
Solar Object 2.4
- Finding the Sun
Prophead100
(Gregg Erickson)

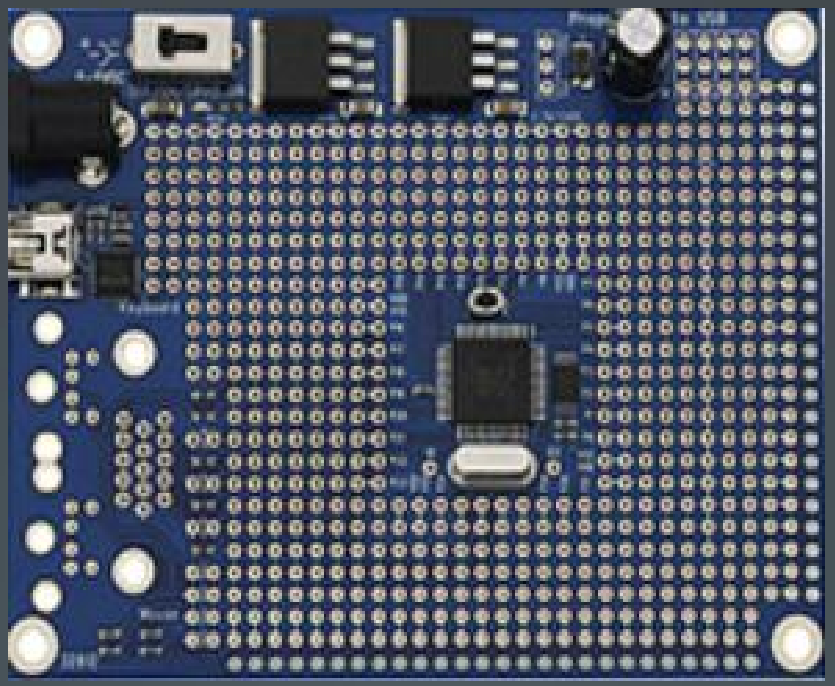
Options to Track Sun

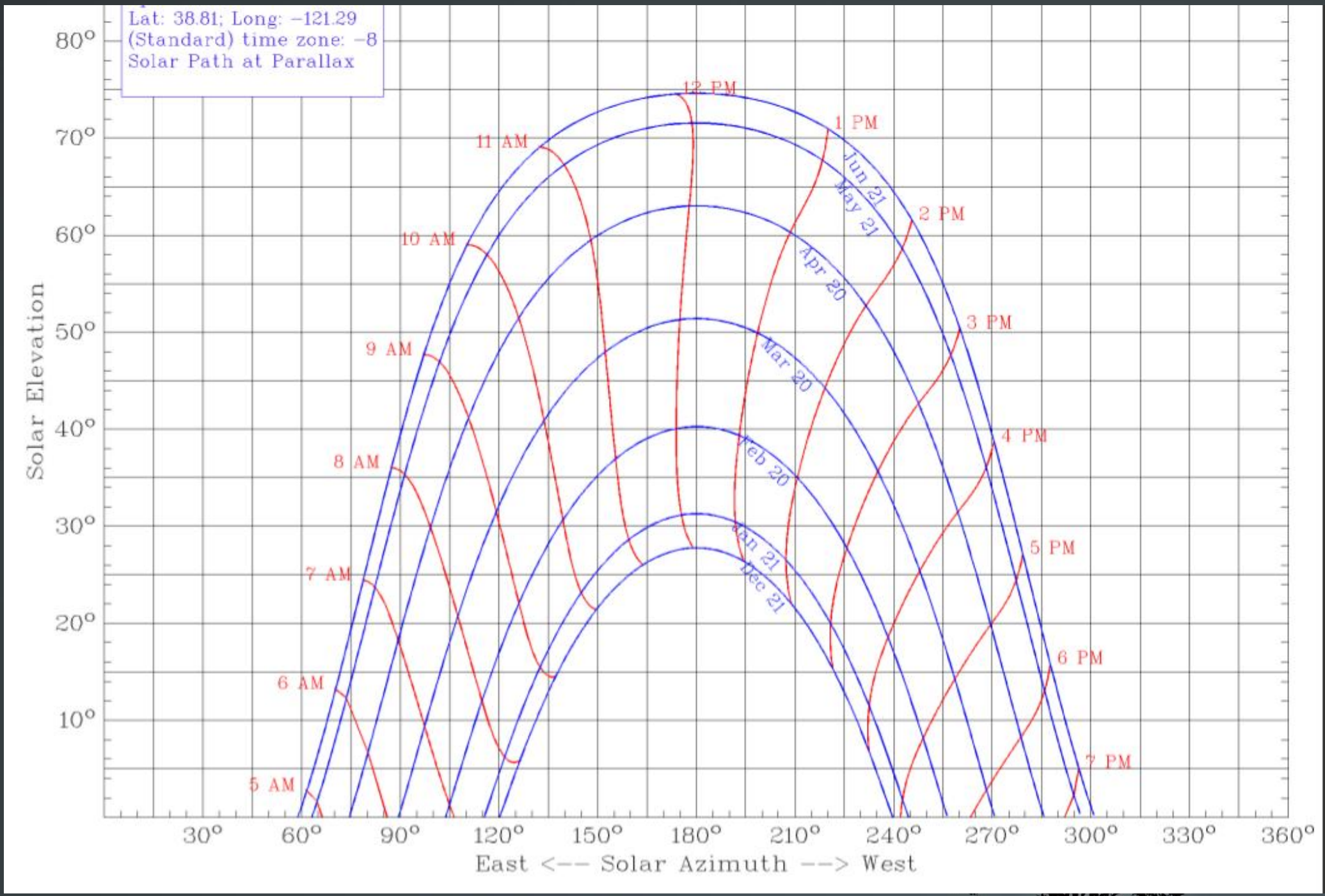
- Timer Motor (always on, 1 axis only)
- Power Curve Tracking (clear days only)
- Paired Light Sensors (searches, not predictive)
- Shadow Camera (searches, sensitive)
- Predefined X Y Table (specific to date & location)
- Calculated (real time/date, variable loc & freq)

