Strategies for effective monitoring of Total Solar Irradiance

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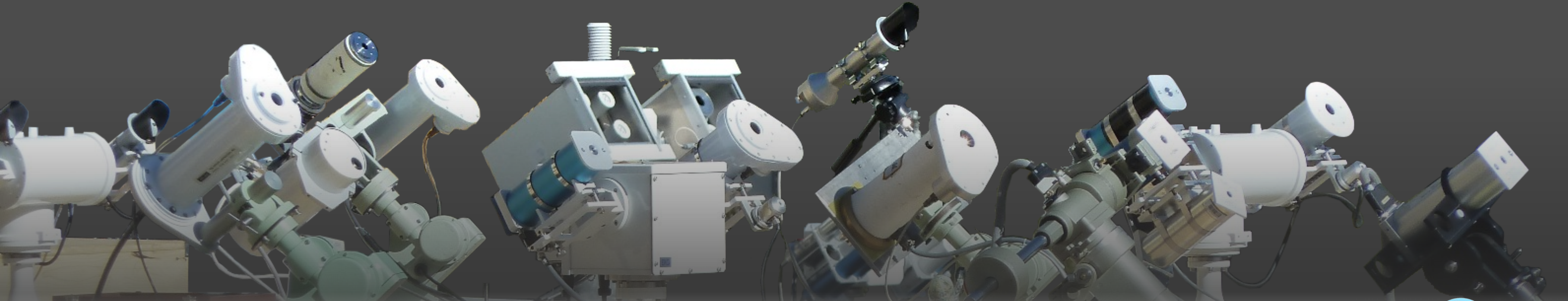

Physikalisch-Meteorologisches Observatorium Davos
World Radiation Center

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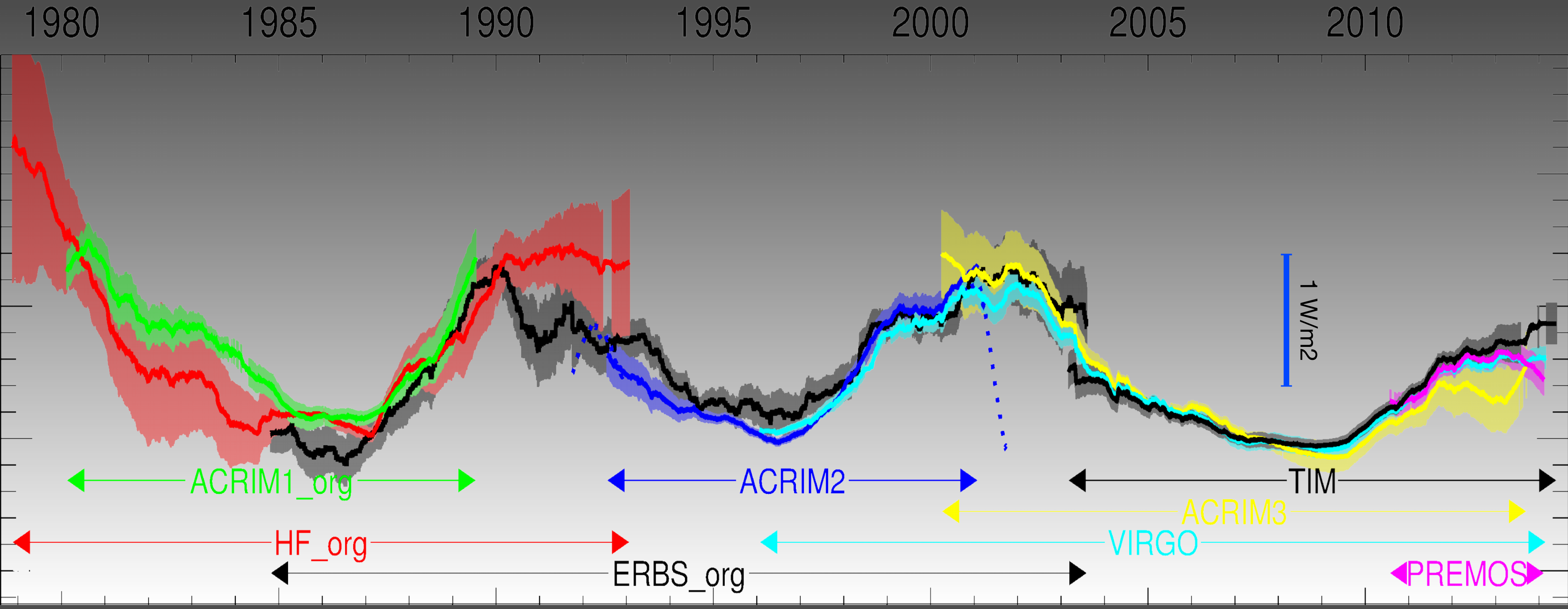
Outline

