OHIO BOARD OF REGENTS

ACTION FUND REQUEST

1. GENERAL INFORMATION

A. Institutional Information

i. Institution: Youngstown State University

ii. Research Officer:
Dr. Peter J. Kasvinsky
Dean of Graduate Studies and Research
Phone: 330-742-3091
FAX: 330-742-1580
E-mail: amgrad03@ysub.ysu.edu

iii. Principal Investigator:
Dr. Allen D. Hunter
Professor of Chemistry and Director of the YSU Structure Center
Director of the Advanced Diffraction Studies Consortium
Phone: 330-742-7176
FAX: 330-742-1579
E-mail: adhunter@cc.ysu.edu

B. Title of Project Proposed: Advanced Diffraction Studies Consortium (ADSC): An Exciting Opportunity For Integrating Predominantly Undergraduate Institutions Into The National Research Enterprise

C. External Funding Agency

i. Name of external funding agency: The National Science Foundation

ii. Title of the agency program announcement: Research Sites for Educators in Chemistry

D. Due date of the proposal as announced by the external funding agency: Jan. 11th, 1999, however, due to the complex consortial nature of this project, we are targeting a submission date of January 6th, 1999 (if possible).

E. Award date as announced by the external funding agency: June 1st, 1999 (expected)

F. Matching requirements as announced by the external funding agency: No specific amount for capital costs is stated in the RFP except that usual NSF policy will be followed. This typically requires a minimum capital match of about 50%. The program officer, Dr. Janet Osteryoung, stated that "substantial cash match would be required for any equipment requested" and when I discussed specific numbers with her, in particular that NSF would be asked for only about 1/3 of the cost of the capital equipment, she indicated that this would be looked upon very favorably as evidence of our commitment to the proposal.

2. BUDGET

A. Total Project Costs (all sources, capital, and other costs):
The approximate total project cost for the five years of this project (1999-2004) is approximately $3,230,000. We will know the final amounts in January when details of the proposal are finalized.

B. Capital Costs (amount of 2A which is capital cost only, by source):
The total capital cost for this project is approximately $848,000. Of this amount, approximately $50,000 will be for equipment to be placed at Bucknell University in Pennsylvania. The capital equipment budget in this grant for Ohio universities is $798,000 for equipment to be placed at YSU, Case Western Reserve

University/The Cleveland Clinic, Kent State University, Wright State University, and the University of Toledo. For this Ohio equipment, we are proposing that 1/3 of the cost come from each of NSF RSEC grant, internal university capital matching funds, and the OBoR Action Fund (i.e., $266,000 from each).

C. Sources of Funds

i. External agency request: from the National Science Foundation
   a. Capital request: $291,000
   b. Non-capital request: ≈$1,709,000

ii. Other external source(s): none
   a. Capital request: none
   b. Non-capital request: none

iii. Institutional match

a. Cash for capital:	YSU capital match:	$189,000
	Wright State University capital match:	$40,000
	Kent State University capital match:	$10,000
	University of Toledo capital match:	$17,000
	CWRU capital match:	$10,000
	Bucknell University capital match:	$25,000
	Total cash match for capital	**291,000**
b. Other match:	non-capital match (current estimate):	$673,000