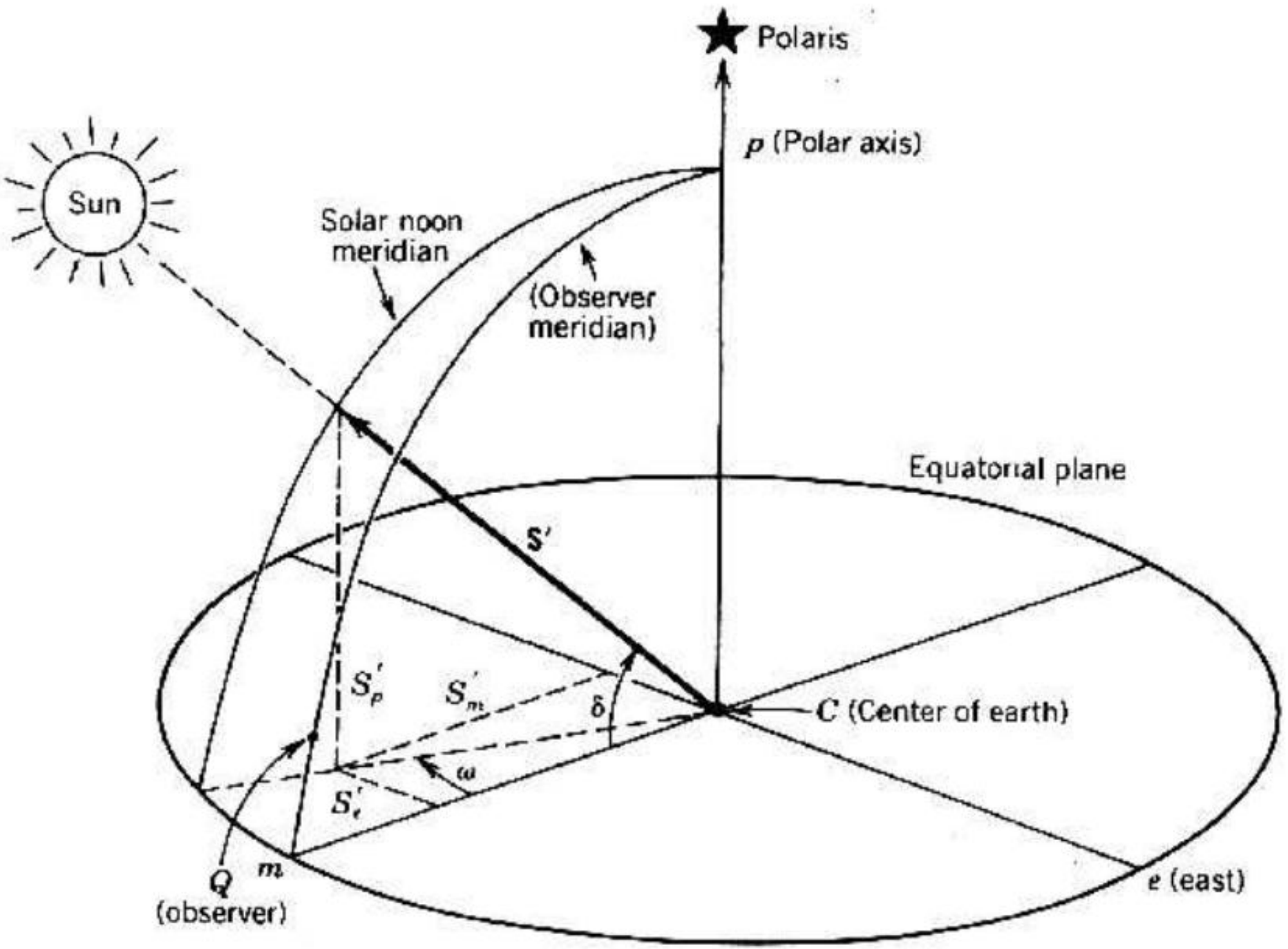
Solar Calculators

… 2006 Rocklin

200 B.C. Greece




Lat: 38.81; Long: -121.29
(Standard) time zone: -8
Solar Path at Parallax
Solar Elevation
80°
70°
60°
50°
40°
30°
20°
10°
12 PM
11 AM
10 AM
9 AM
8 AM
7 AM
6 AM
5 AM
1 PM
2 PM
3 PM
4 PM
5 PM
6 PM
7 PM
Jun 21
May 21
Apr 20
Mar 20
Feb 20
Jan 21
Dec 21
30°
60°
90°
120°
150°
180°
210°
240°
270°
300°
330°
360°
East <-- Solar Azimuth --> West


Polaris
p (Polar axis)
Sun
Solar noon meridian
(Observer meridian)
Equatorial plane
S'
S'_p
S'_m
δ
C (Center of earth)
ω
S'_e
Q (observer)
m
e (east)

What Could a Solar Object Do?

- Aim a Mobile Solar Panel for More Power
- Reflect Sun to a Thermal Panel or Window
- Position a Solar Rover for a Recharge
- Navigate Without GPS
- Scribe a Sun Dial & Predict Shadows
- Position a Sunlight to Match Solar Equinox
- Seasonally Adjust Greenhouse Lights
- Use Sun to Send Morse Code Signals
- Seasonly Adjusted Clock

Solar Object 2.4

- Collection of 20+ Solar Related Methods
  - *Heavily Documented with Floating Point Math*
  - *Formulas with Link to On-Line Book*
  - *Real World Examples*
