JWST Coronagraphic Contrast Sensitivity Working Group Meeting

06/24/21

Agenda

1. Review of inputs, format, and assumptions
2. Implementing these in a coronagraphic sequence

Input files available at:
www.starkspace.com/shared/NIRCAM_OPDS.zip
www.starkspace.com/shared/MIRI_OPDS.zip

These are preliminary; an iteration is expected based on today's meeting.

Each package contains a readme.txt file explaining format and units of files. OPD files are multi-extension fits, with "best case", "nominal", and "requirement" scenarios given by 0 – 2 extensions, respectively. Dynamic terms are 100 x 100 x nt dimensions, where nt is the length of the time vector.

Orientation of all dynamic terms should be identical. **I have not checked if this is the case for the OTE exit pupil WFE.**

Dynamic terms calculated for 5 hours in steps of $\pi/3$ minutes. GTO coronagraph sequences typically take 1-6 hours depending on target, filters, masks, rolls, etc.

Estimating Typical Slew Size

- Pueyo & Hines report the typical slew from the SODRM is ~3 deg
- Evaluating the slew from coronagraphic GTO programs (at right) suggests a mean slew of ~8 deg
- When implementing the impact of the slew on WFE, we basically assume it is all pitch

Currently adopting 3 deg for ”best case” scenario and 10 deg for “nominal” scenario. This is conservative. Could revise downward.

GTO Progran	PI	Target name	Science RA (deg)	Science Dec (deg)	Ref RA (deg)	Ref Dec (deg)	Slew Angle (deg)
1184	Schlieder	AU Mic	311.3	-31.3	56.8	-2	256.181069
		HIP 17695	56.8	-2	64.3	8.8	13.1487642
		G 7-34	64.3	8.8	73.1	-16.8	27.0702789
		TYC 5899	73.1	-16.8	311.3	-31.3	238.640923
		Fomalhaut C	342	-24.4	91.2	-34.6	251.007331
		AP Col	91.2	-34.6	146.2	-12.3	59.3488837
		2MJ0944	146.2	-12.3	54.9	-35.4	94.1769611
		LP 944-20	54.9	-35.4	70.9	0	38.8479086
		2MJ0443	70.9	0	342	-24.4	272.19583
1193	Beichman	Vega	279.2	38.8	258.8	36.8	20.4978048
		Vega	279.2	38.8	310.4	45.3	31.8698917
		Eps Eri	53.2	-9.5	56.5	-12.1	4.20119031
		Eps Eri	53.2	-9.5	55.8	-9.8	2.61725047
		Fomalhaut	344.4	-29.6	343.8	-29.6	0.6
		Fomalhaut	344.4	-29.6	343.7	-15.8	13.8177422
1194	Beichman	HR 8799	346.9	21.1	351.3	23.4	4.96487663
		HR 8799	346.9	21.1	346.6	19.9	1.23693169
1195	Beichman	HD 95086	164.3	-68.7	165.5	-64.3	4.5607017
1241	Ressler	51 Eri	69.4	-2.5	71.2	-2.6	1.80277564
		Kappa And	355.1	44.3	355	45.4	1.1045361
		Beta Pic	86.8	-51.1	87.5	-56.2	5.14781507
		HR 2562	102.5	-60.2	101.2	-61.2	1.64012195
1412	Perrin	51 Eri	69.4	-2.5	72.2	-5.7	4.25205833
1183	Gaspar	HD 10647	25.6	-53.7	40.6	-50.8	15.2777616
		HD 107146	184.8	16.5	192.2	12.1	8.6092973
		HD 181327	290.7	-54.5	289.5	-53.4	1.62788206
		HD 61005	113.9	-32.2	108.6	-30.7	5.50817574
		HD 32297	75.6	7.5	74	5.4	2.64007576
1411	Stark	Beta Pic	86.8	-51.1	102	-61.9	18.6461792
						Mean	7.53115342
						Median	4.40638001
						Stddev	8.3071452

Amplitude Assumptions

Magnitudes of effects span from “best” to “requirement” in 3 values: [Best, Likely/Midpoint, Requirement]

- Best = best case scenario with no MUF
- Requirement = requirement is usually the worst case scenario (worst case slew w/ MUF)
- Likely/midpoint = expected performance when possible, midpoint used when there is insufficient information

