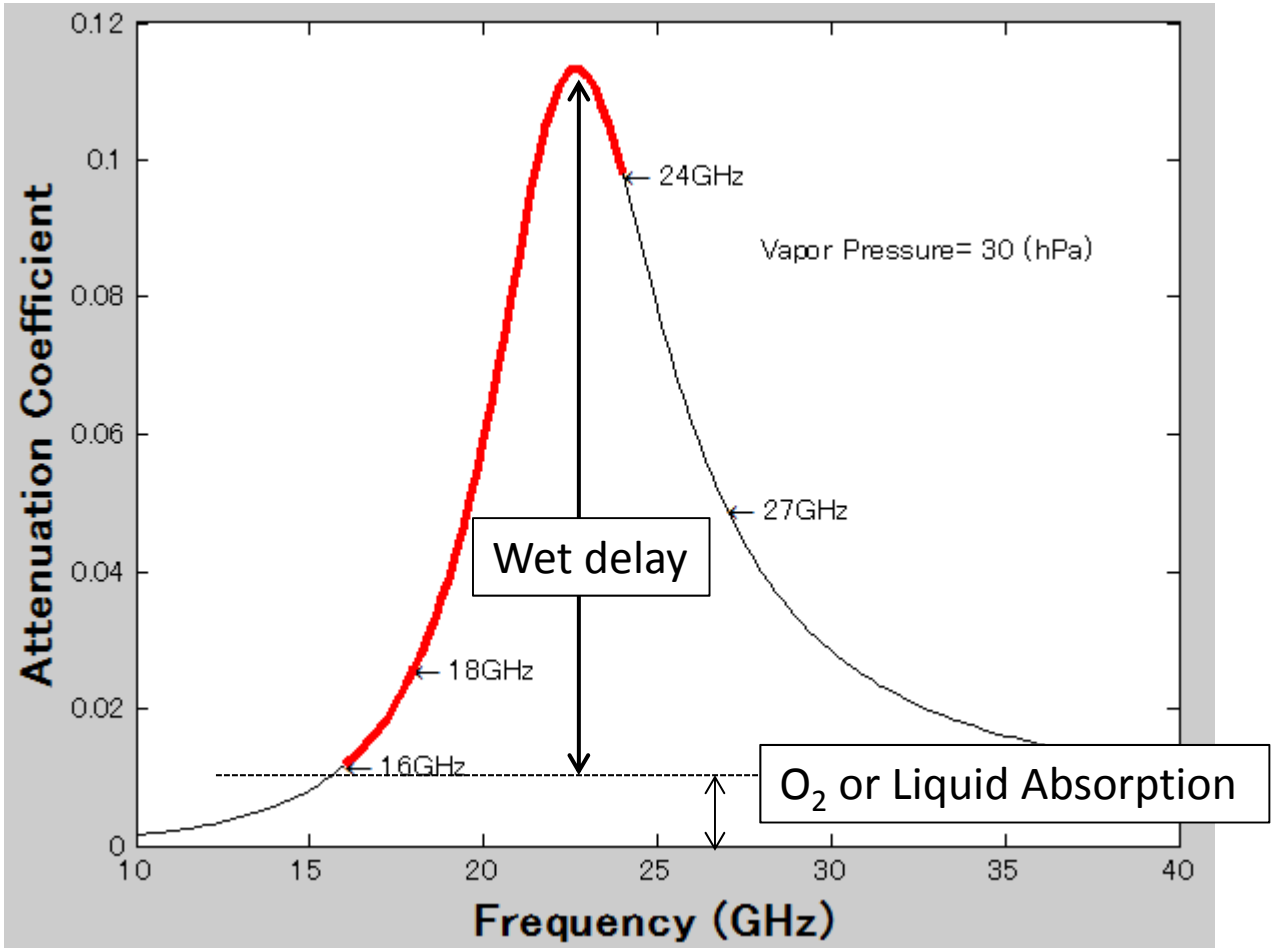
VLBI懇談会シンポジウム＠帝京科学大学
２０１７年１２月２３日

２０GHz帯広帯域受信モジュールの開発と科学技術利用

国立天文台名誉教授
川口則幸

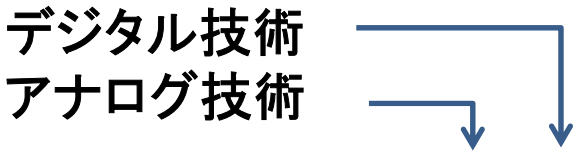
Wideband Digital WV Line Profiler

16-24GHz



MATLAB: Line_Profile_plot_Japan.m

SKA周波数プラン



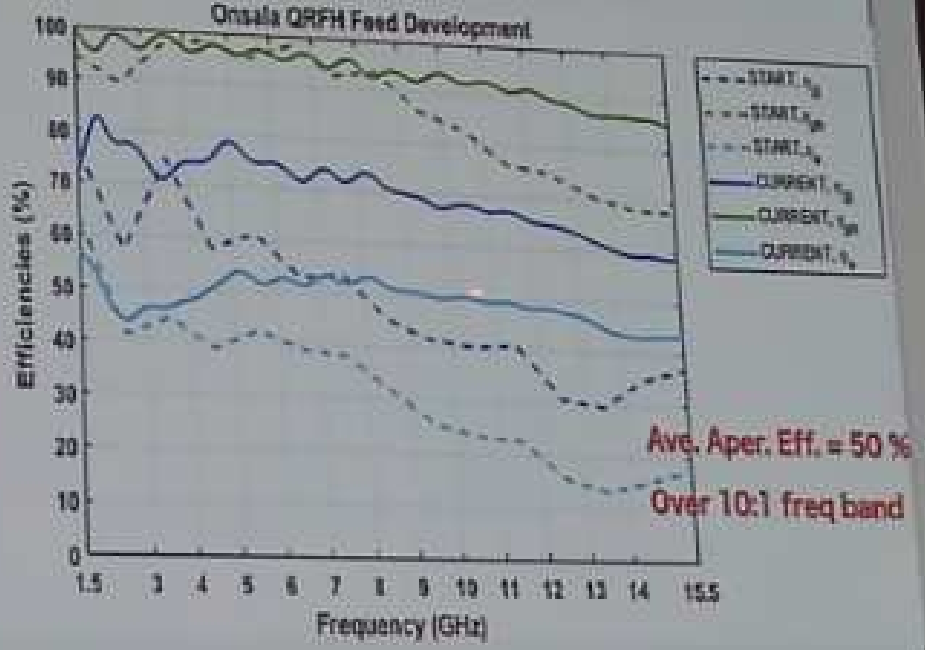
Name	Freq. Range	Science Target		
Band1	350-1050MHz	Pulsar		
Band2	950-1760MHz	HI, OH	JIL	
Band3	1650-3050MHz	Continuum, Geodesy		
Band4	2.8-5.18GHz	Continuum, Geodesy	VGOS	
Band5a	5.0-9.25GHz	CH3OH, Continuum, Geodesy		
Band5b	9.0-16.7GHz	Continuum, Geodesy		
Band5c	14-26GHz	H2O, NH3	JIL	

EVN news: BRAND

"BRAND EVN" (which stands for **Broad Band** European **VLBI Network**). BRAND will be a receiver with an unprecedented bandwidth ranging from 1.5GHZ to 15.5 GHz. This frequency range is an order of magnitude larger than any existing single radio receiver. The advantages are evident: due to the larger bandwidth BRAND will increase the sensitivity of a radio observatory enormously. The effort for maintenance will drop significantly and there will be no time losses when changing frequency ranges.

