Digital Finders
and their impact on visual observing

How can this technology improve
<u>your</u> Deep Sky Observing?

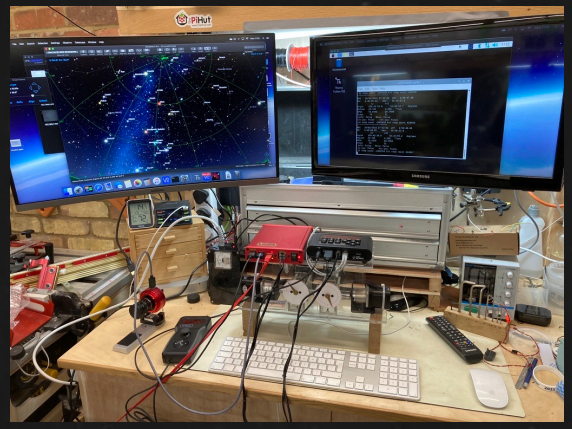
Keith Venables FRAS
11th October 2025
Portland XVIII Alt-Az Workshop

First - a bit about me

- Degree in astrophysics
- Career in engineering & science
- 25 years ago I re-discovered practical astronomy
- Equatorial 18” Newtonian in home-made dome
- 10 years at the WSP
- 20 Consecutive years at the TSP, last few as ‘ATM Program Director’

a bit more about my projects

- Ongoing project to continually rebuild my 18” ‘Dobsonian’
  - Maximise performance and minimise size & weight
  - Applying my engineering skills with latest technology
  - After 5 iterations it is finally mechanically excellent
  - ScopeDog belt & roller drive system
- Became interested in Digital Finders
  - processors, cameras & software developing fast
  - About time visual observers had access

