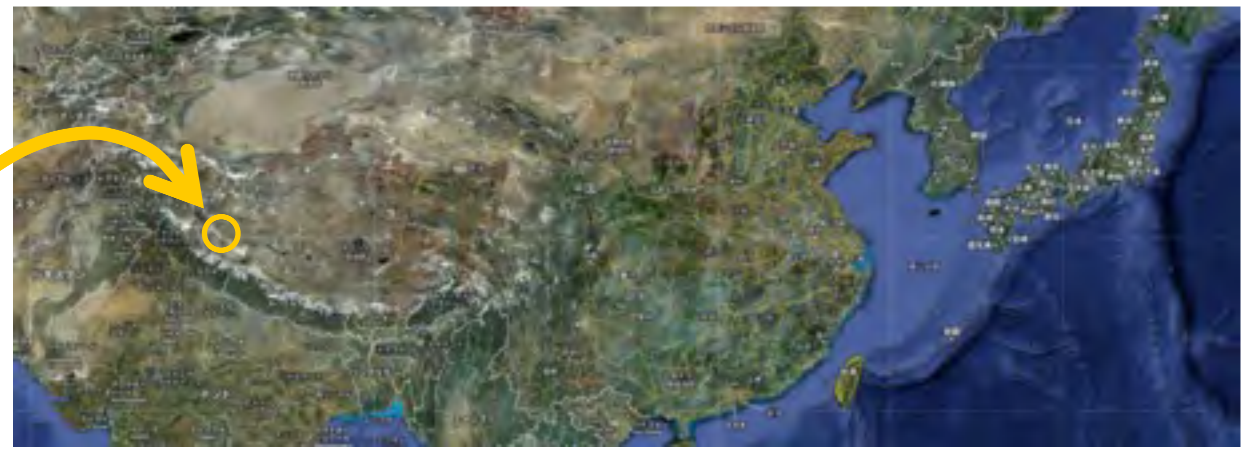
HinOTORI

Hiroshima University Operated Tibet Optical Robotic Imager



Following up EM counterpart of GW using a new robotic telescope with 3 colours camera in Tibet

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HinOTORI members in collaboration with

NAOC Ali observertory, NAOJ

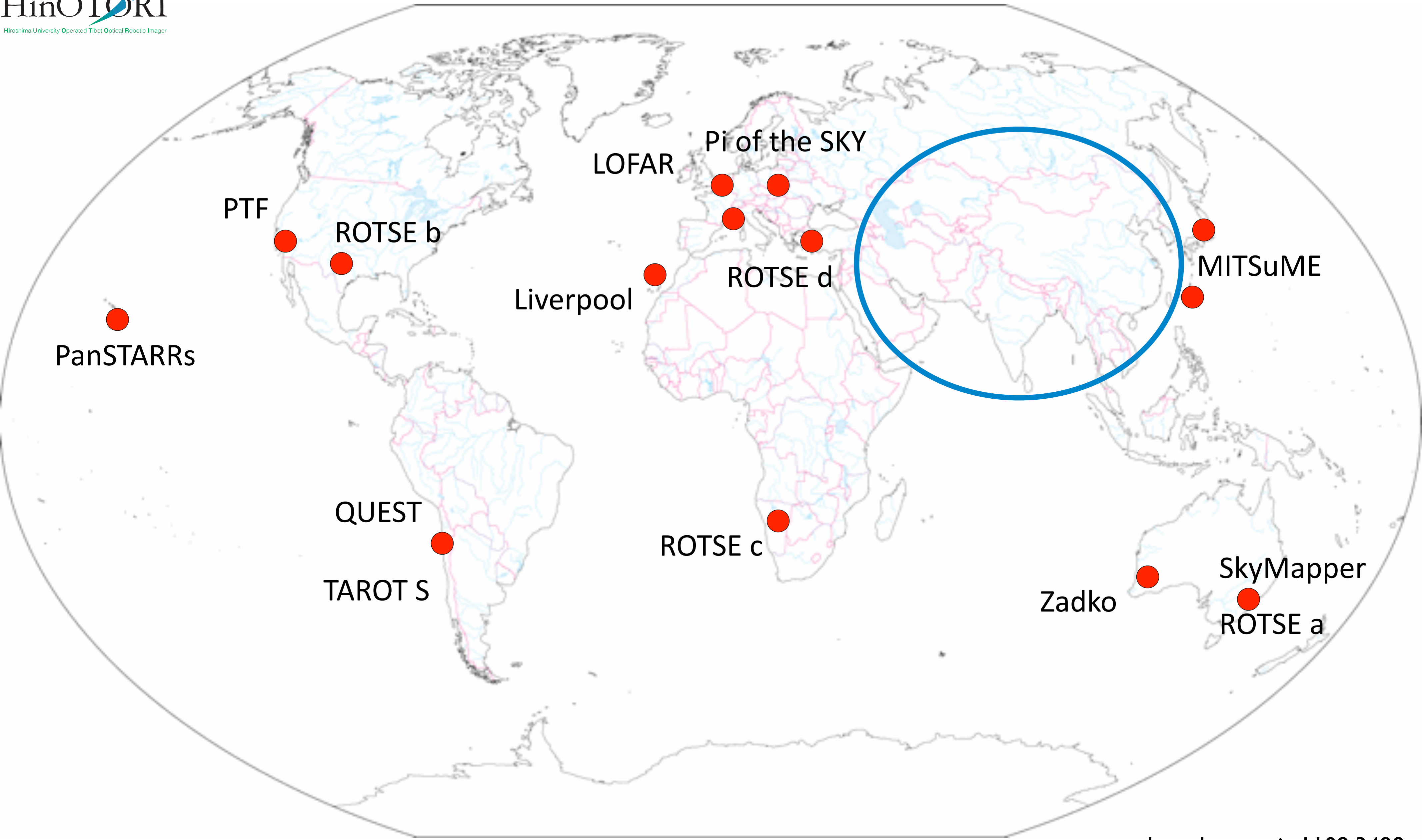
Background

- Gravitational Wave (GW) “emits” from SN or a collapse of compact objects
- Large GW experiments are constructing and will start to find GW sources in 2017 with 100 deg^2 of positional accuracy.

