

Di Li · 李蒞

CRAFTS: PI (首席)

FAST: Deputy Chief Engineer (副总工)

Timeline

- **Project Approval:**
December, 2007
- **Construction Commence:** March, 2011 (¥1.15Billion)
- **Openning ceremony:** Sep. 25, 2016
- **Commissioning:** 2016 - ~2018
 - 19 beam L-band array: to be delivered in Nov., 2017
 - Backend upgrade (for commensal survey)
under development, to be expected in early 2018
- **Operation starts:** ~2019

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“**中国天眼**”

Measurement

(1) Anchor Grids

Anchor points: $5\text{cm}+0.5''$

Baseline: 1mm

Time accuracy: 10ms

(2) Feed Cabin

Supporting tower: 2cm

Cabin Initial Position: 2mm

Cabin dynamic measurement: 3mm

Cabin dynamic control: 10mm

Frequency: 5Hz

(3) Primary Panels

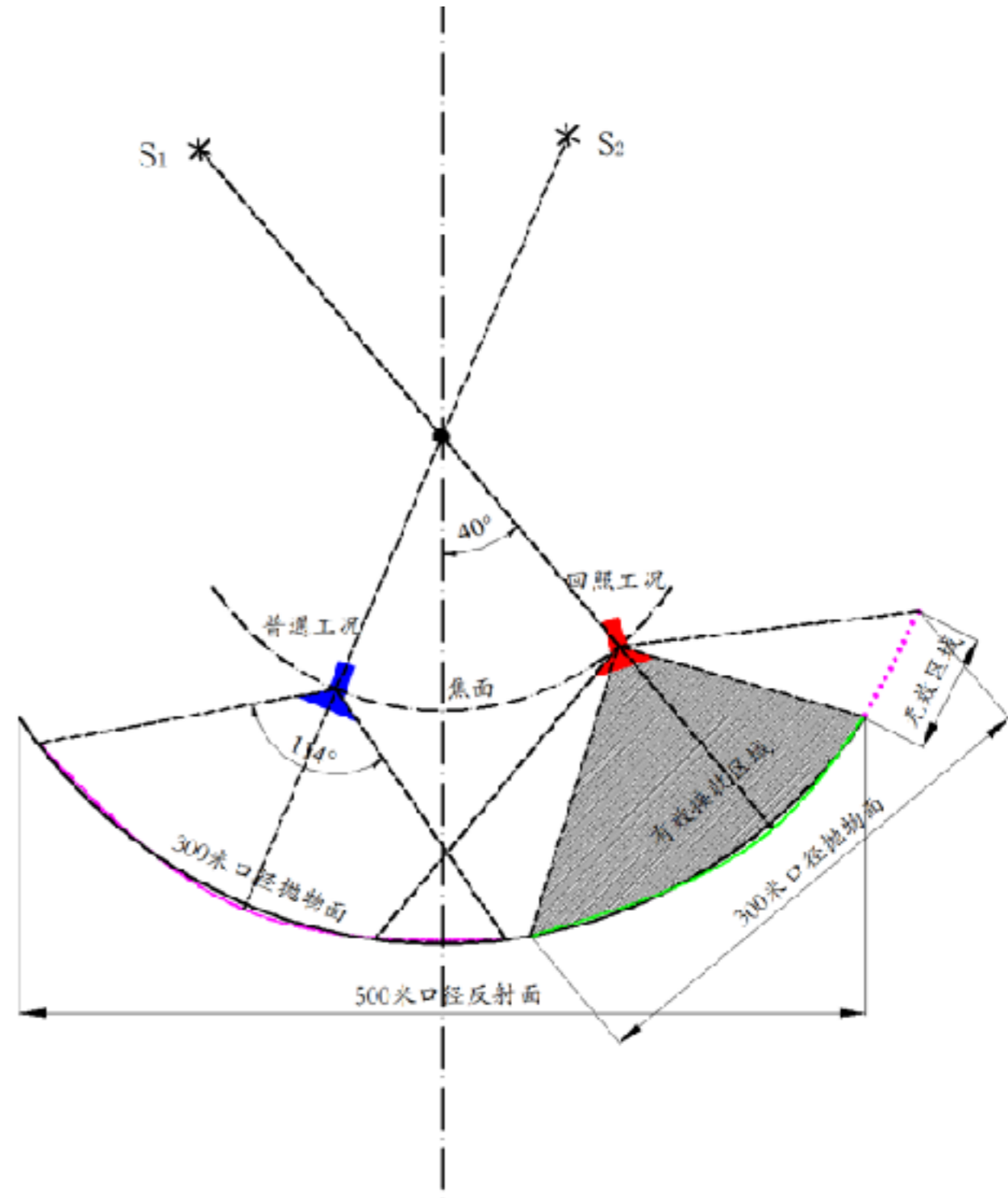
Actuator anchor point: 2cm

Cable mesh system anchor point: 2cm

Panel connecting nodes: 1.5mm

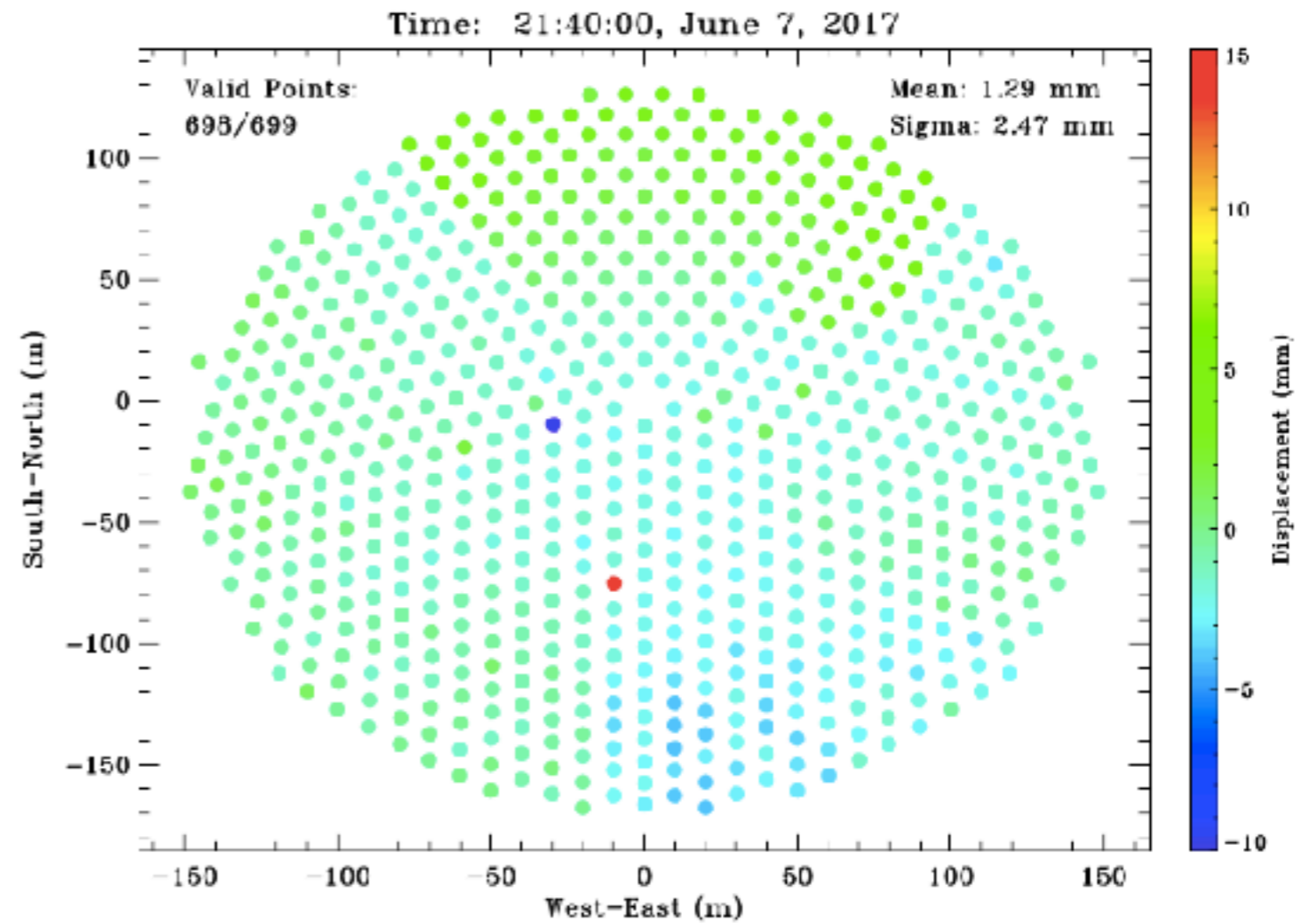
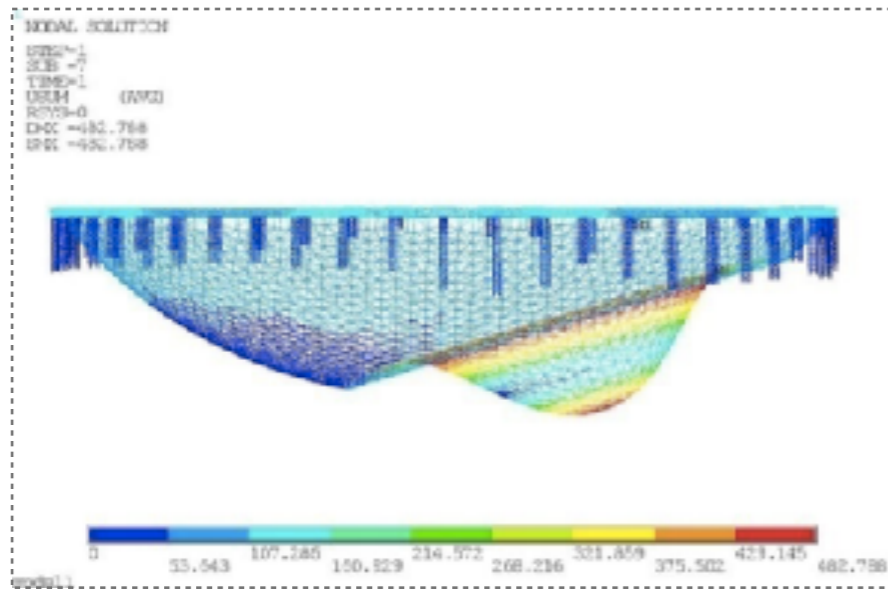
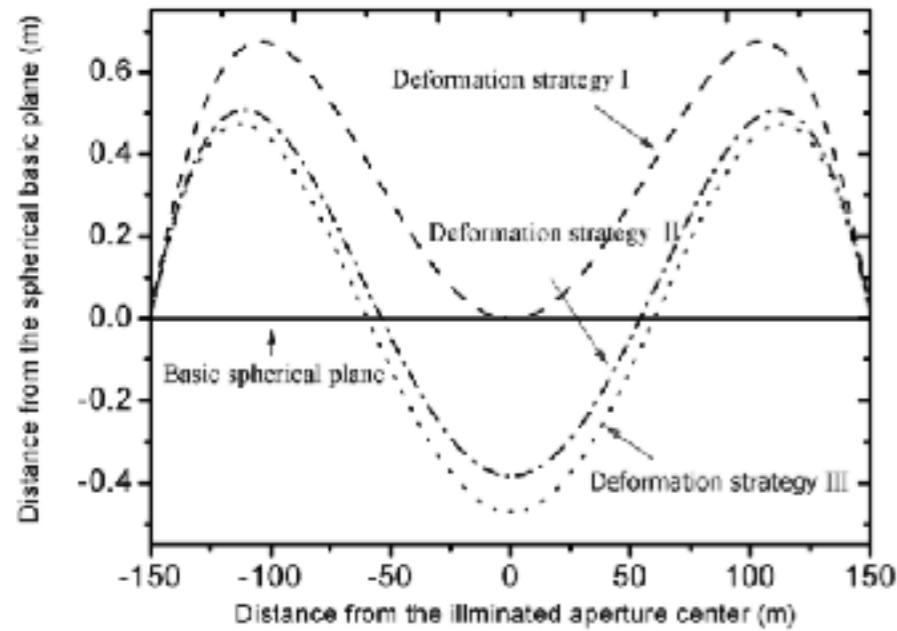
Nodes dynamic measure and control: 2mm

