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(POLARIZED) LIGHT AT THE END OF THE TUNNEL?

Outline

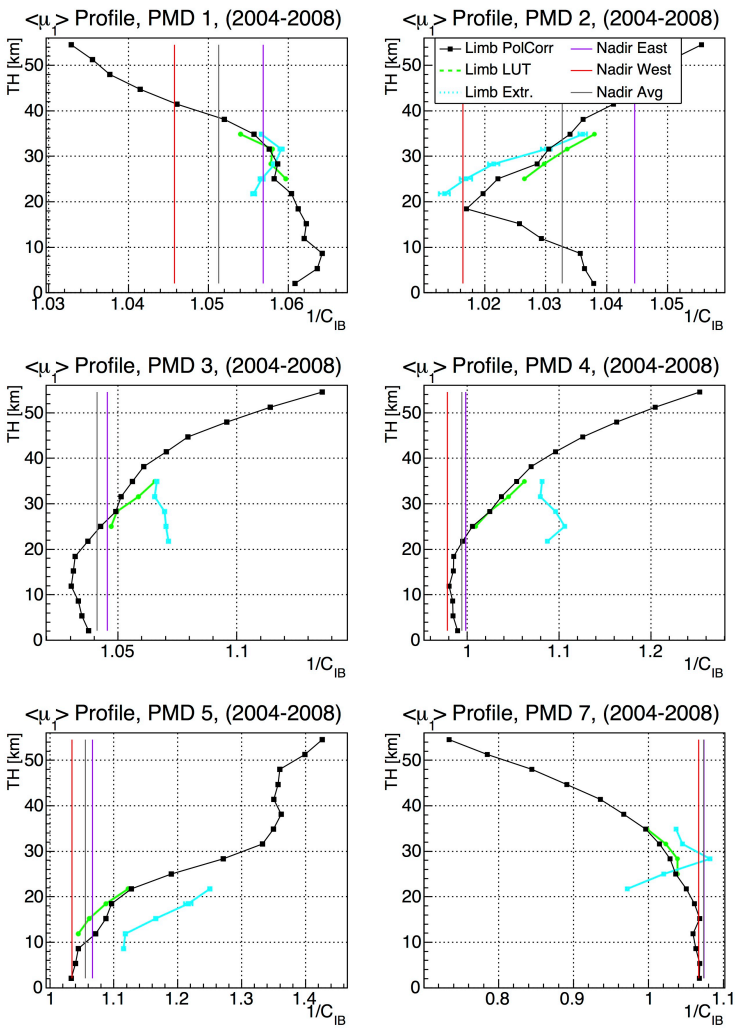
- Some technical details concerning the polarization algorithm
- In-flight phase shift: time dependent or not?
- Adjustment of OBM key data?

Proposed Algorithm Changes

- Nadir:
  - Slight adjustment of geometries where LUTs are to be used for u: at $\cos(\theta)<-0.9$ and small RTM-q values
  - Leads to less artifacts in u, small effect in q
  - NOTE: u will also not be correct, but error from artifacts is larger
- Nadir+limb:
  - Flagging of polarization values?
  - There should be no abnormal values of (q,u) unless the science channel or PMD data themselves have a problem (e.g., spikes, decontamination …)
  - Except (maybe) PMD5 or high TH in limb

Proposed Algorithm Changes

- Limb in-band signal:
  - Scale factor for TH dependence, up to now (ATBD) above TH_{Norm}=28 km (18 km for PMD 5)
  - Suggest to use PMD dependent TH_{Norm}, together with nadir derived scale factor (PMDs 2-7)



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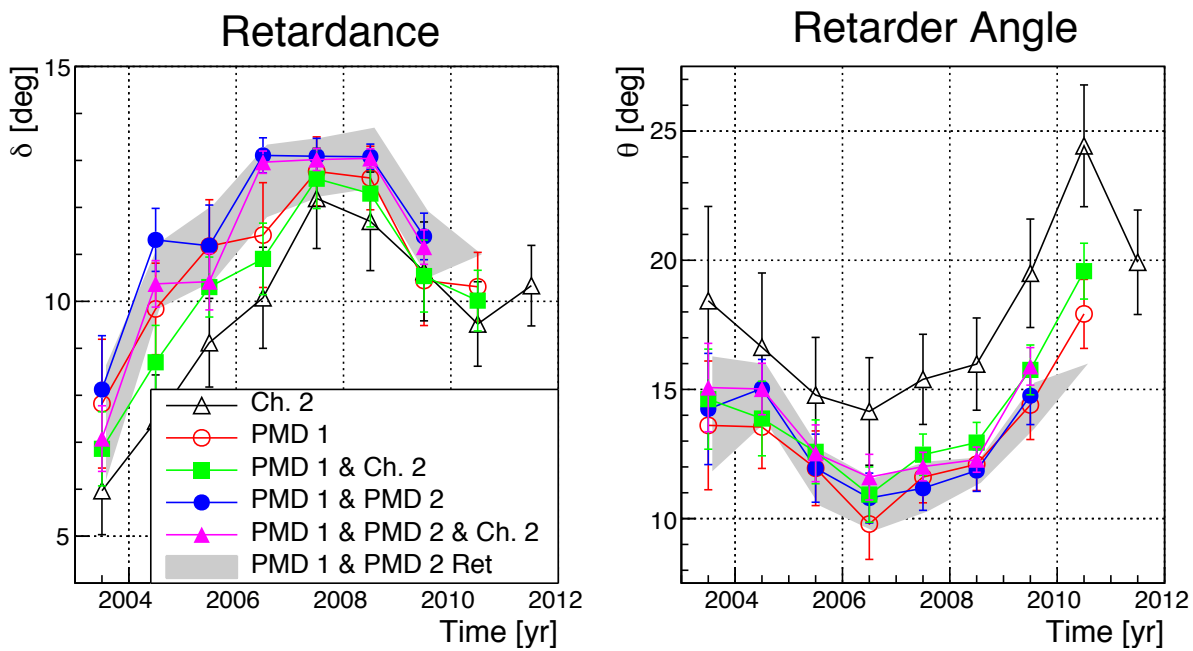
In-Flight Phase Shift

