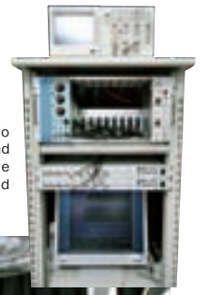
Frontiers of Quantum Information and Communication Technology Using Photons and Semiconductors

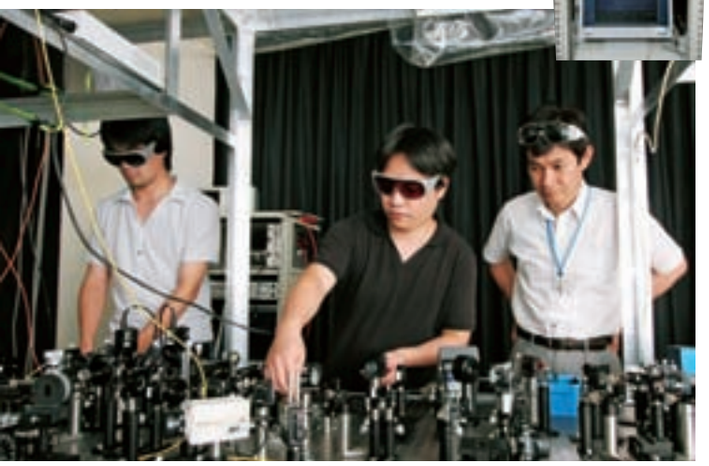
Quantum information and communication (QIC) technology, which goes beyond the limits of existing information and communications technologies using quantum mechanical properties of the electron and photon, has recently attracted a great deal of attention. One of the fundamental technologies for QIC technology is the method of generating and controlling the state of "quantum entanglement," in which a pair of particles has a quantum mechanical correlation. The quantum entanglement is essential to future QIC devices, such as a "quantum computer," "quantum teleportation," and "quantum repeater."

A research group led by Professor Keiichi Edamatsu succeeded in demonstrating the world's first generation of high purity entangled photons from semiconductor material. The research findings were published in Nature in 2004. The team demonstrated a generation of entangled photons with much higher purity in 2007. In 2008, they also demonstrated the proof-of-principle experiment of quantum state transfer from a photon to an electron spin. The research achievement has opened up a new way to produce QIC devices using photons and semiconductor materials.

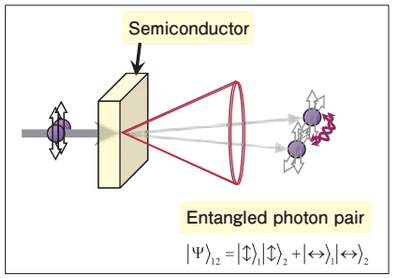
Professor Edamatsu has communed with starlit skies from his childhood, yearning to know about the beauty and marvels of lights. He was also captivated by the mystery of "quantum mechanics" when he studied it at the Physics School, Tohoku University. He said, "My current research activities have been triggered by these experiences."



System to detect and analyze entangled photons



An experiment using entangled photons.



Entangled photon pair generation using a semiconductor.

All members of the research team examine the experimental results and exchange their views, which may produce great ideas.

Adjustment of optical devices, such as laser, is delicate and strict.

The research team on entangled photons. Every team member has his/her own research theme and is striving for research night and day.

Research Institute of Electrical Communication
【Quantum-Optical Information Technology】