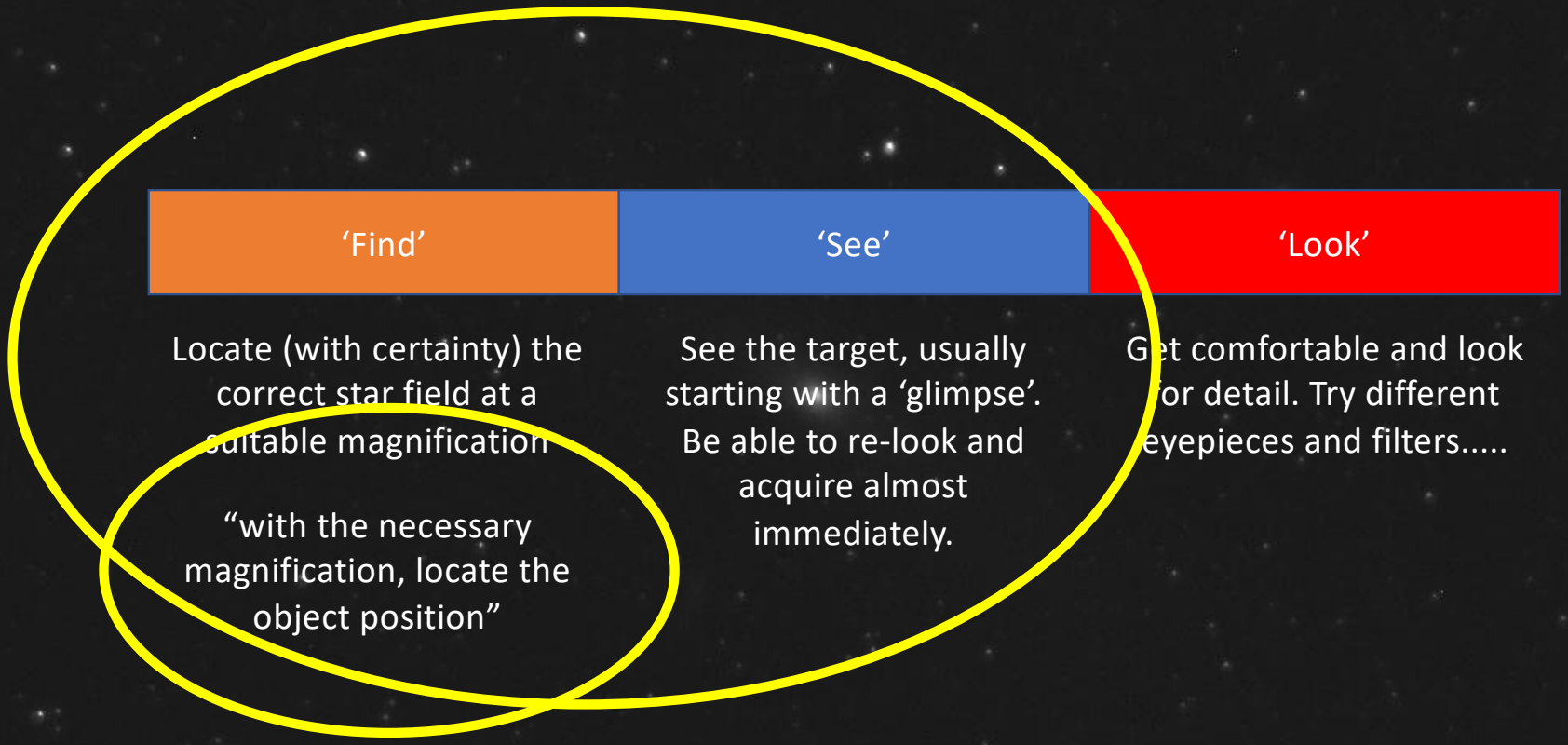


for me, Star Parties are for code development and testing

Hunting or Studying?

- Some like the challenge of finding a target by ‘star hopping’ etc
- Others just want to go there and see it
- Others like me want to see the elusive – ‘push the boundaries’

The classic basics for seeing the ‘elusive’



Optimising the Observing Routine

- William Herschel (1738 – 1822)
  - First 46 'Sweeps' produced only 2 finds (≈ 6 months).
  - Working alone and making his own notes
  - His sister Caroline then started taking his notes leaving him at the telescope
  - An assistant moved the telescope
  - Then produced an average of 2 discoveries per sweep.
  - With only a 15' field of view he was able to discern even extended faint nebulosity (eg North American Nebula)
  - Truly a great observer working at the absolute limits of seeing

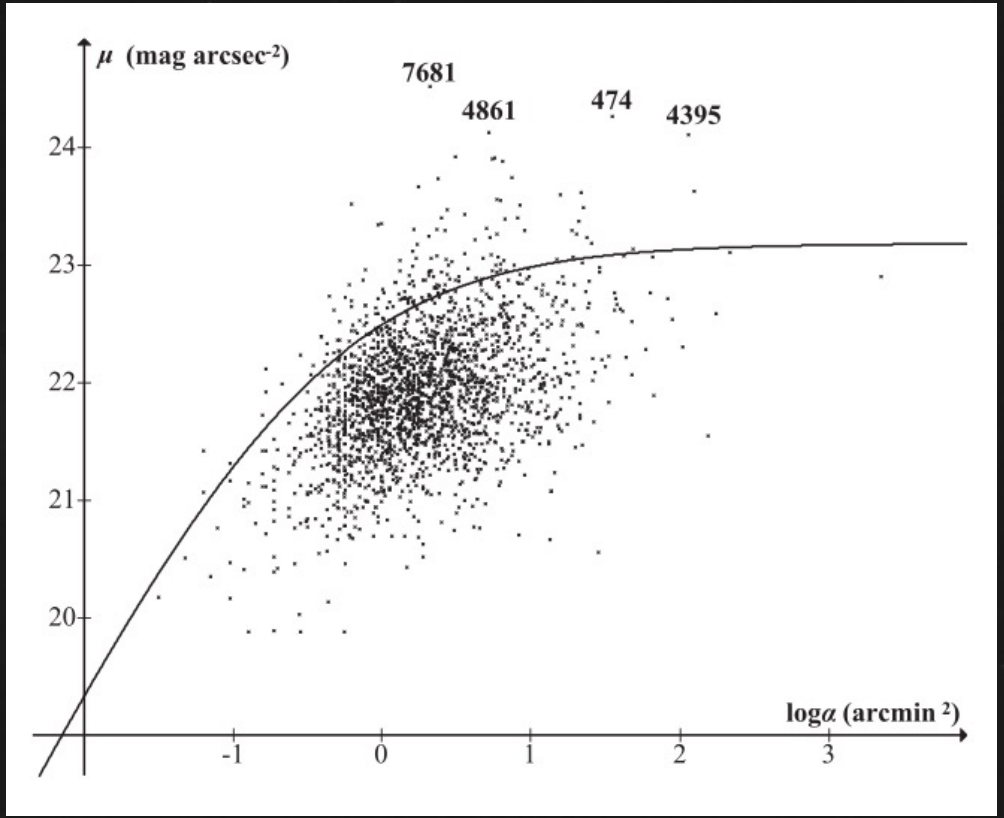
But what are the limits of seeing?

