AST3 in 2015

Zhaohui Shang

National Astronomical Observatories, CAS

Tianjin Normal University

Chinese Center for Antarctic Astronomy

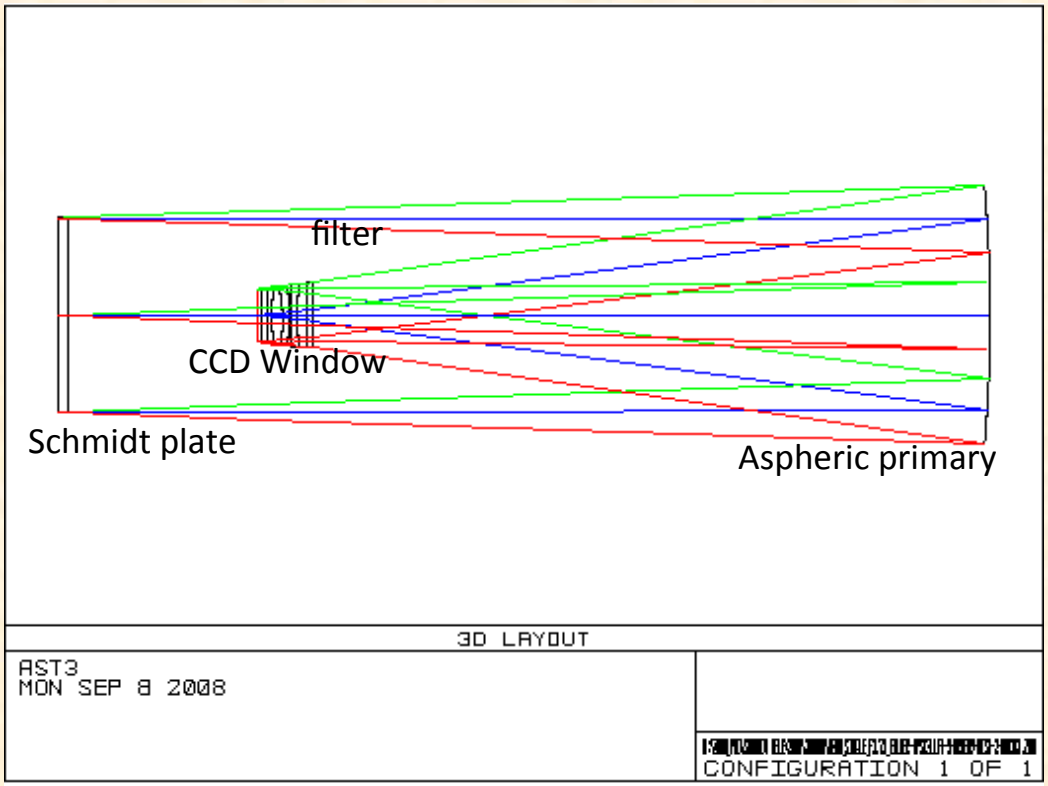
20151127@Tianshui

Outline

1. AST3 in 2013/2014
2. AST3 in 2015

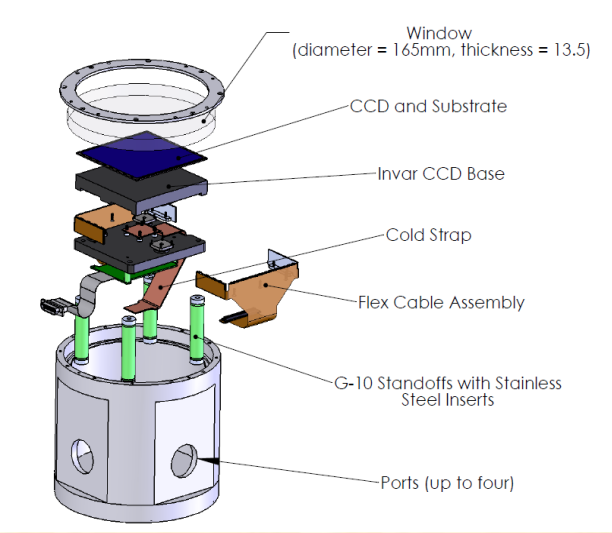
Antactic Survey Telescope x 3 (AST3)

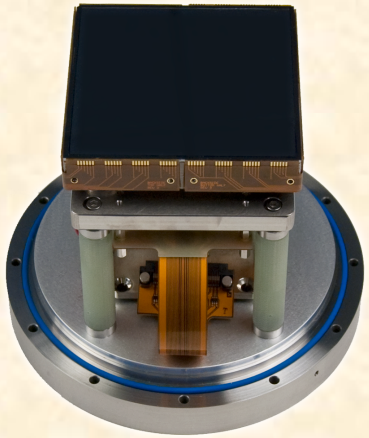
- Three 50/68cm modified Schmidt Telescopes (NIAOT);
  - spherical corrector
  - short tube (optical length 2.4m)
  - aberration correction
  - atmosphere dispersion corrector (ADC)
- Filters: g, r, i

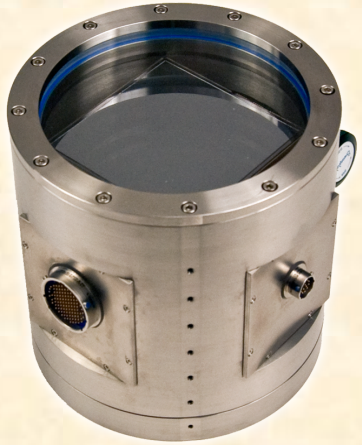


AST3 CCD Camera

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

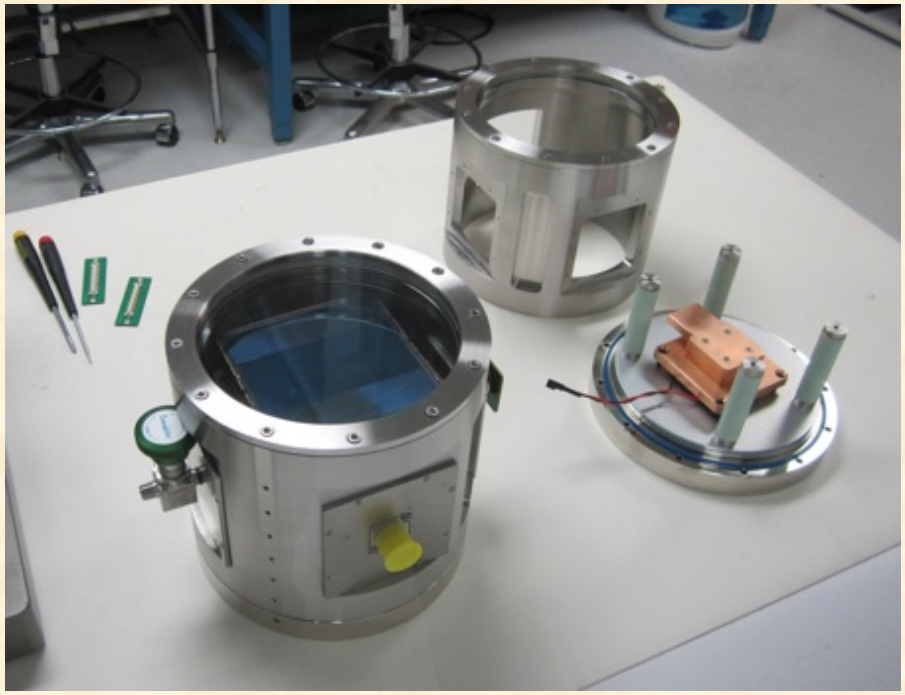


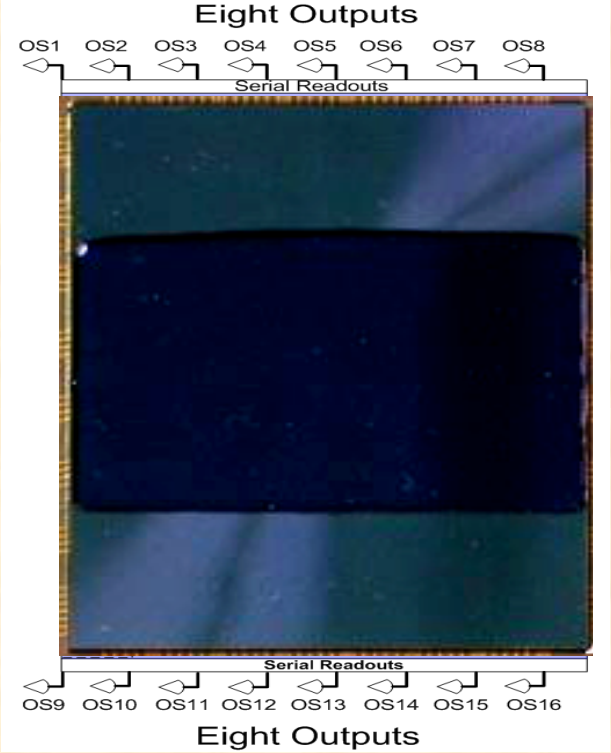




AST3 CCD Camera

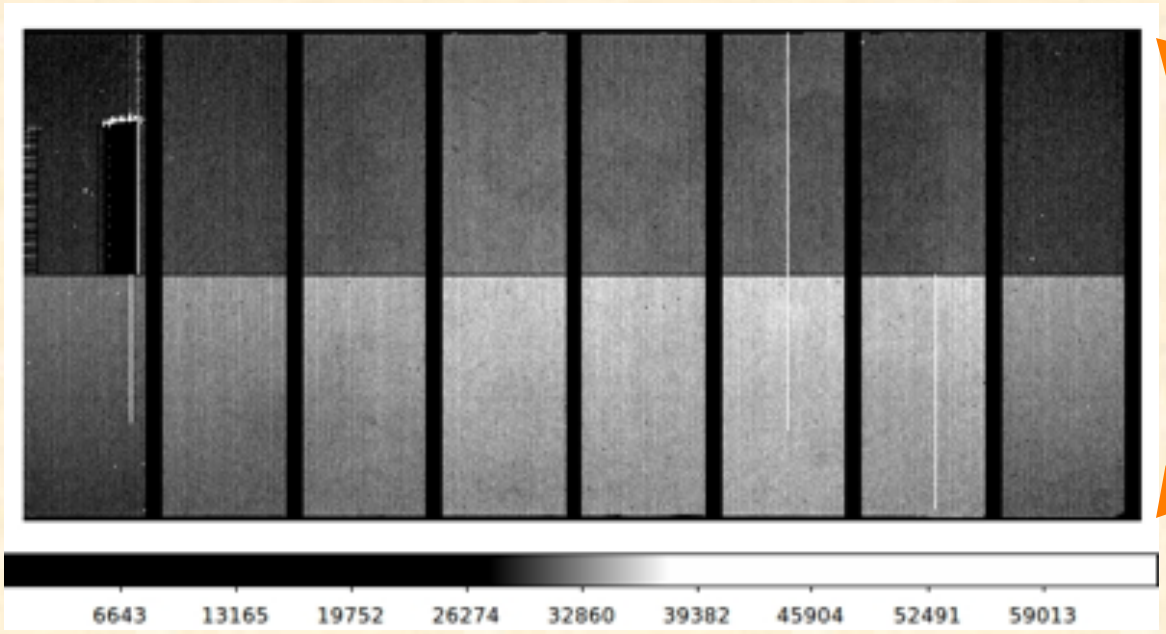
- No shutter, to avoid mechanical failure
- Operated in Frame Transfer mode， 10k x 5k
- FOV: ～4.3 sq. degree
- 16 readout channels for fast readout

