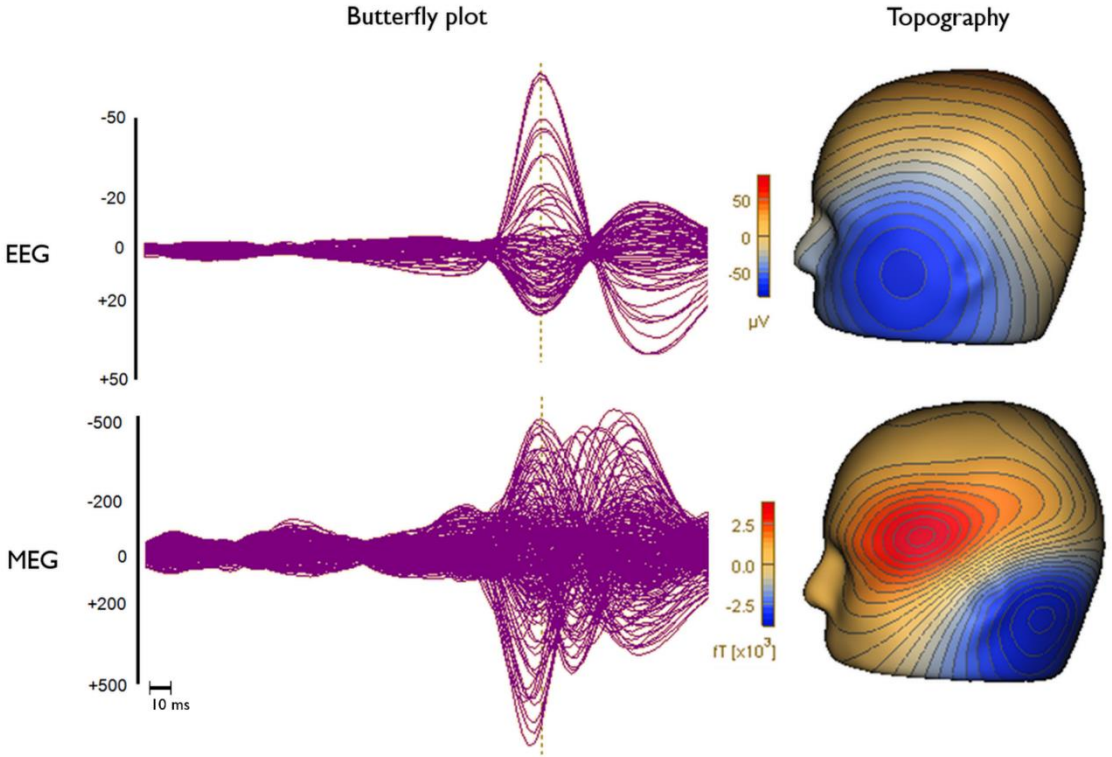


- 17 year old female suffering from pharmaco-resistant focal epilepsy,
- MRI Negative,
- FDG-PET: a diffuse and extended left fronto-temporal hypometabolism.
- Stereo-EEG: 14 intracerebral depth electrodes, 167 contacts

[Aydin, Vorwerk, Dümpelmann, Küpper, Kugel, Heers, Wellmer, Kellinghaus, Haueisen, Rampp, Stefan & Wolters, *PLOS ONE,* 2015]
[Aydin, Vorwerk, Küpper, Heers, Kugel, Galka, Hamid, Wellmer, Kellinghaus, Rampp & Wolters, *PLOS ONE,* 2014]

Spike detection





- Select 10 clear spikes and average
- Template matching
- Visual control
- 200 spikes

"Knowing where a spike or seizure originates from is more important than where it goes. The importance of MEG localization increases if it precedes or is at least synchronous with the correlate EEG spike." (Ebersole & Ebersole 2010)

[Aydin, Vorwerk, Dümpelmann, Küpper, Kugel, Heers, Wellmer, Kellinghaus, Haueisen, Rampp, Stefan & Wolters, *PLOS ONE,* 2015]
[Aydin, Vorwerk, Küpper, Heers, Kugel, Galka, Hamid, Wellmer, Kellinghaus, Rampp & Wolters, *PLOS ONE,* 2014]

Sub-averaging procedure

Av1	Av2	Av3
1	1,2	1,2,4
2	1,3	1,2,5
3	2,3	3,4,5
4	1,4	1,4,2
5	3,5	3,5,4

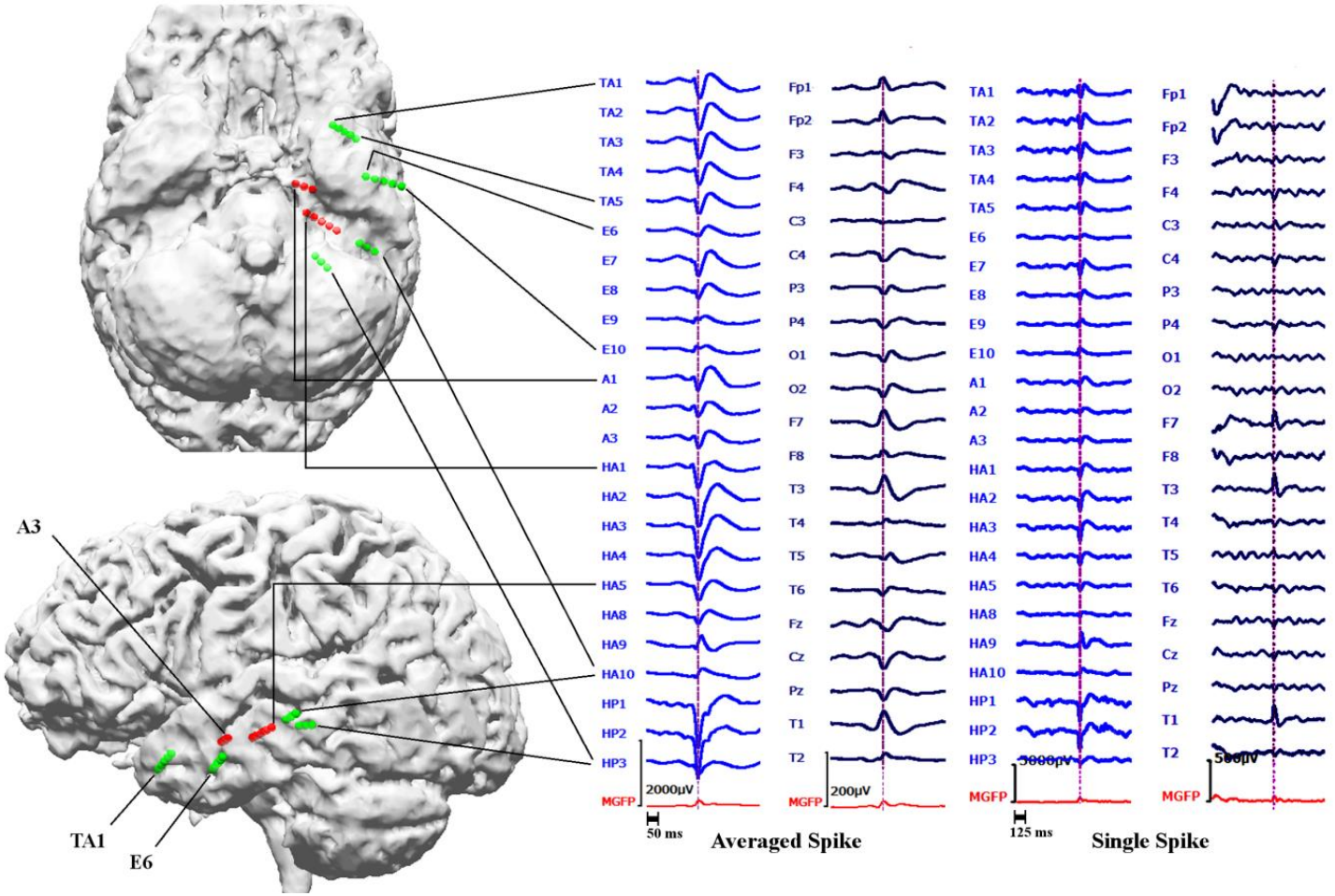
Same spike is not allowed to appear in the same sub-average twice.

- Random sub-averages of 200 single spikes:
  - 200 → Av1
  - 200 → Av5
  - 200 → Av10
  - 200 → Av15
  - 200 → Av20
  - 200 → Av25
  - 200 → Av30
  - 200 → Av35
  - 200 → Av40
  - 200 → Av45
  - 200 → Av50

For EEG, MEG, EMEG and 11 time instants
→ 72600 localization

[Aydin, Vorwerk, Dümpelmann, Küpper, Kugel, Heers, Wellmer, Kellinghaus, Haueisen, Rampp, Stefan & Wolters, *PLOS ONE,* 2015]

