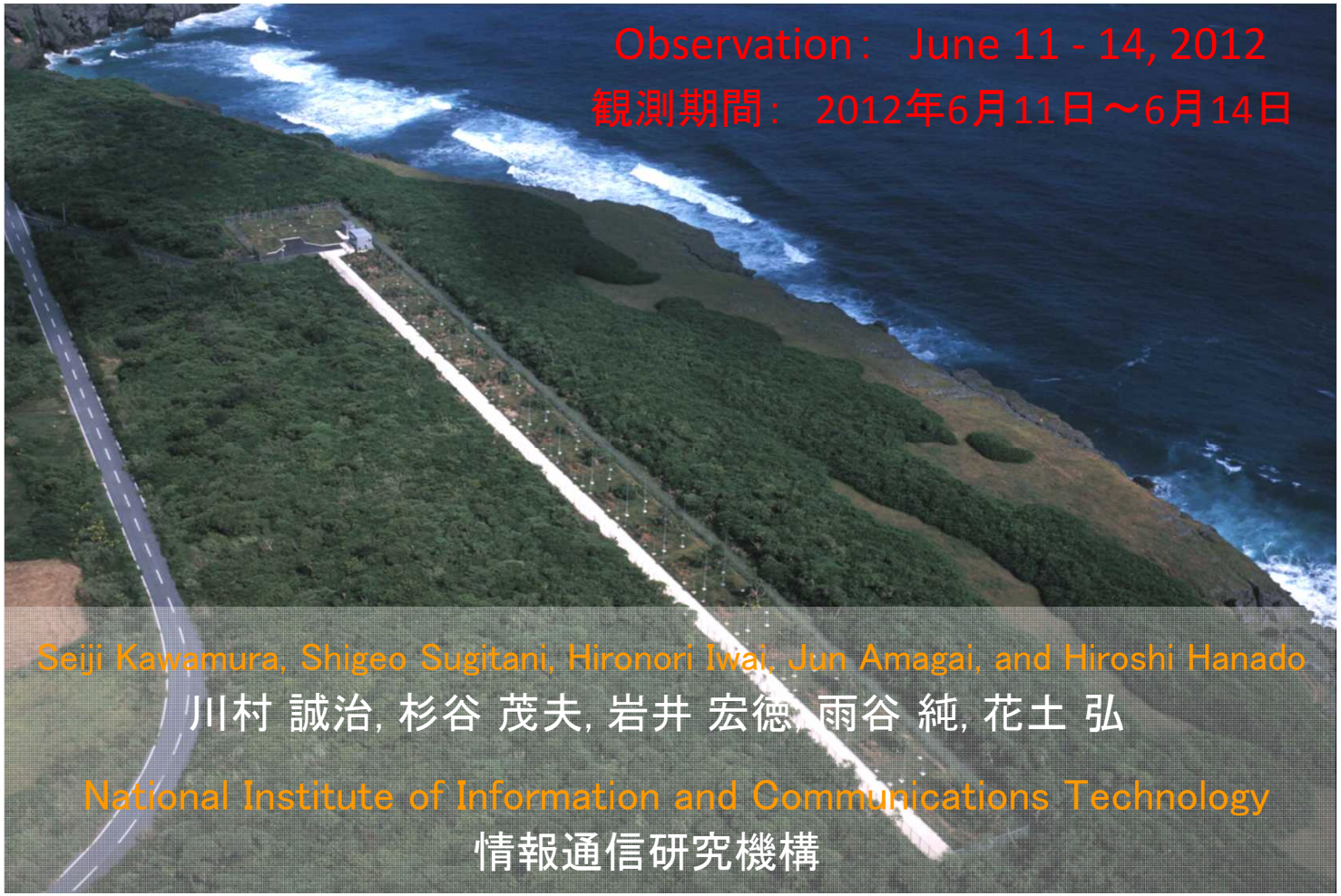
Ocean radar bistatic observation in Yonaguni-island

与那国における海洋レーダ・バイスタティック観測



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川村 誠治, 杉谷 茂夫, 岩井 宏徳, 雨谷 純, 花土 弘
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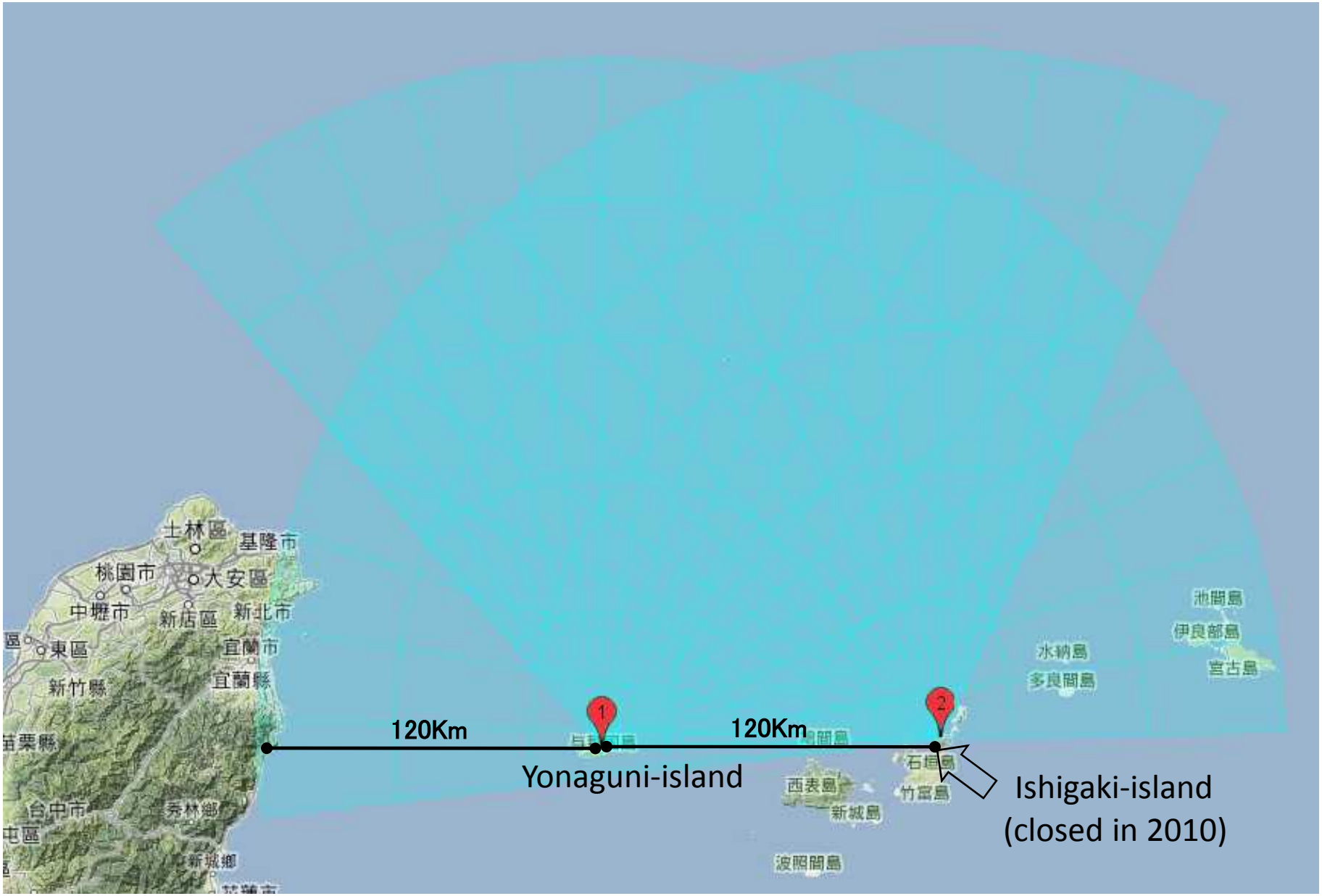
情報通信研究機構

Contents

- Bistatic receiving experiments with software radio receivers in Yonaguni island. Targets are Taiwan ocean radars.
- Last year, we retrieved Doppler spectra using unknown radio waves. An example of passive radar.
- This year, we received radio waves from 4 Taiwan ocean radars, and estimate surface current with the bistatic method.

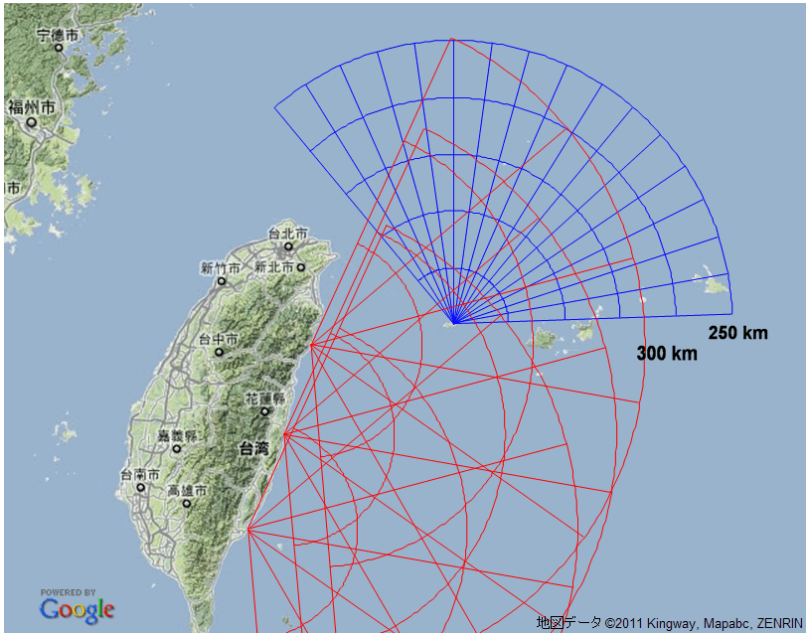
Bistatic Experiments in Yonaguni Island



Last year

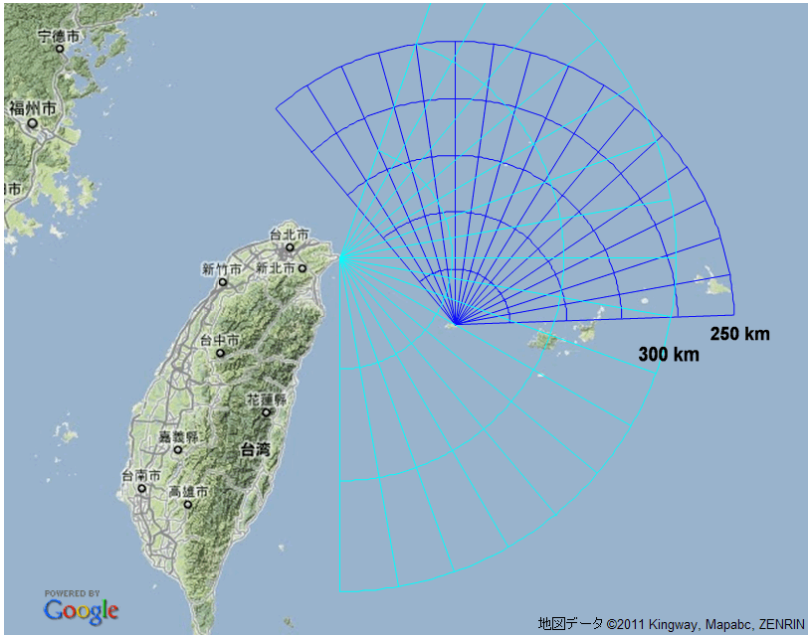
Bistatic Receiving Experiments in Yonaguni Island

