NSF National Quantum Virtual Laboratory (NQVL)

NQVL Webinar: 8/4/2023

Bogdan Mihaila (MPS) for the NQVL Management Team – 8/4/2023

❖ **NQVL Management Team**, a subgroup of the NSF QISE WG:

- Bogdan Mihaila …….. MPS
- Pradeep Fulay …….. TIP
- Dominique Dagenais …….. ENG
- Almadena Chtchelkanova …….. CISE
- Engin Serpersu …….. BIO
- Vinod Lohani …….. EDU

Email: NQVL@nsf.gov

NSF National Quantum Virtual Laboratory (NQVL)

← Search for more funding opportunities

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Important information for proposers

All proposals must be submitted in accordance with the requirements specified in this funding opportunity and in the NSF Proposal & Award Policies & Procedures Guide (PAPPG) that is in effect...

❖ FY 2023 NSF Budget Request to Congress, Emerging Industries - 6

FY 2023 Request funding for the new Directorate for Technology, Innovation, and Partnerships (TIP) […] Investments made possible by the FY 2023 Request level include: […]

- The Quantum Information Science and Engineering (QISE) National Virtual Laboratory (NVL) […] will serve as a *national*, *community-driven* effort that supports the smooth *integration* and *translation* from fundamental science and engineering to *use-inspired* applications.

  Building on the continued and sustained support of fundamental research from existing NSF programs, the NVL will draw together expertise and talent from a broad range of disciplines to enable the creation and application of *functional* quantum devices and systems.

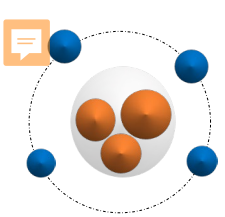
  Coordination will be provided through a virtual infrastructure that serves much like a laboratory to identify roles and resource needs and establish mechanisms to enable all members of the laboratory to communicate and function together as a whole. In this way, the NVL enables anyone to become engaged and contribute to advances in QISE.

NQVL activities will benefit the participation of the entire spectrum of diverse talent in STEM.

From basic science and basic engineering to the resultant technology

Support the smooth transition from basic science and engineering to technologies that will benefit the nation.

Leverage scientific endeavors supported through existing NSF programs.



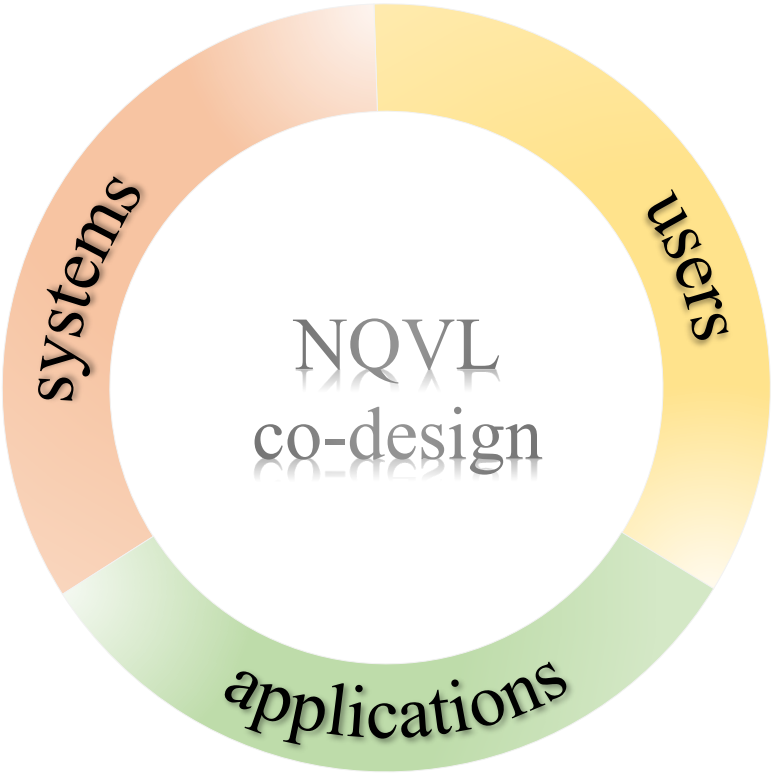
From basic science and basic engineering to the resultant technology

- **Global Leadership**: Drive innovation at *scale* with *speed*
- **TIP**: Translation, Innovation, Partnerships
- **People**: The missing millions

NQVL Vision

Why?

