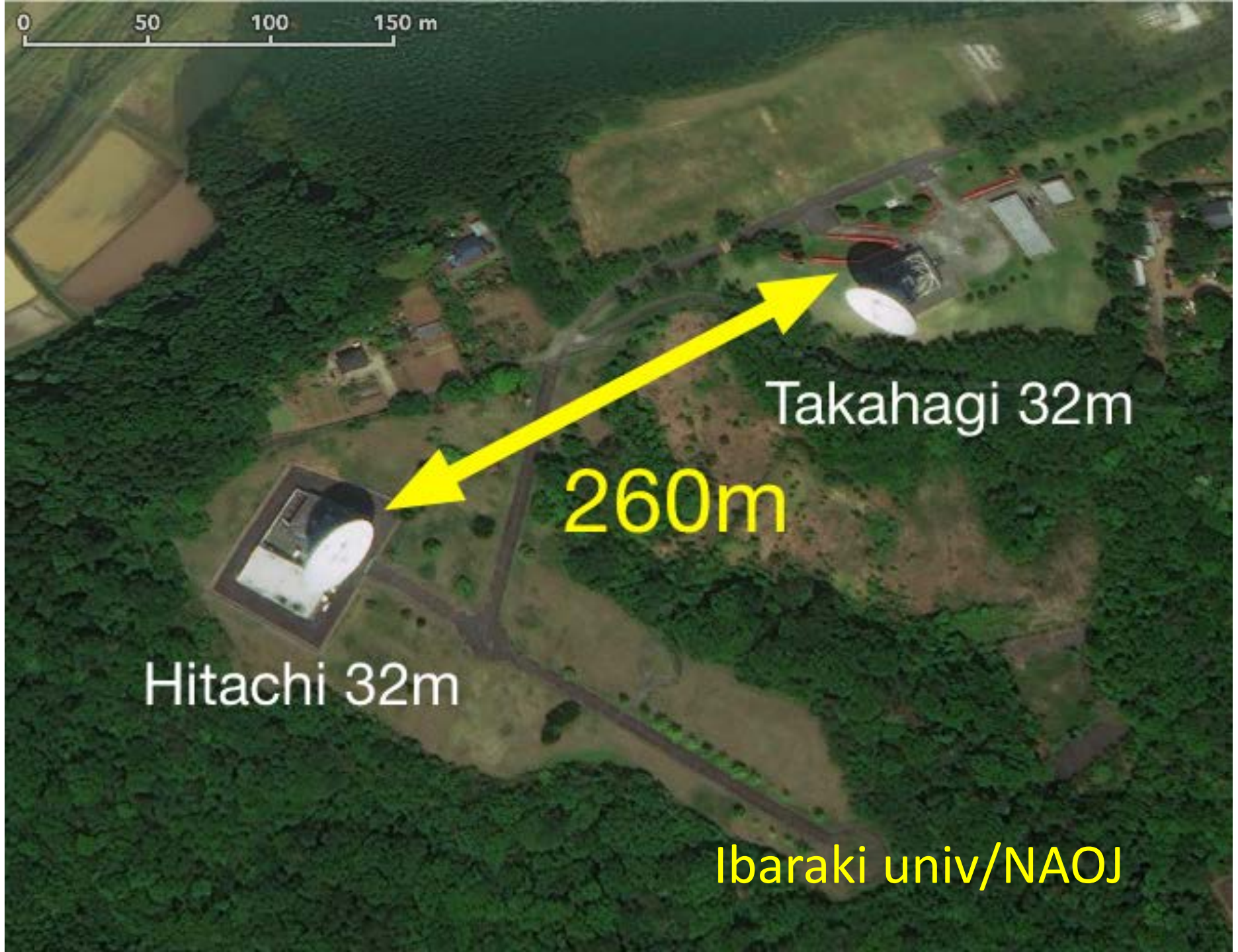
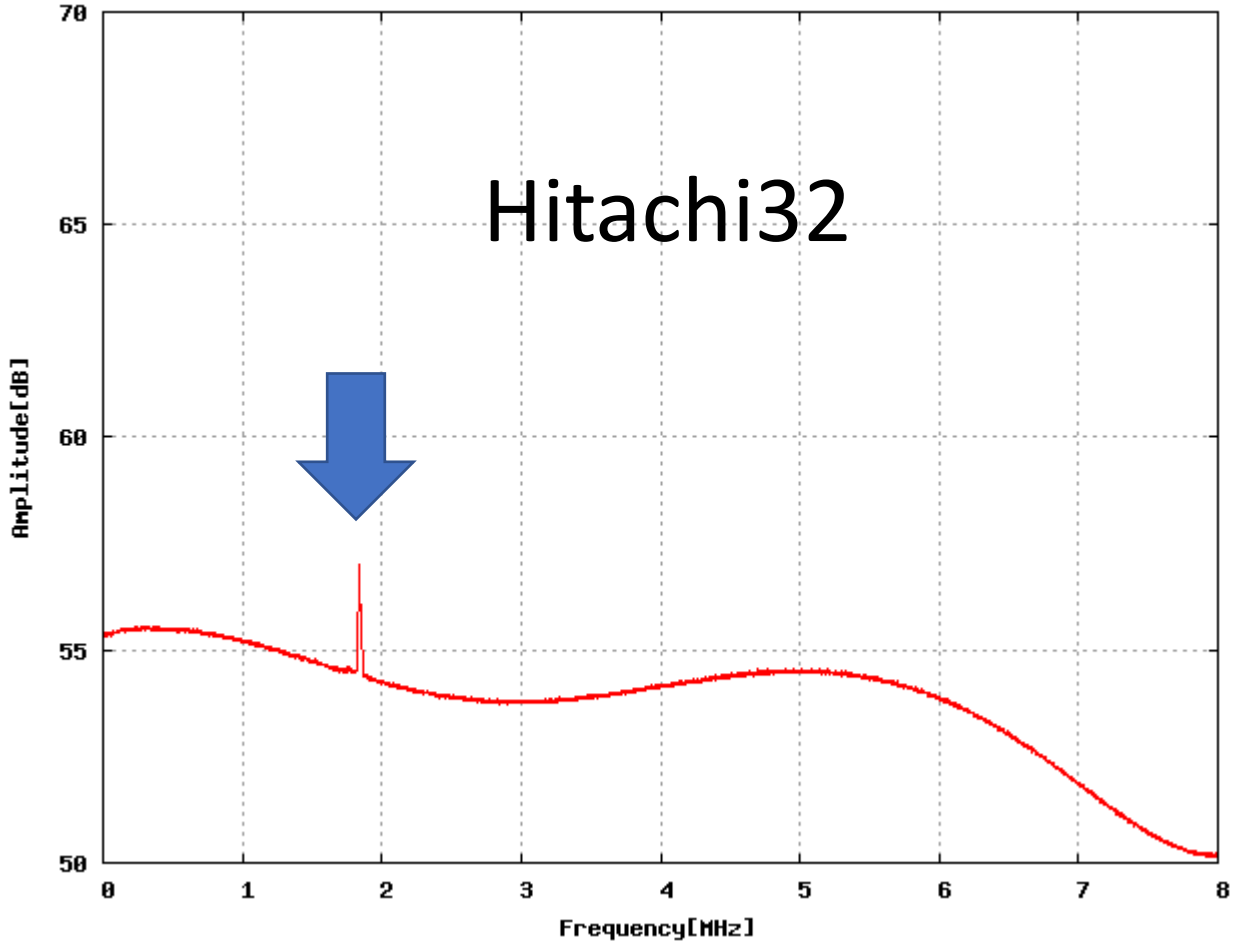
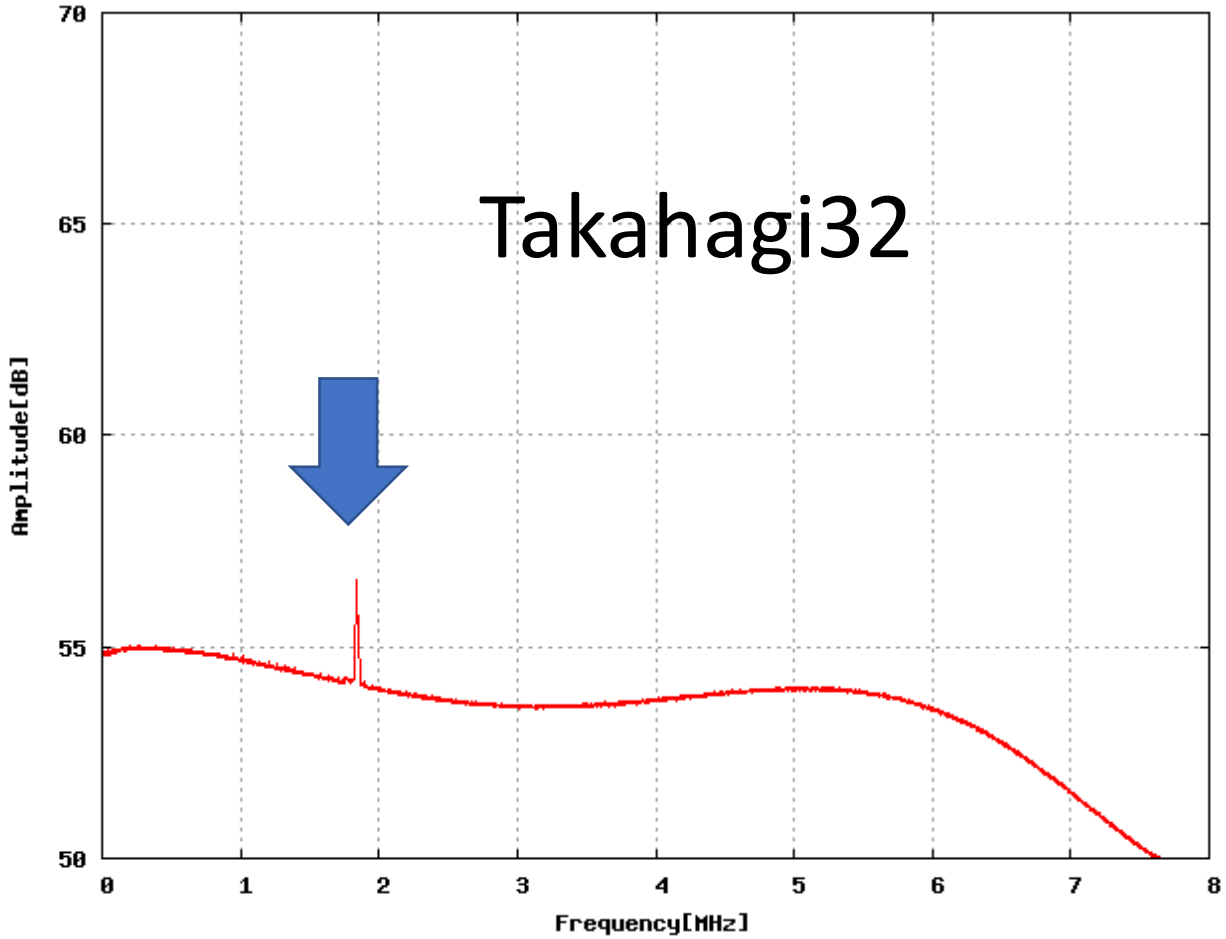

0
50
100
150 m
Takahagi 32m
260m
Hitachi 32m
Ibaraki univ/NAOJ

観測について（See Takefuji+2017）

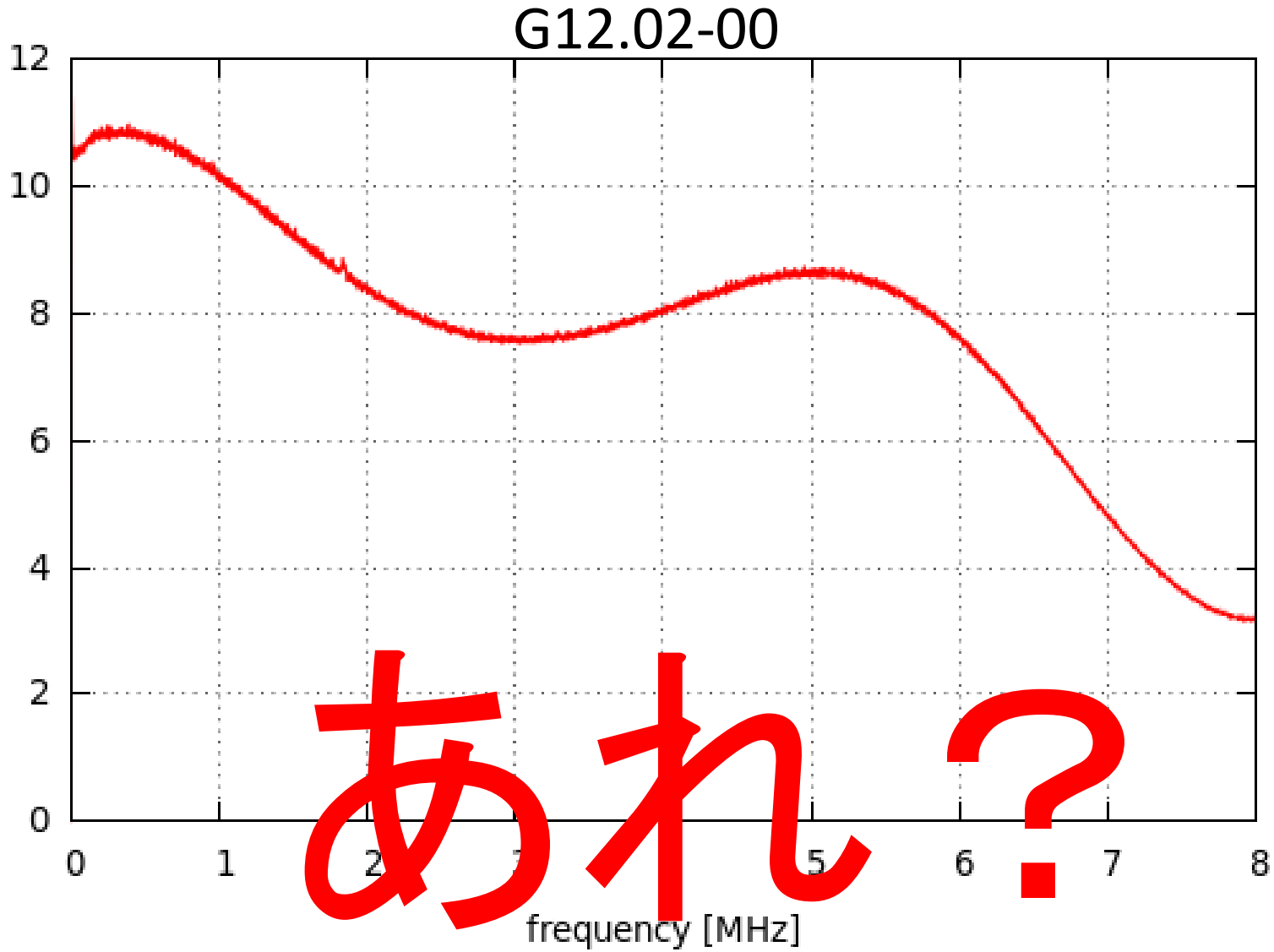
- コード M16300（PI:茨城大学斎藤さん）
- 日立、高萩、鹿島、山口の4局が参加
- 2016/10/26 (DOY300) 2016/10/26 02:30-17:23:30 (UT)
- 観測周波数 6.7GHz, 16 Msps, 4 bit by K5-VSSP32
- 6.7GHzのメタノールメーザーの強度変化とサイズの相関調査
- 各局のクロックオフセットはクエーサーNRAO512による
- 全てのメーザーについて位相合成をほどこす





