The Present Status and Future Plan of the CSRH Project

Yihua Yan & CSRH Team

(Presented by Wei Wang)

National Astronomical Observatories, Chinese Academy of Sciences,

Beijing 100012, China

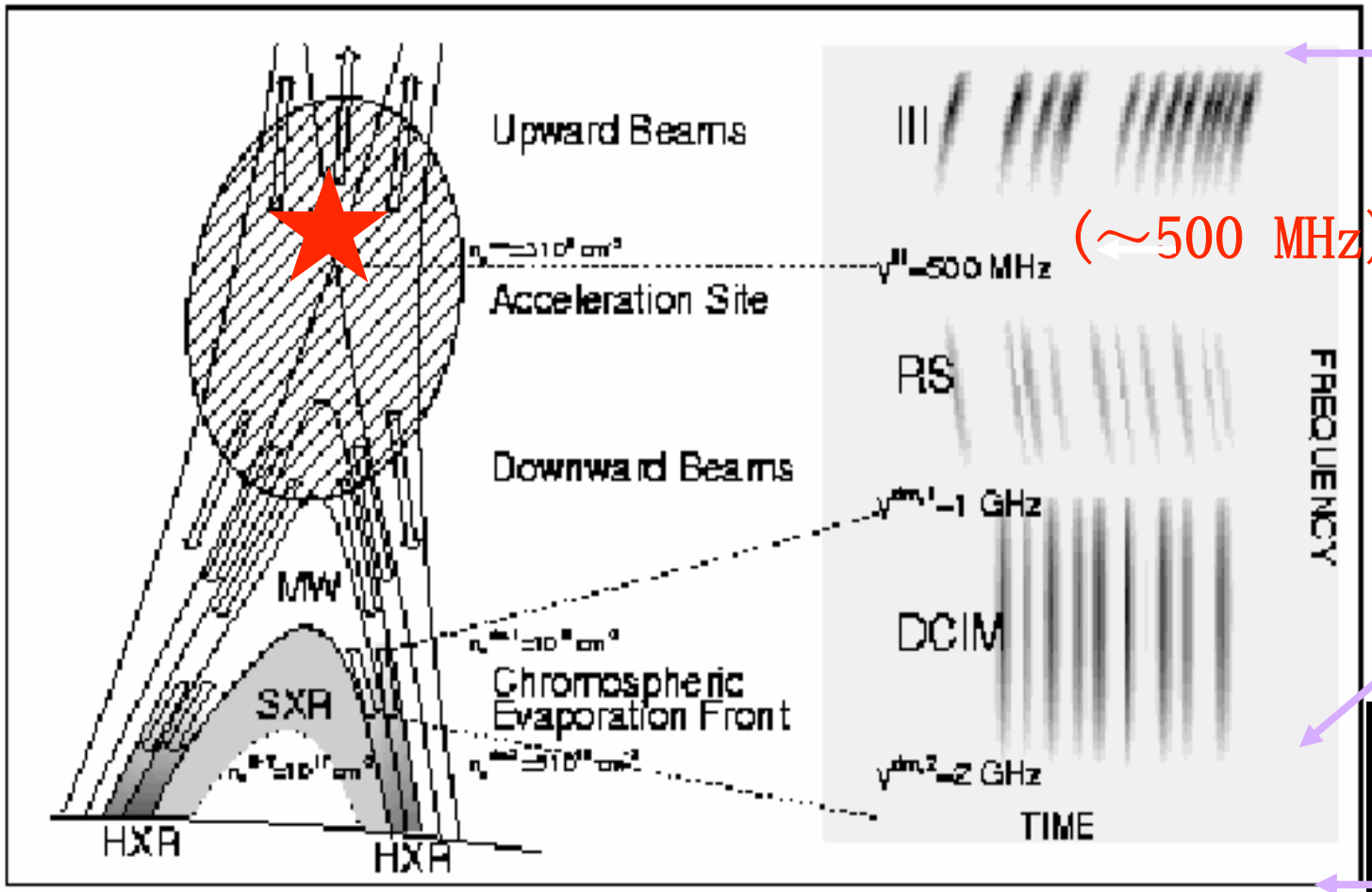
Outline

- Introduction
- Recent progress of CSRH
- Summary

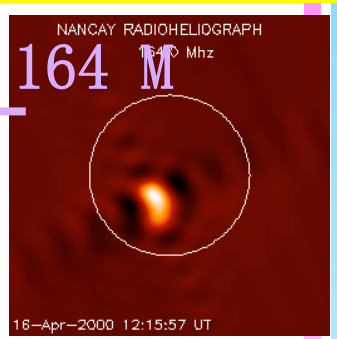
1. Introduction

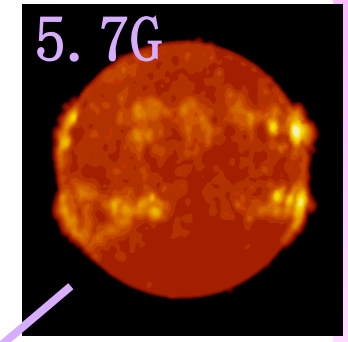
- Coronal Mass Ejections, flares, and solar energetic particles, etc., have great influence in space weather.
- These activities are believed due to sudden energy release, particle acceleration, and/or transportation processes of the solar magnetic field
- Radio bursts are prompt indicators of various solar activities. Therefore radio observations provide important diagnosing tool on the related parameters such as B, n, T, etc.

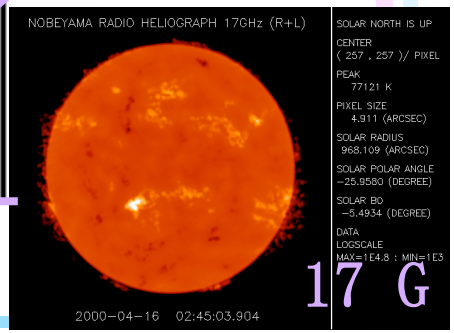
Imaging spectrocopy over cm-λ & dm-λ is important for addressing fundamental problems of energy release, particle acceleration and particle transport (Bastian, et al., ARAA, 1998; Gary & Keller 2004; Aschwanden 2004)



(~500 MHz)





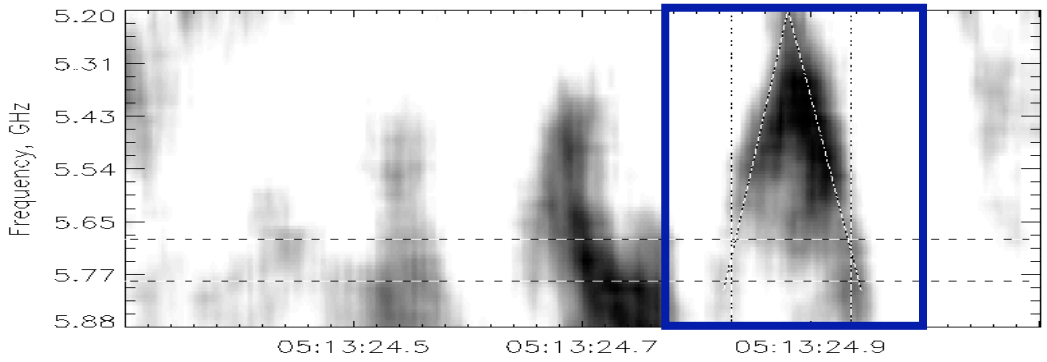


Solar bursts

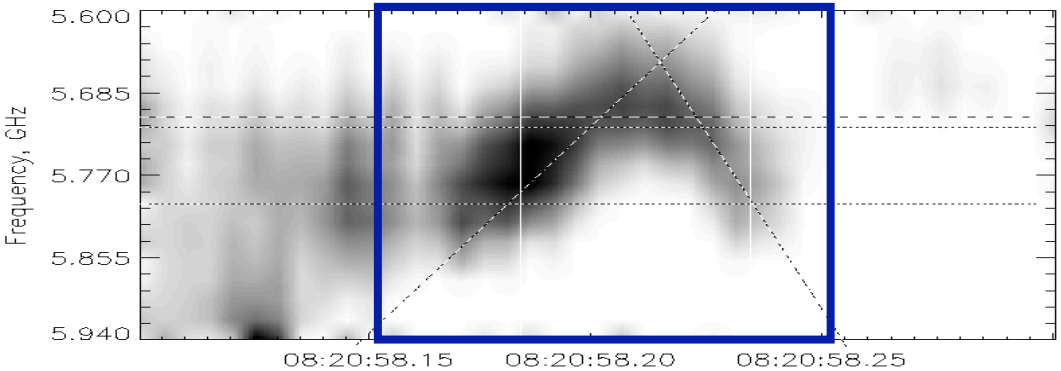
Aschwanden et al.

