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Leiden
The Netherlands

Low field MRI RF coils and SNR improvement

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Citation

Parsa, J. (2026, May 20). *Low field MRI RF coils and SNR improvement*. Retrieved from <https://hdl.handle.net/1887/4303740>

Version: Publisher's Version

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Portfolio

The PhD trajectory – an Overview

I started my PhD in September 2020 at Leiden University Medical Center. My project was about the development of RF coils for MRI systems. In the beginning, I mainly worked on fundamental research and simple coil designs. Soon after, I moved to hands-on work with phased array coils for low-field MRI. Around the same time, I also became interested in fluorine imaging at low low-field MRI. I followed the Introduction for PhD Students course, which gave me a clearer idea of how a PhD in the Netherlands is expected to go and what was needed from me.

In the first months, with good support from my colleagues, I managed to submit two collaborative abstracts to ISMRM 2021. One of our early projects was also published in 2021, which is about the feasibility of ^{19}F imaging at low field. From the start of my PhD, I joined weekly or biweekly group meetings. These meetings gave me the chance to show my results, get feedback, and slowly improve my presentation and English skills. For me, this was very important because it built my confidence to speak about my work in front of both colleagues and the wider scientific community.

In 2021, I continued my work on phased arrays and ^{19}F applications. That year we sent several works to journals and conferences: one paper to *Frontiers in Physics*, two abstracts to ESMRMB, and one abstract to ISMRM. During the online ISMRM 2021 conference, I presented two of my early projects. I also attended the Red Hot Conference, where I met researchers from biology and clinical backgrounds. This experience gave me a broader view of how my work could connect with other fields. Later in the year, I presented a poster and an oral talk at ESMRMB 2021. The poster on denoising low-field MRI images was selected for a poster award. That gave me strong motivation to continue. I also presented my progress a few times per year in department meetings, which helped me practice structuring my scientific story and improved my writing.

At the end of 2021, I submitted another abstract to ISMRM 2022, about denoising in low-field MRI. In the same year, our fluorine paper was published, and I started drafting a new manuscript on denoising. I also joined an MRI workshop that explained the working principles of MRI and gave me much clearer insight into how to use the scanner itself, not just theory.

In 2022, my abstract was accepted for a poster presentation at ISMRM London. I also started a new line of work about the safety assessment of low-field MRI, focusing on SAR simulations. This became another paper. Around the same time, I began teaching: I gave guest lectures on RF coils at TU Delft and also organized a six-month workshop for biology students. Every two weeks, I introduced them to MRI principles. This teaching made me much better at explaining technical things to people without a physics background. I also kept my collaboration with biology colleagues, especially for designing fluorine coils and testing new imaging sequences.

In 2023, I completed the Biostatistics course, which helped me in analyzing my results. In 2024, I also passed the eBROK course, which improved my understanding of how medical research projects should be organized. That year, I presented my SAR research as an oral presentation at ISMRM Benelux in Den Bosch. This was an important step for me because presenting live to a large audience was very different from presenting a poster, and it further developed my presentation skills.

The final year of my PhD focused primarily on improving SNR in low-field MRI systems from a hardware perspective and on developing a phased-array coil. These projects culminated in my most recent publication and enabled me to present the final results of my phased-array coil at ISMRM 2025 as a poster. Achieving phase array results after several years of work felt like a real highlight of my PhD.

In addition to research and teaching, I participated in outreach activities. With our group, I assisted at a public science exhibition in Leiden, where we demonstrated the low-field MRI system to non-scientists. Explaining MRI to a general audience was not easy, but it was highly rewarding and underscored the importance of communicating science to society.

Looking back, my PhD provided me with experience in research, publication, international presentations, teaching, collaboration, and outreach. I moved from learning the basics to developing new methods and conducting safety assessments, while also improving my communication skills and gaining experience leading workshops. These activities prepared me well for my future career in MRI research and development.

CRediT statement for the Chapters in this thesis

CRediT table for the thesis of Javad Parsa

Ch.	Type*	Short Title	Conceptualization	Data Curation	Formal Analysis	Funding Acquisition	Investigation	Methodology	Project Administration	Resources	Software	Supervision	Validation	Visualization	Writing – Original Draft	Writing – Review & Editing	Preregistered	Preprinted	Published with Peer Review
1	Introduction	Introduction	█														<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	PhD project chapter	SAR simulations for low-field MRI	█	█	█		█	█	█			█	█	█	█	█	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	PhD project chapter	A method for EMI reduction in MRI	█	█	█		█	█	█			█	█	█	█	█	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	PhD project chapter	SNR trade-offs for Halbach MRI	█	█	█		█	█	█			█	█	█	█	█	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	PhD project chapter	Very low field 19F MRI	█	█	█		█	█	█			█	█	█	█	█	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
6	Discussion	Summery and General Discussion	█														<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

*PhD project chapters are the direct result of the PhD project of the PhD candidate. Some theses also include Collaboration Chapters, to which the PhD candidate has contributed but fall outside the PhD project.

