Multi-scale fibre-based optical frequency combs: science, technology and applications (MEFISTA)

Deliverable D6.6 (D31) Dissemination and Outreach Portfolio

Project details

Project Number	861152	Project Acronym	MEFISTA
Project Title	Multi-scale fibre-based optical frequency combs: science, technology and applications		
Project website	https://mefista.astonphotonics.uk/		
Starting date	01/02/2020		
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Document details

Title	Dissemination and outreach portfolio		
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Dissemination level

Public (PU)	X
Confidential, only for members of the consortium (including Commission Services)	

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Acronyms

AIPT	Aston Institute Of Photonic Technologies, UK
Alpha RLH	Alpha RLH, France
AST	Aston University, UK
CA	Consortium Agreement
DTU	Technical University of Denmark
EC	European Commission
EPFL	École Polytechnique Fédérale de Lausanne, Switzerland
ETN	European Training Network
ESR	Early Stage Researcher
GA	Grant Agreement
ITN	Innovative Training Network
ULille	Université de Lille, France
NKT	NKT Photonics, Denmark
OFC	Optical frequency combs
RDM	RDM Group, UK
SB	Supervisory Board
UPC	Universitat Politècnica de Catalunya, Spain

Consortium

EXECUTIVE SUMMARY

This deliverable demonstrates the Scientific Research Output of the MEFISTA European Training Network (ETN, EC GA 861152) and the dissemination measures taken in terms of peer-reviewed publications, conference papers and invited talks, public deliverables, posters and seminars.

The main aim of these dissemination activities has been to publicize the project's research results, raising their profile and maximising the impact of MEFISTA's research results by making them freely available and easily discoverable to a predominantly academic audience.

Regarding dissemination, MEFISTA ESRs have exceeded the requirements of the GA:

- They have published **18 peer-reviewed journal articles** (five of these being high impact)
- Given **7 talks** at Conference on Lasers and ElectroOptics (CLEO) Europe, CLEO USA, the European Conference on Optical Communication (ECOC), The International Society for Optics and Photonics (SPIE) and the International Conference on Transparent Optical Networks (ICTON) and had **9 papers** feature in conference proceedings, **totalling 16**
- Given **24 workshop talks**
- Given **9 local seminar talks**
- Produced **10 posters**

A more detailed list of output – journals, conference papers, conference talks and posters, with open access links - is given in section 1.

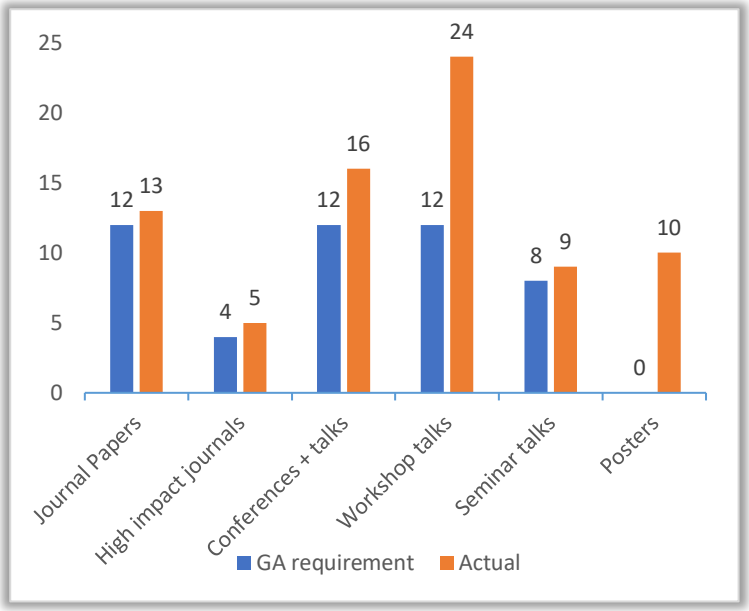

Figure 1 Grant requirements versus actual

MEFISTA's six ESRs have at time of writing (July 2024, M54) completed 22 of the project's 23 scientific deliverables, with the final deliverable (D4.4) only partially achieved. Open access links to public scientific deliverables are in section 1.1.

In terms of outreach, MEFISTA has had a presence on the following social media platforms: YouTube, Twitter/X and Instagram, and it has published a six-part podcast (featuring each ESR) and four

annual Mailchimp newsletters. More on public engagement in section 2 with links to the social media content where applicable.

Other outreach events include a college talk on MSCA programmes to young students in India and a Smart City technology event in the UK.

This report covers the entire 4-year MEFISTA European Training Network (EC GA 861152).

CONTEXT OF THE MEFISTA ETN PROJECT

Horizon2020 European Training Network (ETN) MEFISTA (Multi-scale fibre-based optical frequency combs: science, technology and applications) is a doctoral-level training network funded by the EC under Horizon2020 Marie Skłodowska-Curie Actions.

The programme has trained six Early-Stage Researchers (ESRs) and has focused on the development of optical frequency combs (OFCs), a tool for measuring very high light frequencies.

The project has aimed to make important innovative steps in the generation of specialised laser waveforms, mid-infrared tuneable dual-comb sources and manufacturing of mode-locked fibre lasers, plus the use of frequency combs in laser radar/LIDAR in autonomous cars.

All MEFISTA ESRs have benefited from secondments and a comprehensive training programme during their PhD featuring technical and entrepreneurial training, plus transferable skills training.

1 SCIENTIFIC PROJECT OUTPUT AND ITS DISSEMINATION

MEFISTA ETN is a medium-sized project with six Early Stage Researchers (ESRs).

Project results have been disseminated to the scientific community through scientific deliverables (section 1.1); published peer-reviewed journal papers and chapters (section 1.2); peer-reviewed conference proceedings (section 1.3); peer-reviewed conference talks and invited talks (section 1.4), non peer-reviewed conferences talks (section 1.5); posters (section 1.6); submitted papers (section 7); PhD theses (section 1.8); peer-reviewed scientific papers (section 1.9) and seminar talks (section 1.10).

Approved 6 Month Project Extension:

Because the project started during the height of COVID, the start dates of three ESRs were delayed, leading to a delay in the achieving deliverables.

- ESR2 Mohammad Nayeem Akhter started in June 2022, M17
- ESR4 Qing Wang started in May 2021, M16
- ESR5 Alberto Cuevas Rodriguez started in April 2021, M15

Consequently, a 6-month project extension was granted in late 2022 by the Project Officer, extending it from 48 months to 54, making MEFISTA's end date 31 July 2024, not 31 January 2024. The remaining deliverables and milestones had an altered delivery date of M54 and this extra time allowed more articles to be published too.

From Annex 1 of Description of the Action (Part B), MEFISTA's dissemination were as follows:

- 12 Conference Papers
- 12 Journal Papers
- 4 extra high rated journal papers (E.g. Physical Review Letters, Scientific Reports, Optics).
- 8 seminar talks around the host institutes
- 12 workshop talks

Totals achieved at the end of the project:

At the time of writing, July 2024, M54, MEFISTA's six ESRs have published:

- 18 peer reviewed journal papers (this figure includes two book chapter contributions and five high impact journals)
- They have taken part in nine conference proceedings
- They have presented seven peer-reviewed conference talks
- Produced one peer-reviewed paper, published on the pre-publication server Arxiv
- Given one non-peer-reviewed conference talk
- One of the ESRs' theses has been published (ESR1)
- Given 24 MEFISTA Workshop talks
- Given nine seminar talks
- Presented 10 posters, nine of which are published on Zenodo, the tenth pending
- Produced two submitted papers (in the process of being assessed for acceptance)

Open Access (OA) of research output has been a strong commitment in MEFISTA.

