Sloan Digital Sky Survey Status

Presentation to the Physics Advisory Committee November 12, 2004

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Experimental Astrophysics Group

Fermilab

Outline

- **Status of SDSS**
- **Status of SDSS-II: SEGUE and Supernova Survey**

Sloan Digital Sky Survey (E885)

Goal:

Conduct fundamental research in cosmology, particularly formation and evolution of galaxies and large scale structure

Approach:

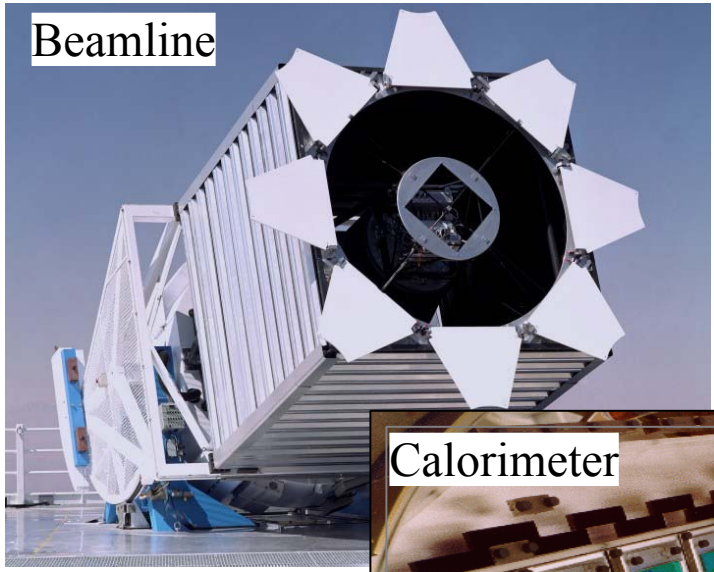
Digital map of ¼ of sky in 5 bands
Spectra of 1 million galaxies,
100,000 quasars

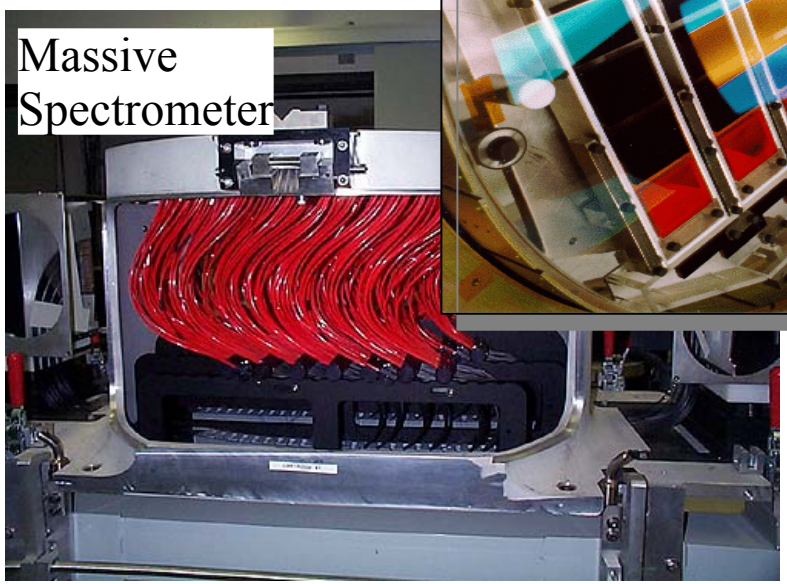
Resources:

2.5 m telescope in New Mexico
Large CCD camera
640 fiber spectrograph
14 partner institutions

Operations:

2000-2005





Participating Institutions

University of Chicago
Fermi National Accelerator Laboratory
Institute for Advanced Study
Japan Participation Group
Johns Hopkins University
Korean Scientist Group ***(new since last PAC report)***
Los Alamos National Laboratory
Max Planck Institute for Astronomy, Heidelberg
Max Planck Institute for Astrophysics, Garching
New Mexico State University
University of Pittsburgh
Princeton University
US Naval Observatory
University of Washington

FNAL in SDSS

Role:

- Data acquisition
- Data processing
- Survey Planning
- Data distribution
- Support telescope and instrument systems

Participants:

- EAG
- TAG
- PPD
- CD (outside EAG)