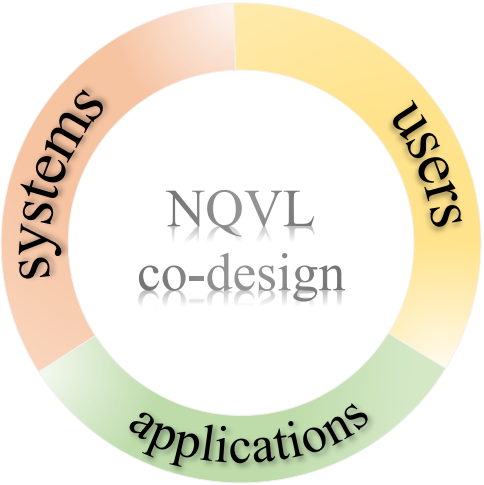
Quantum Technologies that benefit the economy and national security of the United States are required to fulfill the NQI Act mission.



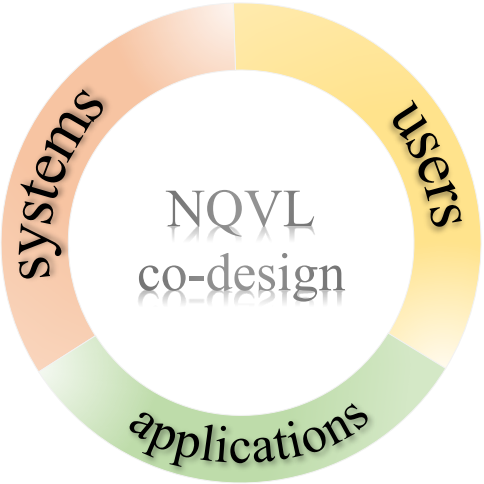
NQVL Vision

What?

- Quantum S&T Demonstration
  - ✓ use current state-of-the-art, build systems (gen0)
  - ✓ support users to develop use-cases
  - ✓ co-design systems and technology platforms
  - ✓ drive innovation to upgrade systems (next gen)



NQVL Vision

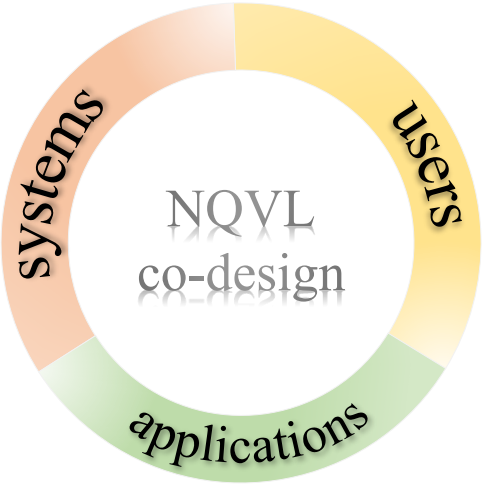


How?

- Support *basic* research and *use-inspired* research
- Seek synergies with intentionality
- Foster a dynamic equilibrium

  goal-oriented R&D (long term) & projects (finite duration)

NQVL Vision



Why NSF?

- Build systems for curiosity-driven research
  QISE as an *enabler* of scientific discovery
- Fundamental science & engineering
  QT is in the *precompetitive* phase: science-*first* approach

❖ NQVL: Guiding Principles

- **Multidisciplinary**: BIO, CISE, EDU, ENG, MPS, TIP; Convergence.
- **People**: Community-driven. National effort.
- **Broadening Participation**: Lower barriers at *all* entry points. Create a User Community.
- **Clear/Targeted/Actionable**:
  - Demonstrate Quantum Advantage for *practical* applications.
    → accelerate the development of platforms and facilitate user access.
  - Deliver Quantum Technology the same way we deliver a Project.
- **NSF strengths** in basic S&E: Goal-oriented basic S&E amplifies ongoing efforts.
- **Uniqueness**:
  - QISE as an enabler for scientific discovery.
  - US inter-agency and industry *collaboration*, *cooperation*, and *coordination*.
- **Sustainability**:
  - Research to transition to Core Programs when the integrated effort is completed.
  - Distributed model: no brick & mortar, people are distributed.