Human contrast threshold and astronomical visibility

Andrew Crumey, *MNRAS* ***442****, 2600–2619 (2014)*

- Thorough re-examination of previous work (Blackwell, Curtiss, Clark, Schaefer, et al)
- Normalised previous disparate findings using a number of factors (Observer, equipment, light pollution, etc).
- Applied his new analysis to the established data.
- William Herschel data plotted here
- He missed very few he ‘might have seen’

Can we match his performance?

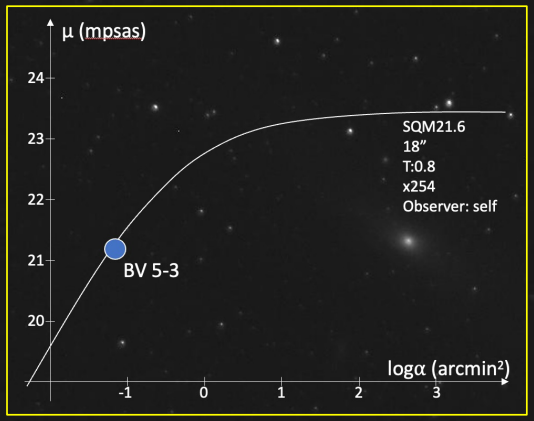


Herschel’s 17.5” NGC observations

Practical aspects of ‘seeing’

- Must maintain and protect the fullest dark adaptation
  - Personal experiments improved my limiting magnitude by 1.8!

  (https://astrokeith.com/seeking-the-very-elusive.pdf)
- Averted Vision
  - Up to 2 magnitudes difference across the retina rods alone
  - Most effective when the target position in the eyepiece field is known.
- Example:
  - BV 5-3 - a challenging target in an 18” (SB ≈ 21. 2mag)
  - In my eyepiece field but 3 out of 4 couldn’t see it.
  - When told exactly where it was, 3 out of 4 could see it.



Protecting dark adaptation and optimising averted vision is critical

Finding the Target – a new approach

(For visual observers)

Like Herschel, sometimes we need an assistant!

- Digital Finders are like car sat-navs

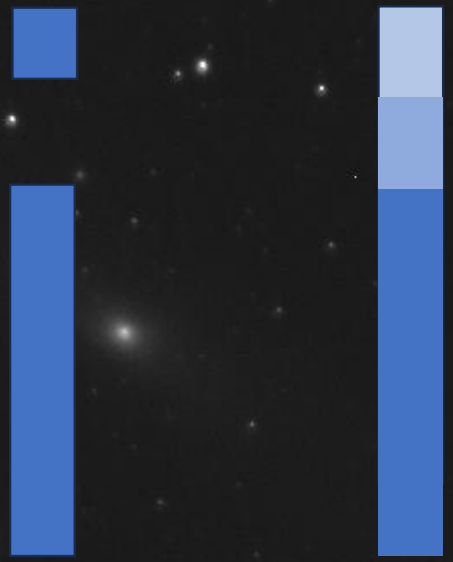
- Getting you to your destination
  - No searching
  - No charts or maps
  - No getting lost!
  - No distractions
  - Less stress

Past & Recent developments in Plate-Solving

- Astro-photographers have long moved to plate-solving
  - Small camera field of view.
  - They want maximum time on target
  - They had cameras and computers already.
  - Plate-solving for most has completely removed the need for accurate alignment
- Many plate-solving applications run on small computers and even smart phones.
- Celestron StarSense is the first commercial use of a plate-solving finder for visual use.
  - Growing in popularity but not easily integrated with other scopes
- PiFinder is proving very popular