Dissemination Table

1- Parsa J, O'Reilly T, de Vos B, Webb A. Design and testing of a four-channel receive array coil on a 50 mT permanent magnet system. <i>Proc Intl Soc Mag Reson Med.</i> 2021;29:4037. Abstract presented at: ISMRM & SMRT Annual Meeting; 2021 May 15–20; Online.	
Chapter in this thesis	not in this thesis
Conference contributions of the PhD candidate	Description + URL
2- Parsa J, Webb A. Low field 19F imaging of perfluorooctylbromide: eliminating chemical shift effects and minimizing scalar coupling signal loss. <i>Proc Intl Soc Mag Reson Med.</i> 2021;29:1803. Abstract presented at: ISMRM & SMRT Annual Meeting; 2021 May 15–20; Online.	
Chapter in this thesis	not in this thesis
Conference contributions of the PhD candidate	Description + URL
3- Parsa J, O'Reilly T, Webb A. Low field 19F imaging of perfluorooctylbromide: eliminating chemical shift effects and minimizing scalar coupling signal loss. <i>Journal of Magnetic Resonance, Volume 325, April 2021, 106946.</i>	
Chapter in this thesis	5
Registered report	DOI
4- de Vos B, Parsa J, Abdulrazaq Z, Teeuwisse WM, Van Speybroeck CDE, de Gans DH, Remis RF, O'Reilly T, Webb AG. Design, characterisation and performance of an improved portable and sustainable low-field MRI system. <i>Front Phys.</i> 2021 Jul 26;9:701157.	
Chapter in this thesis	not in this thesis
Registered report	DOI
Publication in peer reviewed journal/platform	DOI
5- Parsa J, de Vos B, Webb A. A receiver coil-based method for reduction of electromagnetic interference on a 50 mT permanent magnet system. <i>MAGMA.</i> 2021;34(Suppl 1): 212. Abstract presented at: ESMRMB 2021, 38th Annual Scientific Meeting; 2021 Oct 7–9; Online.	

Chapter in this thesis	not in this thesis
Conference contributions of the PhD candidate	Description + URL
6- Parsa J, Webb A. An editing method for imaging different perfluorocarbons at low magnetic field. <i>MAGMA</i> . 2021;34(Suppl 1):193. Abstract presented at: ESMRMB 2021, 38th Annual Scientific Meeting; 2021 Oct 7–9; Online.	
Chapter in this thesis	not in this thesis
Conference contributions of the PhD candidate	Description + URL
7- Parsa J, O'reilly T, Webb A. A new single channel method for electromagnetic interference reduction on a 50 mT permanent magnet system. <i>Proc Intl Soc Mag Reson Med</i> . 2022;30:6293. Abstract presented at: ISMRM & ISMRT Annual Meeting; 2022 May 7–12; London, UK.	
Chapter in this thesis	not in this thesis
Conference contributions of the PhD candidate	Description + URL
8- Parsa J, O'Reilly T, Webb A. A single-coil-based method for electromagnetic interference reduction in point-of-care low field MRI systems. <i>J Magn Reson</i> . 2023 Jan;346:107355.	
Chapter in this thesis	3
Publication in peer-reviewed journal/platform	DOI
9- Parsa J, Webb A. Specific absorption rate (SAR) simulations for ultra-low-field (<0.1 T) MRI systems. <i>Proc Intl Soc Mag Reson Med</i> . 2023;31:2686. Abstract presented at: ISMRM & ISMRT Annual Meeting; 2023 Jun 3–9; Toronto, ON, Canada.	
Chapter in this thesis	not in this thesis
Conference contributions of the PhD candidate	Description + URL
10- Parsa J, Webb A. Effect of the RF shield-to-coil distance on coil efficiency for a 46 mT Halbach-based point-of-care MRI system. <i>Proc Intl Soc Mag Reson Med</i> . 2024;32:2839. Abstract presented at: ISMRM & ISMRT Annual Meeting; 2024 May 4–9; Singapore.	
Chapter in this thesis	not in this thesis
Conference contributions of the PhD candidate	Description + URL
11- Parsa J, Webb A. Specific absorption rate (SAR) simulations for low-field (<0.1 T) MRI systems. <i>Magn Reson Mater Phy</i> . 2023 Mar;36:429-438.	
Chapter in this thesis	2
Publication in peer reviewed journal/platform	DOI
12- Parsa J, Webb A. Signal-to-noise trade-offs between magnet diameter and shield-to-coil distance for cylindrical Halbach-based portable MRI systems for neuroimaging. <i>Magn Reson Mater Phy</i> . 2025;38:97-105.	
Chapter in this thesis	4
Publication in peer reviewed journal/platform	DOI
13- Parsa J, Lena B, Dong Y, Webb A. An inherently decoupled three-element solenoidal array coil for accelerated imaging on a 46 mT Halbach-based permanent magnet system. <i>Proc Intl Soc Mag Reson Med</i> . 2025;50:0498. Abstract presented at: ISMRM & ISMRT Annual Meeting; 2025 May 10–15; USA.	
Chapter in this thesis	not in this thesis
Conference contributions of the PhD candidate	Description + URL
14- Lena B, de Vos B, Guallart-Naval T, Parsa J, García Cristóbal P, van den Broek R, Najac C, Alonso J, Webb A. Subject grounding to reduce electromagnetic interference for MRI scanners operating in unshielded environments. <i>arXiv [Preprint]</i> . 2025 Jul 10:2507.07459.	
Chapter in this thesis	not in this thesis
Preprint	URL/ DOI
Publication in peer reviewed journal/platform	URL/ DOI