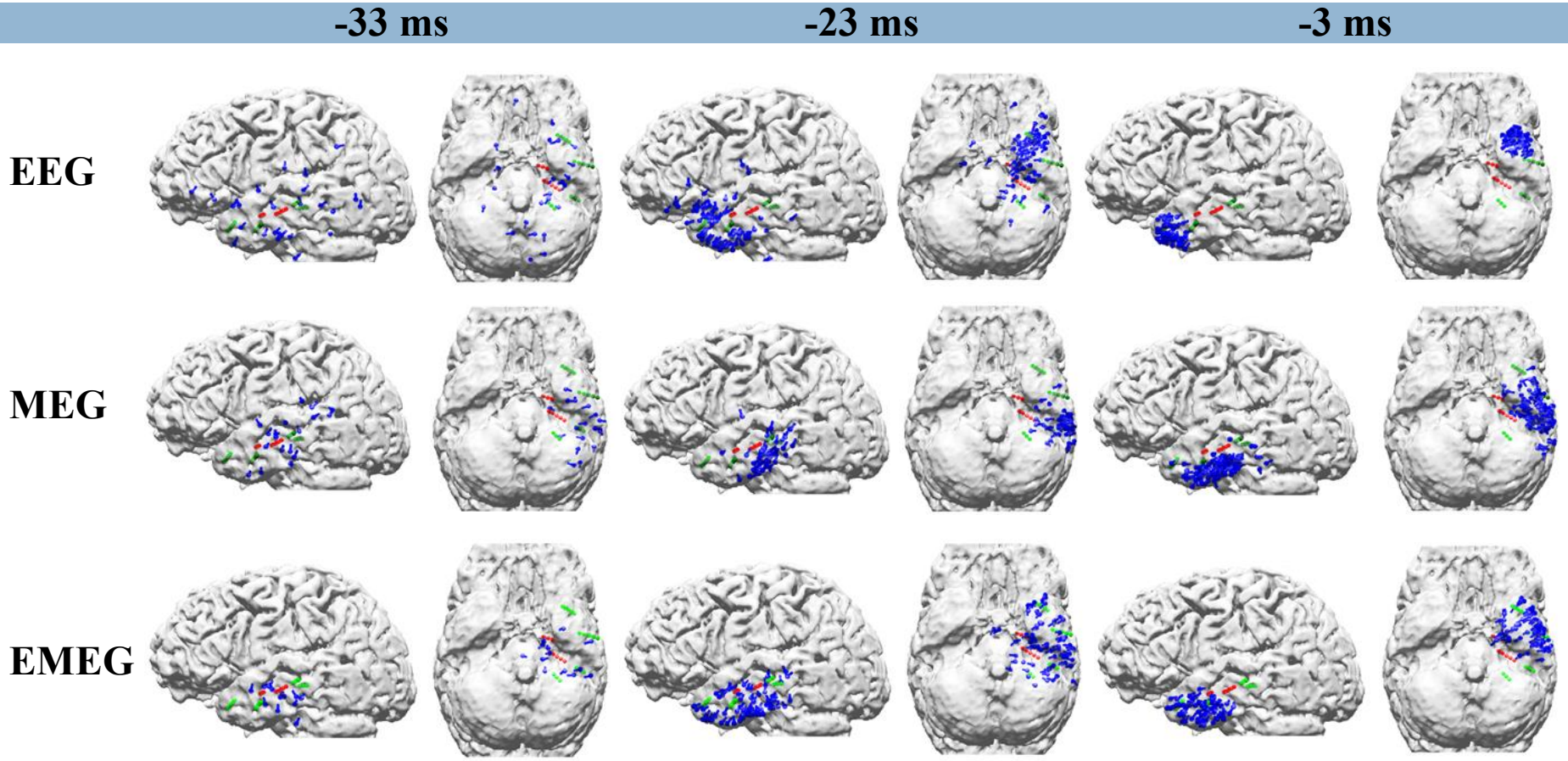
Example sEEG and EEG spikes



The union of green and red spheres shows the sEEG leads measuring interictal activity, and red spheres alone show the leads measuring seizure onset.

[Aydin, Vorwerk, Dümpelmann, Küpper, Kugel, Heers, Wellmer, Kellinghaus, Haueisen, Rampp, Stefan & Wolters, *PLOS ONE,* 2015]

Source reconstructions of Av10 at different instants of time



EEG, MEG and EMEG dipole scan peaks of Av10 for different time points. Blue dipoles illustrate the noninvasive reconstructions, both green and red spheres show the sEEG leads where frequent interictal activity can be measured, and only red spheres show seizure onset leads.

Structure

- Complementarity of EEG and MEG
- How to exploit this complementarity in combined EEG/MEG source analysis
- Focal epilepsy patient case studies
  - EEG reconstruction of ictal activity
  - Reconstruction of propagation pathway
  - Multifocal epilepsy
  - Epilepsy and pregnancy
  - Broca epilepsy
- Summary

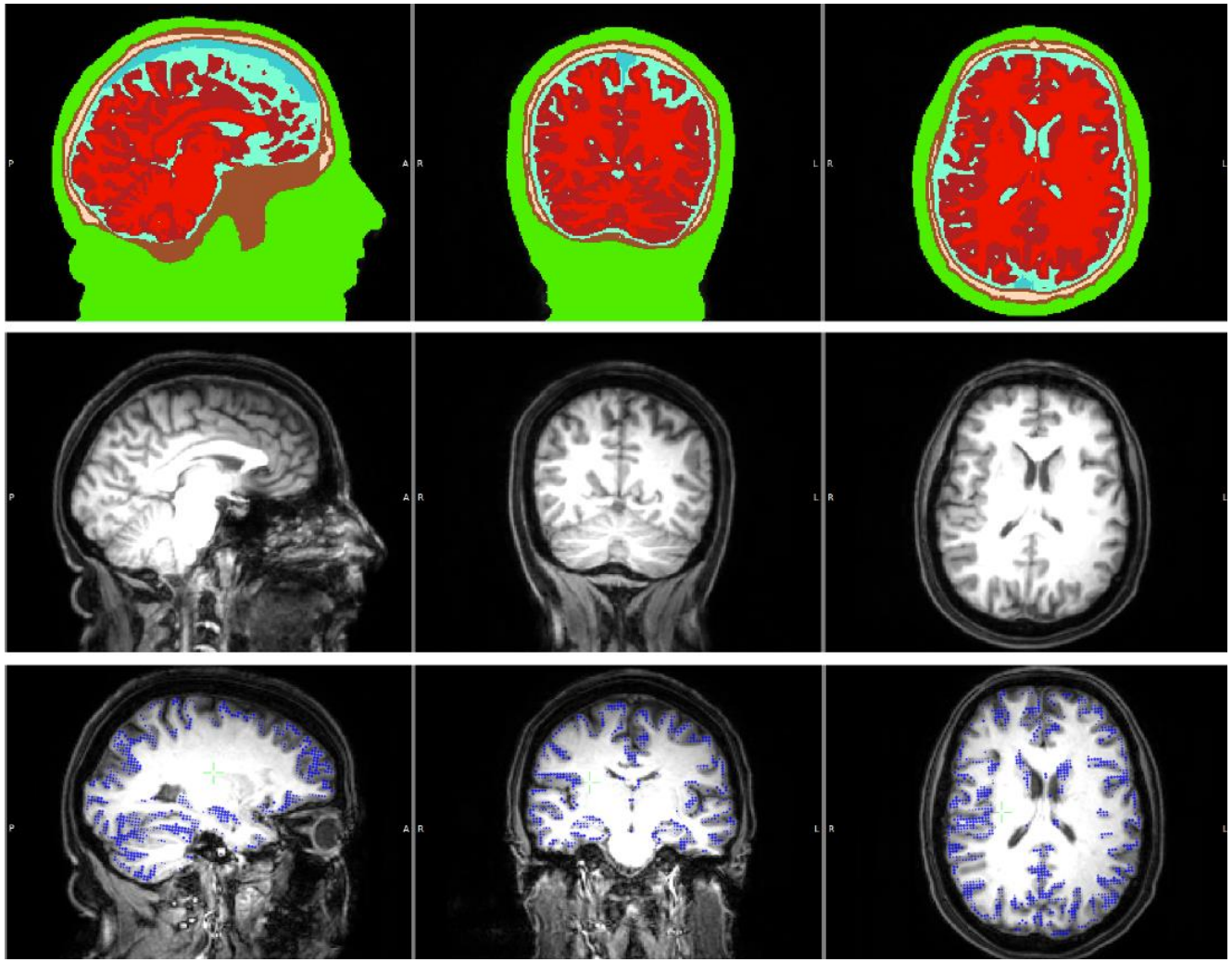
[Aydin, Rampp, Wollbrink, Kugel, Cho, Knösche, Grova, Wellmer & Wolters, *Brain Topography, 2017*]
[Ümit Aydin, *PhD dissertation in Biomed.Eng.*, 2015]

Patient

- 49 years old woman, suffering since 47 years under pharmaco-resistent focal epilepsy
- 8 different drugs and still 100-200 seizures per month
- Seizure-semiology: Tingling in right anterior chest-area, rising nausea, loss of conscience, tonic and hypermotoric movements of right arm and leg

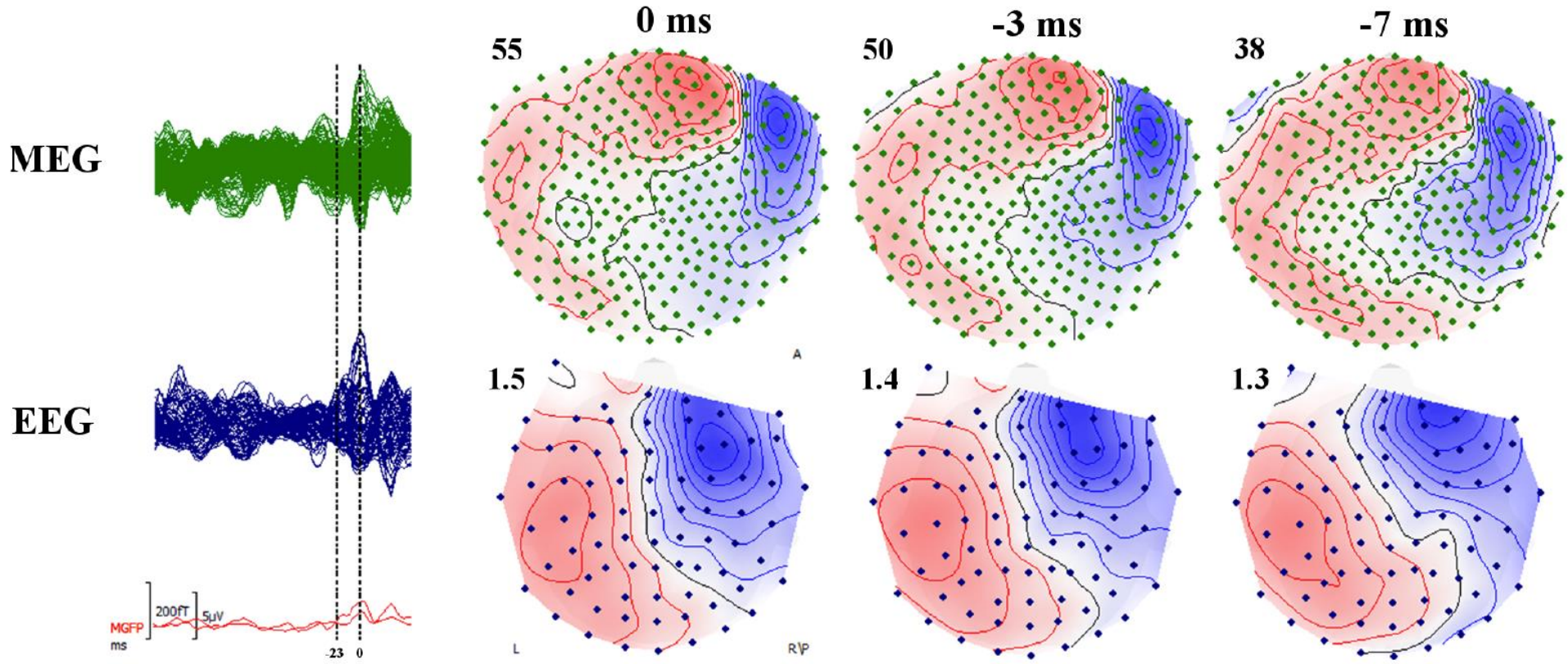
[Aydin, Rampp, Wollbrink, Kugel, Cho, Knösche, Grova, Wellmer & Wolters, *Brain Topography, 2017*]
[Ümit Aydin, *PhD dissertation in Biomed.Eng.*, 2015]

