

**Department of Energy and National Science Foundation  
Status Review of the QuarkNet Project  
February 2003**

A joint Department of Energy (DOE) and National Science Foundation status review of the QuarkNet project was held on February 12, 2003 at the DOE facility in Germantown, Maryland. The review committee was chaired by Kathy Turner (SC-22) and consisted of six DOE and one NSF reviewers. A complete list of the attendees is attached.

The QuarkNet project began in 1999 as a joint NSF/DOE research-based high-energy physics teacher education project. Marjorie Bardeen (Fermilab) serves as the spokesperson and is one of four managers as shown in the attached organization chart. QuarkNet is a partnership of high school teachers and mentor physicists working in the field of high-energy physics at universities and laboratories across the country. It provides long-term professional development for local high school physics teachers through research experiences and workshops as well as sustained support over many years. Through these activities, the teachers enhance their knowledge and understanding of science and technology research. They transfer this experience to their classrooms, engaging their students in both the substance and processes of contemporary research as appropriate for the high school classroom.

The charge for the review (see attached) was to determine the current status of the project as well as the progress made since the December 2001 review. In particular, the committee was asked to review the project scope in terms of management, costs, schedule and development of the QuarkNet centers as well as assess the project's plans for addressing the recommendations made at the last review and the impact that QuarkNet has made toward the professional development goals for teachers. In addition, they were asked to review the funding profile and its impact on the project as well as the mitigation plans if the funding does not match the projected costs.

**Introduction**

The project, starting its fifth year of activity, is jointly supported by the Department of Energy (HEP division) and the National Science Foundation (MPS, EPP and ESIE divisions). The QuarkNet project was originally based on university and laboratory "centers" with physicist mentors that are participating in the Large Hadron Collider (LHC) experimental collaborations (Atlas and CMS) at CERN in Geneva, Switzerland and the Tevatron experimental collaborations (DZero and CDF) at Fermilab. It has since expanded to also include centers with participation in experiments that are broadly representative of the field of high-energy physics. Teachers have had research experience on the BaBar, CDMS, CKM, GLAST, JLab Hall B, K2K, Milagro, MINOS, Pierre Auger (Argentina), RHIC experiments (PHENIX and STAR) and Super-Kamiokande. The teachers have participated in this research at the university-based centers as well as at the following national laboratories: ANL, BNL, FNAL, JLab, LANL, LBNL, and SLAC. The project plans to ramp-up to its planned steady-state level of 60 centers that will continue through the life of the LHC program at CERN.

In order to be part of the project and run a center, the physicist-mentors make a long-term commitment to participate for the duration of the project. The teachers who are recruited to participate in the centers also make a long-term commitment. There has been some turnover in mentors and teachers.

### **Development of the Centers**

A center has two stages of development, termed Center I and II, before getting to its steady-state level termed Center III or Center IV. At each center, there are at least two physicist mentors who agree to provide the initial research experiences for the teachers and to offer, with lead teachers, a staff development institute for associate teachers and to mentor teachers over the life of the project. During the academic year, the physicists maintain frequent contact with the teachers.

#### Center I

In the first year of a center's participation, the physicist mentors recruit two "lead" teachers for the project. The teachers attend a one-week high-energy physics orientation workshop arranged by the QuarkNet staff and usually held at Fermilab. The teachers participate in a seven-week research project with the physicists, usually at the center. Depending on the researcher's work, teachers may spend some time at the lab where the experiment is conducted.

#### Center II

In the second year of a center's participation, the physicists and the lead teachers recruit up to ten "associate" teachers. The full complement of teachers attend a three-week research-based institute at their local center focusing on teacher professional development. The new teachers learn about high-energy physics, research methods and inquiry-based teaching and learning, tailored to their needs.

#### Center III

In the third and subsequent years of a center's participation, QuarkNet provides support for teachers to spend the equivalent of one-week in follow-on activities.

During each year of the ramp-up, the QuarkNet staff recruits up to twelve new Center I's, and the previous ones move to the next stage. At the end of five years, QuarkNet expects to reach a steady-state of participants, involving 60 centers, 120 physicists, 720 high school teachers, and potentially reaching 100,000 students.

