Progress on AST3-3 IR Camera Design

Jessica Zheng

Michael Ashley, Michael Burton, Vlad Churilov, Robert Content, Peter Gillingham, Karl Glazebrook, Lu Haiping, Mike Ireland, Jon Lawrence, Anna Moore, Jeremy Mould, Nick Staszak, Julia Time, Peter Tuthill, Lifang Wang, Xiangyan Yuan, Li Zhengyang, Yongtian Zhu

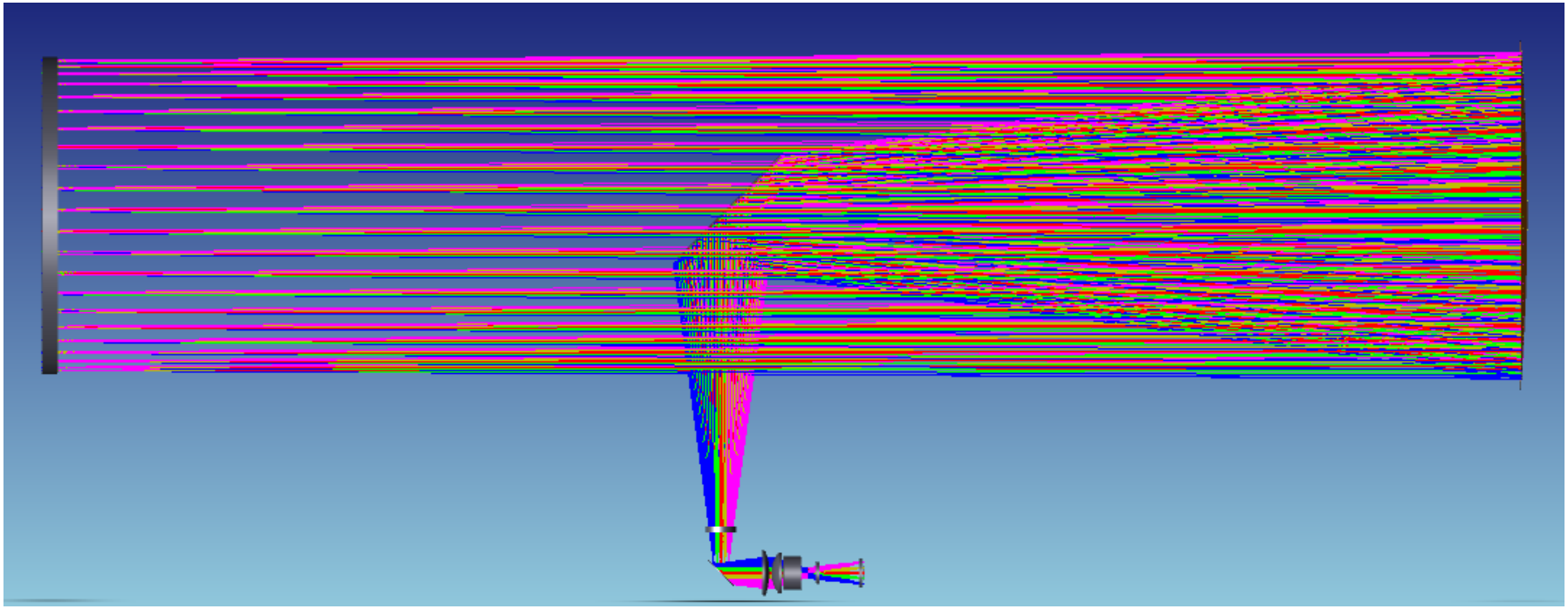
AST3-3 IR Camera and KISS

- AST3-NIR is version of AST3 dedicated to conduct the KISS infrared sky survey at Kdark.
- Technical concept developed during early 2014.
- China responsible for telescope hardware and control, logistics, deployment.
- Australia responsible for instrument hardware and control, and power generation system.
- AST3-3 telescope already funded and currently is at manufacturing. IR camera funded by Australian government LIEF grant 2014(PI:Jeremy Mould) .
- Project Kick-off meeting happened during 2015 International Collaboration Meeting on Antarctic Survey Telescopes (AST3), March, Hong Kong 2015.