8MHz幅

G12.02-00



日立３２と高萩３２の合成

２つのベクトル和

$$P_{sum} = |P_a + P_b|,$$

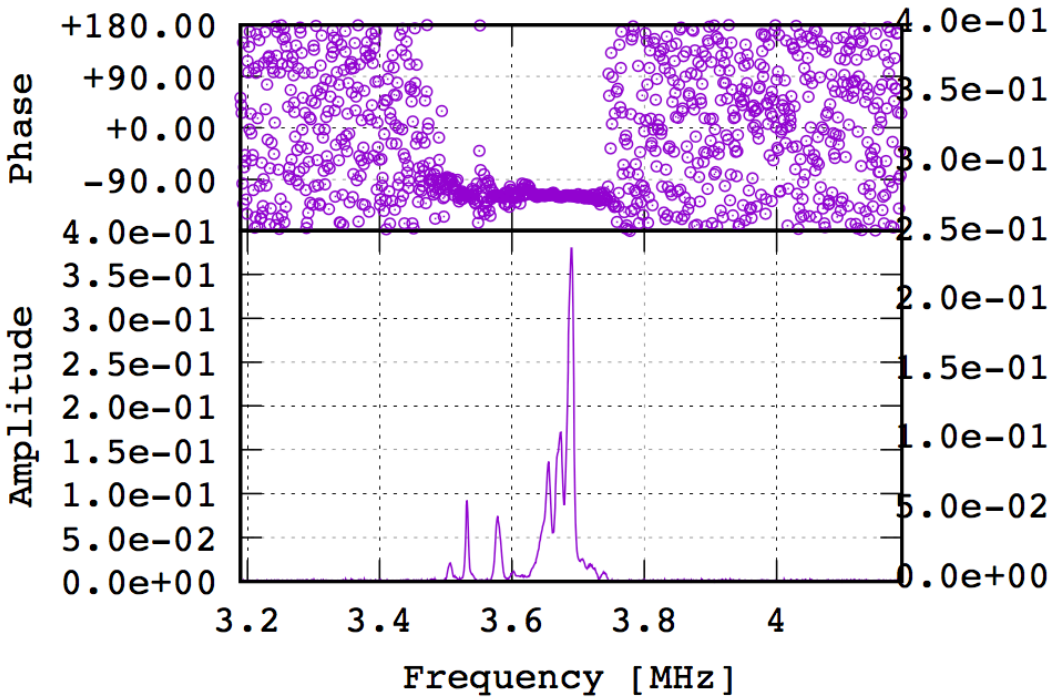
$$= \sqrt{P_a^2 + P_b^2 + 2P_aP_bcos\theta}.$$

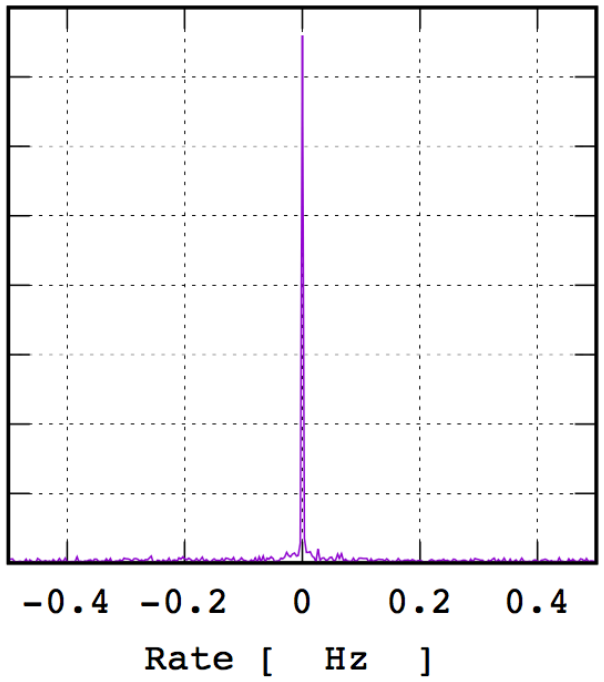
θの決め方

① VLBI処理

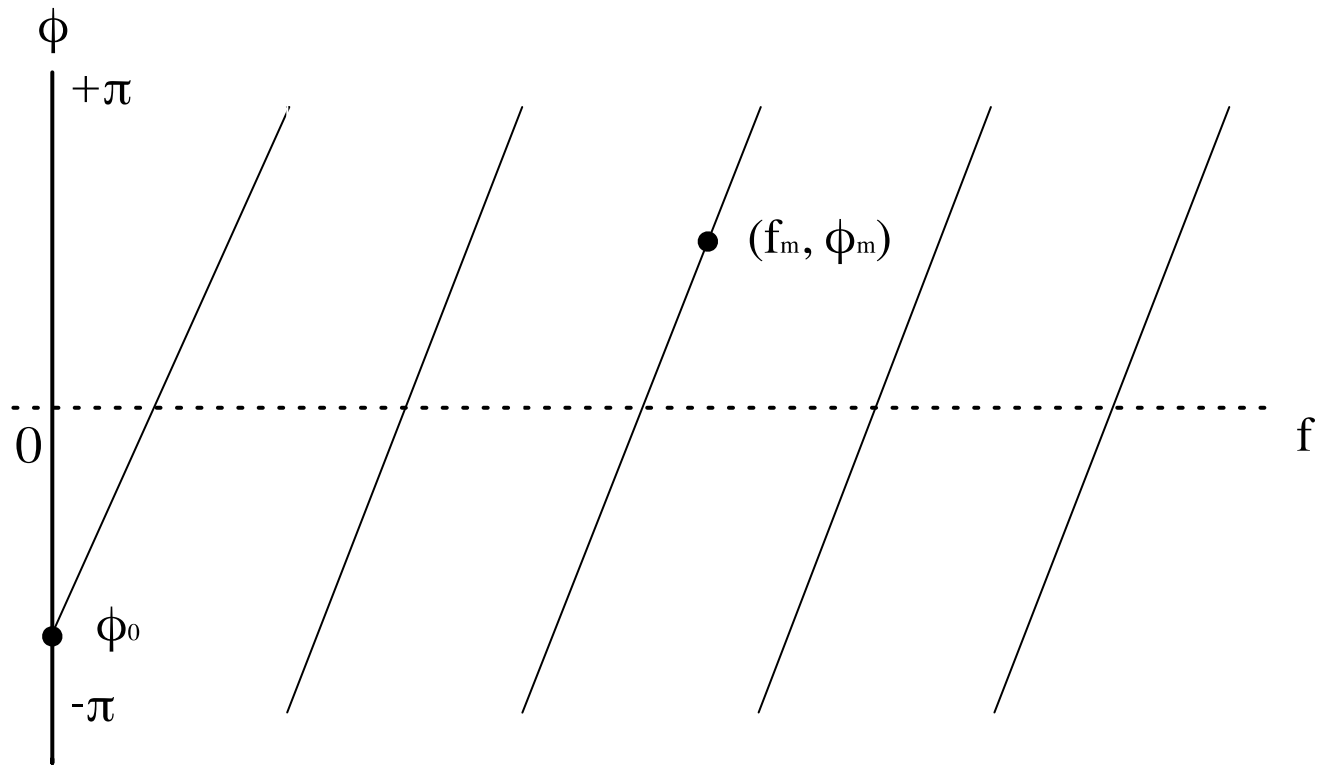
② 合成後のメーザー強度比較

6.7GHzメーザーのライン幅は100kHzオーダー
→ 遅延が決定できない






```
Epoch     : 2016/300 10:47:30
Station-1:              HITAL
Station-2:           TAKAHAGI
Source    :     35.20-07[  M]
Length    :  300.000000[sec]
Sampling  :   16000000[sps]
Frequency: +6664.000000[MHz]
Peak Amp  :   37.988780[ % ]
Peak Phs  : -118.409321[deg]
Peak Freq:    +3.689453[MHz]
Rate      :    +0.000000[mHz]
SNR       :  607.847215
```

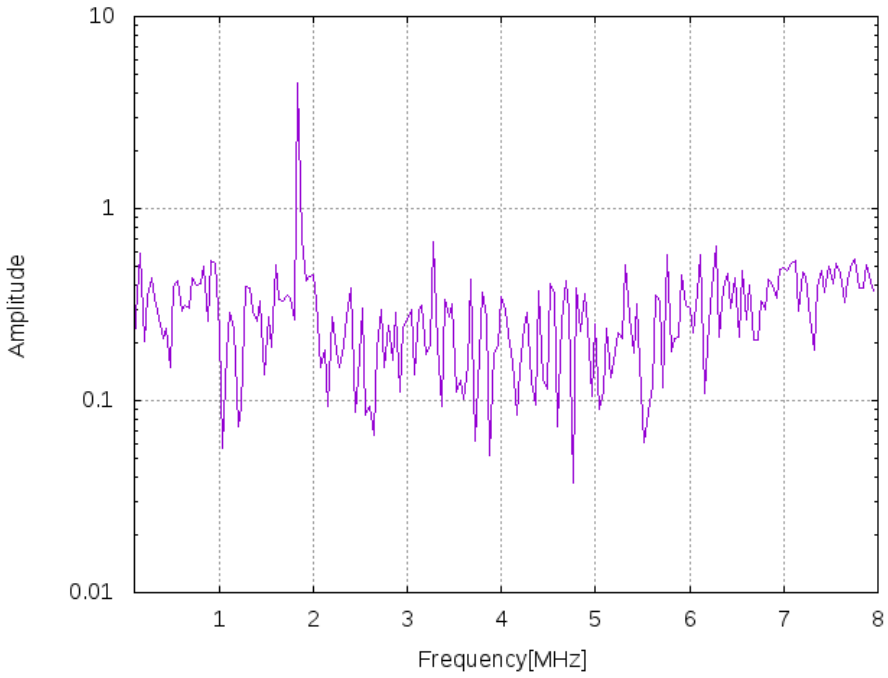


$$\phi_0 = \phi_m - 2\pi f_m \tau_g \ \ (mod \ \ 2\pi).$$

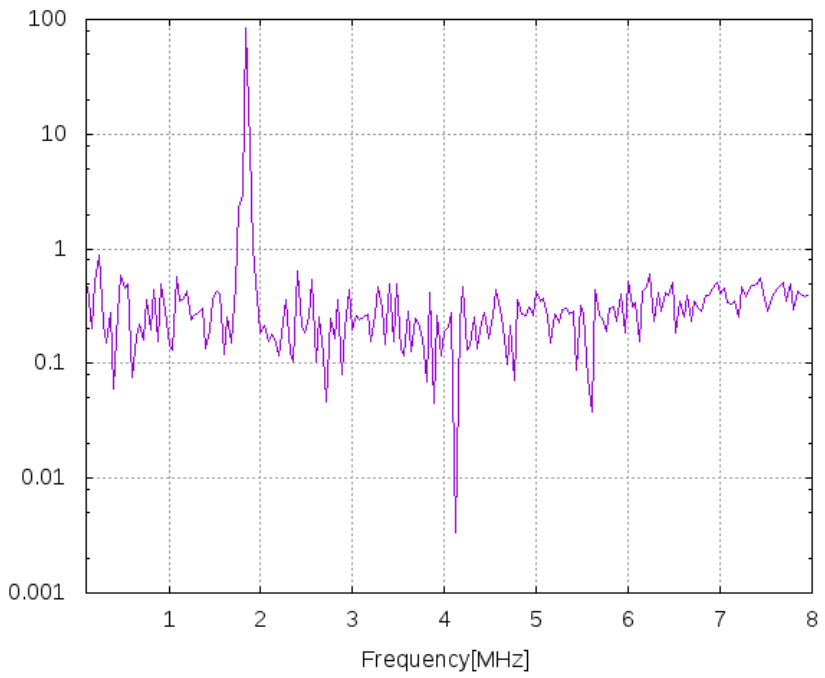
τ_gは予測値とクロックオフセット含む

Trial Phase determination using Cross-correlation spectrometry(Takefuji+2016)

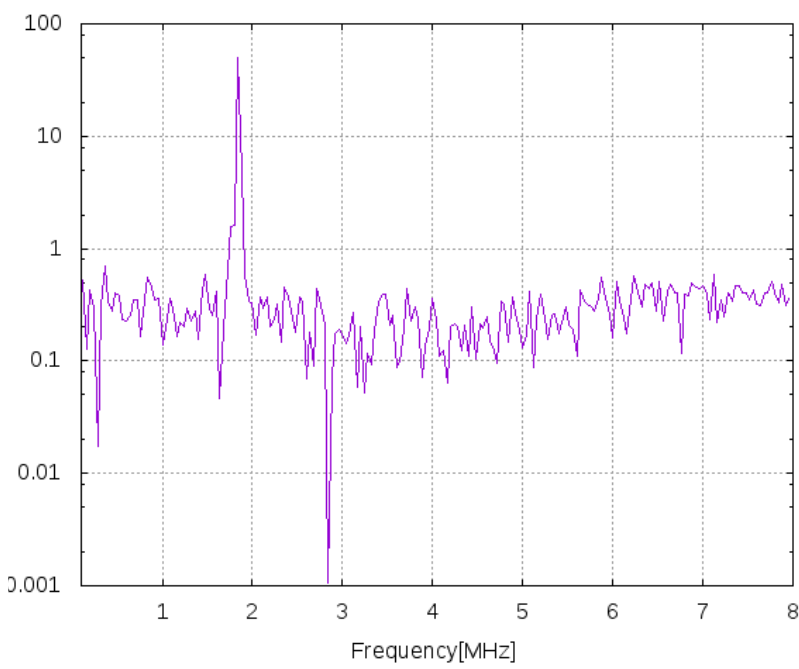
- combination by 120 degree step -> Estimate the phase