Experiments : September 20 – 22, 2011



Red : TORI routine obs.
Center frequency : 4.58 MHz

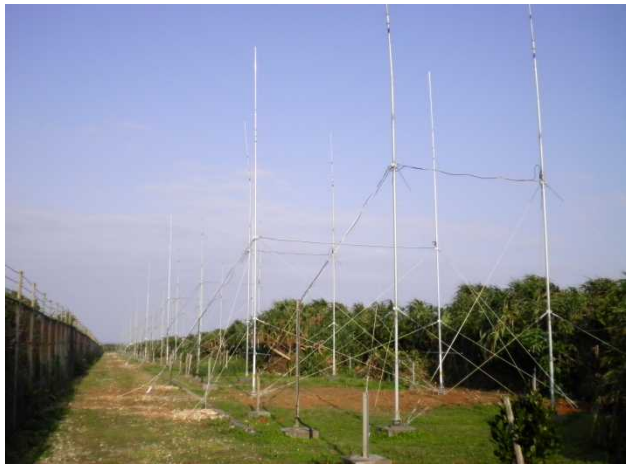
Blue : NICT ocean radar

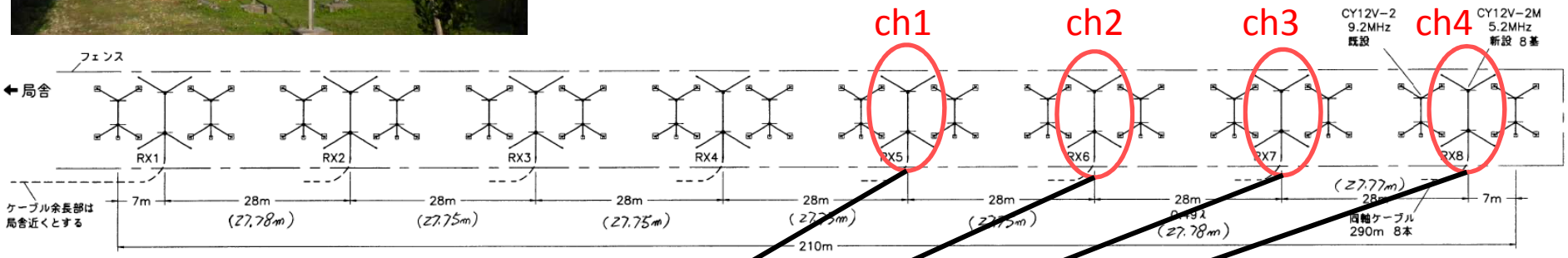


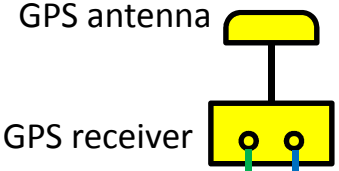
Light blue : TORI test obs.
（Sept. 2011）
Center frequency : 4.58 MHz

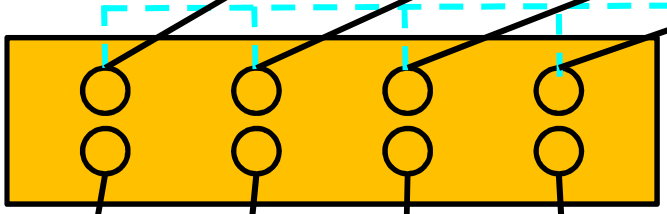
Last year

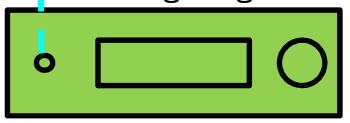
Bistatic Receiving System in Yonaguni Island



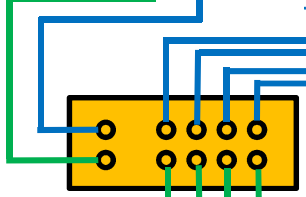


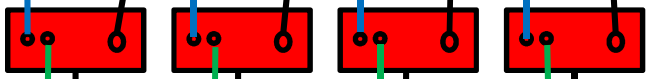


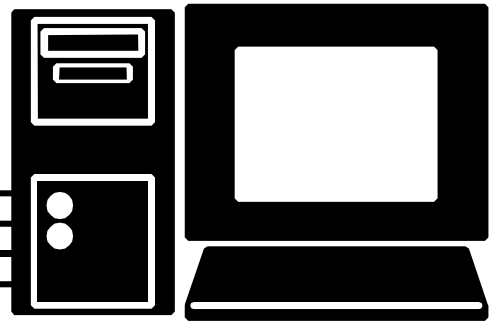




(for phase calibration)







Divider of GPS signals

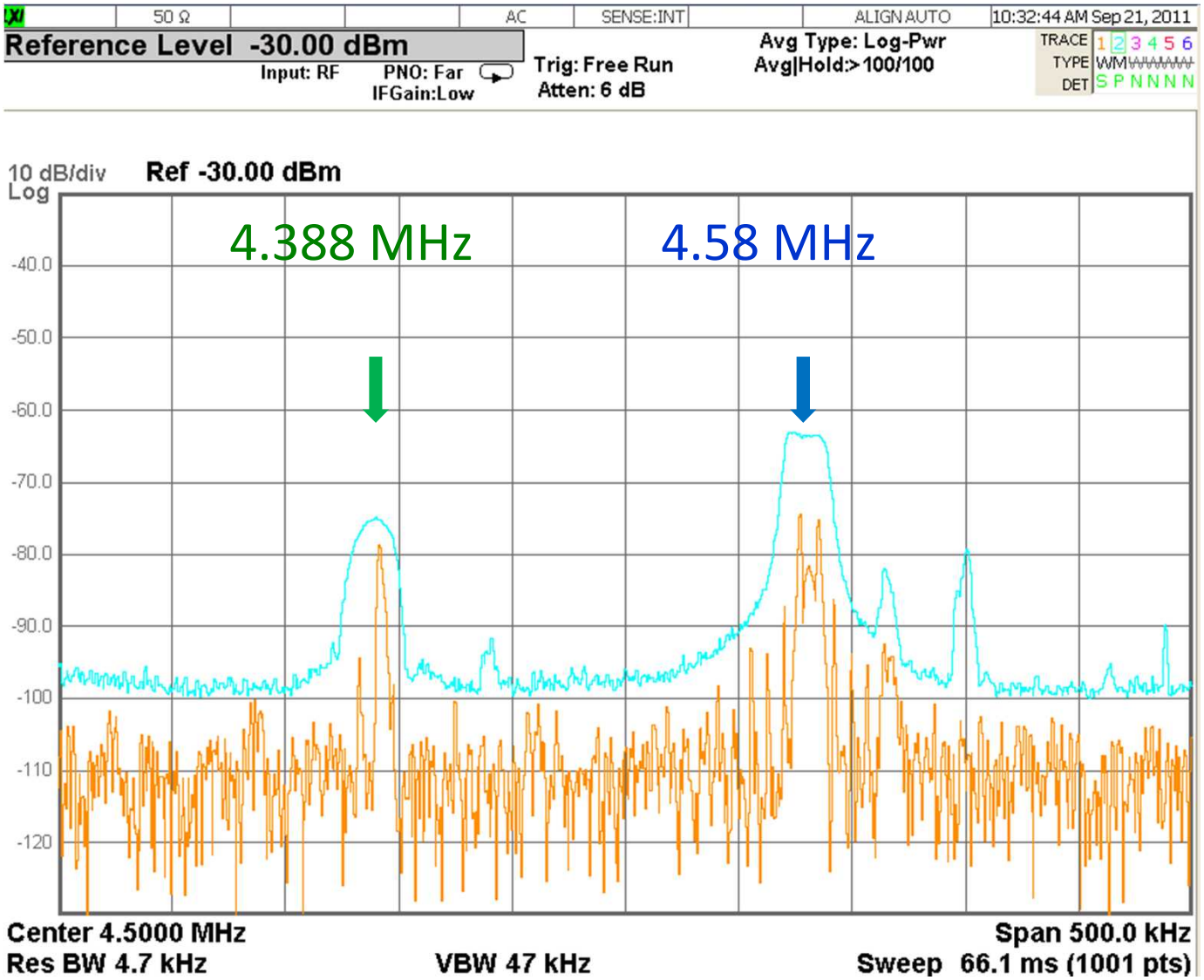
1 PPS

USRP2

LAN

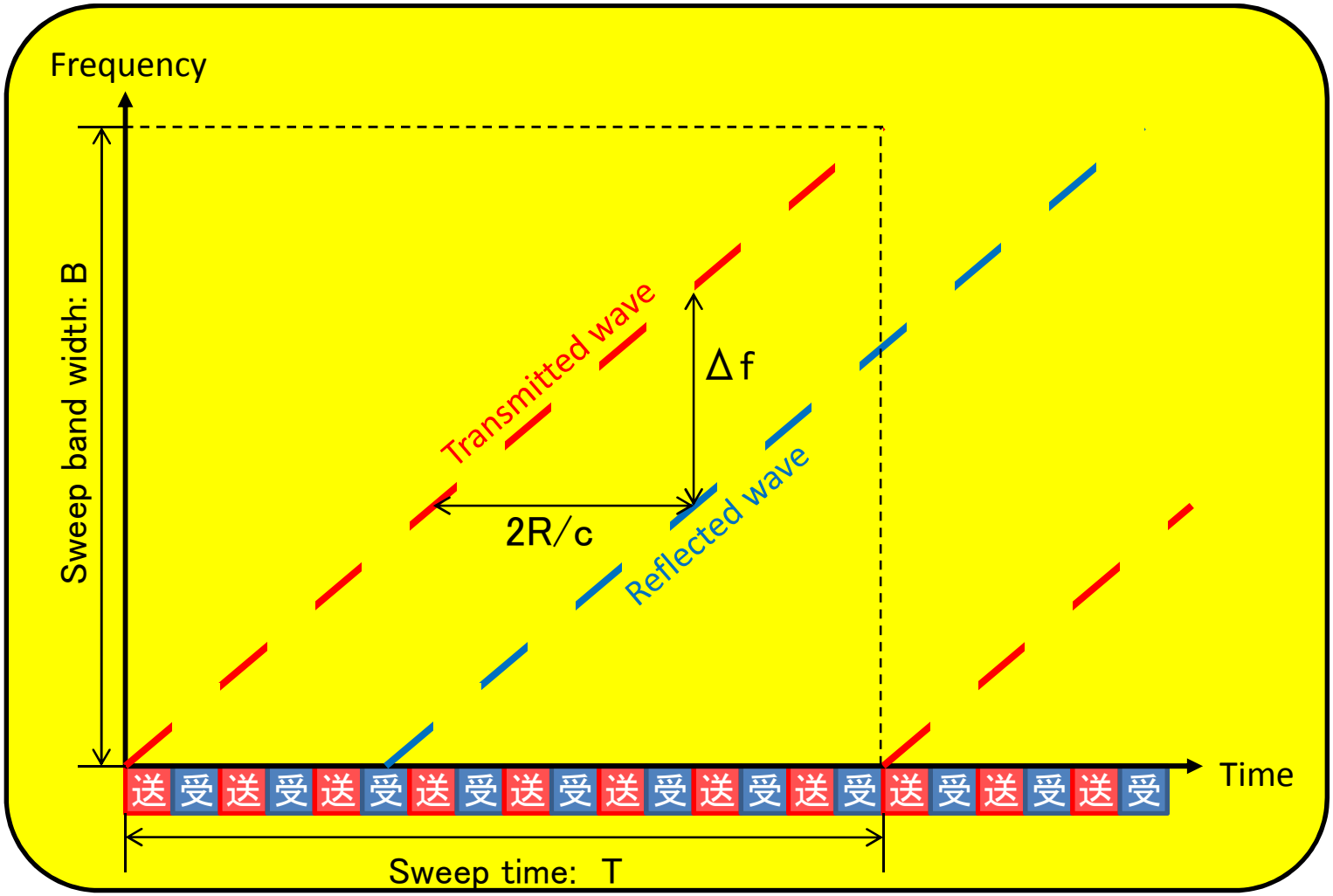
Screen of spectrum analyzer at Yonaguni island (span: 4.25 – 4.75 MHz)

Last year



Principle of Ocean Radar (FMICW Radar)

