



VIPERLAB

FULLY CONNECTED VIRTUAL AND PHYSICAL
PEROVSKITE PHOTOVOLTAICS LAB

**D5.18 Final evaluation of knowledge
exchange, results on dissemination and
Personnel exchange in the VIPERLAB
project and strategies to exploit long
term relationships and
multidisciplinary collaboration
among European R&DI Community**

**DELIVERABLE
REPORT**

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FULLY CONNECTED VIRTUAL AND PHYSICAL PEROVSKITE PHOTOVOLTAICS LAB VIPERLAB

DELIVERABLE

D5.18 FINAL EVALUATION OF KNOWLEDGE EXCHANGE,
RESULTS ON DISSEMINATION AND PERSONNEL EXCHANGE IN
THE VIPERLAB PROJECT AND STRATEGIES TO EXPLOIT LONG
TERM RELATIONSHIPS AND MULTIDISCIPLINARY
COLLABORATION AMONG EUROPEAN R&DI COMMUNITY

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DISCLAIMER

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EXECUTIVE SUMMARY

The various outcomes and activities of VIPERLAB are extensively documented in the project's deliverables, which provide a detailed account of the progress and achievements made throughout its lifecycle. This report emphasizes the importance of evaluating key aspects of the project, such as knowledge exchange, dissemination results, and personnel exchange activities. Additionally, it highlights strategies developed to exploit long-term relationships and foster multidisciplinary collaboration within the European RDI community. These evaluations not only demonstrate the project's immediate impact but also ensure that the framework for ongoing collaboration and innovation remains robust and effective. The VIPERLAB project has played a critical role in advancing the research and development community focused on perovskite-based technologies. Serving as a central hub for collaboration among research, development, and innovation (RDI) institutions, industries, and socio-political stakeholders, VIPERLAB has been instrumental in accelerating progress in this emerging field. By promoting the dissemination of cutting-edge results, harmonized protocols, and best practices, the project has fostered an environment of knowledge sharing and innovation across Europe. A cornerstone of VIPERLAB's efforts has been its robust program of interactive training courses, workshops, and personnel exchange initiatives. These activities were carefully designed to equip researchers, developers, and industry professionals with the expertise needed to effectively access and utilize advanced perovskite research infrastructure. This focus on skill-building and collaboration has strengthened the perovskite research community, enhancing the collective capacity to address key scientific and technological challenges. Throughout its duration, VIPERLAB has established itself as a key driver of progress in the perovskite RDI community. The project's dissemination activities, including workshops and training sessions, have provided invaluable opportunities for participants to engage with the latest advancements and best practices in perovskite research. Moreover, personnel exchange programs have fostered strong, long-lasting relationships between institutions, creating a solid foundation for multidisciplinary collaborations. This final evaluation report highlights the impact of VIPERLAB's efforts on the European perovskite research community. It outlines the achievements in dissemination and capacity building while presenting a strategic roadmap for sustained collaboration and innovation; it consolidates the outcomes of these dissemination efforts, highlighting the project's achievements and laying out a future roadmap for continued collaboration and knowledge transfer within the European RDI landscape. By solidifying networks and fostering a culture of shared expertise, VIPERLAB has significantly contributed to positioning Europe as a leader in perovskite research and technology development. The strategies outlined in this report aim to ensure that the partnerships and synergies cultivated during the project will contribute to sustained innovation and development beyond its lifecycle.

1. INTRODUCTION

This report provides a comprehensive evaluation of the key activities and outcomes of the VIPERLAB project, emphasizing its significant contributions to fostering knowledge exchange, dissemination of results, and personnel exchange within the European research, development, and innovation (RDI) community. VIPERLAB has played a crucial role in advancing the field of perovskite technologies, creating a collaborative ecosystem that promotes shared expertise, harmonized protocols, and long-term multidisciplinary partnerships. These efforts have not only addressed pressing scientific and technological challenges but have also laid the foundation for Europe's leadership in this rapidly growing field.



The report specifically focuses on the tasks undertaken by ENEA and its partners, which were instrumental in shaping the project's impact and ensuring the sustainability of its outcomes. These tasks addressed a wide range of objectives, from raising public awareness to fostering collaboration through personnel exchange and training and ensuring open access to data for future research. Each task has contributed to the overarching goals of VIPERLAB in a unique and complementary way.

- **Task NA2.1: Setting up communication tools for general public awareness**

Recognizing the importance of public engagement, this task established effective communication tools to inform the general public about the objectives, progress, and achievements of VIPERLAB. By increasing public awareness, the project aimed to generate interest in perovskite technologies and their potential societal and environmental benefits. A variety of communication strategies were implemented, including public-facing websites, press releases, and social media campaigns, ensuring that key messages reached a broad audience.

