Ulastai Observatory &

21 CentiMeter Array (21CMA)

Xiang-Ping Wu

(on behalf of the 21CMA Collaborations)


1. A historic review
2. Infrastructure
3. 21CMA observations
4. Future plan
5. About the site

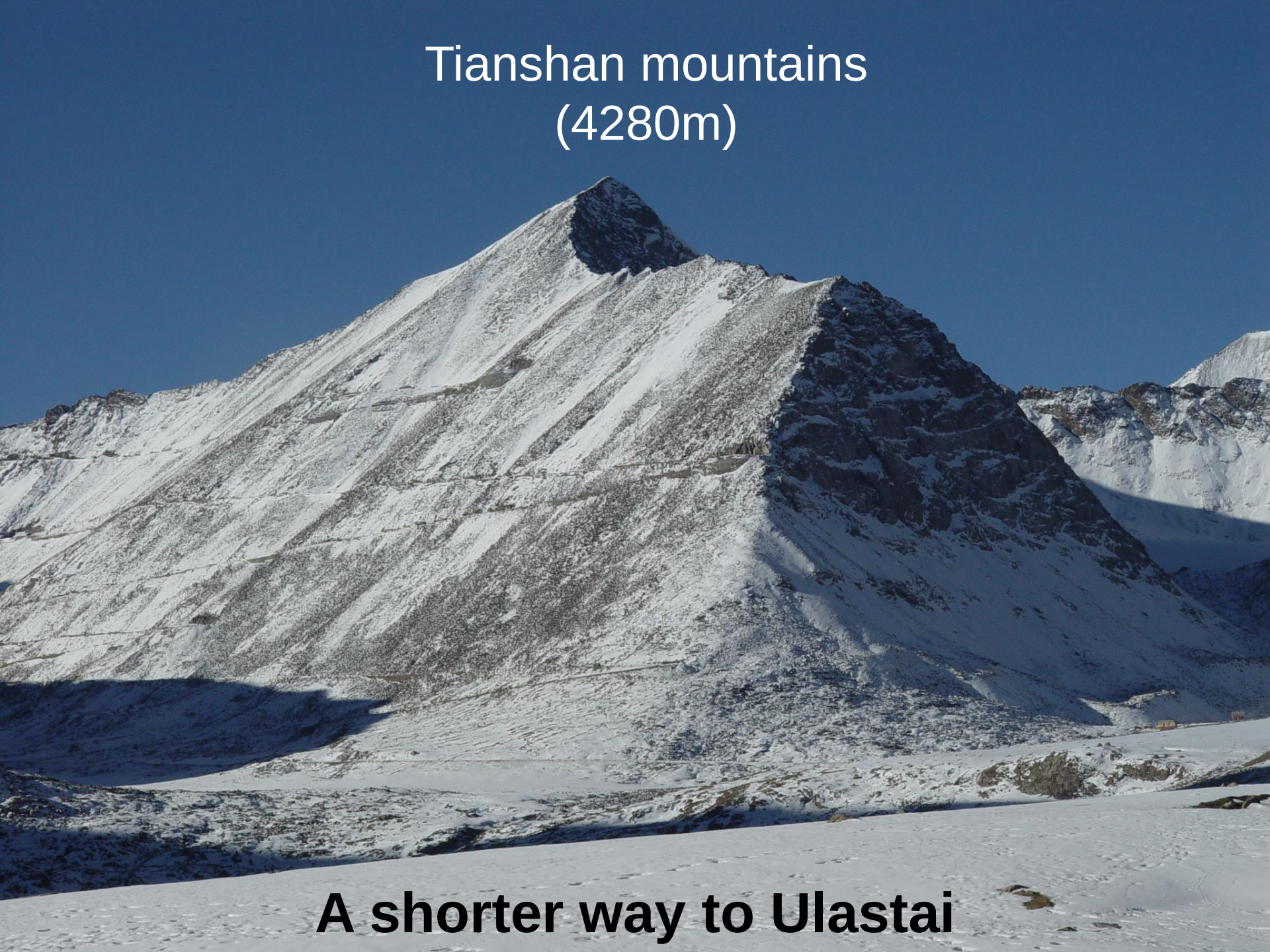
Where is the site ?

21CMA Site


RUSSIA
KAZAKSTAN
MONGOLIA
XINJIANG
GANSU
QINGHAI
XIZANG
SICHUAN
INDIA
BHUTAN
BANGLADESH
BURMA
THAILAND
LAOS
VIETNAM
China
International boundary
Province-level boundary
National capital
Province-level capital
Railroad
Road
500 Kilometers
500 Miles


Shitizi
JUNGGAR
Ürümqi
Microsoft MapPoint
VLBI
DI
Yongfengqu
Banfanggou
Chaiwopu
Miaorgou
Yanhu
Panjiadi
Dabancheng
Daheyan
Houxia
Hougou
XINJIANG
UYGUR
AUTONOMOUS REGION
Baiyanghe
Turpan
Zhan
Xiaocaohu
Bujay
Ewirgol
TURPAN
Yilahu
Ulastai
Bayan Gol
Ulanlinggi
Toksun
Balguntay
PENDI
Bort
Ma'anqiao
Hejing
Hoxud
Bayan
Tagarqi
Kümüx
Yushugou
Uxxaktal
Kaidu He
©2003 Microsoft Corp.
43° 30'
43°
42° 30'
87°
87° 30'
88°
88° 30'
89°


Shitizi
JUNGGAR
Ürümqi
PENDI
Chaiwopu
Yongfengqu
Banfanggou
Miaorgou
43° 30'
Yanhu
Panjiadi
Dabancheng
Daheyan
150km
Houxia
Hougou
XINJIANG
Turpan
Zhan
Baiyanghe
UYGUR
Xiaocaohu
AUTONOMOUS REGION
43°
Ewirgol
400km
Yilahu
TURPAN
Bayan Gol
Ulastai
Ulanlinggi
Toksun
Balguntay
PENDI
Bort
42° 30'
Transportation
Ma'anqiao
Hejing
Hoxud
Bayan
Kümüx
Tagarqi
Yushugou
Uxxaktal
©2003 Microsoft Corp.
87°
87° 30'
88°
88° 30'
89°


Tianshan mountains
(4280m)
A shorter way to Ulastai

A shorter way to Ulastai

A shorter way to Ulastai

August 13 2007

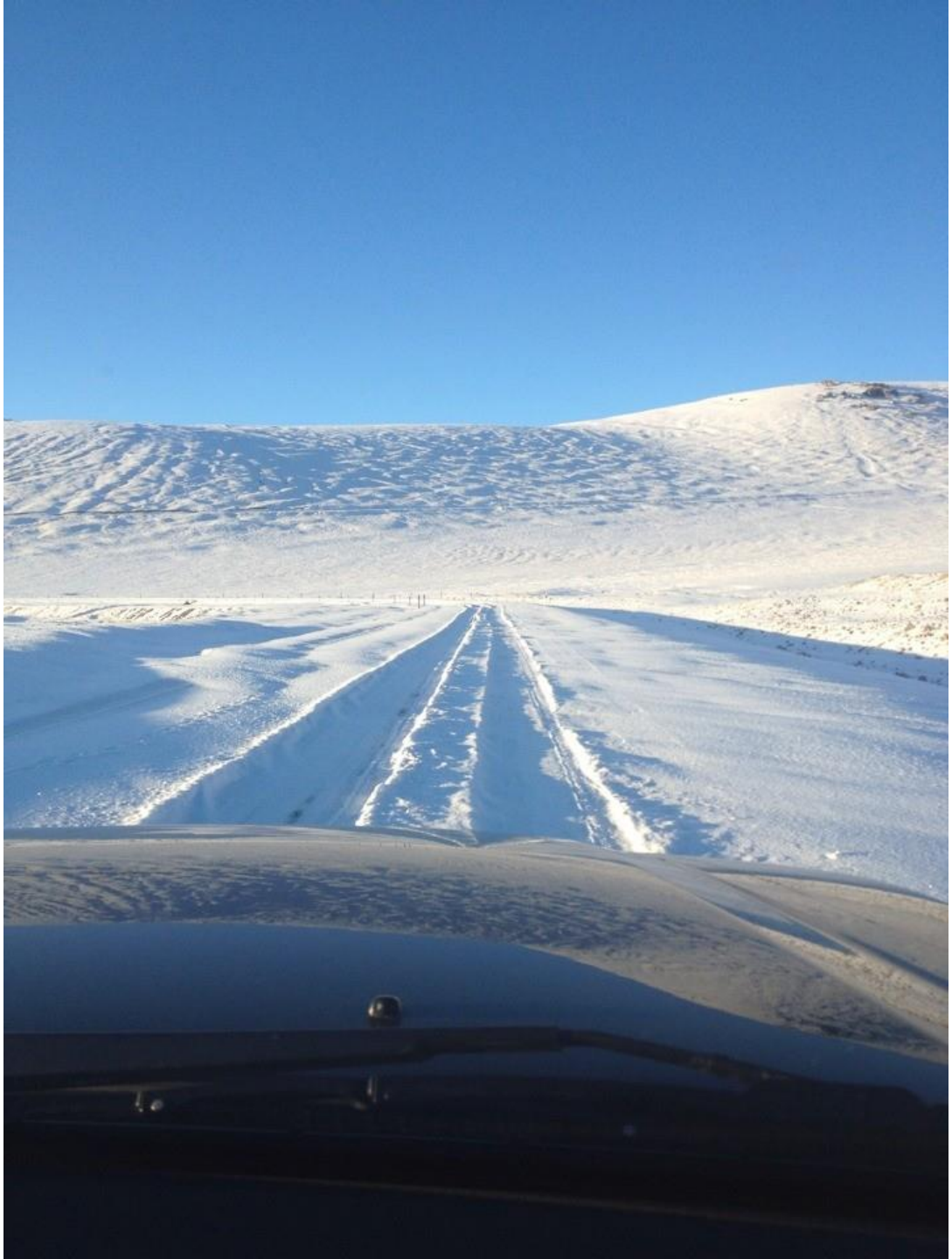
A shorter way to Ulastai

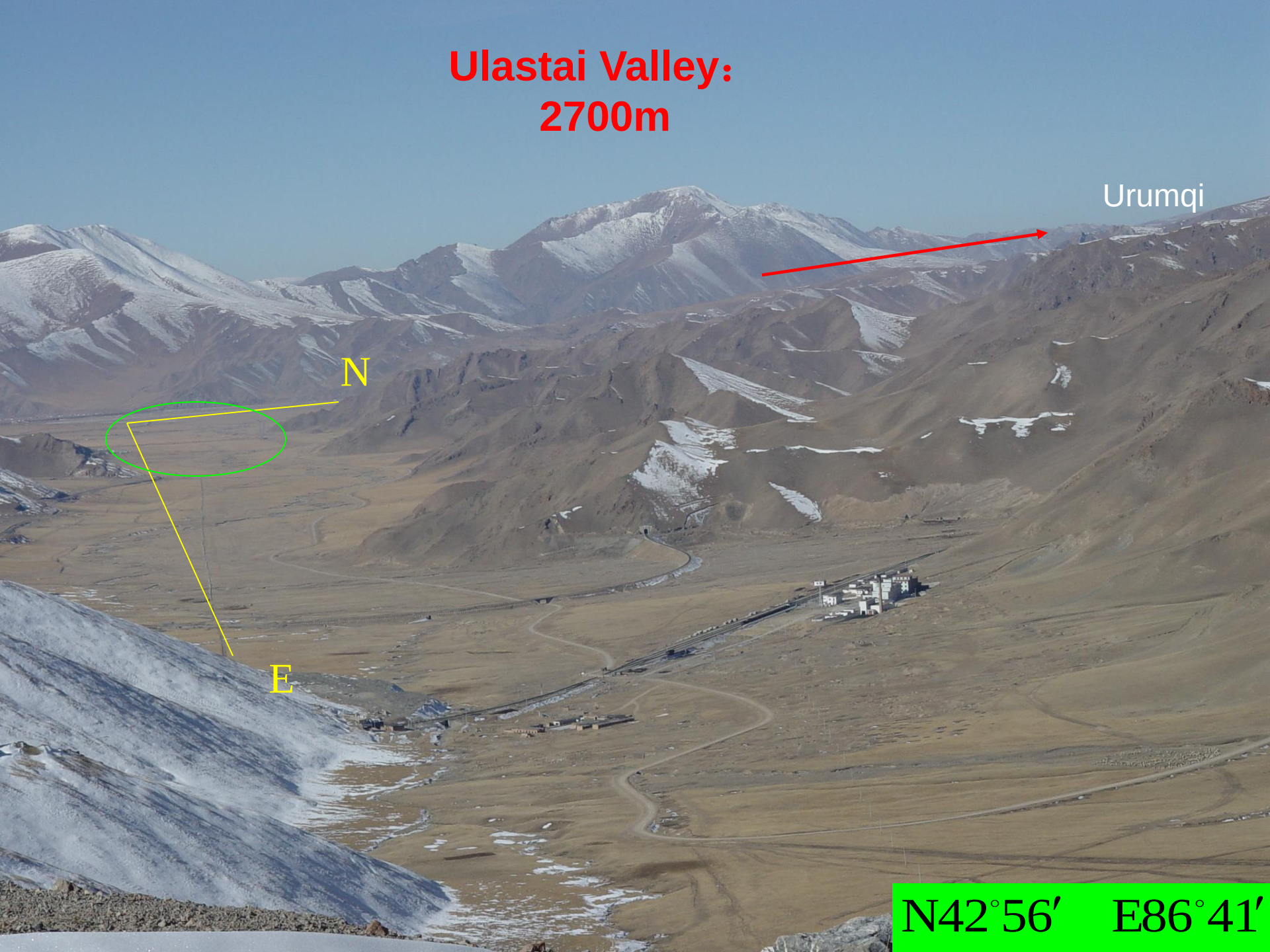

Tiger’s mouth


Shitizi
JUNGGAR
Ürümqi
PENDI
Chaiwopu
Yongfengqu
Banfanggou
Miaorgou
43° 30'
Yanhu
Panjiadi
Dabancheng
Daheyan
150km
Houxia
Hougou
XINJIANG
Turpan
Zhan
Baiyanghe
UYGUR
Xiaocaohu
AUTONOMOUS REGION
43°
Ewirgol
400km
Yilahu
TURPAN
Bayan Gol
Ulastai
Ulanlinggi
Toksun
Balguntay
PENDI
Bort
42° 30'
Transportation
Ma'anqiao
Hejing
Hoxud
Bayan
Kümüx
Tagarqi
Yushugou
Uxxaktal
©2003 Microsoft Corp.
87°
87° 30'
88°
88° 30'
89°

