

A photograph of a modern building with a glass facade and a courtyard. The building has a grid of dark window frames. In the foreground, there is a paved courtyard with a tree on the left and a wooden bench on the right. The sky is bright and overcast.

# ARCHER

Research & Prototype Foundry Archer operates in,  
Sydney, Australia.

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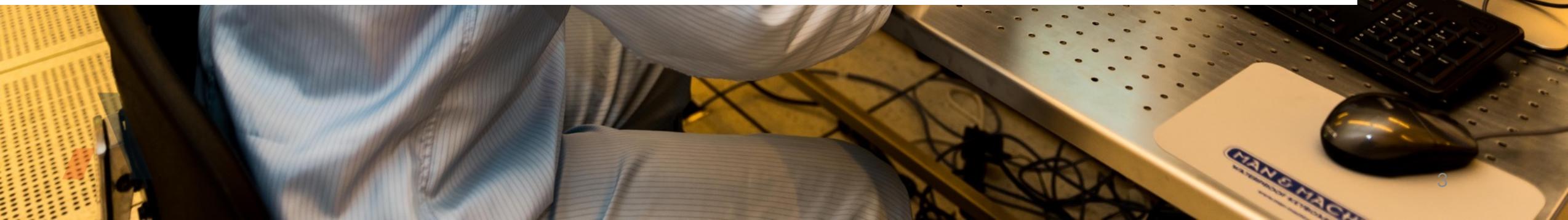
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This presentation contains information which was reported in ASX announcements lodged between 1 October 2017 and 25 October 2021 (together the “Announcements”). All material assumptions and technical parameters set out in the Announcements continue to apply and have not materially changed. The Announcements can be viewed online at <https://www.archerx.com.au>.

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# ARCHER IS ONE OF A FEW COMPANIES IN THE WORLD DEVELOPING A QUANTUM COMPUTING PROCESSOR



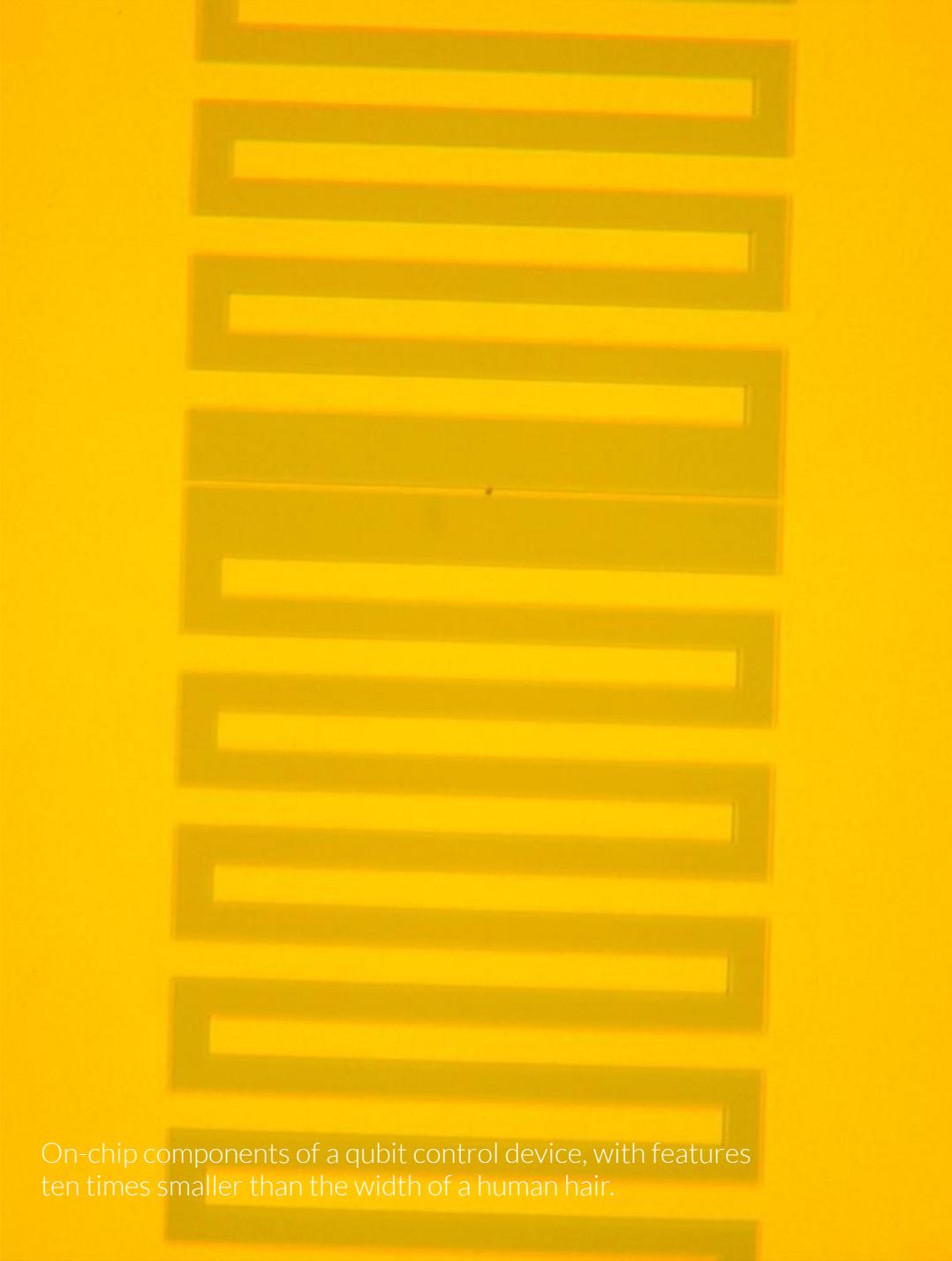
## / Company Overview

Archer is a technology company that is developing advanced semiconductor devices, including chips relevant to quantum computing and medical diagnostics. Archer is long-term value driven and creates maximum value by<sup>†</sup>:

- + Progressing its technology development, including its <sup>12</sup>CQ quantum computing processor chip (“<sup>12</sup>CQ chip”) and graphene-based biosensor chip (“biochip”).
- + Utilising Tier 1 tech development infrastructure and facilities, R&D, people and IP, to support pre-market development.
- + Protecting key intellectual property assets (e.g. patents and patent applications) with global competitive advantages.
- + Applying a business model that values partnerships, as a key player<sup>‡</sup> in global networks coordinated by large companies.

<sup>†</sup> <https://www.bcg.com/en-au/publications/2019/dawn-deep-tech-ecosystem>

<sup>‡</sup> <https://www.nature.com/articles/s42254-020-00247-5>; also <https://www.ibm.com/quantum-computing/network/members/>



On-chip components of a qubit control device, with features ten times smaller than the width of a human hair.

## / Experienced Board and Management



**Executive Chairman**  
Greg English  
*LLB, BE (Mining)*



**Non-Executive Director**  
Alice McCleary  
*DUniv, BEc FCA FTIA FAICD*



**Non-Executive Director**  
Kenneth Williams  
*BEc (Hons), M APP FIN, FAIC*



**Non-Executive Director**  
Bernadette Harkin  
*MBA, GAICD*



**Chief Executive Officer**  
Mohammad Choucair  
*PhD, FRACI FRSN GAICD*



**Chief Financial Officer &  
Company Secretary**  
Damien Connor  
*CA GAICD AGIA B.Com*



†Alice McCleary to retire at Company 2021 AGM.



