United Nations/Japan Workshop on Space Weather
"Science and Data Products from ISWI Instruments"

ICSWSE

Development of TNU-SuperSID teaching module: enhancing student's knowledge in space science

Le Minh Tan
Department of Physics, Faculty of Natural Science and Technology
Tay Nguyen University, Vietnam

2 - 6 March, 2015
Fukuoka, Japan

Overview

- Introduction
- Development of TNU-SuperSID teaching module.
- Educating process
- Conclusion

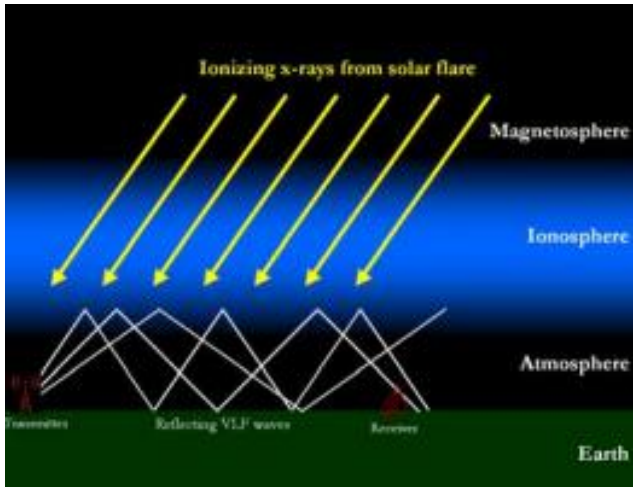
Introduction

- **The VLF (3 – 30 kHz) signals propagate in the Earth - Ionosphere waveguide.**

- **In normal conditions, X-rays radiated from the Sun affect the D layer insignificantly. When the solar flares occur, the strong ionizing radiation causes the electron density of the D layer to dramatically increase with 1-2 orders of magnitude, and hence the sudden changes of amplitude and phase of the VLF signals are found at the VLF receivers.**

[D. Grubor et al. 2008]

- **This phenomenon is known as Sudden Ionosphere Disturbance (SID).**



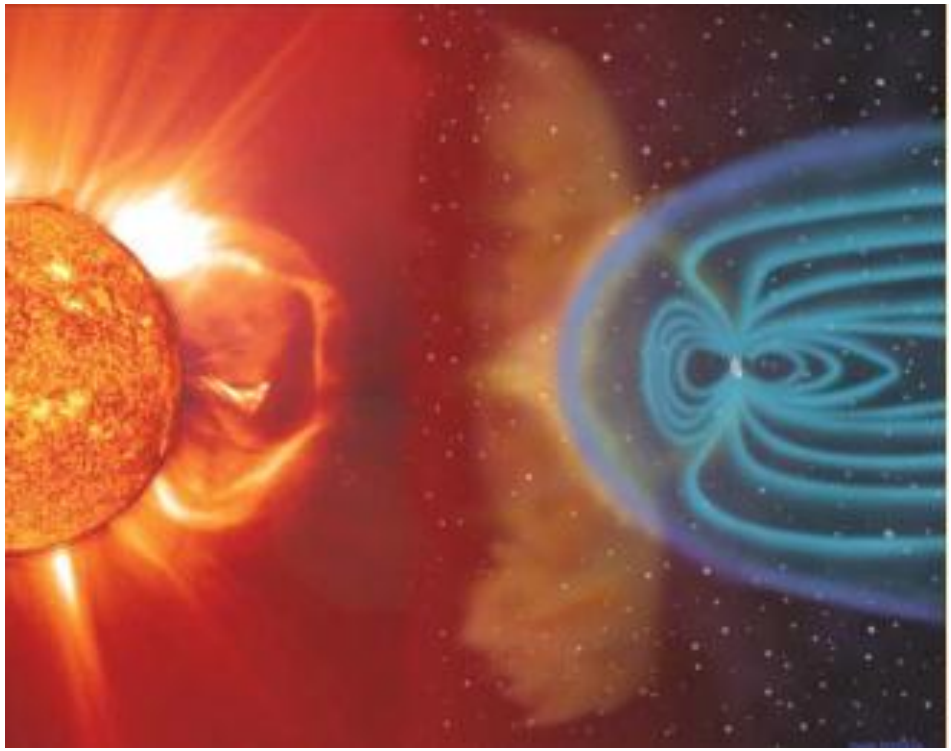
Solar flare event on the 10 September 2010, NASA.

Introduction

Solar flares induces a wide spectrum of radio noise which can direcly interfere with VHF signals.

Particles such as electrons, protons, etc. are ejected from the Sun. The plasma clouds consisting of those particles are called Coronal Mass Ejection (CME).

[SuperSID manual, 2009]



[The Potential Role of WMO in Space Weather, WMO Space Programme, SP-5, 2008]

Introduction

Those matters cause ionospheric storms which disrupt satellites and communications; magnetic storms that damage currents in power grids; as well as radiation storms that endanger human lives.