Frequency: 0.0017Hz



FAST Optics

Surface Offsets



June 2017

Measurements and Modeling

Jiang et al. 2015 "Studying solutions for the fatigue of the FAST cable-net structure caused by the process of changing shape", Research in Astronomy and Astrophysics

Dynamic Fibers

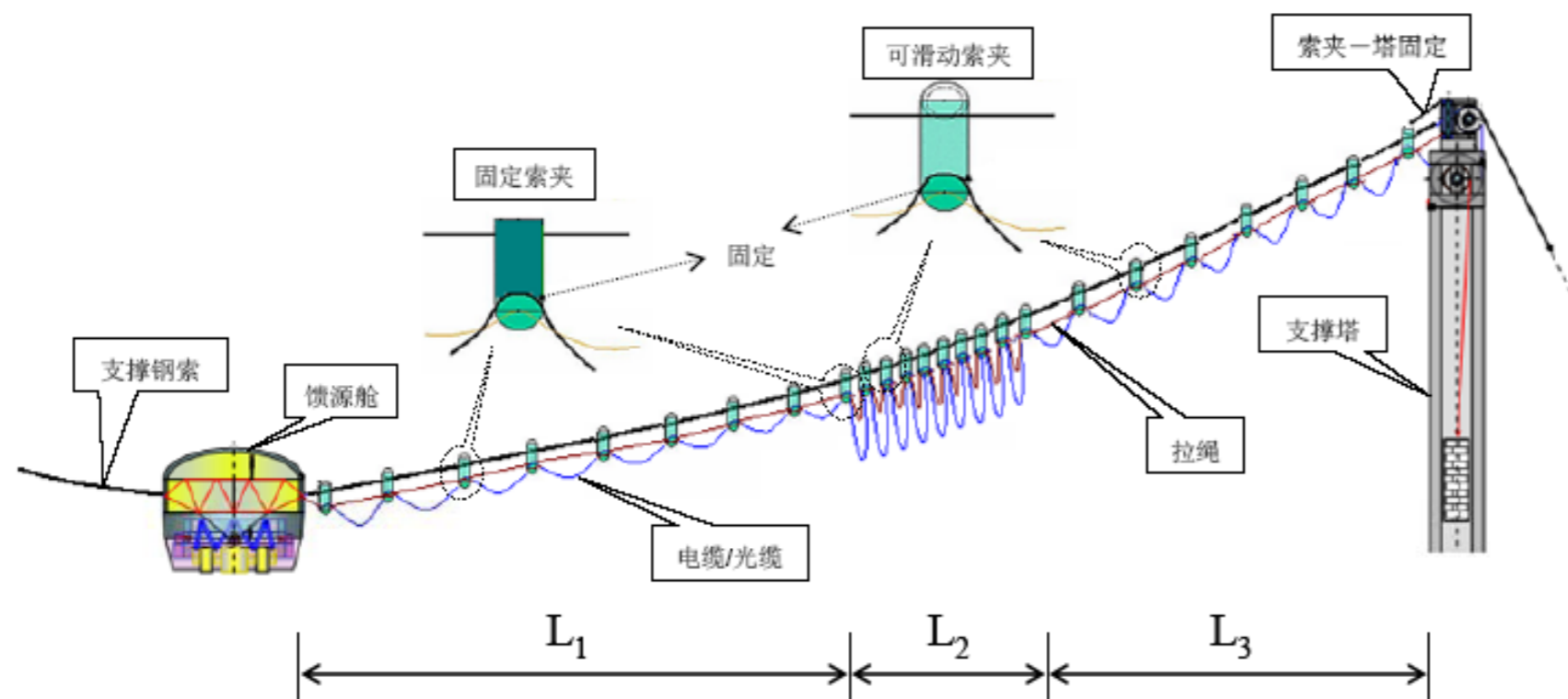


图 1 窗帘式缆线入舱方案示意图

Dynamic Fibers

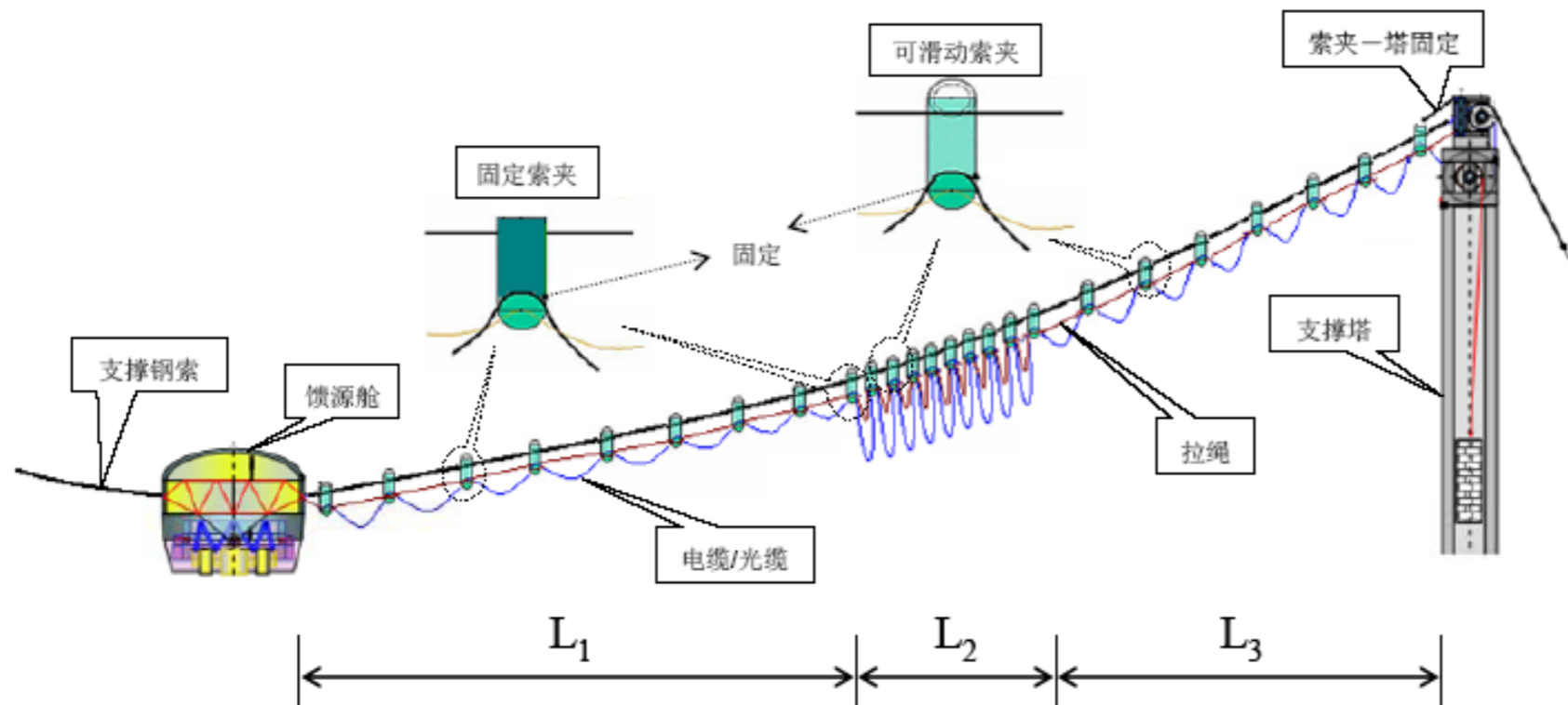


图 1 窗帘式缆线入舱方案示意图

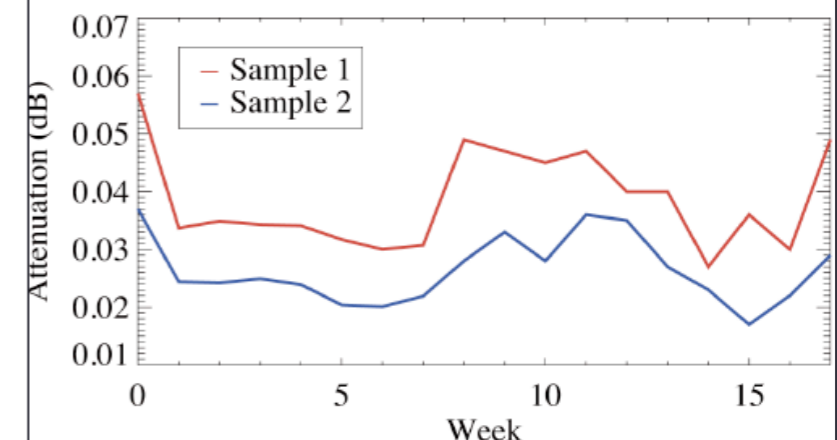


Figure 3. *Upper:* Installation of a suspension cable equipped with optical fiber and power cables. *Lower:* The attenuation of two optical fibers. Data are provided by Beijing BLADE Telecommunication Technical Development Co.

