Appendix E

# HRMA Dimensional Data

## *Terrance J. Gaetz*

In this appendix we gather together various mechanical dimensions relevant to the HRMA design and performance. Where possible, measured, as-built dimensions are provided; otherwise, the dimensions are obtained from the mechanical drawings, or from EKC technical notes. In some cases, the dimensions need to be built up from the component drawings.

## E.1 HRMA Axial Datum Locations

The HRMA Central Aperture Plate (CAP) is the fundamental reference for HRMA buildup. High precision datums were machined at three locations on the paraboloid side (Datum -A-) and on the hyperboloid side (Datum -D-). These were to be machined to within 0.5 mil and the -A- and -D- Datums were to be parallel to within 1 mil. The design CAP -A- to -D- thickness is $1.968^{+.000}_{-.010}$ inches (drawing EK5010-001). The measured as-built CAP Datum -A- to Datum -D- thickness is 1.965 inches (Discher (1996)).

Working forward from the Center Aperture Plate (CAP), the major assemblies relevant to the axial positioning of the HRMA optics and the associated baffles are

- HRMA Outer Cylinder (attached to CAP; interfaces with the Forward HRMA Structure [FHS] and the Aft HRMA Structure [AHS]).
- Forward HRMA Structure (FHS); includes the Forward Heater Plate (FHP).
- Thermal Precollimator; interfaces to the FHS. The precollimator includes ten thermal baffles; the forwardmost baffle includes tantalum and is also a critical X-ray baffle.

Working aftward from the CAP, the major assemblies relevant to the axial positioning of the HRMA optics and the associated baffles and the Fiducial Transfer System Periscope are (see Figure E.1):

- HRMA Outer Cylinder (attached to CAP; interfaces with the FHS and the AHS).
- Aft HRMA Structure (AHS); interfaces to the HRMA Outer Cylinder and includes the Aft Heater Plate (AHP) and 5 thermal baffles.
- Fiducial Transfer System Periscope.

The axial datum locations are summarized in Figure E.1, adapted from Discher (1996). The dimensions have been recalculated, based on the as-measured dimensions, taking $X = 0$ at the CAP Datum -A- plane.

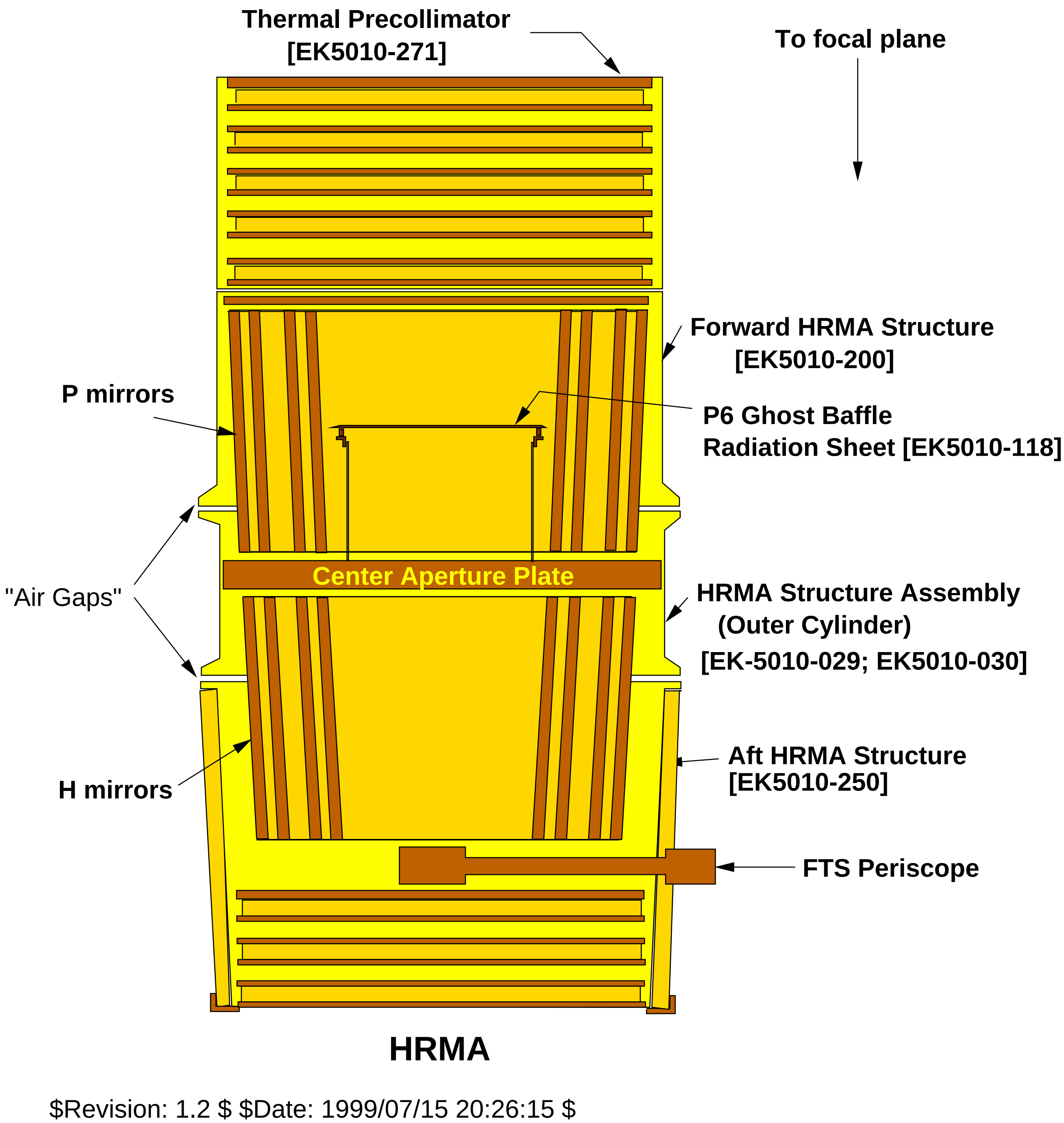


Figure E.1: Schematic of relevant HRMA assemblies

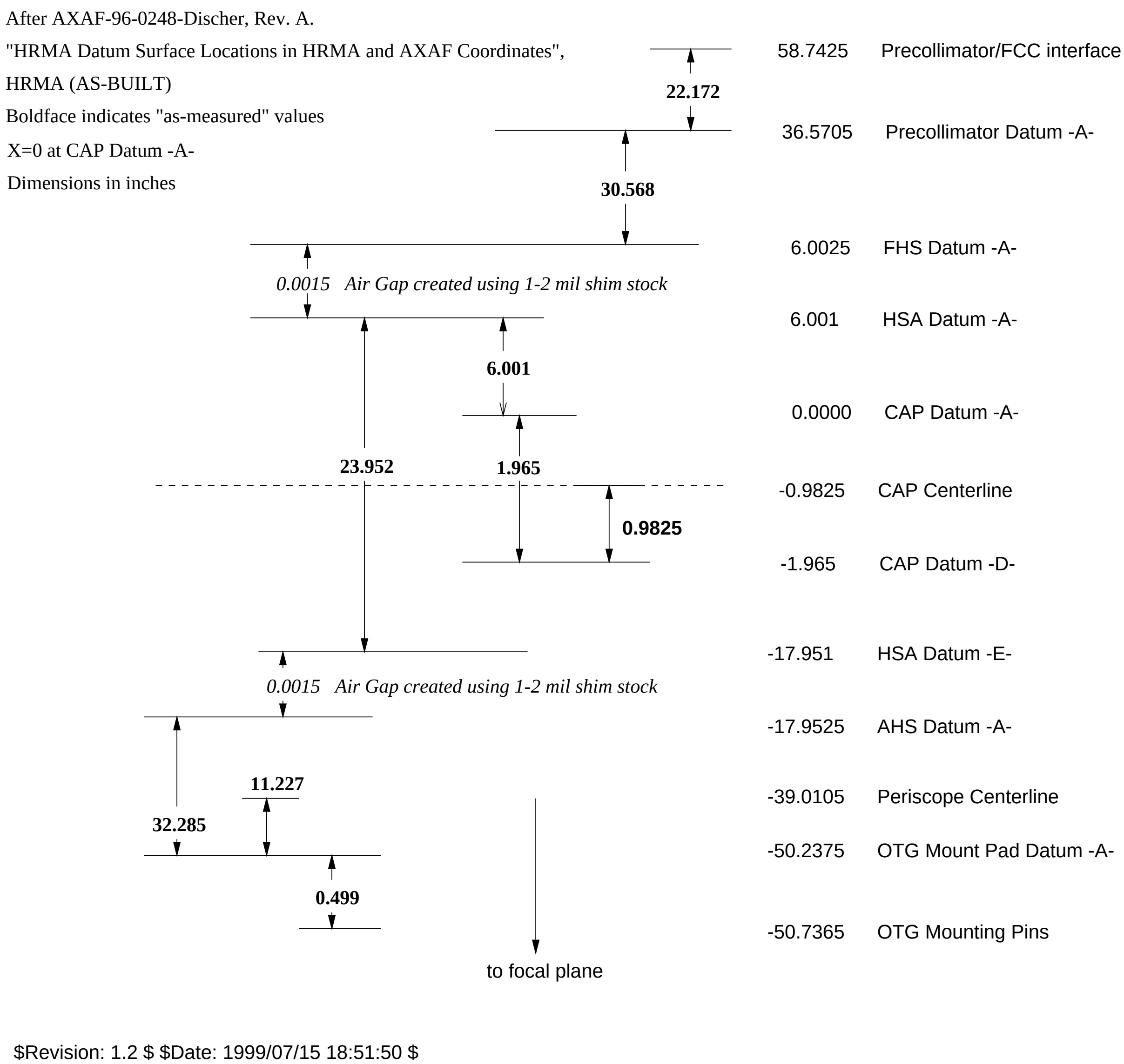


Figure E.2: HRMA Axial Datum Locations. After Discher (1996). Discher incorrectly swaps the labels for CAP Datum -A- and -D-; this has been corrected. Datum -A- is on the P-side of the CAP, and Datum -D- is on the H-side of the CAP.

