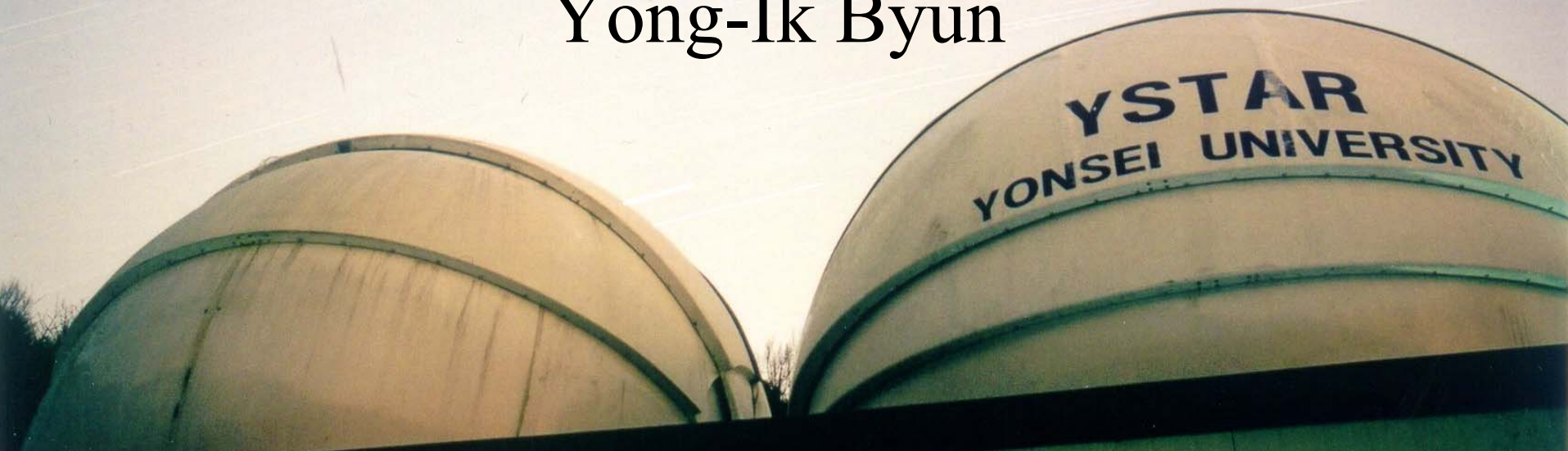


YSTAR

Whole Sky Variability Survey

Yong-Ik Byun



Yonsei University, Korea

Introducing ...

Yonsei University Observatory (YUO)

In 70's & 80's, YUO was very active in photometry of eclipsing binaries However,

before 1998

- **Equipment : 24 inch telescope not used for 10 years & no instruments**
- **No research staff (i.e. no graduate students at observatory)**
- **1 administration staff**
- **No laboratory, no R&D activity**
- **Low annual university funding**

- **YSTAR started as a survival path for YUO as a formal university research institute**
 - to start active laboratories and enhance technical capabilities
 - to gather fund & people
 - to establish infrastructure for front-line research

YSTAR goals

YSTAR 延世大學校探查望遠鏡全球配置計劃

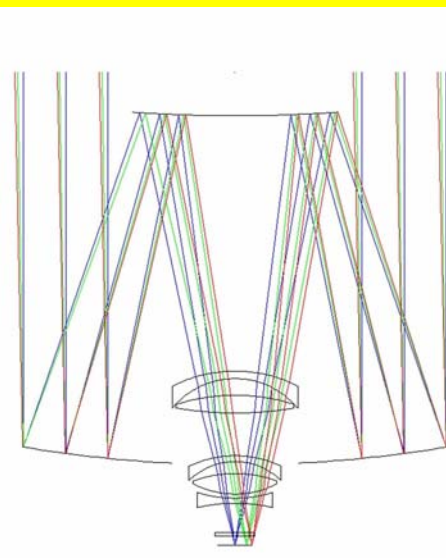
Yonsei Survey Telescopes for Astronomical Research



延世大學校 天文臺 + 韓國天文研究院

YSTAR

New Wide-Field Telescopes for Exclusive Survey Use



ϕ 50cm F1.9
2° FOV/2K CCD
TAOS duplicate

YSTAR as a General Survey Facility

(Three Torus/TAOS scopes + future telescopes)