Li et al. 2015

FAST对技术进步的贡献

之 索网结构

超强的疲劳性能



- ✓ 依托FAST 研制的高性能钢索结构，在200 万次循环加载条件下的疲劳强度可达**500MPa**，是目前相关标准规范的**2.5倍**，在国际范围内尚未见先例。
- ✓ 超高的疲劳性能使该种钢绞线在一些特种领域中有良好的应用前景，例如：**摩天轮辐射索、体育场馆及航空母舰阻拦索等。**

超高的精度要求



- ✓ 在FAST工程需求的牵引下，建立了高精度索结构生产体系，实现了我国索结构工业的精细化管理。目前**精度为±1mm**，标准规范为**±15mm**。
- ✓ 该生产体系已经在**港珠澳大桥斜拉索**等其它项目中得以应用，使我国的钢索结构生产制造水平得到巨大提升。

超大的索网跨度



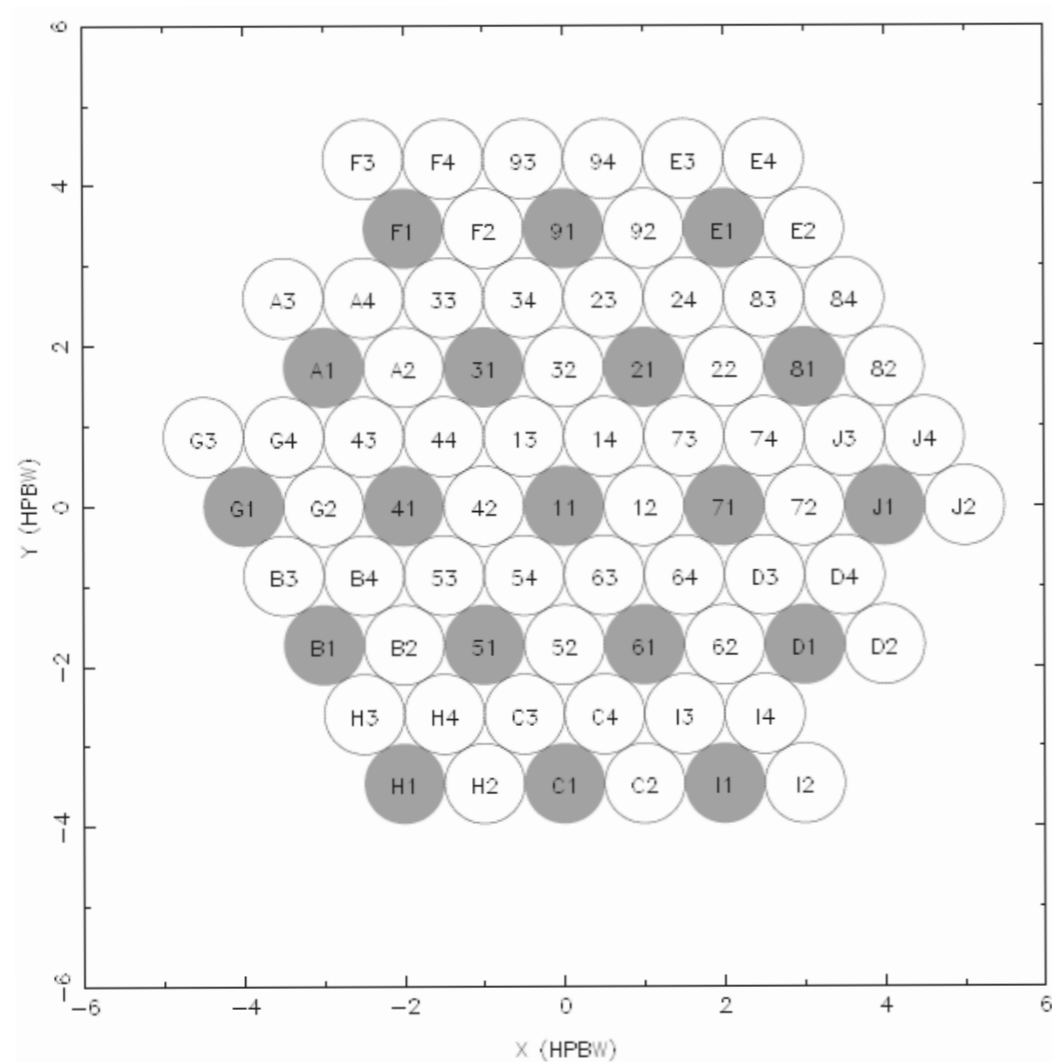
- ✓ **大跨度索膜结构安装技术**：FAST工程索网结构有**500米**的跨度，这在世界范围内极为罕见，加之地处山区，场地限制极为苛刻。
- ✓ 在制造、安装过程中产生了大量具有我国**自主知识产权的专利技术**，也发表了**10余篇文章**。



