

# Radio telescopes in China

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March 2018



ASTRONOMY AND SPACE SCIENCE  
[www.csiro.au](http://www.csiro.au)





# Single dish telescopes!

China has a large number of single dish radio telescopes

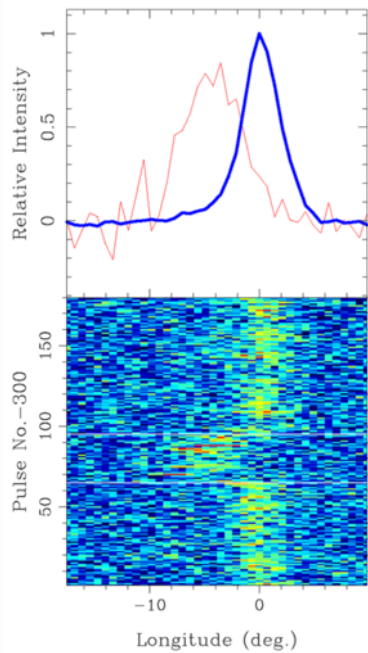
China has the largest single dish radio telescope (FAST – 500m diameter)

China will soon have the largest steerable single dish telescope (QTT)

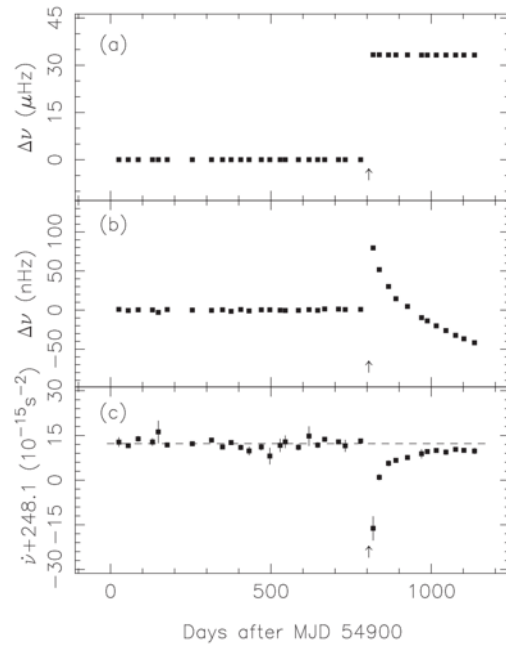
Telescope	Diameter	Frequency coverage
Nanshan	25m	1.4GHz-27GHz (surface to 43GHz)
Yunnan radio telescope	40m	
Tianma/Shanghai	65m	1.4GHz-43GHz
Jiamusi	66m	2GHz
FAST	500m	270MHz-1.6GHz (surface to ~5GHz)
Qitai (QTT)	110m	150MHz-115GHz
JinLin Han's group proposal	Multiple ~120m telescopes	~1.4GHz

# Enthusiasm for pulsar science

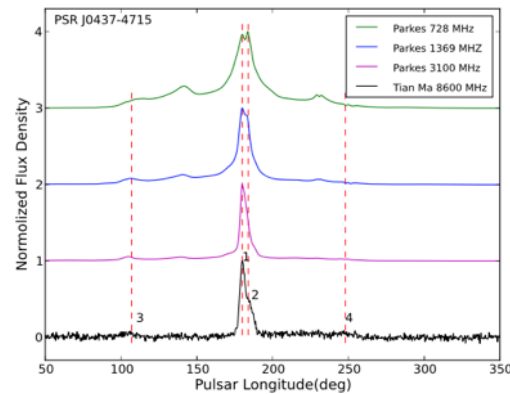
Han et al. (2016),  
**Jiamusi**  
observations of  
abnormal emission  
events in a pulsar



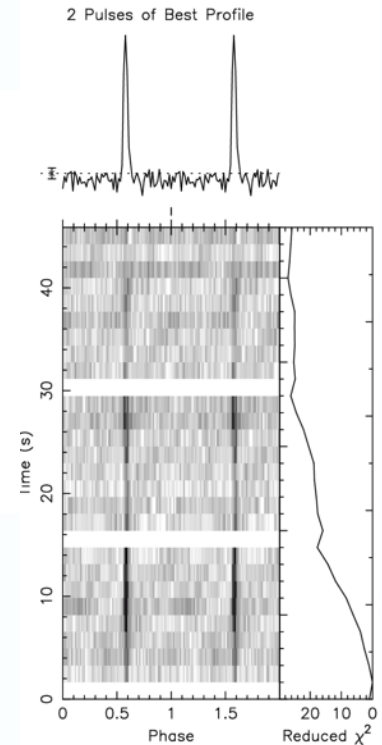
Yuan et al. (2017),  
**Nanshan**  
observations over  
14yr of a glitching  
pulsar



