Modulo 2:

Riferimento a linee guida	FORM N.: 9 PROGRAM EVALUATION FORM
3	Nome programma:
	Photometry and Light Engineering
3	Responsabile programma
	Lorenzo Fellin
3	Obiettivi specifici del programma
	This program started almost with the constitution of the Laboratory of Photometry and Light Engineering, approximately in 2000. The Laboratory was born also from the need of creating a centre specialized in photometry which could be a support for the claims of the company located in the North-East of Italy. Despite its restricted dimensions, it includes the good photometric instrumentation and equipment here briefly listed: - an integrating sphere for luminous flux measuring (1,5 m in diameter); - an automatically controlled goniometer used in reflectometric analysis of surfaces and for measuring the intensity distribution of light sources; - an optical table with vibration control; - basic photometric instrumentation (luxmeters, radiometers, luminance meters, spectroradiometer, CCD cameras used as multi-luminance meter, ...). The program activities can be grouped in four main fields; they are strongly connected and interacting, necessarily: • exterior lighting; • reflectometric analysis of surfaces; • works of art lighting; • analysis of lighting sources. The interaction among the themes can be highlighted analyzing the specific activities. Owing to the high interactions among the themes, also their resources and results are shared. Furthermore, other initiatives are on the way to start new contracts in innovation fields like - tunnel lighting; - non conventional lighting systems. Although the Laboratory starts its activity few time ago, time required for trimming some test equipment, it is at the centre of some signed research contracts. Furthermore, the laboratory performs also a support activity for light designer, constructors and installer of lighting systems, aiming at rising ideas and initiatives for new specific research contracts.
3	Progetti in corso
	Progetto 1: ***Exterior Lighting*** The main aim of a good lighting is allowing to carry out the visual task efficiently in a comfortable way. As examples, it has to grant the road safety allowing a driver to perceive an obstacle over the roadway without using an extreme attention effort; it should allow the enjoyment of towns, monuments and works of arts without wasting energy. There is a compromise between the best object visibility, a visual

comfort and the minimal energy consumption and disturbance.

The optimization of a design of road lighting system requires the knowledge and the analysis of the lighting sources and of the reflecting properties of the involved surfaces. Furthermore, the design should consider how much of the irradiated power is used for the defined aim (the visibility and the safety on the road), or scattered to produce a diffuse lighting of the night sky, named light pollution.

The activity performed in this project aimed at quantifying the consideration here above reported, suggesting the application of methods having particular attention to the energy saving contemporarily to the best visibility on the road.

Present national standards on motor way and tunnel lighting, like Italian UNI 10439:2001 and UNI 11095:2003 standards, provide light engineering requirements considered able to grant the minimal correct visual perception of the road in terms of minimal illuminance and luminance on the road surface and on the lateral surface of tunnel. These values depend on the lighting system and the reflecting properties of surfaces. The visibility of an object placed on the road depends on emitted luminous flux and global reflection properties, of course; the project aimed at showing that it depends also on the kind of lighting source, its directivity and spectrum, together on the directional reflecting properties of the materials used to realize the surfaces of buildings, roads, traffic tunnel, ... In fact these last are backgrounds which the object has to be showed up and are indirect lighting sources for the obstacle against the driver.

