Recent Progress of VGOS and its contribution to GGOS

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IVS: International VLBI Service for Geodesy and Astrometry

- An international collaboration of organizations which operate or support International Geodetic/Astrometric VLBI
- Established in 1999
- 85 components supported by 43 institutions in 20 countries
- Providing TRF, CRF, EOP products as a service of IAG, IAU and WDS
VGOS: A New VLBI Observing System

- More accurate estimation of position and velocity
- Sparse observations (2 to 4 times per week)
- Time lag from observations to products

VGOS: VLBI Global Observing System

A new VLBI Observing System by IVS to contribute to GGOS

2003～2005
General Concept by IVS WG3

2005～2009
Technical Design by VLBI2010 Committee

2009～
Implementation by VGOS Project Executive Committee
Overview of VGOS

**Broadband**

- **Freq. Range**
  - Legacy: 2, 8 GHz
  - VGOS: 2 – 14 GHz

- **Antenna Size**
  - Legacy: 5 – 100 m
  - VGOS: 12 – 13 m

- **Slew Speed**
  - ~ 3 deg/sec
  - ~ 12 deg/sec

- **Rec. Rate**
  - ~ 1 Gbps
  - ~ 32 Gbps

**Mid-size, Fast-slew Telescope**

**High-Rate Data Processing**

**Goal of VGOS**

- Accurate pos/vel determination of 1mm, 0.1mm/yr
- Continuous observation of 24/7/365
- Products available with low-latency
**VGOS at GSI (Ishioka station)**

<table>
<thead>
<tr>
<th>Description</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Diameter</td>
<td>13.2 m</td>
</tr>
<tr>
<td>Slew rate</td>
<td></td>
</tr>
<tr>
<td>Az</td>
<td>12 deg/sec</td>
</tr>
<tr>
<td>El</td>
<td>6 deg/sec</td>
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<tr>
<td>Optical system</td>
<td>Ring Focus</td>
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<tr>
<td>Frequency Range</td>
<td></td>
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<tr>
<td>S/X-bands</td>
<td>2, 8 GHz</td>
</tr>
<tr>
<td>Broadband</td>
<td>3~14 GHz</td>
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</table>
VGOS at GSI (Ishioka station)

2014
- Mar. Antenna Installation

2015
- Feb. Test observation with S/X-bands

2016
- Feb. Building Installation
- May Regular observation with S/X
- Aug.-Sep. VGOS Test

2017
- Jan. UT1 observation
- Mar. Retirement of Tsukuba
- Nov.-Dec. VGOS Demo (CONT17)

2018
- Jun.-Sep. VGOS Test (IVS, AOV, NICT)
Current Status of VGOS Network

Operating (6)
Current Status of VGOS Network

- Biweekly VGOS test observations (+ Westford) coordinated by IVS
- Correlated at MIT Haystack
- Improvement of operation, establishment of correlation processes
Current Status of VGOS Network

Testing (2)  
Updating (6)
Latest VGOS Station

NY ÅLESUND 78°56'N 11°56'E
Current Status of VGOS Network

- **Constructing (5)**
  - Tahiti (2022~)
  - McDonald (2019~)
  - Svetloe (2018~)
  - Metsahovi (2019~)
  - Gran Canaria (2019~)

- **Planning (5)**
  - Chiangmai (2020?)
  - Flores (2022?)
  - Brazil
  - Brazil
  - McDonald (2019~)
Current Status of VGOS Network

- Operating (6)
- Testing (2)
- Updating (6)
- Constructing (5)
- Planning (5)

~15 stations by 2020
Finally 20+ station network?
Current Issues and Prospects

• Purpose of current VGOS test observations: Accumulating knowledge of full end-to-end operation

• Correlation is a bottleneck
  ✓ Only Haystack can correlate VGOS data
  ✓ Under establishment of correlation processes
  ✓ (Sometimes) Unstable observing systems
Current Issues and Prospects

• Purpose of current VGOS test observations: Accumulating knowledge of full end-to-end operation

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• Sharing the know-how of correlation
  ✓ Processing manual “Cookbook” is under preparation
  ✓ VGOS Correlation Workshop in May 2019 at Haystack

• “Mixed Mode” observation
“Mixed mode” Observation

- VGOS stations (broadband) participate in Legacy (S/X-bands) observation

- Continuity of products is secured when transition of observing system from Legacy to VGOS
  - VGOS stations are integrated in current products
  - Improvement of current products

- Different correlation processes are necessary among Legacy-Legacy, Legacy-VGOS, VGOS-VGOS baselines
  - First international test was conducted in July
  - Data are being correlated at Haystack
  - Next test is planned in December (RD1810)

(Niell et al. 2018) IVS-GM
Current Issues and Prospects

- Continuous Observation
  ✓ Observing plan for transition
  ✓ “Dynamic Scheduling (at UTAS)”

- Low-latency products
  ✓ Data transfer via high-speed network
  ✓ Distributed Correlation, Cloud Correlation
  ✓ Automation of correlation and analysis

- Expansion of Station Network
  ✓ South America, Africa, Antarctica⋯
• IVS is implementing a new VLBI observing system “VGOS” to contribute to GGOS
• VGOS tests are performed biweekly with 7 stations
• VGOS network is expanding gradually → ~15 by 2020, 20+ finally?
• Correlation is a current bottleneck → Sharing knowledge, “Mixed mode” Observation
• Expansion of stations and correlators might advance VGOS development rapidly
• Next challenge is realization of continuous observation and low-latency products
Thank you for your kind attention.