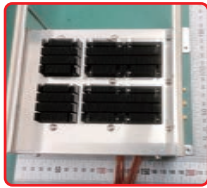


Direct RF Sampler with Digital Signal Processing

Ken-ichi Harada, Yuichi Chikahiro, Kensuke Ozeki, Yoshinori Hayashi, Hirofumi Onuki, Kenji Ema

Sampler development history

2019 ~ | 4th Generation
Sampler with Digital Signal Processing

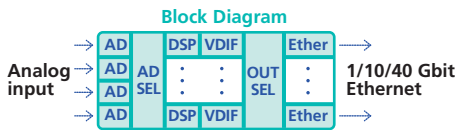


DRS4
Sampling speed 16GHz x 2ch
Analog bandwidth 24GHz
DBBC, FFT, Correlator

2011 ~ | 3rd Generation
Sampler with Digital Signal Processing



OCTAD, K6/GALAS
Sampling speed 16GHz x 4ch
Analog bandwidth 24GHz
DBBC, FFT, Correlator



2010 ~ | 2nd Generation
Sampler



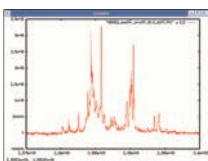
ADX
Sampling speed 8GHz x 2ch
Analog bandwidth 8GHz

2009 ~ | 1st Generation
Sampler

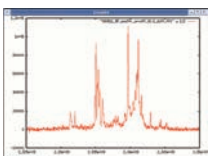


PANDA
Sampling speed 4GHz x 2ch
Analog bandwidth 8GHz

2008 | Direct RF Sampling
verification @NRO 45m

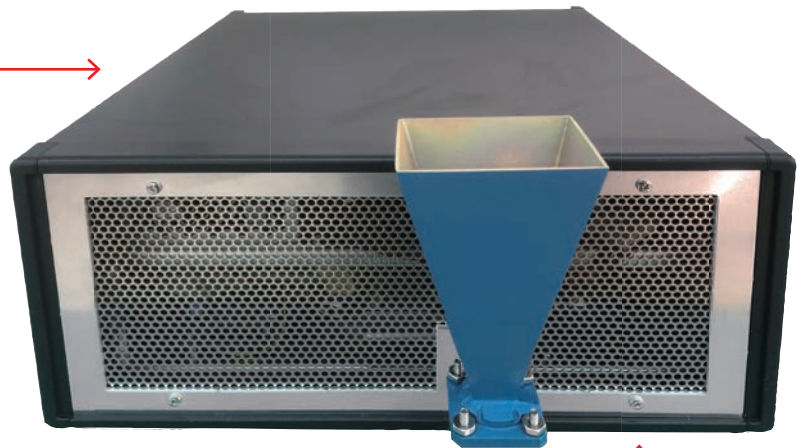


Digitized after frequency conversion at local frequency 19.85GHz (IF sampling)
※ The figures shows a partial enlargement



Directly digitized the 20-24GHz RF signal at 8Gbps without frequency conversion (Direct RF sampling)
※ The figures shows a partial enlargement

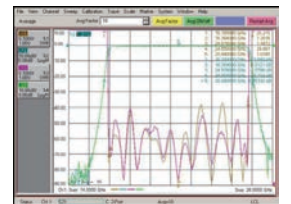
Digital Water Vapor Radiometer (Digital WVR)



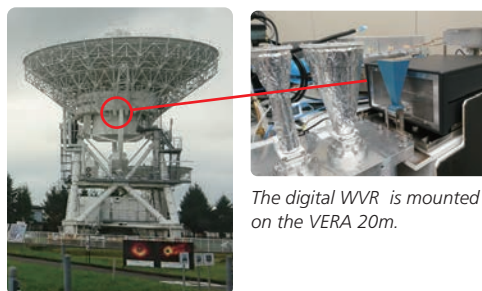
The 16-24GHz RF signal is received by a horn antenna, amplified and directly digitized at 16Gbps without frequency conversion (Direct RF sampling). The sampled signal is converted to power spectrum by FFT. From the wideband spectrum the water vapor emission is separated from the liquid water thermal emission and reduced for the wet delay (Excess Path Length).