BRAND (Effelsberg)

- 1.5 – 15.5 GHz (10:1)
- Quad-Ridge Flared Horn (QRFH)
- Ave. η_a = 50 % (light blue curve)

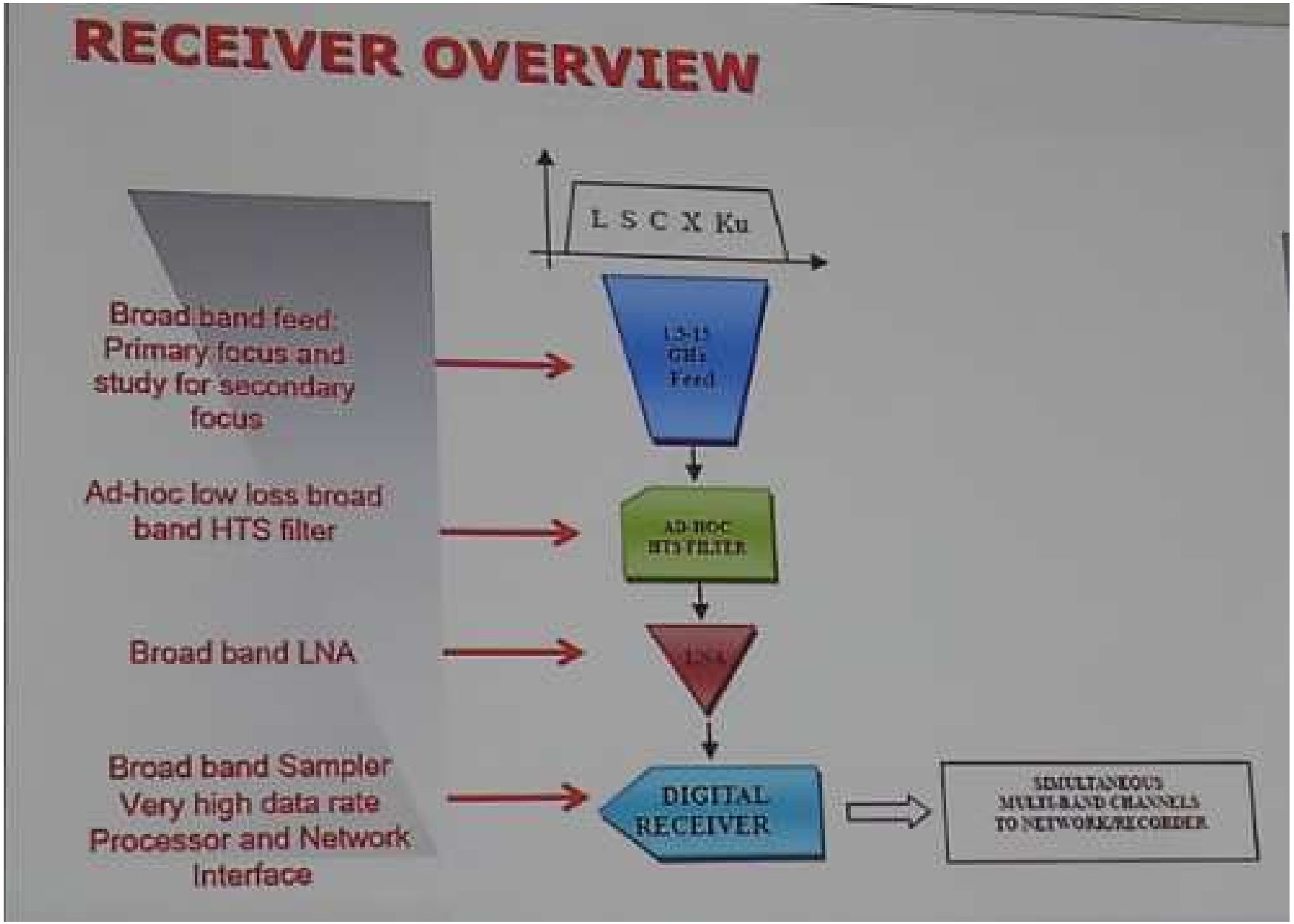


J. Flygare, M. Pantaleev, and S. Ohlsson
"BRAND: Ultra-Wideband Feed Development for the European VLBI Network - A Dielectrically Loaded Decade Bandwidth Quad-Ridge Flared Horn"
12th European Conference on Antennas and Propagation (EuCAP), London 2018 April (Submitted)

