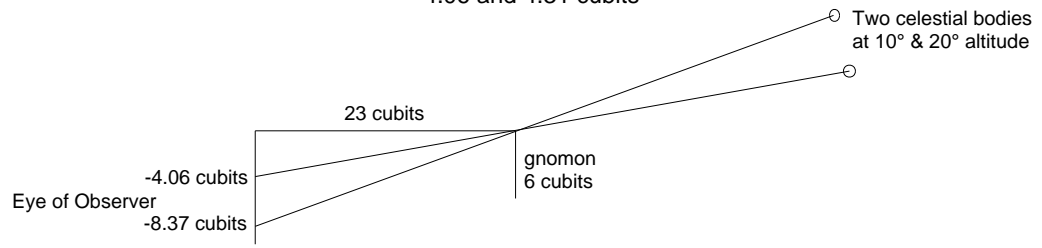
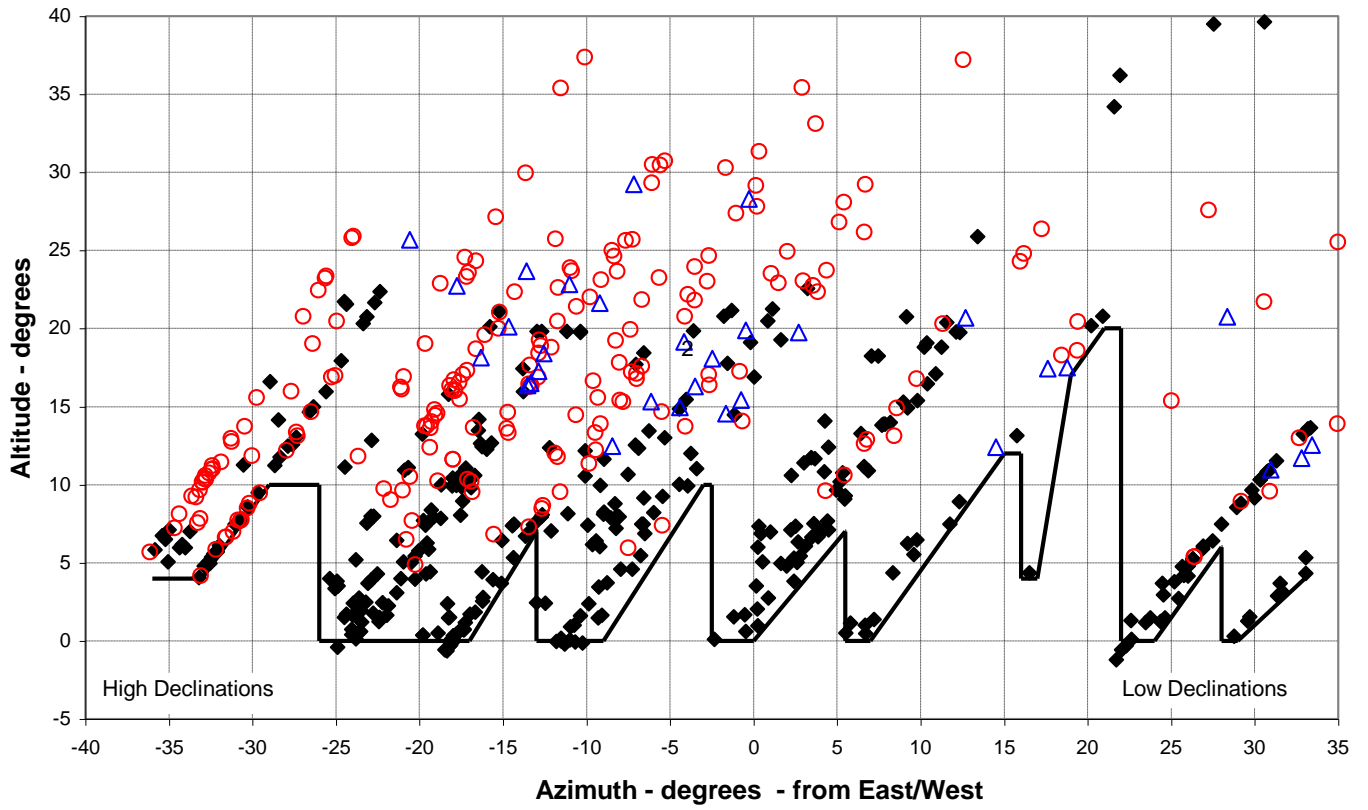


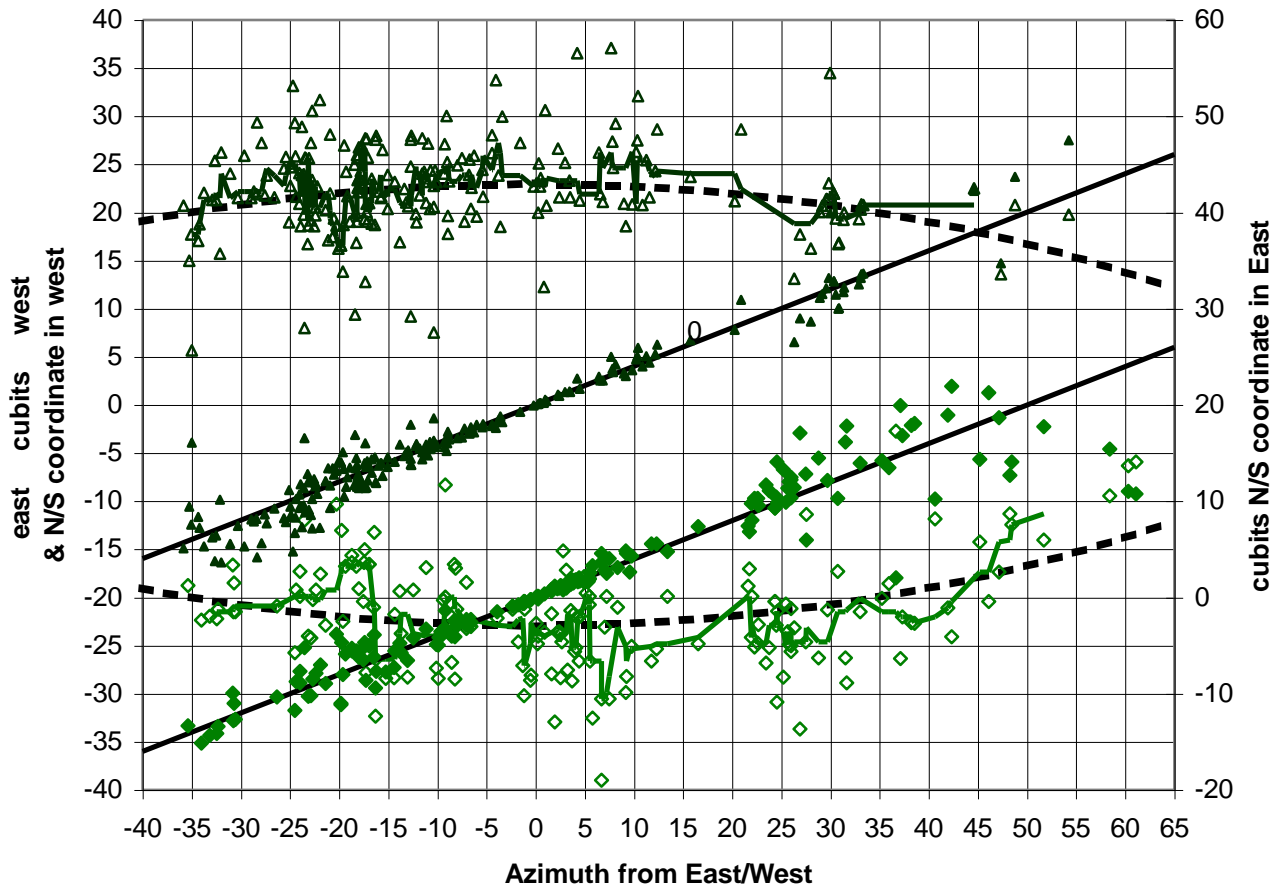
1. Cross-section of proposed device
with observer 23 cubits from gnomon
10° intervals measure, in vertical plane,
4.06 and 4.31 cubits



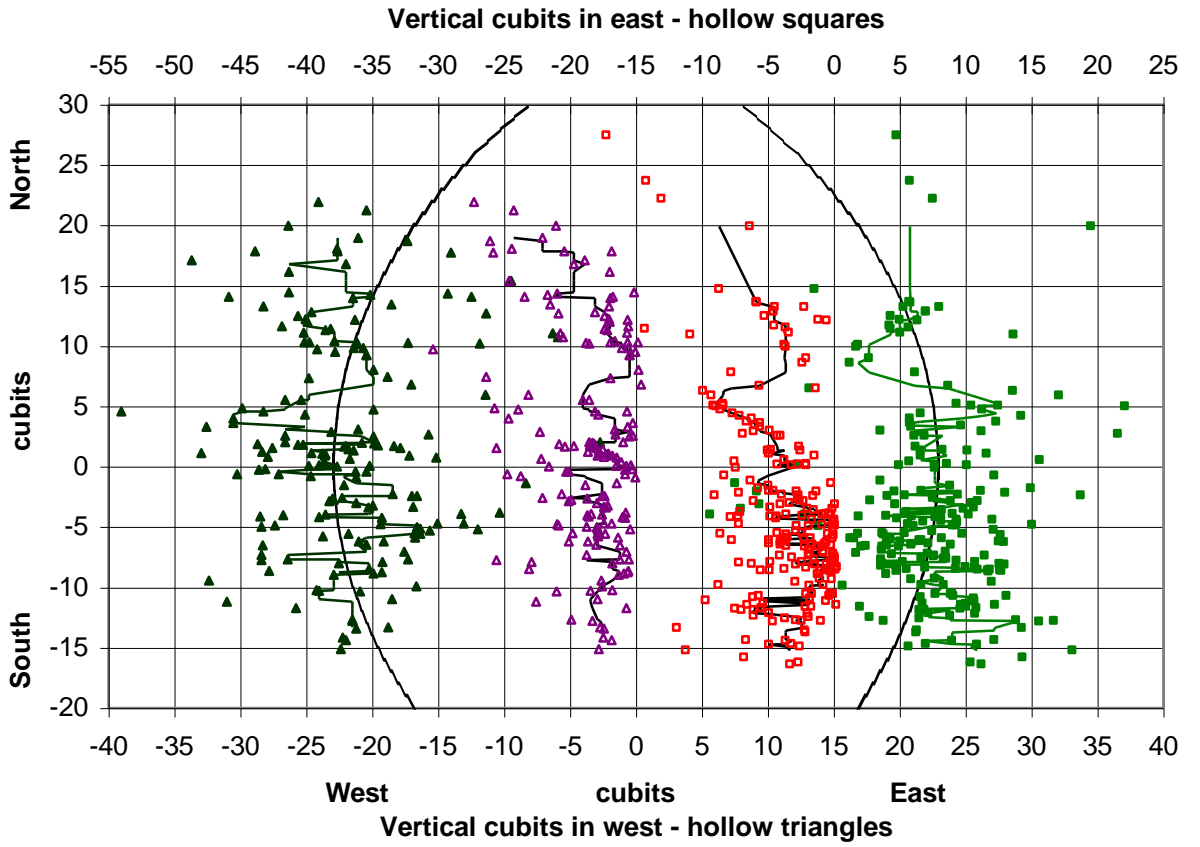
2. Positions Observer's Eye for Star
656 Passages - Calculated Distance Apart within 0.2% of Recorded Up/down Cubits
Best Alignment: Longitude - squares, R.A - circles, Azimuth - triangles
Continuous line marks lack of horizon observations (both E & W)

