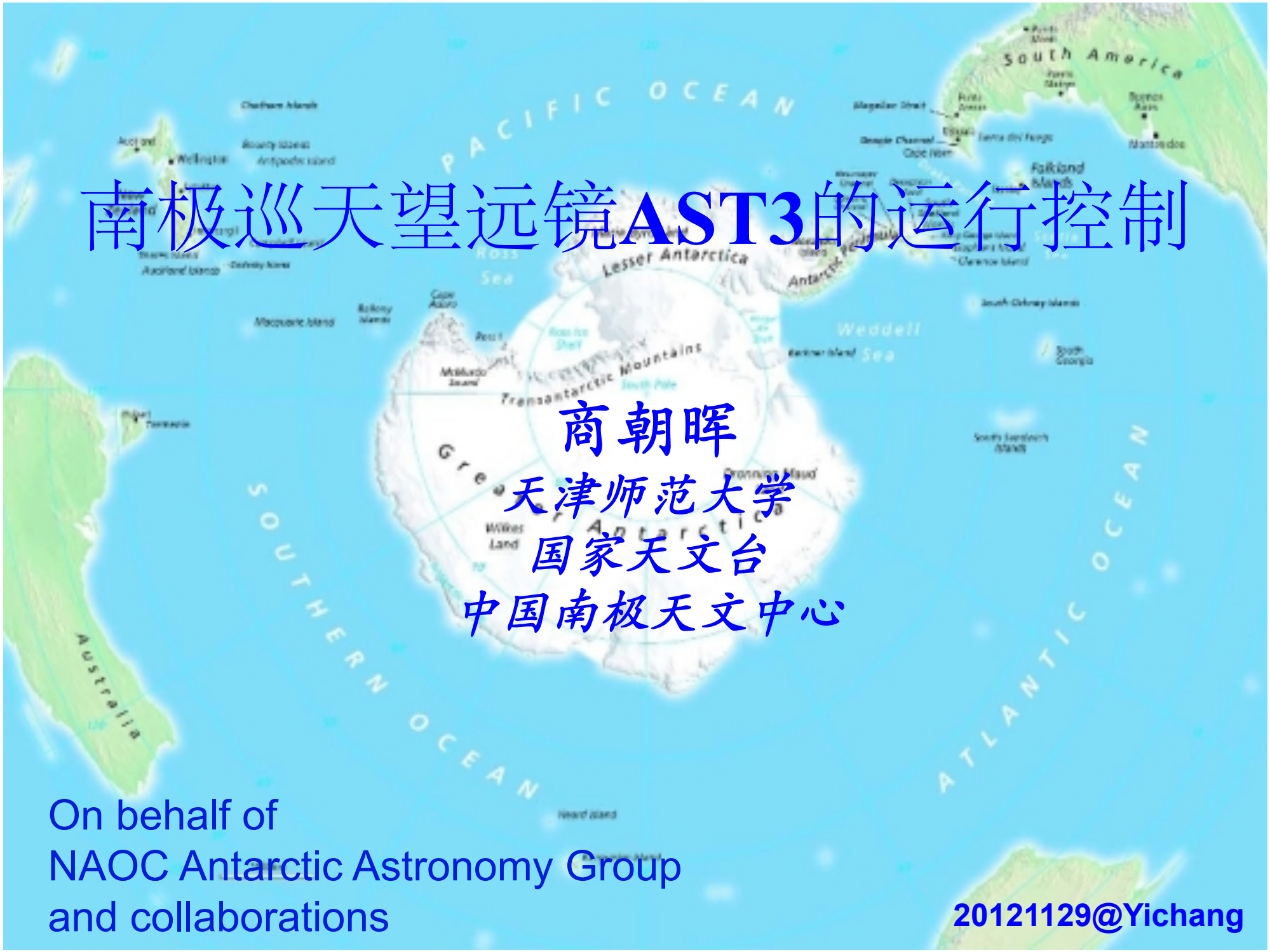



# 南极巡天望远镜AST3的运行控制


商朝晖

天津师范大学

国家天文台

中国南极天文中心


On behalf of
NAOC Antarctic Astronomy Group
and collaborations

20121129@Yichang

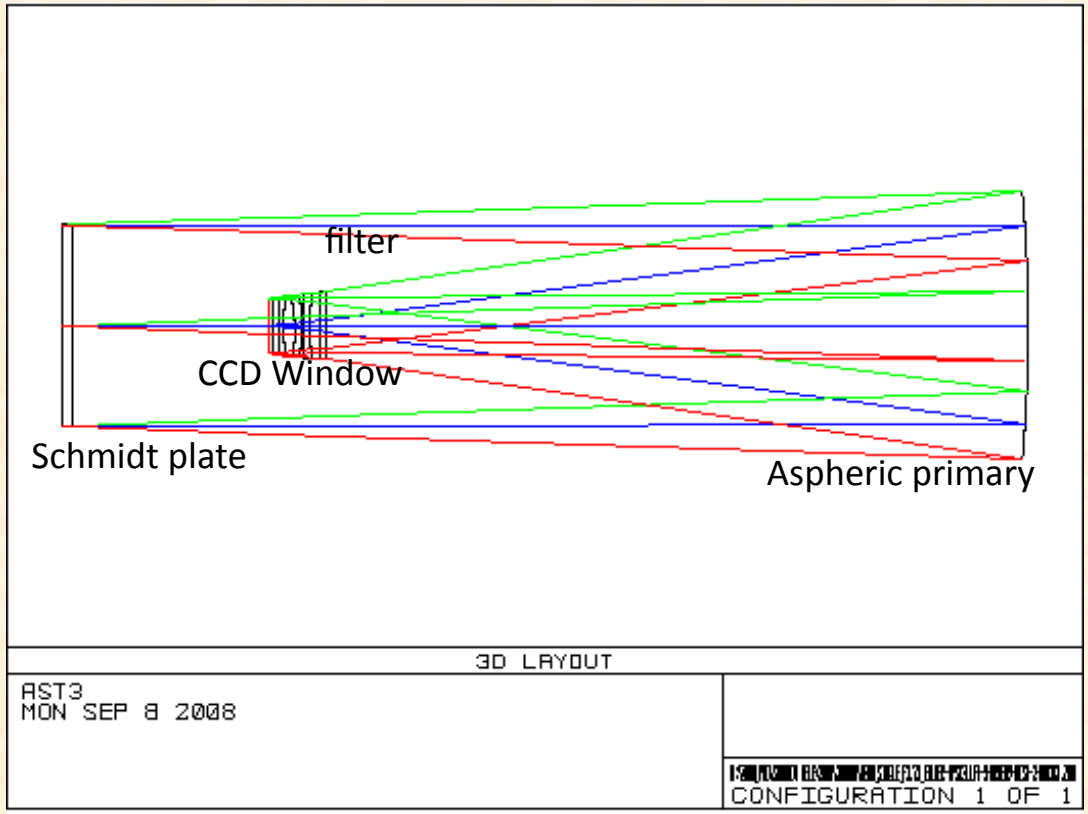
# Outline

- AST 3 system
- 2012 Operation
- Operation and Control systems
  - Computers, disk arrays
  - Survey softwares

# AST3 System

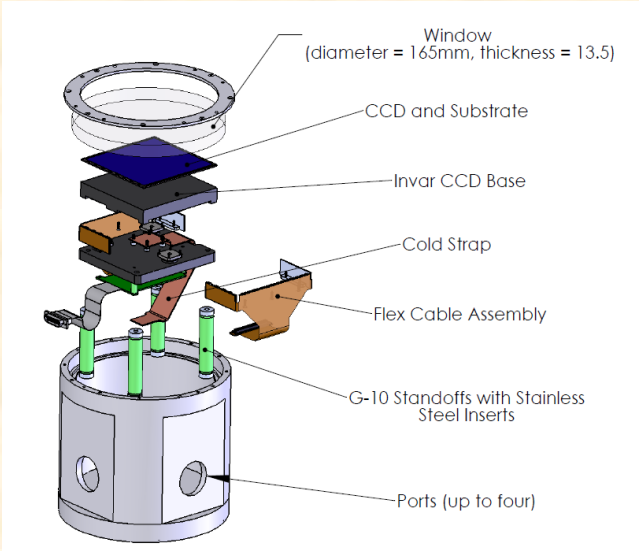
# Antactic Survey Telescope x 3 (AST3)

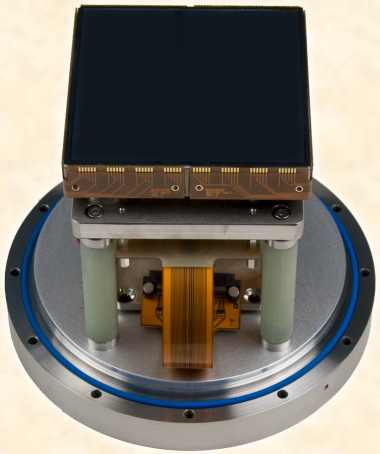
- Three 50/68cm modified Schmidt Telescopes (NIAOT);
  - spherical corrector
  - short tube
  - aberration correction
  - atmosphere dispersion corrector (ADC)
- Filters: g, r, i, IR(?),

