

**Proposal Status** | [MAIN](#) ▶**Organization:** New Jersey Institute of Technology**Review #2**

Proposal Number:	0923199
Performing Organization:	NJIT
NSF Program:	Major Research Instrumentation
Principal Investigator:	Goode, Philip
Proposal Title:	MRI: Development of Cryogenic Infrared Spectrograph for the 1.6 Meter Solar Telescope in Big Bear
Rating:	Excellent

REVIEW:

What is the intellectual merit of the proposed activity?
Strengths

The project proposes a four-year program to develop the Cryogenic InfraRed Spectrograph (CIRS) which will be mounted on the 1.6 m New Solar Telescope (NST) at Big Bear Solar Observatory (BBSO). CIRS is conceived as a prototype of a new generation of IR spectrographs which will provide huge step forward in understanding the physical state and structure of the solar atmosphere.

Development of CIRS has two important scientific aspects: i) CIRS/NST will provide the scientific community with the fundamental high-sensitivity/high-resolution/high-cadence data on the solar small-scale weak magnetic field, which is essential for the comprehension of the structure and dynamics of the solar atmosphere; ii) CIRS will be a significant testbed for the still more advanced spectrographs planned for the 4 m Advanced Technology Solar Telescope (ATST), which will be built at the National Solar Observatory over the next decade.

CIRS will be operating in the range 1-5 μ m, with emphasis on the high-cadence polarimetry in spectral lines of high magnetic sensitivity, at high spatial resolution. This type of measurements can be successfully performed only on large-aperture telescopes, such as NST. The proposed implementation of CIRS to NST will largely increase the performance and merit of NST itself, which was largely funded by an NSF MRI grant.

The spectroscopy in the near-infrared domain is essential in getting a direct insight into the change of the physical conditions from the photosphere up to upper-chromospheric layers. This includes the temperature-minimum region, whose nature is still poorly known, largely due to lack of instruments like CIRS. The polarimetry in the near-infrared range is the only tool that can reveal the structure and distribution of weak magnetic fields, which is the central problem in understanding the origin of the solar chromosphere and its dynamics. Furthermore, the CIRS performances also allow observations/measurements of dimmer targets such as sunspot umbrae and off-limb features.

It is important to note that CIRS/NST will have fully-open data policy, and certainly, the CIRS data will be widely used by scientists worldwide in various aspects of the solar physics research. Furthermore, a substantial portion of the NST observing time will be open to the community. Beside their direct empirical significance, the CIRS data will be of vital importance for the theoretical research on the nature of solar and stellar atmospheres.

Another important aspect of developing CIRS is related to building still more complex spectrographs, foreseen for instruments like, e.g., ATST. In designing and constructing so advanced instruments it is extremely important to rely on experiences from previous endeavors. In this respect, the practice and subtleties applied in developing CIRS will be of inestimable help.

The project is well conceived, precisely specifying the aim, state of the art, methodology, and the strategy of building the instrument. The PI of the project, Prof. Philip Goode and CO-PIs are highly experienced experts in designing and building advanced instruments for solar research. In addition, they will be helped by several instrument-building experts from other US institutions, which guarantees a successful completion of the instrument construction and setting it into operational mode. The team also includes very distinguished scientists acting at the frontiers of solar physics research (including PI himself), particularly related to the physics of the solar atmosphere. This assures that the CIRS deliverables will be well-adjusted to real

needs of the solar physics community, and on the other hand, will reinforce research activities at BBSO.

Weaknesses (intellectual merit)

none

What are the broader impacts of the proposed activity?

Strengths

There are several broader impacts of the proposed project. The most important one is inclusion of young instrument-building scientists into the project. In past decades, most of these scientists were directed towards space projects due to rapidly growing needs for space-borne instruments. This resulted in a deficit of experts in building advanced ground-based instruments, especially those devoted to the solar physics research. In this respect, the CIRS project is of great importance, since it will help continuing a long and fruitful BBSO tradition of training young scientist in getting skills for building high-tech instruments.

The proposed project also takes care about the teaching program at the New Jersey Institute of Technology (NJIT). For example, BBSO has a video-conferencing center, which will be used for joint seminars and classroom teaching at NJIT. Furthermore, two PhD students (funded from other resources) will be involved in the CIRS project. One graduate student will be trained in spectrograph design, and will also assist with the set-up, observation and data analysis. In addition, 1-2 undergraduates are foreseen to spend the summer at BBSO. The NST will be used as a teaching tool for optics, mechanics, computer control and solar physics. Thus, the teaching aspect of the proposed project is important in the scientific education and training students for their scientific and/or technological careers.

The CIRS data will be widely used by scientists worldwide, including theoretical astrophysicists and probably also laboratory physicists who deal with the IR spectral analysis and atomic physics. Thus, the project has a strong multidisciplinary aspect and promotes collaboration of scientists from different research areas.

Weaknesses (broader impacts)

none

Is management plan appropriate?

For instrument acquisition proposals: Evaluate whether the plan: 1) includes sufficient infrastructure and technical expertise to allow effective usage of the instrument; and 2) provides organizational commitments for operations and maintenance.

For instrument development proposals: Evaluate whether the plan has a realistic schedule and mechanisms to deal with potential risks. In addition, evaluate the availability of appropriate technical expertise to design and construct the instrument and the cost of the new technology.

Strengths

CIRS will be a substantial improvement over the existing solar IR spectrographs: it will be the first fully cryogenic spectrograph, since the existing instruments are still based on warm optics. Furthermore, it will be mounted on NST, which is the most capable solar instrument due to its large aperture. This will provide a significant advance in the high-spatial and high-cadence and high Zeeman sensitivity observations of the Sun's atmosphere from the photosphere through the chromosphere. Such observations are strongly needed to reveal characteristics of a weak small-scale magnetic field, which is essential for resolving the nature of the solar chromosphere.

The cost of building such an advanced new-technology instrument is fully appropriate. The financial aspect is carefully planned. A significant part of program costs is covered from other resources. Furthermore, the costs are significantly reduced by the fact that CIRS will be mounted on NST, so many parts of the system will be shared with other instruments. Another significant saving is related to the fact that the team members are either employed at BBSO, or are funded from other resources.

The management and timelines are adequate and realistic. The design of the instrument, technical details, and the plan of actions are carefully elaborated. Special attention is paid to foreseeing potential problems and their solutions. To reduce risks, several highly-experienced experts from other institutions will be engaged as consultants.

Weaknesses (management plan)

none

Rationale for rating

Considering all three NSF MRI criteria, the project is of the highest quality. The proposed instrument development and the related scientific research will provide construction of a new generation of solar instruments, which will enable a huge step forward in understanding the physical state and structure of the solar atmosphere.

The project deserves the highest priority for support.

[◀ Back to Proposal Status Detail](#)