PHD2 Best Practices

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Getting Started

- Use the new-profile wizard to specify connections

- Enter correct values for camera pixel size and *guide scope* focal length

- 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 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
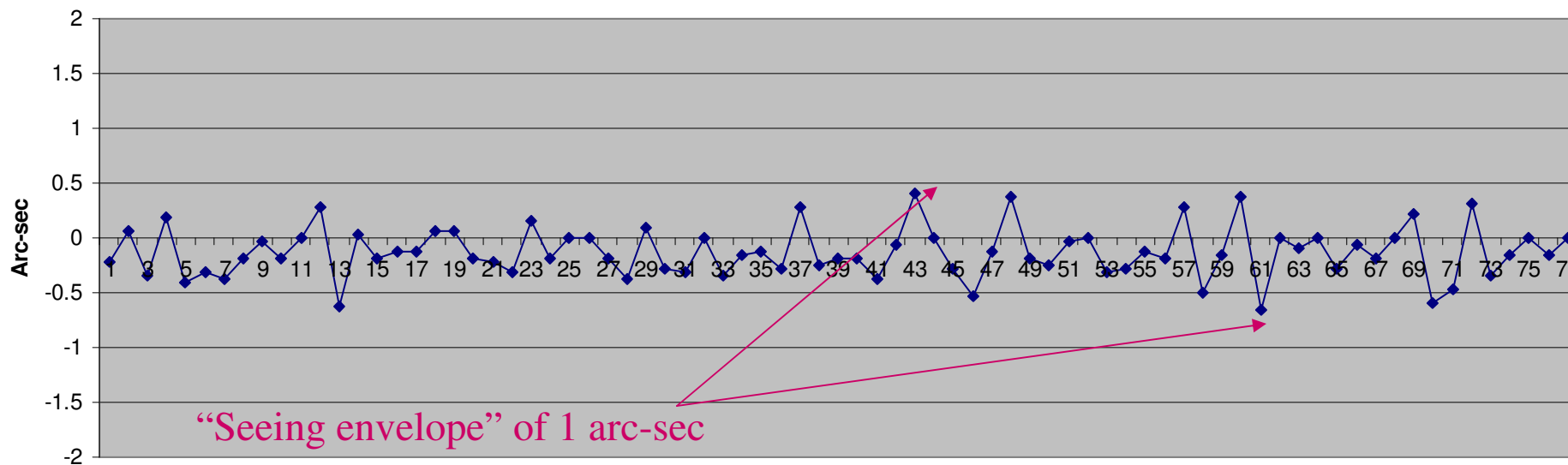
Looping

- Use guide exposure times in the 2-4 sec range if possible
  - You can't correct for seeing – ignore the siren's song of rapid, short exposures
  - Longer exposures average out seeing and make guiding easier
  - Keep the exposure short enough to react to the steepest tracking error – but not below 1 sec