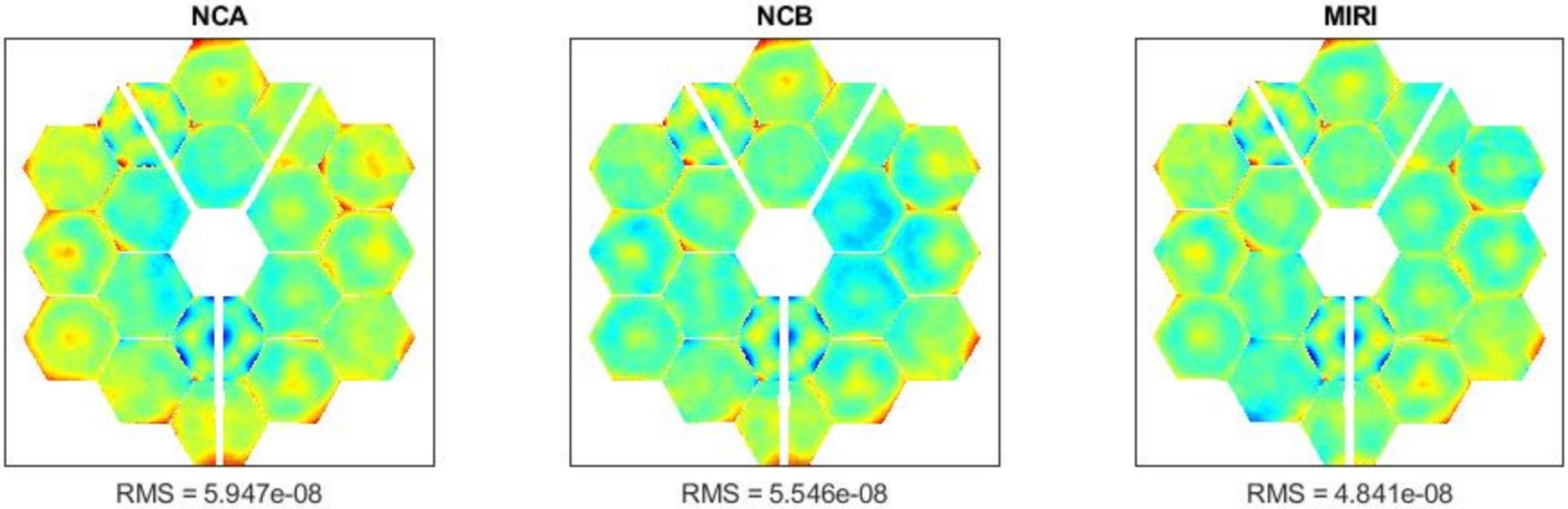
- Yellow highlight indicates TBR
- Pink highlight indicates value I made up
- No highlight indicates it was recommended/checked with the reference(s) indicated

Mode	NIRCam	MIRI
Target Acq	2D Gaussian [5, 7, 10 mas] per axis 1σ *Ref: Peiman & Mario G*	2D Gaussian [5, 7, 10 mas] per axis 1σ *Ref: Hines / Lajoie et al. (2016)*
Pupil shear	N/A	[0%, 2%, 4%] *Ref: Cavarroc et al. (2008)*
LOS Jitter	2D Gaussian [2.5,3.8, 5.8 mas] per axis 1σ *Ref: Peiman*	2D Gaussian [2.5,3.8,5.8 mas] per axis 1σ *Ref: Peiman*
IEC Oscillations	OPD vs time (sinusoidal), fixed DT=0.25 C, scale by MUF [MUF=1,MUF=1.7,MUF=2.8] *Ref: Joe Howard*	OPD vs time (sinusoidal), fixed DT=0.25 C, scale by MUF [MUF=1,MUF=1.7,MUF=2.8] *Ref: Joe Howard*
Frill/close-out	OPD vs time (exponential decay), fixed time constant [small slew (3 deg) no MUF, typical (10 deg) slew no MUF, requirement] *Ref: Joe Howard, Hines & Pueyo*	OPD vs time (exponential decay), fixed time constant [small slew (3 deg) no MUF, typical (10 deg) slew no MUF, requirement] *Ref: Joe Howard, Hines & Pueyo*
Thermal drift	OPD vs time (exponential decay), fixed time constant [small slew (3 deg) no MUF, typical (10 deg) slew no MUF, requirement] *Ref: Joe Howard, Hines & Pueyo*	OPD vs time (exponential decay), fixed time constant [small slew (3 deg) no MUF, typical (10 deg) slew no MUF, requirement] *Ref: Joe Howard, Hines & Pueyo*
Deployed dynamics	OPD vs time (segment-level randomization) [TBD w/ Joe] *Ref: Joe Howard*	OPD vs time (segment-level randomization) [TBD w/ Joe] *Ref: Joe Howard*

