

# ***An Overview of a Decade GOME-1 Operations and Performance***

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# Overview

## I. ERS-2 Mission History

1. Mission Plan Highlights
2. GOME Special Operations

## II. GOME-1 Engineering Performance

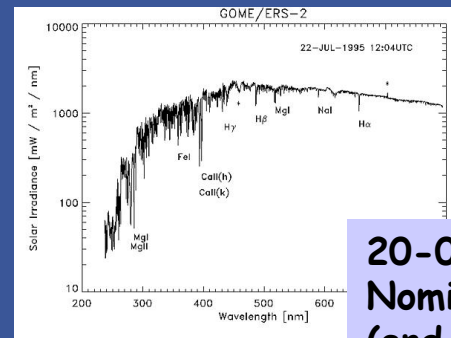
1. Routine Monitoring on GOME instrument parameters at ESRIN
2. Diffuser Reflectivity
3. Dark Signal Analysis
4. GOME-1 Thermal Environment
5. Calibration Lamp
6. Optical Throughput
7. Pointing Performance
8. GOME-1 Scan Mirror Performance
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# I. ERS-2 Mission History

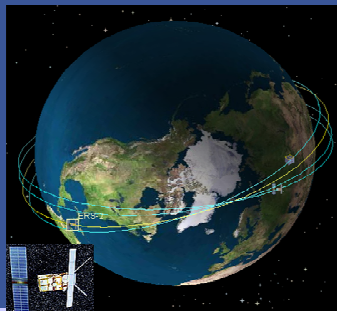
## 1. Mission Plan highlights



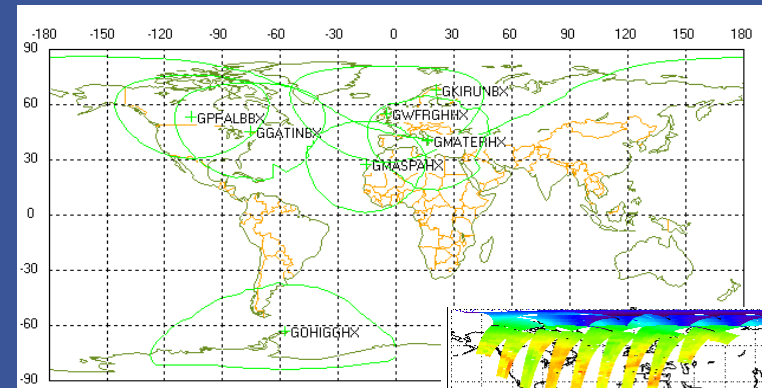
21-04-1995 launch



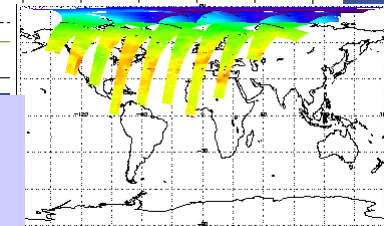
20-07-1995 start of *GOME-1*  
Nominal Daily Operations  
(end of Commissioning Phase)



