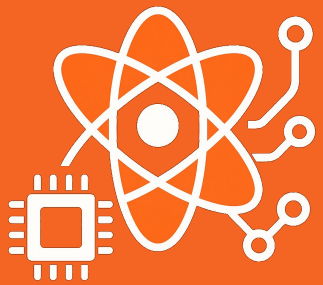
The State of Quantum Science & Technology (QST) in Ghana:

Addressing the Quantum Divide and Promoting Global Inclusion Through the SDGs

By Henry Martin (PhD), MCP, KNUST

Africa Regional Conference & Exhibition on Education & Skills Development (ARC-EDS 2025)

1. Quantum Science & Technology

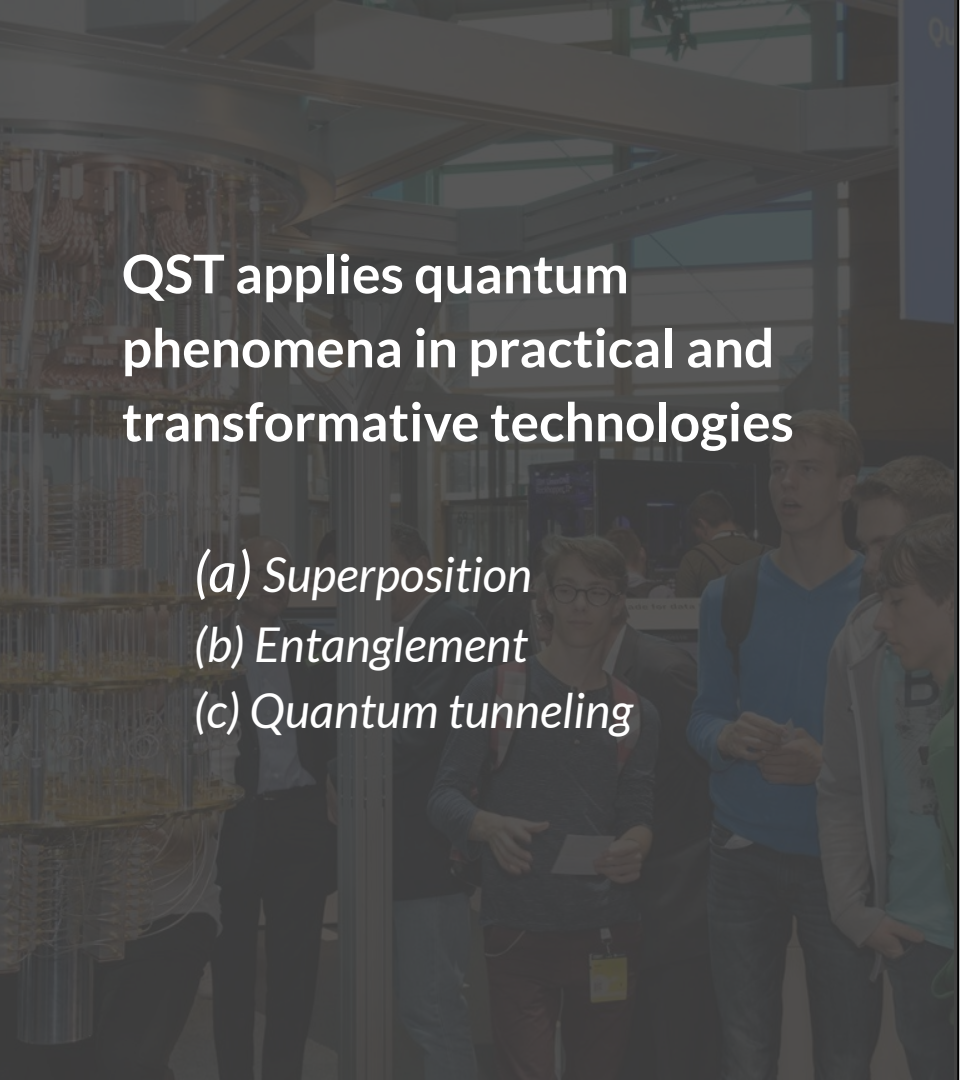


What is QST?

1. A field of science that builds on core principles of quantum mechanics
2. Interdisciplinary
3. Aims to achieve capabilities beyond classical systems

