

Highly accurate FTIR instrument for space observation



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Sept. 2019



Infrared payload from SITP

- MVISR, FY-1A to -1D
- VIRR, FY-3A to -3C, heritage from FY-1
- IRAS, FY-3A to -3C
- ERM, FY-3A to -3C ...
- MERSI, FY-3A to -3D...
- HIRAS, FY-3D ...
- scanning radiometer, FY-2A to -2H
- AGRI, FY-4A...
- GIIRS, FY-4A...
- COCS, HY-1A to 1C... marine satellites
- IRS, HJ-1B... Disaster and Environment Monitoring Satellites,
- AHSI, Resources satellites, GF-5, ZY-1 02D...
- laser altimeter , CE-1 to -4... lunar exploration
- Spectral imager, CE-3

From **EXPERIMENTAL** to **OPERATIONAL**



Infrared sounder for FY-3

- IRAS
- Spectral range: $0.69 \sim 15.5 \mu\text{m}$,
channel numbers: 26,
- cross-track scanning: $\pm 49.5^\circ$
- (2172 km),
- Spatial resolution: 17.0 km
- → HIRAS
- *channel* numbers: > 1300
- Spectral resolution: 0.625cm^{-1}
- Spatial resolution: 17.0 km
- Accuracy: $< 1\text{K}$

Channel No.	Channel central wave number (cm^{-1})	Central wavelength (μm)	Half-power bandwidth (cm^{-1})	Main absorber
1	669	14.95	3	CO_2
2	680	14.71	10	CO_2
3	690	14.49	12	CO_2
4	703	14.22	16	CO_2
5	716	13.97	16	CO_2
6	733	13.64	16	$\text{CO}_2/\text{H}_2\text{O}$
7	749	13.35	16	$\text{CO}_2/\text{H}_2\text{O}$
8	802	12.47	30	Window
9	900	11.11	35	Window
10	1030	9.71	25	O_3
11	1345	7.45	50	H_2O
12	1365	7.33	40	H_2O
13	1533	6.52	55	H_2O
14	2,188	4.57	23	H_2O
15	2,210	4.52	23	N_2O
16	2,235	4.47	23	$\text{CO}_2/\text{N}_2\text{O}$
17	2,245	4.45	23	$\text{CO}_2/\text{N}_2\text{O}$
18	2,388	4.19	25	CO_2
19	2,515	3.98	35	Window
20	2,660	3.76	100	Window
21	14,500	0.69	1,00	Window
22	11,299	0.885	385	Window
23	10,638	0.94	550	H_2O
24	10,638	0.94	200	H_2O
25	8,065	1.24	650	H_2O
26	6,098	1.64	450	H_2O



Infrared sounder for FY-3

HIRAS instrument specification improvement for FY-3 D/E

Band	Spectral Range (cm ⁻¹)	Spectral Resolutio n (cm ⁻¹)	Sensitivity (NEΔT@280K)			Num of Channels
			FY-3D	FY-3E		
LWIR	650~1136 (15.38μm~8.8 μm)	0.625	0.15(Expectation) 0.4K(Requirement)	650 ~667 cm ⁻¹	0.8K	778
				667~689 cm ⁻¹	0.4K	
				689~1000 cm ⁻¹	0.2K	
				1000~1136 cm ⁻¹	0.4K	
MWIR1	1210~1750 (8.26μm~5.71 μm)	1.25	0.1(Expectation) 0.7K(Requirement)	1210~1538 cm ⁻¹	0.2K	433
				1538~1750 cm ⁻¹	0.3K	
MWIR2	2155~2550 (4.64μm~3.92 μm)	2.5	0.3(Expectation) 1.2K(Requirement)	2155~2300 cm ⁻¹	0.3K	159
				2300~2550 cm ⁻¹	0.5K	



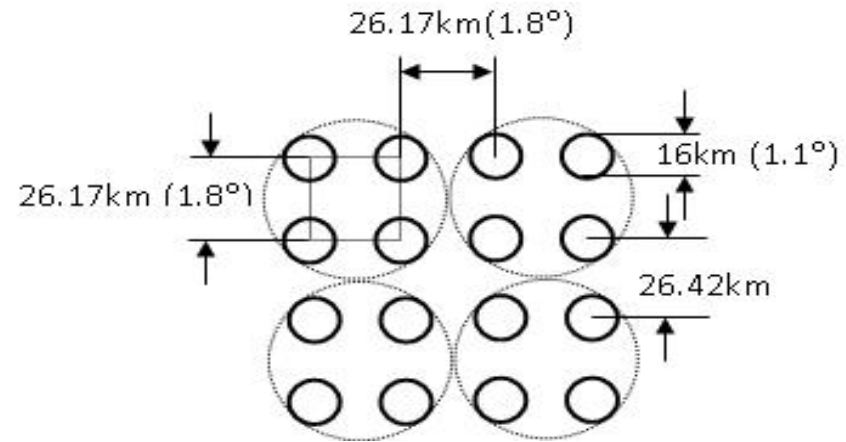
Infrared sounder for FY-3

✓ **HIRAS scan, field-of-regard (FOR), field-of-view (FOV)**

✓ **2×2 Four detectors define 1 FOR**

◆ **33 sweeps, including 29 Earth Scene (ES), 2 Deep Space (DS) & 2 Internal Calibration Target (ICT) measurements**

◆ **Nadir spatial resolution is 16km**

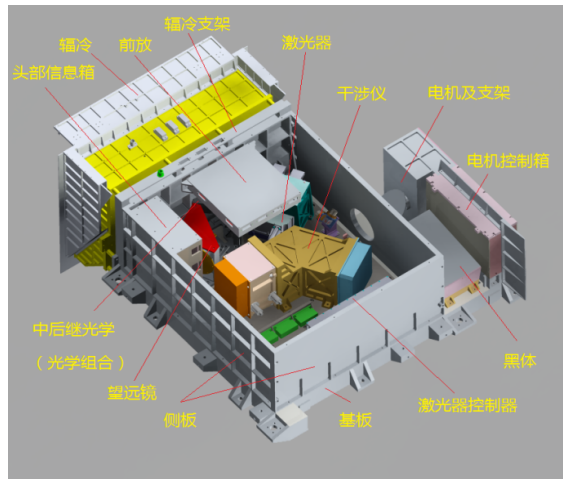


Band	Spectral Range (cm ⁻¹)	Spectral Resolution (cm ⁻¹)	Sensitivity (NEΔT@280K)	No of Channels
LW	650*~1136 (15.38μm~8.8 μm)	0.625	0.15~0.4K	778
MW	1210~1750 (8.26μm~5.71 μm)	1.25	0.1~0.7K	433
SW	2155~2550 (4.64μm~3.92 μm)	2.5	0.3~1.2K	159

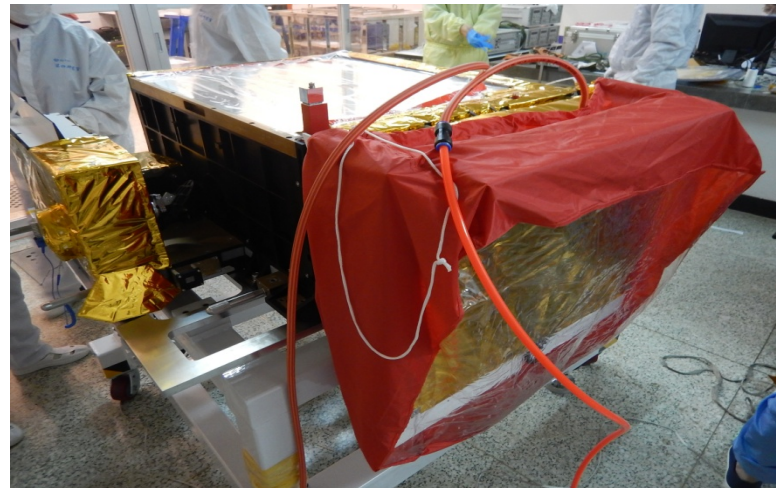


Infrared sounder for FY-3

- FY-3D HIRAS
- a Fourier transform interferometer
- With high spectral resolution, low radiometric noise and high spectral and radiometric accuracy



Instrument structure



HIRAS

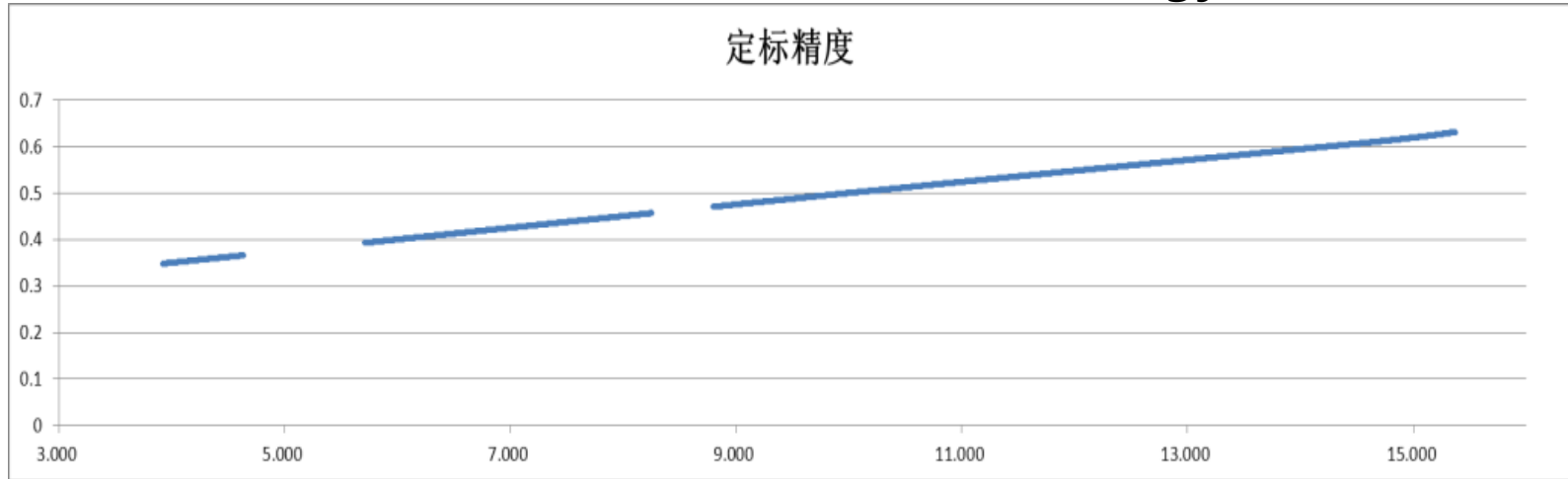


Infrared sounder for FY-3

FY-3D/ HIRAS

Total radiometric uncertainty

- Main contributor : **calibration blackbody temperature, stability and emissivity.**
- **all traceable to National Institute of Metrology, China(NIM)**



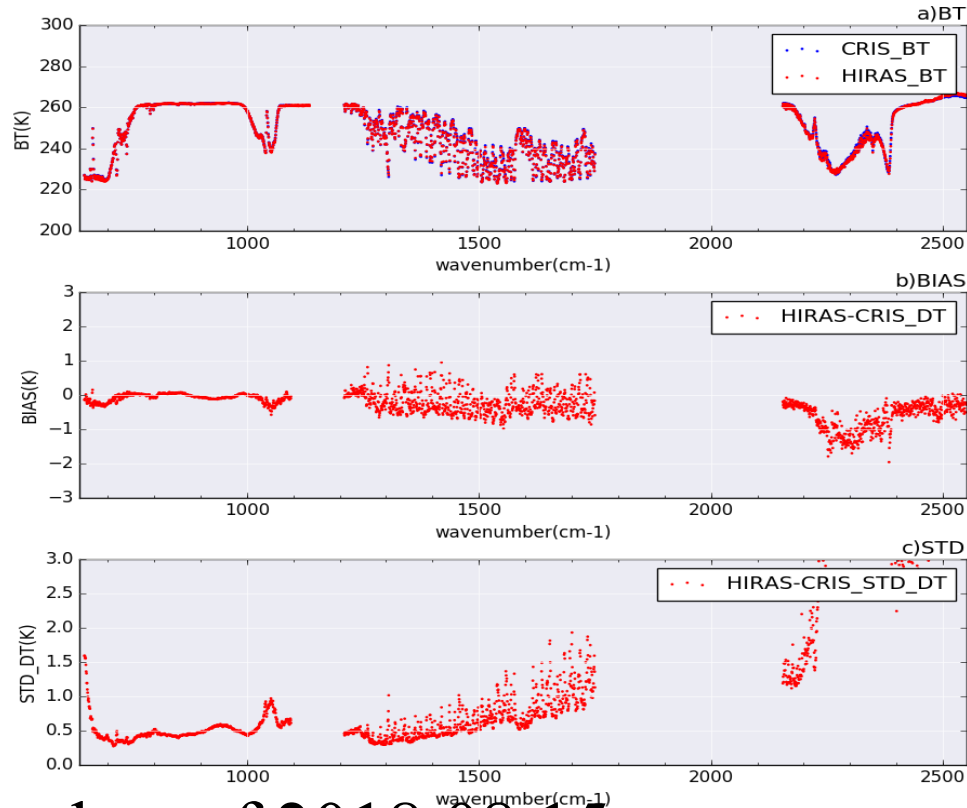
Contribution does not include detector nonlinearity



Infrared sounder for FY-3

SNO: HIRAS II & CRIS

FY3D HIRAS-CRIS of 20180815

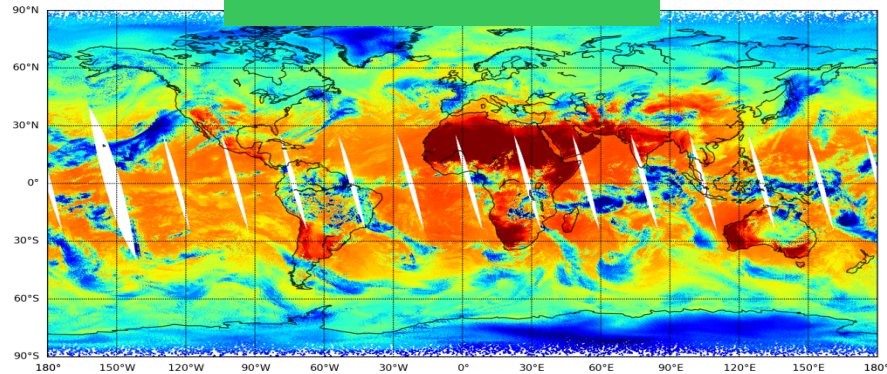


based on the data of 2018.08.15

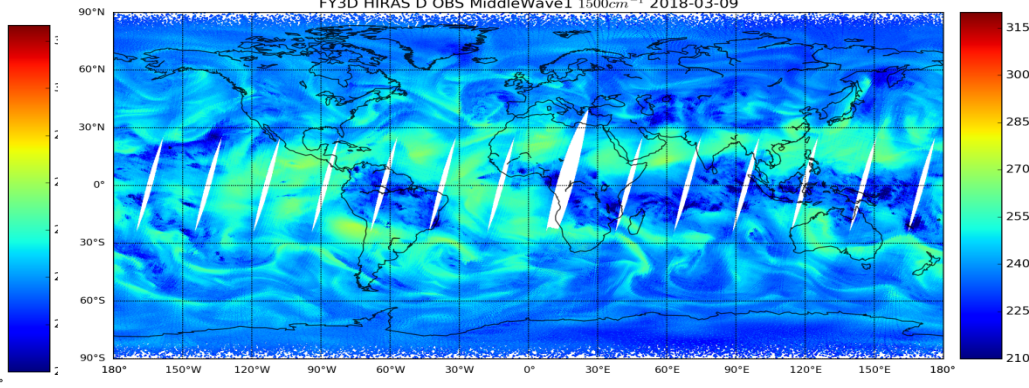
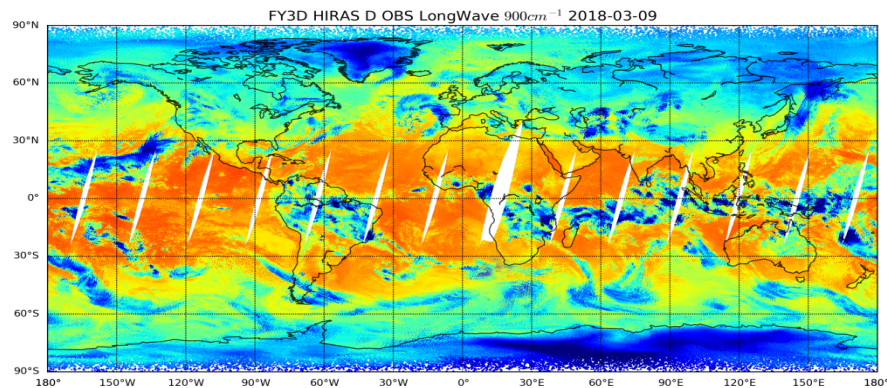
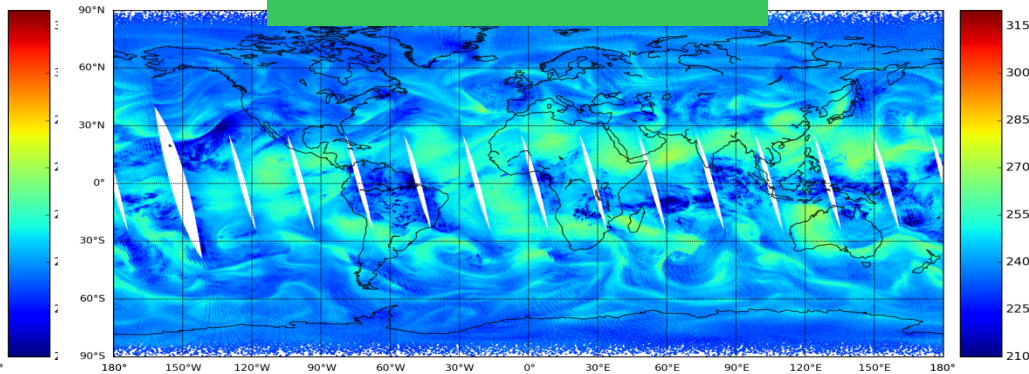
From CMA

Day-1 Global BT(Real Part)

LW 900cm⁻¹



MW 1500cm⁻¹



After data downlink, ground system generates L0 data, decodes them into L1A data and then processes the data into L1 & OBC



Meteorological Satellites

Advanced Geostationary Radiometric Imager (AGRI) specification improvement

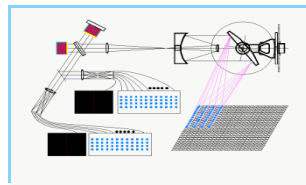
		FY-4A	FY-4B
Spectral number		14	15
Spatial resolution	Visible	0.5-1km	0.5-1km
	Swir	2km	2km
	Mwir/Lwir	4km	4km
Temporal resolution		15min/disk	15min/disk
Sensitivity	Solar reflective band	SNR=200 @ $\rho = 100\%$	SNR=200 @ $\rho = 100\%$
	Infrared band	NEDT=0.2k @300k	NEDT=0.2k @300k