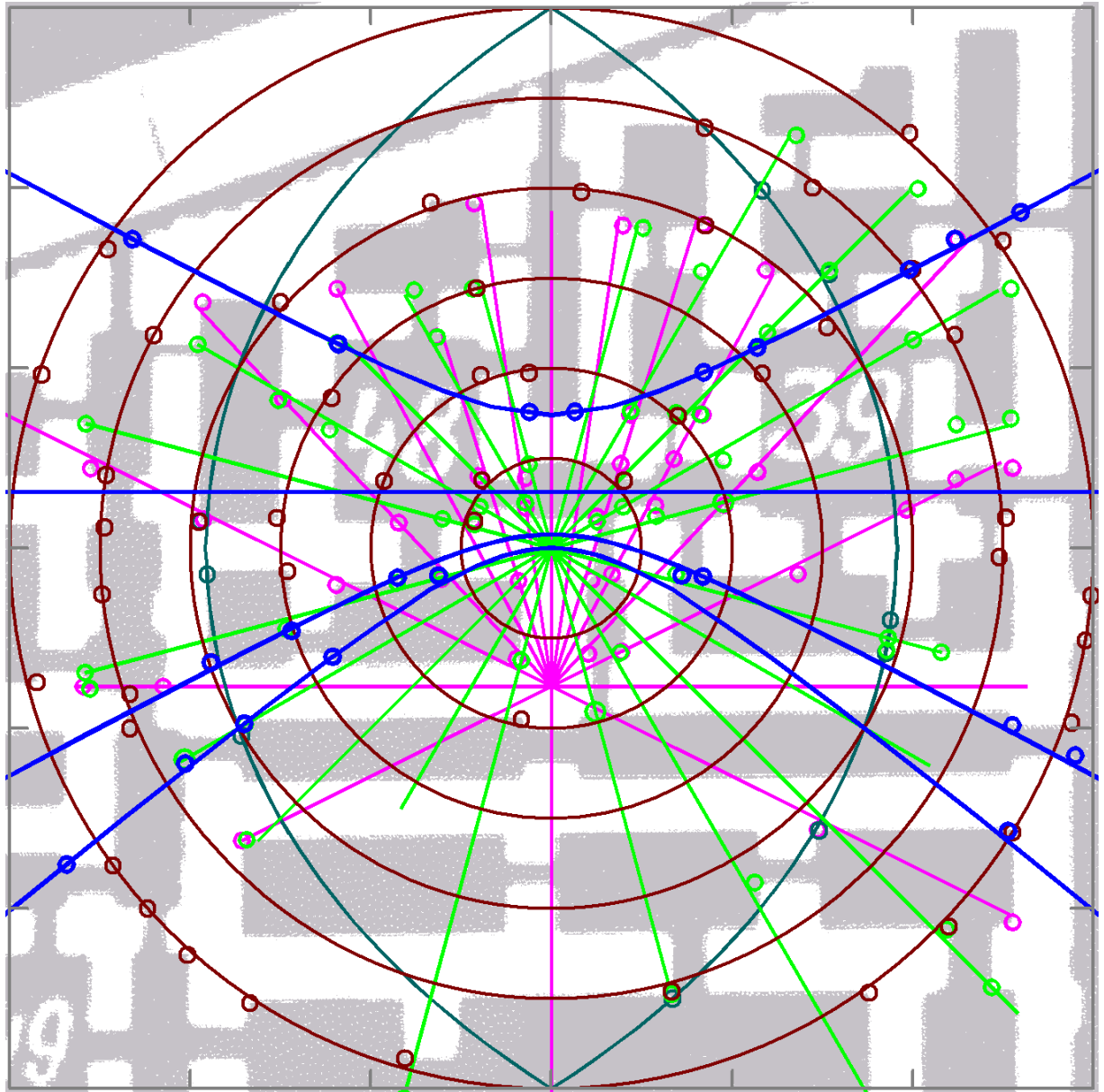


3. 386 Passages well-aligned Longitude
Positions Observer for star
Azimuth & separately W/E & N/S coordinates
diagonal lines 2.5° (azimuth) per N/S cubit
Continuous lines moving means (7 passages) of W/E coordinates
Dashed lines calculated values



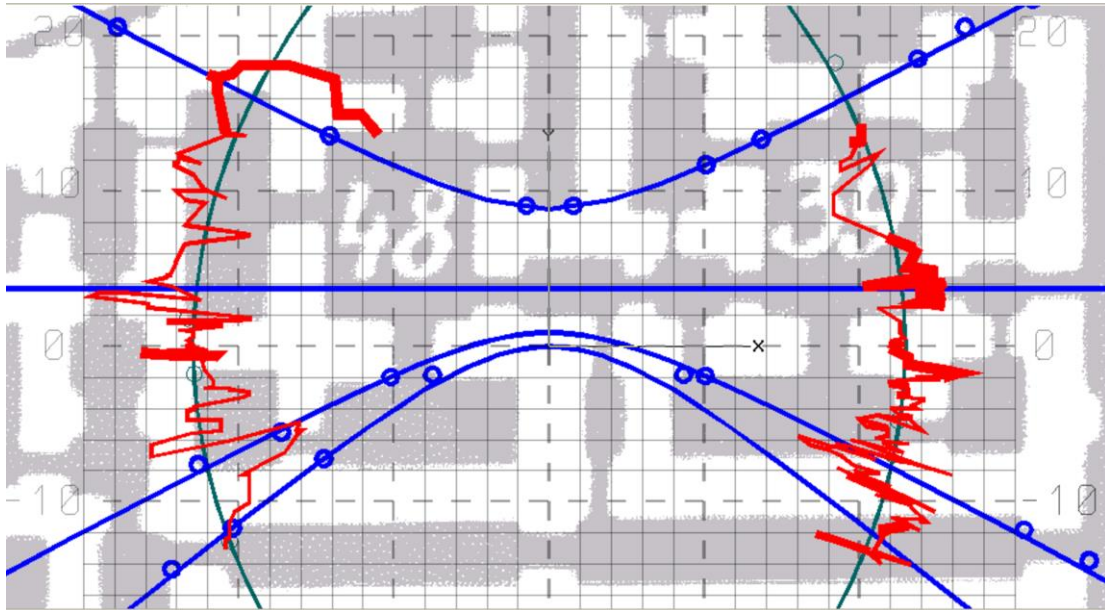
4. Passages best aligned in longitude
Observer's positions in plan & vertically
In East Observer's vertical position (top scale)
Continous lines - moving averages of 7
Dashed arcs - stepped curves
Significant anomaly ca. 5 cubits north of gnomon



