



The ICTP Winter College on Optics and Photonics: Gallieno Denardo's legacy

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In memory of Professor Gallieno Denardo, ICTP Italy

This write up presents an overview of the initiatives and activities developed under the long-standing leadership of the late Prof Gallieno Denardo, who directed the optics and photonics programs at the International Centre for Theoretical Physics (ICTP) in Trieste, Italy. His vision and commitment played a pivotal role in advancing research, education, and international collaboration in optics and photonics, particularly in developing countries.

1 Introduction: Denardo and the First Winter College on Optics

(This section was contributed by Chris Dainty)

1. Background

I first met Gallieno Denardo at a meeting that he organised at The International Centre for Theoretical Physics (ICTP) in Trieste in February 1991. Hans Tiziani, Anna Consortini and I were representing The International Commission for Optics (ICO) to explore how we might collaborate with ICTP, given that a core mission for both organisations was, and is, to support scientists working in less-developed countries.

ICTP was founded in 1964 by Nobel Laureate Abdus Salam, and funded initially by the Italian Government, and later also by UNESCO and the International Atomic Energy Agency. Its goal was to foster high level research in the physical and mathematical sciences, keeping in mind the needs of developing countries, and the focus was always aimed at maintaining the very highest standards in all aspects of its operation. It continues its mission to this day. Before travelling to Trieste I met Abdus Salam on one of his rather infrequent visits to Imperial College, where he was Professor of Theoretical Physics, and he spoke warmly of Denardo and encouraged ICO to collaborate with ICTP.

ICTP, or more precisely an offshoot, The International Centre for Science and High Technology (ICS), had already established in 1980, under Denardo's leadership, a series of Training Colleges in the Physics and Technology of Lasers and Optical Fibres, lasting around 3 weeks in January/February. Our visit was timed to coincide with this. Denardo's background was in relativity, so his view of "optics" at the time was very much the same as most mainstream physicists that is focussing on the relatively new discoveries of lasers and optical fibres. In contrast, the remit of ICO covered the whole of optics and indeed emphasised the more traditional aspects of optics (including optical design, imaging and metrology) that underpinned

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many applications of optics. One feature of the Training College was the establishment by Denardo of a practical laboratory, ably and enthusiastically run by Miltcho Danailov who was a young student of Gallieno.

ICTP and ICO differed in many respects of course, but not least was that ICTP was relatively well funded, thanks to the generosity of the Italian Government, whereas ICO was not, in fact it had (and has) no funded staff at all and a tiny budget. But ICO, as the World Body for Optics had the support of many leading optics researchers who were willing to donate their time to supporting the goals of both ICO and ICTP. So the essence of the collaboration was that ICTP had a huge network of potential beneficiaries of a School on Optics, and had all the logistical and financial support to organise Schools (including an on-site residence in Trieste), and ICO could provide the technical experts for the School.

This was the background to our meeting with Gallieno Denardo in February 1991.

2. Planning for the Winter College

The Agenda for the meeting was to explore how ICO and ICTP might work together for the benefit of optics students and researchers in developing countries. As our meeting progressed, it became clear to me that Gallieno Denardo was a remarkable person, someone with impeccable politeness and courtesy and someone who immediately made you feel that he valued your opinion and friendship. At the same time he was passionate about serving scientists from the developing world in a practical way, and worked tirelessly on this endeavour. It was only later, during the School itself that I also saw he worked long days and evenings to attend to the minutest organisational details to ensure actions and events ran smoothly.

At this first meeting, we jointly resolved to work together on the existing 3 week Training College in Lasers and Fibre Optics, organise a new 3 week Winter School in Optics in February 1993 (to immediately follow the Training College) and to exchange information to extend our respective networks. The new School was a bold step at the time for ICTP, requiring a significant financial and logistical investment in a technical area that was not in the mainstream of ICTP activities, and it was only because of Denardo's perseverance and dedication that this happened at all; and 33 years later, the School is still thriving.

The Directors of the School were J C Dainty, A Consortini, P Hariharan and H J Tiziani, with G Denardo as Local Organiser and P Chavel as ICO Liaison. It was to be held from 8-26 February 1993 at the Miramare Campus in Trieste, hosted by ICTP and ICS. In early 1992 the organisation was well under way, as the following extract from the "President's Column" in the ICO Newsletter (Jan 1992) indicates [1]:

"The ICTP and ICS have a tradition of organizing similar Schools since 1973 and these are rather special. Although participation from students of all countries is encouraged, the Schools are specifically aimed at students from developing and non-industrialized countries, for whom financial support is available. These Schools therefore have a unique international flavor. The Schools are also of the very highest quality: the lectures are delivered by internationally acknowledged experts who generally are only too pleased to impart their knowledge to the enthusiastic students from diverse backgrounds and cultures. Indeed, most lecturers regard it as a great privilege to participate in the Schools. For all participants, the Schools are a unique opportunity to understand and appreciate more fully the problems, scientific or social, of others from different backgrounds."

"Our Winter School on Optics will maintain all of the traditions of the ICTP/ICS Schools, extending their coverage to engineering optics and I am sure we shall have no difficulty in attracting outstanding lecturers to participate. We are particularly keen to set up a few laboratory experiments. Thanks to the generosity of Newport Corporation, Spindler & Hoyer and Panasonic, the ICTP already has experimental equipment for basic holography and optical spatial filtering (as well as for a wide variety of experiments on lasers and optical fibres), and we hope that other equipment manufacturers will donate (or, for very expensive or specialized equipment, loan) instruments and devices so that more experiments can be offered."

The support provided by the optics industry for this School was a new activity for both ICTP and ICO and transformed our ability to enhance the Lasers and Fibre Optics Laboratory already established at ICTP under Denardo's leadership. The new experiments were not just "show and tell" demonstrations, but real hands-on activities of the type needed to learn how to build optical systems and instruments, as well as teach fundamental principles. As any experimentalist knows, a huge amount of work goes into designing and documenting lab experiments, and much of the lead up to the School involved preparation of the lab work.