Some options for digital finders

	Requires App	Own catalogues	Primary technology
• Celestron StarSense			Plate-Solver
• PiFinder			Plate-Solver
• Star Hopper			Plate-Solver
• MeMstar			Inertial
• AstroHopper			Inertial
• eFinder			Plate-Solver



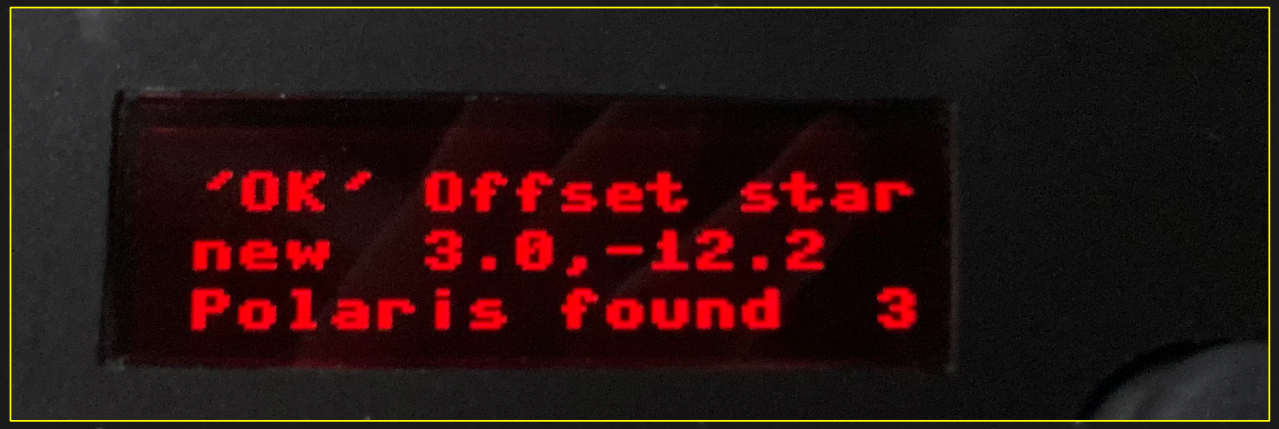
eFinder

- Primarily, plate-solving for the Nexus DSC
  - Secondary ‘Live’ mode. (No Nexus DSC)
  - Open source code – flexible interface

Early Version

eFinder Functions

- semi-automatic calibration of eFinder to main scope offset.



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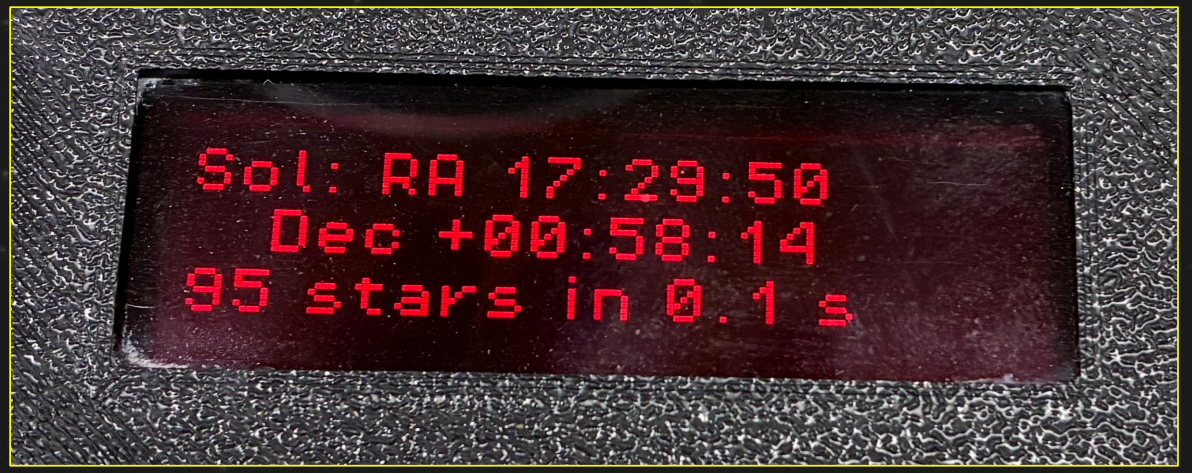
- Display current telescope position, with respect to true RA & Dec
- Perform Nexus DSC ‘Local Sync’ anywhere, anytime.
- Refine a GoTo, (aka ‘GoTo++’)
- ‘Live’ mode
  - No Nexus DSC
  - SkySafari via Wifi