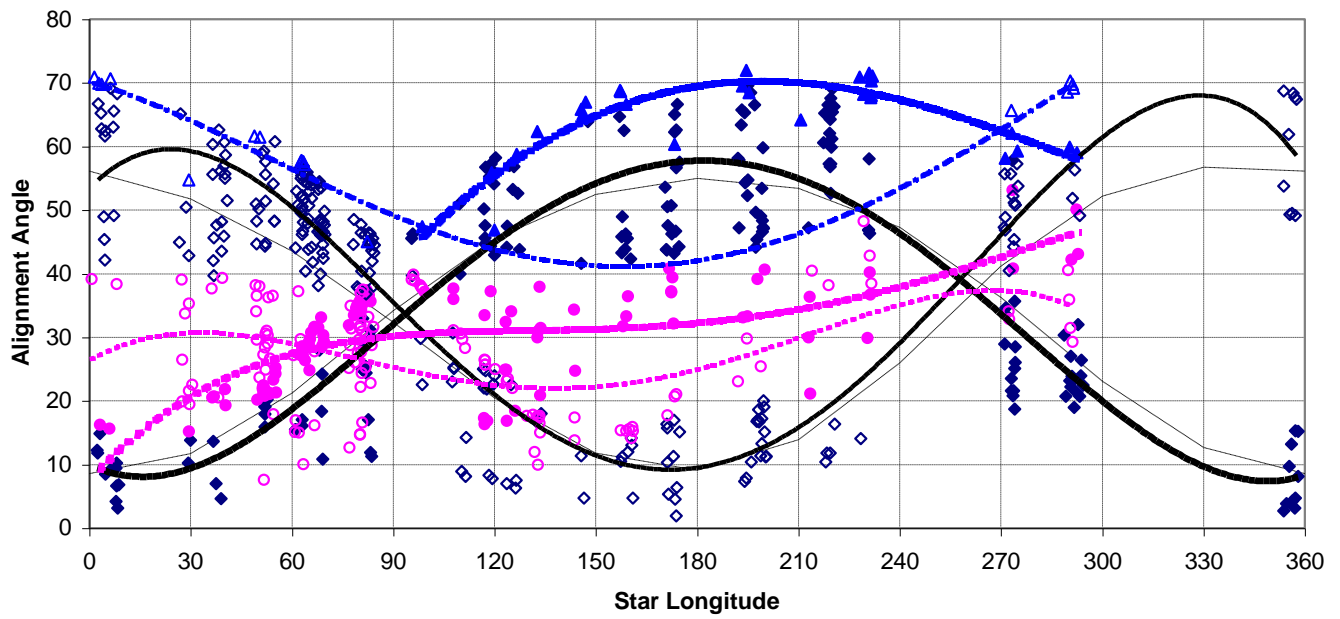


5. Plan of Babylon Palace North of Western Court,
 assuming 6 cubit gnomon showing
 outline square side 72 cubits – 37.4m
 stepped curves for observer
 concentric circles - radii from 6 to 36 cubits
 lines radiating from gnomon at 15° intervals
 lines radiating from pole at one hour intervals
 small circles mark where lines meet wall junctions
 in blue, paths of sun at equinoxes and solstices
 with the equivalent path of stars that transit overhead

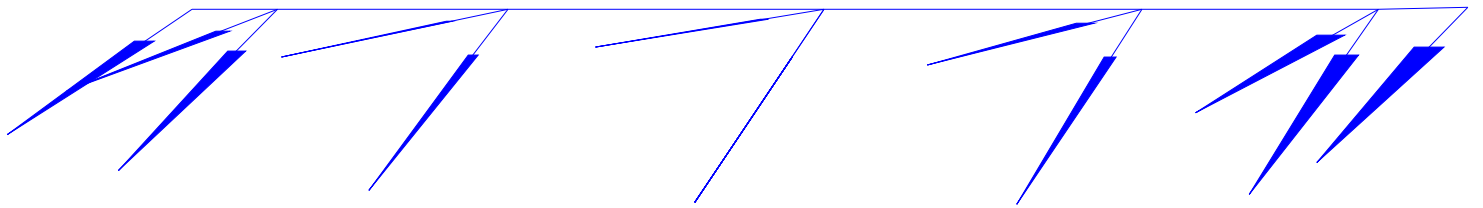
6. Enlargement of Figure 5, showing
calculated mean positions of observer in red
(thicker lines indicate greater depth)
square grid with sides of 2 cubits (ca. 1.04m)
in blue, paths of sun at equinoxes and solstices
with the equivalent path of stars that transit overhead



7. Positions Observer's Eye for Star
656 well-aligned Passages when in West or East
better aligned in Longitude (squares), R.A. (circles) or Azimuth (triangles)
dashed lines assume exact alignment in longitude near horizon



8. Schematic Cross-section of Device in East & West
showing 4 cubit rod at 30° intervals of longitude
lower body at 2° altitude



8B Comparison of frequencies of radiocarbon samples and placing of megaliths at Nabta Playa

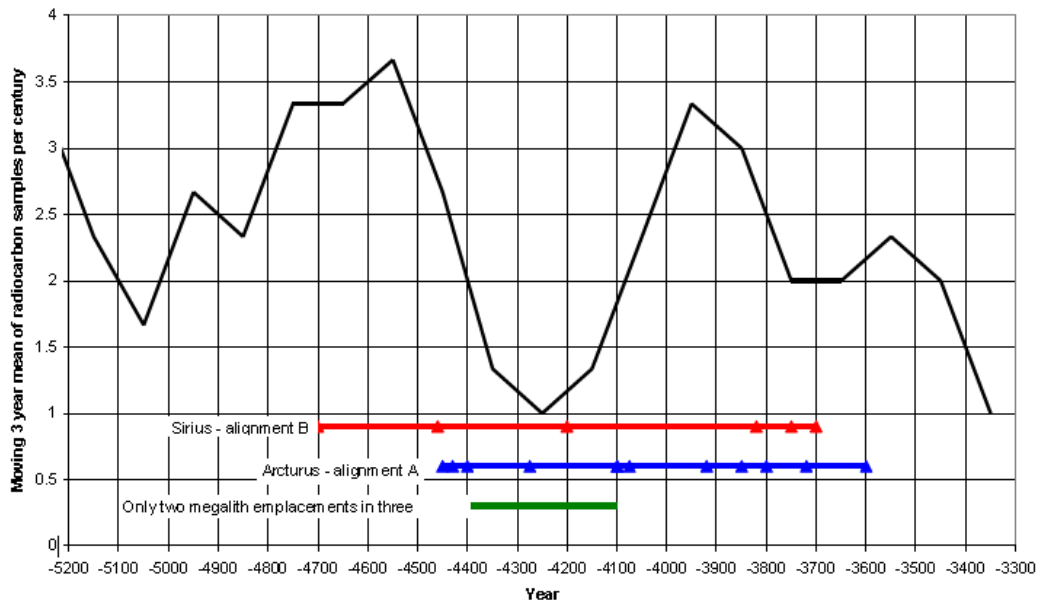


Fig 8c2. Hierakonpolis HK29B Three Possible Layouts
 Red - Gnomon 4.0m - Declination -24.1°
 Dashed Red - Gnomon 1.4m - Declination -29.6°
 Green - Gnomon 5.5m - Declination -24.1°
 Dashed Green - see text
 Blue - Gnomon 4.78m - Principal line - Declination -35.7°
 Dotted Blue lines radiate around blue cross

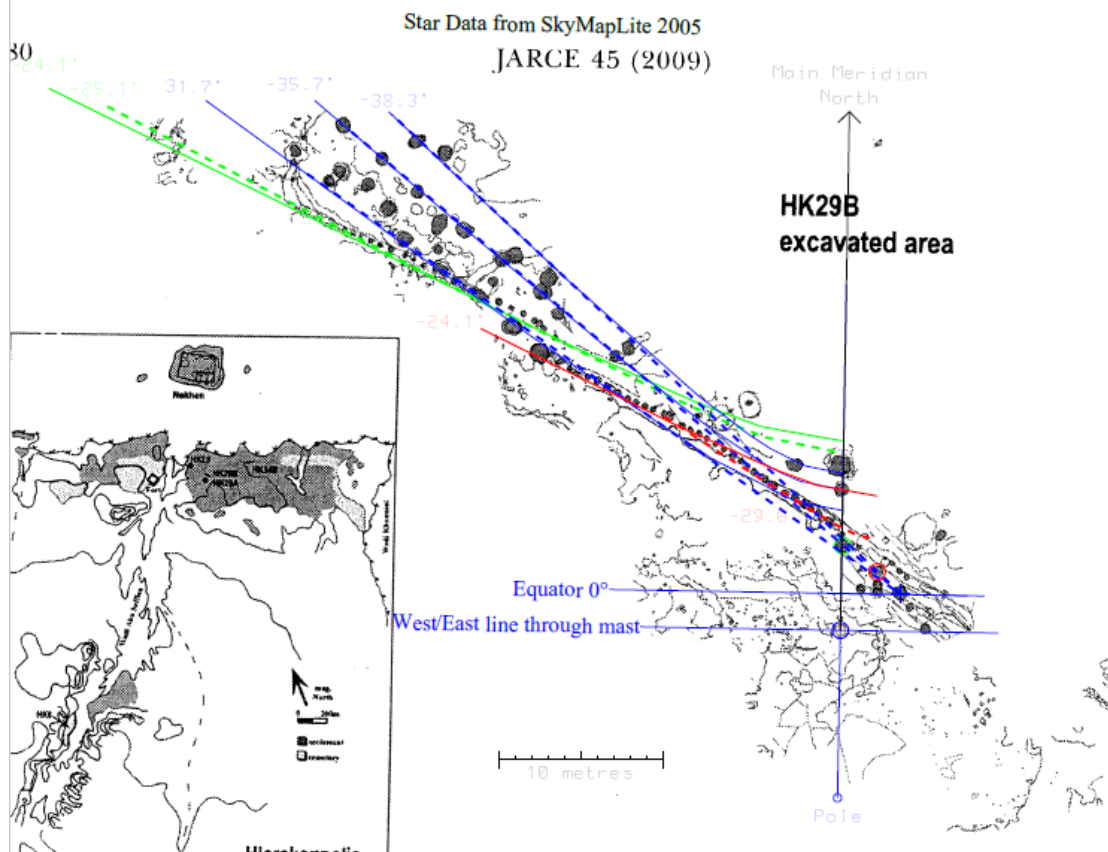


Fig.8d Hierakonpolis HK29A Phase 1 (-3500)
 (For greater detail see Friedman 2009, Fig.8)
 Dotted Black - lines at 45° to meridian, X & Y
 Dashed Black - Unexcavated courtyard perimeter
 Blue - lines of constant declination
 Red - Hour-lines & degrees (Time) to Meridian
 Brown - post holes south of courtyard