The modern scientific approach to safety of road users considers the visibility of a standardized object placed on the roadway in different positions. It evolved from specifications of the minimum pavement luminance, intended to grant the visibility of dark objects and mitigate the effects of glare, to providing a lighting system based upon a visibility standard (called small target visibility or STV) that is intended to improve the visibility of objects of varying size and reflectance while mitigating the effects of glare. This last approach is the suggestion of the CIE publication 115-1995 “Recommendations for the lighting of roads for motor and pedestrian traffic” and of the standard ANSI/IESNA RP-8-00 "Roadway Lighting". The project analyzes the application of the approach based on the analysis of the luminance of “the small target” to Italian roads. The activity highlights the differences in engineering performance requested for the lighting plant, in particular for real cases among the Italian road scenery. While according to Italian and European standards the parameters depend on the traffic speed, the STV method takes into account also the probability of the accident with a pedestrian. It implies the two approaches suggest similar luminance values for local roads, while the method suggested by CIE recommends lower value in freeways and expressway where the pedestrian crash is less probable. As a consequence, different energy consumptions could result, therefore, adopting the modern approach is convenient definitely, when the management of the plant is considered [1, 3]. The next actions to be undertaken is to realize two lighting plants according the two standards and evaluating also their efficacy considering both in terms of safety and comfort of drivers. The results could be the basis of supporting the new method for Italian and European standards.

As the luminance contrast of the target depends on the reflection of its background, in this context, the photometric characterization of road paving and wayside surfaces assumes a great importance, also from the point of view of energy saving.

Progetto 2: ***Light pollution***

The social importance of outdoor lighting is apparent, particularly the need for public lighting to ensure a safe and comfortable environment by night to all road users

and to allow people to enjoy their towns by night. However, such benefits are sided by effects due to the luminous flux both emitted upward by lighting installations and unavoidably reflected upward by lit surfaces, increasing sky luminance and reducing the visibility of the stars.

After the emission of the standard UNI 10819 supported by scientific bases, there was a rapid growing of local (regional) law often imposing hard bonds on the light directly emitted by the devices. In fact they locate in this luminous flux the most light emitted toward the sky. As a consequence of the reduction of the light scattered from luminaries, and requiring to grant a minimal luminance on the road surfaces, this approach imply the number of the light centres will increase and with it the cost of the plant and the energy consumption. As the laws deals with only one of the possible light pollution causes, they could not assure their main aim of improving of astronomical.

A project starts in 2004, without specific financial support, aiming at analyzing lighting systems of cities from the point of view of the lost luminous flux, the flux emitted toward the sky, considering it as an index of the efficiency of the overall lighting plant and highlighting the roles of the flux directly emitted from the light devices and the light reflected by lit surfaces.

A cavity model is used for evaluating the effect of the light emitted by the luminaires of the lighting installations of a city on artificial sky luminance. According to this approach, the artificial sky luminance effect is manly due to the luminous flux reflected by surfaces of road and buildings. Researches showed that a big town can contribute to sky luminance at large distances, however, also a high number of small sources can produce the same effects: this is the situation in the North-East of Italy, where most urban sites are small. Two areas were considered in the presented research: Torino, a medium sized town in the North-West, and some small cities in the Po plain in North-East of Italy. The measurements of the luminance of some cities in two different environments, with distributed and concentrated urban densities, were used to verify the validity of the cavity model approach.

The luminance of the cities was measured by night from the top of hills through a multi-luminance meter, which is equipped with a CCD matrix, in both the situations. Observing the cities, it can be noted the most luminaires are hidden in the cavities created by streets and buildings and that consequently cities behave like diffusing luminous sources. A further confirmation of this behaviour comes from the comparison between the luminance measurements and the same values estimated from the through the evaluation of the installed luminous flux reflected upwards by the lit surfaces of the cities, which in this way are assimilated to diffusing sources. The good agreement in between the results obtained according to the cavity model for the towns in the Venetian plain, where the population is distributed on large areas, and for Turin, where urban life is concentrated, confirms that the exterior lighting installations in urban sites behave like diffusing luminous sources, the reason being that most luminaires are embedded into the town cavities. The immediate consequence is that the luminous flux directly emitted upwards by the luminaires on the artificial sky luminance produce minor effect, the most relevant parameter being the lighting levels in the streets [23].

