

PHD2 Best Practices

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Getting Started

- Use the new-profile wizard to specify equipment connections
- Enter correct values for camera pixel size *guide scope* focal length, and binning
- Build and use a dark library for the camera – the wizard will help you do that
- Use a separate profile for each gear combination

Gear Connections

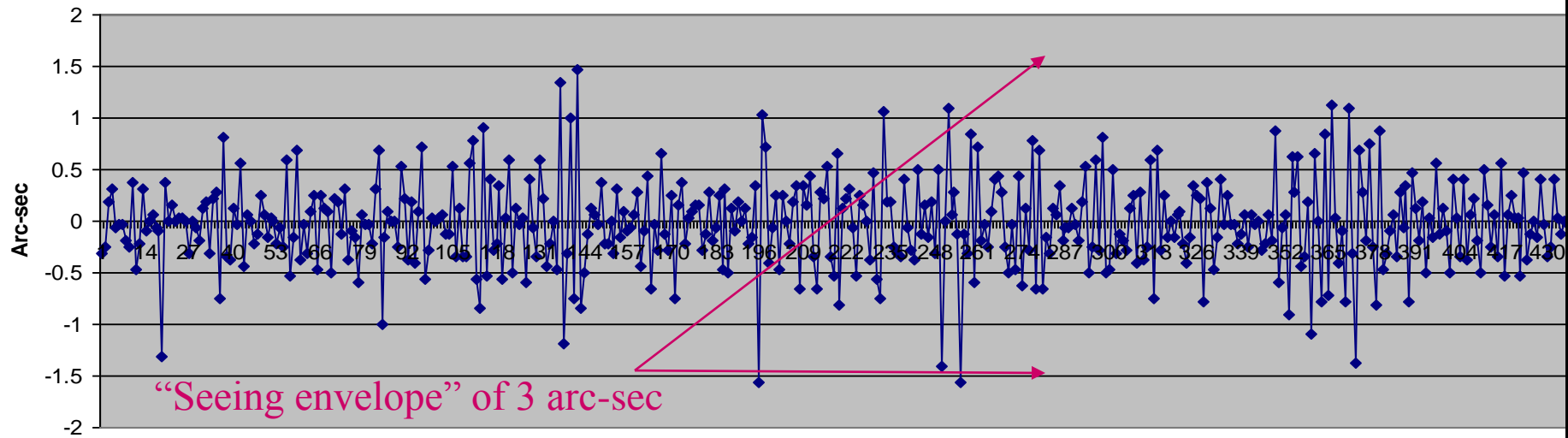
- Use ASCOM or INDI* pulse-guiding instead of ST-4 guiding if mount supports it
- Get the benefits of one less cable and better logging/diagnostics
- If you do use ST-4 guiding, use ASCOM for the PHD2 ‘aux mount’ connection

*ASCOM and INDI provide similar functionality in PHD2; INDI users can substitute INDI for ASCOM throughout this presentation

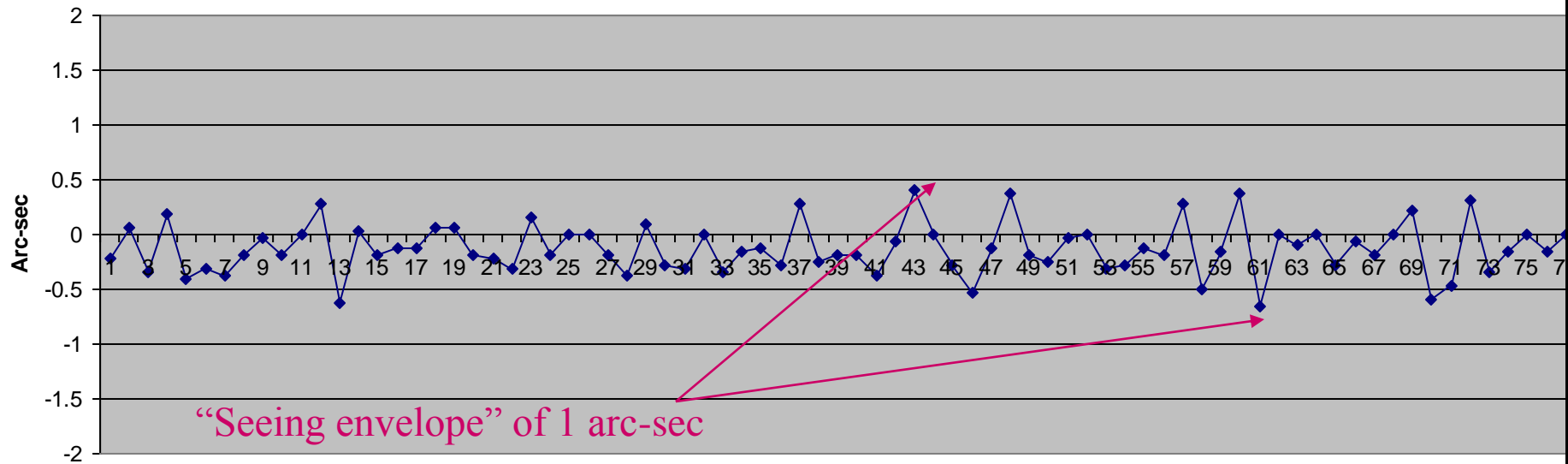
Looping

- For mounts with good RA tracking, aim for guide exposure times in the 2-4 sec range
 - You can't correct for seeing – ignore the siren's song of rapid, short exposures
 - Longer exposures average out seeing and make guiding easier
- Mounts with higher RA tracking error require shorter exposures, 1.0 - 1.5s
 - Keep the exposure short enough to react to the steepest tracking error – but not below 1 sec