Considered QS

- Hatree Fork
- Density Functional Theory
- Matrix Product
- Others



QST applies quantum phenomena in practical and transformative technologies

(a) Superposition
(b) Entanglement
(c) Quantum tunneling

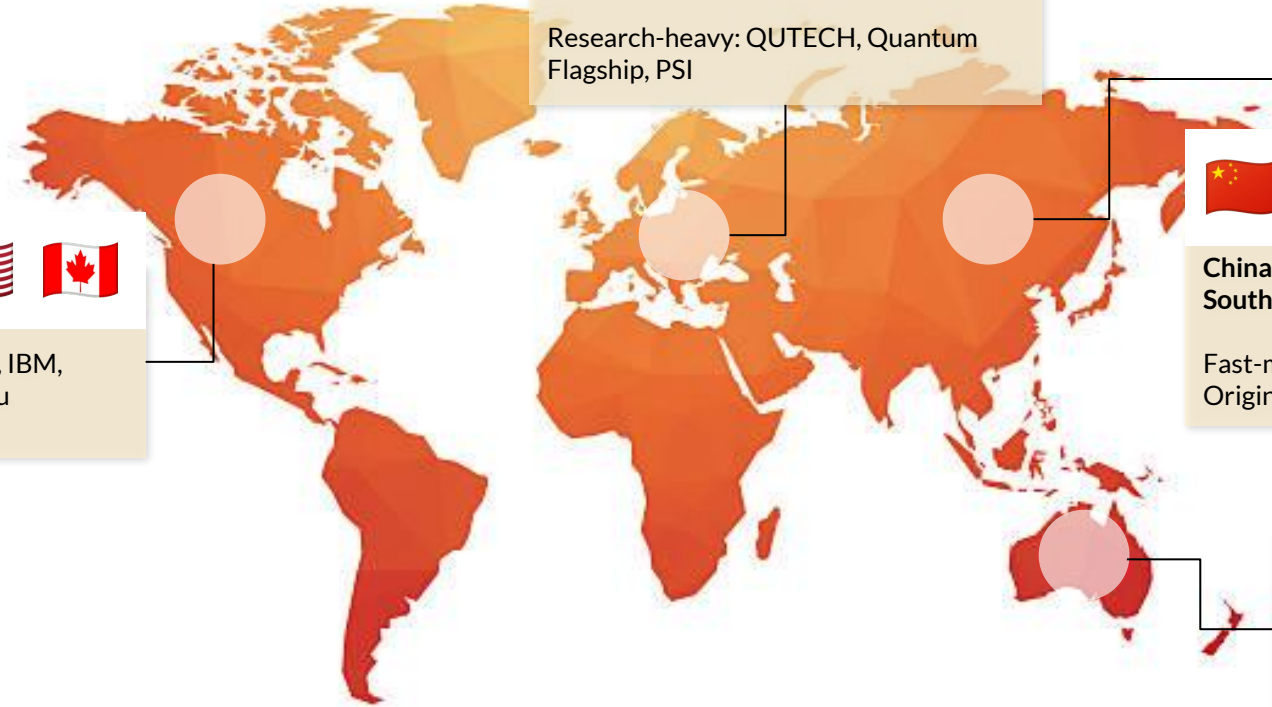
Why it matters

Enables breakthroughs in:

- Quantum computing
- Quantum communication
- Quantum sensing & metrology
- Quantum materials
- Quantum finance
- Others

2. Global Landscape of Quantum Science

Leading Countries in QST



Germany | France | Netherlands | UK | Italy

Research-heavy: QUTECH, Quantum Flagship, PSI

USA | Canada

Tech-driven: Google, IBM, IonQ, Rigetti, Xanadu

China | Japan | Singapore | South Korea

Fast-moving: Alibaba, Baidu, OriginQ, USTC

Australia

Silicon qubits, quantum control (UNSW, U. Sydney)

3. African Landscape of Quantum Science

Leading Countries in QST

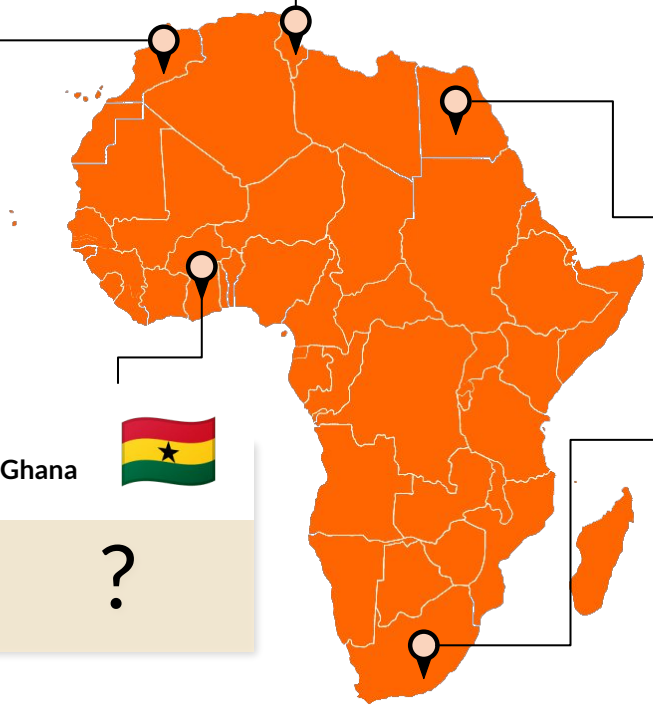
Africa Quantum Consortium (AQC)
Advocating for Africa's inclusion in the global quantum ecosystem.

Tunisia

Research in quantum computing. Joint efforts via Tunisian Quantum Network, QUANTUN & QWorld.

Morocco

Academic research in quantum optics and QKD; regional collaboration.



Egypt

Investments in QKD, quantum computing, and regional research programs.

Ghana

?

South Africa

National QST strategy (QuTI), strong research in quantum optics, quantum computing and host of key events.

Africa Quantum Alliance
(Afriqa)

Quantum research in Africa is mostly computational

(“classical simulations of quantum systems”)

Terminology Note:

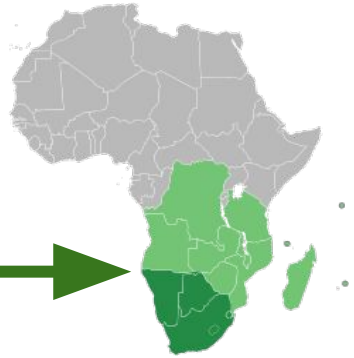
Here, **“classical quantum science”** will refer to **classical computational methods** used to study quantum systems

Not implying it’s outdated

CHPC Resources

RESEARCH COMMUNITY

- South African Academic Institutions & Research Facilities
- Southern Africa Community partners
- **SKA partner countries**