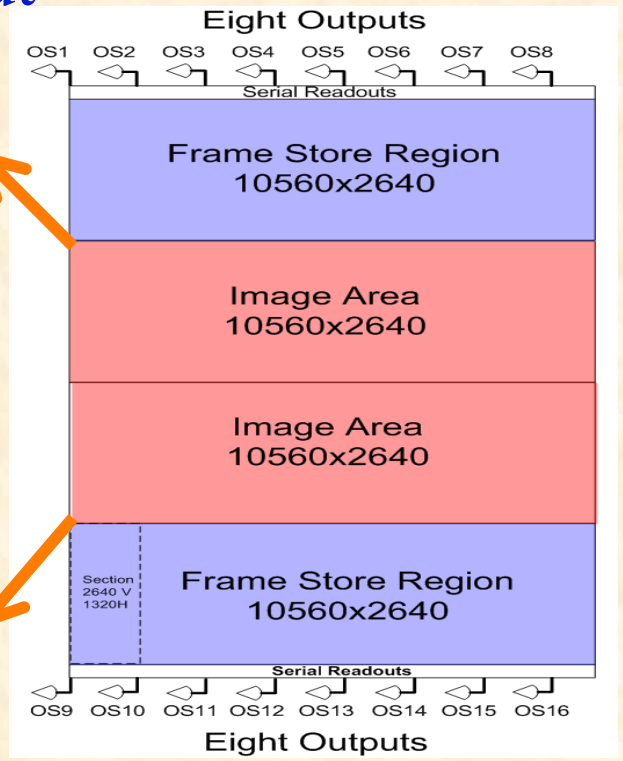




AST3 CCD Camera

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

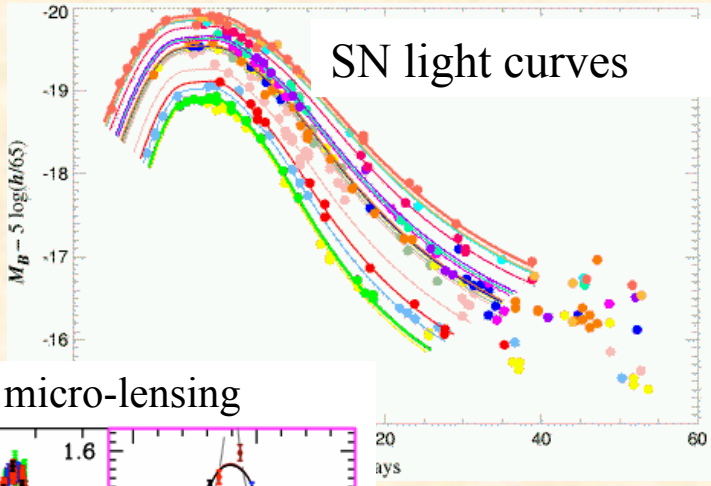


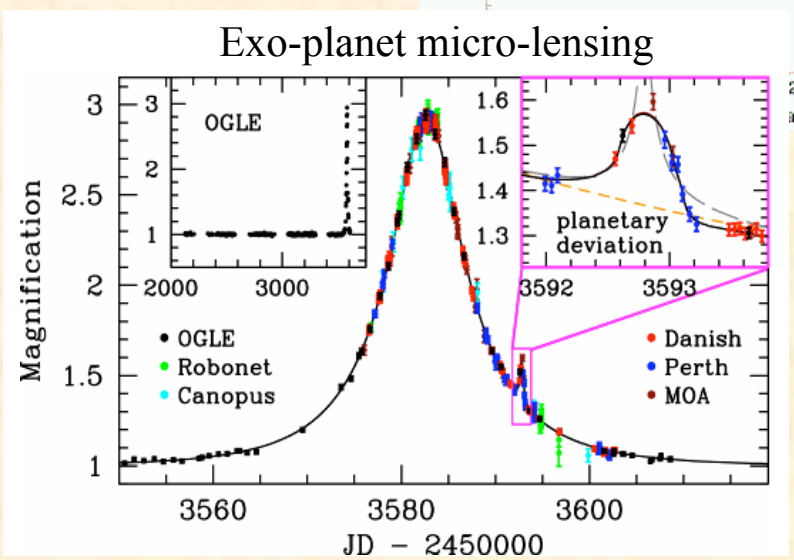


- Overscan: 180 columns/channel, 20 lines

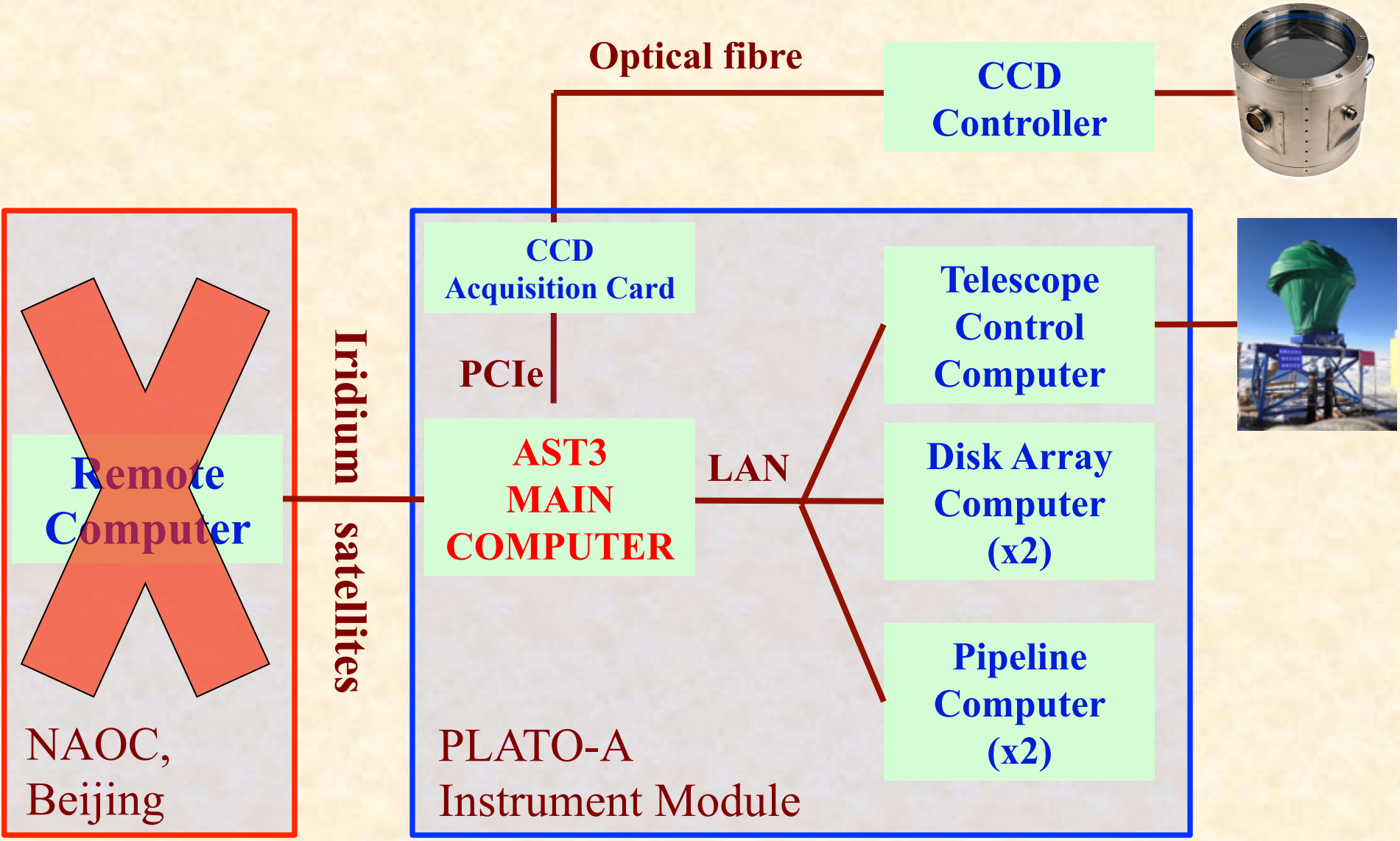
AST3 Sciences--- Time domain astronomy

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





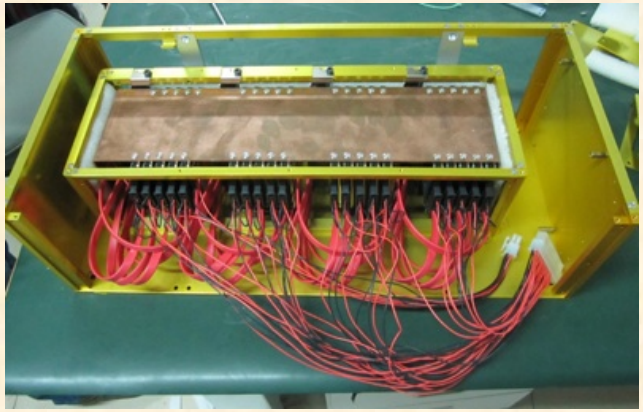
AST3 Operation -- unattended, fully automatic



AST3 Control, Operation and Data (COD) System

for low temperature, low air pressure, unattended operation

1. Customized computer systems
2. Customized data storage system
3. Lots of redundancies (every possible spot)
4. Complicated survey software
   (to ensure fully automatic operation)
   - Survey control (telescope, CCD, data…)
   - Survey scheduling (obs. efficiency)
   - Real-time Pipeline and database
     (bandwidth too low to transfer images)
   - Transient alert
   - Logs of everything



Hardware Redundancy

to reduce single-point failure

- Data Storage (computer+disk array) x 2
- Pipeline computer x 2
- Multiple power control PDU

2014-2015 improvements:

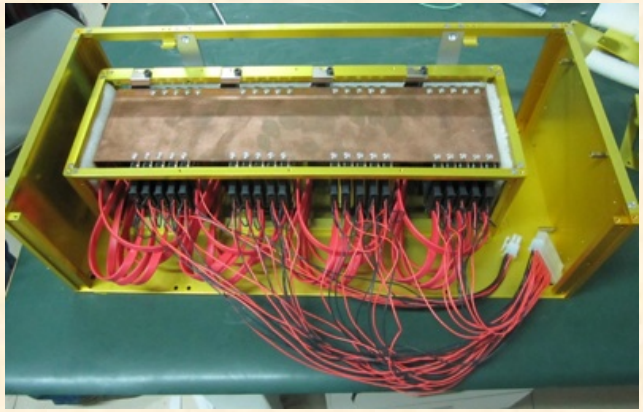
- Main Computer x 2
- Power supply x 2
- CCD Fiber-optic Communication x 2
- Computer network (2 Ethernet cards, 1 USB wireless card)

1-to-2 fiber-optic

AST3 Control, Operation and Data (COD) System

for low temperature, low air pressure, unattended operation

1. Customized computer systems
2. Customized data storage system
3. Lots of redundancies (every possible spot)
4. Complicated survey software
   (to ensure fully automatic operation)
   - Survey control (telescope, CCD, data…)
   - Survey scheduling (obs. efficiency)
   - Real-time Pipeline and database
     (bandwidth too low to transfer images)
   - Transient alert
   - Logs of everything



