

Autoguiding – a Deep Look

A Meade LX200 telescope is mounted on a motorized base with an autoguider. The telescope is white with black accents and has "MEADE LX200" printed on its side. It is mounted on a metal platform with a railing. The background shows a landscape with trees and a building under a clear sky.

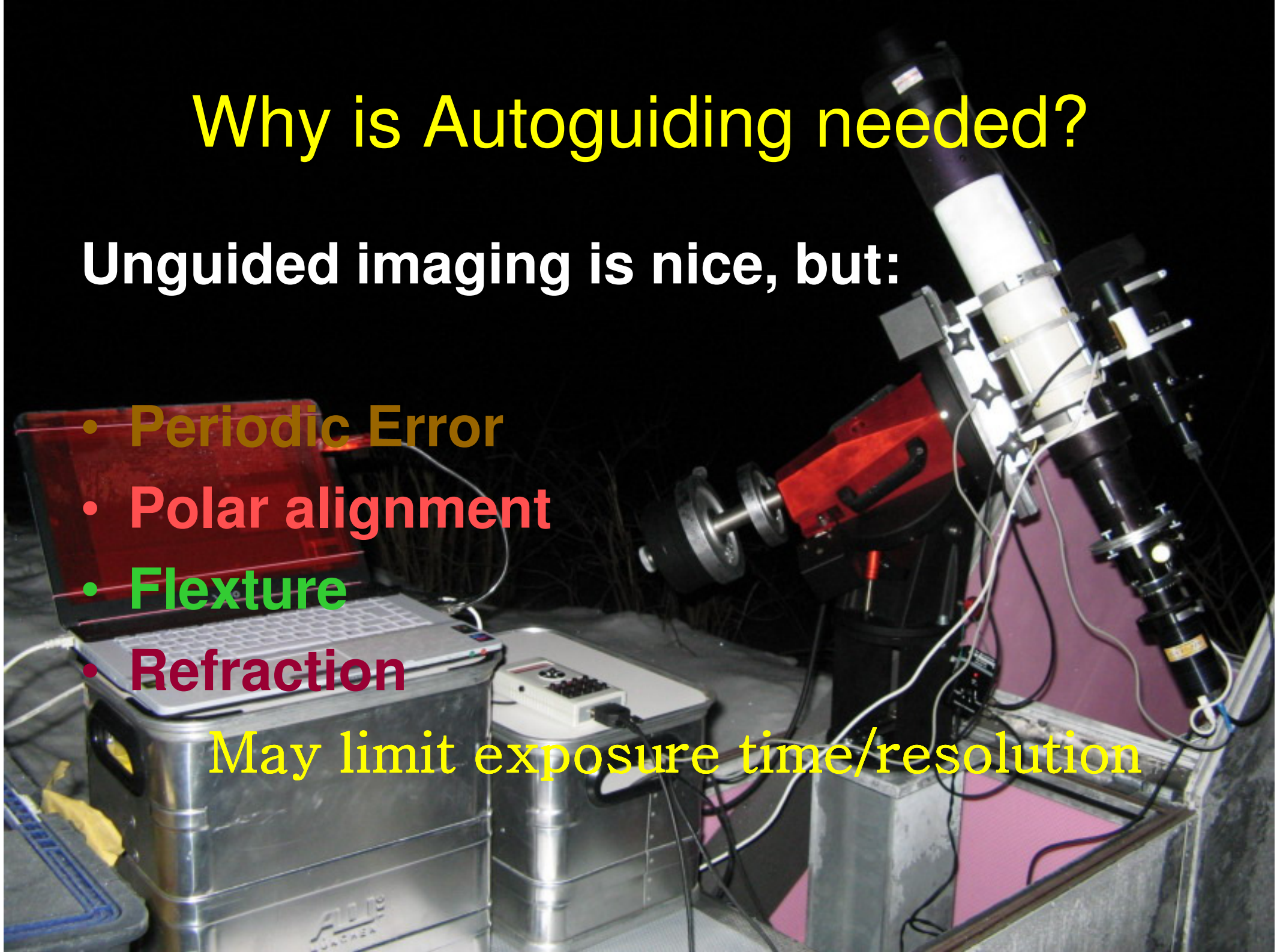
András Dán, MSc, Hungary
CEDIC, Linz, April 2009.

