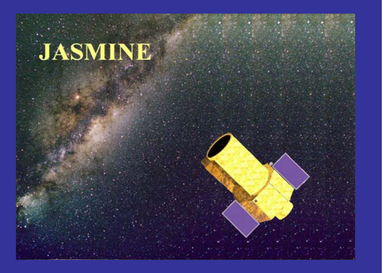
ELSA conference 2010 – Gaia: at the frontiers of astrometry, 7–11, June 2010

Performance evaluation of Nano-JASMINE



○Y. Hatsutori, Y. Kobayashi, N. Gouda, T. Yano (National Astronomical Observatory of Japan),
J. Murooka, Y. Niwa (The University of Tokyo) and Y. Yamada ()

Abstract

We report the results of performance evaluation of the first Japanese astrometry satellite, Nano-JASMINE. It is a very small satellite and weighs only 35 kg. It aims to carry out astrometry measurement of nearby bright stars (z<7.5mag) with an accuracy of 3 milli-arcseconds. Nano-JASMINE is to be launched by Cyclone-4 rocket in August 2011 from Brazil. The current status is in the process of evaluating the performances. A series of performance tests and numerical analysis were conducted. As a result, the engineering model (EM) of the telescope was measured to be achieving a diffraction-limited performance and confirmed that it has an enough performance for scientific astrometry.

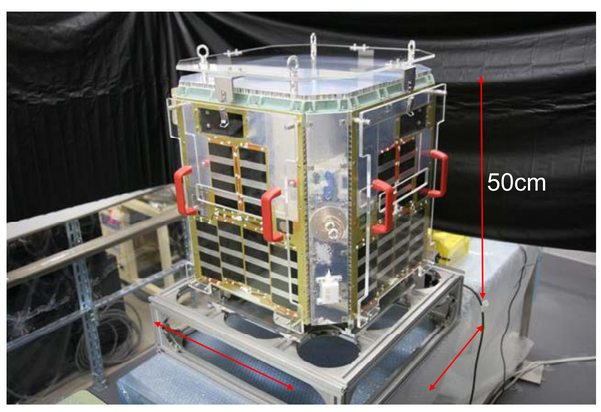
Nano-JASMINE

First satellite of JASMINE（Japan Astrometry Satellite Mission for Infrared Exploration） Series

Objective of Nano-JASMINE

Through Nano-JASMINE Project, we experiment the first space astrometry mission in Japan and accumulate technology and know-how for Small-JASMINE (Second satellite of JASMINE series).

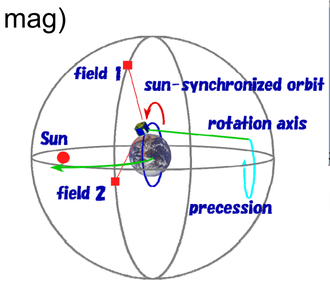
Moreover, almost 15 years have passed since the end of the Hipparcos mission. Errors in a proper motion have accumulated over the years. Even if we measure the same stars that were observed by HIPPARCOS with the same accuracy, we can significantly improve the accuracy of proper motion.



Outlook of Nano-JASMINE
(Engineering Model)

Features of Nano-JASMINE

- First space astrometry satellite of Japan
- Size: 50 x 50 x 50 cm
- Wight: 35kg
- Observation Wavelength: 600 – 1000 nm (zw-band)
- Observation accuracy: 3mas (zw<7.5 mag)
- Orbit: Sun-Synchronous Orbit
- Altitude: 600 – 1000 km
- Mission Life Time: 2years



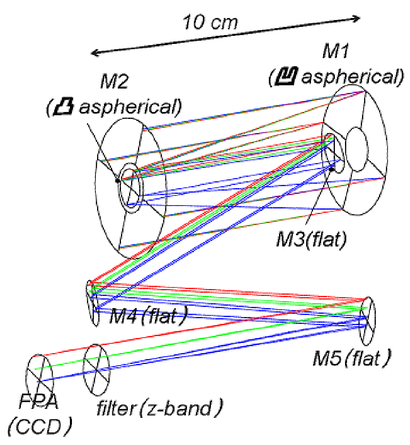
Launch

Nano-JASMINE is to be launched at August 2011 from Alcantara Launch Center at Brazil by Cyclon-4 rocket.

Location of Alcantara Launch Center (Brazil)

Cyclone-4 Rocket
© SDO Yuzhnoye

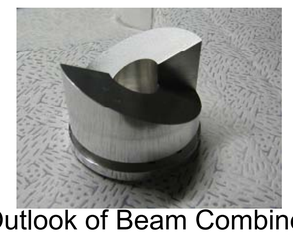
Optical System of Nano-JASMINE



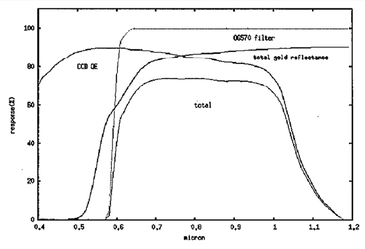
Optical Layout of Telescope
（Beam-Combiner appears around M2）

Specifications of Telescope

Specification	Aperture	5cm
	Focal Length	167cm(F/33)
	Type	Ritchey – Chretien
	Field of View	0.5 x 0.5 deg
	Basic Angle	99.5 deg
	Observation Wavelength	zw-band(600-1000nm)
	Detector	Full Depletion CCD 1kx1k pix (Time Delayed Integration)
	Scale of pixel	15μm ⇒ 1.76 arcsec/pix
	Operating Temperature	−50℃～−100℃
Requirement	Stability of Basic Angle	＜1mas／100min (orbital period)
	Through put	T＞80%

