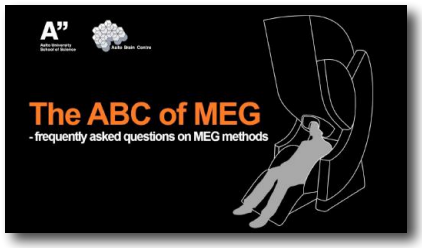
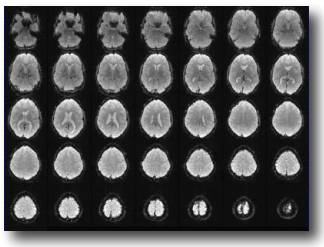
ANNUAL REPORT OF

AALTO NEUROIMAGING

AALTO UNIVERSITY SCHOOL OF SCIENCE

2015





Composed by Toni Auranen, Veikko Jousmäki, and Mikko Nyrhinen

April 5, 2015

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Director's executive summary

Aalto NeuroImaging (ANI) has been operational for three years. In 2015, the governmental decisions to reduce basic funding to the universities resulted in statutory negotiations at Aalto University, and organizational changes have been pushing ANI back and forth like a tidal wave. Finally, we survived through the statutory negotiations with minor scratches although the process was threatening our basic operation.

Brain Research Unit of O.V. Lounasmaa Laboratory was merged together with the Department of Biomedical Engineering and Computational Science in the beginning of 2015 to form the Department of Neuroscience and Biomedical Engineering (NBE, http://nbe.aalto.fi). Since organizational changes are always major events, I hope that the synergy within the new department will result in a success and very positive scientific collaboration. We also made a plan to move the MEG Core to the Health Technology House next to the new joint office space of NBE. Unfortunately, the School of Science decided not to support the plan and MEG Core will stay in its present location for the time being. Good news is that MEG Core will be available 24/7 without any major breaks in 2016.

Two main pioneers in MEG, Academician Riitta Hari and Professor Matti Hämäläinen, decided to downshift their professional careers at Aalto University in 2015. Riitta Hari retired in January 2016 and Matti Hämäläinen returned to his professor position at MGH/HST Athinoula A Martinos Center in Boston. ANI would not exist without their significant contributions. In addition, I have been very privileged to have their supervision, guidance, and support in several ways.

I'm really happy to see that our scientific output has increased from 32 publications in 2013 to 46 publications in 2015. At the same time, the scientific quality, measured by impact factors, has been at excellent level.

Financially, the year 2015 was negative. AMI Centre was the best part of ANI whereas both MEG Core and Aalto TMS made negative results. The use of MEG Core was dropped down from 1006 hours to 781 hours. Unfortunately, Aalto TMS laboratory's take-off phase has been delayed in establishing steady user base. ANI has introduced a new price list for the year 2016 to compensate the negative result. Hopefully, the usage of Aalto TMS and MEG Core will increase in 2016 to make both ends of the budget meet.

In 2015, ANI received major financial support, 40% of the budget, from the Aalto University School of Science. The support was mainly used to reduce the fees of the users from the Aalto University and NEUROIMAGING infrastructure. Hopefully, the financial support will continue in the future since it is a very important support to research and education at the Aalto University. In addition, Aalto Brain Centre (ABC, http://brainscience.aalto.fi), the neuroscience and neurotechnology initiative of the Aalto University, has financially supported ANI measurements in 2015 and the support will continue in 2016.

As a highlight of the year, ANI organized a symposium "Ultra-High Field MRI: Transition to Human 7 T in Finland" together with ABC, NBE, and Finnish Infrastructures for Functional Imaging (FIFI) consortium. The workshop was a very successful feasibility study for the next step towards the national 7 T Hub at Aalto University.

Finally, I would like to express my gratitude to our staff and users. Your efforts has been very important and valuable both for the infrastructure and neuroscience community. Together we stand, divided we fall.

Magnetically yours,
Veikko Jousmäki

1 Introduction

Aalto NeuroImaging (ANI, http://ani.aalto.fi) research infrastructure was established on January 1st, 2013 at Aalto University School of Science (SCI). ANI research infrastructure houses three functional neuroimaging modalities, navigated and repetitive transcranial magnetic stimulation (nTMS and rTMS) at Aalto TMS laboratory, functional magnetic resonance imaging (fMRI) at Advanced Magnetic Imaging (AMI) Centre, and magnetoencephalography (MEG) at MEG Core. ANI is part of Aalto University School of Science and administrated by Department of Neuroscience and Biomedical Engineering (NBE), a newly established department merging together Brain Research Unit of former O.V. Lounasmaa Laboratory and Department of Biomedical Engineering and Computational Science, since the beginning of 2015. Both AMI Centre and MEG Core are well established and have a long history and tradition starting from the Helsinki University of Technology whereas Aalto TMS was established in 2013. Docent Veikko Jousmäki from the NBE has been the ANI director since February 1st, 2013.

ANI is part of NEUROIMAGING research infrastructure (http://neuroimaging.fi) administrated by Aalto University together with University of Helsinki (UH) and Hospital District of Helsinki and Uusimaa (HUS, Helsingin ja Uudenmaan sairaahoitopiirin kuntayhtymä) in the capital region. NEUROIMAGING established in 2011, is based on agreement between AU, UH, and HUS, and covers, in addition to Aalto TMS, AMI Centre, and MEG Core in the Otaniemi campus, also the BioMag Laboratory (http://www.biomag.hus.fi) located at the Meilahti hospital. The goal of the NEUROIMAGING agreement, in brief, is to enhance joint use and development of the large-scale brain imaging facilities. ANI and NEUROIMAGING, were granted with recognition on "Finland's strategy and roadmap for research infrastructures 2014–2020" (2014) by the Academy of Finland and Ministry of Education and Culture. ANI and NEUROIMAGING are also actively involved in establishing the Finnish Infrastructures for Functional Imaging (FIFI, http://functionalimaging.fi) consortium. FIFI is a national-level large-scale infrastructure providing open access services in functional *in vivo* imaging of humans and animals. FIFI aims to guarantee that cutting-edge imaging technology is widely available for research and development projects both in academia and industry to enhance the science and to exploit the biomedical imaging infrastructures to the fullest. FIFI partners serve more than 700 users annually.

The NEUROIMAGING Steering Board comprised two members from the Aalto University (Dean Risto Nieminen, Academy Professor Riitta Salmelin), two from the UH (Professor Kimmo Alho, Professor Timo Erkinjuntti whose acting deputies have been Professors Teija M. Kujala and Pentti Tienari, respectively), and two from HUS (Director Pekka Tervahartiala, Chief Physician Erika Kirveskari). The Directors of the units act as experts with the right to speak in Steering Board meetings (ANI: Director Veikko Jousmäki, DrTech Toni Auranen; BioMag: Director Jyrki Mäkelä, DrTech Juha Montonen). The Steering Board had three meetings in 2015; the appointed chairman of the Steering Board for the first three-year period (2014–2016) is Dean Risto Nieminen and the secretary in 2015 was DrTech Juha Montonen. Academy Professor Riitta Salmelin has also played a vital role in the FIFI consortium coordination.

Aalto NeuroImaging infrastructure brings new possibilities and openings for the brain research community. Our aim is to maintain and develop the best possible infrastructure for functional brain imaging. All our units have their own budget and they are open for brain research community and other users. We have fixed user fees, our budget is transparent, and we meet the requirements set by the Academy of Finland, Tekes – the Finnish Funding Agency for Innovation, and European Research Council. We are strongly supporting neuroscience, one of the research focus areas of the Aalto University, as well as Aalto Brain Centre (established in 2014), Aalto University's initiative in neuroscience and neurotechnology.

1.1 Aalto TMS

Aalto TMS laboratory (http://tms.aalto.fi) was inaugurated in early 2013. It offers researchers unique possibilities for multi-modal neuroimaging techniques. The laboratory contains top-of-the-line navigated transcranial magnetic stimulation (nTMS) and electroencephalography (EEG) systems.

nTMS -system with two stimulation units (Bistim^2 and Super Rapid^2 Plus^1, Magstim Company Ltd., United Kingdom) and various coils makes numerous TMS and rTMS examination setups possible. Bistim^2 consists of two Magstim 200 units with a connection module making possible to deliver paired pulses or one high-energy pulse in to a single stimulation coil. Connection module can also be disconnected making it possible to use two Magstim 200 units as separate stimulation devices. For this purpose the laboratory has two 70 mm figure of eight coils making dual-site stimulations with the system possible. Also the new neuronavigation software (Visor2) version has a support for dual coil navigation. Super Rapid^2 Plus^1 consists of three power supply units which enable highpower/frequency stimulations. 70-mm air-cooled figure-of-eight coil makes high power/frequency scenarios possible without having to change the coil during or between sessions. With the two stimulation systems together, it is possible to do even triple-site stimulations in the laboratory.

In addition, the 64-channel EEG-system with 16 EMG channels (NeurOne, Mega Electronics Ltd., Kuopio, Finland), specially designed for co-registration with TMS, can be used to map stimulus event-related responses simultaneously. The laboratory also contains a dedicated system for audio and visual studies with Matlab, E-Prime, and Presentation software available for stimulus delivery.

Aalto TMS has been designed to maximize user and test subject comfort. For example, there are four 42” LCD screens for neuronavigation, ceiling-mounted arm for the navigation camera, salli saddle chair with elbow rest, three coil holders (2x Magstim and a custom build), an adjustable table and chair for visual stimulation system, and a head rest for test subject head support.

In the year 2014 Aalto TMS and AMI Centre started building a setup that enables concurrent transcranial magnetic stimulations and functional magnetic resonance imaging (fMRI). The work was continued in the year 2015. Total number of billed hours in 2015 was 56.5 h which was less than in 2014, so there is still much to improve for the next year.

1.2 AMI Centre

AMI Centre (http://ami.aalto.fi) houses a research-dedicated, modern 3T Siemens Skyra (Siemens Healthcare, Erlangen, Germany) magnetic resonance imaging (MRI) scanner. For almost fifteen years, several research teams from Aalto University, University of Helsinki (UH), Helsinki and Uusimaa Hospital District (HUS), as well as others (other academic users and industry) have used the facilities of AMI Centre for research and education. Since it’s inauguration, AMI Centre has operated smoothly with only a few notable interruptions of use, such as a three months downtime in 2011, when the Skyra system was installed to replace our previous 3T MRI scanner (SIGNA^{TM} GE Healthcare Ltd.) operational since 2002.

The current system houses 48 independent measurement channels, and since the purchase of our latest imaging coil, our users have had three distinct head coil arrays to choose from according to their needs; 32-channel head coil for excellent signal-to-noise ratio, a slightly more spacious 20-ch head-neck coil to be used with simultaneous EEG recordings, for example, and a custom-made modified version of the 32-channel head coil for excellent visual field of view for the volunteer. Our scanner is equipped with the TimTX TrueShape and syngo ZOOMit –updates enabling the latest possibilities in parallel transmission for MRI and fMRI. We have a state-of-the-art Full HD Panasonic 3-DLP projector (PT-DZ110XE) with a custom made lens system for visual stimulation in addition to well-designed stimulus delivery systems and robust eye tracking (EyeLink 1000, SR Research Ltd.) as well as simultaneous EEG

recording (BrainAmp MR+, Brain Products GmbH) and physiological signal recording/monitoring (BIOPAC Systems, Inc.) capabilities. We continue to offer exquisite surroundings for functional magnetic resonance imaging studies and neuroscience research.

As expected, in 2015 the magnet use was again, for a fourth year in a row, well over the 1000 paid hours mark. The total number of used hours (not including maintenance and free pilot hours) reached 1319 hours, which was close to the all-time high of 1495 hours in 2014. As a general trend since 2008, the usage has been increasing and we are looking forward to further boosting the usage especially during outside prime-time (Mon–Fri, 9–16) hours by improving our services and teaching MRI usage within the Aalto NeuroImaging research infrastructure.

1.3 MEG Core

The main research instrument of the MEG Core (http://meg.aalto.fi) is a modern 306-channel neuromagnetometer (Elekta Neuromag™, Elekta Oy, Helsinki), which was upgraded in 2008. It houses 204 gradiometers and 102 magnetometers with whole-scalp coverage. The device includes 64 EEG channels and 8 additional analog inputs for monitoring purposes. The MEG device is located within a 3-layer magnetically shielded room (MSR; Imedco AG, Hägendorf, Switzerland) that provides >100 dB attenuation of the external magnetic disturbances over a wide bandwidth. MEG Core has extremely low magnetic ambient noise level.

During MEG recordings, stimulators are available, *e.g.*, for auditory (Etymotic Research, Chicago, IL; ADU-2, Unides Design Ay, Helsinki; Sound Shower, Panphonics Oy, Tampere, Finland), tactile (constant current electric stimulator, (Medizin Technik Schwind, Germany), pneumatic tactile stimulator (built for the purpose in Germany), vibrotactile stimulator (built at BRU), manually-operated brush stimulator (built at BRU), visual (Panasonic 7700 DLP projector with a back projection screen), and pain (Neurotest thulium-YAG laser, Baasel Lasertech GmbH, Starnberg, Germany) stimulation. For monitoring purposes, MEG Core has eye trackers (SensoMotoric Instruments GmbH, Teltow, Germany and ASL Applied Science Laboratories, Bedford, MA USA), and home-made accelerometer-based monitoring devices. In addition, MEG Core has several home-made response pads and strong knowhow in building and testing MEG compatible stimulators.

The usage of MEG Core was reduced in 2015 due to the fact that two professors in the MEG field decided to downshift their activities at MEG Core. Academician Riitta Hari retired in Jan 2016 and professor Matti Hämäläinen decided to carry on his career at MGH/MIT in Boston. It will take some time and additional resources for us to reach the levels of these highly acknowledged pioneers in MEG.

The plans for the office space and MEG Core removals were made in 2015. These issues also affected the activity at MEG Core although the final removal day for the office space was finally postponed to 2016 and the MEG Core will stay at its present location for the time being.

2 Location, facilities, organization, and mission

The Aalto NeuroImaging infrastructure facilities are located on the campus of the Aalto University in Otaniemi area. Aalto TMS (tms.aalto.fi) and AMI Centre (ami.aalto.fi) are both located in the Magnet Building (Otakaari 5 I, Espoo, Finland), AMI occupying 350 m^2 in floors 1–3 and TMS about 50 m^2 in the fourth floor. MEG Core (meg.aalto.fi) resides in Nano Building (Puumiehenkuja 2), having 120 m^2 of laboratory space. All three parts of the ANI infrastructure have a joint online reservation system at anitime.aalto.fi. For more detailed information, see ani.aalto.fi.

The main research tools at Aalto TMS are two neuronavigated transcranial magnetic stimulation systems (Bistim^2 and Rapid^2, The Magstim Company Ltd., United Kingdom) combined with

electroencephalogram mapping (NeurOne, Mega Electronics Ltd., Kuopio, Finland). The laboratory is in very close proximity of our MRI scanner, making it very easy to combine anatomical MR-images to TMS neuronavigation, and to make offline fMRI-TMS studies accessible. Professor Synnöve Carlson is the Scientific Director of the TMS laboratory.

Currently, AMI Centre maintains the 3T MRI scanner (Siemens Skyra, Siemens Healthcare, Erlangen, Germany), develops the related infrastructure, and offers services to research teams at and outside the Aalto University. AMI Centre aims to provide an innovative environment for development and promotion of new imaging methods based on magnetic resonance imaging. The AMI personnel develop new techniques in close collaboration with other users. In 2015, the AMI Centre's research fields included functional and structural brain imaging, diffusion tensor imaging (DTI) and tractography of white matter axon bundles, as well as development of new methods and applications of MRI technology. The technical director of AMI Centre is Staff Scientist, DrTech Toni Auranen.

MEG Core offers excellent environment for magnetoencephalographic (MEG) measurements. MEG Core has three strong supports, *i.e.*, a modern MEG device, a variety of stimulators and monitoring devices, and magnetically quiet laboratory space. The MEG Core with its low-noise, well-equipped environment is currently one of the world's best laboratories to make MEG research. In addition to Aalto NeuroImaging duties, Docent Veikko Jousmäki acts also as the MEG Core Director.

3 Achievements

Aalto NeuroImaging serves as an infrastructure that provides top-level brain imaging facilities for multiple research teams, among them many National Centers of Excellence selected by the Academy of Finland. ANI as such, has limited own research program, and thus the scientific achievements and key performance indicators listed below, containing data collected at ANI, reflect the research interests of all the users of the infrastructure in 2015.

