



Title: Antenna Coordinate Systems	Owner: Selina	Date: 2020-05-27
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Antenna Coordinate Systems

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Change Record

Version	Date	Author	Affected Section(s)	Reason
01	2020-05-26	R. Selina, S. Sturgis	All	First draft from Antenna Technical Requirements Appendix. Incorporated updated figures for focus and main reflector coordinate systems.
02	2020-05-26	R. Selina	3.3	Minor correction to MR coordinate system origin definition language.
03	2020-05-27	A. Lear	All	Minor copyedits.
04	2020-05-27	R. Selina, S. Sturgis	3.2, 3.3	Updated to clearer figures, and minor text clarifications based on feedback from W. Grammer.
A	2020-05-27	A. Lear	All	Prepared PDF for approvals and release.



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I Introduction

1.1 Purpose

This document defines the coordinate systems used to describe the geometry and position of the antennas within the ngVLA.

1.2 Scope

The scope of this document is all ngVLA Antennas, including the 18m Main Array (MA) antenna and the 6m Short Baseline Array (SBA) antenna. It is also applicable to the software systems that control these antennas, and the foundations that support them.

2 Related Documents and Drawings

2.1 Applicable Documents

The following documents are applicable to this Technical Specification to the extent specified. In the event of conflict between the documents referenced herein and the content of this Technical Specification, the content of the highest-level requirements document shall be considered the superseding requirement.

Ref. No.	Document Title	Rev/Doc. No.
AD01	ngVLA System LI Requirements	020.10.15.10.00-0003-REQ
AD02	ngVLA Antenna Technical Requirements	020.25.00.00.00-0001-REQ
AD03	ngVLA Short Baseline Array Antenna Technical Requirements	020.47.05.00.00-0001-REQ

2.2 Reference Documents

The following references provide supporting context:

Ref. No.	Document Title	Rev/Doc. No.
RD01	Designing Classical Offset Cassegrain or Gregorian Dual-Reflector Antennas from Combinations of Prescribed Geometric Parameters	Christophe Granet, <i>IEEE Antennas and Propagation Magazine</i> , Vol. 44, No. 3, June 2002

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3 Antenna Coordinate Systems

3.1 Antenna Pad Coordinate System

The Antenna Pad Coordinate System (or Foundation Coordinate System) is indicated by O_P , X_P , Y_P , Z_P to denote the origin and three Cartesian coordinate vectors, as shown in Figure 1.