Coherent emission: U-burst

30 March 2001

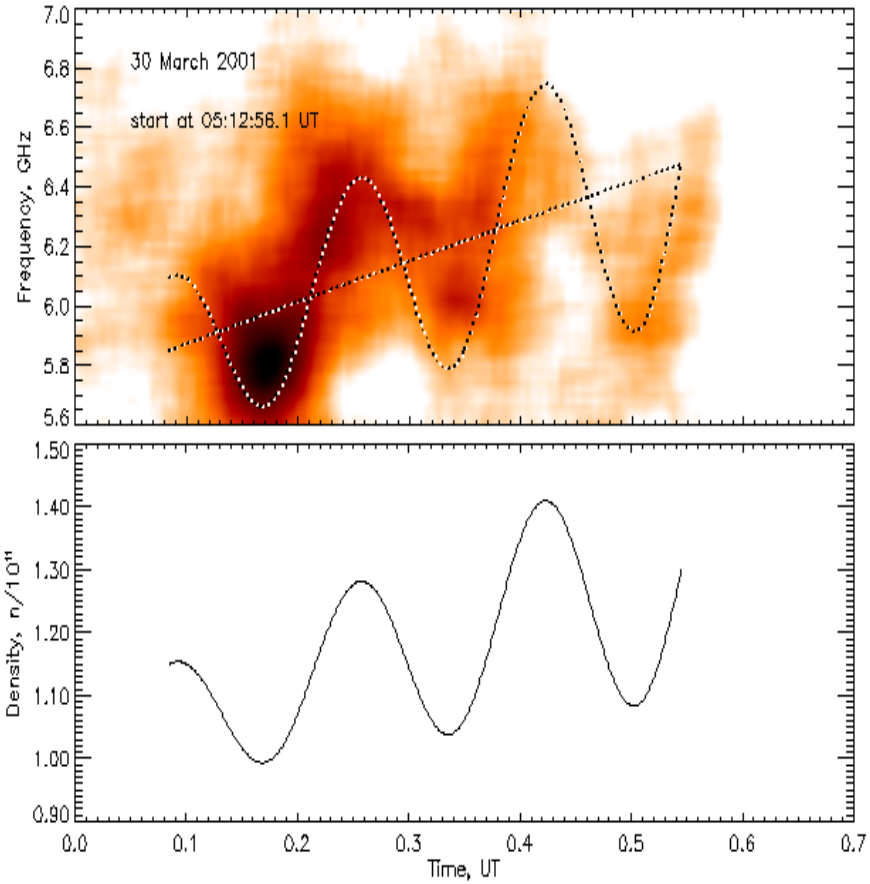


17 September 2001



- Exciter at m-dm λ's: e-beam moving along a magnetic loop with density minimum at the loop top. Plasma parameters are stationary.
- But the SSRT image show distance between sources at different branches is short (<30 Mm).
- In cm- λ' s U-structures are produced by density variations due to a plasma response to a heating pulse. The source size along the loop is order of a few Mm.

Bounce period or transverse MHD oscillations of loop?



Two variants to explain:

- Bounce period of the short electron beam in the long magnetic loop.

From lifetime duration follows beam velocity of 0.45c and the loop length about 20 Mm

- Transverse MHD oscillations of the loop (for B=100 G, diameter of the loop must be about 100 km)

Trend of the frequency drifting rate corresponds to density rising

$$\partial f/\partial t \approx 1.25\ GHz/s \Rightarrow \partial n/\partial t \approx 5\times10^{10} cm^{-3}/s$$

Altyntsev A.T, et al. (2003, A&A)

require a new instrument: capable of true imaging spectroscopy, with high temporal, spatial, and spectral resolutions ---- CSRH or FASR.

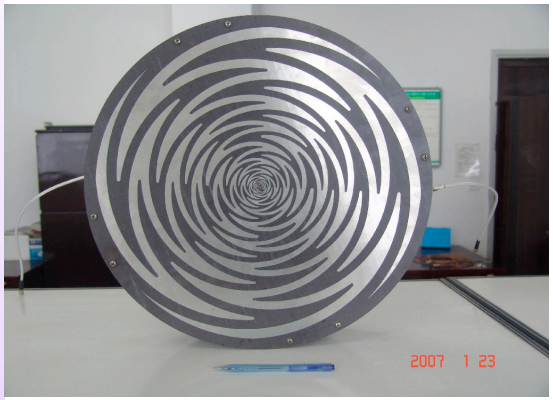
2. Recent Progresses of CSRH

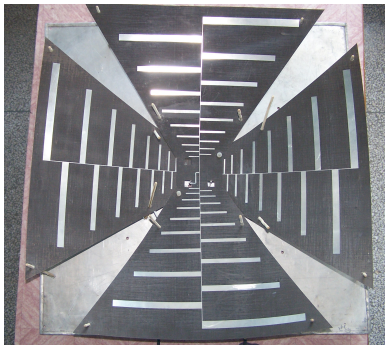
- Array design and radio image process studies
- Antenna & feed design
- Analog & Digital correlation receivers (design & simulations)
- 2-element aperture synthesis prototype
- Site survey & RF monitoring
- Field construction of CSRH

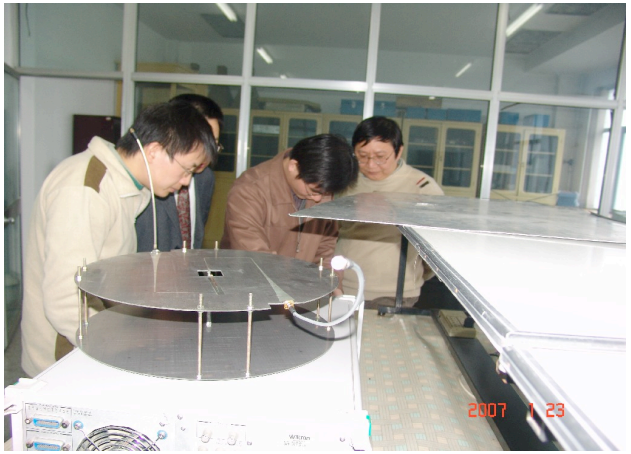
CSRH Specifications

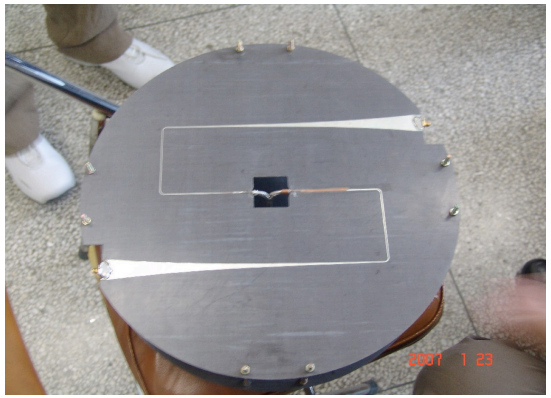
Range	**~0.4–15 GHz**	**（λ：~75 –2 cm）**
Frequency Res.	**64 chan**	**（I: 0.4-2 GHz）**
	32 or 64 chan	**（II: 2-15 GHz）**
Spatial Res.	**1.3”– 50”**	
Temporal Res.	**~<100 ms**	**（0.4-15 GHz)**
Dynamic Range	**25 db**	**（snapshot）**
Polarizations	**Dual circular L, R**	
Array	**I:**	**40×4.5m**
	II:	**60×2m parabolic antennas**
Lmax	**3 km**	
Field of view	**0.6°– 7°**	