- Previously on "Lost":
  - Found data early in the mission to be consistent with retarder model for in-flight phase shift
- And now the continuation:
  - Refined analysis, investigate time dependence and systematic errors
  - Different fit methods and models

In-Flight Phase Shift: Results

- Results:
  - A single on-ground to in-flight phase shift does not describe the time dependence of the data, with V9.02 mirror degradation
  - The fit quality degrades with time



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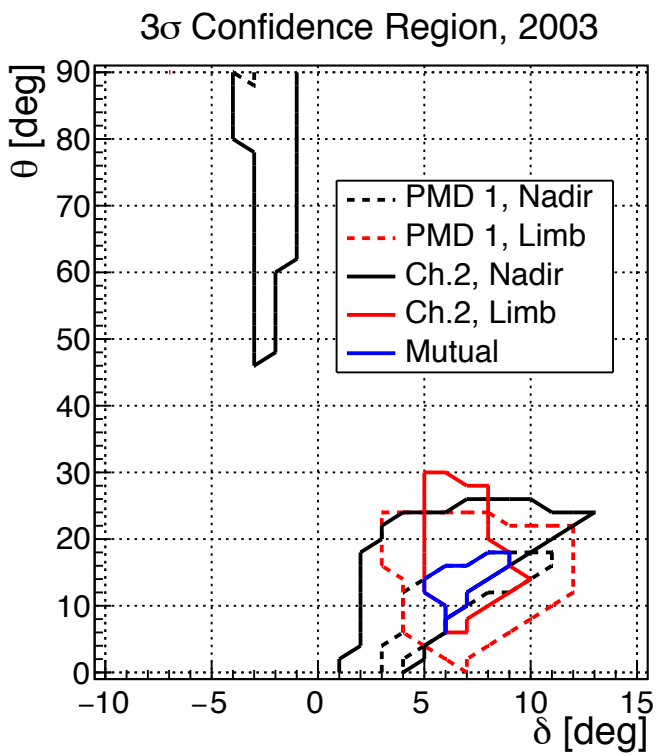
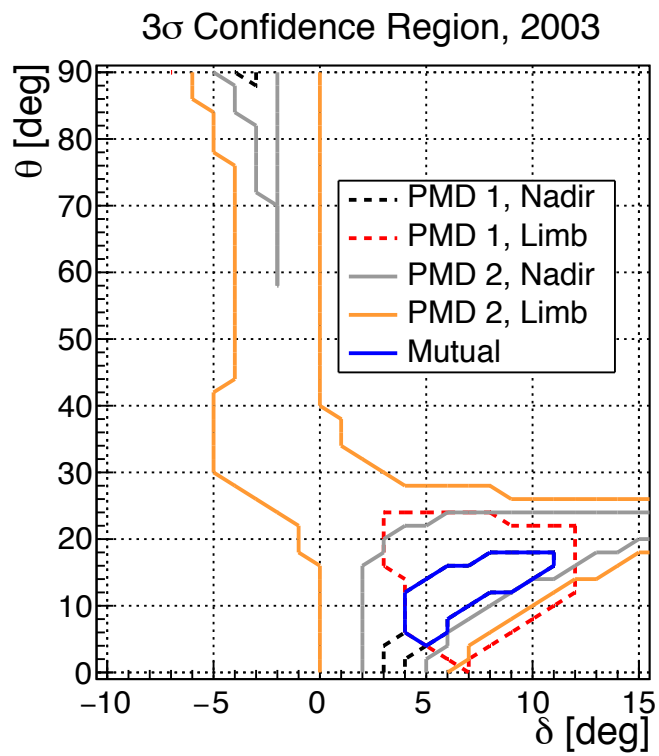
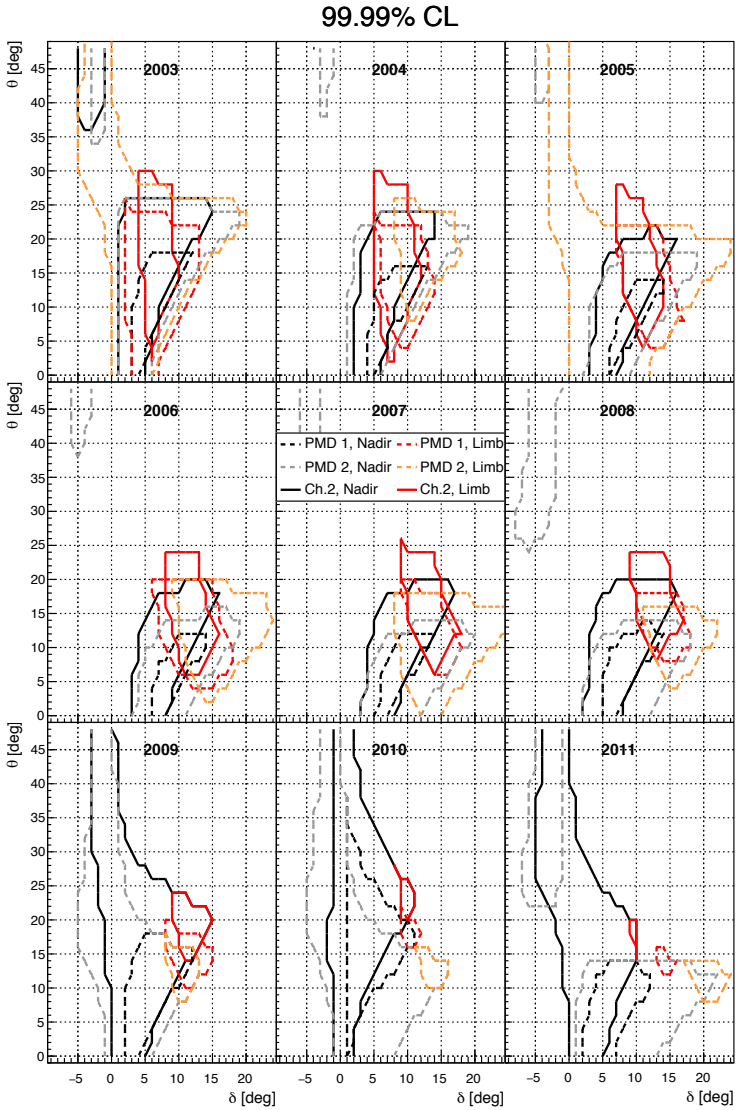