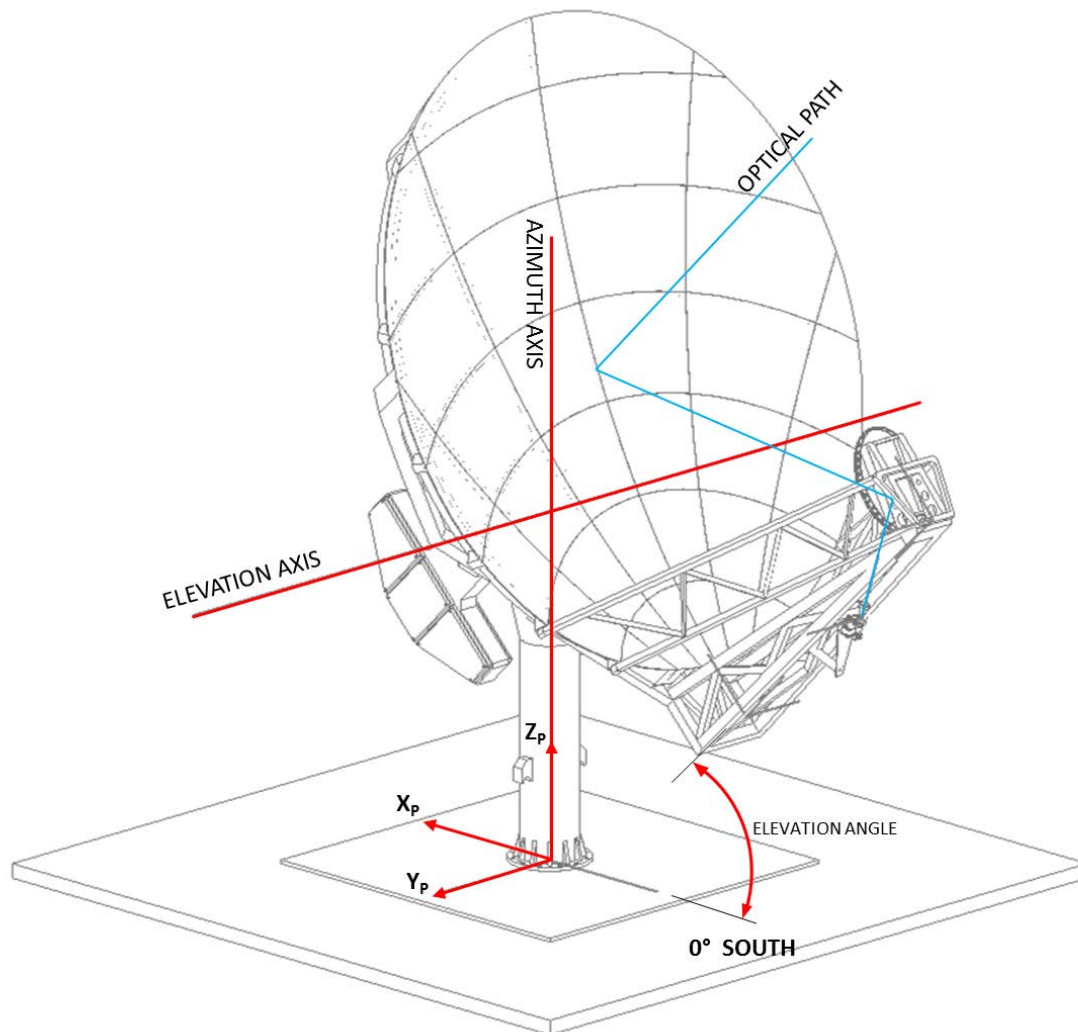


Figure 1 – The antenna pad coordinate system and major axes. Separate Cartesian reference frames define the mirror surfaces, the focus, and the pad respectively. The antenna design is diagrammatic only.

The Pad Coordinate system is based on the right-hand rule, with the Z_P corresponding to the local vertical, positive direction toward zenith, the X_P axis pointing to the geographic North, and the Y_P axis pointing to geographic West. The origin of the system is in the plane of the embedded flanges or bolts at the top of the antenna pad, at the nominal center of the as-built pad, with Z_P sharing the azimuth axis of the antenna.

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3.2 Antenna Focus Coordinate System

The focal coordinate system is defined in Figure 2.

This coordinate system is also a Cartesian coordinate system, with coordinates indicated by F_0 , X_F , Y_F , Z_F .

The position of the origin, F_0 , is the nominal secondary focus of the antenna. Z_F is aligned with the optical boresight from the subreflector, and is positive towards the subreflector. The X_F axis is positive towards the optical boresight as seen from the origin, along the plane of optical symmetry. Y_F is given according to the right hand rule.

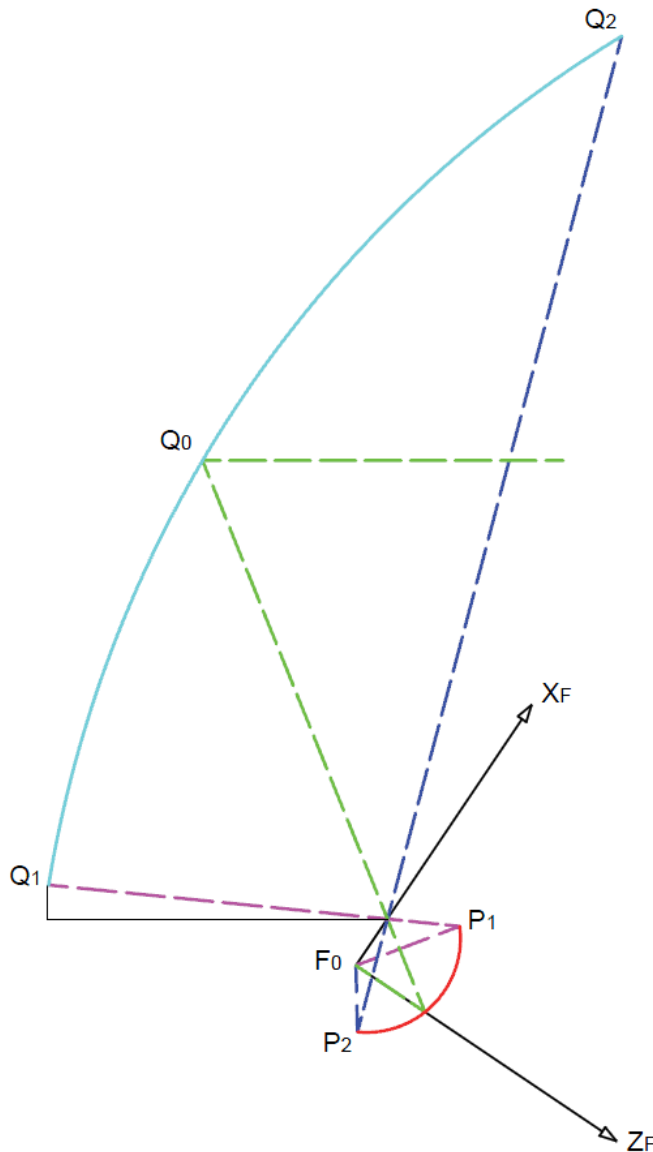


Figure 2 – Antenna Focus Coordinate System. Y_F is given by the right hand rule.