Aiming at improving the confidence on the use of the cavity model, the light emission of a city far and lone from other lighting sources was considered. From the observing locations, beyond and sideways the city there should be spaces free from lighting sources, therefore it could be useful there are hills or mountains all around the city under analysis. Therefore, a second step, based on a founding of 55000 €, was activated in 2005; it deals with the characterization of the luminous flux of a alpine city, Trento, in the North – East of Italy. Its purpose is defining some quality indexes able to describe in a global and effective way the efficiency of the light engineering solution

adopted in the city. This result required adequate correlation among measurements of the upward luminous flux, the installed flux and the installed electrical power.

The program is subdivided in

- Measurements of the luminous flux emitted by the public lighting system, observing the city from site with small elevation from the city, estimate of the visible luminaires from the same site, measurements of the artificial sky luminance in good whether conditions and with new moon. Also colorimetric measurements could help in localizing the main disturbance sources.
- Elaboration of available data on the installed luminaires and power to estimate the upward luminous flux. Some surveys of the illuminance and luminance on citizen roads can allow to verify the state of the lighting plants.
- Comparison between the measured an estimated scattered flux and artificial sky luminance.

The results of the project will be an exhausting and objective knowledge of the phenomenon. It could be the support for local regulations of lighting plants, they could be based on criteria aiming at minimizing the energy cost and the ambient and citizens disturbance. Furthermore, they could contribute to the updating process of the CIE publication n. 126, presenting in international circuits Italian experience and needs of local exterior lighting.

Progetto 3: ***Reflectometric analysis of surfaces***

Reflection properties of surfaces is of fundamental importance in designing a lighting plant for exterior, interior and also for highlight works of arts and improve their enjoyment. The here presented project is devoted to the measurements of these quantities. An important part of the period from year 2001 and year 2005 was devoted to provide and to characterize the first instrumentation for surface analysis and to adjust the measurement procedure. With this aim the Laboratory was equipped by instrumentation able

- to analyze the reflection properties of road paving and tunnel cover, both in situ and dealing with samples;
- to evaluate how different materials used for road paving and tunnel cover could influence the luminance of the portions of the roadway;
- to estimate the effect on the visibility of an obstacle on the roadway of the real reflection properties, experimentally measured, for different lighting solutions.

The Laboratory equipment includes lighting sources (incandescent and discharge sources), a goniometric system able at orienting an object arbitrarily. Over it can be place samples, e.g. taken from the road paving, or lighting sources, like luminaries.

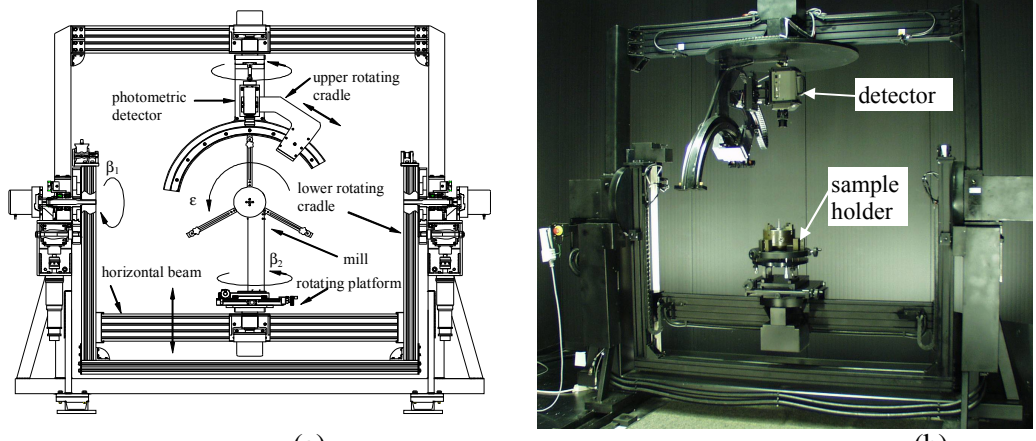
The Athenaeum judged this project worthy of a special financing assigning a first fund in 2000 to acquire the basic photometric instrumentation and a second fund of to realize the special goniometer which takes up in 2004.