3. Course Outline and Delivery

The School itself consisted of approximately 40 lectures, seminars (by the participating students) and optical design and practical laboratory sessions over a three week period. The final list of courses and lecturers were (see ICO Newsletter, July 2018 http://e-ico.org/sites/default/files/pdfs/ICO_July_2018.pdf, accessed 10/10/2025):

Geometrical Optics (G Molesini, Italy)
Optical Design (M J Kidger, UK)
Diffraction and Imaging (A Consortini, Italy and J C Dainty, UK)
Fabrication and Testing of Optical Components (D Malacara, Mexico)
Interferometry and Metrology (H J Tiziani, Germany)
Visual Optical Instrumentation (W Brouwer, USA)
Thin Film Optics (A Piegari, S Scaglioni and E Masetti, Italy)
Light Detectors (A A D Canas, UK)
Holography (P Hariharan, Australia)
Fourier Optics and Photorefractive Materials (S Mallick, France)
Medical Applications (R Pratesi, Italy)
Modern Microscopy (P A Benedetti, Italy)
Coherence of Light (F Gori, Italy)
Optical Computing (B Wherrett, UK and A W Lohmann, Germany)
Optical Industrial Measurements (F Docchio, Italy)

4. The emphasis of the course was on practical optics. The detailed laboratory list was:

- Fourier Optics and spatial Filtering,
 - Holography,
 - Fabrication and Testing of Thin Films,
 - Interferometric Testing,
 - Photorefractive Effect,
 - Interference and Diffraction Phenomena,
 - Photon Counting Statistics,
 - Berry's Phase.
- A special feature was the optical design exercises, provided by Dr. M J Kidger (UK) on a set of 12 fast PCs, provided free by Kidger Optics. Each student had the opportunity to see how simple lenses, such as doublets and triplets were optimised in their design and how professional designers approached more complex problems.

Approximately 12 research seminars were given by participants during the School on topics ranging from Laser Guide Stars to (Optical) Studies of Beverages available in Zimbabwe.

During the College there was a Reception hosted by ICO. The hosted Reception became a tradition for all subsequent Winter Colleges.

The Winter College was attended by about 85 students. By including Teachers and Directors the total number of participants was 104, a big effort financial even for the ICTP.

At the end of the College Denardo gave a form to each student with a number of questions from which he was able to understand that the College was an interesting and relevant scientific event for the great majority of them.

At a Meeting at the end of the College it was then decided to organize a Second Winter College in 1995, and other colleges in subsequent years.

2 Second and subsequent Colleges, and other Denardo's important initiatives

(This section was contributed by Anna Consortini)

1. First Meeting him

The first time that I heard Prof. Gallieno Denardo's name was at a meeting of the Bureau of the International Commission for Optics, ICO, at the end of the nineteen-eighties. Collaboration programs for teaching Optics with the International Centre for Theoretical Physics, ICTP, Trieste, were discussed, under promotion of Prof Chris Dainty. ICO and ICTP had the same purpose of promoting science.

My direct knowledge of Prof Gallieno Denardo was in February 1991, when I visited the ICTP for establishing the collaboration. As a first step Prof Dainty was invited to be one of the Directors of the Training College on "*Lasers and Optical Fibers*" expected in 1992, with the purpose of maintaining the collaboration in subsequent years. In the collaboration there was distribution of information on the ICO optics activity by sending, free, 400 copies of the ICO Newsletter to the ICTP "*Laser, Atomic and Molecular Physics*" mailing list. As ICTP head of the Office of External Activities Gallieno Denardo was promoting and driving this activity. It was also decided to organize a joint ICO-ICTP school on Optics called "Winter College on Optics", devoted to Doc and Post-Doc participants from developing countries. It is to be noted that applicants to the first Winter College were more than 500 and we meet again for the selection.

Prof Denardo welcomed me in a very kind and friendly way, and soon I realized that this was his usual behavior, be it with important collaborators or with students from any side of the world or with local workers. The common Italian language helped much our interaction, from now on sometimes I will refer to him as Gallieno.

I was strongly impressed when he showed me the well-equipped Laser Laboratory that he had organized in about ten years, during the Schools on lasers, with the supervision of Prof Orazio Svelto and the precious collaboration of Miltcho Danailov a young student. There were many Lasers, donated by different institutions and industries, I still remember a High-power Spectra Physics Laser and an "open" He-Ne Laser donated by the "Istituto Nazionale di Ottica" Florence, where the students could directly see how a laser works.

This laboratory was used for the Winter College by organizing a number of experiments of basic Optics with material carried by the Teachers. In addition, a dark camera to produce holograms was built.

Gallieno was very concerned about the different levels of basic preparation of students coming from different developing countries and suggested starting our lectures at a low level and then increasing while progressing so that some attendees could follow at least up to some point. We were all concerned about the financial effort by the ICTP and, to allow as many attendees as possible, the Directors took care

of choosing self-sustaining teachers or teachers from not too far. At the end of the First College it was decided to organize another College two years later, in 1995. It was also decided that the Directors team should include a woman, a person from a developing country and a person from Italy. Although this was not a written rule, it was almost always taken into account up to now. Denardo also paid much attention to the presence of women, following the policy of the ICTP.

2. Second Winter College and subsequent ones

Unfortunately, no ICTP link is available for early Winter Colleges until 2002. For the period until 2002 there is an ICTP repository from lecture notes from the scanner historical archives <https://indico.ictp.it/event/a02251/overview>. Here one can find lecture notes from some teachers, unfortunately not all. The descriptions of these Colleges are based on my personal paper archive.

The second "Winter College on Optics" lasted 3 weeks from 21 February to 10 March 1995. Directors A. Consortini (Italy), C.Dainty (UK), Kehar Singh (India), Chris Velzel (Netherlands). G. Denardo was the local Director.

- The announcement of the College included a list of 41 suggested readings to the students, either books or papers from Journals.