❖ Community Workshop Reports:

✓ Accelerating Progress Towards Practical Quantum Advantage, a National Science Foundation Project Scoping Workshop (2022), https://arxiv.org/abs/2210.14757

- Quantum Computer Systems for Scientific Discovery, PRX Quantum 2, 017001 (2021) https://doi.org/10.1103/PRXQuantum.2.017001 arXiv:1912.07577v3 [quant-ph]
- Development of Quantum InterConnects for Next-Generation Information Technologies, PRX Quantum 2, 017002 (2021) https://doi.org/10.1103/PRXQuantum.2.017002 arXiv:1912.06642v2 [quant-ph]
- Quantum Simulators: Architectures and Opportunities, PRX Quantum 2, 017003 (2021) https://doi.org/10.1103/PRXQuantum.2.017003 arXiv:1912.06938v2 [quant-ph]

❖ NQVL:QSTD Solicitation NSF 23-604 – Underpinnings:

- Division of Physics: Investigator-Initiated Research Projects (PHY), NSF 21-593
  - three-phase development process for mid-scale and long-term projects
- Gen-4 Engineering Research Centers (ERC): Convergent Research and Innovation through Inclusive Partnerships and Workforce Development, NSF 22-580

- Convergence Accelerator Program (TIP)
  - the two-phase Convergence Research Focus informed the NQVL Pilot/Design phases

- Guidelines for Planning and Managing the Major Research Equipment and Facilities Construction (MREFC) Account, https://www.nsf.gov/bfa/docs/mrefcguidelines1206.pdf
- Research Infrastructure Guide (RIG), December 2021, NSF 21-107

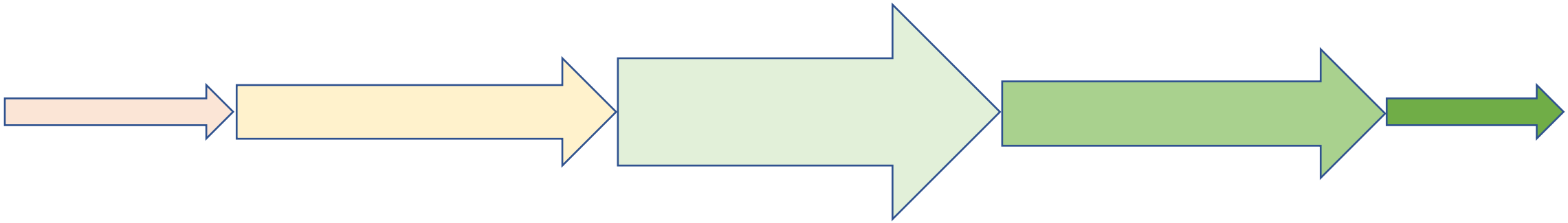
❖ NQVL Components:

- ✓ NQVL:QSTD – Quantum Science and Technology Demonstration projects. These projects will make up the scientific and engineering core of the activities that combine to form a federated NQVL infrastructure. QSTDs are expected to pass through three phases: *Pilot*, *Design*, and *Implementation*. Given the project nature of the NQVL:QSTD activity it is expected that the participants will proceed through *all* three project development phases.
- NQVL:TAQS – Provide resources to support research and development of enabling technologies identified by the NQVL:QSTD projects as they *mature* through the various phases.
- NQVL:Central – NQVL Planning and Coordination. NSF anticipates support for one NQVL Central Hub that will perform three distinct functions: i) promote collaboration and networking between the NQVL project teams; ii) promote engagement with the broad QISE community, partnerships with others and outreach activities to the general public; and iii) facilitate community oversight and the development of success metrics and benchmarks.

  The first function will enable the identification and potential exchange of component parts among the teams, especially in the Implementation phase. The other two functions recognize the need for greater accountability to the wider QISE community and to the public.