### E.1.1 HRMA Baffle Plates

The basic properties of the HRMA baffle plates are listed in Table E.1. These are all thermal baffles used in controlling the temperatures in the HRMA interior. Note that Precollimator Baffle Plate 1 also serves as a critical X-Ray baffle, and helps to determine the ghost imaging and vignetting properties of the HRMA.

| Drawing | Precollimator & FHS plates | AHS plates | axial thickness (inches) | composition |
|---|---|---|---|---|
| EK5010-208 | #1 | | 0.105 | GREP (T300) + Tantalum [1] |
| EK5010-221 | #2–#8 | | 0.075 | GREP (T300) |
| EK5010-207 | #9, #10 | #2–#5 | 0.050 | GREP (P75) |
| EK5010-209 | | #6 | 0.075 | GREP (P75) |
| EK5010-210 | FHP | AHP | 0.250 | GREP (P75) |

[1] 0.05" GREP + 0.005" Ta + 0.05" GREP

Table E.1: Baffle plate information

### E.1.2 P6 Ghost Baffle

In order to control the ghost imaging performance of the HRMA, an additional baffle is placed in the P6 interior space; Figure E.1.2 is a schematic drawing of the baffle. A 5 mil thick tantalum *radiation sheet* is attached to an aluminum support structure which in turn is mounted directly to the P side of the Center Aperture Plate.

### E.1.3 HRMA Structure Assembly (HSA)

The HRMA Structure Assembly is detailed in drawings EK5010-029 (HRMA Outer Cylinder) and EK5010-030 (HRMA Structure Assembly). The primary axial datum is Datum -A- at the forward edge of the HSA; this mounts to the Forward HRMA Structure at FHS Datum -A-. The distance from HSA Datum -A- to the aft mounting points for the outer cylinder is nominally $23.950 \pm 0.010$ inches; the measured distance is 23.952 inches (EK5010-029 S/N#02; see Discher (1996)) The measured distance from CAP Datum -A- to HSA Datum -A- is 6.001 inches (Discher (1996); note that Discher labels CAP Datum -A- as -D- and *vice versa*).

### E.1.4 Forward HRMA Structure (FHS)

Datum -A- for the Forward HRMA Structure (FHS) is at the aft mounting plane. The FHS Datum -A- plane is separated from the HSA Datum -A- plane by an air gap created using 1–2 mil shim stock; in the following we take the gap to be 1.5 mil.

The nominal axial length of the FHS from Datum -A- to the forward mounting points (where the FHS mounts to the thermal precollimator) is 30.565 inches (EK5010-200 sheet 1); the measured distance from FHS Datum -A- to Precollimator Datum -A- (aft of the Precollimator) is 30.568 inches (Discher (1996)).

The axial location of the Forward Heater Plate relative to FHS Datum -A- can be obtained from drawing EK5010-200; Figure E.1.4 is a schematic version of the drawing. The forward edge of the Forward Heater Plate (FHP) is 1.795 inches aft of the forward edge of the Forward HRMA Structure (Section H-H of drawing EK5010-200). The FHP is constructed from P75 Graphite Epoxy (GREP) and is 0.25 inches thick axially (EK5010-210). Using the HRMA datum surface

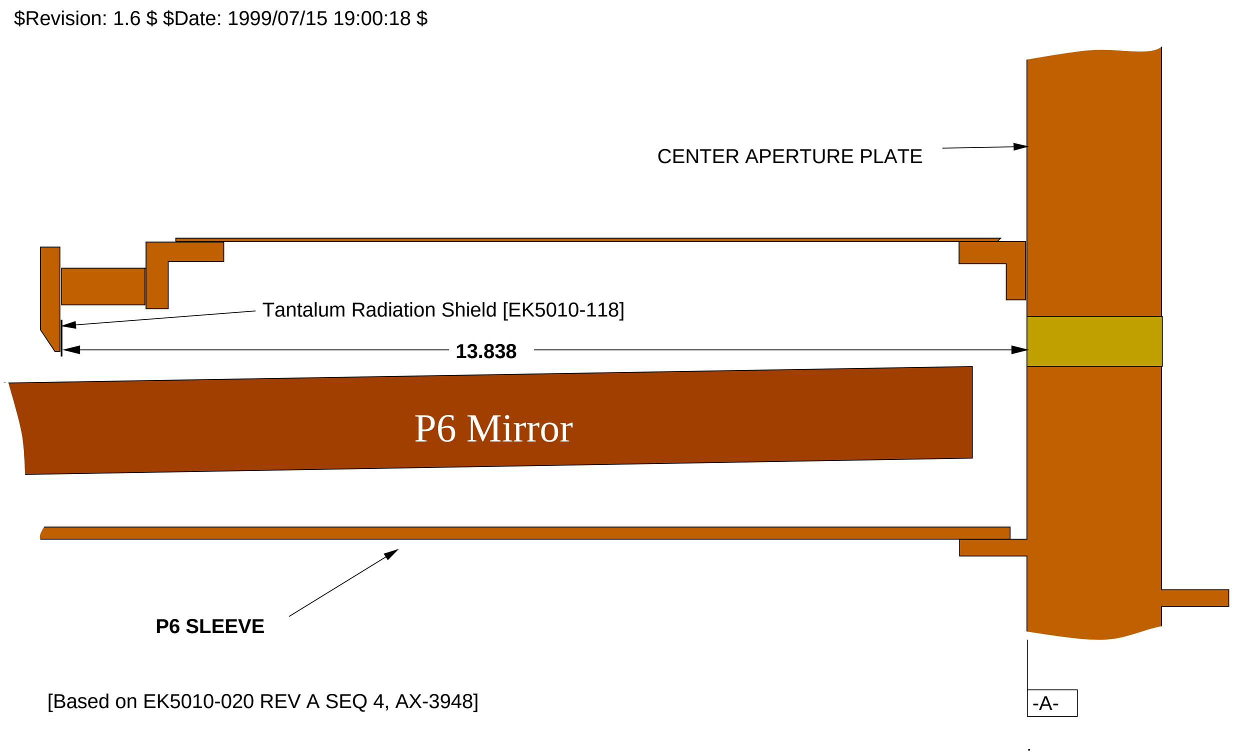


Figure E.3: Schematic of the P6 Ghost Baffle, based on drawing EK5010-020, Rev A, Seq 4. All dimensions are in inches.

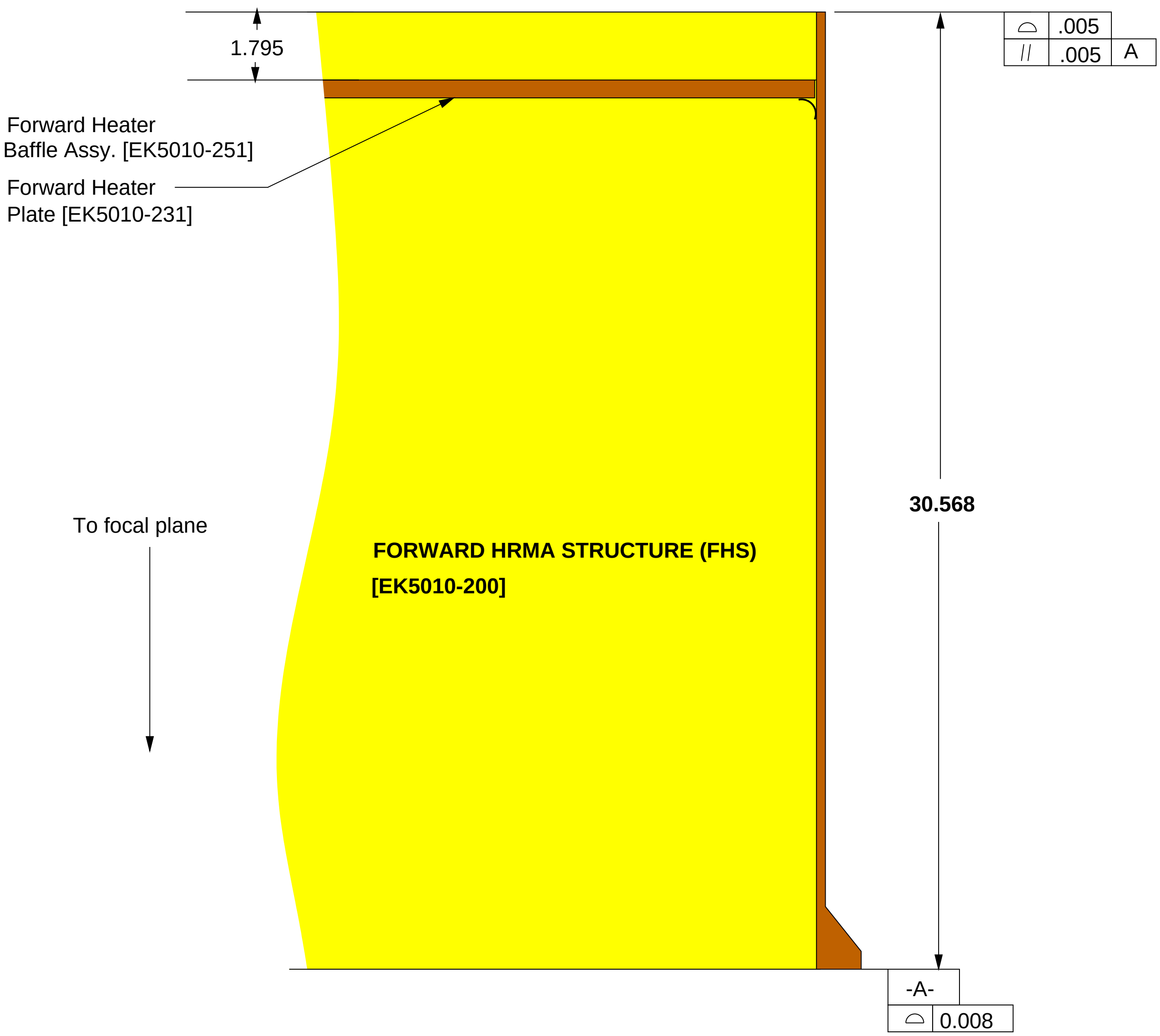


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Figure E.4: Schematic of the Forward HRMA Structure (based on drawing EK5010-200) including dimensional information. All dimensions are in inches.

locations (Figure E.1) the axial location of the forward ($+X$) side of the Forward Heater plate is calculated in Table E.2; the position is compared against the design in Table E.3.

| $X_{fwd}$ [1] (inches) | Calculation (inches) | Baffle Plate |
|---|---|---|
| 34.7755 | 36.5705 − 1.795 | Forward Heater Plate |

[1] Relative to CAP Datum -A-.