Skull-conductivity calibrated realistic head model and cortical source space



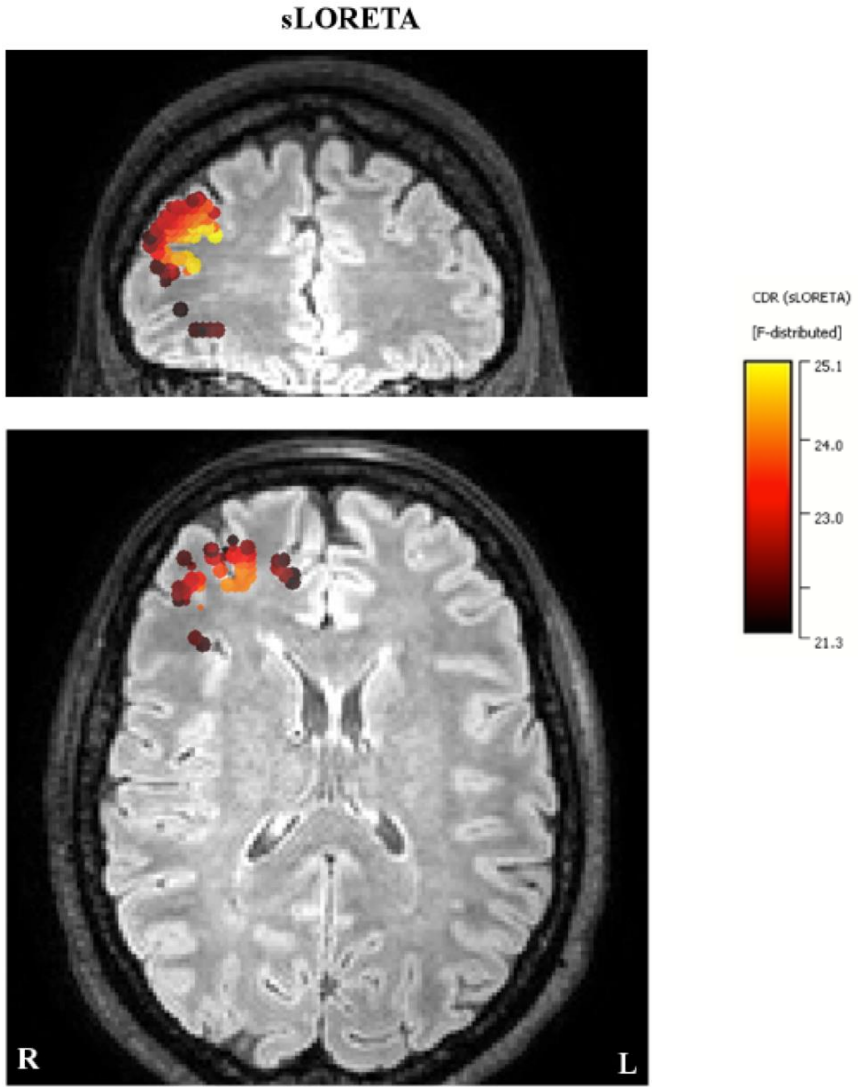
[Aydin, Rampp, Wollbrink, Kugel, Cho, Knösche, Grova, Wellmer & Wolters, *Brain Topography, 2017*]
[Ümit Aydin, *PhD dissertation in Biomed.Eng.*, 2015]

10 averaged spikes at maximum global field power: Time-point 0 ms



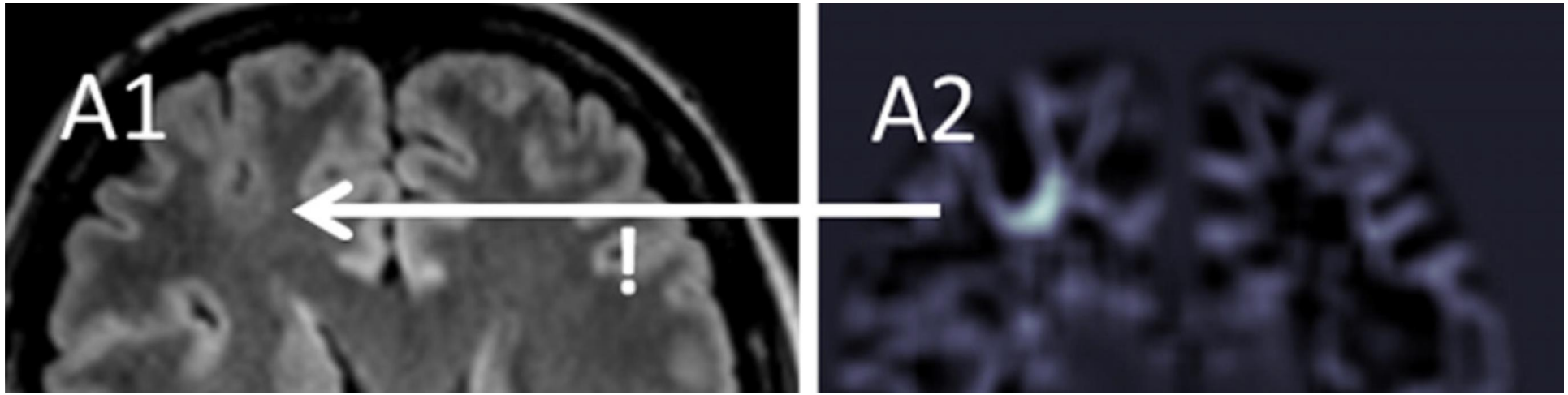
[Aydin, Rampp, Wollbrink, Kugel, Cho, Knösche, Grova, Wellmer & Wolters, *Brain Topography, 2017*]
[Ümit Aydin, *PhD dissertation in Biomed.Eng.*, 2015]

EMEG source analysis at -7 ms (radiological convention)



[Aydin, Rampp, Wollbrink, Kugel, Cho, Knösche, Grova, Wellmer & Wolters, *Brain Topography, 2017*]
[Ümit Aydin, *PhD dissertation in Biomed.Eng.*, 2015]

3D-FLAIR 3T-MRI and morphometric analysis

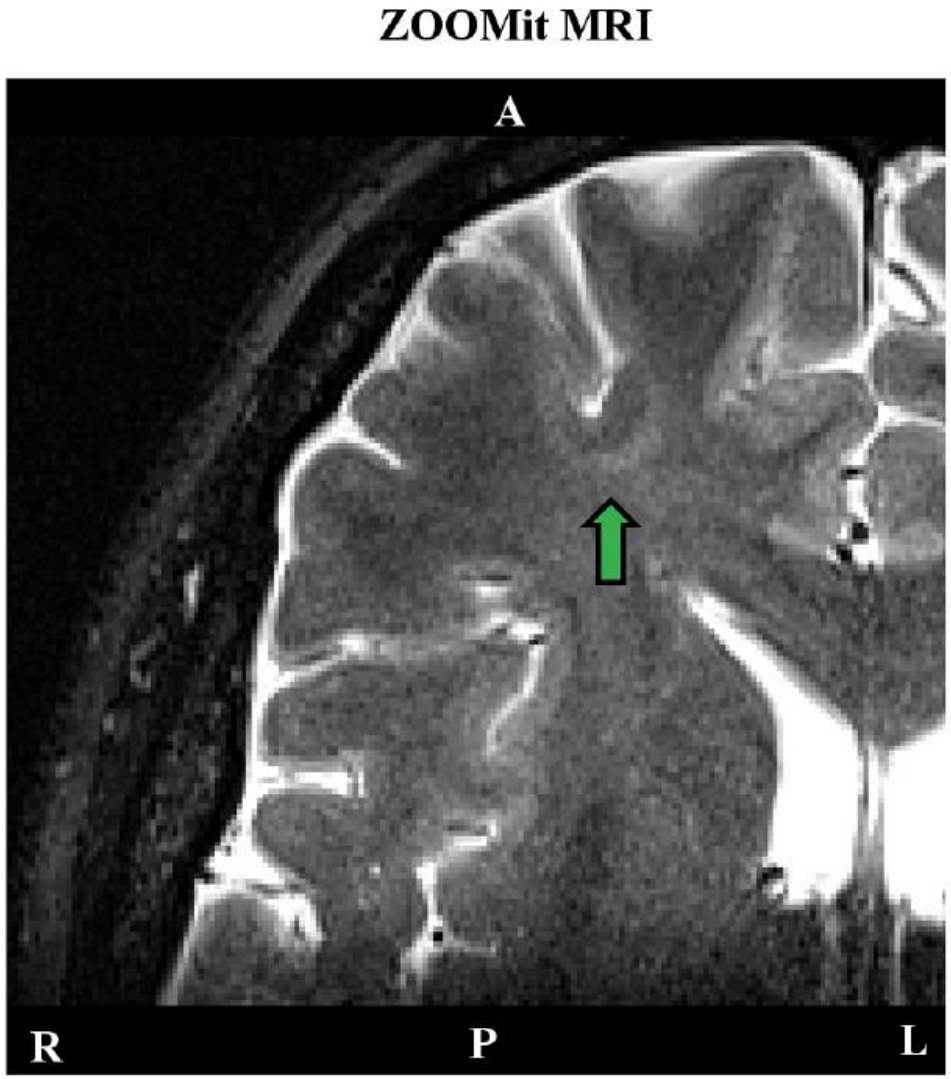


Retrospectively visible in 3D-FLAIR a subtle right-frontal „bottom of sulcus“ focal cortical dysplasia (FCD)...

...that was confirmed in morphometric analysis (MAP07: Huppertz et al., 2005)...

[Aydin, Rampp, Wollbrink, Kugel, Cho, Knösche, Grova, Wellmer & Wolters, *Brain Topography, 2017*]
[Ümit Aydin, *PhD dissertation in Biomed.Eng.*, 2015]

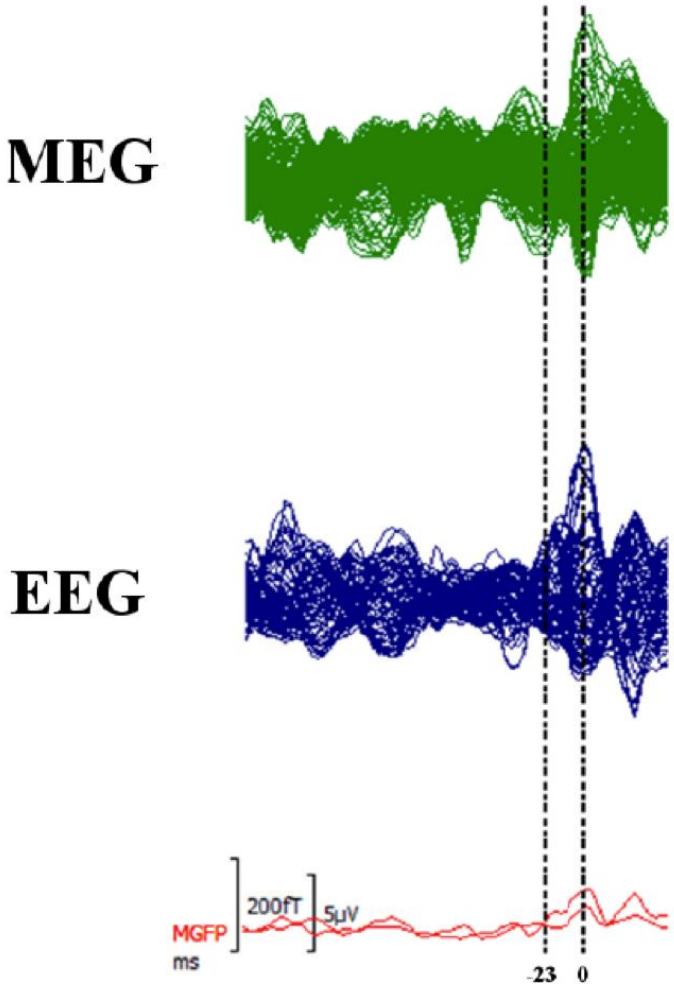
ZOOMit MRI in pre-localized ROI at -7 ms