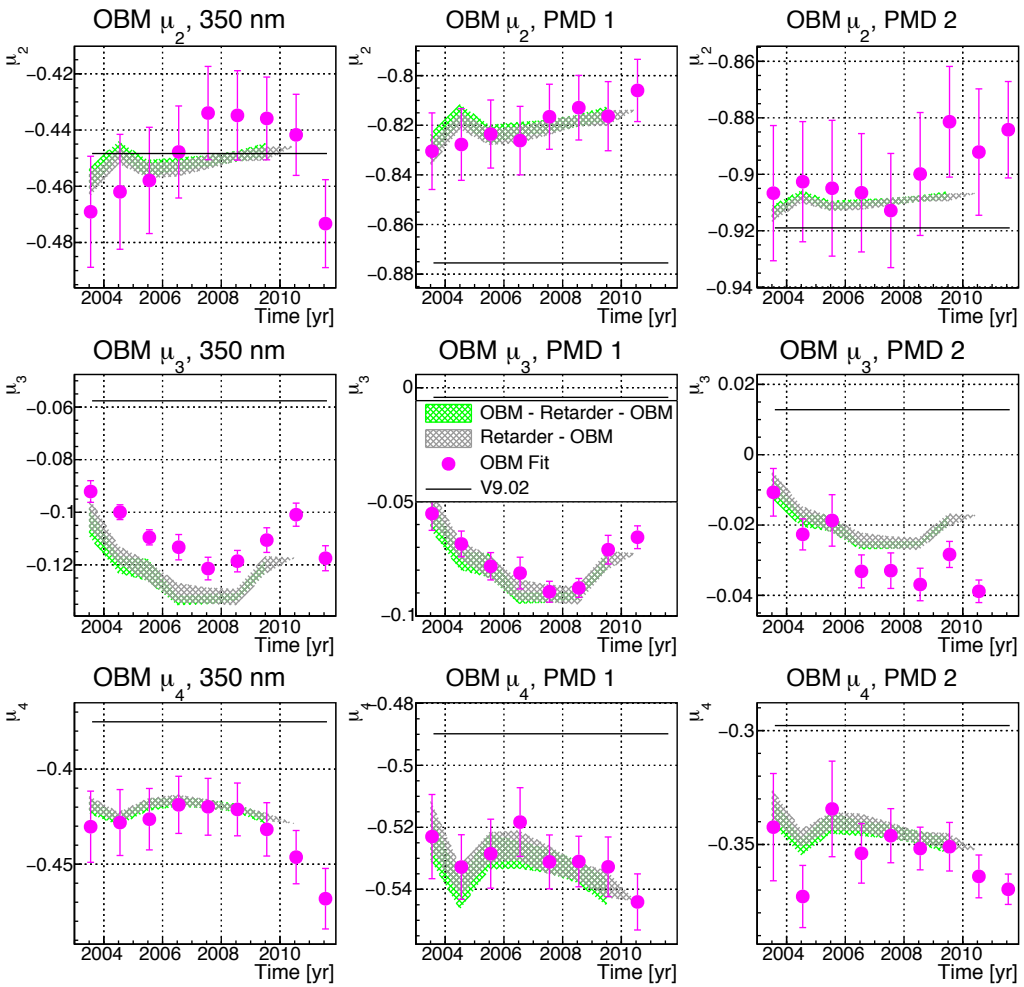
In-Flight Phase Shift: Results

- Results:
  - A single on-ground to in-flight phase shift does not describe the time dependence of the data, with V9.02 mirror degradation
  - The fit quality degrades with time
  - Less consistency between limb and nadir as mirror contamination becomes more important



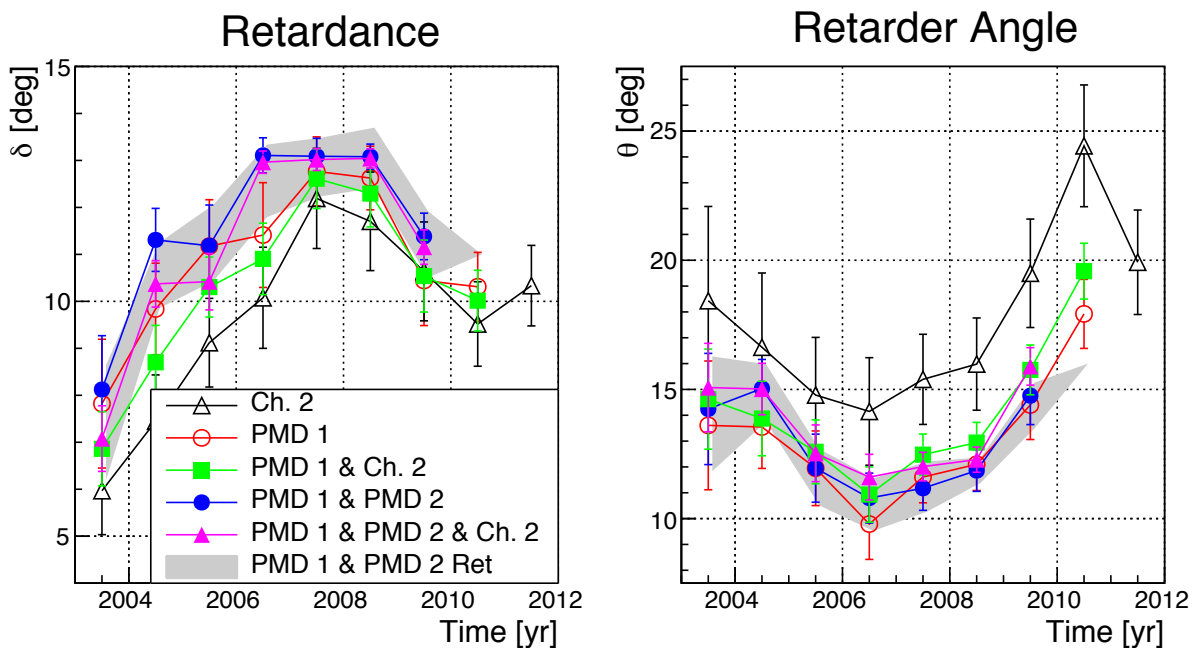
In-Flight Phase Shift: OBM fit

- Instead of retarder model, fit directly the OBM vector:
  - Direct fit to OBM also shows time dependence with V9.02
  - NOTE: NO assumption on wavelength dependence in OBM fit!
    - Retarder: 1/λ



