

The Impact of the International Year of Light and its legacy

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ABSTRACT

The paper will focus on the activities of the International Year of Light and Optical Technologies 2015 (IYL) with their impact in life, science, art, culture, education and outreach as well as the importance in promoting the objectives for sustainable development. It describes our activities carried out in the run-up to or during the IYL, as well as reports on the generic projects that led to the success of the IYL. The success of the IYL is illustrated by examples and statistics. Relating to the potential and success of the IYL, the impact and the genesis of the International Day of Light (IDL) is presented. Impressions from the opening ceremony of the IYL in Paris at UNESCO headquarters and the Inaugural Ceremony of the IDL will then be covered. A second focus is placed on the interdisciplinary media projects realized by the students of our university dedicated to these events. Finally, an analysis of the impact and legacy of IYL and IDL will be presented.

Keywords: International Year of Light, IYL, International Day of Light, IDL,

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1. INTERNATIONAL YEAR OF LIGHT (IYL) 2015

Continuing the tradition of UNESCO International Theme Years, after the International Year of Astronomy 2009 and the International Year of Mathematics 2013, the IYL successfully followed in this series in 2015. Figure 1 shows a collection of artworks created by our students in advance to promote the IYL.



Figure 1. Artwork poster: Magic of Light. © Offenburg-university.de

Today, eight years after the IYL 2015, we can look back on a successful cooperation of optical societies worldwide, celebrated in 147 countries. [1]. With more than 13,000 distinct events, reach an audience estimated at over 100 million, it turned out to be the most successful “International Year” celebrated by UNESCO (Fig. 2.) [1]. The IYL 2015 website was accessed from 191 countries, and 24 commemorative postage stamps were created [2]. See the IYL 2015 Final Report for more information [2].

An important factor guaranteeing the success was an excellent preparation process that began several years in advance. For us at Offenburg University it was a special pleasure to be involved in the preparations and implementation of the IYL.

In preparing and celebrating the IYL 2015, we implemented the following projects and events. An important feature in the implementation of the projects was that they were carried out with a large participation of students from Offenburg University. In addition, the list is supplemented with the purpose and availability of the projects and events.

1. *IYL 2015 art poster collection, Magic of Light website*

- promotion, celebration and legacy
- worldwide availability

2. *Art poster “No Football – Just Photonics” Magic of Light website*

- promotion, celebration and legacy
- worldwide availability

3. *Smart interactive projection*

- celebration during the IYL 2015 opening ceremony
- shown in the foyer of the Paris UNESCO building
- worldwide availability

4. *University for Children “The Magic of Light”*

- winter lecture program
- celebration, regional

5. *University for Children “Across the Universe with Relativity and Quantum Theory”*

- summer lecture program
- celebration, regional

6. *Twitter-wall World of Photonics - Munich*

- celebration
- International Congress Center at Laser Munich/Germany (June 2015): European Conference on Lasers; Electro-Optics, International Quantum Electronics Conference OSA, EPS, Optical Metrology 2015 SPIE
- worldwide availability

7. *Twitter-wall Merida*

- celebration during the IYL 2015 closing ceremony at Yucatán Convention Center Merida
- worldwide availability



Figure 2. Logo International Year of Light (IYL)

8. *A Century of General Relativity Theory*

- Lecture evening
- celebration, regional

9. *Live broadcasting of the total lunar eclipse 2015*

- promotion, celebration and legacy
- worldwide availability

10. *Students Meet Scientists*

- Google Glass developer (2015) and SPIE President Elect 2023 Dr. Bernard Kress
- celebration and legacy, regional

11. *“Invisible Light”*

- promotion, celebration and legacy
- worldwide availability

12. *Film Festival Merida Mexico*

- two Film contributions
- celebration and legacy, Yucatán Convention Center Merida/Mexico
- worldwide availability

Some of the more significant and sustainable projects featured for the IYL 2015 will be presented in more detail next.

1.1 “Magic of Light” Art Poster Collection

Our first and one of the most ambitious projects was to create a poster collection “Magic of Light” (Fig. 1.) designed by students from media and design programs to highlight the IYL 2015. In this interdisciplinary project, we proposed for guidance the IYL 2015 milestones and encouraged our students to contribute their own ideas as well.

