

SOLAR SPECTRAL IRRADIANCE MEASUREMENTS ON SPACELAB I

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SOLAR SPECTRUM FROM 180 TO 3200 NM

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BELGIUM.

D. LABS

LANDESSTERNWARTE  
KOENIGSTUHL  
D - 6900 HEIDELBERG 1  
W, GERMANY

R. PASTIELS

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B - 1180 BRUXELLES  
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GOJENBERGSWEG 112  
D - 2050 HAMBURG 80  
W, GERMANY

# I. SCIENTIFIC AIMS

1. MEASUREMENT OF SOLAR SPECTRAL IRRADIANCE IN THE WAVELENGTH INTERVAL 180 - 3200 NM  
ACCURACY REQUESTED : FROM 5% AROUND 200 NM TO 1% VIS AND IR
2. MEASUREMENT OF POSSIBLE LONG-TERM VARIATIONS OF THE SOLAR SPECTRAL IRRADIANCE  
11-YR CYCLE → < 30% (HEATH 100%!) AT 200 NM  
< 1% IN VIS AND IR  
  
PRECISION REQUESTED      0.1% VIS  
                                     1% UV

THESE MEASUREMENTS ARE NEEDED FOR

AERONOMY (MIDDLE ATMOSPHERE)	<u>UV</u>	VIS	-
CLIMATOLOGY (RADIATION BUDGET)	UV	<u>VIS</u>	<u>IR</u>
SOLAR PHYSICS (PHOTOSPHERIC MODEL)	<u>UV</u>	<u>VIS</u>	<u>IR</u>

THESE MEASUREMENTS WILL BE CORRELATED WITH THOSE OBTAINED BY THE ABSOLUTE RADIOMETER MEASURING THE "SOLAR CONSTANT" AND ITS POSSIBLE VARIATIONS.

## II. INSTRUMENTATION

THE INSTRUMENT INCLUDES :

- SPECTROMETER
- 3 DETECTORS 23 KG
- ELECTRONIC 44 x 32 x 61 CM
- IN-FLIGHT CALIBRATION LAMPS

### 1. SPECTROMETER :

- 3 DOUBLE MONOCHROMATOR WITH HOLOGRAPHIC CONCAVE GRATING (J,-Y).
- 6 GRATINGS MOUNTED ON THE SAME SHAFT
- PRECISION OF ROTATION :  $\pm 2$  ARC SEC.
- ANGLE OF ROTATION :  $26^{\circ}17'$
- STEPPER MOTOR - NUMBER OF STEPS : 631
- TRANSMITTING DIFFUSOR (GRIND) AT THE ENTRANCE SLIT
- MIRRORS
- FILTERS TO AVOID ORDER OVERLAPS

	WAVELENGTH RANGE	BANDPASS	GRATINGS	
	NM	NM	LINES.MM <sup>-1</sup>	$\phi$ MM
UV	160 - 365	1	3600	28
VIS	277 - 889	1	1281	17
IR	805 - 3160	20	354	17

