



## THE CALIFORNIA INSTITUTE OF TECHNOLOGY

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January 19, 2003

Professor Philip R. Goode  
Director, Big Bear Solar Observatory  
40386 N. Shore Lane  
Big Bear City, CA 92314

Dear Phil:

I am pleased to write in support of your NSF MRI proposal for a 1.6m clear-aperture telescope.

Although I am not a solar astronomer myself, I do serve on the BBSO advisory committee. I am also very familiar with the observatory's operations as a member of the "night shift" observing earthshine with the BBSO facilities for the past five years. In those capacities, I have been impressed with the competence and dedication of the BBSO staff, and the many improvements that have been made since NJIT took over operations from Caltech. Particularly noteworthy are the steps to make it a true user facility and the staff's ability to undertake complex technical efforts, such as the new instrumentation on the existing BBSO telescope.

University facilities play a special dual role in research and education, allowing the discovery of new knowledge while training the next generation of researchers. I've seen this happen first hand at BBSO during the past five years, and expect that the proposed new telescope would serve very well in this same tradition. Further, it would put the world's largest aperture solar telescope at a superb site in the US, keeping pace with developments in Europe.

In sum, this looks to me like an excellent project, combining science, technology, and education, and I can endorse it most strongly.

Yours sincerely,

Steven E. Koonin



Christopher M. Johns-Krull  
Assistant Professor  
Department of Physics and Astronomy  
Rice University  
6100 Main St., MS-108  
Houston, TX 77005

January 17, 2003

Philip R. Goode  
Distinguished Professor of Physics  
Director, Big Bear Solar Observatory  
New Jersey Institute of Technology  
40386 N. Shore Lane  
Big Bear City, CA 92314

Dear Phil,

I am writing in support of your proposal to upgrade Big Bear Solar Observatory (BBSO) by replacing its current principal telescope with a modern, off-axis, 1.6 m instrument (the NST). Such an advance would be a great asset to solar physics in the United States. BBSO is located at an excellent site and recent advances made in the use of active optics and image reconstruction techniques are now delivering spatial resolution comparable to the best observatories in the world. This new instrument will go even further, permitting advances in many of the outstanding problems in solar physics. Studies in recent years have revealed the ever finer spatial scales over which the key physics involved in solar phenomena are occurring. Most of this is related to the size scale of solar flux tubes. Current solar telescopes using adaptive optics are now approaching this scale, but their relatively small size results in a lack of light (yes even from the Sun) to produce images, spectra, magnetograms, etc., on a time scale relevant for many of the processes. This is particularly true for solar flares. Study of the reconnection process will greatly benefit from high cadence, adaptive optic imaging on a 1.6 m class telescope. Such high cadence, high resolution imaging will also be critical for studies of the evolution of the small scale magnetic field on the Sun. There is great current interest in this component. It is likely this small scale component is produced by a turbulent dynamo, theories of which are just now beginning to be developed. These theories need better data to be adequately tested. This small scale component may also produce micro-flaring events in sufficient number to heat the solar corona (one of the great outstanding problems in solar physics). The NST will make great strides in these areas. Completion of the NST in 2006 will permit important studies of the Sun at solar minimum, and ensure that it is fully operational and complimented with instrumentation before the next solar maximum.

While BBSO is a research unit of the New Jersey Institute of Technology, one of its great strengths and assets to the US community is the observatory's outside users program. I have used the facilities at BBSO on several occasions in my studies of proton acceleration in solar flares. Not only was BBSO readily accessible to me as an outside user, it provided the best observational setup for my experiment in terms of instrument facilities available in the US. The extremely good seeing at BBSO and the specific instrument capabilities of the Video Magnetograph (VGM) were both important to the success of my study. Though I have not used the new instrument yet, BBSO has upgraded the VGM with the Digital Vector Magnetograph, which provides more sensitivity and flexibility. This attests to the state-of-the-art facilities BBSO maintains, both for use by BBSO researchers, but for the solar community as a whole. Finally, university-based solar observatories in the United States are critical for the training of the next generation of solar physicists in our country. Our continued reliance on orbital technology for our daily lives requires a better understanding of the solar influence on the Earth. We call this space weather, and the NST at BBSO will provide many of the key observations required to advance our knowledge in this important field.