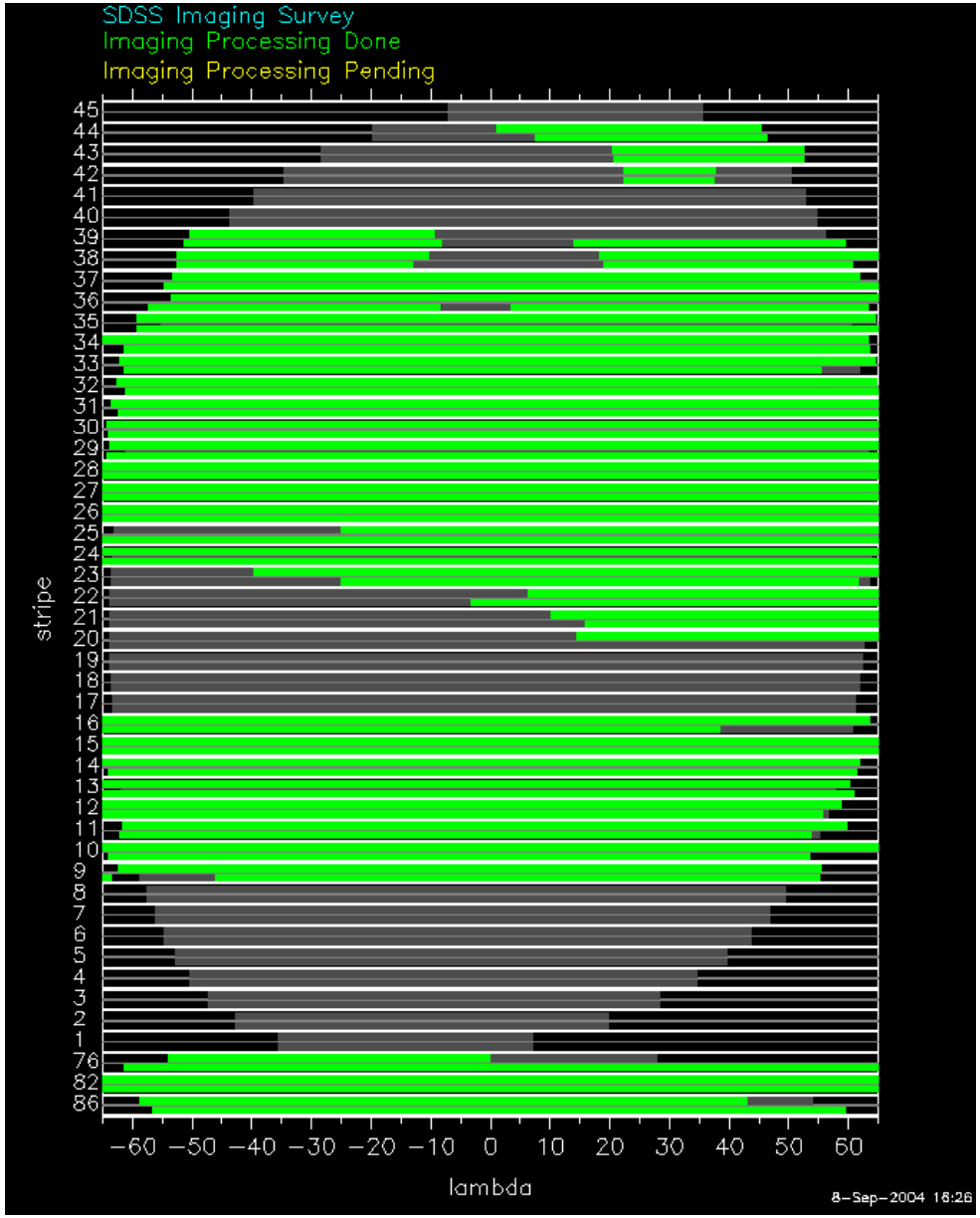
Science:

- Large-scale structure
- Weak lensing and strong lensing
- Galaxy clusters
- Milky Way halo structure
- Dark energy
- Galaxy evolution
- QSO luminosity functions
- Supernovae
- Near Earth Asteroids

from B. Boroski

Imaging Progress

- 1,310 sq. deg. of new "footprint" imaging data collected during the past observing season on the Northern Galactic Cap (NGC)
- 6,917 sq. deg. "footprint" area to date
- Observing strategy: *image whenever conditions are suitable*
- Slowly but surely we're closing the gap!
  - Rough estimate of the area of gap remaining: ~1500 sq. deg.

