Commissioning of a new ING DIMM at ORM

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Overview

- Introduction to Seeing + DIMMs.
- The new DIMM (R2D2).
- Initial R2D2 tests (internal and with old DIMM),
- Problems with R2D2 commissioning + solutions.
- R2D2 at present.
- Comparison of new DIMM with old ING DIMM.
- Comparison of seeing measurements with two ING DIMMs, TNG DIMM and WHT.
Seeing

- Seeing is the apparent “twinkling” of stars.
- Turbulent layers of air refract light and disrupt the wavefront.
- This “blurs” the star during an exposure.
- The size (or FWHM) of the resulting seeing disk is measured in arcseconds.
- Seeing limits resolution of astronomical observations and causes scintillation.
Need to monitor the seeing for quality control and the planning of observations.

Differential Image Motion Monitors (DIMMs) are used.

DIMMs have two entrance apertures which produces two images of the same star separated by the distance between apertures.

Differential motion of the two images is used to produce a seeing measurement.

Effects of windshake or tracking errors are essentially negligible.

What’s a DIMM?
DIMMs at ORM

- ING’s RoboDIMM (RD), next to the William Herschel Telescope.
- IAC DIMM and TNG DIMM.
- Generally comparable seeing measurements, but TNG DIMM seems to measure better seeing — due to location on mountain?
RoboDIMM2 ("R2D2") is a new DIMM located in the same tower as RoboDIMM.

Advantages over RoboDIMM:
- Faster CCD readout - seeing measurements every 40s instead of 4 minutes.
- More robust and accurate mount.
- Can recover pointing after power loss.

Based on the TNG DIMM.

First light September 2018.
Early work focused on comparing R2D2 to RoboDIMM as a check.

Certain nights showed different seeing measurements between DIMMs (despite being in same tower).

Also having many problems with R2D2 not finding (or losing) stars. More on this later.
● Different stars being tracked - cause of discrepancy?
DIMM Images
R2D2 Internal Tests

- Two seeing measurements - transverse and longitudinal.
- Found large discrepancies between the two some nights.
- Image scale? CCD rotation? Need to test on sky.
Spent several nights at the WHT controlling and monitoring the DIMMs to check different aspects of R2D2.

These tests included:
- CCD image scale test (measure distance between binary star pair on the CCD).
- Focus test.
- CCD orientation.

Noticed while performing these tests that the DIMM pointing was very bad.
Still having problems with R2D2 not finding stars, or losing them mid-measurement.

On a DIMM test night in late February, this was solved:
  ○ Manually created a 16 star pointing model by slewing to known stars and centering them in the CCD FOV by hand.
  ○ Success! R2D2 is now consistently finding stars and all are fairly well centred.

Further problems (memory leaks + server crashes), but all were eventually solved.
R2D2 Now

- Consistently finding stars and continuing to track them properly.
- Memory leak and server problems fixed.
- Overall R2D2 operating as planned.
- Measuring differences against TNG DIMM - likely due to position on the mountain.
- Need to check with old DIMM (RoboDIMM) to ensure there’s no discrepancy.
R2D2 Now

Feb 20 - July 01
R2D2 Now

- Distributions are very close:
  - R2D2 Mean = 0.89
  - RoboDIMM Mean = 0.91
  - R2D2 Median = 0.78
  - RoboDIMM Median = 0.82

- RoboDIMM seems to systematically report slightly higher seeing measurements.
- Data taken from periods of stable seeing for both DIMMS, from Feb 20th until the present.
- Gradient is less than 1
  ⇒ RD tends to measure slightly higher seeing

RD Gradient = 0.972 +/- 0.001
RD Intercept = -0.0 +/- 0.0
Correlation Coefficient (R^2) = 0.9004620032082521

L/T Ratio Median = 1.0067327055157127
L/T Ratio Mean = 1.0032407701842825
R2D2 seeing measurements are consistent with RoboDIMM measurements.

- Slight (<0.1") offset in values reported
  - RoboDIMM more sensitive to higher seeing values.
- Data binned every 5 minutes for both DIMMs:
  - Number of 5 min periods with measurement(s):
    - R2D2 = 37499
    - RoboDIMM = 37516

⇒ R2D2 is reporting seeing values 99.95% of the time that RoboDIMM is.
With R2D2 reliably working, we can look into how seeing varies over the observatory site.

- ING DIMM tower is ~75m away from the WHT dome.
- Night of 2019/06/18 is very interesting - DIMMs show spike in seeing over 2hrs while TNG DIMM reports stable seeing.
- Continuous observations with LIRIS performed on this night, so can compare ING DIMMs with TNG DIMM and WHT.
Comparison with WHT Seeing
2019-06-19
- Spike in seeing around 00:00UT not seen by WHT!

- Evidence that bad seeing events can be localized.

- Bad DIMM seeing may not mean bad WHT seeing, despite being only ~75m apart.
Summary

● R2D2 is now working and following RoboDIMM measurements 99.95% of the time.
● Consistency in seeing reported by the two ING DIMMs.
● Differences between ING DIMMs and other DIMMs likely due to local seeing variations.
● Periods of bad seeing can be very localised; reported bad DIMM seeing may not be seen at WHT.