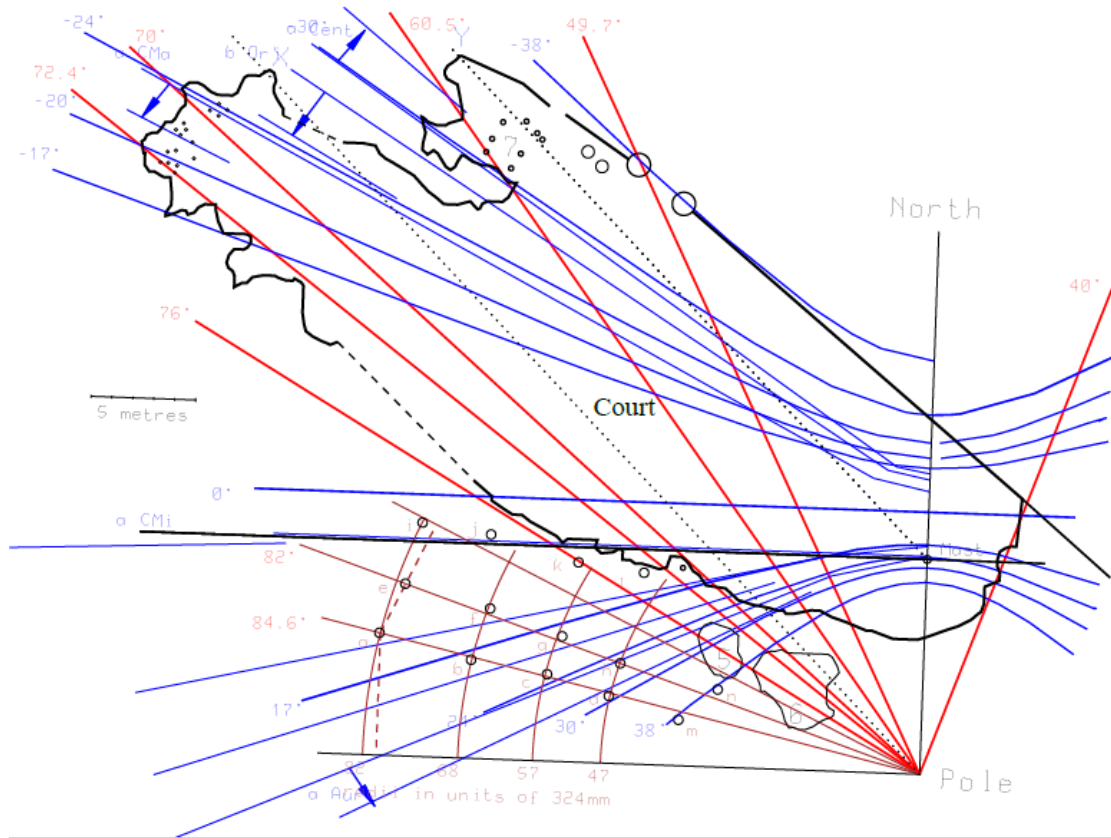


Fig.8e Hierakonpolis HK29A Phase 2 (-3300)
 (For greater detail see Friedman Jarce 45 2009, Fig.9)

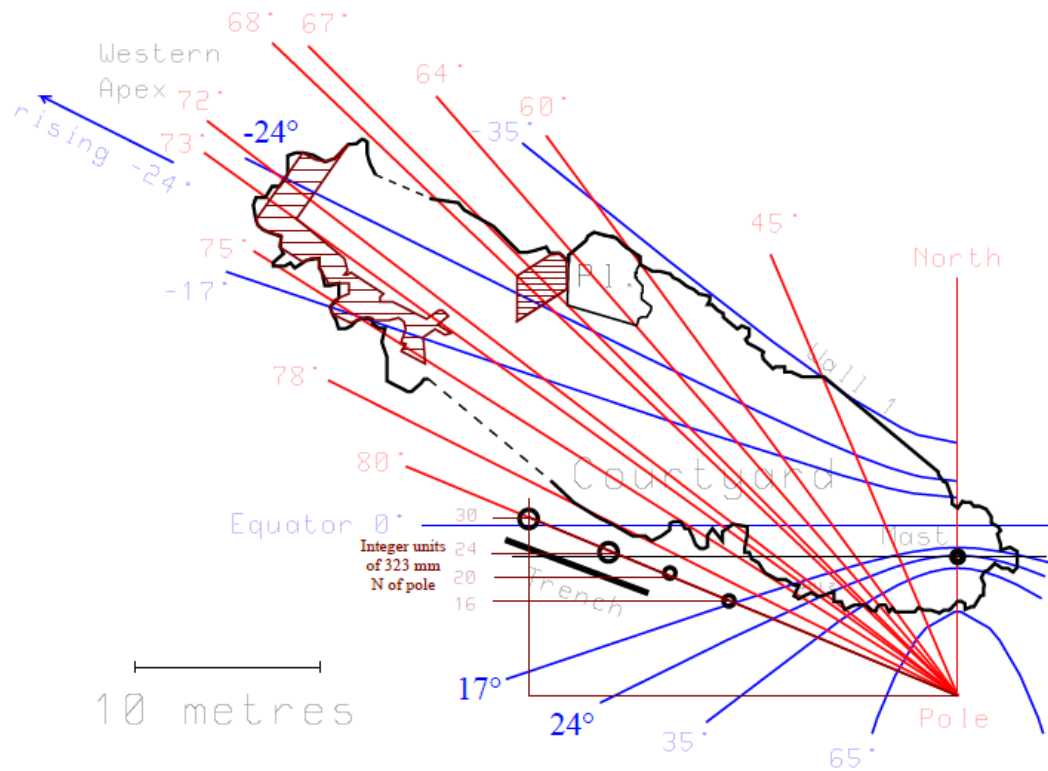
Dashed Black - Unexcavated courtyard perimeter

Blue - Lines of Constant Declination

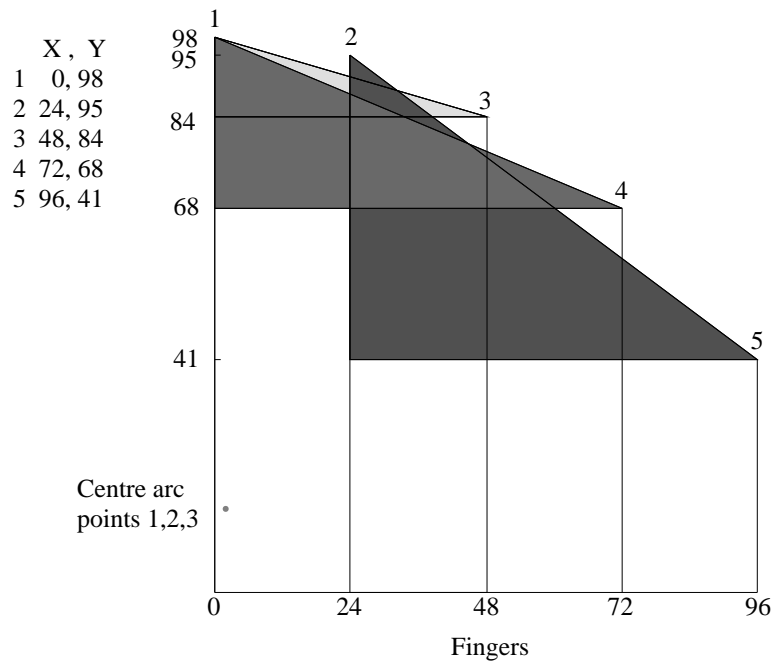
Red - Hour-lines & degrees (time) to meridian

Brown - 4 post holes & 5,12,13 (x6) triangle

Brown hatched - Brickwork Western Apex



9. Saqqara Curve with Five Points



Centres Arcs
points 3,4,5
points 1,3,5

9a Pepi II Pyramid Complex. Green Rectangular grid with 28.8 cubit squares
 Black Dotted grid & circles with 25 cubit squares
 Yellow Pythagorean Triangles
 Blue Shadows of bodies with declination -12° & , in east, 0° , all at 10° intervals. in west equatorial shadow 35° from meridian, ignoring girdle
 Red Standard short hours of 40 minutes on declinations 0° ($50/40^\circ$) & -12° ($40/30^\circ$).