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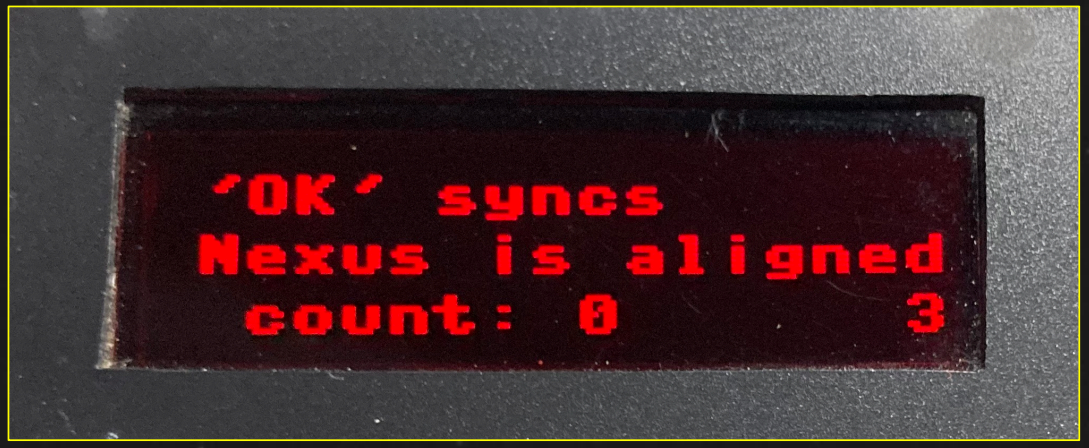

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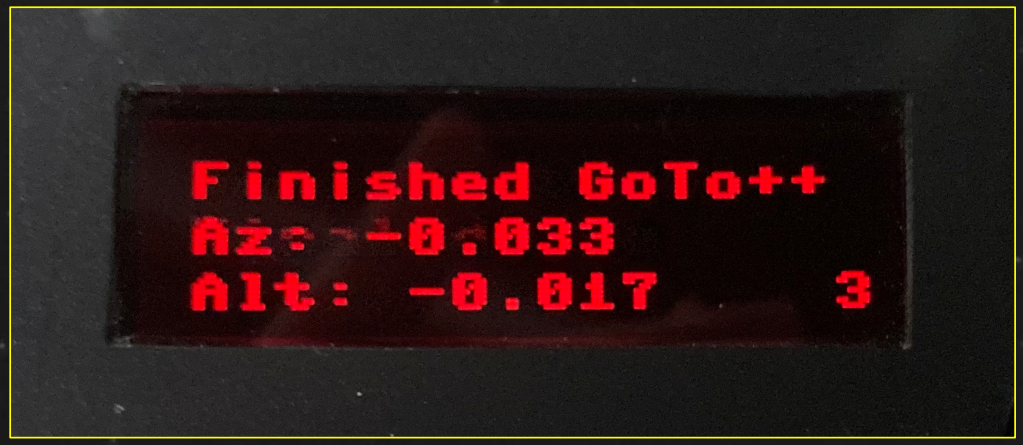