Ticker

**AXE**

*Australian Securities Exchange listing*

Sector

**Semiconductors**

Market Capitalisation

**A\$362m**

*As of 25 Oct 2021*

Peers

**Intel, AMD, IonQ  
Rigetti, NVIDIA**

*Chosen by similar industry, tech, or activity*

Cash at Bank

**A\$29.4m**

*No corporate debt. As of 21 Oct 2021*

Share Price

**A\$1.515**

*As of 25 Oct 2021*

Key Activities

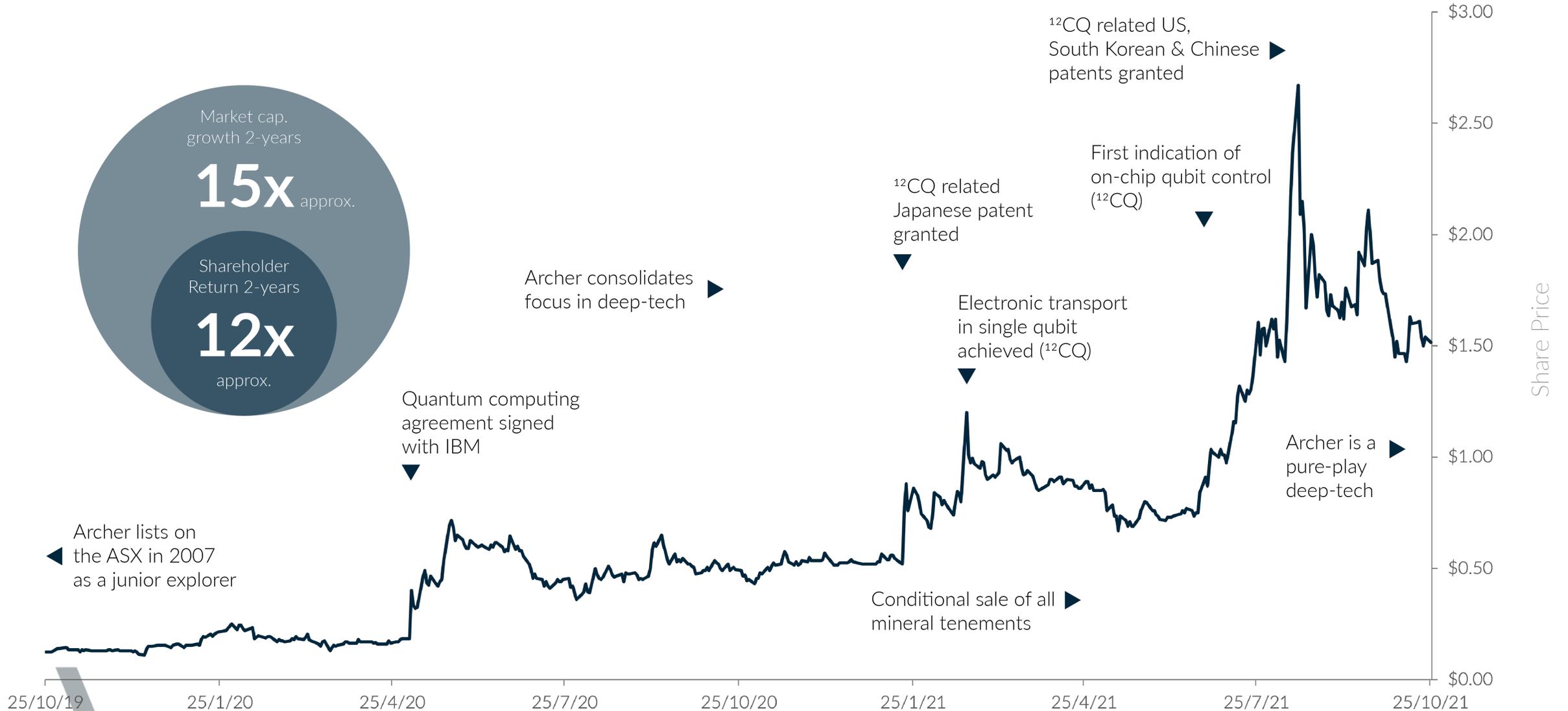
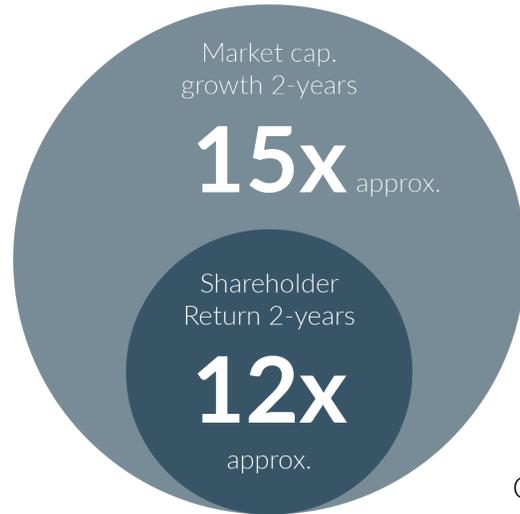
**Quantum computing, deep tech,  
semiconductor devices, chips**

Shareholder Return

**+206%**

*12 months as of 25 Oct 2021*

# / Company Strategy in Action



As of 25 October 2021.

A person wearing a blue cleanroom suit, including a hood and gloves, is working on a complex piece of industrial machinery. The person is leaning over the machine, which has various components, pipes, and a control panel. The background shows a cleanroom environment with other equipment and a door.

# ARCHER IS DEVELOPING ADVANCED SEMICONDUCTOR DEVICES

## / Semiconductor Industry

Archer is a technology company that operates within the semiconductor industry:

- + The Office of the NSW Chief Scientist & Engineer<sup>†</sup> presents a positive long-term outlook for the potential of increased participation by companies such as Archer in the global semiconductor sector.
- + The largest areas of opportunity for the scaleup of companies such as Archer in the global semiconductor industry, includes enhancing domestic capability in semiconductor design, fabrication, and prototyping.
- + According to KPMG\*, the top issues facing the semiconductor industry over the next three years include supply chain disruption, talent risk, and cross border regulations.

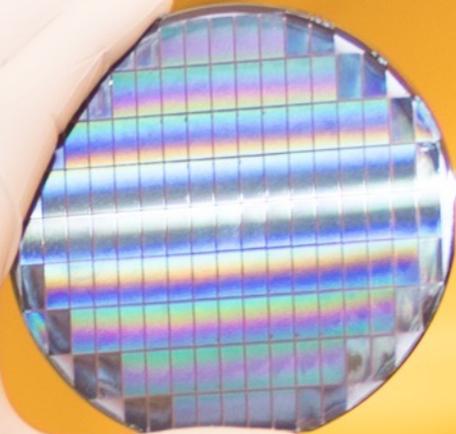
<sup>†</sup> <https://www.chiefscientist.nsw.gov.au/independent-reports/australian-semiconductor-sector-study>  
 Further Insights: <https://www.mckinsey.com/industries/semiconductors/our-insights>  
 Also; \*<https://advisory.kpmg.us/articles/2021/global-semiconductor-industry-outlook-2021.html>

### Products representing growth opportunity for the semiconductor industry over the next year

(Averages on a 1 to 5 scale with 1=Low growth opportunity and 5=High growth opportunity.)

	2021 Outlook	2020 Outlook
Sensors/MEMS	3.8	3.7
Analog/RF/Mixed Signal	3.7	3.5
Microprocessors (GPU/MCU/MPU)	3.6	3.2
Optoelectronics	3.3	3.1
Memory (Flash, DRAM)	3.3	3.0
Other Logic	3.0	2.8
Discrettes	2.9	2.6

**QUANTUM  
COMPUTING IS  
REVOLUTIONARY  
DEEP-TECH**



# / Quantum Computing vs. Classical Computing

$|\psi\rangle$  Quantum computing qubit is a new way to represent information using quantum states in different materials and light

$|\phi\rangle$  Qubit materials are the physical basis of quantum computing tech e.g. silicon, superconductors, diamond and carbon, etc.