Oct 2001 Zero Gyro Mode



Jun-2003 ERS-2 tape  
recorder failure



# I. ERS-2 Mission History

## 2. GOME-1 Special Operations

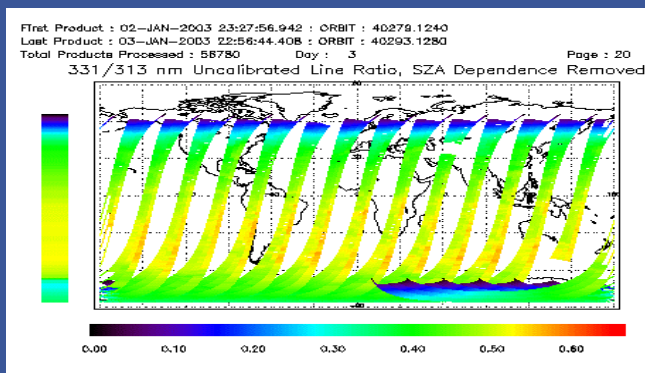
- Solar Calibration Measurements (**since 30/05/1995**)
- Daily Calibration Lamp Measurements (**30/05/1995 – 06/09/2001**)
- Monthly/Quarterly Calibration Measurements (Diffuser Charact.) (**monthly since 28/07/1995, reduced to quarterly since July 2004**)
- Calibration Measurements with un-cooled detectors after an instrument switch-off
- Moon Measurements (**between July 1995 – January 2001 + test Jul. 2002**)
- Nadir Static View
- Polar View Timelines (**since June 1995**)
- Operational Switch-off and Switch-on (**since April 2000**)
- Narrow Swath (**since 14/06/1997**)

## II. GOME-1 Engineering Performance

### 1. Routine Monitoring on GOME instrument parameters at ESRIN

- Automated Quality Assurance tool is analysing EGOI (Extracted GOME Instrument Header) – L0 data operationally. Mainly info on telemetry parameters is available and quick look images give first quality feedback on measurement data.
- Data is collected in database, to allow Long Term Trend Monitoring
- Daily summary on instrument health sent out by E-mail to NRT users
- Weekly summary sent to processing centre at D-PAC
- Monthly Reports, Yearly Reports, Long Term trend analysis available on-line