Impact factors for the publication series are shown and the classification of the publications (julkaisufoorumi.fi; JuFo) is based on the instructions by the Finnish Ministry of Culture and Education, 2010. The indication **TMS**, **AMI**, and **MEG** after the impact factor and classification mark, denote which resource or equipment was used in the work, respectively.

3.1 Scientific publications in international journals

PUBLISHED (situation Jan 2016)

1) Alho J, Salminen N, Sams M, Hietanen JK, and Nummenmaa L: **Facilitated early cortical processing of nude human bodies**. *Biological Psychology* 2015, 109: 103–110. (IF 3.403, JuFo: 2, A1, **AMI**, **MEG**)

2) Alho K, Salmi J, Koistinen S, Salonen O, and Rinne T: **Top-down controlled and bottom-up triggered orienting of auditory attention to pitch activate overlapping brain networks**. *Brain Research* 2015, 1626: 136–145. (IF 2.843, JuFo: 1, A1, **AMI**)

3) Alluri V, Brattico E, Toiviainen P, Burunat I, Bogert B, Numminen J, and Kliuchko M: **Musical expertise modulates functional connectivity of limbic regions during continuous music listening**.

Psychomusicology: Music, Mind, and Brain 2015, 443–454. (IF not available yet, JuFo: 1, A1, **AMI**)

4) Bona S, Cattaneo Z, and Silvanto J: **The causal role of the occipital face area (OFA) and lateral occipital (LO) cortex in symmetry perception**. *The Journal of Neuroscience* 2015, 35: 731–738. (IF 6.344, JuFo: 3, A1, **AMI**)

5) Bourguignon M, Piitulainen H, De Tiège X, Jousmäki V and Hari R: **Corticokinematic coherence mainly reflects movement-induced proprioceptive feedback**. *NeuroImage* 2015, 106: 382–390. (IF 6.357, JuFo: 2, A1, **MEG**)

6) Burunat I, Brattico E, Puoliväli T, Ristaniemi T, Sams M, and Toiviainen P: **Action in perception: prominent visuo-motor functional symmetry in musicians during music listening**. *PLoS ONE* 2015, DOI: 10.1371/journal.pone.0138238. (IF 3.234, JuFo: 1, A1, **AMI**)

7) Carlson E, Saarikallio S, Toiviainen P, Bogert B, Kliuchko M, and Brattico E: **Maladaptive and adaptive emotion regulation through music: a behavioral and neuroimaging study of males and females**. *Frontiers in Human Neuroscience* 2015, 9: 466, DOI: 10.3389/fnhum.2015.00466. (IF 3.626, JuFo: 1, A1, **AMI**)

8) Gogulski J, Boldt R, Savolainen P, Guzmán-López J, Carlson S, and Pertovaara A: **A segregated neural pathway for prefrontal top-down control of tactile temporal discrimination**. *Cerebral Cortex* 2015, 25: 161–166. (IF 8.665, JuFo: 3, A1, **AMI**)

9) Halko M-L, Mäkelä T, Nummenmaa L, Hlushchuk Y, and Schürmann M: **Hedonic context modulates risky choices and reward responses in amygdala and dorsal striatum**. *Journal of Neuroscience, Psychology and Economics* 2015, 8: 100–115. (IF 1.121, JuFo: 1, A1, **AMI**)

10) Heikkinen H, Sharifian F, Vigário R, Vanni S. **Feedback to distal dendrites links fMRI signals to neural receptive fields in a spiking network model of the visual cortex**. *Journal of Neurophysiology* 2015, 114: 57–69. (IF 2.887, JuFo: 2, A1, **AMI**)

11) Heinonen J: **Analysing e-services and mobile applications with companied conjoint analysis and fMRI technique**. *International Journal of E-Services and Mobile Applications* 2015, 7: 57–72. (IF not available, JuFo: 1, A1, **AMI**)

12) Himberg T, Hirvenkari L, Mandel A, and Hari R: **Word-by-word entrainment of speech rhythm during joint story building**. *Frontiers in Psychology* 2015, 6: 797. (IF 2.560, JuFo: 1, A1, **MEG**)

13) Hlushchuk Y, Simões-Franklin C, Nangini C, and Hari R: **Stimulus-rate sensitivity discerns area 3b of the human primary somatosensory cortex**. *PLoS ONE* 2015, DOI: 10.1371/journal.pone.0128462. (IF 3.234, JuFo: 1, A1, **AMI**)

14) Häkkinen S, Ovaska N, and Rinne T: **Processing of pitch and location in human auditory cortex during visual and auditory tasks**. *Frontiers in Psychology* 2015, 6: 1678. (IF 2.560, JuFo: 1, A1, **AMI**)

15) Kauppi JP, Kandemir M, Saarinen V-M, Hirvenkari L, Parkkonen L, Klami A, Hari R, and Kaski S: **Towards brain-activity-controlled information retrieval: decoding image relevance from MEG signals**. *NeuroImage* 2015, 112: 288–298. (IF 6.357, JuFo: 2, A1, **MEG**)

16) Kauttonen J, Hlushchuk Y, and Tikka P: **Optimizing methods for linking cinematic features to fMRI data**. *NeuroImage* 2015, 110: 136–148. (IF 6.357, JuFo: 2, A1, **AMI**)

17) Kirveskari E, Vartiainen NV, Kallio-Laine K, Kalso E, and Forss N: **Normal laser-evoked cortical responses in patients with chronic hemibody pain**. *European Journal of Pain* 2015, 19: 1168–1176. (IF 2.928, JuFo: 1, A1, **MEG**)

18) Liljeström M, Kujala J, Stevenson C, and Salmelin R: **Dynamic reconfiguration of the language network preceding onset of speech in picture naming**. *Human Brain Mapping* 2015, Electronic publication ahead of print. (IF 5.969, JuFo: 3, A1, **AMI**, **MEG**)

19) Liljeström M, Stevenson C, Kujala J, and Salmelin R: **Task- and stimulus-related cortical networks in language production: exploring similarity of MEG- and fMRI-derived functional connectivity**. *NeuroImage* 2015, 120: 75–87. (IF 6.357, JuFo: 2, A1, **AMI**, **MEG**)

20) Mandel A, Helokunnas S, Pihko E, and Hari R: **Brain responds to other person's eye blinks in a natural setting the more empathetic the viewer the stronger the responses**. *European Journal of Neuroscience* 2015, 42: 2508–2514. (IF 3.181, JuFo: 1, A1, **MEG**)

21) Ménoret M, Bourguignon M, and Hari R: **Modulation of rolandic beta-band oscillations during motor imagery of joint actions**. *PLoS ONE* 2015, DOI: 10.1371/journal.pone.0131655. (IF 3.234, JuFo: 1, A1, **MEG**)

22) Moisala M, Salmela V, Salo E, Carlson S, Vuontela V, Salonen O, and Alho K: **Brain activity during devided and selective attention to auditory and visual sentence comprehension tasks**.

Frontiers in Human Neuroscience 2015, 9: 86, DOI: 10.3389/fnhum.2015.00086. (IF 3.626, JuFo: 1, A1, **AMI**)

23) Mäntylä T, Mantere O, Raij TT, Kieseppä T, Laitinen H, Leiviskä J, Torniainen M, Tuominen L, Vaarala O, and Suvisaari J: **Altered activation of innate immunity associates with white matter volume and diffusion in first-episode psychosis**. *PLoS ONE* 2015, DOI: 10.1371/journal.pone.0125112. (IF 3.234, JuFo: 1, A1, **AMI**)

24) Nieminen JO, Koponen LM, and Ilmoniemi RJ: **Experimental characterization of the electric field distribution induced by TMS devices**. *Brain Stimulation* 2015, 8: 582–589. (IF 4.399, JuFo: 2, A1, **TMS**)

25) Nora A, Renvall H, Kim JY, Service E, and Salmelin R: **Distinct effects of memory retrieval and articulatory preparation when learning and accessing new word forms**. *PLoS ONE* 2015, DOI: 10.1371/journal.pone.0126652. (IF 3.234, JuFo: 1, A1, **AMI**, **MEG**)

26) Pamilo S, Malinen S, Hotta J, and Seppä M: **A correlation-based method for extracting subject-specific components and artifacts from group-fMRI data**. *European Journal of Neuroscience* 2015, 42: 2726–2741. (IF 3.181, JuFo: 1, A1, **AMI**)

