A brief commentary on psiQUANTUM

C.P. Foley

This information has been gathered considering the literature, patent data bases and other material at hand.

The psiQUANTUM web site has their history with scientific milestones:

Year	Breakthrough and reference	Who did it
2003	Demonstration of an all-optical quantum controlled-NOT gate https://www.nature.com/articles/nature02054	JL O'Brien, GJ Pryde, AG White, TC Ralph and D Branning Griffith, UQ, U Illinois
2005	Resource-Efficient Linear Optical Quantum Computation https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.95.010501	DE Browne and T Rudolf Imperial College and Oxford U
2008	Silica-on-Silicon Waveguide Quantum Circuits https://www.science.org/doi/abs/10.1126/science.1155441	A Politi, MJ Cryan, JG Rarity, S Yu and JL O'Brien U Bristol,
2013	Quantum chip connected to internet is yours to command https://www.newscientist.com/article/dn24159-quantum-chip-connected-to-internet-is-yours-to-command/	Article in New Scientist by third party not a peer reviewed paper
2014	A variational eigenvalue solver on a photonic quantum processor https://www.nature.com/articles/ncomms5213	A Peruzzo J McClean P Shadbolt, MH Yung, XQ Zhou, P. Love A Asprp-Guzik and JL O'Brien U Syd, U Bristol, Harvard, Tsingua U, Haverford College,
2015	From Three-Photon Greenberger-Horne-Zeilinger States to Ballistic Universal Quantum Computation https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.115.020502	M Gimeno-Segovia, P Shadbolt, DE Browne and T Rudolph Imperial and UCL
2015	PsiQUANTUM founded	J O'Brien, T Rudolf, P Shadbolt and Mark Thompson
2021 Jan	Fusion-based quantum computation https://arxiv.org/abs/2101.09310 Note not yet published submitted 26/1/21	S. Bartolucci, P. Birchall, H. Bombin, H. Cable, C. Dawson, M. Gimeno-Segovia, E Johnston, K Kieling, N Nickerson, M Pant, F. Pastawski, T Rudolf and C. Sparrow psiQUANTUM
2021 May	Announce plan to build a full scale QC with Global Foundries	Press release
2021 Jul	Series D funding raises $450M.	Press release.

Research Literature

A Web of Science search has 10 psiQuantum papers listed when searched using psiQuantum as the address. One is a guest editorial, 2 are conference abstracts. One paper is where the author has listed that they moved to psiQuantum but the work was done by Nokia Bell Labs. It also appears that many of the authors publish papers only using their academic address instead and not psiQuantum as the address. psiQuantum web site has a list of papers to refer to:

- Arxiv 4 – still in peer review and in some cases for some time
- Published 2

Google Scholar lists for the founders show they are publishing papers from their university addresses and not including psiQuantum. s33(a)(iii)

Patents

Derwent patent search using psiQuantum as the assignee has 116 patents listed. For comparison: SQC has 3 listed (noting much of their IP is probably still with the Centre), Rigetti has 73, ColdQuanta 43.

Technical status

At the meeting last week with psiQuantum, they put up a list of their target, status and state of the art.

This was not necessarily an authorised list to share. I have not been able it find this list on any web site or publication. s47(1)(b)

s47(1)(b)

This suggests these parameters can be met.

s47(1)(b)

s47G(1)

s33(a)(iii)

s22(1)(a)(ii)

From: Foley, Cathy
Sent: Thursday, 7 September 2023 7:38 PM
To: s22(1)(a)(ii)
Subject: s47G(1)

[SEC=OFFICIAL:Sensitive]

Hi Anthony,

s47G(1)

s47G(1)

s47G(1)

We might need to ask a bit more about their cryogenic modules. Also there might be some magnetic field impacts on their superconducting nanowire sensors that they may not realise will be an issue. Part of the packaging and systems integration. A lot of people who have not worked with superconductors do not realise that there are self-field effects and cross talk. I forgot to ask about that. This si very different from semiconductor components.

Cathy

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Advices Photonics Industry in Australia.

Summary

- Australia has no capability or IP in s47(1)(b) for photonics use.
- Australia has no research published concerning s47(1)(b) for photonics applications.
- Australia has no open access dedicated capability in ANFF or other facilities for depositing s47(1)(b) . They have generic deposition systems that could be used for this deposition.
- PsiQuantum have s47(1)(b) of the IP for s47(1)(b) photonics inventions.
- Plans for packing c be aligned or support program being considered in NSW.

s47(1)(b)

- PsiQuatnum could consider setting up s47(1)(b) foundry and fabrication of single photon detectros in Australia.

s47(1)(b)

s47(1)(b)

Where Australian strengths are:

Australia has been considering a photonics industry since the late 1990's.[1] With several other reports, a roadmap[2] by AEEMA in 2005 and a review of the Photonics industry in Australia and New Zealand in the ANZ OS in 2020[3]. Note this report is being updated for publication soon.

The ASPI Critical Technology tracker has Australia ranked in the top ten for research quality in photonic sensors which is a subset of the full research capacity:

- U Adelaide as 58th of world institutions ranked on H factor
- ANU 68th ranked on top 10% of publications s33(a)(iii)
- Australia is ranked 7th in the world for best quality research based on H factor and
- 9th based on proportion of publications in the top 10%.
- Australia produces 1.3% of the world's research in this subfield.