1 sec guide exposures

Arc-sec

"Seeing envelope" of 3 arc-sec

4 sec guide exposures

Arc-sec

"Seeing envelope" of 1 arc-sec
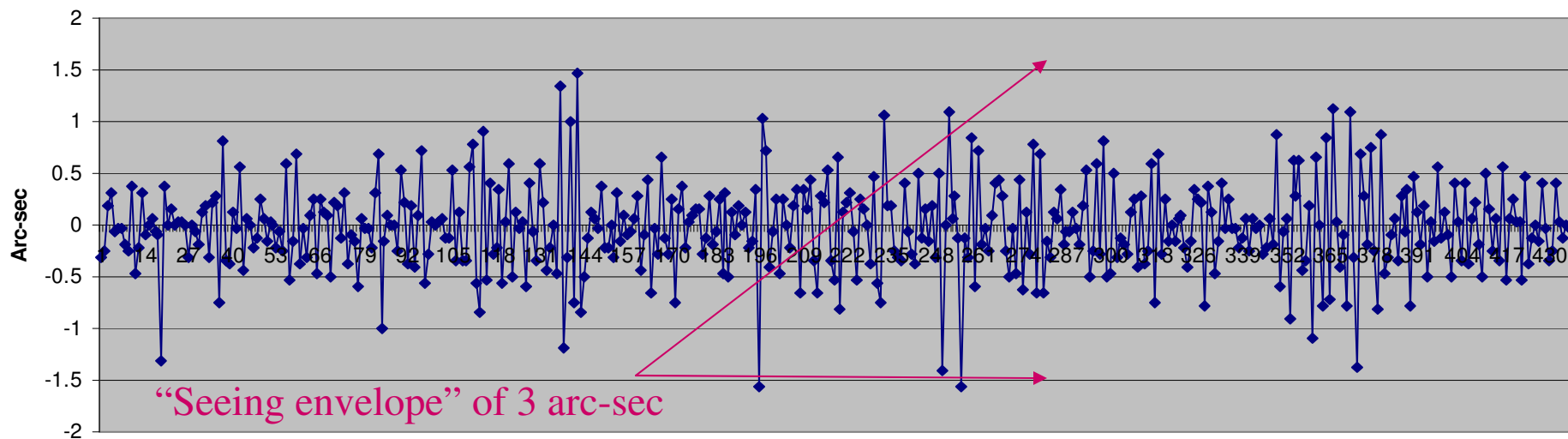
Looping

- Choose a suitable guide star
  - You can let PHD2 auto-select the star (<alt>s)
  - Adjust the gamma-slider to see all the stars
  - Don't pick a bright, saturated star
  - Increase the guide exposure if necessary
  - Use the star-profile tool to confirm focus and shape – you want a pointed top

Calibrating

- Get a good calibration, then re-use it
  - Within +/- 10 degrees of celestial equator (Dec=0)
  - Within an hour of celestial meridian
  - Don't ignore calibration alerts – use the help file to fix or work around mount problems

Calibration

- Set the 'Auto Restore Calibration' option in the Guiding tab of the Brain dialog
- Re-do calibration only when necessary
  - Equipment change in existing profile (don't do this)
  - 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 the drift alignment tool to get within a few arc-minutes of the pole
  - 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	3	arcmins	Convert MM.SS
Guide Star Angle	1	degrees	Convert MM Convert D.MMSS
Focal Length	2540	millimeters	
Time	10	minutes	Convert seconds Convert MM.SS
→ Declination	70	degrees	Convert DDD.MMSS

Calculate

→ Field Rotation 4.95 microns

Field rotation of < 1 px for common set-ups

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
- Drift align when stars are first visible
- Start guiding

Scenario 2: Permanent Setup

- Reload profile with existing calibration
- Run the GA for 1-2 minutes if you want to check seeing conditions
- 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
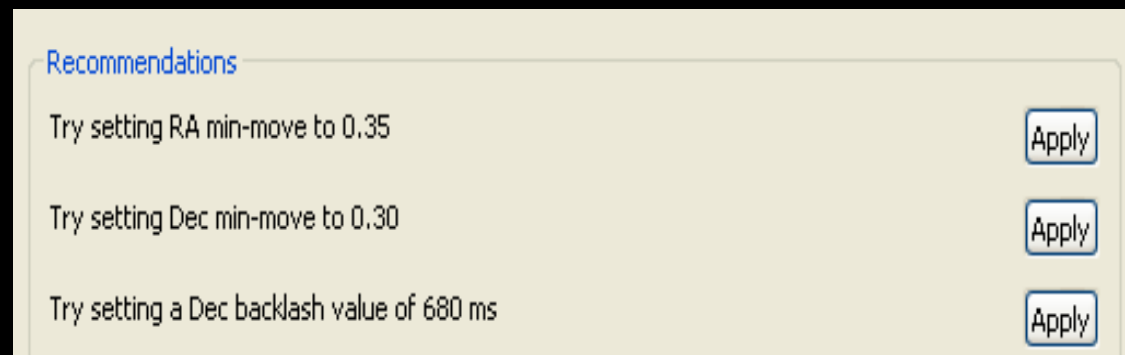- Stay away from all the "tuning" and correction features in EQASCOM