❖Quantum Science and Technology Demonstration (QSTD) Project Timeline

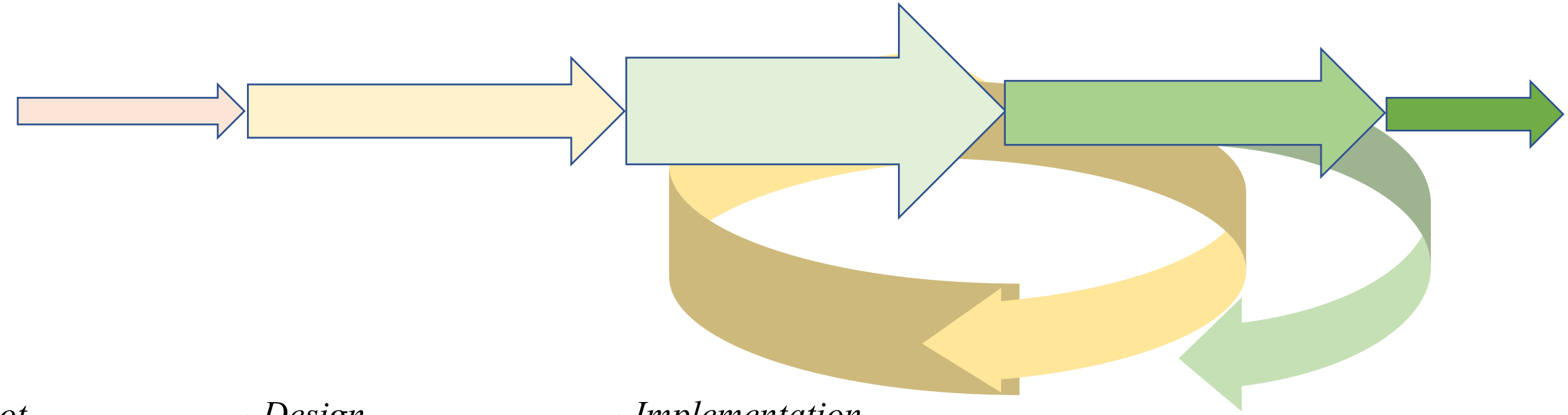
* Contingent on availability of funds and quality of proposals



Pilot	*Design*	*Implementation*
$1M	$2M/year	$7M/year
12 months	1-2 years	5 years (Final Design: 2yrs, Operations: 3yrs) – Renewable once
Select: 10* projects	* Down select	* Down select
Starts *: FY24,FY25	Starts *: FY25,FY26,FY27	Starts *: FY26,FY27,FY28
○ *Conceptual* design	○ *Preliminary* design	○ *Final* design

- Integration
- Testing
- Commissioning
- Operations
- User Support

❖ *Next*-Generation Enabling Technology Development



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- *Conceptual* design
- *Preliminary* design
- *Final* design

- Integration
- Testing
- Commissioning

- Operations
- User Support

❖ *Next*-Generation Enabling Technology Development

* Note: The number of awards will depend on the availability of funds and the quality of the proposals.

1. **PILOT**: Budget: $1M – Duration: 12 months
   - Develop *conceptual* design
   - Define requirements and prioritize research objectives
   - Identify enabling technologies and risks
   - Identify critical partnerships and dependencies
   - Develop top-down cost and contingency estimates
   - Develop *initial* risk assessment
   - Develop the *initial* Project Execution Plan
   - Develop *initial* Workforce Development Plan
   - 9 months SV review, Go-No-Go decision

2. **DESIGN**: Budget: $2M/year – Duration: 1–2 years
   - Develop *preliminary* design
   - Develop enabling technology
   - Update risk analysis, develop risk mitigation strategies
   - Develop bottoms-up cost and contingency estimates
   - Develop *preliminary* operations cost
   - Develop Project Management Control System
   - Develop *preliminary* Project Execution Plan
   - Develop *preliminary* Workforce Development Plan
   - Identify key staff
   - 9 months & 18 months SV review, Go-No-Go decision