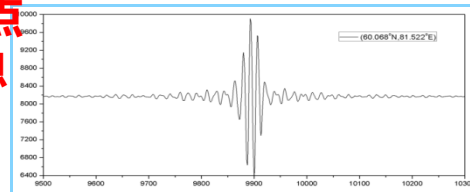
Infrared sounder for FY-4

Geostationary Interfering InfraRed Sounder (GIIRS)

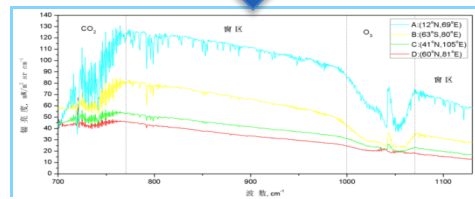
- $4.44\mu\text{m} - 6.06\mu\text{m}$ 、 $8.85\mu\text{m} - 14.3\mu\text{m}$
- Resolution: 0.625 cm^{-1}
- Spectral stability : $<10\text{ppm}$
- 67min, $5000\text{km} \times 5000\text{km}$



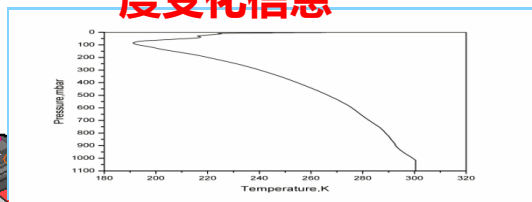
记录各点
干涉信息



计算各光谱
信息点

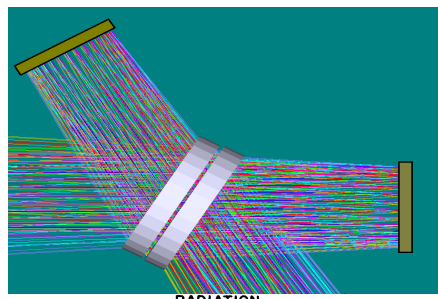
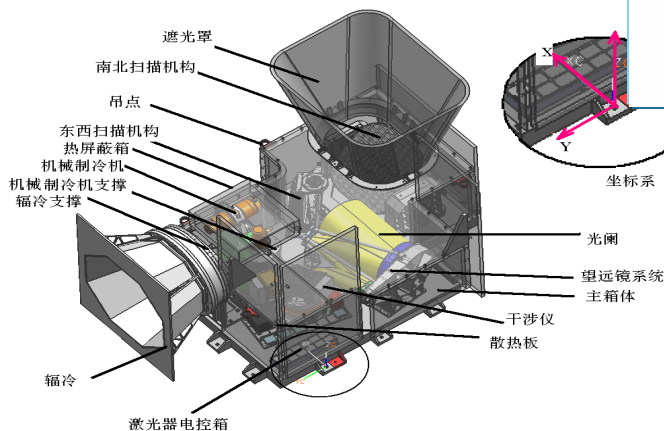


获得动态温湿
度变化信息



反演大气
温湿度参数

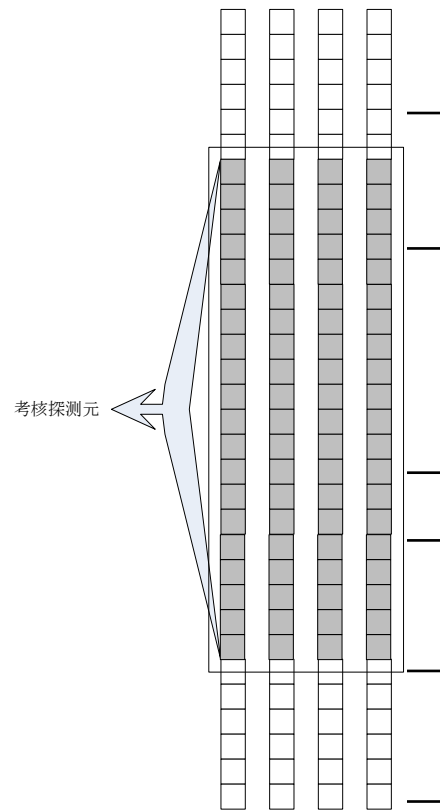
Calibration accuracy $0.7\text{K}@300\text{K}$

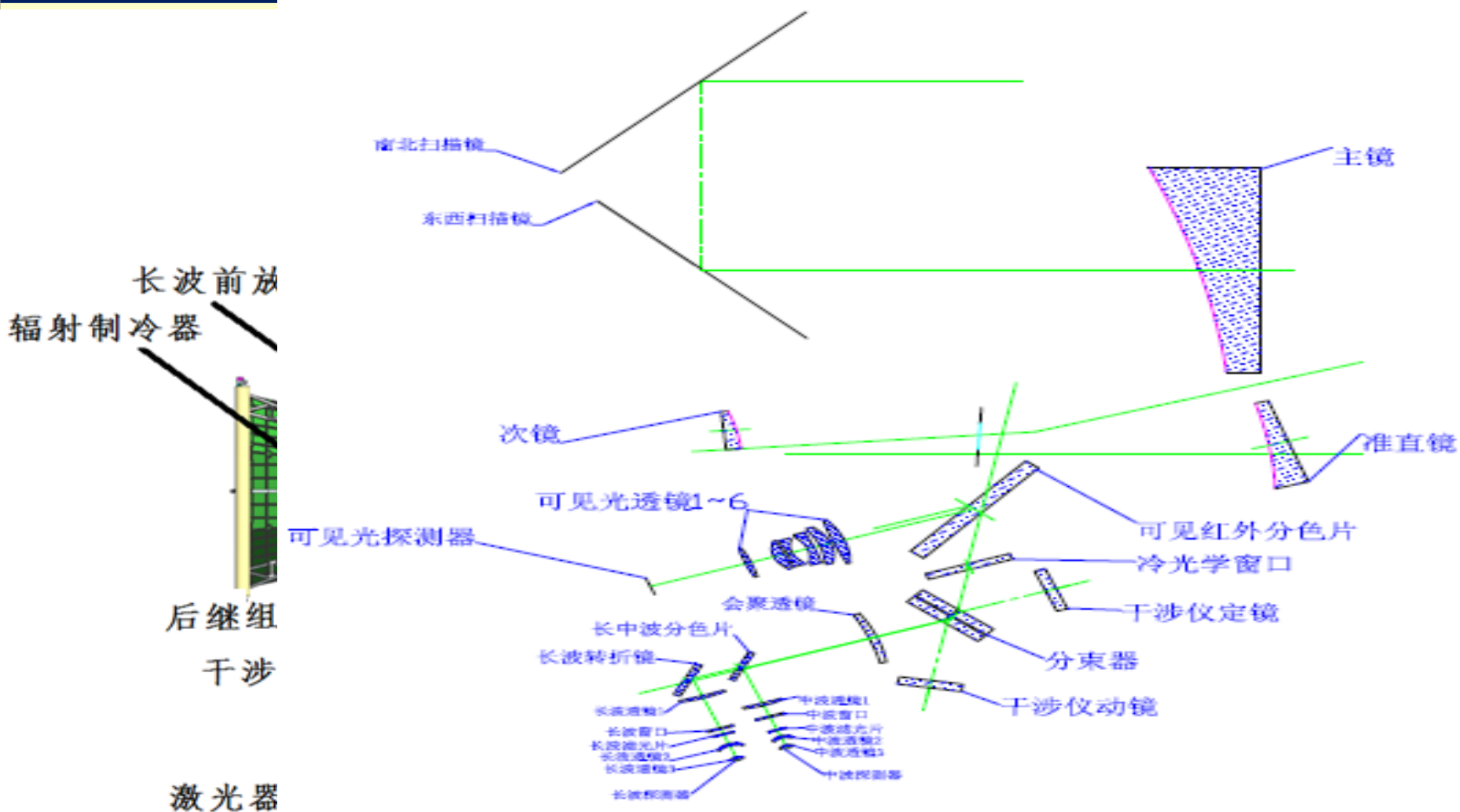




Infrared sounder for FY-4

Wavelength range	长波：700~1130 cm^{-1} 短/中波：1650~2250 cm^{-1} 可见光：0.55~0.75 μm
Spectral resolution (cm^{-1})	中小尺度探测：长波0.8；中波1.6 区域探测：长波1.6；中波3.2
sensitivity ($\text{mW}/\text{m}^2\text{sr cm}^{-1}$)	中小尺度：长波0.5~1.1；中波：0.1~ 区域（大步）：长波0.5~1.1；中波： 可见光波段：S/N $\geq$ 200 ($\rho=100\%$)
Spatial resolution	星下点：16km（红外）；2km（可见光
Time resolution	中小尺度：35分钟 区域：67分钟
Area range	中小尺度：1000km $\times$ 1000km 区域：5000km $\times$ 5000km



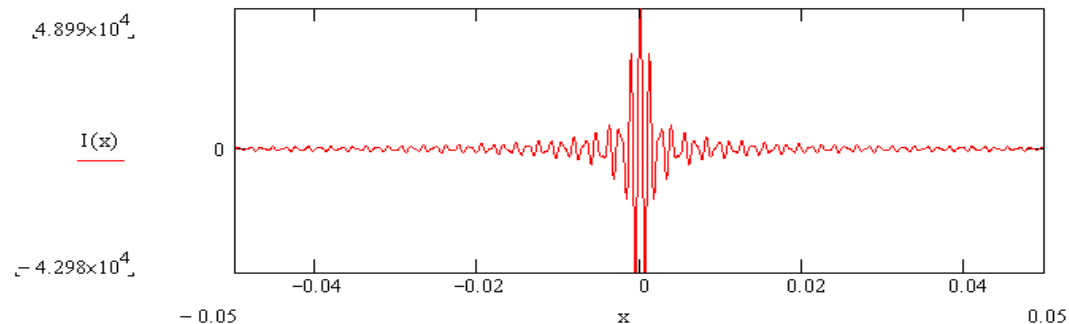




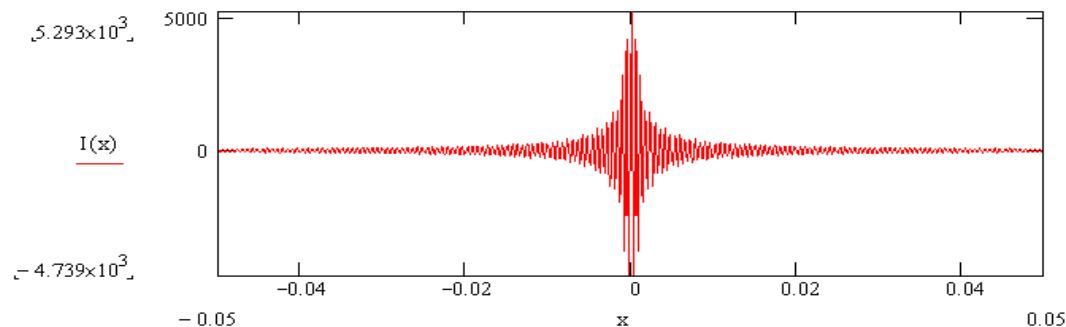
Infrared sounder for FY-4

$$I_{out}(x) = M \int_0^{+\infty} I_{in}(\sigma) \cos(2\pi\sigma x) d\sigma$$

长波:

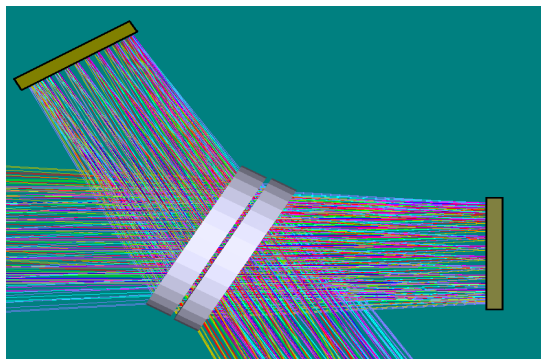
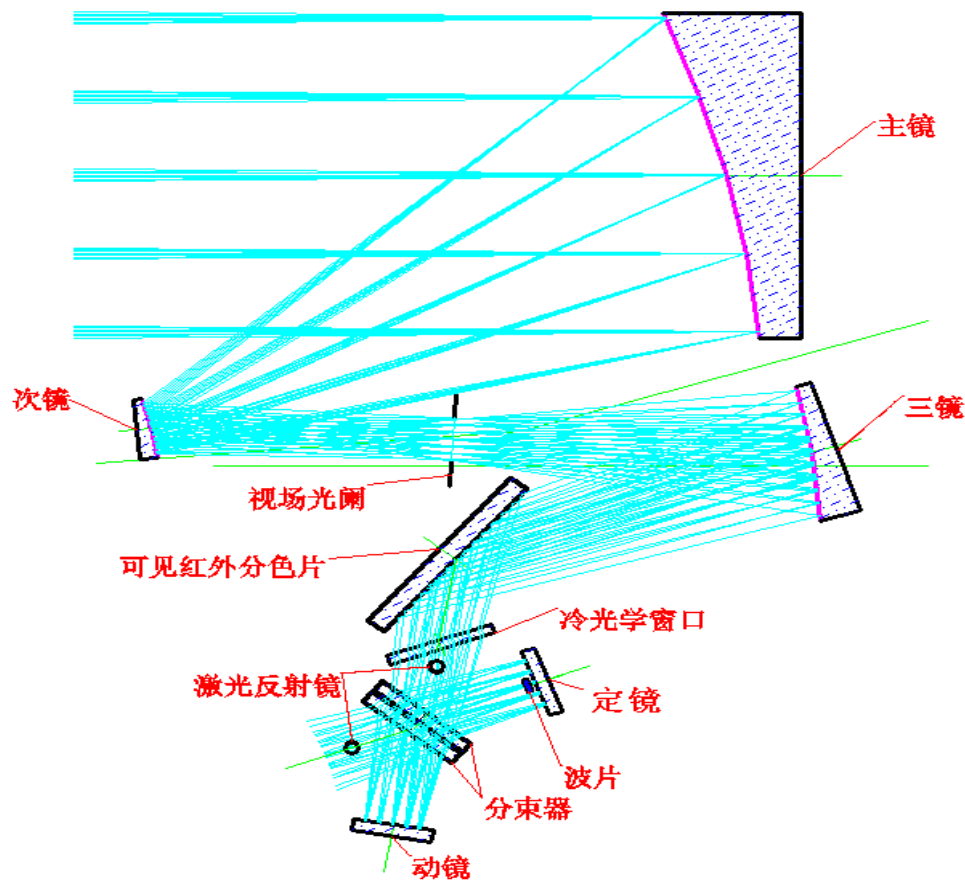


中波:



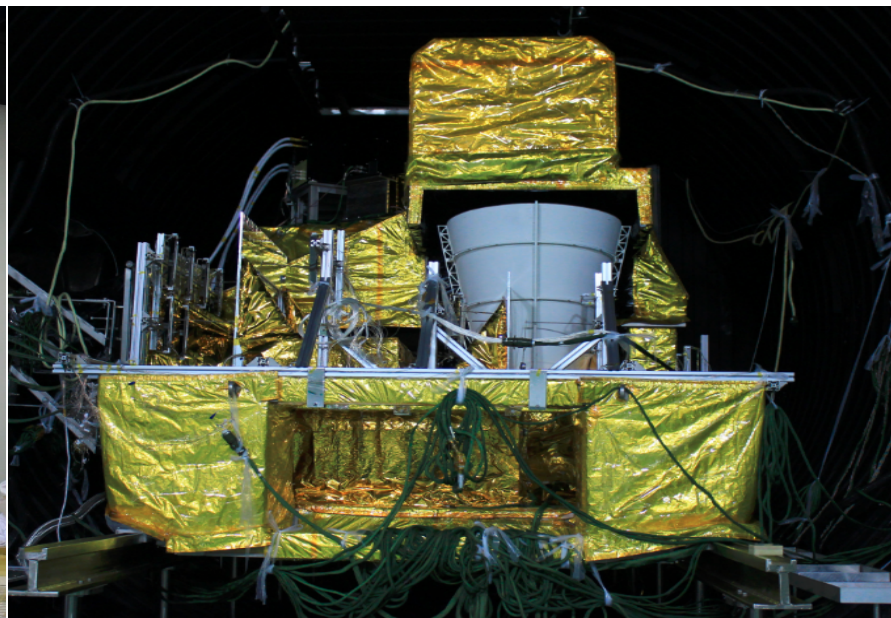
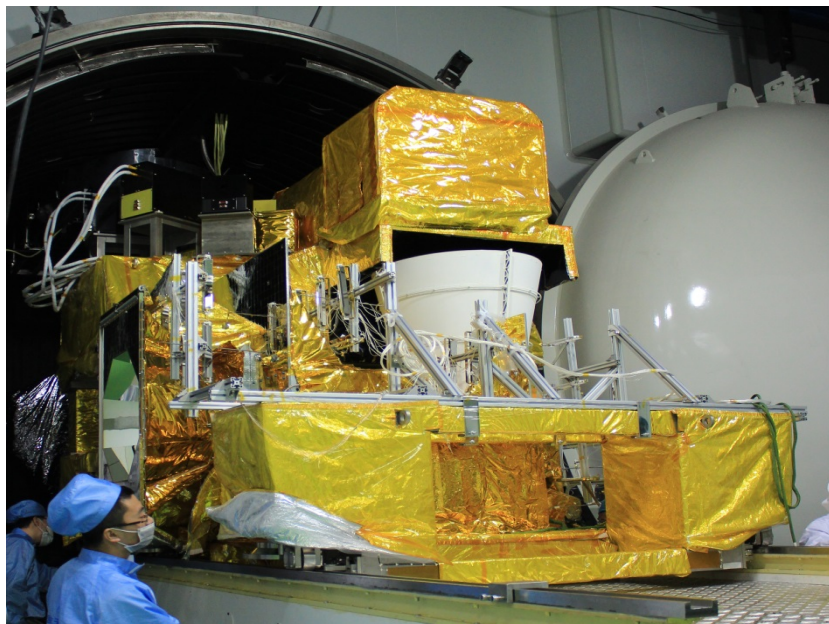


