A Moon Bounce Experiment With A 32m KDDI Cassegrain Antenna

A Special Station

8N1EME

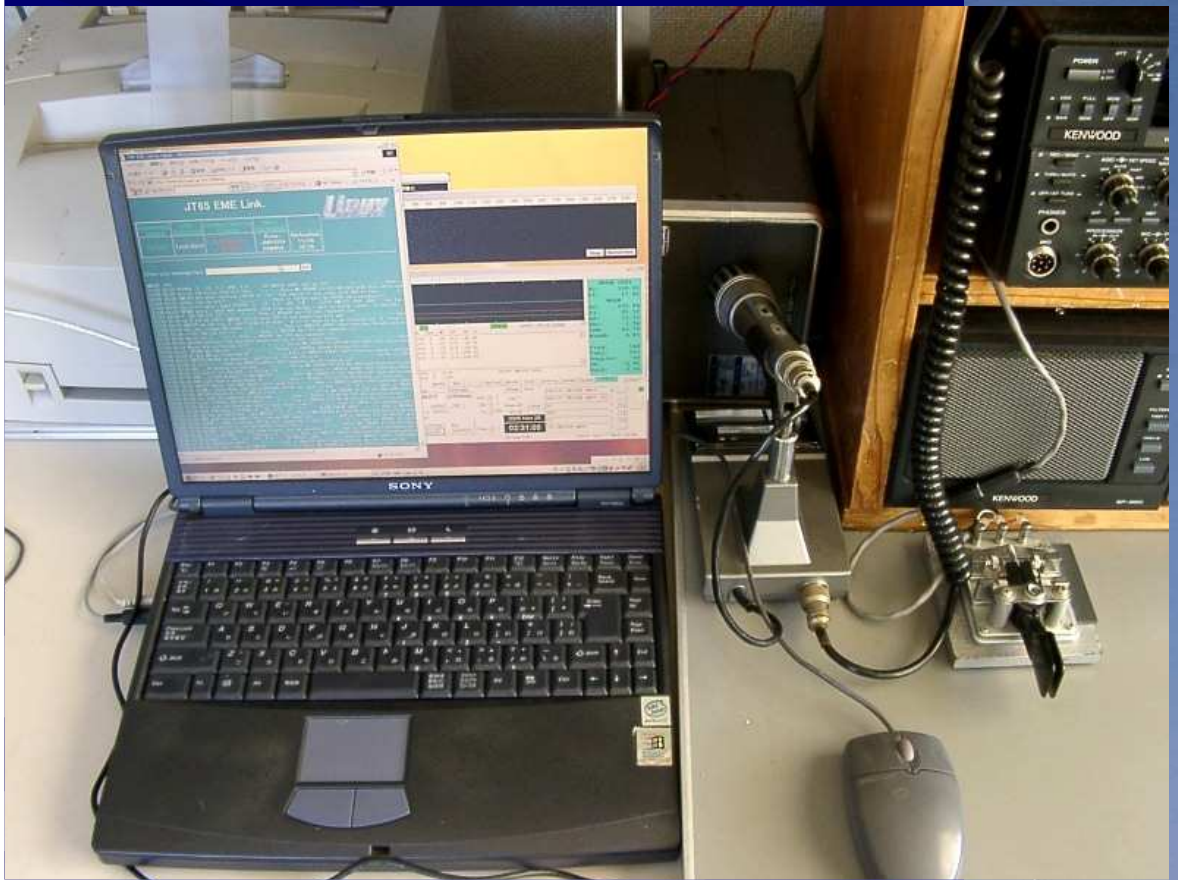
Project BIG-DISH 2007

JH1KRC JM1GSH JH1NBN JH1EFA JJ1NNJ 7M2PDT
JA1BGU JE1BNZ JK1KXH JH0XHL/1 JH2COZ JA5FNX
JH5AKH JH5FOQ JH6RTO JA9BOH JA0BZC JA0TJU
JA0GPT JH0MHE JA1NKV JA4BLC JH3EAO JA6CZD
JA9BOH et al.

JM1GSH Kony

- 144 MHz JT65B
- Very active
- One of QM06 guys
- The KDDI satellite communication center is near him

Speaker-Microphone interface works fine for JT65B…



JH1KRC

1296 MHz

432 MHz

4.4 m　500 W+


DANGER
HIGH VOLTAGE
327 cavity
7213 cavities

JA6XKQ/1 visited and inspected
the wave-guide feed for 5760 MHz

Preparing for
5760 MHz /
10.45 GHz

License pending:

5760 MHz

500 watt

10.450 GHz

300 watt

KDDIのパラボラアンテナ

「電波望遠鏡に」

センター閉鎖で 改造の計画

高萩市石滝と日立市十王町にまたがり、13基の巨大パラボラアンテナが並ぶKDDI茨城衛星通信センター[2]が役目を終え、今年末で閉鎖される。そのうちの2基を国立天文台が電波望遠鏡に改造し、国内の他の3か所のアンテナとのネットワークで宇宙空間の謎を探ろうという構想が持ち上がっている。

ネットワークには鹿嶋市の情報通信研究機構、つくば市の国土地理院、長野県佐久市の宇宙航空研究開発機構臼田宇宙空間観測所のアンテナが加わる。KDDIセンターを含めた4局をブロードバンド（高速大容量通信）の光ファイバーケーブルでつなぎ、毎月2日程度、宇宙観測をする。

光ファイバーでつなぐと、受信する信号の帯域が既存の電波望遠鏡に比べ、数十倍に広がり、弱い電波の天体画像でも即時に作成できる。4局の位置関係が三角形になる点も、よりはっきりな映像を得るのに有利で、世界最高レベルの感度が実現できるという。実際の観測は茨城大理学部の横沢正芳教授（59）らの研究グループに打診しており、横沢教授側も前向きだ。

鹿嶋は人工衛星を使った通信研究、つくばは天緯度・経度の精密測定、佐久は人工衛星の追跡がそれぞれの本来の業務だが、いずれも電波望遠鏡への転用が可能で、これまでも国立天文台との共同天体観測の実績がある。また、国立天文台は2002年からKDDIの山口衛星通信センター（山口市）の不要アンテナを譲ってもらい、山口大と共同で宇宙観測している。

横沢教授は「宇宙の果ての銀河、超新星からの微弱電波を観測できるので、ビックバン後の宇宙の膨張、銀河や惑星の形成過程などの解明に大きな成果が望める」と話している。

KDDIは学術利用を条件に、茨城衛星通信センター閉鎖後のアンテナ群や13万4000平方㍍の土地を無償譲渡する方針だ。宇宙観測もこれに沿った構想だが、横沢教授らはもう一つ、小学生から大学生を対象にした宇宙電波科学研究教育センターの設置計画案を地元の高萩、日立両市に提案している。

子供の理数離れに歯止めをかけるため、体験学習型科学館や植物園、簡易宿泊施設を建て、天体観測や科学実験、植物観察をしてもらおうという計画。

こうした跡地論議の高まりに、日立市は「大きなアンテナ群は地元のシンボルでもあり、科学技術振興のためにも施設を残したい。茨城大の計画が固まれば、高萩市と利用法を検討したい」と考え、高萩市も「跡地利用は県、日立市と一体で検討していきたい」と話している。

電波望遠鏡としての再利用計画が浮上した茨城衛星通信センターの直径32ｍのアンテナ

国内他のアンテナと結び 宇宙を観測

KDDI茨城衛星通信センター　日本の国際衛星通信発祥の地。1963年11月に開設され、初の日米間テレビ衛星の受信実験でケネディ大統領暗殺という歴史的事件を受信した。今年限りでKDDI山口衛星通信センターに機能が統合される。

Modification to be a Radio Telescope….

One day
a newspaper
tells us
an unexpected
plan about
a ***BIG DISH*** of
KDDI
Satellite Center
in Ibaraki, Japan.

June, 2006


国際電信電話株式会社
茨城宇宙通信実験所
IbarakiSpaceCommunicationCenter
Kokusai Denshin Denwa Co., Ltd.


第一回日米間
人工衛星
中継テレビ放送

Planning the EME Operation

- KDDI-Ibaraki Satellite Communication Center in Takahagi City, Japan, was built as a communication node for INTELSAT services toward the Pacific areas.
- There are several immense parabolic dish antennas and associated infrastructure buildings for administrative, research, construction and maintenance purposes.

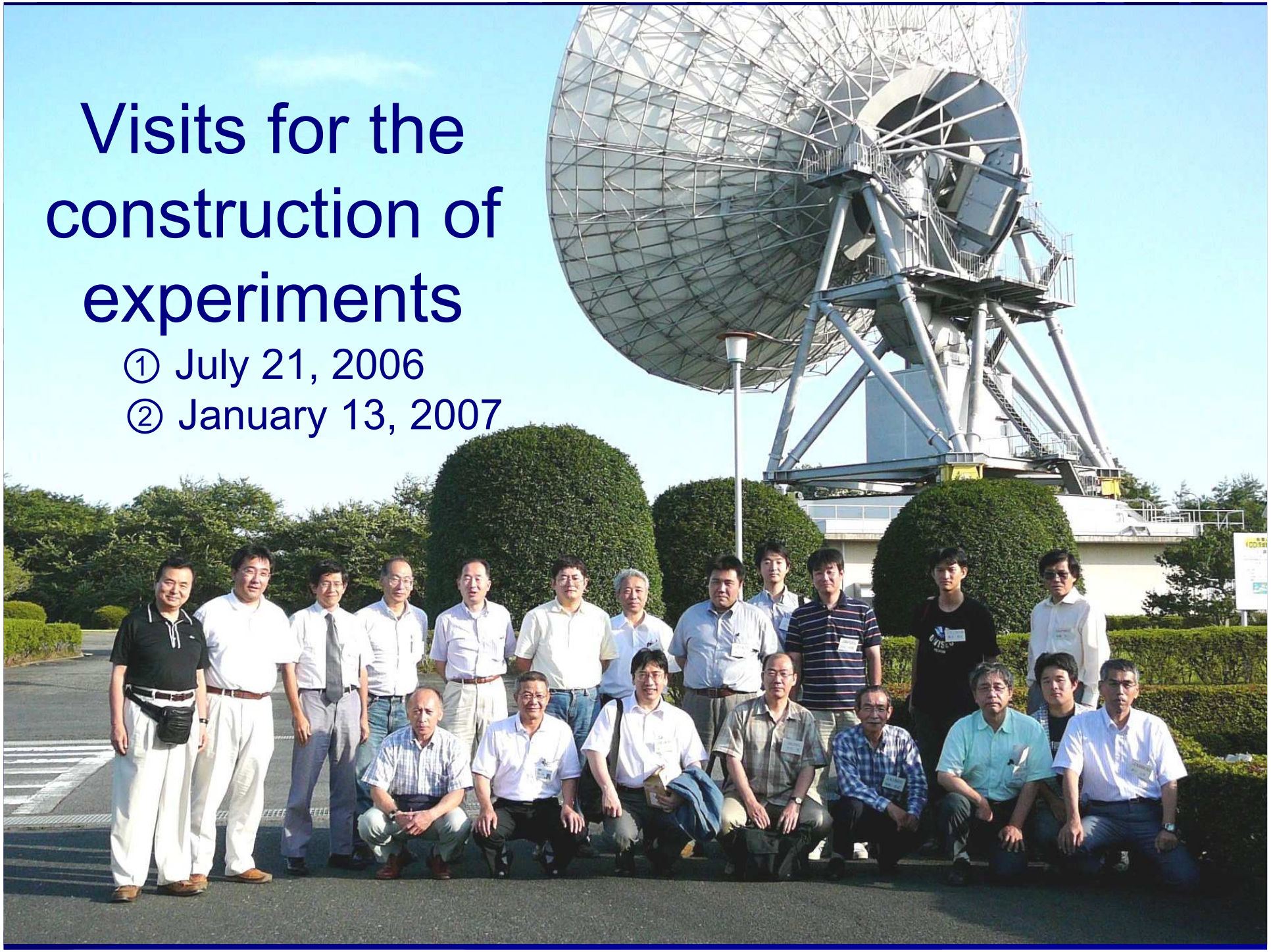
- Already, not all KDDI antennas are in active services; some antennas being in stand-by mode.
- 2006 a group of Japanese amateur radio enthusiasts met for their special planning at KDDI-Ibaraki Satellite Communication Center
- A proposal was initiated:

  Moon-bounce communications using their 32-meter dish antenna

Visits for the construction of experiments

① July 21, 2006

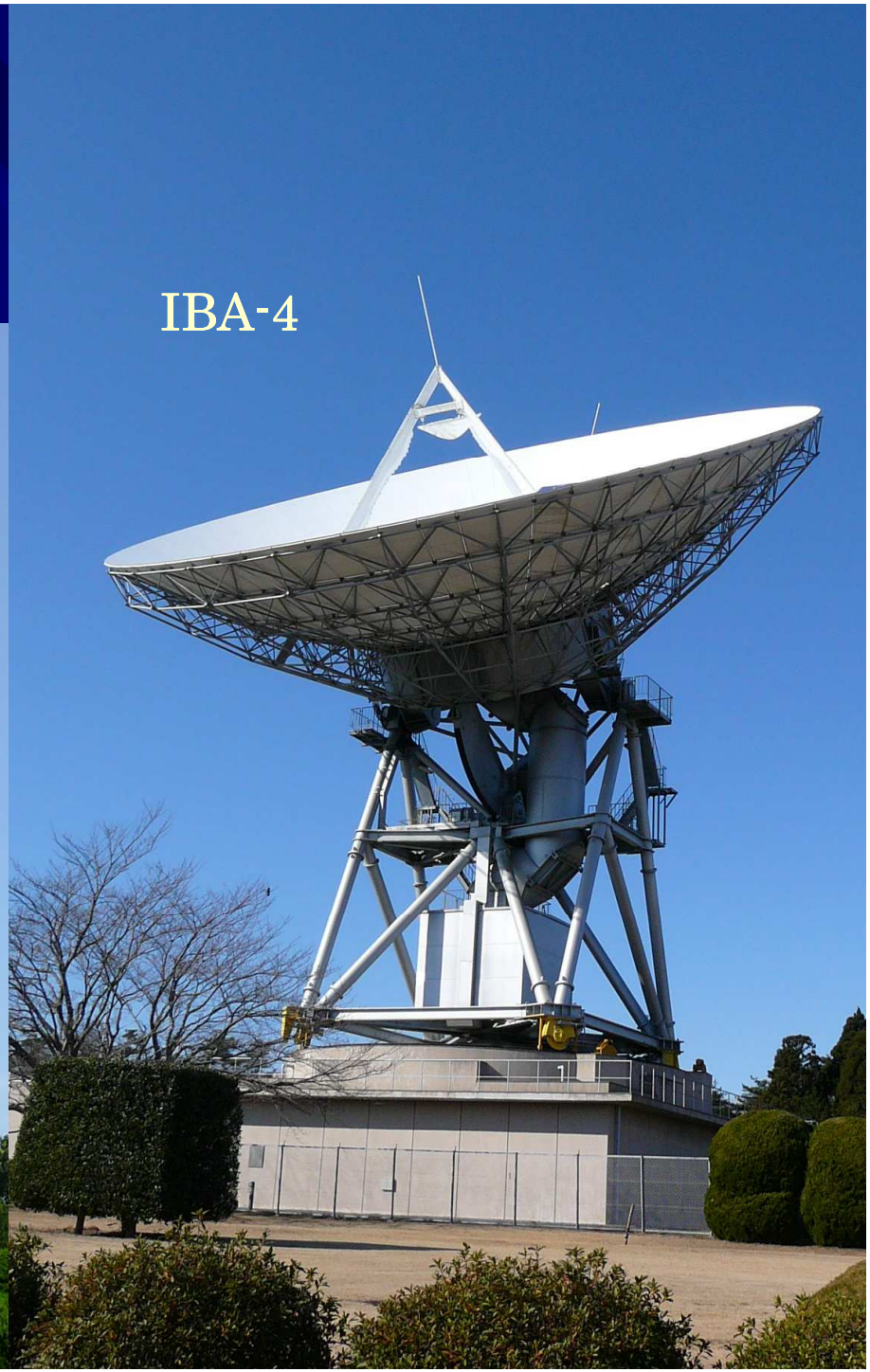
② January 13, 2007



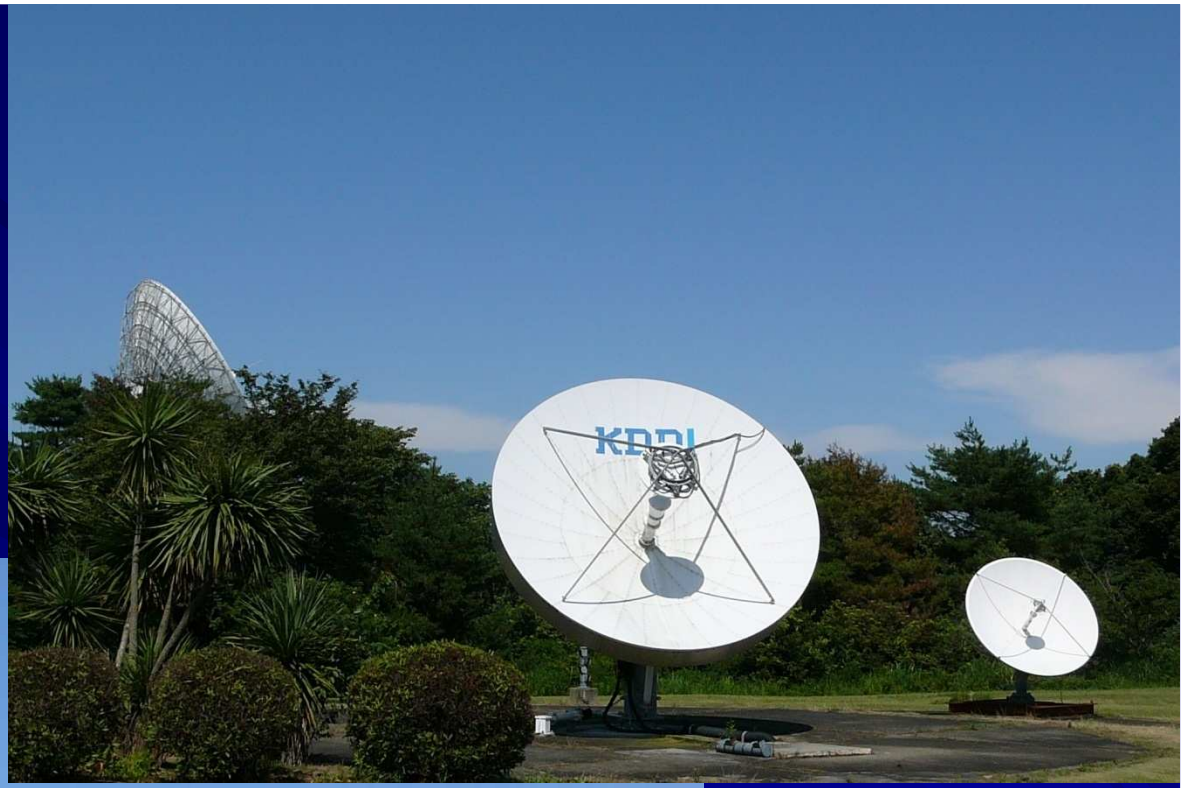
3 2 m Cassegrain antennas

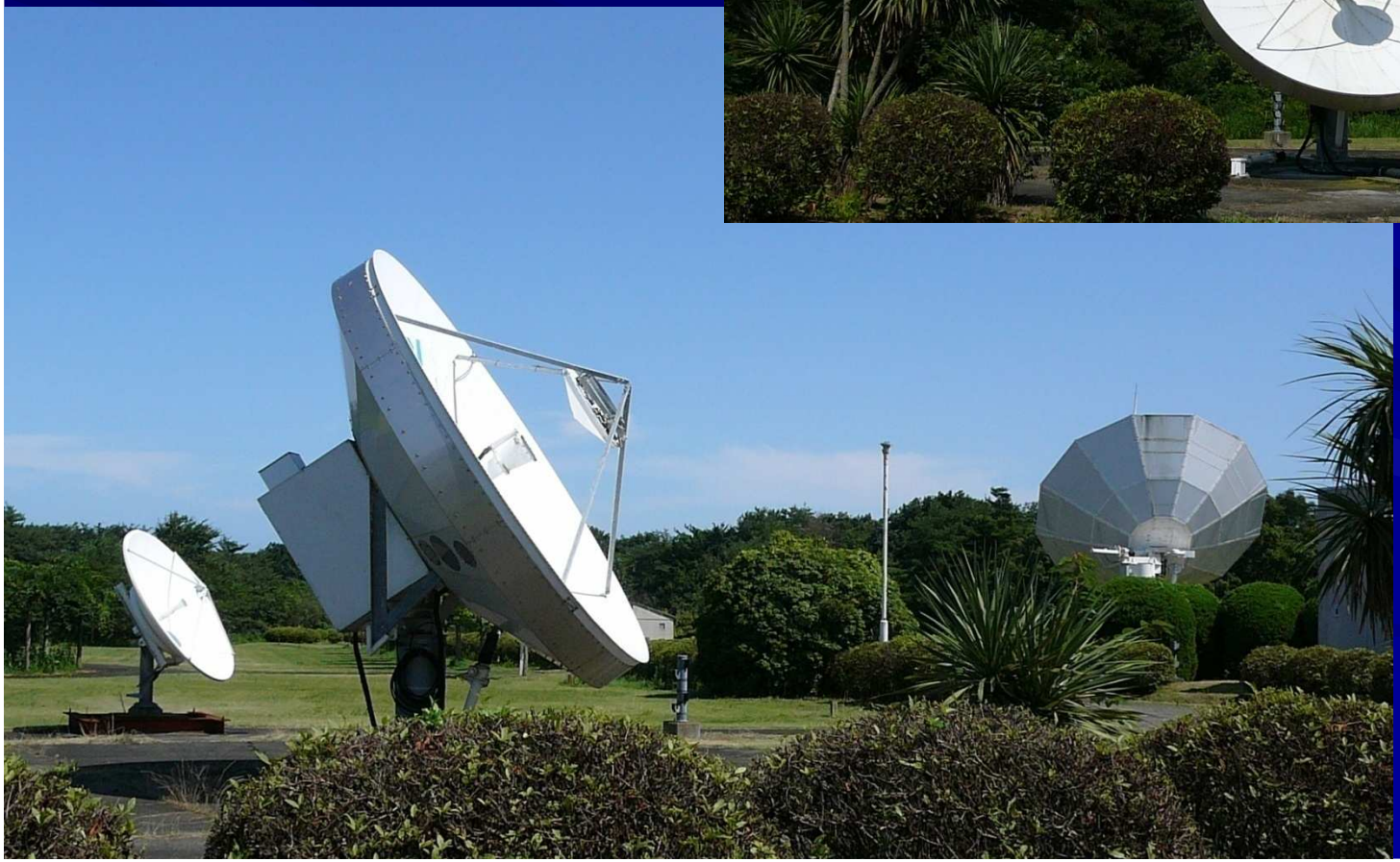
IBA-5

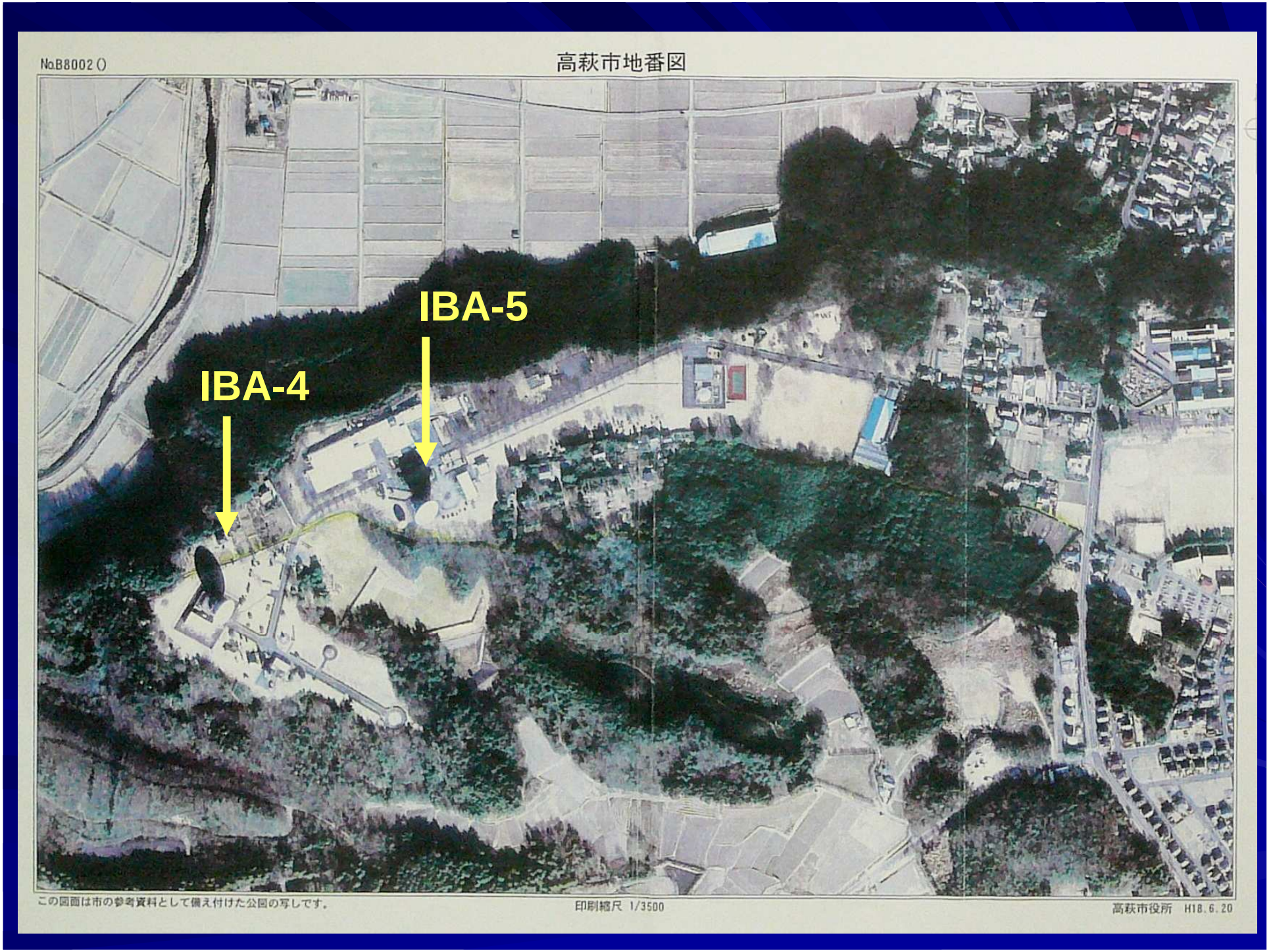
IBA-4



… and many others






No.B8002 ()
高萩市地番図
IBA-5
IBA-4
この図面は市の参考資料として備え付けた公図の写しです。
印刷縮尺 1/3500
高萩市役所 H18.6.20

PLAN

- Which frequencies & Equipments are needed?
  Antenna feeds, LNAs, HPAs
- Operation schedules depend on the moon paths
- Talks with KDDI, JARL, and Governmental Telecomm offices
- Construction for the station, adjustment, exhibition, lectures, etc. within six months!!