- Predicts Angles to the Sun
- Calculates Angles to Reflect on Targets
- Provides Daily Solar Statistics

Example Documentation

```
Pub DayLight_Hours(WS )| DHours

    "Returns Daylight Hours Based Upon Angle Hours in a Day

     'Equation 3.23
     'Calculate Hours in a Day based upon Hour Angle
     'that passes at 15 degrees per hour.
     'Returns a floating point from a floating point input
     'Annual Total Aywhere on Earth=4380 Hrs
     'if you add all days together for a sigle site

      Dhours:=fmath.fdiv(fmath.fmul(Ws,2.0),15.0)

      Return DHours
```

Solar Object 2.4 – Input/Outputs

- Input
  - Time (Local Time, Daylight Savings)
  - Location (Latitude, Longitude)
  - Target (Distance: East, North, Height)
- Outputs
  - Direction to the Sun (Azimuth, Altitude)
  - Heliostat Mirror to Target (Azimuth, Altitude)
  - Almanac (Sunrise, Sunset, Twilight, Solar Noon)

Solar Object 2.4 – Secondary Outputs

- Time
  - Day of Year, Solar Time, Equation of Time
- Angles
  - Declination, Hour Angle, Theta Angle
- Atmospheric & Reflection Effects
  - Refraction
  - Reflection Cosine Losses

