MARBLE (Multiple Antenna Radio-interferometry for Baseline Length Evaluation): Development of a compact VLBI system for calibrating GNSS and electronic distance measurement devices

[1]ICHIKAWA Ryuichi, [2]ISHII Atsutoshi, [3]TAKIGUCHI Hiroshi, KIMURA Moritaka, [1]SEKIDO Mamoru, [1]TAKEFUJI Kazuhiro, [1]UJIHARA Hideki, [1]HOBIGER Thomas, [1]HANADO Yuko, [1]KOYAMA Yasuhiro, [1]KONDO Tetsuro, [4]KURIHARA Shinobu, [4]KOKADO Kensuke, [4]KAWABATA Ryoji, [2]NOZAWA Kentaro, [2]MUKAI Yasuko, [4]KURODA Jiro, [4]ISHIHARA Misao, [4]ATSUZAKA Shigeru

[1] National Institute of Information and Communications Technology (NICT), Japan
[2] Advanced Engineering Services Co., Ltd, Japan
[3] Auckland University of Technology, New Zealand
[4] Geospatial Information Authority of Japan (GSI)


34m antenna
Compact VLBI system

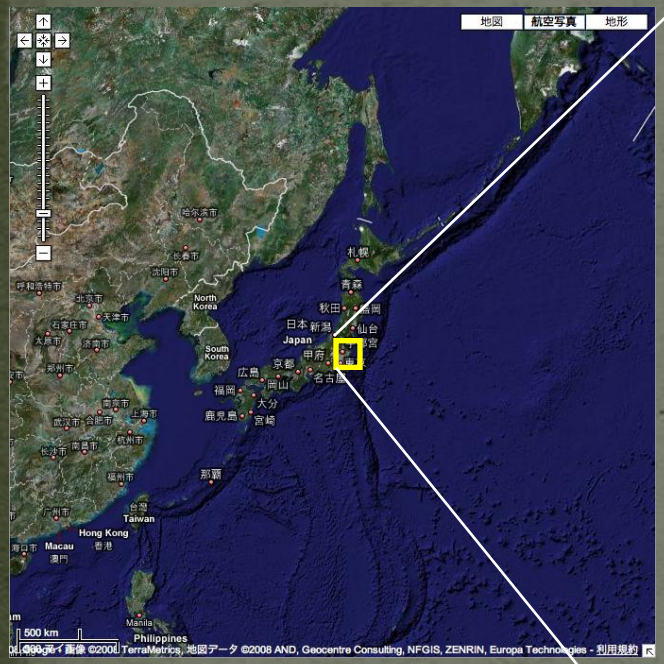
Outline

- Motivation
- Observation Concept
- Development of Compact VLBI System
- Geodetic Experiments
- Summary
- Outlook
  - T&F transfer using VLBI