iv. ACTION fund request (may not exceed C(iii)a): $266,000

D. Proposed expenditures:

Budget Summary

Budget Category and Detailed Information for the 5 years of the project	NSF Request ($ in thousands)	Internal Match ($ in thousands)	Action Fund Request ($ in thousands)	Total Funds ($ in thousands)
Capital Equipment (i.e., name of system followed by the total purchase cost in thousands and the name of the institution(s) providing the match)				
(1) CCD Single Crystal Diffractometer System (303, YSU)	101	101	101	
(2) Powder Diffractometer System (153, YSU)	51	51	51	
(3) Protein Crystallography Data System (60, YSU and CWRU/Cleveland Clinic)	20	20	20	
(4) Film X-Ray Diffraction System (60, YSU and Kent)	20	20	20	
(5) Single Crystal Diffractometer (120, Wright)	40	40	40	
(6) MB-CAT Beamline Aperture and Collimator System (102, YSU, Toledo, and CWRU)	34	34	34	
(7) Diffractometer Upgrade (50, Bucknell in PA)	25	25		
(Totals for Capital Equipment in each category)	(291)	(291)	(266)	848
Crystallographic software and data bases	60			60
Salaries and Benefits (initials where known and total cost in thousands)				
(1) Project Director (295, ADH)	85	210		
(2) YSU faculty participants (150, TRW and MAS)		150		
(3) YSU support staff (145, RH, RH, SVB, etc.)		145		
(4) Crystallographic Lab Director (252)	84	168		842
Research Support for Undergraduate Faculty and Students				

(1) Salary/Stipends (2) Research Funds (non-capital)	500 400			 900
Advanced Diffraction Summer School Costs	150			150
Direct Program Administration, Evaluation, and Dissemination Expenses	150			150
Overhead (calculated at 32% of salaries and benefits totaling ≈ $700K)	280			280
Totals	2,000	964	266	3,230

The total capital equipment request from the NSF is $291,000 while the total request from the Action Fund is $266,000 and the institutional cash match on equipment is $291,000. Thus, we are only requesting 34% of the total capital cost of this project from the external agency, 32% from OBoR, and 34% from institutional resources. However, we are requesting a total of $2,000,000 in cash from the NSF which is over 60% of the total project costs (i.e., $3,230,000, cash and in-kind contributions) and about 80% of the total cash costs of this project (i.e., approximately $2,500,000). In this context, the $291,000 capital request from NSF is extremely reasonable as is the $266,000 requested from the Action Fund.

3. PROJECT DESCRIPTION

A. Brief Description of the RSEC Program and the ADSC

The Research Sites for Educators in Chemistry, RSEC, program is a new initiative from the Division of Chemistry at the National Science Foundation. It is designed to promote collaborations between predominantly undergraduate institutions, major research universities, and other federal and corporate organizations. These collaborations are meant to be regionally based, topically focussed, to eventually become self sustaining, and to serve as national models. The central goal is to integrate undergraduate faculty and students into the national research enterprise.

The current proposal for the Advanced Diffraction Studies Consortium, ADSC, arose out of the existing long term research and education interactions in the area of diffraction methods between institutions and individuals in our region (defined as northern Ohio and western Pennsylvania). These research and educational interactions grew from several sources, most importantly the Pittsburgh Diffraction Society, the American Crystallographic Summer School, and several consortia funded by previous OBoR Investment Fund grants, especially the Ohio NMR and Crystallography Consortia. These helped nourish ongoing collaborations between individuals and institutions and have created one of the richest webs of crystallographic/diffraction collaborations in the United States. It therefore seemed natural to expand upon the current crystallographic strengths of our region and form the ADSC (this organization was formally constituted on December 12th of 1998). The ADSC is committed to the enrichment of diffraction research and education, especially that involving undergraduate faculty and students, and to the enhancement of our national prominence in these areas.

Crystallography is arguably the single most important method for determining the structures of materials in the solid state and certainly gives the most detailed structural information we have available. It includes a range of X-ray and neutron diffraction techniques that are used on single crystal and powdered (polycrystalline and amorphous) samples. The relative importance of diffraction methods in structural studies is rapidly growing due to recent and ongoing advances in the theory of diffraction, in computer technology, in crystallographic software, and in diffractometer hardware (including sources, optics, sample stages, detectors, and controls). These advances have simultaneously reduced the cost and increased the speed and sensitivity of individual data collections. This has substantially increased the pace at which diffraction data is collected and *potentially* increased the quality of this data. The relative difficulty in using this new diffractometer hardware and crystallographic software has also rapidly decreased. This increased pace of data collection and decreasing difficulty of usage has meant that a *large and growing proportion* of diffraction data is no longer collected and analyzed by crystallographic professionals. Rather, this data is more and more often collected and analyzed by *crystallographic novices* (e.g., synthetic chemists, biologists, materials scientists) far too many of whom have had little and/or only weak training in diffraction methods. On the other hand, the speed and ease with which

modern diffraction methods can answer structural questions in biology, chemistry, engineering, geology, materials science, physics, etc., means that its use and importance will continue to grow. Responding to the challenges and opportunities posed by these trends in a positive and productive fashion is central to what we are attempting with this grant application.