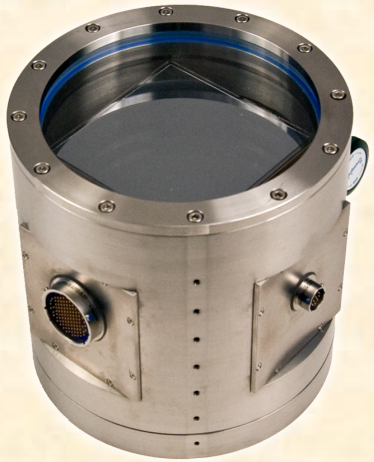


# AST3 CCD Camera

- CCD camera (STA1600-FT)
  - 10k x 10k (largest single CCD chip)
  - 9 micron/pixel
- Plate Scale: 1”/pixel

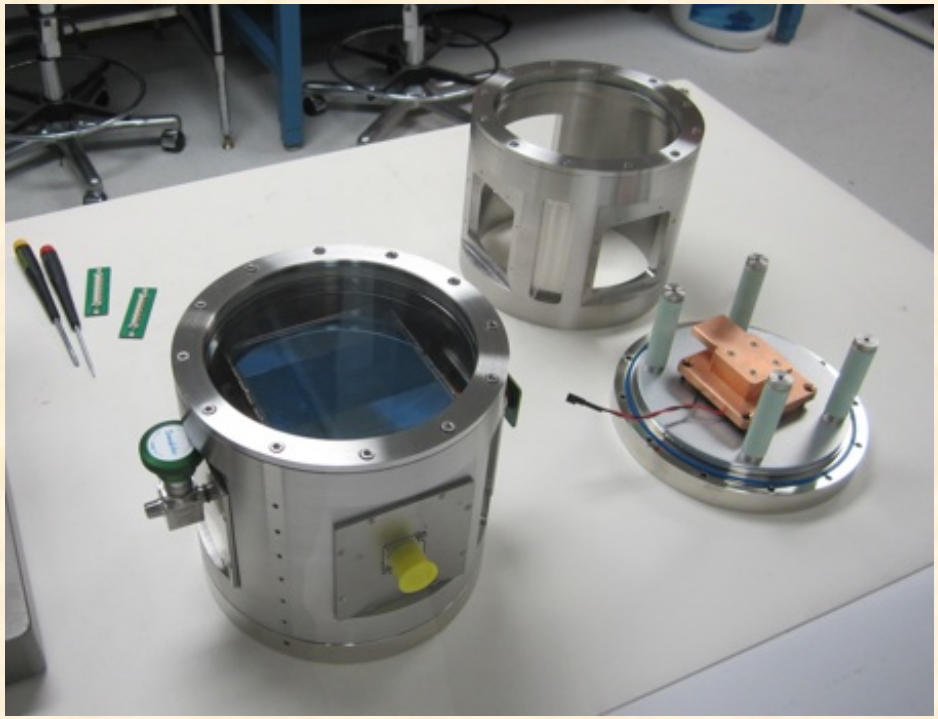


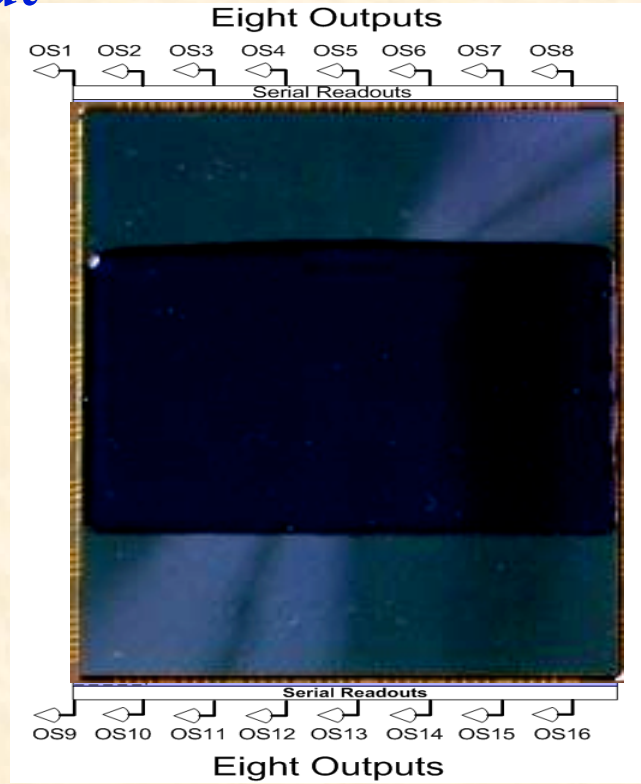





# AST3 CCD Camera

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





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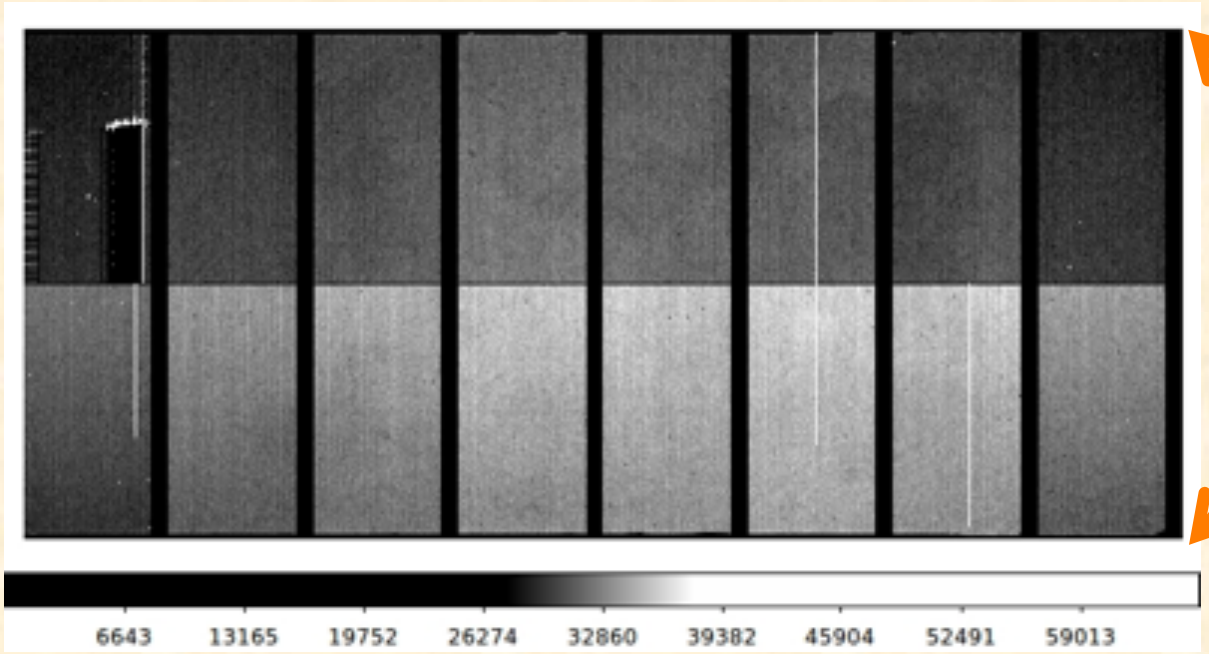
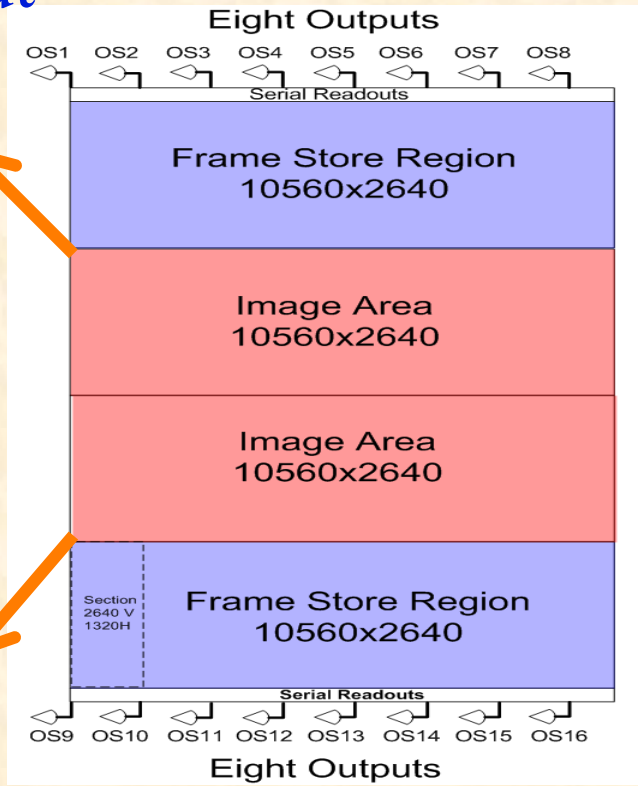
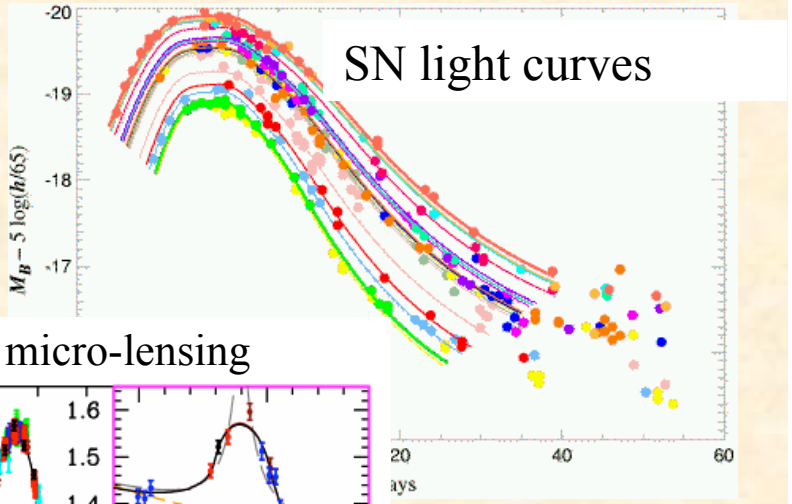