1 sec guide exposures



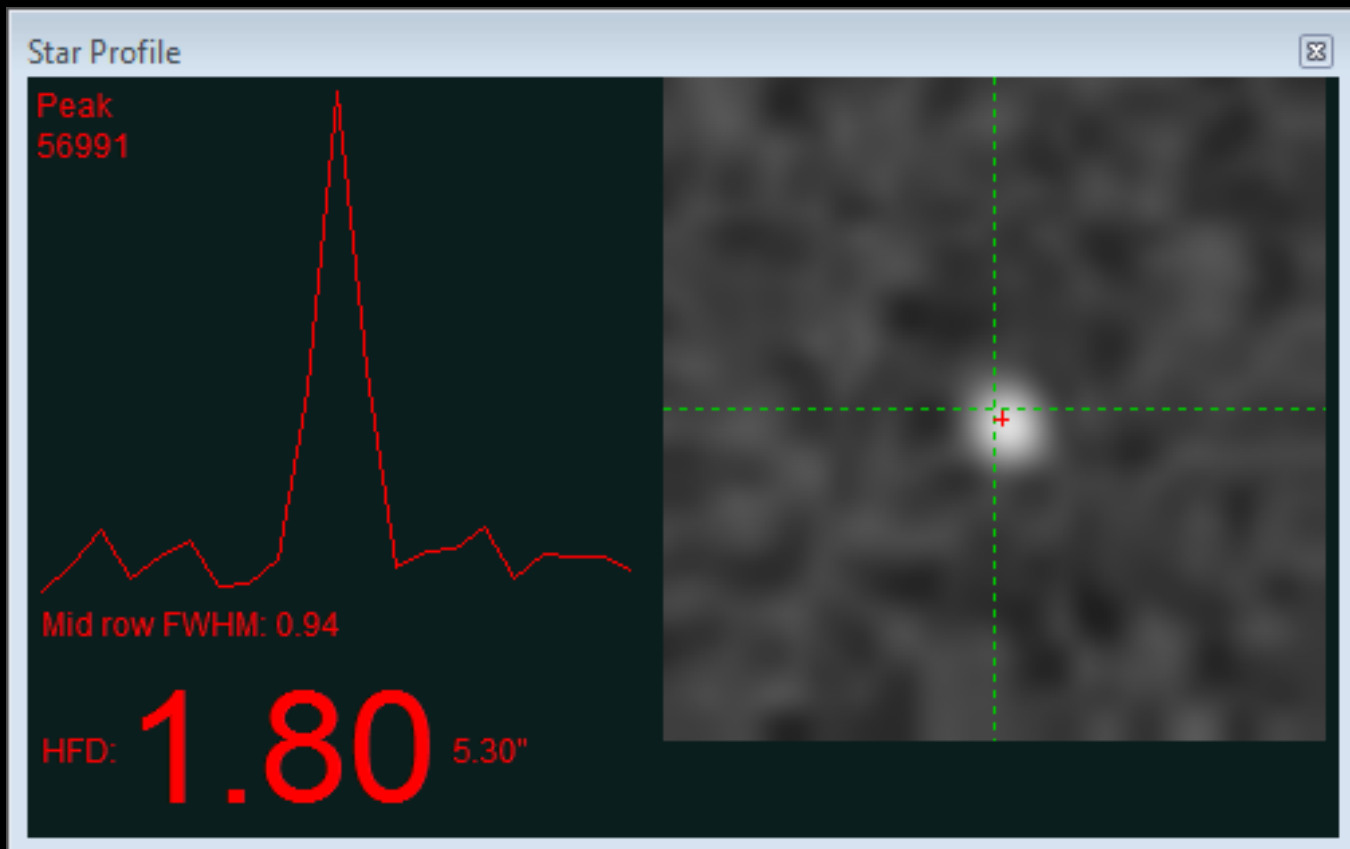
4 sec guide exposures



Looping

- Choose a suitable guide star
 - Let PHD2 auto-select the star 
 - Based on multi-factor analysis of available stars
 - Nearly always better than you can do manually
 - Increase the guide exposure if necessary
 - Use the star-profile tool to confirm focus and shape – you want a pointed top
 - Use min-HFD and star-saturation detection controls to tune auto star selection

Star-Profile Tool



Calibrating

- Get a good calibration, then re-use it
 - Within +/- 20 degrees of celestial equator (Dec=0)
 - Within an hour of celestial meridian
 - For mounts with Dec backlash, manually move mount north immediately before calibration
 - Don't ignore calibration alerts – use the help file to fix or work around mount problems