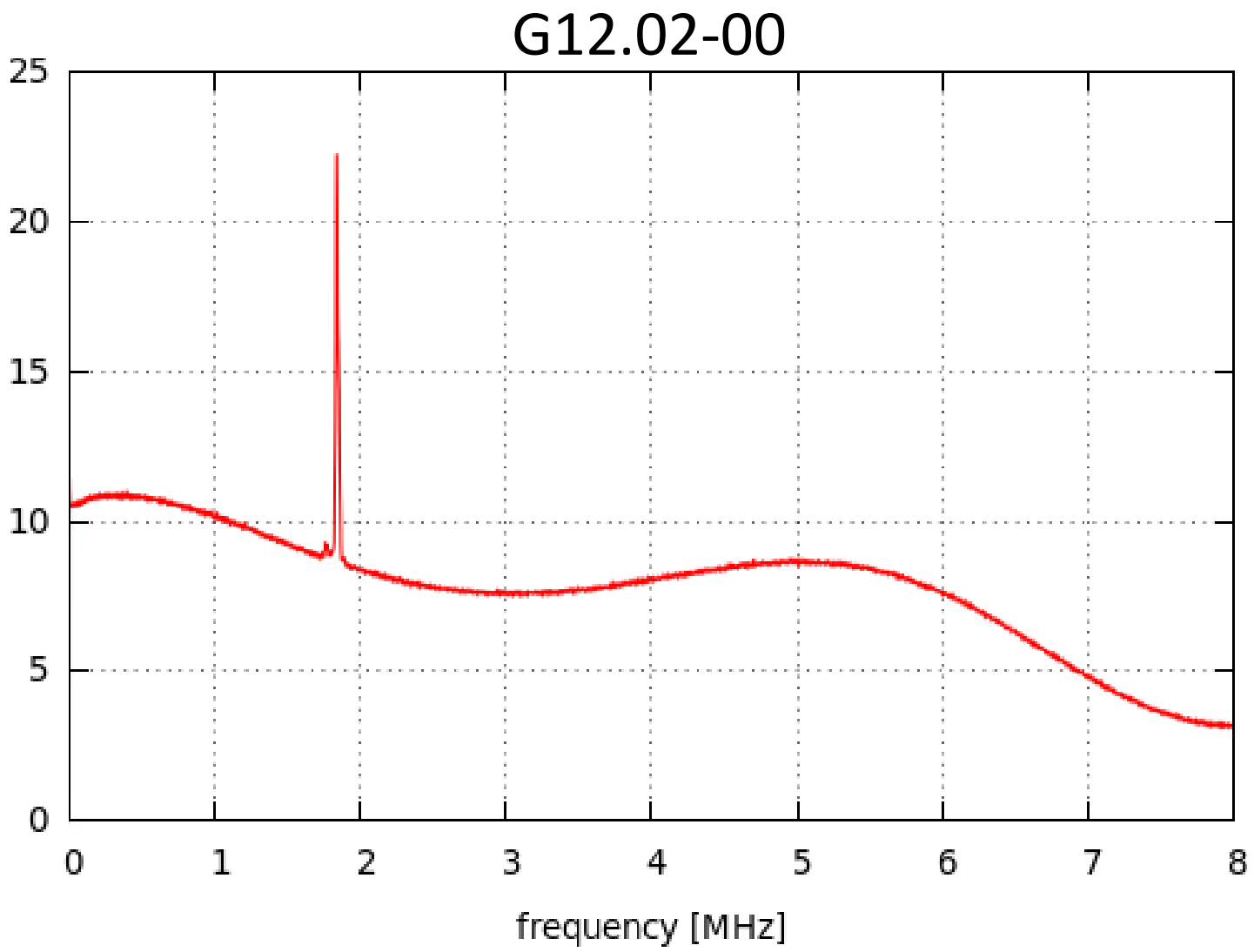
θ = 0 deg

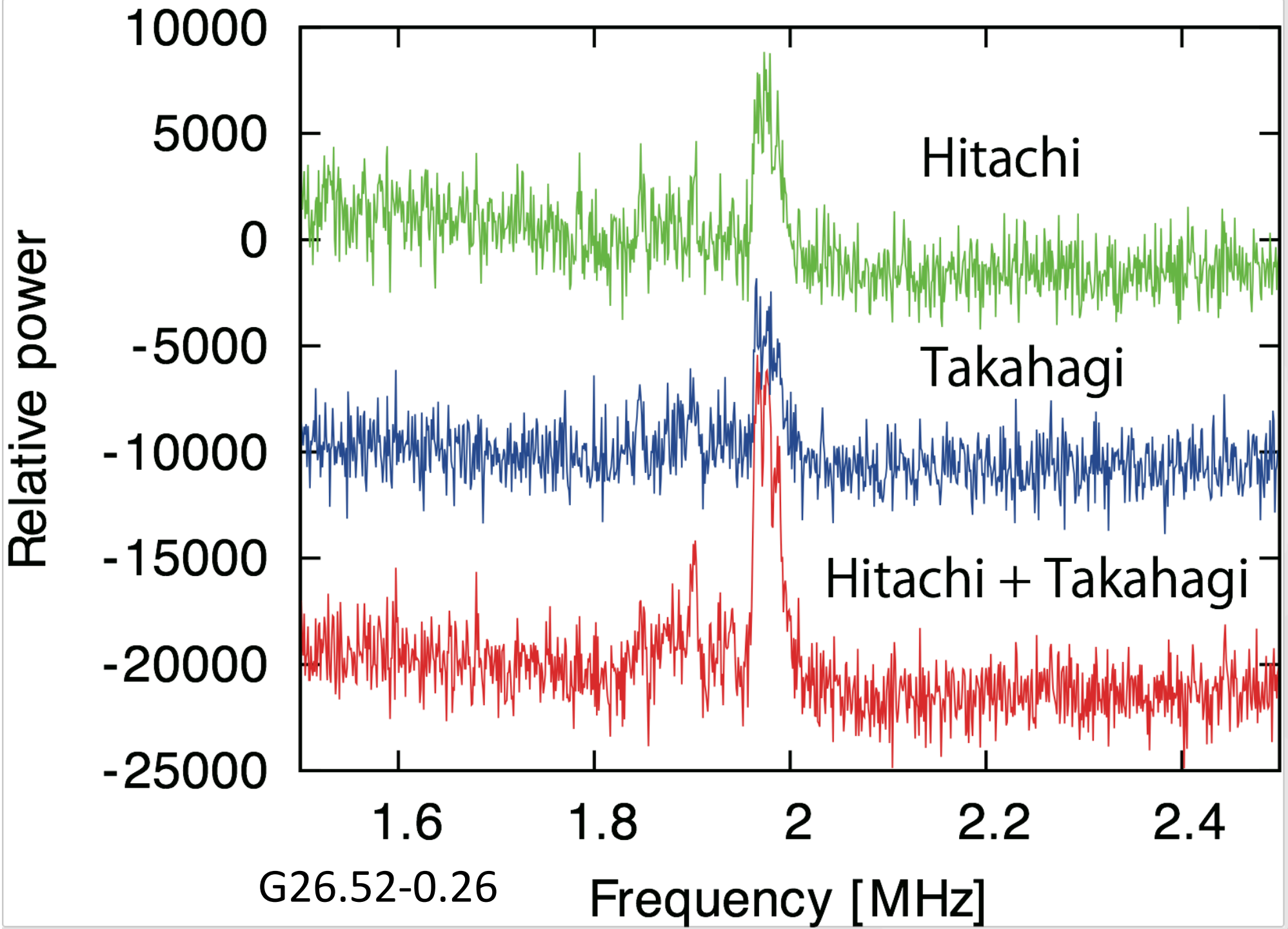


θ = 120 deg



θ = -120 deg


G12.02-00
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
frequency [MHz]

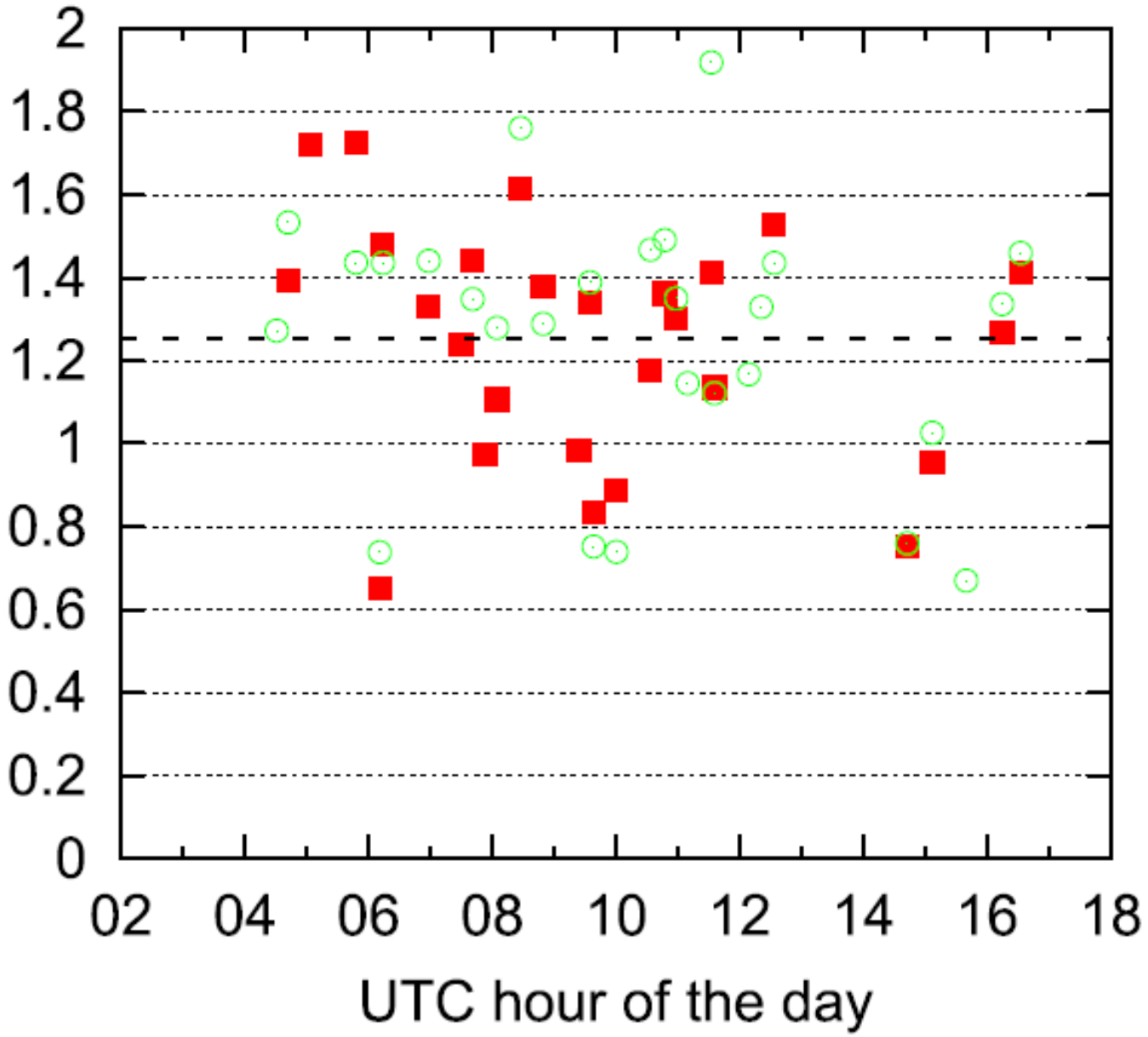

10000
5000
0
-5000
-10000
-15000
-20000
-25000
Relative power
Hitachi
Takahagi
Hitachi + Takahagi
1.6
1.8
2
2.2
2.4
G26.52-0.26
Frequency [MHz]

相関係数比較

日高VS 鹿島/山口

÷

日立VS 鹿島/山口



感度比較

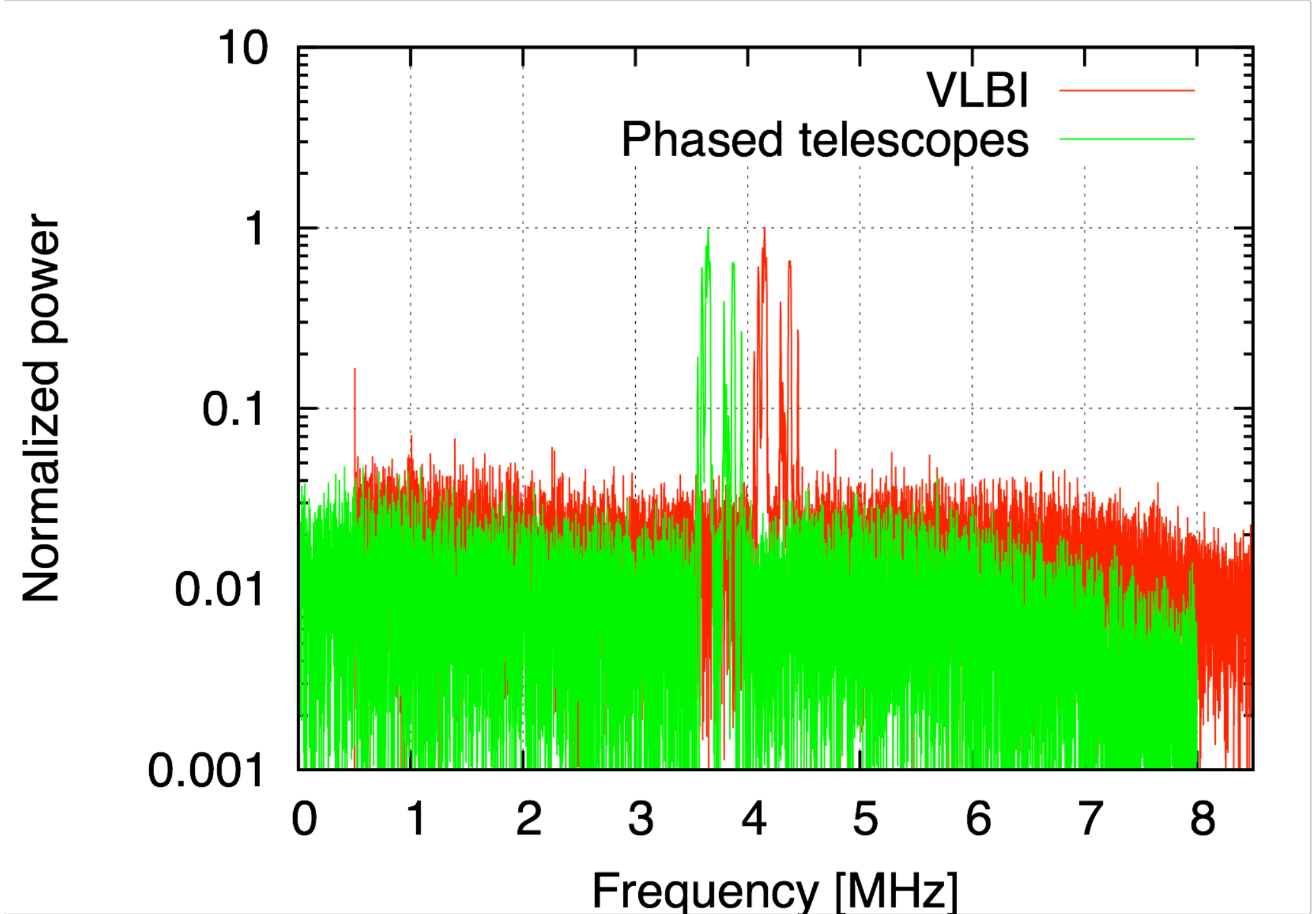
- シングルディッシュ

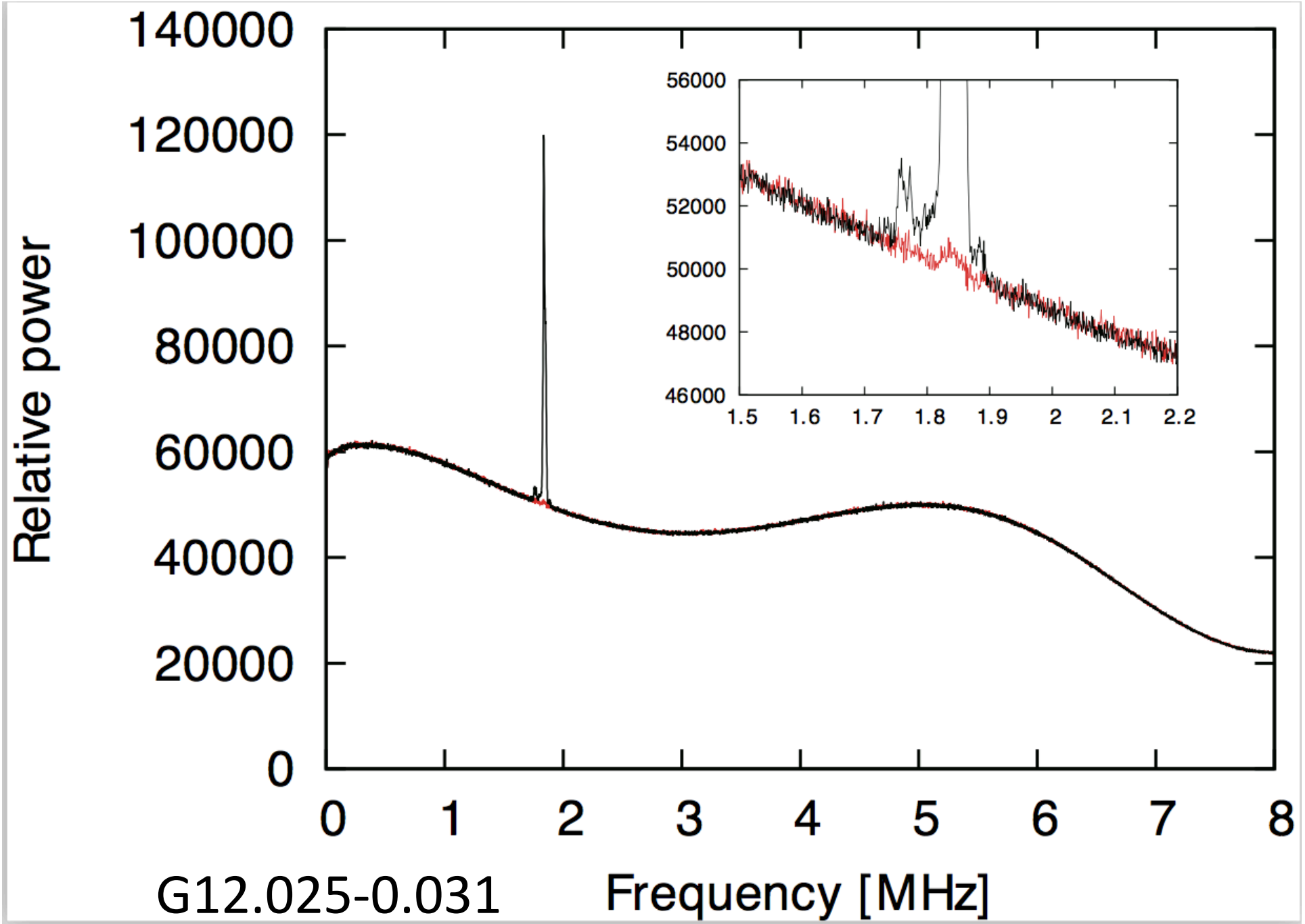
$$SNR_{single} = \frac{GS\sqrt{B\tau}}{T_{sys}}.$$

