

# Marco A. Villena

Senior Postdoctoral Researcher  
King Abdullah University of Science and Technology (KAUST)  
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## EDUCATION

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2015	<b>Ph.D. in Physics</b> Thesis: “Study, modeling, and simulation of RRAM memories”	University of Granada, Spain
2012	<b>Master of Science</b> Thesis: “Methods and advanced techniques in Physics”	University of Granada, Spain
2010	<b>Bachelor in Physics</b>	University of Granada, Spain

## COURSES

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2022	<b>Higher Education Teaching Certificate</b> Grade: 92/100	Harvard BOK
2022	<b>Communicating with Diplomacy and Tact</b> Certificate number: AdV7EONteON4s0mgH7_rpbijrrk3 NASBA ID: #140940	LinkedIn Learning
2022	<b>Learning Data Science: Understanding the Basics</b> Certificate number: ASD6lqq0LJlIE844kVT18jlp0Uqx	LinkedIn Learning
2022	<b>Speaking Confidently and Effectively</b> Certificate number: AVgKkbDw8wJs21dumfjEl9gqBbQT	LinkedIn Learning
2021	<b>Strategic Negotiation</b> Certificate number: AepCjgsg3f8MOe1nvvdaw2vNY8r1 NASBA ID: #140940	LinkedIn Learning
2021	<b>Applied Plotting, Charting &amp; Data Representation in Python</b> Verify at <a href="https://coursera.org/verify/DJVM7FV2UL8K">coursera.org/verify/DJVM7FV2UL8K</a>	University of Michigan, USA
2021	<b>Data Visualization for Data Analysis and Analytics</b> Certificate number: AdnnUCt-6TnUHUPYjDbfvK87NTgp NASBA ID: #140940	LinkedIn Learning
2019	<b>Machine Learning</b> Verify at <a href="https://coursera.org/verify/5VVTDDXAS35R">coursera.org/verify/5VVTDDXAS35R</a>	Stanford University, USA

## PROFESSIONAL EXPERIENCE

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2022 –	<b>Senior Postdoctoral researcher</b>	KAUST, Saudi Arabia
2019 – 2022	<b>Physicist/scientist at AI R&amp;D department</b>	Applied Materials, Italy
2017 – 2019	<b>Postdoctoral fellow</b>	Stanford University, USA
2016 – 2019	<b>Postdoctoral researcher</b>	Soochow University, China

## TEACHING ACTIVITIES

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2023	<b>Master lecture: <i>Fabrication and characterization of electronic devices from the perspective of the industry: memristors based on 2D materials for neuromorphic circuits</i></b> <i>Hours: 2 hours</i>	University of Granada, Spain
2022 – 2023	<b>Teaching Assistant</b> <i>Course Title: Electronic Properties of Materials</i>	KAUST, Saudi Arabia
2001 – 2016	<b>Private tutor for Bachelor students</b> <i>Hours: 1084 hours with high school and bachelor students.</i>	Academia en Casa, Spain

## SCHOLARSHIPS/AWARDS

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2017	<b>Winner of the Suzhou NANO-CIC postdoctoral fellow</b>	Prize: 30.000USD
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## PATENTS

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2019	Marco A. Villena, Biyu Guo, Mario Lanza (Chinese names: 马尔科·维勒纳, 郭碧雨, 马里奥·兰扎), <b>Method for optimizing the use of conductive atomic force microscopes and digital source meters</b> (China, Application No. CN111122912A).
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## SCIENTIFIC ACTIVITIES

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- 2019 – Member of the technical committee of IPFA 2019 ([www.ipfa-ieee.org](http://www.ipfa-ieee.org)).
- 2017 – Reviewer of Scientific Reports, Wiley Publishing Group, Nature Publishing Group, and IEEE Publishing group.
- 2017 – Leader of the discussion group. The IEEE IIRW 2017 workshop ([www.iirw.org](http://www.iirw.org)).
- 2017 – Chair of organizing committee. ChinaRRAM workshop, Suzhou, China ([www.chinarram.org](http://www.chinarram.org)).
- 2017 – Member, Research Network “Institute of Electrical and Electronics Engineers”.
- 2016 – Member, Network of Researchers China-Spain. “RICE” ([www.ric-e.net](http://www.ric-e.net)).
- 2013 – Developer of SIM2RRAM simulation tool ([www.marcoavillena.com](http://www.marcoavillena.com)).