Last year

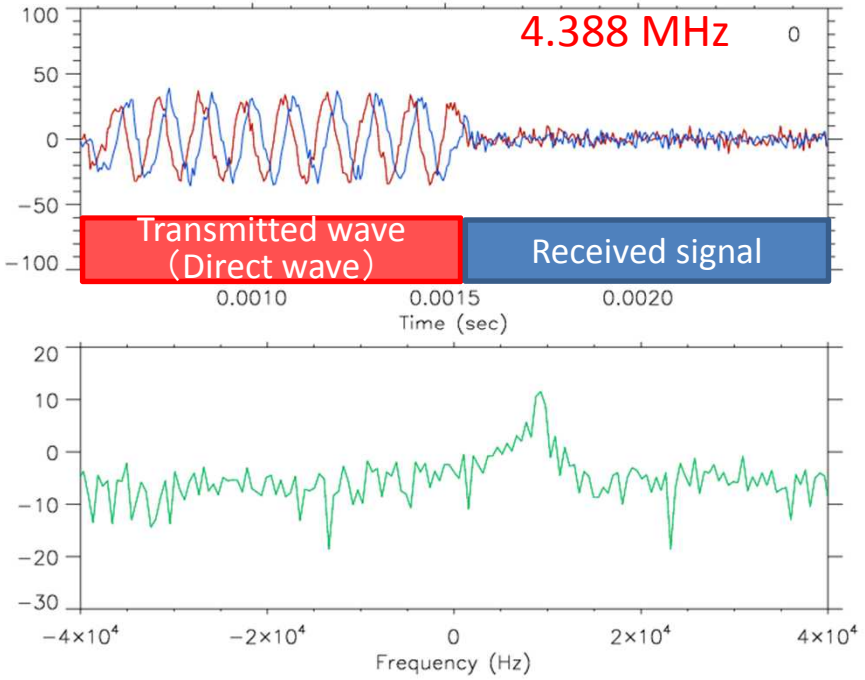


$$\text{Range}: \quad R = \frac{c\,T}{2B}\,\Delta f$$

Last year

Sampled Data with USRP2

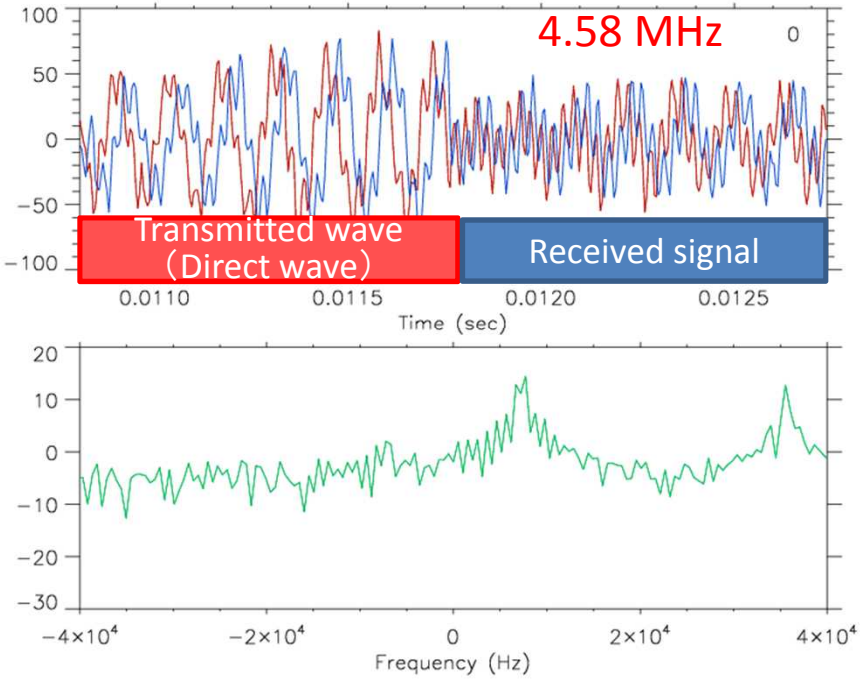
Unknown signal



One sweep: 514 pulses for 1 s

Clear and simple sweep is assumed to be a signal from one ocean radar.

TORI Ocean Radar

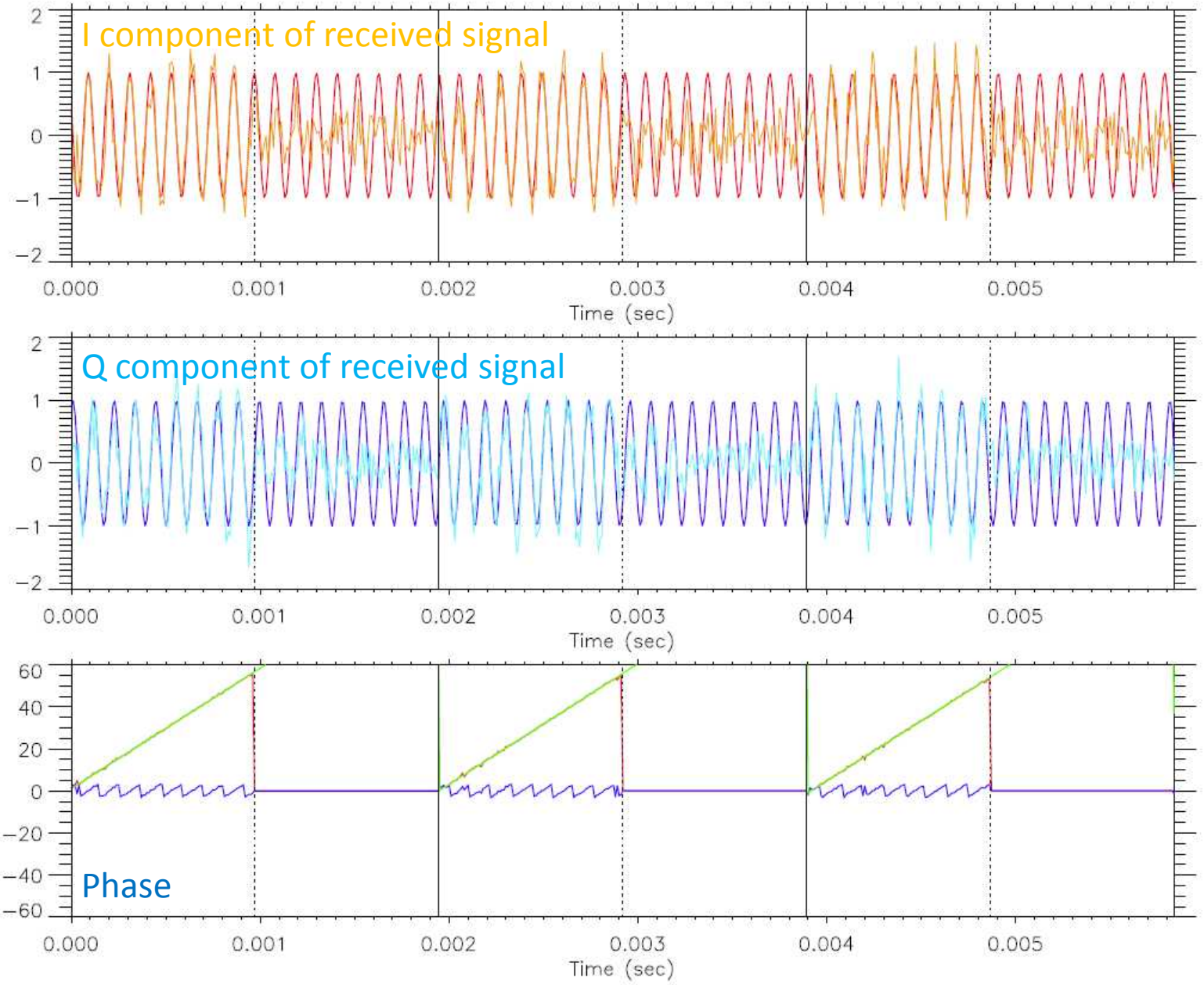


One sweep: 514 pulses for 1 s

Signals from some radars are seemed to be mixed.

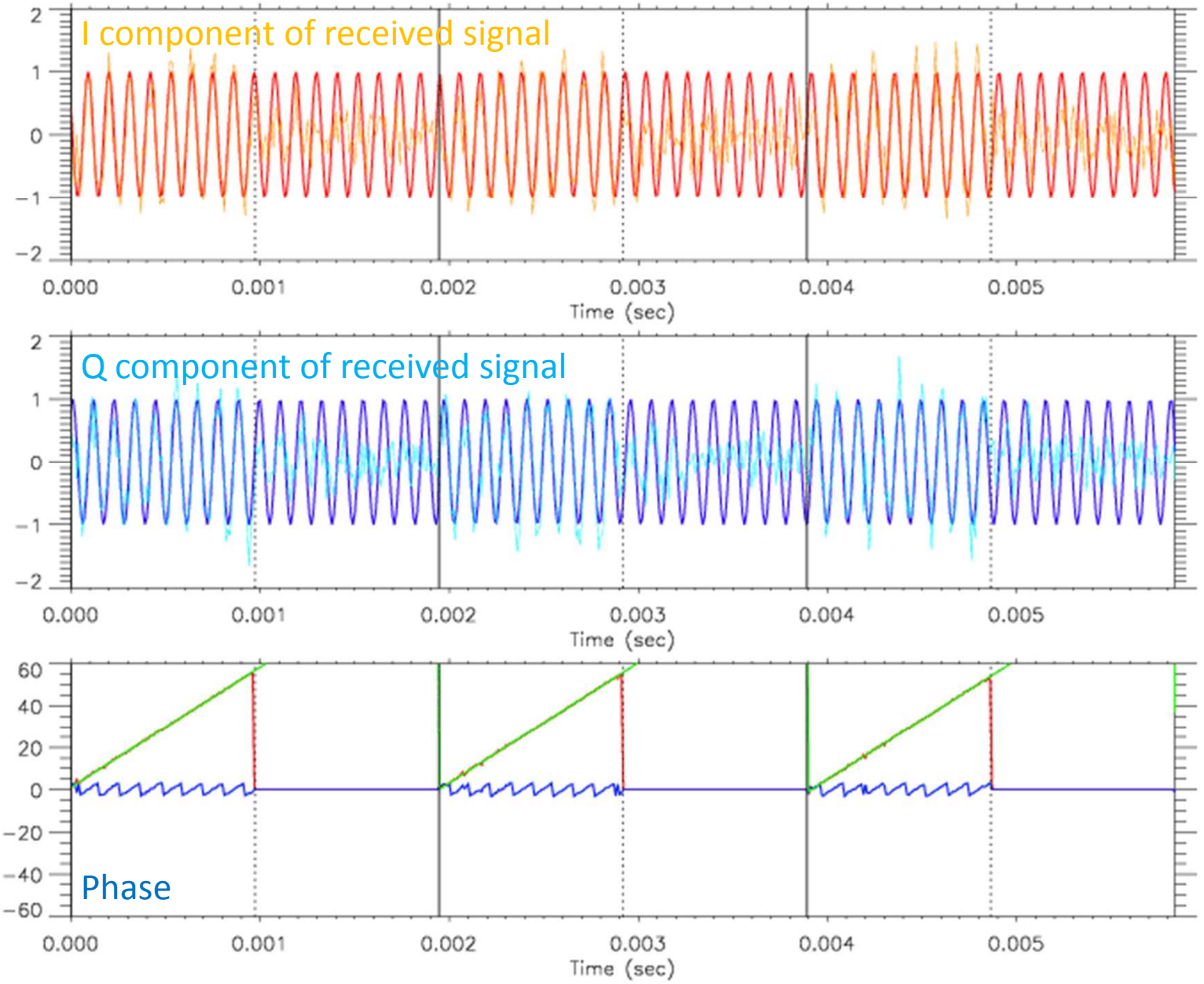
Reproduction of Transmitted wave — using received direct wave —

Last year



Reproduction of Transmitted wave — using received direct wave —

Last year

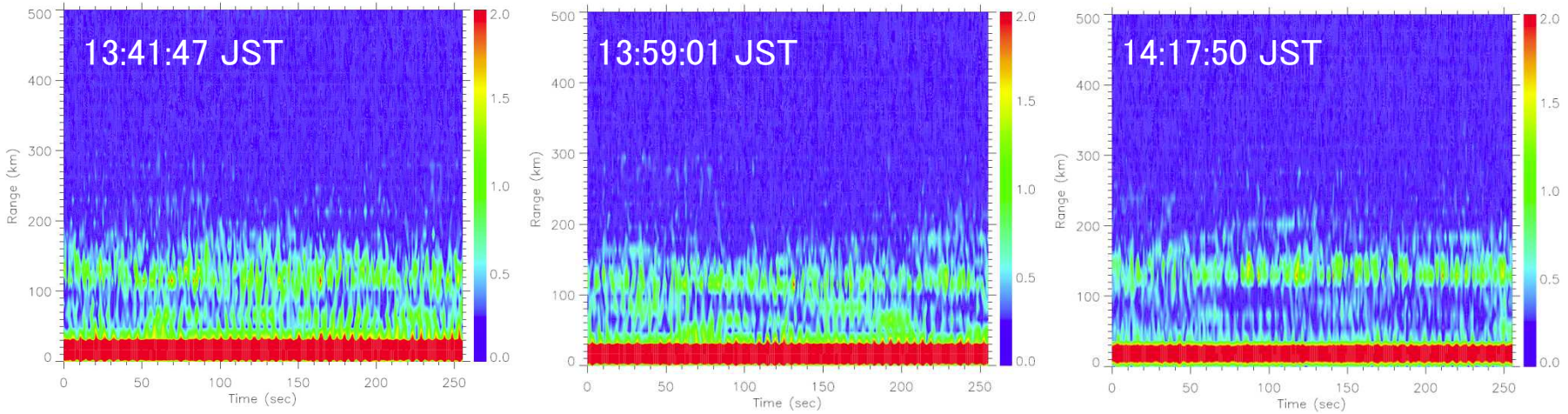


Last year

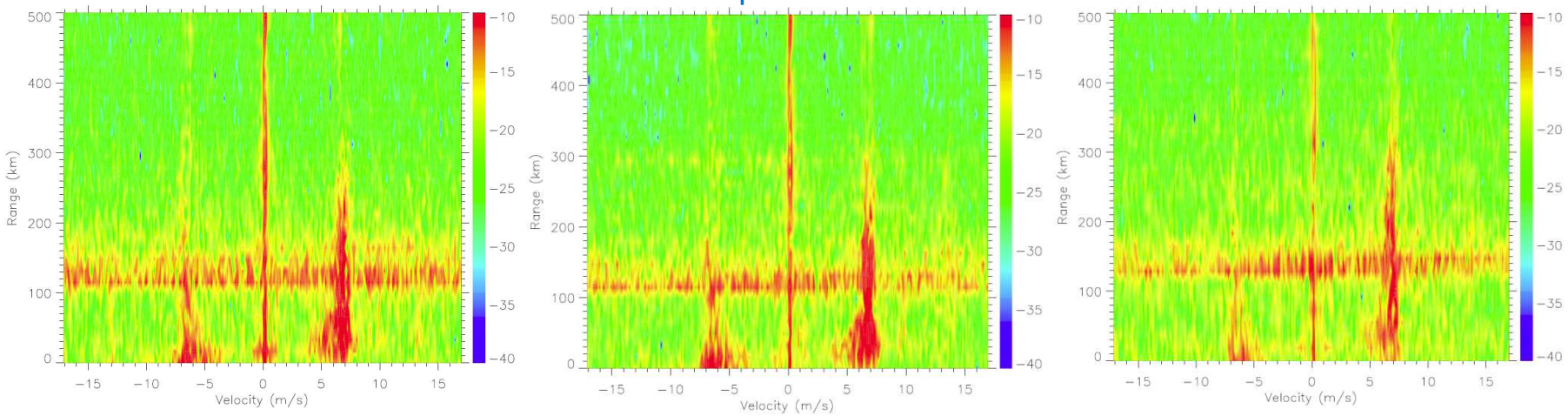
Examples of Retrieved Spectra (4.388 MHz)