B. Project Goals

The ADSC has set a series of goals for itself and funding of the RSEC proposal will speed us on our route to these goals. The core goals we have articulated include:

i. *Collaborative Research Programs*: This project will help develop new long term research collaborations between member faculty and institutions. These collaborations will include those between undergraduate faculty and established researchers at the PhD institutions, between researchers at universities and those at federal labs, between faculty and local industry, and between researchers and students. This will accelerate the integration of faculty from predominantly undergraduate institutions into the national research enterprise.

ii. *Sustainable Research Programs*: This project will help develop sustainable research programs at undergraduate research institutions. These will be supported by the new collaborations, training opportunities, access to facilities, and development of a peer network. These new and reinvigorated research programs will result in an increased stream of publications and external grant support.

iii. *Regional Research Facilities*: This project will establish a series of accessible regional crystallographic/diffraction research facilities that are available to undergraduate faculty and students at costs consistent with their resources. This network of new and upgraded facilities will include those for conventional diffraction experiments through those for the most advanced diffraction studies. Facilities suitable for conventional to moderately advanced experiments will be put in place within a short drive of all participating institutions while access will be provided to the most advanced experimental tools at nationally prominent diffraction facilities and federal labs. In addition, YSU will provide a full function diffraction facility to which samples can be sent for remote data collection at no direct cost to undergraduate faculty and students.

iv. *Professional Development Opportunities*: The ADSC will organize and offer a series of student and professional development training opportunities. These will include intensive “hands on” summer short courses, mostly to be offered at YSU, ranging from introductory single crystal and powder methods to the most advanced diffraction methods courses taught by experts in the field. In addition, the participating faculty will have available a network of facilities on which their new skills can be used and more experienced crystallographic/diffraction methods experts with whom they can consult. The collaborative research initiatives will also provide more extended training opportunities (i.e., akin to apprenticeships).

v. *Strengthening the Educational Pipeline*: As part of its efforts, the ADSC will develop new tools for crystallographic/diffraction methods education. These, along with the summer short courses and research experiences, will reinvigorate the teaching of diffraction topics throughout our region. In addition, there will be additional research opportunities for these students on diffraction related topics. These factors, in turn, will provide an increased stream of more highly motivated, educated, and experienced undergraduate students to proceed into our regional PhD programs and into local industry. A central component of all of these efforts will be attempts to diversify the student populations moving towards research and industrial careers. A special effort will be place upon recruiting from populations traditionally under represented and under served in science and engineering.

C. Project Outline

This project will have several major components that are reflected in the budget above. These components include:

i. *Building Accessible Diffraction Facilities for Routine and Advanced Studies.* The proposed capital budget will be used to fund the upgrading of the X-ray diffraction facilities at four of the host institutions in the consortium. Of particular note are the facilities at YSU which will be used for both onsite and remote

data collection (i.e., with the assistance of the new lab director), access to a new beam line on the Advanced Photon Source (i.e., the MB-CAT) through the funding of its Beamline Aperture and Collimator System, and access to a complete range of crystallographic data bases at YSU.

ii. *Support for Undergraduate Faculty Research*. The majority of the proposed budget will fund approximately 50 competitively awarded Undergraduate Faculty Summer Fellowships. These will pay faculty summer support of $7,500 for faculty from predominantly undergraduate schools engaged in collaborative research at the PhD schools as well as contributing about $6,000 towards their research costs. [Note: All Faculty Fellows from predominantly undergraduate schools will be assisted in preparing external grant proposals. Submission of these will be one condition of their Fellowships.] This component will be central in integrating these faculty into the national research enterprise.

