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Steinbeis-Edition

Steinbeis-Europa-Zentrum, Steinbeis 2i GmbH,
Photonics-Cluster-Austria (Ed.)

Towards Best Practice in Photonics Outreach for the General Public

PHOTONICS PUBLIC PRIVATE PARTNERSHIP

PHOTONICS21

Photonics4All
Discover the Power of Light

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Towards Best Practice in Photonics Outreach for the General Public

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Foreword

Optics and *photonics* are widely regarded today as key technologies. Many science and technology experts have described the 21st century as the century of the photon because optics and photonics technologies are providing science and industry with a wide-range of essential applications impacting nearly all areas of our lives! In fact, Photonics has been recognized as a *Key Enabling Technology* (KET) by the European Commission in a Communication[1] dating back to 2009. However, despite its importance photonics is still not a well-known technology to a majority of people.

This handbook is devoted to all those public and private organizations willing to organize outreach activities for the general public. In particular, we address universities, research centres, science centres, museums, that have outreach at the core of their activity, and also city councils, regional administrations and national governments interested in the promotion of scientific knowledge to the general public.

The objective of this handbook is to *summarize best practice on how to promote photonics and light-based technologies to the general public.* We hope that our experiences in the Photonics4All project will serve all those interested as a useful inspiration and guide when promoting photonics. The handbook is not meant to be authoritative, nor exhaustive in terms of photonics outreach, which is why we decided to publish this document with the title 'Towards Best Practice in Photonics Outreach', but we hope it provides an overview of the best working approaches undertaken in the Photonics4All project and benefits the network of science communicators throughout Europe. The handbook should be relevant to all those interested in outreach, whether a newcomer or more experienced science communicators, please pick and choose the elements that are relevant for your own outreach activity. The text in this handbook is accompanied by practical and user-friendly information in the annex; pages of which can be printed out individually. Policy makers too can also find relevant information in the conclusions at the end of the booklet.

1 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52009DC0512&from=EN

Please note that two other handbooks are available in this series; one on photonics outreach activities targeted at young people and students in Photonics, and a second on best practices in Photonics outreach with Entrepreneurs.

A number of partners have contributed to this publication throughout the project; from the initial proposal of good practices, to the selection of topics and to the final product. We would like to thank the European Commission and Photonics21 for the promotion of the project "Photonics4All" under the EU program "Horizon 2020" for research and innovation, along with our partners who have supported our work during the lifetime of the project. We would like particularly to thank our sister projects "GoPhoton!" and "Light2015" for sharing their best practice in how to increase awareness of photonics.

Photonics4All Consortium,
December 2016

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1 Introduction

The following activities and outreach tools created during the Photonics4All project are described in this handbook: Photonics Campaigns, photonics outreach bookmarks, the Omnilight Laboratory (innovative new Photonics lecturing demonstration equipment), Photonics radio and television presentations, Photonics Science Slams. In each section which describes the activity or tool we include the following; a description of each activity, an outline of the intended target groups, how the event was organised / the tool developed, along with methods to assess the impact of each type of activity, and our experiences and recommendations of delivering the activity or working with the tool. At the end of the handbook are Annexes which detail event planning tools, contact details for each partner (Annex 4) – all of whom can be contacted for further information), along with a short description of the Photonics4All project (Annex 3).

2 Photonics Campaigns

Figure 1: The Bratislava Light Event. Source: Photographed by Dusan Chorvat

Objective: To *incorporate an element of Photonics Outreach into local events conducted during the holiday season* (e. g. Christmas markets or festivals). Adding Advanced light sources such as lasers and Light Emitting Diodes (LEDs), can be used in light decorations and city art / light projections during the holiday season. Lighting displays can provide an excellent vehicle for *educating society about photonics applications.*

Target group: The general public as illustrated in Figure 1. The photograph was taken in Bratislava during a light event supported by Photonics4All.

Organisation: By including a Photonics Campaign within existing public events dedicated to light (e. g. festivals of light), photonics applications are both demon-

strated and illustrate their importance in our daily lives. City organisations can also present and promote locally important photonics applications; such as solar energy or sensing (for example for water quality control). In addition, a festival campaign might tag on to another related activities such as the 'International Year of Light 2015' (which proved a perfect platform for Photonics4All events), or other STEM promotional events.

Some festival campaigns during Photonics4All took place in lecture rooms or theatres (e. g. Dome of Vision in Stockholm) which allowed 200-500 people to participate. The format and structure of such events are versatile and can look different for each one, for example some events were organized in public places like public squares, in tents with exhibitions and shows, and other events included lectures and hand-on exhibitions in more formal venues such as museums or science centres. All events were free of charge.

Impact measurement: The events can reach many thousands of people and more through participation, media coverage and marketing. The reach of the event will depend on the structure and venue. If the whole city is the location, of course the number of visitors is higher than if the event is held in a museum or science centre, etc. It is difficult to accurately determine the number of participants at free large-scale events designed to incorporate the whole city when wanting quantitative data. It may be possible to use on-line free ticketing sites such as 'Eventbrite' for some events where there needs to be limited participation, however. In order to determine the significance of the event for participants, qualitative data capture would need to be used for evaluation purposes. A sample / small number of the general public could be interviewed informally to determine their enjoyment of the event, and to discover what they learned, or thought about the event, or paper-based competitions which include an element of evaluation can be used.

