

# Gemini Automated Scheduler: Historical Analysis of Queue Plans

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## The Automated Scheduler

- Today:
  - Queue plans designed by a human Queue Coordinator (QC) every day
  - Separate plans for the most likely sets of conditions
  - Observer must switch between static plans as conditions change
  - Observer must incorporate ToO's (Targets of Opportunity) as they arrive
    - Expected increase of ToO's with Vera Rubin Observatory
- Team developing an automated scheduler

## Scoring

- Automated scheduler should reproduce human decisions
  - Starting point - assume QC plan is the optimal plan
- A scoring algorithm is used to evaluate and prioritize observations
- Terms currently considered, with weighting to be determined:
  - TAC science ranking (Band)
  - Pre-imaging
  - Internal priority
  - Conditions match
  - Program Completion
  - Visibility Fraction (Visfrac)
  - Hour angle weight

## Data Analysis

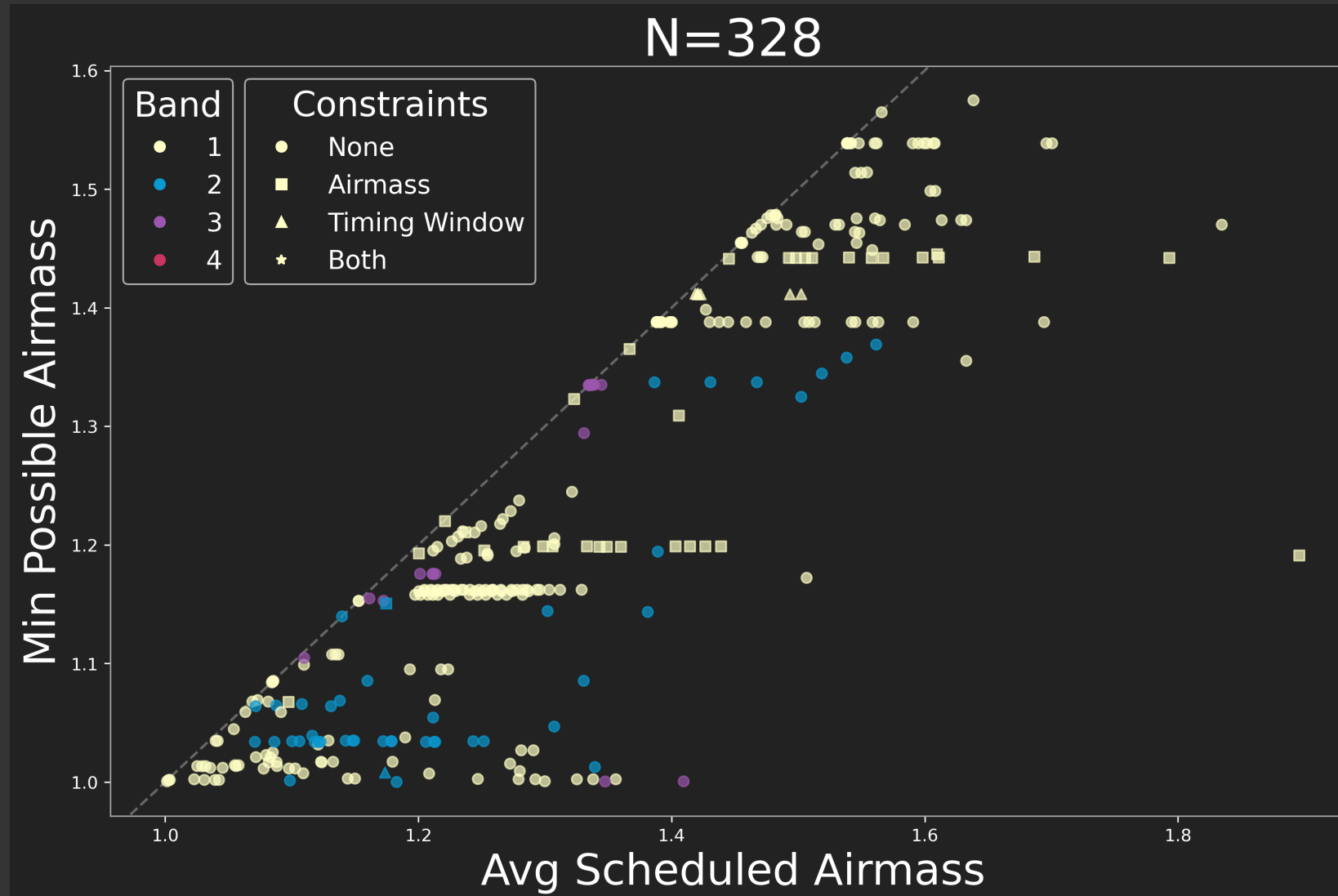
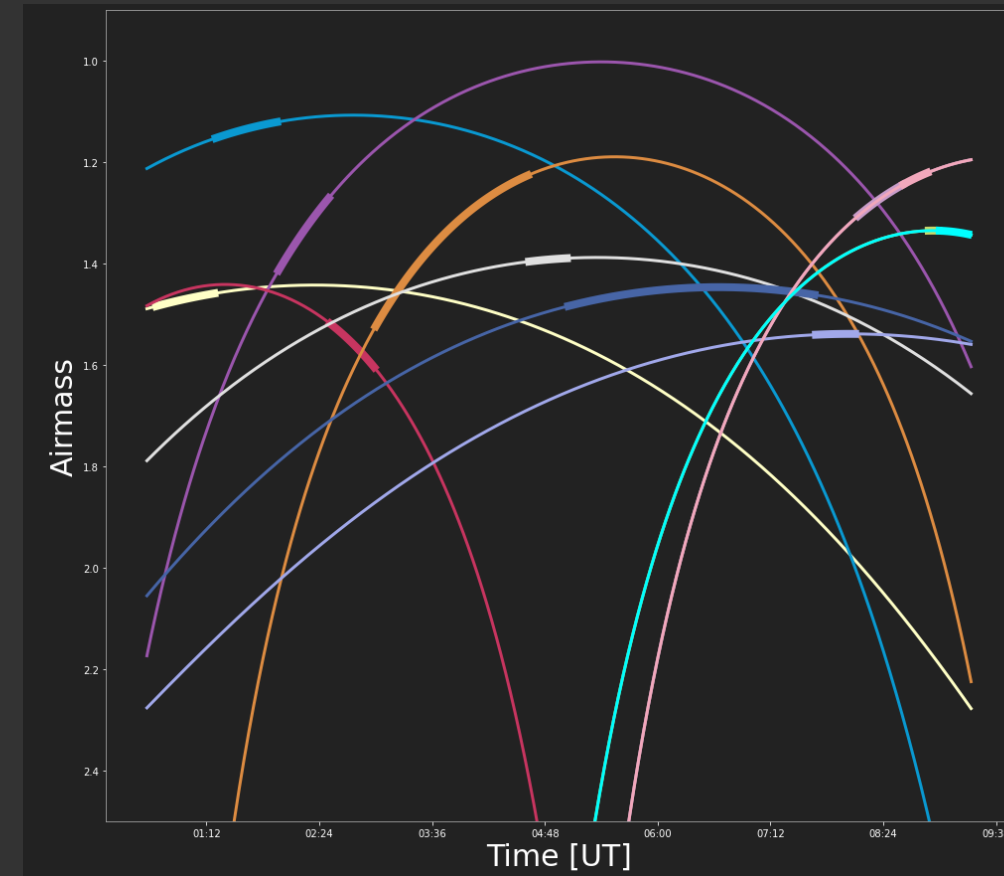
Code written in Python  
 Analysis of limited data set thus far:  
 February 2019 - Gemini South - IQ70 CC50 plans  
 Proof of concept that will be expanded in future