## SCIENTIFIC SOFTWARE DEVELOPED

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- SIM<sup>2</sup>RRAM**  
*Simulation tool for RRAM memories based on Finite-elements methods* ([www.marcoavillena.com](http://www.marcoavillena.com)).
- Split-DOS for VASP**  
*Software for managing and analyzing of the density of state data calculated by VASP* ([www.marcoavillena.com](http://www.marcoavillena.com)).
- SCIR** (Structure Classification by Image Recognition)  
*Software for automatic classification of crystallographic structures by image recognition techniques.*

#### 4. AReDeReSC

*Software for the automatic detection of Reset events during I-V curve measurement on memristor. This software has been designed to work with the Keysight B1500A semiconductor parameter analyzer. (Software for internal use only at Mario Lanza's group, Soochow University)*

## PUBLICATIONS

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1. Kaichen Zhu, Sebastian Pazos, Fernando Aguirre, Yaqing Shen, Yue Yuan, Wenwen Zheng, Osamah Alharbi, **Marco A. Villena**, Bin Fang, Xinyi Li, Alessandro Milozzi, Matteo Farronato, Miguel Muñoz-Rojo, Tao Wang, Ren Li, Hossein Fariborzi, Juan B. Roldan, Guenther Benstetter, Xixiang Zhang, Husam Alshareef, Tibor Grasser, Huaqiang Wu, Daniele Ielmini, Mario Lanza, "Hybrid 2D/CMOS microchips for memristive applications," *Nature*, (Accepted, March 2023).
2. S. Pazos, T. Becker, **M. A. Villena**, W. Zheng, Y. Shen, Y. Yuan, O. Alharbi, K. Zhu, J. B. Roldán, G. Wirth, F. Palumbo, M. Lanza, "High-temporal-resolution characterization reveals outstanding random telegraph noise and the origin of dielectric breakdown in h-BN memristors," *Advanced Functional Materials*, 2213816 (2023).
3. Juan B. Roldán, E. Miranda, D. Maldonado, A. N. Mikhaylov, N. V. Agudov, A. A. Dubkov, M. N. Koryazhkina, M. B. González, **M. A. Villena**, S. Poblador, M. Saludes-Tapia, R. Picos, F. Jiménez-Molinos, S. G. Stavrinides, E. Salvador, F. J. Alonso, F. Campabadal, B. Spagnolo, M. Lanza, L. O. Chua, "Variability in Resistive Memories," *Advanced Intelligent Systems*, 22003388 (2022).