Zhao et al. (2017),  
**Shanghai**  
observations of 26  
pulsars



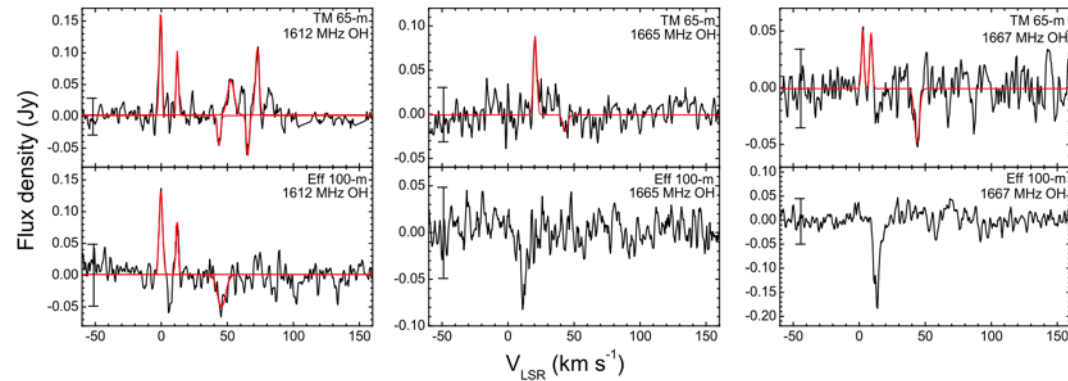
Unpublished  
pulsar  
discovered by  
**FAST**



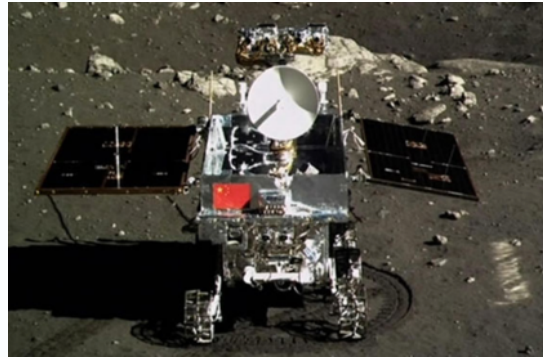


# Not just pulsars

Chen et al. (2017), OH-maser studies using **Shanghai** telescope



Huang et al. (2016), VLBI positioning of lunar lander



FRB search: Yunnan, Shanghai and Nanshan searching for FRBs. Yunnan observing 24/7 with FRB backend since Dec 2017. No detection yet.

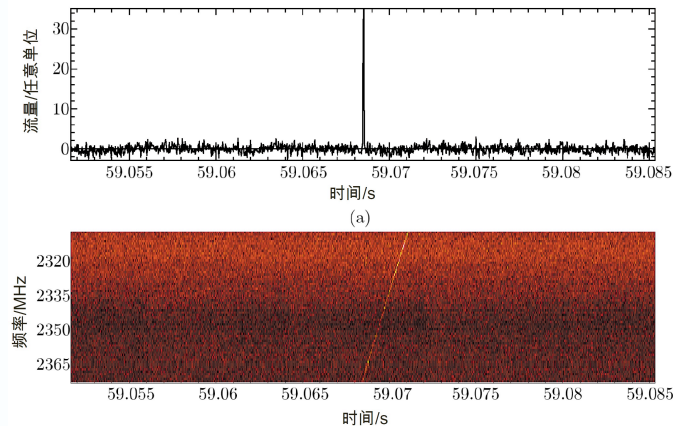


VLBI science: part of numerous networks including increasing baseline lengths in the European VLBI network

Also solar studies, Tianlai project to search for dark energy ....

