Towards an All-Sky Radio Telescope

Steve Croft
UC Berkeley
“That star’s flashing!”

–Jocelyn Bell Burnell
“SETI is a critical component of the future science case of SKA”

–Phil Diamond
“a general-purpose machine that will make new discoveries”

“exploration of the unknown”
“Plenty of things keep me awake at night”

–Phil Diamond
“Plenty of things keep me awake at night”

–Phil Diamond

- CDR challenges
- IP
- Procurement
- Signing agreements
- ...

[Image of a person climbing a mountain of paperwork]
• Pointing in a particular direction
• Precisely made parts
• Moving parts
• Used by only one person at once
• All-seeing array with thousands to millions of elements and computers
• Push aperture arrays to high frequency to maximize FOV
• Use PAFs at high frequencies with cheap prime focus dishes
• Harness RFI mitigation techniques
• Synergies between science and tech
“It takes leadership”

–Arnold van Ardenne
“Success will be difficult”

–Mike Garrett
• No signs of advanced civilizations in astronomy data (just vanilla astrophysics)
• No evidence of visits to the solar system
• Intelligent life took a long time to arise here
• Radio-bright phase may be short
• Technosignatures may be rare
“At GHz frequencies, FOV hasn’t developed much since Reber”
“What if the signals are in a dimension we are not very sensitive to? Might AI help?”

–Mike Garrett

“If we had computerized the search, would pulsars have been discovered?”

–Jocelyn Bell Burnell
“Is intelligence a common outcome?”

– Andrew Siemion
“... a Silicon Valley approach ...”
“A non-detection with SKA2 can put strong constraints on the probability that there are any Arecibo-like signals crossing Earth”

Claudio Grimaldi
SNR = 180 in 1 sec with SKA1-MID
“How do we turn this telescope into a big single dish?”

– Mike Garrett
- Manageable data rate, good directivity with beamforming, but collapses FOV
- How about interferometry?
- Natural filter for RFI
- Can stack in frequency or position

- Computationally expensive for high frequency resolution
- Voltage buffer can enable both beamforming and interferometry
Lynch, Zhang, Werthimer, Prinsloo
Technosignatures Fit Naturally Under The Astrobiology Umbrella

Astrobiology

Finding Habitable Worlds Through The Deliberate Actions Of The Inhabitants

Biosignatures

Technosignatures

Jill Tarter
“SETI 2040?”

– Jill Tarter
• Airport radar from $10^4$ stars
• 133,000 antennas
• 24 triggers per day $\rightarrow$ 3.1 PB
“Be prepared for large data volumes”

–Andre van Es
“Does SKA increase the size of the haystack in ways which help or hinder SETI? Yes.”

– William Edmondson
Fig. 7.1. The U.S. Army listens for Martian radio signals, according to the plan of David P. Todd, as pictured in *Radio Age* for October 1924.
“Looking for an extraterrestrial requires us to be really imaginative and not just build a better dipole.”

– William Edmondson
“We’d love to build an anomaly detector or serendipity machine”

– Andrew Siemion
“This work is only the beginning … of applying machine learning to radio astronomy”

—Gerry Zhang
only cyclostationary sources

radar reflection off aircraft

pulsars

satellite & aircraft communications signals

reflection off LEO space debris

only cyclostationary sources that are static on the sky

Expect all to be known pulsars/RRATs

only cyclostationary sources that are static on the sky and not previously catalogued

unknown pulsar? ET?
“The best minds on the planet thinking what we can do in the next ten years”

– Mike Garrett
• Community list

• Slack

• BL WFRS Calls

• Meeting summary in A&G

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