Solar Object 2.4 – Time Methods

- Equation of Time (*Sun's Position Relative to Orbit & Rotation*)
  - PUB Equation_Of_Time3(N)
  - PUB Equation_Of_Time2(N)
  - PUB Equation_Of_Time(N)
- PUB Solar_Time_From_AngleHour(Dy) – *Relative to Sky*
- PUB Local_Clock_Time(Hr, Lng, Mrdn, ET, D) – *Relative to Sun*
- PUB Solar_Clock_Time(Hr, Lng, Mrdn, ET, D) – *Relative to Clock*
- PUB Scout_Time(STime, Srise, Sset) – *Variable Time Based on Sun*

Solar Object 2.4 – Position Methods

- PUB Sun_Position(AzPtr, AltPtr, mo, dd, yy, hh, mm, ss, ds, lat, lng)

  - *Azimuth and Altitude Angles to the Sun*

  - PUB Get_Altitude(mo, dd, yy, hh, mm, ss, ds, lat, lng)
  - PUB Get_Azimuth(mo, dd, yy, hh, mm, ss, ds, lat, lng)
    - PUB Azimuth_Calc(Delta, Lat, Omega, Alpha)
    - PUB Altitude_Calc(delta, Lat, Omega)

- PUB Helio_Altitude(AzPtr, AltPtr, ThetaPtr, FlightPtr, Az, Alt, N, E, Z)

  - Azimuth and Altitude Angles Mirror Reflecting the Sun to a Target

Solar Object 2.4 – Loss Methods

- PUB Refraction(h) – *Atmospheric Light Bending*
  - PUB Refraction_Main(h)
  - PUB Refraction_Min(h)
  - PUB Refraction_Neg(h)
- PUB Get_Spreading_Loss(N, P, SizePtr) - *Reflection Sizing*
- PUB Get_Cosine_Loss(Theta) – *Angular Reflection Loss*
- PUB Get_Elevation_Loss(D) – *Elevation Drop due to Earth's Curve*

Solar Object 2.4 - Demos

- Solar_Almanac (*Daily Solar Data*)
- Solar_Path_Demo (*Quick Daily Trace*)
- Analemma_Trace_Demo (*Seasonal Pattern*)
- Solar_Tracker_Demo (*Real Time Track Sun*)
- Heliostat_Demo (*Reflect Sun to a Target*)

Demo: Solar_Almanac

- Sunrise & Sunset (Azimuth & Time)
- Twilight Times (Civil, Nautical, Astronomic)
- Solar Noon (Time, Height)
- Daylength (Hours), Sun Height (Angle)
- Semi-Hourly Direction Table (Azimuth, Altitude)