Photo 1. Participants to the Second Winter College in the front entrance of the Main Building, (now Leonardo Building). Seating in the second row from left the Directors: Gallieno Denardo second with glasses, Kehar Singh with Sunglasses, Chris Dainty, Anna Consortini. Photographer "(Scrobogna L. Ludovico)/ICTP Photo Archives"

- The College Opening and welcome was by Prof L. Bertocchi, ICTP Director. In the afternoon, ICTP officers explained several ICTP facilities: The Library, The Donation Programme, and The Association/Federation Schemes.

- The Topics included both fundamental of Optics and some more modern subjects with respect to the First College: Diffraction and Imaging (A Consortini), Fourier Optics and Information Processing (C Dainty), Medical Imaging (G Zaccanti), Coherence (F Gori), Holography (P Hariharan), Optical Detectors (G Longobardi), Near-Field Optics (A Lewis), Photorefractives (K Singh), Optics for environmental sensing (S Svanberg), Optical storage (T Tatsumo), Super-resolution (CHF Velzel), Diffractive Optics (J Turunen), Adaptive Optics (F Merkle), Laser Molecular Spectroscopy (M Inguscio), Optical Computing (P Chavel).

-Seminars on special or update subjects were also organized: Adaptive Optics (C Dainty), Evanescent Waves (A Consortini), Interference at the Single Photon Level (P Hariharan), Correlation Methods in Optical Information Processing: Theory and Applications (K Chalasinska-Macucokow), Colour Image Recognition (M J Yzuel), Image Correlation Using Photorefractive Materials (S Mallik). - The Laboratory Experiments also took place on subjects analogous to the previous College. After an introductory session, there were 15 Laboratory Sessions.

- Seminars by students of LAMP (Laser, Atomic and Molecular Physics, Association) took place as in the First College.

- Visits to the "Sinchrotrone at Laboratory Elettra", not included in the program, were organized in two different afternoons by M. Danailov. In all subsequent Winter Colleges these visits became a classic inclusion in the program.

Students were 86, teachers 13, directors who also were teaching 5, Total 104 Participants.

The "Third Winter College on Optics" was 9-27 February 1998. Directors: T. Asakura, P. Chavel, G. Denardo, A. Sona and A. Friberg.

Description of this College can be found on "Towards ICO-18, June 1999 "pp. 74-75, the so-called ICO Green Book available on request. Unlike the previous two Colleges the Third one was devoted to more specialized and updated subjects, in large variety, as described by the list of Topics and Teachers.

Here, I summarize: Fundamental of Solitons (L Mollenauer), Non-linear Optics (M Kauranen), Near-field Optical Microscopy (D van Labeke), Diffractive Optics (P Chavel), Guided-wave Technology (B P Pal), Photorefractive Materials (Y Tomita), Near-field Interactions (V Sandoghdar), Atomic Force Microscope (B Cappella), Laser Speckles (T Asakura), Optical shop testing (D Malacara), Ultrafast Pulse Technology (P Saari), Integrated Optics (G C Righini), Confocal Scanning Microscopy (T Wilson), Current Problems in Optical Scattering (M Nieto-Vesperinas), Pattern Recognition Filters (P Réfrégier), Modern Optical Coherence Theory (A T Friberg), Holographic Memories (D Psaltis), Artificial Retina Chips (E Lange), Characterization of Laser Beams (A Sona),



Photo 2. Gallieno Denardo discussing with P K Datta of IIT Kharagpur, India, one of the lecturer of the 2002 Winter College.

As in the previous Winter Colleges, Experiments in the Lab were made. This was the last time in this Laboratory.

- From the year 2000 on, each Winter College was on a precise specialized topic, for instance:

- 2000 ICTP/ICO/OSA Winter College on "Optics and Photonics" 7-24 February. Directors: A Friberg, A Gatak, F Gori, G T Sincerbox, G Denardo. (Here, some texts from the repository <https://indico.ictp.it/event/a02076/overview>)

-2002 ICTP/ICO/OSA Winter College on "*Ultrafast Non-Linear Optics*" 18-February-1 March. Directors: S De Silvestri, G Korn, O E Martinez, G Denardo. <https://indico.ictp.it/event/a01129/>

In 2000 OSA (now OPTICA), gave a contribution to the College of \$5,000, and the OSA name was included in the announcement. (See Towards ICO-19, edited by ICO Secretary Pierre Chavel, June 2002, p 84). I still remember a happy Gallieno telling me "*Anna, there is very good news, OSA has given a large contribution to the College*". This was the first one by a professional Optics Society. It continued up to now and subsequently many other Optics Societies followed as described in [Sect 4](#). In the same year the ICO contribution for the Reception was raised from \$1,000 to \$1,500.

3. The Laboratory Problem

In 1995 a new ICTP director, Prof M A Virasoro, was appointed for 7 years. He was a famous theoretical Physics Professor, and thought that theory was the way for the development of underdeveloped countries. Therefore, in 1998 he dismissed the Laboratory and all instruments were transferred to Elettra. This was commented negatively by many scientists, in particular from those institutions who had donated the instruments helping to setup the Laboratory. Prof Tito Arecchi, the Director of the "Istituto Nazionale di Ottica", Florence, showed me a strong letter where he asked "*how you took the liberty on throwing out donated things?*". I discussed this problem with Gallieno and he told me that sending all material to the Elettra was the "only way to save it".

Gallieno, unlike Virasoro, was thinking that Optics is the way that allows development because optics instruments are not too expensive to buy while those countries "will never be able to build large facilities such as the accelerator in Genève". Giving the instruments to the Elettra was later confirmed a way to preserve a Laboratory. There was a good relationship, still going on, between ICTP and Elettra. ICTP also lost Dr Miltcho Danailov who moved to Elettra and is now a very famous scientist of Fermi Lab.

