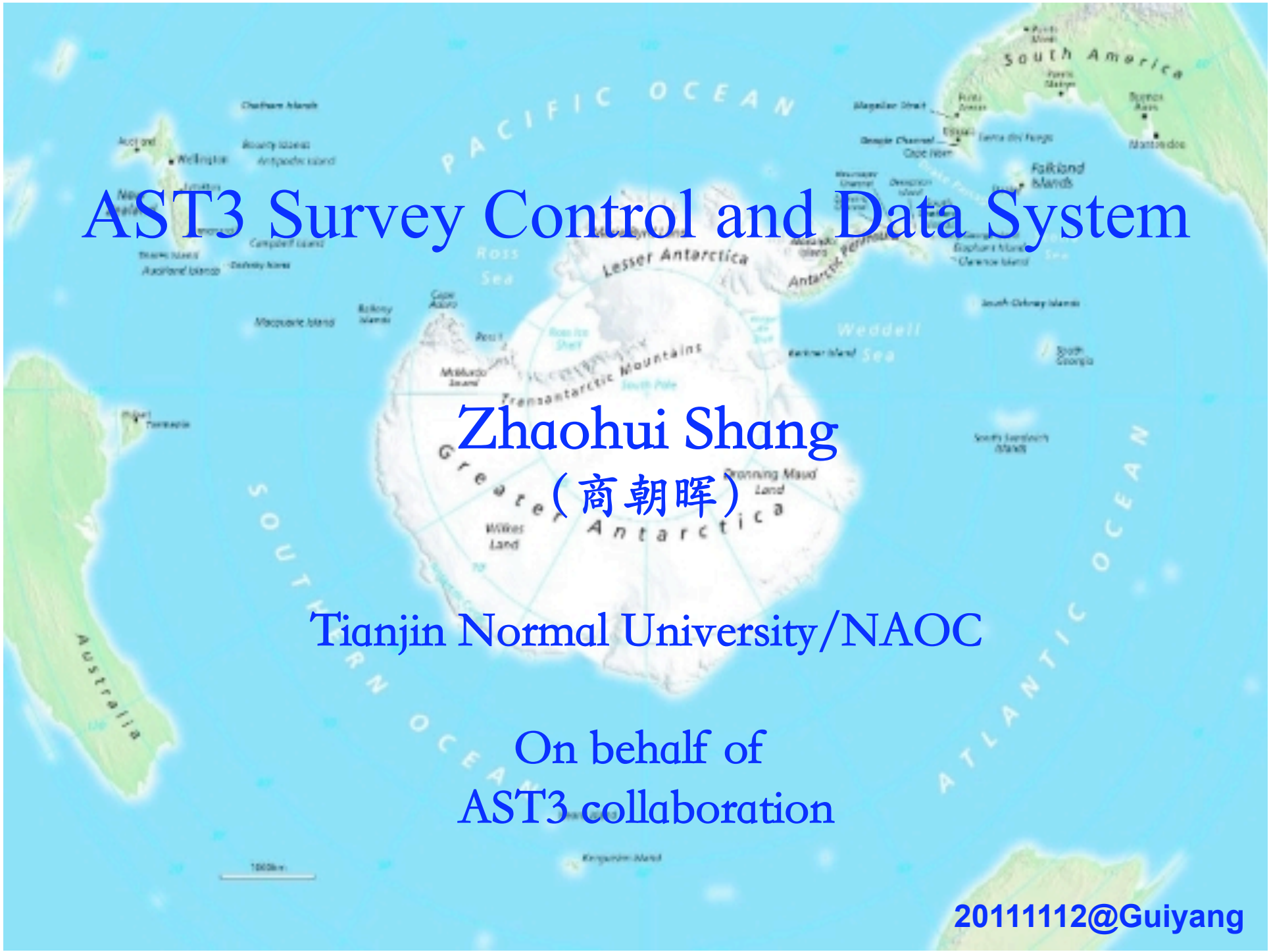


AST3 Survey Control and Data System

Zhaohui Shang
(商朝晖)

Tianjin Normal University/NAOC

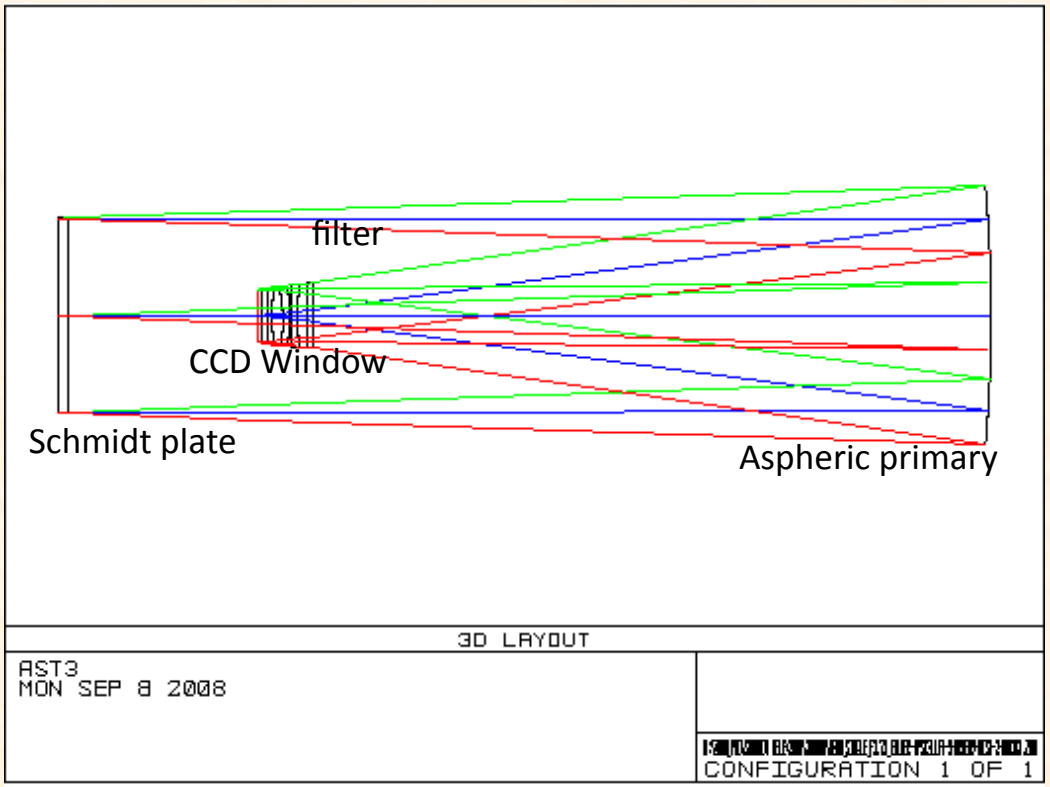
On behalf of
AST3 collaboration

20111112@Guiyang

Telescope and CCD Camera

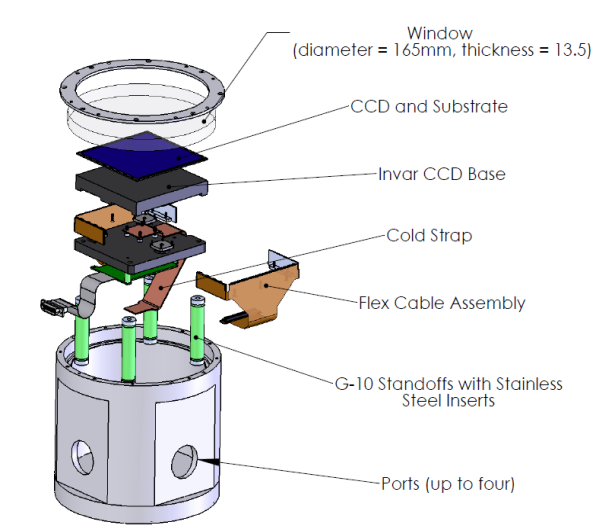
Antactic Survey Telescope x 3 (AST3)

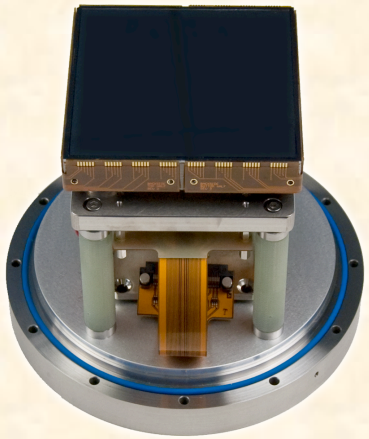
- Three 50/68cm modified Schmidt Telescopes (NIAOT);
  - spherical corrector
  - short tube
  - aberration correction
  - atmosphere dispersion corrector (ADC)
- Filters: g, r, i, IR(?),

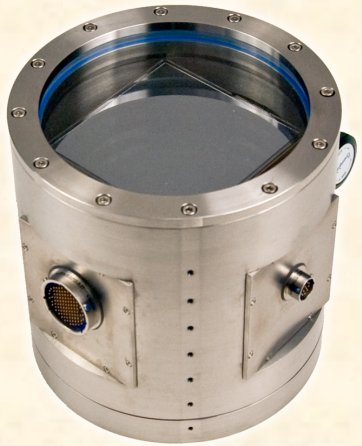


Antactic Survey Telescope x 3 (AST3)

