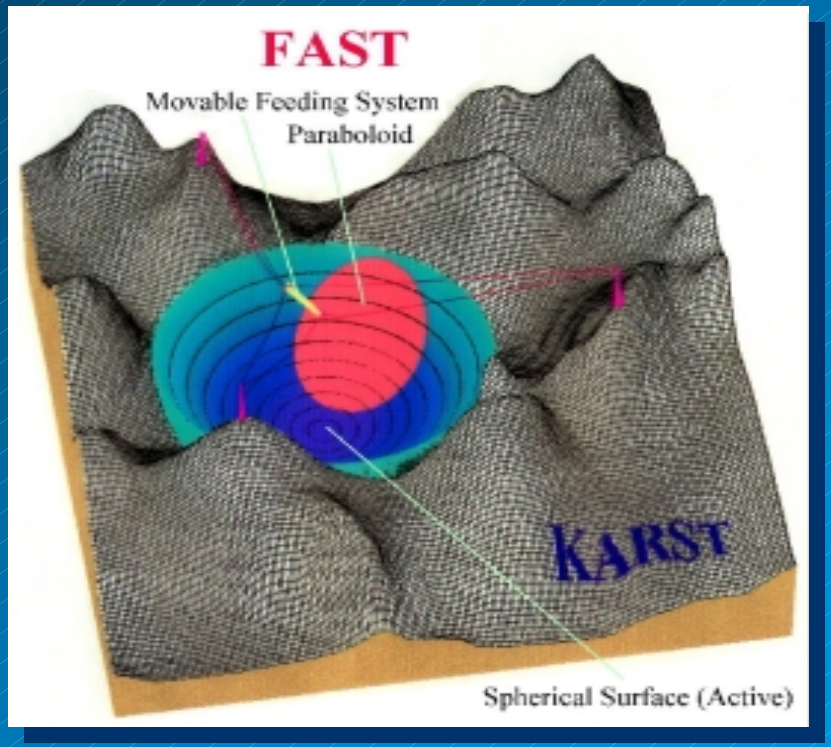
Status Report on

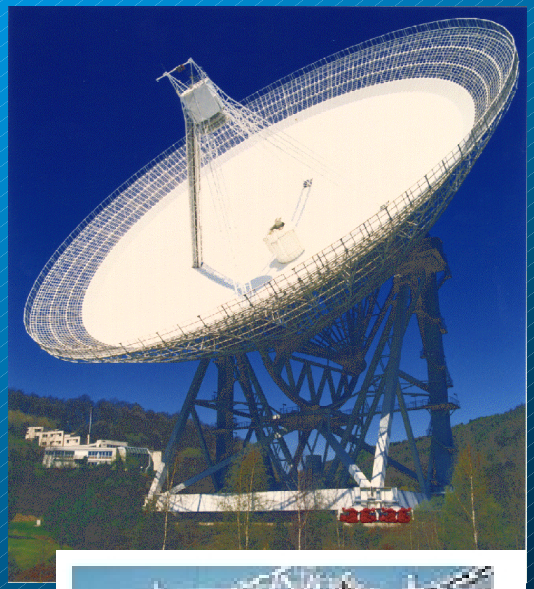


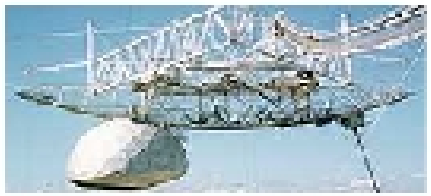
Bo Peng, R. Nan, Y. Qiu, W. Zhu, L. Zhu, Y. Su

National Astronomical Observatories China

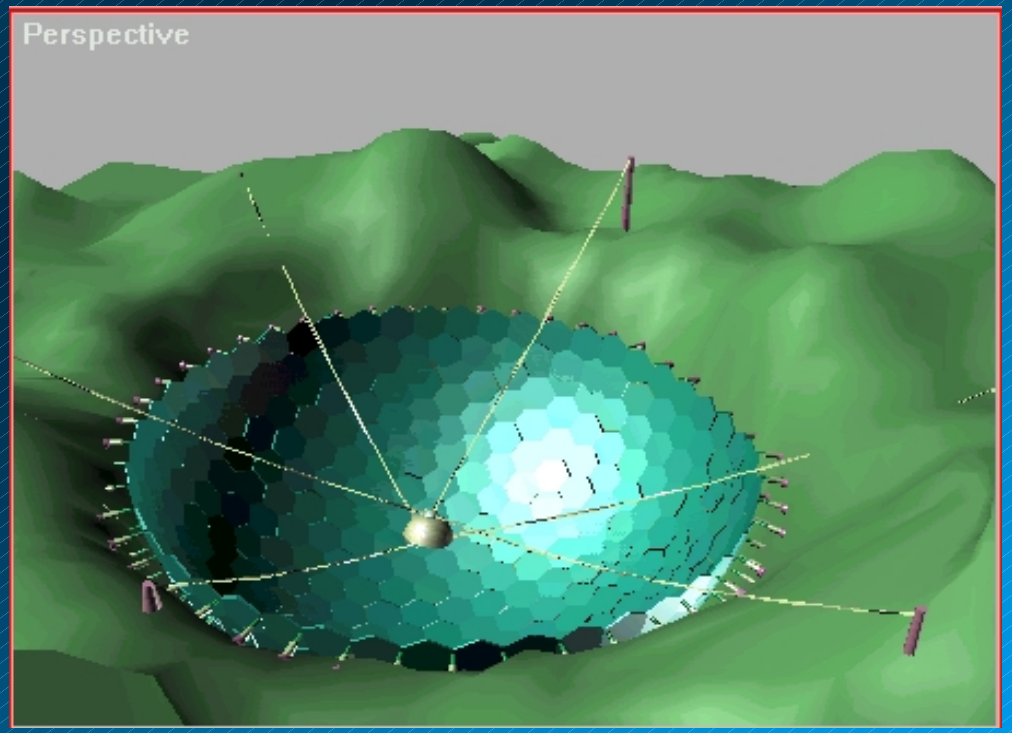
- Introduction
- Site surveying
- Active main reflector
- Feed supporting system without platform
- Timelines and Alliances

1.Introduction



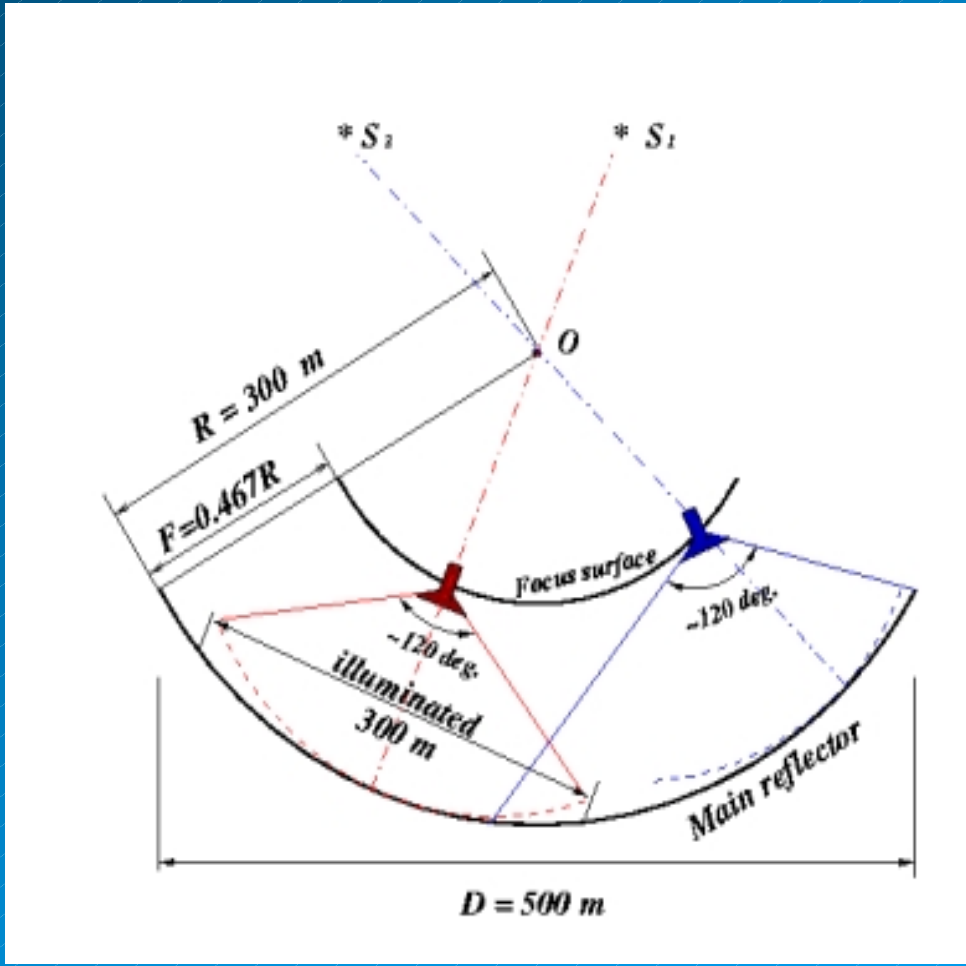


***F*ive-hundred-meter**
***A*perture**
***S*pherical**
***T*elescope**



Specification

- Reflector: R～300 m, D～500 m,
  opening angle θ ～120°
  D_{eff} = 300 m
- Sky coverage: max. zenith angle 40°
  (to ~70° with large efficiency loss)
- Frequencies（GHz）: 0.3-1.72,
  2.15-2.35,2.8-3.3,4.5-5.1,5.7-6.7,8.0-8.8
- Pointing Accuracy: 4″
- Slewing : 10°/min



Science Case

Collecting area of a telescope is a figure of merit of that instrument's capability. Some key projects:

1. HI in the Galaxy and extragalaxies.

- blind detection of HI at z ~ 0.3 to 0.7
- HI in warm shell of AGNs to z ~ 8 ?
- failed galaxies in voids

2. A huge VLBI element.

The number of observable will increase over 1 order of magnitude

3. Pulsar survey and follow-up observations.

- detect 7000 more in less than 1 year
- 10s extragalactic pulsars
- find rare-type: tight binaries, ms pulsars, pulsar-BH, …
- individual pulse studies

4. ‘ Normal’ radio stars

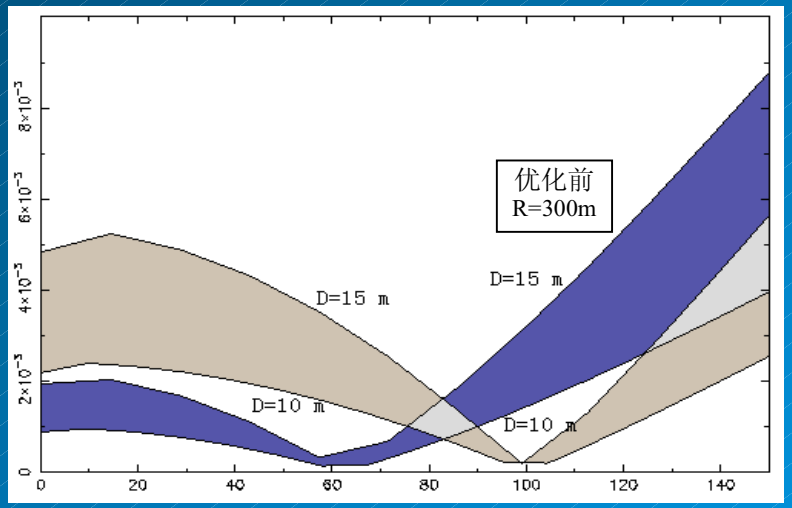
deep surveys, stellar wind studies, OB stars, Flares, SNs, …