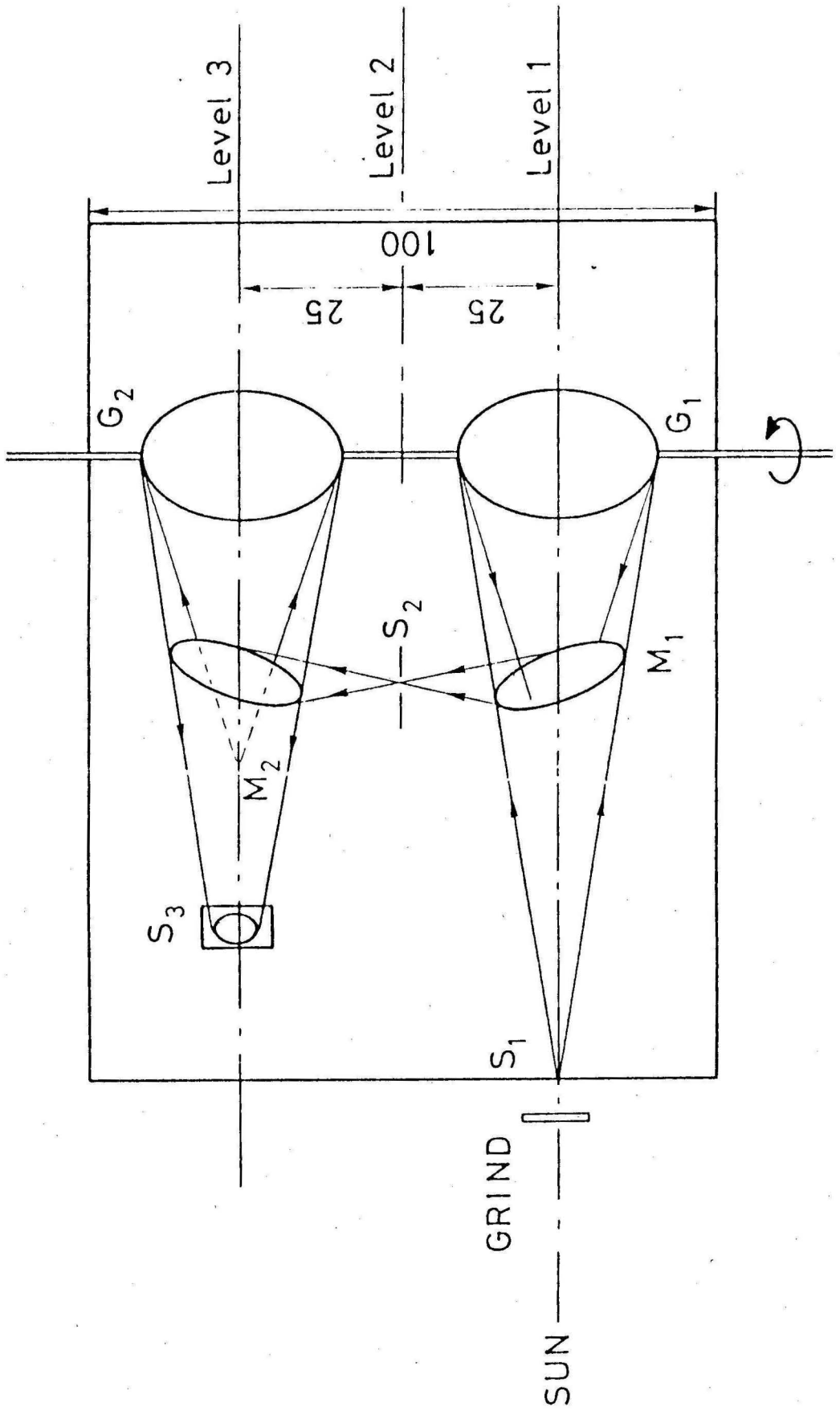


Figure 1.