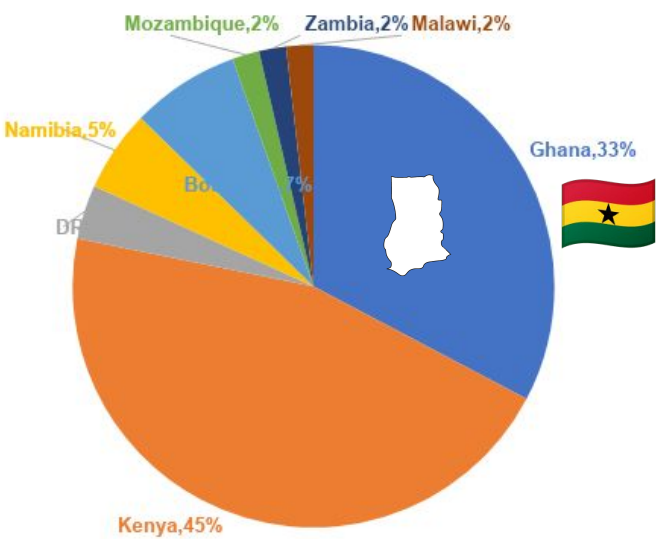


Dr. Happy Sithole
NICIS Centre Manager

NICIS CHPC

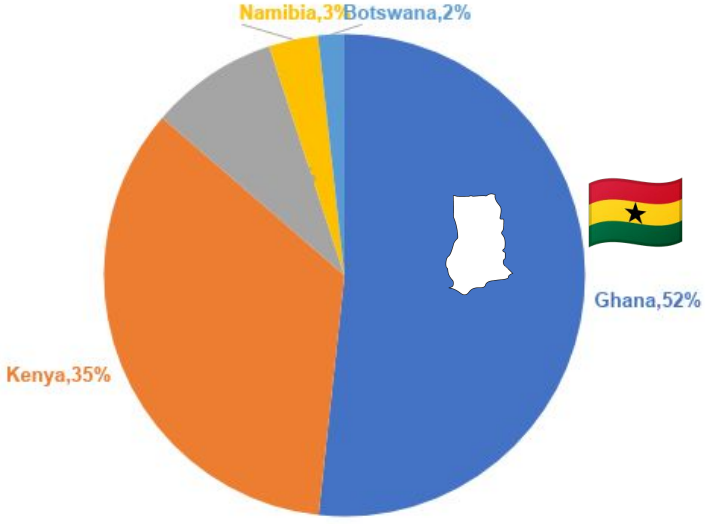
CHPC Use: African Partners Total Active* Programmes

(Past 6 months)



 # Active Programmes

Total: 55

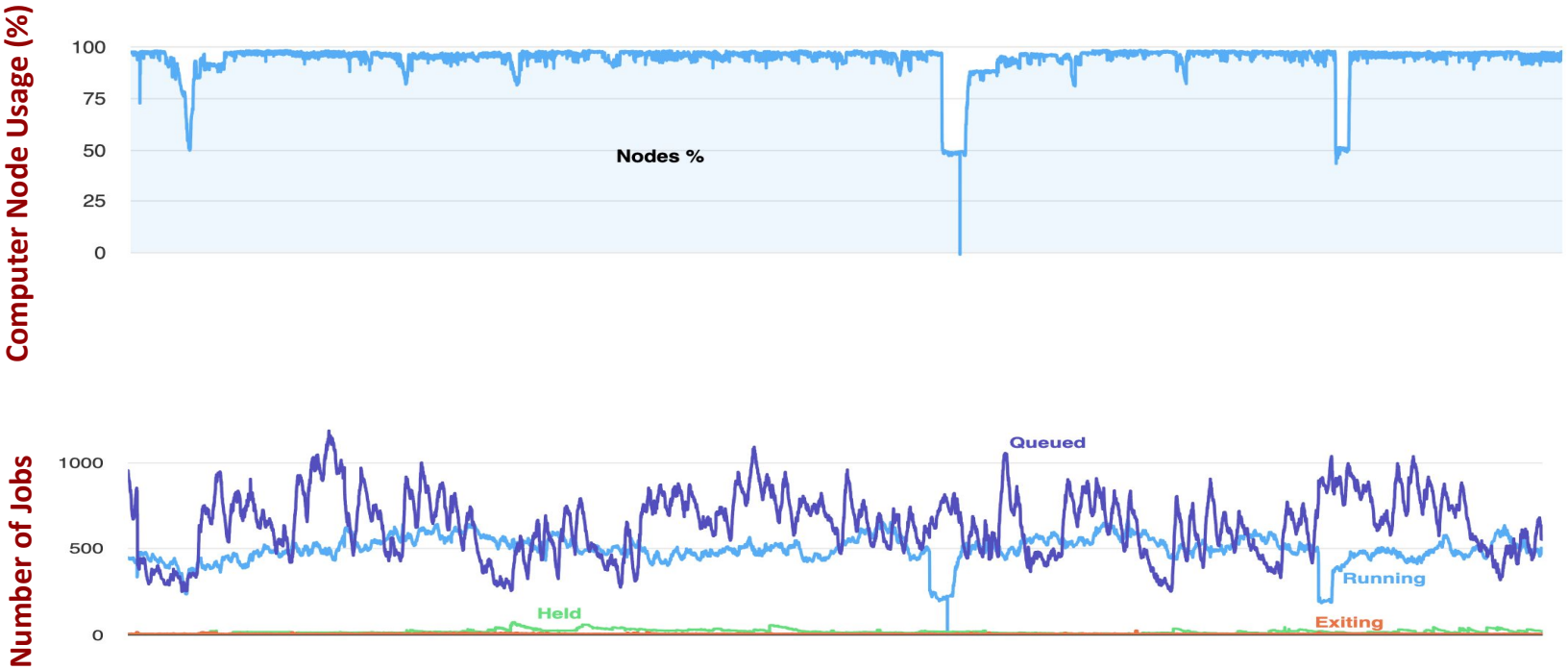


 # Hours Used (Million)

Total: 174 million

***Active** refers to at least 1000 compute hours used over the relevant period.*

CHPC Lengau Usage : CPU Cluster



4. Ghana's Current State of Quantum Science

Current Capacity

UG: Mathematics (Quantum Gravity), Physics (Computational Physics)

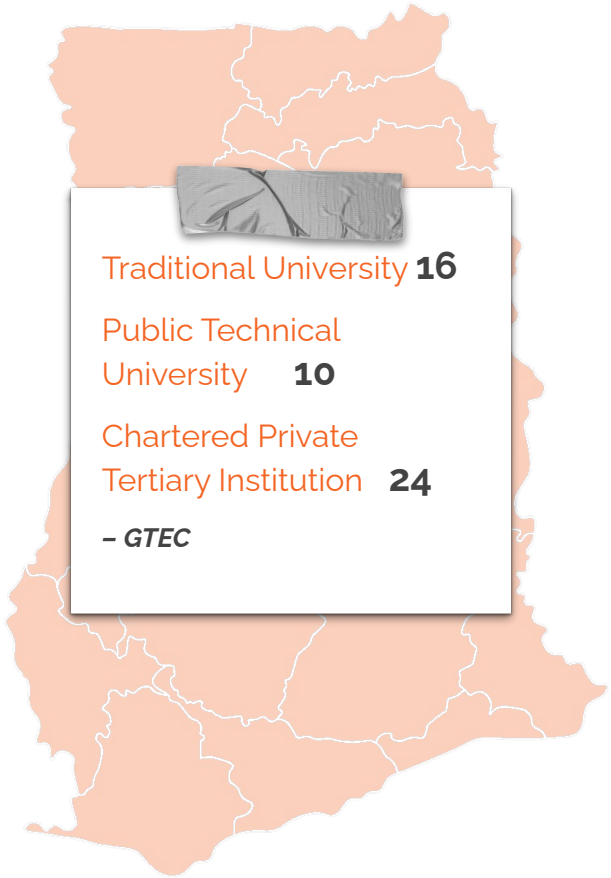
UDS: Computational Physics*

UCC: Physics (LAFOC, CTC)

