# The First Year of KOKEE12M-WETTZ13S VGOS Intensive Scheduling: Status and Efforts Towards Improvement

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## Introduction

The KOKEE12M-WETTZ13S (K2-Ws) VGOS Intensive series began on January 4, 2021. Evaluation of the first year of schedules has shown that the series is performing reasonably well, but the schedules could be improved. For example, the number of scheduled observations in a typical 2021 K2-Ws session is approximately half that of the first few MACGO12M-WETTZ13S Intensive sessions, and scheduling fewer observations negatively impacts UT1 results. Also, preliminary analysis of the scheduled and achieved SNRs of the K2-Ws observations and the SNRs' ratios shows examples where the achieved SNRs are either too high, indicating long observations that could have been replaced by a greater number of shorter observations, or too low, indicating a lack of robustness that could lead to observation loss. In this poster we describe key aspects of how the K2-Ws Intensives have been scheduled during 2021. Then we discuss the areas of concern and the status of efforts to make improvements in these areas.

## Key Scheduling Aspects in 2021

- Scheduling was done by the Sked program, mainly through automated scheduling.
- Manual scheduling was used mainly to insert calibrator observations at least 15 minutes apart at times when Sked selected the target calibrator source or a source at a similar RA and declination.
- Manual scheduling was used for other details such as completing a schedule that stopped early.

| Scheduling aspect | | Impact | Plans for improvement? |
|---|---|---|---|
| Calibrator observations | Three 120 second observations | Calibrator observations can replace multiple shorter scans, lowering the number of observations and in turn degrading the UT1 results. | no |
| Station SEFDS | Updated for each schedule based on the averages of SEFDs from station start/stop messages (when available). Averages from the past day, week, two weeks, and month are considered. | SEFDs contribute to the scheduled scan lengths, which affect the number of scheduled observations (and in turn UT1) and the observed SNRs. | yes |
| Source fluxes | Catalogued ~ once per week after analysts have used Snranal to calculate the fluxes using the latest R1s and R4s. | Fluxes contribute to the scheduled scan lengths. | yes |
| 2021 scan length targets | Minimum 40 seconds<br>Maximum 200 seconds | Targets set the scheduled scan length limits. | started |

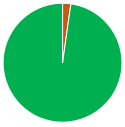
## Observed SNRs and Observed to Scheduled SNR Ratios

### SNRs

Most scans succeeded (were correlated with an SNR of at least 7).

Most SNR failures seem to be unrelated to the schedule.

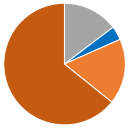
**All observations' SNRs**



SNR ≥ 7 success: 4816 (97.8%)

0 ≤ SNR < 7 failure: 109 (2.2%)

**SNRs of 109 failed observations**



Confirmed unrelated: 70 (64.2%)

Believed unrelated: 19 (17.4%)

Cause not known: 16 (14.7%)

**Only four (3.7%) of the SNR failures appear to be related to the schedule (specifically to the source fluxes used).**

### SNR Ratios

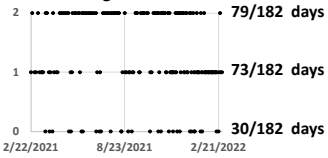
But the averages of each session's observed to scheduled SNR ratios indicate some problems.

**Session SNR ratio averages**


Lower averages show an overestimation of source and/or station strength that could lead to observation loss. Higher averages show underestimation that kept additional observations from being scheduled. We prefer SNR ratios to be between 0.9 and 1.1. NB: The ratios have been halved because observed SNRs are based on four bands while scheduled SNRs are based on one band.

### Influence of Station SEFDs

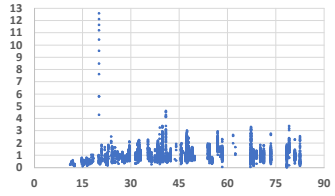
**Number of stations (K2 and/or Ws) with good SEFD measurements on a date when a schedule was generated or observed**




- It is hard to use the latest SEFDs in scheduling and to assess the effects of the SEFDs on the SNR ratios because stations do not always have time to provide SEFDs in their start/stop messages, and strong sources are not always available. During the year shown, both stations' SEFDs were available only 79 out of 182 scheduling and observing days.
- The GSFC Analysis Center is discussing ways to improve SEFD selection and prediction.

### Influence of Source Fluxes

**SNR ratio vs. source declination in degrees**




- A preliminary look shows that the ratios >= 4 are due to the fluxes of two sources in two source catalogs.
- All 130 observations of declination <= 17.16 degrees have SNR ratios < 1. This behavior is not seen in the S/X sessions, so it might be due to the small data set. But this should be watched for possible significance.

