P.O. Box 5000
Upton, NY 11973-5000
managed by Brookhaven Science Associates
for the U.S. Department of Energy

Subject:

Procurement of Ultra-High Vacuum Compatible Hybrid Pixel Detector System for the Booster Polarimeter

The Booster Polarimeter is a beam instrumentation system at Brookhaven National Laboratory (BNL) will be used to measure the transverse spin polarization of proton beams in the Alternating Gradient Synchrotron (AGS) Booster. Accurate polarization measurements in the Booster are essential for preserving and characterizing beam polarization prior to injection into the AGS and ultimately the future Electron-Ion Collider (EIC). Brookhaven Science Associates (BSA) requires the procurement of an ultra-high vacuum (UHV) compatible detector assembly with a 300 µm thick silicon sensor for use in the Booster Polarimeter.

1. Scope

The vendor shall design, fabricate, test, and deliver a complete UHV-compatible hybrid pixel detector system meeting the performance and interface requirements defined in this SOW to BNL for use in the Booster Polarimeter. The base procurement quantity is two (2) detector units; with an option for an additional four (4) and six (6) units.

2. Detector Requirements

The detector shall be a hybrid pixel detector system providing the following minimum performance:

a. **Sensor**: Silicon sensor, 300 µm thick.
b. **Pixel Size and Array**: Pixel pitch of 55 µm × 55 µm or smaller, with a minimum active area of approximately 28 mm × 24 mm.
c. **Readout Mode**: Simultaneous per-pixel Time-of-Arrival (ToA) and Time-over-Threshold (ToT) capability.
d. **Configuration**: The detector may be configured as a single chip or tiled multi-chip (quad) arrangement, provided it meets the minimum active area and performance requirements above.
e. **Operating Requirements**: The system shall support external trigger and external clock inputs for synchronization with accelerator timing systems.
f. Heatsink and metallic enclosure shall be provided.

3. Readout Electronics and Interface

a. AdvaBoard USB-C readout (or equivalent) with support for external trigger input and external clock input (for synchronization with accelerator timing).
b. Peltier or water thermoelectric cooling with PID temperature control.
c. All necessary cables for data, power, and cooling connections.

"This document contains BNL procurement requirements and specifications for solicitation and technical evaluation. The information is high-level and does not include the detail necessary for "development" or "production" as defined under 15 CFR §772.1, 22 CFR §120.33, or 10 CFR Part 810; therefore, it does not constitute export-controlled technology or technical data."

d. Software development kit (SDK) and PIXET PRO software (or equivalent) enabling access to all detector parameters, data collection, and processing. A software license permitting use in a scientific research environment at BNL shall be included.

4. Vacuum Compatibility

This is a critical requirement. All materials of the complete detector assembly that are exposed to vacuum must be compatible with UHV conditions — including sensor board, frontend electronics, feedthrough, enclosure, etc.

a. The vendor shall demonstrate compatibility with a vacuum level of $\leq 5\times10^{-9}$ mbar.

b. Only low-outgassing materials shall be used throughout the assembly. The following materials are provided as examples of acceptable PCB substrate materials; vendors may propose equivalent or superior alternatives with supporting outgassing data (TML ≤ 0.5%, CVCM ≤ 0.1% per ASTM E595):

   i. Core laminate: e.g., Arlon 35N (High Tg, halogen-free FR4 class) or equivalent.

   ii. Prepreg: e.g., Arlon 49N (no-flow prepreg, 1080 style) or equivalent.

   iii. Flexible circuits: e.g., DuPont Pyralux AP (polyimide-based double-sided clad, AP-8535R) or equivalent.

c. The vendor shall provide a complete bill of materials listing all materials and their outgassing data (TML, CVCM) for review by BNL's Vacuum Group prior to fabrication.

d. The vendor shall perform and document a vacuum and outgassing test of all materials and the feedthrough assembly (milestone NRE-2), verifying that the achieved vacuum level meets the $\leq 5\times10^{-9}$ mbar specification. A written test report shall be delivered to BNL.

e. The system must be bakeable to a minimum temperature of 80 C to support UHV compatibility of it and neighboring components in the final assembly.

f. The vendor shall provide a high-level written description of the process or approach used to achieve UHV compatibility. Proprietary details may be protected, but the general methodology must be stated.

g. The vendor shall provide references demonstrating prior delivery of detector systems operating under equivalent UHV conditions, including customer contact information.

5. Vacuum Feedthrough and Flange

a. The detector feedthrough shall be designed for mounting on a ConFlat (CF) flange. The maximum allowable flange size is CF100 (DN100CF); CF63 or smaller is preferred if compatible with all electronic and signal routing requirements of the detector assembly.

b. The vendor shall confirm in the proposal the flange size selected for the design and provide justification based on electronics and signal routing constraints.

c. A custom PCB feedthrough integrated into the flange design shall be provided.

d. The feedthrough design shall maintain UHV integrity consistent with achieving $\leq 5\times10^{-9}$ mbar system vacuum. PCB substrate materials shall meet the outgassing requirements of Section 4.

6. Deliverables

"This document contains BNL procurement requirements and specifications for solicitation and technical evaluation. The information is high-level and does not include the detail necessary for "development" or "production" as defined under 15 CFR §772.1, 22 CFR §120.33, or 10 CFR Part 810; therefore, it does not constitute export-controlled technology or technical data."

DRAFT

The vendor shall provide the following deliverables. Timing is expressed as After Receipt of Order (ARO):

Deliverable	Description	Timing (ARO)
NRE-1: Program Initiation	Kickoff and initial design review; design approach and materials list submitted for BNL Vacuum Group review.	After PO
NRE-2: Vacuum & Outgassing Test	Vacuum/outgassing test of all materials and feedthrough assembly with written test report confirming $\leq 10^{-9}$ mbar compatibility.	3 months
Final Design Approval	Final design report and manufacturing program plan approved by BNL.	6 months
Hardware Delivery	Complete detector units (per ordered quantity) including readout electronics, cables, cooling system, and feedthrough.	~13 months (40-50 weeks minimum)
Site Acceptance Test	On-site (BNL) acceptance test confirming full operation, performed jointly with BNL staff.	1 month after delivery
Documentation Package	As-built drawings, bill of materials, outgassing test report, operations manual, SDK, and software licenses.	With hardware delivery

9. Schedule

The estimated project schedule from Purchase Order (PO) issuance is 40-50 weeks to hardware delivery (approximately 13 months total to delivery, 14-15 months to project completion). Lead times are subject to sensor and component availability. Vendors shall confirm achievability of this schedule or propose an alternative in their proposal and shall notify BNL promptly of any changes.

DRAFT

"This document contains BNL procurement requirements and specifications for solicitation and technical evaluation. The information is high-level and does not include the detail necessary for "development" or "production" as defined under 15 CFR §772.1, 22 CFR §120.33, or 10 CFR Part 810; therefore, it does not constitute export-controlled technology or technical data."