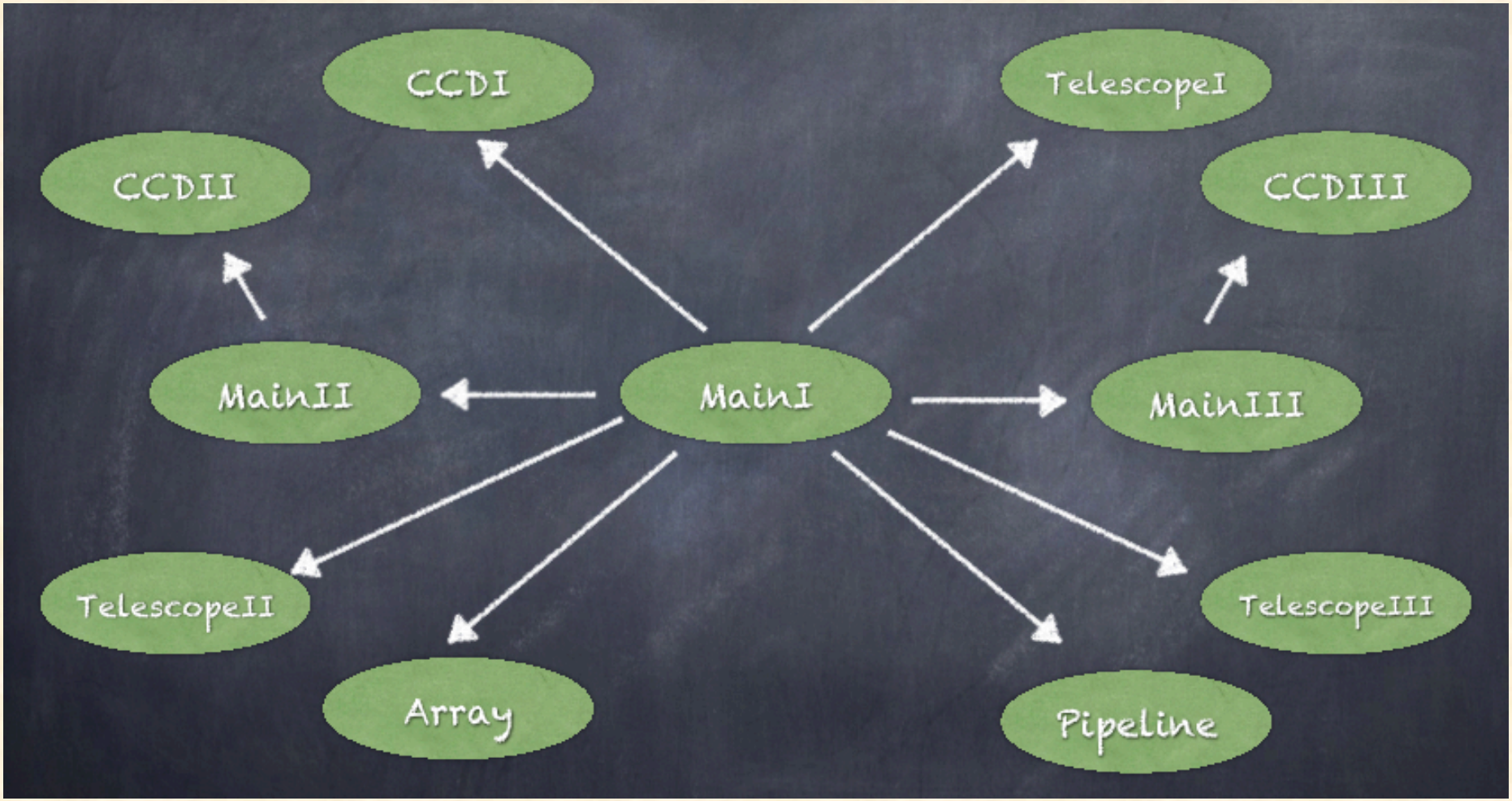
AST3 Software

AST3SUITE

- Related softwares: ast3(STA), tcc(NIAOT), strategy.py(NAOC).
- **Daemons**: long-term running processes that provide various of services, start after system booting, including ast3strategyd, ast3grabd, ast3arrayd, ast3filed, ast3seriald, ast3logd.
- **Basic command**: client programs that user's run them to execute a single task, including ast3strategy, ccd, telescope, ast3sendfile, ast3serial, ast3log.
- **Scripts**: glue basic commands together to complete observation, including ast3skysurvey.

Main Array Pipe Main + Array

AST3 Software

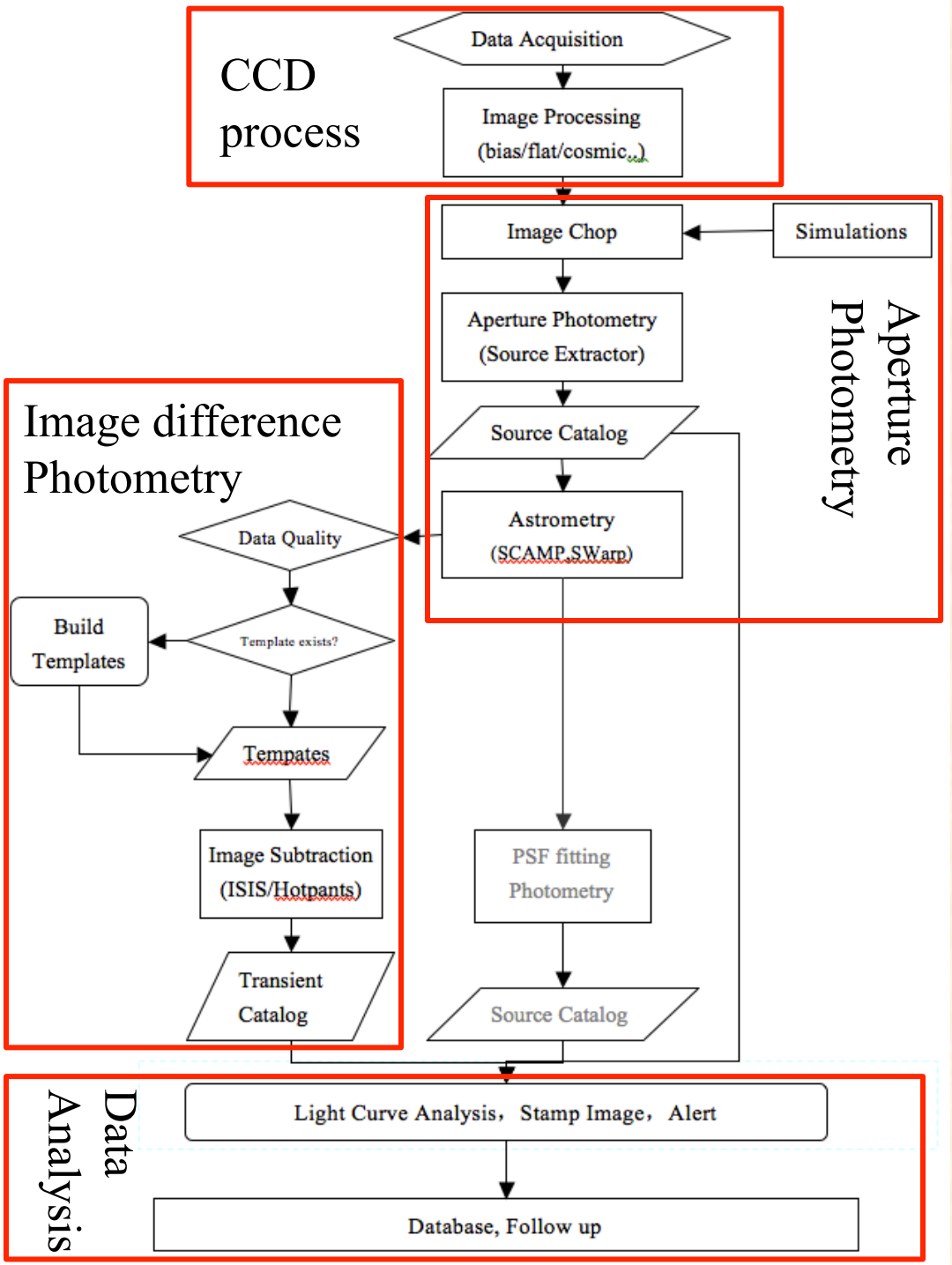


AST3SUITE for 3 telescopes

Photometry Pipeline

- Aperture photometry
  => all sources
- Image difference photometry
  => transients

- Built on OpenSource softwares
- Optimization（e.g. parallelizing）
- Detailed tests to ensure accuracy and reliability

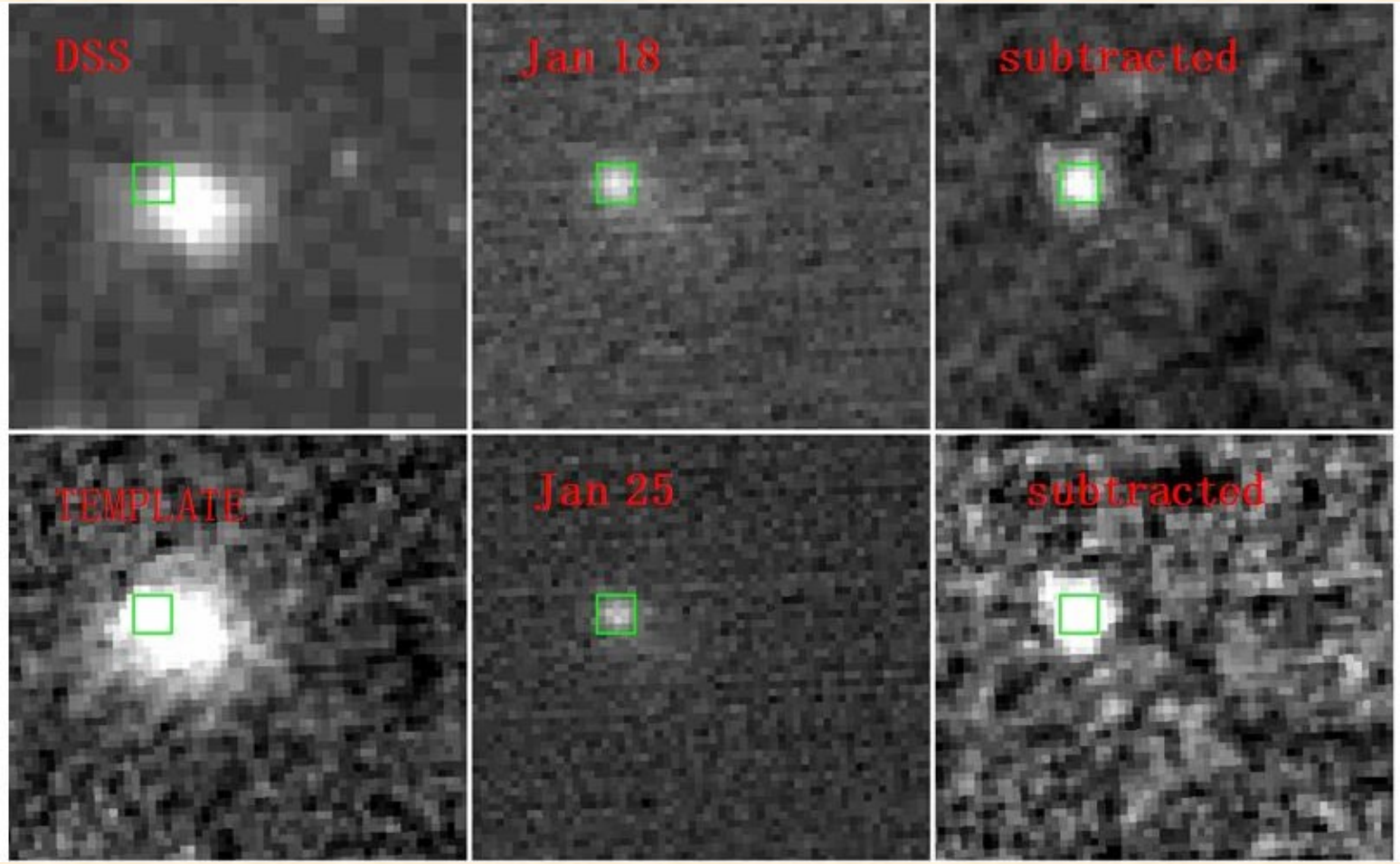


Intensive tests of AST3-2 at Mohe (5 months 2013/2014 winter)