- Past and present TSI time series
- Accuracy and stability
  - Traceability to ground-based standards
  - Traceability to on-orbit standards
  - The “Standard Group” concept
  - Stability issues
- Cubesats

The TSI data record



courtesy C. Fröhlich and ISSI-TSI Team

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Traceability to ground based standards

- World Standard Group (WSG)
  - Air-to-vacuum correction introduces large uncertainty
- TSI Radiometer Facility (TRF, NIST traceable)
  - Monochromatic
  - Scanning-beam irradiance field
- Cryogenic Solar Absolute Radiometer (CSAR)
  - Future possibility

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Traceability to on-orbit standards

- Cryogenic Solar Absolute Radiometer (CSAR)
  - TRURTHS mission proposal
- Space Standard Group

The Standard Group Concept

- The World Standard Group (WSG) has served as a primary reference for ground-based solar irradiance measurements since 1977
  - Stable to within better than 0.1% over 40 years
  - Instrumental problems with any of the WSG radiometers can be identified in a self-consistent way
- Standard Group in space proposed for Chinese FY-3E mission
  - SIAR (China), DIARAD (Belgium), DARA (Switzerland)

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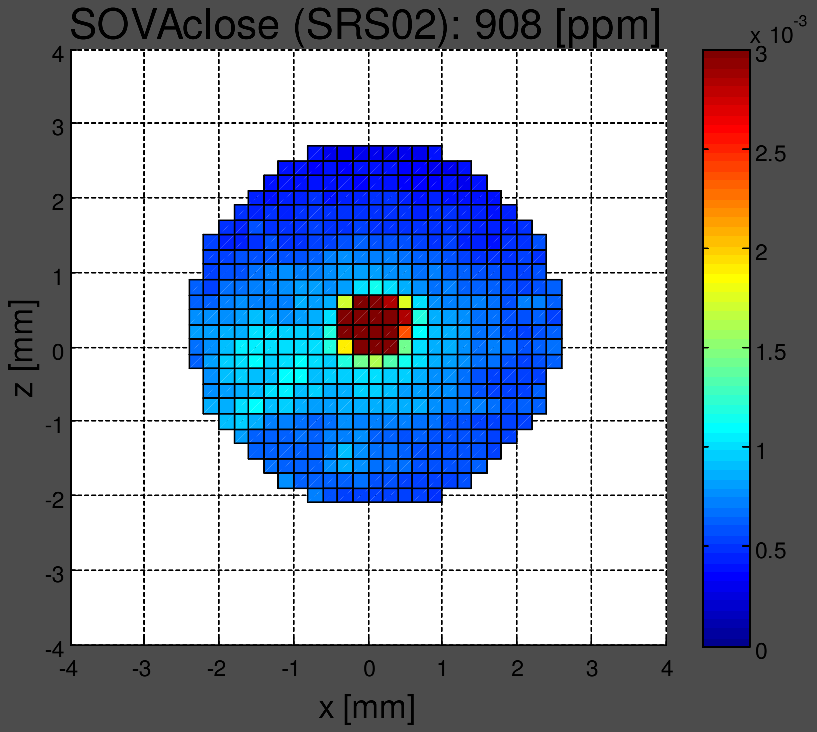
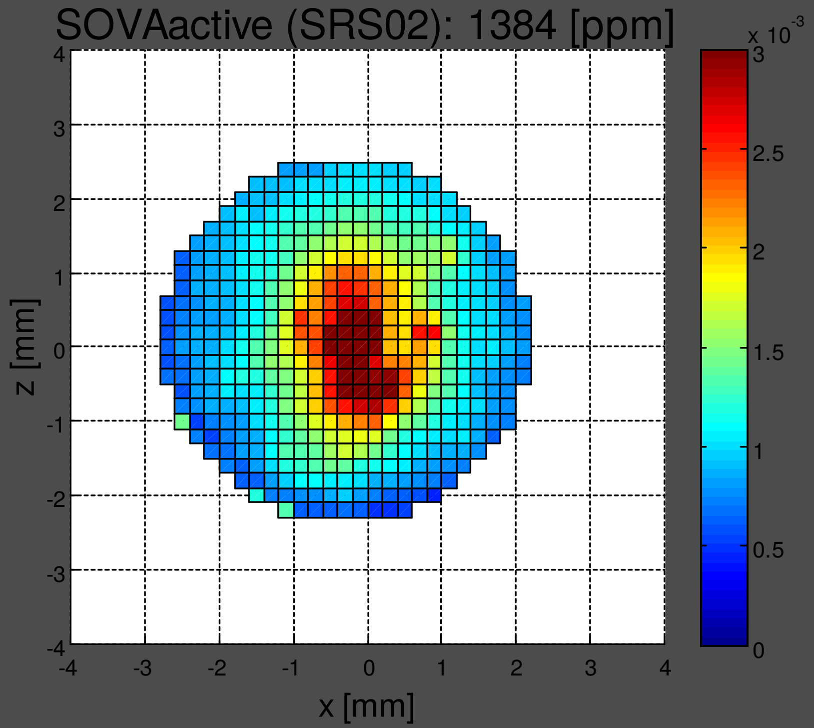
Sources of instability

