# Curriculum Vitae

**Full Name**

Taulu, Samu Juhana

**Date and Place of Birth**

August 1, 1974 Helsinki, Finland

**Current Position**

Associate Professor of Physics, University of Washington, Seattle, USA

Director, I-LABS MEG Brain Imaging Center, University of Washington, Seattle USA

**Education**

Master of Science in Technology, Department of Technical Physics, Helsinki University of Technology, Finland (Apr. 2000)

Doctor of Science (Tech.), Department of Technical Physics, Helsinki University of Technology, Finland (Oct. 2008)

## Main Previous Professional Appointments

Course Assistant at the Laboratory of Biomedical Engineering, Helsinki University of Technology (1997)

Research Assistant at the Low Temperature Laboratory, Helsinki University of Technology (1997-1998)

Researcher at the Low Temperature Laboratory and Master's thesis worker for Neuromag Oy (1998-2000)

Method development engineer, Neuromag Oy Researcher, Elekta Neuromag Oy (2000-2006)

Senior Researcher, Elekta Oy (2009-2012)

Senior Clinical Applications Scientist and Project Manager, Elekta Oy (2012-2014)

## List of publications

### Journal articles


1. Uutela K, Taulu S, and Hämäläinen M, "Detecting and Correcting for Head Movements in Neuromagnetic Measurements", NeuroImage, vol. 14, 1424-1431 (2001). https://www.ncbi.nlm.nih.gov/pubmed/11707098 (DOI: 10.1006/nimg.2001.0915)

2. Pihko E, Lauronen L, Wikström H, Taulu S, Nurminen J, Kivitie-Kallio S, and Okada Y, "Somatosensory evoked potentials and magnetic fields elicited by tactile stimulation of the hand during

active and quiet sleep in newborns", Clin. Neurophysiol., vol. 115, 448-455 (2004). https://www.ncbi.nlm.nih.gov/pubmed/14744587 (DOI: 10.1016/S1388-2457(03)00349-3)

3. Taulu S, Kajola M, Simola J, "The Signal Space Separation Method", Biomed. Tech., vol. 48, 246-249 (2004).

4. Taulu S, Kajola M, and Simola J, "Suppression of Interference and Artifacts by the Signal Space Separation Method", Brain Topography, vol. 16, 269-275 (2004). https://www.ncbi.nlm.nih.gov/pubmed/15379226

5. Cheour M, Imada T, Taulu S, Ahonen A, Salonen J, and Kuhl P, "Magnetoencephalography is feasible for infant assessment of auditory discrimination", Experimental Neurology, vol. 190, 44-51 (2004). https://www.ncbi.nlm.nih.gov/pubmed/15498541 (DOI: 10.1016/j.expneurol.2004.06.030)

6. Taulu S, Simola J, Kajola M, "MEG Recordings of DC Fields Using the Signal Space Separation Method (SSS)", Neurol. Clin. Neurophysiol. 2004 Nov 30; 2004:35. https://www.ncbi.nlm.nih.gov/pubmed/16012635

7. Taulu S and Kajola M, "Presentation of electromagnetic multichannel data: the signal space separation Method", J. Appl. Phys., vol. 97, No. 12, 124905 (10 pages), 2005. http://aip.scitation.org/doi/abs/10.1063/1.1935742 (DOI: 10.1063/1.1935742)

8. Taulu S, Simola J, and Kajola M, "Applications of the Signal Space Separation Method", IEEE Trans. Sign. Proc. vol. 53, No. 9. 3359-3372, 2005. http://ieeexplore.ieee.org/document/1495874/ (DOI: 10.1109/TSP.2005.853302 )

9. Huotilainen M, Kujala A, Hotakainen M, Parkkonen L, Taulu S, Simola J, Nenonen J, Karjalainen M, and Näätänen R, "Short-term memory functions of the human fetus recorded with

magnetoencephalography", NeuroReport, vol. 16(1), 81-84 (2005). https://www.ncbi.nlm.nih.gov/pubmed/15618896

10. Taulu S and Simola J, "Spatiotemporal signal space separation method for rejecting nearby interference in MEG measurements", Phys. Med. Biol., vol. 51, 1759-1768 (2006). https://www.ncbi.nlm.nih.gov/pubmed/16552102 (DOI: 10.1088/0031-9155/51/7/008)