Why is Autoguiding needed?

Unguided imaging is nice, but:

- Periodic Error
- Polar alignment
- Flexure
- Refraction

May limit exposure time/resolution



Do we need long exposures at all?

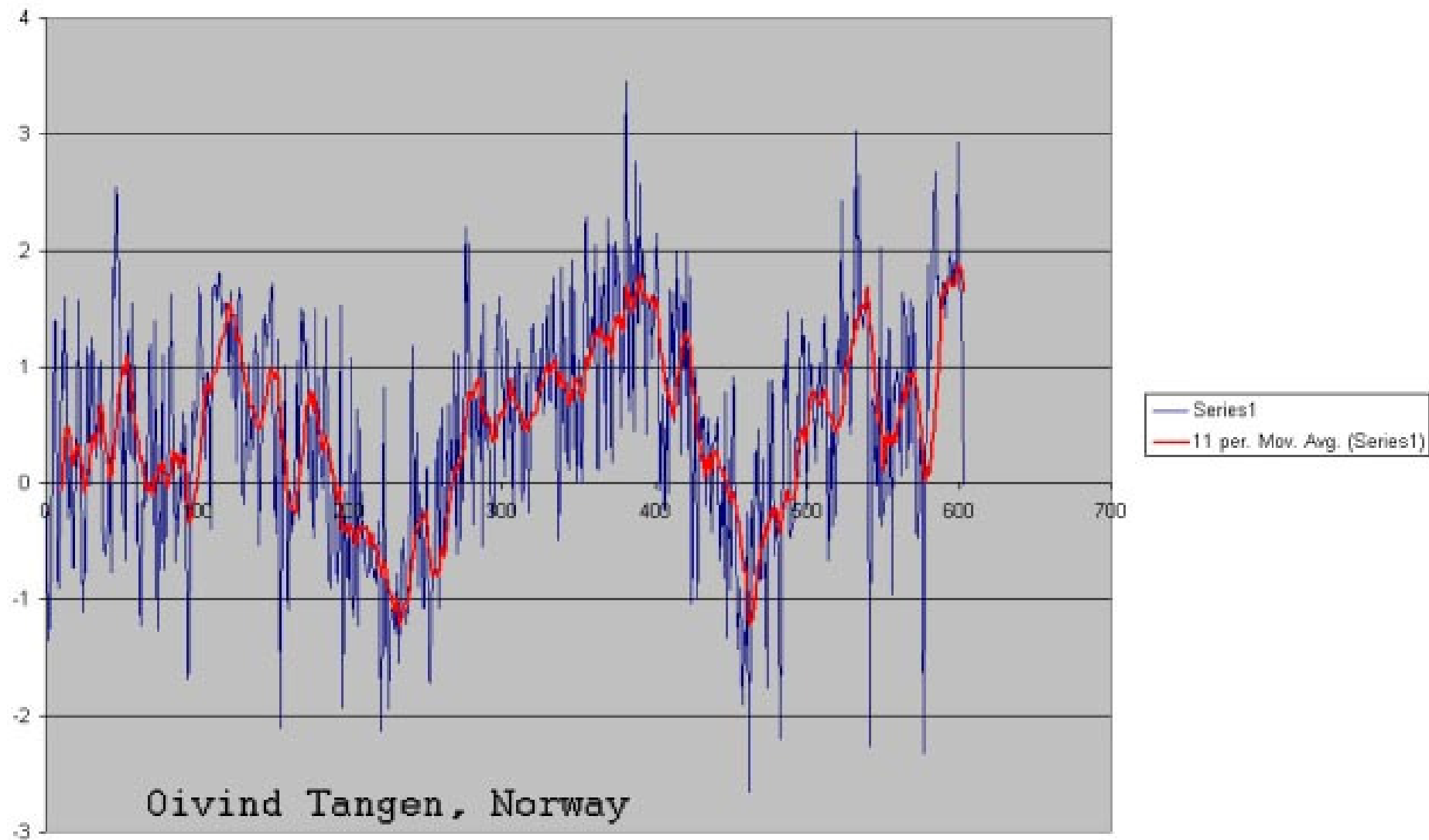
YES, because we have:

- *Narrow band filters*
- *Low surface brightness objects*
- *Multifilter image acquisition that lasts several nights*

Tracking in RA

(for 2-3 sec intervals)

Error Source	Typical value (arcsec)	Characteristics	Relative value
PE+Drift	0,1- 0,4	<i>systematic</i>	10 - 40%
Flexure	0 - 0,02	<i>semi-systematic</i>	
Seeing	0,5 - 2	<i>random</i>	90 - 60%



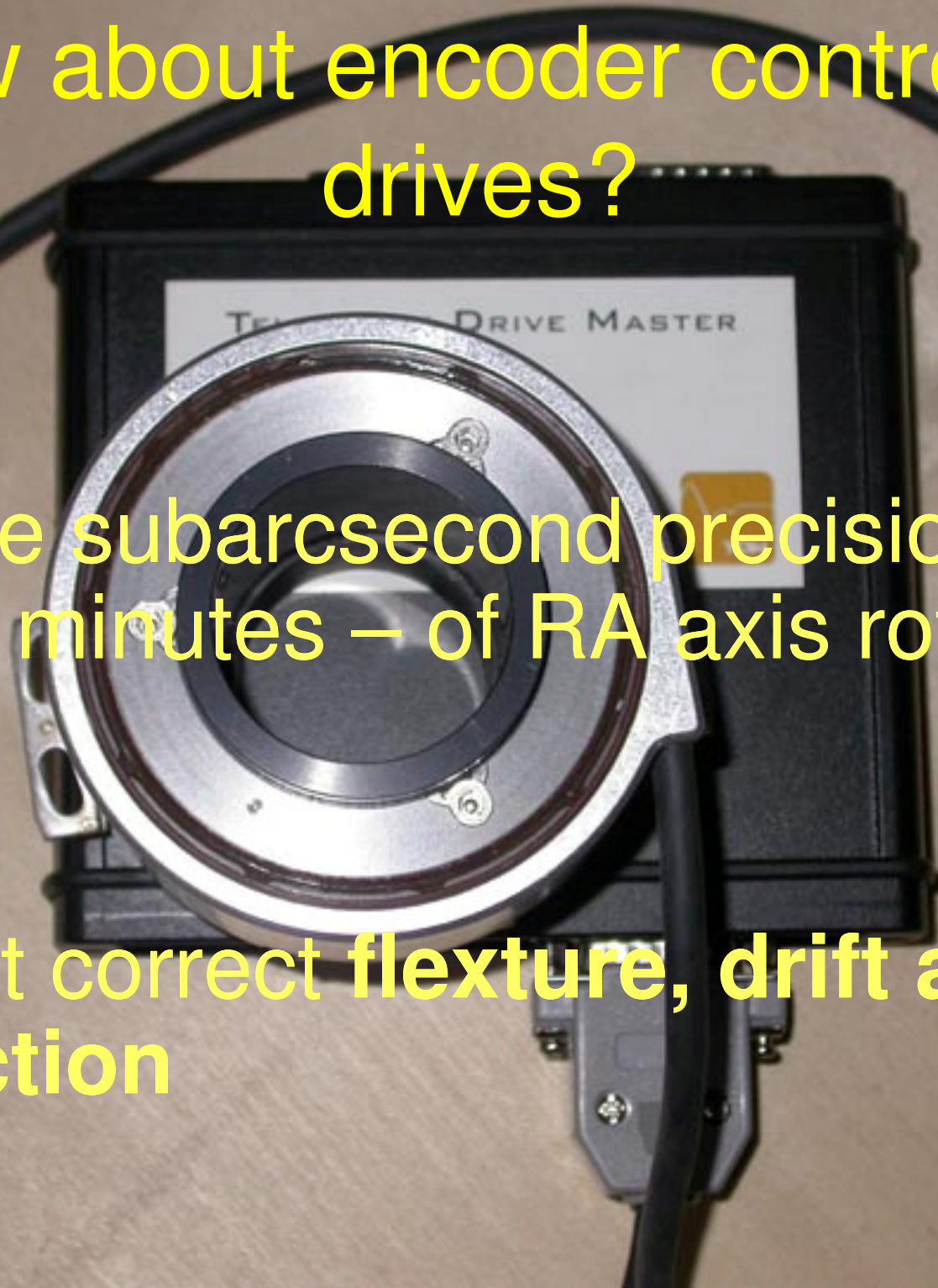
Gemini G42, no PEC, poor seeing

Tracking in DEC

Error Source	Typical value (arcsec)	Characteristics	Relative value
Drift	0 – 0,2	Systematic	10 – 40%
Flexure	0 – 0,05	Semi systematic	
Seeing	0,5 - 2	Random	90 – 60%
RA bearing	0,1 - 2	Random	

How about encoder controlled drives?

- Ensure subarcsecond precision for 10-20 minutes – of RA axis rotation
- Do not correct **flexure, drift and refraction**



Autoguiding parameters

» 1 Calibration

Done under *constant speed* – used in *acceleration*

This ensures a slight undercorrection.



Autoguiding parameters

»2 Guidestar quality

An aberrated or dim stellar image gives unreliable centroid values.

E.g.: off axis situations

Autoguiding parameters

» **3 Exposure time**

- Longer – reduces seeing effects
- Shorter – corrects PE better

Autoguiding parameters

- **4 Aggressiveness**

Compensates seeing and calibration problems.

- **5 Pause after correction**

Helps to avoid oscillations.