In accordance with the GA, MEFISTA has made all its research output either gold or green OA by default.

EC funding has been acknowledged throughout.

All published research is also freely available on the MEFISTA website, at:

https://mefista.astonphotonics.uk/publications/ and https://mefista.astonphotonics.uk/conference-talks-posters/

Posters, and some articles and conference proceedings, have been published on the Open Repository ZENODO https://zenodo.org/ with the occasional paper on the pre-publication server https://arxiv.org.

1.1 PUBLIC SCIENTIFIC DELIVERABLES

Twenty-two of the project's total 23 scientific deliverables have been submitted so far, with the remaining D4.4 partially achieved (Library of the ellipsometric signatures in terms of the objective function; machine learning algorithms, and software towards the objects recognition; the programmed FPGA with ability to recognise the objects in the harsh weather conditions).

Completed public deliverables have been submitted to the European Commission via the Funding and Tender Portal/SyGMA, and been made public / Open Access on the project website https://mefista.astonphotonics.uk/deliverables-public/.

After the 6-month project extension was granted by the Project Officer in May 2023, M40, nine science deliverables D1.3, D1.6-7, D3.4, D4.4-4.8 were given revised due dates of July 31, 2024, M54.

MEFISTA Deliverables (links go to submitted public deliverables on the project website)

D1.1 Numerical model for few mode fibre ring cavities, ULille.

D1.2 Passive cavity architecture based on a Fabry Perot resonator in a few mode fibre.

D1.3 Dual comb generation in passive few mode cavity resonator.

D1.4 Gain through loss mechanism observation in passive fibre ring cavity.

D1.5 Passive PM fibre ring cavity including a PM FBG.

D1.6 Dual frequency comb generation in passive PM fibre ring cavity via the gain through loss mechanism.

D1.7 Optical fibres and Fibre Bragg grating for the project.

D2.1 Theory and experimental demonstration of active PT-modelocking.

D2.2 Passive modelocking due to non-Hermitian modulation of the potential.

D2.3 Modelocking and frequency combs with features on demand.

D2.4 Modelocking and dual frequency comb lasers based on multimode fibres and resonators.

D3.1 Library of characterized 2 µm fibres (active and passive) including all necessary parameters for accurate modelling.

D3.2 Models of pulsed laser architectures operating either in soliton or dissipative soliton resonance. Numerical codes. Fibres and fibre Bragg gratings for dispersion and nonlinearity controlled laser cavities.

D3.3 Measurement of modelocked fibre lasers operating in the 2µm range with controlled cavity dispersion and nonlinearity. Measurement of short-wave infrared E-O frequency comb source.

D3.4 Prototype of single and dual frequency combs in the 2 um band based on fibre laser and E-O source.

D4.1 Test-bed for experimental tests of the EOFC in the context of distance ranging and objects recognition. *Submitted, confidential.*

D4.2 Equations with reduced complexity for theoretical characterisation of the polarisation dynamics of EOFC, numerical codes, results of numerical modelling and simplified analytical approaches to the polarisation dynamics of the mode-locked lasers.

D4.3 Library of the mode-locked regimes with multiscale polarisation dynamics in terms of the objective functions; machine learning algorithms, and software towards the regimes recognition and stabilisation; the programmed FPGA with ability to adjust the dynamics on demand.

D4.4 Library of the ellipsometric signatures in terms of the objective function; machine learning algorithms, and software towards the object's recognition; the programmed FPGA with ability to recognise the objects in the harsh weather conditions. *Partially achieved, confidential.*

D4.5 Test-bed prototype dual comb source for polarisation-based object recognition. *Submitted, confidential.*

D4.6 Test-bed prototype dual comb source for LIDAR applications. *Submitted, confidential.*

D4.7 Patent on dual comb LIDAR for autonomous driving vehicles. *Submitted, confidential.*

D4.8 Patent on comb source for dual comb source for object recognition. *Submitted, confidential.*

1.2 PEER-REVIEWED JOURNAL PAPERS INCLUDING BOOK CHAPTERS (most recent on top)

Highest citation of papers:

Amongst the research output, the highest-cited papers to date (time of writing, July 2024, M54) have been peer-reviewed publications 1.2.17 [first author MEFISTA ESR3 Moritz Bartnick]; 1.2.14 [first author MEFISTA ESR5 Alberto Rodriguez Cuevas]; and 1.2.8 [first author MEFISTA ESR2 Mohammad Nayeem Akhter], with 7, 5 and 4 citations respectively.

Note: It should be noted that publication 1.2.17 has been published for longer, since 2022, compared to 1.2.8 and 1.2.14, both published in 2023.

1.2.1
Anamika Nair Karunakaran, Marco Clementi, Christian Lafforgue, Ozan Yakar, Anton Stroganov, Poul Varming, Minhao Pu, Kresten Yvind, Patrick Montague and Camille Sophie Brès.
"Dissipative Kerr soliton generation at 2 µm in a silicon nitride microresonator," Optics Express, Vol. 32, Issue 9, pp 14929-14939, 2024.
DOI: https://doi.org/10.1364/OE.515225
Open Access: https://opg.optica.org/oe/fulltext.cfm?uri=oe-32-9-14929&id=548795

1.2.2
Mohammad Nayeem Akhter, Salim B. Ivars, Muriel Botey, Ramon Herrero, Kestutis Staliunas.
"Mode-cleaning in antisymmetrically modulated non-Hermitian waveguides," Nanophotonics Journal, Volume 13, No. 7, pp. 1017-1024, De Gruyter, January 12, 2024.
DOI: https://doi.org/10.1515/nanoph-2023-0713
Open Access: https://www.degruyter.com/document/doi/10.1515/nanoph-2023-0713/html
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1.2.3
Zhiwei Huang, Sergey Sergeyev, Qing Wang, Hani Kbashi, Dmitrii Stoliarov, Qianqian Huang, Yuze Dai, Zhijun Yan, Chengbo Mou.
"Dissipative soliton breathing dynamics driven by desynchronization of orthogonal polarization states," Advanced Photonics Nexus, Vol. 2, Issue 6, 066007, SPIE Digital Library, November 23, 2023.
DOI: https://doi.org/10.1117/1.APN.2.6.066007
Open Access: https://publications.aston.ac.uk/id/eprint/45804/1/066007_1.pdf

