Introduction of SmART / QTT Project

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Outline

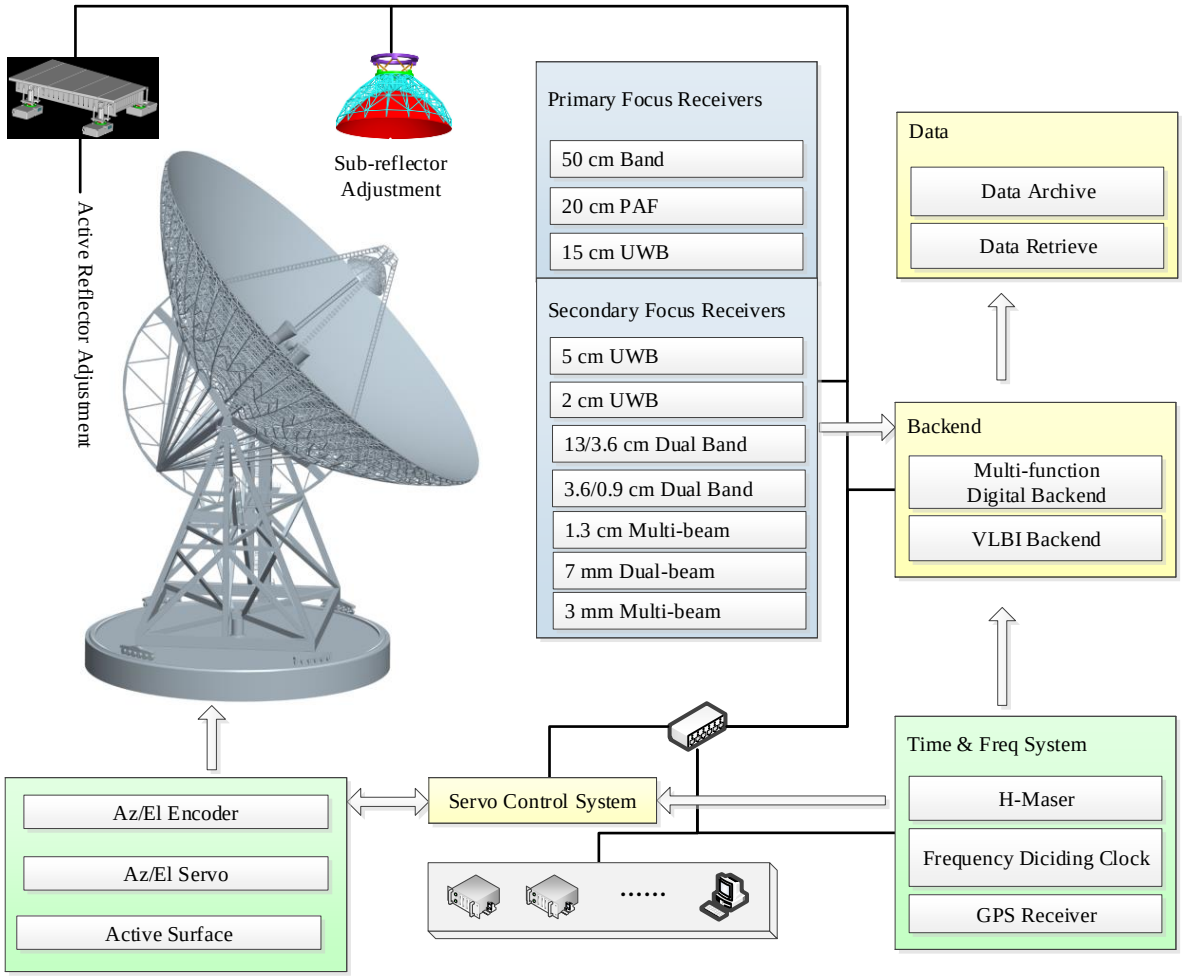
1. Background
2. Present Status
3. Construction Plan

QTT in General

Steerable 110-m Aperture Radio Telescope (SmART)

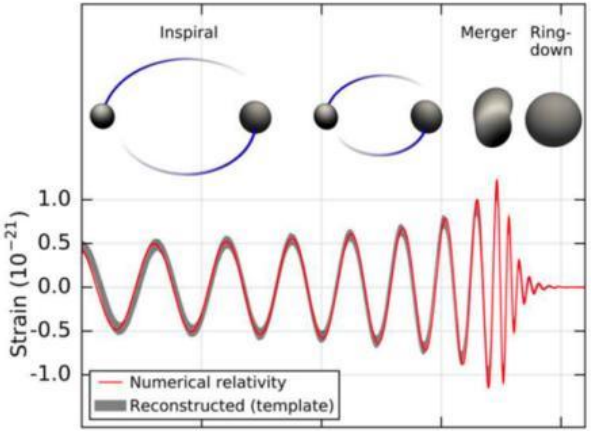
QiTai radio Telescope (QTT)

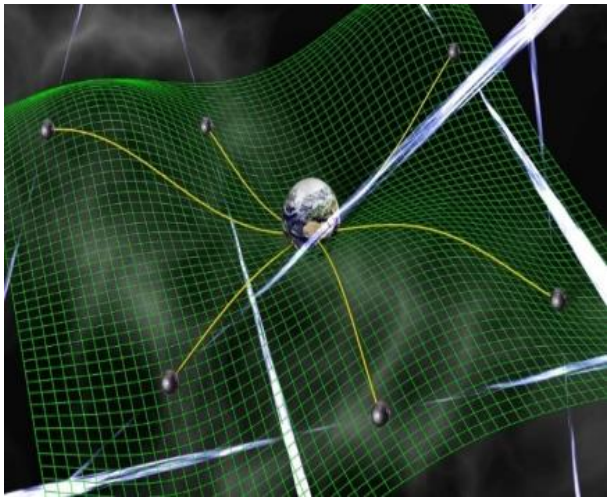
Active Surface， Freq Range 150 MHz – 115 GHz



Science: Gravitational Wave Detection

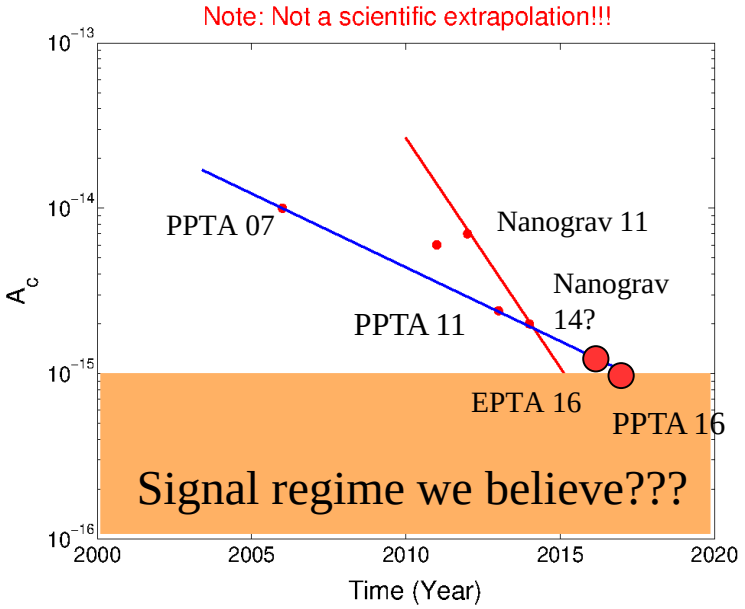
- Interferometer
  - LIGO first detect: GW150914
- Pulsar Timing Array (PTA)
  - PPTA, EPTA, NanoGrav, CPTA