#### Center IV

In addition to the above stages, NSF has funded a stage termed Center IV with four high school student-researchers supervised by one of the teachers. This stage will start in FY 2004 and will apply to those centers that have reached the Center III level. For the length of the grant, six new centers will become Center IV's each year.

In September through December of each year, new Center I's are recruited. In January through May of the next year, the project gets ready for the summer program. The main QuarkNet sessions for the year are held in the summer.

## **Current Status of Project**

The committee found that the current status of the project overall is very good. The centers are being developed at a good rate and according to standards. The development and oversight of the project by the staff is becoming more standardized.

The numbers of centers of each type are shown in the table below as a function of year. The number of centers recruited to start in FY 2003 is listed along with the planned development of centers in future years.

The project reported that it does not have a large number of centers applying that are turned down. The original plan was to have a full complement of 60 centers in FY 2003, though currently there are only 50 on board. This is due principally to funding, but also to the rate of applications.

### **Number of QuarkNet Centers in Each Project Year**

<b>Project Year</b>	<b># Center I</b>	<b># Center II</b>	<b># Center III</b>	<b># Center IV</b>
1999	12			
2000	13	11		
2001	9	13	11	
2002	8	9	24	
2003	10	8	32	
2004	10	10	34	6
2005		10	38	12
2006			32	18
2007			36	24
2008			30	30

Note: Values for 2003 and beyond are planned, based on funding guidance.

The QuarkNet staff members provide services to the centers and teachers as well as guidelines for center performance. Since the last review, the staff has focused on their consistent delivery of services. The staff has instituted weekly meetings via telecon and a face-to-face meeting every other month to facilitate this important activity. To maintain quality control and support for the centers, they visit each center each year. In addition, the staff visit each potentially new center to ensure that roles and responsibilities are understood and can be met.

The staff members, working with the PI's and physicist mentors, provide many services to the project including

- Developing and implementing teacher orientation institute and mentor orientation.
- Maintaining the QuarkNet website.
- Collecting data for outside evaluators.
- Developing online data-based projects, classroom activities and classroom scale cosmic ray detectors to enhance transfer of teachers' increased knowledge to the classroom.
- Developing program materials to assist mentors and teachers as they develop local programs.
- Acting as mentors for teachers and physicist-mentors.

In addition, the staff members also assist with community-building activities for the teachers. This has included providing an e-mail listserv for teacher interactions across the country, connecting teachers and physicist mentors through e-mail and personal contacts, running cross-center symposia, and encouraging and enabling teacher meetings and presentations at the American Association of Physics Teachers (AAPT) conferences.

The QuarkNet project has four measurable goals that relate to teacher development:

- 1) To increase teachers' knowledge of scientific process, particle physics and relationships to curriculum.
- 2) To increase teachers' knowledge of and ability to implement inquiry based teaching methods.
- 3) To increase teachers' contributions to quality and practice of colleagues within the field of science education.
- 4) To support teachers as they facilitate student understanding of and ability to solve science related problems.

QuarkNet offers programs designed and conducted according to "best practices" reported in the National Science Education Standards prepared by a National Research Council (NRC) committee and published by the National Academy Press in 1995.

Evaluations of achieving these goals are done by the project and outside evaluators to provide on-going and timely information for the project to make decisions about program improvement. A variety of qualitative and quantitative instruments are used to collect data. They include site observation and surveys, including pre-and post-surveys and tests, profile templates, staff reports and classroom implementation logs including lesson and unit formats.

### **Action on Previous Recommendations**

There were seven recommendations made by the committee at the previous review. These are summarized below along with the corrective action plans implemented by the project. The committee felt that the corrective action plans put in place by the project were moving forward adequately, except for recommendation 2 which needs more work.