A longer way to Ulastai

A longer way to Ulastai




Ulastai Valley：
2700m
Urumqi
N
E
N42°56′ E86°41′

Ulastai Valley

Site Selection

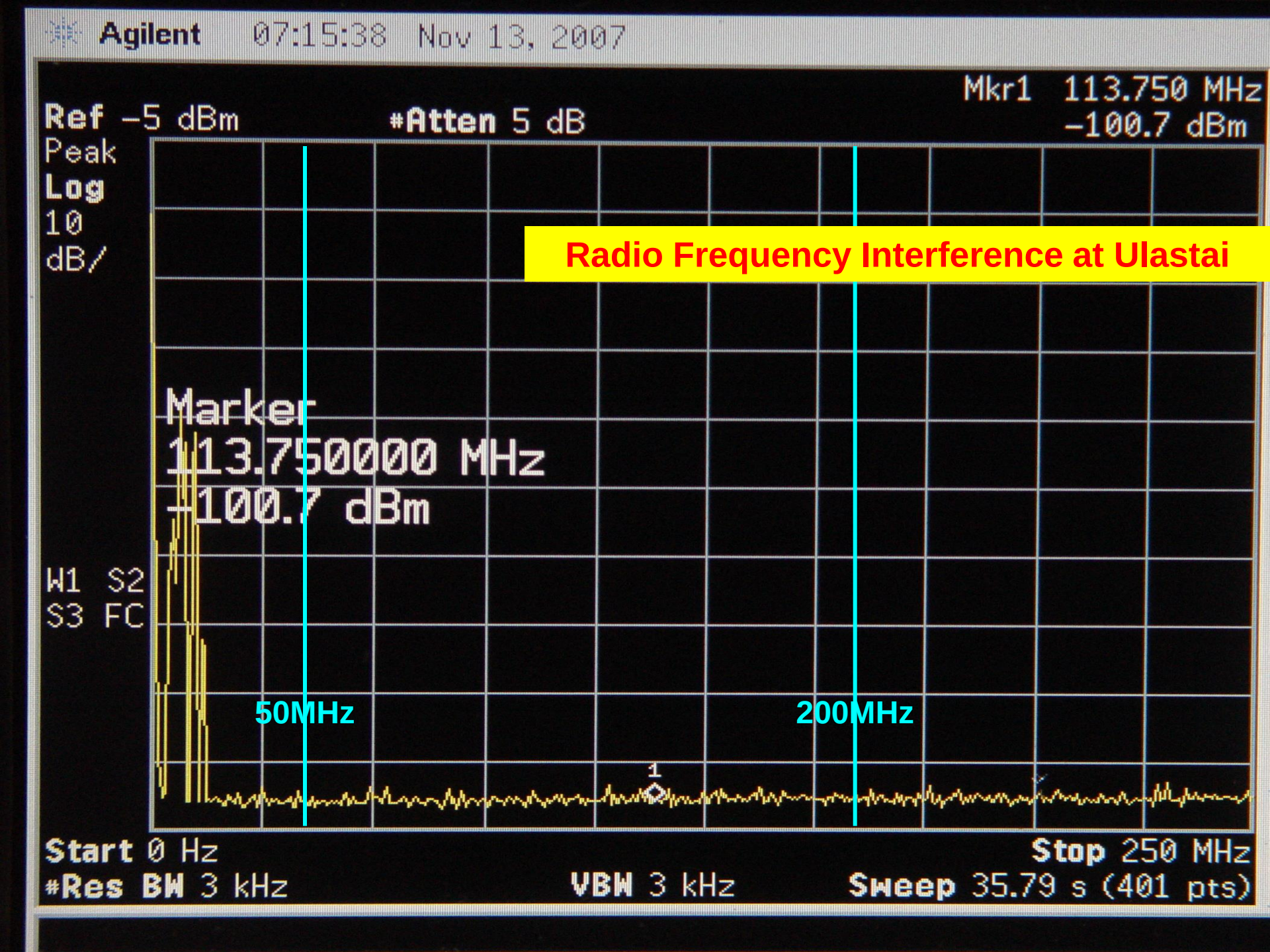
October 2003

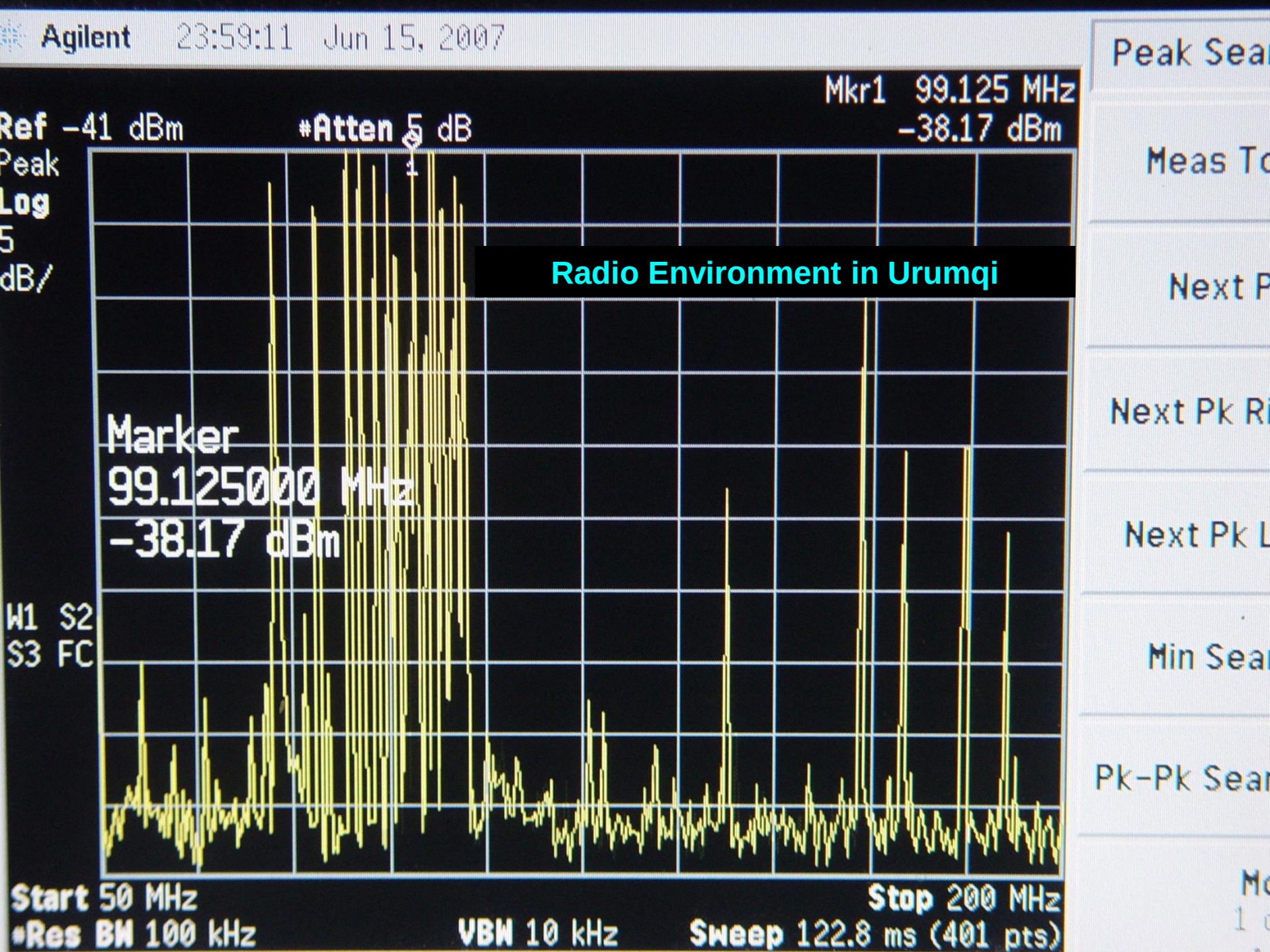

October 2003
ISUZU
Western China

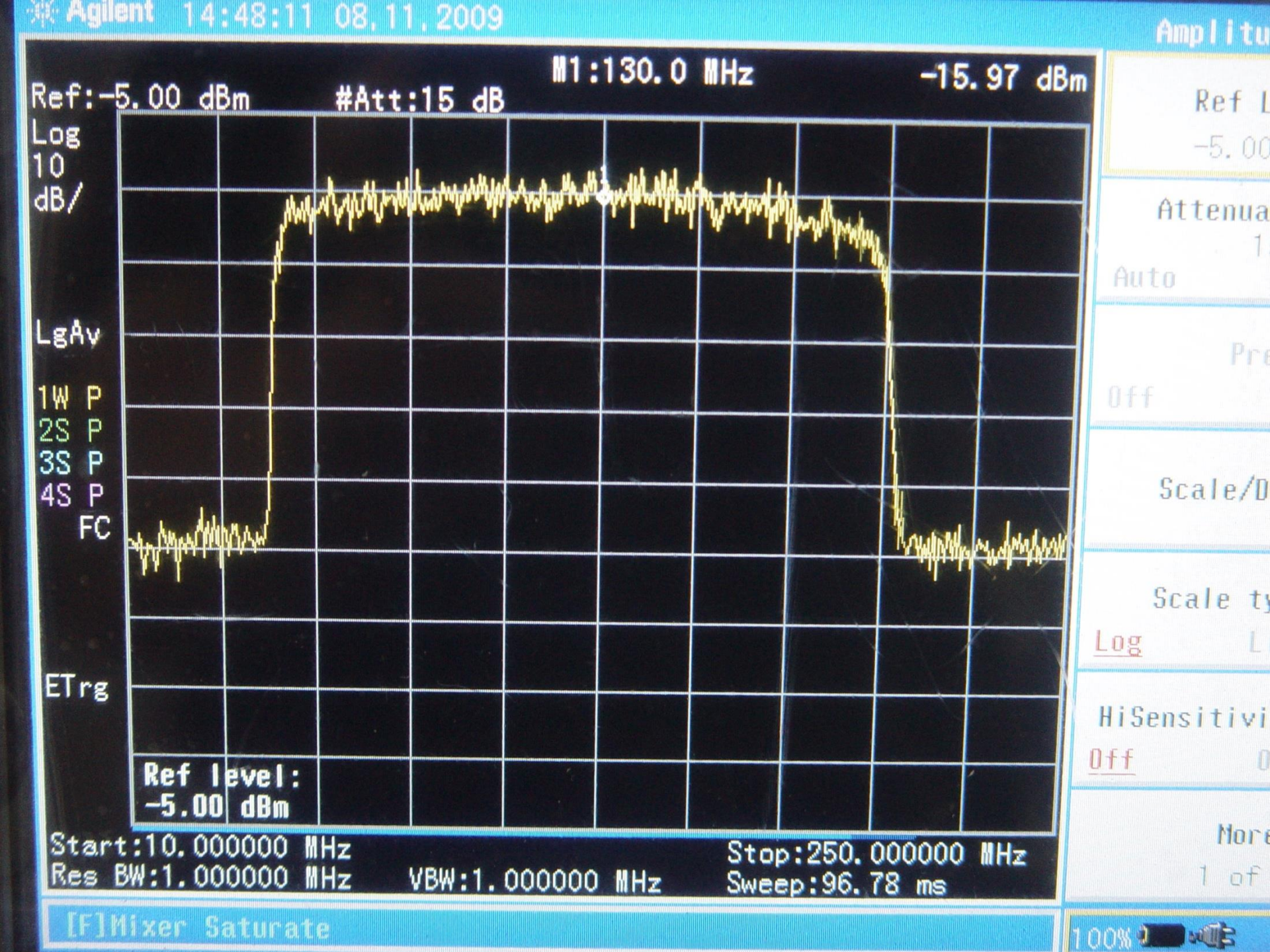

Oct 29, 2003


Nov 15, 2003


Nov 15, 2003


Agilent 07:15:38 Nov 13, 2007
Mkr1 113.750 MHz
-100.7 dBm
Ref -5 dBm
#Atten 5 dB
Peak
Log
10
dB/
Radio Frequency Interference at Ulastai
Marker
113.750000 MHz
-100.7 dBm
W1 S2
S3 FC
50MHz
200MHz
1
Start 0 Hz
Stop 250 MHz
#Res BW 3 kHz
VBW 3 kHz
Sweep 35.79 s (401 pts)


Agilent 23:59:11 Jun 15, 2007
Mkr1 99.125 MHz
-38.17 dBm
Ref -41 dBm
#Atten 5 dB
Peak
Log
5
dB/
Radio Environment in Urumqi
Marker
99.125000 MHz
-38.17 dBm
W1 S2
S3 FC
Start 50 MHz
Stop 200 MHz
#Res BW 100 kHz
VBW 10 kHz
Sweep 122.8 ms (401 pts)
Peak Sea
Meas To
Next P
Next Pk Ri
Next Pk L
Min Sea
Pk-Pk Sear


Agilent 14:48:11 08.11.2009
Amplitu
M1:130.0 MHz
-15.97 dBm
Ref:-5.00 dBm
#Att:15 dB
Log
10
dB/
LgAv
1W P
2S P
3S P
4S P
FC
ETrg
Ref level:
-5.00 dBm
Start:10.000000 MHz
Res BW:1.000000 MHz
VBW:1.000000 MHz
Stop:250.000000 MHz
Sweep:96.78 ms
Ref L
-5.00
Attenua
1
Auto
Pre
Off
Scale/D
Scale ty
Log
HiSensitivi
Off
More
1 of
[F]Mixer Saturate
100%


Mar 3, 2004


Center of the Array
Aug 3, 2004


U.S.NAVY
Aug 22, 2004


Sep 2, 2004

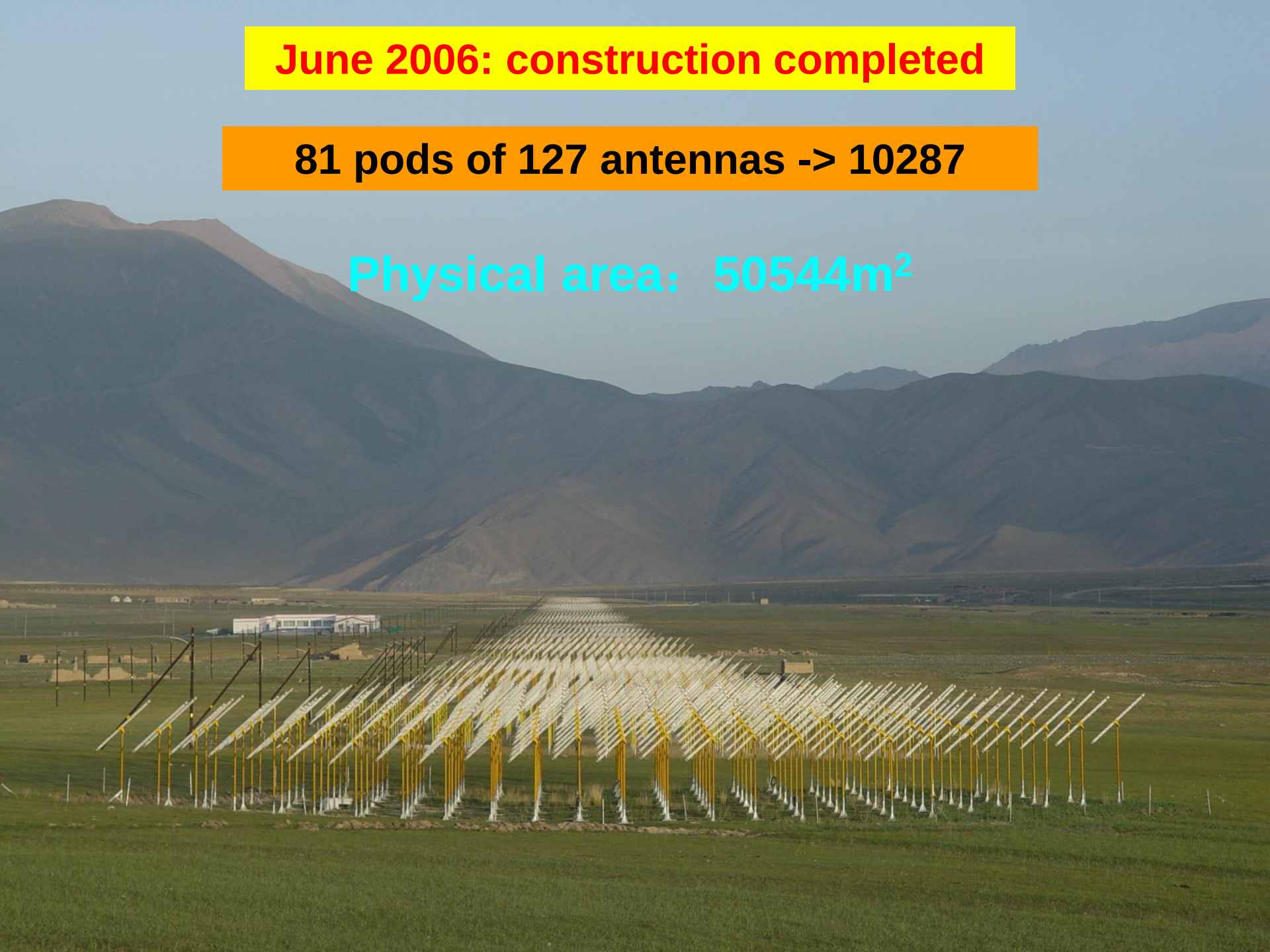

Sept. 1 2004

Setup of 23pods(2921 antennas), Jan.15, 2005


21CMA @ April 2005

21CMA: North-South Baseline Construction (July 2005)

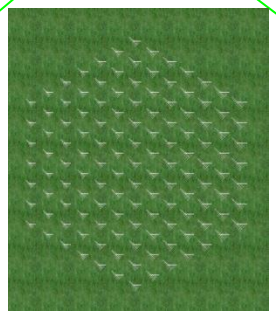
Construction in progress, January 2006


June 2006: construction completed
81 pods of 127 antennas -> 10287
Physical area：50544m2

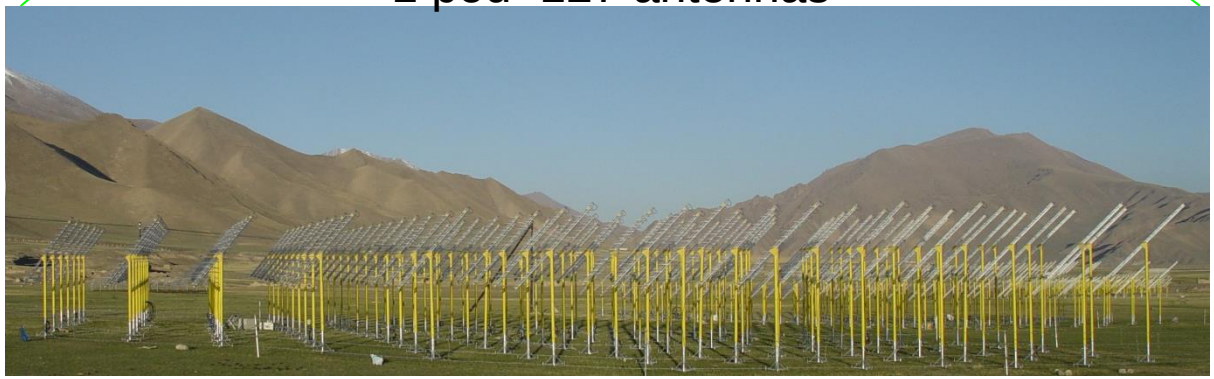
S

N

W



1 pod=127 antennas



control room

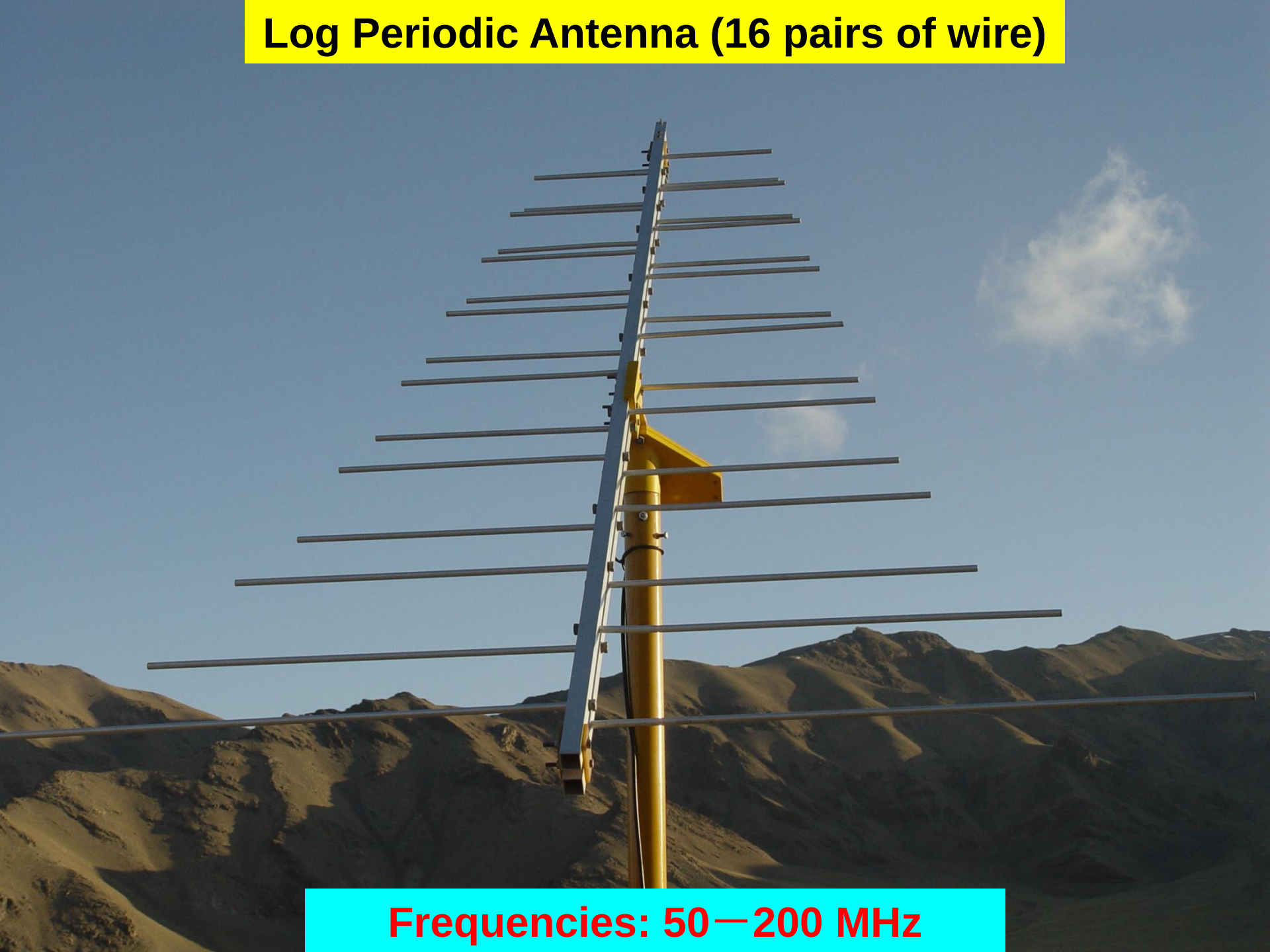
21CMA Layout

81 pods along two perpendicular arms (6km+4km)

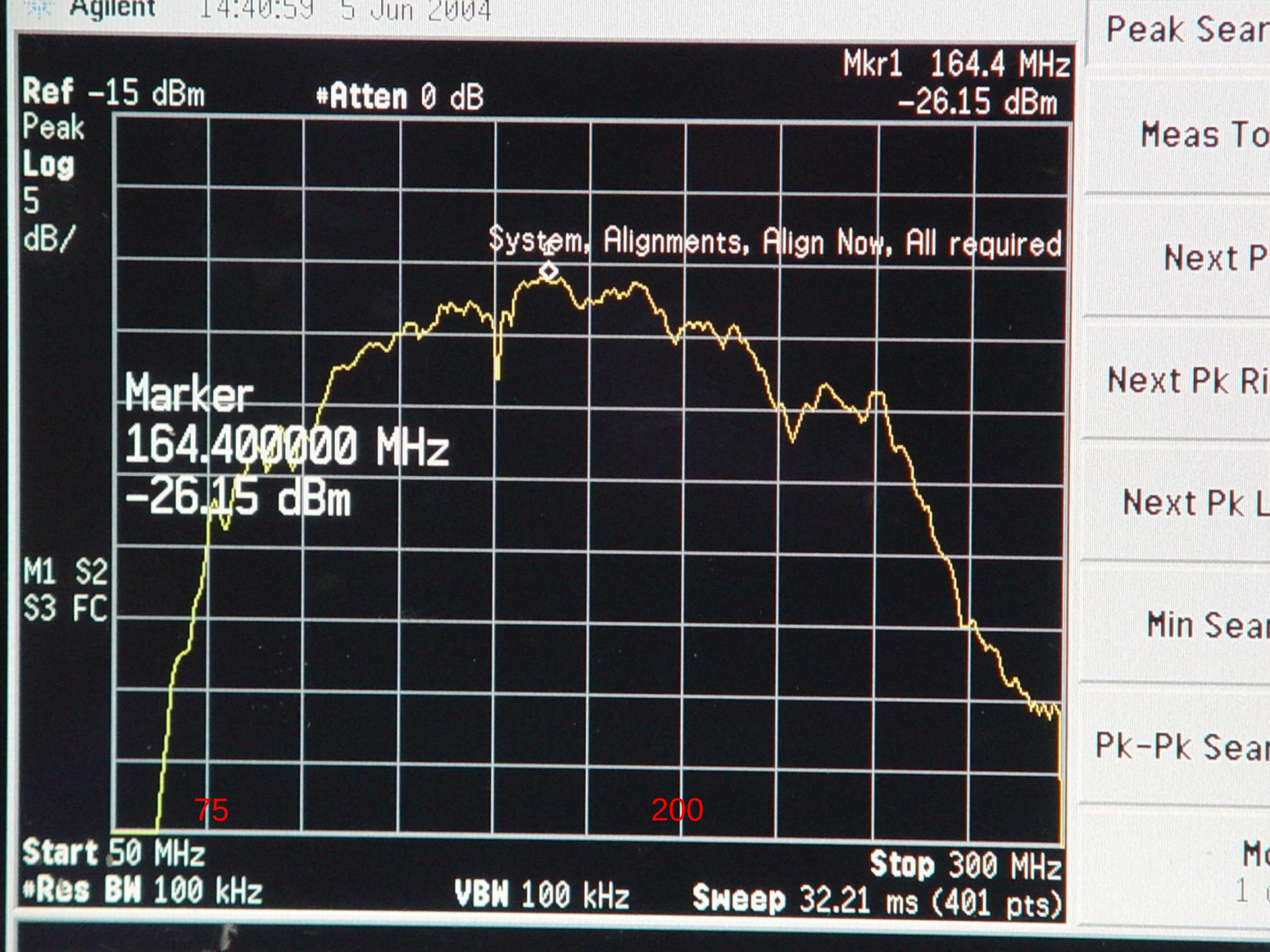
E

Baselines: 3240 Channels: 8192 Correlations: 26,542,080

Log Periodic Antenna (16 pairs of wire)



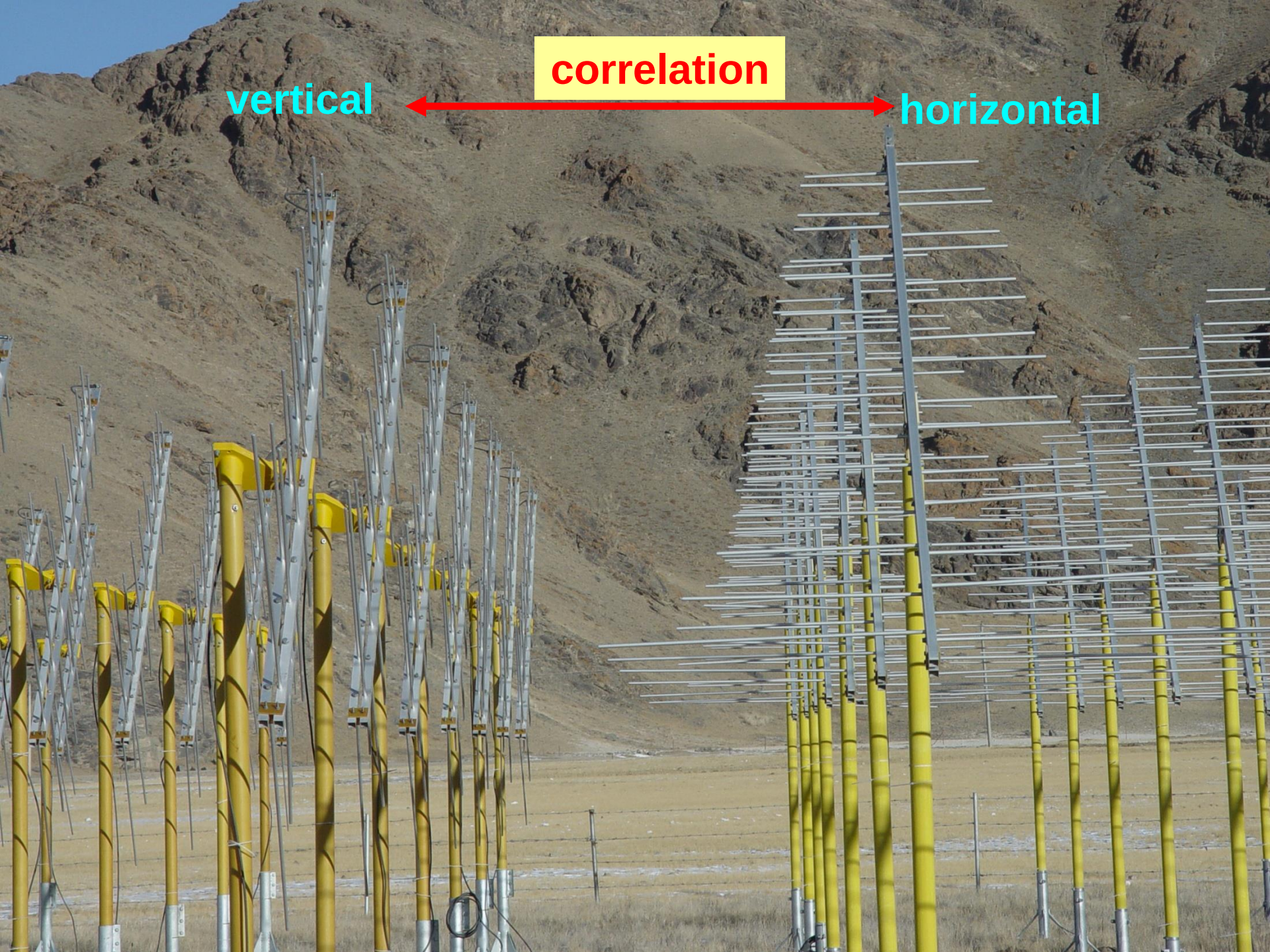
Frequencies: 50—200 MHz


Agilent 14:40:59 5 Jun 2004
Mkr1 164.4 MHz
-26.15 dBm
Ref -15 dBm
#Atten 0 dB
Peak
Log
5
dB/
System, Alignments, Align Now, All required
Marker
164.400000 MHz
-26.15 dBm
M1 S2
S3 FC
75
200
Start 50 MHz
#Res BW 100 kHz
VBW 100 kHz
Stop 300 MHz
Sweep 32.21 ms (401 pts)
Peak Sear
Meas To
Next P
Next Pk Ri
Next Pk L
Min Sear
Pk-Pk Sear