- **Task NA2.2: Dissemination activities**

Dissemination activities were designed to maximize the visibility and impact of the project's findings. These efforts targeted stakeholders in the RDI community, industry, and policymaking sectors, with the goal of facilitating the adoption of best practices and harmonized procedures. A key aspect of this task was the organization of conferences, webinars, and publications, which served as platforms for sharing insights, fostering dialogue, and promoting the practical application of VIPERLAB's outcomes.

- **Task NA2.3: Exchange of personnel to foster collaboration and optimize procedures**

Personnel exchange programs formed the backbone of VIPERLAB's collaboration strategy. These exchanges facilitated the transfer of knowledge, skills, and expertise among participating institutions, fostering stronger relationships and deeper cooperation. By enabling researchers to work closely together, this task also promoted the optimization of research procedures and the harmonization of methodologies, ensuring consistency and comparability across different institutions and projects.

- **Task NA2.4: Courses and workshops for training.**

A series of targeted training courses and workshops were conducted to provide researchers, developers, and industry professionals with the knowledge and skills needed to effectively access and utilize VIPERLAB infrastructure. These interactive sessions were tailored to address specific challenges in perovskite research, from understanding advanced characterization techniques to optimizing device fabrication processes. By equipping participants with cutting-edge expertise, this task strengthened the capacity of the RDI community to tackle critical issues in the field.

- **Task NA2.5: Data management and accessibility to VIPERLAB outputs and individual research data**



Effective data management is a cornerstone of modern research, and this task ensured that VIPERLAB adhered to best practices in this area. By making project outputs and individual research data openly accessible, the task promoted transparency, reproducibility, and further scientific progress. The implementation of user-friendly platforms for data sharing and access has enabled researchers to build on VIPERLAB's work, accelerating innovation in perovskite technologies.

This report evaluates the achievements of these tasks in the context of VIPERLAB's overarching goals, highlighting their contributions to knowledge exchange, dissemination of results, and the facilitation of personnel exchange. It also examines the strategies developed to ensure long-term relationships and multidisciplinary collaboration among the European RDI community. These strategies are crucial for sustaining the momentum generated by VIPERLAB and for addressing future challenges in the perovskite research field.

The activities and outcomes described in this report underscore the central role of VIPERLAB in advancing perovskite technologies and strengthening the European RDI ecosystem. By fostering collaboration, promoting shared expertise, and ensuring open access to data and infrastructure, the project has set a benchmark for innovation and collaboration in the field. As the project ends, the insights and strategies outlined in this report will serve as a valuable roadmap for future efforts to maintain and expand the impact of VIPERLAB within the European and global scientific communities.

2.FINAL EVALUATION OF KNOWLEDGE EXCHANGE, DISSEMINATION, AND COLLABORATION STRATEGIES IN THE VIPERLAB PROJECT

2.1 Dissemination

Dissemination is a cornerstone of any successful research initiative, serving as the bridge between project outcomes and their practical application within a broader community. In the context of the VIPERLAB project, dissemination activities have played a critical role in promoting strategies to foster long-term relationships and multidisciplinary collaboration among the European research, development, and innovation (RDI) community. By ensuring that knowledge generated through the project is shared effectively and widely, dissemination has not only enhanced the visibility and impact of VIPERLAB but has also created the foundation for sustained collaboration and innovation in the field of perovskite technologies.

By communicating the project's achievements to a diverse audience, including researchers, industry stakeholders, policymakers, and the general public, dissemination activities have significantly broadened the reach and influence of VIPERLAB (Deliverable 5.16). Tools such as dedicated project websites, scientific publications, newsletters, webinars, and social media campaigns have ensured that stakeholders across different sectors and disciplines are informed and engaged. This broad awareness has been essential for identifying and connecting with potential collaborators within the European RDI community. By showcasing the project's achievements, dissemination has attracted interest from external parties who recognize the potential for mutual benefit in joining forces with VIPERLAB's network. This has laid the groundwork for building long-term relationships and fostering interdisciplinary approaches to solving complex scientific and technological challenges. At the heart of VIPERLAB's dissemination efforts is the objective of facilitating knowledge exchange. Workshops,