- discovery and long term monitoring of variable stars/galaxies
- identification of moving objects (e.g. **KAO/NEO** & **TAOS/KBO**)
- all sky coverage : several telescopes in both hemispheres
- complete automation in operation & data processing

YSTAR Science Example

Formation & Evolution
of the Galaxy

Formation History of our Galaxy

CURRENT STATUS

- **Uniform & Monolithic Collapse of ELS : not supported**
- **Fragmented sub-structures (small galaxies) seemed to have formed first, then merged into the Galaxy**

Supporting Studies

- stellar streams would survive several Gyrs (Helmi & White 1999)
- **Sgr dSph galaxy & related halo structures** (Ibata et al 2001, Ivezić et al 2000, Vivas et al 2001)
- **efforts are being made to detect more halo structures**

Major Halo Tracers

- **Globular Clusters**
- **Giants & Hot HB stars** (e.g. Spaghetti Survey)
- **RR Lyr stars** (e.g. SLOAN, QUEST)

RR Lyr as Tracer of Halo Structure

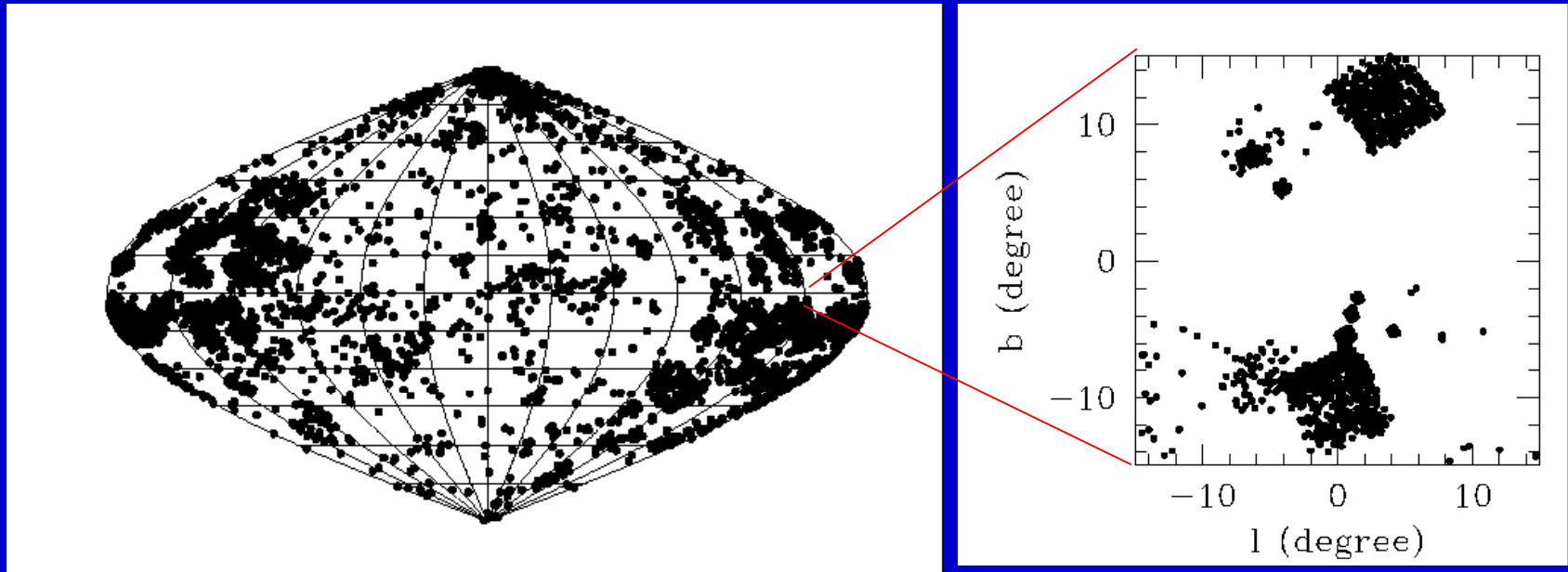
BENEFITS

- bright, easily recognizable, and gives distances
→ 3D structure/clumpiness of Stellar Halo
- (with spectroscopic followup) provides 3D phase-space distribution → dynamical/chemical history of Halo

