# Introduction

Patrick’s paper uses one set of notation while his implementation code uses another, both however are equivalent. These notes bridge the gap and additionally retain valuable insights communicated privately by Patrick.

# Notation

* Roll axis 🡺 Hour angle (equatorial mounts) or azimuth (alt/az mounts)
* Pitch axis 🡺 Declination (equatorial mounts) or altitude (alt/az mounts)

# Dome centre

The primary reference point is the geometric centre of the dome sphere. This is the centre of the sphere from which the dome is made. E.g. if the dome is less than a hemisphere, the reference point is not in the plane of the bottom of the dome but lower than this at the centre of the sphere of which the dome section is a part.

If the dome is more than a hemisphere the centre will be above the plane of the bottom of the dome as shown below.



# Coordinates and Conventions

## X, Y, Z Coordinate System

The x, y, z coordinates for the offset of the mount from the dome geometric centre are:

* X 🡺 East – west (east positive)
* Y 🡺 North – south (north positive)
* Z 🡺 Up – down (up positive)

In equatorial mounts PHI is the site latitude but for Alt/Az mounts PHI is to 90 degrees regardless of the site latitude.

The variable p is called yt in Patrick's code (separation of the two axes)

The variable q is called yt in Patrick's code (Offset of the optical axis along the declination axis)

The variable r is called yo in Patrick's code (separation of the two axes)

The code requires the mechanical roll angle which is calculated from the telescope hour angle (local sidereal time minus right ascension) and declination for equatorial mounts azimuth for alt/az mounts.

## Roll and Pitch Angle Coordinate System

Both roll and pitch axis angles are calculated in the range -180.0 to +180.0 degrees (-π to +π radians)

The coordinate system is “right-handed” with **mechanical** roll angle increasing anticlockwise as viewed from space looking down on the north pole (equatorial) or zenith (alt/az). This means that:

* Equatorial mounts: **Mechanical** hour angle is zero for telescope targets due south and positive for telescope targets to the east of south (the more east the more positive).
* Alt/Az mounts: **Mechanical** azimuth is zero to the south and positive for telescope targets to the east of south.

## Roll Angle

In Patrick’s models zero roll angle is defined as being when a telescope in the northern hemisphere is pointing due SOUTH in the “Normal” pointing state. So for equatorial mounts, the roll angle in both hemispheres is given by:

* Normal pointing state (PierEast) 🡺 minus hour angle
* Through the pole pointing state (PierWest) 🡺 minus (12.0 minus hour angle)

For alt/az mounts it is: 180.0 minus telescope azimuth in both pointing states

## Pitch Angle

The pitch angle is more complex and varies with hemisphere. Zero pitch angle aligns with declination for equatorial mounts and altitude for alt/az mounts.

In the northern hemisphere for equatorial mounts the pitch angle is:

* PierEast 🡺 declination
* PierWest 🡺 180.0 minus declination

In the southern hemisphere

* PierEast 🡺 declination
* PierWest 🡺 minus 180 minus declination (note that declination is negative in the southern hemisphere)

For alt/az mounts the pitch angle equals telescope altitude.