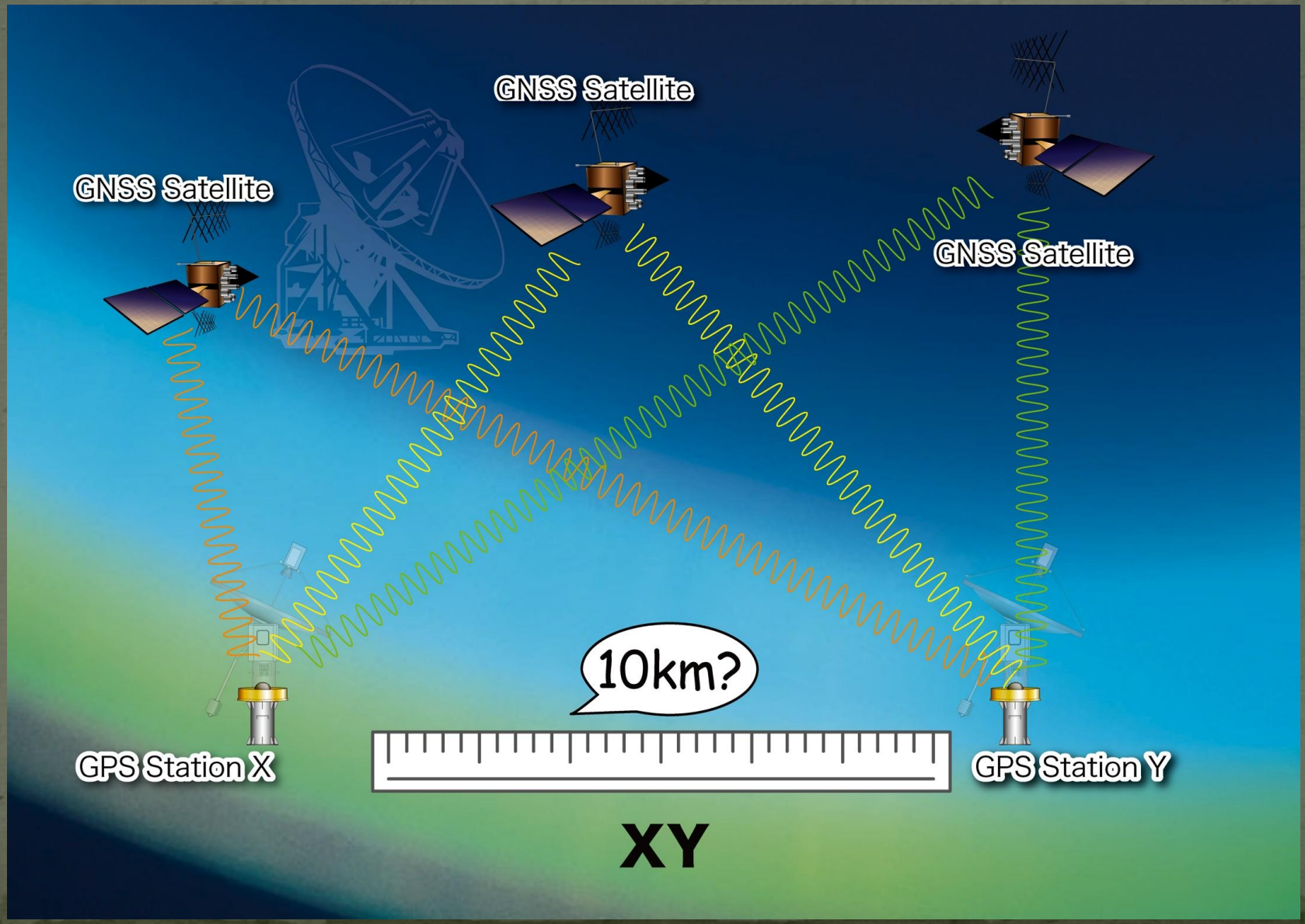
Motivation

to validate accuracy of GPS and EDM survey instruments

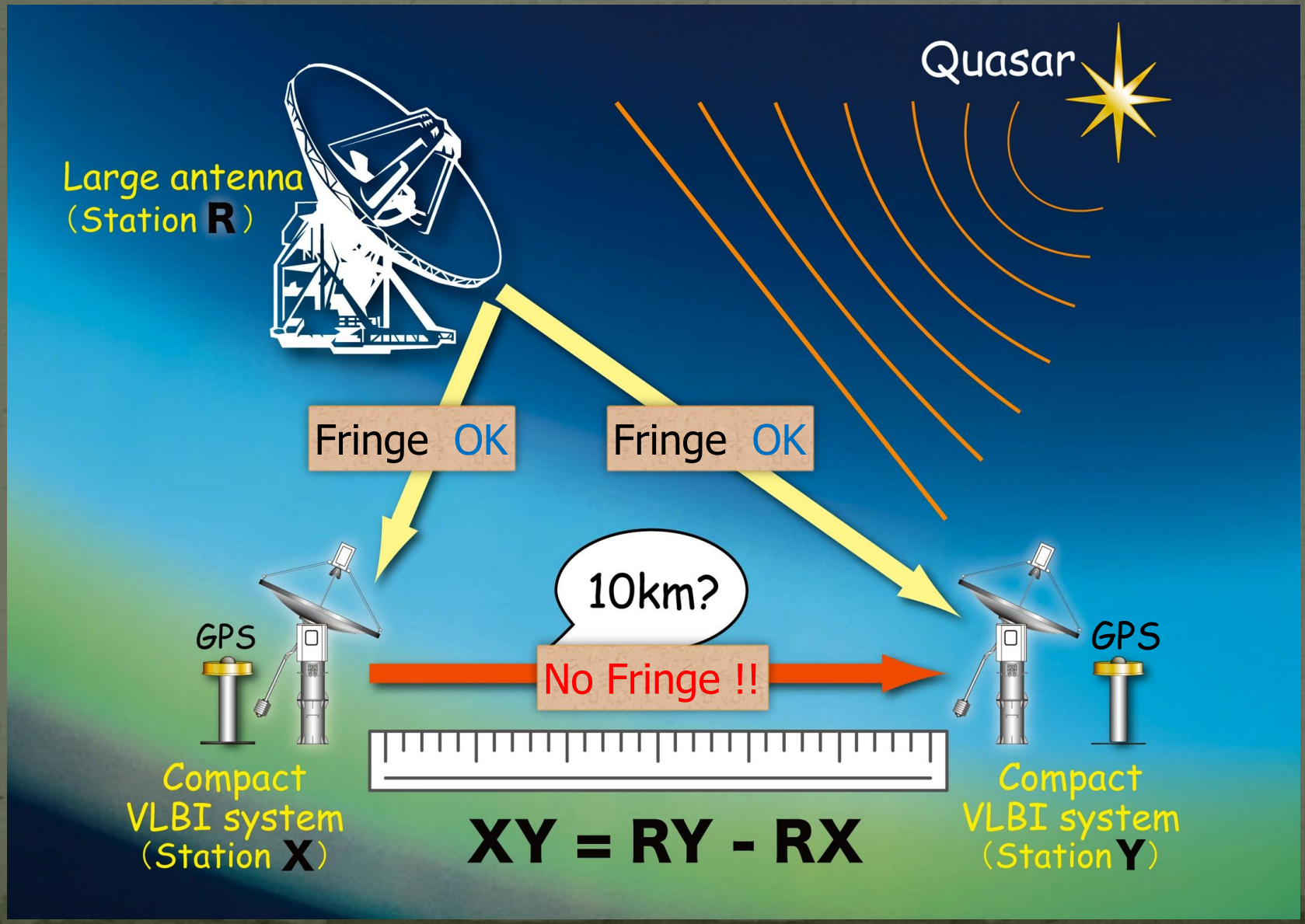
GSI baseline calibration site



Observation Concept



Observation Concept



NICT Kashima Space Technology Center

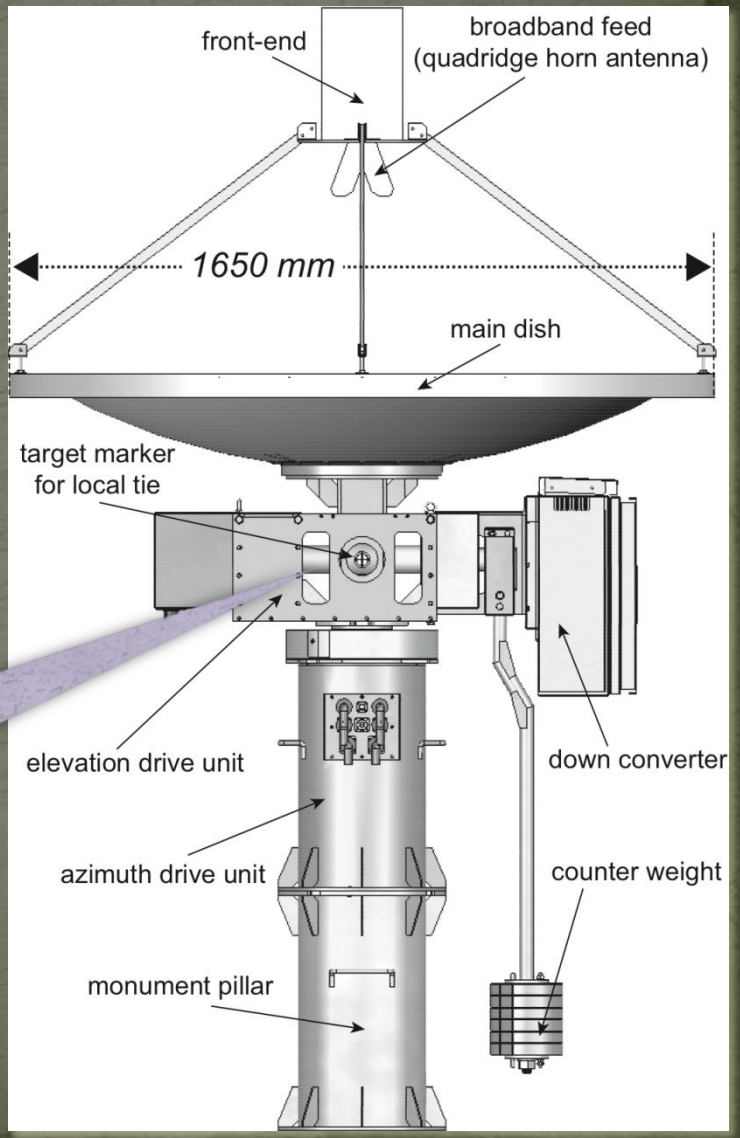