Project BIG-DISH

- Enthusiastic moon-bouncers all over Japan get together
- Local amateurs also get together!
- High precision large aperture antenna for EME
- Space communications for educational effect
- Advanced amateur technology is needed
- A Special license has to be issued to JARL
- The first time in Japanse amateurs' history ! ! !

Purposes of Experiment

- A precise, large scale antenna is used for EME

  (A commercial antenna is used for amateur EME for the first time in Japan)
- EME contacts to small stations
- EME exhibition to radio amateurs
- Scientific exposure to young generation such as school children and students

↓

- A moon-bounce class room under the BIG-DISH

Amateur Radio Station

- Moon bounce communications using a 32m cassegrain feed antenna
- License is issued to JARL Ibaraki Branch
- EME high power license, 500 watts@, through 144 to 5760 MHz
- EME operation by the Project BIG-DISH menbers
- Non-EME communications by local club members

Restrictions by KDDI

- No hurt to the antenna structure
- No disturbance to the commercial communications
- Keep secret rules
- All payment by amateurs
- Insurance
- Return to the original state

etc.

Memorandum

- Memoranda were signed by KDDI, JARL and Project BIG-DISH by the end of December 2006.

IBA-4


衛星通信アンテナ装置
形　　式　カセグレンアンテナ
周 波 数　送信 5850～6425 MHz
　　受信 3625～4200 MHz
主反射鏡　直径 32m
副反射鏡　直径 2.9m
一次放射器　4回反射集束ビーム方式
駆動方式　サイリスタ制御電気モータ駆動
駆動角度範囲　水平 ±200° 俯仰 0°~+92°
最大駆動角速度　水平 0.3°/s 俯仰 0.3°/s
運用可能最大風速　瞬間 33 m/s
設計最大風速　瞬間 60 m/s
可動部重量　約380t
昭和58年10月完成
三菱電機株式会社製


KDDI

Project BIG-DISH
< Fundamental design 1 >

- Moon-bounce experiment in a large scale
  = Multiple frequencies and modes

- Popular bands for EME
  144MHz/432MHz/1296MHz

- Nearly original designed frequency
  5760MHz

< Fundamental design 2 >

- TX → Legal limit high power
  500 watts output

  RX → Lowest noise figure, highest gain
  LNA NF: 0.2 – 0.5 dB
  Gain: 30 – 40 dB

- Modes → CW, SSB and JT65

< Fundamental design 3 >

- Microwave EME 5.7GHz

- TX Legal limit high power
  500 watts output
- RX Lowest noise figure, highest gain
  LNA NF: 0.5 dB
  Gain: 30 – 40 dB

Modes: CW, SSB and FM

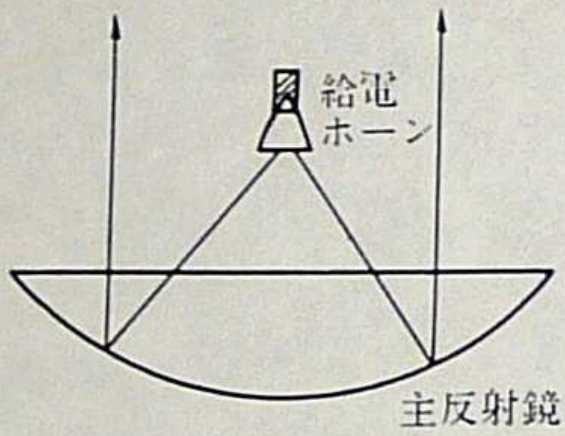
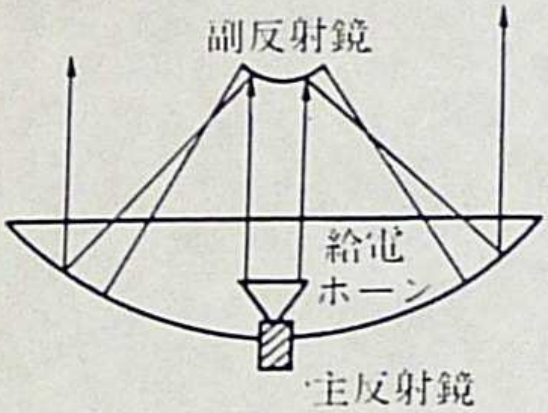
Project BIG-DISH

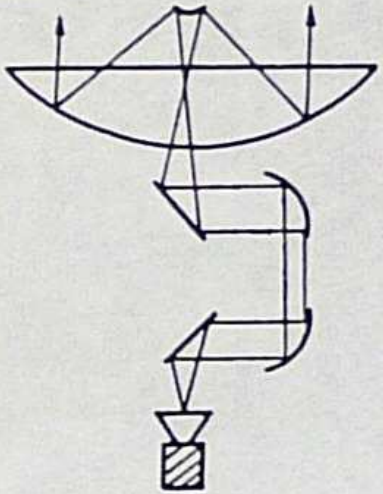
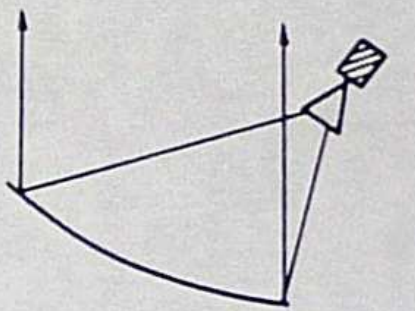
< Fundamental policy >

To be a EME marker signal on each band!!

BIG-SIGNAL!

FROM BIG-DISH!

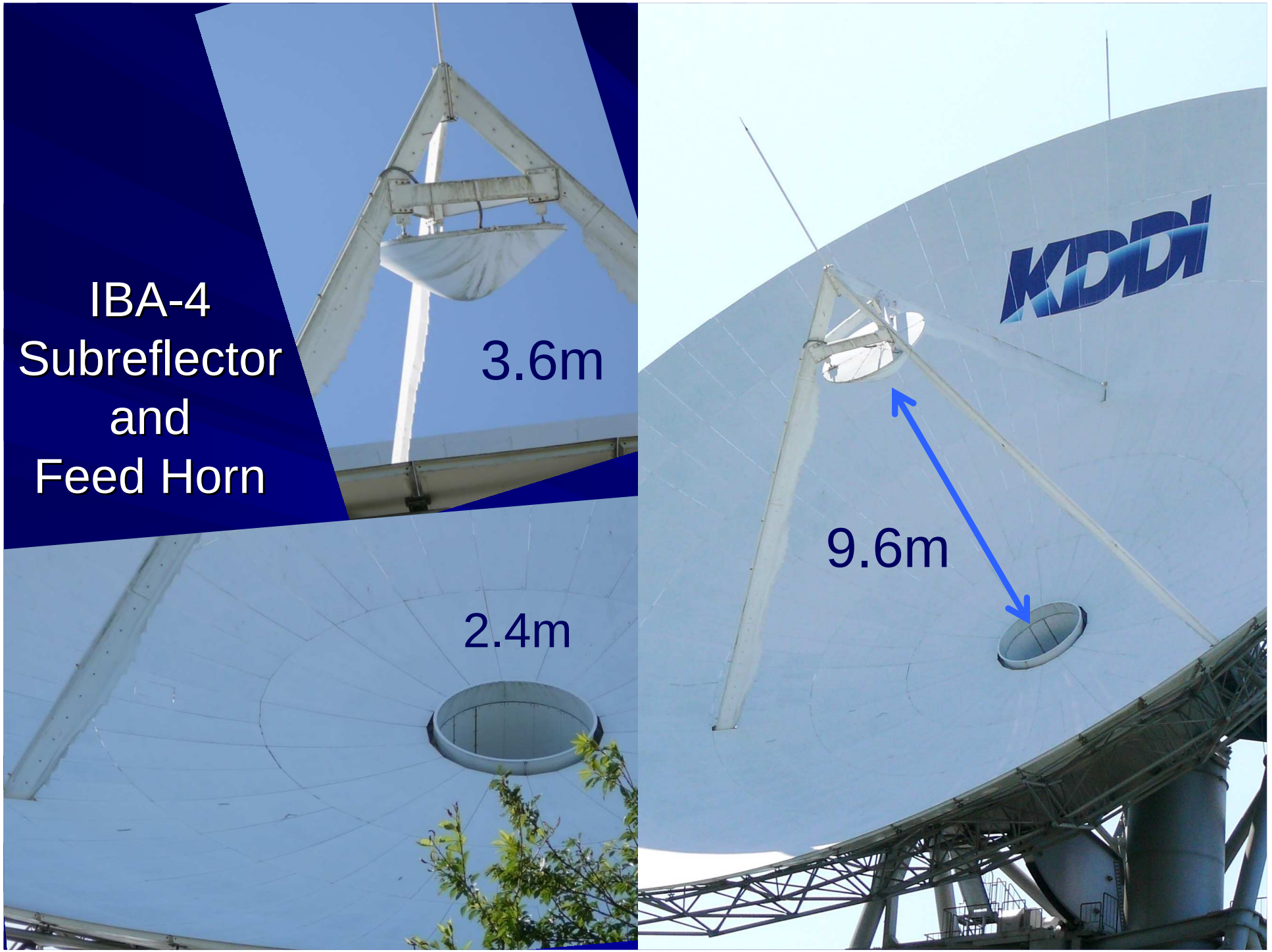
名称	焦点給電パラボラアンテナ	カセグレンアンテナ
形状		
特徴	・構造簡易，安価 ・低効率 ・サイドローブ特性が悪い ・大口径アンテナには不適 (送信機との距離が長い)	・高効率，低雑音 ・サイドローブ特性もある程度良い ・若干高価
適用領域	・小型地球局用 ・受信専用局用	・中大地球局を含め広く使用されている

ビーム給電型カセグレンアンテナ	オフセットパラボラアンテナ	オ
		
・高効率，低雑音 ・送受信機が地上に固定設置できる ・サイドローブ特性良好 ・高価	・高効率，低雑音 ・低サイドローブ ・ビームは若干非対称	
・大型地球局に好適 ・インテルサットの30 m 級地球局で使われている	・小型，高性能地球局に好適	

出典：

「衛星通信入門」

オーム社


IBA-4
Subreflector
and
Feed Horn
3.6m
2.4m
9.6m
KDDI

Inspection

Kony JM1GSH
comes out from the hatch

January 2007


KDDI

C-BAND FEED HORN, 2.4M

4th REFLECTOR

How do you illuminate the sub-reflector for moon-bounce?

SUB-REFLECTOR, 3.6M

Antenna For Moon-Bouce

- Accurate moon tracking
  → Programmed tracking
- High gain and low noise temperature
  → High G/T ratio
  Low side-lobe levels
- High power handling capability

AZ-EL rotation

0-370 deg. Azimuth

5-110 deg. Elevation

Programmed tracking

Original computer program:

Put in the moon data of every one hour.
Compensation by smoothening the values.

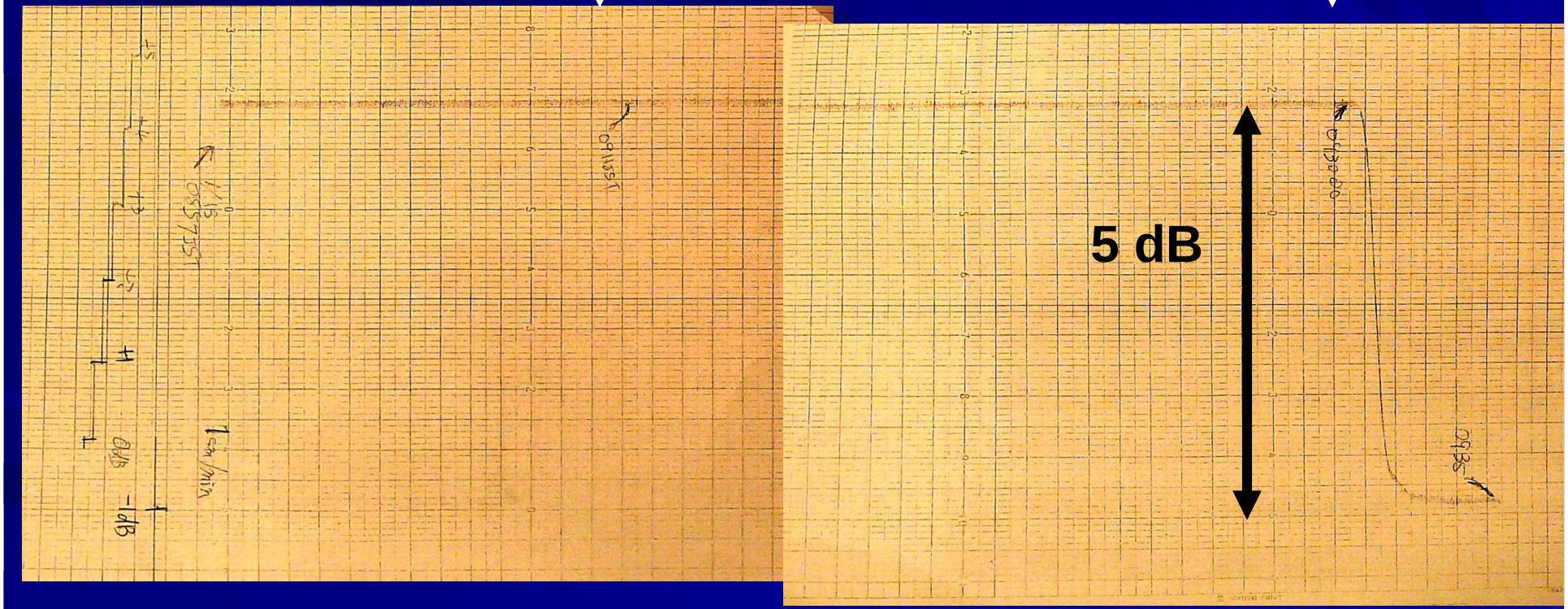
		EME forcast		IBK-4 Program Track			
UTC	Local	Az	El	Az	El	Az dev	El dev
07/01/12 17:00	07/01/13 02:00	119.32	8.83	119.3200	8.8300	0.0000	0.0000
07/01/12 17:10	07/01/13 02:10	120.97	10.48	120.5825	10.0394	0.3875	0.4406
07/01/12 17:20	07/01/13 02:20	122.67	12.10	122.0980	11.4601	0.5720	0.6399
07/01/12 17:30	07/01/13 02:30	124.40	13.70	123.8269	13.0419	0.5731	0.6581
07/01/12 17:40	07/01/13 02:40	126.19	15.26	125.7286	14.7343	0.4614	0.5257
07/01/12 17:50	07/01/13 02:50	128.01	16.77	127.7631	16.4871	0.2469	0.2829
07/01/12 18:00	07/01/13 03:00	129.89	18.25	129.8900	18.2500	0.0000	0.0000
07/01/12 18:10	07/01/13 03:10	131.82	19.69	131.8261	19.6990	-0.0061	-0.0090
07/01/12 18:20	07/01/13 03:20	133.81	21.09	133.8158	21.1043	-0.0058	-0.0143
07/01/12 18:30	07/01/13 03:30	135.85	22.46	135.8606	22.4625	-0.0106	-0.0025
07/01/12 18:40	07/01/13 03:40	137.96	23.77	137.9620	23.7701	-0.0020	-0.0001
07/01/12 18:50	07/01/13 03:50	140.12	25.02	140.1213	25.0238	-0.0013	-0.0038
07/01/12 19:00	07/01/13 04:00	142.34	26.22	142.3400	26.2200	0.0000	0.0000
07/01/12 19:10	07/01/13 04:10	144.63	27.36	144.6376	27.3559	-0.0076	0.0041
07/01/12 19:20	07/01/13 04:20	146.98	28.43	146.9944	28.4275	-0.0144	0.0025
07/01/12 19:30	07/01/13 04:30	149.39	29.44	149.4088	29.4312	-0.0188	0.0088
07/01/12 19:40	07/01/13 04:40	151.86	30.37	151.8789	30.3636	-0.0189	0.0064
07/01/12 19:50	07/01/13 04:50	154.39	31.22	154.4032	31.2210	-0.0132	-0.0010
07/01/12 20:00	07/01/13 05:00	156.98	32.00	156.9800	32.0000	0.0000	0.0000
07/01/12 20:10	07/01/13 05:10	159.62	32.70	159.6330	32.6895	-0.0130	0.0105
07/01/12 20:20	07/01/13 05:20	162.31	33.30	162.3309	33.2948	-0.0209	0.0052
07/01/12 20:30	07/01/13 05:30	165.05	33.82	165.0675	33.8138	-0.0175	0.0062
07/01/12 20:40	07/01/13 05:40	167.82	34.25	167.8369	34.2441	-0.0169	0.0059
07/01/12 20:50	07/01/13 05:50	170.62	34.59	170.6331	34.5836	-0.0131	0.0064
07/01/12 21:00	07/01/13 06:00	173.45	34.83	173.4500	34.8300	0.0000	0.0000
		176.29	34.97	176.2908	34.9652	-0.0008	0.0048
		179.14	35.02	179.1388	35.0057	0.0012	0.0143
		181.99	34.96	181.9862	34.9519	0.0038	0.0081
		184.83	34.81	184.8257	34.8043	0.0043	0.0057
		187.65	34.57	187.6495	34.5635	0.0005	0.0065
		190.45	34.23	190.4500	34.2300	0.0000	0.0000
07/01/12 22:10	07/01/13 07:10	193.21	33.79	193.2022	33.7907	0.0078	-0.0007

Moon Position data
from EME PLANNER
F1EHN

Moon Noise Measurement with Programmed Tracking

Programmed tracking

Stopped

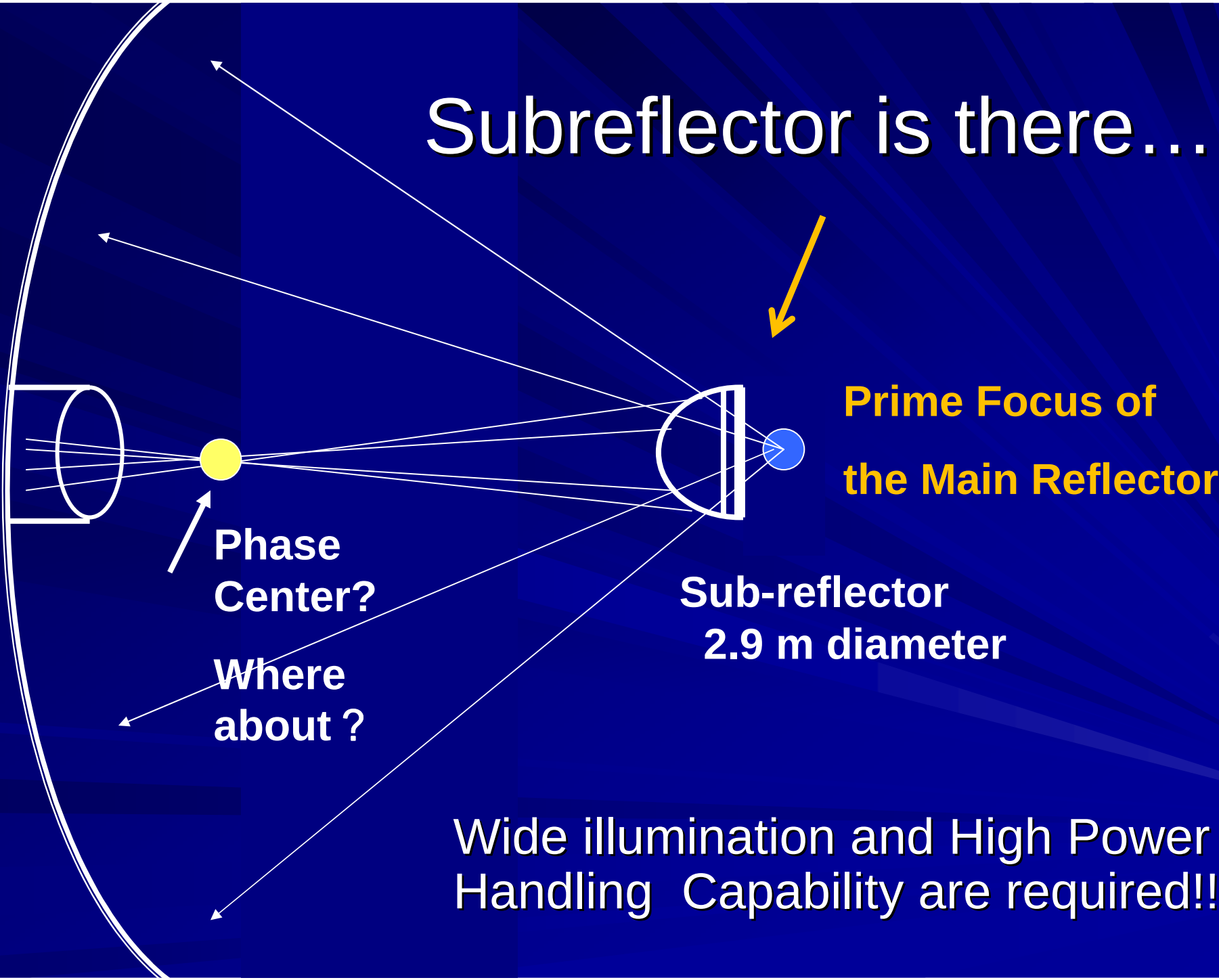


Moon Noise was recorded with the IBA-4 4GHz receiver

Characteristics of Parabolic Reflector

- Wide-band reflector
- Effective diameter could be >10 wave-length
- Need antenna feed for each band?

Subreflector is there…



Wide illumination and High Power Handling Capability are required!!

A Subreflector is there…
How to treat it?

Do not remove! It's a fundamental rrestriction

Antenna feed for EME could be …

- For 144MHz, 432MHz and 1296MHz:
  1) Use of a Yagi feed?
  2) A loop feed in front of the subreflector?
  3) A round feed horn in position?

etc.

→ High power capability and a wide-angle radiation pattern are necessary!!