Costs: Overall cost of the large scale public events usually spans from tens to hundreds of thousands of Euro. The costs of dedicated Photonics campaign depend very much on how many tools and materials already exist, as well the organization's general commitment to such activities. Overall estimate for one public installation is in the range of 1,000-10,000 Euros, with the additional resources needed for organization purposes.

Gained experience and recommendations: The general public thoroughly enjoy and appreciate the light-based art installations and technical demonstrations. For a successful Photonics campaign, and to ensure public visibility, it is advisable to exceed normal commercial lightning conditions with elements of interactivity and / or large-scale installations (e. g. lighting up whole buildings or large symbolic objects).

The organization of events can be complex and time-consuming, but will differ from venue to venue. The organizer needs to take into account that the procedure of obtaining necessary permissions for public performance which could take weeks. (Notifying a UK Airport that a city laser display is planned needs to be done 2-3 months in advance of the event, while other countries or cities planning time might be far less). (Please see a planning tool in Annex 1 which can assist with event and evaluation planning.)

Safety Considerations: working with powerful light (LEDS, projections system, or lasers) in an environment not designed for public performance with these light sources inherently holds risks and therefore safety of the public and organisers is of great concern. All risks should be identified and mitigated for. Local guidance for working with lasers and LED's should be researched. (The UK's guide to laser safety in public displays is entitled "Safety of Display Lasers" and is produced by PLASA in conjunction with the UK's Health and Safety Executive. The guide can be downloaded for free and can be found online[2].

Consider also the maximum number of people that can safely attend the event and instruct the main event organizers about the inherent risks of working with your equipment through a thorough written risk assessment. It is most important to decide what will happen in case of emergency (For example researching local eye-hospitals and obtaining telephone numbers, location and directions to them), although the greatest risk in using lasers or powerful light sources is likely to be electrical hazards. So the possibility of poor weather / rain needs to be planned for to avoid electrical hazards.

2 http://www.plasa.org/technical/guidance/PLASA_Laser_Guidance.pdf.)

In terms of generally *event planning* there may be various unexpected expenses, such as ensuring local darkness (city lights may need to be turned off – which can incur a cost) or providing electricity for the outdoor installation. These costs and unexpected planning issues will need to be expected and accounted for as contingencies in budget / time allocations during planning preparations. With the campaign focusing on the conscious impact the display will have on the general public, it is also crucial to develop advertising and explanatory material for the campaign (e. g. press releases, posters, flyers) and distribute it to the press and target group with enough time in reserve. Marketing the event can occur through City magazines for local residents, City event websites, local newspapers, libraries, through schools, community groups etc., and local radio and TV (with interviews where possible).

It was noted during the Campaigns that the general public stay at events far longer where *catering* can be purchased.

Here are some impressions of light festivals:

Figure 2: Some impressions of Light Festivals in Photonics4All. Source: Photographed by Peter Trojan and Dusan Chorvat

Knowledge angel / point of contact: Petra Bindig, Photonics Sweden

3 Photonics Bookmarks

Objective: The purpose of these bookmarks is to *increase the public's awareness of photonics in general – and particularly of the technological advances photonics have made which have changed and improved everyday life.* The bookmarks may be used at all kind of outreach events where members of the public have no special interest in science, such as at general fairs, Christmas markets or light events. The bookmarks may also be given out in schools, colleges and universities – or given to teachers to disseminate. In addition, the bookmarks can be distributed to local authorities in order to promote photonics to our politicians and elected people to inform them about the importance of photonics to our future. Therefore the bookmarks are a very important resource for very different types of outreach activity aimed at the general public.

Target group: general public from 6-77+ years of age!

Development:
Choice of design: At the beginning of the Photonics4All project we planned to create a general brochure to include several questions about photonics. We soon realized that this format (a large flyer, or even a booklet) would not be taken away by the public because it would be too big and / or not appealing); and if it was taken it may, possibly have only been scanned / read quickly then discarded. Our idea, then in order to prevent the information from being discarded, was to produce attractive small-sized bookmarks that people wanted to keep and not throw away. So, the front of our bookmarks features beautiful high-definition images giving the impression of a high quality bookmark that may have been purchased in a shop. The back of the bookmark contains a question relating to the picture overleaf that invites the reader to continue reading. The questions and descriptions on the bookmark are short, simple and fascinating and we have high hopes that the messages are read and the bookmark reused "as a bookmark". The impact is then much larger than the originally intended brochure.

Figure 3: Photonics4All bookmark (front and back side) on the colour of soap bubbles. Source: bookmark Photonics4All project

You may think along these lines when designing something to increase the public's awareness in any scientific subject.

Topics: Several topics were selected for the bookmarks and others can be developed in a similar format. The following questions and descriptions were used in the Photonics4All bookmarks:

- How can Light Emitting Diodes (LEDs) transform local food production?
- How does light make computers and phones smaller and faster?
- How can light replace a needle?
- How can light help solve crimes?
- Why do soap bubbles have colour?
- How light is revolutionizing the manufacturing of things?
- How many blueray movies can you download through one submarine cable?
- Do you know why the rear brake lights of cars are red?
- How light enables you to travel in time?
- How light helps improving grades?
- Do you know how the metal pieces of your car were welded?
- Do cells have colours?
- How can UV fight Ebola?

After the title question a short and very precise text describing how photonics is used to answer these questions and solve the problems was outlined. The bookmark text was then translated into different eight European languages: German, French, Dutch, Swedish, Spanish, Italian, Russian and Portuguese. The electronic version of the bookmarks is available on the project website[3] in all these languages.