In the subsequent Colleges some experiments were again made in the classrooms, by using material carried by the Teachers. But I always felt the need for an Optics Laboratory. Maybe someone remembers how many times, in Meetings after 2002, I insisted on the need of rebuilding an Optical Laboratory in the ICTP. This was in the end promoted by Prof Joe Niemela, who took care of the College from 2008, after the death of Denardo. The solution was found also thanks to the arrival of Dr Humberto Cabrera in the ICTP in 2014 and to his availability to set up a small Laboratory. Now there is a well-equipped Laboratory in the Multidisciplinary building (Multidisciplinary Laboratory) where Dr Cabrera and his collaborators do important research, with corresponding publications, collaborate with the preparatory School (see also below) and play an important role in Winter Colleges.

4. The Preparatory School

As already mentioned, Denardo paid always much attention to the preparation of the attendees and to the course returns. Initially, with the ICS, he devoted a week after a School to a workshop on more applied subjects, with a low number of students, typically 15. For instance, in 2000, the week after the Winter College there was a Training Course on the use of software for optical design and optimization, organized by the ICS who also was a partner in the Colleges.

- In 2006 Denardo started a Preparatory School on "*Mathematical Methods for Optics*" of the "Winter College on: Quantum and Classical Aspects of Information Optics", by utilizing the first week of the College. Consequently, the College lasted two weeks. The School was theoretical and devoted to the College attendees. Directors: V Lakshminarayanan (Venguru), M Alonso and T D Visser (Netherlands).

- Again in 2007 a "Preparatory School to the Winter College on Fibre Optics, Fibre Lasers and Sensors", was Organized and directed by G Denardo himself the week before the College. It was devoted to selected applicants to the College who needed refreshment or basic fundamentals.

- The 2008 "Winter College on Micro and Nano Photonics for life Sciences", from 11 to 22 February that Gallieno was organizing at the time of his death in the summer of 2007, also included the Preparatory School from 4 to 8 February.

- From 2008 on, the Preparatory School took always place the week before the College, under the direction of Prof Joe Niemela, who nicely replaced Denardo. The School included both theoretical and experimental activity, each year on subjects related to the Winter College. The experimental activity was made in a class room with some instruments carried by the teachers and some others borrowed from the Elettra, thanks to Dr M Danailov. For many years, until 2020 M Alonso (computer simulations. His Mathematica Programs are recorded in the corresponding links) and A. Consortini (experiments), with help of I Ashraf (theory and experiments), took care of the Preparatory School. From 2014, Dr Humberto Cabrera joined the Preparatory School with new experiments in the Multidisciplinary Laboratory.

5. ICO/ICTP Award now ICO/ICTP Gallieno Denardo Award (https://e-ico.org/blog/wp-content/uploads/2022/02/ICO_news_jul_18.pdf)

The idea of having a "Joint" ICO/ICTP award in Optics started from a conversation between Gallieno Denardo and me in the beginning of 1999. Gallieno was much concerned, doubting that he would be able to continue supporting an award for Pakistan students, he had established and personally funded, in honor of his late friend Mohammad Sarwar Khalid Razmi, professor of nuclear physics. An award for young scientists from developing countries, the ICTP Prize, was already active but it included several different disciplines such as physics, mathematics and medicine.

On my side, I was the chair of the ICO Galileo Galilei Medal and many times, in meetings of the ICO Bureau, I pointed out the lack of awardee young scientists from developing countries, in both ICO Prize and Galileo Galilei Medal. During an ICO Bureau Meeting in Tianjin, China, August 1998, the point was discussed and the Bureau agreed that "it may be appropriate to think about a new award" (see Towards ICO-18 June 1999, p 40).

Considering these premises, we (Gallieno and I) agreed that we could ask ICTP and ICO, respectively, about the possibility of establishing a joint award in optics devoted to young researchers from developing countries.

In the case of ICO, the next opportunity to present and discuss the idea to the ICO Bureau was at the two Meetings, scheduled during the General ICO Assembly, ICO-18 in San Francisco, USA, few months later, August 1999. The first Bureau Meeting was before the General Assembly and the other after it. Year 1999 was my last term, as Past President, in the Bureau. During the first meeting, the Bureau approved unanimously the proposal to establish a "joint" award and asked me to contact Denardo (who was at the ICTP in Trieste) and do as much as possible to have the proposal ready, in agreement with ICTP, for the General Assembly. In a couple of days, by long telephone calls and strong activity, it was possible to prepare the proposal and, importantly, Denardo obtained the agreement of the ICTP. The ICO-18 General Assembly approved the proposal, leaving some details to the Bureau.

Gallieno and I drafted the complete rules for the ICO/ICTP award, at its second Meeting the Bureau approved the rules and decided that the first call for nominations "will be issued almost immediately", so that the award winner could be decided before the Winter College on Optics, February 2000.

A four members Award Committee was formed, in which two members, A. A. Friesem (chair) and A. Consortini were from ICO and G. Denardo and M. Danailov from ICTP. We succeeded in delivering the first ICO/ICTP Award in February 2000.

After the death of Denardo, in 2007, I proposed to introduce the name of Gallieno Denardo for the award name, and this was unanimously accepted by ICO and ICTP.

List of winners: 2000 Arbab Ali Khan, Pakistan, 2001 Arashmid Nahal, Iran (ex aequo), 2001 Fernando Pérez Quintian Argentina (ex aequo), 2002 Alphan Sennaroglu, Turkey, 2003 Robert Szpocs Hungary, 2004 Imrana Ashraf Zahid, Pakistan (ex aequo), 2004 Revati Nitin Kulcarni, India (ex aequo), 2005 Sarun Sumriddetchkajorn, Thailand, 2006 Héctor Manuel Moya-Cessa, Mexico, 2007 Svetlana Boriskina Ukraine, 2008 Mourad Zhagal, Tunisia, 2009 Saifollah Rasouli, Iran, 2010 Cleber Mendonca, Brasil, 2011 Iván Moreno, Mexico, 2011 Ryan Balili, Philippines, 2012 Selcuk Akturk, Turkey, 2013 Mohammad D Al-Amri, Saudi Arabia, 2014 M. Florencia Pascual-Winter, Argentina (ex aequo), 2014 John Fredy Barrera Ramirez, Colombia (ex aequo), 2015 Rim Cherif, Tunisia (ex aequo), 2015 Rajan Jha, India (ex aequo), 2016 Mati Horprathum, Thailand, 2017 Goutam K Samanta, India, 2018 Urbasi Sinha, India, 2019 Christian T. Schniegelow, Argentina, 2019 Muhammad Faryad, Pakistan, 2020 Kok Sing Lim, Malaysia, 2021 David Hayrapetyan, Armenia, 2022 Venkata R Supradeepa, India, 2023 Muhammad Q Mehmood, Pakistan, 2025 Gustavo Grinblat, Argentina, 2025 Omnia H A Nematalla, Egypt.

