# Polar Alignment using Plate Solving

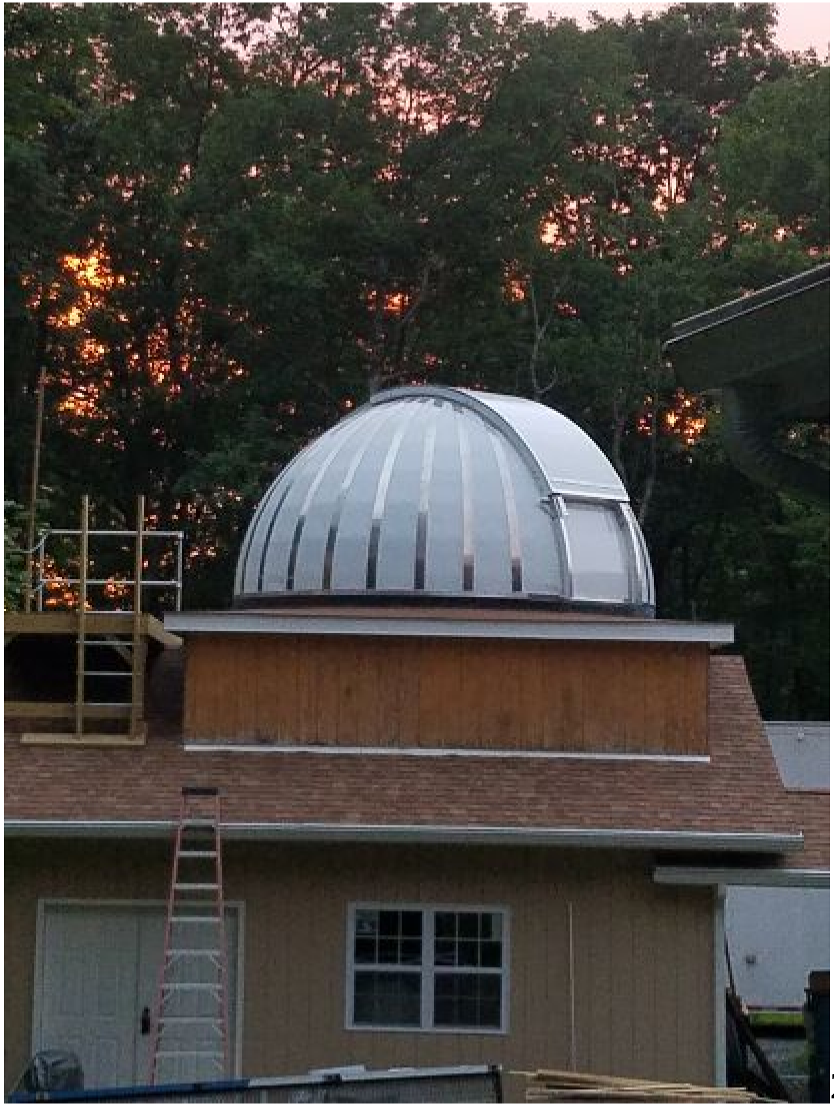
## Novel way of doing Polar Alignment

Mark Sproul
Springfield Telescope Makers
Oct 2021

PDF file of this presentation can be downloaded from
https://github.com/msproul/AlpacaPi/tree/main/docs

# My Observatory

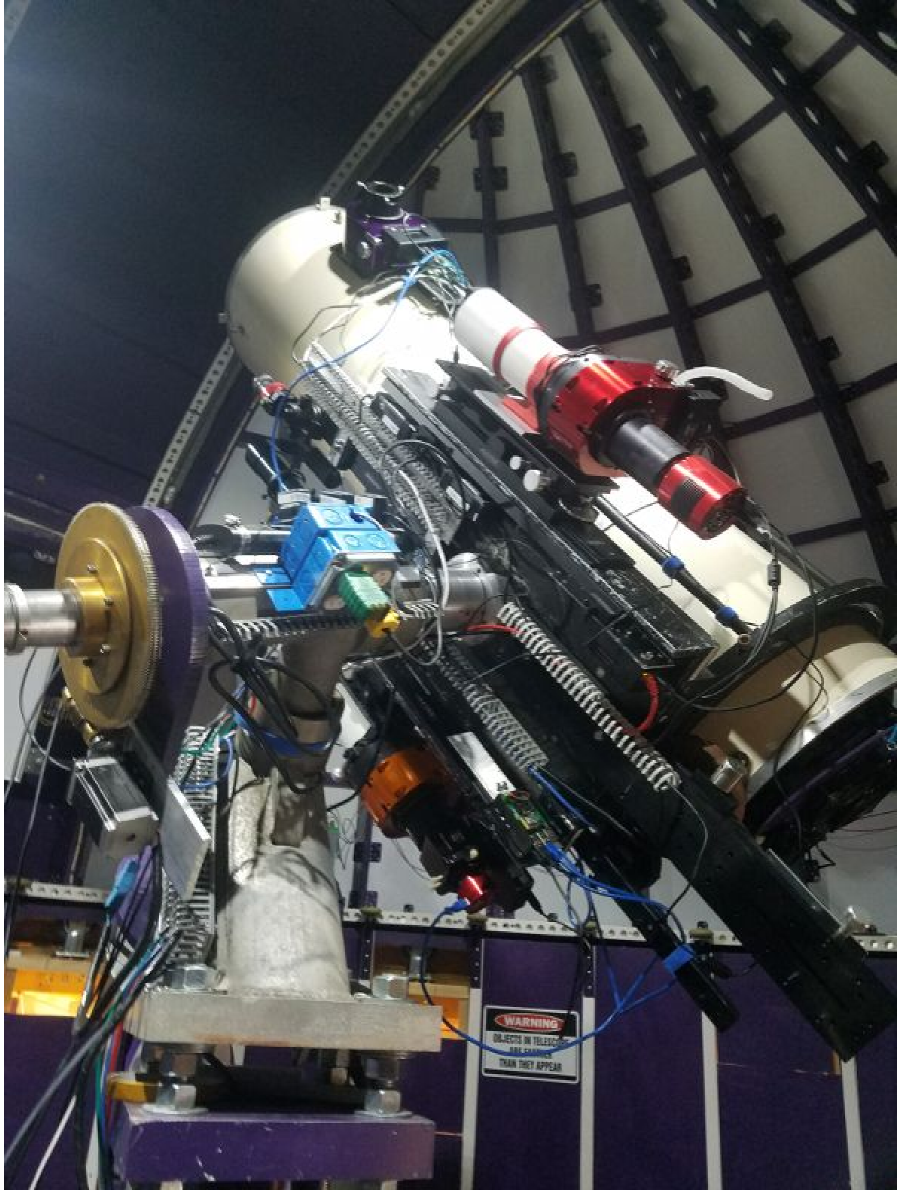
- 15 foot diameter home built dome
- Pike County Pennsylvania

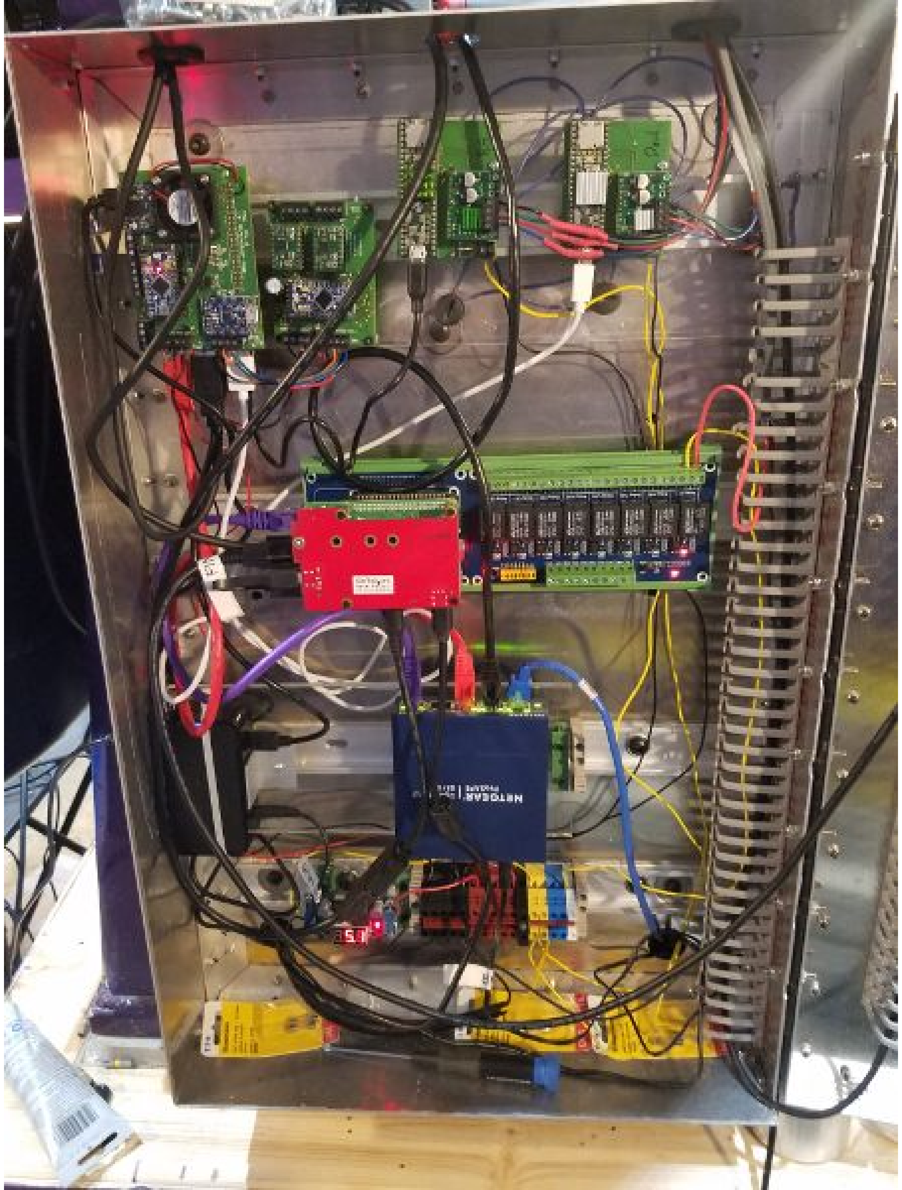


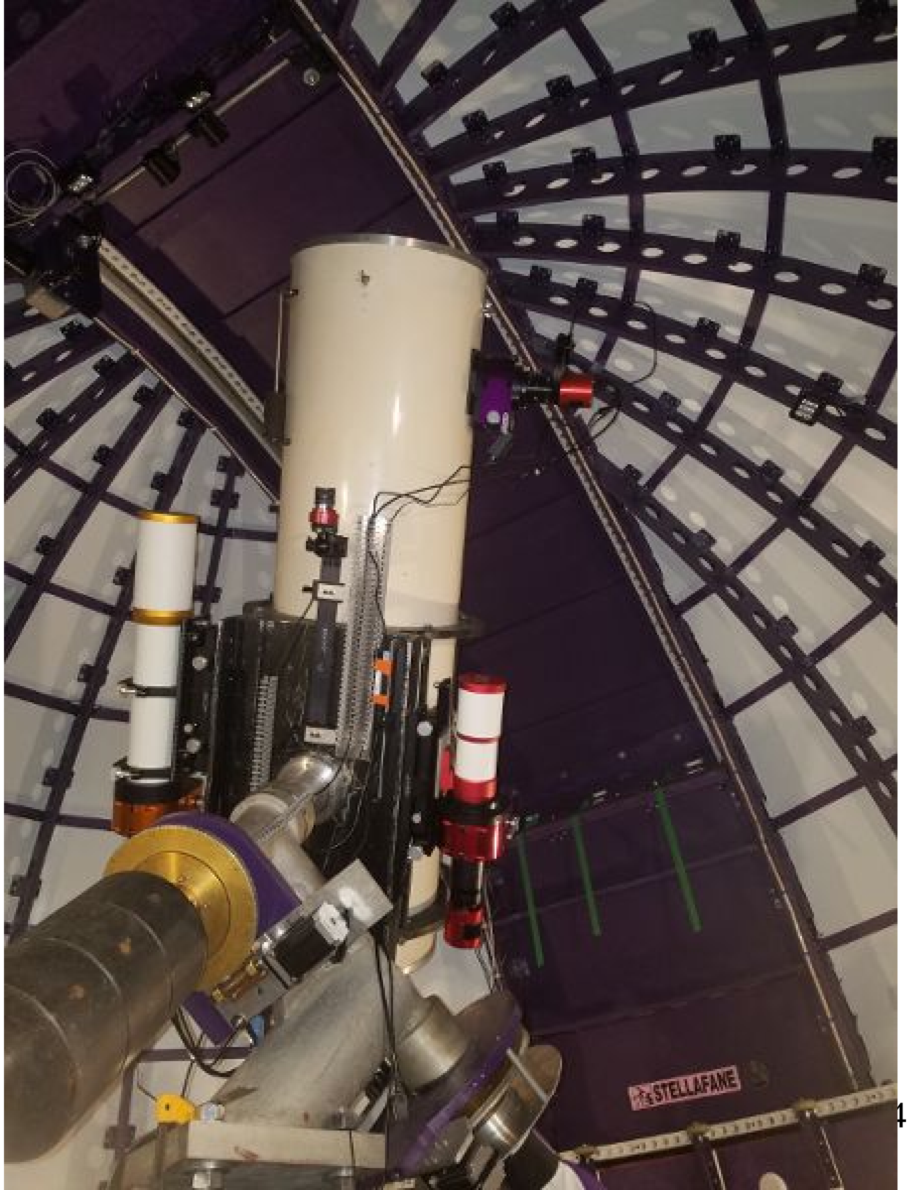
# My Scope

3 Main Scopes
- 16 inch Newtonian (F4.15)
- 4 inch refractor (WO102)
- 3 inch refractor (WO71)

Finder scope
Guide Scope
6 Raspberry Pi’s
170 lbs counter weight
Total moving mass ~400 pounds
German Equatorial Mount with 2.5” shafts






STELLAFANE

<----

Adjustment Nuts on 1 inch diameter rods

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Adjustment Tools

# Many ways, tried and true

- Built in polar scope
- Drift method
- QHY Polemaster
- Software
  - K-Stars
  - Lots of others

# What DIDN’T work (for me)

- Drift method

  8 months working at it, just made it worse

- QHY Polemaster
  - Bought one used, no way to accurately mount it

# What to do NEXT???

- Figure out WHERE I am pointing????

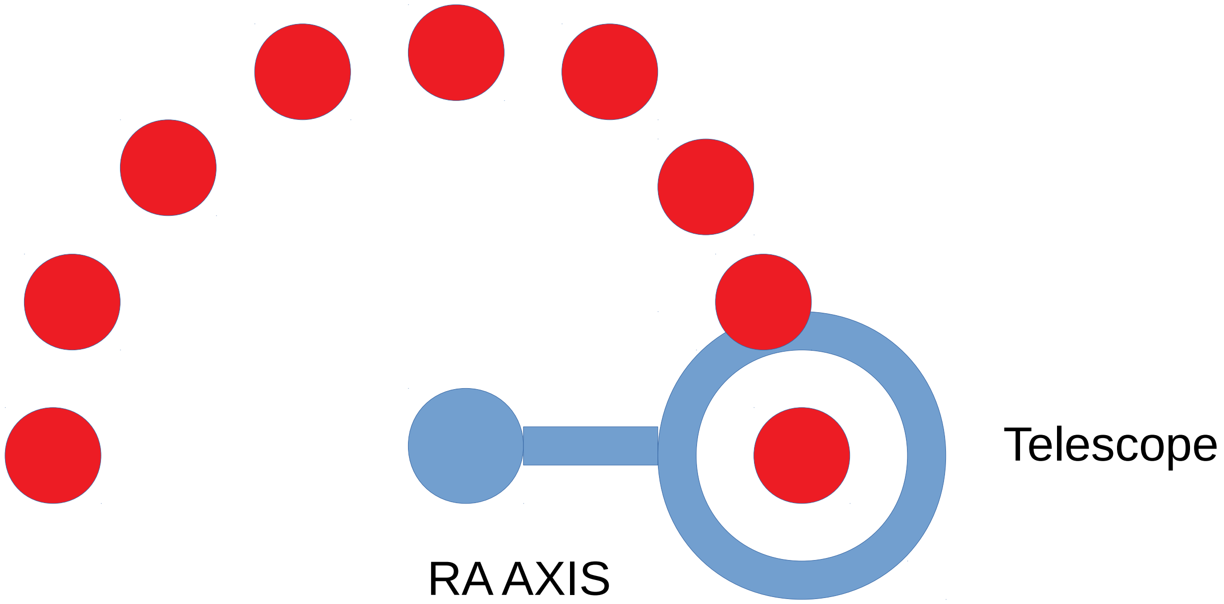
# Theory

- Take a series of pictures while rotating around the RA axis <u>WITHOUT</u> tracking turned on and <u>WITHOUT</u> changing DEC.