Prototypes of Sinuous Feed in 0.4-15 GHz

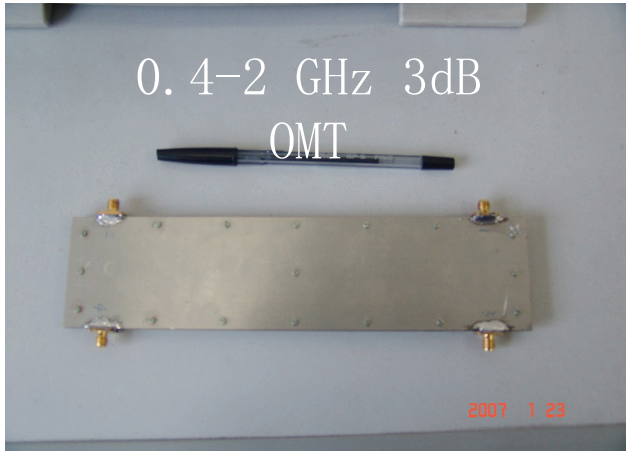






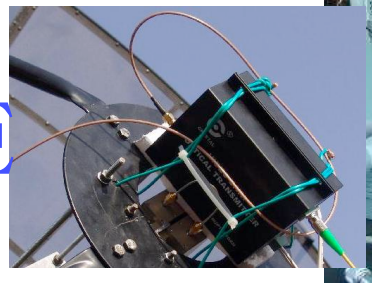


Assembly of feed in 0.4-2 GHz

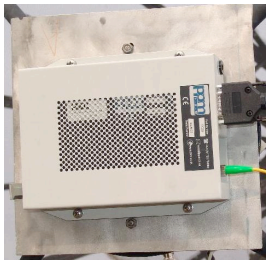


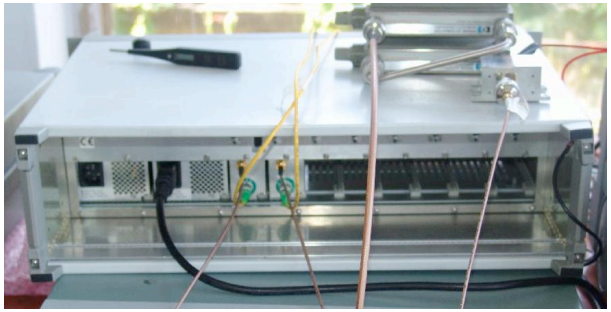
FOXCOM

EMCORE

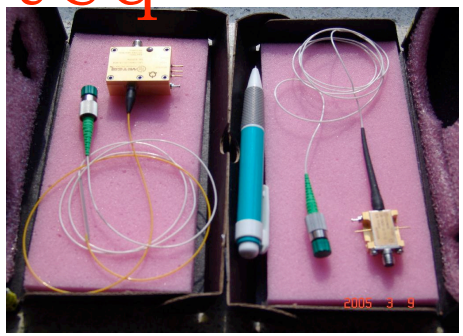


PPM





Miteq



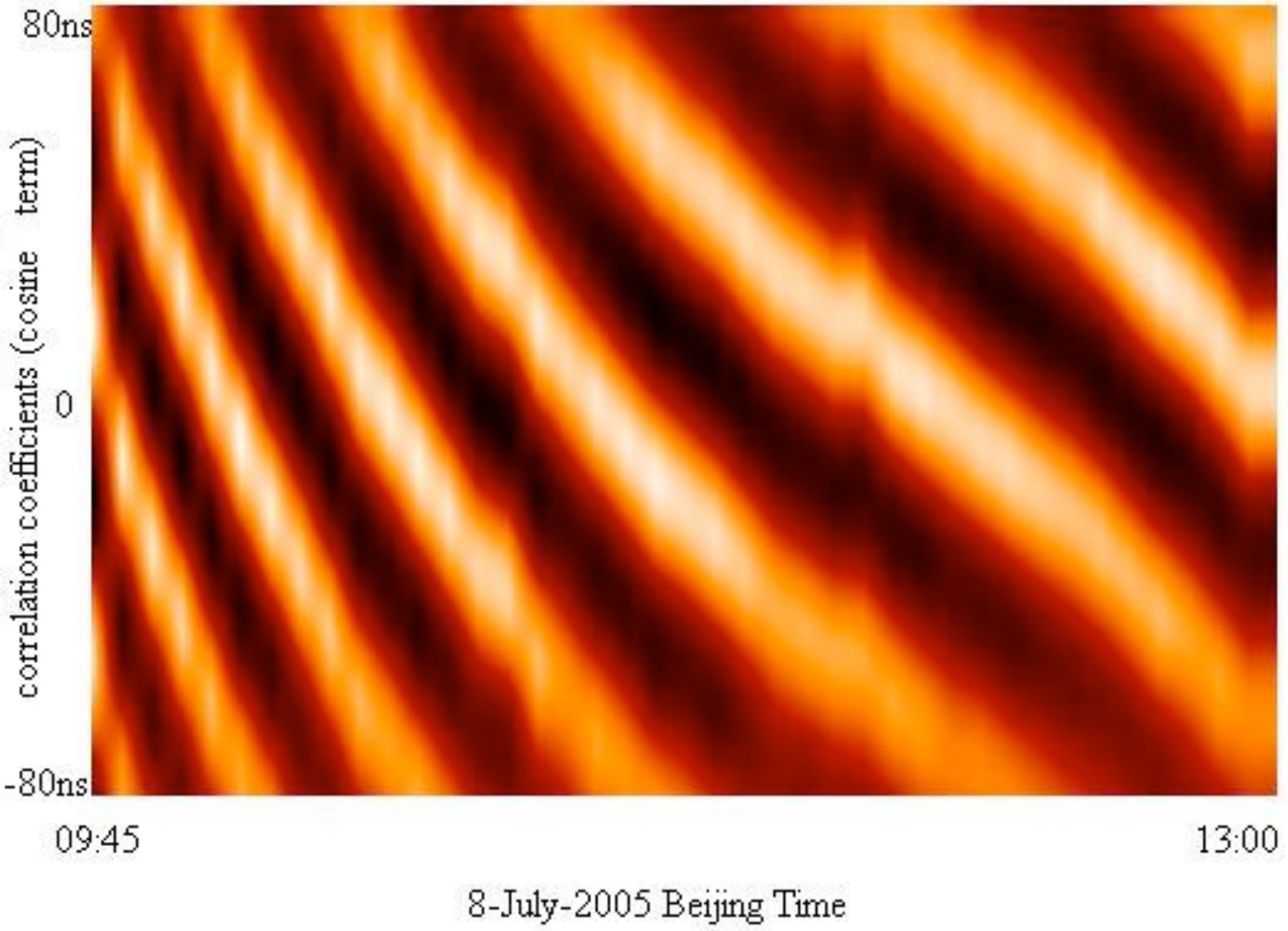
Optic transmitters and receivers

2-element prototype

Indoor:

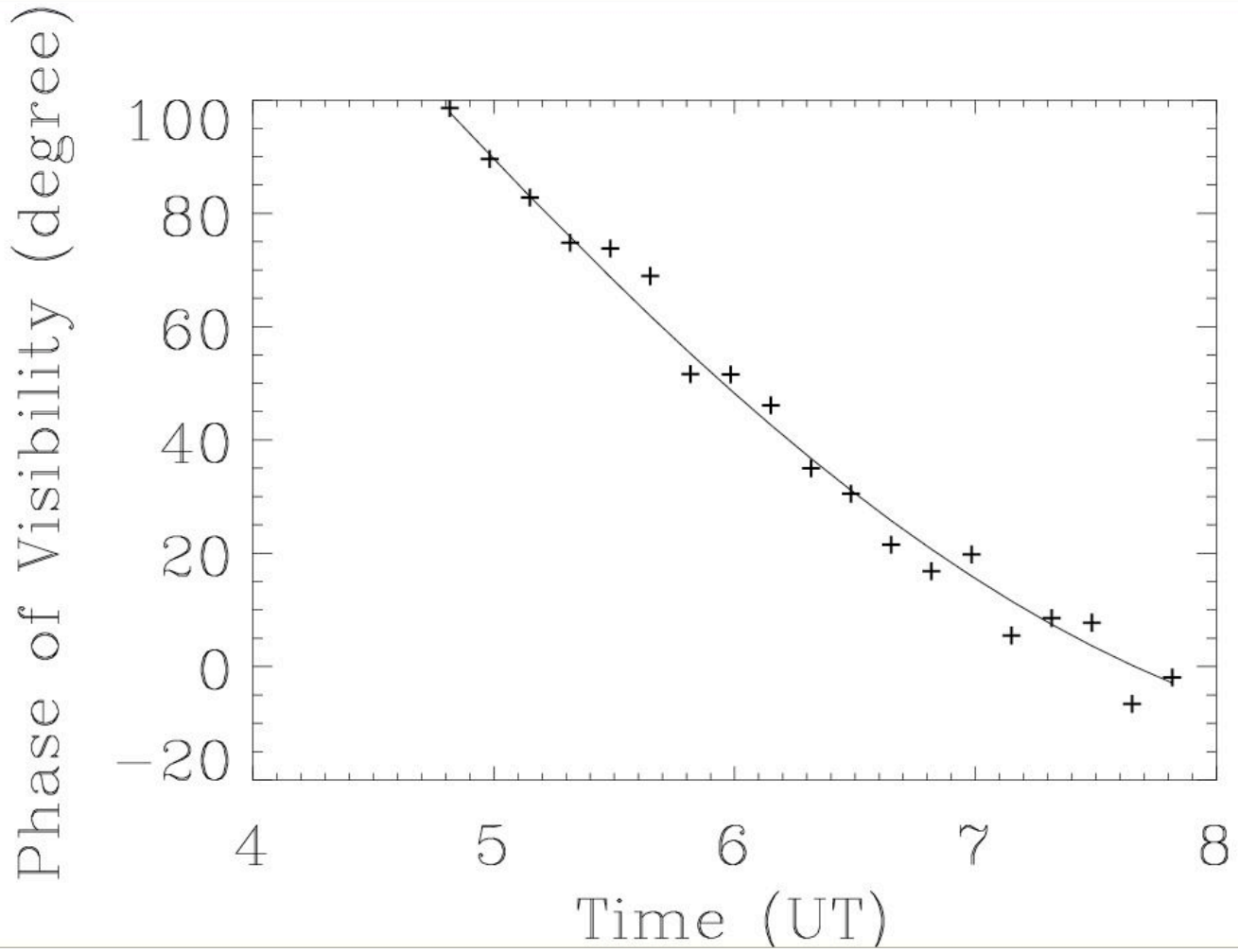
OP Rx,
Ana. Rx.
A/D
Digital
Delay &
Correl.