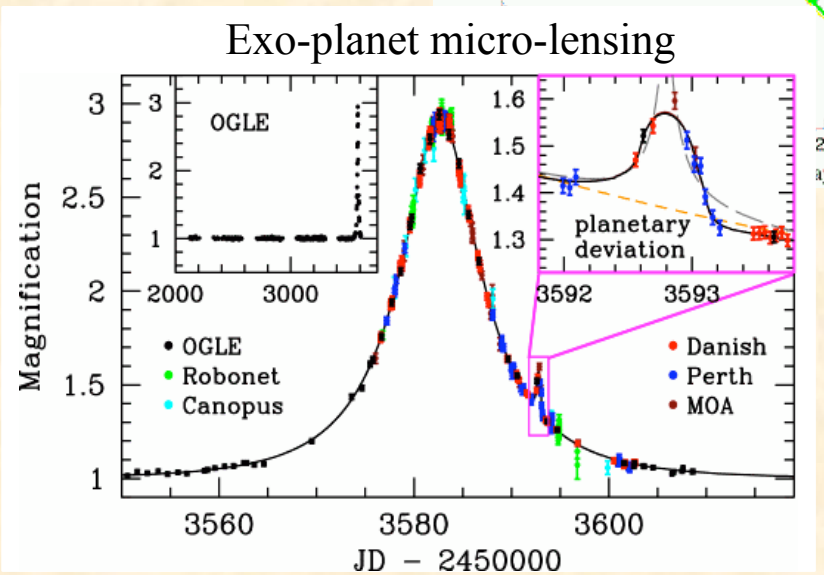




- Overscan: 180 columns/channel, 20 lines

# 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
- …



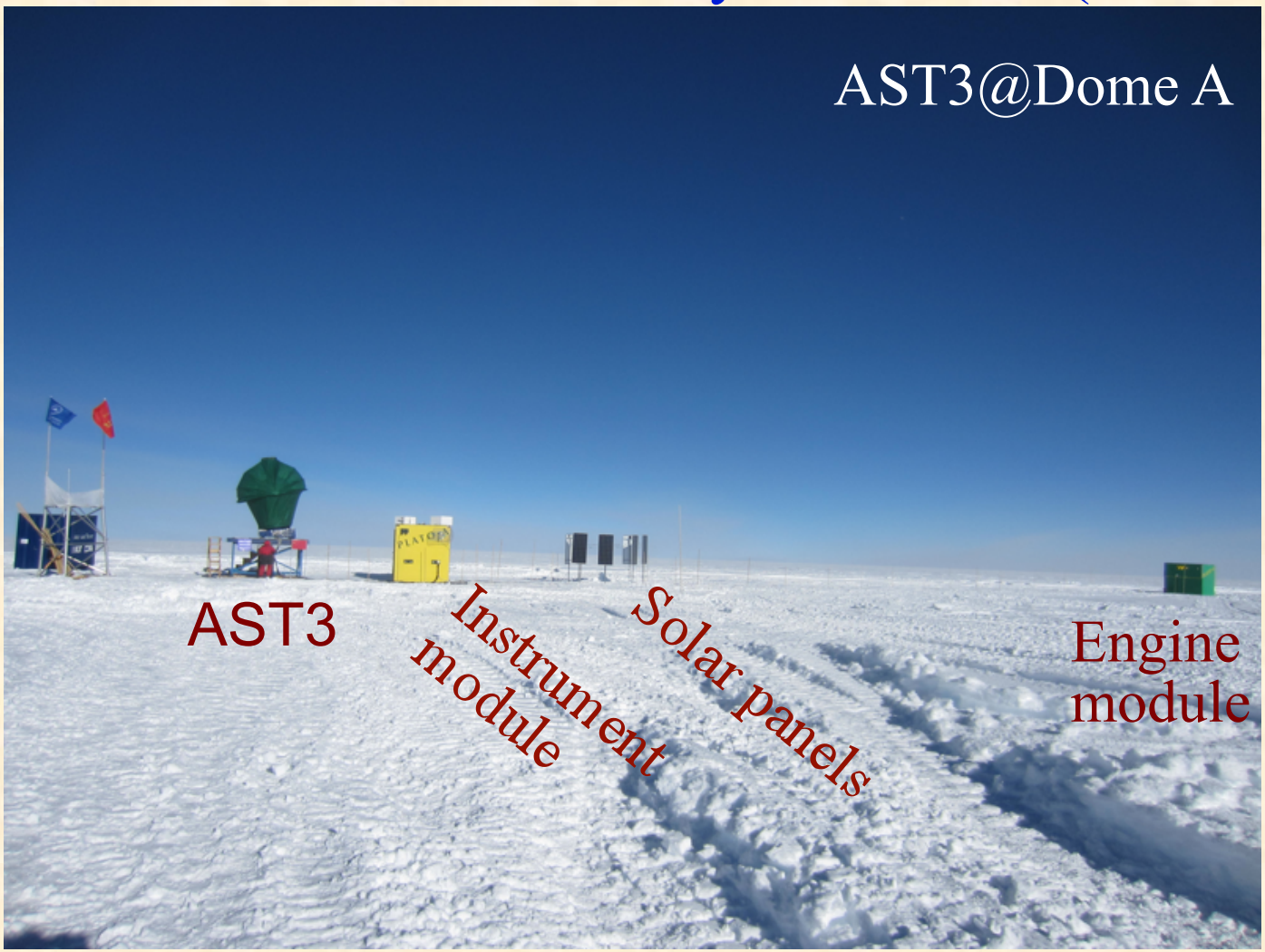




- High quality data
- Accruate photometry
- Real-time

# 2012 Operation

# AST3-1

- Installed the 1st telescope at Dome A in January 2012
- Power and communication by PLATO-A (UNSW)

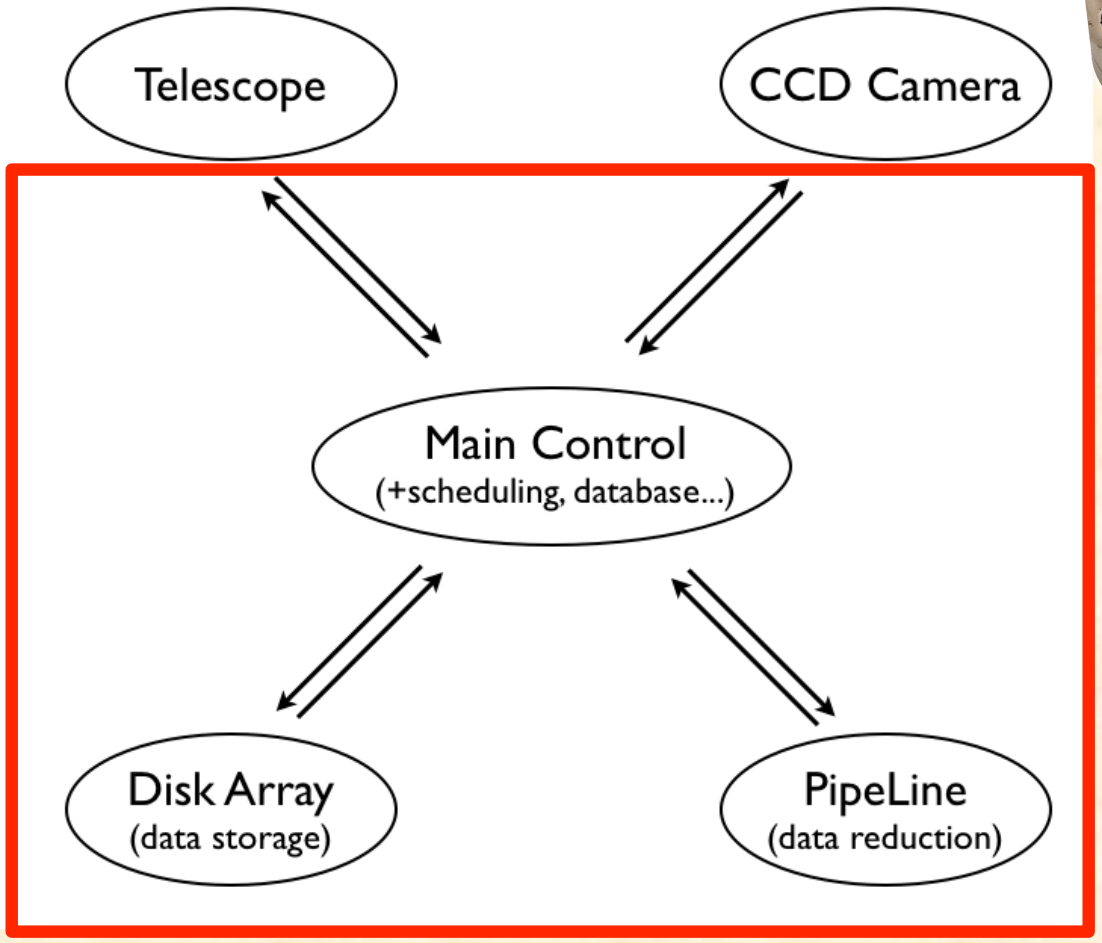


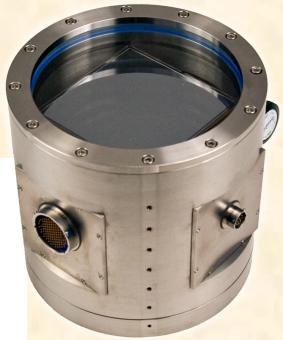
# AST3 Control, Operation and Data System (CODS)