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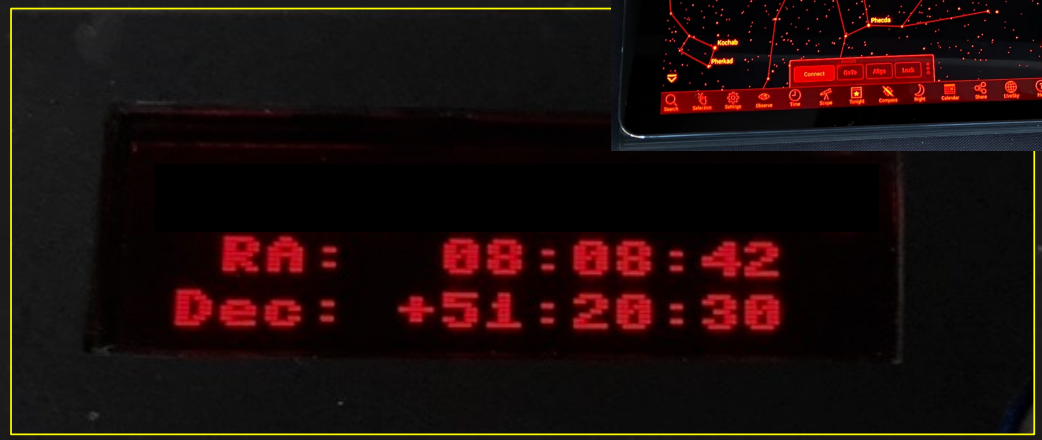
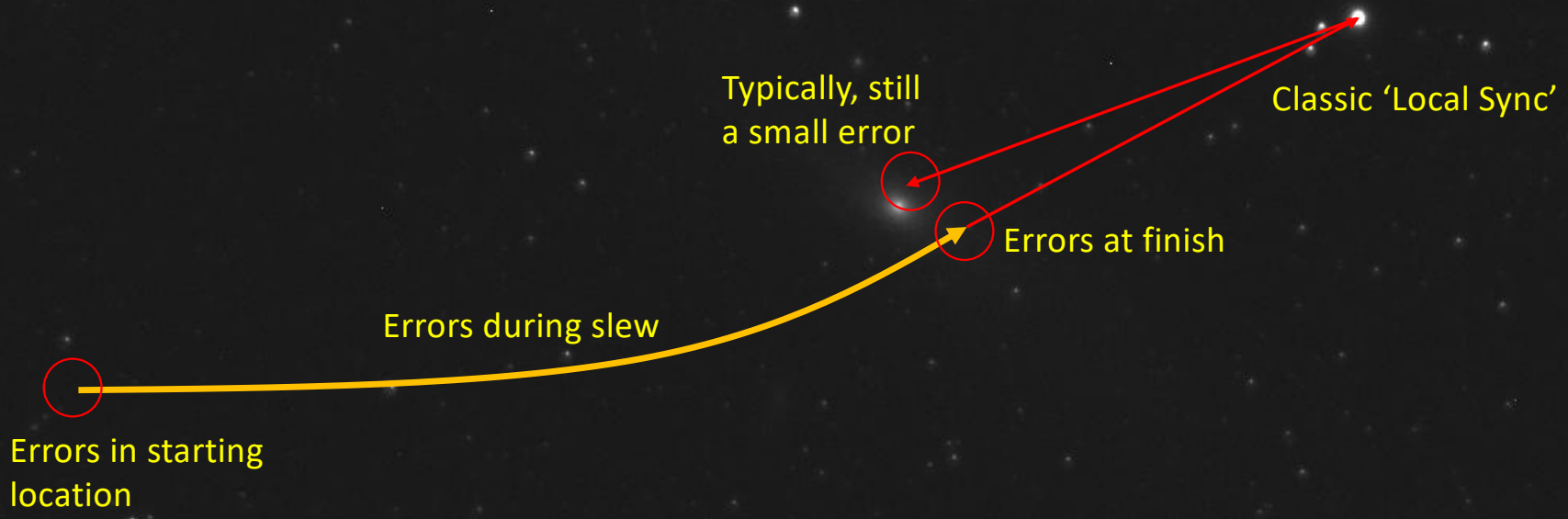


