Apache Point Observatory
Sunspot, New Mexico

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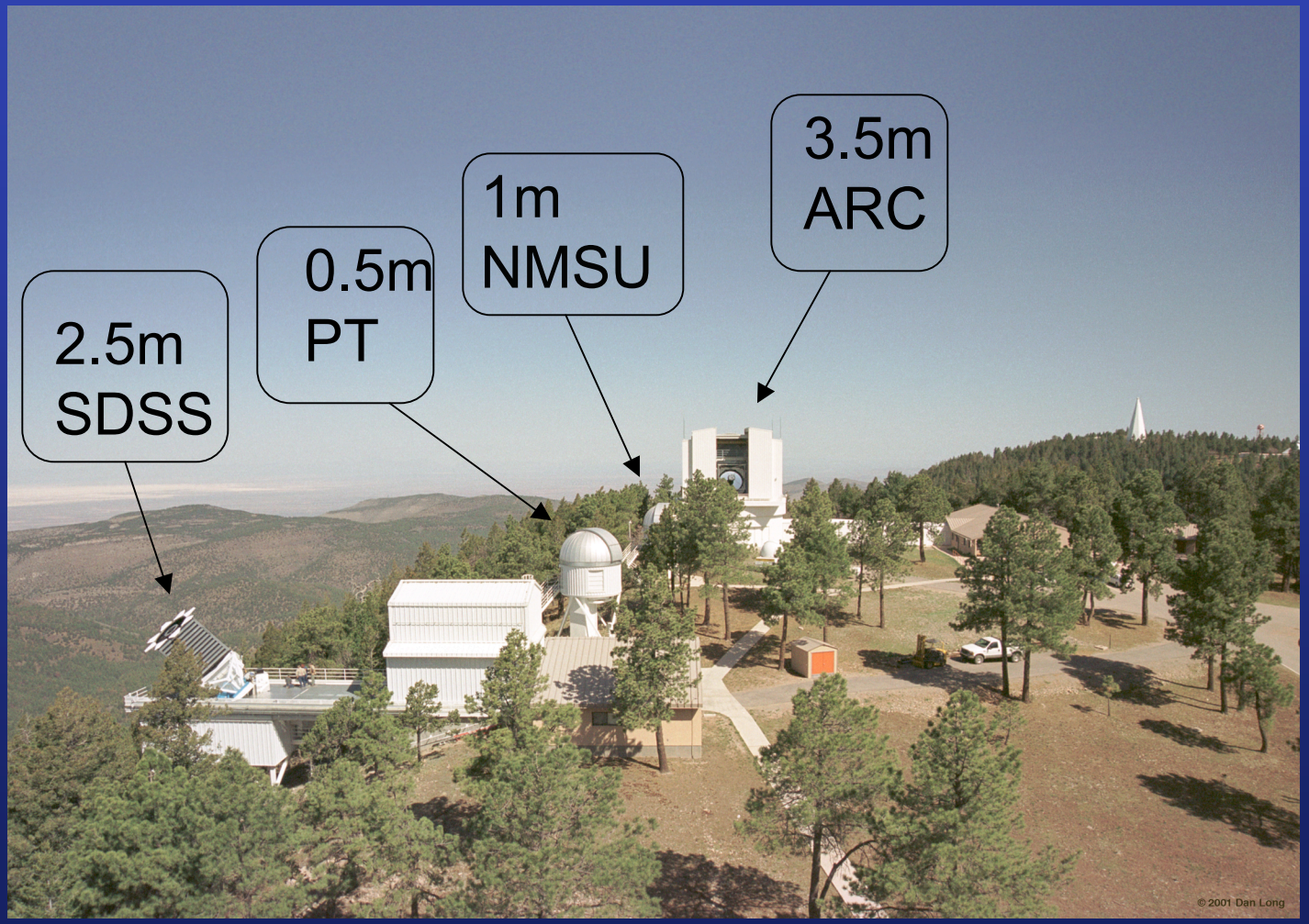
Director, ARC 3.5m Telescope