- Three 50/68cm modified Schmidt Telescopes;
- Filters: g, r, i, IR(?),
- CCD: 10k x 10k, 9 micron/pixel (STA1600-FT)
  - To be operated with 10k x 5k
  - Frame transfer
- Plate Scale: 1 arcsec/pixel
- FOV: ~ 4.3 square deg

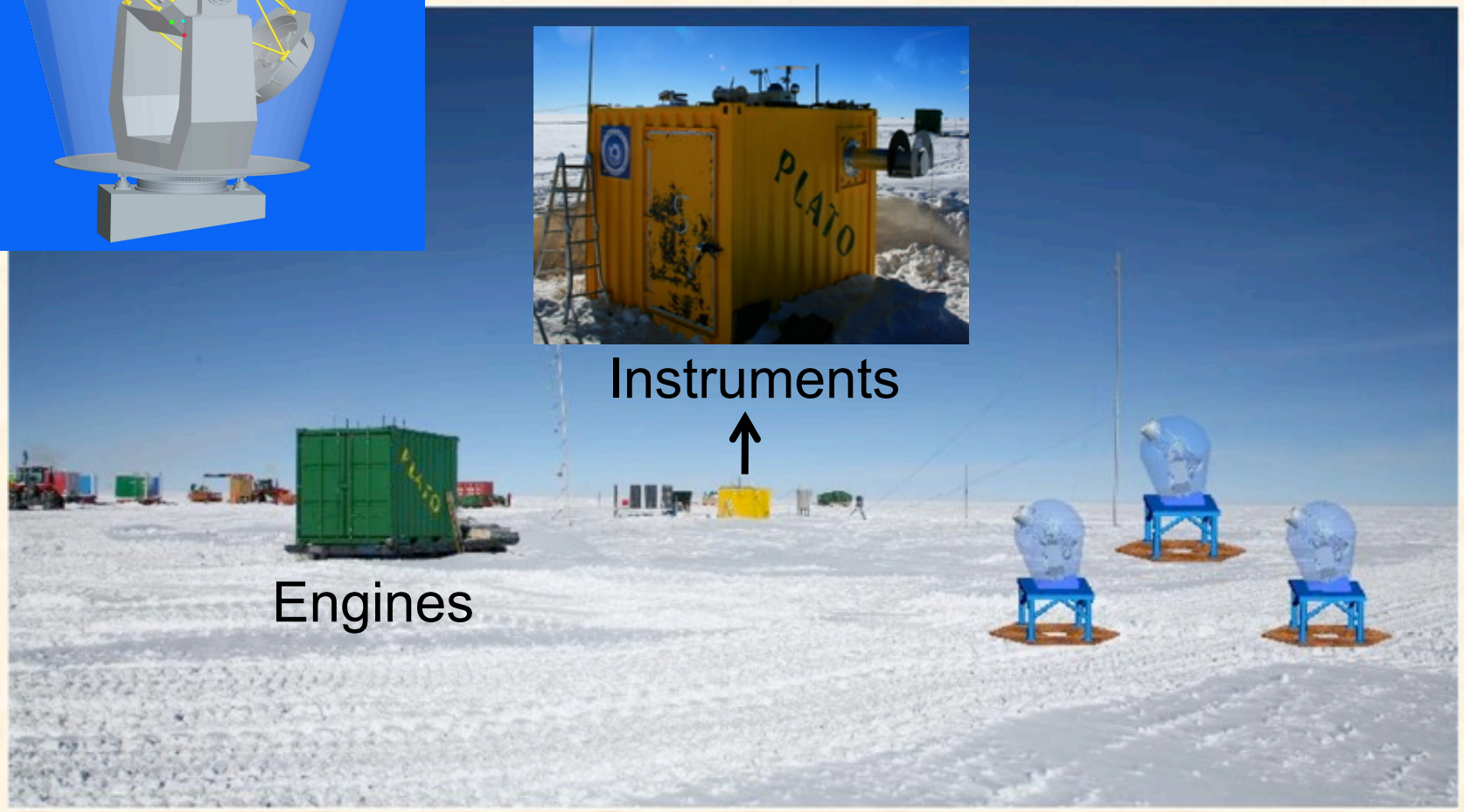






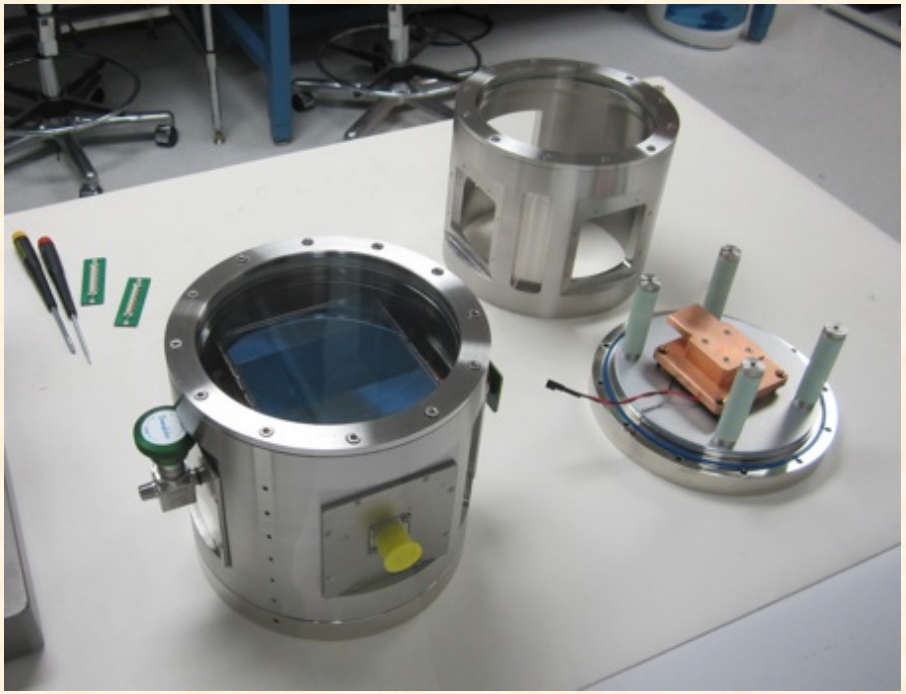
Antactic Survey Telescope x 3 (AST3)

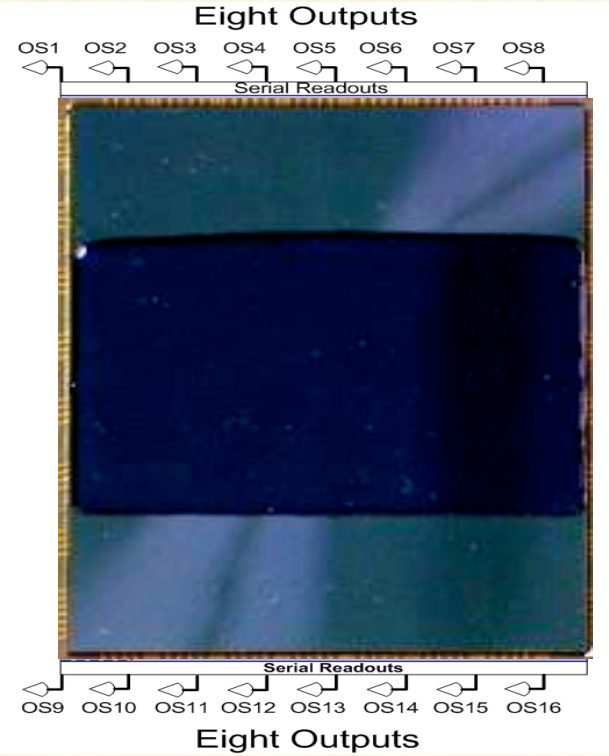
- Plan to install one in 2011
- Power supplied by PLATO-A (UNSW)



AST3 CCD Camera

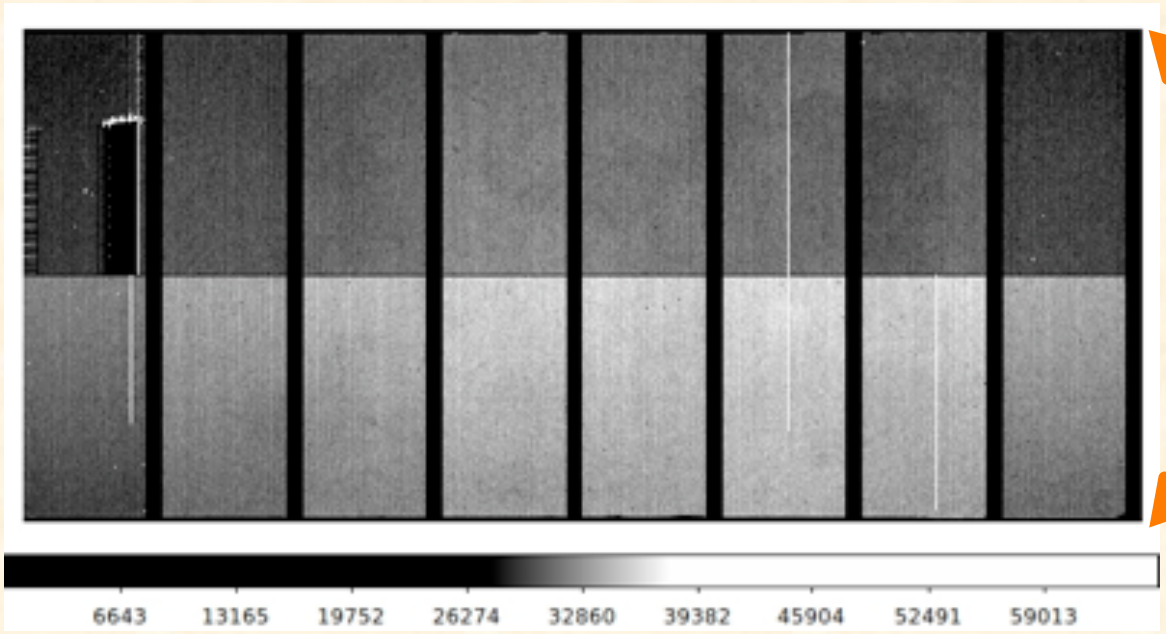
- No shutter
- To be operated in Frame Transfer mode， 10k x 5k
- FOV: ～4.3 sq. degree
- 16 readout channels