3. **IMPLEMENTATION**: Budget: $7M/year – Duration: 5 years, Renewable once

A. Final Design Stage: Duration: 2 years
   - Develop *final* design
   - Harden key technologies
   - Refine bottoms-up cost and contingency estimates
   - Finalize risk assessment and mitigation plan
   - Finalize Project Management plan
   - Develop Project Execution Plan (PEP)
   - Finalize Workforce Development Plan (WDP)
   - Complete recruitment of key staff
   - Monthly meetings w/ NSF
   - Intermediate Monthly Reports
   - 9 months & 18 months reviews, Go-No-Go decision

B. Operations Stage
   - Monthly meetings w/ NSF
   - Intermediate Quarterly Reports
   - Annual SV Panel review

Adapted from the Guidelines for Planning and Managing the Major Research Equipment and Facilities Construction (MREFC) Account

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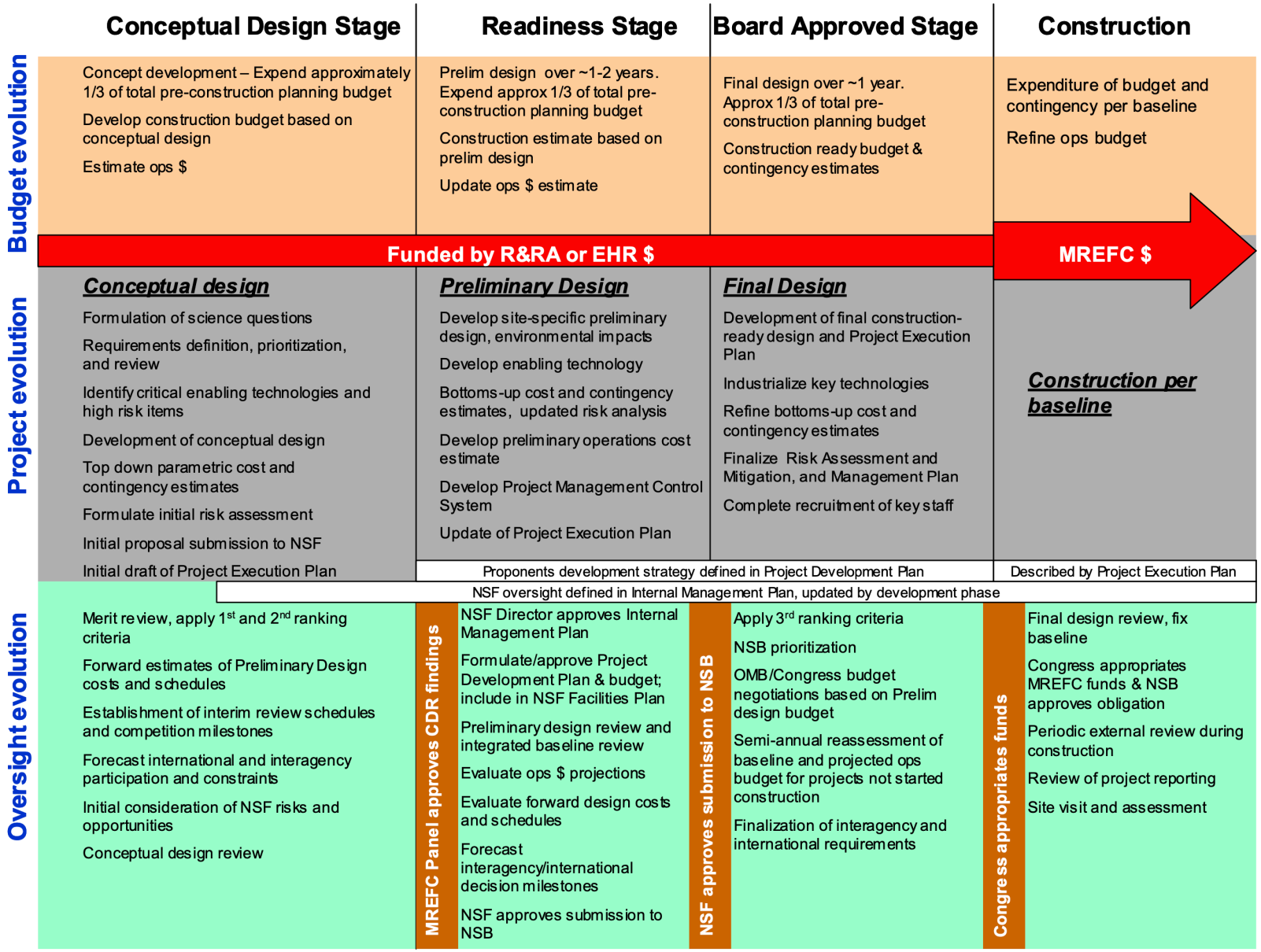
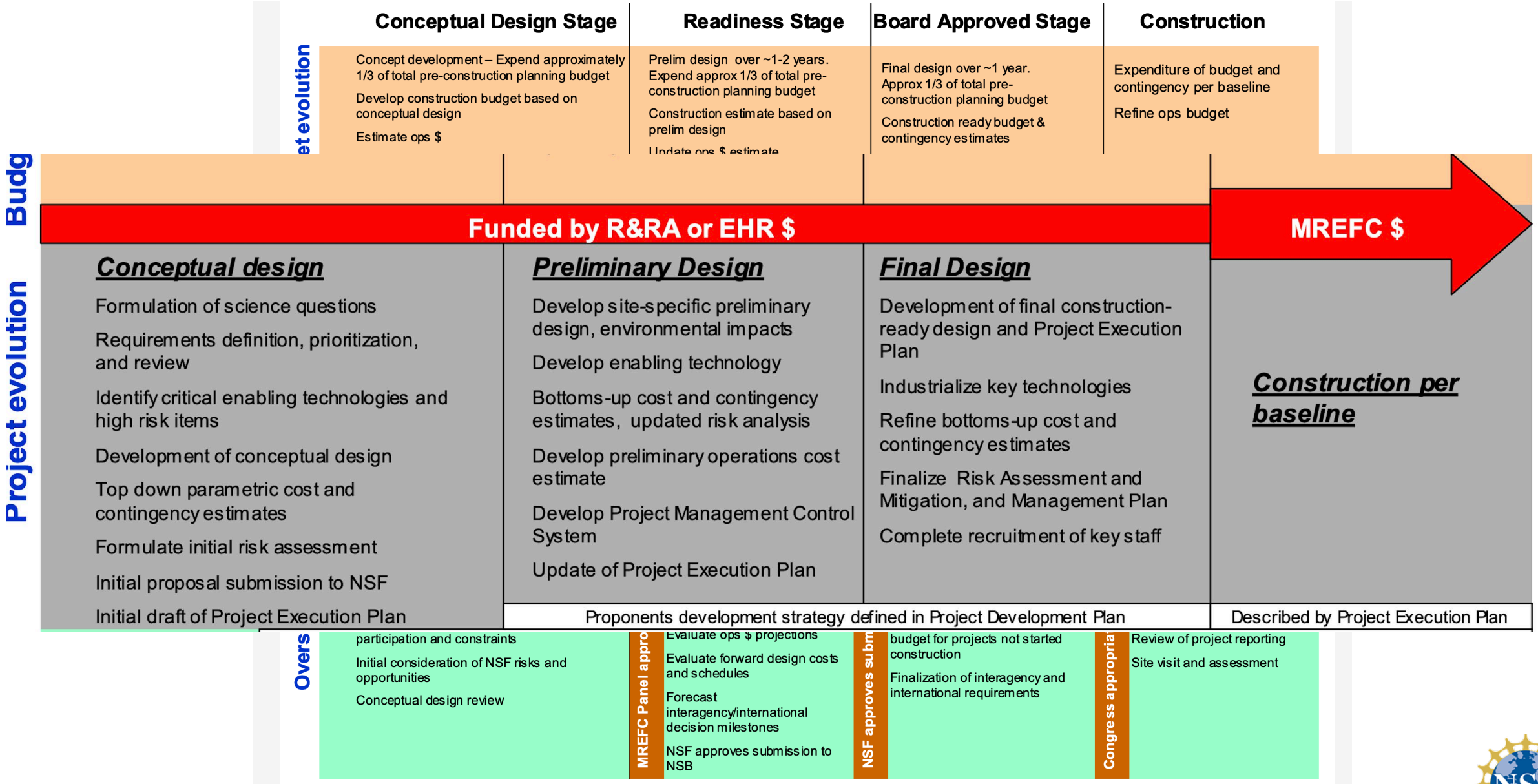
Figure 1: *Summary of the pre-construction planning and development process for candidate MREFC projects.*