4. Mario Lanza, Rainer Waser, Daniele Ielmini, J Joshua Yang, Ludovic Goux, Jordi Suñe, Anthony Joseph Kenyon, Adnan Mehonic, Sabina Spiga, Vikas Rana, Stefan Wiefels, Stephan Menzel, Ilia Valov, **Marco A Villena**, Enrique Miranda, Xu Jing, Francesca Campabadal, Mireia B Gonzalez, Fernando Aguirre, Felix Palumbo, Kaichen Zhu, Juan Bautista Roldan, Francesco Maria Puglisi, Luca Larcher, Tuo-Hung Hou, Themis Prodromakis, Yuchao Yang, Peng Huang, Tianqing Wan, Yang Chai, Kin Leong Pey, Nagarajan Raghavan, Salvador Dueñas, Tao Wang, Qiangfei Xia, Sebastian Pazos, "Standards for the characterization of endurance in resistive switching devices," *ACS nano* 15, 17214 – 17231 (2021).
5. M. Pešić, B. Beltrando, A. Padovani, S. Gangopadhyay, M. Kaliappan, M. Haverty, **M. A. Villena**, E. Piccinini, M. Bertocchi, T. Chiang, L. Larcher, J. Strand, A. L. Shluger, "Variability sources and reliability of 3D—FeFETs," in *2021 IEEE International Reliability Physics Symposium (IRPS) (pp. 1-7). IEEE (2021)*.
6. Bin Yuan, Xianhu Liang, Liubiao Zhong, Yuanyuan Shi, Felix Palumbo, Shaochuan Chen, Fei Hui, Xu Jing, **Marco A. Villena**, Lin Jiang, Mario Lanza, "150 nm × 200 nm Cross-Point Hexagonal Boron Nitride Based Memristors," *Advanced Electronic Materials* 6(12), 1900115 (2020).
7. Peisong Liu, Huanhuan Yu, Fei Hui, **Marco A Villena**, Xiaohong Li, Mario Lanza, Zhijun Zhang, "Fabrication of 3D silica with outstanding organic molecule separation and self-cleaning performance," *Applied Surface Science* 511, 145537 (2020).
8. J.B. Roldán, D. Maldonado, F. Jiménez-Molinos, C. Acal, J.E. Ruiz-Castro, A.M. Aguilera, F. Hui, J. Kong, Y. Shi, X. Jing, C. Wen, **M.A. Villena**, M. Lanza, "Reversible dielectric breakdown in h-BN stacks: a statistical study of the switching voltages," *2020 IEEE International Reliability Physics Symposium (IRPS). IEEE, (2020)*.
9. **Marco A. Villena**, Blanka Magyari-Köpe, Yoshio Nishi, Paul C. McIntyre, Mario Lanza, "Effect of IrO<sub>2</sub> spatial distribution on the stability and charge distribution of Ti<sub>1-x</sub>Ir<sub>x</sub>O<sub>2</sub> alloys," *Chemistry of Materials* 31(21), 8742-8751 (2019).
10. Shaochuan Chen, Seyedreza Noori, **Marco A. Villena**, Yuanyuan Shi, Tingting Han, Ying Zuo, Maria Pia Pedferri, Dmitri Strukov, Mario Lanza, Maria Vittoria Diamanti, "Memristive Electronic Synapses Made by Anodic Oxidation," *Chemistry of Materials* 31(20), 8394-8401 (2019).
11. Kaichen Zhu, Xianhu Liang, Bin Yuan, **Marco A. Villena**, Chao Wen, Tao Wang, Shaochuan Chen, Fei Hui, Yuanyuan Shi, Mario Lanza, "Tristate graphene-boron nitride-graphene cross-point memristors," *ACS Applied Materials and Interfaces*, 11, 37999-38005 (2019).

