

Matthias Hoelzl

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Research Interests

The focus of our research is on **large-scale instabilities in tokamak plasmas**. Simulations in particular with the **non-linear extended MHD code JOREK** (see here) aim to interpret and predict the non-linear dynamics of such instabilities in magnetically confined fusion plasmas. The focus is on studies of **edge localized modes (ELMs)**, **disruptions**, vertical displacement events (VDEs), tearing modes, **runaway electrons**, and techniques for the control, suppression, or mitigation of these phenomena. The physics models and numerical methods of the code are continuously developed further. The research is carried out in a strong international team.

Curriculum Vitae

- Since 2019: Deputy group leader MHD and fast particles at Max Planck Institute for Plasma Physics.
- Since 2015: Principal Investigator of two EUROfusion Enabling Research Projects with more than 30 contributors.
- Since 2013: Staff scientist at Max Planck Institute for Plasma Physics.
- 2010 to 2013: Postdoctoral Researcher at Max Planck Institute for Plasma Physics including research stays at CEA/IRFM Cadarache and ITER Organization.
- 2010: PhD in physics from Technical University Munich: *Diffusive Heat Transport across Magnetic Islands and Stochastic Layers in Tokamaks*

Project Grants

Full list at matthias-hoelzl.org/projects.html

- Singh Verma P., [Hoelzl M.](#), Huijsmans G.T.A. – *Optimization of the efficiency and scalability of the solver in the non-linear MHD code JOREK*. – EUROfusion High Level Support Team Project (7/2019–12/2020).
- [Hoelzl M.](#) (PI), Huijsmans G.T.A., Atanasiu C.V., Bandaru V.K., Becoulet M., Bhole A., Cathey A., Dvornova A., Franck E., Futatani S., Guillard H., Latu G., Liu F., Nardon E., Nkonga B., Pamela S., Passeron C., Smith S., Strumberger E., van Vugt D. – *Strengthening the non-linear MHD code JOREK for application to key questions of the fusion roadmap*. – **EUROfusion Enabling Research Project** (1/2019–12/2020).
- [Hoelzl M.](#) (PI), Bandaru V., Hindenlang F., Cathey A., Nikulsin N., Ramasamy R., Wieschollek F., Huijsmans G.T.A., Nardon E., Latu G., van Vugt D., Artola J., Franck E., Gruca M. – *Computing time for non-linear MHD simulations of disruptions and ELMs and developments for efficiency and stellarator geometry*. – Marconi-Fusion Supercomputer (01/2019–12/2019).
- [Hoelzl M.](#) (PI), Atanasiu C., Bandaru V.K., Strumberger E., Lackner K. – *Implementation and validation of a model for halo-currents in the non-linear MHD code JOREK and demonstration of 3-D VDEs simulations in ITER*. – **ITER Project** (12/2016–4/2019).

Publications

Full list at matthias-hoelzl.org/publications.html

- [Hoelzl M.](#), Hu D., Nardon E., Huijsmans G.T.A., JOREK Team, ASDEX Upgrade Team. – *First predictive simulations for deuterium shattered pellet injection in ASDEX Upgrade*. – Physics of Plasmas 27, 022510 (2020). arXiv:1910.06095.
- Nikulsin N., [Hoelzl M.](#), Zocco A., Lackner K., Günter S. – *Reduced and full MHD formulations for stellarator geometries*. – Physics of Plasmas 26, 102109 (2019). arXiv:1907.12486.