Infrared sounder for FY-4



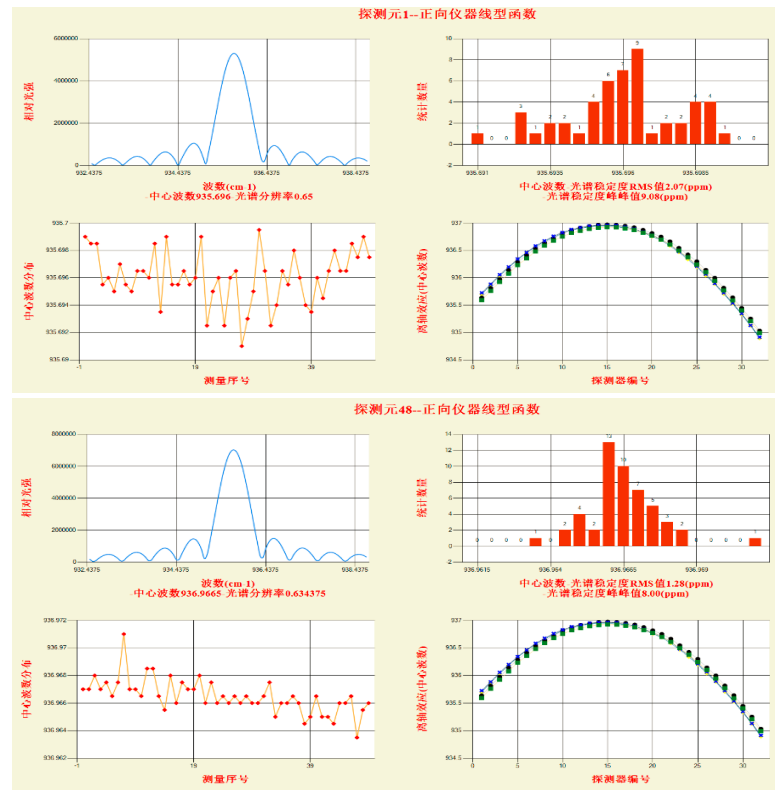
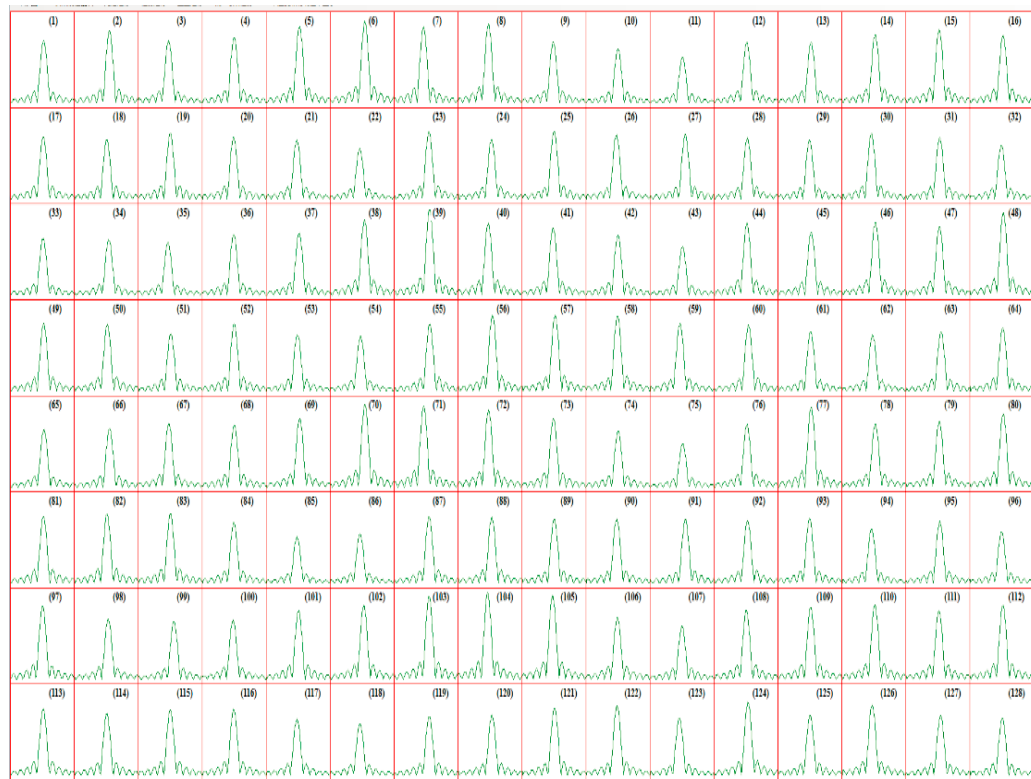
望远镜及干涉仪光路

- Vacuum test



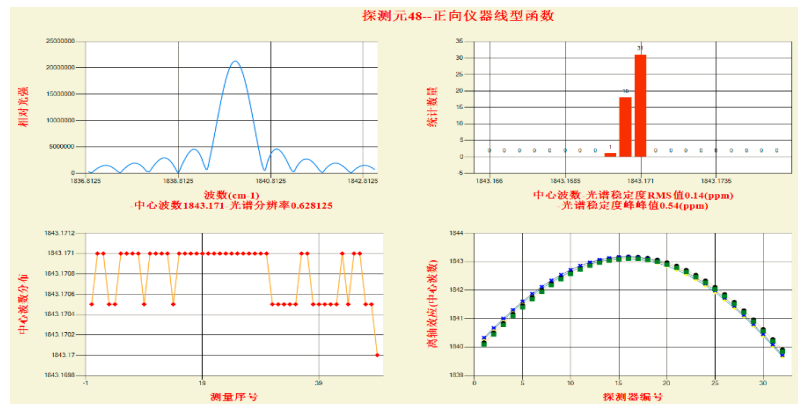
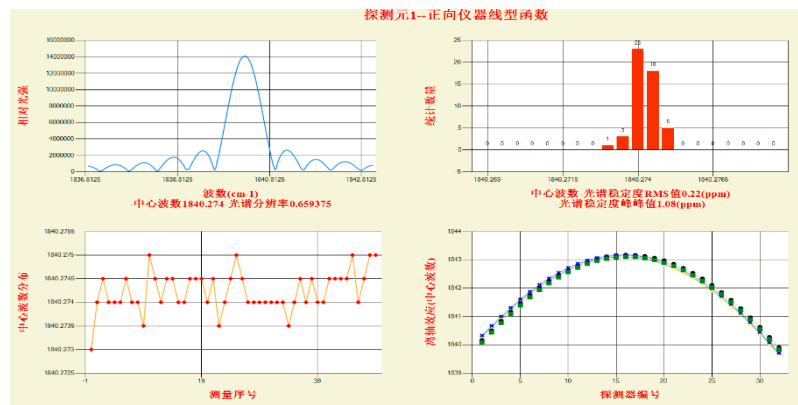
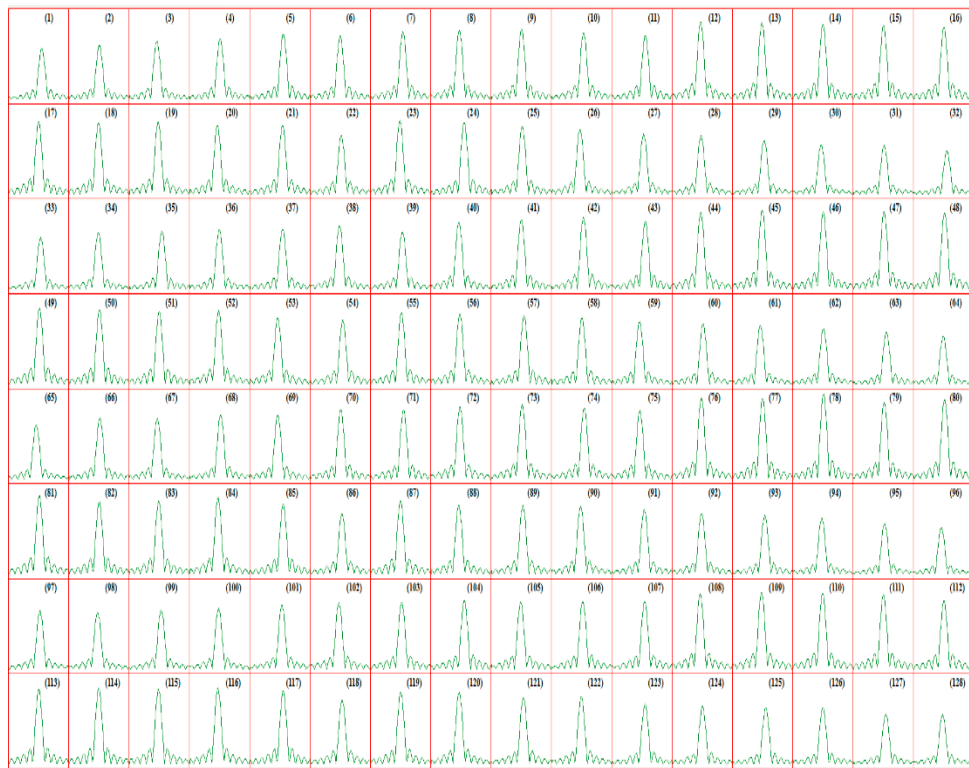


◆ Spectral resolution & ILS for LWIR of GIIRS





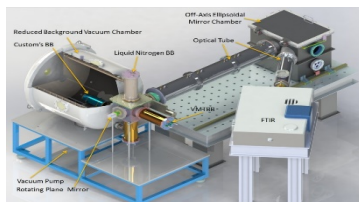
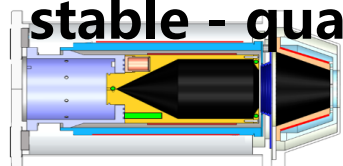
◆ Spectral resolution & ILS for MWIR of GIIRS



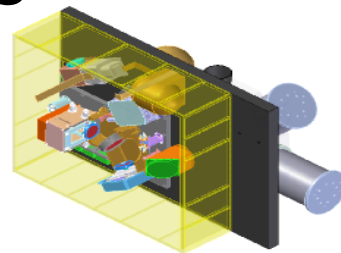
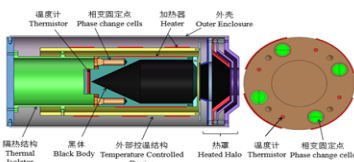


Space Radiometric Benchmark Reference of Infrared Spectral Segment

Remote sensing instruments must be accurate and stable - quantification of remote sensing data



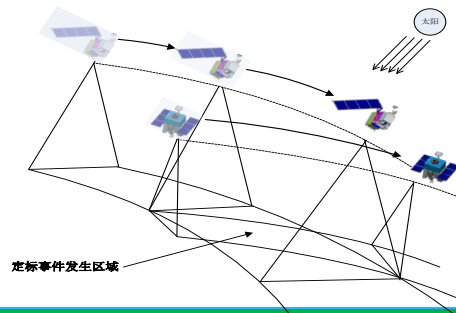
Infrared Radiometric Benchmark Reference Source



Space-borne Infrared Radometric Reference Payload

- On-orbit IR source
- SI trace in laboratory
- Traceable FTIR Prototype
- On orbit payload

**On-orbit calibration
Benchmark transmission**



Benchmark Reference Satellite





Key technologies for Infrared SI-traceability

- Key technologies for Infrared SI-traceability
 - Interferometer for space
 - Detectors
 - Temperature
- Standard Facility
 - miniature
 - SI benchmark transfer
- Radiance Temperature
 - Custom VTBB

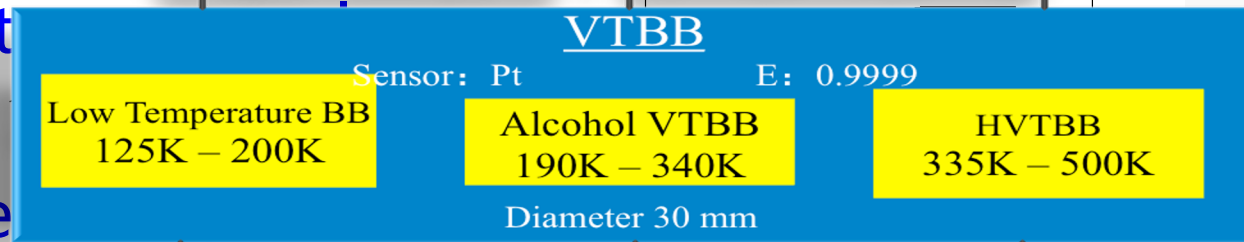
FP



FTIR
3 μm - 1000 μm

Radiation Thermometry
8 μm - 14 μm

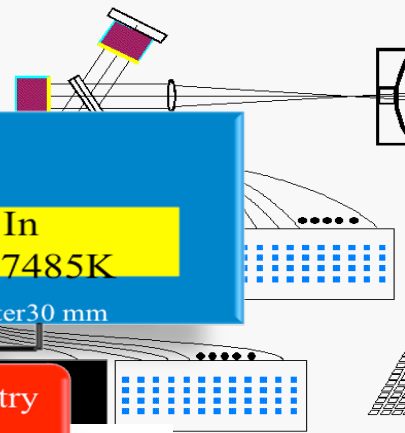
VTBB



FTIR
3 μm - 1000 μm

Radiation Thermometry
8 μm - 14 μm

Custom VTBB





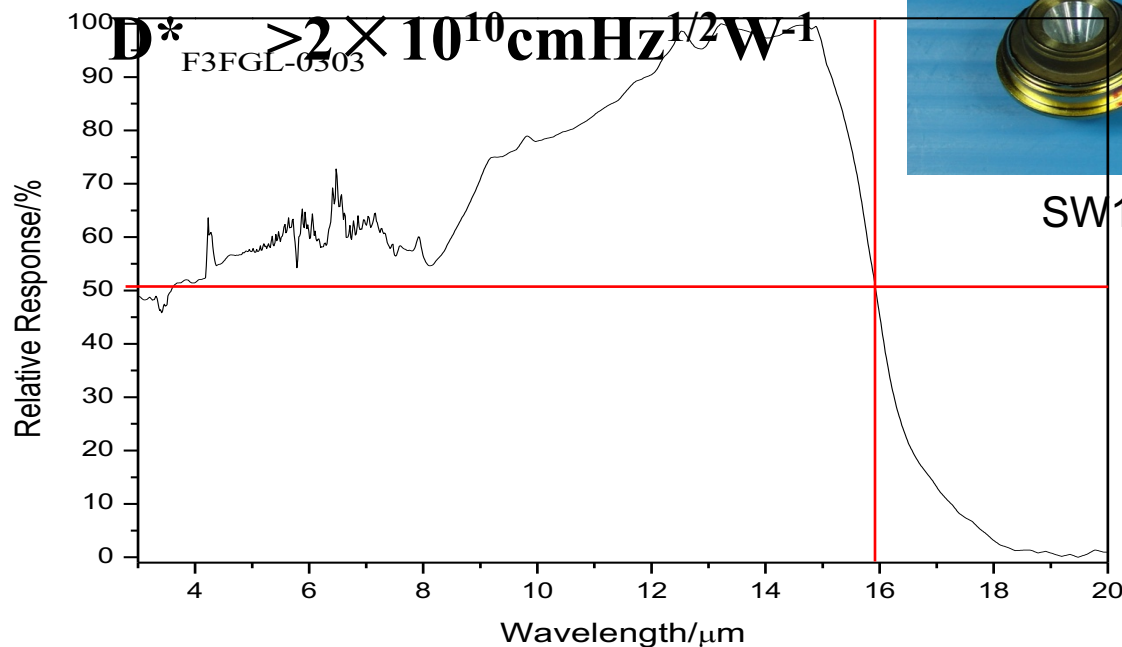
Infrared sensors

中国科学院上海技术物理研究所
SHANGHAI INSTITUTE OF TECHNICAL PHYSICS
CHINESE ACADEMY OF SCIENCES

Long Wave HgCdTe detector (6~15 μm)

Cut-off wavelength $>15.4\mu\text{m}@100\text{K}$, almost $16\mu\text{m}$

Size: $2.2\text{mm} \times 2.2\text{mm}$



SW1,

SW2,

MW,

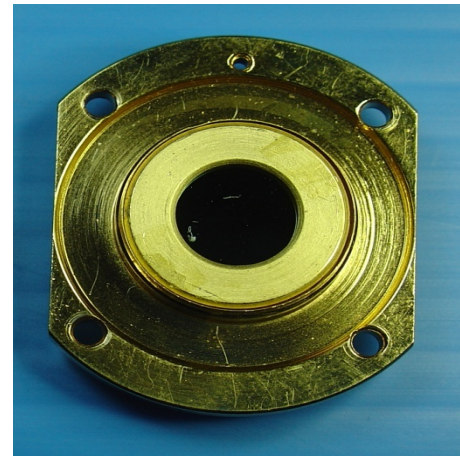
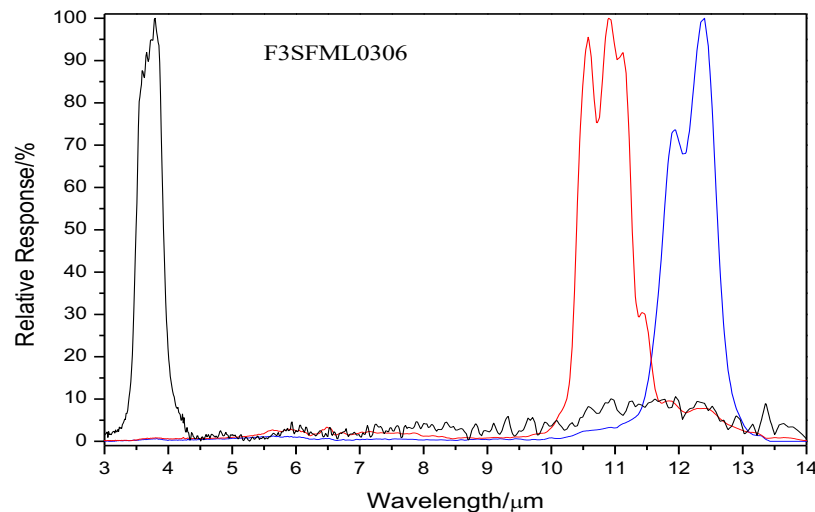
VLW



