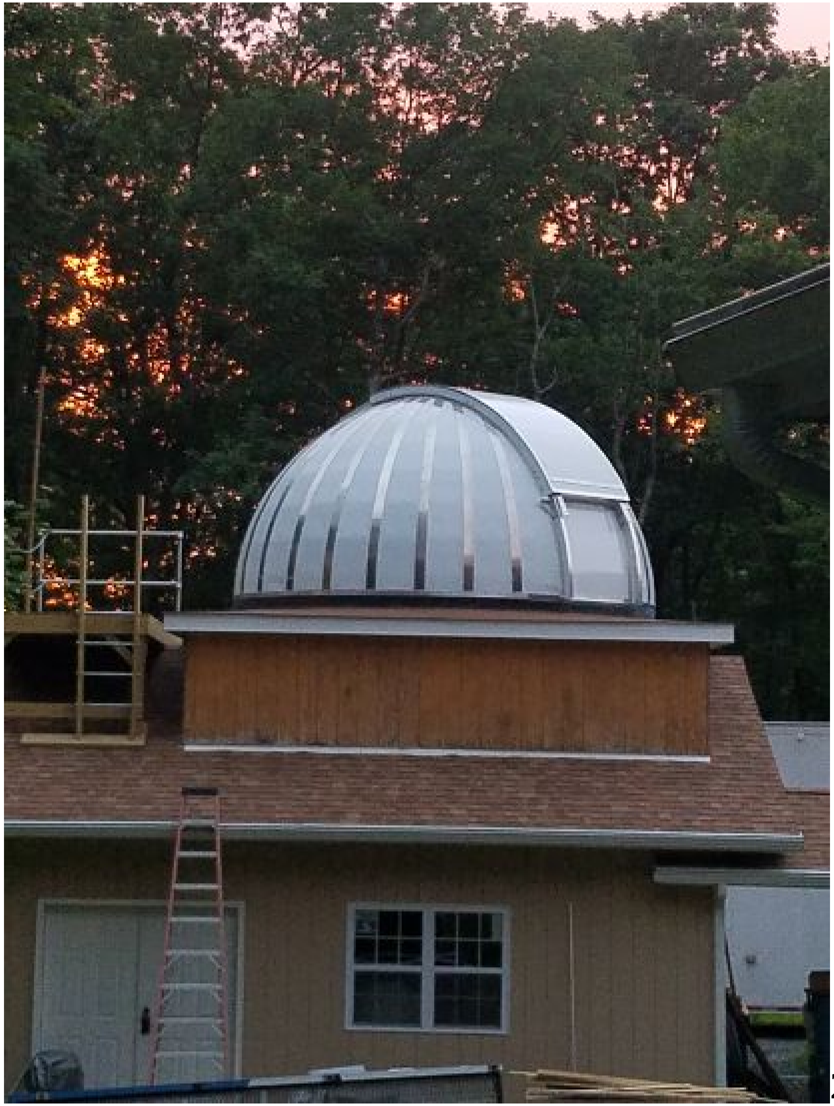
Polar Alignment using Plate Solving

Novel way of doing Polar Alignment

Mark Sproul
Springfield Telescope Makers
Oct 2021

My Observatory

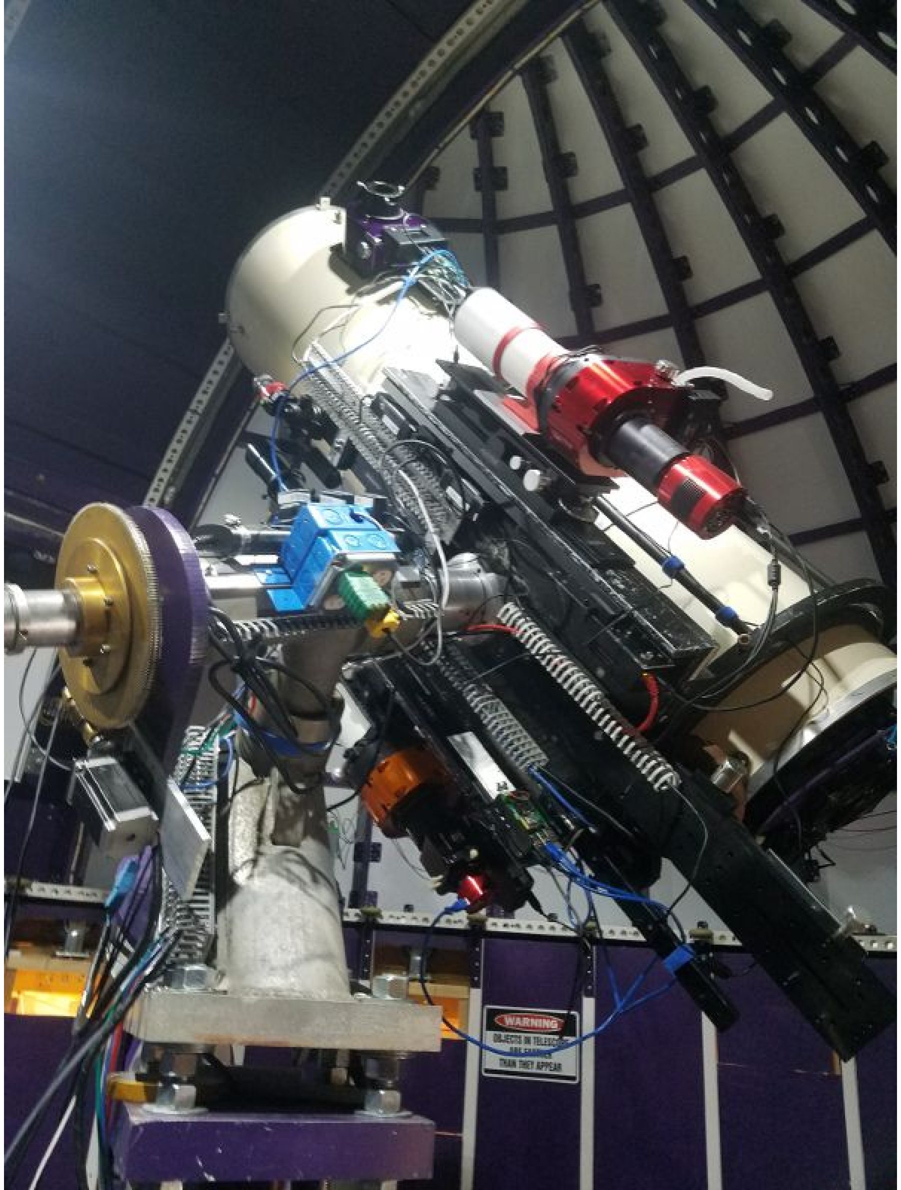
- 15 foot diameter home built dome
- Pike County Pennsylvania

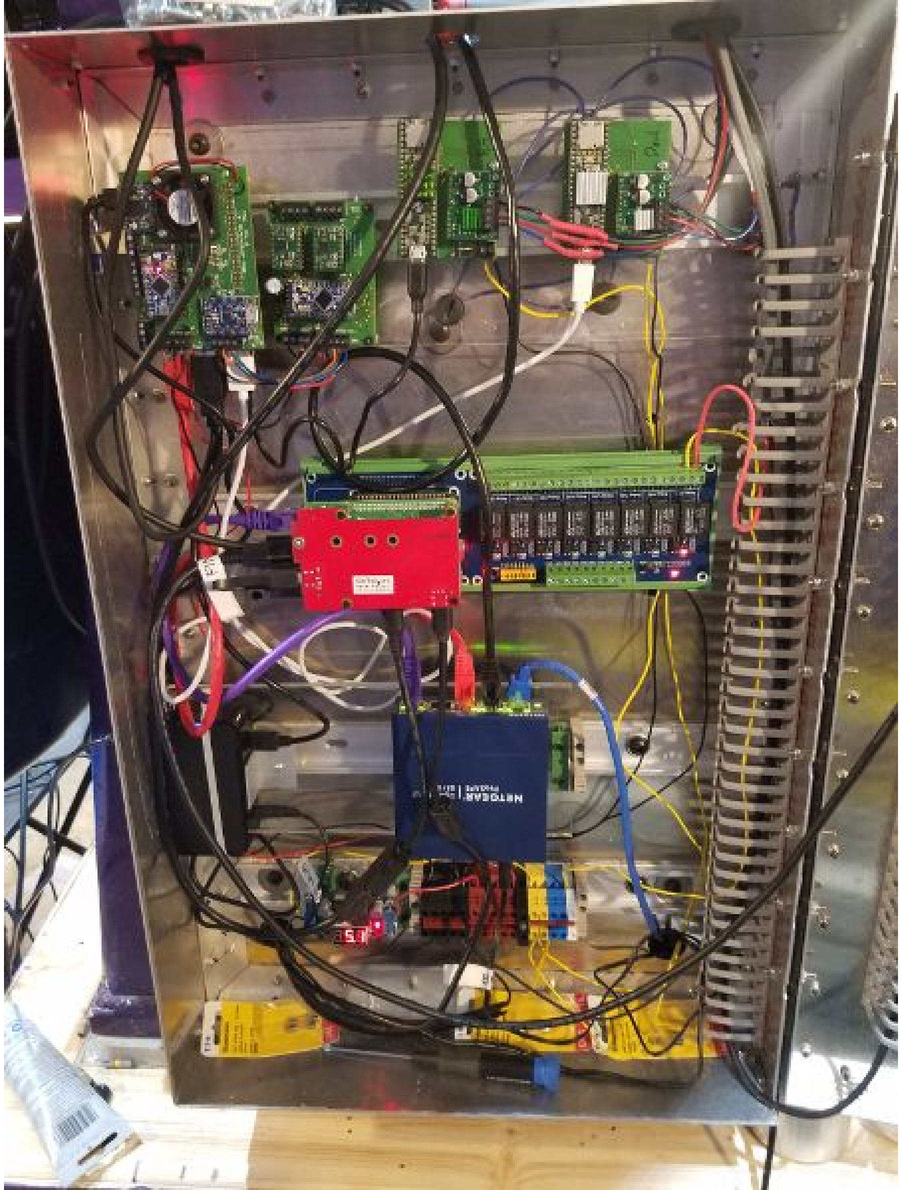


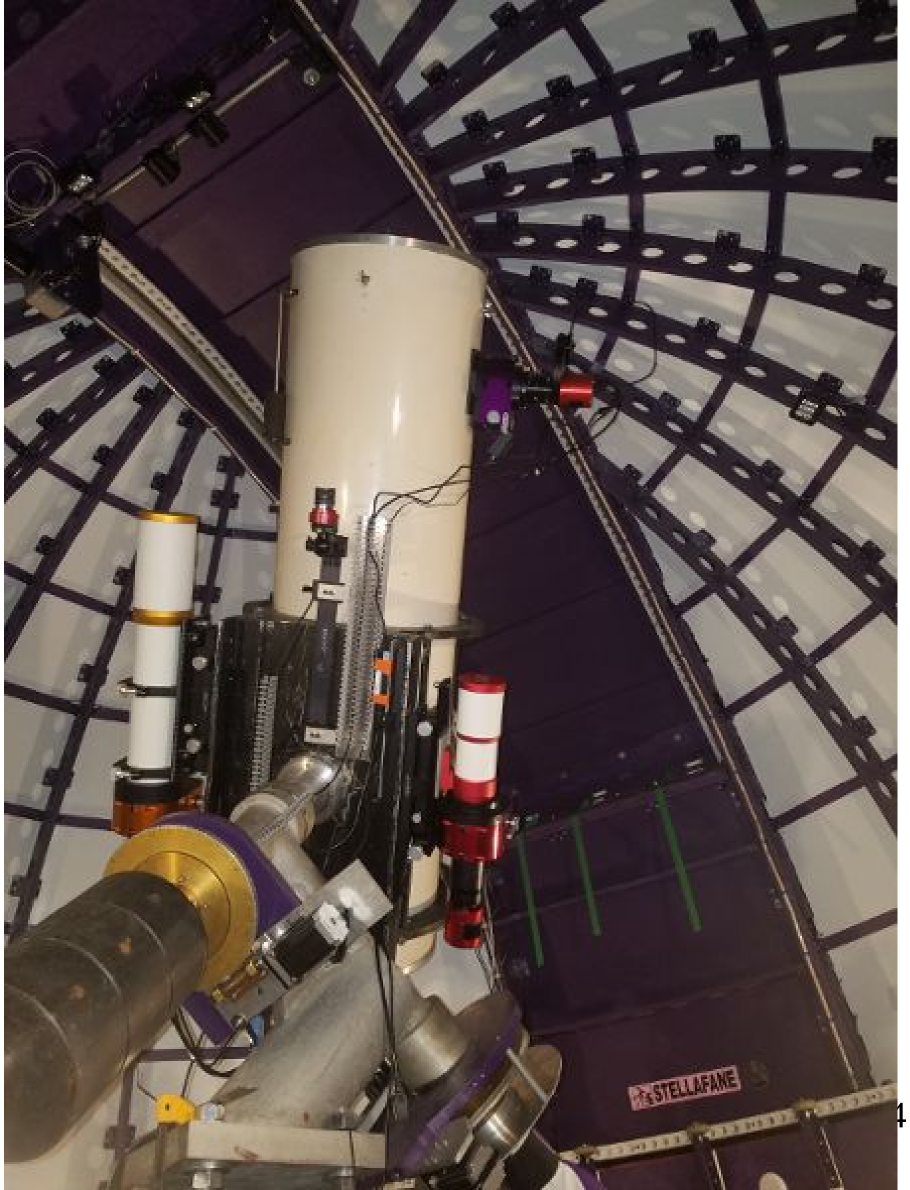
My Scope

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




NETGEAR


STELLAFANE

<----

Adjustment Nuts on 1 inch diameter rods

---->

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

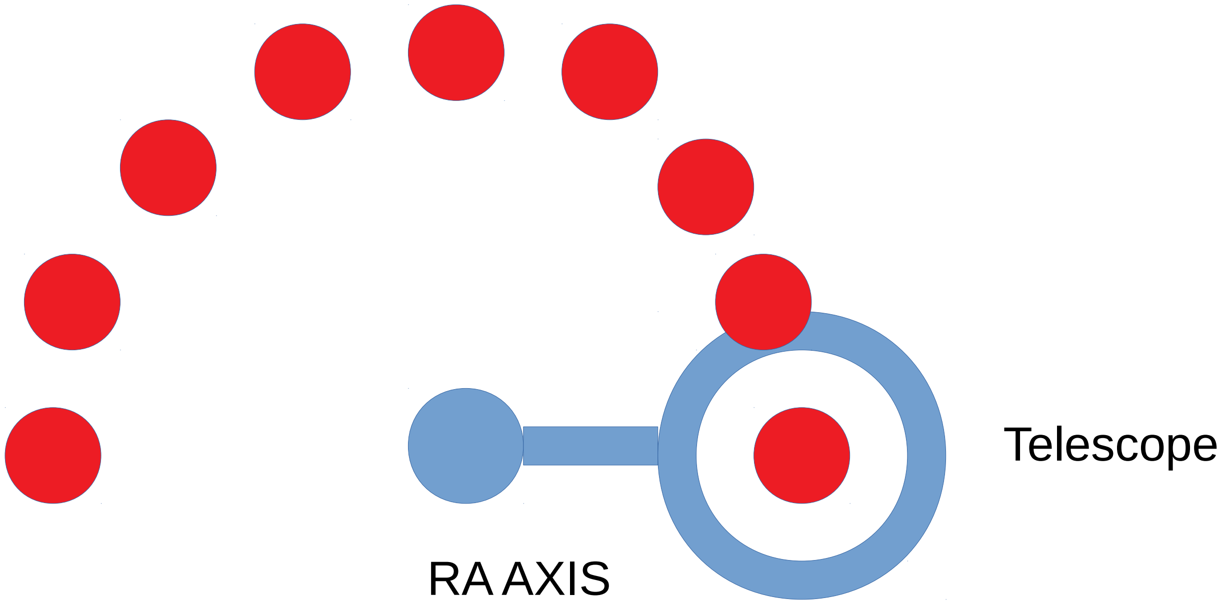
What to do NEXT???