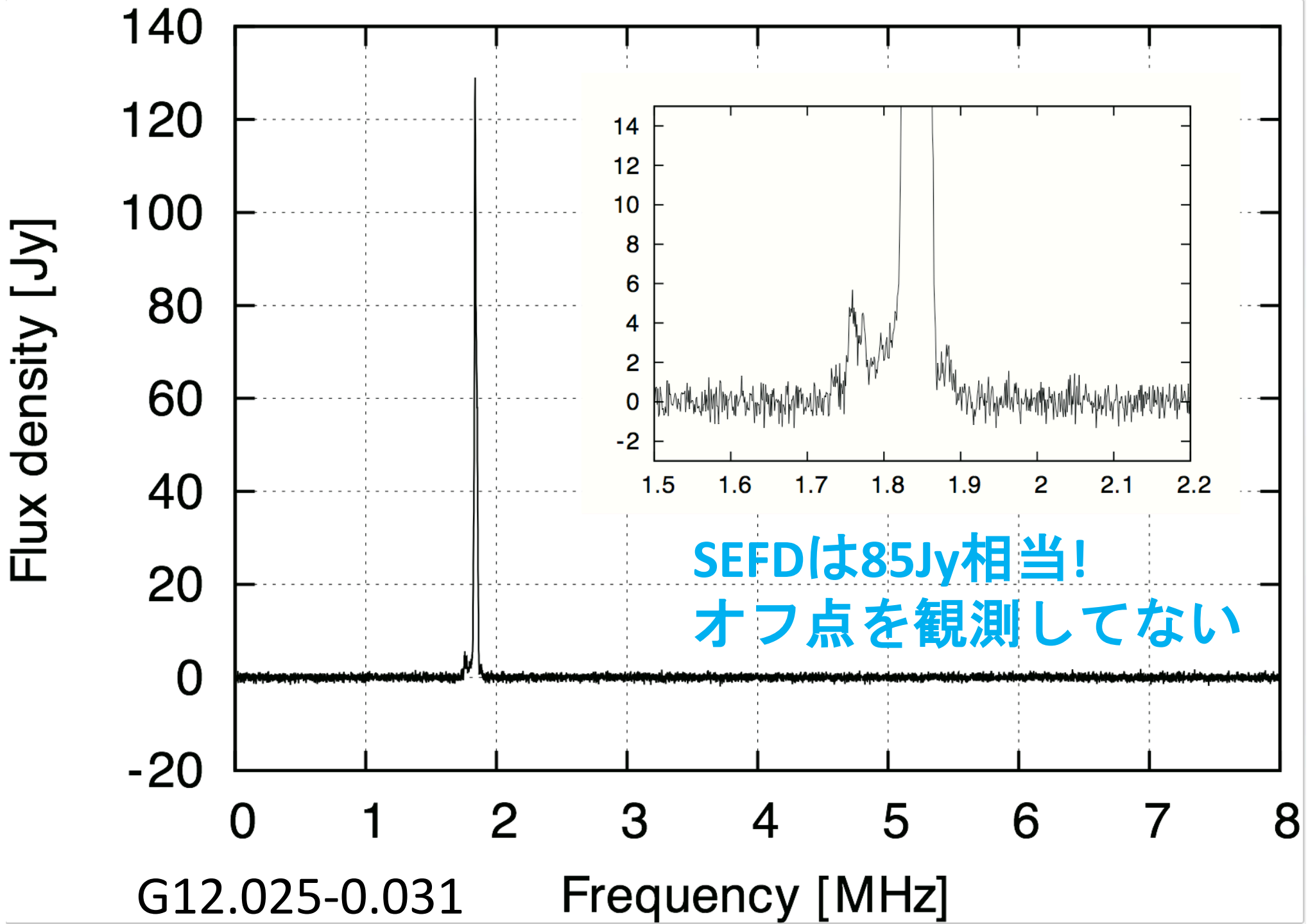
- VLBI

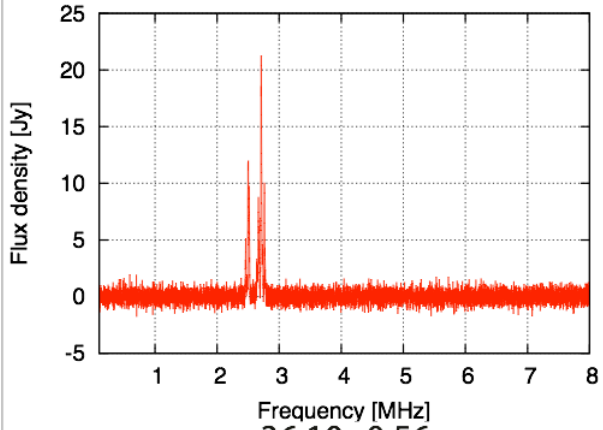
$$SNR_{VLBI} = \frac{GS\sqrt{2B\tau}}{\sqrt{T_{sys_i}T_{sys_j}}}.$$

シングル ＊√2　＝　VLBI
2倍サイズのアンテナ　＝　VLBI *√2
実際に、スペクトルを比較してみる

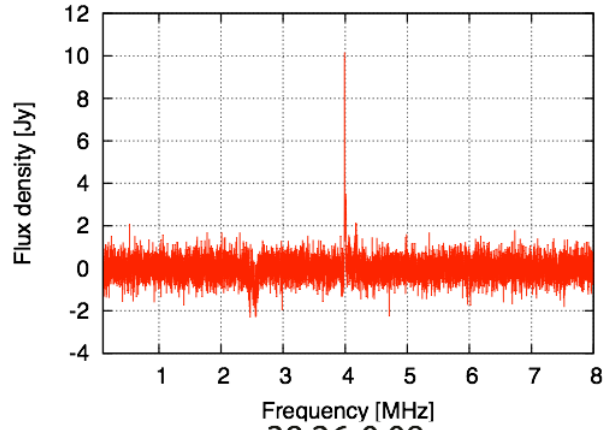

VLBI
Phased telescopes
Normalized power
10
1
0.1
0.01
0.001
0
1
2
3
4
5
6
7
8
Frequency [MHz]


140000
120000
100000
80000
60000
40000
20000
0
Relative power
0
1
2
3
4
5
6
7
8
Frequency [MHz]
56000
54000
52000
50000
48000
46000
1.5
1.6
1.7
1.8
1.9
2
2.1
2.2
G12.025-0.031

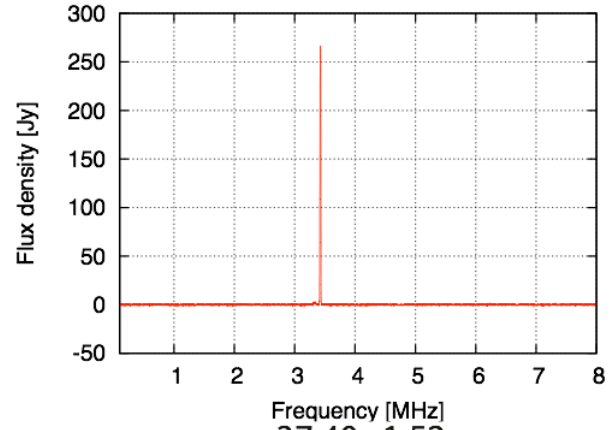

Flux density [Jy]
140
120
100
80
60
40
20
0
-20
0
1
2
3
4
5
6
7
8
Frequency [MHz]
14
12
10
8
6
4
2
0
-2
1.5
1.6
1.7
1.8
1.9
2
2.1
2.2
SEFDは85Jy相当!
オフ点を観測してない
G12.025-0.031