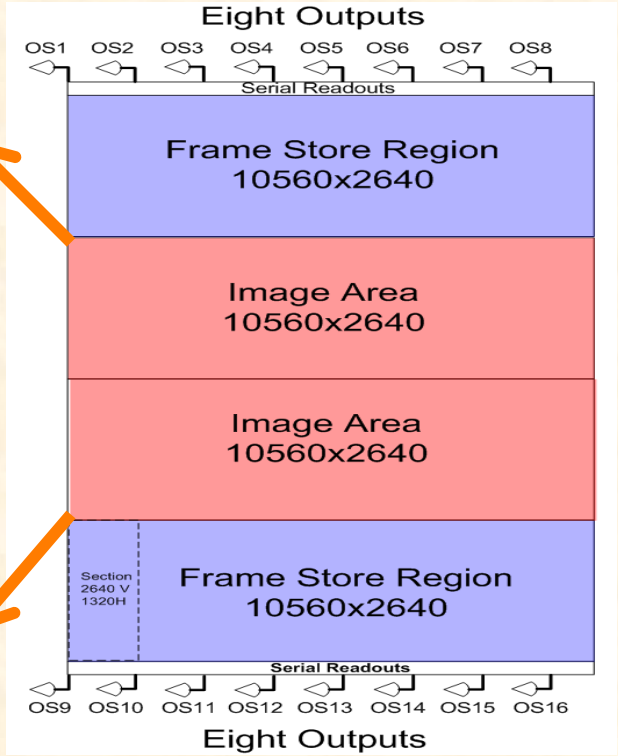




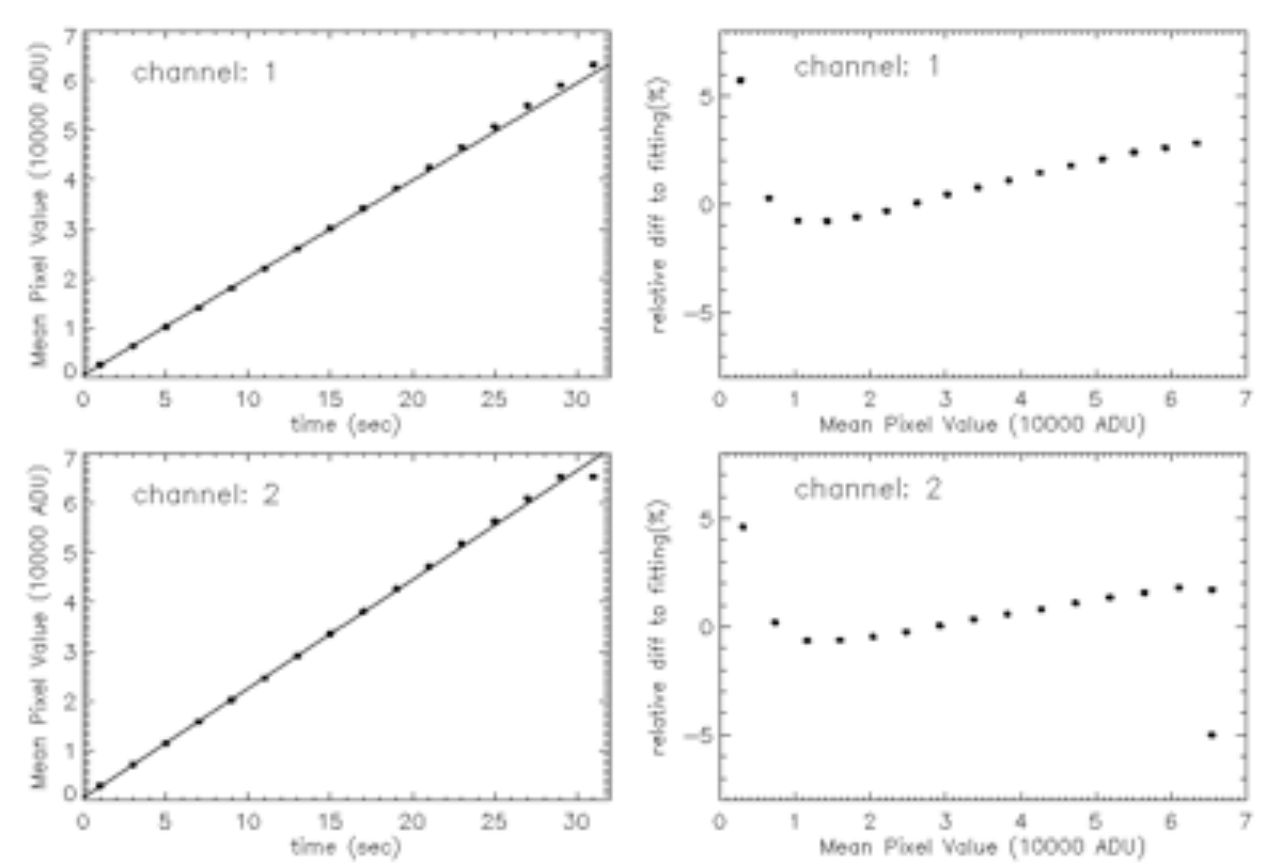
AST3 CCD Camera

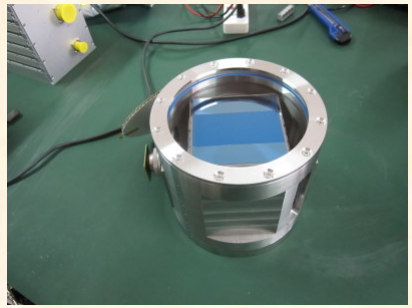
- No shutter
- To be operated with Frame Transfer， 10k x 5k
- FOV: ～4.3 sq. degree
- 16 readout channel