- To confirm GW detection, important to locate counterpart phenomena.
- To understand nature of GW sources, important to monitor optical flux and variation with multi-band.

- Our approach is to construct a global optical monitoring network

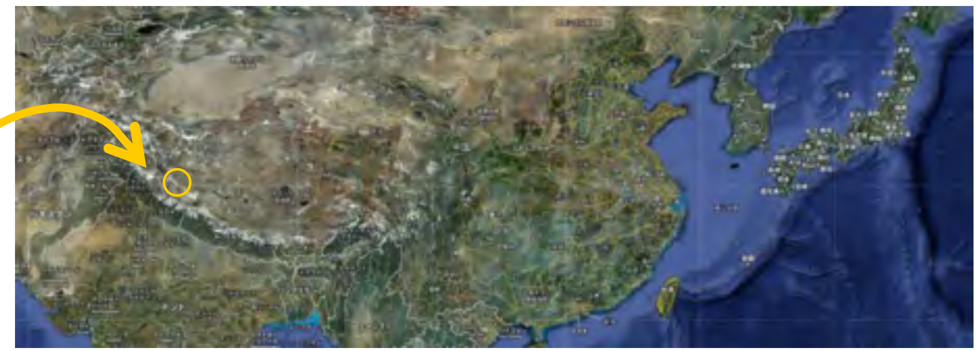
Current Automatic ToO survey telescopes



based on arxiv:1109.3498

Ali, Tibet (西藏阿里)

- One of candidate sites developed by Prof Yao (NAOC)



Comparison with world's class observatory

	Subaru	Gar
Location	Maunakea, Hawaii	Ali, Tibet
Clear sky ratio	74% (avg. Jan 2000-)	75% (Jan2013)
Seeing	0.64" (avg. Jan 2000-)	0.8" (Oct.-Nov. 2011)
Best seeing		0.37" (Nov. 2011)
Altitude	4200m	5100m
Acesss	Easy	Near by airport

Key points of this project

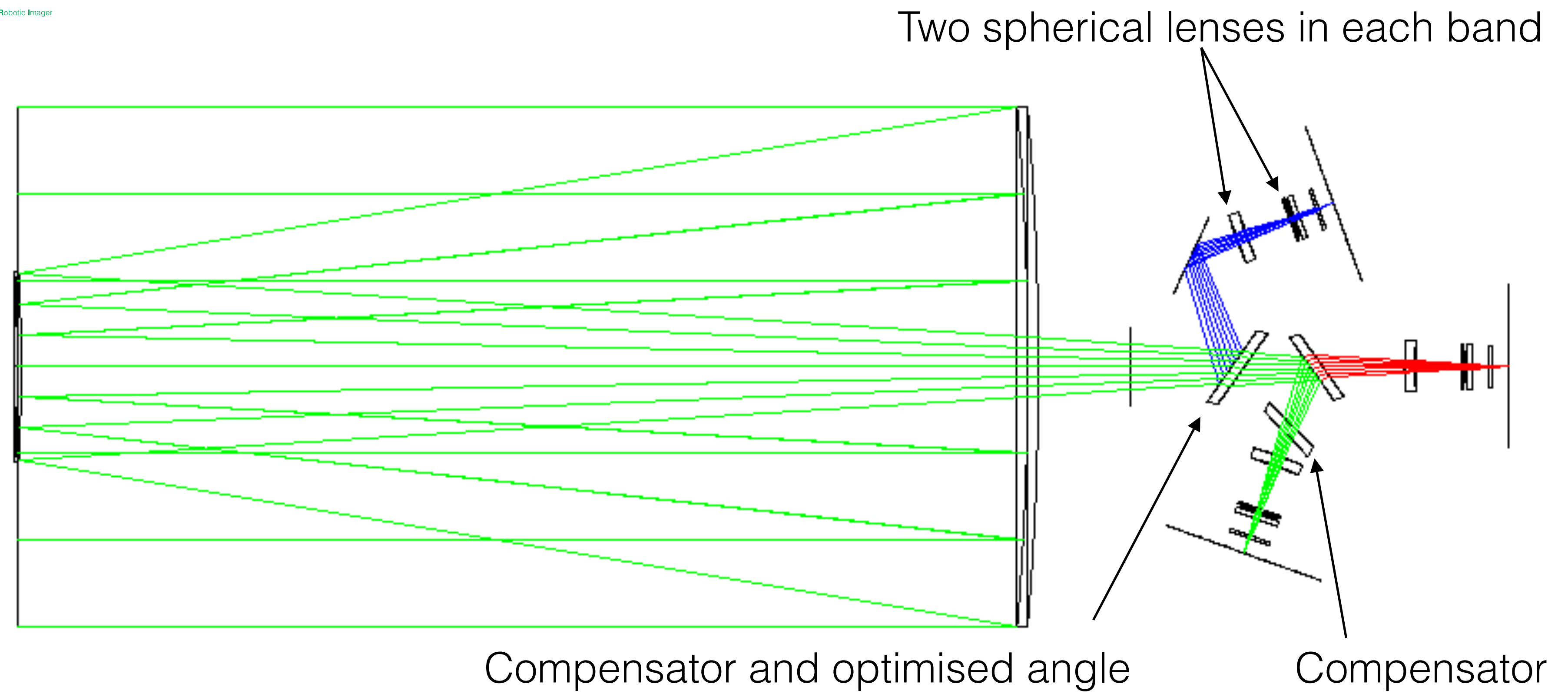
- Wide field imaging capability to make survey faster
  →**50cm, F/8 RC+Corrector lens (23’x23’)**
- Fine image quality to obtain high S/N
  →**Introducing the compensator (spot rms < 0.7”)**
- A merit of high altitude (5100m)
  →**u-channel**