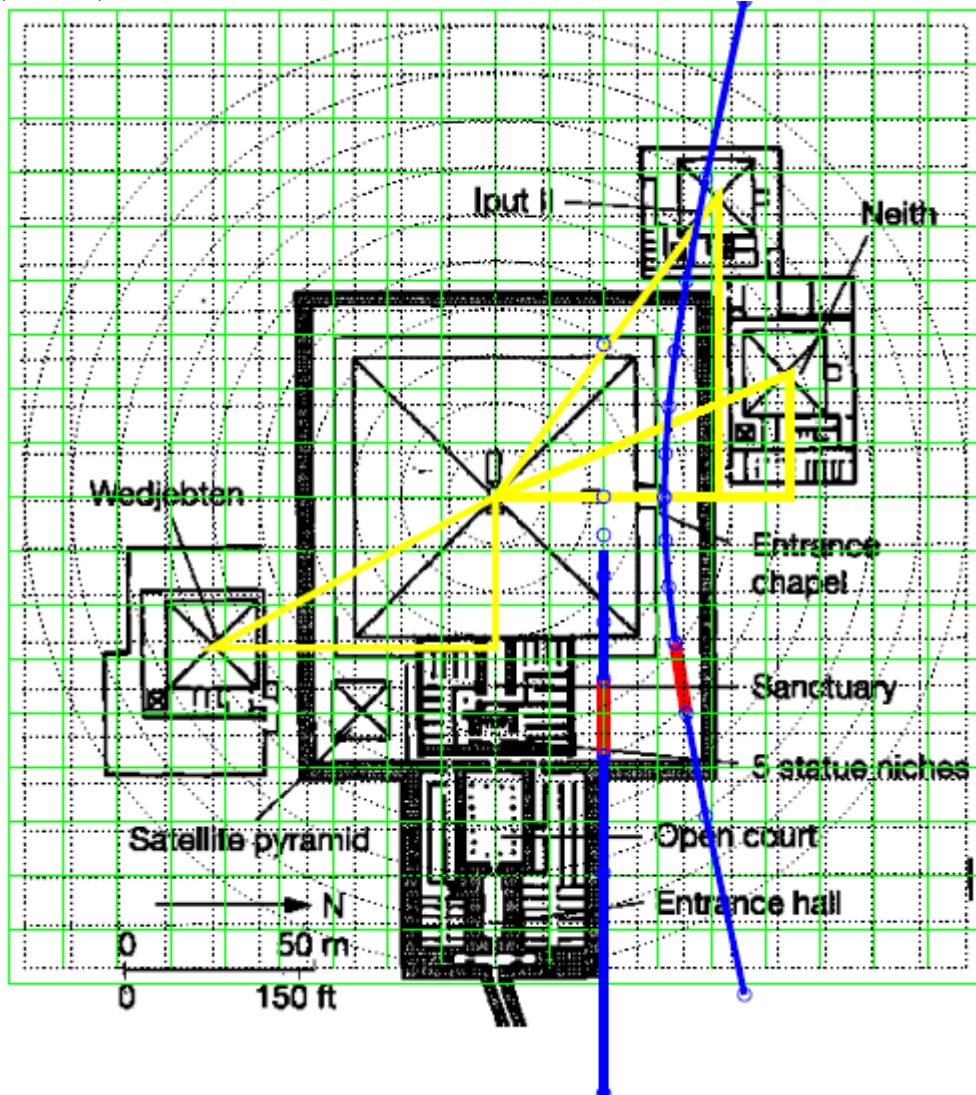


Fig.9b Horus Eye Fractions

Red $1/2$ Green $1/16$

Yellow $1/4$ Black $1/32$

Blue $1/8$ Grey(2) $1/64$

First Quadrant of Spiral

Total area 32 sq. units

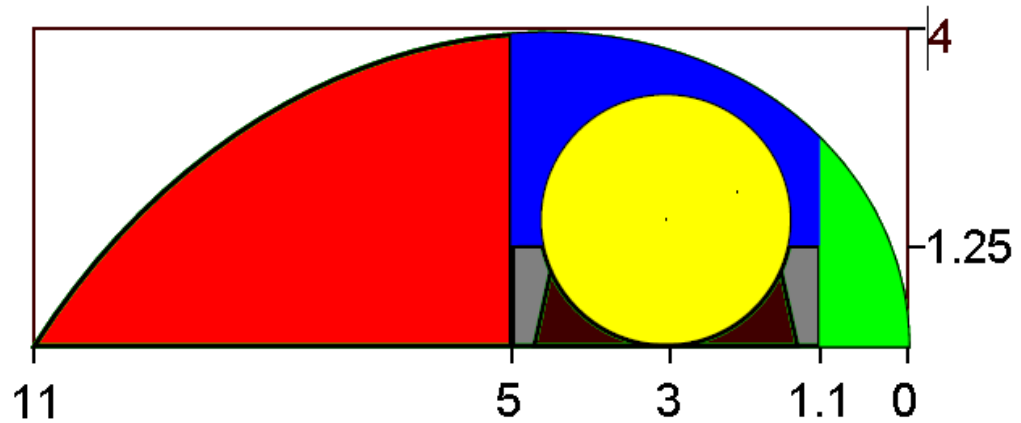


Fig. 9c Four 4th Dynasty Pyramids - Sneferu (3) & Khufu (1) - 2610/-2580
 Red - Hour-lines, around Pole, with Respective Times from Transit
 Blue - Lines of Constant Declination
 Scales Vary but Base Side/Height shown below Name
 → North

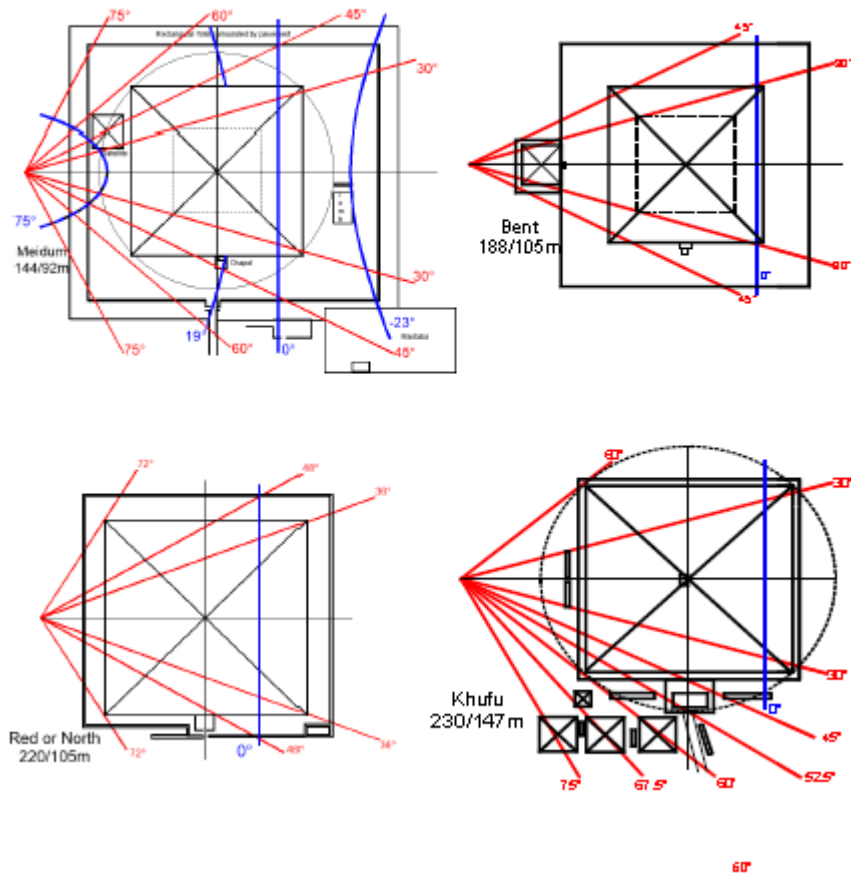


Fig 9d Four Pyramids - Kefre, Menkaure, Userkat & Sahure -2540/-2480

Red - Hour-lines, around Pole, with Respective Times from Transit

Blue - Equator

Scales vary but Base Side/Height shown below Name

→ North

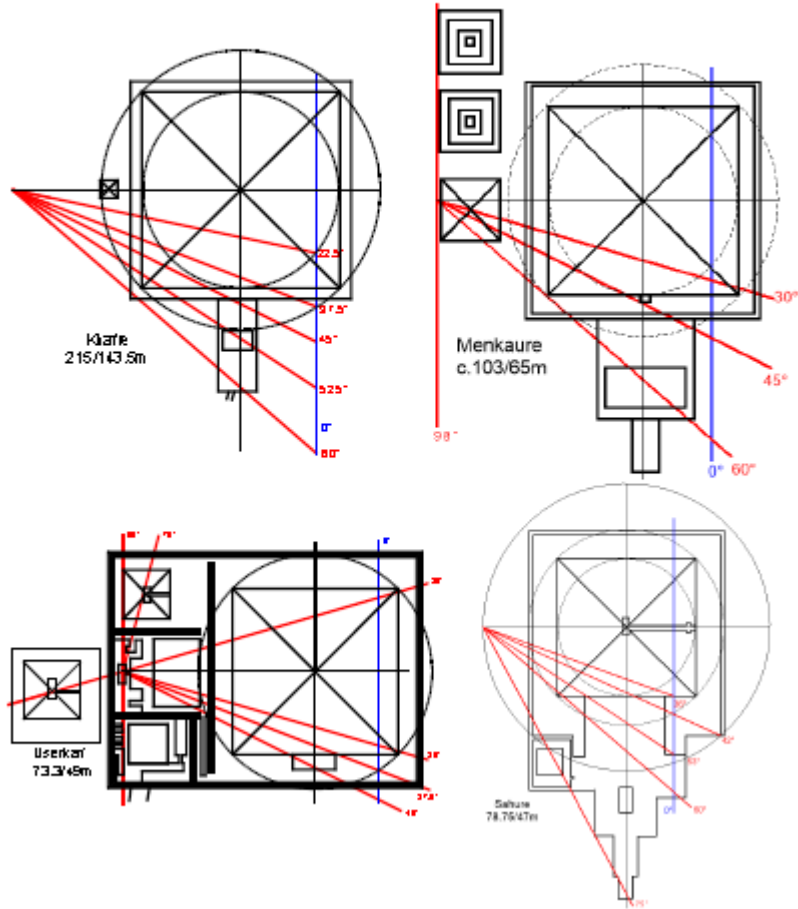


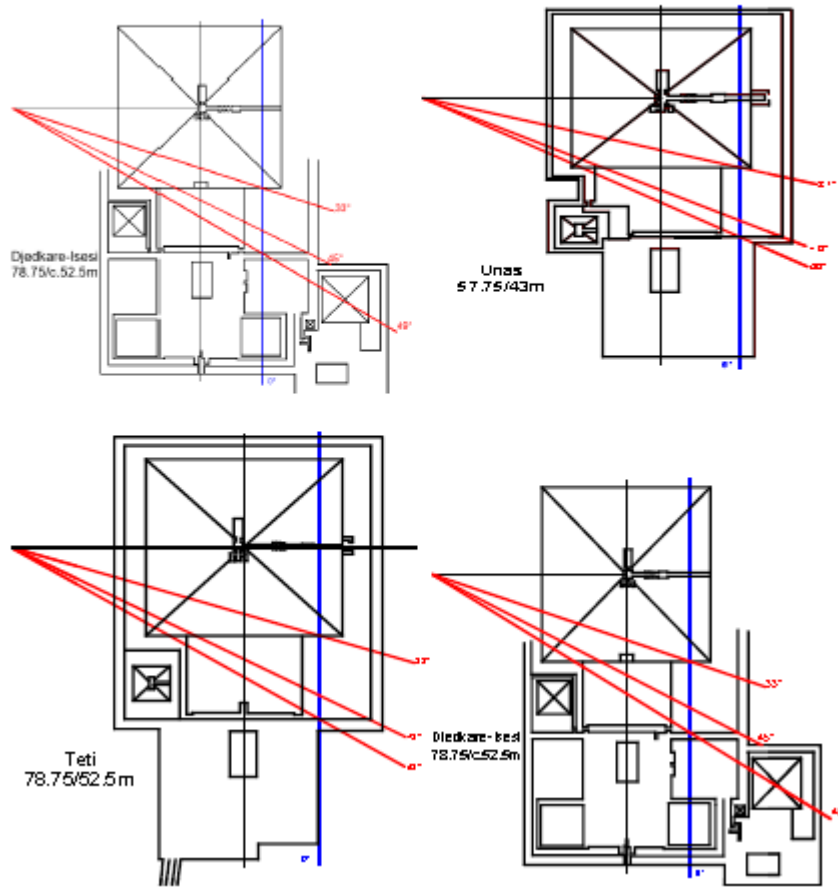
Fig.9e Four Pyramids Djedkare-Isesi, Unas, Teti & Pepi I -2400/-2300

