關鍵議題研究中心採購申請書

請購標的品名(中)	「多位元邏輯閘控制軟體」之軟體授權
請購標的品名(英)政採必填	Boulder Opal License
採購標的之性質種類	■財物(包含儀器設備、試劑耗材、財物購置、訂製、租賃、權利使用等..) □勞務(包含專業服務、技術服務、資訊服務、研究發展、維修、訓練、勞力等) □工程
規格及數量	1. 規格(廠牌名稱及型號、規格貨所需功能簡述) 詳如規格需求書 2. 履約期限：■本案分3批交貨，第1批履約期限為2024年11月30日、第2批履約期限為2025年6月30日，第三批履約期限為2025年12月1日。 3. 付款方式：■分期付款。 第一期款50%，第二期款25%，第三期款25%。付款方式為電匯，共分三期付款: 第一期款契約價金50%;第二期款契約價金25%;第三期款契約價金25%;各期款項在廠商提供控制程式授權碼經我方測試驗收完成後付款。驗收標準如附件。無保固期。 4. 保固期限：■ 無保固期 5. 交貨地點：中研院南部院區關鍵議題中心 6. 本採購以■外購方式進行
預估經費來源	113年 7104量子科技/業務費 (業務費流用至設備費) 資齡7
預估金額	美金112,200元
採購理由說明	
逕行(或限制)採購理由說明	一、因實驗研究需要，擬以逕行採購方式向澳洲「Q-CTRL」公司購買「多位元邏輯閘控制軟體Boulder Opal and Scale Up 」之軟體授權。 二、目前正在執行中的量子電腦計畫目標是要建構一台可擴充的高性能量子電腦，這量子電腦的核心就是量子處理器(QPU)，也因此是我們實驗室的核心工作。要能夠充分發揮QPU的效能，就需要有很優秀精準的量子位元控制程式，但由於系統的複雜性，控制程式已經成為另一門專業的工作，而這需要極大的人力與腦力資源的投資，這包含在量子物理、計算機邏輯程式以及大數據處理的專業訓練。由於專業領域上的不同，也為推進計畫的進度並力求QPU的表現，專業的量子控制程式開發公司因此應運而生。而在這方面，Q-Ctrl 公司 是這個領域的佼佼者。透過使用人工智慧驅動的量子基礎設施軟體，Q-Ctrl 能夠設計各種邏輯閘操作，使其對於開放環境中不可避免的相干性誤差具有極強的抵抗力。Q-Ctrl 技術通過解決該領域中最困難的問題，改變了量子計算機的實用性和效能。例如，他們在 IBM 的 Eagle 127q 設備上實現了 60 位元的 GHZ 態，而在這之前的紀錄僅為 32 位元 GHZ 態。此外，Q-Ctrl

	還致力於自動化專案，以提高多家公司學校(Quantware, Intel, Atom Computing NTT, and PASQAL, Chalmers, Nord Quantique 等)的運營效率和設備效能。例如，Q-Ctrl 能夠在不到 90 分鐘內完成對 IBM 量子位元控制設備的自動校準，而對另一家主要的 QPU 供應商 Regetti，則將調校時間從 4 天縮短至不到 4 小時。這些穩健性和自動化功能為我們提供了尖端工具，讓我們能夠在實用性方面不斷提高 QPU 的可擴展性。在這一採購案，Q-Ctrl 將以 Quantum Machines 控制儀器開發並以我們實驗室製作出來的 QPU 為樣品，首先先優化雙位元邏輯閘，之後隨者我們 QPU 位元的推展，最後拓展至 20 位元的操作。這不僅將可以表現出我們設計製作的 QPU 的能力，從長遠來看，更可通過抑制主要的誤差來源，使用我們的 QPU 執行必要的量子錯誤更正，並實現通用的超導量子電腦。本次採購將依程式完成度付款，並在時間上搭配我們計畫執行上的進度與需求，將會依照完成階段進行三期付款。 三、本標的為澳洲 Q-CTRL 公司專為我們量子晶片開發之軟體產品，屬獨家製造、獨家供應。由於國內無代理，故擬以逕行採購方式向原廠購買其產品「多位元邏輯閘控制軟體(Boulder Opal)之軟體建置及服務」，所需費用為新台幣 3,625,000 元(美金 112,200)元。敬請同意。
檢附文件	1.報價單 2.逕行採購理由說明書 3.需求規格書 4.採購單
備註	