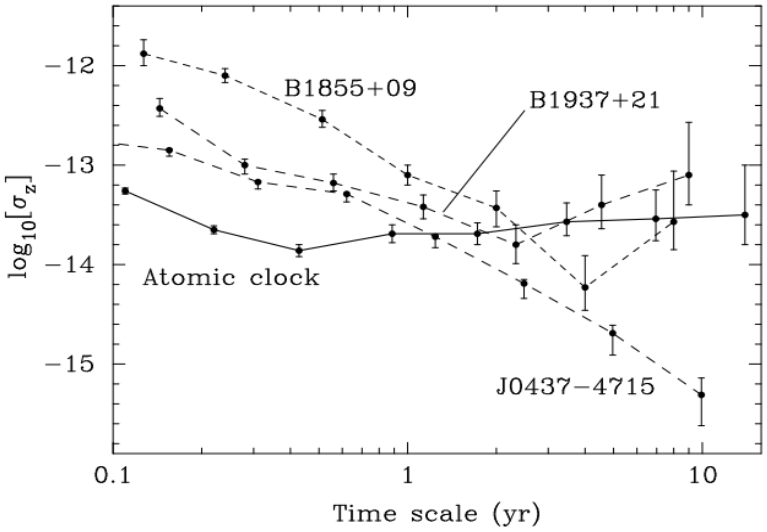


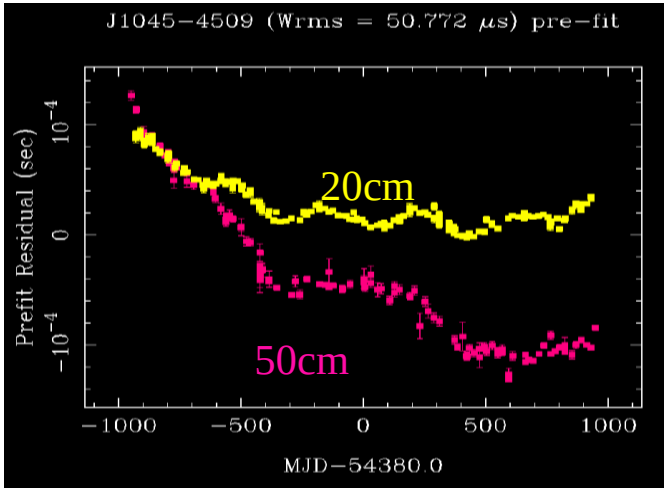


QTT & CPTA

- Theoretical prediction for PTA
- QTT increase sensitivity by 20%
- CPTA
- Bottleneck of PTA（Hobbs, 2016）
  - Interstellar propagation
  - Jitter
- Pulsar clock

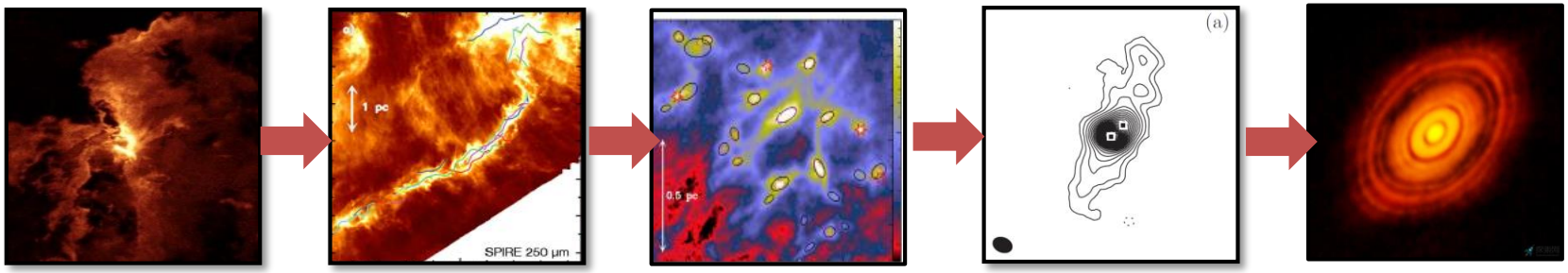






PSR J1045－4509, reduced 50% residual after DM correction

Science: Star formation & origin of organic molecules

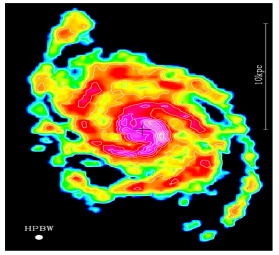


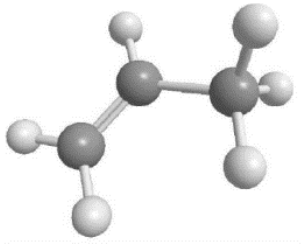
Giant molecular cloud → Filament → Dense clump → Dense core → Proto star

QTT: high sensitivity, medium resolution

Interferometer: high resolut i on

- The large scale molecular line survey
- Structure, dynamics and magnetic field of the Milk Way and nearby galaxies
- Formation of large organic molecules and origin of life

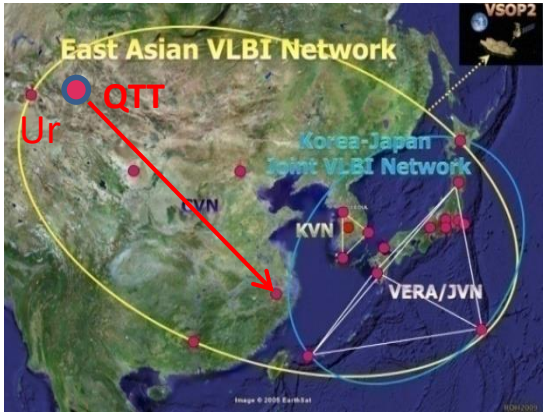


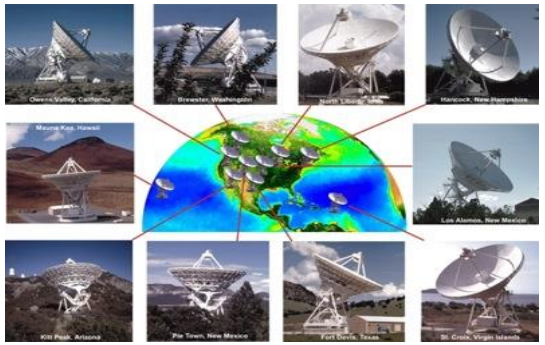


7 mm & 3 mm: ¾ of year PWV < 10 mm @site

Science: VLBI Astrophysics & Astrometry

- Improve UV coverage
- Sensitivity
  - QTT-TM65: 10 times higher than 25m-25m
  - CVN ～ 1.8, EVN ～ 30-70%
- Improve mm-VLBI
  - Fine structure of AGNs & special galaxies: central engine, jet
- Deep astrometry
  - Increase number of compact radio sources, improve frame connection
  - Parallax: structure of Milky Way, position, distance & proper motion of outer spiral arms
  - Spacecraft orbit measurement