<http://earth.esa.int/ers/eo4.96/performance/>

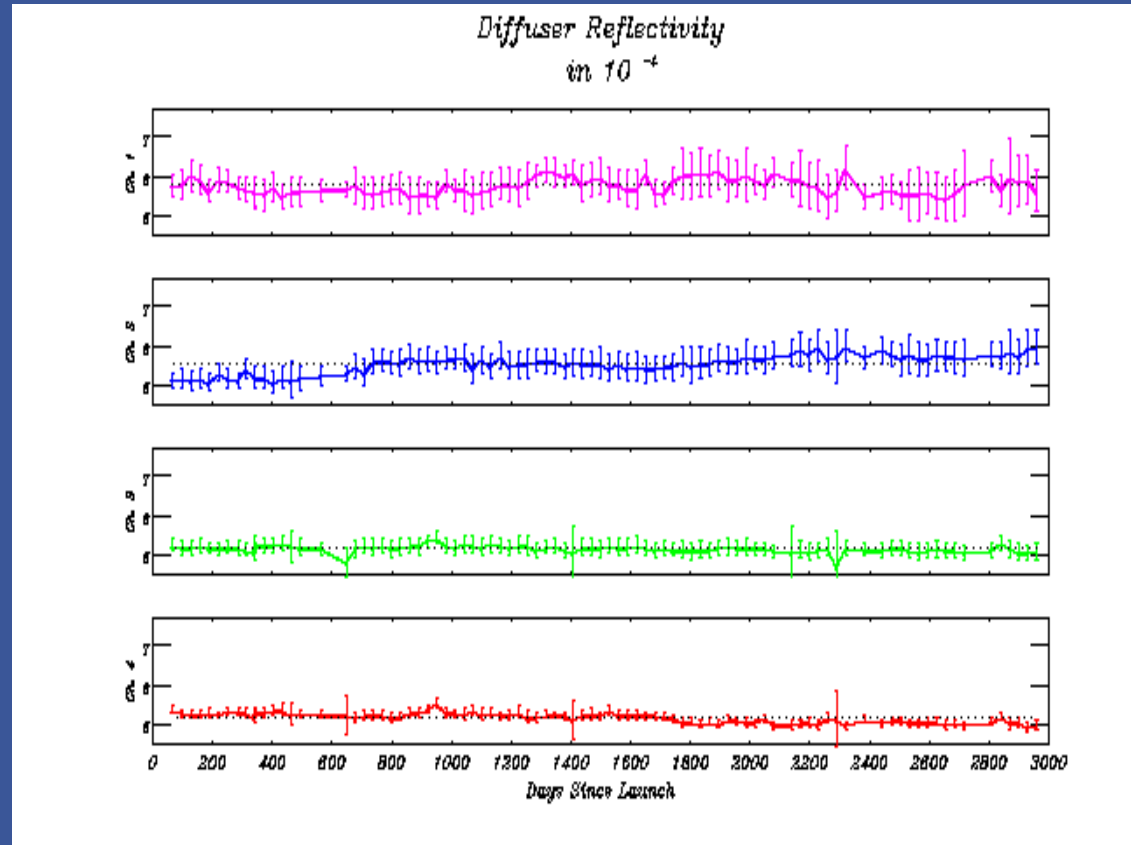


Quicklook image: Ozone Line Ratio (ozone lines 331nm/313nm) gives a relative indication on ozone field

## II. GOME-1 Engineering Performance

### 2. Diffuser Reflectivity: July 1995 – May 2003

- Ratio of calibration Lamp Measurements and the Lamp measurements via the diffuser
- Due to ERS-2 tape recorder failure, full data sets, needed for the analysis are not available anymore since June 2003
- Diffuser Reflectivity is stable during first 8 years of mission



## II. GOME-1 Engineering Performance

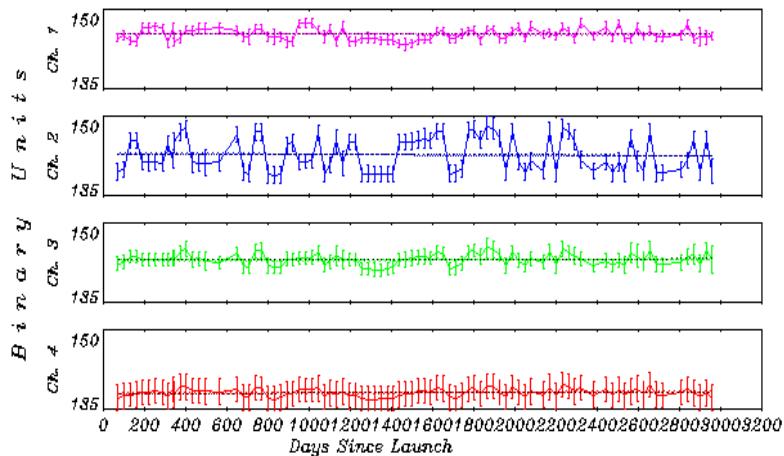
### 3. Dark Current Analysis: July 1995 – May 2003

Dark Signal consists of two parts

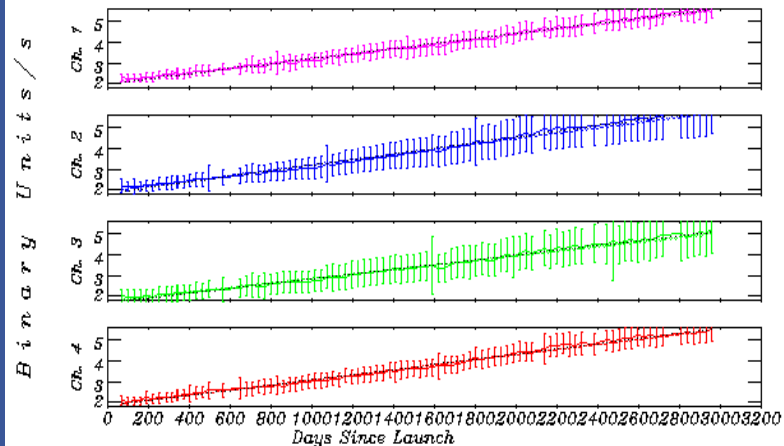
1. FPRN (Fixed Pattern Readout Noise) a constant value (between 140 – 150 BU)
2. LC (Leakage Current) which is the time dependent component