Relevant Surveys and ‘sorry’ Status

- wide-field variability surveys discontinued after 70's
- modern surveys restricted to Bulge, LMC, SMC etc.
- only a few thousand RR Lyr known (GCVS), but mostly with inaccurate photographic magnitudes

Distribution of known RR Lyr (GCVS)



- complete only to ~ 10 mag
- sky coverage & survey depth very irregular

**YSTAR will identify RR Lyr stars out to 20kpc from the Sun
mapping the structure and dynamical history of Galactic Halo**

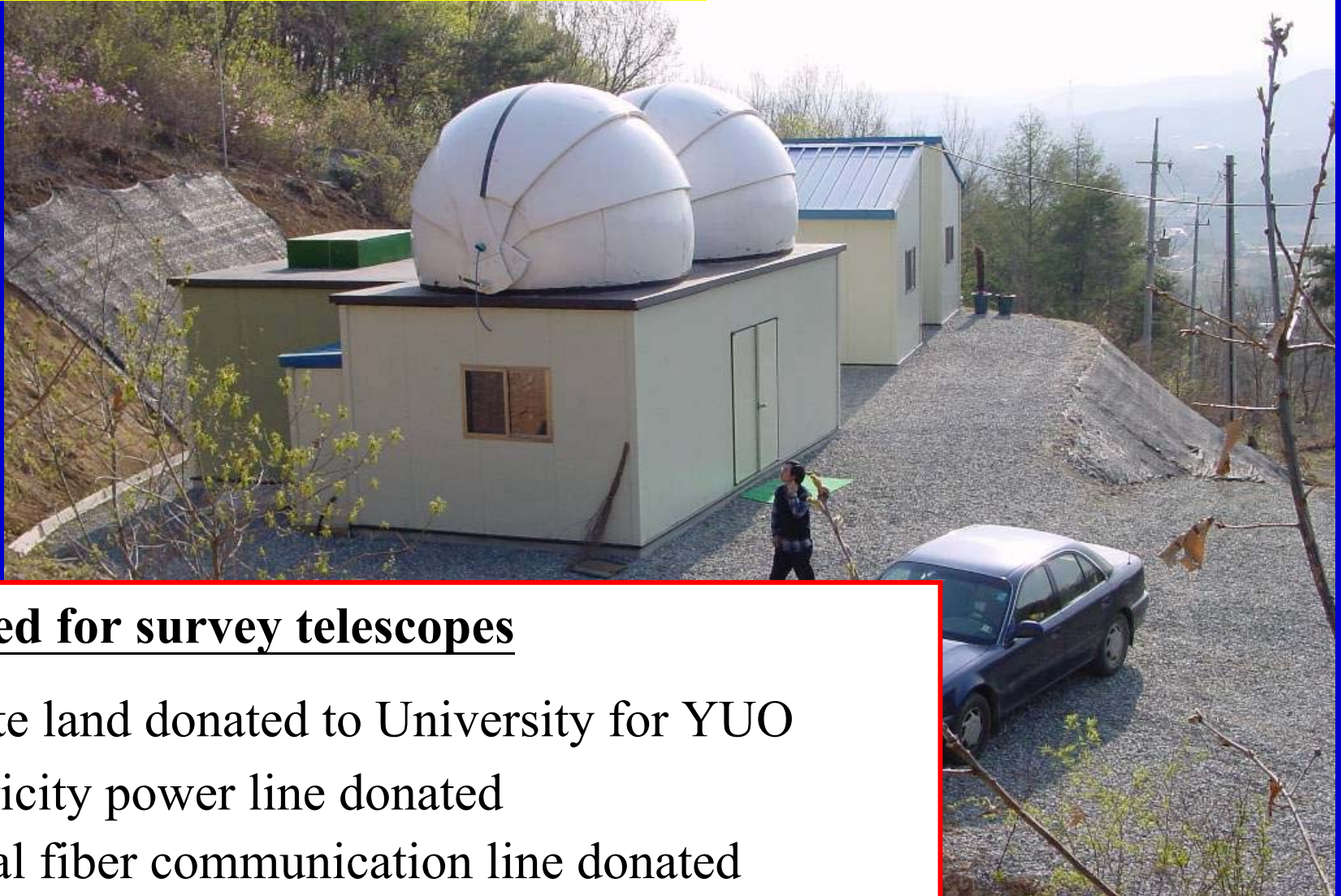
YSTAR : interim achievements ...