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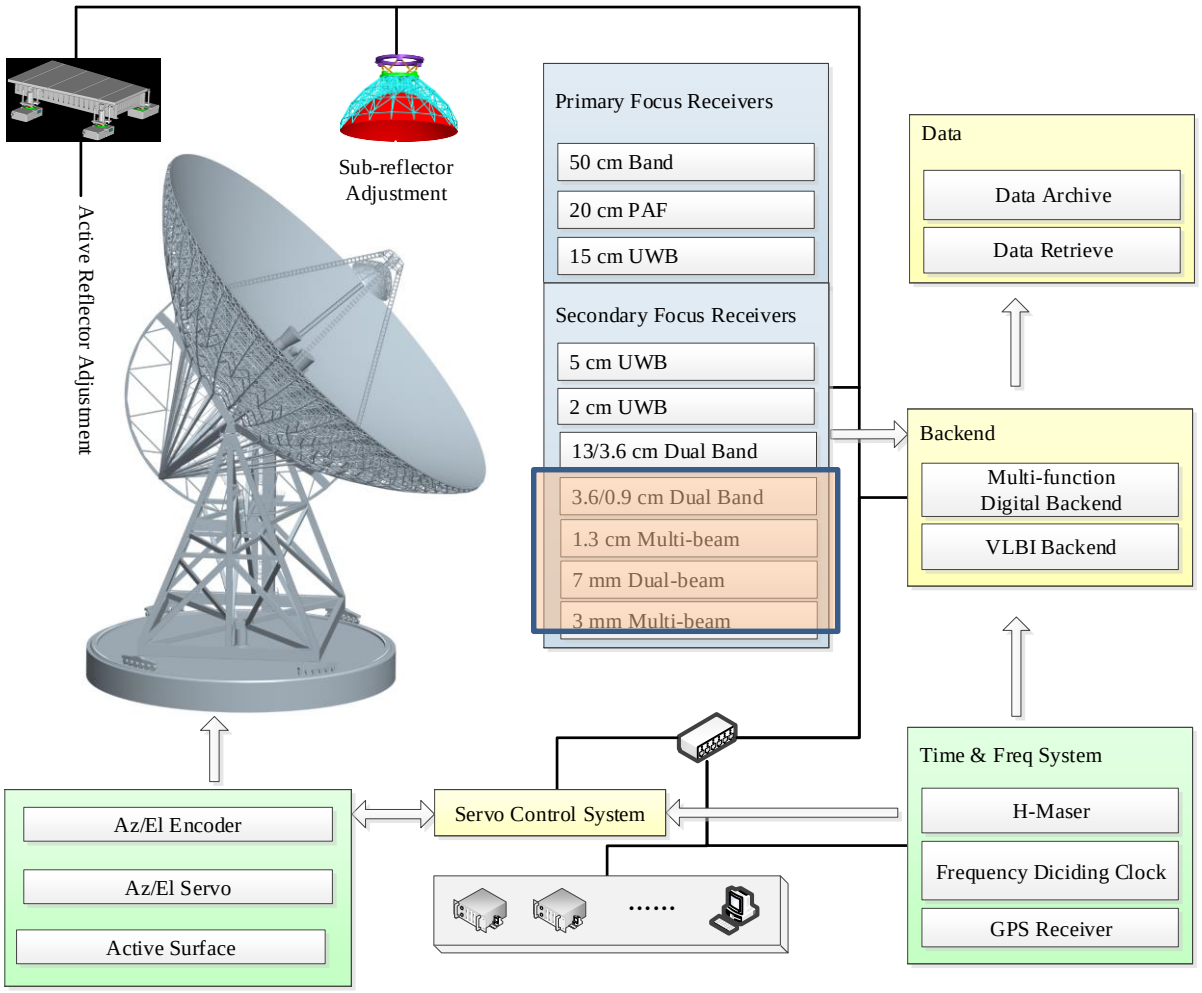
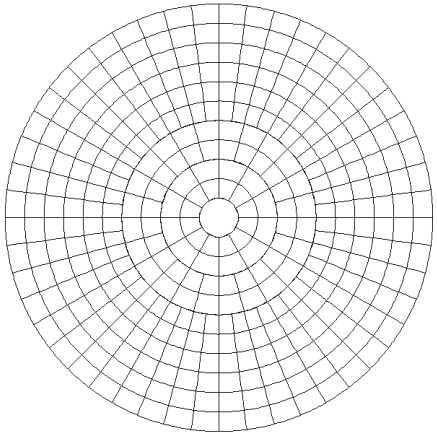
Funding

- Funding: 700M, by XJ & CAS 13·5 plan
- Final approval: NDRC in processing

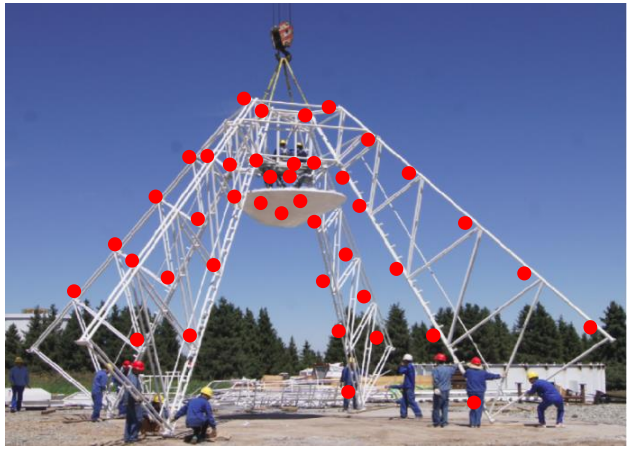


Structure

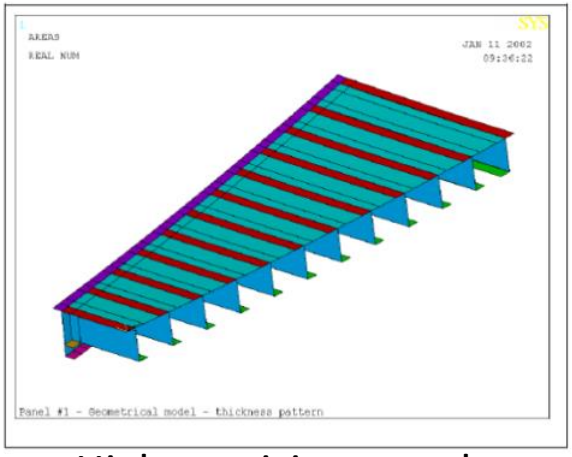
Truss & panel (Qian Xu et al. 2016)