iii. *Support for Student Research.* The proposed budget will also fund approximately 50 Fellowships for undergraduate and MS students and high school teachers engaged in collaborative research projects. This will serve to help get these students at the non-PhD schools involved in nationally prominent research at earlier stages in their careers.

iv. *Support for Intensive Summer Short Courses in Diffraction Methods.* The proposed budget will fund approximately graduate level courses 3 to 4 courses each year. These intensive "hands on" short courses will range from basic single crystal and powder methods to the most advanced diffraction methods.

vi. *Support for Minority Enhancement Programs.* The proposed budget will provide seed funding for a series of minority recruitment and retention efforts.

vii. *Support for Evaluation and Dissemination*. The proposed budget will fund a series of efforts to evaluate the strengths and weakness of the consortium's activities and to disseminate the research and educational results.

D. Major Project Participants

The complete list of institutional participants has not yet been completed. [Note: We are awaiting decisions from about one quarter of the predominantly undergraduate schools and a few companies that we have contacted who have been invited to participate. However, based on current trends and initial feedback from them we expect about 90% of them to participate.] Our current working list is presented in section 4 below, a final listing will be available when the RSEC proposal is submitted.

E. Timeline

The program officer at NSF, Dr. Janet Osteryoung, has stated that the expected starting date for the RSEC grants is June 1st of 1999. These RSEC grant are for 5 years (i.e., until June 1st, 2004) and, as per our discussions with Dr. Osteryoung, we plan on using the 1 year no-cost project extension that NSF provides (i.e., so that our project has until June 1st, 2005 to be totally completed). Following, is our current timeline:

Year 1	1999-2000	Award of grant, purchase of instrumentation, installation of ADSC Crystallography Lab at YSU including hiring of Lab Manager and diffraction facilities at other participants, initiation of collaborative research projects, award of Fellowships for the summer of 2000, application for NSF-REU grants to support additional undergraduate collaborators, NSF-CCLI grants to fund additional educational initiatives, and Dreyfus teacher/scholar grant.
Year 2	2000-2001	About 20 undergraduate faculty and 5 students will participate in collaborative research projects at host schools funded by Consortium Fellowships, 1st year of summer schools, award of Fellowships for summer of 2001, 1st intensive evaluation cycle, application for external grants by all Faculty Fellows, application for additional external funding opportunities by consortium.
Year 3	2001-2002	About 15 undergraduate faculty and 10 students will participate in collaborative research projects at host schools funded by Consortium Fellowships, 2nd year of summer schools, award of Fellowships for summer of 2002, 2nd intensive evaluation

		cycle and 1st dissemination cycle, application for external grants by all Faculty Fellows, application for additional external funding opportunities by consortium.
Year 4	2002-2003	About 10 undergraduate faculty and 15 students will participate in collaborative research projects at host schools funded by Consortium Fellowships, 3rd year of summer schools, award of Fellowships for summer of 2003, 3rd intensive evaluation cycle and 2nd dissemination cycle, application for external grants by all Faculty Fellows, application for additional external funding opportunities by consortium.
Year 5	2003-2004	About 5 undergraduate faculty and 20 students will participate in collaborative research projects at host schools funded by Consortium Fellowships, 4th year of summer schools, award of Fellowships for summer of 2003, 4th intensive evaluation cycle and 3rd dissemination cycle, application for external grants by all Faculty Fellows, application for additional external funding opportunities by consortium.
Year 6	2004-2005	Completion of RSEC project, 5th year of summer schools, final evaluation and dissemination cycles, application for external grants by all Faculty Fellows, application for additional external funding opportunities by consortium, final reports to NSF and all participants.