Red - Hour-lines, around Pole, with respective Times from Transit

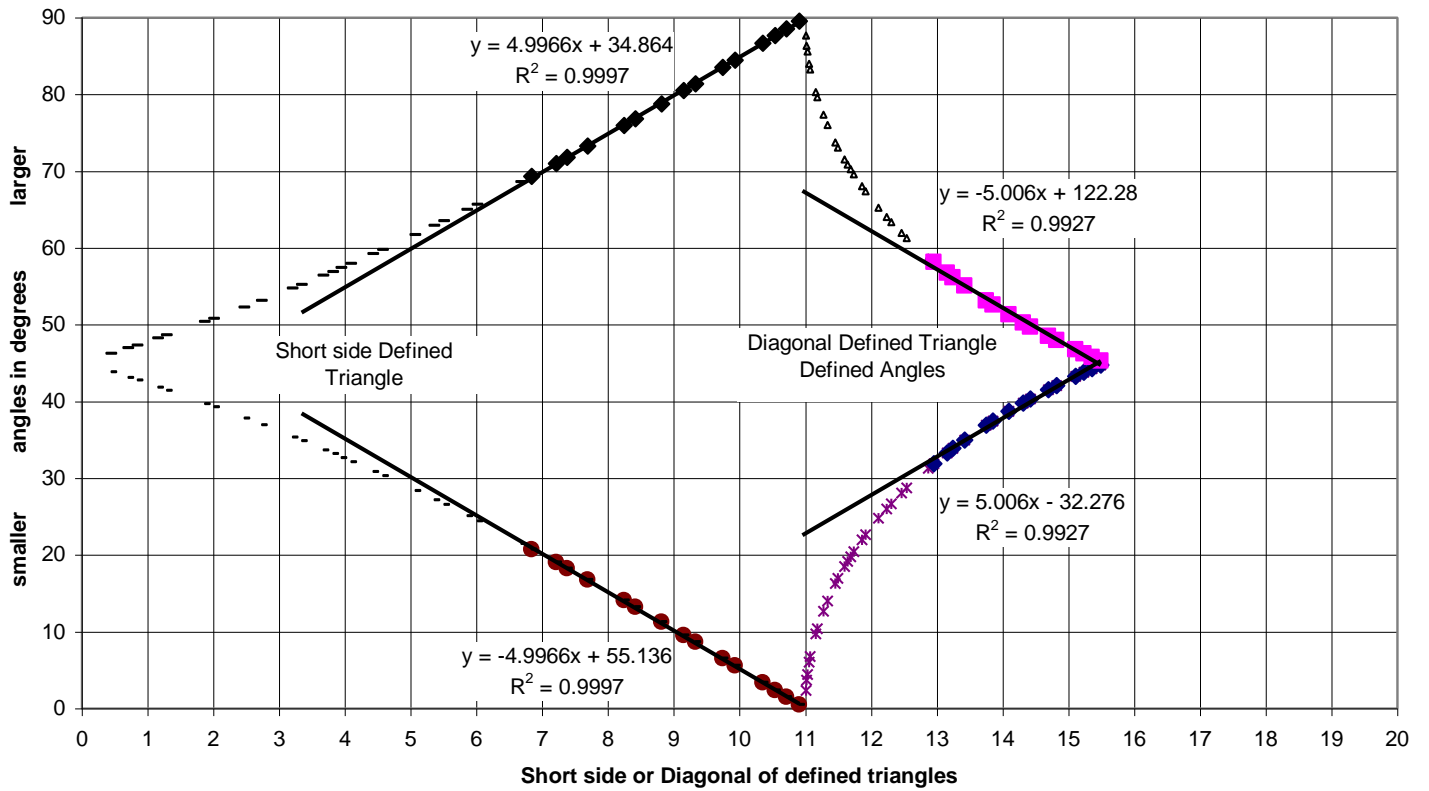
Blue - Equator

Scales Vary, but Base Side/Height shown below Name

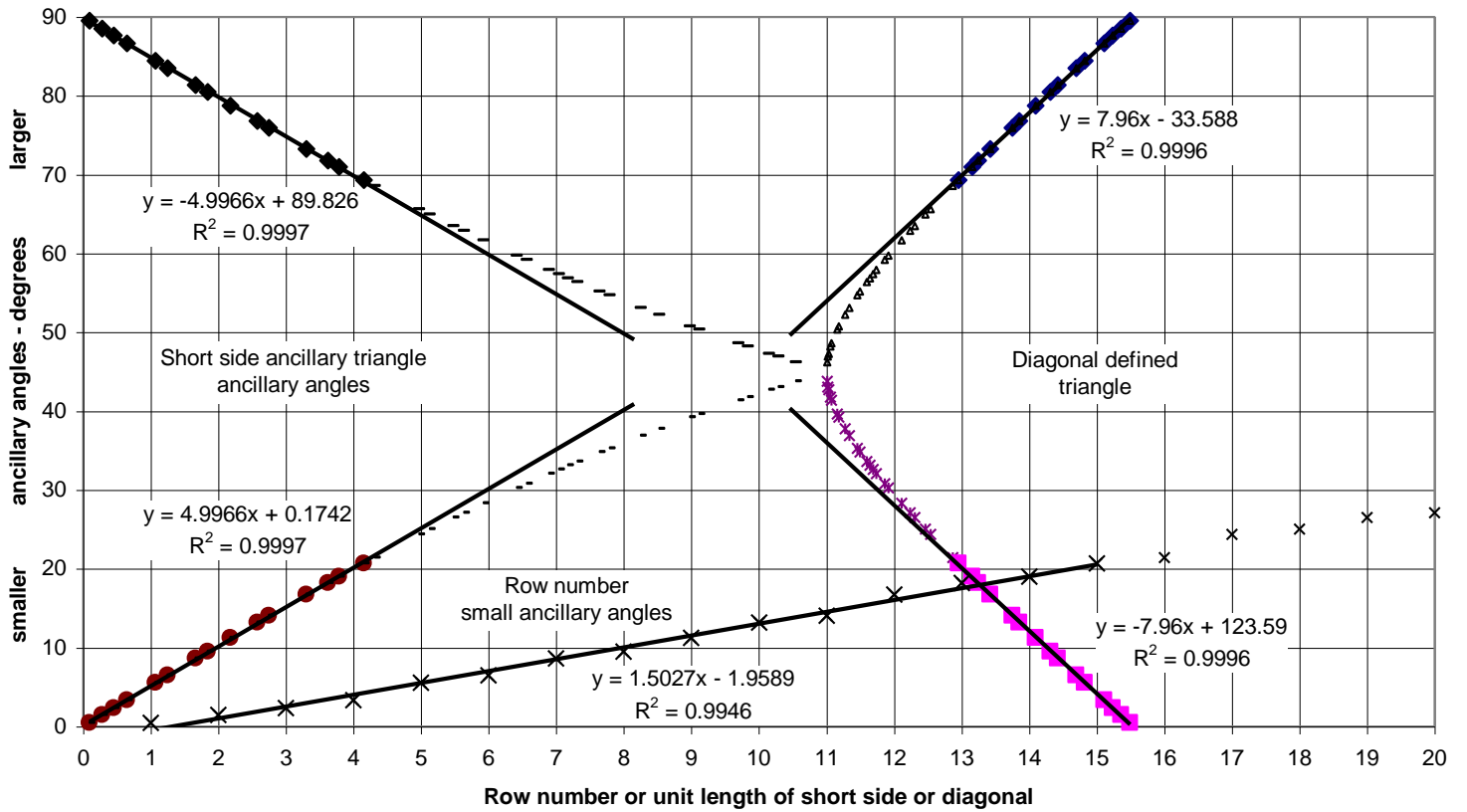
→ North



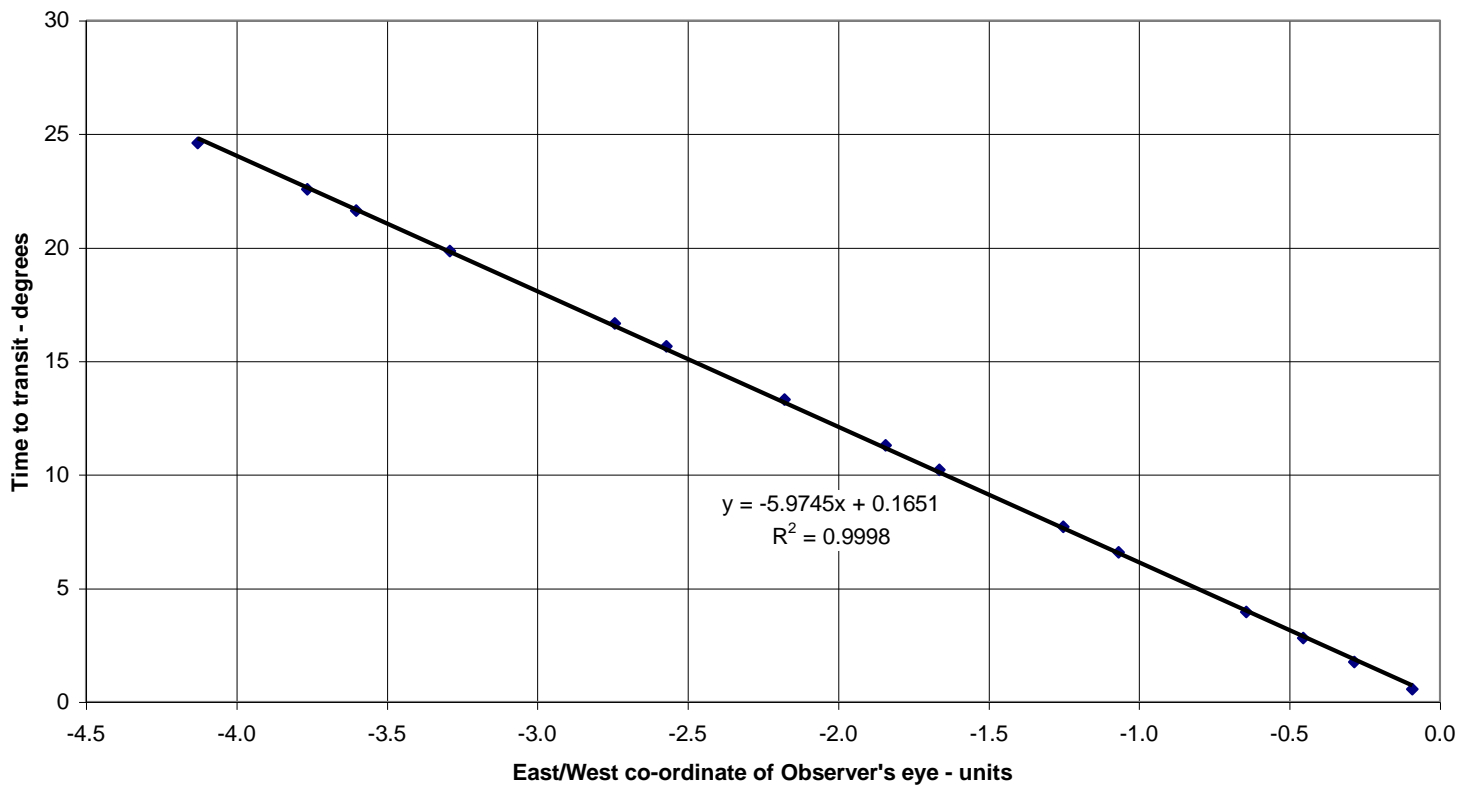
**10. Plimpton 322 - Plot of short side or diagonal & angles
of triangles with long side scaled to 11 units
Enlarged markers & trendlines for 15 extant rows**



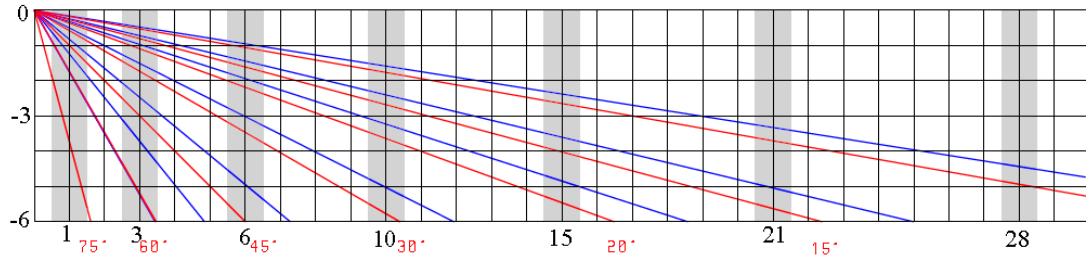
**11. Plimton 322 - Plot of short side or diagonal & angles
of ancillary triangles with long side scaled to 11 units
plus row number & small ancillary angles
Enlarged markers & trend lines for 15 extant rows**



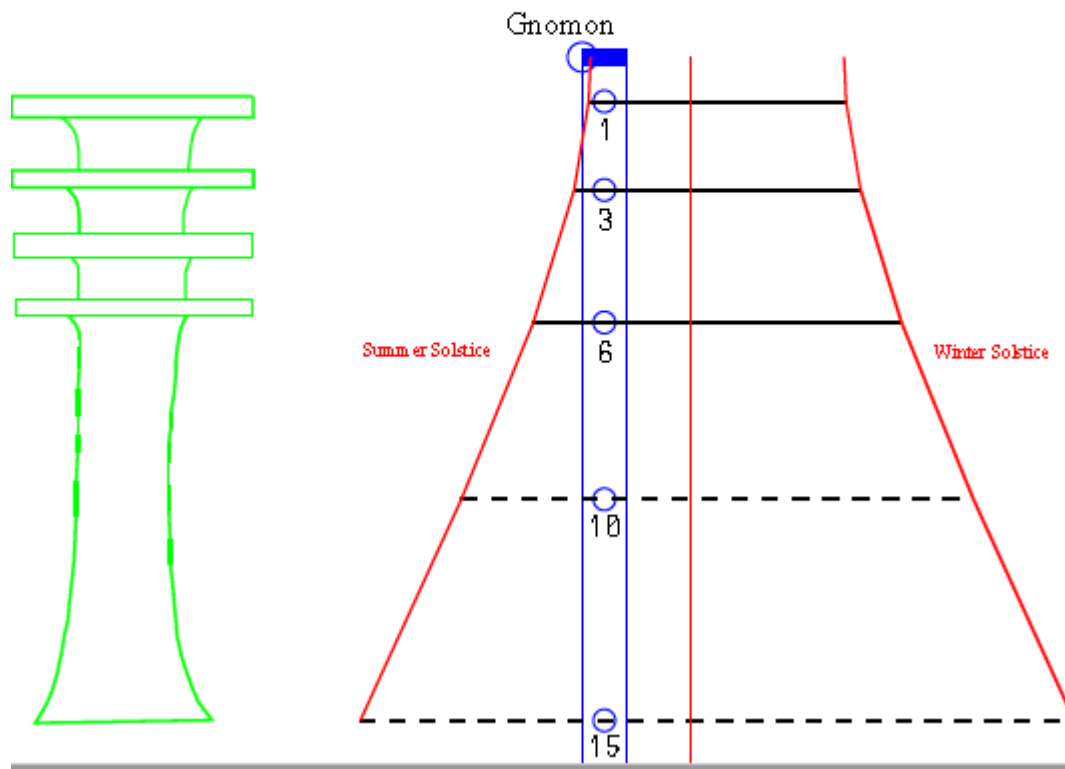
**12. East/West Position of Observer's Eye
and time to transit with a gnomon of 11 units
Small Ancillary angle in Plimpton 322 assumed to correspond to
zenith distance of stars that transit overhead on a latitude of 32.5°**