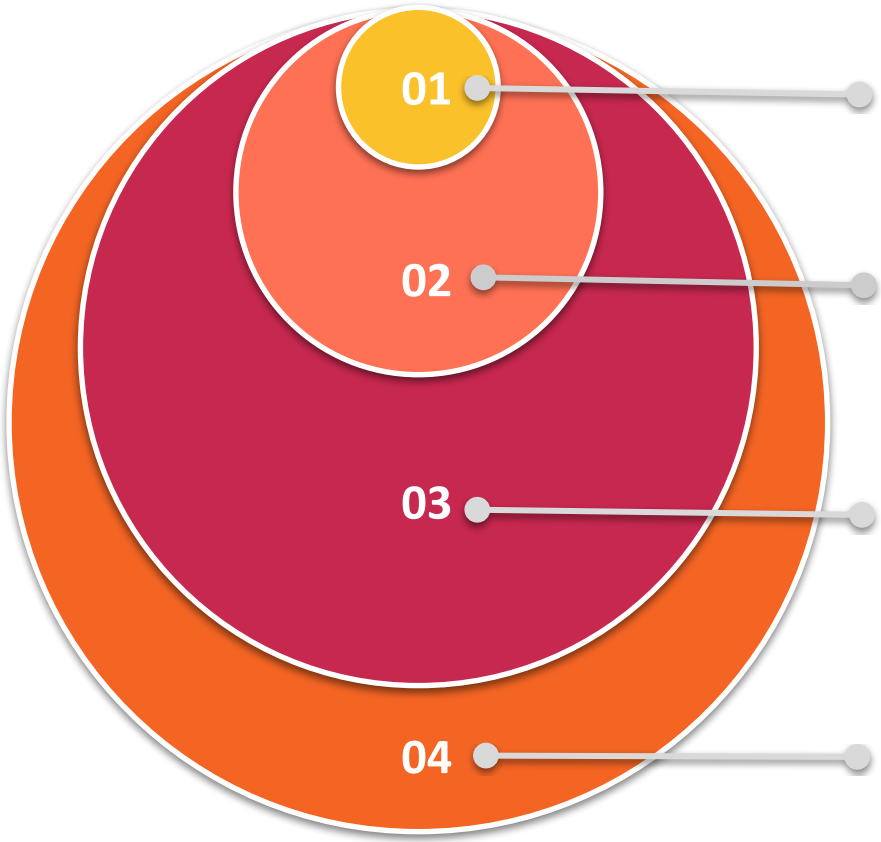
UENR: Computer Science (QML in finance)

CKT: Computational Physics*

KNUST: Physics (MCP, GPOL), Chemistry (CCL), Engineering (KEEP*), Mathematics (Quantum Finance)



Components of Quantum E&R in Ghana



1. Quantum Experiment

2. Quantum Technology/Engineering

None/Very Limited: High cost and infrastructure requirements.

3. Quantum Computation & Simulation

Increasing interest in quantum algorithm and quantum machine learning

4. Classical simulations of quantum systems

Requires few resources. Africa's active quantum research area

5. Quantum Theory

Most universities have some activity

Current State

(Reality Check)

01 **No National QST Strategy**

02 No dedicated QST centre

03 QM is taught at university level, but mostly theoretical and not application-driven

04 No significant involvement in global quantum tech efforts: **no quantum computing, quantum optics, quantum communication initiatives, etc.**

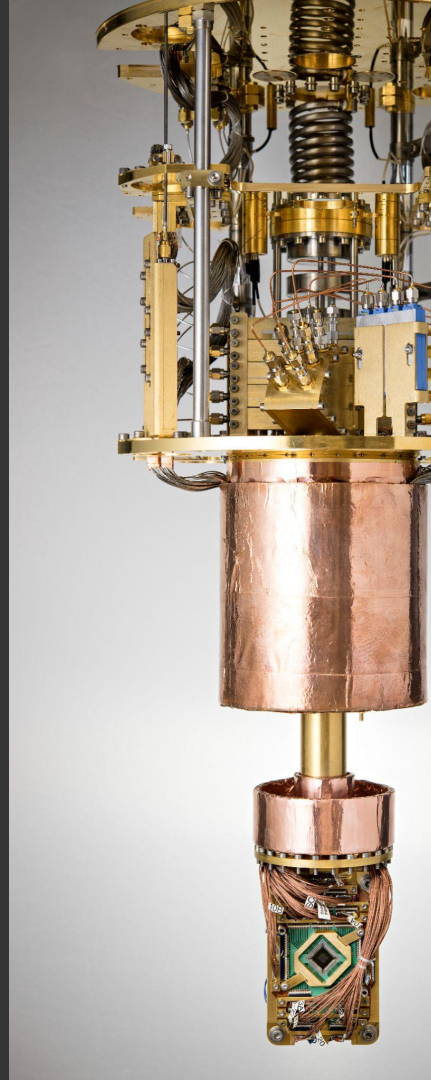
05 **Most** research in quantum-related fields = **classical simulations**

06 Thus, **Ghana is not yet part of the quantum economy** that is rapidly forming globally

This is the **"Quantum Divide"** — **Ghana** (and much of Africa) **risks** being **left out** of a transformative technological revolution.

THE BIG IDEA:

“Establishing a National QST Strategy via a Cluster of Centres of Excellence (ACE-QST), using a proven educational-research pipeline to bridge the quantum divide and foster global inclusion aligned with the SDGs.”