11. Imada T, Zhang Y, Cheour M, Taulu S, Ahonen A, and Kuhl P, "Infant speech perception activates Broca's area: a developmental magnetoencephalography study", Neuroreport, vol. 17, no. 10, 957-962 (2006). https://www.ncbi.nlm.nih.gov/pubmed/16791084 (DOI: 10.1097/01.wnr.0000223387.51704.89)

12. Medvedovsky M., Taulu S., Bikmullina R., Paetau R., "Artifact and head movement compensation in MEG", Neurology, Neurophysiology and Neuroscience 2007:4 (October 29, 2007). https://www.ncbi.nlm.nih.gov/pubmed/18066426

13. Nurminen J, Taulu S, and Okada Y, "Effects of sensor calibration, balancing and parametrization on the signal space separation method", Phys. Med. Biol. 53(7), 1975-1987, (2008). https://www.ncbi.nlm.nih.gov/pubmed/18354243 (DOI: 10.1088/0031-9155/53/7/012)

14. Taulu S and Hari R: Removal of magnetoencephalographic artifacts with temporal signal-space separation: Demonstration with single-trial auditory-evoked responses. Hum Brain Mapp. 30(5):1524-34, (2009). https://www.ncbi.nlm.nih.gov/pubmed/18661502 (DOI: 10.1002/hbm.20627)

15. Taulu S and Simola J, "Multipole-based coordinate representation of a magnetic multichannel signal and its application in source modeling". Report TKK-F-A-855. http://lib.tkk.fi/Diss/2008/isbn9789512295654/article1.pdf

16. Medvedovsky M, Taulu S, Bikmullina R, Ahonen A, and Paetau R, "Fine tuning the correlation limit of spatio-temporal signal space separation for magnetoencephalography", J Neurosci Methods 177, 203-211, (2009). https://www.ncbi.nlm.nih.gov/pubmed/18996412 (DOI:10.1016/j.jneumeth.2008.09.035)

17. Vrba J, Taulu S, Nenonen J, and Ahonen A, "Signal Space Separation Beamformer", Brain Topogr. 23, 128-133, (2010). https://www.ncbi.nlm.nih.gov/pubmed/19943101 (DOI: 10.1007/s10548-009-0120-7)

18. Song T, Cui L, Gaa K, Feffer L, Taulu S, Lee R, Huang M, "Signal space separation algorithm and its application on suppressing artifacts caused by vagus nerve stimulation for magnetoencephalography recordings", J Clin Neurophysiol 2009 Dec; 26(6):392-400. https://www.ncbi.nlm.nih.gov/pubmed/19952563 (DOI: 10.1097/WNP.0b013e3181c29896)

19. Guo C, Li X, Taulu S, Wang W, and Weber DJ, "Real-Time Robust Signal Space Separation for Magnetoencephalography", IEEE Trans Biomed. Eng., 57(8), 1856-1866 (2010). https://www.ncbi.nlm.nih.gov/pubmed/20176529 (DOI: 10.1109/TBME.2010.2043358)

20. Nurminen J, Taulu S, and Okada Y, "Improving the performance of the signal space separation method by comprehensive spatial sampling", Phys. Med. Biol., 55, 1491-1503 (2010). https://www.ncbi.nlm.nih.gov/pubmed/20157231 (DOI: 10.1088/0031-9155/55/5/015)

21. Airaksinen K, Mäkelä J, Taulu S, Ahonen A, Nurminen J, Schnitzler A, and Pekkonen E, "Effects of DBS on auditory and somatosensory processing in Parkinson's disease", Hum. Brain Mapp. 32, 1091-1099, (2011). https://www.ncbi.nlm.nih.gov/pubmed/20645306 (DOI: 10.1002/hbm.21096)

22. Medvedovsky M, Taulu S, Gaily E, Metsähonkala L, Mäkelä J, Ekstein D, Kipervasser S, Neufeld M, Kramer U, Blomstedt G, Fried I, Karppinen A, Veshchev I, Roivainen R, Ben-Zeev B, Goldberg-Stern H, Wilenius J, Paetau R, "Sensitivity and specificity of seizure-onset zone estimation by ictal magnetoencephalography", Epilepsia, 53, 1649-1657, (2012). https://www.ncbi.nlm.nih.gov/pubmed/22780219 (DOI: 10.1111/j.1528-1167.2012.03574.x)

23. Airaksinen K, Butorina A, Pekkonen E, Nurminen J, Taulu S, Ahonen A, Schnitzler A, Mäkelä J, "Somatomotor mu rhythm amplitude correlates with rigidity during DBS in Parkinsonian patients", Clin. Neurophys., 123, 2010-2017, (2012). https://www.ncbi.nlm.nih.gov/pubmed/22513261 (DOI: 10.1016/j.clinph.2012.03.004)