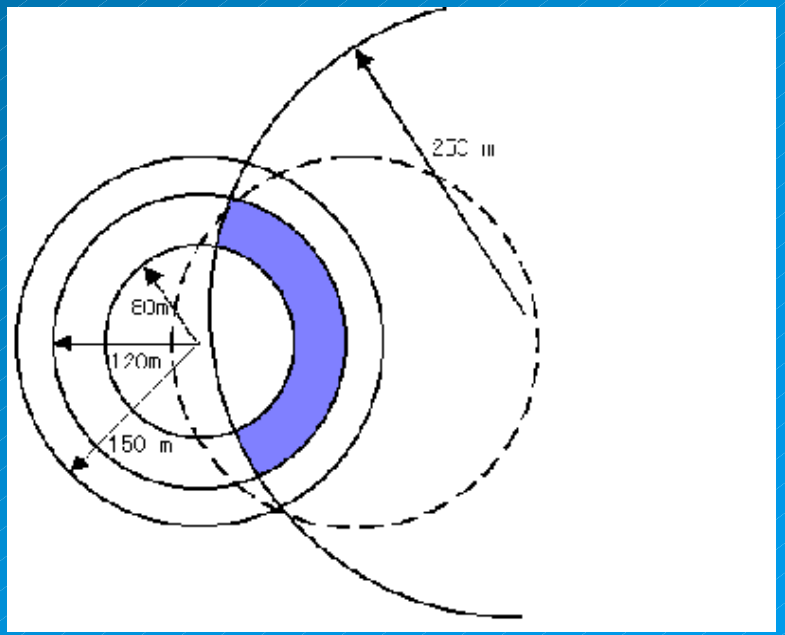
5. SETI - Search for Extraterrestrial Intelligent Life.

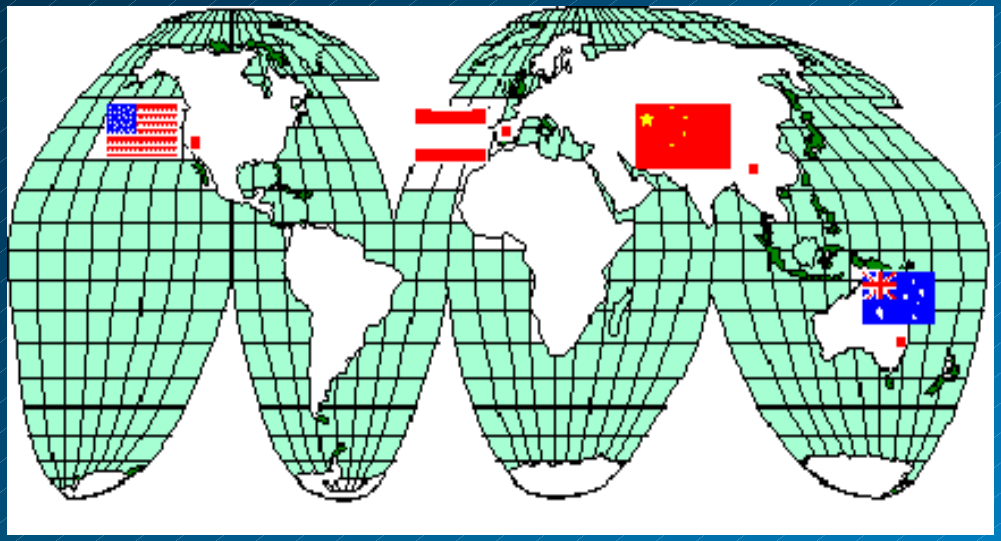
enlarge the number of targets by Phoenix to ~ 4000

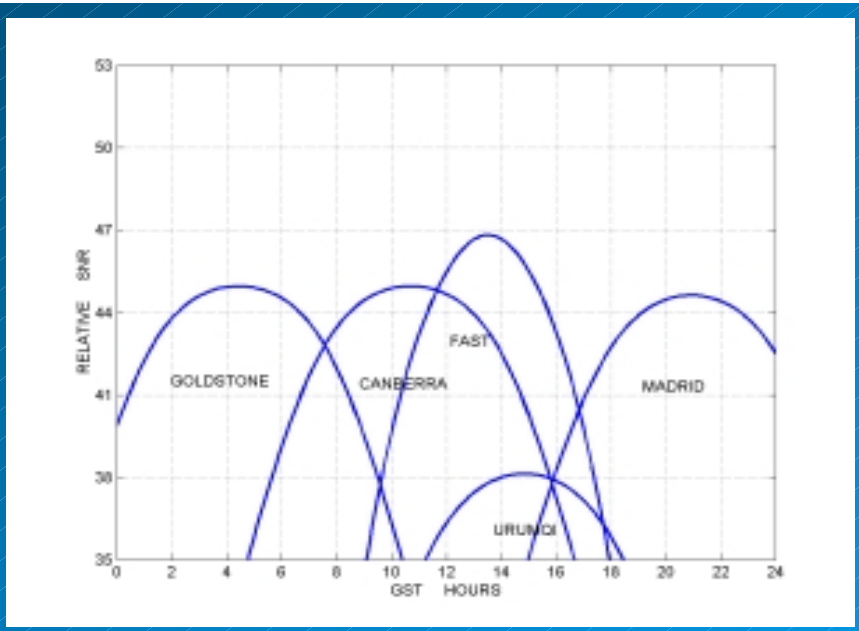
6. Deep Space Network .

at Ku (12 GHz) band, efficiency ?







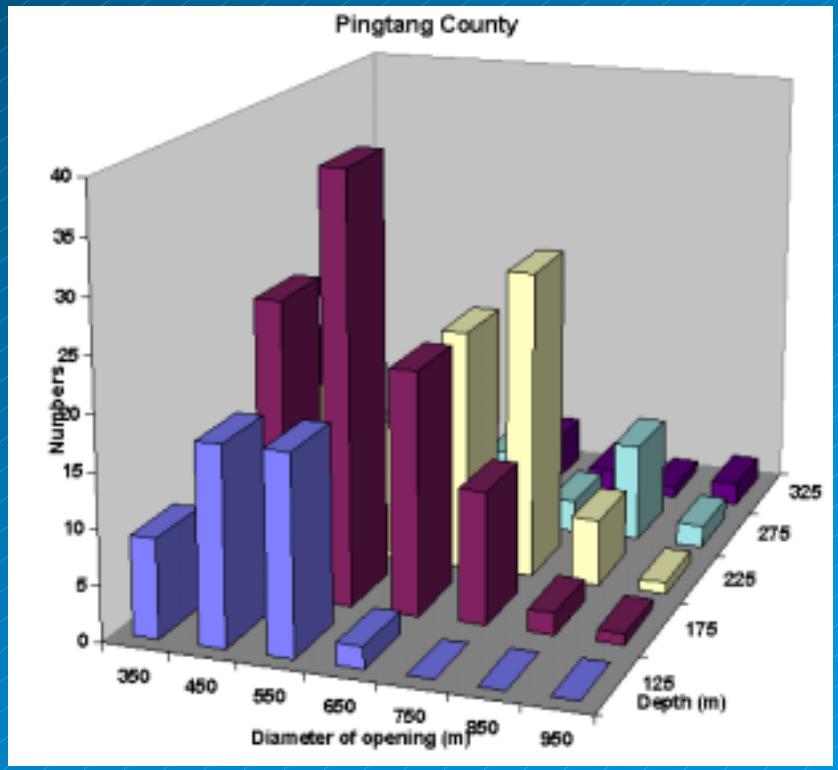


Communication link at Ku band while the FAST joins the DSN

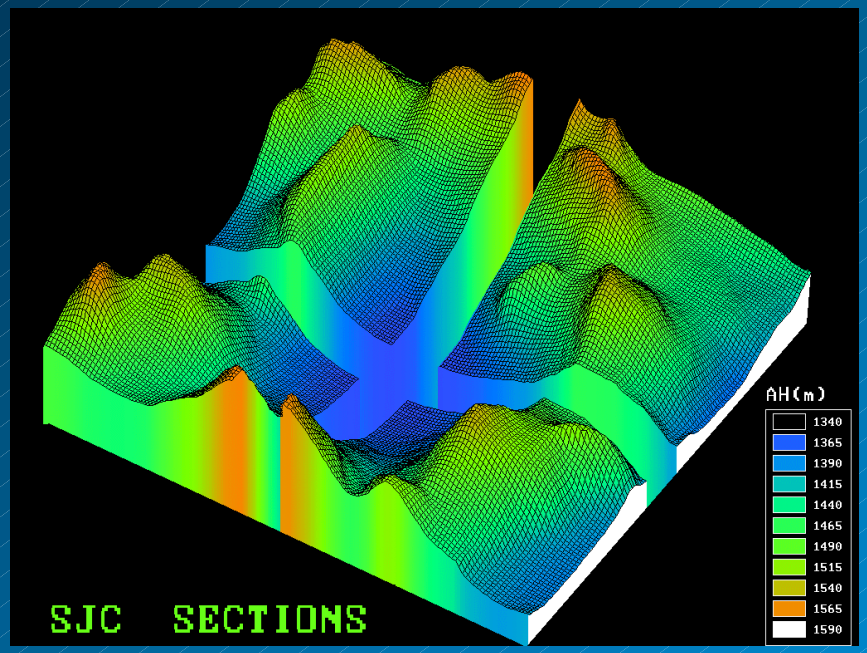
2. Site surveying in Guizhou

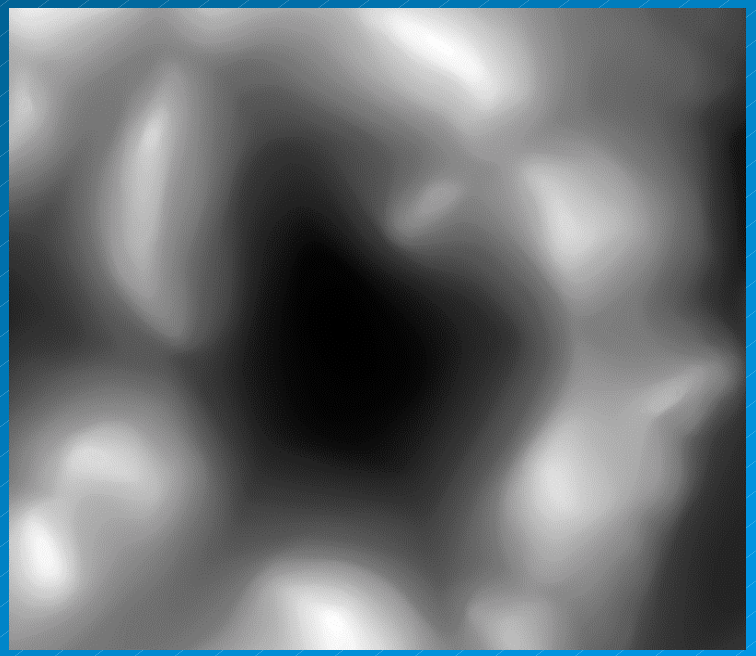
Since 1994, site survey started in the south of Guizhou province of China. Large amount of karst depressions were investigated with the RS, GIS and on-the-sport observations.