6. A special recognition to Prof Denardo by the General Assembly of the 2004 RIAO/OPTILAS Conference in Isla Margarita, Venezuela.

At the beginning of the nineteen-nineties there were two competing Conferences: RIAO, "Reunión Iberoamericana de Óptica", and OPTILAS "Latin American Meeting on Laser Optics and their Applications", that were attended by Spanish and Portuguese speaking scientists. Spanish and Portuguese languages were also allowed. Thanks to the ICO Bureau advice, and mostly to the efforts of Prof Maria J Yzuel, the organizers of the two conferences agreed to join into one event RIAO/OPTILAS, in 1998.

Almost all scientists were had a connection with the ICTP, mostly with Prof. Denardo. In 2004 they decided to deliver a Recognition Plate "to Dr G Denardo from ICTP for his continuing support of scientific activities in developing countries". The delivery was planned during the Assembly of Conference RIAO/OPTILAS in, Isla Margarita, Venezuela, in 2004. Although invited, Prof Denardo was unable to go and the plate was given to Prof Consortini to present it to Prof Denardo at the next event at the ICTP.

The next event was the Winter College on Optics and Photonics, February 2005. In **Photo 3** Prof Consortini is shown presenting **Recognition Plate** to Gallieno Denardo.



Photo 3. Anna Consortini presenting a Plate to Prof Gallieno Denardo during the Award Ceremony of the Winter College on Optics and Photonics, February 2005. Photographer (Silvano M Massimo)/ICTP Photo Archives.

My last contact with Gallieno was, by telephone, a few days before his sudden death. He told me that he broke something in a home accident. He was recovering, was going to the ICTP and in few days the plaster "*will be removed*".

After his death the ICTP decided to print a volume "*Remembering Gallieno Denardo 1935-2007*" [2], and to devote him a classroom: Denardo Room in the Adriatico building. It was near other rooms devoted to important scientists. The photo was hanging there for many years. When the room was equipped with computers, and was renamed Denardo Computer Room, the photo disappeared.

When the first winner of the "ICO/ICTP Gallieno Denardo Award" received it, Denardo's wife was invited and we had the opportunity of remembering a dear colleague and friend with her.

3 TSOSA, an offshoot of the Winter College on Optics

(This section was contributed by Pierre Chavel)

I first met Gallieno Denardo when I lectured on optical interconnects in March 1990 at ICTP during the "UNESCO Spring School on Fourier Optics and Holography", one of the events among his preliminary contacts to link ICTP and the field of Optics. Shortly thereafter, I was involved in the early ICTP/ICO Winter Colleges on Optics as one of relatively many scientists active within ICO. I participated as a lecturer in 1995 and as one director in 1998. Later on, I also served as a laboratory class instructor. After the first Optics laboratory closed, together with my colleague Nicolas Dubreuil of Institut d'Optique, we brought a ready-to use hands-on practical experiment on photorefractive effects to Trieste during the Winter College. All this created many opportunities to discover the outstanding facilities available at ICTP for the interaction between visitors and fellows from all over the world, and to appreciate the inspiring atmosphere that benefited from Gallieno's exceptional personality.

In these lines, I wish to report as one first-hand witness about the introduction of one more of Gallieno Denardo's initiatives, namely TSOSA, the "*Trieste System Optical Sciences and Applications*" advisory group, which has obviously found its place as it is currently in its 23rd year of existence. The concept of the "Trieste system" had been introduced around ICTP by one of its founders, Italian theoretical physicist Paolo Budinich, and TSOSA is its extension to Optics. Around 2002, Gallieno was seeking opportunities to associate the Optics community worldwide with the new ICTP activities in Optics research, not only through the then already established Winter College: he was taking initiatives to raise not only support, but also and mostly awareness of the opportunities that could be offered by a tight connection between Optics research institutions in the "West" and the laboratory of excellence that he wanted to promote at ICTP.

Gallieno Denardo invited two of the most prominent Optics related international learned societies, OSA and then SPIE, to co-sponsor the Winter College. Taking that opportunity, he established an annual meeting to promote further interactions. As one significant example, he strongly encouraged the concept: doctoral thesis preparation in Optics at ICTP with two co-advisors, one from ICTP and one from an Italian University (or possibly some other place), much in the spirit of the long-standing ICTP STEP program existing in the historical ICTP disciplines. As reported by Maria Calvo, then the ICO Secretary, in the July 2003 ICO Newsletter (https://www.e-ico.org/blog/wp-content/uploads/2022/06/ICO_news_jul_03.pdf), the inaugural meeting was organized at Trieste on the 20th February 2003. I had just left the ICO Bureau and participated as a personal guest of Gallieno Denardo. A significant part of the time was spent drafting "terms of reference" seeking a name for the group. "TSOSA" came up as the working name, but everyone seems to have been happy with it since then. The core part of those terms of reference speaks for itself:

"The TSOSA Advisory Group is established with the purpose to offer advice on the development and coordination of activities on Optics and Photonics carried out or planned by the Trieste System".

It is initially established by the following Organizations:

ICO, OSA, SPIE, OWLS, IAEA, UNESCO and Institutions of the Trieste System i.e. ICTP, ICS, TWAS, ICGEB, Elettra Synchrotron Light Facility and the Laser laboratory at Elettra.