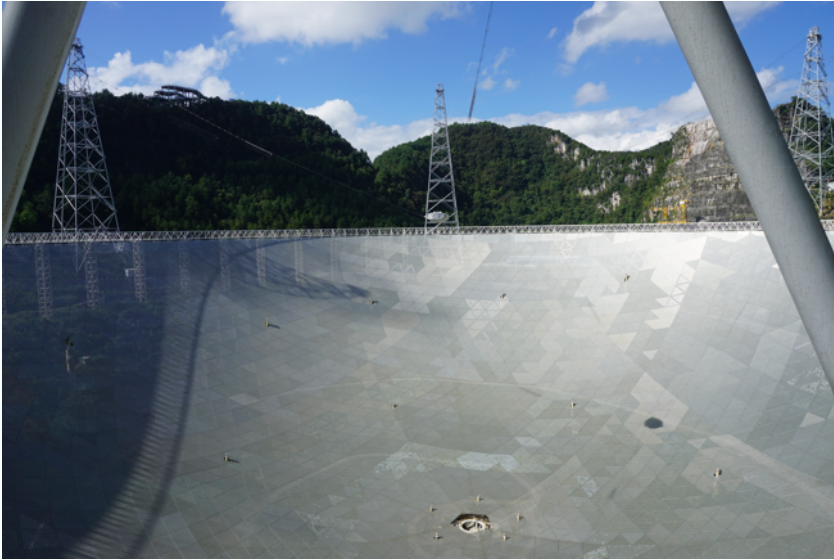
# Shanghai TianMa telescope (TMRT)

1. 65-m, fully steerable telescope
2. Active surface system installed
3. 1-50GHz in 8 bands
4. Detector suite for spectroscopy, pulsar observations, continuum, VLBI
5. “2014-2017: on-site system testing; science observation at L/S/C/X; active surface tested; Ku, X/Ka, K and Q band commissioning; project accomplished!”
6. DIBAS backend is an updated combination of GUPPI and Vegas providing 800MHz of bandwidth.



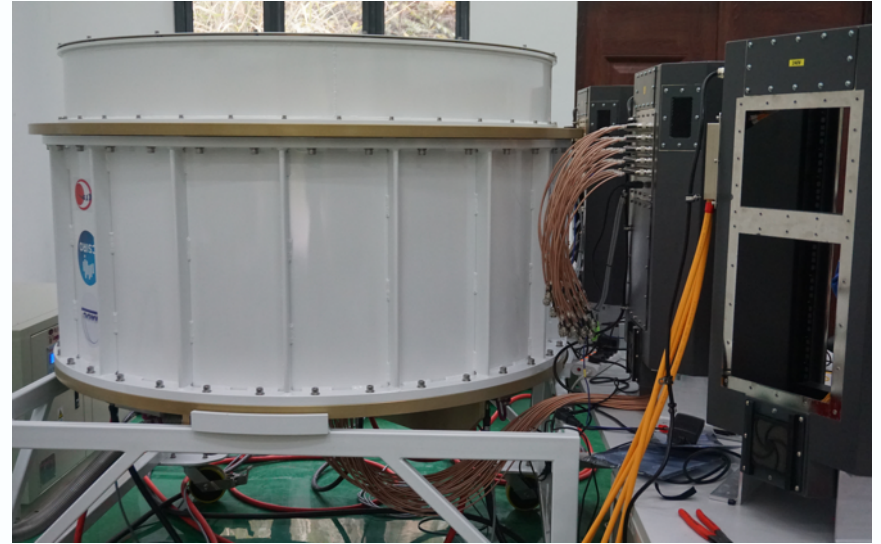
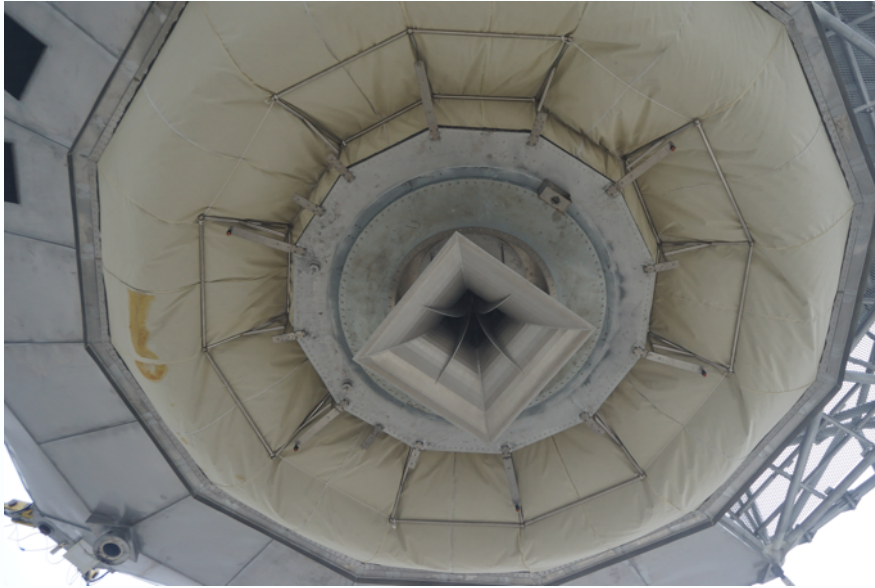


