

SOFIA

Observation planning

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SOFIA Science Planning – time scales

- **Long Range Planning** (Full Cycle/year – **Cycle Scheduler**)
 - Instrument cadence
 - A/C maintenance schedule
 - Southern Deployment (instrument selection)
 - PSI team availability
- **Science Flight Planning** (Flight Series/month – **Short Term Scheduler**)
 - Detailed observation lay-out (match obs. requests to flight legs)
 - Weather (water vapor) considerations, airspace constraints
 - Calibrations
 - Science scripting
- **“FAA Flight planning”** (Individual flights/days)
 - Weather, wind updates
 - SUA activations, etc.

Cycle Planning

Long term – Cycle – Scheduling

- After the SMO Director (U.S.) and Deputy (German) make and compare proposal selections, an instrument cadence is laid out for the year and nominal assignments of each target is done for each “Flight Series”
- Cycle scheduling depends on
 - Aircraft maintenance requirements and phasing
 - Availability of PSI instruments and instrument teams
 - Target visibility
 - Balancing outbound and homebound observations
 - Terrestrial Doppler shifts (e.g. [O I] line)
 - Phasing requirements, e.g. Solar System targets, Exo-planets
 - Southern Hemisphere deployment logistics
- Cycle scheduling, so far, primarily done “by hand”
 - Software tool “Cycle Scheduler” being optimized

Long Term planning - future

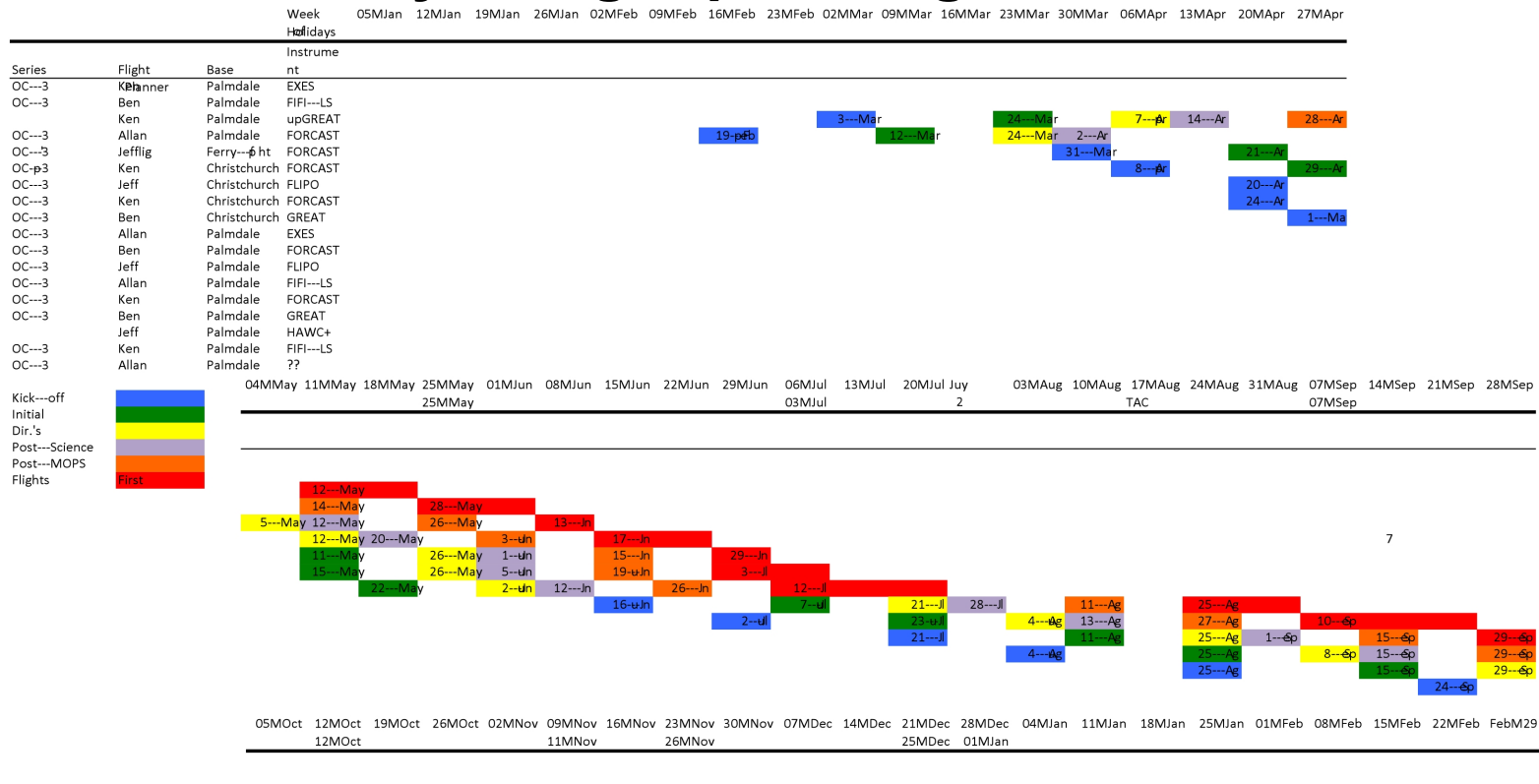
- As we have more instruments and more observing, an automated planning process will be critical
 - “Cycle Scheduler”
- Need to “exercise” the existing software to find its weaknesses and resolve them
 - Deal with timing constraints, target monitoring, water vapor, etc.
- Account for non-target constraints
 - Holidays (US/DE), maintenance, SI (team) availability, etc.
- Currently; single, part time, software developer (on this)
 - testing and validation by flight planners