Lattitude: 52°N
T: -30°C~-40°C
(in winter)

AST3-2 Mohe Test – SN Survey

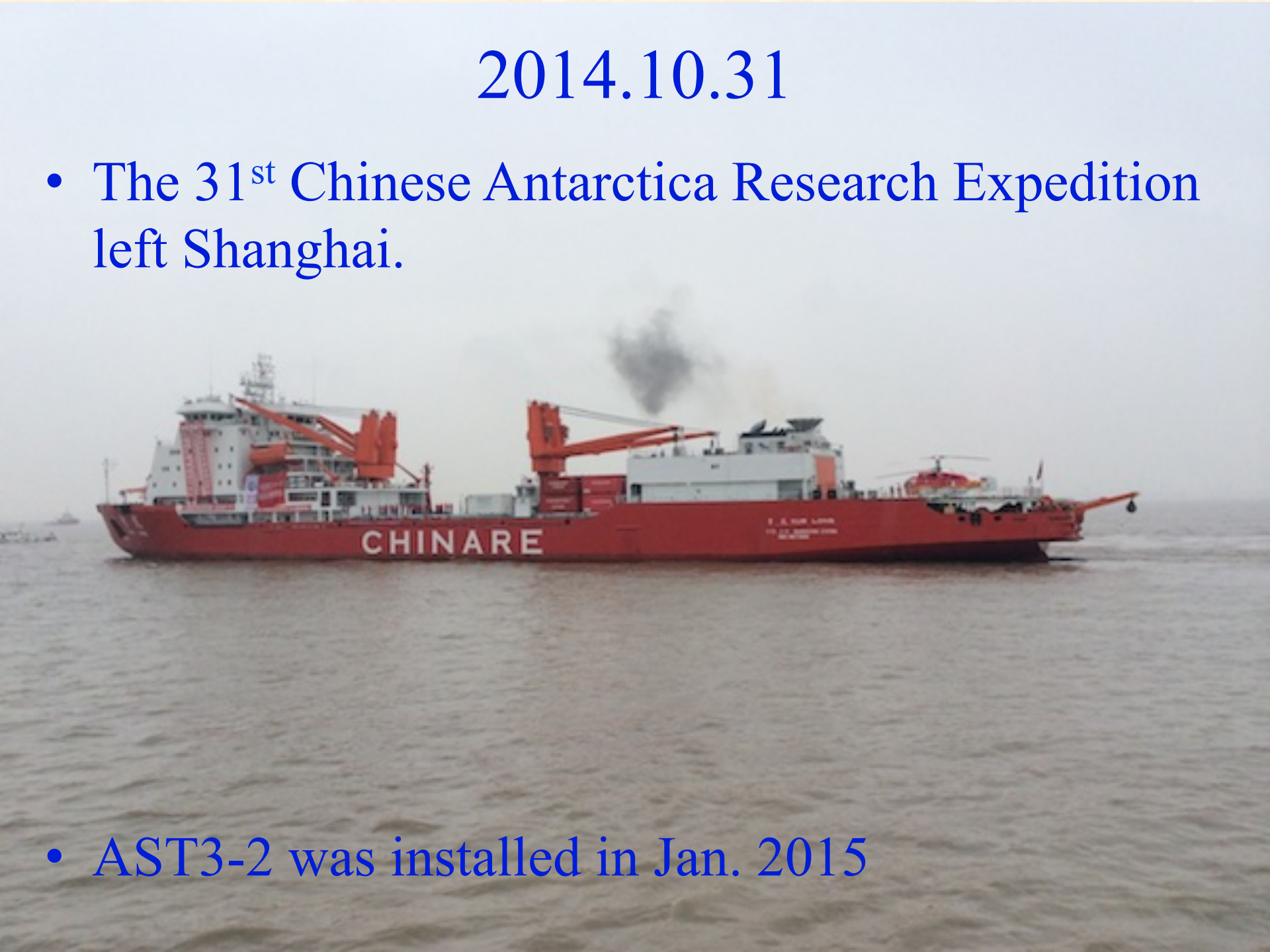
AST3-2 Discovered SN2014M



Spectroscopically confirmed by Lijiang 2.4m (TNT group)

2014.10.31

- The 31st Chinese Antarctica Research Expedition left Shanghai.



- AST3-2 was installed in Jan. 2015

AST3 in 2015

2014/2015 Traverse

- Fujia DU (杜福嘉)，Zhengyang LI (李正阳)

With help of the entire traverse team.

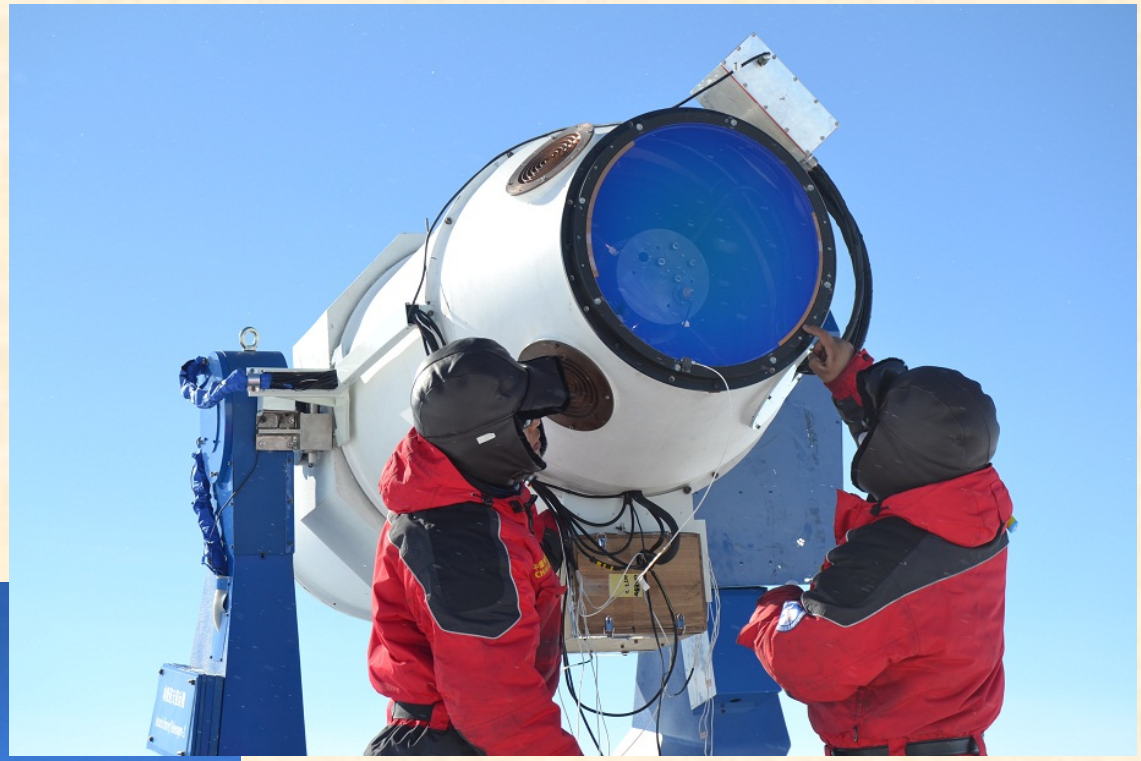
2014/2015 Traverse

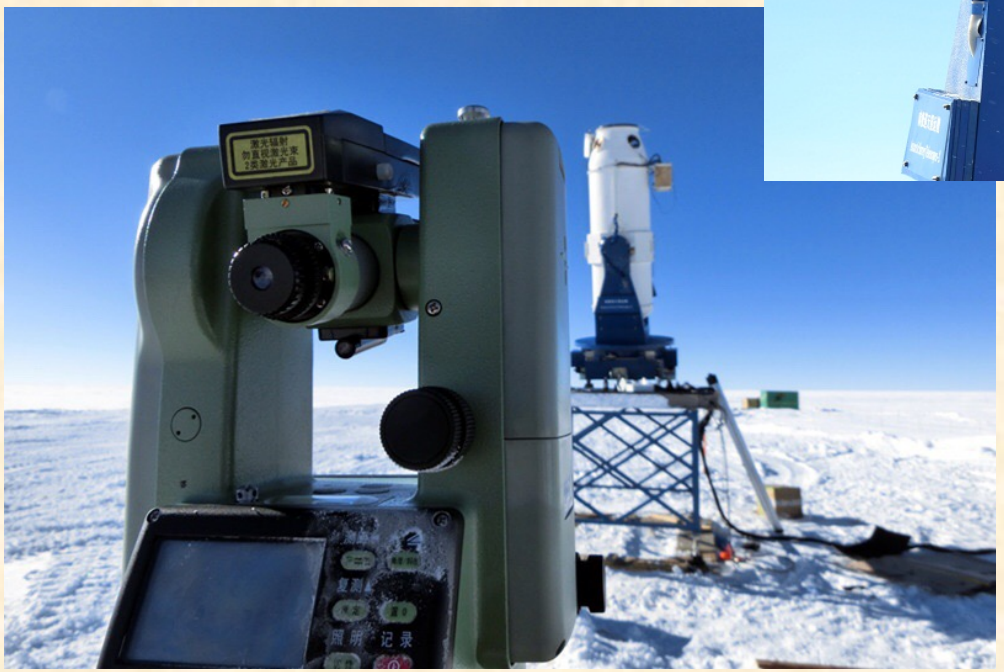
Dome A
- 4100m
- -30°C to -40°C

Dec. 30, 2014 --
Jan 23, 2015
(only 25 days)