Still waiting on these, but amplitude is small

Static WFE

1024x1024 Post-WFSC Static WFE at OTE exit pupil

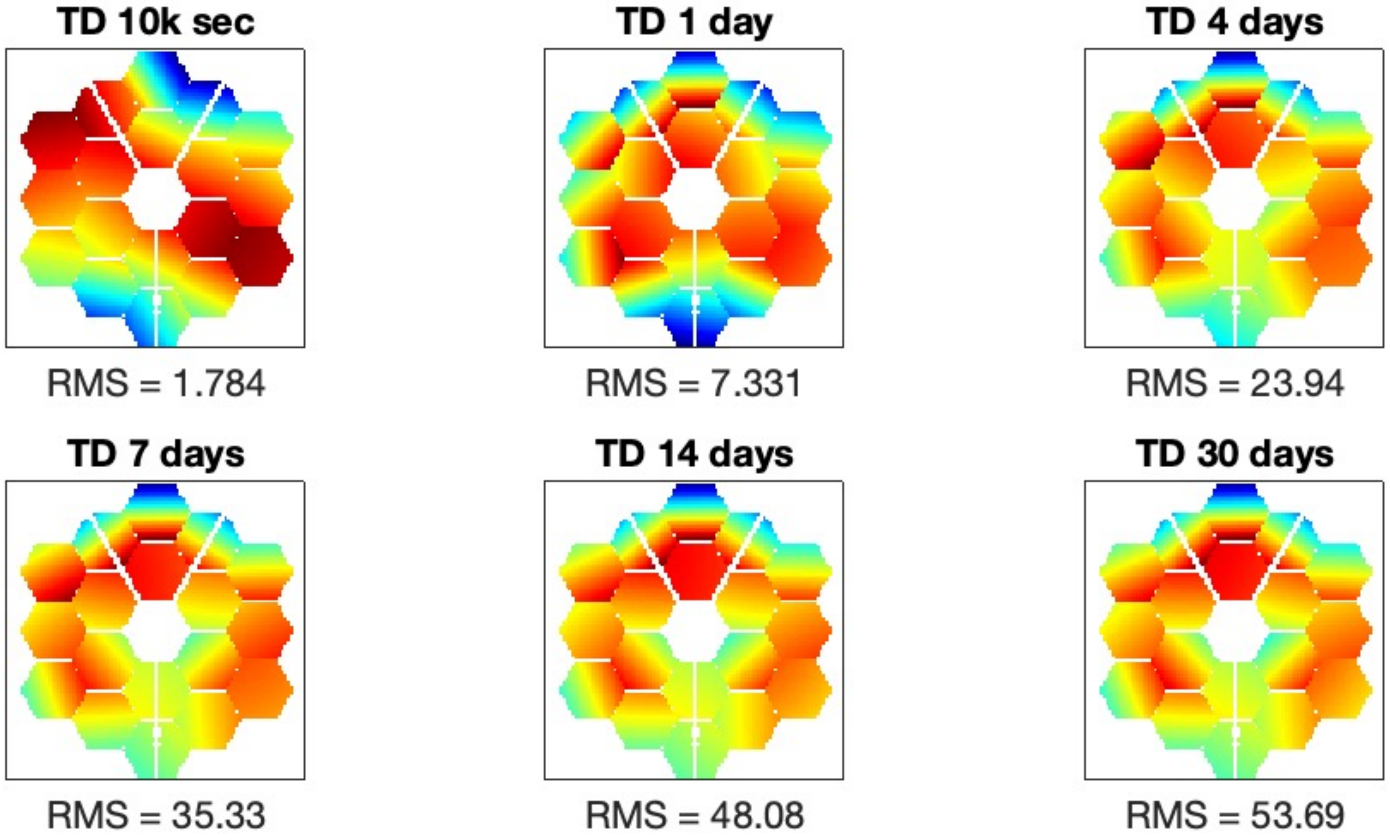


Joe Howard

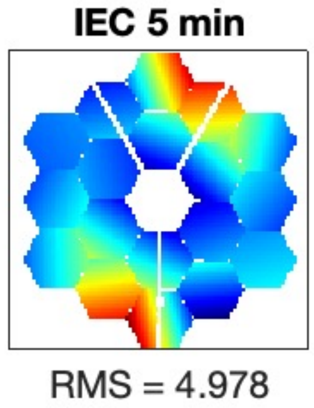
These are nominal WFE errors w/out jitter or stability included

