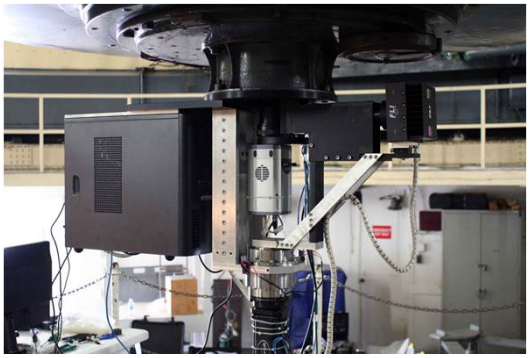
Early Science Results from CQUEAN Commissioning Observation

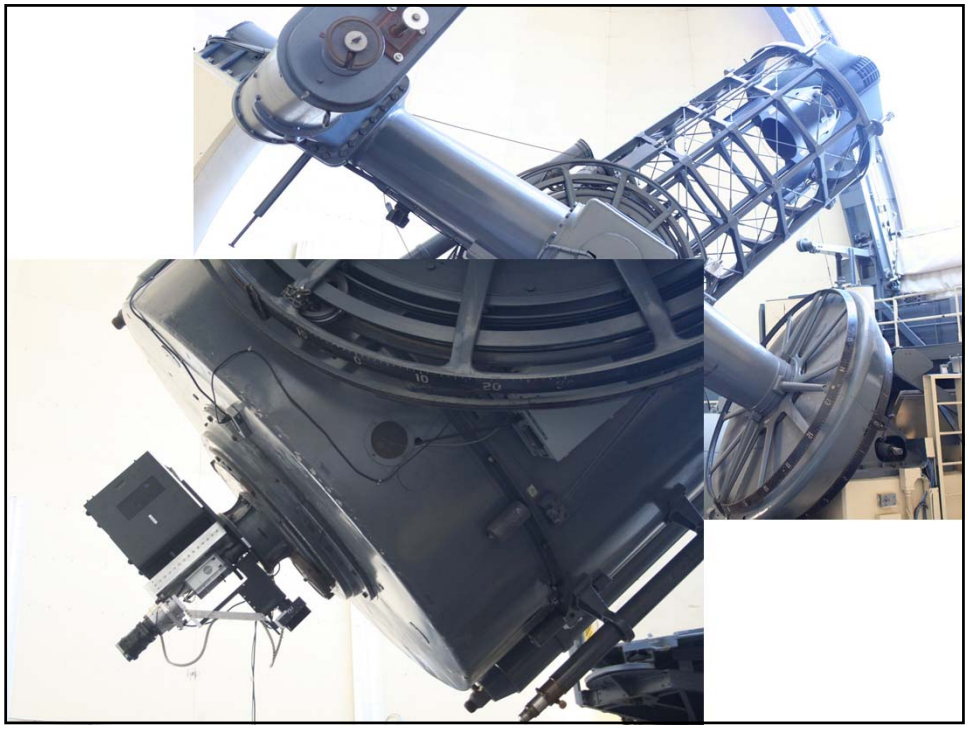
– Unique Views on Gamma Ray Bursts to High Redshift Quasars –

Myungshin Im (SNU), Soojong Pak (KHU),
Won-Kee Park, Changsu Choi, Yiseul Jeon (SNU), Eunbin Kim,
Hyeonju Jeong, Jinyoung Kim & Juhee Lim (KH)

CQUEAN

- Camera for Quasars in EArly uNiverse
- Fast (~1+ year) development, low cost (0.12 billion won) proto-type instrument for CEOU