- Bandaru V., [Hoelzl M.](#), Artola F.J., Papp G., Huijsmans G.T.A. – *Simulating the non-linear interaction of relativistic electrons and tokamak plasma instabilities: Implementation and validation of a fluid model.* – Physical Review E 99, 063317 (2019). arXiv:1906.12137
- van Vugt D.C., Huijsmans G.T.A., [Hoelzl M.](#), Loarte A., Lopes Cardozo N.J. – *Kinetic modelling of ELM-induced W transport in ASDEX Upgrade.* – Physics of Plasmas 26, 042508 (2019)
- Orain F., [Hoelzl M.](#), Mink F., Willensdorfer M., Dunne M., Viezzer E., Becoulet M., Huijsmans G., Pamela S., Suttrop W., Günter S., Lackner K., ASDEX Upgrade Team, EUROfusion MST1 Team. – *Non-linear modeling of the threshold between ELM mitigation and ELM suppression by resonant magnetic perturbations in ASDEX Upgrade* – Physics of Plasmas 26, 042503 (2019). arXiv:1902.00398
- Meshcheriakov D., [Hoelzl M.](#), Igochine V., Fietz S., Orain F., Huijsmans G.T.A., Maraschek M., Dunne M., McDermott R., Zohm H., Lackner K., Günter S., ASDEX Upgrade Team, EUROfusion MST1 Team. – *Numerical study of tearing mode seeding in tokamak X-point plasma* – Physics of Plasmas 26, 042504 (2019). arXiv:1904.07542
- Vanovac B., Wolfrum E., [Hoelzl M.](#), Willensdorfer M., Cavedon M., Harrer G.F., Mink F., Denk S.S., Dunne M., Manz P., Luhmann Jr. N C, and the ASDEX Upgrade Team. – *Characterization of low frequency inter-ELM modes at the pedestal top of H-mode discharge at ASDEX Upgrade* – Nuclear Fusion 58, 112011 (2018)
- Artola F.J., Huijsmans G.T.A., [Hoelzl M.](#), Beyer P., Loarte A., Gribov Y. – *Non-linear magnetohydrodynamic simulations of Edge Localised Modes triggering via vertical oscillations.* – Nuclear Fusion 58, 096018 (2018).
- [Hoelzl M.](#), Huijsmans G.T.A., Orain F., Artola F.J., Pamela S., Becoulet M., van Vugt D., Liu F., Futatani S., Lessig A., Wolfrum E., Mink F., Trier E., Dunne M., Viezzer E., Eich T., Vanovac B., Frassinetti L., Guenter S., Lackner K., Krebs I., ASDEX Upgrade Team, EUROfusion MST1 Team – *Insights into type-I ELMs and ELM control methods from JOEKE MHD simulations.* – Contributions to Plasma Physics 58, 518 (2018).
- Mink F., [Hoelzl M.](#), Wolfrum E., Orain F., Dunne M., Lessig A., Pamela S., Manz P., Maraschek M., Huijsmans G.T.A., Becoulet M., Laggner F.M., Cavedon M., Lackner K., Guenter S., Stroth U. – *Nonlinear coupling induced toroidal structure of edge localized modes.* – Nuclear Fusion 58, 026011 (2018).
- Sommariva C., Nardon E., Beyer P., [Hoelzl M.](#), Huysmans G.T.A., van Vugt D., JET Contributors. – *Test particles dynamics in the JOEKE 3D non-linear MHD code and application to electron transport in a disruption simulation.* – Nuclear Fusion 58, 016043 (2018). arxiv:1704.08955
- Nardon E., Fil A., [Hoelzl M.](#), Huijsmans G., JET Contributors. – *Progress in understanding disruptions triggered by massive gas injection via 3D non-linear MHD modelling with JOEKE.* – Plasma Physics and Controlled Fusion 59, 014006 (10/2016).
- Orain F., [Hoelzl M.](#), Viezzer E., Dunne M., Willensdorfer M., Suttrop W., Strumberger E., Guenter S., Lessig A., ASDEX Upgrade Team, Becoulet M., Huijsmans G.T.A., Morales J., Kirk A., Pamela S., Cahyna P., EUROfusion MST1 Team. – *Non-linear modeling of the plasma response to RMPs in ASDEX Upgrade.* – Nuclear Fusion 57, 022013 (09/2016). arxiv:1602.07564
- Franck E., [Hoelzl M.](#), Lessig A., Sonnendrücker E. – *Energy conservation and numerical stability for the reduced MHD models of the non-linear JOEKE code.* – ESAIM: Mathematical Modelling and Numerical Analysis 49, 1331 (08/2015). arxiv:1408.2099
- Fil A., Nardon E., [Hoelzl M.](#), Huijsmans G.T.A., Orain F., Bécoulet M., Beyer P., Dif-Pradalier G., Guirlet R., Koslowski H.R., Lehnen M., Morales J., Pamela S., Passeron C., Reux C., Saint-Laurent F. and JET contributors. – *Modeling a massive gas injection triggered disruption in JET with the JOEKE code.* – Physics of Plasmas 22, 062509 (06/2015).
- [Hoelzl M.](#), Huijsmans G.T.A., Merkel P., Atanasiu C., Lackner K., Nardon E., Aleynikova K., Liu F., Strumberger E., McAdams R., Chapman I., Fil A. – *Non-Linear Simulations of MHD Instabilities in Tokamaks Including Eddy Current Effects and Perspectives for the Extension to Halo Currents.* – Journal of Physics: Conference Series 561, 012011 (12/2014). arxiv:1408.6379
- Krebs I., [Hoelzl M.](#), Lackner K., Günter S. – *Nonlinear excitation of low-n harmonics in reduced MHD simulations of edge-localized modes.* – Physics of Plasmas, 20, 082506 (08/2013). arxiv:1305.3727
- [Hoelzl M.](#), Merkel P., Huysmans G.T.A., Nardon E., McAdams R., Chapman I. – *Coupling the JOEKE and STARWALL Codes for Non-linear Resistive-wall Simulations.* – Journal of Physics: Conference Series, 401, 012010 (12/2012). arxiv:1206.2748
- [Hoelzl M.](#), Günter S., Wenninger R.P., Mueller W.-C., Huysmans G.T.A., Lackner K., Krebs I., ASDEX Upgrade Team. – *Reduced-MHD Simulations of Toroidally and Poloidally Localized ELMs.* – Physics of Plasmas, 19, 082505 (08/2012). arxiv:1201.5765