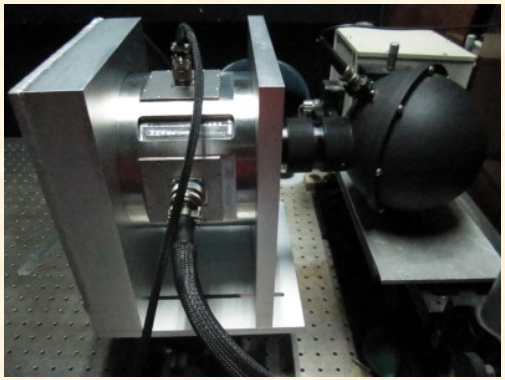




CCD Properties



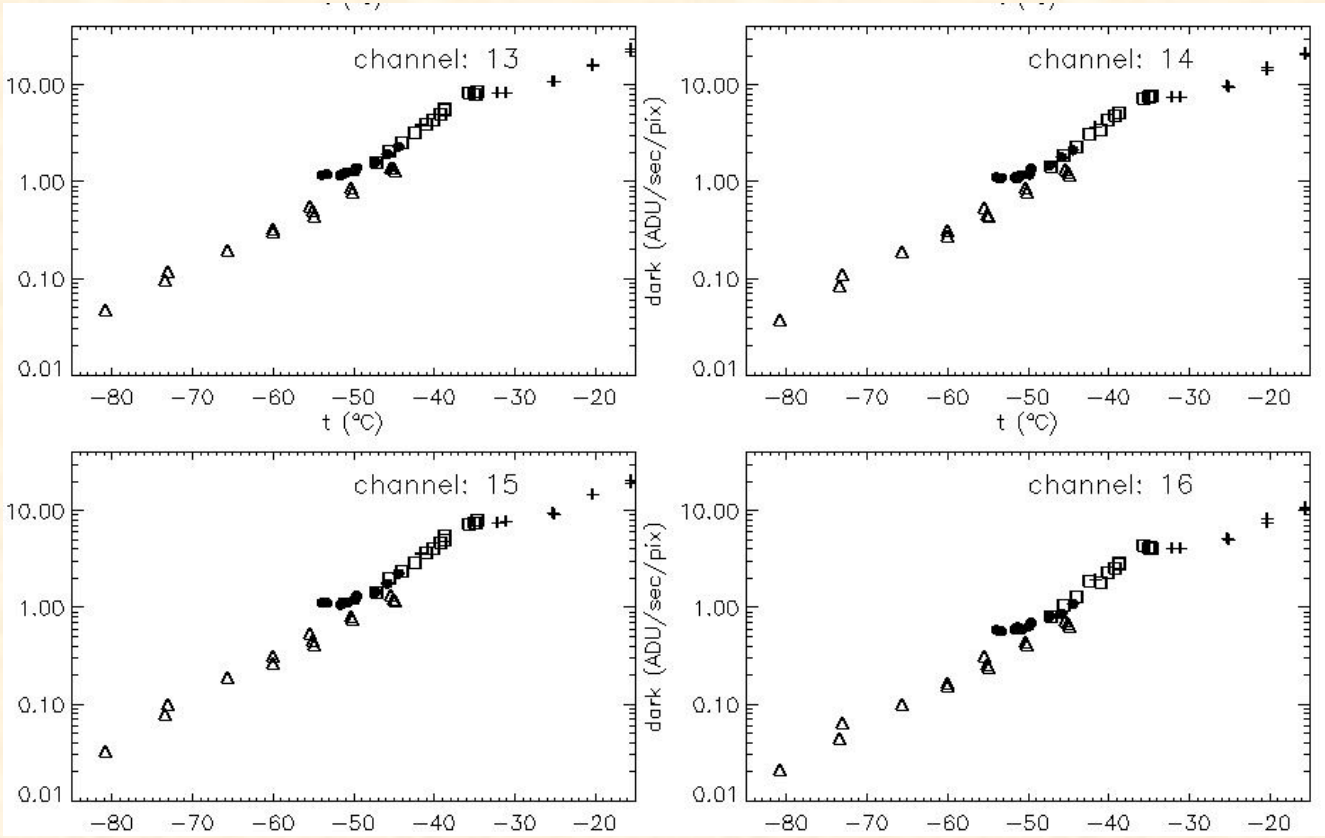




CCD linearity

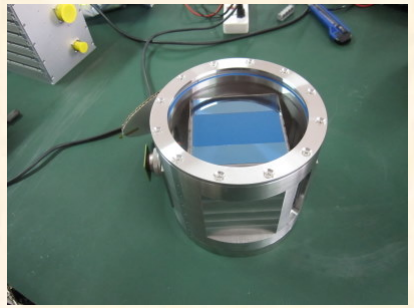
CCD Properties

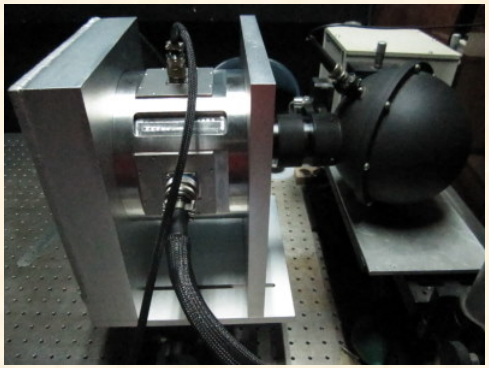
- CCD dark current：<0.2e-/s/pix @-70℃



ADU/s/pix

Temperature (℃)

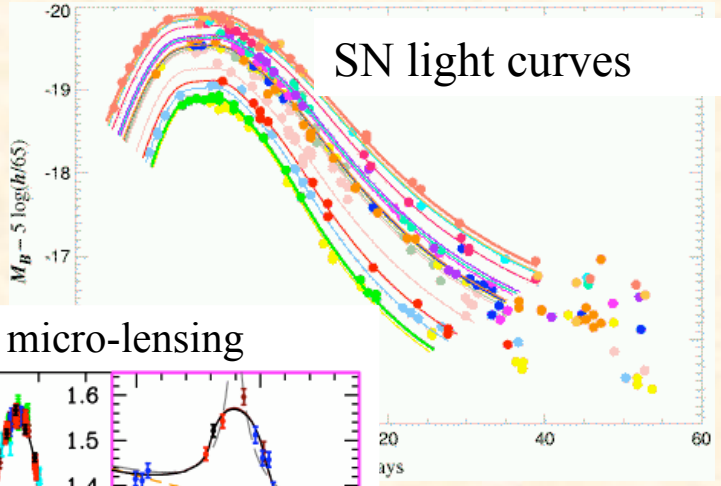


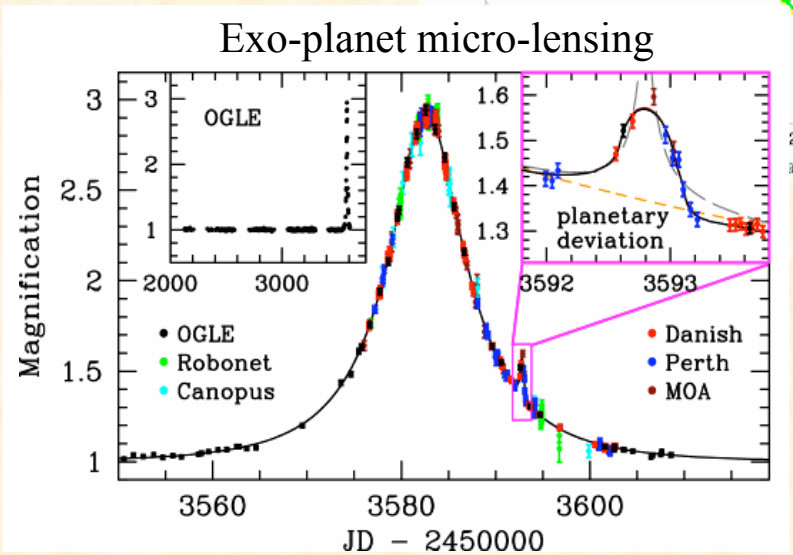


- CCD readout noise：fast mode 10e-; slow mode 5e-

AST3 Sciences--- Time domain astronomy

- Supernova
  - Very early discovery
  - Uniform, multi-color light-curve
- Ex-solar planets
  - Transients
  - Micro-lensing
- Variable stars
- Quasar, AGN
- Gamma-ray bursts
- LMC,SMC
  - Nova
  - Micro-lensing
- …