Infrared sensors

Space-borne Infrared detectors, Mercury Cadmium Telluride Detectors

⊙ MW and LW triple-band infrared detector assembly



Response spectra

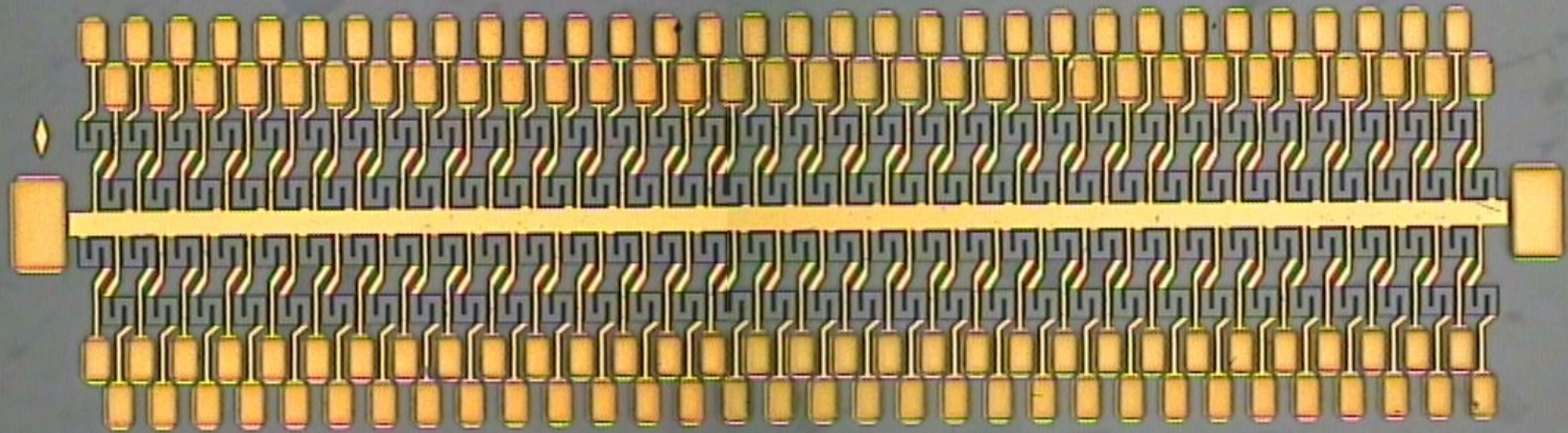
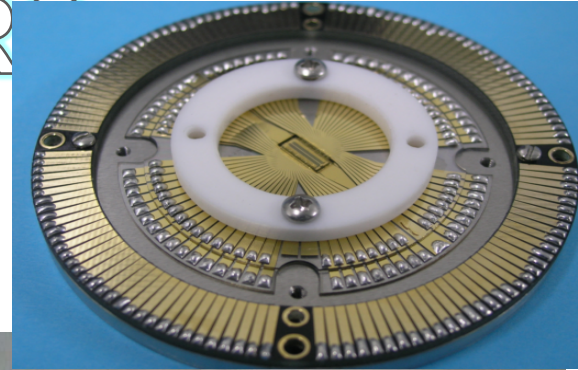
Photo of the assembly



Infrared sensors

- Long Wavelength detector: the cutoff wavelength is over 15 micron.
- Scale: 32×4

Detectors for FY4 GIIR





Optical Thin Films

中国科学院上海技术物理研究所
SHANGHAI INSTITUTE OF TECHNICAL PHYSICS
CHINESE ACADEMY OF SCIENCES

编号	星号	载荷名称	通道数	波段范围 μm	备注
FY	FY-1A/1B	多通道可见红外扫描辐射计MVISR	5/5	0.58-12.5	试验
	FY-1C/1D		10/10	0.50-0.99	业务
	FY-2A/2B	扩展的可见红外旋转扫描辐射计S-VISSR	6/6		试验
	FY-2C/2D/2E		8/8/8		业务
	FY-3A/3B	可见红外辐射计VIRR	10/10	0.40-12.5	试验
		红外大气探测仪IRAS	26/26	0.69-15.5	
		中分辨率光谱成像仪MERSI	20/20	0.40-12.5	
		TOU	6/6	0.309-0.361	
		SBUS	12/12	0.252-0.340	
		ERM	2/2	0.2-50	
	FY-3C	可见红外辐射计VIRR	10	0.40-12.5	业务
		红外大气探测仪IRAS	26	0.69-12.5	
		中分辨率光谱成像仪MERSI	20	0.40-12.5	
		TOU	6	309-361	
		SBUS	12	252-340	
		ERM	2	0.2-50	
HY	HY-1A	海洋水色和温度扫描仪COCTS	10	0.4-12.5	业务
		海岸区域成像仪CZI	4	0.4-0.9	
	HY-1B	COCTS	10	0.4-12.5	业务
		海岸区域成像仪CZI	4	0.4-0.9	

编号	星号	载荷名称	通道数	波段范围 μm	备注
Chang E	CE-1	IIM成像干涉分光计	32	0.40-1.0	业务
	CE-3	可见近红外成像光谱仪VNIS	2	0.45-2.4	业务
		极紫外成像仪EUV	1	0.034	
SHIJIAN	SHIJIAN-9A	高性能小相机	4	0.45-0.89	业务
	SHIJIAN-9B	长波红外相机LWIR Camera	4	8-12.5	业务
HJ	HJ-1A	宽视场CCD相机WVC	4	0.4-0.9	业务
	HJ-1B	宽视场CCD相机WVC	4	0.4-0.9	
		红外多光谱扫描仪IRMSS	4	0.7-12.5	
CBERS	CBERS-1	高分辨率CCD相机HRCC	5	0.4-0.90	试验
		红外多光谱扫描仪IRMSS	4	0.5-12.5	
		宽视场成像WFI	2	0.6-0.9	
	CBERS-2	高分辨率CCD相机HRCC	5	0.4-0.90	业务
		红外多光谱扫描仪IRMSS	4	0.5-12.5	
		宽视场成像WFI	2	0.6-0.9	
	CBERS-2B	HRCC	5	0.4-0.90	业务
		高分辨率全色相机HRPC	1	0.5-0.8	
		WFI	2	0.6-0.9	
		TAC (Three-line Array Camera)	1	0.5-0.8	
ZY-3A		MSC (Multispectral Camera)	4	0.4-0.9	试验

More than **60%** of optical filters and **90%** of infrared optical filters used in the space optical payloads launched by China were manufactured by SITP.

(Source: <https://directory.exported.org> / updated Dec.2014)

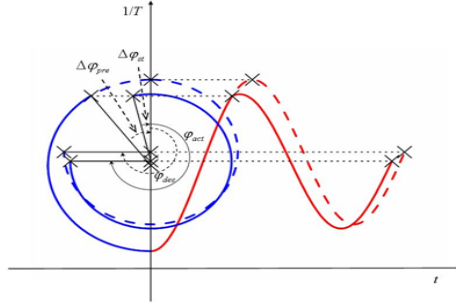


Optical Thin Films

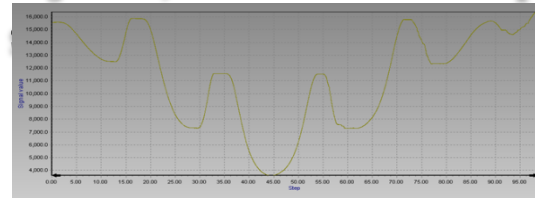
中国科学院上海技术物理研究所
SHANGHAI INSTITUTE OF TECHNICAL PHYSICS
CHINESE ACADEMY OF SCIENCES

Advanced Depositing Method & Better Spectrum Shape

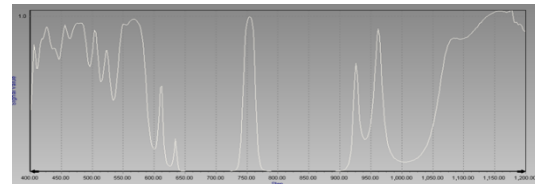
- Original monitoring method for depositing dielectric layers of quarter-wave and non-quarter-wave thickness, real-time thickness measurement, *in-situ* spectrum monitoring.
- Applied in several projects, such as band pass filter on FY-2 (Fengyun-II) F Satellite, and the



The schematic diagram of monitoring method

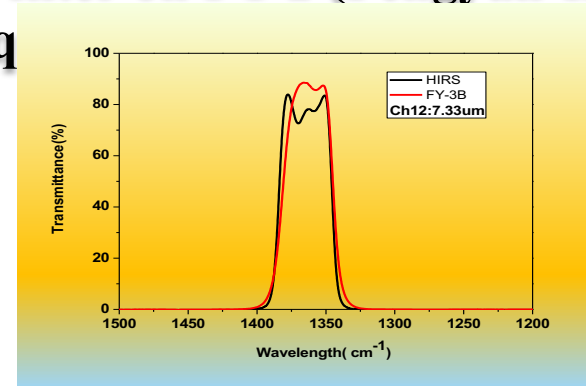


Monitoring curve



in-situ spectrum

req



Spectrum curves of an infrared filter for FY-3B by SITP and for HIRS by US

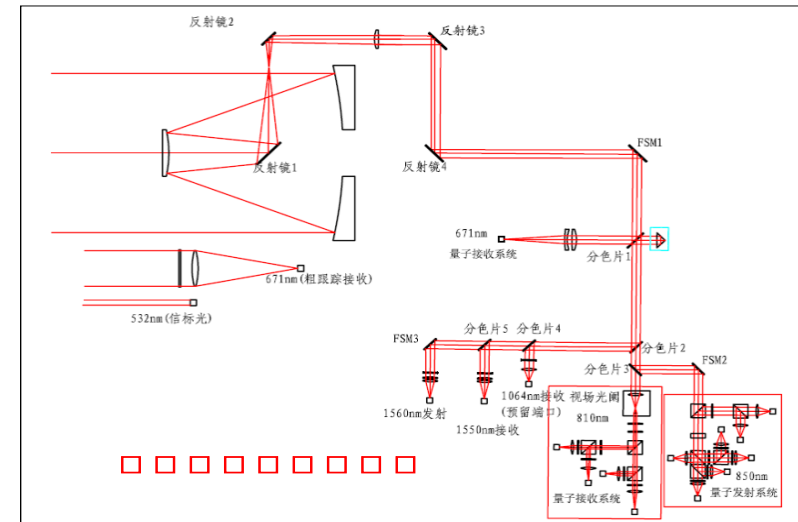


Optical Thin Films

中国科学院上海技术物理研究所
SHANGHAI INSTITUTE OF TECHNICAL PHYSICS
CHINESE ACADEMY OF SCIENCES

Polarization Modulation by Optical Films

Many IR optical elements are used in quantum teleportation system and optical communication field. Optical films are necessary to keep quantum state and select spectral signal.



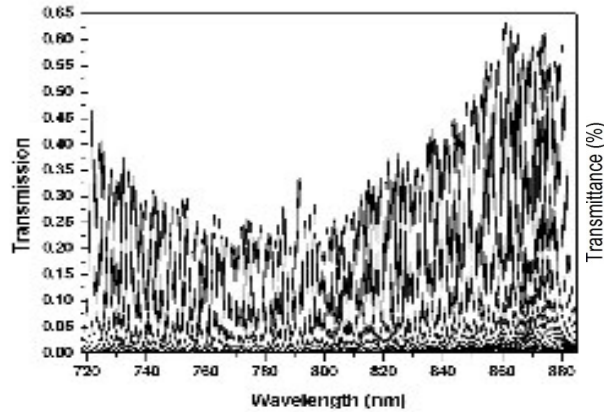
- polarization extinction ratio of film element 10000~5000: 1.
- polarization extinction ratio of system 200: 1.



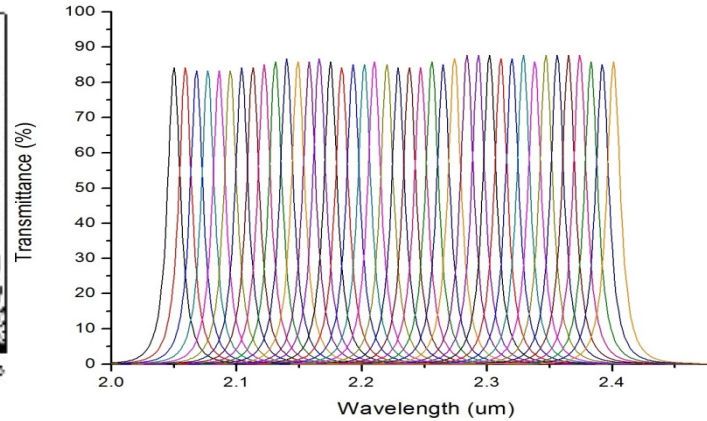
Optical Thin Films

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SHANGHAI INSTITUTE OF TECHNICAL PHYSICS
CHINESE ACADEMY OF SCIENCES

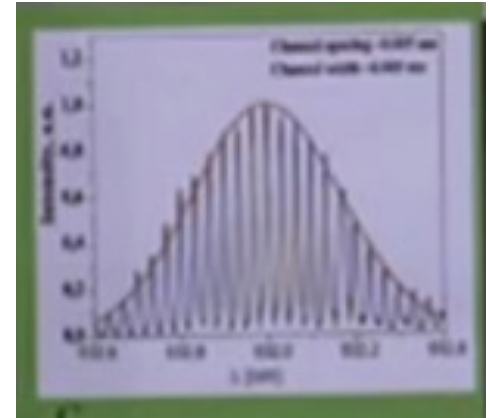
Researches on spectrum control of film in SITP



IBPF with 128×1 channels
(Fundamental research
in SITP)



IBPF with 40 channels
(Engineering research in
SITP)

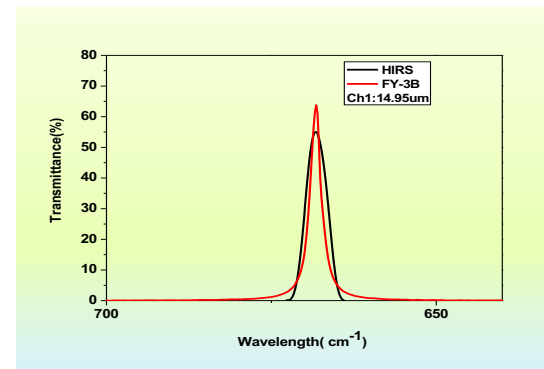
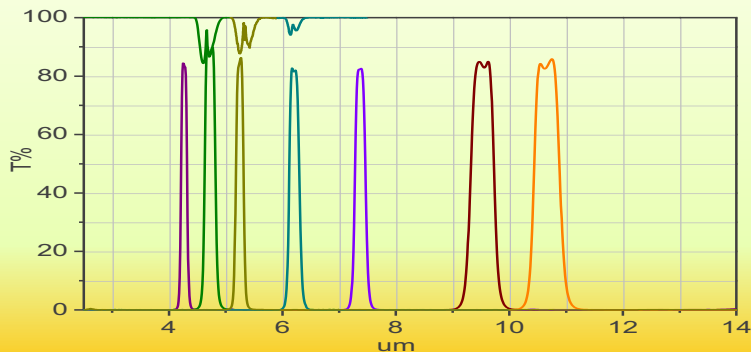


**Working spectrum of hand
type IR spectrometer**
(Research Project in Israel)

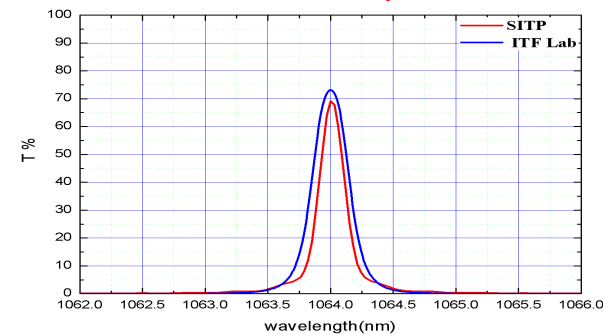


Infrared Narrow Bandpass Filter(IRNBF)

- FY-3B IRAS is the only one on-orbit remote-sensing apparatus with very long wave channel $14.95\mu\text{m}$ (669cm^{-1}) .
- SITP pioneers in very long wave NBF study



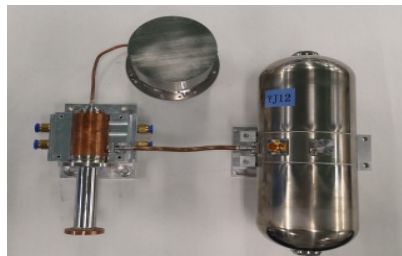
14.95um NBF by SITP



0.19nmFWHM NBF by SITP

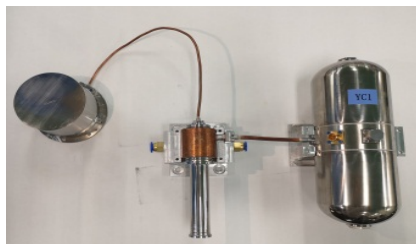
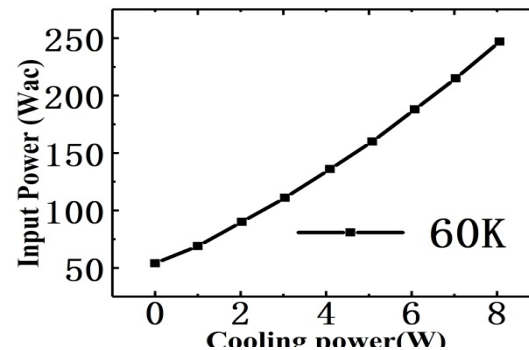


Cooler



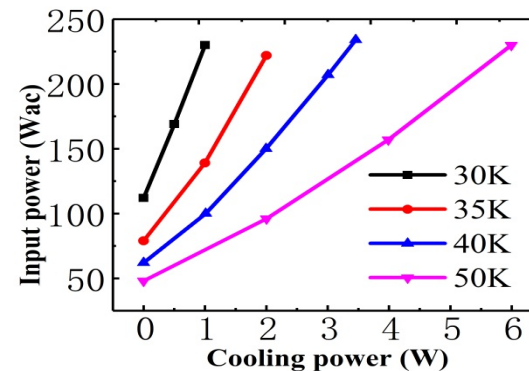
60K cryocooler

Normally performance:
6W@60K@188Wac
8.5kg



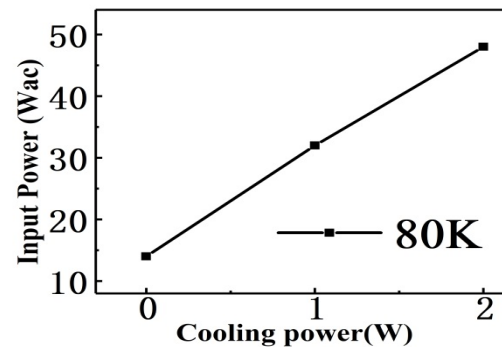
30~50K cryocooler

Normally performance:
2w@40K@ 150Wac
8.5kg



80K cryocooler

Normally performance:
1@80K@32Wac
1.3kg





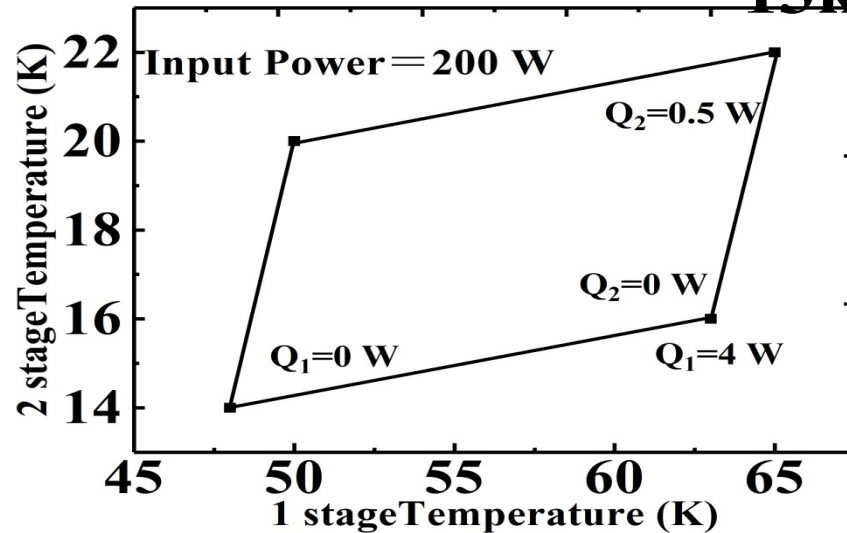
Cooler



Normally performance:

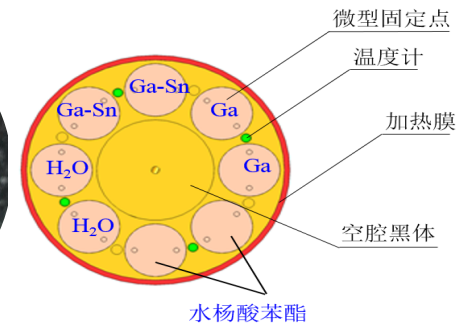
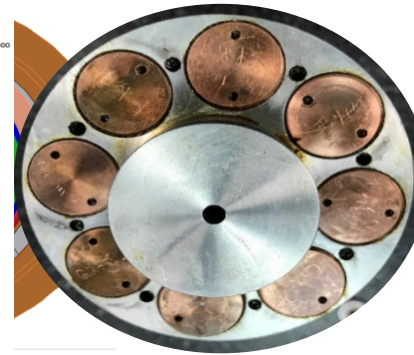
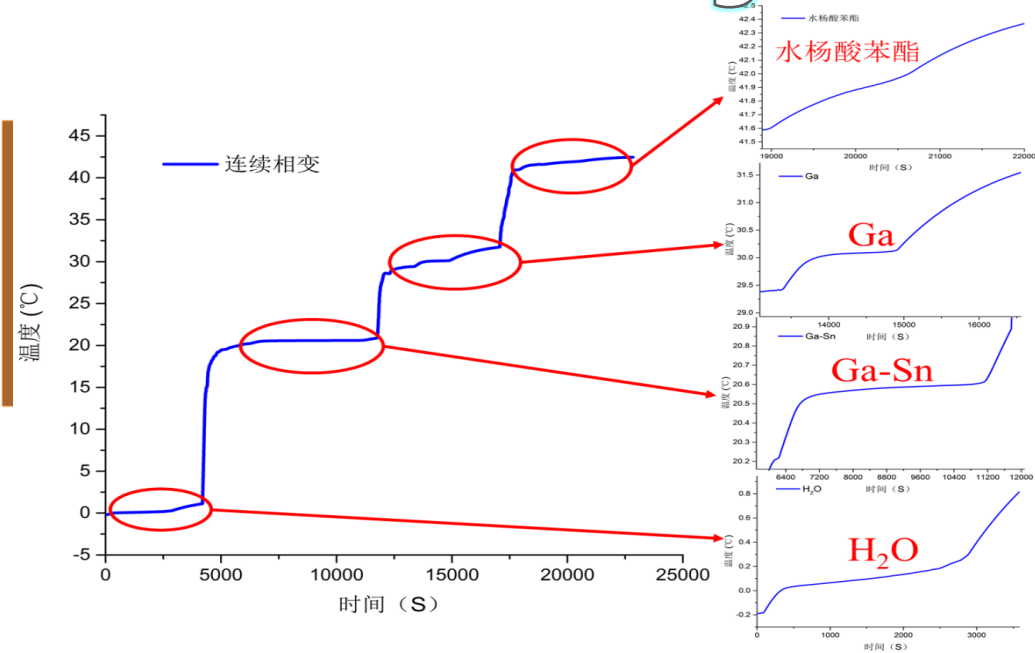
$0.5\text{W}@20\text{K}@200\text{Wac}$

13kg





Finished with supporting from National High-tech R&D Program



70K to 350K;

DT

Temperature Uncertainty
of the blackbody ≤ 84 mK
($k=2$)

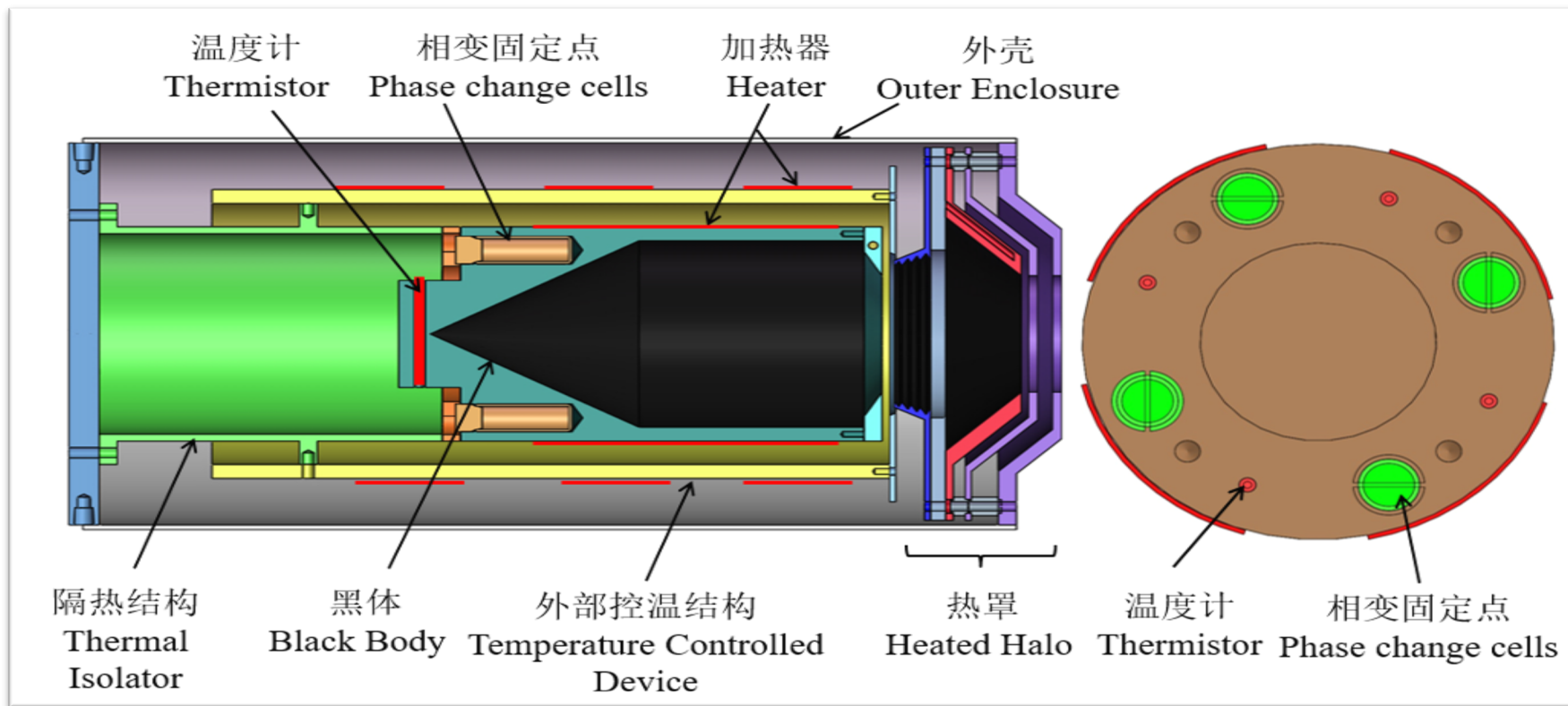
Phase change
fixed points,
stability ≤ 10 mK ($k=2$)

类别	H ₂ O	Ga-Sn	Ga	水杨酸苯酯
性能				
稳定性 (mK)	3.9	1.5	2.0	1.0
温坪值 (K)	273.339	293.779	303.262	315.137



On-orbit Blackbody

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SHANGHAI INSTITUTE OF TECHNICAL PHYSICS
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$$\tilde{I}_\lambda = \varepsilon_\lambda L_\lambda(T_{bb}) + (1 - \varepsilon_\lambda) I_\lambda(T_{bg})$$

$$I_\lambda(T_{bg}) = FL_\lambda(T_{halo}) + (1 - F)L_\lambda(T_{bg})$$

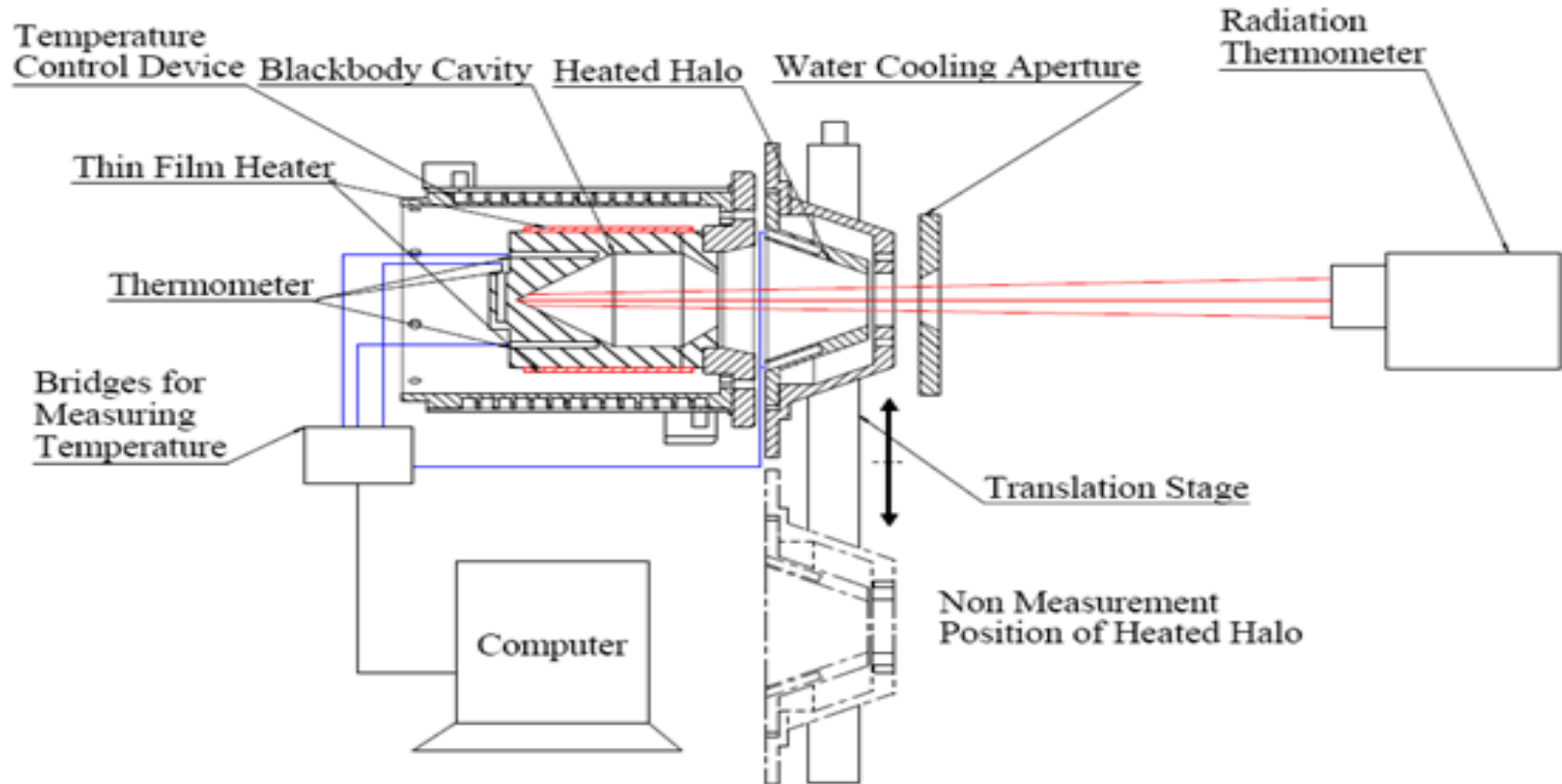
$$\varepsilon_\lambda = \frac{\tilde{I}_\lambda - I_\lambda(T_{rm})}{B_\lambda(T_{bb}) - I_\lambda(T_{rm})}$$



On-orbit Blackbody

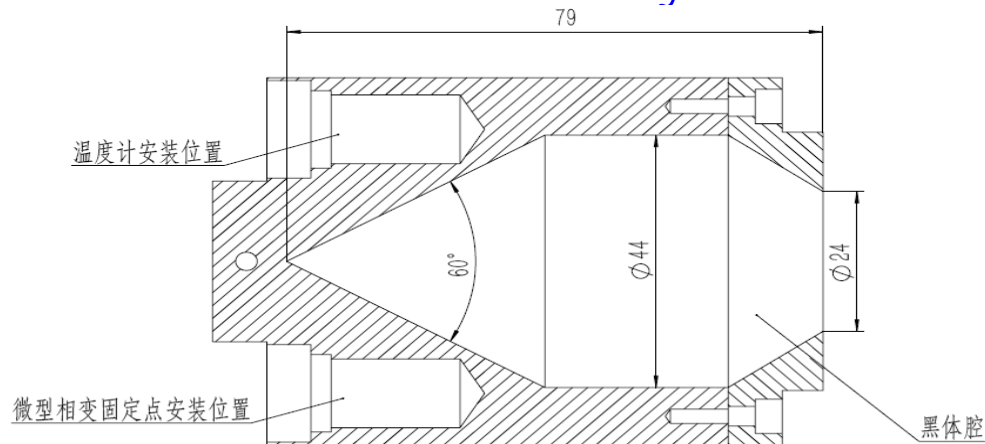
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CHINESE ACADEMY OF SCIENCES

Facility





Simulation Emissivity



STEEP3 0.9970

Material	Al
Diameter of cavity	44 mm
Diameter of Aperture	24 mm
Depth	79 mm
Angle	60°
E of coating	0.92



On-orbit Blackbody

中国科学院上海技术物理研究所
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Result

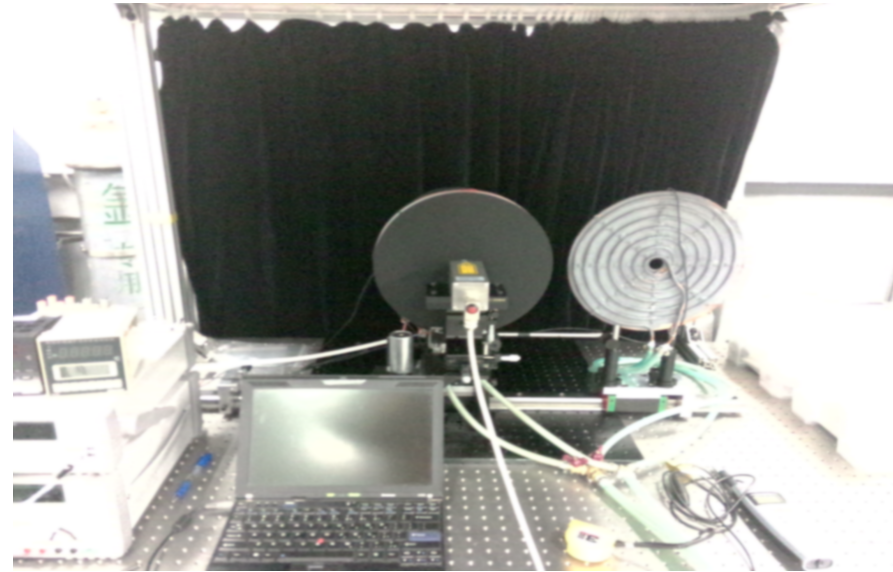
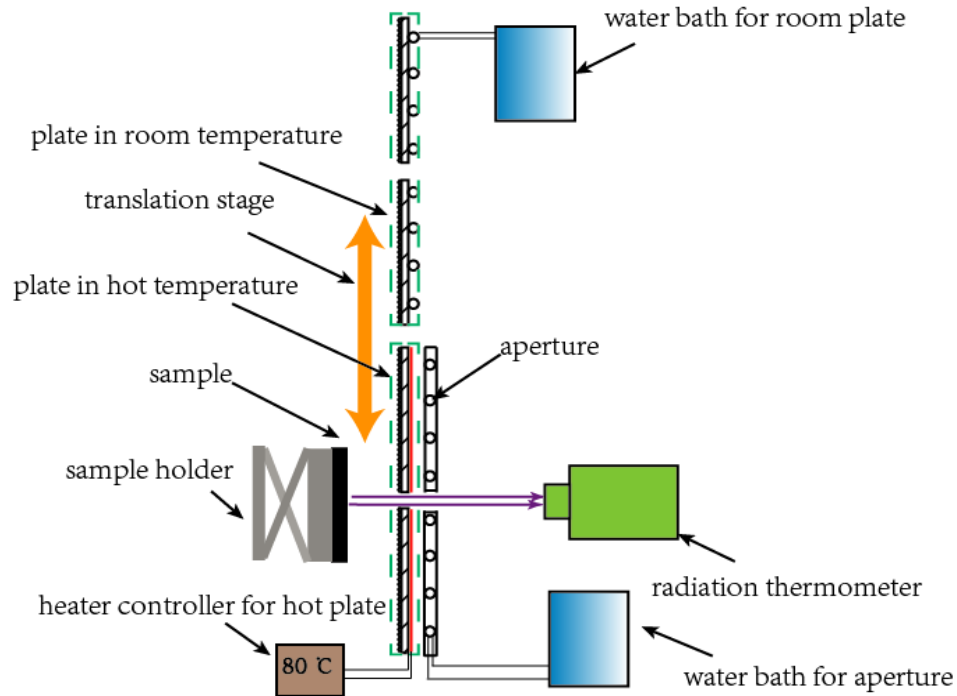
DATE	BB T (K)	HH T (K)	Diff HH BB (K)	A T (K)	RT T (K)	E
2014/11/6	305.09	364.34	59.25	299.25	305.40	0.9963
	303.60	379.28	75.69	299.65	304.04	0.9955
2014/11/5	303.01	347.24	44.24	299.55	303.45	0.9958
	303.39	363.31	59.92	300.15	303.87	0.9959
	305.92	381.65	75.73	300.45	306.33	0.9958
2014/11/4	302.95	347.01	44.06	300.05	303.38	0.9962
	303.22	379.06	75.85	299.85	303.70	0.9951
2014/10/17	301.36	361.38	60.02	295.85	301.55	0.9967
2014/10/15	301.86	359.91	58.05	295.75	301.97	0.9974
2014/10/14	294.33	356.93	62.60	294.75	294.46	0.9965
平均值						0.9961
标准差						

10 times measurements during 20 days. The average of E is 0.9961, SD 0.07 %。



On-orbit Blackbody

Facility

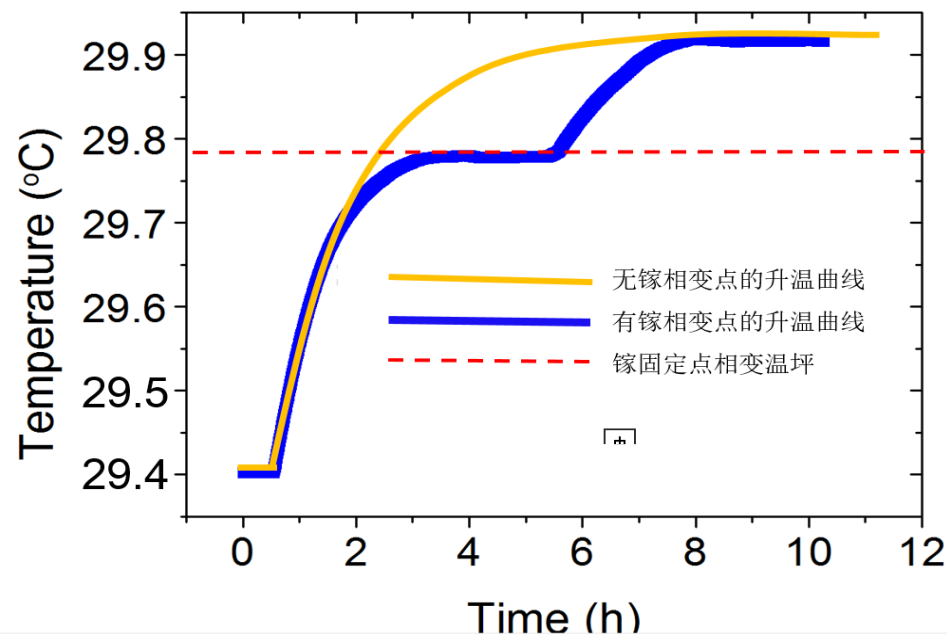




Miniature Fixed Point

Fixed points are used to define the ITS-90.