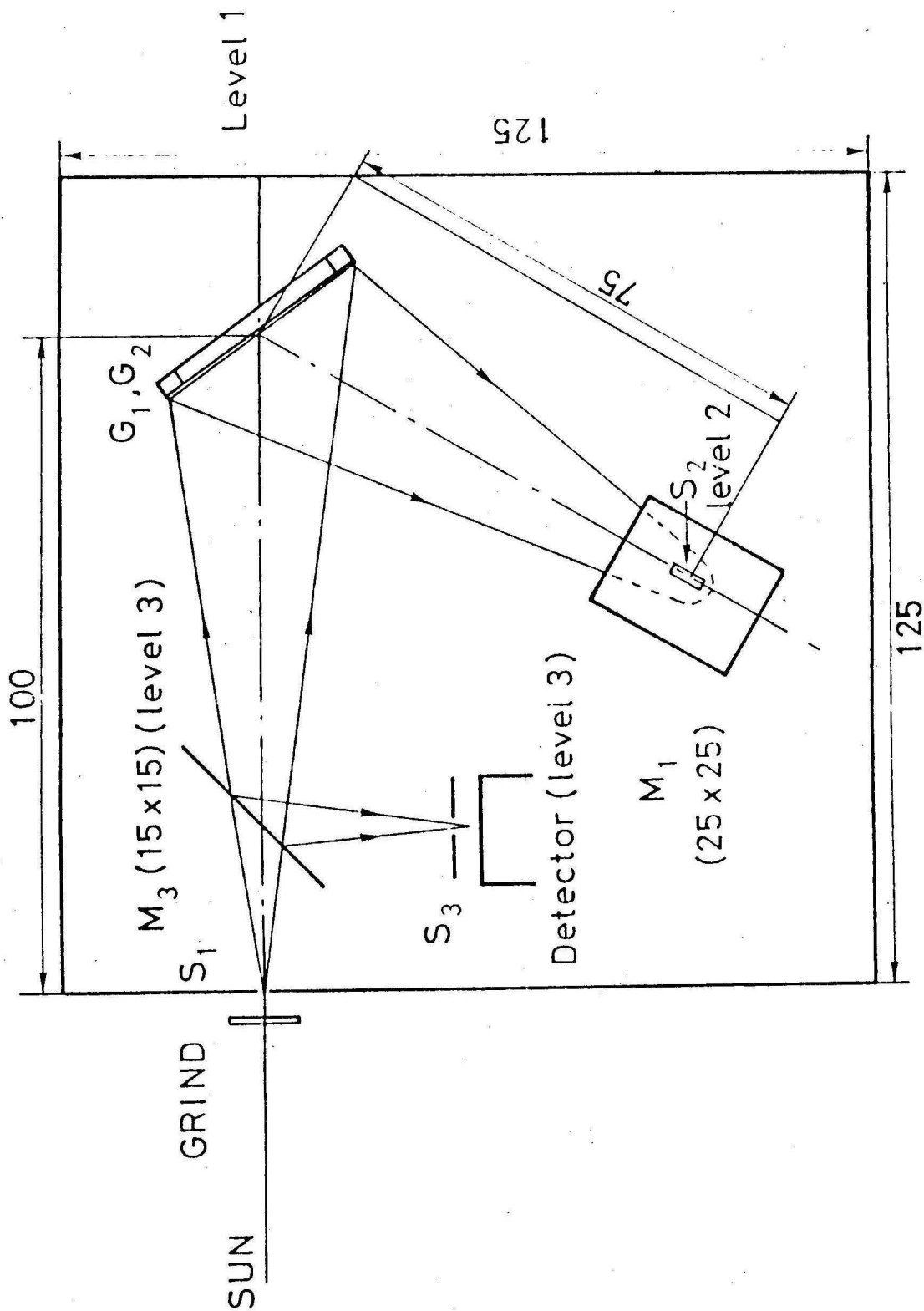
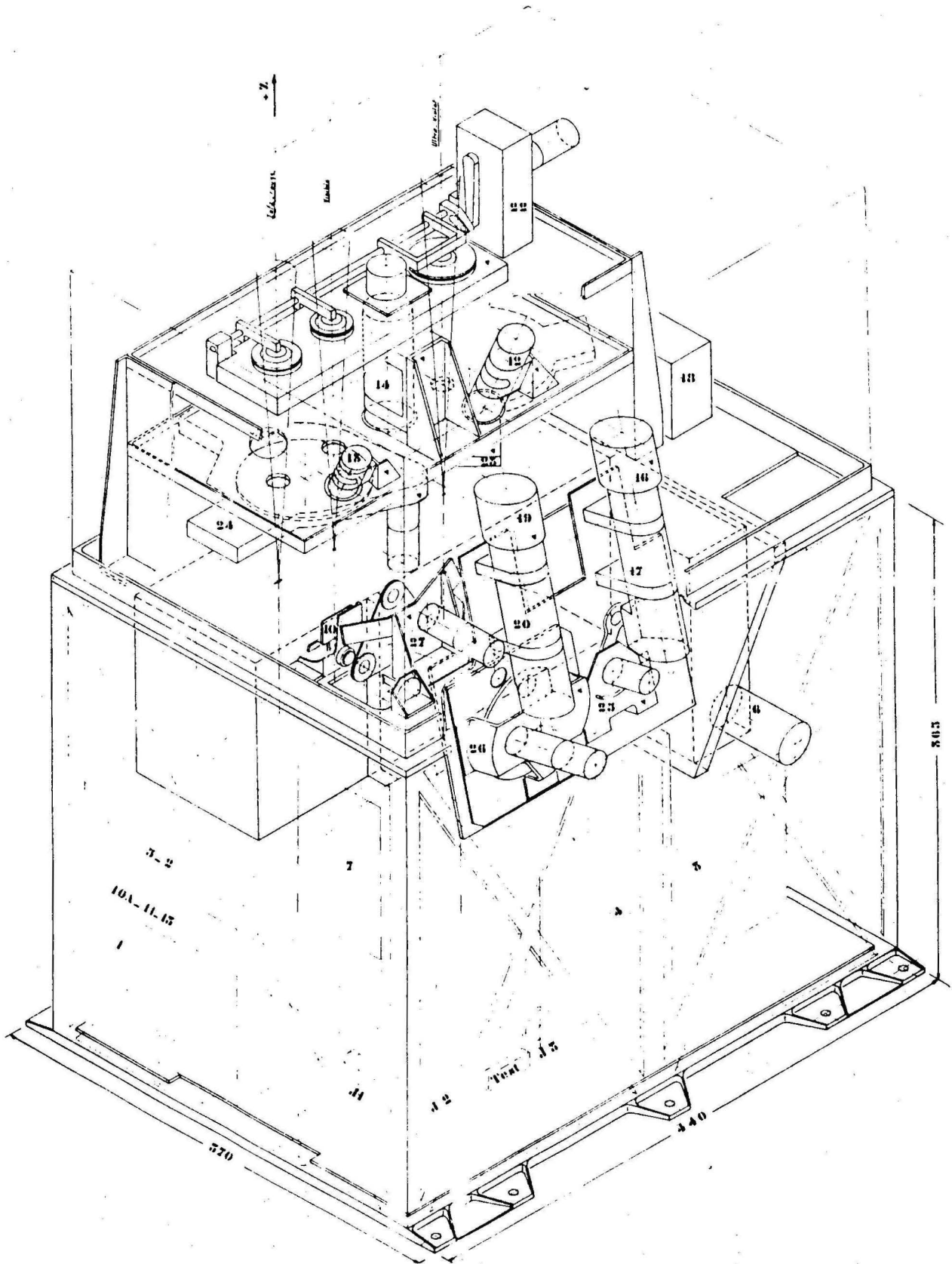