2015 Milestone Anniversaries in Light Science

Several major anniversaries in 2015 have significantly influenced the attractiveness of IYL 2015 [1]. These were:

- 1015:** *Alhazen*, Arabian mathematician, physicist and optician - inventor of the magnifying lens (loupe) –, completes his seven-volume treatise, “Treasure of Optics”
- 1615:** French-Huguenot engineer *Salomon de Caus* invents the prototype of a solar-driven engine
- 1815:** *Augustin-Jean Fresnel* introduces the theory of light as a wave
- 1865:** *James Clerk Maxwell* rigorously describes the electromagnetic theory of light
- 1905:** *Albert Einstein* published the explanation of the photoelectric effect, which earned him the Nobel Prize
- 1915:** *David Hilbert* and *Albert Einstein* develop the theory of relativity, showing how light is at the center of the very structure of space and time
- 1965:** *Arno Allan Penzias* and *Robert W. Wilson* discover the cosmic microwave background, an electromagnetic echo of the very creation of the universe
Charles Kuen Kao and optical fibre technology

Figure 1, shows a selection of the best works, which were combined on a postcard used for promotional purposes in the run-up to the IYL2015. In a larger poster format, this selection was also exhibited to promote the IYL 2015 at the following venues:

- International Congress Center at Laser Munich/Germany (May 2013)
- Education & Training in Optics & Photonics ETOP in Porto/Portugal (July 2013): OSA, SPIE, EPS
- Optics & Photonics in San Diego/USA (August 2013): SPIE
- Frontiers in Optics in Orlando/USA (October 2013): OSA
- Allied Arts of Whatcom County in Bellingham, WA/USA (January 2014)
- Opening Ceremony, UNESCO Headquarters in Paris/France (19-20 January 2015)

The posters can continue to be used to reference the event also in the future, thanks to their enormous, worldwide impact factor. By mid-2016, we had received a total of ca. 2600 user requests and counted more than 10,000 poster downloads from around the world. A number that far exceeded our expectations. From our point of view, it is also notable that until the beginning of 2014, when googling for "International Year of Light", the Magic of Light website appeared as the first search result.

Another created poster series “No football, Just photonics” (Fig. 3.) could round up the success. The core idea of the series was to transfer optical components and devices:

- an optical comb generator,
- Raman scattering,
- a photo coupler,
- an optical ring resonator,
- an optical fiber,
- an optical amplifier,
- a Mach-Zehnder coupler,
- erbium-doped fiber amplifiers,

all working their magic on a soccer field (Fig. 3) [3].



Figure 3. Artwork poster: “No football, Just photonics”. © offenburg-university.de
 Featured in the poster series “No football, Just photonics” are: optical comb generator, Raman scattering, photo coupler, optical ring resonator, optical fiber, optical amplifier, Mach-Zehnder coupler, erbium-doped fiber amplifiers

1.2 Live broadcasts of astronomical events highlighting the IYL and the IDL

During the IYL 2015, in the early morning hours of September 28th, a total lunar eclipse occurred, presenting an excellent opportunity to highlight the IYL 2015 at Offenburg University with a live broadcasting event. Starting just after midnight, we reported from astronomical observatories around the world, conducted interviews with scientists and covered a range of other astronomical topics.

The live broadcast was viewed by over 70,000 viewers from 143 different countries, totaling more than half a million viewer minutes during four hours of broadcasting.

We have reported about our experiences in previous papers, “Astronomical phenomena: Events with high impact factor in teaching Optics and Photonics” [4] and “Astronomical events and how to photograph them” [5].

Furthermore, the eBook "Moonbook" prepared by our students can be downloaded for free [6].

With the experience from the previous live broadcasts, we have decided to broadcast the longest total lunar eclipse of the 21st century on July 27th, 2018. This time we have decided not to use a studio and to take advantage of the landscape of the highest peak in the Black Forest, the Feldberg. In addition, we streamed this live broadcast in 4K.

Our expectations were far exceeded when we noticed that our broadcast was viewed by almost half a million viewers. At the second event, we could still refer to the IDL and emphasize the importance of optics and photonics in society, science, technology and art, even though the lunar eclipse did not coincide with the IDL day.