F. Major Individual Research Projects

Even today, the large majority of diffraction studies that are done are "routine" powder and single crystal studies of small molecules and extended solids. These types of studies are still (and for the foreseeable future will remain) the major interest of most non-crystallographers and novices and will represent the large majority of samples who's data they will want to collect and solve. To meet this need, training in the best procedures for collecting data on routine single crystal and powder samples and then solving for their structures must remain the first stage of our educational program. Until undergraduate faculty and students feel comfortable doing this, they will not be ready to begin more advanced diffraction studies. The consortium must also provide facilities at which these undergraduate faculty and students can conveniently, quickly, and at little for no cost collect such data. Youngstown State University will play the central role in this area for the "basic" courses on diffraction methods. We plan on offering such access, through the consortium, to undergraduate faculty and student users on single crystal diffractometers equipped with both serial and area detectors and on a powder diffractometer. They will be able to access these capabilities either by bringing their samples to YSU or by sending them here by mail and having the diffraction technician collect the data. They can then either solve the structures themselves or do so collaboratively with either one of the YSU staff or another researcher in the consortium. This proposal is structured such that they should have quick access at no direct cost to themselves for ambient temperature data collections (for the reasonably expected number of samples).

Once these faculty and students get familiar with conventional powder and single crystal diffraction methods, it is expected that many of them will be attracted to more "cutting edge" diffraction methods that "push the frontiers" of what is possible. Here the focus will be on the use of high resolution diffraction methods to solve important problems of fundamental and applied chemical interest. They will be introduced to such methods through participation in a series of advanced summer school courses to be held at several of the host institutions. This will facilitate their joining collaborative research projects with skilled crystallographers at the major research institutions, initially funded by the consortial Research Fellowships. After two years of this fellowship support it is expected that these individuals will be fully productive members of the collaborative teams and that their further collaborative or individual participation in these projects should be fundable by conventional granting channels.

The specific types of diffraction facilities which these teaching and research efforts will require and the types of research each will support are outlined below:

Quality Conventional Single Crystal X-ray Diffraction Studies This type of studies will represent a substantial majority of single crystal samples for which data will be collected and analyzed. Fortunately, these "routine" single crystal studies of small molecules, extended solids, and minerals can be done, with proper training and appropriate access, by relative novices using any modern single crystal diffractometer. Such diffractometers are available at each of the host sites, although access policies for instruments at each will differ. With funding of the equipment upgrades in the proposed budget, Youngstown State University will be able to fulfill a large part of this requirement for offsite undergraduate faculty and students. The consortium

will offer "basic training" courses in single crystal methods at our YSU summer school and will provide an appropriate structure solution software package to its graduates. Various consortium members will provide advice and consultation for dealing with problem structures. These types of studies can be done on conventional "lab" diffractometers equipped with serial detectors. Data collection times can be decreased, signal to noise ratios improved, or more weakly diffracting crystals used if these diffractometers are equipped with area detectors (most commonly CCD systems but also imaging plate systems) and/or higher intensity sources (e.g., sealed tube units with Gobel optics or rotating anode sources) are used.

Quality Conventional Single Crystal Diffraction Studies on Weakly Diffracting Samples. The use of synchrotron sources are required where one has particularly small and/or otherwise weakly diffracting crystals for which quality data couldn't be collected with an area detector and/or rotating anode system. If one is interested in accurate hydrogen atom positions (or other weakly diffracting elements in the presence of heavier elements) one must use neutron diffraction. Access to such high intensity and neutron sources will be facilitated by the consortium through access to the national labs.

Quality Conventional Powder X-ray Diffraction Studies This type of studies will represent a substantial majority of powder samples for which data will be collected and analyzed. Fortunately, these "routine" powder studies can be done, with proper training and appropriate access, by relative novices on any suitable powder diffractometer. Such powder diffractometers are available at many of the host sites and even at some of the smaller schools, although access policies for instruments at each will differ. With funding of the equipment purchases in the proposed budget, Youngstown State University will be able to fulfill a significant part of this requirement for offsite undergraduate faculty and students. The consortium will offer "basic training" courses in powder methods at our summer school and will provide an appropriate powder diffraction package to its graduates. Various consortium members will provide advice and consultation for dealing with problem structures. The use of more modern powder diffractometers with high intensity sources, area detectors, and/or automated sample changers can substantially increase data collection speed and data quality while decreasing the operator's workload.