Data of climate, hydrogeology and engineering geology, resource environment and RFI have been collected and exhaustively studied.



DTM Image



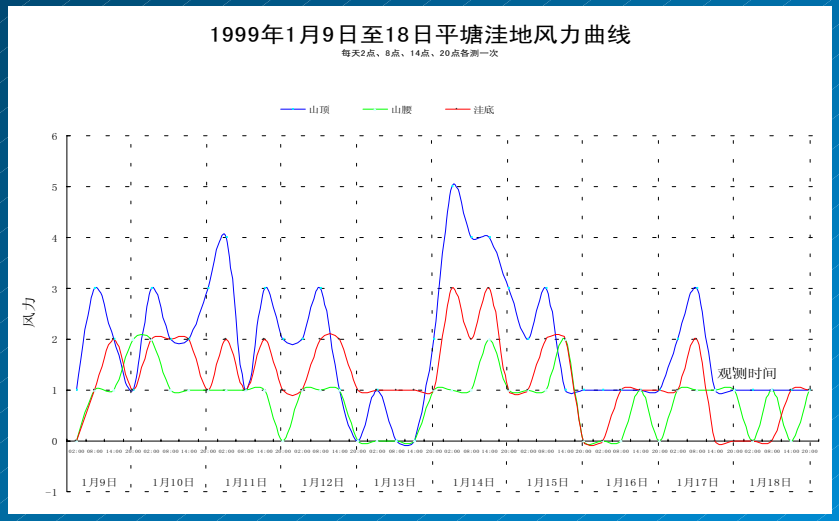


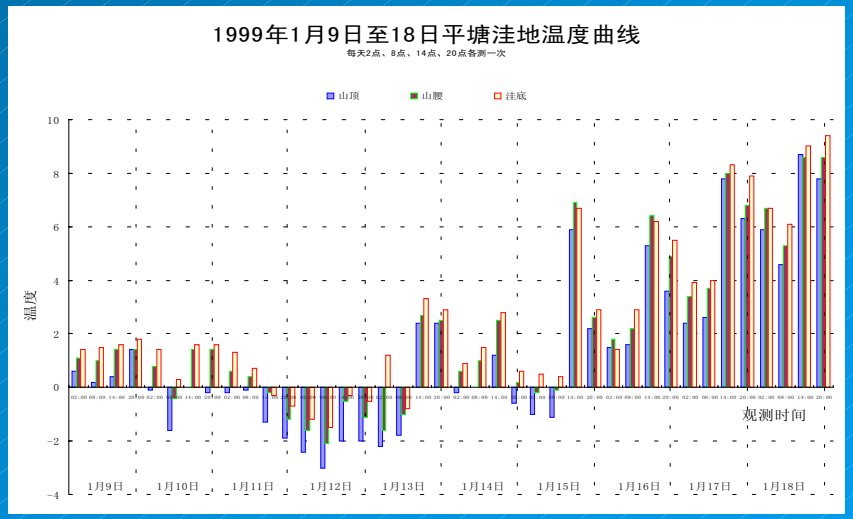
Shangjiachong Depression, 5 m /pixel

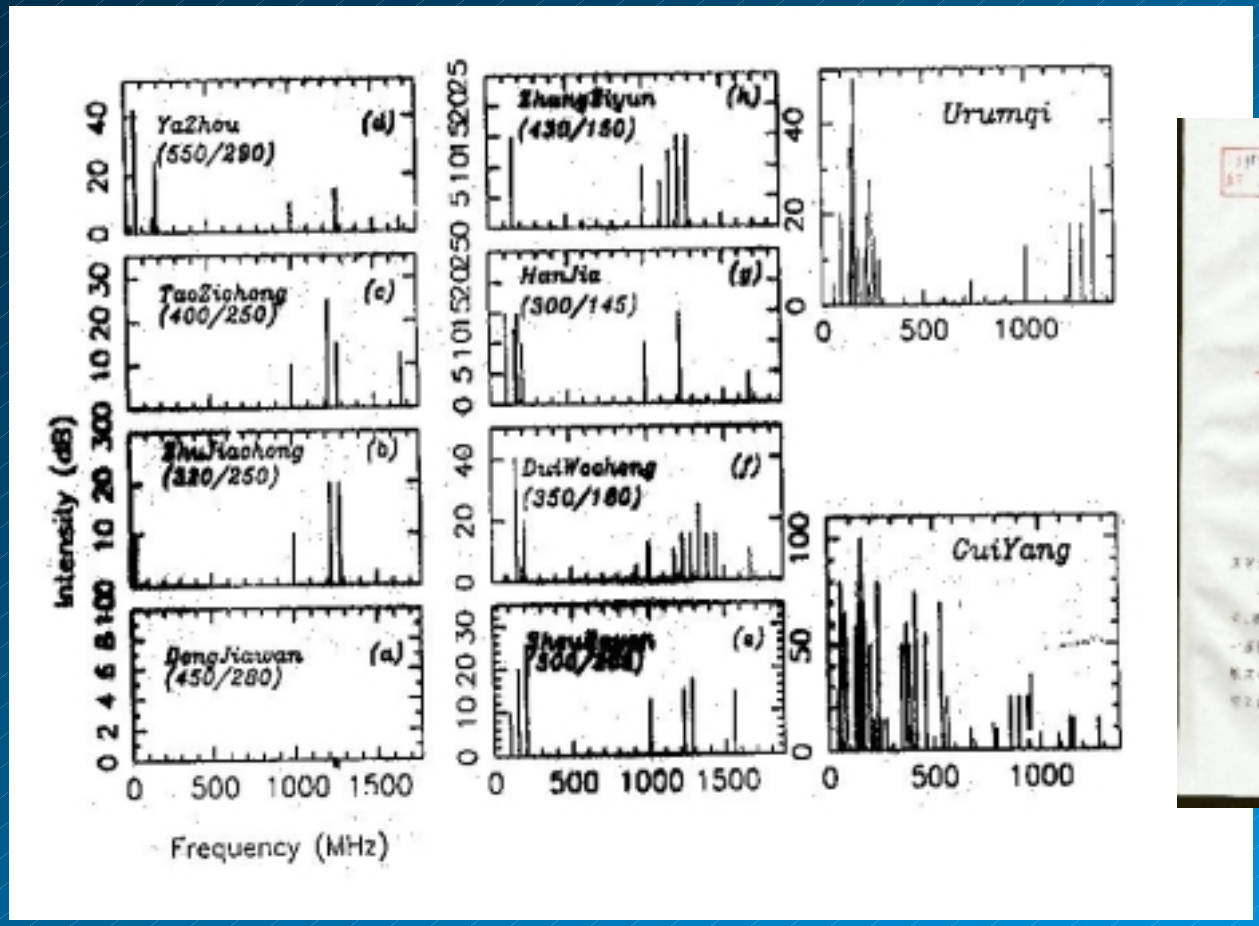
Climate at one depression on small scale

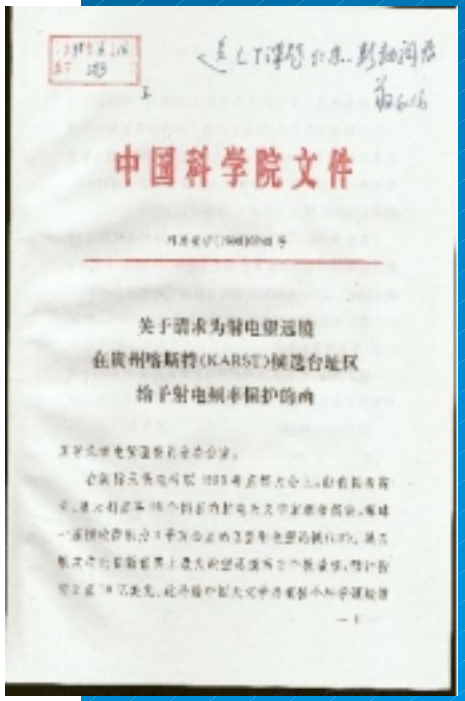
Statistics of climate data from 1961 to 1998

	Highest Temp. (℃)	Lowest Temp. (℃)	Maximum Drift (℃/day)	Maximum Wind (m/s)	Precipitation (mm/yr)	Ice rain (times/yr)	Days/yr (Wind>8m/s)
Pingtang County	38.1	-7.7	25.5	17	1258	1.2(weak)	2.7 days
Puding County	34.3	-11.1	24.6	20	1449.1	1.3(weak)	








中国科学院文件

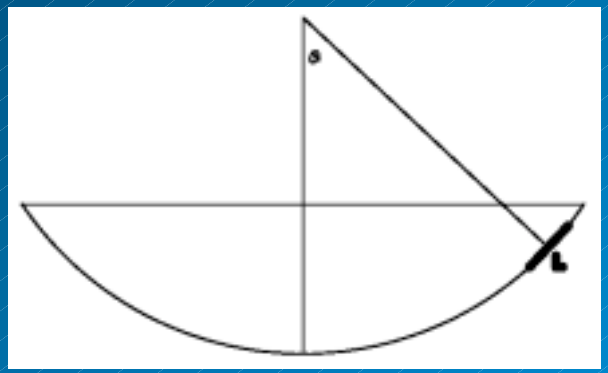
关于请求为射电望远镜
在贵州喀斯特(KARST)候选台址区
给予射电频率保护的函

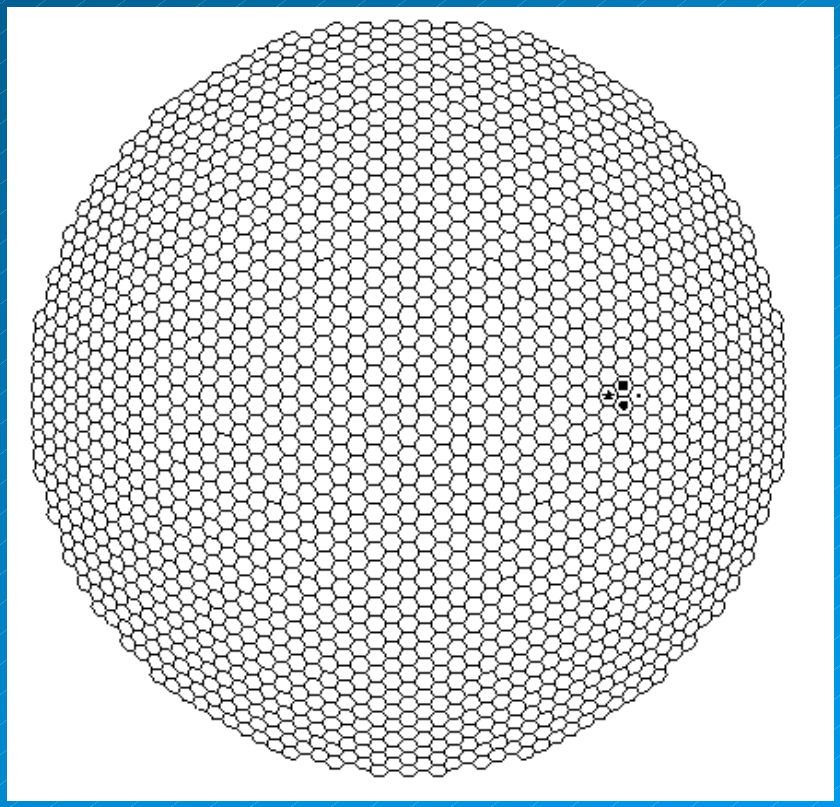
Interference monitoring at some locations (left) and the agreement on radio environment protection by the provincial RC and the BAO (right)