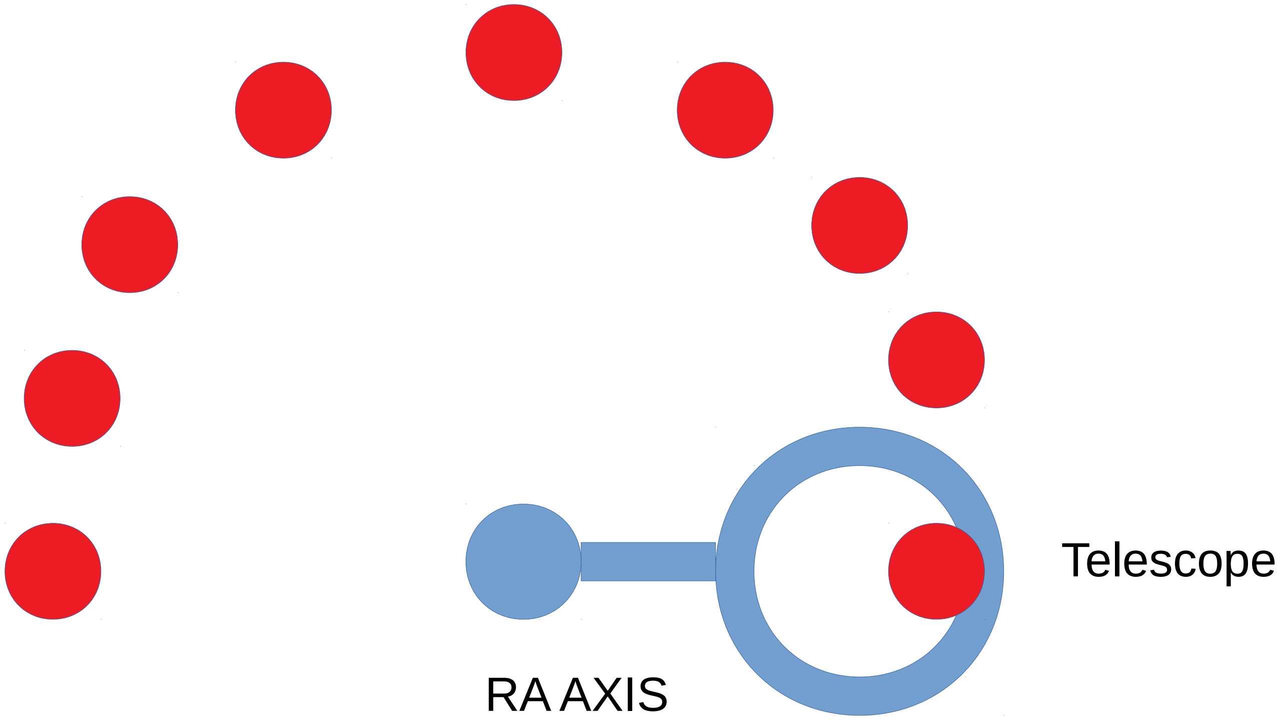
- Plot the center points of each picture, this should generate an arc

- The center of the arc is where RA is pointed

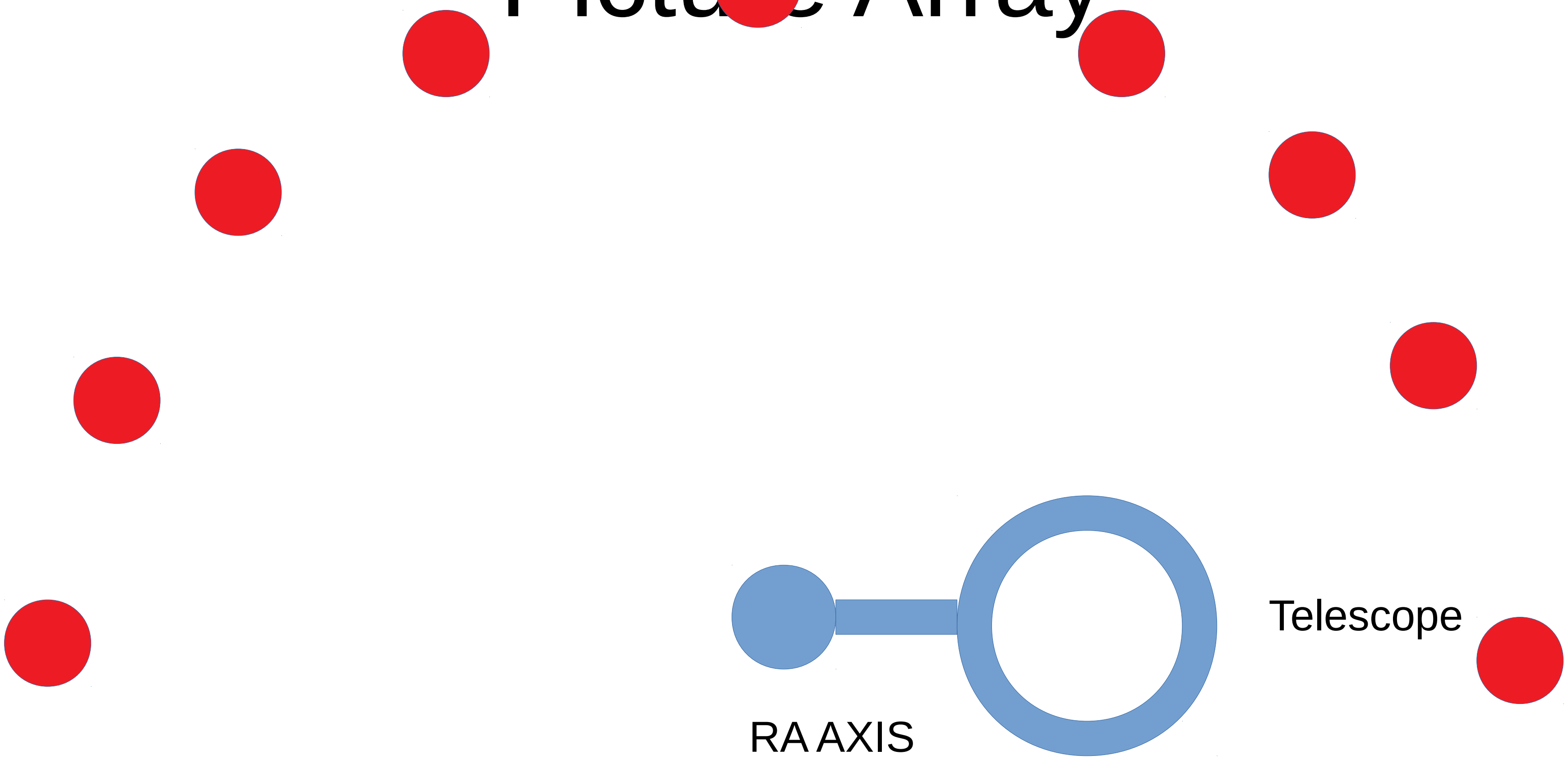
# Picture Array



# Picture Array



# Picture Array



# Astrometry.net


on 2021-08-26T00:35:33Z
as " E-17-2021-08-25T01_49...16.jpg "
(Submission 4925429)
under *Attribution-NonCommercial 3.0 Unported*

publicly visible: **yes** | no

## Job Status

Job 5629977:
Success

## Calibration

| | |
|---|---|
| Center (RA, Dec): | (282.251, 87.149) |
| Center (RA, hms): | $18^h\ 49^m\ 00.350^s$ |
| Center (Dec, dms): | +87° 08' 57.559" |
| Size: | 31.9 x 24.1 arcmin |
| Radius: | 0.333 deg |
| Pixel scale: | 0.411 arcsec/pixel |
| Orientation: | Up is 305 degrees E of N |
| WCS file: | wcs.fits |
| New FITS image: | new-image.fits |
| Reference stars nearby (RA,Dec table): | rdls.fits |
| Stars detected in your images (x,y | axy.fits |

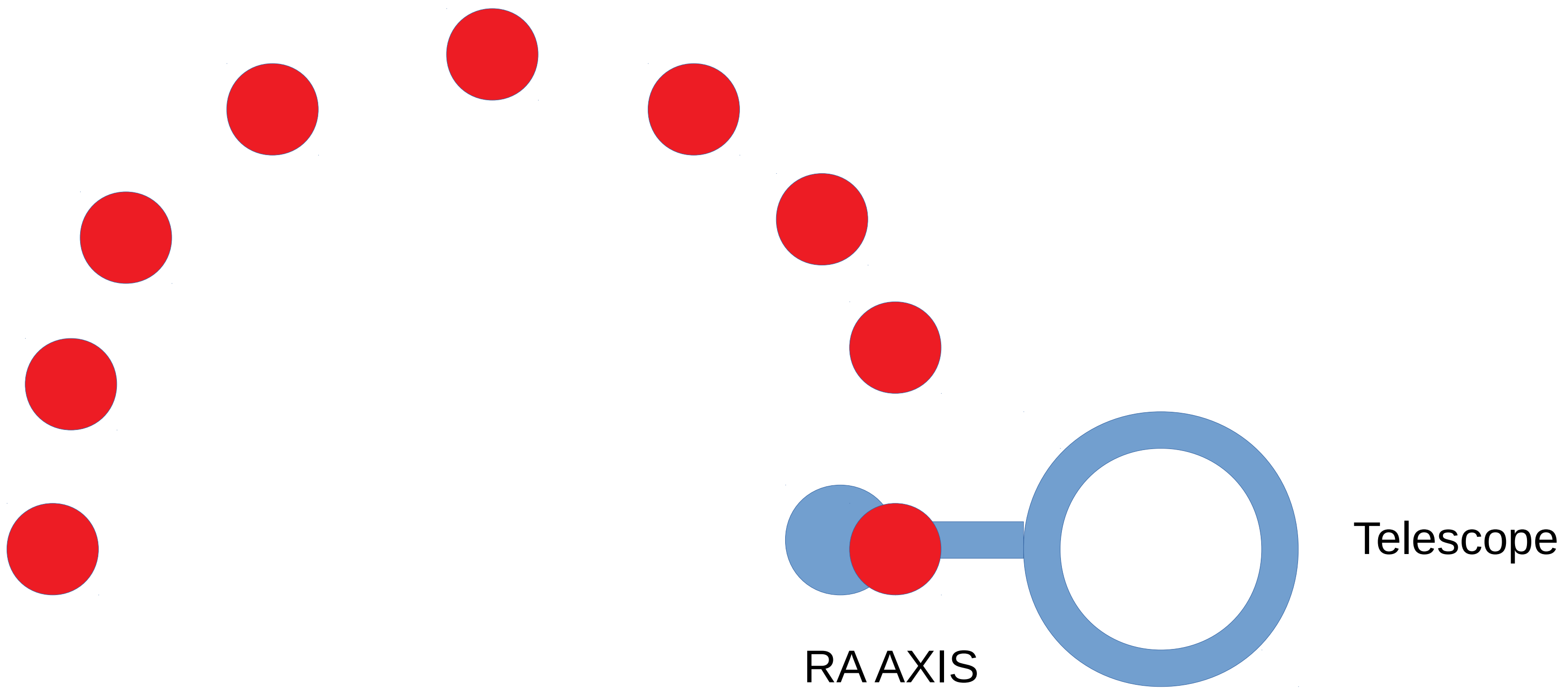
# Special Objects

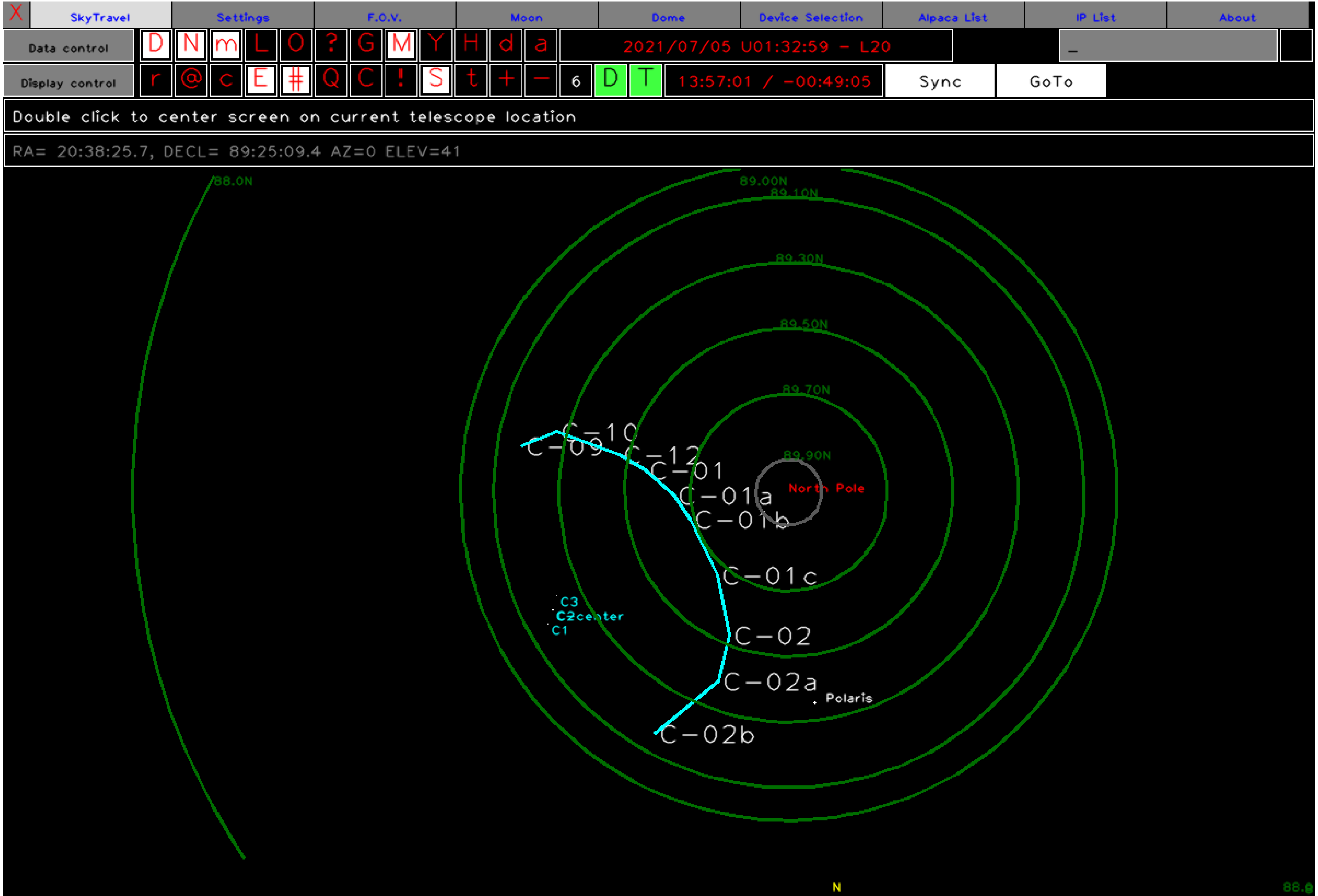
- # July 4th, 2021
- C-09 10 7 13.666 89 10 20.873
- C-10 10 26 7.848 89 16 08.653
- C-11 10 3 0.336 89 20 06.477
- C-12 10 17 34.816 89 28 16.307
- C-01 10 3 42.384 89 33 24.364
- C-01a 9 22 32.986 89 38 53.870
- C-01b 8 26 3.155 89 41 17.671
- C-01c 6 11 38.237 89 40 05.569
- C-02 4 58 16.122 89 31 48.547
- C-02a 4 48 50.126 89 23 09.162
- C-02b 5 23 40.917 89 09 39.456
- C-03 5 33 22.312 88 54 41.756

- # Aug 12, 2021
- D-01 3 59 58.709 89 21 45.927
- D-02 4 03 56.111 89 21 53.330
- D-03 3 44 35.271 89 22 32.839
- D-04 3 19 11.633 89 23 22.069
- D-05 2 55 55.243 89 24 09.338
- D-06 2 31 23.711 89 27 50.02
- D-07 1 45 48.602 89 29 16.603
- D-08 0 48 47.696 89 29 3.645
- D-09 23 51 21.394 89 26 54.663
- D-10 23 2 57.408 89 28 25.010
- D-11 21 55 3.401 89 29 2.260
- D-12 21 6 34.346 89 29 7.683
- D-13 20 26 23.988 89 28 37.730
- D-14 19 14 55.178 89 27 32.860
- D-15 17 56 58.162 89 25 39.815
- D-16 17 31 13.109 89 23 20.973

- #Aug 24, 2021
- E-01 4 44 59.254 87 07 3.997
- E-02 4 17 26.036 87 07 48.038
- E-03 3 50 22.011 87 08 39.364
- E-04 3 26 55.760 87 11 49.242
- E-05 2 59 29.684 87 13 19.530
- E-06 2 27 23.428 87 14 7.700
- E-07 1 47 25.186 87 14 59.649
- E-08 1 0 19.140 87 16 9.261
- E-09 0 13 59.637 87 16 46.602
- E-10 23 35 16.183 87 13 50.746
- E-11 22 58 44.322 87 14 2.168
- E-12 22 14 17.611 87 14 18.613
- E-13 21 28 32.173 87 14 42.577
- E-14 20 47 45.622 87 13 50.575
- E-15 20 2 54.672 87 12 45.113
- E-16 19 21 5.467 87 11 30.324
- E-17 18 49 0.350 87 08 57.559

