SSERVI NESS Site Visit & SC Meeting Session Overview

Global 21-cm Signal III: Analysis of Observational Data

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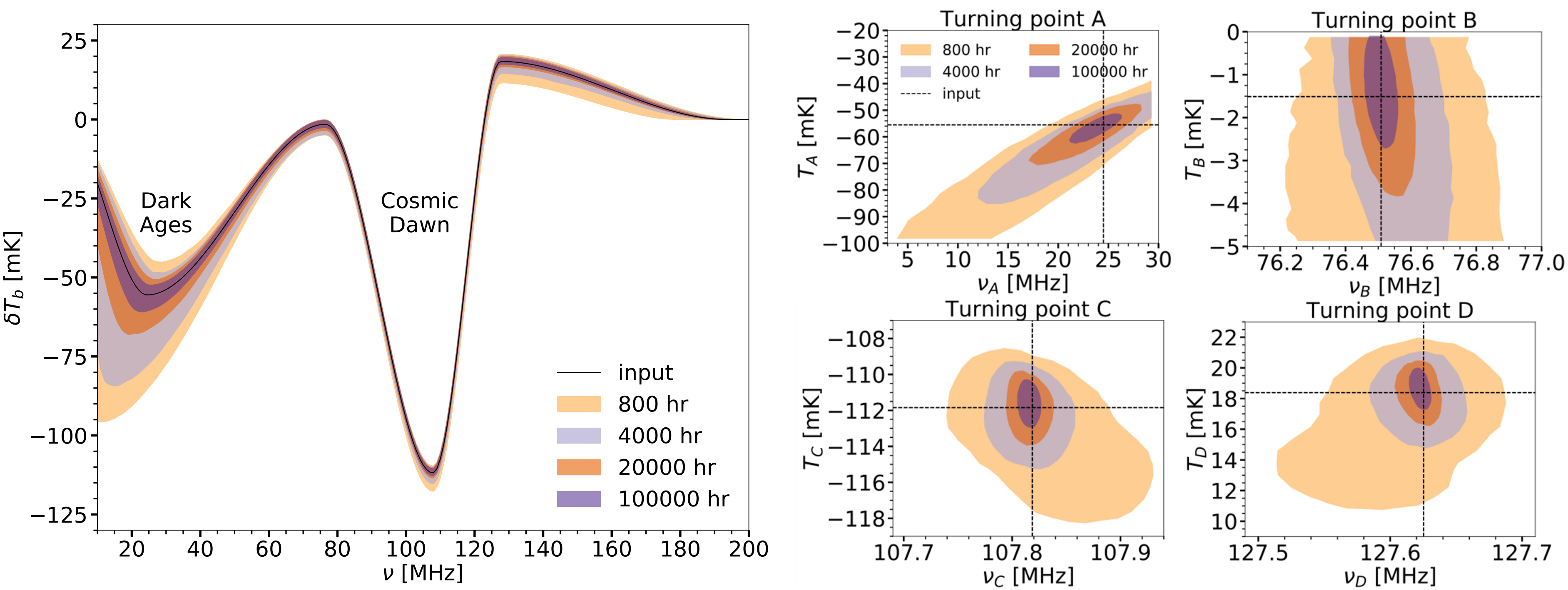
OUTLINE OF DATA ANALYSIS CHALLENGES

- Accurately and precisely extracting the small global 21-cm signal from within a foreground 4-6 orders of magnitude larger.
- Limited available information on both the signal and systematics of the experiment, such as the beam-weighted foreground, etc., including potential overlaps between the spectral shapes of the signal and systematics.
- Modelling the unknown signal to constrain meaningful cosmological and astrophysical parameters.
- For ground-based experiments, the systematics can include terrestrial radio frequency interference (RFI) and ionospheric effects.

FORECAST EXAMPLES OF SIGNAL EXTRACTION AND PARAMETER CONSTRAINTS



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The space-based DAPPER mission concept aims at measuring both the Dark Ages and the Cosmic Dawn troughs in the global 21-cm spectrum.

ADDRESSING THESE CHALLENGES WITH TOOLS SUCH AS: PATTERN RECOGNITION, BAYESIAN INFERENCE, MANY SPECTRA

- Employ training sets based on theory, simulations and measurements to describe each not well-defined component (signal and systematics) with the aim to properly encompass the corresponding uncertainties.

- These can be specifically suited for a given experiment, be arbitrarily complex (avoiding e.g. the necessity for smooth, phenomenological foregrounds), and directly include beam effects.

- Utilize then techniques such as Singular Value Decomposition to model the training sets.

- Jointly fit the signal and systematics to account for the covariance between components.

- Use multiple correlated spectra for different times/sky views and polarization parameters at once to differentiate between beam-weighted foreground/systematics and signal, to significantly lower uncertainties.

- Constrain nonlinear physical parameters using simultaneous Bayesian inference techniques such as Markov Chain Monte Carlo (MCMC) and Nested Sampling. Analytically marginalize over nuisance parameters as possible at each step of the calculation for efficiency.