Deal with Backlash

- Less-expensive mounts often have substantial Dec backlash
  - Adjust the gear mesh if you can
  - Use uni-directional Dec guiding if you can't improve the mount
- Ignore RA backlash – it's irrelevant if guide speed is <= 1x sidereal

Use the Guiding Assistant

- Better understand your mount's behavior
- Get a sense of your seeing conditions
- Measure the backlash at least once
- Pay attention to the GA recommendations

GA
Example

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

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

- Remember that under-correction is better than over-correction

*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)

What If the Guiding Looks Bad

- Be sure to look at the numbers
  - Reset to the default guiding parameters
  - Use the guiding graph or review the log afterward: 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 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
  - 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 10-sec samples
  - 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 often but not always
  - Move the mount north at guide speed for 20 seconds before starting the calibration

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
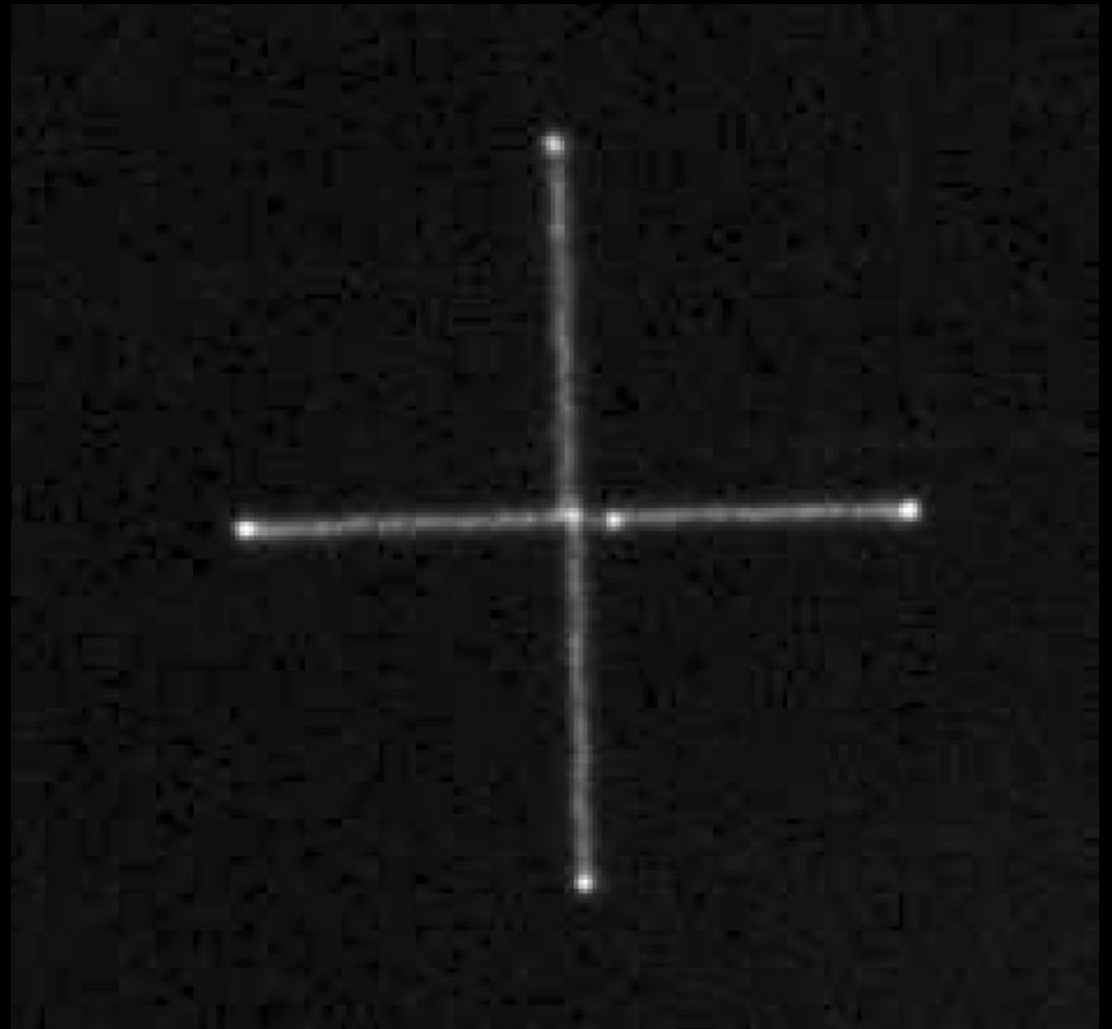
Look at the Mount's Behavior