Table E.2: FHS baffle plate axial positions

| Baffle Plate | $X_{fwd}$ (inches) | $X_{fwd,corr}^{[2]}$ (inches) | $X_{Casey}$ [3] (inches) | $X_{fwd,corr} - X_{Casey}$ (inches) |
|---|---|---|---|---|
| FHP | 34.7755 | 35.758 | 35.745 | +0.013 |

[1]Corrected for 1/2 CAP Datum -A- to -D- distance
[2]Design value (Casey (1994))

Table E.3: FHP as-built axial position *vs.* design.

### E.1.5 Thermal Precollimator

The (thermal) Precollimator mounts to the forward edge of the Forward HRMA structure. The axial length of the Precollimator is 22.170 inches (EK5010-271); the measured distance from Precollimator Datum -A- to the Precollimator to Forward Contamination Cover interface is 22.172 inches (Discher (1996)).

The Precollimator includes ten baffle plates, the forwardmost one of which also serves as a critical X-ray baffle. Based on Section G–G of drawing EK5010-271, the distances from Precollimator Datum -A- to the aft side of of the plates in baffle assemblies #4, #6, #8, and #10 are 14.855, 10.045, 5.235, and 0.475 inches, respectively. In addition, the distance from the foward edge of one plate to the aft edge of the next (forward) plate is $2.320 \pm 0.010$ inches. Figure E.1.5 is a schematic version of drawing EK5010-271. From these dimensions, using the HRMA datum surface locations (Figure E.1) together with the plate thickness information (Table E.1) we can reconstruct the locations of the forward ($+X$) faces of the Precollimator baffles; see Table E.4. These axial positions are compared to those in the original design (Casey (1994)) in Table E.5.

### E.1.6 Aft HRMA Structure (AHS)

Datum -A- for the Aft HRMA Structure (AHS) is at its forward mounting plane; it attaches to the HRMA Structure Assembly at the HSA Datum -E- plane. The AHS Datum -E- plane is separated from the AHS Datum -A- plane by an air gap created using 1–2 mil shim stock; in the following we take the gap to be 1.5 mil.

The Aft HRMA Structure contains six baffle plates, labeled AHP (Aft Heater Plate), 2, 3, 4, 5, and 6. The axial locations of the AHS baffle plates can be obtained from drawing EK5010-250; Figure E.1.6 is a schematic version of the drawing. The basic dimensions are summarized in Table E.6; these can be combined with HRMA datum surface locations (Figure E.1) and baffle plate thicknesses (Table E.1) to get the axial positions of the forward ($+X$) faces of the AHS baffle plates (Table E.7); in Table E.8, these values are compared against the design values.

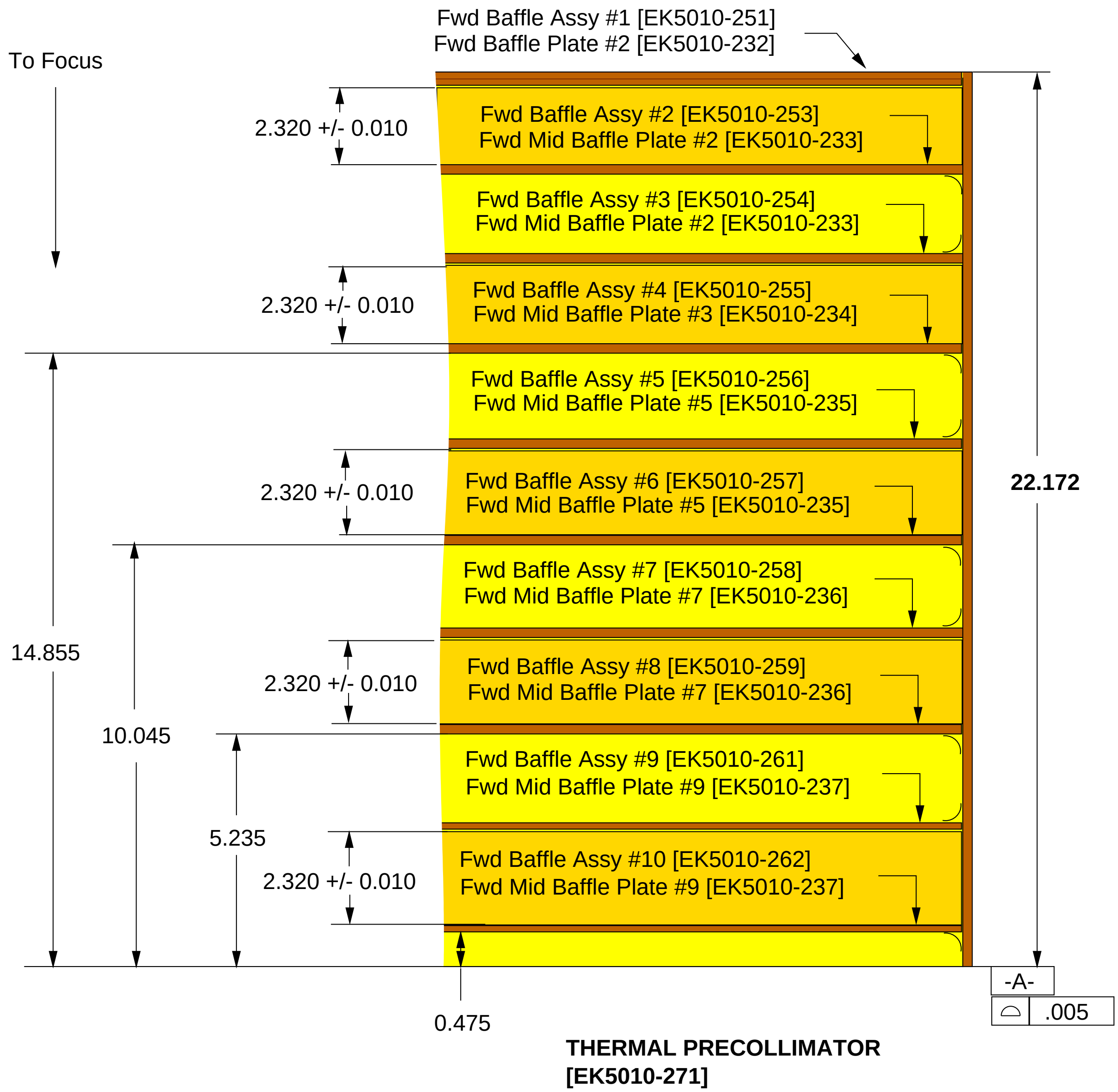


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Figure E.5: Schematic of the Thermal Precollimator (based on drawing EK5010-271, the Baffle Assembly drawings EK5010-252–259, EK5010-261–262, and Discher (1996)). All dimensions are in inches. See Table E.14 for the baffle nomenclature.

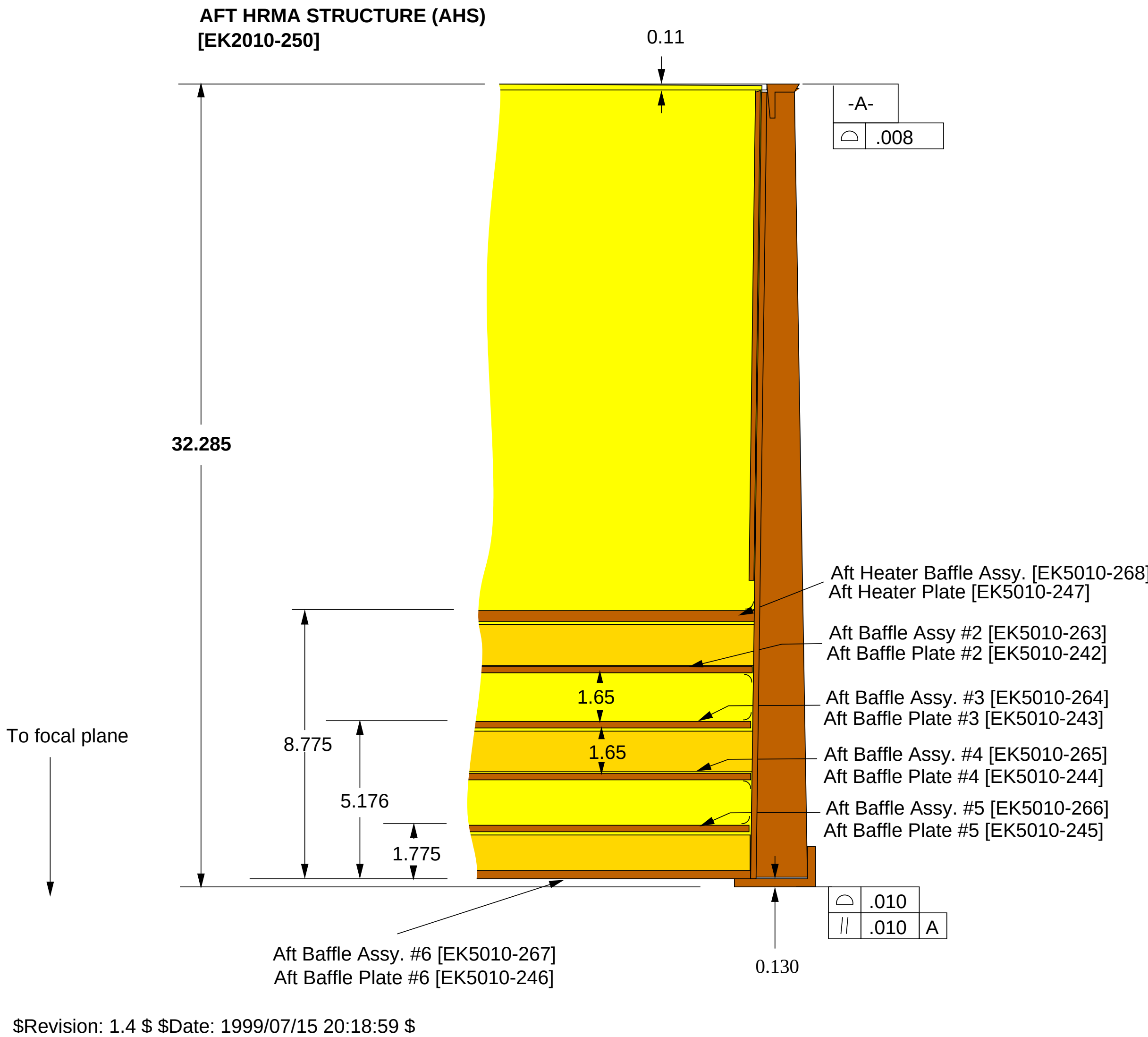


Figure E.6: Schematic of the Aft HRMA Structure (based on drawing EK5010-250 sheet 5) including dimensional information. All dimensions are in inches. See Table E.14 for the baffle nomenclature.