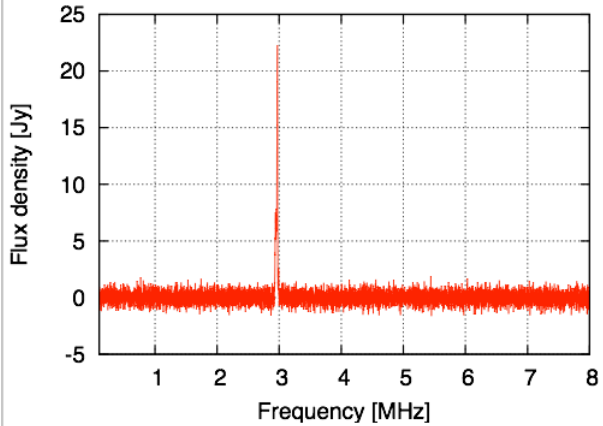
36.10+0.56



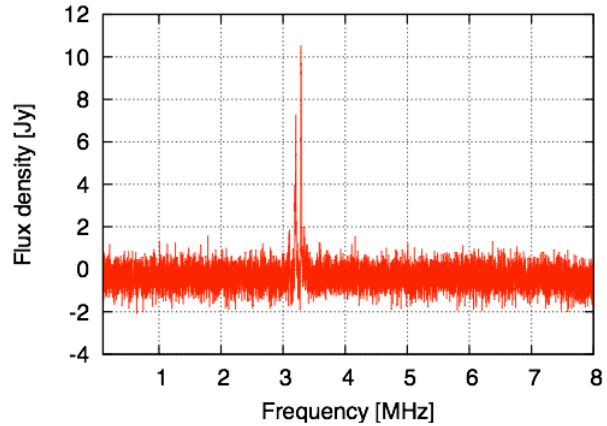
38.26-0.08



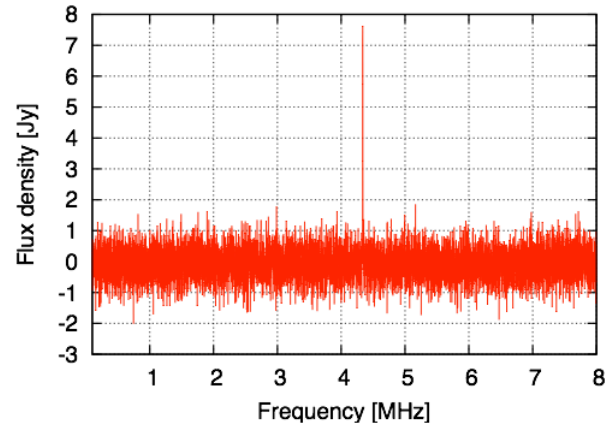
37.40+1.52



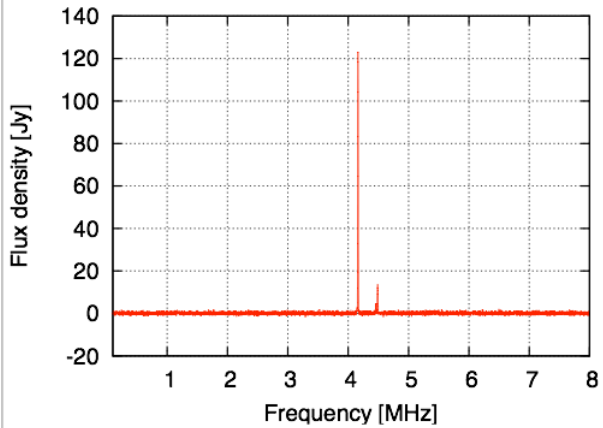
35.79-0.17



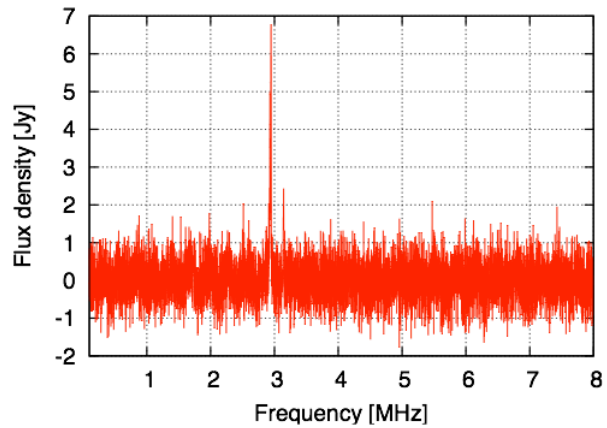
43.87-0.77



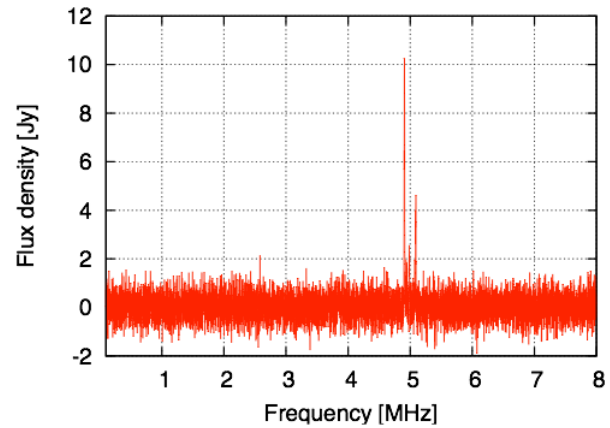
52.20+0.72



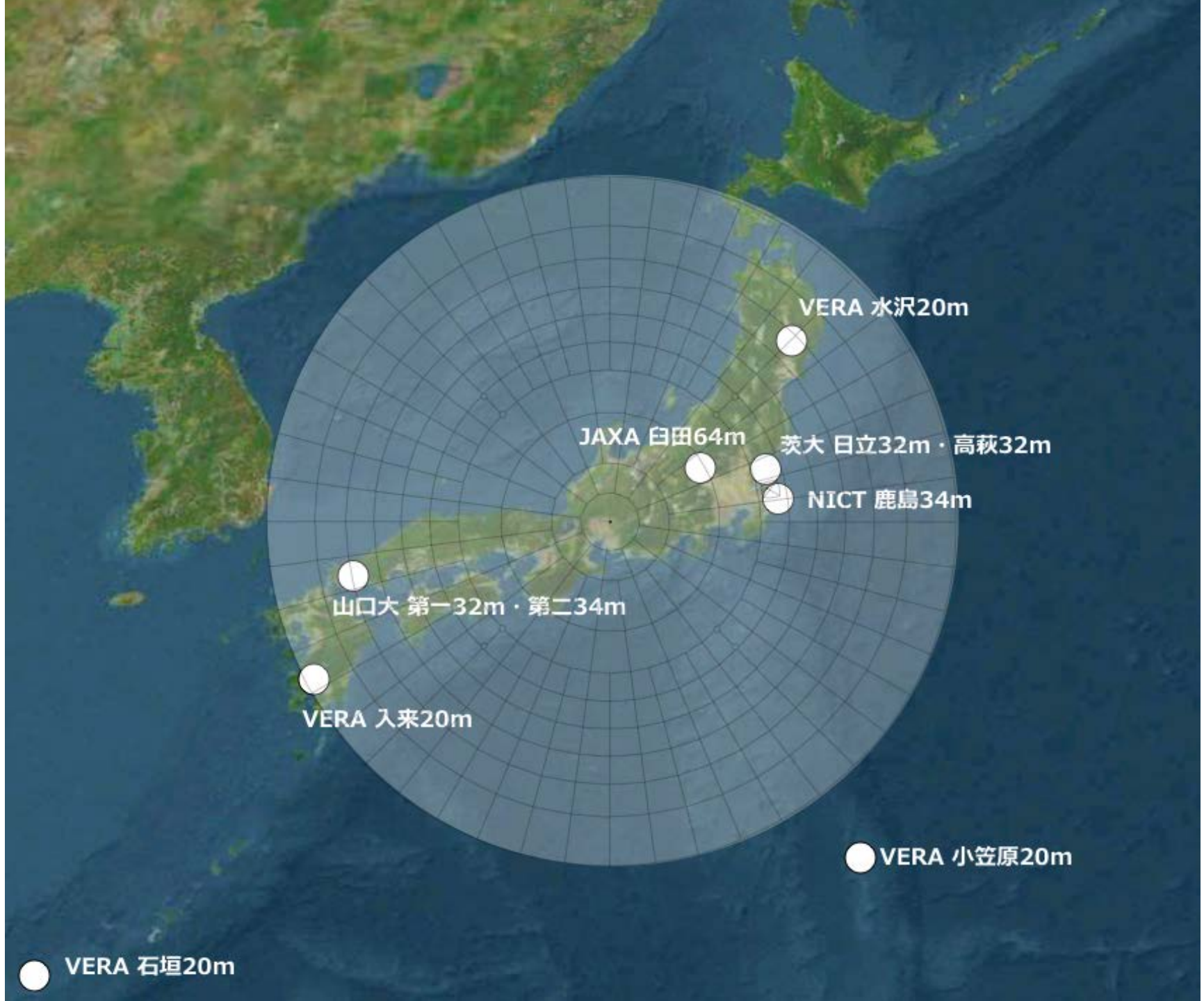
69.52-0.97



52.66-1.09

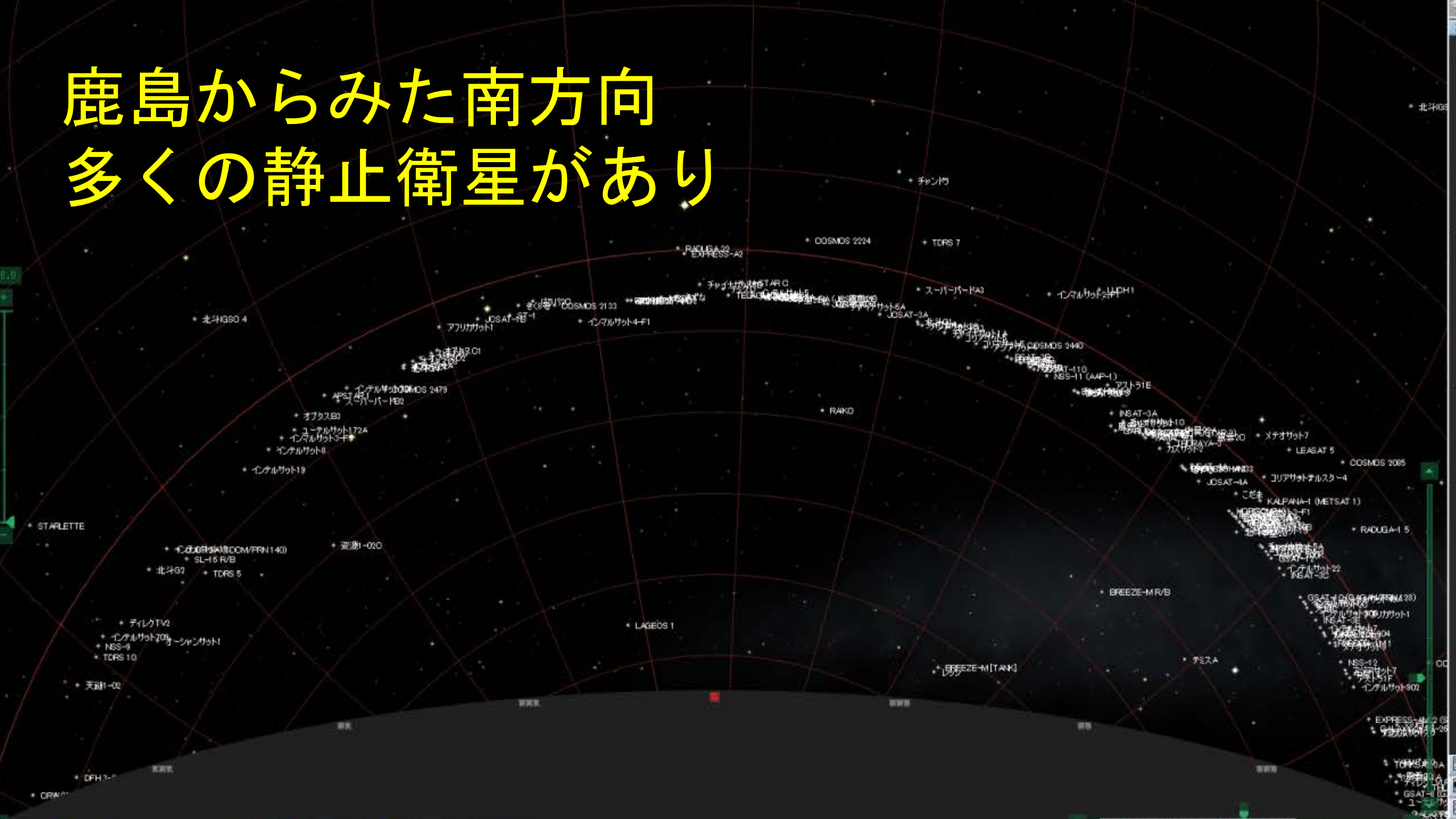


IRS22198+6336


VERA 水沢20m
JAXA 臼田64m
茨大 日立32m・高萩32m
NICT 鹿島34m
山口大 第一32m・第二34m
VERA 入来20m
VERA 小笠原20m
VERA 石垣20m

位相を合わせるのが最も重要かつ大変

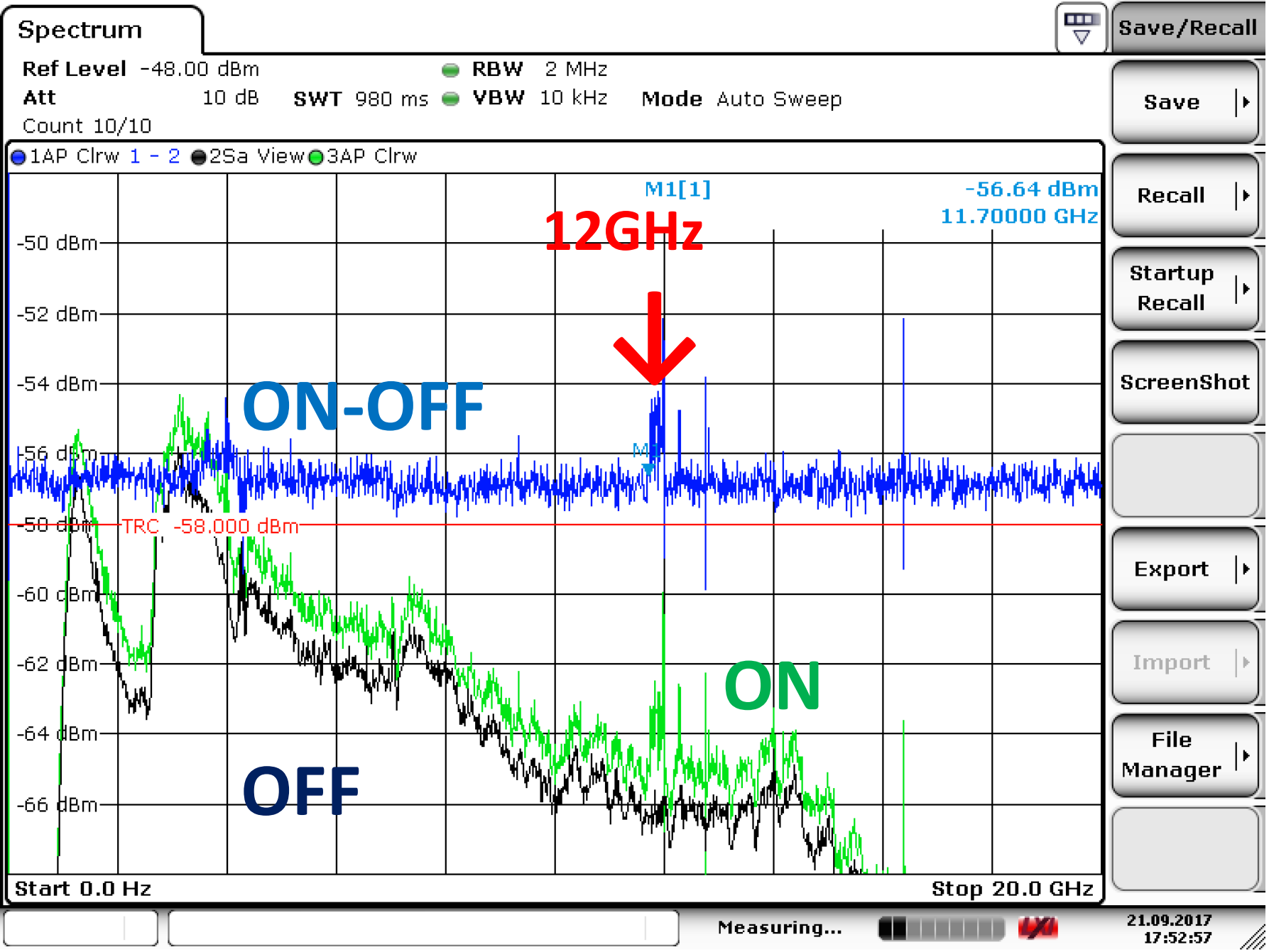
鹿島からみた南方向
多くの静止衛星があり



- Satellite survey
  - Kashima 34m with NINJA feed
  - 3-15GHz
  - V-polarization

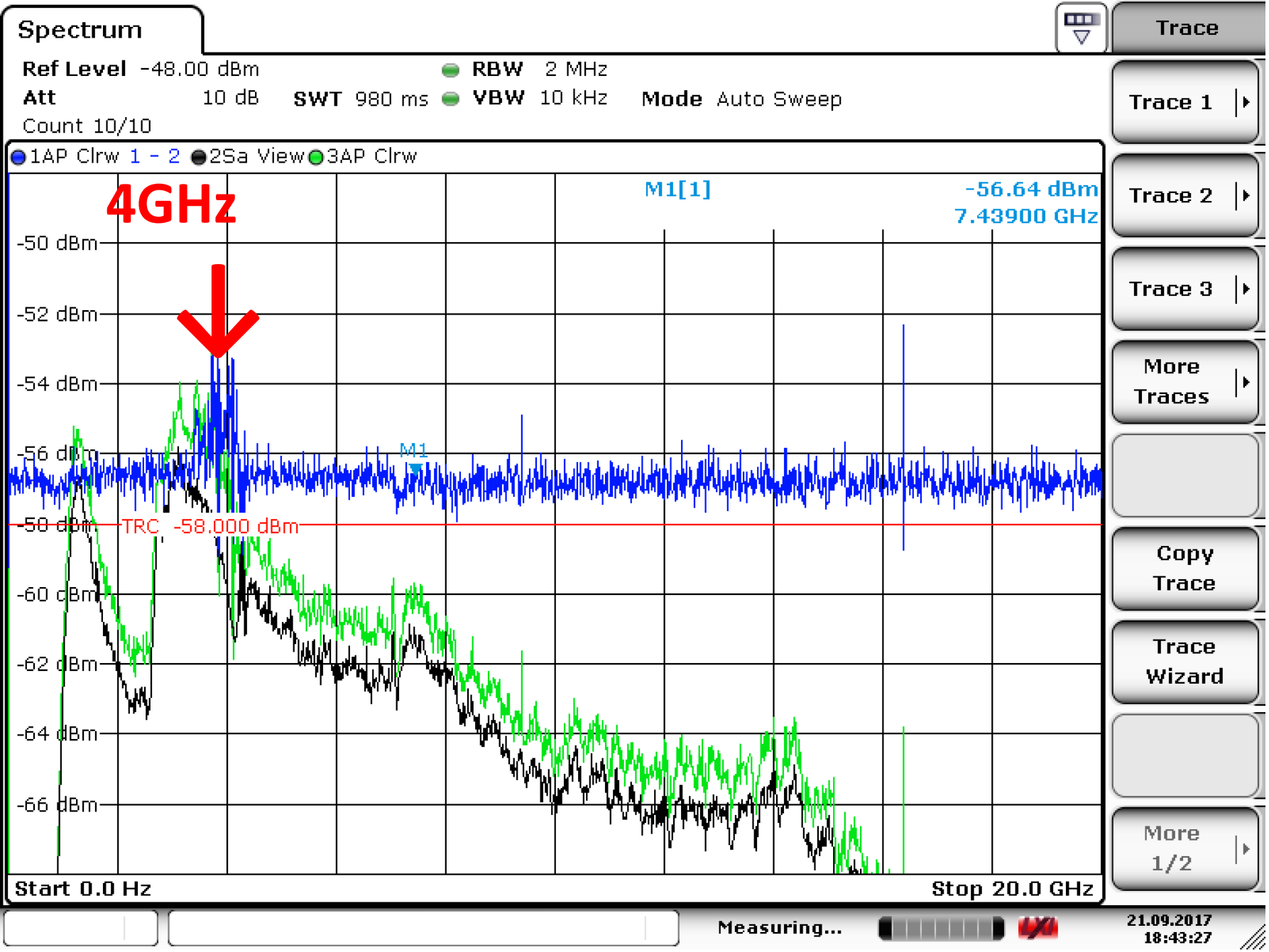
- Broadcast satellite is allocated the frequency range of mostly 4GHz and 12 GHz
- Some satellites emit 3GHz, 7GHz(?), 11GHz

- **直視危険!**
- **10dB attenuator before LNA**



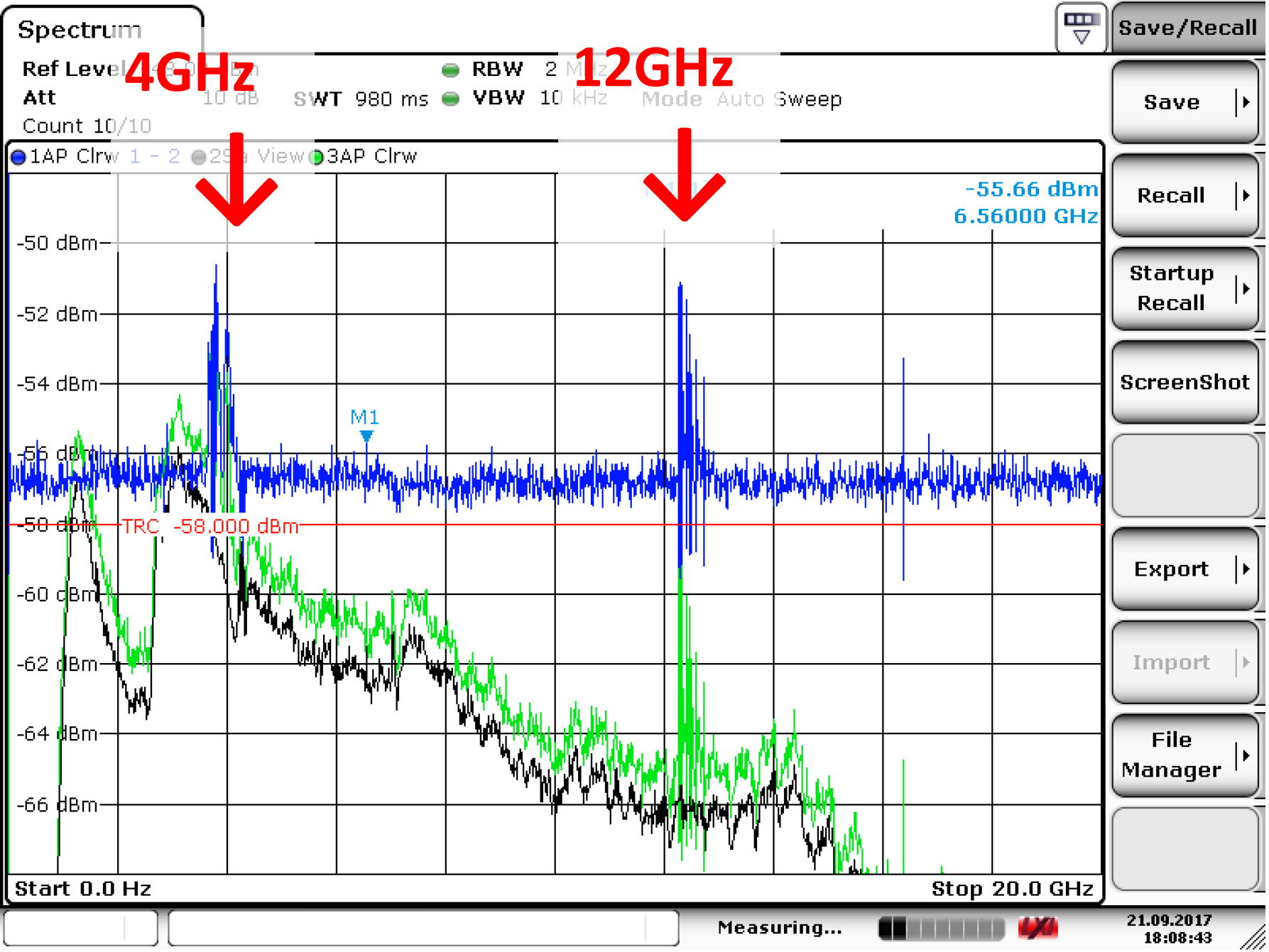
- range of 0-20GHz
- RBW 2MHz
- beam direction for satellite ABS7