Dynamic WFE Terms

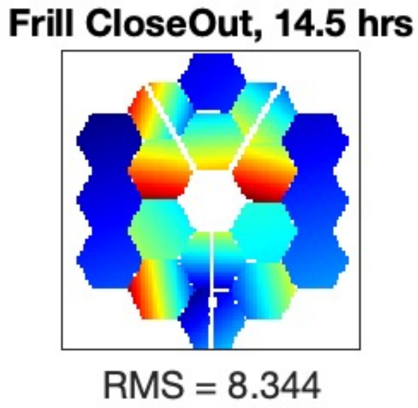
Thermal Relaxation (alignment + figure drift)



IEC Oscillations



Frill/Close-Out



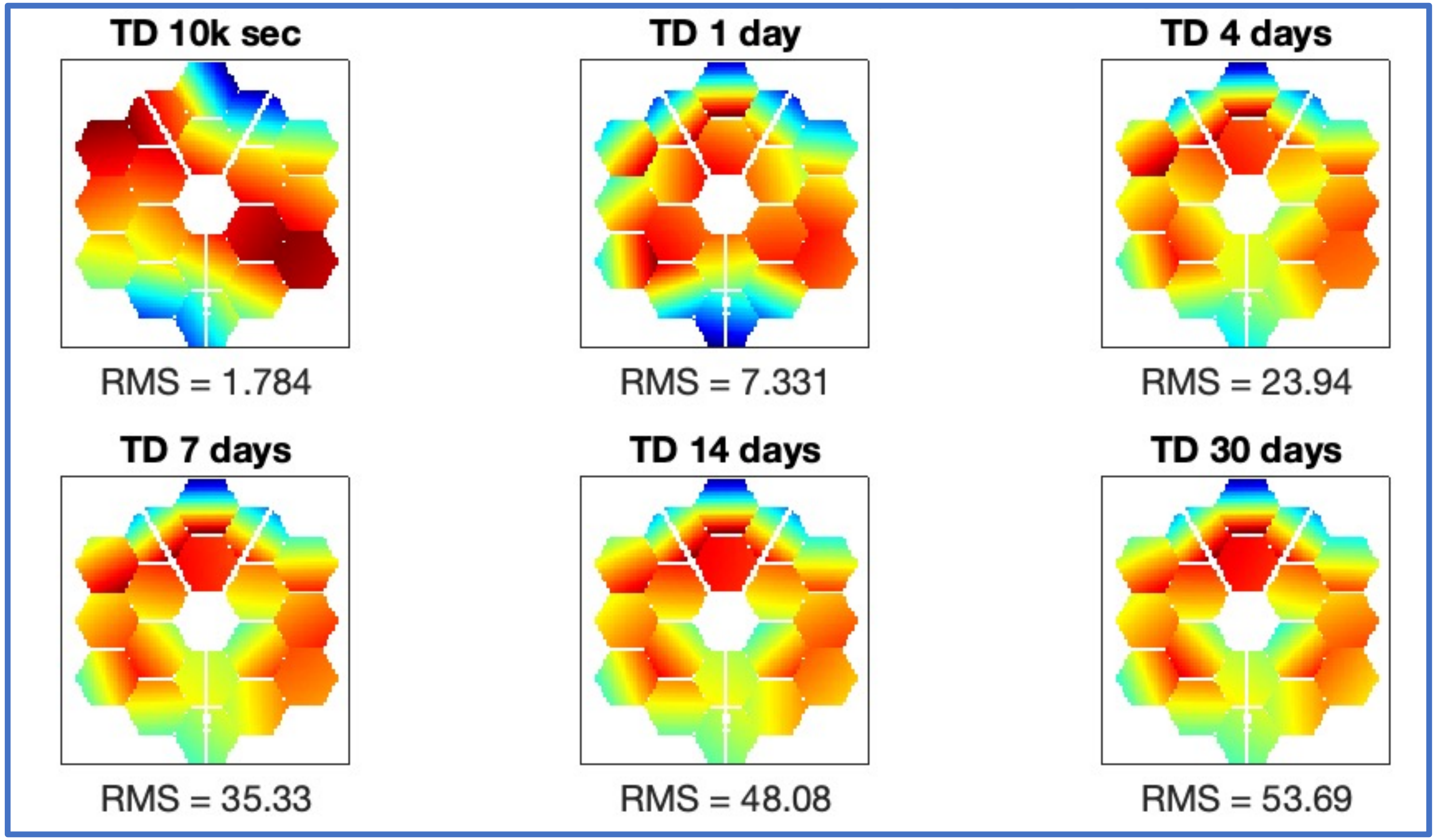