1.2.4
Alberto Rodriguez Cuevas, Igor Kudelin, Hani J. Kbashi, Sergey Sergeyev.
"Single-shot dynamics of dual-comb generation in a polarization-multiplexing fiber laser," Scientific Reports volume 13, Article number: 19673, November 11, 2023.
DOI: https://doi.org/10.1038/s41598-023-46999-9
Open Access here: https://www.nature.com/articles/s41598-023-46999-9
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1.2.5
J. Connor Skehan*, Anamika Nair Karunakaran*, Poul Varming, Óskar B. Helgason, Patrick B. Montague, Jochen Schröder, Minhao Pu, Kresten Yvind, Victor Torres-Company, and Peter A. Andrekson.
"Thermorefractive noise reduction of photonic molecule frequency combs using an alloptical servo loop," Optics Express, Volume 31, Issue 21, pp 35208-35217, October 2023.
*Both authors contributed equally.
DOI: https://doi.org/10.1364/OE.496895
Open Access: https://opg.optica.org/oe/fulltext.cfm?uri=oe-31-21-35208&id=540602

1.2.6
Stefano Negrini, Jean Baptiste Ceppe, Matteo Conforti, Auro M Perego, Alexandre Kudlinski, Arnaud Mussot.
"Coexistence of gain-through-filtering and parametric instability in a fiber ring cavity," Optics Express, Volume 31, Issue 22, pp 37011-37018. Optical Society of America, October 18, 2023.
DOI: https://doi.org/10.1364/OE.498572
Open Access: https://hal.science/hal-04250890/file/oe-31-22-37011.pdf
and https://opg.optica.org/oe/fulltext.cfm?uri=oe-31-22-37011&id=540966

1.2.7
Hani J. Kbashi; Vishal Sharma; Sergey V. Sergeyev.
"Tunable Multiwavelength SOA-Based Fiber Laser," Electronics; Volume 12; Issue 15; Pages: 3277, July 30, 2023.
DOI: https://doi.org/10.3390/electronics12153277
Open Access: https://www.mdpi.com/2079-9292/12/15/3277

1.2.8
Mohammad Nayeem Akhter, Salim B. Ivars, Muriel Botey, Ramon Herrero, Kestutis Staliunas.
"Non-Hermitian Mode Cleaning in Periodically Modulated Multimode Fibers," Physical Review Letters, Vol 131, Issue 4, pp. 043604. July 28, 2023.
DOI: https://doi.org/10.1103/PhysRevLett.131.043604
Open Access: https://arxiv.org/abs/2211.12762
https://arxiv.org/ftp/arxiv/papers/2211/2211.12762.pdf
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1.2.9
Stefano Negrini, Saliya Coulibaly, François Copie, Majid Taki, Arnaud Mussot.
"Pump-cavity synchronization mismatch in modulation instability induced optical frequency combs," Physical Review Research; Vol. 5, Issue 2, May 30, 2023.
DOI: https://doi.org/10.1103/PhysRevResearch.5.023133
Open Access: https://zenodo.org/records/11066106 and
https://journals.aps.org/prresearch/pdf/10.1103/PhysRevResearch.5.023133

1.2.10
Sergey Sergeyev, Chengbo Mou, Hani J. Kbashi, Stanislav Kolpakov.
Book title: Polarization Dynamics of Mode-Locked Fiber Lasers.
Chapter 1: Polarization Dynamics in Mode-Locked Fiber Lasers, CRC Press, April 20, 2023.
DOI: http://doi.org/10.1201/9781003206767-1
Open Access:
https://research.aston.ac.uk/files/106661231/S_Sergeyev_et_al_Ch_1_Polarization_dynamics_in_mode_locked_fiber_lasers.pdf

1.2.11
Kbashi, Hani J. and Sharma, Vishal. Editors Sergey V. Sergeyev, Chengbo Mou.
Book title: "Polarization Dynamics of Mode-Locked Fiber Lasers."
Chapter 8: "Dual-Wavelength Fiber Laser for 5G and Lidar Applications," CRC Press, April 20, 2023.
DOI: http://doi.org/10.1201/9781003206767-8
Open Access:
https://research.aston.ac.uk/en/publications/dual-wavelength-fiber-laser-for-5g-and-lidar-applications

1.2.12
M. Bartnick, G. Bharathan, T. A. Goebel, R. G. Krämer, S. Nolte, C.-S. Brés.
"Wavelength-stabilized figure-of-9 thulium-doped all-fiber laser emitting 560 fs pulses," Laser Physics, IOP Publishing, Volume 34 (2), pp. 25101, December 2023.
DOI: https://doi.org/10.1088/1555-6611/ad1504
Open Access: https://iopscience.iop.org/article/10.1088/1555-6611/ad1504/pdf
Cited by 1

1.2.13
M. Bartnick, G. Bharathan, C.-S. Brès.
"Polarization-multiplexed thulium-doped fiber laser for free-running dual-comb generation," Fiber lasers XX: technology and systems, Volume 12400 (SPIE Digital Library), pp. 151–152, March 2023.
DOI: https://doi.org/10.1117/12.2648361
Open Access: https://infoscience.epfl.ch/record/310695?ln=en&v=pdf

1.2.14
Alberto Rodriguez Cuevas, Hani J. Kbashi, Dmitrii Stoliarov, Sergey Sergeyev.
"Polarization dynamics, stability and tunability of a dual-comb polarization-multiplexing ring-cavity fiber laser," Elsevier, ScienceDirect, Results in Physics, Volume 46, March 2023.
DOI: https://doi.org/10.1016/j.rinp.2023.106260
Open Access:
https://reader.elsevier.com/reader/sd/pii/S2211379723000530?token=42EC457BBF99E4E59B4335F6A8DA86E5F2F73DC3FBEE44477DAB30CA3BA30022A71609E1D6E8735D9364B604689E0A41&originRegion=eu-west-1&originCreation=20230213140214
Cited by 5

1.2.15
Hani Kbashi, S. Kolpakov, Sergey Sergeyev.
"Fast and slow optical rogue waves in the fiber laser," Frontiers, Vol. 10, pp 1235, November 30, 2022.
DOI: https://doi.org/10.3389/fphy.2022.1048508
Open Access: https://www.frontiersin.org/articles/10.3389/fphy.2022.1048508/full

1.2.16
Sergey Sergeyev, Mahmoud Eliwa, Hani Kbashi.
"Polarization attractors driven by vector soliton rain," Optica Publishing Group, Optics Express, Vol. 30, Issue 20, pp 35663-35670, September 15, 2022.
DOI: https://doi.org/10.1364/OE.462491
Open Access: https://opg.optica.org/oe/fulltext.cfm?uri=oe-30-20-35663&id=502636

1.2.17
Moritz Bartnick, Gayathri Bharathan, Thorsten A. Goebel, Ria G. Krämer, Stefan Nolte, Camille-Sophie Brès.
"Wavelength-stabilized tunable mode-locked thulium-doped fiber laser beyond 2 μm," Optica Publishing Group, Optics Letters, Volume 47, Issue 8, pp. 2085-2088, April 13, 2022.
DOI: https://doi.org/10.1364/ol.453936
Open Access: https://opg.optica.org/ol/fulltext.cfm?uri=ol-47-8-2085&id=471389
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1.2.18

Sergey Sergeyev, Stanislav Kolpakov, Yury Loika.
"Vector harmonic mode-locking by acoustic resonance," Optica Publishing Group, Photonics Research, Volume 9, Issue 8, pp 1432-1438, July 8, 2021.
DOI: https://doi.org/10.1364/PRJ.424759
Open Access: https://opg.optica.org/prj/fulltext.cfm?uri=prj-9-8-1432&id=453142