Date: 21.SEP.2017 17:52:58



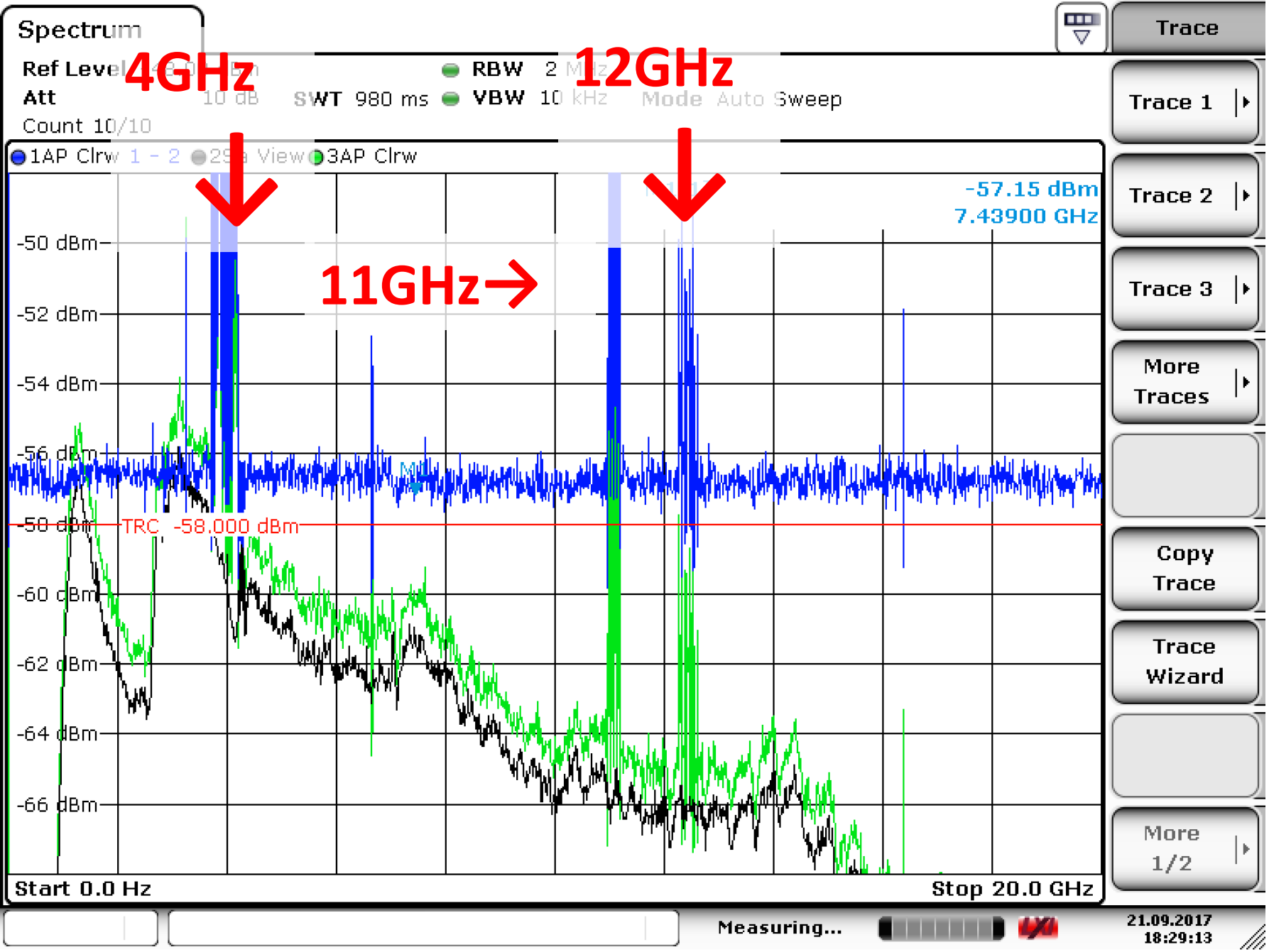
- direction for APSTAR6

Date: 21.SEP.2017 18:43:27



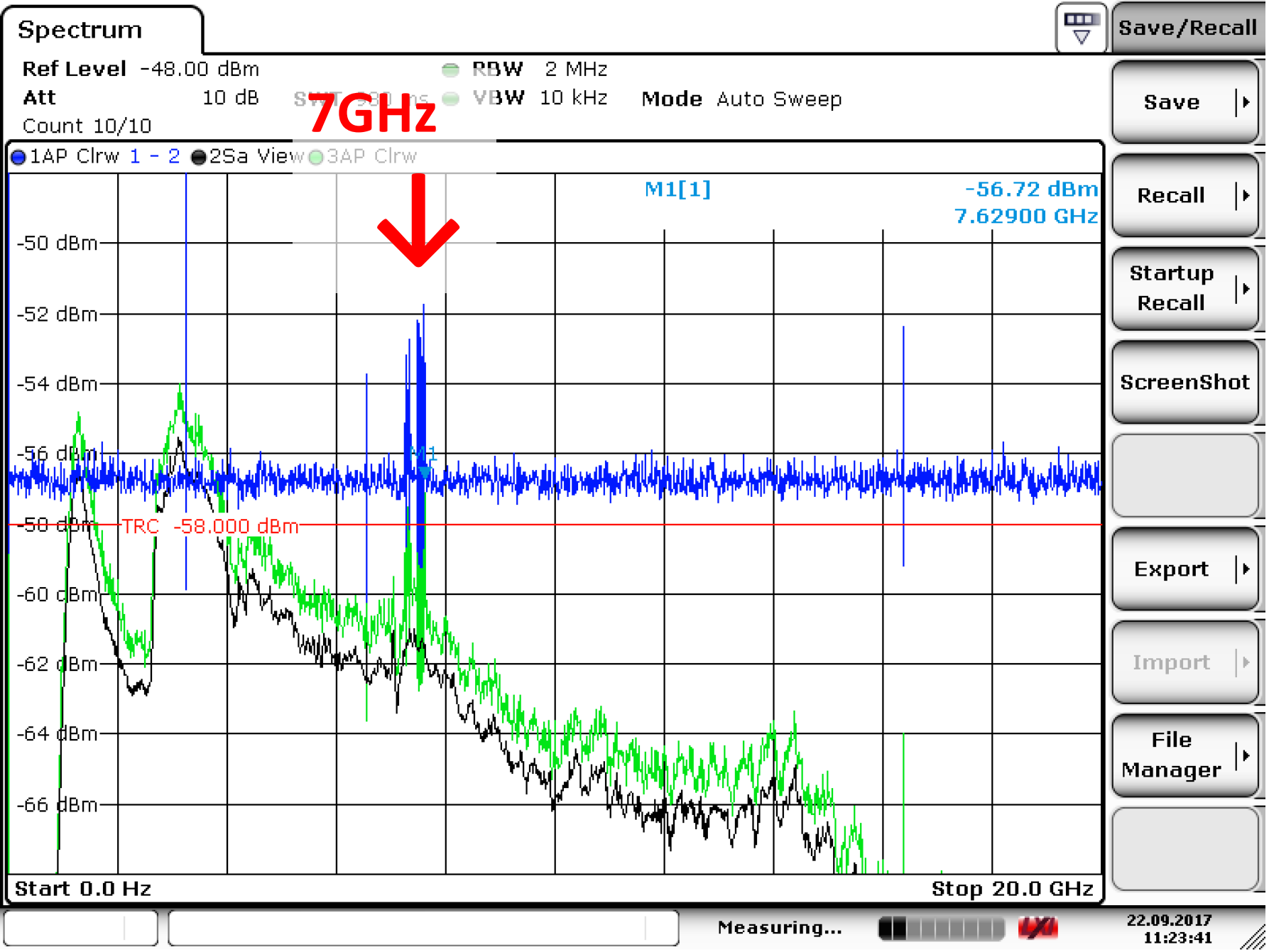
- direction for asiasat5

Date: 21.SEP.2017 18:08:43



- direction for chinasat12

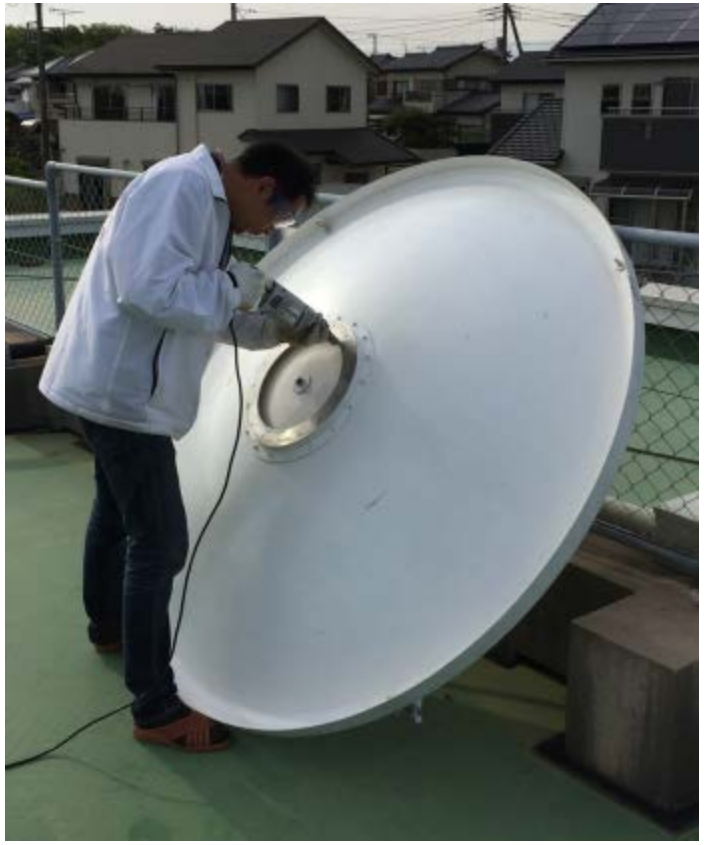
Date: 21.SEP.2017 18:29:13



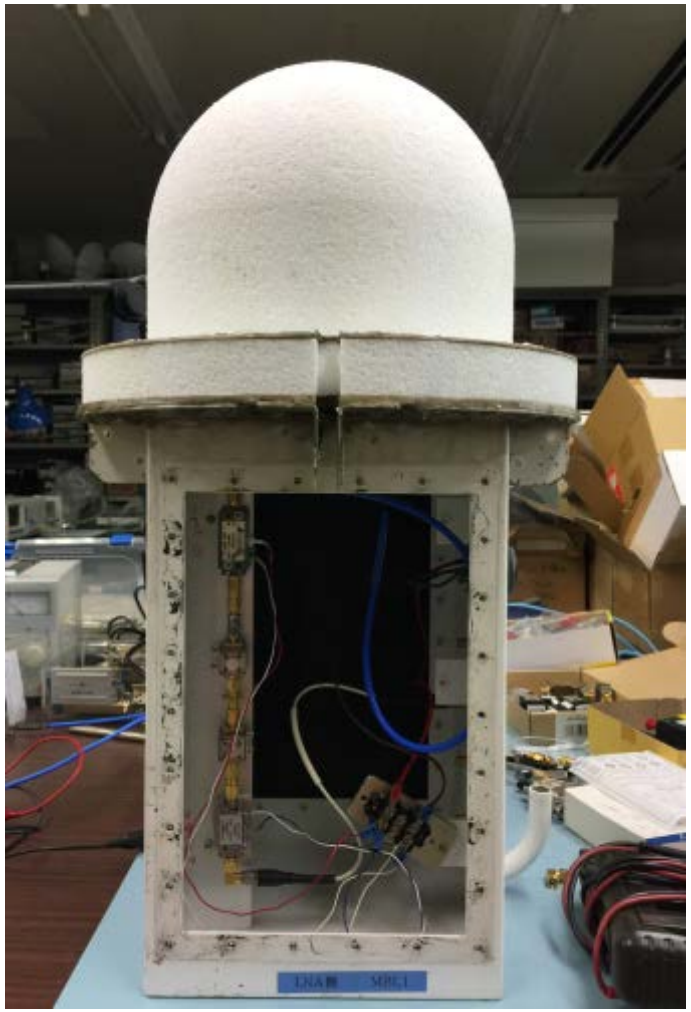
- direction for Superbird2

Date: 22.SEP.2017 11:23:41

Holography for Kashima 34 m

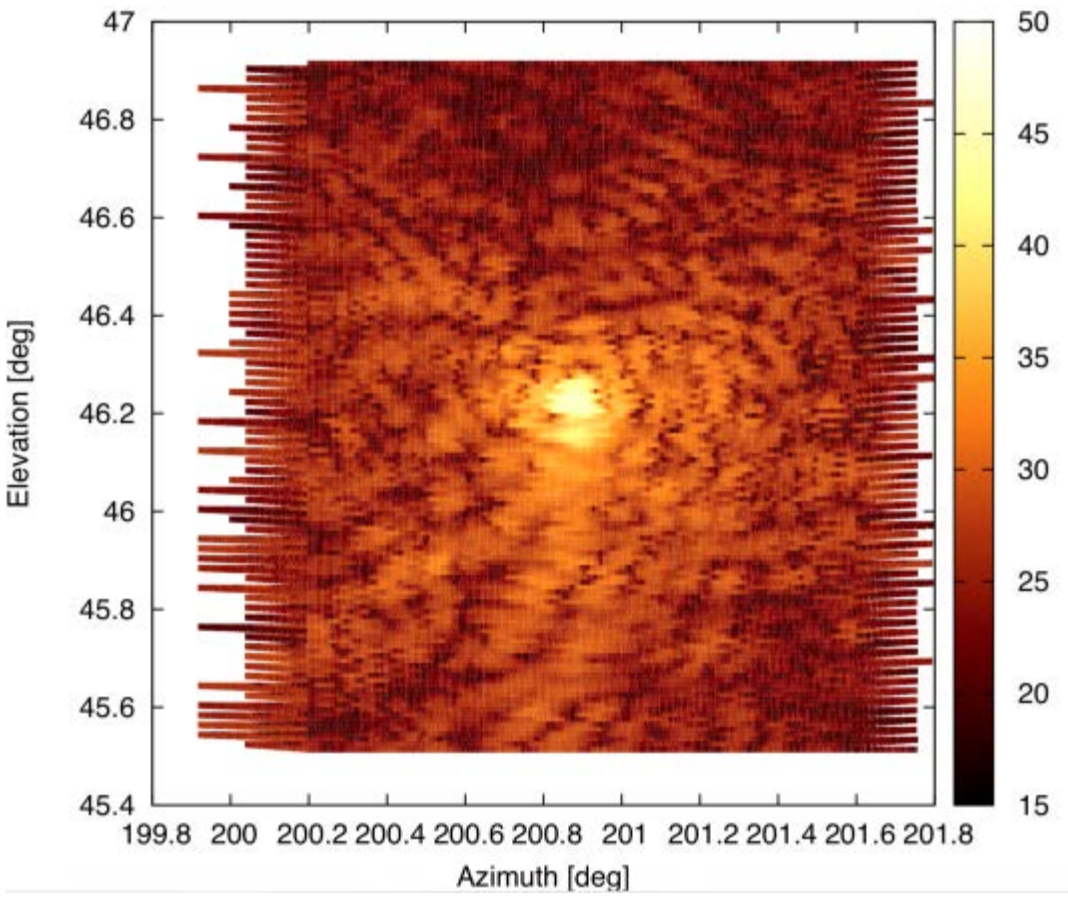


Reuse the main surface of compact antenna

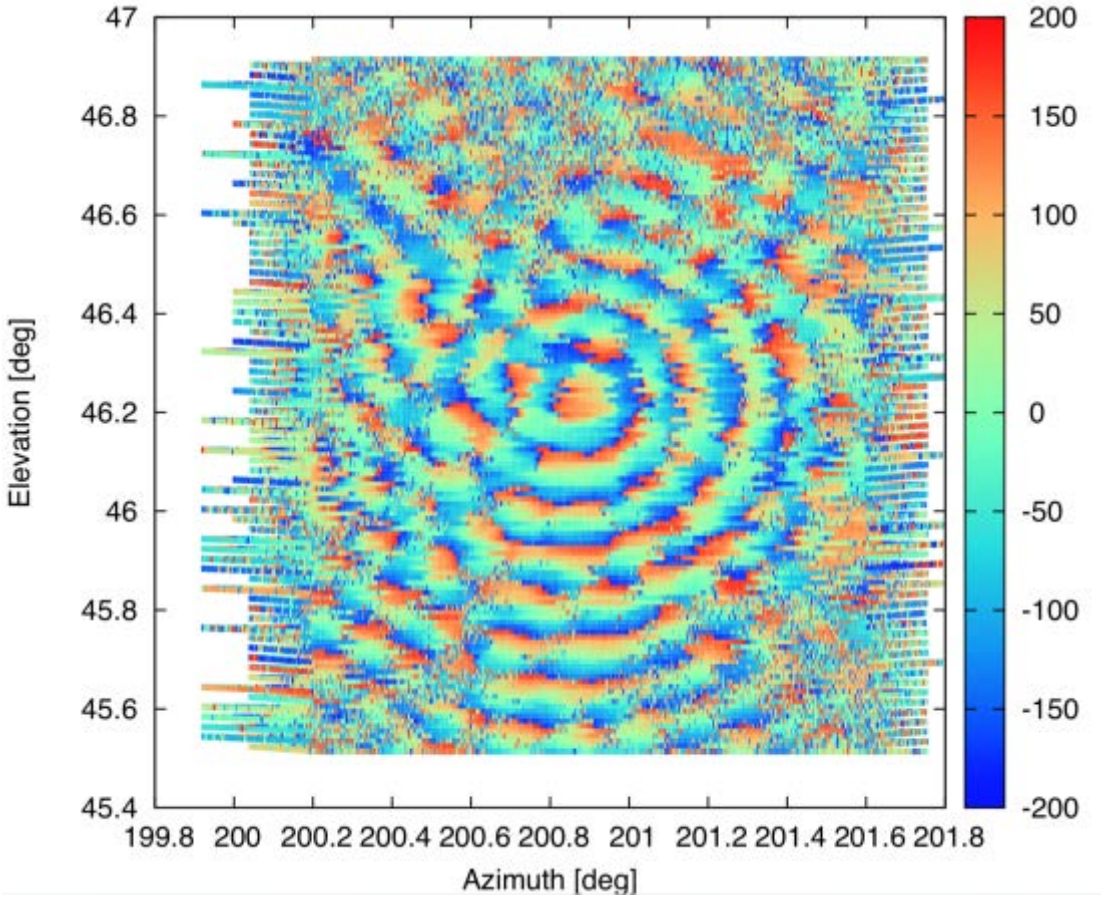


- satellite JCSAT-3A
  - AZ,EL=(200.87d,46.241d)