The increase of LC is linear 11-14% per channel per year

*Fixed Pattern Readout Noise*



*Leakage Current*

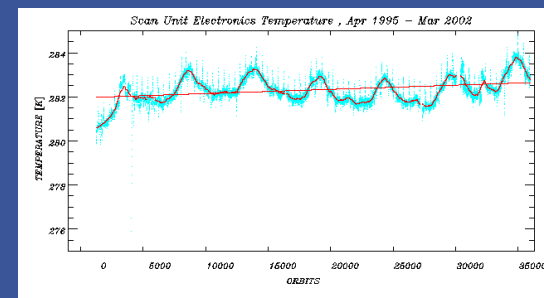
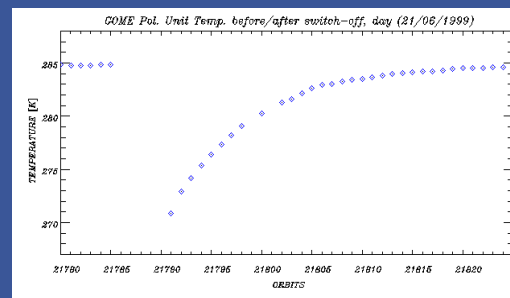
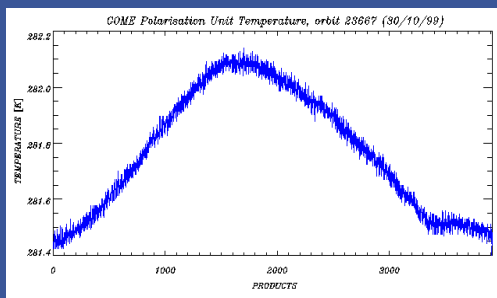
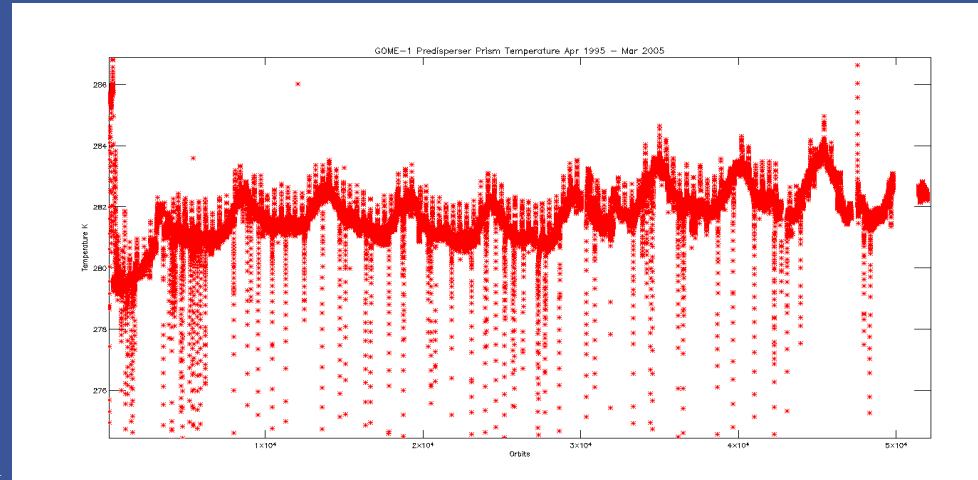


## II. GOME-1 Engineering Performance

### 4. GOME Thermal Environment

Typical characteristics:

- 4 Detectors cooled constantly at 235K
- Orbital variation due to eclipse, ca 0.8K
- Seasonal variation due to earth-sun distance
- Cool-down during switch off, ca 20 K lower than nominally
- Calibration lamp usage increases thermal environment up to 1.5 K while monthly cal.
- After 10 years life time slowly linear increase, by about 1 K - 1.5 K