Multiple Antenna Radio-interferometer for Baseline Length Evaluation

MARBLE System

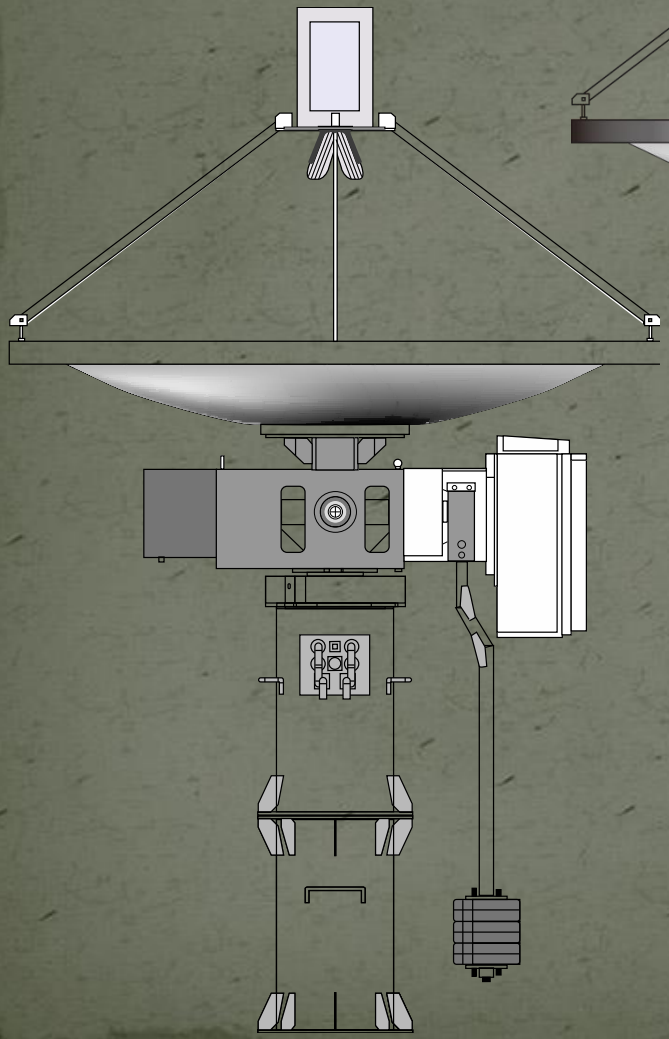
Development

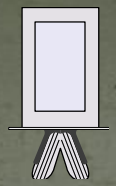
Specifications of MARBLE compact VLBI system

- Dish Diameter: 1.5-1.65m
- Primary Focus Feed
- Mount: AZ/EL
- Slew Speed: > 5° /sec
- Transportability