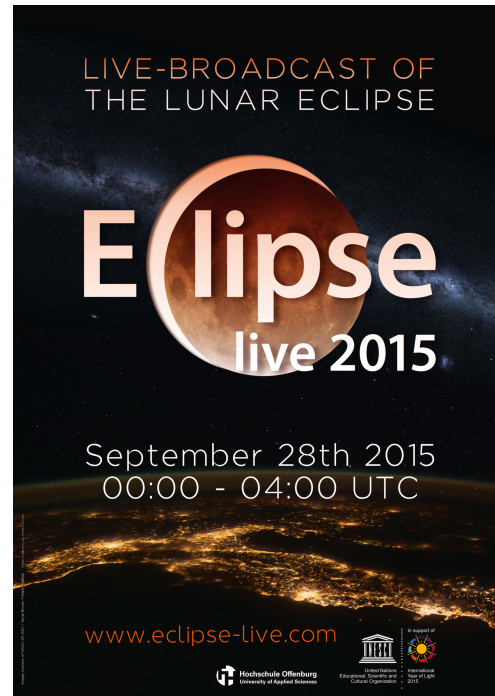


Fig. 4: Live broadcasts poster
© Luis Arellano / Offenburg University



Figure 5. Total lunar eclipse – July 27th, 2018, from Feldberg in the Black Forest

1.3 A Century of General Relativity Theory

One of the major milestones of the IYL 2015 was the centennial of Albert Einstein's General Relativity Theory, in which he showed how light is at the center of every structure of space and time.

On November 25th, 1915 Einstein revolutionized the field of physics with the publication of his General Relativity Theory. In recognition of this extraordinary achievement, Offenburg hosted a lecture evening on the exact same day, 100 years later. As a highlight of the IYL 2015, the event was well publicized through the local press and attracted a wide audience. Nevertheless, the number of about 450 participants far exceeded our expectations.

As invited speaker, we were very happy to welcome the Director of the German Mathematical Institute from Oberwolfach, Professor Stephan Klaus. This allowed us to draw special attention to "The Race for the General Relativity Theory" between Einstein and David Hilbert. The two other lectures of the evening were:

- "Dare for more geometry" and
- "Albert Einstein – 100 Jahre General Relativity Theory"

The speakers managed to not only make the significance of the General Relativity Theory tangible to a broad audience, but also explain its controversial nature and the competition surrounding it at the time of its development.

A central aspect were the predictions postulated with the General Relativity Theory – only when one of them was actually proven, through the total solar eclipse of 1919, did Einstein become the celebrated 'pop star of science' as which we know him today. The seven major predictions Einstein had made regarded the following: [7]

- Perihelion precession of Mercury
- Deflection of light by the Sun
- Gravitational redshift
- Expansion of the universe
- Gravitational radiation and gravitational waves
- Black holes
- Cosmological constant

The lectures were accompanied by many illustrative experiments, including an experiment demonstrating the principle of measuring gravitational waves – the only prediction of Einstein's not yet proven by then, on November 25th, 2015. In retrospect, we have been especially happy about this part of the evening, as on February 11th, 2016 the LIGO Observatories announced their detection of gravitational waves: They were measured during a collision of two black holes having masses of around 29 and 36 sun masses, which circled around each other and then merged into one black hole of 62 sun masses. In accordance with Einstein's famous equation, $E = mc^2$, the resulting difference of three sun masses was energy emitted in gravitational waves. Thanks to the light, and to laser, we can still measure this fusion today, 1.3 billion years after the fact. With his General Relativity Theory, Einstein had predicted such measurements 100 years earlier. [8]

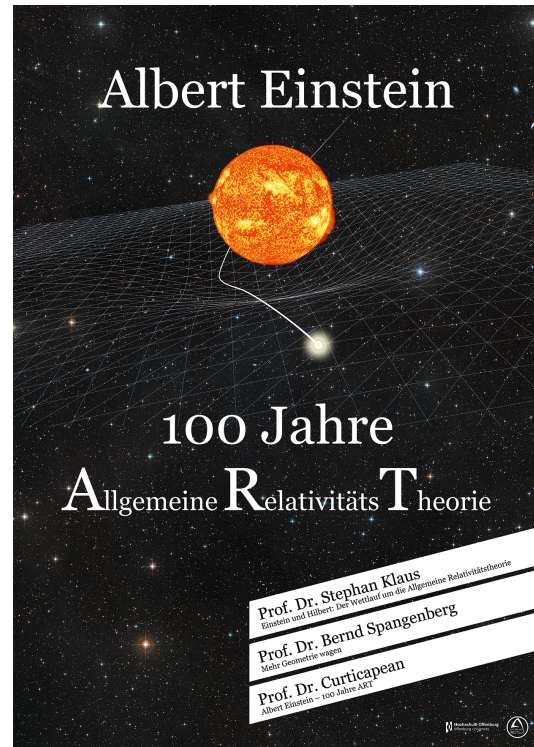


Fig. 6: Event poster of the meeting "A Century of General Relativity Theory" © Luis Arellano / Offenburg University

Other significant achievements of Einstein's were cited in the lectures as well. Even without the theory of relativity, science historians consider Einstein as one of the most important physicists. To him we also owe the photoelectric cell, laser, the development of plastics, the fields of astrophysics and nuclear physics. Without General Relativity Theory we would not have sharp images on TV and computer screens and no precise GPS navigation tools. In short, without Einstein we would almost certainly not have the living standard we enjoy today.