conferences, and training sessions have served as critical platforms for bringing together researchers, developers, and industry professionals to share insights and best practices. These events have not only enabled the transfer of technical knowledge but have also encouraged the exchange of ideas, perspectives, and expertise across disciplines. The collaborative environments fostered through dissemination activities have been instrumental in breaking down silos within the European RDI community. By providing opportunities for researchers from diverse fields to interact and learn from one another, VIPERLAB has encouraged a culture of collaboration that extends beyond the project's immediate scope. This has not only enhanced the quality of research but has also led to the development of innovative solutions that leverage the strengths of multiple disciplines. A key focus of VIPERLAB's dissemination strategy has been the promotion of harmonized practices and standards across the European RDI community. By sharing standardized protocols, methodologies, and best practices through training sessions (section 2.3) and technical publications (Deliverable 5.16), the project has ensured consistency and comparability in research efforts across institutions. This harmonization is particularly important for fostering effective collaboration, as it reduces barriers to cooperation and enables seamless integration of efforts across different research teams and facilities. The dissemination of these harmonized practices has not only facilitated collaboration within the VIPERLAB network but has also positioned the project as a leader in setting benchmarks for the broader perovskite research community. By promoting adherence to common standards, VIPERLAB has enhanced the reliability and reproducibility of research outcomes, thereby strengthening the foundation for future collaborative efforts.

One of the most significant impacts of VIPERLAB's dissemination activities has been the establishment of long-term relationships among stakeholders in the European RDI community. The networks formed through workshops, personnel exchange programs, and collaborative projects have created lasting connections that extend beyond the lifecycle of the VIPERLAB project. These relationships are critical for sustaining momentum in perovskite research and for addressing emerging challenges in the field. Dissemination activities have played a pivotal role in nurturing these relationships by creating opportunities for regular interaction and collaboration. By facilitating dialogue and partnership-building, VIPERLAB has enabled researchers, industry leaders, and policymakers to identify common goals and align their efforts toward achieving them. This has not only strengthened the European RDI ecosystem but has also positioned it as a global leader in perovskite technologies. Multidisciplinary collaboration is essential for addressing the complex challenges associated with perovskite research and development. VIPERLAB's dissemination strategy has actively encouraged such collaboration by bringing together experts from diverse fields, including material science, chemistry, physics, engineering, and industry. By creating platforms for interdisciplinary dialogue, dissemination activities have fostered a holistic approach to research and innovation.

For example, training sessions and workshops (Sections 2.3 and 2.4) organized by VIPERLAB have often featured contributions from experts across multiple disciplines, providing participants with a well-rounded perspective on the challenges and opportunities in perovskite research. This interdisciplinary exposure has not only enriched the knowledge of participants but has also inspired new research directions and collaborations that transcend traditional disciplinary boundaries.

Dissemination is not merely about sharing knowledge; it is also about creating mechanisms for sustained collaboration. VIPERLAB has strategically used its dissemination activities to develop frameworks and strategies that ensure the continuity of relationships and partnerships formed during



the project. These include the creation of knowledge repositories, the development of collaborative research platforms, and the establishment of long-term agreements for data sharing and joint research initiatives. By embedding these sustainability measures into its dissemination strategy, VIPERLAB has ensured that the benefits of its efforts will continue to accrue long after the project's conclusion. This forward-looking approach has been instrumental in positioning the European RDI community for continued success in the field of perovskite technologies.

Dissemination has been a vital component of the VIPERLAB project, driving its success in promoting long-term relationships and multidisciplinary collaboration among the European RDI community. By building awareness, facilitating knowledge exchange, promoting harmonized practices, and fostering sustainable networks, dissemination activities have amplified the impact of VIPERLAB and created a strong foundation for future innovation. As the project concludes, the relationships, knowledge, and strategies cultivated through its dissemination efforts will continue to play a pivotal role in advancing the field of perovskite research and in maintaining Europe's leadership in this transformative area of science and technology.

2.2 Knowledge Exchange

Within the VIPERLAB project, knowledge exchange has been a central pillar, driving collaboration, enhancing research quality, and fostering the growth of a robust European research, development, and innovation (RDI) community. The VIPERLAB Knowledge Exchange Platform (KEP) has had a pivotal role in the project's data and information management strategy, particularly when enhanced and interactive engagement with users is essential. Unlike traditional static web pages, KEP functioned as a dynamic platform offering open access to a wide range of resources, including publications, preprints, tools, methodologies, videos, and presentations. Beyond serving as a data repository, KEP acts as an integrated hub for improving data dissemination and communication, facilitating efficient sharing of information. It caters to both specialized audiences and the general public by providing educational materials, fostering discussions, supporting database development, and enabling feedback collection and user analytics, ensuring continuous improvement and broad engagement (Deliverable 5.15). By facilitating the free flow of ideas, expertise, and best practices among researchers, developers, and industry stakeholders, VIPERLAB has ensured that the latest advancements in perovskite technologies are effectively leveraged to address scientific and technological challenges.

