# ION BEAMS AND ION-ACCELERATORS FOR BIOLOGY-ORIENTATED APPLICATIONS AND RESEARCHES – CMU PRACTICES

## L.D. YU<sup>1,2</sup>

 <sup>1</sup> Plasma and Beam Physics Research Facility, Department of Physics and Materials Science, Faculty of Science, Chiang Mai University, Chiang Mai 50200, Thailand
<sup>2</sup> Thailand Center of Excellence in Physics, Commission on Higher Education, 328 Si Ayutthaya Road, Bangkok 10400, Thailand

#### B. PHANCHAISRI<sup>1,2,3</sup>, J. TECHARANG<sup>1,2,3</sup>

 <sup>1</sup> Plasma and Beam Physics Research Facility, Department of Physics and Materials Science, Faculty of Science, Chiang Mai University, Chiang Mai 50200, Thailand
<sup>2</sup> Thailand Center of Excellence in Physics, Commission on Higher Education, 328 Si Ayutthaya Road, Bangkok 10400, Thailand
<sup>3</sup> Science and Technology Research Institute, Chiang Mai University, Chiang Mai 50200, Thailand

#### U. TIPPAWAN<sup>1</sup>

<sup>1</sup> Plasma and Beam Physics Research Facility, Department of Physics and Materials Science, Faculty of Science, Chiang Mai University, Chiang Mai 50200, Thailand

## S. ANUNTALABHOCHAI<sup>4,5</sup>

<sup>4</sup> Department of Biology, Faculty of Science, Chiang Mai University, Chiang Mai 50200, Thailand <sup>5</sup> Biotechnology Unit, University of Phayao, Phayao 56000, Thailand

#### T. BOONYAWAN<sup>6</sup>

<sup>6</sup> PET/CT & Cyclotron Center, Center for Medical Excellence, Chiang Mai University, Chiang Mai 50200, Thailand

## T. VILAITHONG<sup>2</sup>

<sup>2</sup> Thailand Center of Excellence in Physics, Commission on Higher Education, 328 Si Ayutthaya Road, Bangkok 10400, Thailand

Applications and researches of ion beams and ion-accelerators for the biology-orientated purposes have been rigorously developed at Chiang Mai University (CMU), Thailand, the national ion beam and accelerator research center, for more than two decades. The work is highly multiple, touching equipment development, genetic engineering, materials science, analytical technology, cell and molecular biology, biomedicine, and life science. The ion beam and ion-accelerator facilities for biology at CMU included in-house-developed 150-kV mass-analyzed and non-mass-analyzed horizontal and vertical ion implanters, respectively, 220-kV Varian ion implanter, 30-kV bioengineering-specialized vertical ion implanter, 25-kV plasma immersion ion implanter, 10-kV neutralized ion beam implanter, low-energy single ion implanter, low-energy Mark II broad-beam high-output ion source based ion implanter, 1.7-MV Tandetron tandem accelerator for ion beam analysis, and 20-MeV cyclotron for medical applications. Relevant applications involved ion-beam-assisted gene/DNA transfer in bacterial, plant and mammalian cells, ion beam induced mutations in rice, horticultural plants, vegetables and bacteria, ion-bombardment altered cell adhesion or attachment on material surfaces, ion beam analysis

of biological samples, ion beam lithography of biological microfluidic devices/patterns, and cyclotronproduction of radiopharmaceuticals for diagnostic services. Researches concerned covered physical mechanisms of ion-beam-assisted gene/DNA transfer into cells and ion-beam-induced mutations of cells, low-energy ion bombardment effect on DNA strand breaks for fundamental understanding of ion beam effect on genetics including both experiments and computer program simulations of ultra-low energy ion impact on DNA, single-ion irradiation of cells for hyper low dose effect on cancer cell death, and cyclotron manufacture of radiopharmaceuticals for multi-purpose diagnostics. The presentation reviews all of these practices with the achievements such as hundreds of publications and presentations, some patents, tens of government-registered ion-beam-induced rice mutant lines, and a number of radiopharmaceuticals applied in clinics, etc., and highlights their socioeconomic impacts on the national developments. The programs have been supported not only by the governmental agencies but also by international cooperation particularly including the International Atomic Energy Agency (IAEA)'s supports.