| $X_{fwd}$ [1] (inches) | Calculation (inches) | Baffle Plate[2] |
|---|---|---|
| 58.7425 | 36.5705 + 22.172 | Precollimator plate #1 |
| 37.0955 | 36.5705 + 0.475 + 0.050 | Precollimator plate #10 |
| 41.8805 | 36.5705 + 5.235 + 0.075 | Precollimator plate #8 |
| 46.6905 | 36.5705 + 10.045 + 0.075 | Precollimator plate #6 |
| 51.5005 | 36.5705 + 14.855 + 0.075 | Precollimator plate #4 |
| 39.4655 | 37.0955 + 2.320 + 0.050 | Precollimator plate #9 |
| 44.2755 | 41.8805 + 2.320 + 0.075 | Precollimator plate #7 |
| 49.0855 | 46.6905 + 2.320 + 0.075 | Precollimator plate #5 |
| 53.8955 | 51.5005 + 2.320 + 0.075 | Precollimator plate #3 |
| 56.3175 | 58.7425 − 2.320 − 0.105 | Precollimator plate #2 |

[1]Relative to CAP Datum -A-.
[2]See Table E.14 for the baffle nomenclature.

Table E.4: Precollimator baffle plate axial positions

## E.2 HRMA Mirror Spacing

A critical aspect of the HRMA design is the positioning of the mirrors relative to the CAP datums. The P to H optic separation controls the influence of symmetric errors, and the relative P to H positioning for different shells controls the axial parfocalization. The mirror axial positions were measured during HRMA assembly and alignment by gauging from CAP reference Datum -A- (in the case of the P optics) and Datum -D- (in the case of the H optics). Figure E.7 is a schematic of the mirror positioning relative to the CAP, and Table E.9 summarizes the measurements.

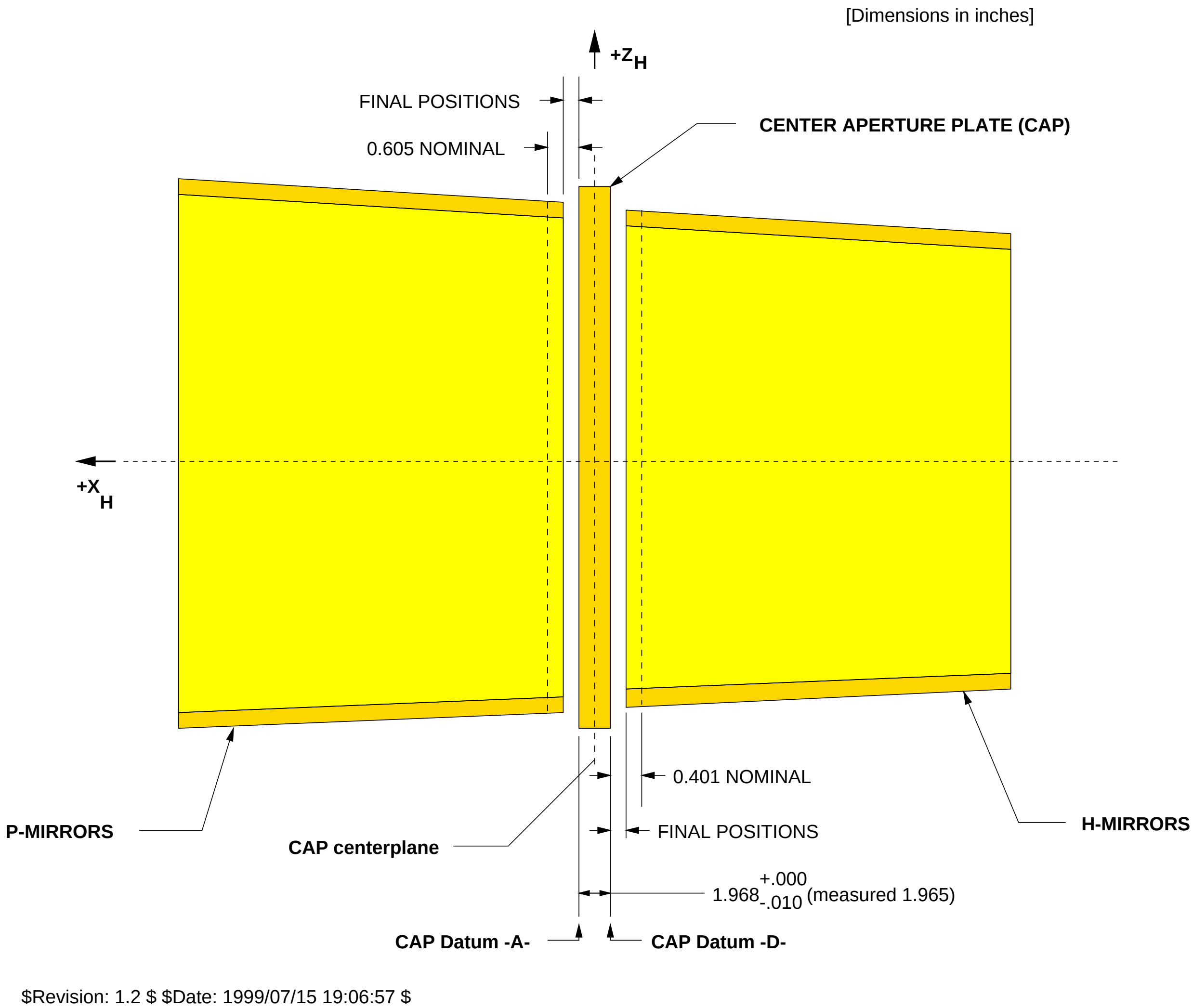


Figure E.7: Schematic of HRMA mirror positions. Adapted from a K. A. Havey (EKC) schematic."

| Baffle Plate[1] | $X_{fwd}$ (inches) | $X_{fwd,corr}^{[2]}$ (inches) | $X_{Casey}$ [3] (inches) | $X_{fwd,corr} - X_{Casey}$ (inches) |
|---|---|---|---|---|
| #1 | 58.7425 | 59.725 | 59.710 | +0.015 |
| #2 | 56.3175 | 57.300 | 57.280 | +0.020 |
| #3 | 53.8955 | 54.878 | 54.875 | +0.003 |
| #4 | 51.5005 | 52.483 | 52.470 | +0.013 |
| #5 | 49.0855 | 50.068 | 50.065 | +0.003 |
| #6 | 46.6905 | 47.673 | 47.660 | +0.013 |
| #7 | 44.2755 | 45.258 | 45.255 | +0.003 |
| #8 | 41.8805 | 42.863 | 42.850 | +0.013 |
| #9 | 39.4655 | 40.448 | 40.445 | +0.003 |
| #10 | 37.0955 | 38.078 | 38.065 | +0.013 |

[1]See Table E.14 for the baffle nomenclature.
[2]Corrected for 1/2 CAP Datum -A- to -D- distance
[3]Design value (Casey (1994)); baffle thickness ignored.

Table E.5: Precollimator as-built baffle plate axial positions *vs.* design.

| $X_{fwd}$ (inches) | Calculation (inches) | Aft HRMA Structure distances[1] |
|---|---|---|
| 32.100 | $32.285 - 0.11 - 0.075$ | AHS Datum -A- to fwd edge of plate #6 |
| 32.175 | $32.285 - 0.11$ | AHS Datum -A- to aft edge of plate #6 |
| 1.775 | | aft edge plate #6 to fwd edge plate #5 |
| 5.175 | | aft edge plate #6 to fwd edge plate #3 |
| 8.775 | | aft edge plate #6 to fwd edge Aft Heater Plate (AHP) |
| 1.65 | | aft edge plate #3 to fwd edge plate #4 |
| 1.65 | | fwd edge plate #3 to aft edge plate #2 |

[1]See Table E.14 for the baffle nomenclature.

Table E.6: AHS baffle plate axial information

| $X$ [1] (inches) | Calculation (inches) | Baffle Plate[2] |
|---|---|---|
| −50.0525 | $-17.9525 - 32.100$ | Aft HRMA Structure plate #6 (fwd) |
| −50.1275 | $-17.9525 - 32.175$ | Aft HRMA Structure plate #6 (aft) |
| −41.3525 | $-50.1275 + 8.775$ | Aft Heater Plate (fwd) |
| −48.3525 | $-50.1275 + 1.775$ | Aft HRMA Structure plate #5 (fwd) |
| −44.9525 | $-50.1275 + 5.175$ | Aft HRMA Structure plate #3 (fwd) |
| −46.6525 | $-44.9525 - 0.050 - 1.650$ | Aft HRMA Structure plate #4 (fwd) |
| −43.2525 | $-44.9525 + 0.050 + 1.650$ | Aft HRMA Structure plate #2 (fwd) |

[1]Relative to CAP Datum -A-.
[2]See Table E.14 for the baffle nomenclature.