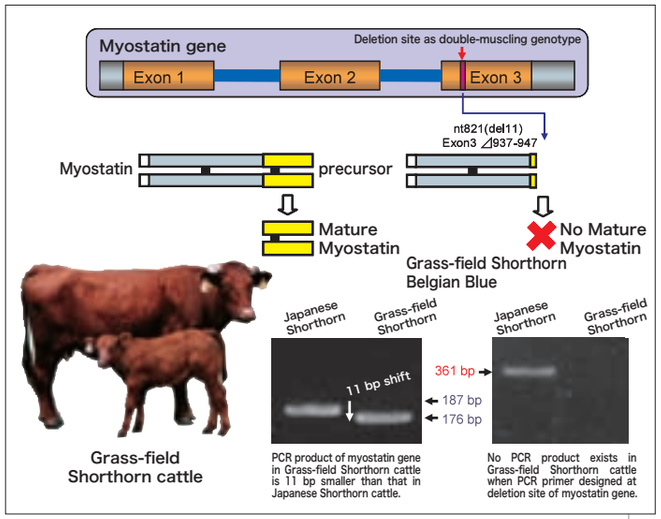
Keiichi Edamatsu

Professor

Born in 1959. Received B.S., M.S., and D.S. degrees in Physics from Tohoku University. Worked at Tohoku University, California Institute of Technology, and Osaka University. In 2003, he assumed his current position as a professor at the Research Institute of Electrical Communication, Tohoku University.

http://www.quantum.riec.tohoku.ac.jp

Elucidating the Mechanisms of Grass-field Shorthorn Cattle to Improve Lean Beef Production



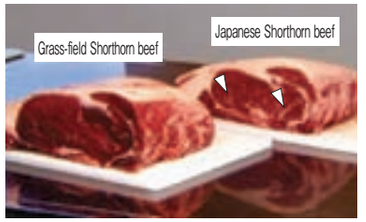
Double-muscling phenotype in Grass-field Shorthorn cattle

The research team led by Professor Takahiro Yamaguchi makes full use the latest cellular and molecular biology technologies to carry out studies on bio-mechanisms in ruminants and the associated applied science.

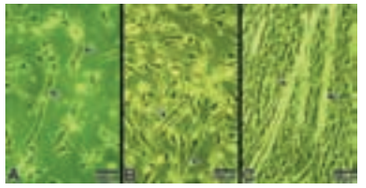
The representative research achievements in this laboratory are the elucidation of myogenesis in cattle to improve meat production. The research team developed Grass-field Shorthorn cattle that are naturally deficient in myostatin, a negative regulator of muscle development and growth, from the family of Japanese Shorthorn cattle. Grass-field Shorthorn cattle have the same double-muscled (DM) phenotype as Belgian blue cattle, producing a carcass that is classified as a superior beef grade in Europe. The healthier lean beef production in Grass-field Shorthorn cattle is about 1.5 times more than that of Japanese Shorthorn cattle. The cattle strain is promising as a beef cattle resource to increase beef production in our country.

The research team also first established cloned DM-derived myoblasts and succeeded in forming myotubes in vitro. This culture system gave us new myostatin information concerning the mechanisms of myogenesis and the endocrine effects. The discoveries anticipate great research advances in the myology and also open up a new field for myostatin research not only in agricultural science but also in medical science.

An assessment of consumers on beef of Grass-field Shorthorn cattle has been significantly judged as "low calorie tender lean beef". This research project is funded by the Bio-oriented Technology Research Advancement Institution (BRAIN) and is proceeding with practical applications.



Increased production of healthier lean beef in Grass-field Shorthorn cattle. Arrowheads show fat deposition in beef.



Myogenesis of bovine myoblasts *in vitro*.
A: Myoblasts in growth medium (arrows). B: Immature myotubes formed by myoblasts (arrows). C: Developed myotubes (arrows)

Grass-field Shorthorn cattle have approximately 1.5 times higher beef productivity than Japanese Shorthorn cattle.

Graduate School of Agricultural Science
【Functional Morphology】

Takahiro Yamaguchi

Professor

Born In 1946, he completed his doctoral course at the Graduate School of Agricultural Science, Tohoku University. He worked at the Medical School of Tohoku University and then the Medical School of Texas University. In 2000, he assumed a position as a professor at the Faculty of Graduate School of Agricultural Science, Tohoku University.

http://www.agri.tohoku.ac.jp/keitai/index.html