HgCdTe APD **O**ptimization for **L**idar **D**etection **O**f gree**N**house gases

Grant Agreement n° 776390

Deliverable D7.2– Dissemination and Exploitation Plan

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Document Abstract

This deliverable aims to define an effective long-term strategy to pursue the following objectives:

- Make the project widely known to raise awareness on the project and stimulate interest
- Disseminate the results of the project and transfer the knowledge generated by the project
- Explore and assess emerging application areas to facilitate the exploitation of the project's results

The strategy for dissemination and exploitation of the project's results is structured around these principles:

- Description of the strategic objectives and targeted audiences
- Definition of clear key messages
- Description of Dissemination and Communication activities
- Description of the envisaged project exploitation routes

The current status of the different issues, achievements towards the objectives and measurable indicators are reported, thus giving the progress of the different activities up to project month 30, and outlining the work to be done in the next months.

The dissemination and exploitation plans will continue to be further refined and improved until the project completion.

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1 THE PROJECT

1.1 CONTEXT

Lidar remote sensing of the earth's atmosphere is one of the main challenges in coping with the effects and causes of global warming caused by the emission of greenhouse gases. The present operating Lidar missions are all implanted on large satellite platforms due to the size of the telescope and high energy laser modules required to ensure a sufficient collection of light to extract the signal from the detector noise.

Thanks to the involvement of 6 technical academic and industry partners, an innovative concept was launched aiming to develop a new detection chain which will improve the performance of the Lidars on large platforms and/or reduce the Lidar payload to be integrated in the future micro and mini-satellites. The performance increase is obtained by the optimization of HgCdTe avalanche photodiodes that will be hybridized to a CMOS Readout Circuit providing two operation modes and designed to meet the most demanding requirements for Lidar applications in terms of sensitivity, dynamic range and temporal resolution. This project, named "HOLDON" is funded by the European Union Horizon 2020 Research and Innovation program.

1.2 PARTNERSHIP

The HOLDON consortium is coordinated by Commissariat à l'énergie atomique et aux énergies alternatives (P01 CEA-LETI), France, and is composed of 6 technical partners:

- **Research and Technology Organization (RTO)**

Commissariat à l'énergie atomique et aux énergies alternatives (P01 CEA), France

- **Academic Institutions**

Ecole Polytechnique - Laboratoire de Météorologie Dynamique (P03 EP/LMD), France
Deutsches Zentrum für Luft und Raumfahrt - Institut für Physik der Atmosphäre, Oberpfaffenhofen, (P04 DLR-IPA), Germany

- **Industry Partners**

Airbus Defence and Space SAS (P02 AIRBUS), France
ALTER TECHNOLOGY (P05 ALTER), Spain

- **Small and Medium Entreprises (SMEs)**

ID Quantique SA (P06 IDQ), Switzerland
AK GROUP (P07 AK), France, is the partner in charge of facilitating dissemination, communication and exploitation activities.

1.3 GOALS AND OBJECTIVES

The HOLDON project aims to:

- **Objective 1**: Design and manufacture a cutting-edge photon noise limited Lidar detection chain
- **Objective 2**: Validate the adequacy between Lidar detection key performances and requirements for future space missions
- **Objective 3**: Demonstrate the improvement achieved with the cutting-edge detection chain for greenhouse gases detection

2 DEFINITIONS

In the context of this report, we consider the following definitions, from the H2020 references (EC Research & Innovation Participant Portal Glossary/Reference Terms and IPR Helpdesk).

By signing the EC Grant Agreement participants agree to:

Promote the action and its results, by providing targeted information to multiple audiences (including the media and the public), in a strategic and effective manner and possibly engaging in a two-way exchange (Article 38 of the Model Grant Agreement).

Disseminate results — as soon as possible — through appropriate means, including in scientific publications (Article 29 of the Model Grant Agreement).

Ensure open access (free of charge, online access for any user) to all peer-reviewed scientific publications relating to its results (Article 29 of the Model Grant Agreement).

Ensure 'exploitation' of the results — up to four years after the end of the project – by using them in further research activities; developing, creating or marketing a product or process; creating and providing a service, or using them in standardization activities (Article 28 of the Model Grant Agreement).

Results: "any tangible or intangible output of the action, such as data, knowledge and information whatever their form or nature, whether or not they can be protected".

Acknowledge EU funding in all communication, dissemination and exploitation activities (including IPR protection and standards) as well as on all equipment, infrastructure and major results financed by the action by using the wording and criteria specified in the Grant Agreement (Articles 27, 28, 29, 38rastructure and major results financed by the action by using the wording and criteria specified in the Grant Agreement (Articles 27, 28, 29, 38).

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 776390"

