

<b>Title</b>	<b><i>Test-bed for Nanopositioning Technique Enhancement</i></b>			
Project Requestor	Deming Shu			
Date	03-23-2008			
Group Leader(s)	John Quintana			
Machine or Sector Manager	Efim Gluskin and Gabrielle Long			
Category	Accelerator hardware and insertion device upgrades and x-ray science enablers			
Content ID*	APS_XXXXXX	Rev.	ICMS_Revision	ICMS Document Date

\*This row is filled in automatically on check in to ICMS. See Note <sup>1</sup>

**Description:**

<b>Start Year (FY)</b>	<b>2009</b>	<b>Duration (Yr)</b>	<b>5</b>
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**Objectives:**

To construct an experimental test-bed for multidimensional nanopositioning technique enhancement with 30-pm special resolution laser interferometric diagnostic tools.

**Benefit:**

At APS, the required instrument nanopositioning performances and capabilities, such as resolution, dynamic range, repeatability, stability, and multiple axes synchronization, often exceed the limit of commercial availability. With brighter APS x-ray sources and novel x-ray focusing optics, scientists at the APS will need more customized advanced instruments with state-of-the-art nanopositioning capabilities in next five years. The proposed project will prepare a test-bed to support APS scientists and users to meet challenging nanopositioning needs for their scientific goals. The project will benefit APS users who may use x-ray nanoprobe, high-energy-resolution monochromators and analyzers, and sample manipulators with nanometer-scale resolution and stability. The project will also benefit the development of x-ray resonator for cavity FEL for APS ERL upgrade.

**Risks of Project:** See Note <sup>2</sup>

NA

**Consequences of Not Doing Project:** See Note <sup>3</sup>

NA

**Cost/Benefit Analysis:** See Note <sup>4</sup>

NA

**Description:**

Supported by Argonne LDRD program, a 1-D nan positioning system with laser Doppler displacement meter (LDDM) has demonstrated its 30-pm special resolution and 100-pm closed-loop positioning capability [1]. A prototype of hard x-ray nanoprobe, which is acting as a CNM early user instrument (EUI) with 2-D LDDM-based nan positioning stages, has been constructed and demonstrated a relative mechanical stability and repeatability of better than 4 nm between its zone plate optics holder and sample holder [2]. The test results from these prototypes have demonstrated the system stability differences between 1-D and 2-D stages, and have showed that the stacked roller-bearing-based-stages are the major sources for higher vibration noise on a multidimensional nan positioning system.

To overcome the obstacle of developing multidimensional nan positioning system, an experimental test-bed is needed to explore novel design options and to diagnose and optimize their structural dynamics details.

The test-bed includes a 3-D high-resolution, high-stiffness nan positioning system with six laser interferometric encoders with 30-pm special resolution. A metal base with acoustic-insulated housing is part of the construction. A sub-nanometer closed-loop resolution is expected for this 3-D nan positioning test-bed. Cooperated with an existing atomic force microscope head, the test-bed will also have mechanical testing capabilities in subnanometer scale for various commercial and customized nan positioning devices, such as sample manipulators in nanometer scale.

References

- [1] D. Shu, Y. Han, T. S. Toellner, and E. E. Alp, Proc. SPIE Vol. 4771 (2002) pp.78-90.
- [2] D. Shu et al., Proc. 8th Int. Conf. X-ray Microscopy, IPAP Conf. Series 7, (July 2006) 56-58.

**Funding Details**

**Cost: (\$K)**

Use FY08 dollars.

Year	AIP	Contingency
1	60	9
2	80	12
3	80	12
4	50	7.5
5	30	4.5
6		
7		
8		
9		
<b>Total</b>	<b>300</b>	

APS Strategic Planning Proposal

Contingency may be in dollars or percent. Enter figure for total project contingency.

**Effort: (FTE)**

The effort portion need not be filled out in detail by March 28

Year	Mechanical Engineer	Electrical Engineer	Physicist	Software Engineer	Tech	Designer	Post Doc	Total
1								0
2								0
3								0
4								0
5								0
6								0
7								0
8								0
9								0

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**Notes:**

<sup>1</sup> **ICMS.** Check in first revision to ICMS as a *New Check In*. Subsequent revisions should be checked in as revisions to that document i.e. *Check Out* the previous version and *Check In* the new version. Be sure to complete the *Document Date* field on the check in screen.

<sup>2</sup> **Risk Assessment.** Advise of the potential impact to the facility or operations that may result as a consequence of performing the proposed activity. Example: If the proposed project is undertaken then other systems impacted by the work include ... (If no assessment is appropriate then enter NA.)

<sup>3</sup> **Consequence Assessment.** Advise of the potential consequences to the facility or to operations if the proposal is not executed. Example: If the proposed project is not undertaken then \_\_\_\_ may happen to the facility. (If no assessment is appropriate then enter NA.)

<sup>4</sup> **Cost Benefit Analysis.** Describe cost efficiencies or value of the risk mitigated by the expenditure. Example: Failure to complete this maintenance project will result in increased total costs to the APS for emergency repairs and this investment of \_\_\_\_ will also result in improved reliability of \_\_\_\_\_. (If no assessment is appropriate then enter NA.)