Goto++ explained

- Normal Goto



Goto++ explained

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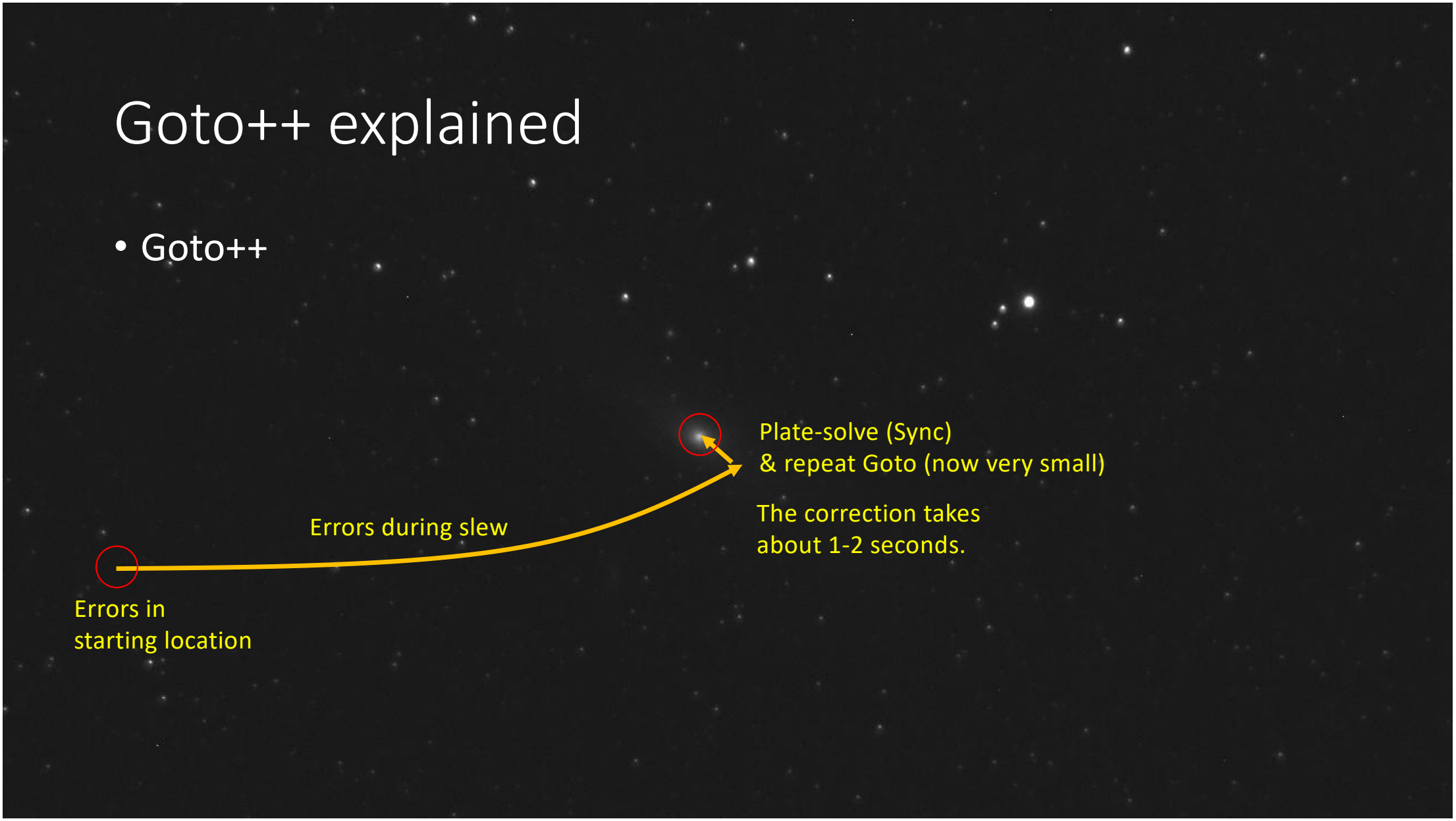


eFinder Lite

- Single box solution
- Just one cable (to Nexus DSC)
- Pi Zero 2W
- Tetra3 solver
- ‘Live’ mode included
- Full hardware & software design released on internet
- Around 100 built worldwide
- Fitted to scopes from 10” to 42”
- Being used with ‘push to’, ScopeDog, ServoCat & SiTech drives
- ScopeDog & SiTech drive users getting <<1 arc minute GoTo++ accuracy