1. Continue the QuarkNet project as designed and modified over the first three years and fulfill its plan within the next two years to reach its original scope of 60 centers with 720 high school teachers and 120 physics mentors. At the end of that time, if the project continues its successful path, the funding agencies should consider additional expansion.
  - o The project continues to work towards the development of the full complement of 60 centers in the QuarkNet project. As discussed above, due to funds and application rate, this ramp-up has not proceeded as quickly as originally designed.

2. Directly involve the PIs and staff in the evaluation process to define more carefully the measurable outcomes of the project. Work with the funding agencies to determine the appropriate level of evaluation consistent with the budget and effort available.
  - The project has worked to define more carefully the measurable outcomes of the project with mentors and participants. They have worked with evaluators to improve data collection instruments. They are exploring ways to work with DOE and NSF EPP to determine the appropriate level of evaluation.
3. Attempt to involve more well-prepared teachers from underrepresented groups as well as from underserved population areas. This will probably require raising the teacher stipend to match their regular wage with a subsequent increase in the QuarkNet budget.
  - Of the most recently added centers, 25% of them have greater than 50% enrollment of minority students in the physics classes, 13% are in rural areas, and 24% are from lower income areas.
4. If more funding is available, add one additional staff member to assure the smooth functioning of the centers.
  - Funding was not available to enable this recommendation.
5. Attempt to increase the information transfer among teachers in QuarkNet by continuing to investigate electronic methods that teachers can and will use. Increase the information transfer to teachers outside of QuarkNet by increasing the number of presentations at appropriate AAPT and APS meetings.
  - The project has created toolkits for teachers for use in the classroom. They have put a consolidated e-mail listserver in place to enhance teacher communications. Teachers are being strongly encouraged to speak at the DPF and AAPT meetings. The QuarkNet staff is working to facilitate this by attending and speaking at conferences.
6. Assist each university center to incorporate other funding sources such as the NSF Research Experience for Teachers (RET) or Department of Education block grants to the states for science and mathematics partnerships to enhance the QuarkNet project at the university centers.
  - The staff has directed centers to potential sources of funds on a case-by-case basis. For example, the project received a State of Illinois grant for approximately \$2K per teacher per year in the Illinois QuarkNet centers. Teachers in Iowa tried to get support from local meat packers and riverboat gambling. The staff is developing a funding toolkit to help centers write proposals and know where to find other funding sources.
7. If at the end of its original plan, the project is functioning smoothly, the funding agencies should consider expanding the original proposal to allow the teachers to work directly with high school students during the summer.
  - NSF is planning on funding this activity starting in FY 2004. The project plans to have its full complement of centers at that time.

- Since this expansion would not follow the DOE workforce development guidelines, funding from DOE will not be used for this expansion of the project.
- There are currently some high school students already working with teachers at the centers. They are funded using experimental project, state and university sources.

**Cost and Schedule**

QuarkNet is a build-to-cost project. The planned cost and schedule was seen as reasonable and adequate by the committee.

The cost per year to run each type of center is shown in the table below. The planned schedule of reaching the full complement of 60 centers in the program and of moving them to the steady state, Center III (for DOE) and Center IV (for NSF), is shown in the table in the “Current Status” section above. Starting in FY04, costs for six of the Center III’s will also include stipends and expenses for two teachers to attend a one week “refresher” institute at Fermilab, in addition to their week at the local center.

**QuarkNet Center Costs**

	<b>Center I</b>	<b>Center II</b>	<b>Center III</b>	<b>Center IV</b>
<b>*Cost per Year (\$k)</b>	19.2	13.82	FY03: 6.6 †FY04: 9.6	19.0

\* DOE G&A costs are not included.

† Costs in FY04 and beyond include the one week Fermilab institute, described above.

Other costs include support for the staff members, the outside evaluators and the advisory group. It is assumed that DOE will fund the staff members at LBNL and FNAL and that NSF will fund those at Hampton University and Notre Dame. The evaluators and advisory group are funded by NSF. Other contributions include agency support for the QuarkNet management team, the physicist mentors, and resources at the laboratories and universities.

The breakdown of costs each year is shown in the table below, including full G&A costs. The costs in FY09 and beyond are considered flat except for increases due to inflation, since the project will be in a steady state operation. These costs are based on a full complement of teachers at each center.