- 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
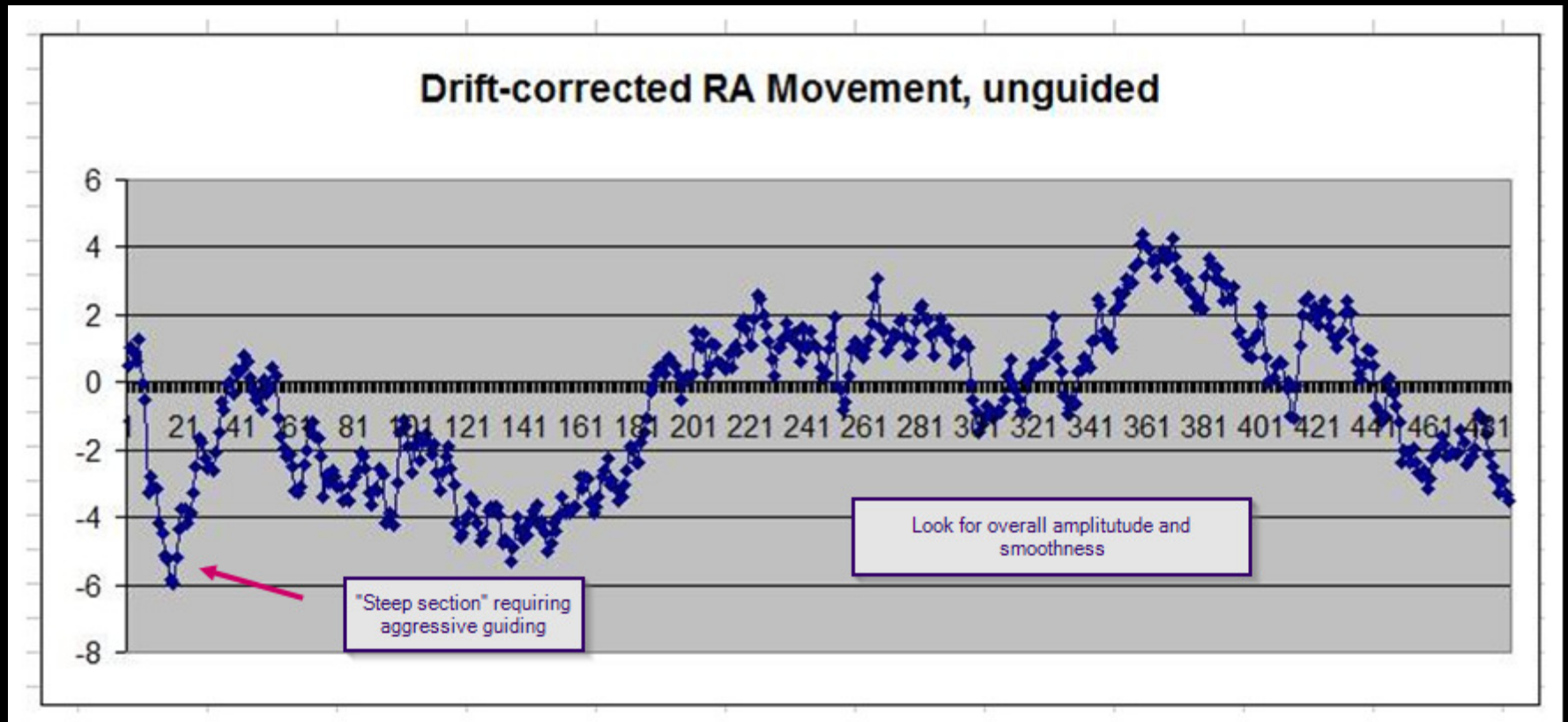