Outdoor: 2*4.5m dish
Feed, LNA, Op.
Tx 1.2-1.8GHz
1Km Op.Fib.

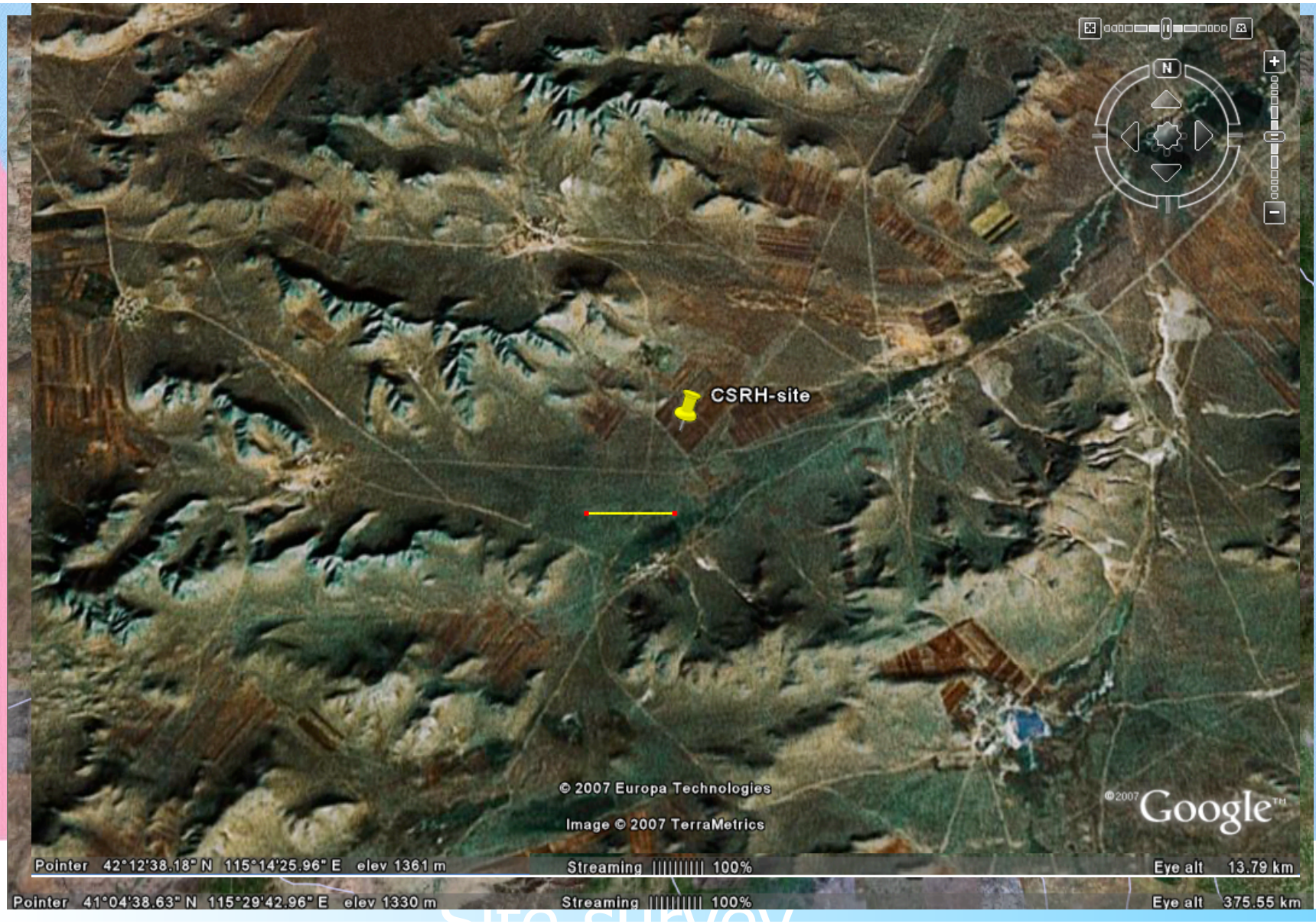


For short baseline of 8 m.

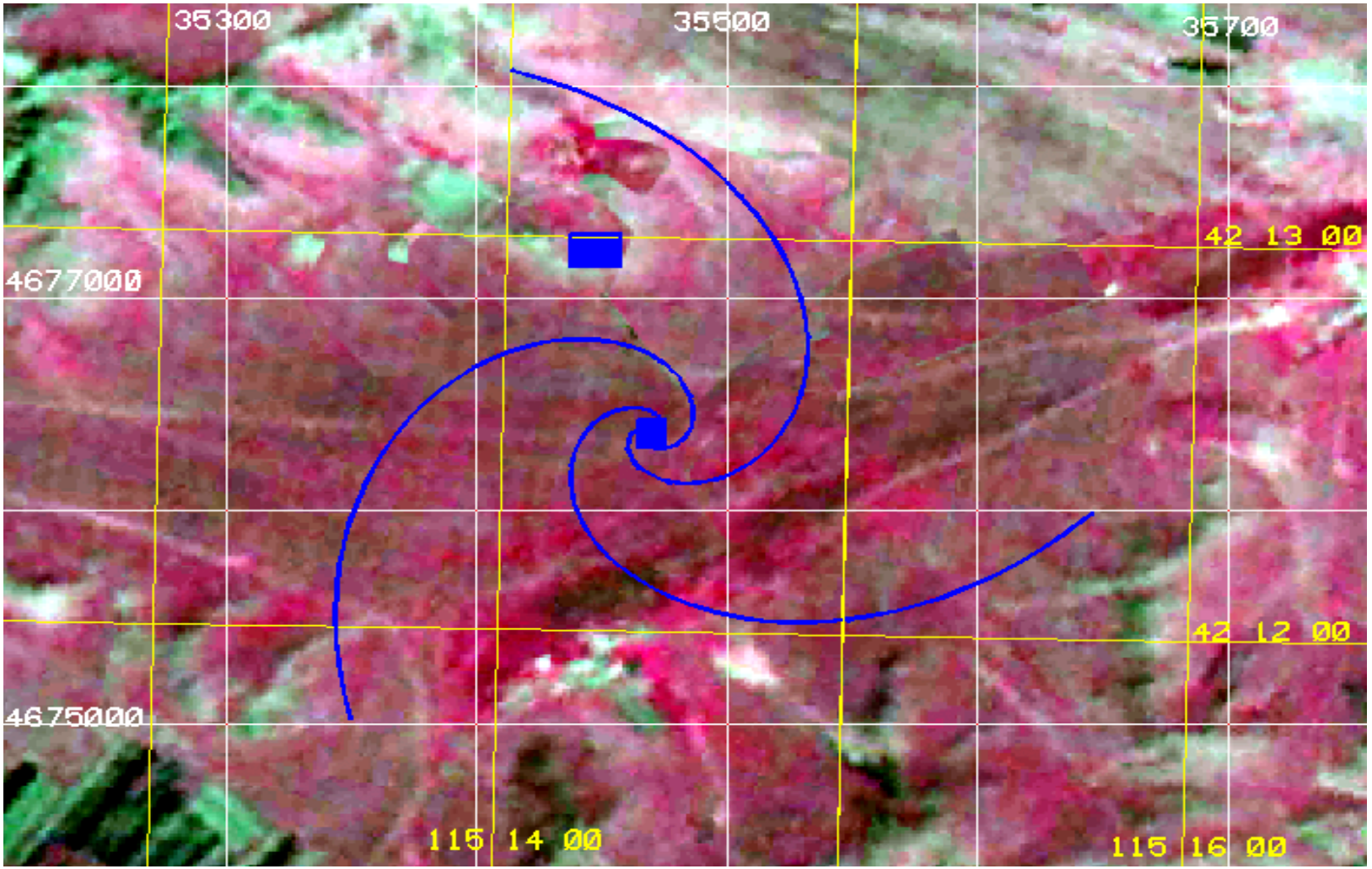
7 July 2005, Phase of Visibilities vs time



——: expected, +: measured (Yan et al., 2009)