## —Hardware + Software

AST3
Telescope

## AST 3 Survey



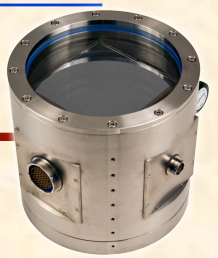



CCD
Camera

特殊要求

- 无人值守
- 低温低压
- 有限能源
- 低带宽
- 冗余
- 容灾

# AST3 Operation



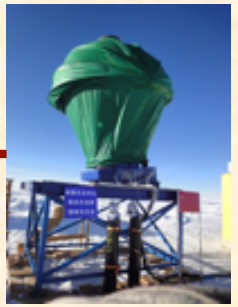
Optical fibre

CCD Controller

CCD Acquisition Card

PCIe

Telescope Control Computer



Remote Computer

Iridium satellites

AST3 MAIN COMPUTER

LAN

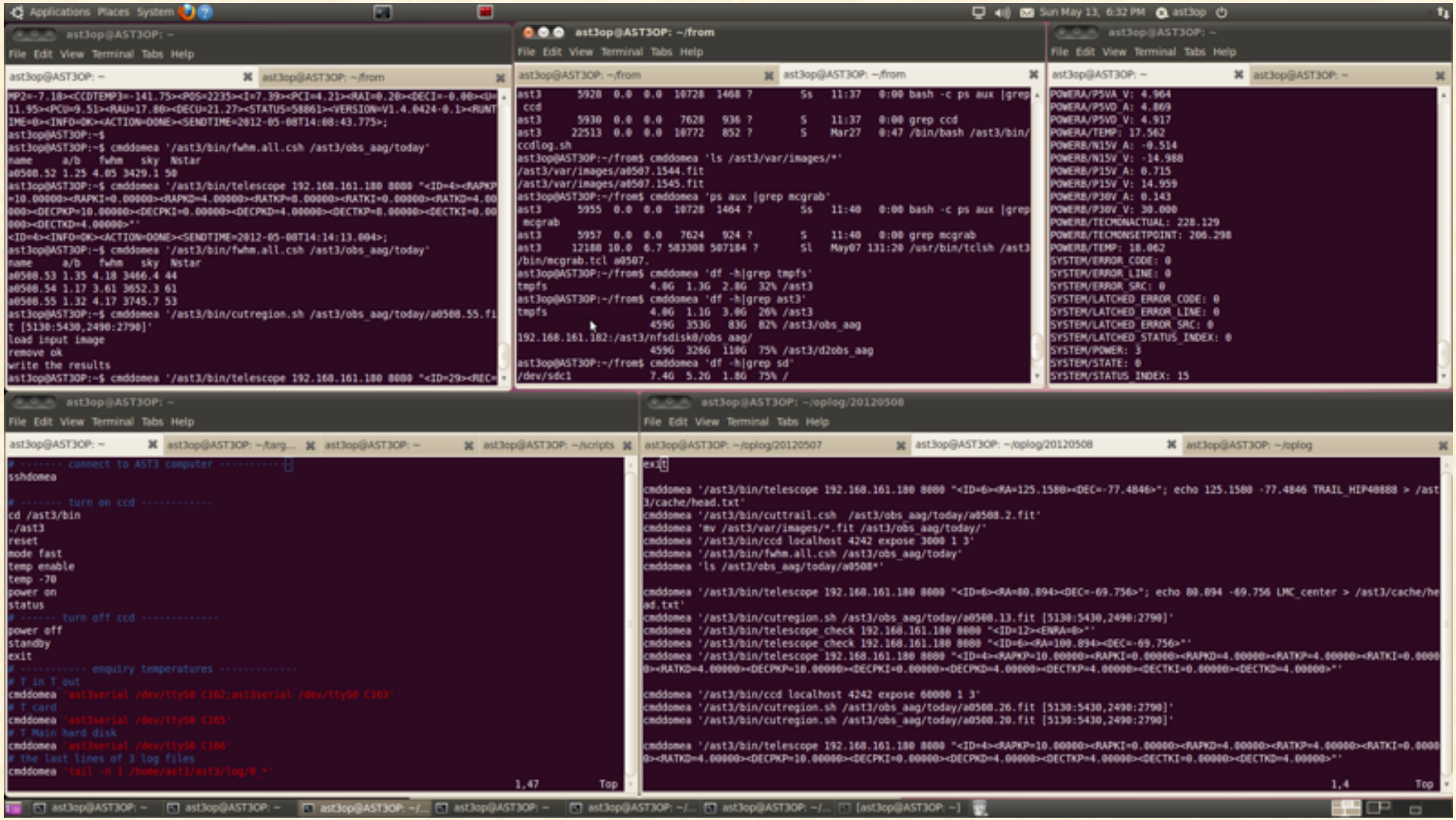
Disk Array Computer (x2)

Pipeline Computer (x2)

