EMC Study in Mingantu Spectral Radioheliograph

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Abstract

There are always the Electromagnetic compatibility (EMC) problems where the electromagnetic phenomenon exists. EMC is an inescapable problem in radio astronomy and also common problem for radio astronomical telescopes. This paper will focused on EMC Study in Mingantu Spectral Radioheliograph

1. Introduction

Mingantu Spectral Radioheliograph (MUSER), solar-dedicated radio image observing equipment [1], has been set up in 2016 in Mingantu Observing Station (MAT) in Inner Mongolia. Its frequency bandwidth is from dm-λ to cm-λ radioheliograph.

The EMC requirement is not so severe like other night radio astronomy, and a radio quiet zone with 10km radius around Mingantu Observing Station has been set up, the MUSER electromagnetic environment is still becoming worse than ever and need to pay more attentions to confront the problem especially in its low frequency array MUSER-I (400MHz-2000MHz).

With total 100 antennas spread over about 10 square kilometers, MUSER has big array coverage area, complicated structure and function. To guarantee this big distributed system to reach its science goals with good performance, there are too many works to do further and in detail. In engineering, EMC is a systematical and comprehensive problem. Although preliminary MUSER EMC works have been done on site selection [2] [3] and electromagnetic environment protection, deeply and systematical EMC study of MUSER are still very important and necessary with emergency for MUSER to achieve its best scientific output.

EMC in MUSER is a challenge:

- 0.4 -15GHz frequency coverage
- 100 antenna
- 3km*3km area
- 3.4km long spiral arms
- High rate data processing
- Mass memory
- Complicate system
- Worsen EM environment

Figure1. Bird's-eye view of MAT

Figure2. MUSER-I and MUSER-II antenna array

This paper focuses on three aspects: 1) EMC design for MUSER-I and MUSER-II; 2) MAT electromagnetic environment protection measures; 3) MAT electromagnetic shielding designing; 4) RFI surveillance.

2. EMC design consideration for MUSER

At the beginning of design, full consideration have been made [4][5] on the questions on EMC of MUSER-I and MUSER-II:

For MUSER-I:

- Mobile is forbidden
- LNA with Limitr and with
- An auto-controlled attenuation will act when RFI exceeds the safe level of expensive RF optical transmission equipment in the front end
- Modular channel box
- Long cable shielding……

For MUSER-II:

- LNA with Attenuation after LNA to limit the highest output level to protect the optical fiber transmission equipment
- LTCC（Low-Temperature Co-fired Ceramics）technology application
- Two IF bandwidth output
- Double IF frequency
- Filter bank
- Twisted-pair line……

However, it's still not enough for MUSER EMC problems.

3.MAT EM environment protection measures

MAT electromagnetic environment protection measures include:

- Setting up a quiet zone with 10km radius with cooperation of the local government
- Power off a mobile communication tower in the south of MAT station about 2km away in 2012
- Constructing an optical fiber communication network for more than one hundred families of local residents

5villages with about 105 shepherd families around the MAT station are the main and potential RFI sources. So an optical fiber cable communication network for all the families was set up in 2014.

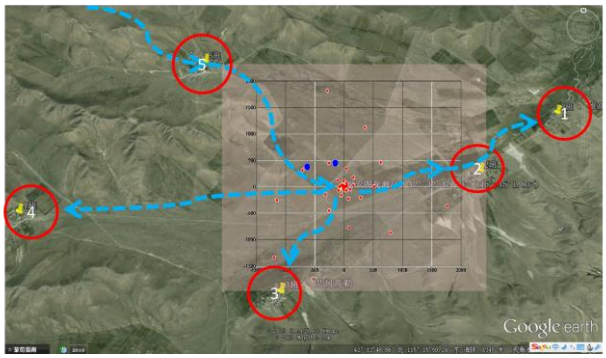

Figure3. diagram of optical fiber cable communication network for 5 villages around MAT

4. MAT EM shielding scheme

RFI comes from outside and inside MAT. A MAT EM shielding scheme has gotten financial support from NAOC for new buildings of MAT for observing equipment and for laboratories. It will be implemented after the MAT construction.