--Ideal for Quickstart & P.E. Kit

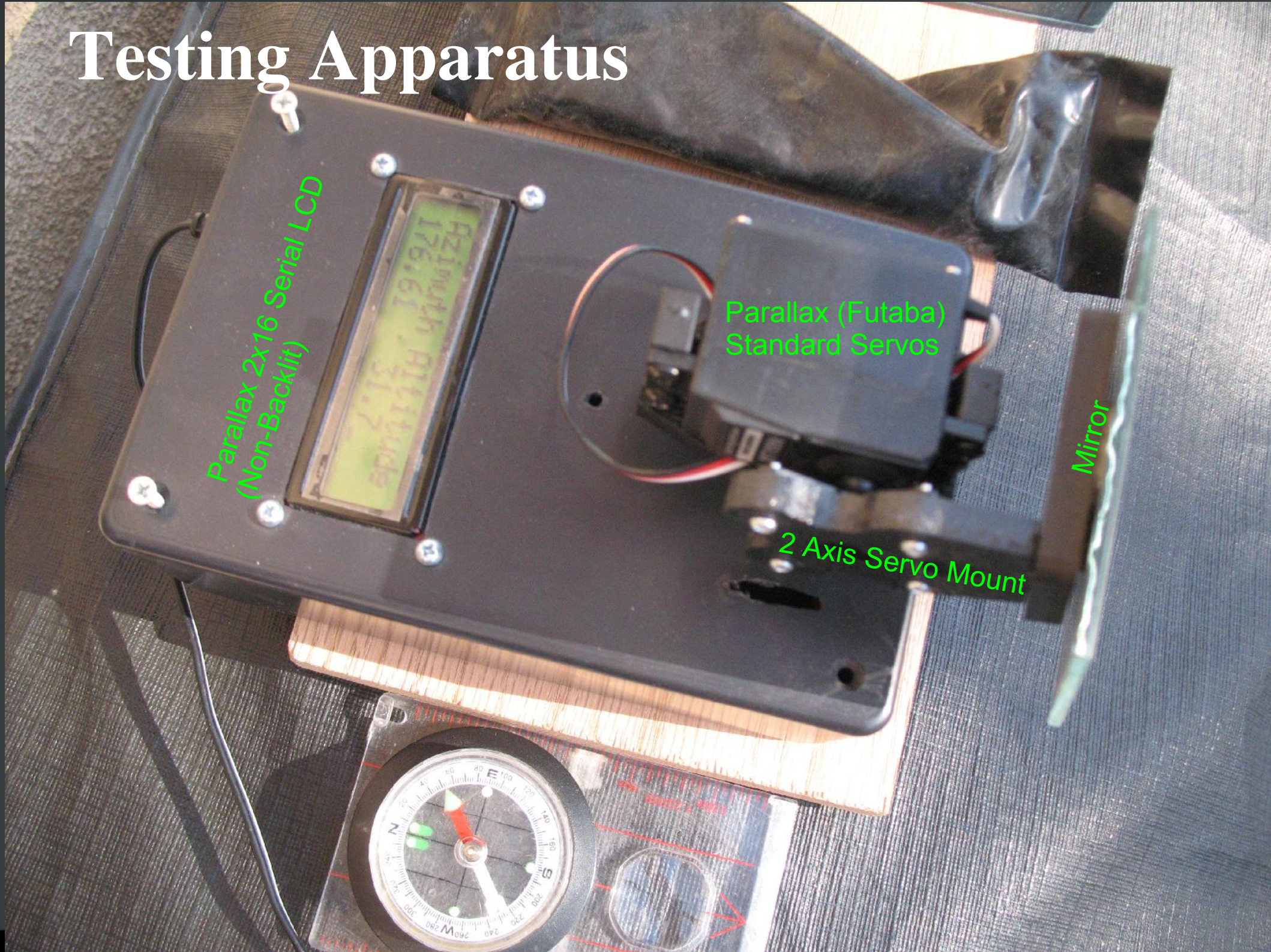
Demos: Tracker & Heliostat

- Real Time Angles (Azimuth, Altitude)
  - Sun Direction
  - Heliostat Target
- Uses Real Time Clock Emulator
- Outputs Details to PC & Direction to LCD
- Drives Two Servos