Surface segment

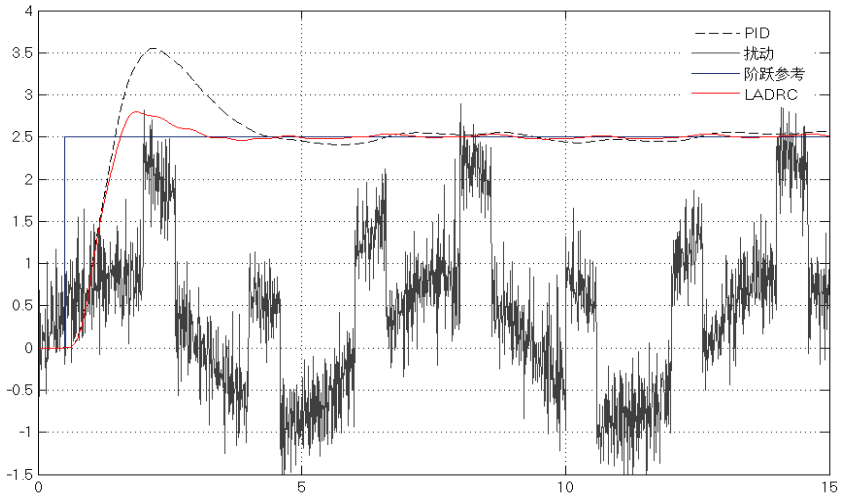


Sub-reflector deformation measurement

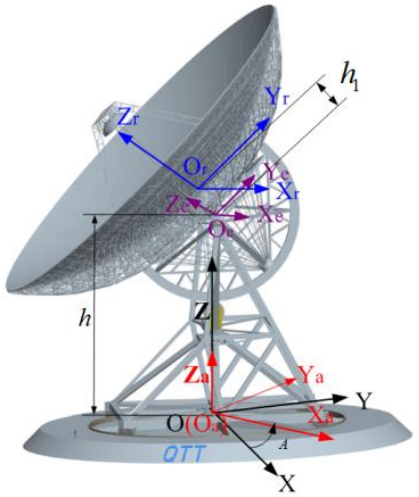


High precision panel

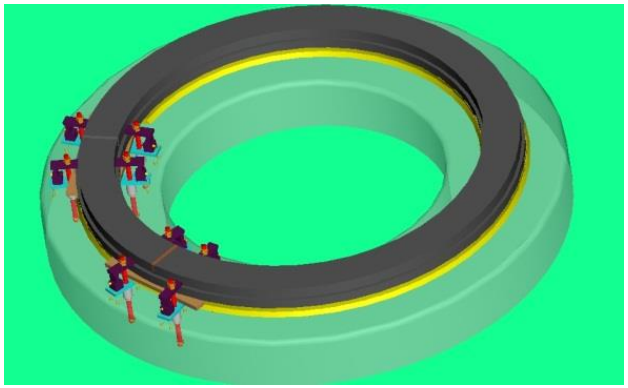
Pointing

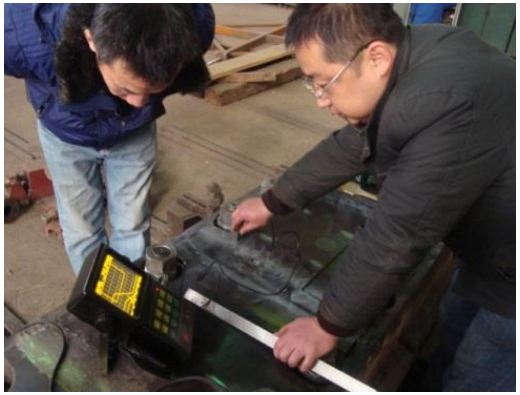


LADRC（Li N. et al., 2017）



Pointing error analysis

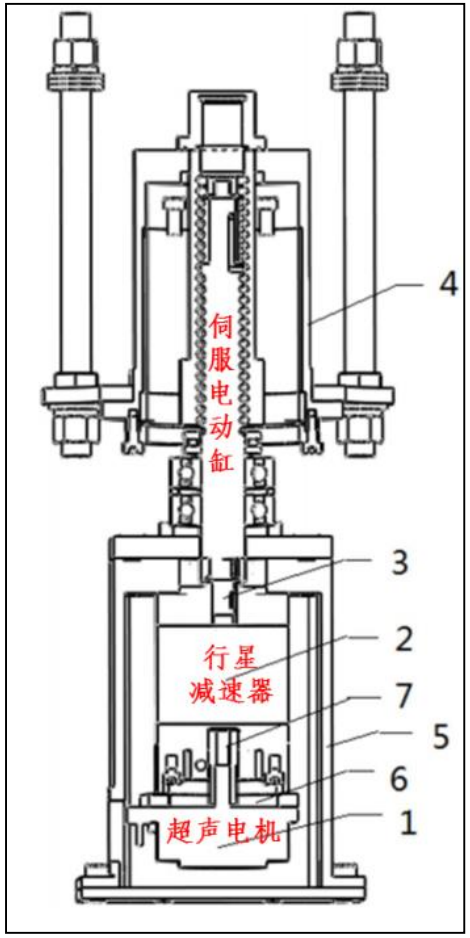




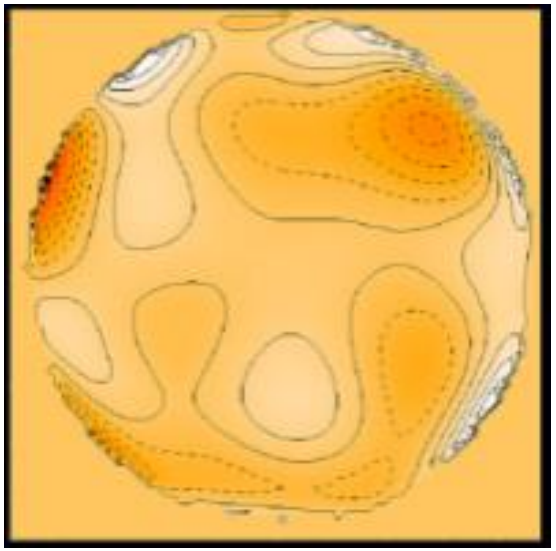
Azimuth track and welding
Track flatness vs pointing