12. **M. A. Villena**, F. Hui, X. Liang, Y. Shi, B. Yuan, X. Jing, K. Zhu, S. Chen, and M. Lanza, "Variability of metal/h-BN/metal memristors grown via chemical vapor deposition on different materials," *Microelectronics Reliability*, 102, 113410 (2019).
13. Bin Yuan, Xianhu Liang, Liubiao Zhong, Yuanyuan Shi, Felix Palumbo, Shaochuan Chen, Fei Hui, Xu Jing, **Marco A. Villena**, Lin Jiang, Mario Lanza, "150 nm × 200 nm Cross-Point Hexagonal Boron Nitride Based Memristors," *In 2019 Electron Devices Technology and Manufacturing Conference (EDTM)* (pp. 258-260). *IEEE* (2019).
14. Mario Lanza, H.-S. Philip Wong, Eric Pop, Daniele Ielmini, Dimitri Strukov, Brian C. Regan, Luca Larcher, **Marco A. Villena**, Jianghua J. Yang, Ludovic Goux, Attilio Belmonte, Yuchao Yang, Francesco M. Puglisi, Jinfeng Kang, Blanka Magyari-Köpe, Eilam Yalon, Anthony Kenyon, Mark Buckwell, Adnan Mehonic, Alexander Shluger, Haitong Li, Tuo-Hung Hou, Boris Hudec, Deji Akinwande, Ruijing Ge, Stefano Ambrogio, Juan B. Roldan, Enrique Miranda, Jordi Suñe, Kin Leong Pey, Xing Wu, Nagarajan Raghavan, Ernest Wu, Wei D. Lu, Gabriele Navarro, Weidong Zhang, Huaqiang Wu, Runwei Li, Alexander Holleitner, Ursula Wurstbauer, Max Lemme, Ming Liu, Shibing Long, Qi Liu, Hangbing Lv, Andrea Padovani, Paolo Pavan, Ilia Valov, Xu Jing, Tingting Han, Kaichen Zhu, Shaochuan Chen, Fei Hui, Yuanyuan Shi, "Recommended methods to study resistive switching devices," *Advanced Electronic Materials*, 1800143 (2018).
15. Fei Hui, Xianhu Liang, Wenjing Fang, Wei Sun Leong, Haozhe Wang, Hui Ying Yang, Yuanyuan Shi, **Marco A. Villena**, Jing Kong, and Mario Lanza, "Uniformity of Multilayer Hexagonal Boron Nitride Dielectric Stacks Grown by Chemical Vapor Deposition on Platinum and Copper Substrates," *In 2018 IEEE International Symposium on the Physical and Failure Analysis of Integrated Circuits (IPFA)* (pp. 1-4). *IEEE* (2018).
16. Fei Hui, **Marco Villena**, Wenjing Fang, Ang-Yu Lu, Jing Kong, Yuanyuan Shi, Xu Jing, Kaichen Zhu, and Mario Lanza, "Synthesis of large-area multilayer hexagonal boron nitride sheets on iron substrates and its use in resistive switching devices," *2D materials*, 5(3), 031011 (2018).
17. Bingru Wang, Na Xiao, Chengbin Pan, Yuanyuan Shi, Fei Hui, Xu Jing, Kaichen Zhu, Biyu Guo, **Marco A. Villena**, Enrique Miranda, and Mario Lanza, "Experimental Observation and Mitigation of Dielectric Screening in Hexagonal Boron Nitride Based Resistive Switching Devices," *Cryst. Res. Technol.*, 53, 1800006 (2018).
18. Felix Palumbo, Xianhu Liang, Bin Yuan, Yuanyuan Shi, Fei Hui, **Marco A. Villena**, and Mario Lanza, "Bimodal Dielectric Breakdown in Electronic Devices Using Chemical Vapor Deposited Hexagonal Boron Nitride as Dielectric," *Advanced Electronic Materials*, 1700506 (2018).
19. Fei Hui, Wenjing Fang, Wei Sun Leong, Tewa Kpulun, Haozhe Wang, Hui Ying Yang, **Marco A. Villena**, Gary Harris, Jing Kong, and Mario Lanza, "Electrical Homogeneity of Large-Area Chemical Vapor Deposited Multilayer Hexagonal Boron Nitride Sheets," *ACS Applied Materials & Interfaces* 9(46), 39895-39900 (2017).
20. Lanlan Jiang, Yuanyuan Shi, Fei Hui, Kechao Tang, Qian Wu, Chengbin Pan, Xu Jing, Hasan Uppal, Felix Palumbo, Guangyuan Lu, Tianru Wu, Haomin Wang, **Marco Villena**, Xiaoming Xie, Paul McIntyre and Mario Lanza, "Dielectric Breakdown in Chemical Vapor Deposited Hexagonal Boron Nitride," *ACS Applied Materials & Interfaces* 9(45), 39758-39770 (2017).
21. **Marco A. Villena**, Juan B. Roldán, Francisco Jiménez-Molinos, Enrique Miranda, Jordi Suñe and Mario Lanza, "SIM<sup>2</sup>RRAM: A physical model for RRAM devices simulation," *Journal of Computational Electronics* pp. 1-26 (2017).
22. E. Miranda, J. Suñe, C. Pan, **M. Villena**, N. Xiao, and M. Lanza, "Equivalent Circuit Model for the Electron Transport in 2D Resistive Switching Material Systems," *Solid-State Device Research Conference (ESSDERC), 47th European* (2017).
23. M. Moner Al Chawa, Rodrigo Picos, Juan B. Roldan, Francisco Jimenez-Molinos, **Marco Antonio Villena** and Carol de Benito, "Exploring Resistive Switching based Memristors in the Charge-Flux Domain, a Modeling Approach," *International Journal of Circuit Theory & Applications*, 1097-007X (2017).