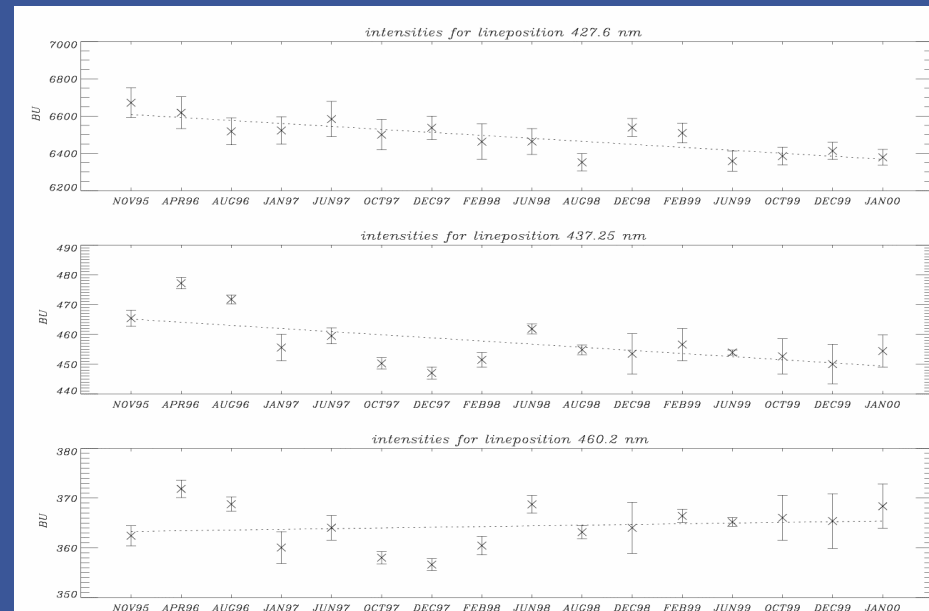
## II. GOME-1 Engineering Performance

### 5. Calibration Lamp Lamp Degradation Analysis

Hollow Cathode Gas Discharge Lamp, filled with Ne, Pt, Cr

- Intensity of 3 selected emission lines of Channel III were studied (427.6nm, 437.25nm, 460.1nm)
- Data used: Monthly calibration sequences (Nov. 1995 – January 2000)

No significant degradation found, decrease between 2-4%

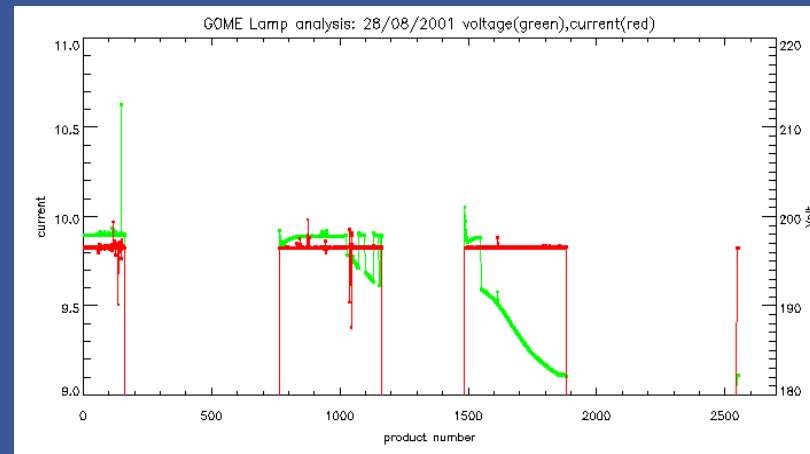
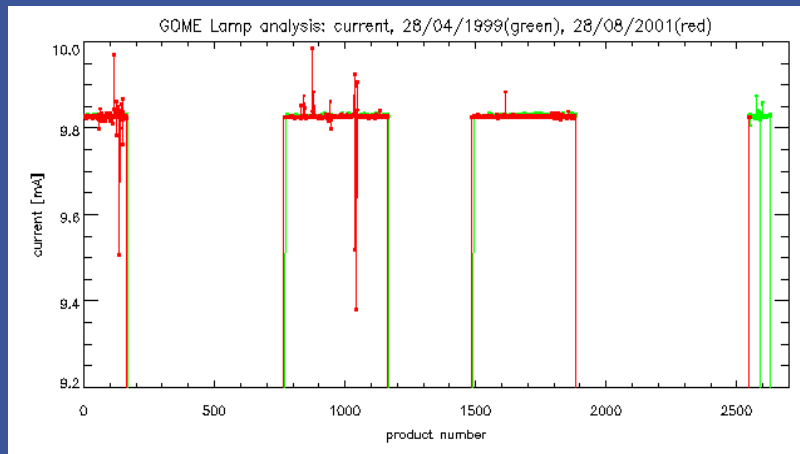


