VGOS, the next-generation broadband signal chain for VLBI Geodesy by MIT/NASA, incorporates a number of technology novelties such as the Calibration Delay Measurement System (CDMS) and the ROACH2-based digital backend (R2DBE). The former is a key component for accurate estimation of instrumental delays; the latter supports 1-GHz bandwidth sampling capability. The CDMS adds active picosecond-level cable delay measurement capabilities to the MIT Haystack calibrator to correct for cable delays, signal phase, and amplitude across the full VGOS band. The R2DBE is currently undergoing zero-baseline testing at the Westford VLBI station.

### VGOS VLBI Signal Chain Frontend
- Frontend noise temperature 40K over 2-14 GHz (max – excluding atmosphere)
- Feed efficiency > 50%
- Aperture efficiency ~ 70% over 2-14GHz
- Spur free dynamic range 90dB in 1Hz bandwidth (min)
- Dual linear H/V polarization with -20dB isolation
- Support for pre-LNA instrumental phase and amplitude monitoring

### VGOS VLBI Signal Chain (SC) Backend
- Supports the Frontend receiver signal to independently to 4 tunable IF conversion bands (RF Distributor v. 2.0)
- Supports 2-14GHz RF down conversion to 2GHz baseband output (UDCs v 2.0)
- Digitizes 512MHz IF bandwidth into 16x32 MHz complex signals into 2bit VDIF format (RDBE-G v 3.0)
- Records data to disk modules at data rates up to 16Gbps (Mark6)

### Calibration
- Provides calibration system for determining instrumental delays in VGOS system (cable delays, signal phase, and signal amplitude)

### R2DBE-G v. 4.0
MHÖ’s 4th-generation digital backend, based upon the Roach2 and Virtex 6 FPGA, is 100% VGOS compliant.
- Supports a 2 IF x 2048 GHz (H&V-pols) IF bandwidth digitized into 64x32 MHz complex signals into 2bit VDIF format.
- ASAIA 5 G sps ADC (2,4,8,16 Gbps)
- Form factor (2U) is same as RDBE-G, with updated configuration
- Four 10G optical SFP+ interfaces
- Command Set is backward compatible with v3.0
- Extended multicast capabilities for monitoring (PCAL, TSYS)

### Testing
- The polyphase filter bank (PFB) FPGA personality, v4.0, verified thru simulation and a zero baseline bench test with existing RDBE-G v3.0.
- Zero-baseline testing continues with RDBE-G v3.0 PFB personality over both 1024 and 2048 GHz bandwidth.

### Calibration: CDMS
- CDMS involves monitoring the electrical length of the signal-carrying cables to enable corrections for cable length variations induced by mechanical, thermal, and any other effects with an RMS accuracy of ±1 picosecond.
- CDMS delay stability is designed to exceed the following standards (Allan standard deviations): 1.8e-14 at 30 s, 5.5e-15 at 100 s, 9.0e-16 at 600 s and 1.0e-16 at 50 min.
- The default cable for delay calibrations is assumed to be an LMR400 coaxial cable; fiber optic cable support may be requested.

The new VGOS Calibration System (VCS) CDMS is integrated with upgraded versions of the existing noise and phase/delay calibration subsystems. The VCS is located in the backend and the frontend of the VGOS SC.