On-board Calibration MOS-IRS and GLI

Jens NIEKE, Ichio ASANUMA

National Space Development Agency of Japan (NASDA)
Earth Observation Research Center (EORC)

On-board calibration comparison

1. MOS-IRS, an experimental coastal zone imaging spectrometer

2. MOS-IRS after 4.5 years of on-board calibration

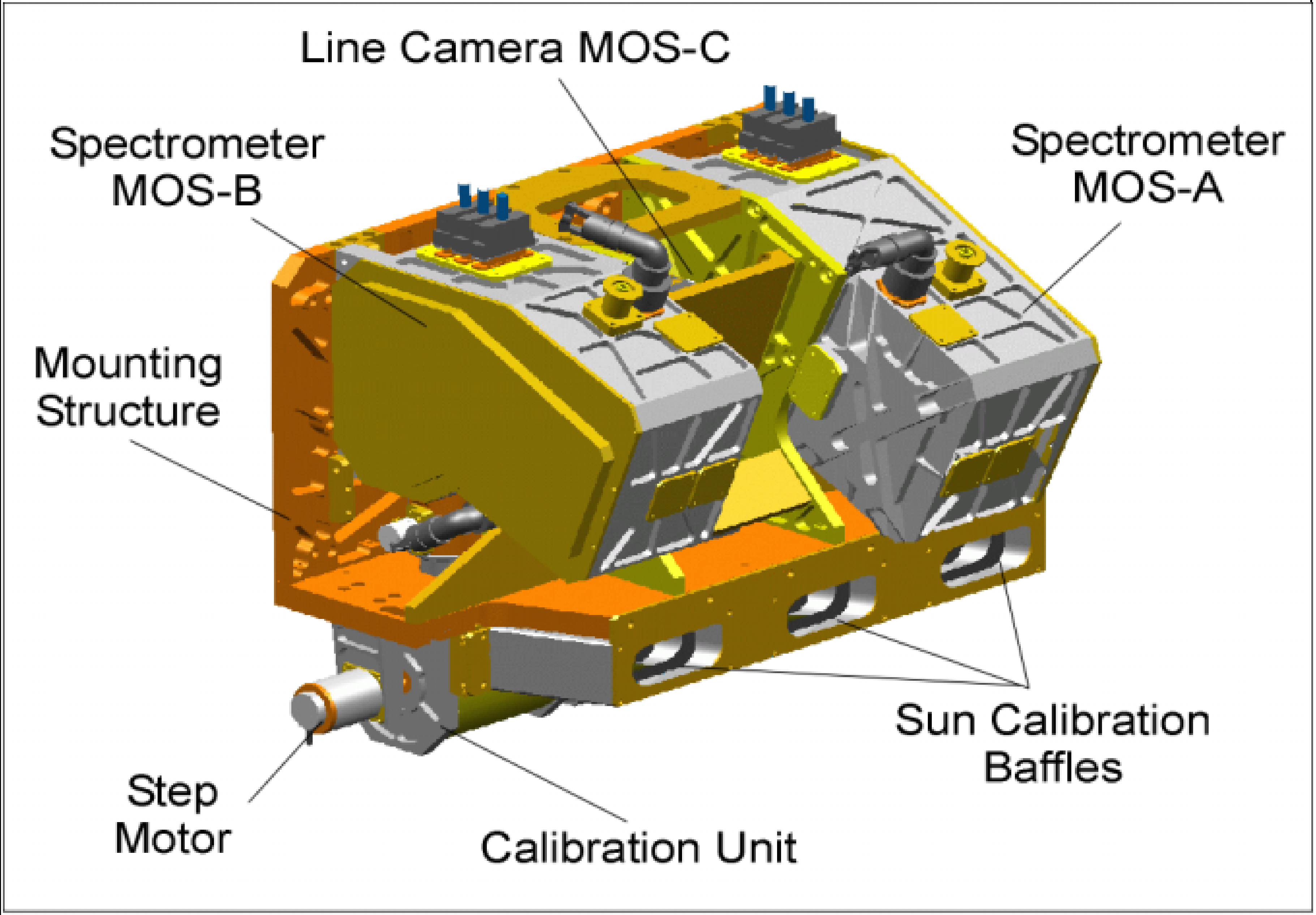
3. GLI, a full operative global orientated whiskbroom scanner