24. Nenonen J, Nurminen J, Kicic D, Bikmullina R, Lioumis P, Jousmäki V, Taulu S, Parkkonen L, Putaala M, and Kähkönen S, "Validation of head movement correction and spatiotemporal signal space separation in Magnetoencephalography", Clin. Neurophys., 123, 2180-2191, (2012). https://www.ncbi.nlm.nih.gov/pubmed/22633918 (DOI: 10.1016/j.clinph.2012.03.080)

25. Nurminen J, Taulu S, Nenonen J, Helle L, Simola J, Ahonen A, "Improving MEG performance with additional tangential sensors," IEEE Trans Biomed Eng, 60, 2559-2566, (2013). https://www.ncbi.nlm.nih.gov/pubmed/23649129 (DOI: 10.1109/TBME.2013.2260541)

26. Bosseler A, Taulu S, Pihko E, Mäkelä J, Imada T, Ahonen A, Kuhl P, "Theta brain rhythms index perceptual narrowing in infant speech perception", Front. Psychol., 11 October 2013. https://www.ncbi.nlm.nih.gov/pubmed/24130536 (DOI: 10.3389/fpsyg.2013.00690)

27. Medvedovsky M, Nenonen J, Koptelova A, Butorina A, Paetau R, Makela J, Ahonen A, Simola J, Gazit T, Taulus S, "Virtual

MEG Helmet: Computer Simulation of an Approach to Neuromagnetic Field Sampling", IEEE J Biomed Health Inform. 2015 Jan 19. https://www.ncbi.nlm.nih.gov/pubmed/25616085 (DOI: 10.1109/JBHI.2015.2392785)

28. Airaksinen K, Makela JP, Nurminen J, Luoma J, Taulu S, Ahonen A, Pekkonen E, "Cortico-muscular coherence in advanced Parkinson's disease with deep brain stimulation", Clin Neurophysiol. 2015 Apr; 126(4):748-55. https://www.ncbi.nlm.nih.gov/pubmed/25218364 (DOI: 10.1016/j.clinph.2014.07.025)

29. Airaksinen K, Lehti T, Nurminen J, Luoma J, Helle L, Taulu S, Pekkonen E, Makela JP, "Cortico-muscular coherence parallels coherence of postural tremor and MEG during static muscle contraction", Neurosci Lett., 2015 Aug 18;602:22-6. https://www.ncbi.nlm.nih.gov/pubmed/26116820 (DOI: 10.1016/j.neulet.2015.06.034)

30. Rodin E, Taulu S, Funke M, Johnson M, Bornfleth H, Constantino T, "Magnetoencephalographic infraslow activity: A feasibility study", J. Clin. Neurophys. 2016; 33(4): pp 350-358. https://www.ncbi.nlm.nih.gov/pubmed/26690547 (DOI: 10.1097/WNP.0000000000000246)

31. Ramirez FN, Ramirez R, Clarke M, Taulu S, Kuhl P. "Speech discrimination in 11-month-old bilingual and monolingual infants: a magnetoencephalography study", Dev Sci. 2016 Apr. https://www.ncbi.nlm.nih.gov/pubmed/27041494 (DOI: 10.1111/desc.12427)

32. Larson E, Taulu S, "The importance of properly compensating for head movements during MEG acquisition across different age groups", Brain Topography. 2017; 30(2): 172-182. https://www.ncbi.nlm.nih.gov/pubmed/27696246 (DOI: 10.1007/s10548-016-0523-1)

33. Jha A, Litvak V, Taulu S, Thevathasan W, Hyam J, Foltynie T, Limousin P, Bogdanovic M, Zrinzo L, Green A, Aziz T, Friston

K, Brown P. “Functional connectivity of the pedunculopontine nucleus and surrounding region in Parkinson’s disease”, Cereb Cortex. 2017; 27(1): 54-67. https://www.ncbi.nlm.nih.gov/pubmed/28316456 (DOI: 10.1093/cercor/bhw340)

34. van Klink N, van Rosmalen F, Nenonen J, Burnos S, Helle L, Taulu S, Furlong PL, Zijlmans M, Hillebrand A. “Automatic detection and visualization of MEG ripple oscillations in epilepsy”, NeuroImage: Clinical. 2017; 15:689-701. https://www.ncbi.nlm.nih.gov/pubmed/28702346 (DOI: 10.1016/j.nicl.2017.06.024)