Figure 2.





### III. SEQUENCING OF MEASUREMENT

- 1 SPECTRUM 15 MIN
- NIGHT : CALIBRATION MODE : LAMP INTENSITIES  
          λ CHECK AND PROFILE DARK, CURRENT
- DAY : SOLAR MODE                    )  
  ) IN ALTERNANCE  
          CALIBRATION MODE         )
- FOR THE FSLP 12 HRS OF MEASUREMENT ARE SCHEDULED
- LAUNCHING DATE AUG. 81 BUT DELAY IS CERTAIN



## CALIBRATION

### 2 MAIN PROBLEMS WITH SPACE OBSERVATIONS OF SOLAR IRRADIANCES :

- VALIDITY OF GROUND CALIBRATION IN SPACE ENVIRONMENT AFTER LAUNCHING
- AGING EFFECTS IN ORBIT

### ADVANTAGES USING THE SPACE SHUTTLE :

- IN-FLIGHT CALIBRATION
- POST-FLIGHT CALIBRATION

### 1. IN-FLIGHT CALIBRATION

- |                                     |  |
|-------------------------------------|--|
| . 2 W RIBBON LAMPS (VACUUM)         | VIS + IR                               |
| . 2 D <sub>2</sub> LAMPS            | UV                                     |
| . 1 HOLLOW CATHOD LAMP<br>(He - Zn) | INSTRUMENT PROFILE<br>WAVELENGTH CHECK |