## Summary

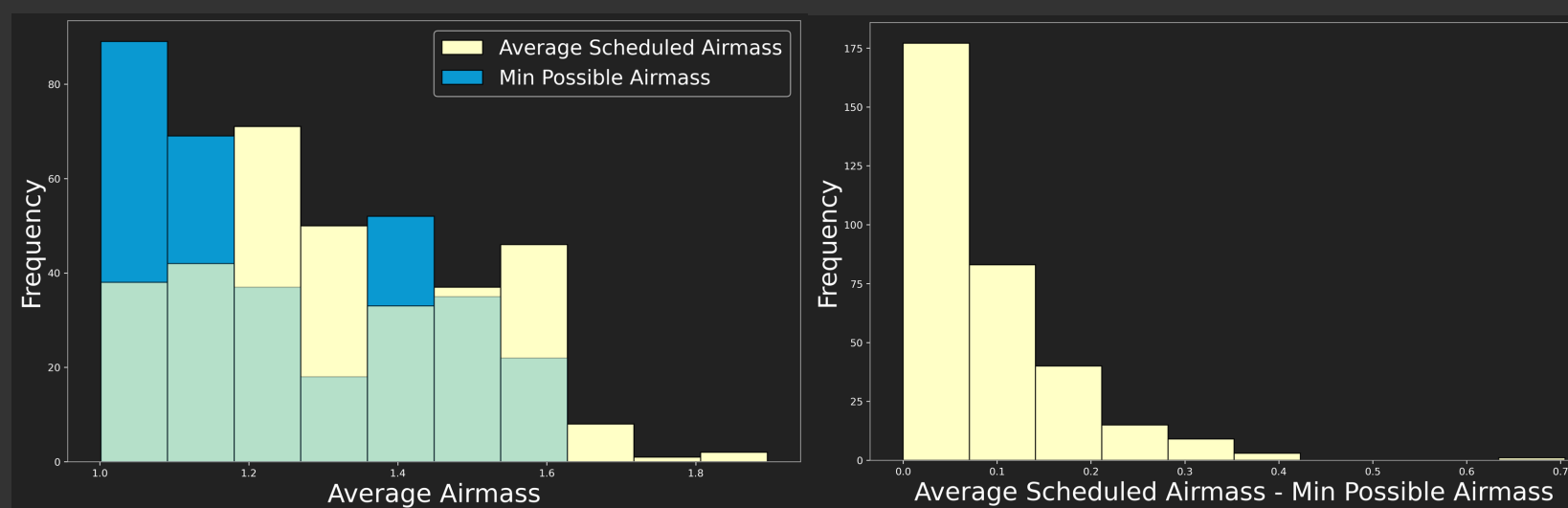
- Data used to inform the Scheduler algorithm
- Operating with the principle the QC plans are the ideal plan
- A tool exists to be used for further analysis
- These are initial results
- More analysis will be required for different sites, larger periods of time, and different plan types