- High quality data
- Accruate photometry
- Real-time

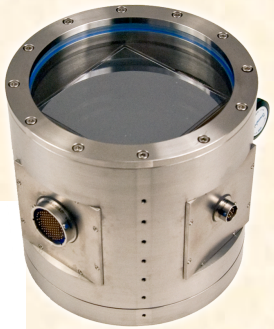
Survey Control and Data System

AST3 Survey Control and Data System

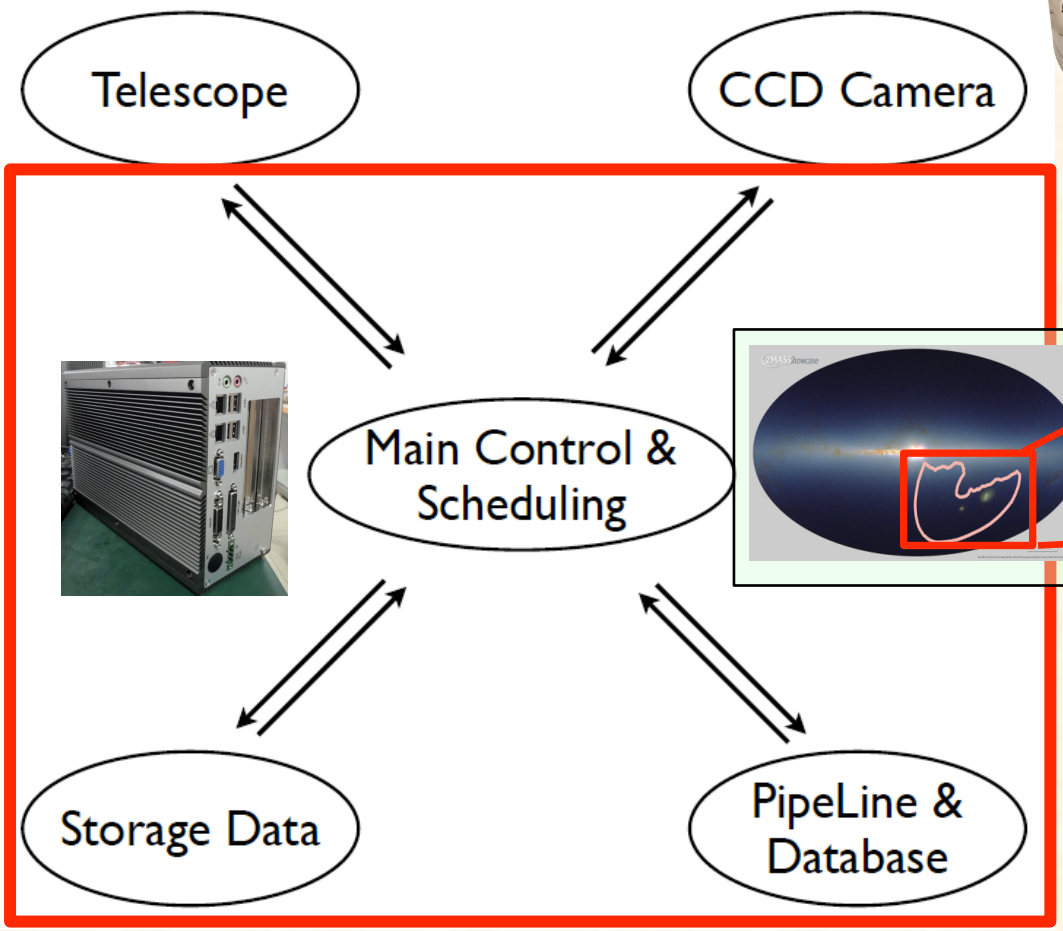
—Hardware + Software

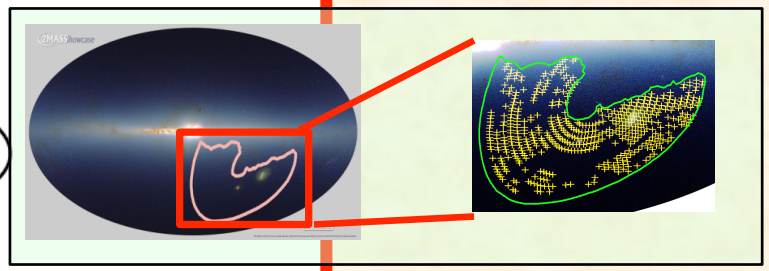
AST3
Telescope

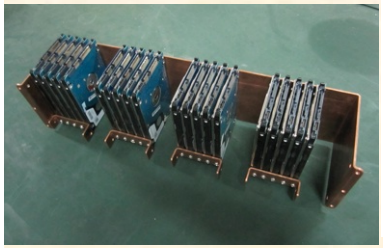
AST 3 Survey

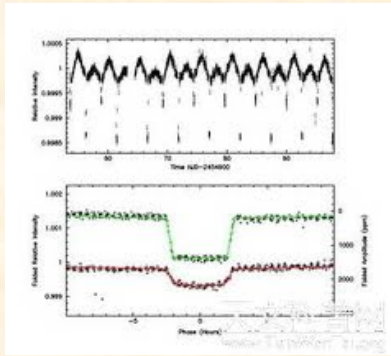


CCD
Camera









AST3 Survey Control and Data System
—Hardware + Software

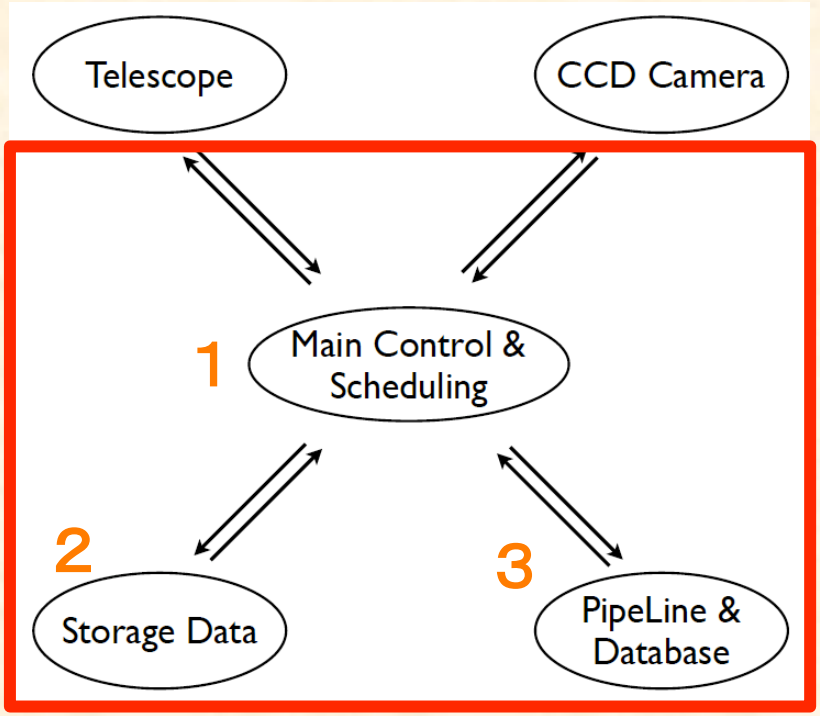
- Survey Control and Data System
  0. Survey areas selection（science driven）
  1. Survey scheduling
  2. Computer, acquisition, and data storage systems
  3. Real-time pipeline
  4. Database

➢ Requirements for Dome A survey
- Unattended, low band-width=> fully automatic
- Hugh amount of data (100MB/image)
- Low temperature, low air pressure
- Low energy consumption
- Disaster tolerance
- Easy installation and maintenance

AST3 Survey Control and Data System—Hardware

Computers, Acquisition, and Storage Systems (Linux)

1. Main Control Computer
   - Survey Scheduling
   - Data Acquisition
   - Control other systems
2. Disk Arrays x 2
3. Pipeline Computer x 2
   - Real-time Pipeline
   - On-site database



Computers, Acquisition, and Storage Systems

Designed based on past experience and actual conditions：

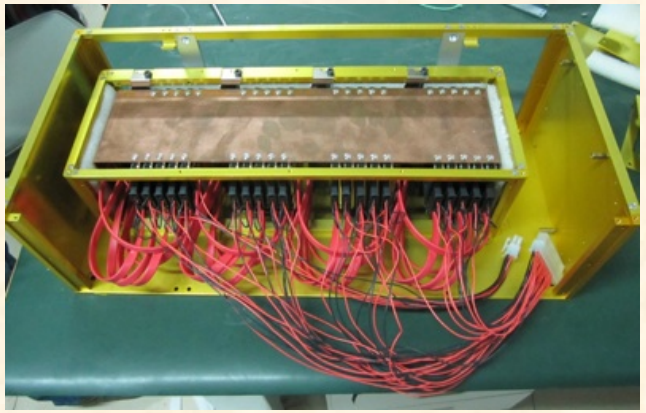
- Low air pressure is not a problem
- Controllable working temperature in PLATO-A （e.g., -10°C）

Computers（x 5）：

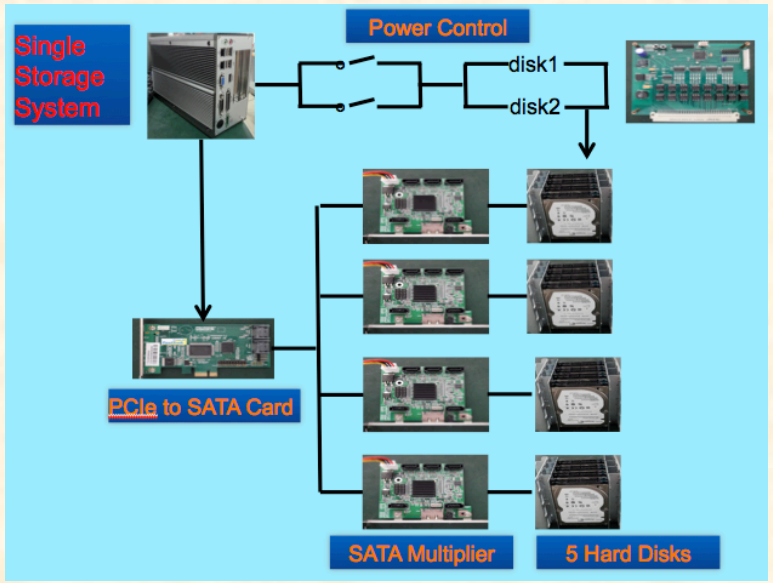
- Laptop configuration
  - Intel® i7-620M and Intel® HM55
  - Low power consumption
    - idle: < 22W
    - disk I/O: < 30W (for main control, storage computers)
    - fully loaded: < 40W (for pipeline computer)
  - i7-620M is fast enough for real-time pipeline
- Low temperature proof （<-20°C）
- Less expensive than high-end products (e.g., military computers)

Computers, Acquisition, and Storage Systems

Data Storage: Disk Arrays:



- Independent computer control
- Low temperature test (2.5 inch disk)
  - ⇒ -9°C cold start（Seagate 500G）
  - ⇒ Much more cost effective than SSD
- Low air pressure test（Yang-Ba-Jing）
- Temperature control system: -5°C～+5°C，
  - ⇒ +40°C power cutoff protection
- 20 disks (10TB) per array
  - ⇒ Enough for 1 telescope, per year
  - ⇒ Easily expandable, data safe
  - ⇒ 2 systems for redundancy
- Only 1 disk is powered on each time, saving energy (35W)



AST3 Survey Control and Data System—Softwares

Design principles:

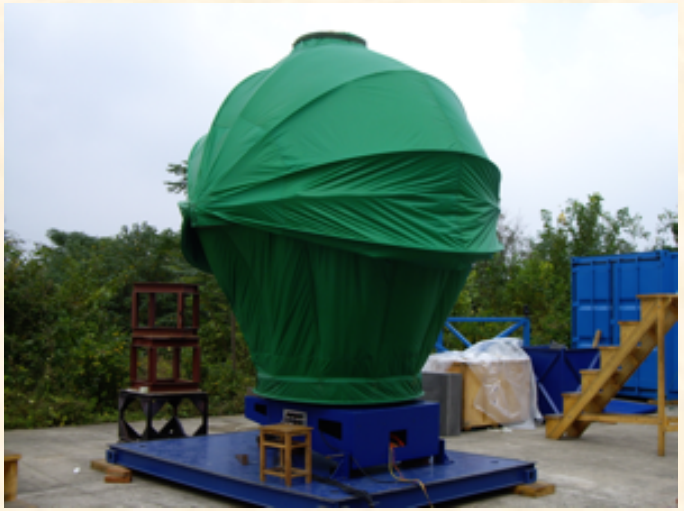
- Fully automatic survey
- Remote control (through configuration files)

- Survey control daemon “ast3d”—mutil-thread process
  - Survey related softwares
    - Survey scheduling
    - Telescope control
    - CCD control
    - CCD data acquisition
  - Other supplementary functions
- Real-time pipeline
- Database