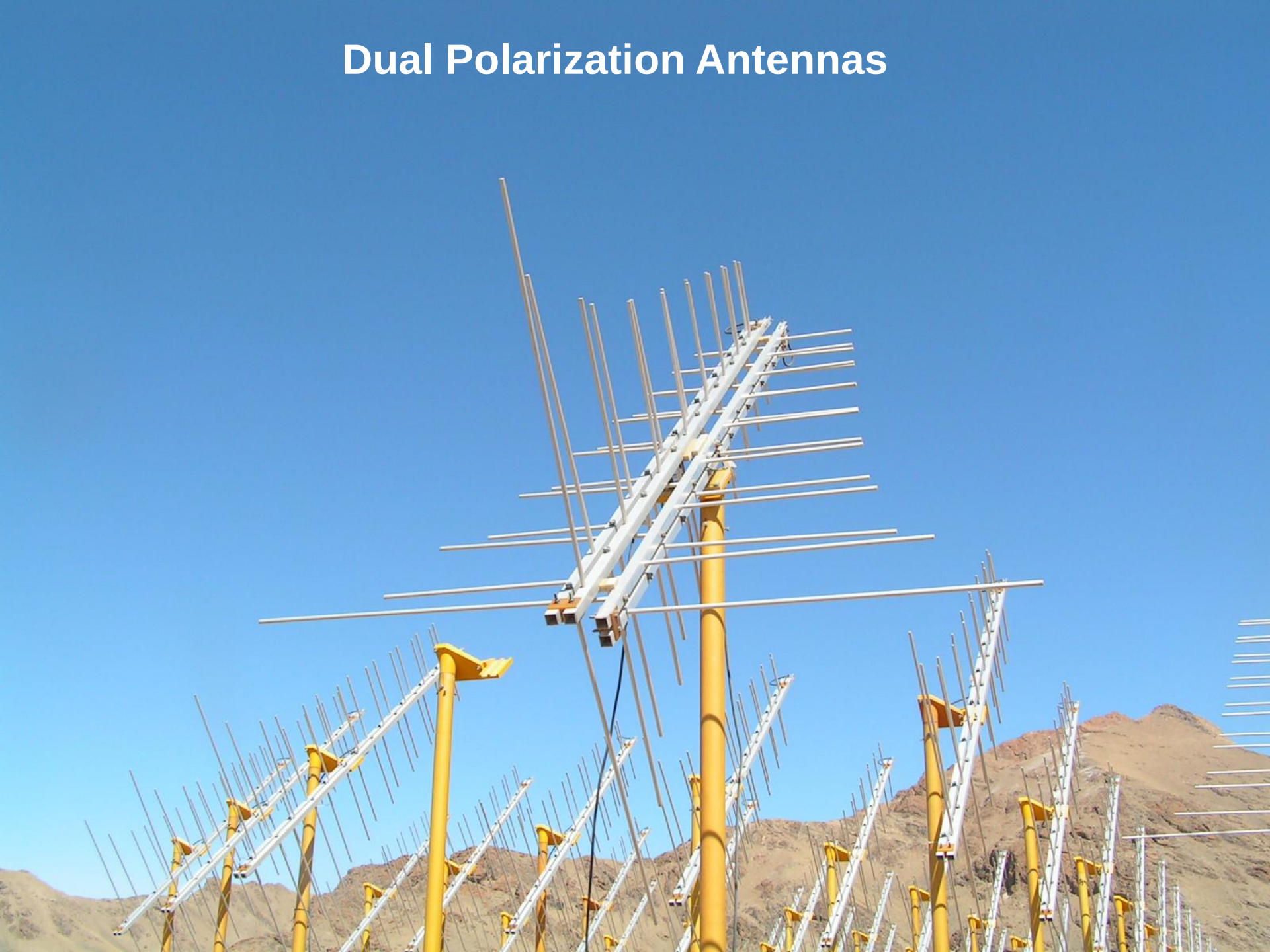
21CMA consists of 81 stations or pods

Log-Periodic Antenna


splitter/combiner
DS4DGH10
REGAL

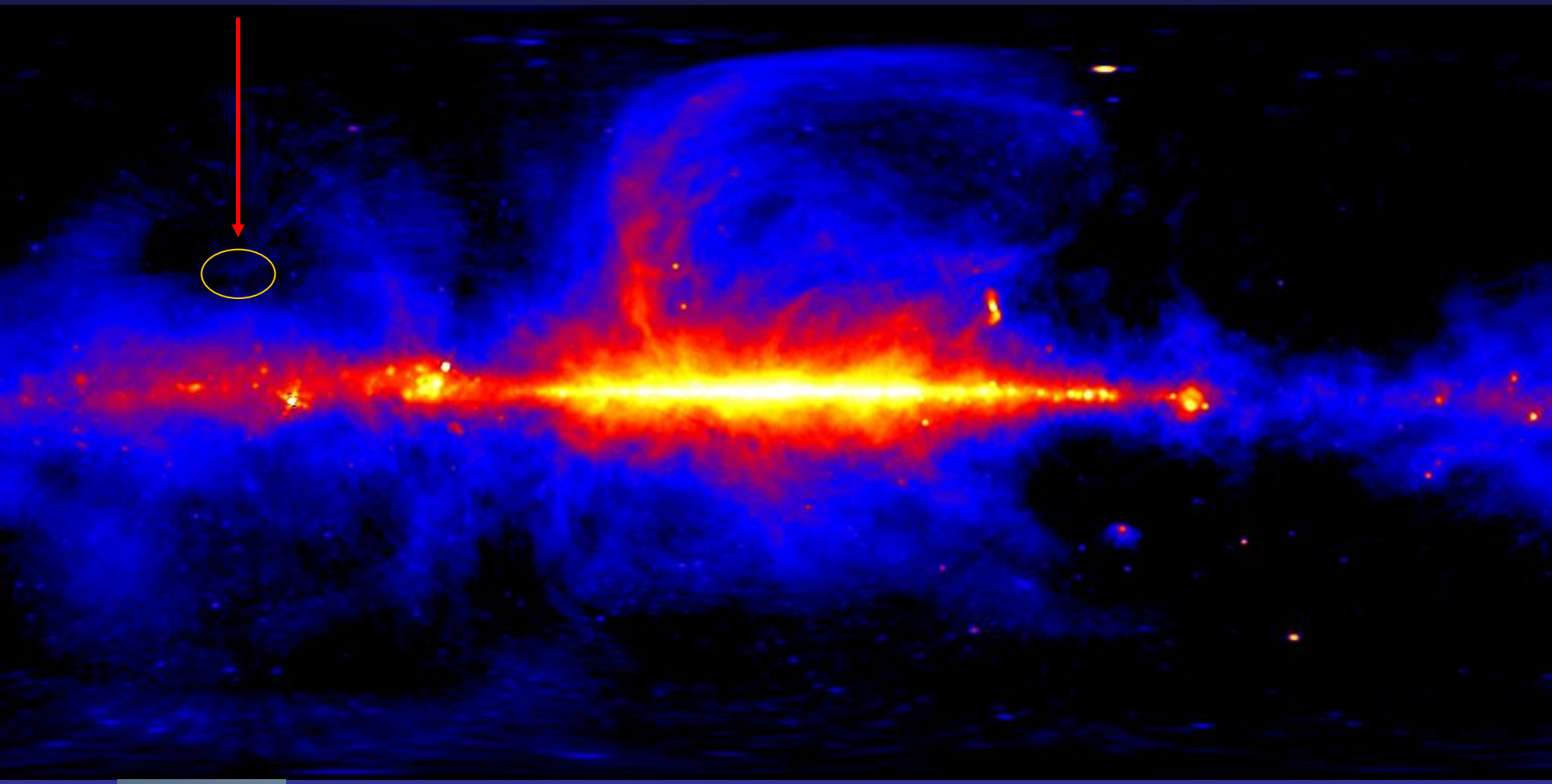

correlation
vertical
horizontal

Dual Polarization Antennas



VHF Sky (408 MHz)

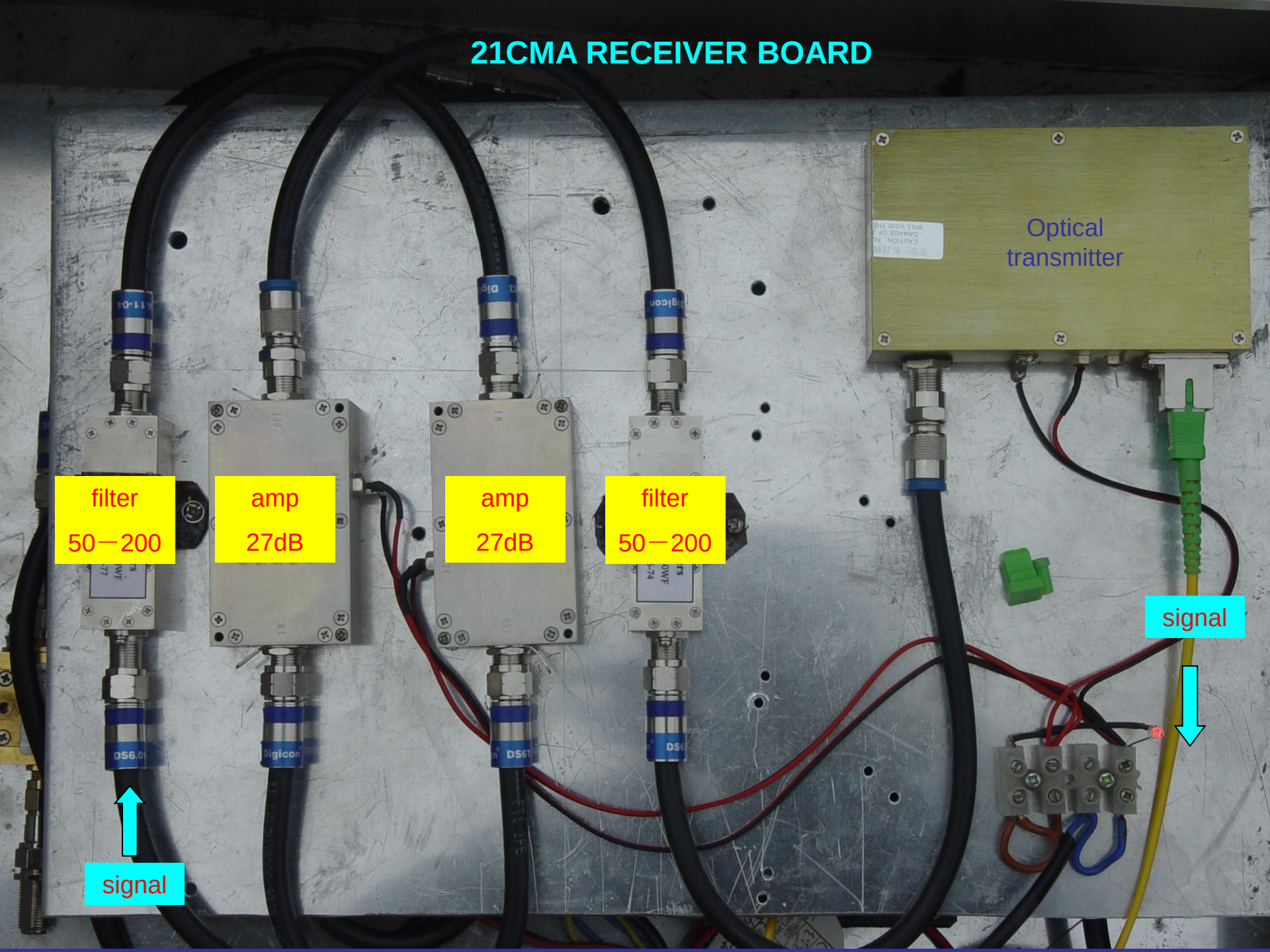
21CMA

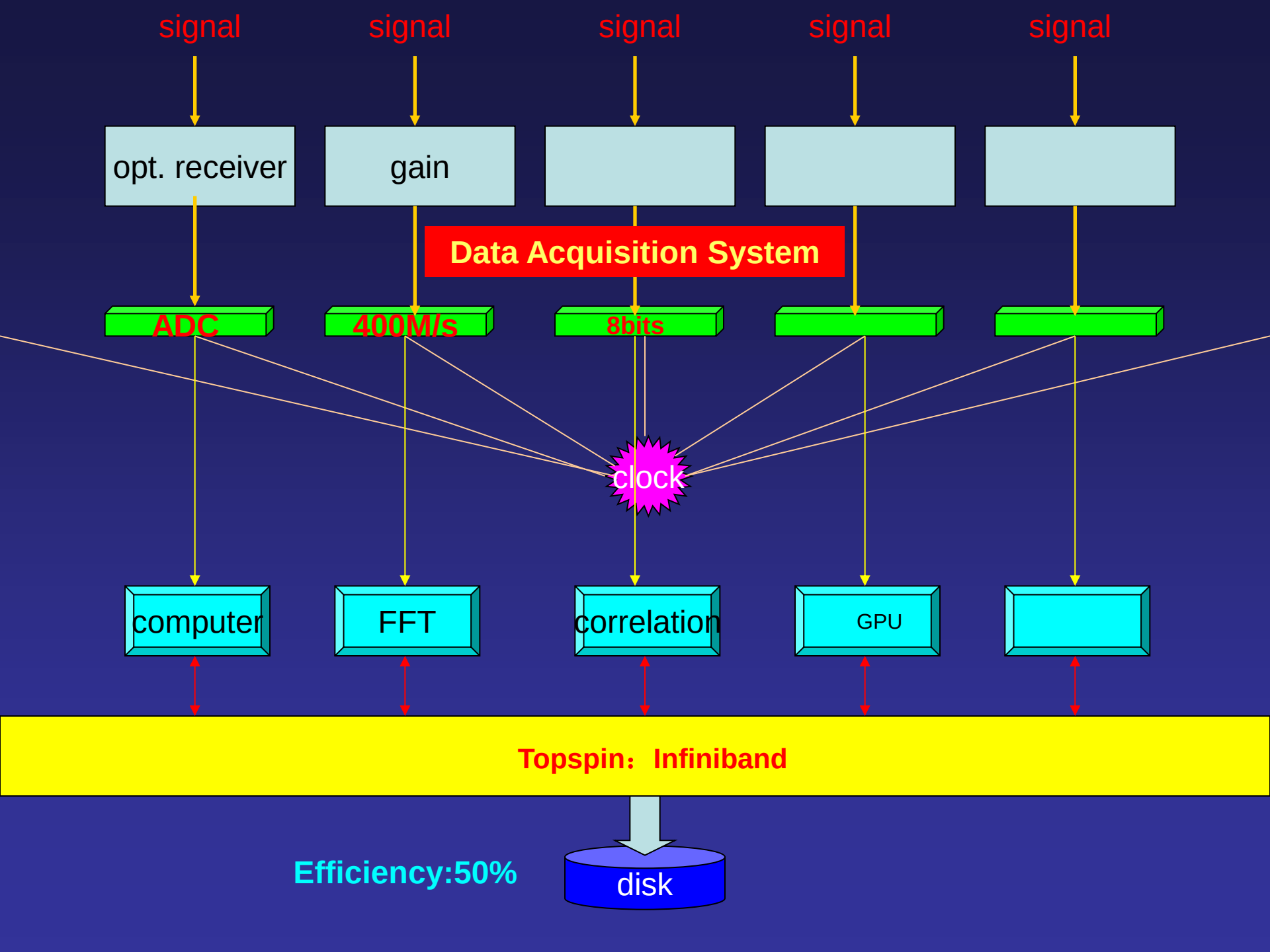


Points at NCP only – economical reason and simplicity

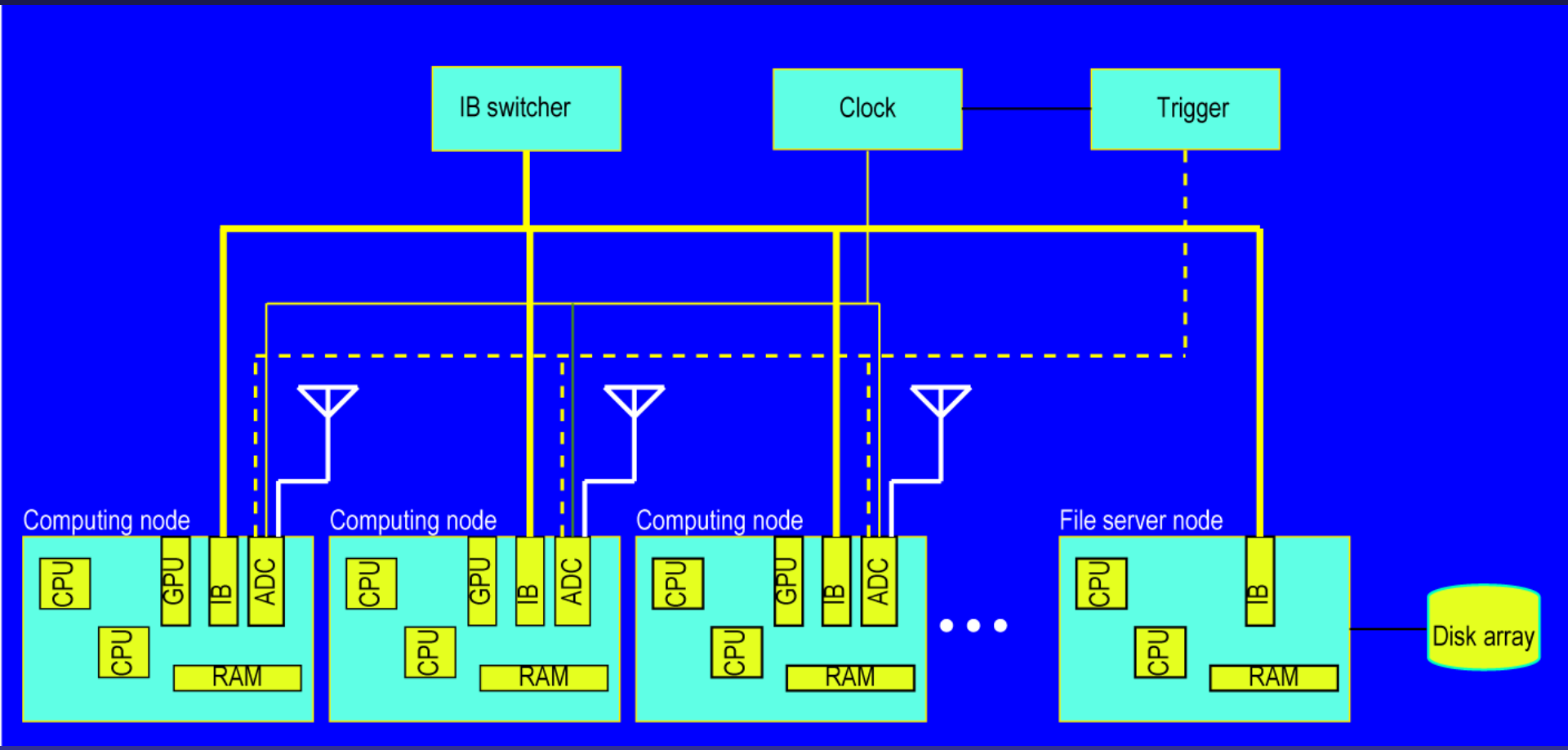

(pre) LNA
(20dB, 50K)
power

21CMA RECEIVER BOARD




signal
signal
signal
signal
signal
opt. receiver
gain
Data Acquisition System
ADC
400M/s
8bits
clock
computer
FFT
correlation
GPU
Topspin：Infiniband
Efficiency:50%
disk