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3.3 Main Reflector Coordinate System

The Main Reflector (MR) coordinate system is a Cartesian coordinate system, based on the right hand rule, which defines the locations of both Main Reflector and Subreflector. This system of coordinates is indicated by O_{MR} , X_{MR} , Y_{MR} , Z_{MR} as shown in Figure 3.

The X_{MR} - Y_{MR} plane is the aperture plane of the main reflector, with the X_{MR} axis on the optical plane of symmetry, perpendicular to the elevation axis. The Z_{MR} axis the nominal boresight of the antenna, positive toward the source, and the Y_{MR} axis according to the right hand rule. As such, when the azimuth of the antenna is equal to zero, the Y_{MR} axis is parallel, to the Y_P axis.

The origin of the MR coordinate system, O_{MR} , is along the optical boresight, with the Z_{MR} zero point defined to be 3000 mm (3.0 m) from the point F_0 to the X_{MR} - Y_{MR} plane as shown in Figure 3.

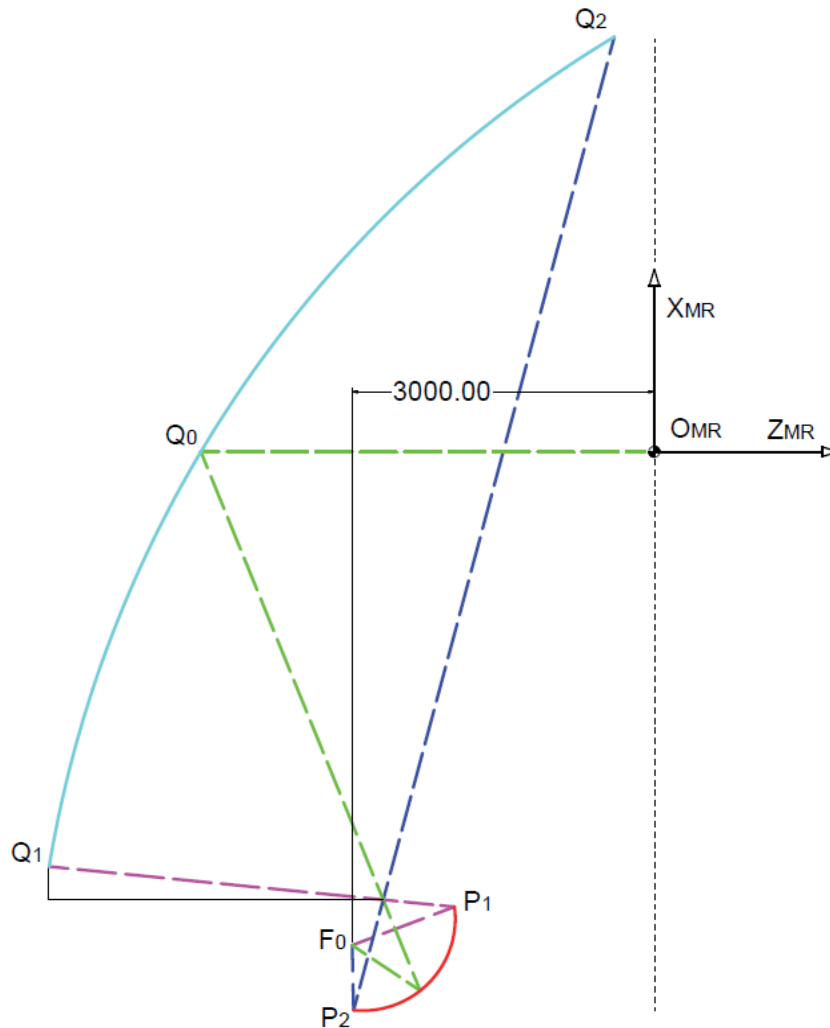


Figure 3 – ngVLA Main Reflector (MR) Coordinate System. Z_{MR} is along the optical boresight, with X_{MR} and Y_{MR} in the aperture plane of the antenna, and Y_{MR} 's orientation defined by the right hand rule. Dimensions given in millimeters.



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3.4 Antenna Azimuth and Elevation Axes

The antenna mount is assumed to be an Altitude-Azimuth mount consistent with AD02 and AD03. The antenna axes of motion are depicted in Figure 1.

The Azimuth angle shall be zero when the antenna is rotated so that Y_{MR} is pointing West. More intuitively, with the antenna pointed to the horizon, the Z_{MR} axis will then point South. The Azimuth angle will count in the positive direction when the antenna moves in the clockwise direction (Azimuth angle = 90 when Y_{MR} is pointing toward North).

The Elevation shall be zero when the Z_{MR} axis is pointing to horizon and to +90 when the Z_{MR} axis is pointing toward zenith.



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4 Appendix

4.1 Abbreviations and Acronyms

Acronym	Description
AD	Applicable Document
MA	Main Array
MR	Main Reflector (Coordinate System)
ngVLA	Next Generation VLA
RD	Reference Document
SBA	Short Baseline Array
TBD	To Be Determined