- [Hoelzl M.](#), Günter S., Classen I., Yu Q., the TEXTOR Team, Delabie E. – *Determination of the heat diffusion anisotropy by comparing measured and simulated electron temperature profiles across magnetic islands.* – Nuclear Fusion, 49, 115009 (09/2009).

Conference and Workshop Contributions

Full list at matthias-hoelzl.org/conferences.html

- **Proposed** [Hoelzl M.](#), Cathey-Cevallos A., Futatani S., Huijsmans G.T.A., Orain F., Dunne M., Pamela S.J.P., Becoulet M., Artola F.J., van Vugt D.C., Smith S.F., Schwarz N., Liu F., Korving S.Q., Gruca M., Günter S., Lackner K., Wolfrum E., Viezzer E., Lang P.T., JOREK Team, ASDEX Upgrade Team, EUROfusion MST1 Team. – *Simulations of edge localized mode dynamics and their control.* – 28th IAEA Fusion Energy Conference (FEC 2020), Nice, France (10/2020).
- **Oral** [Hoelzl M.](#), Cathey-Cevallos C., et al. – *Recent progress in simulating realistic ELM dynamics with JOREK.* – 37th Meeting of the Pedestal and Edge Physics ITPA Topical Group, San Diego, USA (4/2020).
- **Oral** [Hoelzl M.](#), Artola F.J., Bandaru V.K., Nardon E., Wiescholke F., Hu D., Bonfiglio D., Sommariva C., Krebs I., van Vugt D., Meshcheriakov D., Huijsmans G.T.A., JOREK Team – *Disruption oriented research with the JOREK code.* – 8th Runaway Electron Modelling (REM) meeting, Gothenburg, Sweden (1/2020).
- **Invited Oral** [Hoelzl M.](#) – *Edge localized modes and disruptions – Insights into large-scale plasma instabilities from non-linear MHD simulations.* – Institute Colloquium, Max Planck Institute for Plasma Physics, Garching, Germany (12/2018).
- **Invited Oral** [Hoelzl M.](#), G.T.A. Huijsmans, F. Orain, F.J. Artola, S. Pamela, F. Liu., D. van Vugt, S. Futatani, M. Becoulet, A. Cathey, K. Lackner, S. Günter, et al – *Simulating tokamak edge instabilities: advances and challenges.* – 45th European Physical Society Conference on Plasma Physics (EPS), Prague, Czech Republic, I5.J601 [abstract] (7/2018).
- **Invited Oral** [Hoelzl M.](#), Huijsmans G.T.A., Orain F., Artola F.J., Liu F., Futatani S., van Vugt D., Wolfrum E., Mink F., Trier E., Dunne M., Vanovac B., Viezzer E., Lessig A., Becoulet M., Pamela S., Guenter S., Lackner K., Krebs I., Wenninger R., Eich T., Frassinetti L., JOREK Team, ASDEX Upgrade Team, EUROfusion MST1 Team. – *What non-linear simulations can teach about ELM physics.* – 16th International Workshop on Plasma Edge Theory in Fusion Devices, Marseille, France, I3 (09/2017).

Teaching and Supervision

Full list at matthias-hoelzl.org/teaching.html

- Supervision of various Postdoctoral Researchers, PhD, master and bachelor students, as well as many working students. Substitutions for plasma physics lectures at Technical University Munich.

Commitments

- Since 2018: Chair of High Performance Computing Committee and member of IT coordination committee at Max Planck Institute for Plasma Physics
- 2018: Member of EUROfusion Ad Hoc Group on *Disruption and Run-away Electron Research & Development Strategy in view of preparing ITER and DEMO operation*
- 2014 to 2018: Member of scientists' representative council of Max Planck Institute for Plasma Physics
- Since 2013: Coordinator of JOREK code development, organizer of JOREK remote seminar, administrator of JOREK website and collaboration platform
- Referee for: Springer Nature Publishing, Physical Review Letters, Computer Physics Communications, Nuclear Fusion, Physics of Plasmas, Plasma Physics and Controlled Fusion, Physica Scripta, United States Department of Energy, L'Agence nationale de la recherche, Netherlands Organisation for Scientific Research, etc. — *Some of the reviews are listed at Publons.*