Jonas Flygare, Internal Meeting, 6th September, 2017 Onsala, Sweden

Onsala Space Observatory, Department of Space, Earth and Environment Chalmers University of Technology

RECEIVER OVERVIEW



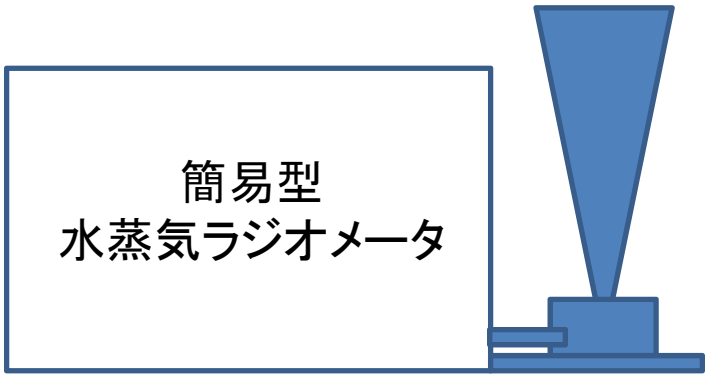

A proposal for K- and C-band simultaneous dual-band observing systems
Aletha de Witt
6th International VLBI Technology Workshop
Bologna, 9-11 October, 2017
NRF
National Research Foundation
HartRAO

国立天文台共同研究開発

- 研究題目
「高精度位置天文研究用水蒸気ラインプロファイラの開発」
- 2017年度から3年間
- メンバ（2017-）
  - 河野裕介、小山友明、鈴木駿策、川口則幸（国立天文台）
  - 長崎岳人（KEK)
  - 前田崇（JAXA)
- 新規加入期待メンバ（2018-）
  - 村田泰宏、土居明広（ISAS）
  - 関戸　衛、岳藤一宏（NICT）

装置イメージ

ホーンは交換可能



初段LNA：LNF-LNC15-29B
36dB,210K @16GHz
35dB,140K @22GHz
34dB,120K @24GHz

アナログ出力は既設のOCTADに接続

PASTERNACK Horn Antenna

15-22GHz

PASTERNACK®
www.pasternack.com

WR-51 Standard Gain Horn Antenna Operates From 15 GHz to 22 GHz With a Nominal 20 dB Gain SMA Female Input Connector

TECHNICAL DATA SHEET **PE9853/SF-20**

WR-51 Standard Gain Horn Antenna Operates From 15 GHz to 22 GHz With a Nominal 20 dB Gain SMA Female Input Connector

Configuration	
Design	WR-51 Standard Gain Horn
Frequency Range, GHz	15 to 22
Polarization	Linear
Interface 1	SMA Female
Electrical Specifications	
Impedance, Ohms	50
Nominal Gain, dB	20
Maximum Input VSWR	1.25:1