27) Parkkonen E, Laaksonen K, Piitulainen H, Parkkonen L, and Forss N: **Modulation of the ~20-Hz motor-cortex rhythm to passive movement and tactile stimulation**. *Brain and Behavior* 2015, DOI: 10.1002/brb3.328. (IF 2.243, JuFo: 1, A1, **MEG**)

28) Piitulainen H, Botter A, Bourguignon M, Jousmäki V, and Hari R: **Spatial variability in cortex-muscle coherence investigated with magnetoencephalography and high-density surface electromyography**. *Journal of Neurophysiology* 2015, 114: 2843–2853. (IF 2.887, JuFo: 2, A1, **MEG**)

29) Piitulainen H, Bourguignon M, Hari R, and Jousmäki V: **MEG-compatible pneumatic device to elicit passive finger and toe movements**. *NeuroImage* 2015, 112: 310–317. (IF 6.357, JuFo: 2, A1, **MEG**)

30) Piitulainen H, Bourguignon M, Smeds E, De Tiège X, Jousmäki V, and Hari R: **Phasic stabilization of the human primary motor cortex by task-unrelated visual and auditory distractors**. *Human Brain Mapping* 2015, 36: 5168–5182. (IF 5.969, JuFo: 3, A1, **AMI**, **MEG**)

31) Raij TT, Mäntylä T, Kieseppä T, and Suvisaari J: **Aberrant functioning of the putamen links**

delusions, antipsychotic drug dose, and compromised connectivity in first episode psychosis—preliminary fMRI findings. *Psychiatry Research* 2015, 233: 201–211. (IF 2.467, JuFo: 1, A1, **AMI**)

32) Roine U, Roine T, Salmi J, Nieminen-von Wendt T, Tani P, Leppämäki S, Rintahaka P, Caeyenberghs K, Leemans A, and Sams M: **Abnormal wiring of the connectome in adults with high-functioning autism spectrum disorder**. *Molecular Autism* 2015, 6: 1–11, DOI: 10.1186/s13229-015-0058-4. (IF 5.413, JuFo: n/a, A1, **AMI**)

33) Roine U, Salmi J, Roine T, Nieminen-von Wendt T, Leppämäki S, Rintahaka P, Tani P, Leemans A, and Sams M: **Constrained spherical deconvolution-based tractography and tract-based spatial statistics show abnormal microstructural organization in Asperger syndrome**. *Molecular Autism* 2015, 6: 4, DOI: 10.1186/2040-2392-6-4. (IF 5.413, JuFo: n/a, A1, **AMI**)

34) Saad E, Wojciechowska M, and Silvanto J: **Partial dissociation in the neural bases of VSTM and imagery in the early visual cortex**. *Neuropsychologia* 2015 75: 143–148. (IF 3.302, JuFo: 2, A1, **TMS**)

35) Saarimäki H, Gotsopoulos A, Jääskeläinen IP, Lampinen J, Vuilleumier P, Sams M, Hari R, and Nummenmaa L: **Discrete neural signatures of basic emotions**. *Cerebral Cortex* 2015, 2015, DOI: 10.1093/cercor/bhv086. (IF 8.665, JuFo: 3, A1, **AMI**)

36) Salminen NH: **Human cortical sensitivity to interaural level differences in low- and high-frequency sounds**. *Journal of the Acoustical Society of America* 2015, DOI: doi: 10.1121/1.4907736. (IF 1.503, JuFo: 2, A1, **MEG**)

37) Salminen NH, Altoè A, Takanen M, Santala O, and Pulkki V: **Human cortical sensitivity to interaural time difference in high-frequency sounds**. *Hearing Research* 2015, 323: 99–106. (IF 2.968, JuFo: 2, A1, **MEG**)

38) Salminen NH, Takanen M, Santala O, Lamminsalo J, Altoè A, and Pulkki V: **Integrated processing of spatial cues in human auditory cortex**. *Hearing Research* 2015, 327: 143–152. (IF 2.968, JuFo: 2, A1, **MEG**)

39) Salo E, Rinne T, Salonen O, and Alho K: **Brain activations during bimodal dual tasks depend on the nature and combination of component tasks**. *Frontiers in Human Neuroscience* 2015, 9: 102, DOI: 10.3389/fnhum.2015.00102. (IF 3.626, JuFo: 1, A1, **AMI**)

40) Talja S, Alho K, and Rinne T: **Source analysis of event-related potentials during pitch**

discrimination and pitch memory task. *Brain Topography* 2015, 28: 445–458. (IF 3.468, JuFo: 1, A1, **AMI**)

41) Vanni S, Sharifian F, Heikkinen H, and Vigário R: **Modeling fMRI signals can provide insights into neural processing in the cerebral cortex**. *Journal of Neurophysiology* 2015, 114: 768–780. (IF 2.887, JuFo: 2, A1, **AMI**)

42) Zhdanov A, Nurminen J, Baess P, Hirvenkari L, Jousmäki V, Mäkelä J, Mandel A, Hari R, and Parkkonen L: **An internet-based real-time audiovisual link for dual MEG recordings**. *PLoS ONE* 2015, DOI: 10.1371/journal.pone.0128485. (IF 3.234, JuFo: 1, A1, **MEG**)

43) Zhou G, Hotta J, Lehtinen M, Forss N, and Hari R: **Enlargement of choroid plexus in complex regional pain syndrome**. *Scientific Reports* 2015, 5: 14329, DOI: 10.1038/srep14329. (IF 5.578, JuFo: 2, A1, **AMI**)

IN PRESS (situation Jan 2016)

1) Brattico E, Bogert B, Alluri V, Tervaniemi M, Eerola T, and Jacobsen T: **It's sad but I like it: the neural dissociation between musical emotions and liking in experts and laypersons**. *Frontiers in Human Neuroscience* 2015, Accepted. (IF 3.626, JuFo: 1, A1, **AMI**)

2) Burunat I, Toiviainen P, Alluri V, Bogert B, Ristaniemi T, Sams M, and Brattico E: **The reliability of continuous brain responses during naturalistic listening to music**. *NeuroImage* 2015, Electronic publication ahead of print. (IF 6.357, JuFo: 2, A1, **AMI**)

3) Glerean E, Pan RK, Salmi J, Kujala R, Lahnakoski JM, Roine U, Nummenmaa L, Leppämäki S, Nieminen-von Wendt T, Tani P, Saramäki J, Sams M, Jääskeläinen I: **Reorganization of functionally connected brain subnetworks in high-functioning autism**. *Human Brain Mapping* 2015, Electronic publication ahead of print. (IF 5.969, JuFo: 3, A1, **AMI**)

4) Jääskeläinen IP, Halme H-L, Agam Y, Glerean E, Lahnakoski JM, Sams M, Tapani K, Ahveninen J, and Manoach DS: **Neural mechanisms supporting evaluation of others' errors in real-life like conditions**. *Scientific Reports* 2015, Electronic publication ahead of print. (IF 5.578, JuFo: 2, A1, **AMI**)

5) Kaltiainen HL, Helle LM, Renvall HM, and Forss NH: **Slow wave oscillations in awake healthy subjects – methodological and physiological considerations**. *Journal of Clinical Neurophysiology* 2015, Accepted. (IF 1.429, JuFo: 1, A1, **MEG**)

6) Komulainen E, Heikkilä R, Meskanen K, Raij TT, Nummenmaa L, Lahti J, Jylhä P, Melartin T, Harmer CJ, Isometsä E, and Ekelund J: **A single dose of mirtazapine attenuates neural responses to self-referential processing**. *Journal of Psychopharmacology* 2015, Electronic publication ahead of print. (IF 3.898, JuFo: 1, A1, **AMI**)

7) Mandel A, Bourguignon M, Parkkonen L, and Hari R: **Sensorimotor activation related to speaker vs. listener role during natural conversation**. *Neuroscience* Letters 2015, Electronic publication ahead of print. (IF 2.030, JuFo: 1, A1, **MEG**)

8) Salmela VR, Henriksson L, and Vanni S: **Radial frequency analysis of contour shapes in the visual cortex**. *PLoS Computational Biology* 2015, Accepted. (IF 4.620, JuFo: 2, A1, **AMI**)

9) Sharifian F, Heikkinen H, Vigário R, and Vanni S: **Contextual modulation is related to efficiency in a spiking network model of visual cortex**. *Frontiers in Computational Neuroscience* 2015, Electronic publication ahead of print. (IF 2.201, JuFo: 1, A1, **AMI**)