One of the primary benefits of knowledge exchange is its ability to accelerate innovation. By creating the KEP platforms for researchers and developers to share their findings and insights, VIPERLAB has reduced duplication of effort and allowed participants to build on one another's work. Workshops, conferences, and personnel exchange programs have served as vital conduits for this exchange, enabling participants to access diverse perspectives and cutting-edge expertise. The collaborative environments fostered by VIPERLAB have proven especially valuable in addressing the interdisciplinary nature of perovskite research, which spans materials science, chemistry, physics, and engineering. By bringing together experts from these fields, knowledge exchange has catalysed the development of holistic solutions and innovative approaches that would be difficult to achieve in isolation. Knowledge exchange also plays a crucial role in enhancing the quality and rigor of research. Through VIPERLAB's training sessions and workshops, researchers have been exposed to standardized methodologies (Section 2.4), best practices, and state-of-the-art techniques, ensuring the consistency and reliability of their work. This harmonization of research practices across



institutions has not only improved the reproducibility of results but has also facilitated more meaningful comparisons and collaborations across the European RDI community. Moreover, the exchange of knowledge has allowed researchers to identify and address gaps in their understanding, driving continuous improvement and refinement of their approaches. This iterative process has been instrumental in advancing the field of perovskite technologies and in positioning Europe as a leader in this area. Knowledge exchange has been at the heart of VIPERLAB's efforts to foster collaboration and build a cohesive RDI community. By creating opportunities for regular interaction and dialogue, the project has strengthened relationships among researchers, institutions, and industry stakeholders. These connections have not only enhanced the flow of knowledge but have also laid the foundation for long-term partnerships and joint research initiatives.

The collaborative culture cultivated by VIPERLAB has extended beyond the project's immediate network, influencing the broader European RDI community. By demonstrating the value of knowledge exchange, VIPERLAB has encouraged other initiatives to adopt similar practices, amplifying its impact and fostering a more interconnected research ecosystem. The multidisciplinary nature of perovskite research requires a high level of coordination and integration among diverse fields. Knowledge exchange has been critical in bridging these disciplinary divides, enabling researchers to understand and apply insights from areas outside their expertise. Through VIPERLAB's workshops and training sessions, participants have gained exposure to a wide range of topics, from advanced material characterization techniques to device fabrication and scaling.

This interdisciplinary exposure has not only enriched individual participants' knowledge but has also inspired new research directions and collaborations. By promoting a culture of openness and curiosity, knowledge exchange has ensured that the European RDI community remains agile and adaptable in addressing emerging challenges.

Finally, knowledge exchange has been instrumental in ensuring the long-term impact of VIPERLAB's efforts. By embedding knowledge-sharing mechanisms into the project's activities—such as open-access data platforms, standardized protocols, and collaborative research tools—VIPERLAB has created a legacy that will continue to benefit the perovskite RDI community beyond the project's duration. The networks and practices established through knowledge exchange will remain valuable resources for researchers, enabling ongoing collaboration and innovation. This sustainability is a testament to the central role of knowledge exchange in achieving VIPERLAB's goals and in supporting the broader advancement of perovskite technologies.

2.3 Training workshops

During all the project lifetime many activities and a lot of effort for the design and running of several workshops on specific topic has been implemented by partners (in table 1 we give a short list of actions described in D5.15). In addition, more details about the event can be found on VIPERLAB's knowledge exchange platform: <https://www.viperlab-kep.eu/workshop.asp>. Training workshops have proven to be a cornerstone of fostering long-term relationships and multidisciplinary collaboration within the European R&DI community. Through these initiatives, VIPERLAB has successfully brought together diverse stakeholders, facilitating the exchange of expertise and knowledge across scientific and industrial domains. This approach has not only accelerated the integration of cutting-edge research but also laid the groundwork for sustained partnerships that extend beyond the project's scope.



Table 1: Examples (not all) of Training workshops of VIPERLAB project.