Apache Point Observatory



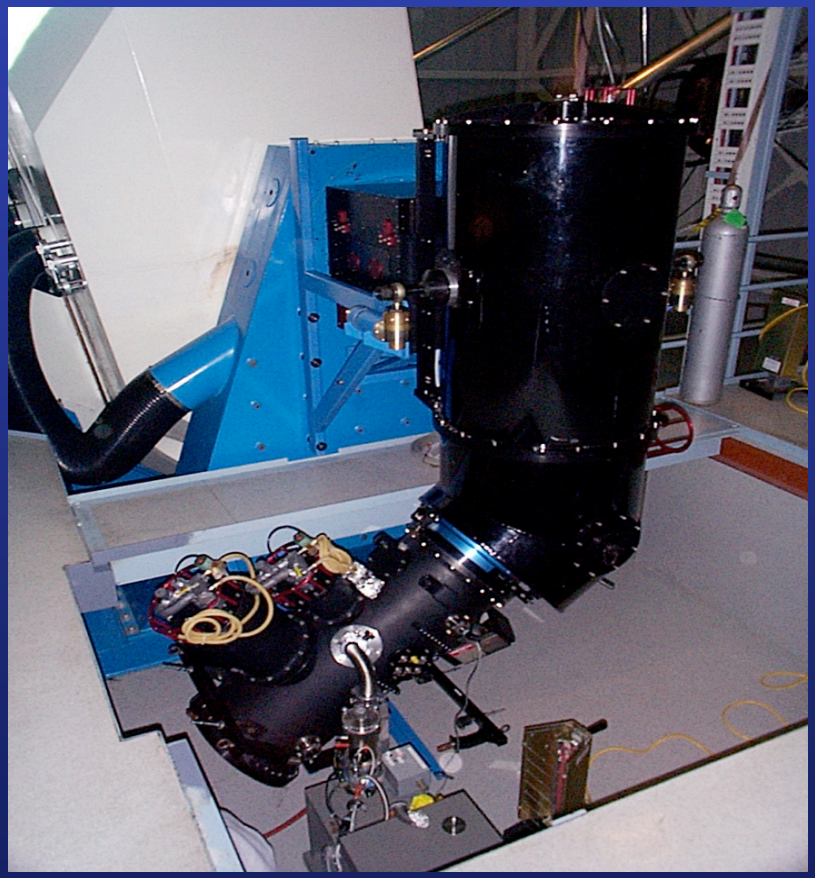
Astrophysical Research Corporation (ARC) Partner Institutions

- University of Washington (25.0%)
- University of Chicago (17.0%)
- Princeton University (15.6%)
- New Mexico State University (15.6%)
- University of Colorado (12.5%)
- Johns Hopkins University (8.0%)
- University of Virginia (6.3%)

ARC 3.5m Telescope

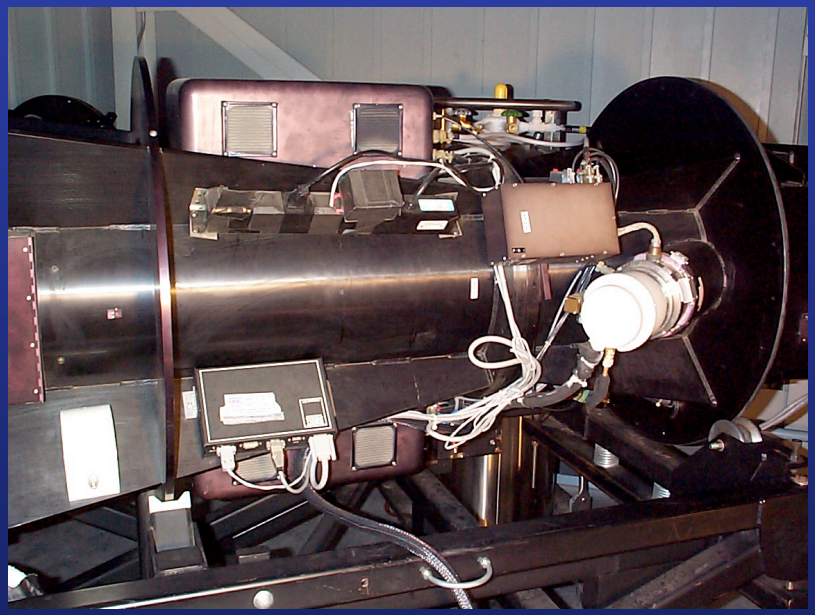
- 3.5m borosilicate primary mirror from Arizona Steward Observatory Mirror Lab
- Alt-az telescope mount, used mostly at f/10 Nasmyth ports, NA1 and NA2
- NA1 has permanently mounted echelle spectrograph
- NA2 has instrument rotator, several instruments (optical and near IR)
- Quick change capability (15 min)
- Scheduled in half nights, most observing is remote by University partners using TUI (Telescope User Interface) software

