UPDATE ON POLARIZATION ALGORITHM

SQWG MTR
Feb 2016

P. Liebing, IUP Bremen

Outline

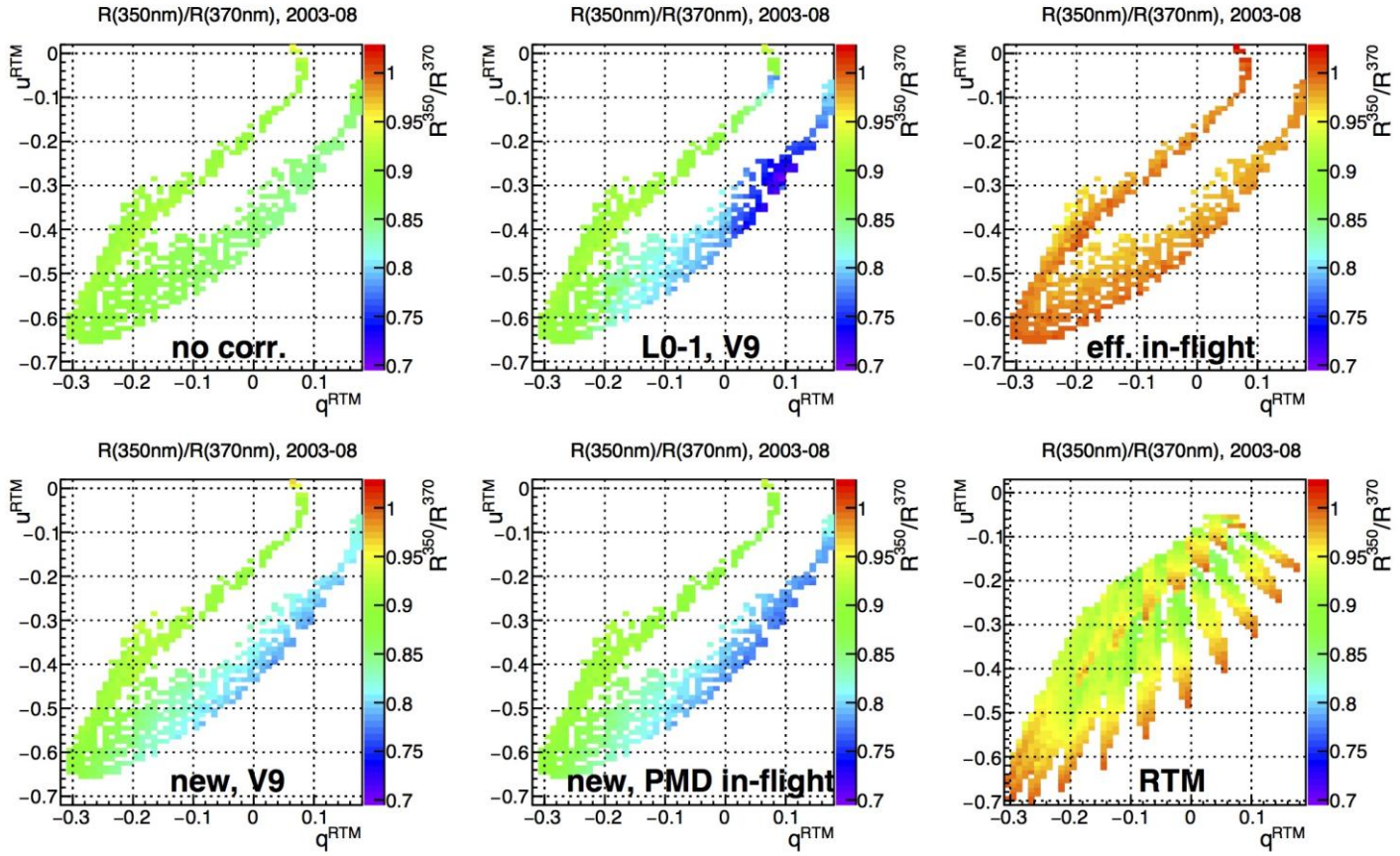
- Update on 350 nm feature
- Update on nadir algorithm for “insensitive”geometries
- Phase shift

The Infamous Feature

- TN showed that polarization correction does not improve the feature at 350 nm in limb
- That was a bug! (Don't ask)
- Indeed it's not as bad:

The Infamous Feature

- Effect of polarization correction (limb) on R(350nm)/R(370nm) vs. expected (q,u) (with bug):



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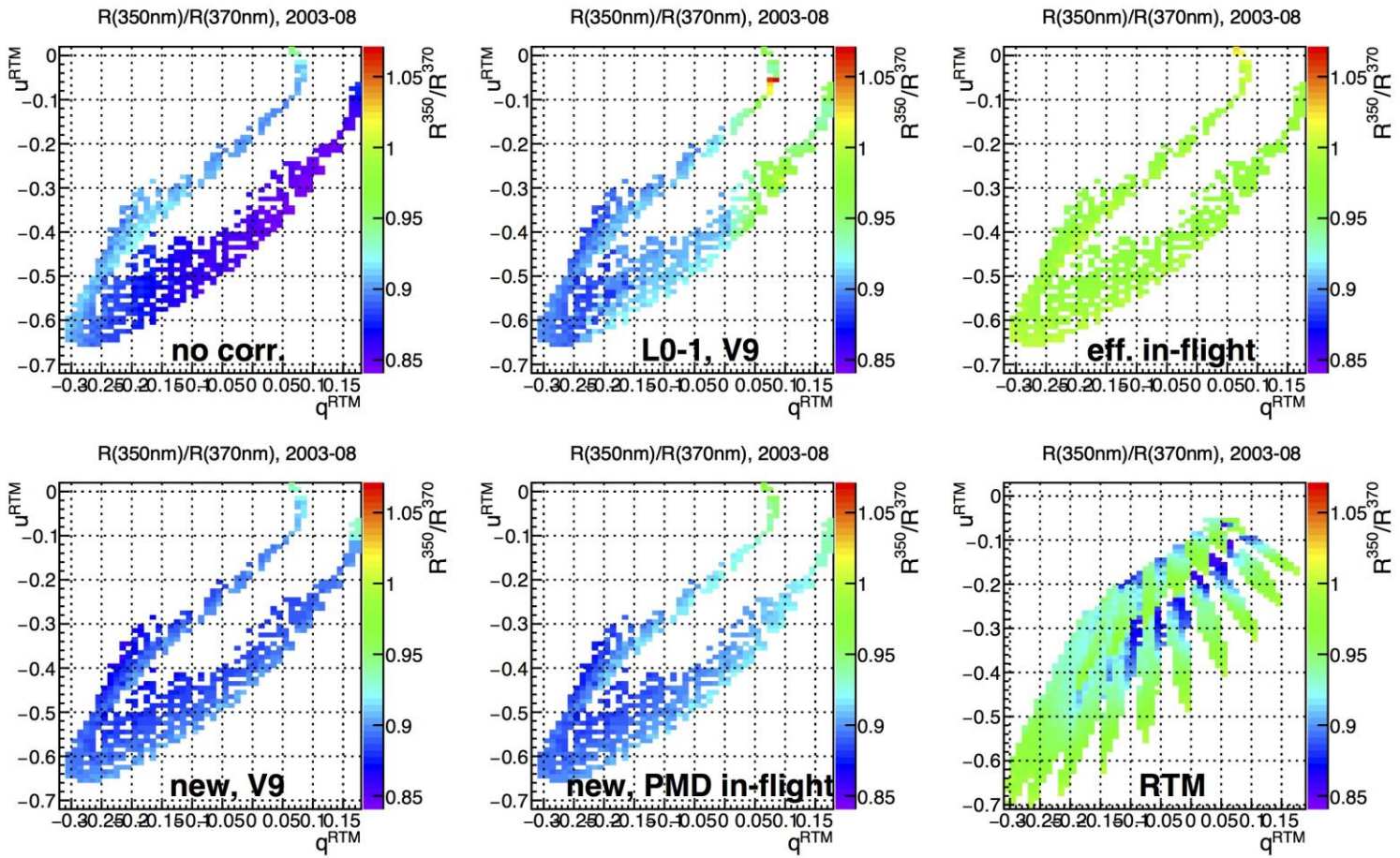


The Infamous Feature

- TN showed that polarization correction does not improve the feature at 350 nm in limb
- That was a bug! (Don't ask)
- Indeed it's not as bad:
  - With polarization correction from new algorithm the ratio R(350nm)/R(370nm) is more similar to expected behavior
  - Even though polarization values from in-flight MMEs are more realistic than the pure mirror model ones, R(350nm)/R(370nm) does not improve drastically compared to MM
  - See below …

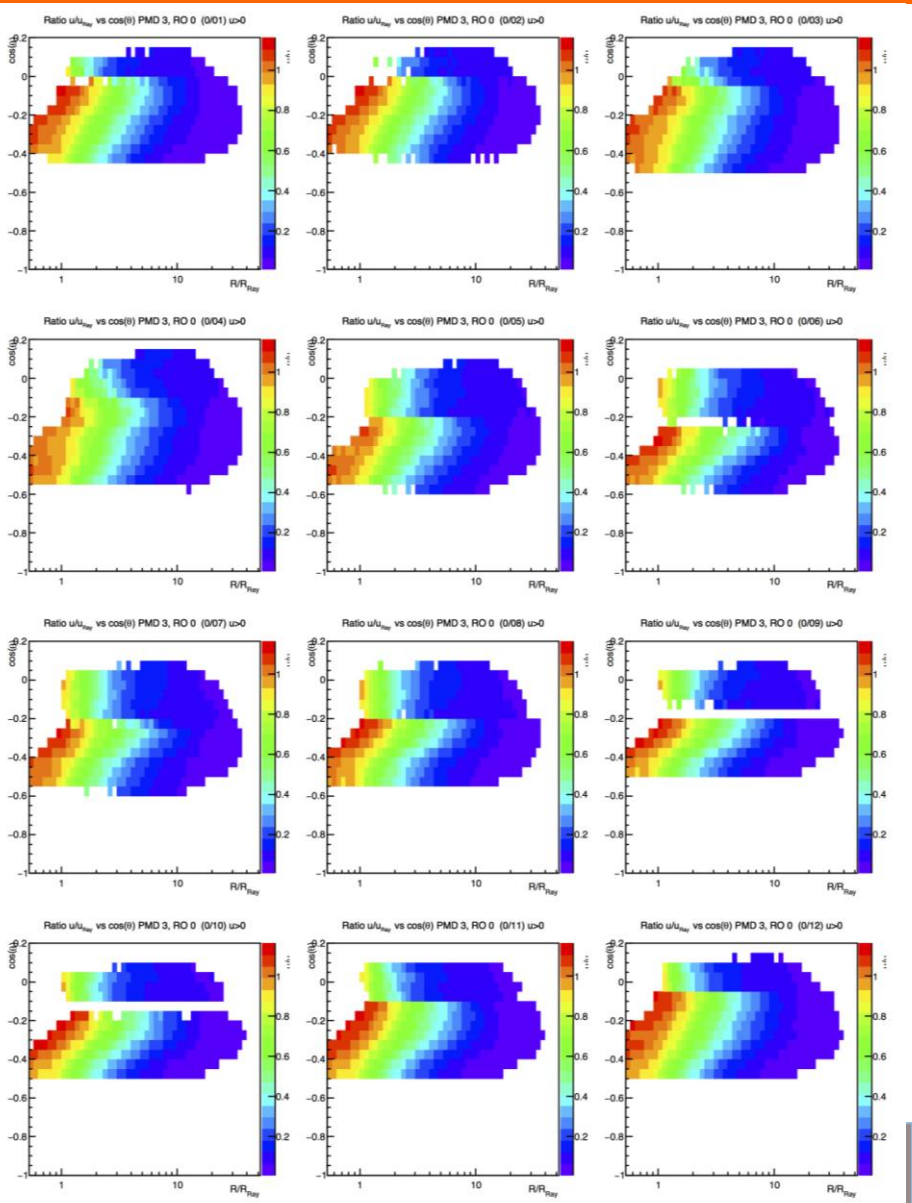
Nadir Polarization

- Exact strategy for nadir measurements with low polarization sensitivity was still missing
  - Neither extensive RTM nor representative data available (PARASOL only for one month, only PMDs 2-4)
- The stupid (but ingenious ;-)) solution is to just take SCIA data.
- Though again involves the use of LUTs as a function of:
  - Readout (i.e., ESM angle)
  - Season (i.e., month)
  - The sign of u (!) (or of tan( ))
  - Surface (land or ocean)
  - Scattering angle
  - Reflectance
- TN has already been updated, can be released any time soon

Nadir Polarization

Example: PMD 3 for readout 0 for each month

- Strategy: Use the results for $u(PMD)/u_{RTM}$ for measurements with high sensitivity and average, fit and smooth to cover all possible geometries and reflectances
- Separation into readouts, seasons etc. to get most representative distribution



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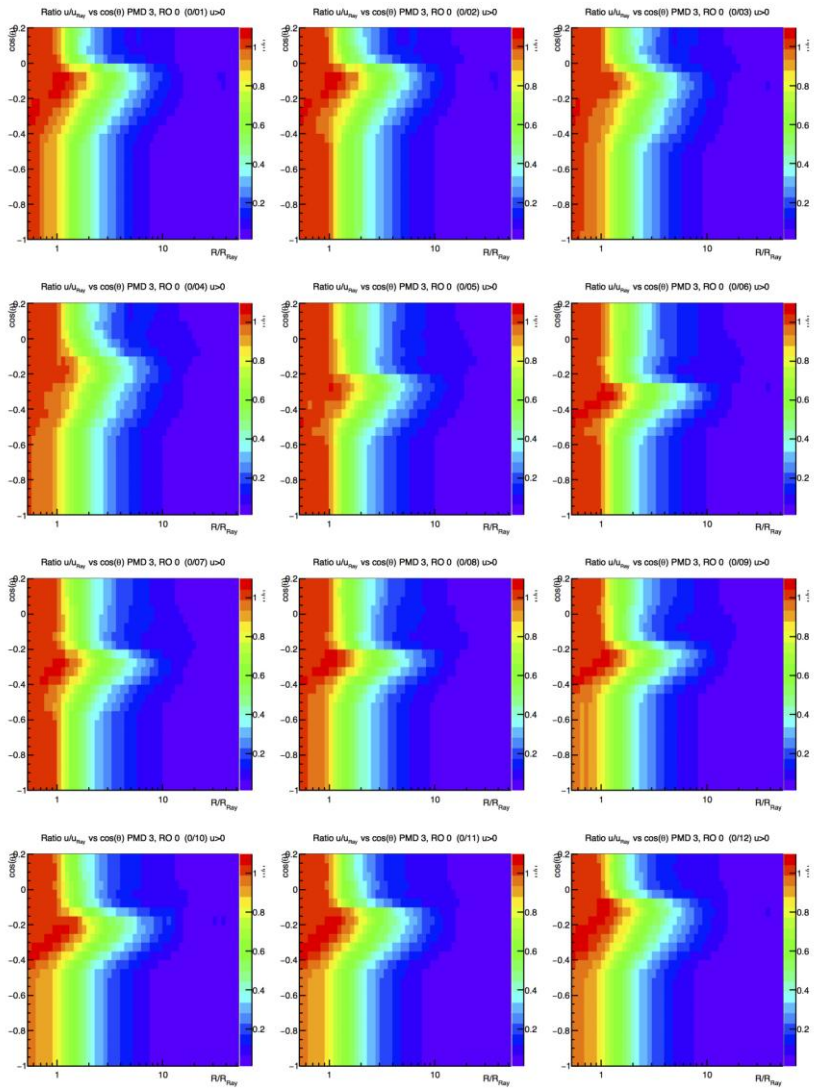

