Special Session GEEF 2025

Yonsei's Past, Present, and Future

(2. Yonsei University's Quantum Technology for the SDGs)

Date: March 13, 2025

Place: Millenium Hall, Sinchon Campus

CONCEPT NOTE

1. Forum Outline

Session	Special Session: Yonsei's Past, Present, and Future (2. Yonsei University's Quantum Technology for the SDGs)
Speakers	Prof. Jae-Ho Cheong, M.D. Ph.D (Senior Vice President, Yonsei Science Park (YSP) Project)
Date	March 13, 2025, Special Session (KST 10:30am –11:15am)
Venue	Yonsei University (Sinchon Campus, Seoul, Korea) & Online
Audience	Approximately 2,000 attendees from 26 countries (2025)
On-Air	IGEE at Yonsei University Official YouTube Channel
Language	Korean/English (Interpretation services provided for all sessions)

2. Background & Rationale:

The journey of quantum technology, as a realization of quantum dynamics theory, traces back to foundational discoveries that revolutionized our understanding of the physical world. From J.J. Thomson's discovery of the electron in 1896 to Planck's quantum hypothesis in 1900, Einstein's photoelectric effect in 1905, and Bohr's atomic model in 1913, each breakthrough contributed to a deeper understanding of quantum phenomena. This scientific evolution continued through De Broglie's matter waves (1924), Heisenberg's matrix mechanics (1925), Schrödinger's wave equation (1926), the Heisenberg Uncertainty Principle (1927), and the profound implications of the EPR paradox (1935).

Today, these theoretical foundations have materialized into quantum computing technology, offering unprecedented capabilities in addressing global challenges, particularly in healthcare and drug discovery. Yonsei University's establishment of a quantum research center, featuring South Korea's first 127-qubit IBM Quantum System One, aligns with the Yonsei vision of pursuing truth, freedom, and social engagement/ contribution, via applying quantum technology to current biomedical challenges.

This forum session examines how Yonsei's quantum computing goals/applications in healthcare and drug development contribute to the overarching theme of "Bridging Divides

for a Sustainable Future" while specifically addressing UN Sustainable Development Goal 3 (SDG 3): ensuring healthy lives and promoting well-being for all ages. Yonsei's quantum computing goals align with Yonsei's vision to "produce trailblazing research and knowledge that can solve difficult challenges facing the planet and humankind.

Key Challenges Addressed in SDG 3:

1. Universal Health Coverage

- Quantum computing enables more efficient drug discovery processes, potentially reducing medication costs and providing affordable medicines.
- Support the creation of a sustainable medical ecosystem accessible to all populations by improving global access to essential medicines and developing treatments for rare diseases.

2. Communicable Disease Control

- Improved prediction for pandemic threats, such as forecasting infection rates, deaths, and recovery cases using various statistical and machine learning approaches.
- Faster response times in creating targeted therapeutics, such as vaccines, by enhanced molecular modeling for developing effective treatments.

3. Non-communicable Disease Management

- More precise drug development (or personalized medicine) for chronic conditions via analyzing complex genetic datasets with quantum algorithms
- Cost-effective treatment options for long-term care, via predictive analytics for disease progression

This forum session will discuss how Yonsei University's vision for quantum computing in healthcare and drug discovery represents an innovative approach to achieving S.D.G. 3 targets, while supporting the broader goal of sustainable development. The application of quantum computing in healthcare and drug discovery represents a crucial step toward ensuring that humanity thrives together, without leaving anyone behind. By examining specific applications and potential impacts, the session will demonstrate how this technology can help bridge the divide between current healthcare challenges and future solutions, ensuring sustainable global health and well-being.

3. Session Objectives:

This presentation aims to examine the transformative potential of quantum computing technology in pharmaceutical research and its role in achieving affordable and sustainable healthcare for all. The discussion will demonstrate how this technological advancement aligns with the United Nations' Sustainable Development Goal #3, which focuses on ensuring good health and well-being for people of all ages.

The convergence of quantum computing technology and global healthcare presents unprecedented opportunities at the frontier of drug discovery and development. As quantum computers emerge as a revolutionary toolkit in addressing humanity's grand challenges, their applications extend beyond climate change and energy crises to the fundamental domain of human health and well-being.

Key Topics:

1. Current limitations in traditional drug discovery methodologies and the quantum computing paradigm's distinctive approach

2. Strategic applications of quantum computing in:

- Drug discovery acceleration and optimization for affordable medicine
- Development of precision medicine protocols
- Enhanced pandemic prediction and preparedness systems

3. The implications for healthcare accessibility and affordability, with particular focus on underserved populations.

The session will elaborate on how quantum computing represents a fundamental shift in disease understanding and treatment methodologies. While the technology remains in its developmental stages, its potential to revolutionize healthcare delivery and contribute to global well-being positions it as a critical frontier in modern scientific advancement.

This exploration of the intersection between quantum technology and human health reveals how advanced computational capabilities can address fundamental healthcare challenges, potentially transforming the landscape of global medical research and treatment accessibility.

4. Moderator (n=1) & Panelist (n=3~4):

- **[Speaker]**

  Jae-Ho Cheong

  - Senior Vice President, Yonsei Science Park (YSP) Project
  - Dean, Institute of Convergence Science and Technology, Yonsei University
  - Director, Yonsei Quantum Initiative
  - Professor, Department of Surgery, Yonsei University College of Medicine

5. Session Format and Flow (15 minutes):

1. Introduction (2-3 minutes)

- **Opening Hook**: A compelling statistical/real-world example highlighting the limitations of current pharmaceutical research (e.g., the time and cost of drug development).
- **Current Bottlenecks**: Explain the slow, expensive, and computationally intensive nature of drug discovery.
- **Need for a Paradigm Shift**: Introduce quantum computing as a potential solution.

2. The Quantum Advantage in Pharmaceutical Research (5 minutes)

- **How Quantum Computing Works (Brief Explanation)**: Provide a simplified explanation of quantum computing's ability to handle complex calculations.
- **Key Applications**:
  - **Drug Discovery Acceleration**: How quantum simulations speed up molecular interaction analysis.
  - **Precision Medicine**: Tailoring treatments to individual genetic profiles using quantum algorithms.
  - **Pandemic Prediction & Preparedness**: Quantum-enhanced modeling of viral mutations and drug resistance.

3. Implications for Global Healthcare Access & Affordability (3 minutes)

- **Impact on Drug Costs & Availability**: Discuss how quantum-driven efficiency could lower costs and expand access to medicines.
- **Focus on Underserved Populations**: Address the role of quantum technology in democratizing healthcare innovations.

4. Conclusion & Call to Action (1-2 minutes)

- **Recap of Key Points**: Reinforce how quantum computing could revolutionize drug discovery and healthcare accessibility.
- **Future Outlook**: Acknowledge the ongoing development of quantum technology and its potential for real-world impact.
- **Call to Action**: Encourage further exploration, investment, and collaboration in quantum healthcare research.

6. Potential Outcomes and Future Directions:

- **Increased awareness** of quantum computing principles and their real-world applications in healthcare.
- **Encouraging broader participation** in discussions about quantum technology, fostering an informed society.
- **Inspiring students, researchers, and policymakers** to explore quantum computing's role in healthcare innovation.