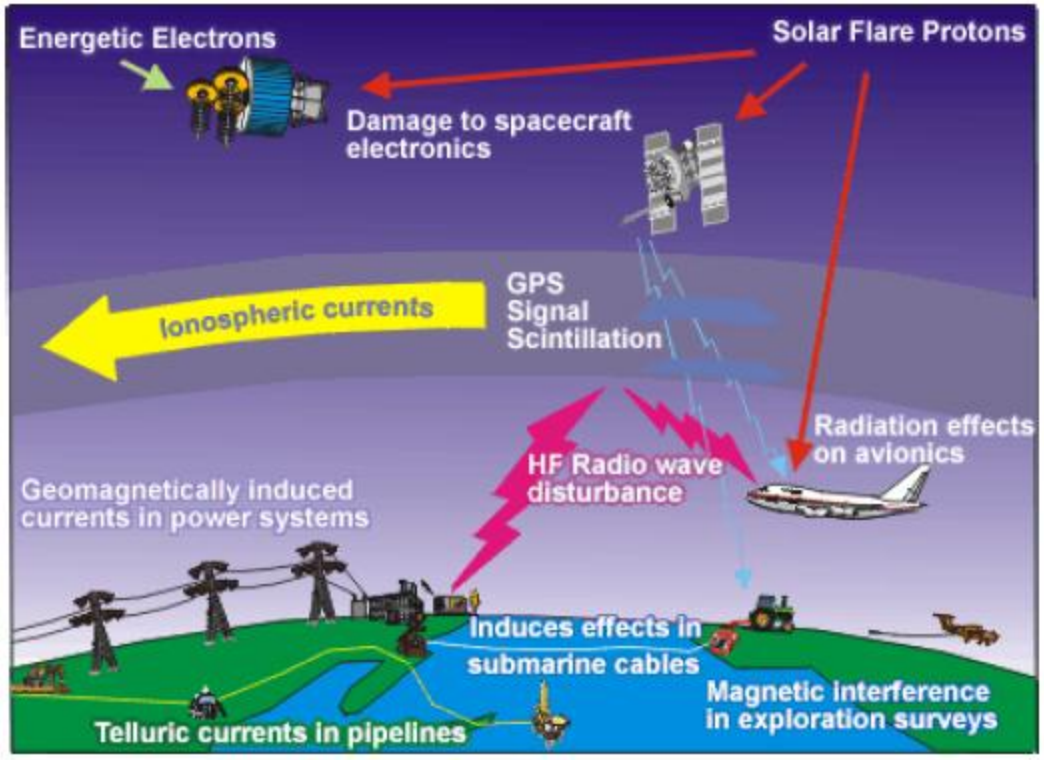


Image source: NASA

- **Space Weather also spans other large fields: solar physics, plasma physics, and stellar astronomy.** [The Potential Role of WMO in Space Weather, WMO Space Programme, SP-5, 2008]
- **The ionospheric studies serving the prediction of Space Weather becomes imperative.**