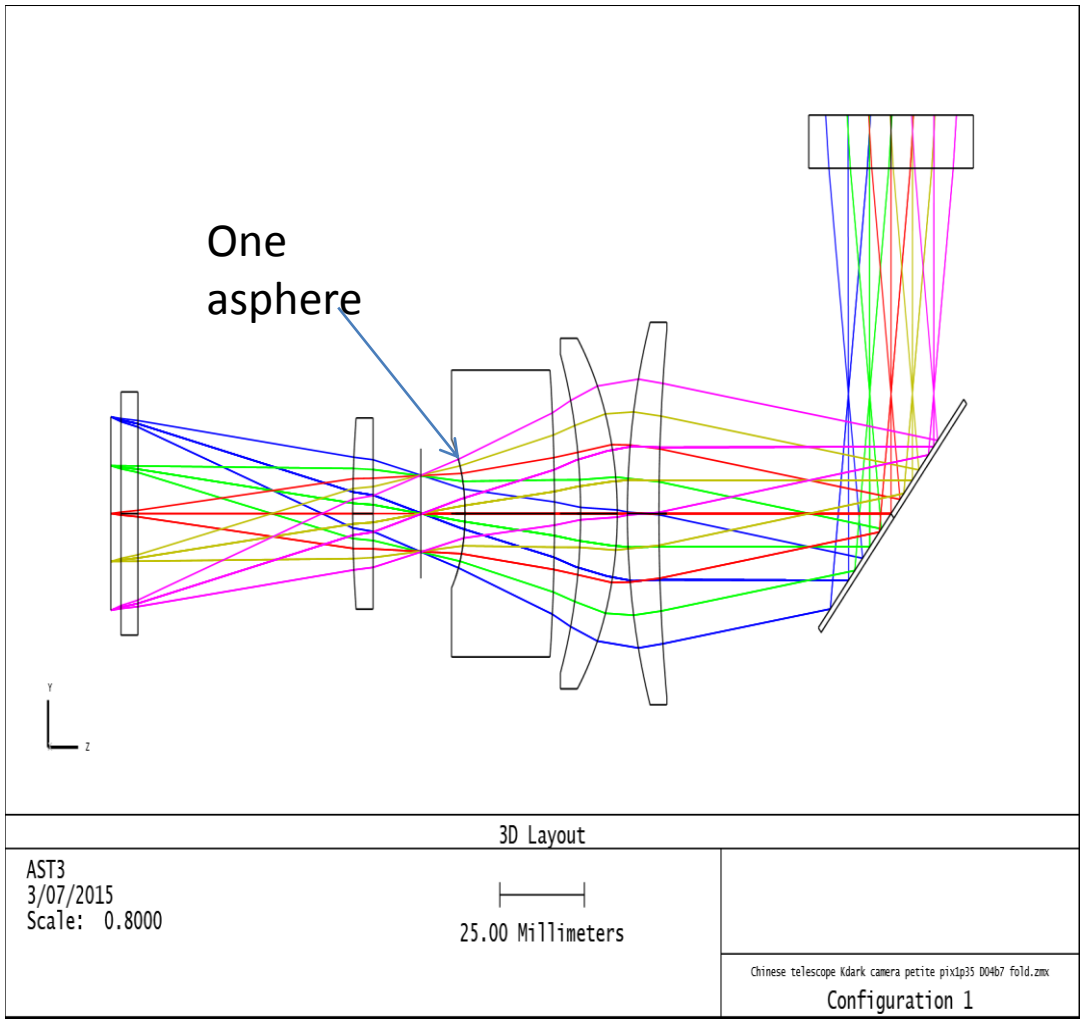
Key parameters
(thanks to Jeremy, Jon and Xiangyan)

Parameter	Value
λ (Δλ)	2.36 (0.18) μm (K_{dark})
Diameter	68cm
Image Quality	1.9″ (1.1 x diffraction limit)
Array	2048 x 2048, 18μm pixels H2RG Teledyne preferred
Sampling	1″
Field of View	30′ x 30′
Achieving:	
Background limited integration time	25 secs
1σ 25 seconds	18.0 mags.
10σ 1 hour	18.5 mags.
Saturation limit (in 25 sec)	K_{dark} = 11.1 mags.
With Background Sky [South Pole]	K_{dark} = 17.0 mags/arc²=100μJy/arc²

