

## Preliminary Thesis Outline

### 1. Introduction

#### (a) Background

- i. 21-cm Basics
- ii. History of the Intergalactic Medium
  - A. Cosmic Microwave Background and the Epoch of Recombination
  - B. Dark Ages
  - C. Cosmic Dawn
  - D. Epoch of Reionization
  - E. Galaxy Evolution (is there a formal name?)
- iii. Dark Energy and Cosmic Structure
- iv. Intensity Mapping

#### (b) Experiments

- i. Global 21-cm Spectrum: SCI-HI
- ii. 21-cm Intensity Mapping: GBT

### 2. SCI-HI System Development

#### (a) Antenna

- i. Design Considerations
- ii. Simulation
- iii. Scale Model Testing
- iv. Antenna Pattern and Impedence
- v. Construction
- vi. Portability and Travel

#### (b) Electronics

- i. Calibration Switch
- ii. Amplifiers
- iii. Impedence and Efficiency
- iv. Filters and Attenuation

#### (c) Data Processing (aka Computer)

- i. ADC (sampling, integration, etc)
- ii. Power (AC vs DC, Consumption and Heating)
- iii. Noise Generation

- iv. Faraday Cage
- 3. Radio Frequency Interference (RFI) and Site Testing
  - (a) Overview
  - (b) Site Evaluations
    - i. Pittsburgh
    - ii. Zona del Silencio
    - iii. Algonquin
    - iv. Green Bank, West Virginia
  - (c) Isla Guadalupe
    - i. Site evaluation (aka summit vs fishing village)
    - ii. Logistical Challenges
    - iii. Weather Impacts (both to experiment and to expeditions)
    - iv. Measurements
  - (d) Potential Low RFI Sites
    - i. Isla Socorro
    - ii. Isla Clarion
    - iii. South Africa (Marion and Gough Islands)
- 4. SCI-HI Data Processing
  - (a) Pre-calibration Processing
    - i. Integration and Sampling
    - ii. RFI
      - A. Ionospheric effects
      - B. FM band
      - C. AM band
      - D. Time variability
      - E. Local RFI (aka village generator, spark plugs for trucks, etc.)
  - (b) Calibration
    - i. Calibration Datasets
    - ii. Impedence and Efficiency
    - iii. Milky Way Galaxy (GSM) Modelling
    - iv. Calibration Factor (K)
      - A. Johnson Noise Calibration

- B. Daily Variance and GSM Modelling
  - C. GSM Calibration
  - D.  $\Delta$ GSM Calibration
- v. 21-cm Signal Loss and Calibration
- (c) Foreground Removal
  - i. Polynomial Fitting
  - ii. Residuals
  - iii. Frequency Limitations
- 5. GBT-IM Calibration
  - (a) Observing
    - i. Scan Strategy
    - ii. Calibration Scans
    - iii. Field Coverage
  - (b) Calibration
    - i. Stokes Parameters
    - ii. Absolute Flux Calibration
    - iii. Full Mueller Calibration
    - iv. Significant Mueller Parameters
    - v. Time Variability
- 6. Current Results and Future Plans
  - (a) Expanded Green Bank Dataset (including larger fields)
  - (b) Green Bank 9-element or Parkes (?)
  - (c) HIRAX (?)
  - (d) Current Dataset and Future Deployments of SCI-HI
  - (e) Expansion with South Africa