NSF's RUI Grant

Advice on Writing Competitive Proposals

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A proposal is a request for funding to support your long-term research plans. Your goal is to present your proposed work in the context of the major questions driving your discipline as well as the academic environment and available resources of your institution.

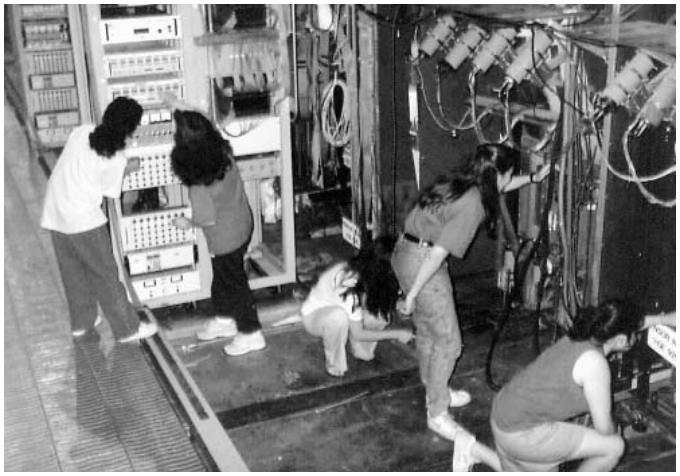
Title: RUI: Search for Exotic Particles at the MiniBooNE Experiment
NSF RUI Award: $120,000

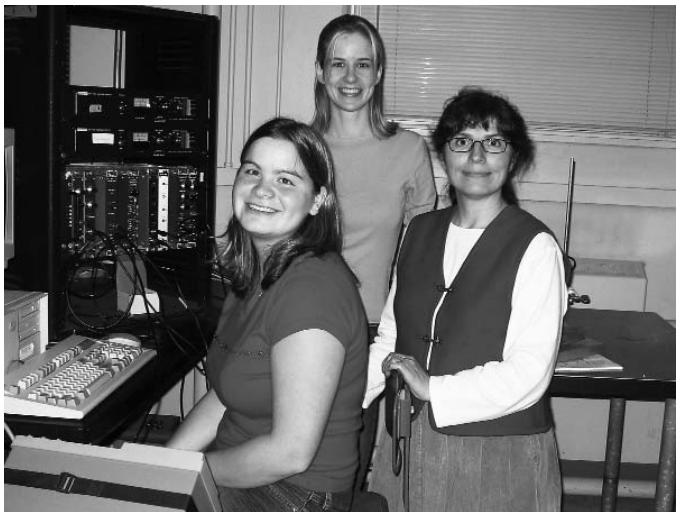
Title: A Double Vertex Search for Neutral Heavy Leptons at Fermilab
NSF RUI Award: $99,862

Getting Started

The Two Parts of a Proposal. All successful proposals have as their foundation a clear plan to gain new knowledge or to understand a relevant scientific question. Developing a **plan** and then making it clear are the two parts of proposal writing. The first part is introspective in nature, and requires defining the long-term direction of one's research. Despite what people tell you, this is the hardest thing about preparing a proposal; it is **not** in the writing but in the planning that must happen before you put pen to paper. The second stage lies in the written presentation of that plan. This demands the best of one's communication skills in order to convey a scheme that is carefully conceived, thoughtfully structured, and appropriately suited for a researcher at a predominantly undergraduate institution.

Identifying the Theme. This is the single, most important aspect of your proposal. Your research plans must fit into the context of the current, bigger questions in your field. It need not provide a complete answer, but it should connect with the present knowledge. The best-written proposal in the world will not be funded if the research is not relevant or does not have merit.





Above: Performing the regular four-hourly check of the NuTeV neutrinodetector at Fermi National Accelerator Laboratory. From left: Pauline Tabibian, Sally Koutsoliotas, Rachel Gall, Sabine Lammers, and Violita Hernandez.

Below: Physics majors, Jaime Wallace (left) and Theresa Sheard (center), with Sally Koutsoliotas (right) at the detector testing station.

"... you may find that there are many possible paths and numerous projects that you would like to undertake. Resist the temptation to include them all in your proposal, as this will make it appear unfocused, or worse, unrealistically ambitious."

When you begin thinking about the direction of your research interests, you may find that there are many possible paths and numerous projects that you would like to undertake. Resist the temptation to include them all in your proposal, as this will make it appear unfocused, or worse, unrealistically ambitious. Your goal is to come across as competent, both in your abilities as a scientist who can accomplish the proposed work and in the skills necessary to manage your time and budget your funds. The type of things you choose to include in your proposal will affect how credible you are perceived to be.

While it may not be feasible to include all your projects in the proposal, it is helpful to list them. Select the few that most closely relate to each other and to current questions in your field. This will form the **theme** of your proposal. Too often, proposals either contain so many projects that it is inconceivable that three years of full-time work will complete them, or there does not appear to be any logical link between the apparent laundry list of intended studies.

Another approach is to first choose a theme for your research and then develop a series of connected projects that relate to it. Some of the projects may involve new techniques while others could be extensions of previous work. When proposing new methods, preliminary proof-of-principle results are extremely helpful in convincing the reviewers of your potential for success. Be wary of presenting a proposal centered around a solitary project, as this is neither a sustainable, long-term research plan nor the purpose of the RUI Program.

The Right Frame of Mind. To shift into the second phase of the proposal preparation process, it is particularly helpful to read through the NSF's Grant Proposal Guide (GPG, NSF 04-23) and the RUI Program Announcement (NSF 00-144), available at the NSF webpage **http://www.nsf.gov**. On first reading, concentrate on section II C of the GPG, especially part 2, which describes the "Sections of the Proposal." You will need to familiarize yourself with both documents, and this is the natural time to begin. All the technical details, such as page limitations, the location of deadlines, page margins, allowable font sizes, etc., are contained in the GPG. Moreover, the two review criteria by which your proposal will be assessed, intellectual merit and broader impacts, are described explicitly.

The NSF guidelines are helpful as you make the transition from the overall, guiding theme to the specific details on which you will focus. It is exactly the right starting point. Too often, guidelines are not followed, making the evaluation process a difficult and frustrating task for the reviewers.

Developing the Plan. Begin months ahead of your deadline, preferably prior to the summer before the submission deadline. Having established the scientific theme, consider ways to strengthen your proposal. Planning well in advance allows you time to optimize your summer activities as well as to begin the dialog with your department chair and university administration. Things to explore are:

1. Are there any papers or technical memos that you could complete before the submission of your proposal?

2. Can you prioritize your summer projects in such a way that will support your proposed work (e.g. collect preliminary data, modify or develop new techniques, perform proof-of-principle experiments, etc.)?

3. Is it beneficial to explore new collaborations with researchers at other institutions that could either provide enhanced facilities or offer expertise to complement your own?

4. Are there conferences where you could present recent results and heighten the visibility of your work? This is also a good way to discuss your work with colleagues, and may lead to ideas that enhance your overall plan.

5. Do you have a sabbatical scheduled during the period of your planned grant? If so, it may be valuable to explore collaborations with researchers at other institutions and build this into your proposal.

6. Does your institution support faculty development programs that you could use to tie in to your proposed research plan? For example, course release programs (that reduce teaching load to allow additional time for research during the academic year), undergraduate summer research internships (to support students), opportunities for student housing during the summers, travel funds (either for faculty members or students),

computer resources (machines or computing time). This is one way to establish institutional support of your work.

The goal is to present the strongest case possible to your reviewers. Preliminary results and related papers, as well as experience with undergraduate research provide solid evidence that you are in an excellent position to conduct the proposed work.

Preparing to Write

As a final step before writing the first draft, I suggest sketching out a time-line for the years covered by the proposal. For each semester (term) and each summer, briefly list the activities you expect to accomplish. Identify the projects you will work on, how many students you will supervise and what they will do, expected milestones, planned travel to work with collaborators, etc. You may find that your time-line becomes sketchy after the first year or so. That is normal. But it is critical that you think about this planning and that it comes across in your proposal.

Having framed the initial concept for a research plan, I find it best to just start writing, beginning with the project description. I strongly advocate structuring the text with section headings and sub-headings. It makes proposals immensely easier to read and very helpful when returning to search for information.

Elements of the Proposal

The Project Description. The "Project Description" is the place where you present the argument for supporting your proposed work. While only 15 pages are allocated for this task, begin with the broader picture describing the current, major questions in your field. This will decrease the space available for your detailed description, but it is essential that you place your work in perspective. Once a compelling argument has been made for your general field of research, it becomes a natural extension to discuss the focus and goals of your specific work. Perhaps your work represents one approach in a given area (e.g. searching/investigating a particular phenomenon using just one of a series of possible mechanisms). If so, describe why further knowledge of that particular phenomenon is valuable and timely, and explain how your specific plans fit into the concerted efforts of your field and how you are well suited to conduct the proposed work.

Having a complete first draft, I find it helps to set it aside for a little time before revising it. As you revise each of the numerous drafts, keep in mind the questions reviewers will ask:

1. Have you included enough details to show that you have a clear, thoroughly considered plan?

2. Have you sufficiently emphasized the expected significance of your results?

3. Do you refer to prior work in building a case that you have the experience and knowledge to execute the planned projects? (This is a good place to include references to your papers.) Is this a natural extension of your work? Do not expect reviewers to be familiar with your work, and usually they will not read your papers, so the proposal is their main source of information about your previous research.

4. Do possible obstacles or challenges exist in your proposed plan, and if so, have you given them due regard? Do not overlook them or treat them too lightly. Did you provide for contingencies where necessary, and how will this affect the degree of success of your final goal?

5. Do you intend to collaborate with others, and is this documented? A letter of support from a potential collaborator is an excellent endorsement and should be included in the "Supplementary Documents" section.

6. Have you identified smaller projects suitable for undergraduate involvement? Use past experiences and observations to make your case that such projects are both reasonable (in terms of time-frame) and accessible to undergraduate students. Can they be extended to honors thesis projects? Do you intend to do so?

7. Are the summers, and other periods when more research time is available, well planned out? Consider including a tentative year-by-year schedule of the major stages of your planned work.

8. Have you discussed the broader impacts of your proposed work in a substantial manner? Include some discussion relating to the implications of your proposed work to the broader community, as this constitutes one of the NSF's two review criteria. While you may think it obvious that your proposed work will promote teaching, training, and learning in your students, state this clearly and explore other opportunities such as the development of curriculum materials, etc. A helpful set of examples is provided on the NSF web page, **http://www.nsf.gov/pubs/2003/nsf032/biexamples.pdf**.

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Finally, I always find some space to include a brief discussion of the benefits of research at an undergraduate institution. While this is the domain of the RUI Impact Statement, I feel that my work with undergraduates is an inherent characteristic of any research plan I develop, and include it as such. I use this section to give an impression of the nature of past work with students as well as providing a perspective of research at a predominantly undergraduate institution (PUI).

Preparing the Budget. Be aware that the budget takes some time to prepare and requires the assistance of your university administration. In some cases, your institution may need a month or more to process your proposed budget. If your institution has an Office of Sponsored Scholarship, then they will be familiar with the technical aspects of this process. Also, it is important to appreciate that the budget comprises two distinct and complementary parts: the actual numbers (on the official NSF forms) and the reasons for them (the Budget Justification). The Budget Justification provides an opportunity to set your requests in context and offers a means of conveying the care and attention you have made in preparing the final numbers.

Items to include may be:

Personnel — This is usually summer salary for yourself and stipends for undergraduate students, either summer or hourly during the academic year.

Travel — These funds provide for attendance at regional, national, and international meetings. Include the cost of travel, accommodation, registration fees, etc. Also provide for the attendance and participation of your undergraduate students. Think about travel to visit collaborators and consider having collaborators visit you.

Equipment (major and minor) — Any major pieces of equipment require some words of justification. Describe your needs in the context of its contribution to the success of your project. Your request is further strengthened if you can show that it has the potential of serving your department as a whole: can other researchers also use this equipment, or can it be incorporated into the curriculum?

Other Direct Costs — This category covers a miscellany of topics. For an experimentalist, a great deal of the day-to-day costs for research falls under the category of "supplies." In some fields, page charges are significant and should be estimated and included here. Also, include any research books and materials that will be needed by your students.

Do not deliberately leave things out of the budget in order to make your proposal more "attractive." The NSF wants to fund the best proposals and to give the PIs the resources they need to do good work.

The RUI Impact Statement. The RUI Impact Statement distinguishes RUI proposals from the more common, individual researcher proposals. This is the opportunity to describe the academic environment of your institution, and place your proposed work, its pace, and the budget, in context. Keep in mind that many reviewers are from large, research universities and have limited experience with the environment, culture, and conditions at a PUI. For some, the absence of graduate students and post-doctoral associates comes as a stark revelation.

Again, the NSF guidelines describing the RUI Impact Statement are excellent starting points for preparing this document. Below I describe the structure I have used; each section was a paragraph or two in my statement.

The Institution and Department — Paint the picture of what it is like to be a researcher at your institution. Describe the size of your institution, its mission, any characteristics that help to identify your student body (e.g. are there professional schools? is it a regional institution? are there many first-time college families?), etc. Include relevant facts about your department: number of faculty members, level of research activity, and variety of research interests. Also discuss institutional priorities such as commitment to teaching; mention course load, other service responsibilities and expectations.

Role of Research at Institution — Describe research expectations; highlight the lack of graduate students and post-doctoral associates. This is an important impression to make to reviewers who may not always appreciate the research conditions at a PUI.

Role of Research in Department — Describe the level of commitment to undergraduate research: is it incorporated into the curriculum (is there a philosophy of discovery-based learning, an honors/senior thesis requirement, a summer research program)? Include both faculty and student participation in research programs. Also mention support staff and, if appropriate, whether you have a

commitment of their support in your project. Finally, discuss the number of majors in your department, the proportion that gain research experience, and their career paths after graduation.

What Your Project Can Offer — This falls into three categories: benefits to the investigator, those to the participants (such as undergraduate students), and those to the department and institution as a whole. Given that one of the three specific objectives of the NSF's RUI Program is to "promote the integration of research and education," the involvement of undergraduate students in your research activities is important and should be emphasized. Discuss past work with students, highlighting any student presentations made at meetings or papers with student co-authors. Referees view experience in undergraduate research very positively.

Institutional Support of Your Research Activities — It is natural to separate this discussion into prior and anticipated support of your research. The NSF wants you to succeed and cares about institutional commitment such as start-up funds, travel funds for conferences, course release programs, housing support for students, equipment purchases or contributions to large purchases, etc.

Other Things — How will you select the undergraduate students to participate in your project? Do you plan to monitor student's progress beyond graduation? Also, describe how this project will impact you as a faculty member at a PUI; what opportunities will it bring to your teaching (i.e. new lab experiences, senior theses)?

Getting Feedback

The importance of asking people to comment on your proposal cannot be emphasized enough! Once I have an acceptable version, I ask at least two carefully chosen people to read through it. One is usually a research collaborator who is able to comment on the scientific content, and the second is a colleague who can critically advise on aspects of grammar, structure, and flow of the text. After discussion and further revision, I have a version that is "close-to-final."

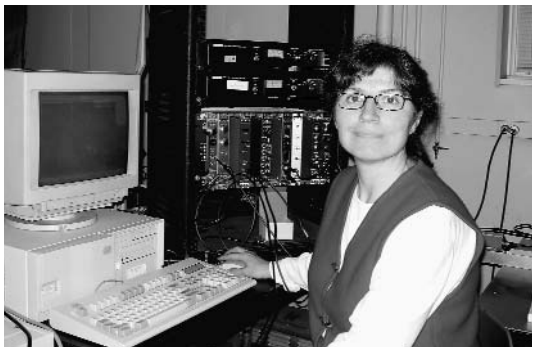
At this point, I ask the most senior researcher in my field that I know (and has the time) to look over my proposal. I hope for substantial comments that will strengthen the overall proposal. This may be in the form of over-looked references, questions relating to the schedule of work, the handling of contingencies, etc. An experienced perspective is invaluable and should be sought only near the end.

If you do not have people available to help you, consider contacting the CUR mentoring service. They will assist you in finding a CUR member who would be able to provide feedback.

Final Comments

In my experiences as a reviewer, I mostly look for an indication that the investigator is embarking on a course that will lead to good things. While this may appear a little general, a proposal cannot help but give an insight into the nature of the author's care, attention to detail, and the rigor of his or her work. By its very character, a proposal reflects the quality of the author's work, so take the necessary time to craft it well. A strong, clear statement of your research goals and planned activities will impress upon the reviewers your commitment to careful work of a high quality.

Sally Koutsoliotas is an associate professor in the Physics Department at Bucknell University, Lewisburg, Pennsylvania. Her research lies in experimental high-energy physics, where she and her students are searching for exotic particles beyond the Standard Model as part of the MiniBooNE neutrino oscillation experiment at Fermilab, Illinois. She has been a CUR Councilor (Physics) since 2002.



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