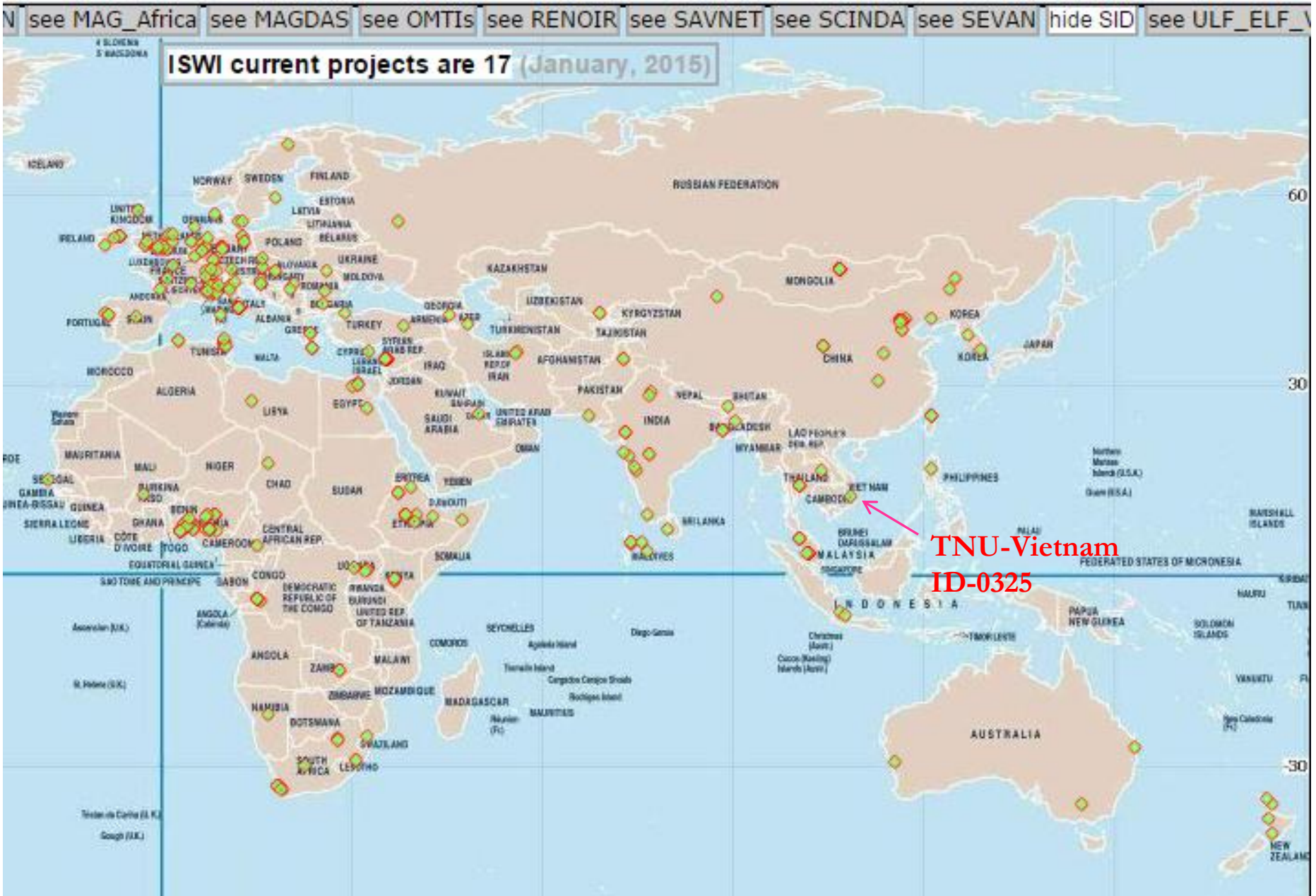
Introduction

- Our department has participated in International Space Weather Initiative (ISWI), and a SuperSID version supported by Stanford University has operated since 2012 (monitor ID: TNU-0325)
  - *Tracking a Solar Flare to its Source on the Sun*
  - *Predicting Flares*

Introduction

SuperSID monitor installed in the beginning of 2012

Introduction

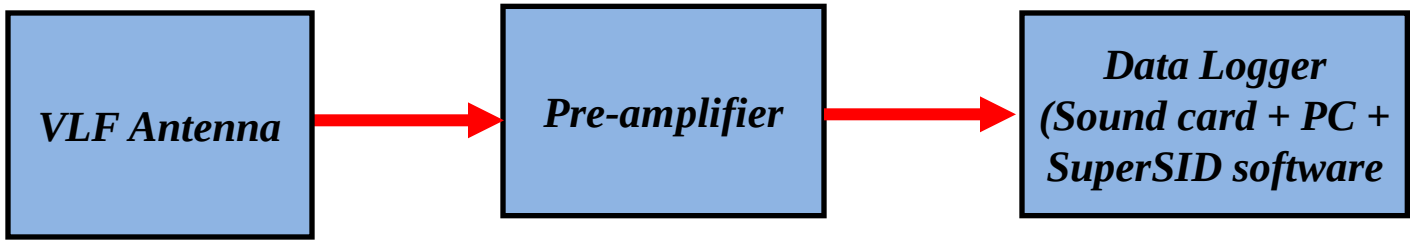


Introduction

- We designed the SuperSID teaching module for undergraduate-student education and research activities at Tay Nguyen University.

This topic aims to report the development of TNU-SuperSID teaching module, give some experimental results and propose the educating process

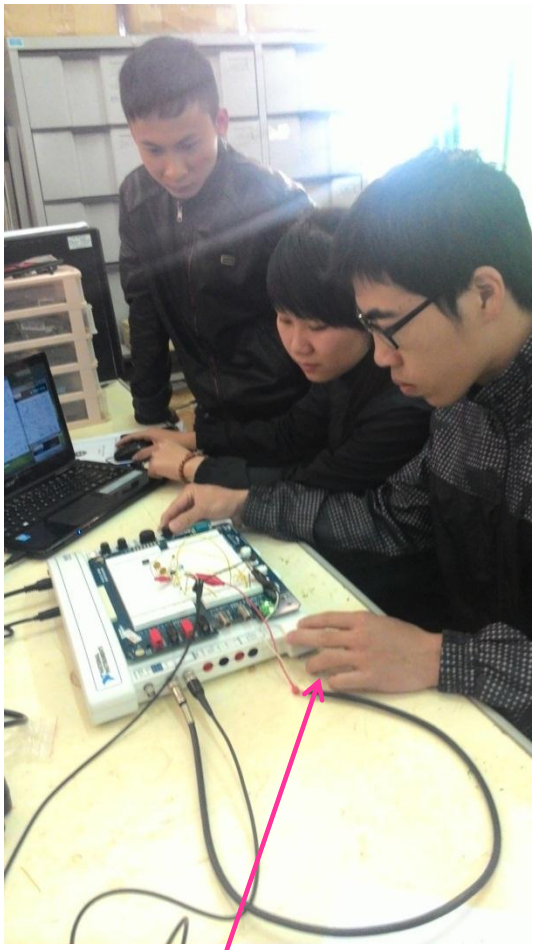
Development of TNU_SuperSID teaching module