$|\downarrow_x\rangle$  Qubit processor unit (QPU) is the most crucial hardware device of a quantum computer, and is an entirely new type of processor technology

$|\uparrow_x\rangle$  Quantum computing represents the next generation of powerful computing & is under development, with limited ownership & use

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 01101100 01110011 00100000 01101001 01100001  
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$$|\psi\rangle = a_\psi |\uparrow_z\rangle + b_\psi |\downarrow_z\rangle$$

$$\sum_{x \in \{0, \dots, Q-1\}; f(x)=z} \omega^{xy} = \sum_{b=0}^{m-1} \omega^{(x_0+rb)y} = \omega^{x_0y} \sum_{b=0}^{m-1} \omega^{rby}$$

$$Pr(|y, z\rangle) = \left| \frac{1}{Q} \sum_{x \in \{0, \dots, Q-1\}; f(x)=z} \omega^{xy} \right|^2 = \frac{1}{Q^2} \left| \sum_{b=0}^{m-1} \omega^{(x_0+rb)y} \right|^2 = \frac{1}{Q^2} |\omega^{x_0y}|^2 \left| \sum_{b=0}^{m-1} \omega^{rby} \right|^2 = \frac{1}{Q^2} \left| \sum_{b=0}^{m-1} \omega^{rby} \right|^2 = \frac{1}{Q^2} \frac{\omega^{mry} - 1}{\omega^{ry} - 1}$$

**00** Classical bit is processable information in a binary 0 or 1 state as a static, electronic signal

**01** Semiconductor materials are the basis of modern tech and used to make transistors & capacitors

**10** Central processing unit (CPU) is the device inside phones & PCs responsible for performance and function *i.e* processor chip

**11** Modern computing in phones, tablets, & PCs is converging, needing more powerful 'PUs' *e.g.* functionality



\*More information, by Dr M. Choucair, Mar 26 2021: <https://www.ibm.com/blogs/ibm-anz/why-quantum-deserves-your-attention/>



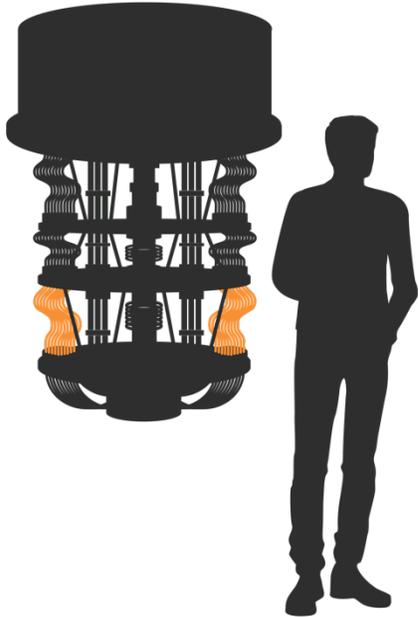
## / Unique Technological Advantage

Archer is in the developmental stage of building an operational quantum computing qubit processor chip ( $^{12}\text{CQ}$  chip):

- + Using a qubit material with the proven potential to enable chip operation at room-temperature *and* integration onboard electronic devices<sup>†</sup>.
- + The  $^{12}\text{CQ}$  chip would potentially allow for practicality and miniaturisation of a quantum computing processor device onboard mobile devices for faster and increased power in AI, Big Data, and Fintech applications.
- +  $^{12}\text{CQ}$  qubit advantageous to other qubit systems, which require low temperatures, high/low pressures, well-defined crystals, atomic manipulation, photonics, lasers, or metals to currently operate and scale.

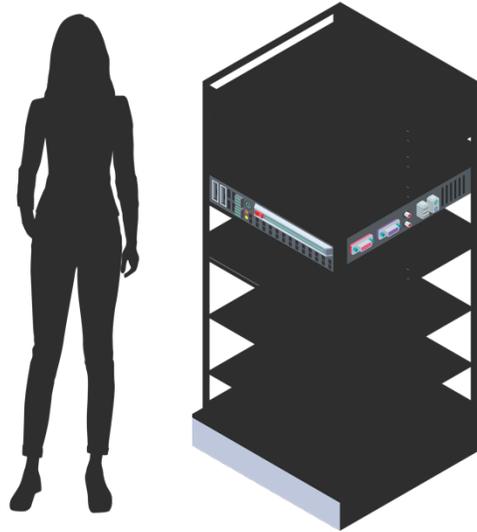
<sup>†</sup> <https://www.nature.com/articles/ncomms12232>

## / Accessibility and Use in Quantum Computing



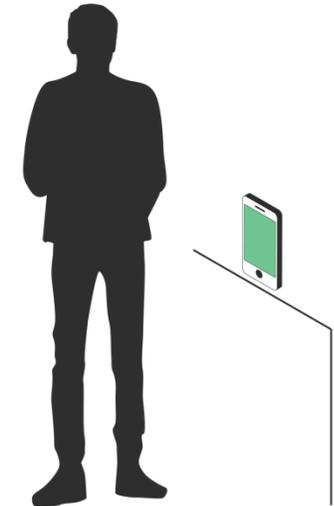
### Cloud-based

- + Require ultra-low temperatures and infrastructure to operate. Accessed via the cloud. e.g. Superconductor, silicon, topological.



### Edge and/or Cloud-based

- + Operate at room temperature but are difficult to integrate into modern devices. Installed on-site. e.g. Photonic, ion-traps, diamond.