Partner	Date start	Date End	Place	Attendees	Person VIPERLAB involved
HZB	18/03/2024	28/04/2024	Online/Berlin, HZB	33	Marcus Bär, Regan Willks (HZB)
HZB, FZJ	26/07/2023	26/07/2023	Erlangen-Germany	25	N. Maticiu, E. Unger (HZB), J. Hauch, M. Sytnyk (FZJ)
HZB	04/09/2023	09/09/2023	Hirschegg, Austria	56	Eva Unger (HZB)
UNITOV, HZB, EPFL, CEA, IMEC, AIT	04/09/2023	08/09/2023	Talamone, Italy	40	A. Di Carlo, F. Brunetti, C. Barollo, N. Maticiu, S. Cros, I. Gordon, S. Abermann, C. Wolff, P. Delli Veneri ISOPHOS 2023 summer school
IMEC	13/12/2023	13/12/2023	Online/ Genk, BE	53	A. Aguirre and A. Krishna (IMEC)
HZB	27/02/2023	01/03/2023	Berlin, Germany	12	J. Dagar (HZB)
HZB	03/04/2023	06/04/2023	Berlin, Germany	15	J. Dagar (HZB)
HZB	18/03/2023	19/03/2023	Berlin, Germany	28	J. Dagar (HZB)
UNITOV	03/09/2024	05/09/2024	Talamone, Italy	40	A. Di Carlo, F. Brunetti, T. Watson ISOPHOS 2024 summer school
HZB	01/09/2024	08/09/2024	Hirschegg, Austria	30	E. Unger Lecture on Perovskite Solar Cells
HZB	30/09/2024	02/10/2024	Berlin, Germany	45	E. Unger, N. Maticiu, S. Cros, T. Watson, M. Schubert, F. Brunetti, R. Schlatmann, A. Aguirre, P. Graniero, M. Lira Cantu, J. Hauch, ISOS workshops
HZB	30/05/2024	01/06/24	Berlin, Germany	27	J. Dagar (HZB) Slot-die coating workshop with industry

As an important example, the Viperlab Data Management Workshop, held on 26 July 2023, was a key achievement in advancing data management practices for materials research, particularly in the context of solar perovskite materials and devices. This full-day event served as a dynamic platform for fostering collaboration and updating participants—researchers, industry professionals, and other stakeholders—on innovative strategies and opportunities offered by the NOMAD-LAB and NEO4J



databases. By bringing together experts from German research institutes and representatives of these databases, the workshop demonstrated the importance of multidisciplinary collaboration in enhancing data management capabilities. A key takeaway from the event was the critical role of applying FAIR principles to research data. Discussions highlighted the potential of extending existing data environments and creating integrated research frameworks that leverage data-driven approaches. Sessions delved into semantically linked materials data, the creation of specialized ontologies for targeted research areas, and the transition toward Digital Twin concepts in materials research. Updates on curated databases for emerging photovoltaic technologies emphasized the growing importance of tailored, accessible data solutions.

The workshop underscored the value of hands-on engagement through networking, interactive knowledge exchange, and a visit to the AMANDA Lab. These elements not only deepened participants' understanding of cutting-edge research but also demonstrated the long-term impact of such training events in building relationships and supporting collaborative innovation within the European R&DI community.



Figure 1: ISOPHOS Summer School organized by VIPERLAB 4-8 September 2023 in Talamone, Italy.

The three editions of the International School on Hybrid and Organic Photovoltaics (ISOPHOS) take place in Talamone, Tuscany, Italy and was organized by UNITOV (A. Di Carlo and F. Brunetti). Designed for PhD students, Postdocs, and researchers, the school featured lectures by experts,



primarily from VIPERLAB, covering various areas of photovoltaic technology. In addition to the lectures, a hands-on session provided students with the opportunity to engage with advanced characterization tools. Participants were also able to present their own research, exchange ideas, and discuss solutions in an informal atmosphere. This setting fostered lively discussions and helped establish a robust PV network among students and experts.

VIPERLAB launched in 2022 a series of workshops on LCA Methodology Harmonization where several partners and many EU projects with activities on perovskite related LCA were involved. After the first two release of the workshop participants decided to structure this informal meeting in a well-structured series of workshops called SAIPho Sustainable Assessment of Innovative Photovoltaics. The first edition of the workshop was organized by the University of Siena on 14-15/11/2023. Thus, SAIPho23 represents the follow-up of the first LCA Harmonization Workshop that successfully took place in Brussels in March 2023 bringing together several groups/institutes conducting LCA within diverse ongoing and completed EU projects on perovskite photovoltaics, such as VIPERLAB, TRIUMPH, IBC4EU, PILATUS, PEPPERONI, VALHALLA, SOLARUP, MC2.0, DIAMOND, ESPRESSO, APOLO, PERTPV etc.



Figure 2: SAIPho23 Organized by University of Siena, represents the follow up of the series of workshops organized by VIPERLAB on Harmonization of LCA for perovskite PV technology.

As an example of this approach, we highlight the 15th edition of the International Summit on Organic and Hybrid Perovskite Solar Cell Stability (ISOS 15) organized by the group of Helmholtz-Center Berlin (HZB) and the Humboldt University from 30th September to 2nd of October in Berlin.



The summit has been an important forum for the ongoing discussion on topics of stability of organic and hybrid perovskite solar cells since 2008. It has resulted in impactful outcomes such as the ISOS protocols for the ageing of third generation solar cells and is driven by a worldwide community of research experts on the topic of stability of such solar cell, but also discussing challenges like the metrology of ageing experiments as well as proper design of such experiments.