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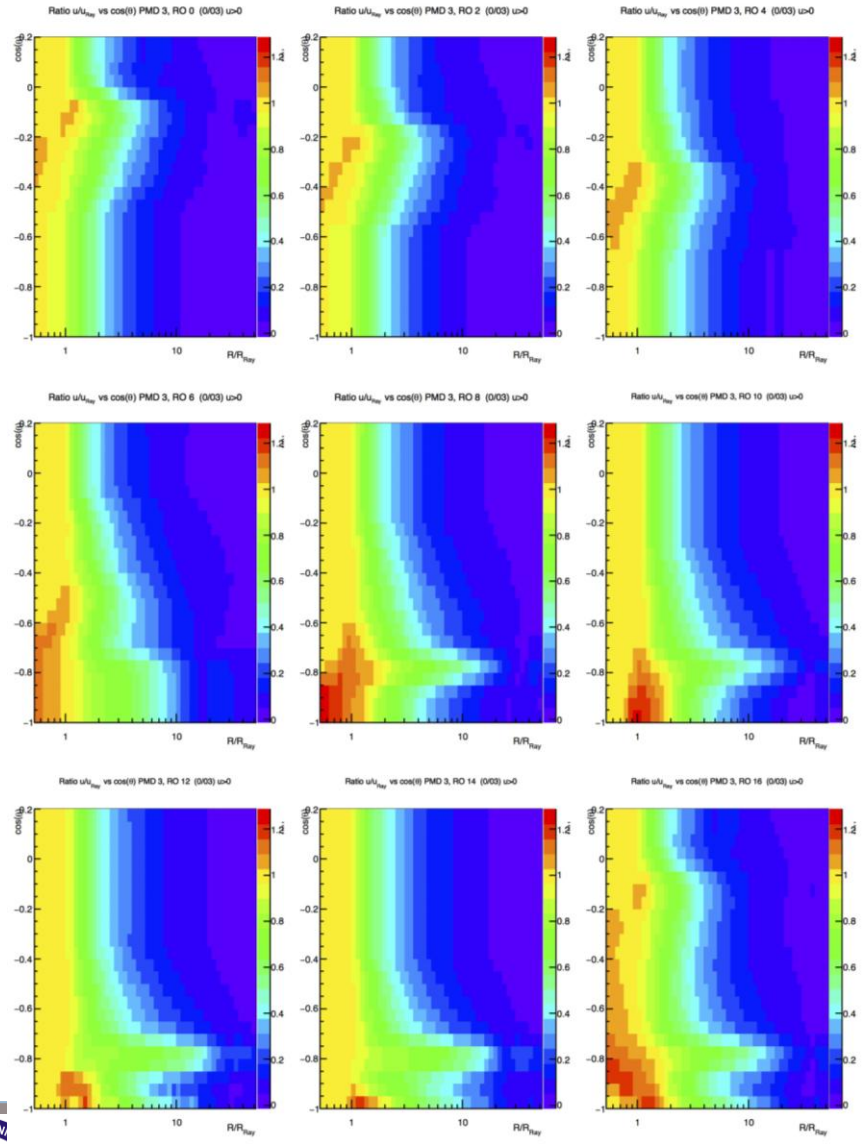
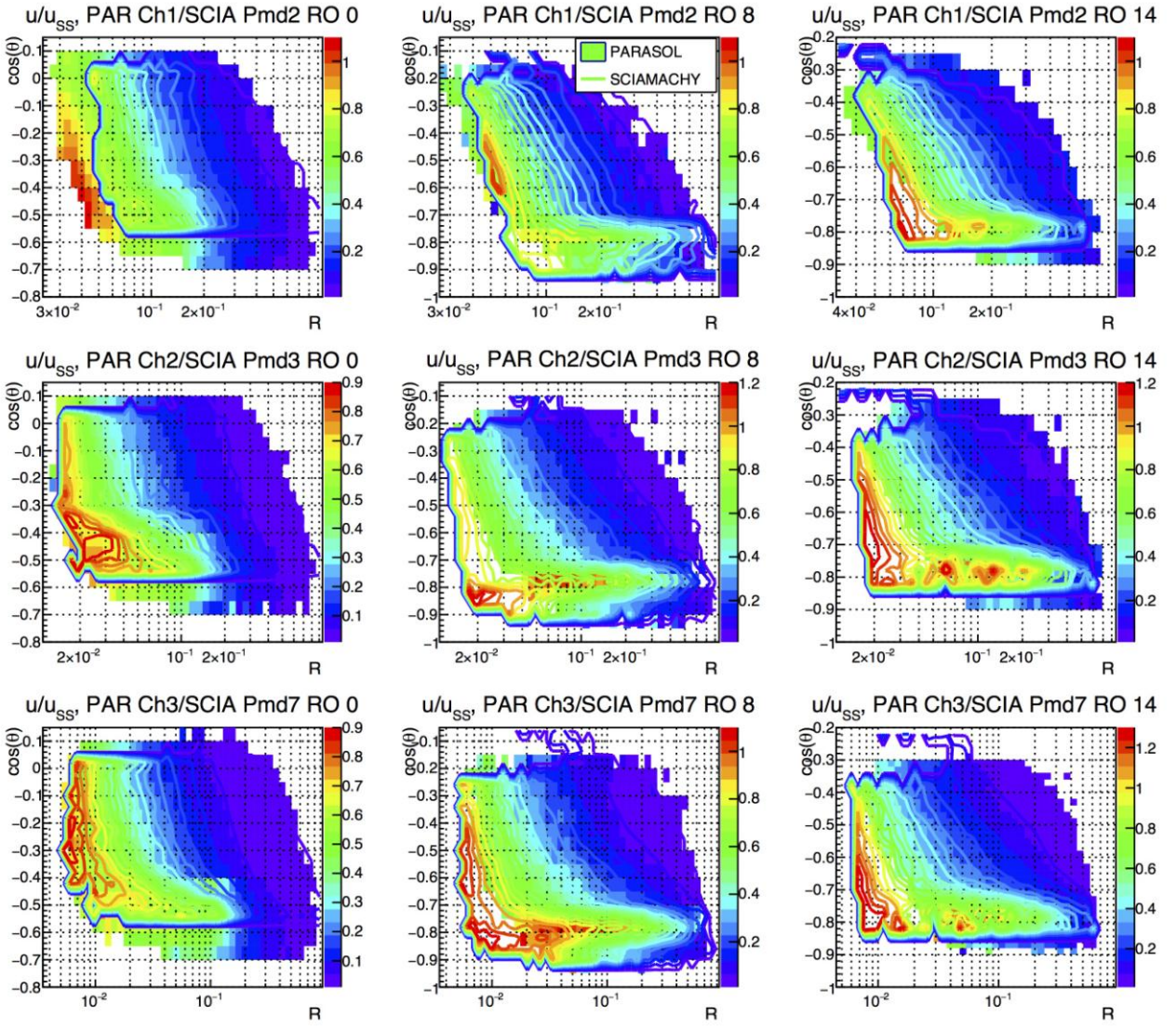


Nadir Polarization: Validation

- SCIA-PARASOL comparison (2007-08)
- Same viewing angles, roughly the same latitudes
- u/u_{SS} vs. cos(\) and reflectance
- Box color plot = PARASOL
- Contours = SCIA



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The (Retarder) Matrix Revisited

- What about that dreaded phase shift?
- Remember: With V8 key data it was not possible to find a sensible phase shift that consistently explained limb and nadir in-flight polarization
- Eventually, an error in the mirror model was found by Thijs and Ralph, which fixed nadir MMEs and improved Limb MMEs ➔V9 key data
- However, UV-VIS limb MMEs still differ from in-flight
- Could an instrumental phase shift fix this?

The (Retarder) Matrix Revisited

- Once more: fit retarder parameters to in-flight "effective MMEs"
  - Retarder angle $\backslash$
  - Retardance (the actual phase shift): ^{TM} at 300 nm (evolves as $\sim 1/\lambda$)
- Fit the PMD phase shift w/o a science channel phase shift
  - It does not make much of a difference
  - Only look at PMD 1 and 2
- Fit a science channel phase shift to R(350nm)/R(370nm)

The (Retarder) Matrix Revisited

- Limb and Nadir would still give mutually distinct minima
  - **Though they are close!**
- Consider systematic errors?
- Nadir MMEs from mirror model agree within errors with in-flight:
  - Contrain phase shift from limb by requiring to not make nadir worse!

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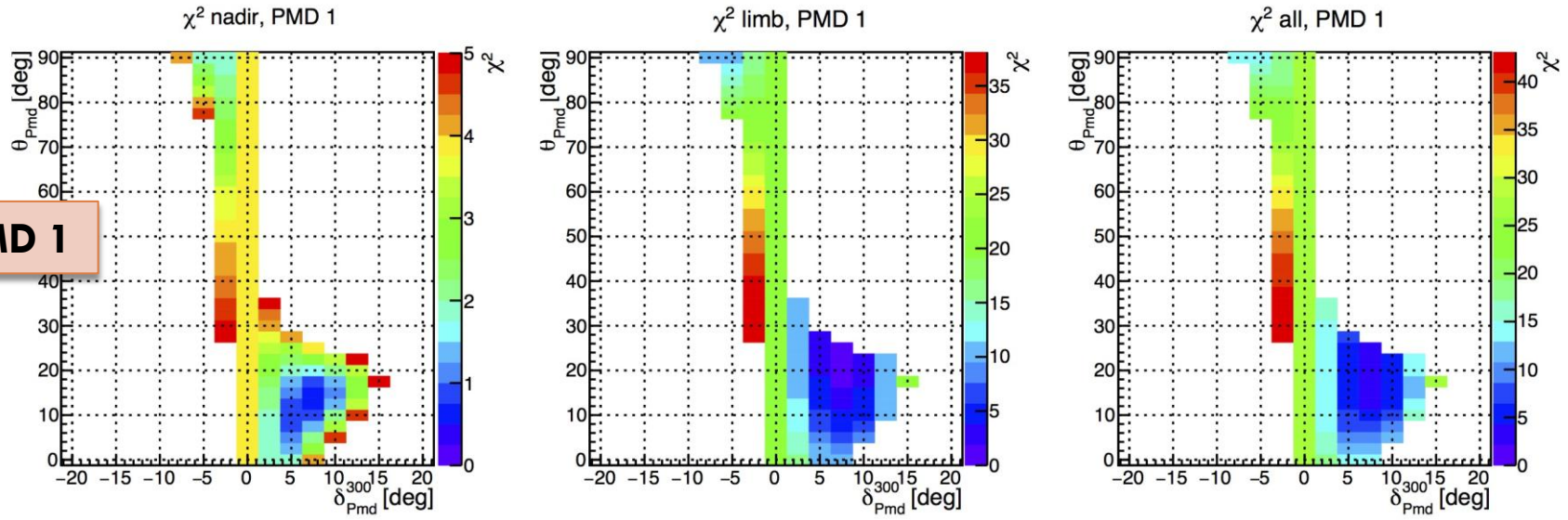

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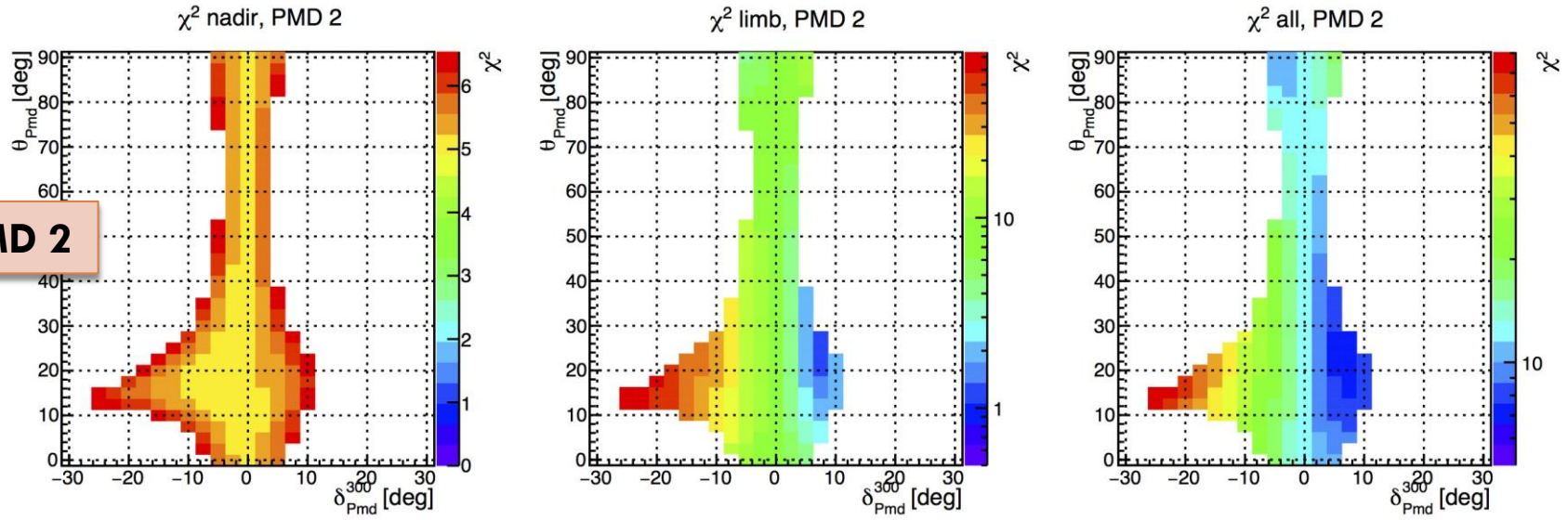
PMD 2



  - Note: parameters for PMDs 1+2 are roughly the same!