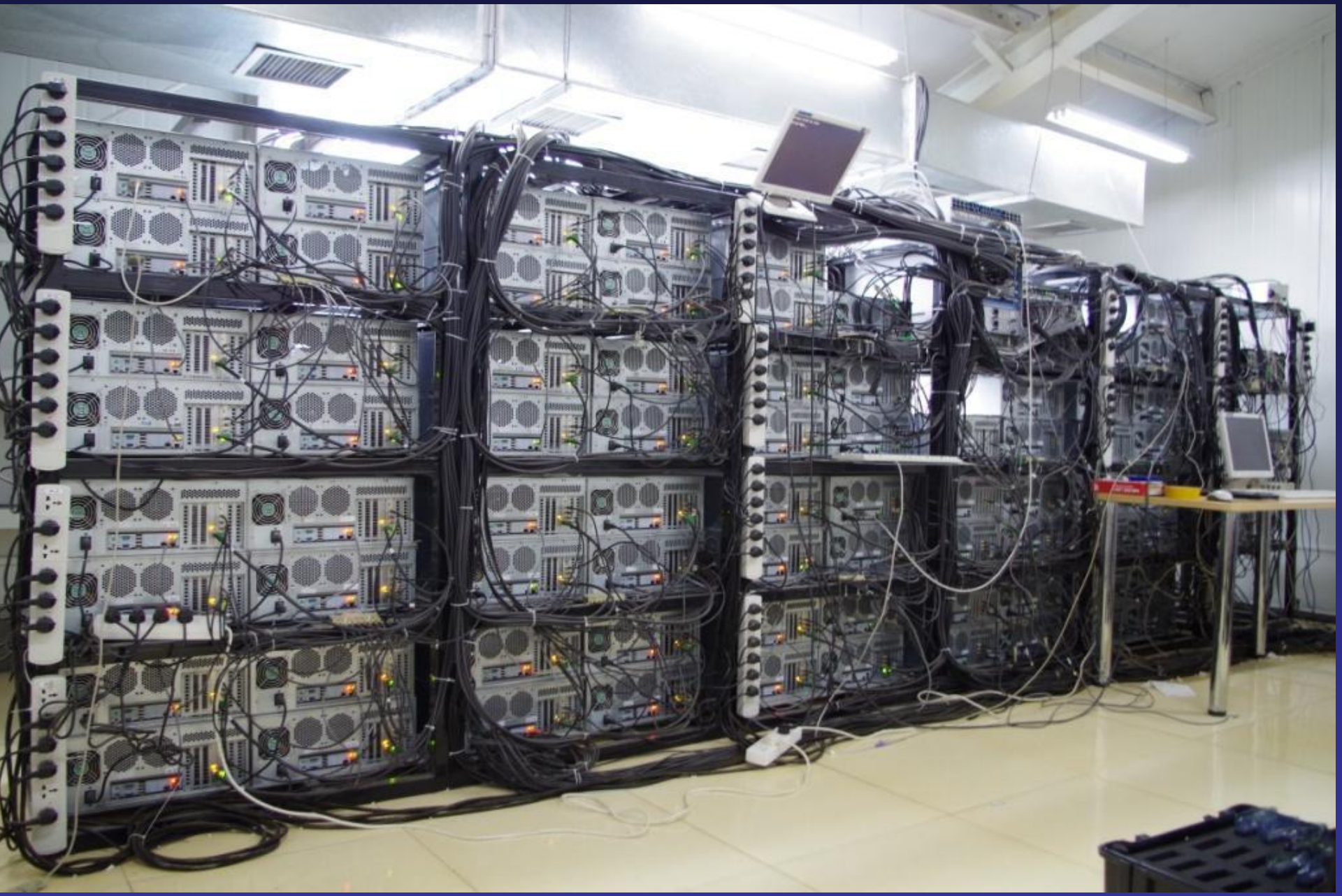
Data Communication



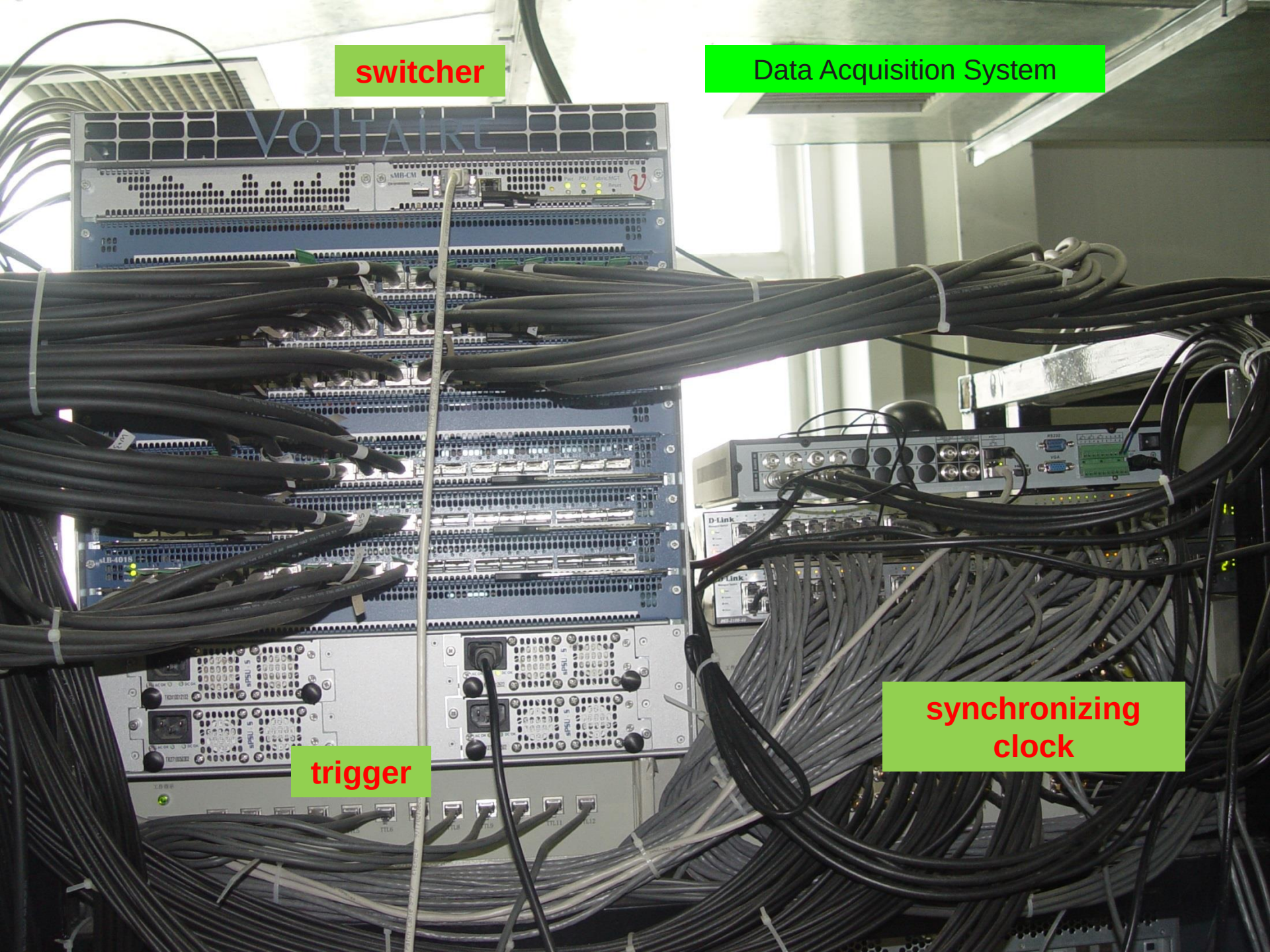
Efficiency:50%

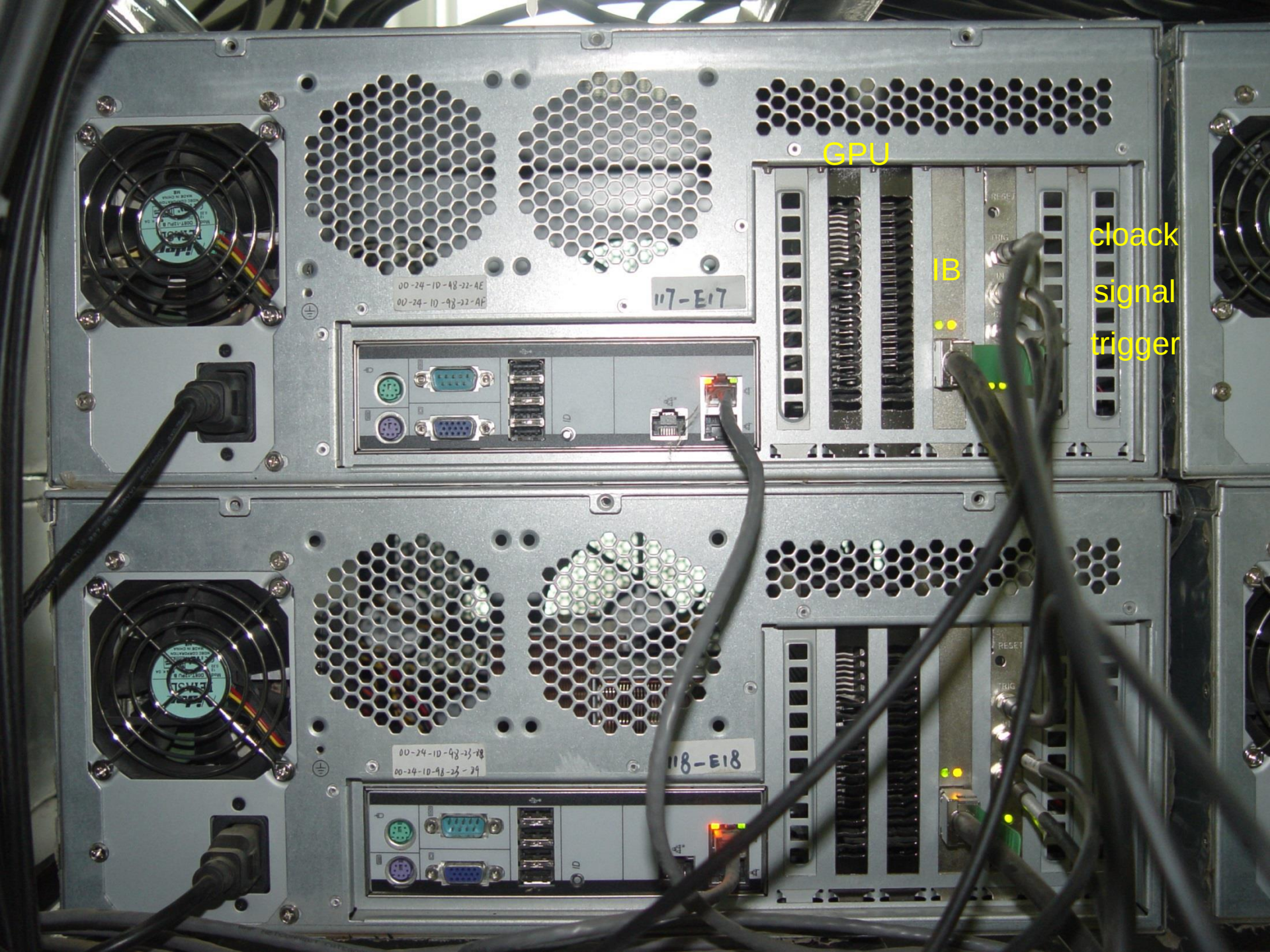
32G/s


Optical Receivers

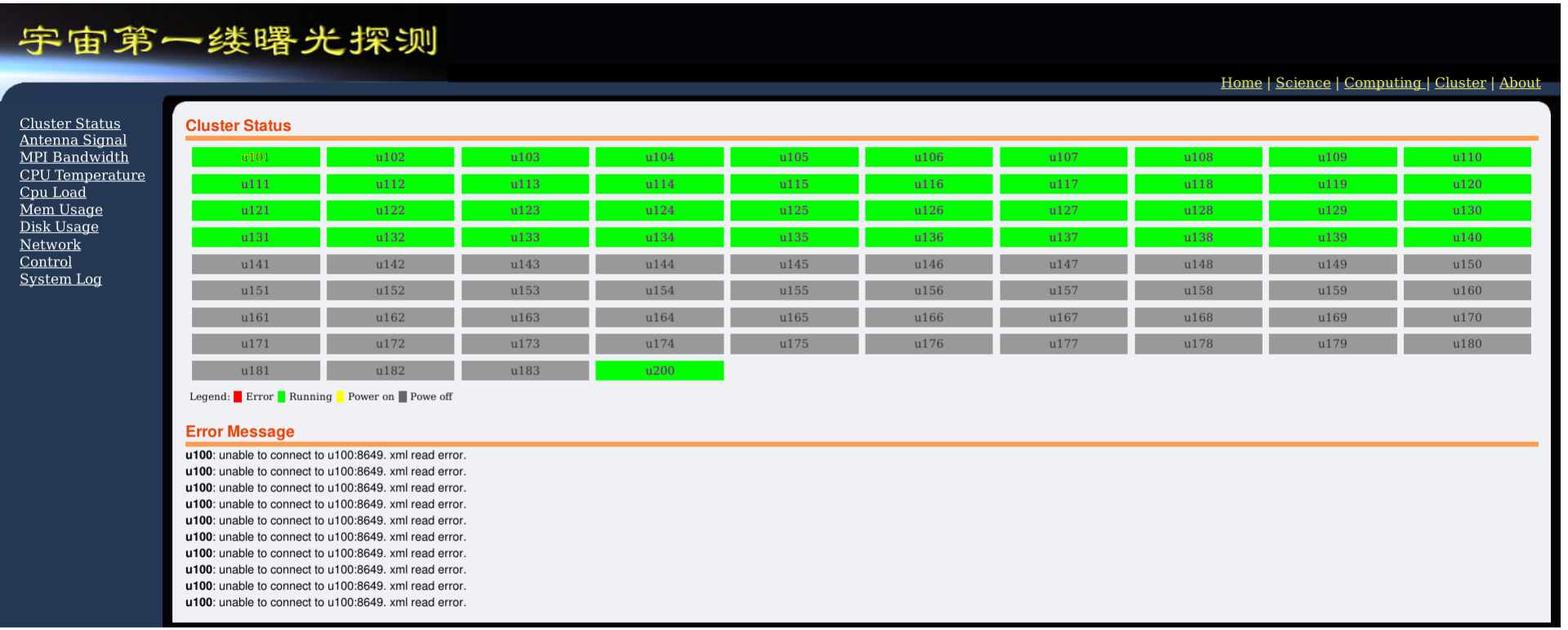


21CAM Data Acquisition System


switcher
Data Acquisition System
synchronizing clock
trigger


GPU
IB
cloack
signal
trigger

Remote Control System



Remote Control System

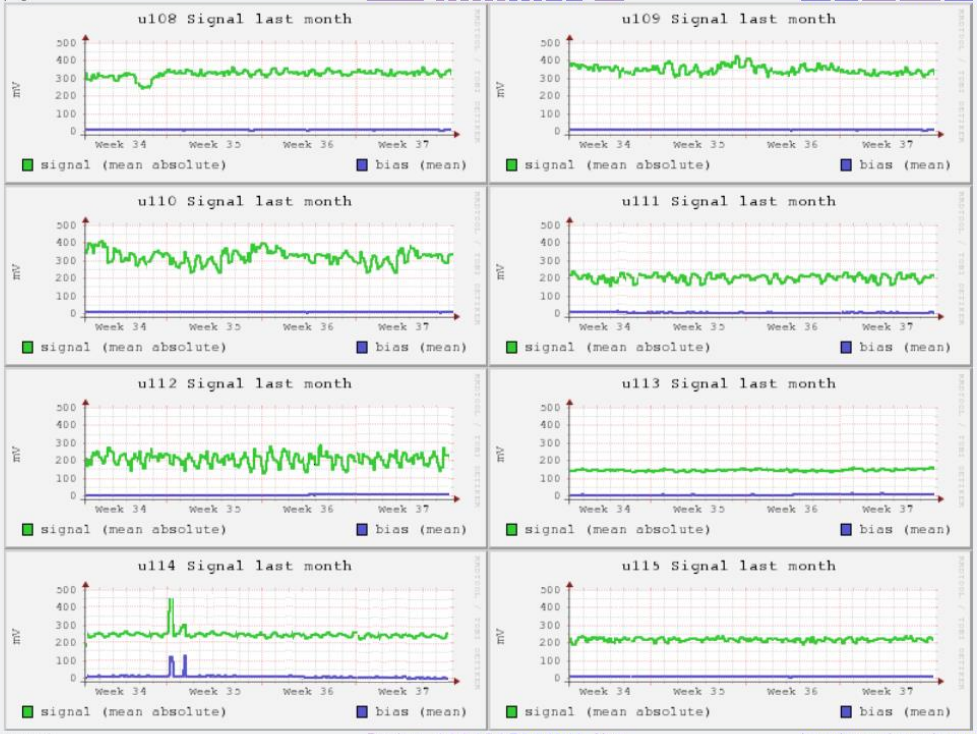
宇宙第一缕曙光探测

Home | Science | Computing | Cluster | About

- Cluster Status
- Antenna Signal
- MPI Bandwidth
- CPU Temperature
- Cpu Load
- Mem Usage
- Disk Usage
- Network
- Control
- System Log

