Project Plan

February 3, 2004

IPRO 309

Integrated Turn-Key X-Ray Fluorescence Analysis System
Using Bent Laue Optics

Project Team

Instructor: Dr. Grant Bunker, IIT BCPS

Sponsor: Quercus X-Ray Technologies, LLC

Team Members: Jim Adduci, Justin Ferguson, Isaac Martis, Ken McIvor, Josh Sammons, Kelli Shaver, George Takhtamyshev, Deepti Yadlapalli

Objectives

This IPRO team project will explore different conceptual designs for an integrated, self-aligning x-ray fluorescence analyzer which utilizes the Bent Crystal Laue Analyzer technology developed by Quercus X-Ray Technologies. In addition to researching and evaluating technologies relevant to the construction of such a system, this project will endeavor to design system prototypes using different combinations of promising or innovative technologies. Such designs will emphasize performance, reliability, simplicity, and manufacturing cost. Time permitting, prototypes of these designs will be implemented and evaluated using laboratory space at IIT, provided by Quercus. This groundwork will ultimately lead to a commercial product that will be used for x-ray research in Physics, Chemistry, Biology, Metallurgical and Materials Engineering, Environmental Science and Engineering, and Geology.

Background

Quercus X-Ray Technologies is a new venture, founded by members of the IIT physics faculty. Quercus has developed and is presently selling Bent Crystal Laue Analyzers (BCLAs), which select a particular wavelength of incident x-ray photons and reject photons of other energies. The primary application of this technology is to select specific x-ray fluorescence lines emitted from samples during x-ray fluorescence and x-ray absorption fine structure (XAFS) experiments. Unlike conventional solid state x-ray detectors, BCLAs allow for the rejection of undesired photons before they are detected, reducing the chance of detector saturation. Not only is this is a vital characteristic in circumstances where there is a small signal masked by a large amount of background, but it enables the design of a fluorescence analysis system that does not require an expensive sold state detector. Quercus intends to use this advantage to develop an inexpensive and complete x-ray fluorescence analysis solution for use in industry and scientific research.

Financial support for this IPRO is provided by a peer reviewed Small Business Innovation Research grant to Quercus X-Ray Technologies, LLC.

Methodology and Expected Results

Adequately addressing the objectives of this IPRO team project requires each objective be addressed in a separate\ manner. Researching relevant technologies is a relatively linear, group-oriented process, in which each group will develop an expertise in a different area of technology. Selecting concepts and specific products for evaluation and development will require the participation of the entire IPRO project team. The development or procurement of these selected concepts and products and their subsequent evaluation will be conducted using a flexible, highly iterative process which centers around small teams working in parallel. Developing prototype designs for the x-ray fluorescence analysis system will require both the participation of the entire IPRO project team. Depending on time constraints and the availability of necessary components, the IPRO project team may then implement one or more of the prototype designs.

1. Research areas of technology relevant to the development of an integrated x-ray fluorescence analysis system which uses BCLAs. The IPRO project team will divide into three groups, each of which will research a different area of technology.
    - **X-Ray Detection –** solid-state detectors, ionization chambers, Lytle detectors, PIN diodes, and the supporting electronics each technology requires.
    - **Positioning and Motion Control –** stages, hexapod platforms, motors, and motor control electronics.
    - **Data Acquisition and Control –** D.A.C. software, computer platforms, operating systems, and end-user applications.
2. Each group will prepare and present a short presentation on their findings and recommendations for the selection of concepts and products to evaluate.
3. Each group will write a survey document detailing the results of their research into their assigned area of technology. These documents will also present the recommended concepts and projects and the reasons for their recommendations.
4. Using the group recommendations, the IPRO project team will select concepts and products from each area of technology for evaluation. Systems integration, electronics support, power requirements, and component cost are factors to be considered during the selection process.
5. Individual concepts and products will be developed procured and evaluated by the IPRO team members, working together in small groups. These groups will purchase existing products or work to develop a concept into a prototype for evaluation. Groups will be responsible for documenting the procurement process for each component, whether purchased or developed in-house. After procurement, the suitability of components for inclusion in a design prototype will be evaluated. Groups will be responsible for documenting the evaluation process for each component and its results.
6. Using the information gathered through this evaluation process, the IPRO project team will develop prototype designs using the appropriate combinations of components. These designs will be fully documented by the IPRO project team.
7. Time and resources permitting, the IPRO project team will work to implement one or more of the prototype designs and evaluate the working prototypes. The IPRO team will document the evaluation process used and the results obtained for each prototype evaluated.

Project Budget

Quercus X-Ray Technologies, the IPRO sponsor, will provide ten thousand dollars to cover the cost of purchasing products for evaluation and components to facilitate the development and evaluation of new technologies.

X-Ray Detection *Detectors, detector components, electronics*	$6,000.00
Positioning and Motion Control *Stages, motors, motor controllers*	$3,000.00
Miscellaneous Expenses *Materials, software, supplies*	$1,000.00

The IPRO program will provide $1000 to purchase materials, software, and miscellaneous supplies when educational discounts are available. This funding will also be used to cover expenses incurred by the IPRO Project Team.

Miscellaneous Expenses *Materials, software, supplies*	$800.00
IPRO Project Team Expenses *IPRO poster, office services, travel expenses*	$200.00

Quercus will also be providing the IPRO project team with laboratory space, computers, and other equipment necessary for this project.

Schedule of Tasks

	Feb				Mar		Break		Apr				May	
Task	**Wk 3**	**Wk 4**	**Wk 5**	**Wk 6**	**Wk 7**	**Wk 8**	**Wk 9**	**Wk 10**	**Wk 11**	**Wk 12**	**Wk 13**	**Wk 14**	**Wk 15**	**Wk 16**
Research Technologies														
Group Presentations														
Technology Surveys														
Concept/Product Selection														
Procure and Evaluate														
Prototype Design														
Website														
Mid-Term Progress Report														
Abstract														
Poster														
Oral Presentation														
Final Report														
CD-ROM														

Project Milestones

Project Plan due	February 06
Research presentations	February 10
Survey documents completed	February 12
Concept/Product Selection begins	February 12

Project Plan due	February 06
Selection completed	February 17
Mid-Term Progress Report due	March 12
Spring Break	March 15 – March 19
Prototype Design begins	April 06
Abstract and Poster due	April 26
Web Site and Oral Presentation due	April 28
IPRO Projects Day conference	April 30
Final Report and CD-ROM due	May 07

Team Member Assignments For Research

X-Ray Detection - Justin Ferguson, Isaac Martis, Deepti Yadlapalli

Positioning and Motion Control - Jim Adduci, Kelli Shaver, George Takhtamyshev

Data Acquisition and Control - Ken McIvor, Josh Sammons