Plan of Calibration and Validation of FY-3 Instruments and Products

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Contents

1. Introduction

- ✓ **Calibration is Aimed at FY-3 Sensors (Instrument). It ensures that the instrument data are usable.**
- ✓ **Validation ensures that the environmental data products are usable.**
- ✓ **Both CAL & VAL ensure mission success, meet the specification and user requirements.**

2. Plan of FY-3 CAL (1/2)

(1) Prelaunch CAL (VIS, NIR, IR, MW)

1) CAl at the Instrument Manufacture

Normal Condition

Vacuum Condition

2) Ground Based Testing

MWHS, SBUV, TOU

3) Aircraft Based Testing

MERSI, MWTS, MWHS

2. Plan of FY-3 CAL (2/2)

(2) On-orbit CAL

1) Perform on –orbit CAL routinely Based on the formulation in Lab. CAL
2) Vicarious CAL in the 3 fields:
   Qinghai Lake, IR
   Dunhuang, VIS, NIR
   Yunnan Lincang, MW
3) Inter CAL (FY-3/NOAA/AQUA/METOP….
4) Intra CAL (FY-3…….
5) Ground based remote sensing data, such as AERI

3. Plan of FY-3 VAL

- ✓ **Prelaunch:**
  - **(1) Construct Simulating Data for FY-3 Instruments**
    - **1) using current satellite data**
    - **2) theoretical calculation with radiant transfer model**
  - **(2) Development of FY-3 Products**
  - **(3) Select Ground Truth, such as, Conventional Data, Model Analysis (T213, NCEP, ECMWF), other Center Products, such as NESDIS,…..**
  - **(4) VAL Team**

- **After launch:**

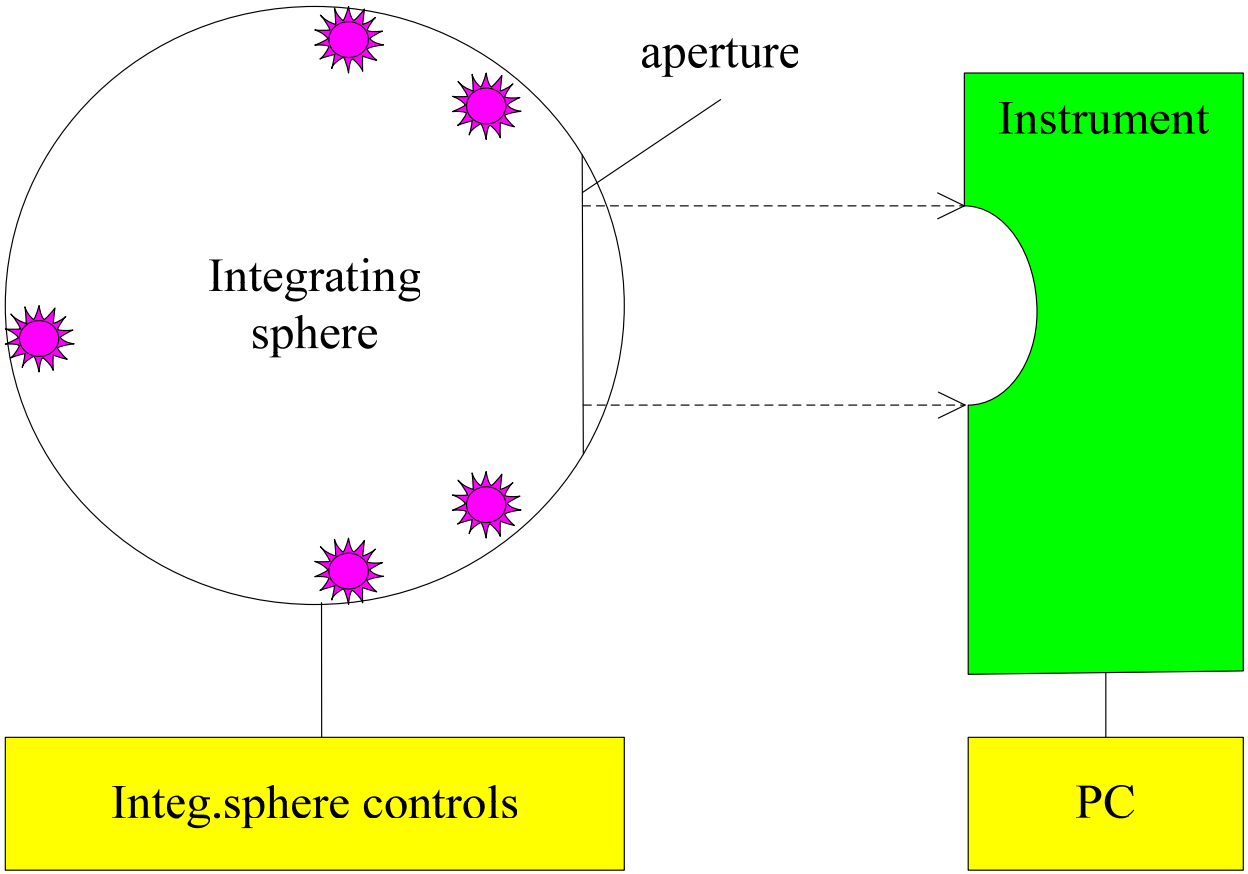
  (1) Perform Comparison between the Quantitative Product and Ground truth Data Routinely, such us Bias, Mean, Standard Deviation.