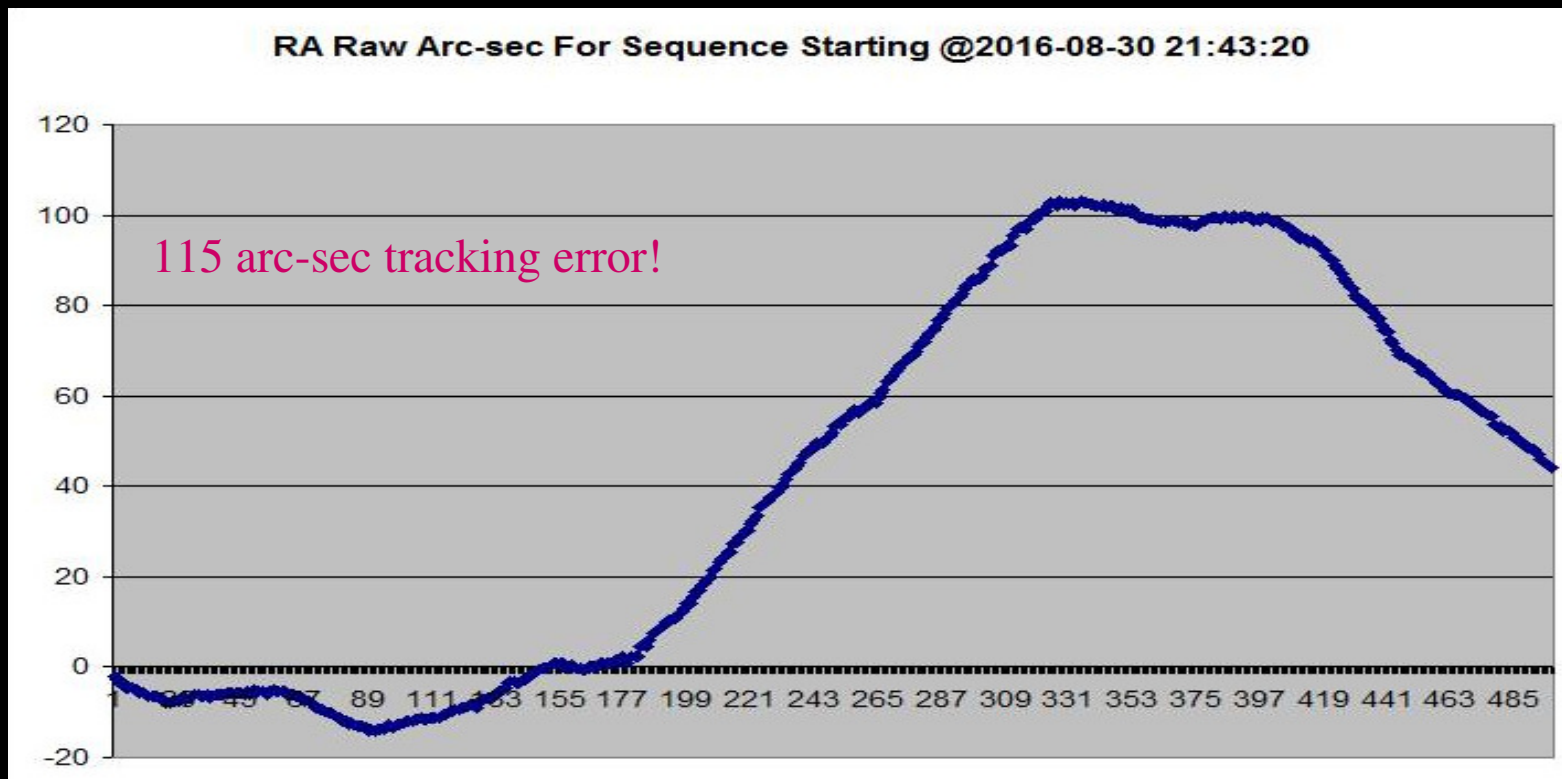
Guiding Assistant Results