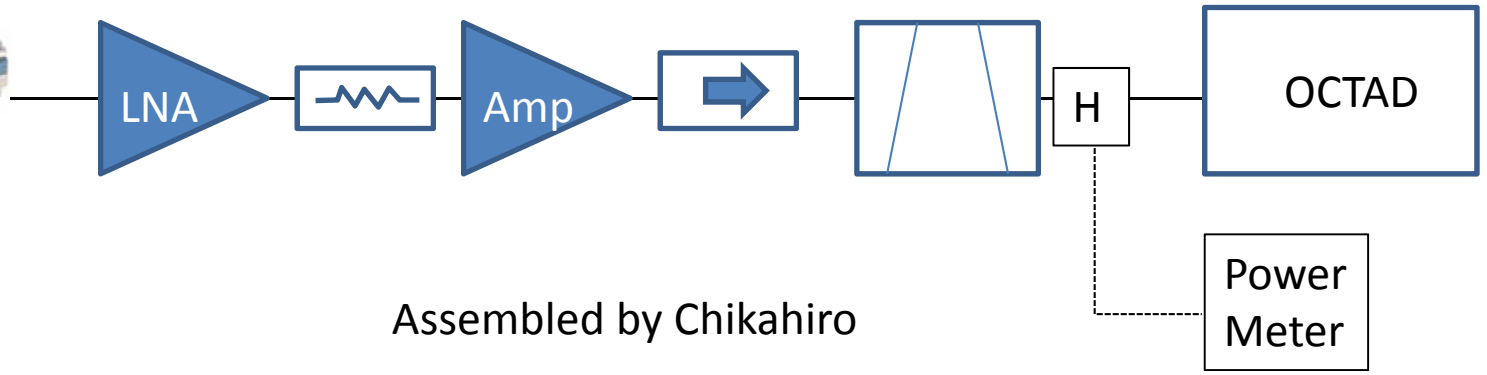
$D=20dBi$

$\theta_{\mathrm{HPBW}} = 11.5\ deg$

(VERA 20m=11 deg)

試験構成と計測データ

	Phys. Temp	PM (dBm)	Octad (3bit)	Octad (1bit)
Hot	300K			
Cold	80K			
Sly (Zenith)				
Sky (Slant)				