2014/2015 Traverse

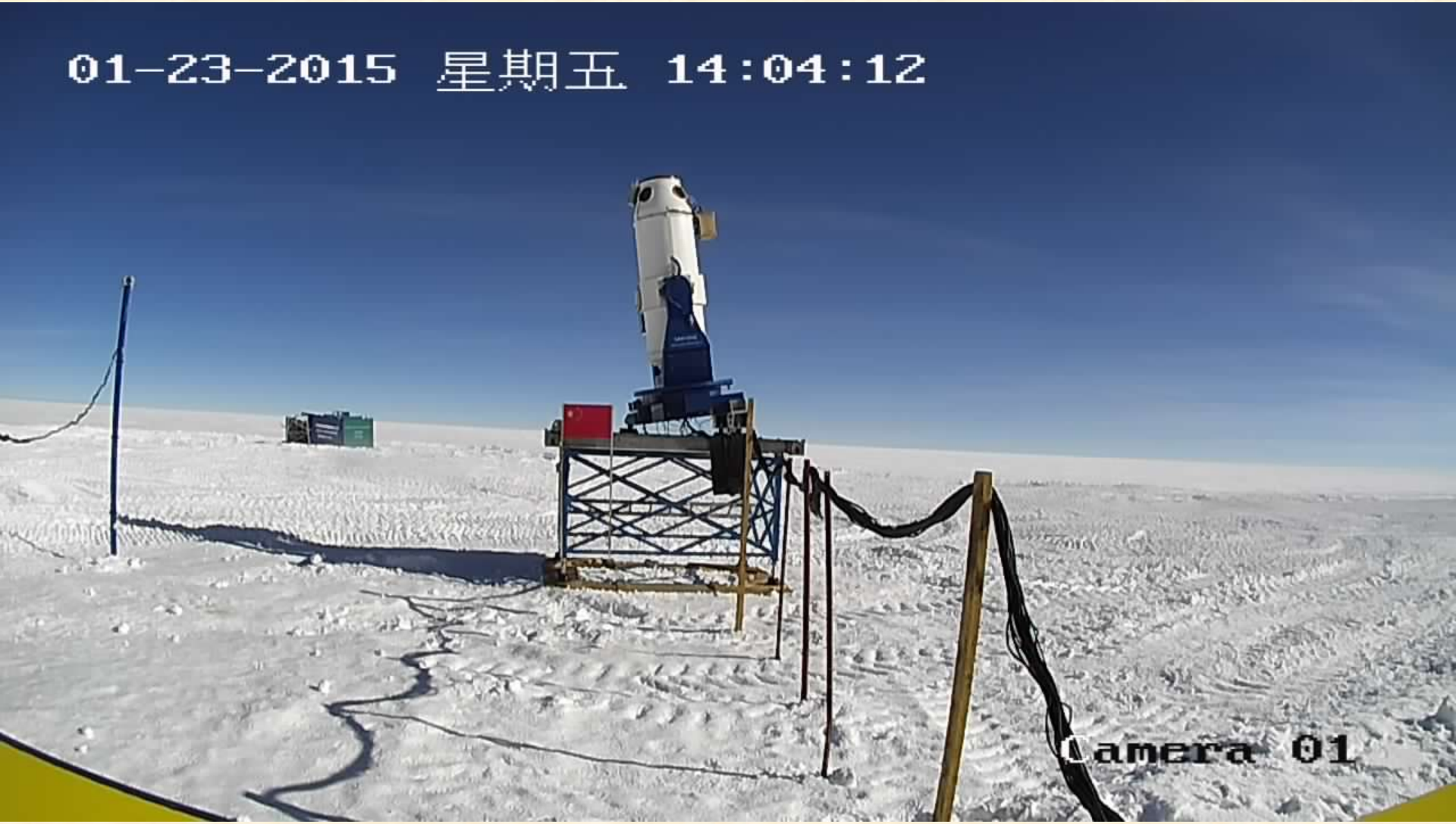
Dome A
- 4100m
- -30°C to -40°C



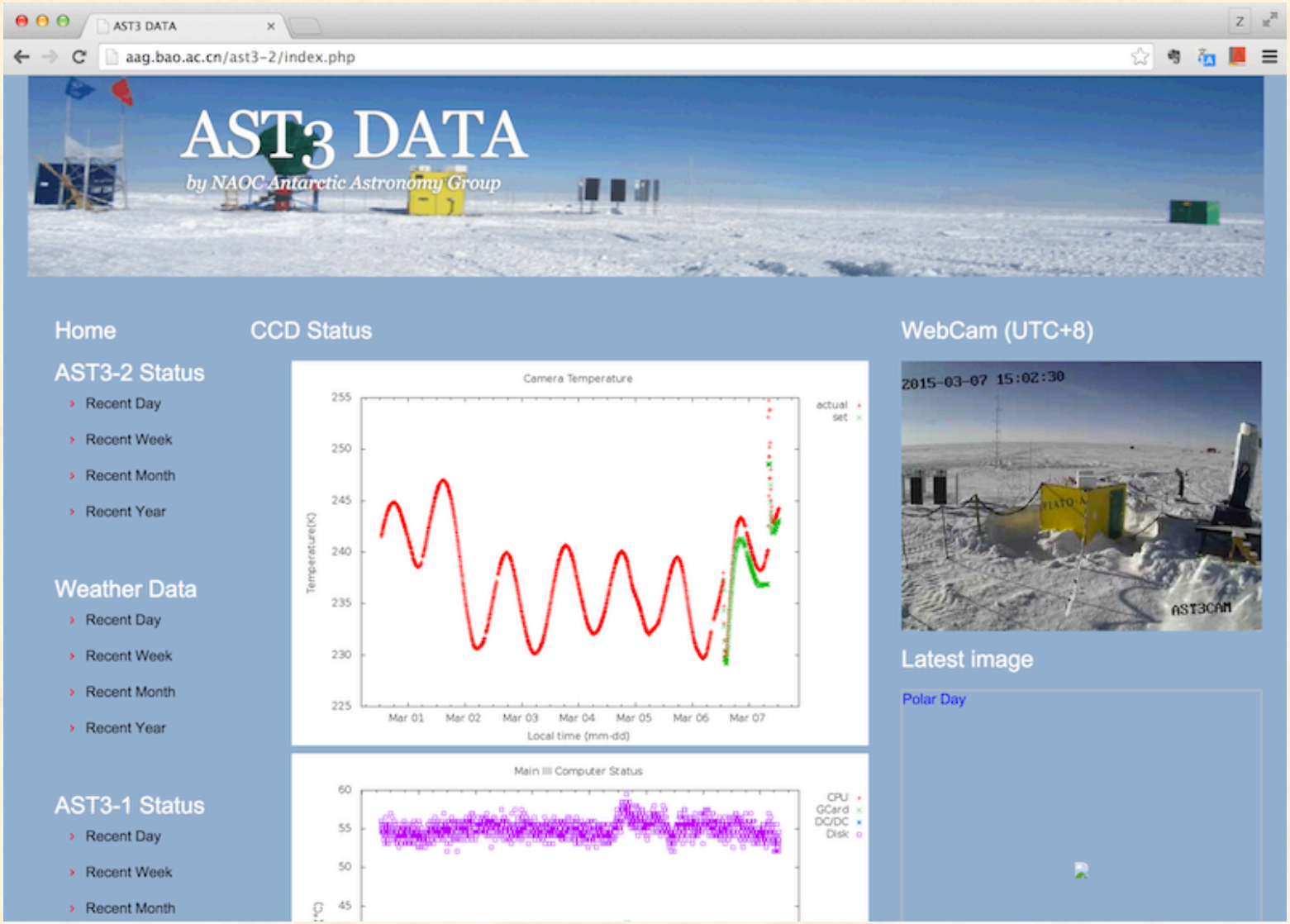


Dec. 30, 2014 --
Jan 23, 2015
(only 25 days)