Our telescope

- Alluna Optics, Germany
- Ritchey-Chrétien
- D=510mm, F/8
- back focus: 455, usable 350mm

- Commercial product (but custom order to extend back focus)
- Dealt in Japan

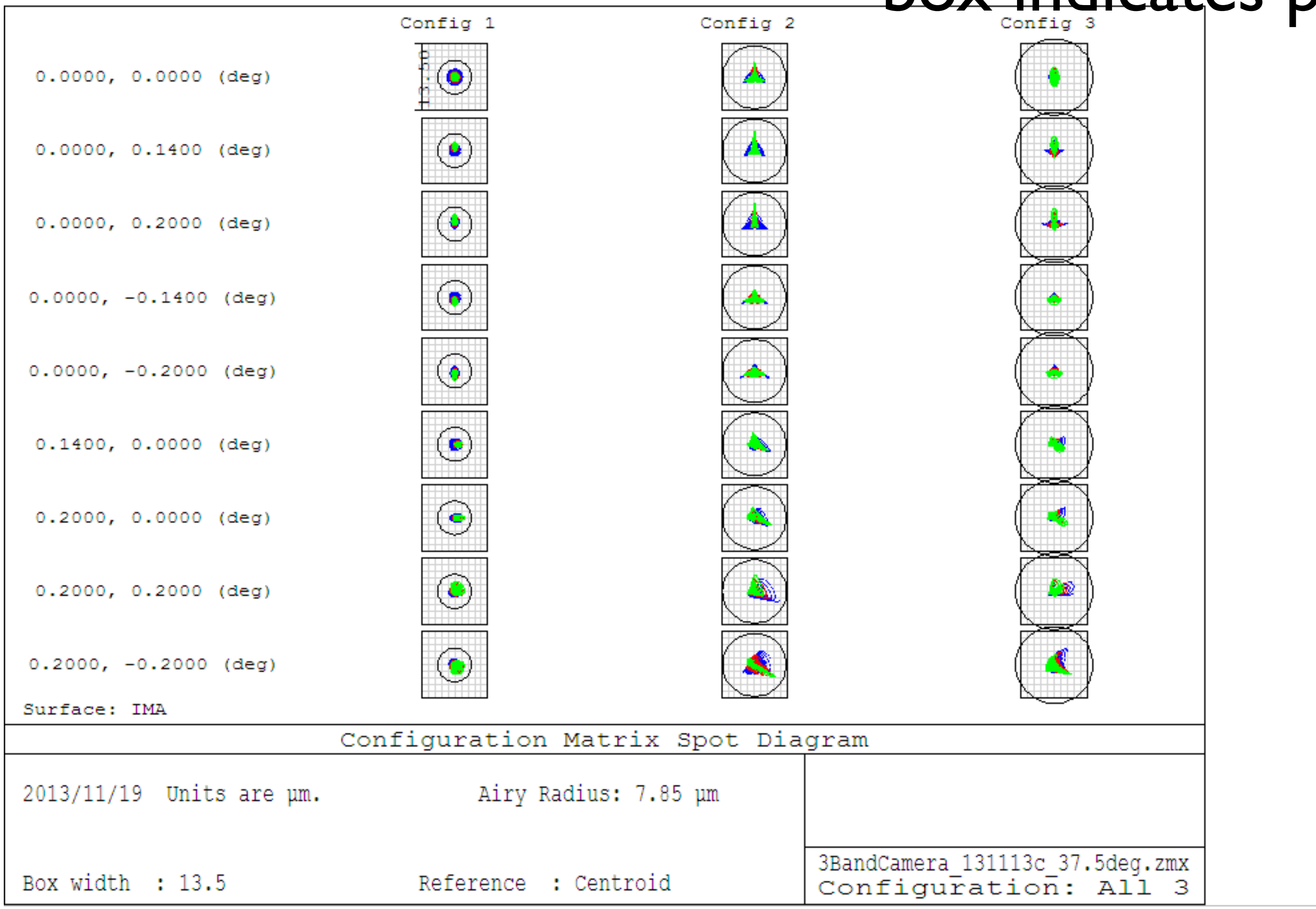
Final design of optical system layout



- Two spherical lenses perfectly correct aberrations
- Compensator is introduced
- Less bending angle as possible (~0.5deg)
- AR coating is optimised on each channel ~98-99%