Figure 1: HOLDON statement to acknowledge EU funding

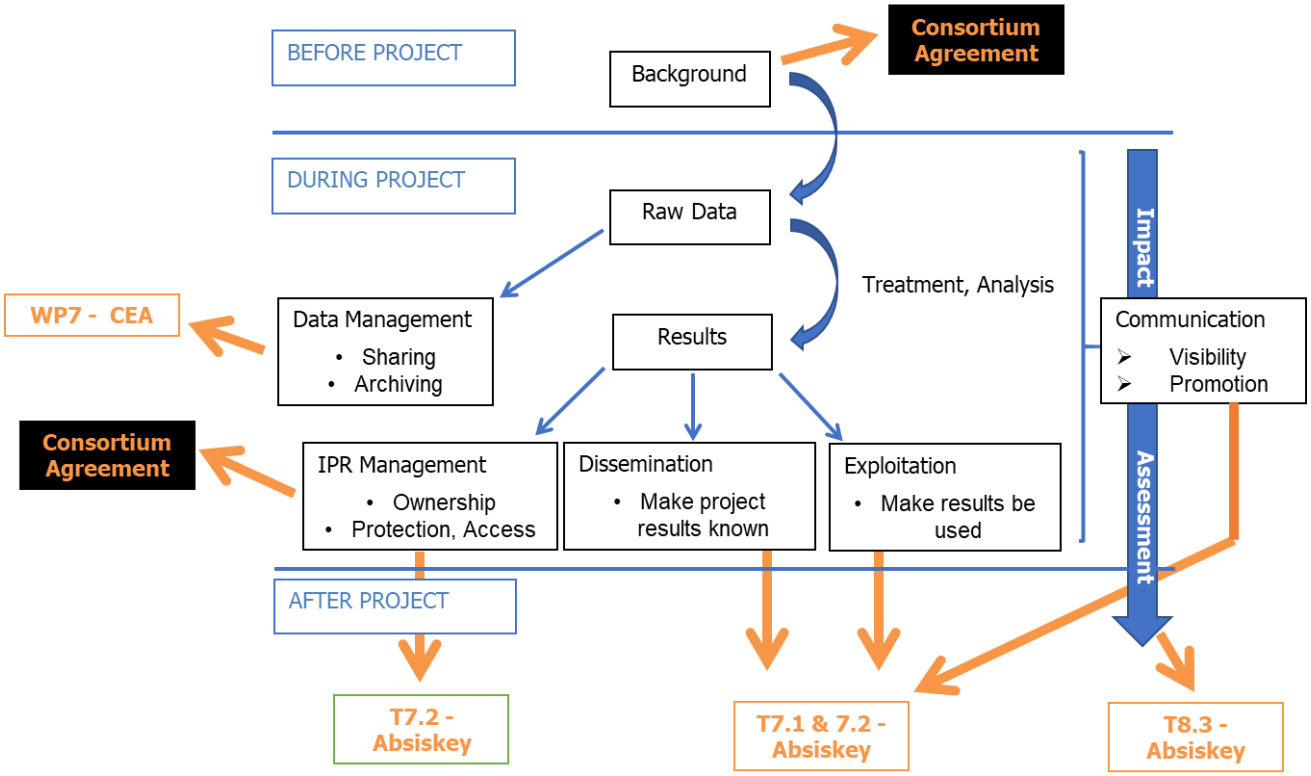

Figure 2: Process involved in the valorization of the project and its results

Communication, dissemination and exploitation must be addressed through an integrated approach that strategically plans activities with clear objectives, defined targets, relevant messages, right medium and means that must be identified and implemented.

Communication, dissemination and exploitation activities are closely linked: although they can be considered separately, they are often complementary since one drives the other and vice versa. What differentiate them from another are the objectives, focus and target groups they address.

To build this integrated and strategic approach, the following steps must be implemented:

- Description of the project key exploitable results, outcomes, knowledge, their exploitation route and IP management;
- Identification of the main objectives of the communication-dissemination-exploitation strategy and of the relevant target audiences;
- Definition of clear messages in accordance with the project objectives;
- Identification of proper communication means and tools;
- Formalization of the activity roadmap planning.

3 STRATEGIC OBJECTIVES AND TARGETED AUDIENCES

3.1 MAIN OBJECTIVES OF THE COMMUNICATION, DISSEMINATION, EXPLOITATION STRATEGY

- Embed the project results into the practices of the partners;
- Make available the knowledge generated through the project to all interested organizations;
- Establish links with related on-going research initiatives;
- Trigger further development and research in Space R&D - Optical equipment and instrument technology – The satellite earth observation sector - Detector Technologies - Remote Sensing Instruments / Sensors;
- Set the foundations for further commercial exploitation and opportunities;
- Help attract additional funding to increase the TRL levels of the technologies and tools developed;
- Make the project's work widely known, attract civil society attention and generate interest for the exploitation of the results;
- Inform decision makers about HOLDON important outcomes.

3.2 TARGETED AUDIENCES

The groups of target audiences of the project for communication, dissemination and exploitation purposes are shown in the picture below.

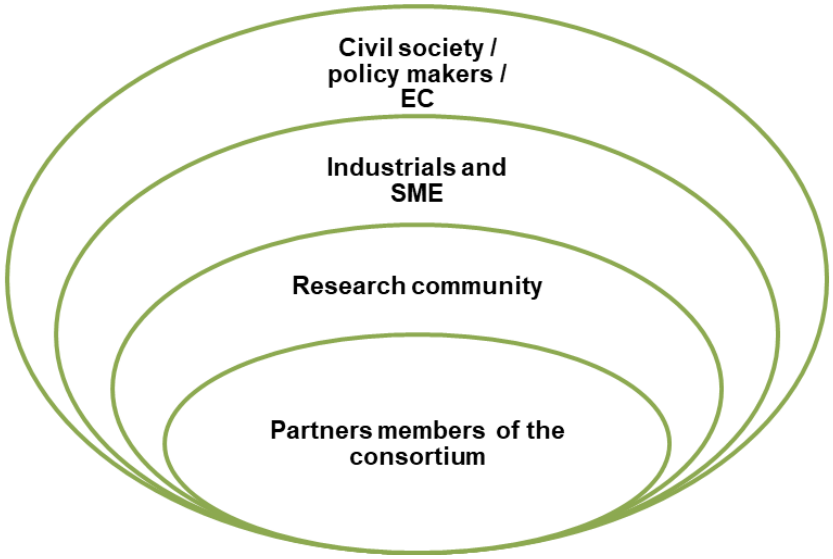

Figure 3: Targeted audience of the HOLDON project

3.2.1 Members of the consortium

- RTO; Academic Institutions; Industry Partners; SMEs;
- Highly involved in the project;
- High expectations about the outcomes as WP are interdependent to build on HOLDON final results;
- Expect to trigger further developments in next generation of Earth observation Lidar missions and associated applications; HgCdTe APD detectors regarding Photon counting, Free space optics applications;
- Expect to set the foundations for further commercial exploitation;
- Get information mainly through scientific events and papers, or professional workshops;
- Shall establish links with other R&I activities (see table 3 below).

3.2.2 Research community

- Mainly researchers and engineers specialized in Lidar detector; greenhouse measurements; meteorology; aerospace applications & electronics;
- Expect to be informed of the knowledge and technologies generated through the project.
- Expect to develop new collaborative research activities including fundamental research and research for industry and space applications;
- Get information mainly through scientific events and papers;
- Some use professional Social Media (Research Gate, LinkedIn).

3.2.3 Industrials and SMEs

- Industry actors in the sector of Lidar detectors, aerospace industries; electronics. SMEs in the sector of cryptography, photon counting, free space optics & imaging domain; national climate services;
- Expect to develop synergies with academics in order to develop new commercial activities;
- Get information mainly through professional Social Media, newsletters, professional events.