2 m 144 MHz

70 cm 432 MHz

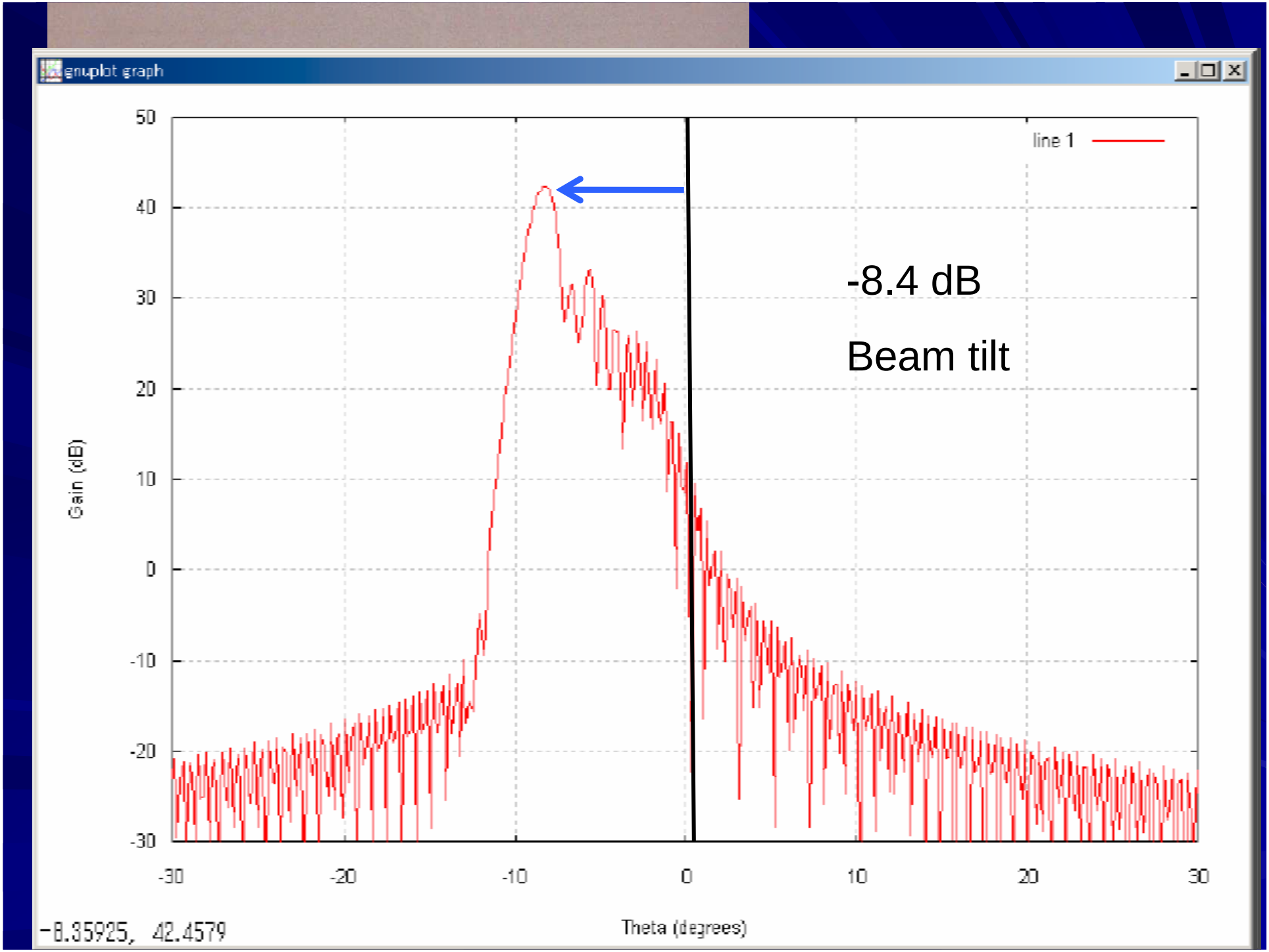
Stacked Yagi-feed

Beam width ?
>140 °

Stacking space?

Multi-band ?

= Difficult!!


gnuplot graph
line 1
-8.4 dB
Beam tilt
Gain (dB)
Theta (degrees)
50
40
30
20
10
0
-10
-20
-30
-30
-20
-10
0
10
20
30
-8.35925, 42.4579

Defocused Feed

Axial defocusing

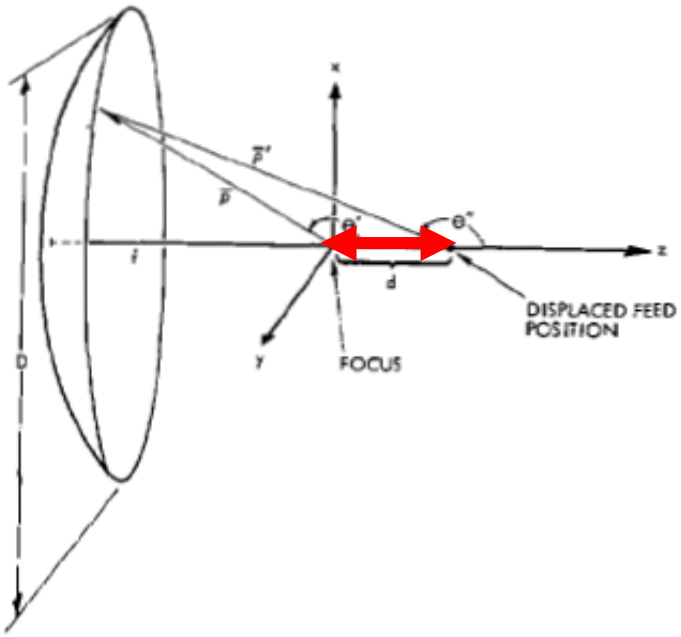


Fig. 1. Geometry of paraboloid with axially defocused feed.

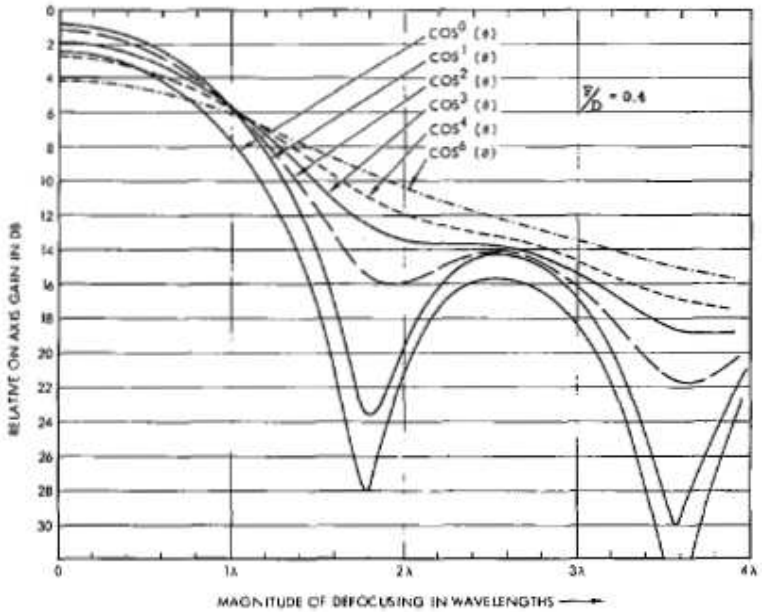


Fig. 4. Relative boresight gain as function of defocusing for $\cos^N \theta$ illumination.

IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, JANUARY 1973

Radiation from a Paraboloid with an Axially Defocused Feed

PAUL G. INGERSON AND WILLARD V. T. RUSCH

Use of the original antenna

- 5760MHz:

  Original feed horn is a proper choice for this band. Available:

  High power handling capability

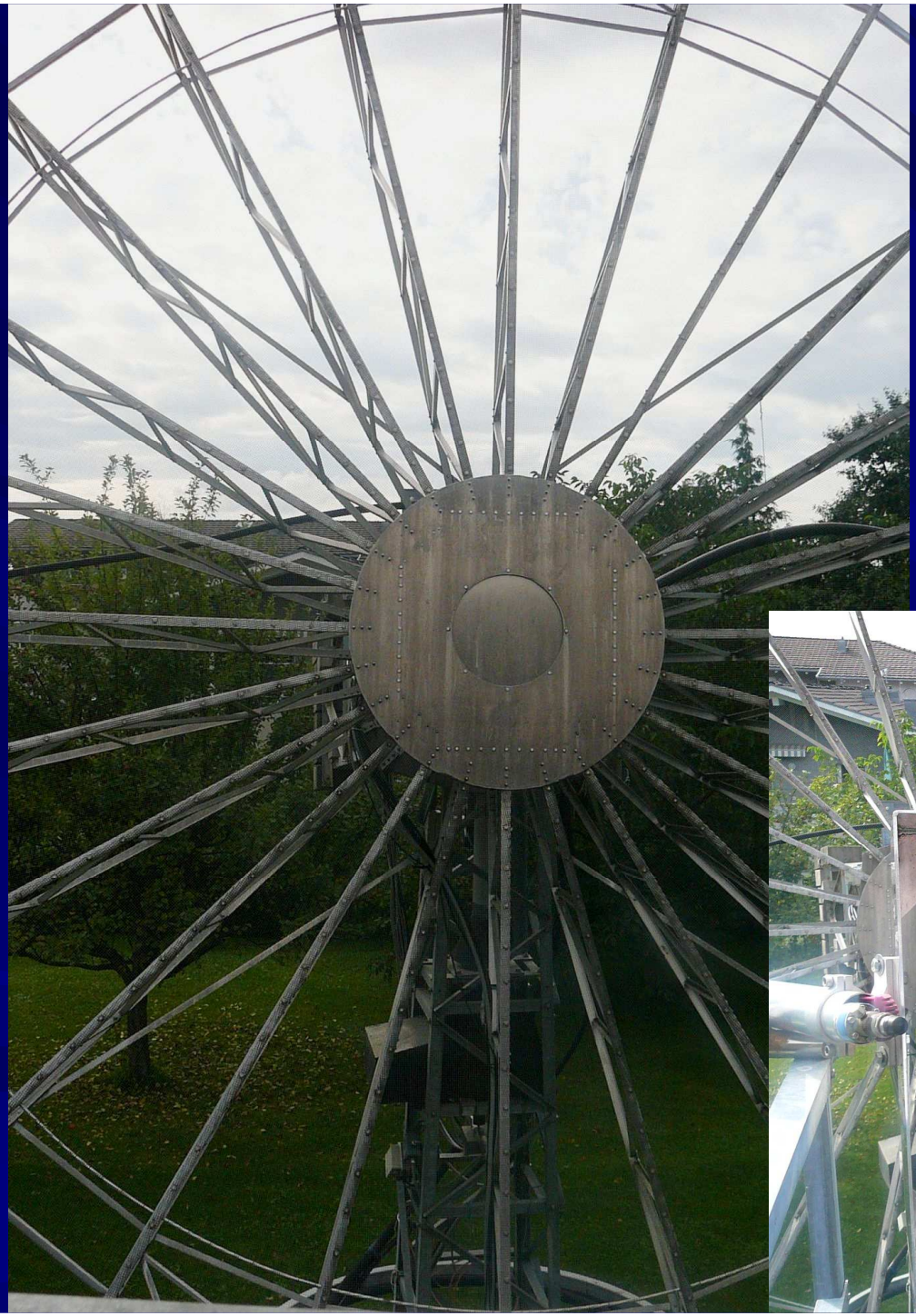
  Wide-beam pattern to illuminate 32m dish

  R/L helical circular polarization

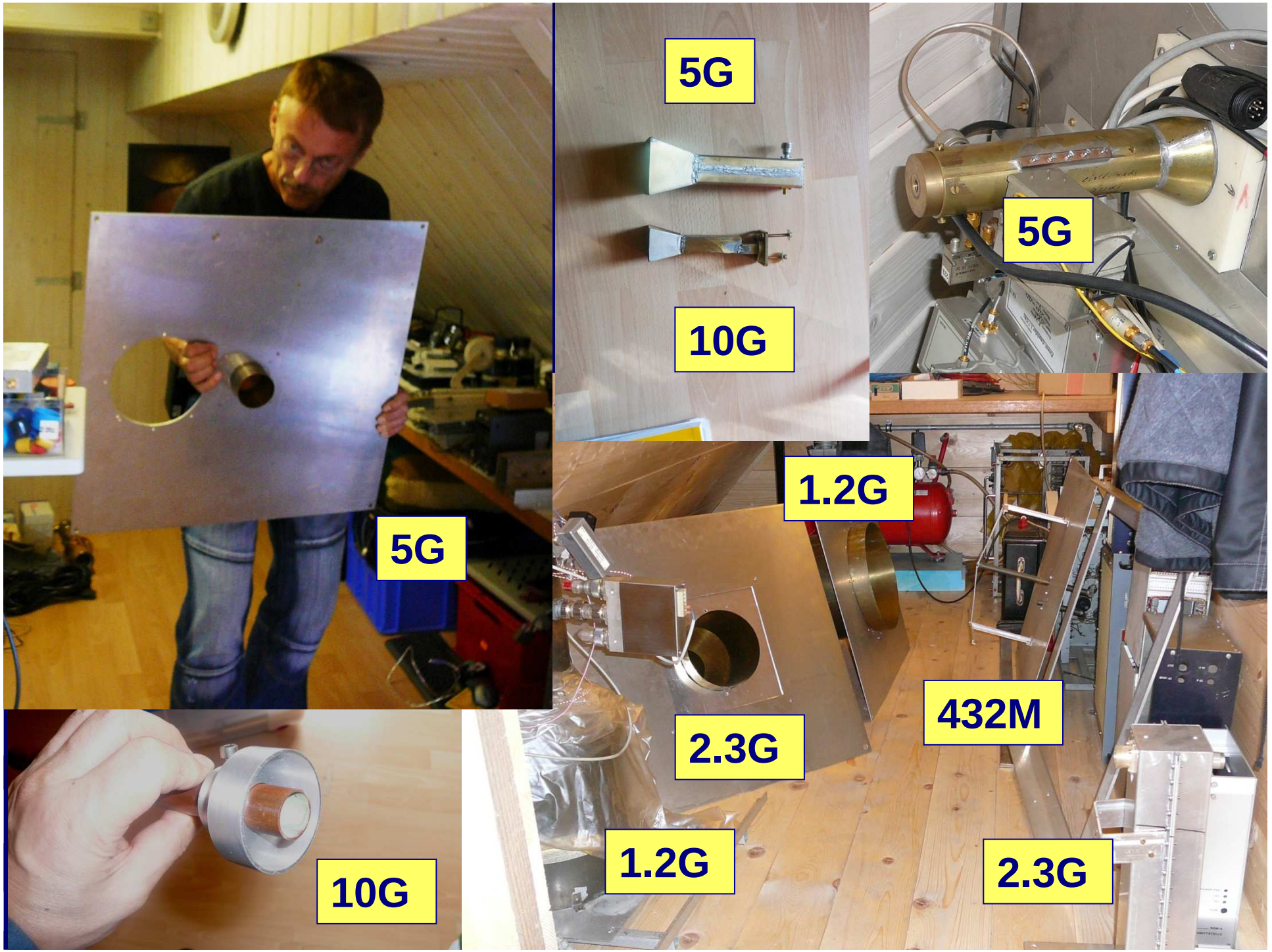
  → The most favorable operating frequency is 5760MHz. Antenna gain = 64dBi

Multi-band operation

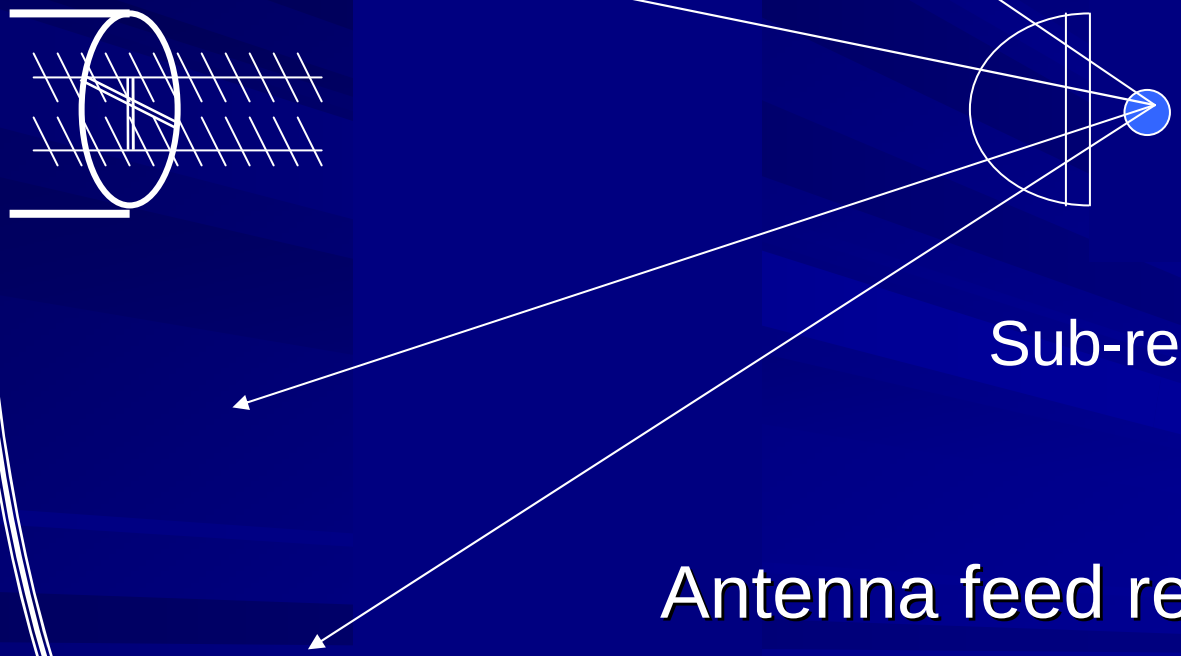
How to change the antenna feeds?



OE9ERC
Erich
8 m dish


5G
10G
5G
5G
1.2G
2.3G
1.2G
432M
2.3G
10G

Prime focus is behind the Sub-reflector



Prime focus of the main reflector

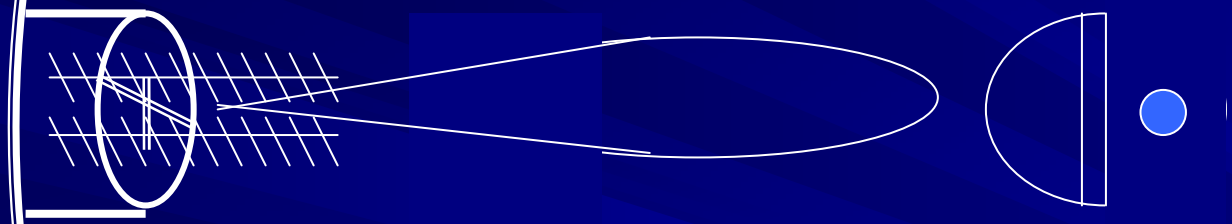
Sub-reflector

Antenna feed requires:

Wide radiation angel = 140 deg.

High power handling = 500 watts

Prime focus is behind the Sub-reflector



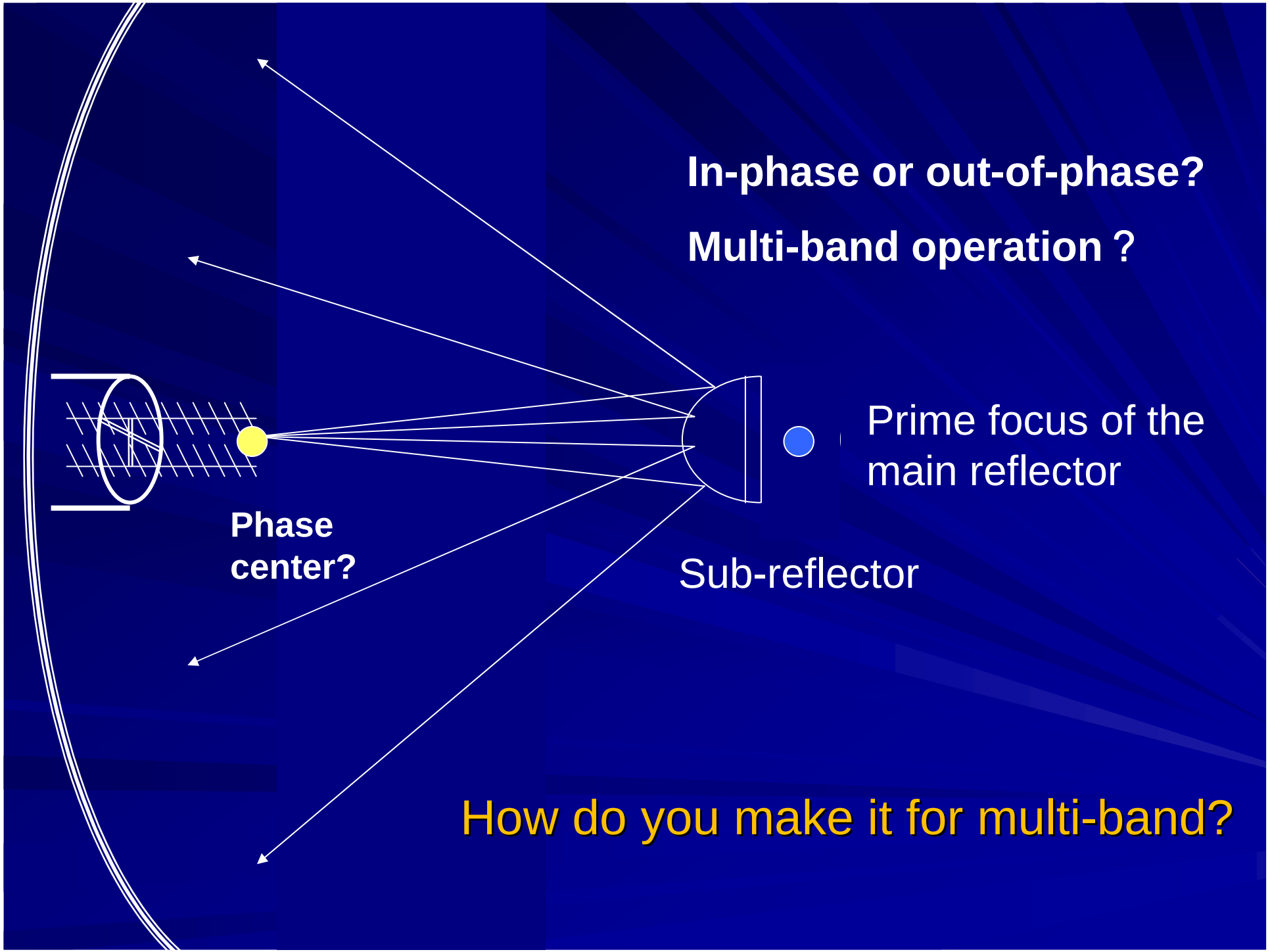
Prime focus of the main reflector

Sub-reflector

Use YAGI antenna

in the phase center of the dish

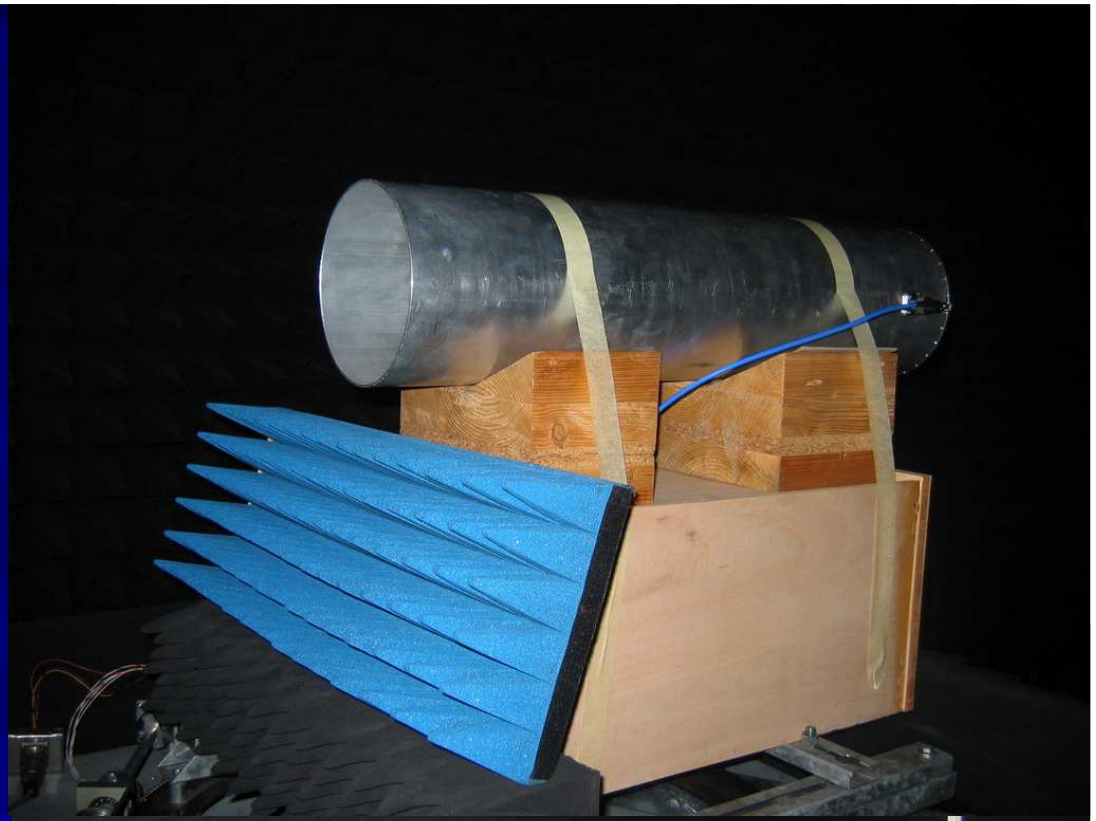
<Method> Model 2x1230, Two 30-element YAGIs
Boom length 2 3 0 0 mm
Catalogue gain 24dBi, Power rate 300Wpep

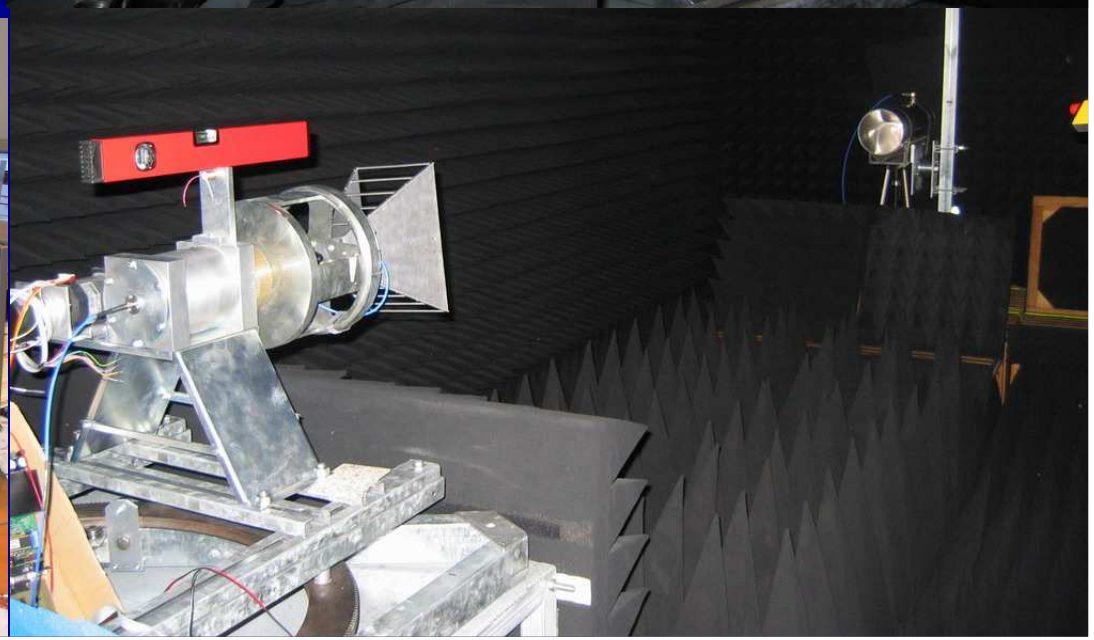

In-phase or out-of-phase?
Multi-band operation ?
Prime focus of the main reflector
Phase center?
Sub-reflector
How do you make it for multi-band?