Einstein was the only scientist ever to receive a ticker-tape parade in New York City, on April 2nd, 1921 [9]. Another aspect highlighted during the lecture program was Einstein's achievements as a human being, a pacifist and human-rights activist. To give only a few examples, he was one of the few scientists opposing the First World War; he was the youngest member admitted, on June 7th 1924, to the order of merit "Pour le Mérite", but renounced his membership in 1933 [11]; he was offered the presidency of Israel in 1952 [11]; he was co-author of the 1955 Russell-Einstein Manifesto [10] highlighting the dangers posed by nuclear weapons and calling for peaceful resolutions to international conflict, which is widely regarded as the beginning of the peace movement.

2. INTERNATIONAL DAY OF LIGHT (IDL)

As a legacy of the IYL 2015, we have used the opportunity and the gained momentum to continue in our activities. We have found it natural to carry on the idea of the IDL to further our existing projects and start new ones.

The resolution of the UNESCO Executive Council to introduce an IDL on May 16th every year was endorsed by the UNESCO General Conference at its 39th session on November 7th, 2017 [12].

The International Day of Light is a global initiative that provides an annual focal point for the continued appreciation of light and the role it plays in science, culture and art, education, and sustainable development, and in fields as diverse as medicine, communications, and energy. The broad theme of light will allow many different sectors of society worldwide to participate in activities that demonstrates how science, technology, art and culture can help achieve the goals of UNESCO – education, equality, and peace [12].

The response on the first International Day of Light 2018 on May 16th was very great. According to the organizers, more than 200 events from 54 countries were organized [12].

The IDL is held on May 16th every year as a commemoration of May 16th, 1960, when the first laser operated [13].

Motivated by the success during the IYL 2015, we continued to involve the students in interdisciplinary projects. Not uncommonly, the best results are achieved when participants from different fields work together on the same topic. In our case it was media students as well as students for the teaching profession. This time we wanted to create a motif for the IDL. We integrated this topic into the appropriate curriculum. The lecture on photography and lighting was the best choice. On the subject of long-term exposure and light painting, we elaborated on a practical application that led to a final result. The mentioned stylistic methods were used but also a digital processing was necessary. The result can be seen in Figure 8. Another aim of the lecture was to participate at the Photo contest. The work was submitted and to our pleasure it was in the top selection of about 1000 submissions of the Photo contest. All the more our joy was when we see our photo on the SPIE poster at the IDL Inaugural Ceremony May 16th, 2018 at the UNESCO Headquarter in Paris and also as a SPIE give away in form of a lenticular bookmark with our motive. The IDL Steering Committee also selected our motif for the long-term advertising (Fig. 8).



Figure 7. Logo International Day of Light (IDL)



Figure 8. Postcard International Day of Light IDL © Offenburg University

2.1 Live Interactive Twitter Wall

Another successfully realized project was an interactive Twitter wall (Fig. 9, Fig. 10). This allowed live visualization of all tweets with the hashtag #IYL2015, or #IDL2018 respectively on a globe. Furthermore, the tweet senders had the opportunity to follow their tweets live online on the Twitter Wall. The Twitter wall was performed at several main events:

- Opening Ceremony of the IYL 2015 at the UNESCO Headquarter – Paris January 2015
- World of Photonics – Munich June 2015
- Closing Ceremony of the IYL 2015 in Merida February 2016
- IDL – Inaugural Ceremony of the IDL 2015 at the UNESCO Headquarter – Paris May 16th, 2018

So, for example the visualization was projected in the foyer of the UNESCO headquarters building during the opening ceremony of the IYL 2015, but also allowed for worldwide interaction, meaning that people who were not present at the opening ceremonies could still participate by visiting the website.