Overview of completed courses and other training

Completed courses and other training		
Mandatory activities		
Month / Year	Title (+description if needed)	hours
06/2021	Leiden University Onboarding Programme Inform & Connect (2 activities)	5
04/2021	Responsible Research (2 activities)	42
02/2022	Basic Methods and Reasoning in Biostatistics	42
Scientific courses, workshops, and other training activities		
Month / Year	Title (+description if needed)	hours
10/2021	ESMRMB 2021	35
09/2021	17th In vivo NMR course	42
05/2021	ISMIRM 2021	40
05/2022	ISMIRM 2022 London	42
06/2022	Red Hot conference (23th & 24th)	24
06/2023	ISMIRM 2023 Toronto	42
05/2024	ISMIRM 2024 Singapore	42
Transferable skills, workshops, and other training activities		
Month / Year	Title (+description if needed)	hours
06/2021	RF coils in TU Delft	12
01–06/2022	Teaching basic MRI principles at MR Forum	60
06/2022	RF coils in TU Delft	12
01–08/2022	Master Student	42
05/2024	RF coils in TU Delft	12
06/2024	Supervising Master Student	20

Acknowledgements

Starting a PhD is a challenging experience, particularly during the coronavirus pandemic and while relocating to another country. However, with the support of kind colleagues and friends, the experience became easier than I had initially anticipated. The period I spent at the Gorter MRI Center was immensely rewarding, thanks to the remarkable people I worked alongside.

I am deeply grateful to my supervisor, Andrew, whose scientific expertise and thoughtful guidance were instrumental throughout this research. Your wisdom guided me through all the ups and downs of this journey, and I always felt your support. I also thank my co-supervisor, Thijs, whose insights provided unique perspectives and helped me. Your warmth and friendliness made the Gorter group feel like a family.

The low-field group, with which I worked primarily, would not have been the same without several key individuals. Tom, when I first embarked on this journey, your guidance helped me find my footing, and I am truly grateful. I am pleased that you are continuing your work in open-source low-field MRI. Bart, we spent the most time working side by side, and I cannot thank you enough for making the daily grind feel effortless with your uplifting energy and vitality. Bea and Chloé, it was such a stroke of luck that you joined the team. I cherish the many happy moments we shared, and I'm sure your work on sequences will prove just how capable our system is. Aram, your arrival truly made the department feel like home, and I am certain that your AI expertise will lead to groundbreaking developments in the field. Ruben, you are unique in lecturing while scanning. I am sure you make scanning easier for volunteers. Wouter, thank you sincerely for everything you have taught me. The insights you shared into both life and craftsmanship have been invaluable.

Special thanks to my office mates, the (wo)man cave. Emiel, thank you for your hospitality and positive energy. We shared many good moments and memories; our coffee time was unique. Danielle, I appreciate your early morning company and the running tips. Donnie, thank you for showing me the Scottish culture, and I will never forget our teatime. Michael, you are a coffee legend, and thank you for all the coffee tips. I'm thrilled that you've started your café. Leon, I was lucky to have you back in the Netherlands, as the last year of my PhD with you as my office mate was wonderful. Helena, you are the queen of the cave. I am glad that you are taking care of my thrones, and thank you for all the positive energy and laughter.

And to all cave crews, please continue to take care of the office and welcome everyone with a Calvé peanut butter sandwich.

I would also like to express my special thanks to the entire Gorter Center. We created valuable memories at every stage. Kirsten, I am grateful for the wonderful experiences we shared. With Lydiane and Jasmine, sharing good food, games, and memories will never get old, thank you for your hospitality. Yiming, you are truly a K-space minimalist, and I appreciate that you taught me part of it. Working on low-field MRI with Corné and discussing ideas with Martijn and Lena are moments I truly cherish. Finally, I would like to extend my special thanks to Fieke, Navid, Balazs, Barbara, Kevin, Lisa, Rosanne, Ivana, Ingmar, Ernst, Nina, Madda, and Susi. Our coffee breaks, lunches, and conferences were made unforgettable because of you. I truly hope we remain in touch.

To my friends outside the Gorter Center, thank you for your constant support and encouragement. You made the hardest days lighter and the journey more meaningful. I'm grateful for the laughter, conversations, and shared moments; even if I can't name everyone, please know you are deeply appreciated.

Finally, I extend my deepest gratitude to my family. Mom and Dad, despite the distance and the pandemic, your support always reached me and carried me through difficult times. Robab jan and Karim jan, you have been like parents to me, and I truly appreciate your steady encouragement and positive energy. To my brothers and sisters, thank you for always standing by me; even from Iran, your support warmed the cold days in the Netherlands. Last but for sure not least, Donya, the love of my life, your unwavering support gave me the courage to start this journey and the strength to finish it. My gratitude is boundless.