Septum Feed

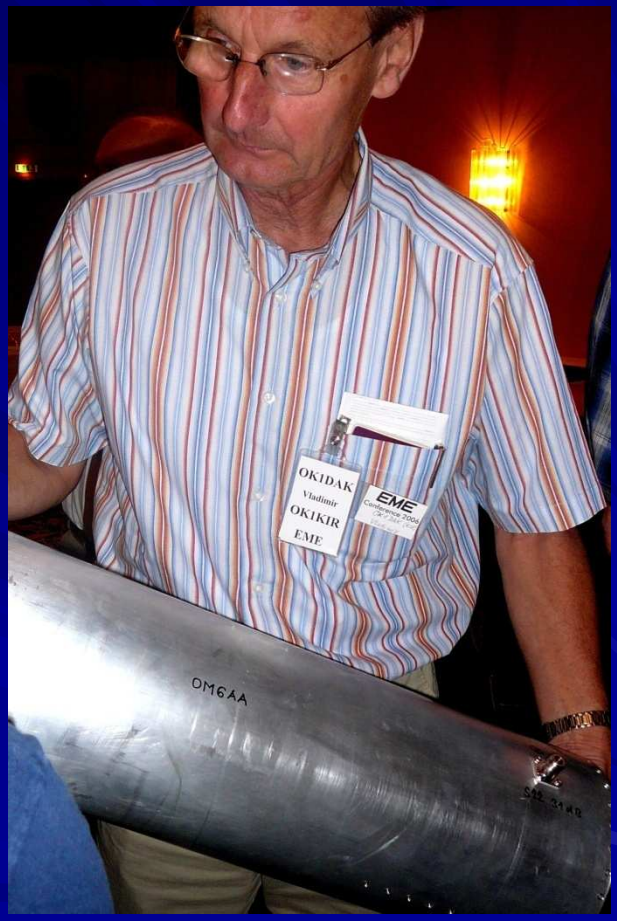
Czech Technical University

OM6AA
Mr. Hazdra
OM1ATT et al.



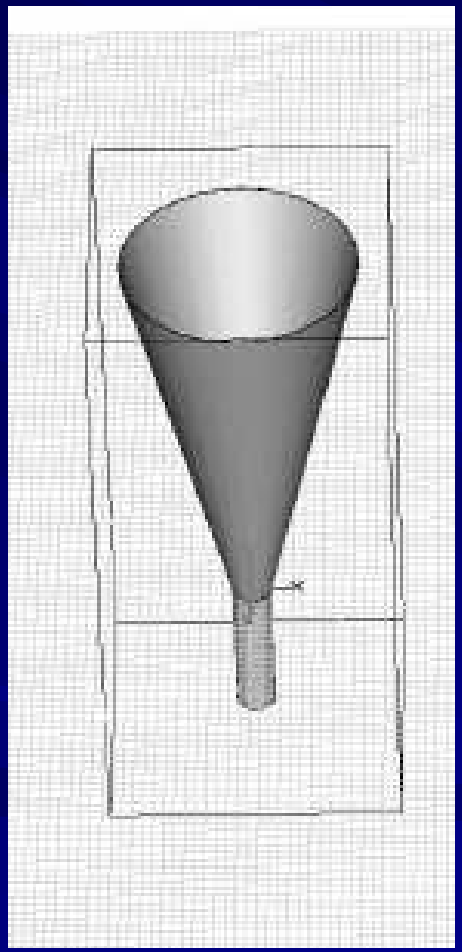


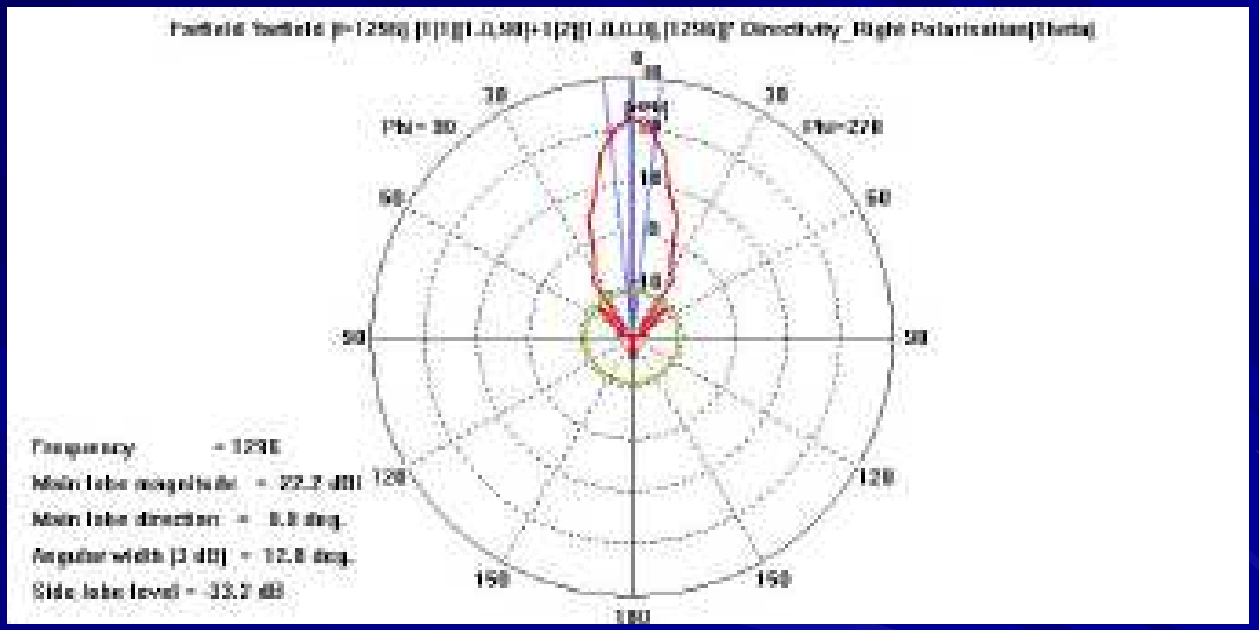
Round Septum Feed



S11 better than 30 dB
Port to port isolation S 21= 26 dB
Circularity in boresight transmittion = 0.2 dB

Round Feed Horn





Gain 22 dBi

Angular width 12.8 deg.

10 WL

Use of US Army antenna

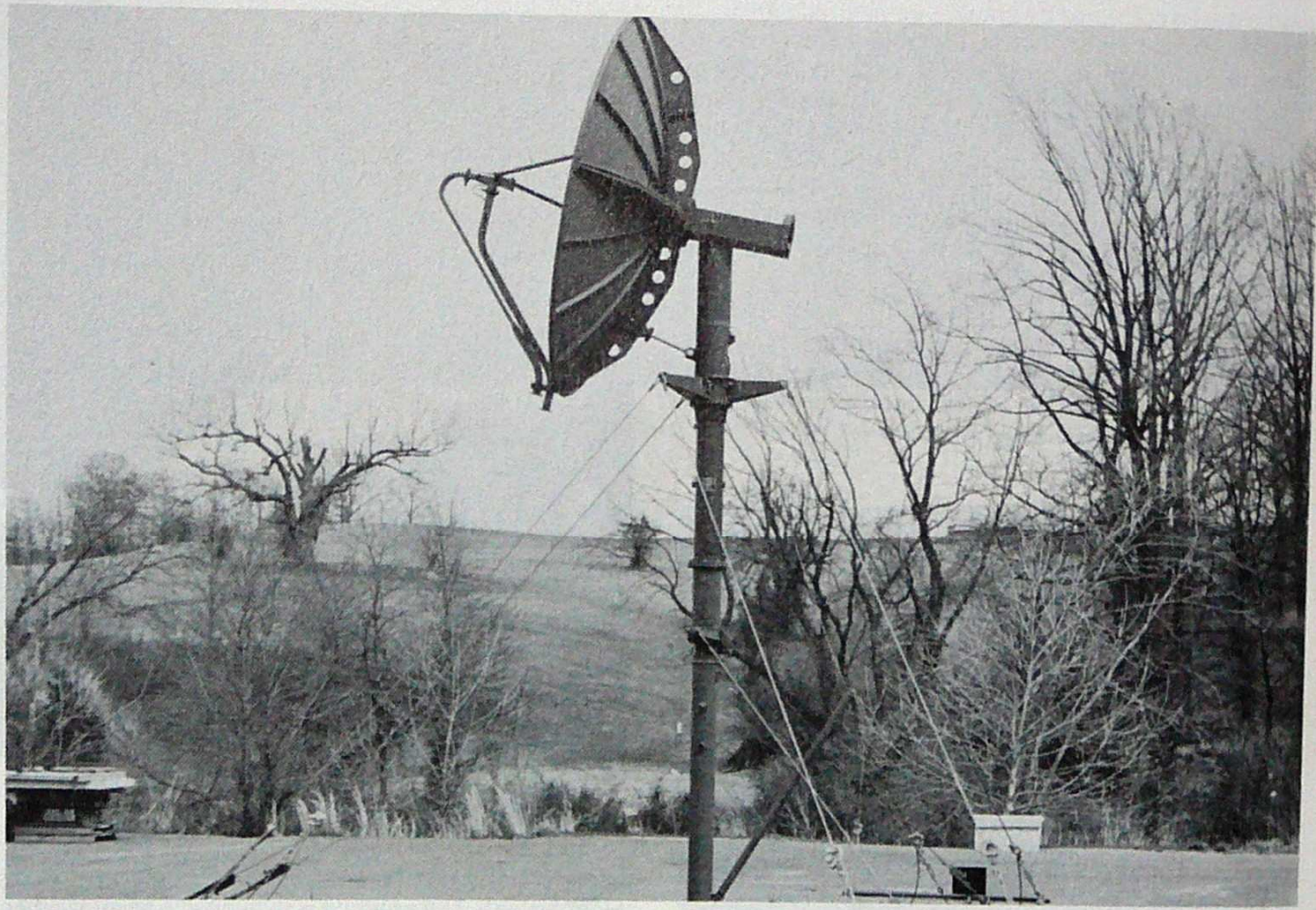
VSRT-2

2.4m alminium

5 GHz

Portable

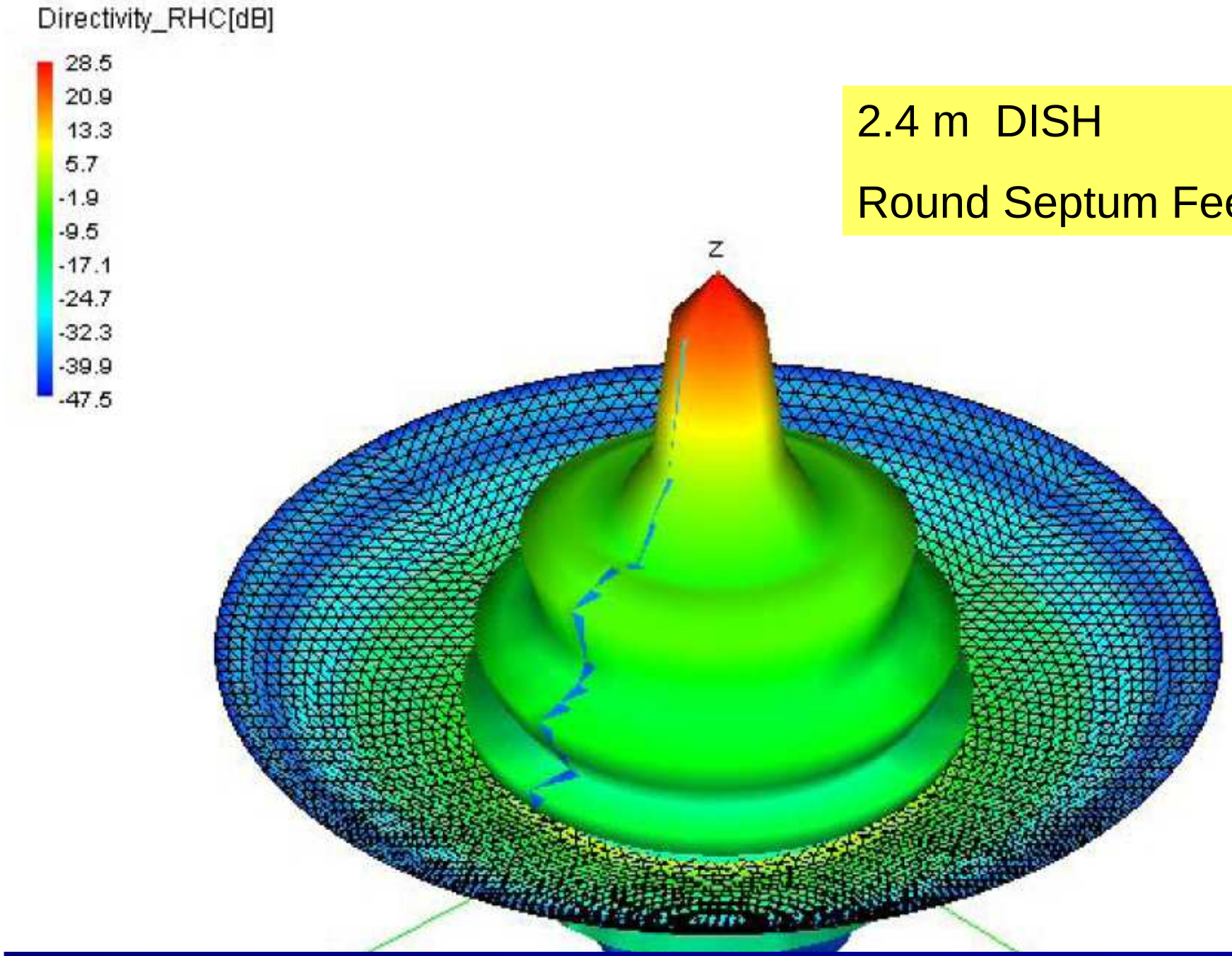
Jane Military Communication



VSRT-2 antenna

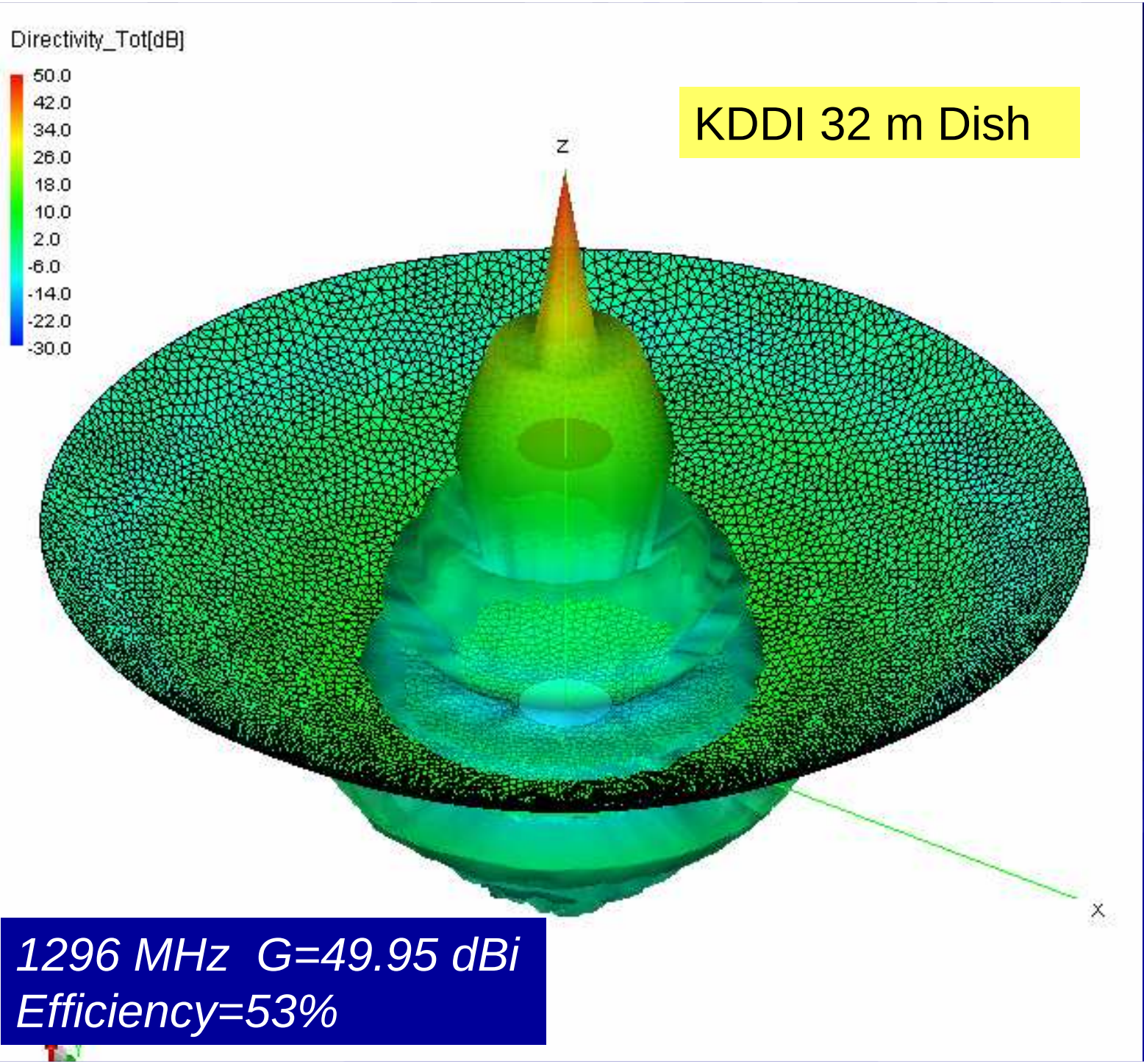
VSRT-2 Very short-range Transportable Antenna

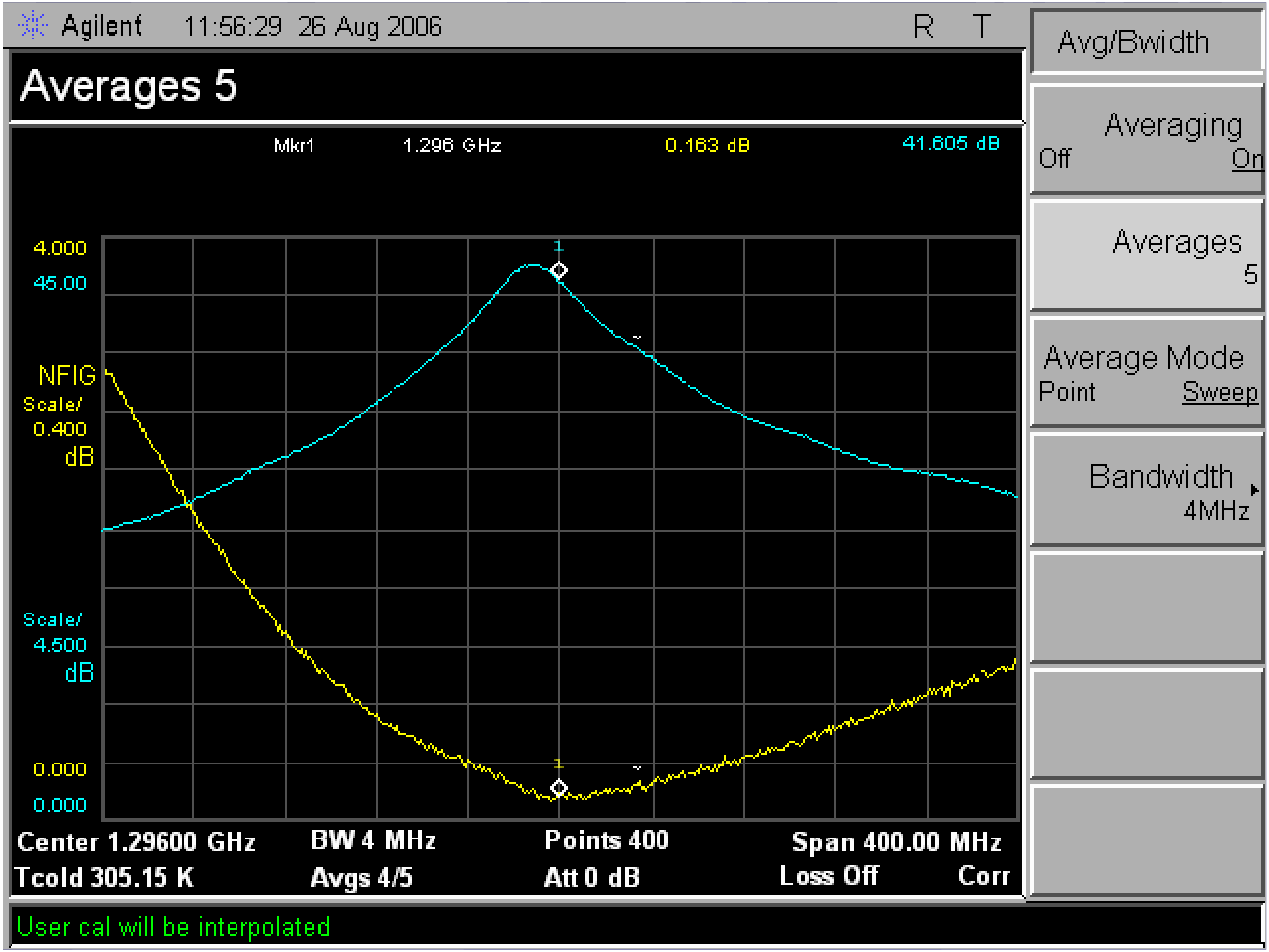
The VSRT-2 is designed to be used with the AN/TRC-97A radio at 4.4 to 5 GHz with transmit power up to 2 kW CW. It can operate in winds up to 161 km/h