The goniometer located in the Laboratory allows the sample under test to be rotated, arbitrarily setting the incident direction of the shooting light and observing direction, according to specification suggested by technical publication of Commission Internationale de l'Eclairage (CIE). It is a prototypical evolution and improvement of the goniometer used at I.N.RI.M. to analyze retroreflecting material. It has to grant a high resolution and accuracy for every revolution angle, aiming at satisfying the prescriptions of national and international standard. Considered its origin, the system allows at analyzing the reflection of surfaces at small angles from the direction of the incident light. The features introduced in the design of this new goniometric system allow lighting the surface from a direction by chance and observing the reflected light

from every direction in the hemisphere over the surface. It is possible to know the reflection behaviour of the surface completely, for every lit and observing direction [12, 15, 16, 18].

The analysis of the metrological performances of the system are completed just, verifying the uncertainty specifications for the angular positioning, equal to 0,1°, are satisfied for everyone of the five revolution motion [24]. The goniophotometer, including the goniometric system and the lighting and detection systems are completely automated allowing an easy managing of the huge data amount.

To simplify the measurement procedure, in particular for studying road paving, a portable goniophotometer was realized. It allows to perform the analysis of a portion of road avoiding the extraction of a sample [10]. The system working in manual way, now, could be automated in the future.



(a) (b)

(a) Front view of the goniometer installed in the photometric laboratory
(b) Configuration of the goniometer for the measurement of the luminance coefficient of a road core

The detectors available in the Laboratory, and used for the analysis of incident and reflected light, allow to study both photometric and radiometric quantities, in fact some of them are equipped by photopic filters as required by standards, others deal with the light spectrum, allowing also colorimetric analysis. Particular attention was used to instrumentation devoted to luminance measurements providing the Laboratory with a multi-luminance meter equipped by a CCD sensor. It is equivalent to a high number of luminance meter, as many as the pixels of the CCD sensor. By it a luminance image of the framed scene can be obtained and, considering the contribution of each pixel, a spatial resolution is achieved. During laboratory tests, this feature allows to discriminate the light reflected by the sample under test from the light scattered by object close to it, like the supporting and orienting system. In external measurements, e.g. of the luminance of road paving, it allowed to reduce the effect of luminous sources framed by the instrument. The multi luminance meter of the Laboratory is constituted by a commercial scientific CCD camera and a high quality photographic lens, not foreseen for the camera, originally. A calibration of the instrument was need to know its performance correctly [9, 20].

A research contract was activated within this project with an Italian branch of Alcoa Wheels, Alcoa is the world's leading producer of primary aluminium, fabricated aluminium, and alumina. The aim was redefining the lighting system used to detect small aesthetic defects on wheels during the production. The activity consist in

analyzing different lighting solution defining the light source positions aiming at the optimization of the luminance contrast produced by the defects on the wheel surface. As the wheels presented a reflection very close to specular behaviour, the activity required to take into account and to minimize the glare, as it acts in reducing the sensibility in detecting the defects.

Progetto 4: ***Lighting of works of art***

The activity of the project intend to define procedures able to suggest the best luminous sources to be used to light works of art, in order to achieve the best colour rendering and reducing at minimum the risk of degradation [].

The aim of the light design for work of art is to reproduce as close as possible the same effect of the light condition foreseen by the artist, allowing the public to enjoy a masterpiece in similar colour rendering of when the work was created. The same light should be used during restoring activity avoiding the restorer work to alter the colour of the work leading to dramatic results.