3. Main reflector

Segmentation of the reflector

One proposed scheme is to divide the whole cap into 1788 hexagons with side ~ 7 m long.The dimension of the element along the altitude is shortened by Sinc θ。





Scaled model for the reflector

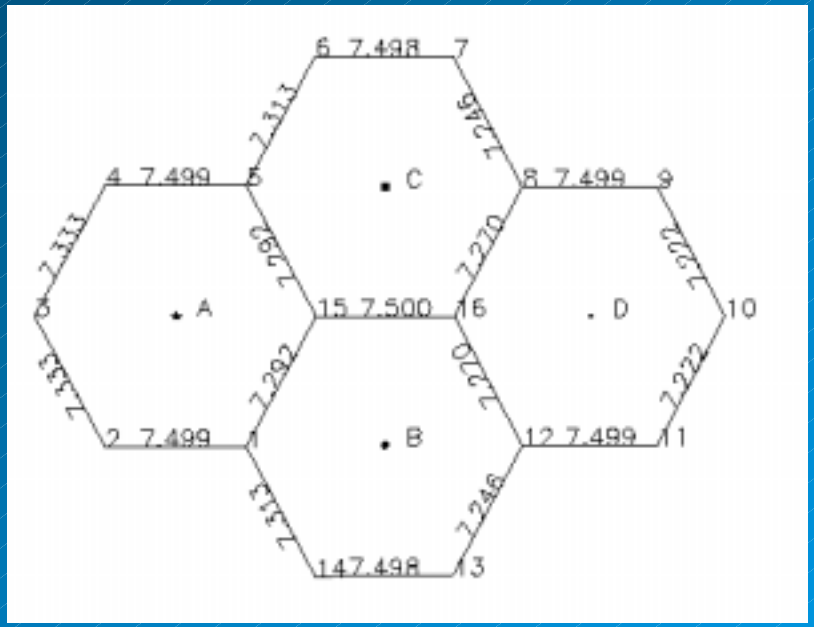
Error distributions

The final accuracy of the reflector is determined by λ/16 at highest frequency（5GHz). Surface error is ~ 4 mm, which are distributed as below:

Components	allowed error(mm)
1.Curvature deviation of spherical and parabolic (illuminated area 300m）	3.5
2.Fit between flat panels and spherical element（R=300m）	1
3.Manufacture, mount, gravity effect ...	1.5
4.Actuator	0.5
5.Measurement	0.5
总误差	~4

Scaled model and experiment

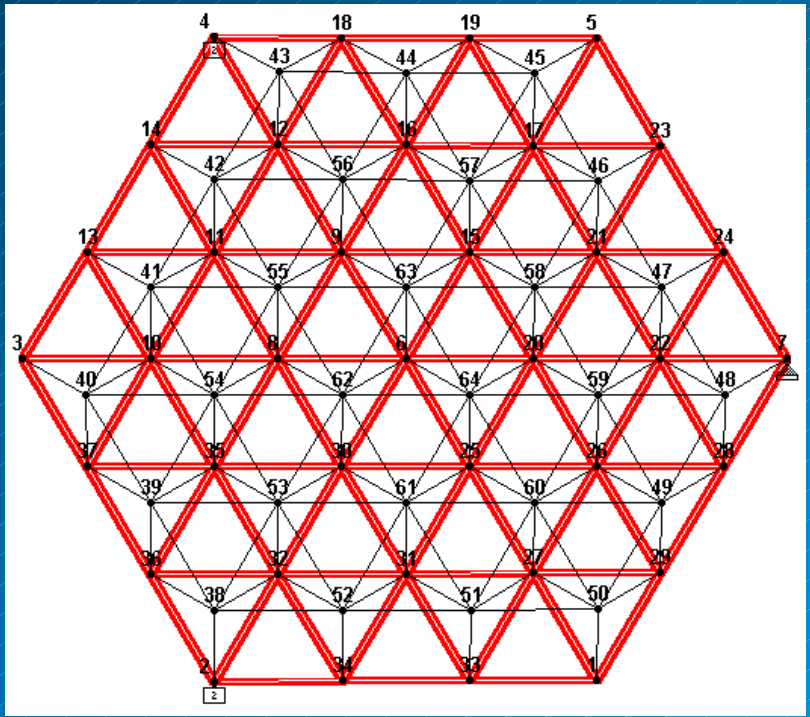
- Four elements at moderate height of the cap are selected as the test-bed of the reflector.
- Temp. range -10°～40°C; operating wind load 4 m/s; surviving 20 m/s。

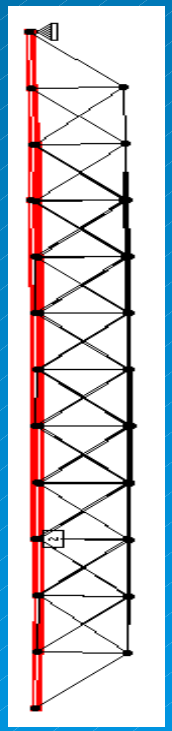


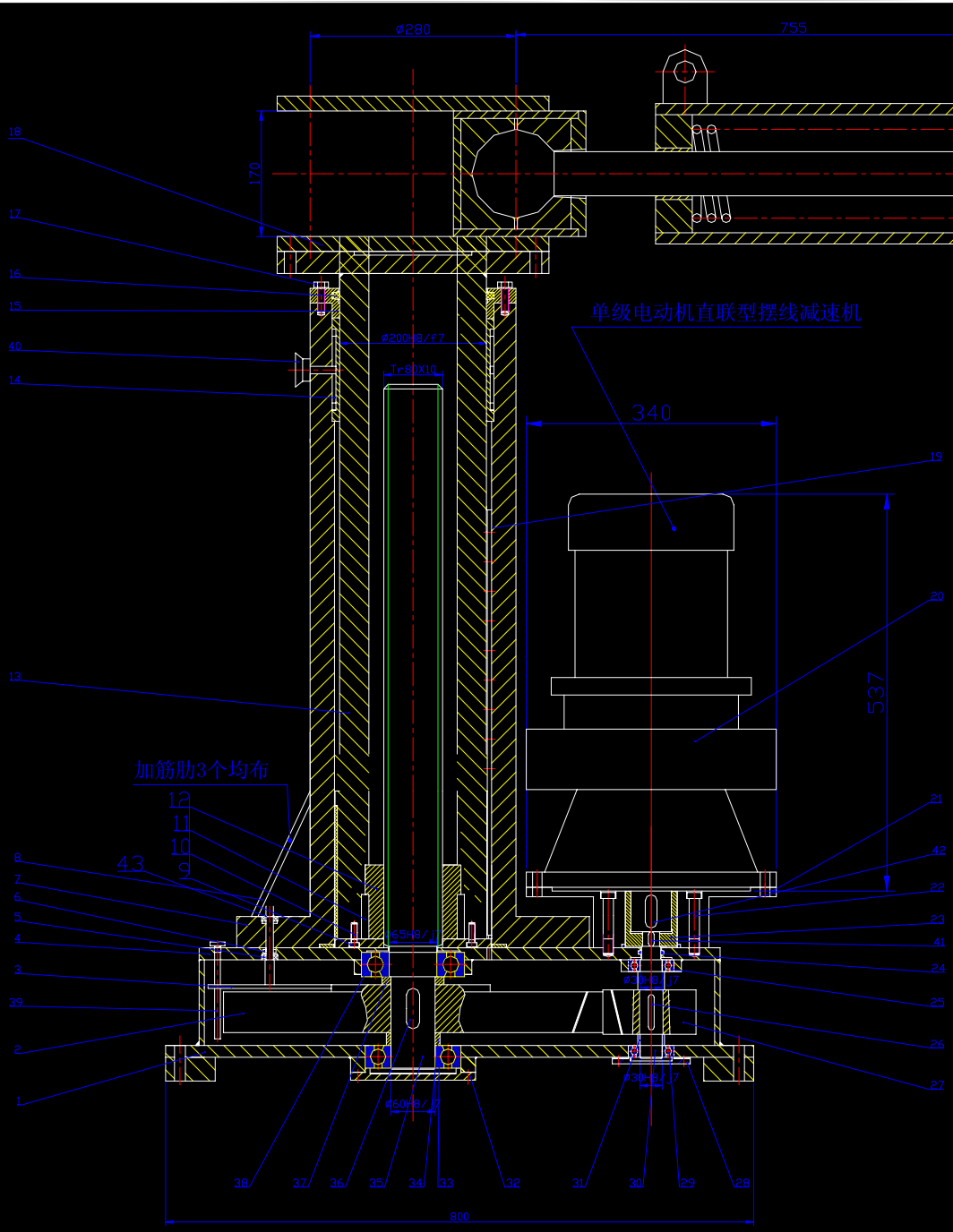
- Scale factor is 1：3。3 types of designs will be qualified according to the experiment results combined with the principle of the similarity.
- The surface elements including actuators, mechanical and electronic control are designed and processed in the Tongji University, Nanjing Astronomical Instrument Center and Xi'an Navigation Institute respectively. Different parts will be assembled and tested in Shanghai in September of 2000.

Element model

- 2 kinds of surface element are designed by the Tongji University - one is made of aluminum, another has aluminum panels mounted on the steel back structure.