2014/2015 Traverse

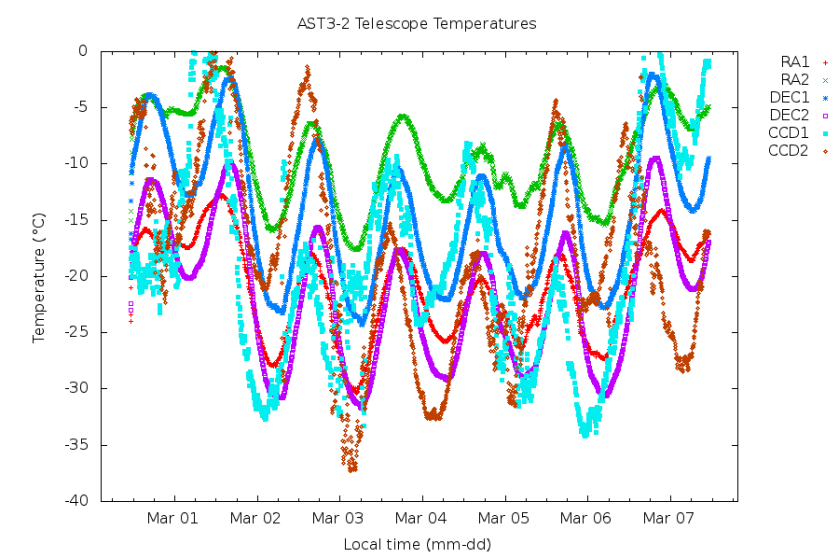


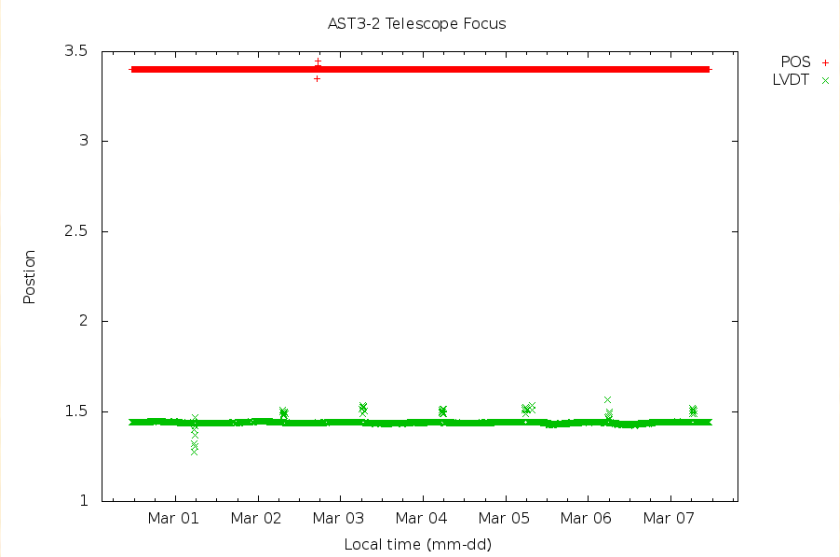
2015 Operation – Live status

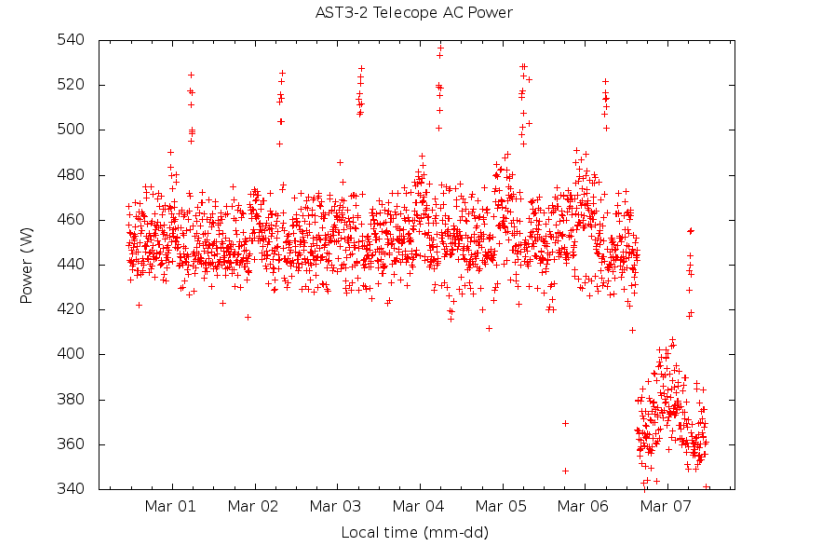


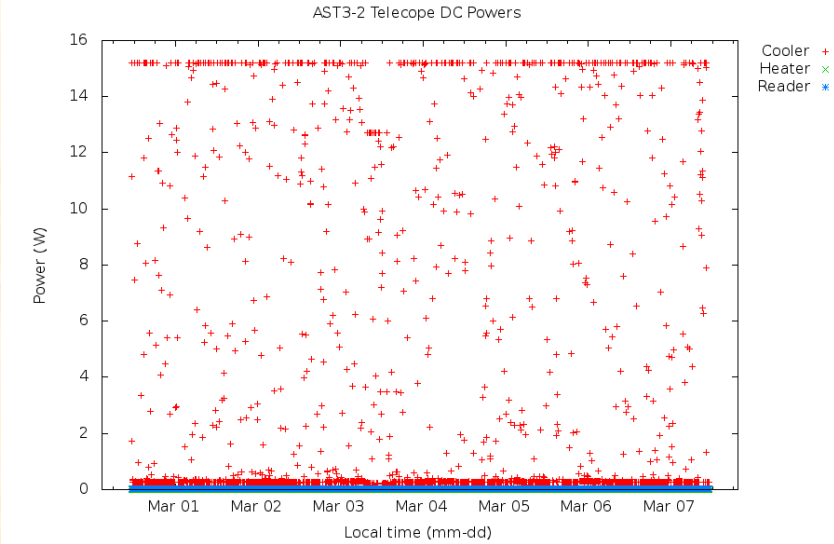
http://aag.bao.ac.cn/ast3-2/

2015 Operation – Live status



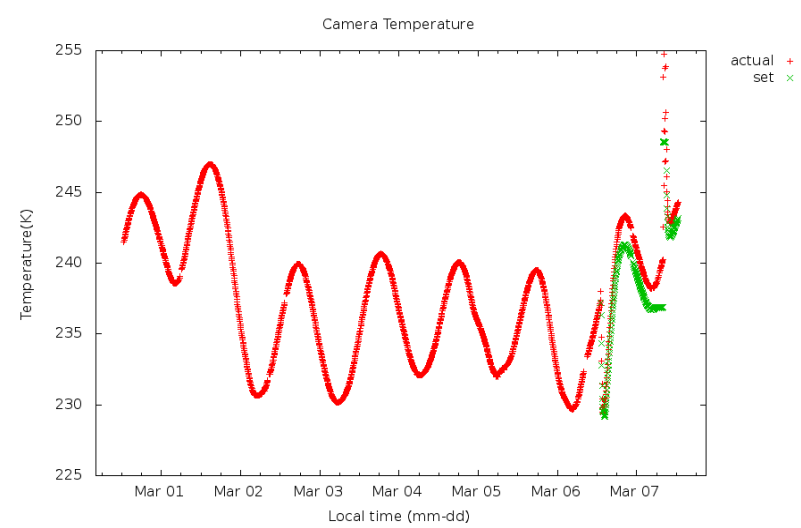


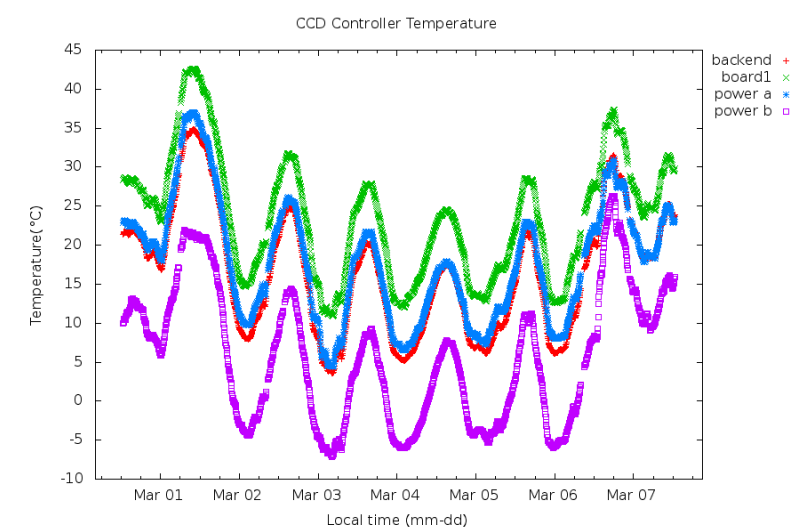


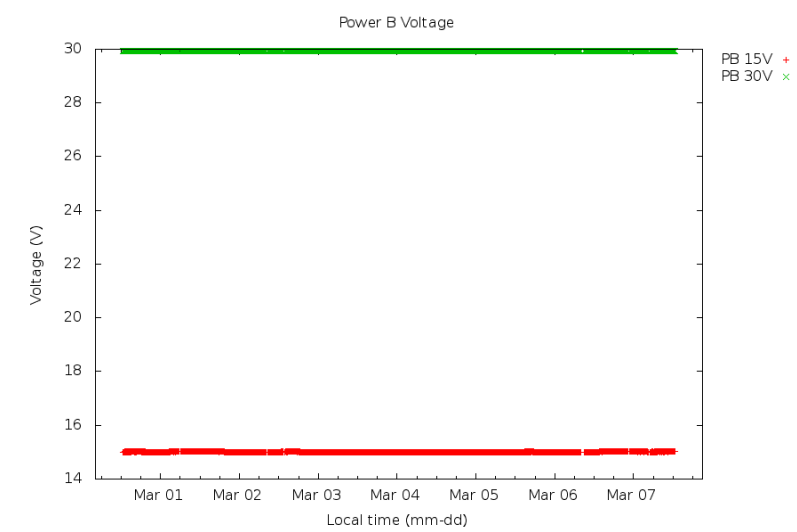


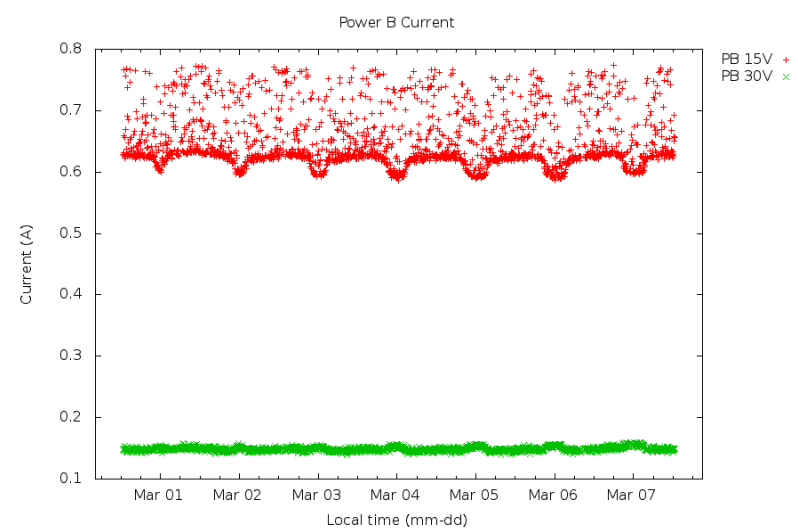
Telescope status

2015 Operation – Live status



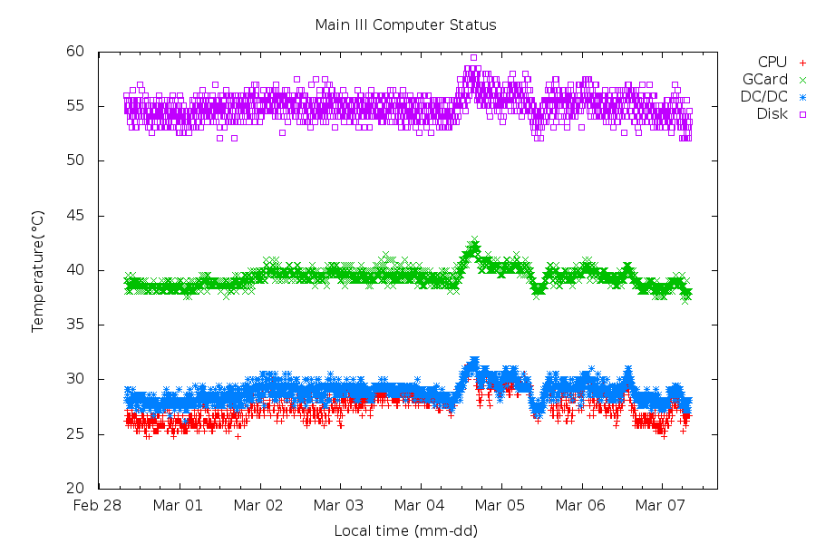


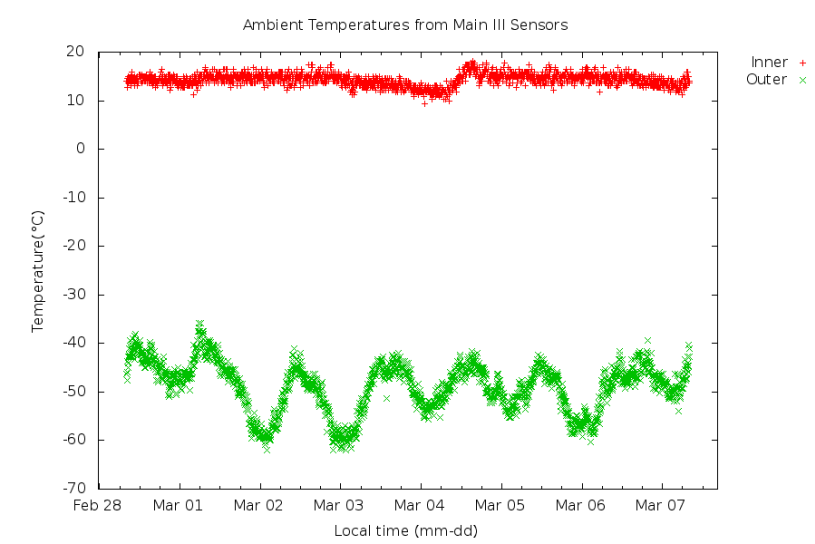


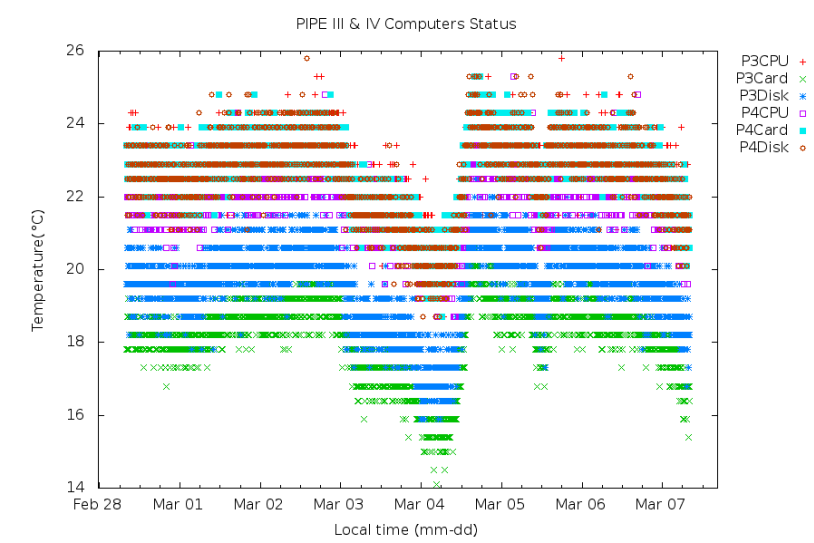


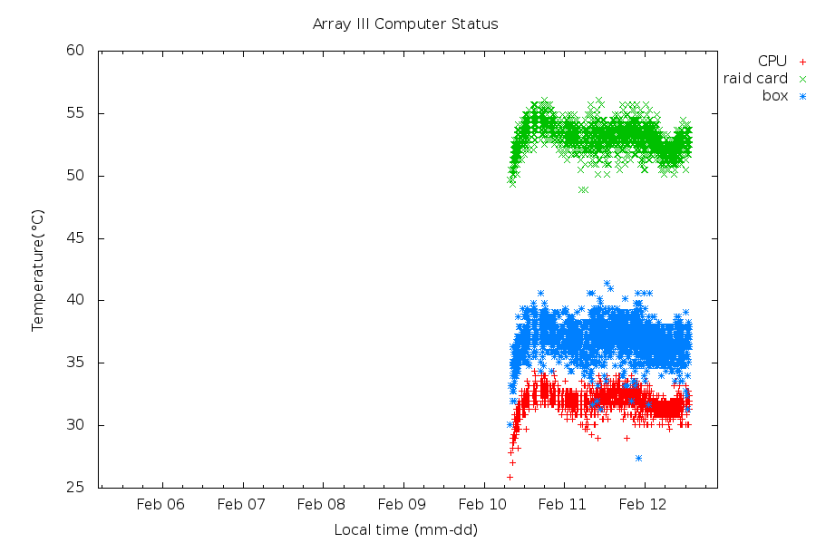
CCD camera status

2015 Operation – Live status



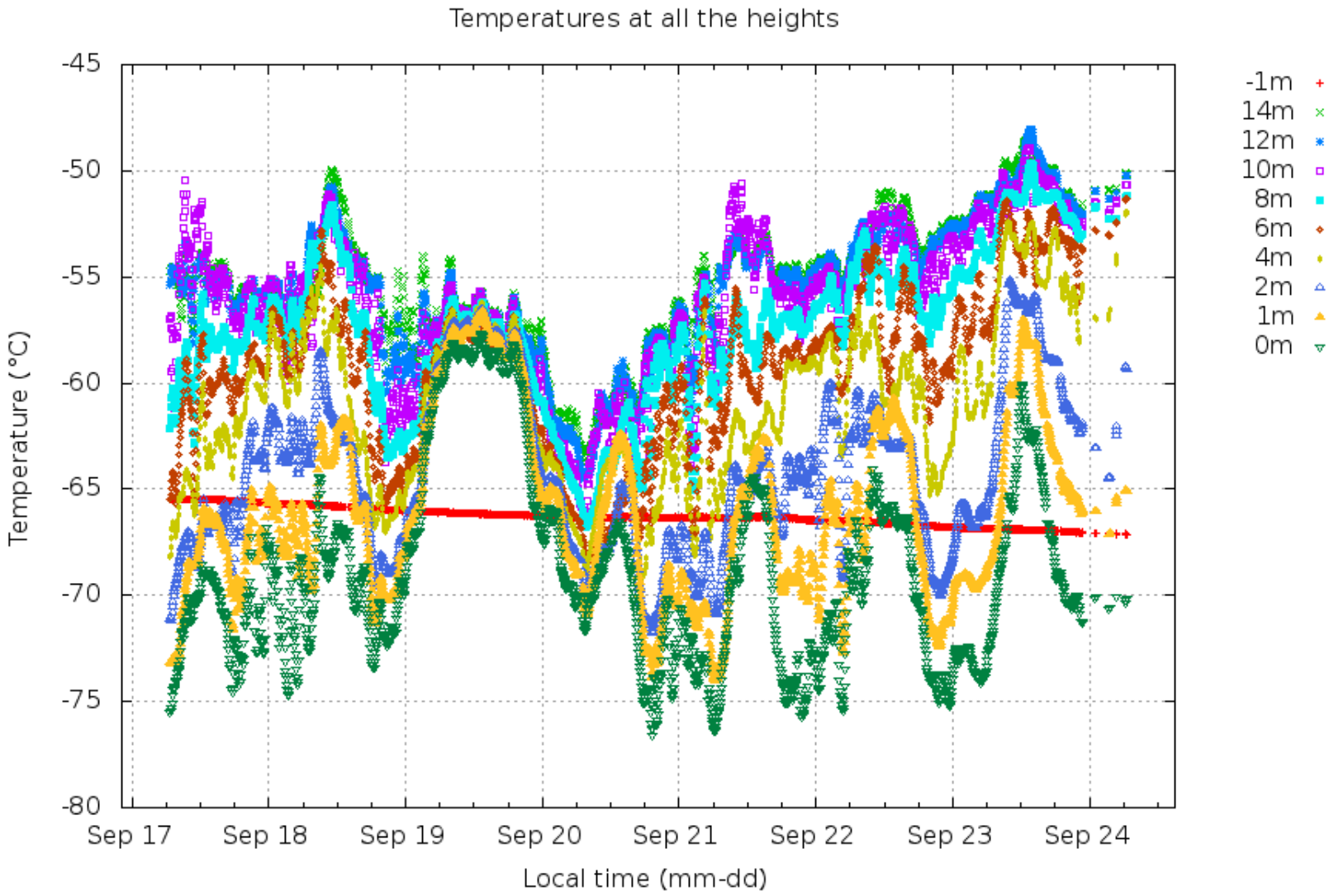






COD (operation) status

2015 Operation – Live status



KLAWS-Temperature