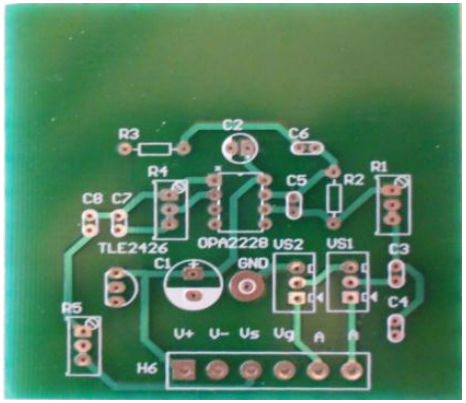
Development of VLF antenna

- Magnetic antenna
- Loop: 20 turns of 24 AWG copper wire.
- Base of square: 1m
- $R_{dc} = 5.7\ \Omega$
- L= 50 mH

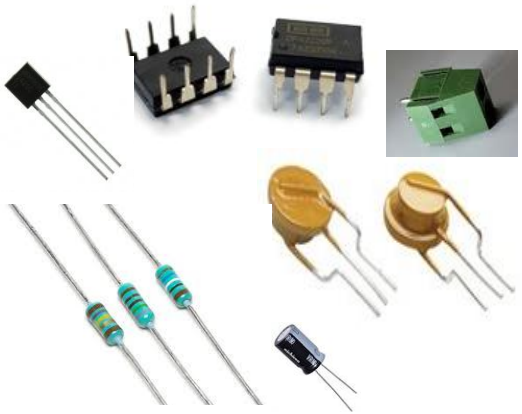
Development of Pre-amplifier



TESTING BY USING ELVIS II+

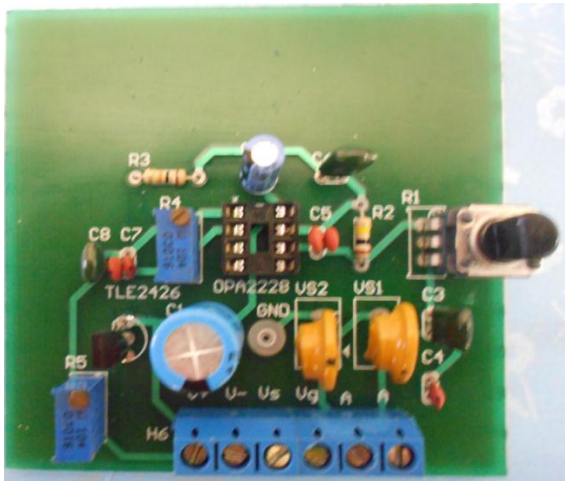


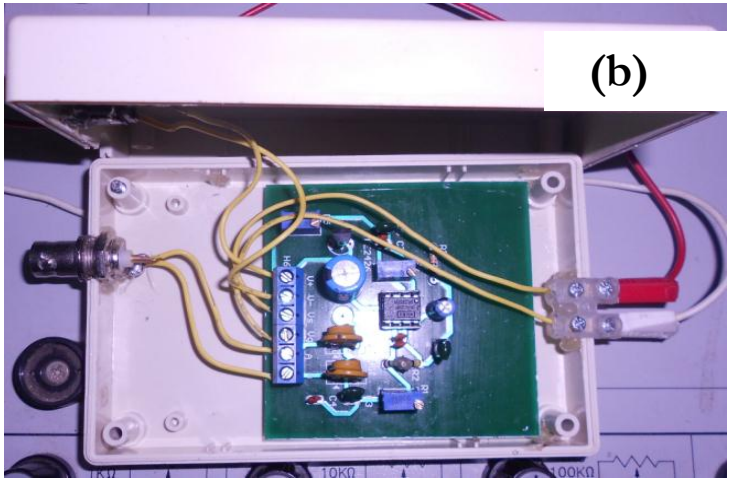
PCB (Printed circuit board)



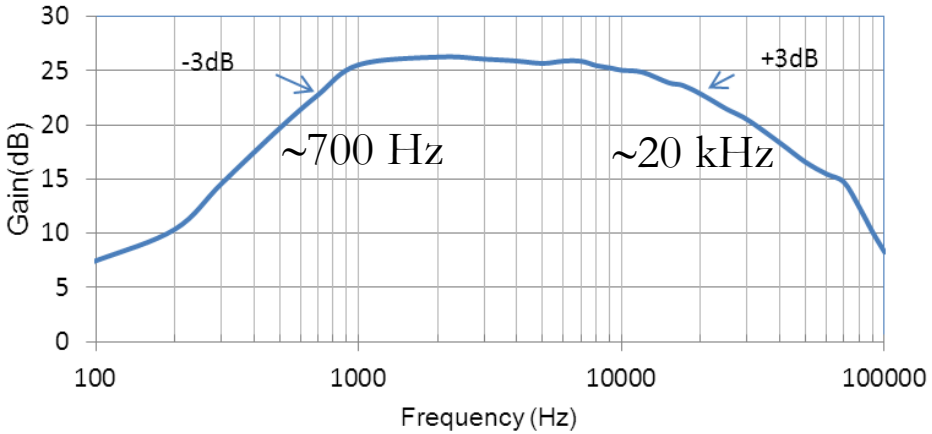
ASSEMBLING

Development of Pre-amplifier





PCB after assembly with electronic components



The frequency response

- Flat frequency response:
  Gain ~ 26 dB
  - Low-band filter
  - High-band filter