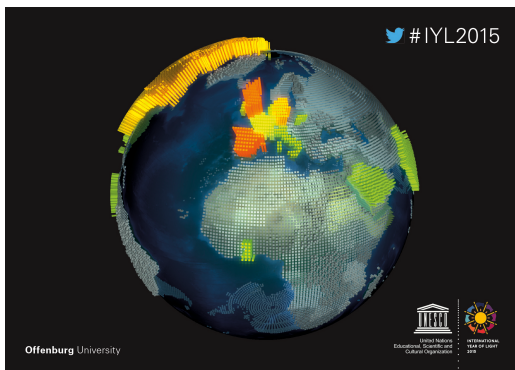


Figure 9: Twitter Wall



Fig. 10. Twitter Wall operating at World of Photonics in Munich

2.2 "A Maze: Ingenious Pipes" An Interactive Projection with Photo Shooting

"A Maze: Ingenious Pipes" was an interactive projection where attendees could stage themselves and print out a Polaroid photo, resulting in some amazing shots through the projection of maze-like pipeline on their face.

This interactive project is involving projection and photography simultaneously. In a dark room, a pattern is projected onto the participants face. The pattern is randomly generated by a computer and has an evolving shape similar to dendritic growth or maze-like pipeline. The participants are given a self-timer and see themselves in a control monitor. Depending on the pattern the participant can trigger the timer and have the image printed out as a Polaroid photograph

This project engaged a group of students, who had to bring in their combined knowledge of computer science, electrical engineering, design and photography to master the installation. Meanwhile we have added an extension such that the resulting image is sent to the participant's mobile phone and can be viewed in 3D using a cardboard. A sample of this type of result can be seen in Figure 11. As can be seen in this example, this installation was also presented at the ETOP in Quebec.



Fig. 11. Example of a stereoscopic image that was sent to the participant's mobile phone.

2.3 Helium Neon LASER – Plasma LASER Exhibition

To underline the special meaning of the day May 16th, the day when the first laser operated (1960) [13], we set up a HeNe laser at the International Day of Light Inaugural Ceremony. It was not a ruby laser like Theodore Maiman's (Fig. 8) [14], but a HeNe plasma laser that was manufactured in the late 1960s. By this we wanted to focus the attention of the audience to the importance of the date and finally it is also a big highlight to operate an old HeNe plasma laser [15] (Figure 12)!

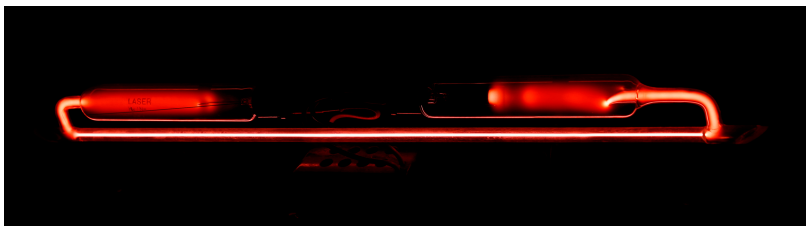


Figure 12. HeNe operating Laser

Some technical details: The helium–neon laser or simply HeNe laser, is a gas (plasma) laser and the gain medium consists of a mixture of 75% helium and 25% neon at a total pressure of about 1 mm of Hg. The HeNe laser operates at a wavelength of 632.8 nm, in the red part of the visible spectrum.

2.4 Interactive Interdisciplinary Art and Photonics Project - "The Power of Your Eye"

An interactive media installation entitled "The Power of Your Eye," based on the principle of eye tracking, was also presented at the IDL Inaugural Ceremony at UNESCO Headquarters in Paris. The interaction was described on the postcard (Figure 13). The viewer looks at the screen and fixes their gaze on one of the circles on it. The fixated circle then begins to rotate; when it is fixated again, it comes to a standstill. To determine the position of

the gaze, an eye-tracking bar is attached to the lower edge of the screen. In our media installation, a commercial eye tracking bar was used. It takes over the movement of the computer mouse, and is controlled accordingly by the participant's image.

The animation of the circles was programmed using Adobe Flash that time. The circles themselves are the result of different patterns created with ten LEDs on a rotating disk by long-term exposure. A special challenge was the calibration of the eye-tracking bar in order to match as large a number of participants as possible without calibrating for each individual.