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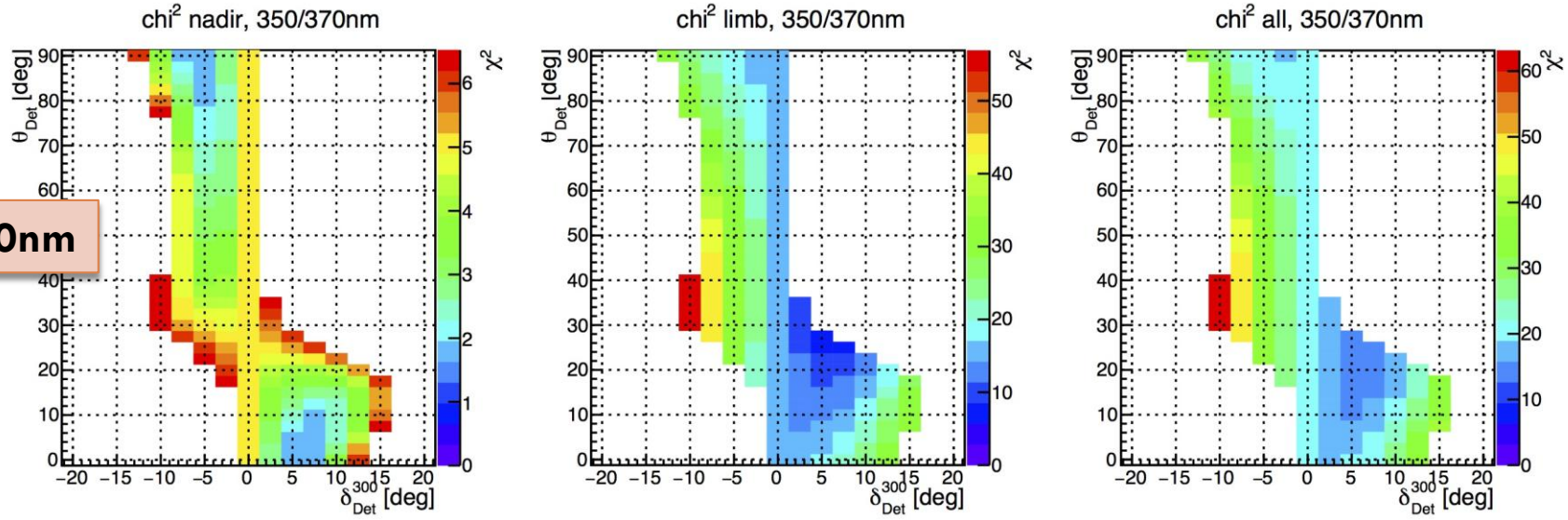
350nm



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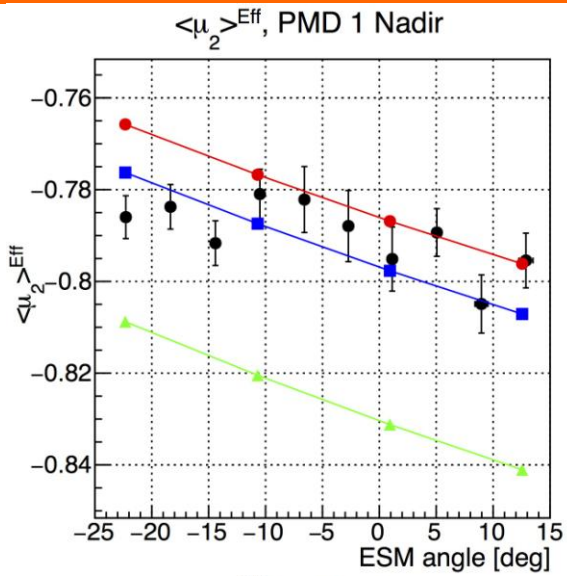
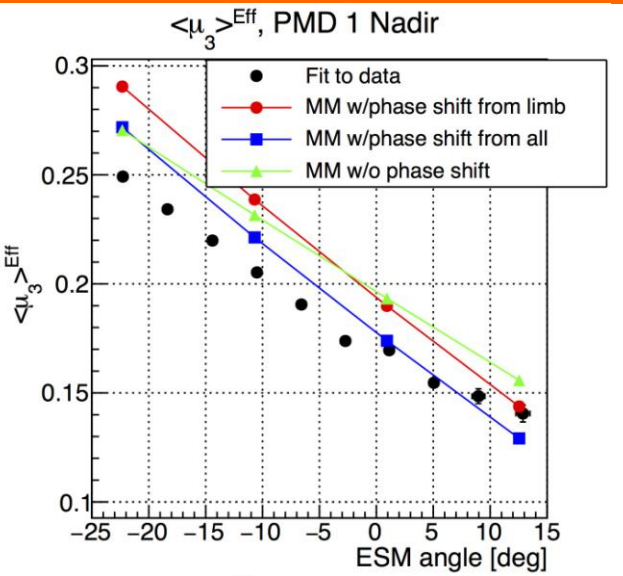
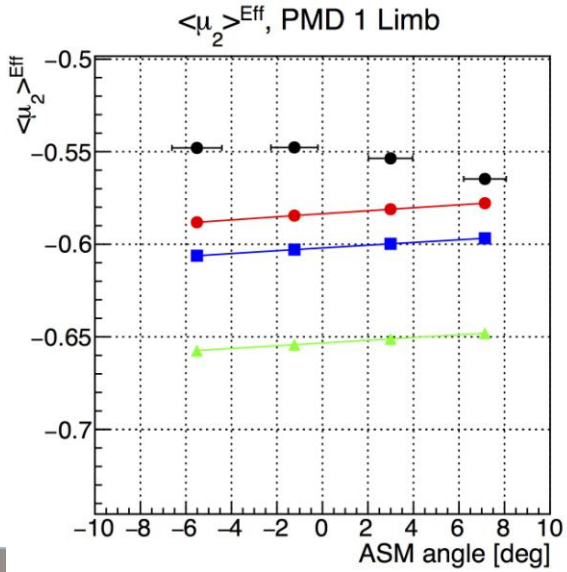
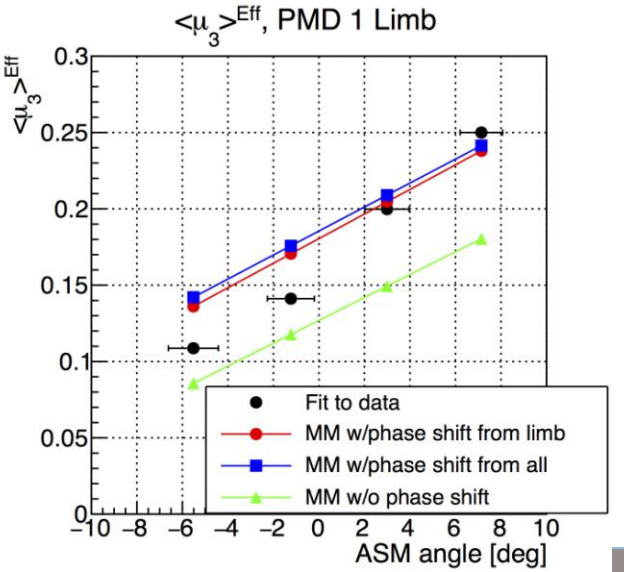
The (Retarder) Matrix Revisited

- Effective MMEs for PMD 1
  - From phase shift fit to limb alone and to all
  - From mirror model w/o phase shift
  - From in-flight fits



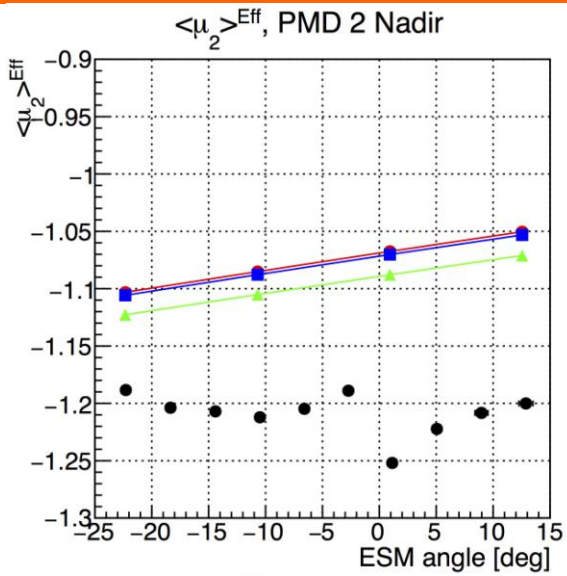


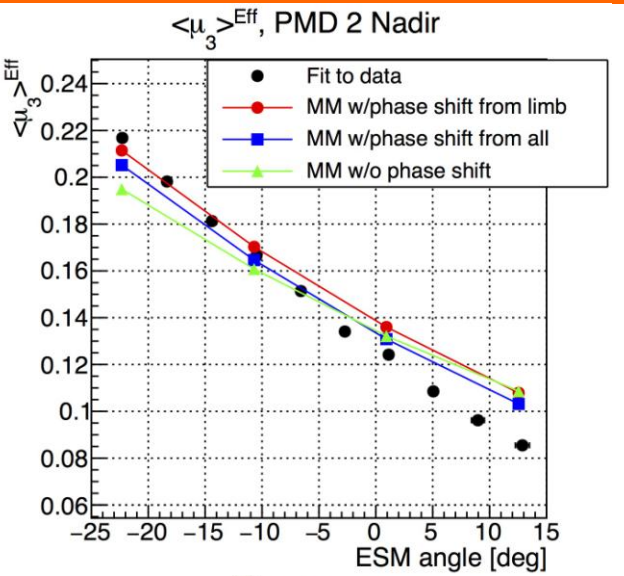


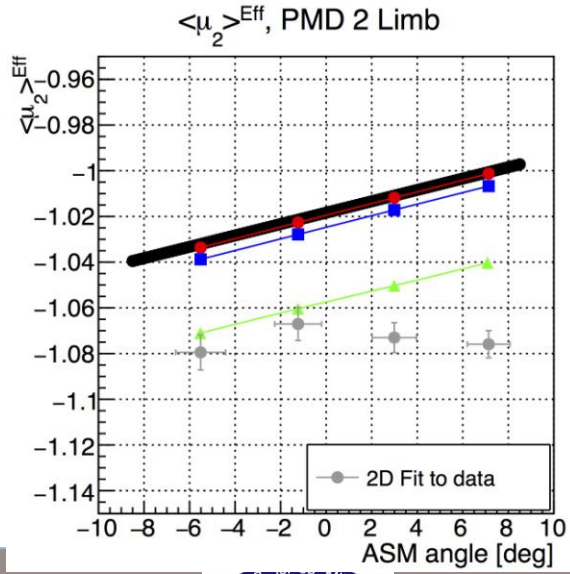


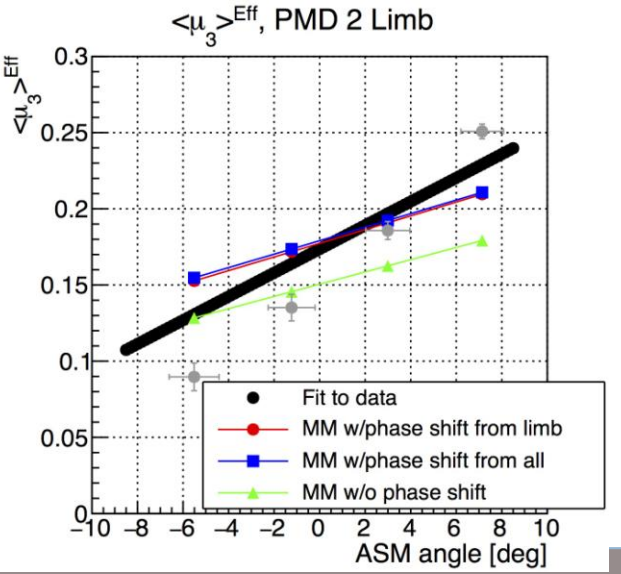
The (Retarder) Matrix Revisited

- Effective MMEs for PMD 2
  - From phase shift fit to limb alone and to all
  - From mirror model w/o phase shift
  - From in-flight fits









