

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:	Lim, Eun-Kyung	Korea Astronomy and Space Science institute
Co-I*:	Cho, Kyung-Suk	Korea Astronomy and Space Science institute
	Yurchyshyn, Vasyl	New Jersey Institute of Technology
	Chae, Jongchul	Seoul National University

*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:**
- Flexible Date: 7 days between July 06 - July 31**
- 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

*Note that Fridays may be occupied for telescope engineering time.

2 Scientific Rationale

2.1 Title

Chromospheric Fine-scale Structures in Sunspots and their associated Wave Properties

2.2 Abstract

We propose to observe fine-scale chromospheric oscillatory structures inside a sunspot with VIS and NIRIS instruments of the NST to study their associated wave properties. Motivated by the previous NST/FISS observations of propagating slow magnetoacoustic waves in a pore, and the NST/VIS detection of these chromospheric fine-scale oscillating structures, we aim to study the wave properties of chromospheric fine structures in detail. In specific, Doppler velocity pattern and the magnetic field geometry of the chromospheric fine structures will be investigated using high time cadence VIS observations along with NIRIS data. Those properties should be important to understand the wave phenomena of the fine structures, and has not been studied in detail yet.

2.3 Short Summary of the Request

We request 7 days of the telescope time under the fine observing conditions to observe sunspots with the VIS, BFI (TiO) and NIRIS. Since we are interested in wave properties, the most important component of these observations should be both the high spatial resolution and the time cadence. In order to increase the time cadence of the VIS, we will reduce the number of VIS wavelength points to 3 ($\pm 0.4, 0 \text{ \AA}$).

2.4 Scientific Rationale

Due to the interaction between photospheric oscillations and the complex magnetic structure of a sunspot, various dynamical phenomena such as waves or shocks are observed with a diverse range of scales in sunspot umbra. High-resolution imaging spectrometer, such as VIS/NST, provides a good chance of both resolving fine-scale oscillating structures and investigating their wave properties. Besides the fact that such a fine-scale structure itself has not been well studied before, the relationship between its oscillatory motion and other sunspot waves is not well understood. By utilizing the high spatial resolution of the VIS with increased time cadence, we expect to study the wave properties of chromospheric fine-scale structures, such as the spatial distribution of the wave source, relationship with the running penumbral wave, and the effect of the magnetic field distribution on the wave properties.

2.5 Results from Previous NST Observations

Previous FISS/NST observations detected oscillation in the pore atmosphere, and recently it has been verified that such oscillation is actually a slow magnetoacoustic wave propagating along the pore magnetic field. Although the study showed that the detected wave source is not single but multiple, the spatial resolution of the FISS image was not high enough to check the fine structures or spatial distribution of the wave source in the pore. Recently published high resolution VIS observations detected fine-scale chromospheric structures inside a sunspot umbra oscillating along the strong sunspot magnetic field. The study suggested that they are wave phenomena and related with the onset of running penumbral waves.

2.6 List of Relevant Publications

Cho, K.-S., Bong, S.-C., Nakariakov, V. M. et al. 2015, ApJ, 802, 45

Yurchyshyn, V., Abramenko, V., Kosovichev, A. et al. 2014, ApJ, 787, 58

2.7 Expected Results

We expect to understand the wave properties of chromospheric oscillating fine structures, and also their relationship with other previously known sunspot waves.

3 Observing Programme

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

The most important component of this observation is to obtain VIS data with high time cadence of 10 seconds. In order for that, we will reduce VIS wavelength points to 3 : 0.0, ± 0.4 Å. For

the BFI and NIRIS, standard observing mode is sufficient. The preferred time cadence of the NIRIS is 1 minute.

3.3 Target and Conditions

The aimed target is a number of sunspots and pores not effected by any abrupt flaring events. Sunspots that are slightly tilted are preferred.