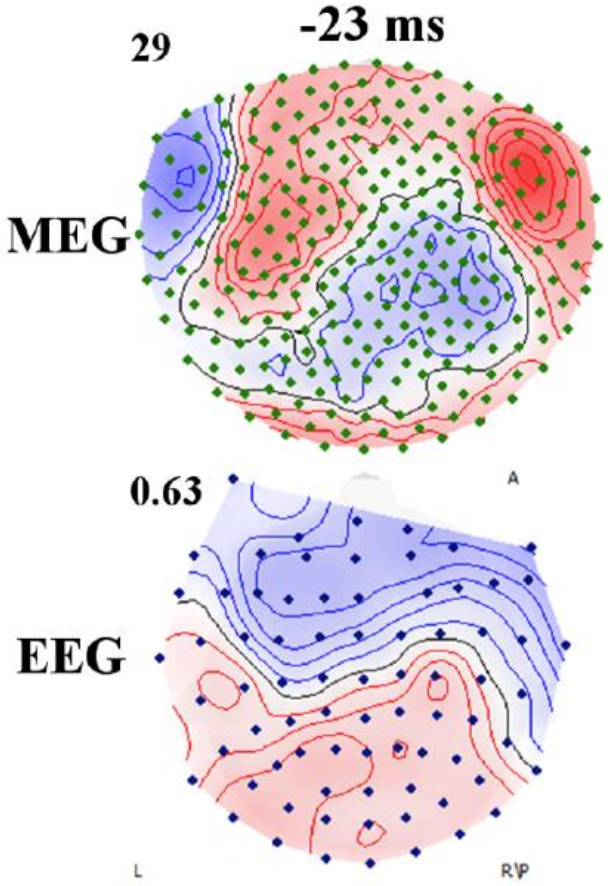


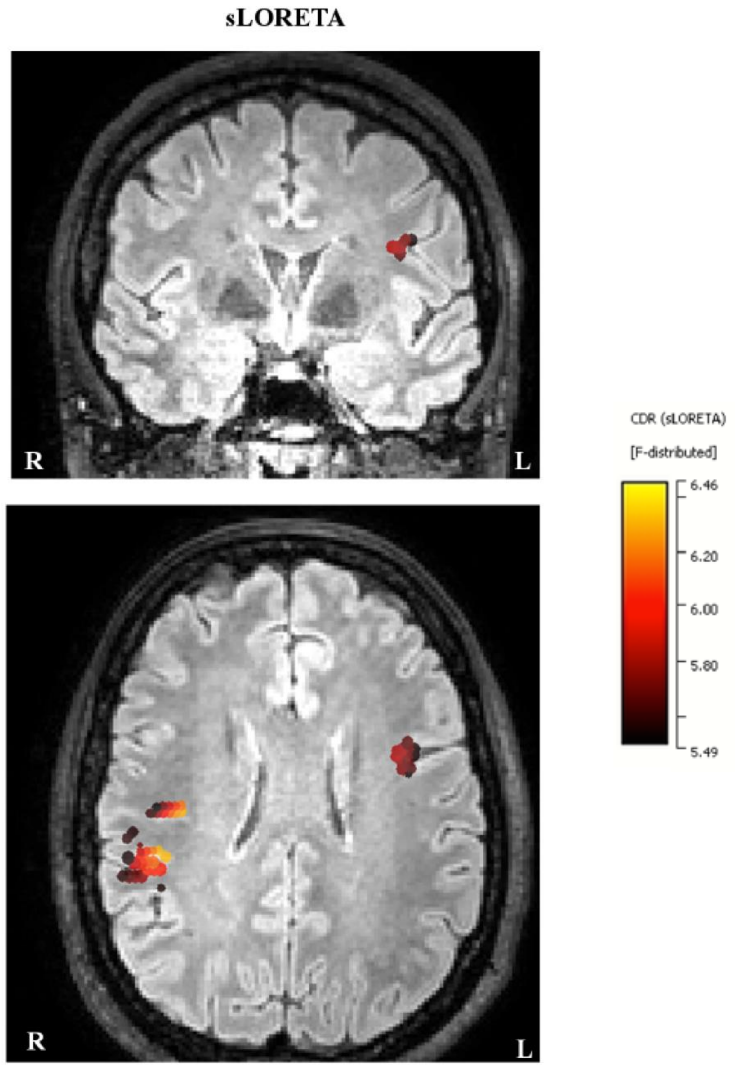
...as well as when using a 3T MRI T2 ZOOMit „parallel transmit“ sequence with 0.5 mm isotropic resolution (Siemens, Erlangen; Riffel et al., 2015).

[Aydin, Rampp, Wollbrink, Kugel, Cho, Knösche, Grova, Wellmer & Wolters, *Brain Topography, 2017*]
[Ümit Aydin, *PhD dissertation in Biomed.Eng.*, 2015]

MEG and EEG topographies and EMEG source analysis at -23 ms

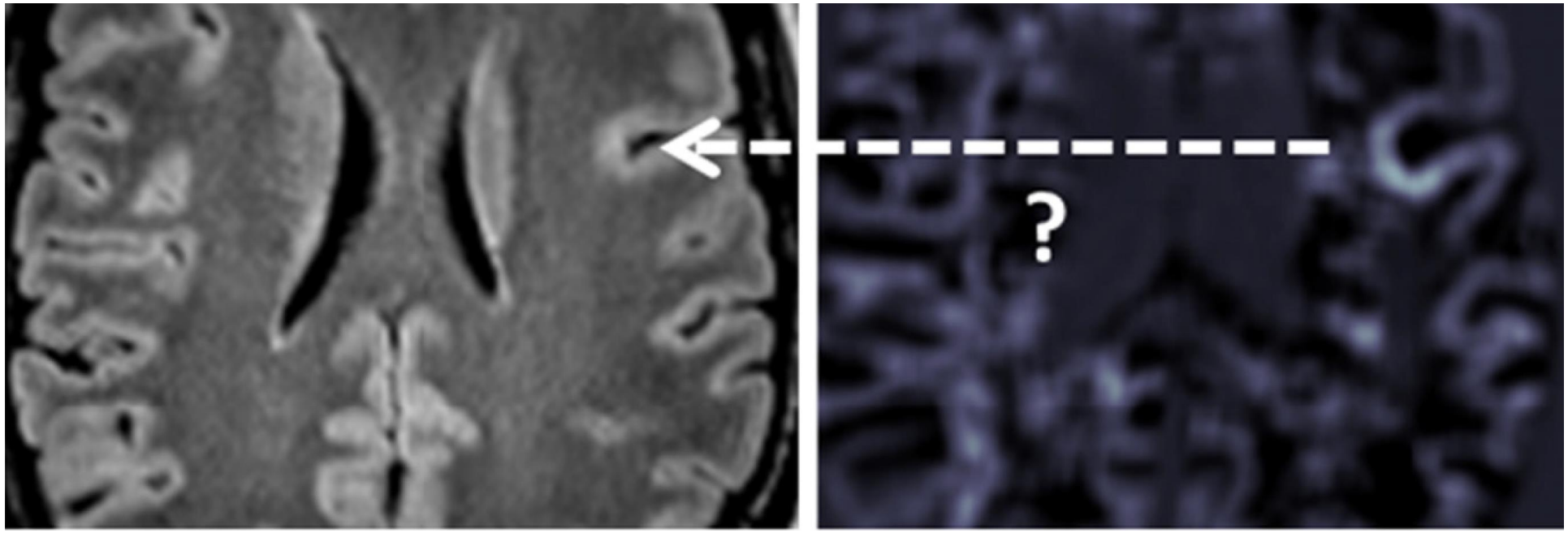






[Aydin, Rampp, Wollbrink, Kugel, Cho, Knösche, Grova, Wellmer & Wolters, *Brain Topography, 2017*]
[Ümit Aydin, *PhD dissertation in Biomed.Eng.*, 2015]

3T MRI (3D-FLAIR) and morphometric analysis

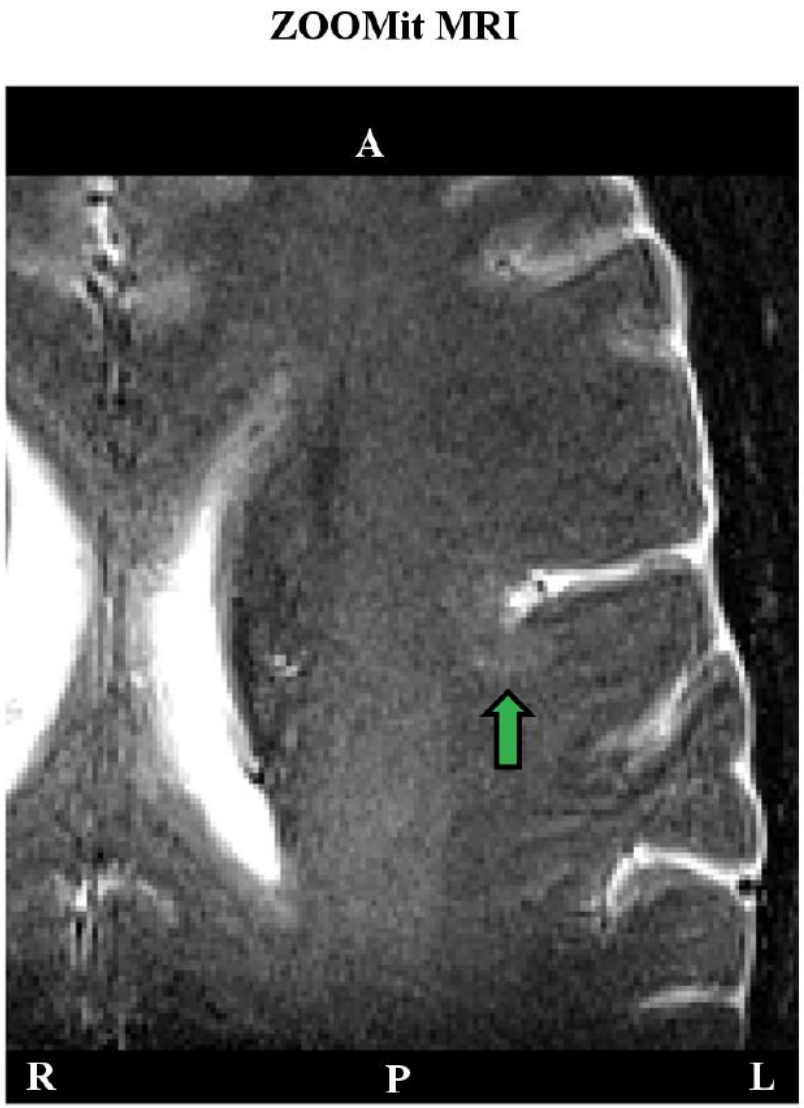


Even retrospectively in 3D-FLAIR hardly visible „left supra-insular “ FCD...