Deployed Dynamics

TBD

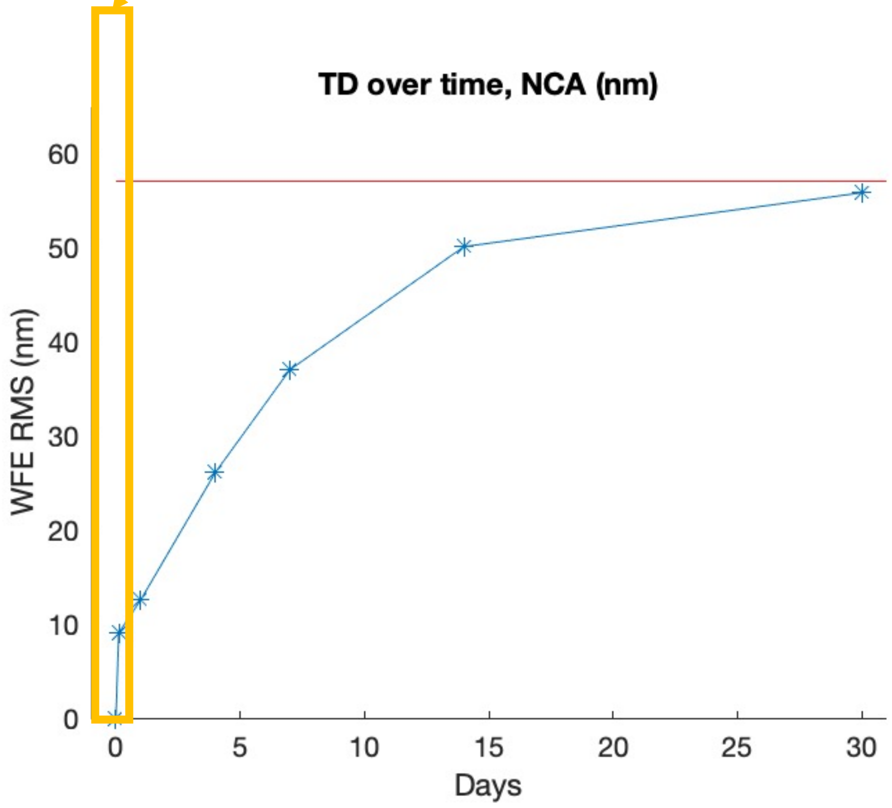
Joe Howard

Thermal Relaxation

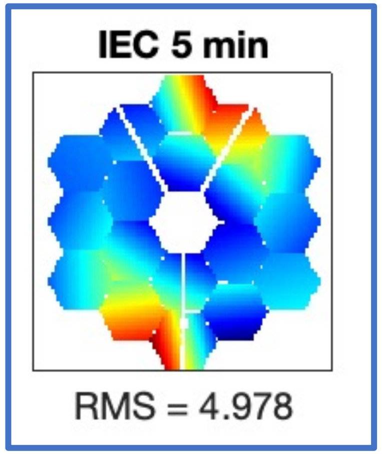
Thermal Relaxation (alignment + figure drift)