The method applied is based on the spectral-photometric characterization of the surface to be lit, therefore the reflection properties of the work and of object in the environment have to be measured. The properties of the work of art are described by the luminance coefficient, including non diffuse behaviour of the reflection. Same samples considered significant for the colorimetric description of the work are analyzed. On the basis of historical investigation or objective evaluations, the most probably lighting source is chosen as a reference to evaluated the perceived colour of the samples when lit by its light. As this source could not realizable or could present a spectrum dangerous for the works of art, a mix of artificial sources is trimmed to minimize the difference of the chromatic coordinates of the samples lit by the reference and the proposed light. The approach is similar the one recommended by CIE for evaluating the colour rendering index, the advantage is that its is applied to the real colours present in the work and not on the fourteen standardized colour samples, in fact they could be not significant for the work we are dealing with.

Contemporarily attention has to be used to the illuminance level and exposure to light. Both low level of exposure, suggest to prevent works damage, and low values of blue and red spectral components can vary the colour rendering. It has to be taken into account when the artificial lighting source is considered.

A significant activity refers to the colorimetric characterization of an important work of art, the Giotto's frescos in the Scrovegni Chapel [4, 7, 8]. It was accomplished in collaboration with the Istituto Elettrotecnico Nazionale "G. Ferraris", now Istituto Nazionale di Ricerca Metrologica (I.N.RI.M). This study was the basis for the design of its lighting system. The results were appreciated by the Italian Conservation Service and Trust, particularly. The constituted the object of a presentation at the Accademia dei Lincei in Roma [4].

A similar activity was performed for Villa Barbaro [5] an ancient Middle Ages palace changed in a villa by Andrea Palladio between1550 and 1560 and decorated by with the vastest and most important cycle of frescoes of Paolo Veronese.

Progetto 5: ***Analysis of damage due to electromagnetic radiation on works of arts***

The exposition of works of art required a delicate compromise between the conservation of the works themselves along the time and their lighting, which allows their best enjoying. The material used to make the works of art, in particular organic materials, like paper, cotton, linen, silk, wool, wood, pigments, oil colours, glues, resins, synthetic colours and plastic materials, are damaged by the electromagnetic

radiations used to light the work itself. Among these radiations there is the light required for the human vision and a correct colour rendering of the works. Furthermore the lamps emit ultraviolet and infrared radiations. Electromagnetic radiations can act on the works of art triggering chemical reactions (breaking chemical bonds). It causes the colour fading or changing. The most of tincturing, inks and pigments are damaged by the "light". Furthermore electromagnetic radiation facilitate and accelerate the support aging of materials causing a their weakening and loosing of structural integrity. Infrared radiation, for example, can desiccate same material (e.g. paper) and cause their deformation. The "light" accelerates also other degradation phenomena, like oxidation and reaction involving acids in the air or in the work support.

The "light" effect is irreversible, therefore works of art lighting should be constantly monitored and analyzed considering the exposition time and the "kind" and intensity of the electromagnetic radiation.

The project born in 2005 from the experience on famous works o art (e.g. the Giotto's frecos the Scrovegni' Chapel in Padova) aimed at their correct artificial lighting. It begins with the investigation on the main causes of damage on works of arts, on their synergy and on the quantities able to describe in the damage itself in the most complete way: the activity includes the study of the interaction between electromagnetic radiations (ultraviolet, visible and infrared) and materials which the works of arts are made of (bulk, colours, pigments). Also the conditions of the ambient where the works are conserved or exposed have to be considered (e.g. temperature, humidity, quality of the air), as they, or their variation, are important causes or concomitant cause in producing the damage.

The second step aims at defining reflectometric techniques which could enable to evaluate the quantities used to describe the damage processes. This experimental phase should emphasize how much these parameters are effective in describing the degradation of the works of art. It could be interesting to consider both global quantities, like the reflection factor, and quantities dependent on incident and observing directions, like the luminance coefficient. In describing the damage phenomenon, an important role could be played by the spectral reflectance of portions of the work of art or their colorimetric coordinates; their variations highlight the degradation effect. Some samples, representing the work of art, have to be realized and to aged artificially. During the aging period both the radiation level and the reflection properties of the sample should be recorded. It allow the reconstruction of the exposure and the decay of the samples. From a model of the aging process, a correlation between the damage obtained in normal condition of exposition and conservation and the damage achieved with forcing exposure could be derived.