Current Practices of Autoguiding

- **Guidescope**

Flexible star selection – flexure

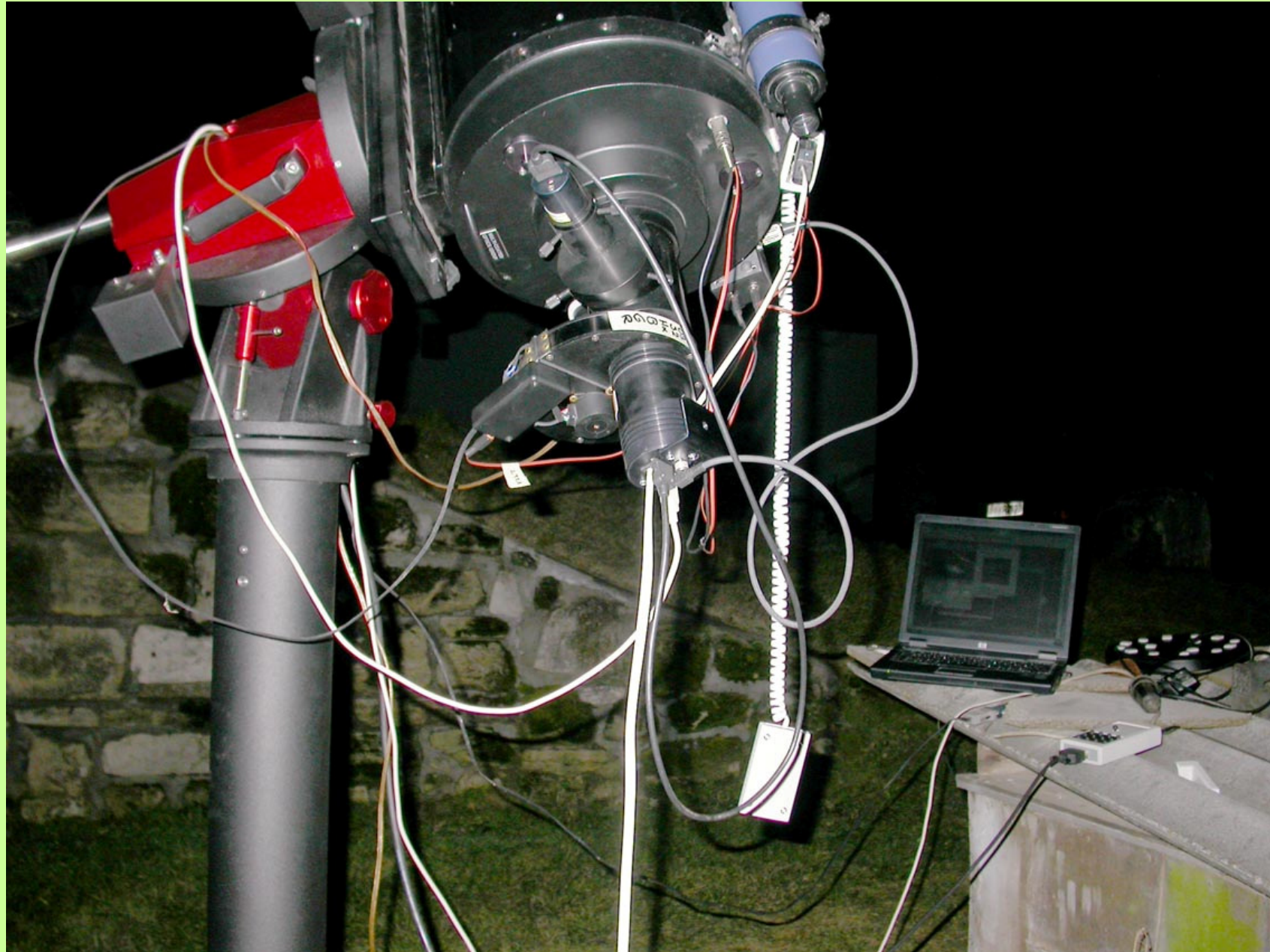
- **Off-Axis**

Good rigidity – small field

Example - guidescope



Example – Off axis



Current Practices

- **Dual Chip**

Highest rigidity – filter problem

- **Interline Transfer Chip**

Simplest solution – image noise

Current Practices

- **Active optics**

Best results – backfocus problems, camera choice limited

Practical Tips

- Minimize flexure

Small weight, reinforcements, quality focuser

- Use threaded or conic interfaces



Oivind Tangen

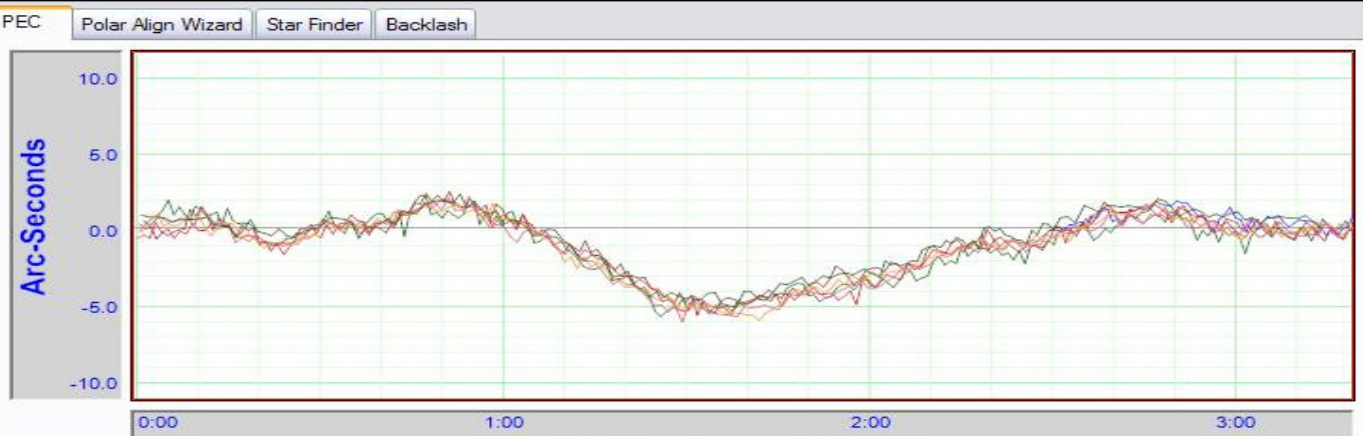
Practical Tips

- PEC active

Longer exposure, less seeing effects

- Small aperture guidescope

Up to 10cm the seeing is always fair



Gemini G42
6" PE

RA Worm

All Cycles Visible

RA Axis: X

Graph Y-Scale: 11.50