Table E.7: AHS baffle plate axial positions

| Baffle Plate[1] | $X_{fwd}$ (inches) | $X_{fwd,corr}^{[2]}$ (inches) | $X_{Casey}$ [3] (inches) | $X_{fwd,corr} - X_{Casey}$ (inches) |
|---|---|---|---|---|
| AHP | −41.3525 | −40.370 | −40.355 | −0.015 |
| #2 | −43.2525 | −42.270 | −42.255 | −0.015 |
| #3 | −44.9525 | −43.970 | −43.955 | −0.015 |
| #4 | −46.6525 | −45.670 | −45.655 | −0.015 |
| #5 | −48.3525 | −47.370 | −47.355 | −0.015 |
| #6 | −50.0525 | −49.070 | −49.055 | −0.015 |

[1]See Table E.14 for the baffle nomenclature.
[2]Corrected for 1/2 CAP Datum -A- to -D- distance
[3]Design value (Casey (1994))

Table E.8: Aft HRMA Structure as-built baffle plate axial positions *vs.* design.

| Mirror | Measurements | | | | | | Specs | | |
|---|---|---|---|---|---|---|---|---|---|
| | A1 (inch) | A2 (inch) | A3 (inch) | Average (inch) | Average (mm) | final rel. to target[4] | Target[1] (inch) | Axial shift[2] (inch) | Nominal (target±shift) |
| P1 | 0.2165 | 0.214 | 0.215 | 0.2152 | 5.466 | −0.0048 | 0.220[3] | 0.385 closer to CAP[3] | 0.605 |
| P3 | 0.6147 | 0.6143 | 0.6145 | 0.6145 | 15.608 | 0.0005 | 0.614 | 0.009 away from CAP | 0.605 |
| P4 | 0.757 | 0.755 | 0.7555 | 0.7558 | 19.197 | −0.0002 | 0.756 | 0.151 away from CAP | 0.605 |
| P6 | 0.944 | 0.943 | 0.9435 | 0.9435 | 23.965 | 0.0005 | 0.943 | 0.338 away from CAP | 0.605 |
| H1 | 0.407 | 0.407 | 0.4065 | 0.4068 | 10.333 | −0.0002 | 0.407 | 0.006 away from CAP | 0.401 |
| H3 | 0.3918 | 0.3912 | 0.3904 | 0.3911 | 9.934 | 0.0001 | 0.391 | 0.010 closer to CAP | 0.401 |
| H4 | 0.3975 | 0.3975 | 0.3975 | 0.3975 | 10.097 | 0.0005 | 0.397 | 0.004 closer to CAP | 0.401 |
| H6 | 0.323 | 0.3235 | 0.323 | 0.3232 | 8.209 | 0.0002 | 0.323 | 0.079 closer to CAP | 0.402 |

[1] Target is the spec value for "final installed position". Values are from mirror interface data drawings, numbers EK5003-101 Rev. A, EK5003-102, EK5003-103, EK5003-104, EK5003-105 Rev. A, EK5003-106, EK5003-107, EK5003-108

[2] Axial shift from nominal position as specified in the mirror interface data drawings, numbers EK5003-101 Rev. A, EK5003-102, EK5003-103, EK5003-104, EK5003-105 Rev. A, EK5003-106, EK5003-107, EK5003-108

[3] Value changed from 0.160" to 0.220" per DCO Rev A2 for EK5003-101. Axial shift was 0.605 - 0.160 = 0.445"
Axial shift recalculated = 0.605" - 0.220" = 0.385"

[4] "+" value means further away from CAP than target; "−" means closer to CAP

Note: CAP required thickness: $1.968^{+0.000}_{-0.010}$ inches
CAP measured thickness: 1.965 inches (per EK5010-001 SN001 inspection report)

Table E.9: HRMA Mirrors: axial locations with respect to the CAP. (Adapted from K. A. Havey [EKC] spreadsheet.)

The data for the mirror length and end cuts are given in Table E.10. An attempt to perform a symmetric error correcting end cut was done for mirror pair P1/H1; the change in mirror figure following the end cut led to the remaining end cuts being performed at the nominal design location prior to final polishing.

| Element | Dim K[1] (mm) | Dim L[2] (mm) | $\Delta Z$[3] (mm) | Reference |
|---|---|---|---|---|
| P1 | 2.020 | 842.215±0.013 | 95.290 | TE-E10-1455A |
| P3 | 1.977 | 842.208±0.018 | 74.223 | TE-E10-1501 |
| P4 | 2.002 | 842.208±0.023 | 74.198 | TE-E10-1491 |
| P6 | 2.007 | 842.209±0.023 | 74.190 | TE-E10-1478 |
| H1 | 1.998 | 842.192±0.014 | 77.818 | TE-E10-1456B |
| H3 | 2.007 | 842.197±0.018 | 74.193 | TE-E10-1506A |
| H4 | 2.015 | 842.225±0.023 | 74.185 | TE-E10-1496C |
| H6 | 2.017 | 842.200±0.023 | 74.183 | TE-E10-1485 |

[1]SECA location
[2]Mirror element length
[3]End cut location

Table E.10: AXAF element interface data, Reid (1997)

From the measurements in Table E.9 and the mirror lengths in Table E.10, the $X$ coordinates (in mm) of key points used in the optical design can be calculated (see Table E.11 and Table E.12). The coordinate $X$ is the nominal optical axis with $X = 0$ at the plane defined by the CAP Datum -A- points, and $X$ increasing from the focal plane towards the HRMA. Note that in Table E.11 and Table E.12, the mirror lengths include the chamfers; according to the specification EQ7-002 (1994), the chamfer is $1.25 \pm 0.75$ mm *radially* at each end of the optic and at an angle of $45 \pm 5°$. The compliance matrices in HDOS DR:VR04 (1995) only note that the chamfer dimensions fall within this specification.

| Mirror | length[1] (mm) | wide end (mm) | midpoint (mm) | narrow end (mm) | X(Datum -A-) (mm) |
|---|---|---|---|---|---|
| P1 | 842.215[2] | 847.681 | 426.574 | 5.466 | 0.0 |
| P3 | 842.208[3] | 857.816 | 436.712 | 15.608 | 0.0 |
| P4 | 842.208[4] | 861.405 | 440.301 | 19.197 | 0.0 |
| P6 | 842.209[5] | 866.174 | 445.070 | 23.965 | 0.0 |

[1]Post endcut glass length; includes the chamfer at each end
[2]EK5003-101 Rev A, *P1 Mirror Interface Data*
[3]EK5003-102, *P3 Mirror Interface Data*
[4]EK5003-103, *P4 Mirror Interface Data*
[5]EK5003-104, *P6 Mirror Interface Data*

Table E.11: HRMA P Mirrors: key axial locations

| Mirror | length[1] (mm) | X(Datum -D-) (mm) | wide end (mm) | midpoint (mm) | narrow end (mm) |
|---|---|---|---|---|---|
| H1 | 842.192[2] | −49.911 | −60.244 | −481.340 | −902.436 |
| H3 | 842.197[3] | −49.911 | −59.845 | −480.944 | −902.042 |
| H4 | 842.225[4] | −49.911 | −60.008 | −481.121 | −902.233 |
| H6 | 842.200[5] | −49.911 | −58.120 | −479.220 | −900.320 |

[1]Post endcut glass length; includes the chamfer at each end
[2]EK5003-105 Rev A, *H1 Mirror Interface Data*
[3]EK5003-106, *H3 Mirror Interface Data*
[4]EK5003-107, *H4 Mirror Interface Data*
[5]EK5003-108, *H6 Mirror Interface Data*

Table E.12: HRMA H Mirrors: key axial locations

## E.3 HRMA Baffles and Obstructions

The tables in the following sections were constructed directly from the `/rdb` data tables in the `/proj/axaf/simul/databases/apertures/data` directory at SAO. Table E.13 indicates the source `rdb` tables. The relation between the raytrace aperture nomenclature and the nomenclature of the EKC drawings is given in Table E.14

| Baffle or Obstruction | Table | `/rdb file` |
|---|---|---|
| Precollimator and FHS | Tables E.15, E.16, E.17, and E.18 | `precoll_rawdata_03.rdb` |
| Aft HRMA Structure | Tables E.19, E.20, E.21, and E.22 | `postcoll_rawdata_02.rdb` |
| CAP Ghost Baffle | Table E.23 | `cap_rawdata_02.rdb` |
| P6 Ghost Baffle | Table E.24 | `ghostbaffle_rawdata_01.rdb` |
| FTS Periscope | Table E.25 | `periscope_rawdata_01.rdb` |

Table E.13: Baffle and Obstruction tables

| Raytrace Nomenclature | EKC Assembly | EKC Baffle Plate |
|---|---|---|
| Precollimator Plate #1 | Fwd Baffle Assy. #1 [EK5010-252] | Fwd Baffle Plate #1 [EK5010-232] |
| Precollimator Plate #2 | Fwd Baffle Assy. #2 [EK5010-253] | Fwd Mid Baffle Plate #2 [EK5010-233] |
| Precollimator Plate #3 | Fwd Baffle Assy. #3 [EK5010-254] | Fwd Mid Baffle Plate #2 [EK5010-233] |
| Precollimator Plate #4 | Fwd Baffle Assy. #4 [EK5010-255] | Fwd Mid Baffle Plate #3 [EK5010-234] |
| Precollimator Plate #5 | Fwd Baffle Assy. #5 [EK5010-256] | Fwd Mid Baffle Plate #5 [EK5010-235] |
| Precollimator Plate #6 | Fwd Baffle Assy. #6 [EK5010-257] | Fwd Mid Baffle Plate #5 [EK5010-235] |
| Precollimator Plate #7 | Fwd Baffle Assy. #7 [EK5010-258] | Fwd Mid Baffle Plate #7 [EK5010-236] |
| Precollimator Plate #8 | Fwd Baffle Assy. #8 [EK5010-259] | Fwd Mid Baffle Plate #7 [EK5010-236] |
| Precollimator Plate #9 | Fwd Baffle Assy. #9 [EK5010-261] | Fwd Mid Baffle Plate #9 [EK5010-237] |
| Precollimator Plate #10 | Fwd Baffle Assy. #10 [EK5010-262] | Fwd Mid Baffle Plate #9 [EK5010-237] |
| Fwd Heater Plate (FHP) | Forward Heater Baffle Assy. [EK5010-251] | Fwd Baffle Plate #1 [EK5010-232] |
| Aft Heater Plate (AFP) | Aft Heater Baffle Assy. [EK5010-268] | Fwd Mid Baffle Plate #9 [EK5010-247] |
| Postcollimator Plate #2 | Aft Baffle Assy. #2 [EK5010-263] | Mid Aft Baffle Plate #2 [EK5010-242] |
| Postcollimator Plate #3 | Aft Baffle Assy. #3 [EK5010-264] | Mid Aft Baffle Plate #2 [EK5010-243] |
| Postcollimator Plate #4 | Aft Baffle Assy. #4 [EK5010-265] | Mid Aft Baffle Plate #4 [EK5010-244] |
| Postcollimator Plate #5 | Aft Baffle Assy. #5 [EK5010-266] | Mid Aft Baffle Plate #5 [EK5010-245] |
| Postcollimator Plate #6 | Aft Baffle Assy. #6 [EK5010-267] | Top Aft Baffle Plate #6 [EK5010-246] |