3.2.4 Civil society / policy makers / European Commission

- Interested in Earth observation mission technologies and greenhouse gases measurement;
- Expect to get information about main project outcomes, and especially about their possible concrete applications;
- Get information mainly through mass medias and Social Media, Web Page.

Table 1: Links to other R&I initiatives

Acronym (COORD.)	Program	End year	Title	Link with HOLDON project	Partner involved
None	R&T CNES	2016	Development and reliability of large area HgCdTe APDs for Lidar applications.	1. Development of an HgCdTe APD detector module using a deported continuous mode amplifier with fixed bandwidth and gain. The detector has been delivered to EP/LMD and is currently used for DIAL CO_2 experiments at EP/LMD. 2. Perform first proton and irradiations tests, which didn't show any significant degradation. The results of these first space qualification tests were positive.	CEA-Leti, CNRS/LMD, CNES
None	R&T CNES DAJ/AR/IB-2016-10117846	2017	Development and characterization of a prototype HgCdTe based APD for Lidar application	The objective is to develop a Lidar module coupling a HgCdTe APD with an existing pre-amplifier using indirect bonding technic in order to experiment operation in linear regime operation and quasi photon counting mode.	CEA-Leti, CNRS/LMD, CNES
None	R&T CNES and AIRBUS	2017	Characterization of existing HgCdTe APD for Lidar applications	HgCdTe APD already developed by CEA-Leti and coupled with COTS pre-amplifier will be characterized with respect to their capabilities to fulfil future Lidar missions at 1.064 µm.	AIRBUS, CEA-Leti, CNES
None	R&T CNES (R-S15/OT-0002-072)	2017	APD with optimized optical coupling	Concentration of the photon flux with an optical component, such as a µ-lens, reported or manufactured at the backside of the HgCdTe APD detector. This leads to an increase in the detector sensitivity without increasing the detector size.	CEA-Leti, CNES
MEATS	CARNOT Institute funding	2013	Mono-element APDs for Telecom and Science	Optimization of HgCdTe APD for single element applications (Bandwidth and dark current) and development of an internal platform for demonstrator design.	CEA-Leti
HLAC Fabien Gibert	ESA	2018	2.05 µm Pulsed Holmium Laser for Atmospheric CO_2 monitoring	2 µm laser source dedicated for space application. EP/LMD has built a second similar 2 µm laser source that will be used in HOLDON. Experience in 2 µm laser for CO_2 DIAL will feed the HOLDON project.	CNRS/LMD
CoMet	DLR, DFG	2019	Carbon Dioxide and Methane Mission for HALO - CoMet	Combining a suite of the best currently available active (Lidar) and passive remote sensors as well as in-situ instruments to collect new data sets and knowledge about the variability of CO_2 and CH_4 on a subcontinental scale.	DLR, MPI-BGC, U Bremen, U Heidelberg
MERLIN Phase C/D	DLR	2021	Methane Remote Sensing Lidar Mission	Preparation of the first ever greenhouse gas Lidar mission	DLR, Airbus

4 KEY MESSAGES

This chapter presents the key messages of the project, ensuring coherence of communication, dissemination and exploitation activities.

Table 2: Key messages of the HOLDON project

Target audience	Objective	Message	Calls to action	KPI's
Partners members of the consortium	▪ Further develop next generation of Earth observation Lidar missions and associated applications; HgCdTe APD detectors regarding Photon counting, Free space optics applications ▪ Transfer the knowledge generated ▪ Set the foundations for further developments of the technology	▪ Working together will allow you to achieve both the project and your own objectives	▪ Make the project known ▪ Disseminate your results ▪ Organize events to raise awareness of the project and its outputs ▪ Establish links to other R&I initiatives	▪ Number of publications in international conferences ▪ Number of publications in international journals ▪ Lectures & posters at international conferences ▪ Number of events organised
Research Community	▪ Establish links with related on-going research initiatives ▪ Build new collaborative research	▪ Project offers opportunities to feed your own research activities and to set up new collaborations	▪ Participate to events organised by the HOLDON consortium ▪ Embed project results into your practices ▪ Use the most significant outcomes to develop new collaborative research activities including fundamental research and research for industry and space applications;	▪ Total number of attendees to events ▪ Impact factor of the publications from the HOLDON project / number of views-downloads (Web Page) ▪ Number of academic followers in the HOLDON Social Media (apart from the HOLDON partners)
Industries and SMEs	▪ Match the project new material and corresponding		▪ Follow the main valuable project outcomes	▪ Number of industry followers in the HOLDON Social Media (apart from the HOLDON partners)

	research advances with market opportunities	Project outcomes offer great opportunities for business	▪ Set the foundations for further commercial exploitation	▪ Number of industrial cooperation agreements ▪ Evidence of transfer of research and innovation into practice (patents, prototypes, licenses) ▪ Number of new products, practices or procedures developed based on outcomes
European Commission, Governments	▪ Increase TRL level of technologies and tools developed	Additional projects can lead to better standardization of the outcomes	▪ Fund additional projects related to HOLDON thematic	▪ Evidence of new funding
Policy Makers	▪ Raise political awareness	Project outcomes offer opportunities to support economy, jobs and growth	▪ Contribute to new policies about HOLDON thematic	▪ Evidence of debates in the media
Civil society	▪ Make the project's activities widely known ▪ Attract civil society attention ▪ Create interest for exploitation of the results	Project outcomes offer opportunities to improve Earth observation mission technologies and greenhouse gases measurement	▪ Visit our Web Page ▪ Follow us on LinkedIn ▪ Share our news with your own networks	▪ Number of Web Page visits ▪ Number of documents downloaded and video views ▪ Number of followers of the HOLDON Social Media (apart from the partners) ▪ Number of people asking for feedback or more information

5 DISSEMINATION AND COMMUNICATION ACTIVITIES

5.1 DISSEMINATION AND COMMUNICATION TOOLS

5.1.1 Project branding, templates, flyer, kakemono/poster

The HOLDON branding has been created at month 9 with the design of an effective original visual identity, including the project logo as well as official project template documents (deliverable template, model project meeting presentation).