- Cavity absorptance
  - Absorptivity
  - Bidirectional reflectance distribution function BRDF
- Stray-light characteristics
- Electronic components
  - Drifts due to aging
  - Drifts due to temperature
- Thermal changes

Cavity aging in orbit



Not exposed to sun



Exposed to sun for ~3 months

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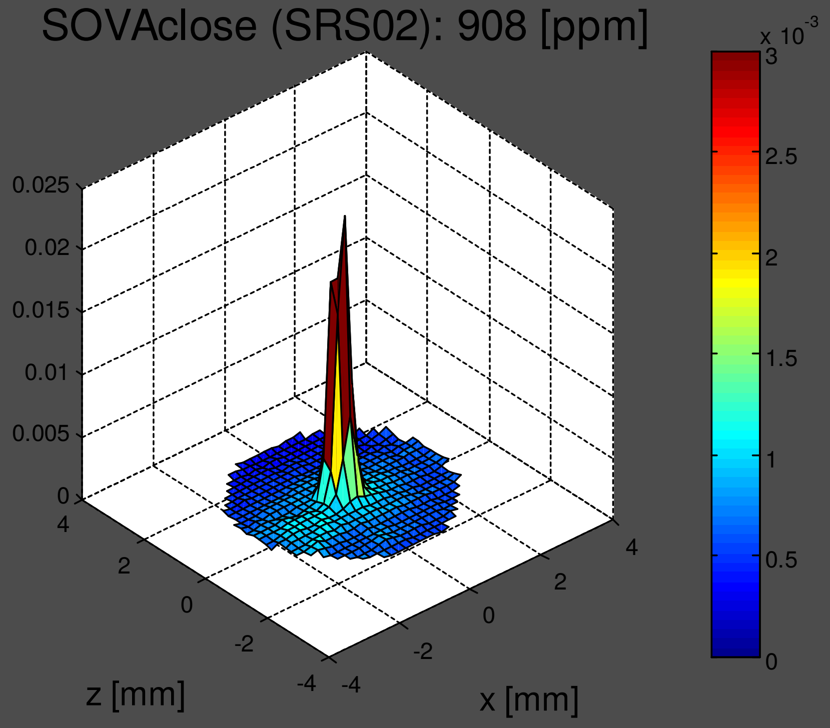
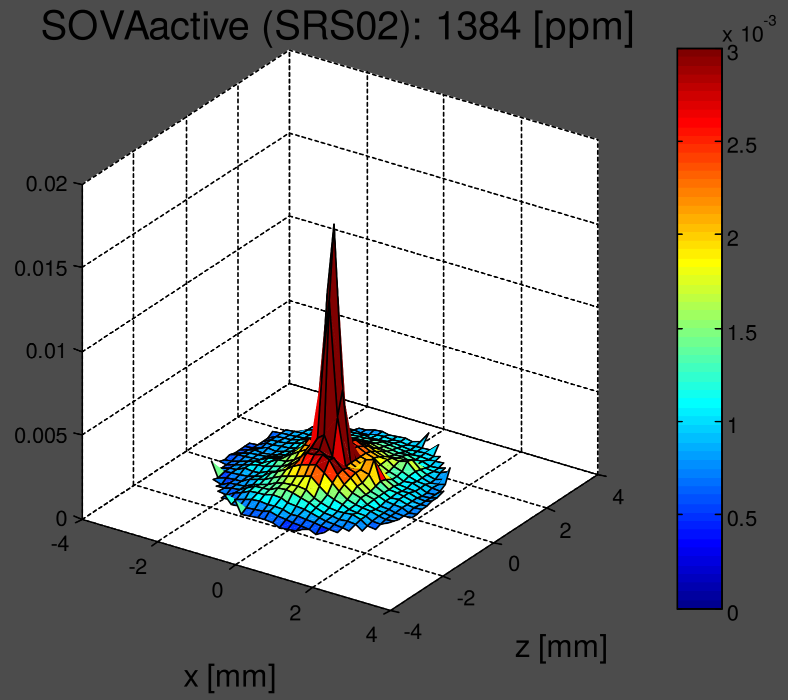
Cavity aging in orbit