3 http://photonics4all.eu/general-public/photonics-bookmarks/

Impact measurement: We recommend a purely *quantitative* impact measurement of such an activity as it is highly superficial and simply tries to raise awareness. It seeks to reach as many people as possible but not in depth. This is why it may only be possible to count the number of distributed bookmarks but not the impact of them themselves.

Costs: The costs of developing and printing depend mainly on print costs in the location of the activity. As a group of very attractive and useful bookmark templates already exists (see above), only new printing is required. Print costs can be quite cheap and therefore we suggest that this is an effective outreach practice.

Gained experience and recommendations: It is rather cheap and easy to disseminate bookmarks. It is also a good way to trigger people to go further and discover more of your project. Design is though essential for success. Bad design (inappropriate size, unclear photos, text), poor quality paper, and your bookmark stays on the stand or goes directly to the trash.

Our experience was that the bookmarks were attractive and very quickly disappeared from the stands. We did notice however, that one of the eight bookmarks was not well received (the baby foot with a medical instrument to measure the cardiac rhythm). It seems that people did not want to take this picture which suggested a baby in ill-health; it might have been that the rejection of this image was instinctive Otherwise though the bookmarks were a great success. Bookmarks also proved popular amongst students, schools and teachers. (With many Photonics4All partners requesting reprints despite having disseminated 2,000 bookmarks each.) These bookmarks then will be used for many purposes far beyond the life of our Photonics4All project (they will for example be used for the next 3 years during the next EU Funded Photonics Outreach project known as PHABLABS4.0) and will continue to be distributed at University Outreach events.

Knowledge angel / point of contact: Aurèle Adam, Technical University Delft

4 OmniLight Laboratory

Objective: *To "promote light with light"*

The OmniLight Laboratory (OLL) is a *hardware and software tool for light-based scientific shows.* It is designed to support photonics professionals give presentations to audiences about light, optics or physics in general, and to maximize the impact of the presentation with on-stage experiments with light.

Target group: general public. The primary intended users of the OmniLight Laboratory are lecturers and presenters that have the appropriate knowledge and background for teaching physics to audiences, as well as those experienced with public laser and optical display installations. The system provides high added value for public scientific presentations and public demonstrations.

Figure 4: The prototype OLL in use at the Photonics Campaign in Bratislava. Source: International Laser Center.

Development: The OmniLight Laboratory prototype is based on combination of a commercially available hardware, software and custom developed instrumentation resulting from a joint development between industry and the Photonics4all consortium.

The OLL system is based on a combination of three elements; a "classical" projection system, using a data / video projector, along with a laser-based (beam-scanning) display, the use of an advanced real-time sensing capabilities such as the Kinect sensor or fiberoptic spectrometer. The combined elements result in a spectacular, interactive photonics education tool, designed to fascinate and educate. The OLL will be available commercially at the completion of the Photonics4All project and can be further developed by customer driven interests. The prototype under development has been documented online[4].

Figure 5: The OLL being demonstrated by Dusan Chorvat on the occasion of a visit of EC Working Party on Research and 31st ERAC plenary meeting 2016. Source: International Laser Center

Impact measurement: As the aim of the OmniLight Laboratory was to improve the quality of professional public talks and performances related to Light and Photonics, measuring the improvement of talks with and without the equipment is a challenge! Audience members though have provided very positive feedback in response to talks whenever the OLL prototype has been used. The University of

4 https://www.youtube.com/watch?v=vBwM1S1yXV8

Southampton – partner in Photonics4All – has expressed great enthusiasm for purchasing the equipment to help them with their photonics outreach programme which has been running for the last 15 years and reached over 100,000 audience members. Pearl John who runs the Photonics Outreach Programme says *'the OmniLight Laboratory is an extraordinary piece of equipment which will revolutionize the University's Photonics Outreach lectures. There is nothing like the OLL on the market. We can't wait to purchase it when the equipment is commercially available'.*

Within then Photonics4All project, the OLL was shown at about 20 events corresponding to a potential outreach of almost 125,000 people already!

Costs: The cost of individual OmniLight Laboratory modules is directly dependent on existing available technology (such as projectors and laser displays) and the size of the intended audience and venue. High-quality projectors and laser displays range from hundreds of euros for low-power indoor devices, to tens of thousands euros for high-power outdoor equipment. The cost of the system dedicated for the mid-scale events (up to 100-300 attendees) can be estimated to 5.000 € for base system to 10.000€ with optional modules.

Gained experience and recommendations:

Safety: The OLL prototype contains a Class 4 laser which is hazardous therefore safety and security issues are to be considered in all planned public events. Each venue and presentation will need to be separately assessed for risk and meet the laser safety standards for the host venue and country. (The UK's guide to laser safety in public displays is entitled "Safety of Display Lasers" and is produced by PLASA in conjunction with the UK's Health and Safety Executive. The guide can be downloaded for free and can be found online[5]).

Knowledge angel / point of contact: Dusan Chorvat, ILC Bratislava

5 http://www.plasa.org/technical/guidance/PLASA_Laser_Guidance.pdf

5 Photonics for Radio or TV

Objective: *To present Photonics to the public via Radio or Television Programmes.* The goal was to present photonics to as many members of the general public as possible through the media. Experts were interviewed and the message was delivered to audiences via Radio and Television programmes.