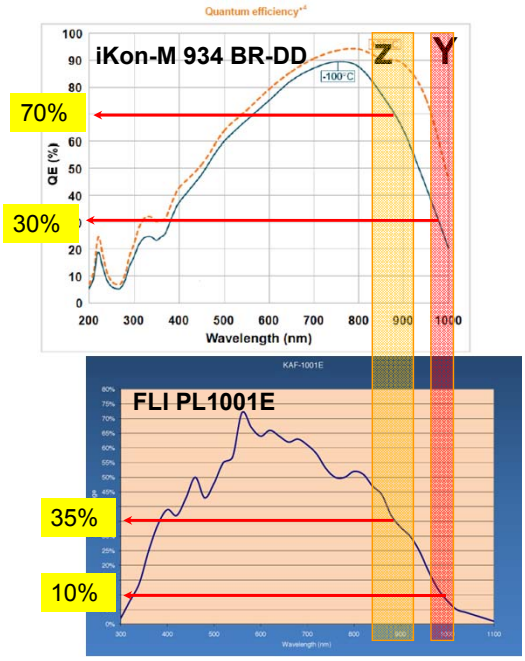




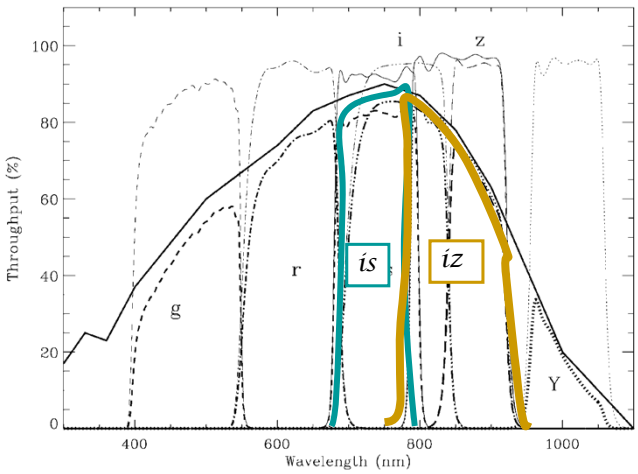
Basic Parameters

Science Camera CCD	E2V Deep Depletion Chip
Format and pixel size	1024 x 1024, 0.276" (13 micron)
FOV	4.7' x 4.7' (with focal reducer)
QE	90% at 0.8 μm, 25% at 1 μm
Readout time	1 sec
Readout noise	8.2 DN
Dark Current (@-70)	0.1 - 0.2 e-/sec
Gain	1.2
Fringe	None
Filters	SDSS g,r,i, LSST z,Y, *is, iz*
Linearity	< 35,000 DN

Q.E.

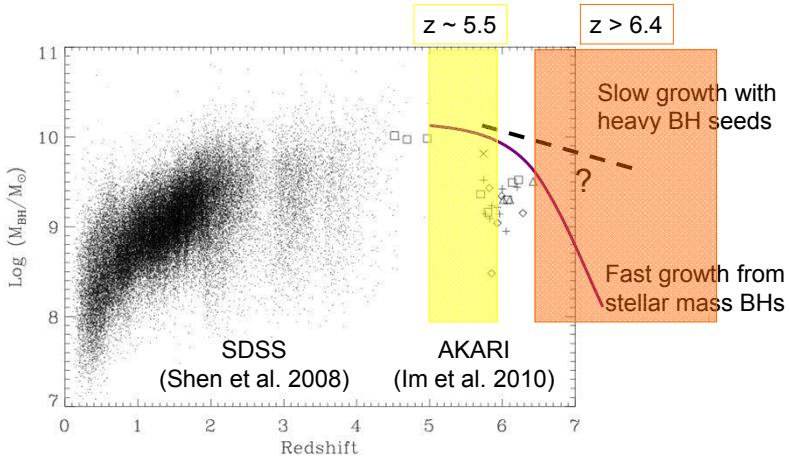


CQUEAN Filters



- SDSS g, r, i, LSST z, Y, and custom *is* and *iz* filters
- 28mm diameter, circular filters

How did SMBHs grew?