- Figure out WHERE I am pointing????

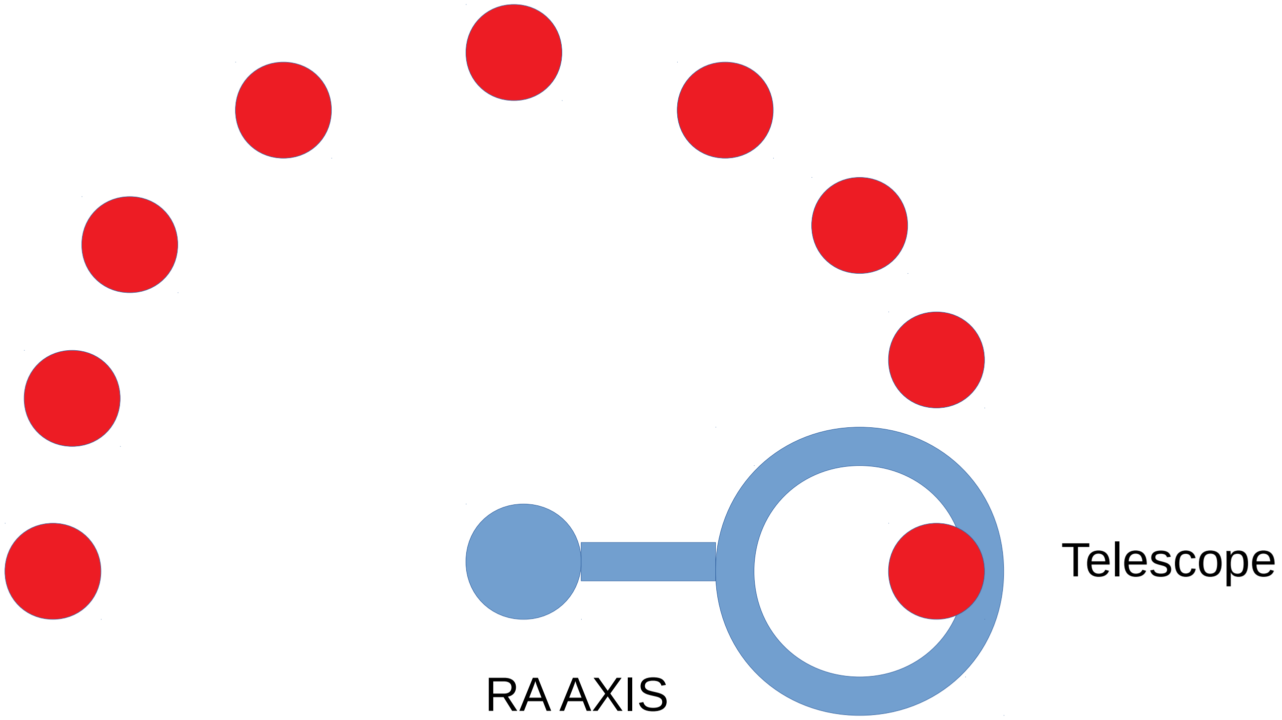
Theory

- Take a series of pictures while rotating around the RA axis WITHOUT tracking turned on and WITHOUT changing DEC.
- Plot the center points of each picture, this should generate an arc
- The center of the arc is where RA is pointed

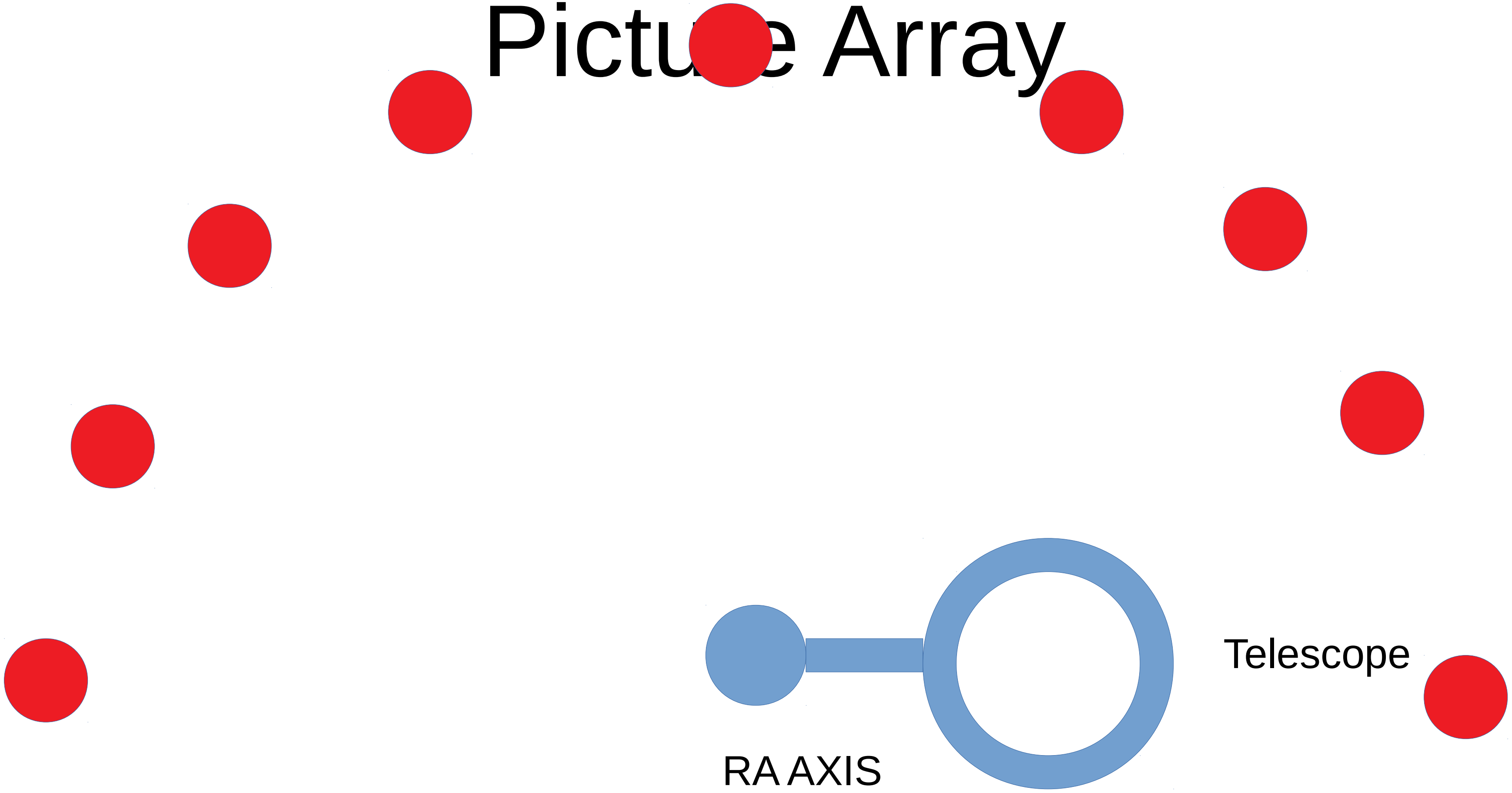
Picture Array



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	

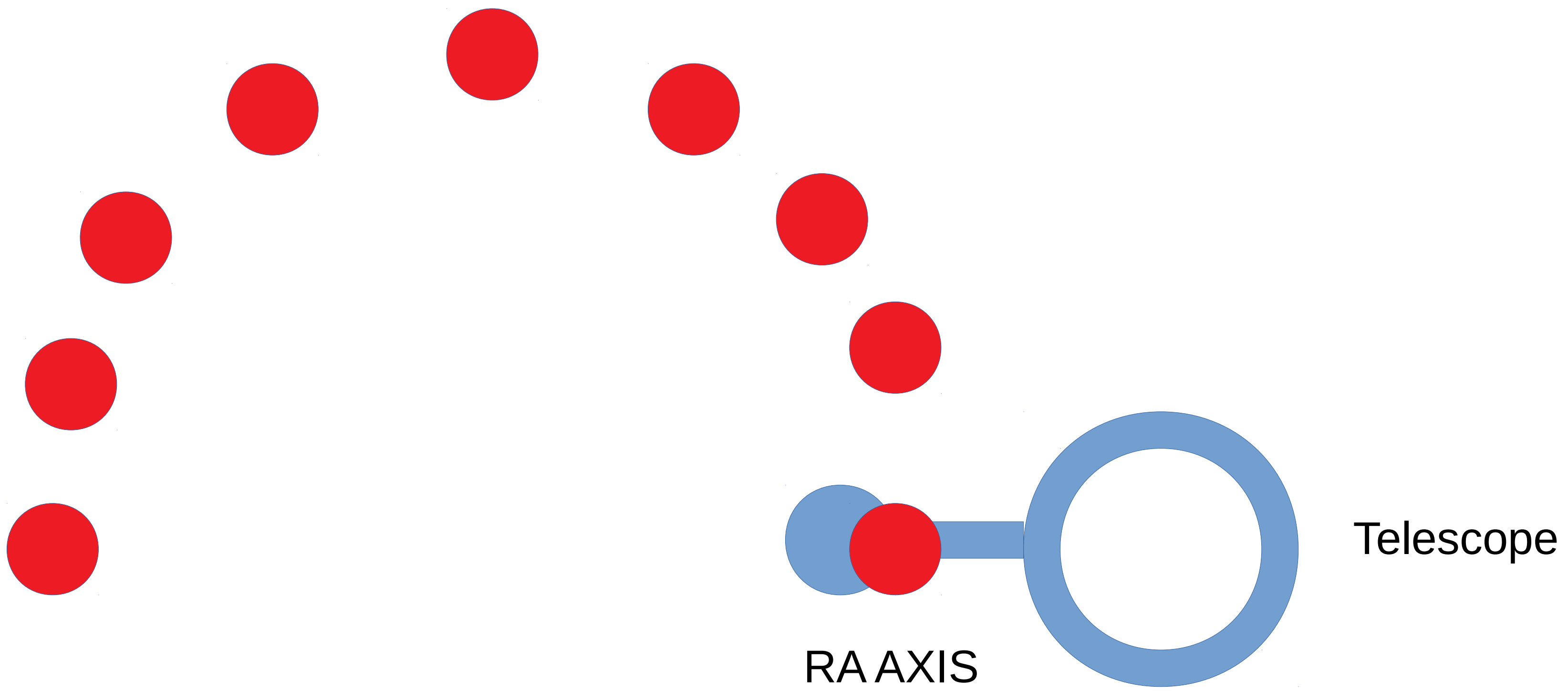
Special Objects

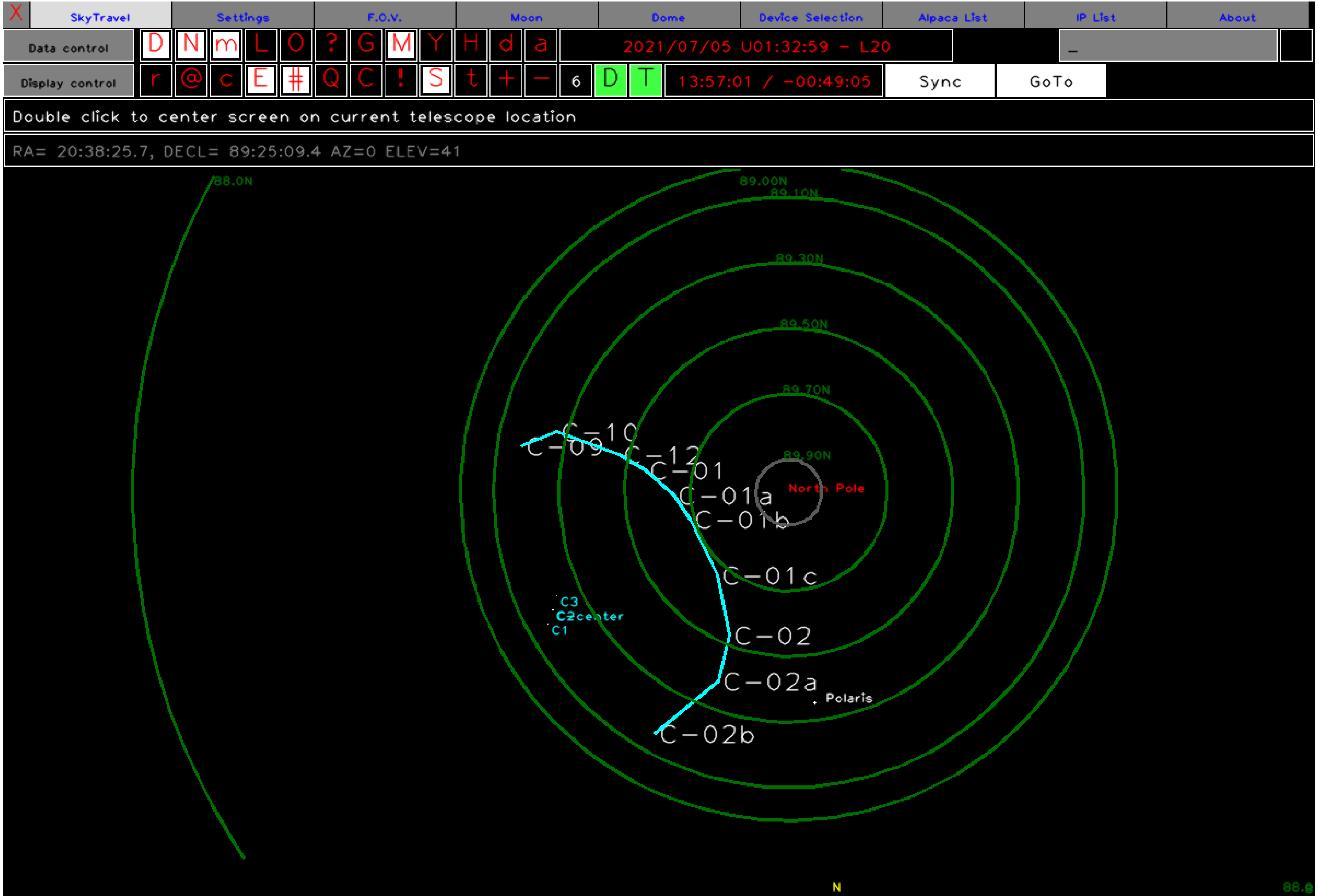
- # July 4th, 2021
- C-09 10 7 13.666 89 10 20.873
- C-10 10 26 7.848 89 16 08.653
- C-11 10 3 0.336 89 20 06.477
- C-12 10 17 34.816 89 28 16.307
- C-01 10 3 42.384 89 33 24.364
- C-01a 9 22 32.986 89 38 53.870
- C-01b 8 26 3.155 89 41 17.671
- C-01c 6 11 38.237 89 40 05.569
- C-02 4 58 16.122 89 31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