10) Zhou G, Bourguignon M, Parkkonen L, and Hari R: **Neural signatures of hand kinematics in leaders vs. followers: a dual-MEG study**. *NeuroImage* 2015, Electronic publication ahead of print. (IF 6.357, JuFo: 2, A1, **MEG**)

3.2 Other scientific publications in meetings and conferences

BOOK CHAPTERS

1) Hari R: **Magnetoencephalography studies of action observation**. Pier Francesco Ferrari and Giacomo Rizzolatti (Eds): New frontiers in mirror neurons research. *Oxford University Press* 2015, 58–70, DOI: 10.1093/acprof:oso/9780199686155.003.0004. (A3, **MEG**)

PROCEEDINGS PAPERS

2) Piitulainen H, Botter A, Bourguignon M, and Hari R: **Spatial variability in cortex–muscle coherence revealed with high-density surface electromyography**. *The 45th annual meeting of the Society for Neuroscience* 2015, Chicago, IL, USA, October 17–21. (A4, **MEG**)

3) Faisal A, Nora A, Seol J, Renvall H, and Salmelin R: **Kernel convolution model for decoding sounds from time-varying neural responses**. *IEEE International Workshop on Pattern Recognition*

in Neuroimaging 2015, Stanford, CA, USA, June 10–12. (A4, **MEG**)

ORAL PRESENTATIONS, INVITED TALKS AND POSTERS

Our users reported **well over 50 oral presentations, invited talks and posters in international and national scientific conferences and meetings** that contain data and/or results based on the fMRI/MRI, MEG or TMS data measured at Aalto NeuroImaging infrastructure. The reader is recommended to take into consideration that the achievements in this category are based solely on notifications from our users and the true number is likely considerably higher, yet very difficult to report accurately. Therefore, they are not listed with detailed information.

OTHER PUBLICATIONS

1) Vanni S and Heikkinen H: **Is there unused capacity in our brain?** (Article in Finnish.) *Duodecim* 2015, 131: 1644–1649. (JuFo: 1, D1, **AMI**)

3.3 Theses

DOCTORAL THESES

1) Enrico Glerean: **Dynamic similarity of brain activity in humans: from single areas to functional networks**. Dissertation for the degree of Doctor of Science in Technology, Aalto University School of Science, Department of Neuroscience and Biomedical Engineering, 2015. Supervisor: Professor Mikko Sams. (G5, **AMI**)

2) Lotta Hirvenkari: **Natural stimuli and experimental setups in the study of the neural basis of social interaction**. Dissertation for the degree of Doctor of Philosophy, University of Helsinki, Faculty of Biological and Environmental Sciences, 2015. Supervisor: Professor Riitta Hari. (Thesis made at Aalto University, School of Science, Department of Neuroscience and Biomedical Engineering, Aalto University School of Science.) (G5, **AMI**, **MEG**)

3) Siina Pamilo: **New approaches to statistical analysis of fMRI data**. Dissertation for the degree of Doctor of Science in Technology, Aalto University School of Science, Department of Neuroscience and Biomedical Engineering, 2015. Supervisor: Professor Riitta Hari. Advisor: DrTech Mika Seppä. (G5, **AMI**)

4) Elyana Saad: **Interaction between visual perception and mental representation of imagery and memory in the early visual areas**. Dissertation for the degree of Doctor of Philosophy, University of Helsinki, Faculty of Behavioural Sciences, 2015. Supervisors: Docent Juha Silvanto, Professor Teija Kujala. (G5, **TMS**)

5) Fariba Sharifian: **Model-based exploration of interactions in the visual cortex**. Dissertation for the degree of Doctor of Science in Technology, Aalto University School of Science, Department of Neuroscience and Biomedical Engineering, 2015. Supervisor: Professor Matti Hämäläinen. Advisor: Docent Simo Vanni. (G5, **AMI**)

MASTERS THESES

1) Jyri Ojala: **Blink-contingent object displacements during tracking: behavioural and neuromagnetic recordings**. Master's thesis for the degree of Master of Science (Technology), Aalto University School of Electrical Engineering, 2015. Supervisor: Professor Lauri Parkkonen. (G2, **MEG**)

2) Aapeli Takala: **Volumetric thermometry with proton resonance**. Master's thesis for the degree of Master of Science (Technology), Aalto University School of Electrical Engineering, 2015. (Thesis made at Aalto University, School of Science, Aalto NeuroImaging, AMI Centre.) Supervisor: Professor Raimo Sepponen. Advisor: DrTech Toni Auranen. (G2, **AMI**)

3) Tuomas Tolvanen: **Virtual column analysis: a novel technique for analyzing functional magnetic resonance imaging data**. Master's thesis for the degree of Master of Science (Technology), Aalto University School of Science, Department of Neuroscience and Biomedical Engineering, 2015. (Thesis made at Aalto University, School of Science, Aalto NeuroImaging, AMI Centre.) Supervisor: Professor Mikko Sams. Advisors: Docent Simo Vanni, DrTech Toni Auranen. (G2, **AMI**)

4) Kaisu Ölander: **Eye movements and early magnetoencephalographic brain responses induced by faces in natural scenes**. Master's thesis for the degree of Master of Science (Technology), Aalto University School of Electrical Engineering, 2015. Supervisor: Professor Riitta Hari. (G2, **MEG**)

3.4 Promoting public awareness

The reader is recommended to take into consideration that the achievements in this category are based on selected notifications from our users and from the information that ANI personnel have received from other sources. The true number of events **promoting public awareness** may thus be considerably higher.

AMI Centre: Background footage for *MTV3 News.* 2015 (**AMI**)

Auranen T and Jousmäki V: Interview for Magazine, *Tekniikan Maailma* 12/2015. **Magneettikuvaus Aalto-yliopiston tutkimuskäytössä.** 6 February 2015. (**AMI**)

Halko M-L: Presentation at *Mikkelin kesäpäivät*. **Päätöksiä järjellä ja tunteella.** 12 June 2015. (**AMI**)

Halko M-L: Lecture at *Kiinteistösijoittamisen ja –liiketoiminnan rahoitus*. **Neurotaloustieteen näkökulmia päätöksenteon perusteisiin.** 2015. (**AMI**)

Hari R: Interview for Newspaper, *Ilta-Sanomat*. **How brain scans could help to predict a person's future.** 12 January 2015. (**AMI**, **MEG**)

Hari R: Interview for Radio, *YLE puhe, Finnish Broadcasting Company*. **Ihmisen mieli @ Puheen iltapäivä.** 14 April 2015. (**AMI**, **MEG**)

Hari R: Interview for Newspaper, *Svenska Dagbladet*. **Interview about two-person neuroscience.** 9 June 2015. (**AMI**, **MEG**)

Hari R: Interview for Radio, *Danish Broadcastin Company*. **Interview about the topic of plenary talk @ TSC2015.** 9 June 2015. (**AMI**, **MEG**)

Hari R: Interview for Radio, *Finnish Broadcasting Company*. **Radioateljee: Käsi.** 18 December 2015. (**AMI**, **MEG**)

Maunula S: Article in *Tradenomit työelämää kehittämässä, Laurea, Vantaa.* **Markkinointitutkimusta neurotutkimuksen keinoin.** 2015 (**AMI**)

Moisala M: Interview for *Yle News (Web).* **Tuleeko digimaailman lapsista heinäsirkkoja vai huippuosaajia.** 17 February 2015. (**AMI**)

Moisala M: Interview for *Radio Nova.* **The effects of gaming on the brain.** 26 February 2015. (**AMI**)

Moisala M: Lecture at *Loistava tulevaisuus –series, Helsinki.* **Vaikuttaako tietoteknologian käyttö aivoihin.** 4 February 2015. (**AMI**)

Moisala M: Interview for *ScienceNews (Web).* **Multitaskers do worse on tasks that require focus.** 19 October 2015. (**AMI**)

Moisala M: Interview for *Helsinki Times (Kuukausiliite).* **Omat aivot ohjasivat alalle.** 7 November 2015. (**AMI**)

Rikandi E: Interview for Magazine, *Daily Mirror*. **Scientists use Tim Burton's Alice in Wonderland movie to detect early signs of PSYCHOSIS.** August 2015 (**AMI**)

Saarimäki H: Interview for TV-program, *YLE Puoli seitsemän.* 6 May 2015. (**AMI**)

Suomala J: Interview for *Prisma Studio, YLE TV1*. **Story about neuromarketing.** 18 March 2015. (**AMI**)

3.5 Scientific awards and positions of trust

Senior Scientist Veikko Jousmäki was attributed to a visiting professor (3-year period starting from October 1st, 2015) at the Department of Clinical Neuroscience, Karolinska Institutet, Stockholm, Sweden.