September 21, 2011

Time series of received signal for 256 sec.



Spectra



Summary of experiments in last year

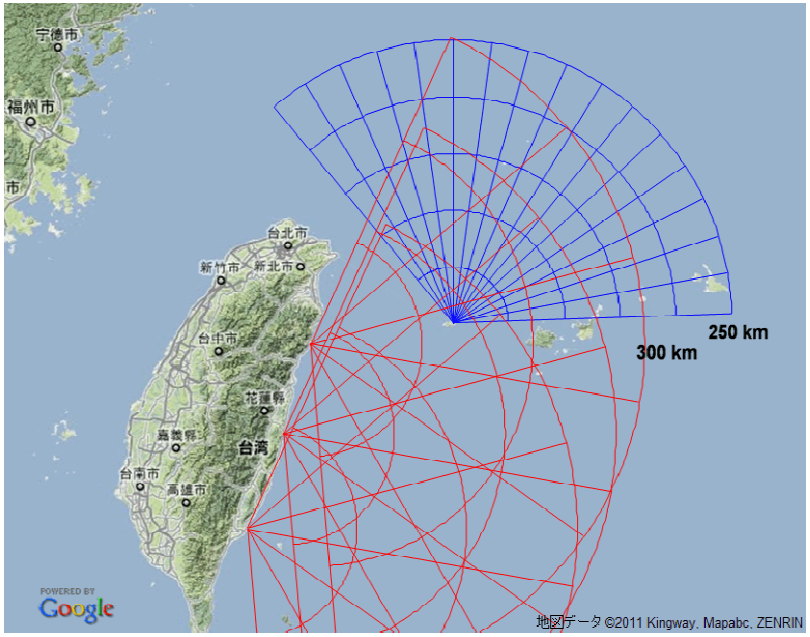
- Unknown radio waves are analyzed.

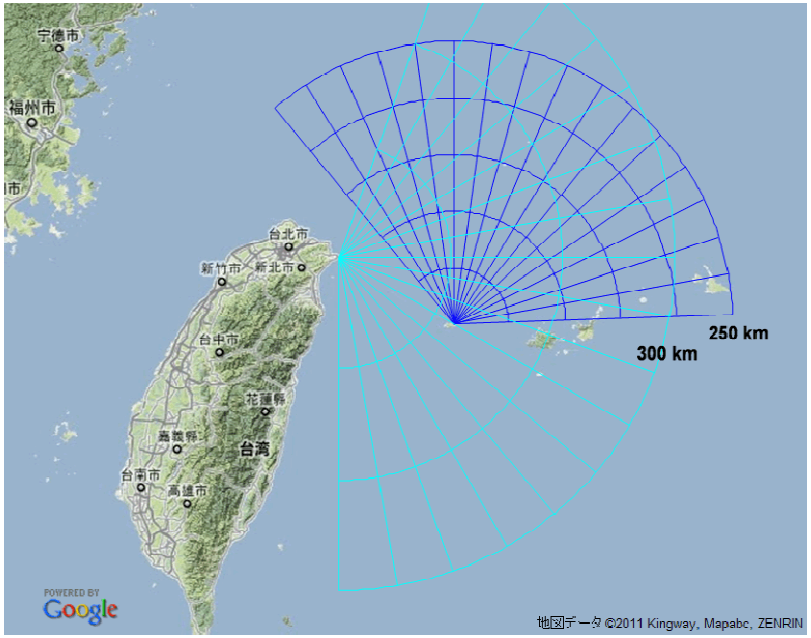
  We do NOT know the position, sweep frequency, delay time, and so on.
- We retrieved Doppler spectra by reproducing transmitted waves from direct received signals.
- An example of "Passive Radar".
- Accuracy of estimated frequency (sweep band) of transmitted wave is important.

This year, we try to analyze signals from known four Taiwan ocean radars, whose frequency is 4.58 MHz.

Bistatic Receiving Experiments in Yonaguni Island

Experiments： June 11 – 14, 2012



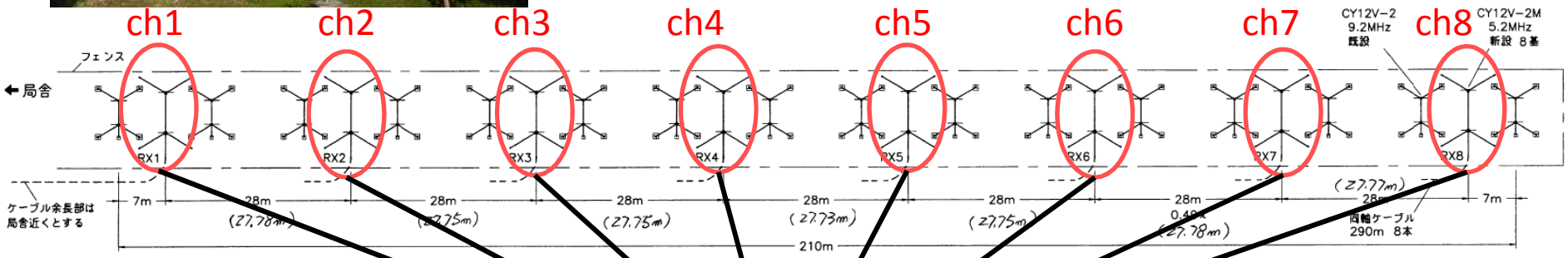


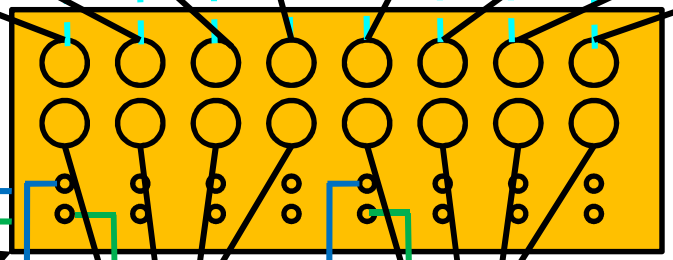
Red：TORI routine obs.
Center frequency：4.58 MHz