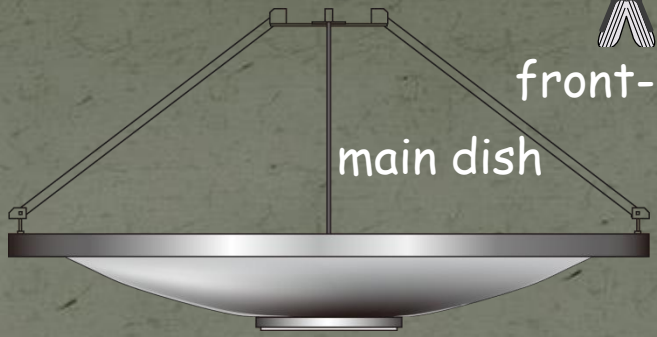


Transportability

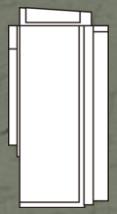




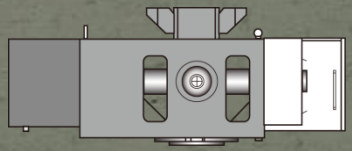
front-end



main dish

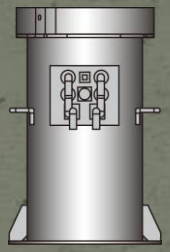


down converter



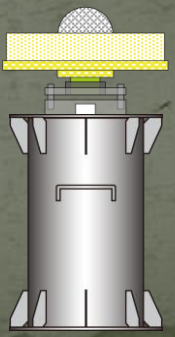
elevation drive unit

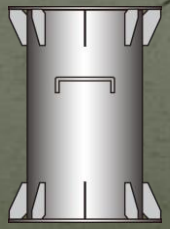
counter weight



azimuth drive unit

GPS Observation



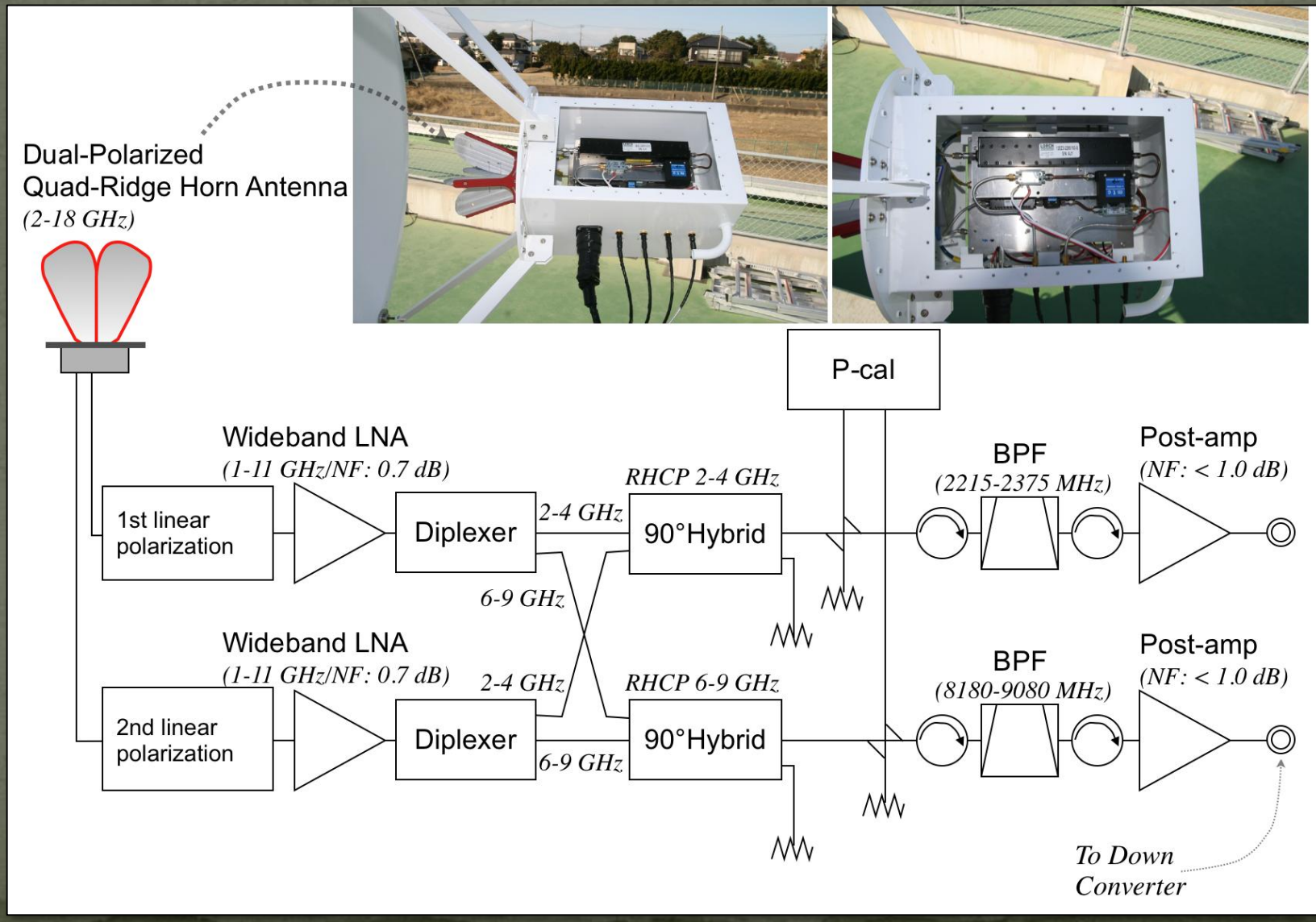


monument pillar

