

NOTES FROM THE END OF THE WORKSHOP DISCUSSION

Non-GBT Instruments:

- Pulsar Timing Array:
 - o At least 1 GBT of collecting area
 - o Instantaneous field of view needs to be fairly large
 - o Scan the sky (much of the sky) daily
 - o Dedicated to pulsar studies (24 hours/day)
 - o Cost to build of \$10M-\$100sM;
- Solar Physics Array
 - o Does not need a cryo system
 - o Does not need very wideband
 - o Only runs when sun is up (tracks sun)
 - o Runs to <30 GHz
 - o <1,000 dishes
- FRB array

GBT Instruments:

- Wideband Feeds:
 - o Pulsars:
 - Ideal Center Frequency of 2-2.5 GHz;
 - Bandwidth as large as possible
 - 6x feed would be about 0.7 – 4.2 GHz (very roughly)
 - o SETI:
 - Ideally low end is >3-4 GHz
 - Maximize frequency span (3-18; 4-24; etc.)
 - o Radio Recombination Lines:
 - 3-15 GHz range
 - Must have high baseline stability (over bandwidth)
 - o Astrochemistry:
 - As wide as possible
 - 10-50 GHz would do well
 - Must have very high spectral resolution or the wide bandwidth is not worthwhile
- Arrays:
 - o OH Survey:
 - At least the 1665/1667 MHz lines;
 - Prefer to also have 1720 MHz lines included
 - Needs narrow instantaneous bandwidth (just covering the lines of interest)
 - o Deep HI Survey
 - Around 1 GHz
 - Roughly 1-1.4 would be good, but lower is better
 - Potentially could make one instrument with OH survey

- Both require very clean beam – Its possible PAFS would not work
 - Star Formation
 - K-band (Ammonia mapping)
 - W-band (many different molecular species, from 70-116 GHz)
 - Need good spectral resolution
 - W-band Need wide bandwidth
 - Astrochemistry
 - K, Q, and W band, ideally
 - Needs high spectral resolution over all else
 - Comets
 - W-band array with high spectral resolution, wide bandwidth
 - Pulsars
 - 800 MHz PAF would fill a unique niche
 - HI Intensity
 - 800 MHz PAF may be ideal here
 - Questions arose as to what this provides over CHIME
 - S-Z Clusters
 - MUSTANG-2 is ideal (for now!)
- Telescope Improvements/Concepts
 - Commensal observations are important, and should be included whenever possible
 - High frequency telescope improvements are needed if we develop high frequency instruments
 - Pointing: Improve pointing to increase use of telescope at high frequencies in the wind
 - Surface: Rapid OOF holography would open up GBT to daytime high frequency observations
 - Combined, the GBT's time for high frequency could double
 - RFI Mitigation and improvements are necessary at all frequencies
 - Possible explore the idea of rearranging the receiver/cabin room

Possible Instrumentation Paths

Traditional Feed Horn Arrays: Star & Galaxy Formation/Evolution, Astrochemistry, Solar System

ARGUS

- Traditional feed horn array
- Prototype for larger array

ARGUS+

- Replica of ARGUS, with more pixels
- Infrastructure upgrade required:
 - Include upgrade to IF system (to 100+ lines)
 - Expansion of backend to accommodate instrument (10x current backend)
 - Surface OOF improvements (daytime high frequency)
 - Data reduction pipeline for large array

KFPA+

- Next instrument for star formation/astrochemistry community
- Takes advantage of existing infrastructure improvements

Wideband Feeds

Pulsars, Fundamental Physics, SETI, Astrochemistry

0.8-4(ish) GHz

- Ideal for pulsar timing;
- Can be used for SETI (non-ideal)
- Not of significant interest for other science (due to higher system temperature)
- Infrastructure upgrade:
 - Backend expansion (double)

3-15(ish) GHz

- Primary interest is radio recombination lines
- Also of interest to SETI, Astrochemistry
- must have stable baselines
- Infrastructure upgrade:
 - IF system (stable, wide enough bandwidth)
 - Can use backend developed for .8-4 GHz feed

10-50+ GHz

- Primary interest is Astrochemistry
- Also of interest to SETI
- Infrastructure upgrade:
 - IF system (use same system as ARGUS+)
 - Backend developed for ARGUS+

Phased Array Feeds

Pulsar searches, HI Intensity Mapping, Deep HI Surveys, OH Mapping, More?

800 MHz

- Ideal for pulsar searches, HI Intensity Mapping
- Utility needs to be considered, versus what can be learned from CHIME
- Excellent system for science; would allow for testing of cross-talk removal
- Infrastructure upgrade:
 - New beamformer (can use hardware from ARGUS+)

1-2 GHz

- Deep HI Surveys, OH Mapping
- Only of interest if cross talk can be minimized (cannot lose the advantage of the GBT's clean beam)
- Must have stable baselines for OH studies
- Infrastructure upgrade:
 - Same beamformer as above

Higher
Frequencies

- Of interest to almost every area of science
- Next frequency focus would depend on state of the traditional feedhorn arrays & technology readiness

Idealized Instruments

Deep HI Surveys, OH Mapping

1-2GHz

- May be more effective to built an ideal L-band feed
- Of interest to deep HI surveys, OH mapping
- Depnds on ability of PAFs to cleanly map the sky
- Infrastructure upgrades (preferred):
 - Cleaner baselines
 - Ability to readily run commensal

Telescope Upgrades

GBT Surface Improvements

- Realtime OOF Holography during the day (e.g. Leica Scanners)
- Increase the number of hours available for high frequency observations by an additional 25%-40%
- Of interest to: star & galaxy formation and evolution, clusters, S-Z effect, solar system, astrochemistry
- Desired by ARGUS, ARGUS+, MUSTANG-2, w-band

GBT Pointing Improvements

- Allow for high frequency observations in high winds
- May increase number of hours available by 10%-30%
- Of interest to: star & galaxy formation and evolution, clusters, S-Z effect, solar system, astrochemistry
- Desired by all >10G observers

RFI Mitigation/Improvements

- Could include: better RFI scans, RFI excision techniques, possible focus on reduced RFI in certain frequency bands
- Of interest to every area of science
- Needed by wideband feeds

Increased signal processing capability

- Increased capability for digital backend
- Needed by: ARGUS+, KFPA+, wideband feeds, next beamformer
- Could be used now by, e.g., astrochemistry community
- Of interest to every area of science
- Requires anything from 2-10x current capability

Increased signal transport capacity

- Increased capability for additional pixels
- Needed by: ARGUS+, KFPA+, possibly wideband feeds
- Of interest to every area of science
- Requires a overhaul of system; Could include increased stability, commensal possibilities