1.3 PEER-REVIEWED CONFERENCE PROCEEDINGS (most recent on top)

1.3.1
Anamika Nair Karunakaran, Marco Clementi, Christian Lafforgue, Ozan Yakar, Anton Stroganov, Poul Varming, Minhao Pu, Kresten Yvind, Patrick Montague and Camille-Sophie Brès.
"MidIR Soliton Microcomb Generation in Silicon Nitride Microring Resonators," European Conference on Optical Communications (ECOC), October 1-5, 2023, Glasgow, Scotland.
DOI: https://doi.org/10.1049/icp.2023.2365

1.3.2
Mohammad Nayeem Akhter, S. B. Ivars, Ramon Herrero, Kestutis Staliunas, Muriel Botey.
"Self-Cleaning in non-Hermitian Linear Multimode Fibers," International Conference on Transparent Optical Networks. 23rd International Conference on Transparent Optical Networks, (ICTON), July 2-6, 2023, Bucharest, Romania.
DOI: https://doi.org/10.1109/icton59386.2023.10207367
Open Access: https://upcommons.upc.edu/handle/2117/396970

1.3.3
Mohammad Nayeem Akhter, Salim B. Ivars, Muriel Boety, Ramon Herrero, and Kestutis Staliunas.
"Non-Hermitian light control in periodically modulated multimode fibers," SPIE Optics + Optoelectronics, April 24-27, 2023, Prague, Czech Republic.
DOI: https://doi.org/10.1117/12.2665720
Open Access: https://upcommons.upc.edu/handle/2117/396969

1.3.4
Zhiwei Huang, Sergey Sergeyev, Qianqian Huang, Zhikun Xing, Zhijun Yan, and Chengbo Mou.
"Breathers driven by polarization instabilities," CLEO: Applications and Technology 2022, Joint Poster Session II-B (Virtual) (JW3B), May 15-20, 2022, San Jose, California, USA.
DOI: https://doi.org/10.1364/cleo_at.2022.jw3b.47
Open Access article:
https://publications.aston.ac.uk/id/eprint/43864/1/Huang_Sergeyev_et_al_Nonlinear_Polarization_Rotation_CLEO_2022_SES_v1.pdf

1.3.5
Stefano Negrini, François Copie, Saliya Coulibaly, Matteo Conforti, Alexandre Kudlinski, Arnaud Mussot.
"Effect of synchronization mismatch on modulation instability in passive fiber-ring cavity," Conference on Lasers and Electro-Optics Europe & European Quantum Electronics Conference (CLEO/Europe-EQEC). IEEE Publisher, July 21-25, 2021.
DOI: http://doi.org/10.1109/cleo/europe-eqec52157.2021.9541780
Open Access: https://zenodo.org/records/11065417

1.3.6
Moritz Bartnick; Gayathri Bharathan; Thorsten A. Goebel; Ria G. Krämer; Stefan Nolte; Camille-Sophie Brès.
"Wavelength-stabilized tunable mode-locked thulium-doped fiber laser beyond 2 µm," ELIOS, Journee du GDR, October 19-21, 2021, Lille, France.

DOI: https://doi.org/10.1364/OL.453936

1.3.7
Stefano Negrini, 2021.
"Coexistence of Gain through Filtering and Boundary Conditions parametric gains in an optical cavity," ELIOS, Journee du GDR, October 19-21, 2021, Lille, France,
https://elios2021.sciencesconf.org/
Open Access: https://hal.science/hal-04250890/file/oe-31-22-37011.pdf

1.3.8
Stefano Negrini, François Copie, Saliya Coulibaly, Matteo Conforti, Alexandre Kudlinski, Arnaud Mussot.
"Effect of synchronization mismatch on modulation instability in passive fiber-ring cavity," ELIOS Journees du GDR, ELIOS 2021, October 19-21, 2021, Lille, France.
DOI: https://doi.org/10.1109/CLEO/Europe-EQEC52157.2021.9541780

1.3.9
Stefano Negrini, François Copie, Saliya Coulibaly, Matteo Confortim, Alexandre Kudlinski, Arnaud Mussot.
"Effect of synchronization mismatch on modulation instability in passive fiber-ring cavity," Optique Dijon Conference, 5-9 July 2021, Dijon, France.
Open Access: https://zenodo.org/records/11065417

1.4 PEER-REVIEWED CONFERENCE TALKS including invited talks (most recent on top)

1.4.1
Alberto Rodriguez Cuevas, Dmitrii Stoliarov, Hani J. Kbashi & Sergey Sergeyev.
"Achieving Multiple-Days Stability in a Single-Cavity Dual-Comb laser for Spectroscopic Applications," IEEE 2024 Summer Topicals Meeting Series, 16 July 2024, Bridgetown, Barbados.
DOI and Open Access coming.

1.4.2
Mohammad Nayeem Akhter, Ramon Herrero, Kestutis Staliunas, Muriel Botey.
"Asymmetric mode-coupling in Antisymmetric non-Hermitian waveguides," 24th International Conference on Transparent Optical Networks (ICTON), IEEE: July 14-18, 2024, Bari, Italy.

1.4.3
Mohammad Nayeem Akhter, Ramon Herrero, Muriel Botey, Kestutis Staliuna.
"Non-Hermitian mode-cleaning in linear and nonlinear optical waveguides," at the upcoming 14th International Conference on Metamaterials, Photonic Crystals and Plasmonics (META 2024): July 16-19, 2024, Toyama, Japan.

1.4.4
Anamika Nair Karunakaran, Angelo Manetta, Poul Varming, M. Pu, V. Torres-Company, K. Yvind and Patrick Montague.
"Reducing Frequency Noise in Dark Pulse Kerr Combs," Conference on Lasers and ElectroOptics/USA, (CLEO/USA, May 2024).
DOI and Open Access coming.

1.4.5
Stefano Negrini, Auro Perego, Matteo Conforti, Arnaud Mussot.
"Double-frequency-comb-like source with PM passive fibre cavity and Gain Through Filtering," (invited talk) European Optical Society Annual Meeting (EOSAM), September 11-15, 2023, Dijon France.

DOI: https://doi.org/10.1051/epjconf/202328707014
Open Access: https://zenodo.org/records/11065948

1.4.6
Kestutis Staliunas
"Laser transverse patterns control by non-Hermitian actions," keynote talk presented at the Conference on Lasers and Electro-Optics (CLEO/EQEC) Munich, Germany, June 26, 2023.

1.4.7
Mohammad Nayeem Akhter, Salim B. Ivars, Ramon Herrero, Muriel Boety, Kestutis Staliunas.
"Light control by Non-Hermitian modulation in multimode fiber," META Conference 2022, 12th International Conference on Metamaterials, Photonic Crystals and Plasmonics, Spain, July 19-22, 2022. Oral presentation.
https://upcommons.upc.edu/bitstream/handle/2117/384280/Akhter_META22.pdf?sequence=1&isAllowed=y

1.5 CONFERENCE TALKS (not peer-reviewed)

1.5.1
Alberto Rodriguez Cuevas, Hani J. Kbashi, Dmitrii Stoliarov, Sergey Sergeyev.
"Photon 2022 Study of Stability, Tunability and Polarization Dynamics in a Polarization-Multiplexing Ring-Cavity Fibre Laser for Dual-Comb Generation'," Photon 2022, 30 August-2 September 2022, Nottingham, UK.