## II. GOME-1 Engineering Performance

### 5. Calibration Lamp Failures (LF)

If the voltage of the calibration lamp has not reached it's standard value of about 197 V in the start up period of 10 sec, or the voltage drops down to below 180V, automatically the operation of the calibration lamp is aborted.

- First occurrence LF in October 1997
- Increase of Number of Lamp Failures led to changes in the Calibration Lamp Usage during 1998, 2001 and 2004 (see table next slide)



## II. GOME-1 Engineering Performance

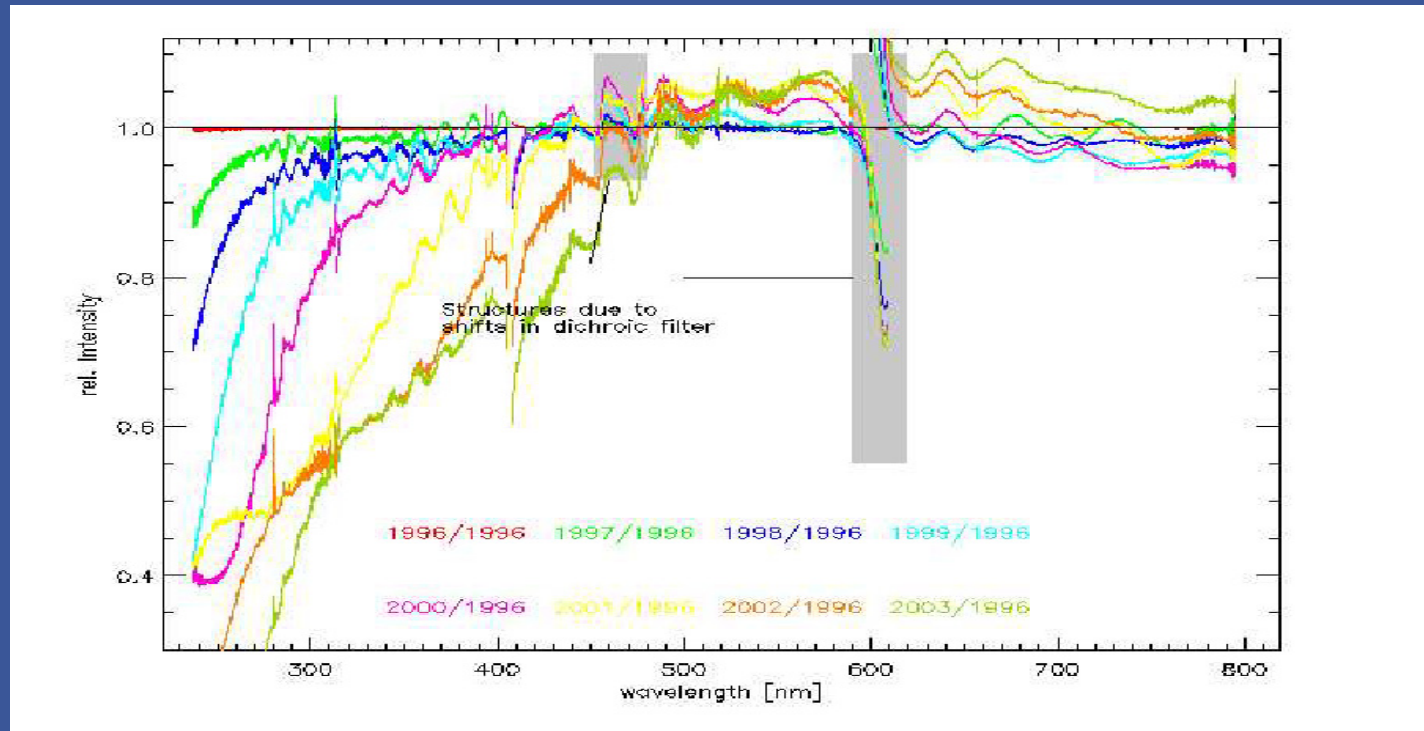
### 5. Consequences on Calibration Lamp usage