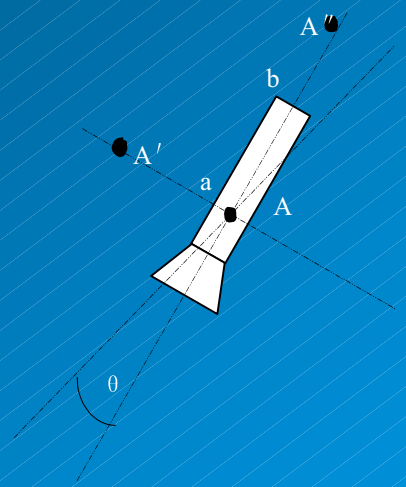
说明：
z1=44,d1=132
z2=172,d2=516
m=3

序号	代号	名称	数量	材料	单件	总计	备注
43	GB894.1-86	弹性挡圈	1				
42	GB1096-79	平键（A型）	1				
41	GB1096-79	平键（A型）	1				
40		油嘴	1				
39		油标尺	1				
38	GB/T292-93	滚动轴承	1				
37		套筒	1				
36	GB1096-79	平键（A型）	1				
35		轴	1				
34		套筒	1				
33	GB/T292-93	滚动轴承	1				
32		端盖	1				
31		套筒	1				
30		轴	1				
29	GB/T292-93	滚动轴承	1				
28		端盖	1				
27		小齿轮	1				
26	GB1096-79	平键（A型）	1				
25	GB/T292-93	滚动轴承	1				
24	JB/ZQ4606-86	毛毡油封	1				
23		套筒	1				
22	GB70-85	螺钉	1				
21		支架	1				
20		电机直连型减速机	1				
19		导向键	1				
18		球铰连接	1				
17	GB5780-86	螺栓	1				
16	JB/ZQ4606-86	毛毡油封	1				
15		法兰	1				
14		导向套筒	1				
13		支撑杆	1	45			
12		大螺母	1	45			
11	GB1096-79	平键(B型)	1				
10	GB70-85	螺钉	1				
9		压盖	1	45			
8		加筋肋	1	45			
7		导向支撑	1	45			
6	GB6578-86	A型橡胶防尘圈	1	45			
5	GB/T276-93	滚动轴承	2				
4		机盖	1	45			
3		小齿轮	1	45			
2		大齿轮	1	45			
1		机座	1	45			

图名	比例		图号
	件数		
制图	重量	材料	
描图			同济大学机械工程系
审核			

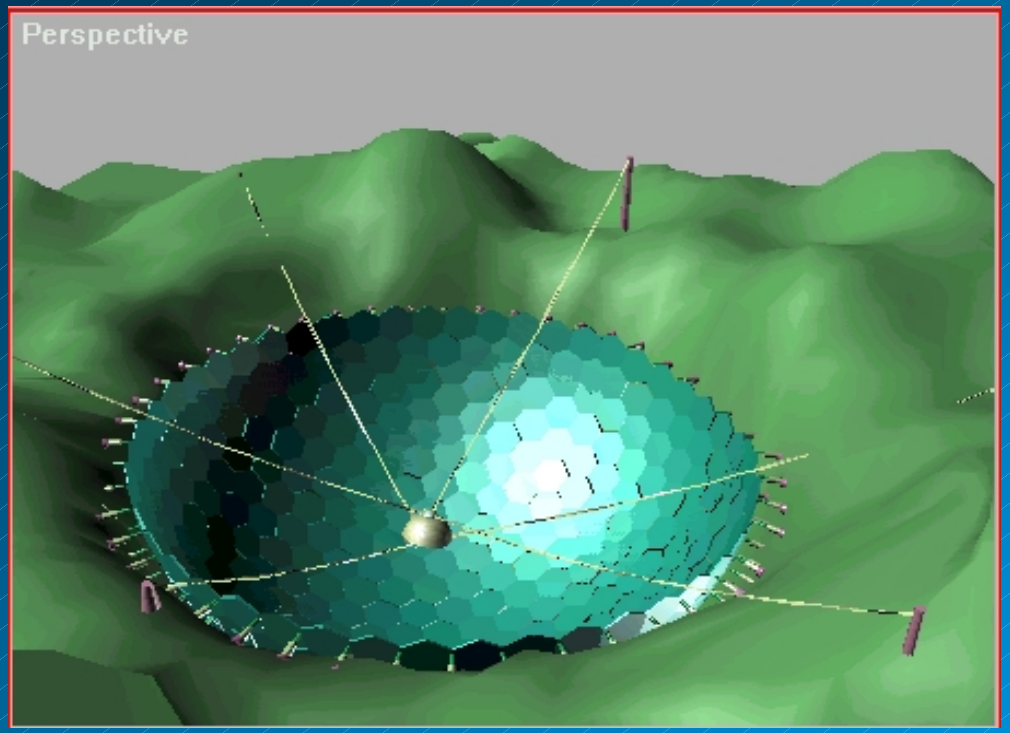
4. Pointing and Tracking

General



- For a pointing error $f_{max} < 0.1$ x BW at 5 GHz, a<4mm。While b~4mm, the loss g is ~ 1%，negligible。As $\theta = 1^{o}$，g < 0.4%，side lobe level increases by 0.5 db，and beam mispoints by 6×10^{-6} arcsec。In general, feed platform as rigid body of 6 freedoms needs a position accuracy up to 4 mm in air.

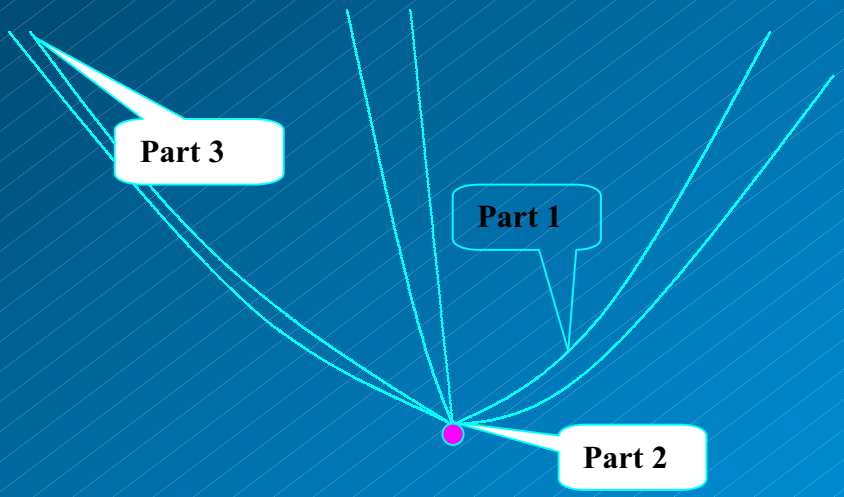
Receiver cable support system without platform (Xidian)

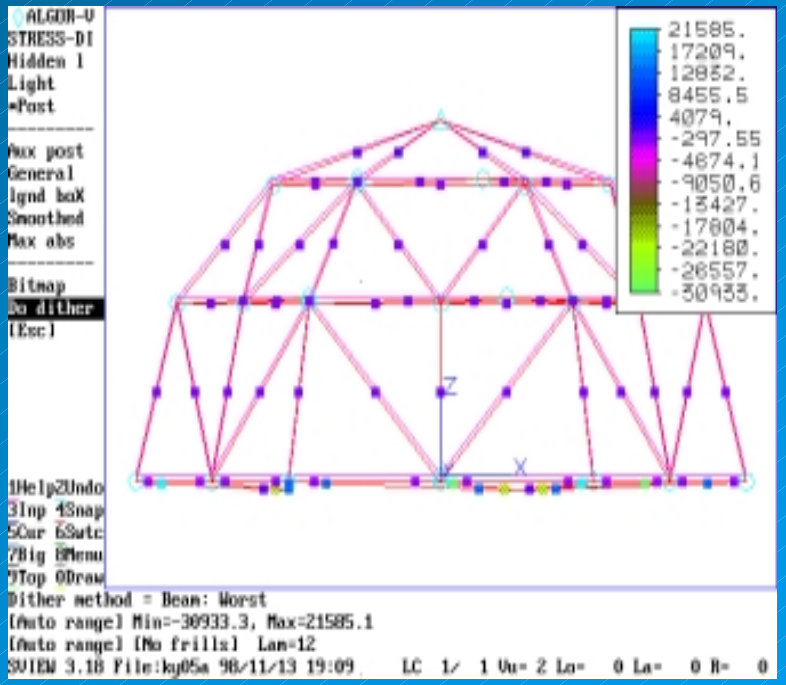


- **Payload of the feed cabin is ~ 30 T. Weight of feeds and front end on the secondary stabilizer is ~ 3T。**
- **The feed cabin moves on the focusing surface of 250 m diameter. The axis of the cabin is adjustable within 40° at least in order to achieve large zenith angle up to 60° Maximum tracking speed ~1.5cm/s and maximum speed while slewing ~50cm/s。**

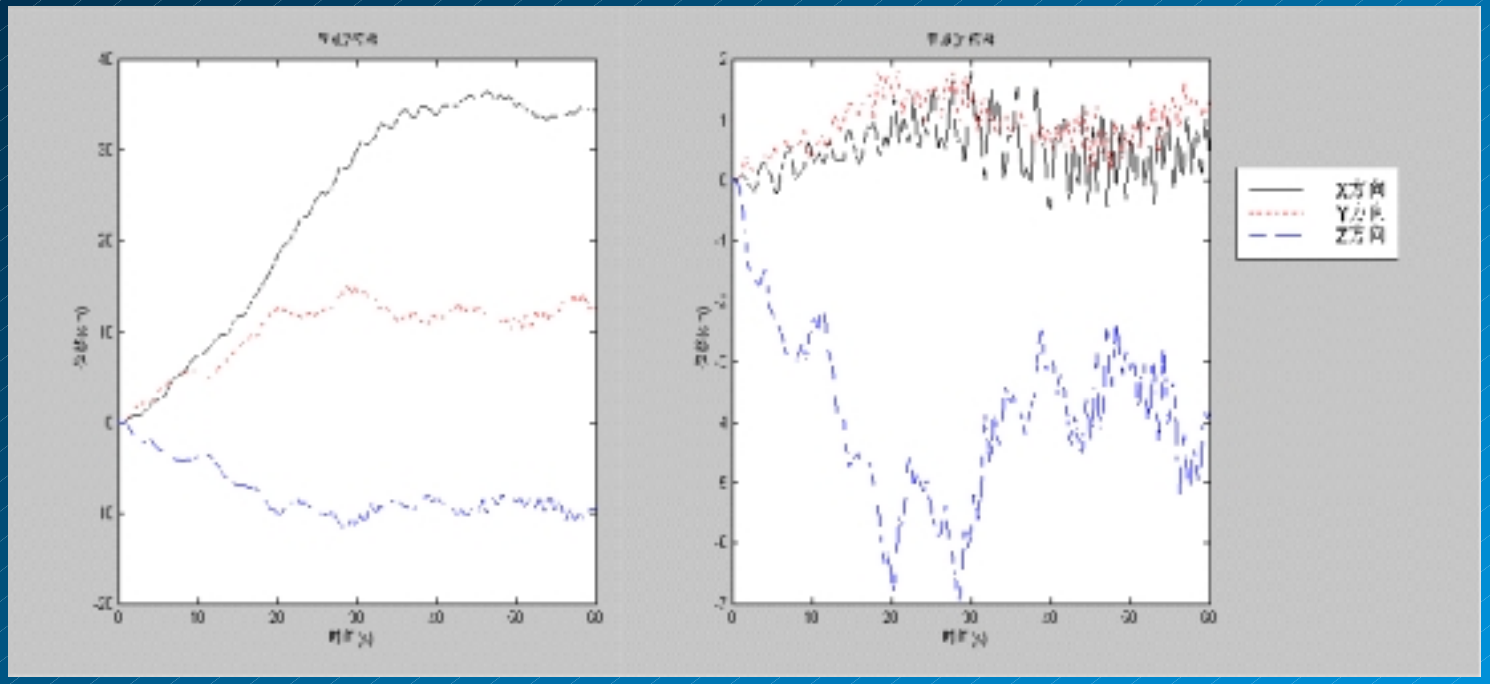
Optmechatronics on feed support with span cable

- **Summary: There are 6 suspended cables driven by servo-mechanism, to move the focus cabin on the caustic surface within an error volume. The secondary adjustable system, Stewart platform manipulator, is necessary to accurately position the group of pre-amplifier with feed in the cabin.**