TNU_SuperSID system

Preamplifier Sound card PC & SuperSID software

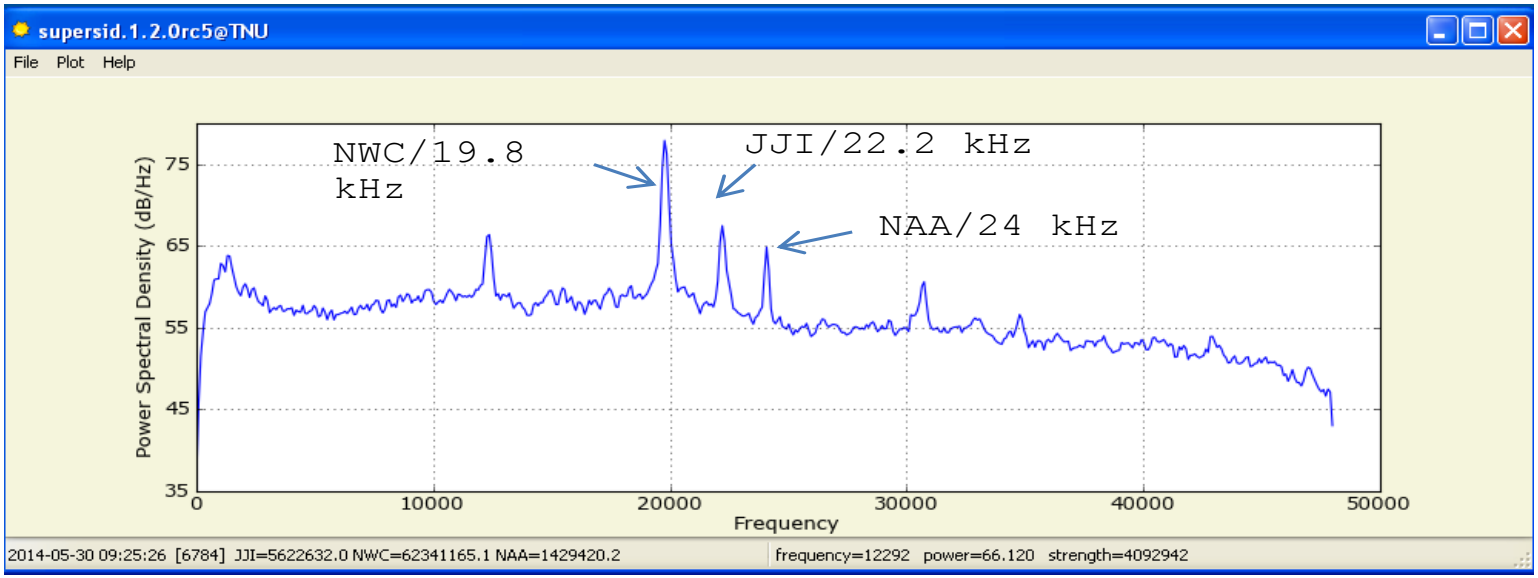
The installed system of TNU-SuperSID receiver.