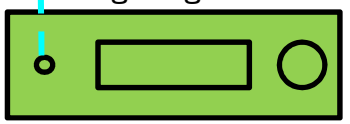
Blue：NICT ocean radar

Light blue：TORI test obs.
（Sept. 2011）
Center frequency：4.58 MHz

Bistatic Receiving System in Yonaguni Island

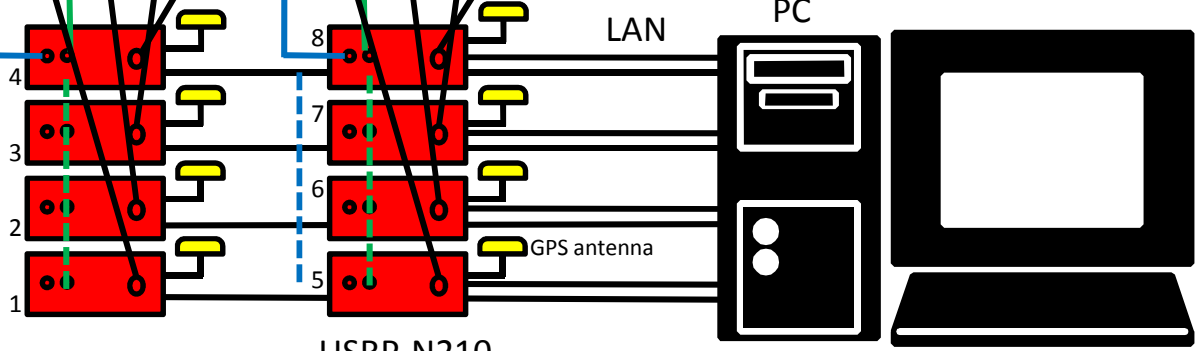




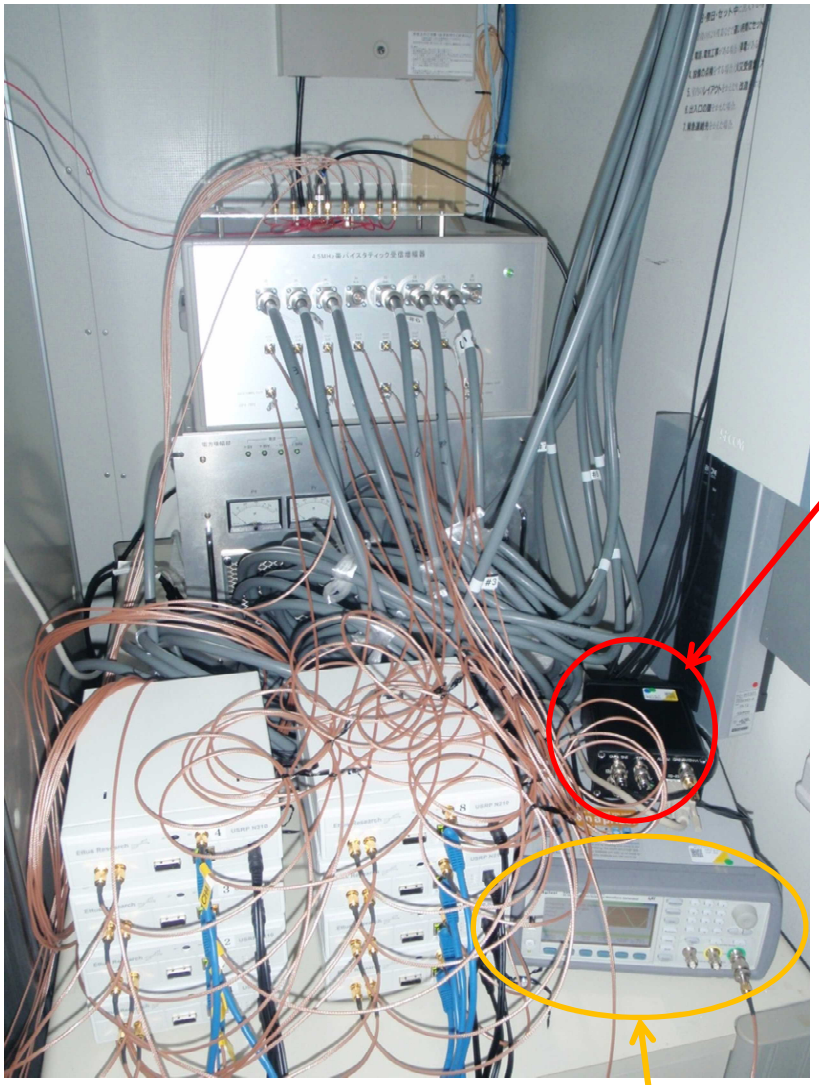


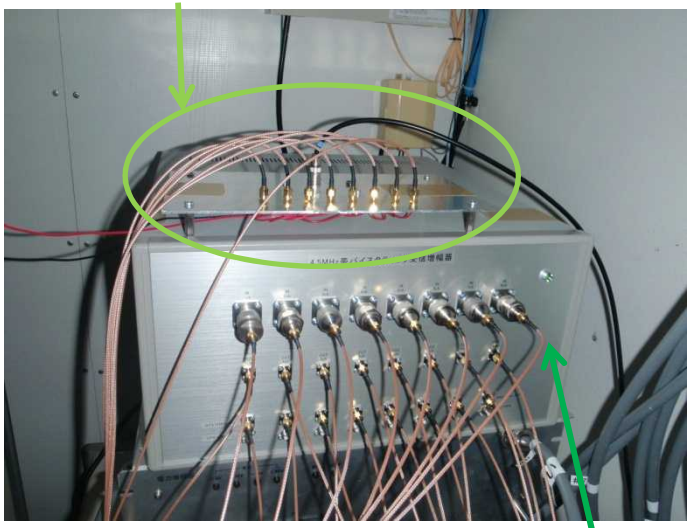
AMP＆Filter
Divider of GPS signals

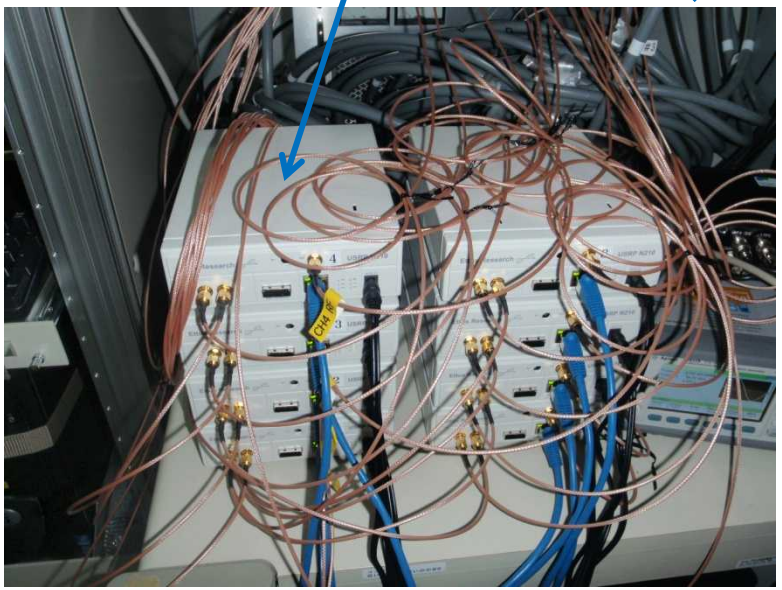
USRP-N210



Photos of receiving system

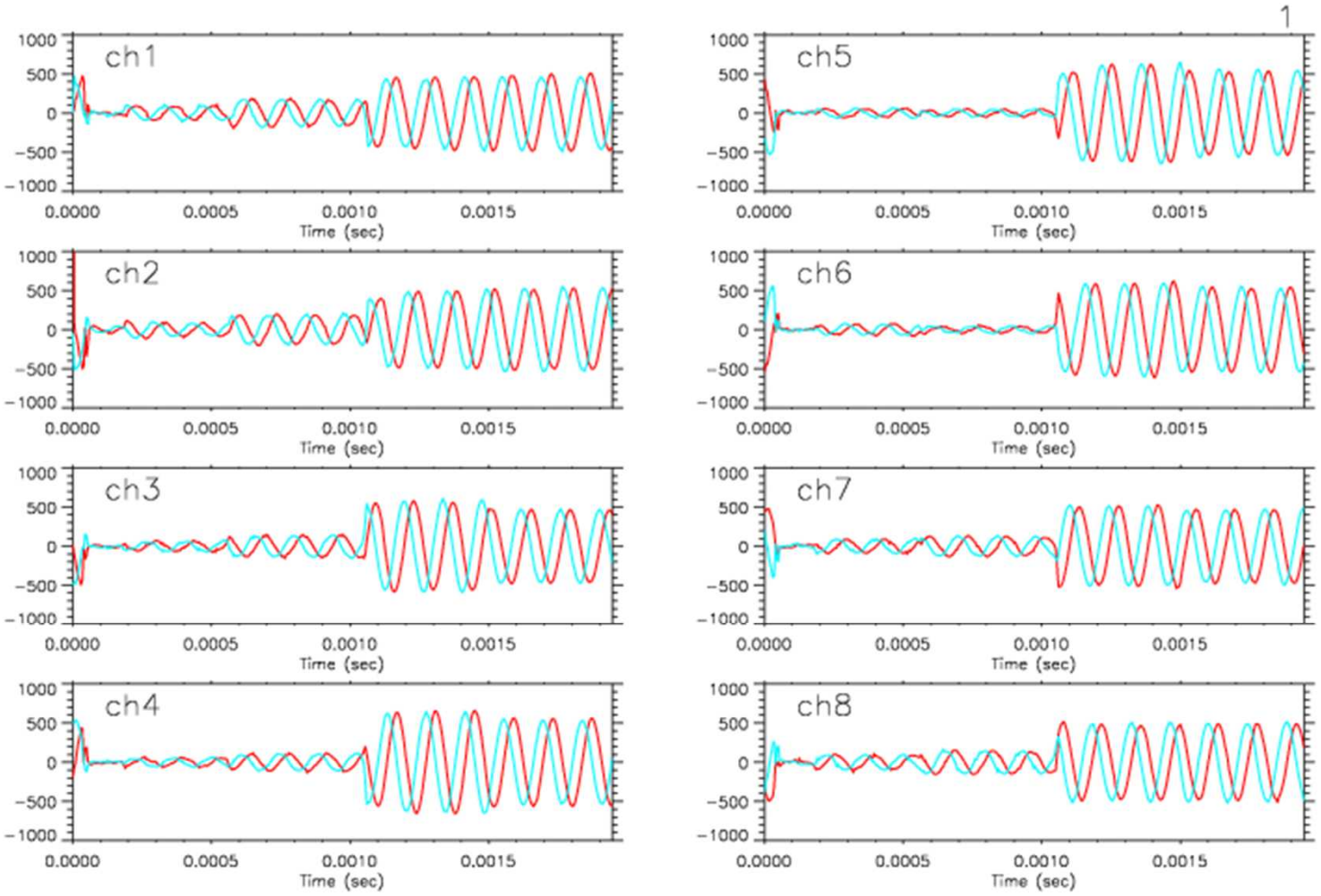




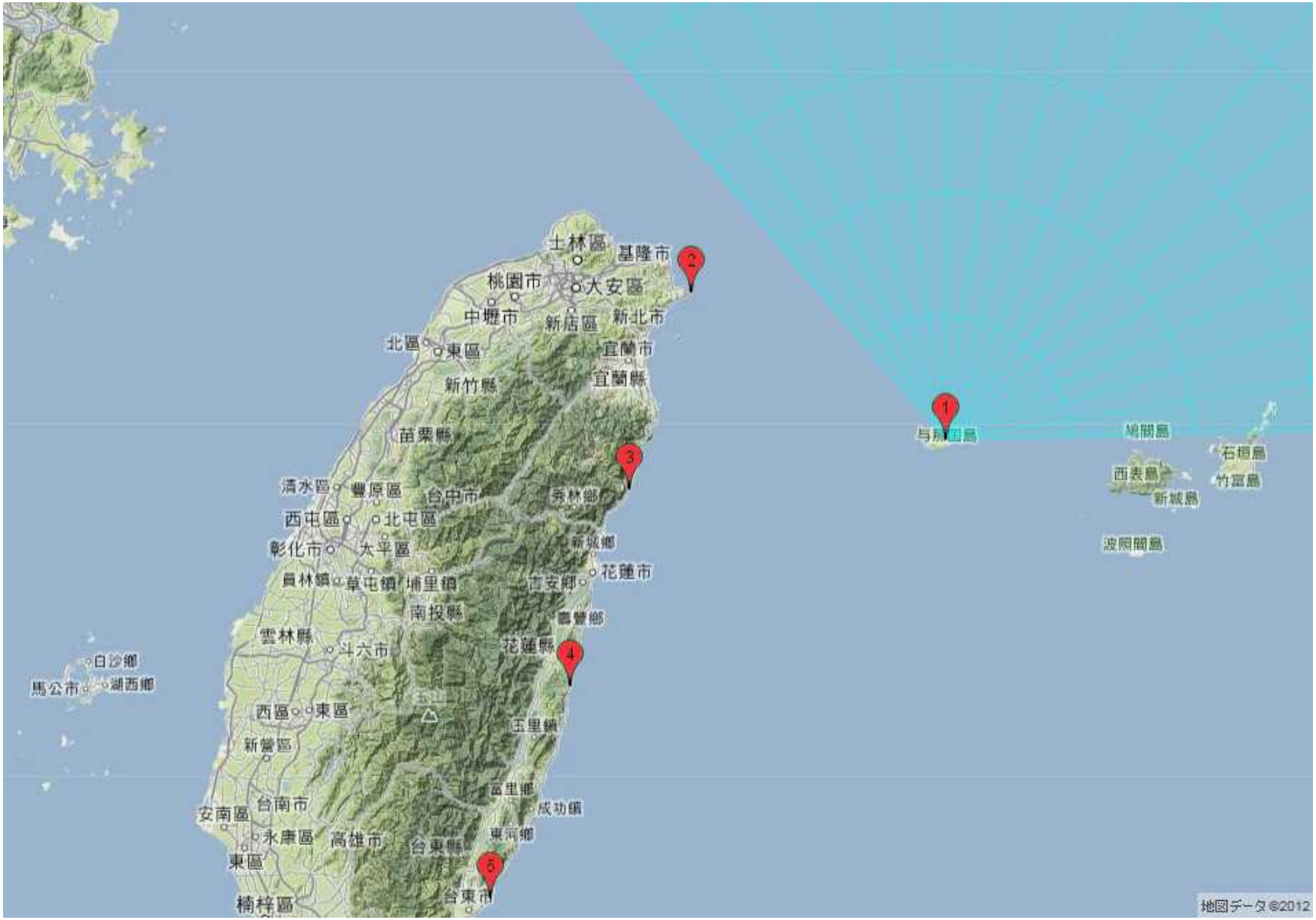


Received signals with each antenna

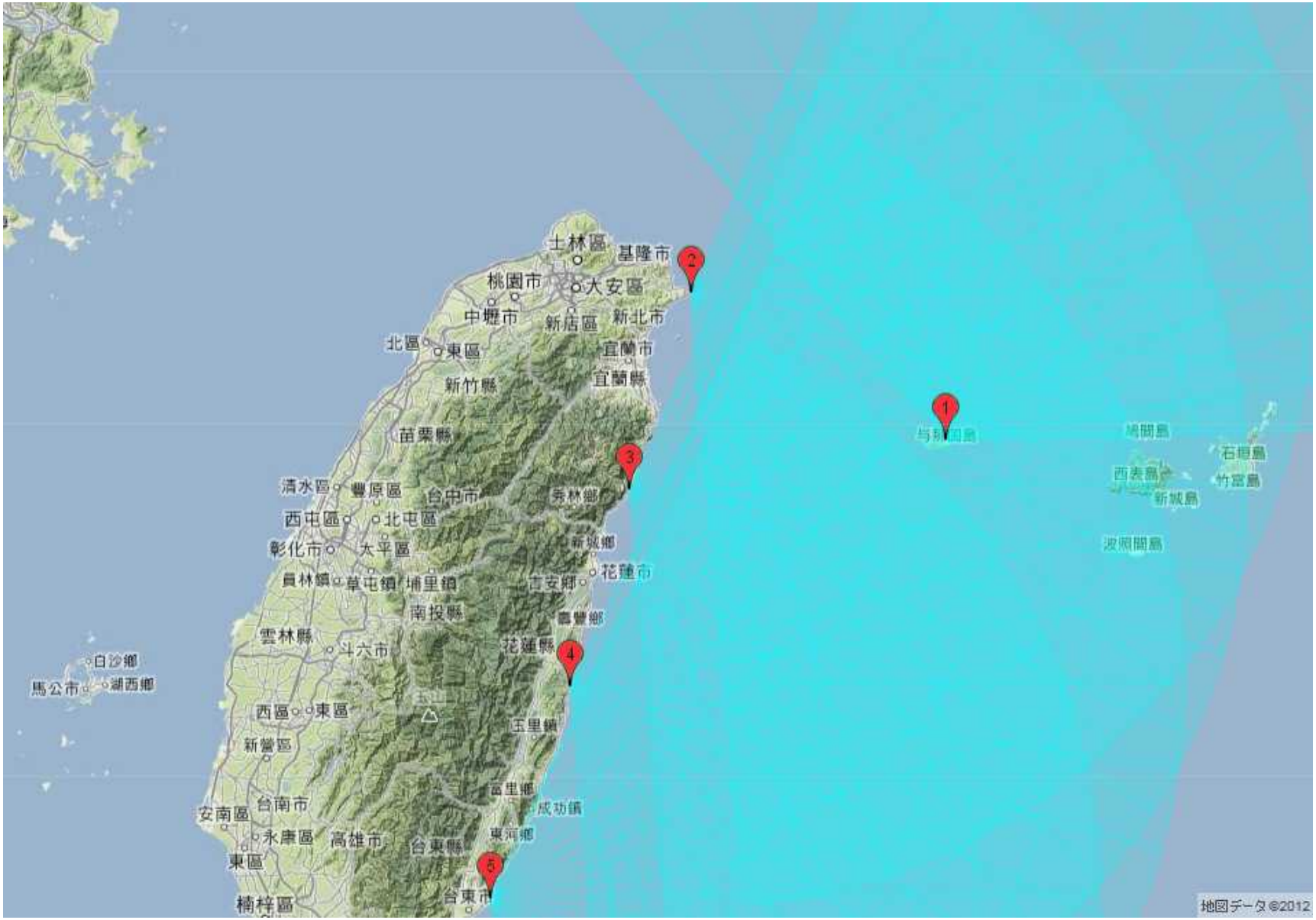
Phase differences between each channels are calibrated.