国内
NAOC,
Beijing

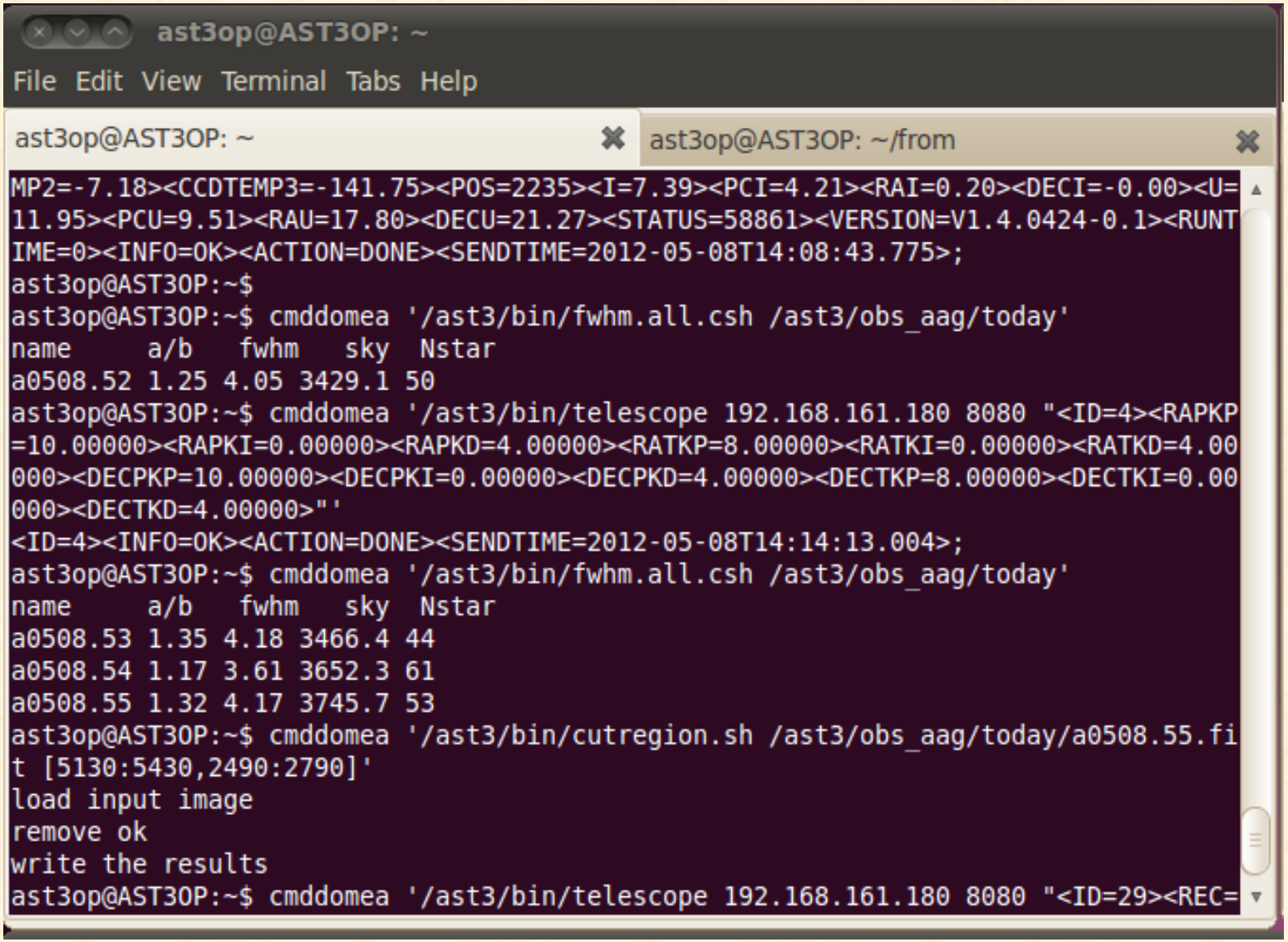
南极
PLATO-A
Instrument Module

# AST3 Operation (remote control)



Screenshot of NAOC computer during operation

# AST3 Operation (remote control)




**No GUI. Command-line instructions**

# AST3 Operation (remote control)

运行

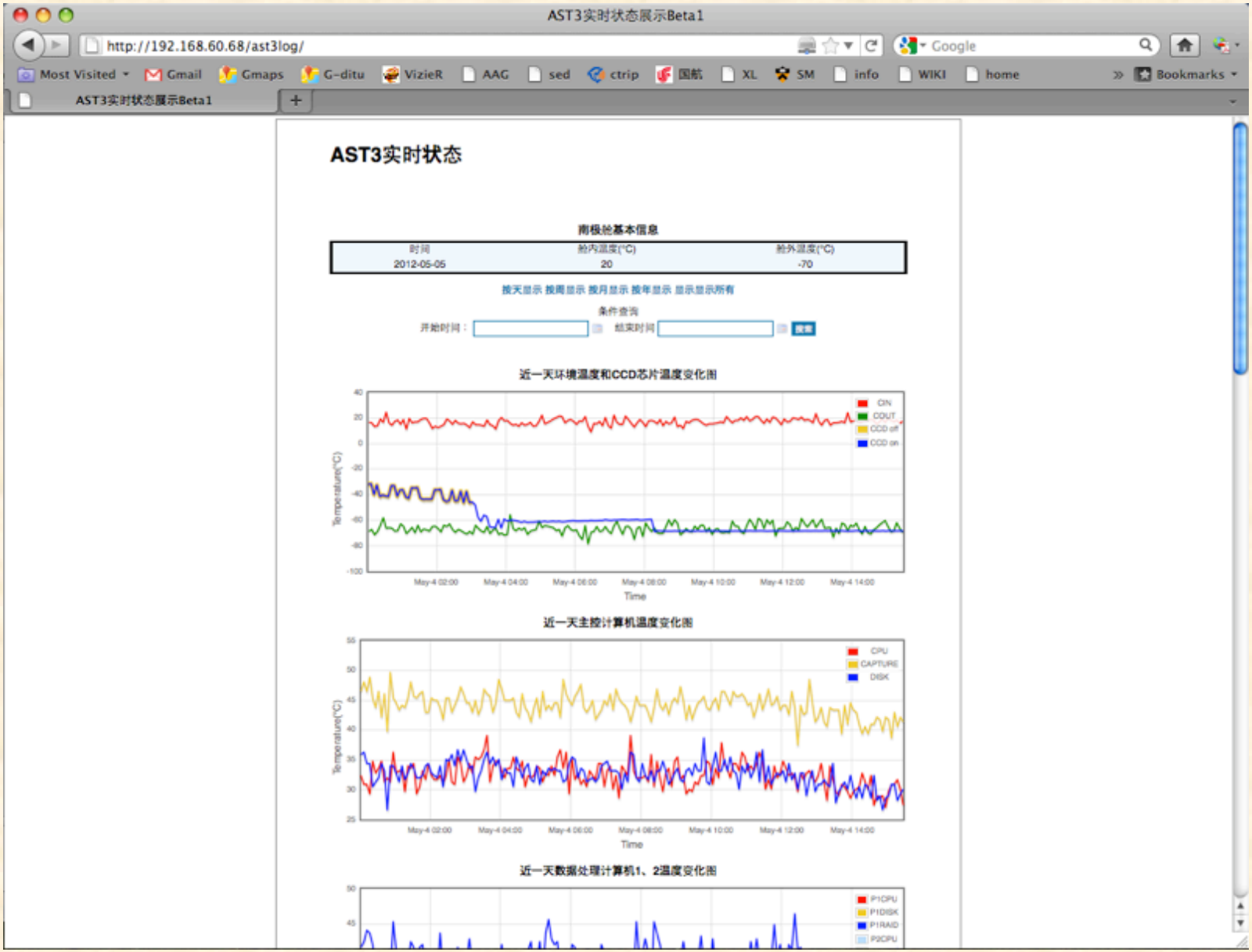
- 望远镜指令集 (pointing, tracking, …)
- CCD 相机指令集 (exposure， …)
- 运控计算机指令集 (power, temperature etc.)
- 数据（初步）处理和分析
  e.g., 图像测光和统计

```
ast3op@AST3OP:~$ cmddomea '/ast3/bin/fwhm.all.csh /ast3/obs_aag/today'
name      a/b    fwhm    sky   Nstar
a0508.53 1.35 4.18 3466.4 44
a0508.54 1.17 3.61 3652.3 61
a0508.55 1.32 4.17 3745.7 53
```

At a later stage, we were able to use scripts for all observations, making the survey semi-automatic.

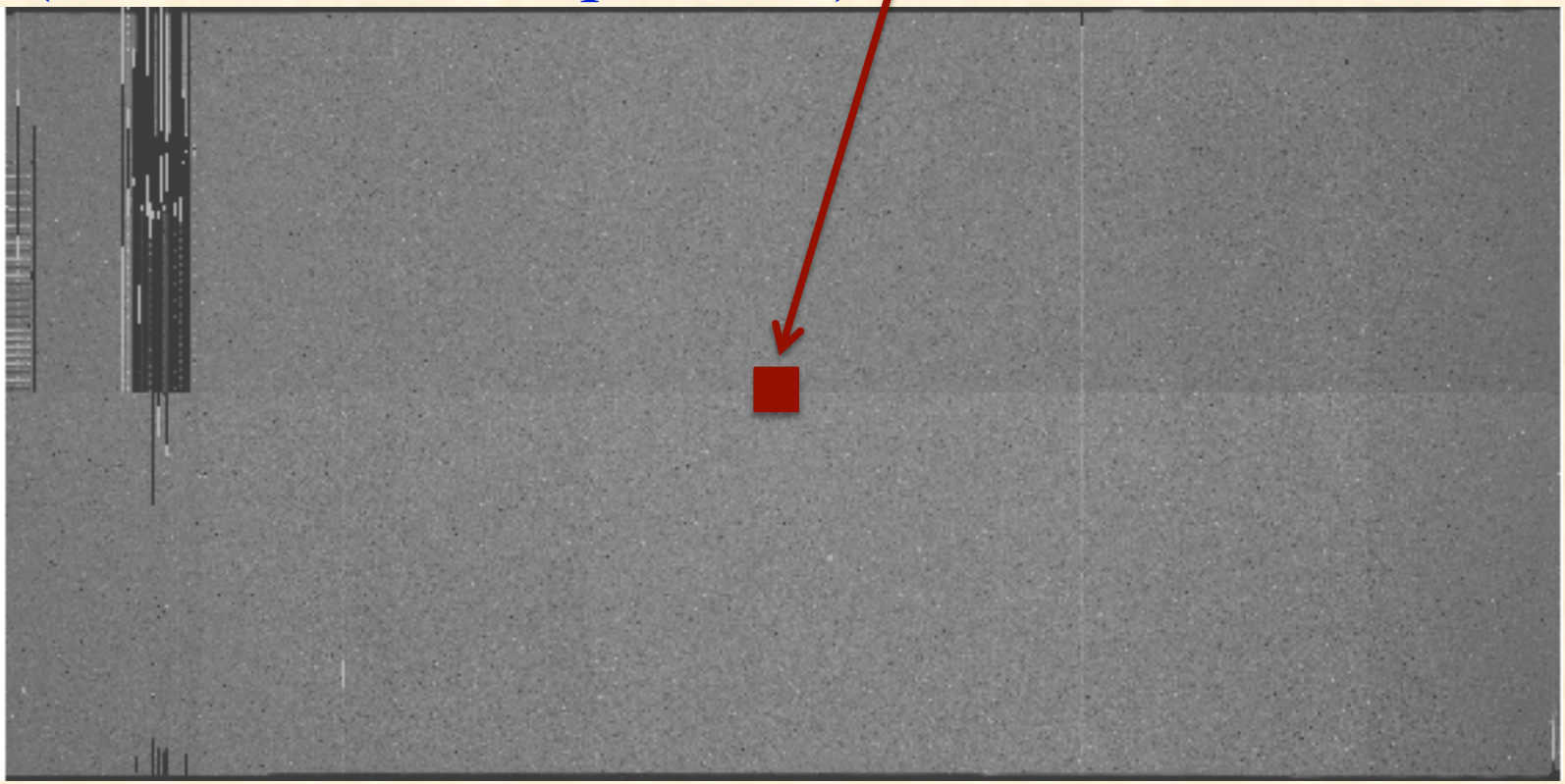
# AST3 Operation GUI for real-time status