Unguided Performance Examples

Mount RA tracking with No PEC

Unguided Performance Examples

Mount RA tracking with PEC Active

Unguided Performance Examples

RA Raw Arc-sec For Sequence Starting @2016-08-30 21:43:20
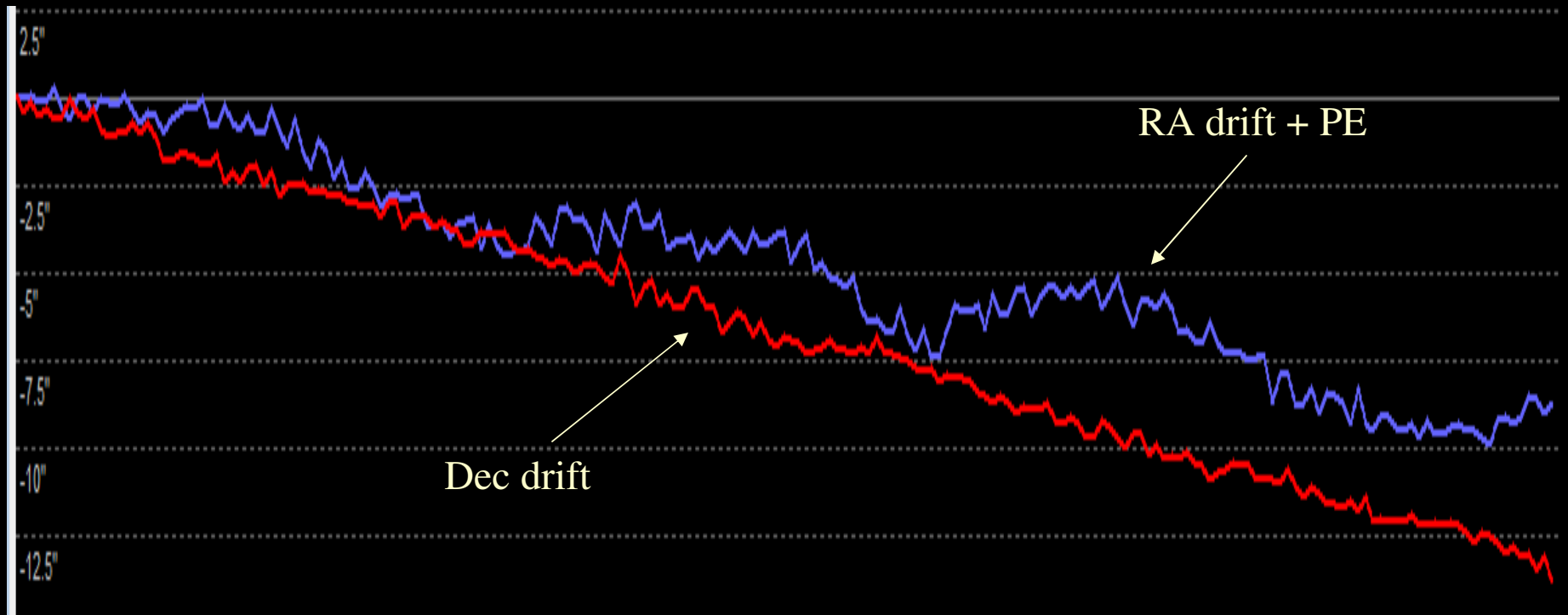
115 arc-sec tracking error!