AST3-3 IR Camera Preliminary Design

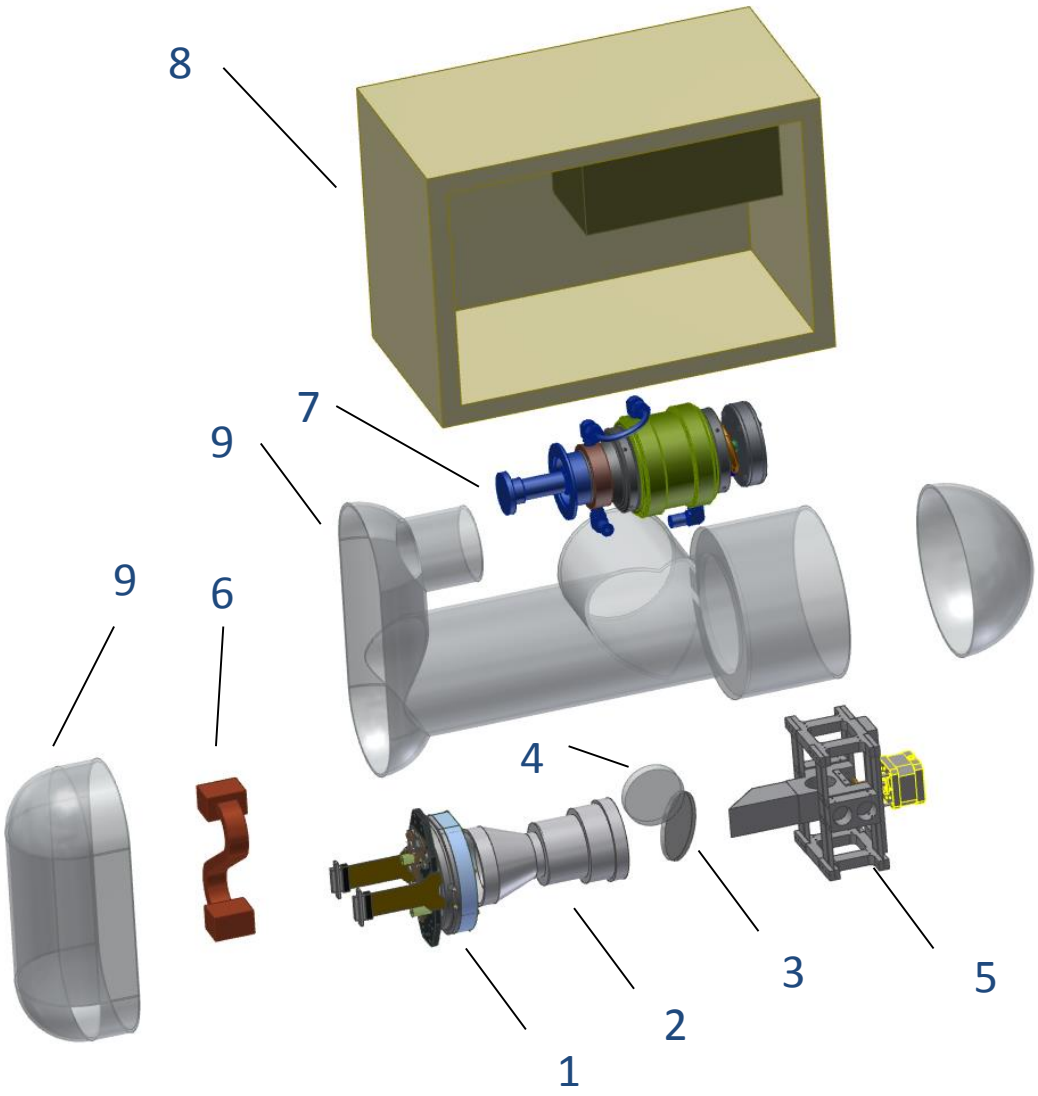


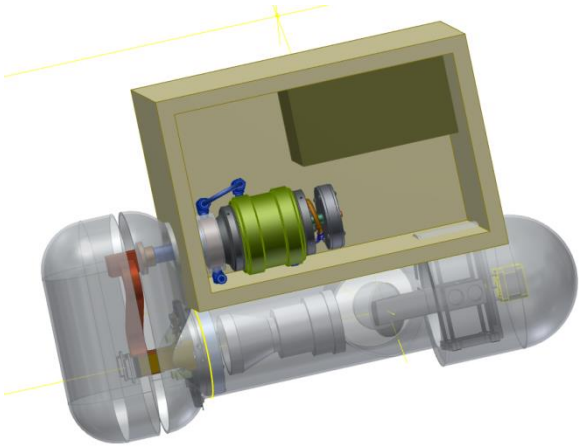
Optical design of IR camera



- Design has one asphere.
- Pixel size:
  - ✓ 18 µm.
  - ✓ 1.35” based on approximate calculations of size of total PSF including diffraction, as-designed aberrations, tolerances and seeing.
- Field:
  - ✓ 2048 x 2048 pixels.
  - ✓ 2765” x 2765”.

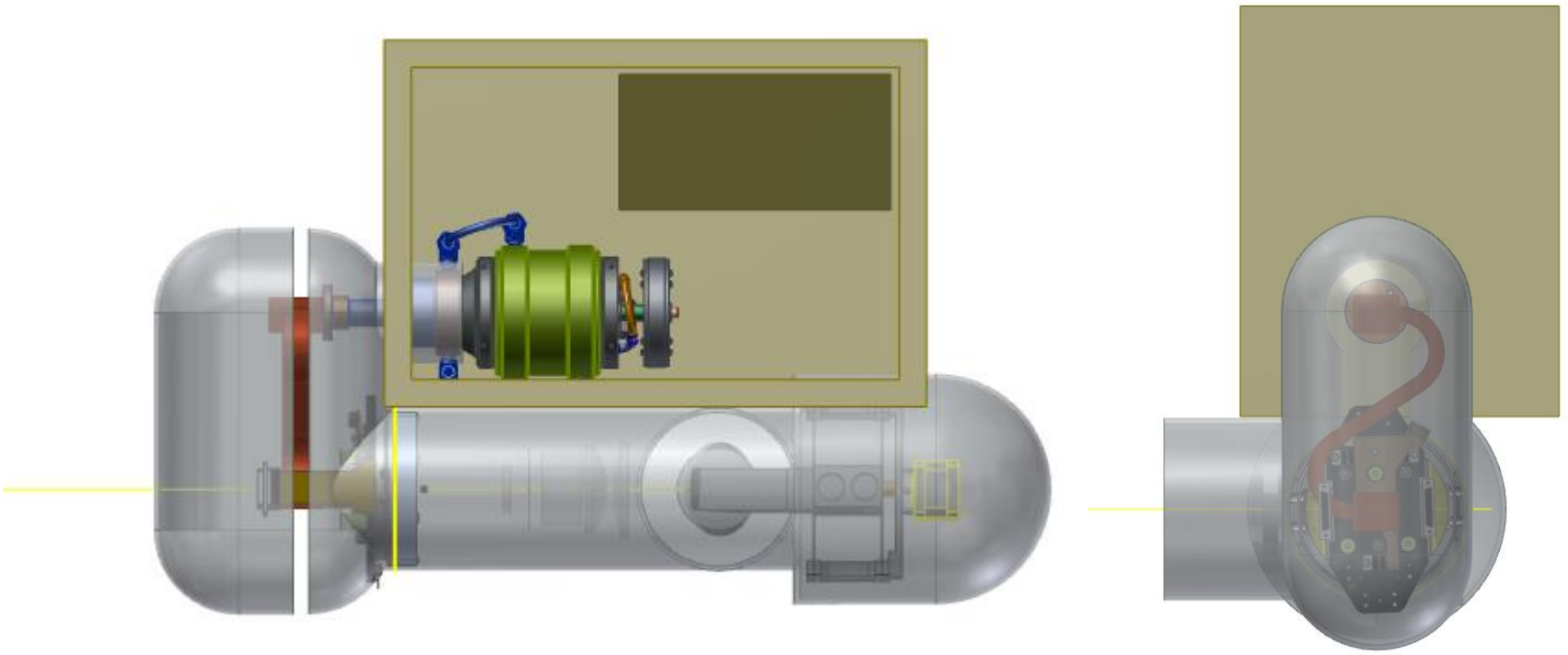
IR camera Concept





1 – Detector assembly
2 – Optical Camera
3 – mirror
4 - Vacuum window
5 – Focusing Mechanism
6 – Cold Strap
7 – Cryocooler (Sunpower Stirling)
8 – Electronics Thermal Cabinet
9 – Vacuum vessel