Figure 4: Brand of the HOLDON project

Figure 5: HOLDON kakemono/poster

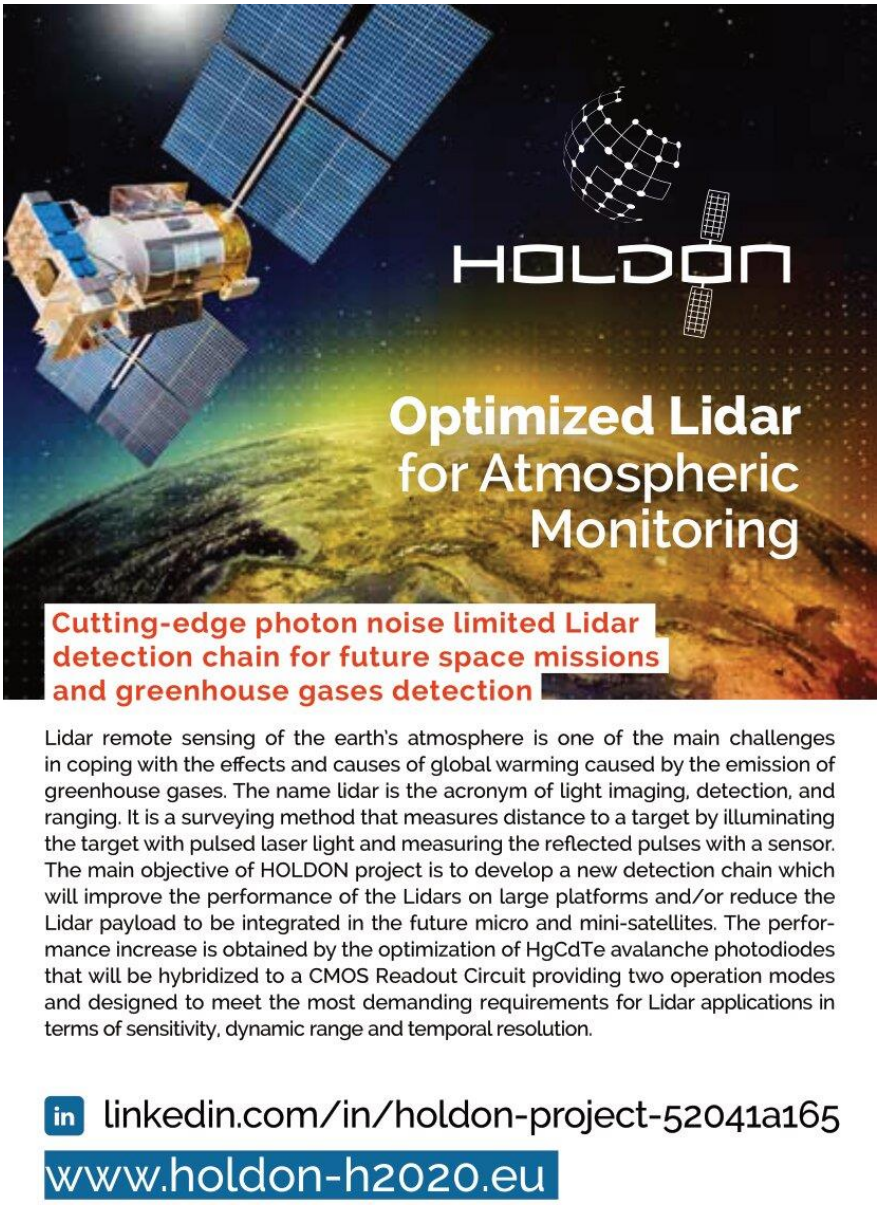

Figure 6: HOLDON flyer

5.1.2 Project Web Page

The Web Page is a key means for dissemination and external one-way communication. The HOLDON web address (http://holdon-h2020.eu) has been created at month 6 (June 2018). The Web Page has been continuously fed to keep the audience informed and ensure interest of already attracted visitors.

The Web Page key metrics are regularly checked, at least for each meeting. They include the following indicators: number of sessions, number of users and new users, average session duration, number of documents downloaded, geographical distribution of the users.

5.1.3 Reference to the project on the partners' Web Pages

To optimize the communication on the project, all the partners have been asked to make a reference to the HOLDON project on their own organizations' websites.

Tableau 3: Reference to the project on each partner's website

Partner	Website URL	Reference of the HOLDON project
P01 CEA	http://www.leti-cea.fr/cea-tech/leti/Pages/Accueil.aspx	NO
P02 AIRBUS	https://www.airbus.com/space.html	NO
P03 EP/LMD	https://www.ens.psl.eu/laboratoire/laboratoire-de-meteorologie-dynamique-umr8539	NO
P04 DLR	https://www.dlr.de/pa/en/desktopdefault.aspx/	YES
P05 ALTER	https://www.altertechnology-group.com/en/home/	NO
P06 IDQ	https://www.idquantique.com/	NO
P07 AK	http://www.absiskey.com/	NO

5.1.4 Social Media

The HOLDON Social Media is also a key means for external one-way communication. A LinkedIn account has been created at month 6 (June 2018) and is continuously fed to keep the audience informed and invite them to visit the webpage.
LinkedIn is widely used by the scientific community and professionals in general.
The following indicators are regularly checked: number of articles/posts, number of followers, number of profile visits, number of views, number of likes. If relevant, accounts of other linked R&I initiatives could be followed.

5.2 DISSEMINATION AND COMMUNICATION MEANS

5.2.1 Events

As covered in the chapter 3 Key Exploitable Results, Outcomes, Knowledge organizing and participating to events is an important measure to ensure exploitation of the results, as well as fulfill the communication and dissemination objectives.

5.2.1.1 Events to be organized by the project consortium

A demonstrator workshop will be organized at the end of the project (date to be defined) to disseminate the findings of the project mainly for external stakeholders and especially towards industry actors and the applied research community.