Table E.14: Raytrace and EKC baffle nomenclature

### E.3.1 Thermal Precollimator and Forward HRMA Structure Baffles

The dimensions for the annular baffle openings were read from the "action copy" of each baffle drawing (see the *drawing* column in Tables E.15 to E.18). Note that plates 1 to 10 are installed in the Precollimator, while the FHP is installed in the Forward HRMA Structure. Table E.1 lists the plate thicknesses. Precollimator plate 1 also serves as a critical X-ray baffle; the tolerances on its radial dimensions are tighter than those for the other baffles, and it also includes a Tantalum layer. Plate 1 is a sandwich of a 5 mil Tantalum sheet between 50 mil GREP layers. Each baffle plate (including the FHP) includes twelve 0.5 inch radial support struts at intervals of 30 degrees from $+Y$.

| shell | baffle | $X_{fwd}$[1] (in) | $\Delta X_{GREP}$ (in) | $\Delta X_{Ta}$ (in) | $R_i$ (in) | $R_o$ (in) | tol $R_i$[2] (in) | tol $R_o$[2] (in) | baffle plate drawing |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 58.7425 | 0.105 | 0.005 | 23.137 | 24.356 | 0.020 | 0.020 | EK5010−232 |
| 1 | 2 | 56.3175 | 0.050 | 0.000 | 23.085 | 24.412 | 0.050 | 0.050 | EK5010−233 |
| 1 | 3 | 53.8955 | 0.050 | 0.000 | 23.085 | 24.412 | 0.050 | 0.050 | EK5010−233 |
| 1 | 4 | 51.5005 | 0.075 | 0.000 | 23.121 | 24.384 | 0.050 | 0.050 | EK5010−234 |
| 1 | 5 | 49.0855 | 0.075 | 0.000 | 23.139 | 24.371 | 0.050 | 0.050 | EK5010−235 |
| 1 | 6 | 46.6905 | 0.075 | 0.000 | 23.139 | 24.371 | 0.050 | 0.050 | EK5010−235 |
| 1 | 7 | 44.2755 | 0.075 | 0.000 | 23.175 | 24.344 | 0.050 | 0.050 | EK5010−236 |
| 1 | 8 | 41.8805 | 0.075 | 0.000 | 23.175 | 24.344 | 0.050 | 0.050 | EK5010−236 |
| 1 | 9 | 39.4655 | 0.050 | 0.000 | 23.211 | 24.316 | 0.050 | 0.050 | EK5010−237 |
| 1 | 10 | 37.0955 | 0.050 | 0.000 | 23.211 | 24.316 | 0.050 | 0.050 | EK5010−237 |
| 1 | FHP | 34.7755 | 0.250 | 0.000 | 23.346 | 24.190 | 0.050 | 0.050 | EK5010−231 |

[1] Table E.4, Table E.2,
[1] Casey (1994). Fabrication tolerance is ±9 mils.

Table E.15: Precollimator and Forward Hrma Structure Baffle Data; Shell 1.

| shell | baffle | $X_{fwd}$[1] (in) | $\Delta X_{GREP}$ (in) | $\Delta X_{Ta}$ (in) | $R_i$ (in) | $R_o$ (in) | tol $R_i$[2] (in) | tol $R_o$[2] (in) | baffle plate drawing |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 1 | 58.7425 | 0.105 | 0.005 | 18.524 | 19.647 | 0.020 | 0.020 | EK5010−232 |
| 3 | 2 | 56.3175 | 0.050 | 0.000 | 18.472 | 19.704 | 0.050 | 0.050 | EK5010−233 |
| 3 | 3 | 53.8955 | 0.050 | 0.000 | 18.472 | 19.704 | 0.050 | 0.050 | EK5010−233 |
| 3 | 4 | 51.5005 | 0.075 | 0.000 | 18.508 | 19.676 | 0.050 | 0.050 | EK5010−234 |
| 3 | 5 | 49.0855 | 0.075 | 0.000 | 18.526 | 19.663 | 0.050 | 0.050 | EK5010−235 |
| 3 | 6 | 46.6905 | 0.075 | 0.000 | 18.526 | 19.663 | 0.050 | 0.050 | EK5010−235 |
| 3 | 7 | 44.2755 | 0.075 | 0.000 | 18.562 | 19.636 | 0.050 | 0.050 | EK5010−236 |
| 3 | 8 | 41.8805 | 0.075 | 0.000 | 18.562 | 19.636 | 0.050 | 0.050 | EK5010−236 |
| 3 | 9 | 39.4655 | 0.050 | 0.000 | 18.598 | 19.608 | 0.050 | 0.050 | EK5010−237 |
| 3 | 10 | 37.0955 | 0.050 | 0.000 | 18.598 | 19.608 | 0.050 | 0.050 | EK5010−237 |
| 3 | FHP | 34.7755 | 0.250 | 0.000 | 18.733 | 19.482 | 0.050 | 0.050 | EK5010−231 |

[1] Table E.4, Table E.2,
[1] Casey (1994). Fabrication tolerance is ±9 mils.

Table E.16: Precollimator and Forward Hrma Structure Baffle Data; Shell 3.

| shell | baffle | $X_{fwd}$[1] (in) | $\Delta X_{GREP}$ (in) | $\Delta X_{Ta}$ (in) | $R_i$ (in) | $R_o$ (in) | tol $R_i$[2] (in) | tol $R_o$[2] (in) | baffle plate drawing |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 1 | 58.7425 | 0.105 | 0.005 | 16.301 | 17.327 | 0.020 | 0.020 | EK5010−232 |
| 4 | 2 | 56.3175 | 0.075 | 0.000 | 16.249 | 17.388 | 0.050 | 0.050 | EK5010−233 |
| 4 | 3 | 53.8955 | 0.075 | 0.000 | 16.249 | 17.388 | 0.050 | 0.050 | EK5010−233 |
| 4 | 4 | 51.5005 | 0.075 | 0.000 | 16.285 | 17.369 | 0.050 | 0.050 | EK5010−234 |
| 4 | 5 | 49.0855 | 0.075 | 0.000 | 16.303 | 17.360 | 0.050 | 0.050 | EK5010−235 |
| 4 | 6 | 46.6905 | 0.075 | 0.000 | 16.303 | 17.360 | 0.050 | 0.050 | EK5010−235 |
| 4 | 7 | 44.2755 | 0.075 | 0.000 | 16.339 | 17.341 | 0.050 | 0.050 | EK5010−236 |
| 4 | 8 | 41.8805 | 0.075 | 0.000 | 16.339 | 17.341 | 0.050 | 0.050 | EK5010−236 |
| 4 | 9 | 39.4655 | 0.050 | 0.000 | 16.375 | 17.322 | 0.050 | 0.050 | EK5010−237 |
| 4 | 10 | 37.0955 | 0.050 | 0.000 | 16.375 | 17.322 | 0.050 | 0.050 | EK5010−237 |
| 4 | FHP | 34.7755 | 0.250 | 0.000 | 16.510 | 17.204 | 0.050 | 0.050 | EK5010−231 |

[1] Table E.4, Table E.2,
[1] Casey (1994). Fabrication tolerance is ±9 mils.

Table E.17: Precollimator and Forward Hrma Structure Baffle Data; Shell 4.

| shell | baffle | $X_{fwd}$[1] (in) | $\Delta X_{GREP}$ (in) | $\Delta X_{Ta}$ (in) | $R_i$ (in) | $R_o$ (in) | tol $R_i$[2] (in) | tol $R_o$[2] (in) | baffle plate drawing |
|---|---|---|---|---|---|---|---|---|---|
| 6 | 1 | 58.7425 | 0.105 | 0.005 | 12.149 | 12.873 | 0.020 | 0.020 | EK5010−232 |
| 6 | 2 | 56.3175 | 0.075 | 0.000 | 12.086 | 12.938 | 0.050 | 0.050 | EK5010−233 |
| 6 | 3 | 53.8955 | 0.075 | 0.000 | 12.086 | 12.938 | 0.050 | 0.050 | EK5010−233 |
| 6 | 4 | 51.5005 | 0.075 | 0.000 | 12.102 | 12.930 | 0.050 | 0.050 | EK5010−234 |
| 6 | 5 | 49.0855 | 0.075 | 0.000 | 12.109 | 12.926 | 0.050 | 0.050 | EK5010−235 |
| 6 | 6 | 46.6905 | 0.075 | 0.000 | 12.109 | 12.926 | 0.050 | 0.050 | EK5010−235 |
| 6 | 7 | 44.2755 | 0.075 | 0.000 | 12.124 | 12.918 | 0.050 | 0.050 | EK5010−236 |
| 6 | 8 | 41.8805 | 0.075 | 0.000 | 12.124 | 12.918 | 0.050 | 0.050 | EK5010−236 |
| 6 | 9 | 39.4655 | 0.050 | 0.000 | 12.140 | 12.909 | 0.050 | 0.050 | EK5010−237 |
| 6 | 10 | 37.0955 | 0.050 | 0.000 | 12.140 | 12.909 | 0.050 | 0.050 | EK5010−237 |
| 6 | FHP | 34.7755 | 0.250 | 0.000 | 12.255 | 12.801 | 0.050 | 0.050 | EK5010−231 |

[1] Table E.4, Table E.2,
[1] Casey (1994). Fabrication tolerance is ±9 mils.

Table E.18: Precollimator and Forward Hrma Structure Baffle Data; Shell 6.