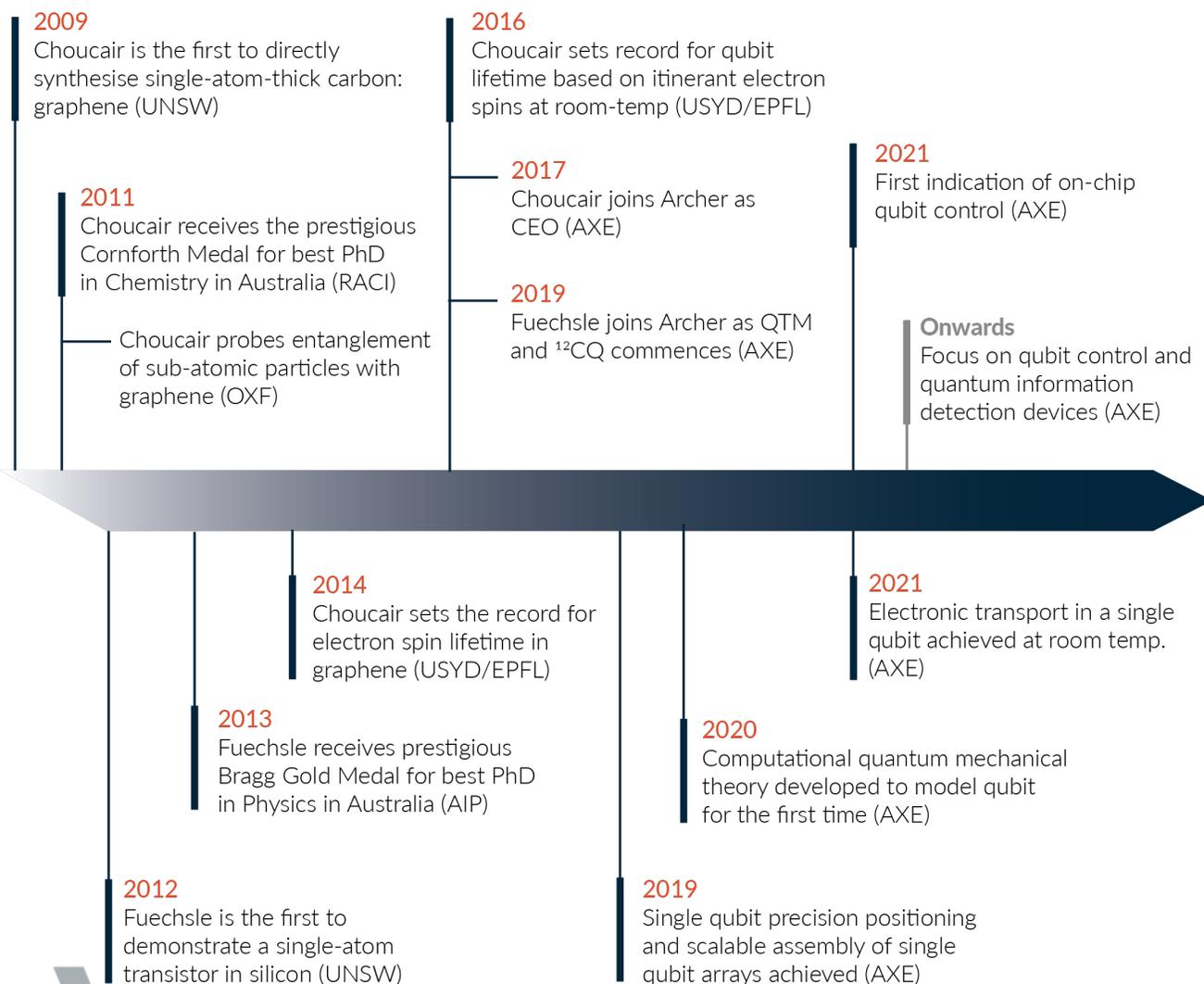


### Quantum Powered Mobile Devices

- + QPMDs will require practical qubit processors that integrate into modern devices. e.g.  $^{12}\text{CQ}$  chip development.



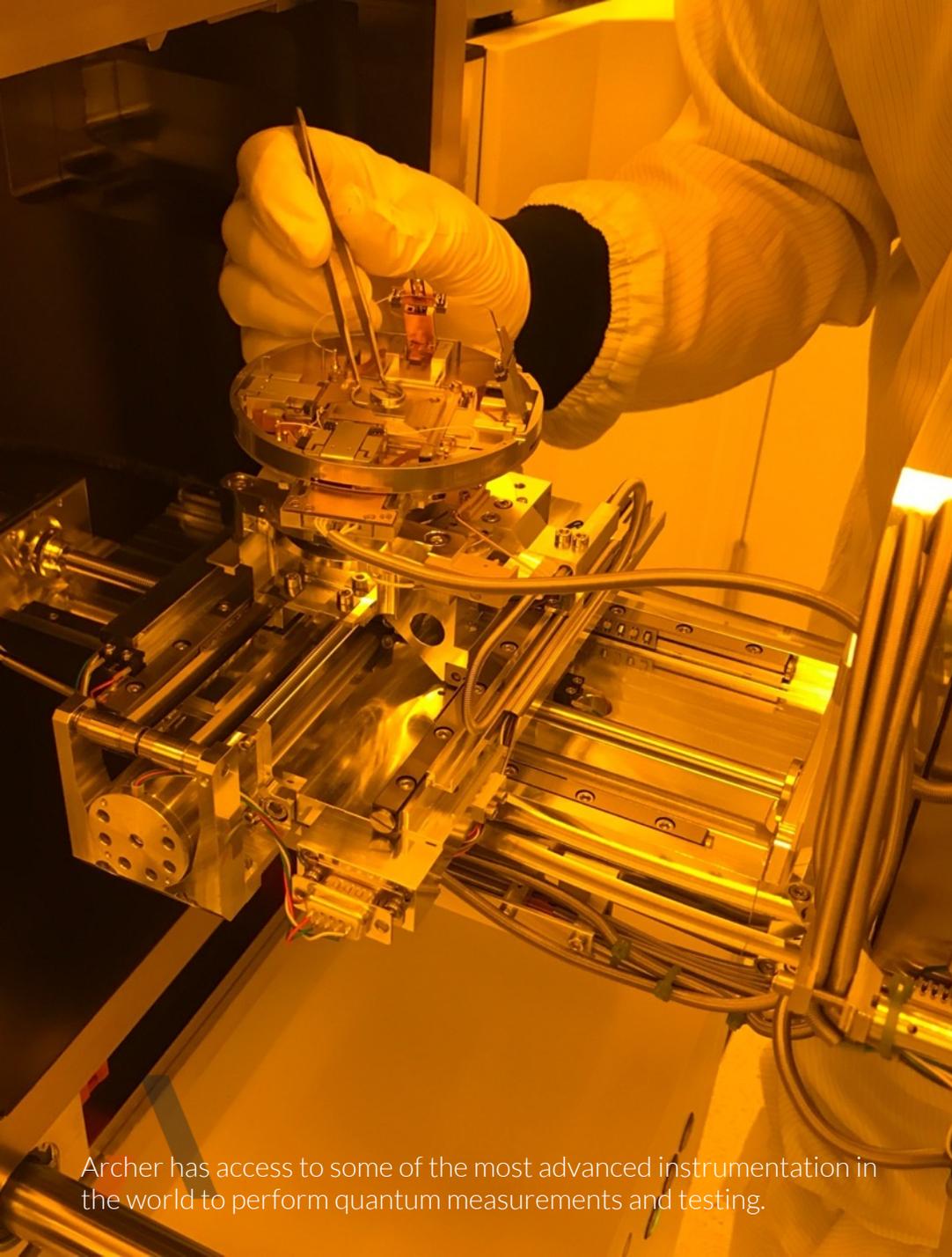
## / Record Setting Innovation



† References: <https://www.nature.com/articles/nnano.2008.365>; <https://www.nature.com/articles/nnano.2012.21>; <https://www.nature.com/articles/ncomms12232>; <https://pubs.acs.org/doi/10.1021/nl202866q>; <https://doi.org/10.1016/j.carbon.2014.03.046>



Archer has access to institutional deep tech infrastructure across Australia to build and test its quantum materials and devices.



Archer has access to some of the most advanced instrumentation in the world to perform quantum measurements and testing.

## / Era of Quantum Computing

According to BCG<sup>†</sup> and Goldman Sachs<sup>‡</sup>, value for investors in the quantum computing economy is expected to increase rapidly as quantum hardware is developed:

- + The CSIRO<sup>§</sup> reported Australian quantum tech could create A\$4 billion revenue and 16,000 new jobs by 2040.
- + The US National Quantum Initiative Act was signed into US law on Dec 21, 2018\* with the US planning to invest US\$170+ billion on advanced tech and semiconductors including quantum computing\*\*.
- + The International Roadmap for Devices and Systems lists Quantum Computing a key tech in the 'post-Moore' era<sup>‡</sup>.