三峡大学合作

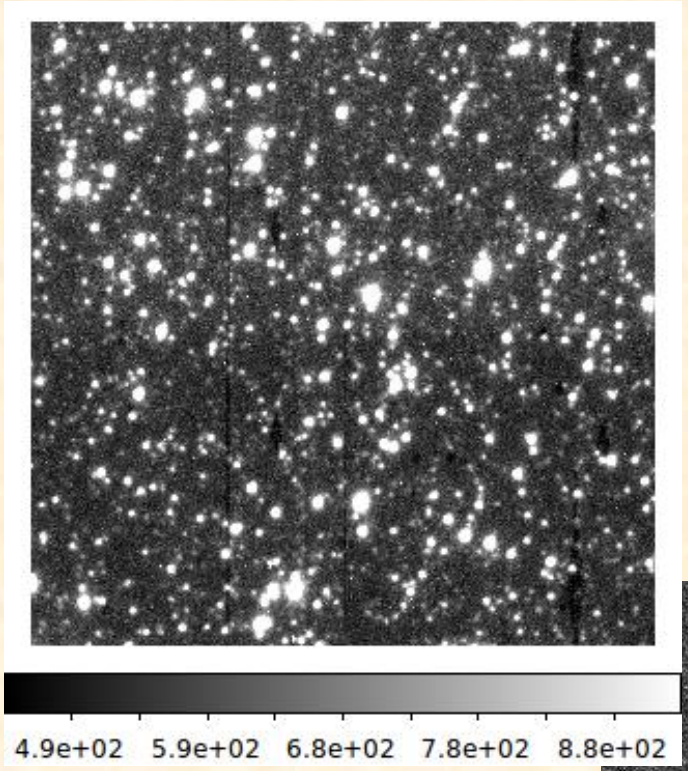


# AST3 data

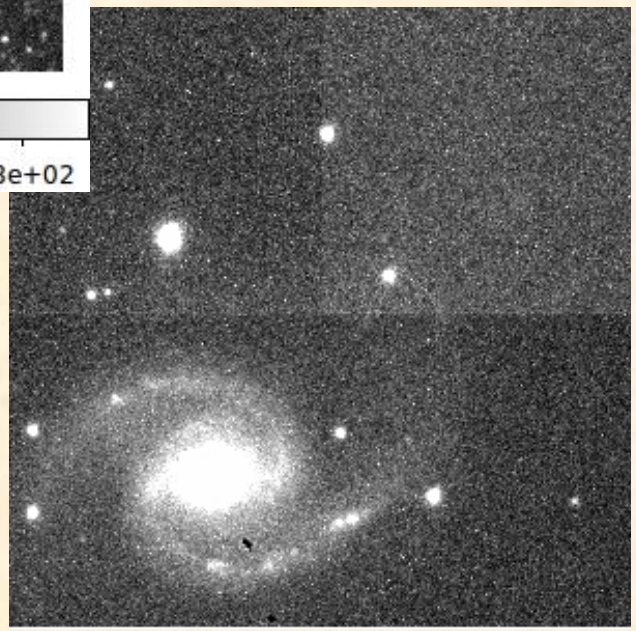
- Each CCD image: 10k x 5K (>100 Mbytes)
- Data transfer rate via Iridium OpenPort: $10/MB
- Stamp images: 300x300 （1/600 of a full frame) (~80KB after compression)

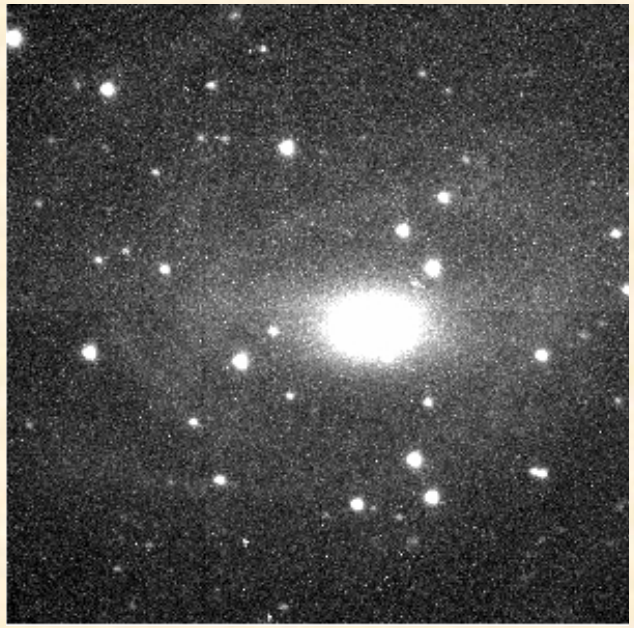


# Science Observations



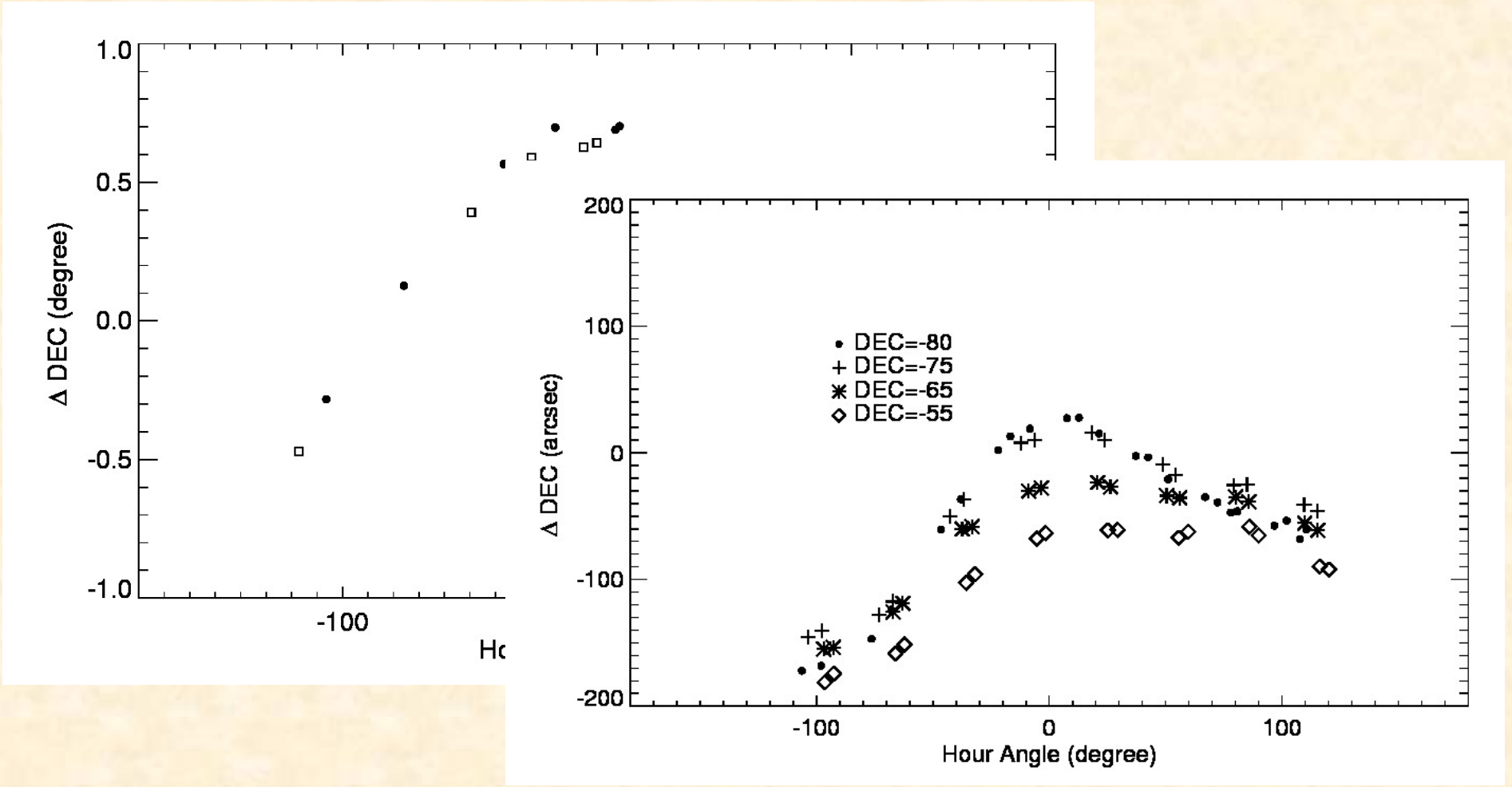

Obs in 2012: late March ~ early May
Targets: SNe, LMC, transit, QSO…





# Engineering Runs

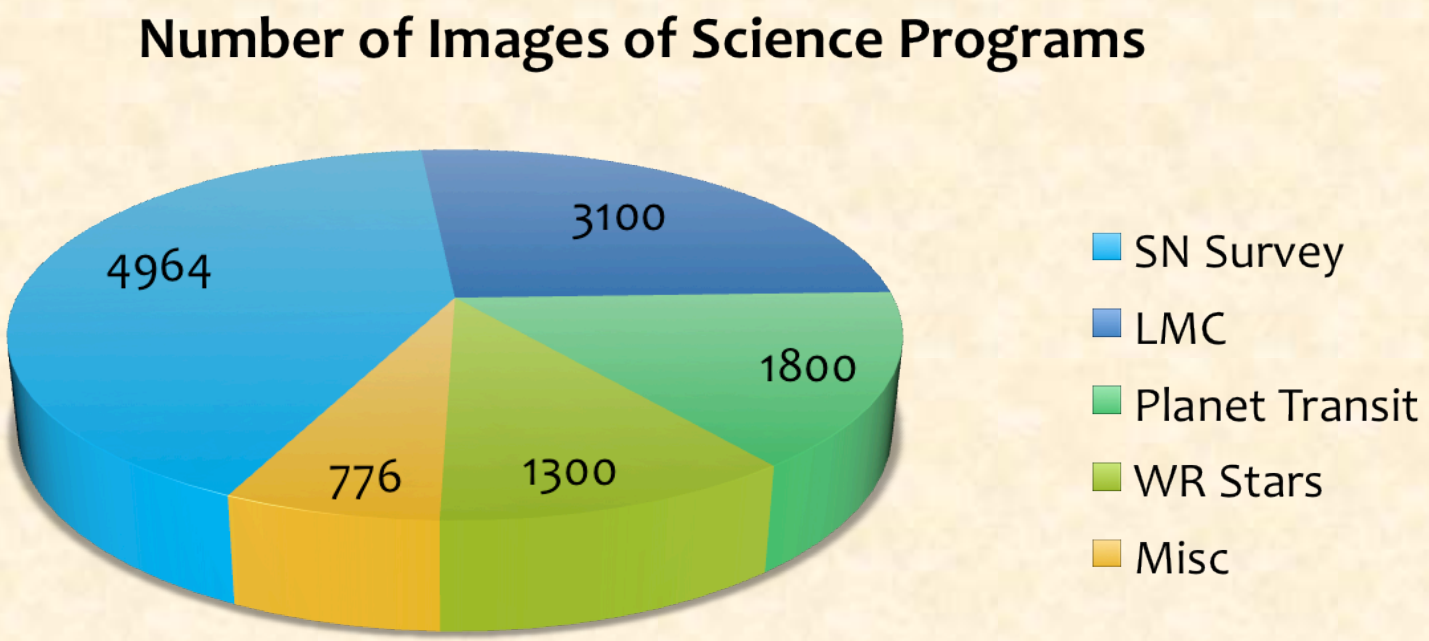
- Telescope Pointing Correction (TPoint)



# Summary of AST3 Operation

- Operation stopped in May due to a power-supply problem
- Collected 23,200 images, about 2.7TB data
- Sensitivity: i=19 (3 sigma) in 1 minute
- Image quality ~ FWHM~2”.0 (1”/pix, resolution limited by optics)
- No obvious clouds except for three nights

# Summary of AST3 Operation




We look forward to retrieving all the data next year.