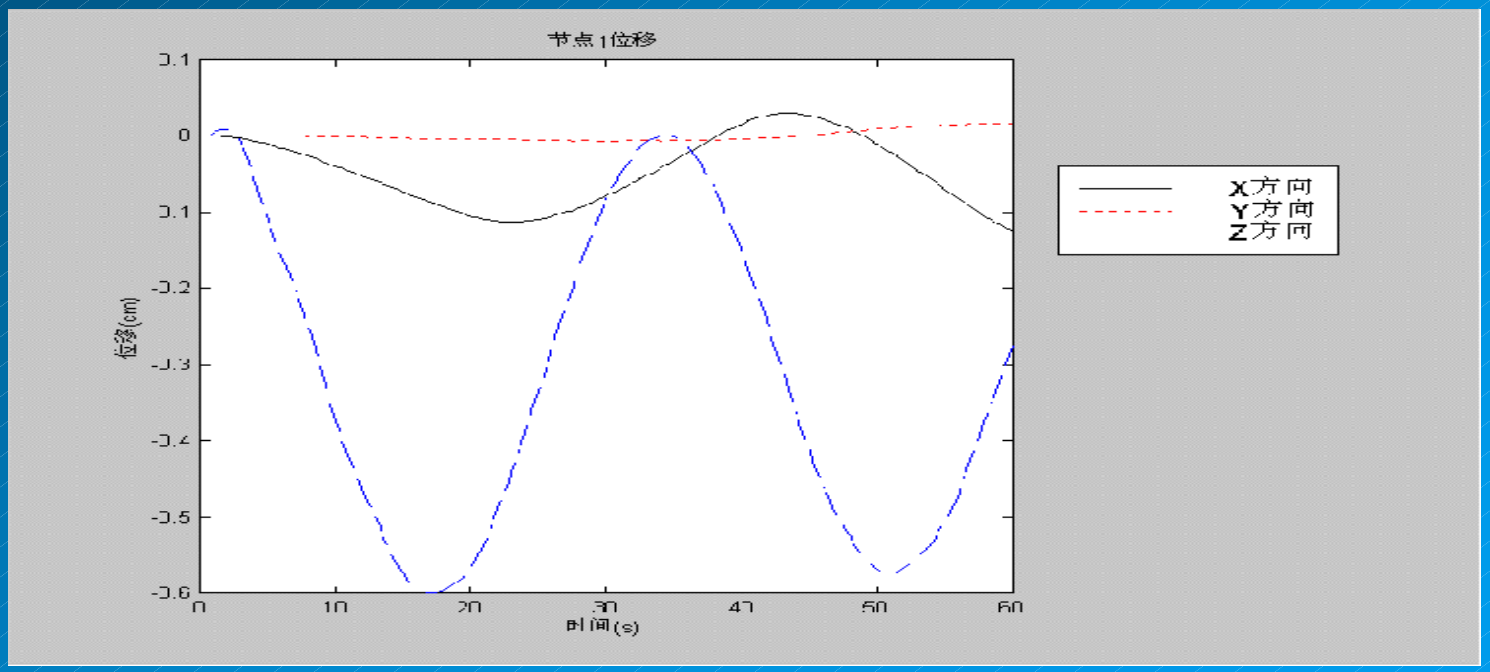




D2
V=17m/s
C=100



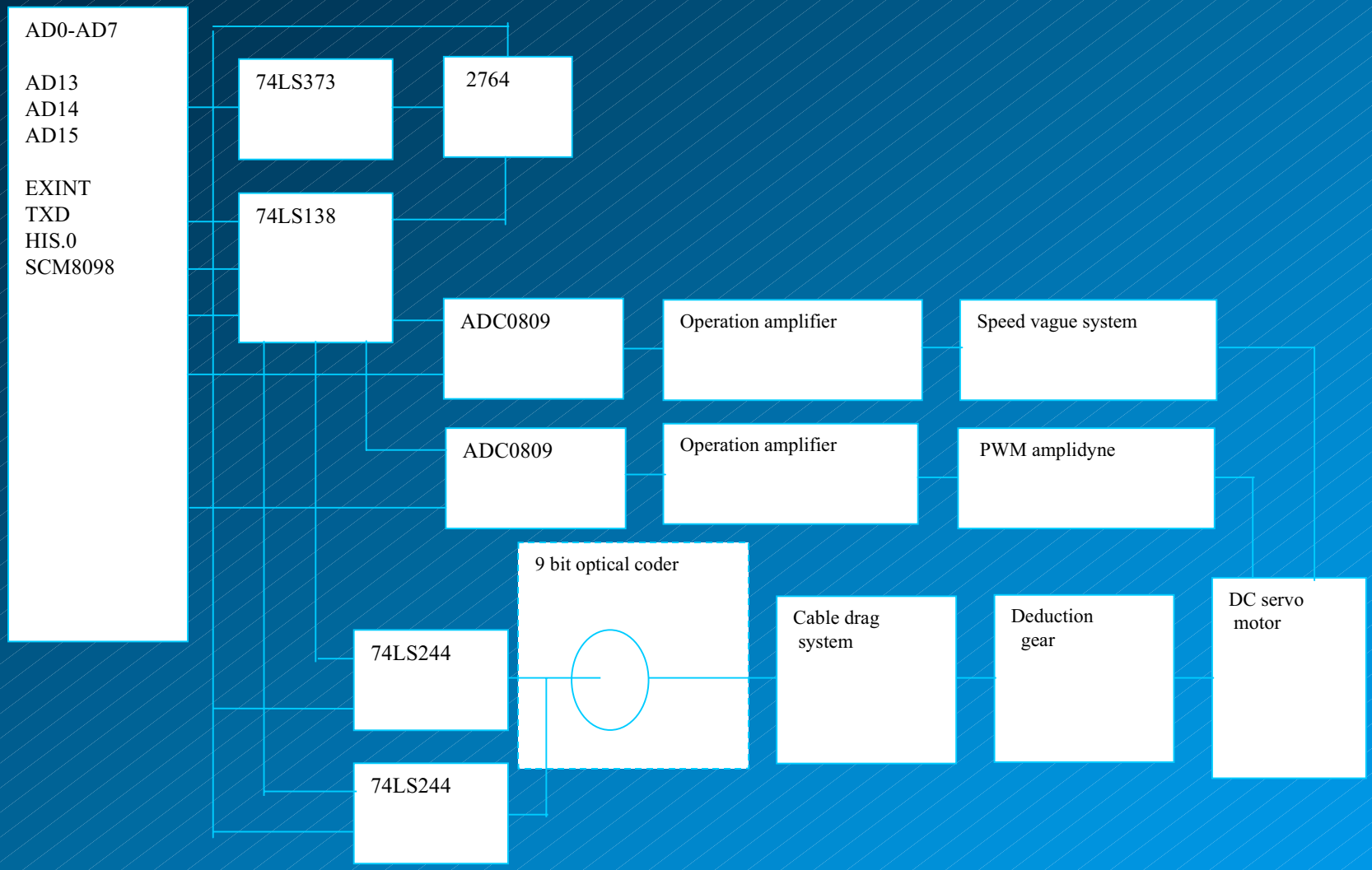
Shedding
vortex
vibration



Some conclusions

- Displacements at extreme points are large due to the low stiffness, prestress is required.
- Maximum displacement of the cabin is 50 cm under the wind speed 17 m/s, seldom in GZ
- Natural oscillating frequency is below 1 Hz, which defines the spectral coverage of the mechanical control.

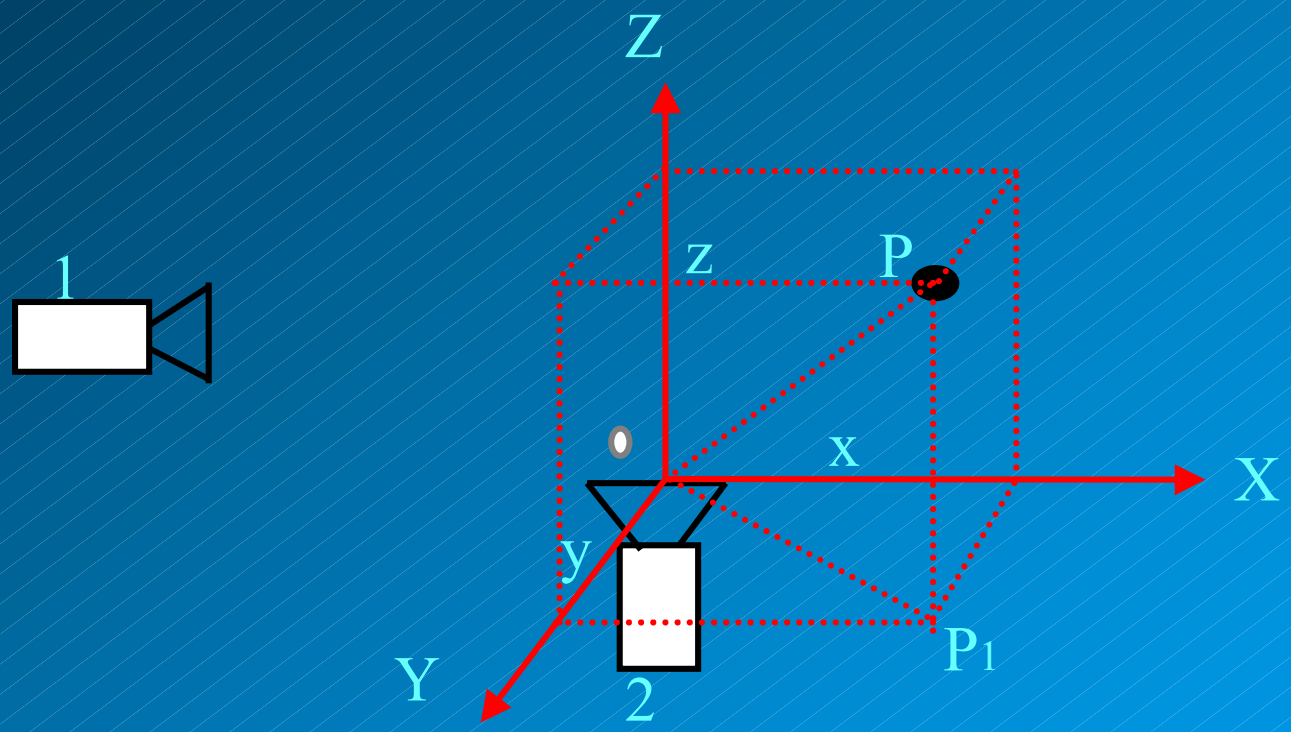
5 m scaled model for the cable and cabin system (Xidian Uni.)