The (Retarder) Matrix Revisited

- Effective MMEs for 350 mn
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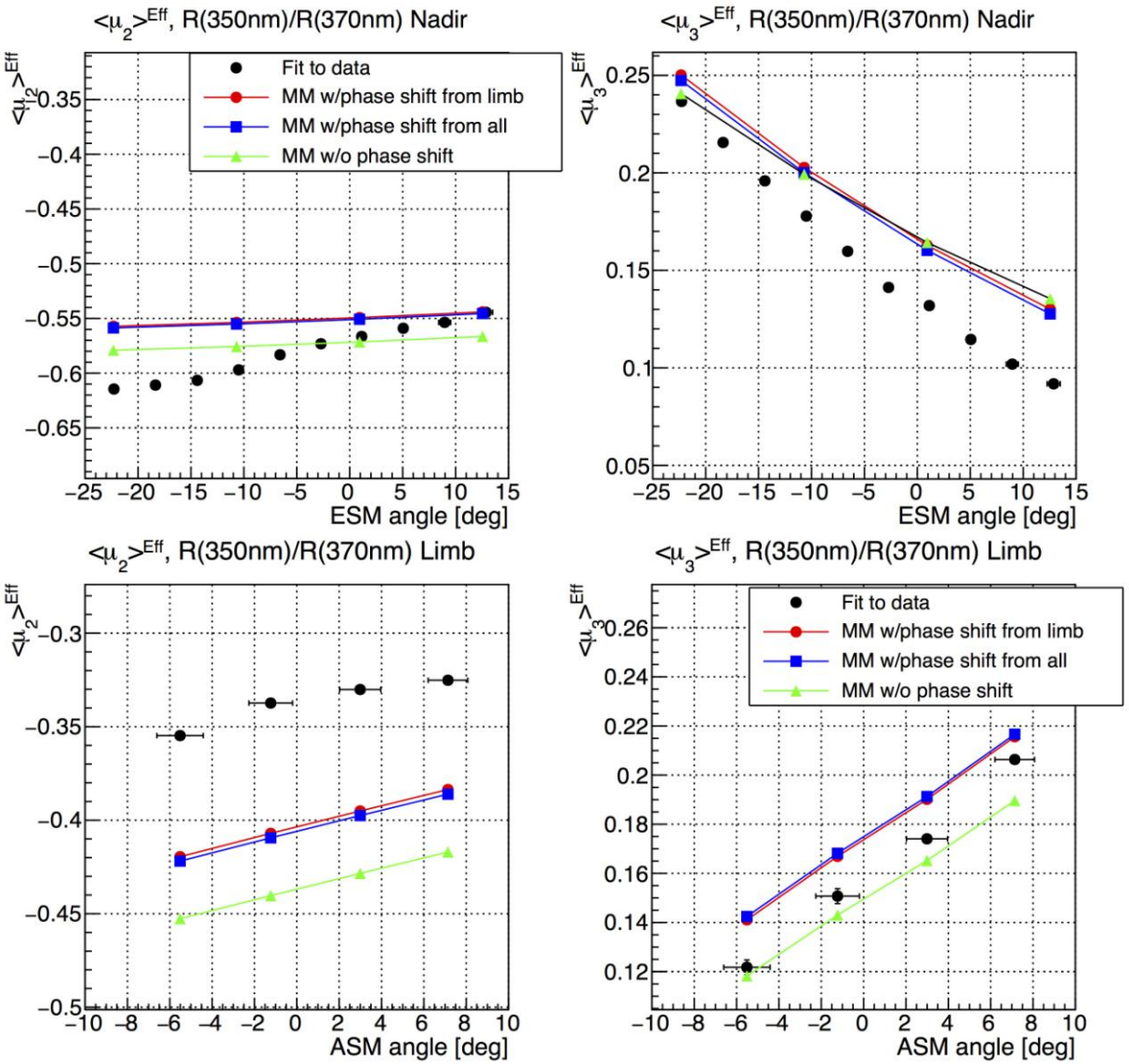

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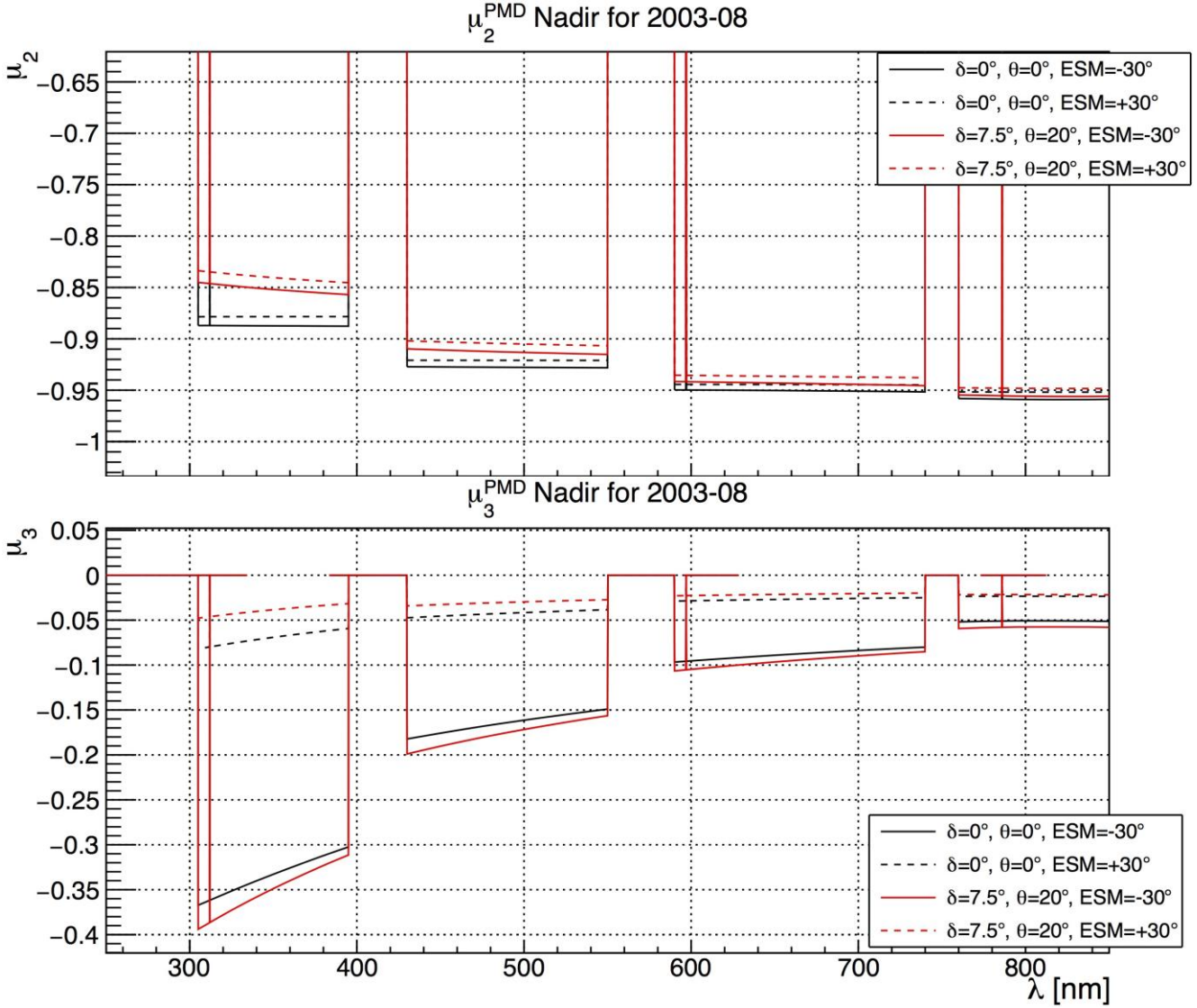
The (Retarder) Matrix Revisited

- MMEs for PMDs with fitted phase shift (Nadir)
  - TM =7.5, \= 25



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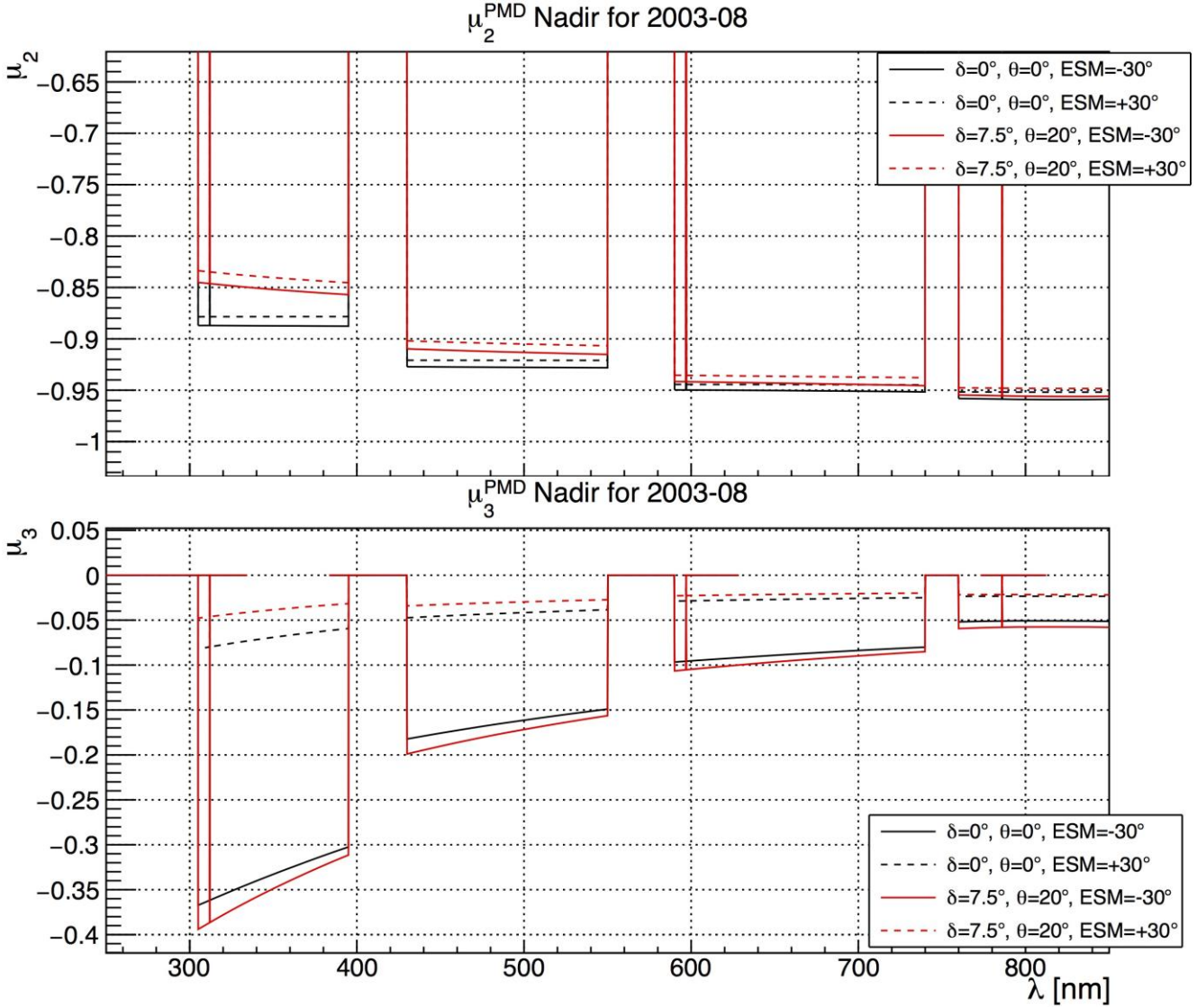

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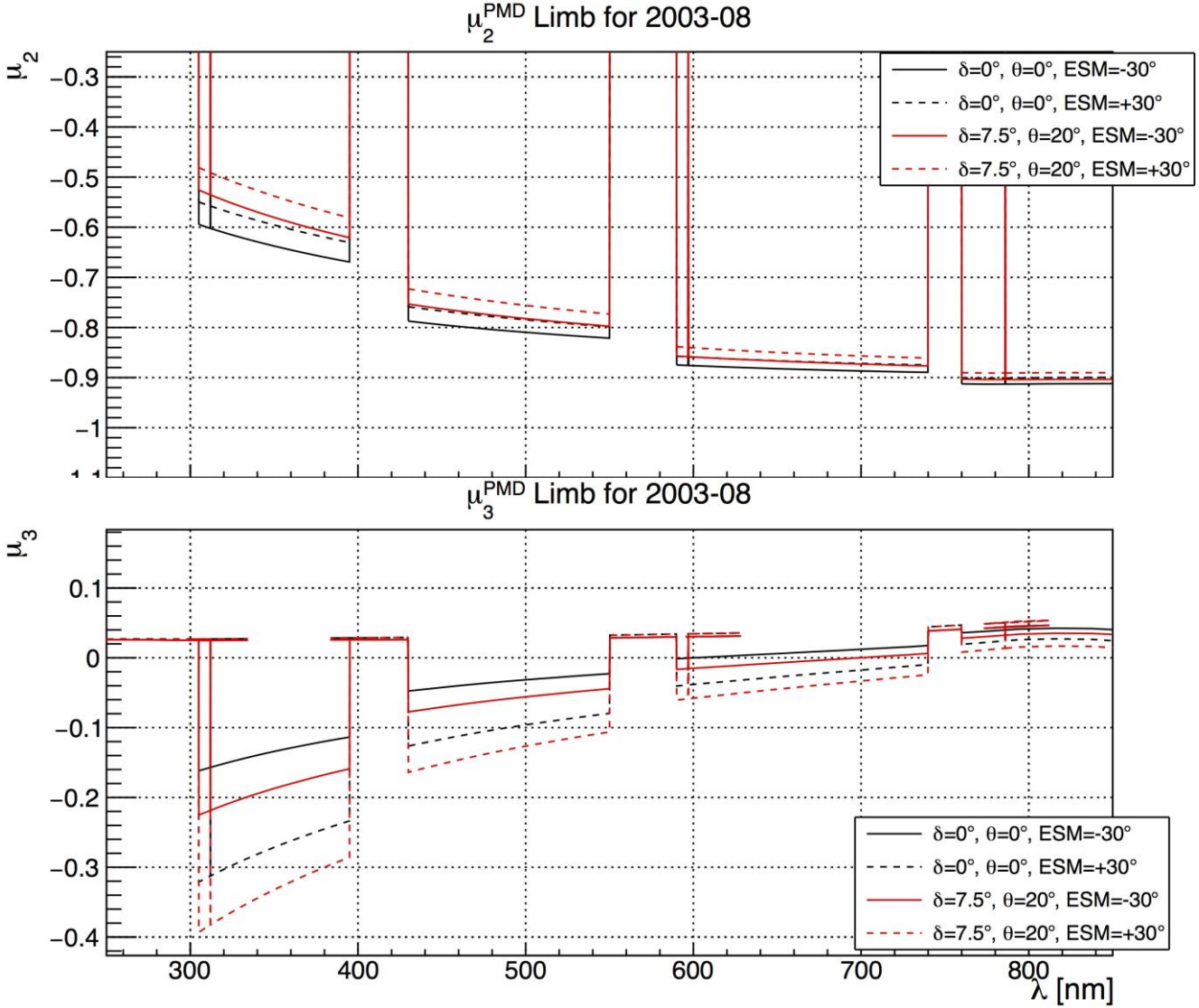