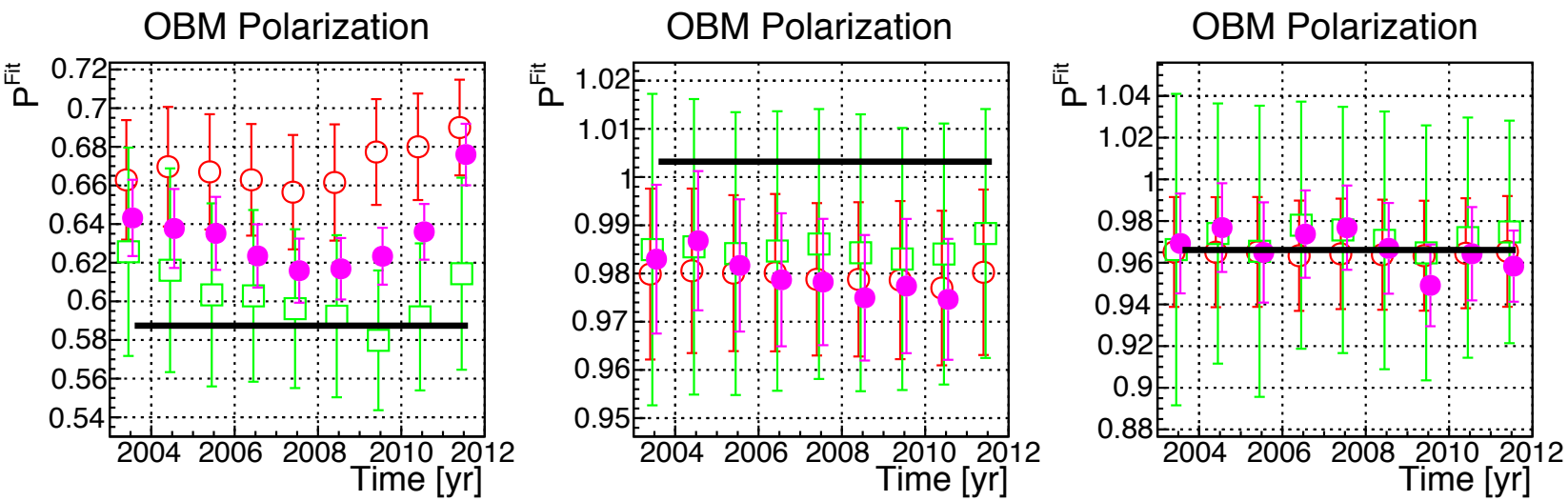
In-Flight Phase Shift: OBM fit

- Instead of retarder model, fit directly the OBM vector:
  - Use fitted OBM vector to derive retarder parameters
  - Consistent values for retarder parameters, if on-ground OBM vector for PMD 1 is corrected for 2% depolarization



In-Flight Phase Shift: OBM fit

- Instead of retarder model, fit directly the OBM vector:
  - Consistent values for retarder parameters, if on-ground OBM vector for PMD 1 is corrected for 2% depolarization
    - Could be included in OBM keydata, i.e., μ_1(PMD 1)≈1.02
  - Depolarization of PMD 1 constant