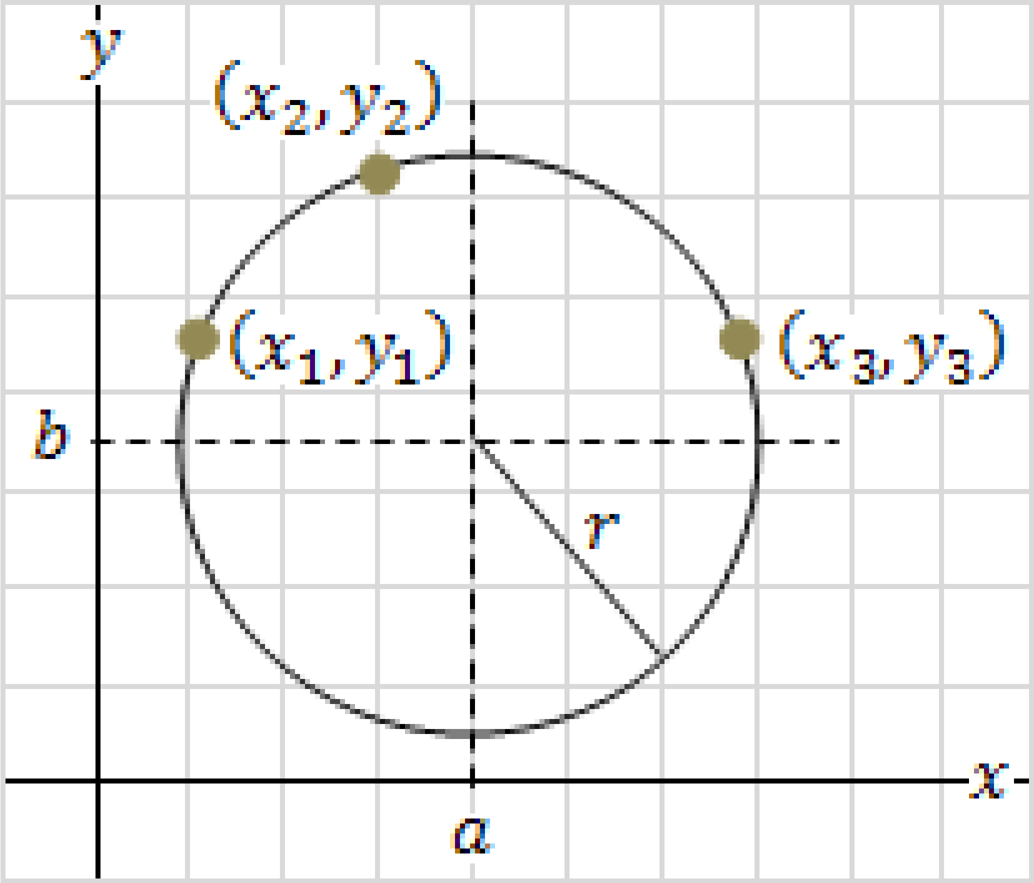
# Picture Array



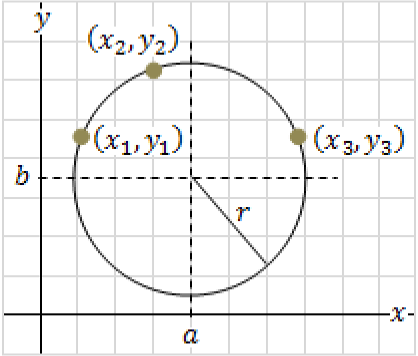


X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
2021/07/05 U01:32:59 - L20
Display control
r @ c E # Q C ! S t + - 6 D T
13:57:01 / -00:49:05
Sync
GoTo
Double click to center screen on current telescope location
RA= 20:38:25.7, DECL= 89:25:09.4 AZ=0 ELEV=41
88.0N
89.00N
89.10N
89.30N
89.50N
89.70N
89.90N
North Pole
C-10
C-09
C-12
C-01
C-01a
C-01b
C-01c
C-02
C-02a
C-02b
Polaris
C3
C2center
C1
N

# 3 Points Make a circle



# 3 Points Make a circle




The equation of the circle is described by the equation:

$$Ax^2 + Ay^2 + Bx + Cy + D = 0$$

After substituting the three given points which lies on the circle we get the set of equations that can be described by the determinant:

$$\begin{vmatrix} x^2+y^2 & x & y & 1 \\ x_1{}^2+y_1{}^2 & x_1 & y_1 & 1 \\ x_2{}^2+y_2{}^2 & x_2 & y_2 & 1 \\ x_3{}^2+y_3{}^2 & x_3 & y_3 & 1 \end{vmatrix} = 0$$

- http://ambrsoft.com/TrigoCalc/Circle3D.htm

# 3 Points Make a circle

$$A = \begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix} \quad B = -\begin{vmatrix} x_1{}^2 + y_1{}^2 & y_1 & 1 \\ x_2{}^2 + y_2{}^2 & y_2 & 1 \\ x_3{}^2 + y_3{}^2 & y_3 & 1 \end{vmatrix} \quad C = \begin{vmatrix} x_1{}^2 + y_1{}^2 & x_1 & 1 \\ x_2{}^2 + y_2{}^2 & x_2 & 1 \\ x_3{}^2 + y_3{}^2 & x_3 & 1 \end{vmatrix} \quad D = -\begin{vmatrix} x_1{}^2 + y_1{}^2 & x_1 & y_1 \\ x_2{}^2 + y_2{}^2 & x_2 & y_2 \\ x_3{}^2 + y_3{}^2 & x_3 & y_3 \end{vmatrix}$$

$$A = x_1(y_2 - y_3) - y_1(x_2 - x_3) + x_2y_3 - x_3y_2$$

$$B = (x_1{}^2 + y_1{}^2)(y_3 - y_2) + (x_2{}^2 + y_2{}^2)(y_1 - y_3) + (x_3{}^2 + y_3{}^2)(y_2 - y_1)$$

$$C = (x_1{}^2 + y_1{}^2)(x_2 - x_3) + (x_2{}^2 + y_2{}^2)(x_3 - x_1) + (x_3{}^2 + y_3{}^2)(x_1 - x_2)$$

$$D = (x_1{}^2 + y_1{}^2)(x_3y_2 - x_2y_3) + (x_2{}^2 + y_2{}^2)(x_1y_3 - x_3y_1) + (x_3{}^2 + y_3{}^2)(x_2y_1 - x_1y_2)$$

$$x = \frac{(x_1{}^2 + y_1{}^2)(y_2 - y_3) + (x_2{}^2 + y_2{}^2)(y_3 - y_1) + (x_3{}^2 + y_3{}^2)(y_1 - y_2)}{2(x_1(y_2 - y_3) - y_1(x_2 - x_3) + x_2y_3 - x_3y_2)} = -\frac{B}{2A}$$

$$y = \frac{(x_1{}^2 + y_1{}^2)(x_3 - x_2) + (x_2{}^2 + y_2{}^2)(x_1 - x_3) + (x_3{}^2 + y_3{}^2)(x_2 - x_1)}{2(x_1(y_2 - y_3) - y_1(x_2 - x_3) + x_2y_3 - x_3y_2)} = -\frac{C}{2A}$$

$$r = \sqrt{(x - x_1)^2 + (y - y_1)^2} = \sqrt{\frac{B^2 + C^2 - 4AD}{4A^2}}$$

# 3 Points Make a circle

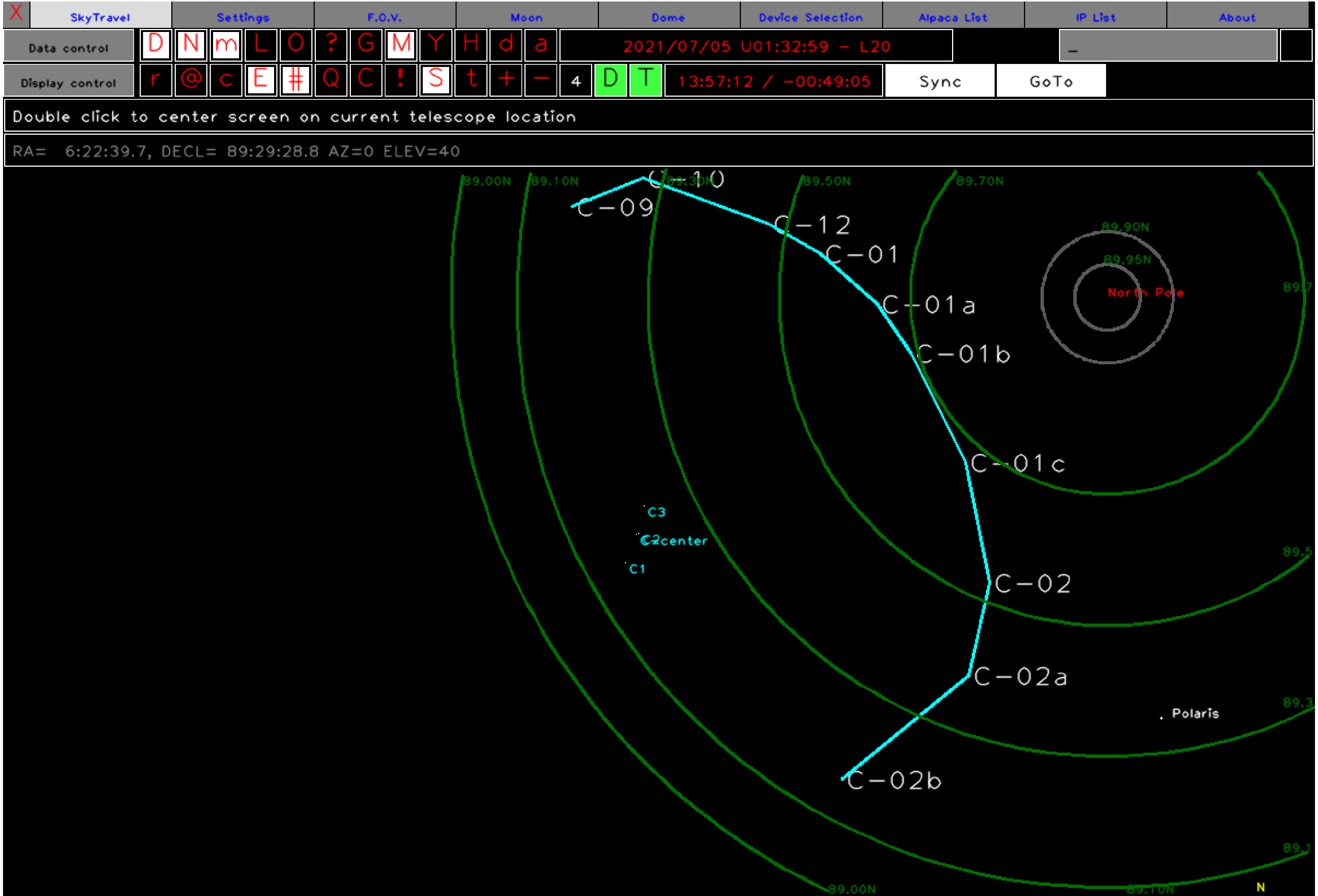
- BUT…….

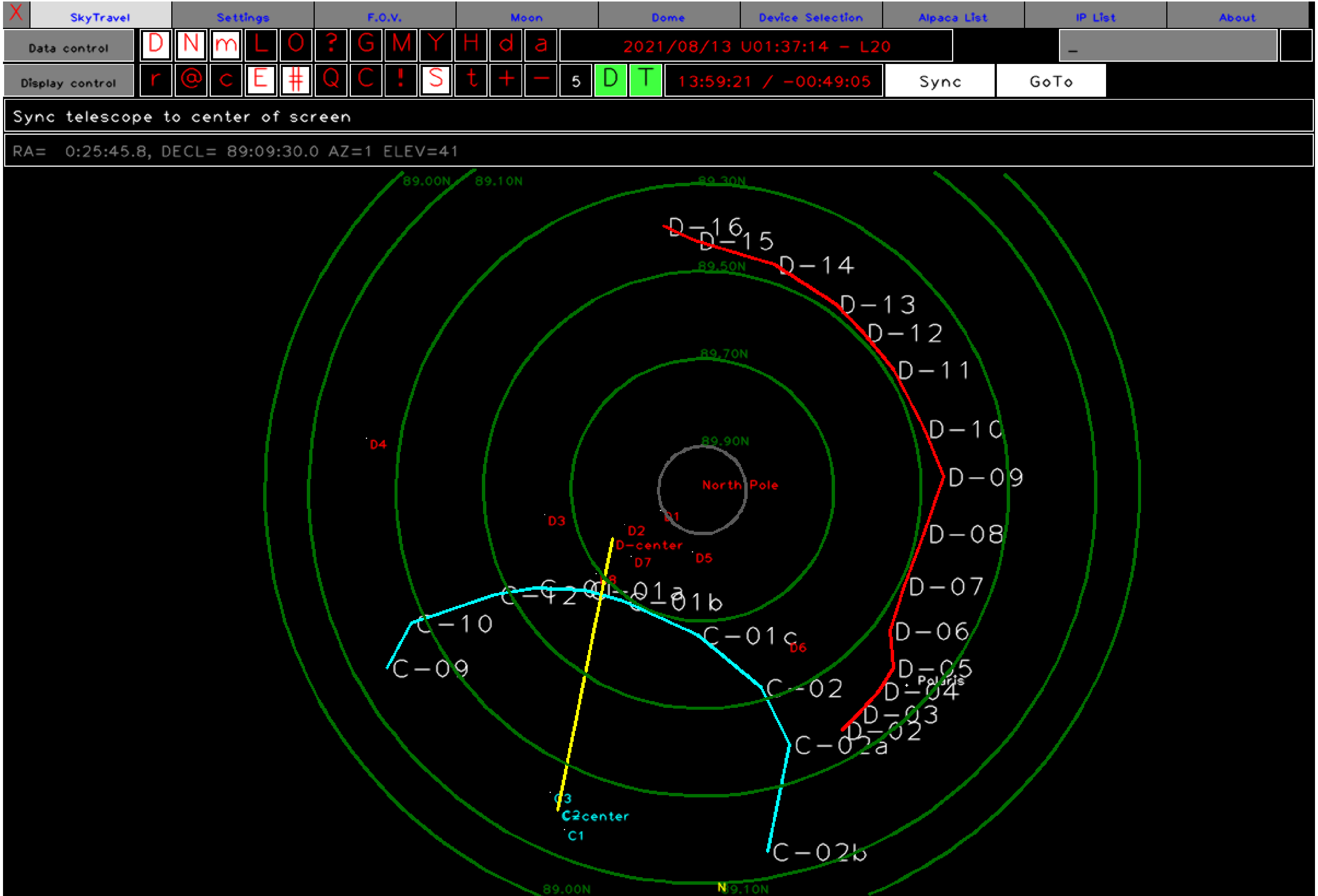
  All of this is in Cartesian coordinates.

  And, we have polar coordinates with the "center" at the equator……..

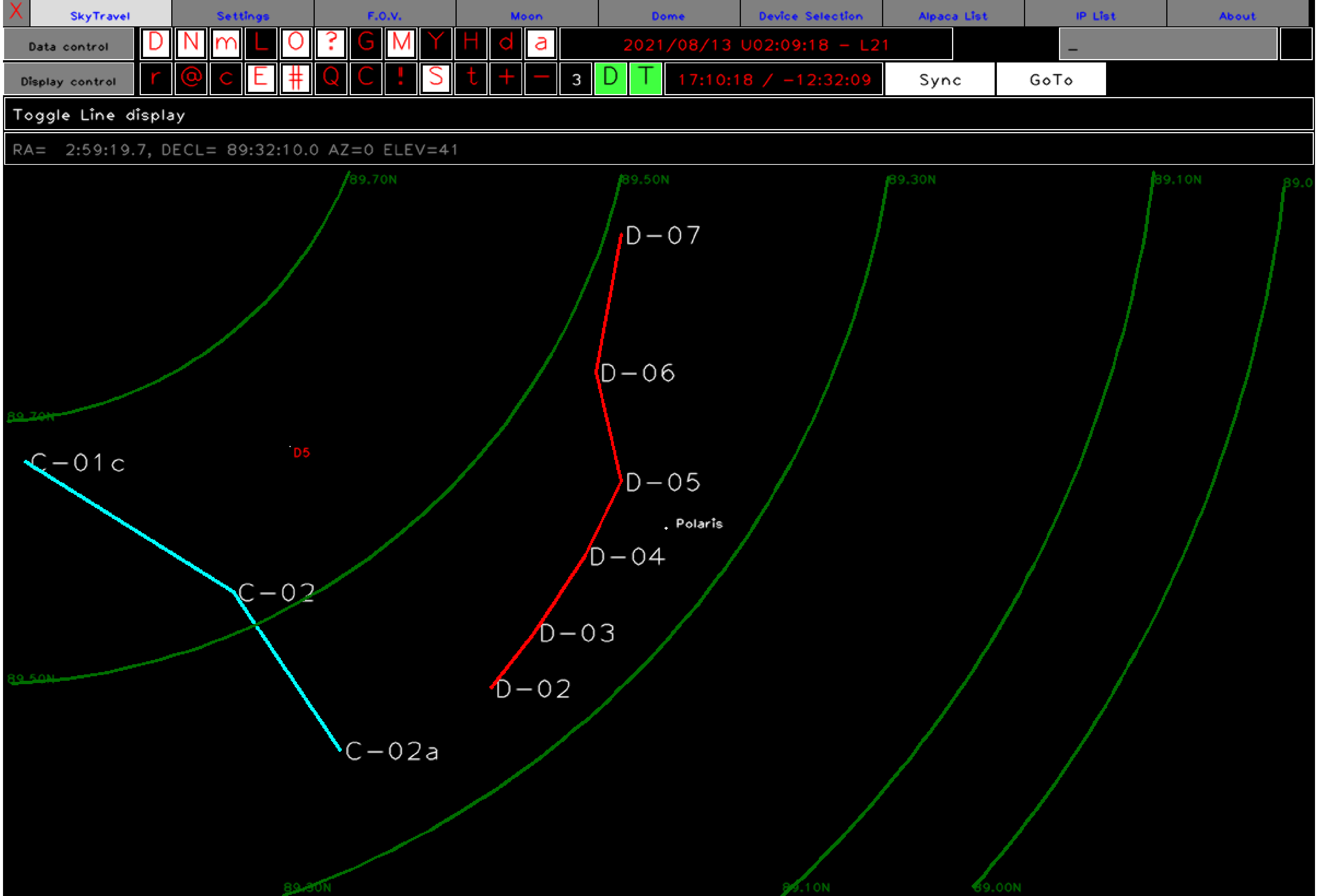
# 3 Points Make a circle

- So…
- R = 90.0 – DEC   - makes coordinates relative to the north pole
- Theta = RA (converted from Hours to Degrees/Radians)
- Convert to Cartesian (x = R cos (theta)  y = R sin (theta)
- Do the 3 point math
- Find the Average (in Cartesian coordinates)
- Convert all back to Polar
  - remember to adjust back for equator relative
- Plot on the sky