Echelle Spectrograph



- R = 30,000
- Full wavelength coverage from 3500-9800A
- V~15 in one hour (S/N=10)
- Remote operation with TUI

Dual Imaging Spectrograph (DIS)

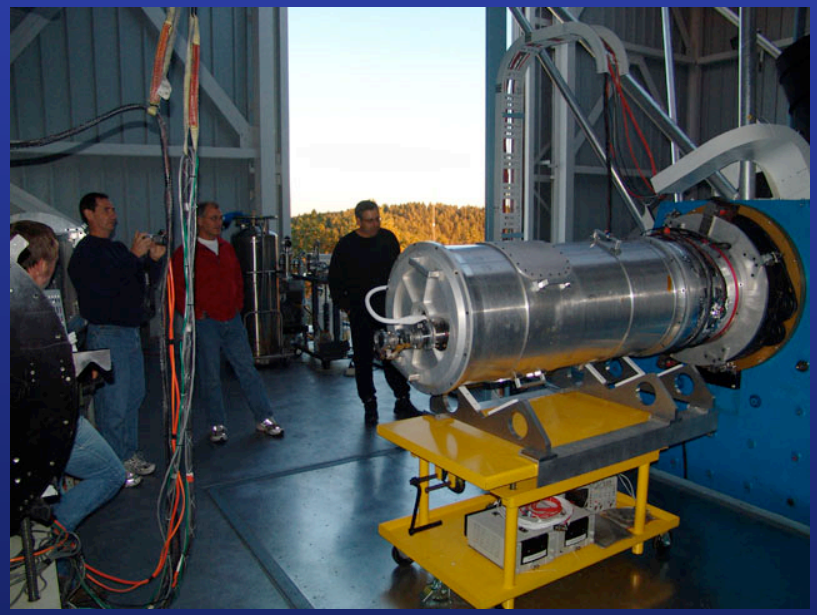


- Blue and red channels split by dichroic at 6000A, observe both simultaneously
- High (R=5000) and low (R=1000) resolution
- V~20 in one hour (S/N=10)
- Remote operation with TUI

Optical Imaging Camera (SPIcam)

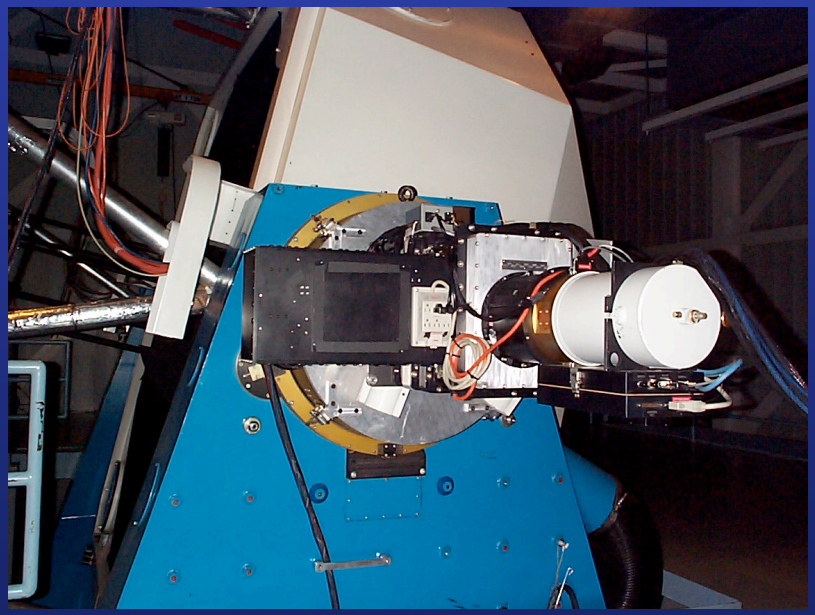
- 2048x2048 CCD, 7.5'x7.5' FOV
- UBVRI, ugriz, many narrow band filters
- V~22 in 5 min (S/N = 10)
- Operated remotely with linux interface

Near Infrared Camera (NIC-FPS)



- Newest instrument, (December, 2004) built by U. Colorado
- 1024x1024 HAWAII-1RG detector gives 4.5'x4.5' FOV
- ZJHK + narrow band filters
- J~20 in 5 min (S/N=10)
- Remote operation with TUI