1.Survey Control Daemon -- ast3d

Multi-thread process

- Survey Control thread
  - Survey scheduling
  - Telescope pointing, focusing
  - Acquisition
  - Distributing images to storage and pipeline
- CCD Controal thread
  - Power on/off CCD as scheduled
- Config update thread
  - No need to restart ast3d
- De-snow thread
- Alarm thread（telescope, CCD）



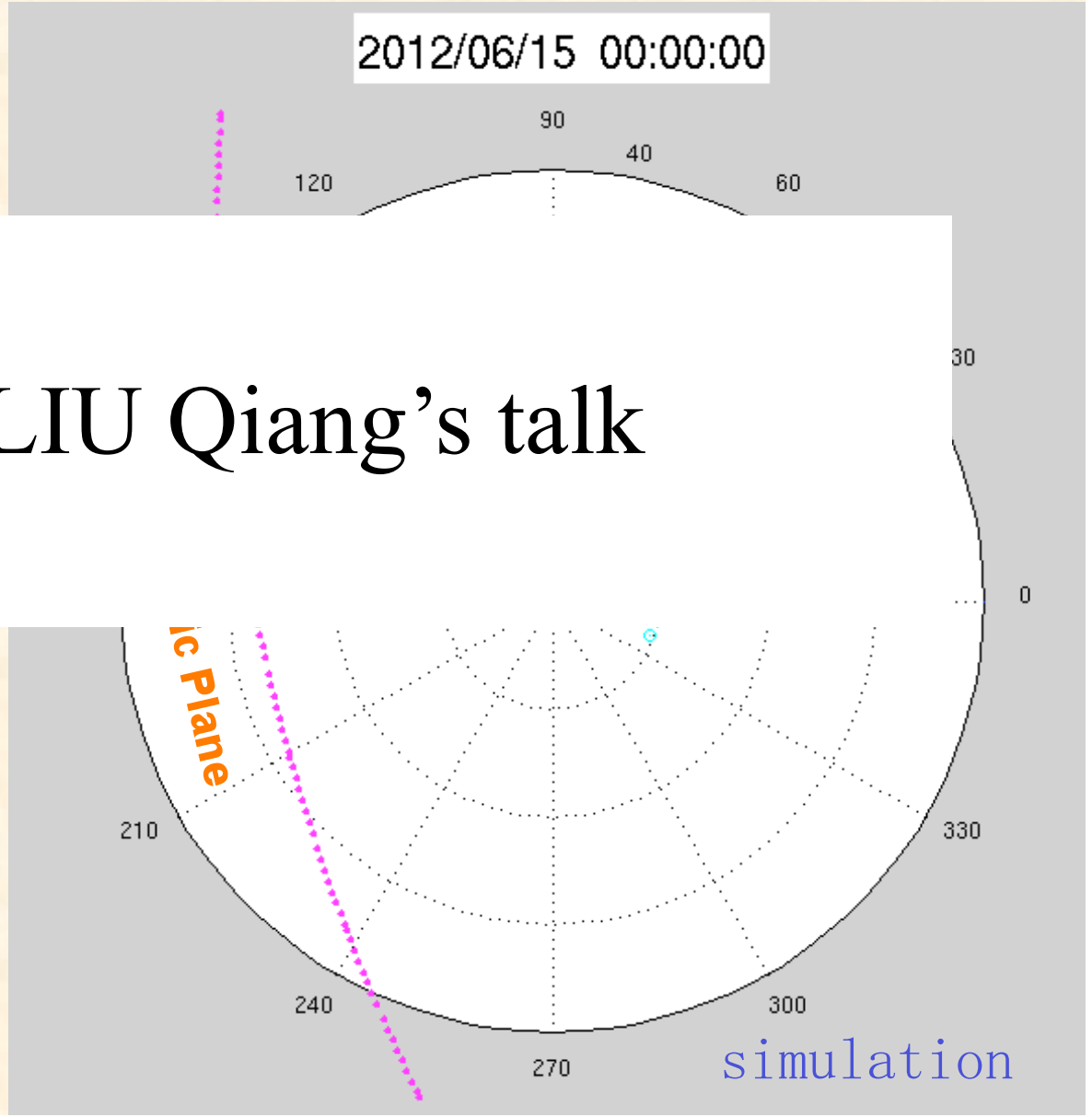
2. Survey Scheduling, Telescope and CCD Control

Survey Scheduling

Automatically select the best field from the survey areas maximizing t

- Sun altitude
- Zenith distar
- Minimize tel
- Low sky background

LIU Qiang's talk



2. Survey Scheduling, Telescope and CCD Control

Telescope Control

ast3d communicates with telescope control server (NIAOT) via local network

XU Lingzhe's talk

CCD Control and Image Acquisition

ast3d communicates with CCD controller

- command-line (for testing)
- contact server via local network (for survey)