The miniature fixed points as the standard are used to calibrate the thermometers working on the on-orbit blackbody.





On-orbit Blackbody

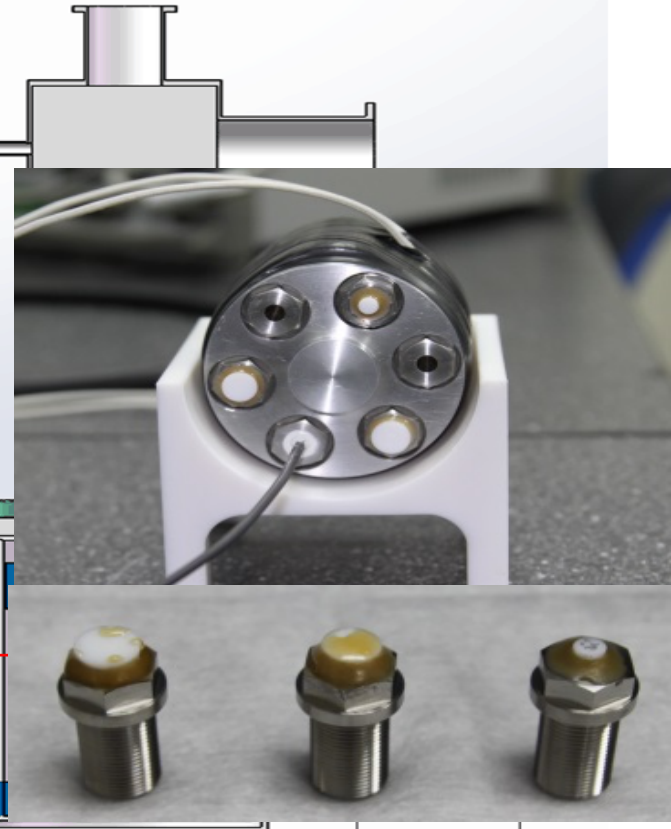
Facility

Digital
multimeter



source

Small-size fixed



微型固定点测量装置剖面图

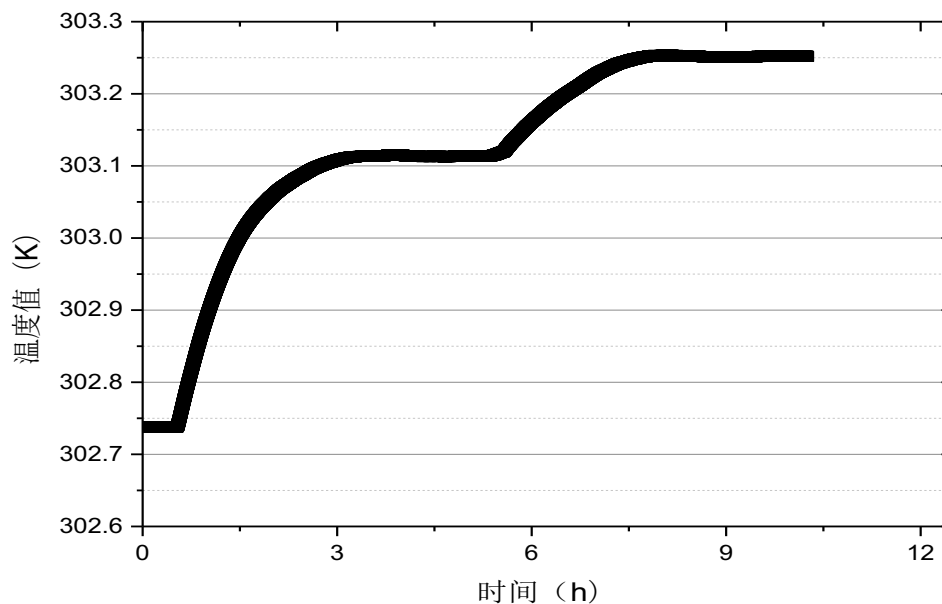


Ga miniature fixed point

The bath keep at 302.75 K. Heat the cavity with 0.1W

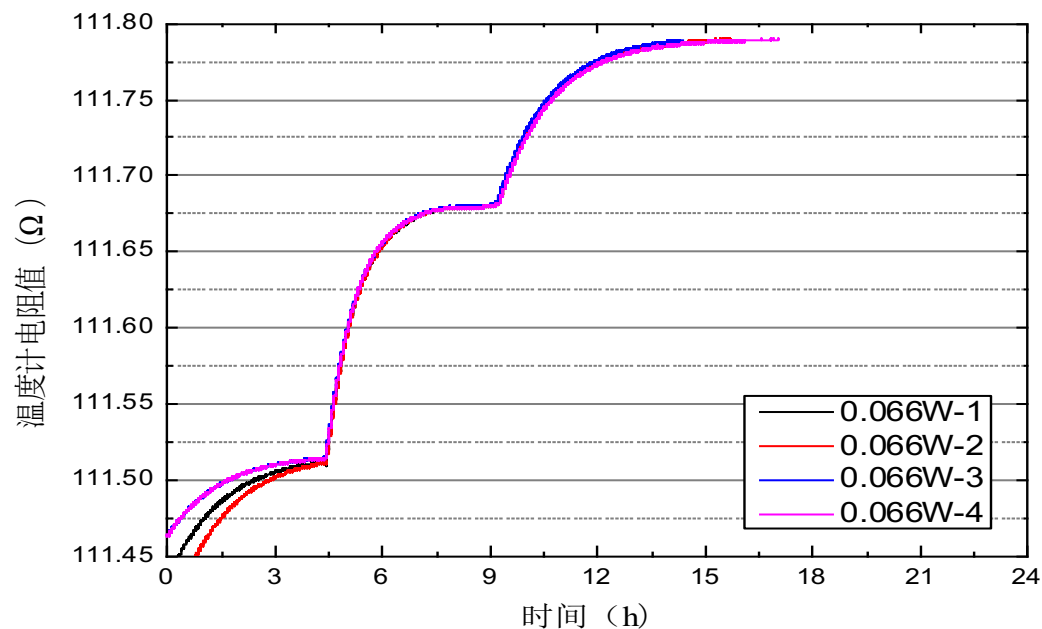
Platform 2 h

Melting point at 303.113
with SD 1 mK.





Ga fixed point repeatability at same condition



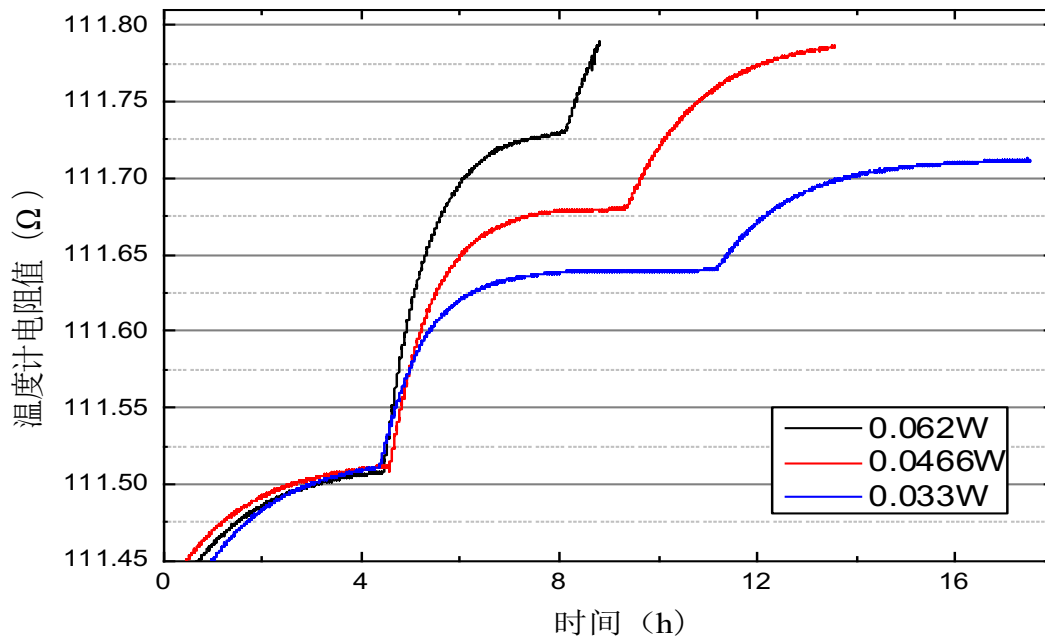
Dates	
2015/4/25	303.218
2015/4/27	303.219
2015/5/5	303.220
2015/5/8	303.218
Average	303.219
SD	1.2mK



The curve of melting at different power

The bath keeps at 302.75 K, the power of cavity heater is 0.066 W, 0.0466 W and 0.033W

Ga melting point temperature
(111.573 K)。



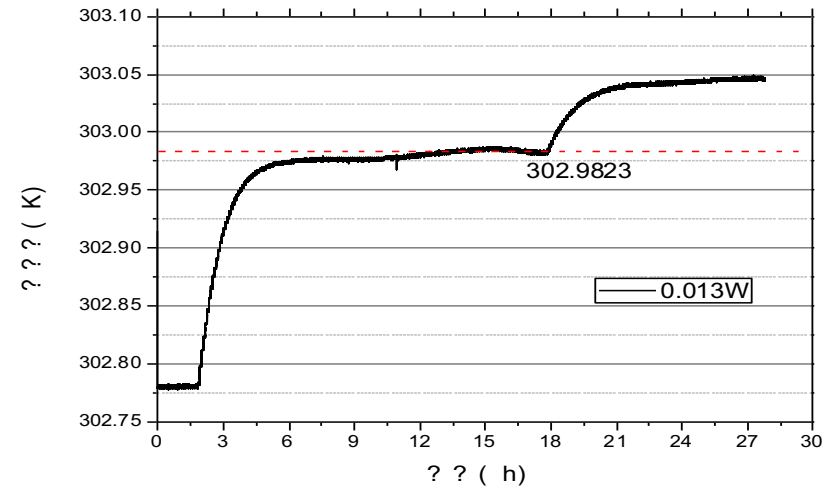
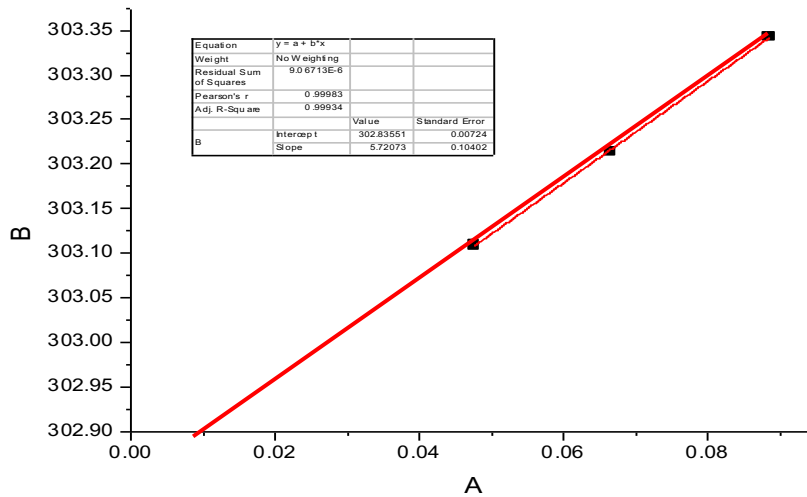


2. On-orbit blackbody

Formula: $T = 302.8355 + 5.72073 \times P$

Between the temperature and power. P is the power

From this formula, the melting point is 302.9825K when the power is 0.0013 W





Supported by National Key R&D Program of China

Spectral range	600 cm⁻¹ ~2700cm
Spectral resolution	Better than 0.5cm ⁻¹
IFOV	17km
Sensitivity	0.1K@270K
Uncertainty	≤0.2K (<i>k</i> =2) spectrometer: ≤0.085K (<i>k</i> =1) blackbody: ≤0.050K (<i>k</i> =1)
emissivity	> 0.999
Diameter of blackbody	60mm
Temperature range	250-330K
No. of fixed points	3 -4
Uncertainty of emissivity	≤4*10 ⁻³
Reproducibility of Ga	≤10mK
Precision of data preprocessing	2nm 0.2K



Research objectives

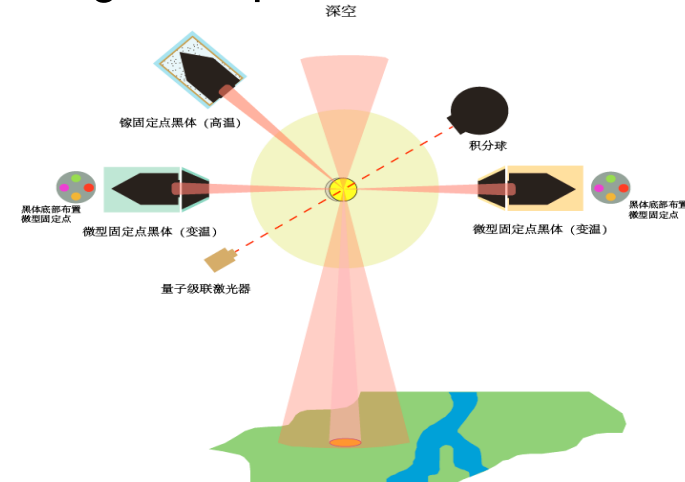
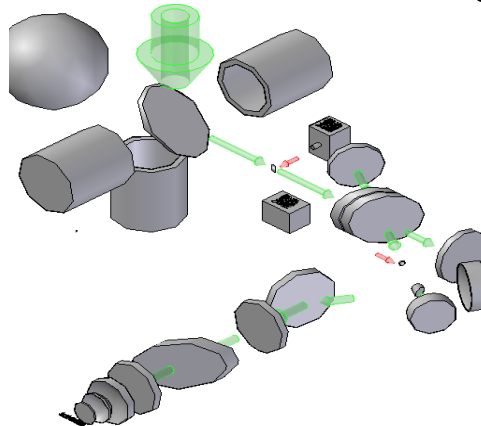
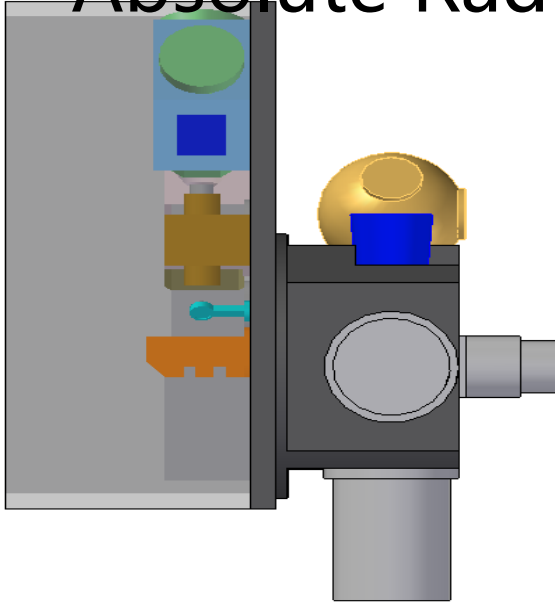
中国科学院上海技术物理研究所
MUSAT INSTITUTE OF TECHNICAL PHYSICS
CHINESE ACADEMY OF SCIENCES

- Solving the benchmark reference problem of space radiation observation for climate change research.
- Developed an infrared radiation benchmark reference prototype with absolute calibration uncertainty less than 0.2K ($k=2$).
- Breaking through the problem of the value transfer on-orbit of the phase change fixed-point.
- Breaking through higher performance Fourier infrared spectroscopy