Sound card: 96 kHz , 16 bit precision

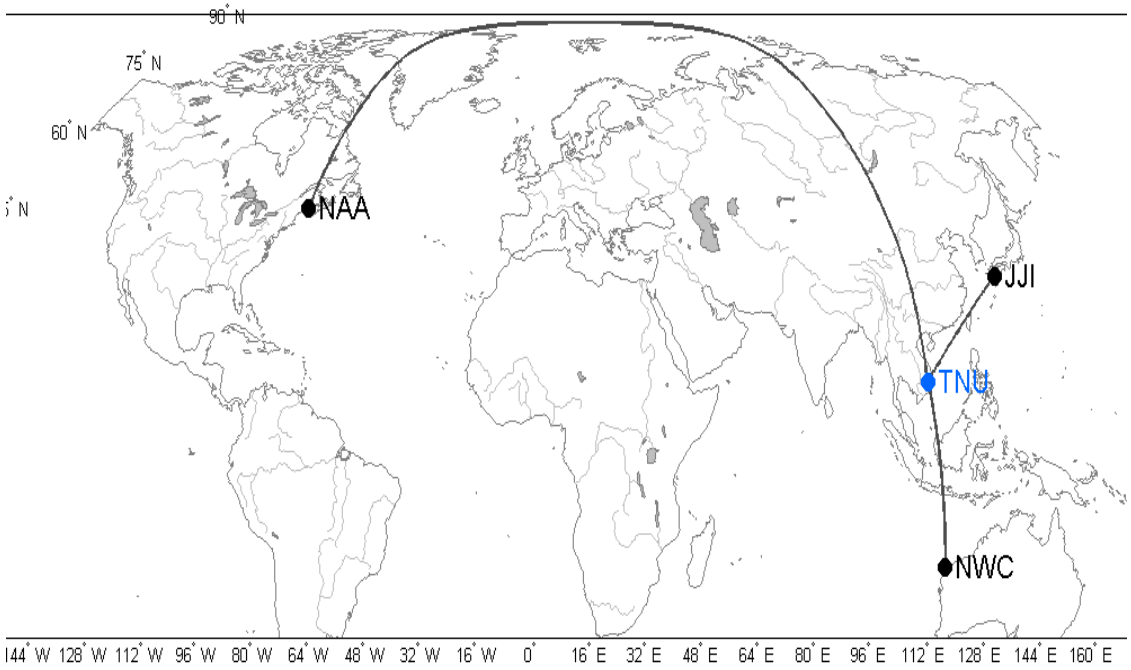
PC synchronized by a time server

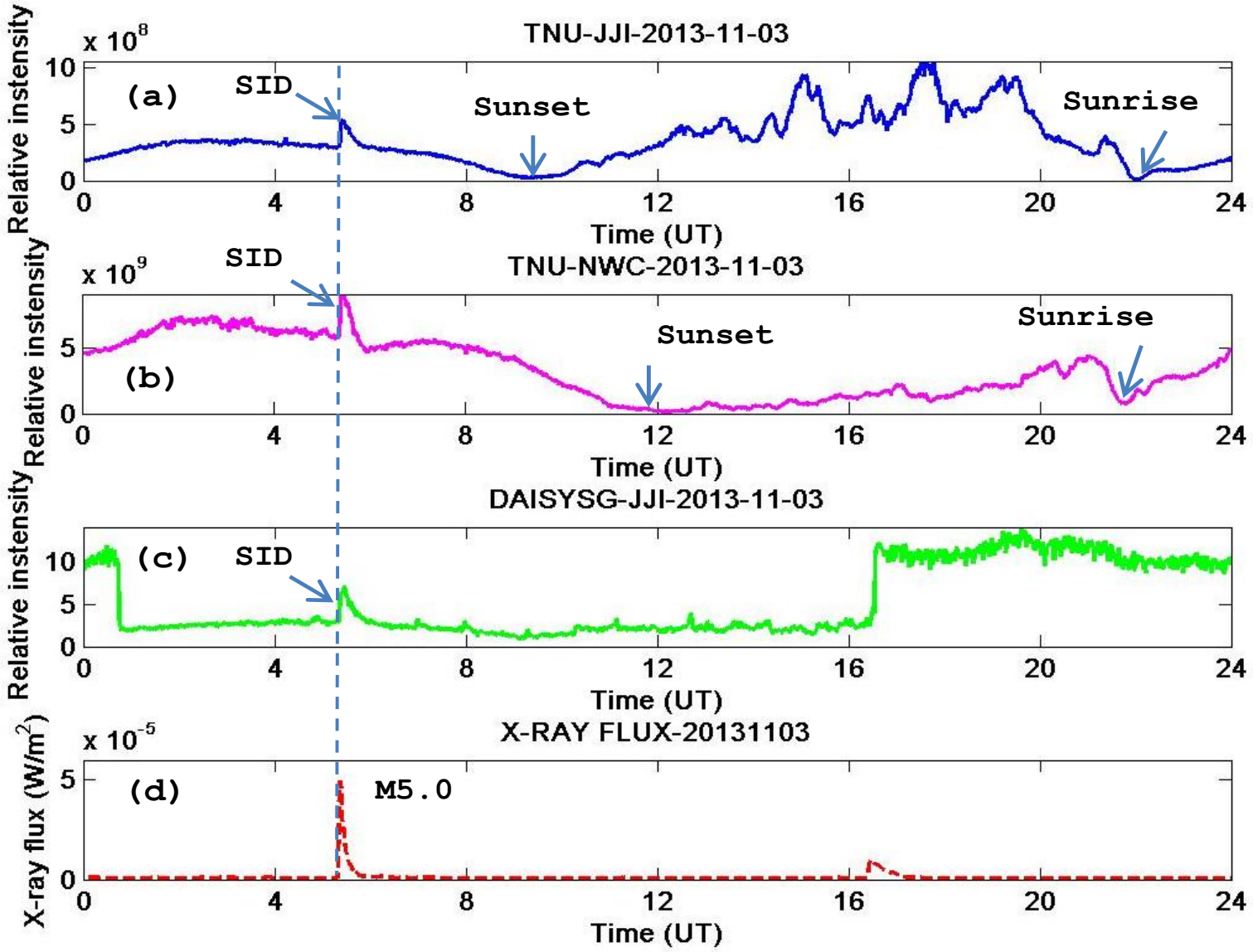
Cable length: 150 m

The audio transformer 1:1.