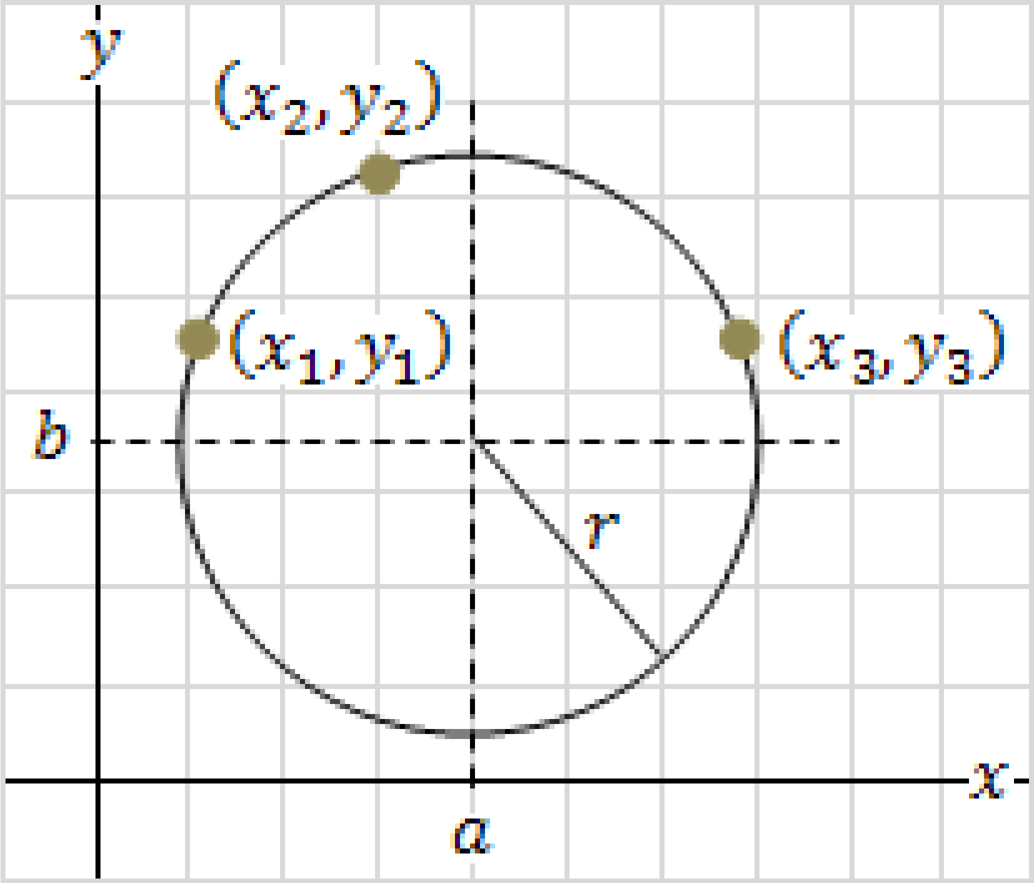
- #Aug 24, 2021
- E-01 4 44 59.254 87 07 3.997
- E-02 4 17 26.036 87 07 48.038
- E-03 3 50 22.011 87 08 39.364
- E-04 3 26 55.760 87 11 49.242
- E-05 2 59 29.684 87 13 19.530
- E-06 2 27 23.428 87 14 7.700
- E-07 1 47 25.186 87 14 59.649
- E-08 1 0 19.140 87 16 9.261
- E-09 0 13 59.637 87 16 46.602
- 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

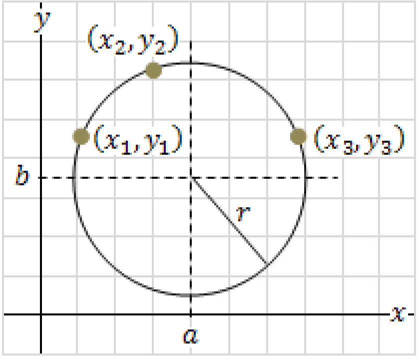



X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
2021/07/05 U01:32:59 - L20
Display control
r @ c E # Q C ! S t + - 6 D T
13:57:01 / -00:49:05
Sync
GoTo
Double click to center screen on current telescope location
RA= 20:38:25.7, DECL= 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
C3
C2center
C1
Polaris
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

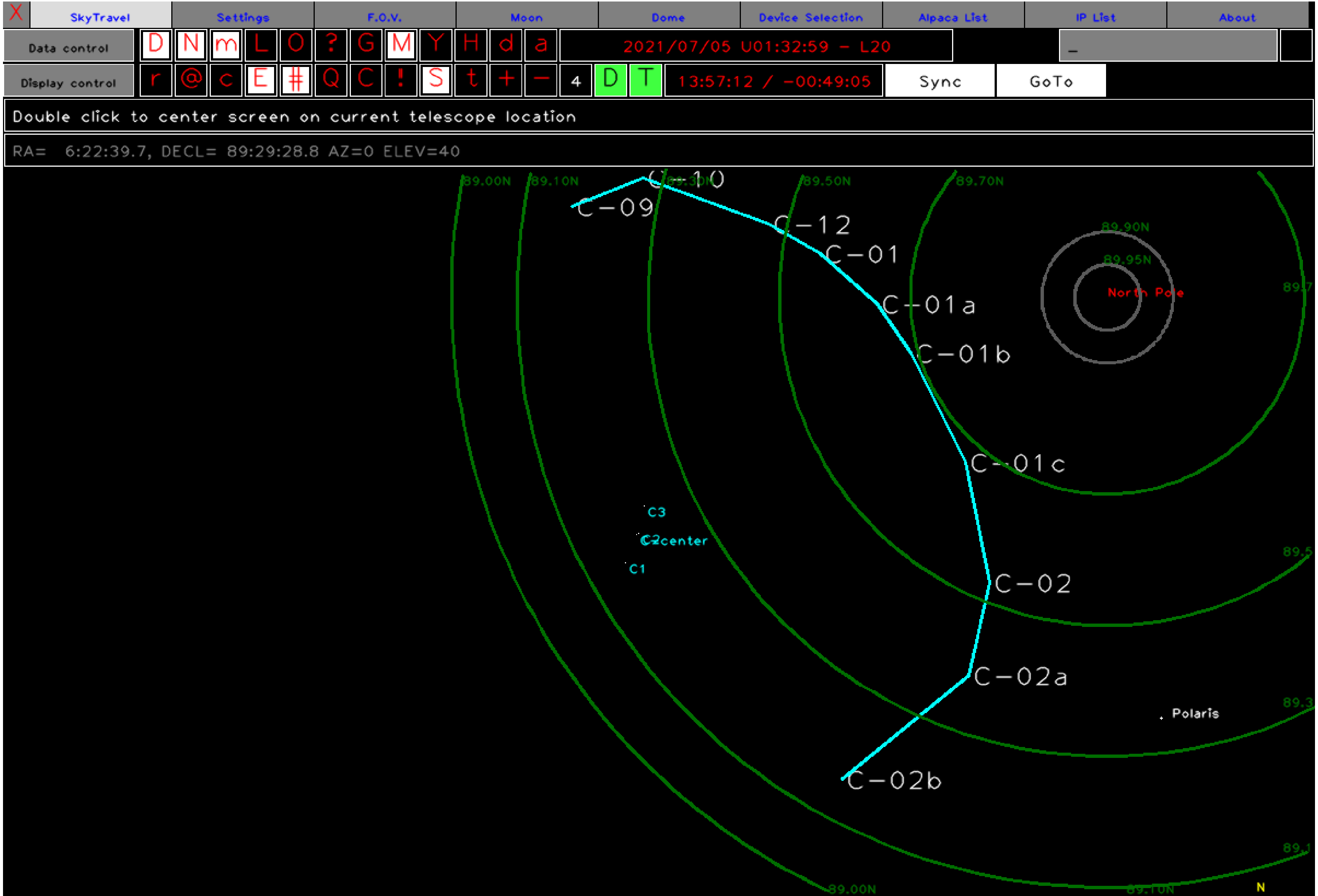
- BUT…….

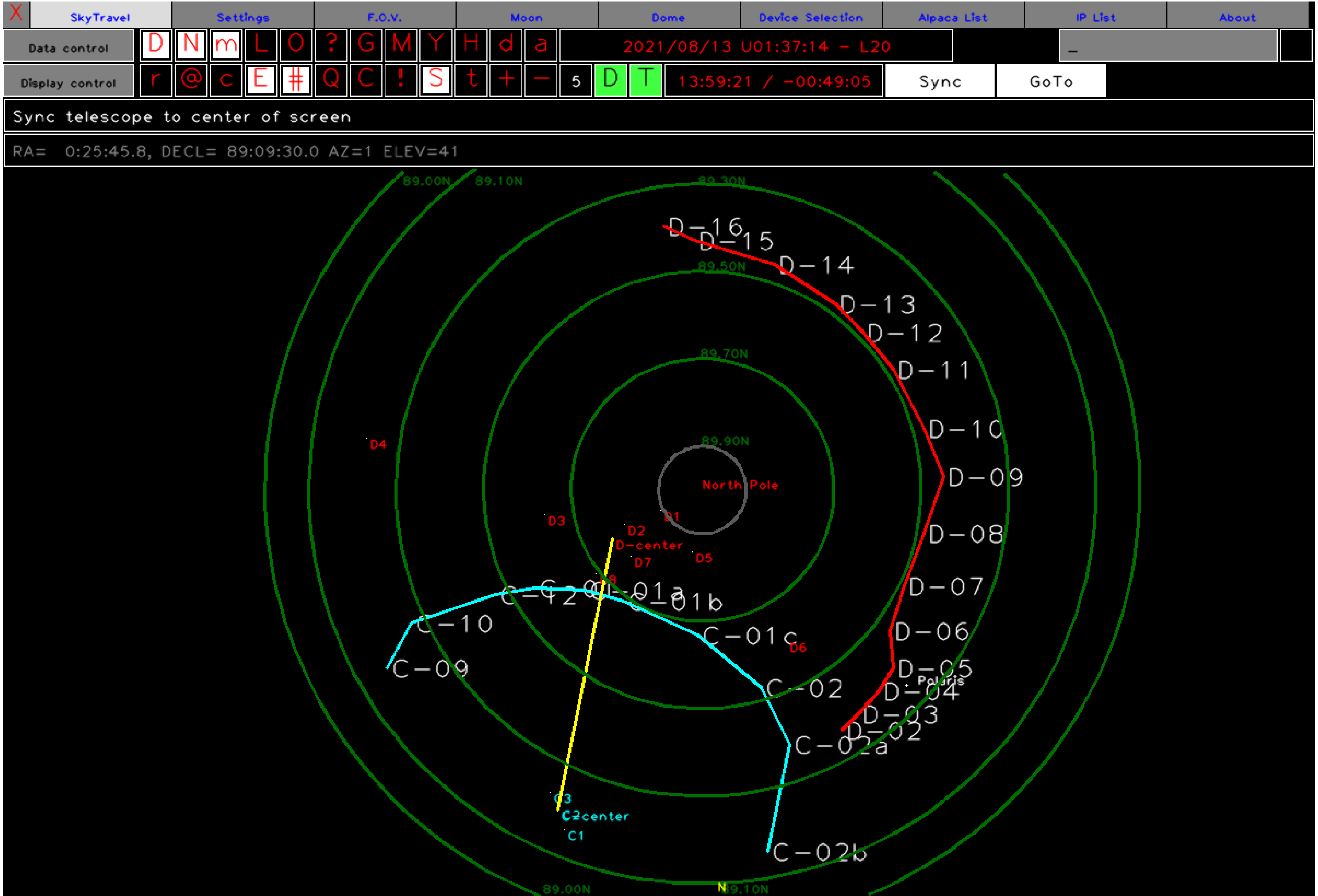
  All of this is in Cartesian coordinates.

