



**Consortium Name:** The Bloch, End-to-end Quantum Solutions at Scale

**Geography:** Chicago Naperville Elgin, IL IN WI MSA (Chicago MSA)

**Core Technology Area:** Quantum computing and quantum communications within KTFA #3, Quantum information science and technology (QIST)

**Constraints Met by Consortium:** Covered by Chicago EDA Regional Office; Significantly engages and benefits underserved communities in and near metropolitan areas.

**Abbreviations:** Consortium members' abbreviations can be found in CQE commitment letter.

## KEY DESIGNATION FACTORS FOR THE BLOCH

Led by CQE, "The Bloch" will lead the US in quantum computing and quantum communications within KFTA #3, QIST. Chicago's advantage lies in its research at leading QIST universities and National Labs, which is maturing into a cohort of companies eager to pursue QIST solutions for today's complex problems. The Chicago MSA is fertile ground for QIST customer adoption; no sector comprises more than 13% (World Business Chicago, 2022), of the regional economy, providing opportunities across sectors including finance, transportation, manufacturing, healthcare, and defense. The region has a unique joint commitment to ensure that underserved communities propel QIST by prioritizing their needs and jobs.

### FACTOR 1: Regional Technology-based Potential for Global Competitiveness

**Nature and Magnitude of Core Technology Area:** QIST will solve industry problems to address economic and national security. When realized, quantum computers will perform calculations faster than today's to model advanced optimization and simulation for logistics and drug discovery. Quantum communications will send secure data, preventing undetectable interception. The QIST market is still considered nascent with a rapidly growing market potential: \$106B and Compound Annual Growth Rate (CAGR) of over 30% by 2040. A Chicago MSA Tech Hub is estimated to capture up to 13% of market share by 2035 and up to \$8B in revenue annually, assuming a \$67B global market (McKinsey, 2023).

**Vision:** The Bloch will address dual market failures that prevent QIST companies from growing and being rapidly adopted. We will bring QIST to leading industries to jointly develop solutions of economic and national security importance. The Bloch members have committed to inclusively:

- 1. Establish end-to-end QIST industry solutions:** Our consortium represents multiple industries (finance, transportation, manufacturing) committed to building solutions for their sectors. As an initial focus, The Bloch will build on efforts with the financial sector, a top regional cluster in the Chicago MSA (US Cluster Mapping, 2023), with further initial focus on identity and fraud, a high potential area for QIST solutions that impact national security and underserved communities. This use case will be used to build a repeatable model to be adapted for other industries.
- 2. Build capacity for QIST companies:** QIST companies need facilities and equipment to grow and scale in the region (GAO, 2021). Universities and National Labs will explore opportunities to increase access to existing facilities, while economic development and public-private groups will build a first-in-the-nation collection of open-access shared use facilities across the MSA. These are critical for startups and growing companies to develop and manufacture devices, such as quantum repeaters needed for secure quantum-enhanced financial transactions.
- 3. Create pathways for QIST jobs:** Workforce training organizations, universities, and colleges commit to developing training and job placement programs, considering the labor needs of QIST companies and the industries that adopt the technologies. Economic development organizations will connect to labor unions to develop training and jobs for union members. For example, quantum proficient software engineers will be needed for finance to develop industry solutions, thereby creating a pathway for QIST jobs.

**Catalyzing Role of Designation and Phase II Implementation Funding:** Tech Hub Designation and funding is critical to the MSA for: **1)** Growing existing momentum and advancing opportunities to become a leader in building QIST solutions for industry; **2)** Creating shared-use facilities that complement existing infrastructure (cost- and space-prohibitive hardware is a major barrier for emerging companies) **3)** Scaling the STEM talent pool and workforce development to train QIST workforce, ensuring underserved communities are represented.