Flight Planning

Flight Series Planning

- The planning for a flight series has many stake holders and require a significant time. Starts 10 weeks before first flight (FF)
- FF-10 weeks Flight Series Kick-off meeting
 - Science inputs from SMO dir., Oper. Inputs from IS, SciOps, TO, MD
 - *Science Flight planner uses in*
- FF-7 weeks Initial flight plans delivered by Flight Planner
 - *Instrument Scientist, AD-SciOps, SMO Dir., evaluate and iterate w. SFP*
- FF-5 weeks SMO Director's Review
 - Do the trade-offs conform to SMO Director's priorities, are any trades, risks or priorities correctly accounted for?
- FF-4 weeks "Post Science" plans due
 - *SFP update/finalize plans, based on inputs from Dir. Rev.*
- FF-2 weeks "Post MOPS" plans due
 - *Mission Ops. review and update for target acquisition, TA setup, SUA avoidance, flight altitude, etc. issues.*

Cy 3 Flight planning time line



Flight Series Planning – practicalities

- Observations are divided into “Must Do”, “Do if Time” and Survey (Based on TAC grades and SMO Director decision)
 - Scheduling priority in that order, then by TAC grade
 - Considerations are also given to achieving significant parts of program (“publishable observations”)
 - Non-unique solution – scientific judgment will always be needed
- Calibration observations and any engineering/instrument tests must also be incorporated
 - Small list of good calibrators
- Flight Planner and Instrument/Support Scientist work closely together in developing plans - I(/S)S charged with knowing the science requirement
 - For the PSI’s the instrument PI is more directly involved in planning

Flight Series Planning - II

- FF-1 week Flight Plans due to Pilot's Office
 - Mission Planner ("DAOFF") reviews flights: takeoff and landing, SUAs, Air Traffic Control concerns

Now working on individual flights. "T" is the takeoff time of an individual flight in the series.