Not exposed to sun



Exposed to sun for ~3 months

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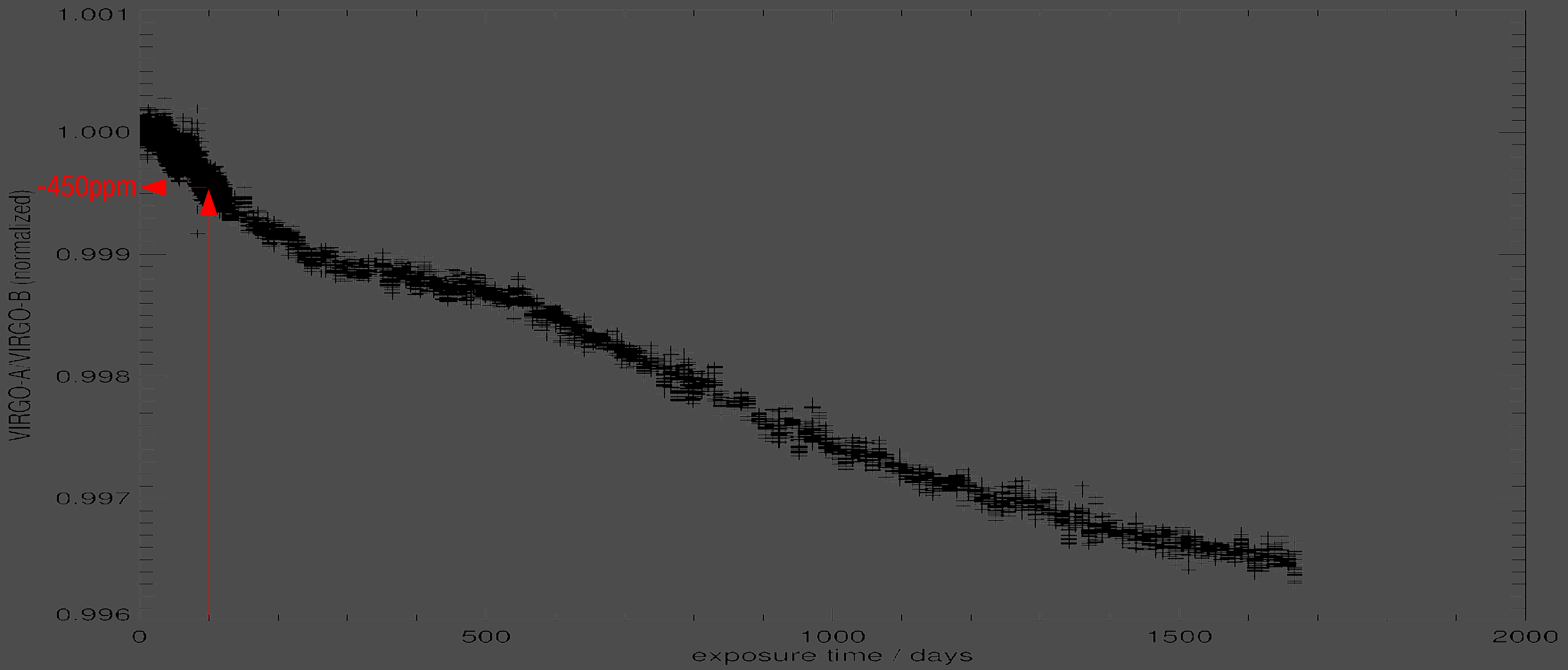
PMO6 sensitivity loss in orbit