Calibration

- Re-do calibration only when necessary
 - Equipment change in existing profile (don't do this – use a separate profile instead)
 - Change in mount guide speed settings
 - Rotation of guide camera or OAG by more than a few degrees
- Note: recalibration is still required if no ASCOM 'mount' or 'aux-mount' connection is used

Polar Alignment

- Get a good polar alignment, but don't be obsessive-compulsive about it
 - Use one of the drift alignment tools to get within a few arc-minutes of the pole
 - Misalignment of as much as 10 arc-minutes can help mounts with lots of Dec backlash
 - Check for field rotation when imaging near the pole
 - [Online field rotation calculator](#)

Polar Alignment Calculator

Calculate Field Rotation for Polar Alignment Error

→ Alignment Error arcmins

Guide Star Angle degrees

Focal Length millimeters

Time minutes

→ Declination degrees

→ Field Rotation microns

Field rotation of < 1 px for common set-ups

<http://celestialwonders.com/tools/rotationMaxErrorCalc.html>

Scenario 1: Portable Setup

- Attach guide camera in same position – painter's tape marks will work
- Position mount in same location using marks on ground
- Reload profile with existing calibration
- Polar align when stars are first visible
- Start guiding

Scenario 2: Permanent Setup

- Reload profile with existing calibration
- Start guiding!

Mount Settings

- Use periodic error correction if the mount supports it
 - Use an app, don't try to do it manually
 - Run through several worm cycles to get a more accurate correction curve
- Use guide speeds in the range of 0.5x – 1.0x sidereal

Mount Settings

- Don't use backlash settings in the mount
(*aka* backlash compensation / anti-backlash / TVC)



If using EQMOD EQASCOM, follow instructions here:

<https://github.com/OpenPHDGuiding/phd2/wiki/EQASCOM-Settings>

Deal with Backlash

- Less-expensive mounts often have substantial Dec backlash
 - Adjust the gear mesh if you can
 - De-tune polar alignment by up to 10 arc-min
 - Use uni-directional Dec guiding if you can't improve the mount
- Ignore RA backlash – it's irrelevant if guide speed is $\leq 1x$ sidereal

Use the Guiding Assistant

- When setting up your equipment for the first time in PHD2, always run the Guiding Assistant once to establish effective initial min-move, backlash compensation, and guide camera exposure settings
- Run again later as needed to
 - Better understand your mount's behavior
 - Get a sense of your seeing conditions
 - Get updated recommendations for settings

Use the Guiding Assistant

- Pay attention to the GA recommendations



Recommendations

Try setting RA min-move to 0.35	Apply
Try setting Dec min-move to 0.30	Apply
Try setting a Dec backlash value of 680 ms	Apply

GA
Example

Guide Parameter Adjustments

- Always start with default settings – use ‘Reset’ buttons if you’re not sure
- Be conservative with adjustments
- Keep min-moves larger than the typical seeing fluctuations
 - Dec guiding should be conservative (larger min-move)
 - RA guiding can be a bit more aggressive (smaller min-move) to correct periodic error
- Remember that under-correction is better than over-correction, especially for Dec

Remember What Guiding Can Handle

- “Slow and steady” errors
 - Tracking rate errors
 - Atmospheric refraction
 - Some kinds of flexure (not differential)
 - Residual periodic error
 - Drift from polar alignment error

And What It Can't...

- High-frequency, random star movement
 - Most seeing effects
 - Poorly-behaved hardware
 - Sudden shifts/deflections
 - Vibration
- Differential flexure
- Large Dec backlash
- Field rotation

What If You Have Basic Problems

- Use the help resources
 - Interactive Help in PHD2, including index
 - HTML and PDF versions here:
<http://openphdguiding.org/documentation/>
 - Basic questions are quite likely answered in the Help content

What If You Have Basic Problems

- Ask for help on the PHD2 forum
 - Be specific about what you did and what you saw
 - Submit both the guide and debug log files (yes, you have them)
 - Use the Upload Logs wizard in PHD2 to select and upload log files

What If the Guiding Looks Bad

- Be sure to look at the numbers
 - Reset to the default guiding parameters
 - Use the PHD2 LogViewer tool to analyze 15+ min guiding sessions <http://adgsoftware.com/phd2utils/>
 - Judge performance in arc-sec, not pixels
 - Don't just react to a “spiky” graph
 - Try initially for guiding RMS of around 1 arc-sec
 - Distinguish between unusual incidents and longer-term performance

What If the Guiding Looks Bad

- Read the log analysis tutorial:
<http://openphdguiding.org/tutorial-analyzing-phd2-guiding-results/>
- Ask for help on the PHD2 forum – always with a guide log

Improving the Guiding Performance

- Be systematic and methodical when trying to improve performance
 - Don't thrash the guiding parameters!
 - Experiment only on a night of average to good seeing for your site and not when you're trying to image
 - Do testing high in the sky and near Dec = 0
 - Look at long guiding intervals – don't get fooled by randomness
 - Make single, small adjustments for a specific purpose – then look at the results

