

OBSERVING TIME PROPOSAL FORM FOR NEW SOLAR TELESCOPE (NST)

Important Notes:

Two Proposal Submission Deadlines:

- 15 April 2015 for Session 1 (May 1 - June 30)
- 1 June 2015 for Session 2 (July 1 - 31 and September 15 - October 31)

1. Time window available for 2015: May 1 - July 31 and September 15 - October 31;
2. For the information of NST and BBSO, please visit <http://www.bbso.njit.edu>;
3. For the instrument information, feel free to contact Prof. Wenda Cao at wcao@bbso.njit.edu;
4. Final decision on telescope allocation for session 1 and session 2 will be made no later than April 25 and June 15 2015, respectively by BBSO Telescope Allocation Committee (TAC). High priority may be given to the PIs who produced good scientific results from the previous observations, to the proposals with scientifically challenging and achievable objectives, and the observing proposal with coordinated observations.

Make sure to submit your proposal in PDF format to Wenda Cao (TAC chair) via wcao@bbso.njit.edu before the deadlines

Qualified internal and external applicants:

1. Internal applicants refer to the scientific staff residing at BBSO, scientists and students in NJIT's Center for Solar-Terrestrial Research, and BBSO partners.
2. External applicants refer to the scientists and students from the institutes or universities in USA recognized by NSF or NASA.
3. The PI must have a PhD degree or be a PhD student with the supervisor as the Co-I.

Acknowledgement Requirement:

Please acknowledge BBSO and the instrument PIs in the paper relevant to this observation:
BBSO operation is supported by NJIT, US NSF AGS-1250818 and NASA NNX13AG14G

1 General Information

1.1 Applicant Name and Affiliation

PI:	Phil Goode	New Jersey Institute of Technology
Co-I*:	Dirk Schmidt, Jose Marino	National Solar Observatory (and BBSO)
Co-I*:	Nicolas Gorceix, Wenda Cao	New Jersey Institute of Technology

*Note that Co-Is have the same data access rights as the PI. Please coordinate data access among team members.

1.2 Proposal Information

- ☐ Renewal or continuation
- ☒ Linked to an US NSF funding
- ☐ Linked to an NASA funding
- ☐ Linked to a PhD thesis in preparation and led by a PhD student
- ☐ A coordinated observation with a ground-based telescope
- ☐ A coordinated observation with a space-based observatory (e.g. IRIS or Hinode)

1.3 Observing Conditions

- ☒ Good Seeing
- ☒ Sky Clarity
- ☐ Low Water Vapor
- ☐ Specific Solar Activity
- ☐ Quiet Sun Observation
- ☐ Solar Limb Tracking

1.4 Preferred Observing Date and Time*

- ☒ Fixed Date: 11 - 22 May 2015
 - ☐ Flexible Date: 5 - 7 days
 - ☐ Fixed Observing Time: 18:20:45 UT - 19:00:05 UT
 - ☒ Suggested Observing Time: 16:30:00 UT - 22:30:00 UT
 - ☐ Observing Conditions Permitting
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*Note that Fridays may be occupied for telescope engineering time.

2 Scientific Rationale

2.1 Title

MCAO Studies Using 1.6 m NST

2.2 Abstract

NSF-ATI is funding final development of the NST's MCAO system bringing it from engineering first light to an operational system. This is the second two week run in this project. The goals are 1) determine the optimal order of DMs, in particular where in the sequence of DMs should one place the on-axis DM; 2) including a much more sophisticated reconstructor that will improve statistics; 3) observe with all three DMs. 2) and 3) will benefit from good seeing.

2.3 Short Summary of the Request

The proposed observations have two fundamental objectives that are essential for solar MCAO project, in general and the BBSO MCAO project in particular.