**Management**

The QuarkNet management team appears strong and cohesive. The management team organizes the project, works to secure funding, provides reports to the funding agencies, responds to requests for information and represents the project at reviews. Monthly meetings are held for fiscal planning and resolving issues.

**QuarkNet Project Costs per FY (\$k) - includes full G&A**

	<b>FY03</b>	<b>FY04</b>	<b>FY05</b>	<b>FY06</b>	<b>FY07</b>	<b>FY08</b>
Staff <sup>1</sup>	708.5	737.3	764.8	793.1	834.2	865.3
Center I (#centers)	164.5 (8)	205.6 (10)	--	--	--	--
Center II	110.4 (8)	143.8 (10)	143.8 (10)	--	--	--
Center III <sup>2</sup>	220.2 (32)	255.2 (34)	284.4 (38)	313.6 (42)	274.0 (36)	234.4 (30)
Center IV	--	114 (6)	228 (12)	342 (18)	456 (24)	570 (30)
Misc <sup>3</sup>	72.4	98.5	98.5	98.5	98.5	98.5
<b>TOTAL</b>	<b>1,276.0</b>	<b>1,554.4</b>	<b>1,519.6</b>	<b>1,547.1</b>	<b>1,662.6</b>	<b>1,768.2</b>

1. Staff funding consists of salaries for the staff teachers and secretary, fringe, overhead, travel, and G&A costs.
2. Beginning in FY04, this includes the additional one-week Fermilab institute as described above.
3. Miscellaneous expenses include funds for outside evaluators, advisory group and M&S.

**Funding**

After the December 2001 review, NSF approved a planned funding profile for FY 2002 through FY 2006 that matched the planned costs. The NSF funding will be provided by the Directorate for Elementary, Secondary and Informal Education (ESIE) and the Directorate for Mathematics and Physical Sciences (MPS) through Multidisciplinary Activities (MDA) and Elementary Particle Physics (EPP). DOE approved a planned funding profile from FY 2003 to FY 2006 that was shown at the review. The funding for FY 2007 and beyond is planned to remain flat at \$750k. The DOE funding is provided by the Division of High Energy Physics. The planned funding levels from each agency are shown in the table below.

**Planned Funding Profile (\$K)**

(FY 1998 – FY 2002 are actual funding amounts)

<b>Fiscal year</b>	<b>NSF-ESIE<sup>†</sup></b>	<b>NSF<sup>‡</sup></b>	<b>DOE-HEP*</b>	<b>TOTAL</b>
<b>1998</b>	--	188.8	--	<b>188.8</b>
<b>1999</b>	317.4	250.0	152.8	<b>720.2</b>
<b>2000</b>	353.2	275.0	261.0	<b>889.2</b>
<b>2001</b>	324.8	361.0	316.0	<b>1,001.8</b>
<b>2002</b>	290.5	530.9	375.0	<b>1,196.4</b>
<b>2003</b>	169.0	682.0	475.0	<b>1,326.0</b>
<b>2004</b>	--	756.0	575.0	<b>1,331.0</b>
<b>2005</b>	--	801.0	675.0	<b>1,476.0</b>
<b>2006</b>	--	889.0	750.0	<b>1,639.0</b>

<sup>‡</sup> Funds are from the EPP, MPS and OMA divisions at NSF. The award goes to Notre Dame. The NSF-ESIE funds are included in this column, starting in FY 2004.

<sup>†</sup> Award goes to Fermilab; FY runs from June through May

\* DOE funding in FY 2006 and beyond is planned to remain flat at \$750K.

At the beginning of FY 2003, the project planned their year's operations according to their cost layout. The planned funding is less than the costs for FY 2003. To make up the difference, the QuarkNet management will work to secure funds elsewhere as needed and may reduce scope. The QuarkNet management has agreed to adjust the scope of the project in the following years according to the planned funding profile shown in the table.