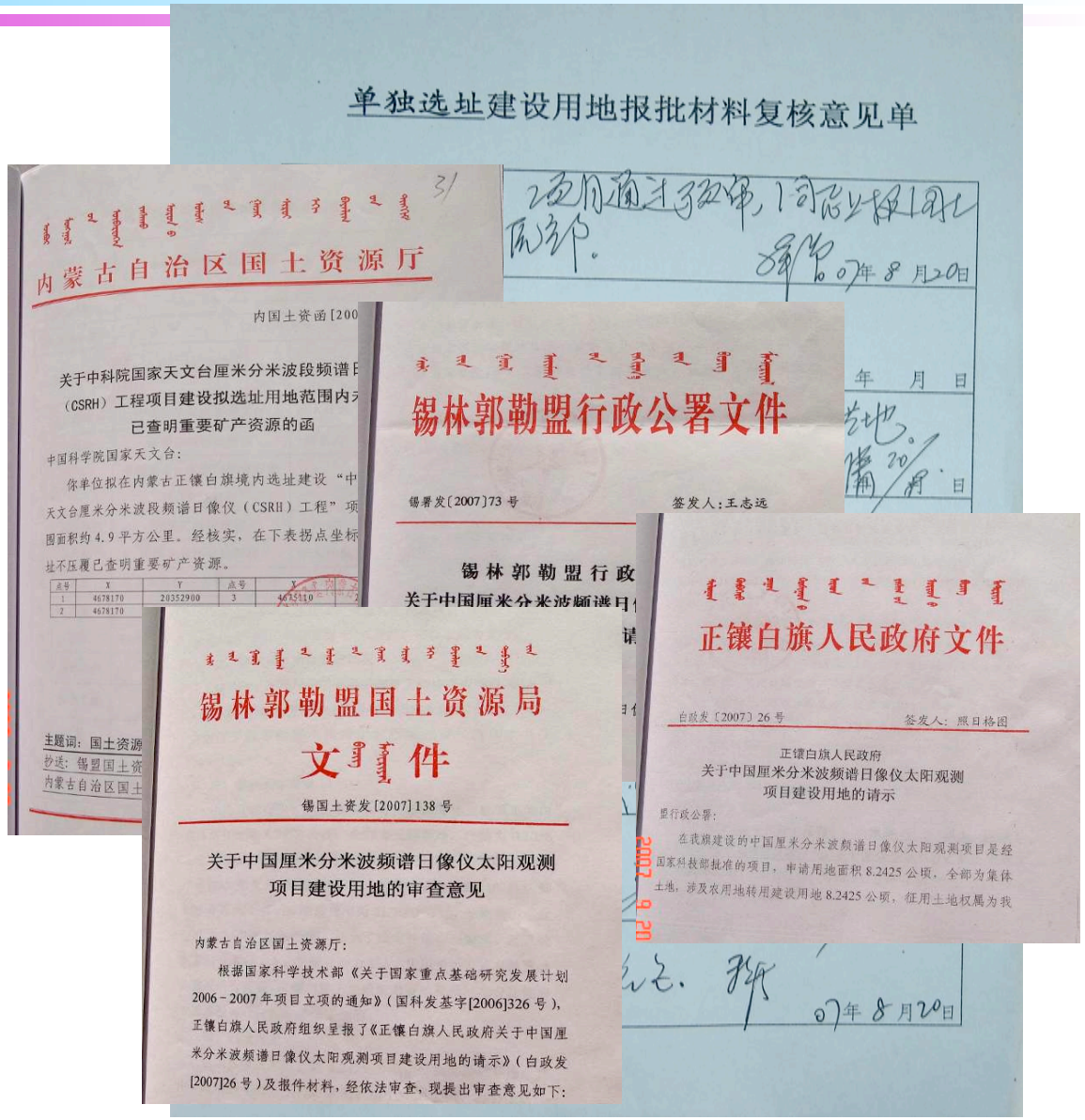

CSRH-site
© 2007 Europa Technologies
Image © 2007 TerraMetrics
©2007 Google™
Pointer 42°12'38.18" N 115°14'25.96" E elev 1361 m
Streaming 100%
Eye alt 13.79 km
Pointer 41°04'38.63" N 115°29'42.96" E elev 1330 m
Streaming 100%
Eye alt 375.55 km

Site survey


35300
35500
35700
42 13 00
4677000
42 12 00
4675000
115 14 00
115 16 00

Officially approved the Land Transfer to NAOC by Inner Mongolian Government in Dec 2007

Passed evaluations of 8 divisions:



Radio Quiet Zone Protection issued by Frequency Allocation Committee of Inner Mongolia, China

内蒙古自治区无线电管理委员会办公室文件

内无办［2007］131 号

关于对正镶白旗太阳射电日像仪重点电磁保护的通知

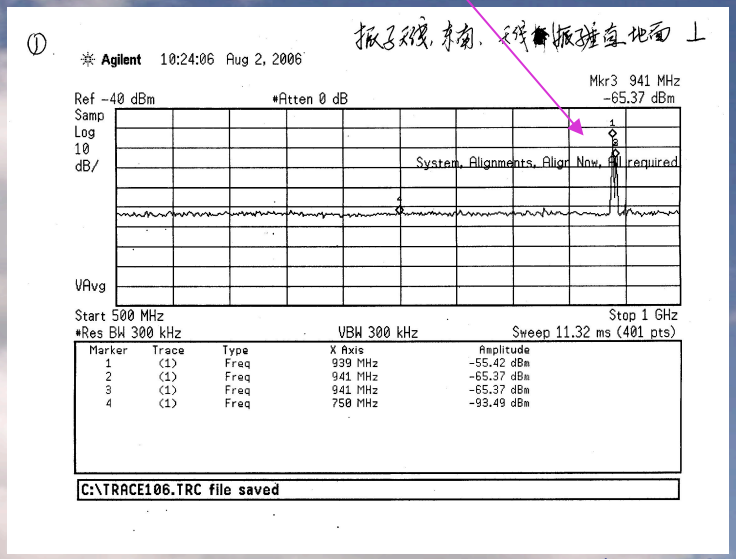
锡林郭勒盟行署办公室，锡林郭勒盟无线电管理处，正镶白旗人民政府办公室，民航华北地区空中交通管理局内蒙古分局，各电信运营企业：

中科院国家天文台新建正镶白旗太阳射电观测站是国家 973 计划重点项目，该站厘米分米波频谱日像仪通过对太阳射电成像观测，研究日冕磁场结构与演化，从而在国际上首次实现在厘米-分米波段上同时以高空间、高时间、高频率观测太阳活动的动力学性质，在空间天气监测和研究中起到重要作用。作为国际新一代射电日像仪，可望在日冕物理研究中取得重要原创性研究成果。

