BROOKHAVEN NATIONAL LABORATORY
PROPOSAL INFORMATION QUESTIONNAIRE
LABORATORY DIRECTED RESEARCH AND DEVELOPMENT PROGRAM

PRINCIPAL INVESTIGATOR	Vincent Garonne	**PHONE**	
DEPARTMENT/DIVISION	NPP / SDCC	**DATE**	5/1/2022
OTHER INVESTIGATORS	Ai Kagawa, Jerome Lauret, Qiulan Huang, Xin Dai, Kevin Brown		
TITLE OF PROPOSAL **TYPE A**	Anomaly detection, predictive maintenance and facility optimization for Scientific Discovery		
PROPOSAL TERM (month/year)	From 10/1/2022	Through	

SUMMARY OF PROPOSAL

Description of Project:
Large scientific instruments, such as Collider-Accelerators and computing centers, are difficult to operate and optimize as they have many complex and interdependent components (hardware, software, sensors, control variables, etc.). These components are sensitive to a slew of factors involving network systems, latencies, hardware, and user behavior. The rapid adoption of new bleeding-edge technologies keeps increasing instrumental complexity and operational cost. To cope with the challenges of a modern scientific facility, we need a more advanced global intelligent system to 1) detect anomalies and non-optimal setups, 2) predict imminent failures, and 3) provide adaptive feedback.
The goal of this project is to build an intelligent system that can detect anomalies and predict maintenance needs by collecting and analyzing large volumes of information from the facility resources. This project will bring critical benefits to both Collider-Accelerators and SDCC. 1) Prognostics: detecting anomalous behavior will improve our ability to prevent failures and increase availability, 2) Optimization: tuning and optimizing the control variables of accelerators can minimize beam losses while maximizing beam quality for the experiments, and 3) Modeling: the state-of-the-art AI/ML solution developed in the project can be applied to other facilities. Our proposed model will provide self-tuning optimization, automated maintenance, and fault recovery. It will support the SDCC and the Science programs to fulfill its increasing computing needs and hardware control in a cost-effective manner.

Expected Results:
The research goal of this proposal is to build an intelligent system that provides anomaly detection and predictive maintenance for different domain areas at BNL, e.g., accelerators and SDCC. We will design a data collection and mining architecture and use AI/ML methods to analyze the large volumes of information (> KHz) coming from different sensors. The successful implementation of such a system will include the data correlation analysis, performance metric definition, fault diagnosis algorithm development, and the implementation of a fault progression model to safeguard critical systems. This intelligent system will support automated maintenance

and self-tuning optimization, which are crucial for detecting incipient failures as early as possible and enabling rapid, automated fault recovery.

INSTRUCTIONS

Under **Description of Project**, provide a summary of the scientific/technological concept of the proposed project including the motivation for the research and the approach that will be used to conduct the investigation. *Briefly explain in a paragraph or less the competitive advantage of your approach.* Also indicate how the project meets the general characteristics of the LDRD Program and how it is tied to the DOE Mission.

Under **Expected Results**, clearly state the expected results and how they will impact our understanding of the science/technology.

These items should not exceed one page. The content should be understandable by a non-expert. This will greatly improve your chances for success. Please define all acronyms initially. Follow the Summary of Proposal with a proposal not to exceed five pages that includes a concise state-of-the-art review, well supported by references, which do not count toward the five-page limit. Please include high-level deliverables and milestones for the duration of the project in the proposal and success metrics. The milestones are of great importance for setting realistic expectations for the project and for keeping the research on track. (Note that a mid-year review is required, and milestones will be reviewed then.)

Complete the Questionnaire, paying close attention to Items 1 “Alignment with the Mission and Vision” and 2 “Potential Future Funding.” Since the primary purposes of Type A LDRD funding are to support Laboratory priority programs and those that might lead to new directions for future support, both of these will be important considerations during the selection process. Explicit estimates of the financial return on investment are expected in the Potential Future Funding section (Item 2). Proposals will be returned if these sections aren’t completed. In addition, please fill out Items 3 and 4, which are a “Budget Justification” and the “Name of Suggested BNL Reviewers.” Attach a budget in the suggested template, indicating the intent to use collaborators, postdoctoral research associates, and/or students, and obtain the required approvals. Also new this year in the Approvals section is a determination (highlighted in yellow) delegated to the Principal Investigator’s Chair/Division Manager if the project is a sensitive technology under the S&T Risk Matrix. No other attachments are needed. Go to the LDRD website for further information. **The Instructions should be removed before proceeding.**