Huge RA Tracking Error

Unguided Performance Examples

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

Unguided Performance Examples

RA drift + PE

Dec drift

Dec and RA Drift Rates – Polar alignment and 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
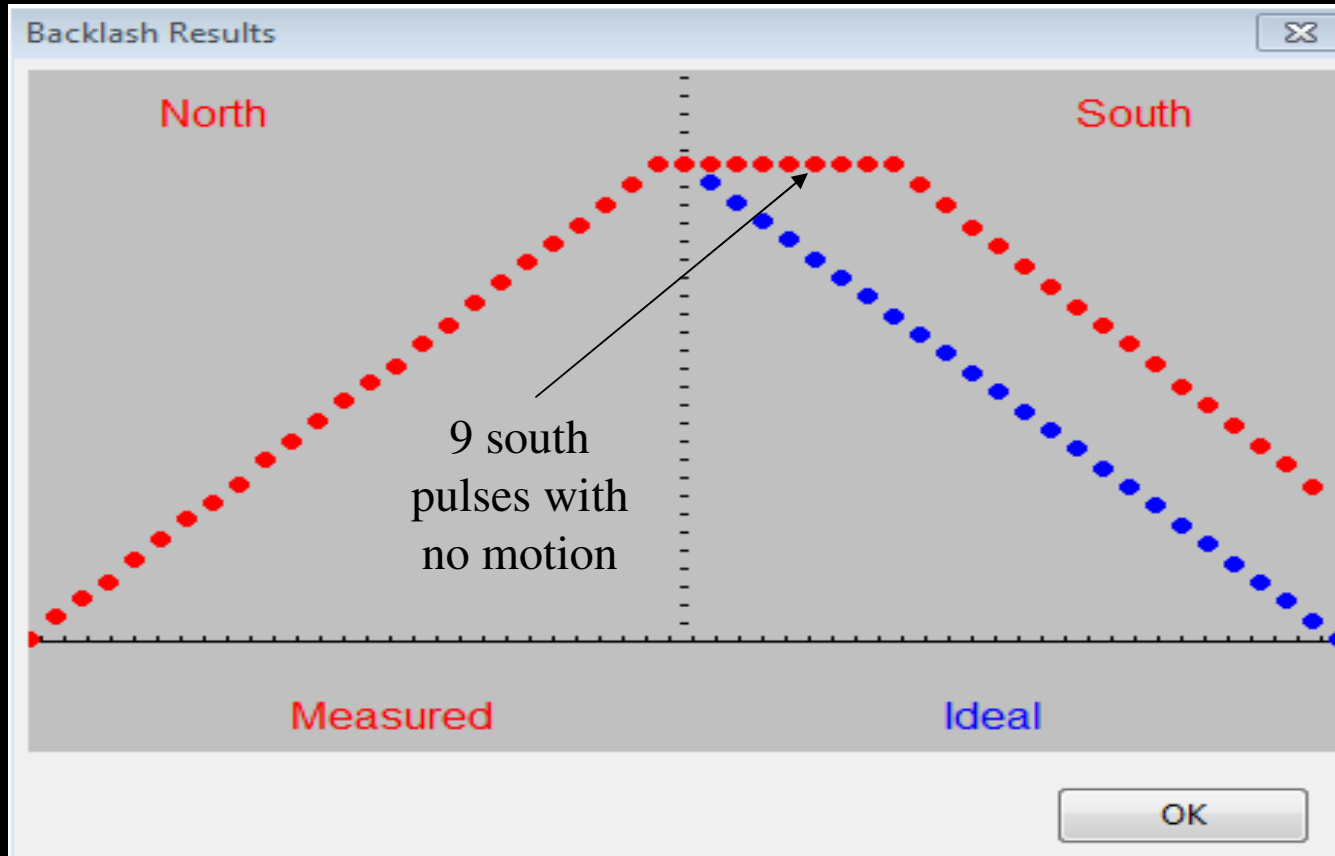
Example of large Dec backlash

Perspective

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