- RADIATING SURFACES ARE IMAGED BY LENSES ON THE GRIND
- DIAMETER OF LENSES ARE CHOSEN SO THAT THE SIGNAL OUTPUT FROM LAMPS IS NEARLY EQUAL TO THE CORRESPONDING SOLAR SIGNAL OUTPUT
- LAMPS ARE FIXED (DISTANCES ARE MECHANICALLY DEFINED AND STABLE)
- T°, VOLTAGE AND CURRENT ARE MONITORED
- ALL THE LAMPS ARE MADE BY ORIGINAL HANAU QUARZ LAMPEN GMBH (SPECIAL DEVELOPMENT)
- THE PURPOSE OF THESE LAMPS IS ONLY TO CHECK THE STABILITY OF THE INSTRUMENT IN ORBIT

- CONSEQUENTLY, ABSOLUTE IRRADIANCES OF THESE LAMPS ARE NOT NEEDED BUT COMPARISON WITH OTHER TRANSFER SOURCE STANDARDS ARE FORSEEN BEFORE AND AFTER FLIGHT IN ORDER TO DETECT ANY AGING EFFECTS OF THESE LAMPS.

## 2. GROUND CALIBRATION

- ABSOLUTE CALIBRATION USING BLACKBODY RADIATION FOR  $\lambda > 200$  NM WILL BE MADE IN HEIDELBERG.
- ACCURACY  $\pm$  5%  $\lambda < 250$  NM
  - $\pm$  3%  $250 < \lambda < 300$  NM
  - $\pm$  2%  $300 < \lambda < 400$  NM
  - $\pm$  1%  $400 < \lambda$
- FULFILLED REQUIREMENTS FOR ABSOLUTE VALUES OF SOLAR SPECTRAL IRRADIANCE
- LONG-TIME STABILITY OF THE RADIATION SCALE IS THE FUNDAMENTAL PROBLEM IF VARIATIONS  $< 1\%$  HAS TO BE DETECTED IN THE VISIBLE AND IN THE IR WAVELENGTH RANGE
- TWO SETS OF LAMPS WILL BE USED TO SOLVE THIS PROBLEM :
  - 10 W RIBBON LAMPS (TYPE W176 - OSRAM) FOR  $\lambda > 250$  NM
  - 10 D<sub>2</sub> LAMPS (TYPE HANAU D 60 END ON) FOR  $\lambda < 350$  NM
  - 5 OF EACH TYPE ARE KEPT IN THE LABORATORY
  - 5 OF EACH TYPE ARE TRAVALLING WITH THE INSTRUMENT

### AGING OF THE LABORATORY SET OF LAMPS

W  $< 0.2\%$  FOR 100 HRS OF BURNING TIME  
(WITH AC OPERATION)

D<sub>2</sub> 3% FOR 100 HRS OF BURNING TIME

THE LAMPS KEPT IN THE LABORATORY DO NOT WORK MORE THAN 10 HRS PER YEAR.

ALL THESE LAMPS WILL BE CALIBRATED AGAINST THE BLACKBODY IRRADIANCE.

- RELATIVE RADIATION SCALE IS GIVEN BY THESE LAMP SETS
- CORRECTION OF THE ABSOLUTE RADIATION SCALE ARE POSSIBLE IN THE FUTURE.
- INTERCOMPARISONS WITH NBS STANDARDS ARE HIGHLY DESIRABLE (SOURCES AND DETECTORS)
- COMPARISONS WITH ABSOLUTE RADIOMETER ARE FORSEEN AT GROUND AND IN ORBIT
- INDEPENDENT EXPERIMENTS ON THE SAME PAYLOAD ARE VERY DESIRABLE TO INCREASE THE RELIABILITY OF THE RESULTS.