...that could also only weakly be confirmed by morphometric analysis (MAP07: Huppertz et al., 2005)...

[Aydin, Rampp, Wollbrink, Kugel, Cho, Knösche, Grova, Wellmer & Wolters, *Brain Topography, 2017*]
[Ümit Aydin, *PhD dissertation in Biomed.Eng.*, 2015]

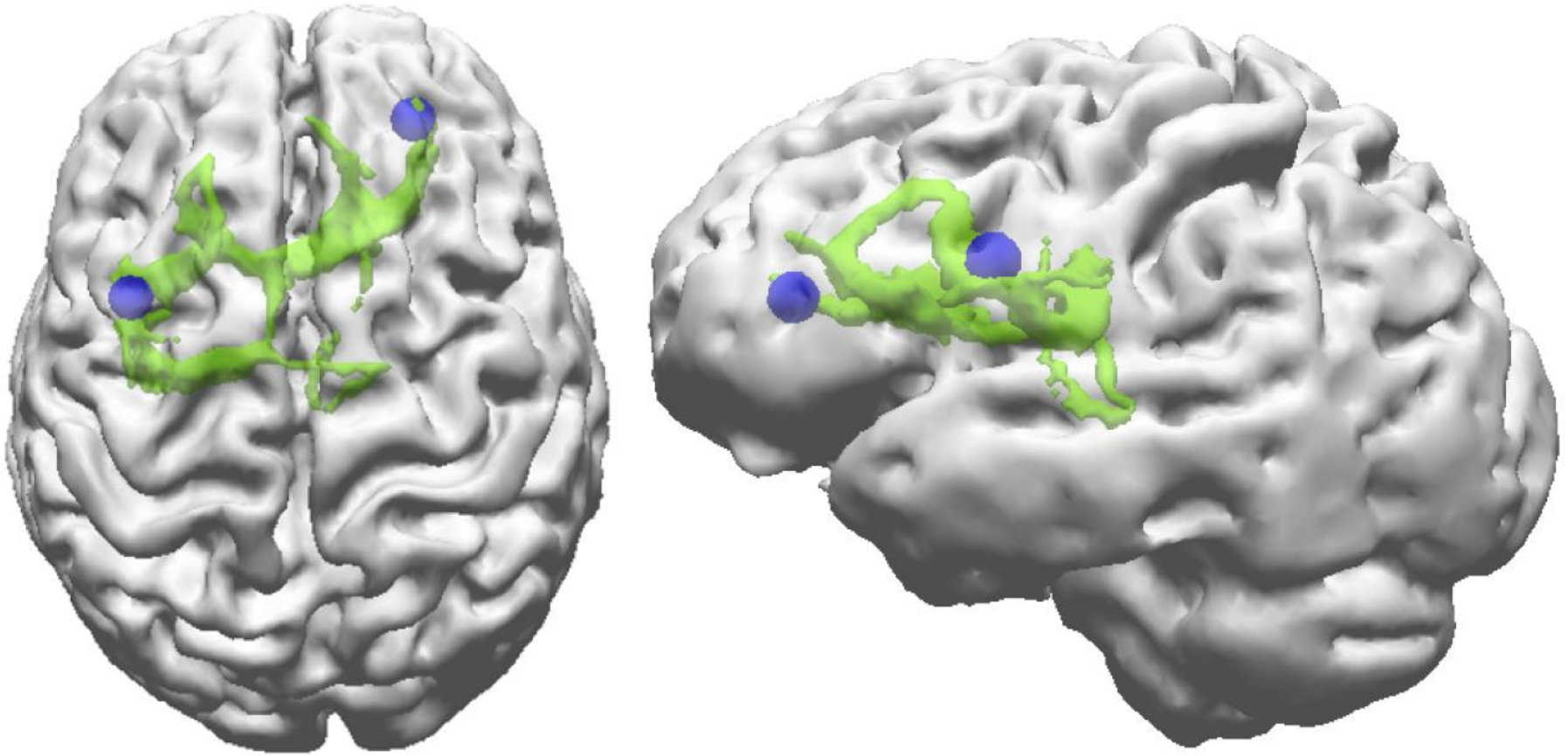
ZOOMit MRI in pre-localized ROI at -23 ms (radiological convention)



..., but a little bit better visible in the T2 ZOOMit.

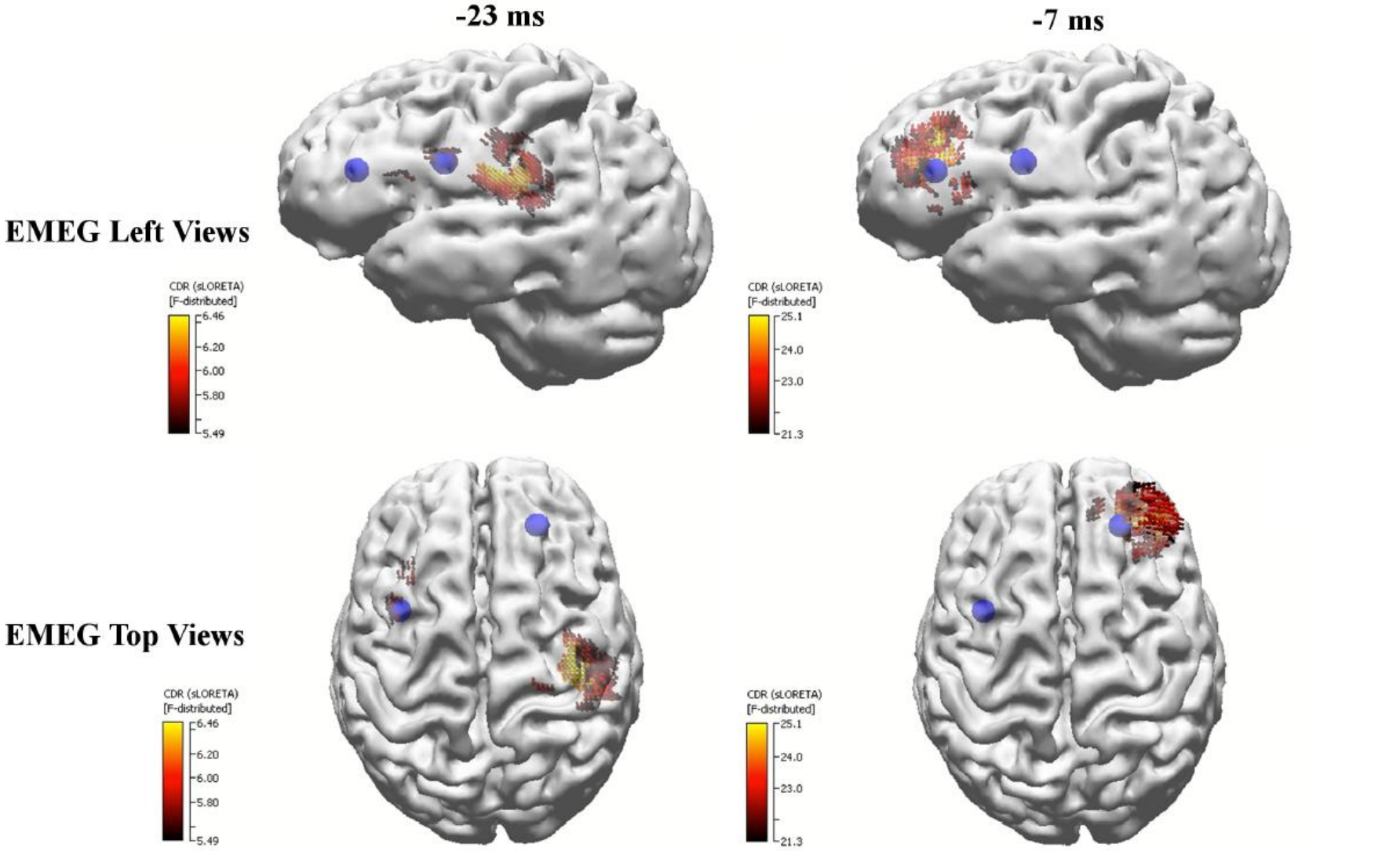
[Aydin, Rampp, Wollbrink, Kugel, Cho, Knösche, Grova, Wellmer & Wolters, *Brain Topography, 2017*]
[Ümit Aydin, *PhD dissertation in Biomed.Eng.*, 2015]

DTI tractography between both localized FCDs



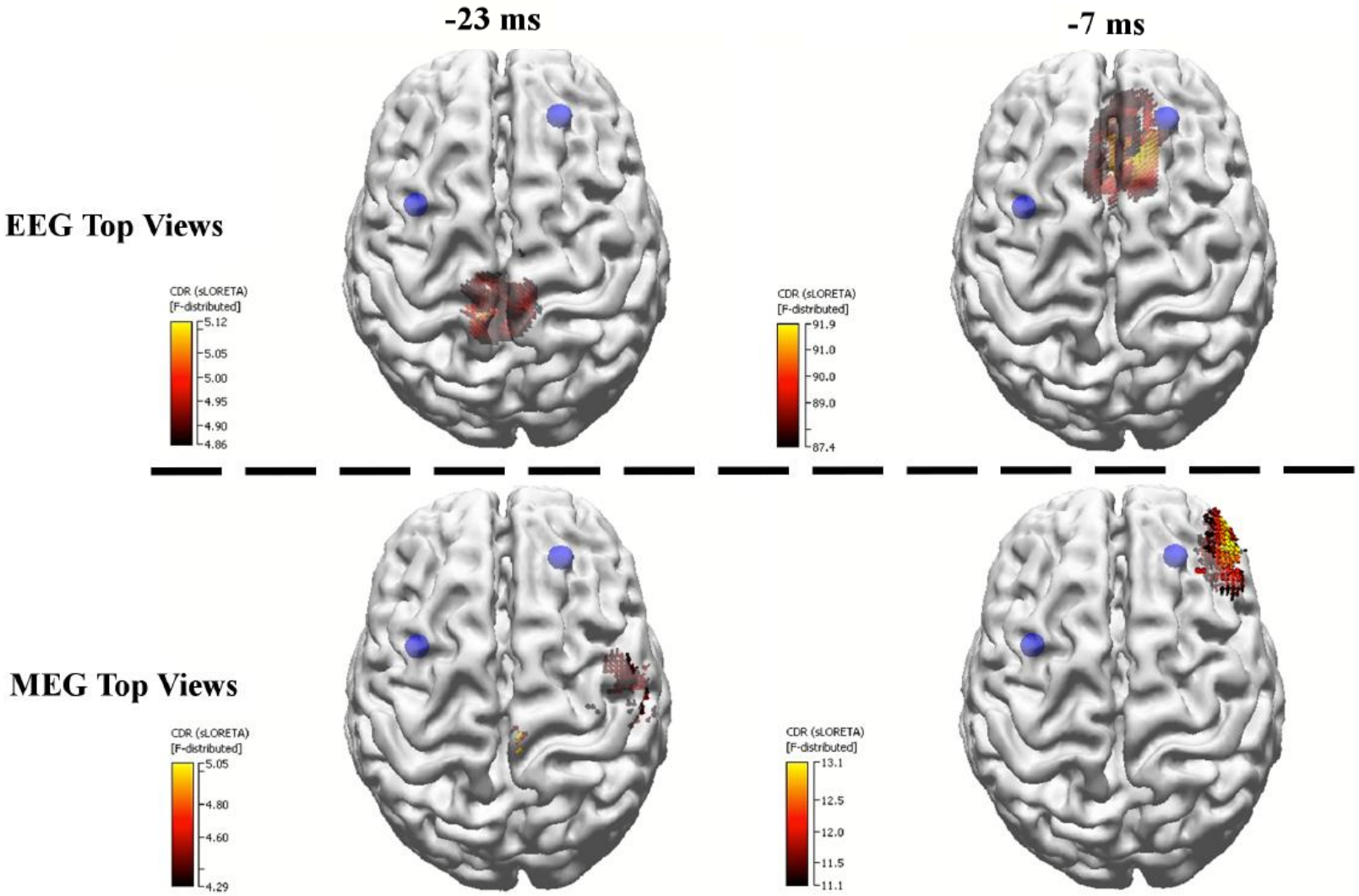
[Aydin, Rampp, Wollbrink, Kugel, Cho, Knösche, Grova, Wellmer & Wolters, *Brain Topography, 2017*]
[Ümit Aydin, *PhD dissertation in Biomed.Eng.*, 2015]