Contemporarily to the definition of the aging test the design of a system performing a continuous monitoring of the work of art has start, so that it can be used during the accelerated aging exposition of sample. A limited number of spy quantities are selected among those used for a complete description of the damaging process. They give a raw description of the phenomenon, but succeed in synthesizing in a sketch the interaction among the work of art, the electromagnetic radiations and other ambient quantities. The reduced number of the quantities makes cheaper the measurement, the manipulation and their recording. At the end the monitoring system has to be reduced in size to obtain an object compatible with the hypothesis of large diffusion of such a device in an exposure ambient.

This project is supported by the Istituto Veneto di Scienze, Lettere ed Arti, by grants up to 36000 € for young graduates and by the Fondazione Cassa di Risparmio Padova e Rovigo (CARIPARO), by a specific funding of 64000 € for new scientific instrumentation.

	Progetto 6: ***Analysis of light sources*** Most of the photometric instrumentation are devoted and calibrated to analyze with a adequate uncertainty the light emitted by conventional sources. This calibration could bring to large errors when the instruments are used in different conditions. On the other hand, it is important allowing to measure photometric quantities related to a lighting source in well known conditions. The attention of the Laboratory activity was focused on analyzing the behaviour of photometric instrumentation when it considers non conventional sources, in particular LED sources, as they are considered sources of the next years. LEDs differ substantially from common, incandescent and fluorescent, lamps, in particular in terms of physical size, spectral and spatial distribution of power. Their spectra, about 20 nm wide, are not as narrow as a spectral line, but they are narrower than the spectrum of the sources commonly used to calibrate photometric instruments. This specific characteristic causes a different behavior of the instrument when such a light source is considered. The output of a photometric instrument should be the average of the power emitted/reflected by the "source", weighted by the spectral sensitivity of the average human eye for photopic vision standardized by the Commission International de Éclairage (CIE). Obviously, the weighting function implemented in the instrument, the relative spectral responsivity of the photometer, is only an approximation of standardized spectral photopic sensitivity therefore a spectral mismatch happens. The instrument is usually calibrated by using an incandescent lamp approximating the CIE standard illuminant A covering the whole visible range, so as it provides correct values of the related quantity for this kind of source. When light sources with spectral power distributions different than the standard lamp are analyzed an error could appear: when wide spectra are considered the mismatch can be partially compensated, high error can appear when a light with narrow spectrum is considered, e.g. LED spectrum. The Laboratory are developing new methods and procedures able to quantify the error and to correct it for a right LED characterization, when common instruments do not grant enough accurate measurements [17, 21]. Examples of application of measurements on LED are the analysis of performance of traffic light carried on in the research contract with ASPE, and the activity of characterization of power LEDs for general lighting application [19] within the athenaeum project in collaboration with the Dipartimento di Ingegneria dell'Informazione of this University. A second study aims at defining the supply condition for the best stability of the light source, in particular for discharge lamps. An increased repeatability of the luminous flux could improve the quality in characterizing luminaires, in fact, they are qualified by the luminous flux emitted from the luminaires normalized by the flux of the nude lamp. When the lamp operates with supply voltage, the flux presents a low repeatability and a high uncertainty on the luminaire efficiency appears, the results could be improved imposing the power supplied to the lamp. During this project an accurate power meter was realized to know the power supplied to a discharge lamp [11, 22]. It will be part of a control system able at stabilizing the power on the lamp and consequently its luminous flux.
4.b	Risorse personale
	[professori ordinari, associati, ricercatori e dottorandi, borsisti post dottorato, assegnasti, personale tecnico-amministrativo] A deficiency on the side of human resources has to be highlighted; presently, they consist of one full professor, in part time, he is devoted to the management of our