With Best Regards,

Christopher M. Johns-Krull



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January 13, 2003

Dr. Philip R. Goode  
Distinguished Professor of Physics, New Jersey Institute of Technology  
Director, Big Bear Solar Observatory  
40386 N. Shore Lane  
Big Bear City, CA 92314

Dear Colleagues,

I have been asked to provide a letter of endorsement for the "New Solar Telescope" (NST), a 1.6m aperture off-axis telescope that would be built at BBSO by a team of Solar Physicists and Astronomers from the New Jersey Institute of Technology and the University of Hawaii. I think the proposed telescope is an excellent idea for a project that will develop important new technologies and advance the fields of Solar Physics and Solar Astronomy in a time frame (coming online in ~2006) that will greatly aid the future deployment of the planned ATST facility (~2010), and will make significant contributions to solar science in the near future. The BBSO-UH team has just the right expertise to design and build this facility.

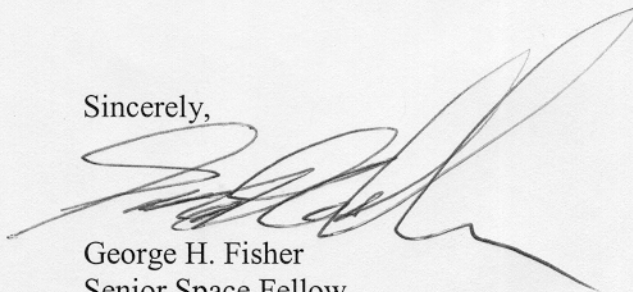
Over the past 5 years or so, I have been a frequent visitor to BBSO, along with my colleague Prof. Chris Johns-Krull, who is now at Rice University. During this time, we've been using BBSO as "guest observers", measuring the linear polarization state of H $\alpha$  in a search for signatures of proton-beams in solar flares. The BBSO staff provided us with excellent technical and logistical support. I was very impressed with the lack of bureaucracy at BBSO, the efficiency of their operation, and the scientific and technical competence of the staff. Such a small, informal operation provides an excellent counterpoint to large national facilities, and provides an essential, hands-on training ground for graduate students interested in solar instrumentation, since BBSO is one of only 2 university-run solar observatories in the US (the other one is at UH).

A testbed for NST concepts is the Solar-C telescope, which is being built by UH on Haleakala, and is now almost complete. Some of the support for the Solar-C effort comes from the Solar MURI grant "Understanding Magnetic Eruptions on the Sun and their Interplanetary Consequences", for which I am the PI. The objective of the Solar MURI project is to develop a quantitative numerical modeling-framework that evolves magnetic eruptions on the Sun, and to test these models with observational data. We recently had a workshop at UH on the use of Solar-C measurements in support of the MURI effort, in particular the use of infra-red polarimetry, which can be used to determine the magnetic field in the solar corona. The ability

to measure magnetic fields in the corona is one of the pillars of the Solar MURI project. These pioneering measurements will be made over the next few years, but will be limited by the modest aperture of Solar-C. The larger aperture of NST would be the logical next step to take what we learn from Solar-C and create a better suite of instruments. In a similar vein, the progress that is made with NST will assist in the instrument design for ATST, in turn increasing the usefulness of that effort for Solar Physics.

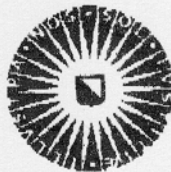
In summary, I strongly endorse the NST concept and look forward to seeing many exciting new scientific results that will be taken with the new telescope. NST will advance solar instrumentation, train new graduate students in the critically important instrumentation area, and will be useful to the scientific community at large.

Sincerely,

A handwritten signature in black ink, appearing to read 'G. Fisher', written over a large, faint, circular watermark or stamp.

George H. Fisher  
Senior Space Fellow  
Space Sciences Laboratory

Universiteit Utrecht  
 Faculteit Natuur- en Sterrenkunde



prof. dr. R.J. Rutten  
 Sterrekundig Instituut, Utrecht  
 Institutt for Teoretisk Astrofysikk, Oslo

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Utrecht, Jan 17 2003

Prof. Philip R. Goode, Director  
 Big Bear Solar Observatory  
 40386 N. Shore Lane  
 Big Bear City, CA 92314  
 USA  
 fax: 00-1-909-860-4240

To whom it may concern,

This is a letter concerning the plan to equip the Big Bear Solar Observatory (BBSO) with a solar telescope of 160 cm aperture. I have received the project summary drafted by Profs. Goode (NJIT) and Kuhn (UH) and base my comments on this draft.