Overview: EMEG source analysis



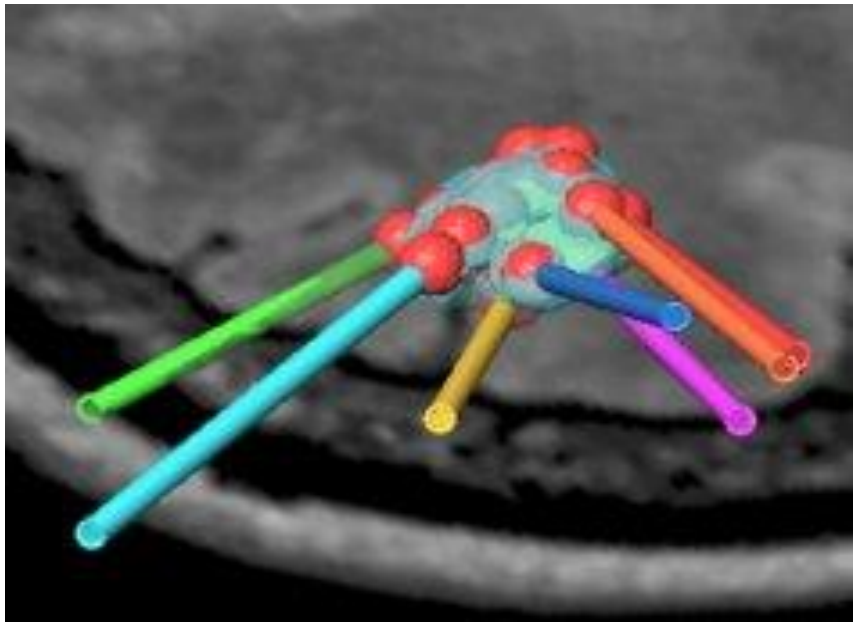
[Aydin, Rampp, Wollbrink, Kugel, Cho, Knösche, Grova, Wellmer & Wolters, *Brain Topography, 2017*]
[Ümit Aydin, *PhD dissertation in Biomed.Eng.*, 2015]

Information in single modality EEG or MEG too noisy



[Wellmer, Parpalev, Rampp, Popkirov, Kugel, Aydin, Wolters, von Lehe, Voges, *Epilepsy Research*, 2016]

Radio-frequency thermo-coagulation (RFTC)



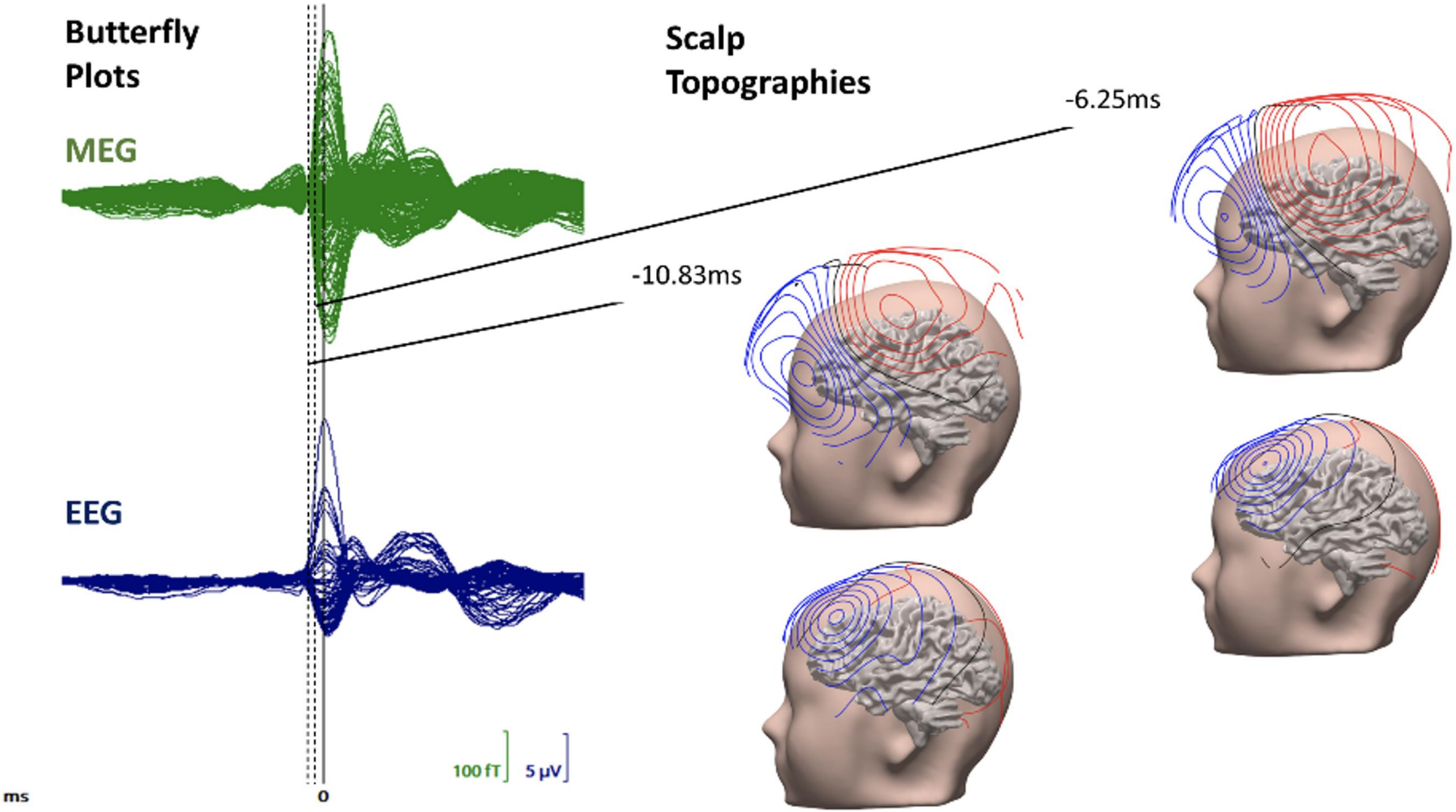
Patient got RFTC in left supra-insular FCD and positive outcome supported our diagnosis

Structure

- Complementarity of EEG and MEG
- How to exploit this complementarity in combined EEG/MEG source analysis
- Focal epilepsy patient case studies
  - EEG reconstruction of ictal activity
  - Reconstruction of propagation pathway
  - Multifocal epilepsy
  - Broca epilepsy
  - Epilepsy and pregnancy
- Summary

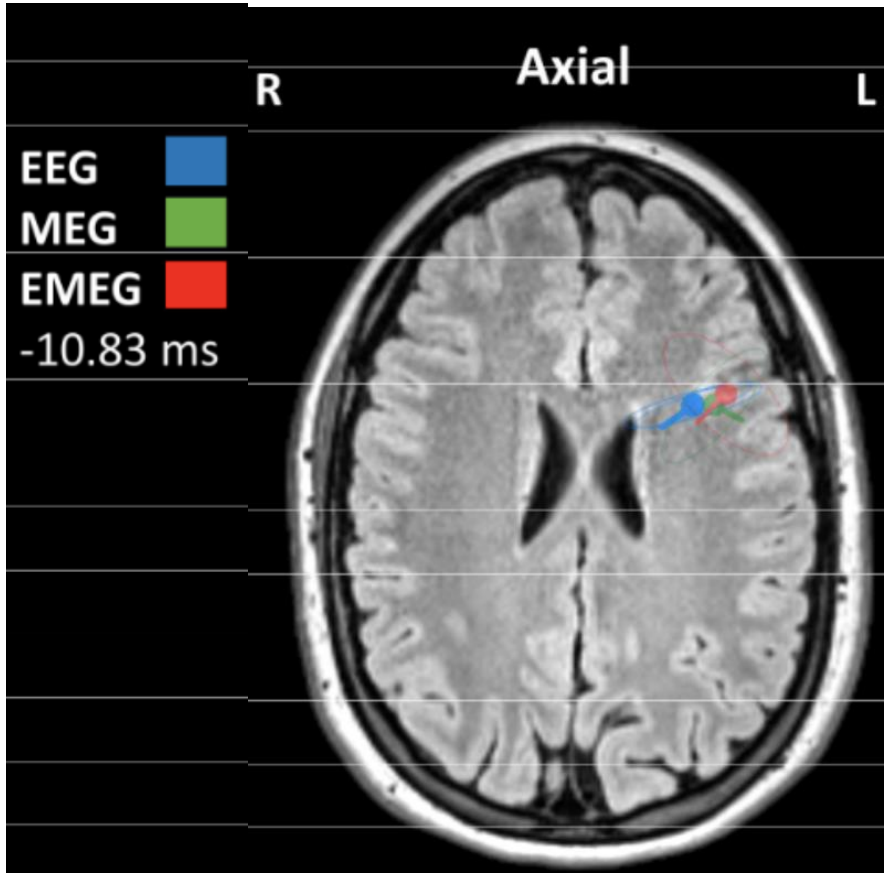
[Antonakakis, Kaiser, Rampp, Kovac, Wiendl, Stummer, Gross, Kellinghaus, Khaleghi-Ghadiri, Möddel, Wolters, *Brain Stimulation*, 2024]