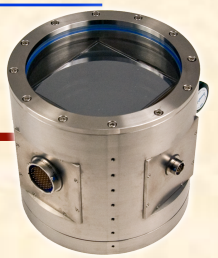
# What we learned from AST3 Operation

- Low temperature and pressure tests works
- Low power computers work
- Redundancy is necessary
- Problem with the most reliable device (PDB) which never had problems before

- Never be too optimistic on anything
- Reduce single-point failures
  - Dual power supply
  - Dual network connection
  - …
- Redundancy, redundancy, and redundancy

2012-2013

# AST3 Operation



Optical fibre

CCD Controller

CCD Acquisition Card

PCIe

Iridium satellites

Remote Computer

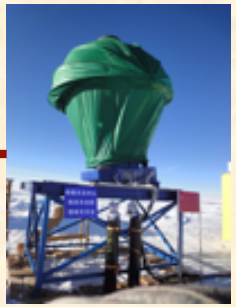
AST3 MAIN COMPUTER X 2

LAN

Telescope Control Computer

Disk Array Computer (x2)

Pipeline Computer (x2)



NAOC, Beijing

PLATO-A Instrument Module

# 硬件冗余设计

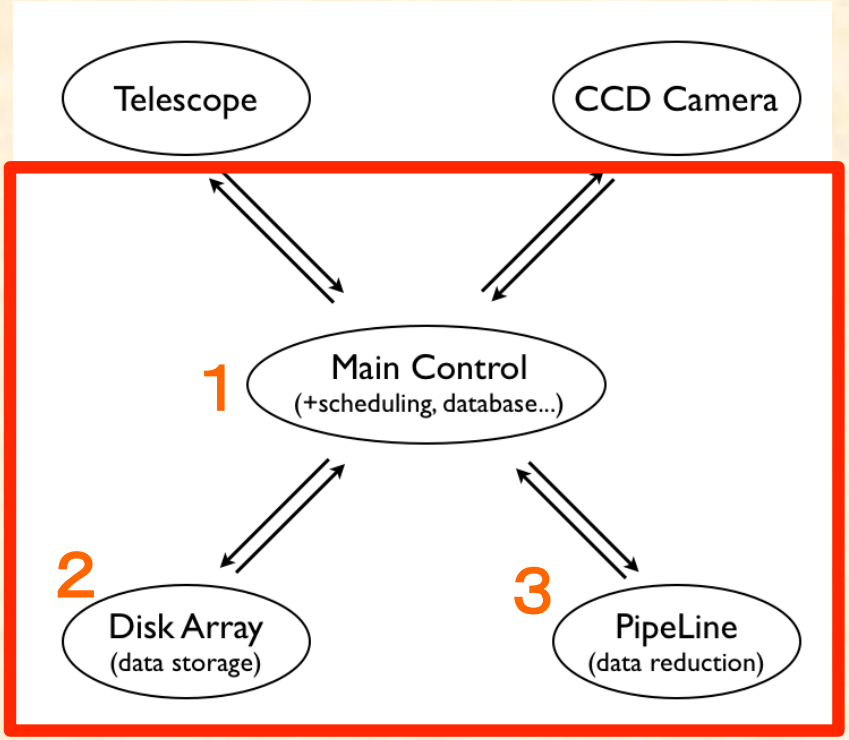
Reduce single-point failure

- 数据存储的冗余
- 数据处理计算机的冗余
- 开关电源PDU的冗余
- 主控计算机的冗余（2台）
- 主控计算机供电的冗余
- CCD通讯的冗余(光纤法兰)
- 网络通讯的冗余(两个千兆网卡，一个USB无线网卡)

# AST3 Control, Operation and Data System—Hardware

## Computers, Acquisition, and Storage Systems (Linux)

1. Main Control Computer x 2
   - Survey Scheduling
   - Data Acquisition
   - Database
   - Control other systems
2. Disk Arrays x 2
3. Pipeline Computer x 2
   - Real-time Pipeline
     (bandwidth too low to transfer images)