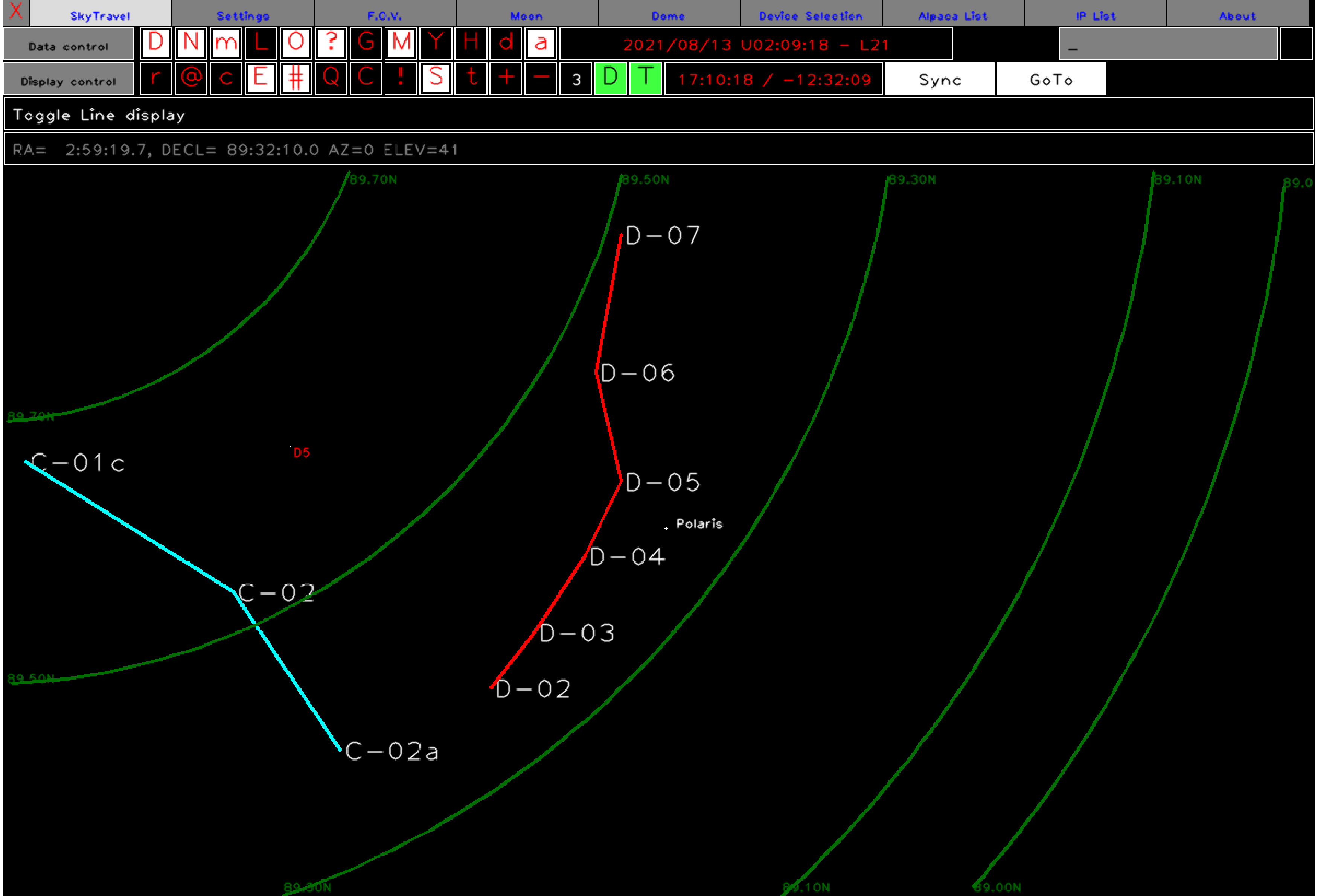
  And, we have polar coordinates with the “center” at the equator……..

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

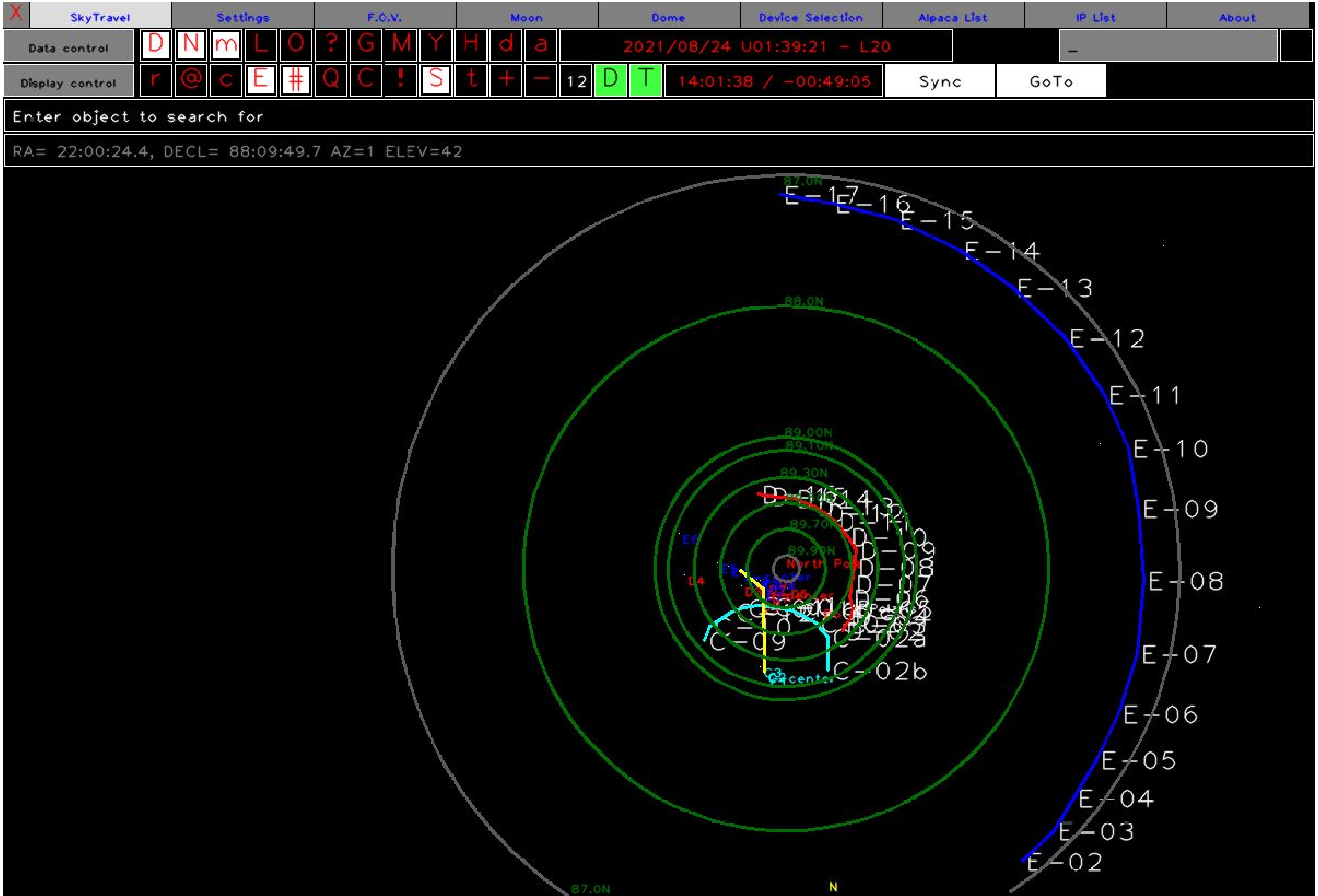

X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
2021/07/05 U01:32:59 - L20
Display control
r @ c E # Q C ! S t + - 4 D T
13:57:12 / -00:49:05
Sync
GoTo
Double click to center screen on current telescope location
RA= 6:22:39.7, DECL= 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-10
C-12
C-01
C-01a
C-01b
C-01c
C-02
C-02a
C-02b
C3
C2center
C1
Polaris
N

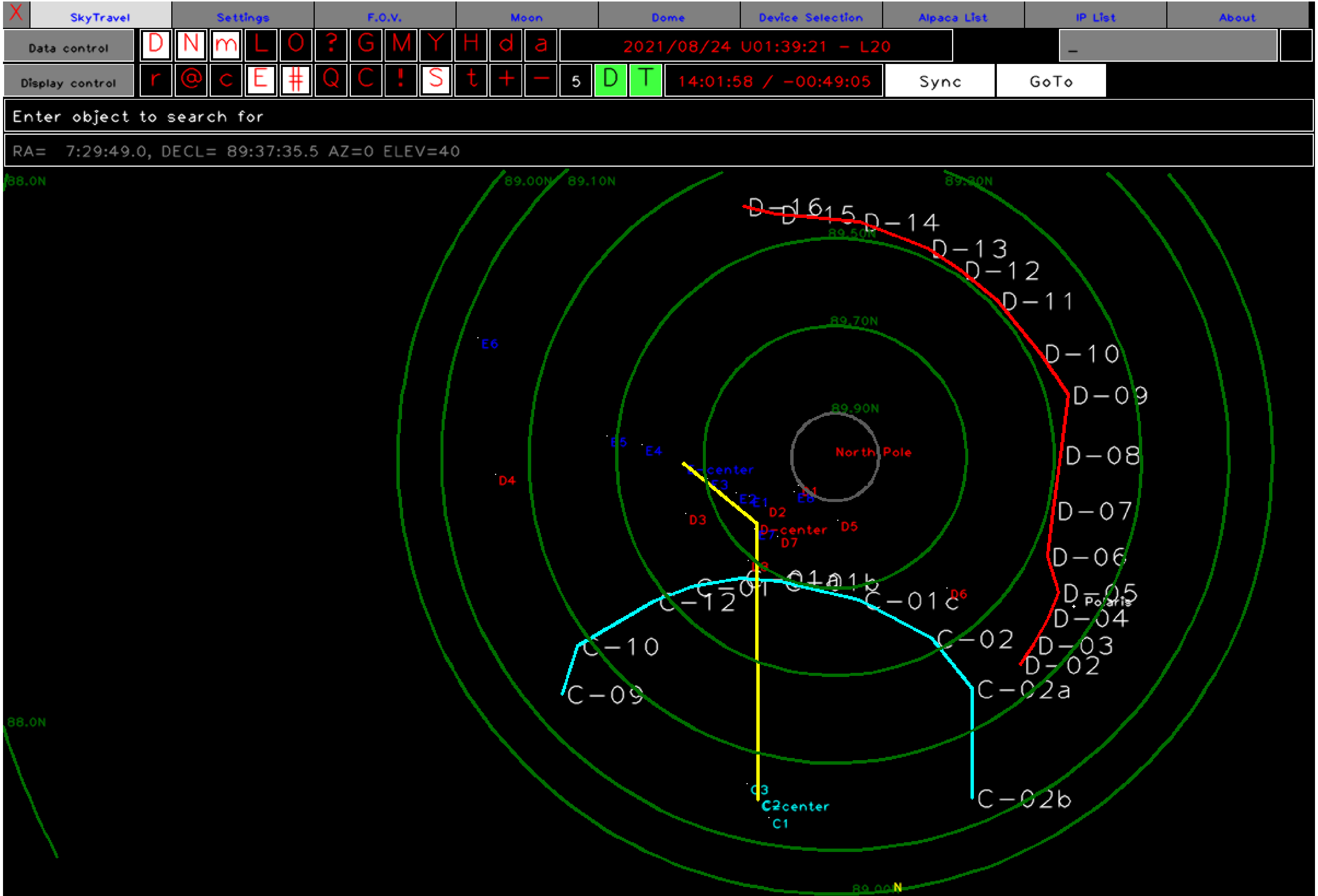

X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
2021/08/13 U01:37:14 - L20
Display control
r @ c E # Q C ! S t + - 5 D T
13:59:21 / -00:49:05
Sync
GoTo
Sync telescope to center of screen
RA= 0:25:45.8, DECL= 89:09:30.0 AZ=1 ELEV=41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