2015 Operation – Live status

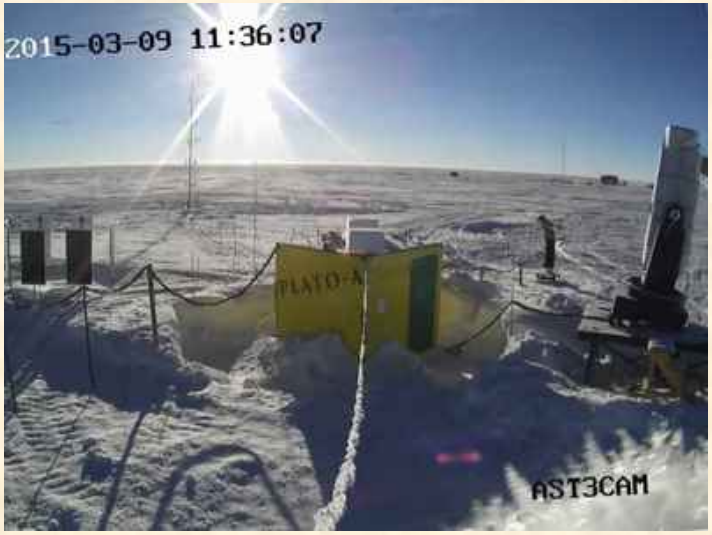
- 15m mast.
- Temperature x 10
- Anemometers x 7
- Barometer x 1
- Humidity x 1

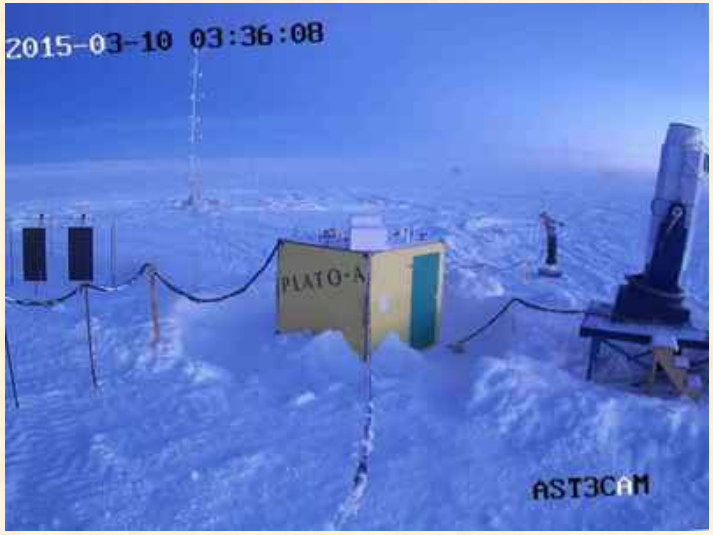
http://aag.bao.ac.cn/klaws/

KLAWS-2G

2016年1月
将协助我国首架南极固定翼飞机首飞昆仑站

2015 Operation – Live status





Webcam suffering from frost

2015 Survey Scheduler

Telescope + CCD camera status

- Readout time
  - 2.5 sec for fast mode
  - 40 sec for slow mode
- Exposure time
  - 2.5 min/field (including overhead)

2015 Survey Scheduler (redesigned)

Survey Modes

- SN survey
  - 1000 sq. degrees (about 250 fields)
  - cadence ~ 1 day
  - redesigned to assign different priorities for different fields
- Exo-planet survey mode
  - 2（or more）fields: continuous, repeated observations
- Special mode
  - Observe immediately when triggered