Expected spot diagram

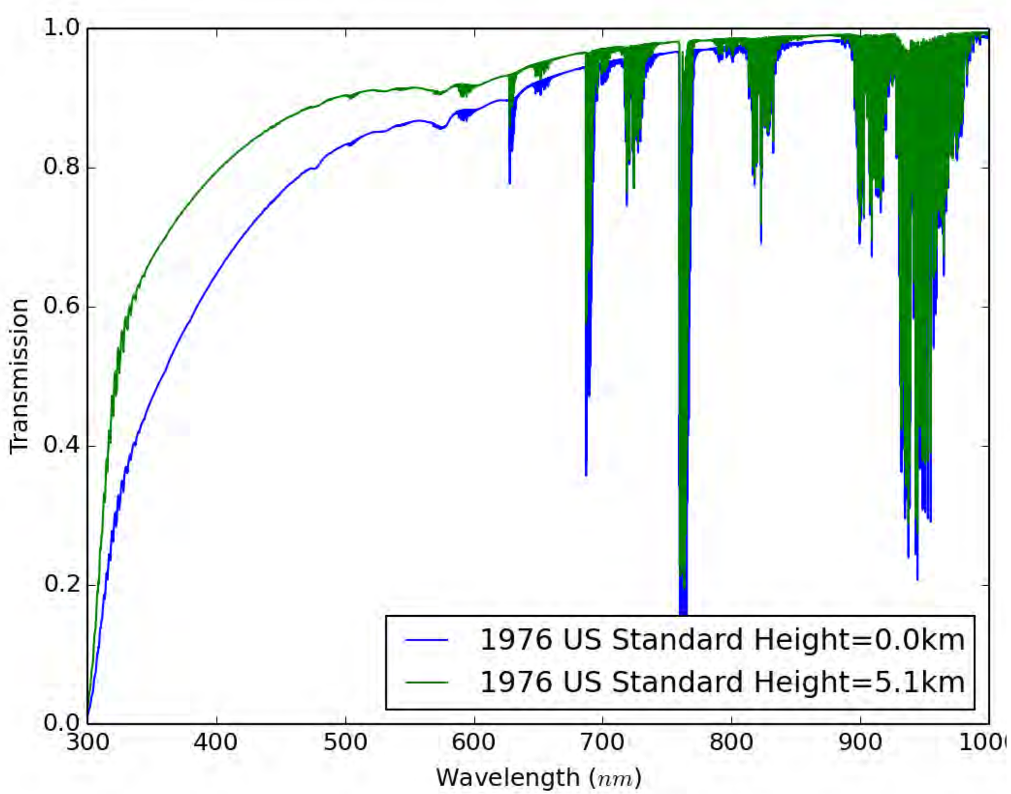
box indicates pixel size

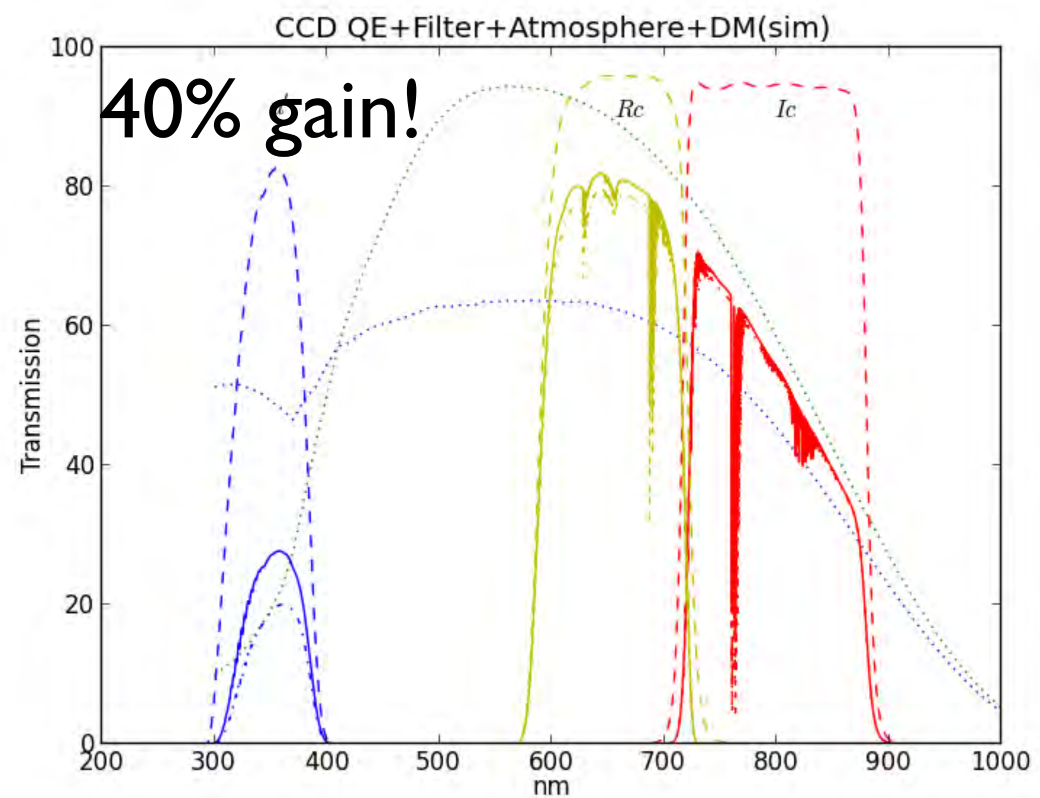


All spots are enough small compared to pixel and airy spot

u-band capability

- Usual optical glasses and atmosphere absorb UV photons
  - choose a UV enhanced CCD
  - Select Fused silica to obtain UV photons
  - Also altitude of Ali helps to collect UV photons