First, the plans include using the on-axis WFS in the MCAO focus while relocating one DM to the pupil downstream of the high-altitude DMs. For this very first test of this configuration, we will move one of the high-altitude DMs while leaving DM1 of AO-308 at its place and not using it actively. This configuration implies advantages and disadvantages over the configuration that has been used so far. It will be the first ever on-Sun experiment of its kind, and hence is very exciting and important because it addresses the basic optical configuration of a solar MCAO system. We will decide during the run when, and whether to switch back to the prior configuration for a comparison based on the degree of success, as well as the effects of seeing and weather conditions.

The second goal is to test a fundamental modification in the reconstructor. We plan on using a statistical reconstruction matrix that Jose Marino has been using in his simulations. This method adds additional regularizations to the inversion and aims for minimization of the mean square error by taking the turbulence strength and the measurement errors into account. It is important, but difficult to determine these parameters for a real system. We also hope to benefit from good and more stable seeing and weather conditions.

As well, we will push harder on including the third DM in the reconstruction. We have had marginal success in including the third DM, but success may come from a better reconstructor coupled with some good seeing.

We have had initial success in our MCAO winter run. These were the first successful solar MCO data. Now we are ready to move to the next step as detailed above and will benefit from good seeing.

We have longed planned for two weeks of MCAO run in May, but need to move this forward from the end of May. The reasons for moving the run forward include giving Dirk more time

for analysis of the run data before he leaves for a GREGOR MCAO run beginning in early June. The timing of the GREGOR run is recent news. Further, we want to complete the testing of the DM's figures to understand how the Strehl of DM1 and DM2 might be improved (unlike DM3, DM1 and DM2 were not figured under bias and these two probably need to be re-figured under bias). We will do this in collaboration with Northrup-Grumman who is the DM vendor. Finally, the CSTR AdComm meeting has been scheduled and would interfere with the originally scheduled MCAO run during the last two weeks in May.

We emphasize that MCAO is an essential technology for correcting the full field of view on solar observations, which in turn will enable one to make high-resolution, sub-second cadence diffraction limited observations of dynamical events like flares for the first time to elucidate phenomena that have been beyond our grasp.

2.4 Results from Previous NST Observations

In February 2015 we had the first successful MCAO run (2DMs) ever recorded. This motivates the observations proposed here.

2.5 List of Relevant Publications

Two MCAO Papers in SPIE Meeting in Montreal in June 2014:

Optical design of the Big Bear Solar Observatory's multi-conjugate adaptive optics system 2014SPIE.9148E..50Z Zhang, Xianyu; Gorceix, Nicolas; Schmidt, Dirk; Goode, Philip R.; Cao, Wenda; Rimmele, Thomas R.; Coulter, Roy

The multi-conjugate adaptive optics system of the New Solar Telescope at Big Bear Solar Observatory 2014SPIE.9148E..2US Schmidt, Dirk; Gorceix, Nicolas; Zhang, Xianyu; Marino, Jose; Coulter, Roy; Shumko, Sergey; Goode, Phil; Rimmele, Thomas; Berkefeld, Thomas

2.6 Expected Results

Address long standing issues about the optimal ordering of DMs and an improved reconstructor leading to better statistical results in MCAO.

3 Observing Program

Utilize MCAO Setup we have in place and record data with science camera.

3.1 Instrumentation Requirements*

☒ Adaptive Optics (AO-308)

☒ Broad-band Filter Imager (BFI)

- ☐ **Fast Imaging Solar Spectrograph (FISS)**
- ☐ **Visible Imaging Spectrometer (VIS)**
- ☐ **Infrared Imaging Spectro-polarimeter (NIRIS)**
- ☐ **Cryogenic Infrared Spectrograph (CYRA)**
- ☐ **Other**

*Note that FISS and VIS can't be used simultaneously. CYRA can't operate with all other instruments simultaneously.

3.2 Observational Strategy

Alternate placement of on-axis DM and reconstructors and record and determine post-facto the precision of the results from the DM order switching and the utility of the improved reconstructor.

The better the seeing the more useful the scheduled observations will be.