- **identified potential colleagues (in Korea) for**
 - discovery & light curves of new variable stars in millions
 - other variable events : AGN and GRB
- **found funding from school, government and private donations**
- **joined by KAO; together planning major expansion**
- **started working on future telescopes**
- **identified overseas observatories interested in hosting YSTAR**
- **started optical/electronic labs and begin to attract students**
- **hired people using external fund (1 research professor, 1 postdoc)**

YSTAR : mishaps and disasters ...

- **dome failures & instrument failures**
- **telescope difficulties**
 - **optical collimation & mechanical reliability**
 - **difficulties in automation**
- **database and storage problems, software and hardware**
 - **opportunities for further learning, but caused delays**
- **no long term funding yet → constant struggle**

Yonsei Survey Observatory 2000. 11.



Test bed for survey telescopes

- private land donated to University for YUO
- electricity power line donated
- optical fiber communication line donated
- road pavement donated by local city government

Remote Monitoring Screen



Telescope Control Panel GUI

XObservatory -- Version 1.23

NU

Positions

	RA(J2000)	Dec(J2000)	HA	Altitude	Azimuth	Dome Az
Current	9:30:07.3	72:49:06	0:00:00.0	58:50:55	0:00:00	
Target						
Difference						

Camera

Filter ☐ ☒

Focus, μm ☒

Temp, $^{\circ}\text{C}$ ☐

Cooler ☐

Status ☐

Kotator ☐

Lights ☒ 1 ☐ 2 ☐

Control

Stop **Quit**

Find Homes **Find Limits**

Test **Reload**

Calib Axes ☐ **No Confirm**

Auto Focus ☐ **Batch Mode**

Paddle ☐ **Beeping**

Status

Batch ☐

Tracking ☐

Slewing ☐

Homing ☐

Limiting ☐

Weather ☐

Confirm ☐

Roof ☐

Service **Stow** **Slew**

Telescope

Site Information at Clear Sky Institute

Local	UT	UT Date	LST	JD	Moon
16:22:53	21:22:53	24-Jun-2000	9:30:05	2451720.391	52% NW -3

Wind	Direction	Temp	Pressure	Humidity	Rain
		(10.0 C)	(1010 mBar)		

Messages

```
21:18:36 UT: Welcome, telescope user.
21:18:37 UT: Lights: Reset complete
21:18:37 UT: Dome: Reset complete
21:18:37 UT: Focus: Reset complete
21:18:37 UT: Filter: Reset complete
21:18:37 UT: Telescope: Reset complete
```

Camera 3.14

File Tools Expose Options

x= 376 y= 524 v= 2107

devic0005.frc : 10-Apr-00 17:52:33 2005 C

Glass

Glass statistics

Min:	530	Max:	3196
Mean:	575	at X:	375
Median:	561	at Y:	523
Std D:	139.5	SD>M:	239.3