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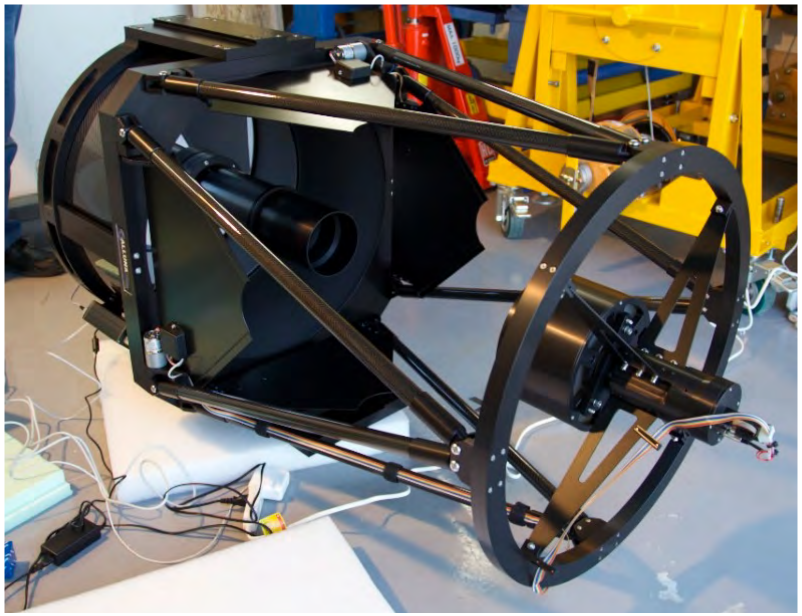
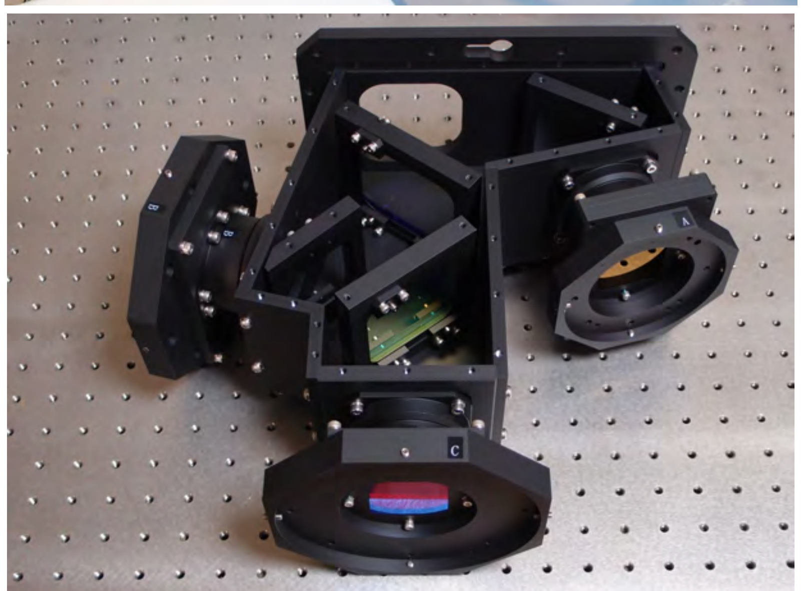
Arrived components