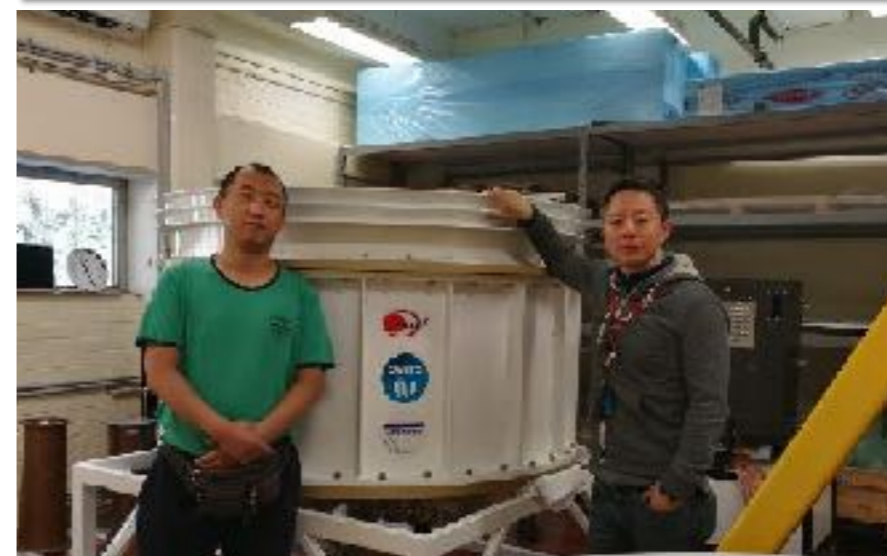


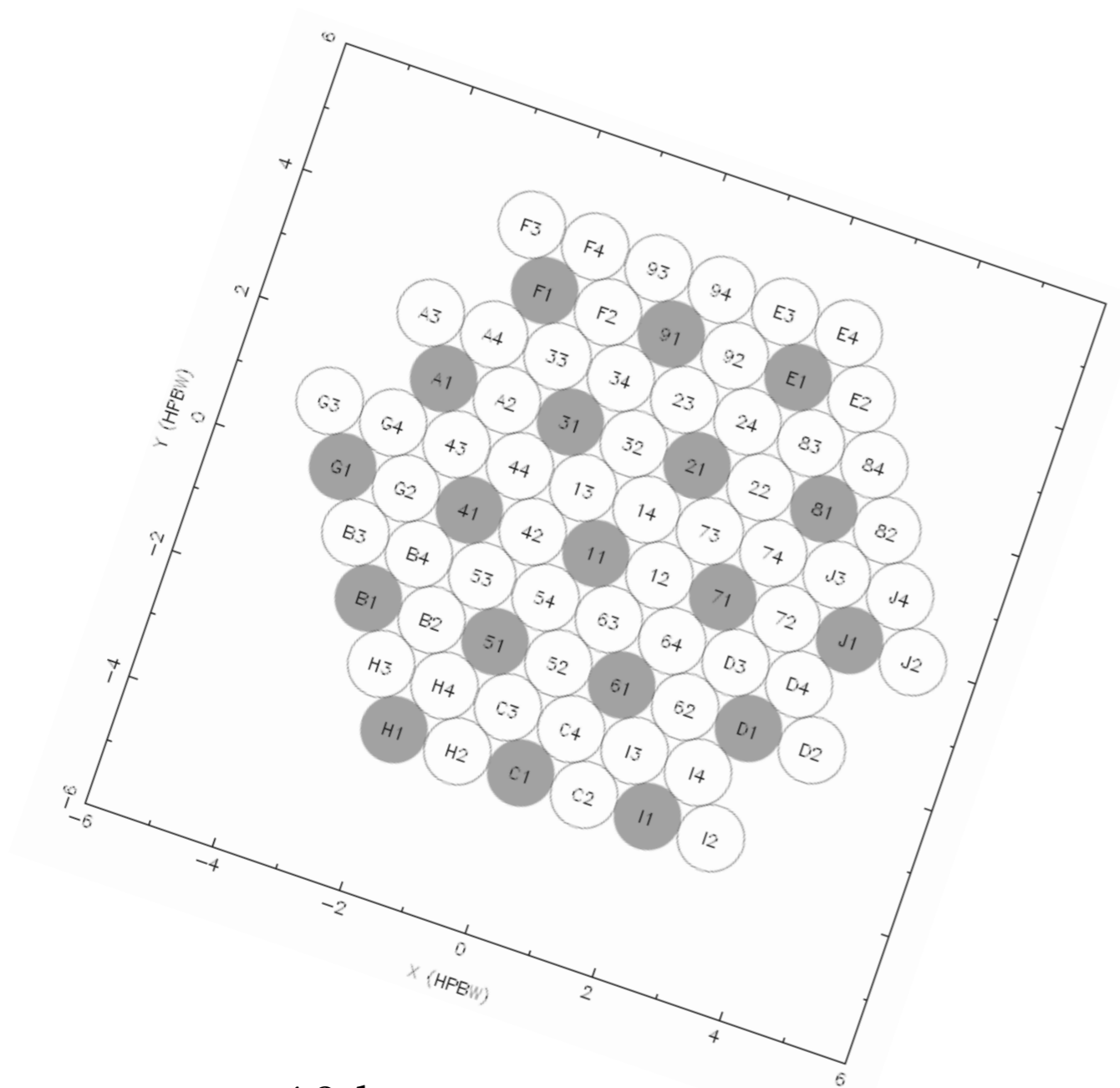
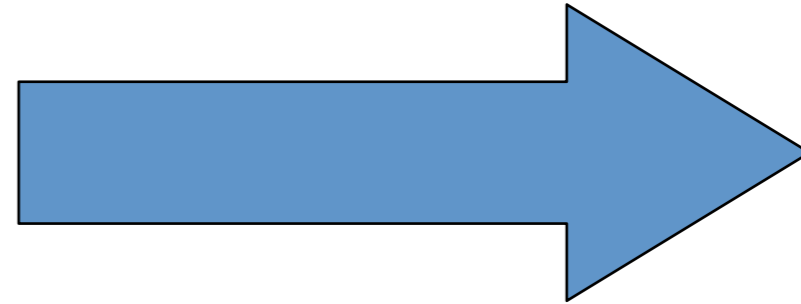






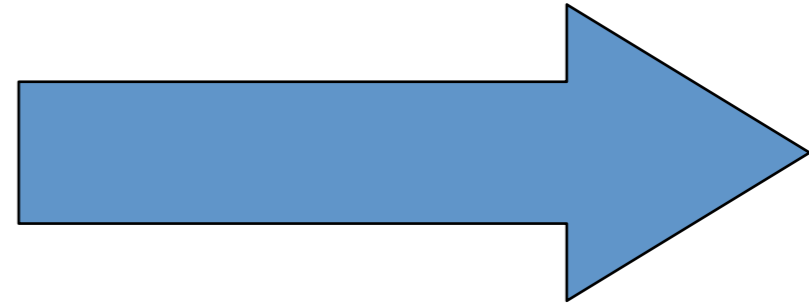
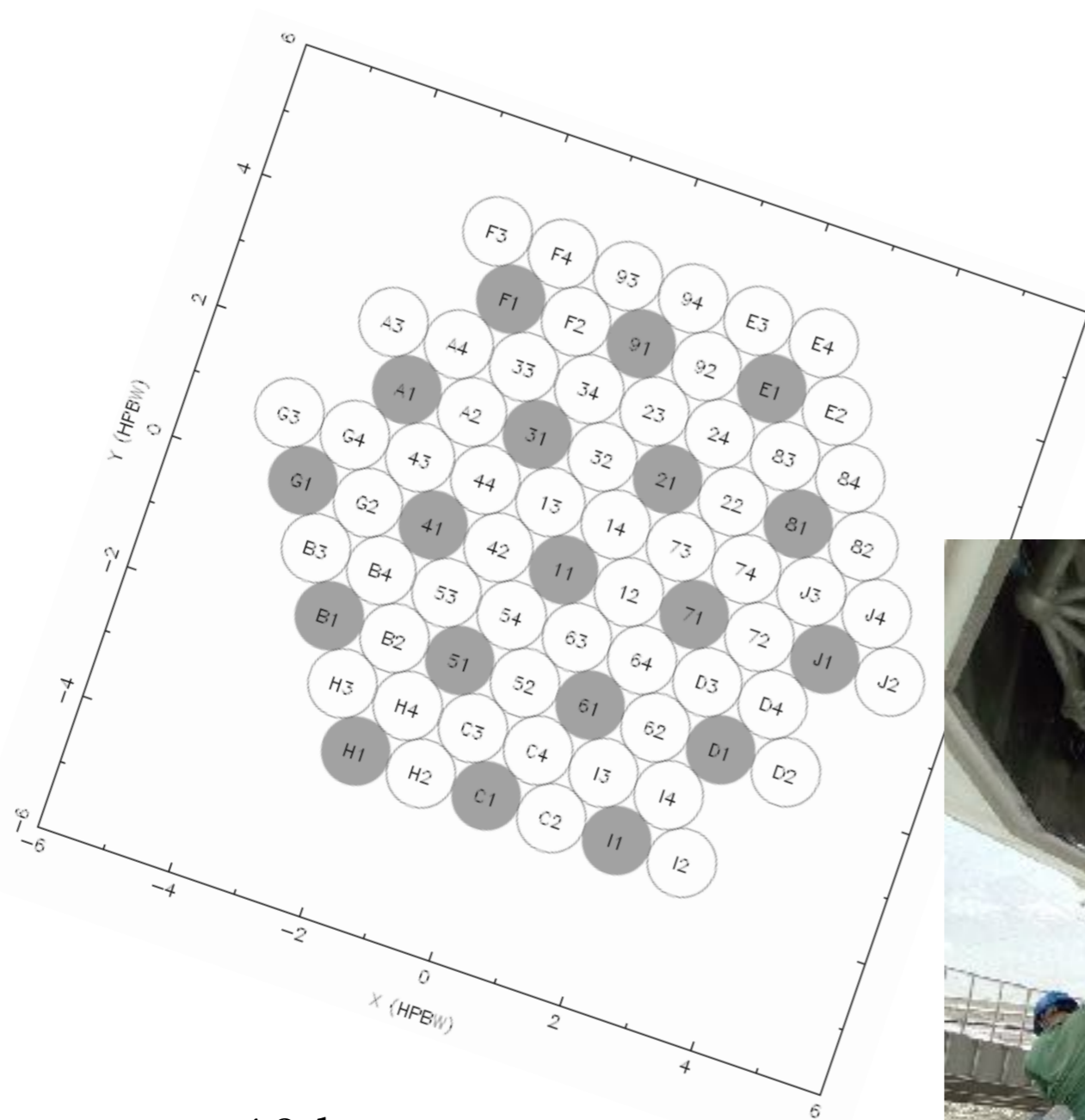
- 19 beams
- 1.05 – 1.45 GHz, $\sim 23\text{K } T_{\text{sys}}$