# FAST and the CRAFTS project



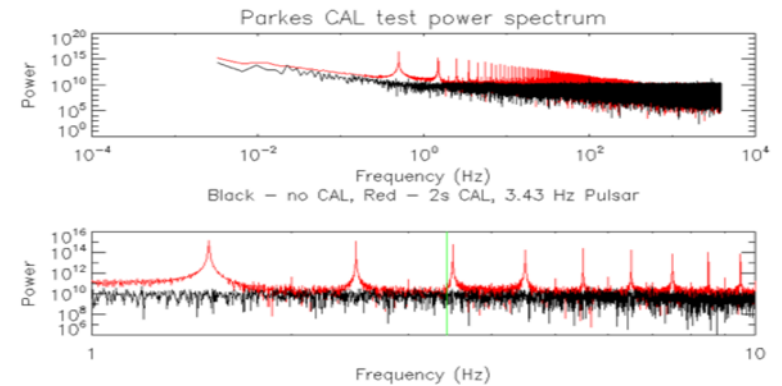


# FAST and the CRAFTS project



# FAST and the CRAFTS project

1. FAST currently using wide-band receiver to observe pulsars, HI and OH.
2. Now have ~40 pulsar candidates. ~10 confirmed by Parkes!
3. <http://crafts.bao.ac.cn> - CRAFTS (The Commensal Radio Astronomy FAST Survey) will start soon with the 19-beam receiver
4. Drift-scan, all-sky survey for pulsars and HI.



How to calibrate the data streams?

Data volume likely 144TB/day!  
- How to transfer, store and process?

- Prediction for discoveries:
  - More than 1000 pulsars (including first pulsars in M31)
  - 10s of FRBs
  - 100s of thousands of HI galaxies

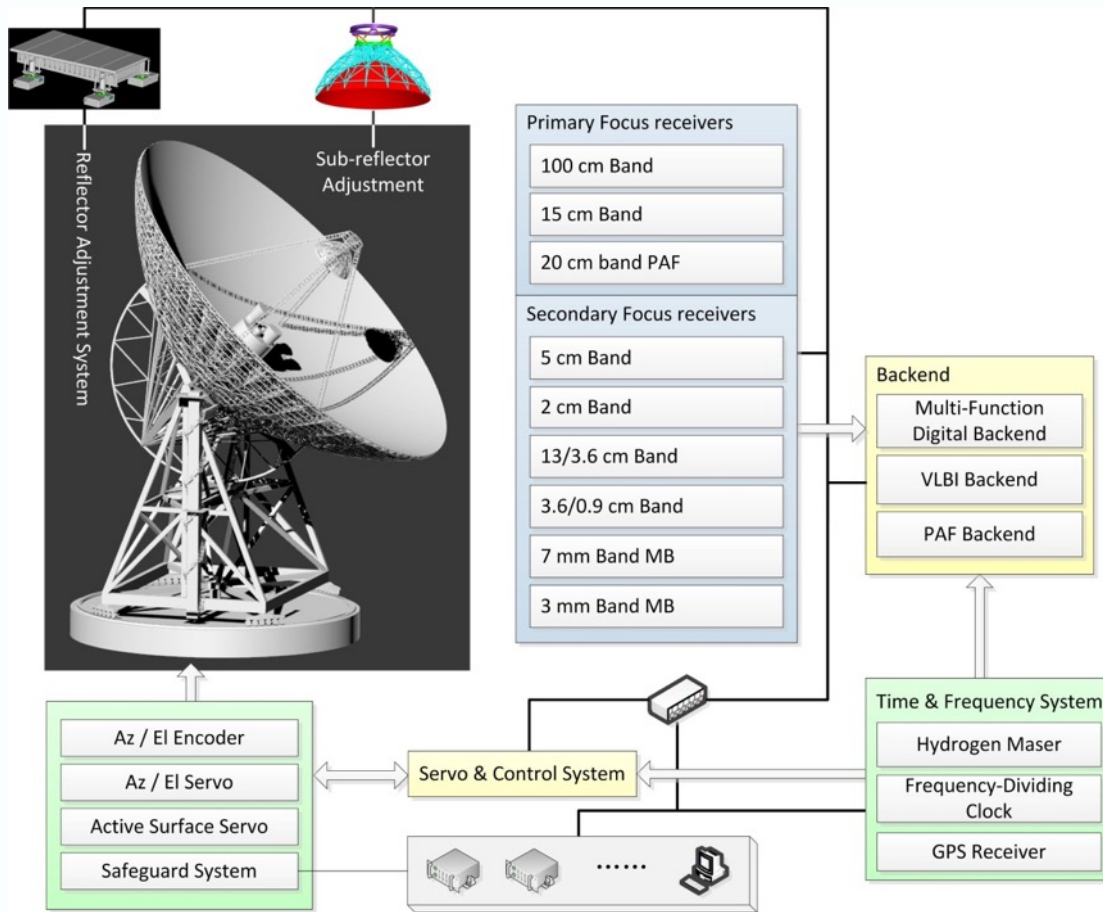
■ Half-day (morning) workshop in Marsfield on April 23<sup>rd</sup>. Please come!