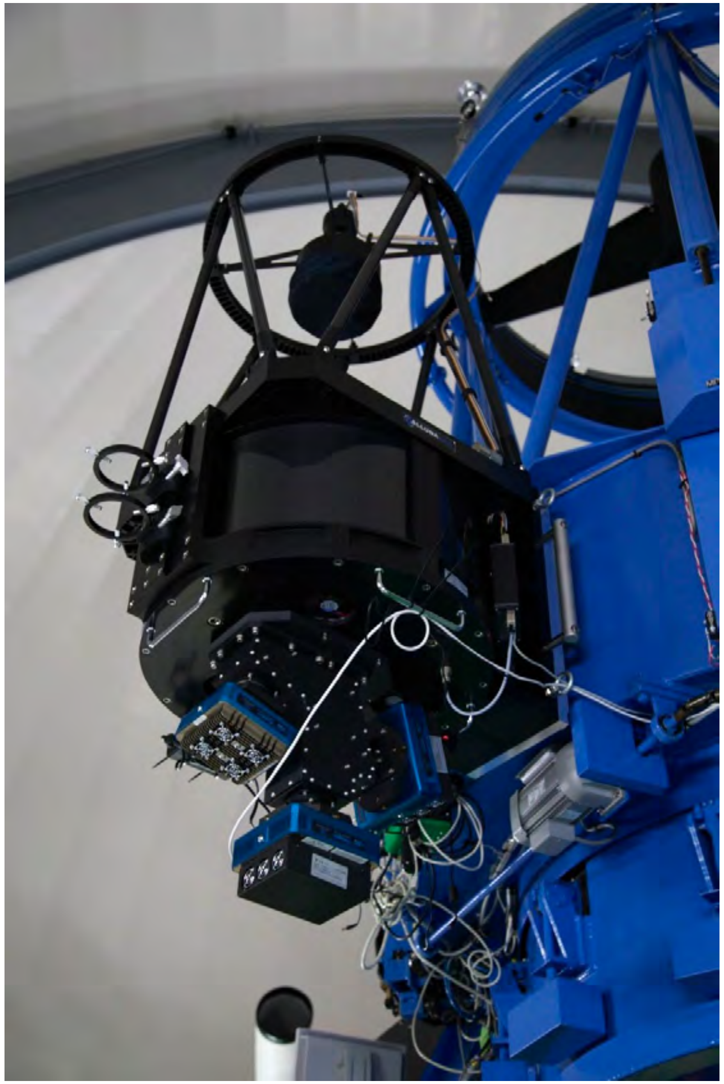
50cm telescope



Corrector system

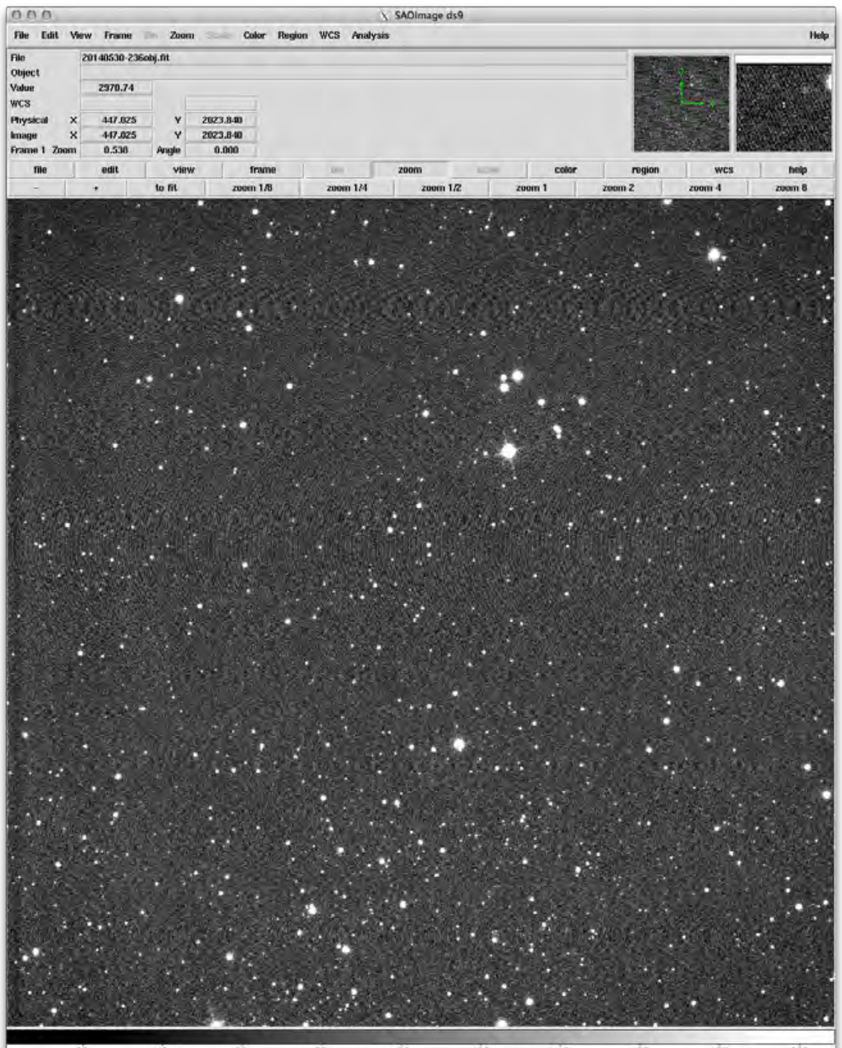
Equatorial mount

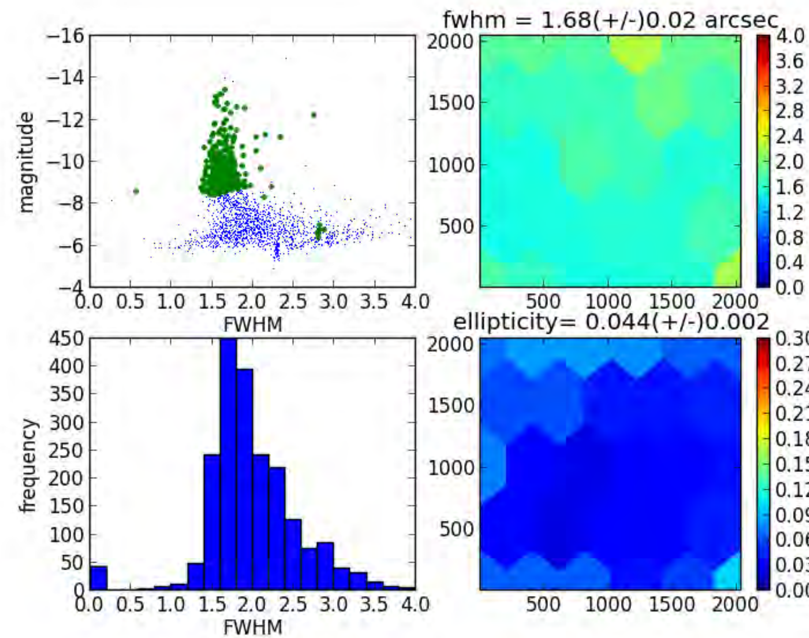
Optical adjustment with Kanata



- Test on Kanata telescope
- Assembling and developing softwares

Telescope spec / performance test





- Δ(Focal length) ~1%
- Δ(Backfocus) <1%
- No significant degradation
- Hard to achieve sub arcsec