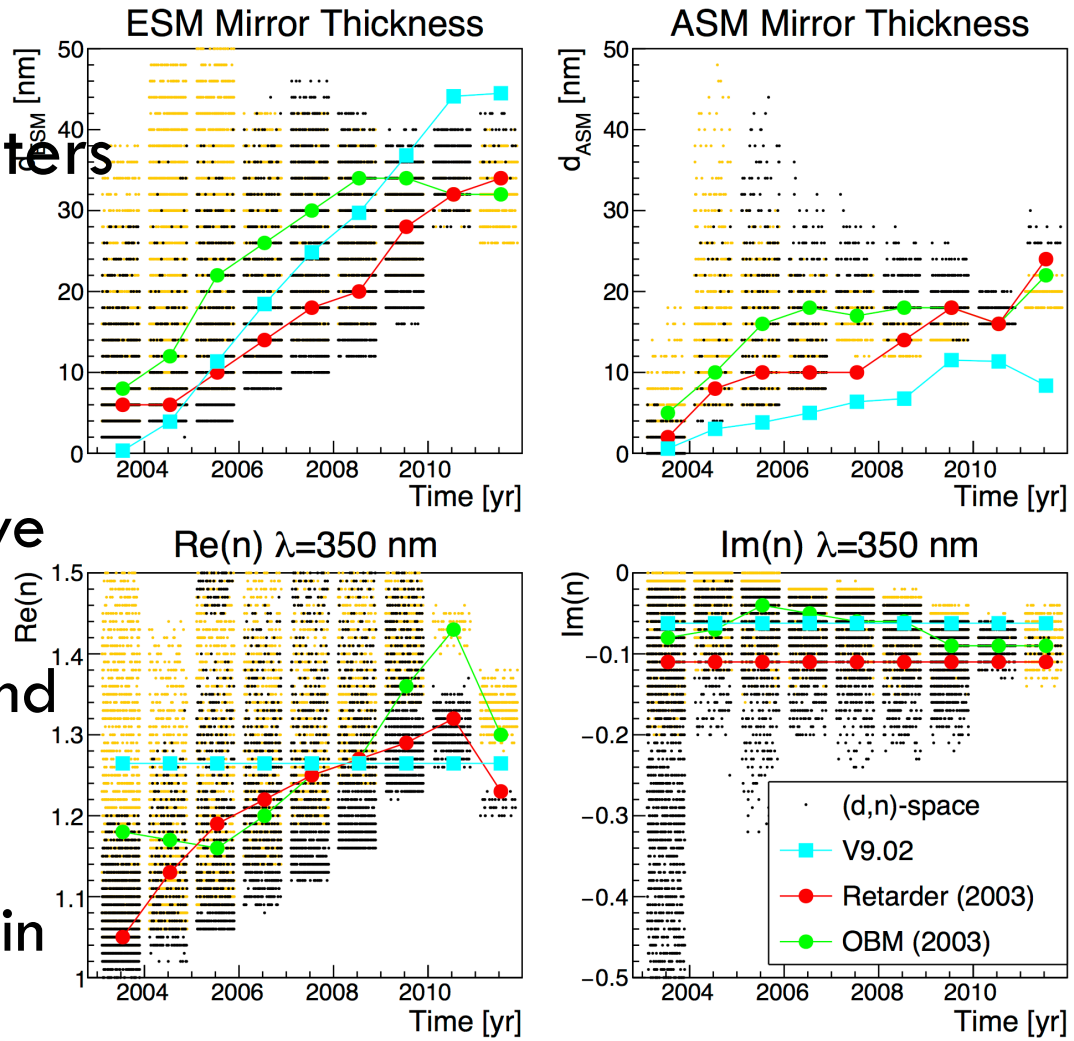


Phase Shift and Mirror Model

- Assume constant OBM vector
  1. On-ground key data
  2. Phase shift / OBM fit for 2003
- Fit mirror model parameters (thicknesses and refractive index)
  - using only polarization data + constraint on throughput
- Result of 1.)
  - No set of mirror parameters is able to describe data using on-ground OBM
  - Definitely on-ground to in-flight OBM change!
  - Real instrument change?
  - Error in on-ground calibration/analysis?