Goddard Fabry-Perot Spectrograph



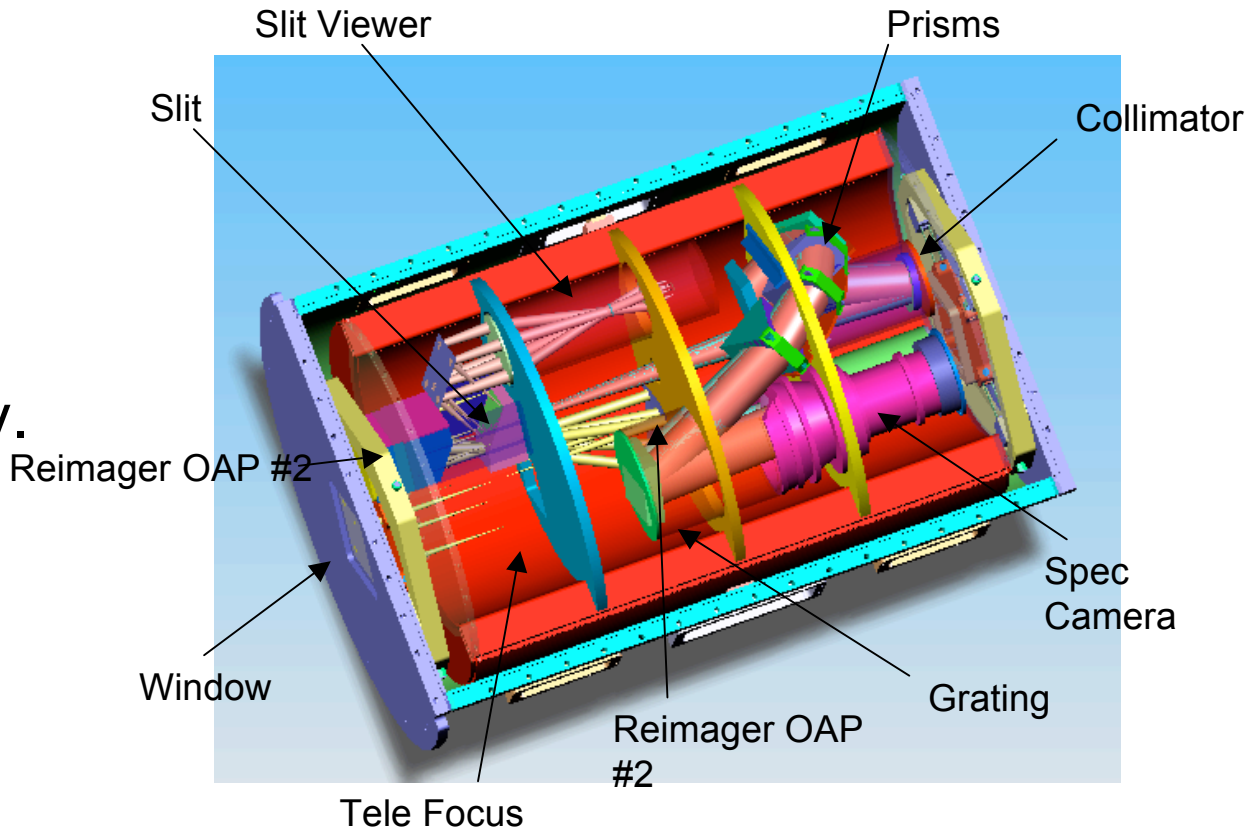
- High resolution narrow band imaging
- Permanent Visitor instrument, Bruce Woodgate (NASA)
- Possible to operate remotely

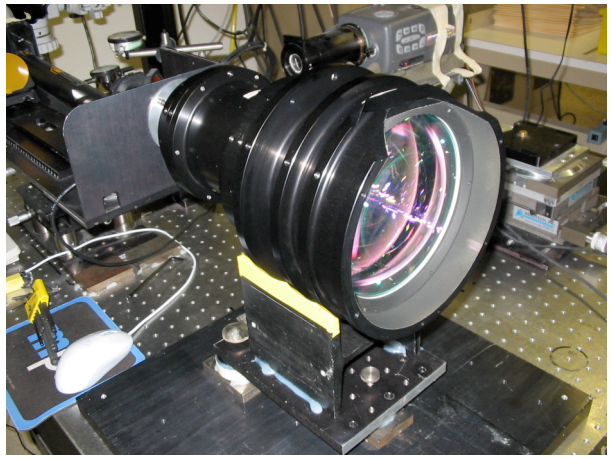
Near Infrared Spectrograph (TripleSpec)