1.6 POSTERS (most recent on top)

Wherever possible MEFISTA encourages its ESRs to make posters and papers presented at conferences open access by depositing the final version in the ZENODO repository https://zenodo.org/ or similar. Here they are allocated a DOI which can be brought into SyGMa, linking this content to the project output on CORDIS.

1.6.1
Alberto Rodriguez Cuevas, Dmitrii Stoliarov, Igor Kudelin, & Sergey Sergeyev.
"Stable Dual Vector Soliton Generation in a Single Cavity," May 8, CLEO, USA 2024.
DOI and Open Access coming.

1.6.2
M. N. Akhter, R. Herrero, M. Botey and K. Staliunas.
"Unidirectional mode coupling in Non Hermitian Waveguides," SPIE Europe, April 7-11, 2024, Strasbourg, France.
DOI and Open Access: https://doi.org/10.5281/zenodo.10942962

1.6.3
Alberto Rodriguez Cuevas; Hani J. Kbashi; Dmitrii Stoliarov; Sergey Sergeyev.
"Stable Asynchronous Vector Soliton Generation in an All-fiber Single Cavity Laser," FreQomb: Optical Frequency Combs Workshop, November 29, 2023, AIPT, Aston University, Birmingham, UK.
Open Access: https://doi.org/10.5281/zenodo.10217519

1.6.4
M. N. Akhter, R. Herrero, M. Botey and K. Staliunas.
"Mode-cleaning in Non-Hermitian Fibers and Waveguides," Nanophotonics and Micro/Nano Optics International Conference (NANOP), November 27-29, 2023, Barcelona, Spain.
DOI and Open Access: https://doi.org/10.5281/zenodo.10942778

1.6.5
M. N. Akhter, S. B. Ivars, R. Herrero, M. Botey and K. Staliunas.
"Unidirectional mode coupling in graded index fibers," 13th International Conference on Metamaterials, Photonic Crystals and Plasmonics (META 2023): July 18-21, 2023, Paris, France.
DOI and Open Access: https://doi.org/10.5281/zenodo.10942298

1.6.6
D. Stoliarov; Q. Wang; S. Sergeyev; H. Kbashi; Z. Huang; and C. Mou.
"Slow Vector Breathers," Conference on Lasers & Electro-Optics (CLEO/EQEC), June 28, 2023, Munich, Germany.
Open Access here https://doi.org/10.5281/zenodo.8249622

1.6.7
A.N. Karunakaran, A. Manetta, P. Varming, O.B. Helgason, P. Montague, M. Pu: V. Torres-Company and K. Yvind.
"Stable soliton comb from dual ring microresonators," Conference on Lasers and Electro-Optics (CLEO/EQEC), June 27, 2023, Munich, Germany.
Open Access here: https://doi.org/10.5281/zenodo.8309475

1.6.8
A. Rodriguez Cuevas, H. J. Kbashi, D. Stoliarov, and S. Sergeyev.
"Tunable Polarization-Multiplexed Single-Cavity Dual-Comb," Conference on Lasers and Electro-Optics (CLEO/EQEC), June 26, 2023, Munich, Germany.
Open Access here: https://doi.org/10.5281/zenodo.8302014

1.6.9
Qing Wang, Zhiwei Huang, Chengo Mou, Zhijun Yan, Hani Kbashi, Sergey Sergeyev.
"Breather Dynamics driven by Polarization instability in Nonlinear Polarization Rotation (NPR) mode locked fibre laser," Photon 2022, 30 August-2 September, Nottingham, UK.
Open Access here: https://doi.org/10.5281/zenodo.10964542

1.6.10
A. Rodriguez Cuevas, Igor Kudelin, H. J. Kbashi, and S. Sergeyev.
"Dual-Comb Build-Up Dynamics in Polarization-Multiplexing Fibre Laser," Photon 2022, 30 August-2 September, Nottingham, UK.
Open Access here: https://doi.org/10.5281/zenodo.10985367

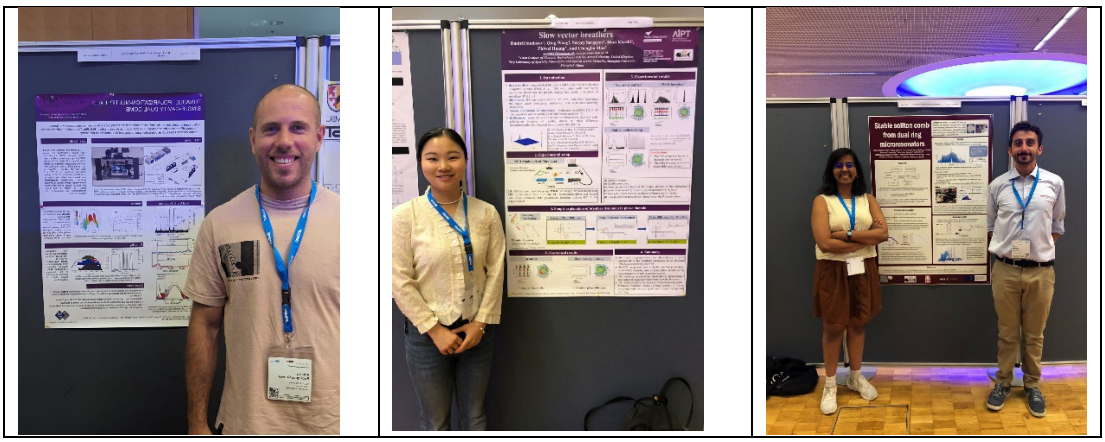


Figure 2 MEFISTA ESRs at CLEO Europe 2023 with their posters: Left to right, Alberto Rodriguez Cuevas ESR5; Qing Wang ESR4; Anamika Nair Karunakaran ESR6.

1.7 SUBMITTED PAPERS

1.7.1
Moritz Bartnick, Stefano Negrini, Camille-Sophie Brès, Arnaud Mussot.
"Observation of modulation instability in a fiber ring resonator at 2 µm wavelength," Optics Letters.

1.7.2
Moritz Bartnick, Stefano Negrini, Camille-Sophie Brès, Arnaud Mussot.
"Modulation instability in a fiber ring resonator with thulium-doped active fiber," IEEE Photonics Conference, (IPC), 10-14 November 2024, Rome.

1.8 PHDs

Of the six ESRs in MEFISTA, one has submitted a PhD thesis, with the remaining four currently in preparation. ESR4 did not enrol onto a PhD, a matter the Project Officer is aware of, and will not produce a thesis.

1.8.1
Stefano Negrini.
"Gain Through Filtering in fiber cavity resonator," PhD Thesis from November 2023 available at:
Open Access: https://theses.fr/2023ULILR049?domaine=theses

1.9 SCIENTIFIC PAPERS (peer-reviewed)

MEFISTA has made use of the pre-publication server Arxiv – this repository is openly accessible.