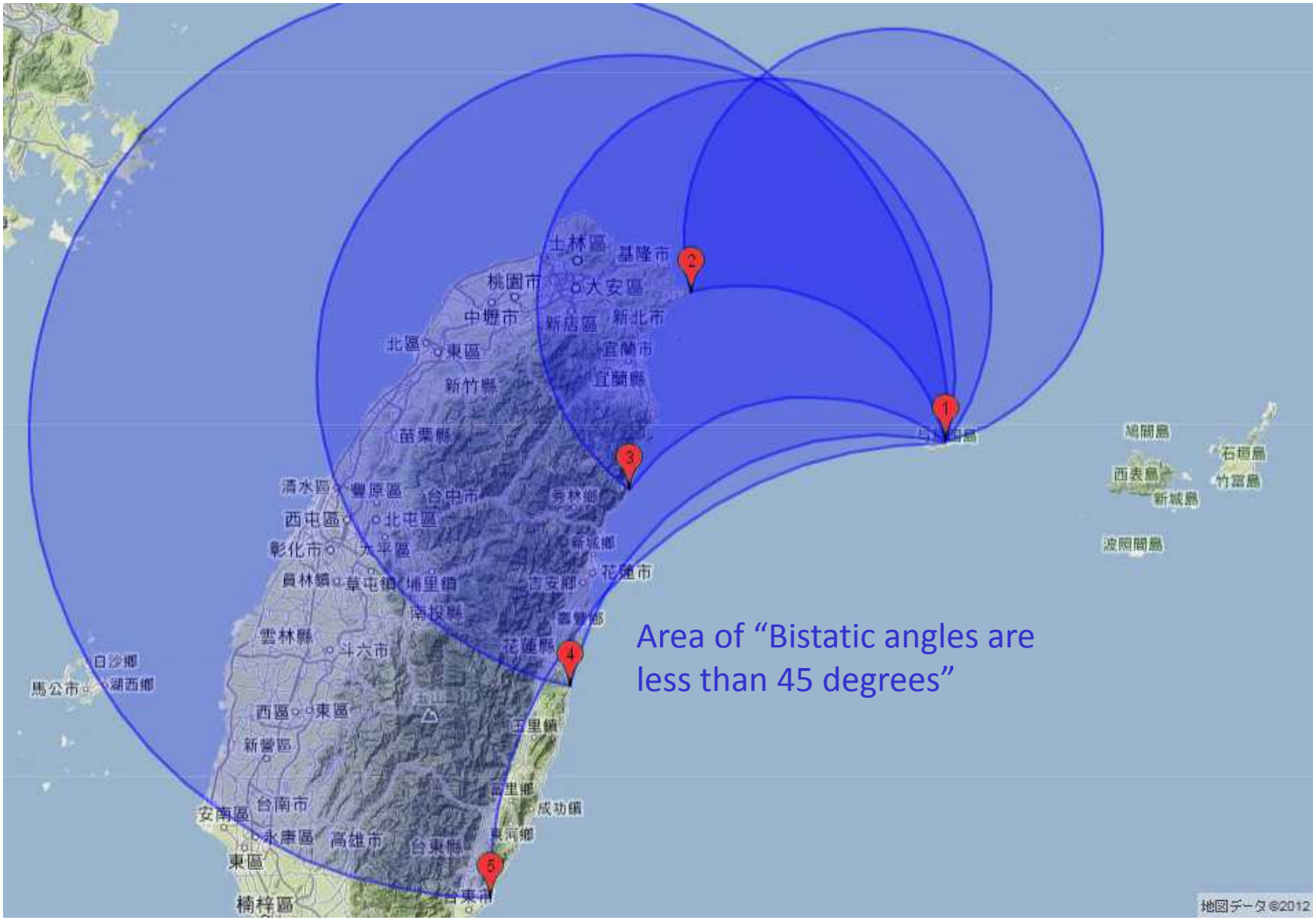
Position of each site



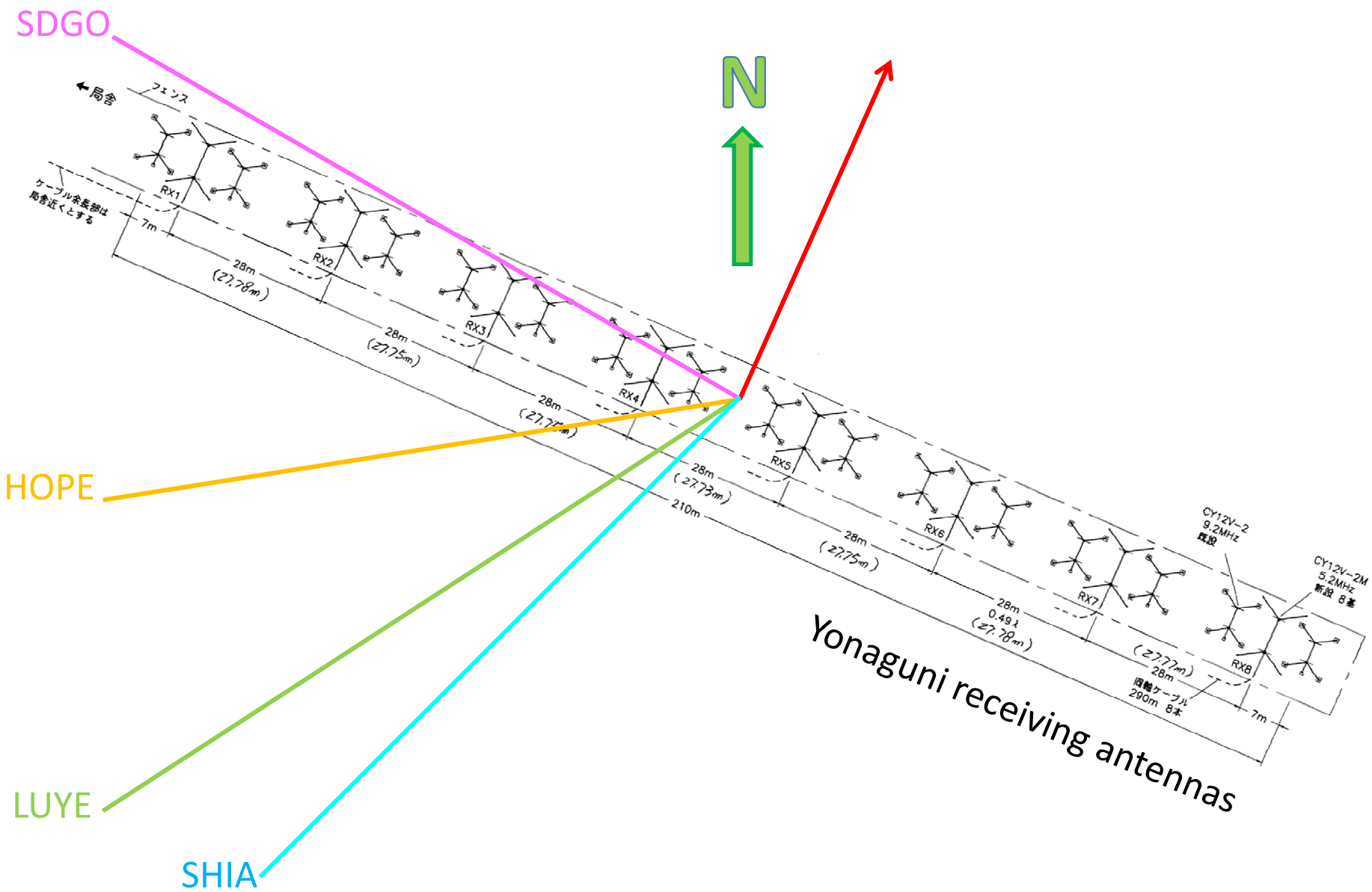
Position of each site



Position of each site

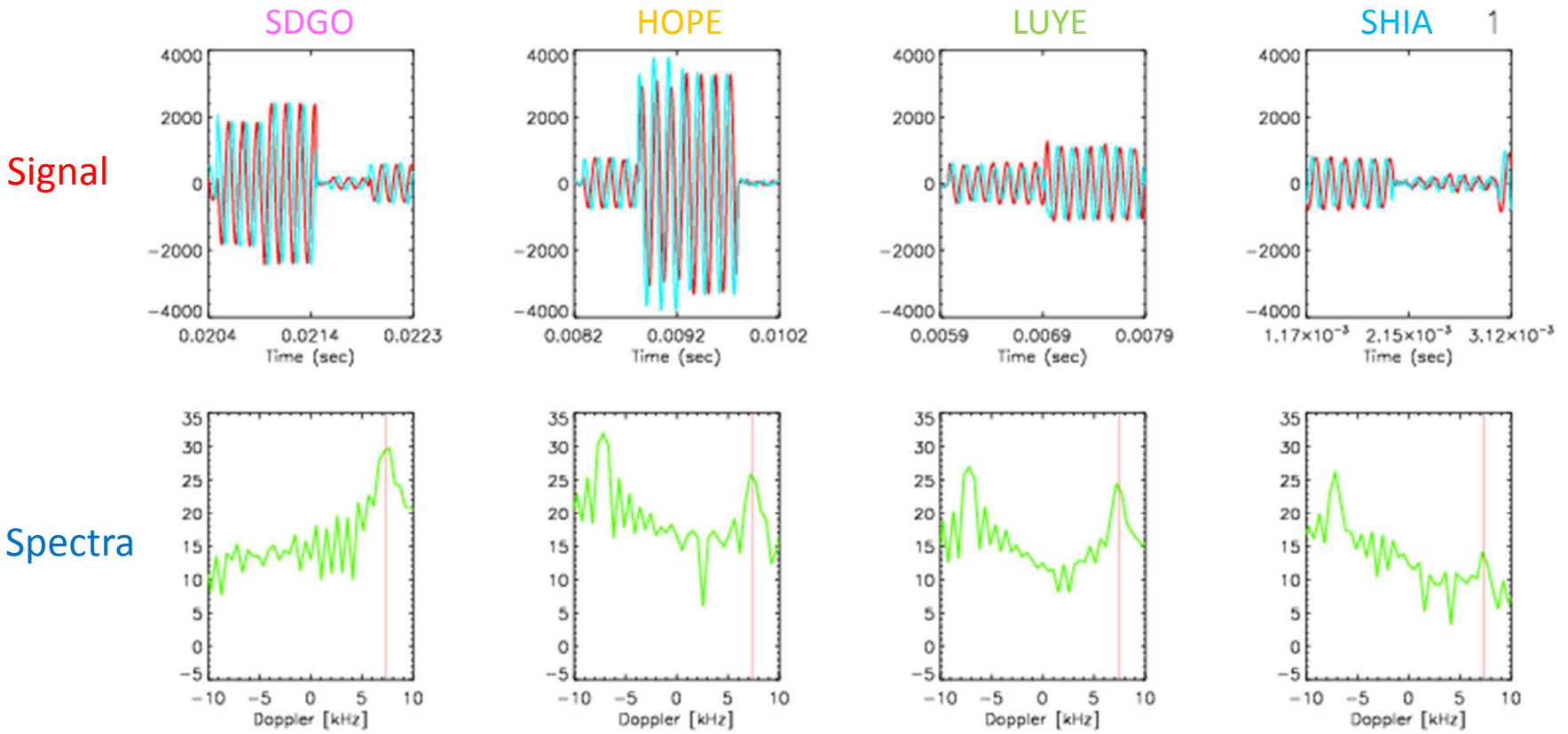


Direction to each site

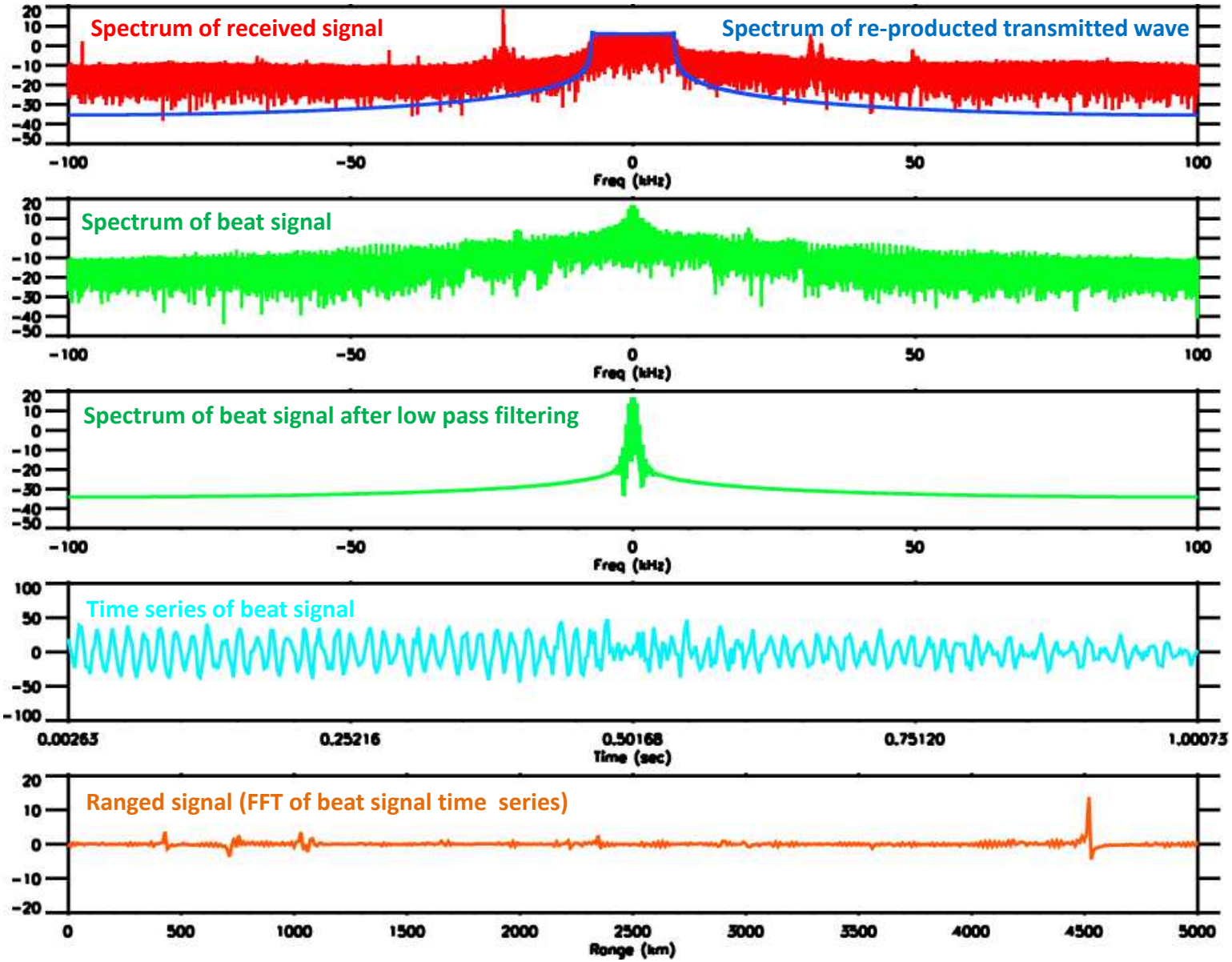


Received signals from each radar site

Receiving beams are composed to the direction of each radar site.