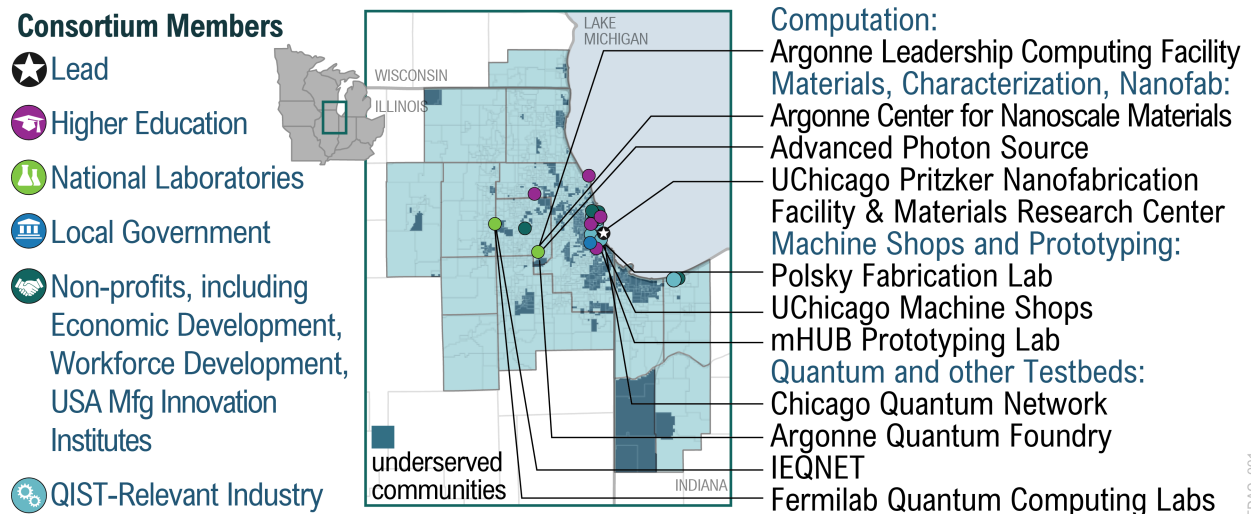
**Inventory of Existing Assets, Resources, and Capabilities:** Inventory includes the 124-mile Chicago Quantum Network, one of the longest in the US (Almeida, 2022); Duality, the first QIST accelerator in the US, supporting 15 startups and 6 new offices, attracting venture capital; and a NSF Type-2 Regional Innovation Engines finalist, the only in quantum technology (NSF, 2023). More assets, resources and capabilities are listed in **Figure 1**.

**Research Leadership:** The globally-recognized region’s 150 QIST researchers have \$450M in federal funds, 40% of National Quantum Initiative Act NSF and DOE centers: QuBBE, UChicago; HQAN, UIUC; Q-NEXT, Argonne; SQMS, Fermilab (NSF, 2023) (U.S. DOE, 2023), the largest QISE contracts per capita (WTIA, 2023), \$200M from the state of Illinois for research infrastructure, convened by CQE, one of the largest collaborative QIST teams in the country.

**Private Sector (see Factor 2):** Chicago MSA has a large, diversified economy, a dynamic startup ecosystem, and a robust record of private sector partnerships. There is a desire to build quantum solutions for industry markets and a need for expanded infrastructure and facilities to grow QIST companies to realize industry opportunities. Momentum can be seen through established efforts in finance with member Discover and a working group to develop QIST solutions for fraud.

**Education and Workforce (see Factor 5):** A robust QIST workforce pipeline is critical to advance quantum solutions, both in industry and academia, and the Chicago MSA is poised to deliver on this. The region has one of the 10 largest STEM workforces in the country and is in the top 10% of annual STEM graduates, with many workers in quantum-adjacent roles.

**Regional Share and Number of Jobs:** The region has 2-3% of the global QIST market today. With EDA and aligned commitments, the MSA could account for 13% by 2035. With only 4-6%, the MSA’s quantum workforce could be 5,600-8,300 strong by 2035 (vs. 300 today) with many non-PhDs in technical and non-technical roles. Most roles would exceed the regional median salary of \$66,000 [median wage of \$102-126,000 for adjacent roles today (McKinsey, 2023)].



**Figure 1: Assets, Resources, and Capabilities.** Consortium members and a selection of existing state-of-the-art computing, materials processing, and quantum measurement facilities.

**Equity and Diversity (see Factor 4):** The region promotes diversity in QIST and diverse STEM pathways. The Bloch is a pioneer, ensuring that industry demands are met inclusively.

## **FACTOR 2: Role of the Private Sector**

**Private Sector Consortium Members and Roles in Core Technology Area:** The Bloch has a history of private sector quantum computing and communications activity, including corporate partners, employers, researchers, and customers (**See Factor 3**). Members span industries with interest in using QIST solutions and users of infrastructure and facilities to grow QIST companies.

**Private Sector Strategy:** Chicago MSA has a large, diversified economy, second to New York in the number of Fortune 500 companies (Khan, 2022); a dynamic inclusive startup ecosystem, ranked #2 for women and BIPOC founders, home of the nation's first quantum accelerator; and a robust record of private sector partnerships.