## Airmass

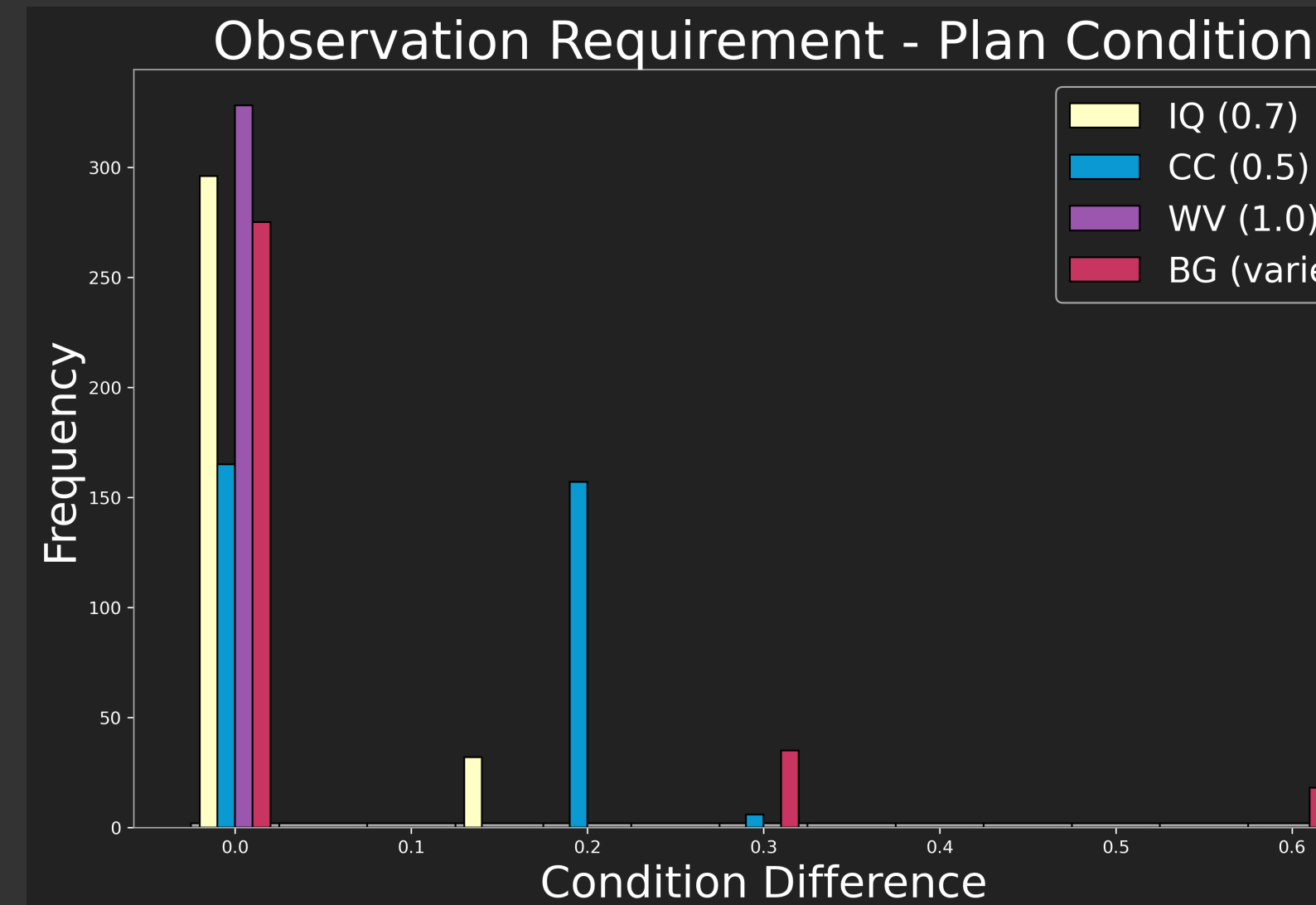
- Assuming no other constraints, the best time to schedule an observation is at the minimum airmass
- In isolation, all observations would be done at minimum airmass
- Optimize schedule to obtain all measurements at lowest airmass possible



