

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)
- DPSA0sac: Double-pass raytraces to simulate HATS measurements
- SA0sac: 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 DPSA0sac coordinates differ from the standard SA0sac coordinates by a flip of 180° about the X_{SA0sac} 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, SA0sac, 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 SA0sac 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 SA0sac 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

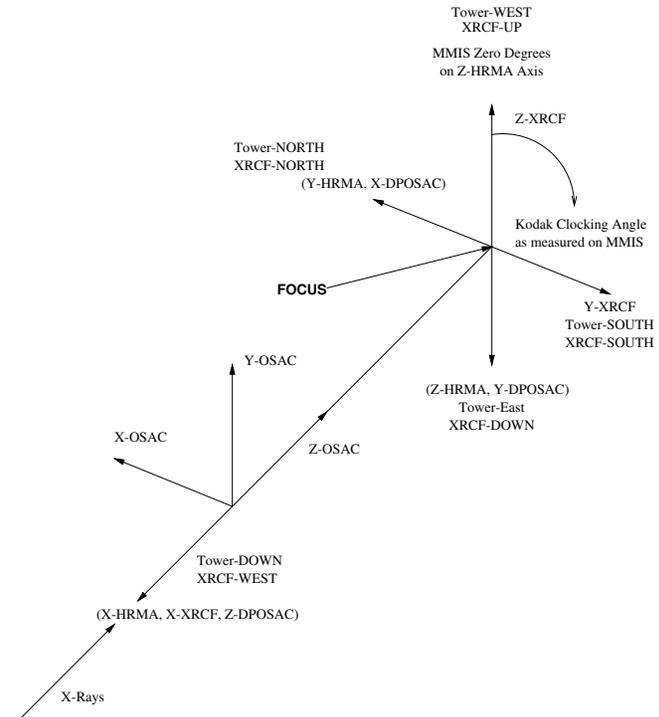


Figure B.1: Relations between HATS tower, XRCF, and SA0sac coordinates

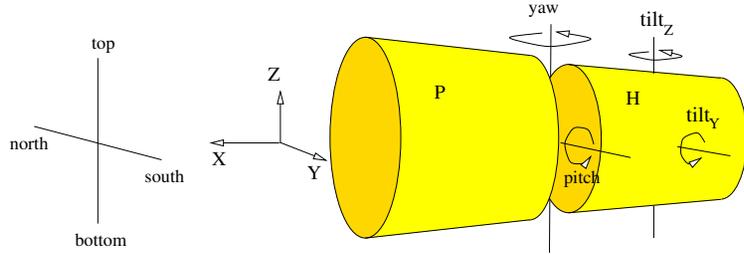


Figure B.2: Schematic of XRCF coordinate and rotation conventions

- 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

$$\begin{aligned}
 +bundle_el_{SAOsac} &= -bundle_el_{DPSAOsac} = -pitch \\
 +bundle_az_{SAOsac} &= -bundle_az_{DPSAOsac} = -yaw
 \end{aligned}$$

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

Table B.2: Relations between coordinate systems

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