  (2) Improve Product Algorithm

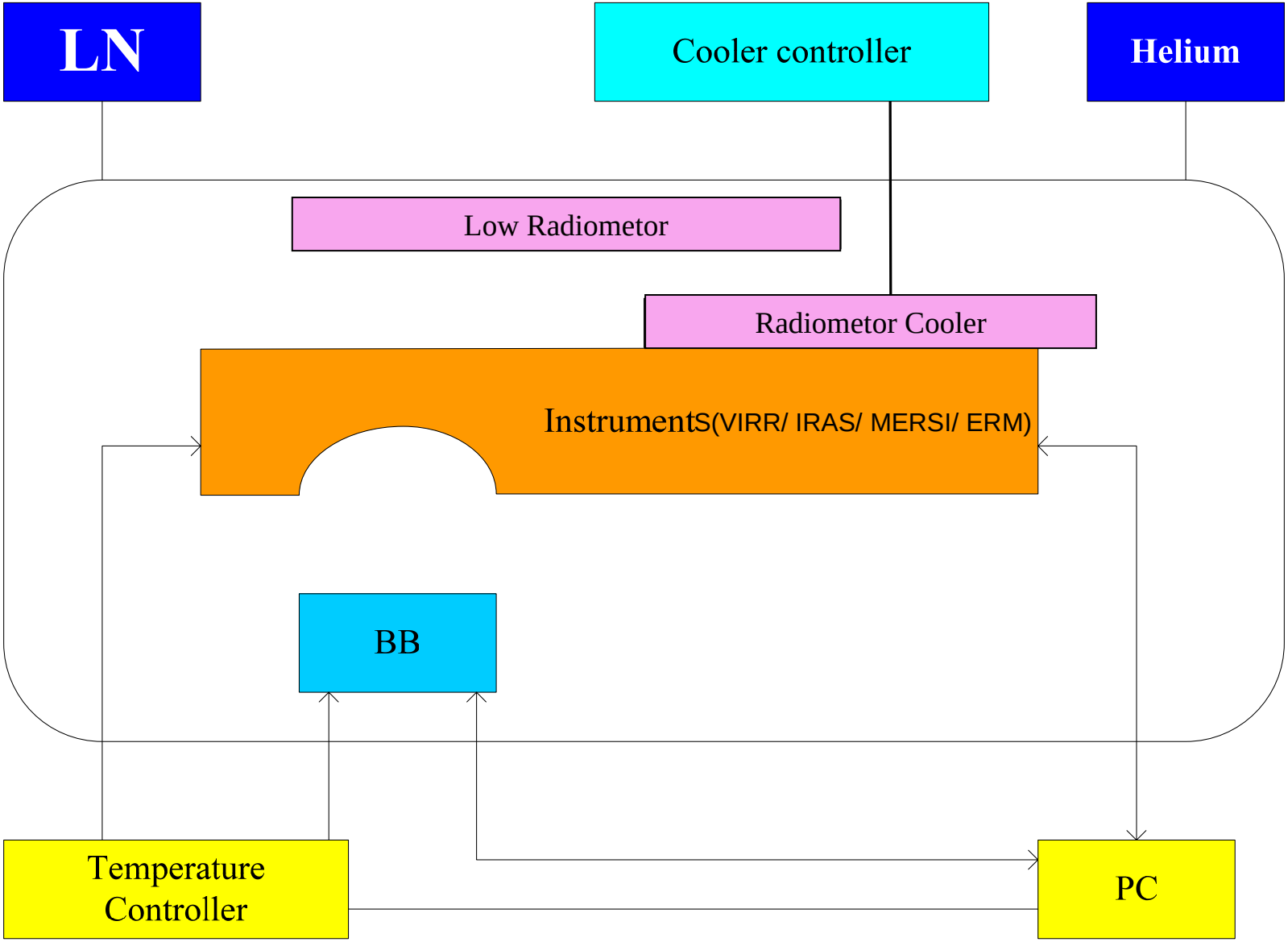
4. What We Have Done for FY-3

(1) CAL for all Instruments at Engineering Mode

Visible & Near IR Calibration Diagram



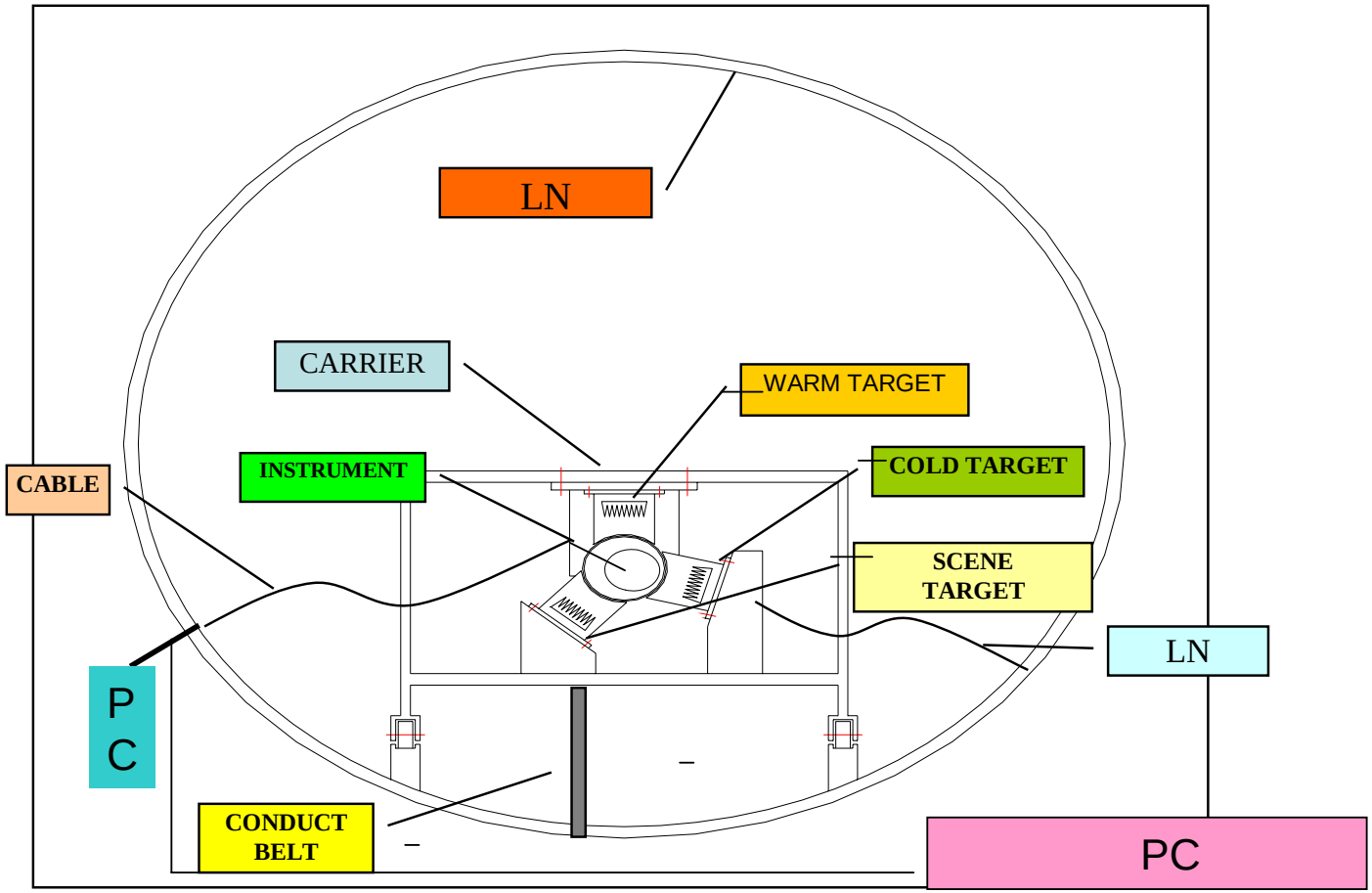
20 Lamps on 0



IR Calibration Diagram

P: 3× 10^{-5} Pa
He: 15K
LN: 86K
BB: 180K—330K
Instrument: 0° —35□

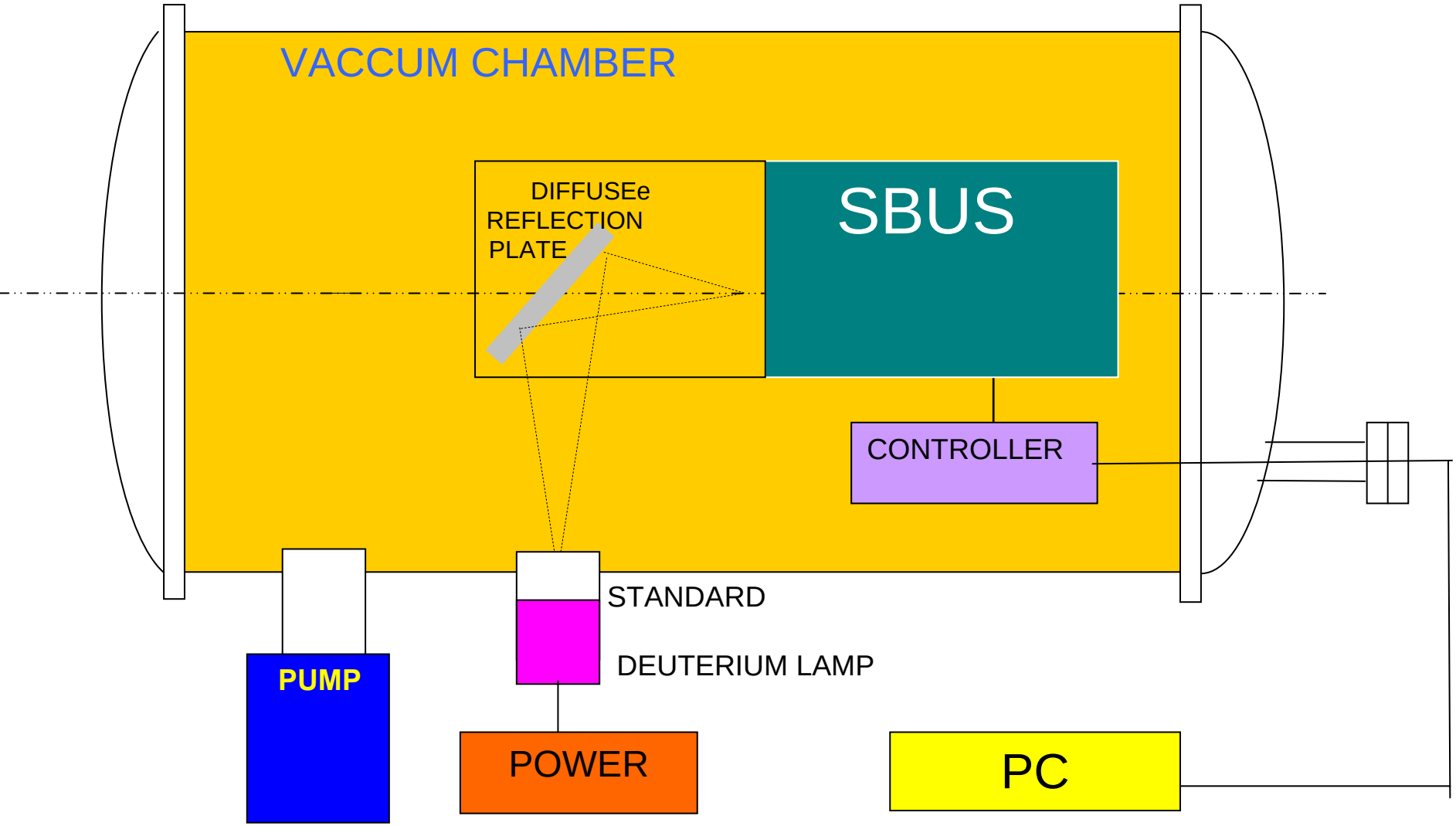
MW T / V CALIBRATION DAIGRAM



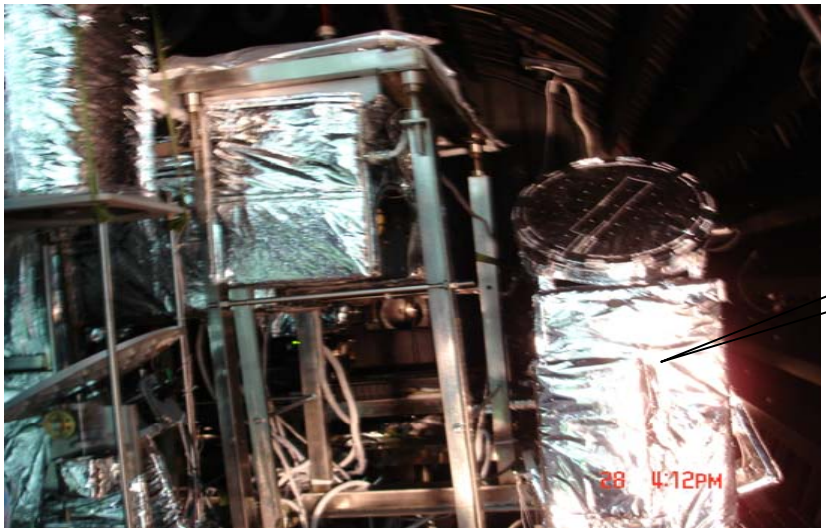
P:1.3 E-3Pa ; INSTRUMENT T: -5---35

Scene target T: 110-350k; Cold Target T: 85K

160nm~250nm VACUUM CALIBRATOIN DAIGRAM



VACUUM CHAMBER

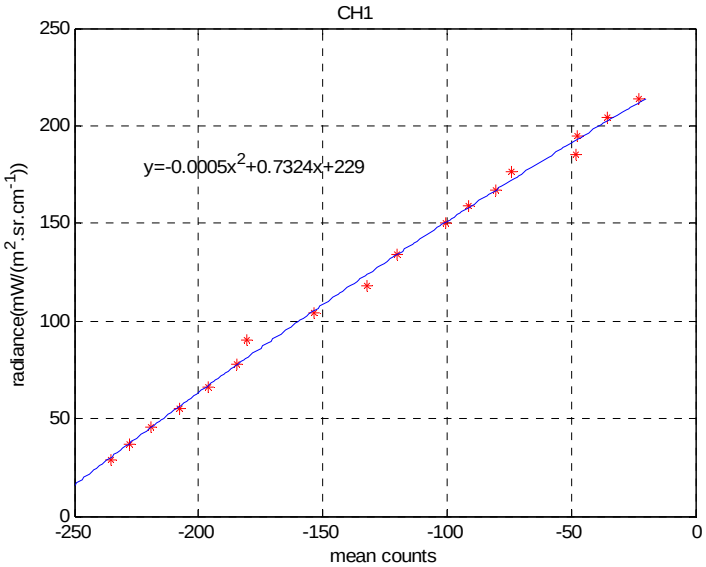


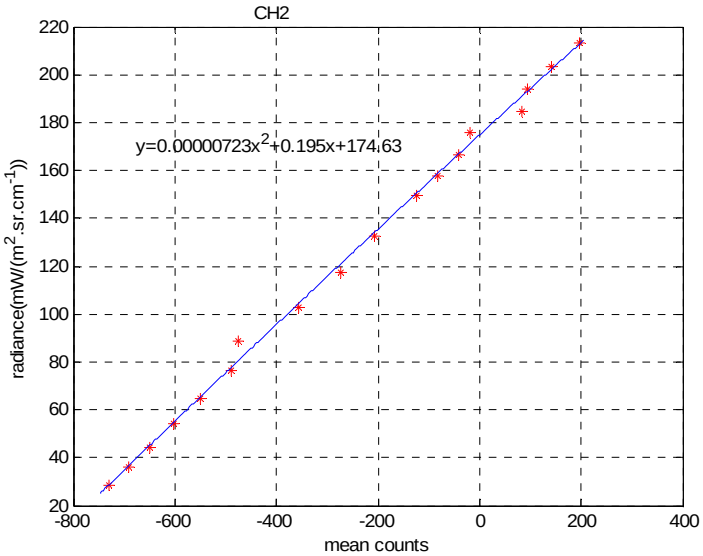
IR

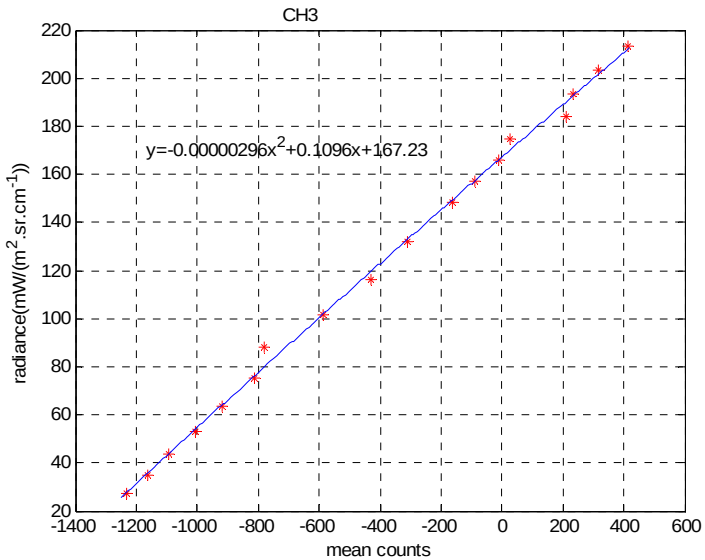
MW

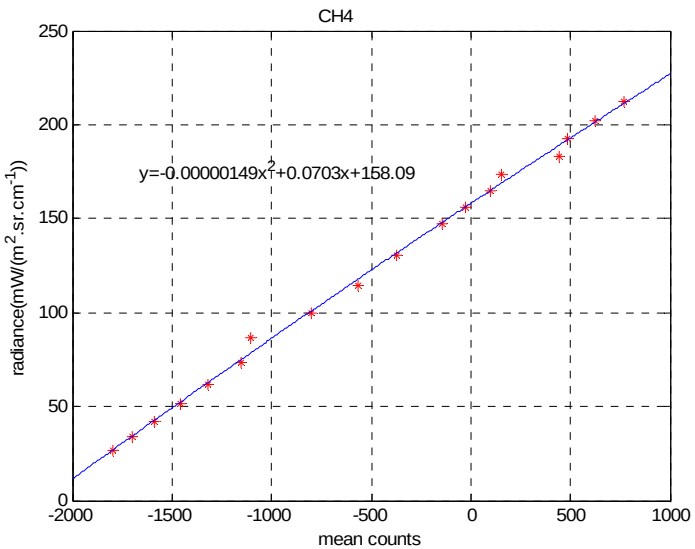
SBUS

IRAS CAL Curve (1/2)