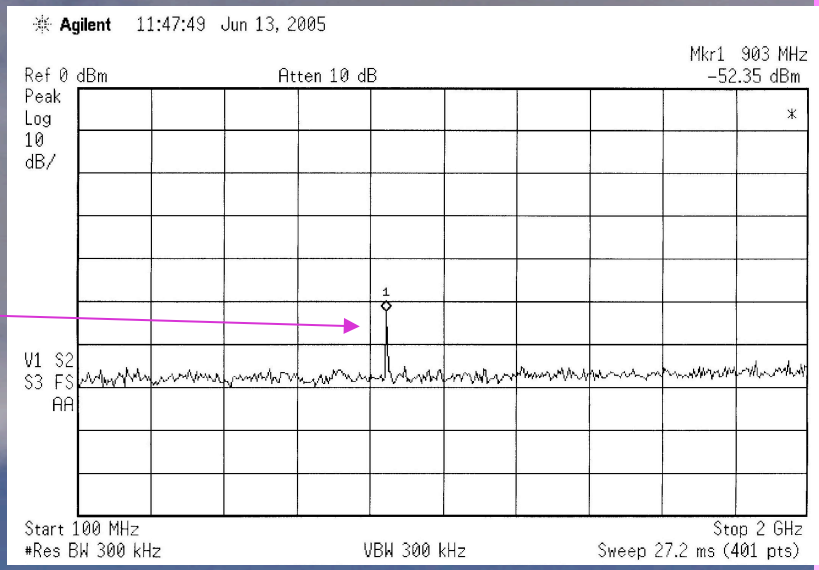
RFI monitoring from 400 MHz to 15GHz

RFI Measurements

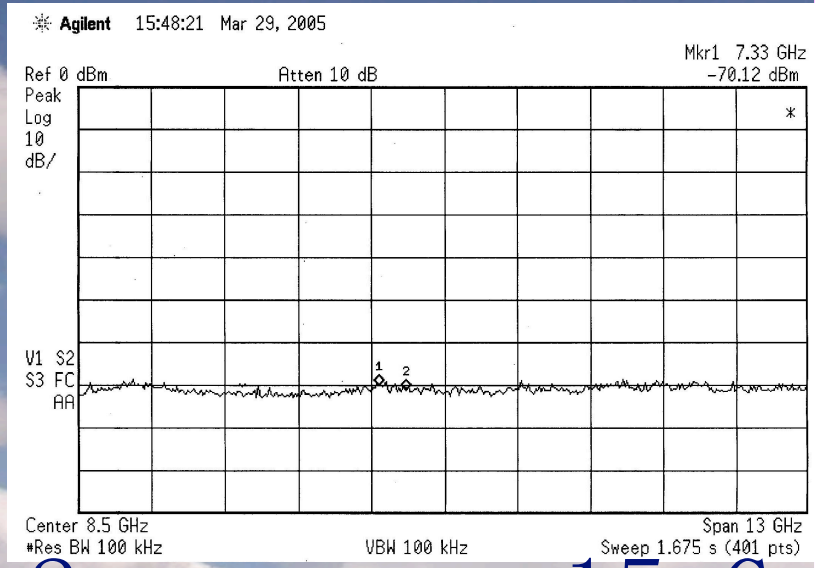
Mobile phone signals



0.5 1 G



0.1 2 G

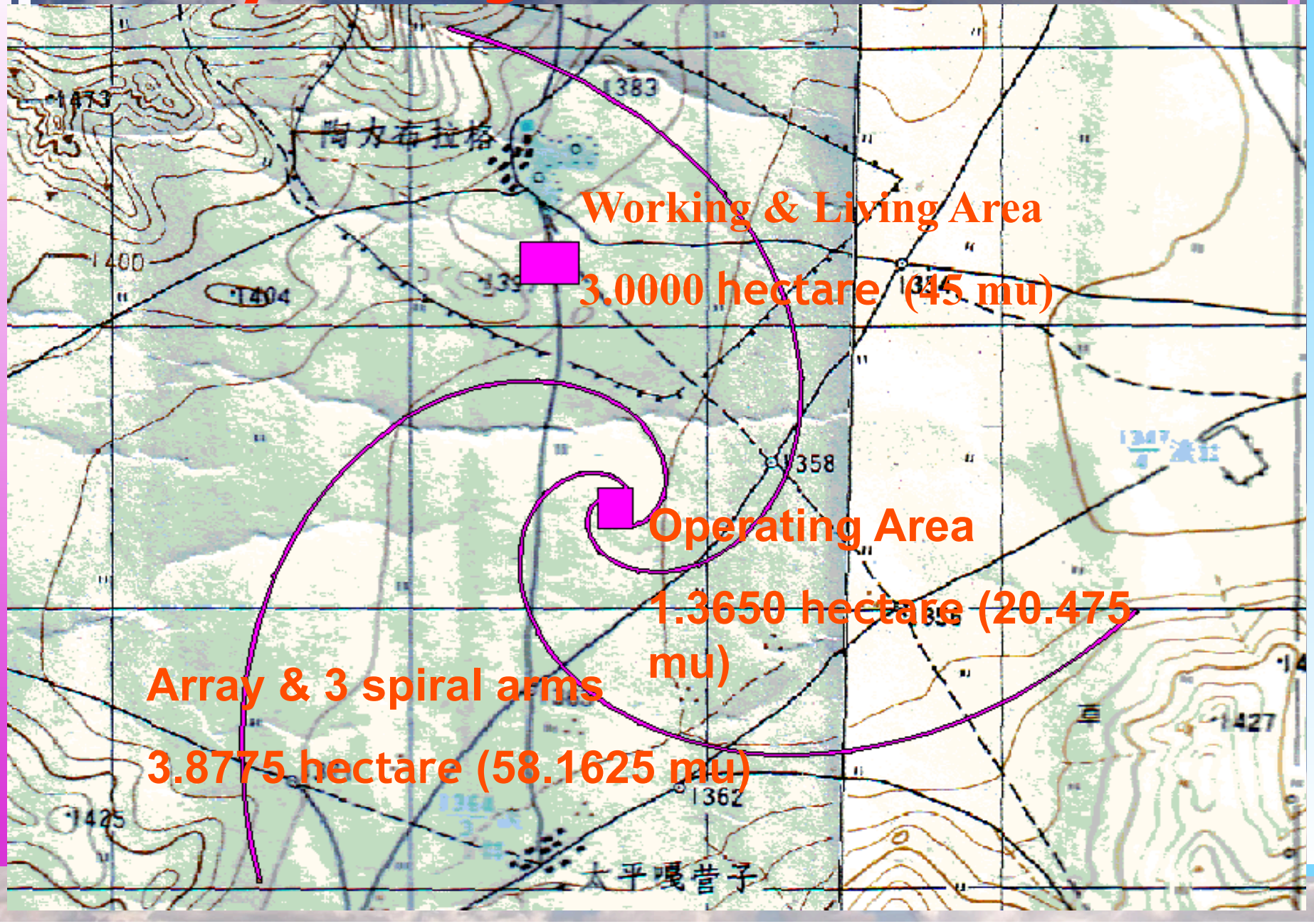


2 15 G

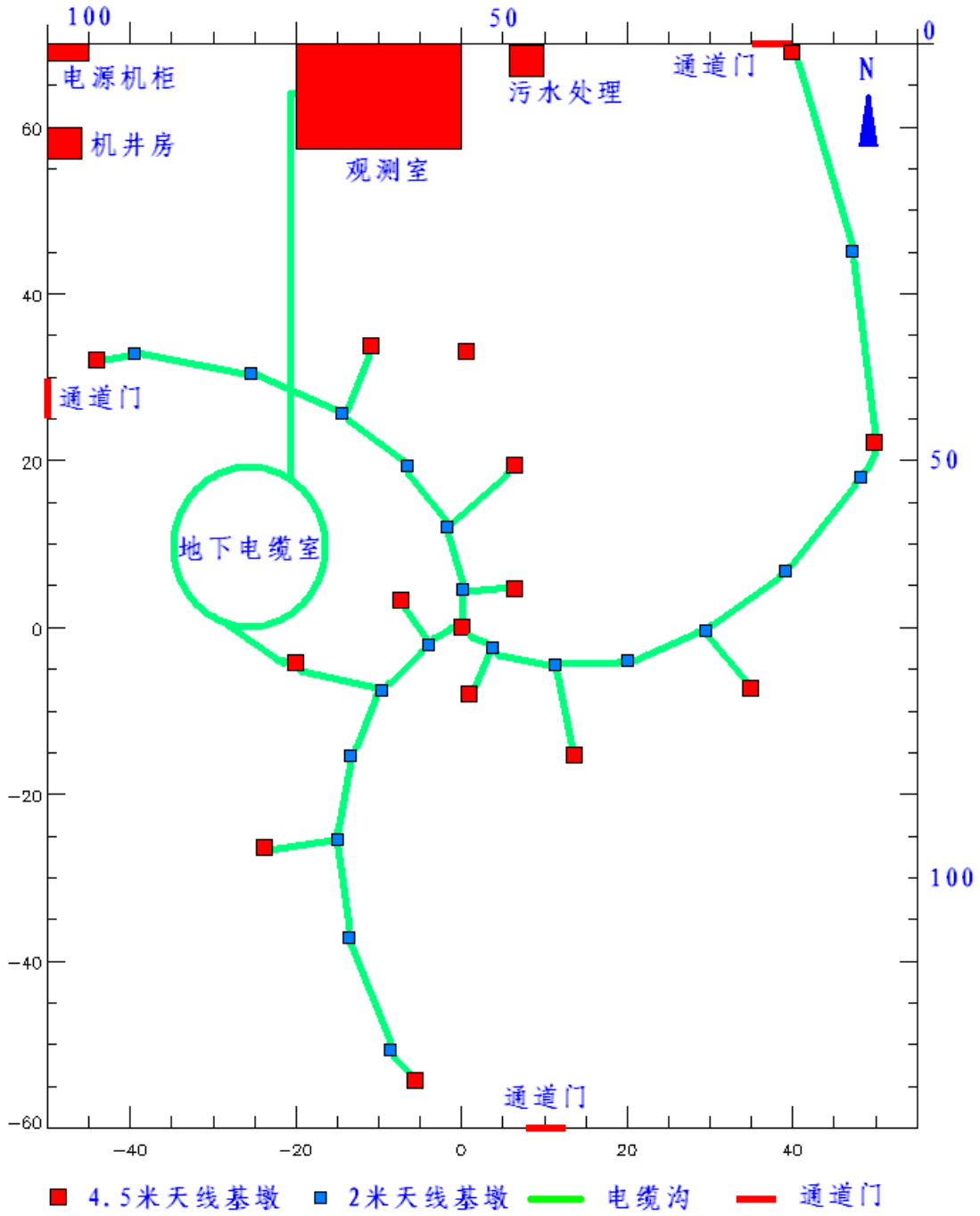
Site view

East South West North

Array arrangement



Working and Living Area

