

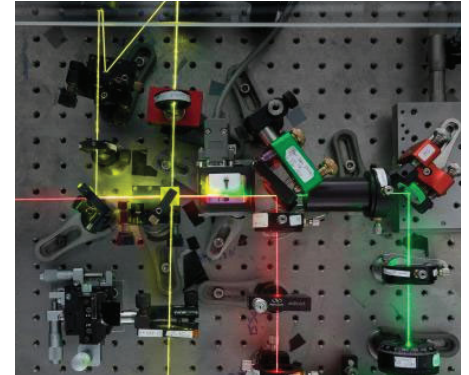


**Area of Impact: Materials for New Technologies**  
**Specialty: Materials for New Technologies**

Light plays a central role in our civilization: from its use in art, like painting and photography, to the knowledge of the universe that we have achieved thanks to it. Light has, however, manifestations and properties that are less obvious, but of great impact on our daily lives. Our Nucleus Center studies precisely these characteristics of light. In particular, we are interested in the quantum properties of light, those made noticeable when we have small amounts of light, for example, a single photon, and its interaction with matter, or when light travels within photonic chips. We design methods to store, process and transmit a large amount of information in a single photon.

The applications of our studies, that integrate quantum properties and systems of nonlinear optics, are varied. Since we have learned to control key properties of light, including its degree of entanglement, we perform experimental demonstrations of the most fundamental predictions of quantum mechanics. We demonstrate experimentally quantum cryptographic protocols, a technique that allows the codification of information in light and transmission thereof so that it is impossible for unauthorized users to access it. We also use systems of non-linear optics to generate light switches and propagate light without loss or distortion. We refer to these applications as quantum technologies.

The scientific results of our investigations are published in Nature Communications, Scientific Reports and Physical Review Letters.



- First experimental realization of a quantum cryptography protocol in dimension 16: SCIENTIFIC REPORTS 3, 2316. DOI: 10.1038/srep02316 (2013).
- Distribution at a distance (3.6 km) of quantum entanglement of the energy/time type of two photons in an installed fiber-optic network: NATURE COMMUNICATIONS 4: 2871. DOI: 10.1038 (2014).
- Application of a Kochen-Specker test of quantum information processing in a single photon: PHYSICAL REVIEW LETTERS 113, 090404 (2014).
- Implementation of a Bell inequality on a fiber-optic network to prove fundamental properties of Quantum Mechanics that do not suffer the problem of post-selection: PHYSICAL REVIEW LETTERS 115, 030503 (2015).
- Discovery of a new form of light localization, this is absolutely scatter-free propagation in waveguides, and their experimental demonstration: PHYSICAL REVIEW LETTERS 114, 245503 (2015).

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## RESEARCHERS

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## RESEARCH TOPICS

- Quantum systems of higher dimensions.
- Nonlinear optics.
- Waveguides and quantum light.

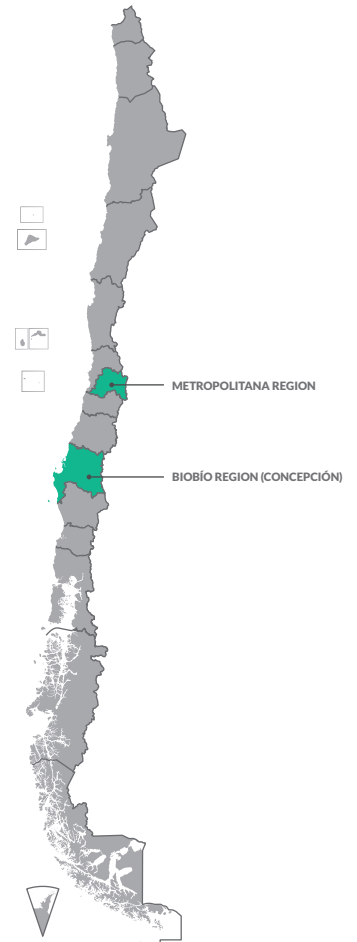
## NOTED OUTREACH ACTIVITIES

- **Summer School of Optics and Photonics:** undergraduate and graduate students attended lectures and mini courses taught by researchers who are developing their work at national and international laboratories. The backbone is quantum physics.
- **Play “W = S” exposing aspects of the life of physicist William Shockley,** Nobel Prize winner for the invention of the transistor. The play was written by Chilean physicist Iván Schueller and Adam Smith and adapted by Leyla Selman (National Playwriting Award 2003) and directed by Manuel Loyola (Teatro Oracle). The on stage version, suitable for all audiences, had eight runs covering the cities Concepcion, Los Angeles, Chillan, Talca and Curicó.
- **Photons to School:** interactive portable laboratory that can demonstrate properties of light such as interference, diffraction and polarization. In addition, the laboratory can show wave-particle duality, characteristic of quantum systems, by a Quantum Erasing experiment. High school students from 8th to 12th grade and general audiences can attend. This activity has been carried out continuously in the last three years in the BioBío Region.

PRODUCTIVITY PUBLICATIONS  
(BETWEEN 2013-2014)  
ISI: 58 | PATENTS: 1 (in review)

ACTIVE MILLENNIUM NUCLEUS CENTER  
From 12/24/2011 to 12/24/2017  
The Millennium Nucleus Centers can be renewed after 3 years, reaching a maximum of 6 years.

PRESENCE  
METROPOLITANA REGION  
BIOBÍO REGION



## HOST INSTITUTIONS:

