

NATIONAL SCIENCE FOUNDATION
Review (Jacket Copy)

Proposal:1404271

PI Name: Gilman, Ronald

Title: Collaborative Research: Equipment for and Running of the PSI MUSE Experiment

Institution: Rutgers University New Brunswick

NSF Program: Hadrons and Light Nuclei

Principal Investigator: Gilman, Ronald

Received Date: 03/01/2014

Rating: Very Good

Review:

In the context of the five review elements, please evaluate the strengths and weaknesses of the proposal with respect to intellectual merit.

The proposed research, the MUSE experiment at PSI, is designed to address one of the most intriguing and troubling open questions in nuclear physics today, and arguably, more broadly in elementary particle physics. The crux of the problem lies in the >7 sigma discrepancy between the electron and muon based determinations of the proton radius, present since the 2010 publication of the PSI muonic hydrogen Lamb shift results. The solution of the proton radius puzzle is as remote today as it has been since its first emergence. Various possible explanations have been offered, ranging from changing the value of the Rydberg constant to adding new particles to the Standard Model; none proving wholly satisfactory to date. The proposed program of a series combined measurements of electron, positron, and muon (both polarities) scattering by protons is highly appropriate in addressing some of the perceived weaknesses of prior lepton scattering experiments. MUSE has the potential to cancel some of the important sources of systematic uncertainties that arise when combining or comparing individual disparate electron, positron and μ^+/μ^- scattering results. The intellectual merit, timeliness, and scientific justification of the proposed research is thus beyond doubt. The authors' idea of a well controlled series of combined scattering measurements is excellent. It is then no surprise that the experiment is approved and supported by PSI with high priority.

The groups involved in the collaborative research project clearly have the expertise and personnel to address the task at hand at the level required. The separation of responsibilities is reasonable and should result in successful construction of the proposed detection and data acquisition apparatus. The ultimate success of this project, however, hinges critically on effective control of systematic uncertainties. Sadly, the present NSF proposal does not provide any details on this topic, omitting even a schematic representation of the full apparatus, and focusing instead on motivating the experiment through a detailed discussion of the proton radius puzzle itself, a well established problem to any reader active in the broader field of subatomic physics. A single table of the main sources of systematic uncertainties, required levels at which they should be controlled to achieve the overall goal, and a brief discussion of the steps that proposers intend to take to get there, would have been most helpful. Only by searching the web can a reader glean some information on this topic; even then it is primarily given in qualitative rather than quantitative form. While it is not unusual that in the course of precision measurements researchers discover unanticipated sources of systematic uncertainty, and have to deal with them subsequently, it is highly beneficial to start the project with an "error budget" which provides critical guidance in every step of the project.

NATIONAL SCIENCE FOUNDATION
Review (Jacket Copy)

Proposal:1404271

PI Name:Gilman , Ronald

In the context of the five review elements, please
evaluate the strengths and weaknesses of the proposal with respect to broader impacts.

The proposed line of research has the potential to impact science well outside the scope of nuclear physics alone. Additionally, it will educate and train junior physicists in high-level research skills at the frontiers of modern research. The broader impact of this project is about as high as can be expected of a nuclear physics experiment.

Please evaluate the strengths and
weaknesses of the proposal with respect to any additional solicitation-specific review criteria, if
applicable

Summary Statement

I support the proposed research idea and approach strongly; it is an excellent and timely proposal. My only reservations have to do with the absence of a meaningful quantitative discussion of the systematic uncertainties. The collaboration has conducted a feasibility/test run at PSI. I have not been able to find detailed information on the results of the test run and its impact on the "error budget" (that may be due to my limited search abilities). The authors should be strongly encouraged to provide this information if they have not already done so.

Reviewer: Pocanic, Dinko

Institution at Time of Review:

Department of Physics
University of Virginia P.O.Box 400714
382 McCormick Road
CHARLOTTESVILLE, VA 22904-4714

Suggested Reviewers:

None

Conflict of Interest:

None.