5.2.1.2 Participation by the project consortium to international events

To promote the HOLDON project and its results, and make them widely known, participation to international events such as conferences and workshops is also key to serve the communication, dissemination and exploitation objectives. The main targeted events are summarized below:

- 29th International Laser Radar Conference, 2019, date & place to be defined;
- SPIE Remote Sensing - Sensors, Systems, and Next-Generation Satellites, every year in September (Europe);
- International Conference on Space Optics (ICSO) 2018, and 2020, date & place to be defined;
- IR Colloquium in Germany every two years;
- OPTRO in Paris every two years (2020,2022);
- ICSO (ESA-CNES) every two years in Europe;
- CNES CCT workshops (France);
- SPIE Defence and Commercial Sensing, every year in April (USA);
- International II-VI Workshop every year in October (USA);
- AGU Fall Meeting, American Geophysical Union, date & place to be defined;
- EGU General Assembly; European Geosciences Union, Vienna, date to be defined;
- International Workshop on Greenhouse Gas Measurements from Space (IWGGMS), biannual, date & place to be defined;
- COSPAR Scientific Assembly, Organizer: Committee on Space Research, biannual, date & place to be defined.
- SPIE Photonics West 2020 exhibitions. San Francisco CA, USAientific Assembly, Organizer: Committee on Space Research, biannual, date & place to be defined

5.2.2 Publications

5.2.2.1 Scientific Publications

Scientific dissemination activities presenting the scientific advances being achieved in HOLDON, throughout the project duration also relates to publication in international conferences and publication of articles in scientific journals. The selection of international journals listed below has been made according the individual dissemination plan of the partners.

- Atmospheric Measurement Techniques;
- Atmospheric Physic and Chemistry;
- Journal of electronic Materials (JEM);
- Journal of crystal growth (JCG);
- Optics Express;
- Applied Optics;
- Applied Physics B;
- CEAS Space Journal.

5.2.2.2 Non-scientific publications

The achievements made in HOLDON will be disseminated via non-scientific publications (press releases, e-news) toward the general public (citizens, public and private organizations including industry, SMEs, policy makers) interested in Earth observation mission technologies and greenhouse gases measurement.

5.3 GOOD PRACTICES TO BE FOLLOWED WHILE IMPLEMENTING COMMUNICATION AND DISSEMINATION ACTIVITIES

5.3.1 Web Page, Social Media and general communication

On a monthly basis: AK asks the partners to send new contents: information, results, pictures or any relevant material to be published on the Web Page and Social Media.

Before each consortium meeting: AK asks the partners to fill in the monitoring tool in order to track past and future communication and dissemination activities.

5.3.2 Events organized by the project consortium

2 months before the event:

- AK asks the partners to create the event flyer/schedule/registration form and to promote the event on their organization website
- AK publishes an announcement about the event on the HOLDON Web Page and the Social Media, using the flyer/schedule/registration form provided by the partners.

1 month before the event:

- AK republishes the same announcement about the event on the Social Media.

1 week before the event:

- AK publishes a final reminder about the event on the Social Media.
- AK reminds partners organizing the event to take pictures during the event.

During the event:

- The organizing partners' communication departments should facilitate uptakes of the events (photos, articles, and interviews) to promote the HOLDON project on their own websites.
- AK will then make reference to these materials on the HOLDON Web Page and the Social Media

Within one month after the event:

- AK asks the organizing partners to send contents of the event to be published on the Web Page and the Social Media.

5.3.3 Participation to international events by the project consortium

2 months before the event:

- AK asks the partners if they intend to participate to events
- If yes, AK reminds the partners to promote the HOLDON project (using promotion tools such as the flyer, poster/kakemono) and its outcomes (during lectures and specific poster sessions).

On the month of the event:

- AK publishes the piece of news in the Web Page and the Social Media, about the participation of the HOLDON project partner(s) to the event
- AK reminds the partner(s) to take pictures at the event

Within one month after the event:

- AK asks the relevant partner(s) to send contents such as photos or any other materials) and reports on the participation to the event in the Web Page and the Social Media.

6 EXPLOITATION ACTIVITIES

The exploitation activities aim to describe how the results arising from the project will be used and more generally will concretize the value and impact of the R&I activity for societal challenges.

6.1 BACKGROUND

During the proposal stage, the partners have listed the components of their background likely to be brought to the project and the potential rights attached to them.

IDQ has identified the following background as accessible under fair and reasonable conditions to be agreed between the partners:

Stirling Cooler:

- know how on vacuum chamber,
- know-how on temperature control

Interface Board:

- know how on thermal management,
- PCB at high vacuum and cryogenic temperatures,
- packaging and fiber-coupling of detector

Acquisition Board:

- High speed interface between FPGA and PC including VHDL and API implementations
- GUI (Graphical User Interface) developments.

For the other consortium members, none of their data, know-how or information have been identified as needed for the implementation of the project.

6.2 EXPECTED HOLDON RESULTS, OUTCOMES, KNOWLEDGE

This step intends to answer the following questions:

- **What are the expected key exploitable results, outcomes, knowledge of the project?**
- **How are they going to be used and by whom?**
- **What are the means to ensure their exploitation?**

The dissemination and further exploitation strategy of the project will extensively target industrial stakeholders. Due to the low TRL of the technology, activities aiming at direct commercialization and industrial implementation during or immediately after the project are premature and will have to take place only after further technology development.

As planned in the Description of Action (DoA), CEA has set up an Advisory Board, that plays a key role and serves both to ensure the industrial relevance of the project activities and to communicate project results to the industry. The Advisory Board is composed of 4 members for guidance, advice and evaluation, coming from such as companies that have a commercial interest in the technology (Earth observation mission technologies, greenhouse gases measurement, cryptography, photon counting and imaging domains). At month 30, the Advisory Board composition is the following:

- LYNRED (ex-SOFRADIR), represented by Mr. Philippe Chorier (France);
- Prof. Jean-Pierre Wolf (bio-photonics expert, professor in physics, University of Geneva);
- CNES, represented by Mr. Alain Bardoux (France);
- RIEGL Laser Measurement Systems GmbH (Germany).

So the HOLDON exploitation plans must be based on a common reflection to anticipate and prepare future relevant actions in order to convert the knowledge and technology demonstrations obtained during the project. A solid basis for discussion will be the results detailed in the deliverables D1.3 Evaluation of technical and scientific perspectives for future Lidar programs and D1.4 Lidar hybrid detector flight models development plan. Both deliverables are related Task 1.3 – Evaluation of the Lidar hybrid detector performance for future Lidar programs and definition of a development plan to reach flight model manufacturing level.

The project results, outcomes or knowledge and exploitation activities as planned in the DoA for each partner is reminded below.