Figure 3: The ISOS-15 summit organized by HZB within the VIPERLAB project.

A key lesson learned is the transformative impact of interactive and targeted training sessions in building a cohesive network, enhancing the dissemination of project outcomes, and strengthening the foundation for future collaborative endeavours in Europe's innovation landscape.

2.4 Training courses

Training courses delivered in the VIPERLABS's research infrastructures has been essential for equipping students with the knowledge and skills required to engage effectively in advanced scientific research and innovation. These courses provided invaluable hands-on experience, introducing students to state-of-the-art technologies, methodologies, and protocols crucial for navigating and utilizing complex infrastructures.

Such training not only builds technical competence but also fosters an understanding of interdisciplinary collaboration, preparing students to contribute meaningfully to diverse research communities. By bridging the gap between theoretical knowledge and practical application, these courses empower the next generation of scientists to address global challenges and drive innovation.

Investing in training programs for students ensures the sustainable use and development of research infrastructures while cultivating a pipeline of skilled professionals capable of advancing science and technology for societal benefit.

Table 2 presents some of the training courses performed in the VIPERLAB project (the complete list in Deliverable D5.15, D5.7)



Table 2: Examples Training Courses delivered in the VIPERLAB project.

Nr.	Partner(s)	Date start	Date End	Place	# persons	Person VIPERLAB involved	Link and Comments
Course for graduate students "Chemistry of Solar cells"							
1	HZB	18/10/23	06/02/24	HZB and Humboldt University, Berlin	3	Eva Unger	The course was organized in person.
Course for students "Photovoltaics engineering"							
2	Fraunhofer CSP/MWS	01/04/24	31/07/24	Hochschule Merseburg	10	Christian Hagendorf, Marko Turek, Stefan Lange	The course was organized in person.
Guest lecture for students of 'Nanoelectronics Master'							
3	IMEC	15/11/23	15/11/23	University of Hasselt	7	Aranzazu Aguirre	The course was organized in person and online
VIPERLAB Webinar on Standardisation for Perovskite PV							
5	AIT/HZB/CENE	17/01/24	17/01/24	ONLINE	123	Stephan Abermann, Natalia Maticiuc, Eva Unger, Jean Hauch	https://www.viperlab-kep.eu/webinars.asp?i=42&t=VIPERLAB_Webinar_on_Standardisation_for_Perovskite_PV
KSEMAW: AN OPEN-SOURCE SOFTWARE FOR THE SPECTROPHOTOMETRIC, ELLIPSOMETRIC AND PHOTOTHERMAL DEFLECTION SPECTROSCOPY							
6	ENEA	11/01/24	11/04/24	online	60	Natalia Maticiuc (HZB), Francesco Roca (ENEA), Manuela Ferrara (ENEA), Marco Montecchi (ENEA), Alberto Mittiga (ENEA)	https://www.viperlab-kep.eu/webinars.asp?i=43&t=KSEMAW:anopen-sourcesoftwareforthespectrophotometric,ellipsometricandphotothermaldeflectionspectroscopy
Course "Solar cell characterization"							
7	Fraunhofer (ISE)	17/04/24	17/07/24	at Univ. Freiburg, Program	20	Martin Schubert	in person



				Sustainable Systems Engineering			
Infrastructure webinars							
8	TNO, Swansea University	13/11/23	13/11/23	online	53 YouTube: TNO 254 SWANSEA A 219	Natalia MATICIUC (HZB) Valerio ZARDETTO (TNO) David BEYNON (SWANSEA) Rahul PATIDAR (SWANSEA)	https://www.viperlab.eu/webinars.asp?i=38&t=TNO-Solliance+eamp:Swansea+Uni+Manufacturing+and+testing+facilities
9	CEA/IMEC	28/06/23	28/06/23	online	42 YouTube IMEC 481 CEA 254	Francesco ROCA (ENEA) Natalia MATICIUC (HZB) Stéphane CROS (CEA) Aranzazu AGUIRRE (IMEC)	https://www.viperlab.eu/webinars.asp?i=32&t=CEA-PSK+Platform+eamp:IMEC+thin+film+lab+Infrastructures%27+presentation

Training played an important role in fostering long-term relationships and multidisciplinary collaboration within perovskite community that VIPERLAB fostered. By equipping researchers and professionals with shared knowledge, harmonized practices, and cutting-edge skills, training programs created a foundation for seamless collaboration across disciplines and institutions. These initiatives enhanced mutual understanding, strengthened networks, and ensured that diverse expertise was effectively integrated to address complex challenges. Ultimately, the investment in training supported the sustainable growth of the RDI community, enabling it to thrive in an increasingly interconnected and multidisciplinary landscape.