Being built by Univ. Virginia (with Cornell, Caltech)

Planned to Arrive at APO Spring 2007

R=3000, JHK spectral regions simultaneously





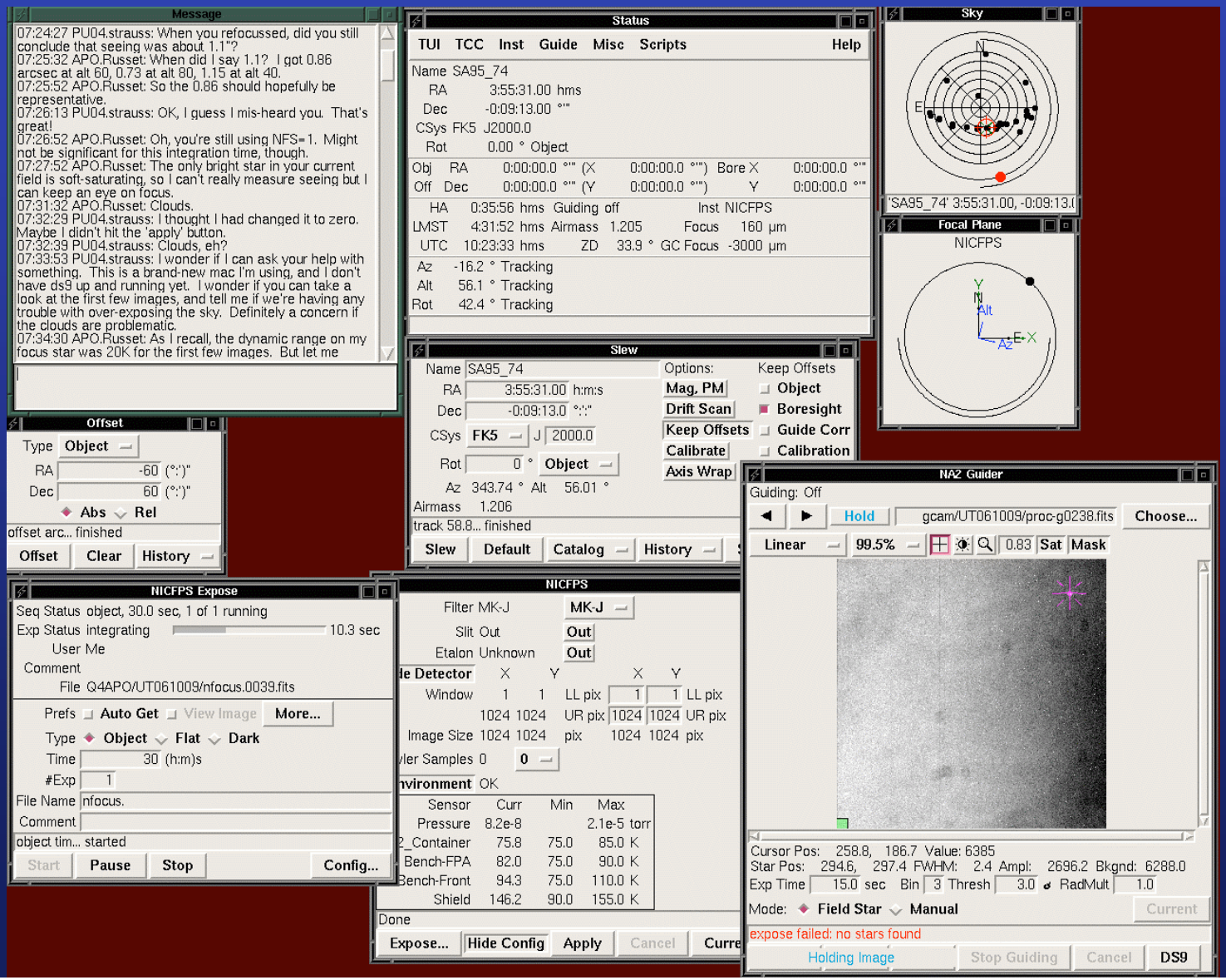
7-element refractive camera

3.5m - New instruments

- High speed photometric camera - copy of successful Texas instrument (U. Washington)
- High resolution near-IR spectrograph (U. Florida)