1.9.1
Huang, Zhiwei; Sergeyev, Sergey; Wang, Qing; Kbashi, Hani; Stoliarov, Dmitrii; Huang, Qianqian; Dai, Yuze; Yan, Zhijun; Mou, Chengbo.
"Vector Soliton Breathing Dynamics," November 17, 2022, Cornell University, USA.
DOI: https://doi.org/10.48550/arXiv.2211.09550
Open Access: https://arxiv.org/ftp/arxiv/papers/2211/2211.09550.pdf

1.10 SEMINAR TALKS (most recent first)

Nine seminar talks were given during the life of the project. Eight is the GA requirement.

- Stephano Negrini, ESR1, ULille, PhD days, May 2023
- Stephano Negrini, ESR1, ULille, Photonique group meeting, March 2023
- Stephano Negrini, ESR1, ULille, PhD days (Journeé des Doctorant/tes, May 2022
- Stephano Negrini, ESR1, ULille, Photonique group meeting, April 2022
- Moritz Bartnick ESR3, EPFL, Oral presentation SPIE Photonics Europe, Wavelength-stabilized mode-locked thulium-doped fiber laser operating between 1958 and 2008nm, April 2022
- Mohammad Nayeem Akhter, ESR2, UPC, Poster presentation at SPIE Photonics Europe, Non-Hermitian management of light in multimode fibers, April 2022
- Stephano Negrini, ESR1, ULille, Photonique group meeting, October 2021
- Stephano Negrini, ESR1, ULille, Photonique group meeting, June 2021
- Moritz Bartnick ESR3, EPFL, EPFL Poster presentation, 2021

2 PUBLIC ENGAGEMENT

Outreach and public engagement activities in MEFISTA were designed to engage a large and diverse audience from all spectrums of society.

Below is a summary of outreach activities during the whole life of the project.

2.1 MEFISTA PODCAST

In summer and autumn 2021, MEFISTA launched a monthly, 6-part, half-hour, outreach podcast featuring all six ESRs talking about their research. An idea born out of Covid restrictions, the podcast has been available for free download on a global platform and was great interview practice for the ESRs, making them talk about their research in everyday language, also mentioning the opportunities afforded by MSCA programmes.

The podcast series is available on Apple and Spotify. At the time of writing in July 2024, M54, the podcast had amassed 320 listens, averaging around 50 plays per episode.

Figure 3 MEFISTA Podcast, featuring all six ESRs, 2021

2.2 MEFISTA ON INSTAGRAM

In summer 2021, a MEFISTA Instagram profile was launched to promote the project and the new podcast, alongside promoting other activities such as the open-to-all workshop in Lille and MSCA Programmes generally. At time of writing, July 2024, M54, MEFISTA had 104 Instagram followers and follows 122 profiles.
https://www.instagram.com/mefista_research/

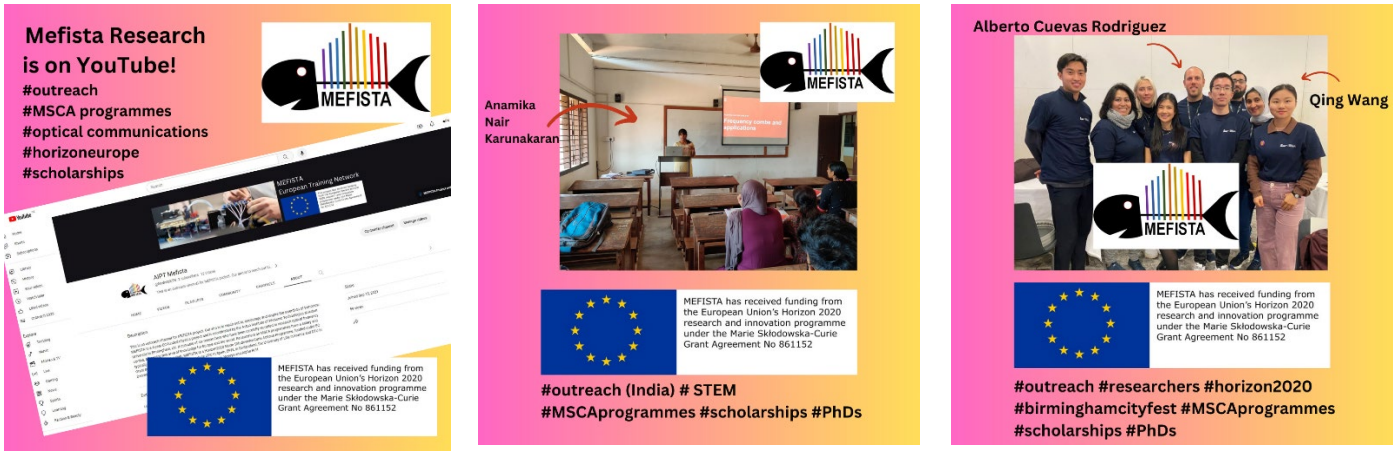


Figure 4 Examples of MEFISTA posts on Instagram (Promoting YouTube channel; publicising outreach in India and in Birmingham and trailing the MEFISTA outreach podcast)

2.3 MEFISTA ON YOUTUBE

In summer 2023, MEFISTA launched a YouTube channel for the purpose of outreach at https://www.youtube.com/@MefistaETN.

All the ESRs were at Aston for their 2nd Annual Workshop and the third Transferrable Skills Workshop on careers and CVs, so video clips were able to be filmed in person.

At the time of writing, July 2024, M54, views per clip ranged from seven to 22. There is a total of 12 published clips, and eight of these are 'Shorts' (clips of a 1 minute or less). According to Statista.com, YouTube reported that the Shorts feature amasses over 30 billion daily views from users all over the world, so it is a good place to be for outreach.