### E.3.2 Aft HRMA Structure Baffles

The dimensions for the annular baffle openings were read from the "action copy" of the baffle drawing (the *drawing* column in Tables E.19 to E.22). The forwardmost plate is the Aft Heater Plate (AHP) and it is thicker than the remaining AHS plates. The AHS baffle plates are made of GREP. Each baffle plate (including the AHP) includes twelve 0.5 inch radial support struts at intervals of 30 degrees from $+Y$.

| shell | baffle | $X_{fwd}$[1] (in) | $\Delta X_{GREP}$ (in) | $R_i$ (in) | $R_o$ (in) | tol $R_i$[2] (in) | tol $R_o$[2] (in) | baffle plate drawing |
|---|---|---|---|---|---|---|---|---|
| 1 | AHP | −41.3525 | 0.250 | 21.028 | 21.809 | 0.050 | 0.050 | EK5010−247 |
| 1 | 2 | −43.2525 | 0.050 | 20.801 | 21.802 | 0.050 | 0.050 | EK5010−242 |
| 1 | 3 | −44.9525 | 0.050 | 20.687 | 21.706 | 0.050 | 0.050 | EK5010−243 |
| 1 | 4 | −46.6525 | 0.050 | 20.573 | 21.610 | 0.050 | 0.050 | EK5010−244 |
| 1 | 5 | −48.3525 | 0.050 | 20.459 | 21.515 | 0.050 | 0.050 | EK5010−245 |
| 1 | 6 | −50.0525 | 0.075 | 20.445 | 21.319 | 0.050 | 0.050 | EK5010−246 |

[1] Table E.7
[2] Casey (1994). Fabrication tolerance is ±9 mils.

Table E.19: Aft Hrma Structure Baffle Data; Shell 1.

| shell | baffle | $X_{fwd}$[1] (in) | $\Delta X_{GREP}$ (in) | $R_i$ (in) | $R_o$ (in) | tol $R_i$[2] (in) | tol $R_o$[2] (in) | baffle plate drawing |
|---|---|---|---|---|---|---|---|---|
| 3 | AHP | −41.3525 | 0.250 | 16.813 | 17.564 | 0.050 | 0.050 | EK5010−247 |
| 3 | 2 | −43.2525 | 0.050 | 16.604 | 17.580 | 0.050 | 0.050 | EK5010−242 |
| 3 | 3 | −44.9525 | 0.050 | 16.507 | 17.504 | 0.050 | 0.050 | EK5010−243 |
| 3 | 4 | −46.6525 | 0.050 | 16.409 | 17.429 | 0.050 | 0.050 | EK5010−244 |
| 3 | 5 | −48.3525 | 0.050 | 16.312 | 17.353 | 0.050 | 0.050 | EK5010−245 |
| 3 | 6 | −50.0525 | 0.075 | 16.314 | 17.178 | 0.050 | 0.050 | EK5010−246 |

[1] Table E.7
[2] Casey (1994). Fabrication tolerance is ±9 mils.

Table E.20: Aft Hrma Structure Baffle Data; Shell 3.

| shell | baffle | $X_{fwd}$[1] (in) | $\Delta X_{GREP}$ (in) | $R_i$ (in) | $R_o$ (in) | tol $R_i$[2] (in) | tol $R_o$[2] (in) | baffle plate drawing |
|---|---|---|---|---|---|---|---|---|
| 4 | AHP | −41.3525 | 0.250 | 14.763 | 15.513 | 0.050 | 0.050 | EK5010−247 |
| 4 | 2 | −43.2525 | 0.050 | 14.565 | 15.540 | 0.050 | 0.050 | EK5010−242 |
| 4 | 3 | −44.9525 | 0.050 | 14.477 | 15.474 | 0.050 | 0.050 | EK5010−243 |
| 4 | 4 | −46.6525 | 0.050 | 14.389 | 15.409 | 0.050 | 0.050 | EK5010−244 |
| 4 | 5 | −48.3525 | 0.050 | 14.302 | 15.343 | 0.050 | 0.050 | EK5010−245 |
| 4 | 6 | −50.0525 | 0.075 | 14.314 | 15.177 | 0.050 | 0.050 | EK5010−246 |

[1] Table E.7

[2] Casey (1994). Fabrication tolerance is ±9 mils.

Table E.21: Aft Hrma Structure Baffle Data; Shell 4.

| shell | baffle | $X_{fwd}$[1] (in) | $\Delta X_{GREP}$ (in) | $R_i$ (in) | $R_o$ (in) | tol $R_i$[2] (in) | tol $R_o$[2] (in) | baffle plate drawing |
|---|---|---|---|---|---|---|---|---|
| 6 | AHP | −41.3525 | 0.250 | 10.934 | 11.548 | 0.050 | 0.050 | EK5010−247 |
| 6 | 2 | −43.2525 | 0.050 | 10.760 | 11.596 | 0.050 | 0.050 | EK5010−242 |
| 6 | 3 | −44.9525 | 0.050 | 10.694 | 11.549 | 0.050 | 0.050 | EK5010−243 |
| 6 | 4 | −46.6525 | 0.050 | 10.628 | 11.502 | 0.050 | 0.050 | EK5010−244 |
| 6 | 5 | −48.3525 | 0.050 | 10.562 | 11.456 | 0.050 | 0.050 | EK5010−245 |
| 6 | 6 | −50.0525 | 0.075 | 10.596 | 11.309 | 0.050 | 0.050 | EK5010−246 |

[1] Table E.7

[2] Casey (1994). Fabrication tolerance is ±9 mils.

Table E.22: Aft Hrma Structure Baffle Data; Shell 6.

### E.3.3 CAP Ghost Baffles

The HRMA ghost baffle design includes Tantalum baffles located at the aft (H) side of the Center Aperture Plate. These baffles are mounted on thin aluminum support plates, and includes Tantalum *radiation sheets* which provides the critical X-ray baffle edge. Each shell has twelve CAP baffle pieces, one for each sector of the CAP. The radius of the ghost baffle was read from the Tantalum *radiation sheet* drawing listed in the *drawing* column in Table E.23. The outer radii listed in the table correspond to the edges of the annular slots machined into the CAP. Each shell is also obstructed by twelve CAP radial support struts (0.75 inches wide) spaced at 30° intervals from $+Y$.

| shell | baffle | $X_{fwd}$ (in) | $R_i$ (in) | $R_o$ (in) | tol $R_i$[1] (in) | tol $R_o$[1] (in) | radiation sheet drawing |
|---|---|---|---|---|---|---|---|
| 1 | CAP_D | −1.965 | 23.086 | 23.76 | 0.020 | 0.050 | EK5010−097 |
| 3 | CAP_D | −1.965 | 18.577 | 19.15 | 0.020 | 0.050 | EK5010−114 |
| 4 | CAP_D | −1.965 | 16.386 | 16.92 | 0.020 | 0.050 | EK5010−096 |
| 6 | CAP_D | −1.965 | 12.172 | 12.58 | 0.020 | 0.050 | EK5010−098 |

[1] Casey (1994). Fabrication tolerance is ±9 mils.

Table E.23: CAP Ghost Baffle Data.

### E.3.4 P6 Ghost Baffle

The outer radius of the P6 ghost baffle was read from the Tantalum *radiation sheet* drawing listed in the the *drawing* column in Table E.24. The ghost baffle is mounted on an aluminum annular plate attached to a cylindrical structure which mounts directly to the P-side of the CAP. Because only one critical edge is needed, this baffle has no radial support struts obstructing the clear aperture.

| shell | baffle | $X_{fwd}$ (in) | $\Delta X_{Ta}$ (in) | $R_o$ (in) | tol $R_o$[1] (in) | radiation sheet drawing |
|---|---|---|---|---|---|---|
| 6 | P6 baffle | 13.838 | 0.005 | 12.416 | 0.020 | EK5010−118 |

[1] Casey (1994). Fabrication tolerance is ±9 mils.

Table E.24: P6 Ghost Baffle Data.

### E.3.5 Fiducial Transfer System Periscope

The Fiducial Transfer System (FTS) periscope is an additional obstruction in the X-Ray path. It lies mostly in the shadow of a CAP radial strut (in the $[-Y, -Z]$ quadrant, 30° from $-Y$; a diagram of the Periscope is shown in Figure E.8, and the $Y - Z$ clocking of the Periscope is shown in Figure E.9.

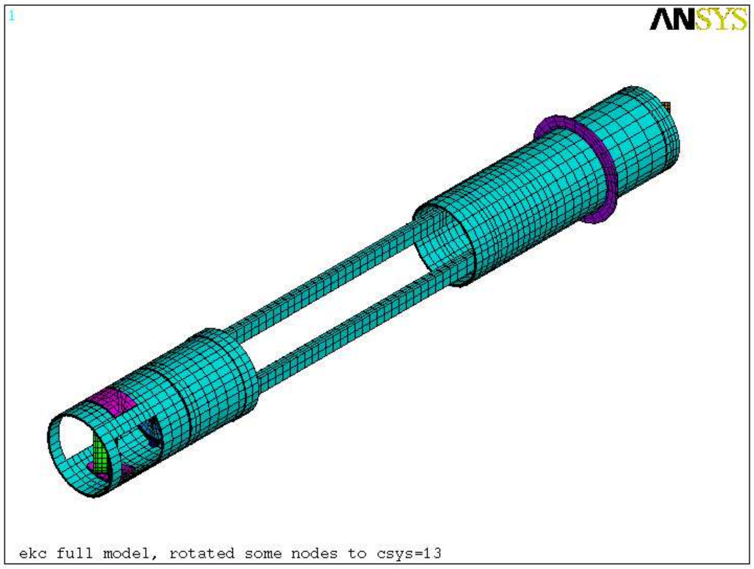


Figure E.8: EKC Solid Model of Fiducial Transfer System Periscope.