NICT Kashima Space Technology Center

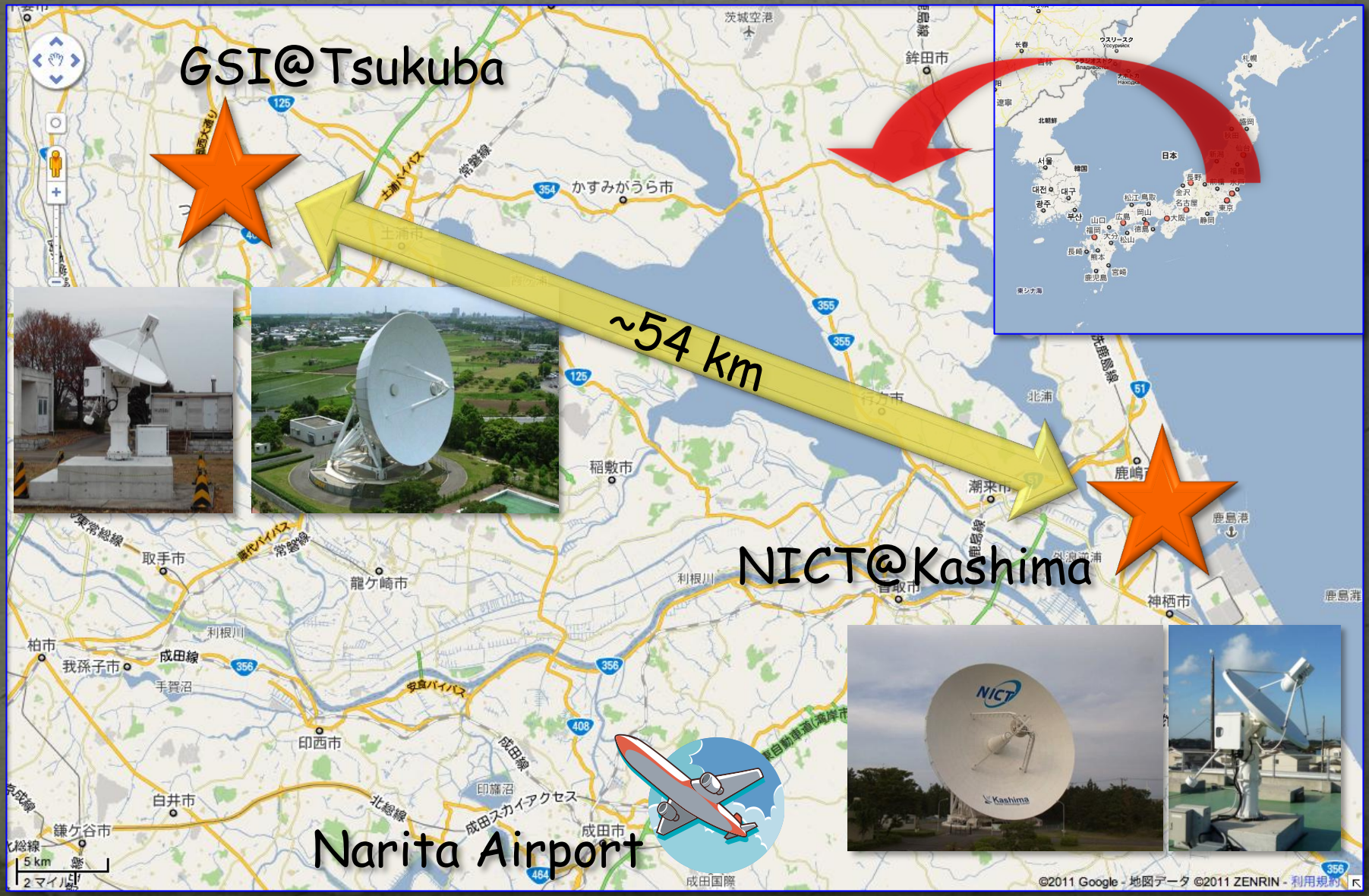
Installation

Front-end system

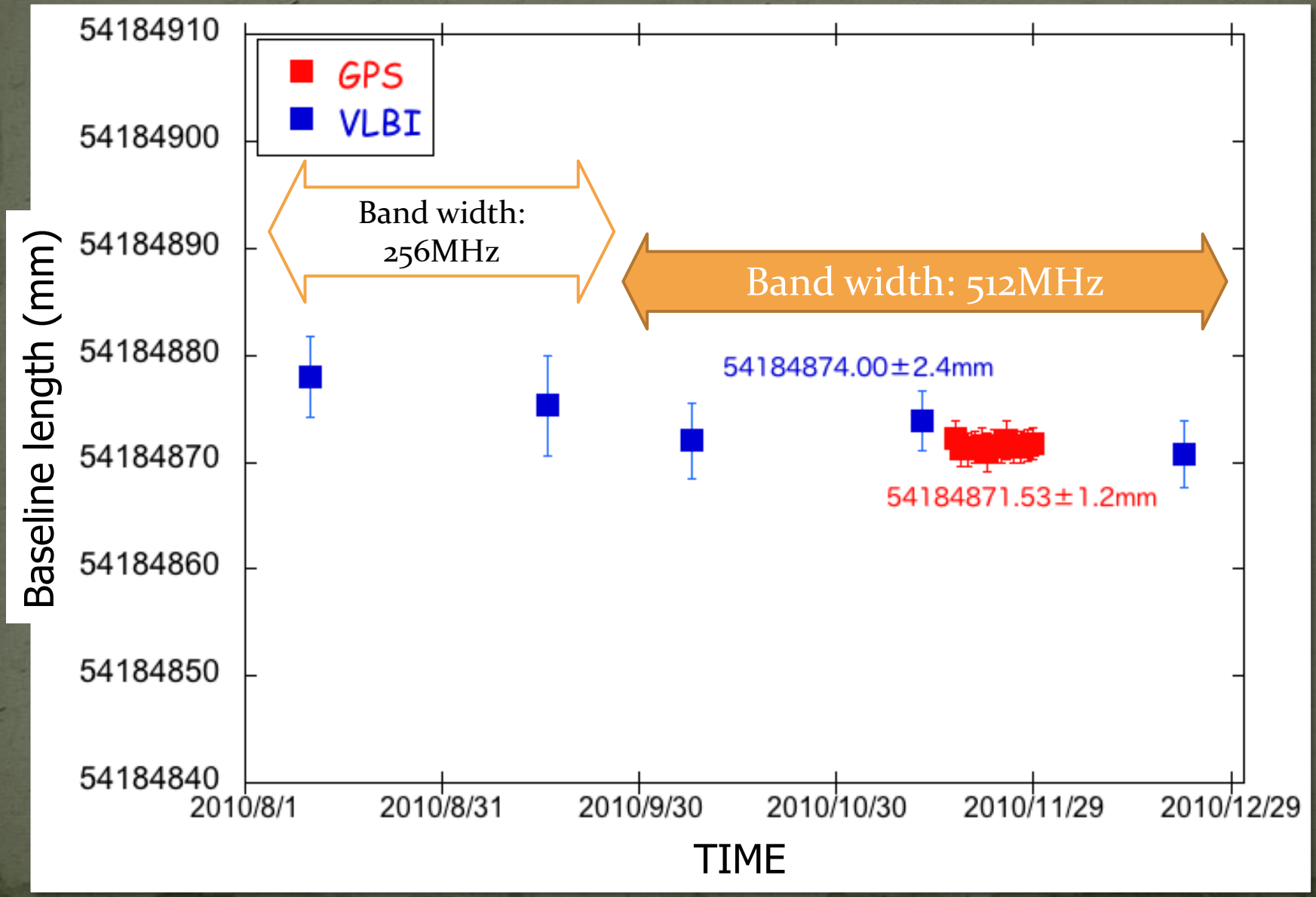


Geodetic experiments

Station location

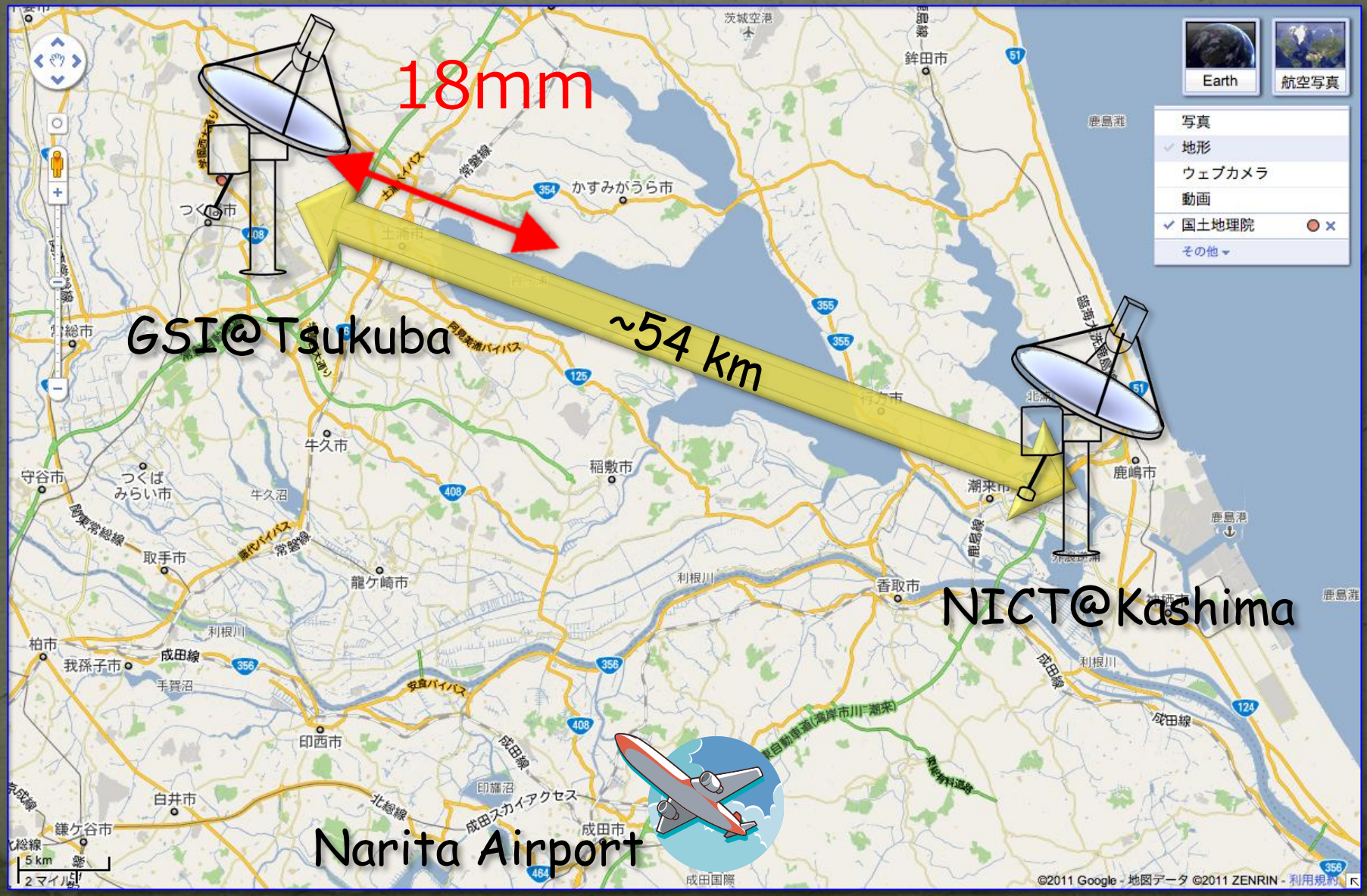


Results

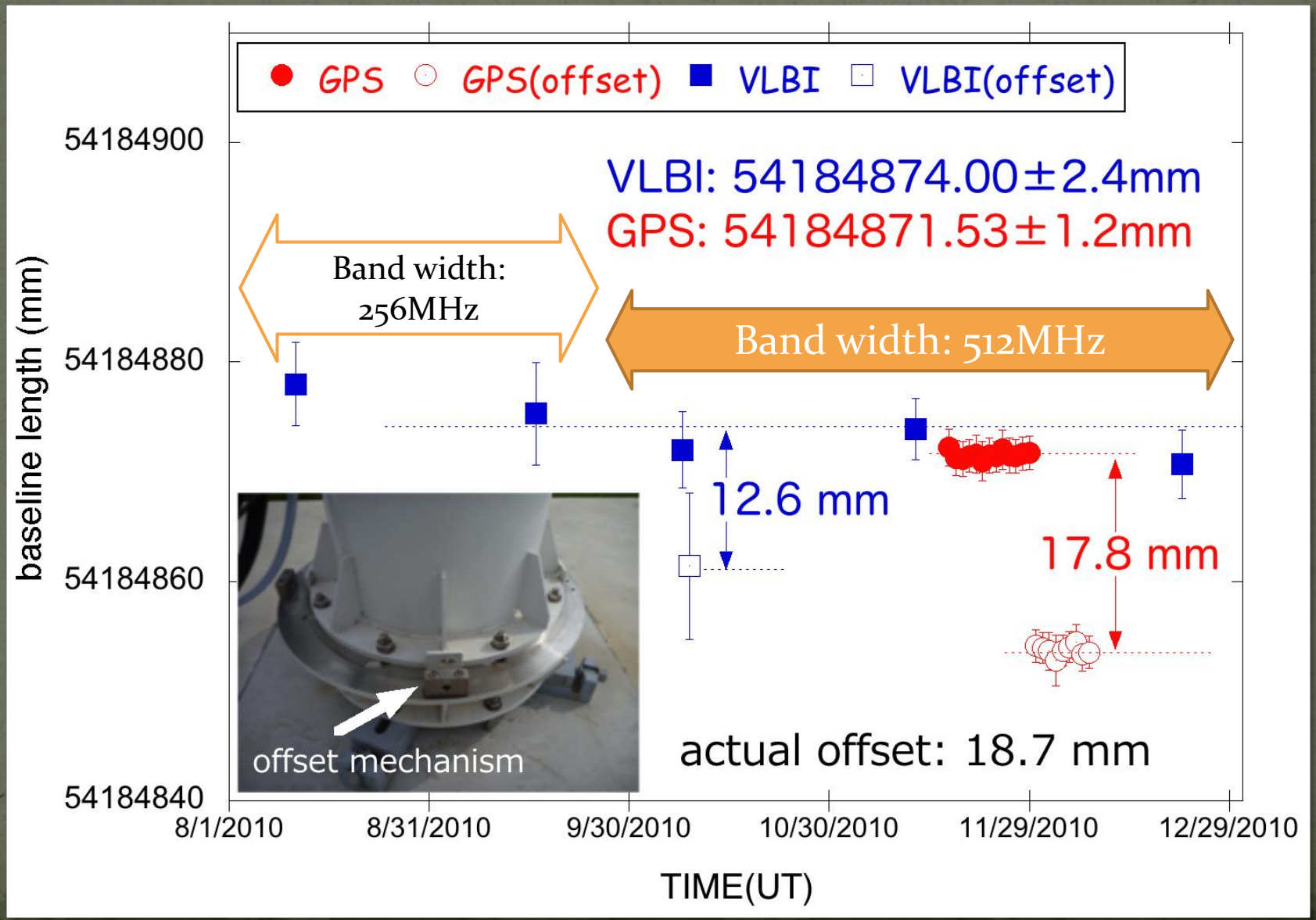

GPS
VLBI
Band width:
256MHz
Band width: 512MHz
54184874.00±2.4mm
54184871.53±1.2mm
Baseline length (mm)
54184910
54184900
54184890
54184880
54184870
54184860
54184850
54184840
2010/8/1
2010/8/31
2010/9/30
2010/10/30
2010/11/29
2010/12/29
TIME

Accuracy assessment using slide mechanism

Accuracy assessment using slide mechanism –cont'd-



Results


GPS
GPS(offset)
VLBI
VLBI(offset)
VLBI: 54184874.00±2.4mm
GPS: 54184871.53±1.2mm
Band width: 256MHz
Band width: 512MHz
12.6 mm
17.8 mm
offset mechanism
actual offset: 18.7 mm
baseline length (mm)
54184900
54184880
54184860
54184840
8/1/2010
8/31/2010
9/30/2010
10/30/2010
11/29/2010
12/29/2010
TIME(UT)

Summary

- We have developed two compact VLBI system with 1.6 m diameter aperture antenna in order to provide reference baseline lengths for GPS and EDM calibration.
- We have carried out seven VLBI experiments on the Kashima-Tsukuba baseline (about 54 km) using the compact VLBI system during December 2009 - December 2010. The averaged baseline length and repeatability of the experiments is 54184874.0±2.4 mm.