4. GLI on-board calibration

5. Comparison GLI — MOS-IRS calibration

6. Conclusion

National Space Development Agency of Japan (NASDA)



Imaging Spectrometer MOS-IRS

National Space Development Agency of Japan (NASDA)

Deutsches Zentrum für Luft- und Raumfahrt e.V.
Institut für Weltraumsensorik und Planetenerkundung

Modular Optoelectronic Scanner MOS - Main Parameters

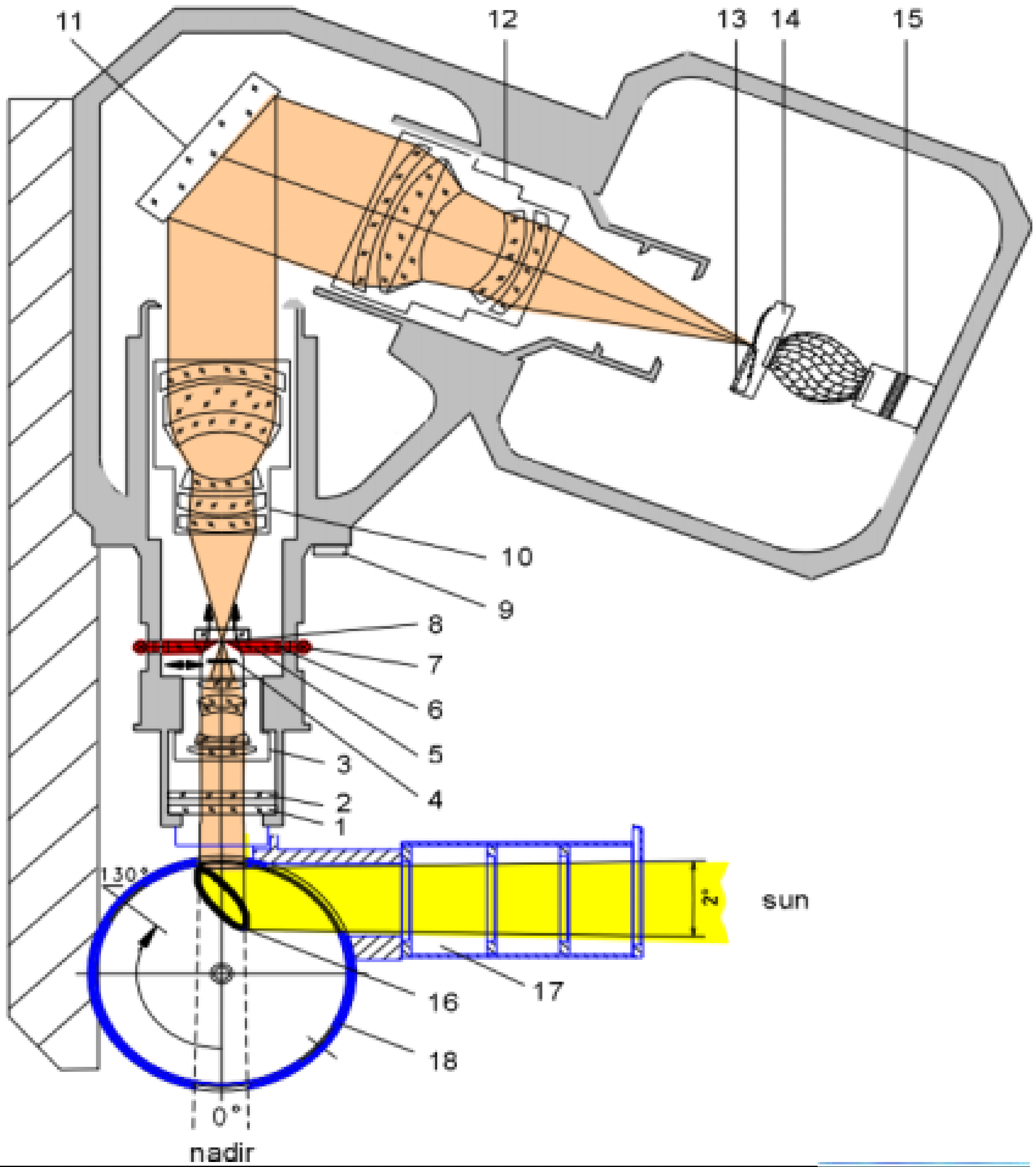
Parameter	MOS-A	MOS-B	MOS-C
Spectral Range [nm]	755 - 768	408 - 1010	SWIR
No. of Channels	4	13	1
Wavelengths [nm]	756.7; 760.6; 763.5; 766.4 O_2 A-band	408; 443; 485; 520; 570; 615; 650; 685; 750; 870; 1010 815; 945 (H_2O-vapor)	1600
spectral halfwidth [nm]	1.4	10	100
FOV along track x [deg] across track [deg]	0.344 13.6	0.094 14.0	0.14 13.4
Swath Width [km]	195	200	192
No. of Pixels	140	384	299
Pixel Size x*y [km^2]	1.57x1.4	0.52x0.52	0.52x0.64
Measuring Range L_{min} .. L_{max} [$\mu W cm^{-2} nm^{-1} sr^{-1}$]	0.1 ...40	0.2 .. 65	0.5 .. 18
$\Delta L/L$ [%]	0.3	1.0	2.0