以下欄位由承辦人員填寫			
採購方式	1. 辦理方式：☑逕行採購 、☐公告招標、☐公開招標、☐限制性招標、☐其他: 2. 議價方式：☐由請購單位與廠商口頭議價、☑與廠商開會議價。 3. 是否訂定合約：☑是、☐否。		
底價訂定	☑是，請購設施建議底價。 ☐其他: ☐否，小額採購(30 萬元)得不訂底價。		
請購人	採購人員	會計人員	單位主管
陳啟東	關鍵議題研究中心組員 黃齡嫻	關鍵議題研究中心組員 王薇茵	關鍵議題研究中心主任 李超煌

多位元邏輯閘控制軟體(Boulder Opal)之軟體建置及服務
規格需求書

Part 1: Delivery: Nov. 30, 2024

Onsite Software Installation:

○ Q-CTRL R&D team will conduct onsite installation of software at the Academia Sinica Lab.

- **Two-qubit gate and GHZ demonstration**

  Deliverable 1: Experiment initialization and technical handoff

  Description: Set up the prerequisite infrastructure and information handoff to complete the POC. This includes a technical briefing between Sinica and Q-CTRL to understand the current hardware states and formalize the official Target Values and setting up the necessary network access to Sinica HW.

  Success Criteria: Q-CTRL confirms all baseline metrics have been gathered, final target values set, and stable device access has been achieved.

  Deliverable 2: Experimentally tested two-qubit gate protocols.

  Description: Q-CTRL will create a process to design, calibrate, and optimize a two-qubit gate waveform with the goal to maximize gate fidelity on current 5-qubit devices.

  Success Criteria: Q-CTRL demonstrates performance at or above the target value in the above table. Or, demonstration of maximum possible performance given any hardware coherence limitations.

  Deliverable 3: GHZ state optimization through improved two-qubit waveform pulse protocols.

  Description: Using the novel two-qubit gate waveforms, Q-CTRL will test the fidelity of GHZ state preparation and identify residual errors likely arising from circuit-level sources, such as crosstalk. Only gate-level improvements will be used during these experiments on the current 5 qubit devices.

  Deliverable 4: Routine transfer to advanced devices

  Description: All work from Deliverables 1, 2, and 3 will be ported over to the new advanced device types.

  Success Criteria: N/A

License granted : Boulder Opal Performance Annual License

Part 2: Delivery: June 30, 2025

- **Scale up to 5-qubit**

  Deliverable: Integration of new two-qubit gate subroutines.

  Description: Upon completion of Part 1, Q-CTRL will provide an integrated version of those Part 1 routines for Sinica to use as needed. This includes native support for Quantum Machines controllers, and validation within their existing software infrastructure. This will only be done for the advanced devices.

  Success Criteria: Fully integrated solutions that provide the ability to invoke the new two-qubit gate optimization routine within the Sinica environment.

License granted : Boulder Opal Scale up 5 Qubit License

Part 3: Delivery: December 1, 2025

- **Scale up to 20-qubit**

  Deliverable: Collaborating on next steps

  Description: Based on the results and findings from Part 1 and 2, Q-CTRL will provide one or more options for continued performance improvements (unless none are evident). This may include:

  1. Further GHZ state optimizations based on circuit-level error suppression
  2. Automation and scope expansion of existing gate optimization protocols.
  3. A report of additional findings from Phase 1 and 2 of performance limiting factors not related to Q-CTRL scope (for example hardware related limitations)

  Success Criteria: Options delivered to Sinica and decisions made about next steps

License granted : Boulder Opal Scale up 20 Qubit License

報價單

Q-CTRL

Q-CTRL INC
1335 4th street
Santa Monica, CA
90401-1363
USA

Phone: +1 949 627 7524
Email: Dustin@q-ctrl.com

Quotation Number:
BoulderQuotation_AS01SEP24
Date:
01 September 2024
Quote Expiration Date:
30 November 2024

Academia Sinica
Address 1
Address 2
Country
+00 (000)10 101 1010

Dear Professor Chong,

Thank you for your interest in QCTRL. We value your organization and are committed to your success. We appreciate the opportunity to provide this quotation of Boulder Opal Scale up and look forward to working with Academia Sinica. This quote shall remain valid for 90 days from the date of this document.