35. Larson E, Taulu S. “Reducing Sensor Noise in Multichannel Arrays Using Oversampled Temporal Projection”, IEEE Trans Biomed. Eng. 2018; 65(5): 1002-1013. https://www.ncbi.nlm.nih.gov/pubmed/28783620 (DOI: 10.1109/TBME.2017.2734641) [Epub ahead of print]

36. Hari R, Baillet S, Barnes G, Burgess R, Forss N, Gross J, Hämäläinen M, Jensen O, Kakigi R, Mauguière F, Nakasatio N, Puce A, Romani GL, Schnitzler A, and Taulu S, “Practical guidelines for magnetoencephalography (MEG): Report of an IFCN committee”, Clinical Neurophysiol. Accepted for publication in Clinical Neurophysiology.

37. Jas M, Leppäkangas J, Engemann D, Larson E, Taulu S, Hämäläinen M, Gramfort A, ”A reproducible MEG/EEG group study with the MNE software: recommendations, quality assessments, and good practices”, Frontiers in neuroscience. 2018; 12 530.

38. Meltzoff A, Ramirez R, Saby J, Larson E, Taulu S, Marshall P, “Infant brain responses to felt and observed touch of hands and feet: an MEG study”, Developmental Science. Jan 14 2018.

39. Chang Y-C, Khan S, Taulu S, Kuperberg G, Brown E, Hämäläinen M, Temereanca S, ”Left-lateralized contributions of saccades to cortical activity during a one-back word recognition

task", Frontiers in Neural Circuits. May 16 2018.

40. Luoma J, Pekkonen E, Airaksinen K, Helle L, Nurminen J, Taulu S, Mäkelä, "Spontaneous sensorimotor cortical activity is suppressed by deep brain stimulation in patients with advanced Parkinson's disease", Neuroscience Letters. 2018; 683:48-53.

41. Borna A, Carter T, Colombo A, Jau Y-Y, McKay J, Weisend M, Taulu S, Stephen J, Schwindt P, "Non-invasive Functional-Brain-Imaging with an OPM-based Magnetoencephalography System", PLOS ONE, https://doi.org/10.1371/journal.pone.0227684. 2020.

42. Bourguignon M, Molinaro N, Lizarazu M, Taulu S, Jousmäki V, Lallier M, Carreiras M, De Tiege X, "Neocortical activity tracks syllable and phrasal structure of self-produced speech during reading aloud", accepted for publication in Neuroimage.

43. Clarke M, Larson E, Tavabi K, Taulu S, "Effectively combining temporal noise suppression methods in magnetoencephalography", accepted for publication in Journal of Neuroscience Methods.

44. Taulu S, Larson E, "Unified expression of quasi-static electromagnetic field: Demonstration with MEG and EEG signals", accepted for publication in IEEE Transactions of Biomedical Engineering.

45. Helle L, Nenonen J, Larson E, Parkkonen L, Simola J, Taulu S, "Extended Signal Space Separation method for improved interference suppression in MEG", submitted.

46. Mittag M, Larson E, Clarke M, Taulu S, Kuhl P, "Auditory deficits in infants at risk of dyslexia during a linguistic sensitive period predict future language", submitted.

**Selected Conference Proceedings**

Taulu S, Simola J, Kajola M, “Clinical Applications of the Signal Space Separation Method”, International Congress Series, vol. 1270, 32-37 (2004).

Taulu S, Simola J, Kajola M, “Software Magnetic Shield by Signal Space Separation (SSS)”, Proc. Biomag2004.

Mäkelä J, Taulu S, Ahonen A, Pohjola J, and Pekkonen E, "Effects of subthalamic nucleus stimulation on spontaneous sensorimotor MEG activity in a Parkinsonian patient", International Congress Series : vol. 1300, pp. 345-348 (2007).

Nenonen J, Taulu S, Kajola M, and Ahonen A, “Total information extracted from MEG measurements”, International Congress Series : vol. 1300, pp. 245-248 (2007).

Lioumis P, Taulu S, Kičić D, Nurminen J, Kähkönen S, Nenonen J, Montonen J, ”Standardization of MEG sensors by the Signal Space Separation Method”, International Congress Series : vol. 1300, pp. 237-240 (2007).