- Frequency band 12GHz
- 16Msps,8bit by k5/vssp32
- V-polarization
- Zigzag schedule

相関処理結果（34m−reference antenna）

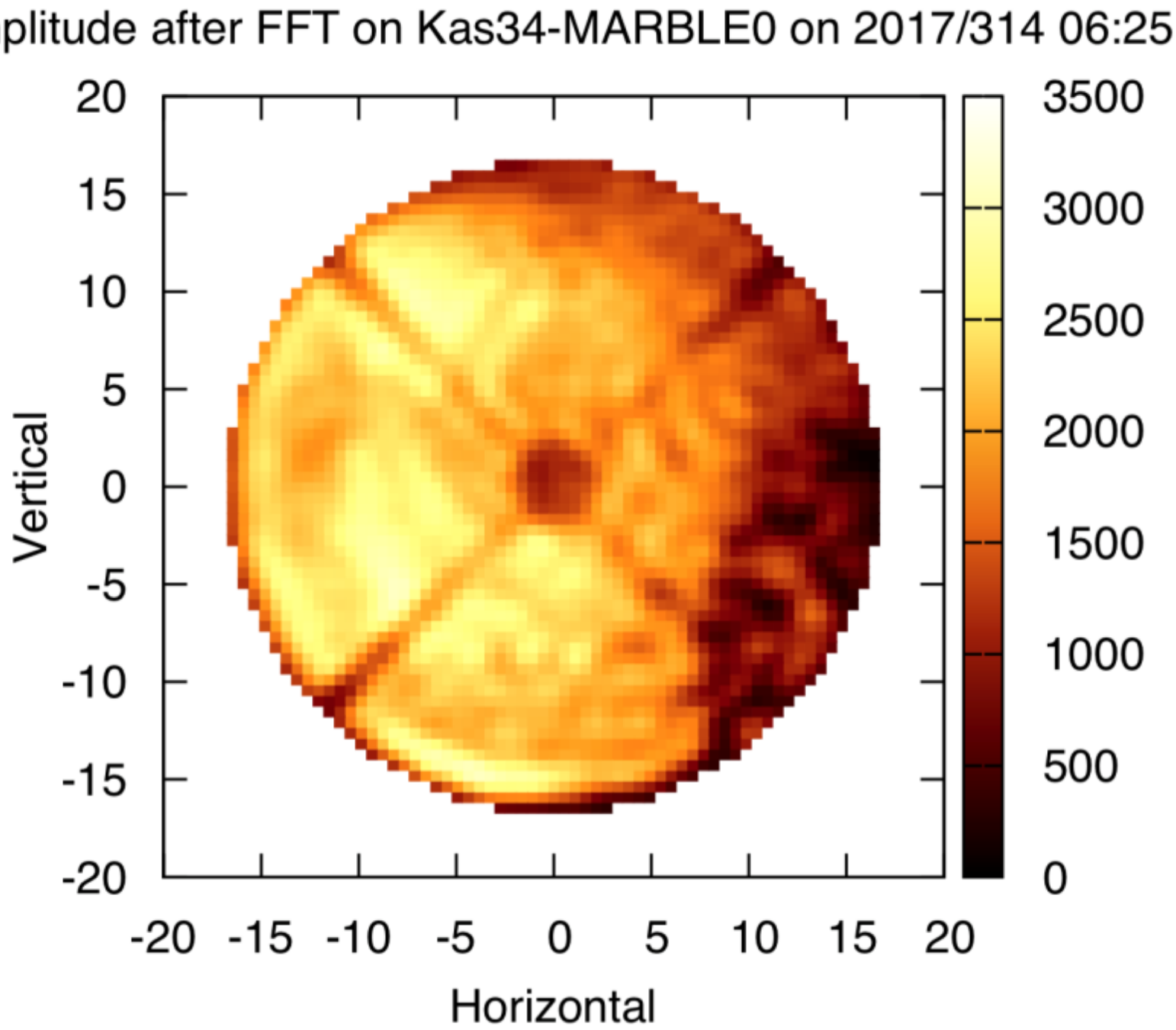


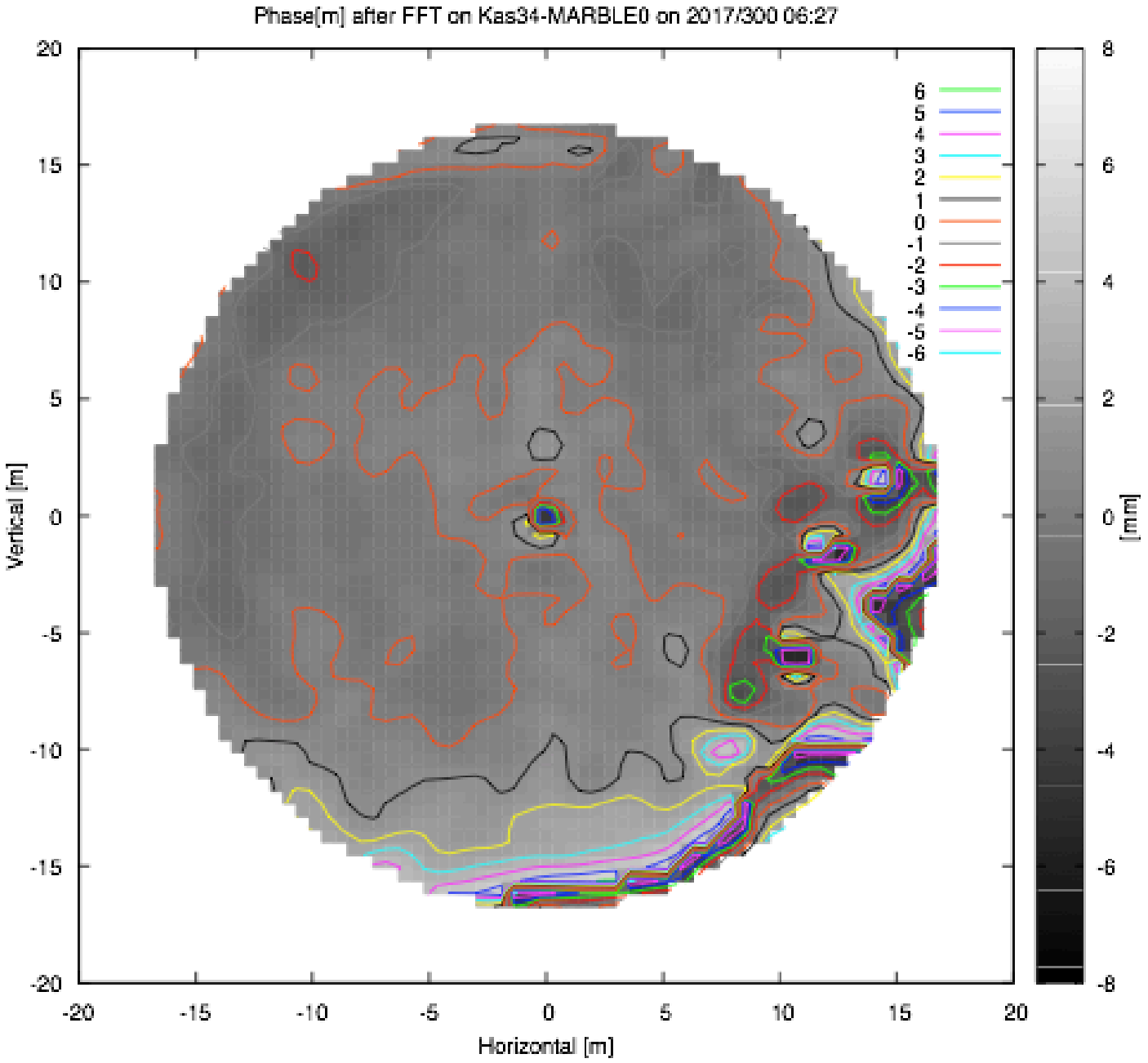
2017/314 06:25



2017/314 06:25

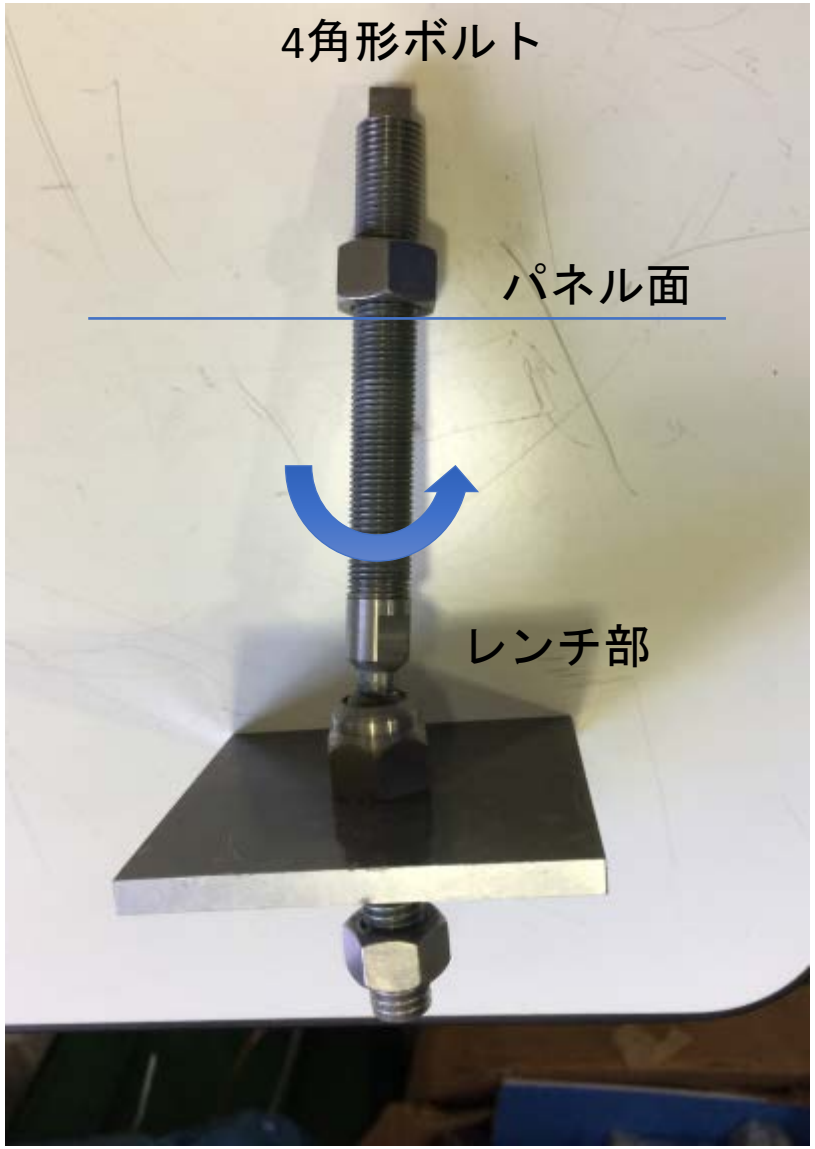
2D-F


Amplitude after FFT on Kas34-MARBLE0 on 2017/314 06:25
Vertical
Horizontal
20
15
10
5
0
-5
-10
-15
-20
-20 -15 -10 -5 0 5 10 15 20
3500
3000
2500
2000
1500
1000
500
0


Phase[m] after FFT on Kas34-MARBLE0 on 2017/300 06:27
Vertical [m]
Horizontal [m]
[mm]
20
15
10
5
0
-5
-10
-15
-20
8
6
4
2
0
-2
-4
-6
-8
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6