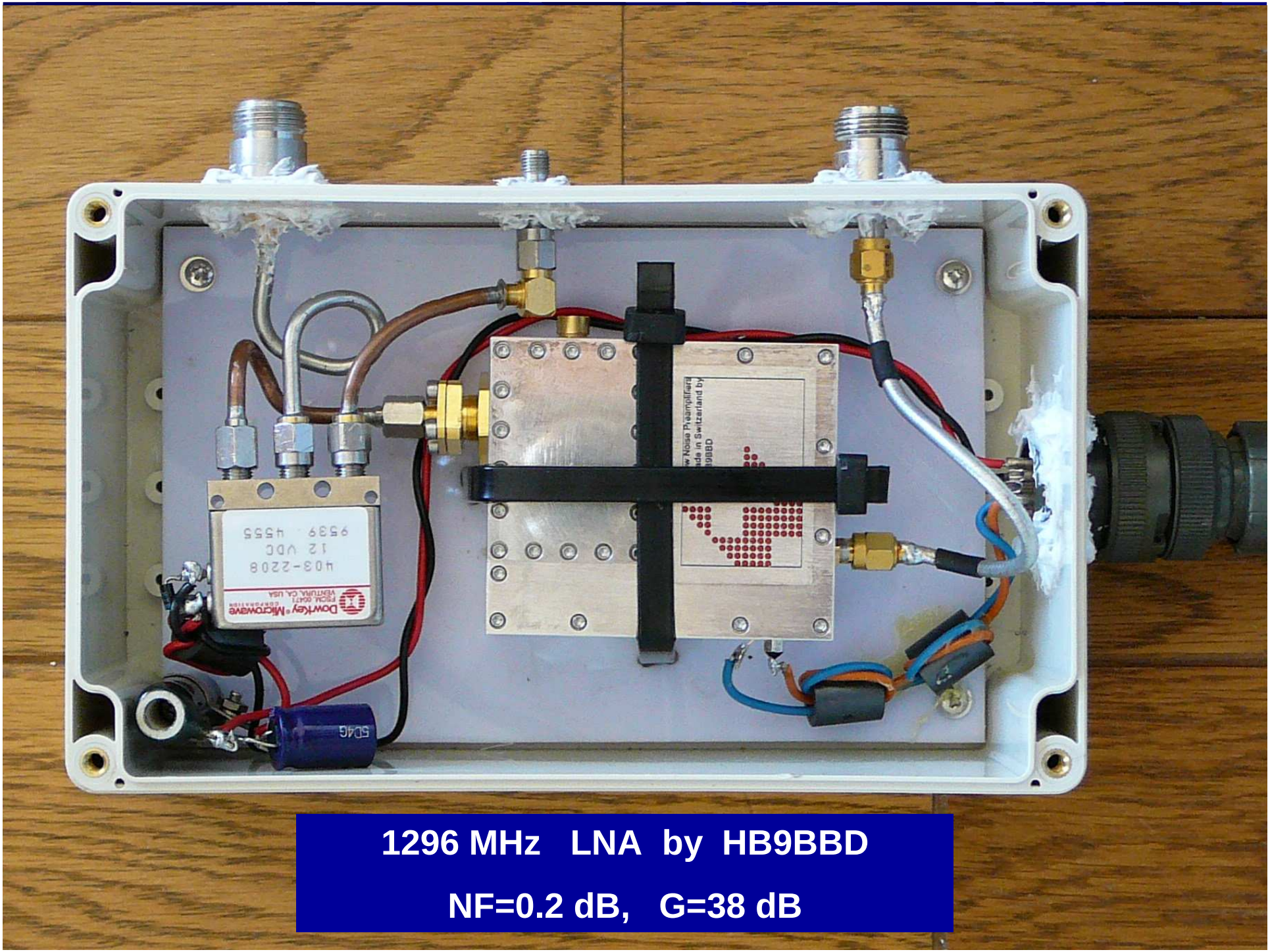


2.4 m DISH

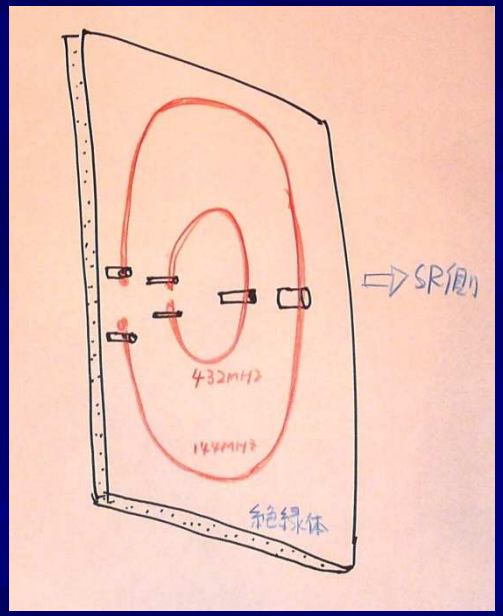
Round Septum Feed

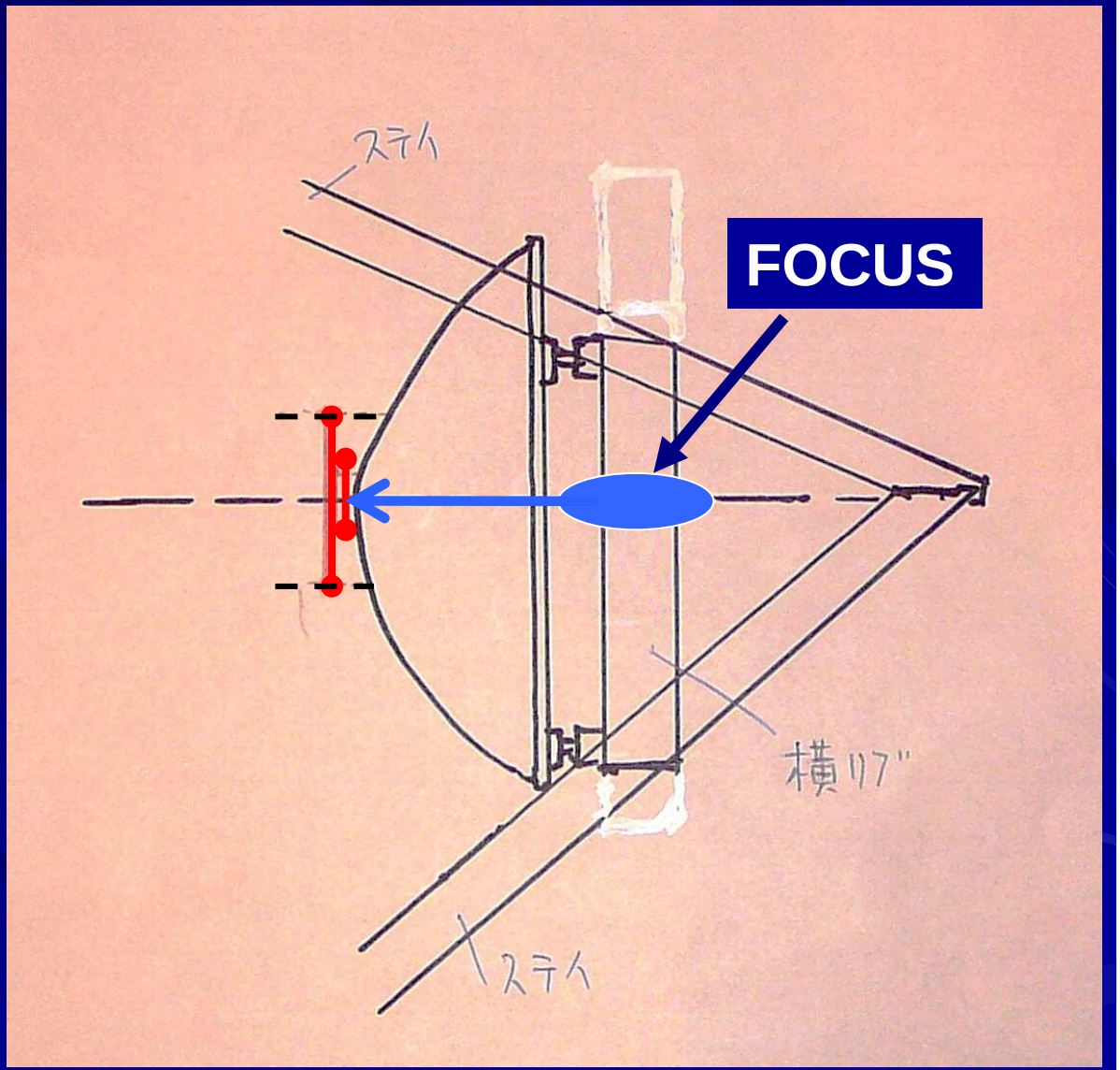

Directivity_Tot[dB]
50.0
42.0
34.0
26.0
18.0
10.0
2.0
-6.0
-14.0
-22.0
-30.0
KDDI 32 m Dish
z
x
1296 MHz G=49.95 dBi
Efficiency=53%


Agilent 11:56:29 26 Aug 2006
R T
Averages 5
Mkr1 1.296 GHz 0.163 dB 41.605 dB
4.000
46.00
NFIG
Scale/
0.400
dB
Scale/
4.500
dB
0.000
0.000
Center 1.29600 GHz
BW 4 MHz
Points 400
Span 400.00 MHz
Tcold 305.15 K
Avgs 4/5
Att 0 dB
Loss Off
Corr
User cal will be interpolated
Avg/Bwidth
Averaging
Off On
Averages
5
Average Mode
Point Sweep
Bandwidth
4MHz

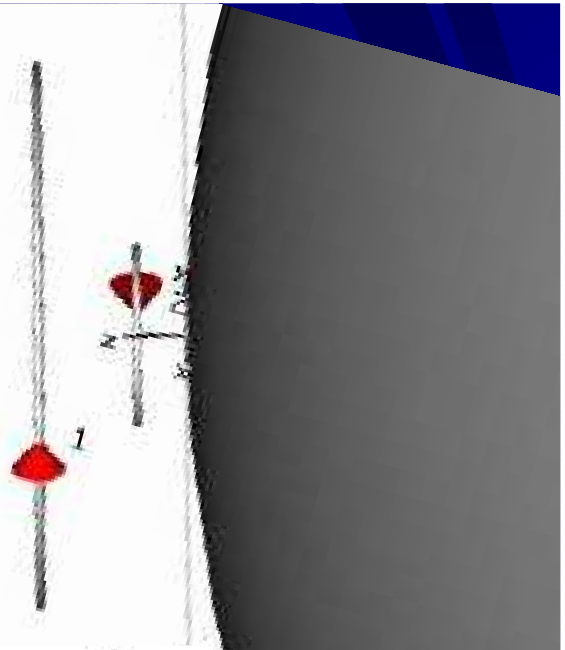

1296 MHz LNA by HB9BBD
NF=0.2 dB, G=38 dB

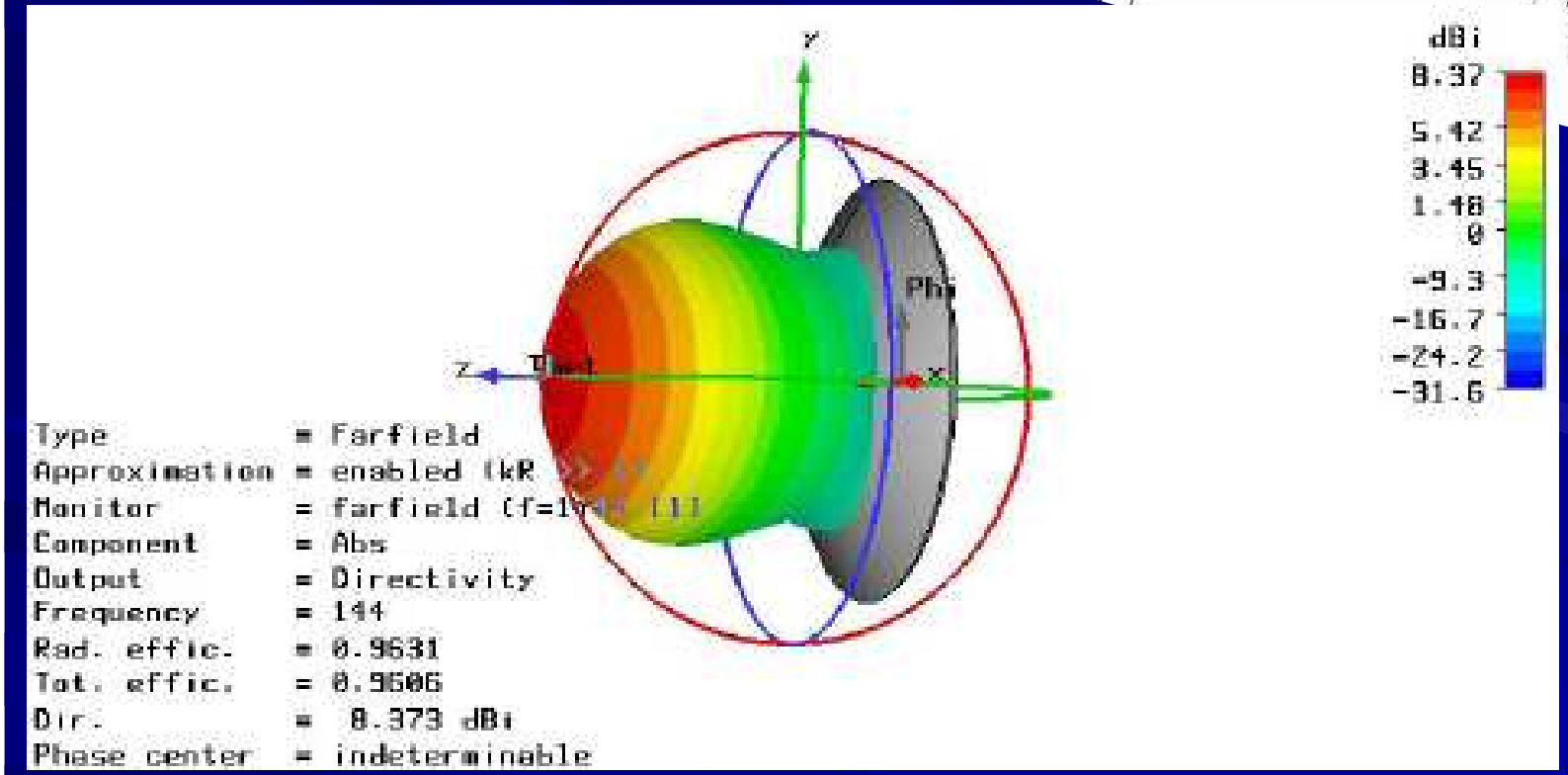
144 & 432 MHz Loop Feed

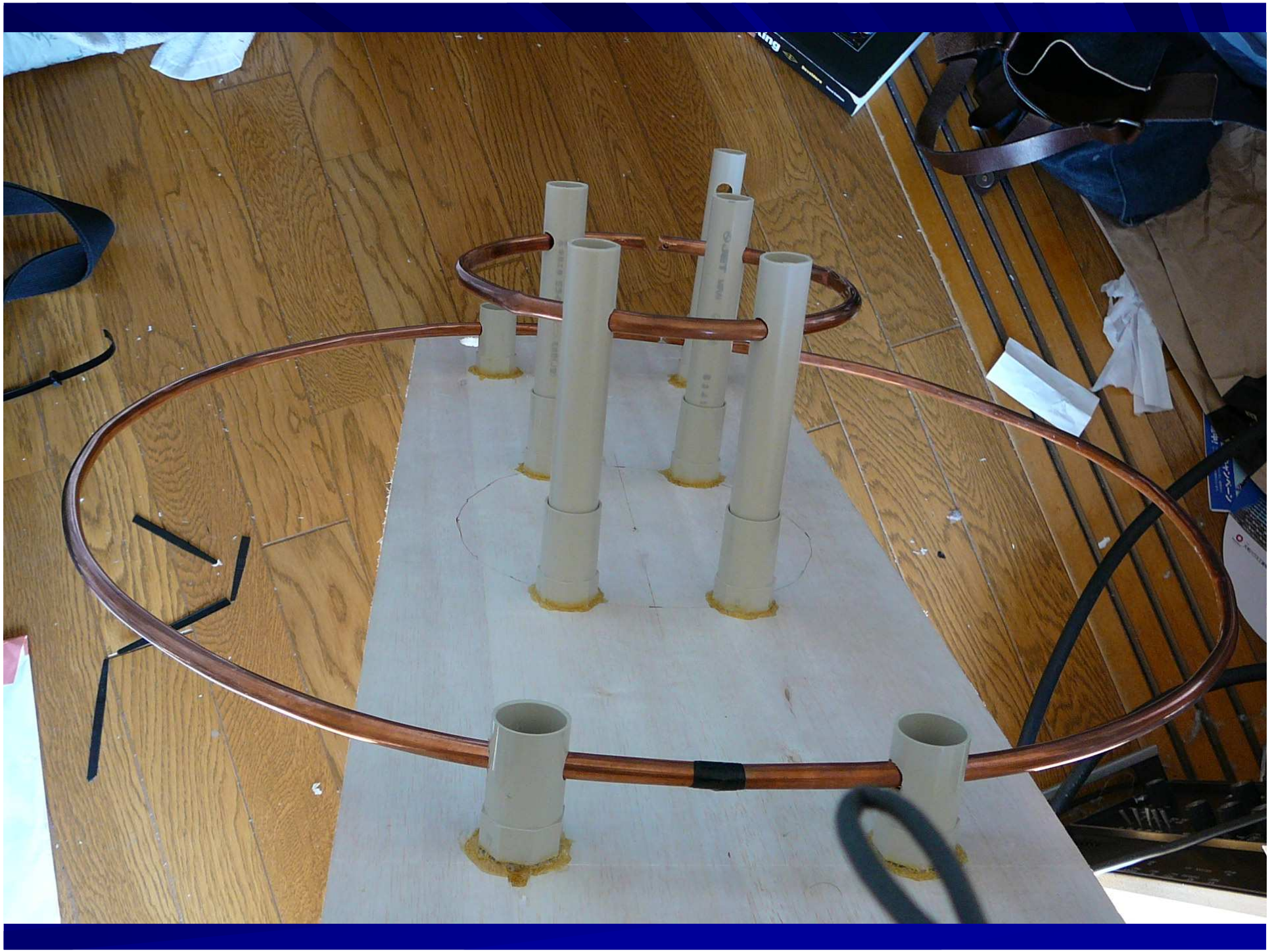




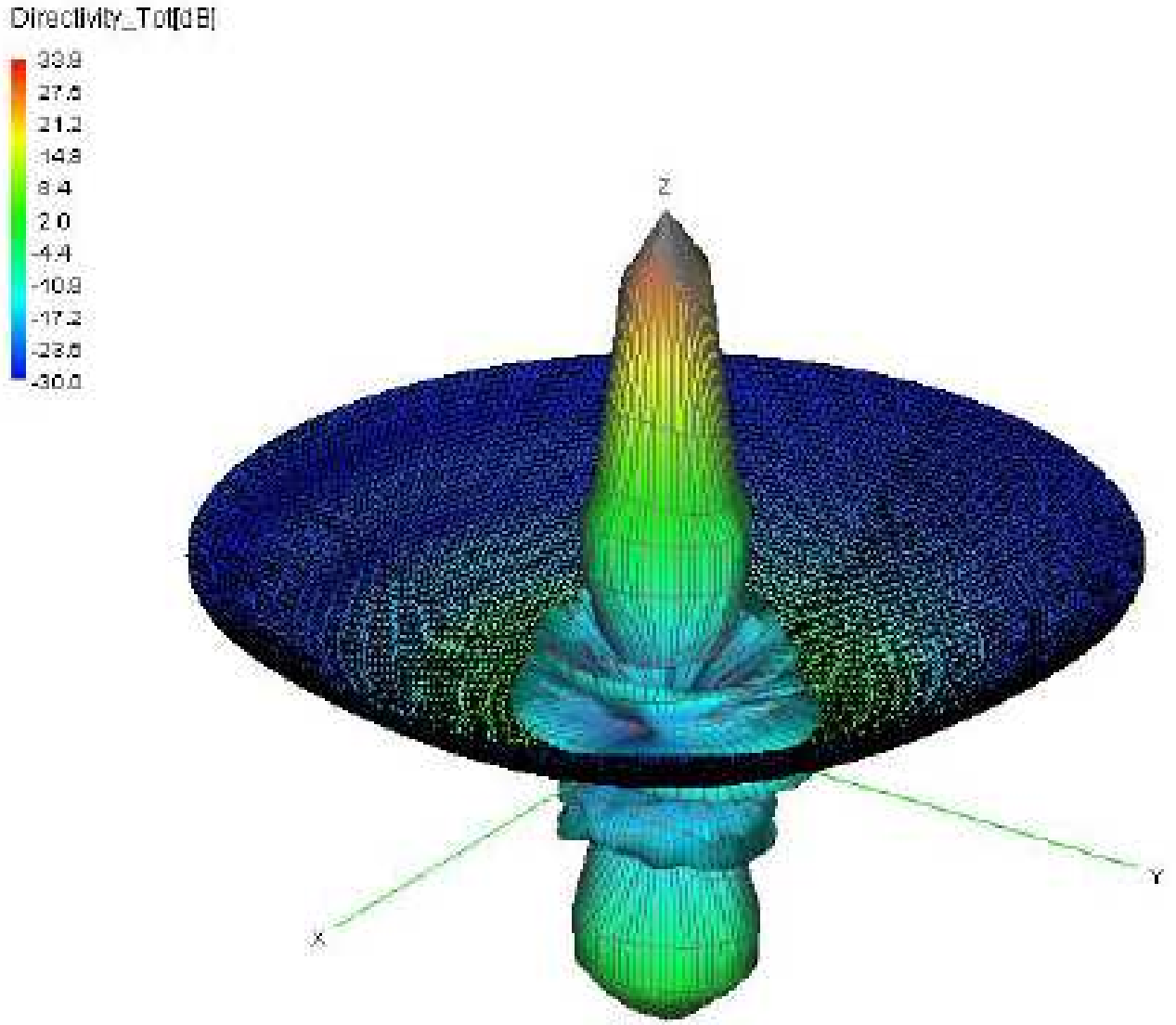
144&432 MHz Loop Feed





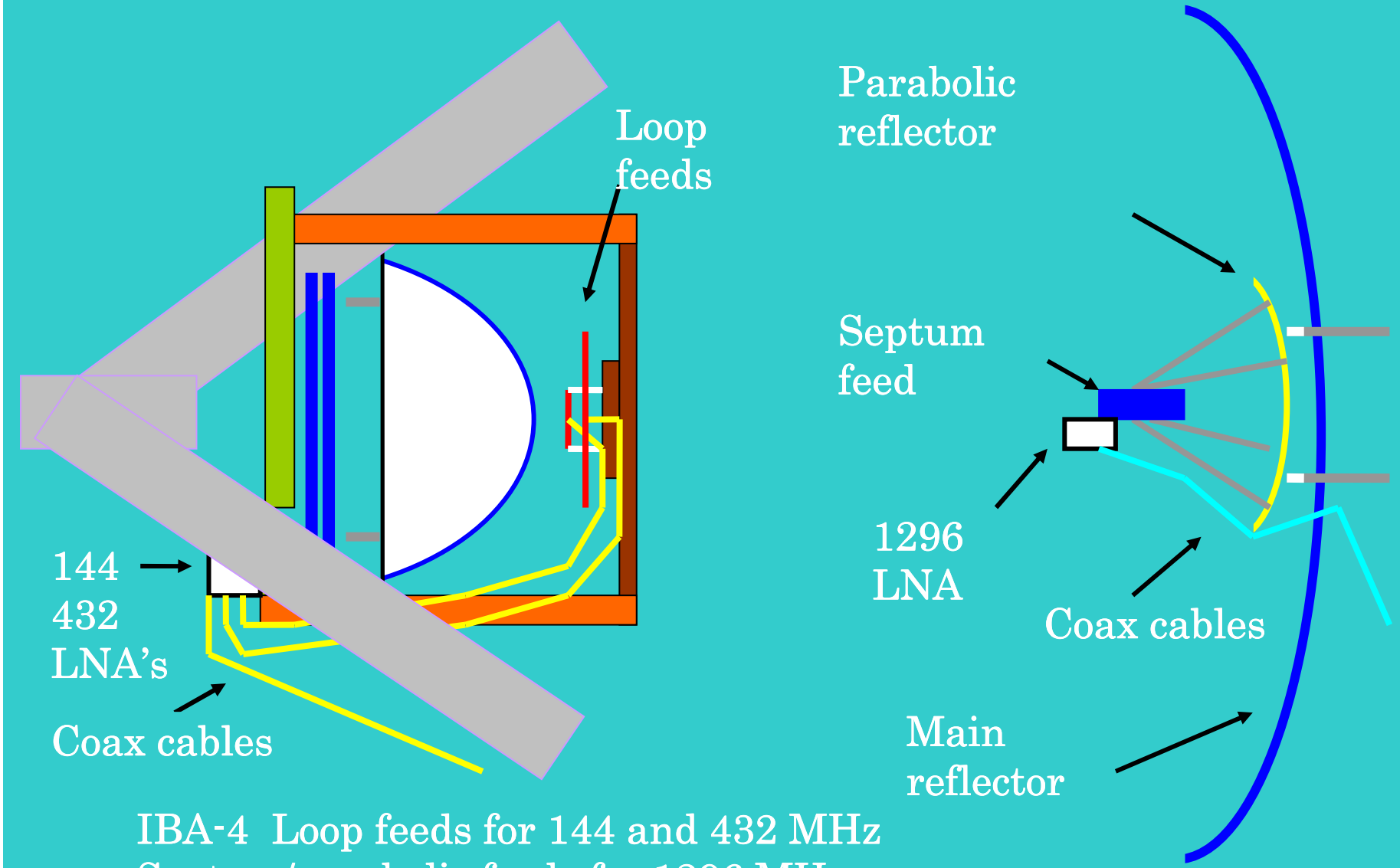


Loop Feed 144 & 432

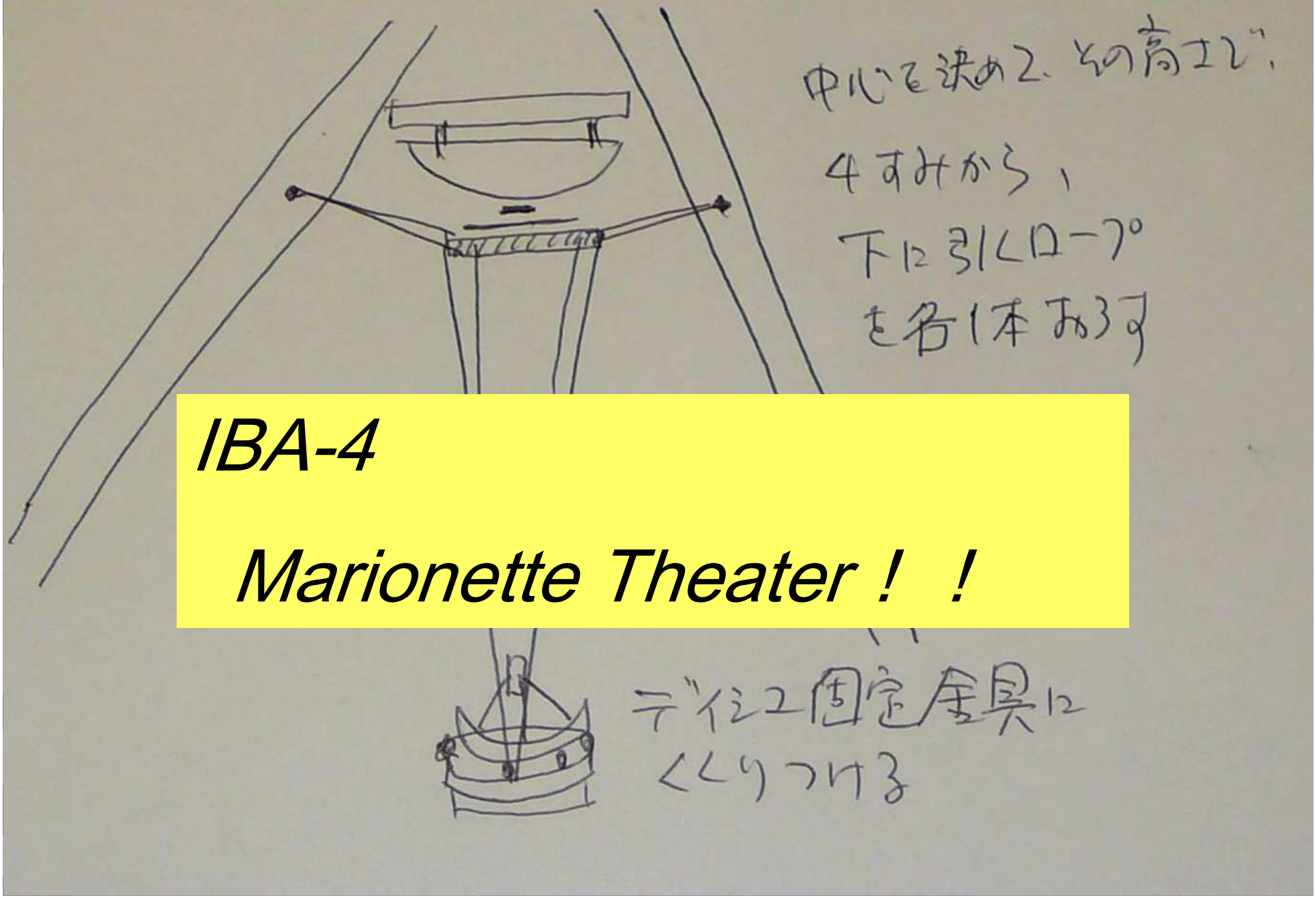


144 MHz 28.5 dBi Efficiency 30.3%

432 MHz 33.9 dBi Efficiency 11.8 %



IBA-4 Loop feeds for 144 and 432 MHz
Septum/parabolic feeds for 1296 MHz



IBA-4

Marionette Theater ！ ！

Planned EME

- Basically Random QSOsn only
- Frequencies

  144MHz, 432MHz, 1296MHz and 5760MHz
- Modes: CW, SSB and JT65B
- Reports： R S T or TMO
- Estimated small stations to contact with:

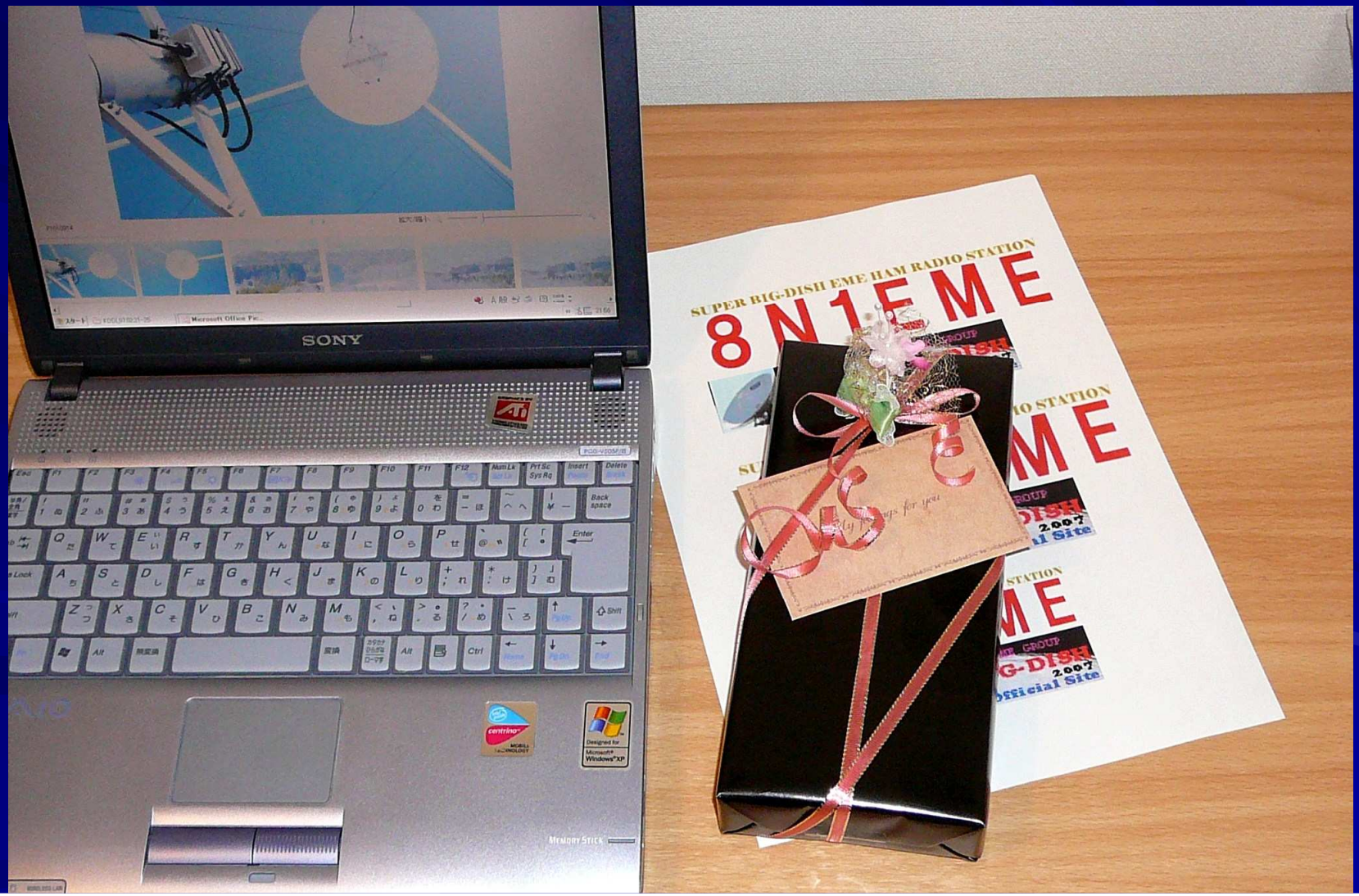
  144MHz：2x11-el Yagi, 50W JT 6 5 B

  432MHz：2x27-ele Yagi, 50W JT 6 5 B

  1296MHz：3m DISH, 10W CW

  5760MHz：2m DISH, 2W CW

Project BIG-DISH
Callsign 8N1EME



BIG-DISH 8N1EME

BIG-DISH &

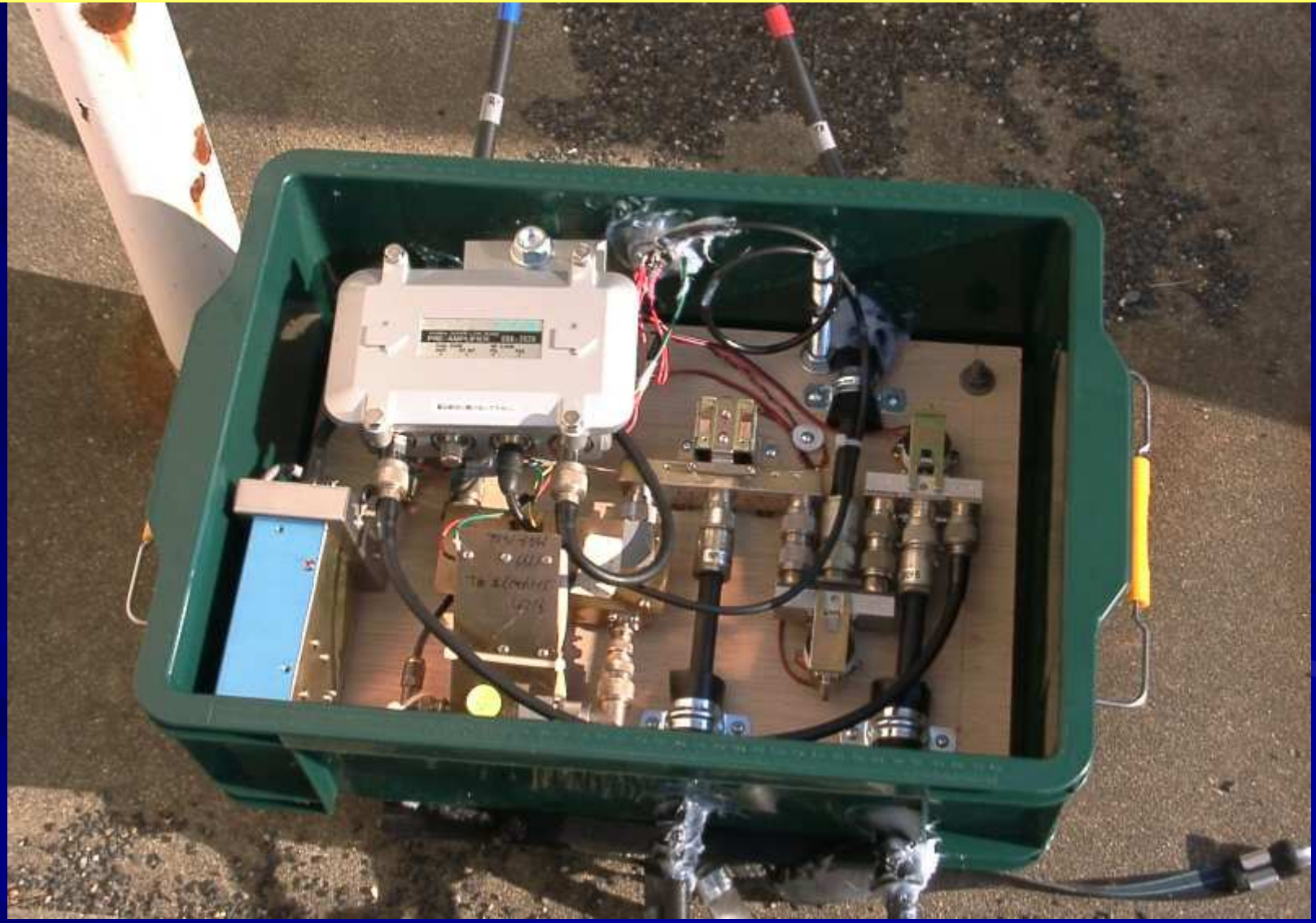
Small dish

a la carte

In

Marionette Theater

144/432 MHz LNAs & RYs




KDDI


Small-dish mount: Designed by JH1EFA

8N1EME

at

IBA-4

KDDI 32-m


KDDI

RFI test transmission

- IBA-4 Elevation angle 90 degrees
- RFI to the present C-band receiver

  9 x 432 = 3888 MHz

  3 x 1296 = 3888 MHz
- Any TVI to neighbors

The present Radio Station Regulation requests to amateurs on UHF that any spurious radiation level should be

no more than -60 dB

below the fundamental, as well as

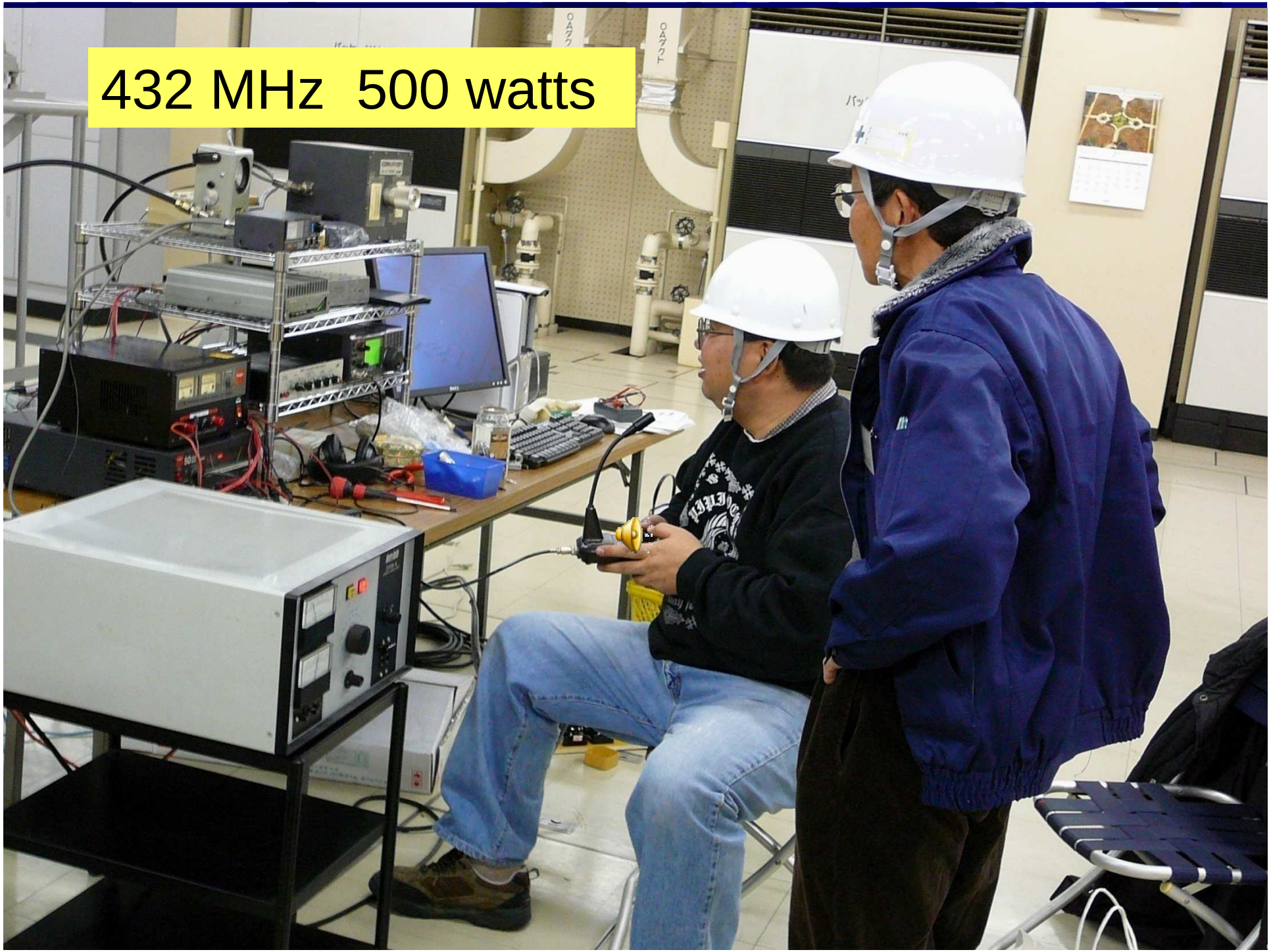
not more than 1mW.

Spurious radiation should be:

For 500W output

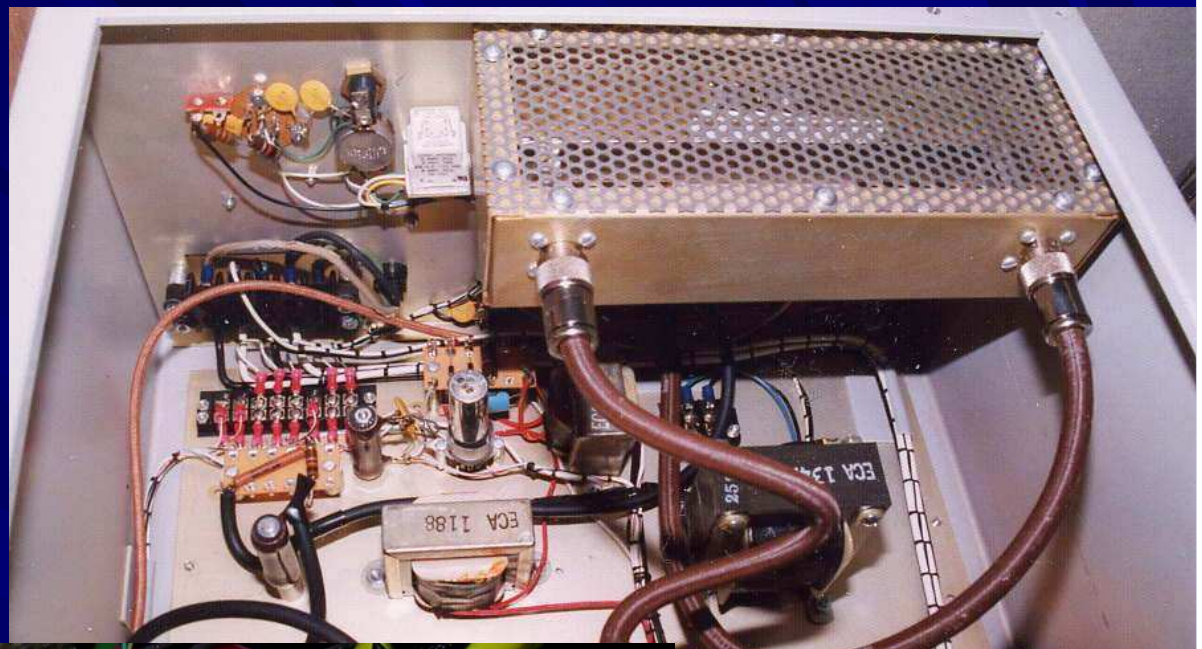
→ no more than 0.5mW

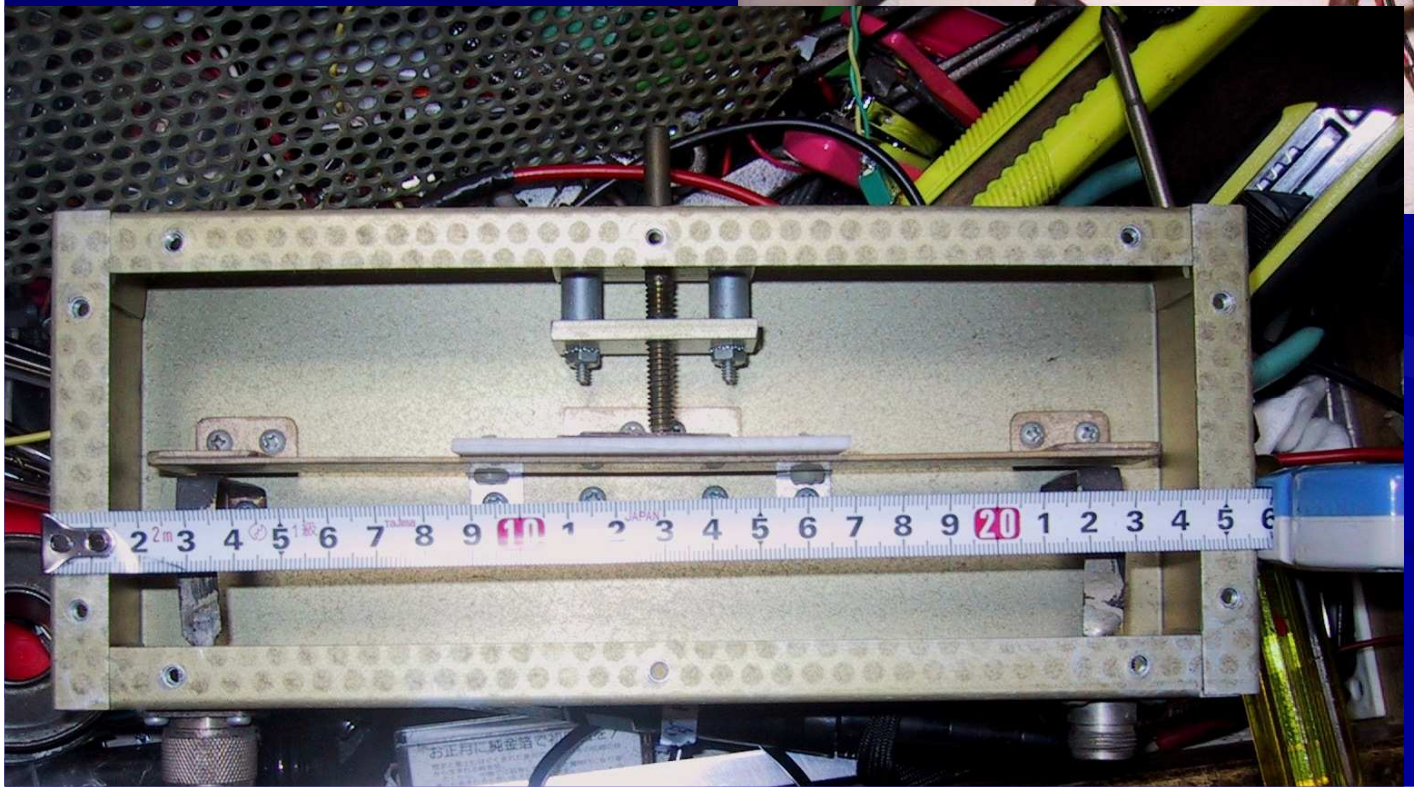
and below -60dB


432 MHz 500 watts

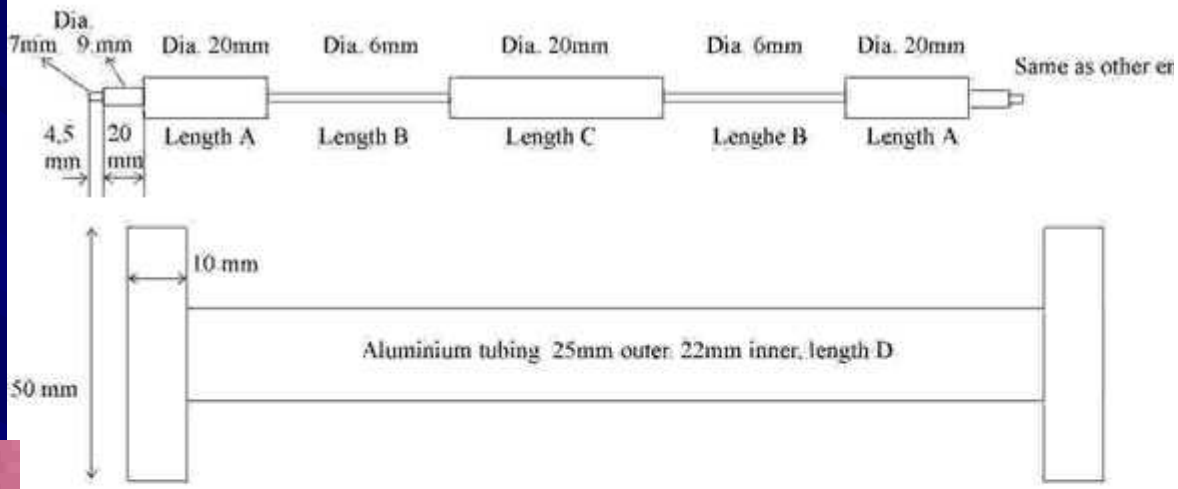
RF Filters

Henry Radio





Low Pass Filters 7/16 connector



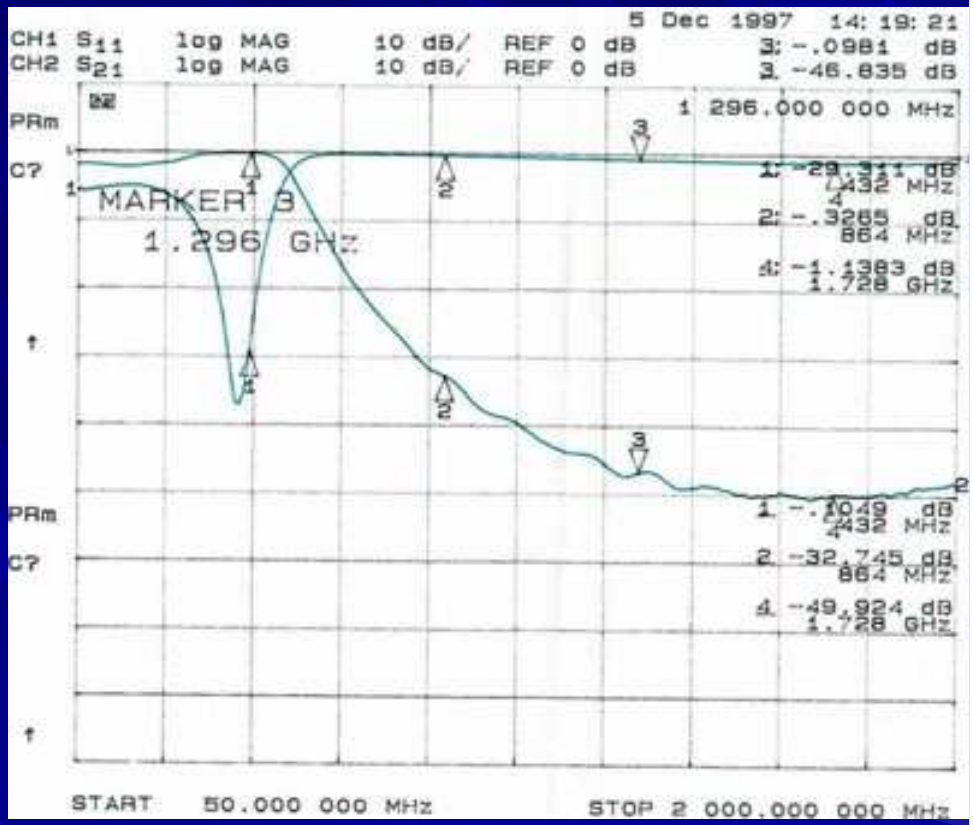
HP Low Pass Filters Dimensions

	Length A	Length B	Length C	Length D
144 MHz	38.4 mm	175 mm	87.6 mm	Abt.554mm
432 MHz	12.8 mm	58.4 mm	29.2 mm	Abt.211 mm