3.6 Summary of achievements

This table depicts a summary of the highlights of the achievements presented in this chapter and from previous years since Aalto NeuroImaging started to operate in 2013.

	Refereed papers*	**In-press papers***	**PhD theses**	**MSc theses**
ANI total 2015	**46**	**10**	**5**	**4**
TMS used in	*2*	*0*	*1*	*0*
AMI used in	*28*	*7*	*4*	*2*
MEG used in	*21*	*3*	*1*	*2*
ANI total 2014	**33**	**7**	**4**	**1**
TMS used in	*0*	*1*	*0*	*0*
AMI used in	*26*	*4*	*4*	*1*
MEG used in	*13*	*2*	*0*	*0*
ANI total 2013	**32**	**13**	**5**	**4**
TMS used in	*0*	*0*	*0*	*1*
AMI used in	*25*	*11*	*5*	*2*
MEG used in	*11*	*4*	*0*	*1*

* Including refereed conference proceedings papers and book chapters

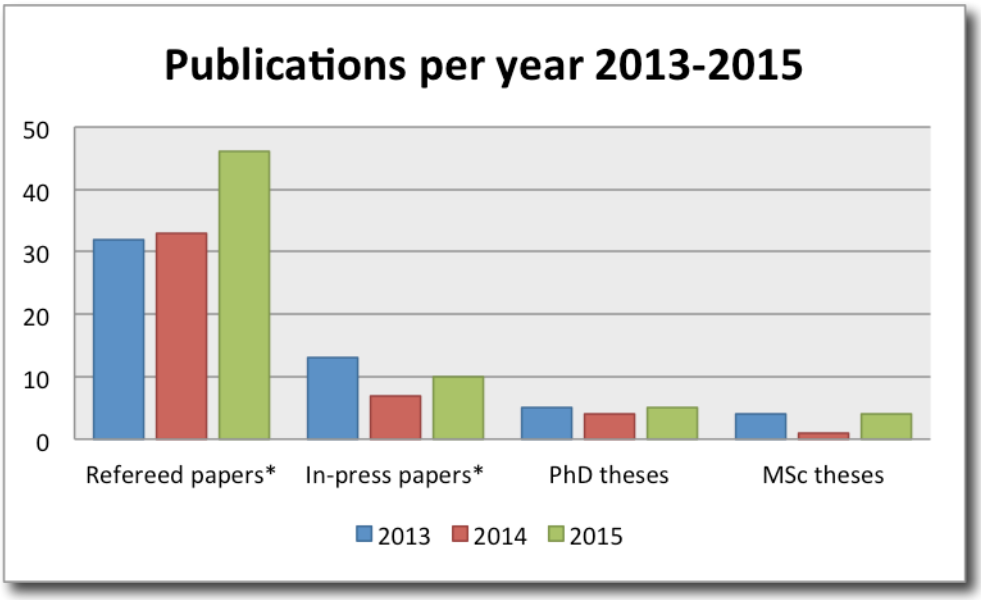

Figure 1 Total number of published achievements (2013–2015) where data gathered at the Aalto NeuroImaging infrastructure were used.

4 Technical development

While keeping the infrastructure operational and of the highest quality for our users, ANI infrastructure personnel is also actively involved in many technological and methodological development projects that may not result in publications, but stand out as improved services and possibilities for the users to benefit from the infrastructure. Below, some important projects and advances made in 2015 are described. Many of these projects are done in direct collaboration with our users and, therefore, they often interact with academically funded research projects resulting in achievements listed in the previous chapter.

AALTO TMS

Improving of Aalto TMS laboratory's facilities continued in the year 2015 including the construction of the concurrent TMS–fMRI system. Operation of TMS-coil in the presence of strong external magnetic field (3T MRI) caused unexpected safety issues in terms of acoustic noise pressure. In order to measure the acoustic noise pressure when operating the TMS-coil in the MRI-unit, a measurement system was build and calibration measurements for the system were done in co-operation with the Department of Signal Processing and Acoustics, Aalto University School of Science. In addition, new TMS-coil holder was built for concurrent TMS–fMRI and the stability of the holder was measured by acceleration measurements.

New improvements to working and test-subject comfort were implemented. For example, Salli saddle chair with elbow rest was purchased in order the make TMS-stimulations by hand easier. More stable version of the TMS-coil holder was also purchased to the laboratory. In order to get the latest version of Visor2, a 2-year remote support was purchased and a new software version of Visor2.1.4 was installed. NT-112 coil tracker was purchased for the dual-coil navigation feature. At the same time, the pointer tool (NT-115) was upgraded because of small deformation of the tool and improvements to the usability. A toolbox for controlling Magstim TMS-stimulators by external software was build. This new feature will be demonstrated for the users in 2016.

In 2016 Aalto TMS will aim to have additional scientific projects and some improvements in the facility following the needs stemming from our users. In addition, Aalto TMS is participating in planning seminars to ANI users. Users' training will also be held to train and attract new users.

AMI CENTRE

We have been very pleased with the Siemens Skyra scanner since its installation at the end of 2011. In 2015, we have learned and taken into use the Siemens TimTX TrueShape and syngo ZOOMit – update enabling the latest possibilities in using parallel transmission (pTX) and shimming in MRI and fMRI as well as the RESOLVE sequence for performing multishot diffusion weighted imaging. The update provides improved image quality (less artefactual distortion and blurring, as well as diminished detrimental effects of motion and flow), or alternatively, parallel imaging may be exploited to scan a target notably faster than prior to the update. As an important feature, the fully dynamic pTX makes it possible to create a zoomed field-of-view (FOV) to enable improved spatial resolution and reduced ghosting for small target areas than without pTX-methods. RESOLVE may prove to be useful in acquiring high-resolution and high-quality diffusion weighted images in special cases, and also when imaging locations with strong susceptibility artefacts. The downside is that the imaging time is still considerably longer than with conventional diffusion sequences. Previously, AMI Centre has also trained personnel for making sequence code modifications with the Siemens IDEA environment. Slight

modifications have been needed so far in some pilot projects. The scanner has operated in the software level VD13C.

As previously, measurements of combined EEG–fMRI, eye-tracking, and acquisition of galvanic skin response and other physiological signals, such as respiration, plethysmography, EKG, and EMG, have been routinely performed throughout the year in AMI Centre. Several smaller upgrades took place during 2015, such as updating the stimulus delivery computer, building a stable power source for the eye tracking system, as well as upgrading the amplifiers for the auditory stimulus system. Our staff constantly follows the current trends in fMRI stimulation/response systems and attended several roadshows of different manufactures as well. All our devices (both custom-made and commercial ones) are available to all users of AMI Centre. A great example is a recently purchased and developed Braille stimulus system by one research group. This system is now available on request also for other users.

In 2015, AMI Centre has continued collaborating with DrTech Ville Renvall from Aalto University School of Science (AU SCI), Department of Neuroscience and Biomedical Engineering (NBE) on developing a two-person fMRI measurement setup. This ongoing development project includes, for example, a custom-built 2-person headcoil for the Siemens Skyra scanner. As mentioned in the previous chapter, AMI Centre is involved in building a concurrent TMS–fMRI measurement setup with Aalto TMS. This work is going to continue in 2016. The project of improving the quality assurance (QA) procedures of AMI Centre has continued in 2015, and the new methods are planned to be taken into use in 2016.

In 2016 we continue improving our stimulus systems to meet the demands from our users. In addition, we are actively finding sources for funding the 128-channel RF-receiver expansion for Siemens Skyra and a new 64-channel head/neck coil for advanced fMRI purposes. Funding is also needed for the latest software update for the Skyra, the E11C (available fall 2016), which would provide some intriguing possibilities, such as the simultaneous multislice (SMS) EPI acquisition. This may prove to be an extremely vital update for our users.

MEG CORE

MEG Core upgraded stimulus computers and developed further gadgets based on pneumatic artificial muscles (PAMs). ANI/MEG Core has also contributed to the technological development of the speech paradigm in nTMS by providing the idea of using accelerometer in the speech paradigm to detect precisely the onset of the utterance in noisy nTMS lab. ANI also provided the accelerometer needed for the purpose (Vitikainen AM, Mäkelä E, Lioumis P, Jousmäki V, and Mäkelä JP: **Accelerometer-based automatic voice onset detection in speech mapping with navigated repetitive transcranial magnetic stimulation.** *Journal of Neuroscience Methods* 2015, 253: 70–77).