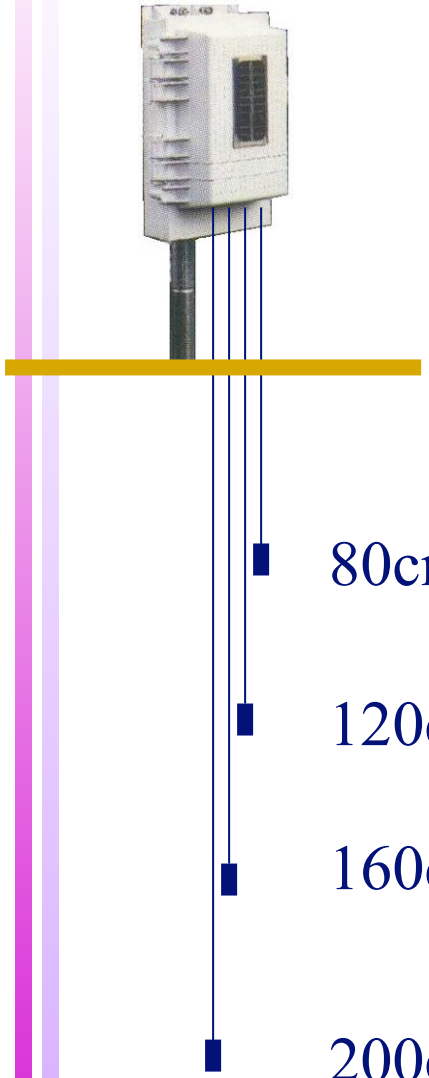


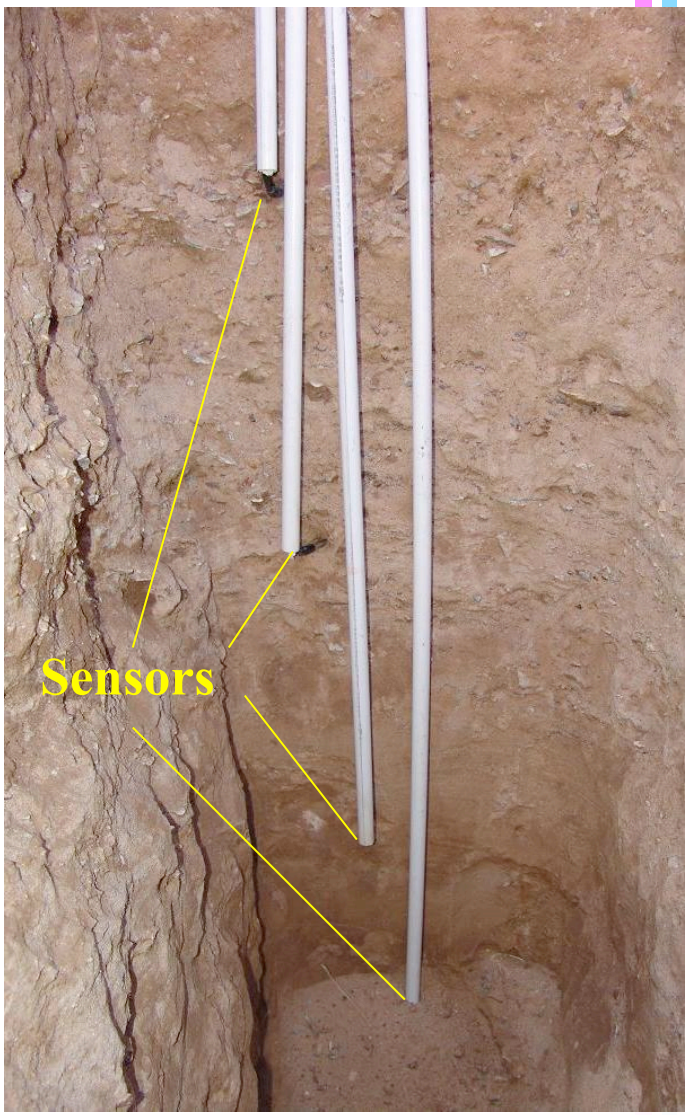
Schematic arrangement in central operating area

S

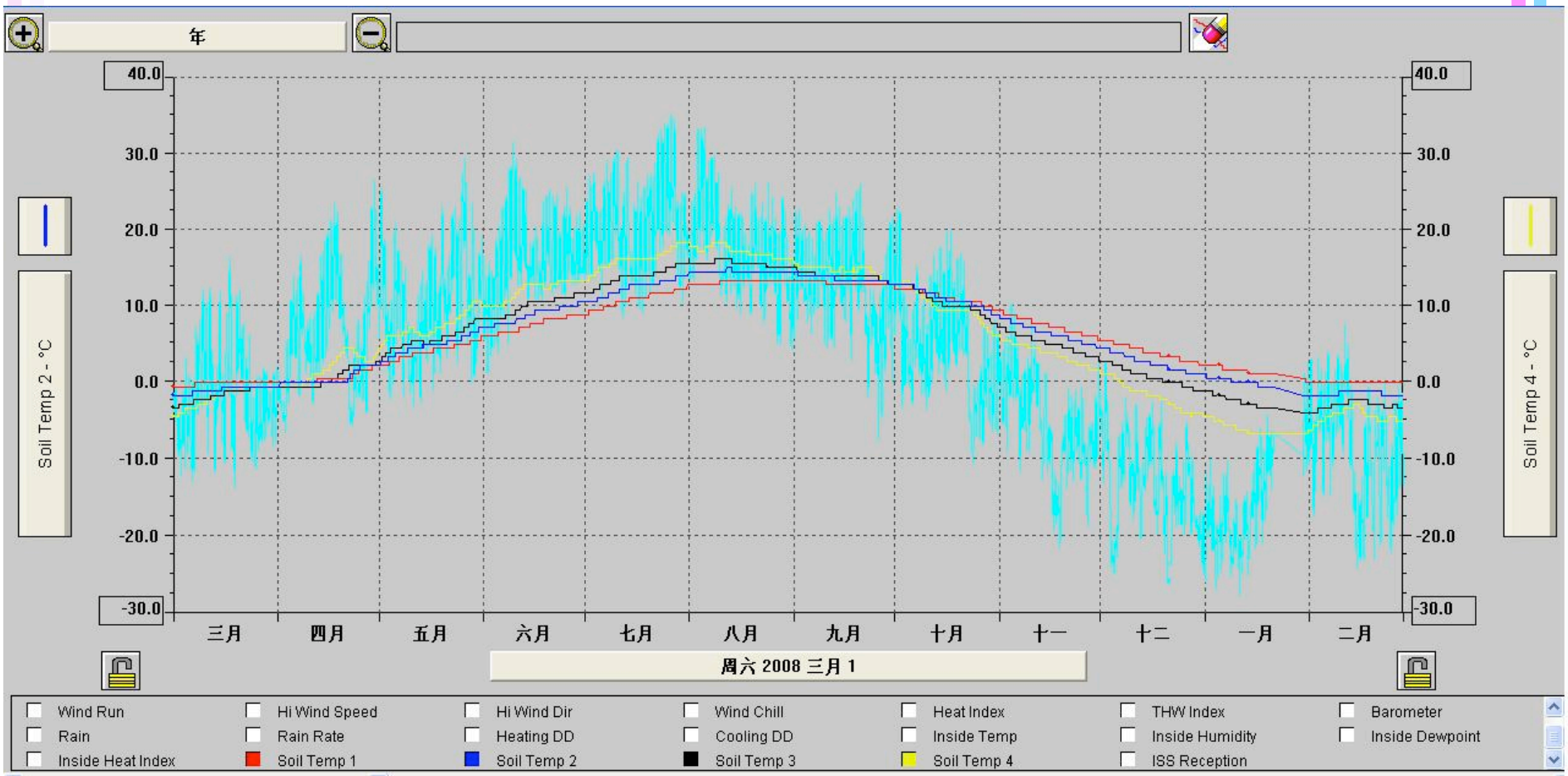
Construction of an Automatic Weather Station in Nov. 2007

Measurements of Soil Temperatures





Distribution of soil temperatures (March 2008 - March 2009)