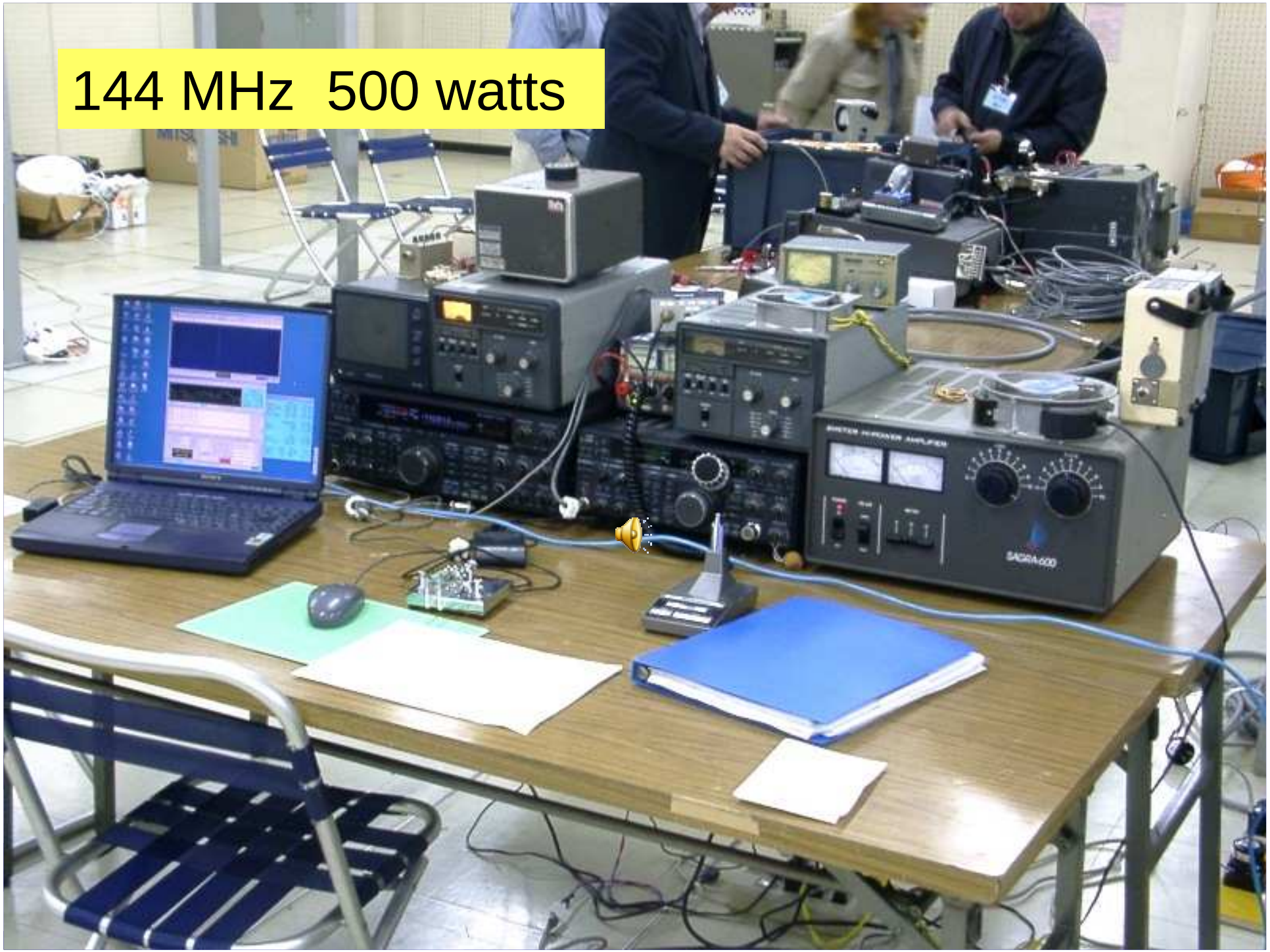
PA3CSG,
17-12-1997 N

PA3CSG Filters

144 MHz

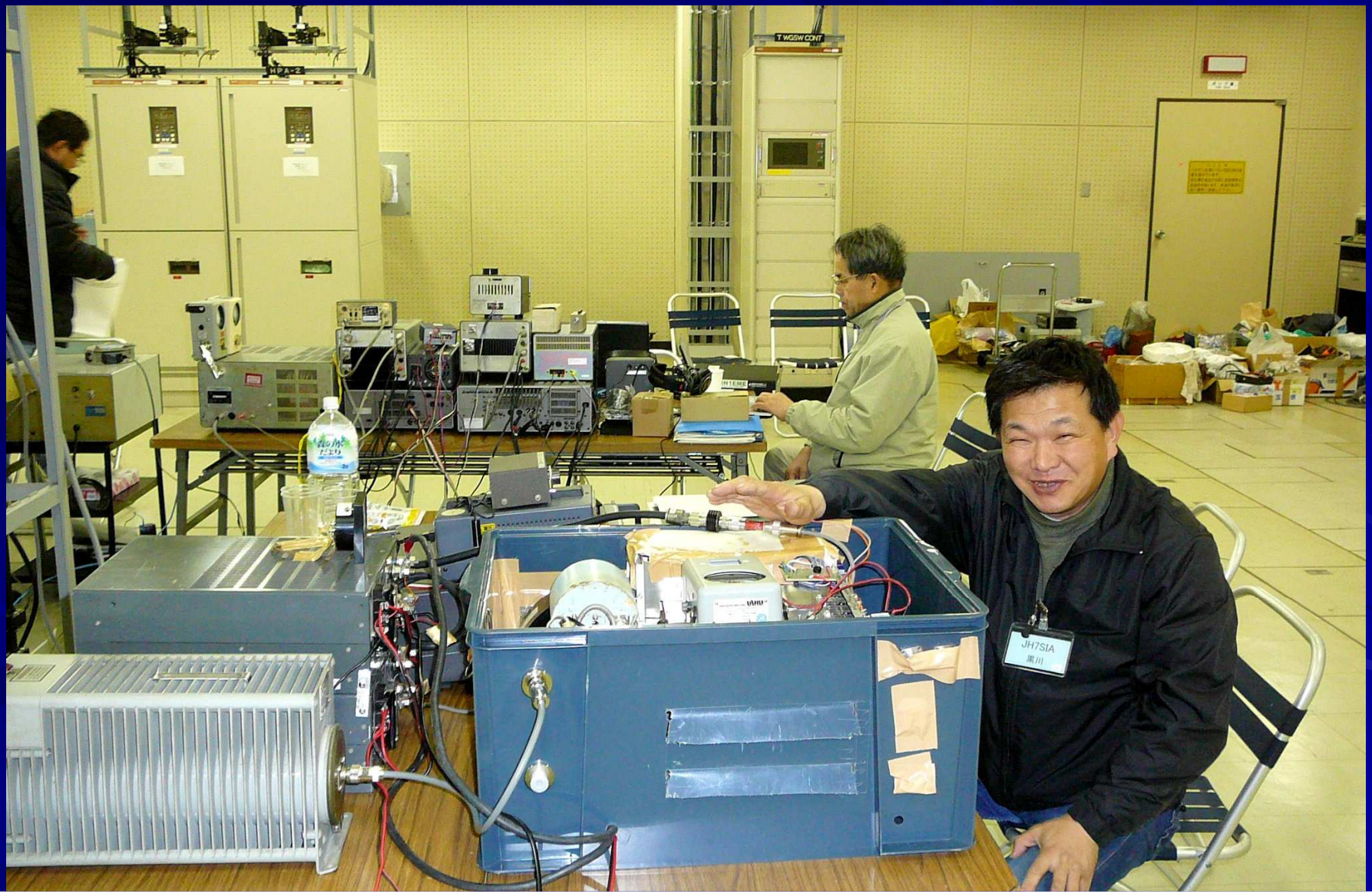


432 MHz


144 MHz 500 watts

1296 MHz 500 watts

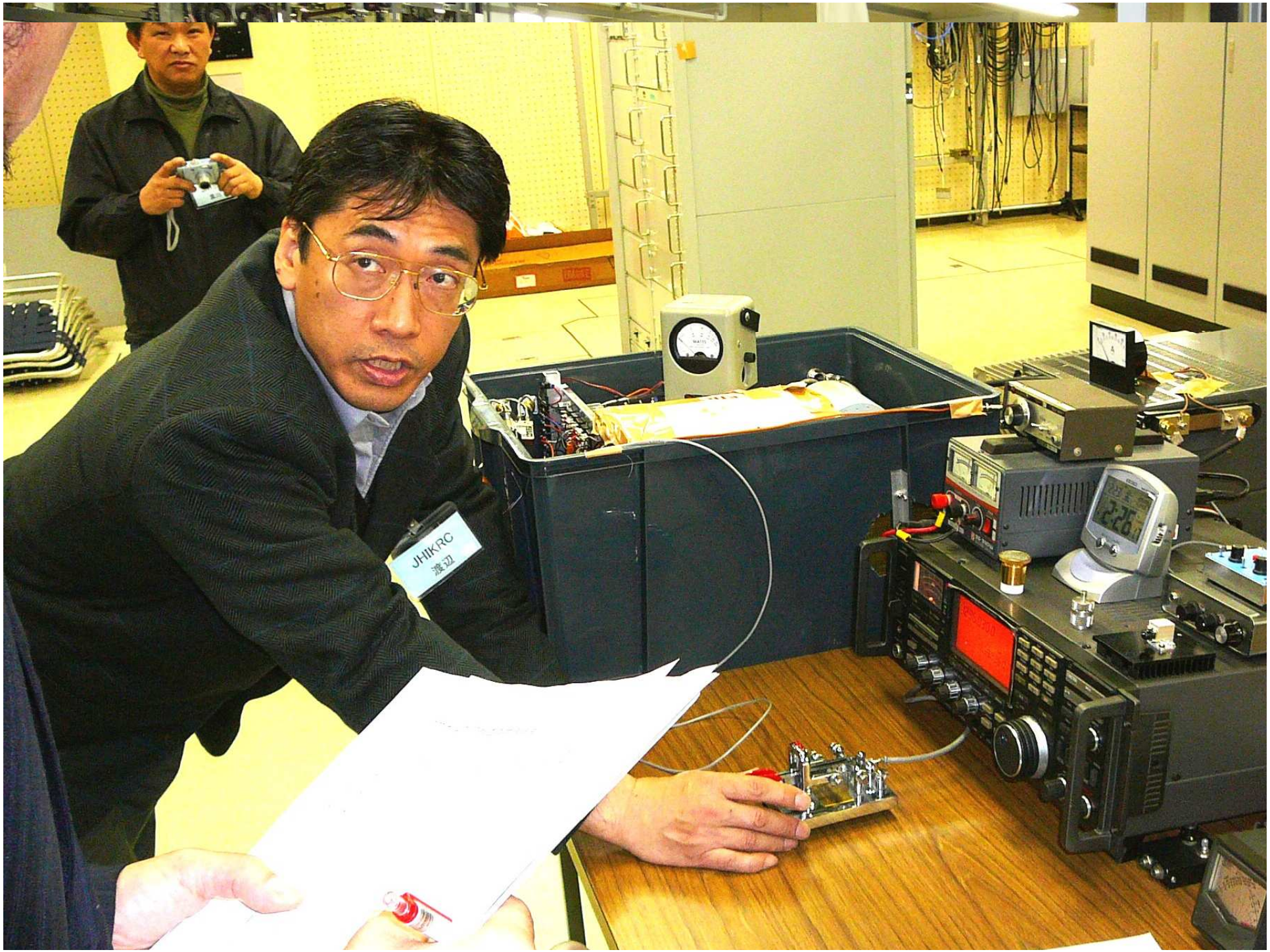
1296 MHz　500 watts



Inspection by Telecom

- Transmitter data (input/output power, spurious suppression characteristics, filter attenuation curves, etc.) were submitted previously.
- Inspection of the equipments, antennas, working data, and a QSO test were requested.
- 432 MHz CW-QSO: 8N1EME – JA6AHB

RST 599/599

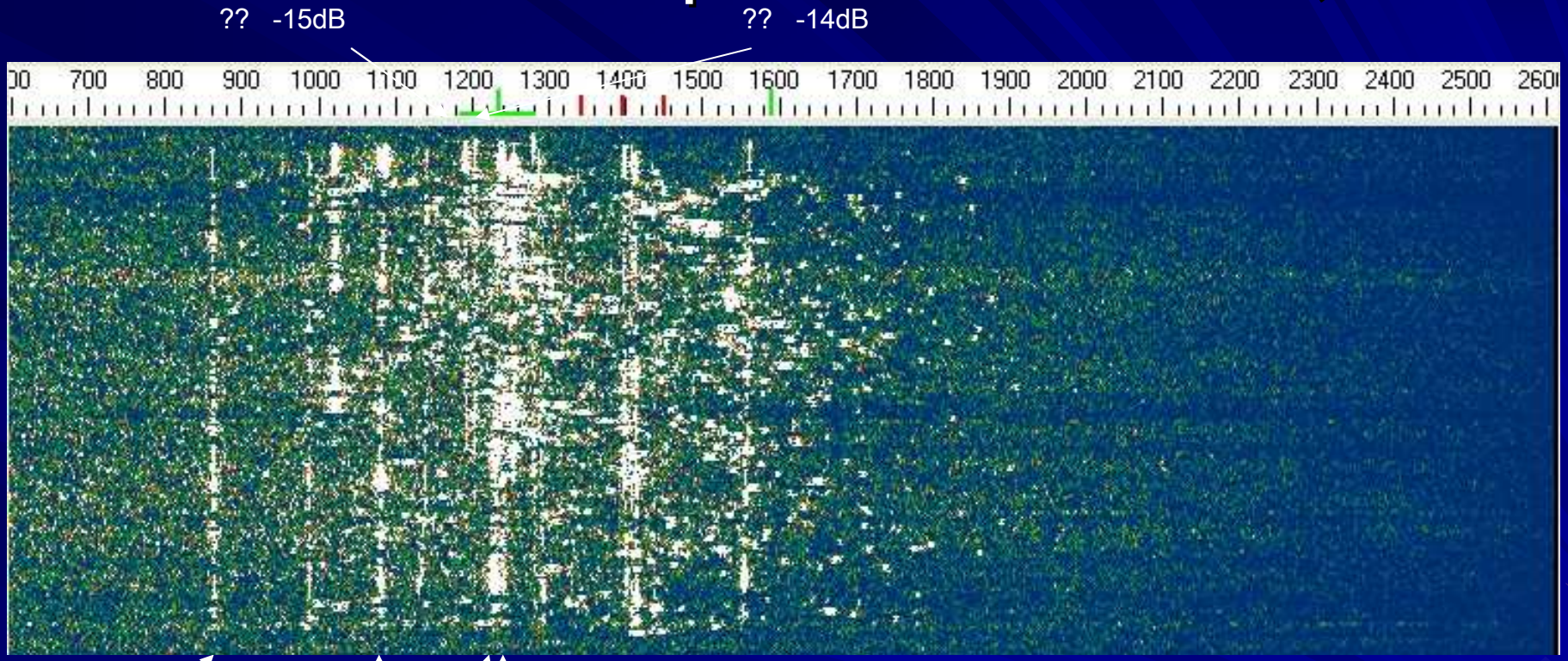

JH1KRC
渡辺


SEIKO
WATTS
SWITCH-MODE POWER SUPPLY
SS-330W
ICOM
IC-970D
MULTI BAND ALL MODE TRANSCEIVER
LCD CENTRAL MONITORING SYSTEM
1296.032.3
869.775.0
8N1E
1296N

HB9BBD received at 8N1EME 1296 MHz

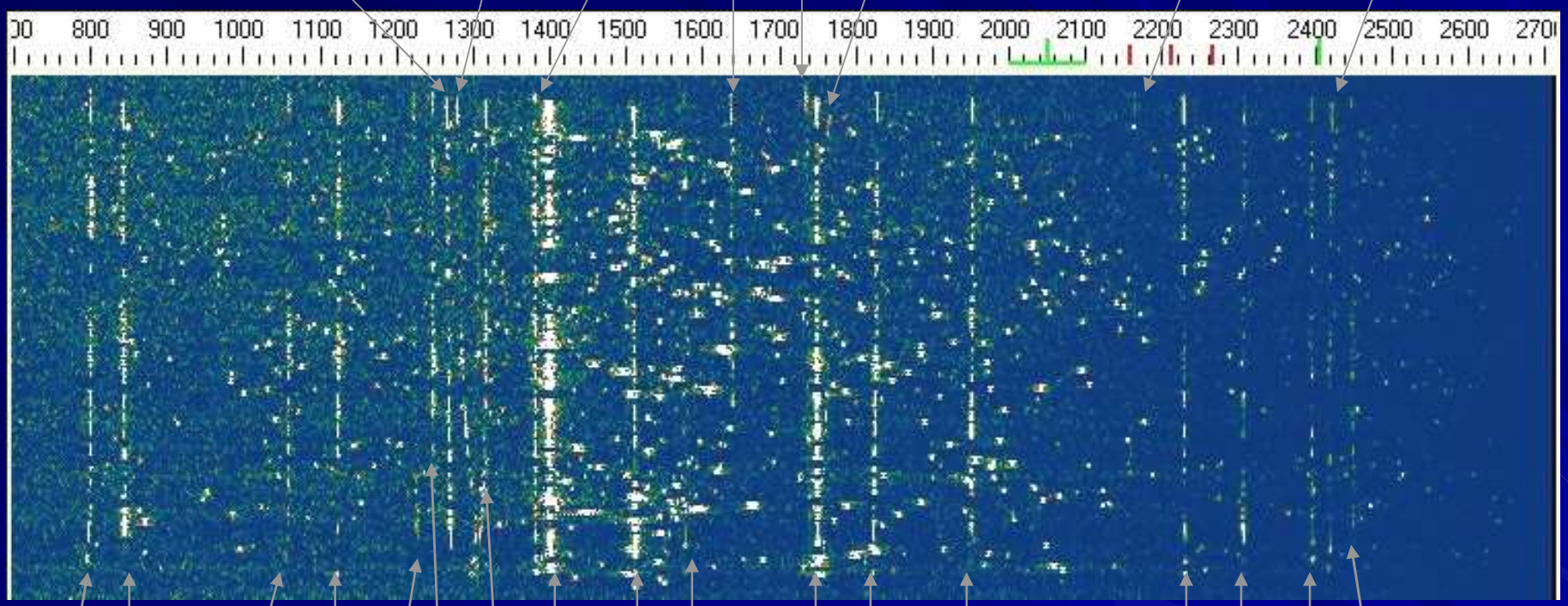
1296 MHz Pile Up

144MHz Pile up 10:29Z Feb 25, 2007

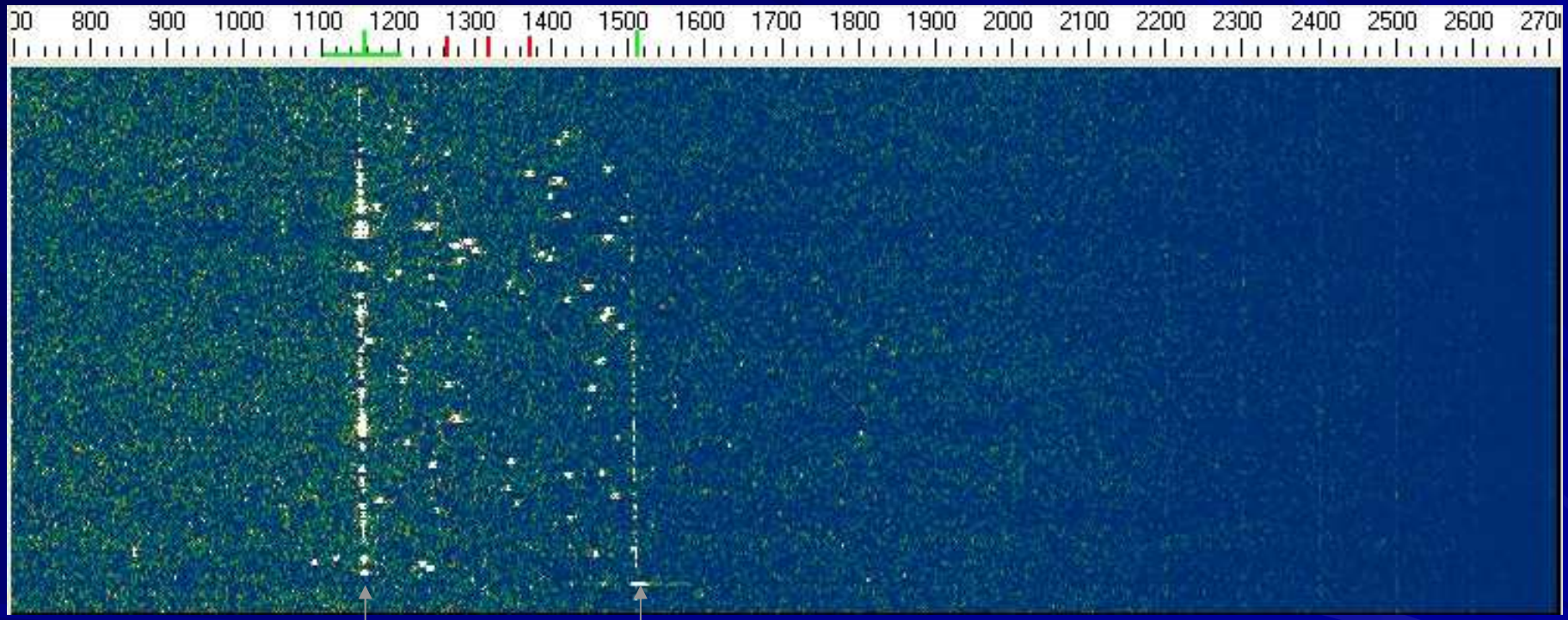


Among the Big-Signals in pile-up, there were seven weak signals of -20dBs were masked.