MEG Core has also upgraded the technical research agreement with Elekta Oy in 2014. Within this contract, we have developed and tested new Elekta products. In addition, we have trained new Elekta MEG users at MEG Core.

In 2016, MEG Core will continue to improve the facility with the main emphasis on usability of the MEG lab since the lab will stay 200 m away from the office space.

5 Equipment use and infrastructure funding

AALTO TMS

Total number of invoiced hours in 2015 was 54.5. A total of 54.5 hours was used to user and safety courses. A total of 29 hours was used to demonstrate the laboratory to various interested parties. In addition, a total of approximately 100 hours were used to technical development and service. In the third year of operation, the total number of invoiced hours in Aalto TMS was unfortunately below the expected. There are two main explanations to the low usage hours in Aalto TMS; the start-up phase took longer than estimated and, in addition, there is currently a lack of post-doc level TMS researchers in Aalto TMS user base.

	AALTO TMS (hours used)			**2015**
	2013	*2014*	**2015**	**%**
Users				
NBE (previously BRU)	*118.5*	*98*	-	-
ABC	-	-	31.5	22.8
UH	-	*22.5*	23	16.7
Training	*11*	*42*	54.5	39.5
Demos, Workshops, Visitors	*28*	*5*	29	21.0
Free pilots	-	*22.5*	-	-
All users total	***157.5***	***190***	**138**	**100.0**
Service	*100*	*50*	100	

MEG CORE

The total use of MEG Core was 781.5 hours (service hours excluded). The usage was reduced from the last year. Department of Neuroscience and Biomedical Engineering (NBE) and Elekta training were the main users of the facility.

	MEG Core (hours used)			**2015**
	2013	*2014*	**2015**	**%**
Users				
NBE (BRU/MEG Core)	*754*	*329*	468	59.9
NBE (BECS)	*196*	*159.5*		
ABC	-	-	24.5	3.1
HUS collaboration	*265*	*24.5*	12	1.5
Outside visitors	*19*	*18*	27.5	3.5
Elekta (intro training)	*64*	*188.5*	-	-
Elekta (service training)	*135*	*29.5*	125	16.0
Courses	-	*4*	5	0.6
Visitors	-	*54*	46	5.9
Free pilots	-	*200*	73.5	9.4
All users total	***1433***	***1006***	**781.5**	**100.0**
Service (helium refills)	*156*	*207*	158	

AMI CENTRE

In 2015, the total use of AMI Centre's magnet reached the second highest in more than ten years with 1319 hours (out of which over 80% during prime time). The biggest single users were University of Helsinki users (several groups from many departments added up to 38% of the total). From Aalto University, the biggest users were Department of Neuroscience and Biomedical Engineering (NBE; previously BRU and BECS) (21.6%) and groups supported by the Aalto Brain Centre (12.4%). We were delighted to see that groups affiliated with Hospital District of Helsinki and Uusimaa (HUS) increased their usage considerably.

Radiographer assistance is still very much needed and extremely important part of our operation as many groups measure only during prime time (Mon–Fri, 9–16) when this service is available. Last-minute cancellations have increased during the past two years, but on the other hand, the new Siemens scanner has proven to be very stable, decreasing the need for maintenance during prime time hours.

	AMI CENTRE (hours used)											**2015**	
	2004	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	**2015**	**%**
Aalto users													
NBE (BECS)	*173*	*168*	*194.5*	*98*	*85*	*84*	*108*	*194*	*50*	*231*	*365.75*	285	21.6
NBE (BRU)	*286*	*529*	*479.5*	*622*	*339*	*253*	*227*	*335*	*286*	*185*	*178.25*		
ABC	-	-	-	-	-	-	-	-	-	-	-	163.5	12.4
aivoAALTO	-	-	-	-	-	*28*	*252*	*115*	*177*	*201*	*125.5*	-	-
AMI Centre[1]	*230*	*151*	*154*	*85*	*27*	*46*	*56*	*47*	*92*	*39*	*71.5*	97.5	7.4
NeuroCine	-	-	-	-	-	-	-	-	-	-	*10*	31	2.4
Others[*]	-	*16*	-	-	-	-	*7*	*53*	*30*	*3*	-	-	-
Aalto users total	***689***	***864***	***828***	***805***	***451***	***411***	***650***	***744***	***635***	***659***	***751***	**591.5**	**44.8**
Outside users													
UH	*115*	*76*	*81.5*	*126*	*126*	*172*	*268*	*131*	*339*	*286*	*526.5*	501.5	38.0
HUS	*37*	*19*	*18*	*10*	*10*	*4*	*4*	*5*	*82*	*60*	*43*	109.5	8.3
Other academic[#]	*283*	*35*	*27.5*	*7*	*24*	*91*	*10*	*63*	*57*	*61*	*174.5*	116.5	8.8
Others (industry etc.)	*2*	*9*	*50*	*20*	*40*	*47*	*35*	*16*	*3*	-	-	-	-
Outside users total	***437***	***139***	***177***	***163***	***200***	***314***	***317***	***215***	***481***	***407***	***744***	**727.5**	**55.2**
All users total	***1126***	***1003***	***1005***	***968***	***651***	***725***	***967***	***959***	***1116***	***1066***	***1495***	**1319**	**100.0**
Radiographer	-	-	-	*577*	*410*	*508*	*663*	*553*	*641*	*647*	*744.5*	*819.5*	
Radiogr. %	-	-	-	*60%*	*63%*	*70%*	*69%*	*58%*	*57%*	*61%*	*50%*	*62%*	
Service[1, 2]	-	-	-	*214*	*234*	*218*	*212*	*735*[3]	*180*	*185*	*195*	*228*	
Free pilots[1]	-	-	-	-	-	-	*5*	*13*	*6*	*5*	*10.5*	*25*	
Cancellations[4]	-	-	-	*~30*	*~20*	*~5*	*~5*	*32*	*55*	*65*	*180.5*	*127.5*	

[1] Not invoiced: Service times, AMI Centre's technical development projects, Complimentary phantom pilots
[2] Includes: GE/Siemens maintenance (prime time only), AMI maintenance, trainings, visits
[3] Including the 3-month downtime for Scanner change (approx. 575 prime time hours)
[4] Late cancellations (not invoiced), 2015 reasons: 1. Subject notification/no-show 2. Other reasons
[*] Includes: SHOK, Department of Acoustics and Signal Processing, Applied Electronics Laboratory, BIT Research Centre
[#] In 2015: THL, University of Jyväskylä, Laurea University of Applied Sciences

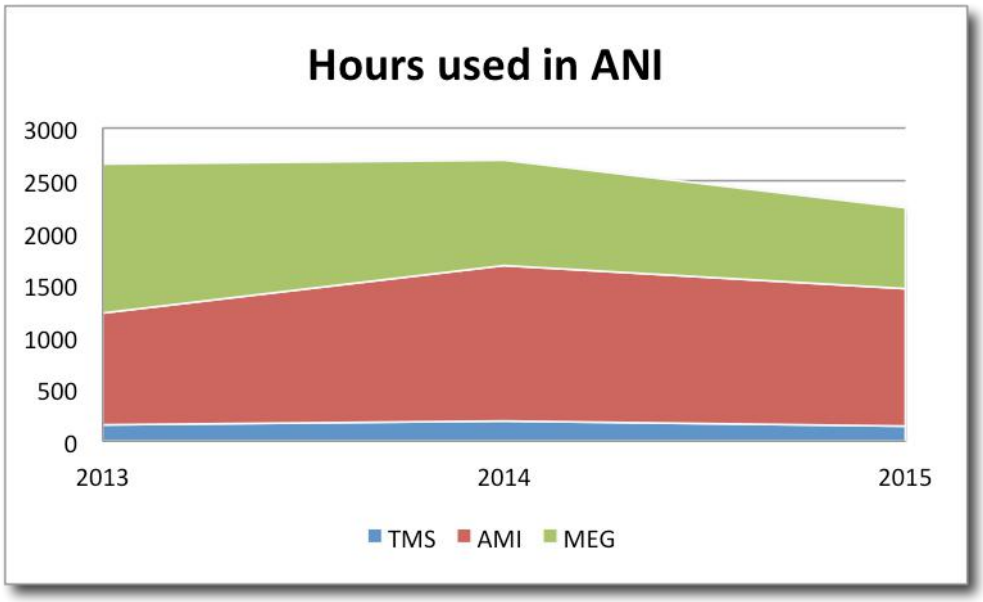

Figure 2 Total number of used hours of the Aalto NeuroImaging infrastructure during 2013–2015. The numbers do not include service hours, but they include non-invoiced hours for scientific internal development, teaching purposes and similar use.