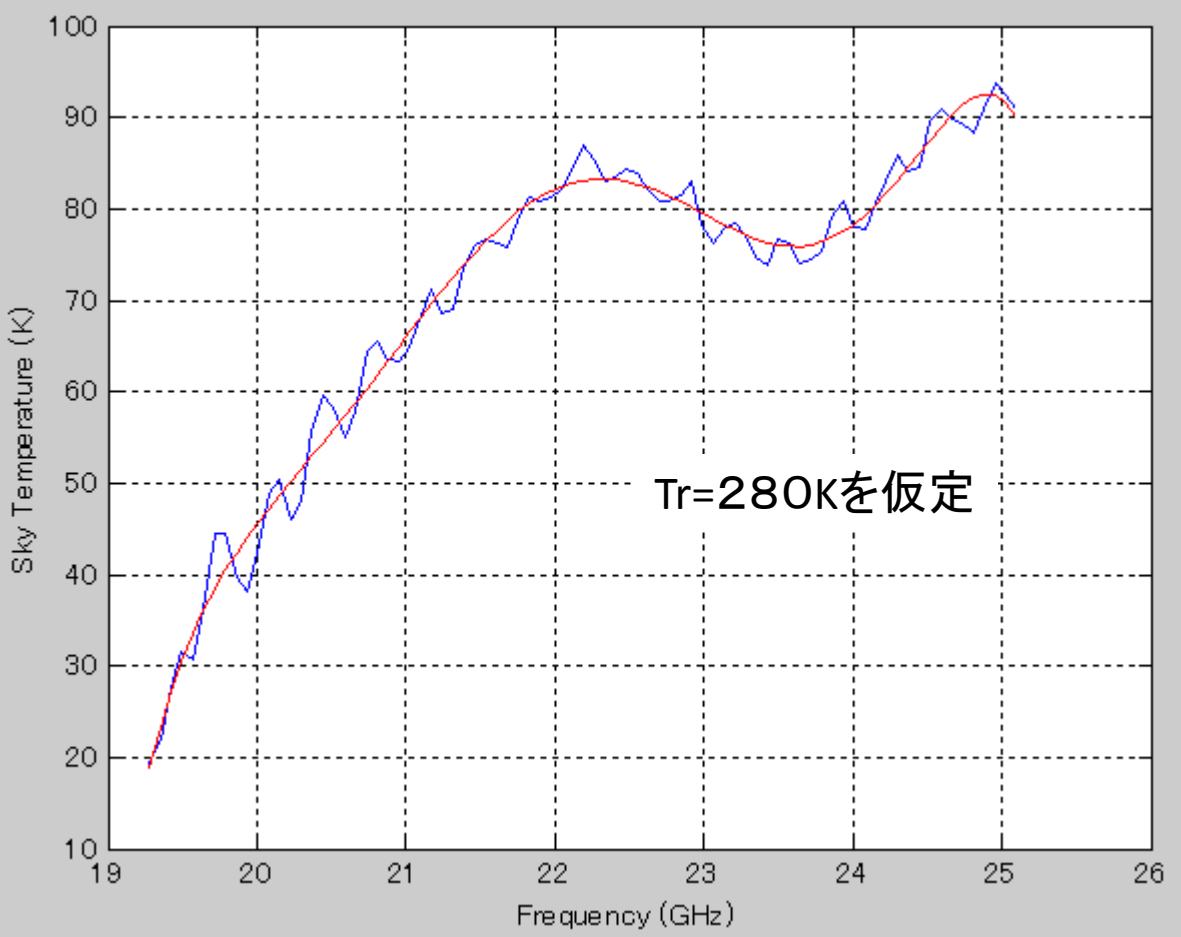
Assembled by Chikahiro

工場試験風景（屋外）

2017年7月3日

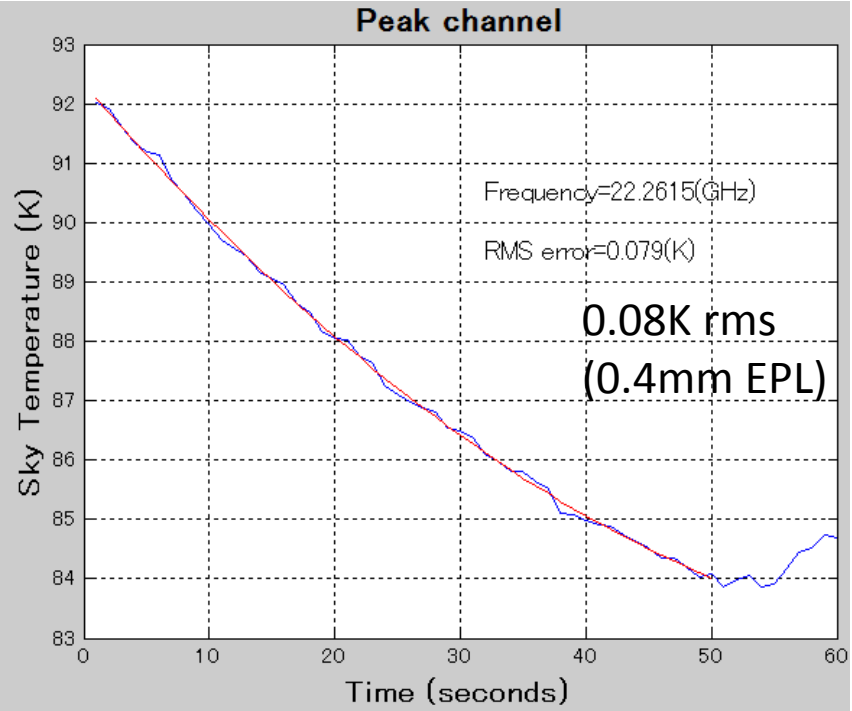
Sky雑音のスペクトル

1分間平均スペクトルを多項式フィットして残差を定在波パターンとした。



スペクトルピークの時間安定度

F=22.2615GHz



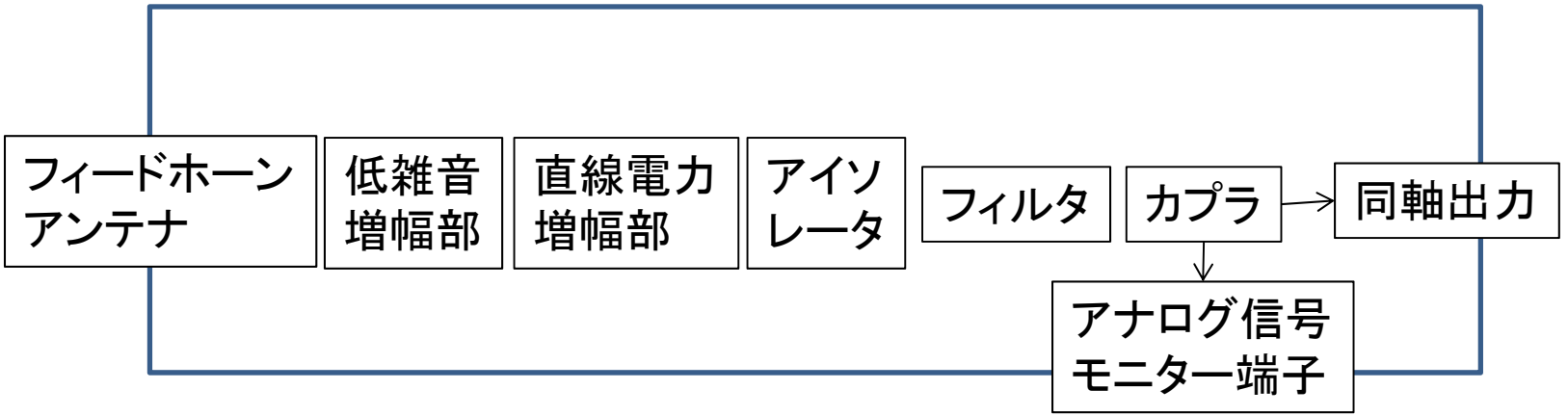
- The sky temperature at a spectral peak is decreasing with time.
- This will probably show the decrease in the liquid attenuation.
- Stability after removing the systematic change is about 0.08K.
- Te stability is almost in a same order of magnitude as the ensemble stability.
- That proves that the measurements satisfy the ergodic statistics.

０．１Ｋの水蒸気放射温度の計測精度は通過光路長（EPL)で０．５mmに相当
全スペクトル情報を使うことで０．０５mm

Stabilities of world WVRs

Name	Stability @ 1second
DSN WVR	5×10^{-12}
SHAO WVR	5×10^{-12}
University of Bern （UoB)	1.7×10^{-12}
HALCA Phase Transfer	1.0×10^{-12}
UoB Correlation WVR	1.0×10^{-12}
DSN Advanced WVR for Cassini of NASA	6×10^{-13}
Australian WVR	4×10^{-13}
NAOJ WVR	1.7×10^{-13}
Hydrogen Maser Oscillator	1×10^{-13}