X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
2021/07/05 U01:32:59 - L20
Display control
r @ c E # Q C ! S t + -
4
D T
13:57:12 / -00:49:05
Sync
GoTo
Double click to center screen on current telescope location
RA= 6:22:39.7, DECL= 89:29:28.8 AZ=0 ELEV=40
89.00N
89.10N
89.50N
89.70N
89.90N
89.95N
North Pole
C-09
C-12
C-01
C-01a
C-01b
C-01c
C-02
C-02a
C-02b
C3
C2center
C1
Polaris
N

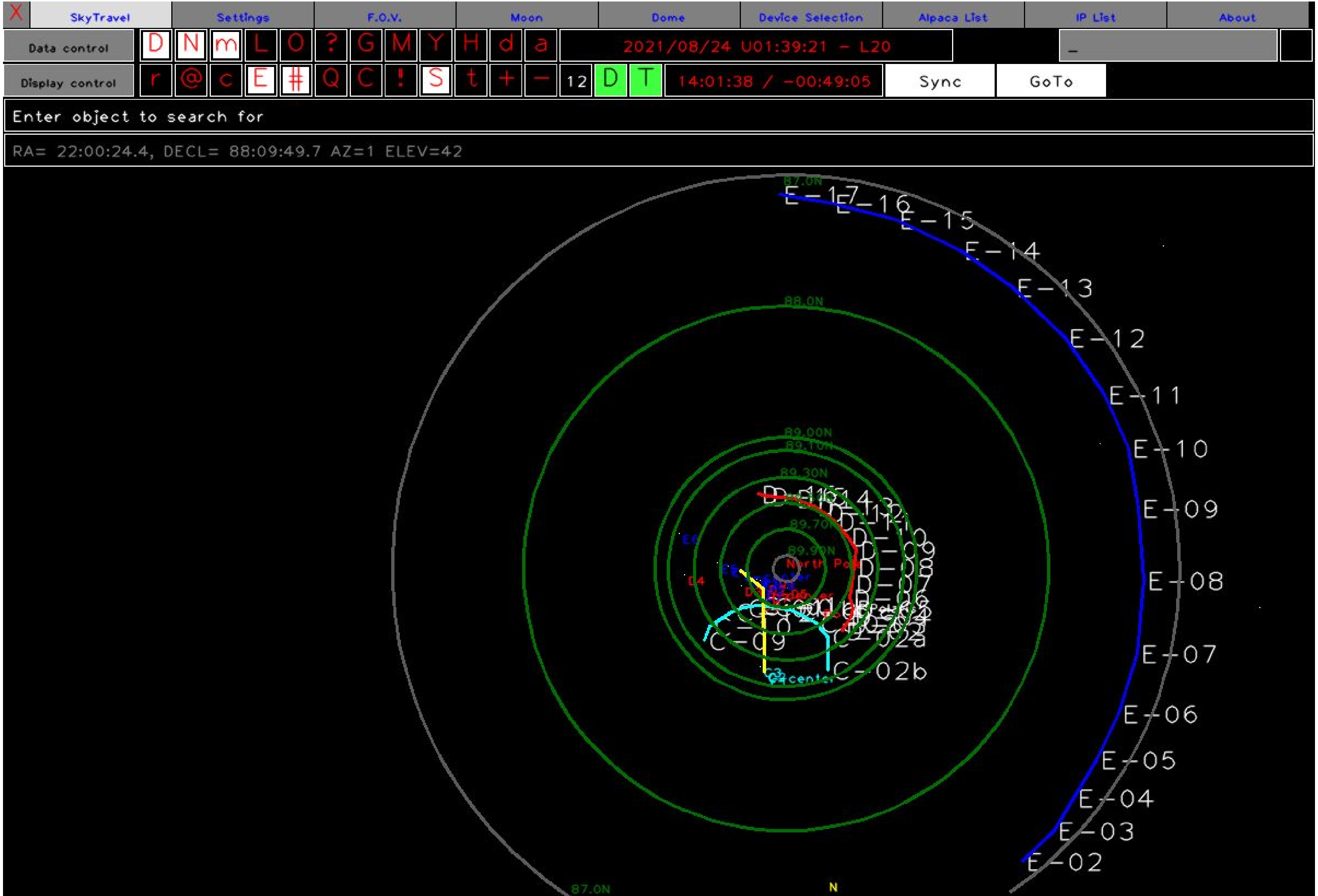


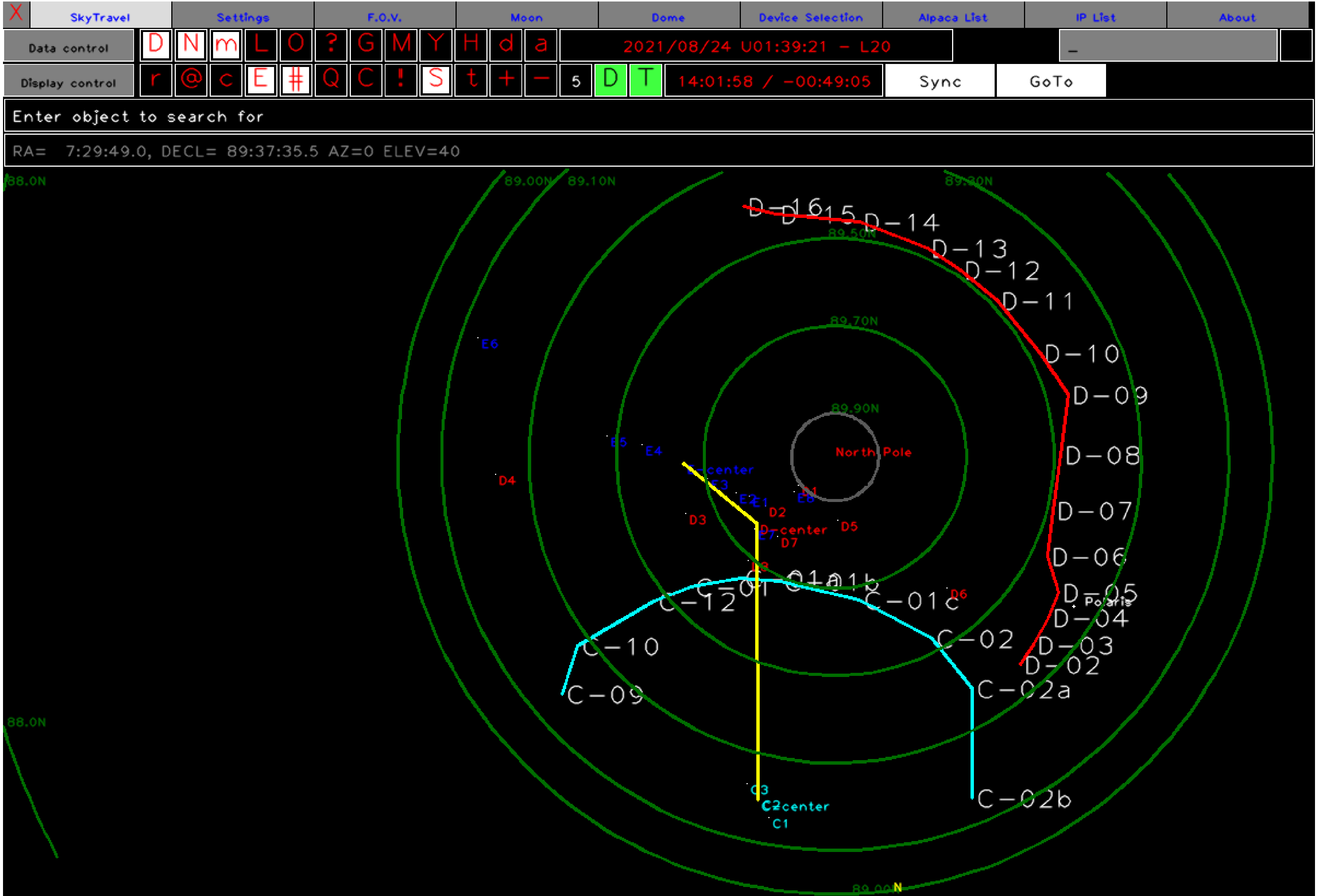
X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
2021/08/13 U01:37:14 - L20
Display control
r @ c E # Q C ! S t + - 5 D T
13:59:21 / -00:49:05
Sync
GoTo
Sync telescope to center of screen
RA= 0:25:45.8, DECL= 89:09:30.0 AZ=1 ELEV=41
89.00N
89.10N
89.30N
89.50N
89.70N
89.90N
North Pole
D-16
D-15
D-14
D-13
D-12
D-11
D-10
D-09
D-08
D-07
D-06
D-05
D-04
D-03
D-02
Polaris
D1
D2
D3
D4
D5
D6
D7
D-center
C-01a
C-01b
C-01c
C-02
C-02a
C-02b
C-09
C-10
C-12
C1
C3
C2center
N

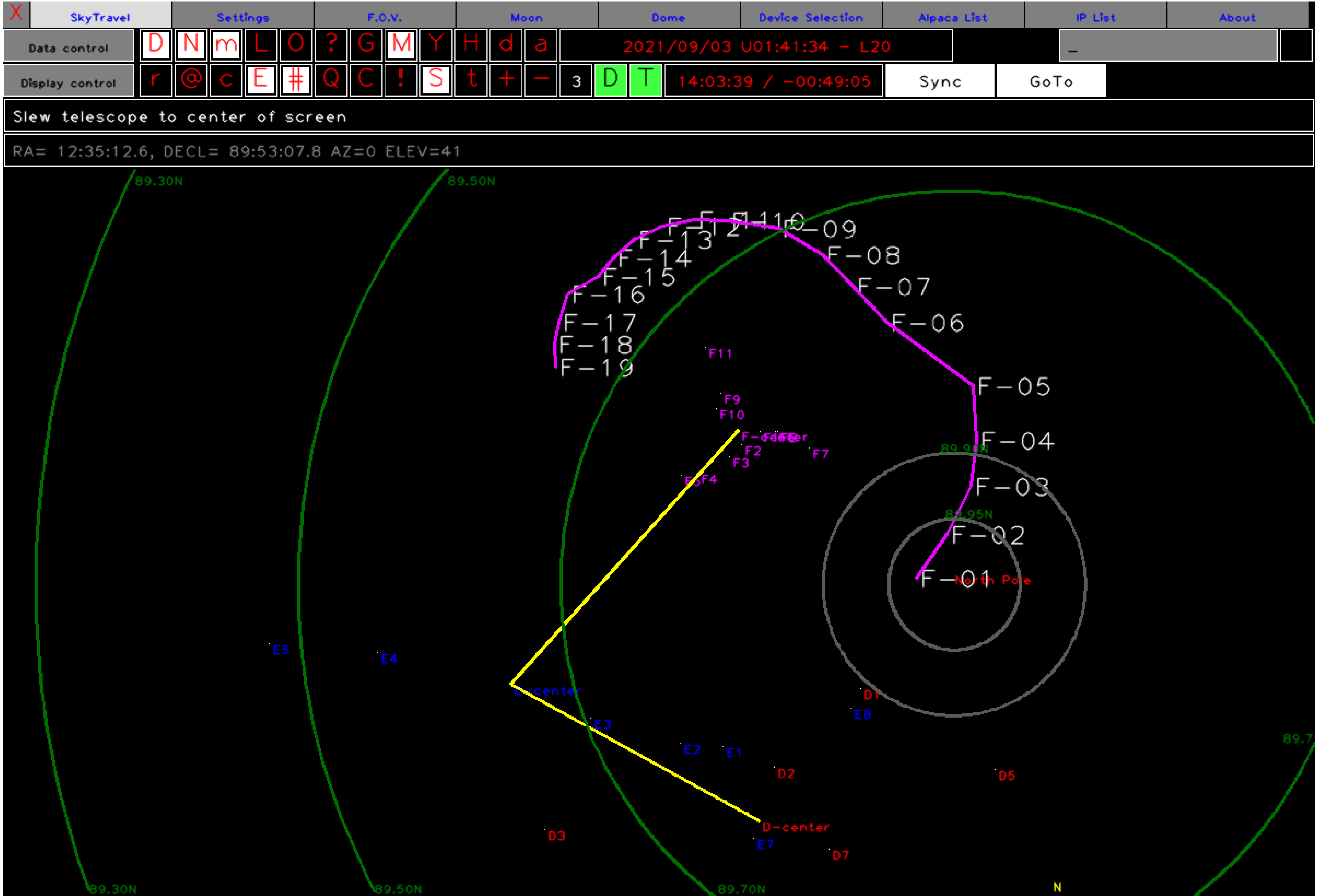


X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
2021/08/13 U02:09:18 - L21
Display control
r @ c E # Q C ! S t + - 3 D T
17:10:18 / -12:32:09
Sync
GoTo
Toggle Line display
RA= 2:59:19.7, DECL= 89:32:10.0 AZ=0 ELEV=41
89.70N
89.50N
89.30N
89.10N
D-07
D-06
D-05
D-04
D-03
D-02
Polaris
D5
C-01c
C-02
C-02a
89.30N
89.10N
89.00N