<sup>†</sup> <https://www.bcg.com/en-au/publications/2019/quantum-computers-create-value-when.aspx>

<sup>‡</sup> <http://www.goldmansachs.com/our-thinking/pages/toshiya-hari-quantum-computing.html>

<sup>§</sup> <https://www.csiro.au/en/Showcase/quantum/>

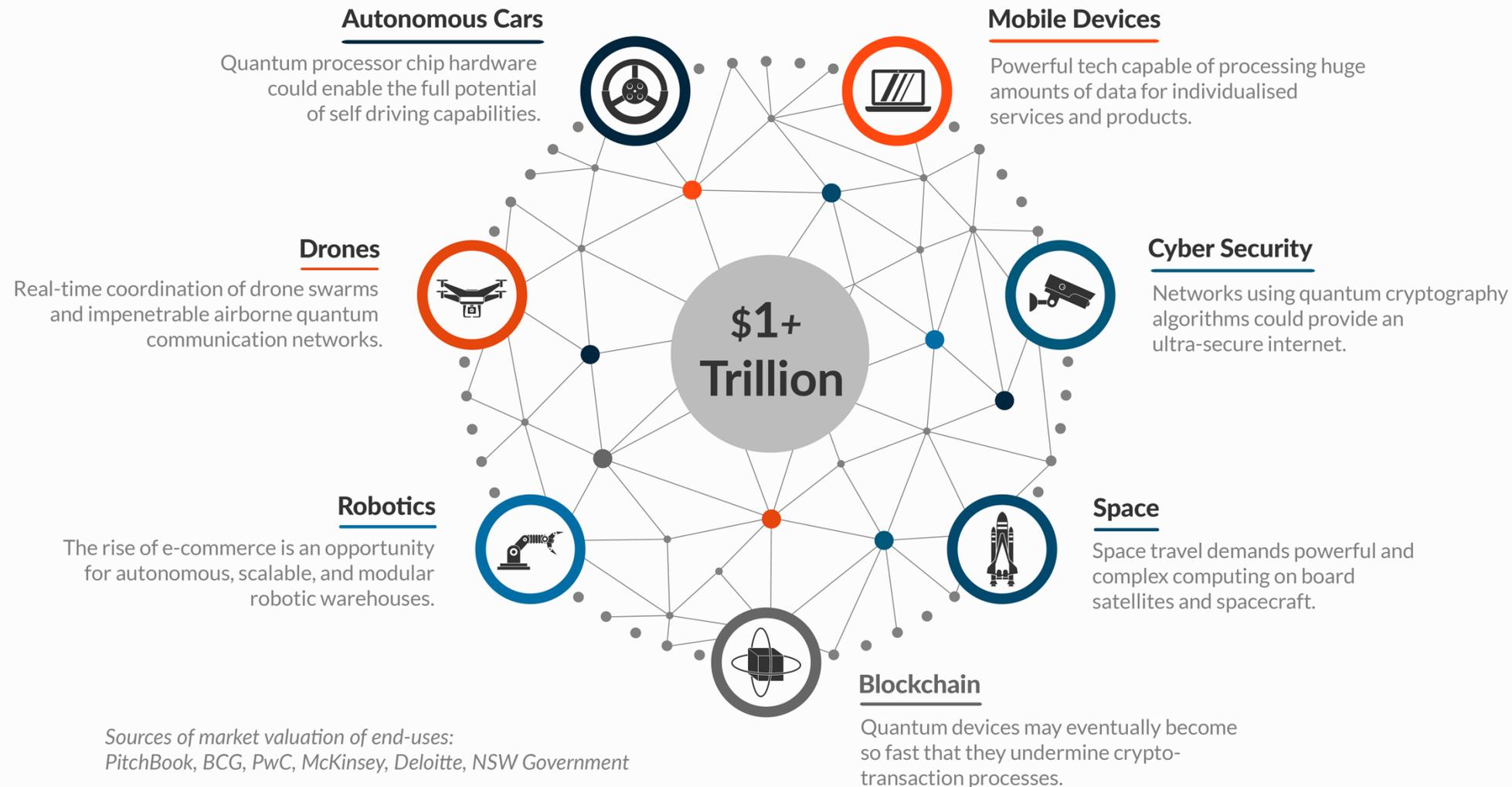
\* <https://www.congress.gov/bill/115th-congress/house-bill/6227>

\*\* <https://www.congress.gov/bill/117th-congress/senate-bill/1260>

<sup>‡</sup> [https://en.wikipedia.org/wiki/International\\_Roadmap\\_for\\_Devices\\_and\\_Systems](https://en.wikipedia.org/wiki/International_Roadmap_for_Devices_and_Systems)

# The Future of Technology

We expect Archer's quantum chip technology to create entirely new quantum computing powered mobile devices that enable industry-wide innovation.

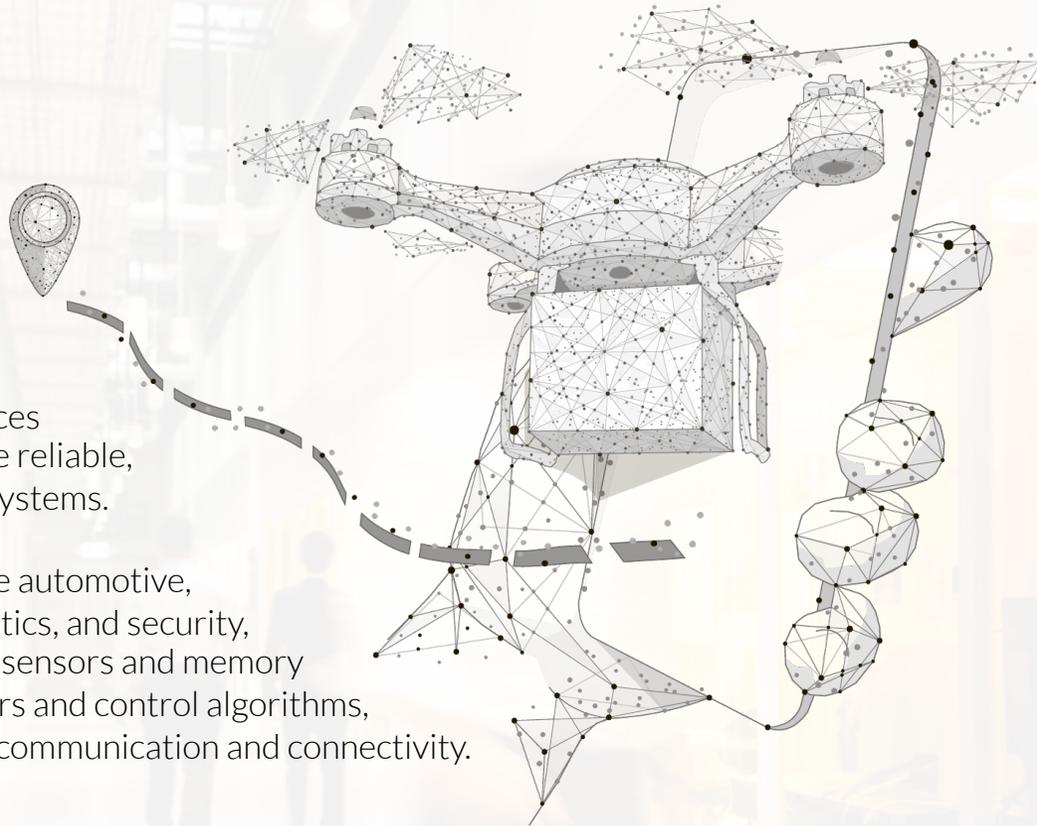


# Mobile-centric quantum powered applications

## Autonomous Technology

Over the next decade, quantum powered devices could enable safer, more reliable, and truly autonomous systems.

Mobile end-uses include automotive, maritime, aviation, robotics, and security, requiring integration of sensors and memory with quantum processors and control algorithms, embedded with secure communication and connectivity.



## Application Areas

Finance

24

Nature

111

Machine Learning

32

Optimisation

28

Number of publications from members of the IBM Quantum Network as of April 2021. Nature includes the fields of physics and chemistry.

## Quantum Computing Collaborations

**IBM Q  
Network**

Archer is a member of the IBM Quantum Network and the associated Quantum Startup Program.