I know both proposers and their work well, hold them in high regard, and also have high respect for the qualities and track records of their teams. My conclusion is that this is an excellent and exciting plan, a logical step for the 2006-201+ era (since Solar-B fills the smaller-telescope niche from 2006 while ATST will initiate larger-aperture solar physics only after 2010), and very likely to be highly successful. I explain this conclusion below.

My own credentials are the following. I am a solar physicist at Utrecht University in the Netherlands and at Oslo University in Norway. I am program leader "Solar Astronomy" at Utrecht and project scientist (effectively director) of the Dutch Open Telescope (DOT) on La Palma in the Canary Islands. I also lead the European Solar Magnetism Network (ESMN). The DOT website, the ESMN website, and my own website (URL's specified above) furnish further information.

Let me first paint the landscape = optical solar observing on an international scale. The DOT and BBSO occupy comparable niches in solar physics, especially when the DOT is seen as a tandem sister to the SST, the brand-new Swedish Solar Telescope on La Palma from whose building the DOT is operated. The DOT is a 45-cm aperture multi-wavelength imager consistently applying speckle reconstruction to achieve long-duration tomographic imaging of the solar atmosphere at 0.2 arcsec resolution. The 96-cm SST employs adaptive optics (AO) plus phase-diverse restoration to obtain 0.1 arcsec resolution, and will be equipped with a spectrometer and magnetometers in addition to its imaging capability. The DOT-SST tandem is presently the

European counterpart to the US high-resolution efforts at NSO (the DST at Sacramento Peak) and BBSO. The SST is the first telescope to approach meter class resolution in solar physics. Its first images, recently published in *Nature*, dramatically prove that doubling angular resolution from 0.5-m to 1-m aperture brings dramatic change in the intrinsic nature of the solar scene.

Various plans now exist around the world to build larger than 1-m telescopes. It must be emphasized that only very recently it has become practical to do so. Solar telescopes have always been small compared to nighttime telescopes, with apertures ranging from 0.3 m to 0.7 m, but these "small" telescopes were effectively already too large in terms of angular resolution. Even at La Palma and BBSO the Fried parameter  $r_0$  describing atmospheric quality in terms of equivalent telescope aperture exceeds 20 cm only occasionally. Super-seeing commensurate with meter-class aperture may occur in perfect weather but waiting for that might take many years. Even half-meter telescopes are usually far too large. With respect to angular resolution there is no point in building larger solar telescopes if the atmospheric deterioration is not corrected (or avoided by going to space, orders of magnitude more expensive). The recent developments in speckle burst collection and reconstruction, phase-diverse imaging and reconstruction, and real-time adaptive optics and multi-conjugate adaptive optics currently cause a high-resolution revolution in which solar physics may finally get to the intrinsic scale of the basic phenomena underlying solar structures and dynamics. This is not only a matter of snapshot resolution, but requires consistent-quality high-resolution observing, simultaneously in different diagnostics, over considerable durations at high cadence. Just a cursory inspection of the DOT movies at <http://dot.astro.uu.nl> shows the importance of consistent long-duration sequence gathering: the sun is dynamic at every time scale, and it is essential to be able to study dynamical changes without perturbation from the changing seeing permitted by the earth's atmosphere.

The major plan is the NSO-led ATST development aiming at a 4-m class telescope. The principal driver for the 4-m aperture size is the need to gather enough photons: at high resolution solar observing is photon-starved. This sounds surprising to nighttime astronomers, but at high angular resolution the quantity to consider is intensity, not irradiance flux, and the solar intensity is just as low as from any other cool star. Aperture increase does not change the photon flux per diffraction-limited resolution element whereas the permitted integration time (set by the solar scene change speed, e.g., the sound speed) diminishes with increasing resolution. The number of photons available for detection therefore goes actually down with increasing aperture. The need for 4-m aperture therefore comes from the requirement to feed sufficient photon flux into spectrometers, full-Stokes spectropolarimeters and tunable Fabry-Perot interferometers whose narrow bandpasses decimate the photon take spectrally and whose application often requires very high S/N (as in polarimetry where images or spectra using only a small fraction of the light are subtracted). In these photon-limited applications optimal wavefront correction means restoring as many Zernike coefficients as the system order can reliably handle at a given angular resolution, say 0.1 arcsec.