Both relying on individual PI-led NSF grants

Telescope User Interface (TUI)



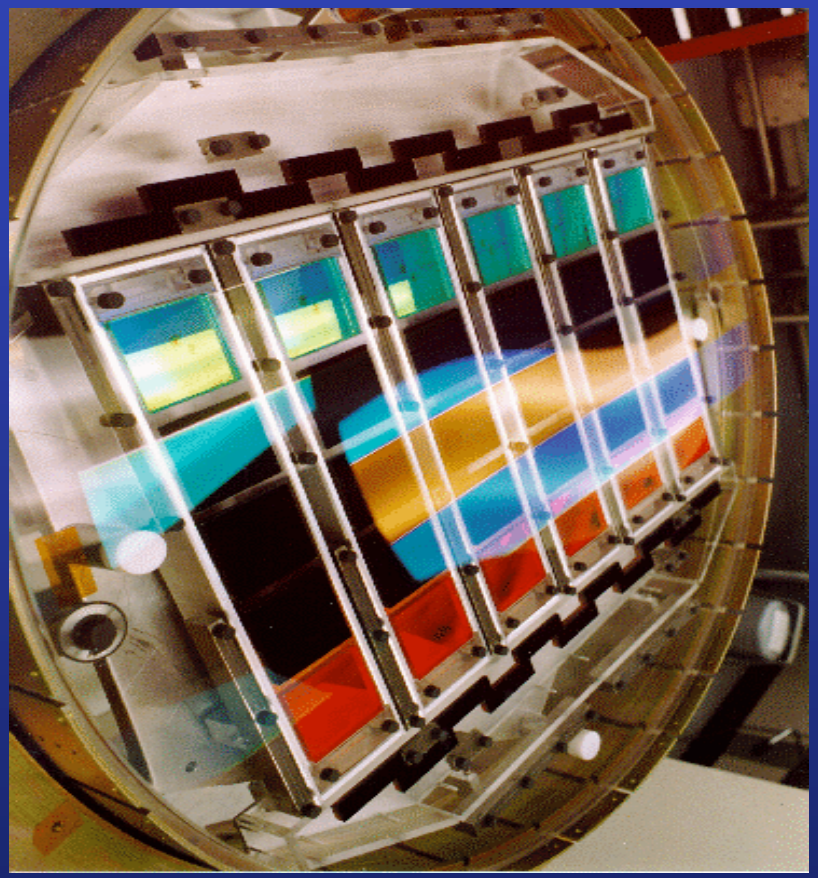
APOLLO Lunar Laser Ranging

- Fire laser at the moon through the 3.5m
- Send 10^{17} photons in short bursts, receive 10 back (reflected off retro-reflectors left by APOLLO astronauts)
- Calculate distance to the moon from timing information
- Improve accuracy from 2cm to 1mm
- Tests of General Relativity, Equivalence Principle

APO 3.5m Attributes

- Flexible scheduling - half nights, rapid followup, target of opportunity, long term monitoring programs, survey followup (SN)
- Fast instrument changes - all instruments available every night
- Remote observing - reduces costs, improves efficiency, allows ToO access
- Graduate student training and access
- Opportunities for university instrumentation groups, innovative programs

APO 2.5m - SDSS



- 5 color (ugriz) imaging
- 2 spectrographs with 320 fibers each
- Survey North Galactic Cap (10,000 sq deg)
- SDSS-I complete, DR5 now public
- SDSS-II underway (finish main survey, SEGUE, Supernovae)

Excellent example of private-public partnership, access to US telescope system

ADS High-Impact Papers 2006

Facility	Number of Citations	Fraction of the Total
SDSS	1843	17.4%
ESO	1365	12.9%
HST	1124	10.6%
WMAP	1121	10.6%
Keck	642	6.0%
Kamiokande	372	3.5%
Chandra	365	3.4%
ACBAR	207	2.0%
NOAO (KPNO/CTIO)	202	1.9%
Las Campanas	176	1.7%