**ARCHER'S TECHNOLOGY  
DEVELOPMENT IS LED BY  
PIONEERING INNOVATORS**





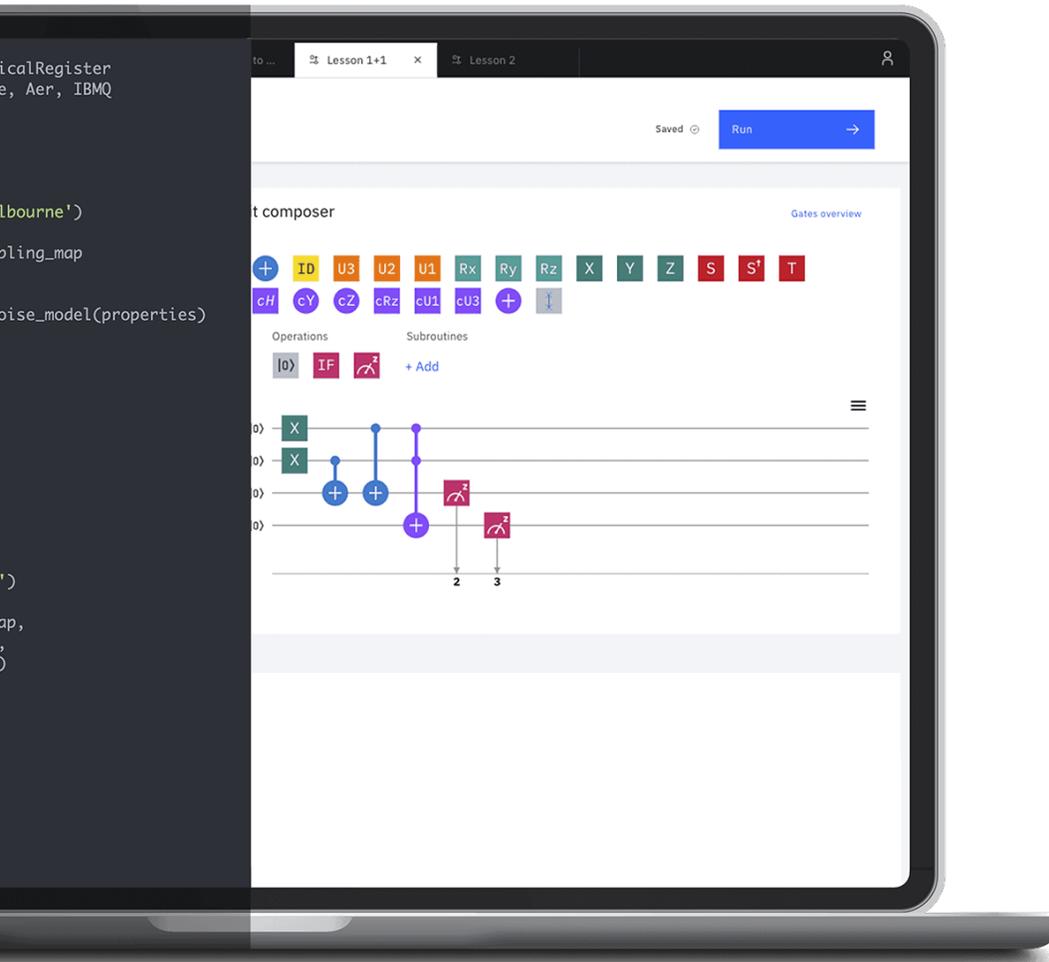
Dr Mohammad Choucair (left) and Dr Martin Fuechsle (right).

## / Innovation and Leadership

The Archer team works with nanotechnologists, physicists, chemists, semiconductor foundry engineers, and quantum algorithm developers from around the world. Archer's  $^{12}\text{CQ}$  chip development is led by:

**Dr Mohammad Choucair** *FRACI FRSN GAICD*. Archer CEO since Dec 2017. PhD in Chemistry (UNSW). Alumni of AGSM UNSW Business School. Former World Economic Forum Global Councillor. Inventor of the  $^{12}\text{CQ}$  quantum computing technology. RACI Cornforth Medallist for the most outstanding Chemistry PhD in Australia. Honorary Fellow of the University of Sydney.

**Dr Martin Fuechsle** *MRSN*. Archer Quantum Technology Manager since Feb 2019. PhD in Physics (UNSW). Over 10 years experience in building quantum computing devices and technology. AIP Bragg Gold Medallist for the most outstanding Physics PhD in Australia. Inventor of the single-atom transistor. Honorary Associate of the University of Sydney.



IBM's Qiskit interface showing a quantum computing gate compiler. Image sourced from IBM website.

## / Global Partnerships

Archer entered into an agreement with IBM to collaborate on the advancement of quantum computing, supporting:

- + Archer's plans to use Qiskit as the software stack for  $^{12}\text{CQ}$  chip processors and to participate in the global IBM Quantum Network<sup>†</sup>.
- + The Company's access to the IBM Quantum Computation Center, which includes the most advanced quantum computers available to explore practical applications.
- + The demonstration of Qiskit's flexibility, integrating with different quantum hardware (e.g.  $^{12}\text{CQ}$  chip processors) to accomplish the goal of enabling *practical* quantum computing applications.

<sup>†</sup>ASX announcement 4 May 2021.



**WELL PROTECTED IP IS  
CHARACTERISTIC OF  
DEEP TECHNOLOGY**

## Exhibit 2. Description of Archer's technology patents and patent applications

Priority Date	Technology Summary
3 Dec 2015	<p>■ <b>A quantum electronic device.</b> Quantum electronic devices for processing qubits represented by an electron spin on a new type of carbon nanomaterial and methods for using this material in quantum computing.</p>

Stage & Coverage	Patent/Application Number
------------------	---------------------------

**Granted**

Japan	6809670
South Korea	10-2288974
China	4606612
United States of America	11126925

**Pending**

Australia	2016363118
Hong Kong	18115770.4
Europe	3383792

15 Feb 2019	<p>■ <b>Graphene complexes and compositions thereof.</b> Complexes comprising graphene compositions, methods of synthesising these complexes and compositions, and the use of these complexes and compositions in biomolecular sensing.</p>
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Stage & Coverage	Patent/Application Number
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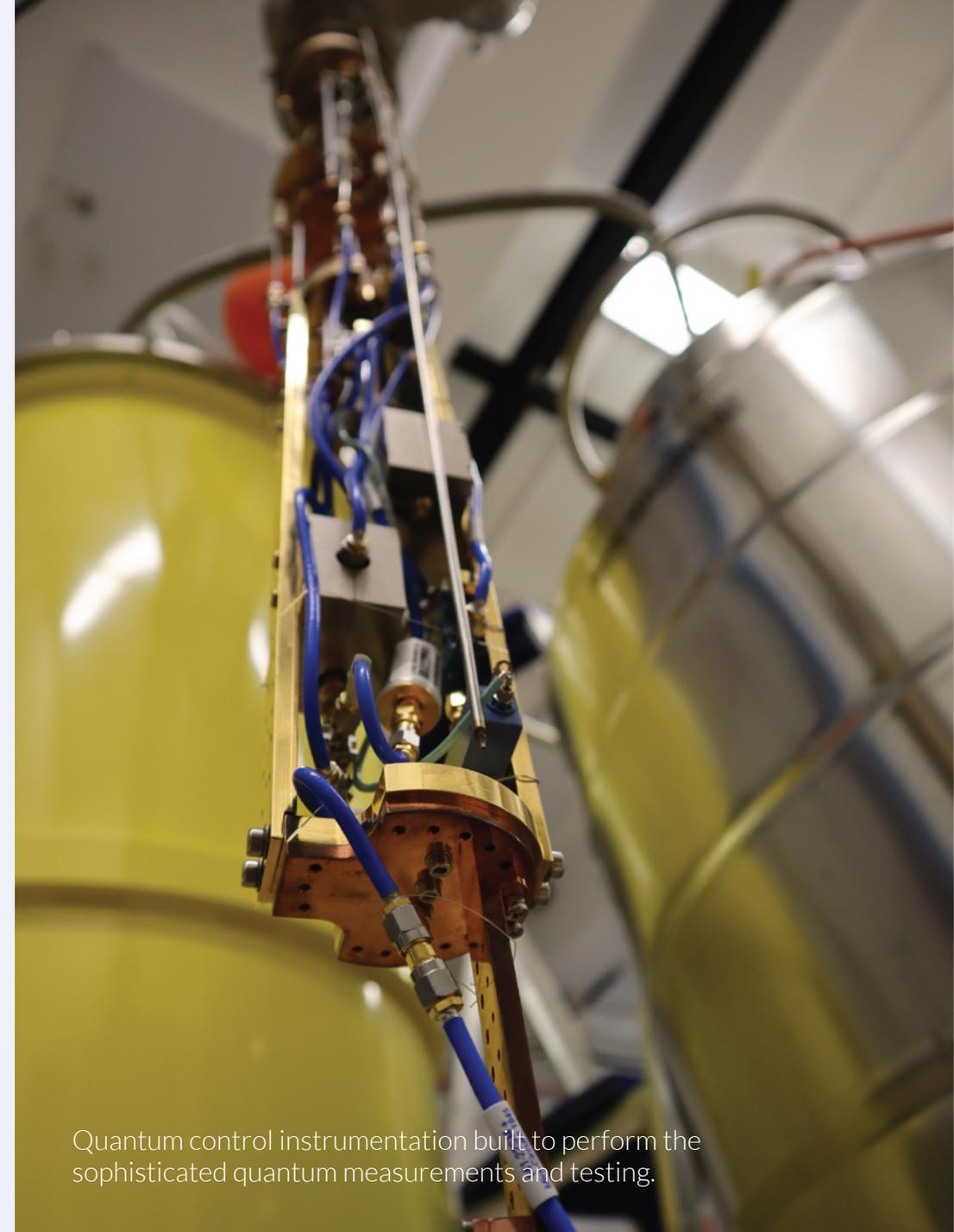
**Pending**