CEA LETI

Planned project results, outcome or knowledge created (initial DoA)

- New IP regarding HgCdTe based APD technology

Planned Exploitation Activities (initial DoA)

- Potential exploitation by Sofradir (now Lynred)
- New R&D opportunities for HgCdTe APD detectors regarding Photon counting, Free space optics applications

AIRBUS

Planned project results, outcome or knowledge created (initial DoA)

- Exhaustive knowledge of the ultimate performances of HgCdTe APD detection module and their sensitivity to operating conditions / interfaces in order to optimize the design of future space Lidar systems and to master associated performances budget

Planned Exploitation Activities (initial DoA)

- To keep and extend AIRBUS position as a Word leader for the development of next generation of Earth observation Lidar missions (including operational ones) and associated applications;
- To design compact, more reliable and affordable Lidar payloads with the potential to be exported and create spin-offs for commercial products;
- To address Free Space Optical telecom market with HgCdTe APD detection modules derived from the ones developed for Lidar applications.

EP / LMD

Planned project results, outcome or knowledge created (initial DoA)

- CO_2 profiling with high resolution precision and accuracy

Planned Exploitation Activities (initial DoA)

- Fundamental science: CO2 transport in the troposphere;
- Industry application: CO2 mapping and emission inventories;
- Space application: proof of concept for a new space-borne CO2 DIAL/IPDA mission.

DLR

Planned project results, outcome or knowledge created (initial DoA)

- Test results and characterization of HOLDON detector within IPDA field measurement of atmospheric methane;
- project ion of results for future airborne and spaceborne Lidars.

Planned Exploitation Activities (initial DoA)

- Fundamental science: better characterization of local CH4 sources, lower errors for regional flux inversion;
- Industry application: CH4 mapping and emission inventories;
- Space applications: CH4 IPDA with higher spatial resolution adopted to future inverse modelling possibilities.

ALTER

Planned project results, outcome or knowledge created (initial DoA)

- Lidar simulator

Planned Exploitation Activities (initial DoA)

- New market strategy with the time to commercialize of about 36 months after completion of the project.

IDQ

Planned project results, outcome or knowledge created (initial DoA)

- Functional proximity electronics and closed-cycle cryocooling system for standalone operation of HgCdTe APDs

Planned Exploitation Activities (initial DoA)

- IDQ (in collaboration with CEA-Leti) will exploit the outcomes of this project to continue developing a standalone HgCdTe APD detection system that will ultimately reach single-photon sensitivity, in particular in at telecom wavelengths. Beyond Lidar, the targeted markets are quantum key distribution, single-photon source characterization, singlet oxygen measurement, photoluminescence, fluorescence lifetime measurement, fiber optics characterization, failure analysis of electronic circuits. Through IDQ's customer basis, a large set of end users (beyond Lidar) will be reached and ultimately exploited through sales.

6.3 IP RIGHTS AND MANAGEMENT

IP strategy aims to secure and manage the project results. To formalize that strategy, several points must be taken into account:

- Ownership of the results (the results belong to the beneficiary generating them; if they have been generated by several partners jointly a joint ownership is concluded);
- Access rights of the results (open access as a general principle of scientific dissemination);
- Whether or not they have to be protected (results can reasonably be expected to be commercially or industrially exploited and protecting them is possible, reasonable and justified);
- Which protection measures will be taken.

7 MONITORING AND ASSESSMENT OF THE DISSEMINATION, COMMUNICATION, EXPLOITATION ACTIVITIES

7.1 MAIN COMMUNICATION ACTIVITIES TO DATE

7.1.1 Web Page and Social Media

7.1.1.1 Web Page

Web Page Frequentation (2018/10/01 – 2019/12/02)

At month 30 the project Web Page frequentation has reached a total of 333 users with an average of **11** users per month visiting the Web Page and a total of **700 visits**. In average, **64.9%** of the users are new visitors. This shows that 30 months after the project kicked off ***HOLDON is still attracting new people***. In average, **31.94%** of the users are returning visitors.

Web Page Traffic acquisition (2018/06/01 – 2020/06/30)

The visitors mainly find the Web Page by typing key words in the search engine (41,3%), then by direct entry of the URL address (39,6%), which demonstrate the efficiency of communication materials (flyer, poster, Social Media).

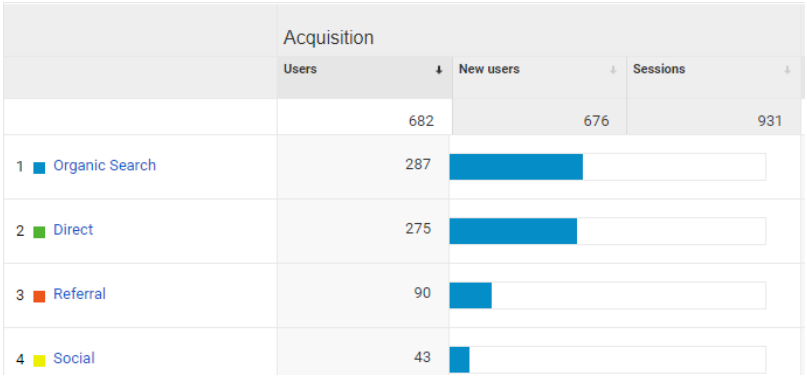

Figure 7: Website traffic acquisition statistics

Web Page visitors' geographical distribution (2018/10/01 – 2019/12/02)

France is in first position with 144 users (20,7%), China is in second with 103 users (14,8%) and the USA is in third position with 72 users (10,3%).