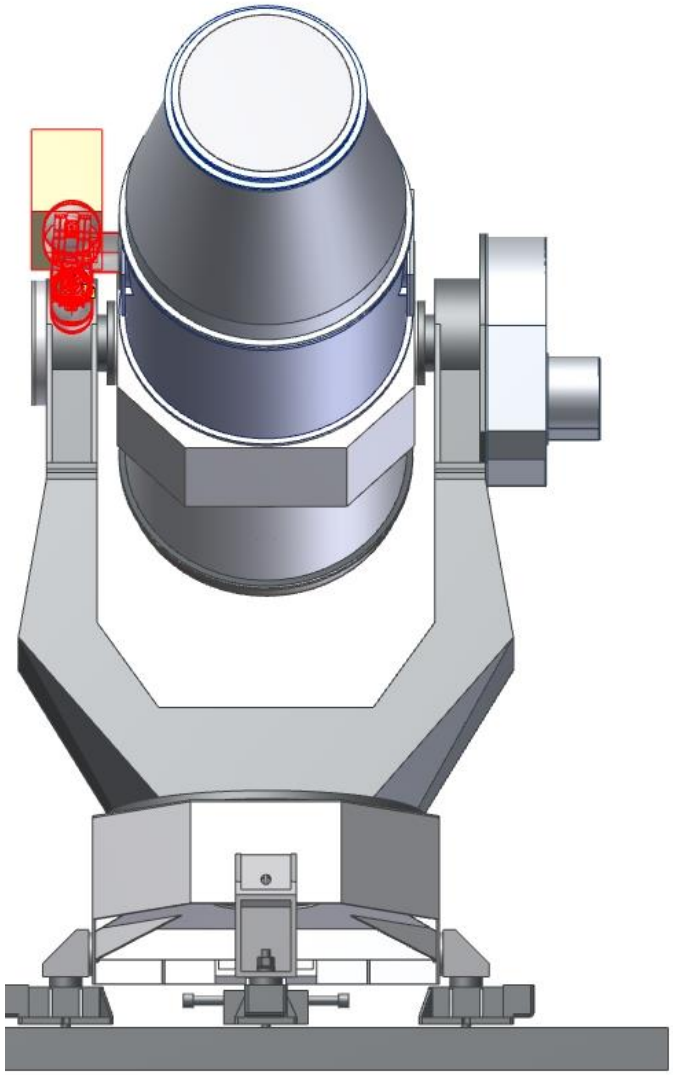
AST3-3 IR Camera Layout



Overall Dimensions, approx: 700 x 500 x 300

Mass approx 30 kg

IR Camera on AST-3 telescope



Stray light and thermal analysis

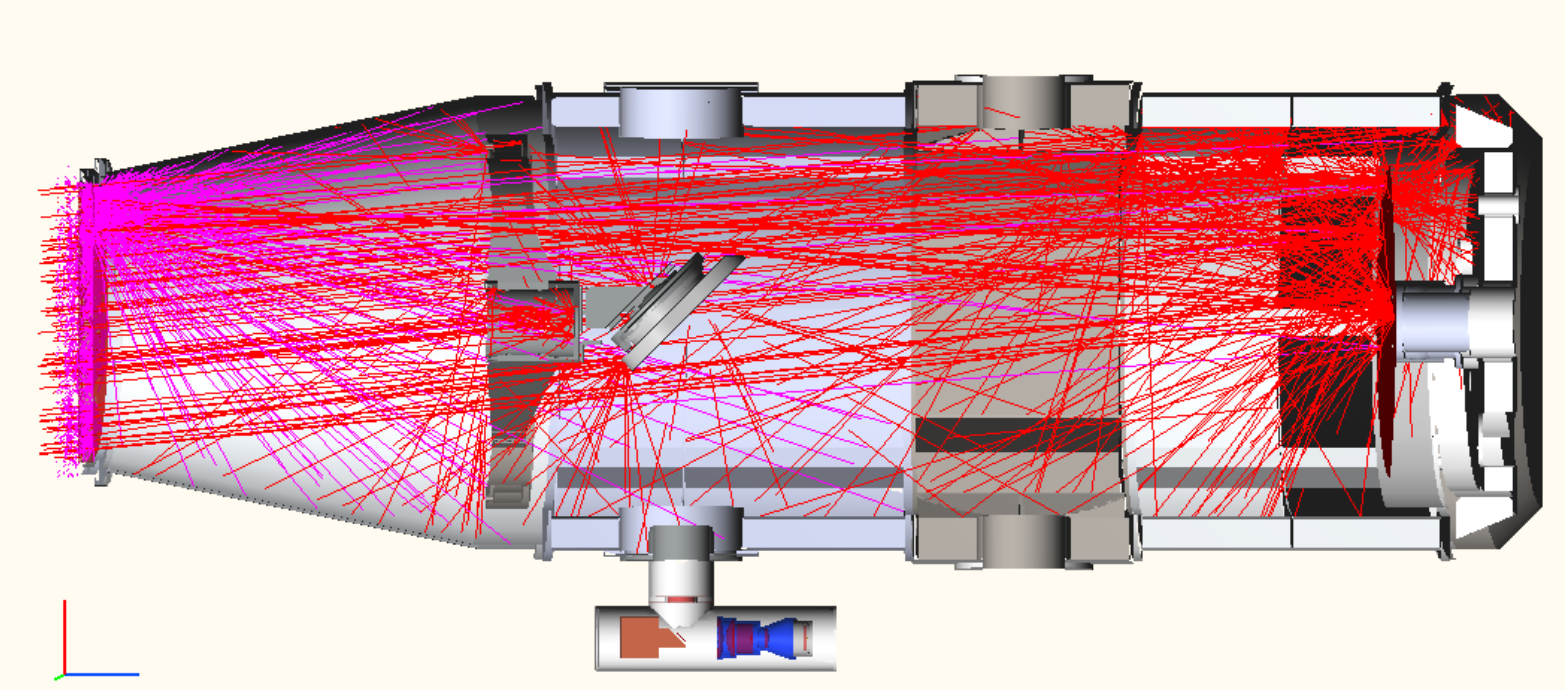
- Scattering light analysis
- Thermal self emission