Below you will find relevant quoted items:

1. Boulder Opal Scale up

Kind Regards,

Dustin Westerfeld
Director Technical Sales Q-CTRL
Dustin@q-ctrl.com
+1 949 627 7524

多位元邏輯閘控制軟體(Boulder Opal)之軟體建置及服務
規格需求書

Part 1: Delivery: Nov. 30, 2024

Onsite Software Installation:

○ Q-CTRL R&D team will conduct onsite installation of software at the Academia Sinica Lab.

- **Two-qubit gate and GHZ demonstration**

  Deliverable 1: Experiment initialization and technical handoff

  Description: Set up the prerequisite infrastructure and information handoff to complete the POC. This includes a technical briefing between Sinica and Q-CTRL to understand the current hardware states and formalize the official Target Values and setting up the necessary network access to Sinica HW.

  Success Criteria: Q-CTRL confirms all baseline metrics have been gathered, final target values set, and stable device access has been achieved.

  Deliverable 2: Experimentally tested two-qubit gate protocols.

  Description: Q-CTRL will create a process to design, calibrate, and optimize a two-qubit gate waveform with the goal to maximize gate fidelity on current 5-qubit devices.

  Success Criteria: Q-CTRL demonstrates performance at or above the target value in the above table. Or, demonstration of maximum possible performance given any hardware coherence limitations.

  Deliverable 3: GHZ state optimization through improved two-qubit waveform pulse protocols.

  Description: Using the novel two-qubit gate waveforms, Q-CTRL will test the fidelity of GHZ state preparation and identify residual errors likely arising from circuit-level sources, such as crosstalk. Only gate-level improvements will be used during these experiments on the current 5 qubit devices.

  Deliverable 4: Routine transfer to advanced devices

  Description: All work from Deliverables 1, 2, and 3 will be ported over to the new advanced device types.

  Success Criteria: N/A

License granted : Boulder Opal Performance Annual License

Part 2: Delivery: June 30, 2025

- **Scale up to 5-qubit**

  Deliverable: Integration of new two-qubit gate subroutines.

  Description: Upon completion of Part 1, Q-CTRL will provide an integrated version of those Part 1 routines for Sinica to use as needed. This includes native support for Quantum Machines controllers, and validation within their existing software infrastructure. This will only be done for the advanced devices.

  Success Criteria: Fully integrated solutions that provide the ability to invoke the new two-qubit gate optimization routine within the Sinica environment.

License granted : Boulder Opal Scale up 5 Qubit License

Part 3: Delivery: December 1, 2025

- **Scale up to 20-qubit**

  Deliverable: Collaborating on next steps

  Description: Based on the results and findings from Part 1 and 2, Q-CTRL will provide one or more options for continued performance improvements (unless none are evident). This may include:

  1. Further GHZ state optimizations based on circuit-level error suppression
  2. Automation and scope expansion of existing gate optimization protocols.
  3. A report of additional findings from Phase 1 and 2 of performance limiting factors not related to Q-CTRL scope (for example hardware related limitations)

  Success Criteria: Options delivered to Sinica and decisions made about next steps

License granted : Boulder Opal Scale up 20 Qubit License

Q-CTRL

Quoted Products

Item	Description Boulder Opal License 1 year	Quantity	Delivery Date	Cost[1]
1	**Boulder Opal Performance Annual License**	1	11/30/2024	$56,100
2	**Boulder Opal Scale Up 5 Qubit License**	1	6/30/2025	$28,050
3	**Boulder Opal Scale Up 20 Qubit License**	1	12/1/2025	$28,050
	TOTAL			$112,200

1 - All prices shown in USD

Delivery Timeline:
Boulder Opal Performance License Upon issue of purchase order or November 30, 2024..
Boulder Opal Scale Up 5 Qubit License - June 30, 2025.
Boulder Opal Scale Up 20 Qubit License - December 1, 2025.

Payment Terms:
All values in USD, applicable sales tax is not included.
Payment by credit card or bank transfer, Net 30
Payments:
3 Total Payments
Payment 1 50% of total
Payment 2 25% of total
Payment 3 25% of total

License Terms:
Available from the Boulder Opal terms of service