Antenna_report

page: 2 Previous 1 2 3 4 5 6 7 8 9 10 11 Next hour day week month year



page: 2 Previous 1 2 3 4 5 6 7 8 9 10 11 Next hour day week month year

Infrastructure Construction

August 2004

Infrastructure Construction

December 25 2004

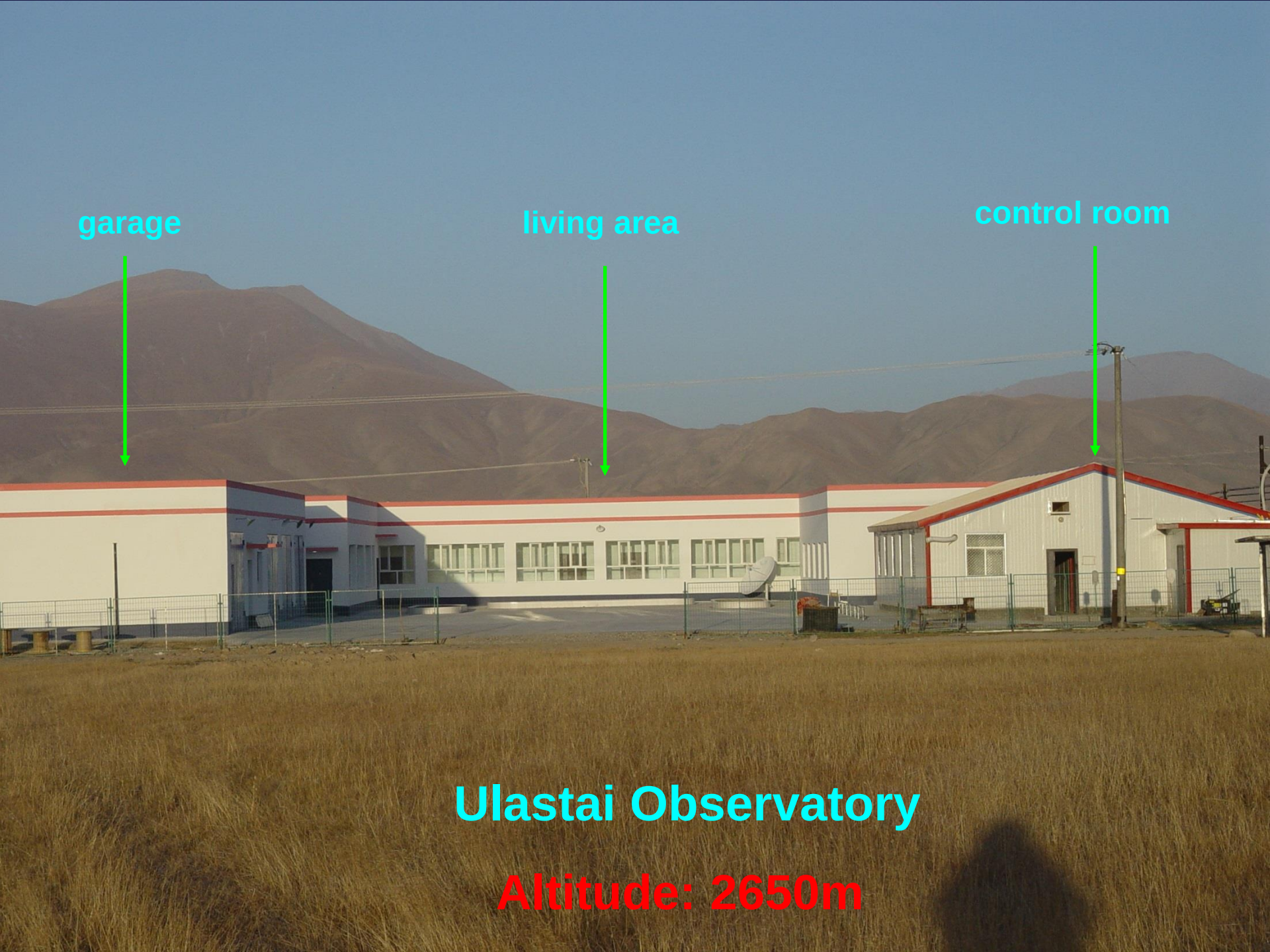

March 13 2005

Infrastructure Construction

Aug. 14, 2005

Infrastructure Construction

Oct. 1, 2005



Ulastai Observatory

Altitude: 2650m

Ulastai Observatory

Ulastai Observatory

21CMA People @ Ulastai

People @ Ulastai

TREND Pioneers @ Ulastai

TREND Pioneers @ Ulastai

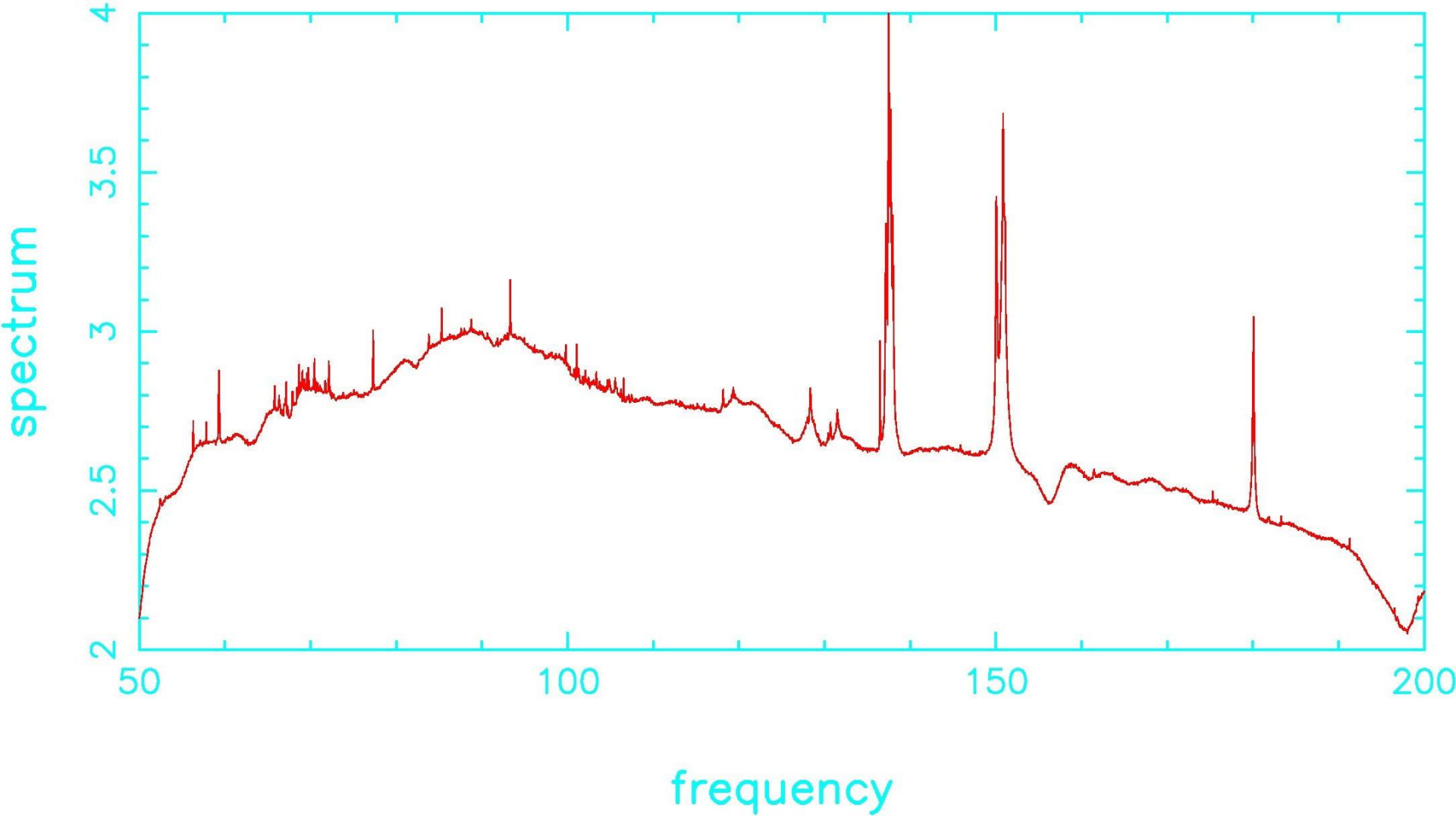

TREND Pioneer @ Ulastai

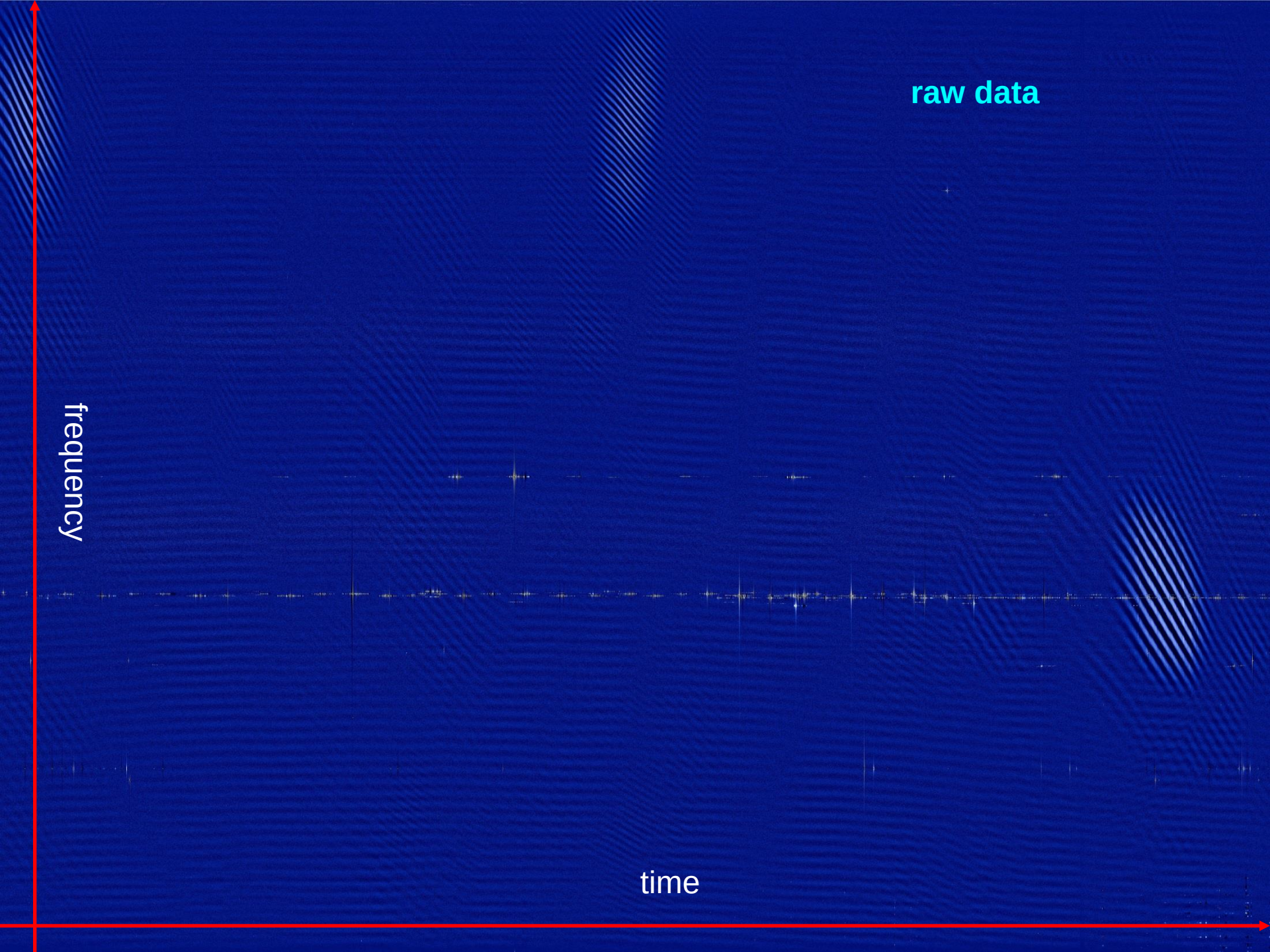
21CMA Observation Log

Year/ month	1	2	3	4	5	6	7	8	9	10	11	12	total
2009	15	6	11	10	8	0	0	0	5	11	10	13	89
2010	31	6	11	7	19	2	5	25	25	15	11	9	166
2011	19	3	28	30	31	26	26	25	27	25	15	0	255
2012	31	25	27	24	16	29	1	1	28	27	7	26	242
2013	20	0	26	26	31	26	20	29	8	16	15	27	244
2014	12	0	27	30	27	26							122
total	128	40	130	127	132	109	52	80	93	94	58	75	**1118**