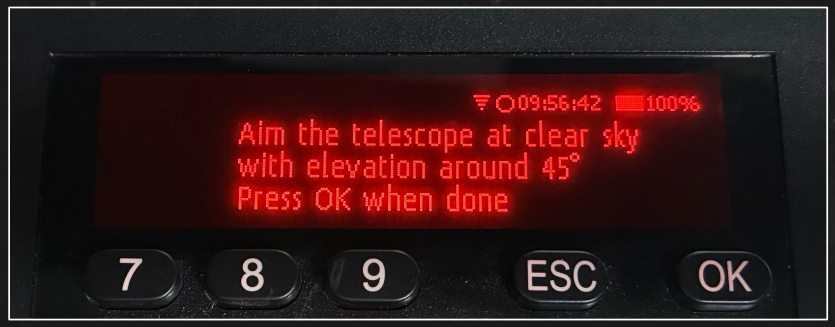
New … ‘Nexus eFinder’

- Fully integrated into Nexus DSC Pro
- Will be available as DIY or ready built

Full launch NEAF 2026

Offset Calibrate

2 point align



Assist

Test Mode

Setup

Info

Benefits

- The encoders provide ...
  - Immediate responsivity
  - Resolution
  - Position while scope moving

- The plate-solver adds ...
  - Better than 1 arc minute true sky accuracy on demand.
  - Faster setting up
  - Faster target location (Push-to or Goto++)
  - Confidence in position.

- But, like all finders it relies on eFinder to main scope remaining aligned!
- eFinder open source code allows any computer to use it.

Comparison of Scope pointing aid types

	Method	Dynamic	Accuracy	Comments	Examples
Push to Scopes	Inertial (compass + accelerometer)	Laggy	~1˚	Lower cost & easy to fit, but usually still requires star hopping to finish	AstroHopper, MeMstar
	Encoders	Excellent	1'-20'	Tried & tested, but requires a well built scope.	Most scope manufacturers plus Nexus, ArgoNavis
	Plate-Solver	None	< 1'	Easy to fit, accurate, but requires patience while finding!	Star Hopper, Celestron StarSense Explorer
	Plate-Solver + Inertial	Laggy	< 1'	Easy to fit and accurate. Fine adjustments can be slow.	PiFinder eFinder 'Live'
	Plate-Solver + Encoders	Excellent	< 1'	Easy addition to some encoder installations to improve accuracy.	eFinder Lite, Nexus eFinder
Driven Scopes	Encoders	Excellent	1'-20'	Tried & tested, but requires a well built scope.	Most scope manufacturers plus Nexus, ArgoNavis, ServoCat, SiTech
	Plate-Solver + Scope encoders	Excellent	<< 1'	Easy addition to some encoder installations to improve accuracy.	eFinder Lite, Nexus eFinder, StarDrive, ScopeDog
	Plate-Solver + Motor Encoders	Very good	<< 1'	Gaining popularity. Lower cost and a simpler install.	ScopeDog Lite. (Seestar!)

Full integration example

- ScopeDog runs the plate-solver code on the scope motor drive processor.
- Plug a camera directly into the drive box
- Scope drive hand pad now shows <u>absolute</u> scope eyepiece centre coordinates

ScopeDog mk3eF with integrated eFinder

- Accurate mounts & encoders are becoming less essential

In Conclusion……

- Very accurate scope positioning can
  - Help maintain Dark Adaptation
  - Greatly assist Averted Vision.
- With some effort, up to two magnitudes deeper is possible.
- A massive difference to the visual observing experience.

- Digital Finders could simplify future scope drives and the user experience.
- They allow scopes to be pointed to sub-arc minute accuracy with respect to actual sky.
- Especially useful with compact and lighter mount designs
- Close integration is key to performance and features

- For me, better DA & minimising the ‘hunt’ allowed much deeper observations

Self Build Option

- eFinder variants
  - About 100 built so far
- Scopedog, with optional integrated eFinder
  - About 50 ScopeDogs built so far (10” to 42”)
- Full self-build designs available on my website
  - Code available from GitHub repository
  - 3d printer designs available

eFinder Lite

Nexus eFinder

ScopeDog with integrated eFinder

www.astrokeith.com
https://github.com/astrokeith
email: efinder@astrokeith.com