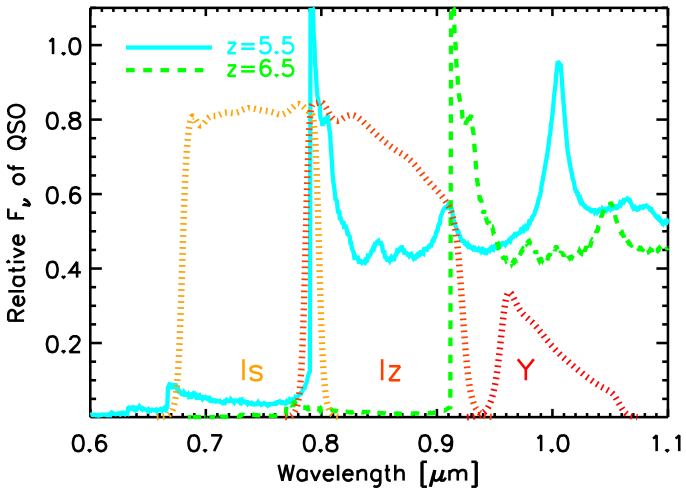


Basic Strategy

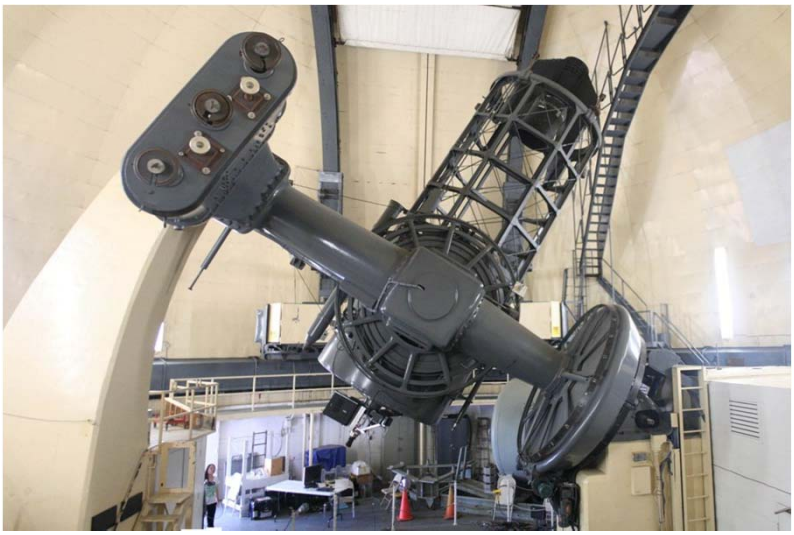
- Select r-band dropouts from SDSS (300,000 candidates over 3,000 deg^2 area)
- Cross-match with Y/J-band data from UKIDSS/LAS (3,000 candidates)
- Follow-up imaging with CQUEAN: 30-50 best candidates

➔ Follow-up spectroscopy

High redshift quasar selection (@ z ~ 5.5, and @ z ~ 6.5)



CQUEAN@2.1-m Struve Telescope

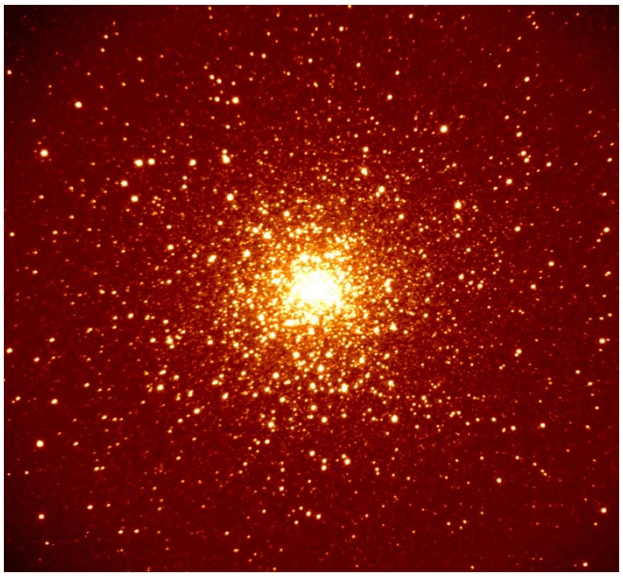


Commissioning run (August 10 – 17, 2010)

- Installation of CQUEAN
- Engineering test of CQUEAN operation (modification of software, etc)
- Test observations
  - Pretty pictures
  - High redshift quasar candidates
  - Gamma Ray Bursts (GRBs)
  - Standard stars

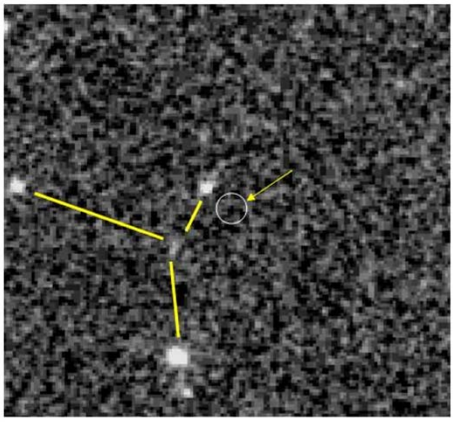
Stephen's Quintet (Arp 319)