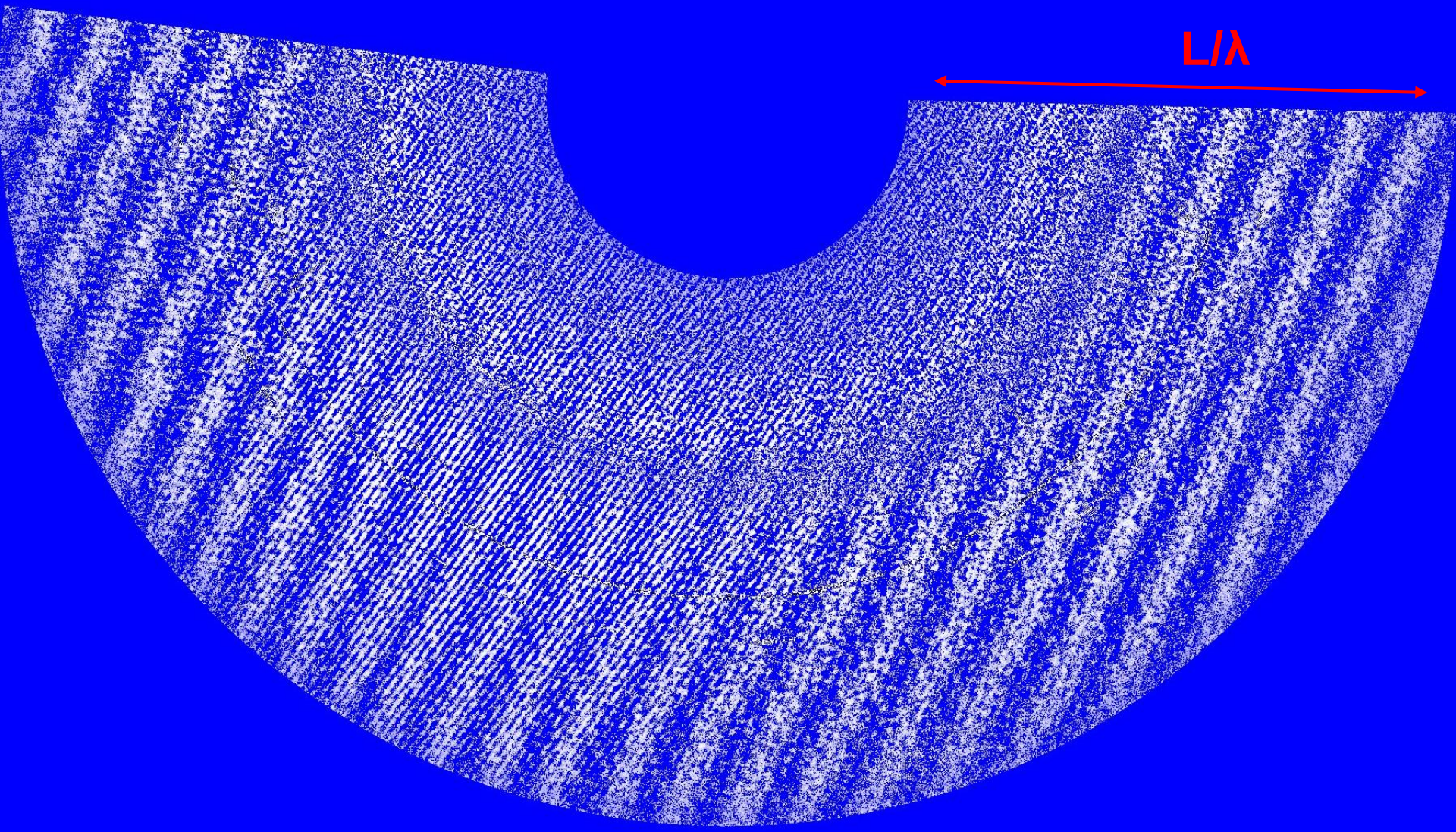
Observing Efficiency = 56%

The Milky Way Dominated Spectrum

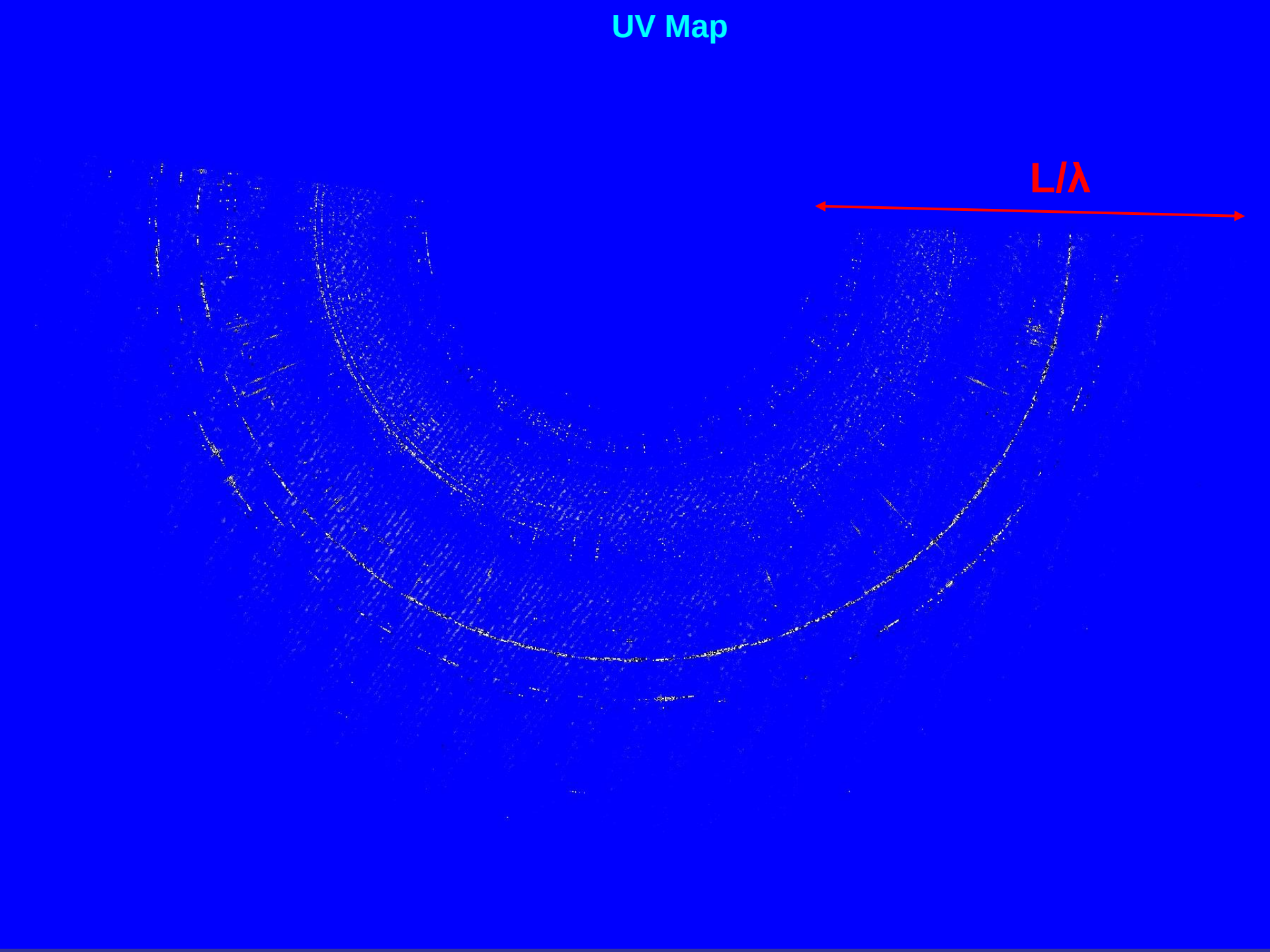


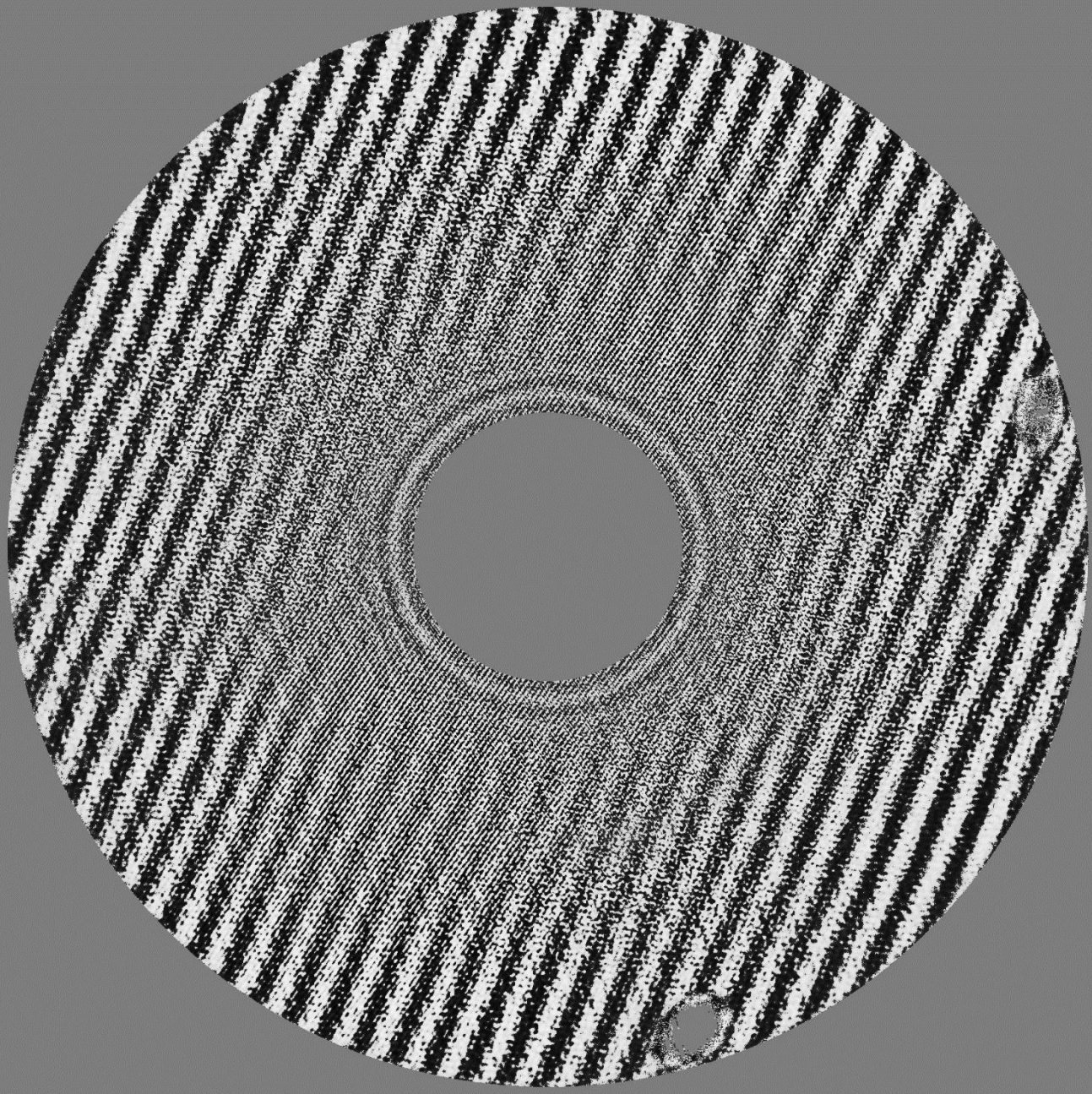

raw data
frequency
time

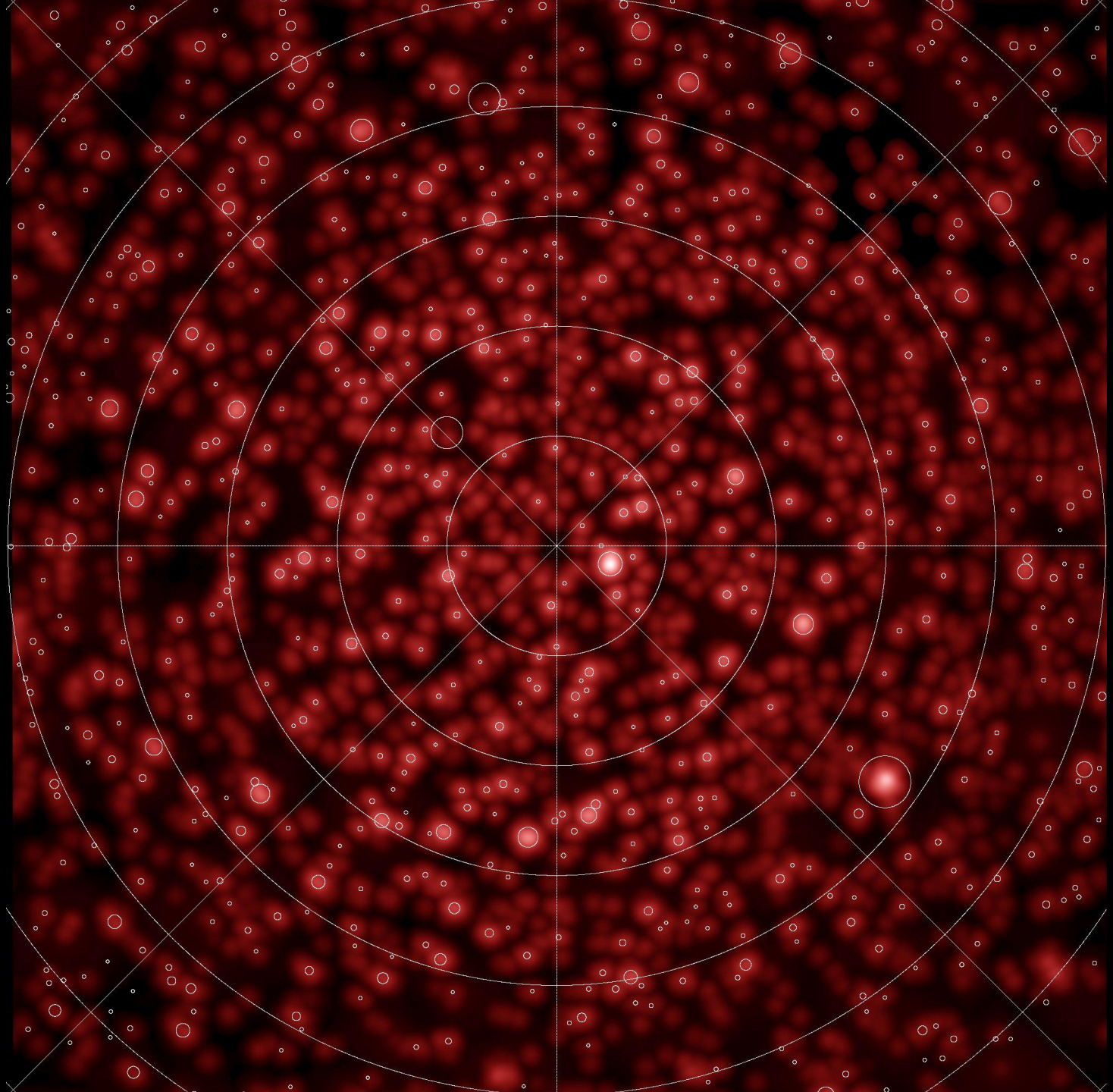
UV Map

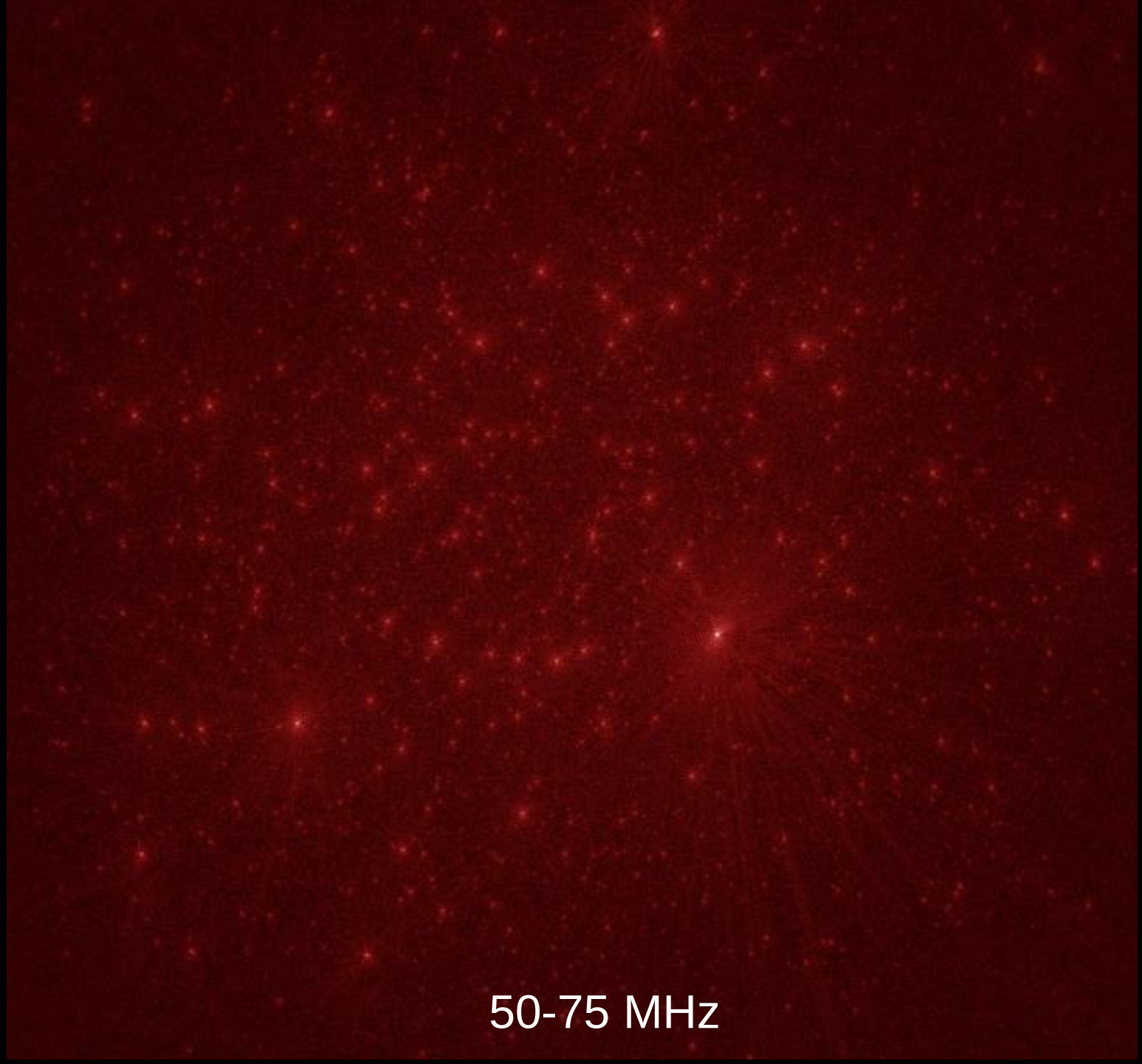


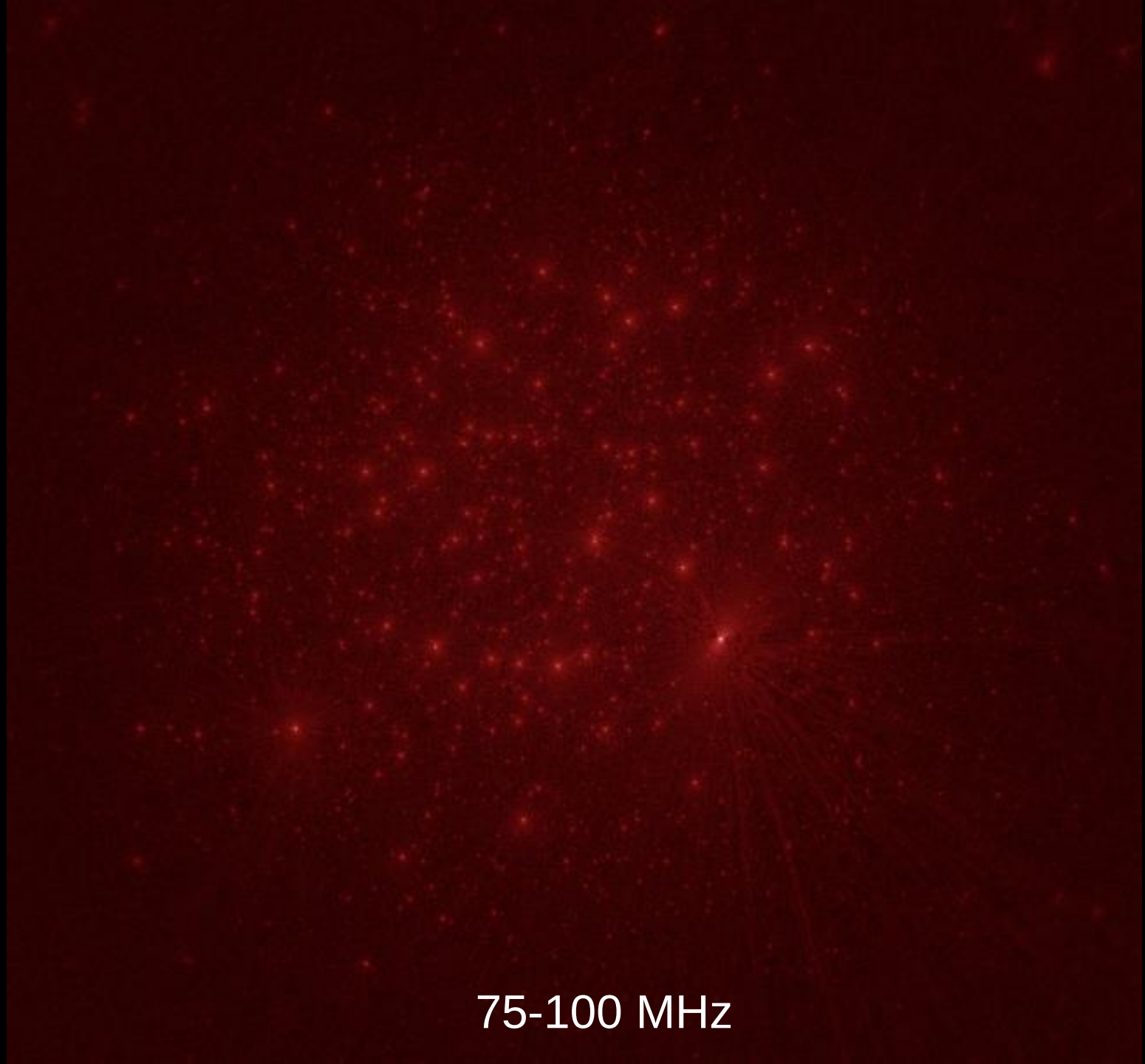
UV Map

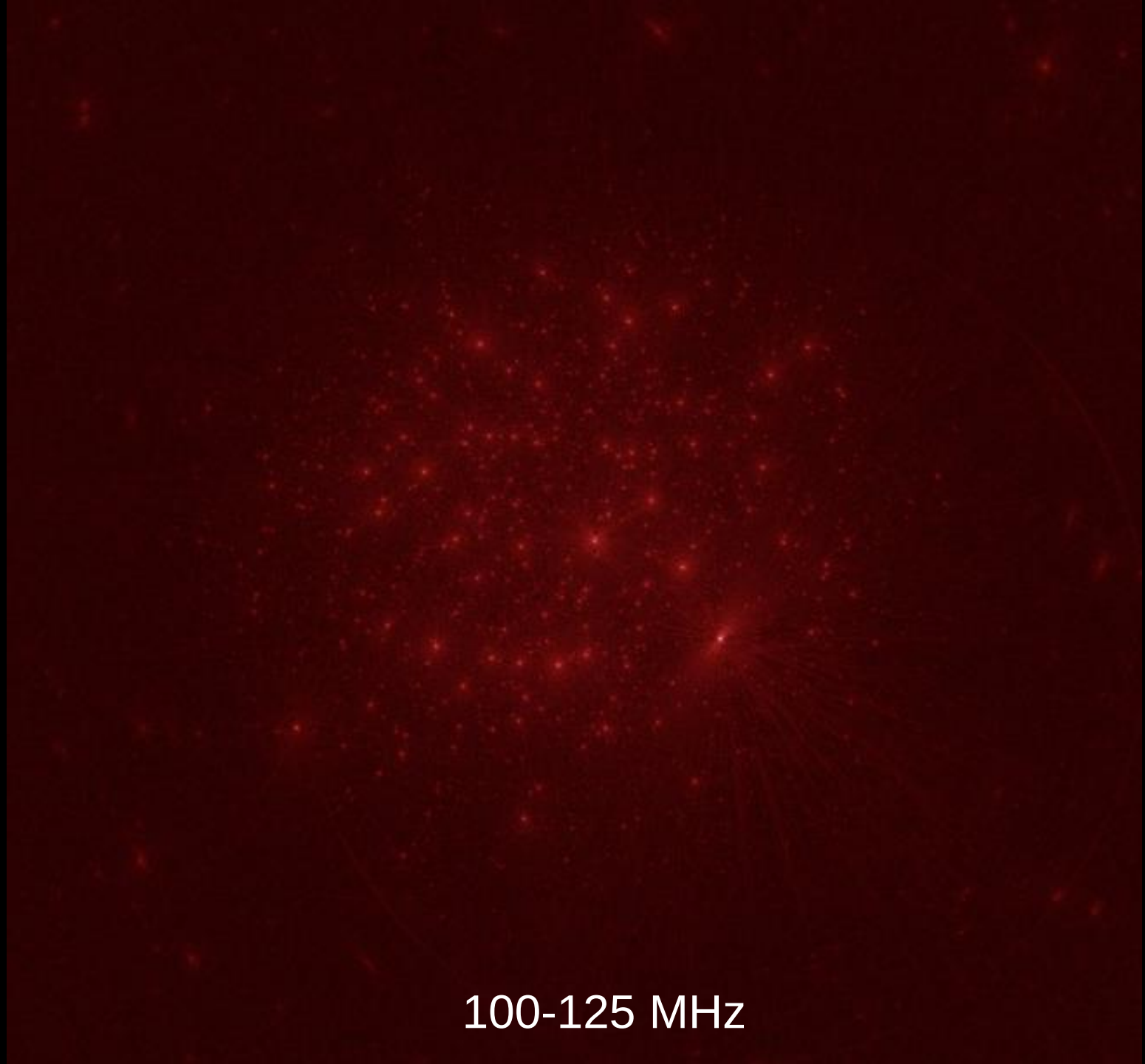


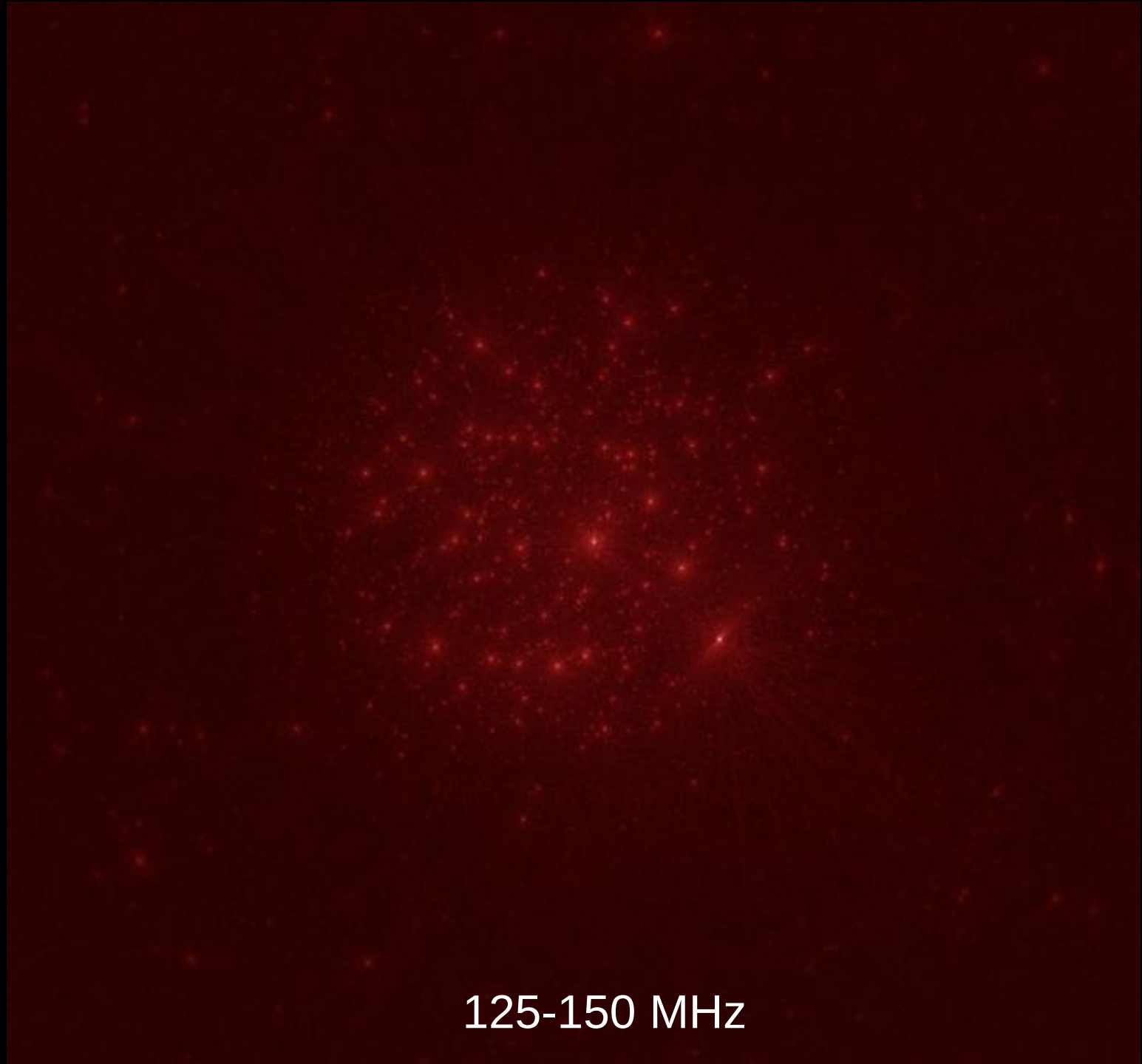


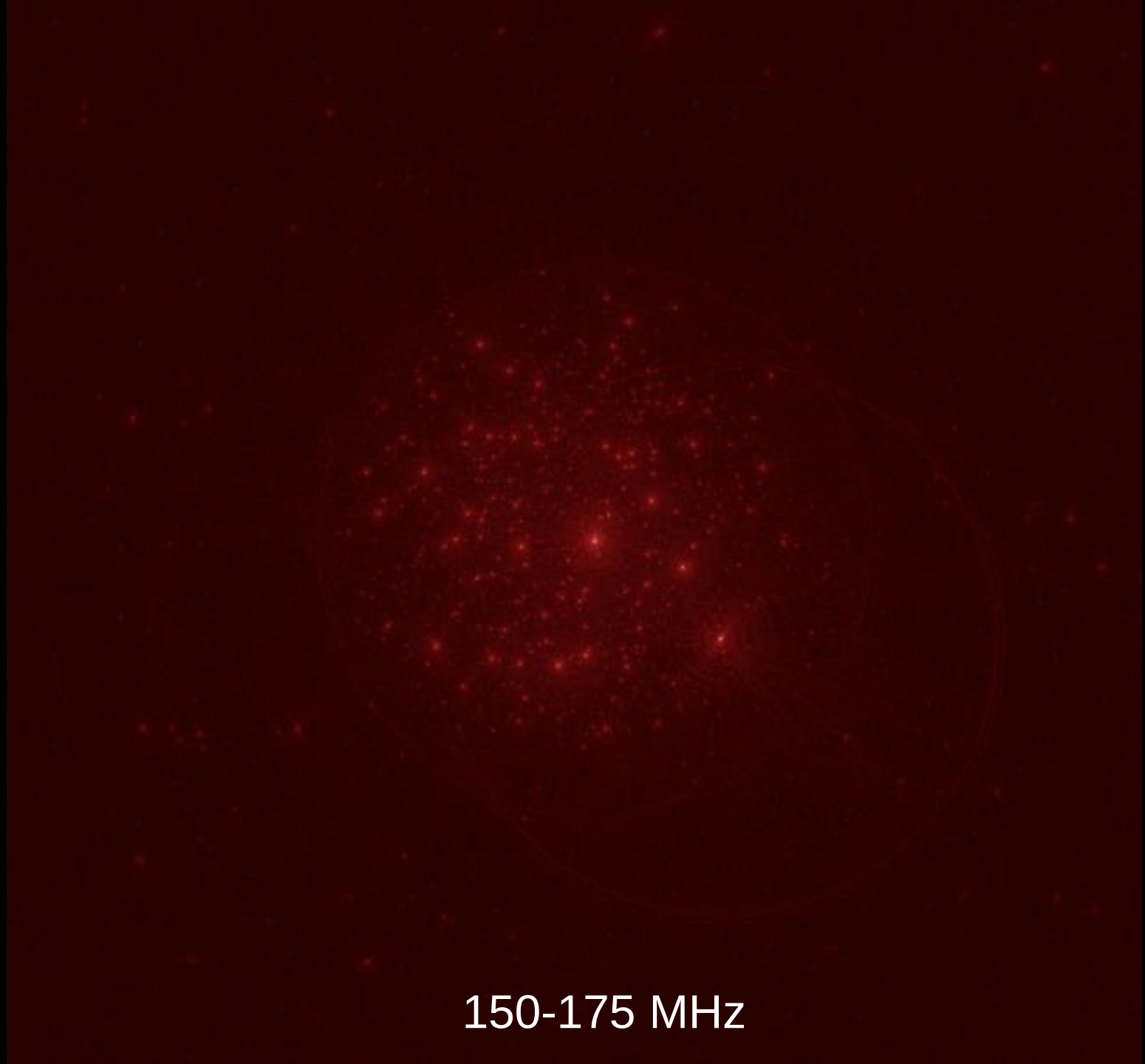


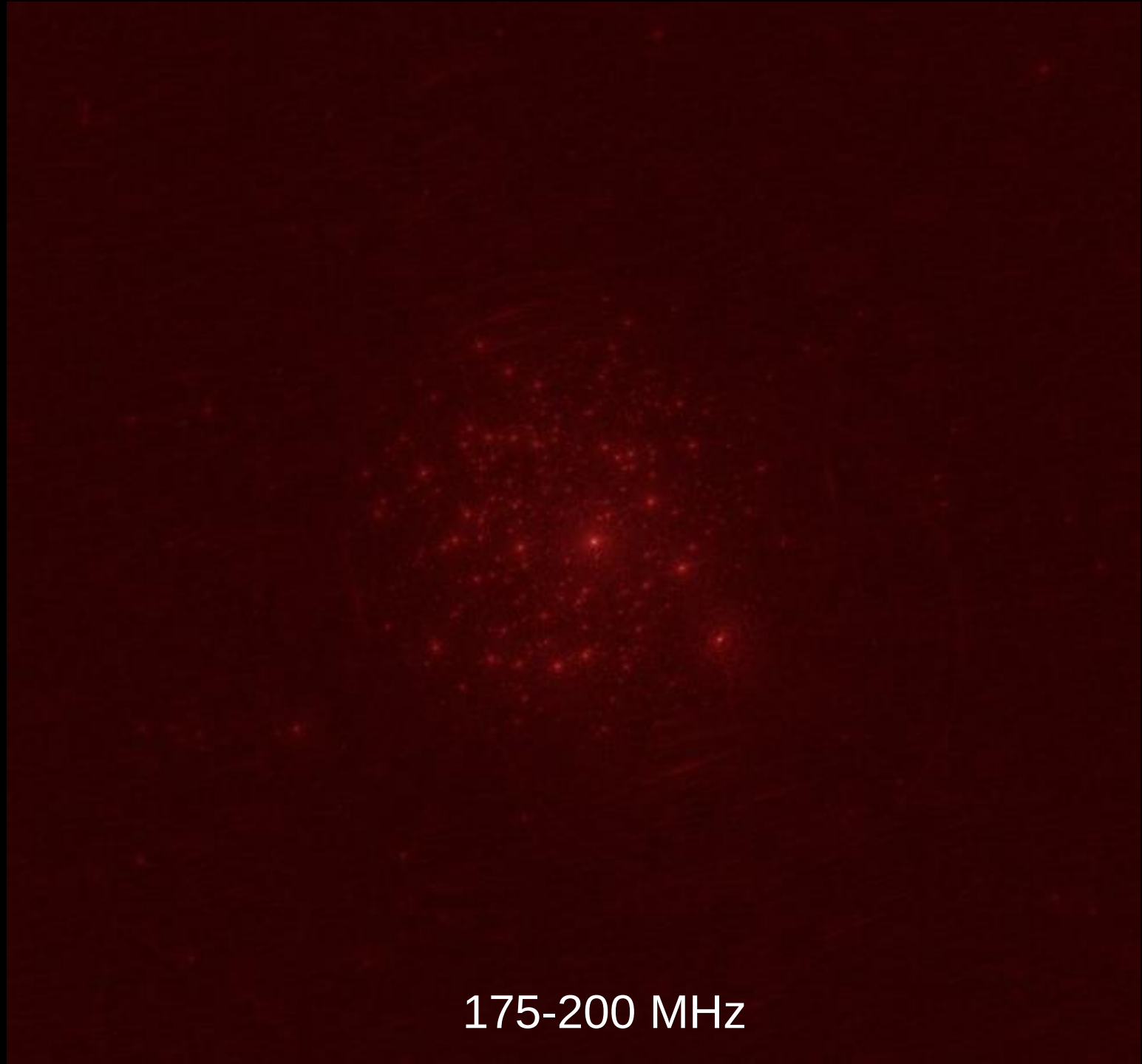

50-75 MHz


75-100 MHz


100-125 MHz

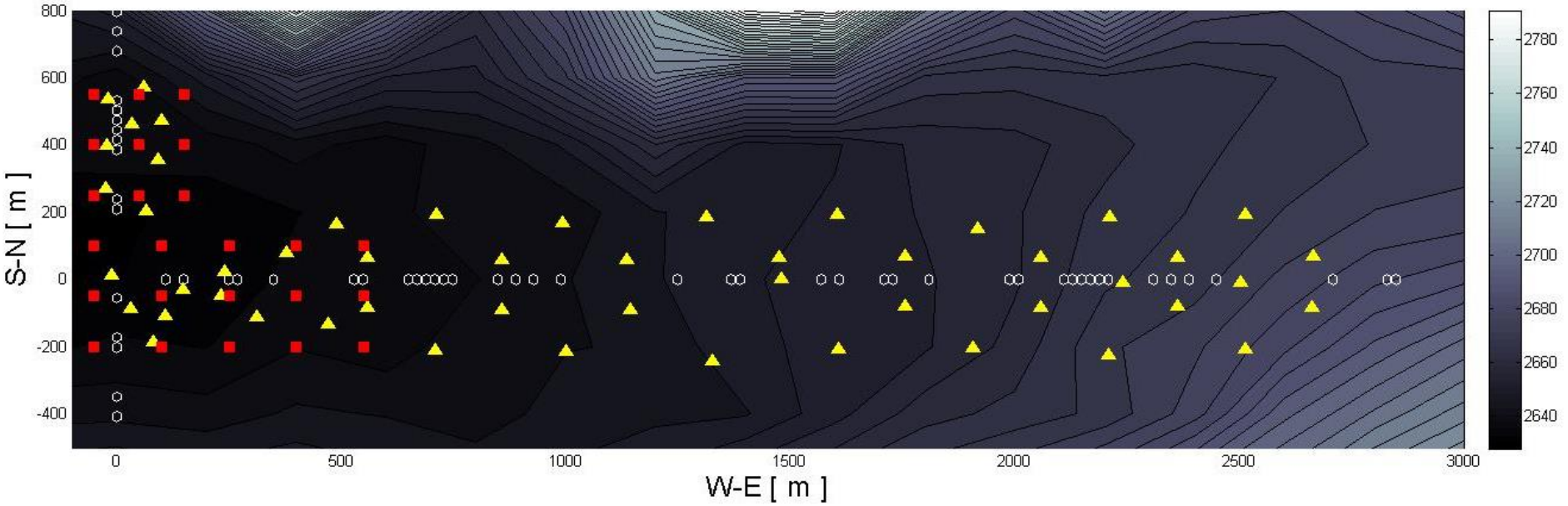

125-150 MHz


150-175 MHz


175-200 MHz

Current TREND

50 Butterfly Antennas at Site




3 Scintillators（Feb 2010）

TREND DAQ System

Fund Situations for TREND

7M RMB over past 6 years

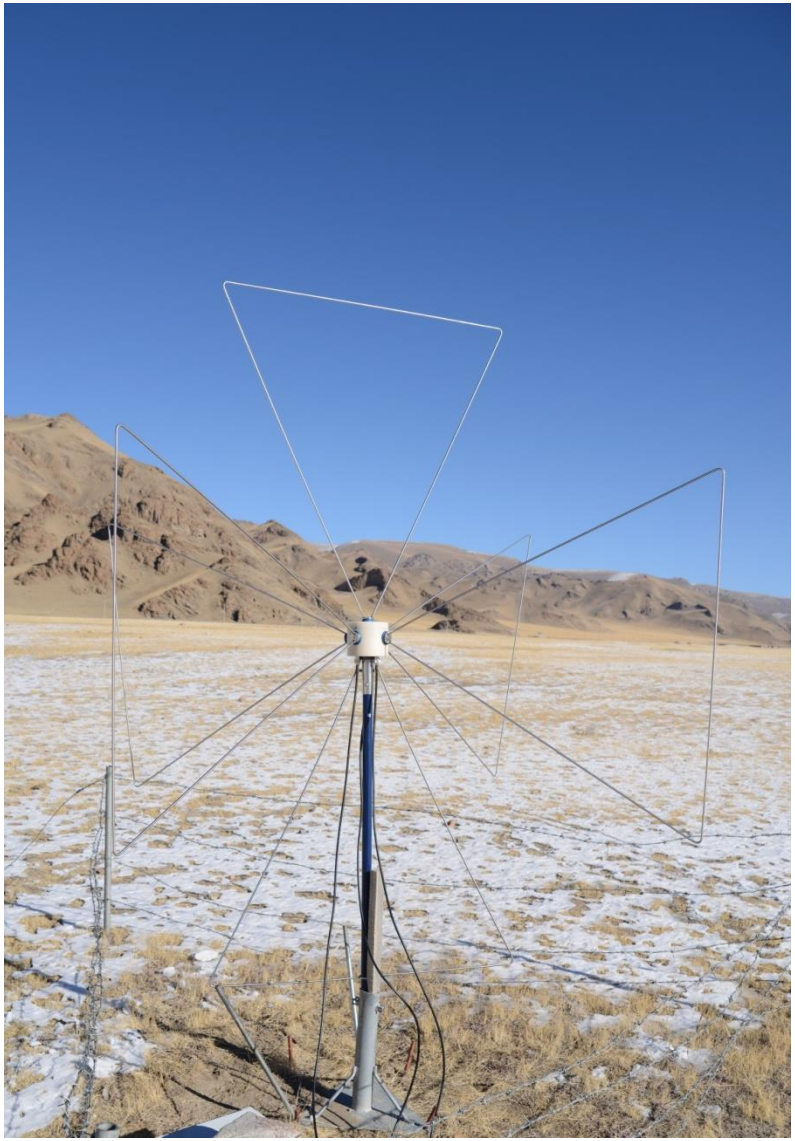
1. ‘First Light’ project (21CMA)： 3M
2. Foreign Experts (Olivier) @ CAS： 0.5M x 2yr 1M
3. Foreign Young Scientist @CAS： 0.165M
4. NSFC： 0.1M