Flexible ruler test
（Lei B., et al., 2016）

Active surface



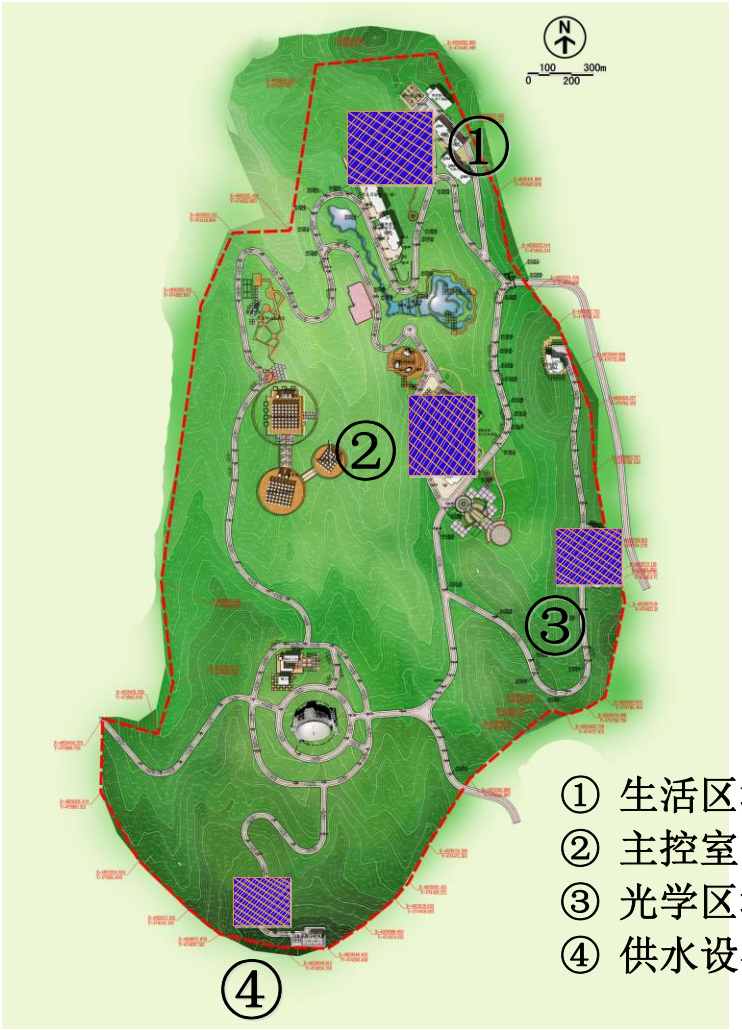
New actuator & anti-fatigue test



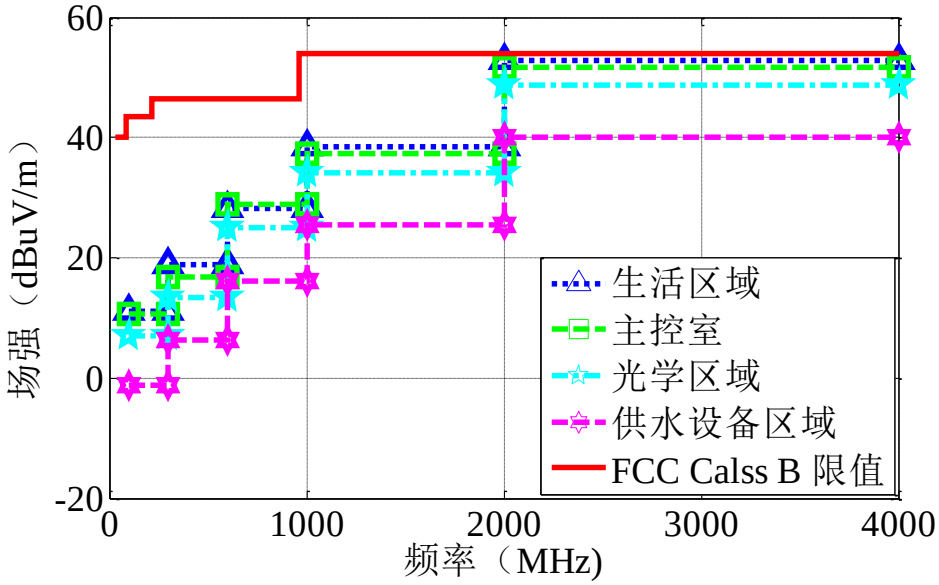
Measurement of primary surface

Working environment:
－40℃ ~ +60℃
Accuracy： 15 μm
Max. Stroke: 50 mm

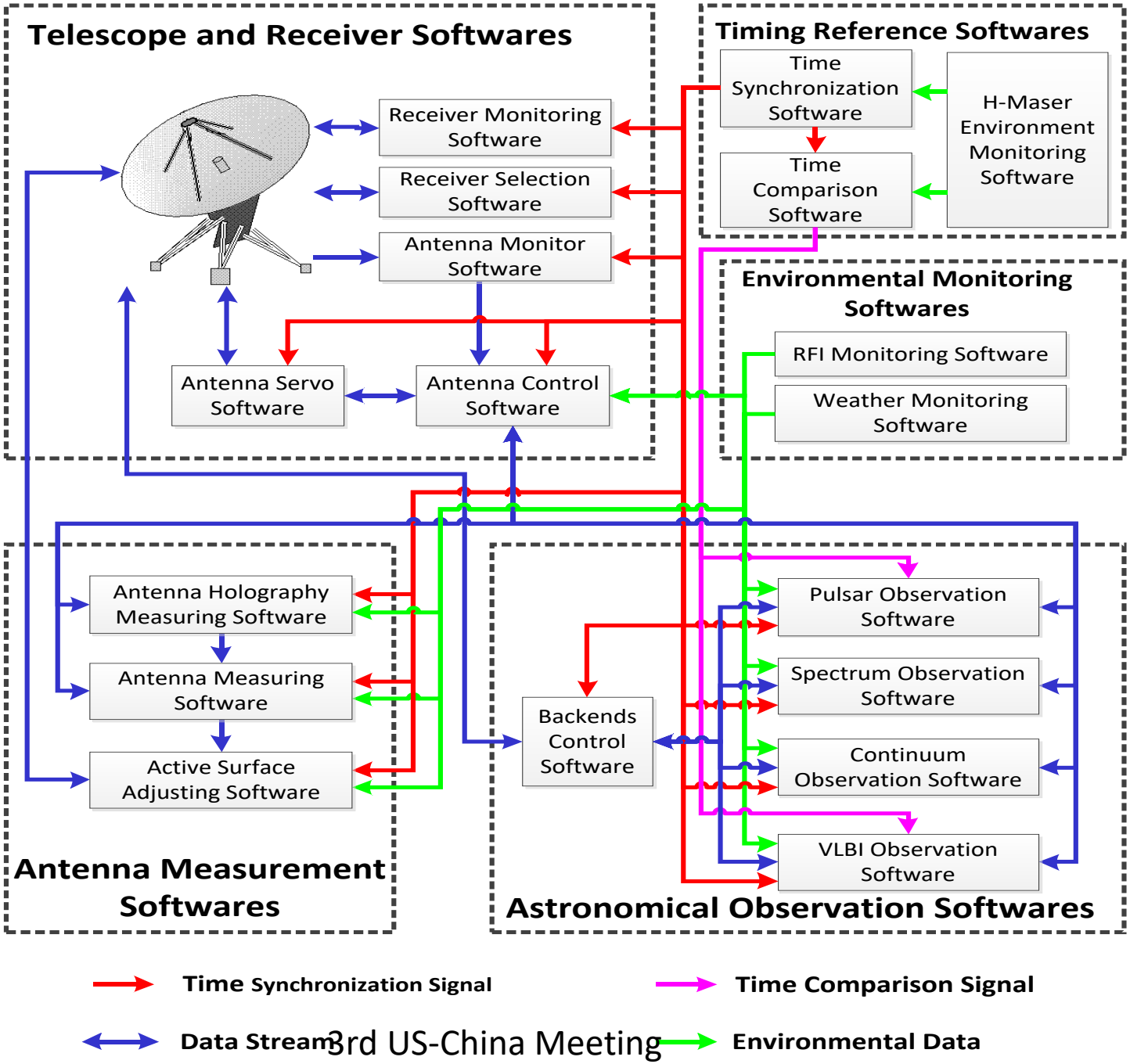
EMC and radio quite zone



① 生活区域
② 主控室
③ 光学区域
④ 供水设备区域



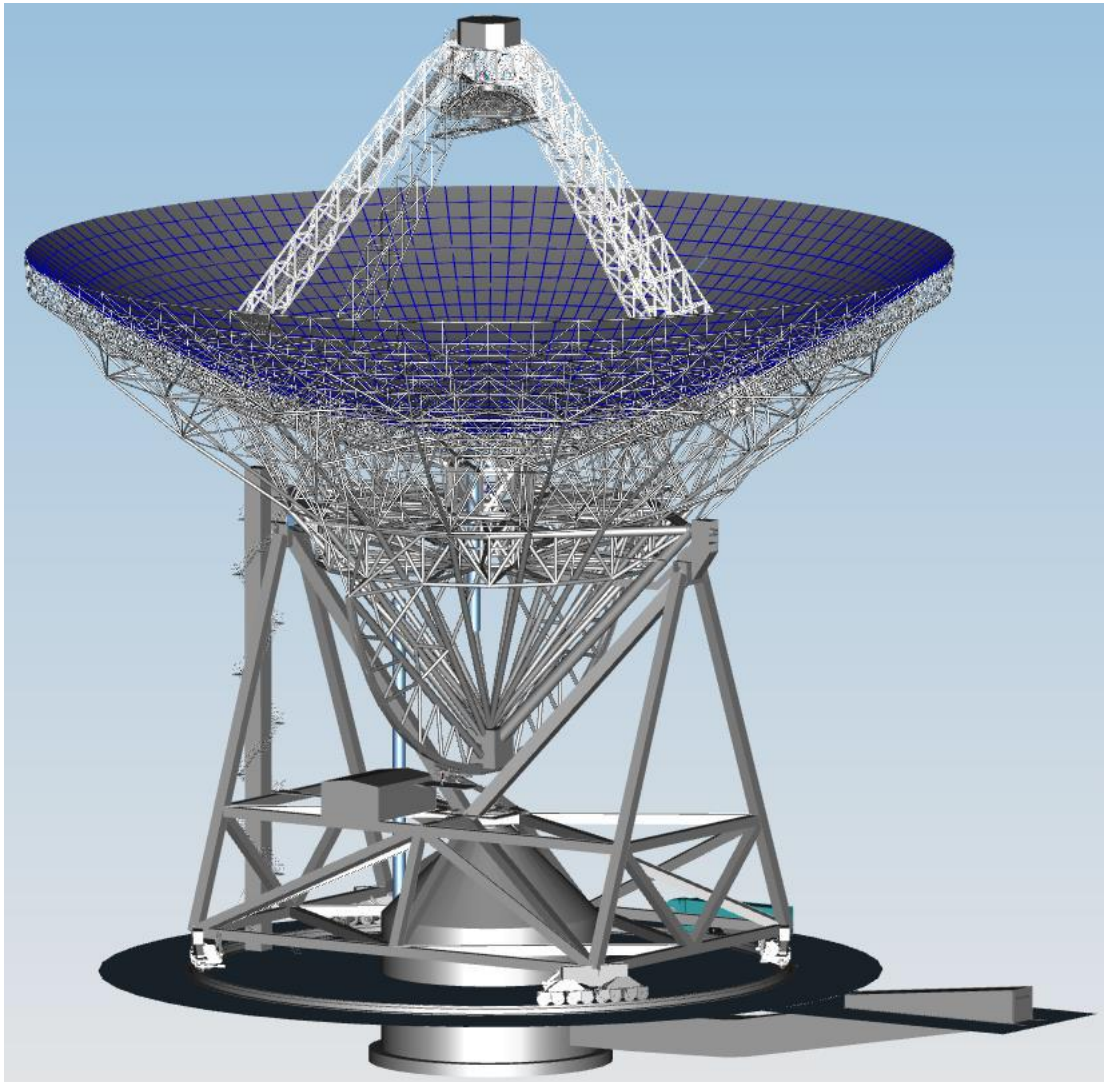
Software

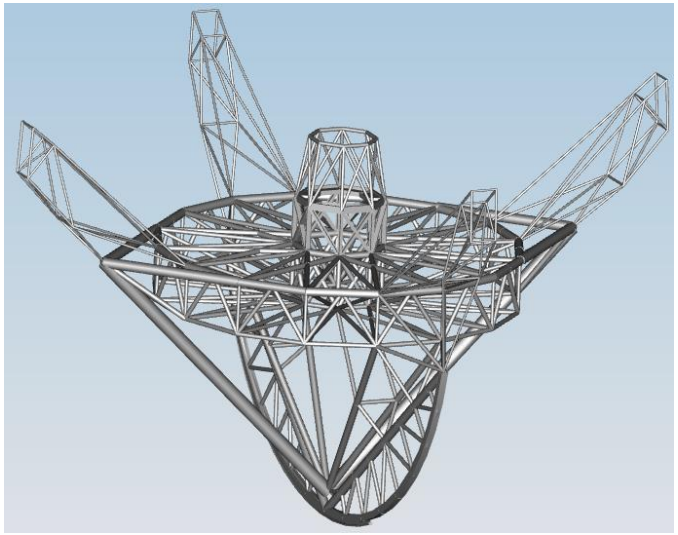

Telescope and Receiver Softwares
Receiver Monitoring Software
Receiver Selection Software
Antenna Monitor Software
Antenna Servo Software
Antenna Control Software
Timing Reference Softwares
Time Synchronization Software
H-Maser Environment Monitoring Software
Time Comparison Software
Environmental Monitoring Softwares
RFI Monitoring Software
Weather Monitoring Software
Antenna Holography Measuring Software
Antenna Measuring Software
Active Surface Adjusting Software
Antenna Measurement Softwares
Backends Control Software
Pulsar Observation Software
Spectrum Observation Software
Continuum Observation Software
VLBI Observation Software
Astronomical Observation Softwares
Time Synchronization Signal
Time Comparison Signal
Data Stream
Environmental Data