# The guest house at FAST



## Steerable 110-m Aperture Radio Telescope (SmART) QiTai radio Telescope (QTT)



Aperture (m)	110
Freq Range (GHz)	0.15~115
Main Reflector r.m.s. (mm)	Active surface Early stage $\leq 0.3$ Long term $\leq 0.2$
Pointing	Early stage 2.5" Long term 1.5"
Shape	Gregorian Parabolic
Focus	Primary & Gregorian
Weight (t)	< 6000




# The Qitai (QTT) 110m telescope

110m fully-steerable telescope to operate from 150MHz to 115GHz.

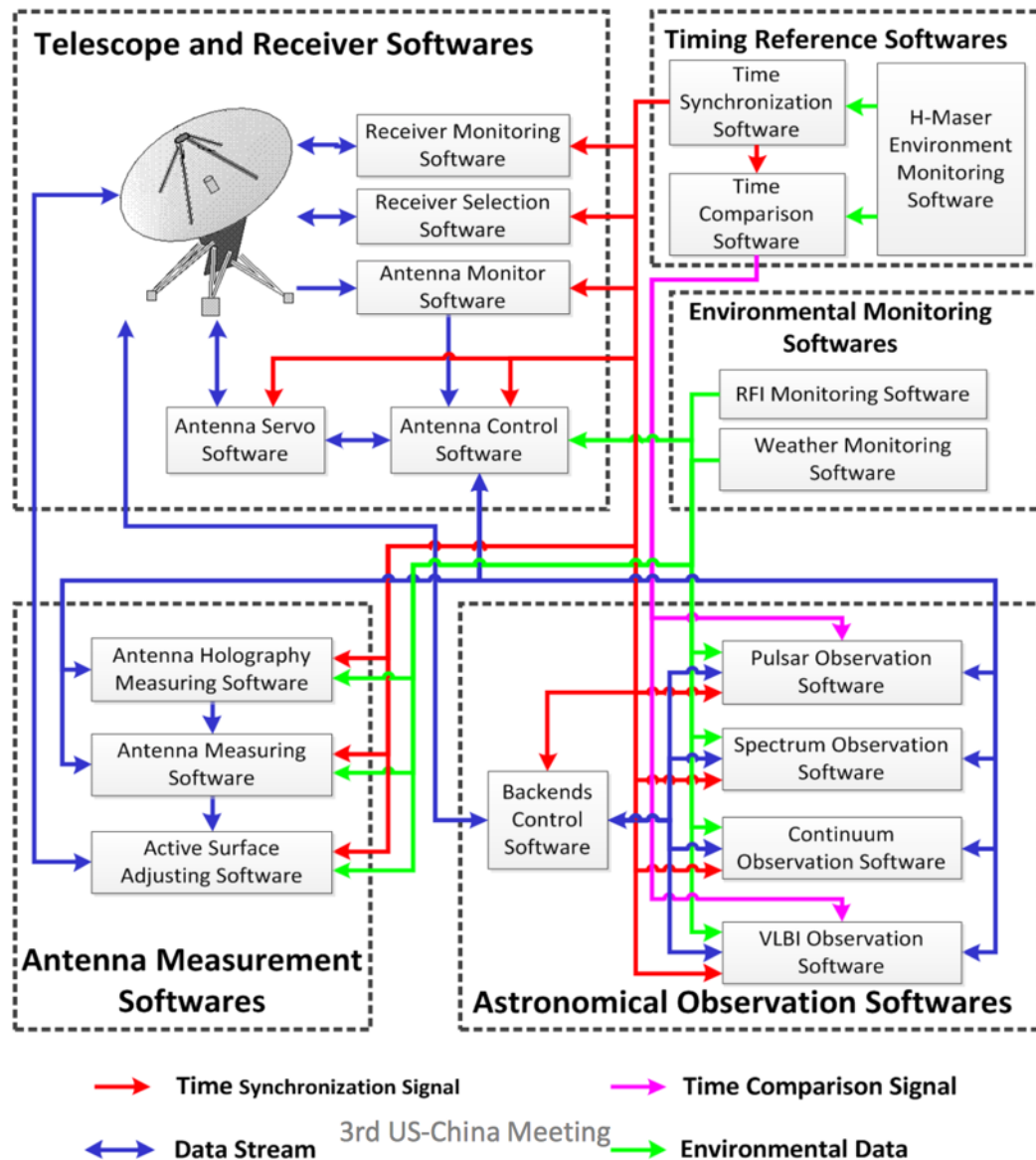


Land acquisition: approved  
Road flattening: done  
Power: 10kV available  
Water supply: build 2018  
Fibre connection: done for construction period



Type	Band (cm)	RF Freq (GHz)	Focus	Feed	Poln	Science Goals
Single Pixel	100	0.15 – 0.6	Primary	Kildal	Linear	Pulsar, RRT
	30	0.6 – 4	Primary	Horn 	Linear	Pulsar, RRT, HI, OH, Galaxies