3.Real-time Pipeline System and Database

Requirements

- Real-time, fast, stable
- Fully automatic
- Automat

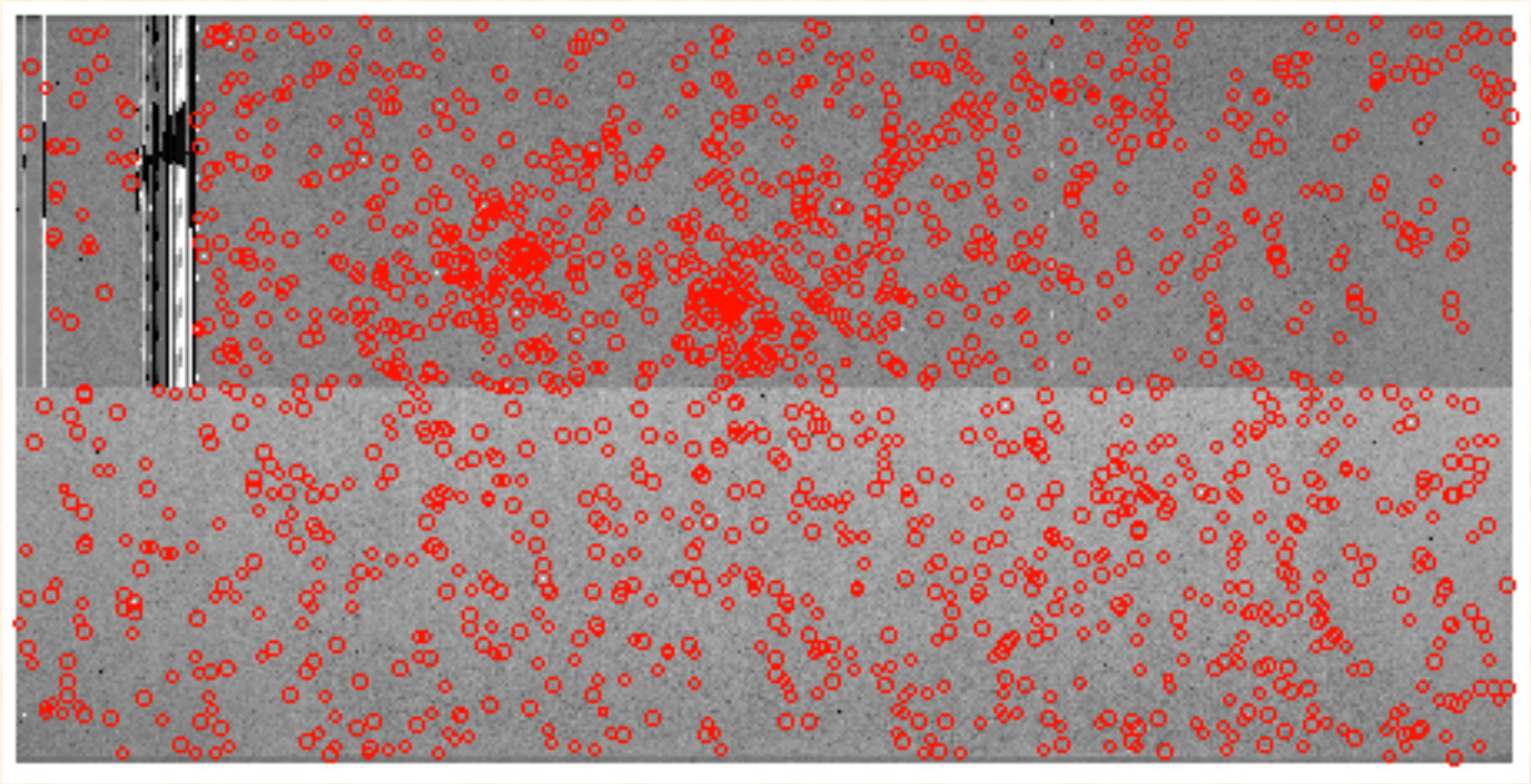
Real-time

1. Daemo
   - Detec
   - Start
2. Pipeline
   - Photometry
   - Astrometry
   - Light-curve analysis (to be added)

MA Bin's talk

Tests

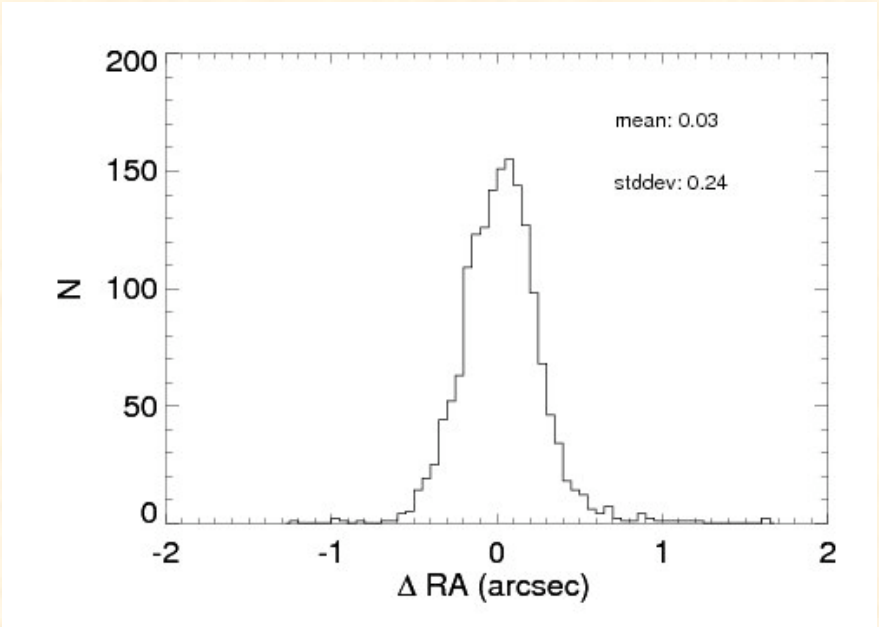
Test Obseration at XuYi



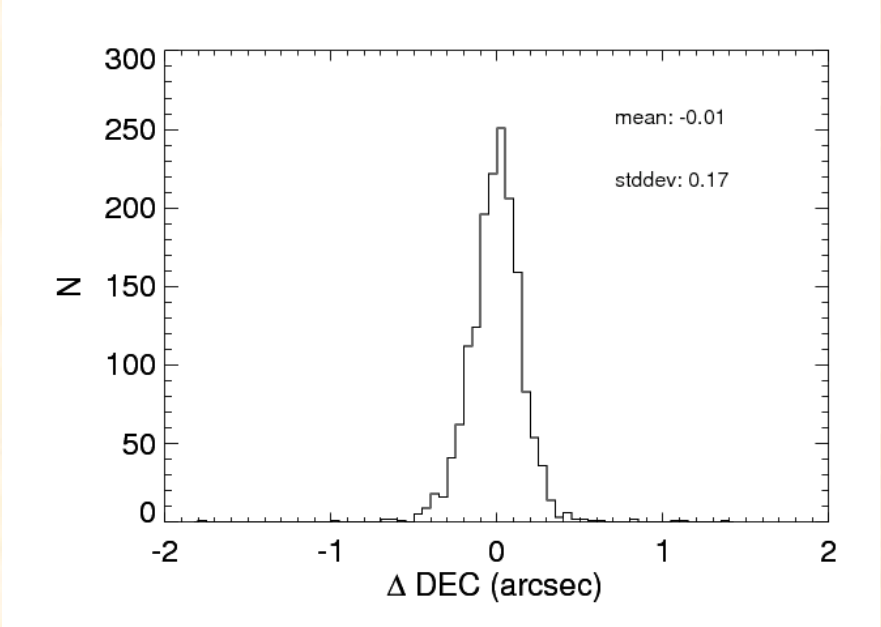
- Double Cluster (NGC884,NGC869,英仙座双星团)
- 1sec exposure, 1600 sources detected.
- CCD temperature ~ 0°C

XuYi test—astrometry（pipeline）

10Kx5K astrometry accuracy 0.2”（1σ, comparing to PPMX）



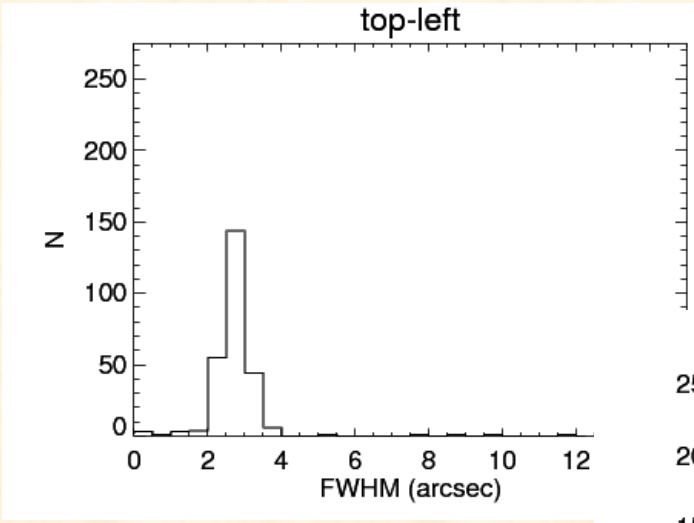
RA-RA0

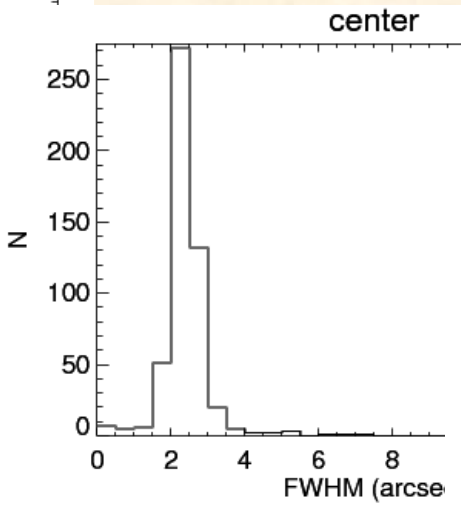


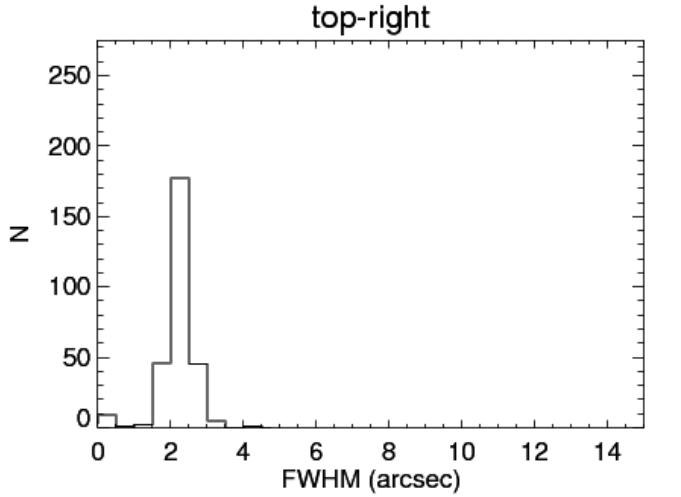
Dec-Dec0

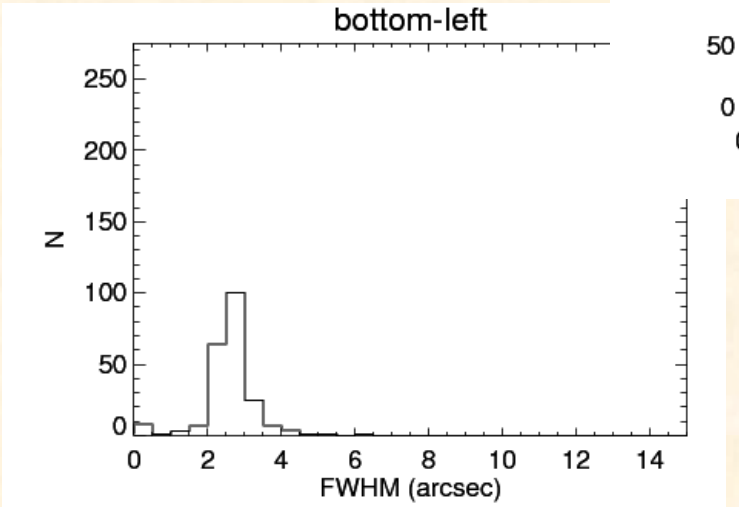
- Double Cluster （NGC884,NGC869,英仙座双星团）
- Astrometry with SCAMP
- PPMX catalog uncertainty ~0.07”

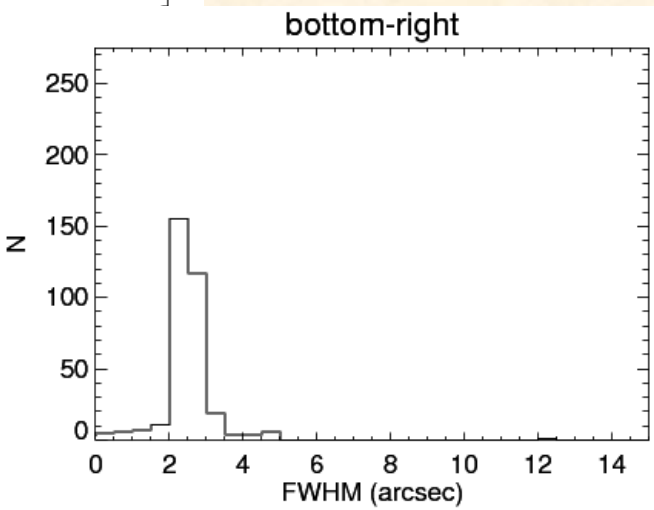
XuYi Test—Image quality on the focal plane