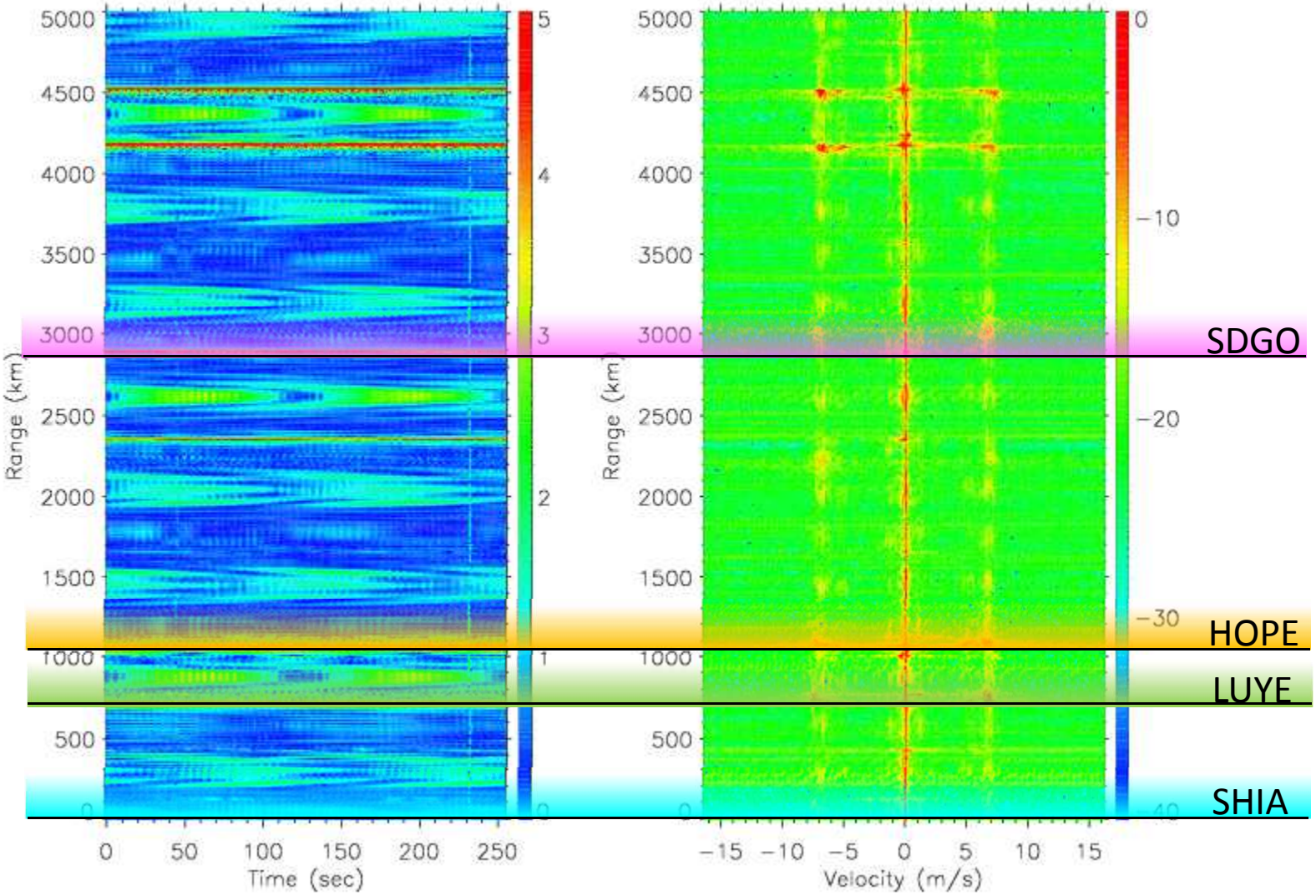
Example of data analysis



Results — Bistatic observation —

2012/6/14 06:05 UT （15:05 JST）

Northward beam from Yonaguni

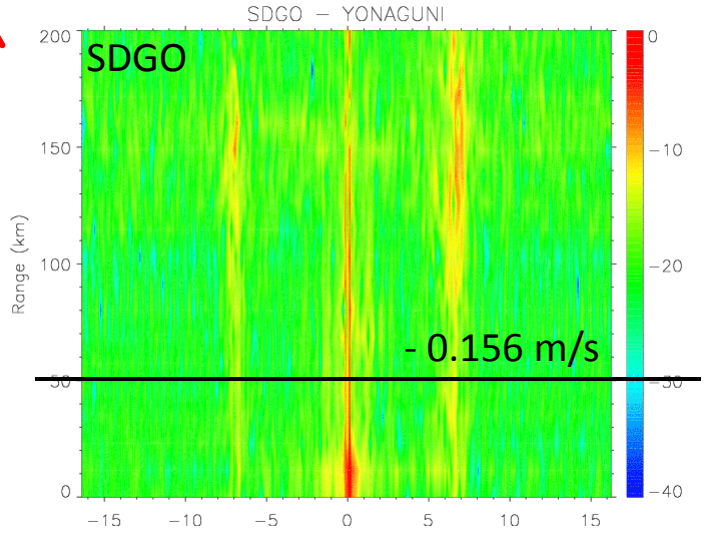


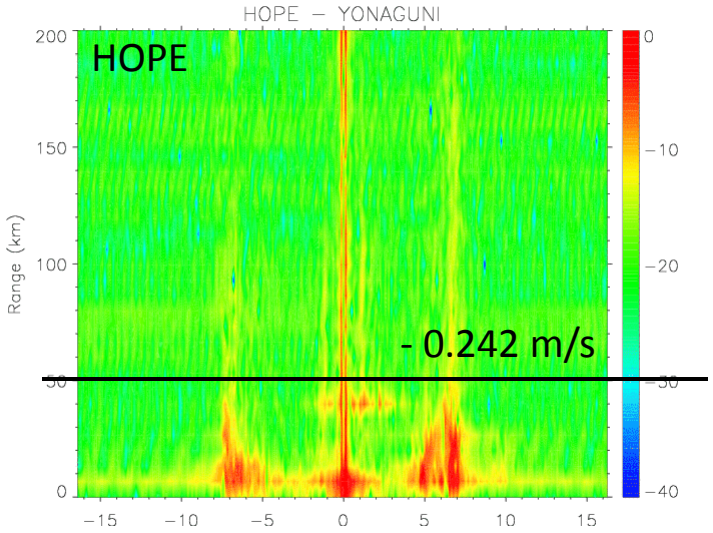
Results — Bistatic observation —

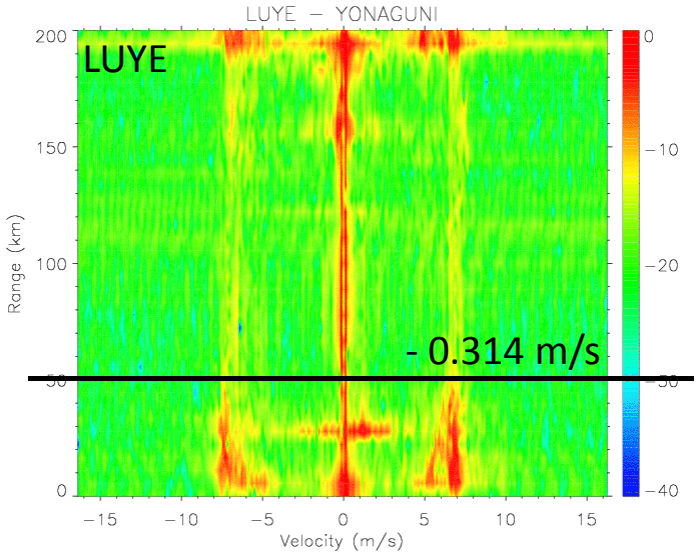
2012/6/14 06:05 UT （15:05 JST）

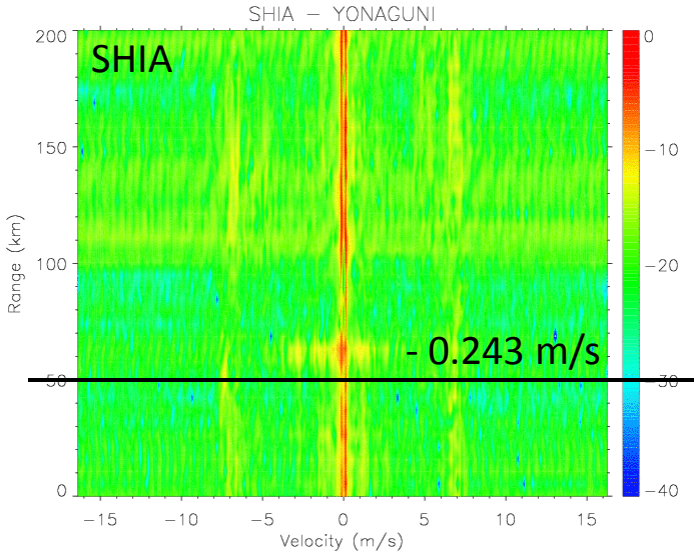
Northward beam from Yonaguni

Range from Yonaguni



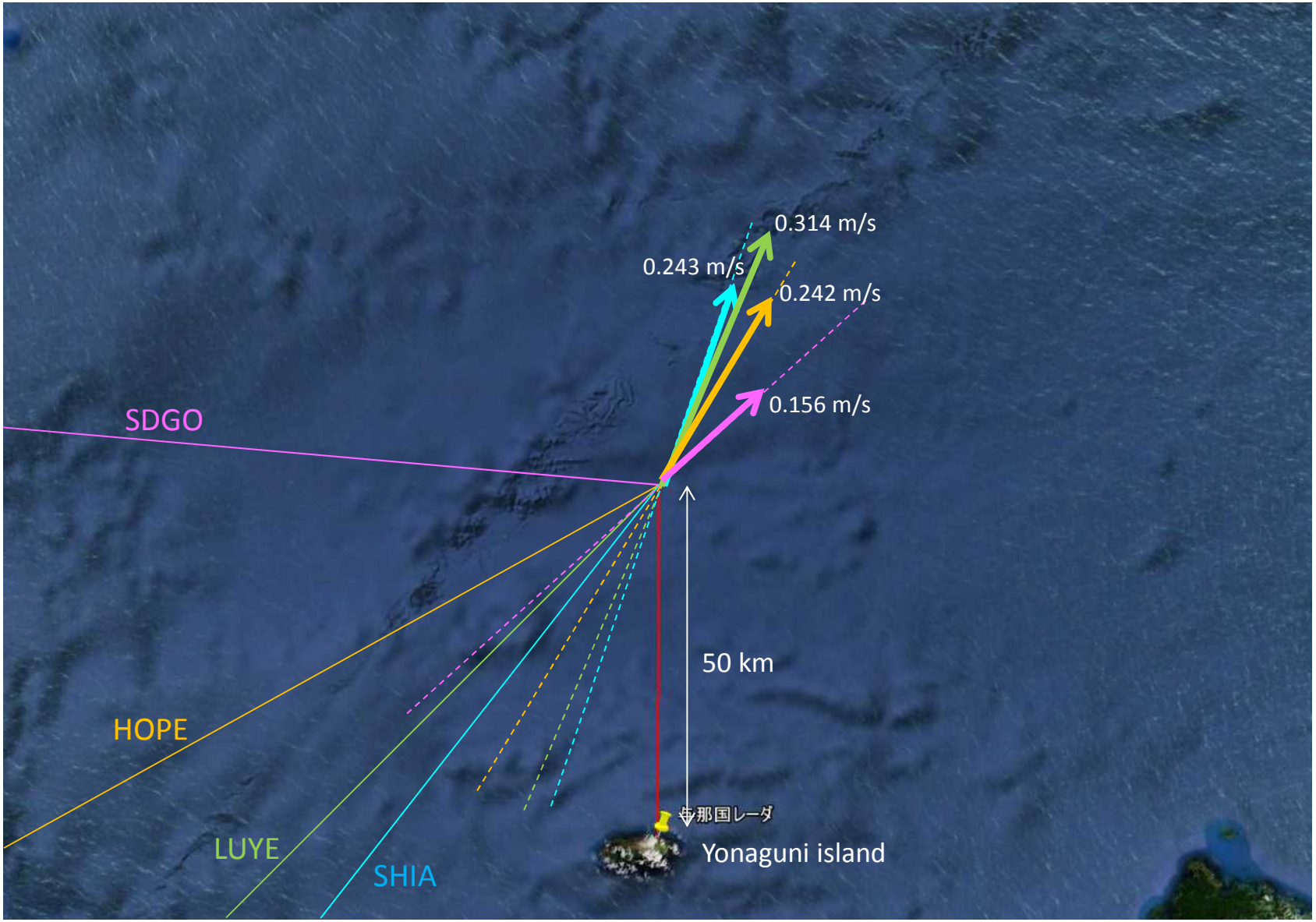






2D current Estimation

2012/6/14　06:05 UT （15:05 JST）

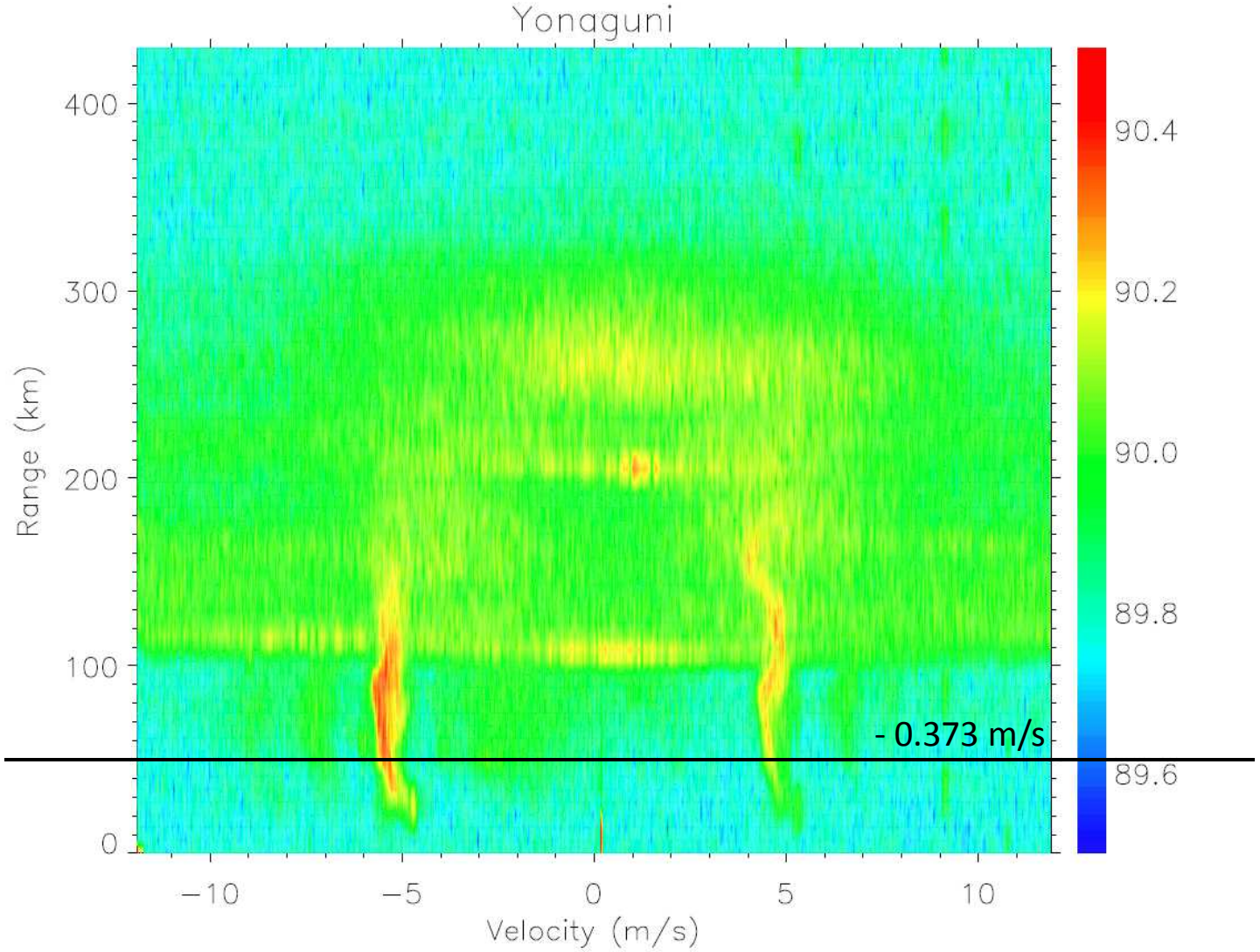


Google Earth

Monostatic observaion from Yonaguni

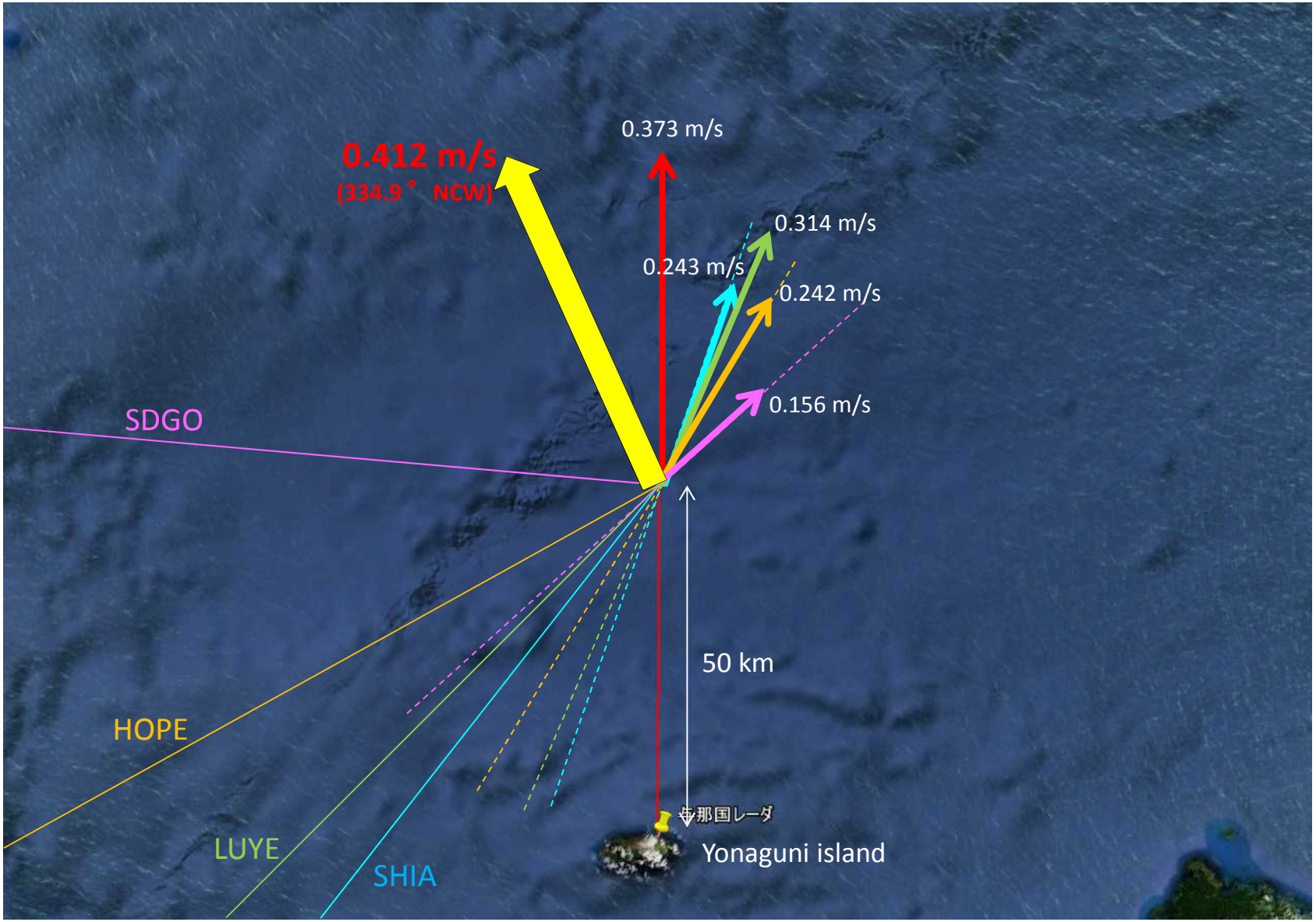
2012/6/14　06:00 UT　（15:00 JST）

Northward beam



2D current Estimation

2012/6/14　06:05 UT （15:05 JST）



Google Earth

Summary

- **Bistatic observation** are conducted during June 11 to 14, 2012 in Yonaguni island.
  - Receiving system is (a little bit) upgraded from last year.
  - GPS time handling, number of channels is 4 to 8, and so on.
- Signals from 4 Taiwan ocean radar, whose frequency is 4.58 MHz, are analyzed.
- Using known information for each site (position, sweep frequency, delay time, and so on), we retrieved signal from each radar at the same time.
- From Doppler spectra from each site and from Yonaguni radar, 2D surface current is estimated.
- In future, we want to
  - estimate 2D surface current for wider area using 8ch DBF.
  - validate 2D surface current.