Surface property parameters(thanks to NIOAT)

material	absorptance	Specular Reflectance	Transmittance	BRDF A	BRDF B	BRDF g	Emissivity
mirror	0.03	0.956	0	0.00096	0.01	2	0.03
lens	0.001	0.015	0.984	0.00001	0.015	2	0.001
Tube/baffle	0.95	0.00001	0	0.0318	1	0	0.95
ITO	0.13	0.00187	0.85	0.0001	0.015	2	0.13

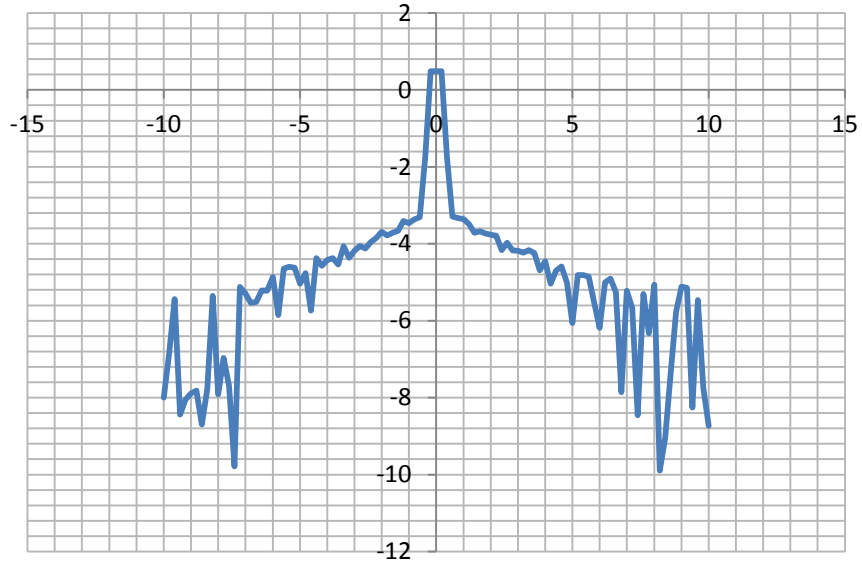
Point Source Transmittance

PST: Standard for stray light rejection evaluation.
PST(θ) = focal plane irradiance/entrance aperture irradiance(θ)