M15

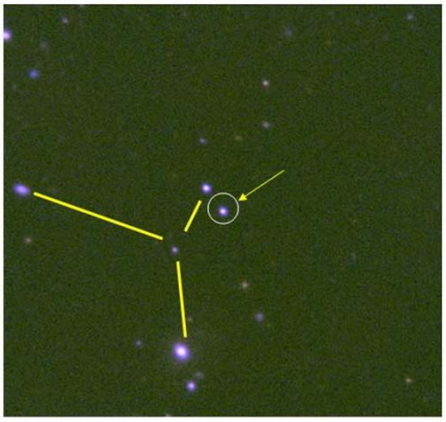


M77

감마선 폭발천체 GRB 100814A (z=1.44) 과거사진과 CQUEAN사진 비교

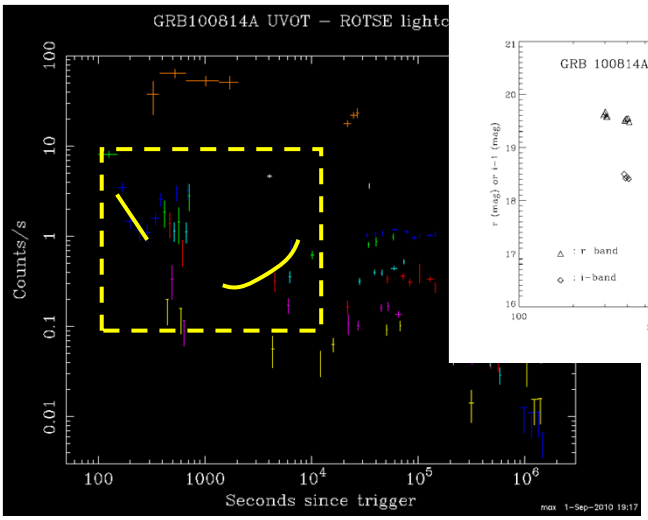


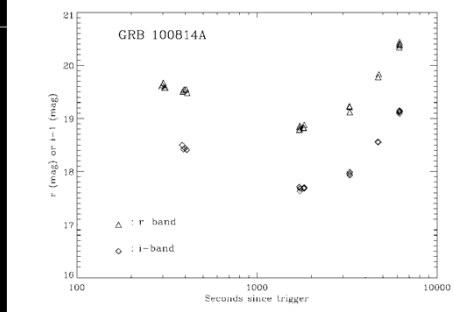
과거 탐사관측자료 사진
GRB 100814A의 모습이
보이지 않음.



시퀀이 포착한 감마선 폭발천체의 모습.
과거에 볼 수 없었던 새로운 천체,
GRB 100814A의 영상이 선명하게 보임.