Participation of other Organizations and Institutions is open and welcome.

The TSOSA Advisory group is assumed to be aware of the activities and programs of its members that promote the advancement of Optics and Photonics for the benefit of Developing Countries and that are related to the Trieste System programs. Developing Countries are defined as per the U.N. rules.

The mandate of the TSOSA Advisory Group is as follows.

- i. To stimulate the consistency of the activities of the member Organizations so as to maximize the outcome.
- ii. Suggest new activities and topics for the Workshops, Courses, Conferences held by the Trieste System.
- iii. Make sure that Optics and Photonics activities of the Trieste System are adequately publicized by the organizing bodies of the TSOSA Advisory Group including the activities held at ICTP and at the ICTP Affiliated Centres.
- iv. To propose new schemes that can improve the activities on Optics and Photonics of the Trieste System.
- v. To stimulate nominations from Developing Countries for fellowships, grants and awards of the respective Societies and Organizations keeping their full autonomy of the final decisions or selections.
- vi. Issue an annual progress report to its member organization governing bodies.

The two parts of **Photo 4** together show the full attendance.



Photo 4. Attendees at the TSOSA inaugural meeting at ICTP, 20th February 2003, from left to right around the table: B K Kim (IAEA), E Arthurs (SPIE), M Altarelli (Elettra Sincrotrone Trieste), G Denardo (ICTP), E Tosatti (ICTP acting Director), M Alarcon (UNESCO), M Danailov (then Elettra Sincrotrone Trieste), G von Bally (OWLS), A Wagué (LAM network), M L Calvo (ICO), V Lakshminarayanan (OSA), A M Johnson (OSA). **Free of rights.**

I attended the first annual meetings until 2006. My records show that my participation was mainly on the definition of topics and directors for the then annual forthcoming Winter Colleges through discussions and e-mail exchanges with Gallieno Denardo. In fact, he knew everything about ICTP, everything about the organization of the Optics community, everything about Optics research in Italy, discussed every topic at length with all those involved, carefully listening to their advices. In my memory, the TSOSA meetings served as a place for Gallieno to share information and give it more resonance, further fertilizing ideas.

4 The Winter College in Optics (2003–2017): Selected Highlights

(This section was contributed by Maria L Calvo)

The first Winter College in Optics was held in 1993 through an agreement between the Abdus Salam International Centre for Theoretical Physics (ICTP) and the International Commission for Optics (ICO). As discussed in Section 1, this inaugural event was co-directed by Anna Consortini, Chris Dainty, Parameswaran Hariharan and Hans J. Tiziani with Gallieno Denardo serving as the local organizer. Focused on optical systems, the College combined lectures with practical laboratory sessions in optical information processing, Fourier optics, and related areas. Since its inception, every Winter College has blended theoretical lectures with hands-on training (see Sections 1 and 2).

Between 2003 and 2017, the College continued to expand both in scope and in international participation. A defining feature of this period was the remarkable contribution of Gallieno Denardo, who coordinated all local activities until his passing in 2007. Denardo played a pivotal role in ensuring that the chosen topics were scientifically relevant, pedagogically engaging, and globally inclusive. Participants and lecturers came from nearly every continent, with no single nationality dominating—creating a uniquely diverse and collaborative atmosphere (Photo 5).



Photo 5. The 2007 Winter College on Optics and Photonics. Left to right: M J Yzuel, G Denardo, S V Boriskina (ICO/ICTP Award 2007), A Consortini, I Ashraf Zahid, M L Calvo, and A Wagué (after Ref. [4]).

A particularly valuable aspect of the Winter Colleges has been the poster sessions, during which participants discuss how universal scientific training can be applied to address local challenges. These exchanges have often inspired innovative, context-specific applications of optical science.

The Winter College program was coordinated annually by the Trieste System Optical Science and Applications (TSOSA) Advisory Group, established in 2003 under Denardo's guidance and supported by the ICTP Directorate. TSOSA ensured continuity, promoted quality improvement, and encouraged the creation of new initiatives (See section 3). A significant milestone came in 2017, when the experimental component was fully integrated as a central part of the College's curriculum—marking an evolution in its pedagogical model [3].

Hands-on laboratory sessions have always been central to the Winter College experience. Designed to be educational, replicable, and resource-efficient, these experiments enable participants to reproduce similar setups at their home institutions, ensuring low-cost infrastructure and thereby extending the College's impact far beyond Trieste (Photo 6).

Table 1 summarizes the Winter Colleges in Optics and Photonics held at ICTP between 2003 and 2017, illustrating the breadth of topics covered—from fundamental optics and quantum physics to technological, biomedical, and industrial applications. The co-directors, drawn from leading institutions worldwide, underscore the College's truly international character. Internet links are included for reference (verified 1/30/2026).



Fig 6. Visit to the Photothermic Spectroscopy Experimental Laboratory during the 2014 Winter College, led by Dr Humberto Cabrera. From left to right: Prof Angela M Guzmán, Prof Mario Bertolotti, Prof Anna Consortini, Prof Maria J Yzuel, Prof Vasudevan Lakshminarayanan, Prof Maria L Calvo, and Prof Natalia Munera (Photo by Prof Joseph Niemela).