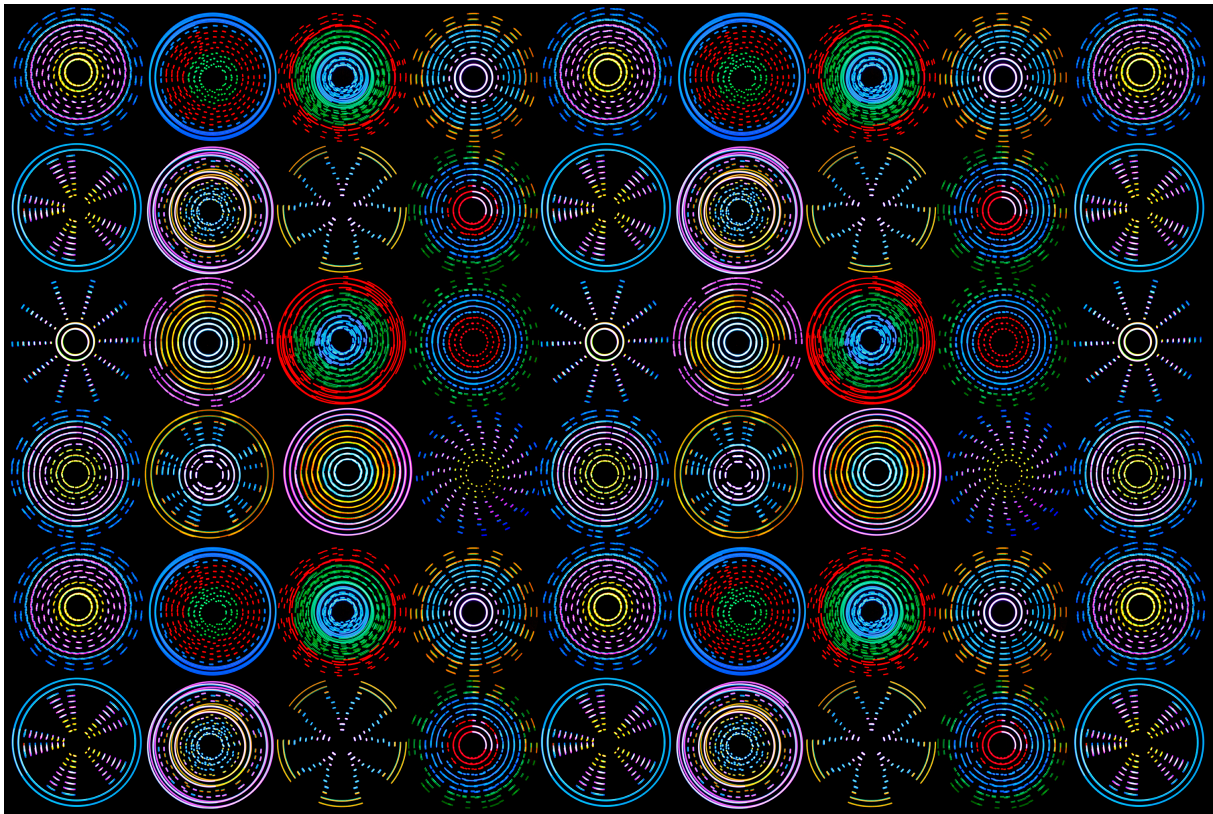


Fig. 13: "The Power of Your Eye" - Postcard with operating instructions on the back side.

CONCLUSIONS

We were very happy to have this opportunity to present the work of our students worldwide and at the same time to be actively involved in promoting the IYL 2015.

We hope that our projects have awakened young people's interest and enthusiasm for physics and, in particular, for optics as the science of the future.

The projects are still exciting, as every year the IDL is celebrated in the optics and photonics community.

The feedback on the first presentations of the poster series to the optical community (SPIE – International Society for Optics and Photonics, OSA – Optical Society of America now Optica, EPS – European Physical Society) was exceedingly positive. After receiving a large number of requests, we decided to make the students' designs accessible to the worldwide community.

Our projects were also included in the essay volume “Reflections from the International Year of Light 2015” (Figure 14) and “The International Year of Light and Light-based Technologies 2015 – Final Report” (Figure 15).

Referring to the IDL, we can conclude that this event is a motivating factor for our students to participate and contribute to interdisciplinary projects focused on optics and photonics. Art students were involved in the presented projects, as well as students from media, computer science and engineering have contributed "Good projects happen when people work in different fields." [16].



Fig. 14. Essay volume “Reflections from the International Year of Light 2015”



Fig. 15. The International Year of Light and Light-based Technologies 2015, A Successful Community Partnership for Global Outreach, – Final Report

In summary, we can look back on a great number of projects and activities dedicated to the IYL 2015 and subsequently to the Inaugural Ceremony of the IDL. Furthermore, we were able to further develop and sustainably establish many projects for the IDL. It is noteworthy that these projects can and will continue as the IDL is celebrated annually on May 16th.

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