ATST will be the international solar physics workhorse, but only after its completion around 2010, so during the next decade. No wonder that there are projects aiming at smaller aperture to get a pre-taste of the high-resolution cake earlier during the present decade. A brief overview:

- SST: Swedish 1-m aperture vacuum refractor, La Palma, operational;
- GREGOR: German 1.5-m aperture open on-axis Gregorian, Tenerife, largely funded, operational after 2005;
- SUNRISE: German-led balloon-borne 1-m on-axis Gregorian, funding requested, first flight

perhaps in 2004;

- MAST: Indian open 1-m reflector, proposal stage;
- DOT<sup>++</sup>: Dutch upgrade of the DOT to 1.5-m aperture, proposal stage;
- NST: BBSO New Solar Telescope, 1.6-m aperture open off-axis Gregorian = present proposal.

Except for the SST and SUNRISE, all projects utilize the "open" principle, relying on wind flushing and possibly enforced air flow control to inhibit internal telescope seeing and building on the successful demonstration of wind flushing by the strong La Palma trade winds by our own DOT. None of the projects preempts the need for ATST for the reasons explained above: quantitative diagnostics need larger aperture in order to gain sufficient S/N even at lower than diffraction-limited resolution. Most of the above projects therefore aim at more limited capability: GREGOR primarily at spectrometry, DOT<sup>++</sup> only at speckle imaging, SUNRISE at Solar-B-like capability at double the Solar-B aperture.

All of these projects supersede Solar-B (launch late 2005) which at 50-cm aperture may be seen as the combination of the DOT (or the late Swedish SVST) and the HAO/NSO Advanced Stokes Polarimeter in space. This statement can also be turned around: if Solar-B functions nominally, there is not much sense in operating and maintaining ground-based half-meter solar telescopes from 2006 onwards unless they fill a special and specific niche. It is therefore very logically to build and operate meter-class telescopes during the half-decade in which Solar-B does and ATST does not yet operate. After 2010, solar physics will undoubtedly need more than just one single multi-meter telescope (compare with the present flurry in 8-m-and-larger nighttime telescope building); it is logical that towards the end of the decade proposals will arise to add multi-meter telescopes to the ATST during the next decade.

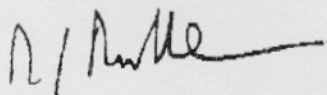
So far the landscape. It obviously has a niche for a 1.6-m telescope at BBSO, as US counterpart to the European efforts (not literally meaning competition; I for one look forward to sequence extension by DOT-NST tandem observing, BBSO taking over when the sun sets at La Palma) and as a science learning step towards ATST. In view of the BBSO track record, science specialisms, and site quality, aiming at an order of 1.5-m telescope is the logical step to take. Making it an open off-axis reflector is just as logical.

I fully support the proposal. Scientifically, it encompasses the science niche which will be covered in my own upcoming DOT<sup>++</sup> proposal to Dutch funding agencies. In a nutshell, this is the transition in structure and dynamics of the solar magnetic field from the photosphere to the corona; in simple words, the issue how photospheric fluxtubes connect to and constrain coronal loops. This is widely seen as one of the principal research areas in solar physics, and to be fundamental for understanding solar space weather modulation.

The DOT<sup>++</sup> will be limited to multi-wavelength imaging only, using speckle reconstruction exclusively, for reasons of manpower, cost ceilings, and also because the DOT lacks the capability to feed solar images onto horizontal benches in an optics lab but needs inflexible, fixed hardware solutions for secondary optics and image acquisition along the telescope itself. The aims for the DOT are therefore far less ambitious than for NST, which will combine easily and flexibly accessed horizontal optics tables with high-order adaptive optics, real-time speckle reconstruction (we do only post-processing at the DOT), and Fabry-Perot spectropolarimetry.

One might expect that I, as DOT director and DOT<sup>++</sup> proposer, should see NST as dangerous competition, a nasty bigger brother across the ocean. Far from it, and not only because NST

will be much less limited than DOT++ in its science applications. Yet apart from the general philosophy of collaboration - wide-spread in solar physics because the sun sets us larger problems than we can handle - and yet apart from the opportunity for DOT++ - NST tandem sequence observing mentioned above, the background to bear in mind is that in the second half of this decade, the SDO mission will flood solar physics and solar physicists with its continuous high-cadence many-wavelength full-disk image streams at 1 arcsec resolution. Ground-based high-resolution telescopes are likely to be constrained even then by say 4Kx4K chips at 0.03 arcsec pixels to only 2-3 arcmin fields, a tiny fraction of the apparent solar disk. We will desperately need multi-telescope observing to enrich low-resolution SDO data mining sufficiently with high-resolution inspection of what the sun is really doing at its more intrinsic scales. Additionally, every solar physics group in the worldwide community must educate itself in high-resolution solar physics on the way to ATST.