Australia	2020220236
United States of America	17429442

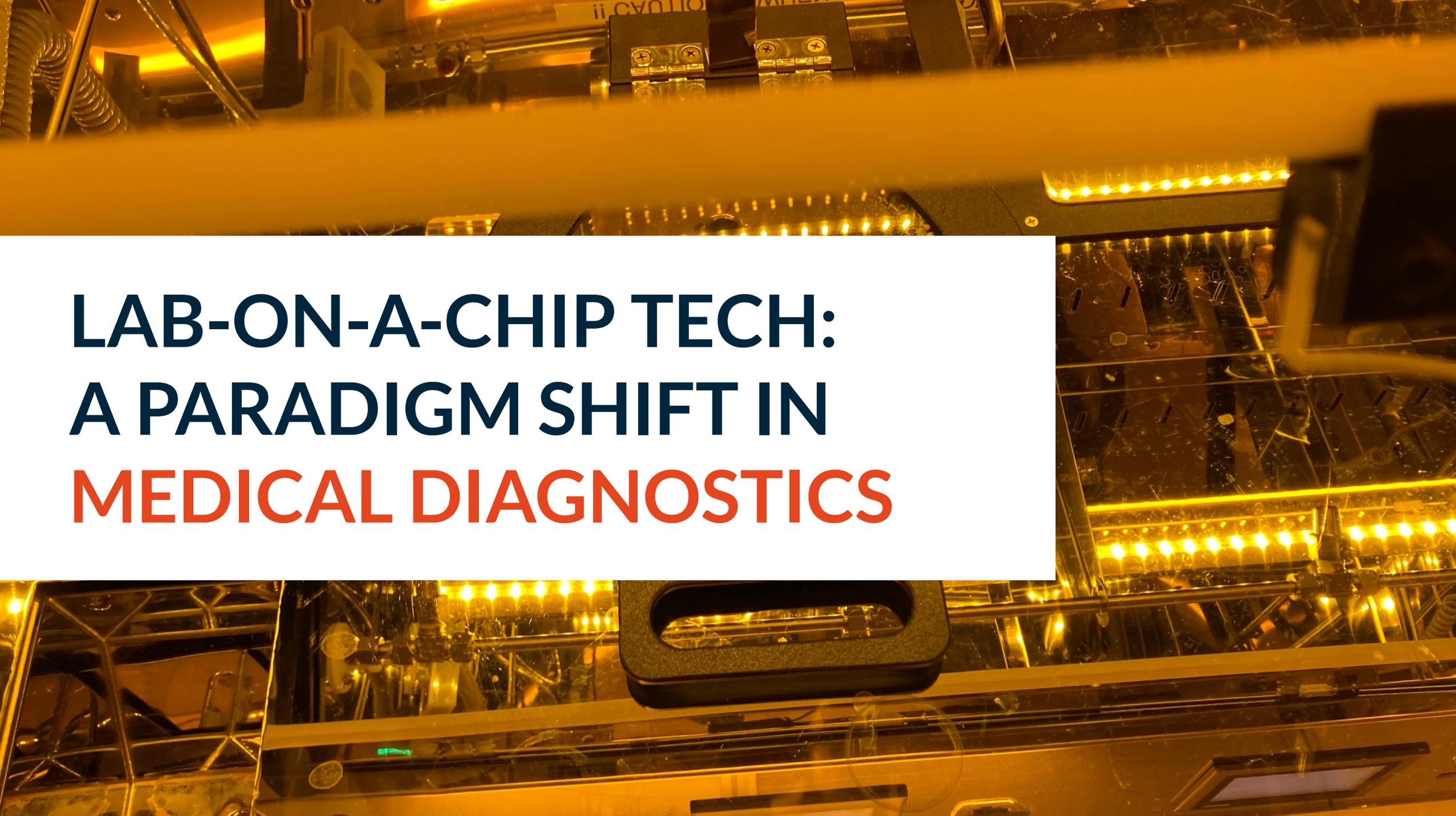
Patent Family

■ <sup>12</sup>CQ chip ■ Biochip

As of 25 Oct 2021. <sup>12</sup>CQ chip related patent portfolio exclusively licenced to Archer from the University of Sydney. Biochip patent applications 100% owned by Archer.



Quantum control instrumentation built to perform the sophisticated quantum measurements and testing.



**LAB-ON-A-CHIP TECH:  
A PARADIGM SHIFT IN  
MEDICAL DIAGNOSTICS**

# / Lab-on-a-Chip Diagnostics

 **Performance**  
Linked to materials' optical, electrical, magnetic, and/or chemical properties

 **Graphene Biosensors**  
Could provide rapid, highly sensitive and low-cost testing for IVDs

 **Limited Materials**  
Few materials available to directly read out molecular-level based bioactivity

 **Ultrasensitivity**  
Graphene is electronically active & biocompatible, disrupting non-portable optical IVDs



 **Biochip Design**  
Subset of Sensors/MEMS chip devices functioning in biological settings

 **Miniaturisation**  
Scaling single or multiple lab processes down to mm-size chip-formats

 **Integration**  
Several lab functions on a single chip, while eliminating some functions

 **Platform Technology**  
Digitising simultaneous biochemical reactions to achieve automation & high throughput

\*More information on Australian regulations related to In-vitro Diagnostics (IVDs): <https://www.tga.gov.au/medical-devices-ivds>  
Learn more about Lab-on-a-Chip technology developments: <https://www.rsc.org/journals-books-databases/about-journals/lab-on-a-chip/>