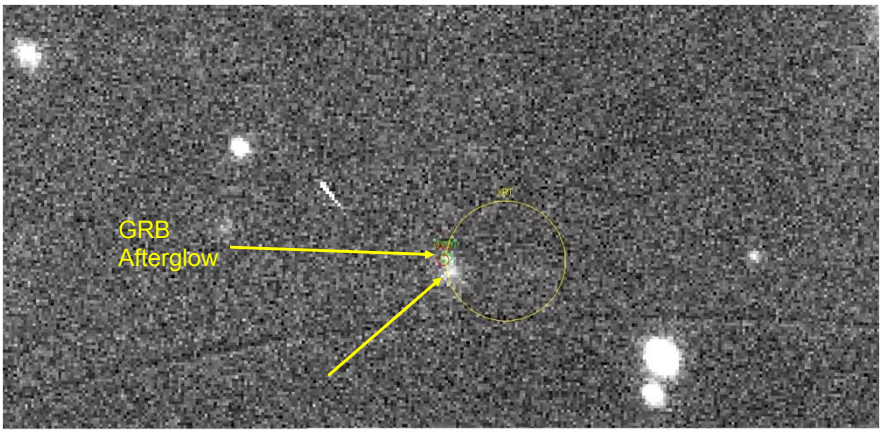
GRB 100814A Light Curve





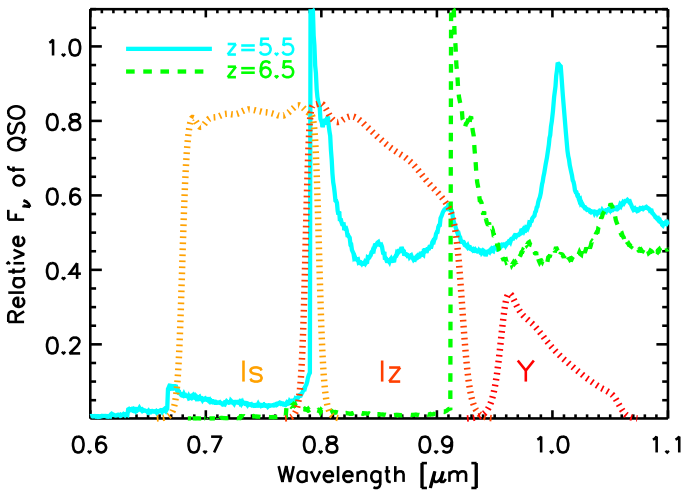
De Pascuale, M., Im, M., Pak, S., W. Park, Y. Jeon, et al. (2010, in prep.)
Im, M., Pak, S., Park, W., Jeon, H., Kim, E., & Kim, J. (2010, GCN Circular,11093)

GRB 100816A, Short GRB at z=0.80

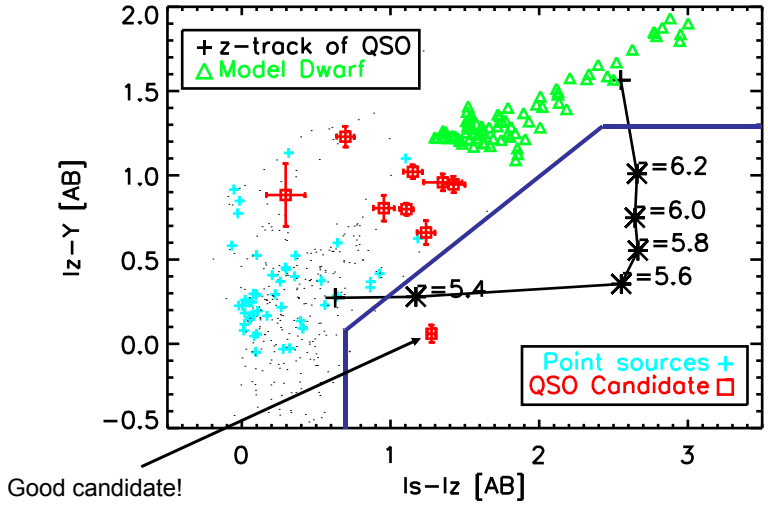


Im, M., Park, W., Pak, S., Jeong, H., Kim, E., & Kim, J.
(2010, GCN Circular 11108)

High redshift quasar selection (@ z ~ 5.5, and @ z ~ 6.5)



Selection of Quasars at 5.3 < z < 6.2



Limiting Magnitude, etc

Filter	λ_{eff} (μm)	Sky Count (DN/sec)	Sky Brightness (mag/arcsec2)	Magnitude Limit (mag at 5-σ, 1hr integration)	T_{eq} (sec)
r	0.623	1.2	21.3	24.1	56.0
i	0.768	4.6	20.6	24.3	14.6
is	0.739	5.0	20.3	24.0	13.4
iz	0.849	8.0	19.8	23.8	8.4
z	0.877	5.2	19.6	23.4	12.9
Y	0.991	3.8	18.5	22.1	17.7

Magnitudes in AB
Numbers are for a dark night
T_{eq}: time when RN = Sky noise

Future plan

- 60 nights per year on 2.1m
- Observe ~4000 targets over 4000 deg^2
  ~30-50 Quasars at z ~ 5.5
  ~ 5 Quasars at z > 6.5

- ~10 - 15 GRBs per year

- Open for UT astronomers