Target group: general public

Organisation: Two routes were taken to create TV footage and produce Radio content within the framework of Photonics4All:

Production through a specialist media agency: To ensure that articles and video interviews were created broadcast most effectively a media agency, AdnKronos was employed. The agency had a guaranteed network of local newspapers and TV channels with national coverage; The agency has a very popular web portal used to present the news, www.adnkronos.com with over 2 million unique visitors / month; its web portal is dedicated both to journalists and the general public; The agency used professional journalists who communicated accurate scientific information successfully to the target audience. The research organization involved in that activity provided agency journalists with suitable sources of scientific information, preparing a list of topics, project information, press releases, images, videos, researcher's contact details and made available appropriate laboratories in which to record images to help prepare our journalistic 'Special' on photonics. The media agency prepared the information and delivered the final product for dissemination[6].

Production by a Filmmaker: During an event a well-known person (like Shuji Nakamura, winner of the 2014 Nobel Prize for Physics) delivered a key note speech and then became available for an interview. The interview was filmed and

6 http://www.adnkronos.com/speciali/ino-cnr

produced by a professional filmmaker. The clip[7] can then be used for publishing on websites to promote Photonics to a wider audience.

Impact Measurement: The reach of this impact can be measured through a number of ways; through determining the average number of estimated viewers for the TV or Radio (data which Radio and TV companies can usually make available) and by noting the number of 'clicks / downloads or 'Likes' when a video link is watched.

Costs: The costs of this type of activity can vary depending on the routes taken. Some media outlets are interested themselves and produce the content free of charge. If a filmmaker or specialized media agency is contracted costs can range from about € 500 upwards.

Gained experience and recommendation: The advantage of this activity is the wide reach within radio, TV or other media. But the significance stays unknown as it is not possible to reach people to evaluate. To do it well it requires significant resources both financially and in person hours. With less promotion only a small number of viewers will be reached.

Knowledge angel / point of contact:
Elisabetta Baldanzi and Maria Bondani, CNR Italy

7 Available by the end of December 2016 and to be found online: http://photonics4all.eu/general-public/photonics-on-radio-and-tv/

6 Photonics Science Slam

Objective: Main objectives of the Photonics Science Slam is to *increase the awareness and interest of the general public in photonics-related science, applied research and its applications,* and to encourage young people to study photonics. A Science Slam is a scientific talk where scientists present their own scientific research work in a given time frame – usually 10 minutes – in front of a non-expert audience. The focus of the event lies on teaching current scientific research and technology to a diverse audience in an entertaining way. The presentations were judged by the audience members.

The Science Slammers were encouraged to deliver their scientific content in a fascinating and informal manner, engaging the audience with amusing scientific histories or demonstrating exciting photonics experiments with links to everyday life.

The audience is given a general introduction to Photonics – the definition and applications, and becomes a more in-depth understanding of 'what Photonics is and what it can do by being given information of cutting edge optical technologies. The content of the 'Slams' included the basic physics of light and light-based technologies, end user and industrial applications, the importance of light and its applications for life and society, discussed actual technical challenges and gave their visions for the future.

Target group: general public

Organisation: The Photonics Science Slam was organized as an *evening event* lasting approximately three hours. The structure of the event included a special act in the beginning, followed by six to eight slams and finished with judging and an award ceremony. Subsequently, a get-together was planned to facilitate the exchange between slammers and the audience.

It is advisable to begin the event with a special performance in order to create the right atmosphere to introduce the audience to Photonics. This special act could be

provided by a musician or artist presenting Photonics, or a simple and impressive presentation with scientific content of a high standard.

A Science Slam – similar to a poetry slam – should combine a lecture / presentation of high scientific content with entertainment as a kind of "infotainment" for the general public while promoting photonics effectively at the same time. In general, everyone is able to apply as a 'slammer', e. g. students and professors or researchers and developers in companies and institutes. The applicants should send a short description of their fascinating, exiting and informative topic to the organizers to verify that the topic is of a suitable standard, entertaining and appropriate for Photonics outreach. The talk should not last for more than ten minutes for a slam. To reach as many people as possible the slams should be held in the local language. It is advisable to reimburse slammers for their travel costs.

Figure 6: Winner of the 1. Photonics4All Science Slam: Master student Carsten Reichert (right), second-place winner: Junior Professor Dr Amitabh Banerji (middle), third-place winner: Dr Robert Löw (left). Source: OptecNet Deutschland

After the Photonics Science Slams, the audience choose the winners. We gave marbles to audience members which they placed in different containers to enable them to vote for each slammer. We awarded our winner with a laser-engraved trophy and a photonics related gift.

The audience consisted of over 100 members of the general public and included young people, and local policy makers e. g. representatives from politics, finance and science.

The final get-together at the end of the event enabled the audience to have a question and answer session with the slammers.

Afterwards a post press release was written and disseminated to local media about the event in order to increase the reach of the event, promoting photonics in general and covering the particulars of the photonics science slam.

Impact Measurement: The impact of such an activity can be determined through the number of people in the audience and the interest of slammers. If the event is to be repeated on more than one occasion it is good practice to evaluate the success of the event, and what the audience learned, through on-line evaluation tools such as Kahoot.com. Furthermore experience has shown that good 'slammers' get invited to perform at other (not Photonics related) events thus spreading the word of Photonics further.