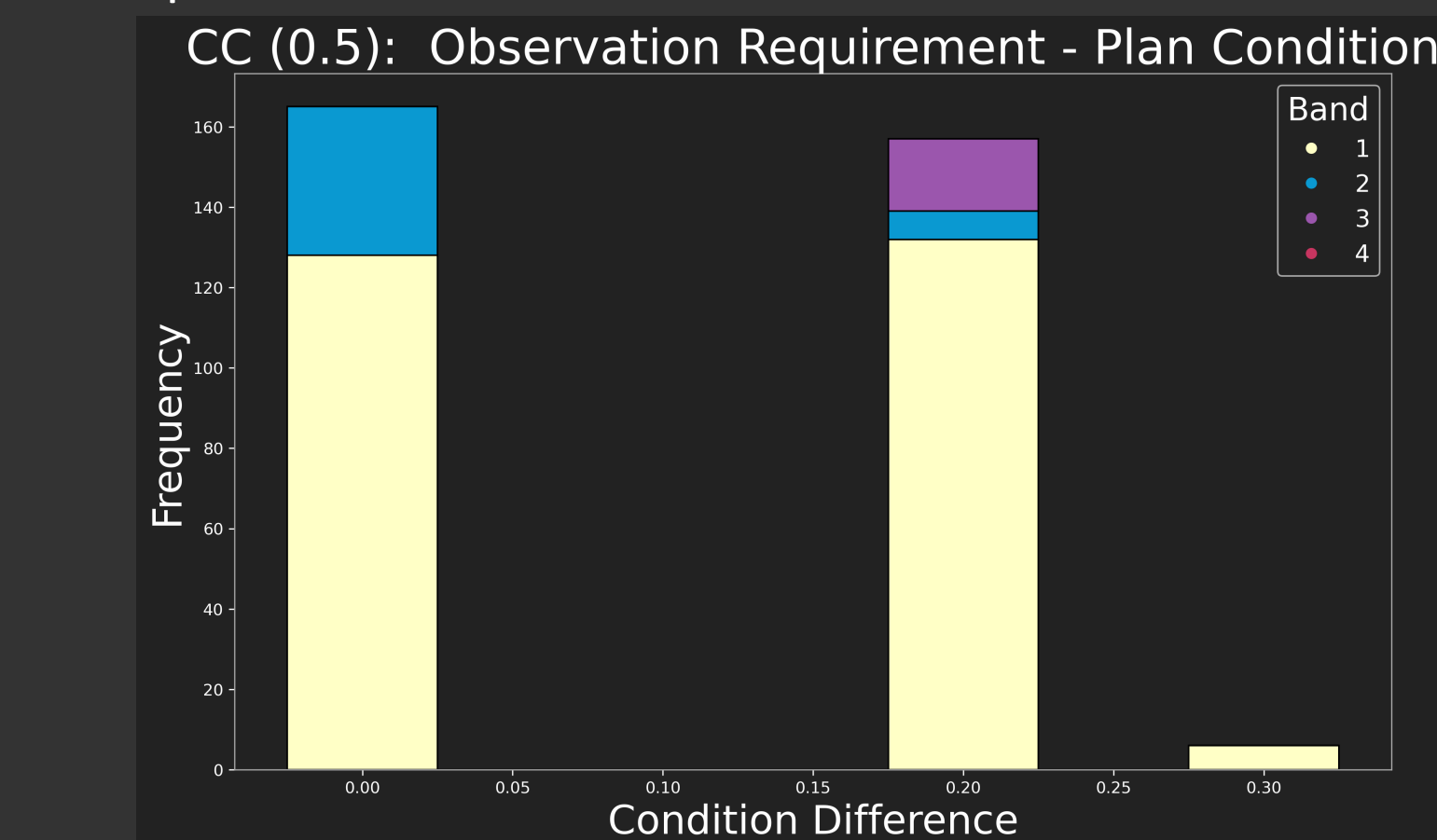
- Average over the scheduled observation
- Minimum possible average airmass while observable
- We can also obtain a distribution to compare to airmasses chosen by the scheduler
- Airmass distributions are reasonable and as expected