2.5 Exchange of personnel

During the VIPERLAB project, the exchange of personnel among partners served as a cornerstone activity to enhance research capabilities, foster collaboration, and strengthen relationships within the European RDI community. These exchanges facilitated the sharing of expertise, harmonization of research methodologies, and optimization of procedures, creating a unified approach to addressing challenges in perovskite technology development. By enabling researchers and professionals to work closely with different institutions and infrastructure, these exchanges encouraged multidisciplinary perspectives and the integration of diverse knowledge. Participants gained valuable



insights and skills while contributing to collaborative projects that advanced the overall goals of the VIPERLAB initiative.

The personnel exchange activities not only supported immediate research objectives but also laid the foundation for long-term relationships among partners. These connections are vital for sustaining collaboration, promoting innovation, and ensuring that the European RDI community remains at the forefront of global advancements in perovskite research. By fostering a culture of cooperation and shared expertise, the VIPERLAB project demonstrated the critical role of personnel exchange in building a resilient and interconnected scientific ecosystem.

Table 3: Examples of Personnel Exchange among the VIPERLAB partners.

From Partner	To Partner	Data Start	Data End	Exchange Person(s)	Activity
CENER	FZJ	08/04/24	12/04/24	Alcia Buceta	Hands-on processing perovskite solar cells at AMANDA infrastructure. In one week, 100 Perovskite solar cell samples were prepared.
UNITOV	TNO	20/01/24	01/02/24	Hafez Nikbakht	Comparison between sputtered SnO ₂ performed in Rome and ALD SnO ₂ performed at TNO
UNITOV	FZJ	01/07/23	28/09/23	Farshad Jafarzadeh	Scaling up of semi-transparent Perovskite Solar Cells for Building Integrated Photovoltaics with Roll-to-roll production.
UNITOV	CEA	05/08/24	09/08/24	Yassine Raoui	Degradation Mechanism of Perovskite and Perovskite-Silicon solar cells based on scalable process of NiOx.
UNITOV	SU	15/07/24	17/08/24	Atiq Ur Rahman	Optimization of solution-processed semi-transparent organic photovoltaics (ST-OPV) mini-module for AGRIVOLTAICS application

2.6 Exploitation & Multidisciplinary

The VIPERLAB project has generated significant outcomes in the areas of knowledge exchange, dissemination, and personnel exchange, offering a strong foundation for long-term relationships and multidisciplinary collaboration within the European RDI community. To ensure the enduring impact of these results, their exploitation must be strategically planned and implemented, fostering innovation and sustained cooperation in perovskite research and related fields.

Dissemination Results: Extending Reach and Building Networks

The dissemination activities of VIPERLAB have successfully raised awareness about perovskite technologies and their potential applications. The networks and connections established during conferences, workshops, and webinars can be further developed to enhance collaboration among RDI stakeholders. Future exploitation strategies should focus on maintaining and expanding these networks by organizing periodic events, such as annual summits or workshops, to provide ongoing platforms for knowledge sharing and partnership building.



Additionally, the dissemination outputs - scientific publications, reports, and communication materials, workshop, courses - should be leveraged to support educational and industry initiatives. These materials can act as resources for academic institutions, informing curricula and inspiring the next generation of researchers. Industry stakeholders can also use them to align their innovations with cutting-edge research findings, fostering stronger academia-industry ties.

Knowledge Exchange: Strengthening Expertise and Innovation

The rich knowledge generated and shared within VIPERLAB serves as a cornerstone for fostering innovation and advancing perovskite technologies. By creating standardized protocols, harmonized methodologies, and a robust framework for data sharing, the project has provided a model for efficient collaboration across institutions and disciplines. These resources can be further exploited by integrating them into European training programs, fostering their adoption in broader research initiatives, and utilizing them to streamline new projects.

Establishing centralized repositories for knowledge and protocols developed in VIPERLAB would ensure continuous accessibility for researchers and developers. These repositories could serve as a knowledge hub, supporting future collaborations and reinforcing the RDI community's capacity to address emerging challenges.

Personnel Exchange: Building Lasting Relationships

The personnel exchange activities of VIPERLAB have been instrumental in fostering trust, collaboration, and shared expertise among project partners. To exploit these outcomes, the partnerships formed during the exchanges should be formalized into long-term collaborations through joint research agreements, co-funded projects, or institutional alliances. These partnerships can enable sustained multidisciplinary efforts and ensure that the relationships and synergies created within VIPERLAB continue to grow.

To expand the impact of personnel exchanges, future programs should be developed to enable a broader range of participants, including early-career researchers, to engage in mobility initiatives. This would not only strengthen individual competencies but also build a culture of collaboration across the European RDI community.