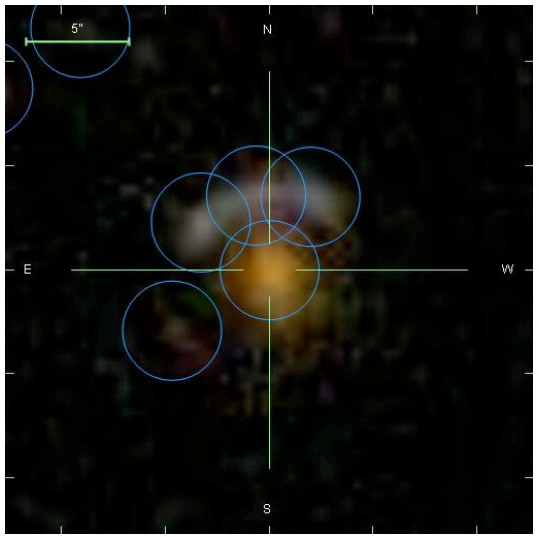
(Bob Williams, statistics compiled for HST)

Take home message:

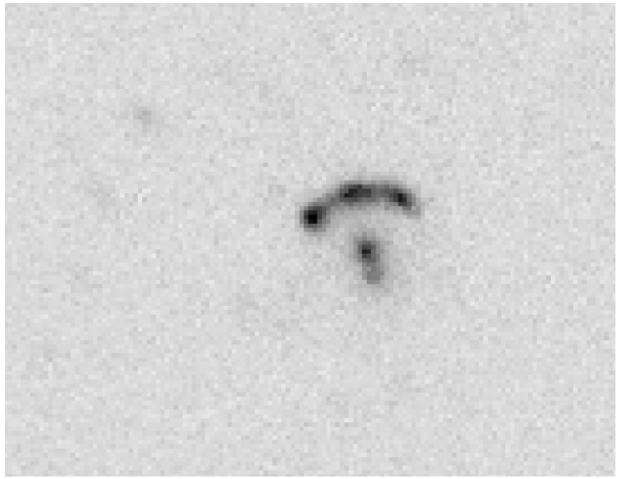
- Surveys are an important part of the telescope system, provide wide access for all parts of the community
- Medium-sized telescopes important for rapid and flexible access, survey followup, training, etc.
- Instrumentation is on the ragged edge, not well addressed by TSIP or PREST for 2 - 5m telescopes

Followup of SDSS Discovery

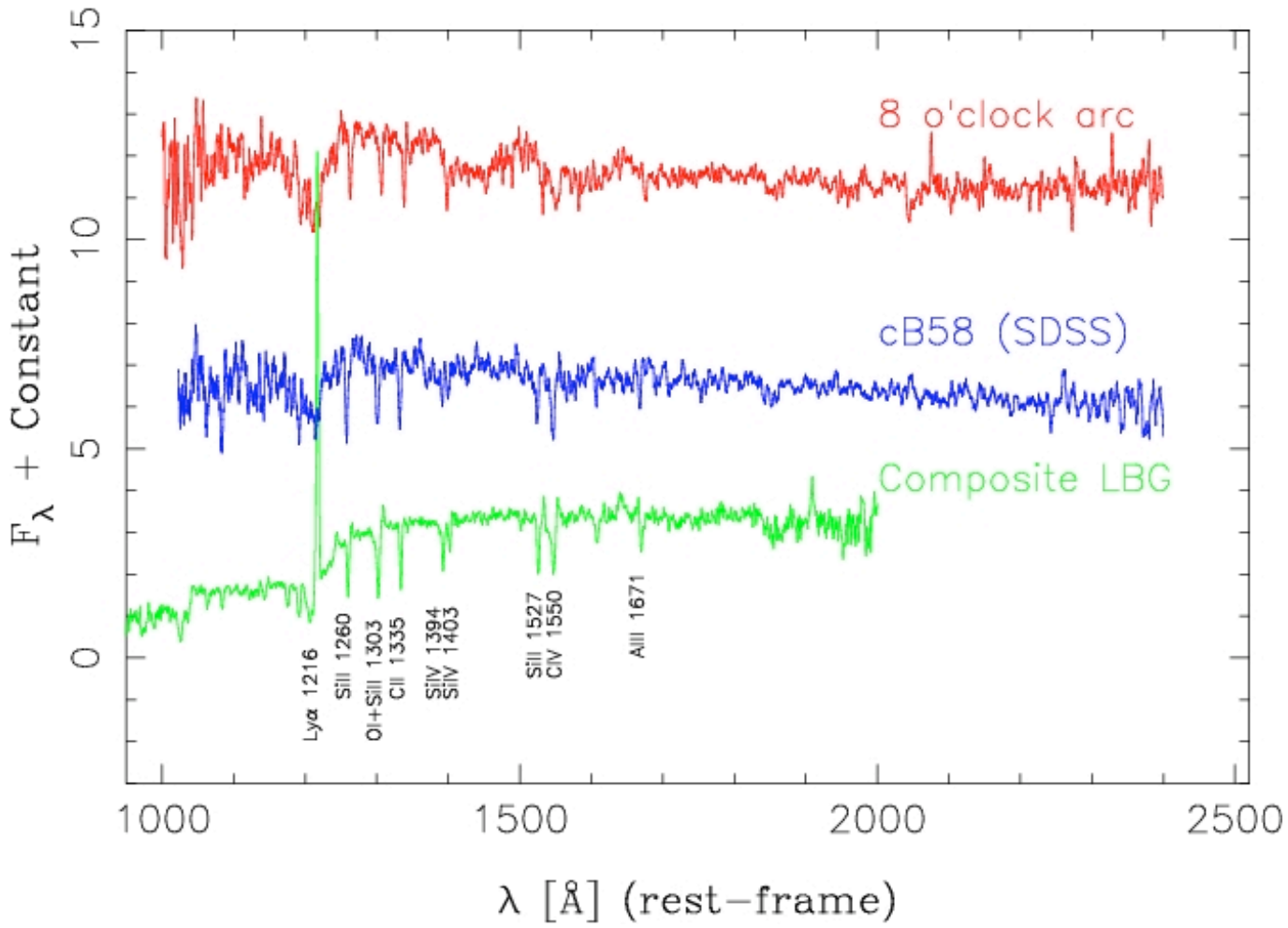
SDSS discovery image shows luminous red galaxy (z=0.38) and blue arc