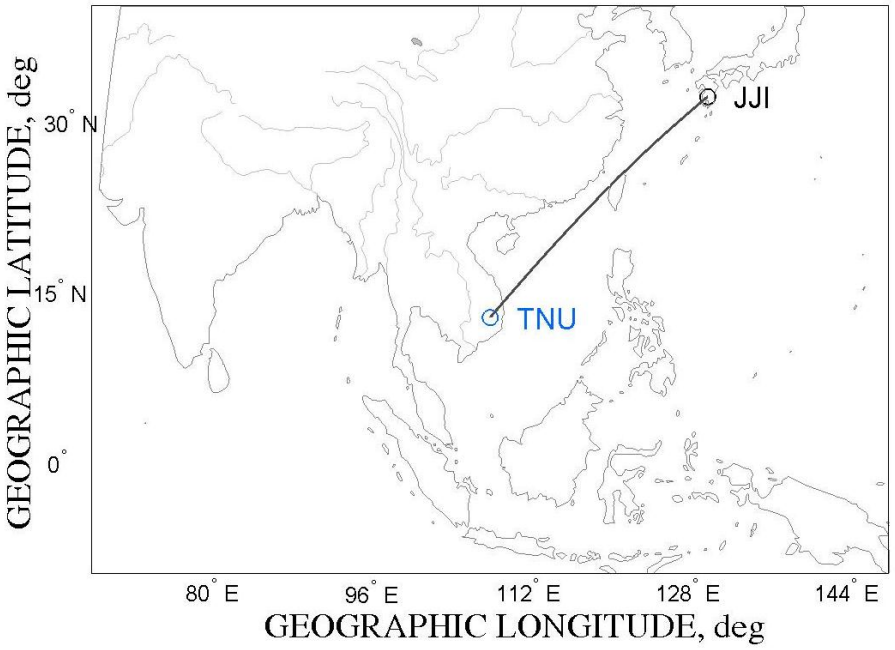
Spectrum of 31 May, 2014. The spikes marked by arrows show the recorded VLF signals from transmitters.

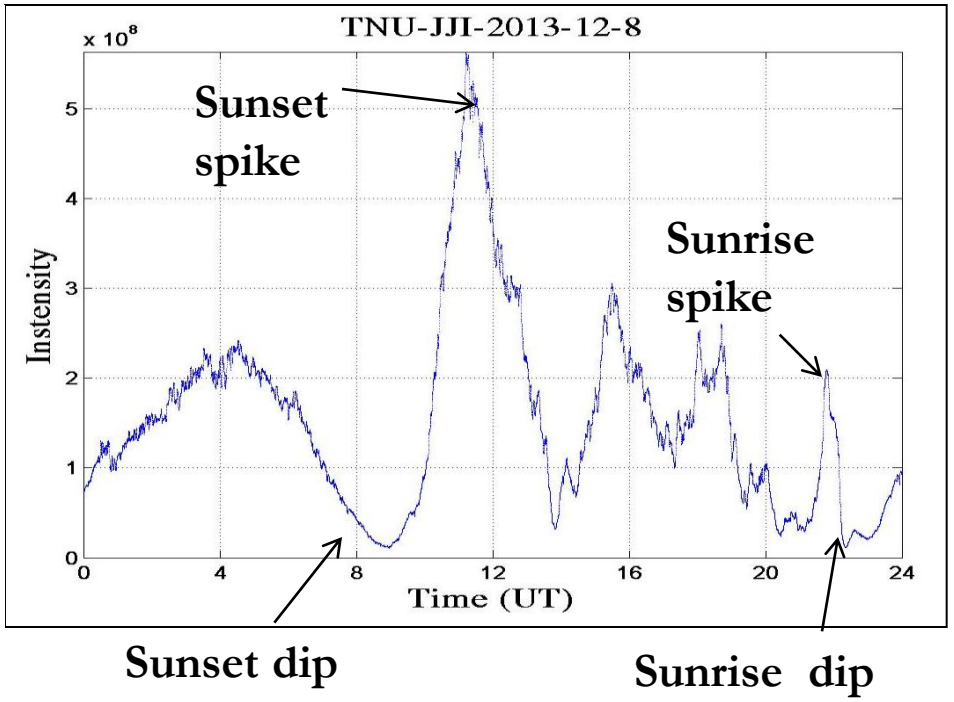




The variation of VLF signal versus time universal time, UT (local time LT = UT + 7), and the recorded Sudden Ionosheric Disturbance due to solar flares with M5.0 class at 5:22 UT on 3 Nov, 2013. a), b) NWC and JJI signal recorded at TNU. c) JJI signal recorded at Daisy, Singapore. d) X-ray flux recorded by GOES.

Sunrise and sunset effect





- JJI transmitter (32.04^{o} N; 130.81^{o} E)