Image quality w/o corrector

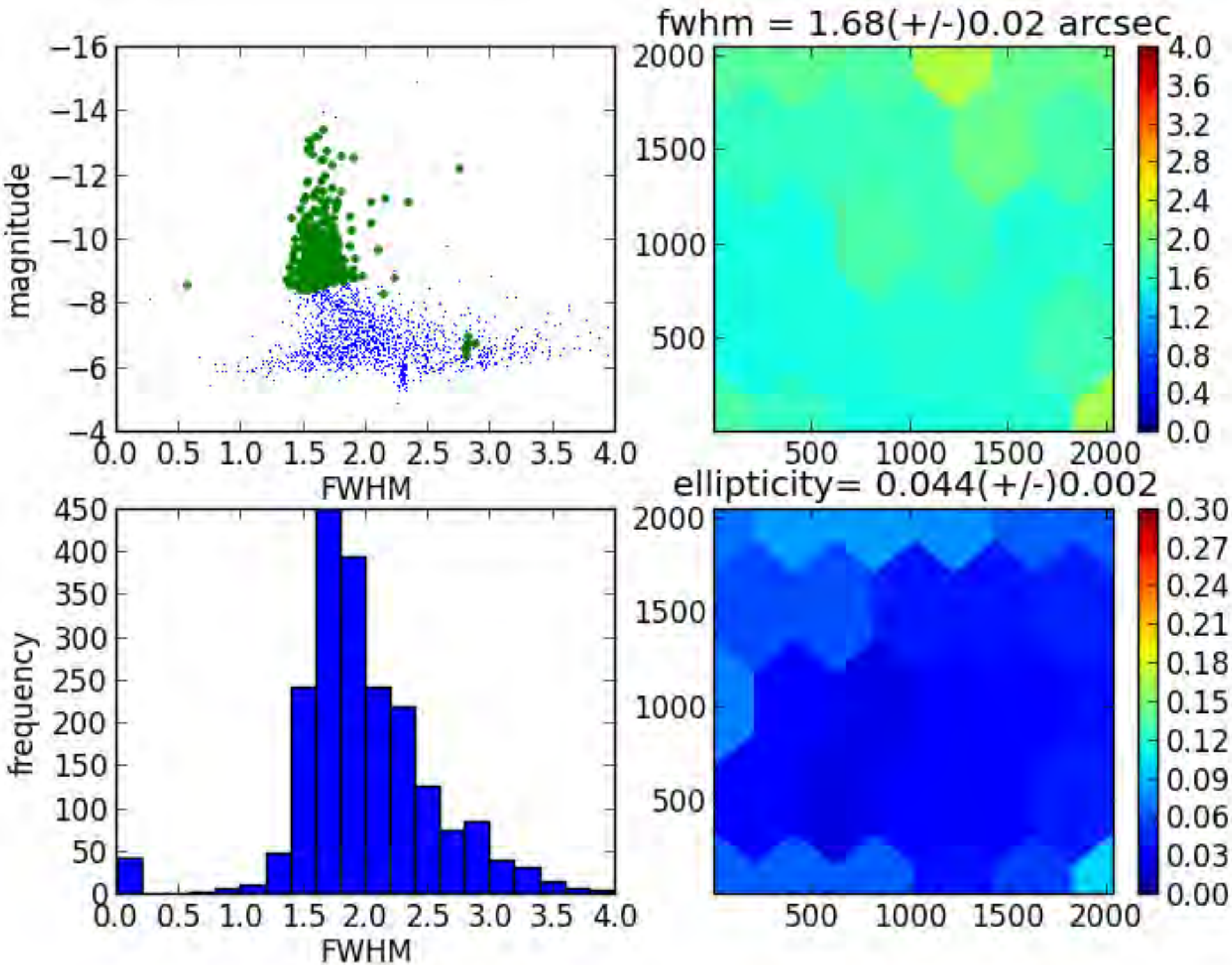
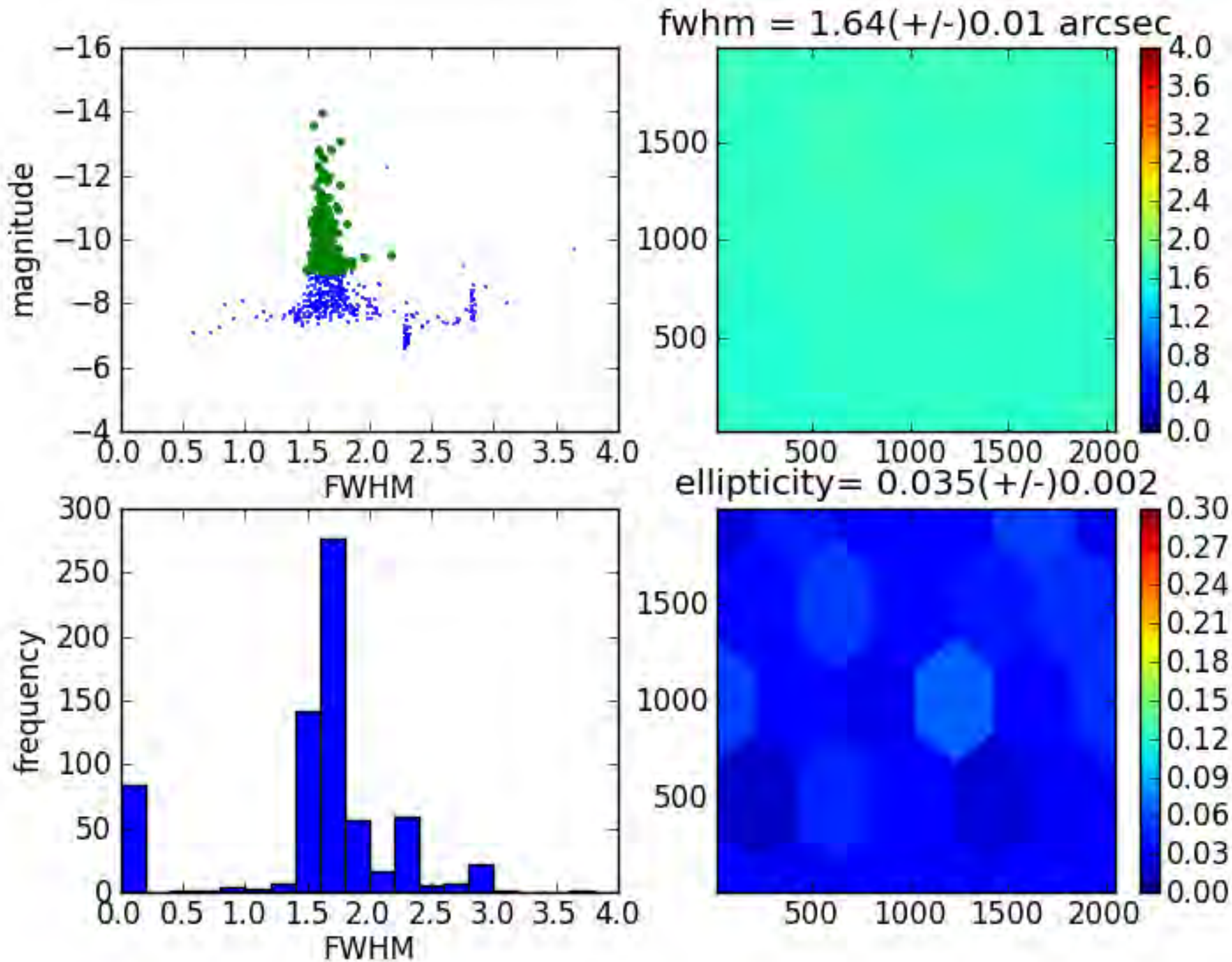
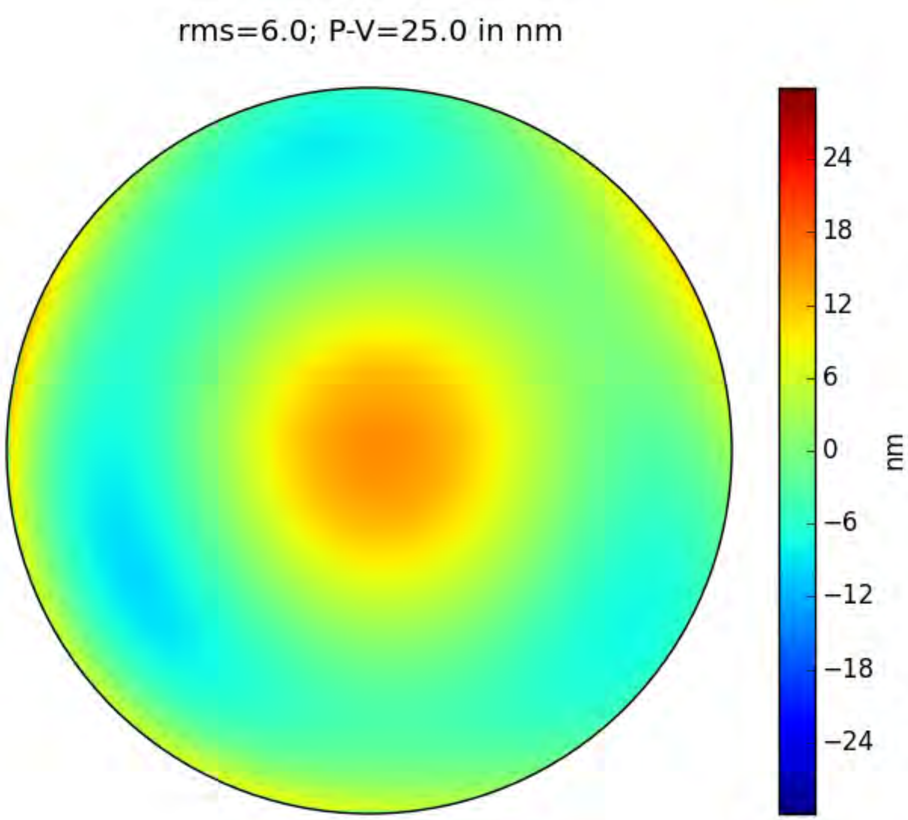


Image quality w/ corrector



Expanding wavefront with Zernike polynomials



- Hartmann const was ~0.7”
- Spherical aberration was dominated
  - must be eliminated by a pair of RC mirrors
- M2 mis-alignment along with optical axis might induce spherical aberration
- Improved const is ~0.3”

Summary

- **Telescope and instrument are under testing** with Kanata telescope
- Developing softwares **to be "robotic"**
- Maybe **solved the entering problem to Tibet**
- **Installation work is planning in this year**