Appendix B

Coordinate Systems

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In this appendix we summarize the relations between various coordinate systems of interest; these include:

Tower:	HRMA Alignment Test System Tower at EKC (HATS measurements)
`DPSAOsac`:	Double-pass raytraces to simulate HATS measurements
`SAOsac`:	standard raytraces (*e.g.*, XRCF conditions)
XRCF:	coordinate system at the XRCF test facility
HRMA:	HRMA-based coordinate system aligned with the standard AXAF coordinate directions

Figure B.1 illustrates the different coordinate systems. Note that the XRCF coordinates differ from the standard HRMA/AXAF coordinate system by a flip of 180° about the X_{HRMA} axis, while the `DPSAOsac` coordinates differ from the standard `SAOsac` coordinates by a flip of 180° about the X_{SAOsac} axis (the Y_{HRMA} axis). Note also that we are primarily concerned here with the directions of the coordinate axes rather than the location of the coordinate origin.

The SAO/MST raytrace system, `SAOsac`, specifies rigid-body positioning in terms of the location and orientation of the body-center of the optic. The body-center "tilt" coordinates are `azmis` and `elmis`, where

`azmis`:	positive rotation about an axis parallel to the `SAOsac` Y axis; positive rotation is right-hand-rule rotation with angle increasing from the $+Z$ axis towards the $+X$ axis. (X' axis is the new X axis after `azmis` rotation; Z' axis is the new Z axis after `azmis` rotation).
`elmis`:	negative rotation about an axis parallel to `SAOsac` X' axis; positive rotation is right-hand-rule with angle increasing from the $+Y$ axis towards the $+Z'$ axis. Positive `elmis` rotation takes $+Z'$ axis towards the $+Y$ axis.

For completeness, the corresponding conventions for mirror element rotations in the HRMA and XRCF coordinates are