Sunrise and sunset effect

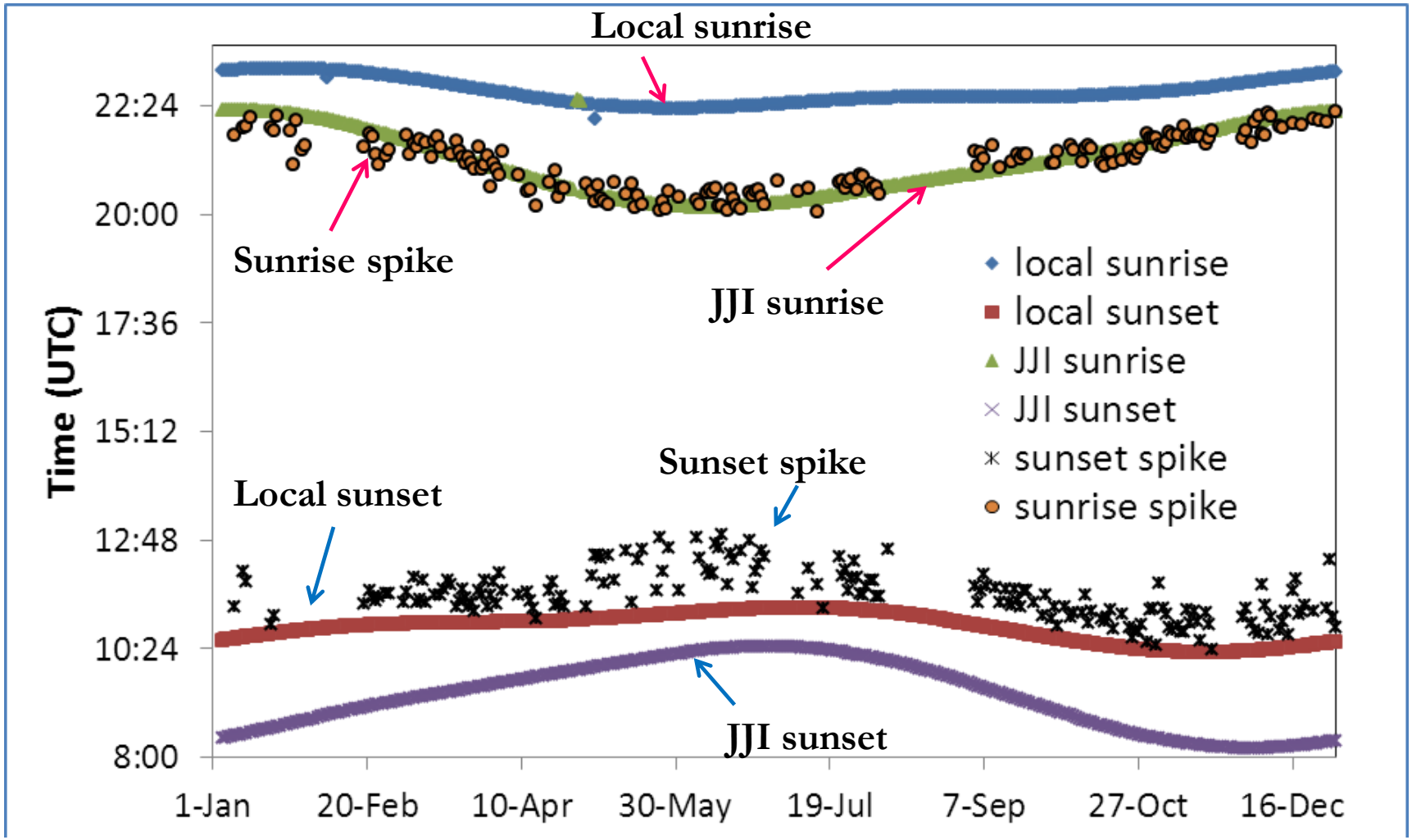
- The ionosphere is ionized before the sun rises and after the sun sets because there is a change in the level of ionization

[Leandra Merola , http://solarcenter.stanford.edu/SID/StudentWork/LeandraMerola.pdf]

- We took a year of data and compared the local sunrise time, the sunrise time by the transmitter, the times of the sunrise

Sunrise and sunset effect

2013, JJI - TNU



The ionosphere above the receiver and transmitter is ionized before the sun even rises at the location of the receiver and transmitter

Educating process

- **We explain:**

- diagram of VLF preamplifier circuit
- operation principles of the antenna
- concepts of space science/Space Weather

and provide the students with electronic components , PBC , antenna wire , user manuals, etc.

- **Step 1:** Building antenna.

- **Step 2:** Testing electronic circuit on break board socket, assembling components on the PCB, and surveying the characteristics of the preamplifier.

- **Step 3:** Connecting the preamplifier with antenna, installing the software and soundcard's driver, testing the receiver, and recording the data.

- **Step 4 :** Comparing SID data recorded with GOES satellite data; comparing with different VLF signals recorded at other stations; determining the dips or spikes during the sunrise/sunset transition and discussing the results and explaining physics processes.

- Step 1 , 2 & 3 can develop students' technical skills. Students can understand the function of low pass filter and high pass filter in the preamplifier when they survey the frequency response.
- With respect to step 4, communication skill, ability to work in groups and data analysis skill of students can be improved.
- By observing the real data, students will have a firm belief in the acquired knowledge of space science.

- Education

Astrophysics and Atmospheric Physics subjects are teached for teaching students in our Department.

- 01 postgraduate student and 02 undergraduate students of Ho Chi Minh city University of Science are studying in Space Physics using SuperSID monitor' data.

- 3 graduated students who participated in the development of TNU-SuperSID teaching module.

Conclusions

- This module can observe the effects of sunrise and sunset phenomena and solar flares on the Earth's ionosphere

- Students can participate in the project with different tasks: antenna construction and preamplifier assembly, system installation, data processing.

- Consequently, students can develop not only their technical skills, working in group and communication skills but knowledge of space science as well.

Future work

- Collaborating with Vietnam Radio Telescope and other universities in Vietnam to install TNU_SuperSID monitor.

- We are going to design the Laboratory of Radio and Space Physics and prepare materials to support other groups the teaching modules.

Acknowledgment

- Special thanks to *Prof. Dr. Deborah Scherrer,* ***Stanford Solar Center for supporting us a SuperSID monitor.***

- I would like to thank ***Office for Outer Space Affairs, United Nations and Committee of UN/Japan Workshop for support.***


Thank you for your attention
VLF group