Pays	Acquisition		
	Utilisateurs ↓	Nouveaux utilisateurs	Sessions
	682 % du total: 100,00 % (682)	678 % du total: 100,30 % (676)	931 % du total: 100,00 % (931)
1. France	**144** (20,69 %)	137 (20,21 %)	264 (28,36 %)
2. China	**103** (14,80 %)	103 (15,19 %)	104 (11,17 %)
3. United States	**72** (10,34 %)	72 (10,62 %)	74 (7,95 %)
4. Spain	**48** (6,90 %)	46 (6,78 %)	111 (11,92 %)
5. Switzerland	**39** (5,60 %)	35 (5,16 %)	56 (6,02 %)
6. (not set)	**35** (5,03 %)	35 (5,16 %)	35 (3,76 %)
7. Germany	**30** (4,31 %)	28 (4,13 %)	36 (3,87 %)
8. Belgium	**21** (3,02 %)	20 (2,95 %)	30 (3,22 %)
9. United Kingdom	**21** (3,02 %)	21 (3,10 %)	31 (3,33 %)
10. Japan	**16** (2,30 %)	16 (2,36 %)	16 (1,72 %)

Figure 8: Web Page visitors' geographical distribution

7.1.1.2 Social Media

LinkedIn (2018/06/01 – 2020/06/30)

A LinkedIn account was created during the first reporting period at month 6. During the first and second reporting period, 15 posts and 7 articles have been published and have been viewed 1105 times (all posts and articles considered).
At the end of the second period (month 30), we have a total of 39 subscribers of which 35 are relationships and 5 are consortium members.

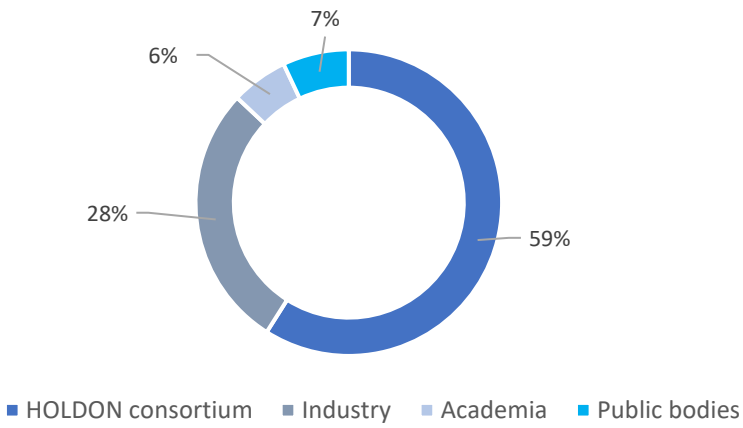

Figure 9: Distribution of LinkedIn audience per sector.

In the first and second reporting periods, the HOLDON LinkedIn page has been followed largely (59%) by the project partner organisations (in majority the industry partners).

At project month 30 we observe that among the visitors outside of the consortium (**41%** in total), **28%** of the followers are from the industry sector (imaging, infrared technologies, Embedded Systems Engineering, GIS and LiDAR engineering, IT security, high-precision quantum optical sensors); **6%** are from academia while **7%** are from public bodies (European Commission, Regional Authority).

7.1.2 Posters/Kakemono and Flyers

Table 4: Posters & Flyers

Subject	Date	Related Event	Involved Partner
POSTERS			
General poster/kakemono: - HOLDON Presentation	9-12 Oct. 2018	ICSO 2018	ALTER
Scientific Poster: 2-µm pulsed Holmium laser for a future CO2/ H2O space lidar mission	9-12 Oct. 2018	ICSO 2018	LMD
FLYERS			
General Flyer: HOLDON Presentation	9-12 Oct. 2018	ICSO 2018	ALTER

7.1.3 Video

A video featuring ALTER presentation was shot on the occasion of the EPIC Meeting on New Space at European Space Agency (12-13 September 2019) (see Table 5 below). The video can be viewed from the HOLDON Web Page and at the following link:

https://vimeopro.com/epicphotonics/esa2019/video/359953462. ALTER presentation is also available for download from the Web Page public documents section.

7.2 MAIN DISSEMINATION ACTIVITIES TO DATE

7.2.1 Participation to international events

Table 5: Participation to international events

Type – Title - URL	Audience (Cat., size)	Place and date	Involved partner (contribution, materials)
Conference ICSO 2018 https://atpi.eventsair.com/QuickEventWebsitePortal/icso-2018/icso	Scientific Community 450	Chania, Greece 09 10 2018	ALTER, CEA Poster + Flyer + Presentation + 2 pictures sent
Workshop Infrared detection for space applications https://www.comet-cnes.fr/en/events/infrared-detection-space-applications	Scientific Community European Country 100	Toulouse, France 03-05 07 2018	CEA Presentation
Workshop Space UV Lidar for Earth observation: from design to flight demonstration	Scientific Community skilled persons in UV detection and instruments from most of European countries plus few non-EU countries 120	Toulouse, France 29 11 2018	AIRBUS Need : VG
Workshop 2nd International Workshop on Space-Based lidar remote sensing techniques and emerging technologies https://www.lidar-workshop-2018.com/	Scientists and technologists from different countries, government agencies, industries and universities 150	Milos Island, Greece 04 06 2018	EPL-LMD Presentation

Type – Title - URL	Audience (Cat., size)	Place and date	Involved partner (contribution, materials)
Congress Research and Development of Defense and Security (VI Congreso I+D Defensa y Seguridad) https://www.tecnologiaeinnovacion.defensa.gob.es/es-es/Presentacion/deseid_2019/Paginas/Defensa.aspx	Researchers in the field of defense and security	Valladolid, Spain 21 11 2018	ALTER
Conference EPIC Meeting on New Space at European Space Agency https://www.epic-assoc.com/epic-meeting-on-photonics-new-space-at-european-space-agency/	Industry and Scientific Community 90	Noordwijk, The Netherlands 12-13 09 2019	ALTER Presentation, Video

7.2.2 Scientific publications

Table 6: Scientific publications

Type	Title	Authors	Year of publication	Status	DOI	Open access: Gold or Green access
Publication in conference proceedings/Workshop	HgCdTe APDs detector developments at CEA/Leti for atmospheric LIDAR and Free space optical communications (oral presentation)	**Johan Rothman**, Pierre Bleuet, Julie Abergel, Sylvain Gout, Gilles Lasfargues, Lydie Mathieu, Jean-Alain Nicolas, Jean-Pierre Rostaing, Stephanie Huet, Pierre Castelein, Kévin Aubaret, Olivier Saint-Pé	2019	Published	https://doi.org/10.1117/12.2536055	GREEN OPEN ACCESS