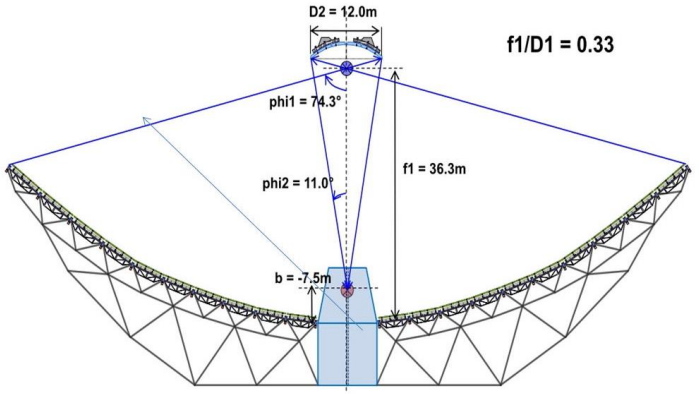
Participants and Roles

Overseas	Domestic
• NRAO: science, receiver, backend • ATNF: science, receiver, backend • Caltech: backend • MPIFR: science • Swinburne University: science, data • SRT Team: science, measurement technology • MTM: preliminary design	**Science:** • NAOC, SHAO, PMO, PKU, NJU, USTC **Technique:** • Xidian, SJTU, HIT, NIAOT • CETC 14, 16, 39, 54, Taiji • Institute of Microelectronic of CAS • Aerospace China 771, Pudaditai, • BIAD, XJ Architect design

Preliminary Design







Assessment of design

- 2012 Nov. 29 – Dec. 1, QTT International Advisory Workshop
- 2017 Jun 26 – 27, QTT Preliminary Design International Advisory Workshop

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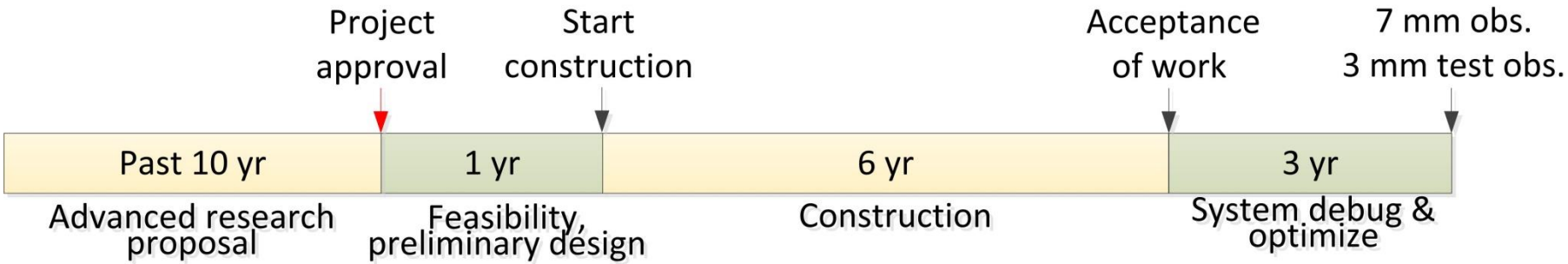
Construction Period



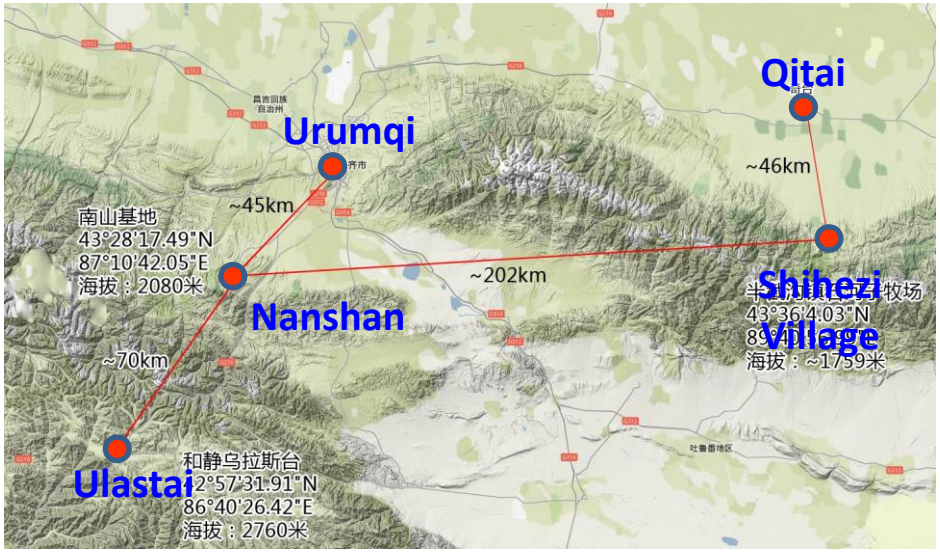
Two stages（6+3）

- 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

Site

- ✓ **Location: QiTai County, XJ**
- ✓ **On Tianshan Mountain**
- ✓ **Altitude 1730—2250m**

- Wind ≤10 m/s ~ 97.5%
- Precipetable water vapor (PWV)
  - Spring: 6.5 mm
  - Summer: 13.6 mm
  - Autumn: 7.5 mm
  - Winter: 2.7 mm
- Temperature range
  - —26.6 ° — +29.3 °



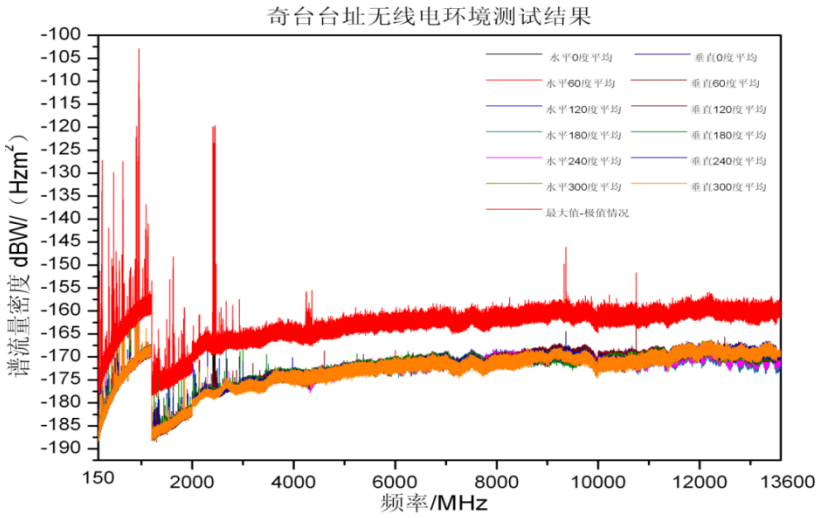
Site location & landscape

Infrastructure

- Land acquisition: approved
- Road to site: done
- Power: 10kV available
- Water supply: build 2018
- Fiber connection available