	5	2 – 12	Greg.	Horn	Linear	Molecular spectrum, Galaxies; VLBI
	1	12 – 36	Greg.	Horn	Linear	Pulsar, H <sub>2</sub> O, NH <sub>3</sub> , VLBI
	0.6	36 – 50	Greg.	Horn	Linear	Molecular spectrum, High-z CO
	0.3	72 – 115	Greg.	Horn	Linear	Molecular spectrum, Galaxies
Dual-Band	13/3.6	2.2 – 2.5 8 – 9	Greg.	Horn	Circular	VLBI, space exploration, System measurement (3.6cm)
	3.6/0.9	8 – 9 30 – 34	Greg.	Horn	Circular	VLBI, space exploration
Multi-Pixel	15	1 – 2	Primary	PAF 	Linear	Pulsar, RRT, HI, OH, Galaxies
	0.6	36 – 50	Greg.	Horn  (multi Beam)	Linear	Molecular spectrum, Galaxies

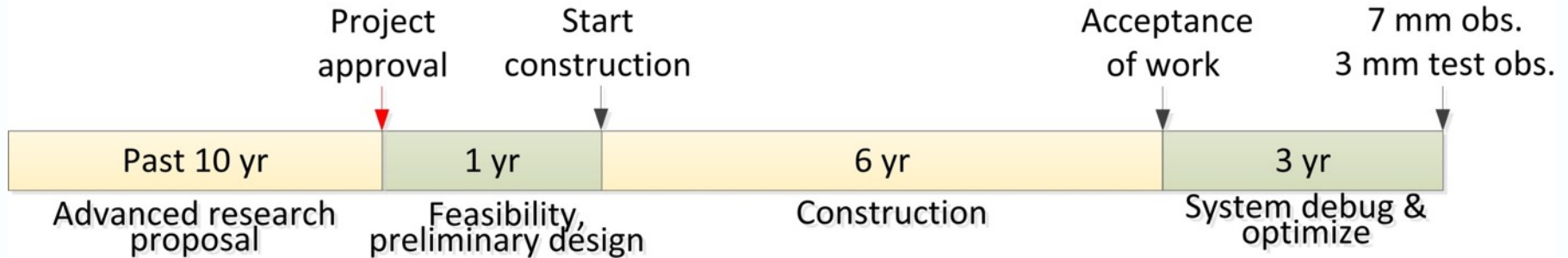




1. In-house designs for control, calibration, monitoring etc.
2. Any suggestions on what you'd do if you were designing an entire system from scratch? – clever calibration procedures?