Very High Resolution Single Crystal Structural Studies One needs superior diffraction facilities, longer data collection times, and greater skill levels to collect data suitable for high resolution structural studies. The skill level needed to correctly analyze this high resolution data for applications such as charge density studies is also much higher, the software is substantially more sophisticated, and such should only be attempted with the assistance of an expert. Access to this methods will therefore typically be limited to individuals who have passed beyond the novice stage through advanced summer courses and/or collaborative research. This data is most commonly collected on the most modern "lab" diffractometers. These are typically fitted with some combination of a high intensity X-ray source (e.g., a sealed tube X-ray source using Gobel optics or a rotating anode X-ray generator) and an area detectors for the multiplex advantage (most commonly a CCD detector). Low temperature data collection will also have to be used for all but the highest melting solids to reduce the displacement parameters. For many studies, one will also have to collect neutron diffraction data (especially if the light atoms are important) and/or data from ultra intense synchrotron radiation sources. Such sources are only available at the national labs such as the Advanced Photon Source in Chicago. Undergraduate faculty in the consortium will have access to this facility through our participation in the MB-CAT beamline to be funded out of this grant. The consortium will assist in this process through the provision of funding for travel and lodging to collect such data and the participation of Cam Hubbard from Oak Ridge.

Advanced Powder Diffraction Studies As with single crystal methods, one can collect high resolution powder diffraction data. This data must be carefully collected with particular attention to accurately measuring base line and peak intensities and profiles since these contain the atomic position information. High resolution powder data, when analyzed by the Rietveld method, allows one to get quality information on the structures of extended solids or structurally simple molecular materials. However, this analysis is very non-trivial and should only be attempted where one has a good starting model and/or the advice of an expert.

In Situ Diffraction Studies Under Extreme Conditions For many materials studies, one desires structural data measured under extreme conditions, most commonly high temperatures and/or pressures. Such facilities are relatively specialized and will be available to consortium members through the participation of Cam Hubbard of the High Temperature Materials Lab at Oak Ridge. It also requires skill with using specialized software and analytical tools.

Line Shape Analysis of Diffraction Peaks The analysis of line shapes of diffraction data is a technique which provides substantial information on topics of great interest to materials scientists, structural engineers, and catalyst developers including: crystallite sizes and size distributions, defect structures and distributions,

crystal strain patterns, etc. Such studies require diffraction data that have been carefully collected to be optimized to reduce the natural line width and also requires skill using specialized software and analytical tools.

Protein Diffraction Studies Proteins and related macromolecules have tremendous significance to both scientific and biomedical research and we have a growing number of experts in their study in our region. They will form a cornerstone of our proposal and these studies will be principally carried out at UT, CWRU, and Pitt.

Materials Diffraction Studies Advanced materials such as solid state oxides and polymers are characterized by a wide variety of diffraction methods including those discussed above. In addition, a wide range of other diffraction methods are also used to determine their morphologies, orientations, defect structures, etc., including diffraction methods that characterize both the bulk and the surface properties of these materials.

G. Expected Educational/Development Outcomes

As has been described above, at the completion of this project we expect to have reinvigorated the teaching of crystallography and diffraction methods and topics related to them in the many universities participating in this project. This will come about because of the new curricular materials to be developed as part of the project, the training of faculty and students in the summer courses, the integration of these schools into the mainstream of the national research enterprise, and the integration of more undergraduate research into the non-PhD schools.

4. COLLABORATION OPPORTUNITIES

As can be seen below, this project involves collaborations between over 3 dozen institutions of higher education, federal labs, and local industry. It is clearly collaborative to its core, being principally designed to increase the opportunities for collaboration between different institutions and faculty in our region (which is about ¾ in Ohio).