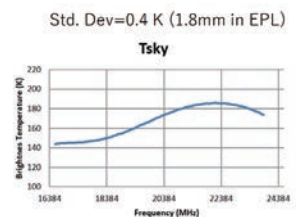
16-24GHz Analog module
Isolator / Amplifier /
Anti-aliasing filter



16-24GHz Anti-aliasing filter characteristics



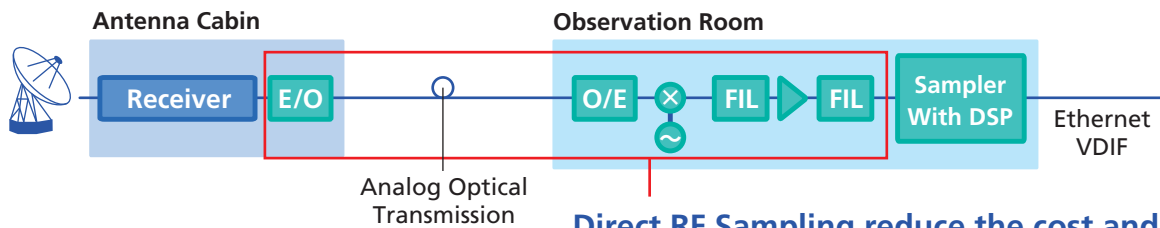
The digital WVR is mounted on the VERA 20m.



Standard deviation of EPL (Excess Path Length) measured with Digital WVR

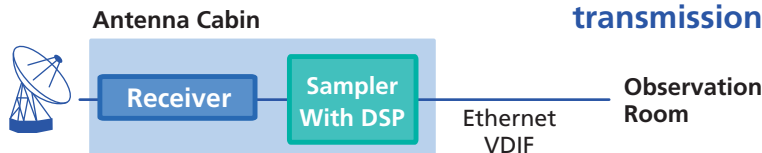
Direct RF Sampling

▶ IF Sampling



Direct RF Sampling reduce the cost and size of the radio telescope systems, because of this technique eliminates the need for analog optical transmission and frequency conversion.

▶ Direct RF Sampling



Removable Storage



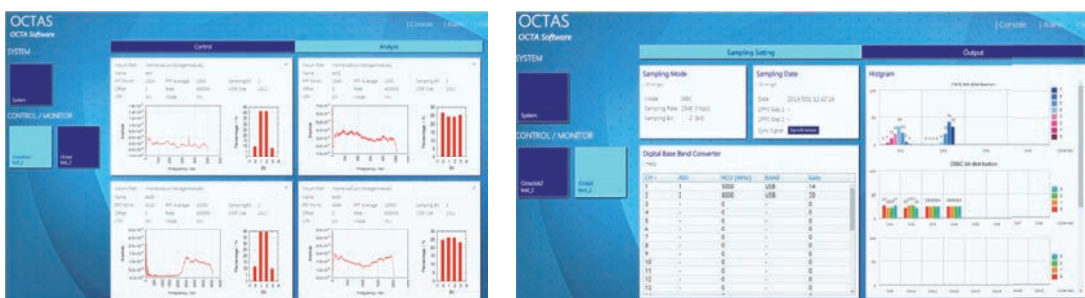
High durability docking connector (Over 10,000 insertions / removals)



Special transport case

- Record/Playback VDIF data stream at 32Gbps via 10/100Gbit Ethernet
- The file system of VDIF data is Linux XFS
- 200Gbps model is under development

Integrated GUI Software



- Control our products (sampler, storage)
- Web base software don't depend on the OS and the machine
- Supports VEX format schedule files