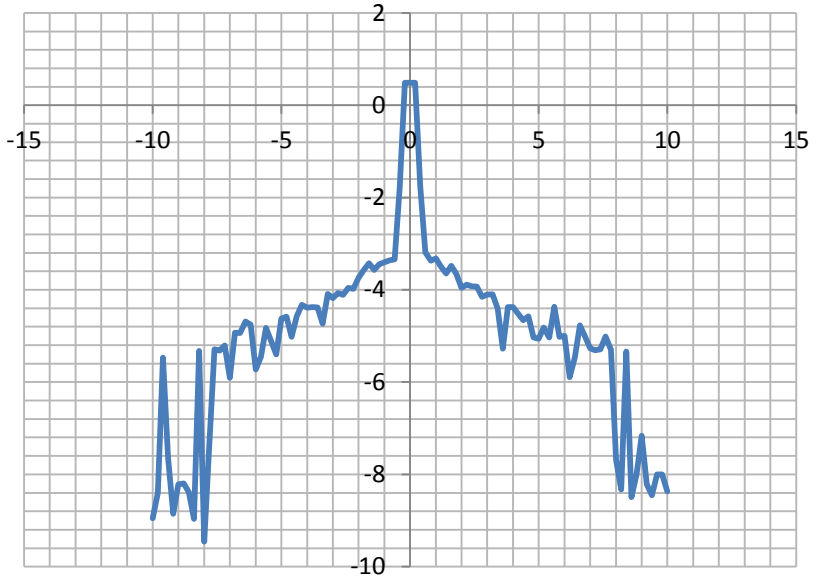


PST for IR camera

PST AST3-3_X direction

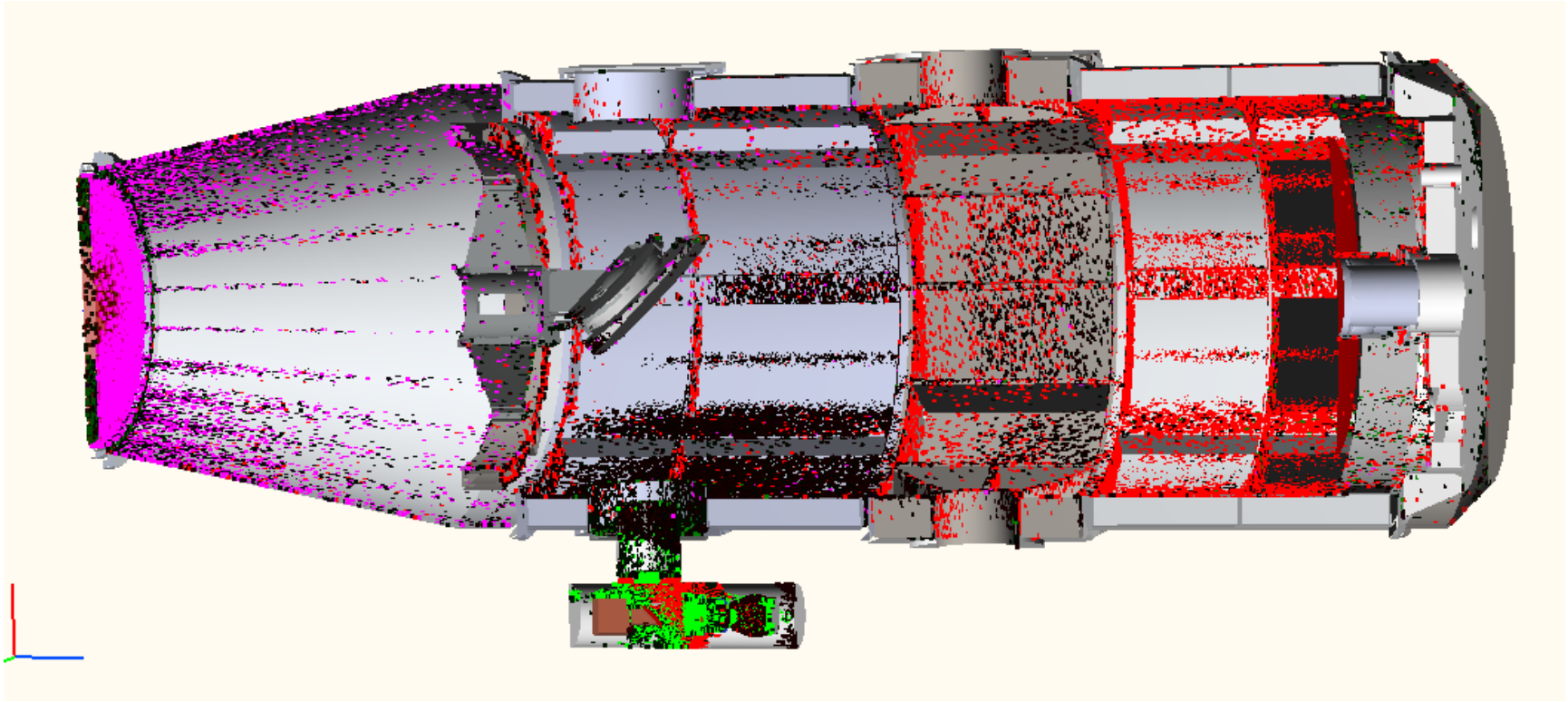


PST IR Camera_Y direction



Thermal self emission

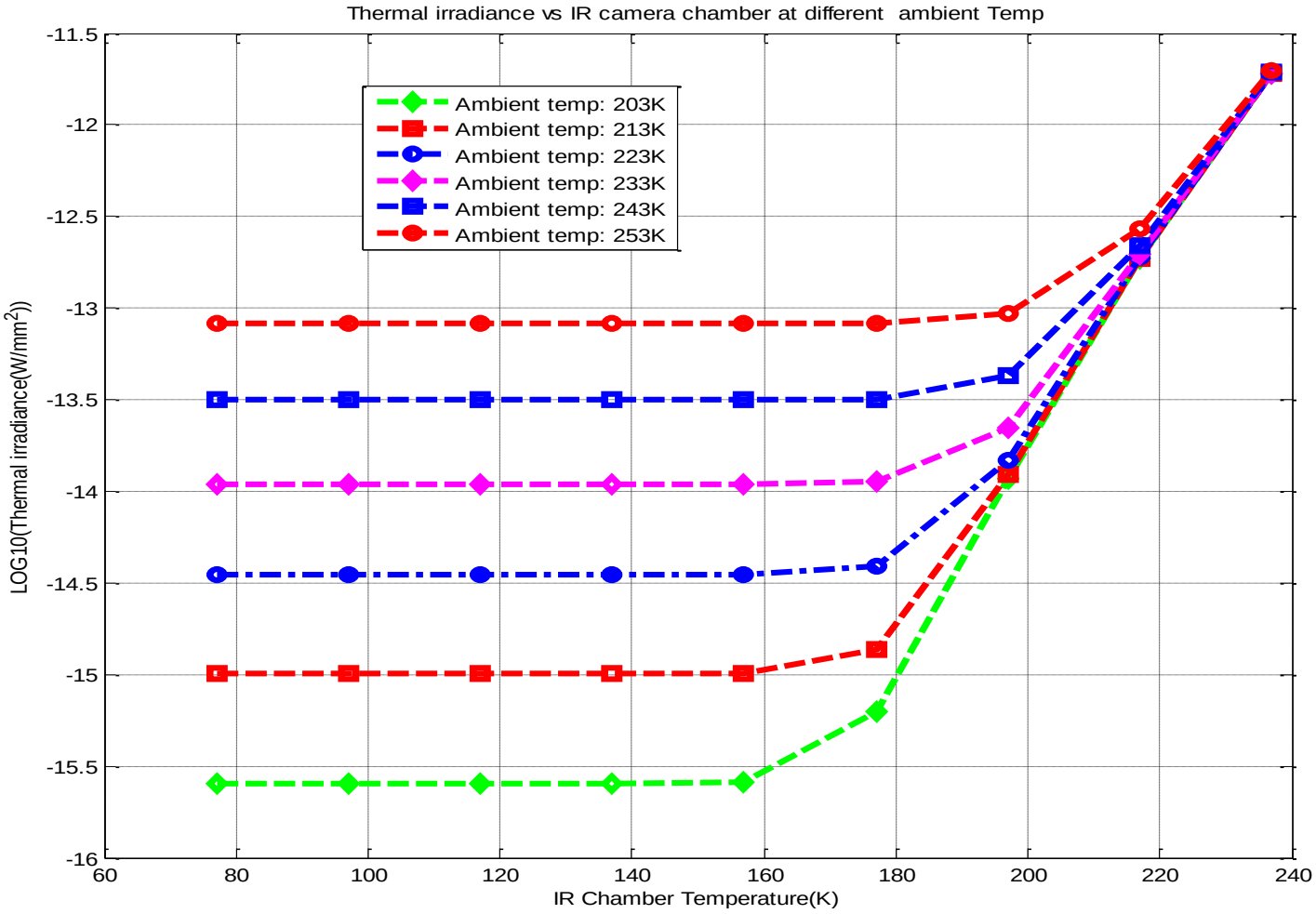
Flooded Light from Detector Surface(Solid angle)