Creating Long-Term Relationships and Multidisciplinary Collaboration

The outcomes of VIPERLAB have laid the groundwork for long-term relationships and multidisciplinary collaboration. To exploit these results fully, the European RDI community should prioritize initiatives that integrate knowledge exchange, dissemination, and personnel mobility into broader research agendas. Establishing collaborative platforms, such as virtual networks or research alliances, will ensure the sustained engagement of stakeholders and the efficient use of shared resources.

Moreover, aligning VIPERLAB's outputs with European innovation frameworks, such as Horizon Europe or national RDI strategies, will amplify their relevance and encourage their integration into future projects. By embedding these results into ongoing and future initiatives, VIPERLAB can continue to drive advancements in perovskite technologies and beyond.



The exploitation of VIPERLAB's results offers a pathway to building a resilient and innovative European RDI community. By strategically leveraging these outcomes, the project's impact can be extended far beyond its duration, fostering enduring relationships, advancing multidisciplinary collaboration, and positioning Europe as a global leader in perovskite research and innovation.

3. CONCLUSIONS

The VIPERLAB project has had a significant and lasting impact on fostering strategies for exploitation and promoting multidisciplinary collaboration within the European research, development, and innovation (RDI) community. Through its well-structured initiatives in knowledge exchange, dissemination, and personnel exchange, VIPERLAB has successfully laid the foundation for sustainable advancements in perovskite technologies and strengthened Europe's leadership in this innovative field.

Knowledge exchange emerged as a cornerstone of the project, enabling the seamless transfer of expertise, insights, and best practices across institutions and disciplines. Workshops, training sessions, and collaborative platforms were instrumental in facilitating this exchange. Researchers were not only exposed to cutting-edge methodologies but also encouraged to integrate knowledge from diverse fields such as materials science, chemistry, physics, and engineering. This interdisciplinary approach addressed complex challenges in perovskite research and ensured that participants were equipped with the skills and understanding necessary to innovate effectively. Additionally, the harmonization of research methodologies and protocols through these activities contributed to the creation of a cohesive and efficient European RDI community.

Dissemination activities amplified the reach and impact of VIPERLAB's outcomes, ensuring that the project's findings and best practices were shared with a wide audience, including researchers, industry stakeholders, and policymakers. By organizing conferences, publishing research papers, and hosting interactive webinars, VIPERLAB not only raised awareness of its achievements but also facilitated the adoption of harmonized standards and procedures. These efforts played a critical role in strengthening the collaborative fabric of the European RDI community, making it more cohesive and aligned in its goals. Furthermore, public-facing communication tools ensured that the benefits of VIPERLAB extended beyond the immediate scientific community, engaging broader audiences and fostering societal support for perovskite research and innovation.

Personnel exchange was another vital aspect of the project, fostering direct collaboration among partners and enhancing the mobility of researchers across institutions. By enabling professionals to work closely with different teams and infrastructure, these exchanges promoted the optimization of research processes and encouraged the sharing of specialized expertise. Participants were able to gain hands-on experience with advanced tools and methodologies while contributing to collaborative research that addressed critical gaps in perovskite development. More importantly, these exchanges established long-lasting relationships between institutions, paving the way for future joint initiatives and creating a tightly knit network of collaborators. The interpersonal connections and trust built through these exchanges have proven invaluable for sustaining multidisciplinary partnerships and ensuring the continuity of innovation.

The collective impact of these activities has been transformative, not only for the immediate goals of VIPERLAB but also for the broader European RDI ecosystem. By integrating knowledge exchange,



effective dissemination, and personnel mobility, VIPERLAB has created a resilient and interconnected community capable of addressing the multifaceted challenges of perovskite research. The project's emphasis on harmonization and collaboration has ensured that its outputs are not only valuable in the short term but also provide a foundation for sustainable exploitation and future growth.

Moreover, VIPERLAB's strategies have highlighted the importance of fostering long-term relationships within the RDI community. These relationships are essential for maintaining momentum in research, ensuring the efficient use of shared infrastructure, and driving innovation that transcends individual disciplines. The project's legacy lies in its ability to connect diverse expertise and foster a spirit of cooperation, which will undoubtedly continue to shape the future of perovskite research and beyond.

In conclusion, the VIPERLAB project has set a benchmark for how collaborative research initiatives can drive scientific progress, create sustainable networks, and promote long-term innovation. Its integrated approach to knowledge exchange, dissemination, and personnel exchange demonstrates how strategic activities can strengthen the European RDI community, positioning it as a global leader in addressing emerging challenges. By prioritizing collaboration and shared expertise, VIPERLAB has established a durable framework for advancing perovskite technologies and fostering a thriving research ecosystem that will continue to deliver impactful results well into the future.