	athenaeum mainly, one associated professor and a technician. An irregular student presence, during their thesis period, partially supports the Laboratory activity. The present year one or two persons should work on works of art lighting, supported by a grant.
5.b	Risorse finanziarie [media quinquennale]
	[la somma di finanziamento ordinario d'Ateneo finanziamenti specifici d'ateneo, finanziamenti specifici da enti di ricerca locali, nazionali e internazionali, finanziamenti da contratti con enti privati.] - Athenaeum financing for the inter department project "Sistemi di illuminazione ad elevata efficienza ed affidabilità basati su diodi LED" (3 persons) of 42258 € - the Istituto Veneto di Scienze, Lettere ed Arti, it supports the Laboratory activity with grants up to 36000 €; - the Fondazione Cassa di Risparmio Padova e Rovigo (CARIPARO), it provides a specific funding of 64000 € to buy new scientific instrumentation. ***Research contracts and external activities*** Although the Laboratory starts its activity few time ago, time required for trimming some test equipment, it is at the centre of some signed research contracts: - with ALCOA to improve the lighting system used in locating small defects on light alloy wheels (6000 €); - with Azenda Specale per l'Energia (ASPE) for the characterization of LED traffic light (9000 €); - with ASPE to analyze the efficiency of lighting plants and the light emission toward the sky in an Italian city (Trento) (55000 €); The laboratory performed also a support activity for light designer, constructors and installer of lighting systems..
7	Rapporti con altri istituti di ricerca a livello locale, nazionale e internazionale
7.a	*[specificare concretamente quanto indicato sotto collaborazioni istituzionalizzate indicate al punto 1 della scheda di Dipartimento]*
7.b	*[Indicare collaborazioni personali non istituzionalizzate ma rilevanti per il programma]* ***Collaborations*** The Laboratory has constant contacts and collaborations with - the Istituto Nazionale di Ricerca Metrologica (I.N.RI.M) "G. Ferraris", the Italian Metrological Institute; - the Electrical University of Saint Petersburg; - the Commission Internationale de l'Eclairage through prof. Paolo Soardo, the Italian representative of CIE and Director of "Luce", the official journal of the Italian Association on Light Engineering (AIDI); - the University Iuav of Venezia through prof. Marina Vio; - the Dipartimnto di Ingegneria dell'Informazione of the Padova University; - the Istituto Veneto di Scienze, Lettere ed Arti;
9	Altre attività rilevanti per la ricerca, a livello di Programma
	[organizzazione di seminari e convegni, partecipazione a seminari e convegni, ecc..] It is worthy of note that prof. L. Fellin is vice president of Italian Association on Light Engineering (AIDI), highlighting the engagement in dissemination of the scientific

	knowledge acquired in the research activity. The present program includes also initiatives of scientific and technical dissemination by organized visits to the Laboratory, conferences and public discussions and round tables. Some of these are: year: 2003 duration: 1 day venue: Catania co-authors: L.Fellin title: roun table: “Illuminare la città – Arte, energia, innovazione” year: 2004 duration: 1 day venue: Padova co-authors: L.Fellin title: round table: “I piani regolatori dell’illuminazione pubblica” year: 2004 duration: 1 day venue: Torino co-authors: L.Fellin, P. Fiorentin title: round table: “Iluminazione stradale e di gallerie – Progressi normativi e scientifici” year: 2005 duration: 1 day venue: Torino co-authors: L.Fellin title: workshop: “Impianti in serie e global service nell’illuminazione pubblica” year: 2005 duration: 1 day venue: Padova co-authors: L.Fellin, P. Fiorentin title: round table: “Illuminazione in galleria” year: 2005 duration: 1 day venue: Roma co-authors: L.Fellin title: International workshop on “Indoor environment quality in museum” year: 2005 duration: 1 day venue: Verona co-authors: L.Fellin title: workshop: “Progetto della luce tra naturale e artificiale Illuminare” year: 2005 duration: 2 day venue:Venezia

co-authors: L.Fellin
title: International Conference: “La luce tra natura e artificio. Illuminare Venezia e le città d’arte?”