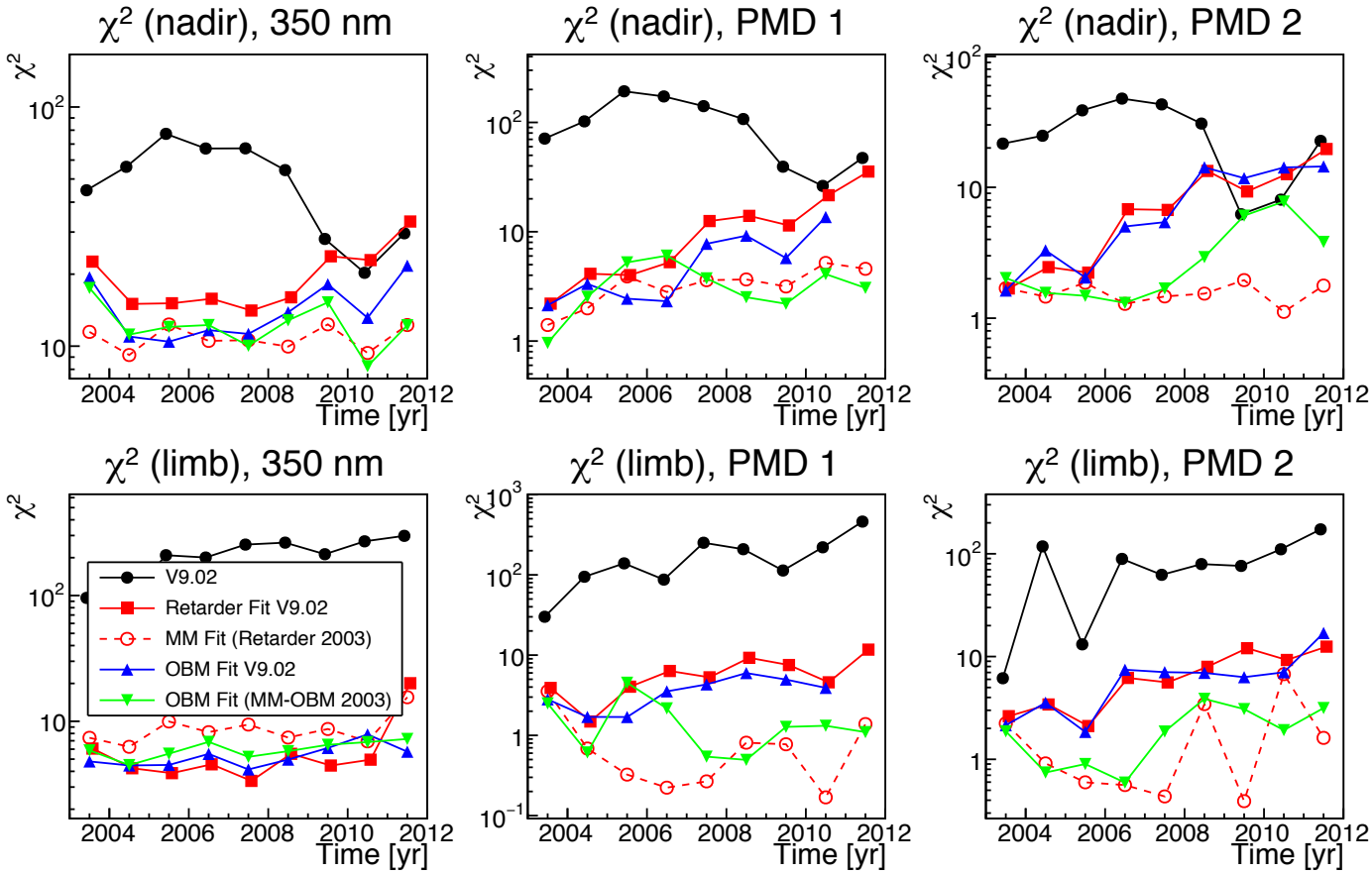
Phase Shift and Mirror Model

- Constant OBM vector (2003)
- Fit mirror model parameters
- Results of 2)
  - Different thicknesses
  - No recovery
  - Time dependent refractive index!
  - Mirror parameters depend on OBM vector
  - OBM vector depends on mirror parameters, even in 2003



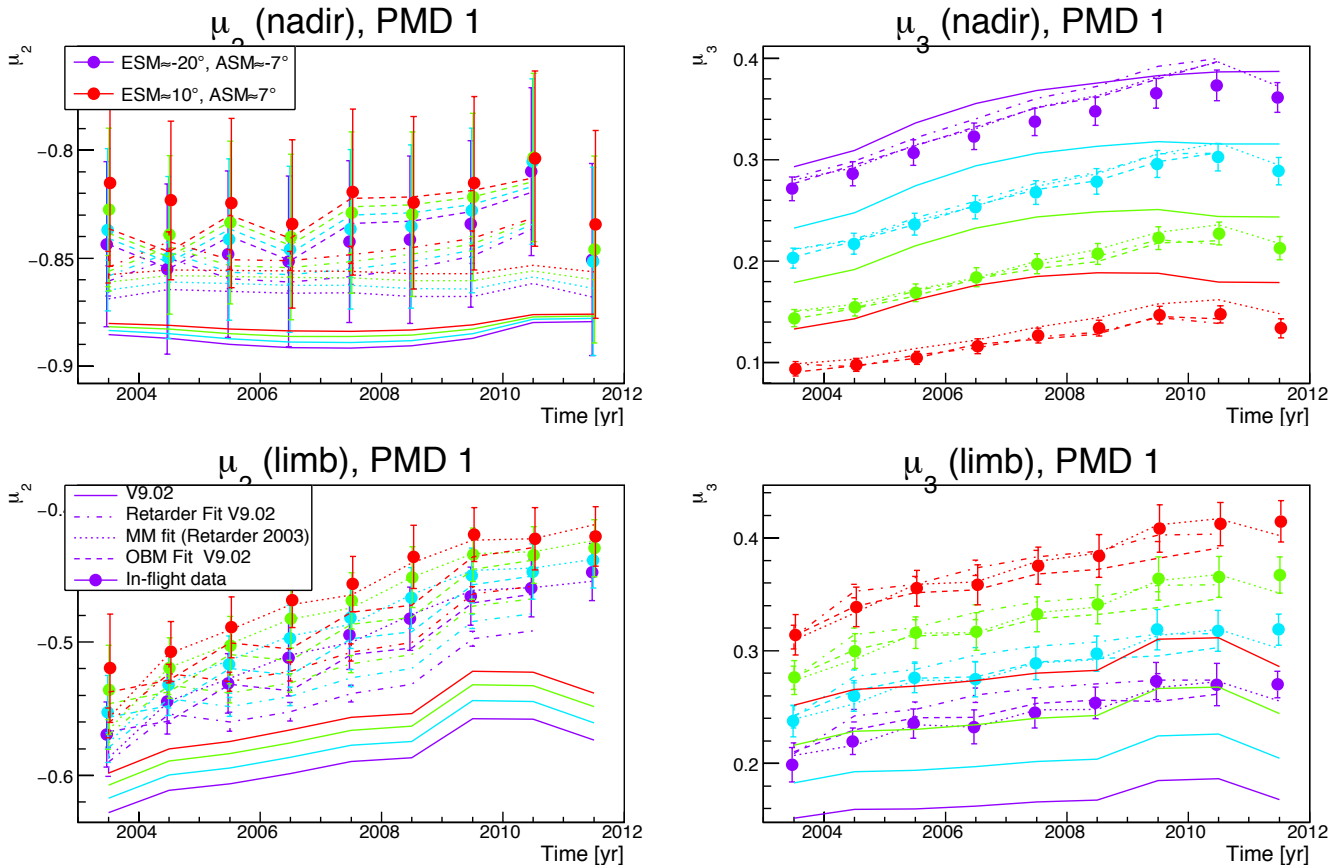
Phase Shift and Mirror Model

- Minimum χ^2 for different fit models vs. time:
  - Using V9.02: increase in time
  - Adjusted mirror model & const. OBM = best fit



Phase Shift and Mirror Model

- MMEs for different fit models vs. time:
  - Polarization adjustment in OBM fixes offset in μ^2-limb
  - Adjusted mirror model & const. OBM = best fit