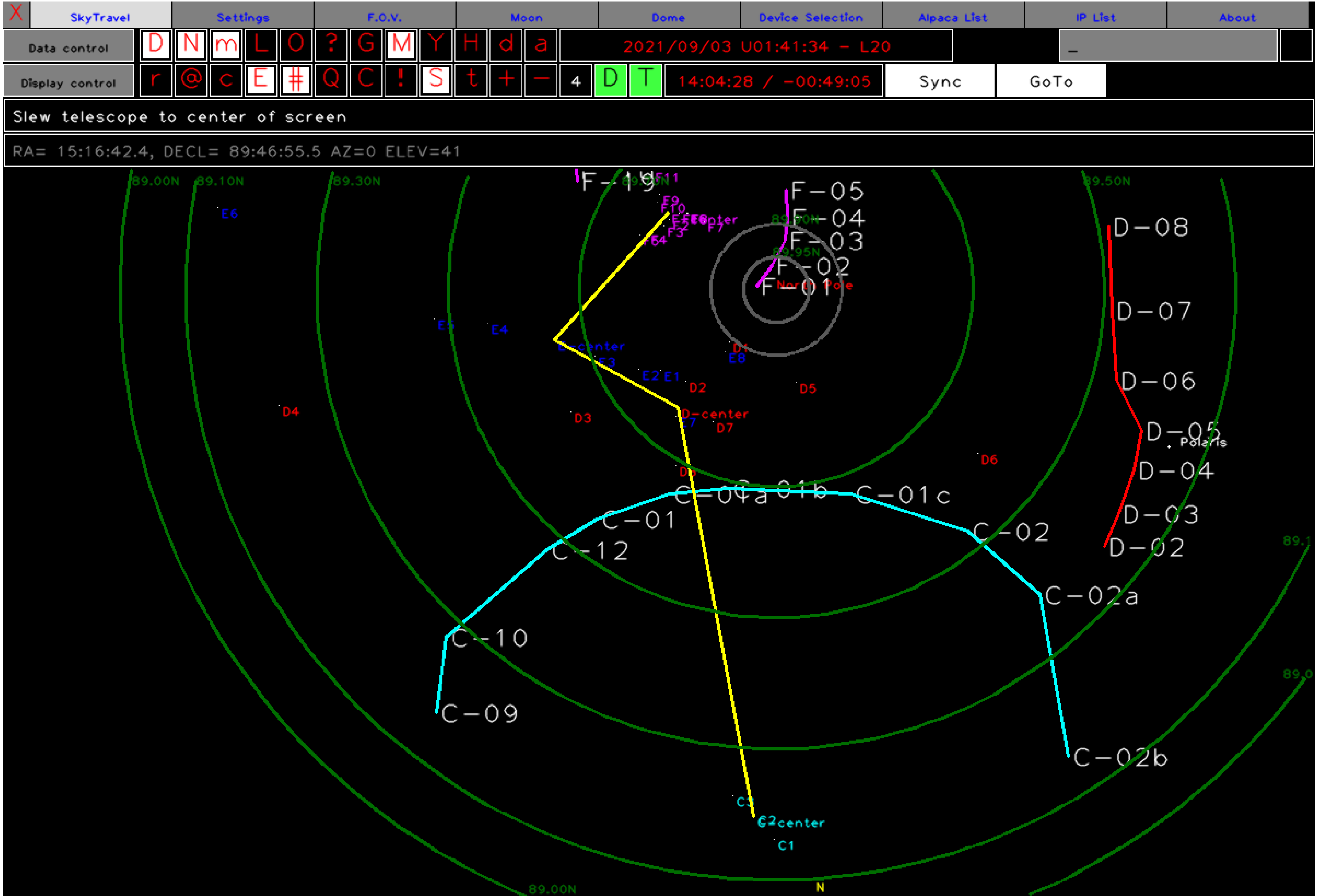
# D05 plate solved w/ Polaris visible

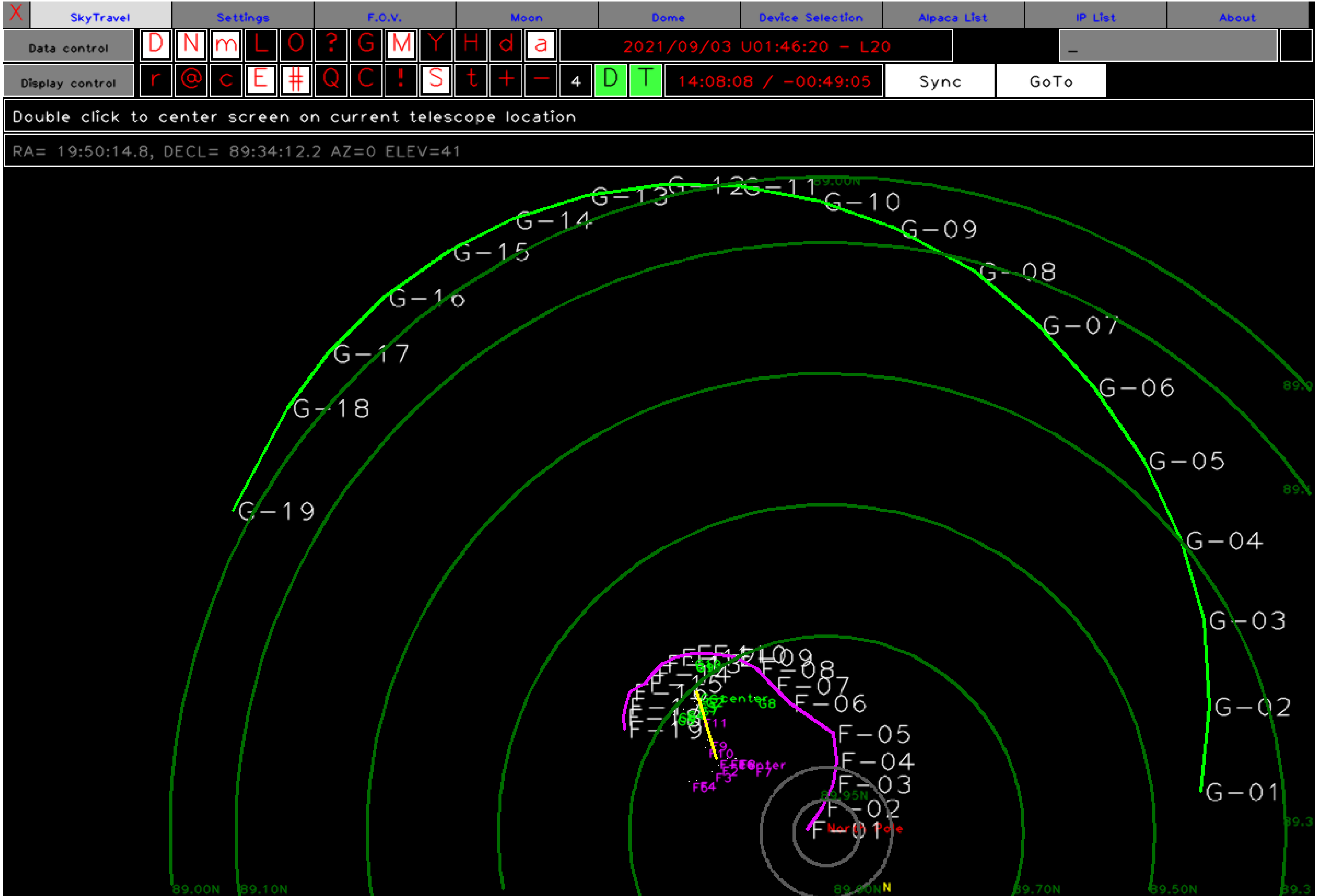

X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
2021/08/24 U01:39:21 - L20
Display control
r @ c E # Q C ! S t + - 12 D T
14:01:38 / -00:49:05
Sync
GoTo
Enter object to search for
RA= 22:00:24.4, DECL= 88:09:49.7 AZ=1 ELEV=42
87.0N
88.0N
89.00N
89.30N
89.70N
89.90N
E-17
E-16
E-15
E-14
E-13
E-12
E-11
E-10
E-09
E-08
E-07
E-06
E-05
E-04
E-03
E-02
C-09
C-02b
N

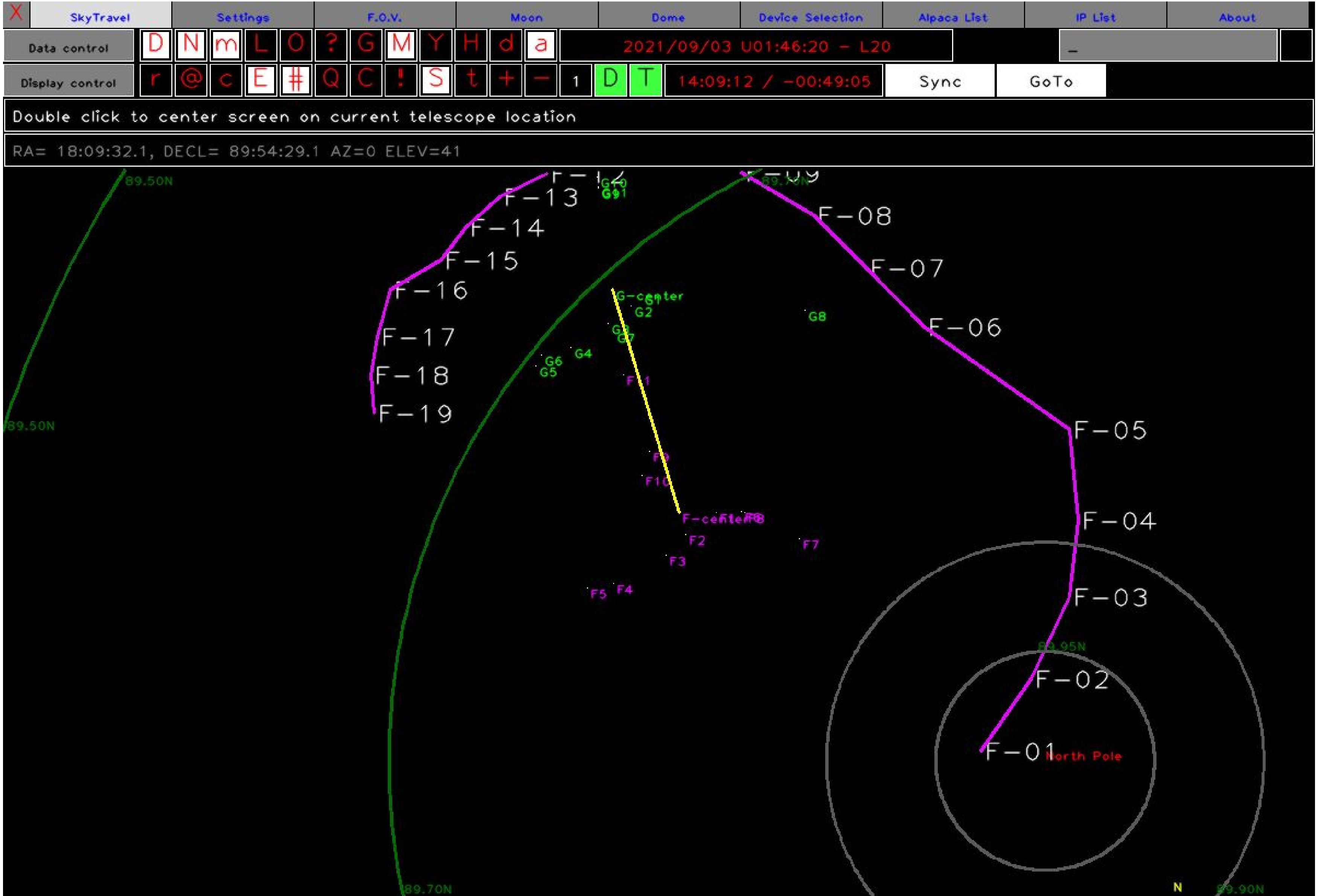

X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
2021/08/24 U01:39:21 - L20
Display control
r @ c E # Q C ! S t + - 5 D T
14:01:58 / -00:49:05
Sync
GoTo
Enter object to search for
RA= 7:29:49.0, DECL= 89:37:35.5 AZ=0 ELEV=40
88.0N
89.00N
89.10N
89.30N
89.50N
89.70N
89.90N
North Pole
D-16
D-14
D-13
D-12
D-11
D-10
D-09
D-08
D-07
D-06
D-05
D-04
D-03
D-02
Polaris
E6
E5
E4
E3
E2
E1
E0
D4
D3
D2
D1
D5
D6
D7
D-center
C-12
C-10
C-09
C-01c
C-02
C-02a
C-02b
C3
C2center
C1

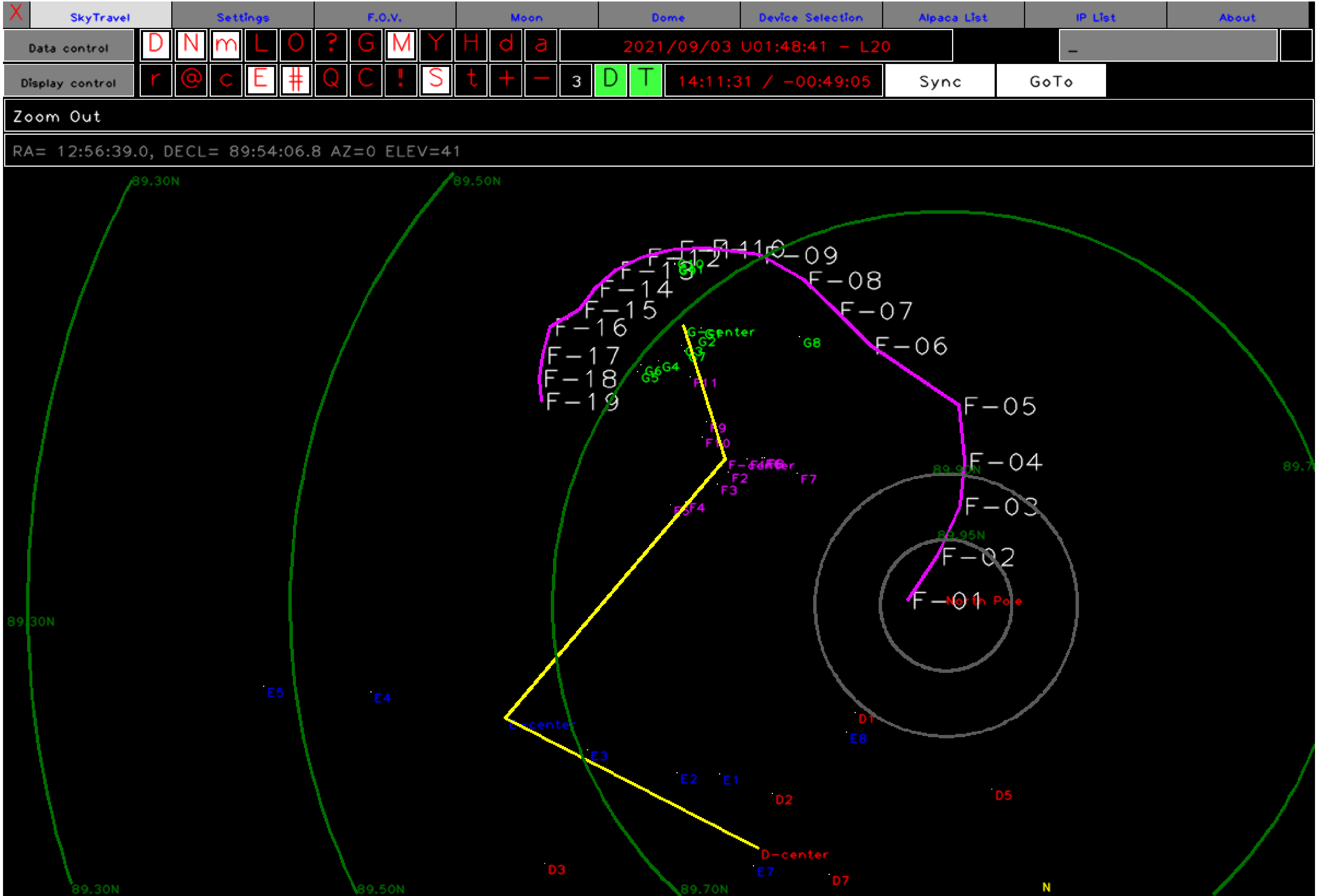


X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
2021/09/03 U01:41:34 - L20
Display control
r @ c E # Q C ! S t + - 3 D T
14:03:39 / -00:49:05
Sync
GoTo
Slew telescope to center of screen
RA= 12:35:12.6, DECL= 89:53:07.8 AZ=0 ELEV=41
89.30N
89.50N
F-09
F-08
F-07
F-06
F-05
F-04
F-02
F-13
F-14
F-15
F-16
F-17
F-18
F11
F9
F10
F2
F3
F7
F4
North Pole
E5
E4
E3
E2
E1
E8
E7
D1
D2
D3
D5
D7
D-center
89.70N
N


X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
2021/09/03 U01:41:34 - L20
Display control
r @ c E # Q C ! S t + -
4
D T
14:04:28 / -00:49:05
Sync
GoTo
Slew telescope to center of screen
RA= 15:16:42.4, DECL= 89:46:55.5 AZ=0 ELEV=41
89.00N
89.10N
89.30N
89.50N
F-05
F-04
F-03
F-02
F-01
North Pole
D-08
D-07
D-06
D-05
Polaris
D-04
D-03
D-02
D-center
D1
D2
D3
D4
D5
D6
D7
E1
E2
E4
E6
E8
C-01
C-01a
C-01b
C-01c
C-02
C-02a
C-02b
C-09
C-10
C-12
C1
C3
C2center
89.00N
N


X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
2021/09/03 U01:46:20 - L20
Display control
r @ c E # Q C ! S t + - 4 D T
14:08:08 / -00:49:05
Sync
GoTo
Double click to center screen on current telescope location
RA= 19:50:14.8, DECL= 89:34:12.2 AZ=0 ELEV=41
G-01
G-02
G-03
G-04
G-05
G-06
G-07
G-08
G-09
G-10
G-11
G-12
G-13
G-14
G-15
G-16
G-17
G-18
G-19
F-01
F-02
F-03
F-04
F-05
F-06
F-07
F-08
F-09
F-19
North Pole
89.00N
89.10N
89.50N
89.70N
89.95N


X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
2021/09/03 U01:46:20 - L20
Display control
r @ c E # Q C ! S t + - 1 D T
14:09:12 / -00:49:05
Sync
GoTo
Double click to center screen on current telescope location
RA= 18:09:32.1, DECL= 89:54:29.1 AZ=0 ELEV=41
89.50N
F-13
F-14
F-15
F-16
F-17
F-18
F-19
F-08
F-07
F-06
F-05
F-04
F-03
F-02
F-01
North Pole
G-center
G2
G8
G4
G6
G5
F2
F3
F7
F4
F5
89.95N
89.70N
89.90N
N


X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
2021/09/03 U01:48:41 - L20
Display control
r @ c E # Q C ! S t + - 3 D T
14:11:31 / -00:49:05
Sync
GoTo
Zoom Out
RA= 12:56:39.0, DECL= 89:54:06.8 AZ=0 ELEV=41
89.30N
89.50N
89.70N
89.90N
89.95N
F-09
F-08
F-07
F-06
F-05
F-04
F-03
F-02
F-01
F-14
F-15
F-16
F-17
F-18
F-19
North Pole
G-center
G8
G4
F11
F9
F10
F2
F3
F4
F7
E5
E4
E3
E2
E1
E8
E7
D1
D2
D3
D5
D7
D-center
N

# TO-DO List

- Obviously I have a few more adjustments to make
- Add plate solving to my software
- Add some automation to the process

# How To

- With the exception of the plate solving, this could be done on manual charts.
- Plate solving
  - https://nova.astrometry.net/
- My software
  - https://github.com/msproul/AlpacaPi

Intermission / Questions

# Part 2

AlpacaPi software, what is it and how does it fit in today's computer controlled environment

# What is AlpacaPi?

- Suite of software I wrote in C++
- Targeted to run on Raspberry-Pi’s
  - Will run on most any Linux
- 131,000 lines of code
- Planetarium code adapted from code Clif Ashcraft wrote for the Commodore 64 in the early 80s (SkyTravel - 7000, lines of code)

# What is AlpacaPi?

- All open source
- Utilizes Alpaca protocol to implement a distributed observatory control system.

# What is Alpaca?

ASCOM Alpaca

# History

- ASCOM developed by Bob Denny 20 years ago.
- Group in UK now controls the published standard
- Most hardware vendors support ASCOM
- Lots of commercial and free software support for ASCOM
- ASCOM only runs on Windows!!!
- April 2019, ASCOM group announced Alpaca

# What is Alpaca?

- Networked version of ASCOM for ALL platforms
- Client / server model that uses:
  - HTTP – Hyper Text Transport Protocol
    - Used by web browsers to talk to web servers
    - Can be use for other purposes
  - JSON Java Script Object Notation
    - Plain text format for keyword / value pairs. Much simpler than XML

# What is Alpaca?

- Data and Commands are ***identical*** to ASCOM
- Transport method changed to HTTP and JSON (ASCOM uses COM on Windows)
- ASCOM limited to single computer
- Alpaca is network based allowing for a fully distributed system
- Backwards compatible with ASCOM via software bridge on Windows

# What is Alpaca?

- WINDOWS IS NOT REQUIRED!!!!!!!!