24. Na Xiao, **Marco A. Villena**, Bin Yuan, Shaochuan Chen, Bingru Wang, Marek Eliáš, Yuanyuan Shi, Fei Hui, Xu Jing, Andrew Scheuermann, Kechao Tang, Paul C. McIntyre and Mario Lanza, "Resistive Random Access Memory Cells with a Bilayer TiO<sub>2</sub>/SiO<sub>x</sub> Insulating Stack for Simultaneous Filamentary and Distributed Resistive Switching," *Advanced Functional Material* 1700384 (2017).
25. Pan Chengbin, Enrique Miranda, **Marco A. Villena**, Na Xiao, Xu Jing, Xie Xiaoming, Fei Hui, Yuanyuan Shi and Mario Lanza, "Model for multi-filamentary conduction in graphene/hexagonal-boron-nitride/graphene based resistive switching devices using the nonlinear Landauer approach," *2D materials* 4, 025099 (2017).
26. **Marco A. Villena**, Juan B. Roldán, Pedro García-Fernández and Francisco Jiménez-Molinos, "Effects of the extension of conductive filaments, a simulation approach," *Journal of Vacuum Science & Technology B*, 35, 01A105 (2017).
27. **M. A. Villena**, J. B. Roldan, M.B. González, P. González-Rodelas, F. Jimenez-Molinos, F. Campabadal and D. Barrera, "A new parameter to characterize the charge transport regime in Ni/HfO<sub>2</sub>/Si-n<sup>+</sup>-based RRAMs," *Solid-State Electronics*, 118, 56-60 (2016).
28. **M. A. Villena**, M. B. González, J. B. Roldan, F. Campabadal, F. Jimenez-Molinos, F. M. Gómez-Campos and J. Suñé, "An in-depth study of thermal effects in reset transitions in HfO<sub>2</sub> based RRAMs," *Solid-State Electronics*, 111, 47-51 (2015).
29. F. Jimenez-Molinos, **M. A. Villena**, J. B. Roldan and A. M. Roldan, "A SPICE Compact Model for Unipolar RRAM reset process analysis," *Electron Devices, IEEE Transactions on*, 62(3), 955-962 (2015).
30. **M. A. Villena**, M. B. González, F. Jimenez-Molinos, F. Campabadal, J. B. Roldan, J. Suñe, E. Romera and E. Miranda, "Simulation of thermal reset transitions in resistive switching memories including quantum effects," *J. Appl. Phys.* 115, 214504 (2014).
31. **M. A. Villena**, J. B. Roldan, F. Jimenez-Molinos, J. Suñe, S. Long, E. Miranda and M. Liu, "A comprehensive analysis on progressive reset transitions in RRAMs," *J. Phys. D: Appl. Phys.* 47, 205102 (2014).
32. **M. A. Villena**, F. Jimenez-Molinos, J. B. Roldan, J. Suñe, S. Long, X. Lian, F. Gamiz and M. Liu, "An in-depth simulation study of thermal reset transitions in resistive switching memories," *J. Appl. Phys.* 114, 144505 (2013).