The Bloch envisions a private sector strategy to: **1) Mobilize industry customers' solutions:** The Bloch members have a history of bringing experts together; co-led by Discover, large and small businesses, QIST companies, and the FBI recently gathered to explore quantum-enabled solutions for financial fraud and set the stage for the initial use cases The Bloch will explore (Federal Reserve Bank of Chicago has also been engaged); **2) Build QIST potential:** Quantum facilities will enable a step-change in bringing quantum to the market. Emerging QIST companies will benefit from accelerators such as Duality, that provide access to capital, facilities, and connections. The Bloch will also connect startups with venture capital (e.g. VCapital, Quantonation, Alumni Ventures, and Exposition Ventures), potential industry customers and peer QIST startups (Inflection, memQ, GLCT, qBraid, QuantCAD) and **3) Grow Private Sector Partnerships:** Toshiba is scaling technologies on the Chicago Quantum Network (Fore, 2022). IBM supports QIST at the UIUC, Discovery Accelerator, joint postdocs with CQE, and has a \$100M investment to develop a more powerful quantum computer with UChicago and UTokyo. Google invested \$50M in UChicago and UTokyo (Wong, 2023). The Bloch will continue this momentum.

## **FACTOR 3: Regional Coordination & Partnerships**

The Bloch has a shared vision to bring quantum computing and communications to the region's industries and jointly develop solutions that impact national, and economic security.

**Leadership and Regional Innovation Officer (RIO):** The CQE, housed at UChicago, is the lead, ensuring strategic alignment, transparency, and accountability to overall program requirements and specific member responsibilities. The CQE will employ the RIO (not yet identified), who will cultivate partnerships, convene stakeholders, and ensure accountability.

**History of Success:** The region has grown 15 startups since 2021 (Duality, 2023), is the only quantum finalist for the NSF Type-2 Regional Innovation Engine (NSF, 2023), and built one of the longest quantum communications networks in the US (Almeida, 2022).

## **FACTOR 4: Equity & Diversity**

**Commitment to Equity and Diversity:** The ecosystem has history of DEIA strategies and commitments, which will be leveraged for The Bloch. Prior successes include the attraction of QIST company EeroQ to grow in an Opportunity Zone; Discover's South Side Chatham Customer Care Center, a community technology hub with more than 500 mostly hyperlocal employees; and P33 and WBC programs increasing early-stage VC funding for female and BIPOC founders. Many Bloch members are in and work with underrepresented communities, such as the co-led Inclusive Innovation in the Sciences, which grows equity across Chicago's South Side through quantum advances. Through programs such as Argonne in Chicago, leading experts engage community members in quantum and other STEM subjects.

**Pipelines and Pathways:** The region has a diverse talent pipeline with above national average share of Hispanic and female STEM graduates (19% and 41%, respectively). Programs such as Open Quantum Initiative Undergraduate (OQI) Fellowships, continue to diversify its QIST workforce. The Bloch's Minority-serving Institutions (MSI) have demonstrated work to ensure continued engagement and representation in QIST planning, including new training programs and facilities. For example, CSU is a pioneer in physics and QIST education with 70% women, 87% Black, 7% Latino populations (NSF QuBBE, 2022) and CCC has multiple partnerships for QIST training.

**DEIA Strategy:** The Bloch will work with underserved communities to expand DEIA by building equitable: **1) Solutions:** As QIST creates new opportunities, The Bloch commits to prioritizing industry applications with equitable benefits. For example, the Bloch will prioritize fraud detection as an early use case. Financial fraud has disproportionate adverse impacts on low-income individuals and QIST-enhanced credit risk assessment/fraud detection has potential to expand services to underbanked communities (Dranoff, 2014). These communities will be engaged to prioritize challenges that QIST can tackle. **2) Physical infrastructure:** The Bloch will prioritize building shared physical infrastructure in underserved economic Opportunity Zones, including on the South and West sides of Chicago and in Northwest Indiana, and bring local neighborhoods into early stages of the planning process. mHUB, Quantum Corridor, and CSU will lead community engagement through working groups. **3) QIST workforce:** Members will develop and expand programs to bring traditionally underserved trainees and graduates into QIST. Evidence-based equity practices will expand programs including the Quantum Institute at CSU with quantum post-baccalaureate certificates (NSF QuBBE, 2022) and inclusive internships through the OQI and i.c.stars. (UChicago, 2023) (National Association of Colleges and Employers, 2022).

## FACTOR 5: Composition and Capacity of the Regional Workforce

**Workforce:** A lack of a quantum computing and communications workforce is a bottleneck across sectors. Chicago has one of the largest pipelines of quantum professionals, including the existing STEM workforce and associates, bachelor, master, and PhD trainees. We had 14,200 STEM degree completions in 2021 – the top 5 in the US. We have a STEM workforce of 261,000, among the 10 largest in the US, including 60,000 in key roles (computer hardware engineers, software developers, and computer systems analysts) with overlapping skill sets to key quantum roles (McKinsey, 2023). The region is poised to meet growing QIST workforce demands. These roles pay up to \$126,000, above the region median of \$66,000.