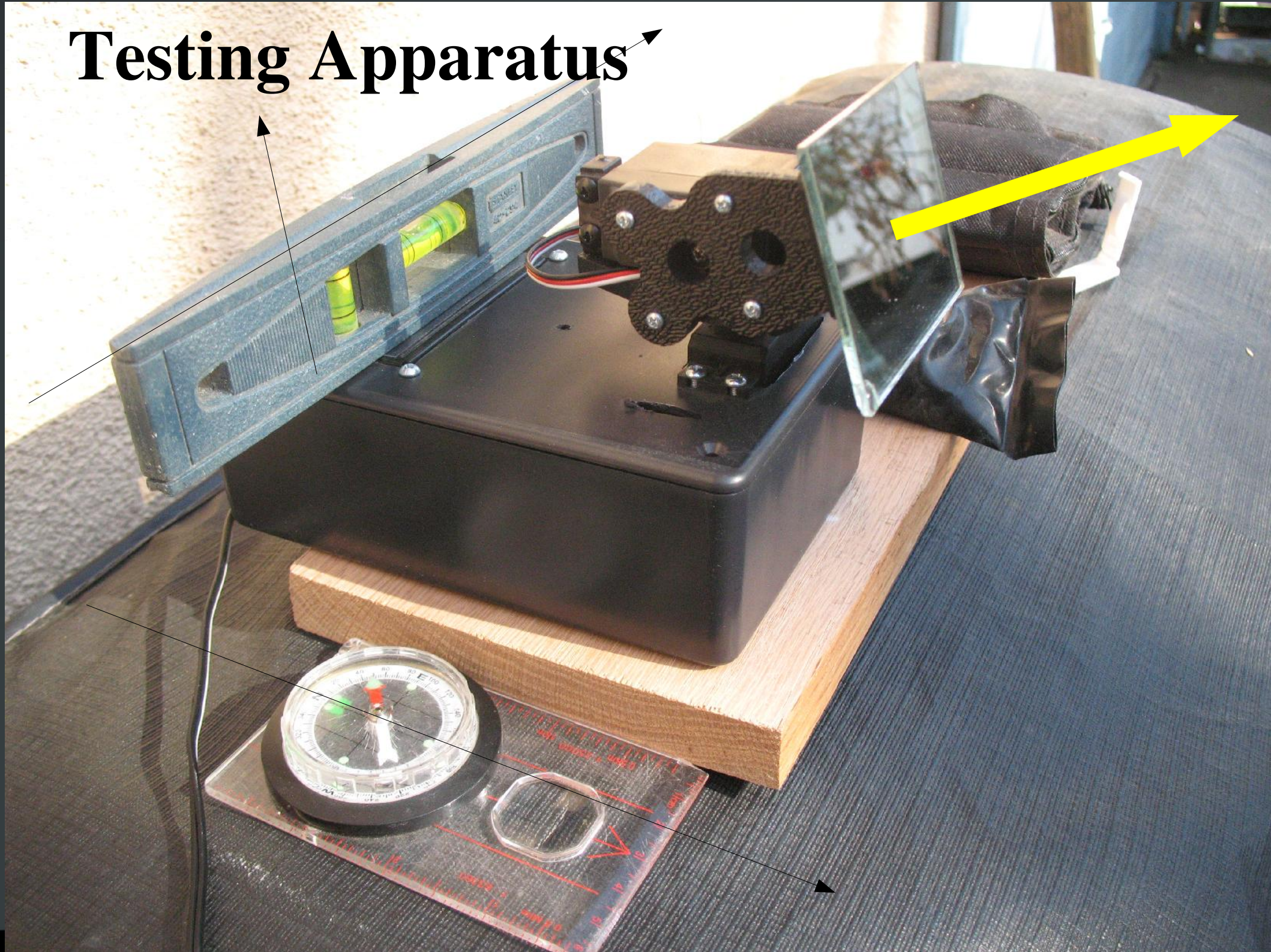
--Ideal for Protoboard & B.O.E

Testing Apparatus

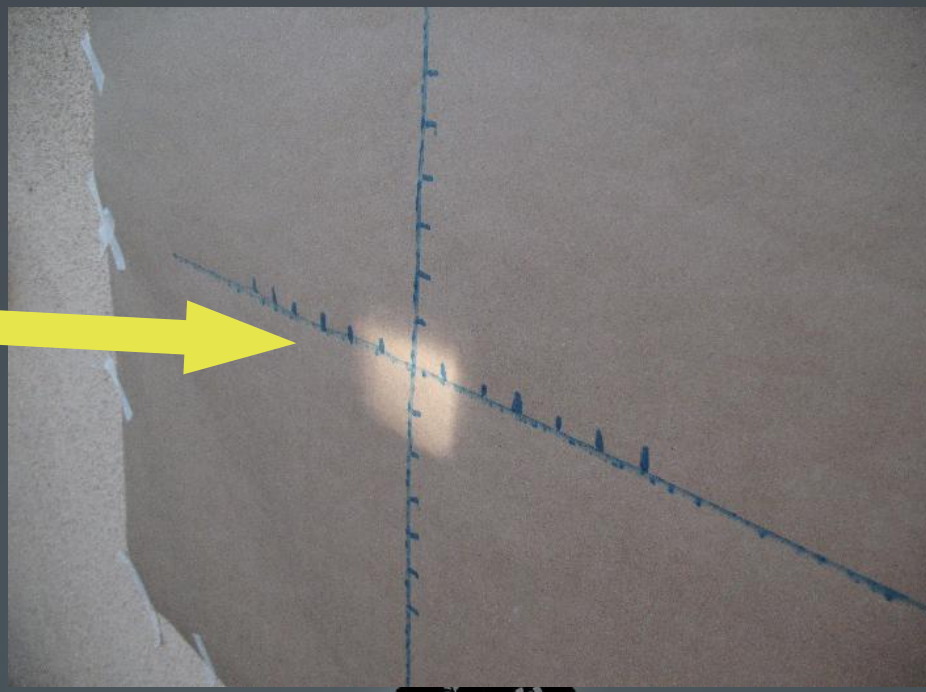
Testing Apparatus



Testing Apparatus



Heliostat - Target



Quick Demos

- Heliostat on Target Video
- Solar Path Trace
- Almanac

- ...Try it yourself, OBEX & Parts List

Thanks

- William B. Stine, Ph.D. - *Power From The Sun*
  - *http://www.powerfromthesun.net*

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- Cam Thompson & Chip Gracey – OBEX Objects
  - Floating Point Math Routines