## CONFERENCES

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1. X. Liang, B. Yuan, Y. Shi, F. Palumbo, S. Chen, F. Hui, X. Jing, **M. A. Villena**, and M. Lanza "150 nm × 200 nm cross point hexagonal boron nitride based memristors with ultra-low currents in high resistive state," *In 2019 Electron Devices Technology and Manufacturing Conference (EDTM), Singapore*, 258-260.
2. Na Xiao, **Marco A. Villena**, Bin Yuan, Shaochuan Chen, Bingru Wang, Marek Eliáš, Yuanyuan Shi, Fei Hui, Xu Jing, Andrew Scheuerman, Kechao Tang, Paul C. McIntyre, and Mario Lanza, "TiO<sub>2</sub>/SiO<sub>x</sub> bilayer insulating stacks for simultaneous filamentary and distributed resistive switching," *In IIRW 2017, International Workshop*.
3. **Marco A. Villena**, "SIM<sup>2</sup>RRAM: New physical model and simulator for Resistive RAM," *In China RRAM 2017, International Workshop*.
4. **Marco A. Villena**, Juan B. Roldán and Francisco Jiménez-Molinos, "Threshold voltage of reset: A new parameter to electrical characterization of RRAM devices," *In China RRAM 2017, International Workshop*.
5. Z. He, **Marco A. Villena**, K. Zhu, S. Chen, B. Wang, X. Liang, B. Yuan and M. Lanza, "Au/Ti/TiO<sub>2</sub>/Au cross point resistive switching cells: experiment and simulation," *In China RRAM 2017, International Workshop*.
6. Na Xiao, **Marco A. Villena**, Yuanyuan Shi, Xu Jing, Fei Hui and Mario Lanza, "Combination of local and distributed resistive switching in ultra-thin (<2nm) TiO<sub>2</sub> films," *In CDE 2017, 11<sup>th</sup> Spanish Conference on Electron Devices*.

7. **M. A. Villena**, J. B. Roldan, M. P. García-Fernández and F. Jimenez-Molinos, "Effects of the extension of conductive filaments within the electrodes in RRAMs, a simulation approach," *In Wodim 2016, 19<sup>th</sup> Workshop on Dielectrics in Microelectronics*.
8. G. González, F. Jimenez-Molinos, **M. A. Villena** and J. B. Roldan, "SPICE simulation of thermal reset transitions in Ni/HfO<sub>2</sub>/Si-n<sup>+</sup> RRAMs including quantum effects," *In Wodim 2016, 19<sup>th</sup> Workshop on Dielectrics in Microelectronics*.
9. R. Picos, J. B. Roldan, M. M. Al Chawa, F. Jimenez-Molinos, **M. A. Villena** and E. Garcia-Moreno, "Exploring ReRRAM-based memristors in the charge-flux domain, a modeling approach," *In IEEE Memristive Systems (MEMRISYS) 2015 International Conference, (pp. 1-2)*.
10. **M. A. Villena**, J.B. Roldán, F. Jiménez-Molinos, E. Romera, P. Cartujo-Cassinello, "A comprehensive resistive memory characterization through the analysis of conductive filaments," *15<sup>th</sup> edition of Trends in Nanotechnology International Conference (TNT2014)*.

## FUNDED NATIONAL AND INTERNATIONAL PROJECTS

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1. Title: Two-dimensional nanomaterial-based electronic synapses for neural computing  
 Entity: *China NSFC Mianshang*  
 Researcher in charge: *Mario Lanza*  
 From: *01/2019 to 12/2022* Funding: 630,000 RMB (~90,000 USD)  
 Reference: *61874075*
2. Title: Electronic synapses based on two dimensional materials for neuromorphic computing  
 Entity: *BRICS - Brazil, Russia, India, China, and South Africa committees*  
 Researcher in charge: *Mario Lanza*  
 From: *01/2019 to 12/2021* Funding: 2,200,000 RMB (~320,000 USD)  
 Reference: *2018YFE0100800*
3. Title: Fabricación, caracterización, simulación, modelado de dispositivos de conmutación resistiva  
 Entity: *Ministerio de Economía, Industria y Competitividad (Spain)*  
 Researcher in charge: *Juan Bautista Roldán Aranda and Francisco Jiménez Molinos*  
 From: *01/01/2018 to 31/12/2020* Funding: 114,950 €  
 Reference: *TEC2017-84321-C4-3-R*

## TECHNICAL SKILLS

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Programming	MATLAB, Python, Linux Bash, Visual Basic .NET, FORTRAN
Design & Simulation	Ginestra, VASP, PSpice, FreeCAD
Other tools	VESTA, CrystalMaker, Blender, Gimp 2, Affinity Designer, Linux (SUSE, Ubuntu), Microsoft Office, LibreOffice