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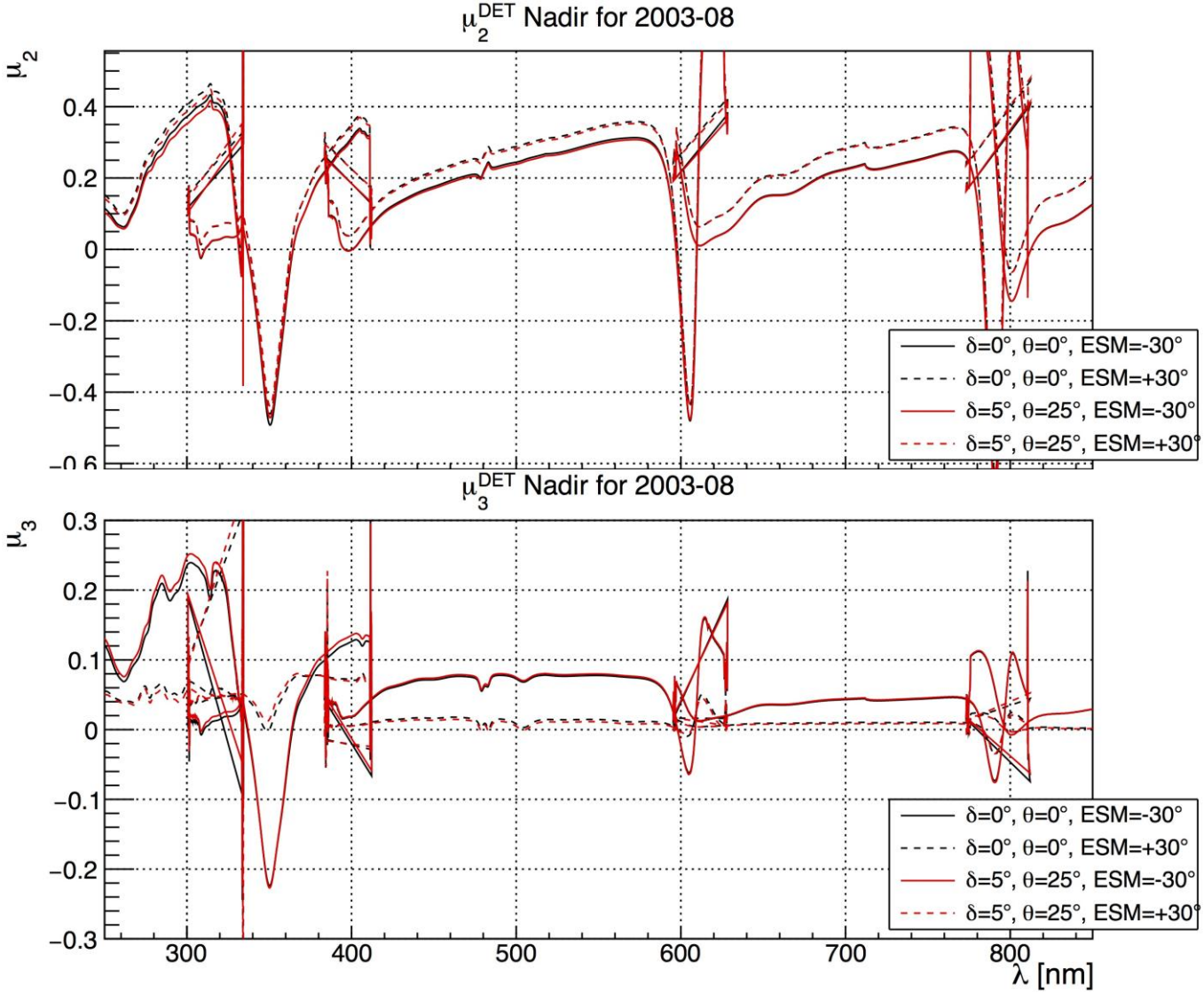

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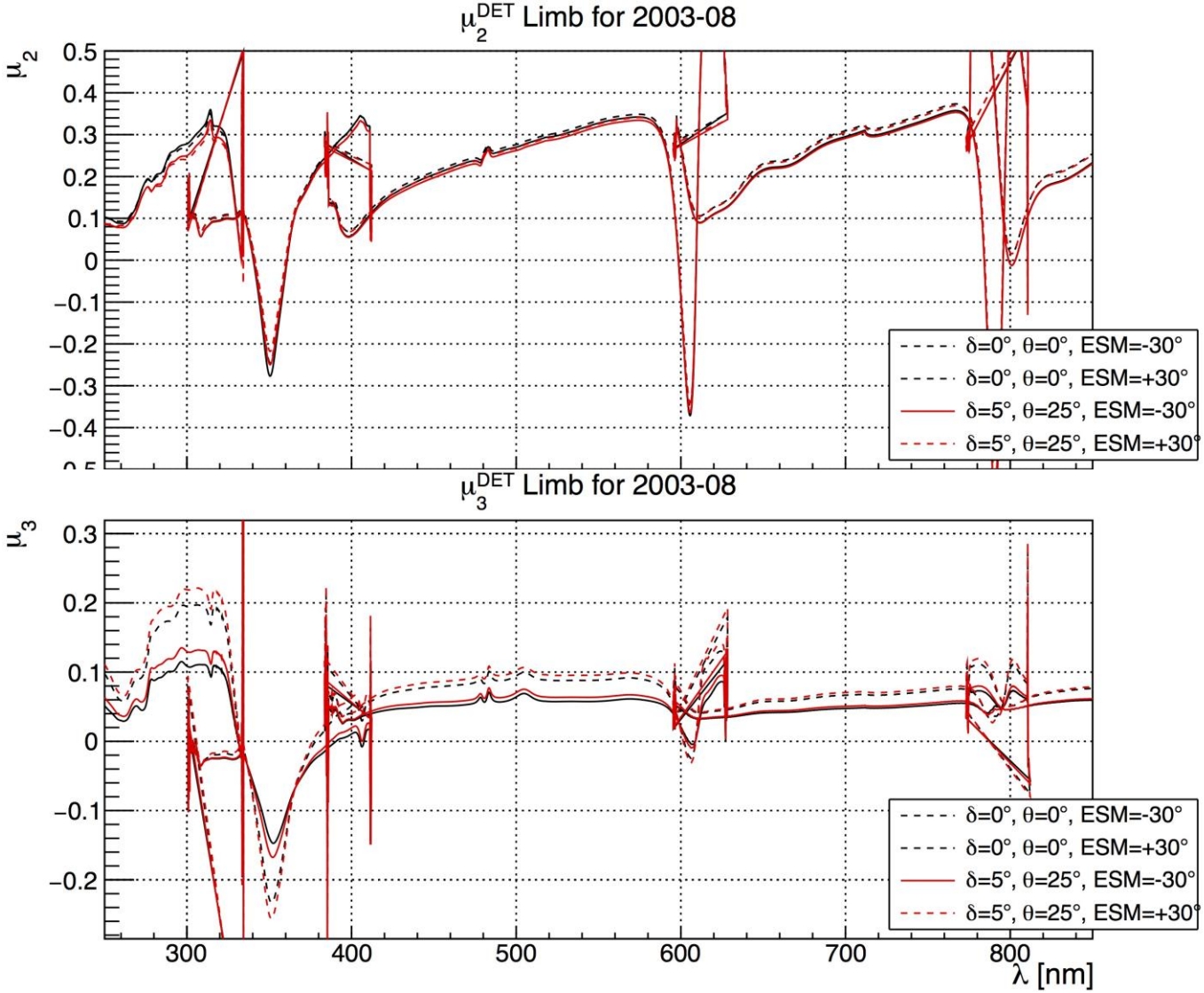

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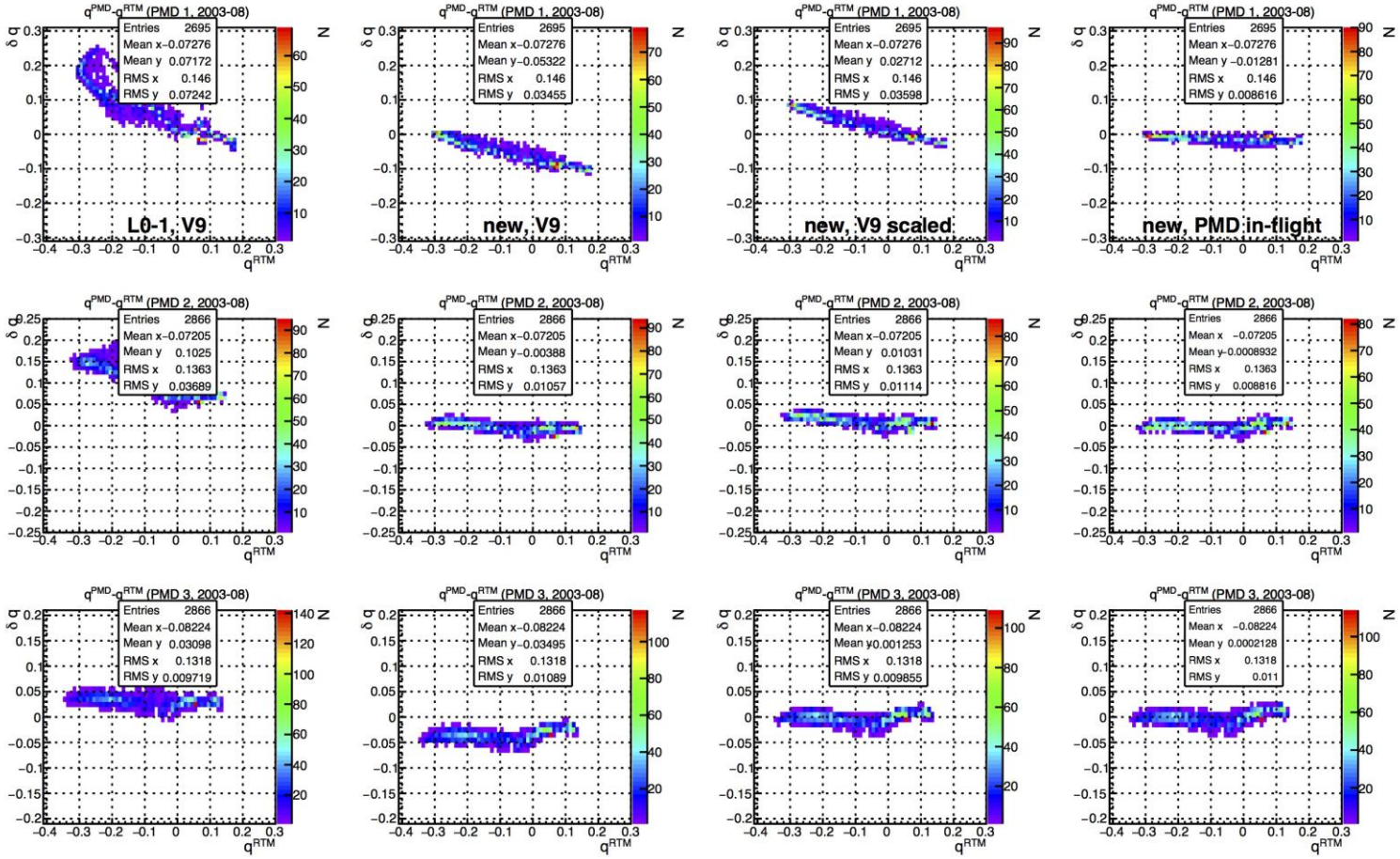
- Why all the fuss?
- Because it solves the limb polarization problem



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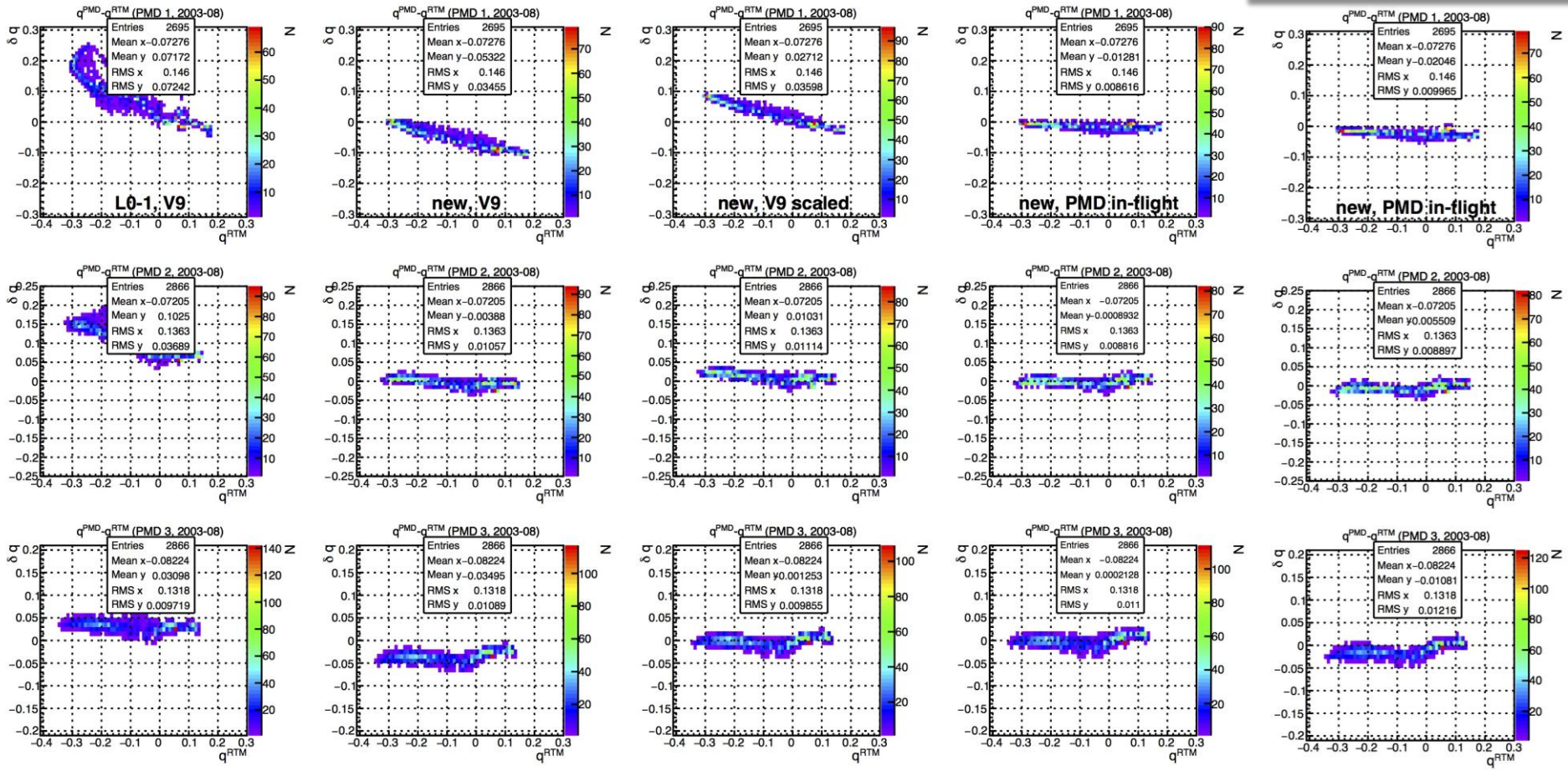
V9 w/Phase Shift