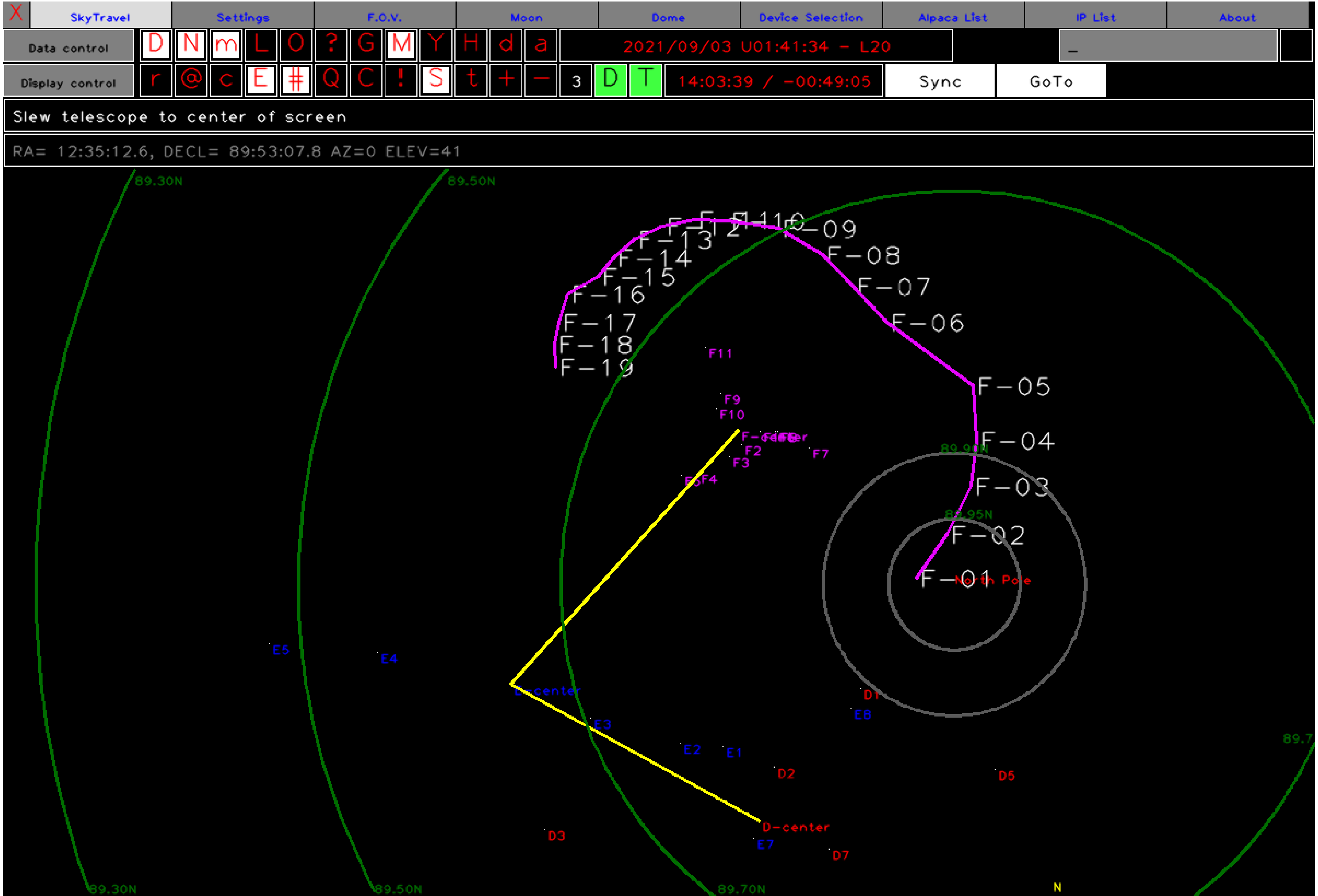


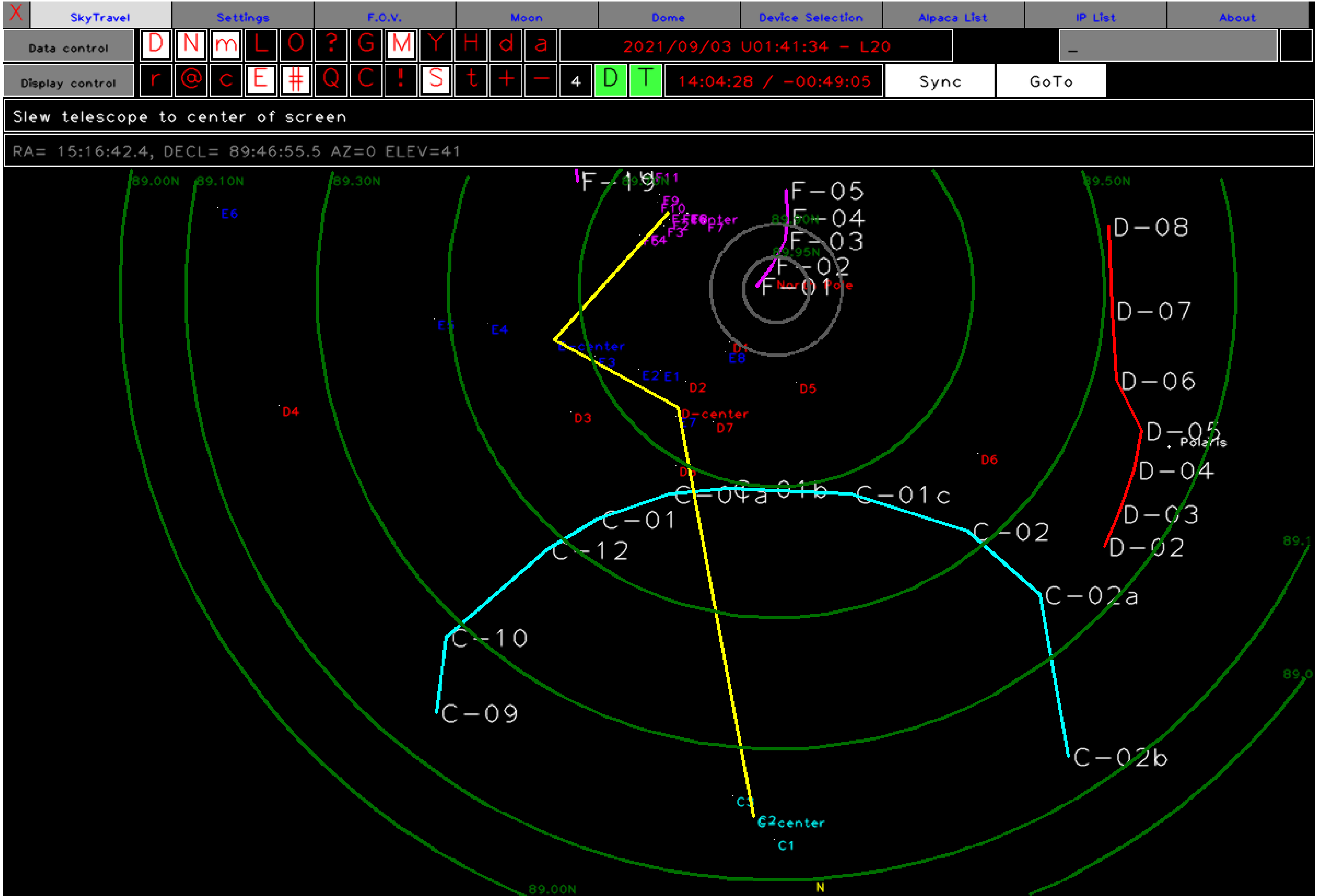
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
Display control
2021/08/13 U02:09:18 - L21
17:10:18 / -12:32:09
Sync
GoTo
Toggle Line display
RA= 2:59:19.7, DECL= 89:32:10.0 AZ=0 ELEV=41
D-07
D-06
D-05
D-04
D-03
D-02
Polaris
C-01c
C-02
C-02a
D5
89.70N
89.50N
89.30N
89.10N
89.00N

D05 plate solved w/ Polaris visible

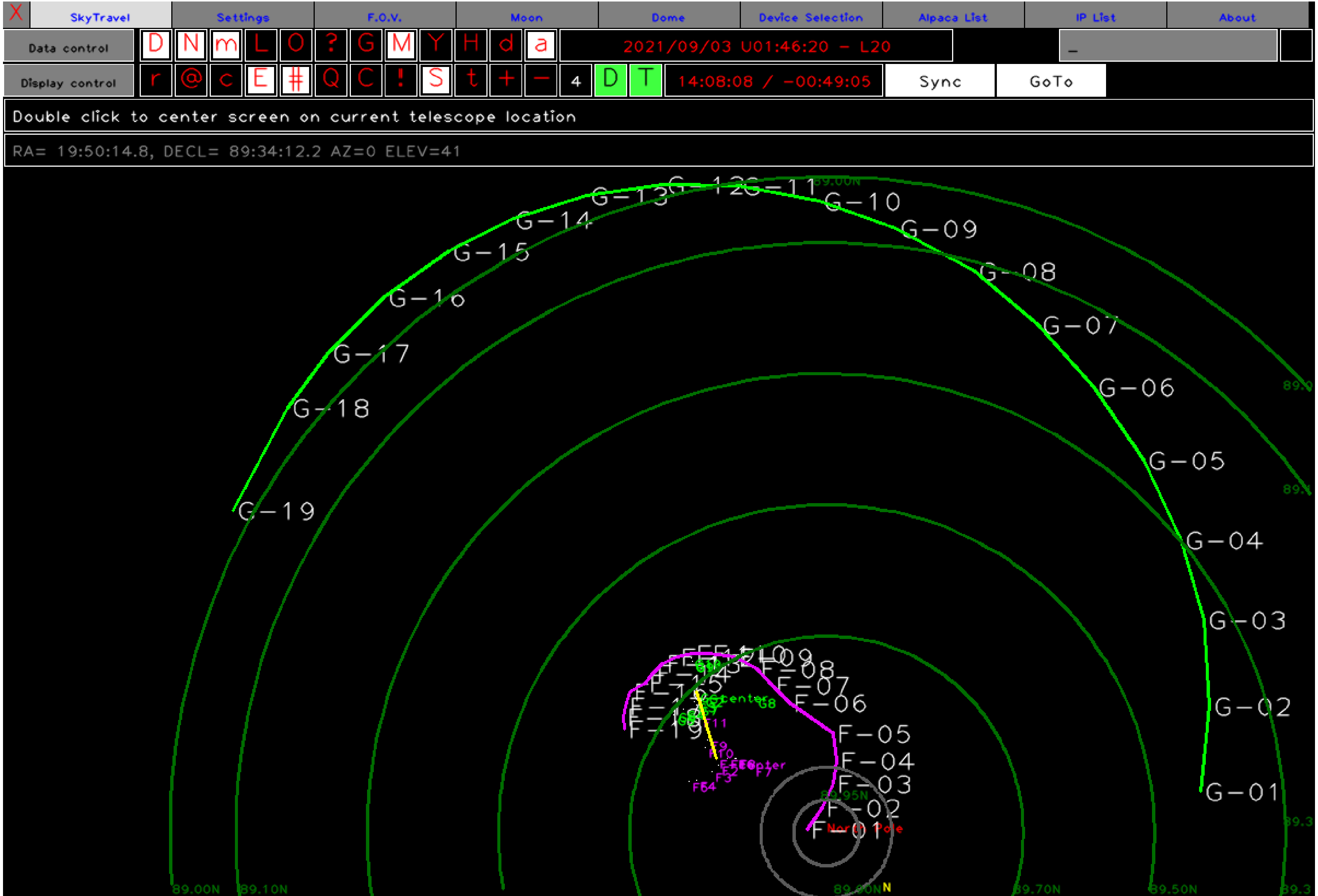

X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
2021/08/24 U01:39:21 - L20
Display control
r @ c E # Q C ! S t + - 12 D T
14:01:38 / -00:49:05
Sync
GoTo
Enter object to search for
RA= 22:00:24.4, DECL= 88:09:49.7 AZ=1 ELEV=42
87.0N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

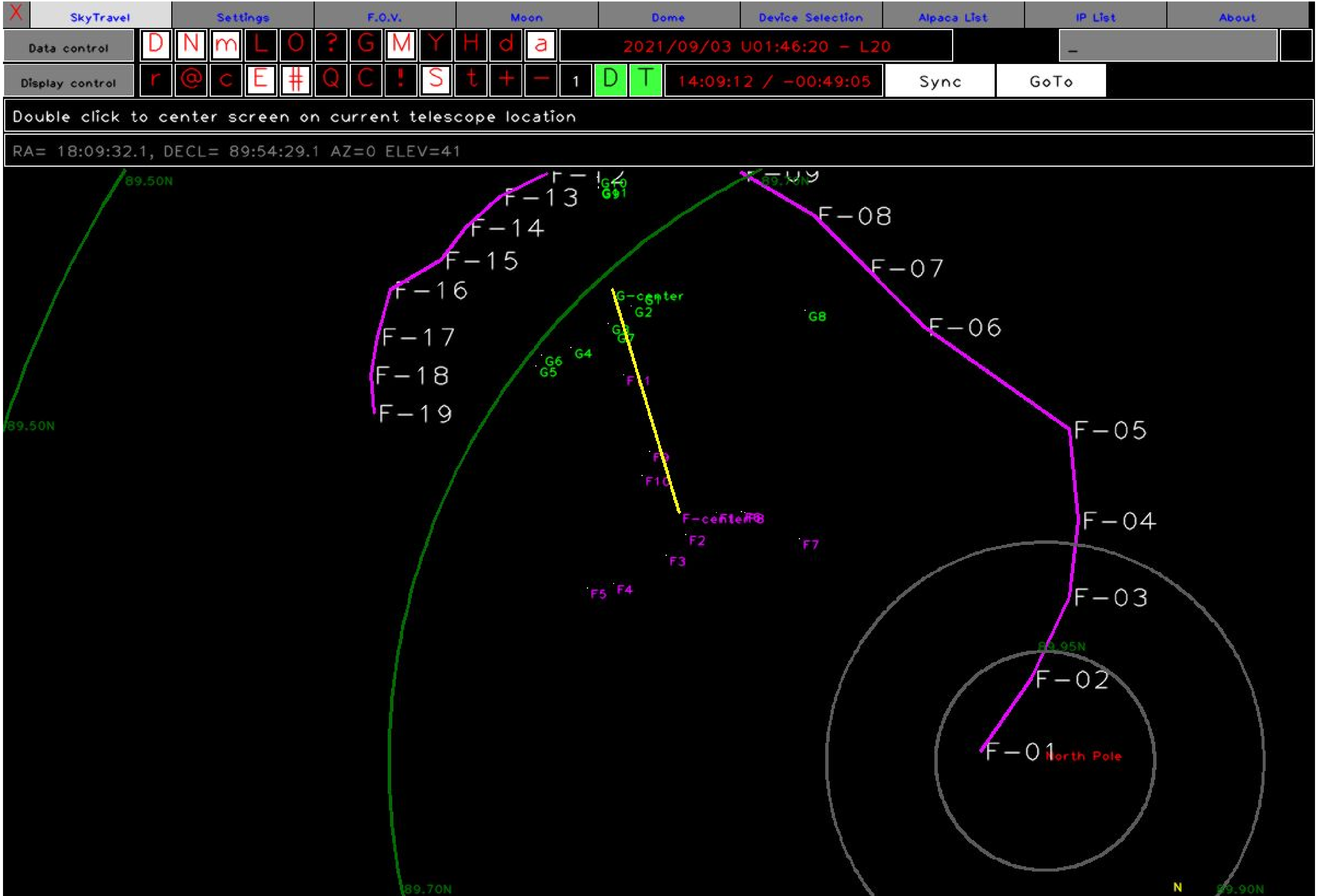

X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
2021/08/24 U01:39:21 - L20
Display control
r @ c E # Q C ! S t + - 5 D T
14:01:58 / -00:49:05
Sync
GoTo
Enter object to search for
RA= 7:29:49.0, DECL= 89:37:35.5 AZ=0 ELEV=40
88.0N
89.00N
89.10N
89.30N
89.50N
89.70N
89.90N
North Pole
Polaris
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
C-01
C-01a
C-01b
C-01c
C-12
C-10
C-09
C-02
C-02a
C-02b
D-center
D1
D2
D3
D4
D5
D6
D7
E-center
E1
E2
E3
E4
E5
E6
E7
C-center
C1
C2
C3
N

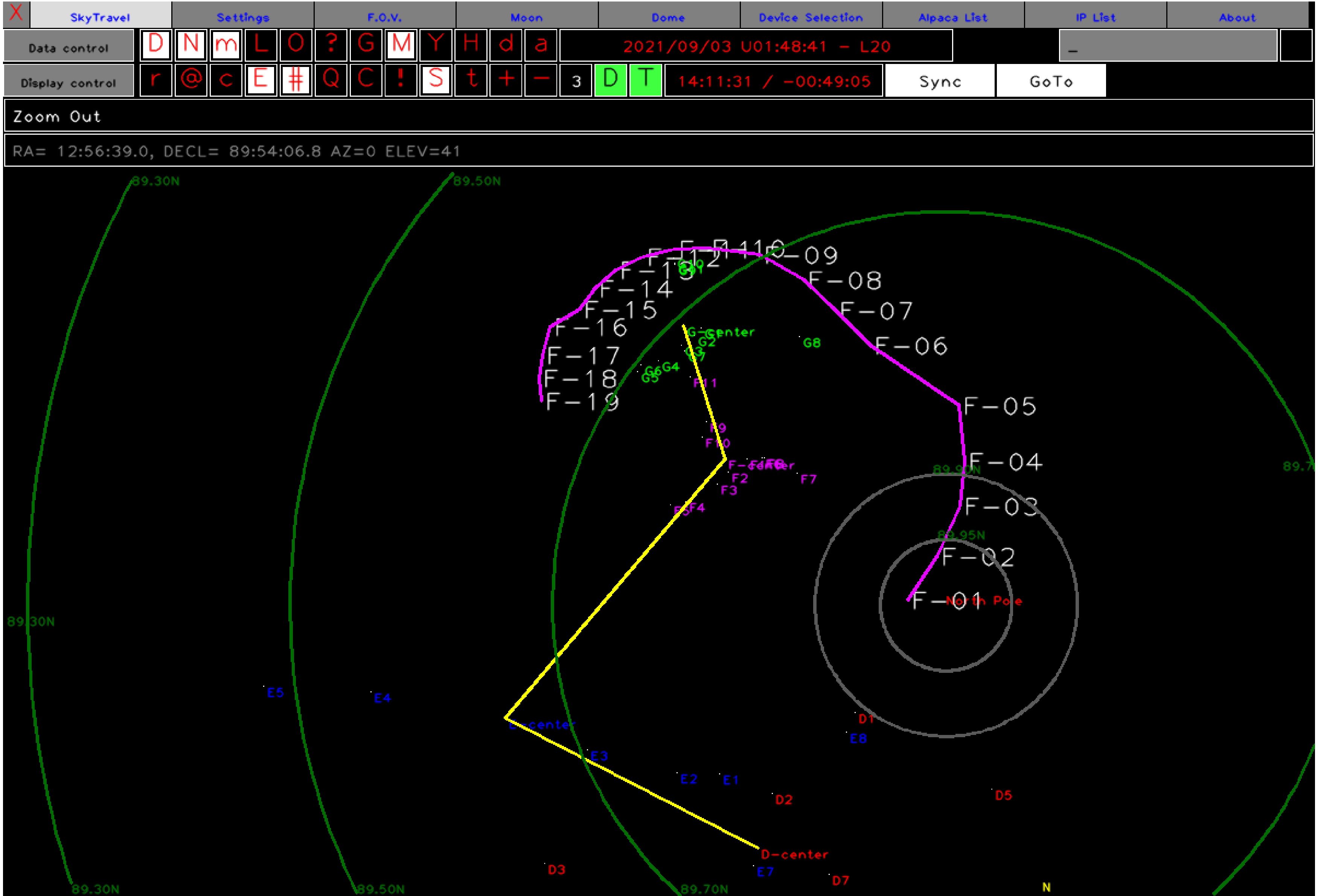

X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
2021/09/03 U01:41:34 - L20
Display control
r @ c E # Q C ! S t + - 3 D T
14:03:39 / -00:49:05
Sync
GoTo
Slew telescope to center of screen
RA= 12:35:12.6, DECL= 89:53:07.8 AZ=0 ELEV=41
89.30N
89.50N
89.70N
F-01
F-02
F-03
F-04
F-05
F-06
F-07
F-08
F-09
F-13
F-14
F-15
F-16
F-17
F-18
F-19
F11
F9
F10
F2
F3
F7
North Pole
E5
E4
E3
E2
E1
E8
E7
D1
D2
D3
D5
D7
D-center
N



SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
Display control
2021/09/03 U01:41:34 - L20
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
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
C-01a
C-01b
C-01c
C-01
C-02
C-12
C-02a
C-10
C-09
C-02b
D-center
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 U01:46:20 - 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
89.70N
89.50N


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
G4
G6
G5
G8
F2
F3
F4
F5
F7
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
G-center
G8
G4
F11
F9
F10
F2
F3
F7
F4
North Pole
D1
E8
E5
E4
E3
E2
E1
D2
D5
D-center
D3
E7
D7
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 fully network based allowing for 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


```
{
	"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.

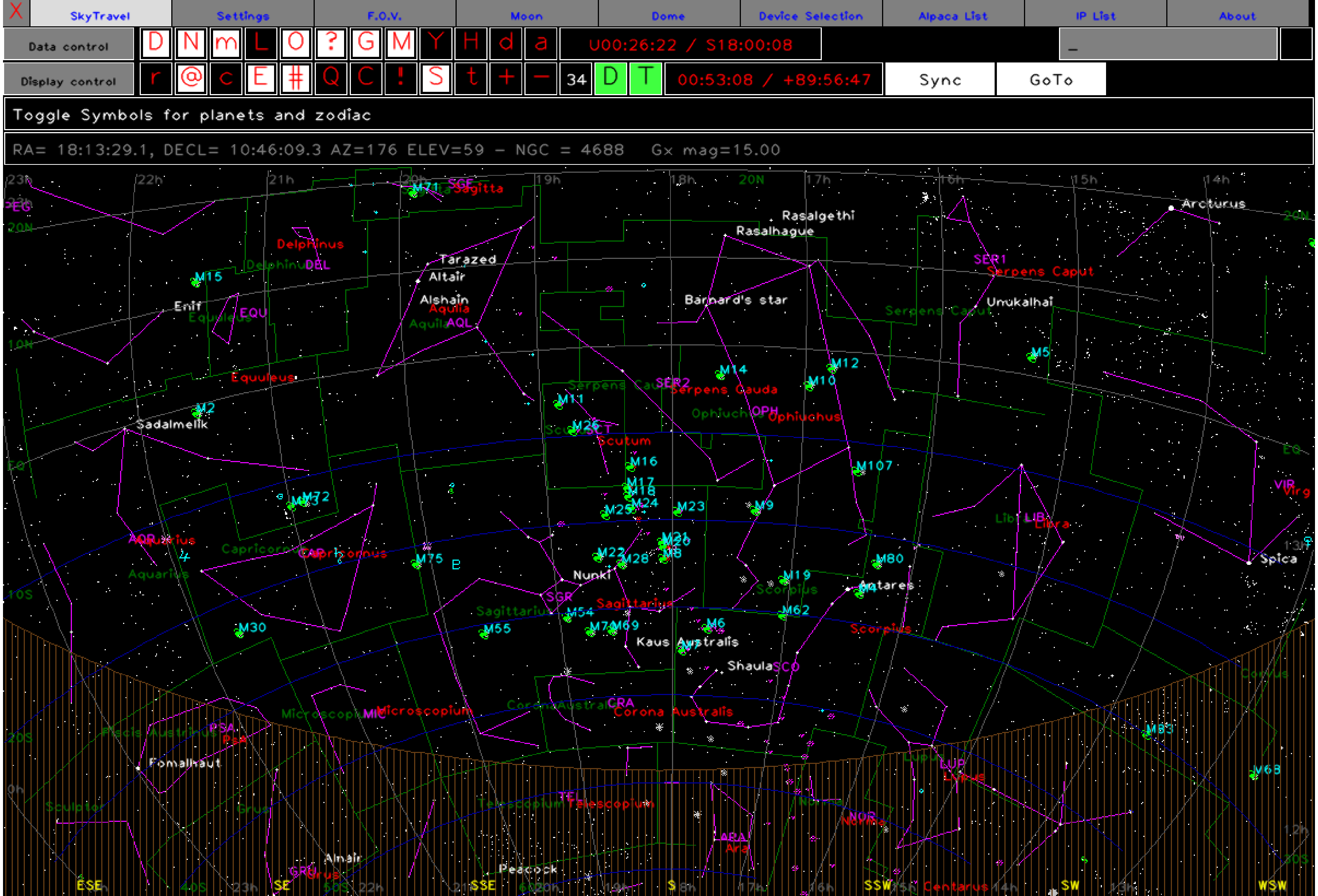
```
curl -X PUT "http://192.168.1.22:6800/api/v1/dome/0/closeshutter"
```

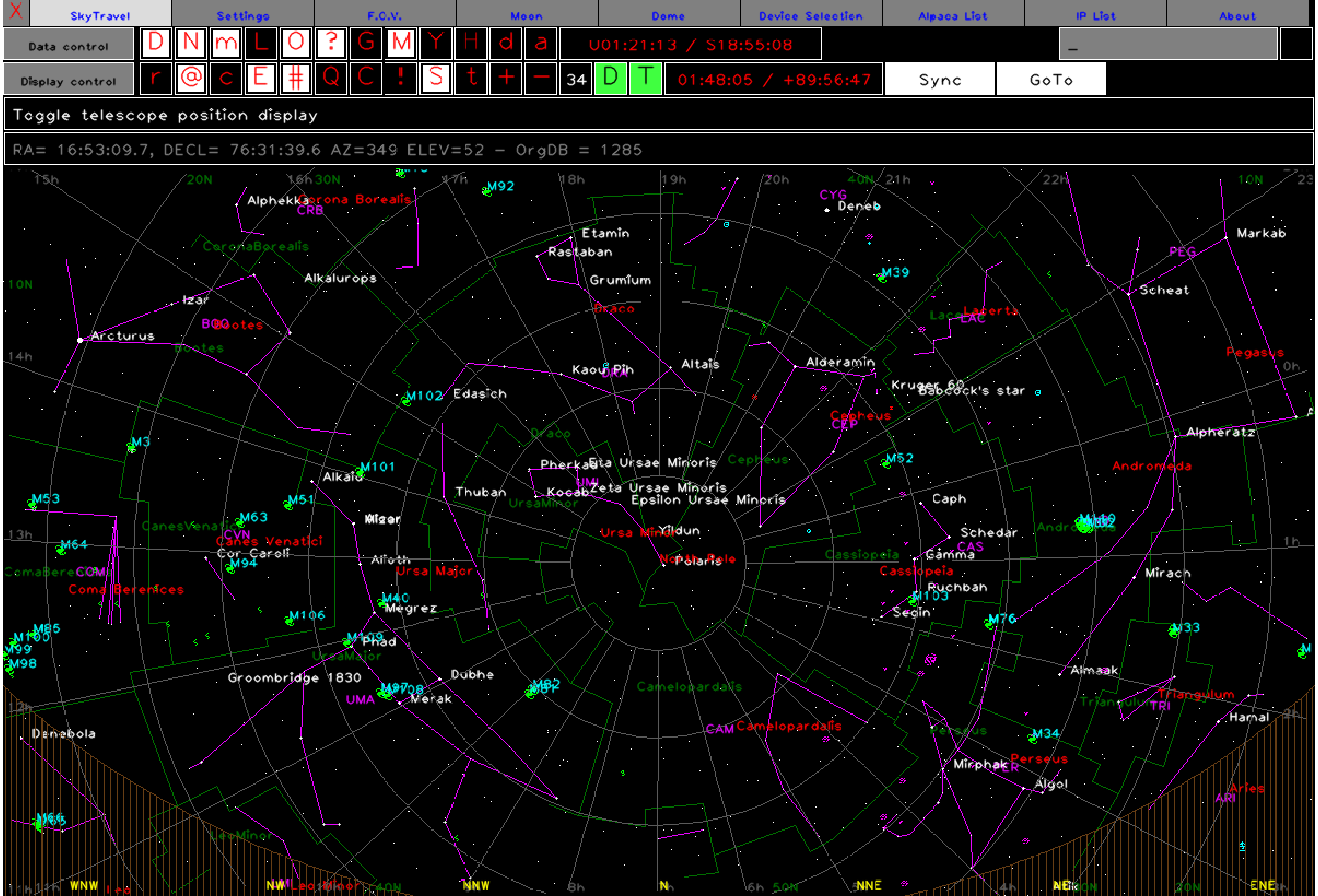
Back to AlpacaPi

- 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.

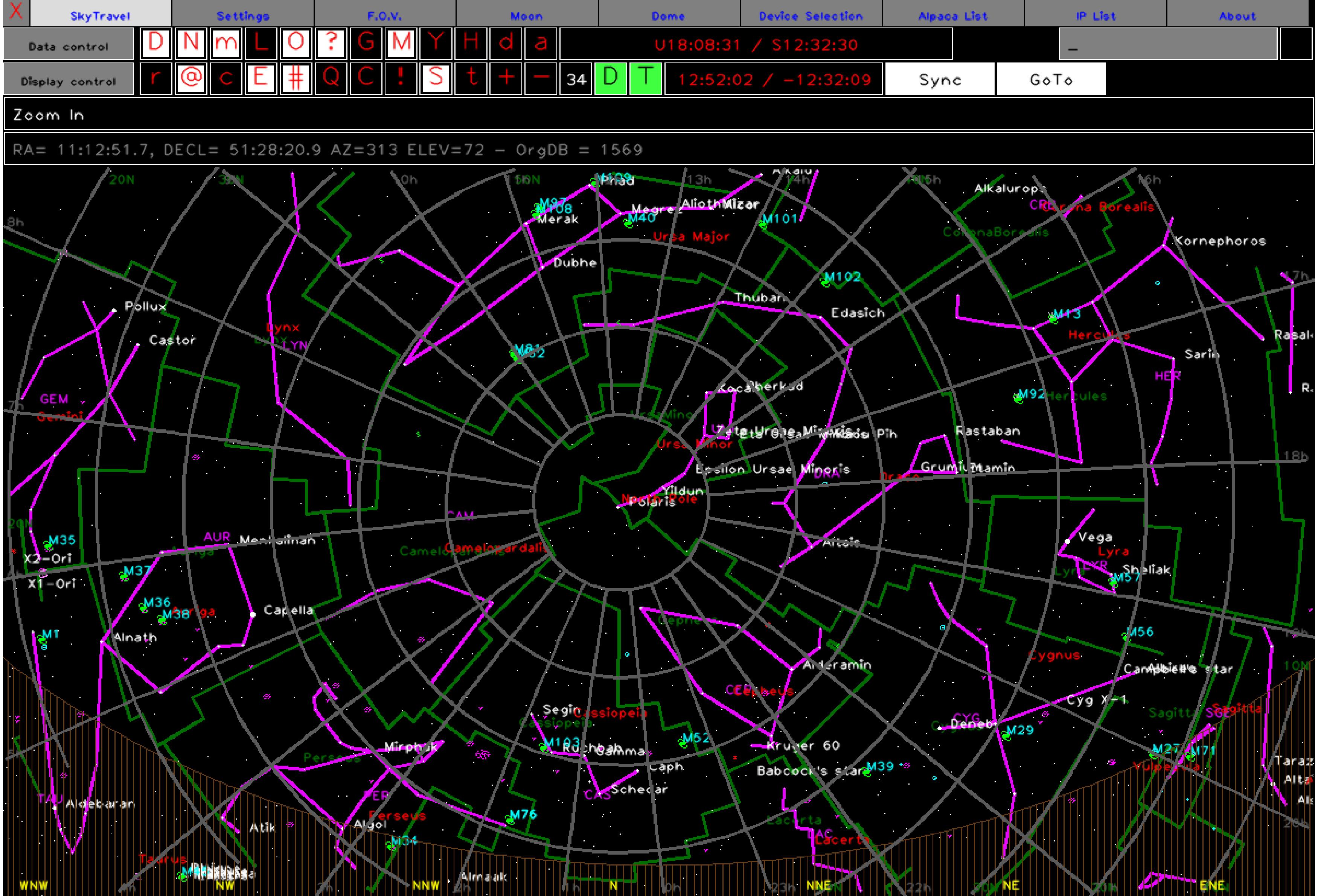
AlpacaPi software suite

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

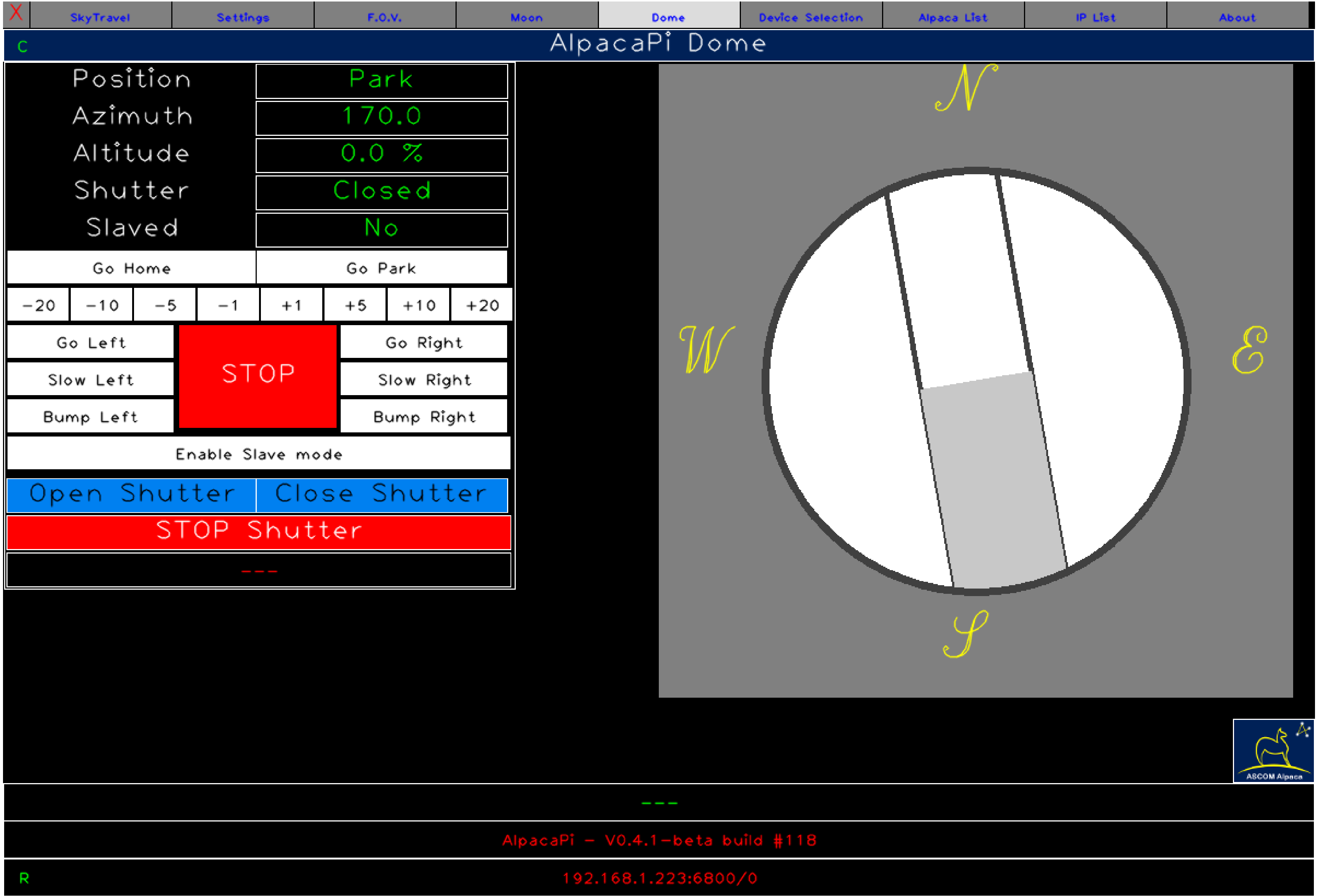

X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
D N m L O ? G M Y H d a
U00:26:22 / S18:00:08
Display control
r @ c E # Q C ! S t + −
34
D T
00:53:08 / +89:56:47
Sync
GoTo
Toggle Symbols for planets and zodiac
RA= 18:13:29.1, DECL= 10:46:09.3 AZ=176 ELEV=59 − NGC = 4688 Gx mag=15.00
Arcturus
Rasalgethi
Rasalhague
Tarazed
Altair
Alshain
Enif
Barnard's star
Unukalhai
Sadalmelik
Nunki
Antares
Spica
Kaus Australis
Shaula