### **Committee Recommendations and Summary**

Overall, the project was seen by the committee as progressing well. The project's work in the development and operations of the centers is impressive. They are doing well in providing materials and services for teacher development and in support of the centers. A more detailed list of what is currently provided and future planning was requested by the committee. Oversight of the centers to ensure continued commitment and adequate level of operation is provided by the staff. It is important that this activity, with consistent measures applied and reporting to the project, be continued over the life of the project.

The corrective action plan to address the recommendations from the December 2001 review was seen as adequate overall and progressing well. The plan for the second recommendation, regarding evaluations of professional development provided by the project is under formative development. Anecdotes describing the outcomes of the project are compelling and should continue to be collected. However, the committee voiced concern that more measurable outcomes were also needed. The committee would like to see more specific ways of ensuring the teachers achieve the goals. The project should work with its outside evaluators and with the agencies to develop specific plans for ways of measuring these goals and the appropriate level of evaluation consistent with budget and effort available.

The schedule for development of all the centers was seen as reasonable. The project is behind the original schedule in the development of all 60 centers, but this is understandable and not seen as a problem.

The planned costs were seen as reasonable and adequate by the committee. Planned funding profiles are now in place by all the agencies. The funding is below the planned operating costs for FY 2003 and FY 2004. The committee recommended that the project readjust in these years to get costs in line with the funding as well as seeking funding from other sources to make up the difference. The project has agreed to tailor the project costs and operations to the planned funding profiles.

The project management team and staff appear strong and cohesive. They have instituted regular phone meetings to ensure that they work closely and consistently as a team as well as providing consistent services to the centers.

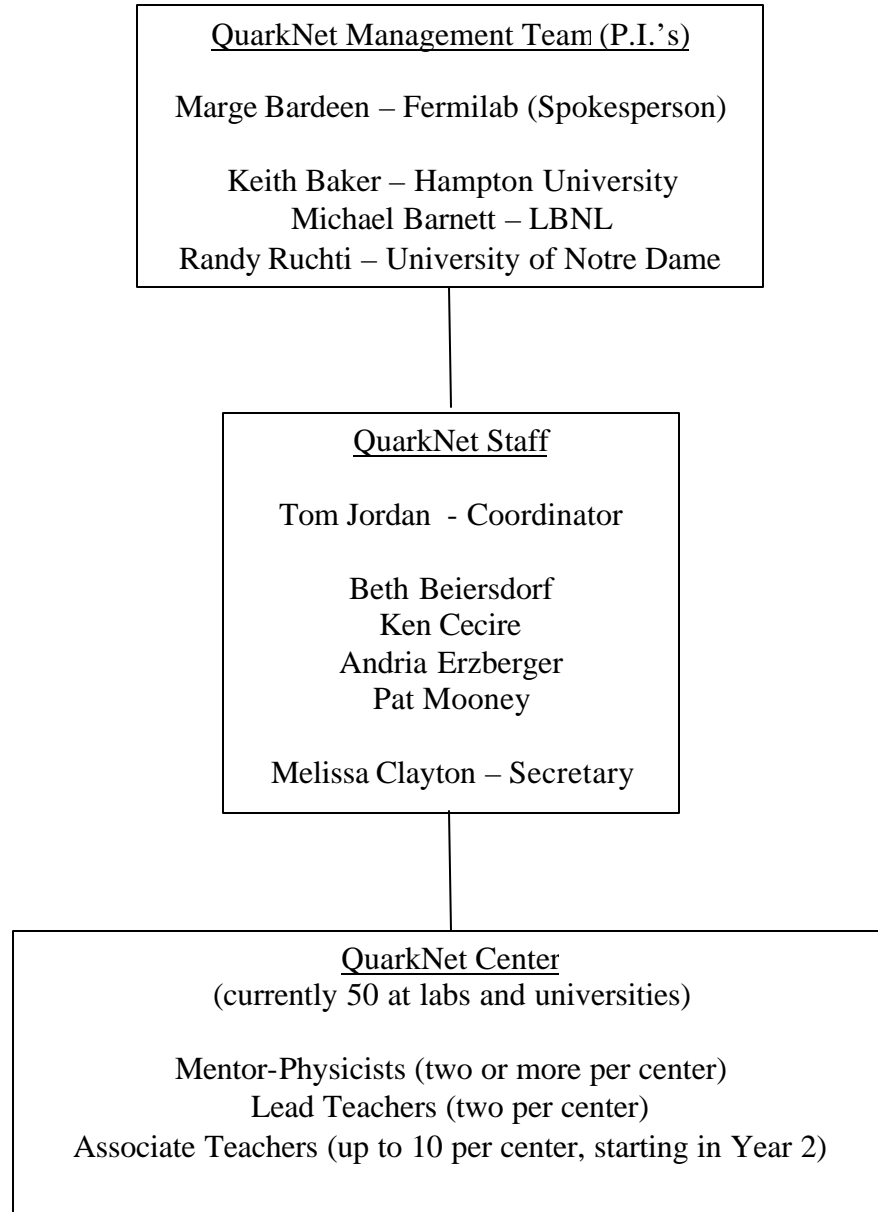
To summarize, the committee was impressed by the work of the QuarkNet project in its development of the centers and professional development of the centers. It is seen as a significant educational and professional development project by both NSF and DOE.