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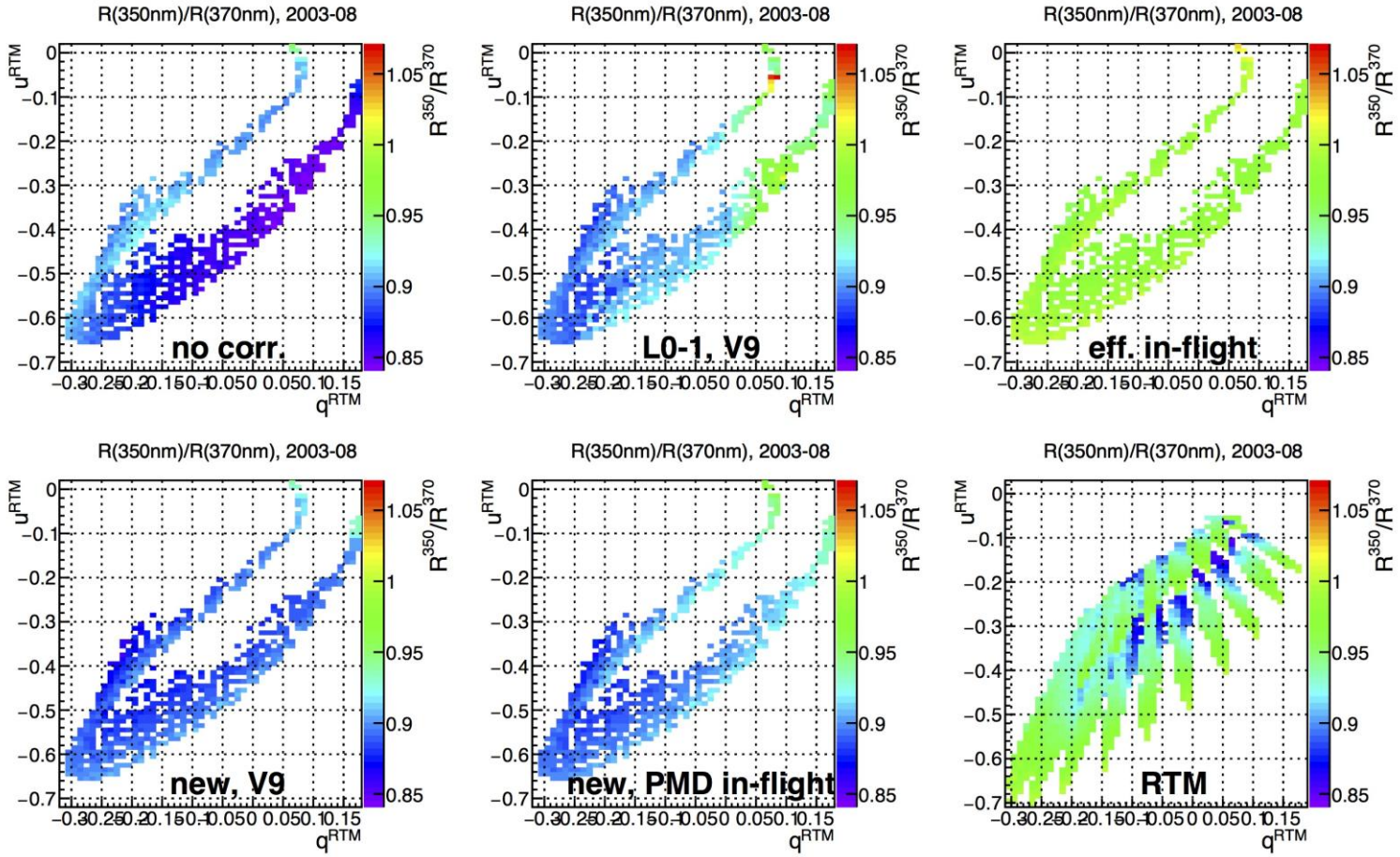

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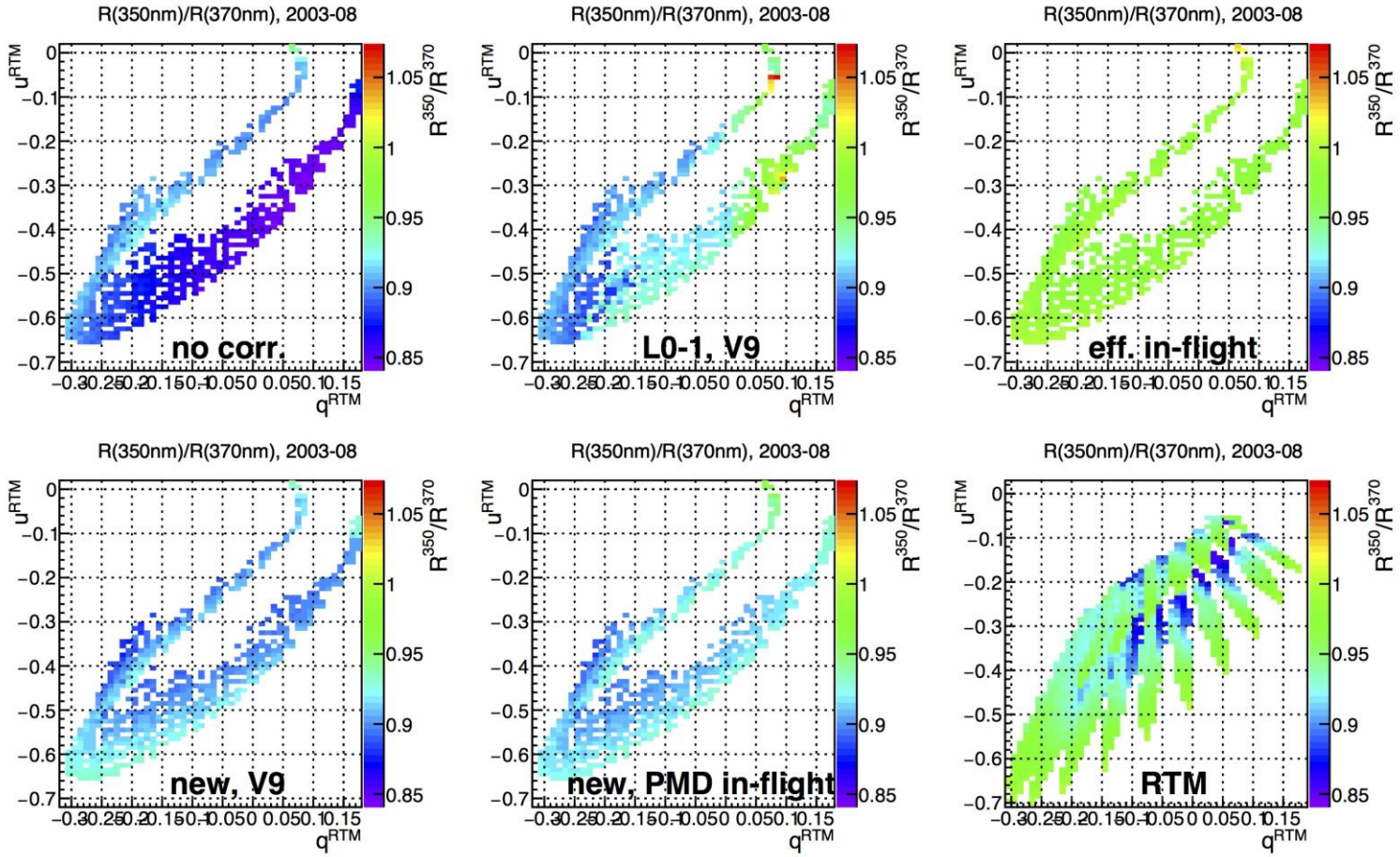

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The (Retarder) Matrix Revisited

- Consistent and physically sensible value for in-flight phase shift can be fitted to data for PMDs and science channels
- It effects polarization key data for wavelengths <500 nm slightly
  - Nadir less than limb
  - $\mu 2$ less than $\mu 3$
  - Science channels less that PMDs (except for 350 nm)
- Improves limb polarization vs. expected
  - NOTE: only removes ***polarization dependence*** of 350 nm feature! There is still going to be a *5% "unpolarized feature"*
- Nadir not yet checked, but expected changes are very small (within errors by definition)
  - IB signal may have to be refitted

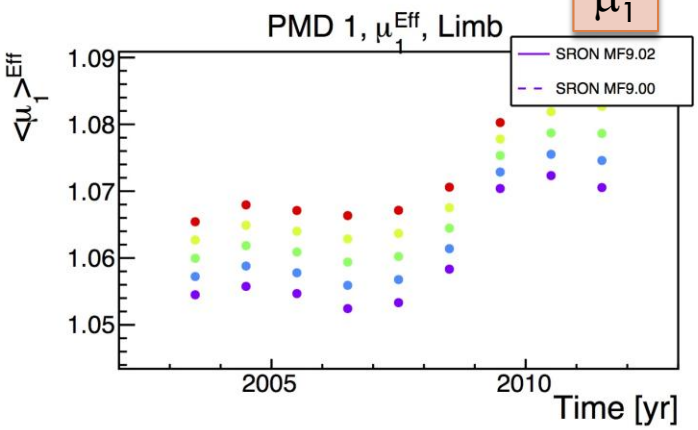
Implementation of Retarder?

- Retarder matrix should be already implemented in mirror model code
- Use (^{TM} , $\backslash$) with prescribed wavelength dependence to calculate end-to-end MMEs
  - One set each for PMDs and science channels
- NOTE: Time dependent phase shift?
  - So far, only 2003 (approximated by August), other years still have to be done
  - No guarantee that time dependence of in-flight MMEs can be described by retarder model
- Fall back solution: Use time dependent fitted MMEs as described in TN

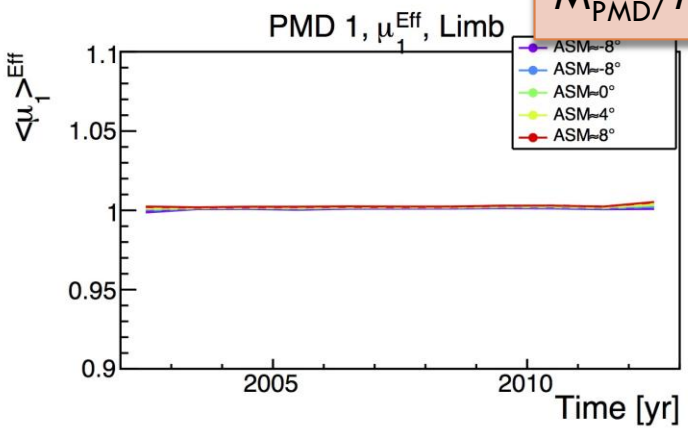
PMD 1 Effective MMEs vs. V9.02, Limb

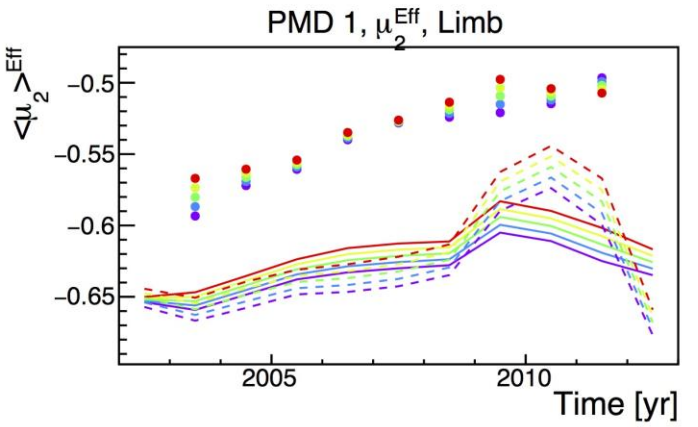
- Effective PMD sensitivities vs. time (1 year average)
- Model: SCIATRAN (q,u)(R)

μ_1

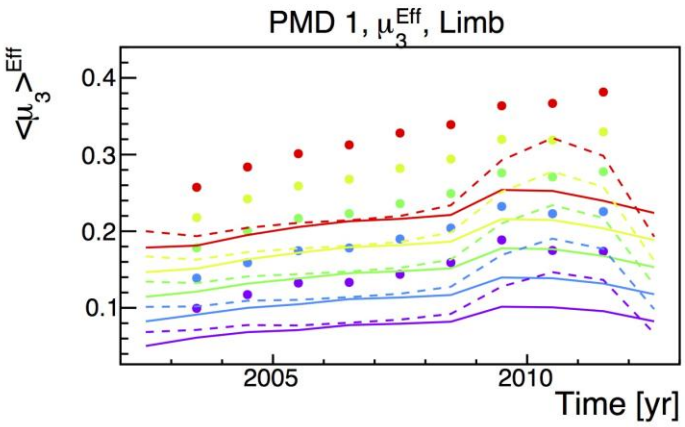


M_{PMD}/M_{DET}





μ^3



Backup

PMD 2 Effective MMEs vs. V9.02, Limb

- Effective PMD sensitivities vs. time (1 year average)
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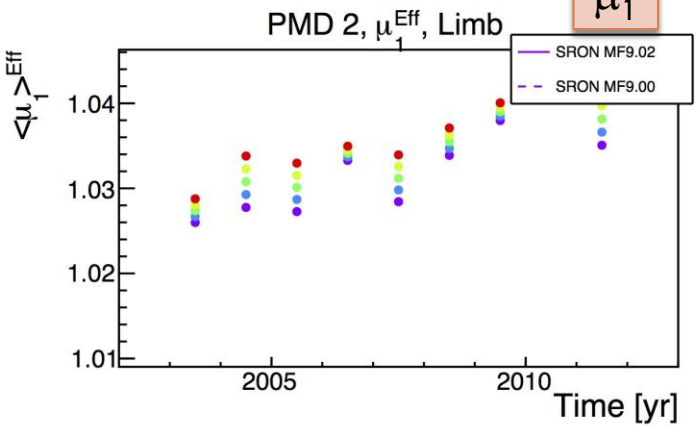
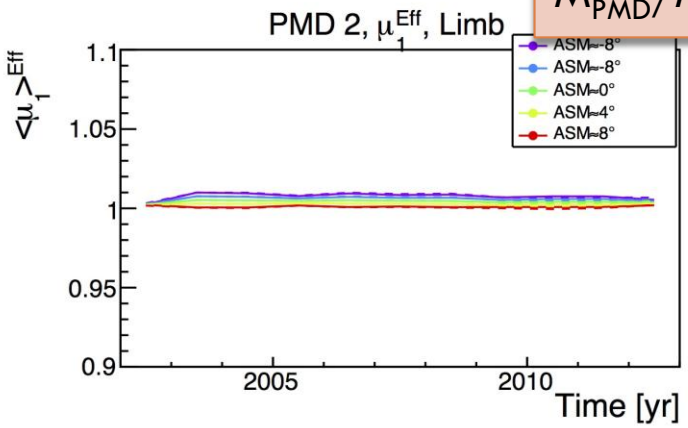
μ_1