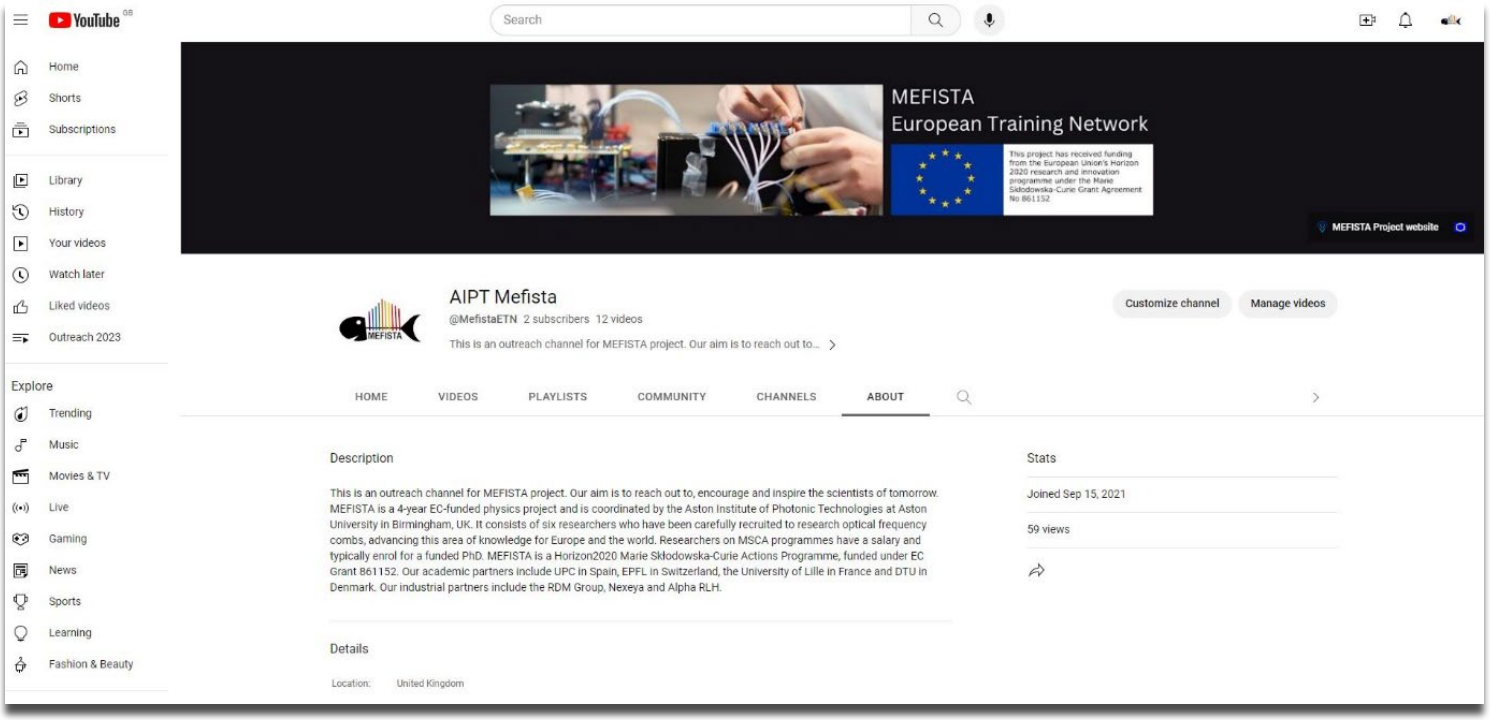


Figure 5 MEFISTA YouTube Channel homepage

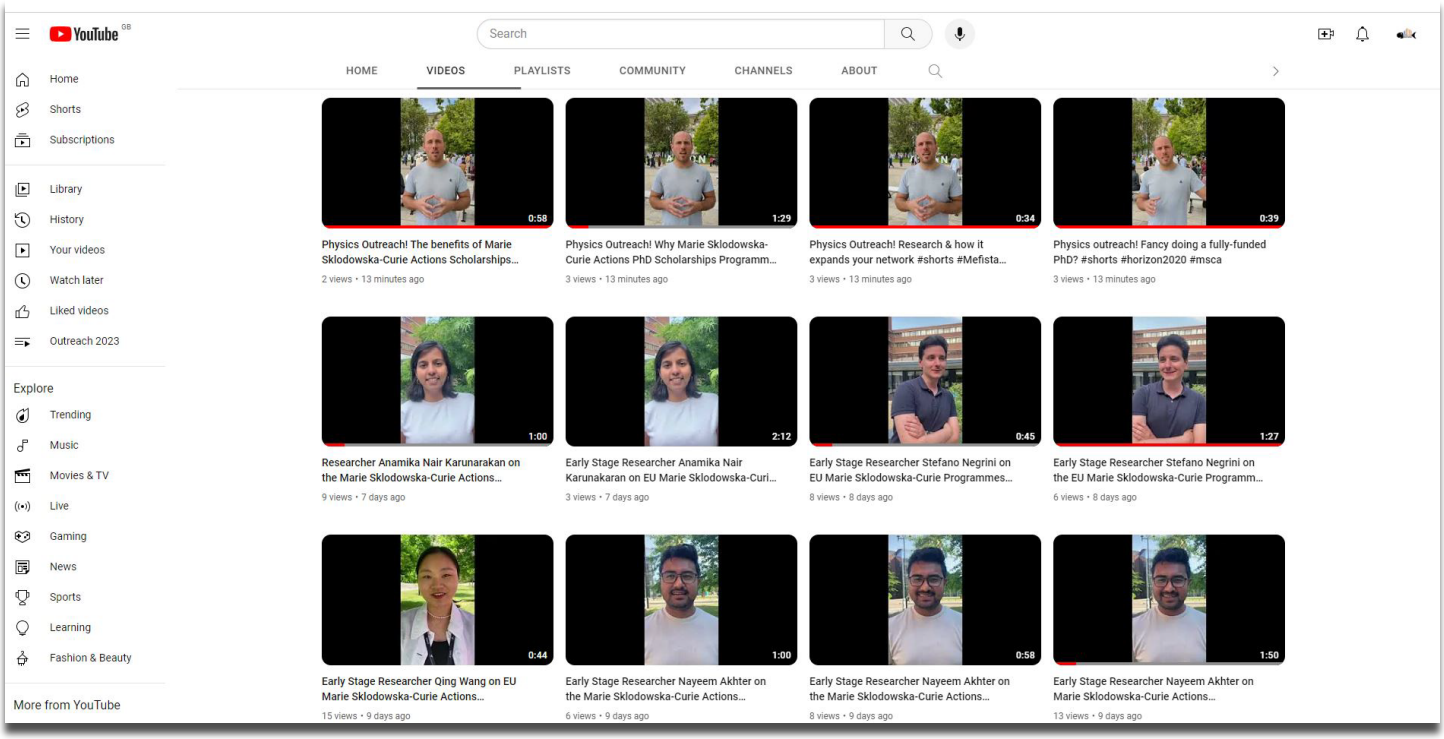


Figure 6 MEFISTA YouTube shorts – snapshot of video thumbnails

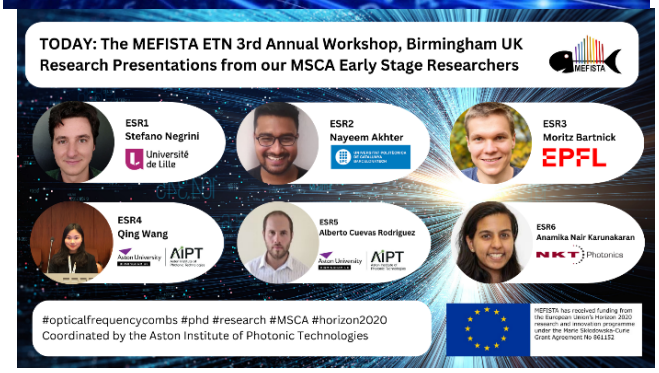
2.4 MEFISTA ON TWITTER/X

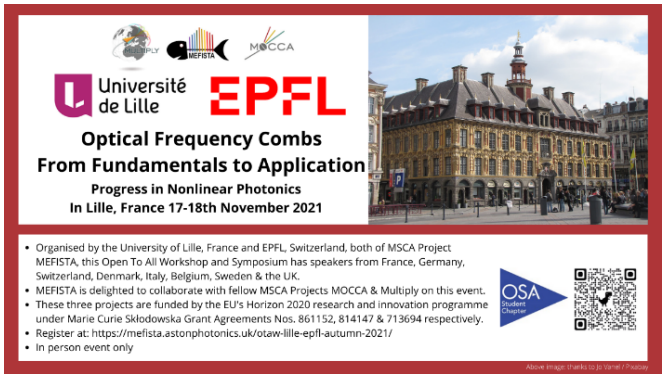
MEFISTA's official Twitter/X feed can be found at https://twitter.com/EtnMefista and at the time of writing (July 2024, M54) the project had 160+ followers.