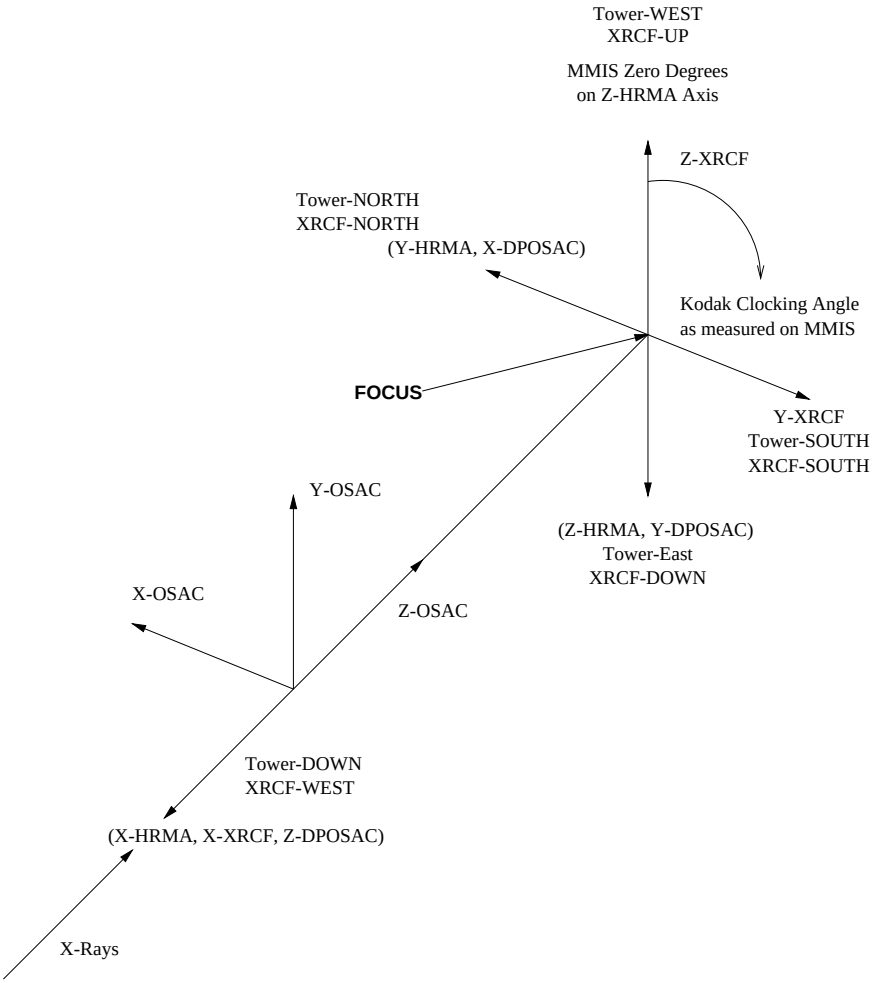

Figure B.1: Relations between HATS tower, XRCF, and `SAOsac` coordinates

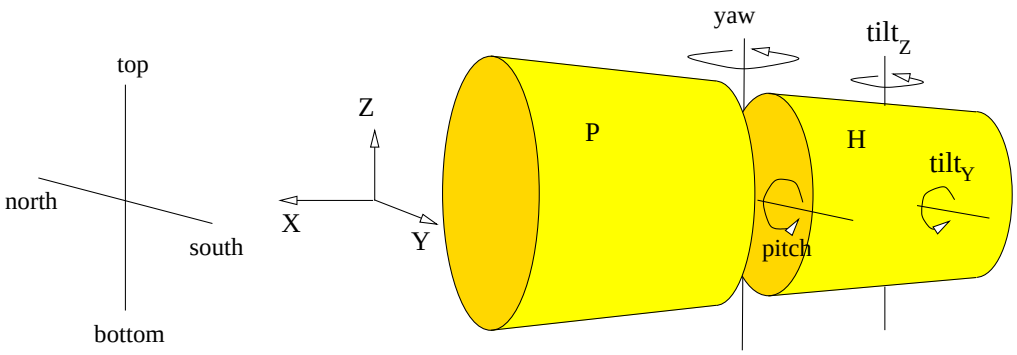

Figure B.2: Schematic of XRCF coordinate and rotation conventions

θ_Y: positive rotation about an axis parallel to the `HRMA` $+Y$ axis; positive rotation is right-hand-rule rotation with angle increasing from the $+Z$ axis towards the $+X$ axis.

θ_Z: positive rotation about an axis parallel to the `HRMA` $+Z$ axis; positive rotation is right-hand-rule rotation with angle increasing from the $+X$ axis towards the $+Y$ axis.

and

$tilt_Y$: positive rotation about an axis parallel to the `XRCF` $+Y$ axis; positive rotation is right-hand-rule rotation with angle increasing from the $+Z$ axis towards the $+X$ axis.

$tilt_Z$: positive rotation about an axis parallel to the `XRCF` $+Z$ axis; positive rotation is right-hand-rule rotation with angle increasing from the $+X$ axis towards the $+Y$ axis.

At the XRCF, the orientation of the HRMA as a whole was specified by *pitch* and *yaw*:

pitch: positive rotation about an axis parallel to the `XRCF` $+Y$ axis. Positive rotation is right-hand-rule rotation with angle increasing from the $+Z$ axis towards the $+X$ axis.

yaw: positive rotation about an axis parallel to the `XRCF` $+Z$ axis. Positive rotation is right-hand-rule rotation with angle increasing from the $+X$ axis towards the $+Y$ axis.

The raytrace simulations are always performed in the appropriate `SAOsac` coordinate system; the orientation of the HRMA relative to the source is given by *bundle_el* and *bundle_az*, the direction *from* the source *towards* HRMA. The relation between *pitch*, *yaw*, *bundle_el*, and *bundle_az* are summarized in Table B.1.

Table B.1: Relations between coordinate systems

$+bundle\_el_{SAOsac}$	=	$-bundle\_el_{DPSAOsac}$	=	$-pitch$
$+bundle\_az_{SAOsac}$	=	$-bundle\_az_{DPSAOsac}$	=	$-yaw$

The relations between coordinate directions are summarized in Table B.2.

Table B.2: Relations between coordinate systems

$+Y_{XRCF}$	=	$-Y_{HRMA}$	=	$-X_{SAOsac}$	=	$-X_{DPSAOsac}$		
$+Z_{XRCF}$	=	$-Z_{HRMA}$	=	$+Y_{SAOsac}$	=	$-Y_{DPSAOsac}$		
$+X_{XRCF}$	=	$+X_{HRMA}$	=	$-Z_{SAOsac}$	=	$+Z_{DPSAOsac}$		
$+tilt_Y$	=	$-\theta_Y$	=	$+elmis_{SAOsac}$	=	$+elmis_{DPSAOsac}$	=	$+pitch$
$+tilt_Z$	=	$-\theta_Z$	=	$+azmis_{SAOsac}$	=	$-azmis_{DPSAOsac}$	=	$+yaw$