Pipeline Model:

Building Human Capacity

MCP Model

Since 2020

Education & Research

(Challenges)

Institutional

- Funding
- Resources
- Personel
- Workload

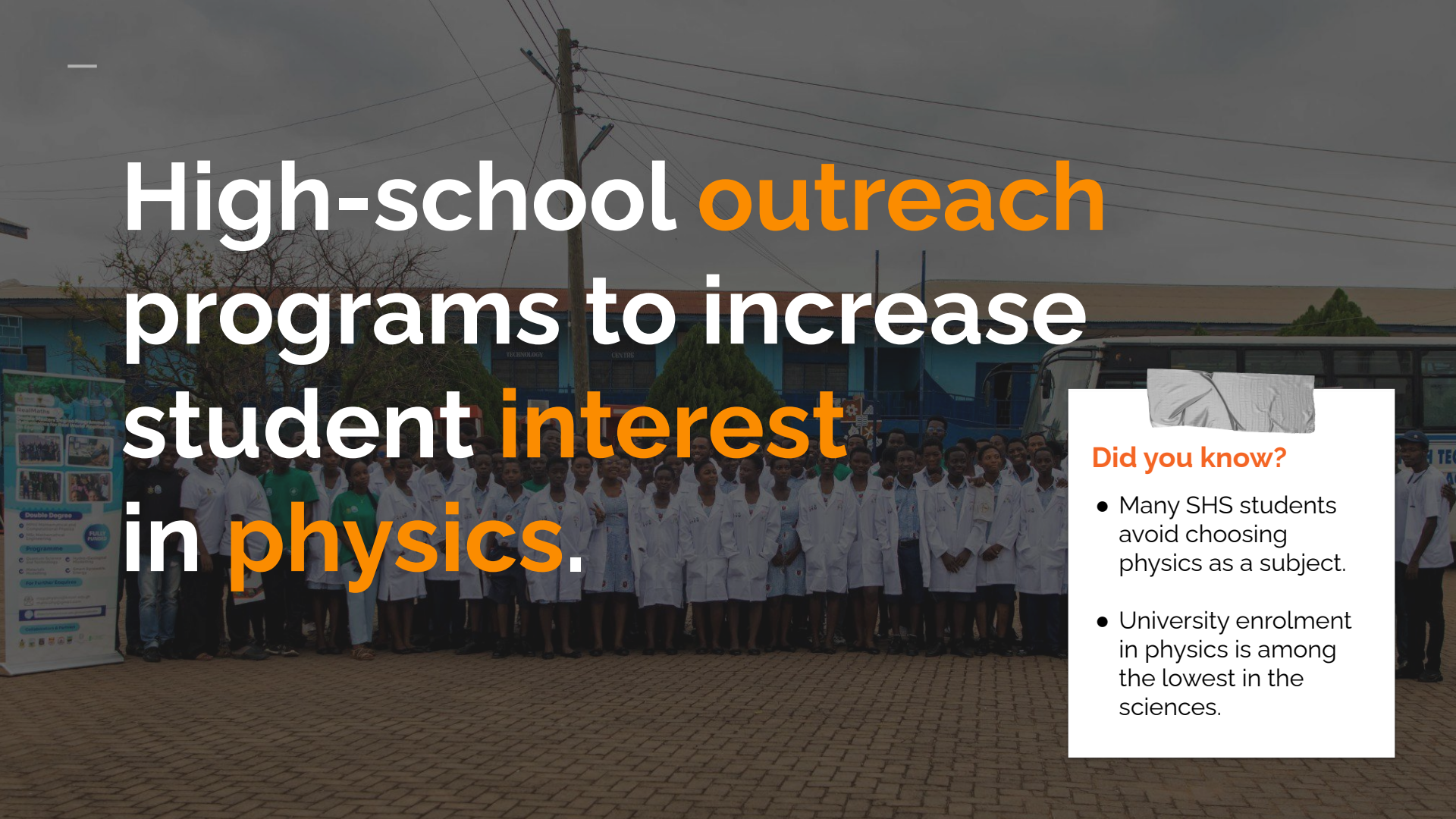
Student

- Interest
- Transition
- Funding
- Job

Governmental & Industrial

- Limited translation of research findings into real-world solutions
- Limited cooperation between industry and academia

High-school outreach programs to increase student interest in physics.



Did you know?

- Many SHS students avoid choosing physics as a subject.
- University enrolment in physics is among the lowest in the sciences.

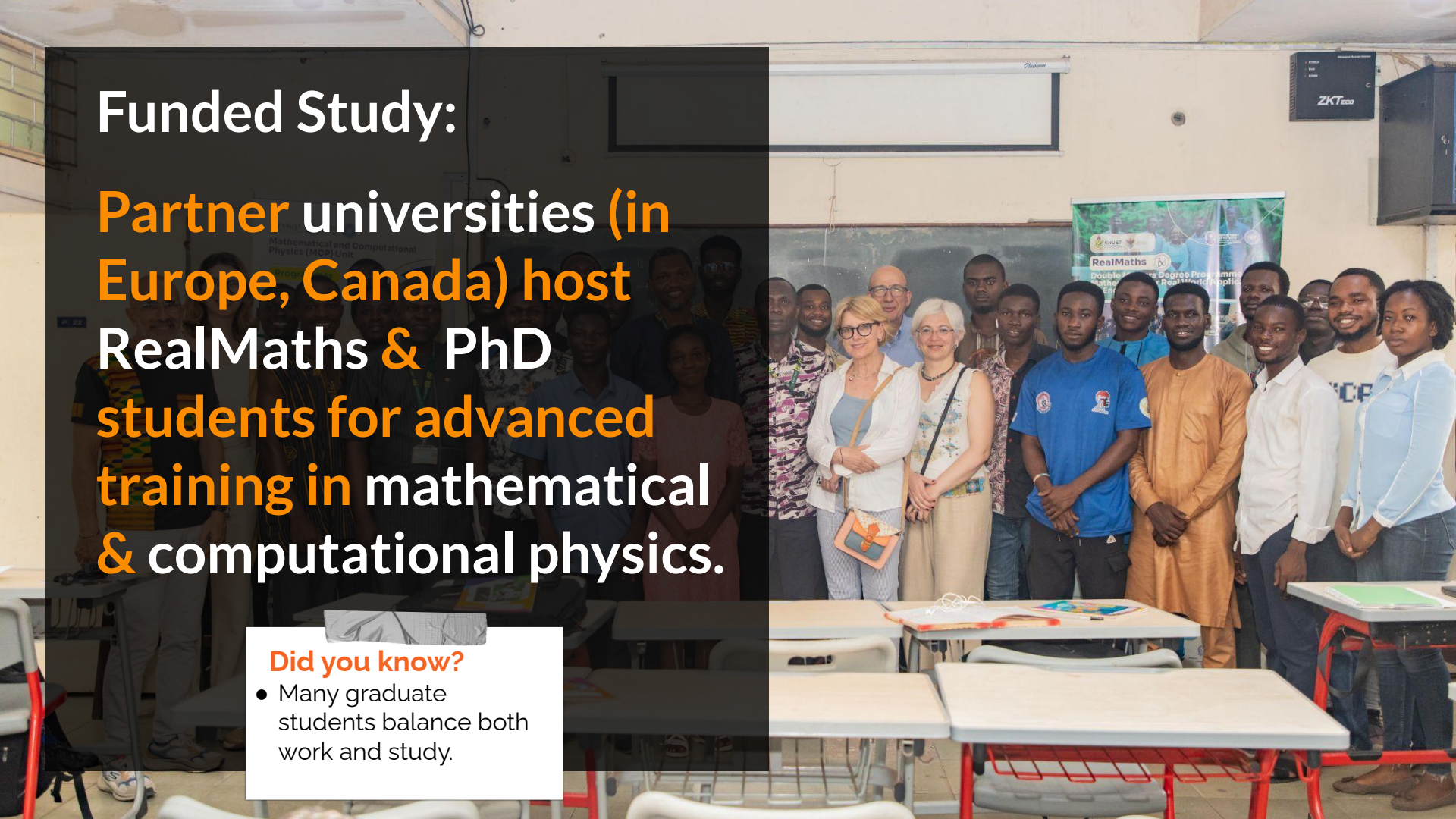
PSI Start, and Bridge programs: Intensive preparatory courses for further studies.