Robert J. Rutten





## Harvard-Smithsonian Center for Astrophysics

60 Garden Street, Cambridge, MA 02138



January 17, 2003

Philip R. Goode  
Director, Big Bear Solar Observatory  
BBSO, 40386 N. Shore Lane  
Big Bear City, CA 92314

Dear Dr. Goode,

This letter is in support of your proposal with Dr. Jeff Kuhn for NSF-ATM-MRI funding to help upgrade Big Bear's 65 cm solar telescope to a 1.6 m clear aperture instrument. This upgrade will make excellent use of an existing telescope at a superb site to build an extraordinary next generation instrument. I have looked carefully at the specifications of the new instrument, and believe that it will be a major new tool for solar research in the relatively near term. The combination of a large clear aperture, a superb observing site, and a high-order adaptive optics correction system should ensure that the telescope will deliver extraordinary angular resolution and thus lead to significant progress in our understanding of fundamental photospheric processes like magnetoconvection, and the chromospheric and coronal response. I am delighted at the prospect that such an instrument will be available to guest observers from the entire US solar community, and rightly so because this will be the way to maximize the scientific return from the instrument.

I wish you the very best for this proposal, and for this exciting new program.

Sincerely,

Robert W. Noyes  
Professor of Astronomy  
Harvard-Smithsonian Center for Astrophysics



# 中国科学院国家天文台

NATIONAL ASTRONOMICAL OBSERVATORIES  
CHINESE ACADEMY OF SCIENCES

Prof. Phil Goode  
Big Bear Solar Observatory  
40386 North Shore Lane  
Big Bear City, CA 92314

December 30, 2002

Dear Prof. Goode:

I am writing this letter to strongly support your proposed project for a 1.6-meter New Solar Telescope (NST) at Big Bear Solar Observatory (BBSO). My recommendations are based on the following reasons:

- (1) I visited BBSO a few times and I believe that BBSO has excellent seeing and weather condition. BBSO is an ideal site for new larger solar telescopes. The open design will get rid of the dome seeing. Huairou Solar Observing Station of my observatories used domeless observing mode and we know its advantage.
- (2) The NST will take the advantage of the Adaptive Optics (AO) system currently under development at BBSO. This will ensure diffraction-limited images. New imaging magnetograph systems in visible and near infrared are perfect focal plan systems for NST which will obtain cutting-edge scientific results, in particular, in the space weather research.
- (3) The development of NST will benefit the design of 4-meter Advanced Technology Solar Telescope (ATST). In addition to the open design, the off-axis design will also be used by ATST.
- (4) BBSO has excellent reputation in first-class research and training of graduate students. This project will further enhance the research and education.

In summary, I believe that the NST is an excellent project, which will benefit the solar physics research in US and in the world.

Sincerely yours,

A handwritten signature in black ink, appearing to read 'G. AI.' with a period at the end.

Guoxiang Ai  
Director of National Astronomical Observatories  
Member of Chinese Academy of Sciences  
Member of Third World Academy of Sciences

Dr. Bernhard Fleck  
SOHO Project Scientist  
ESA Space Science Dept.  
NASA/GSFC Code 682.3  
Greenbelt, MD 20771, USA

Prof. Dr. Philip R. Goode  
Director, Big Bear Solar Observatory  
BBSO, 40386 N. Shore Lane  
Big Bear City, CA 92314

30 December 2002

Dear Prof. Goode,

I am writing to express my strong support for your plans to upgrade Big Bear Solar Observatory with a modern off-axis, 1.6 m clear aperture telescope.

Big Bear Solar Observatory has already played a key role in SOHO coordinated campaigns; it is in fact the most frequent ground-based partner, appearing in one out of five campaigns that involve ground-based support. In addition to these dedicated campaigns, Big Bear's synoptic H $\alpha$  images are regularly used by the SOHO science planners for target selection.