Ceremony for Construction of CSRH at Ming'antu Observing Base on 9/9/2008

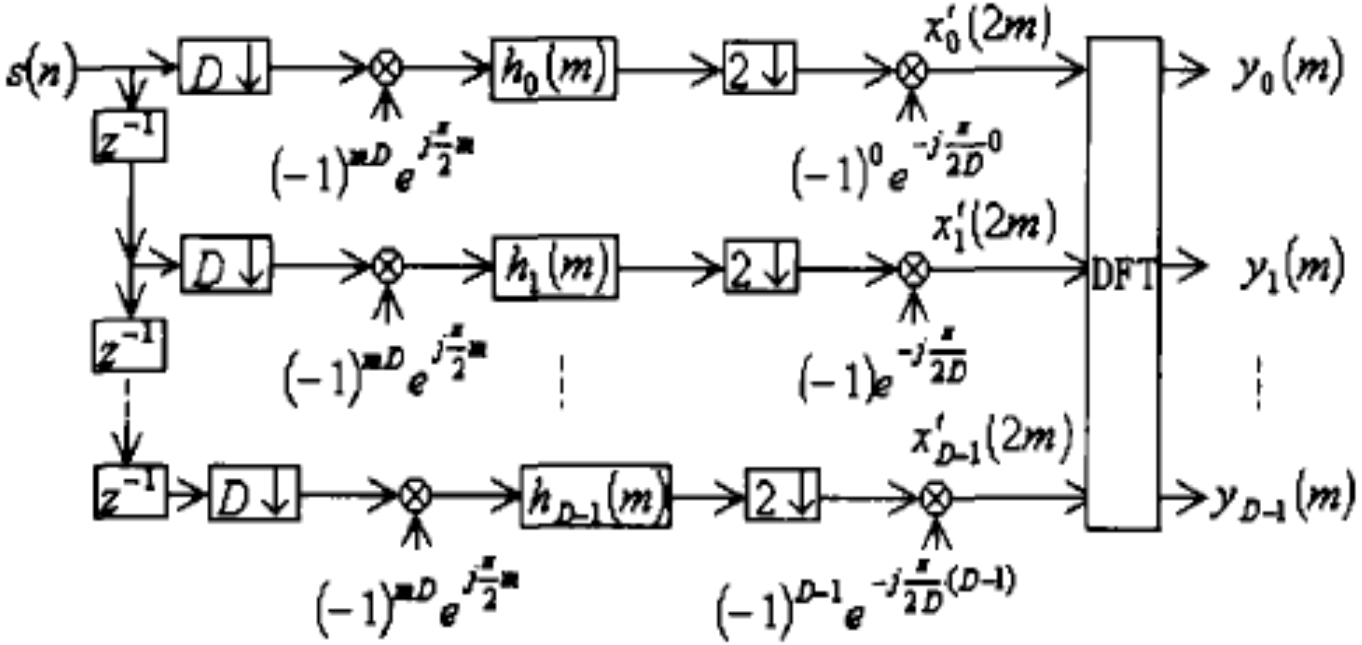
Field Construction

Power supply transformers

Field Construction Water supply

Field Construction Antenna bases

Polyphase filter model & simulations

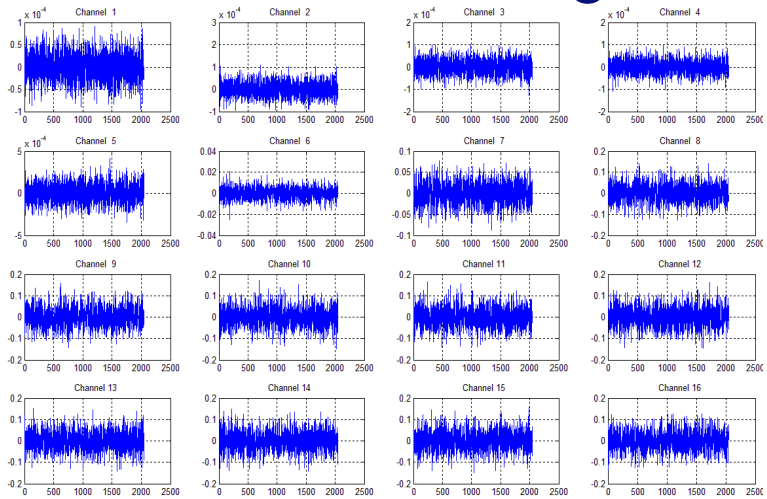


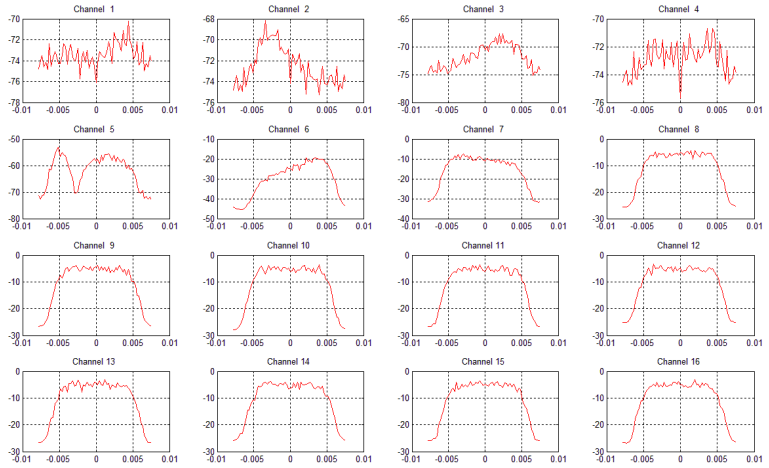
Polyphase filters:

$$h_k(m) = h(mD + k), \quad m = 0,1,2 \cdots\cdots Q-1$$
$$k = 0,1,2 \cdots\cdots D-1$$

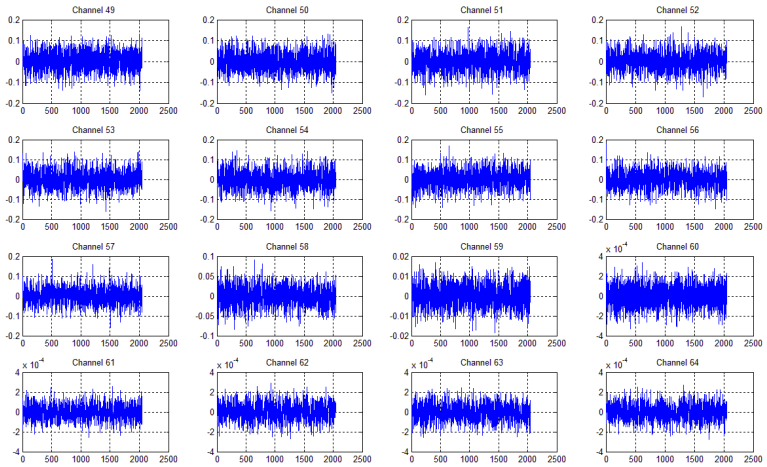
Simulations

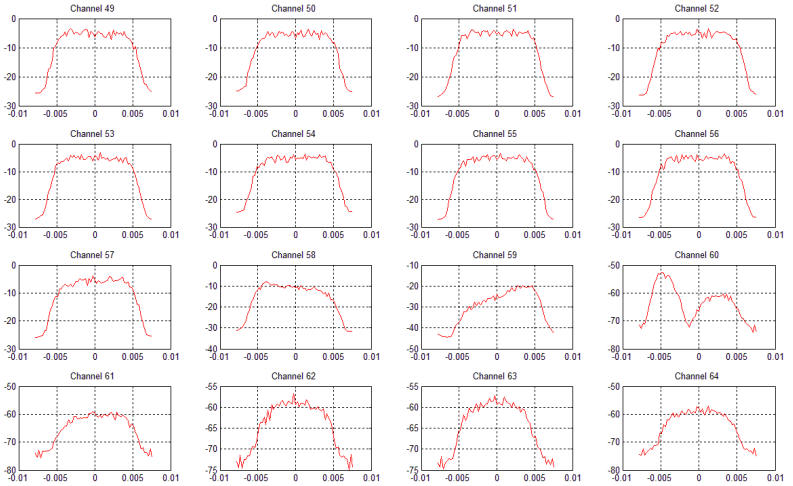
Signals & spectra of first 16 channels





Signals & spectra of last 16 channels





Present Status

I. CAS, NSFC & NAOC plan for future solar facilities in Sep. 2006: 1 of 2 major ground-based instruments be developed in next 5-10 yrs

II. Passed Pre-Evaluation for Land-transfer by Inner Mongolia Government in Dec 2006. Officially approved in Dec. 2007.

III. CSRH-I: included in a "National Basic Research Program 2006-2010" by MOST

IV. 2007-2009 Key Project by CAS-NSFC joint Foundation

Evaluation Meetings on CSRH Designs

3. Summary

I. Radio imaging spectroscopy is in its infancy and will open new observational windows on flares and CMEs.

II. For CSRH, radio quiet zone protection is estblished; CSRH-I construction during 2008-2011; & CSRH-II construction from 2011-2012（?）.