5. NSFC (IHEP+NAOC)： 1M
6. NAOC： 1.9M

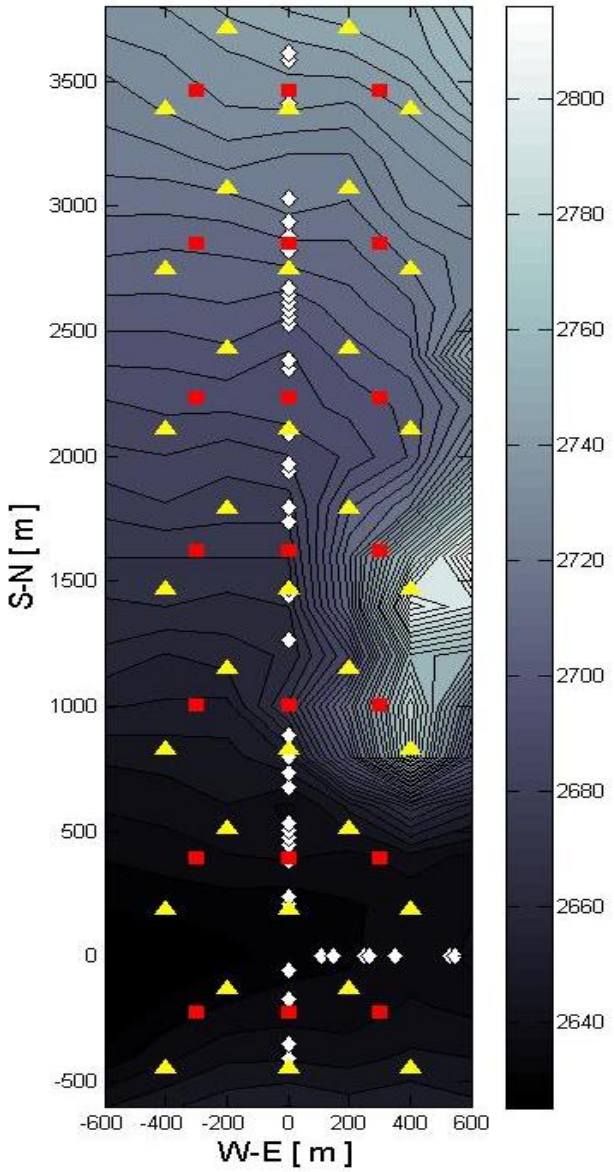
Fund Situations for 21CMA

5M Euros over past 10 years

In Progress

（NSFC 1M ＋ NAOC1.9M ）





Fund Situations for Future Upgrade: 21CMA and GRAND Prototype

1. Maintenance & Operation (Ulastai)： 2M/yr
2. China SKA pathfinder (NAOC) 5M
3. China SKA pathfinder (MOST) 100M (?)

S

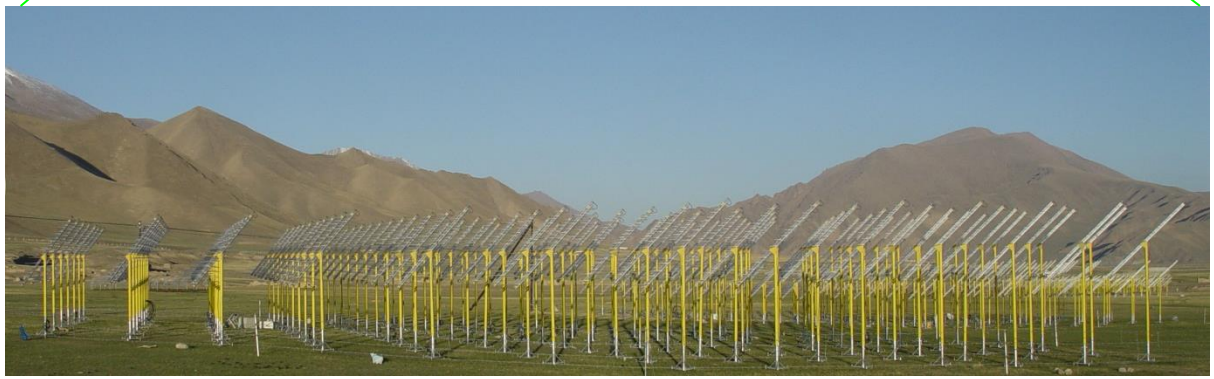
N

W

E

Control room

1 pod=127 antennas



Current status：Only E-W baseline in operation

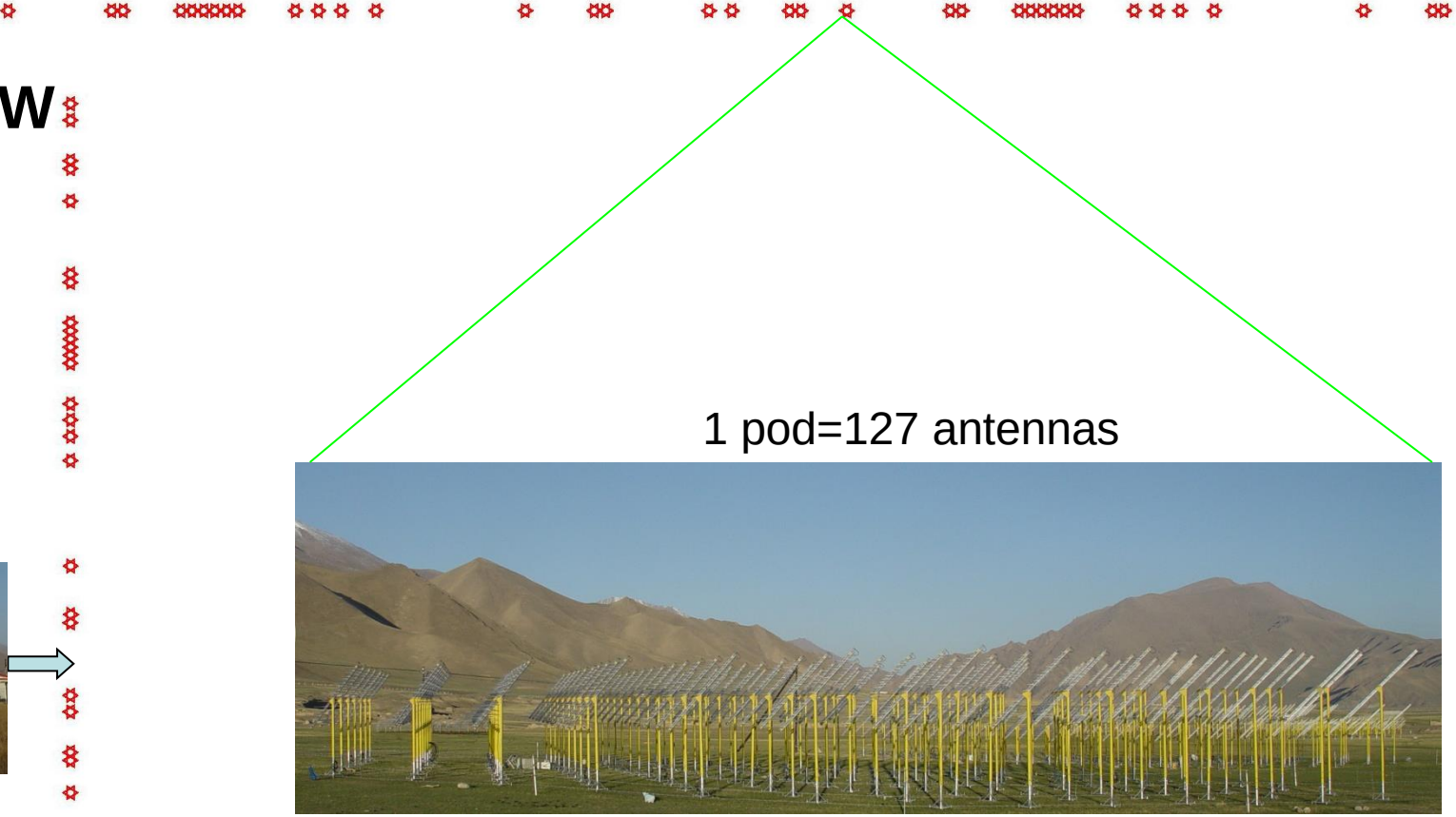
(5080 LNAs，40 GPUs，efficiency=50%）

S

(5080 LNAs，40 GPUs）

N

W

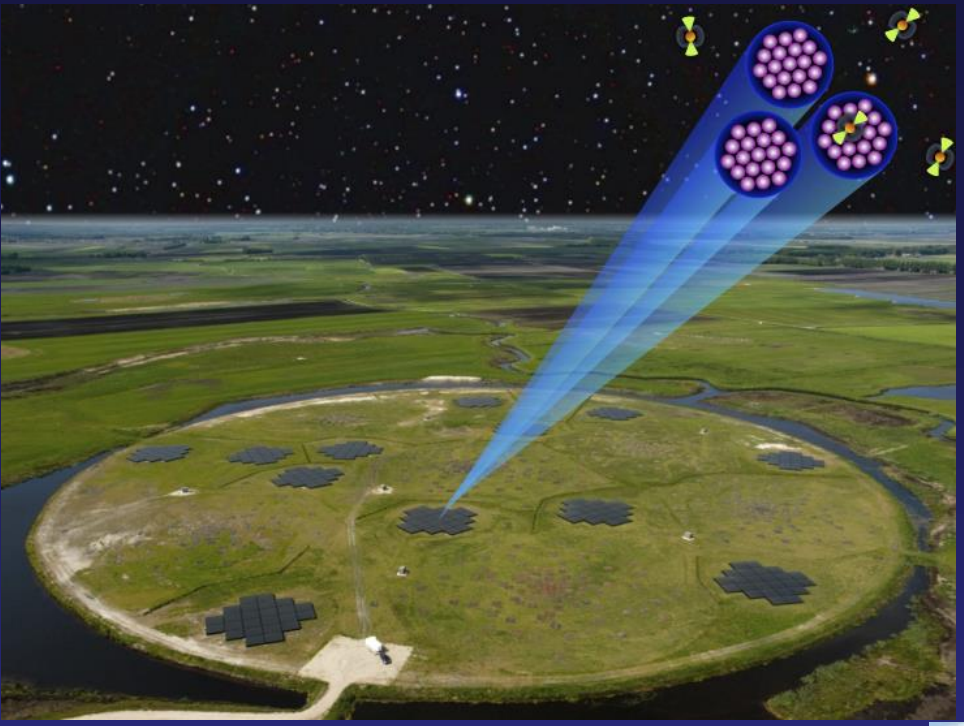


1 pod=127 antennas

控制中心

E

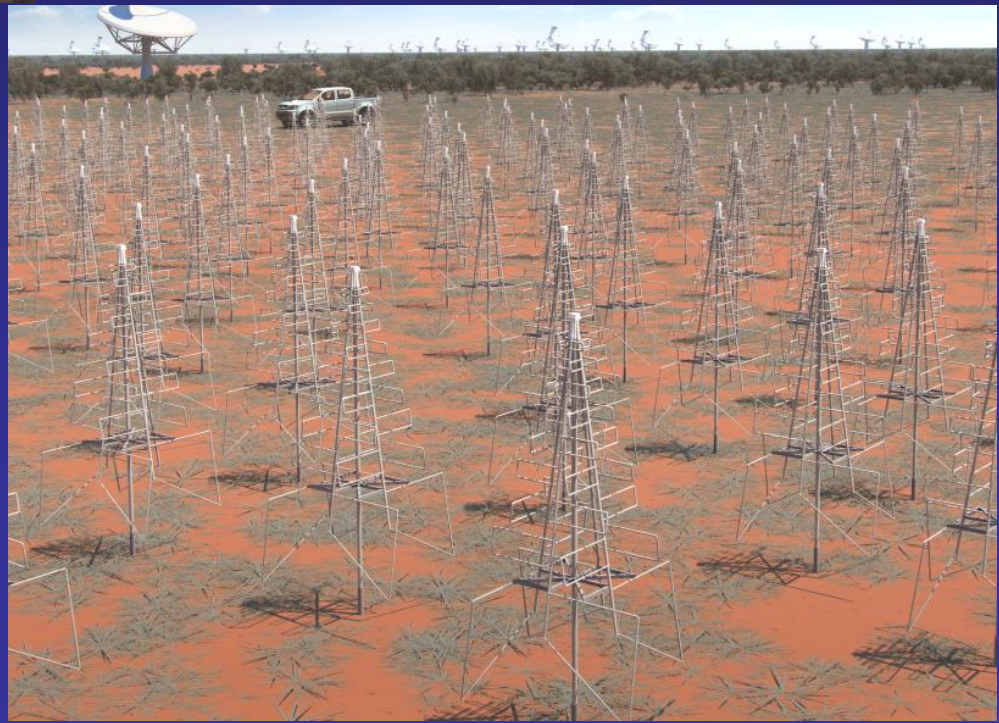
Upgrade the N-S baseline in 2015



Multi Beam (China SKA Pathfinder: 21CMA)

LOFAR

SKA-LOW

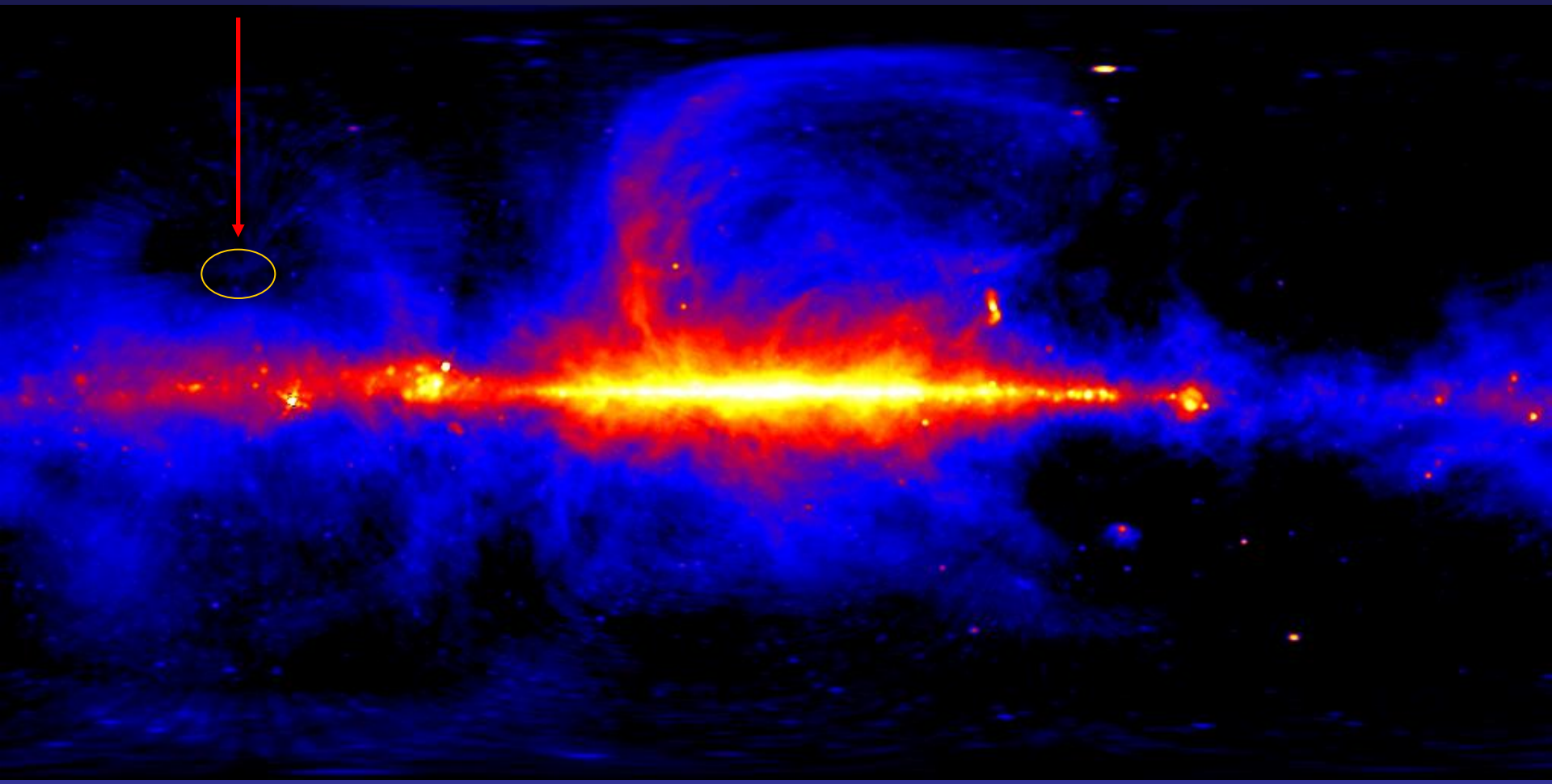


1km

2 pods along E-W baseline

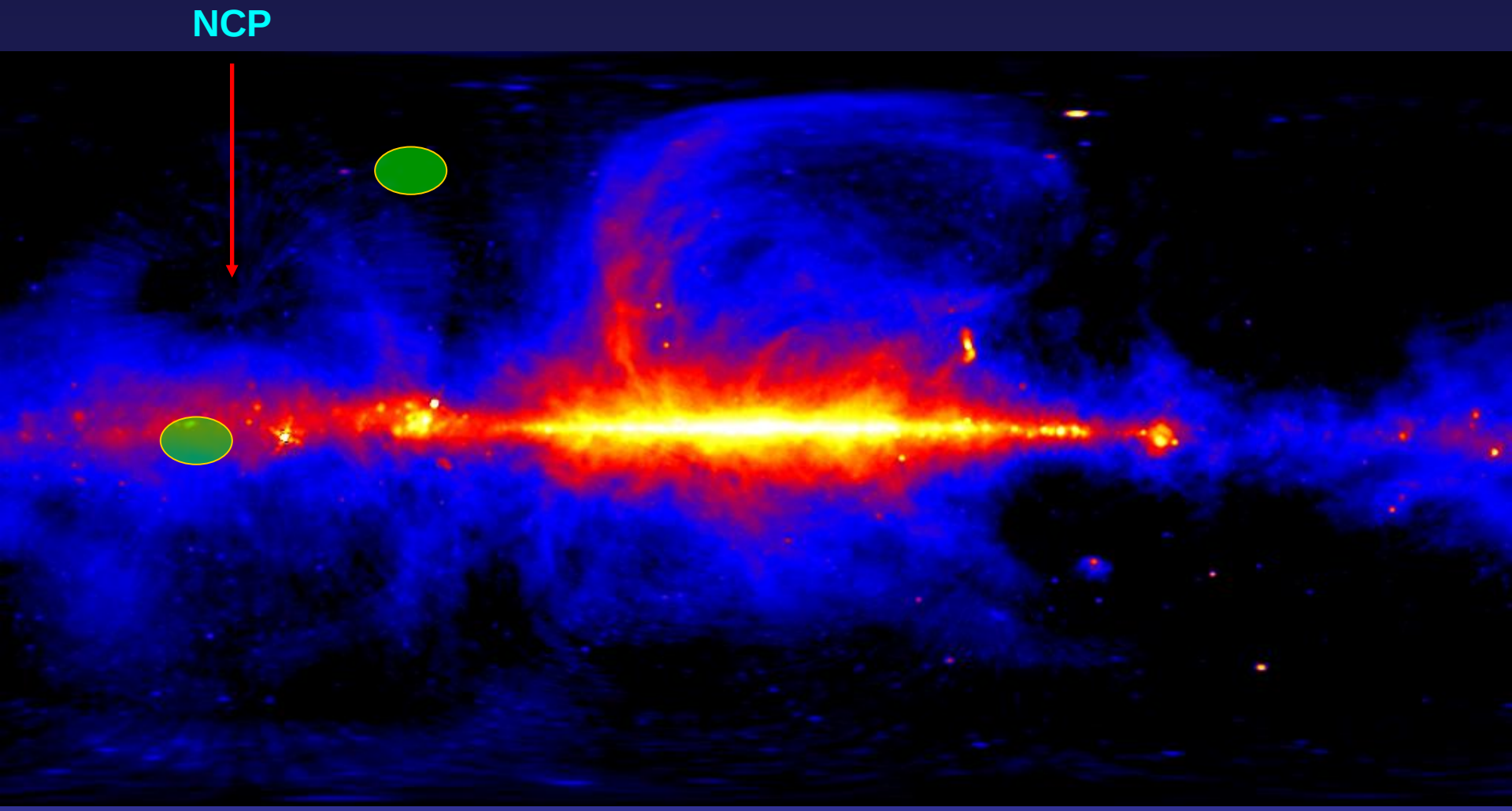
S
N
W
E
Beam-1
Beam-2
Digital
infererometry
Beam-1
Beam-2