## Minimum and Maximum Scan Lengths

### Problem with the 2021 Schedule Configuration

**Problem:** The K2-Ws minimum and maximum scan lengths were 40 and 200 seconds, respectively, during 2021 and January 2022, causing the sessions to have ~ half the scans of the first five Mg-Ws sessions, which had mostly 30 to 48 second scans with a few 120 second scans.

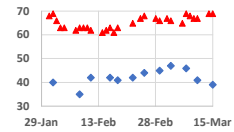
**Solution:** Lower the minimum and maximum scan lengths used in scheduling.

- Several combinations of shorter minimum and maximum scan lengths were tested.
- A 20/60 second minimum/maximum scan length generated some short schedules due to a reduction of the list of sources that could be observed. Reducing the target SNRs from 20 to 15 did not help. But the configuration with 20/60 second minimum/maximum scan lengths and target SNRs of 15 provided the most observations and the best UT1 formal errors.
- On 1/31/2022, testing of the new schedule configuration began in the daily K2-Ws sessions.

### Effect of the New Configuration on Schedules

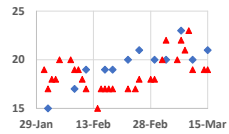
Source availability has a large impact on scheduling one-hour sessions. So, this section compares the first six weeks of the **new sessions** (January 31 to March 15 **2022**) to **old sessions** from the same six weeks in **2021** to ensure that the two sets observed the same areas of the sky. Due to a change in scheduling frequency, there are **12 old sessions** and **29 new sessions.**

**Number of scheduled observations**




**Six weeks 2021 (old) vs. six weeks 2022 (new)**

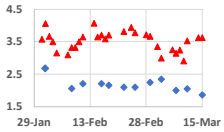
**Number of scheduled sources**




**Six weeks 2021 (old) vs. six weeks 2022 (new)**

The new schedule configuration increases the number of scheduled observations (left) without harming the number of scheduled sources (right).

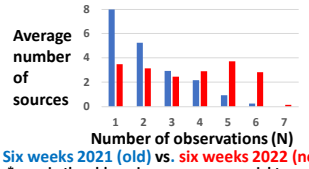
**Number of scheduled observations per source**




**Six weeks 2021 (old) vs. six weeks 2022 (new)**

But the new configuration increases the average number of scheduled observations per source. This decreases robustness because if a source is observed more times, its observations will make up a greater percentage of the schedule, and therefore the loss of the source will have a greater impact on the session.

**Average number of sources per session that were observed N times in the session ***




**Six weeks 2021 (old) vs. six weeks 2022 (new)**

*** e.g., in the old sessions, on average, eight sources were observed one time and 5.3 sources two times.**

A source observed once in a session might not connect well to the solution, but the more observations per source in a session, the more damage if the source fails. The new configuration reduces the average number of sources observed once from 8 in the old sessions to 3.5, but the new sessions have more sources with four or more observations.

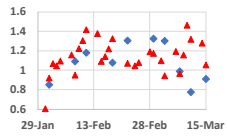
The increased number of observations per source makes the correct setting of station SEFDs and source fluxes during scheduling even more important with the new configuration.

**Observation SNRs**


| | SNR ≥ 7 success | 0 ≤ SNR < 7 failure |
|---|---|---|
| Six weeks 2021 (old) | 413 | 5 |
| Six weeks 2022 (new) | 1889 | 3 |

In its first six weeks, the new configuration has not hurt the observed SNRs. In fact, its SNRs are slightly improved. 0.2% (3) of its observations failed, in contrast to 1.2% (5) of the observations made with the old configuration during the six weeks in 2021.

**Session SNR ratio averages**




**Six weeks 2021 (old) vs. six weeks 2022 (new)**

The SNR ratios averaged over a session also show no problems. There is no obvious difference between the two sets of averages when plotted, and the average of each set's values is 1.1.

**UT1 results are scheduled to be presented by Gipson et al. at 10:30 UT on Wednesday March 30.**

## Conclusions and Acknowledgments

- The 2021 K2-Ws observations have generally good SNRs. But the observed to scheduled session SNR ratios are sometimes too low or too high. Ratios > 4 come from two source fluxes in two catalogs. Usable station SEFDs are not always available, so scheduling, as well as assessment of the observed SNRs, can be difficult.
- The GSFC Analysis Center is discussing ways to improve SEFD selection and prediction.
- The 2021 K2-Ws sessions had scheduled observation counts that were too low, due to large minimum and maximum scan lengths of 40 and 200 seconds, respectively. Starting with the 1/31/2022 schedule, the scan length range has been reduced to 20 to 60 seconds, and the target SNRs have been reduced from 20 to 15 to avoid excluding too many sources.
- The new configuration has improved the number of scheduled observations without harming the SNRs or SNR ratios. But more observations are now scheduled per source, making correct station SEFD and source flux values even more important during scheduling than before.
- We thank Kokee and Wettzell for providing SEFD measurements whenever possible. We thank the Washington Correlator for providing information about the K2-Ws correlation.

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