Judging the Results

- Let your main-camera images be the final word on guiding performance
 - Look at star size and elongation compared to 5-10 sec unguided exposures
 - Look for evidence of differential flexure in long exposures (good guiding but elongated stars)
 - Guiding may not be your limiting factor – it only has to be good enough

Extra Credit:
Dealing with a Cranky Mount

Repeated Calibration Alerts

- Check the help file – Tools/Calibration Details
- Dec backlash is a common problem
 - Alerts happen frequently but not always
 - Move the mount north at guide speed for 20 seconds before starting the calibration
 - De-tune polar alignment to minimize direction reversals

Look at the Mount's Behavior

- Guiding software can't tame a bad mount
- Get over the “I don't really want to know” feeling
- Try the star-cross test for the most basic form of testing

Star-Cross Test

Start 45-sec exposure

At guide speed:

5 sec west

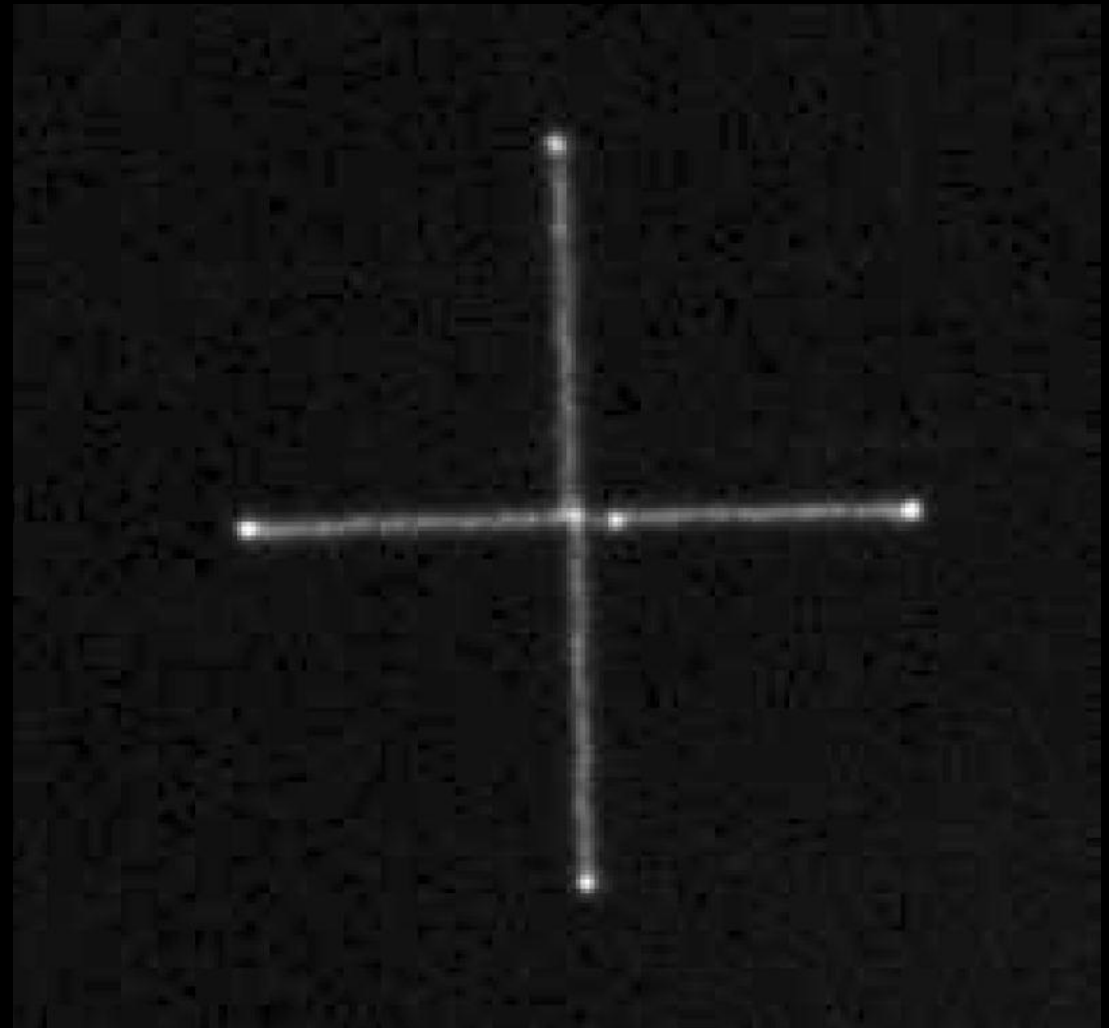
10 sec east

5 sec west

5 sec north

10 sec south

5 sec north



Look at the Mount's Behavior

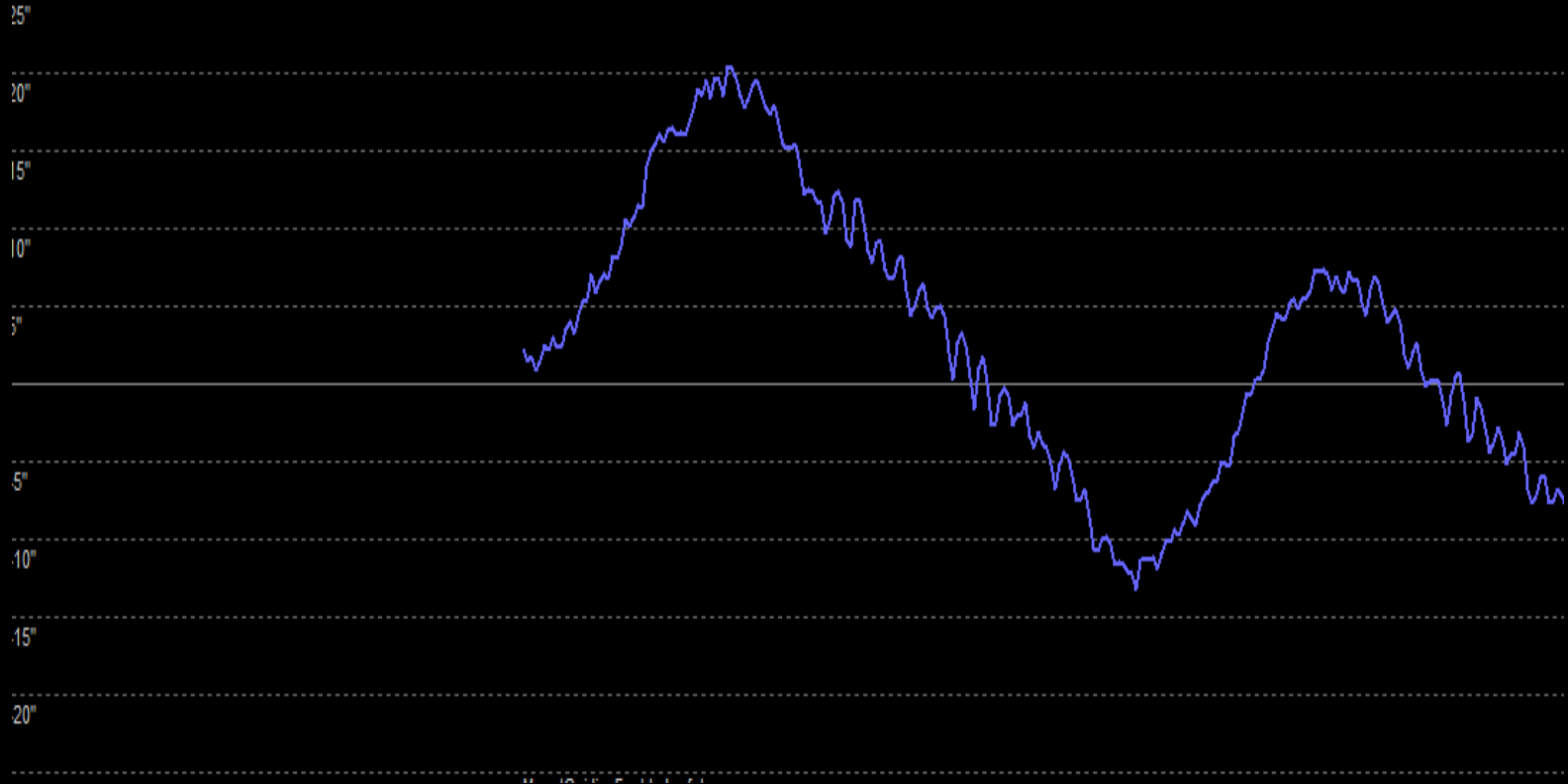
- Disable guiding and watch what happens for 10-15 minutes
- Use the Guiding Assistant
 - Declination backlash
 - RA and Dec drift and peak-to-peak ranges
 - Periodic error
 - Polar alignment error