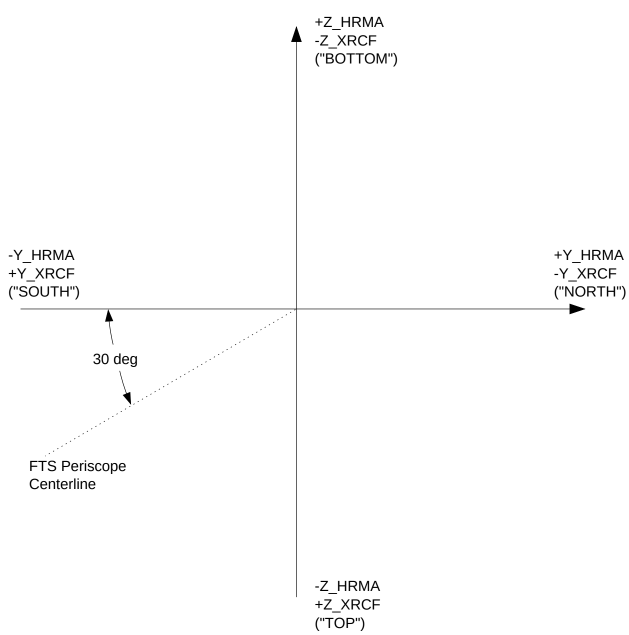


Figure E.9: Clocking angle for the FTS Periscope

The width of the periscope struts in the $Y$–$Z$ plane is 0.72 inches, and the depth of each strut axially is 0.365 inches. The outside to outside dimensions of the struts (in the $X$ direction) are 3.235 inches and the inside to inside dimensions are 2.505 inches; these dimensions were obtained from the 3D solid model from EKC. The critical dimensions for X-Ray obstruction are given in Table E.25.

| baffle | $X$ (in) | Width (in) | $\theta_C$ (°) |
|---|---|---|---|
| Periscope_Fwd | −37.393 | 0.72 | 150.0 |
| Periscope_Aft | −40.628 | 0.72 | 150.0 |

Table E.25: FTS Periscope Data.

## E.4 Relation between HDOS and Raytrace Coordinates

Several HDOS co-ordinate systems are relevant to both the scattering and the surface deformation maps. These are defined in the TRW mirror specification, EQ7-002 (Rev. E). The Telescope Ensemble (TE) coordinate system has its origin at the ideal focus and its $Z$ azis positive (along the optical axis) from the ideal focal plane towards the HRMA. The ideal optical surface geometry with respect to the TE system is specified in EQ7-002.

The HDOS optical metrology data is specified in separate Mirror Element (ME) coordinate systems, one per optic. These ME coordinate systems are aligned with their $Z$ axes along the TE $Z$ axis, but with their zero point (in $Z$) offset such that $Z = 0$ in the ME system is coincident with the beginning of the *uncut* optic (each uncut optic was nominally 39 inches or 990.6 mm long). The $X$ axes are aligned with the optic primary zero azimuth reference fiducial point.

The transformations between the TE system and the ME systems are:

$$Z_{ME} = Z_{TE} - 9103.6 \text{ mm} \quad \text{(for all H}'\text{s)} \tag{E.1}$$

and

$$Z_{ME} = Z_{TE} - 10022.6 \text{ mm} \quad \text{(for all P}'\text{s)} \tag{E.2}$$

The SAOsac raytrace system uses a body centered coordinate system (inherited from OSAC) for each optic; unfortunately, the sense of the raytrace $Z$ axis is opposite that of the HDOS ME systems. The following series of operations is required to go from the HDOS ME coordinate system to the SAO raytrace coordinate system:

1. Translate the origin of the ME coordinate system to the center of the as-cut optic; the distance is: $(Z_{ec} + L/2)$ where $Z_{ec}$ is the narrow end end cut value and $L$ is as-cut optic length.

2. Rotate by 180° about the (translated) $X$ axis (which reverses the sense of the $Z$ axis). This leaves the new $X$ axis aligned with the ME $X$ axis but reverses the sense of the $Y$ axis. Angles in the new system are measured in opposite direction (clocking) in the new system.

3. Rotate about the $Z$ axis to move the $X$ axis from the ME $X$ to the desired SAOsac $X$, by an angle $\theta_C$, the optic clocking angle. We have a choice of sign conventions here, and we have chosen to to define $\theta_C$ as the *positive* angular rotation about the SAOsac $+Z$ axis which is required to align the SAOsac $X$ axis with the ME fiducial ($X_{ME}$ axis).

Working in cylindrical coordinates, the relationships between the ME coordinate system and the SAOsac coordinate system are as follows:

$$Z_O = \left(Z_{ec} + \frac{L}{2}\right) - Z_{ME} \tag{E.3}$$

$$\theta_O = 2\pi - \theta_{ME} + \theta_C \tag{E.4}$$

$$R_O = R_{ME} \tag{E.5}$$

where $Z_O$ and $Z_{ME}$ are the $Z$ coordinates in the SAOsac and ME systems, $\theta_O$ and $\theta_{ME}$ are the rotation angle measured from the corresponding $X$ axis, positive with respect to the respective $Z$ axes, and $R_O$ and $R_{ME}$ are the SAOsac and ME radial coordinates.

Based on the end cut data (Table E.10), the axial data are given in Table E.26. In this table, $Z_{ME,wide}$ and $Z_{ME,narrow}$ are the axial coordinates, in the ME system, of the wide and narrow ends of the optics.

| Element | $Z_{ec}$ (mm) | $L$ (mm) | $Z_{ec} + L/2$ (mm) | ME Data Range $Z_{ME,wide}$ (mm) | $Z_{ME,narrow}$ (mm) |
|---|---|---|---|---|---|
| P1 | 95.290 | 842.215 | 516.397 | 95.290 | 937.050 |
| P3 | 74.223 | 842.208 | 495.327 | 74.223 | 916.431 |
| P4 | 74.198 | 842.208 | 495.302 | 74.198 | 916.406 |
| P6 | 74.190 | 842.209 | 495.294 | 74.190 | 916.399 |
| H1 | 77.818 | 842.192 | 498.914 | 77.818 | 920.010 |
| H3 | 74.193 | 842.197 | 495.291 | 74.193 | 916.390 |
| H4 | 74.185 | 842.225 | 495.297 | 74.185 | 916.410 |
| H6 | 74.183 | 842.200 | 495.293 | 74.183 | 916.383 |

Table E.26: AXAF element axial data.

## E.5 HRMA Optic Prescription

The HRMA optic prescription, adapted from the nominal prescription `ek05lvs` and adjusted for the end cuts, is given in Table E.27. The mirror conics are given by

$$\rho^2 = \rho_0^2 + 2\,K\,z - P\,z^2 \tag{E.6}$$

where $\rho$ is the radius of the conic surface as measured from the optical axis, and $z$ is distance along the optical axis measured from the *body center*, with $z$ positive towards the narrow end of the optic. If $L$ is the total length of the optic, then the forward (*wide end*) of the optic is at $-L/2$ and the aft (*narrow end*) of the optic is at $+L/2$.

| Optic | $P$ | $k$ | $\rho_0$ |
|---|---|---|---|
| h1 | −1.7797716637950735E−03 | −26.0506034413416841 | 579.89015840093919 |
| h3 | −1.1532395834759916E−03 | −16.875942397594130 | 466.64379784205380 |
| h4 | −8.9864417477996457E−04 | −13.150318066441841 | 411.91935912458604 |
| h6 | −4.9625995845653374E−04 | −7.2620248152618760 | 306.09851668776219 |
| p1 | 0.0 | −8.9333113530131421 | 606.86080963697918 |
| p3 | 0.0 | −5.7939624154424676 | 488.46244215611011 |
| p4 | 0.0 | −4.5165799273846270 | 431.26225933154404 |
| p6 | 0.0 | −2.4957050467401789 | 320.56977725634789 |

Table E.27: HRMA Optic Prescription (including end cut) for ideal optics.

## E.6 HRMA Optic Clocking Angles

The orientations of the HRMA, XRCF, and SAOsac coordinate systems are shown in Figure B.1; the convention for Kodak clocking angle on the MMIS is also indicated. The relations between the Kodak clocking convention and the SAOsac and double-pass SAOsac (DPSAOsac) clocking conventions are indicated in Figure E.10.

| Optic | Kodak clocking (°) | SAOsac clocking (°) | DPSAOsac clocking (°) |
|---|---|---|---|
| P1 | 19.00[1] | 109.00 | 251.00 |
| P3 | 41.50[2] | 130.50 | 229.50 |
| P4 | 91.00[3] | 181.00 | 179.00 |
| P6 | 29.00[4] | 119.00 | 241.00 |
| H1 | 65.25[5] | 155.25 | 204.75 |
| H3 | 43.00[6] | 132.00 | 228.00 |
| H4 | 124.00[7] | 214.00 | 146.00 |
| H6 | 311.50[8] | 41.50 | 318.50 |

[1]EK5003-101 Rev A, *P1 Mirror Interface Data*
[2]EK5003-102, *P3 Mirror Interface Data*
[3]EK5003-103, *P4 Mirror Interface Data*
[4]EK5003-104, *P6 Mirror Interface Data*
[5]EK5003-105 Rev A, *H1 Mirror Interface Data*
[6]EK5003-106, *H3 Mirror Interface Data*
[7]EK5003-107, *H4 Mirror Interface Data*
[8]EK5003-108, *H6 Mirror Interface Data*

Table E.28: Mirror clocking data.

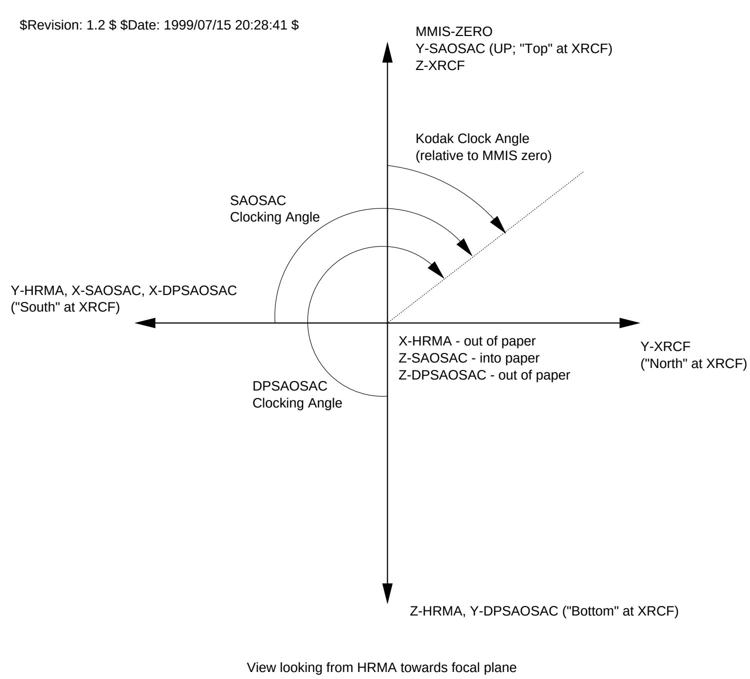


Figure E.10: EKC, SAOsac, and DPSAOsac optic clocking conventions.