SI tracable IR payload

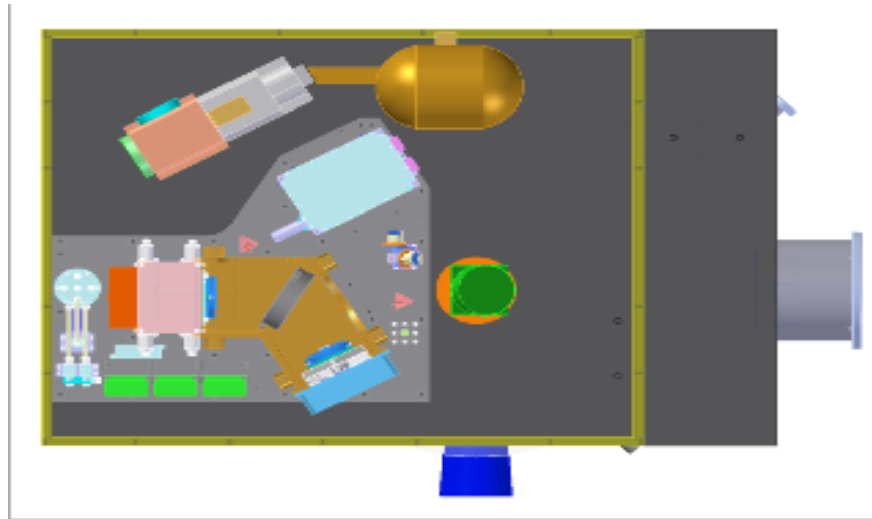
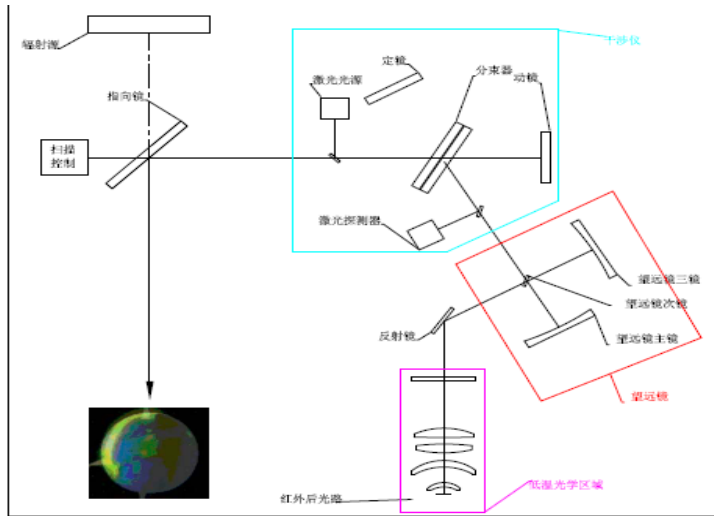
- Fourier interferometer
- IR telescope
- Cooled MCT
- Absolute Radiance blackbody
- SI tracable
- Higher spectral resolution
- Higher accuracy
- Higher sensitivity
- Higher stability
- High temporal resolution





hyperspectral sounder as transfer

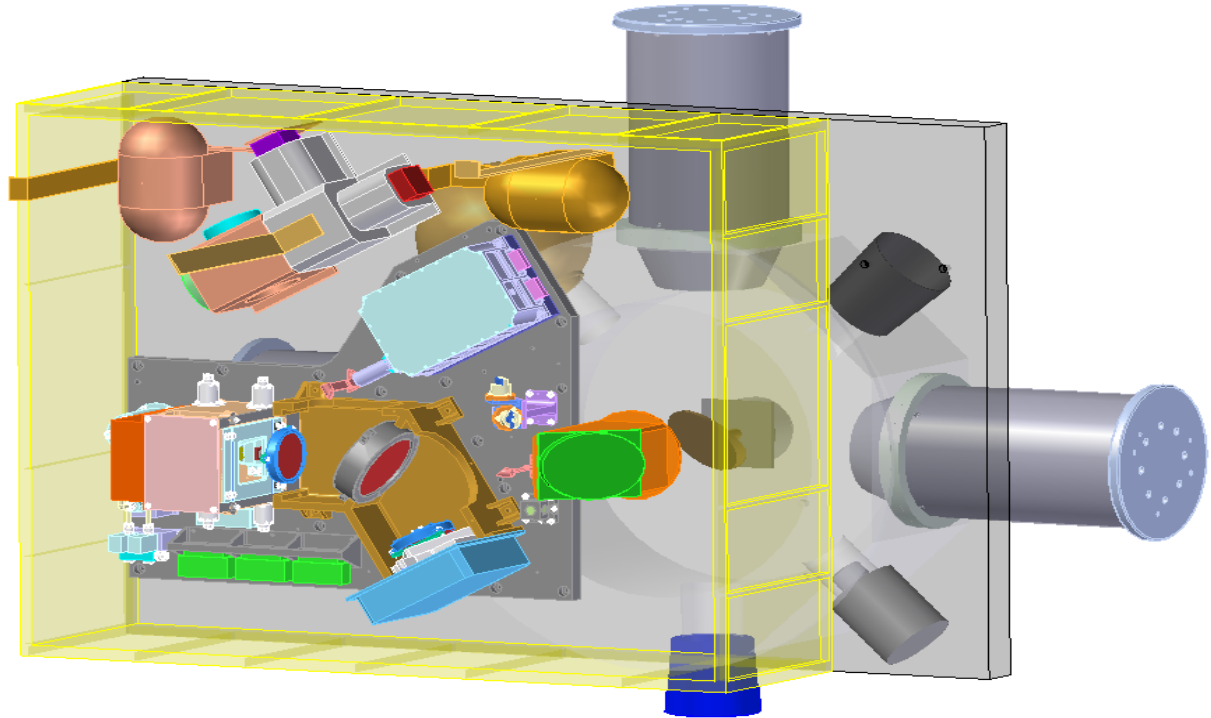
High-precision infrared hyperspectral sounder,
uncertainty 0.085K ($k=1$)





hyperspectral sounder as transfer

High-precision infrared hyperspectral sounder,
uncertainty 0.085K ($k=1$)

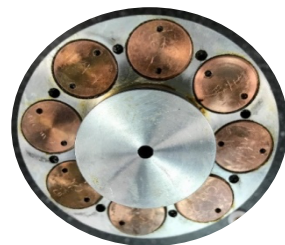
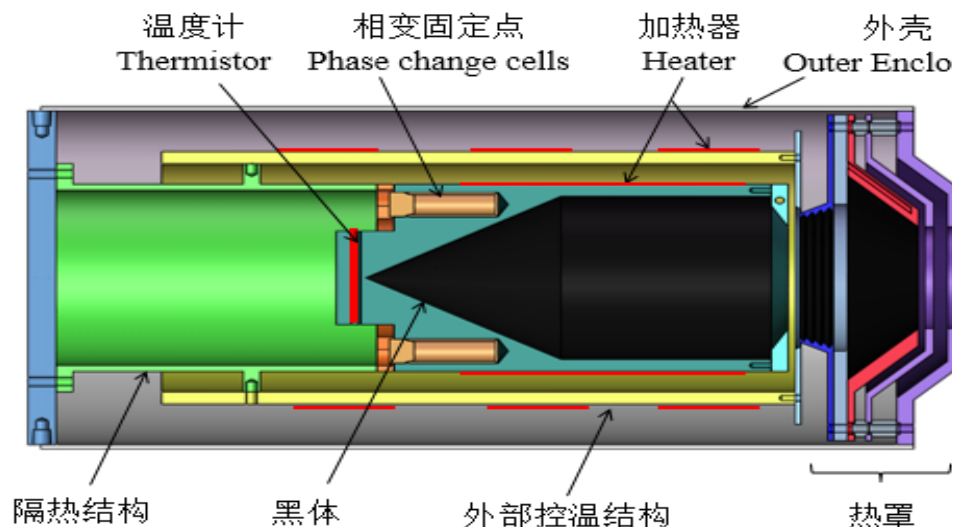




Mini fixed point used

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SHANGHAI INSTITUTE OF TECHNICAL PHYSICS
CHINESE ACADEMY OF SCIENCES

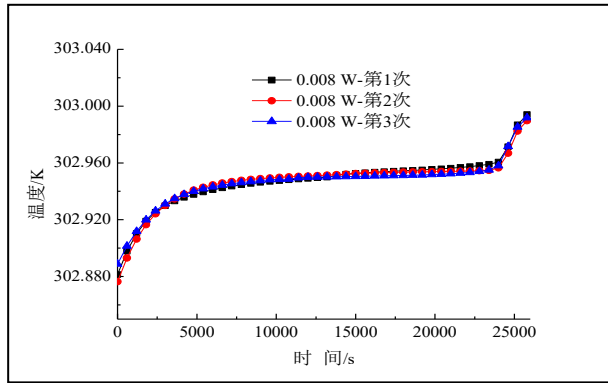
Quantitative traceability technology and international comparison



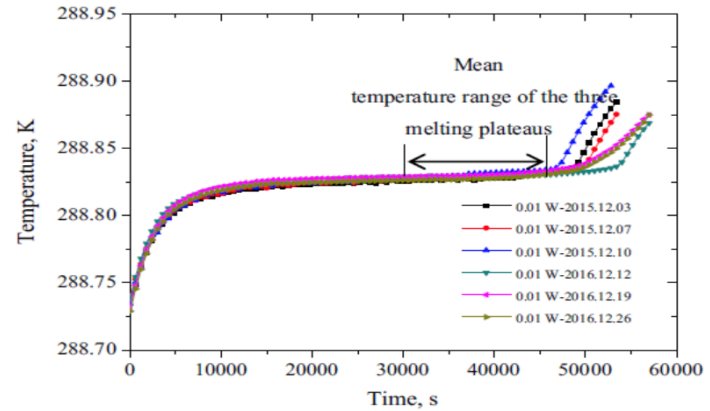
Miniature phase change gallium fixed point variable temperature space reference black body



Phase change cells' stability testing has been carried out



Miniature Ga phase change cell

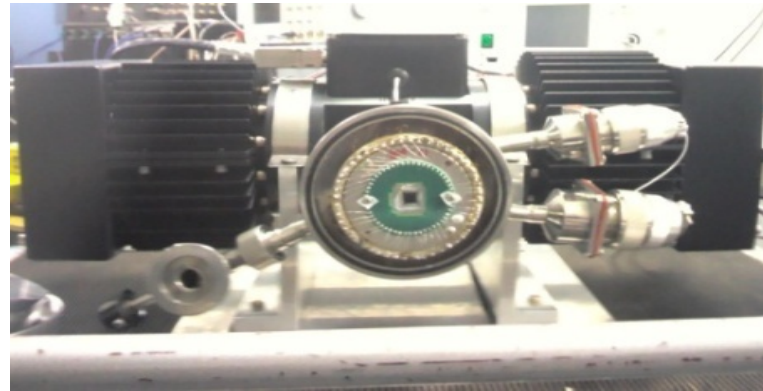
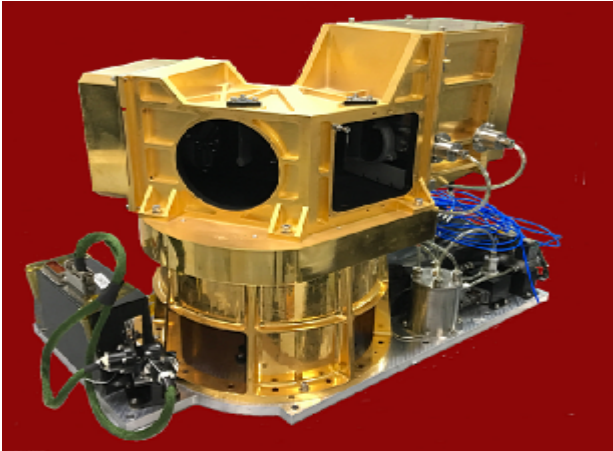
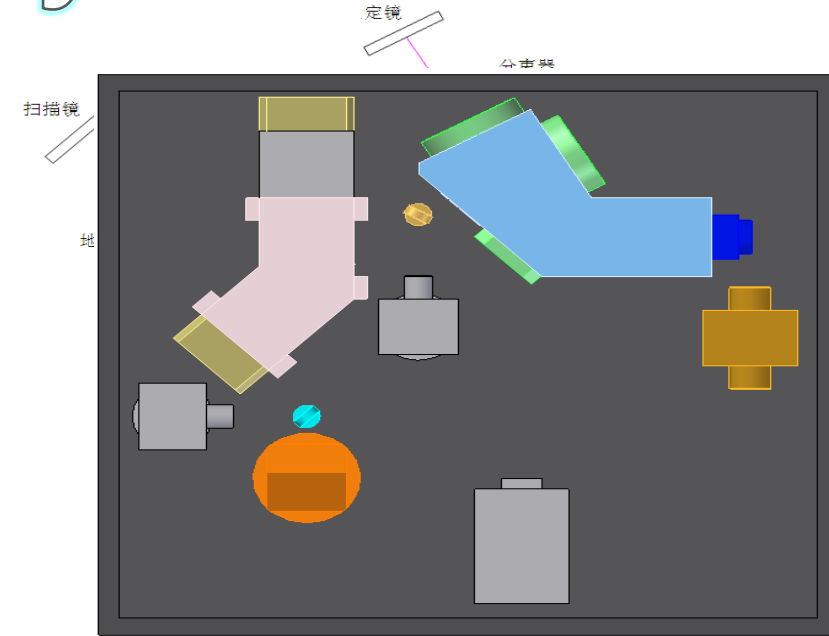


Miniature Ga-In phase change cell



SI tracable IR payload

- Foreward interferometer
- 0.5cm^{-1} resolution ($\pm 10\text{mm}$)
- $0.852\text{ }\mu\text{m}$ diode laser for interferogram sample control
- $< 1\text{ppm}$





SI tracable IR payload

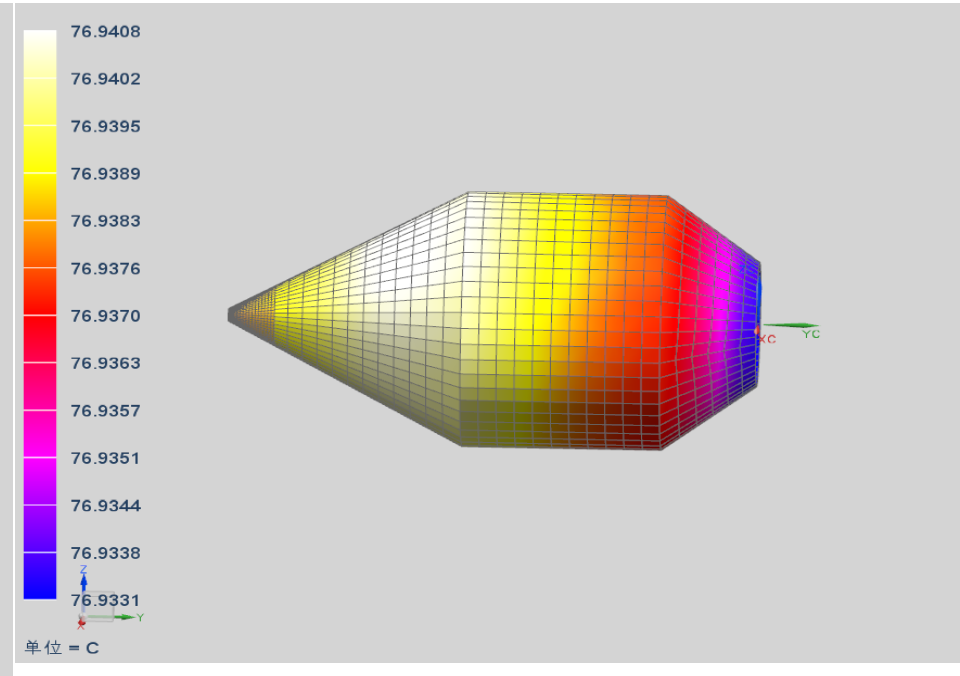
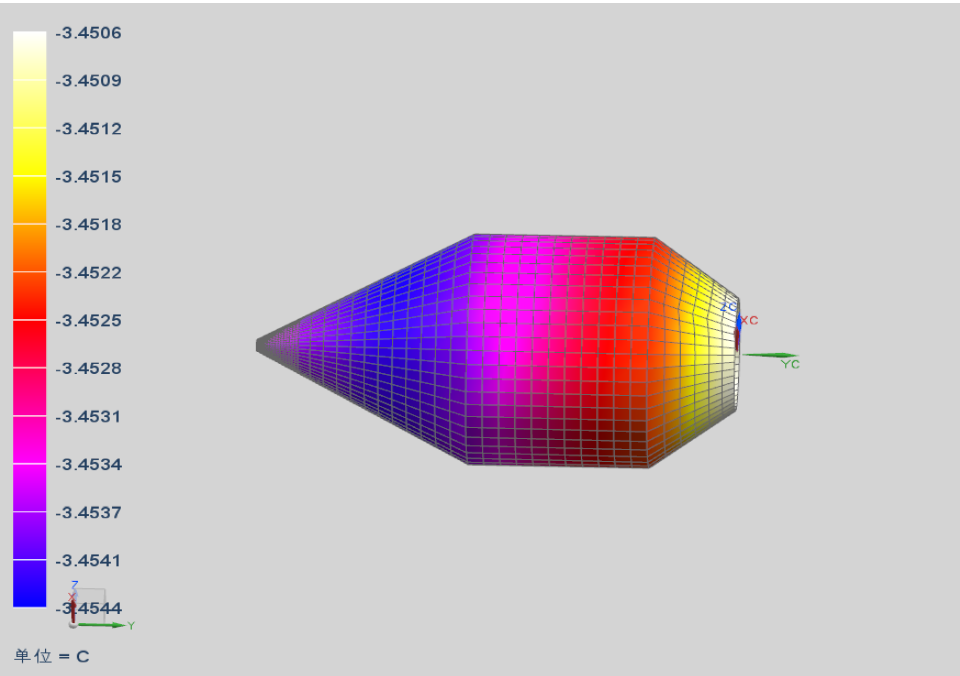
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OF TECHNICAL PHYSICS
INSTITUTE OF SCIENCES

黑体辐射源10 μ m 亮度温度不确定度评定 (20 $^{\circ}$ C 环境温度)

不确定度来源				对输出量贡献, $^{\circ}$ C					
因素		数值	包含因子 k		0	20	50	80	
腔底温度	温度计溯源	0.050 $^{\circ}$ C	2	u_{11}	0.025	0.025	0.025	0.025	
	微型相变固定点复现性	0.010 $^{\circ}$ C	2	u_{12}	0.005	0.005	0.005	0.005	
	控温稳定性	0.010 $^{\circ}$ C	2	u_{13}	0.005	0.005	0.005	0.005	
	温度均匀性	0.060 $^{\circ}$ C	2	u_{14}	0.030	0.030	0.030	0.030	
	电阻或热电势测量	100ppm	2	u_{15}	0.014	0.016	0.018	0.018	
	合成			u_1	0.042	0.043	0.044	0.044	
空腔发射率0.997 +/-0.002		0.002	1.73	u_2	0.024	0.0000	0.032	0.056	
环境温度		2 $^{\circ}$ C	1.73	u_3	0.0000	0.0000	0.0000	0.0000	
合成标准不确定度				u_c	0.057	0.046	0.057	0.073	
扩展不确定度 ($k=2$)					0.112	0.092	0.114	0.146	