Outlook

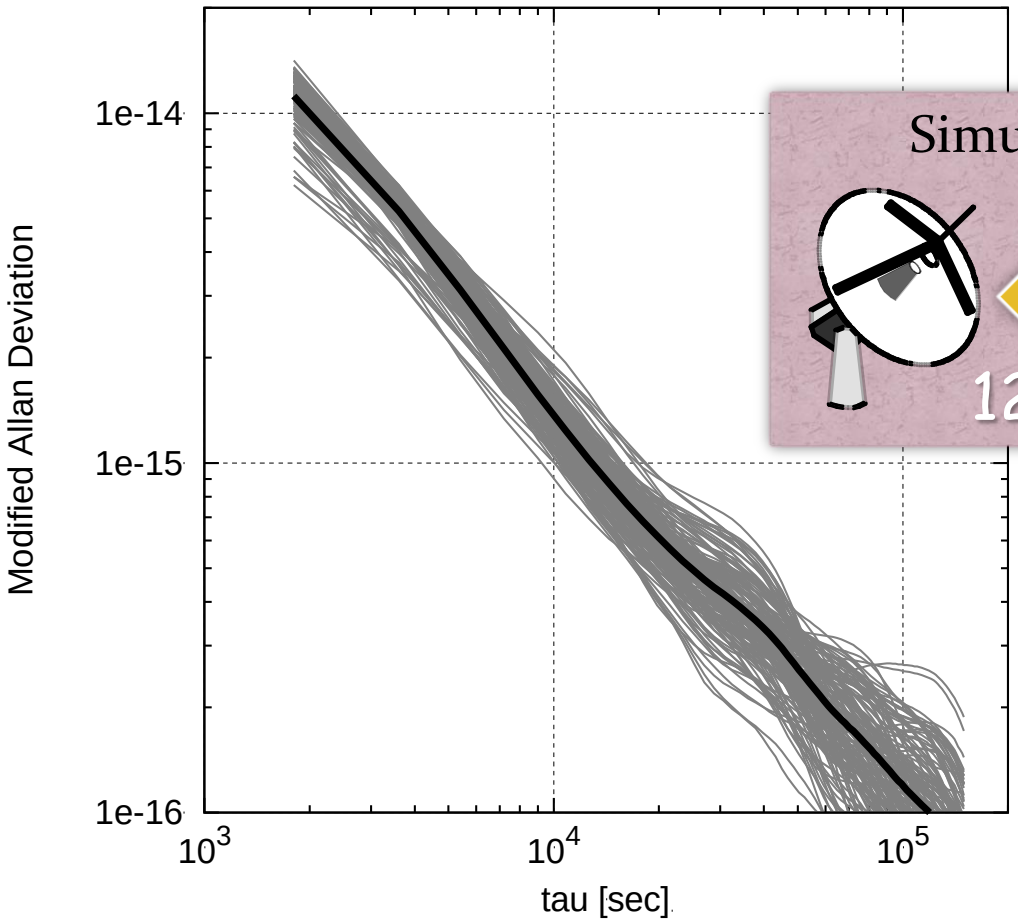
T&F transfer using compact VLBI system

Potential for T&F Transfer using VLBI?

- Current systems provide a frequency link stability of about 2 x 10^{-15} @ 1d (ADEV) (Rieck et al. [2010])
- VLBI2010 is expected to perform much better than current systems
- VLBI2010 will be a continuously operating space geodetic technique
- Only initial cost
- No transponder cost
- prototype VLBI2010 system currently under development → no data for verifying TFT potential

simulations based on VLBI2010 specifications

Simulation result

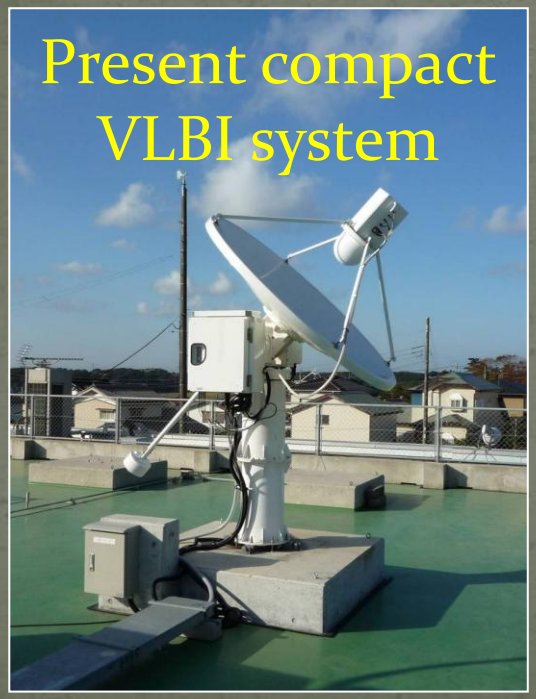


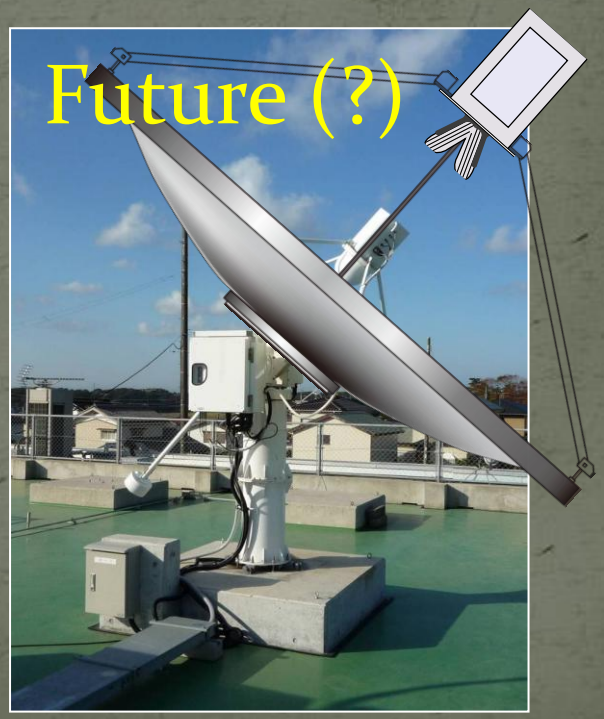
Simulation for antenna size

After WUT group [2011]

T&F transfer using compact VLBI system

- NICT will develop a compact VLBI system that includes the VLBI2010 specification for the purpose of T&F transfer.





Thank you very much for your attention.