Guidelines for Planning and Managing the Major Research Equipment and Facilities Construction (MREFC) Account

Figure 1: *Summary of the pre-construction planning and development process for candidate MREFC projects.*



[Guidelines for Planning and Managing the Major Research Equipment and Facilities Construction (MREFC) Account]

Originally developed by NASA in the 1970s for space exploration technologies, TRLs measure the maturity level of a technology throughout its research, development, and deployment phase progression.

TRLs are based on a scale from 1 to 9, with 9 being the most mature technology.

https://www.twi-global.com/technical-knowledge/faqs/technology-readiness-levels

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NSF National Quantum Virtual Laboratory (NQVL)

Quantum Science and Technology Demonstrations (QSTD): I. Pilot Phase

23-604

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opportunities

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Important information for proposers

All proposals must be submitted in accordance with the requirements specified in this funding opportunity and in the NSF Proposal & Award Policies & Procedures Guide (PAPPG) that is in effect...

❖ QSTD: Pilot Phase: General Comments

- PIs are reminded that the goal of the NQVL program is to accelerate progress towards demonstrations of *practical* quantum advantage, using a *convergent*, *systems engineering*, and *co-design* approach.
- The Program is committed to support *use-inspired* scientific research and technology development for the benefit of the national economy and to strengthen the Nation's strategic, scientific, and technological preeminence.
- **It is *required* that prospective PIs contact the NQVL Program Officer(s) as soon as possible, but not later than two weeks before submitting a proposal in response to this solicitation, to ascertain that the focus and budget of their proposal is appropriate for this solicitation.**

❖ The following language applies to the review of *all* phases of *all* QSTD projects:

- *Scientific* Review
- *Technical* and *Project Management* Review
- *Workforce Development Plan* Review

❖ QSTD: Pilot Phase: Proposal

- **What:** QSTD vision describing the specific Science and/or Technology area that is focus of the translation to be supported under the NQVL program and **who might be the potential users.**
- Why: Scientific and Technology challenges that can be addressed effectively only by a QSTD project.
- How: Plan of activities to address technical challenges.
- Who: Team with the organizational, scientific, technical, and sociocultural skills, trusted by the QISE community.
- **Readiness: Evidence that the QSTD project is feasible** in the time and with the resources afforded by NSF.
- **Community**: Plans for engaging the QISE community in the QSTD planning and execution and for fostering workforce development and promoting broadening participation.
- Partnerships: Dependencies. Synergies. Leverage other NQI-relevant investments by NSF or other U.S. Federal agencies. Public-private partnerships.
- Management and Coordination: Roles and responsibilities of all senior personnel. Deliverables. Timeline. Milestones.
- Outcomes.
- Metrics of Success.

❖ QSTD: Pilot Phase: Proposal (cont.)

- The QSTD Pilot proposal must include the *draft* conceptual design of the QSTD project, contingency, and the planning for the total anticipated number of system integration and development cycles in the QSTD project, including possible operations, as appropriate.
- A QSTD Pilot proposal must include a **full statement of the science and technology goals**, and **sufficient technical detail to appropriately review the proposal**.
- The NQVL program will review the scientific merit on a competitive basis that includes the potential cost to the program of conducting the QSTD development that would be enabled by the instrumentation.
- The affordability of system *fabrication/integration* should be supported by parametric top-down budget estimates to provide a cost range.

❖ NSF strongly suggests that the Pilot teams secure the services of a professional Project Manager.

❖ QSTD: Pilot Phase: Additional Review Criteria

- The NSF proposal review process will review the scientific merit on a competitive basis that includes:
  - ✓ technical readiness of the proposed QSTD project;
  - ✓ potential cost of the proposed QSTD project; *and*
  - ✓ expected QSTD impacts vis-à-vis the goals of the NQVL Program.