PerEpi non-invasive diagnosis: EEG and MEG of averaged 1050 interictal epileptiform discharges (IEDs)

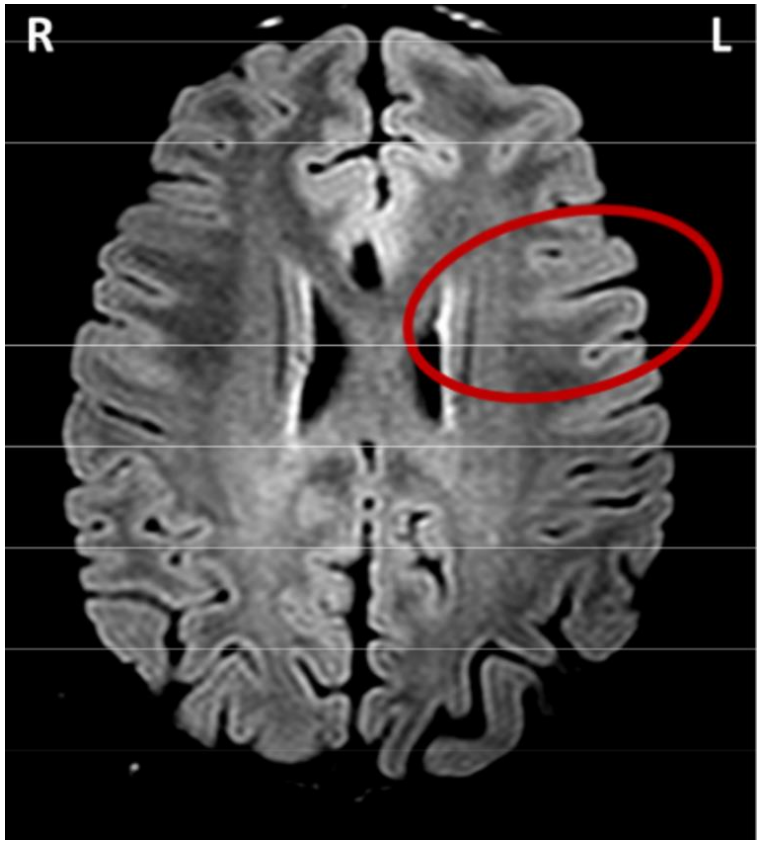


[Antonakakis, Kaiser, Rampp, Kovac, Wiendl, Stummer, Gross, Kellinghaus, Khaleghi-Ghadiri, Möddel, Wolters, *Brain Stimulation*, 2024]

EEG and MEG source analysis of the subaveraged IEDs



Single dipole scan centroid and spread spheres for EEG/MEG/EMEG of >1000 subaverages of 10 spikes



Retrospective MRI analysis showed an FCD type IIb

- Source reconstruction led to detection of focal cortical dysplasia (FCD) of type IIb, which was not described earlier by the neuroradiologist
- Lesion close to Broca's area

Structure

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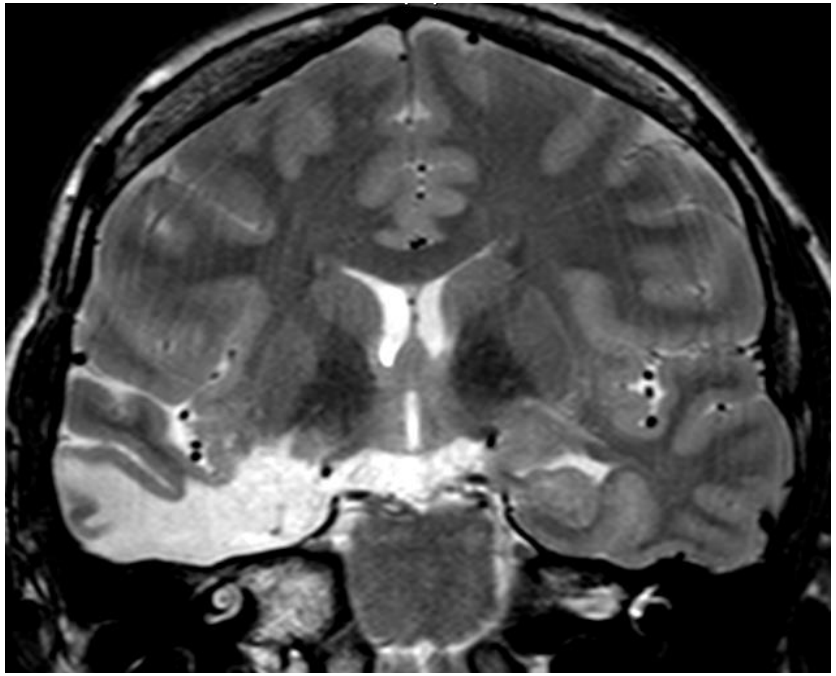
- Summary

Patientin

- 28 Jahre alte Frau, pharmako-resistente Epilepsie seit dem 8.Lebensjahr (2-3 x /Nacht, selten tagsüber)
- Anfallstyp 1 (häufig): Rumpfvorbeugung, Hin- und Herwerfen des Oberkörpers, Vokalisationen für 30 – 60 Sek.
- Anfallstyp 2 (seltener): Bewegungsarrest, Starren, Schmatzen
- Nicht-invasive prächirurgische Diagnostik 2000 an einem großen/bekannten Epilepsiezentrum (14. LJ):
  - MRT: leichtgradige Hippokampussklerose rechts
  - Interiktuale Epilepsie-typische Potentiale rechts temporal
  - EEG-Anfallsbeginn rechts temporal

Neurochirurgie 2000 (nicht am UKM)

- Anteriore Temporallappenresektion rechts inkl. Amygdala-Hippokampektomie (14. LJ / 2000)
- Post-operativ anfallsfrei bzgl. Anfallstyp 2
- Anfallstyp 1 unverändert

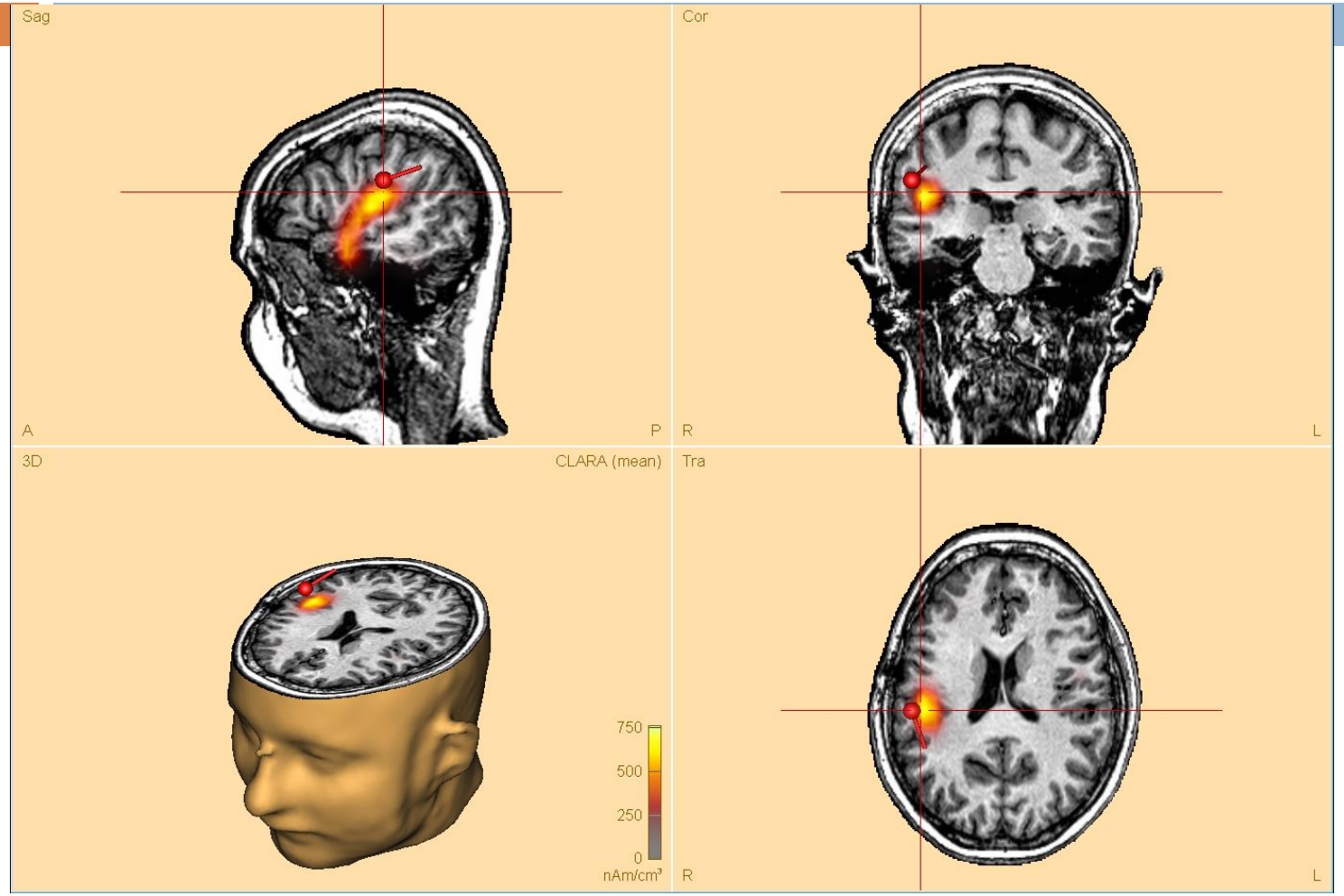


Ab 2014 am UKM

EPILEPSIEZENTRUM
Münster-Osnabrück

- Im Alter von 28.Jahren: Verheiratet und Kinderwunsch, aber bei der hohen Dosierung von Valproat ca. 10% Risiko für kindliche Fehlbildungen
- 2x Versuch, Valproat auszuschleichen scheiterte