PhD granting host institutions: Carnegie Mellon University, Case Western Reserve University, Duquense University, Kent State University, The University of Akron, University of Pittsburgh, University of Toledo.

MS granting host institutions: Bucknell University, Indiana University of Pennsylvania, Wright State University, Youngstown State University.

Non-University Host Institutions: Advanced Photon Source MB-CAT, Cleveland Clinic, NASA Lewis Research Center, Oak Ridge National Lab, Wright-Patterson Air Force Base.

Predominantly Undergraduate Participating Institutions: (degree granting 4 year institutions) Allegheny College, Ashland University, Bowie State University, California State of PA, Carlow College, Central State University, Chatham College, Clarion State University, College of Wooster, Defiance College, Edinboro College, Gannon University, Geneva College, Hiram College, Juniata College, John Carroll University, Lake Erie College, Lincoln University, Malone College, Mercyhurst College, Morgan State University, Mount Union College, Oberlin College, Ohio Northern University, Penn State Erie-The Behrend College, Saint Francis College, Slippery Rock University, Thiel College, University of Pittsburgh at Johnstown, Walsh University, Washington and Jefferson College, Westminster College and (2 year community colleges) Kent State University-Stark Campus, Penn State Beaver, Loraine County Community College, and Wayne College Community College of UA.

Associated Industrial Companies: Abbott Labs, Amoco/BP, Bruker AXS, Dow AgroSciences, Ferro Corp., Genencor, General Motors, Goodyear, Monarch Analytical, Molecular Structure Corporation, Packard Electric, Pfiser, Proctor and Gamble, and Ricerca, Inc.

Following is a list of the senior project participants and their affiliations. The list of senior participants includes: Alan Pinkerton (UT-Chemistry), Bryan Chakoumakos (Oak Ridge-Solid State Chemistry Division), Bryan Craven (IUP-Chemistry), Cam Hubbard (Oak Ridge National), Casey Raymond (Kent-Chemistry), David Grossie (Wright State University-Chemistry), Gloria Borgstahl (UT-Chemistry), Jim Gano (UT-Chemistry), John Rosenberg (Pitt-Biological Sciences), Margaret Kastner (Bucknell-Chemistry), Mark Foster

(U Akron-Polymer Institute), Mike Nathal (NASA-Lewis, Chief of Advanced Metallic Division), Omar Steward (Duquesne-Chemistry and Biochemistry), Sherri Lovelace Cameron (YSU-Chemistry, Coordinator of Minority Enhancement Programs), Shih-Chi Chang (Duquesne-Physics), SongPing D. Huang (Kent-Chemistry), Tim Wagner (YSU-Chemistry), Vivien Yee (Case-Center for Structural Biology and the Cleveland Clinic), Xavier Lee (Case-Biochemistry and Cleveland Clinic), and Xiche Hu (UT-Chemistry).

In addition, over 50 other faculty (3/4 drawn from predominantly undergraduate schools) have indicated that they will participate. They are all named in the full proposal but for space reasons their names and affiliations are omitted here.

5. COMPETITIVE ADVANTAGES RESULTING FROM ACTION FUND SUPPORT FOR THIS PROJECT, FIT WITH INSTITUTIONAL MISSION AND STRATEGIC PLAN FOR RESEARCH INVESTMENTS, CONTRIBUTION TO RESEARCH-ORIENTED INSTRUCTION

The RSEC program from NSF will fund only 5 RSEC centers next year. Clearly, being awarded one of these will be a major achievement for Ohio and will make us a national model. The new diffraction facilities to be funded from this project and the new collaborations it will facilitate will improve Ohio's already strong reputation and role in diffraction research. The roles proposed for each of the participating institutions were designed to fit within their institutional missions and strategic plans. Thus, the PhD schools will be the centers of advanced research while the smaller institutions are focussing on integrating research with their teaching missions at the undergraduate level. The new diffraction equipment to be purchased all fit within the individual institutional research investment plans. Clearly, the integration of teaching and research which we propose will strongly develop research oriented instruction in Ohio.