PROPOSAL

ONE-PAGE VITA FOR EACH PRINCIPAL INVESTIGATOR AND CO-PRINCIPAL INVESTIGATOR

1. ALIGNMENT WITH THE LABORATORY MISSION AND VISION

Type A proposals need to be clearly aligned with BNL's priority programs and initiatives. For FY23, the highest priorities for Type A proposals (not in priority order) are: Accelerator Science and Technology; Atmospheric and Climate Science; Clean Energy; Discovery Science Driven by Human-AI-Facility Integration; High Energy Physics: Understanding the Origin of Space and Time; Isotope Production and R&D Capabilities; Quantum Information Science and Technology; and Research and Development towards the Second Detector at the Electron-Ion Collider.

The Laboratory Initiatives are in the areas of 1. Nuclear Physics; 2. Clean Energy and Climate; 3. Quantum Information Science and Technology; 4. Artificial Intelligence and Data Science; 5. High Energy Physics; 6. Isotope Production; and 7. Accelerator Science and Technology.

Please identify which area(s) the proposal supports.

2. POTENTIAL FUTURE FUNDING

Identify below the Agencies and the specific program/office, which may be interested in supplying future funding. Give some indication of time frame. This information is required.

3. BUDGET JUSTIFICATION

Include a description of all costs requested in your budget. You do not need to describe the Lab burdens.

4. NAME OF SUGGESTED BNL REVIEWERS

Provide the name of four BNL subject matter experts (SMEs). Two of the SMEs may be contacted as potential reviewers of your proposal. Their reviews will be in addition to those conducted by the Associate Lab Directors and their Deputies and the Directors of the Computational Science Initiative and Advanced Technology Research Office, Members of the Brookhaven Council, and Research Staff not associated with the research.

5. EQUIPMENT (Reference: DOE Order 413.2C Chg. 1 (Min Chg) for guidance on equipment restrictions)

Will LDRD funding be used to purchase equipment? Y/N Y/N____

If "Yes," provide cost and description of equipment
Year 1 - $
Year 2 - $
Year 3 - $
Description:

6. HUMAN SUBJECTS (Reference: DOE Order 443.1C)

Are human subjects involved from BNL or a collaborating institution?
Human Subjects is defined as "A living individual from whom an investigator obtains either (1) data about that individual through intervention or interaction with the individual, or (2) identifiable, private information about that individual".

If **yes**, attach copy of the current Institutional Review Board Approval and Informed Consent Form from BNL and/or collaborating institution.

7. VERTEBRATE ANIMALS Y/N _____

Are live, vertebrate animals involved? _____

If **yes**, attach copy of approval from BNL's Institutional Animal Care and Use Committee.

8. NEPA REVIEW Y/N

Are the activities proposed similar to those now carried out in the Department/Division which have been previously reviewed for potential environmental impacts and compliance with federal, state, local rules and regulations, and BNL's Environment, Safety, and Health Standards? (Therefore, if funded, proposed activities would require no additional environmental evaluation.) _____

If **no**, has a NEPA review been completed in accordance with the National Environmental Policy Act (NEPA) and Cultural Resources Evaluations Subject Area and the results documented? Y/N _____

(**Note:** If a NEPA review has not been completed, submit a copy of the work proposal to the BNL NEPA Coordinator for review. No work may commence until the review is completed and documented.)

9. ES&H CONSIDERATIONS Y/N

Does the proposal provide sufficient funding for appropriate decommissioning of the research space when the experiment is complete? _____

Is there an available waste disposal path for project wastes throughout the course of the experiment? Y/N _____

Is funding available to properly dispose of project wastes throughout the course of the experiment? Y/N _____

Are biohazards involved in the proposed work? If yes, attach a current copy of approval from the Institutional Biosafety Committee. Y/N _____

Can the proposed work be carried out within the existing safety envelope of the facility (Facility Use Agreement, Nuclear Facility Authorization Agreement, Accelerator Safety Envelope, etc.) in which it will be performed? Y/N _____

If **no**, attach a statement indicating what has to be done and how modifications will be funded to prepare the facility to accept the work.