2015 Survey Scheduler

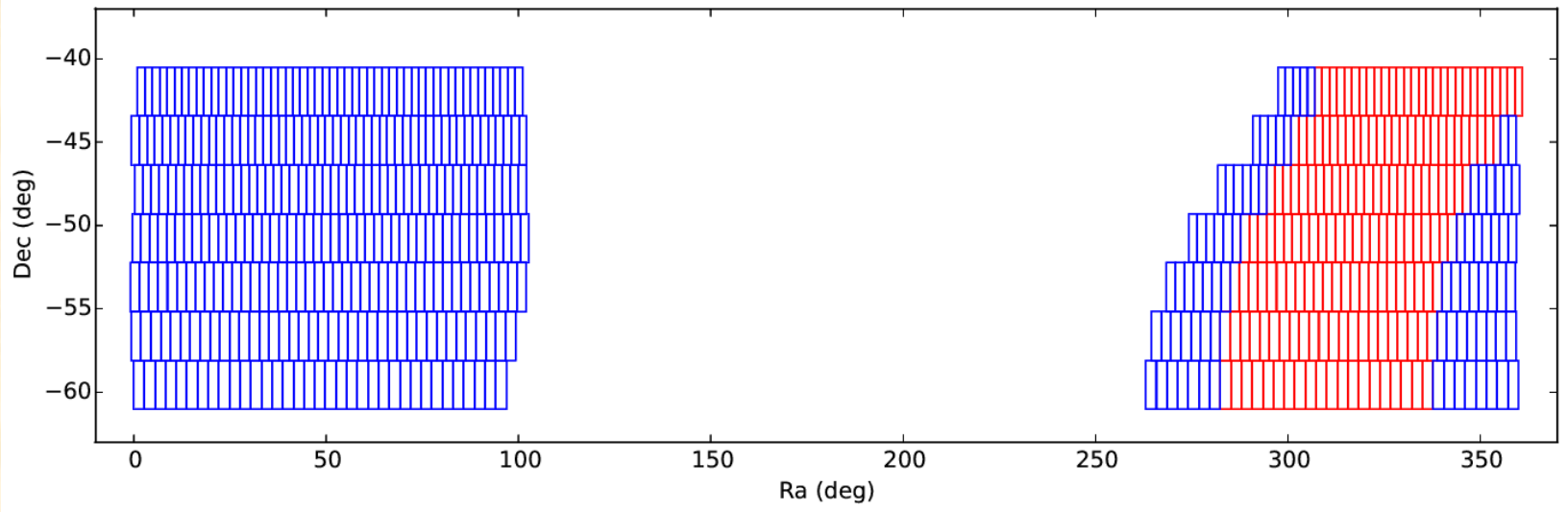
SN Survey

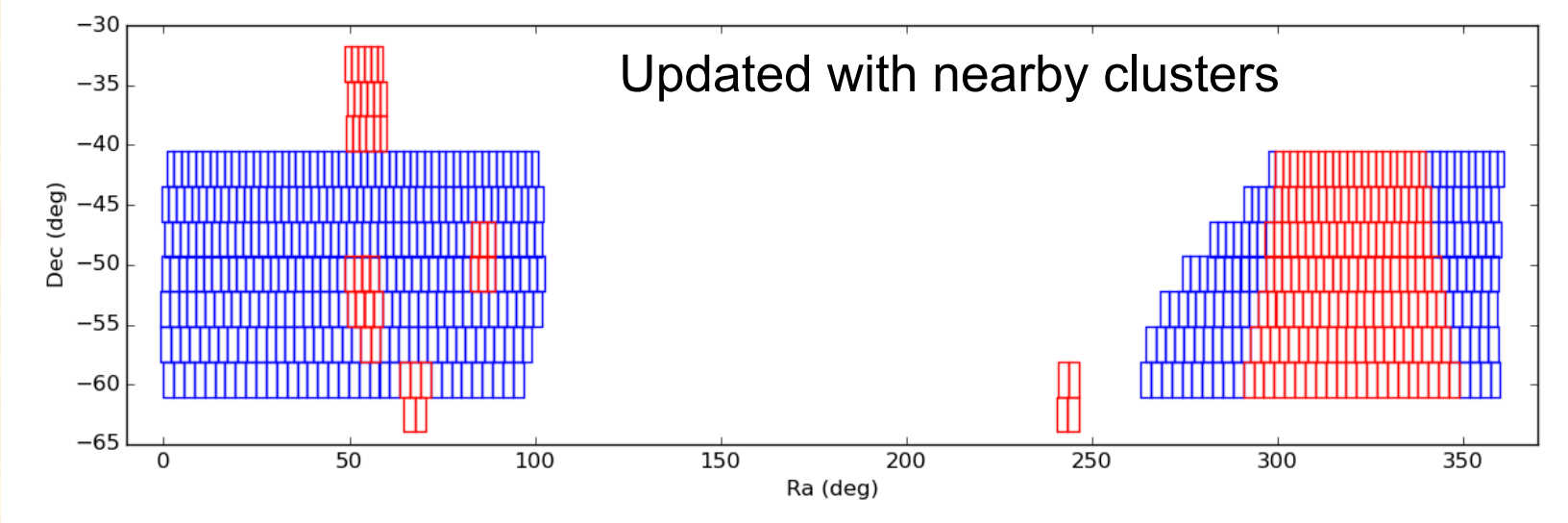
Automatically select the best field from the pre-defined survey areas, maximizing the efficiency.

- Assign priorities to fields
- Galactic latitude > 20°
- Low sky background
  - Sun altitude < -13°
  - Moon distance and phase
- Zenith distance <50°
- Minimize telescope motion

2015 Survey Scheduler

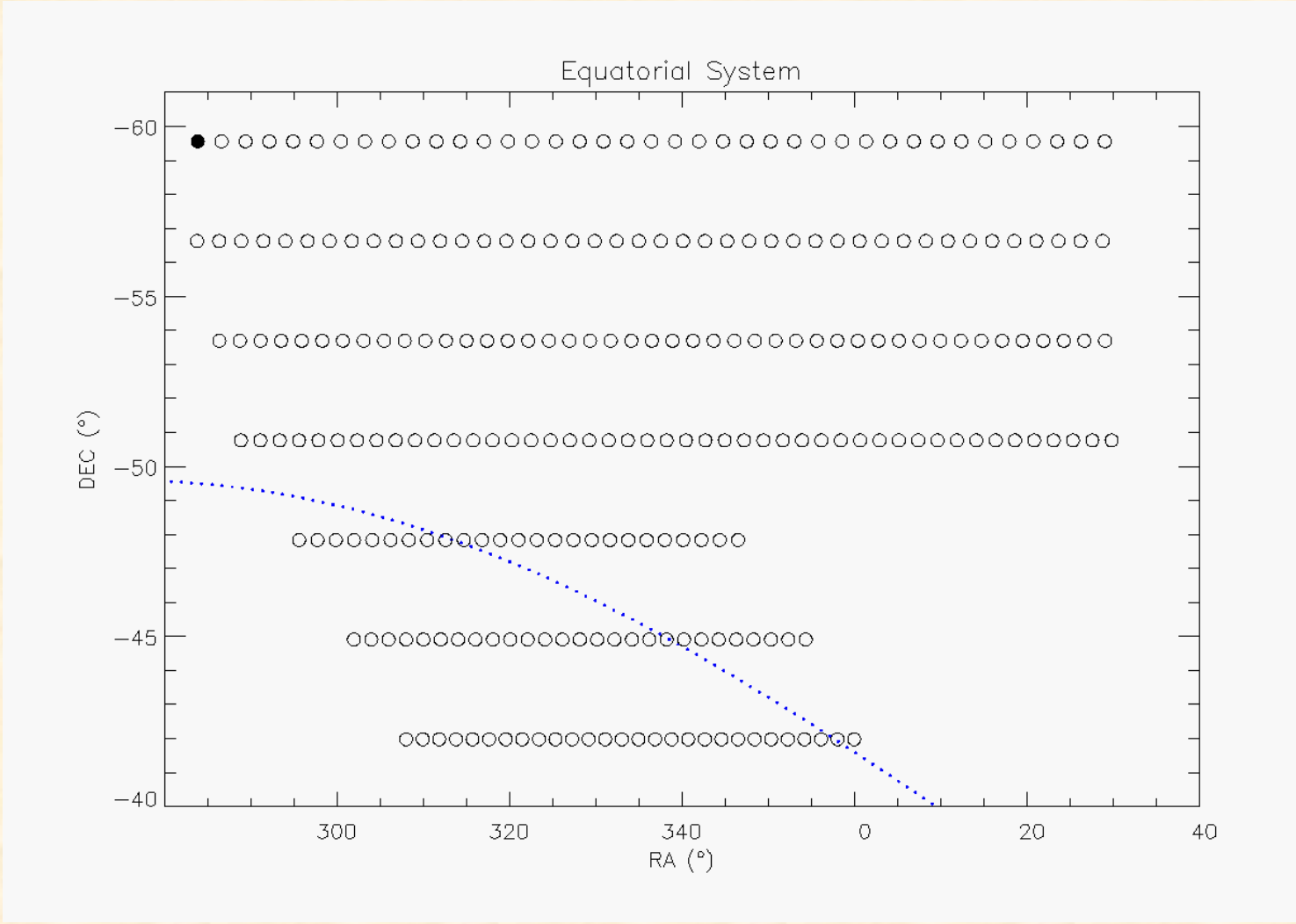
SN survey pre-defined fields (~ 2000 sq. deg, 500 fields)





2015 Survey Scheduling

Simulation for June 25, 2015



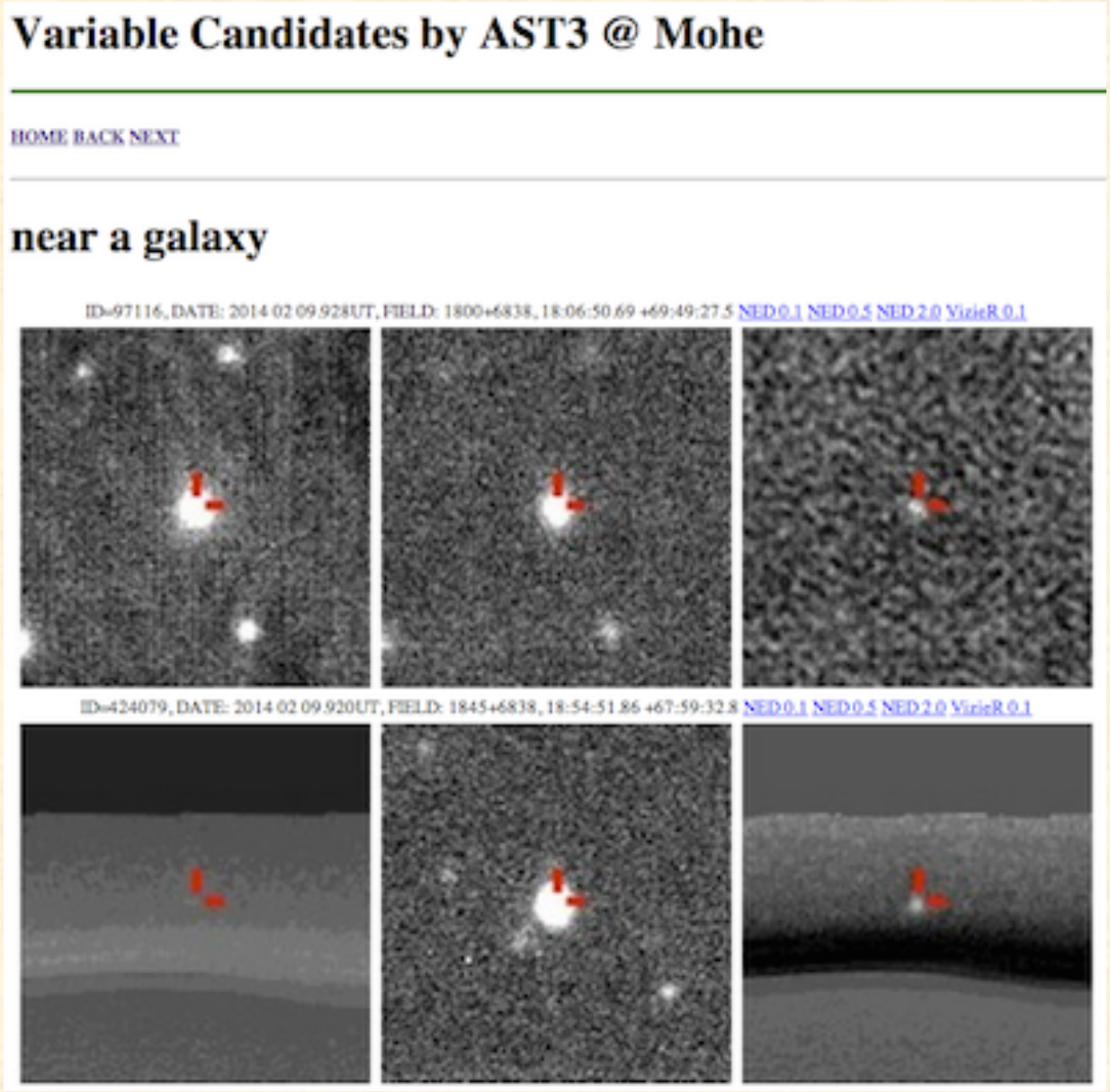
red line: telescope position limit

blue curve: zenith distance=50 deg

2015 Survey

- Exo-planet survey (simi-automatic, NJU)
  - VNC server at NAOC
  - Actual operation in Nanjing
  - Customized data reduction pipeline
- SN survey (fully-automatic)
  - Real-time pipeline
  - Automatic candidates selection

Real-time Transient Candidates Website



Summay

We achieved fully-automatic (robotic) SN survey

- Start/stop survey everyday before polar night
- Selection of survey fields (scheduling)
- Data storage
- Real-time pipeline
    - Aperture photometry
    - Image difference technique (auto template building)
- SN candidate webpage for check
- SMS real-time alert of malfunction etc.

Thanks