# Construction period



## Two stages (6+3)

- 6 yr: Main part finish, 2 cm scientific observation
- 3 yr: Adjust & optimize system, 7 mm scientific observation
- Long term adjust, 3 mm scientific observation

# China and Australia

Chris Christiansen (Usyd, CSIRO) visited China for the first time in 1963. Helped design and build the Miyun radio telescope.

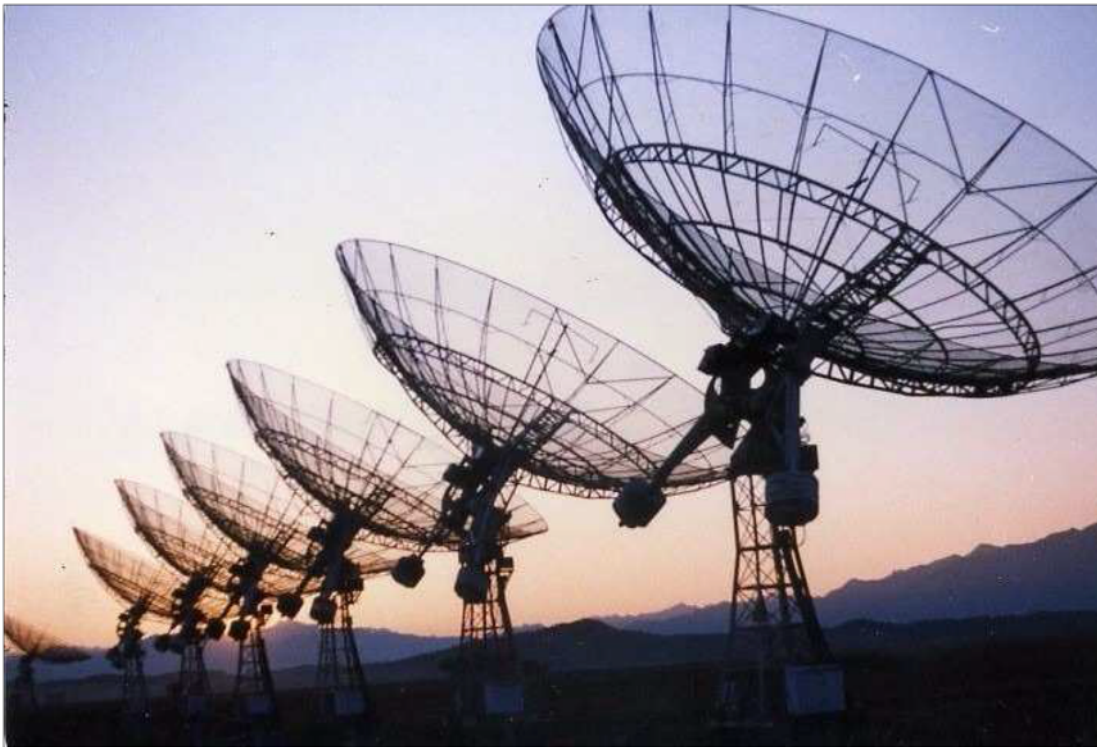


Figure 4: The Miyun 28-antenna Meter Wave Aperture Synthesis Array.

Very strong collaborative projects in radio astronomy between China and Australia continuing ...

# PULSE@Parkes – Parkes observations in China!



Very keen to develop links between local schools near FAST and schools near telescopes in Australia



# Purchase of Parkes observing time

1. FAST team have purchased 100s of hours of Parkes time each semester for the next few years
2. The Parkes observations will be used to:
  - Confirm their pulsar candidates
  - Monitor their new discoveries
  - Help calibrate the FAST observing system
3. CSIRO has lots of further opportunities relating to the Chinese telescopes
  - New receivers (PAFs/ UWLs)
  - Data archiving and processing
  - Science, engineering and outreach collaborations
  - (Telescope scheduling, monitoring & control ...)
4. Similar time-zones => easy to work with the Chinese teams, simultaneous telescope observations ....

# Thank you

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Science**

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