I am convinced that the New Solar Telescope (NST) you are proposing will play an even more important role during the scientific exploitation of the new class of solar data expected from upcoming space missions such as Solar-B, STEREO, SDO, and ESA's Solar Orbiter. All these missions, and STEREO in particular, will benefit tremendously from the ultra-high resolution magnetograms and other dedicated coordinated observations NST will provide. Further, when combined with simultaneous high resolution polarimetry from the Solar Orbiter, i.e. observations from an angular perspective removed from that of the Earth, NST will allow *stereoscopic* observations of the fine structure of the photospheric magnetic field which should reveal its detailed structure *on a physical height scale, rather than an optical depth scale*. Furthermore, such stereoscopic observations should provide the velocity field components in a plane, rather than along just a line-of-sight. Such advances should place tight observational constraints for fundamental processes such as convective collapse, generation and propagation of MDH waves in flux tubes, and the nature of the weak internetwork magnetic field. The key to achieving all this is high spatial resolution, high signal-to-noise, high precision polarimetry, which requires a large primary mirror with adaptive optics.

In addition, the NST would be an ideal instrument for the education and training of the next generation of solar physicists and instrument builders, and it should also be an ideal test-bed for the NSO-led Advanced Technology Solar Telescope (ATST).

I wish you all the success with this exciting and important project.

Sincerely,

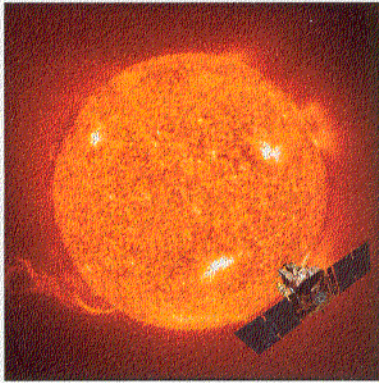


Dr. Bernhard Fleck  
SOHO Project Scientist

**European Space Agency**  
**Agence spatiale européenne**

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2002 December 29

Prof. Philip R. Goode  
Director, Big Bear Solar Observatory  
New Jersey Institute of Technology  
40386 North Shore Lane  
Big Bear City CA 92314

Dear Phil –

I have read with great interest your plan to construct a new, 1.6-meter, off-axis, new solar telescope (NST) at Big Bear. I believe a facility of this size and type is critical for testing principal features of the Advanced Technology Solar Telescope (ATST), particularly the formulation, execution, and operation of an open telescope of off-axis design; the extension of adaptive optics (AO) in the visible and near IR to larger telescopes; and access to far-infrared wavelengths currently poorly supported by most solar telescopes. As you know, it is only in the IR that we can hope to make direct measurements of coronal magnetic fields – the key to understanding the origins of space weather.

I congratulate you on obtaining private and/or matching funds for more than half the estimated cost of the project, and support your application to the National Science Foundation for Major Research Initiative. It is important for the Foundation to realize that your proposal is a significant step in itself, but also one that will provide tests of key enabling technologies for the ATST. Recent and well-publicized developments at the Swedish Solar Telescope on La Palma have shown that we can confidently take the next step up in aperture for AO systems, and the public response to the early La Palma results have shown the deep interest the taxpaying public shows in the kind of science the NST will make possible.

With best wishes for the success of your effort,

(Dr.) Joseph B. Gurman  
US Project Scientist for SOHO



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Dr. Phil Goode  
New Jersey Institution of Technology  
Big Bear Solar Observatory

January 15, 2003

Dear Phil:

Your proposal to develop a 1.6 meter New Solar Telescope (NST) for deployment at Big Bear Solar Observatory is an exciting project and will be a very positive development for solar research, the production of solar astronomers at NJIT/BBSO, and the studies/forecasting of space weather that require sustained, observing campaigns. The partnership for the 4-meter Advanced Technology Solar Telescope has developed design concepts for heat control, the ATST optical train including an off-axis primary and adaptive optics, and is working on enclosures and other issues. We will freely make these concepts available to NJIT for inclusion in its efforts on the NST as appropriate.

In its role of providing solar facilities and research opportunities to the scientific community, NSO endorses your efforts and offers the following level of support. We can provide advice and suggestions that simplify the project. We can critique designs as they are developed and suggest improvements based on our efforts with the ATST design. NSO will stay fully involved in the development of the NJIT and NSO adaptive optics systems intended for the Dunn Solar Telescope and the BBSO 65 cm telescope. These systems will serve as the prototype for the ATST and provide a first, low-order working system for the NST.

With best regards,

A handwritten signature in cursive script that reads "Stephen L. Keil".