APO 3.5m imaging reveals 4 lensed images of background Lyman break galaxy at z=2.73. Brightest LBG known by > 1 mag.



Sahar Allam (FNAL) press release Nov 06, astro-ph/0611138



Same half night - obtained APO 3.5m spectra of lensed images to find redshift, confirm LBG

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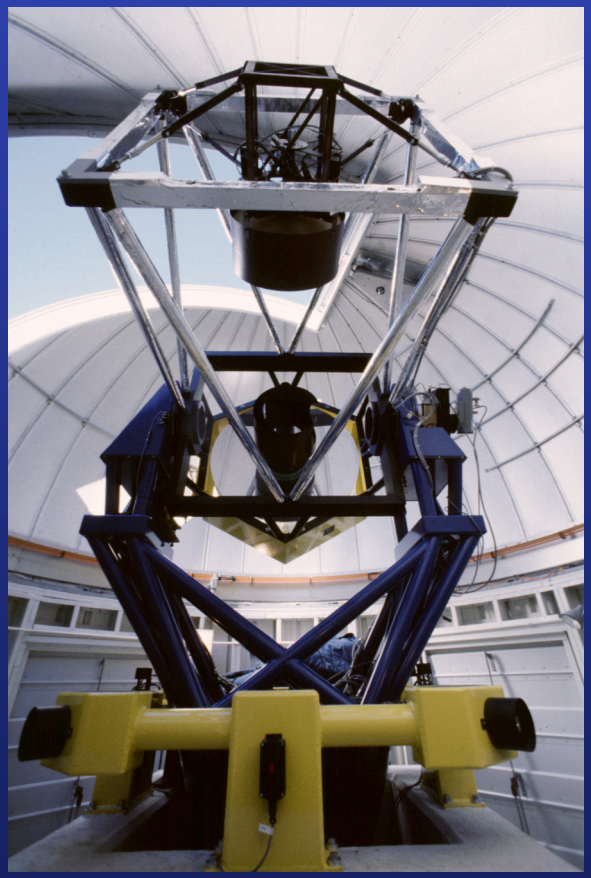
WMAP	1892	24.9%
SDSS	848	11.2%
Keck	562	7.4%
ESO	549	7.2%
HST	466	6.1%
Chandra	380	5.0%
Kamiokande	324	4.3%
2MASS	250	3.3%
XMM-Newton	185	2.4%
CBI	149	2.0%

The NMSU 1m Telescope



- Owned by New Mexico State University
- Robotic Operation
- 2048x2048 (15’ x15’ FOV) CCD imaging camera
- High speed photometer under construction
- Used mostly for variability studies

The 0.5m SDSS Photometric Telescope (PT)

- Automatic operation
- CCD imaging camera
- Observes standard star fields for SDSS calibration
- Used on all photometric nights