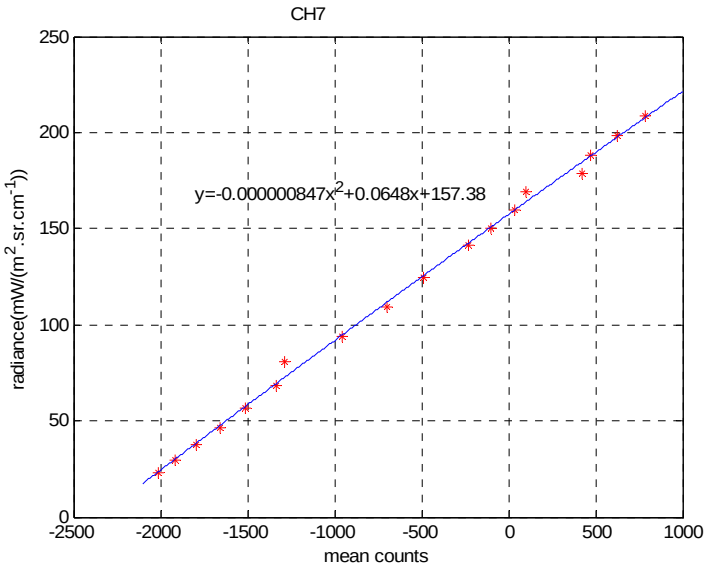


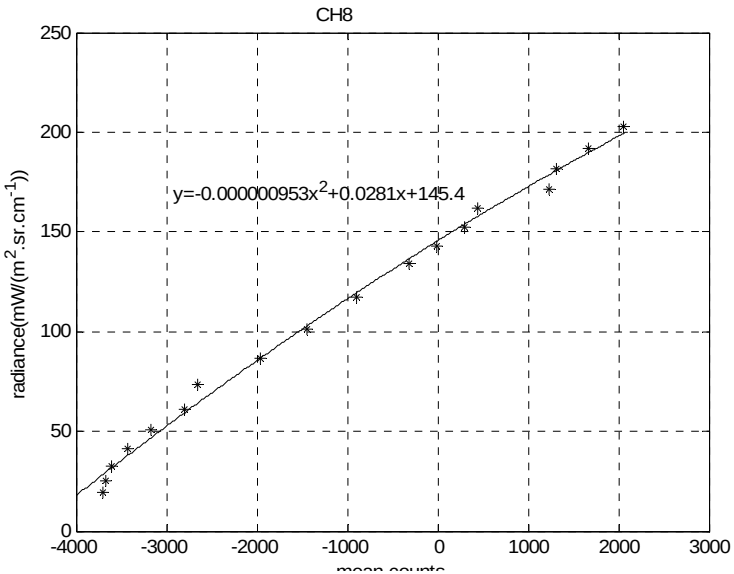


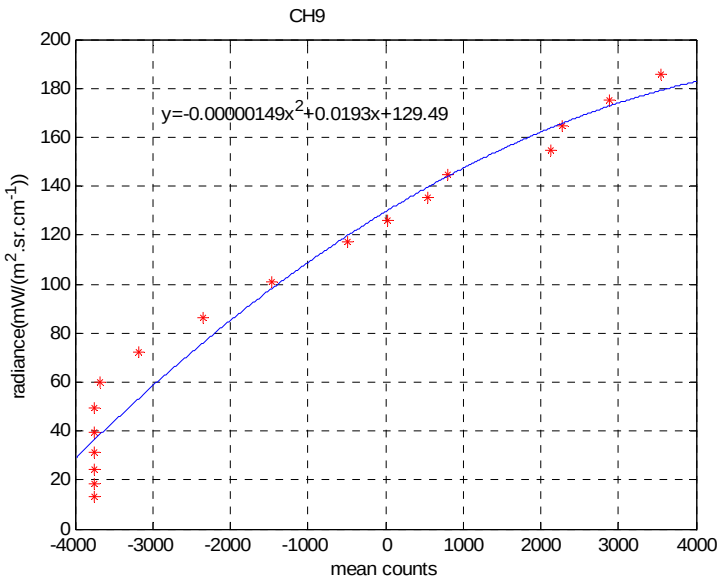


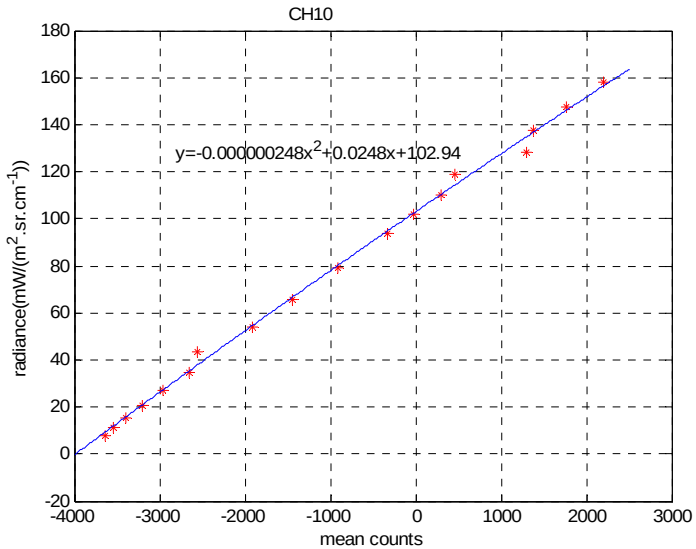


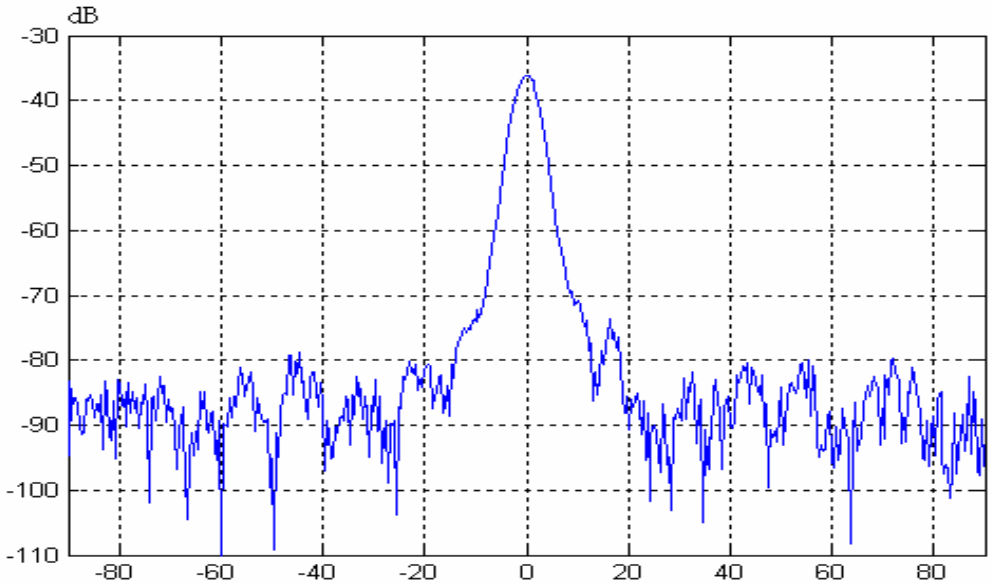
IRAS CAL Curve (2/2)







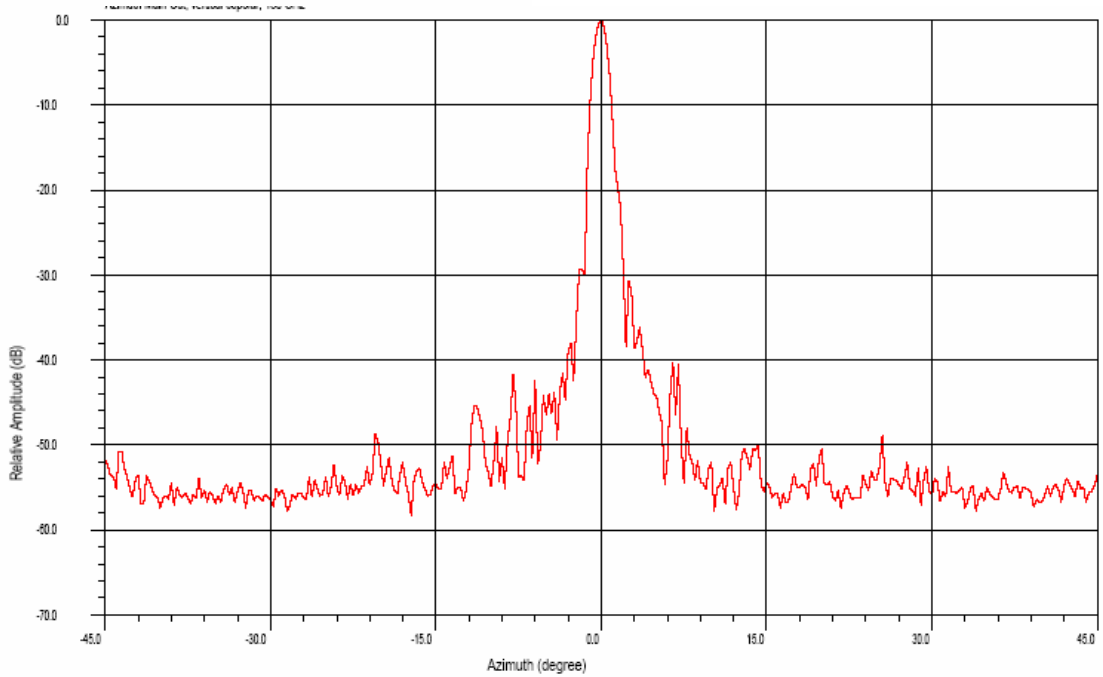




50.3GHz Antenna Pattern

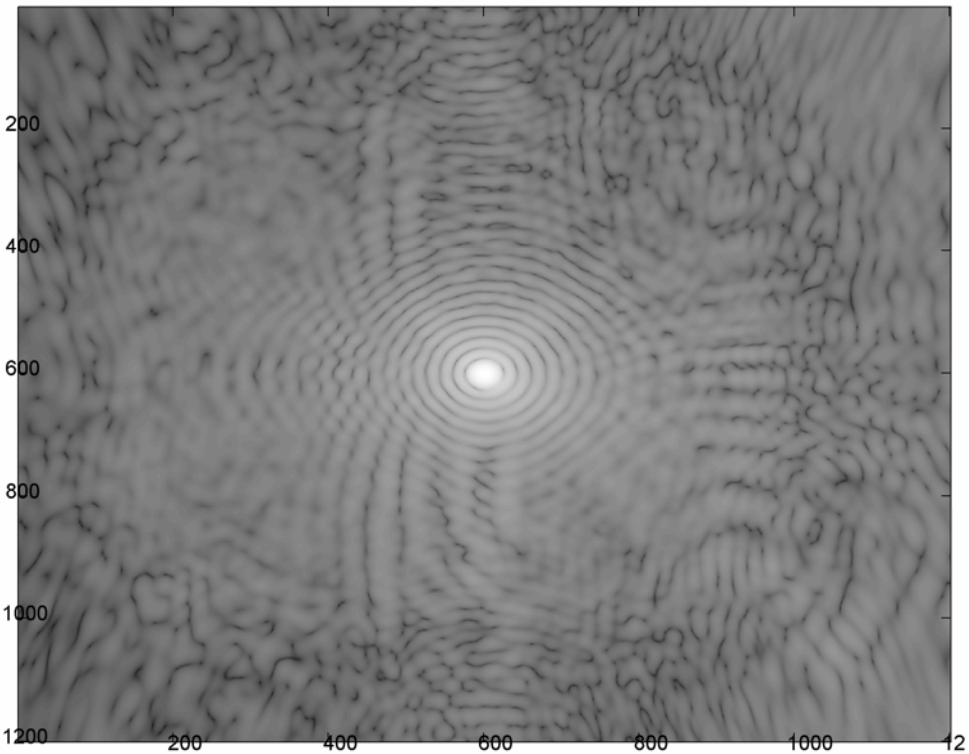
150GHz

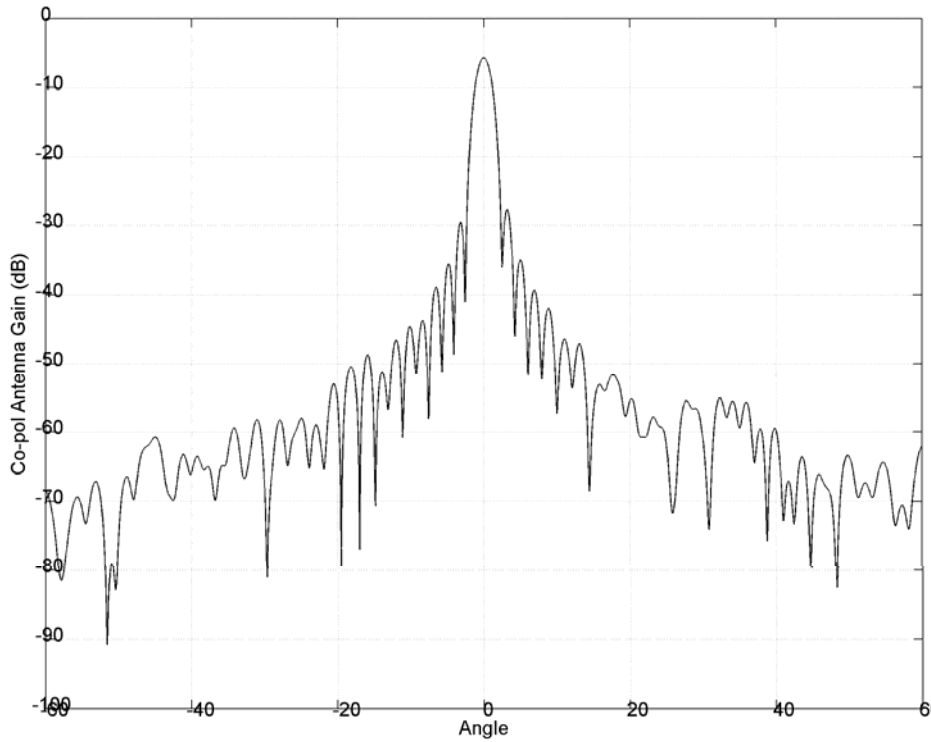
Antenna Pattern
Vertical co-polar



Antenna Pattern Results 10.65GHz

Main beam efficiency: 0.9405





Cold Source

Frequency(GHz)	140*	150±3	183.31±3	183.31±10	220*
ε_f	0.998(4)	0.998(4)	0.998(-1)	0.998(-2)	0.997(7)
$\Delta\varepsilon_f \cdot 10^4$	13.5	11.8	15.5	20	22
$\overline{T}_N(K)$	□78.5				
$\overline{T}_{CO_2}(K)$	□205				
$\overline{T}_K(K)$	□293				
$\Delta\overline{T}_{N,CO_2}(K)$	0.15				
$\Delta\overline{T}^i_{N,CO_2}(K)$	≤0.11				
T_W^K		4.8	3.1	3.1	2.8
$T_W^{CO_2}$		1.9	1.4	1.4	1.0
T_W^K	0				
ΔT_{br}^N		1.9	1.8	1.9	1.9
$\Delta T_{br}^{CO_2}$		1.8	1.7	1.8	1.9
ΔT_{br}^K		1.5	1.6	1.7	1.6
$A_e(sm^2)$	1980				
$\Delta A_e(sm^2)$	30				

Hot Source

Frequency(GHz)	140*	150±3	183.31±3	183.31±10	220*
ε_f	0.9990				
$\Delta\varepsilon_f \cdot 10^4$	10				
$\bar{T}_K(K)$	□293				
$\Delta\bar{T}_K(K)$	≤0.05				
$\Delta\bar{T}_K^i(K)$	≤0.03				
$T_{i_r}^K(K)$	0.05				
$\Delta T_{b_r}^K(K)$	≤1				

(2) Instrument Testing on the Ground

- MWHS
- SBUS & TOU

Purpose of The Field Tests

Performance Testing:

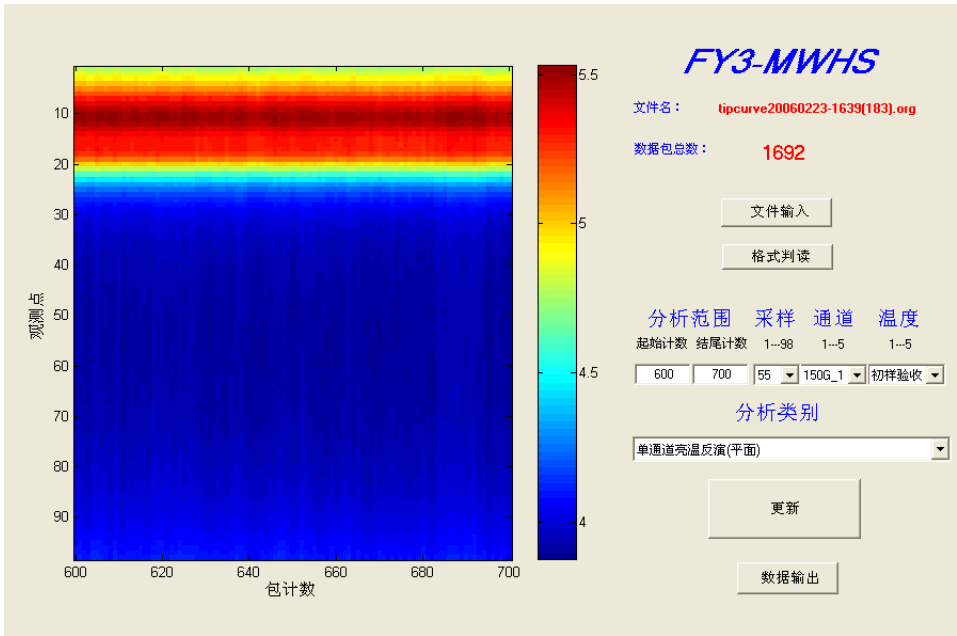
- ✓ **Get knowledge of MWHS,SBUS,TOU**
- ✓ **Observation comparison between SBUS and TOU with the zenith sky radiance.**
- ✓ **Comparison of SBUV ground based direct solar irradiance observation with the theoretical calculation.**

Tipping Curve Calibration Test

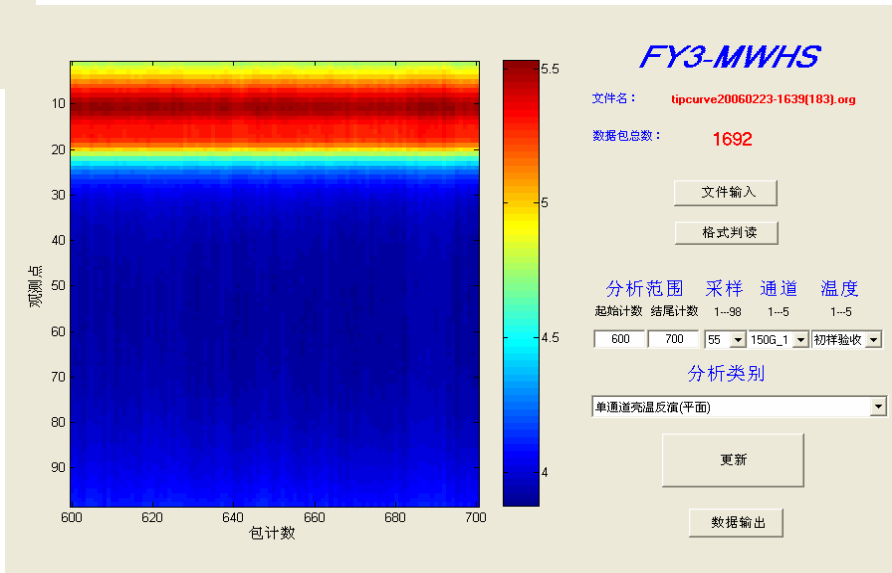
MWHS
Ground Testing
On top of Buliding
In Beijing

24/02/2006

Results of Tipping Curve Calibration Test



Voltage Imager of 150GHz(V)



Voltage Imager of 150GHz(H)

Summery About MWHS Tipping Curve CAL Test

- ✓ **Calibration bias can be up to 0.5K, if the climate averaged *T* be used.**
- ✓ **Pointing error of MWHS can make great uncertainty for calibration. When pointing error is 1°, the calibration error is up to 2K.**
- ✓ **Tapping curve calibration is not good enough for atmosphere absorbing channel.**