Magnification Factor

☒ 1x ☐ 2x ☐ 4x ☐ 8x

Glass size

☒ 16x16 ☐ 32x32 ☐ 64x64

☐ Snap to Max

☐ Show 1D Plots

☐ Overlay Gaussian Fit

1D Plot

Peak: 17.51
Peak: 561.1835

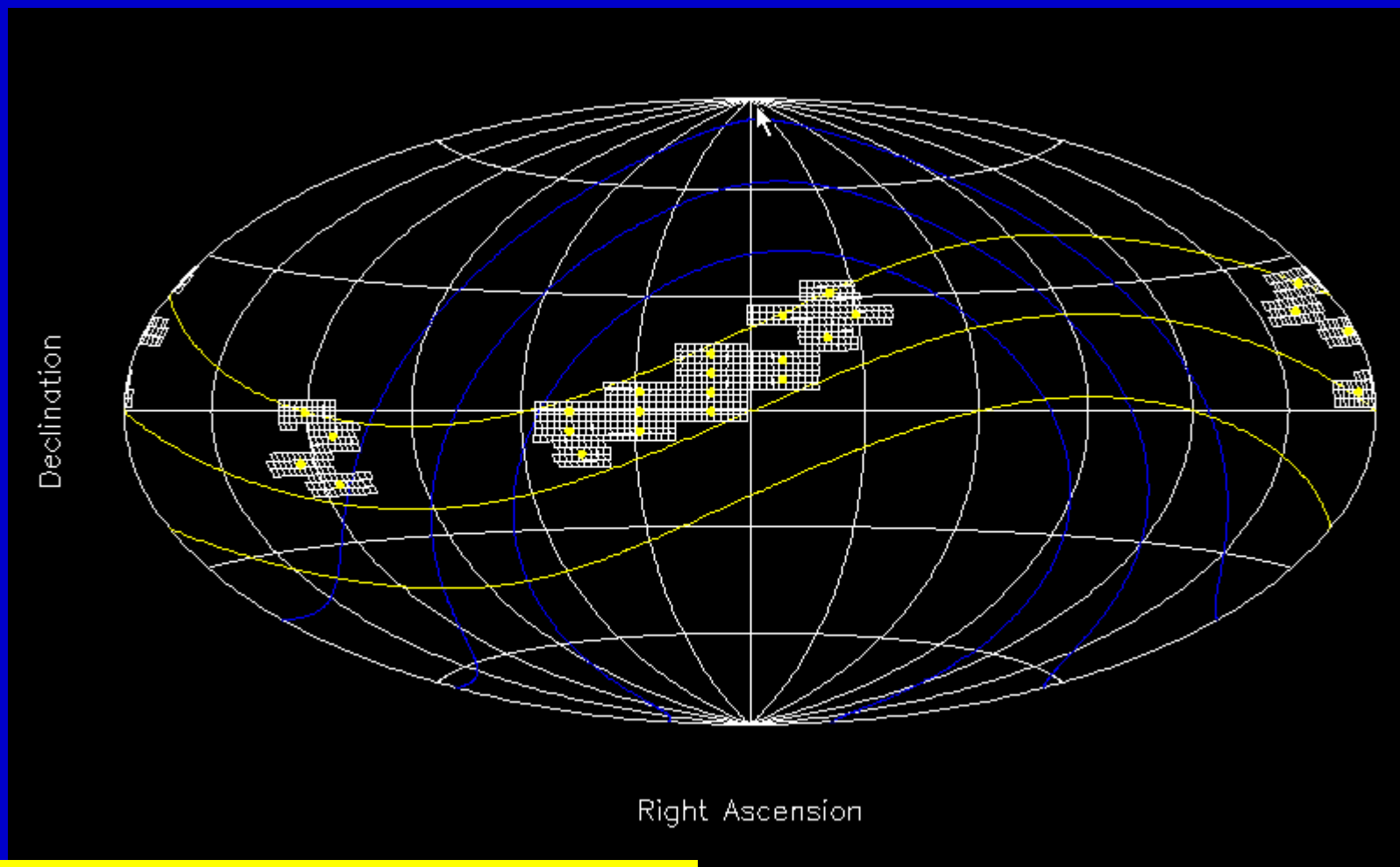
1D Plot

Peak: 14.34
Peak: 561.2093

Close

Roof/Dome

YSTAR-KAO AUTOMATIC SCHEDULER & SURVEY PROGRESS PLANNER



- All Sky covered by 14916 TF
- 1 TC = 33 TF
- Operation based on 452 TC

by **Jang-Hyun Park (KAO)**

YSTAR STATUS 2001.10

Automated Robotic Observation

- Each telescope with GPS, weather, sky monitor
- following routines have been automated
pointing calibration, focus algorithm, target selection, CCD tasks, flatfield acquisition, data archiving, safety check
- **Stability tests of robotic operation now being completed**

Pipelined data processing & Archiving

- Preprocessing automated
- WCS automated (USNO A2.0)
- Stage 1 photometry (SExtractor) & Findmover automated
- Stage 2 photometry (DAOPHOT based) automated
- Variable finder, light curve analyzer being developed
- Data Archive hardware/software being prepared (~5TB)

Sites/Hardware STATUS

South Africa : first YSTAR overseas station

- Station building being constructed
- New enclosure made in Korea
- Telescope will be installed soon (2002. 1)

Australia (Siding Spring) & United States (Kitt Peak)