13 Cross-sections of L-shaped sundial aligned with sun
 Black - 6 x 30 unit grid
 Grey Bands - marks at 1, 3, 6, 10, 15, 21 & 28 +/- 1/2 units
 Red - Altitudes to top of gnomon - 10°, 15°, 20°, 30°, 45°, 60° & 75°
 Blue - Times from Rising - 10°, 15°, 20°, 30°, 45°, 60° & 75° at Equinoxes
 Assumed Latitude 26° No allowance for refraction



14 Plan Sun's Afternoon Shadows (red) Equinoxes and Solstices
 cast by southern corner of flat topped gnomon (blue)
 Gnomon Height & Width 5 & 1 units
 Latitude 26° , Obliquity of Ecliptic 23.83°
 Black Horizontal Lines: continuous - Seasonal time, dashed - equinoctial time
 Djed Pillar at Left



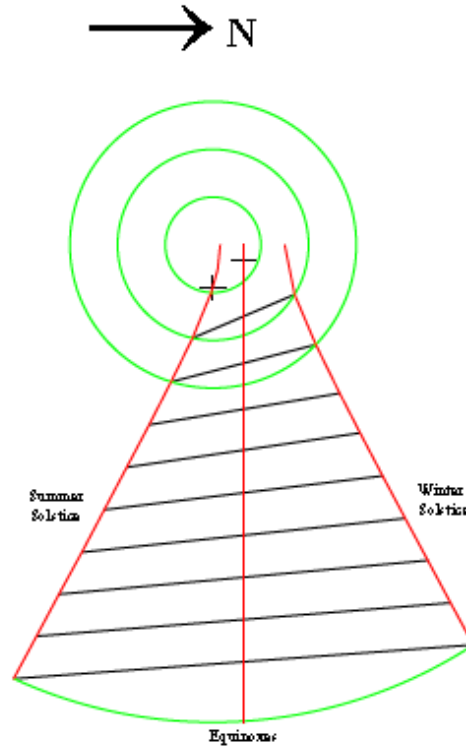
|15. Mul-Apin Shadow Length Scheme -Latitude 32.5° - Obliquity 23.83°

Green - circles around gnomon - radii 1,2 & 3 and arc - 10 cubits.

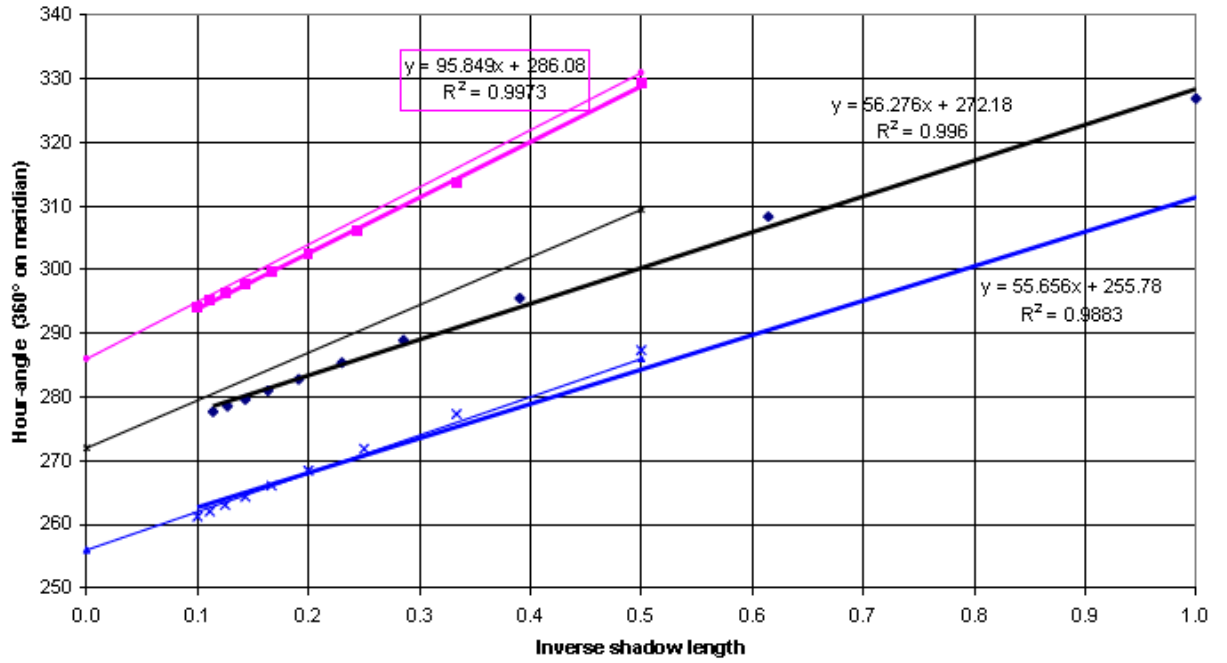
Equinox Values (>3 radius) fixed by intersection of straight black lines joining solstice positions.