Did you know?

- Many bachelor's degree holders are not fully prepared for the demands of graduate-level education.

Funded Study:

Partner universities (in Europe, Canada) host RealMaths & PhD students for advanced training in mathematical & computational physics.



Did you know?

- Many graduate students balance both work and study.

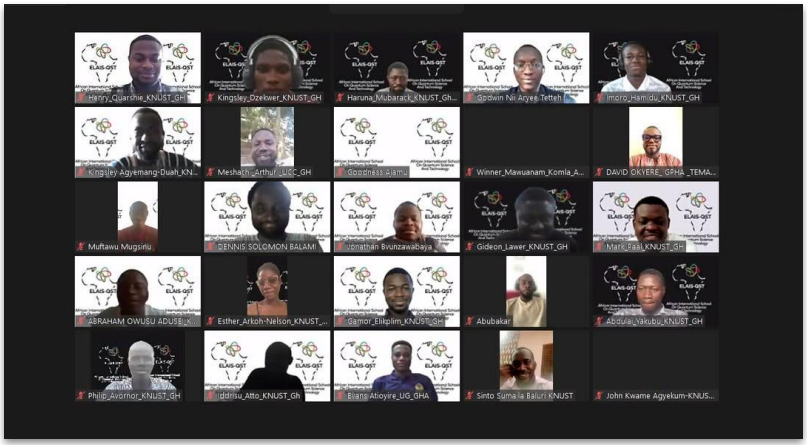
Partnership

- The University of L'Aquila (Italy) has been in partnership with MCP

Research with local relevance

Building on the existing postgraduate exchange, the MCP Unit (KNUST) is undertaking research in areas such water supply chain to tackle pressing water challenges through advanced technology and community engagement

Akwaaba-QST & ELAIS-QST:



ELAIS-QST

- Exposing African students to industry-grade tools and thinking
- Creating networks between African institutions and world-leading quantum companies
- Raising awareness among stakeholders that quantum science is not just an academic exercise but has practical and economic value?

Vision: ACE-QST

ACE-QST

AIMS Ghana

Mathematical formulations in quantum information theory, quantum cryptography etc

CAC Ghana

HPC and simulation capabilities for quantum related research

ECQT Ghana

Hands-on research in quantum photonics, quantum computing architectures, quantum communication etc

Pipeline Steps:

1

Early Identification:

Undergraduates with potential are identified and supported.

2

NSS Integration:

These graduates *may* serve as TAs to retain them in the ecosystem.

3

Bridging Programs:

They take intensive preparatory courses, e.g. PSI

4

Funded MPhil/PhD/PostDoc:

Partner universities (in Europe, Canada, etc.) host students for advanced QST training.

5

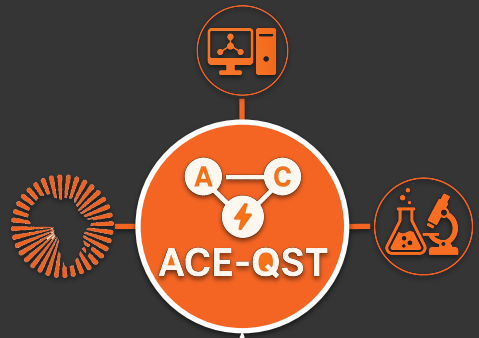
Research with Local Relevance:

PhD/PostDoc research must address industry-linked problems, with local impact.

6

Return to Train Others:

Graduates come back to teach, lead labs, and populate the ACE-QST cluster.



Stages of:

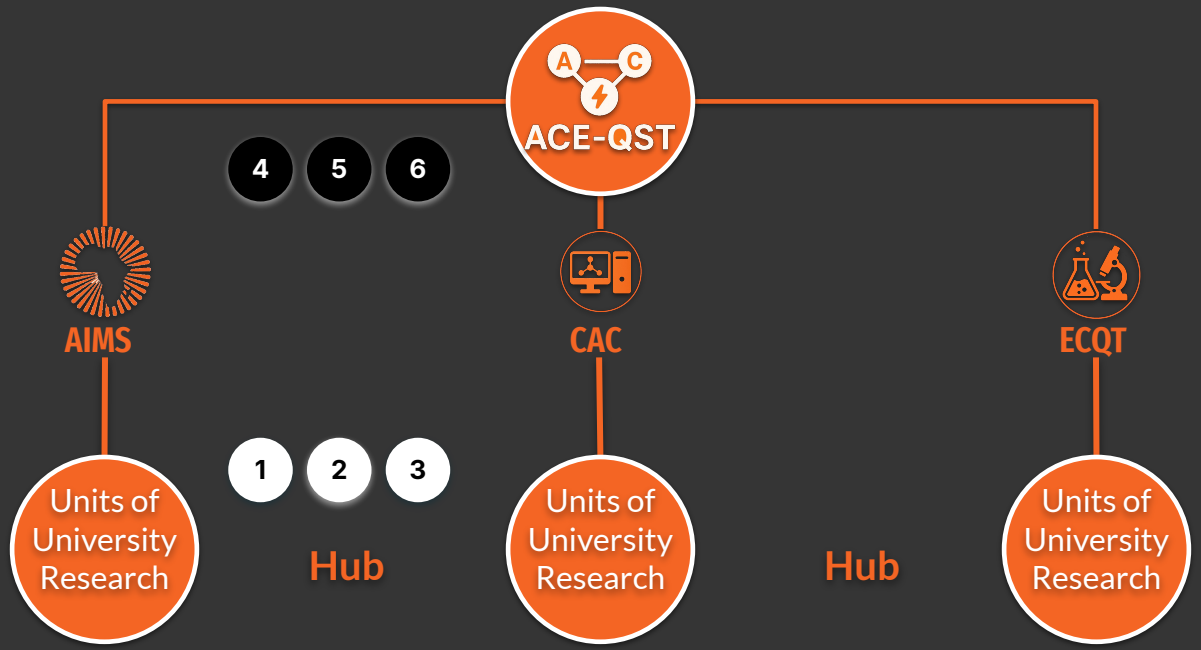
1. Human Capacity Development

2. Harmonization of strategic plan

No taught master's programs at centres.

Master's students may visit for projects.

Centres focus on PhDs and postdocs with clear employment pathways.



UG: MTH (Quantum gravity)

UG: PHY (Com. PHY), CS*, **CKT:** Com. PHY*, **UENR:** CS (QML in finance), **UDS:** Com. PHY*, **KNUST:** PHY (MCP), MTH (QF), CHEM (CCL) **UCC:** PHY (CTC)

KNUST: PHY (GPOL), Engineering (KEEP*), **UCC:** PHY (LAFOC)

The ACE-QST Strategy aims to make Ghana a West African leader in quantum by 2035.

GHANA'S STRENGTHS

- **Emerging Expertise:** Growing community of researchers in mathematical physics, QML, quantum finance, and photonics*
- **Youthful Talent Base:** Large population of young scientists eager to skill up in future technologies.
- **Global Connectivity:** Active participation in African and international quantum networks.

MAIN GOALS

To **develop Ghana's quantum skills pipeline** via education & capacity building.

To **seed a quantum innovation ecosystem** connecting academia, startups, and industry.

To **position Ghana as a hub** for regional collaboration in QST.

FIVE TARGETED AREAS

Quantum Opportunities for Societal Innovation in Ghana

FINANCE

Strengthen fintech innovation and digital banking tools

DRUG DESIGN

Improve the process of discovering and developing new drugs

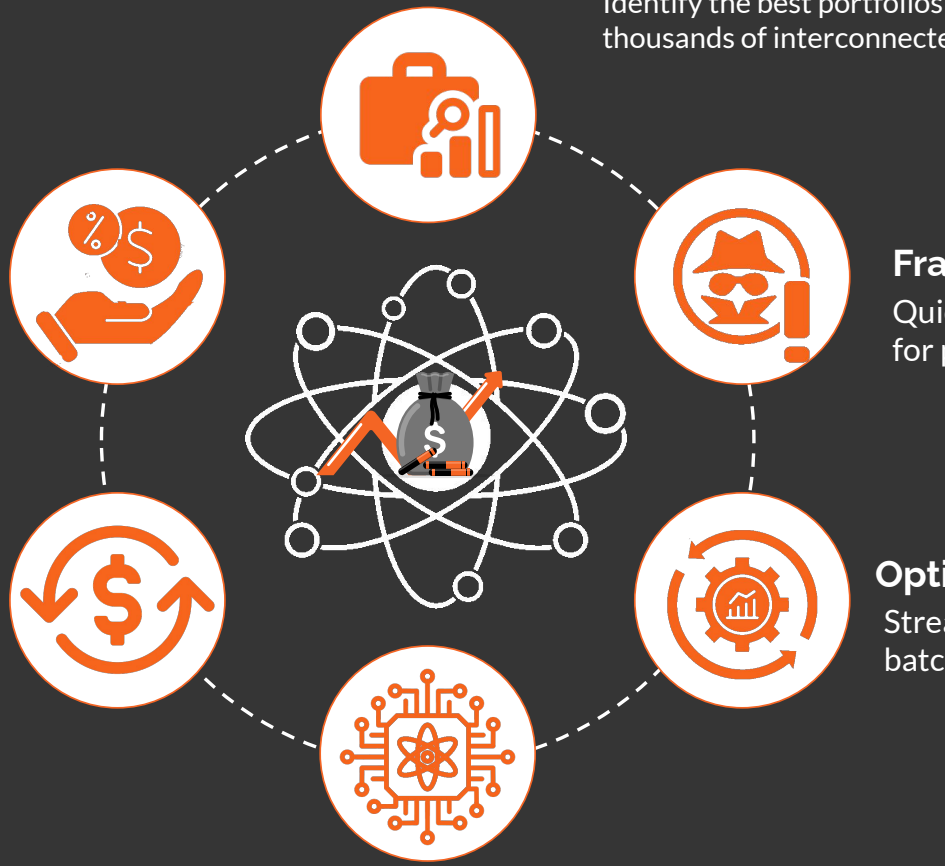
WATER

Improve modeling of water treatment materials

FINANCIAL SERVICES

Portfolio analysis:
Identify the best portfolios from thousands of interconnected assets.

Asset valuation:
Analyze large data sets to assess risk and value assets.



Fraud detection:
Quickly detect fraud indicators for proactive risk management.

High frequency trading:
Execute rapid buy-sell strategies to boost returns and control risk.

Optimization:
Streamline large transaction batches with varied constraints.

Quantum-proofing of cybersecurity systems:
Develop advanced cryptography to protect customer data.

WATER & ENVIRONMENT

(Classical Simulation)

Digital Twin: A virtual replica of the interplay between polluted surface water, reservoir, treatment plants and effluent discharge.