DLR

National Space Development Agency of Japan (NASDA)

MOS - B Optical design with Sun cal unit

1 quartz plate
2 quarter wave plate
3 objective "Tevidon" 1,4/25
4 shutter
5 glass prism
6 filter glass FB 120
7 mini lamp
8 entrance slit
0,041 mm x 6,140 mm
9 adjustment mirror
10 collimator "Pancolar" 1,8/80
11 grating 325 l/mm
12 imager "Pancolar" 2,8/120
13 filter glass RG 5
14 focal plane assembly
15 peltier cooler
16 sun diffuser
17 buffle
18 sun cal unit



Results of MOS-IRS on-board calibration

Lamps: total error: 1.1%; frequency: before each orbit

- relative radiometric, linearity, spectral checks
- show that sensor sensitivity is stable or increases slowly (MOS-B up to +7%)
- no changes of linearity and spectral checks

Sun: total error: 2.0 %; frequency: ca. 15 times a year

- absolute radiometric calibration
- error due to stray light effects in the SunCal Unit (straylight has a strong correlation with seasonal variations of Sun incidence angle)
- no degradation of the diffuser plate

(state: April 1996 — October 2000)

After 4.5 years of MOS-IRS on-board calibration

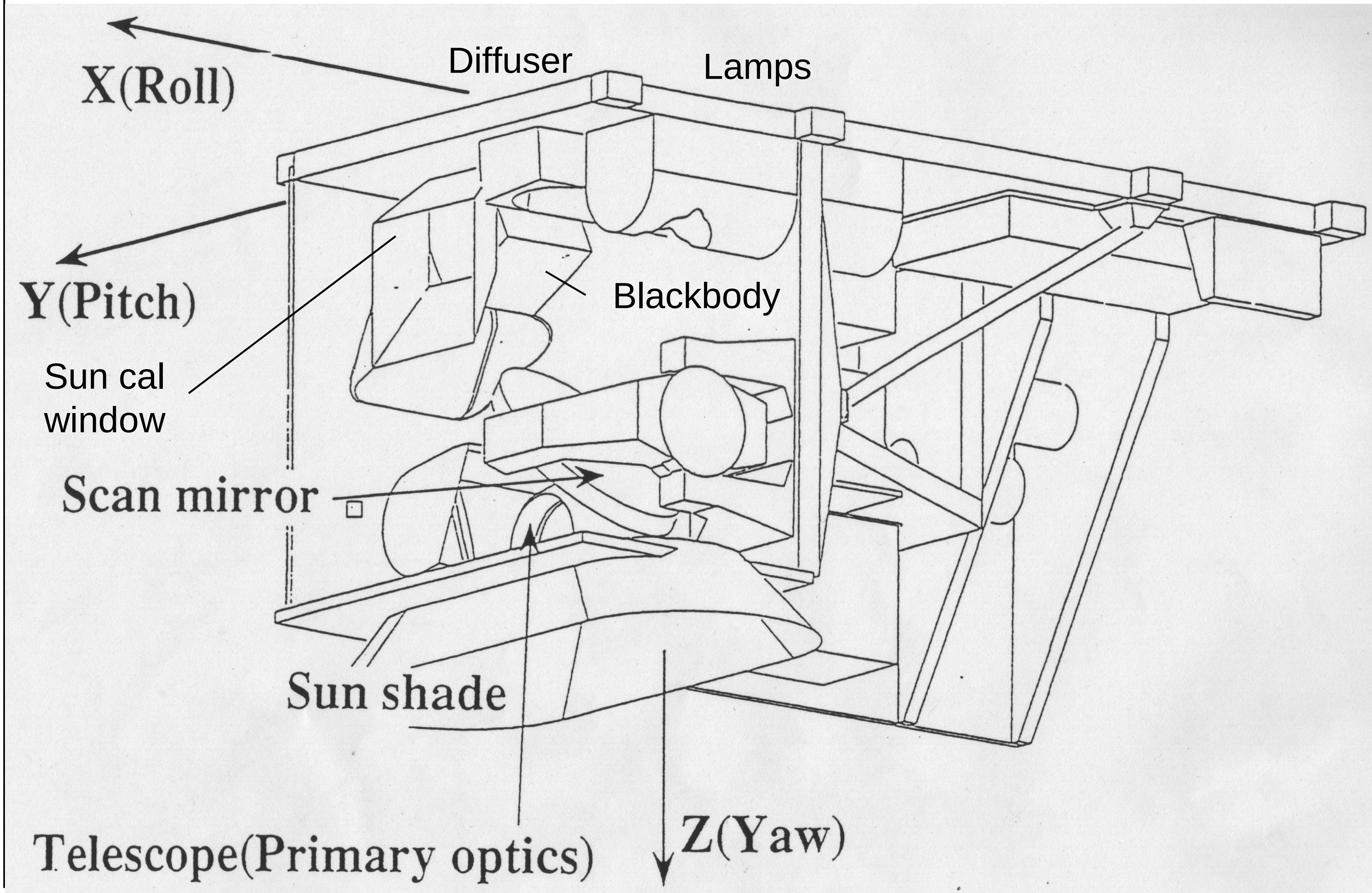
- Sun calibration is a reliable source for absolute calibration
- Spectralon is a very suitable and stable material for in-orbit Sun calibration
- lamp calibration is a reliable source for relative calibration

Lessons learnt:

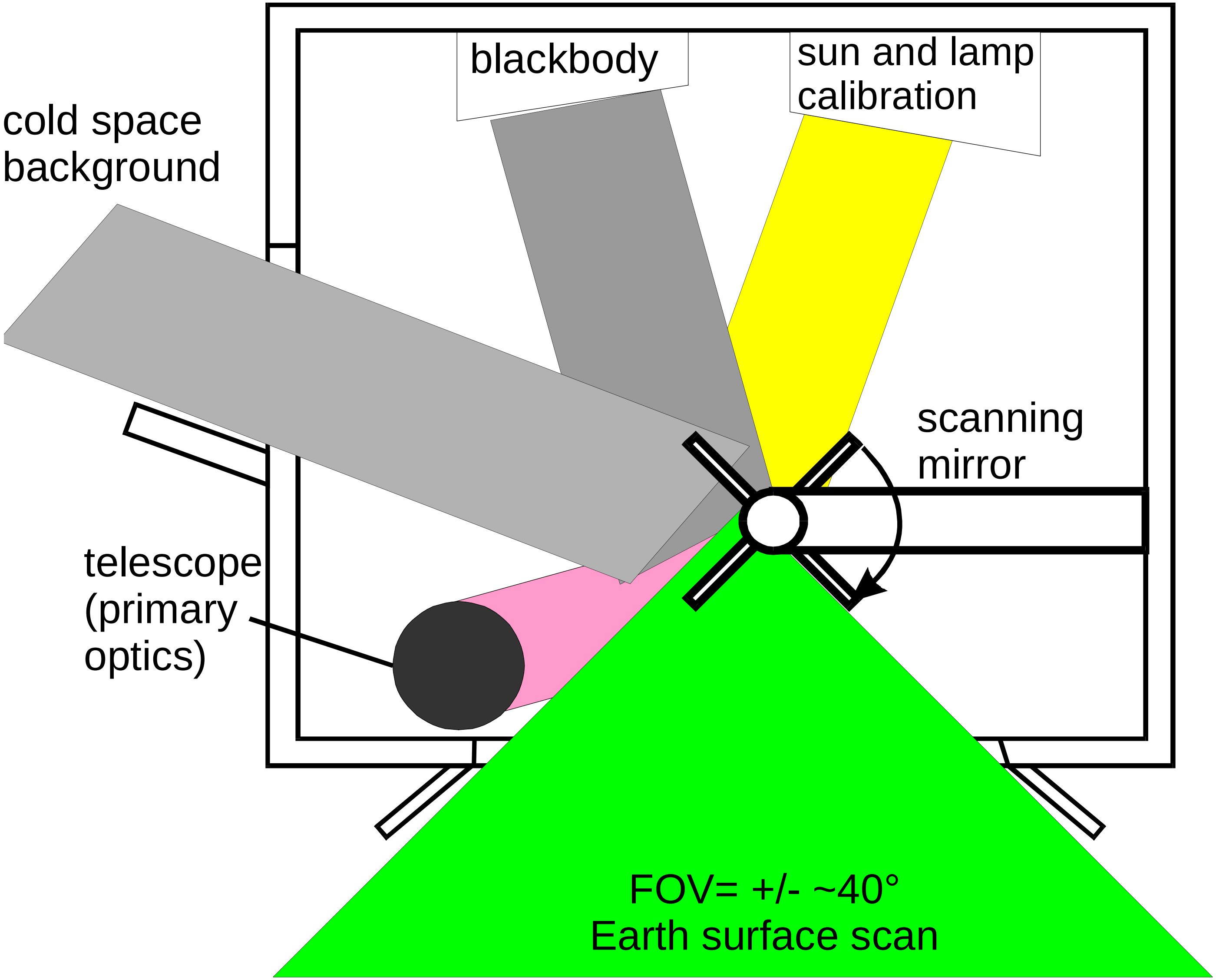
- **accurate knowledge of the orbit and illumination geometry** is very important for accuracy of the Sun calibration
- **more attention to stray light**: reduction by a more symmetrical baffle system with respect to the incoming Sun radiation
- different signal levels of Sun calibration (**grey diffuser**)

Sources: Sümnich & Schwarzer private communication
Sümnich & Schwarzer; In-flight calibration of the MOS; Int.J.Remote Sensing (1998)