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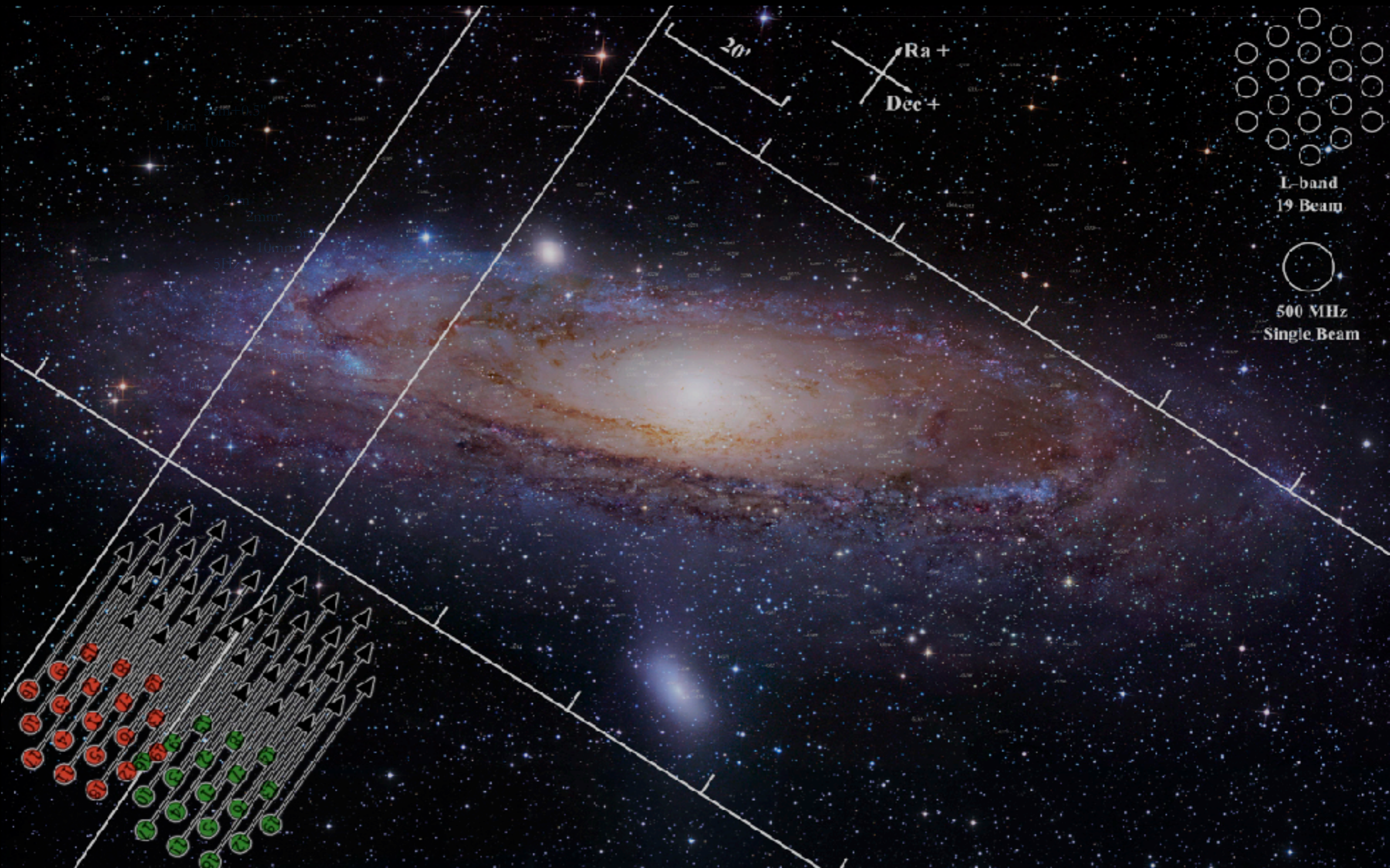
Drift (sidereal): 漂移扫描



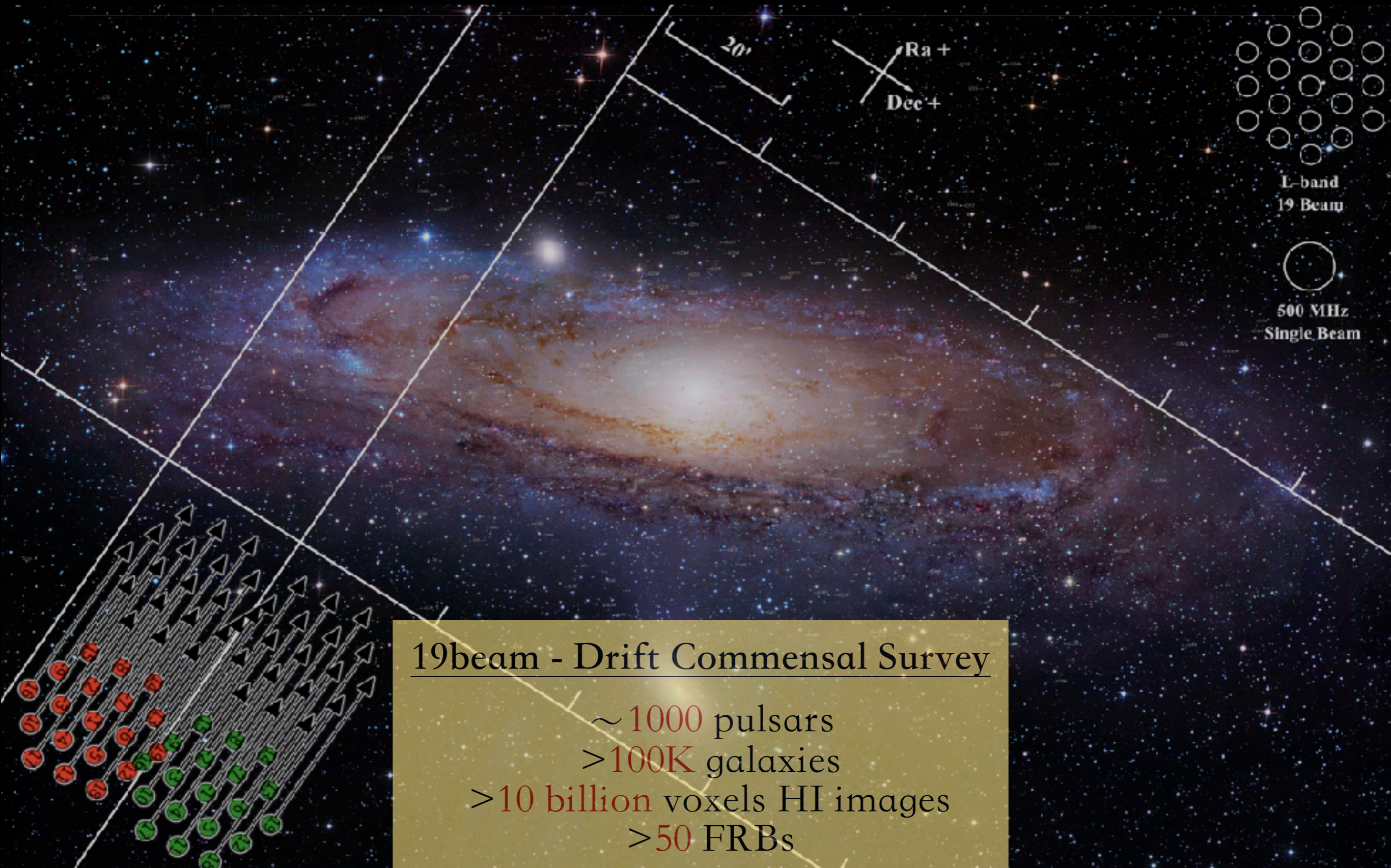
- 19 beams
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Drift (sidereal): 漂移扫描