Stephen L. Keil, Director  
National Solar Observatory



**DEPARTMENT OF THE NAVY**

NAVAL RESEARCH LABORATORY

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IN REPLY REFER TO:

10 Jan 2003

Professor Philip Goode  
Big Bear Solar Observatory  
40386 N. Shore Lane  
Big Bear City, CA 92314

Professor Jeffrey Kuhn  
Institute of Astronomy  
University of Hawaii  
2680 Woodlawn Drive  
Honolulu, HI 96822

Dear Phil and Jeff,

It is with pleasure that I extend to you my support for your proposed New Solar Telescope (NST), adding, I have no doubt, to extensive support from both the solar and space weather communities.

The currently operating BBSO facility, with its 65 cm telescope has, during its decades of operation, contributed seminal new knowledge of the Sun, in addition to earning the respect (and affection) of the many solar observers who have utilized it. However, as a recent NRC study on Ground-Based Solar Research (by the Space Studies Board in 1998) emphasized, the current infrastructure of ground based solar physics research in the USA is in desperate need of revitalization. That study pointed out that future solar research will require spatial resolutions of fractions of an arc second. This mandates the development of a new generation of telescope that combines larger apertures, clever optical design and adaptive optics.

The NST, with its modern off-axis 1.6 m aperture and high order adaptive optics system, represents an important component of the needed revitalization of ground-based solar physics research in the USA. Since the larger 4 meter Advanced Technology Solar Telescope (ATST) is planning to employ a similar approach, the NST can also function as a low-budget test bed for ATST; the testing, validation and development of crucial components and approaches will undoubtedly aid in a more efficient ATST.

With increasing recognition of the societal impacts that solar activity may perpetrate by altering the Earth's environment – influencing both global change and space weather -- comes the obligation for our community to not only explore the Sun for new discoveries but to monitor its behavior with high fidelity and understand the origins of its variability and terrestrial effects. The NST will contribute significantly in this regard, by continuing

and expanding functional observations of both the Sun and earthshine that BBSO already undertakes for the use and benefit of the broader community.

It is gratifying to see the New Jersey Institute of Technology (NJIT) and the University of Hawaii (UH) collaborating to bring their respective special skills to the proposed BBSO/NST effort. In addition to securing efficient utilization of both personnel and fiscal resources, this collaboration will help to reverse a disturbing trend in solar physics in the USA. The recent NRC study of Ground-Based Solar Research identified the decline in solar physics education in research universities as a major pending crisis that threatens the Nation's supply of future scientists. The collaboration of NJIT and UH brings together two of the nations foremost teaching and research universities in solar physics and provides with the NST a crucial new advanced tool for educating and training future solar physicists of the highest quality.

Congratulations on bringing together a first class team to address well-recognized priorities for future solar physics research and applications.

Very best wishes for a successful proposal.

Judith Lean



Research Physicist  
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Washington, DC 20375.



4 January 2000

Reply to Attn of:

SD50

To Whom it May Concern:

I have read the proposal to NSF-MRI from NJIT and UH for partial funding for building a 1.6-meter New Solar Telescope (NST) at BBSO. I find the proposed project to be scientifically compelling, technically sound, and highly cost-effective.

The Japan/US/UK Solar-B space mission, scheduled for launch in 2005, will have a 0.5-meter visible-light telescope equipped with a vector magnetograph. In the perfect seeing of space, with 0.2 arcsec resolution, this telescope will provide "space-truth" observations of the Sun's fine-scale magnetic structure and dynamics, which globally sustain the corona and solar wind, and locally trigger the large magnetic explosions (coronal mass ejections) that produce hazardous space weather. The Solar-B telescope will have a role in solar astronomy analogous to the role that the Hubble Space Telescope has had in night-time astronomy. Large ground-based visible/IR solar telescopes will be able to complement Solar-B in the way that large night-time telescopes (such as the Keck telescopes) have complemented the HST, by providing greater spectral sensitivity via more light from larger apertures and comparable spatial resolution via adaptive optics. The 1.6-meter NST will have 10 times more collecting area than Solar-B, and NST's adaptive optics will give it sustained spatial resolution at or beyond the 0.2 arcsec diffraction limit of Solar-B. Thus, the NST will be well capable of complementing and significantly surpassing the discovery observations from Solar-B.