# HTTP

- HTTP to web server
  - GET /index.html
  - GET /subdirectory/index.php
  - GET /imagedirectory/image.jpg
- Alpaca HTTP
  - GET /api/v1/camera/0/camerastate
  - GET /api/v1/camera/0/pixelsizex
  - PUT /api/v1/camera/0/startexposure
  - PUT /api/v1/dome/0/closeshutter

# JSON

GET /api/v1/camera/0/pixelsizex

returns

{
"Device":"WO102-ZWO ASI1600MM Pro",
"Command":"pixelsizex",
"Value":3.800000,
"ClientTransactionID":4,
"ServerTransactionID":15074,
"ErrorNumber":0,
"ErrorMessage":""
}

# Command Line

Alpaca commands can be sent from a unix command line, no programming required. This allows very easy automation.

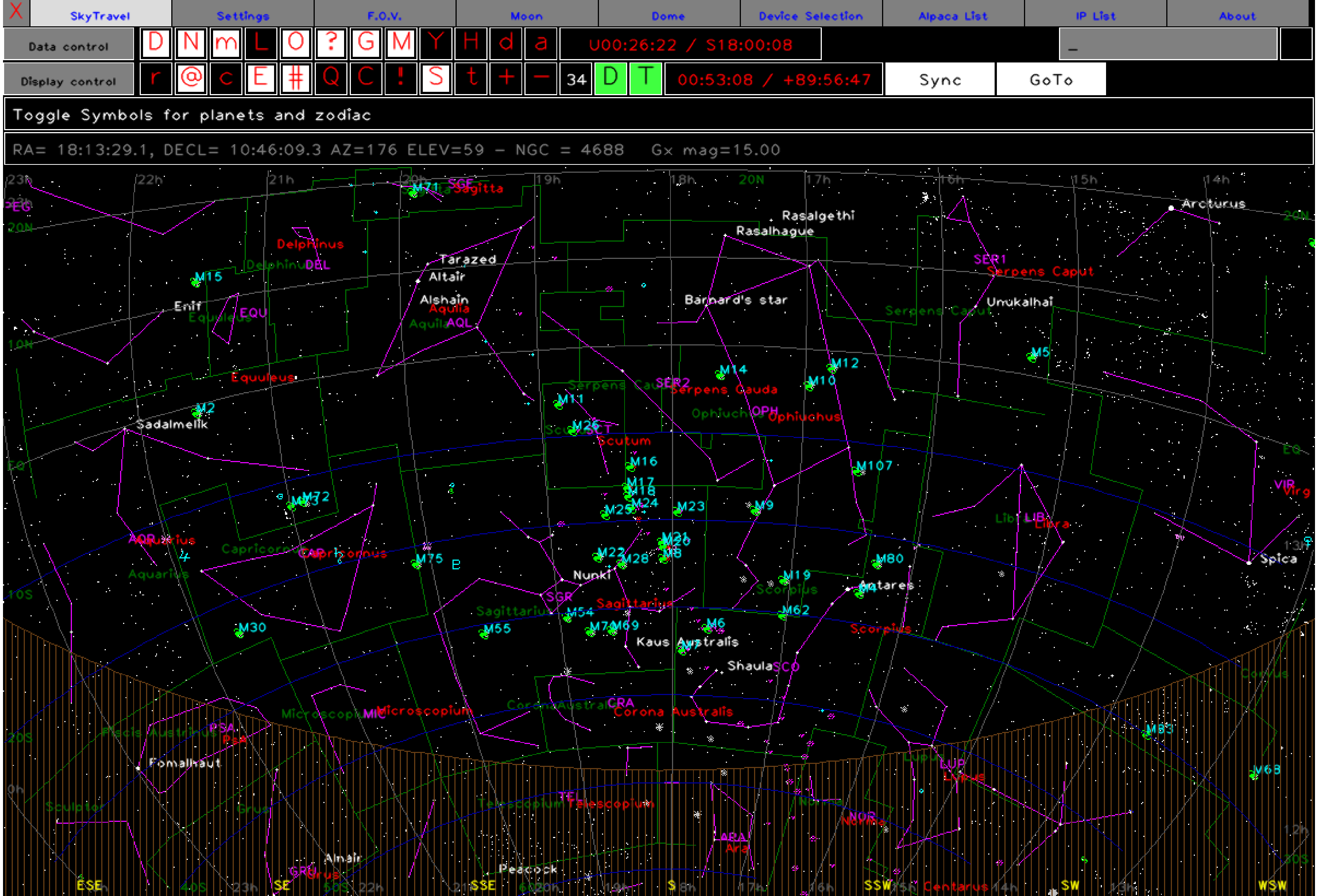
```
curl -X PUT "http://192.168.1.22:6800/api/v1/dome/0/closeshutter"
```

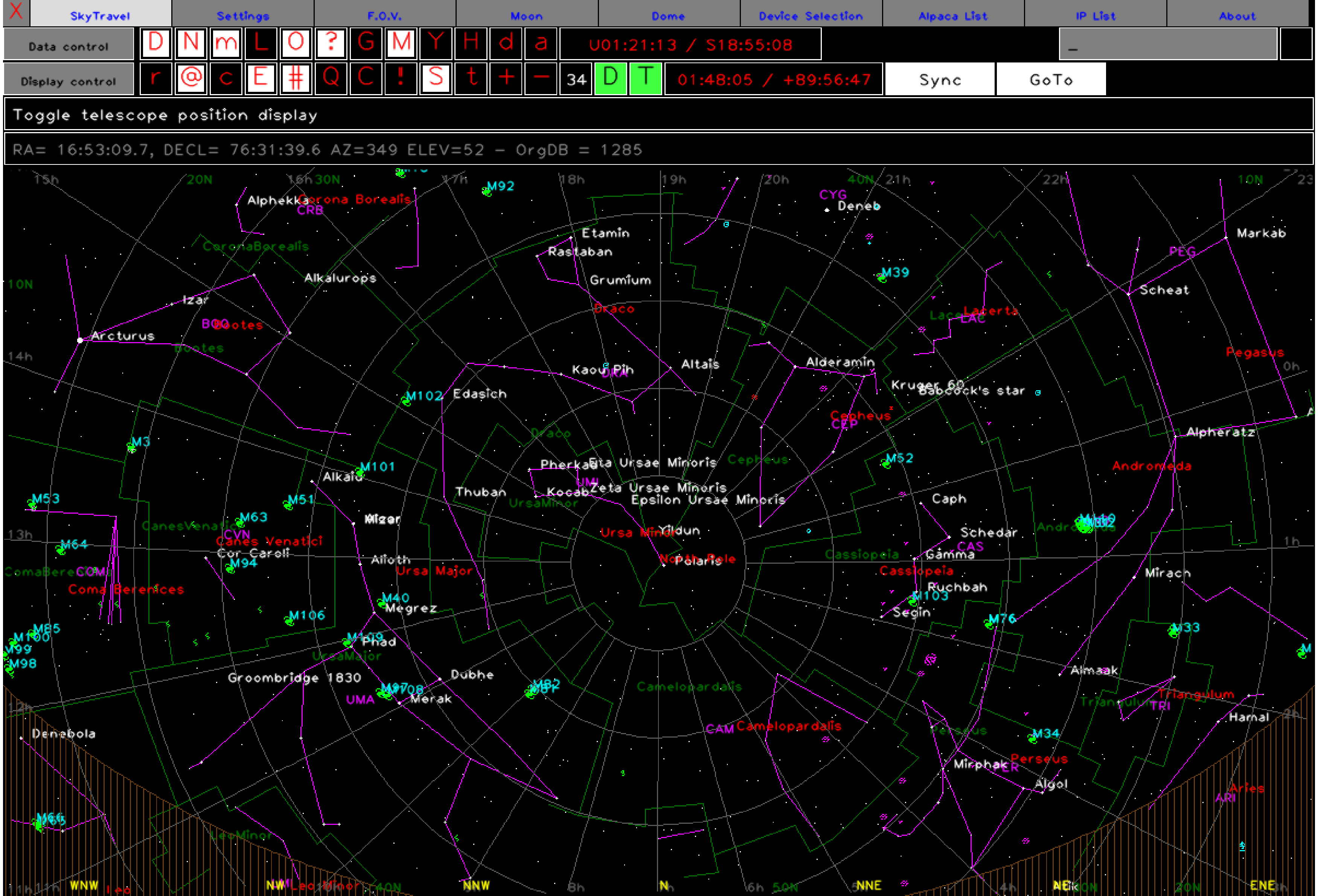
# Back to AlpacaPi

- AlpacaPi is a collection of drivers and clients that implements Alpaca on Linux.
- IMPORTANT NOTE: You can use your existing ASCOM client on Windows to talk to any of my Linux Alpaca drivers.

# AlpacaPi software suite

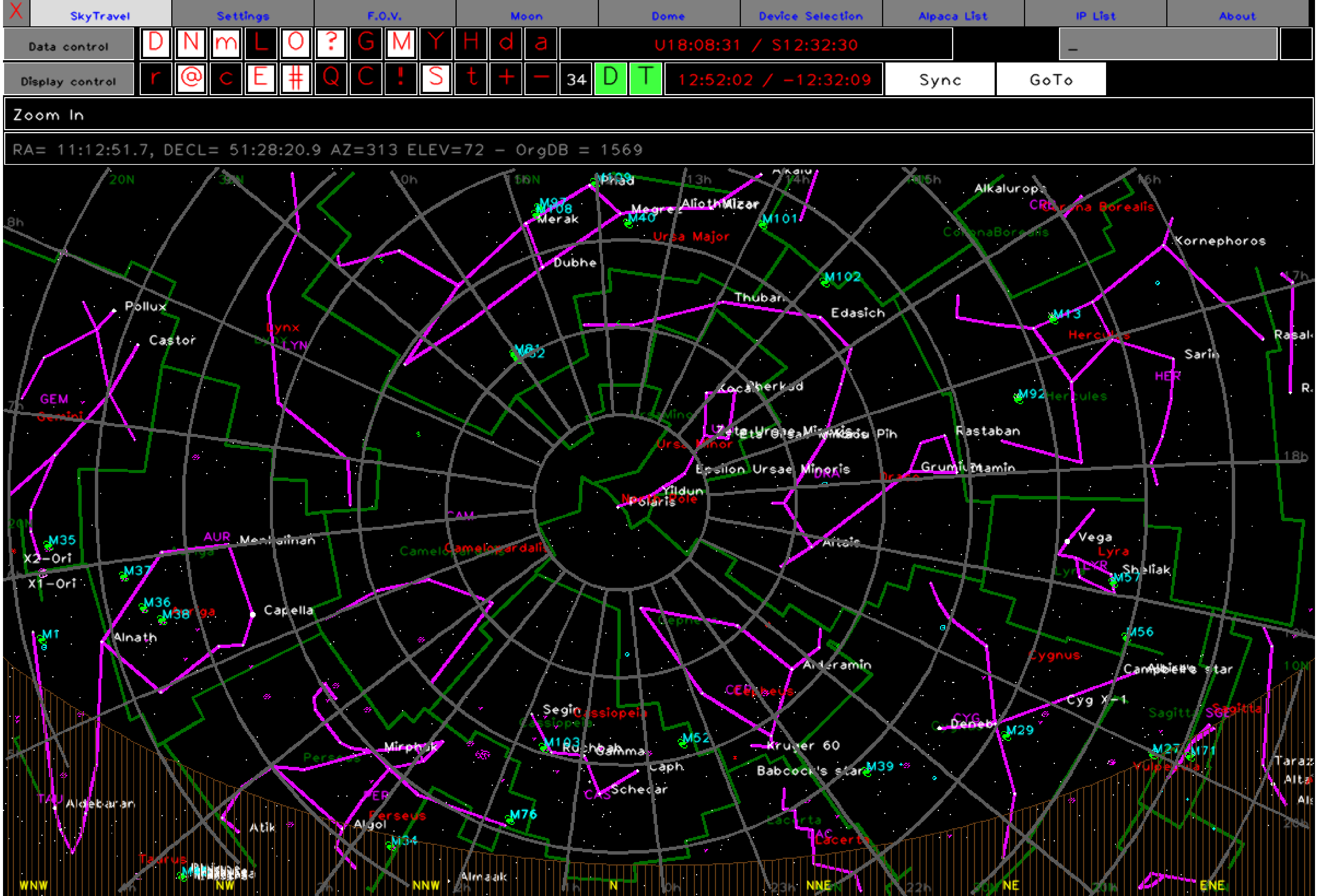
- Drivers
  - Camera
  - Focuser
  - Rotator
  - Filterwheel
  - Dome
  - Calibration
  - Switch
- Clients
  - Controllers for all the drivers
  - Planetarium with full integration to all of the drivers.


X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
U00:26:22 / S18:00:08
Display control
r @ c E # Q C ! S t + −
34
D T
00:53:08 / +89:56:47
Sync
GoTo
Toggle Symbols for planets and zodiac
RA= 18:13:29.1, DECL= 10:46:09.3 AZ=176 ELEV=59 − NGC = 4688 Gx mag=15.00

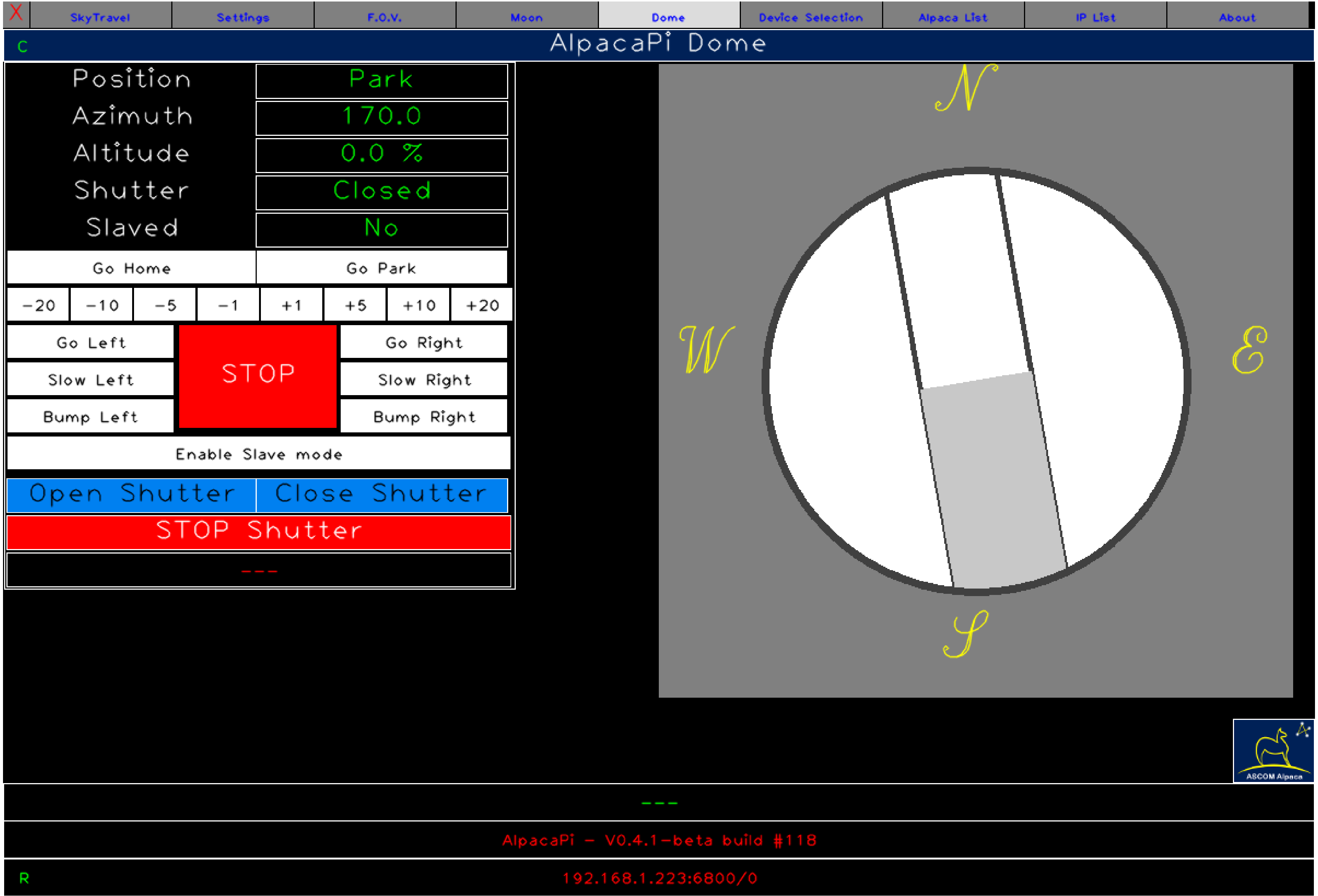


X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
U01:21:13 / S18:55:08
Display control
r @ c E # Q C ! S t + - 34 D T
01:48:05 / +89:56:47
Sync
GoTo
Toggle telescope position display
RA= 16:53:09.7, DECL= 76:31:39.6 AZ=349 ELEV=52 - OrgDB = 1285
Alphekka
Corona Borealis
CRB
Arcturus
Izar
Alkalurops
Etamin
Rastaban
Grumium
Draco
Deneb
CYG
M92
M39
Markab
PEG
Scheat
Pegasus
Kaou Pih
Altais
Alderamin
Kruger 60
Babcock's star
Cepheus
CEP
Edasich
M102
M101
Alkaid
M3
M53
M63
M51
M64
Mizar
Thuban
Pherkad
Eta Ursae Minoris
Kocab
Zeta Ursae Minoris
Epsilon Ursae Minoris
Yildun
Ursa Minor
North Pole
Polaris
M52
Caph
Schedar
CAS
Gamma
Cassiopeia
Ruchbah
M103
Segin
Alpheratz
Andromeda
Mirach
Canes Venatici
CVN
Cor Caroli
M94
Alioth
Ursa Major
Coma Berenices
M40
Megrez
M106
M85
M100
M99
M98
M109
Phad
Groombridge 1830
Dubhe
Merak
UMA
M97
M108
M82
M81
Camelopardalis
CAM
M76
M33
Almaak
Triangulum
TRI
Hamal
Denebola
M34
Mirphak
Perseus
Algol
Aries
ARI
M66
WNW
NW
Leo Minor
NNW
N
NNE
NE
ENE