Commensal Radio Astronomy FAST Survey



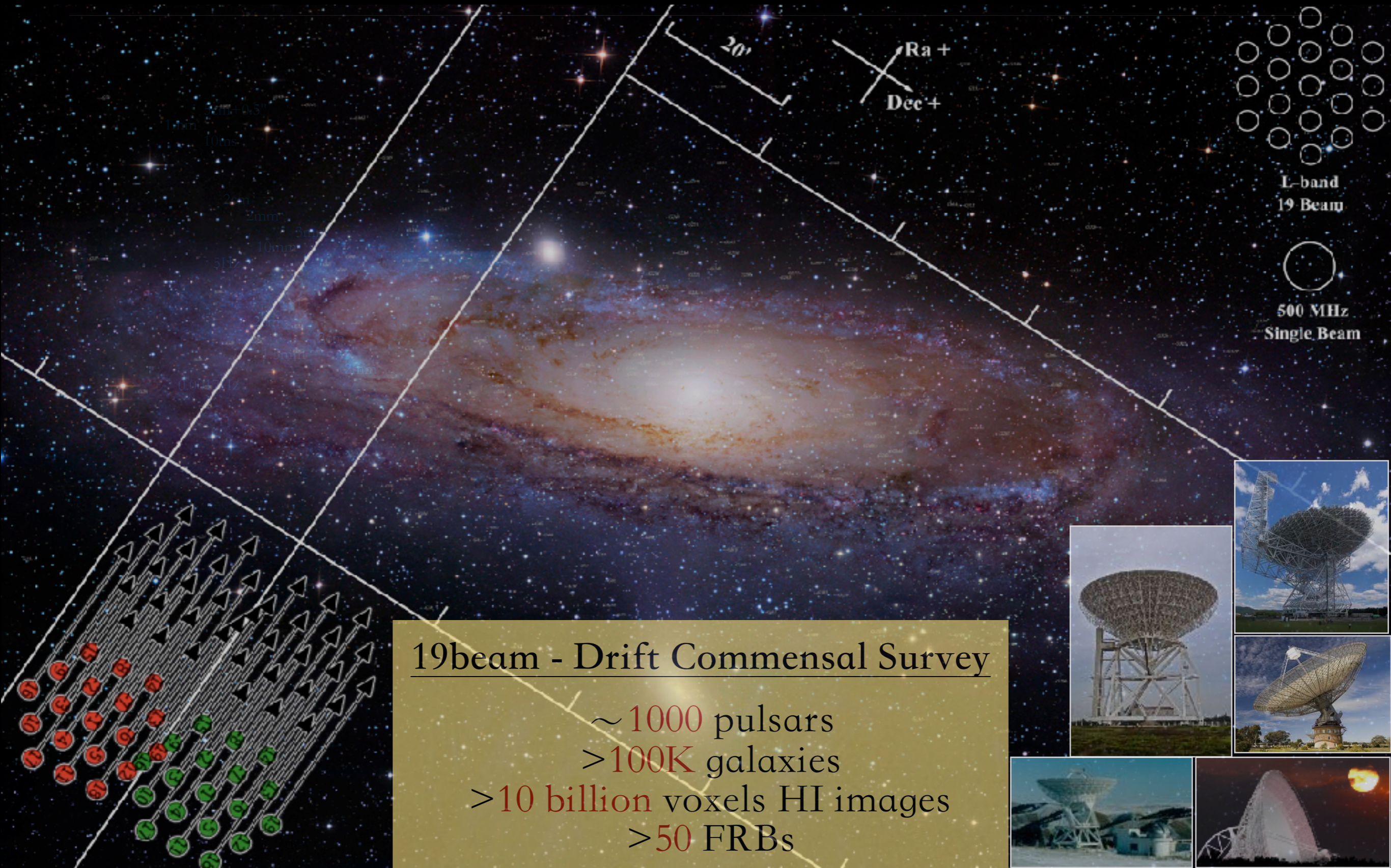
Commensal Radio Astronomy FAST Survey



19beam - Drift Commensal Survey

- ~ 1000 pulsars
- > 100K galaxies
- > 10 billion voxels HI images
- > 50 FRBs

Commensal Radio Astronomy FAST Survey



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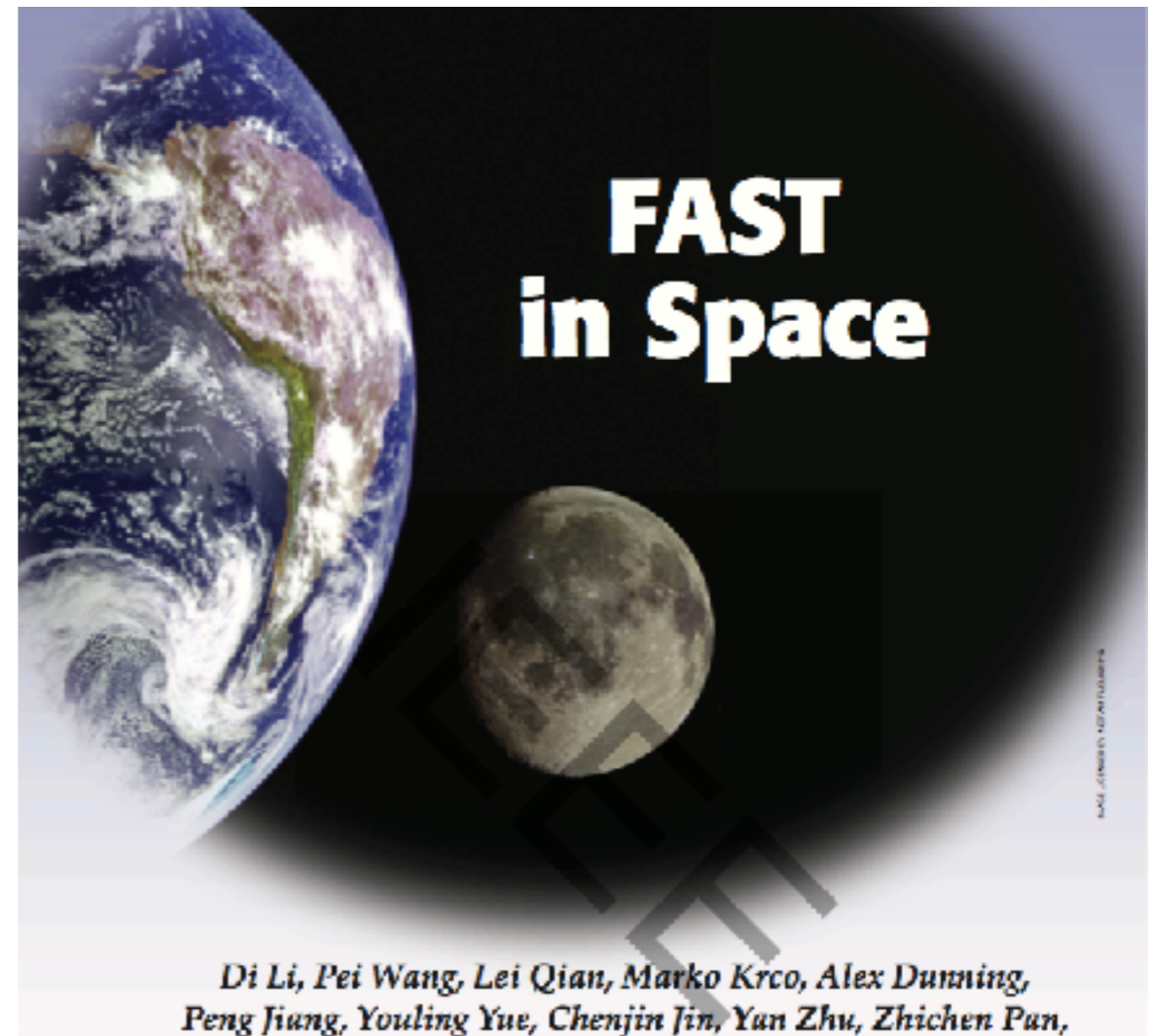
Commensal Radio Astronomy FAST Survey



CRAFTS

Unprecedented commensality: pulsar, galaxy, imaging, and FRB

- Commissioning and survey demonstration
- Secured 1500 hours Parkes time for follow-up
- Negotiation with GBT underway
- Secured 100 hours Effelsberg for follow-up
- PI programs (11) with proposing lead from PKU, NJU, SHAO, XAO, BNU, etc.
- Secured Arecibo DDT, Effelsberg open time
- GBT, Arecibo, Chandra proposals etc. submitted
- Data facility (20PB+200 Tflop+100Gbs) contract signed



Having achieved "first light" immediately prior to the ceremony introducing it on 25 September 2016, China's 500-m aperture spherical radio telescope (FAST) is now being kept busy with commissions. ©Am: Please check previous edit;

original "busily commissioned" is not clear in context. Its innovative design requires >1,000 points to be measured and driven instead of just the two axes of motion, e.g., azimuth and elevation for most conventional antennas, to realize pointing and tracking. We have devised a survey plan to exploit the full sensi-

FAST Pulsar# 1

J1859-01

 CRAFTS
The Chinese Pulsar Astronomy FAST Survey
FAST 首颗毫秒脉冲星探测项目



自转周期:1.832秒

- 距离地球约1.6万光年(色散估计)
- ⊕ 发现时间: FAST 2017/08/22
- ⊕ 验证时间: Parkes 2017/09/10

CRAFTS 项目网站: <http://crafts.bao.ac.cn/pulsar/>

FAST 首成果-

开启中国设备**系统原创**发现的时代

FAST's First MSP

3FGL J0318.1+0252

FL8Y J0318.2+0254

- Fermi unidentified source
- GBT, Arecibo non-detection

Wang et al. 2018, Atel # 10851

*“FAST’s Discovery of a New Millisecond Pulsar (MSP) toward
the Fermi-LAT unassociated source 3FGL J0318.1+0252”*