Fomalhaut
Peacock
Delphinus
Aquila
Equuleus
Serpens Caput
Serpens Cauda
Ophiuchus
Scutum
Aquarius
Capricornus
Sagittarius
Libra
Scorpius
Microscopium
Corona Australis
Telescopium
Lupus
Centaurus
ESE
SE
SSE
S
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
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
Etamin
Rastaban
Grumium
Deneb
CYG
M92
M39
Markab
PEG
Scheat
Alkalurops
Izar
Arcturus
Bootes
Draco
Kaou Pih
Altais
Alderamin
Kruger 60
Babcock's star
Lacerta
LAC
Pegasus
M102
Edasich
Cepheus
CEP
M3
M101
Alkaid
Pherkad
Eta Ursae Minoris
Zeta Ursae Minoris
Epsilon Ursae Minoris
Kocab
Thuban
M52
Caph
Alpheratz
Andromeda
M53
M51
M63
Mizar
Ursa Minor
Yildun
Schedar
CAS
Gamma
CVN
Canes Venatici
Cor Caroli
M94
M64
Alioth
Ursa Major
North Pole
Polaris
Cassiopeia
Mirach
COM
Coma Berenices
Ruchbah
M103
Segin
M40
Megrez
M106
M76
M33
M85
M100
M99
M98
M109
Phad
Almaak
Groombridge 1830
Dubhe
M82
M81
M97
M108
UMA
Merak
Camelopardalis
CAM
Triangulum
TRI
Hamal
Denebola
M34
Mirphak
Perseus
Algol
Aries
ARI
M66
M65
WNW
NW
NNW
N
NNE
NE
ENE


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
Merak
Dubhe
Ursa Major
M101
M102
Thuban
Edasich
Alkalurops
Corona Borealis
Kornephoros
M13
Hercules
Sarin
Pollux
Castor
Lynx
GEM
Gemini
M81
M82
Rastaban
Polaris
North Pole
Yildun
Vega
Lyra
Sheliak
M57
M35
X2-Ori
X1-Ori
M37
M36
M38
Capella
M1
Alnath
AUR
Camelopardalis
M56
Cygnus
Alderamin
Cyg X-1
Deneb
M29
Segin
Cassiopeia
M103
Schedar
Caph
M52
Kruger 60
Babcock's star
M39
Lacerta
Mirphak
Perseus
Algol
M34
Atik
Aldebaran
Taurus
M76
Almaak
WNW
NW
NNW
N
NNE
NE
ENE

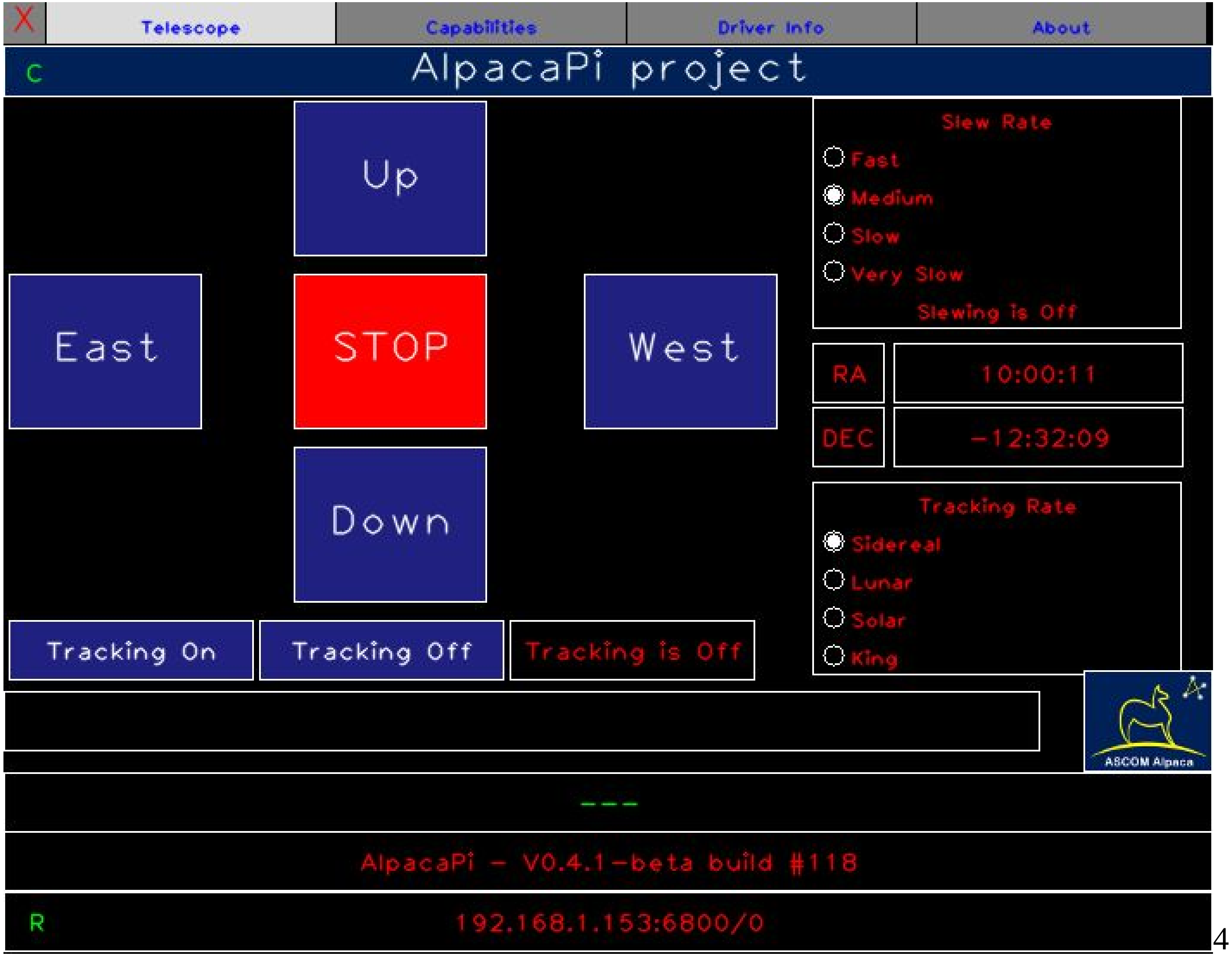
ip-address : port	/etc/hosts	type	name