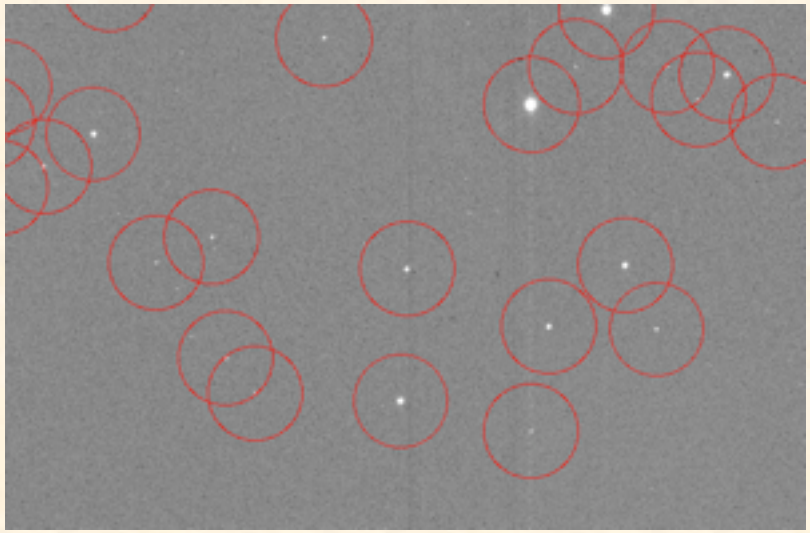


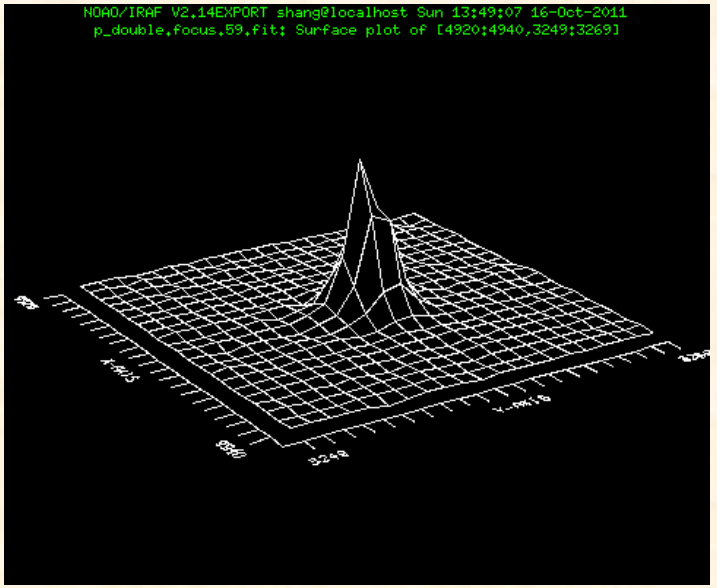


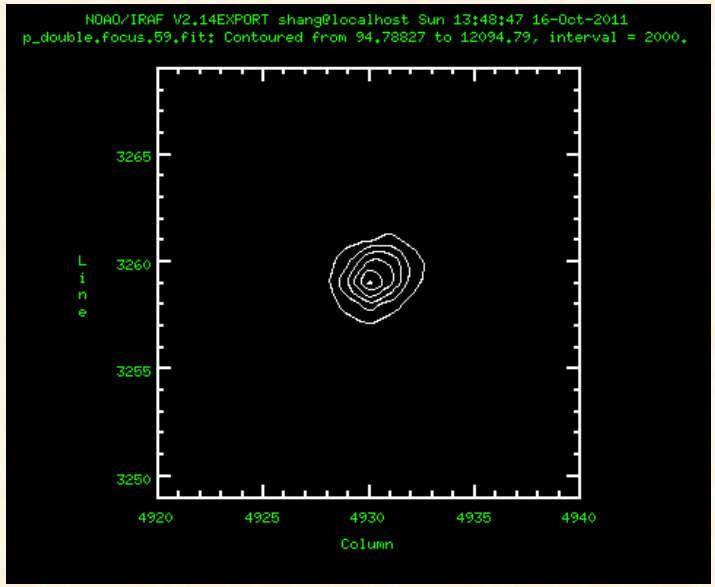


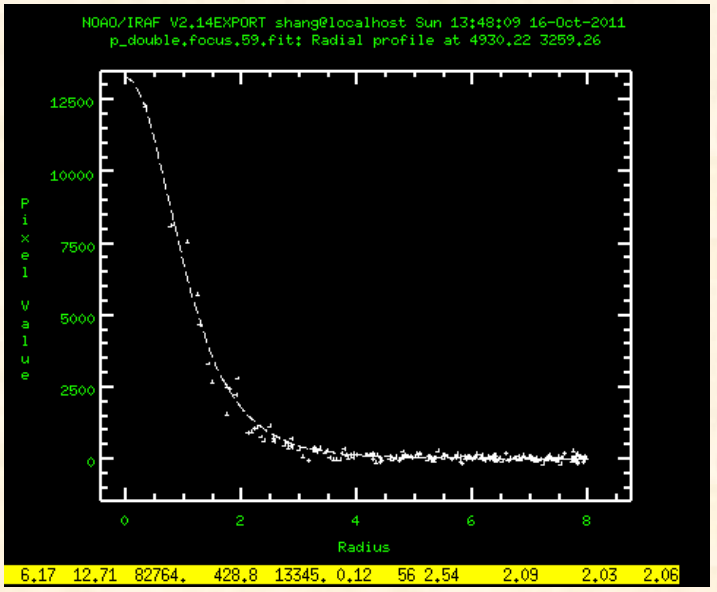


XuYi Test—FWHM<2”

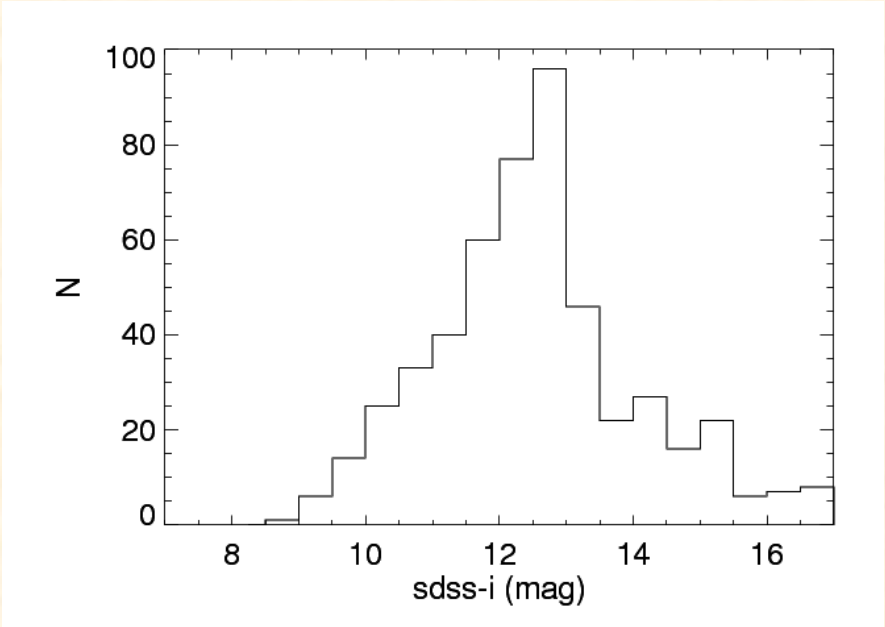


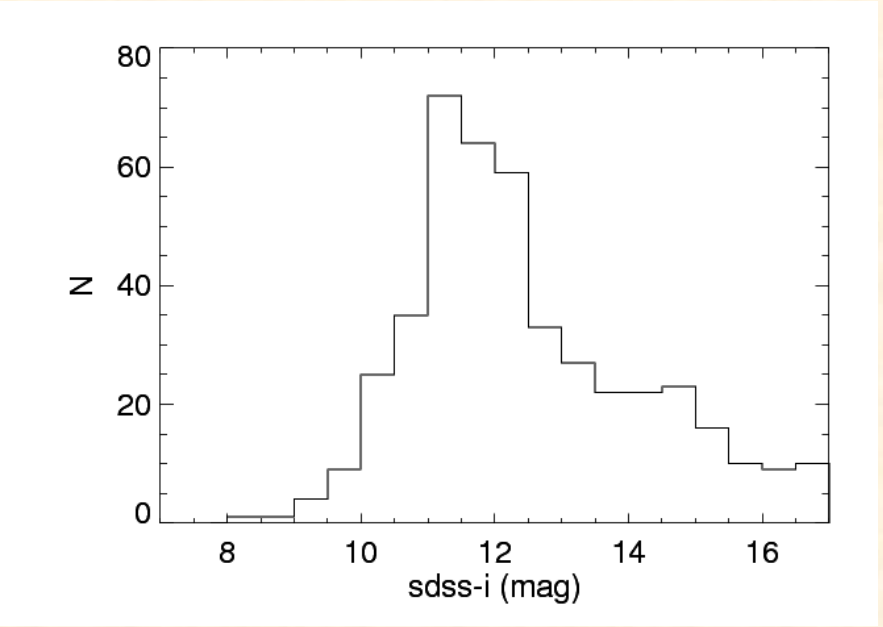






XuYi Test—“Limiting Magnitude”





- Compare with SDSS，i-band
- High dark current（TEC, CCD temperature～0°C）
- Reach 16 mag with a 10sec exposure

- Our team and Icebreaker Xuelong left Tianjin, China on Nov. 3rd.
- We will know more in January, and even more in March!

Thanks !