Type	Title	Authors	Year of publication	Status	DOI	Open access: Gold or Green access
Publication in conference proceedings/Workshop	2-µm pulsed Holmium laser for a future CO2/ H2O space lidar mission - (Poster at the ICSO conference)	**Fabien Gibert,** Dimitri Edouart, Claire Cénac, Paul Monnier	2019	Published	https://doi.org/10.1117/12.2536055	GREEN OPEN ACCESS
Publication in conference proceedings/Workshop	Desarrollo de sistemas para aplicaciones LIDAR	**Rodríguez-Cortina, Mónica**, Adamiec, Pawel, Machón, Álvaro, Perez-Serrano, Antonio, Esquivias, Ignacio, Barbero, Juan y López, Demetrio	2018	Published		NO
Publication in conference proceedings/Workshop	LIDAR echo emulator	**Pawel Adamiec**, Alvaro Machon, Monica Rodriguez Cortina, Alejandro Lopez Moya, Enrique Cordero, Juan Barbero	2019	Published	https://doi.org/10.1117/12.2535985	GREEN OPEN ACCESS
Article in a journal (**Applied Optics**)	2-µm double-pulse single-frequency Tm:fiber laser pumped Ho:YLF laser for a space-borne CO2 lidar	**Fabien Gibert**, Jessica Pellegrino, Dimitri Edouart, Claire Cénac, Laurent Lombard, Julien Le Gouët, Thierry Nuns, Alberto Cosentino, Paolo Spano, Giorgia Di Nepi	2018	Published	https://doi.org/10.1364/AO.57.010370	NO

7.3 MAIN EXPLOITATION ACTIVITIES TO DATE

This section focuses on the individual exploitation strategies of the HOLDON project partners. After reminding the project results, outcomes or knowledge and exploitation activities as envisaged in the DoA (see section 6.2 Expected HOLDON Results, Outcomes, Knowledge) and reported on the actual results, outcomes, knowledge created and further exploitation activities actually carried out by the partners in the period ranging from month 1 (Jan. 2018) to 30 (June 2020).

When asked whether updates to the initial planned results, outcomes or knowledge and exploitation plans were necessary, the partners have reported that so far, the project has not created specific opportunities for that.

The planned results, outcome, knowledge and exploitation activities will guide the actions during the final reporting period, and a final update will be provided at end of the project, based on the progress made and further consideration by the partners.

At month 30, the situation for some partners is therefore the following.

CEA LETI

Actual results, outcome, knowledge created in the period month 1 (Jan. 2018) to 30 (June 2020)
The HOLDON multi-mode ROIC and the high gain/low noise HgCdTe APD chips have been manufactured in the reporting period 2 and are currently under testing/validation. A positive confrontation of the results with the demanding specifications defined for HOLDON, will constitute a good prerequisite for future alternative Lidar exploitation.
The versatility of the HOLDON detector is one important expected asset to address a variety of applications, out of the atmospheric monitoring. Whereas the large UV-NIR spectral range should be covered in this project, a possible extension to MWIR range with different APDs might be possible, which currently arouses the interest of THALES LAS (French OEM) for air-ground LIDAR use.

Exploitation activities carried out in the period month 1 (Jan. 2018) to 30 (June 2020)
Sor far there has not been any exploitation activities carried out from CEA's side.

AIRBUS

Actual results, outcomes, knowledge created in the period month 1 (Jan. 2018) to 30 (June 2020)
Even if most AIRBUS "results/outcomes/knowledge" will be created during the final reporting period, the following can be reported for the current period:

- The successful demonstration that both the continuous mode and On Chip Sampling mode can be implemented together at pre-amplifier level, able to cover the huge dynamic range met for LiDAR missions;
- The achievement in order to design a LiDAR echo simulator able to deliver all three important UV-VIS-NIR wavelengths (355, 532 and 1064 nm)

Exploitation activities carried out in the period month 1 (Jan. 2018) to 30 (June 2020)
Sor far there has not been any exploitation activities carried out from AIRBUS's side.

DLR

Actual results, outcome, knowledge created in the period month 1 (Jan. 2018) to 30 (June 2020)
The above listed activities have not started yet, since for all of them a working detector assembly needs to be delivered to DLR, which will occur in the final reporting period.

Exploitation activities carried out in the period month 1 (Jan. 2018) to 30 (June 2020)

- DLR made a mission proposal to ESAs Call for Earth Explorer-10 Mission Ideas in the beginning of 2018. A water vapor differential absorption lidar on a satellite in a low Earth orbit had been proposed and the HOLDON detector was advertised to ESA as one of the most promising candidates for this system.
- DLR had a talk on the first European lidar conference held in summer 2018 in Thessaloniki, Greece, where new detector concepts for lidar were reviewed. The HOLDON detector was one of the devices which were rated as most promising for future lidar applications.

IDQ

Actual results, outcome, knowledge created in the period month 1 (Jan. 2018) to 30 (June 2020)

- 5 complete proximity electronic system fabricated (including detector board, carrier board and FMC acquisition board);
- FPGA and software (both embedded and on user PC) is under development;
- Mechanical design of the vacuum chamber for the closed-cycle cryocooling system is under development though an external sub-contractor (KADEL).

Exploitation activities carried out in the period month 1 (Jan. 2018) to 30 (June 2020)
Sor far there has not been any exploitation activities carried out from IDQ's side.

At project month 30 the situation regarding the exploitation activities can be summarized as follows: The actual results, outcome, knowledge identified in the period ranging from month 1 (Jan. 2018) to 30 (June 2020) have only led to few exploitation activities. Moreover, the partners have not mentioned any update in their individual planned exploitation activities and no discussion around IP strategy has been necessary at this stage.

The work on the exploitation of the project 'results will be continued in the third reporting period and involve all the partners.

8 CONCLUSION

This public deliverable details the communication-dissemination-exploitation measures aimed at fostering the maximization of the expected impacts of the project. After having identified the project target audiences, it explains where and how to communicate and disseminate about the project and its results. In addition, strategy to be carried out as well as all the means and tools designed and produced for increasing the awareness of the project in the EU context but also for the wider public have been properly described.

Likewise, the scope of the reflection process around the exploitation activities has been defined and the first pieces of knowledge could be collected.

An update of the Dissemination and Exploitation Plan will be prepared at M42. A focus will be made on the Communication and Dissemination activities that have been implement in the final reporting period. As for the Exploitation of the project's results, the progress achieved shall be based on the consortium brainstorming sessions, taking into account any possible changes, scanning the effective obtained results and matching them with the initial ambitions/goals.