10. TYPE OF WORK Select Basic, Applied or Development _____

APPROVALS

Business Operations Manager
Department Chair/Division Manager
To the Department Chair/Division Manager: Please indicate if this project is a sensitive technology under the S&T Risk Matrix. (Note: Red projects require an Access Management Plan.)

- ☐ Green
- ☐ Yellow
- ☐ Red
- ☐ Not Applicable

_____
Print Name

_____
Print Name

Cognizant Associate Lab
Director/Computational Science Initiative
Director/Advanced Technology Research
Office Director

_____
Print Name

BROOKHAVEN NATIONAL LABORATORY

Project Type: -
Initiative:
Department: -
Directorate:
Principal Investigator: -

-

TERM #: mm/dd/yy - mm/dd/yy

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LABOR

TYPE	YEAR 1 FTEs	YEAR 1 COST	YEAR 2 FTEs	YEAR 2 COST	YEAR 3 FTEs	YEAR 3 COST	YEAR 4 FTEs	YEAR 4 COST	TOTAL
SCIENTIFIC/SENIOR PERSONNEL	-	-	-	-	-	-	-	-	-
POST DOCTORAL ASSOCIATES	-	-	-	-	-	-	-	-	-
OTHER PROFESSIONAL	-	-	-	-	-	-	-	-	-
OTHER	-	-	-	-	-	-	-	-	-
TOTAL LABOR	-	$ -	-	$ -	-	$ -	-	$ -	$ -

OTHER LABOR

TYPE	YEAR 1	YEAR 2	YEAR 3	YEAR 4	TOTAL
CONSULTANTS/COLLABORATORS	-			-	-
JOINT APPOINTMENTS	-		-	-	-
DISTRIBUTED LABOR	-		-	-	-
STUDENT CONTRACT			-	-	-
RECHARGES		-	-	-	-
TOTAL OTHER LABOR	$ -	$ -	$ -	$ -	$ -

MATERIALS, SUPPLIES & TRAVEL

TYPE	CY RATE	YEAR 1	YEAR 2	YEAR 3	YEAR 4	TOTAL
MATERIALS & SUPPLIES		-	-	-	-	-
TRAVEL		-	-	-	-	-
EQUIPMENT (LOW/HIGH)		-	-	-	-	-
PURCHASE HIGH VALUE		-	-	-	-	-
TOTAL MATERIALS, SUPPLIES & TRAVEL		$ -	$ -	$ -	$ -	$ -

DEPARTMENTAL OVERHEADS

TYPE	CY RATE	YEAR 1	YEAR 2	YEAR 3	YEAR 4	TOTAL
ELECTRIC	0.00%	-	-	-	-	-
SPACE	0.00%	-	-	-	-	-
WASTE MGMT	0.00%	-	-	-	-	-
ORG. BURDEN	0.00%	-	-	-	-	-
OTHER	0.00%	-	-	-	-	-
TOTAL DEPARTMENTAL OVERHEADS		$ -	$ -	$ -	$ -	$ -

GENERAL & ADMINISTRATIVE OVERHEADS

TYPE	CY RATE	YEAR 1	YEAR 2	YEAR 3	YEAR 4	TOTAL
TRADITIONAL G&A		-	-	-	-	-
COMMON SUPPORT		-	-	-	-	-
TOTAL G&A OVERHEADS		$ -	$ -	$ -	$ -	$ -

TOTAL PROJECT COST	YEAR 1	YEAR 2	YEAR 3	YEAR 4	**TOTAL**
TOTAL DIRECT COSTS	-	-	-	-	-
TOTAL INDIRECT COSTS	-	-	-	-	-
TOTAL PROJECT COST	$ -	$ -	$ -	$ -	$ -

NOTE:	**ITEMIZE CAPITAL INDIVIDUALLY (include item and $ amount)**	
Post Doc Rate Exception:	1.	5.
No cost to be incurred on R/C 170 (Relocation Expense)	2.	6.
Funding for Program Development for more than 2 years is unlikely and cannot exceed 3 years.	3.	7.
	4.	8.