Setup | Acquire Data | Analyze | Frequency Spectrum | Program Mount

Create a PE Curve

Load File

Export Data

User Comments

Worm Period (seconds): 199.45

Image Scale (arc-sec/pixel): 0.751

Num	Time	Worm Cycl
1	0:00:00.015	1
2	0:00:00.937	1
3	0:00:01.750	1
4	0:00:02.640	1
5	0:00:03.515	1
6	0:00:04.390	1
7	0:00:05.281	1

3/12/2009 8:23:50 PM
MaximDL/CCD V5
pulsar

Graph Type: Periodic Error

Drift Fitting: Cubic

RMS Error: 0.551

Periodic Error: +0.3/-0.4

Graph of Data and Fitted PE Curve

FFT Waveform Analysis

Fundamental Freq (cycles/worm period)	Amplitude (arc-seconds)	Phase (degrees)
<input checked="" type="checkbox"/> 1.000	0.103	4.2
<input checked="" type="checkbox"/> 2.000	0.083	261.0
<input checked="" type="checkbox"/> 3.000	0.093	124.6
<input checked="" type="checkbox"/> 4.000	0.073	315.4
<input checked="" type="checkbox"/> 5.000	0.064	237.7
<input checked="" type="checkbox"/> 7.000	0.086	322.0
<input checked="" type="checkbox"/> 9.000	0.082	269.6

RA Axis: X

Initial Worm Phase: 1:30.28

Image Roll (degrees): -89.33

Worm Period (secs): 199.45

Declination: -0.02

Image Scale (arc-sec/pixel): 0.751

Cancel | Export Data

Create PE Curve and Close

1" PE

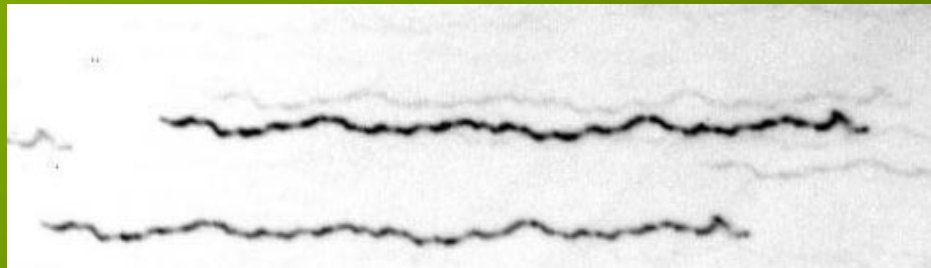
Romulo de Luna F.

Trailed Stars – What shall I do?

- Direction of the trail
 - E-W, N-S, Other
- Set of short expos with intervals
 - 3s expo, 60sec pause, 15 times
(guiding ON)

Trailed Stars

- Compare 1 worm cycle **guided** and **unguided** exposures
- Make startrail images (30"/min drift)



Images courtesy of

- Althoff, Gerd
- Kerschuber, Günther
- Mori, Eiji
- Tangen, Oivind
- Freire, Romulo de Luna

In order of appearance.

Thank you for your attention!