Field Tests with FY-3 Ozone Instruments

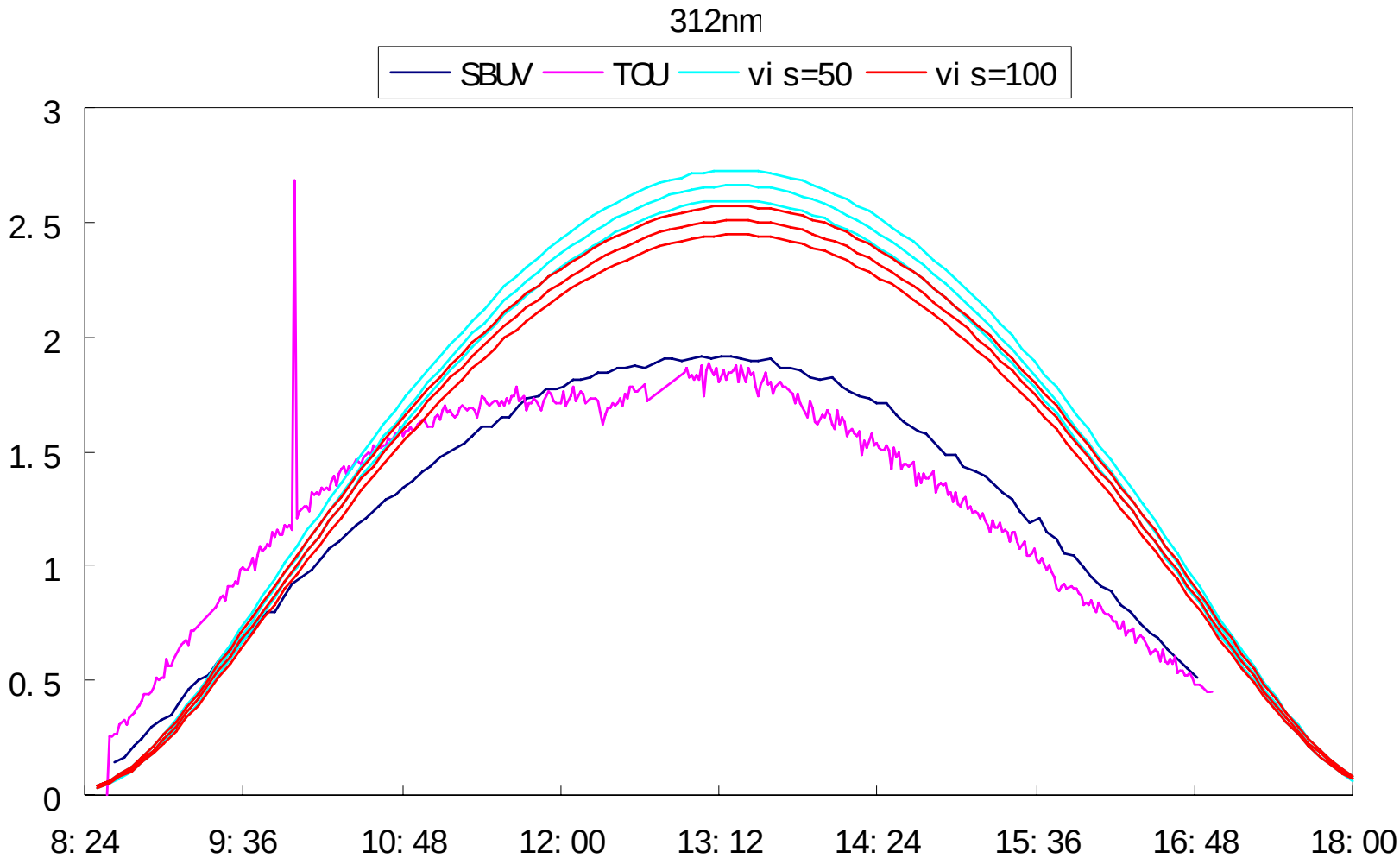
SBUS

Site: Lijiang, YuNan

Time:Nov2005-Dec 2005

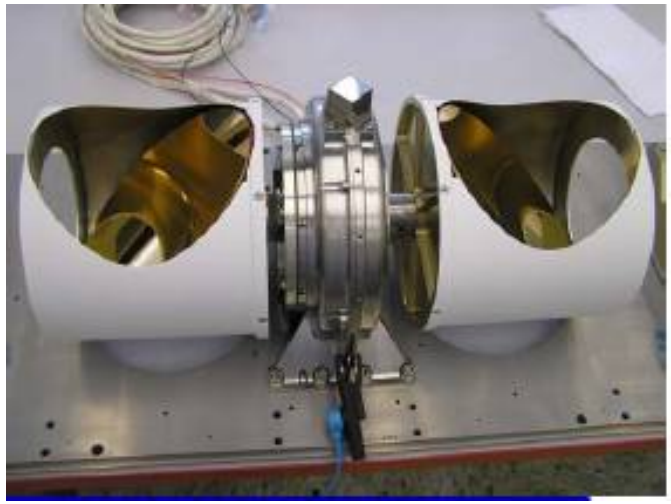
TOU

Comparison Results of 312nm Channel

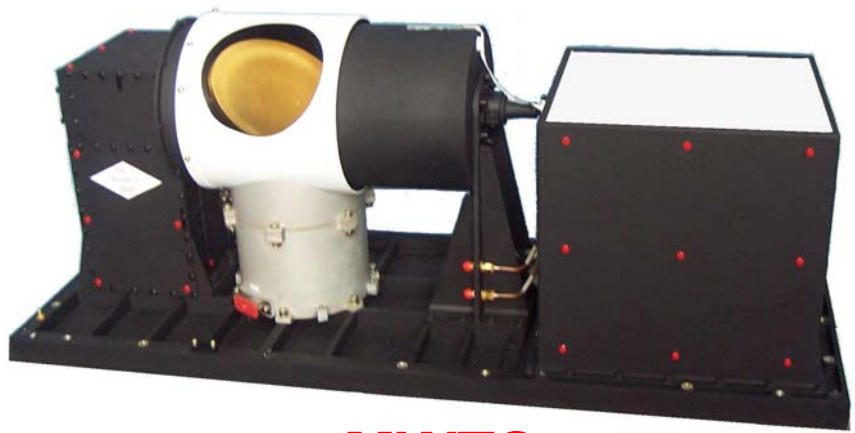


(3) Preparation for Aircraft Based Instrument Testing

MERSI

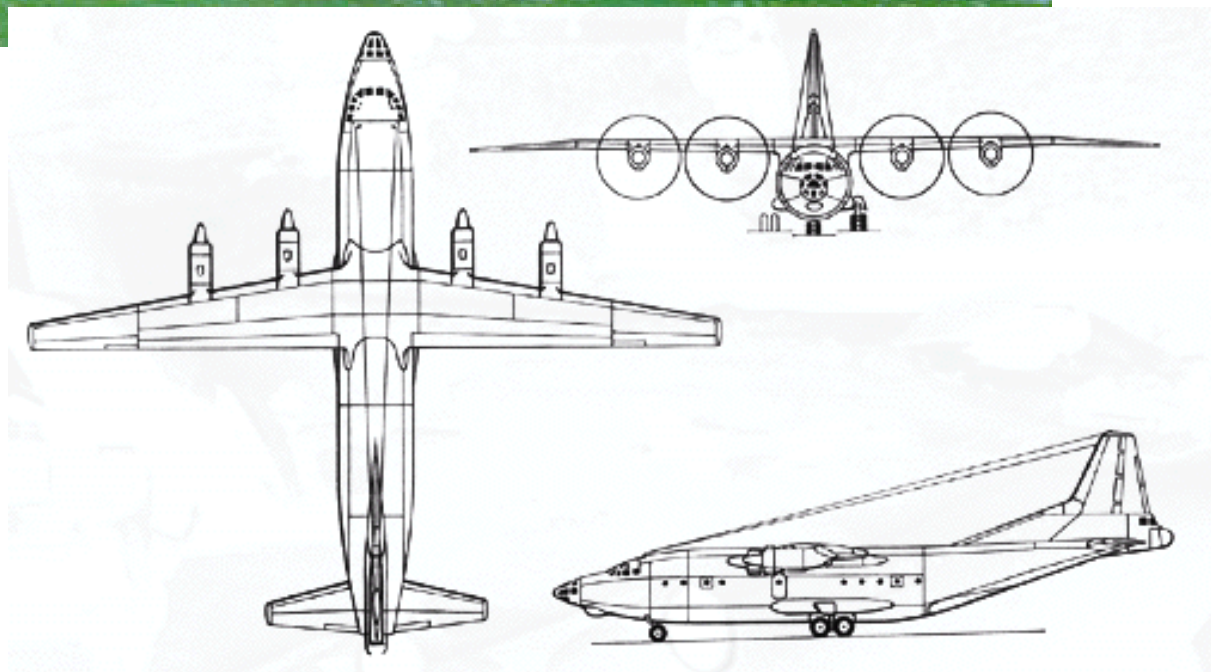


MWHS

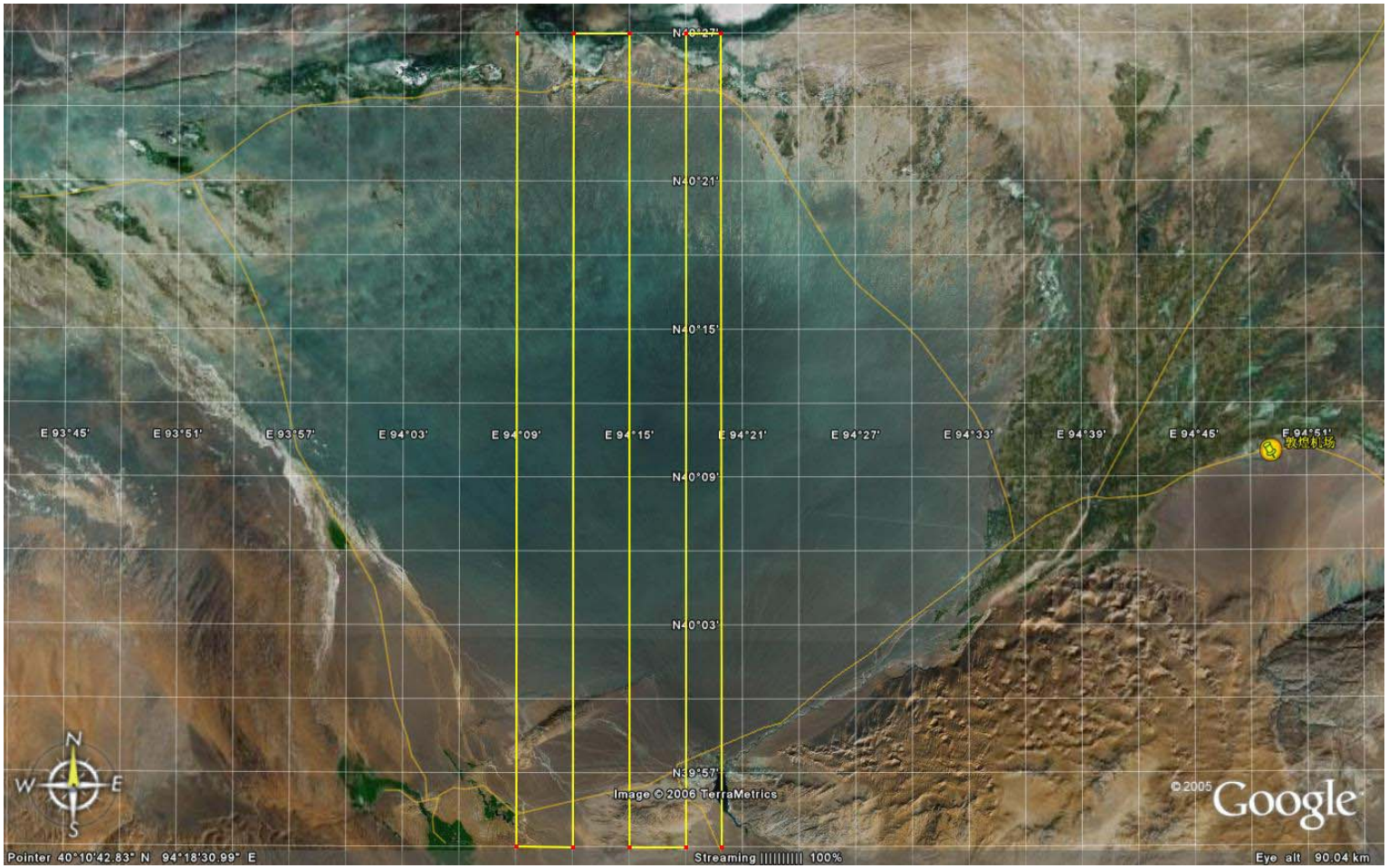


MWTS

Y-8 Flight

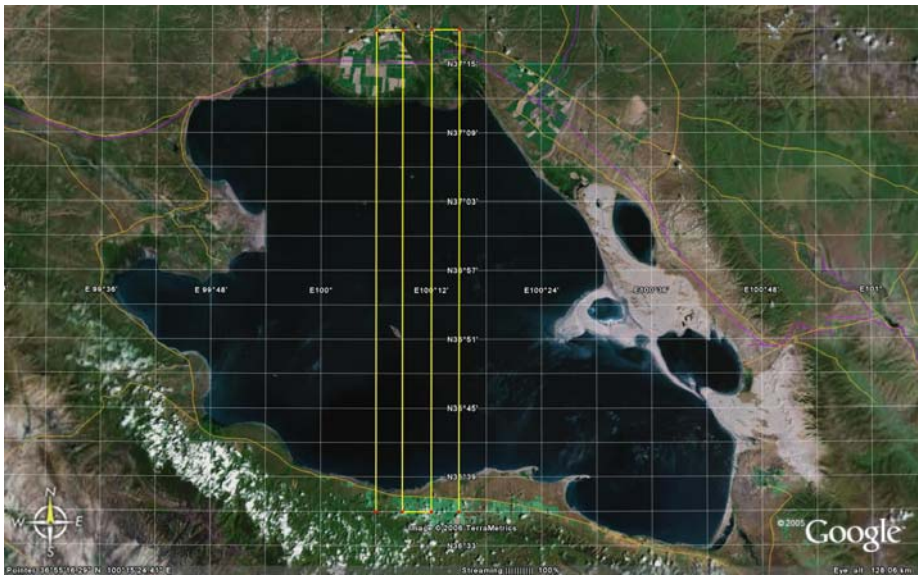


The Flight Path (1/2)

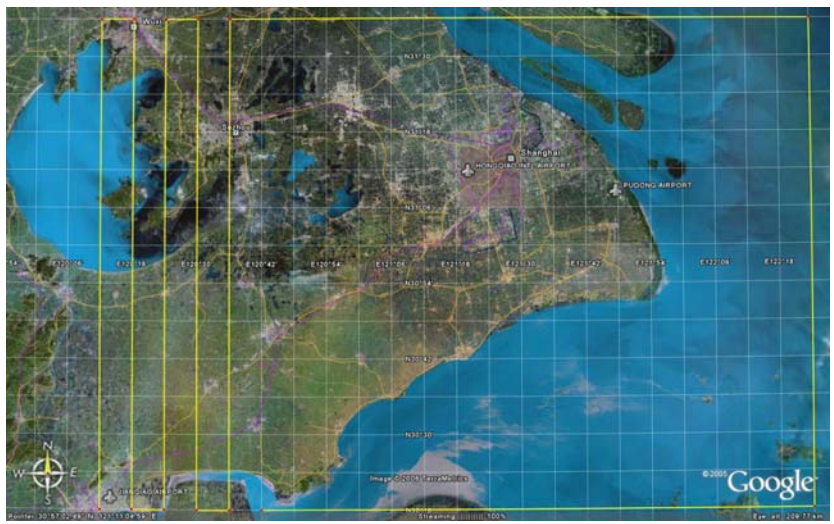


DunHuang

The Flight Path (2/2)



QinHai Lake

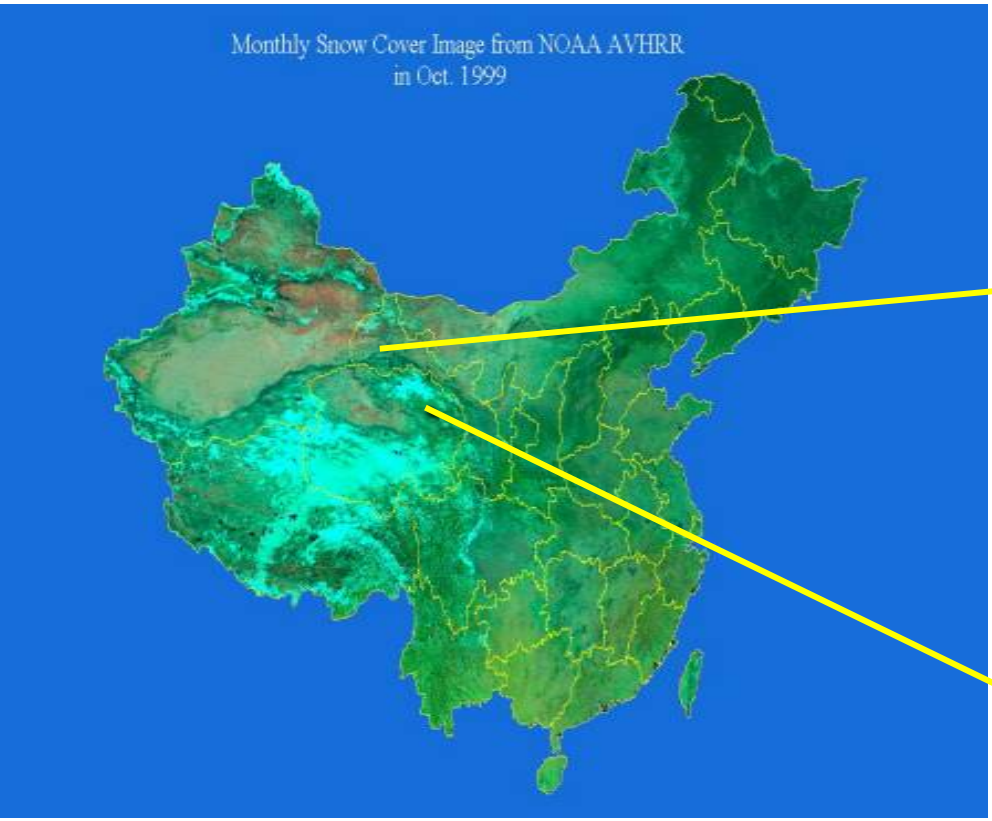


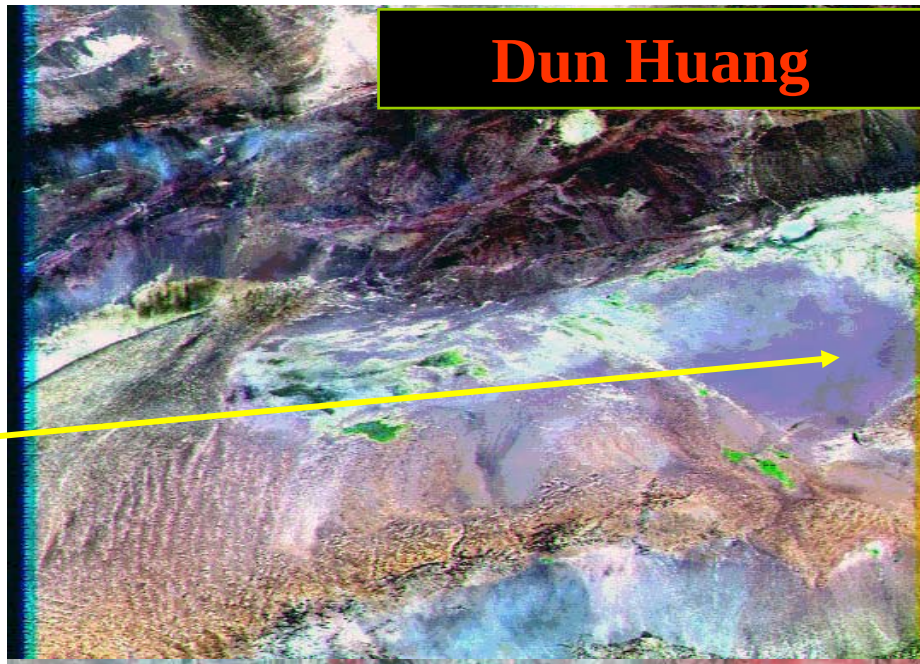
South China

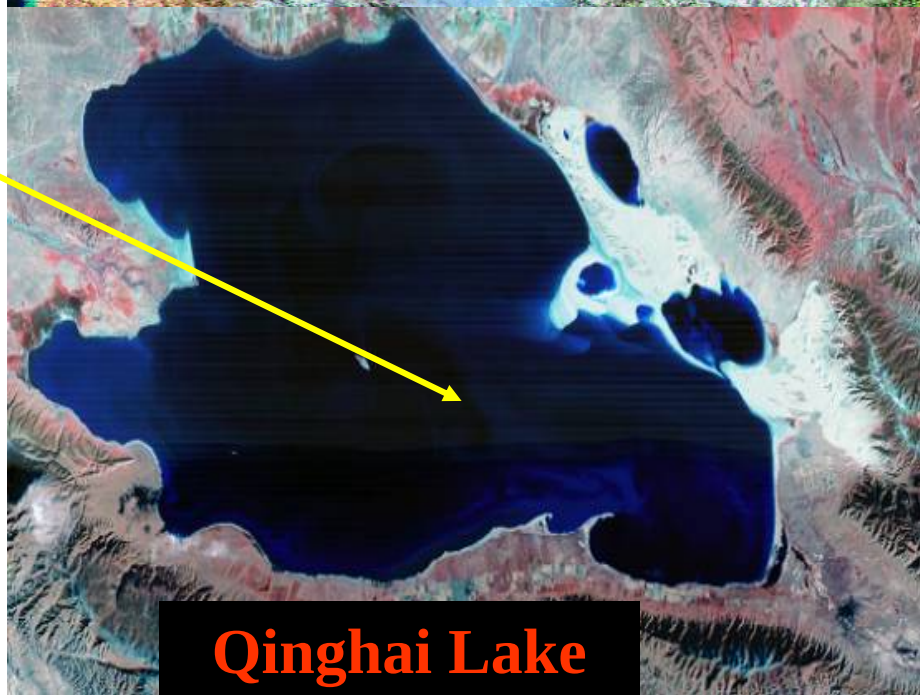
(3) Two Radiometric Calibration Sites are Available for VIS, NIR IR in China

- ✓ In 1994, Dun Huang of Gansu Province and Qinghai Lake of Qinghai Province have been chosen as the two absolute radiometric calibration sites
- ✓ In order to verify the performance of the sites and make calibration data for FY etc. Satellites, 7 Times Simultaneous Observations have been done at/over the two sites Since 1999

CRCS Location







China Radiometric Site

QingHai lake Calibration Site (TIR, VIS, NIR)