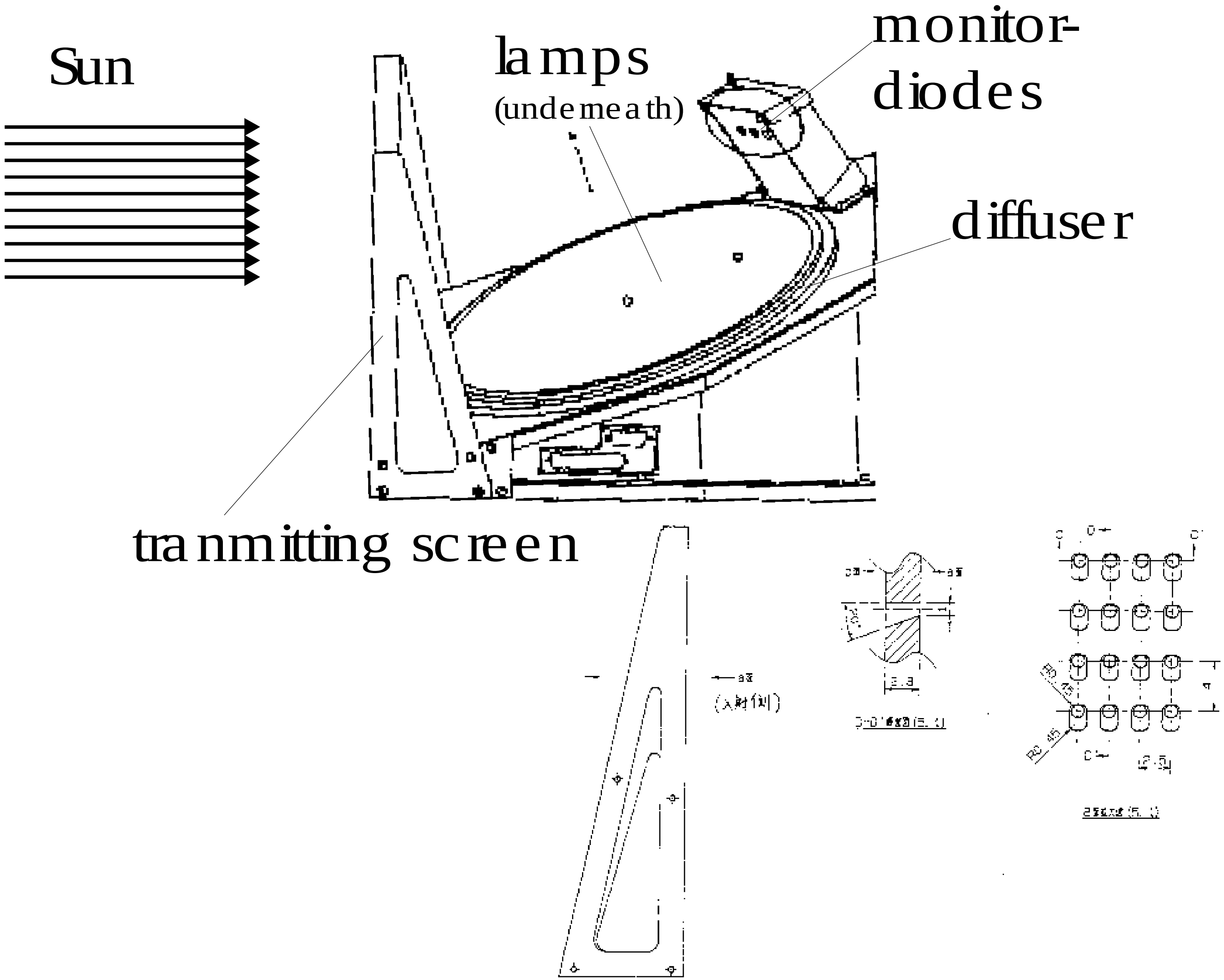
GLI on-board calibration



GLI on-board calibration (1)



GLI on-board calibration (2)



Comparison GLI — MOS-IRS

	GLI	MOS-IRS
Sun:	• Reduction of solar illumination intensity by a transmitting screen (plate with many holes) • Monitor diodes • SunCal every orbit	• Direct Sun illumination • Shutter protects diffuser when SunCal is not required
Lamps:	• LampCal frequently • One signal level for each lamp => no linearity measurements • Monitor diodes	• LampCal every orbit • 2 lamps with different signal levels ensure relative spectral/ radiometric cal. and linearity measurements • No thermal channels
Thermal:	• Blackbody and cold space	• **Excellent results**
Results:	• **Difficult to forecast**	

Conclusion

The high potential of on-board calibration has been shown

- a very high calibration accuracy can be achieved
- in contrast to vicarious calibration, on-board calibration is only technology related

Possible problems for GLI on-board calibration

- possible straylight during Sun calibration
- degradation and/or contamination of the lamps, diffuser and/or transmitting screen