Airaksinen K, Mäkelä J, Taulu S, Ahonen A, Pohjola J, and Pekkonen E, "Auditory evoked fields in patients with advanced Parkinson's disease during deep brain stimulation", in Biomagnetism, Interdisciplinary Research and Exploration, Proceedings of the 16th International Conference on Biomagnetism, BIOMAG 2008. Editors: R. Kakigi, K. Yokosawa, S. Kuriki. Hokkaido University Press, 169-170, (2008).

Nenonen J, Parkkonen L, Helle L, Taulu S, Ahonen A, “Repeatability of AEF and SEF from Static and Moving Head Positions”, 17$^{th}$ International Conference on Biomagnetism, Advances in Biomagnetism – Biomag2010, IFMBE Proceedings, vol. 28, 306-309 (2010).

## Book chapters

"Novel noise reduction methods", in "Magnetoencephalography – From Signals to Dynamic Cortical Networks", Editors: Selma Supek and Cheryl J. Aine, Springer Verlag, Heidelberg, 2014.

## Research funding

- NIH bridge funding for year 2018 on project "Improved Spatial Resolution in Magnetoencephalography with an Optically Pumped Magnetometer Array" in collaboration with Sandia National Laboratories in the role of a co-PI.
- NIH R01 funding on project "Scalable software for distributed processing and visualization of large multi-site MEG/EEG datasets" in collaboration with Massachusetts General Hospital (MGH) and Harvard University in the role of a co-PI.
- NIH U01 funding for years 2019-2024 on project "Wearable Brain Imaging System" in collaboration with Sandia National Laboratories in the role of a co-PI.

## Awards

- Excellence Award at the 2005 MEG Applications Conference (Xylocastro, Greece)
- Outstanding Reviewer Award, Journal of Neuroscience Methods, Nov. 2015.

## Patents

1. Suppression of artifacts in non-invasive multichannel electromagnetic recordings using robust spatiotemporal signal space projections, provisional patent submitted in August of 2018.
2. Reducing sensor noise in multichannel arrays using oversampled temporal projection and associated systems and methods" The patent became public on November 30, 2017.
3. Method for adjusting interference signal space in bio-magnetic field measurements (priority date 2010-07-06)
4. Method for designing coils systems for generation of magnetic fields of desired geometry, a magnetic resonance imaging or magnetoencephalography apparuts with a coil assembly and a computer program (priority date 2010-03-26)
5. Method for separating multichannel signals produced by AC and DC sources from one another (priority date 2004-01-19)
6. Method for interference suppression in a measuring device (priority date 2004-02-13)
7. Analysis of multi-channel measurement data using orthogonal virtual channels (priority date 2007-01-03)
8. Method and device for interference suppression in electromagnetic multi-channel measurement (priority date 2005-04-28)
9. Method and system for processing a multi-channel measurement of magnetic fields (priority date 2003-03-14)
10. Method and device for using a multi-channel measurement signal in determining the current distribution of an object (priority date 2003-09-26)
11. Determining a position of objects in a predetermined coordinate system (priority date 2001-03-19)

## Teaching

- Teacher at the introductory and advanced customer training courses of Elekta Oy
- Guest lecturer at several graduate-level physics courses at Helsinki University
- Instructor of the Master's thesis of Liisa Helle (completed in 2009), Department of Technical Physics, Aalto University, Espoo, Finland.
- Instructor of the doctoral thesis of Dr. Jussi Nurminen (completed in 2014), Department of Technical Physics, Aalto University, Espoo, Finland.
- Currently instructor of the doctoral thesis of M.Sc. Liisa Helle
- Instructor of UW Physics graduate students Zachary Bednarke and Wanjin Yao.
- Currently instructor of 6 UW Physics undergraduate students
- Instructor of the undergraduate course PHYS122 (Electromagnetism) in the fall quarter of 2018 and winter quarter of 2019 at the University of Washington
- Instructor of PHYS 427 / 576 (Applications of Physics) in the spring quarter of 2020 at the University of Washington

**Academic service**

- Member of the graduate student admission committee at UW Physics in 2020

**Other appointments**

- Official opponent of Dr. Julio Hernandez-Pavon's doctoral thesis entitled: "Transcranial magnetic stimulation and EEG in studies of brain functions", Aalto University, School of Science, Espoo Finland, August 13, 2015.
- Guest editor for special issue on MEG/EEG source reconstruction for *Brain Sciences*
- Guest editor for special issue on Neural engineering informatics

for *IEEE Access*.
- Reviewer of over 60 manuscripts in peer-reviewed journals