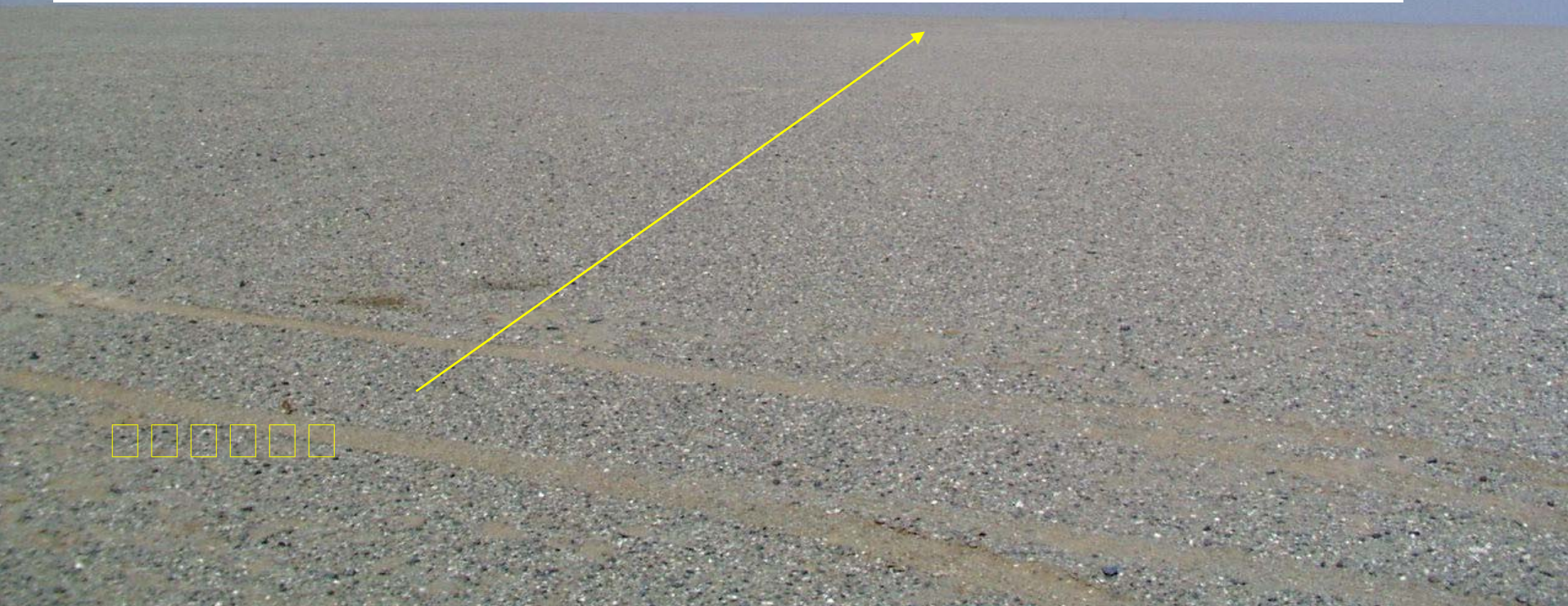
- Location: 37.0°N, 100.0°E, 4635km^2
- Altitude: 3196m
- Water Depth: 20m
- Climate:
- T 0.9°c/y, R 352 mm/y, RH 58% /y
- Sunshine 3000h/y

Good Lambertian feature, dry atmosphere, and high visibility

Dun Huang Calibration Site (VIS, NIR, SIR)

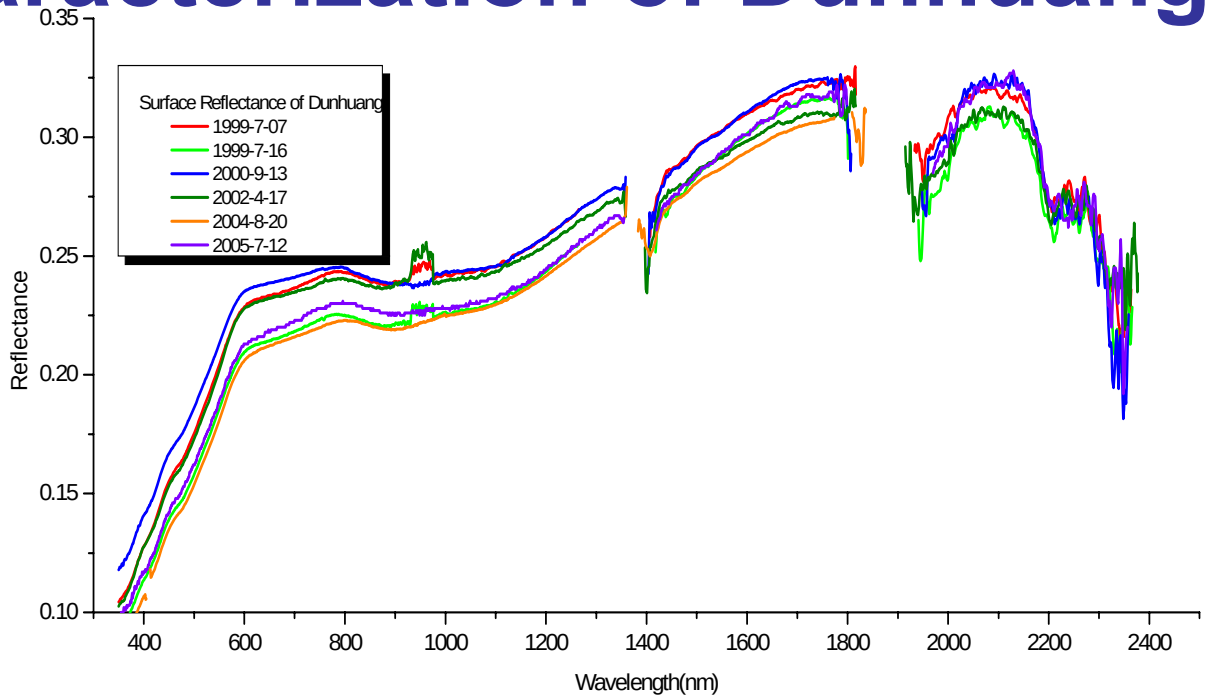
- Location: 40.1°N, 94.3°E, 30km×40km
- Altitude: 1176m
- Surface type: Gobi Desert
- Climate:

T 9.5°c/y, R 42 mm/y, RH 43.9%/y

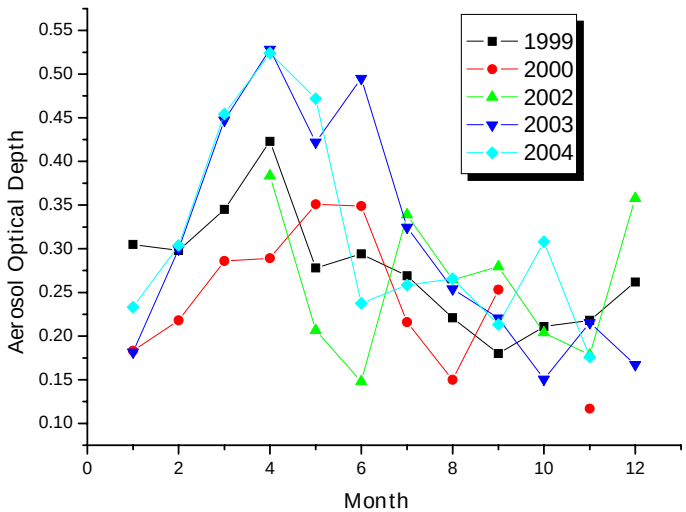


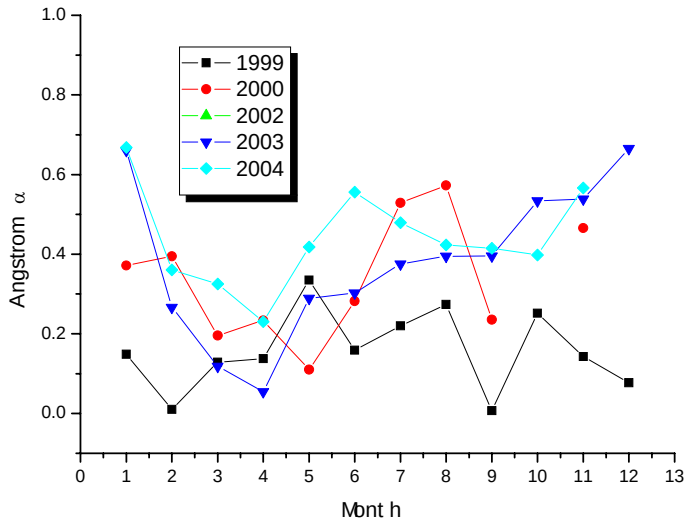
Characterization of Dunhuang site

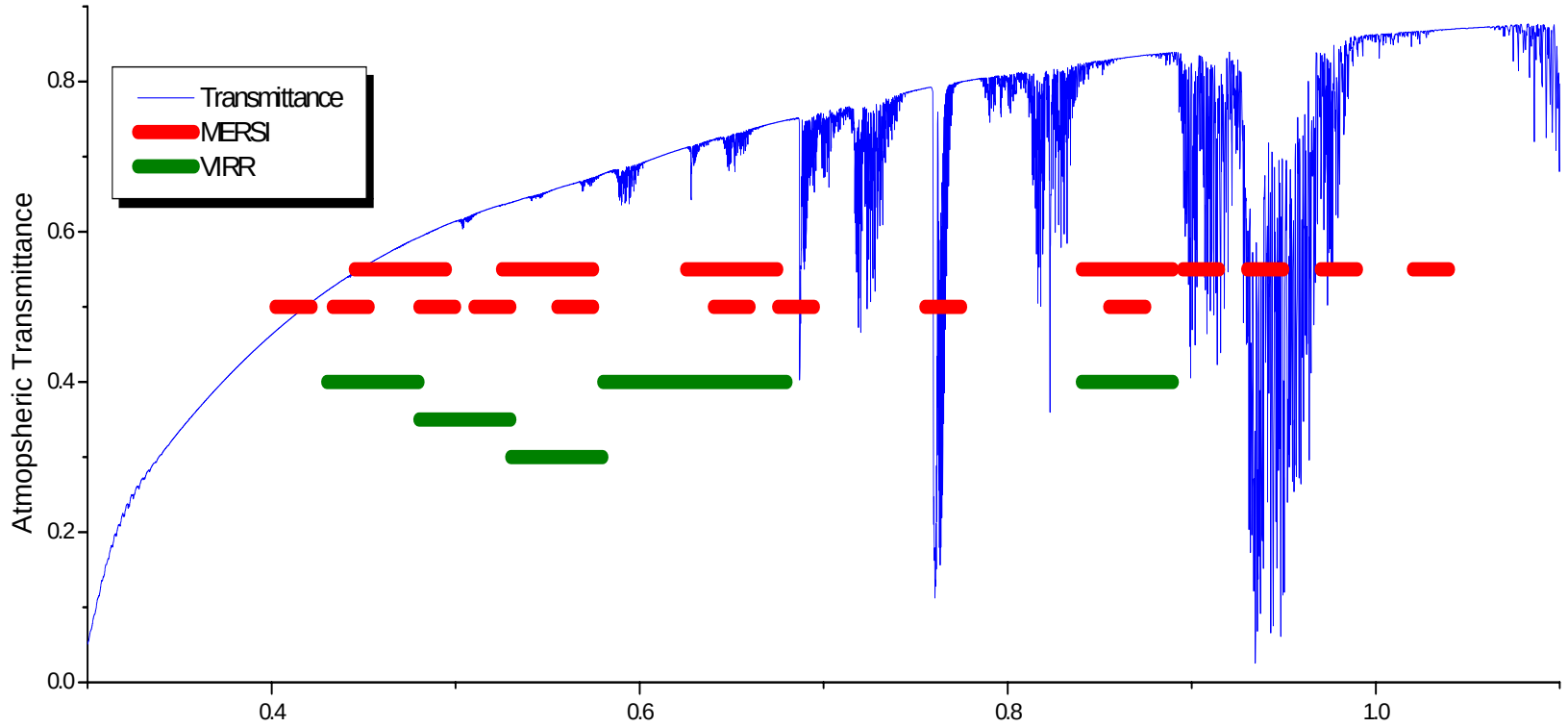
Reflectance:



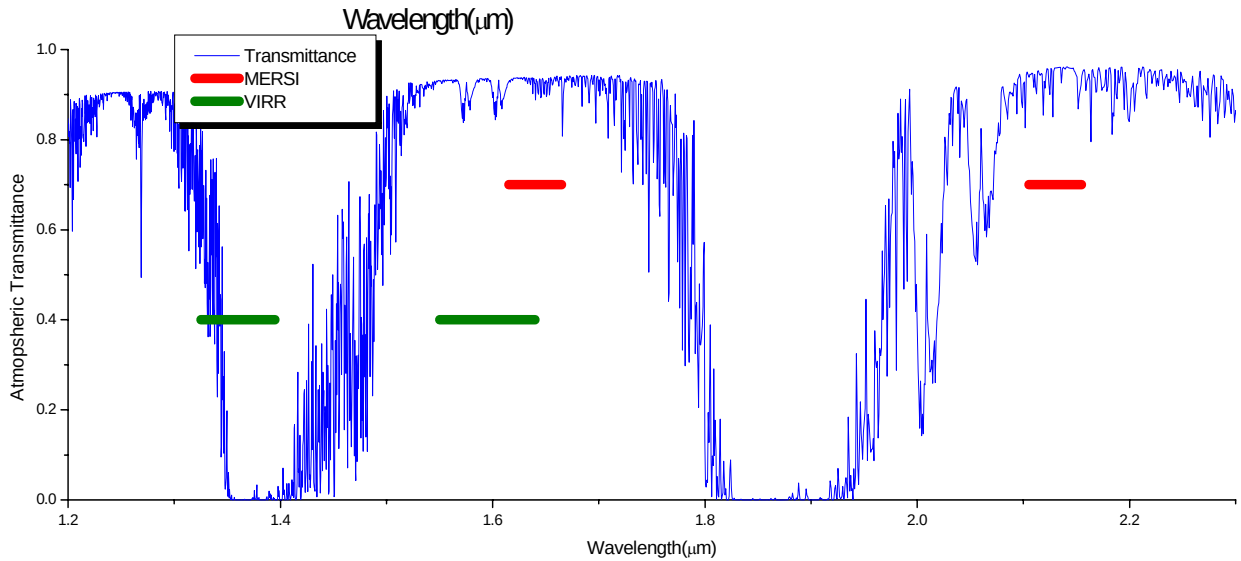
Aerosol:



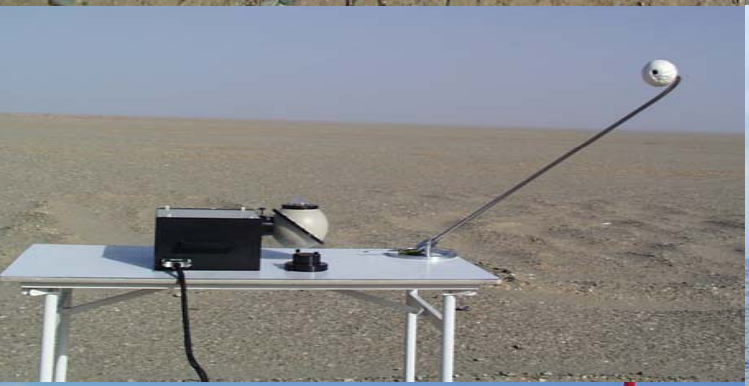


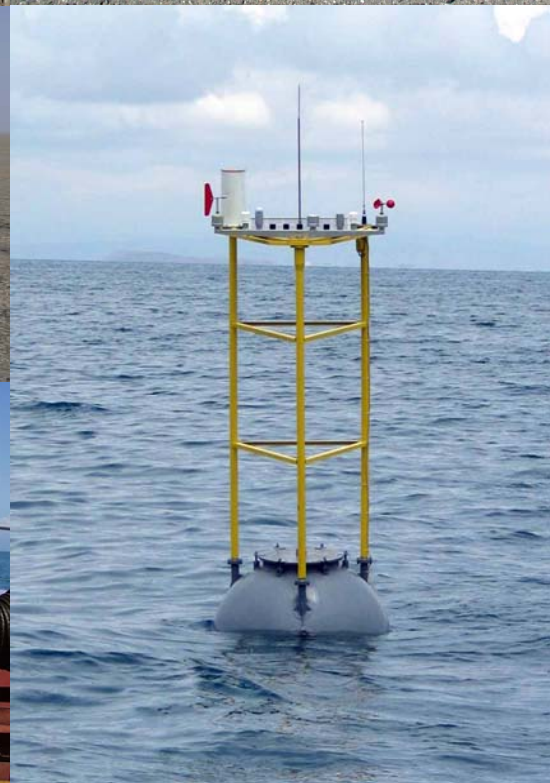


VIRR IR bands	
3	3.55-3.93μm
4	10.3-11.3μm
5	11.5-12.5μm
MERSI IR bands	
5	11.25±1.25μm

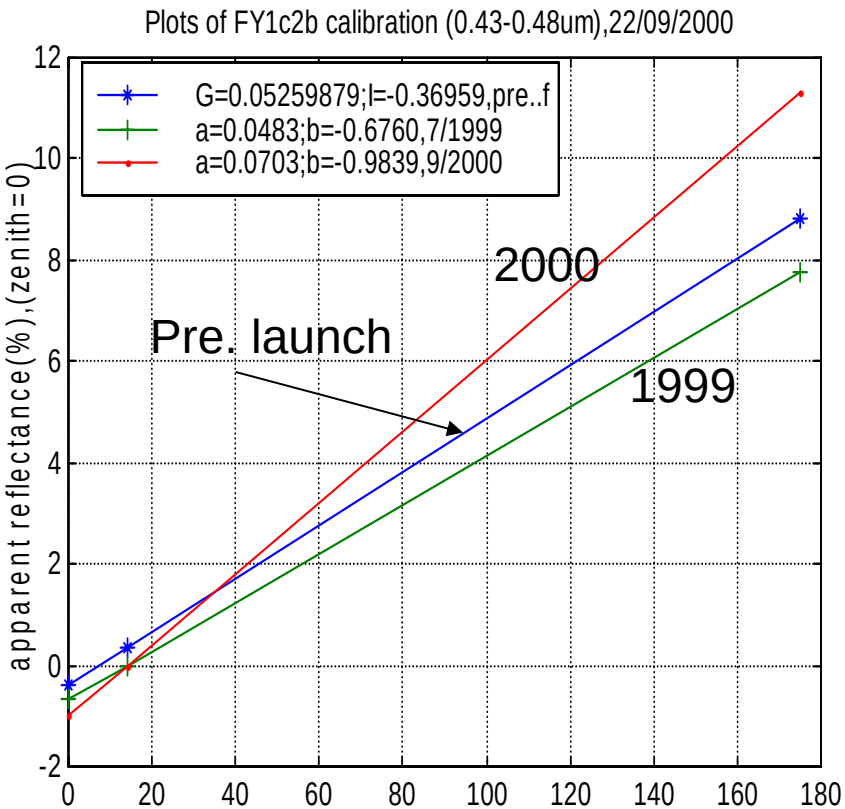


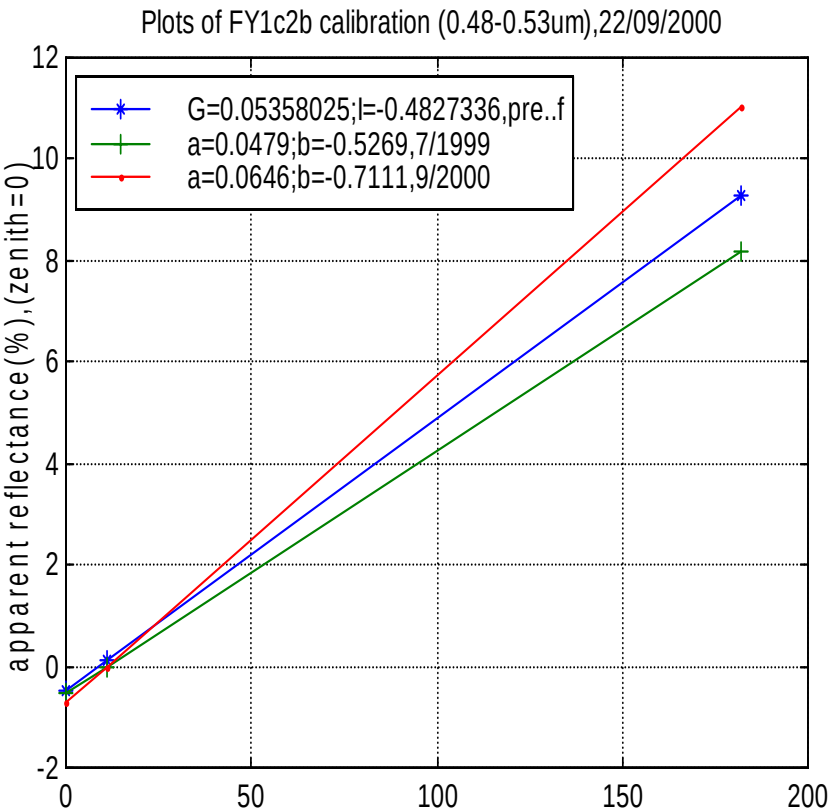
Site calibration field Campaign



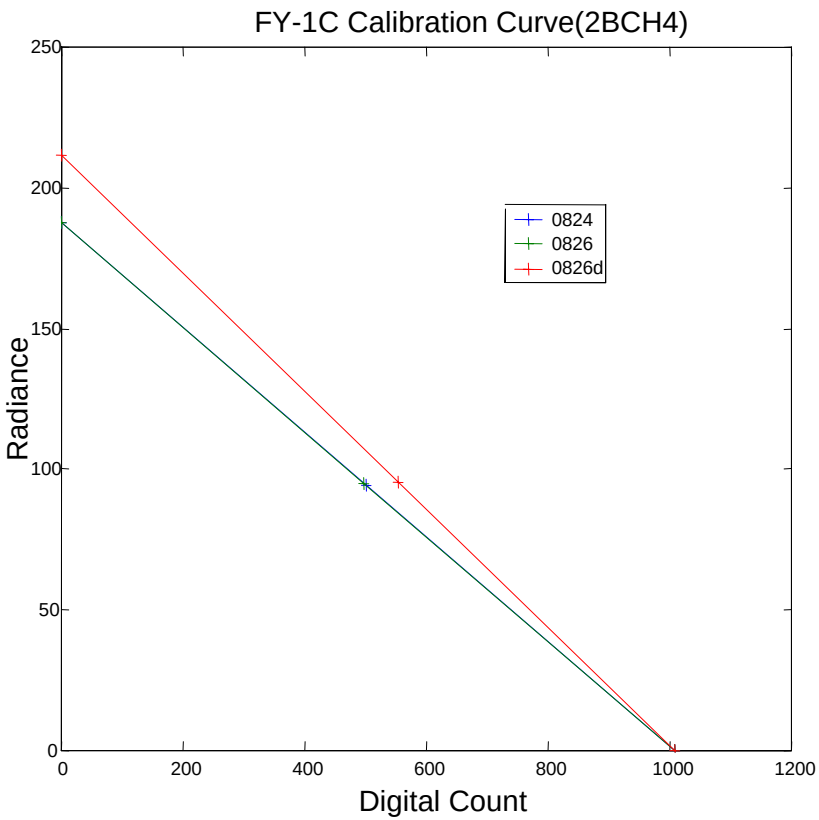


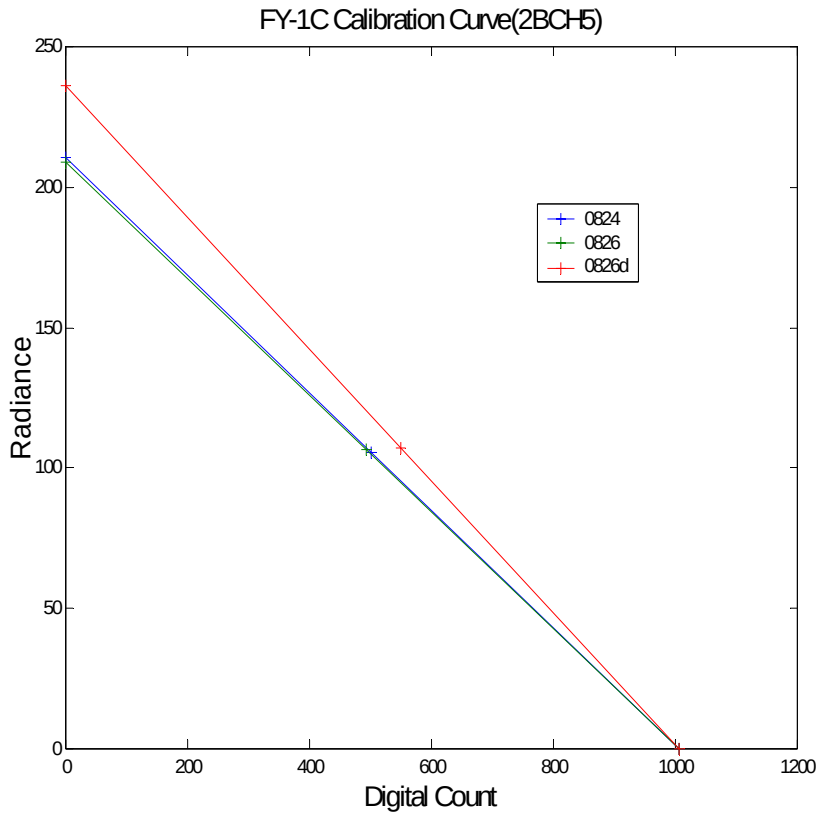
Calibration Curves of FY-1C VIS and Near IR Channels with Time (1/2)





Calibration Curves of FY-1C Thermal IR Channels (2/2)