I was a member of the recent NAS/NRC Task Group on Ground-Based Solar Research (Parker Committee), was a member of the Solar Astronomy Panel (Knoelker Panel) of the NAS/NRC Survey of Astronomy and Astrophysics, and am a member of the Big Bear Solar Observatory Advisory Committee. These groups have all emphatically concluded that it is now technically feasible and scientifically imperative for ground-based solar astronomy to advance into the 0.1 arcsec and higher resolution regime via large-aperture ( $\geq 1$  meter) telescopes equipped with adaptive optics. Such collecting area and resolution are mandatory in order to resolve, measure, and track the magnetic, thermal, and flow structure of the elementary flux tubes in which practically all solar magnetic fields are rooted. The structure and interaction of these magnetic elements in the photosphere and chromosphere are fundamental to all aspects of the magnetic Sun, from the dynamo, to the magnetic modulation of the Sun's luminosity, to coronal heating and the solar wind, to flares and coronal mass ejections. On this basis, the NSF is presently funding the design of the National Solar Observatory Advanced Technology Solar Telescope (ATST), to be built




near the end of this decade. The NST is a valuable and prudent intermediate step for bridging the way to the ATST, both scientifically and technologically. The NST will define the observational questions and limits to be attacked and surpassed by the ATST. Of equal importance, the building and operation of the NST and its adaptive optics will reveal and solve many of the technical problems that will face the ATST.

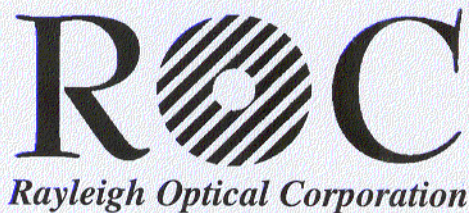
The proposed NST upgrade of BBSO will be carried out by a highly qualified team of world leaders in developing high-resolution solar telescopes, adaptive optics, image reconstruction, and vector magnetographs. With other funding, much of it from NSF, this team is presently developing adaptive optics, real-time image reconstruction, and new visible and IR vector magnetographs for use on the BBSO 65-cm telescope. The NST will parlay the investment in these leading-edge instruments to a much greater science payoff than can be had from the 65-cm telescope. At the same time, the development of the NST and its instrumentation will train several of the next generation of instrumentalist solar astronomers who will use and improve the ATST and its instrumentation.

The proposed NST is a low-cost, low-risk prudent bridge to the ATST, and along the way will complement Solar-B and will make its own discovery observations of the fine-scale magnetic Sun.

Sincerely,

A handwritten signature in cursive script that reads "Ron Moore".

Ron Moore  
Solar Physics Group  
Space Science Department



3720 Commerce Drive  
Suite 1112  
Baltimore, MD. 21227  
Phone/fax: 410-247-6666  
Email: info@rayleighthoptical.com

**Quotation # 03180**

January 14, 2003

Dr. Leonid Didkovsky  
Big Bear Solar Observatory  
Big Bear City, CA 92314

Dear Dr. Didkovsky,

Based on the information sent to us via email on your upcoming need for the fabrication of some optics, I am happy to give you some ROM figures. Please let us know when the information becomes firm so that we may give you a fixed price.

	Primary Mirror (qty=1)	Secondary (qty=1)
Estimated fab. cost (meniscus)	\$270-300K	\$110-120K
Estimated fab. Time		
-meniscus	approx. 10 months	approx. 6months
- plano/plano	an additional month and approximately \$30K	

Notes –

- Customer will provide ROC with a suitable blank, good surface quality and inherent material quality satisfying the project needs. ROC takes no responsibility for customer supplied material (s), except in cases of gross negligence.
- The blank will be delivered in suitable shippable box to the dimensions indicated and with the curve generated (meniscus approximately closest to the parabola). For the secondary we request the parent, this will allow us to choose the best piece meeting your final optical requirements after cutting. No guarantees are offered to the quality of a second piece and availability. Pricing is for one piece.
- Thus far all optical fabrication is to be done on one surface, the front surface. Any additional requirements for the back surfaces will be estimated upon knowledge of the requirements.
- Shipping, taxes (as applicable), coating of any kind are the customer's responsibility. This project is FOB ROC manufacturing facilities.
- Final testing done using phase-measuring interferometry, and at 633nm with its axis looking vertically.

- ROC will request 25% up front along with the purchase order prior to starting the project. Milestone payments will also be requested.
- Final acceptance is done at ROC facilities and is based on compliance to the specifications. Completion of each milestone shall be accompanied by the appropriate data verifying the achievement of the milestone.

Again, thank you for contacting us. I hope this is of help to you and please keep us mind we would like to do the work for you. If you have any questions, please do not hesitate to contact us.

Kind regards,

Vilma Londono-Anderson