**Inclusive STEM and QIST Pathways:** The region's STEM is ahead of peers on racial, ethnic, and gender diversity, with programs to scale the QIST workforce at all levels to meet quantum computing and communications industry demand. **Pre-college:** TeachQuantum and Quantum Academy bring QIST to public teachers. **Community colleges:** Illinois boasts the US's third-largest community college system. More than 80% of science Certificate/Associates earners secure field employment within a year, aligning with QIST goals. Indiana's Ivy Tech is the largest singly accredited US community college. **Four-year universities:** CSU, UChicago, UIC, and UIUC are national leaders in QIST, with QIST AB and PhD programs. CSU graduates 50% of Illinois' Black physics graduates, more than half women. **Training:** i.c.stars, UIUC, City Scholars and Engineering pathways train underrepresented young adults in tech; CQE, UChicago, and UIUC run QISE certificates, and CSU is developing one with QuBBE (NSF QuBBE, 2022). CQE universities and the Moore Foundation, support OQI. **Increasing access:** QIST will integrate with existing initiatives to increase access to higher education and pathways to well-paying jobs, including collaborating with or expanding apprenticeships.

**Regional Coordination:** An EDA-funded P33 regional QIST workforce plan, will enable the scaling of our workforce in conjunction with industry needs and unions for good-paying jobs.

## FACTOR 6: Innovative “Lab to Market” Approaches

**Operating Model for QIST-enabled Industry Solutions:** The Bloch will leverage the region’s industries to bring quantum computing and communications solutions for their markets, national, and economic security. The Bloch will speed regional adoption, building a repeatable operating model for pre-competitive and proprietary industry solutions, starting with finance and including industries like transportation, manufacturing, healthcare, and defense. IBM may co-develop quantum computing software for applications, and demonstrate new quantum applications. MxD will provide manufacturing expertise for QIST encryption, for example, with NIST.

**Financial Sector Launch:** To capitalize on existing momentum, collaboration, and MSA strengths (US Cluster Mapping, 2023), The Bloch will immediately focus on the financial sector, building a QIST-enabled solution framework that can be adapted for other sectors. Discover will lead the development of quantum solutions for finance, including exploring applications of machine learning and quantum key distribution to reduce fraud, which costs the US economy \$85B annually (Federal Trade Commission, 2023). QIST-enabled finance will bring rapid solutions to market, with outsized impacts for underserved groups, creating jobs and spurring investment, with an ultimate impact on the economy and national security.

**Building Capacity through Shared-use facilities:** The Bloch will scale the full stack of materials, devices, and hardware to drive QIST market applications. To enable this vision and build capacity for future applications and companies, The Bloch will build first-in-the-nation open QIST infrastructure and increase QIST company access to shared-use facilities with specialized quantum hardware such as dilution refrigerators and optical tables. It will develop infrastructure with the vibration, temperature controlled, and electrical requirements to manufacture quantum computing and communications hardware. These facilities will be built across the MSA with members such as mHUB (Chicago, IL) and Quantum Corridor’s Fiber Smart House tech workforce development center (Gary, IN), both within underserved communities. The Bloch will also reduce barriers and increase access to existing facilities (See **Figure 1**). Together, this will enable quantum companies to grow in the region, partner with tech-enabled businesses across sectors, and attract capital to underinvested communities.

## FACTOR 7: Impact on Economic and National Security of the Entire US

**Support of National Priorities:** Global leadership in QIST is critical, yet the US lags. Quantum computers stand to break “much of the public key cryptography used on digital systems across the US and around the world.” (The White House, 2022) Quantum communications will protect information critical to the US but, since 2000, has received only 10% of QIST-related patents versus 30% for Japan and Europe and 50% for China. US science publications (21%) lags China (30%). Public QIST investment in the US is \$3.7B compared to China (\$15.3B), and EU (\$8.4B). The UK Quantum Network stretches 254 miles. In 2016, China launched the world’s first ground-to-satellite integrated quantum network (up to 2,858 miles) and in 2017 launched a 1,200-mile optical fiber network between Beijing and Shanghai. Both are significantly longer than any US network, including Chicago’s (124 mi) and New York’s (87 mi). (McKinsey, 2023)

**Regional Economic Impact:** The Bloch will positively impact the local economy, and by 2035, generate an estimated **\$8.7B in annual economic output and create 5,300-8,000** high-paying jobs, according to a McKinsey private report, with the potential to double the regional median wages for adjacent technical roles. Joint efforts building physical and community infrastructure will enable cascading business growth and attraction for the region and its citizens.