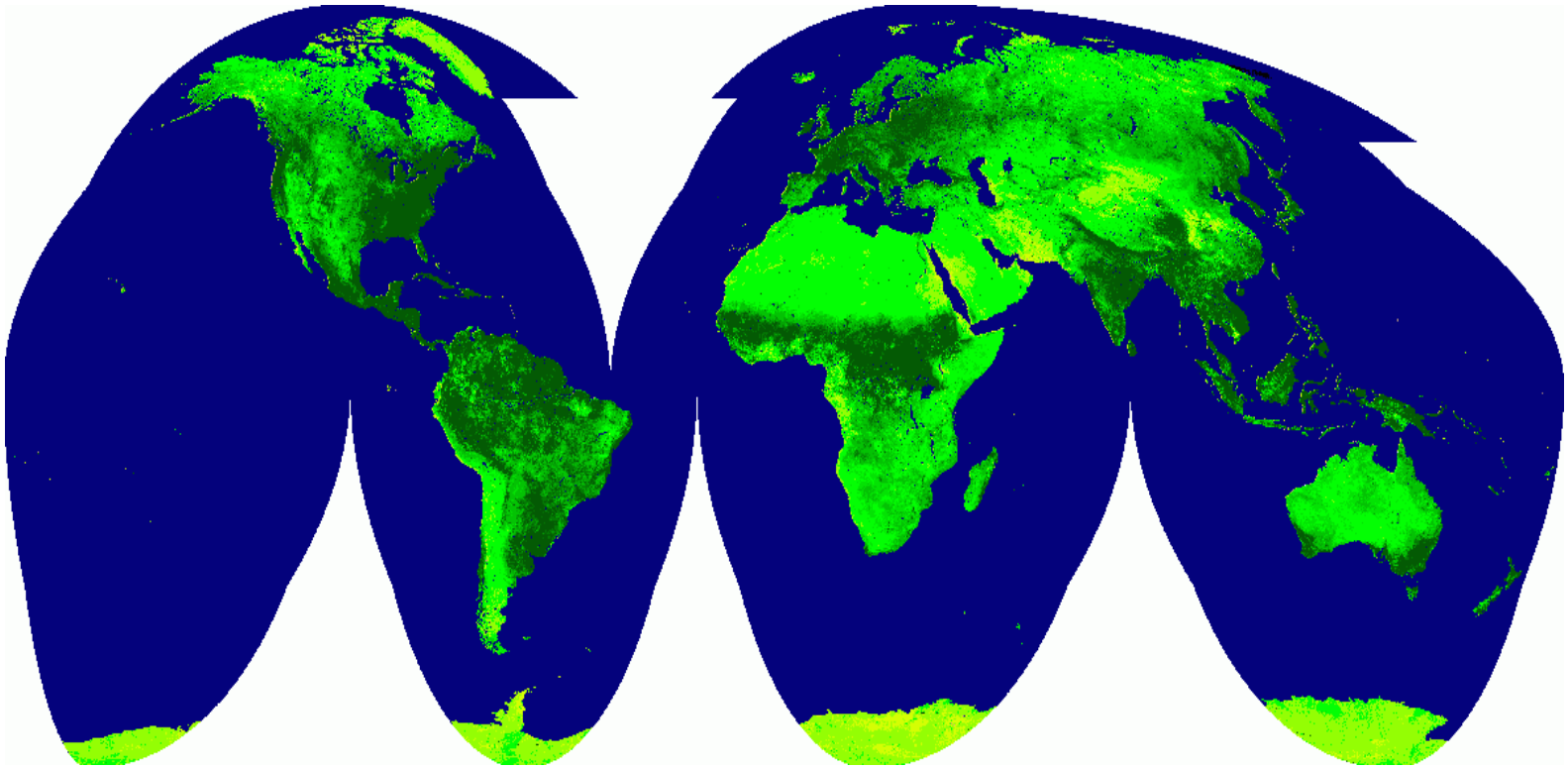




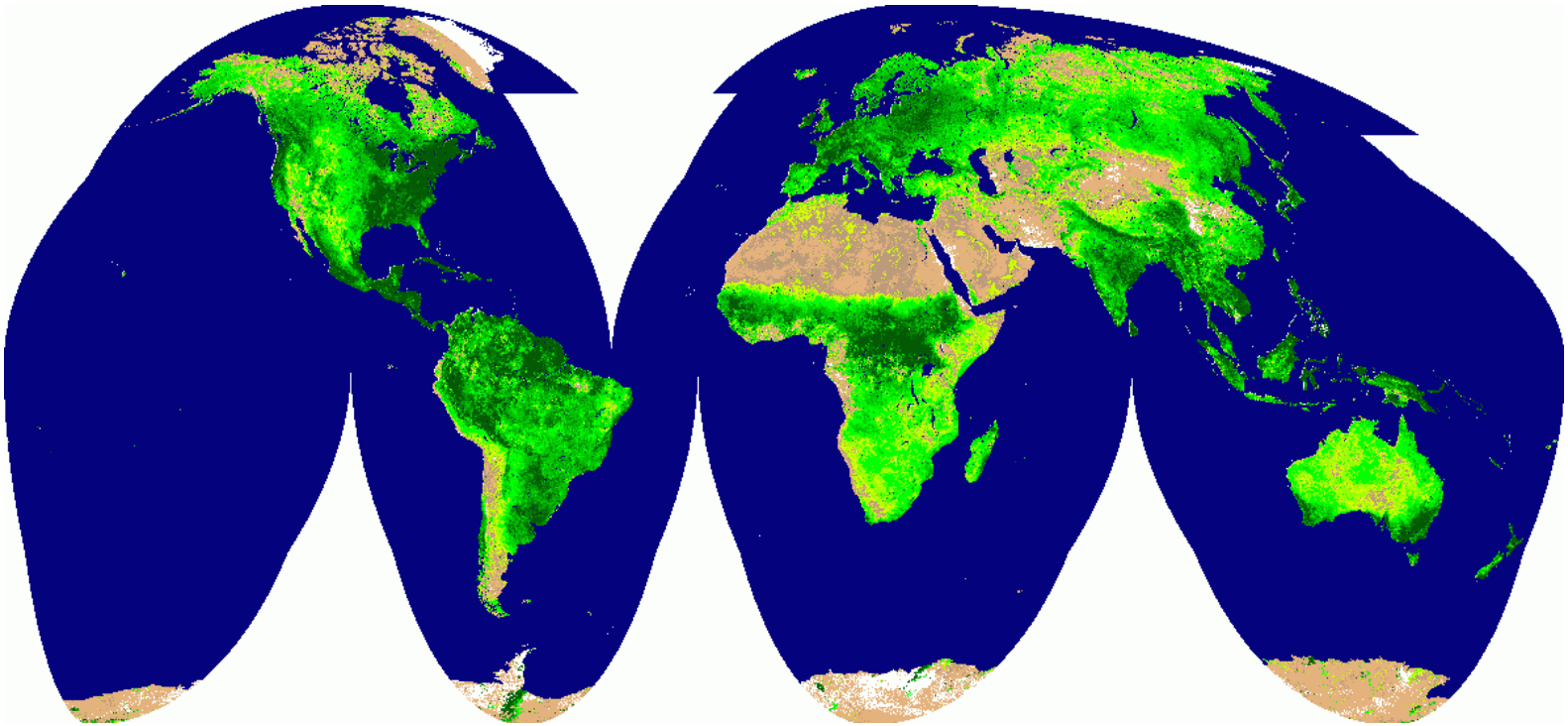
Site CAL Results of FY-1C RSB

Date	Ch1	Ch2	Ch6	Ch7	Ch8	Ch9	Ch10
PreflyCal 1998	0.0918	0.0923	0.0840	0.0526	0.0536	0.0537	0.0952
07/07/1999	0.0829	0.0892	0.0598	0.0483	0.0479	0.0777	0.0902
22/09/2000	0.1414	0.1072	0.0685	0.0703	0.0646	0.0913	0.1094
10/07/2002	0.0959	0.1142	0.0645	0.2199	0.2205	0.0758	0.1163
18/07/2002	0.0954	0.1129	0.0644	0.2338	0.2228	0.0757	0.1123

FY-1C GLOBAL NDVI (BEFORE CAL.)



FY-1C GLOBAL NDVI (AFTER CAL.)



(4) The Proposed CAL Site for Microwave Instrument

- **Location: 23°55′10″N--24°06′15″N, 100 °10 ′15 ″E--100°20′29 ″E**
- **Size: 179km^2**
- **Forest area: 103km^2**

The subtropical rain forest in Yunnan

The observation situation

The Field Site Condition

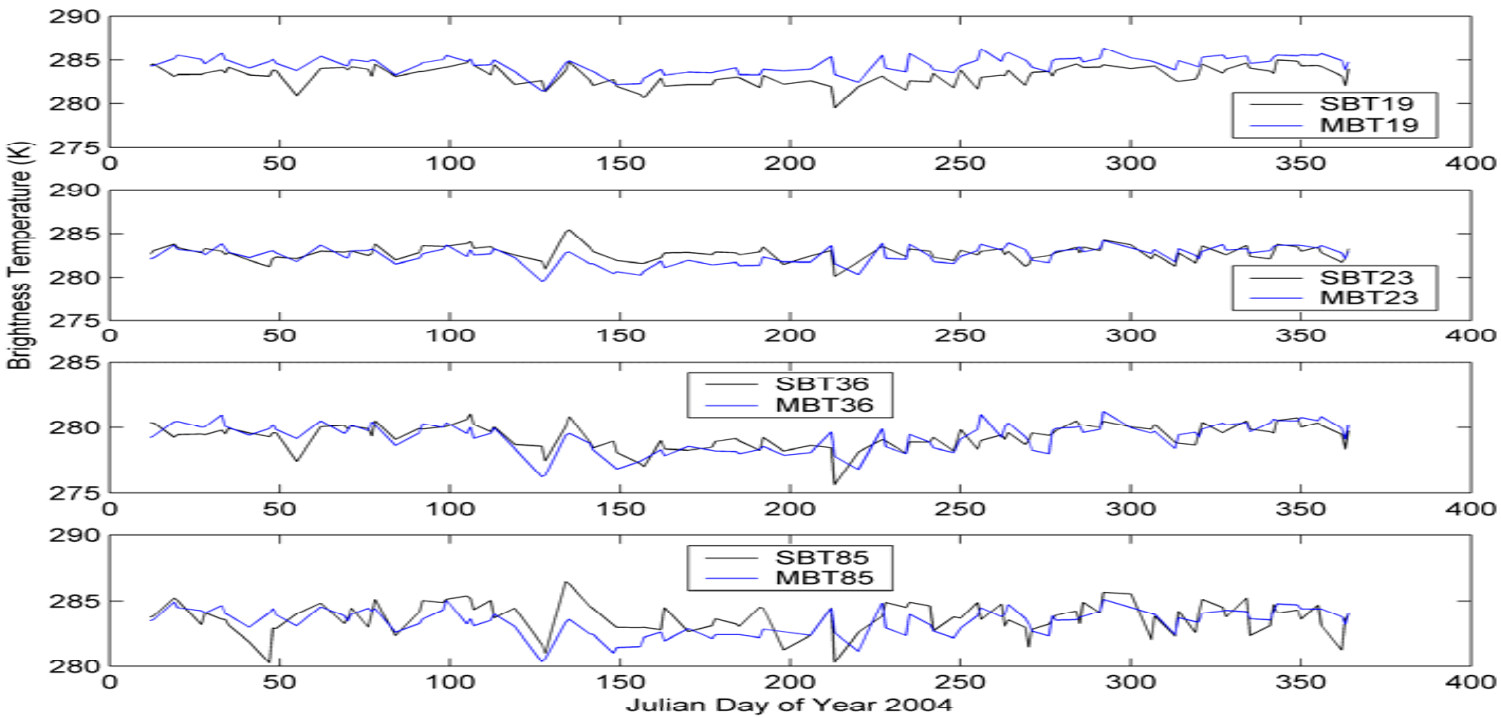
- ✓ The snow mountain nature reserve areas located in the South of the Yunnan, China. It is the cite selected for the microwave radiance cal/val.
- ✓ Climate:
  - ➢ Temperature:
    - the year mean temperature: 7-17□
  - ➢ Precipitation
    - the year precipitation amount: 1240-2900mm
    - the dry season: from November to April
    - the wet season: from May to October
- ✓ Vegetation: subtropical forever green broadleaf

AMAZON Tropic Forest for Microwave CAL

A□4N□1S, 53W□59W **B□5S□10S, 65W□74W**

RESULTS

	SSMI TB	TBc	Bias	Rmse
19GHz	283.3±1K	284.5	-1.2K	0.15K
23GHz	282.7±1K	282.5	0.2K	0.09K
36GHz	279.3±1K	279.3	0.0K	0.08K
85GHz	283.7±1K	283.4	0.3K	0.12K



(5) FY-3A Major Remote Sensing Instruments and Simulating Data(1/2)

Instrument name of FY-3A	Major characteristics	Simulating Data Source for FY-3A
Imaging Mission		
Visible and InfraRed Radiometer (VIRR)	Spectral range: 0.43□12.5μm Channel numbers: 10 Cross track scanning: ±55.4° Spatial resolution: 1.1 KM	VIRR/ FY-1D
Medium Resolution Spectral Imager (MERSI)	Spectral range: 0.41□12.5μm Channel numbers: 20 Cross track scanning: ±55.4° Spatial resolution: 0.25□1KM	MODIS/AQUA
Microwave Radiation Imager (MWRI)	Frequency range: 10.65□150GHz Channel numbers: 12 (6 frequencies with H,V polarization) Conical scanning: 110.8° Spatial resolution: 15-80 KM	AMSR-E/ AQUA
Total Ozone mapping Unit (TOU)	Spectral range: 309□361nm Channel numbers: 6 Cross track scanning: ±56.0° Spatial resolution: 50 KM	TOMS OMI/AURA

FY-3A Major Remote Sensing Instruments Simulating Data Source(2/2)

Sounding Mission		
Infrared Atmospheric Sounder (IRAS)	Spectral range: 0.69□15.5μm Channel numbers: 26 Cross track scanning: ±49.5° Spatial resolution: 17.0 KM	HIRS/NOAA
Microwave Atmospheric Temperature Sounder (MWTS)	Frequency range: 50□57GHz Channel numbers: 4 Cross track scanning: ±48.6° Spatial resolution : 50□75 KM	MSU/NOAA-14 AMSU-A/NOAA-18
Microwave Atmospheric Humidity Sounder (MWHS)	Frequency range: 150□183GHz Channel numbers: 5 Cross track scanning: ±48.95° Spatial resolution (SSP): 15 KM	AMSU-B/NOAA-18
Solar Backscatter Ultraviolet Sounder (SBUS)	Spectral range: 252□280nm Channel numbers: 12 Cross track scanning: ±56.0° Spatial resolution : 200 KM	SBUV/NOAA

(6) VAL Team Is Available

- ✓ **Investigate Data Source**
- ✓ **Evaluate Data for Future FY-3A Products Validation**

Thank you!