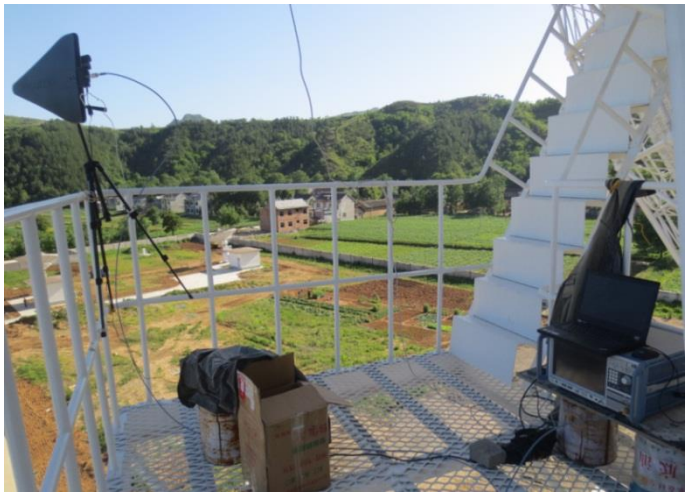
Site Monitoring

- Meteorology monitoring
  - Weather stations
  - Gradient wind tower
  - DIMM
- RFI monitoring



DIMM foundation

Wind tower

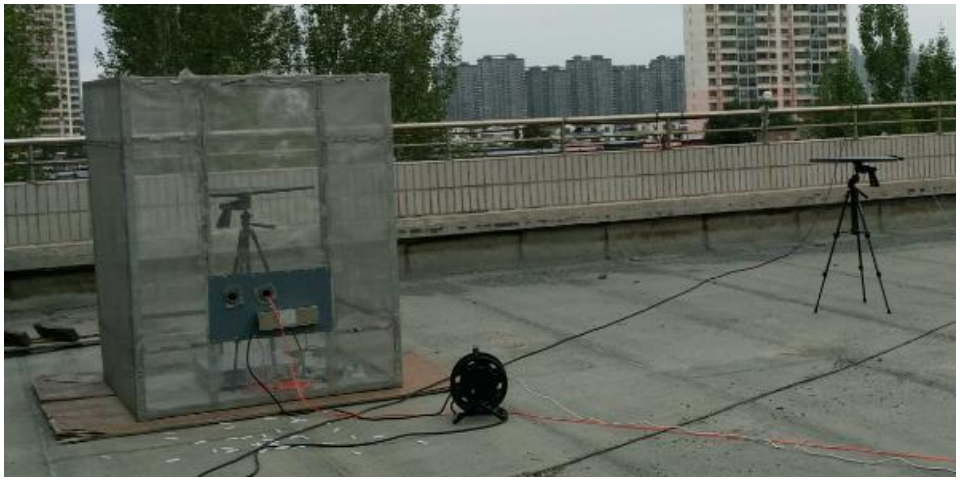


Real-time RFI monitoring

Buildings

Supported by Local

- Dormitory, dining room etc. under construction
- Shielding of buildings

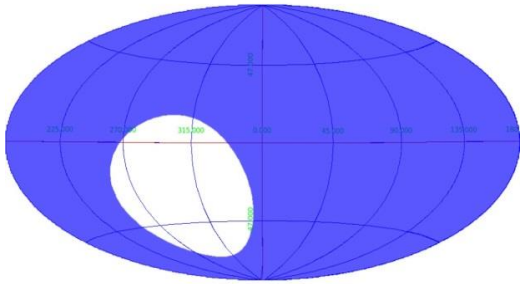


Summary

- QTT frequency 150 MHz - 115 GHz
- Science: GW, pulsar, spectrum, VLBI, space
- Gregorian standard parabolic design
- Active surface, fast measurement are pursued
- Ultra-wide band receiver, multibeam receiver
- EMC design for equipment and shield of buildings
- Preliminary design
- Radio quite zone & protection
- Support from local and CAS
- 1st construction phase: low freq. upto 30 GHz
- Infrastructure prepared for early stage

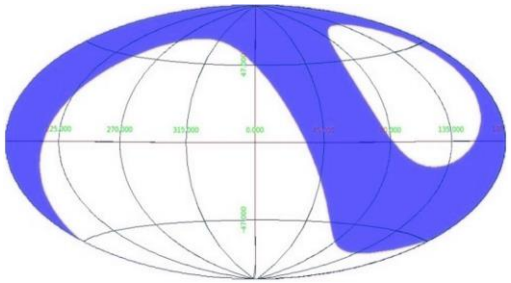
QTT & FAST

● QTT: better sky coverage



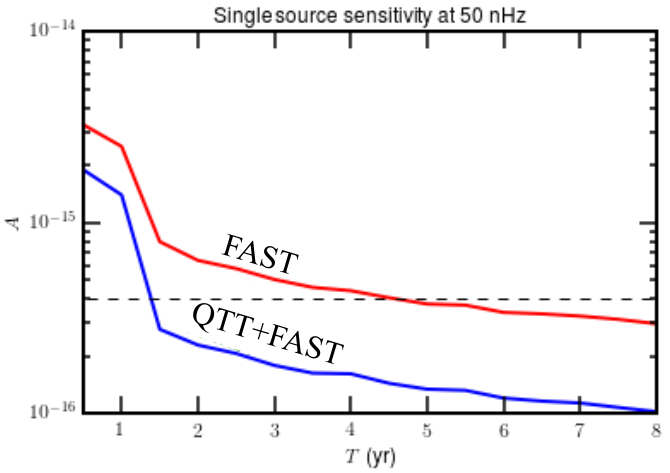
QTT Sky

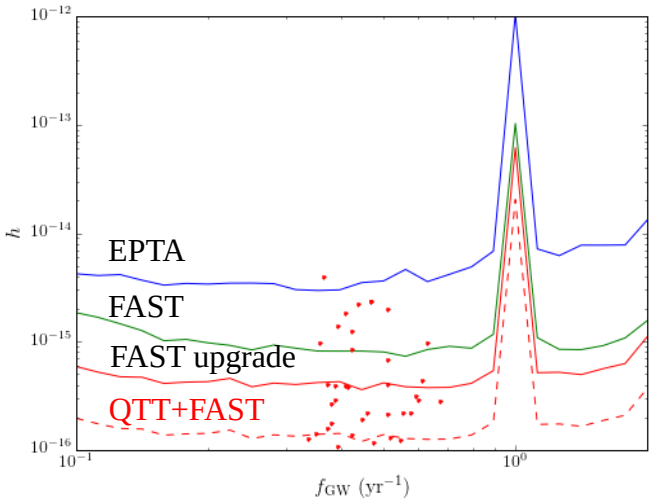
Reach 12° south of Galactic center



FAST Sky

● FAST+QTT: CPTA





Simulated by K. J. Lee