## / Developing Archer's Biochip

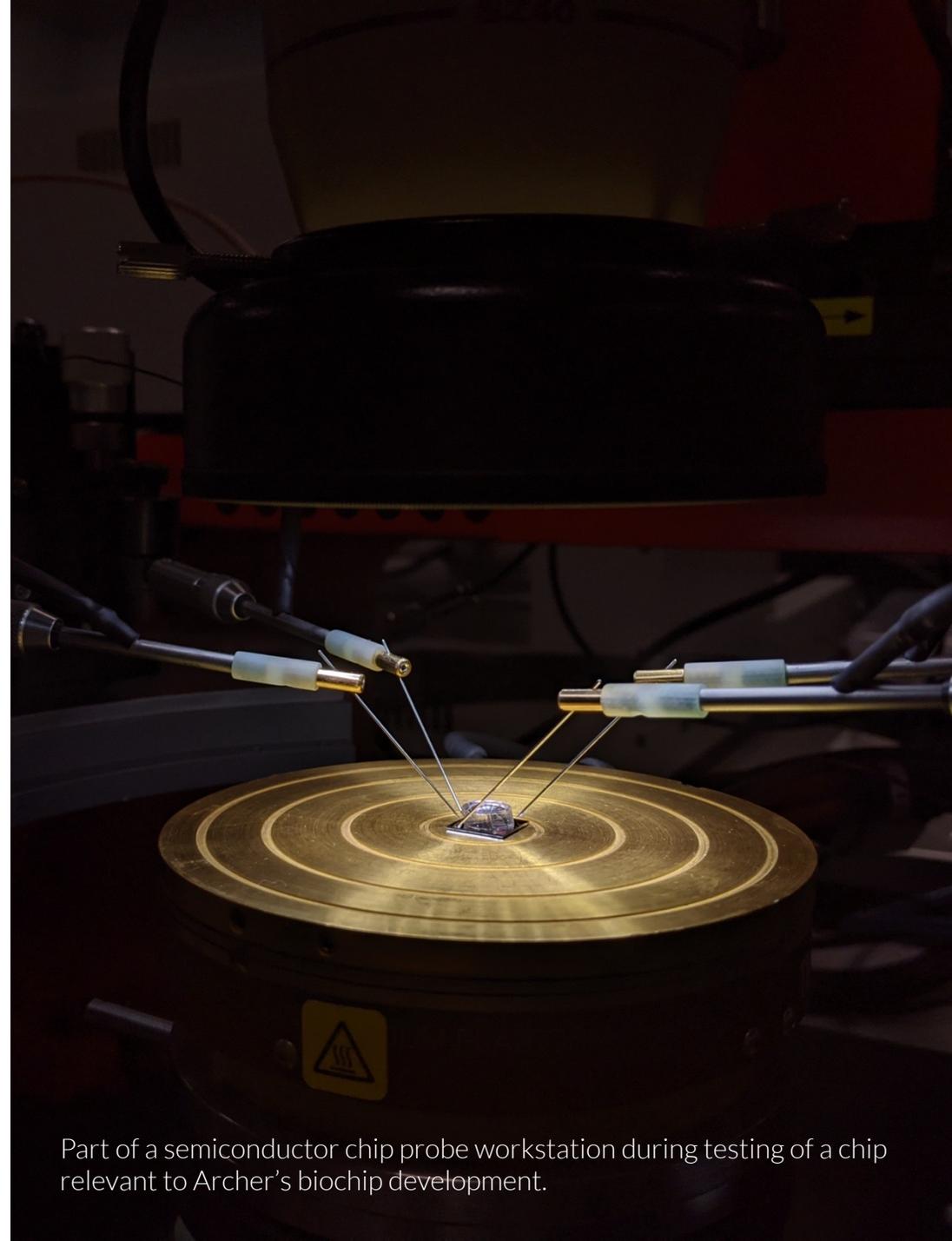
Archer's biochip is in early-stage development and its design principles involve using proprietary graphene materials in integrated circuits, to form key biosensing elements:

- + Archer continues to strategically secure access to local institutional deep-tech infrastructure to grow its capability in semiconductor prototyping production.
- + The Company is working towards developing foundry fabricated graphene transistors using 100% owned IP, at the limits of what can be achieved technologically<sup>‡</sup>.
- + During his PhD at UNSW Sydney, Archer CEO, Dr Mohammad Choucair, was the first in the world to directly synthesise graphene in bulk-scale quantities; and not use graphite<sup>†</sup>.



<sup>‡</sup> International Patent Application No. PCT/AU2020/050128

<sup>†</sup> <https://www.nature.com/articles/nnano.2008.365>



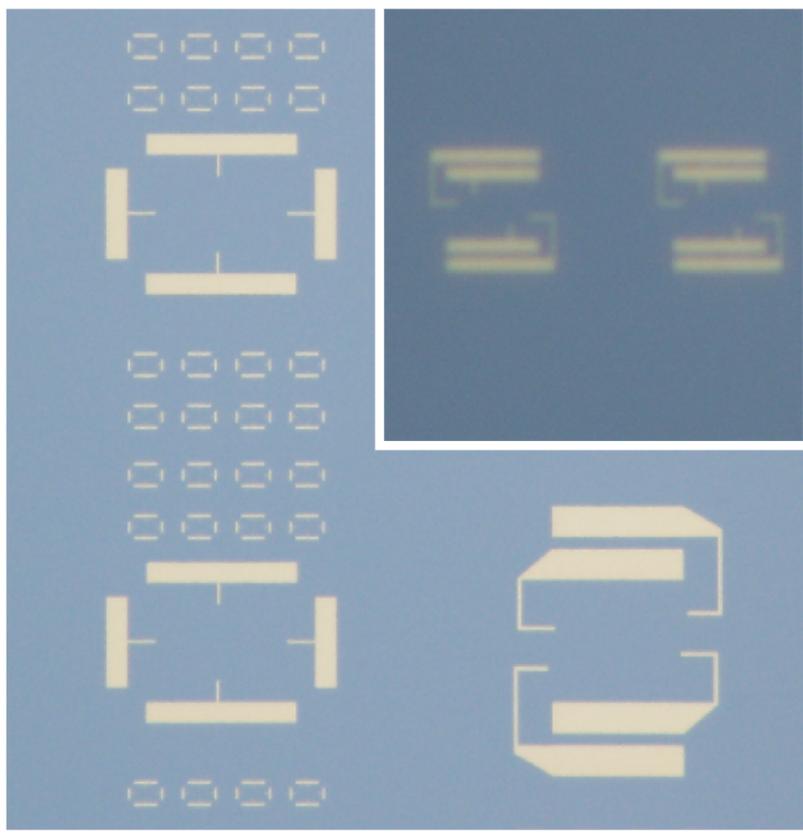
Part of a semiconductor chip probe workstation during testing of a chip relevant to Archer's biochip development.

## / Two-dimensional Miniaturisation

Archer has made rapid progress over the past 12 months and is now able to miniaturise its biosensing components to chip-formats, overcoming a key barrier to entry in lab-on-a-chip device development:

- + Successfully demonstrated fabrication of biosensor components of ca. 100 nm features on silicon wafers\*, which could enable high volume chip production.
- + Company has used and expanded in-house capability to miniaturise key biosensor components from 1 sensor component per  $\text{cm}^2$  to potentially 1 million+ sensor components per  $\text{cm}^2$ .
- + Archer's team includes cross-functional expertise in semiconductor device fabrication, nanotech, advanced materials engineering, and molecular biology, to grow a world-class IP portfolio.

\* The Company is currently working towards achieving best-in-class sub-10 nm feature sizes. ASX announcement 8 April 2021.



Nanofabricated biosensor components on silicon which potentially translate to millions of components per  $\text{cm}^2$ .

**ASX Code: AXE**

ACN: 123 993 233

The Board of Archer authorised this announcement to be given to ASX.

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