- 下部、右側にでこぼこ

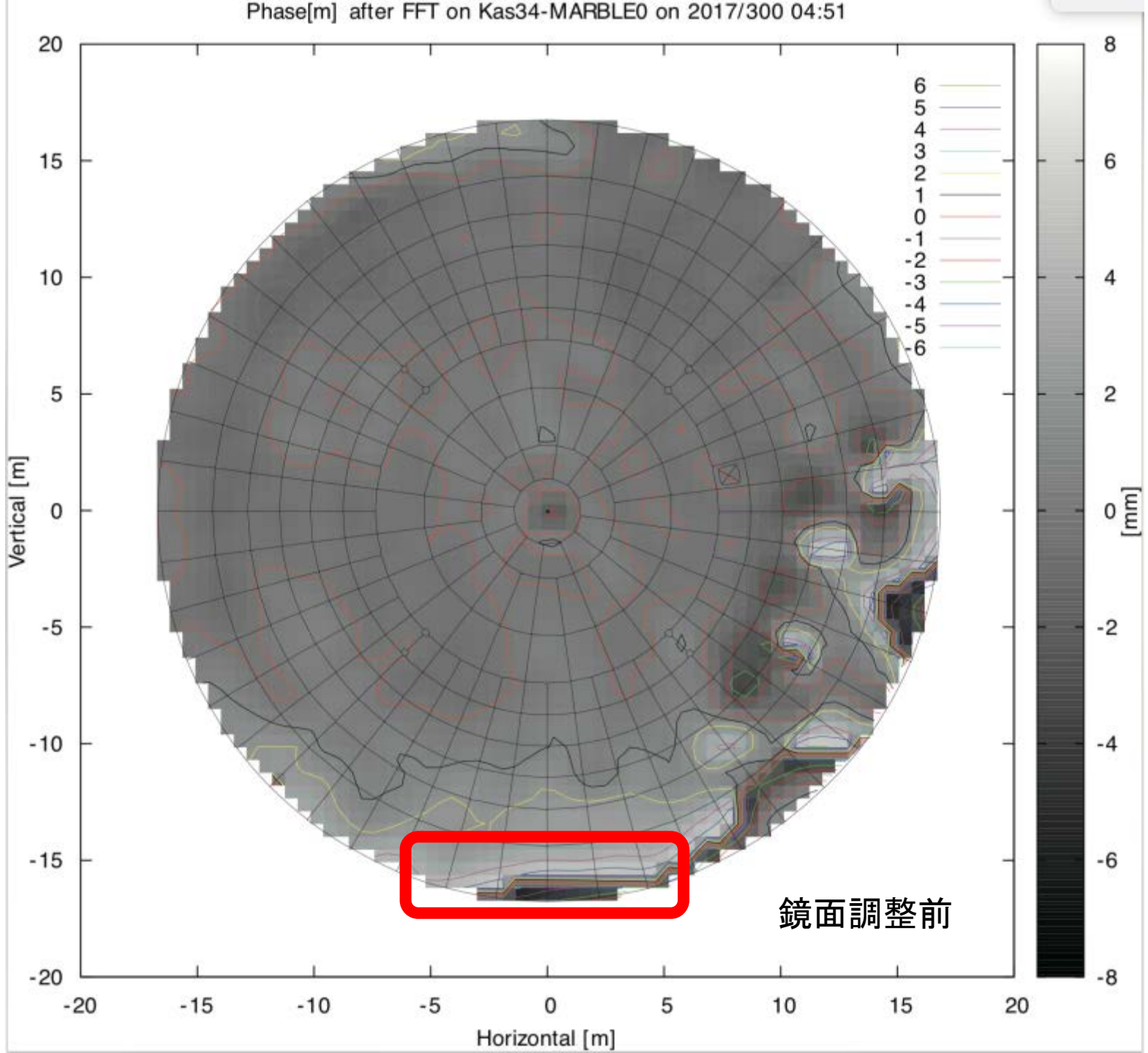
34m鏡面調整

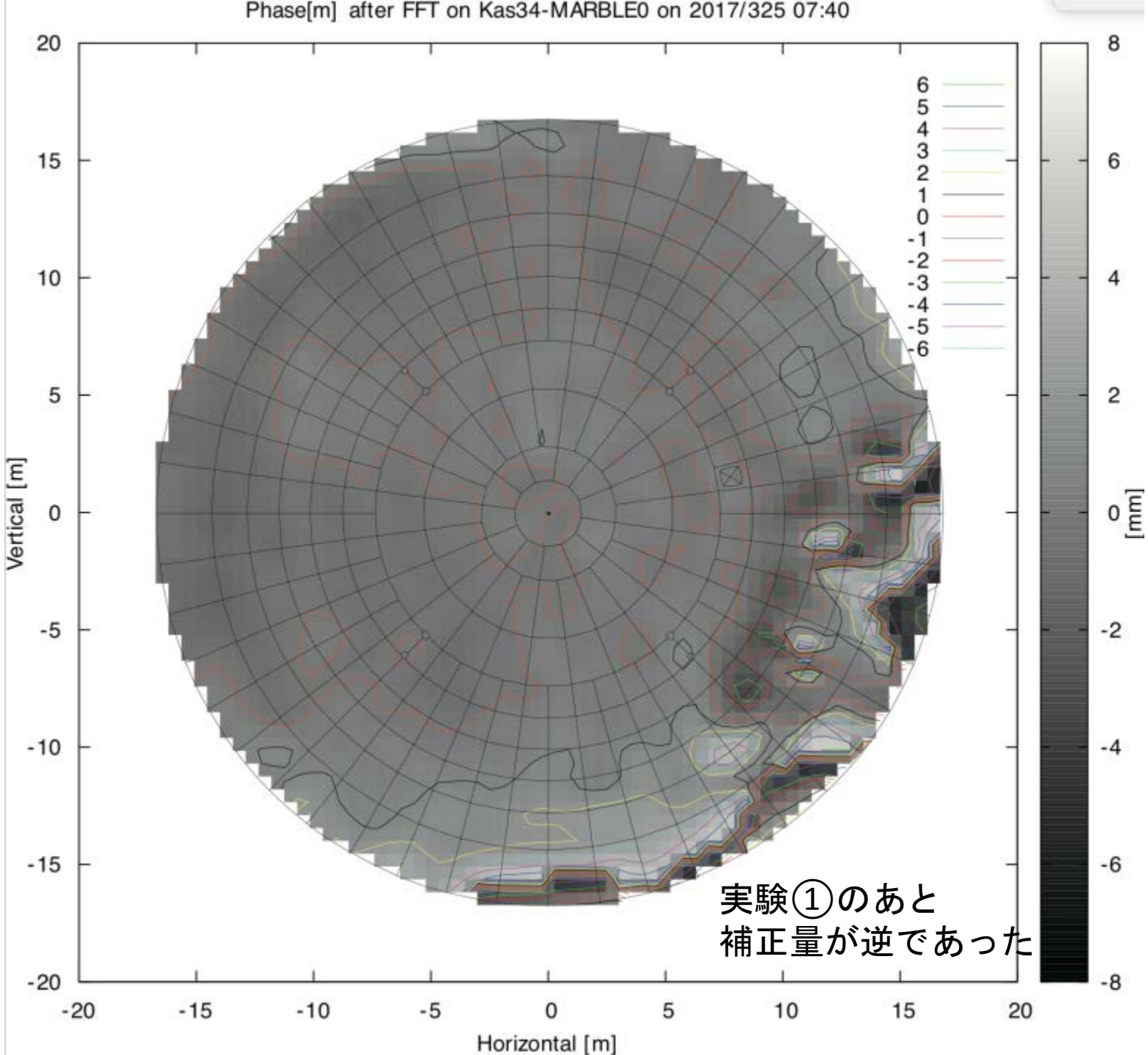


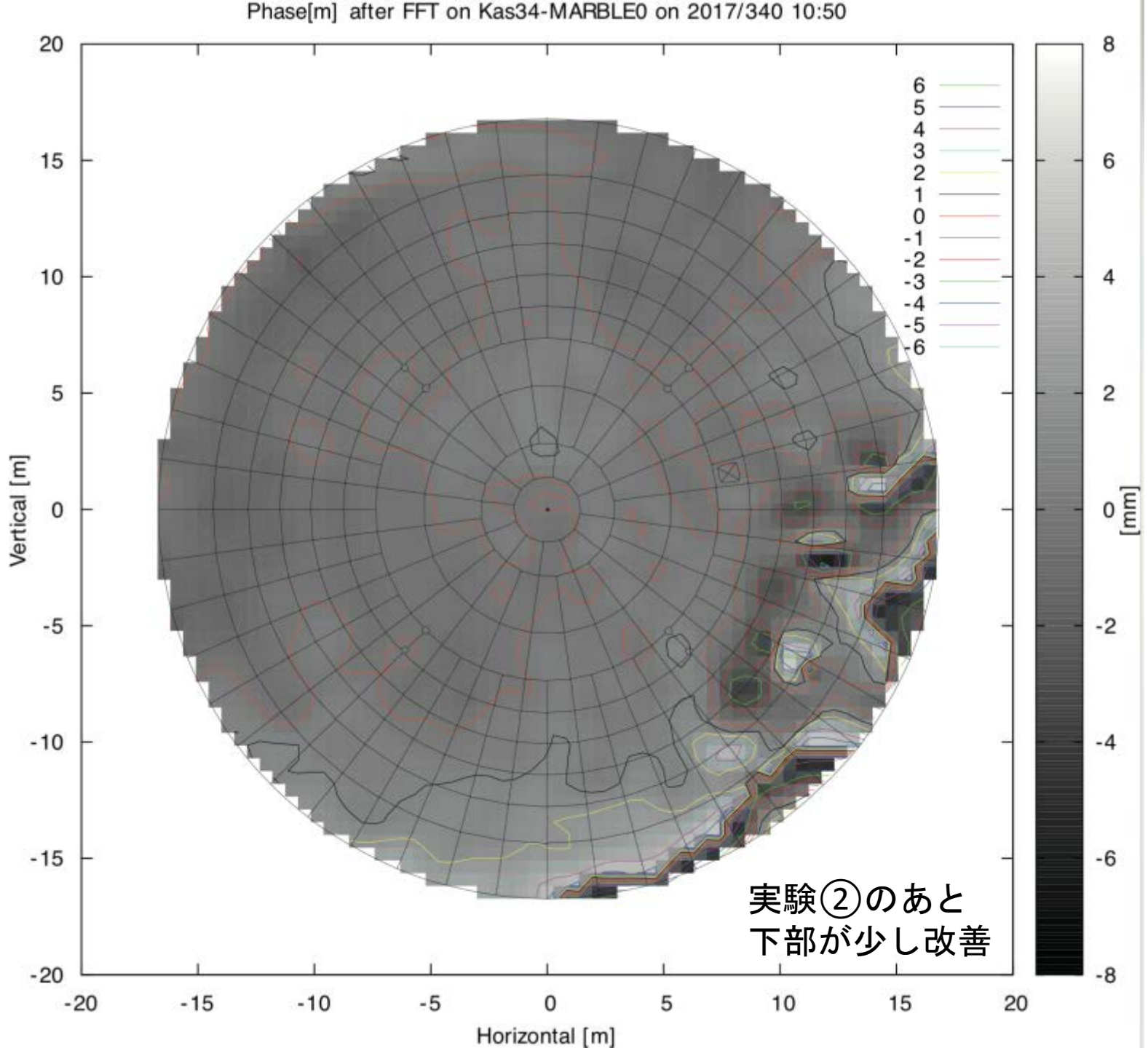
- アンテナパネルは背面にある棒ネジを回すことで、上下移動ができる
- しかしながらパネル面は上下にナット止めされており、背面ナットを回さなければならない
- 反時計回り：パネル下降、時計回り：パネル上昇
- 軸受けボール部を回すことがかなり硬い場合がある

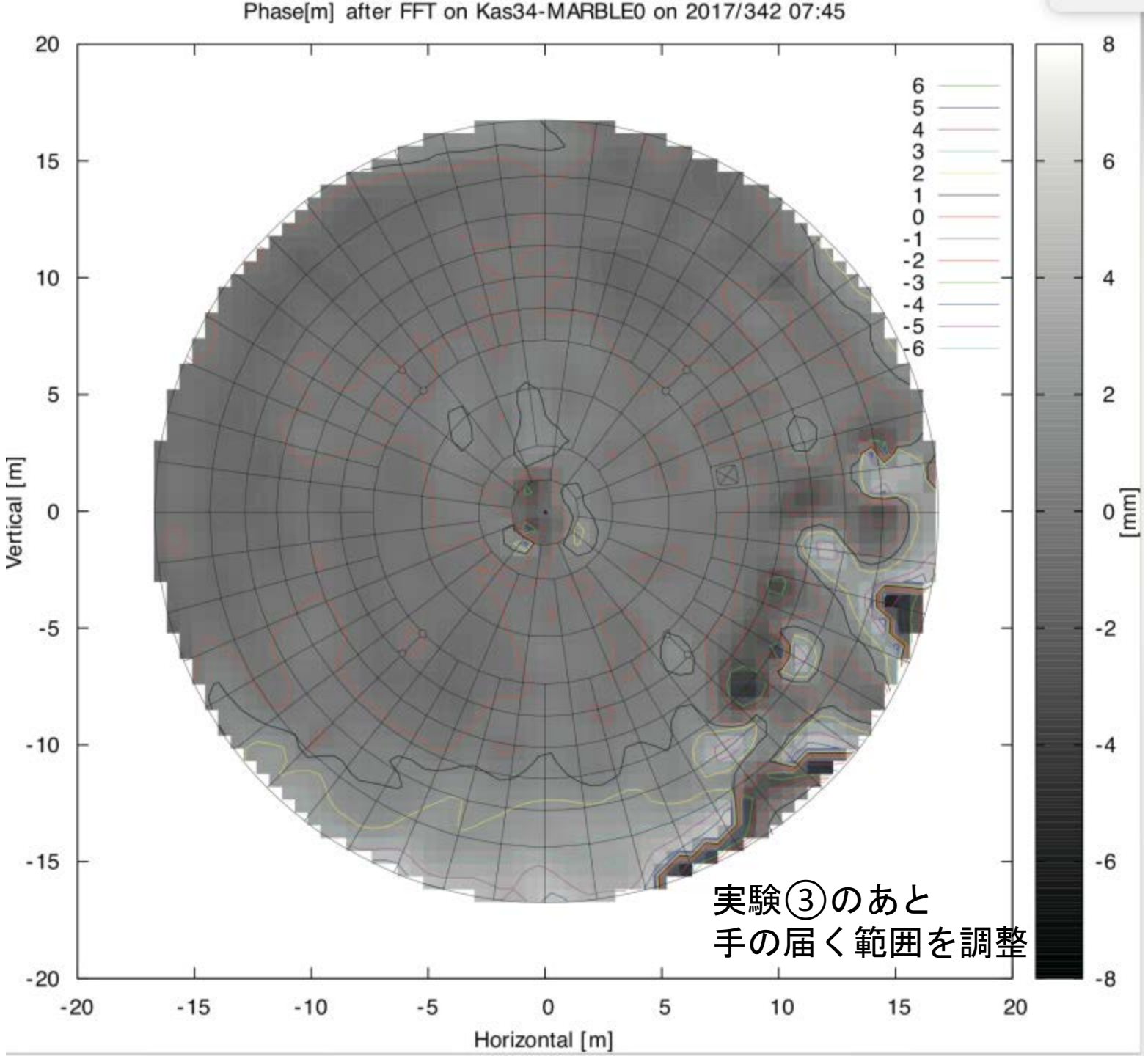
34m鏡面調整

- 実際のパネル調整部（アンテナBottomで最も下がる部分）
- 塗装で覆われており、レンチ部を少し回すことで、塗装を落とす必要がある
- -40度に冷却するスプレーが効果あり（塗布してしばらくすると、回りやすくなる）
- 1回転で約1mmの移動


Phase[m] after FFT on Kas34-MARBLE0 on 2017/300 04:51
Vertical [m]
Horizontal [m]
[mm]
鏡面調整前


Phase[m] after FFT on Kas34-MARBLE0 on 2017/325 07:40
Vertical [m]
Horizontal [m]
[mm]
20
15
10
5
0
-5
-10
-15
-20
8
6
4
2
0
-4
-6
-8
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
実験①のあと
補正量が逆であった


Phase[m] after FFT on Kas34-MARBLE0 on 2017/340 10:50
Vertical [m]
Horizontal [m]
[mm]
20
15
10
5
0
-5
-10
-15
-20
8
6
4
2
0
-2
-4
-6
-8
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
実験②のあと
下部が少し改善


Phase[m] after FFT on Kas34-MARBLE0 on 2017/342 07:45
Vertical [m]
Horizontal [m]
[mm]
20
15
10
5
0
-5
-10
-15
-20
8
6
4
2
0
-2
-4
-6
-8
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
実験③のあと
手の届く範囲を調整

お手々のしわとしわをあわせたら？

θあわせる