3D data cube provided is interpolated over this small range

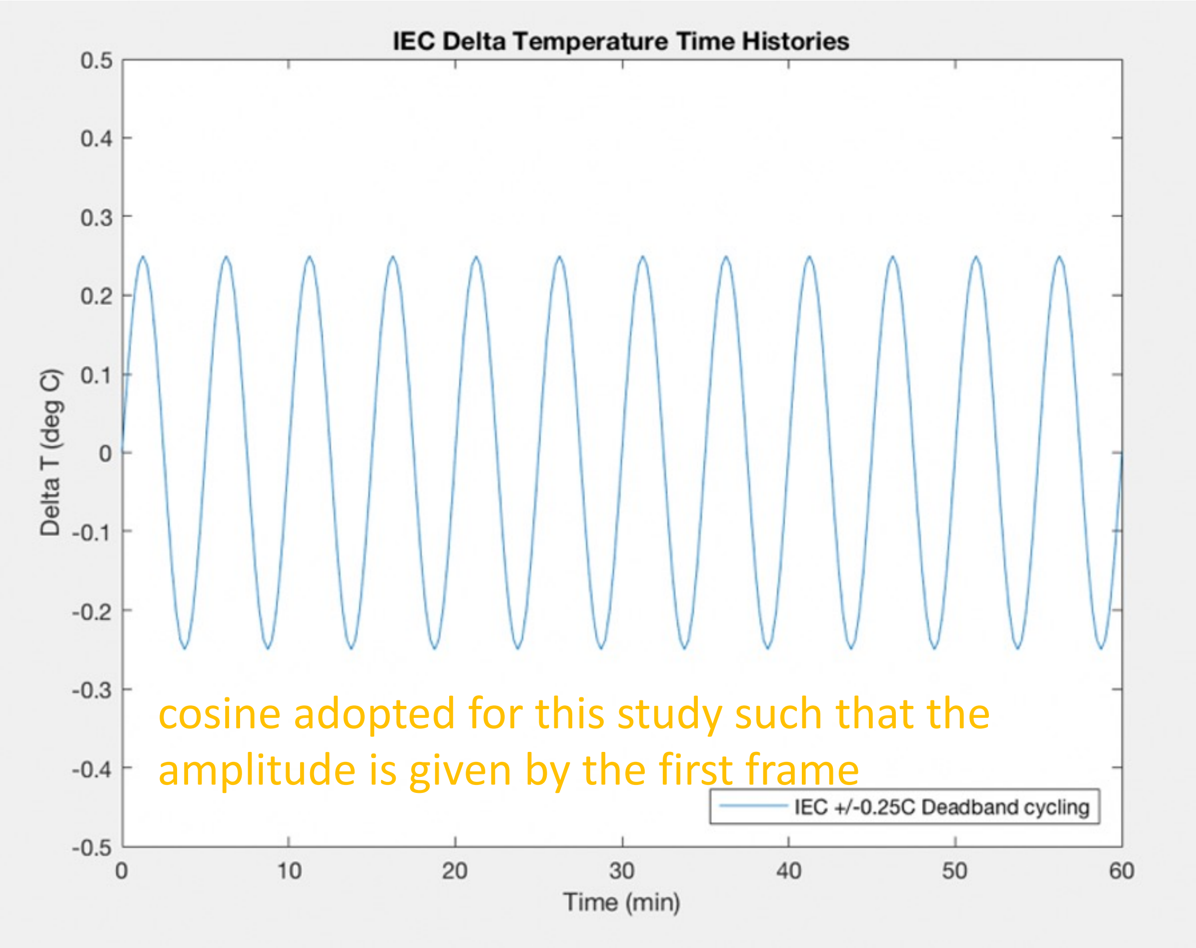


IEC Oscillations

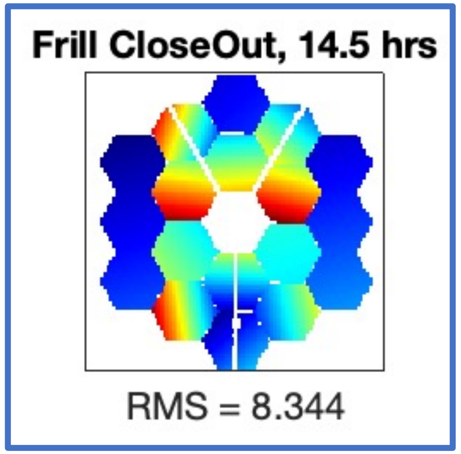


WFE(t) = WFE(t=0) * cos(A * t)

Where A = $2\pi/T$
And T = 5 min



Frill/CO



WFE(t) = WFE_0 * (exp(b*t) - 1)