M_{PMD}/M_{DET}



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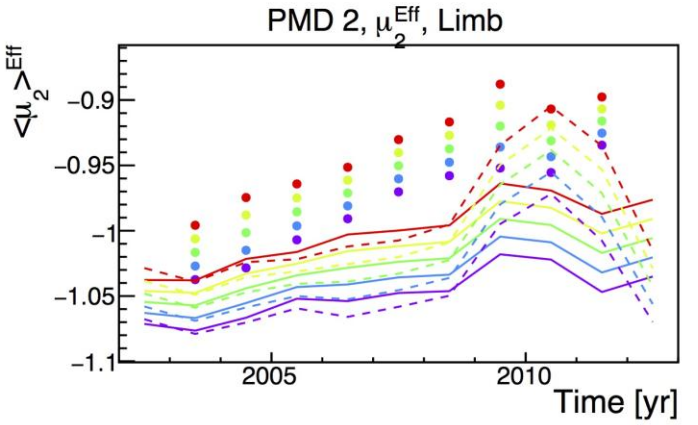

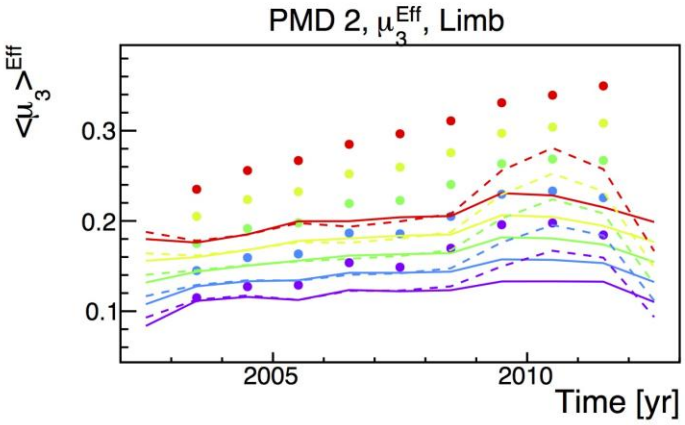

PMD 3 Effective MMEs vs. V9.02, Limb

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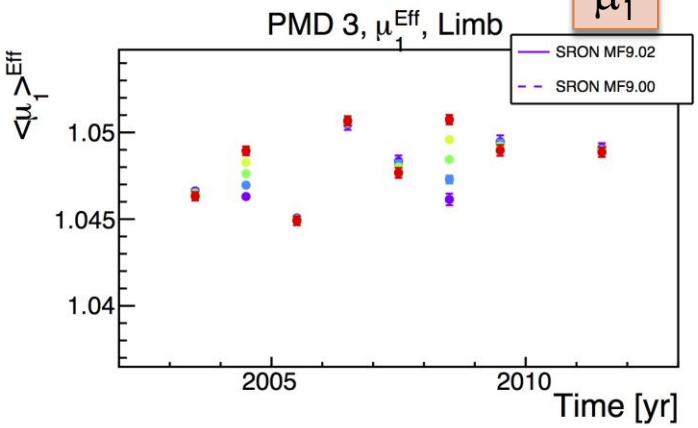
μ_1



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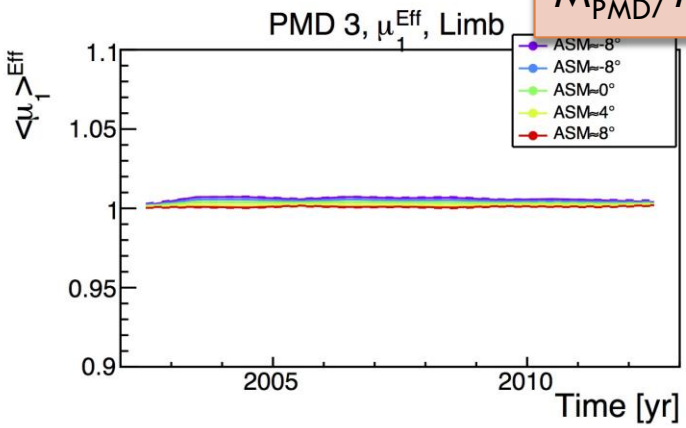
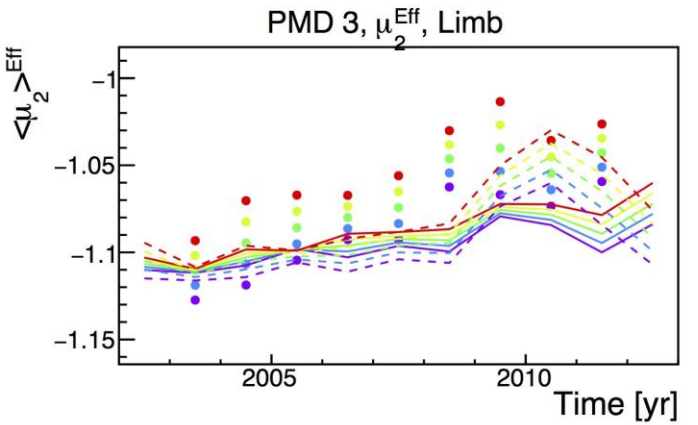
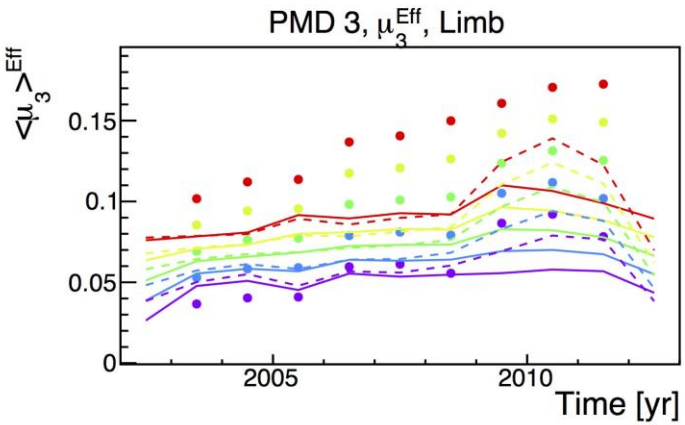




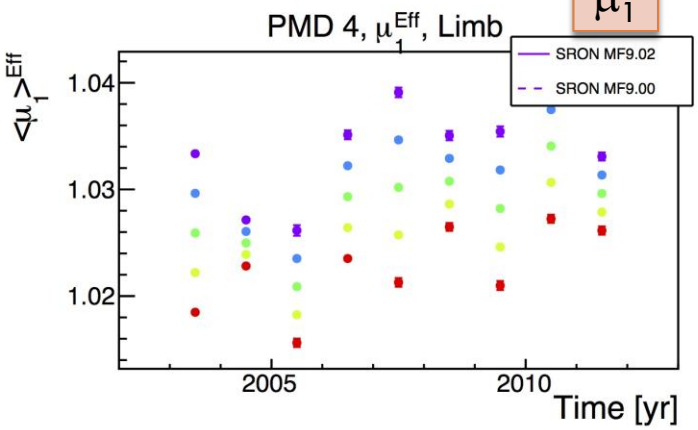
μ^3



PMD 4 Effective MMEs vs. V9.02, Limb

- Effective PMD sensitivities vs. time (1 year average)
- Model: SCIATRAN (q,u)(R)

μ_1



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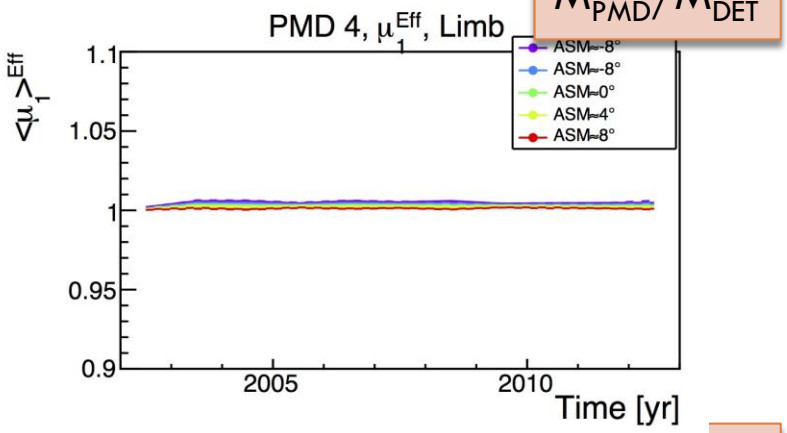
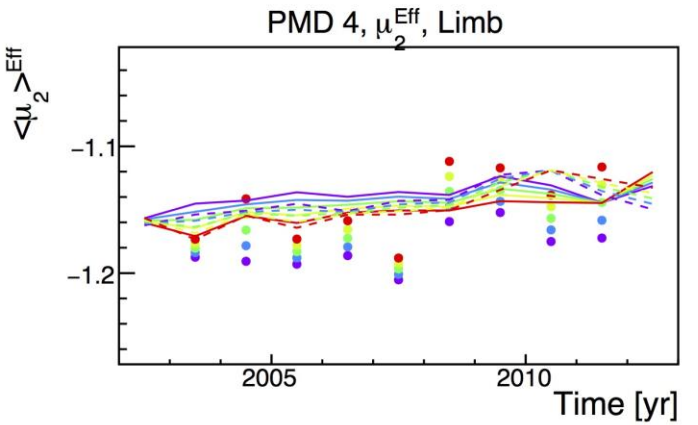
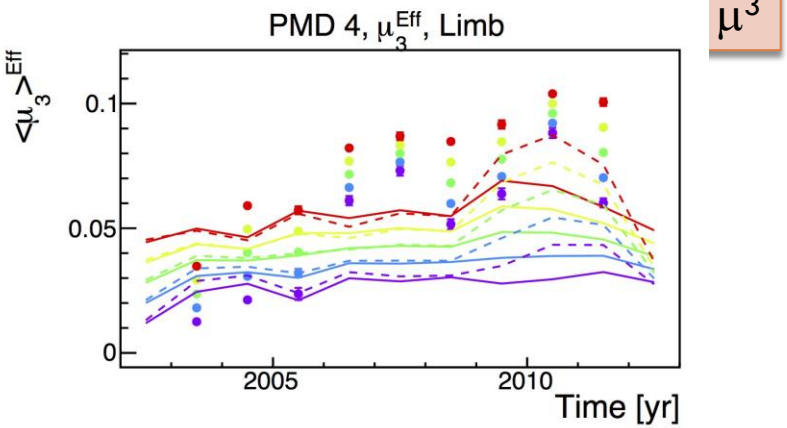




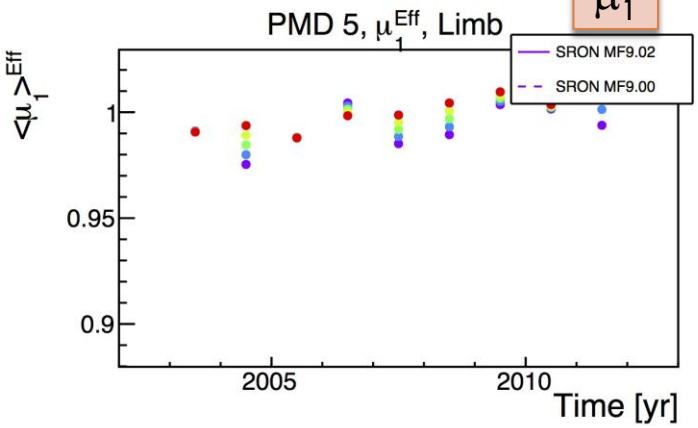
μ^3



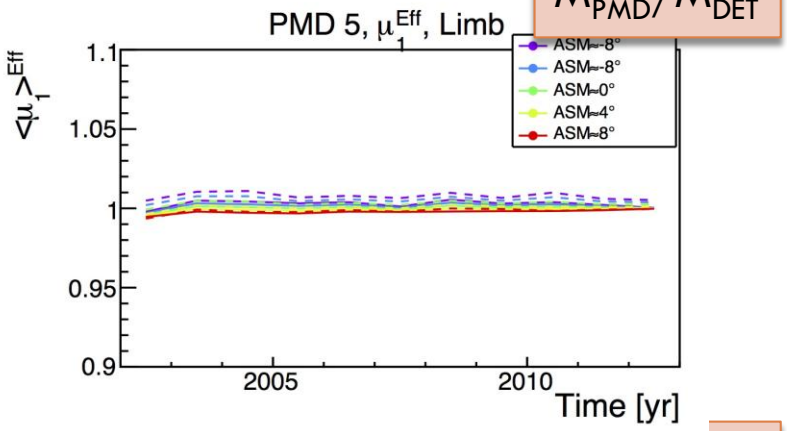
PMD 5 Effective MMEs vs. V9.02, Limb

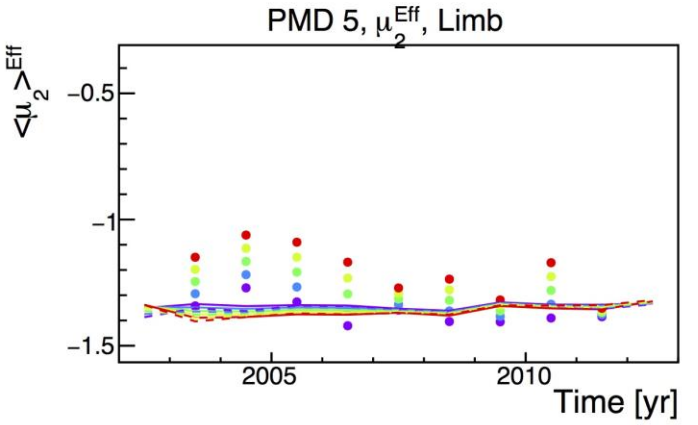
- Effective PMD sensitivities vs. time (1 year average)
- Model: SCIATRAN (q,u)(R)