More effort on on-board calibration such as

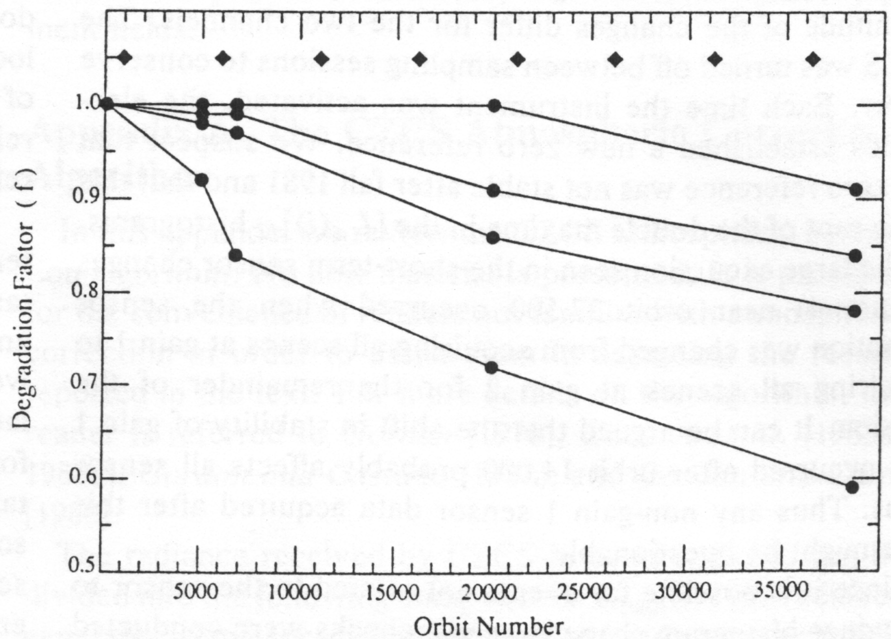
- straylight measurements / simulation (SunCal system)
- degradation measurements / simulation (diffuser, lamps)

After launch calibration of EO Sensors

Why?

possible sensitivity change
of channels during the mission

- 5 - 7 years mission duration
- space environment factors



CZCS channels long-term degradation (1979-86)
(Evans & Gordon 1994)

How accurate?

by **in-flight** calibration:

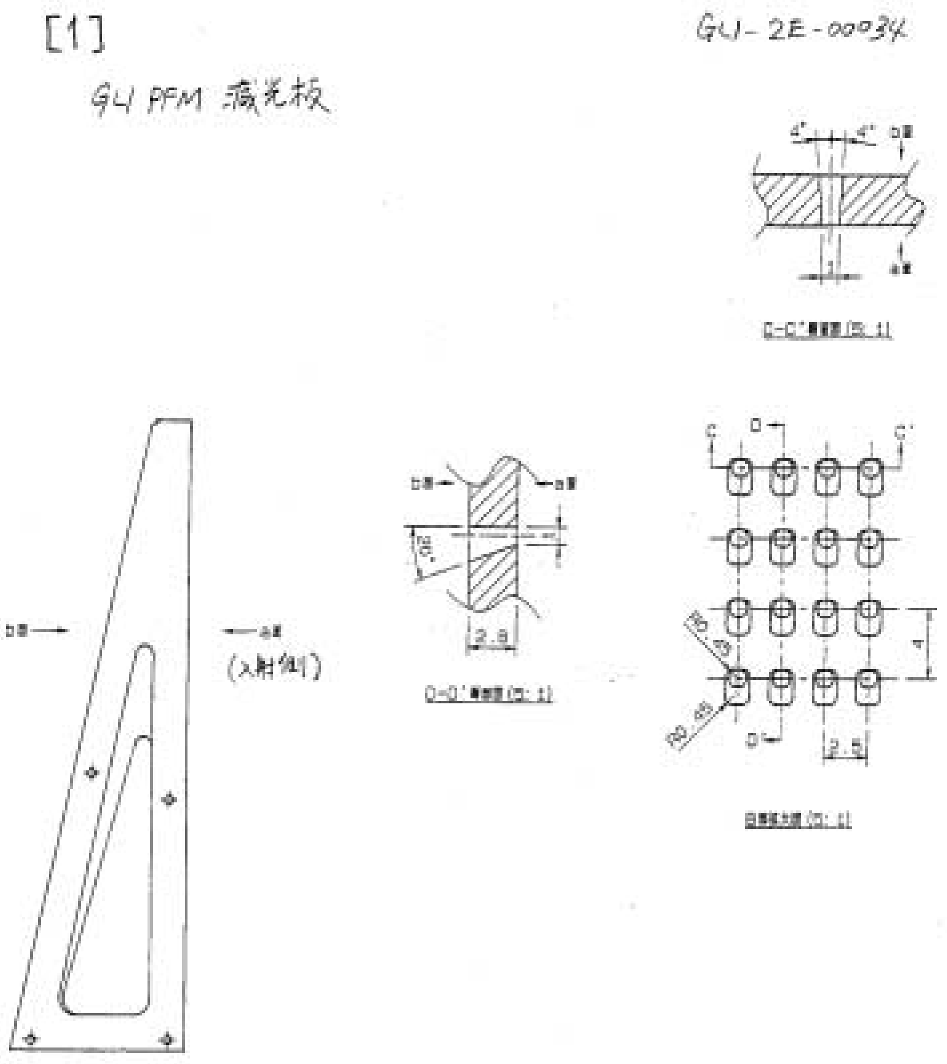
ε **~ 1%**

mainly driven by
- design parameters
- technology related

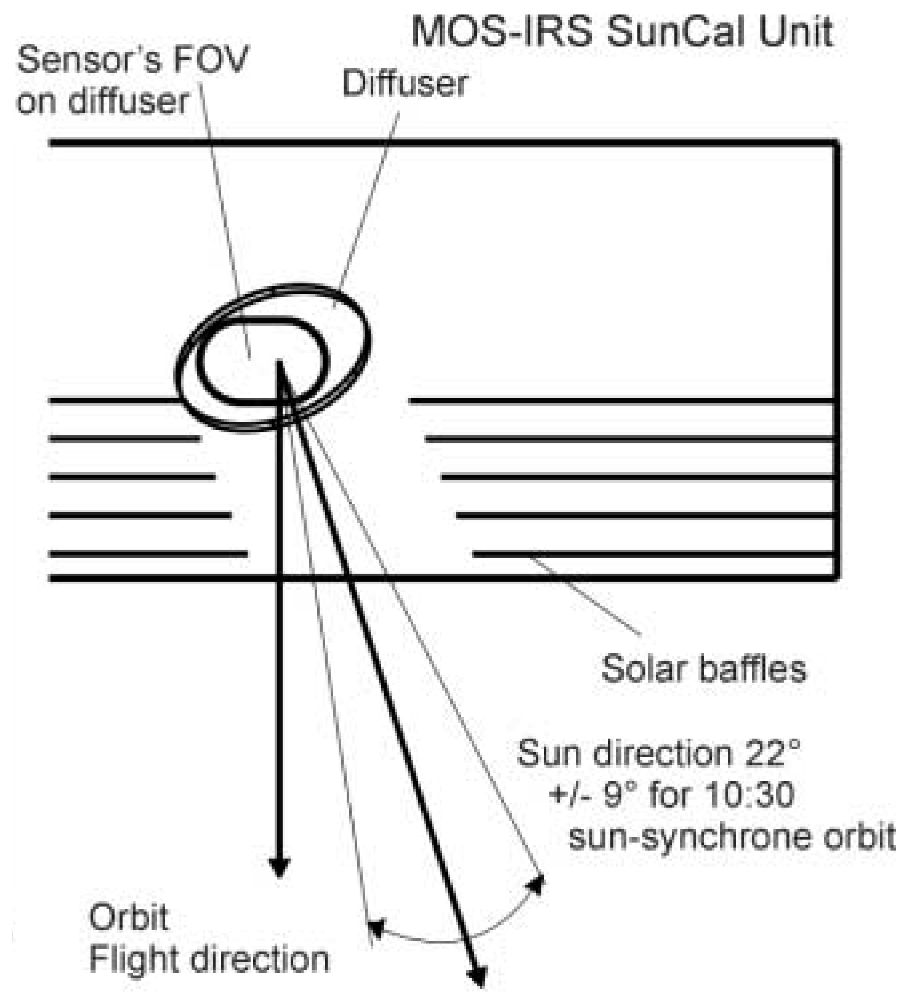
by **vicarious** calibration:

ε **> 3%**

mainly driven by
- dependency on other radiometers
- TOA modelling accuracy



GLI transmitting screen



Seasonal variations of Sun incidence angle in the SunCal Unit

取扱注意
Handle with Care

National Space Development Agency of Japan (NASDA)

IRS-P3 MOS-A,B: Sun calibration, relative variations with time (mean of unsaturated pixels, sun incidence angle, distance sun-earth and dark signal corr.), ref. to 16.5.96 (day137)

19.8.99

channel