Guiding Assistant Results

Other Star Motion

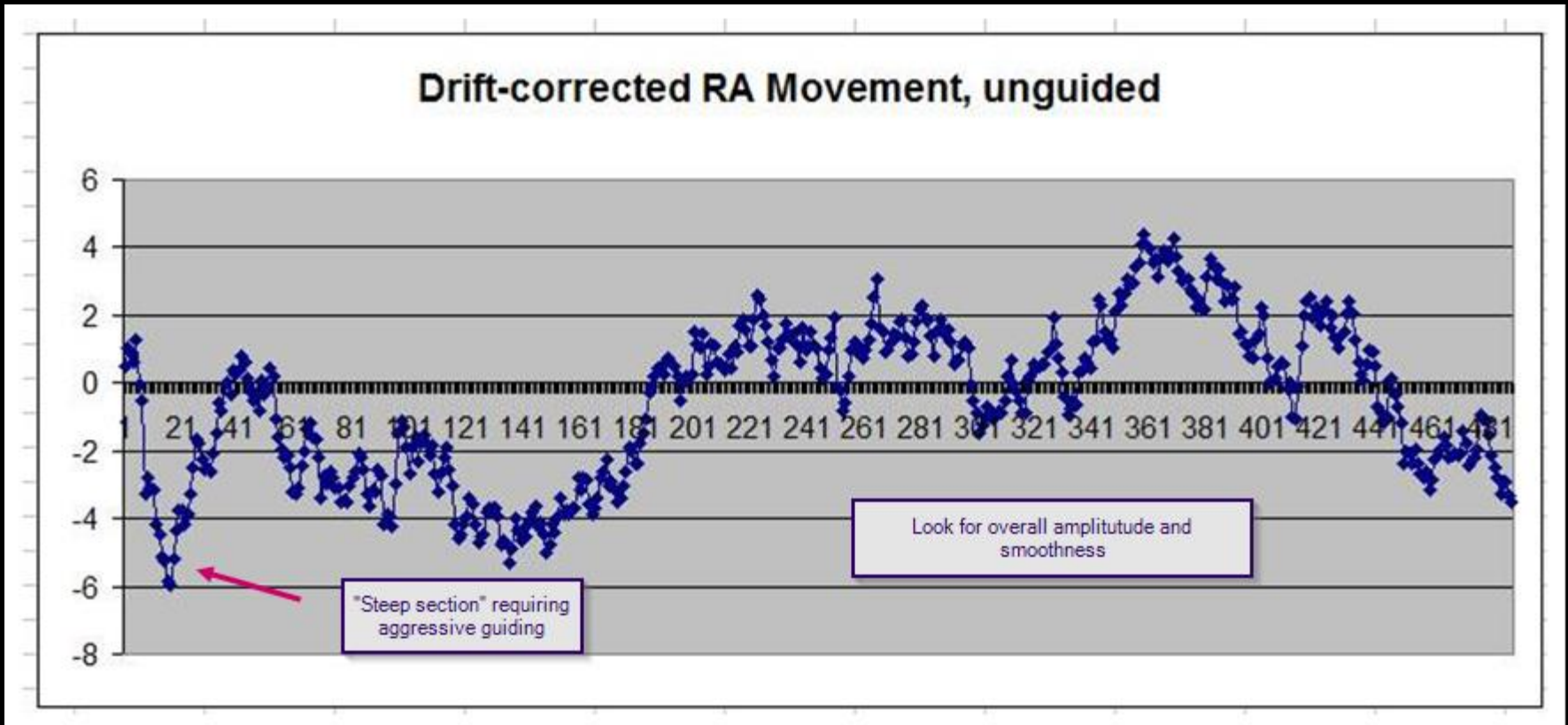
Right ascension, Peak	3.39 px (1.43 arc-sec)
Declination, Peak	2.51 px (1.05 arc-sec)
Right ascension, Peak-Peak	13.98 px (5.89 arc-sec)
Right ascension Drift Rate	0.78 px/min (0.33 arc-sec/min)
Right ascension Max Drift Rate	0.40 px/sec (0.17 arc-sec/sec)
Drift-limiting exposure	1.0 s
Declination Drift Rate	-2.42 px/min (-1.02 arc-sec/min)
Declination Backlash	
Polar Alignment Error	4.3 arc-min