FAST's First MSP

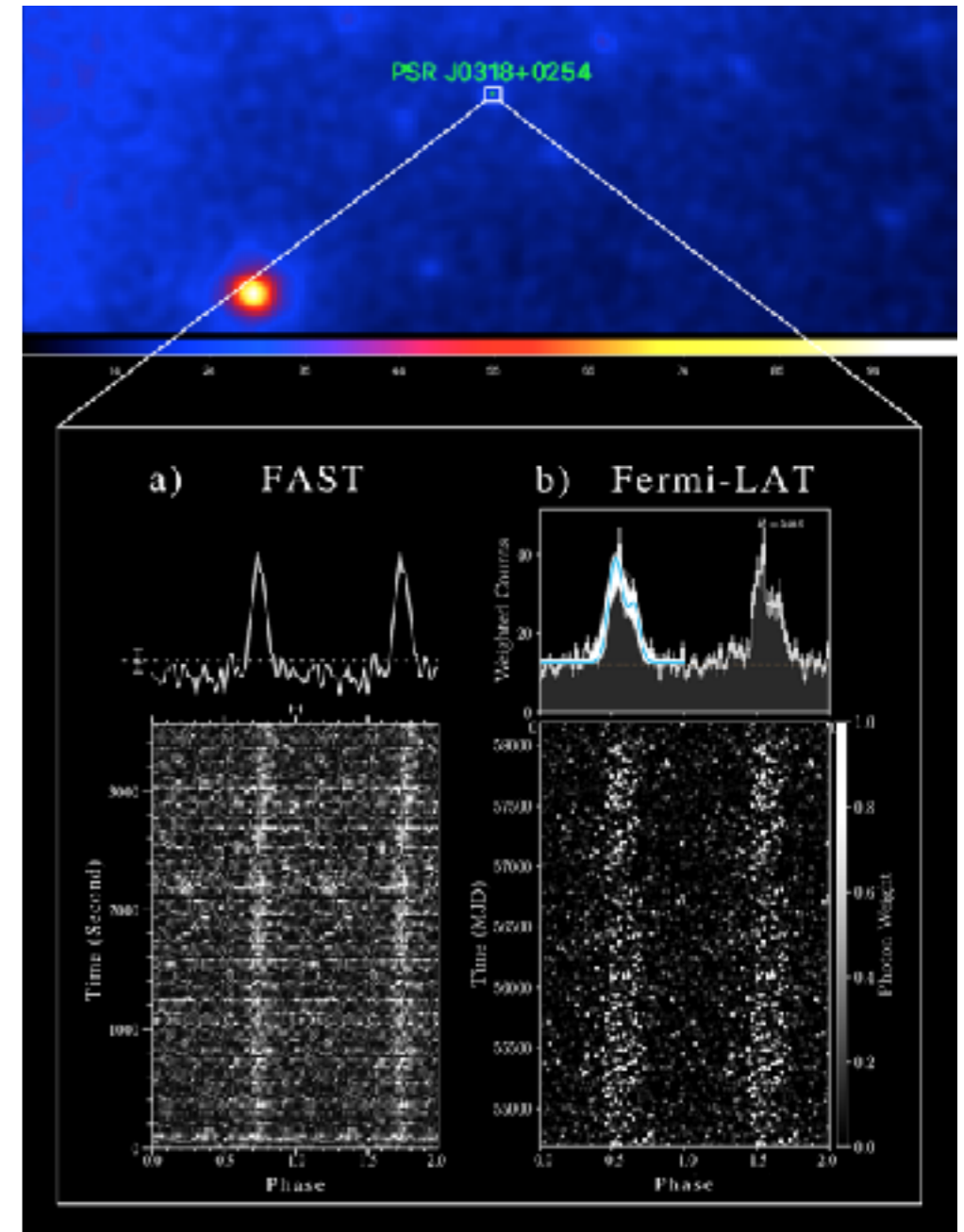
3FGL J0318.1+0252

FL8Y J0318.2+0254

- Fermi unidentified source
- GBT, Arecibo non-detection

PSR J0318+0253
p 5.19 ms; DM 26 pc cm⁻³

- **2018.2.27** FAST one hour tracking
- **2018.4.12** Wang Pei and GNU group discovered the candidate
- **2018.4.18** Colin Clark found the γ -counterpart
- **2018.4.23** Pablo confirm no X-ray, provide limits



Wang et al. 2018, Atel # 10851

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FAST VLBI

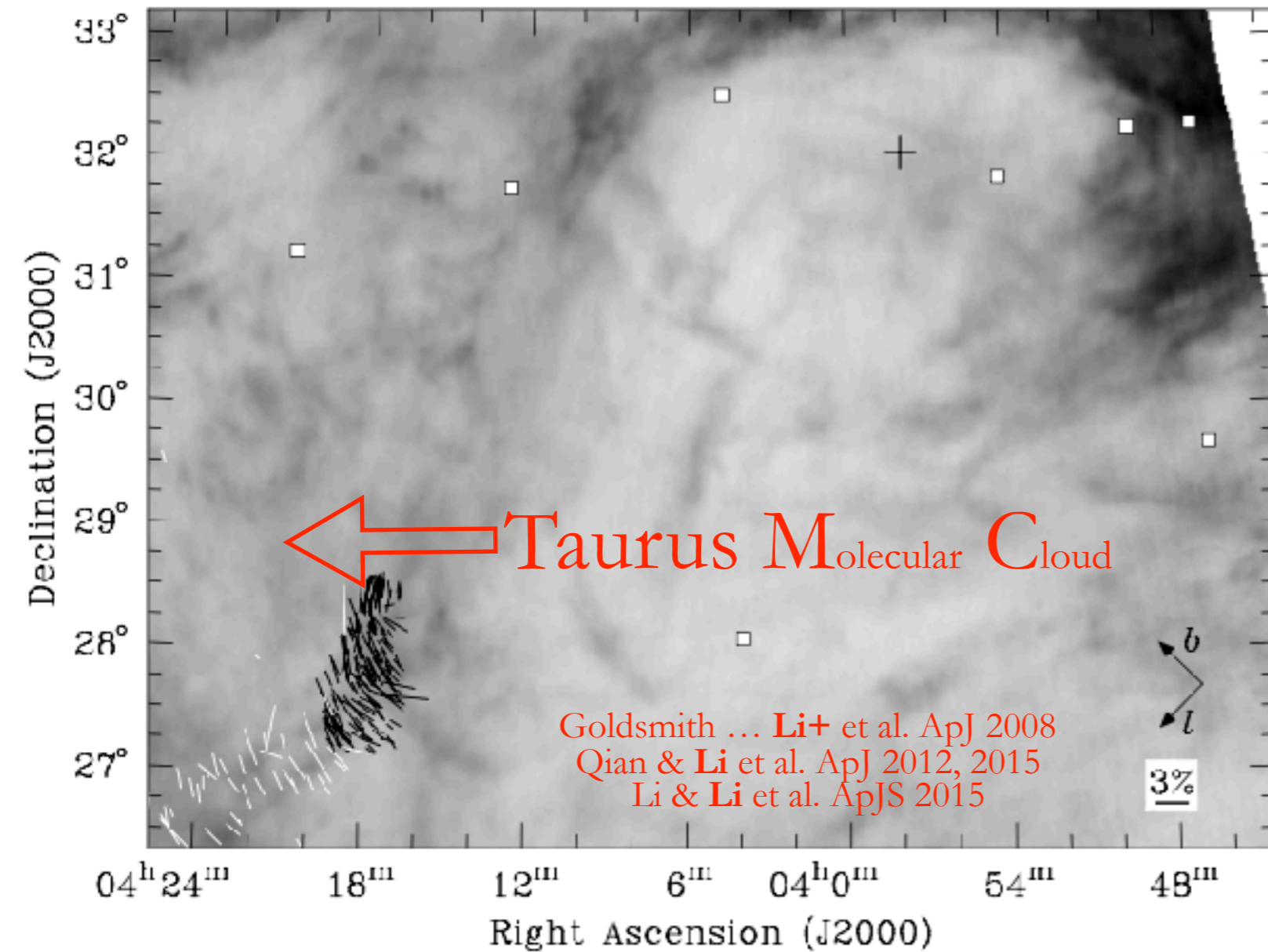
- moving observatory coordinate
- ‘virtual’ phase reference point
- No down-conversion
- 38 synced digitization data stream
- reference antenna?
- A FAST ‘Core’ Array



Lost (maybe) to Carl in Sydney Harbor, on April 21st, 2018

Closest SNR?