### **Action Items**

<b>Action</b>	<b>Responsibility</b>	<b>Due Date</b>
Provide list of current and planned future materials and services to be provided by the QuarkNet project.	QuarkNet	May 15, 2003
Continue consistent oversight of the centers through the life of the project.	QuarkNet	Continuing
Work with the agencies and outside evaluators to determine the appropriate level of evaluation consistent with the budget and effort available.	QuarkNet and Agencies	May 15, 2003 and continuing
Provide updated project operations table with costs adjusted to fit the planned funding profile.	QuarkNet	May 15, 2003
Hold a status review of the project yearly.	QuarkNet and Agencies	Yearly

# QuarkNet Organization Chart



**To:** Kathleen Turner, Program Manager, U.S. Department of Energy

**Date:** 5 February 2003

**Re:** Request to Conduct a Status Review of the QuarkNet Project

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The National Science Foundation (NSF) Elementary Particle Physics (EPP) Program and the Department of Energy (DOE) Division of High Energy Physics (DHEP) requests that a joint status review of the QuarkNet Project be conducted on February 12, 2003 at the Department of Energy in Germantown, Maryland.

Begun in 1999, QuarkNet is a joint NSF/DOE research-based physics education project. Marjorie Bardeen (Fermilab) serves as the spokesperson. QuarkNet, a partnership of high school teachers and physicists, provides long-term professional development and sustained support for teachers. Local physics faculty members at universities and labs around the country partner with teachers providing opportunities for the teachers to participate in frontier high-energy physics research. Through these research experiences, teachers enhance their knowledge and understanding of science and technology research. They transfer this experience to their classrooms engaging their students in both the substance and processes of contemporary research as appropriate for the high school classroom.

This review follows the joint DOE/NSF independent peer review of the QuarkNet project held in December, 2001, in which the committee gave its unanimous recommendation that the project be continued and expanded to its original planned scope. At this review, the Committee made a number of recommendations to the project.

The charge for the February 12, 2003 review is to:

1. Review the current status of the project, including the scope of the project in terms of management, costs, schedule, and development of the QuarkNet sites. What progress has been made in these areas since the December 2001 review?
2. What are the professional development goals for the teachers in the QuarkNet project? Assess the impact that QuarkNet has made toward these goals.
3. Review and assess the corrective action plan that has been put into place to address the recommendations made at the end of the December 2001 review.
4. Review the proposed funding profile over the life of the project. Assess impact on the Project resulting from budgetary constraints. Consider the cases of the funding being flat-flat and rising 10% per year. Review the Project's mitigation plans if the funding provided does not match the request.

We appreciate your assistance in this matter. As you know, these reviews are an important element of the DOE/NSF joint oversight of the QuarkNet Project. Please provide a report summarizing the findings of the review by April 14, 2003.

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**Department of Energy and National Science Foundation  
Status Review of the QuarkNet Project**

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