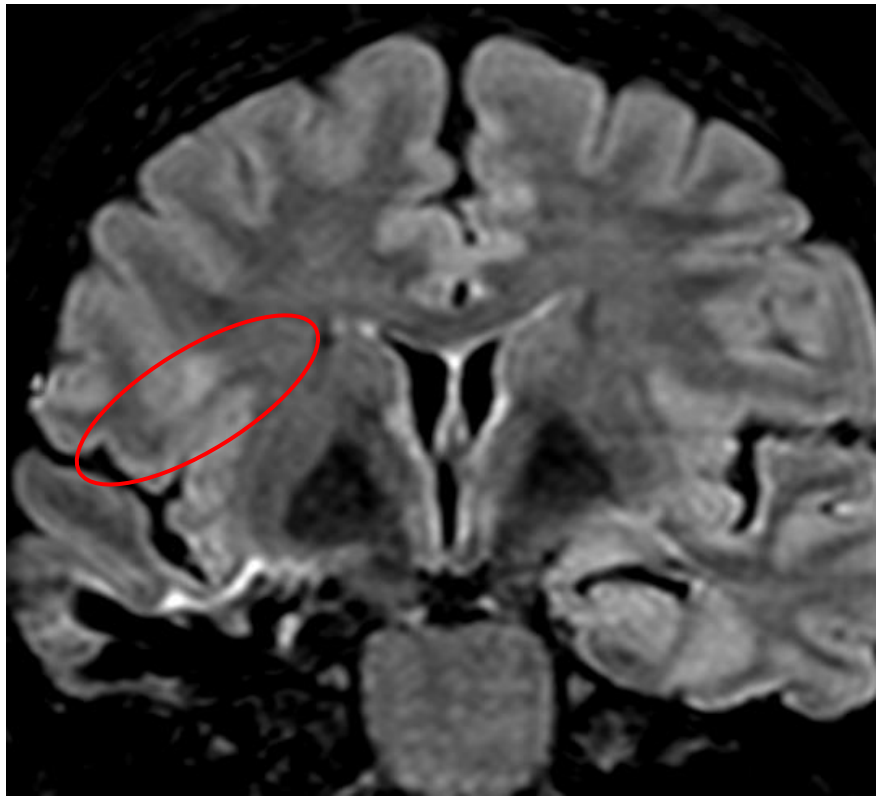
Nicht-invasive prächirurgische Diagnostik 2014

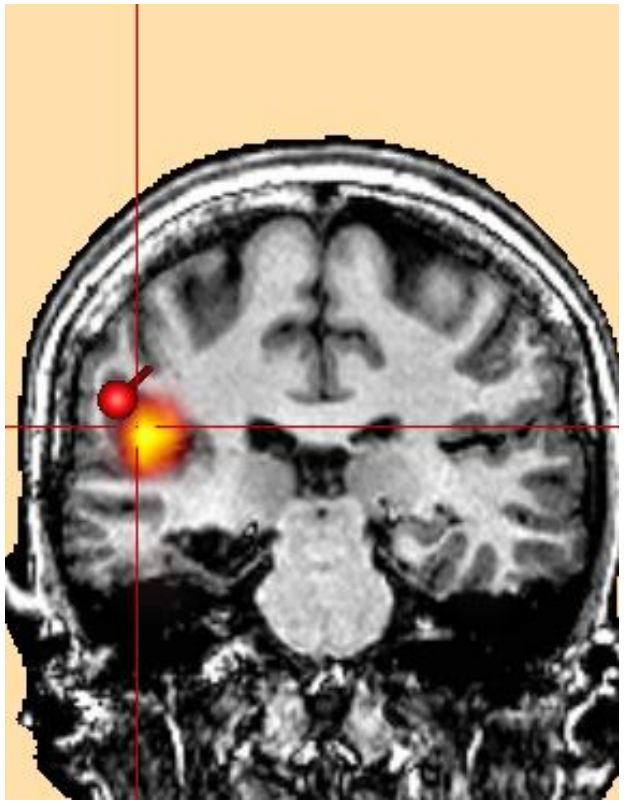


MEG-Quellenanalyse aus 9 gemittelten MEG-Spikes am Spike-Onset rechts-fronto-lateral organisiert

- Dipol-Fit (roter Pfeil)
- Stromdichte-Rekonstruktion (gelb-rotes Patch)

Nicht-invasive prächirurgische Diagnostik 2014

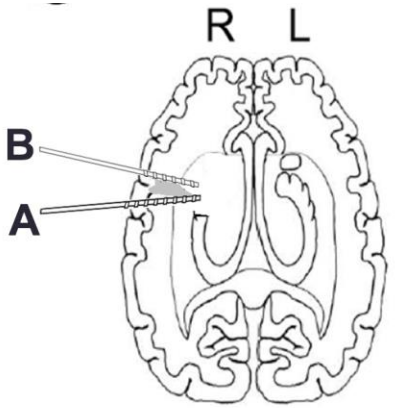


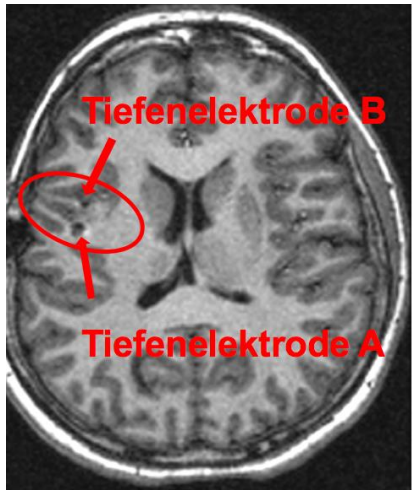


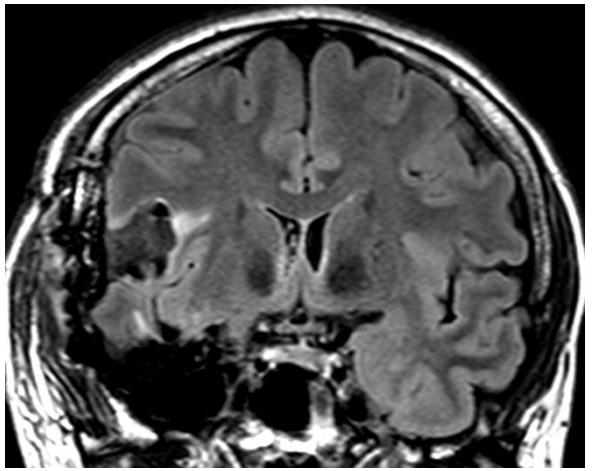
MRT (3T, 3D FLAIR): mögliche FCD rechts fronto-lateral

Neurochirurgie 2015

- Invasive Diagnostik mit 2 Tiefenelektroden:
  Anfallsbeginn in der FCD
- Wada-Test (Injektion eines Narkose-Mittels in die Hirnschlagader): Sprachbereiche nicht betroffen
- Empfehlung zur erweiterten Läsionektomie
- Navigationsgestützte Resektion 07/2015
- Histologie: FCD Typ II B







Postoperatives Ergebnis

- Kein klinisch-neurologisches Defizit
- Post-operativ komplett anfallsfrei
- Da Valproat bereits vor OP abgesetzt wurde, stand einer möglichen Schwangerschaft nichts mehr im Wege

- Emilia *07/2016

Operation statt Medikamente bei Epilepsie und Schwangerschaft

Das Baby kann kommen

Epilepsie-Therapie bei Schwangeren

MÜNSTER. Nicht durchschlafen können, das wird für die werdende Mutter Sonja Plonka nichts Neues sein. Doch bisher war es kein Babygeschrei, das die 29-Jährige um den Schlaf brachte. Drei bis acht epileptische Anfälle plagten sie seit ihrem sechsten Lebensjahr pro Nacht – je nach Medikamentenzusammenstellung. Eine Zeit lang gelang es, dass sie anfallsfrei war. „Mit dem entsprechenden Medikament war mein Wunsch, schwanger zu werden, völlig ausgeschlossen, da die Gefahr für Fehlbildungen zu groß war", erzählt die verheiratete Dortmunderin.

2013 stellte sie sich mit ihrem Wunsch das erste Mal im UKM (Universitätsklinikum Münster) vor, durch einen Aufruf zu einer Studie wurde Plonka auf das Klinikum aufmerksam, heißt es in einer Pressemitteilung.

„Nach einer Messung der magnetischen Aktivität des Gehirns durch das Team von Privat-Dozent Dr. Carsten Wolters vom Institut für Biomagnetismus und einem Forschungs-MRT haben wir eine Anlagestörung im rechten Stirnlappen entdeckt", erklärt Oberarzt Dr. Gabriel Möddel, Leiter des Bereichs Epileptologie in der Klinik für Schlafmedizin und Neuromuskuläre Erkrankungen am UKM. Die Vermutung, den Auslöser für die Anfälle gefunden zu haben, bestätigte sich bei weiterer Diagnostik in der Klinik für Neurochirurgie mittels Tiefenelektroden, die der Patientin für zwei Wochen eingesetzt wurden. „Bereits zehn Sekunden vor dem Anfall konnte man damit millimetergenau die betroffene Stelle im Gehirn definieren", fasst Möddel die Untersuchungsergebnisse zusammen, heißt es weiter.

Vor der OP versicherten sich die Mediziner noch mit dem sogenannten Wada-Test, der durch Injektion eines Narkosemittels in die Hirnschlagader bei der Beurteilung hilft, dass bei einer Hirnoperation keine für die Sprache wichtigen Funktionsbereiche geschädigt werden. „Danach wussten wir, dass wir die zwei betroffenen Zentimeter ohne größeres Risiko entfernen können", erklärt Möddel.

„Dieser Eingriff ist die derzeit wirksamste Therapie bei Epilepsie und Sonja Plonka hat damit eine Chance von 80 Prozent, dass sie anfallsfrei bleibt."

Die elektrische Übererregung von Sonja Plonkas Gehirn ist deutlich auf dem Bildschirm zu sehen. Doch das gehört der Vergangenheit an. Jetzt ist die 29-Jährige anfallsfrei und schwanger – zur Freude von Dr. Gabriel Möddel.

[Westfälische Nachrichten, 18.März 2016]

Zusammenfassung

- MEG-Quellenanalyse kann einen wichtigen Beitrag zur prächirurgischen Epilepsie-Diagnostik leisten
- Könnte zukünftig Patienten u.U. invasive Diagnostik ersparen!?
- MEG weniger durch Knochenlücken beeinflusst als EEG: MEG also insbesondere von Nutzen bei vor-operierten Patienten
- Individuelles FEM-Kopfmodell kann Modellierung des „breach-rhythm“ und damit auch EEG und kombinierte EEG/MEG Quellenanalyse ermöglichen

Structure

- Complementarity of EEG and MEG
- How to exploit this complementarity in combined EEG/MEG source analysis
- Focal epilepsy patient case studies
- Summary

Summary:

- EEG and MEG are modalities with complementary sensitivities
- Combined EEG/MEG source analysis can significantly stabilize the accuracy and confidence of reconstructions (Antonakakis et al., 2019,2020), especially at early (noisy) time points (Aydin et al., 2015,2017)
- The use of earlier activity than spike-peak and spike sub-averaging strategies can avoid mis-localizations due to propagation (Aydin et al., 2015,2017)
- EEG/MEG source analysis for determination of region of interest (ROI) and then morphometric analysis and ZOOMit-MRI in ROI seems a very promising new method (use of “converging evidence”) (Aydin et al., 2017)
- A combined EEG/MEG source analysis should be based on realistic multi-compartment anisotropic head models with individually-calibrated skull conductivity (Aydin et al., 2014, 2015, 2017; Vorwerk et al., 2019; Antonakakis et al., 2019,2020)

Thanks for your attention!

2010-2016

since 2016

IBB's SIM-NEURO work-group