- T – 32 to 36h 36hWx Flight Plan due to Pilot's Office
 - Flight Planners update flight plan to the latest weather forecast
 - Mission Planners recalculate flight plan in pilots' s/w, set Day-of-Flight timeline and fuel load; if the winds pushed the flight plans in SUAs, check for availability
- T – 8 to 12h 12hWx Flight Plan due to Pilot's Office
 - Flight Planners update flight plan to the latest forecast
 - Mission Planners recalculate flight plan in pilots' s/w and file the plan with Air Traffic Control

Flight Series Planning – practical constraints

- Efficient and accurate flight planning requires complete and correct inputs in DCS
 - AORs, observing constraints (target phases etc), GTO inputs
- We only have 3 (1/2) Science Flight Planners
 - Also function as in-flight SFP, help develop software tools
- Flight series often depend on each other
 - Targets may not fit in a series where they were originally assumed, must then be moved forward
 - Northern and Southern series can have very large overlap of inner Galaxy targets.

Flight Series Science Planning

- As the initial flight plans are delivered, the SMO Instrument/Support Scientists and/or instrument PIs develop observing scripts, based on DCS inputs.
 - If any ambiguity arises, the I(/S)S contacts the GI for clarification
- Must also incorporate calibration observation details
- Mainly a manual operation, time constrained
 - Flight legs may not match one-to-one observing requests
 - Software under development
- After the Director's Review is passed, SciOps invites GIs to participate on flights
 - Nominally 2 "GI seats" per flight
 - PI, co-I or (with PIs explicit endorsement) students allowed
 - Seats assigned based on
 - Required/expected in-flight real-time inputs
 - Most observations in a flight
 - Longest observation in a flight
 - "Spread the joy"

Day-of-flight/GI participation

- GIs are allowed and encouraged to participate
 - Often informative, occasionally critical
 - Limited seating, badging requirements (foreign nationals)
- SOFIA is a queue/service mode observatory
 - Highly skilled staff, will acquire observations for the GIs
 - Cannot change flights, target order, leg durations
- Observations are performed via scripts
 - Not always possible/advisable to change on-the-fly
 - Not practical to, routinely, have multiple versions
 - Support Scientist responsible
- Trade-off between flexibility and quality assurance
 - Different between time dependent and “regular” obs.
 - Well characterized data archive important
- Policy for GI in-flight requests published (by W. Reach) in April 2014
 - Distributed to GIs participating in flight

From “SOFIA Guest Investigator Guidelines“ Issued by ADS W. Reach, April 2014

In-flight changes to an observation are discouraged as observations with most SOFIA instruments are executed via pre-validated observing scripts, and as SOFIA observations are also intended to populate a well documented and calibrated data archive.

- Changes that would request in a change of flight plan will not be considered in flight, except in exceptional circumstances. Authority to approve/reject such changes rests with the Mission Director.
- In-flight observation changes that do not require a change in the flight plan (e.g. modification to the selection or relative exposure times in different photometric filters) may be requested and will be considered if they do not violate proprietary rights of other observers and can be implemented at an acceptable risk to execution of the observation. Authority to approve/reject such changes rests with the Instrument Scientist.

Cycle 4

(“Notional” – CfP not yet released)

Cycle 4 Overview

- Duration Feb 2016 – Jan 2017
- US queue: ~500h
- DE queue: ~70h
- Two-instrument Southern Deployment planned

Major Changes from Cycle 3

- Added **capabilities**:
 - HAWC+, FPI, upGREAT (LFA), long-wavelength FLITECAM
- Removed **capabilities** (for Cycle 4):
 - Cross dispersed FORCAST spectroscopy
 - M channel for GREAT
- New **policies**:
 - “Impact Proposal” category – large, multi-year, aimed at focused, specific scientific questions of high potential impact (not, primarily, “just” surveys). Execution/implementation parallel to GTO programs
 - Carry forward highly ranked “southern proposals” for non-selected instruments for two cycles (on request from DSI/Krabbe)
 - Limited funding advertised for Spitzer/Herschel archival work, directly supporting SOFIA observations