Date	Description
20/07/1995 – 01/04/1998	Daily two sequences (duration ca. 240 sec)
02/04/1998 – 06/09/2001	daily one sequence ( duration ca 120 sec)
28/07/1995 – 28/07/2004	Monthly calibration (5 orbits) Every calendar month day 28 (duration ca. 2000 sec per orbit)
Since July 2004	Quarterly calibration (5 orbits) Calendar days 28 Jan., 28 Apr. 28 Jul. 28 Oct.
Since begin of mission 1995	special timeline after instrument switch offs (about 4 times per year 2 sequences with duration 240 sec)

## II. GOME-1 Engineering Performance

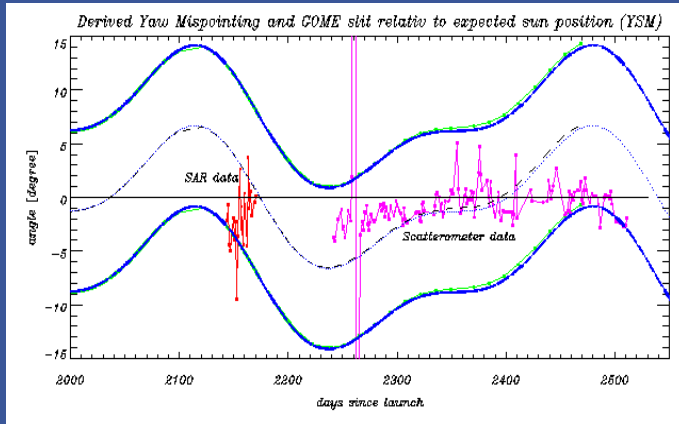
### 6. Optical Throughput

Ratios of solar spectra show gradual degradation of the light path in channel 1, 2, but stability in channel 3 (Ozone Column Retrieval) (analysis by DLR-IMF)



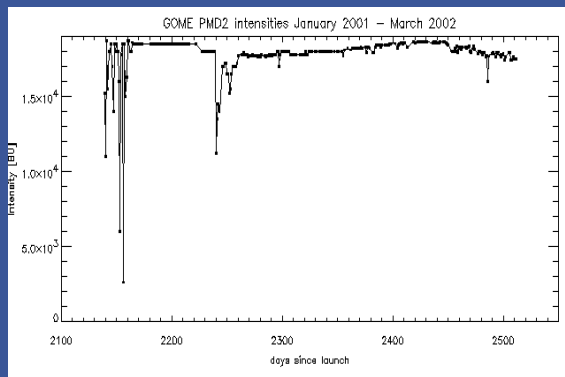
## II. GOME-1 Engineering Performance

### 7. Pointing performance

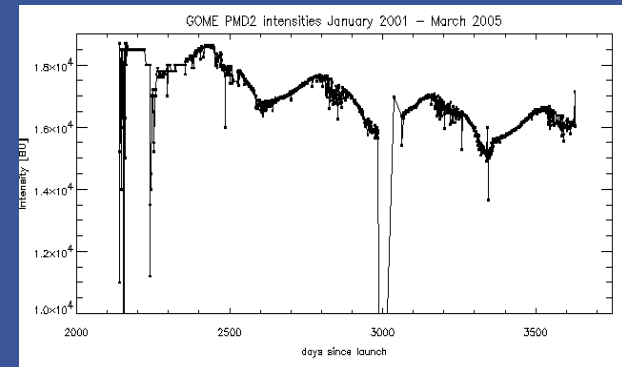


- Failure of Digital Earth Sensor Jan. 2001
  - Zero Gyro Mode (ZGM) implemented June 2001
- Improved attitude