Where b = -1/T
And T = 9 hours

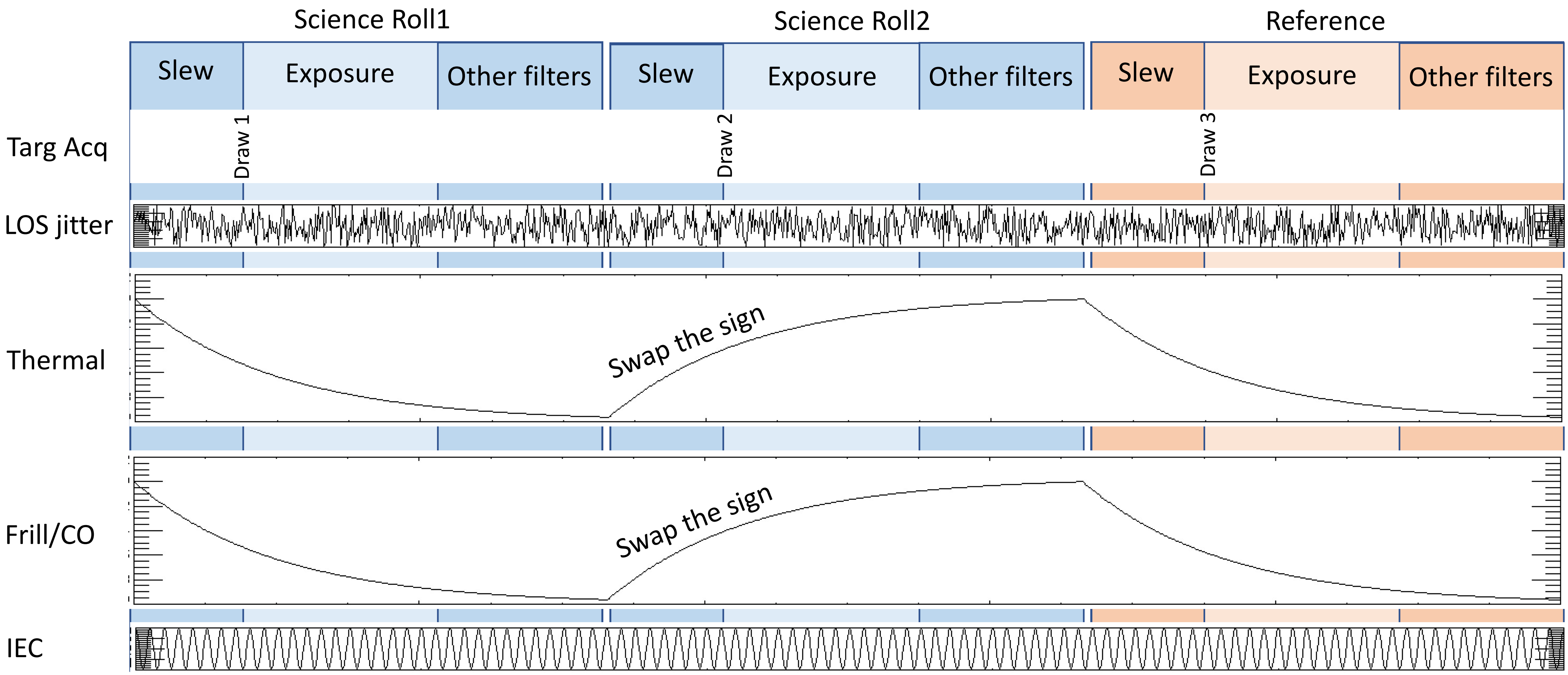
Target Acq

- 1000 draws of a 2D Gaussian of the magnitude decided upon for each scenario
- For each simulation of a coronagraph sequence comprised of N observations, select the next N values

LOS Jitter

- 1000 draws of a 2D Gaussian of the magnitude decided upon for each scenario
- No correspondence to time vector – discussion of implementation

Implementing as a Coronagraphic Sequence



Implementing as a Coronagraphic Sequence

- Science roll1, science roll2, reference vs Science roll1, reference, science roll2
- Exposure times and budgeting for multiple filters
- Slew angles
  - initial vs reference slew—keep them the same and adjust both with the "scenario"?
  - slew between rolls—always 5 deg?
- Slew times (constant vs consistent with assumed slew angle magnitude)
- Swapping sign of thermal and frill/CO WFE maps when slew occurs
- Correlate LOS jitter draws w/ time? Current time sampling would provide 300 total draws over 5 hour time vector. This would change the # of samples if we change anything about the exposure time.