Costs: 2,000 Euros

Gained experience and recommendations: It is advisable to form an organising team between a Photonics expert organisation and e. g. a regional organisation to get a critical mass. Usually the regional partner can provide premises, catering, and technical equipment for stage, lighting and sound, and also can assist with promotional activities. Marketing the event should be done through all available media channels, along with advertising through social media and direct e-mailing of young people and potential slammers. Advertising and acquiring slammers and audience needs a lot of resources. We also experienced that a Photonics Science slam cannot be repeated too often, as the community of slammers is not large enough.

Knowledge angel / point of contact:
Johannes Verst, OptecNet Deutschland / Photonics BW

7 Other Photonics activities for the general public

Daytime Campaigns

Objective: To reach new audiences using creative (or STEAM) approaches.

Target Group: General Public (particularly Mothers and Grandmothers not attending Science events)

Organisation: Wherever members of the general public gather there can be opportunities for Photonics Outreach and the more unexpected the venue the better. Photonics4All partners partnered with a Landscaping and design company 'Elks-Smith' to assist with the design and presentation of a professional show garden which was designed for the UK Royal Horticultural Society's (RHS) Tatton Park Garden Show held during the International Year of Light 2015.

The *design* of show garden entitled 'Reflecting Photonics' was based on fibre optics research and resulted from visits and discussions Helen Elks-Smith the designer, had with Photonics researchers. The Photonics4All partner helped to manufacture the Pavilion and staffed it with photonics researchers during the event. Research students talked about the design of the garden to visitors; the design incorporated plastic panels illuminated through Total Internal Reflection – the physics of which enable the transmission of light signals down fibre optics which run the internet; actual fibre optic components were buried in a well in the Pavilion and the planting was designed to illustrate the electro-magnetic spectrum. Students also showed the visitors their photonics research work, while distributing Photonics4All brochures, and diffraction glasses supplied by SPIE. The researchers used the Photonics Explorer kit demonstrations developed by EYEST$_{vzw}$ in order to demonstrate fibre optic transmission and to show visitors lasers and LEDs.

This interactive element to the garden helped it win the 'People's Choice Award'; the researchers also shared a Science Tent with the Designers in the garden which allowed them to do a small number of hands-on photonics demonstrations with

visitors. Photographs below depict the team in the show garden, the Science tent at the event, researchers talking to the public and the making of the 'Gardener's World' BBC TV Programme.

Figure 7 (left): TV Interview in Reflecting Photonics Show Garden. Source: University of Southampton

Figure 8 (right): Photonics Researcher (left) engages with the public. Source: University of Southampton

Figure 9 (left): Photonics Outreach team in Reflecting Photonics Show Garden Pavilion. Source: University of Southampton

Figure 10 (right): Postgraduate Photonics student in Science Tent in Showgarden. Source: University of Southampton

Outreach team: The Outreach team consisted of a professional Marketing Officer, Public Engagement specialist and a well-trained, experienced group of science Postgraduate communicators. Organisation of the demonstrators included finding demonstrators willing to leave their research for 4 days, training them to enable them to engage with people (particularly women) disinterested in science and photonics, hotel and transport of the equipment and demonstrators and equipment and consumables purchase.

Impact Measurement: The impact of the activity was gauged through a number of methods; determining 'reach' by gathering quantitative data from individual conversations with visitors over 3 days (400+), distribution of leaflets which included an explanation of fibre optics (2,000) number of visitors to the show who would have read the word 'Photonics' in the overall programme (80,000) and a further 3 million viewers of the BBC's "Gardener's World" TV Programme[8] who reported on it, and further press coverage. Qualitative evaluation was carried out by a number of methods – distributing different 'freebies' depending on the depth and length of discussion between visitor and researcher, informal interviews with visitors and observations of visitor behaviour – and through a paper-based competition / evaluation form. The organising team also evaluated their own performance and experiences. These evaluation methods allowed organisers to note change of interest, knowledge and behaviour of those audience members and demonstrators who took part in the evaluation, as a result of the activity.

Costs: 3,000 Euros Sponsorship was obtained from the EPSRC Centre for innovation in Manufacturing (CIMP) as the activity had not been planned for within the Photonics4All budget, but the opportunity arose as a result of the IYL2015.

Knowledge angel / point of contact: Pearl John, University of Southampton, UK

8 http://www.bbc.co.uk/programmes/b063jx52

8 General conclusion and recommendations for policy makers

Conclusion

All these activities were conducted successfully during the project, in order to reach out to the general public and promote Photonics.

The following table summarizes very briefly the advantages and disadvantages of organizing such activities – a more detailed overview table is given in Annex 2:

	Advantages	Disadvantages	Cost €	Results
Photonics Campaign -organising your own event for big audience	Strong interest and high visibility and impact on public	Usually complex organisation and time consuming with high personal involvement	10,000-100,000 per event	Large number of people targeted (10,000+), great enthusiasm and enjoyment generated
Photonics Campaign -organising your own event – presentations, exhibition, workshop	Strong interest from public	Usually complex organisation and time consuming	10,000	Large number of people targeted (1,000+)
Photonics Campaign -joining an existing event	Strong interest from public	high personal involvement	1,000-10,000 for one public installation	Large number of people targeted (10,000+)
Photonics Bookmarks	13 of bookmarks now exist for dissemination	New ones have to be written and designed from scratch, obtaining permissions for photo-graphs to be mass-produced	Printing costs: 100 for 2,000 bookmarks	20,000 bookmarks already distributed on 13 different topics in 10 languages – Great success at every event

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	Advantages	Disadvantages	Cost €	Results
OmniLight Laboratory (OLL)	high added value for public scientific presentations	Safety requirements due to high-powered laser system. Mass production of system underway. Training potentially needed for successful operation.	5.000 to 10.000 for 1 OLL	So far one demonstration prototype
Photonics communication campaign with a professional agency	Reach the largest possible audience, long term presence through internet	If done well requires sizeable resources	500+ upwards	1 English + 4 Italian video clips, 2 written expert interviews and many more articles available
Video interviews of photonics experts	Reach the largest possible audience, long term presence through internet	If done well requires sizeable resources	N.A.	6 video interviews of photonics experts, including one from Nobel prize winner Nakamura – large reach but significance difficult to assess.

