



# Radar System to Measure Vibration of Bridge and Landslide in Real Time

## Landslide Monitoring

### Wide Area Displacement Monitoring

GB-SAR can observe the ground surface displacement over a few km by a single fixed unit at the accuracy of 1mm.

#### Monitoring Area

All the area in a view  
1km width 1km height  
Max Range a few km

#### Accuracy

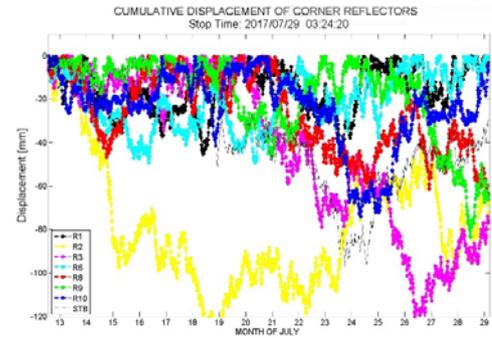
1 min. interval  
1mm Displacement can be detected

#### Advantages to Conventional Methods

- No need to estimate dangerous zones, and one unit can cover large area
- Not affected by Climate



GB-SAR unit set at Minami-Aso



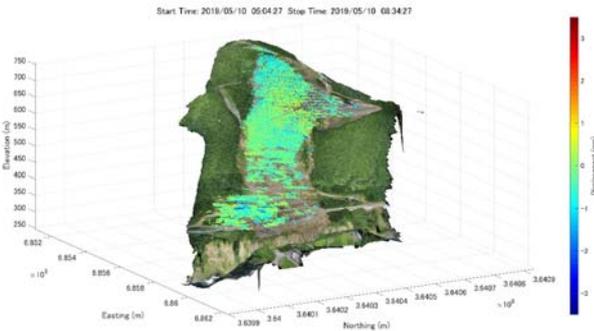
Displacement of Corner Reflectors by GB-SAR

Kumamoto Earthquake in 2016 caused a large landslide. Tohoku University started GB-SAR monitoring of landslide area at Minami-Aso with Kumamoto University and NICT, and have provided early warning information.

This activity is supporting the reconstruction from disaster in Kumamoto. At the same time, we think it is an important social demonstration for landslide monitoring. Based on our experience in East Japan Great Earthquake and Tsunami, Tohoku University will provide technique for mitigation of Natural Disasters.

## Vibration Monitoring of Social Infrastructure

Vibration of objects along 1-D range can be measured by a conventional GB-SAR

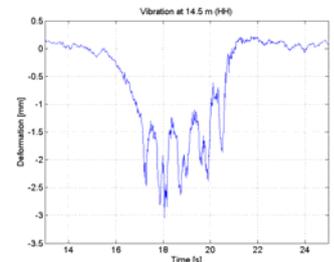


Surface Displacement observed by Interferometric GB-SAR



GB-SAR unit at Tokyo International Airport

Road surface displacement can be remotely monitored



Bridge Vibration measurement by GB-SAR

One train with 4cars can be observed.





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## MIMO-Type GB-SAR

### Vibration Measurement in GB-SAR Image

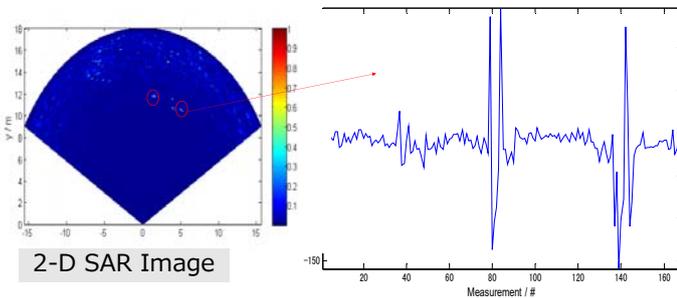
MIMO-Type GB-SAR can measure vibration at any point in a 2-D SAR image.

### Visualization of a few Hz Vibration

It can be used for real-time monitoring of large structures such as bridge, dam and road.



4-8GHz MIMO-Type GB-SAR



Vibration observed by Interferometric SAR



MIMO-Type GB-SAR and targets

- We can pin-point the position of a target in a 2-D SAR image obtained by a MIMO-Type GB-SAR at 4-8GHz
- Vibration of the target can be visualized by Interferometric SAR.

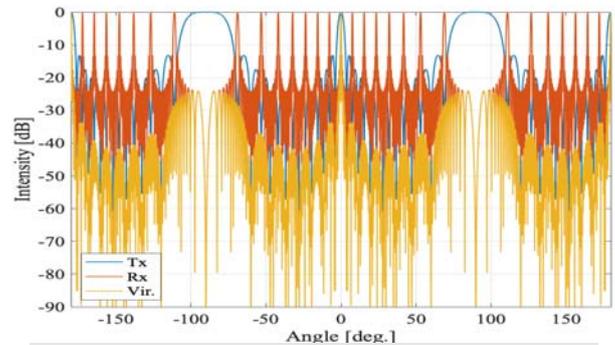
## GB-SAR Prototype

### 32Ch Prototype at 17GHz

32Ch MIMO-Type GB-SAR prototype operating at 17GHz.



Antenna for 17GHz MIMO-Type GB-SAR



Radiation Pattern of GB-SAR

- Conventional GB-SAR has to move the antenna every 5mm for 2-m aperture to satisfy the Nyquist Condition.
- In order to eliminate artifacts, more than 200 antenna elements are required.
- MIMO (Multiple Input Multiple Output)-Type GB-SAR can reduce the number of antenna elements by optimum array design.
- MIMO-Type GB-SAR can achieve PRF over 10Hz, and can measure vibration over a few Hz.

- 17GHz can be used for landslide monitoring. Operation cost can be drastically reduced by introducing MIMO GB-SAR.
- New systems at 25GHz and 70GHz are under development. They will provide higher resolution.