SI tracable IR payload



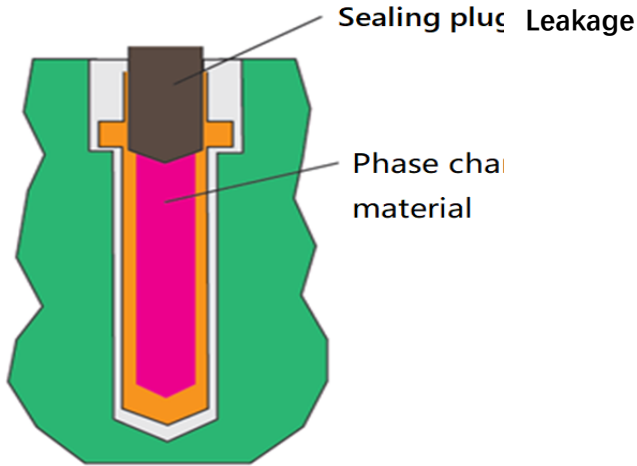
non-uniformity 0.004K at 270K;
non-uniformity 0.007K at 350K;



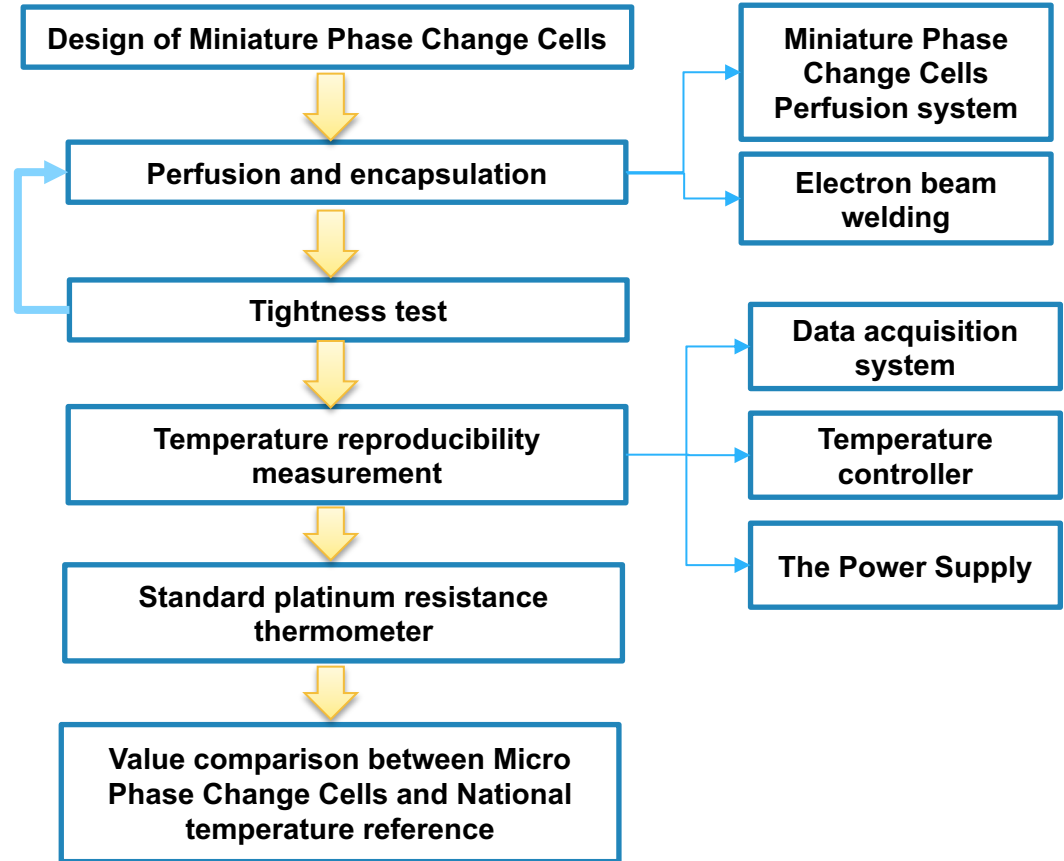
SI tracable IR payload

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INSTITUTE OF TECHNICAL PHYSICS
CHINESE ACADEMY OF SCIENCES

- Development of Phase Change Cells



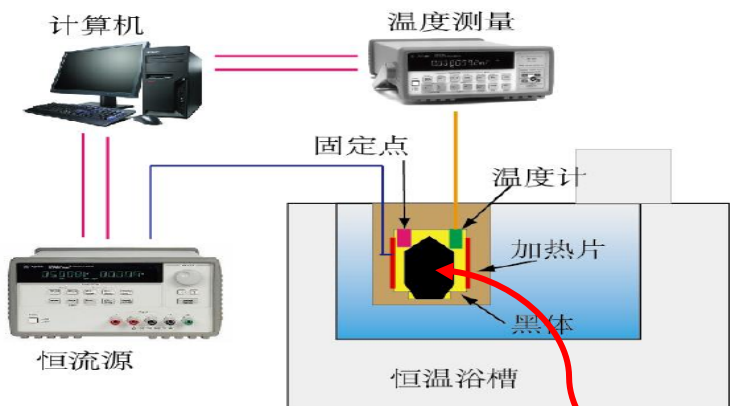
Miniature Phase Change Cell



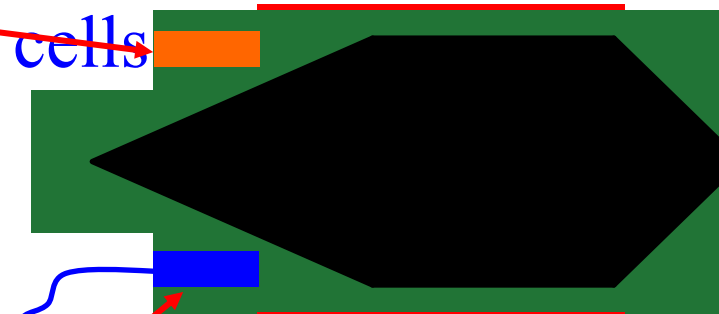
Development of micro phase change cells



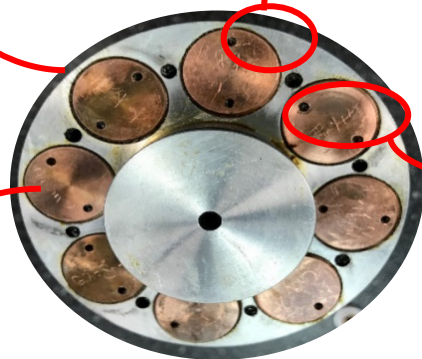
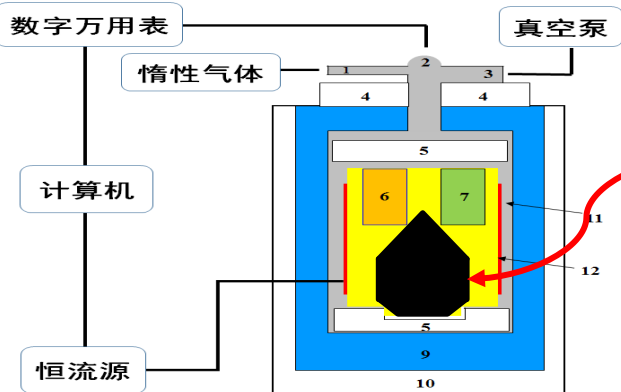
SI tracable IR payload



Phase change cells



(1)



Pt



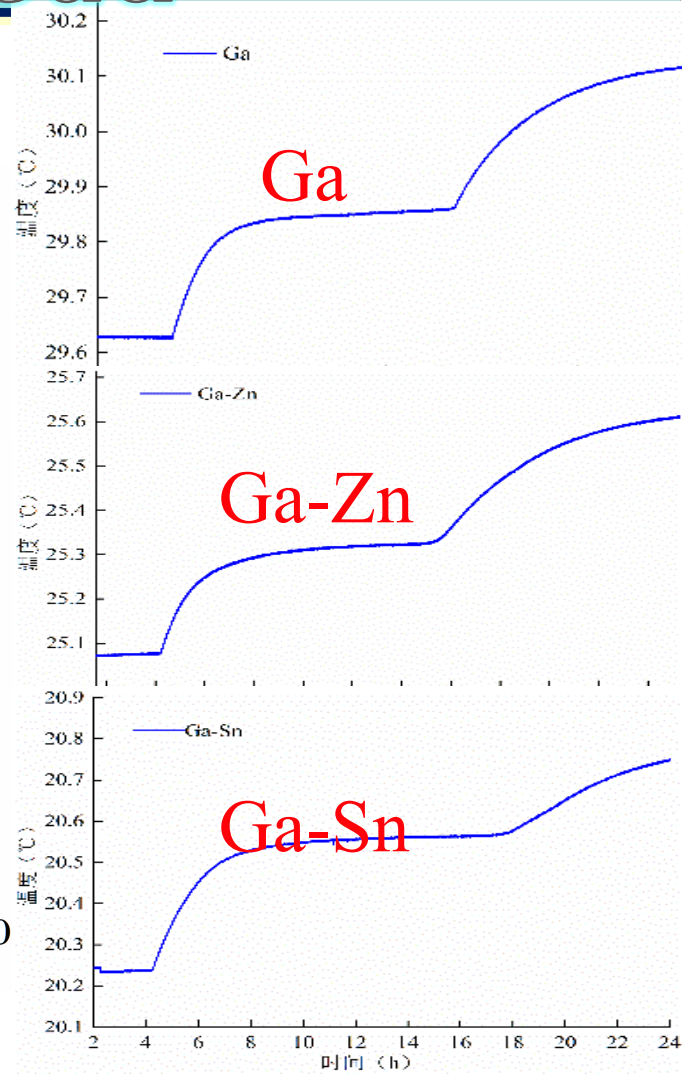
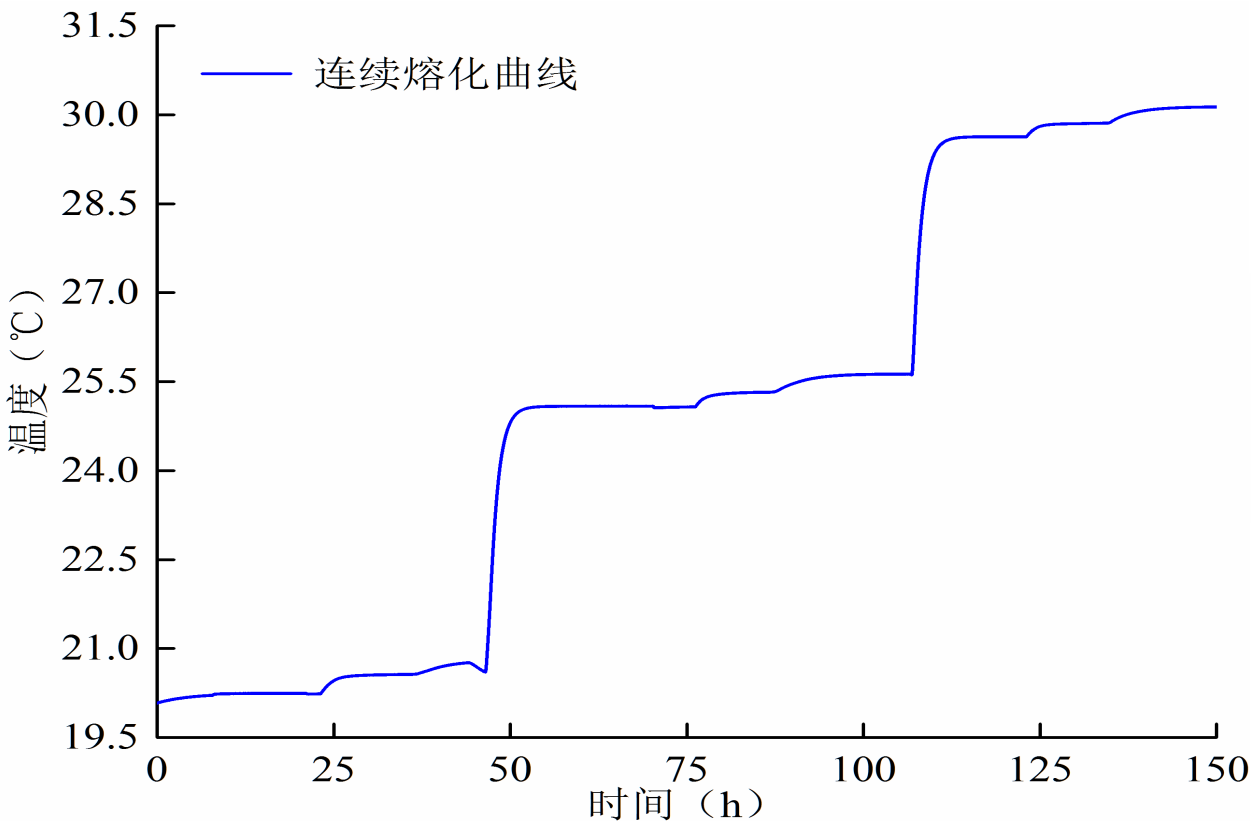
Cavity BB

(2)



SI tracable IR payload

Cells tested



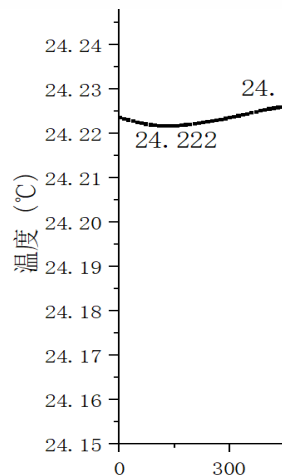
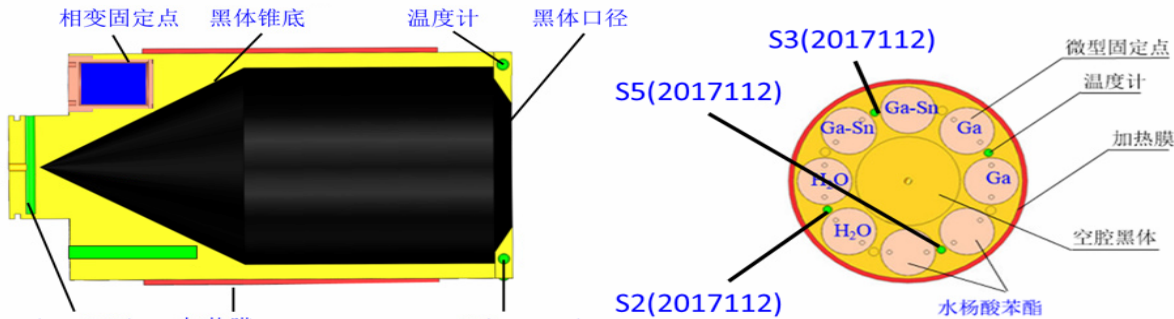


SI tracable IR payload

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INSTITUTE OF TECHNICAL PHYSICS
CHINESE ACADEMY OF SCIENCES

BB tested

Stability

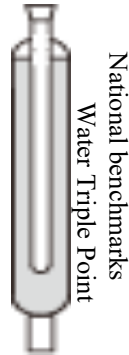
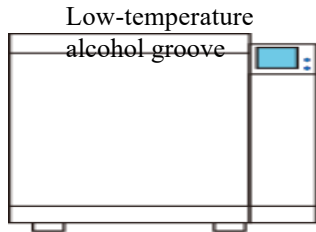
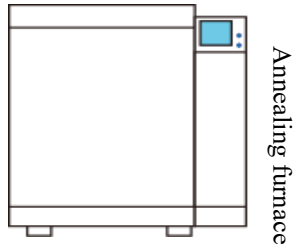
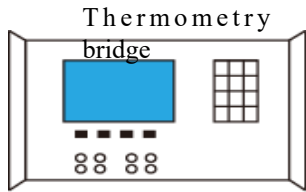


温度点 (°C)		温度点 (K)	日期	空腔底部均匀性 (mK)		空腔轴向均匀性 (mK)		稳定性 (mK)								
-5		268.15	2018.01.13	4		38		3.5								
10		283.15	2018.01.15	4		20		4.1								
			2018.01.19	4		18		2.5								
25		298.15	2018.01.16	6		7		3.4								
35		308.15	2018.01.17	8		13		2.4								
45		318.15	2018.01.18	8		25		1.9								
58		331.15	2018.01.12	11		26		2.4								
			2018.01.18	11		27		2.9								
600 900 1200 1500 时间 (S)			S6(2017097)		-4.762		9.930		24.624		34.422		44.221		57.570	



SI tracable IR payload

Stability of the thermometer



Test Methods: Precision platinum resistance thermometer placed in a temperature annealing furnace (150At °C) annealing from about 2h /Times, by accurately measuring the temperature of the bridge at the triple point of water Resistance thermometer R_{tp} ; Then place it into -80Alcohol °C of the bath to about annealed 2h /Times, and then measured in the temperature measuring bridge triple point of water Resistance thermometer R_{tp} . Upper and lower limits for the heat treatment after a heating cycle, thermal cycling of the thermometer by multiple triple point of water R_{tp} Precision measurements to calculate the stability of platinum resistance thermometer.

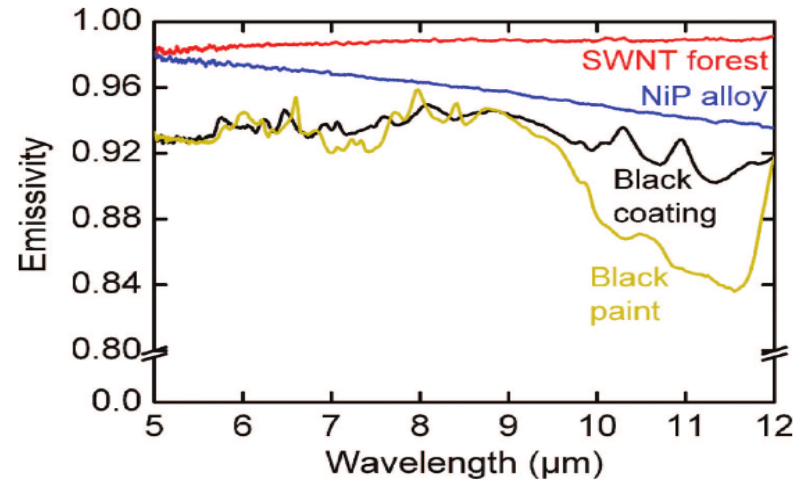
data processing: Multiple triple point of water Resistance thermometer R_{tp} Measurements to calculate the standard deviation.

time	R_{tp}/Ω	
	2017078	2017073
2017.04.18	99.95399	99.79355
2017.10.19	99.94917	99.79591
2018.01.11	99.95041	99.79589
2018.01.19	99.94864	99.79627
average value/ Ω	99.95030	99.79541
standard deviation/mK	4.8	3.1



SI tracable IR payload

Spectral Emissivity will be under study



波长范围

- 3.7-16.7 μm
- 无波长特征

发射率

- 0.999

寿命

- 10年
- 寿命期内的长期演化规律



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谢谢！

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