μ_1

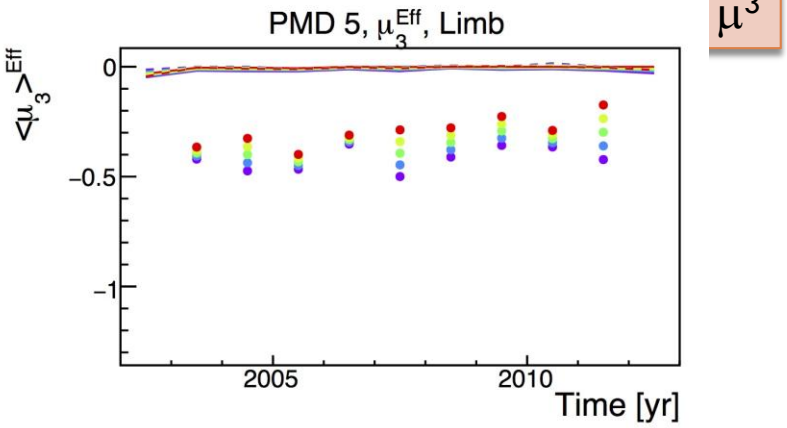


M_{PMD}/M_{DET}





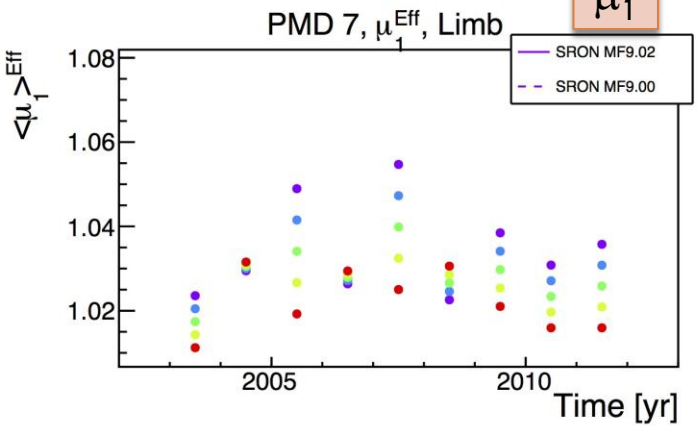
μ^3



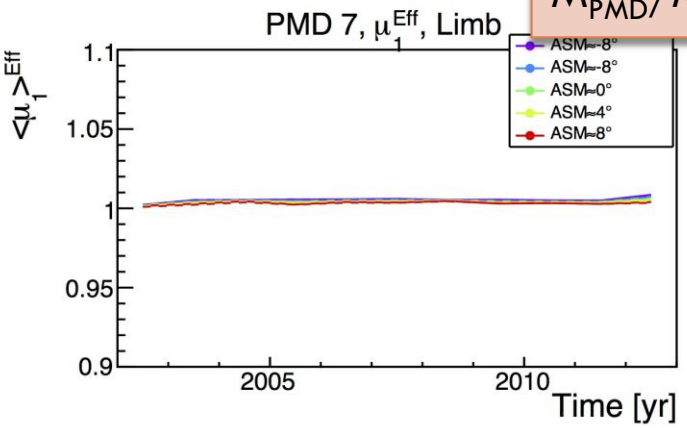
PMD 7 Effective MMEs vs. V9.02, Limb

- Effective PMD sensitivities vs. time (1 year average)
- Model: SCIATRAN (q,u)(R)

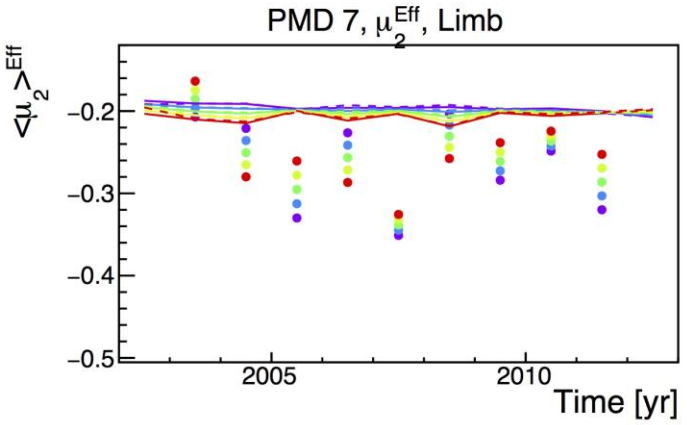
μ_1

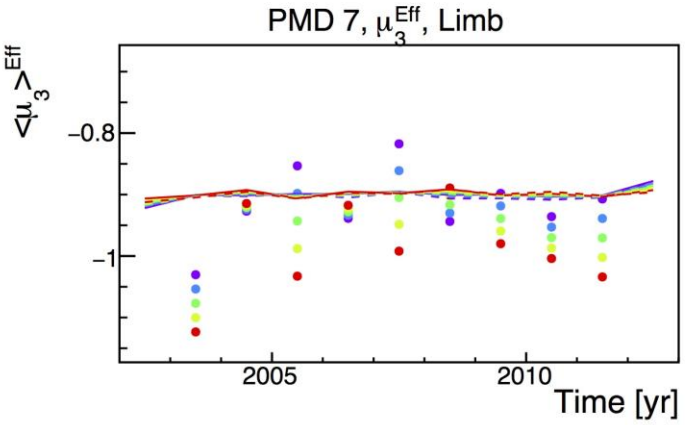


M_{PMD}/M_{DET}



μ^3

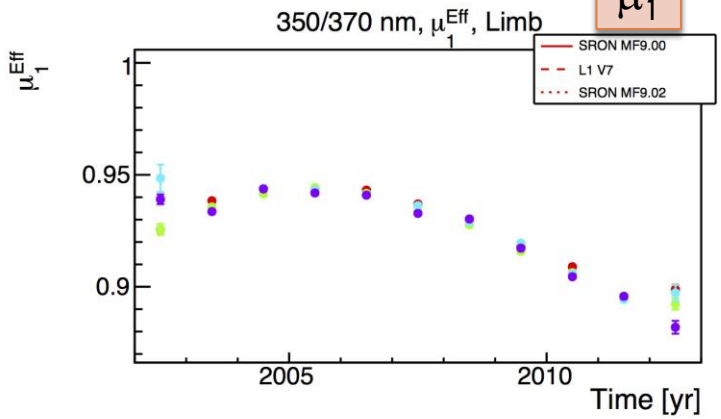




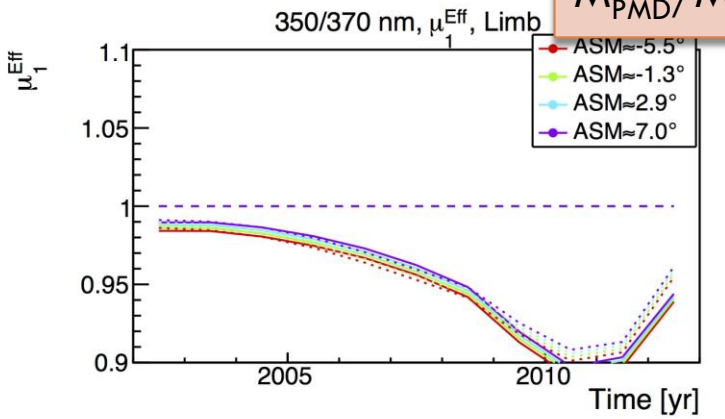
350/370 Effective MMEs vs. V9.02, Limb

- Effective 350/370 nm sensitivities vs. time (1 year average)
- Model: SCIATRAN (q,u)(R)

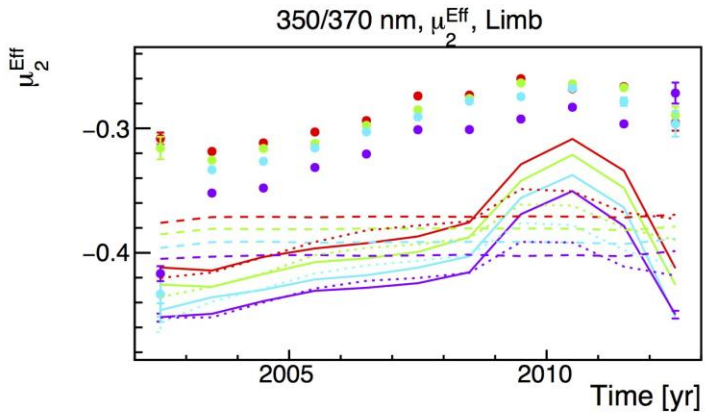
μ_1

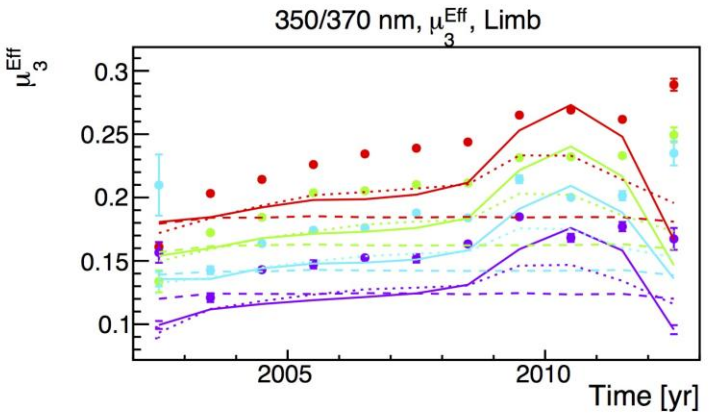


M_{PMD}/M_{DET}



μ^3

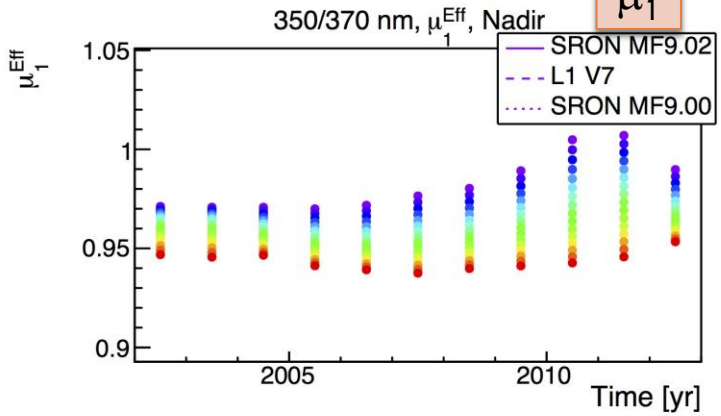




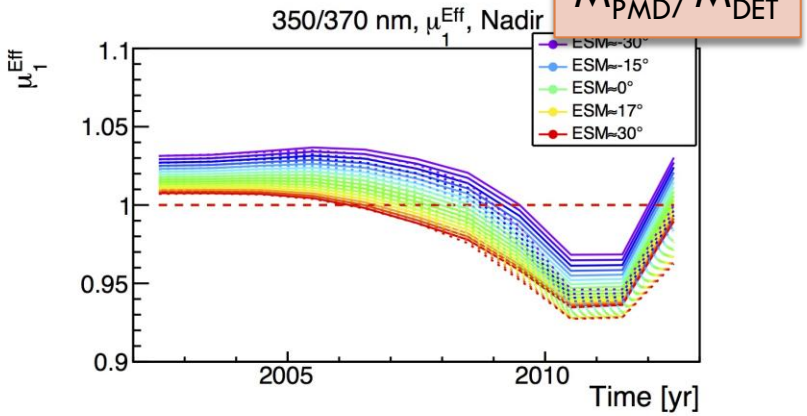
350/370 Effective MMEs vs. V9.02, Limb

- Effective 350/370 nm sensitivities vs. time (1 year average)
- Model: SCIATRAN (q,u)(R)

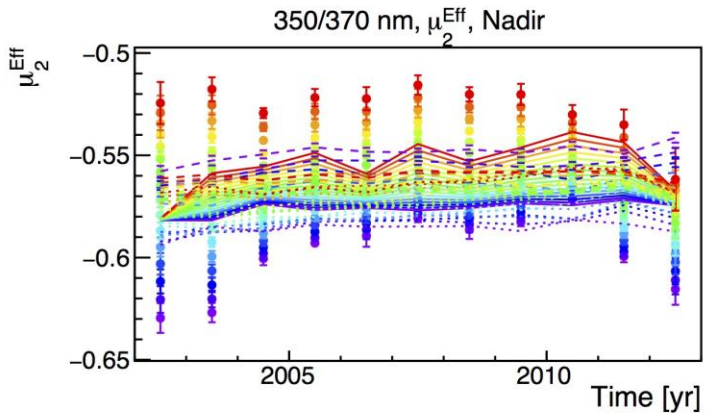
μ_1

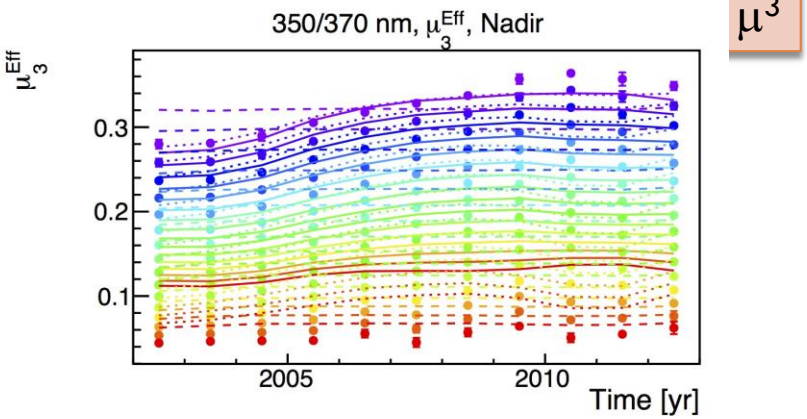


M_{PMD}/M_{DET}



μ^3





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