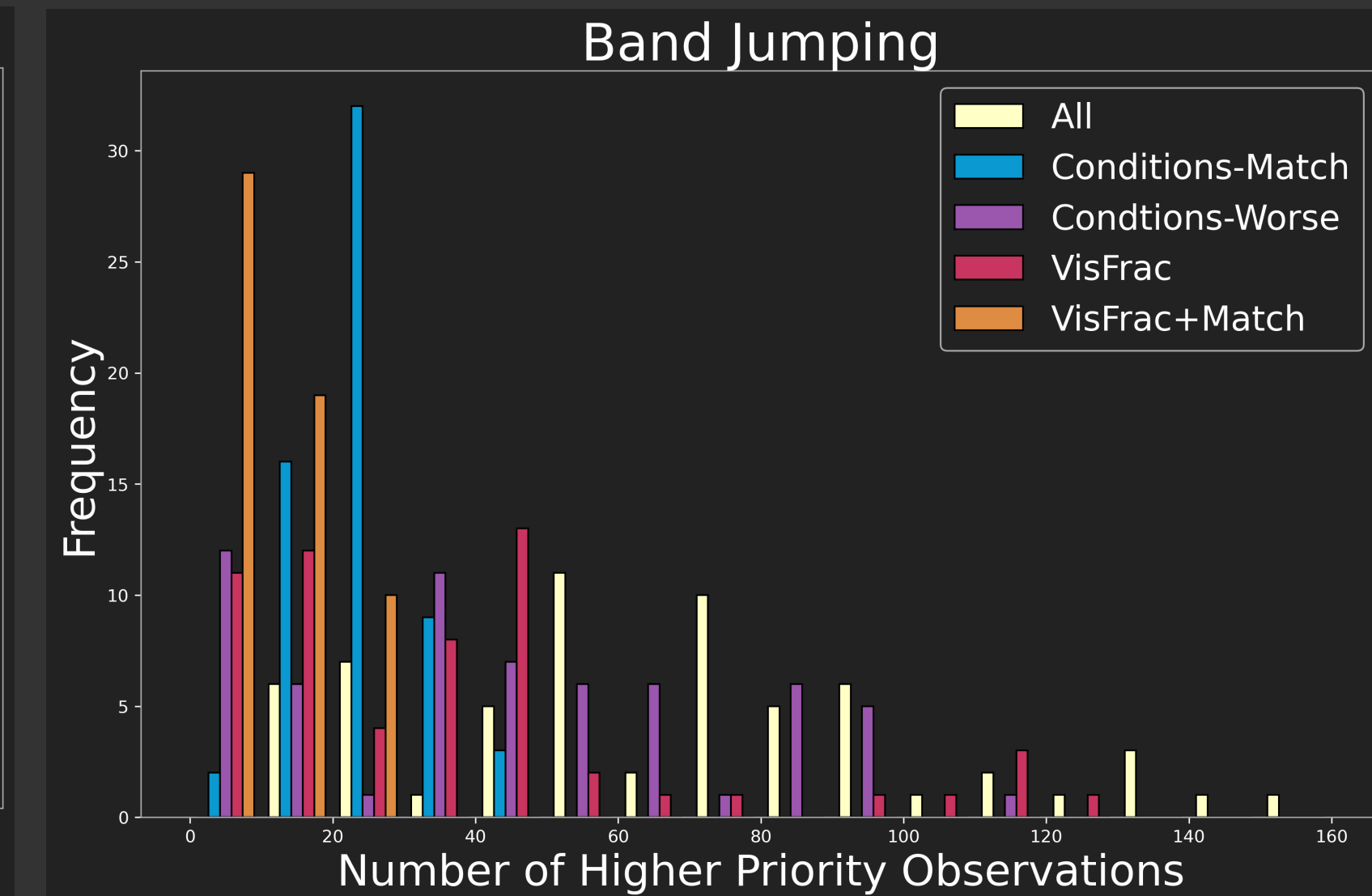
## Conditions



- Simplistically, observation requirements should exactly match the plan conditions
- In practice observations are scheduled in conditions *better* than they require. Why?
- Presented as (Observing Conditions) – (Required Conditions)
- Positive values means better than required conditions
- Zero means conditions match
- Four conditions – Each of which is divided into percentile bins
  - IQ – Image Quality
  - CC – Cloud Cover
  - WV – Water Vapor (not used)
  - BG – Sky Brightness/Background
- Low rank filler programs are observed in better than required conditions



## Band Jumping



- Band jumping occurs whenever a lower ranked observation is scheduled while a higher ranked observation is observable
- Higher priority programs, naively, should be scheduled before lower ranked observation
- This is not always the case. When and why would a lower ranked program be chosen over a higher ranked program?
- Conditions – lower priority needed better conditions than band 1
- Visfrac – Visfrac is given by the length of observation divided by total amount of time observation is visible
  - Fewer opportunities to observe the lower priority observation
- Visfrac and conditions matching combined partially explain band jumping but more variables are needed

## Future Work

- Instrument component availability
  - Examination of how instrument component availability affects QC decisions
- Observation splitting
  - When and how frequently were observation split?
- Long term data analysis
  - Trends in season, site differences
- Include telescope and instrument calendar in visfrac calculation