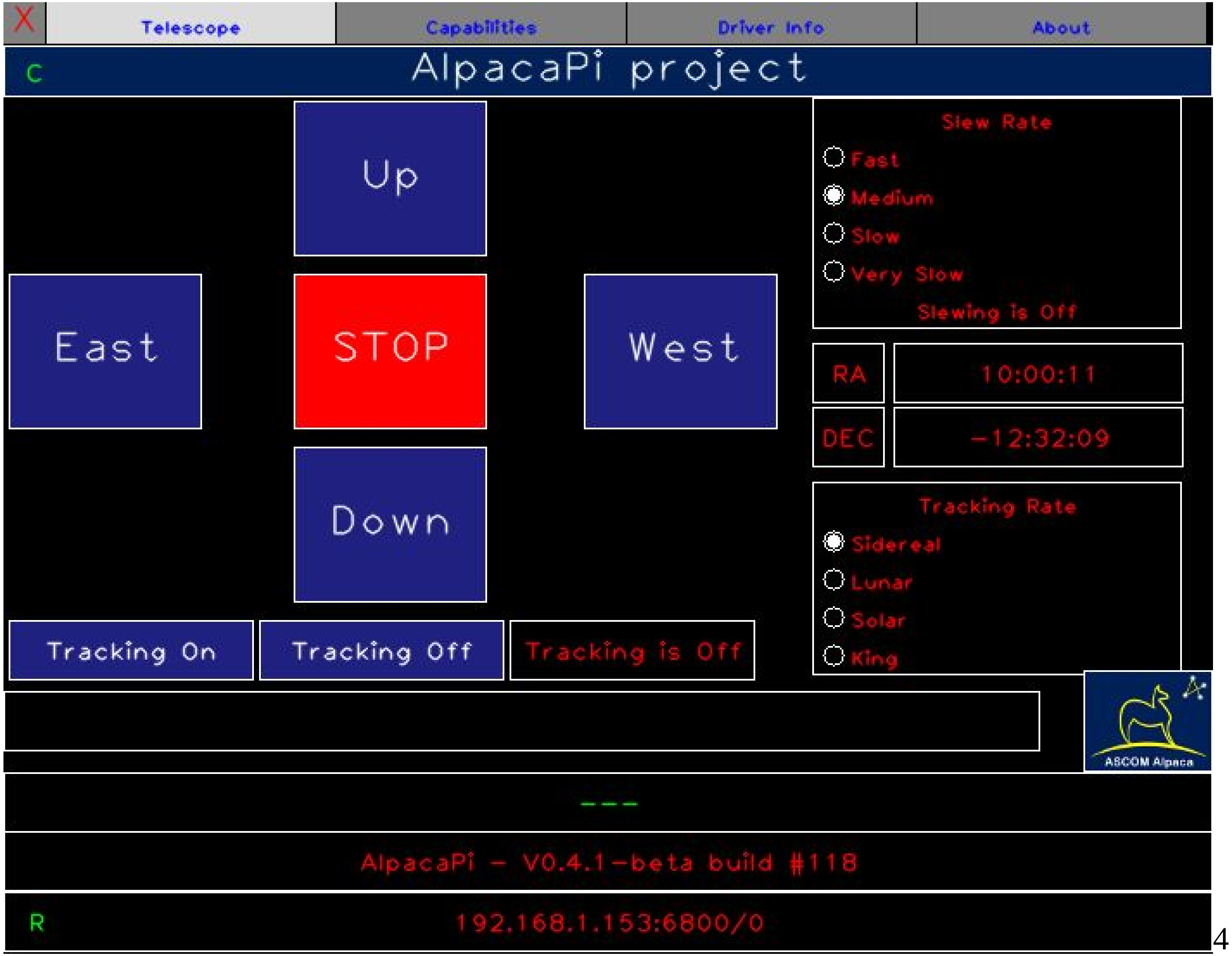

50

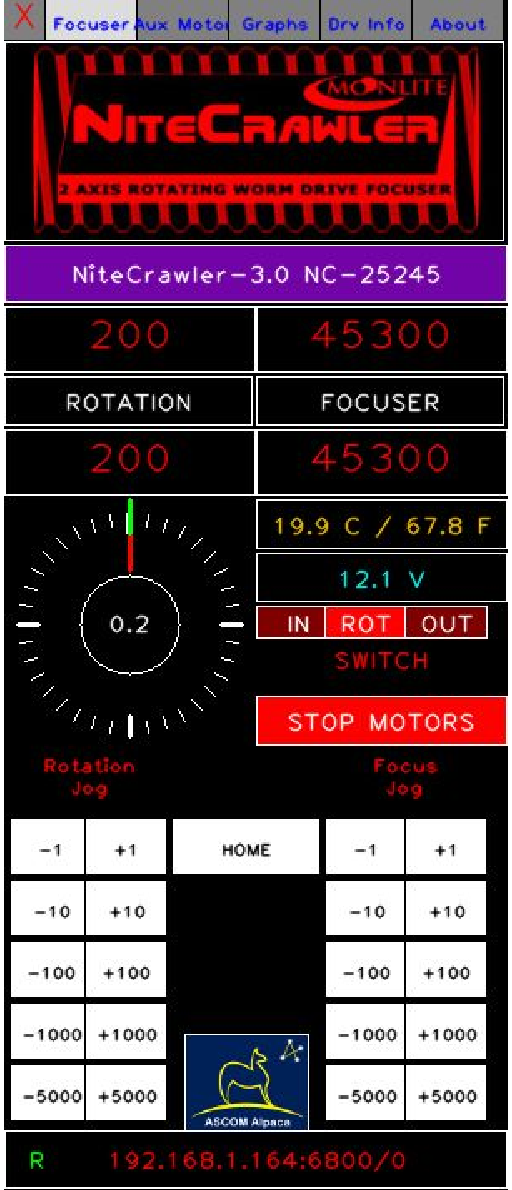

X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
U18:08:31 / S12:32:30
Display control
r @ c E # Q C ! S t + −
34
D T
12:52:02 / −12:32:09
Sync
GoTo
Zoom In
RA= 11:12:51.7, DECL= 51:28:20.9 AZ=313 ELEV=72 − OrgDB = 1569
Pollux
Castor
GEM
Gemini
Lynx
Merak
Dubhe
Megrez
Mizar
Ursa Major
M101
M102
Thuban
Edasich
Kornephoros
Alkalurops
Corona Borealis
M13
Hercules
Sarin
HER
M92
Rastaban
Vega
Lyra
Sheliak
M57
M56
Cygnus
Cyg X-1
Deneb
M29
M27
M71
Polaris
North Pole
Yildun
Epsilon Ursae Minoris
Ursa Minor
M35
X2-Ori
X1-Ori
M37
M36
M38
Capella
AUR
M1
Alnath
Aldebaran
TAU
Taurus
Atik
Algol
Perseus
PER
Mirphak
M34
M76
Almaak
Segin
Cassiopeia
M103
Ruchbah
Gamma
Caph
Schedar
CAS
M52
Kruger 60
Babcock's star
M39
Alderamin
Cepheus
Lacerta
CAM
Camelopardalis
WNW
NW
NNW
N
NNE
NE
ENE

| ip-address : port | /etc/hosts | type | name |
|---|---|---|---|
| 192.168.1.177:6800 | calib | Camera | calib-ZWO ASI034MC |
| 192.168.1.146:6800 | door | Camera | Door-ZWO ASI034MC |
| 192.168.1.165:6800 | finder | Camera | FINDER-ZWO ASI120MC |
| 192.168.1.165:6800 | finder | Camera | FINDER-ZWO ASI120MC-S |
| 192.168.1.164:6800 | newt16 | Camera | NEWT16-ZWO ASI1600MC Pro |
| 192.168.1.173:6800 | wo102 | Camera | WO102-ZWO ASI1600MM Pro |
| 192.168.1.173:6800 | wo102 | Camera | WO102-ZWO ASI290MM |
| 192.168.1.161:6800 | wo71 | Camera | WO71-ZWO ASI120MC-S |
| 192.168.1.177:6800 | calib | CoverCalibrator | CoverCalibration-Raspberry-Pi |
| 192.168.1.223:6800 | dome | Dome | AlpacaPi-Dome |
| 192.168.1.164:6800 | newt16 | Filterwheel | ZWO EFW-5 |
| 192.168.1.173:6800 | wo102 | Filterwheel | ZWO EFW-8 |
| 192.168.1.166:6800 | gyro | Focuser | Moonlite |
| 192.168.1.161:6800 | wo71 | Focuser | NiteCrawler Focuser |
| 192.168.1.164:6800 | newt16 | Focuser | NiteCrawler Focuser |
| 192.168.1.173:6800 | wo102 | Focuser | NiteCrawler Focuser |
| 192.168.1.165:6800 | finder | Multicam | MultiCam |
| 192.168.1.161:6800 | wo71 | Rotator | NiteCrawler Rotator |
| 192.168.1.164:6800 | newt16 | Rotator | NiteCrawler Rotator |
| 192.168.1.173:6800 | wo102 | Rotator | NiteCrawler Rotator |
| 192.168.1.146:6800 | door | Shutter | Arduino-shutter |
| 192.168.1.164:6800 | newt16 | SlitTracker | SlitTracker |
| 192.168.1.146:6800 | door | Switch | Switch-Raspberry-Pi |
| 192.168.1.165:6800 | finder | Switch | Switch-Raspberry-Pi |
| 192.168.1.153:6800 | | Telescope | Telescope-LX200 |


X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
C
AlpacaPi Dome
Position
Park
Azimuth
170.0
Altitude
0.0 %
Shutter
Closed
Slaved
No
Go Home
Go Park
-20
-10
-5
-1
+1
+5
+10
+20
Go Left
STOP
Go Right
Slow Left
Slow Right
Bump Left
Bump Right
Enable Slave mode
Open Shutter
Close Shutter
STOP Shutter
---
N
W
E
S
ASCOM Alpaca
---
AlpacaPi - V0.4.1-beta build #118
R
192.168.1.223:6800/0

# Telescope Control

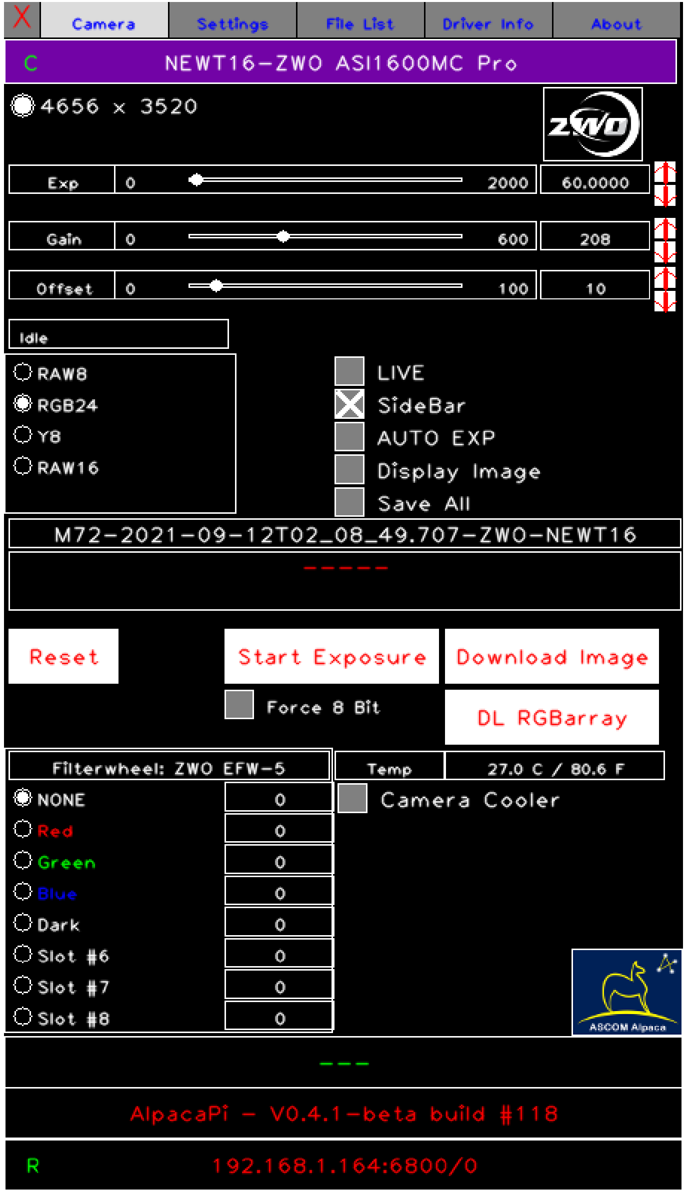





← Focuser Control

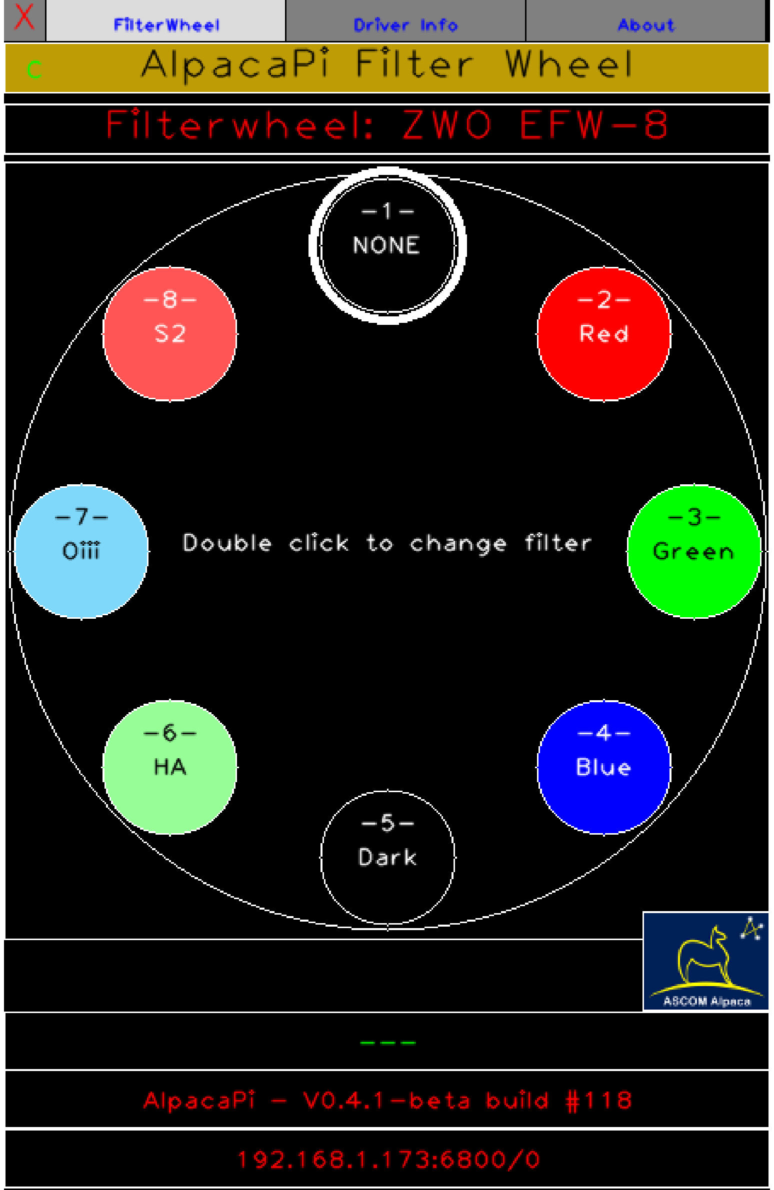
Camera Control →

Filter wheel info is included ->

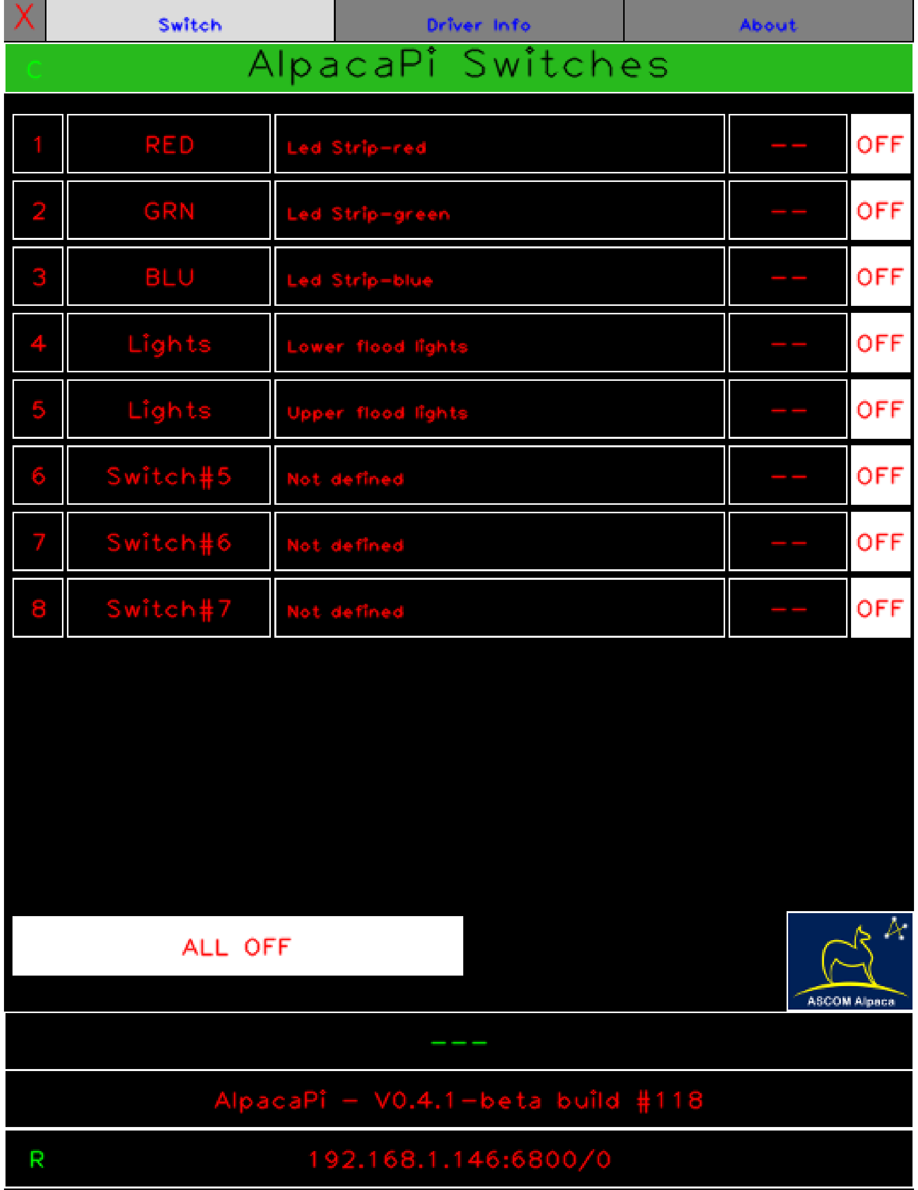


Filter Wheel Control

Double click on any filter to move to that position.