Three Temperature Zones:

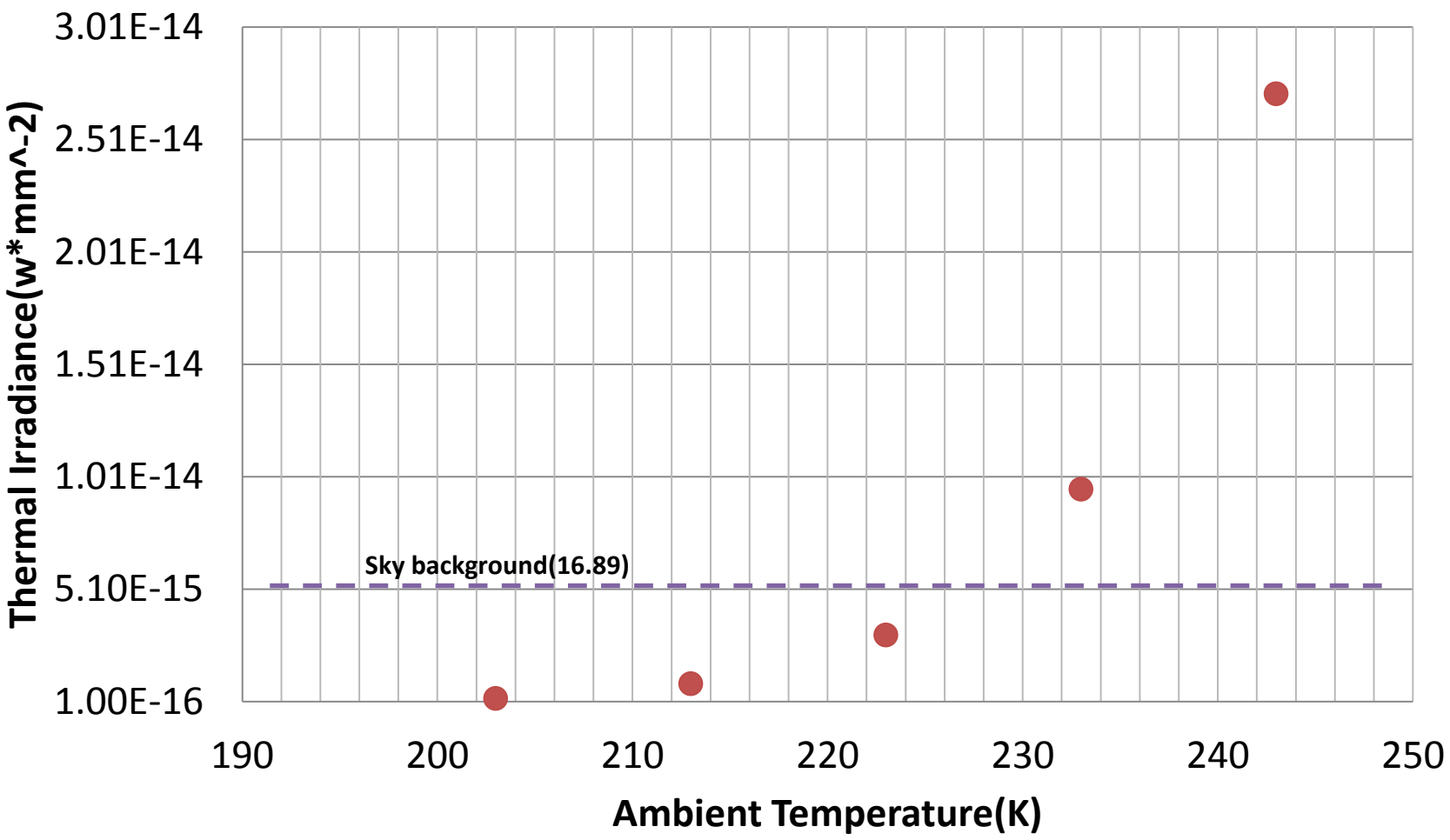
- ✓ Zone1: Ambient temperature.
- ✓ Zone2: IR camera relay lens body.
- ✓ Zone3: Filter and FPA.