INCOME AND OPERATING COSTS 2015

In 2015, the total income of Aalto NeuroImaging (865 k€) was somewhat below to the estimated budget. The income came from user fees (438 k€) and basic funding (427 k€). The total expenses were 1019 k€ (expenses in MEG Core were 340 k€, AMI Centre 536 k€, and Aalto TMS 143 k€) signifying that the budget was 154 k€ on the negative side.

AMI Centre, reaching a great result again in the used hours was able to meet the planned budget with approximately 38% of the income coming from basic funding (planned 40%). MEG Core needed more support (approximately 70%) from ANI basic funding to compensate for some of the ceased large user projects in 2015. Aalto TMS was almost totally supported (approximately 95 %) by ANI to make the startup possible. Adding to the cumulative surplus/deficit from the previous years, the cumulative sum is currently -168 k€.

6 Safety, teaching, seminars, visitors, and travel

AALTO TMS

Aalto TMS Laboratory's own safety and user course which is a prerequisite for all TMS measurements at Aalto TMS was organized 7 times during 2015 and was attended by a total of 21 participants (7 foreigners).

Aalto TMS was part of the organizers of the 3rd Science Factory: TMS–EEG summer school 2015 held on 8th–13th of September (60 participants; 42 foreigners). This included two hands-on TMS–EEG demonstrations at Aalto TMS which was attended by 13 people (11 foreigners). The main event was organized in Pajulahti. Laboratory engineer, MSc Mikko Nyrhinen attended also the scientific part of the summer school.

Aalto TMS organized an event titled "Aalto TMS Demo 2015: Simultaneous Navigation of Two Coils" on 5th of June. The event was participated by 9 people. Aalto TMS housed a demonstration of navigated TMS (5th of November) for the course "TRANSMED: Imaging in Science and Medicine" organized by University of Helsinki. The demonstration was attended by 7 students.

Aalto TMS was part of an internal "ANI Open House" event on 4th of June, were all interested parties could become acquainted with Aalto NeuroImaging facilities. Aalto TMS was visited by 13 people during this event. Also, Aalto TMS and AMI organized an event "SCI-tekniikkakahvit" which was attended by 8 people on 13th of May. Also, Metropolia University of Applied Sciences visited AMI Centre and Aalto TMS on 27th of October. This event was attented by approximately 25 people. Also psychology teachers (PROP ry) visited Aalto TMS and AMI Centre on 2nd of October and this event was participated by 75 people.

Laboratory engineer, MSc Mikko Nyrhinen, attended to national clinical neurophysiology days at Helsinki (2nd–4th of November) and the annual meeting of clinical neurophysiology society on 13th of march.

AMI CENTRE

AMI Centre organizes its own MRI safety course, which is a prerequisite for all MRI scanner users at AMI. It was organized 4 times during 2015 and a total of 24 individuals (6 foreigners) passed it (altogether 487 people have passed it since 2002). Some people, who have not been doing measurements in MRI for a couple of years, have participated in the course again to refresh their safety knowledge related to magnetic resonance imaging.

As a highlight of the year, Aalto NeuroImaging and AMI Centre were involved in organizing a symposium "Ultra-High Field MRI: Transition to Human 7T in Finland" in October 8th–9th together with ABC, NBE and Finnish Infrastructures for Functional Imaging (FIFI) consortium. The purpose of the workshop was to highlight scientific achievements, challenges, and new avenues enabled by ultra-high field MRI. This meeting brought together a group of top-level scientists to give presentations. For further interactions between the speakers (9 top-level experts) and the audience (~120 participants) the program included a panel discussion to address the opportunities and challenges of human ultra-high field MRI. For more information: see, http://tinyurl.com/aalto7t.

AMI personnel hosted several informal visits by groups or individuals of students, researchers, science reporters, and television crews. The knowhow of our experts in fMRI/MRI is delivered to our user groups by arranging unofficial demonstrations of new equipment and magnet use, often based on user's requests and tailored to their specific needs. The visitors included, but not limited to, groups from Aalto University, University of Helsinki, Laurea University of Applied Sciences, Metropolia University

of Applied Sciences, psychcology teachers (PROP ry) as well as a delegation of professors from Indian Institutes of Technology. In addition, professor Lauri Parkkonen from NBE utilized the AMI Centre's scanner and MEG Core in teaching the course "BECS-E5972 Functional Brain Imaging: Practice" in fall 2015. AMI Centre was also visited during the course "NBE-E4000 Principles of Biomedical Imaging" lectured by professor Matti Hämäläinen and other visiting lecturers.

During 2015, the AMI Centre's internal safety committee (whose members were Toni Auranen, Veikko Jousmäki, Ville Renvall, and Raimo Sepponen) had email exchanges and couple of informal meetings (not including all members) in which safety issues and procedures of testing new devices for the MRI environment were evaluated. Additional scientific talks related to AMI activities were included in the laboratory seminars of the Department of Neuroscience and Biomedical Engineering (NBE) and Aalto Brain Centre (ABC). DrTech Toni Auranen also attended the joint event of 17th Kuopio Bio-NMR workshop and 37th Finnish NMR Symposium in Kuopio, April 16th–17th.

MEG CORE

In 2015, MEG Core contributed to Elekta Neuromag Triux introductory MEG courses outside the MEG Core only. Typically, the Introductory Course lasts for 5 days and including both lectures and hands-on data acquisition and analysis sessions. These courses were carried out in collaboration with Elekta Oy. In addition, the Elekta Service Training was organized at MEG Core.

7 Aalto NeuroImaging personnel

7.1 Aalto TMS, AMI Centre, MEG Core

DIRECTORS

Veikko Jousmäki, ANI & MEG Director, PhD, Visiting Professor, Senior Scientist (**MEG**)

Synnöve Carlson, TMS Scientific Director, MD, PhD, Professor of Practice (**TMS**)

Toni Auranen, AMI Technical Director, DrTech, Staff Scientist (**AMI**)

OTHER PERSONNEL

Mia Illman, MEG Technologist (**MEG**)

Helge Kainulainen, Technician (**MEG**)

Marita Kattelus, Radiographer (**AMI**)

Anna Nurmes, Comprehensive school Internship (5 days for **AMI**)

Mikko Nyrhinen, Laboratory Engineer, MSc (**TMS**)

Petteri Räisänen, System Administration/Technical Support (~1 day per week for **ANI**)

Veli-Matti Saarinen, Laboratory Engineer, MSc (~0.5 months for **ANI**)

Ronny Schreiber, System Administration/Technical Support (~1 day per week for **ANI**)

Aapeli Takala, Master's thesis Student (~6 months for **AMI**)

Tuomas Tolvanen, Research Assistant (**AMI**)

7.2 Users and collaborators of ANI (n = 212)

The persons listed below are either, *authors* in scientific publications and theses where Aalto NeuroImaging is indicated in the byline or where data measured at any part of ANI (Aalto **TMS**, **AMI** Centre, **MEG** Core) were used in 2015 (previous years in parentheses), and/or they are members of research teams collecting data or carrying out research on data collected at ANI; the latter names have been collected from the active research permissions as well as project information and user notifications delivered to ANI in 2015. Also the employees of ANI who are performing measurements are listed here.

The total number of users and collaborators of the Aalto NeuroImaging infrastructure in 2015 (2014, 2013) adds up to 212 (214, 220) individual researchers [43 (61, 65) foreigners, 155 (126, 112) individual authors] with AMI Centre affiliating to 172 (174, 189), MEG Core to 67 (76, 51), and Aalto TMS to 12 (10, 5) of them. Out of the total, 113 (112, 113) were affiliated with Aalto University, 52 (45, 51) with University of Helsinki and 20 (20, 10) with HUS, some with double or triple affiliations.

Abbreviations: *AU = Aalto University*
UH = University of Helsinki
HUS = Hospital District of Helsinki and Uusimaa

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