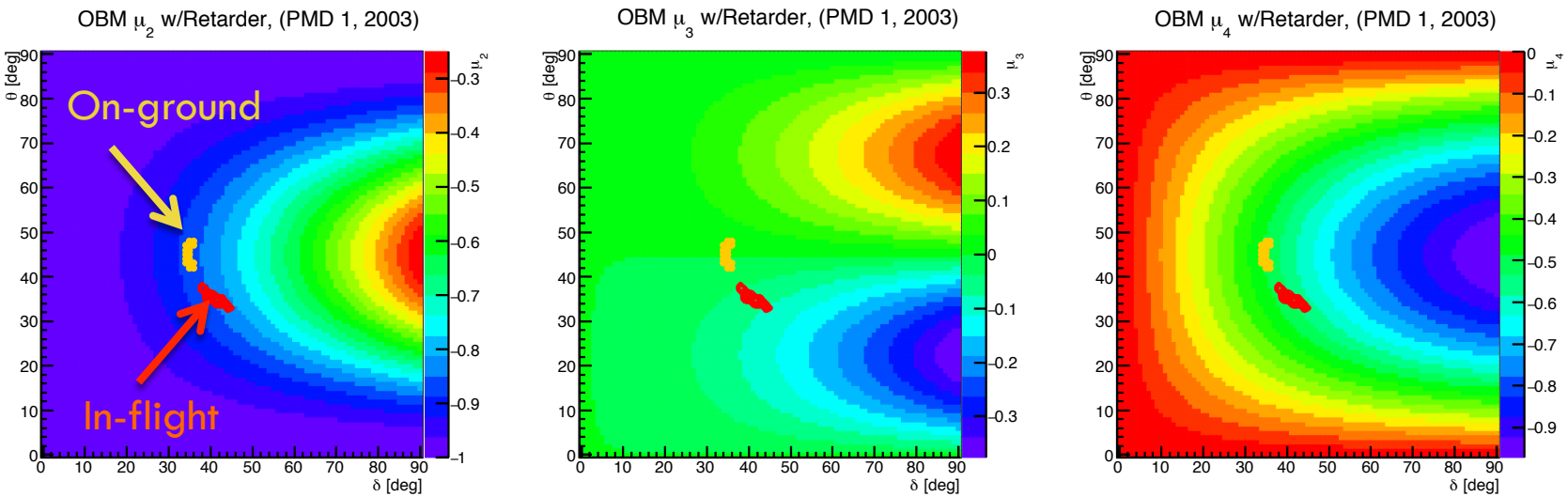


Phase Shift and Mirror Model

- Mirror model parameters and OBM vector are strongly correlated
- Explain data with
  - Time dependent refractive index or/and
  - Time dependent OBM change
- Ideally, mirror model fit would combine in-flight calibration and polarization data to constrain the parameter space
- Practically:
  - Mirror model is as it is
  - OBM adjustment (with retarder) can be time dependent, possibly w/degrading quality and will partially compensate for errors in mirror model

Origin of Phase Shift?

- (Accidental) stress birefringence in predisperser prism?
  - Difference on-ground to in-flight = 5-10 deg corresponds to stress change of ~1-2 MPa
  - Plausible?
- On-ground phase shift: can be determined from on-ground OBM vector asserting that there should be no sensitivity to circular polarization for the PMDs:



Origin of Phase Shift?

- (Accidental) stress birefringence in predisperser prism?
  - Difference on-ground to in-flight = 5-10 deg corresponds to stress change of ~1-2 MPa. Plausible?
- On-ground phase shift: can be determined from on-ground OBM vector asserting that there should be no sensitivity to circular polarization for the PMDs:
  - On ground phase shift is 30 deg!
  - If this is real, there is no reason that this shouldn't happen to any other optical element made of quartz glass
  - ??? Is it real?
  - Accidental stress results in optic axis angle of 45 deg on-ground, which conveniently erases sensitivity to u as any other retarder would generate

Summary

- Investigations on phase shift:
  - On-ground to in-flight change necessary to describe data
  - Actual parameters depend on mirror model, even in 2003
  - Retarder fit can be improved if OBM polarization for PMD 1 is adjusted in key data
  - Time dependence of data can be due to
    - Time dependent OBM
    - Time dependent, different refractive index than SRON
    - Combination of above

Summary

- Using time dependent retarder data means accepting that errors in the mirror model are
  - Partially compensated (for polarization measurements)
  - Propagated into science channel pol. sensitivity with the retarder / stress model
    - $\sim 1/\lambda$ dependence: similar to mirror model dependence on thickness for given n
    - Scan angle dependence: mirror redistributes μ_4 and μ_3, μ_1 and μ_2, retarder shifts μ_2 and μ_4
    - Only small, indirect effect on unpolarized intensities
- There is currently no plausible explanation for
  - Size of on-ground phase shift
  - On-ground to in-flight shift (?)
  - Time dependence in terms of changing stress
- Strategy for V9?