Data Simulation

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Data Simulation Overview

- Experiment Model
  - Experiment Design
  - Sky Model
- Map-domain simulations
- Time-domain simulations
- Today: Quick overview + big questions and challenges
- Thursday: More discussion on how we will use the simulations to validate instrument performance in Technical-to-Measurement parallel

Experiment Design

- Capture a sufficient description of the experiment design including instrument parameters, scan, observation efficiency
  - Instrument parameters: Interface with technical groups
  - Scan strategy and observation efficiency: cross group meetings every other week
- Possible pitfalls:
  - Often need inputs from instrument design before they are ready on the technical side→ Advertise need for input early and more broadly? Some unavoidable?
  - DM asks technical leads for input on known design changes→ Need system for technical leads to update DM on large instrument design changes
  - Limitations on what instrument inputs can be read in from a definition file (e.g. layouts)
- Next steps to a more mature model:
  - Upgrades to instrument model to enable certain systematic studies
  - Deep dive into observation efficiency numbers
  - Possible upgrades to/integration of BoloCalc

Sky Model

Currently relying on simple PySM 2 models extrapolated up to NSIDE 4096:

- Galactic dust, synchrotron, free-free, AME
- Extragalactic CIB, tsz, ksz from Websky
- CMB lensed with Websky potential

Next we will incorporate newer PySM 3 models being developed with support from the Pan Experiment Galactic Science group:

- See for example GNILC-based dust at https://github.com/healpy/pysm/pull/72

Are there other inputs we need to consider adding?

Map-Domain Simulations

Two classes of map-domain simulations:

- Full sky simulations beam-smoothed and bandpass-integrated used as input to the design simulation tool, see the documentation of the Feb 2021 release
- Design simulation tool runs:
  - Uses 10-day time domain simulations of sky, atmosphere and noise, weights them based on the instrument configuration
  - Currently in progress, available in weeks
  - Last year's simulation documentation

Time-Domain Simulations

- Short time-domain sims have been run for use in the design tool
- Verifying the models:
  - Comparison of atmospheric model to timestream data from existing instruments
  - Design tool runs scaled to existing experiments and noise performance compared, can be rescaled to match achieved performance→ No baseline for Chile SATs
- Scaling from achieved performance is critical, but may be insufficient
- We will not rescale the larger data challenge runs→ additional challenge and complexity
  - Use design tool verification to inform larger simulations, but not straightforward
  - One observation efficiency number is not sufficient to simulate large periods of data (e.g. season dates, weather cuts, etc.)
  - Need a thorough verification plan to use these simulations for validation

Time-Domain Simulations

- Noise is not sufficient to validate performance→ Systematic effects
  - Need systematic model and expected mitigation to realistically estimate residual effects
  - Need a realistic understanding of what can be modeled and what resources, input, and effort is needed for that modeling
  - How do we as a project prioritize what to model?
  - Many of the most limiting systematic effects are difficult to model (ground pickup, beam systematics) → How do we handle these?

More on discussion on systematic effects in Technical to Measurement session (Thursday)