Unguided Performance Examples



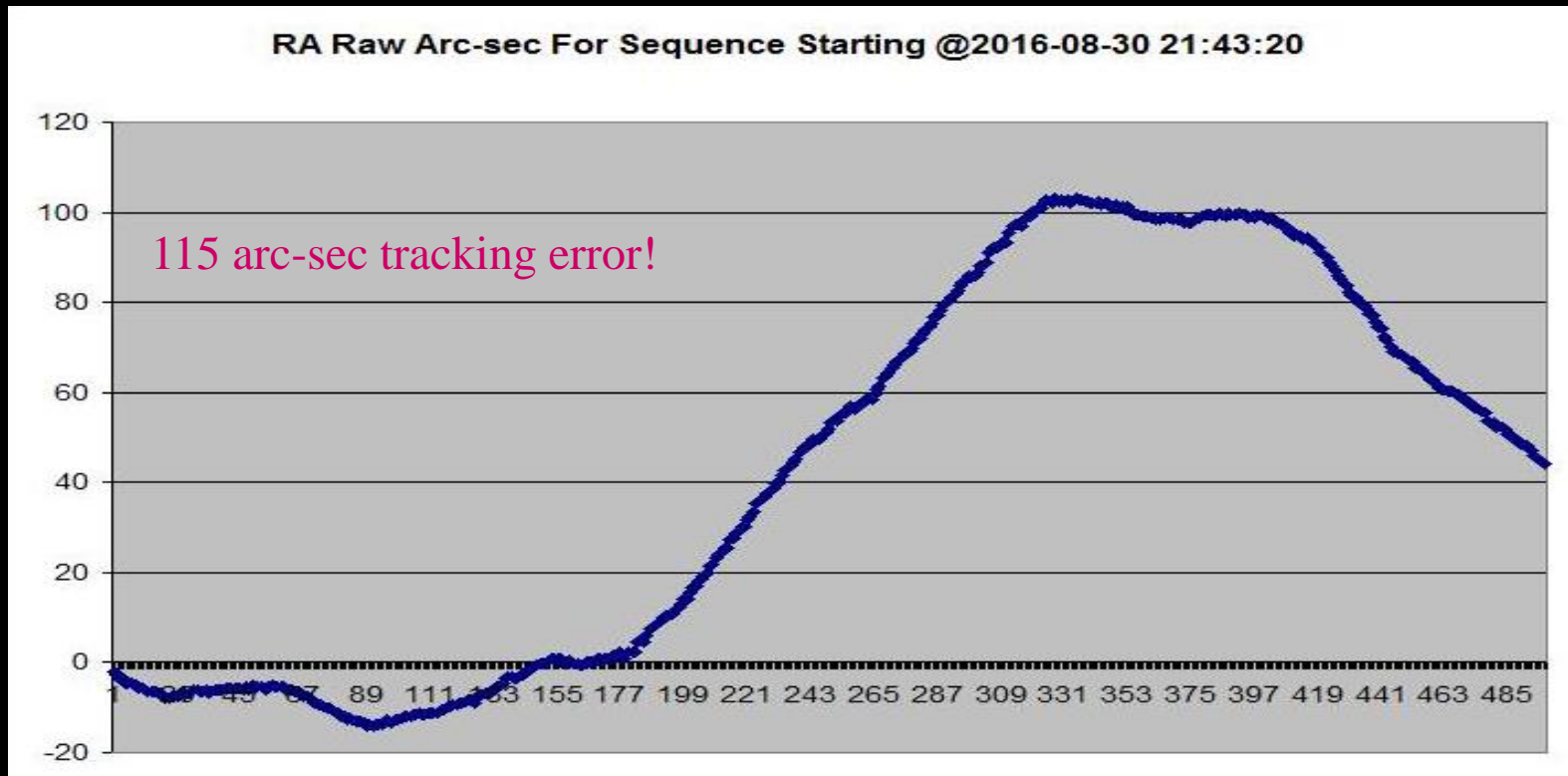
Mount RA tracking with No PEC

Unguided Performance Examples



Mount RA tracking with PEC Active

Unguided Performance Examples



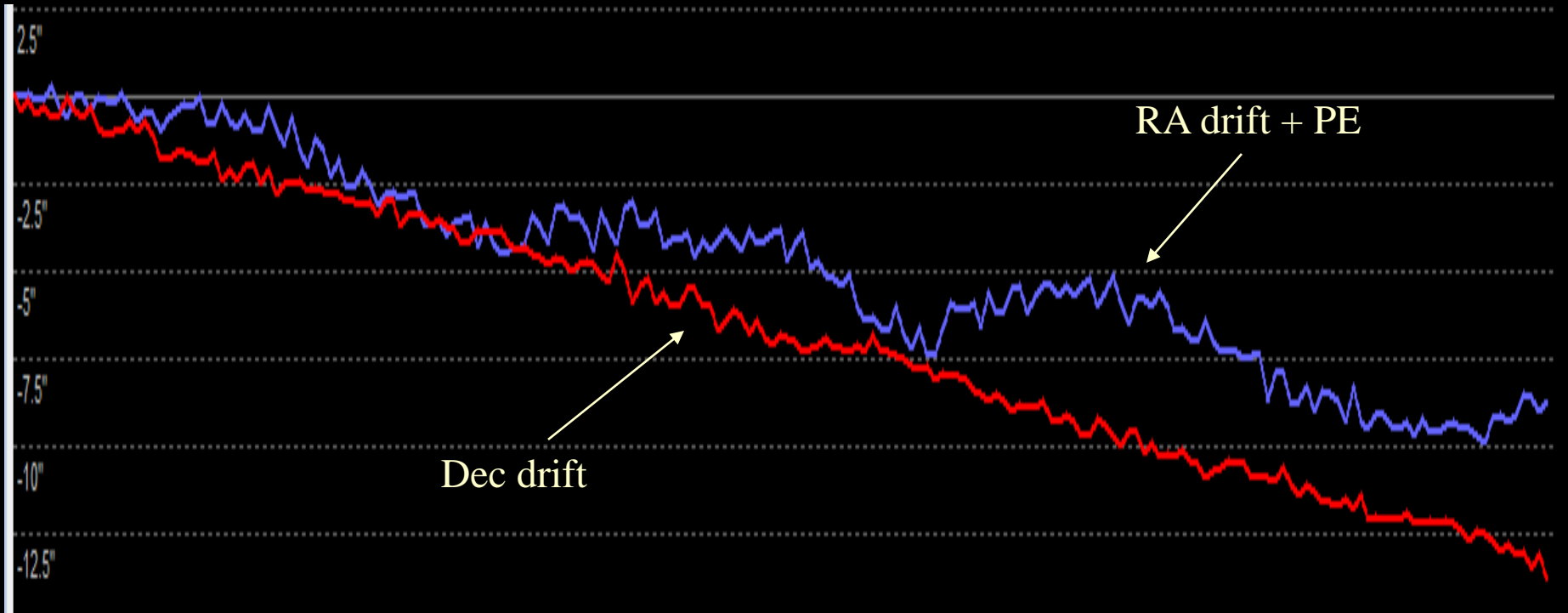
Huge RA Tracking Error

Unguided Performance Examples



Spikes in RA Tracking – Corrected with re-mesh and clean-up

Unguided Performance Examples



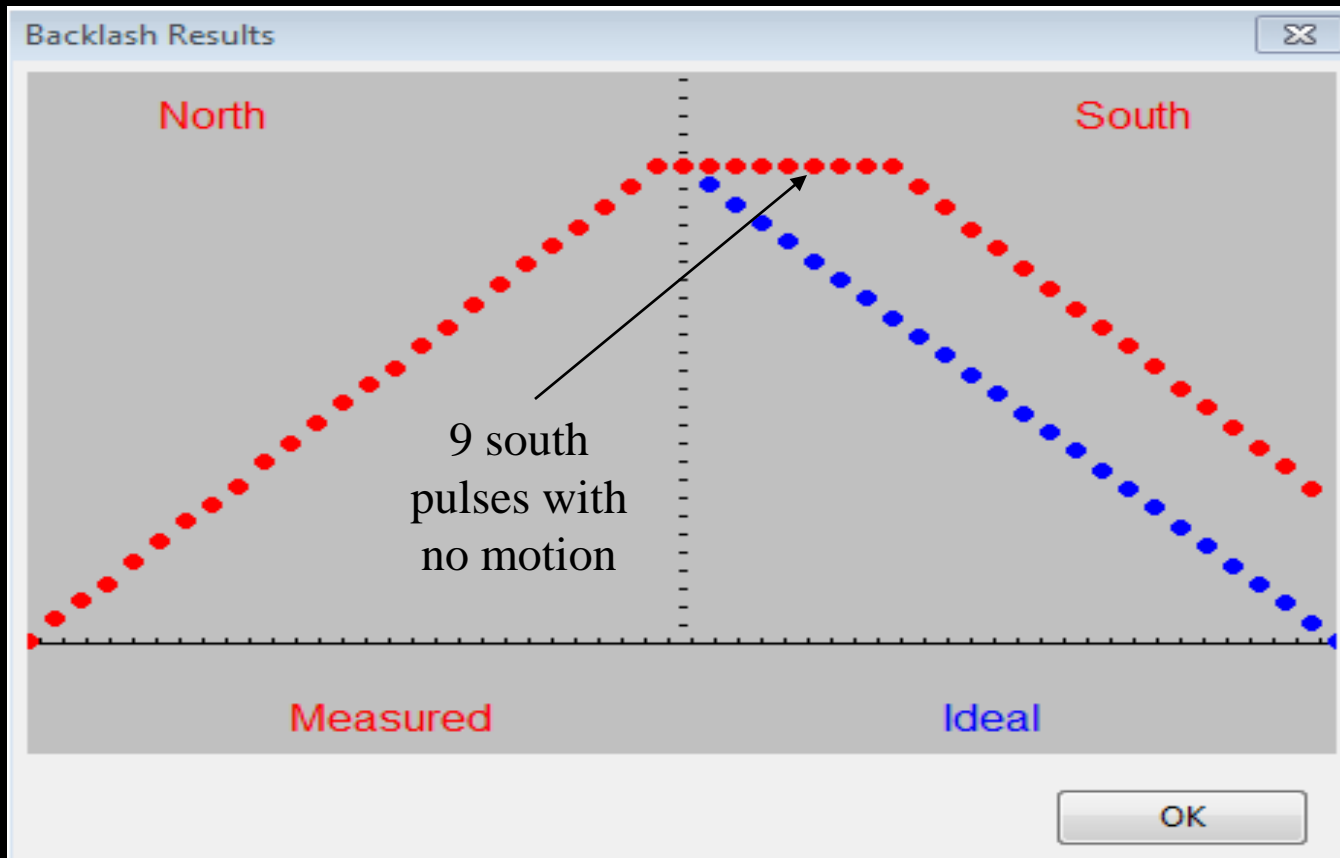
Dec and RA Drift Rates – Polar alignment and some flexure

Measuring Dec Backlash With The Guiding Assistant

Other Star Motion

Right ascension, Peak	0.40 px (1.32 arc-sec)
Declination, Peak	0.27 px (0.89 arc-sec)
Right ascension, Peak-Peak	0.40 px (1.32 arc-sec)
Right ascension Drift Rate	2.51 px/min (8.27 arc-sec/min)
Right ascension Max Drift Rate	0.04 px/sec (0.12 arc-sec/sec)
Drift-limiting exposure	2.9 s
Declination Drift Rate	-0.15 px/min (-0.49 arc-sec/min)
Declination Backlash	1.3 px (289 ms)
Polar Alignment Error	1.9 arc-min

GA Backlash Graph



Example of large Dec backlash

Perspective

Don't go crazy about this stuff –
it's a hobby!