Thermal irradiance when the IR camera body painted with Acktar vacuum black

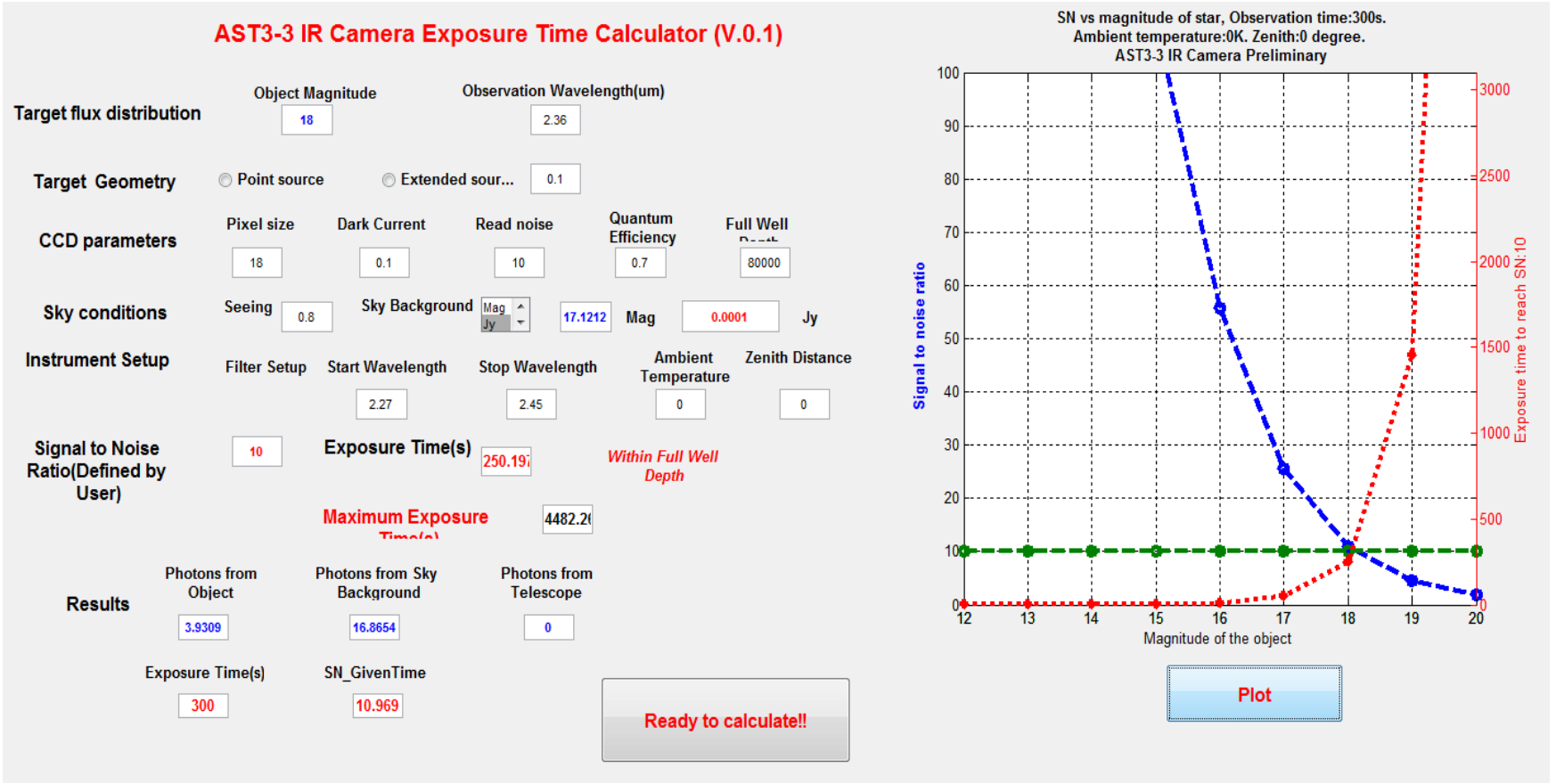


Temperature Zones:

- ✓ Zone1: 198k-235K
- ✓ Zone2: <160K
- ✓ Zone3: 77K


Thermal Self Emission
3.01E-14
2.51E-14
2.01E-14
1.51E-14
1.01E-14
5.10E-15
1.00E-16
Thermal Irradiance(w*mm^-2)
Sky background(16.89)
190
200
210
220
230
240
250
Ambient Temperature(K)

AST3-3 IR camera Exposure time Calculator



Key performance achieved with current design

- FOV: 0.584 degree^2
- 1σ 25 seconds: 18.5 mags at 235K(-38C)
- 10σ 1 hour: 18.7 mags at 235K(-38C)
- Kdark sky background: 100μJy/sec^2

Where are we now?

	Milestone Completion	Due Date
1	Preliminary discussions with DoS re: ITAR	*Jan-15*
2	Project Kick-off (Meeting in Hong Kong)	*Mar-15*
3	Detector & Interface Specification	Jul-15
4	Requirements Review	Aug-15
5	RFQ Teledyne	Aug-15
6	Contract Negotiation (Detector)	Sep-15
7	Purchase Order (Detector)	Oct-15
8	CDR (De-Scope Option)	Dec-15
9	Final Design Review	Apr-16
10	Procurement Lead-time (Detector)	Nov-16
11	Telescope shipped to Australia	Dec-16
12	Float Procurement Lead-time (Detector)	Jan-17
13	AIT @ AAO Facility (location TBD)	Feb. – June
N/A	*Schedule Float*	*~4 months*
14	Camera Pre Delivery Review	Late 2017
15	Shipping to Antarctica	Nov. 2017
16	Commissioning	Jan. 2018
17	Science Survey commences	Feb. 2018


THANK
ALL THE PEOPLE!
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