Table 1. The ICTP Winter College on Optics and Photonics: Data for the period 2003-2017

Year	Winter College topic	Co-directors	Internet link
2003	Biophotonics: Optical Imaging and Manipulation of Molecules and Cells	G von Bally, W French, F S Pavone	chrome-extension://efaidnbmnnnibpcajpglclefindmkaj/ https://www.e-ico.org/blog/wp-content/uploads/2022/06/ICO_news_jul_03.pdf
2004	Interferometry and Applications in Modern Optics	E Arimondo, R Dändliker, R S Sirohi	https://indico.ictp.it/event/a0333/overview
2005	Optics and Photonics in Nanoscience and Nanotechnology	V Degiorgio	https://indico.ictp.it/event/a04179/overview
2006	Quantum and Classical Aspects of Information Optics	M L Calvo, P Knight, P Tombesi	https://indico.ictp.it/event/a05190/
2007	Fibre Optics, Fibre Lasers and Sensors	H Fragnito, A Clarkson, A Mignani	https://indico.ictp.it/event/a06183
2008	Micro- and Nano-Photonics for Life Sciences	M Bertolotti, M Havenith, O E Martinez	https://indico.ictp.it/event/a07141/overview
2009	Optics for Environmental Science	A Consortini, R P Singh, S Svanberg	https://indico.ictp.it/event/a08142/
2010	Optics and Energy	V Lakshminarayanan and G Lanzani	https://indico.ictp.it/event/a09136
2011	Optics in Imaging Science	W T Rhodes, J Ojeda-Castañeda, G Valentini	https://indico.ictp.it/event/a10126/overview

2012	Advances in Nano-Optics and Plasmonics	M Bertolotti, N Zheludev, Z Ben Lakhdar	https://indico.ictp.it/event/a11152
2013	Trends in Laser Development Multidisciplinary Applications to Science and Industry	R Ramponi, F. Mendoza, F Laurell	https://indico.ictp.it/event/a12164
2014	Fundamentals of Photonics — Theory, Devices and Applications	P Cheben, L Ponce, J Niemela, L Pavesi, M L Calvo, M Danailov	https://indico.ictp.it/event/a13188
2015	Light: a Bridge between Earth and Space	A Piegari, E Armandillo, W Chen	https://indico.ictp.it/event/a14287
2016	Optical Frequency Combs	K Corwin, M Marangoni, P Maslowski	https://indico.ictp.it/event/7593/
2017	Advanced Optical Techniques for Bio-imaging	H Cabrera, M L Calvo, A Diaspro, V Lysiuk, N Tosa,	https://indico.ictp.it/event/7920/

Throughout these years, the Winter College received consistent support from the ICO and major scientific societies, including the European Optical Society (EOS), IEEE, OPTICA (former OSA), OWLS, SPIE, and the Italian Society for Optics and Photonics (SIOF).

Denardo's contributions extended far beyond academic coordination; he also oversaw significant improvements to infrastructure for participants. In recognition of his legacy, the Denardo Informatics Laboratory at the ICTP Miramare Building is dedicated to his memory and can accommodate approximately 24 students for informatics work (Photo 7).



Fig 7. Entrance to the Denardo Informatics Laboratory, ICTP Miramare Building (photo courtesy of Dr. Humberto Cabrera).

Colleagues remember Gallieno Denardo for his tenacity, generosity, and vision—qualities that profoundly shaped ICTP's optics programs, including its laboratories, workshops, and the ICO/ICTP Award.

Established in 1999 to honor outstanding researchers under the age of 40 from developing countries, the award was renamed in 2008 as the Gallieno Denardo ICO/ICTP Award in his memory.

Beyond his professional achievements, Denardo's warmth and enthusiasm enriched the ICTP community—whether in scientific meetings, informal discussions, or cultural and musical gatherings [2]. His legacy continues to inspire all who took part in the Winter Colleges.

5 Winter Colleges and events after 2017

(This section was contributed by Anna Consortini)

- In 2018 there was the "Winter College on Extreme Non-linear Optics, Attosecond Science and High-field Physics" from 5 to 16 February. Directors were D Blaschke, F Calegari, M Danailov, Z Wei, J Niemela

<http://indico.ictp.it/event/8295/>.

As described in the poster, the subject was very specialized and up to date, to the purpose of offering the students a broad training on "extreme light science: from ultrashort and ultra-intense laser pulse generation, to Attosecond and Free Electron Laser, FEL Technology, focusing on applications of attosecond pulse generation in atomic and molecular Physics" During the College two simulation sessions were organized in the Computer Lab of the Leonardo Building, and two hands-on sessions in the Multidisciplinary Laboratory. A visit to the FERMI FEL and Elettra Synchrotron Facility was organized as tradition.

The College was attended by 64 students, Males 55%, Females 45%. Faculty 28 Males 75% Females 25% (data from Prof Niemela, TSOSA Meeting of 19 February 2019)

The week before the College the corresponding Preparatory School took place in the Adriatico facility. It was devoted to a restrict numbers of selected students, 27, needing refreshment of fundamental principles. Teachers were: M Alonso Gonzales, I Ashraf, H Cabrera, A Consortini, M Danailov. I still have a copy of the Program that includes: Fourier Theory, Electrodynamics, Wave propagation in optical dispersive media, Nonlinear optics, Optical pulse shaping and short pulse generation, Nonlinear fiber optics and Some other subjects describing the Laboratory experiments.

Three Laboratories took part in the afternoons: Mathematical Workshop (M. Alonso), Multidisciplinary Laboratory (H Cabrera), Optics Laboratory (A Consortini, I Ashraf, M Danailov). To give an idea, here is the list of the experiments in the Optics Laboratory dark room, where three setups of instruments were located for three different experiments: 1) "diffraction as Fourier transform" Demonstration and hands-on. Diffraction of laser light by holes and slits, near and far field; far field as Fourier transform of the field on the aperture. 2) "Diffraction of multicolor light by low frequency gratings", bases for spectroscopy, to show the separation of different frequencies, colors. 3) "Surface waves" (also denoted evanescent waves), by using prisms and laser light to produce them and fibers to reveal them, the bases of coupling between different optics elements.

- In 2019 the "Winter College on Applications of Optics and Photonics in Food Science" took place from 11 to 22 February. Directors were Sarun Sumriddetchkajorn (Thailand), A. G. Mignani (Italy), G. Simpson (New Zealand), J. Niemela (ICTP). <https://indico.ictp.it/event/8643/overview/> As stated in the announcement "the aim of the Winter College is to offer Ph D students and other emerging researchers broad training in the innovative applications of Optics and Photonics in Food and Agriculture". The program is found in the link with copies of talks. An important Optional Section was the experimental HPLC (High-Performance Liquid Chromatography) with thermal lens detection of Carotenoids in food samples & Raman Spectrometer, taking place in the Galileo building, by H Cabrera and collaborators.