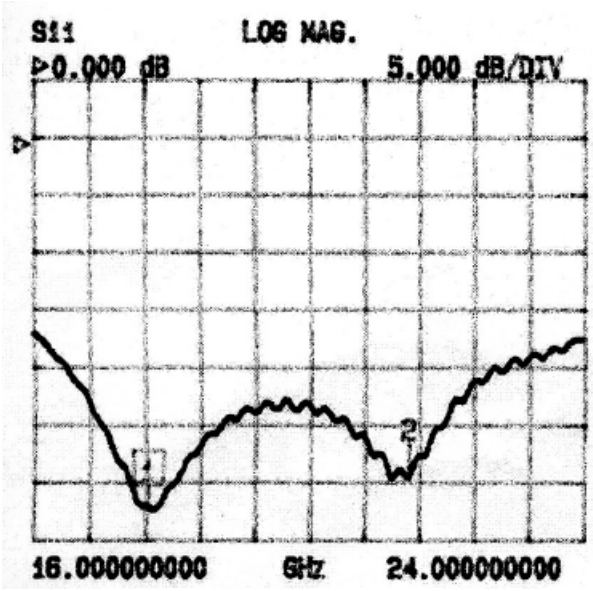
簡易型水蒸気ラジオメータ評価器

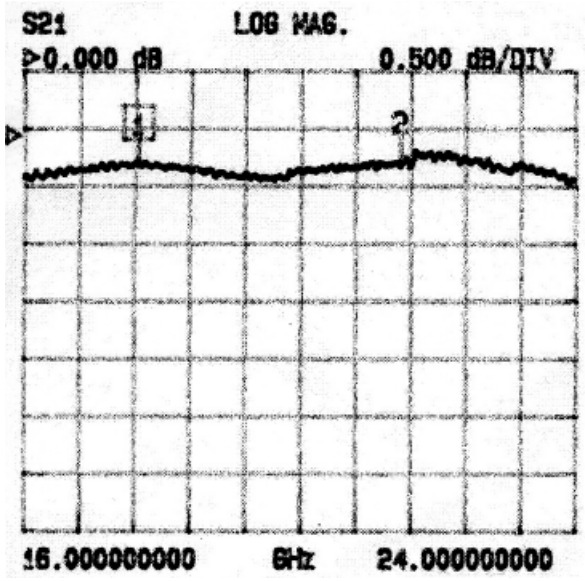


Discussions have already started with KyoCera.

Quest Microwave Isolator

16-24GHz





アイソレータ(2)

広帯域アイソレータモジュール

18-26.5GHz

PASTERNACK
THE ENGINEER'S RF SOURCE

Isolator With 17 dB Isolation From 18 GHz to 26.5 GHz, 1 Watt And SMA Female

Isolators Technical Data Sheet **PE8306**

Features

- 18 to 26.5 GHz Frequency Range
- Max Forward and Reverse Power 1 Watt CW
- Insertion Loss < 0.6 dB
- VSWR < 1.4:1
- Isolation > 17 dB
- SMA Female Connectors

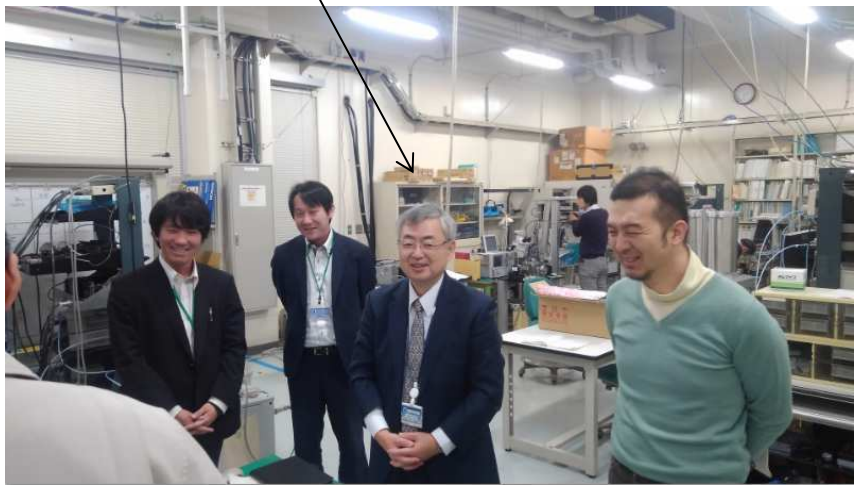
Applications

- Radar Systems
- Military
- Wireless Radio Systems
- Telecom Infrastructure
- Communication Systems
- R&D Labs
- Microwave Radio Systems

国立天文台先端技術センタでの試験

山口大学　山本節夫教授

11.5-29.4GHz



通過帯域（挿入損失＜1dB）
Marker1=11.436GHz
Marker2=29.37GHz

まとめ

- ２２GHz帯広帯域受信機（１６－２４GHz）を開発中
- 水蒸気ラインプロファイルの計測に成功
  - 火山噴煙中の水蒸気量の計測検討中
- LST計画MAOへの応用を検討開始

  LST: Large Submillimeter Telescope
  （野辺山45mの後継機）

  MAO: Millimeter Adaptive Optics
  （主鏡面の変形を計測して鏡面補正）