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	Advantages	Disadvantages	Cost €	Results
Photonics Science Slam	Fun, exciting and informative activity to promote Photonics	- Complex and resource consuming organisation, - limited number of slammers on a specific topic (like Photonics) and in a given geographic area - Audience members already have an interest in Science (although marketing and press coverage will reach larger numbers.	2,000	1 successful Photonics slam with 8 slammers and 100 participants, further science slams organised since then by a regional partner with many YouTube videos available

Evaluation of events which will be repeated could be delegated to external evaluators. Evaluation costs and time need to be planned for as part of the event.

To gather promotional material (pictures, movies) it is important to plan photography or filming in advance and also to consider the necessity for people to grant the rights for using the material.

What extra support could be provided by policy makers?

Various activities targeting the general public should continue to be financially supported to promote the importance of Photonics through grants. To most people the term "Photonics" still does not mean anything, although it is understood to be one of the key technologies of the 21st century by the European Commission. In order for the public to understand both the meaning of the word and the importance that Photonics technologies have in their own lives it is important to explain how Photonics technologies can and are being used to tackle societal challenges.

The above activities have been tested and evaluated in various ways and can be seen as best practice. If conducting such an activity it is advisable to contact the Knowledge angel for an in-depth consultation.

9 Annexes

Annex 1: Planning for Impact tool: Outreach for the General Public

Aims & Objectives: (To include Learning Objectives)	**INPUTS** What is required to achieve the aims & objectives eg: how much time/money resources are needed? What needs to be organised eg. Venue / support.	**ACTIVITIES** What the project does with the resources; its processes, tools, events, activities and actions (ie. what are you going to do?)
To provide an enjoyable opportunity for the general public to learn about photonics and its applications. To raise the awareness of Policy Makers and the General Public of local photonics industries and research institutions. To provide interactive hands-on activities to engage participant's interest in Photonics. To help boost the local economy through tourism. To help foster community and business partnerships To raise the General Public's awareness of local areas/buildings of cultural or historical interest. To provide training opportunities for postgraduates or Industry employees to engage with the public and improve their communication skills	Funding/Time for: -Visits to venues, -Initial creative planning activity -Meetings between civic partners and photonics specialists to brainstorm opportunities -Creation of Risk Assessments and safety planning. Liasiing with airports/police etc. over laser shows fulfilling local safety requirements. -Demonstrators/helpers time to include preparation & delivery eg. planning designing and piloting activities -Event Management staffing and training -Building of event eg. scaffolding, platforms -Equipment & Materials costs for activities Promotional support of event through Marketing and Social Media Hire of Professional photographer for marketing purposes. (Permissions of those photographed to be used in marketing publications) Evaluation costs – preparation, printing, delivery and report. Preparation of giveaways eg. Bookmarks, Educational handouts.	The organiser will - put on a time-limited large-scale Photonics Display in conjunction with local government and business. - Design displays and activities - Test the Light display activities - Assess event and activities for safety risks and mitigate potential hazards. - Produce informational materials eg. educational handouts - Produce marketing material for local websites, newsletters, media information. - Help promote event through media interviews/social media - Evaluate the event (their own performance and the experience of the participants)

http://www.ahrc.ac.uk/documents/guides/logic-models-for-programme-planning-and-evaluation/

OUTPUTS Direct products of the project eg. types, levels & targets of what will be delivered. (What will the participant do/produce?)	**OUTCOMES** Changes in participant behaviour, knowledge, skills, attitudes and level of functioning. What will the participant have learned?	**IMPACT** The intended or unintended change in organisations, communities or systems as a result of the project
The visitor will: Observe light and sound displays. Take part in interactive hands-on optics experiments and demos eg. Omnilight Lab and laser harp Read Educational handouts/materials eg. Bookmarks on Photonics. Complete some sort of evaluation (either through completing a form, be interviewed on the night, sign up for the event on 'Eventbrite' or similar online registration form).	To have an improved level of understanding of photonics: Light Theory and applications. To know and be able to list three applications of photonics. To have a more positive opinion of photonics research and researchers – or to sustain a positive opinion of research and researchers To have enjoyed themselves. To have an Improved level of knowledge with regard to life as a researcher or industry employee in Photonics. For Photonics Professionals to have improved communication and organisational skills.	For participants to be more likely to engage with Photonics Industry. For parents and teachers to encourage students to study physics/photonics. For Photonics Professional to have an improved level of confidence in delivering outreach activities and to have improved communication skills with non-scientists.