- Site permissions obtained

More survey telescopes & More Sites

- Scope 4 and 5 being constructed in Korea (mount only)
- New optical design using primary focus (ϕ 60cm, F2.8)
- two new telescopes to be completed in 2002
- presently seeking site invitation & overseas collaboration

SAAO : Sutherland Observatory

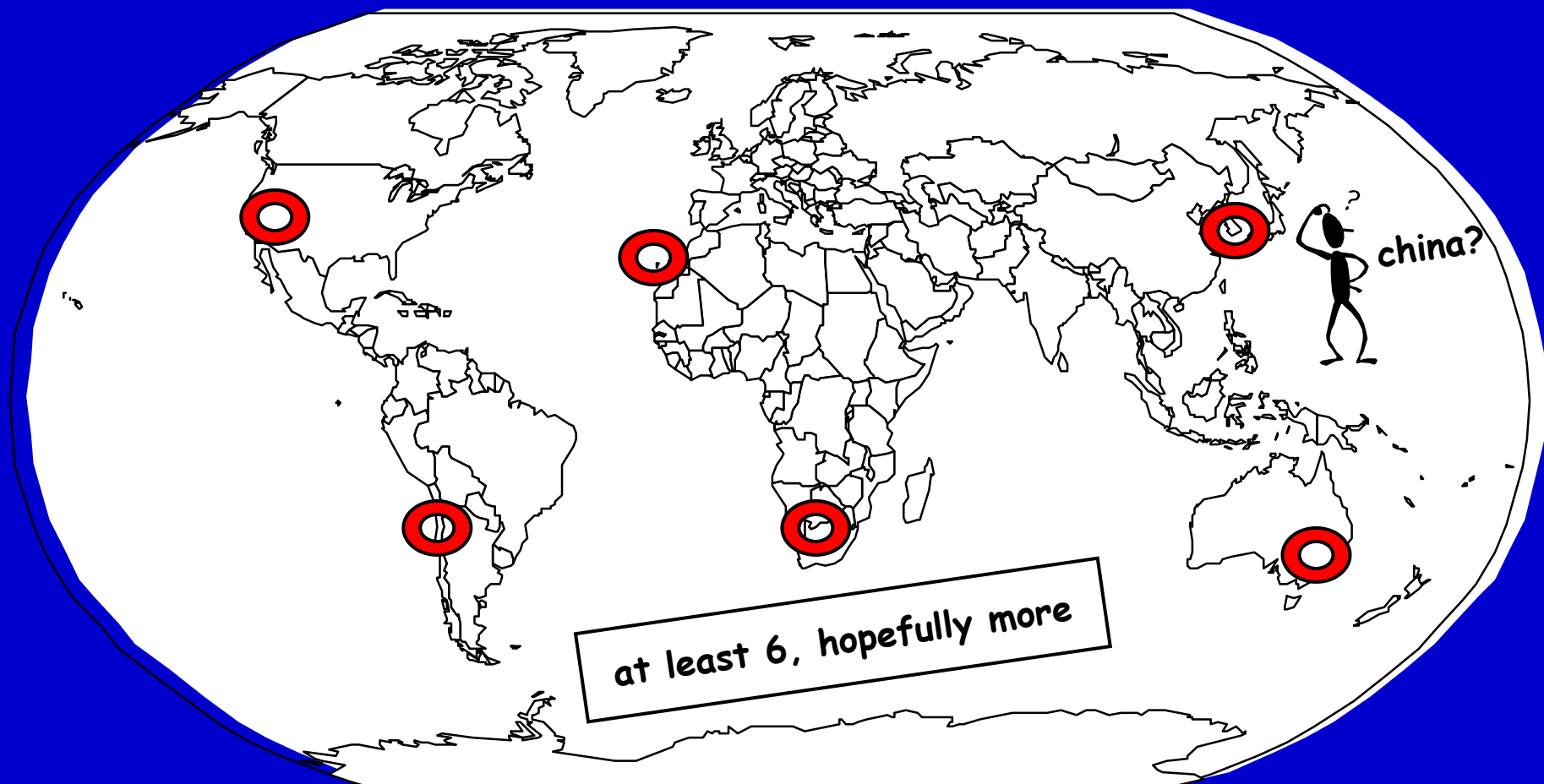
Site for YSTAR Survey Telescope #1



SAAO : Sutherland YSTAR Observatory Ground Breaking & Foundation (2001.9)



YSTAR Network : The Plan



We are interested in

- non-stop access to night sky & efficient coverage
- Research/Education interaction on a global scale

YSTAR

keeps Evolving ...