VHF Sky (408 MHz)



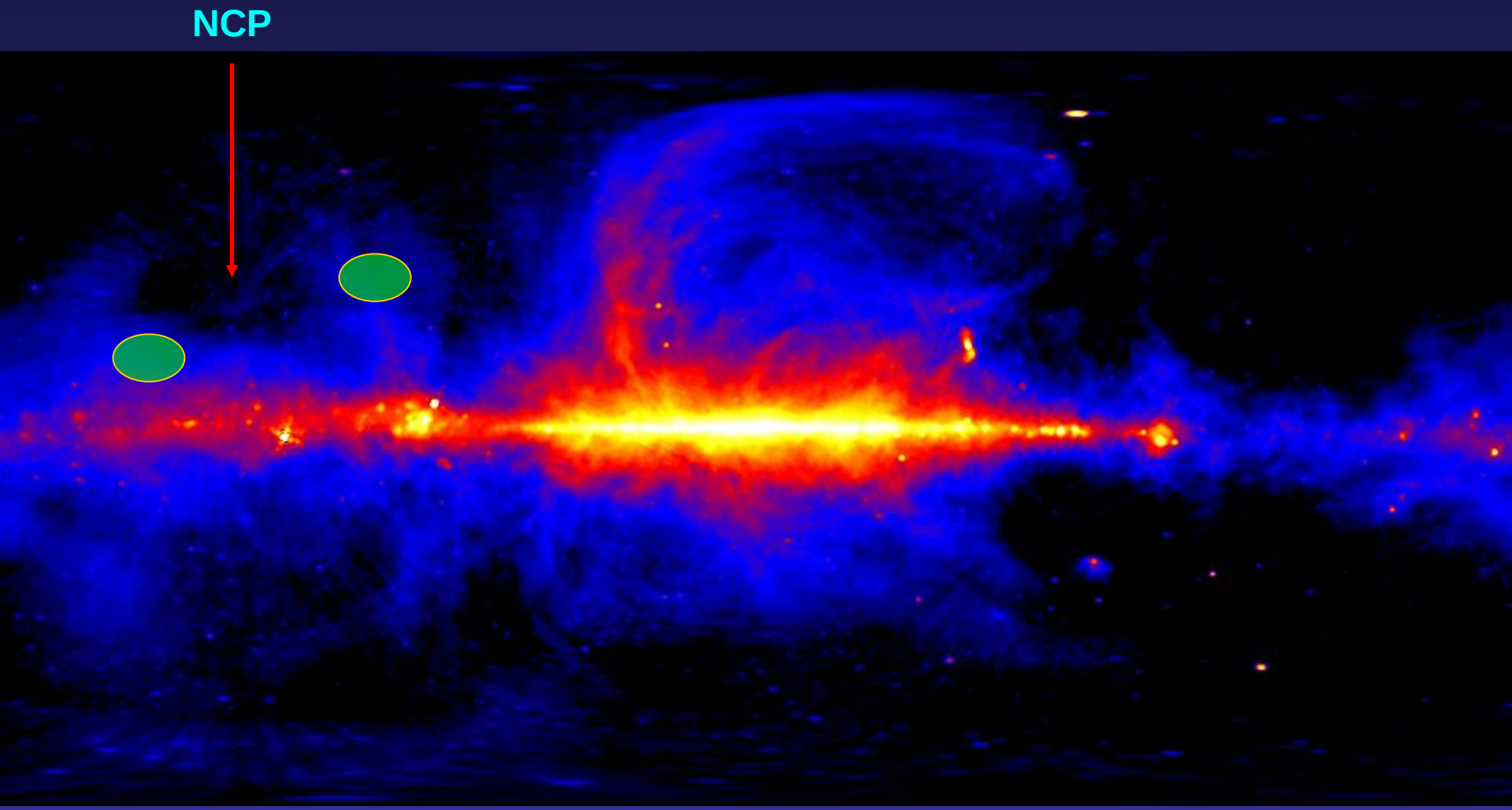
Points at NCP only

VHF Sky (408 MHz)



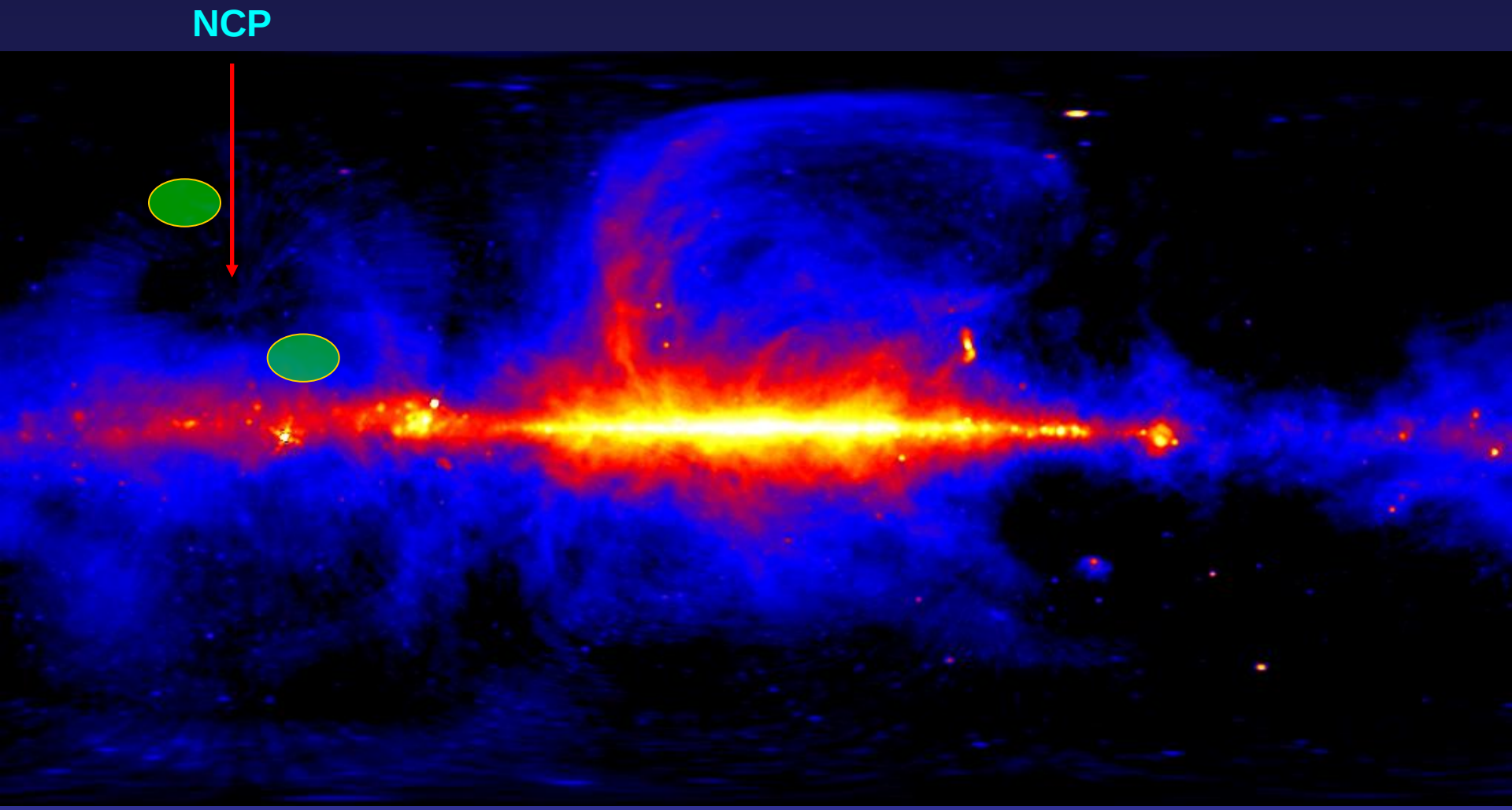
Two Beam Pointing

VHF Sky (408 MHz)



Two Beam Pointing

VHF Sky (408 MHz)

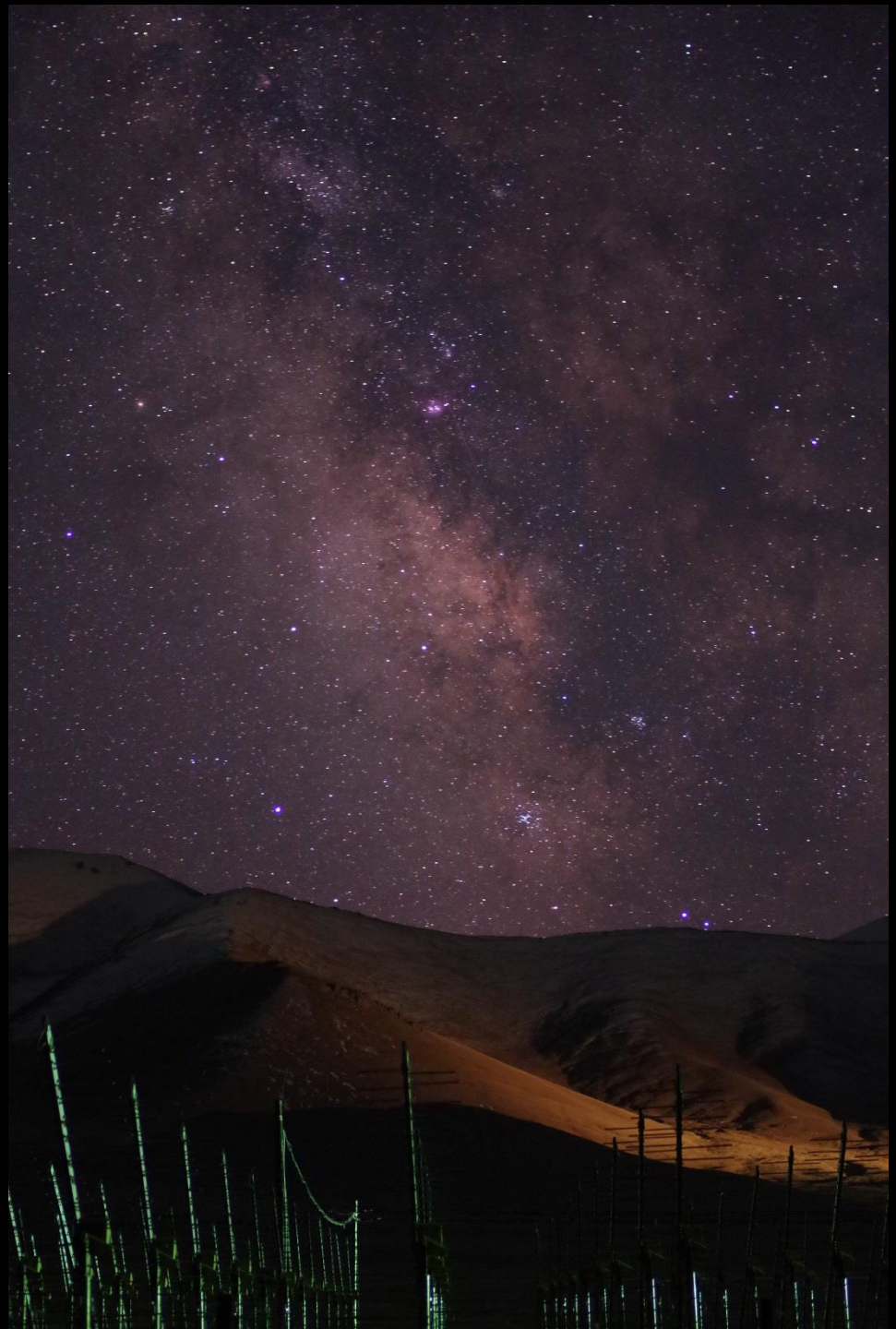


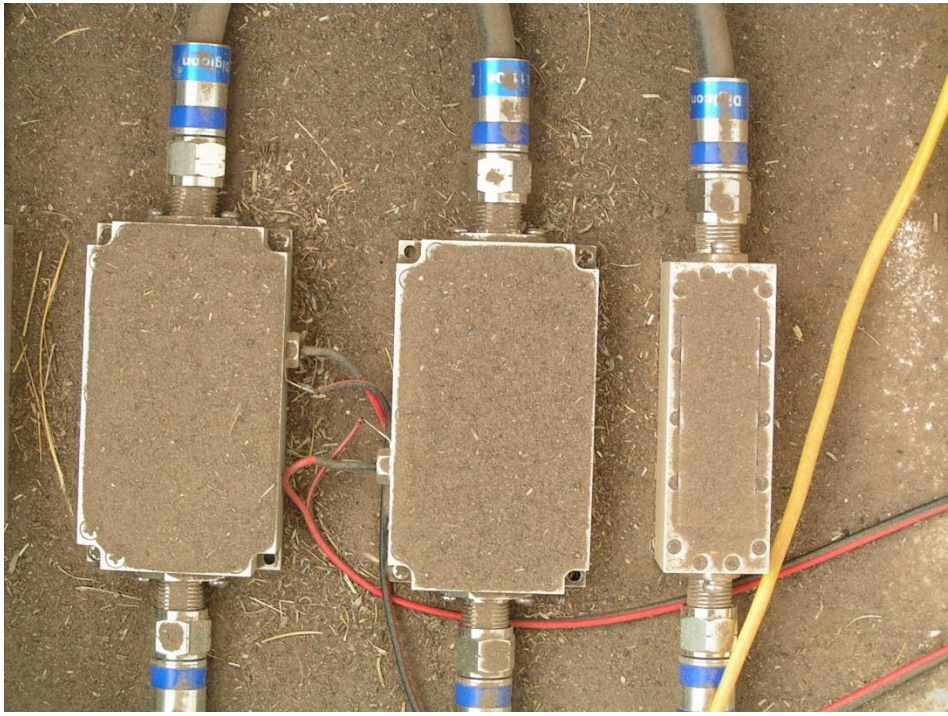
Two Beam Pointing

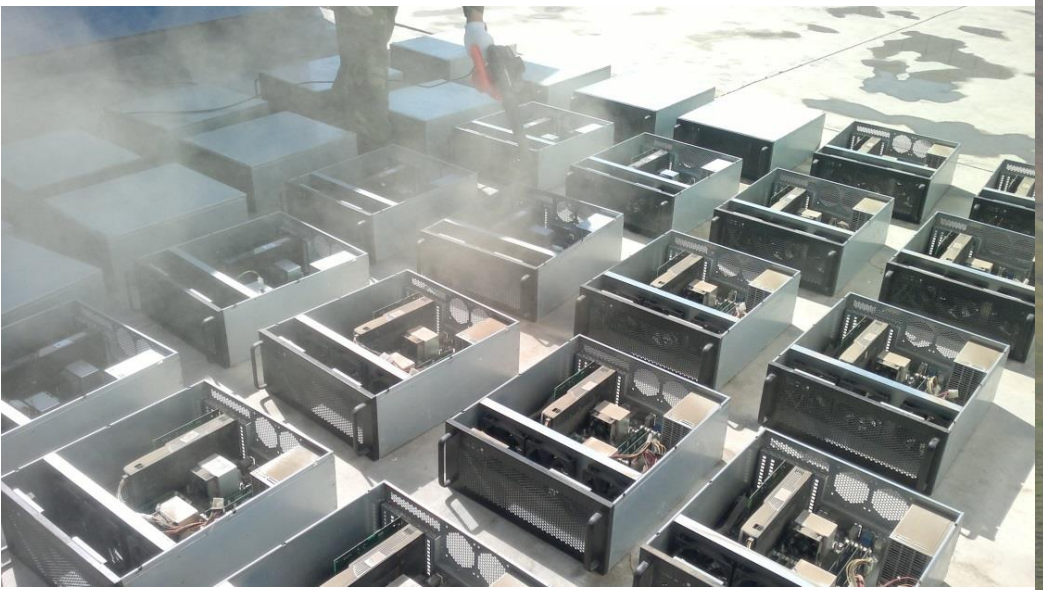
Design Parameters

Baseline	1km
Antenna Units	127
Number of Stations	2
Frequency Range	50-200MHz
Instantaneous Bandwidth	150MHz
Digital Beams	2
ADC precision	12bits
Sampling (beams)	200MHz
Frequency Resolution	24kHz
System Temperature	<50K
Polarization	linear/Full Stokes
Synchronizing clock	400MHz

Ulastai Night
(photo by Junhua Gu)







Unexpected events


-30C
-49C
(2005)

A cool summer

Ulastai, August 2014

animals at site


prairie dog


cattle

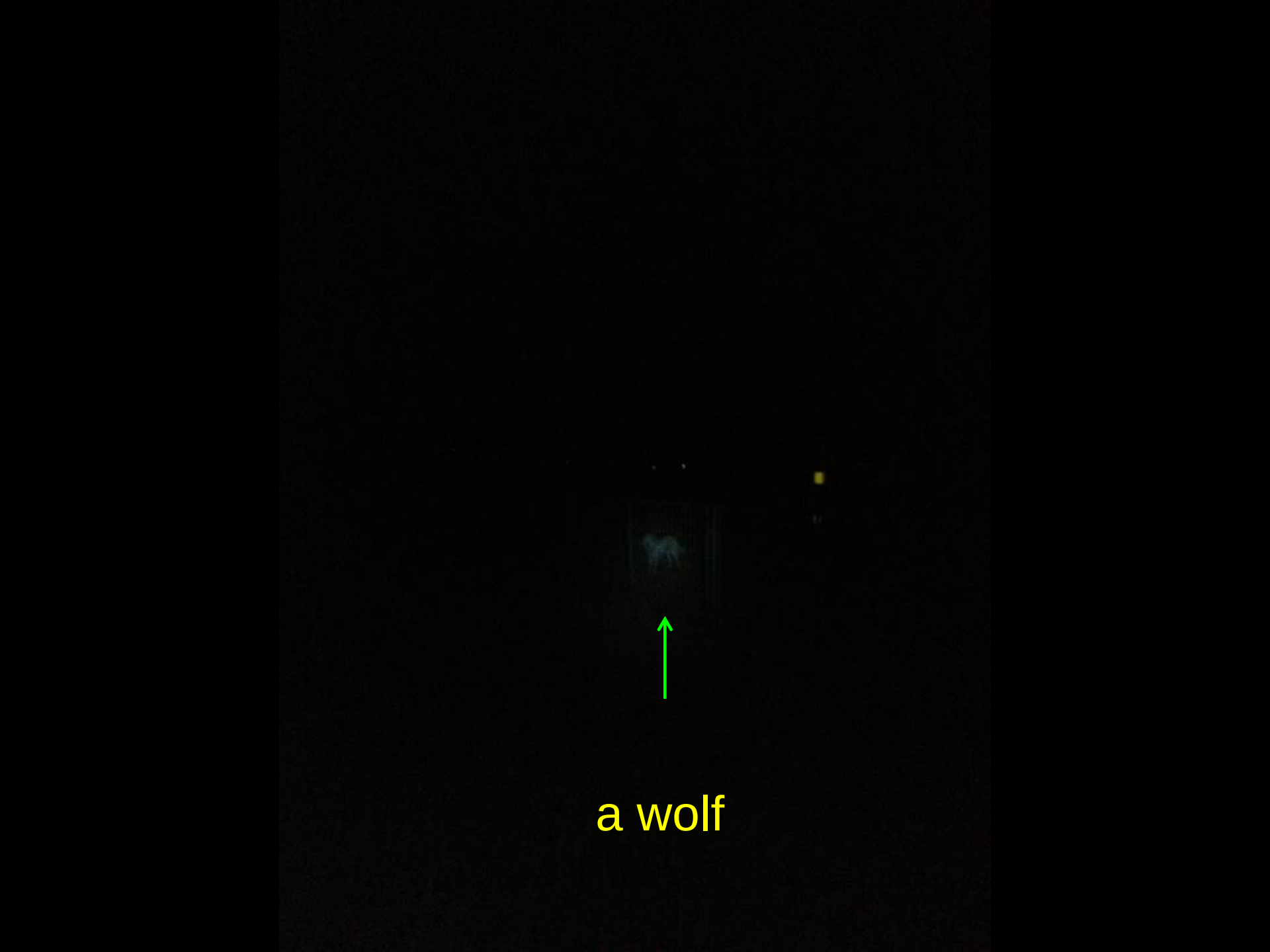
dogs & donkeys


yak

Trouble Makers


Mongolian Gutturosa


vulture


a wolf


A Crazy Guy

Welcome to Ulastai