❖ QSTD: Pilot Phase: Community-Building

- Each QSTD team will convene a QISE community town hall meeting seeking community input, foster an open scientific dialogue, collect baseline data to aid in the development of a diverse workforce development plan, and ensure the broad participation of the entire QISE community.
- The outcome of this activity, in addition to addressing the specific requirements, will be a QISE Strategic Plan for addressing the topic of the QSTD Pilot.
- The QISE Strategic Plans are living documents that will be updated as needed.
- It is expected that the plans to accomplish the proposed scope of work, the methods involved, and the Pilot team may evolve over the course of the various phases.

❖ QSTD: Pilot Phase: Oversight

- Nine (9) months into the project, NSF will conduct a panel review of each Pilot project.

  The purpose of the review would be to assess the progress made by the team, provide feedback, and evaluate the *readiness* of the team to advance to the Design phase of the QSTD development.

  As the QSTD Pilot teams are expected to collaborate, coordinate, and cooperate with each other. Synergies are strongly encouraged.

  QSTD Pilot teams may also choose to consolidate prior to submitting a QSTD Design proposal to advance to the Design phase.

❖ QSTD: Pilot Phase: Proposal Submission

PROGRAM SOLICITATION

NSF 23-604

Letter of Intent Due Date(s) ***(required)*** (due by 5 p.m. submitter's local time):

October 06, 2023

April 09, 2024

Full Proposal Deadline(s) (due by 5 p.m. submitter's local time):

November 30, 2023

June 11, 2024

IMPORTANT INFORMATION AND REVISION NOTES

Any proposal submitted in response to this solicitation should be submitted in accordance with the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) that is in effect for the relevant due date to which the proposal is being submitted. The NSF PAPPG is regularly revised and it is the responsibility of the proposer to ensure that the proposal meets the requirements specified in this solicitation and the applicable version of the PAPPG. Submitting a proposal prior to a specified deadline does not negate this requirement.

❖ QSTD: Pilot Phase: Proposal Submission (cont.)

Additional Information for *all* NQVL Proposals

Although more than one organization may participate in a QSTD proposal, a single organization must accept overall management responsibility for the project. The proposal must be submitted by one organization, with funding provided to any other organization through subawards. The use of the collaborative proposal mechanism is not permitted for QSTD proposals. Subawards are not limited to IHE institutions but may be made to any group identified as eligible for funding by NSF as described in the NSF Proposal and Award Policies and Procedures Guide (PAPPG).

Letters of Support/Endorsement are not permitted.

Letters of Collaboration

Letters of collaboration are limited to stating the intent to collaborate. Endorsements or evaluations of the proposed project are not allowed. The Project Description should document the need for and nature of collaborations, such as intellectual contributions to the project, permission to access a site, an instrument, or a facility, offer of samples and materials for research, logistical support to the research and education program, or mentoring of U.S. students at a foreign site. Letters of collaboration should be included only when the involvement of the external collaborator is critical for the success of the proposed research. Letters of collaboration must follow the following format and be included in the Other Supplementary Documents section of the proposal:

> "If the proposal submitted by Dr. [insert the full name of the Principal Investigator] entitled [insert the proposal title] is selected for funding by the NSF, it is our intent to collaborate and/or commit resources as detailed in the Project Description.
>
> Specifically, our contributions to the project would include:
>
> [followed by a succinct list]."

❖ QSTD: Pilot Phase: Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch
- Non-profit, non-academic organizations: Independent museums, observatories, research laboratories, professional societies and similar organizations located in the U.S. that are directly associated with educational or research activities.

Who May Serve as PI:

The PI must be a faculty member at the Lead Organization or permanent staff person from a non-profit, non-academic organization with authority to act on behalf of the organization. Co-PIs listed on the Cover Sheet may be from organizations other than the Lead Organization.

Limit on Number of Proposals per Organization: 1

Up to **one** (1) QSTD Pilot proposal may be submitted per Lead Organization.

Limit on Number of Proposals per PI or co-PI: 1

An individual may serve as PI or co-PI on no more than **one** (1) QSTD Pilot proposal.

Announcement:

Tentative: Second NQVL Webinar, 1:00pm EDT on Friday, September 8, 2023 – check NQVL program web page.

Email: NQVL@nsf.gov

NQVL Webinar: Questions?