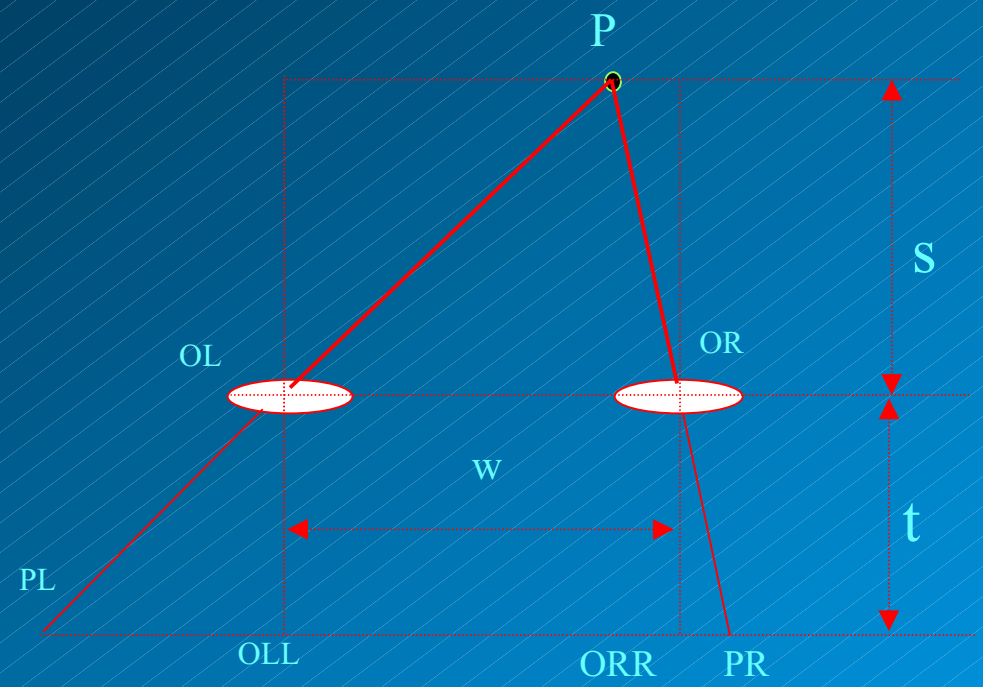
Hardware of digital servo control system

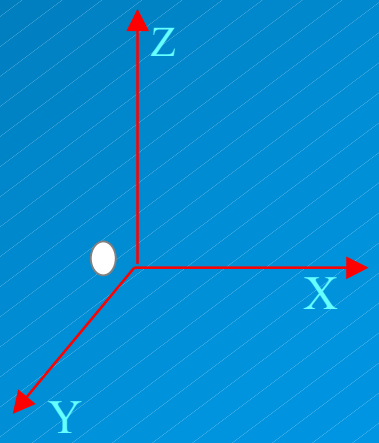
- **Scheme of visual 3-D positioning system**

Spacial photographic positioner : directly perceived, accurate, simple algorism， high quality hardware, complex software and calibration.



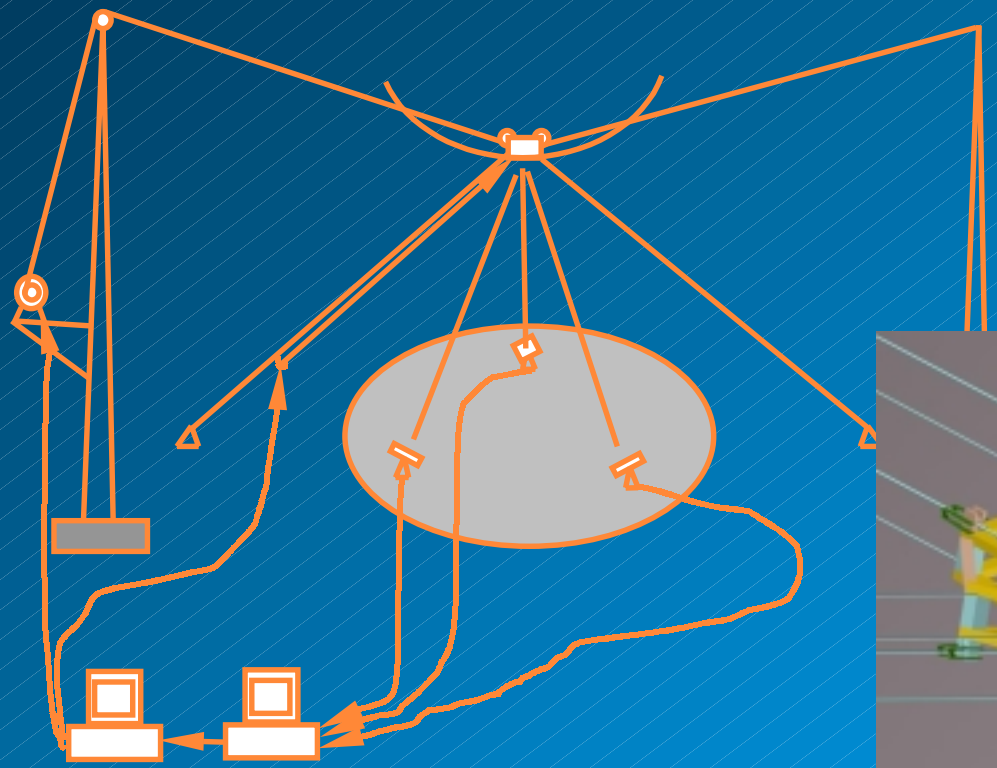
Binocular chromatism positioner: limited FOV, complex algorism

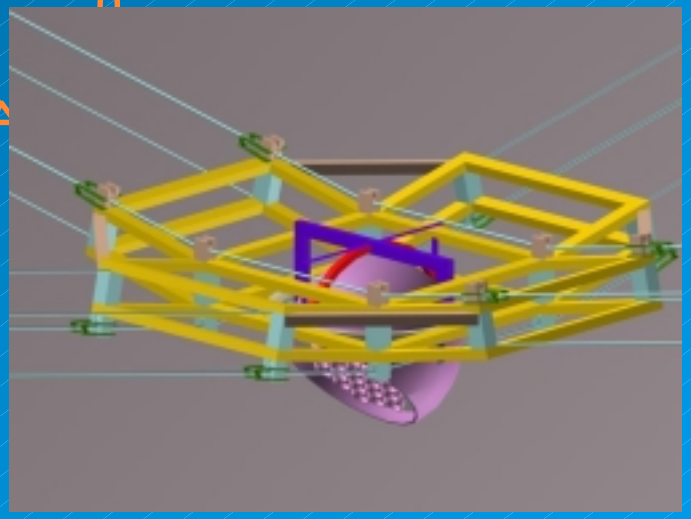




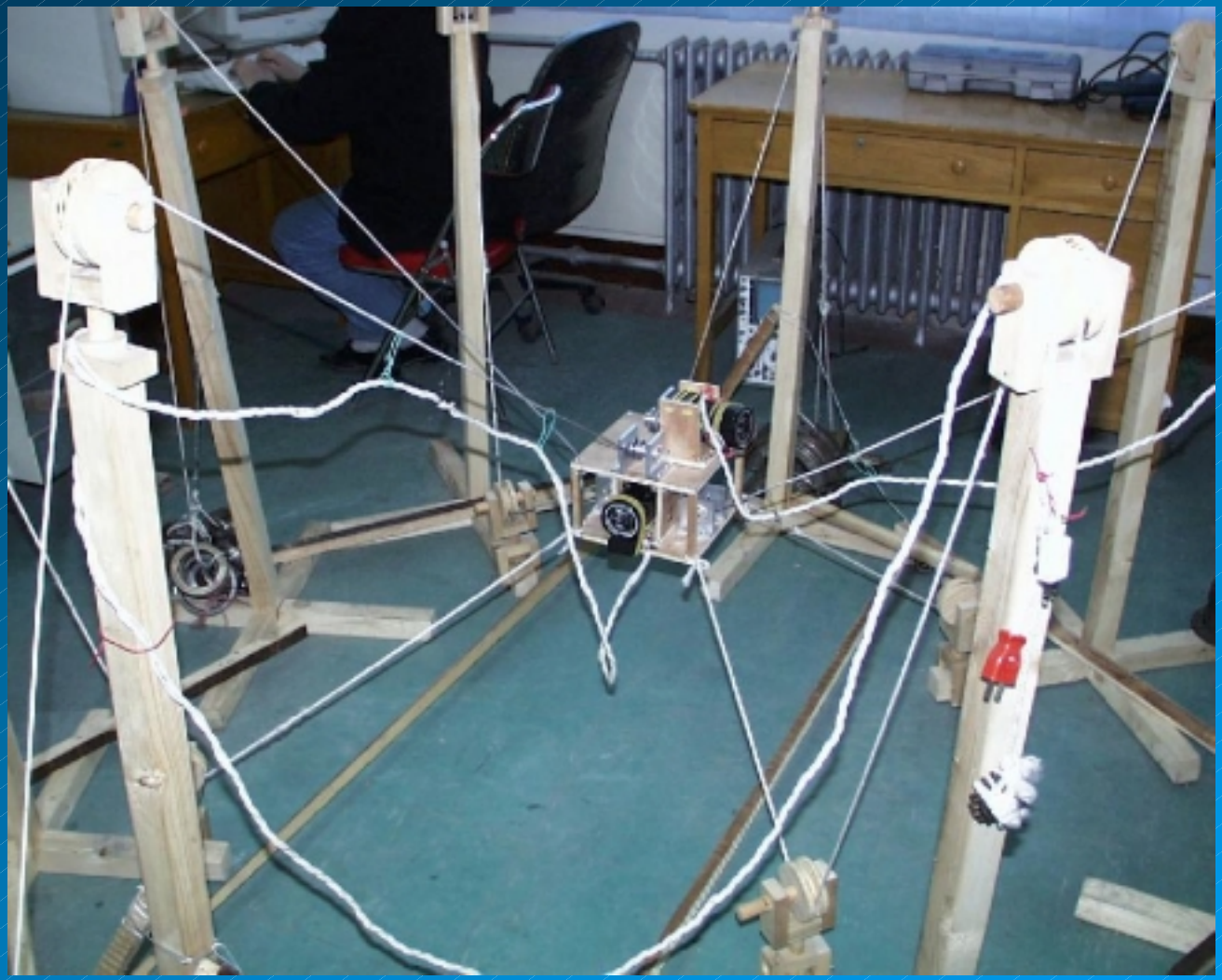
Trolley on two cross sets of cable (Tsinghua Uni.)