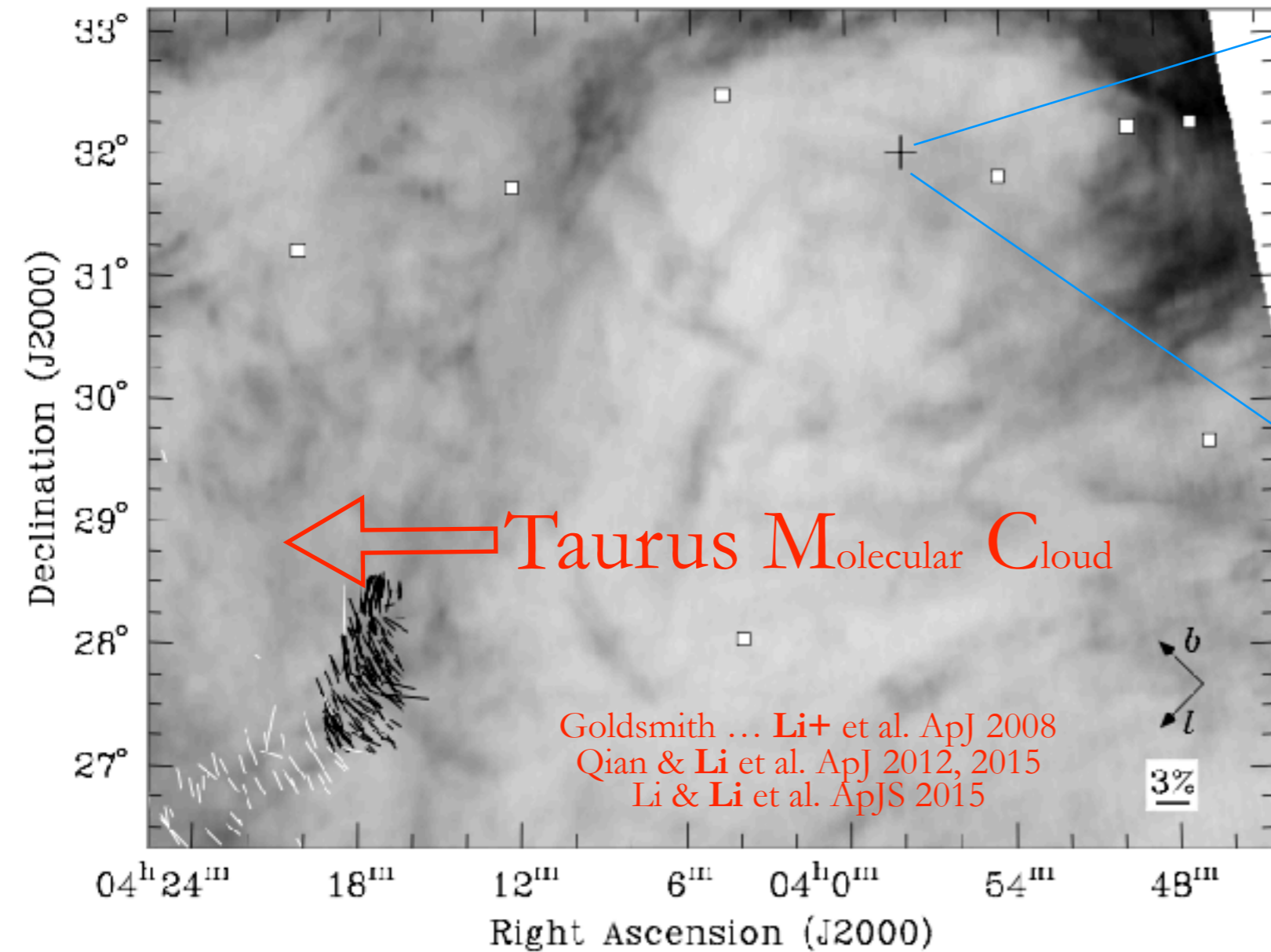
FAST discovers radio pulses from J0357



Chapman ... Li+ et al. ApJ 2011

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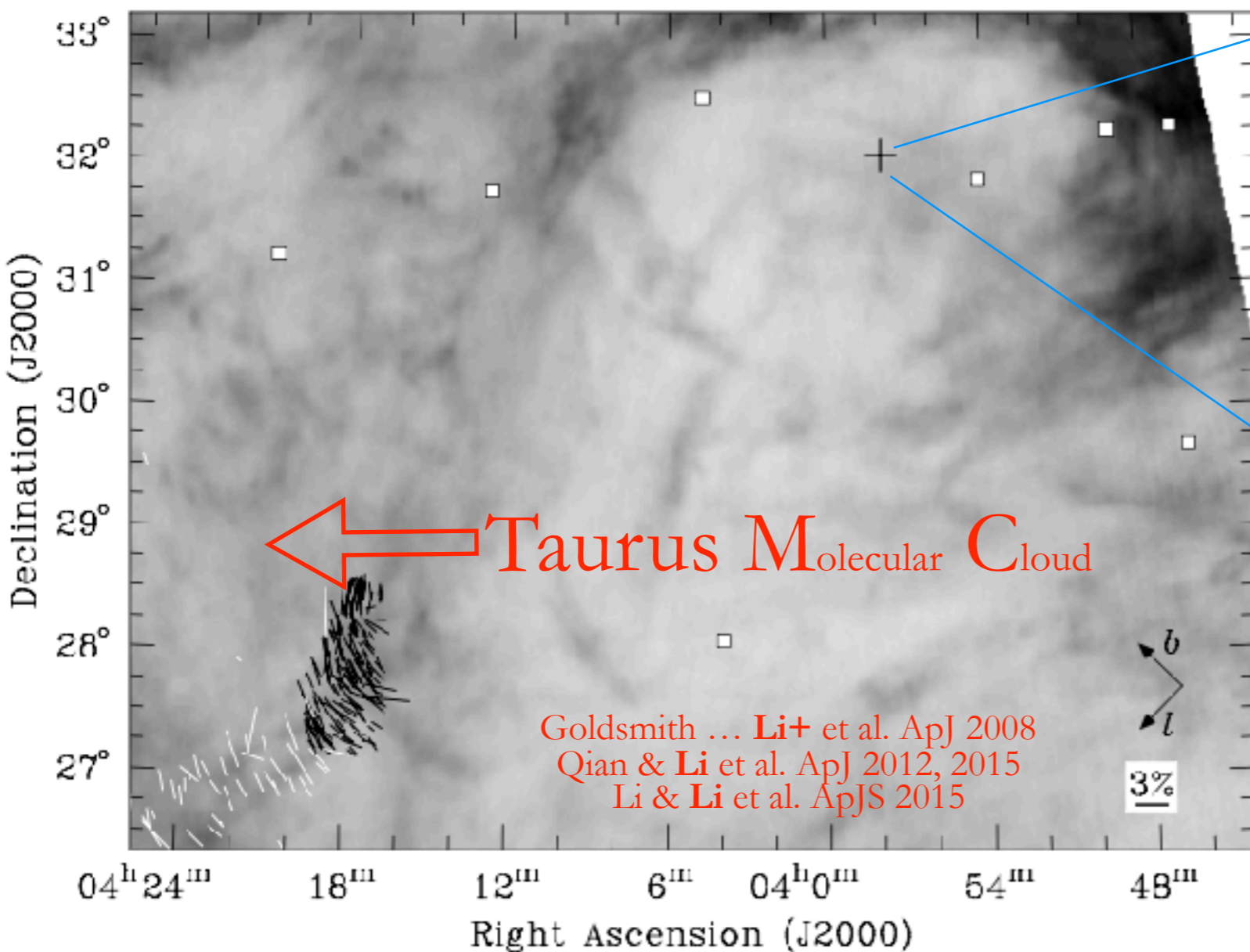


Chandra X-ray Image
De Luca et al. 2011

Chapman ... Li+ et al. ApJ 2011

Closest SNR?

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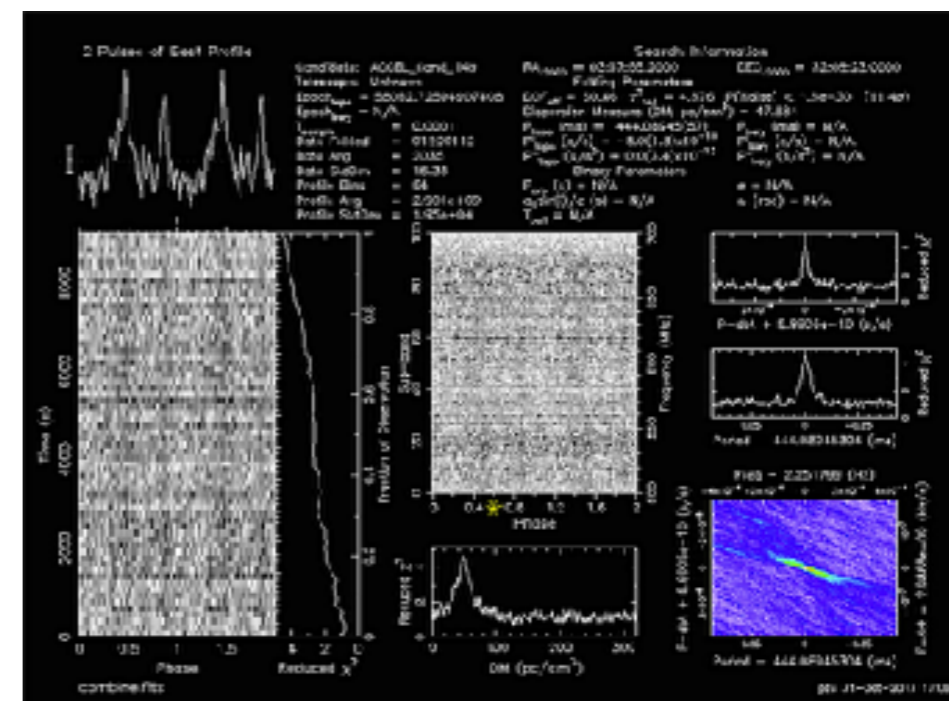


Chandra X-ray Image
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Chapman ... Li+ et al. ApJ 2011

$P = 0.444$ s
 $DM = 47.6$

GBT + Arecibo + HSA Follow-up



Breakthrough Potentials

FAST + new tech. ➔ New Parameters

post-FAST establishment:
current revolution in radio astronomy

- ◆ GW: LIGO
- ◆ 快速射电爆: FRB
- ◆ 相控阵技术: PAF
- ◆ Time Domain Astronomy
- ◆ AI/ML
- ◆ Multi-messenger



LIU LIU
Principal Investigator of the FAST FRB Project
Chief Scientist of NAOC Radio Astronomy Division

Signature

Date



TAKEICHI HOSHINO
Director of LIGO Laboratory

Signature

Date: October 9, 2016



PARTICIPANTS	
Team leader or affiliation	
Li Liu, Principal Investigator	
Jacobs, Thomas, LAT multi-wavelength coordinator	
Smith, Andy, LAT group deputy coordinator	
Sun, Liang, LAT solar wind consortium coordinator	
Chen, Jian, LAT wind gamma-ray detector search	
Wang, C. Y., LAT team with LAT search	
McGee, Tom, LAT team with LAT search	
Yu, Y., FAST Member	
Li, Y., FAST Member	
Guo, H., FAST Member	
Wang, Y., FAST Member	
Wang, Y., FAST Member	
Wang, Y., FAST Member	
Wang, Y., FAST Member	
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FAST-Fermi

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LIU M
Principal Investigator of the FAST FRB Project
Chief Scientist of NAOC Radio Astronomy Division

[Signature]
Date:



Liu M
Director of LIGO Laboratory

[Signature]
Date: October 9, 2016



Meet the Public Studios with the FAST Radio Telescope and the FAST LAT

PARTICIPANTS	
Names (role or affiliation)	
Xiao L. Michelson, LAT Principal Investigator	
Jessica Thompson, LAT multi-wavelength coordinator	
Jessica Smith, LAT science data center coordinator	
Nail S. Raz, LAT solar wind consortium coordinator	
Colin DeKor, LAT wind gamma-ray solar monitor	
Stanley C. Larson, liaison with LAT center	
Andrew Kerr, LAT science solution and	
Jon Van, FAST Mission	
Xu, FAST Project	
Guo, FAST	
Wang, FAST	
Li, FAST	
Chen, FAST	
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Known Knowns; Known Unknowns, Unknown Unknowns