(YUO + KAO effort)

New Enclosure (2001.10)

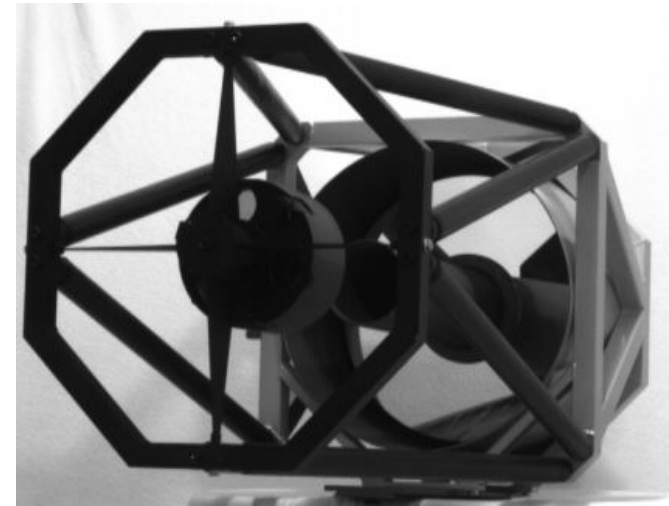
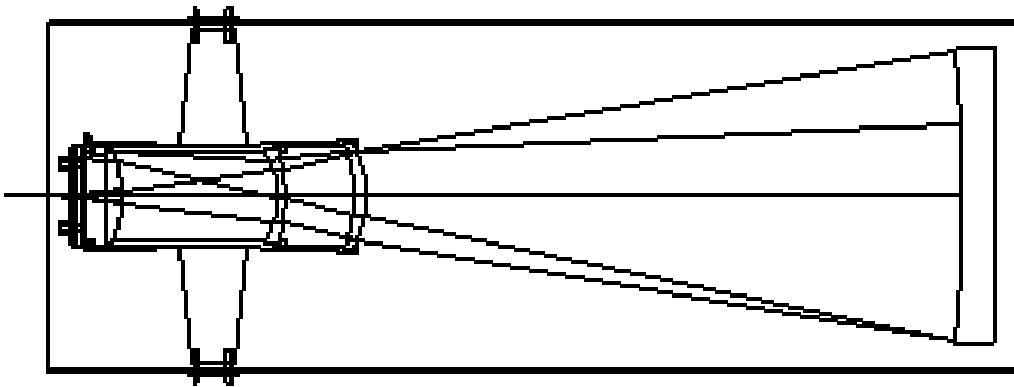


New Telescope Mount (2001.10.29)



New Telescope OTA

- Asteroptik wide-field deltagraph
- 60cm Primary, system F/2.8, lens corrector, 2 degree FOV
- Easy collimation and excellent image quality over the whole FOV
- but needs 4K CCD camera with 15 micron pixel
(Our lab does not have CCD mosaic experience, and wishes collaboration with someone who does)
- 2 OTA's being constructed



Introducing ... The **FUTURE** of Yonsei University Observatory (YUO)

2002

- Overseas YSTAR site development to be continued
 - South Africa, Taiwan (TAOS participation)
- changes are being made in University regulation for YUO
 - YUO will hire its own research staffs with school fund (2 research fellows in 2002 & adjunct positions)
- with KAO, YUO will try for long term government funding

Future

- fund raising effort for massive private donations
- YUO goals for ground-based optical astronomy includes
 - to own a 2 meter class imaging telescope
 - to participate a large aperture spectroscopic telescope
- closer ties to foreign observatories

韓國宇宙電波觀測網(KVN) 延世觀測所

Asia Correlation Center?



In partnership with Korea Astronomy Observatory, Yonsei University Observatory will be working for the new Korean VLBI network. The 20-meter radio telescope and data center facilities will be built in Yonsei University during 2002–2004 period and will become the center of Korean radio interferometry research in the 21st century.

YSTAR 延世大學校探查望遠鏡全球配置計劃 **Yonsei Survey Telescopes for Astronomical Research**



延世大學校 天文臺 + 韓國天文研究院