144 MHz Pile up 10:55Z, Feb 25, 2007



144 MHz Pile up 15:51Z Feb 25, 2007

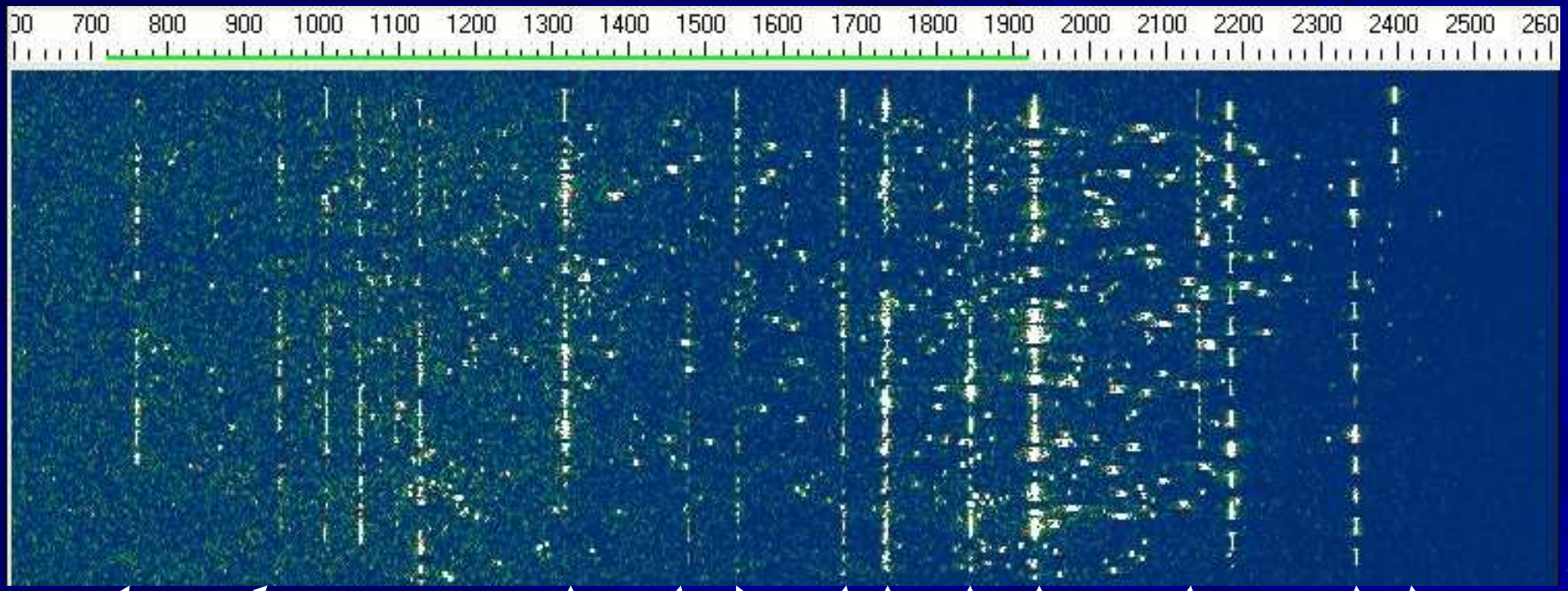


ECHO
-12dB

TROPO
-21dB

JH2COZ PM94

144MHz Pile up 16:15Z Feb 25, 2007



SM5CFS -15dB

OH3KLJ -20dB

DK3WG -16dB

DL7FF -16dB

?? -28dB

YU7AA -15dB

YU1CF -10dB

?? -29dB

?? -25dB

RA4HCN -14dB

IK7EZN -10dB

SV8CS -15dB

RU1AA -6dB

?? -29dB

YO9FRJ -15dB

YO9FRJ RRR

YO9FRJ 73


月面反射通信実験 特別記念アマチュア無線局
8N1EME
公開 運用会場行
送 迎 車
えんがいアマチュア無線クラブ

8N1EME's EME School

EME School

- NHK-TV News, 7 p.m., March 03, 2007

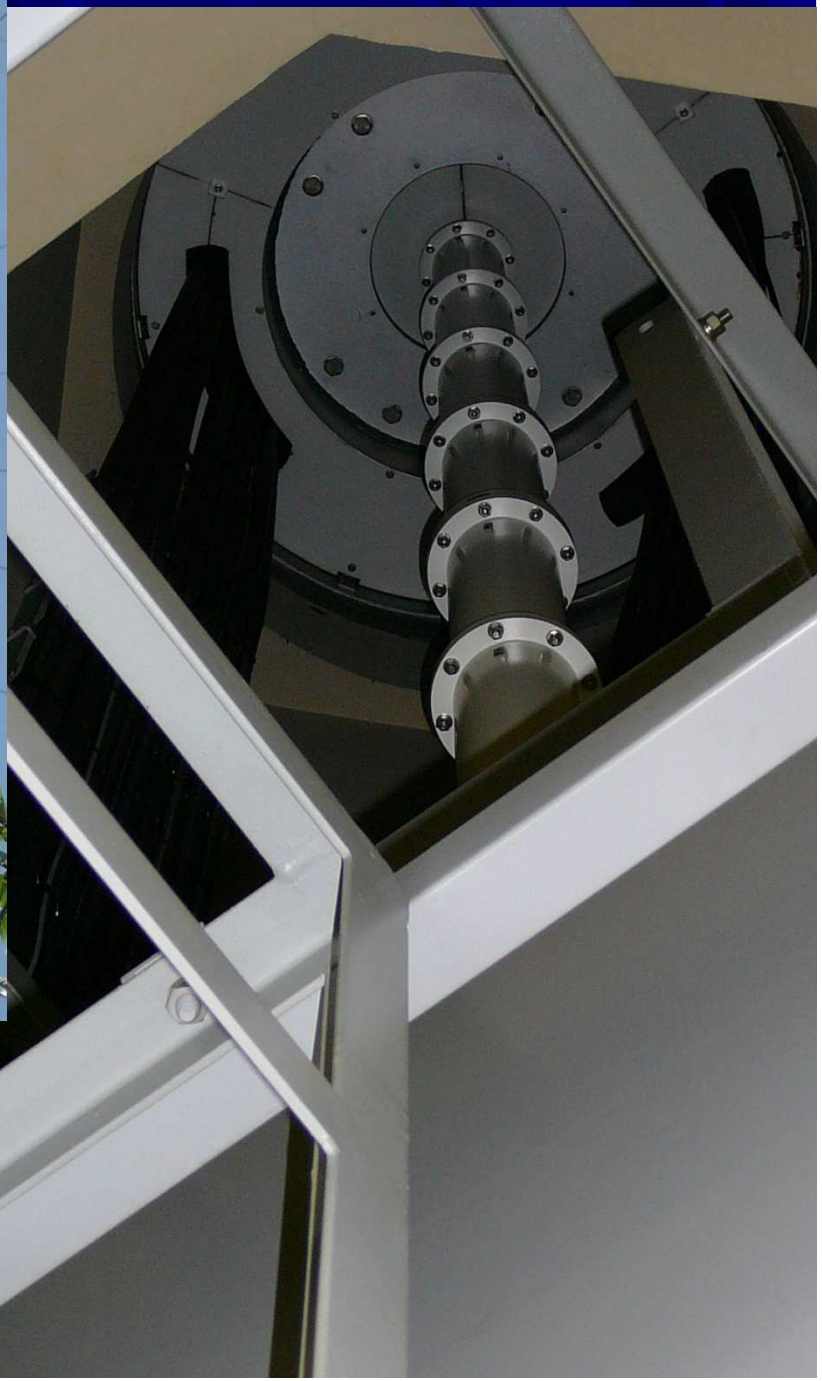

KDDI

5760 MHz 500 watts

- Near original designed frequency of the IBA-4 antenna.
- Wave-guide Connection at the pedestal.
- Estimated gain: 63.8 dBi (2,400,000 times)
- Output power: 1,200,000 kW eirp

AZ-EL control

3 kW TWTA’s & Wave-guides **WR-142**

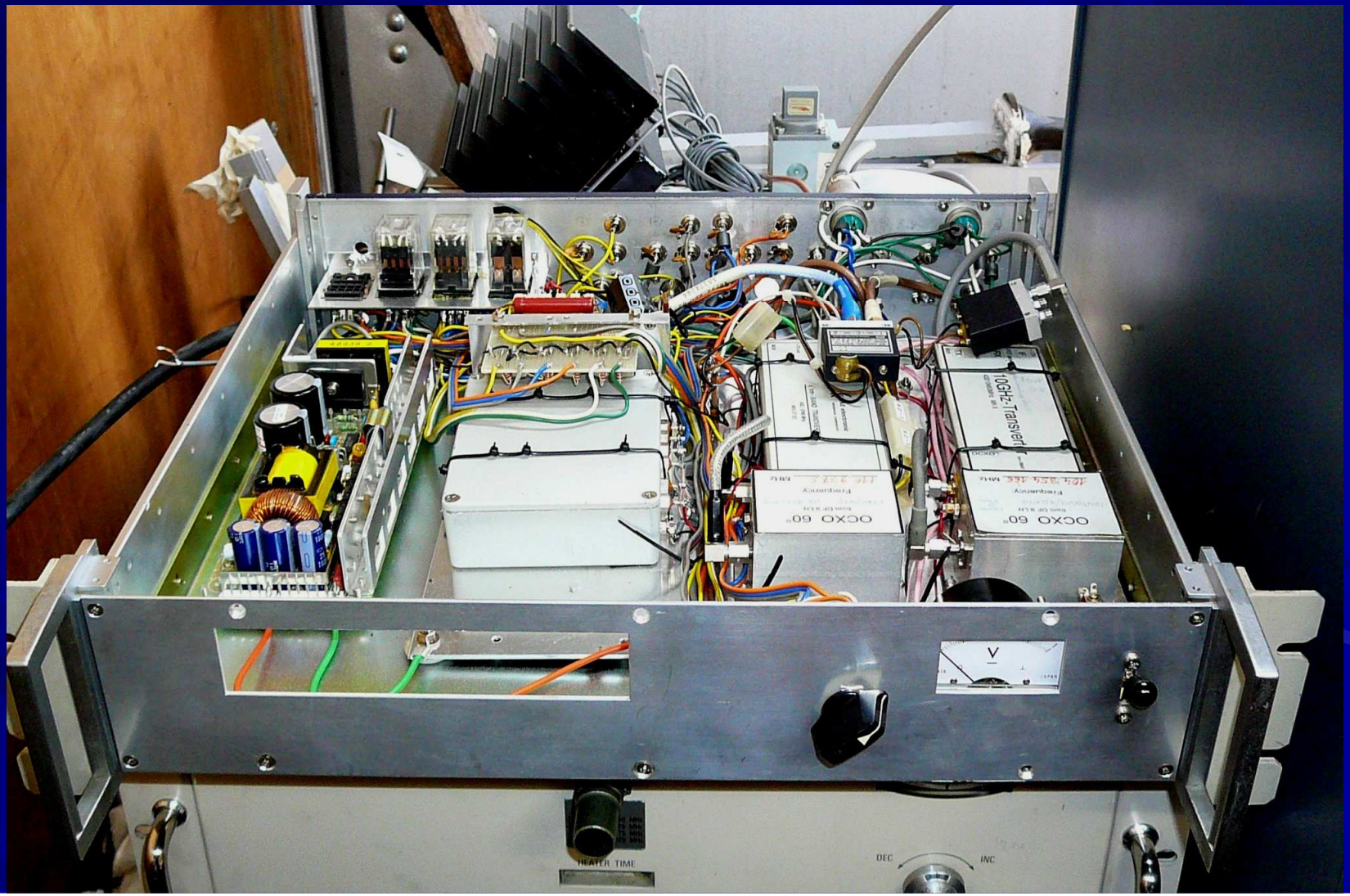


Feed-horn

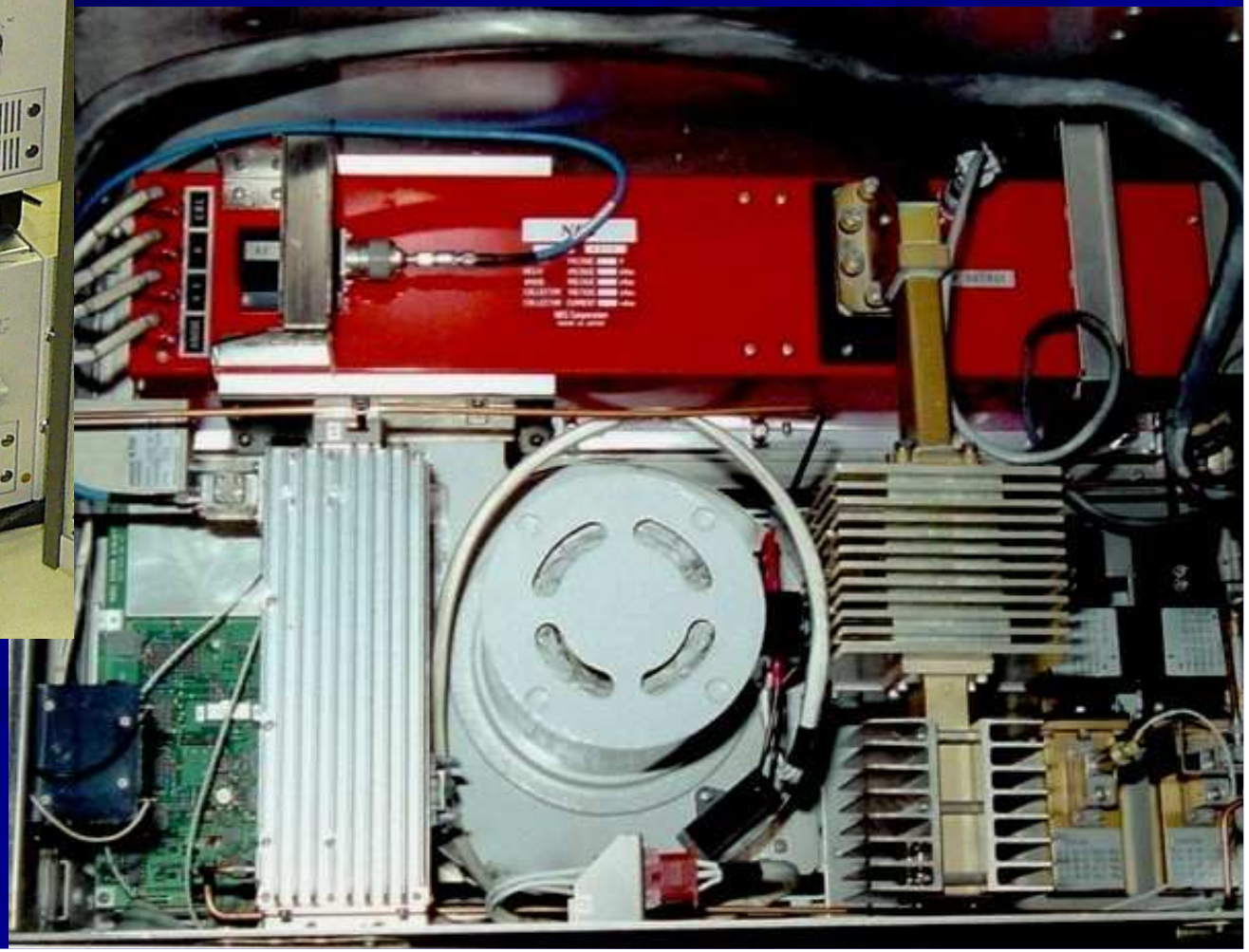
Round wave-guide

5 GHz 500 watts

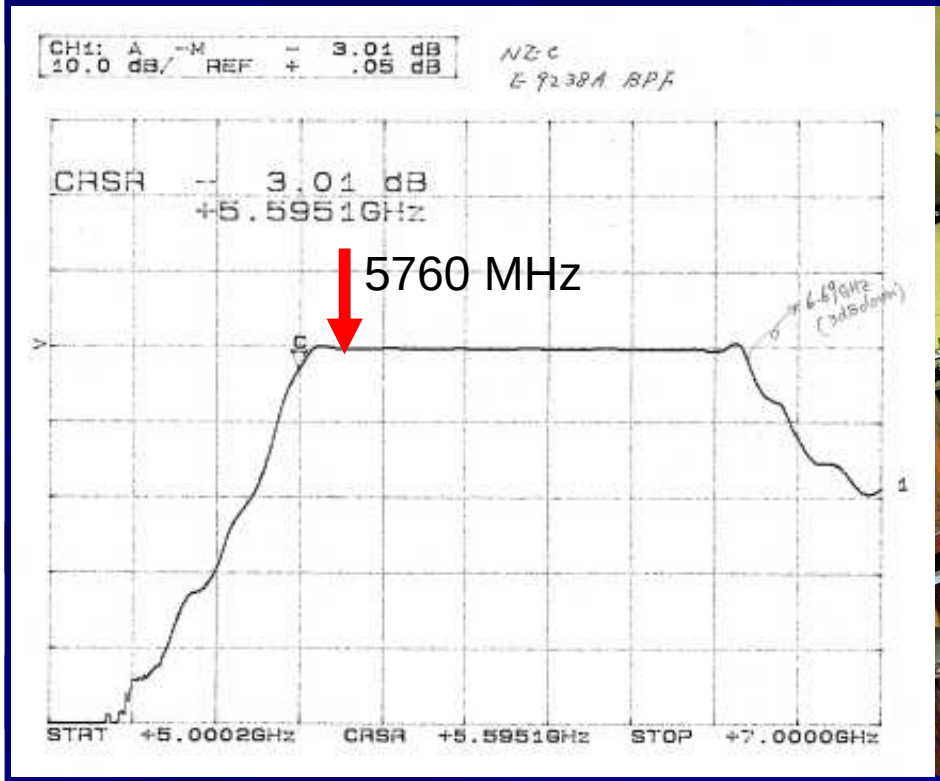
DB6NT Transverters
IF 435 MHz / 5760 MHz / 10 GHz

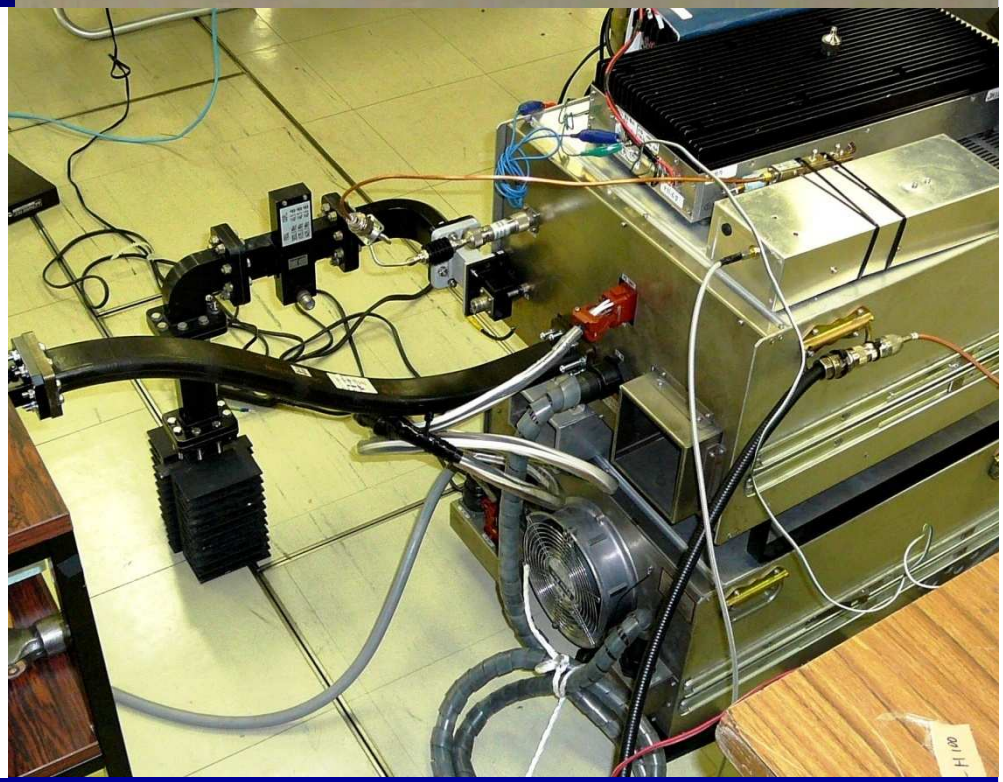


5 GHz TWTA
500 watts

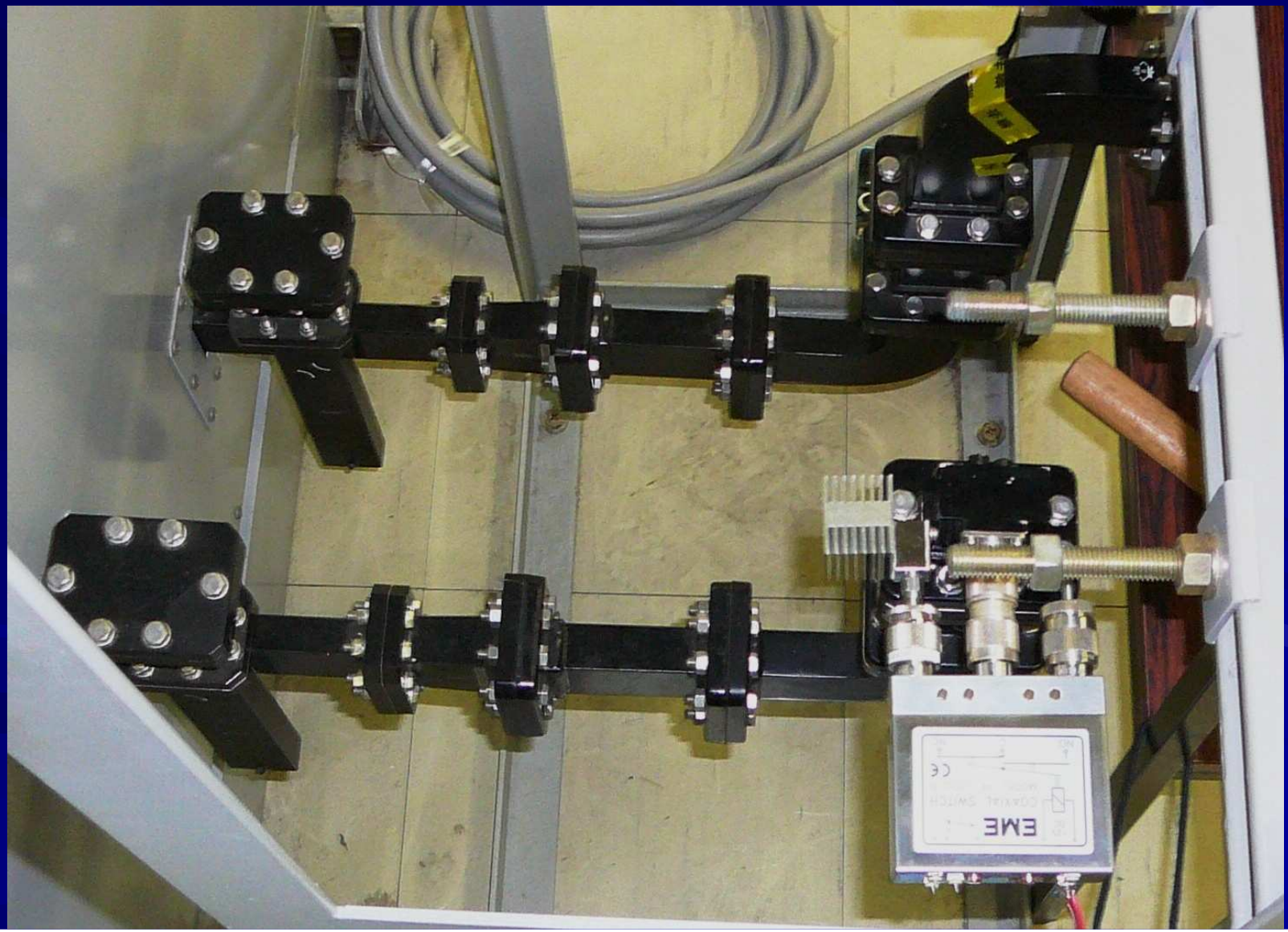


5 GHz TWTA
500 watts





RHCP / LHCP & LNA



5760 MHz 500 watts


茨城衛星通信センター閉局
感謝の集い

8N1EME received at RW1AW

【Project SMALL-ANTENNA】

- Many microwave amateurs joined in the project.
- Members of JAMSAT, MWCY, YAMA, etc.
- Many recordings were reporte
- Not a few tried to contact.

Receiving with small dishes

JR3LGE 45cm BS satellite dish

Japanese CQ ham radio monthly magazine continued to publish our articles for over one year.


Nikon

EME Results

- Random QSOs:　3　2　3
- Operation frequencies:

　　144MHz, 432MHz, 1296MHz and 5760MHz

- Modes：CW, SSB, and JT65B
- Estimated small stations to contact

　　144MHz：2x11-element, 50W　JT 6　5 B　・・・○

　　432MHz：2x27-element, 50W　JT 6　5 B　・・・○

　　1296MHz：3m DISH　10W CW　・・・2

Band and Mode Results
8N1EME

Freq. MHz	CW	SSB	JT65B	Cross-mode	**Total**	WAC	DXCC
144	11	1	142	0	154	4	30
432	34	2	31	0	67	5	21
1296	50	21	0	0	71	4	19
5760	23	6	0	2	31	4	14
Total	118	30	173	2	323	5	

No. of QSOs

144 MHz: 154 QSOs, CW 11 SSB 1 JT65 142

JA 24 OH 3 F 8 PA 12 DL/DK 22 GM 2
G 2 I 6 VK 7 AS RUSSIA 11 USA 13
Eu RUSSIA 14 CT 1 EI 1 OE 1 OK 2
GW 1 SP 1 ON 2 EA 6 SV 3 SM 3
ES 1 ZL 1 OZ 1 S5 2 YO 1 HB9 1
YU 1 VE 1

432 MHz: 67 QSOs, CW 34 SSB 2 JT65 31

JA 16 VK 3 PA 2 OK 3 G 2 OH 4
S5 2 Eu RUSSIA 5 DL/DK 8
SM 5 EA 3 HB9 2 F 3 ZL 1 OZ 1
USA 2 SP 1 UT 1 FR5 1 ZS 1 KL 1

No. of QSOs

1296 MHz: 71 QSOs, CW 50 SSB 21

JA 14 VK 3 KL 1 ES 3 F 4 OZ 1 PA 2
SM 3 OK 3 HB9 2 ON 3 DL/DK 10 LA 3
LX 1 UR 1 W 11 VE 1 I 3 G 2

5760 MHz: 31 QSOs, CW 23 SSB 6
SSB/CW X-MODE 2

JA 9 W 4 EuRUSSIA 2 VK 1 ES 1 VE 1
HB9 1 F 2 I 1 LX 1 OE 2 DL/DK 3
OK 2 GM 1

ALL TOTAL: 323 EME-QSOs including dupes

TNX

The Project BID-DISH would like to thank you for joining us and help for the promoting moon-bounce with a KDDI's 32-m dish through 144 t0 5.7GHz bands.

Hundreds of non-EME amateurs joined us also to see how the moon-bounce is. This project might have contiributed to promote amateur radio activity itself.

The End

(continues?)