# Customized Computer 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）**
- **Low cost**

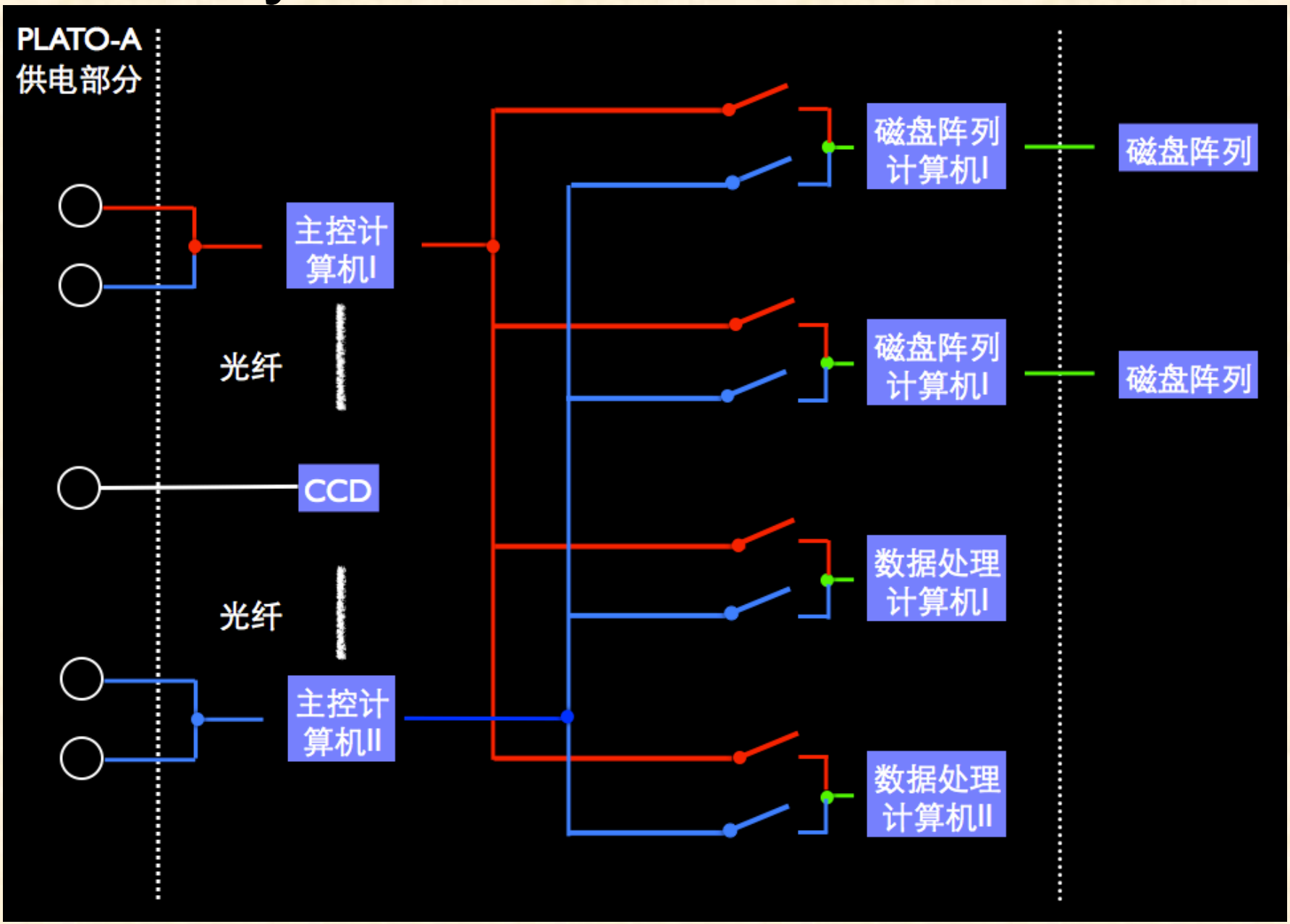
# Computers

## Laptop Configuration

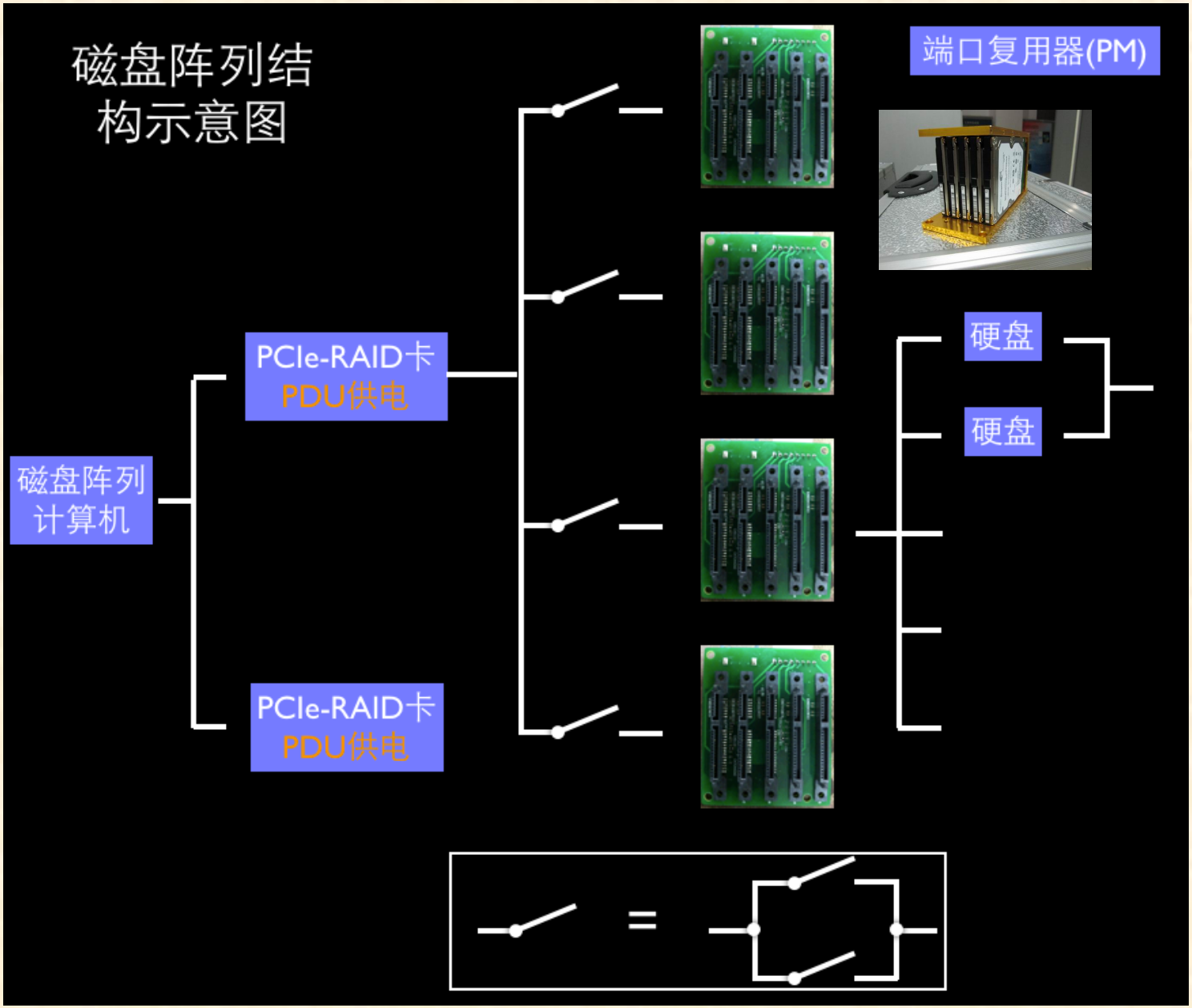
- FPC7502, -20°C
- CFAST卡, -40°C
- i7-620M CPU, 8G内存
- PCIe x 1, PCIe x 16
- COM1-4
- 千兆网口 x 2
- 待机功耗~20W, 正常工作~30W, 满载~40W

各个性能满足AST 3 需求

# System Power Control



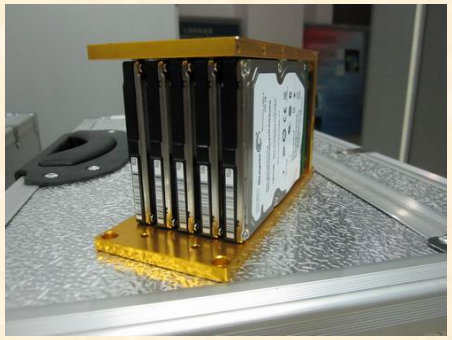
# Customized Data Storage Systems



# AST3存储阵列

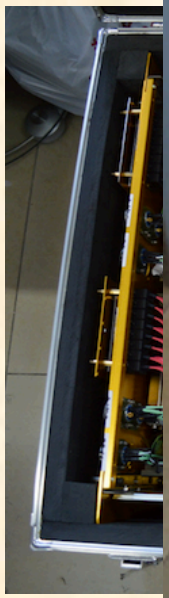
- 易于扩充
- 温控（-5°C到+5°C）
- 笔记本硬盘经过低温测试（SSD太贵）

2011-2012年：
（500Gx5）x4＝10T
两套做冗余和备份



2012-2013年：
（500Gx5）x8＝20T
两套做冗余和备份

# AST3数据处理计算机



昆仑天文

# Software

# 操作系统和运控软件

- UBUNTU 10.04桌面版(内核单独编译)
- AST3 SUITE:
  - 控制, 调度, 图像采集, 数据分发, 日志记录
  - 数据存储管理

# AST3 Control and Data System—Software (Linux)

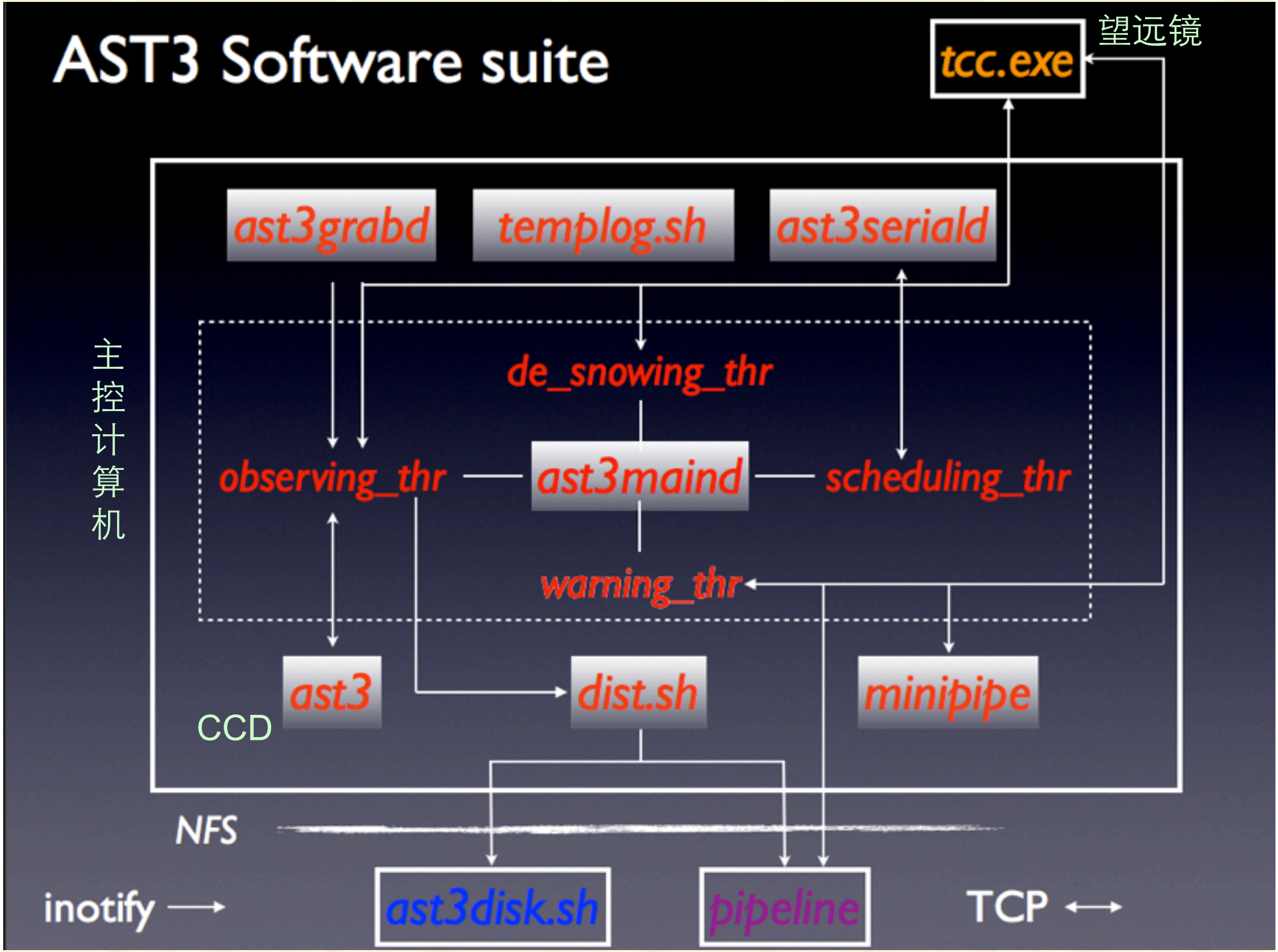
## Original design principles:

- Fully automatic survey
- Limited remote control

## Improvements

- threads => processes (daemon)
- Operation modes
  - Interactive (command-line)
  - Semi-automatic (script-based)
  - Fully automatic, if everything works properly

- Flexible individual instrument control commands (telescope, ccd, ast3serial)


AST3 Software suite
tcc.exe
望远镜
ast3grabd
templog.sh
ast3seriald
主控计算机
de_snowing_thr
observing_thr
ast3maind
scheduling_thr
warning_thr
ast3
CCD
dist.sh
minipipe
NFS
inotify
ast3disk.sh
pipeline
TCP

谢谢！