192.168.1.177:6800	calib	Camera	calib-ZWO ASI034MC
192.168.1.146:6800	door	Camera	Door-ZWO ASI034MC
192.168.1.165:6800	finder	Camera	FINDER-ZWO ASI120MC
192.168.1.165:6800	finder	Camera	FINDER-ZWO ASI120MC-S
192.168.1.164:6800	newt16	Camera	NEWT16-ZWO ASI1600MC 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

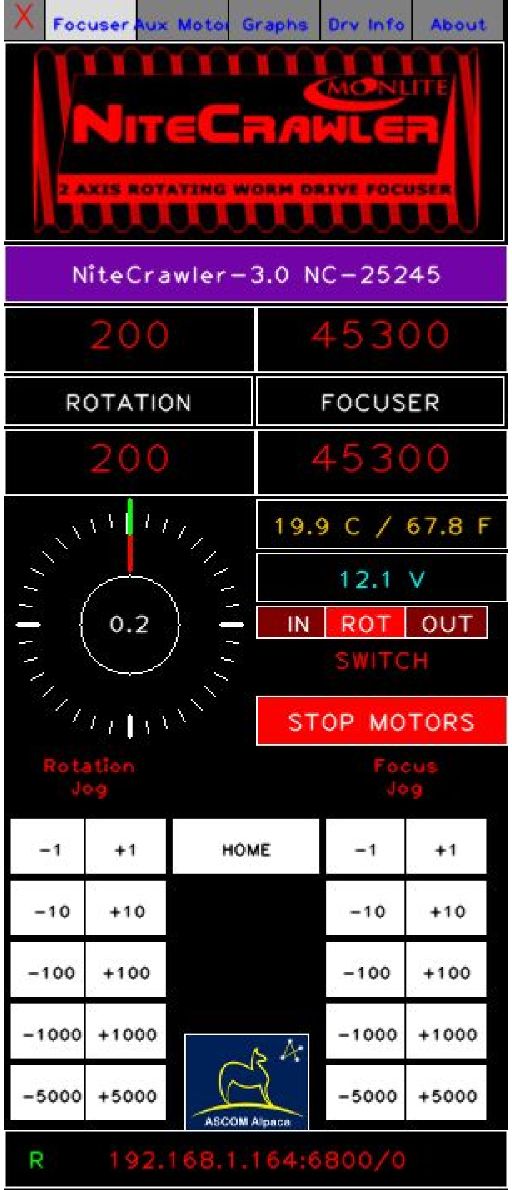

X
SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
C
AlpacaPi Dome
Position
Park
Azimuth
170.0
Altitude
0.0 %
Shutter
Closed
Slaved
No
Go Home
Go Park
-20
-10
-5
-1
+1
+5
+10
+20
Go Left
STOP
Go Right
Slow Left
Slow Right
Bump Left
Bump Right
Enable Slave mode
Open Shutter
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

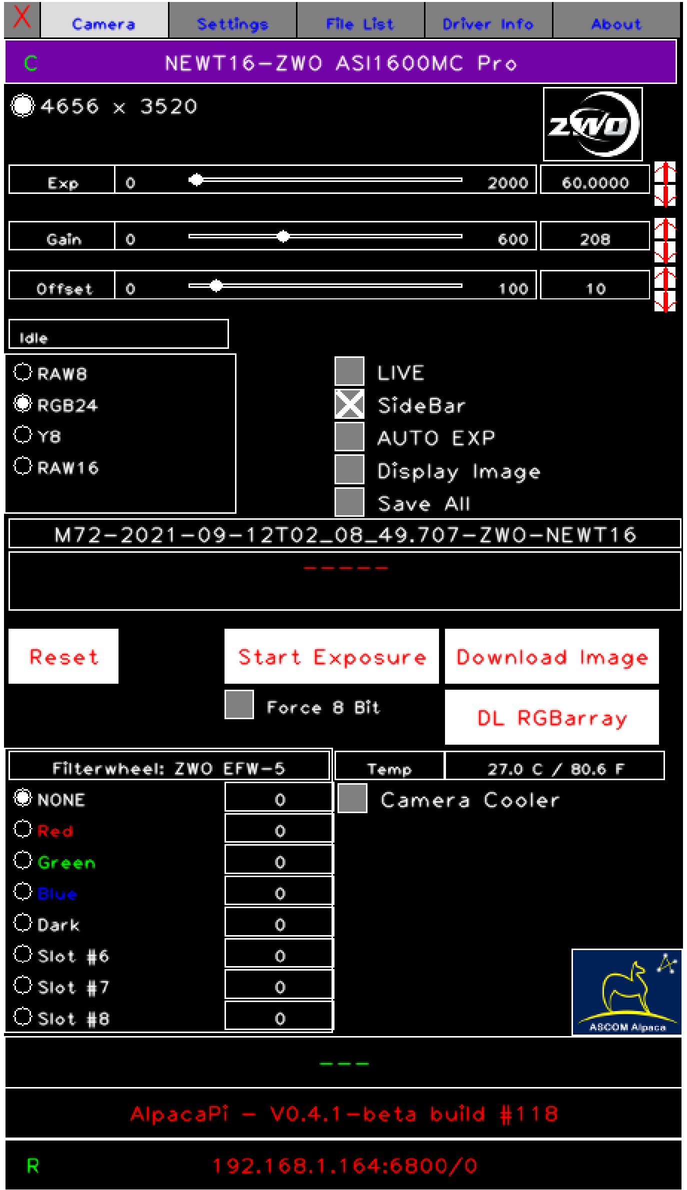




← Focuser Control

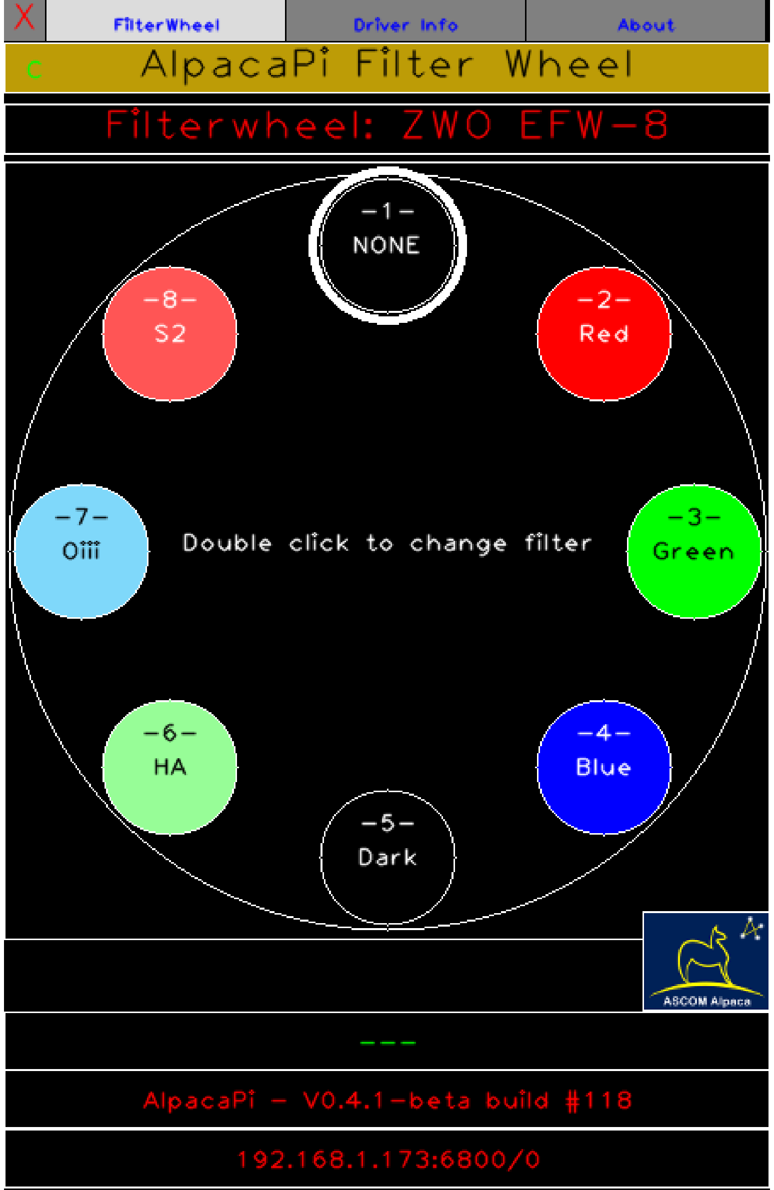
Camera Control →

Filter wheel info is included ->

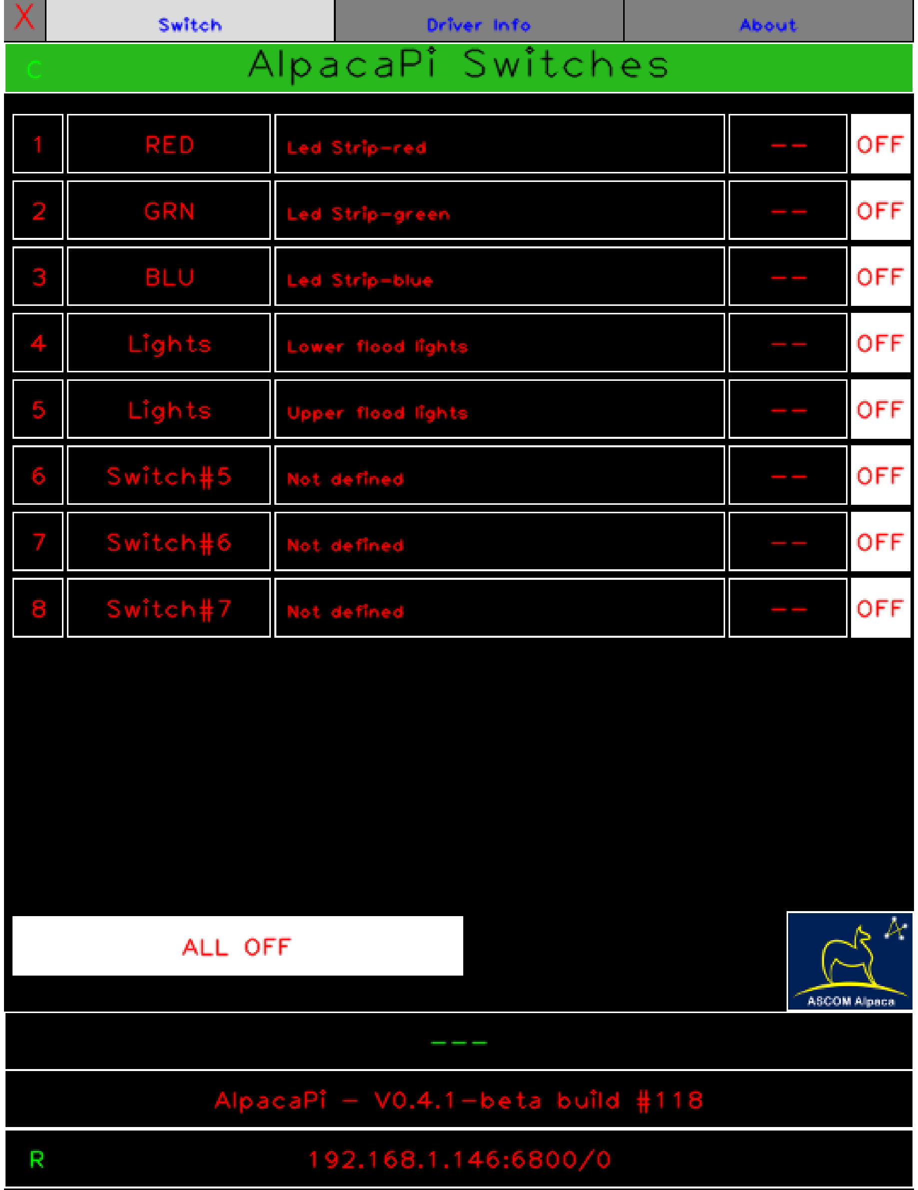


Filter Wheel Control

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

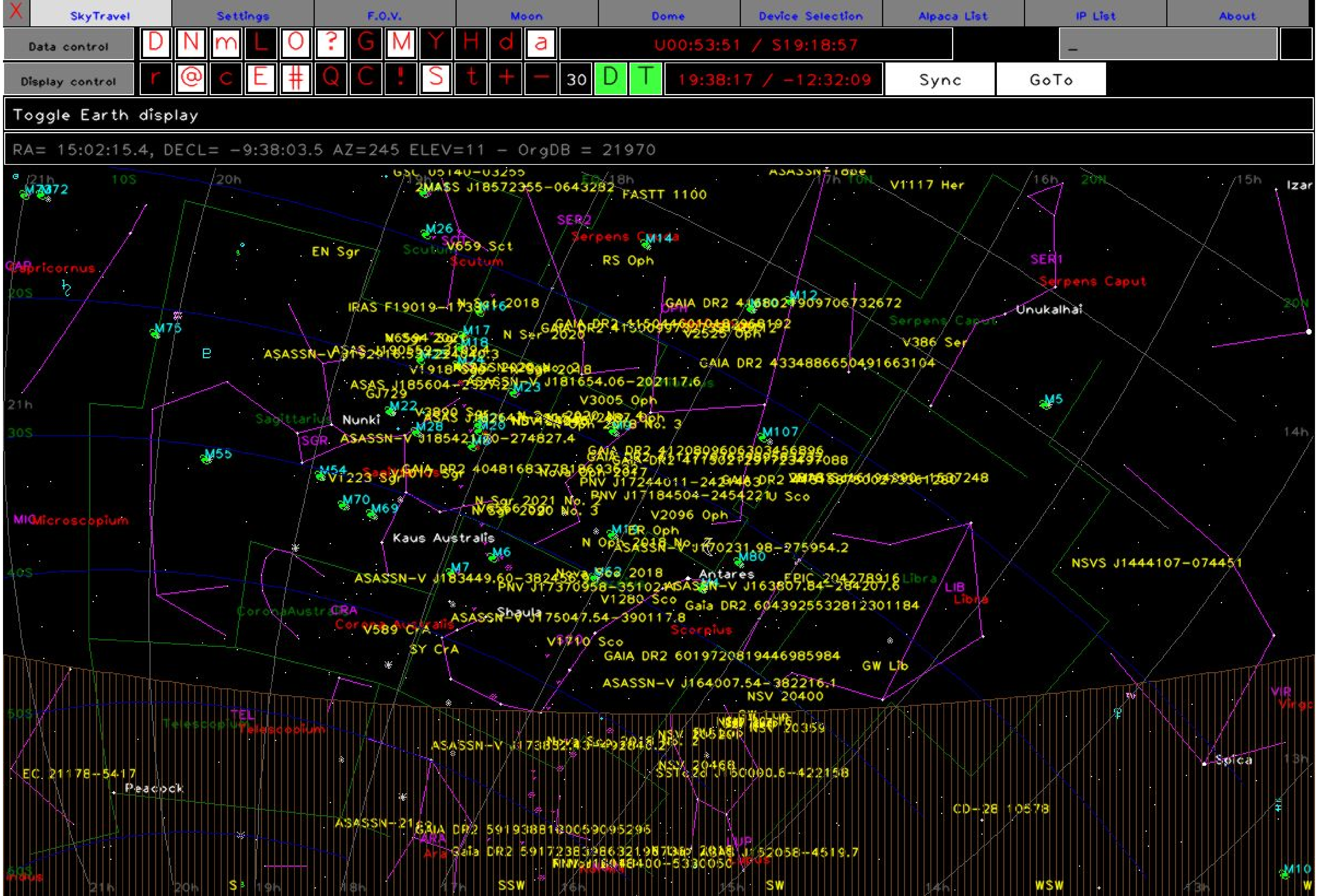
X | Star Object List | About

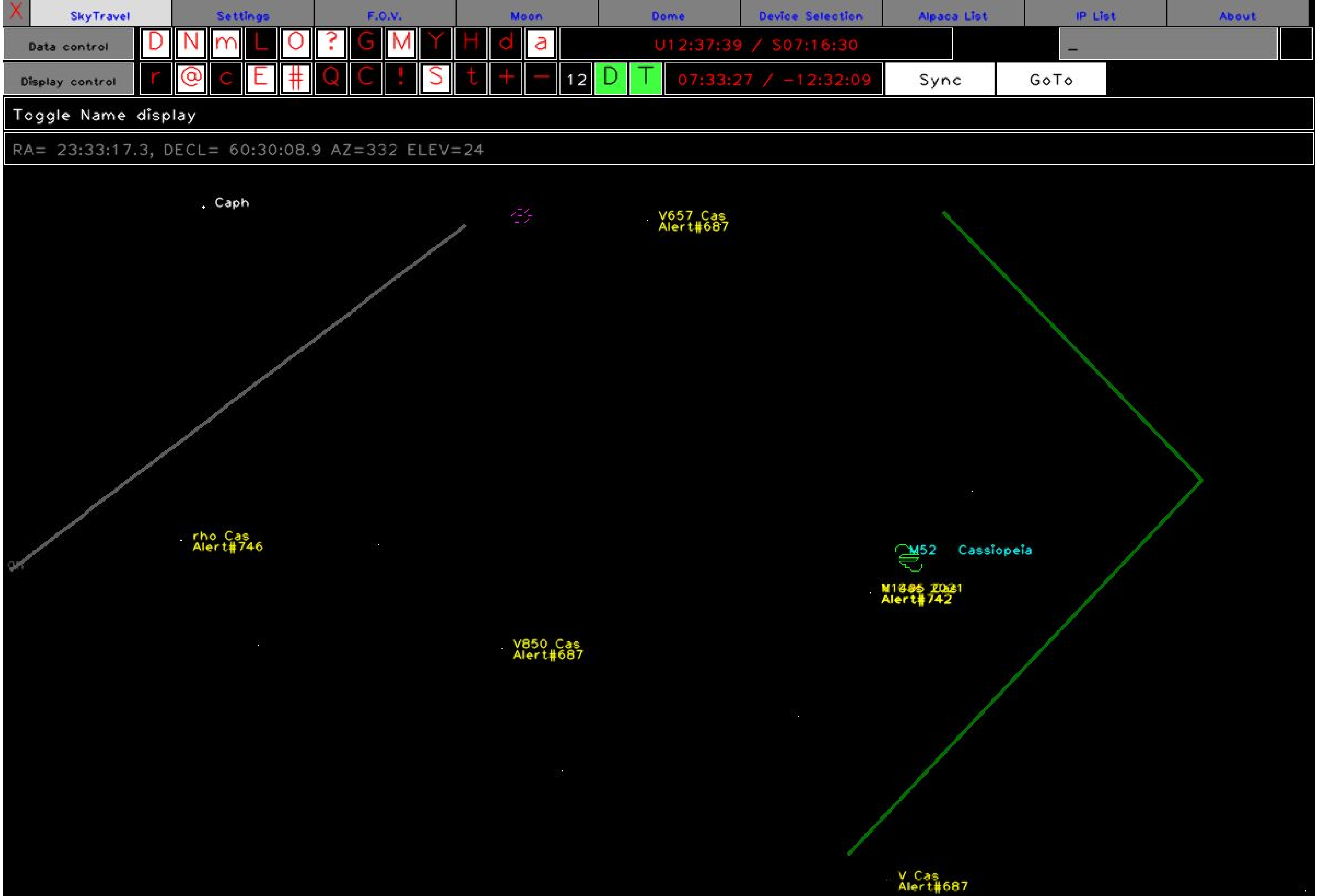
AAVSO List

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
FASTT 1100
V1117 Her
Izar
EN Sgr
V659 Sct
RS Oph
Serpens Caput
Unukalhai
V386 Ser
GAIA DR2 4334886650491663104
M5
V3005 Oph
Nunki
M107
Kaus Australis
Antares
NSVS J1444107-074451
Shaula
Gaia DR2 6043925532812301184
V1710 Sco
GAIA DR2 6019720819446985984
GW Lib
ASASSN-V J164007.54-382216.1
NSV 20400
Spica
CD-28 10578
EC 21178-5417
Peacock
SSW
SW
WSW



SkyTravel
Settings
F.O.V.
Moon
Dome
Device Selection
Alpaca List
IP List
About
Data control
Display control
U12:37:39 / S07:16:30
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

?