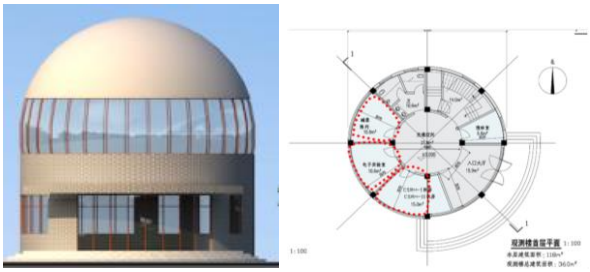

Figure4. MAT observing center and its shielding scheme

5. MAT RFI surveillance

Figure 5 to Figure 8 show the MUSER-I Interference Scan in four 400MHz bandwidth. right ascension from -90 ° to +90 ° , with declination=19.15° , along the sun' s orbit on 2015-05-17 in MAT) There are big differences among different 400MHz bandwidth and between different circular polarizations, as well as in different right ascension angles. So it is not easy to eliminate RFI effects on MUSER.

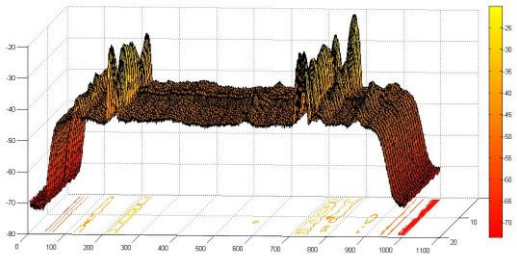

Figure5. 400-800MHz

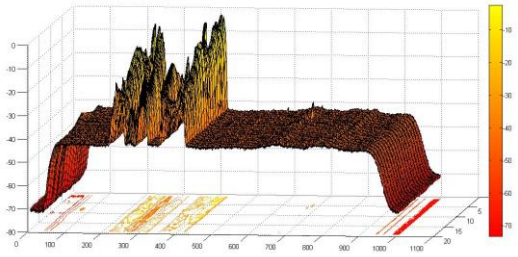

Figure6. 800-1200MHz

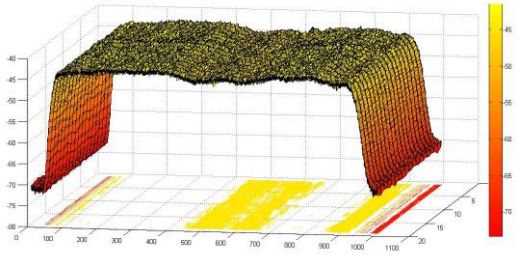

Figure7. 1200-1600MHz

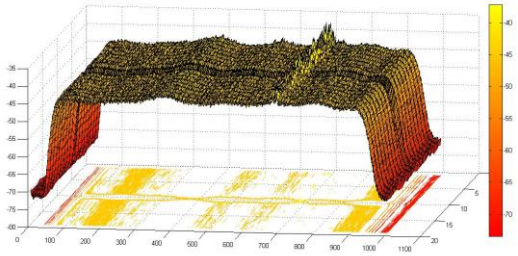

Figure8.1600-2000MHz

Figure 9. and Figure 10. show the MUSER-II Interference Scan right ascension(right ascension from -90 °to +90 °, with declination=19.15° , along the sun orbit on 2015-05-17 in MAT). RFI in MUSER-II is not so severe like MUSER-I. But it is not optimistic with the development of communication technology.

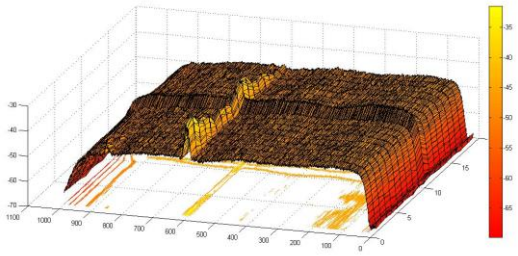

Figure9. MUSER-II 2.0-2.4GHz Left Hand Circular Polarization

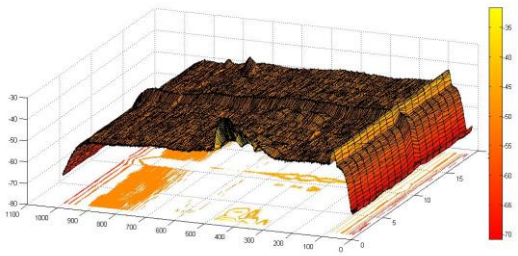

Figure10. MUSER-II 2.4-2.8GHz Left Hand Circular Polarization

6. conclusion

MUSER is a system with 0.4 to 15GHz Wide frequency coverage, 100 antennas ,and spread over 3km*3km.To guarantee this wide distributed system to reach its scientific objectives with good performance, there need to study further and in detail for EMC problems. To deal with the MUSER EMC problems is not only a technical problem, but also a trade-off of cost-efficiency problem

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8. References

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