11 Prodotti della ricerca

11.b

RESEARCH PRODUCTS						
	2001	**2002**	**2003**	**2004**	**2005**	**Total**
Journal papers			2	2	3	7
Chapters in book			1			1
Books/Notes/Reports		1				1
Proceedings of Conferences	2	2	4	5	2	15
Patents						
Other						

11.c

L.Fellin, M. Gubert, P. Iacomussi, G. Rossi, I. Sala, p. Soardo – Characteristics of the system for artificial illumination. Il restauro della Cappella degli Scrovegni (a cura di Giuseppe Basile), pp.501 – 516. Ed. Istituto centrale per il restauro, SKIRA editore, Roma, 2003.

P. Fiorentin, P. Iacomussi, G. Rossi, “A Facility for the Analysis of Reflection Properties of Surfaces”, Proc. of IEEE Instrumentation and Measurement Technology Conference, Como, Italy, May 18-20, 2004, pp. 569-574

P. Fiorentin, P. Iacomussi, G. Rossi, “Characterization and Calibration of a CCD Detector for Light Engineering,”, IEEE Transaction on Instrumentation and Measurement, Vol. 54, No.1, pp.171-177 Feb. 2005

P. Fiorentin, A. Scroccaro, “Accurate Measurement of Active Power of Discharge Lamps”, Proc. of IEEE Instrumentation and Measurement Technology Conference, Ottawa, Canada, May 16-19, 2005, pp. 1937-1941

L. Fellin, P. Fiorentin ,A. Scroccaro, P. Iacomussi, G. Rossi, P. Soardo, “Luminous Emission and Artificial Sky luminance – The Case of the North Italian Cities”, Proc. of European Lighting Conference - LuxEuropa, September 19-21, 2005, p.508

P.S. Nel caso in cui le informazioni disponibili non siano compatibili con il presente modulo è possibile allegare documentazione cartacea indicando negli appositi campi i numeri dei relativi allegati.

Allegato1

Research contracts and external activities

- with ALCOA to improve the lighting system used in locating small defects on light alloy wheels (6000 €);
- with Azenda Specale per l'Energia (ASPE) for the characterization of LED traffic light (9000 €);
- with ASPE to analyze the efficiency of lighting plants and the light emission toward the sky in an Italian city (Trento) (55000 €);

Allegato 2

Elenco dei prodotti e riferimenti bibliografici

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2. P. Iacomussi, G. Rossi, P. Soardo, L.Fellin, "A new method for studing lighting design for works of art", Proc. of European Lighting Conference - LuxEuropa, June 18-20, 2001, p.66-69.
3. M. Bizzaro, L. Fellin, M. Levorato: "Illuminazione di autostrade e superstrade: confronto tra possibili soluzioni tecniche e impiantistiche", Giornata di Studio AIDI – Elettricità Sicura 2002, Padova, 8 Marzo 2002.
4. L. Fellin: "Luce artificiale per gli affreschi di Giotto. La luce dell'arte e l'arte della luce", Ed. Disano illuminazione, Padova, 30 Sett. 2002.
5. C. Falchi, L.Fellin, P. Fiorentin: "Studio colorimetrico degli affreschi di Villa Barbaro e analisi della loro illuminazione artificiale", Convegno Internazionale AIDI, Perugia, 4-5 Dic. 2002.
6. P. Soardo, L.Fellin, P. Iacomussi, G. Rossi: "Risparmio energetico e limitazione del flusso luminoso emesso verso l'alto", Luce, n.1,2003.
7. L. Fellin, P. Iacomussi, G. Rossi, N. Bo, P. Soardo – Lo studio dell'illuminazione della Cappella degli Scrovegni. Luce, n. 4, 2003.
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