Annex 2: Overview and impact table for Photonics4All activities and tools targeted at the general public

Activity in Photonics4All	Target group = TARGET	Measurable aim = AIM	Required skills & infrastructure (things that one must have at hand and that not all organisations necessarily have = competence / material check) = BACKGROUND	Investment (quantification of Time, Money and involved Staff) = INVESTMENT			Estimated number of participants per event – e.g. for one workshop or one children's university = REACH	Estimated level of interaction with participants (low / medium / high) = ENGAGEMENT LEVEL (low = awareness raising, only little interaction with audience; medium = some interactions but only few individuals able to engage themselves; high = lots of interactions and most individuals able to engage themselves)	Estimated significance of the activity in term of change of knowledge and/or change of attitude, interest in photonics (low / medium / high) = SIGNIFICANCE	IMPACT (using low / medium / high scale) defined as REACH X SIGNIFICANCE	Gained experience in Photonics4All		Photonics4ll results
				invested time (in hours) per activity / event	estimated cost / event in Euros excluding personnel costs	number of staff involved					Advantages	Disadvantages	
Photonics Campaign -organising your own event for big audience	general public	Promoting and presenting Photonics to large audience	Event management skills, outreach skills, technical skills	140–840	10,000–100,000 per event	10–30/event	5,000 –100,000	high (for interactive exhibition) to medium or even low (in the case of simple displays such as mapping, show, city lighting etc.)	medium	medium	Strong interest and high visibility and impact on public	Usually complex organisation and time consuming with high personal involvement	Large number of people targeted (10,000+), great enthusiasm and enjoyment generated
Photonics Campaign -organising your own event – presentations, exhibition, workshop	general public	Promoting and presenting Photonics to large audience	Event management skills, outreach skills,	100	10,000	8	1,000+	high	medium	medium	Strong interest from public	Usually complex organisation and time consuming	Large number of people targeted (1,000+)
Photonics Campaign -joining an existing event	general public	Promoting and presenting Photonics to large audience	Outreach skills, technical skills	30	1,000-10,000 for one public installation	2–5	10,000 –100,000	high	medium	medium	Strong interest from public	high personal involvement	Large number of people targeted (10,000+)
Photonics Bookmarks	General Public	Increase visit to website – Interest towards photonics in general)	Knowledge in design for the bookmark and on printing to make the bookmark. Also general knowledge about the subject to choose and get the most interesting points	6 per bookmark topic (80 for 13 topics)	Only printing costs – about 100 Euros for 2,000 bookmarks	1 (plus selection of topics through a panel)	all visitors of light installations get bookmarks at each event, i.e. potentially 10,000+ persons reached	low, it is only promotional. Nevertheless the design makes it that it is in use	medium: introduce the concept of photonics to the audience and how they are surrounded with it, with simple examples.	medium	13 of bookmarks now exist for dissemination	New ones have to be written and designed from scratch, obtaining permissions for photo-graphs to be mass-produced	20,000 bookmarks already distributed on 13 different topics in 10 languages – Great success at every event
New equipment for live experiments and education in Photonics	General public, young people	Promoting and presenting Photonics by public experiment / scientific show	Technical skills for R&D, knowledge of optical engineering	140–840	2,000–20,000 / installation	0–3	30-300 (public show) > 5,000 (exhibition)	medium for public shows, high for interactive exhibit	high	high	high added value for public scientific presentations	Safety requirements due to high-powered laser system. Mass production of system underway. Training potentially needed for successful operation.	OmniLight Laboratory (OLL) prototype, soon commercially available, with a cost of 5,00 to 10,000 Euros

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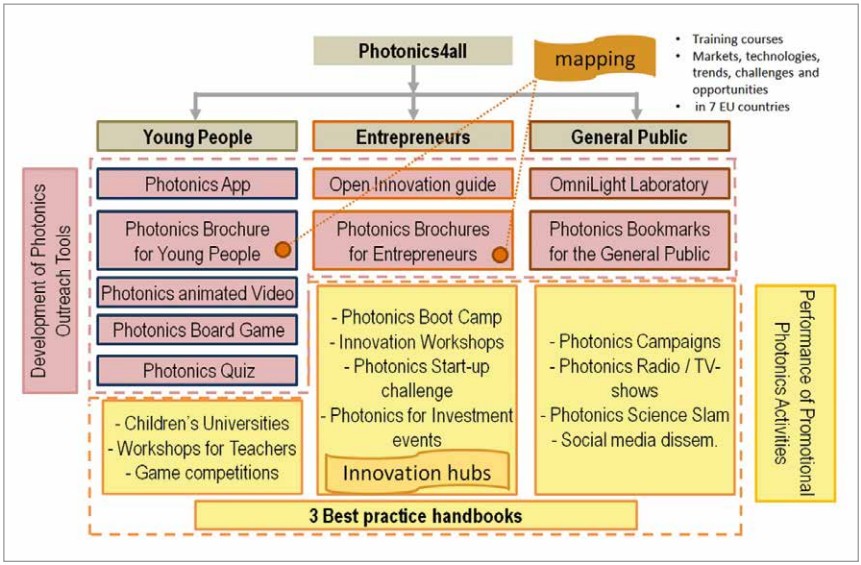
Activity in Photonics4All	Target group = TARGET	Measurable aim = AIM	Required skills & infrastructure (things that one must have at hand and that not all organisations necessarily have = competence / material check) = BACKGROUND	Investment (quantification of Time, Money and involved Staff) = INVESTMENT			Estimated number of participants per event – e.g. for one workshop or one children's university = REACH	Estimated level of interaction with participants (low / medium / high) = ENGAGEMENT LEVEL (low = awareness raising, only little interaction with audience; medium = some interactions but only few individuals able to engage themselves; high = lots of interactions and most individuals able to engage themselves)	Estimated significance of the activity in term of change of knowledge and/ or change of attitude, interest in photonics (low / medium / high) = SIGNIFICANCE	IMPACT (using low / medium / high scale) defined as REACH X SIGNIFICANCE	Gained experience in Photonics4All		Photonics4ll results
				invested time (in hours) per activity / event	estimated cost / event in Euros excluding personnel costs	number of staff involved					Advantages	Disadvantages	
Photonics communication campaign with a professional agency	General public	promote and present Photonics to the general public through media channel like radio or TV as well as various social media channels and the web.	Ability of organising a team involving different skills (scientists, journalists, audio and video technicians)	280	6,000 Euro for the entire activity (1 communication campaign)	1–2	about 2 million potential viewers	low	high	medium to high	Reach the largest possible audience, long term presence through internet	If done well requires sizeable resources	1 English + 4 Italian video clips, 2 written expert interviews and many more articles available here: http://www.adnkronos.com/speciali/ino-cnr
Video interviews of photonics experts	General public	produce an interview with a prominent scientist	Knowledge on organising an interview with a prominent Photonics figure head, technical skills for post-processing of the video	30	N.A.	2–3	N.A.	low	medium	N.A.	Reach the largest possible audience, long term presence through internet	If done well requires sizeable resources	6 video interviews of photonics experts, including one from Nobel prize winner Nakamura – large reach but significance difficult to assess.
Photonics Science Slam	general public, young people	- 6-8 slammers, - audience >100 people, - number of publications reporting on the event	network to RTOs and companies	70	2,000	3	100	low	high	high	Fun, exciting and informative activity to promote Photonics	- Complex and resource consuming organisation, - limited number of slammers on a specific topic (like Photonics) and in a given geographic area - Audience members already have an interest in Science (although marketing and press coverage will reach larger numbers.	1 successful Photonics slam with 8 slammers and 100 participants, further science slams organised since then by a regional partner with many YouTube videos available