Packaging is a weakness for Australia. There is limited capability in CSIRO, RMIT, UNSW and University of Adelaide. This has been recognised in various reviews such as the NSW government review of the semiconductor industry [add ref] and the DSIR report done by BCG on 2021.
s47(1)(b)

NSW government as set up a Semiconductor Sector Service Bureau (S3B) that provides support for industry and researchers to access semiconductor foundries overseas and also provide design training.

Other things Psi are developing they don't list here that could be of interest.

s47(1)(b)

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[1] Photonics: Industry Overview : Update of the 1998 International Photonics Benchmarking Mission Report *Issue 14 of Emerging industries occasional paper*

Contributors	Australia. Department of Industry, Science, and Resources, Australia. Department of Industry, Tourism, and Resources, Australian Electrical and Electronic Manufacturers' Association
Publisher	Department of Industry, Science and Resources, 2002
Length	68 pages

[2] file://prod.protected.ind/user/user09/cf3037/Documents/Quantum/Photonics/2005-photonics-a-roadmap-for-the-australian-photonics-industry-aeema.pdf

[3] https://optics.org.au/resources/Documents/Lighting%20Economic%20Growth.pdf

s47(1)(b)

Australia has been considering a photonics industry since the late 1990's.[4] With several other reports, a roadmap[5] by AEEMA in 2005 and a review of the Photonics industry in Australia and New Zealand in the ANZ OS in 2020[6].

Stuff that might be useful but probably not

Definition of the photonics industry:

Research excellence and capacity:

Web of Science search using "photonic*" and "Australia" found 4988 papers of which 103 were highly cited. Top authors were: [note need to check world number of paper doing this search]

s22(1)(a)(ii)

s22(1)(a)(ii)

s22(1)(a)(ii)

s22(1)(a)(ii)

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Top research organisations were:

I Syd

ANU

Swinburne

RMIT

UTS

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[4]

Photonics: Industry Overview : Update of the 1998 International Photonics Benchmarking Mission Report
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Contributors	Australia. Department of Industry, Science, and Resources, Australia. Department of Industry, Tourism, and Resources, Australian Electrical and Electronic Manufacturers' Association
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[5] file://prod.protected.ind/user/user09/cf3037/Documents/Quantum/Photonics/2005-photonics-a-roadmap-for-the-australian-photonics-industry-aeema.pdf

[6] https://optics.org.au/resources/Documents/Lighting%20Economic%20Growth.pdf

Considering the last 5 years of research:

1343 papers with 542 in the highly cited ranking.

Top researchers:

s22(1)(a)(ii)

s22(1)(a)(ii)

s22(1)(a)(ii)

s22(1)(a)(ii)

s22(1)(a)(ii)

Top research institutions:

ANU

U Syd

RMIT

Swinburne

UTS.

ASPI Critical Tech Tracker has Australia ranked photonic sensors which is a sub set of the full research capacity:

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Australia produces 1.3% of the world's research in this particular subfield.

Industry sector:

Applications:

Health

Ag, mining environment

Energy

Communications

Automotive

Logistics

Defence/security

Smart home

Manufacturing and automation

Market segments:

Communications

Optical storage

I/O

Displays

Energy applications

Optical sensing

Others such as solid state lighting, integrated optics etc

Components

Sources

Detectors

Fibre and cable

Connectors

Passives

Displays Solar cells

Other

Summary of current industry:

Hidden – not have a specific industry code

Distributed – cross cutting

CAGR is about 7-10%

Determined in 2018 to be worth $$4.3B

Employs about 12.7k people

550 companies

Quantum photonics:

Check s22(1)(a)(ii) and s22(1)(a)(ii) on this.

s22(1)(a)(ii)

From: Foley, Cathy
Sent: Thursday, 22 December 2022 3:05 PM
To: s22(1)(a)(ii) ; s22(1)(a)(ii)
Cc: s22(1)(a)(ii) s22(1)(a)(ii)
Subject: RE: Psi Quantum - a couple more questions. [SEC=OFFICIAL]

Hi s22(1)(a)(ii)

Sorry I am sending this at the last moment.

For the technical review, the reviewers need to see:

- For the different components, what is the specification met on the bench and scaled up compared to what the specification is that is needed to deliver a QC. Then if the specification is not met, what other applications could use this level of technical achievement to mitigate the risk if the full error corrected QC is not possible. s47(1)(b)

s47(1)

- The assessors need to determine if the s47(1)(b) are meeting the specification needed for a QC.
- Roadmap is clear and achievable for the s47(1)(b) that still need to be fully developed.
- Assess to potential of their architecture to work.
- Assess the specification and effectiveness of the manufacturable package
- Seek up-to-date information as many of the technical slides have data that is old with the last specific data from 2021.
- s47(1)(b)
- Overall likelihood for success in the time frame psiQuantum has presented.

When I look at Australian capability in this area, most people are conflicted. So I have looked overseas to relevant people I know and respect for the UK and US.
Other names are:

s22(1)(a)(ii)
s22(1)(a)(ii) Including superconducting detector specialist
s22(1)(a)(ii) and recognised leader in quantum engineering and circuits also strong on fabrication s22(1)(a)(ii)
s22(1)(a)(ii) but could be perceived as conflicted as she works with s22(1)(a)(ii)
s22(1)(a)(ii) nanowire single photon detector specialist. Not sure if he is connected to psiqQuantum

Is tis what you are looking for?

Cathy

OFFICIAL