- Overall

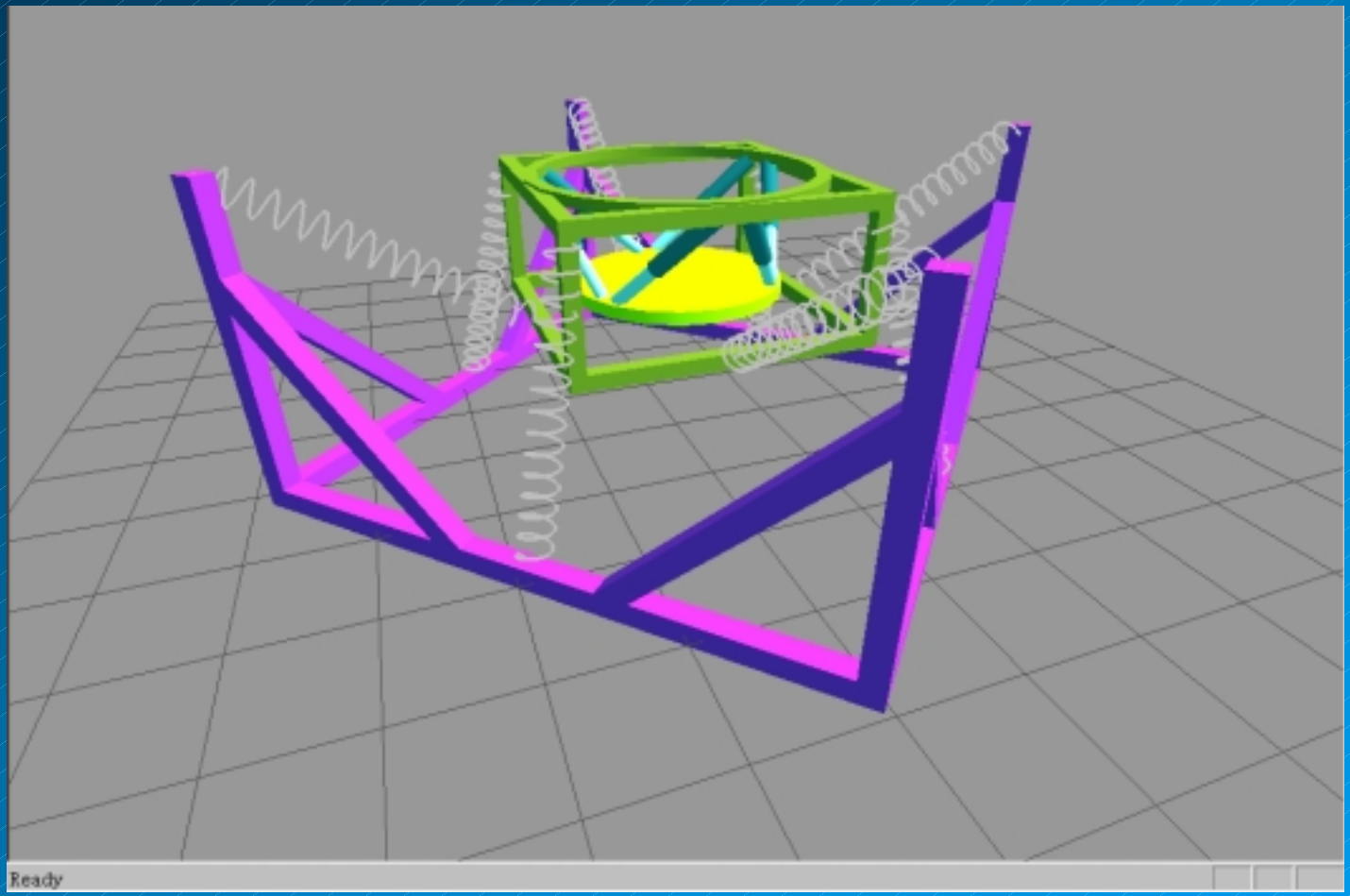




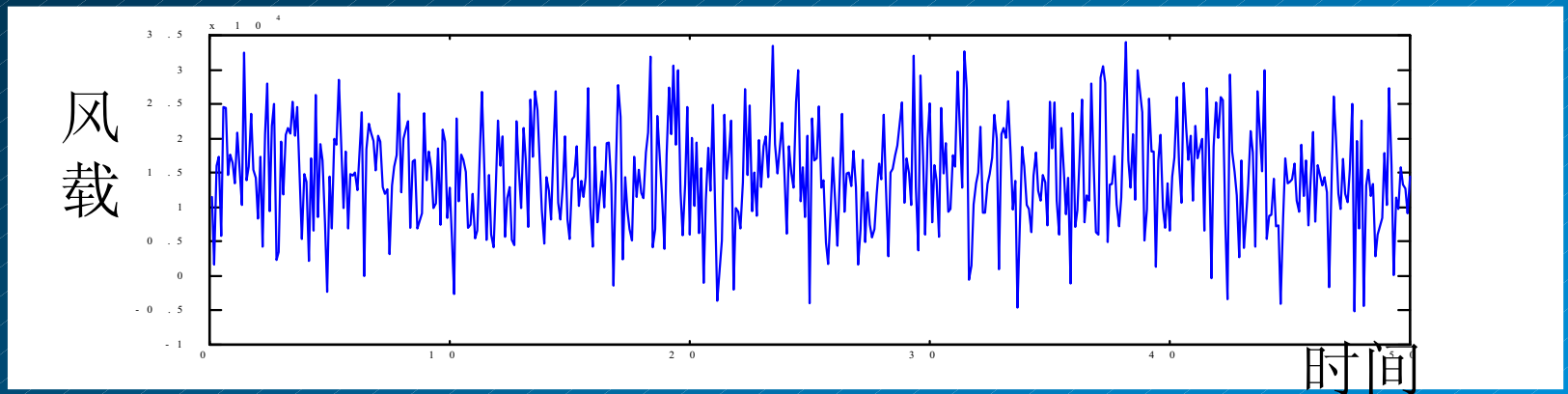
- **2 m scaled model for the cable and trolley sys.** (Tsinghua Uni.)

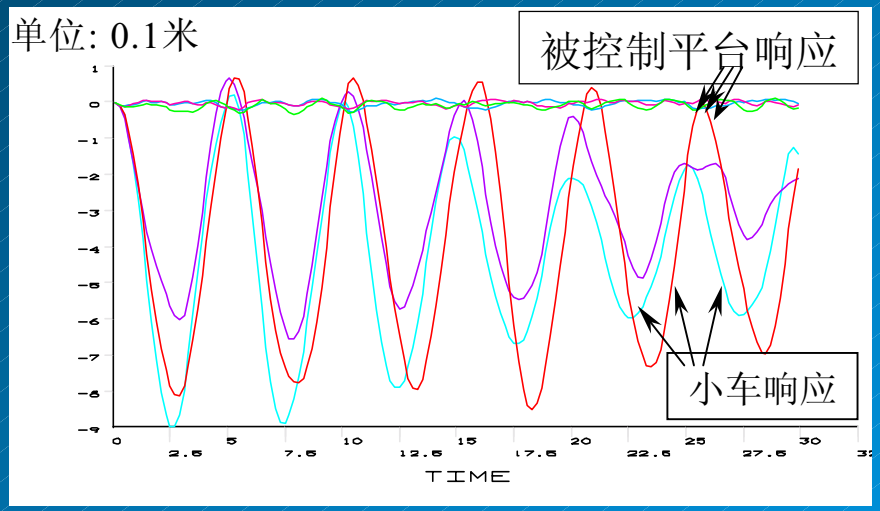


- **Experiment of secondary adjustable system**



- **Results from the simulation of Stewart stabilizer and its control**





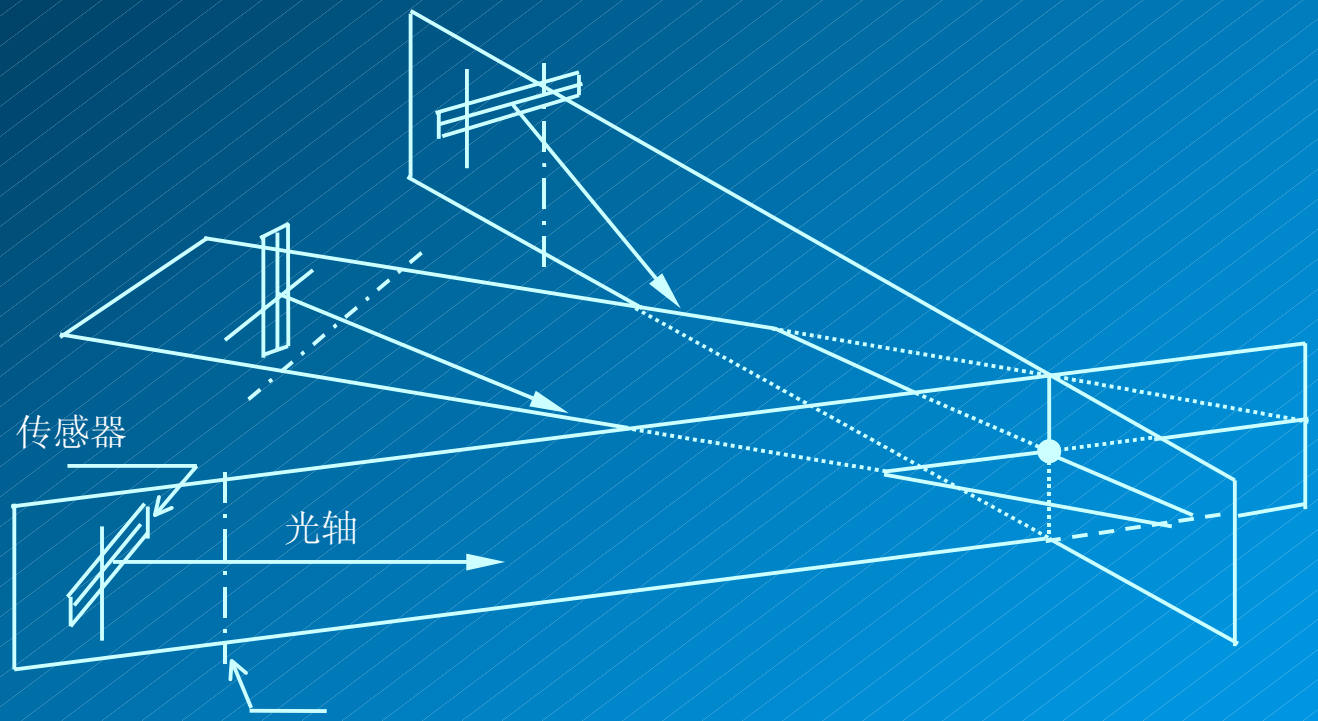
R.m.s displacements of 3 points on the trolley

0.54　　0.39　　0.53　(m)

R.m.s displacements of 3 points on the stabilized platform

0.039　　0.036　　0.033　(m)

- **Measuring the position of the trolley: cylinder lens and 1-D CCD photography; cross point of 3 plans passing the line image determines the coordinates of the object in space.**



one of the key projects in the CAS in 1999.3
prototype for SKA as well as the largest single dish

5 positions in FAST Lab., NAOC
Funds: 1.3 M USD for 2 yrs
MSP: 2001.4 (Concept feasibility)
Construction: Early in 2002 for 5 yrs (?)

Pre-Phase A	Phase A	Phase B/C	Phase D/E
Discuss Possibilities R&D	Plan and define specification	Project plan gets approved	Design and build	Operation & Science

We are here around

Research groups (Alliances)

Subjects	Institution
Main reflector	Astronomical Instrument Center, CAS
Main reflector	Tongji University
Stewart tablizer, manufacture and machenical control	Institute of System Science. CAS Beijing Institute of Technology
Feed supporting system	Tsinghua University
Feed supporting system	Xi Dian University
Static and dynamic analysis on of the cable structure	Institute of Mechanics,CAS
Strategy of the supporting system control	Inistitute of System Science, CAS
Measurements	Zhengzhou Survey & Drawing College
Electromagnetic characteristics of the main reflector	Tsinghua University
Study on feeds	Beijing Institute of Radio Measurement
Site surveying	Remote Sensing application Institut, CAS
Optimazation of the optical geometry	Xi Dian University

International collaboration (suggested)

1. Practical collaboration

- LAR in Canada
- Arecibo Observatory, USA
- Multibeam & Receiver: JB, ATNF
- Science Case assistant (from NFRA, JB, SETI, wherelse)
- EMC, Interfermeter with GMRT
- SETI technology, USA

2. FAST steering committee if approve

Senior engineers who has rich experience in building larger instrument

Movie Show !