Real-Time Monitoring |

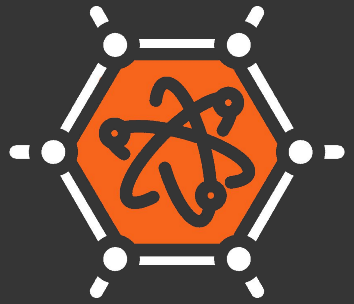
Process Optimization |

Predictive Maintenance |

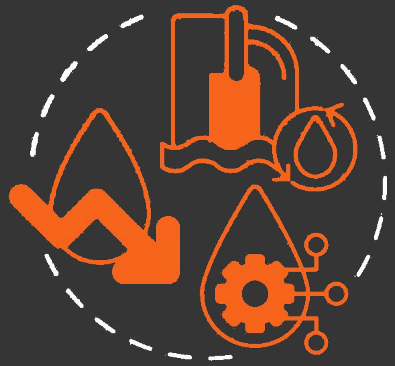
Emergency Response

WATER & ENVIRONMENT

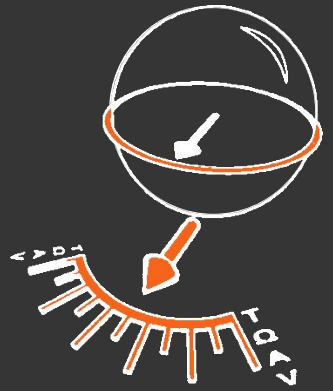
(Quantum Domain)



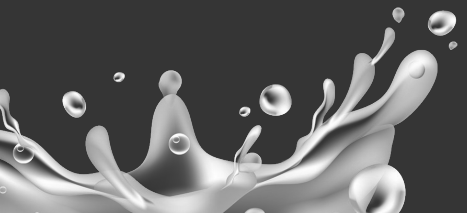
Quantum modeling of water treatment materials



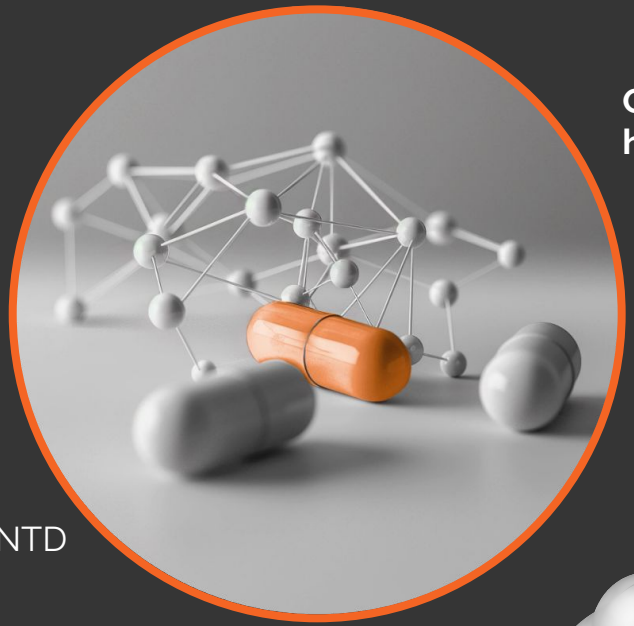
Quantum optimization for water flow management



Quantum sensors for pollutant detection and monitoring



PHARMACEUTICALS & HEALTHCARE

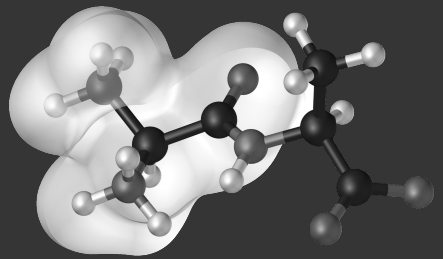


Quantum MRI to improve health checks

Drug discovery using quantum simulation and AI

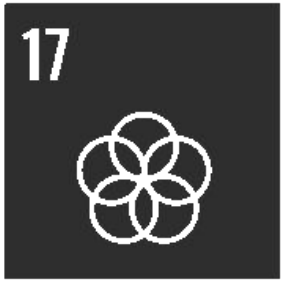
- Affordable malaria and NTD drug development

- Molecular modeling of endemic diseases

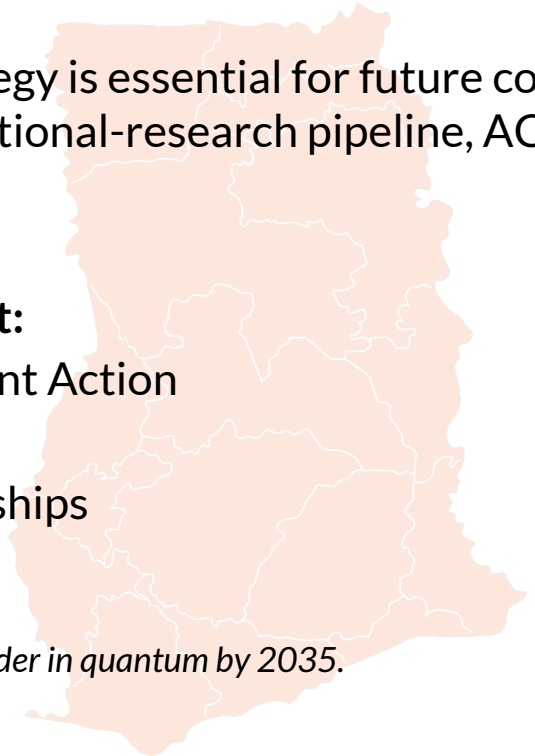


5. ACE-QST and the SDGs

- Cutting-edge training opportunities in a global field
- A pipeline to create jobs in high-tech, innovation-driven areas
- Building national capacity in frontier science and digital infrastructure
- Deliberate inclusion of underrepresented countries in STEM
- International collaborations with the global quantum ecosystem etc.



6. Conclusion



- A National QST Strategy is essential for future competitiveness.
- Using a proven educational-research pipeline, ACE-QST could provide a pathway.

- **Now is the time to act:**
  Policy and Government Action
  Institutional Support
  Coordinated Partnerships

Position Ghana as a West African leader in quantum by 2035.

Thank You !

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