Switch Control

Clicking the RED LED switch turns on some lights.

# AlpacaPi supported hardware

- Cameras
  - ZWO
  - ATIK
  - SVBONY
  - QHY
  - Touptech
  - FLIR
  - SONY
- Focusers
  - Moonlite Nitecrawler
  - Moonlite HiRes
- Filterwheel
  - ZWO
  - ATIK
- Rotator
  - Moonlite Nitecrawler

# AlpacaPi supported hardware

- Dome
  - Raspberry-Pi using motor control boards for Dome
  - Raspberry-Pi using relay board for Roll Off Roof
- Switch
  - Raspberry-Pi using relay board
- Calibration
  - Raspberry-Pi using motor control board to adjust brightness of flat panel

# AAVSO

AAVSO - American Association of Variable Star Observers puts out observations alerts on a regular basis.

You can sign up to receive this via emal OR

Go online and find them

https://filtergraph.com/aavso/api/index#

Supports full API for access

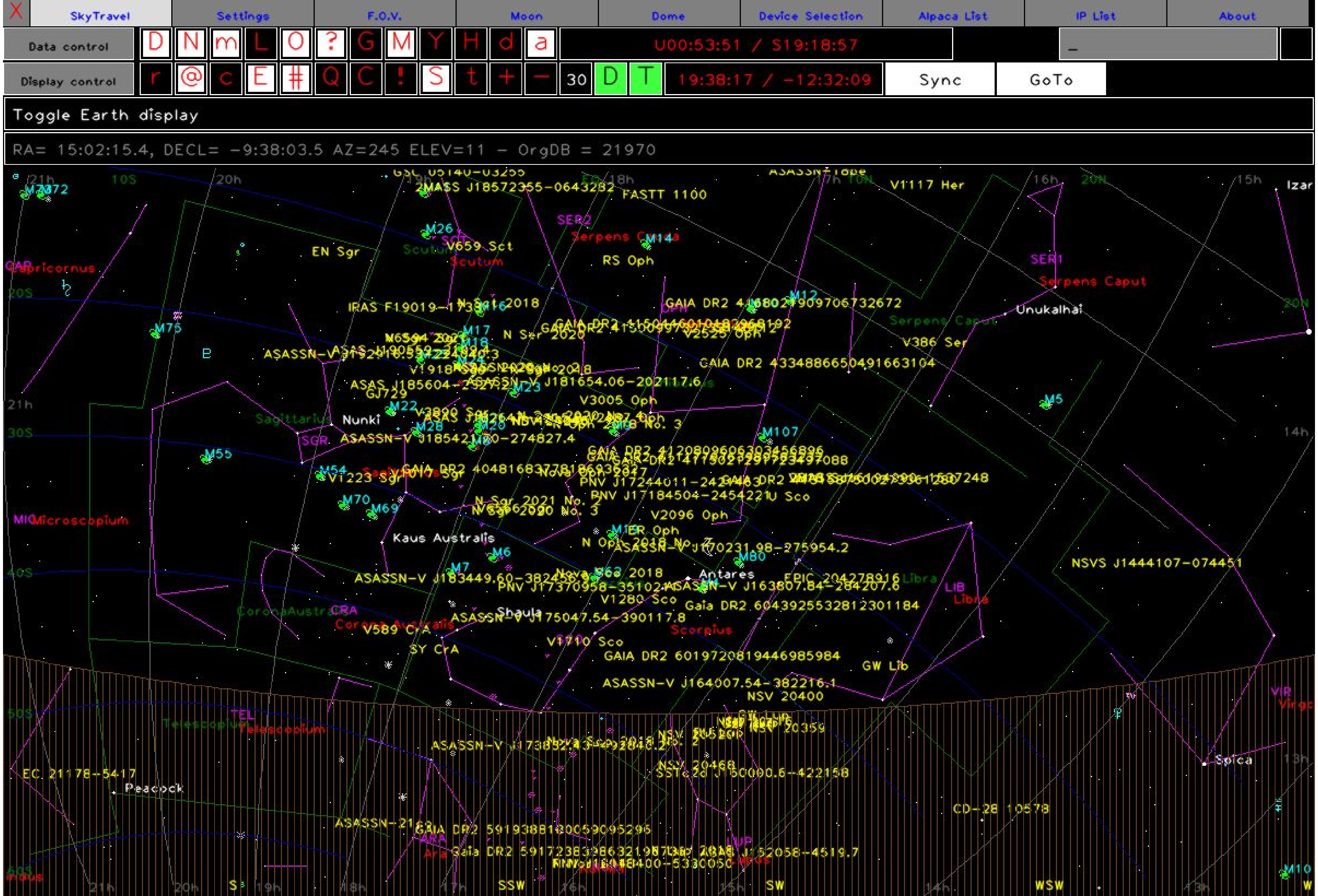
X Star Object List | About

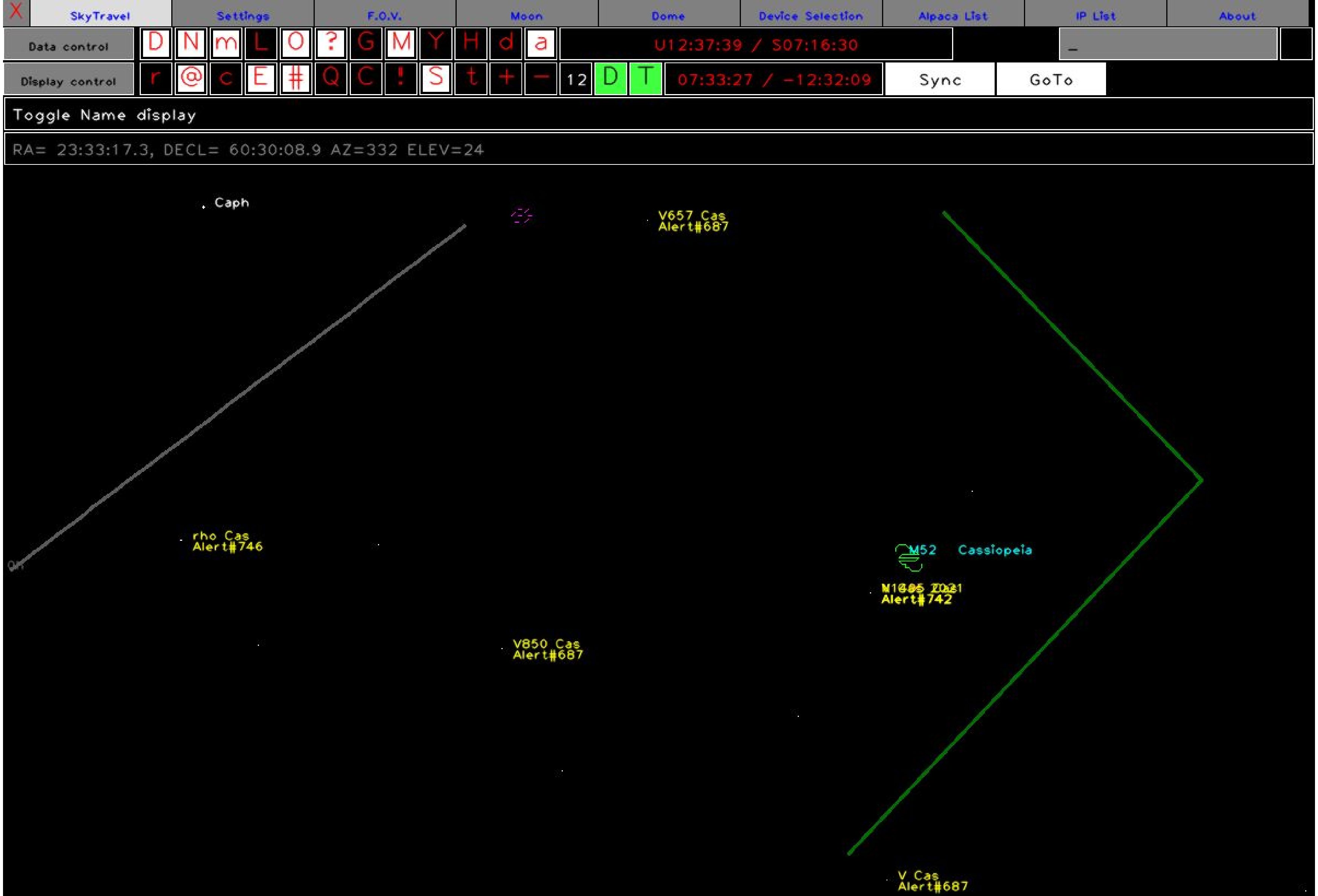
# AAVSO List

| AlertID | Star Name | Right Ascension | Declination | Org RA/DEC |
|---|---|---|---|---|
| 754 | 1SWASP J022916.91-395901.4 | 2:30:08.9 | -39:53:16.2 | 2:29:16.9/-39:59:01.6 |
| 754 | KR Aur | 6:17:06.4 | 28:34:37.5 | 6:15:43.9/ 28:35:08.6 |
| 754 | V442 Oph | 17:33:30.3 | -16:16:13.5 | 17:32:15.1/-16:15:22.1 |
| 754 | GS Pav | -3:49:39.1 | -69:45:06.3 | 20:08:07.6/-69:48:58.8 |
| 754 | V794 Aql | -3:41:17.8 | -3:35:44.4 | 20:17:33.9/ -3:39:51.0 |
| 754 | VY Scl | 0:29:50.6 | -29:39:34.9 | 23:29:00.5/-29:46:46.0 |
| 754 | 1RXS J233801.0+430852 | 0:20:56.6 | 43:16:04.0 | 23:37:59.2/ 43:08:51.0 |
| 754 | V704 And | 0:13:57.5 | 43:38:36.4 | 23:44:57.5/ 43:31:22.3 |
| 754 | HS 0220+0603 | 2:24:10.3 | 6:22:41.9 | 2:23:01.7/ 6:16:49.6 |
| 754 | WX Ari | 2:48:46.6 | 10:41:00.7 | 2:47:36.2/ 10:35:37.7 |
| 754 | V1024 Cep | 5:11:57.2 | 83:20:58.6 | 5:06:48.3/ 83:19:23.3 |
| 754 | LN UMa | 10:06:13.3 | 66:22:53.2 | 10:04:34.7/ 66:29:14.9 |
| 754 | V380 Oph | 17:51:17.3 | 6:05:11.8 | 17:50:13.6/ 6:05:29.3 |
| 754 | V425 Cas | 0:55:16.0 | 53:24:17.0 | 23:03:46.7/ 53:17:14.9 |
| 753 | DO Dra | 11:44:51.2 | 71:34:06.6 | 11:43:38.5/ 71:41:20.5 |
| 753 | DW Cnc | 8:00:07.2 | 16:13:08.8 | 7:58:53.1/ 16:16:45.4 |
| 753 | V515 And | 0:56:33.9 | 46:19:59.0 | 0:55:19.9/ 46:12:57.0 |
| 753 | V1223 Sgr | -5:03:33.9 | -31:08:04.9 | 18:55:02.3/-31:09:49.6 |
| 753 | V1025 Cen | 12:39:27.0 | -38:49:54.5 | 12:38:16.3/-38:42:45.8 |
| 753 | AO Psc | -1:03:34.8 | -3:03:41.9 | 22:55:18.0/ -3:10:40.0 |
| 753 | 1RXS J213344.1+510725 | -2:25:31.1 | 51:13:14.5 | 21:33:43.6/ 51:07:24.7 |
| 752 | RS Oph | 17:51:23.3 | -6:42:46.0 | 17:50:13.2/ -6:42:28.6 |
| 751 | RU Lup | 15:58:08.4 | -37:52:57.2 | 15:56:42.3/-37:49:15.5 |
| 751 | BP Tau | 4:20:37.2 | 29:09:30.7 | 4:19:15.8/ 29:06:26.8 |
| 750 | T CrB | 16:00:24.7 | 25:51:35.1 | 15:59:30.2/ 25:55:12.6 |
| 749 | N Vul 2021 | -3:37:58.8 | 29:18:21.0 | 20:21:07.7/ 29:14:09.1 |
| 748 | SSTc2d J160000.6-422158 | 16:01:30.3 | -42:25:33.0 | 16:00:00.6/-42:21:56.8 |
| 748 | NSV 20468 | 16:02:00.3 | -41:47:12.4 | 16:00:31.0/-41:43:37.0 |
| 747 | V627 Peg | -2:20:55.0 | 26:25:50.8 | 21:38:06.6/ 26:19:56.0 |
| 746 | rho Cas | 0:04:31.2 | 57:37:12.6 | 23:54:23.0/ 57:29:57.8 |
| 745 | N Her 2021 | -5:01:30.8 | 16:55:28.5 | 18:57:31.0/ 16:53:39.6 |
| 744 | V1117 Her | 16:40:08.5 | 9:45:25.9 | 16:39:06.4/ 9:47:55.3 |
| 743 | V603 Aql | -5:09:58.9 | 0:36:36.1 | 18:48:54.6/ 0:35:02.9 |
| 742 | N Cas 2021 | 0:34:13.5 | 61:18:24.8 | 23:24:47.7/ 61:11:14.8 |

Total stars =294

Export to CSV


X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
U00:53:51 / S19:18:57
Display control
r @ c E # Q C ! S t + - 30 D T
19:38:17 / -12:32:09
Sync
GoTo
Toggle Earth display
RA= 15:02:15.4, DECL= -9:38:03.5 AZ=245 ELEV=11 - OrgDB = 21970
2MASS J18572355-0643282
FASTT 1100
V1117 Her
Izar
EN Sgr
V659 Sct
Scutum
RS Oph
Serpens Caput
Unukalhai
Capricornus
V386 Ser
GAIA DR2 4334886650491663104
V3005 Oph
Nunki
Sagittarius
M107
Microscopium
Kaus Australis
Antares
NSVS J1444107-074451
V1280 Sco
Gaia DR2 6043925532812301184
Shaula
Scorpius
V589 CrA
SY CrA
V1710 Sco
GAIA DR2 6019720819446985984
GW Lib
ASASSN-V J164007.54-382216.1
NSV 20400
Telescopium
EC 21178-5417
Peacock
Spica
CD-28 10578
SSW
SW
WSW


X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
U12:37:39 / S07:16:30
Display control
r @ c E # Q C ! S t + −
12
D T
07:33:27 / −12:32:09
Sync
GoTo
Toggle Name display
RA= 23:33:17.3, DECL= 60:30:08.9 AZ=332 ELEV=24
Caph
V657 Cas
Alert#687
rho Cas
Alert#746
M52
Cassiopeia
Alert#742
V850 Cas
Alert#687
V Cas
Alert#687

# Future

- One major hardware vendor already building Alpaca into the device itself.
- At least one major planetarium program is working on Alpaca support
- I predict that ASCOM will be barely breathing in 5 years, replaced entirely by Alpaca

# Future

- Imagine, NO USB cables, only Power Over Ethernet
- Gigabit speeds
- No cable length restrictions like USB3
- Completely Operating System independent. Mix and match any way you like.
- Remote operation very easy to implement.

# Questions

?