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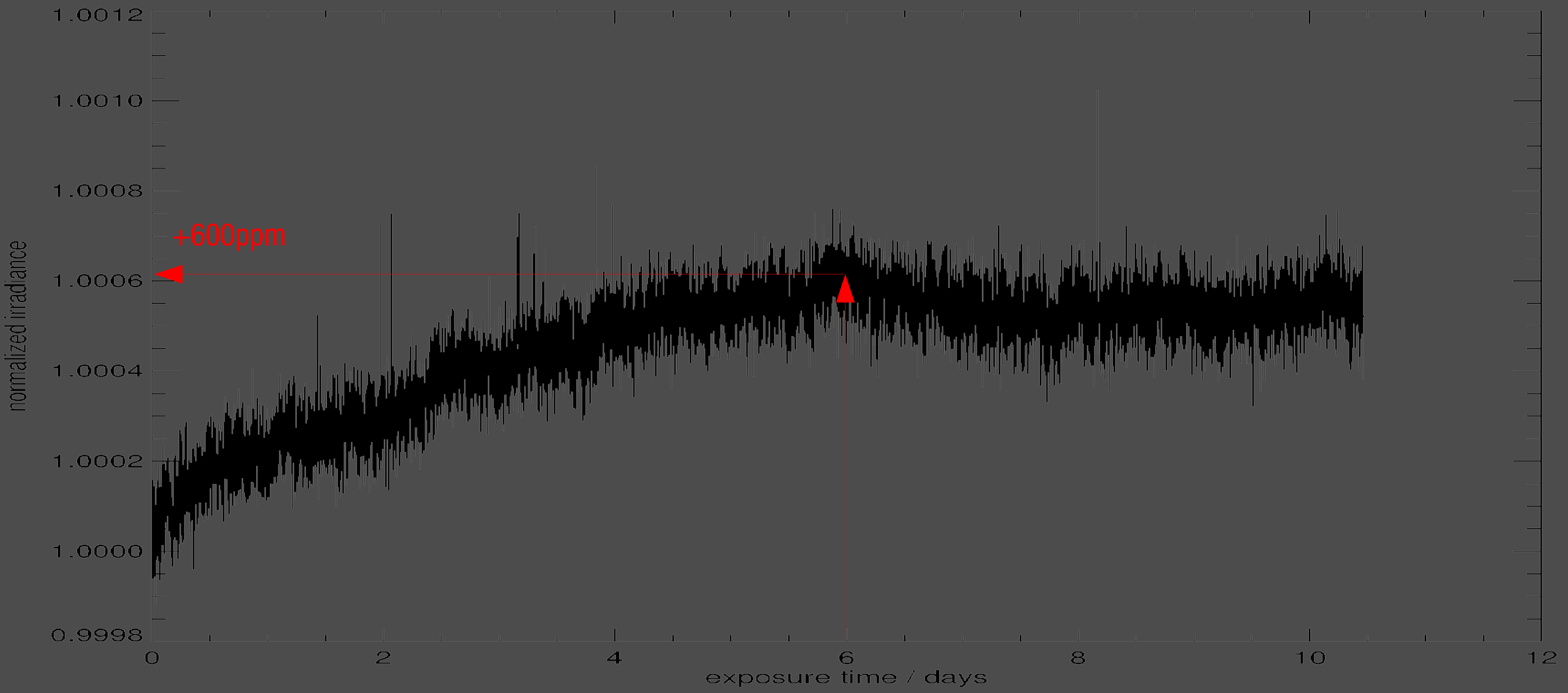
PMO6 sensitivity gain in orbit



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Degradation mechanisms

- Sensitivity loss
  - Could be caused by BRDF change (loss of gloss)
- Early increase
  - Not likely an absorptance gain
  - Stray-light characteristics?

Fleet of TSI radiometers

- Problems
  - Expensive
  - Limited number of suitable missions
  - Cost-benefit ratio
- Solutions
  - Compact and light-weight radiometers (CLARA, DARA)
  - Monitoring iso scientific missions (FY-3E)
  - Scientific benefit less critical for monitoring mission

Cubesats?

- Yes! But:
  - Solar pointing better than 0.5°
  - Thermal management during eclipses
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