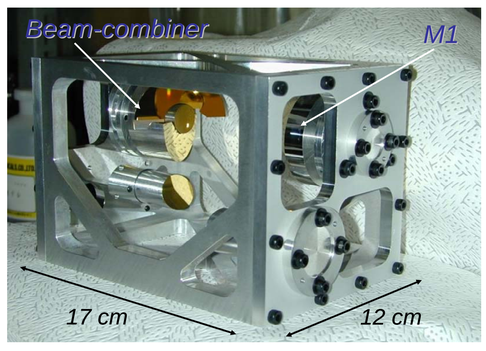


Outlook of Beam Combiner
(Basic Angle : 99.5 deg)



Quantum Efficiency

Nano-JASMINE Telescope



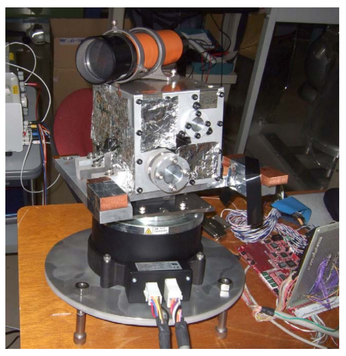
The small reflecting telescope was made of aluminum alloy because of the suppression of effects of strain induced by thermal changes.

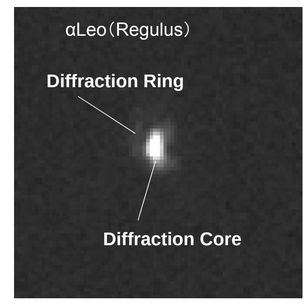
Wavefront Errors

Surface	Shape RMS (nm)	Wavefront RMS (nm)	wavefront RMS (λ/σ at $\lambda = 800$nm)
beam-combiner	15	30	$\lambda/27$
1ry	15	30	$\lambda/27$
2ry	9	18	$\lambda/44$
3ry	10	20	$\lambda/40$
4ry	11	22	$\lambda/36$
5ry	8	16	$\lambda/50$
RSS total	29	57	$\lambda/14$

Total wavefront error is smaller than λ/14

Shot Image (with COTS-CCD)

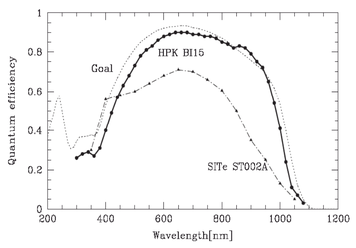




Observed Image

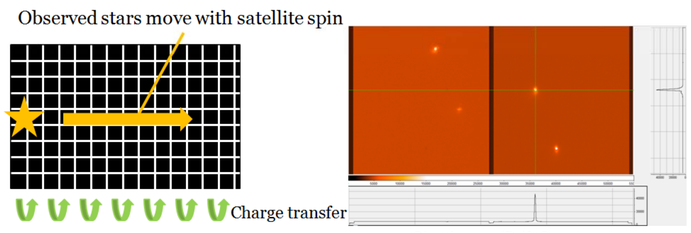
CCD

Parameter	Specification
Pixel Size	15 um square
Number of active pixel	1024 x 1024
Si Thickness	200 um
Vertical clock phase	3Phase
Horizontal clock phase	2Phase
Output	One Stage MOSFET SF 4ch
Package	Aluminum Nitride
CTE	>0.999995
Full well capacity	>150ke-
Readout noise	<10e-



Large QE in near infrared range

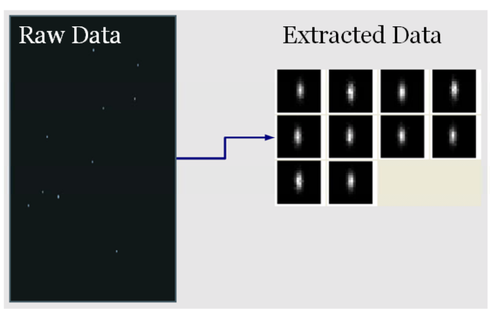
Drift Scan Mode (Time Delayed Integration)



Shot image (Drift Scan)

Charge transfer is synchronized with satellite motion

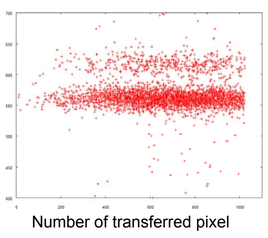
Star Image Extracter



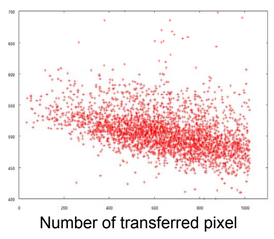
Data rate of raw data: 2Mbps
Down link rate: 100kbps (visibility: 5%)

5×9pixel image around each stars is extracted

Radiation Test



Number of transferred pixel
Before irradiation
(CTE 0.999996)



Number of transferred pixel
After irradiation
(0.9998)

Degradation of CTE can be compensate in analysis

Ground Sation

10m radio antenna
@NAOJ

Uplink and Downlink station

- 3m radio antenna (University of Tokyo, Japan)

Downlink station

- 10m radio antenna (Mizusawa branch of NAOJ)
- Kiruna Tracking Station (Sweden) - TBD