Crosses mark theoretical positions for 60° & 75° (time) for Summer Solstice & Equinoxes.

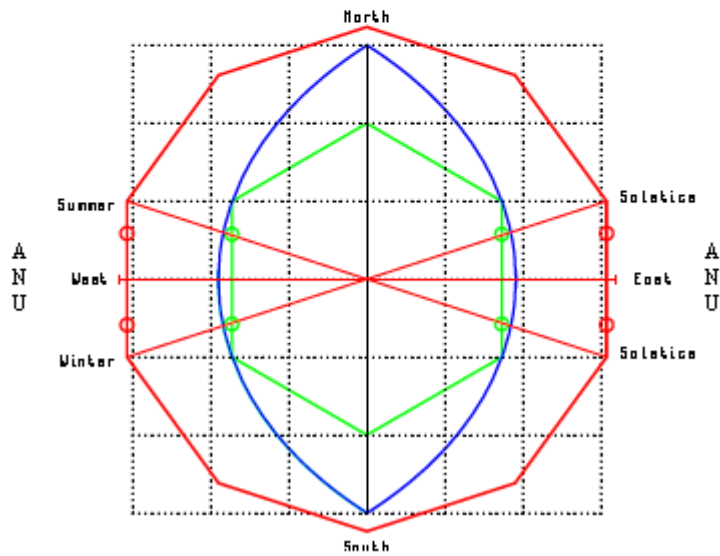
At Winter Solstice shadow does not reach a length of 1 cubit or 90° after rising.



16 Mul-Apin Shadow Length Scheme
Latitude 32.5°, No allowance for refraction
Dashed lines based on Constants/Rising H.A.:
Summer Solstice 60/256°, Equinoxes 75/272° & Winter Solstice 90/286°
Winter Solstice shadow of 1 cubit ignored



17. At the horizon - Latitude 35° , Obliquity 23.9° , no allowance for refraction
 Stepped curve (blue), each N/S cubit equals 2.5° azimuth
 Hexagon (green) with sides 24 cubits (60° azimuth)
 10-sided polygon (red) with sides 24 cubits (36° time)
 grid squares 12 x 12 cubits
 Small circles mark limits, 7 cubits north and south of due east/west,
 for the ANU band in Azimuth and Time



18. Modern Drawing of East-facing Vertical Sundial.

and below

Raising the Djed Pillar
at Abydos c.-1300

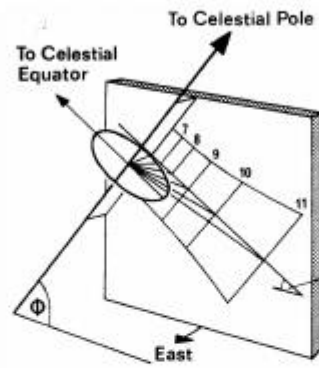


Fig.19 'Ready Reckoner' conversion rising degrees azimuth to time

Latitude 35°, Obliquity 23.8°, no allowance for refraction

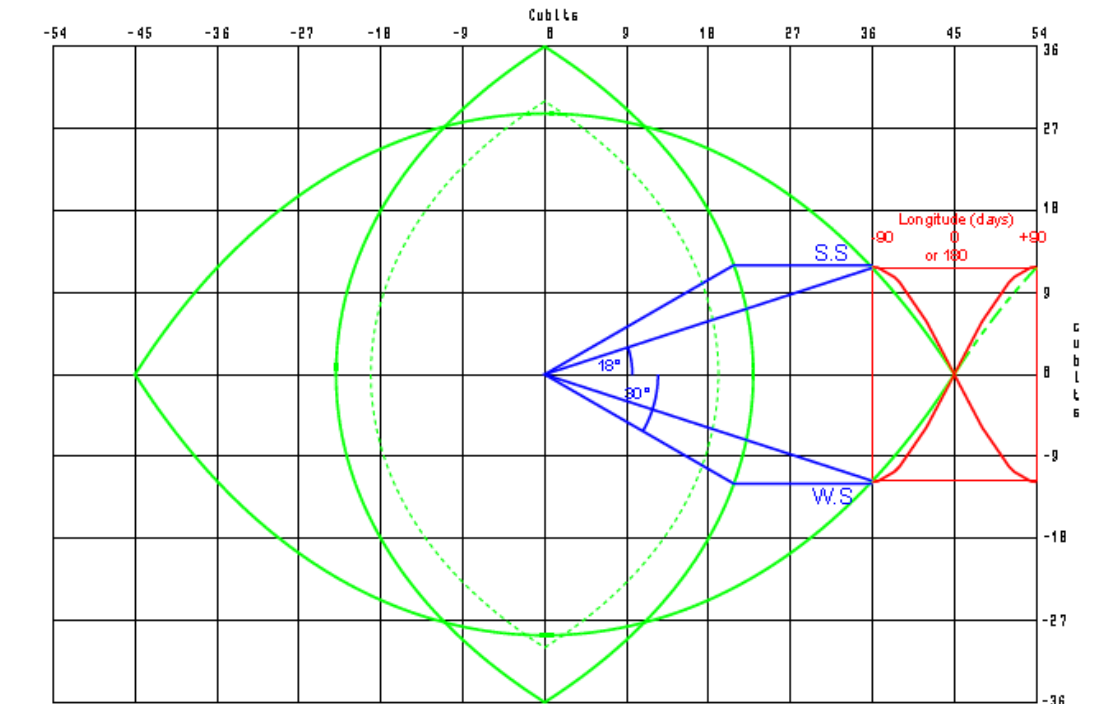
Green - Long axis N/S - each cubit 2.5° azimuth or 3° (dotted)

Long axis E/W - each cubit 2° time

Dashed line - mirror image

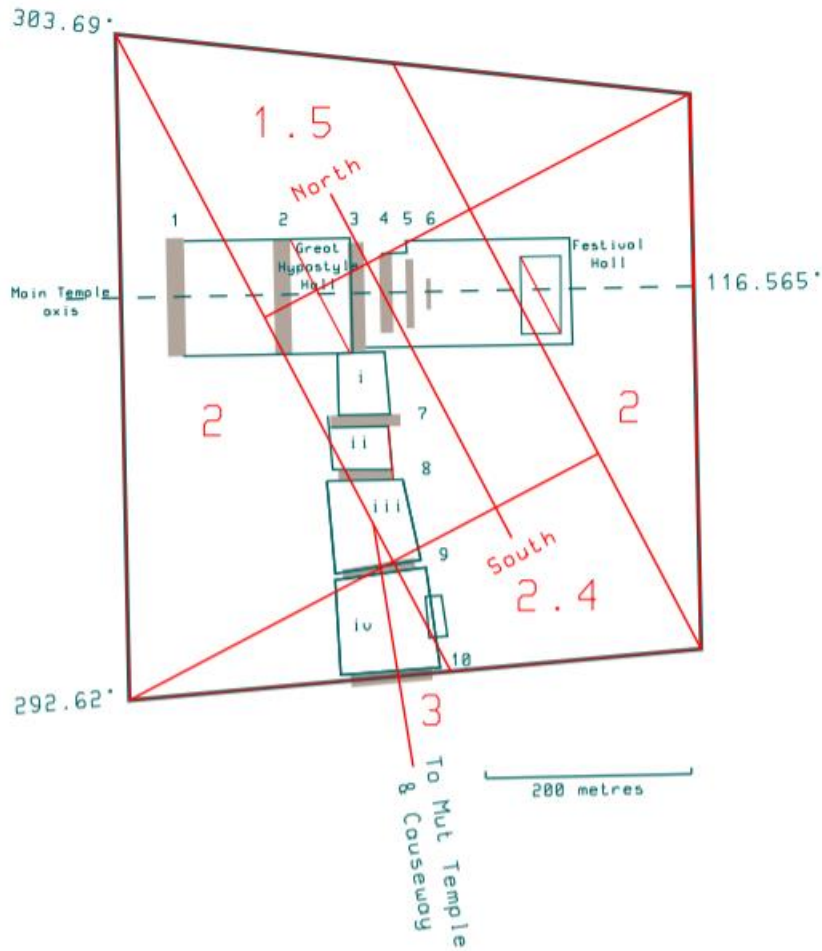
Blue - for solstices 30° azimuth & 18° time from E/W

Red - Longitude (days) instead of cubits for E/W axis



20 Simplified outline of perimeter wall of Amon precinct at Karnak with main elements of temples, pylons (1-10) and courts (i-iv).

Red - triangles used for layout with respective cotangents of smaller angles.



21. Triangulation setting out a rectangular structure (red) with a diagonal of a set length and with the sides at a determined angle (α) from a diagonal direction. Diagonal length in linear units can be expressed as d^2/l , where d and l are the hypotenuse and long side of a Pythagorean triangle.