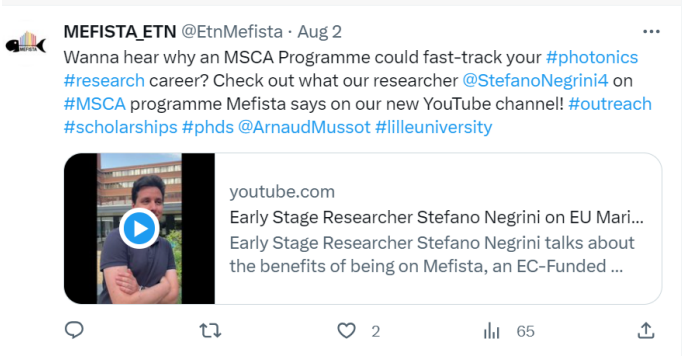
The Twitter/X feed has been populated on average every week with news of and links to MEFISTA publications, posters and conference talks, with outreach photos and outreach video clips. The links lead people to the YouTube channel, to the MEFISTA website to read more, or a conference or publication link.

At the time of writing (July 2024, M54), 250+ individual tweets had been disseminated.

Below are examples of images used on MEFISTA Twitter/X to publicise MSCA programmes, publications, conferences, the YouTube channel and training events.







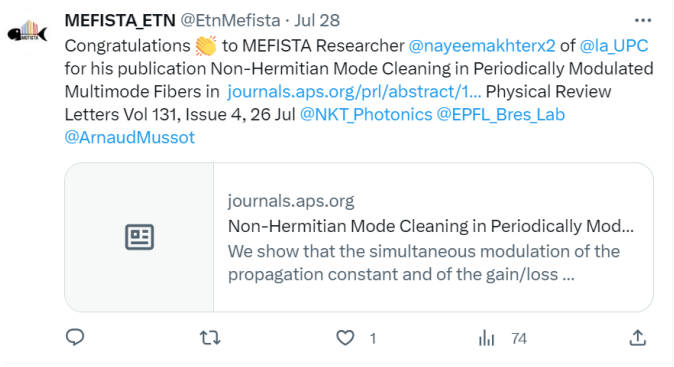


Figure 7 MEFISTA on Twitter: promoting MSCA programmes and publicising publications, deliverables, posters, conferences and training events

2.5 MEFISTA OUTREACH IN SCHOOLS AND THE COMMUNITY (most recent first)

March 2023

ESR5 Alberto Rodriguez Cuevas organised two half-day grant writing workshops (in person and online) for researchers at his host beneficiary, AIPT in Aston, attended by a total of approximately 30 PhD researchers.

December 2022

MEFISTA ESR6 Anamika Nair Karunakaran conducted a piece of outreach in her home country of India. This was a talk on frequency combs and their applications at Malabar Christian college in Kozhikode, Kerala, India. Anamika delivered her talk to a group of twenty Masters students at the institute (picture below).

Figure 8 ESR6 Anamika Nair Karunakaran doing outreach in India

October 2022

MEFISTA ESR4 (Qing Wang of Aston) and ESR5 (Alberto Cuevas Rodriguez of Aston) supported CityFest in Birmingham, UK, (picture below). They shared their knowledge of MSCA programmes and acted as advocates of Science, Technology, Engineering, and Mathematics (STEM) with 100+ students. CityFest is a festival in Birmingham about smart city technologies.

Figure 9 MEFISTA ESR4 and ESR5 at CityFest Smart City Fare, Birmingham UK

ESR4 is Qing Wang, first on the right; ESR5 is Alberto Cuevas Rodriguez, fifth from the left.

June 2022

ESR4 Qing Wang took part in 'Girls into Photonics' via Aston's Optica/SPIE Chapter at Aston University, UK. This involved programming and doing demonstrations of basic optical physics to 50+ students.

June 2021

Behind every great research project there is a project manager making sure projects run smoothly. MEFISTA's Coordinator AIPT celebrated MEFISTA's project manager and project managers on other ITNs at the 8th International Women in Engineering Day. A poster was created to showcase the many ways women help push boundaries in scientific research. The big day itself was on 23 June 2021 and a leaflet was 'engineered' into existence by the Women's Engineering Society.

Figure 10 EC ITNs including MEFISTA on International Women in Engineering Day, 2021

May 2021

To celebrate the International Day of Light at MEFISTA Coordinator AIPT, three of MEFISTA's ESRs (ESR1, Stefano Negrini of Lille, ESR2 Mohammad Nayeem Akhter of UPC and ESR5 Alberto Cuevas

Rodriguez of Aston) described how their research related to the concept of 'Light' (snapshot of articles below).

Figure 11 MEFISTA ESRs contributing articles to the Day of Light 2021

2.6 MEFISTA NEWSLETTERS

MEFISTA has produced four annual Mailchimp-style newsletters where news of publications, research, training and conference updates were included all in one place.

Figure 12 MEFISTA Newsletter

Links to the 4 issues (2021-2024) are given below.

https://mailchi.mp/310368b620fb/mefista-newsletter-issue-1

https://mailchi.mp/931ecf0074f2/mefista-newsletter-issue-2

https://mailchi.mp/c7dd49a48023/mefista-newsletter-issue-8370833

https://mailchi.mp/e130bccb8022/mefista-newsletter-issue-9675045

2.7 Outreach by ESR

ESR1 Stefano Negrini, ULille

MEFISTA YouTube channel, 2023

MEFISTA Podcast, 2021

MEFISTA Twitter

MEFISTA Instagram

Article for Day of Light brochure 2021, Aston, UK

MEFISTA Newsletter (mailchimp)

ESR2 Mohammad Nayeem Akhter, UPC

MEFISTA YouTube channel, 2023

MEFISTA Podcast, 2021

MEFISTA Twitter

MEFISTA Instagram

Article for Day of Light brochure 2021, Aston, UK

MEFISTA Newsletter (mailchimp)

ESR3 Moritz Bartnick, EPFL

MEFISTA Podcast, 2021

MEFISTA Twitter

MEFISTA Instagram

MEFISTA Newsletter (mailchimp)

ESR4 Qing Wang

MEFISTA YouTube channel, 2023

MEFISTA Podcast, 2021

MEFISTA Twitter

MEFISTA Instagram

Girls in Photonics, Aston SPIE Chapter, Birmingham, UK, in person, 2022

CityFest, STEM Advocate, Birmingham, UK, in person, 2022

MEFISTA Newsletter (mailchimp)

ESR5 Alberto Rodriguez Cuevas

MEFISTA YouTube channel, 2023

MEFISTA Podcast, 2021

MEFISTA Twitter

MEFISTA Instagram

Grant-writing workshop, Birmingham, UK, 2023

CityFest, STEM Advocate, Birmingham, UK, in person, 2022

Article for Day of Light brochure 2021, Aston, UK

MEFISTA Newsletter (mailchimp)

ESR6 Anamika Nair Karunakaran, NKT

MEFISTA YouTube channel, 2023

MEFISTA Podcast, 2021

MEFISTA Twitter

MEFISTA Instagram

In-person talk on frequency combs and MSCA programmes at Malabar Christian College, Kerala, India.

MEFISTA Newsletter (mailchimp)

This Project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 861152