The week before the College, from 4 to 8 February, the ICTP Preparatory School was organized, as usual, for a limited number of selected participants. See <http://indico.ictp.it/event/8642/> where the program

is found. There are also details of the experiments of the Mathematica Workshop, of the Spectroscopy and of the Diffraction. Main teachers were Miguel Alonso, Imrana Ashraf, Humberto Cabrera, Anna Consortini, Miltcho Danailov. We organized a Diffraction Laboratory in a room, where the following experiments were made: 1) Michelson Interferometer, 2) Basic of Spectroscopy, 3) Diffraction and Fourier Transforms.

- In 2020 The "Winter College on Optics: Quantum Photonics and Information" was organised from 10 to 21 February. <https://indico.ictp.it/event/9021/> Directors: V Ahufinger, A Bassi, M Paternostro, J Niemela local organizer. The College purpose was "to offer Ph D students and early career researchers training in Quantum Optics and Quantum Information. The College will also offer insight in the new quantum technologies involving the generation and manipulation of photonics and matter-like states"

The Preparatory School was from 3 to 7 February, the week before the College. <http://indico.ictp.it/event/9020/> where one can find the program. The experiments were in the classrooms by M Alonso (computer simulations); by A Consortini and Miltcho Danailov (Diffraction Lab) with the help of I Ashraf (theory and experiments) "on diffraction and Fourier Transform, on Evanescent Waves, on Polarization tests. A special experiment of Michelson Interferometer and Coherence was by M Danailov. In the Multidisciplinary Laboratory by H Cabrera with the help of Nicoleta Tosa an experiment was made on "Optical polarization based logical gate system of ON-OFF type using SPR (Surface Plasmon Resonance) periodic arrays".

The year 2020 was a special one because the Pandemic (COVID) started and our Winter College was the last activity in 2020. At the end of it the ICTP was looked due to the Pandemic.

- In 2021 the Winter College did not take place due to the Pandemic.

- In 2022, due to the Pandemic, the Winter College on Optics: "Theory and applications of LIDAR" (Lidar=Light Detection and Ranging) was a virtual Meeting, on line from 12 to 16 May. <https://indico.ictp.it/event/10058/> Directors: Joe Schaw and J Niemela. "LIDAR is a remote sensing method that allows many applications" some of which were presented, such as in health, archeology, climate science, autonomous vehicles, fisheries, studies of the atmosphere. Due to the situation the College was in reduced shape. There were 118 Participants. There was no Preparatory School.

-In 2023 the "Winter College on: Terahertz Optics and Photonics" was in the form of Hybrid Meeting from 6 to 17 February. <https://indico.ictp.it/event/10058/> Directors: M Jarrahi, C Saraceno and J Niemela. The purpose was to introduce students to the "radiation that belongs to the spectral range between the millimeter wave and the far-infrared parts of the electromagnetic spectrum". Terahertz radiation allows investigation of many materials because given the wavelength can penetrate deeply than optics or infrared radiation.

The attendance was very high. There were 59 participants in presence and 98 participants online. The Faculty were 20. The Preparatory School was canceled due to financial ICTP problems.

-Due to Financial problems, the ICTP Directorate decided to skip the 2024 Winter College on Optics and to postpone it to 2025.

- In 2024 however, the College was replaced by the ICTP Hybrid "East African Summer School on Optics and Lasers". It took place at the National Institute on Optics and Lasers (NIOL) of Multimedia University of Kenya (MMU), Nairobi, Kenya, from 6 to 17 May. Directors H Cabrera Morales (ICTP), J O Gwaro (Masai Mara Univ, Kenya), G K Rumo (MMU) and J Niemela ICTP scientific contact. An exceptional program of Topics and a Set of seven Hands on Experiments took place. The School was possible due to a grant by the ICTP and sponsors as the MMU, NIOL, Masai Mara Univ., ICO, SIOF, SEACOM, OPTICA, Max Planck Institute for the Science of light, just to mention some. More: <https://indico.ictp.it/event/10472/>

- In 2025, in spite of a tremendous reduction of the budget by the ICTP, the "Winter College on Optics: Theoretical and Applied Aspects of Metamaterials and Metasurfaces" took place from 24 February to

7 March. <https://indico.ictp.it/event/10823/> It was the first College completely in person after the Pandemic. Directors: H Cabrera Morales (ICTP), M Q Mehemood Muhammad (Pakistan), J Niemela Local Organizer (ICTP) for the lack of finance there was no Preparatory School.

In spite of all problems due to the Pandemics, the Winter Colleges "survived" and we hope that the initiative will continue for many more years to come.

6 Legacy

We are, and will always remain, profoundly grateful to the memory and legacy of Prof Gallieno Denardo for his tireless efforts to expand optics and photonics training at the ICTP. His work was devoted to young researchers, Ph D students, and teaching colleagues from all over the world. His imprint will endure as ICTP continues its unique programs, grounded in the conviction that education and training in physics—and in science more broadly—are essential to ensuring that new generations will take up the torch and carry forward this vast and demanding endeavor.

Those of us who had the great privilege of knowing and collaborating with Gallieno Denardo will forever carry with us the memory of his brilliant mind and remarkable personality. The ICTP Winter College in Optics continues to be offered, now alternating with a Winter College co-organized by ICTP at other locations around the world. Gallieno's initiative in the early 1990s has had a profound and lasting impact on the development of optics in many countries.

Beyond the Winter College, one may recall the African Laser, Atomic, and Molecular Physics (LAM) network—initiated and supported by ICTP and distributed across several African countries—as well as ICTP's support for the first major ICO event in Africa, held in Dakar in 1998.

With this, the authors seek to convey his work, his initiatives, and his deep dedication, so that new generations may come to know, appreciate, and recognize the unique legacy he has left behind.

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