- yaw axis to average about  $\pm 2.0$  degree
- Less stable during December-March due to increased solar activity



GOME PMD2 max intensities during solar calibration measurements



## II. GOME-1 Engineering Performance

### 8. GOME-1 Scan Mirror performance

#### General:

Nominal Swath Operations: 960 km

Narrow Swath operations: 240 km

Scanner Movement: 3 forward scans + 1 backscan

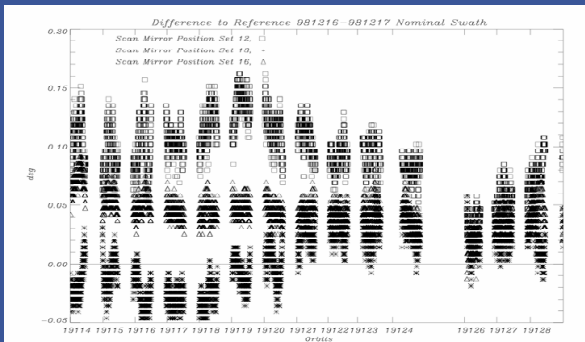
(each scan consists of 16 different position sets)

Monitored: Deviation of Reference Scan Mirror Position to operational SM position

#### Results:

#### 1) Nominal Swath

Deviation Scan Mirror Position sets, during 14 Orbits in Nominal Swath forward scan 3, set 12, 13, 16 (1998-Dec-16)



#### 1) Nominal Swath:

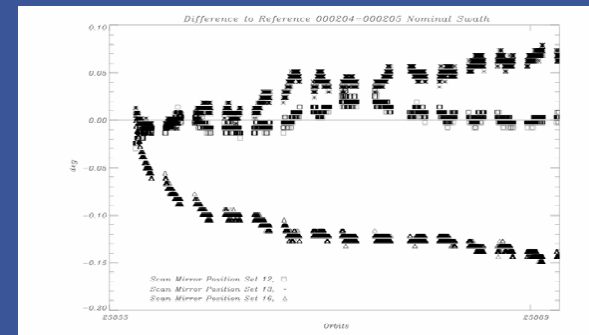
SM position sets stable within one operational day, but significant long term changes 0.12 deg (for Set 12)

#### 2) Narrow Swath:

Deviation of SM position sets during operation of 14 orbits, e.g. set 16 deviates by 0.18 deg

#### 2) Narrow Swath

Deviation Scan Mirror Position sets, during 14 Orbits in Narrow Swath forward scan 3, set 12, 13, 16 (2000-Feb-04)



## II. GOME-1 Engineering Performance

### 9. Transient Anomalies – Single Event Upsets (SEU)

Changes on the on board software (SEU) can be caused by radiation particles. The harm for the operations of GOME depend on which part of the software is hit.

- Statistically occurrences: 3-4 times per year
- Reboot of the on board software by switching off/on GOME cures SEU

### Example of SEU impact on data quality:

05-12-1998 – 11-03-1999,

Intensity jumps in science data channel II, above 390nm (to end of channel)

Intensity jumps in science data channel III, above 580nm (to end of channel)

**Operational switch off/on about every 10 days  
implemented since 14-04- 2000**

# Conclusion

- GOME in Orbit Performance after 10 years very good, besides:
  - Calibration Lamp almost not usable, solution:  
wavelength calibration using Fraunhofer Lines of solar calibration
- Failure of ERS-2 gyroscope could be resolved with specially developed ZGM software
- Loss of ERS-2 taperecorder reduced data coverage to visibility of groundstation segments
- Monitoring results at

<http://earth.esa.int/ers/eeo4.96/performance/>