Annex 3: photonics4All in a nutshell

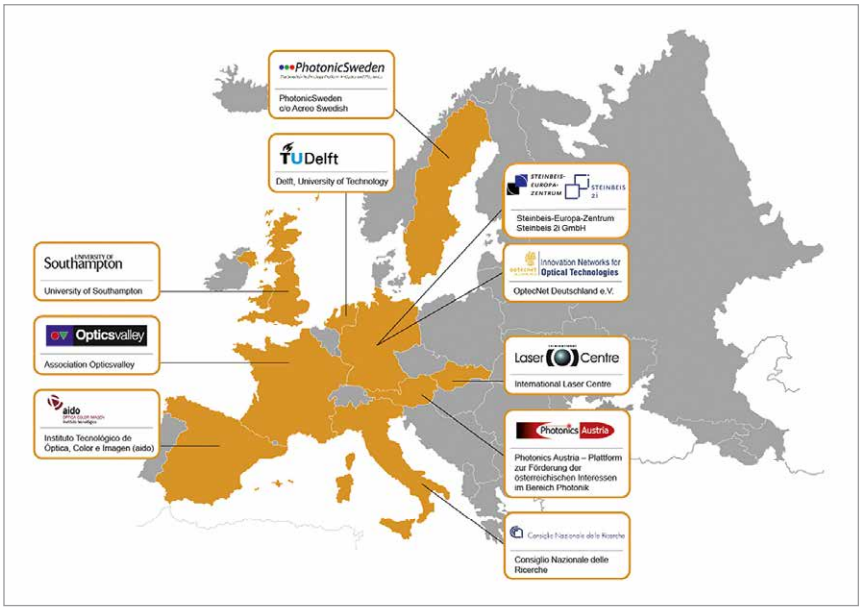
Photonics4All is a Horizon 2020 European Outreach project, funded by the European Commission[9] to promote photonics to young people[10], entrepreneurs[11] and the general public[12] across the EU. Photonics4All has developed a set of new promotional tools and applied them during a wide variety of outreach activities with different audiences.



Discover our unique approach and check out our tools and event at: www.photonics4all.eu!

9 http://ec.europa.eu/index_en.htm
10 http://photonics4all.eu/young-people/
11 http://photonics4all.eu/entrepreneurs/
12 http://photonics4all.eu/general-public/

Annex 4: Photonics4All consortium & contacts



Nota Bene: The Spanish partner of Photonics4All, AIDO, went bankrupt during the project and thus, unfortunately, could only contribute to the project at the beginning.

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Today, optics and photonics technologies have an important impact on nearly every area of our lives, covering a wide range of applications in science and industry. Photonics has been recognized as a Key Enabling Technology (KET) by the European Commission. However, despite its importance photonics is still not well-known to a majority of people.

To challenge this general lack of awareness about photonics, the European Commission funded the Photonics4All outreach project which was designed to promote photonics and light-based technologies to young people, entrepreneurs and the general public throughout the EU. Between January 2015 and December 2016, 9 Photonics4All project partners developed a set of promotional outreach tools which were used successfully during a variety of different outreach activities with over 400,000 people. The project aimed to engage the target groups with photonics and photonics applications, and inspire a greater interest in photonics amongst all those taking part.

This handbook summarizes our best practices in promoting photonics and light-based technologies to the general public. The handbook is aimed at all those public and private organizations willing to organize outreach activities for the general public, and should be useful to newcomers or those more experienced in science communication.

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