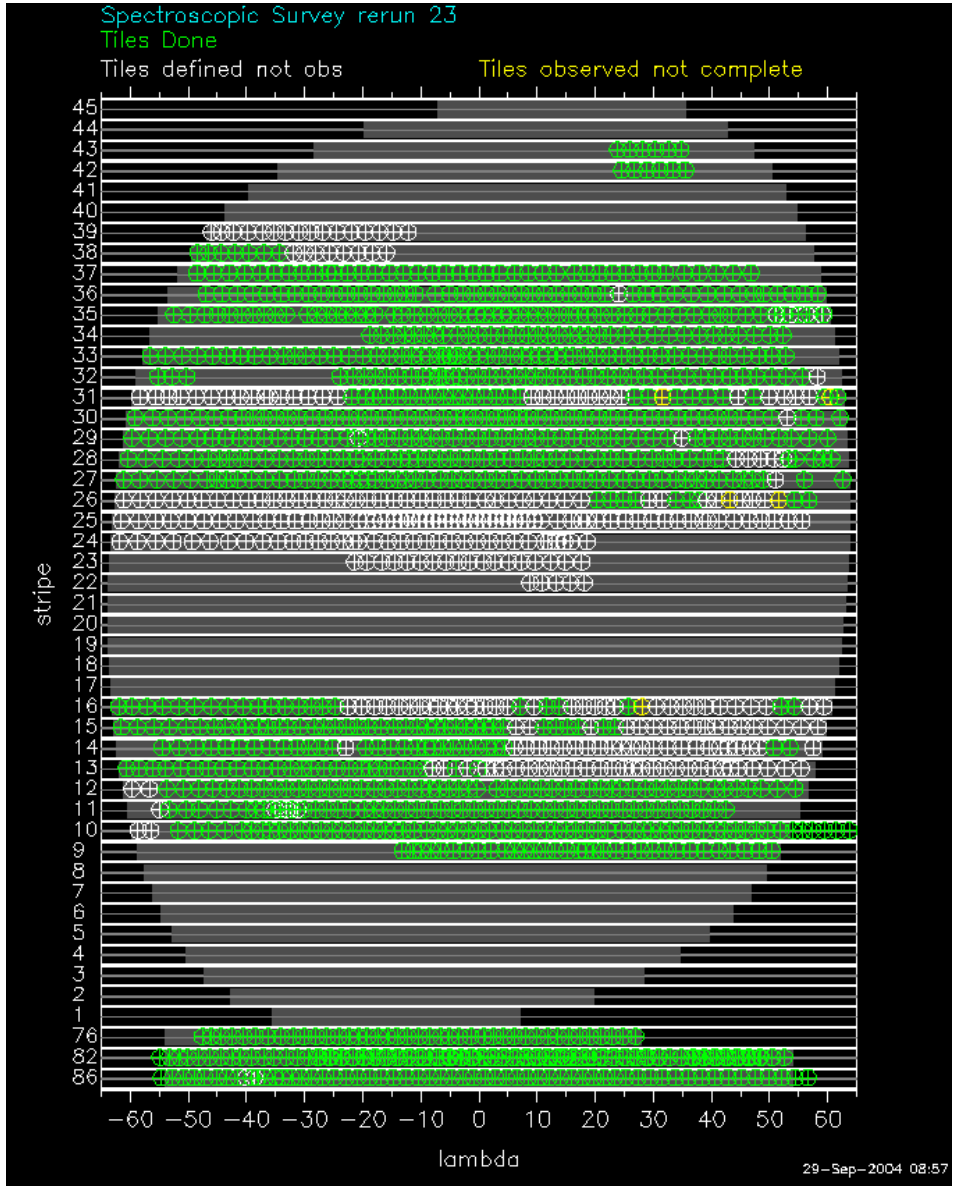


from B. Boroski

Spectroscopic Progress

- Over the past year:
  - 224 tiles on the NGC
  - 136 tile-equivalents on the southern equatorial stripe
- 1060 total main survey tiles
- No shortage of available tiles this year
- Approximately 636 tiles required to fill in the gap on the NGC:

# of tiles in baseline plan: 1540
# of tiles observed to date: 904
Δ = 636



Data Distribution

adapted from
B. Boroski

- **Data Release 3 (DR3)**
  - **Released to the collaboration on May 27, 2004**
  - **Released to the public on September 27, 2004**
    - ***Met our obligation to our funding agencies***
  - **All survey quality imaging data collected through July 2003 plus corresponding spectroscopic data**
    - **Imaging data: 5,282 sq. deg., 141 million objects (6.0 TB images, 1.2 TB catalogs in fits format, 2.3 TB catalogs in SQL database)**
    - **Spectroscopic data: 4,188 sq. deg., spectra of 375,000 galaxies, 51,000 quasars, 71,000 stars (151 GB data volume)**
    - **Full contents are detailed on the DR3 website: www.sdss.org/dr3**

Data Distribution

- **Data Release 4 (DR4)**
  - **All survey-quality imaging data (~6500 sq. deg.) collected through July 2004 and corresponding spectroscopic data**
  - **Release scheduled for July 2005**

- **The public, including collaboration members, have pulled a total of ~19 terabytes to date**

Our Impact

Adapted from B. Boroski & M. Strauss

- As of Nov 11, 2004:
  - 630 published refereed papers that include 'SDSS' or 'Sloan' in their title and/or abstract. 192 of these papers, almost 1/3 of the total, have been published since Jan 2004.
  - These papers have been cited a total of 11,170 times, including 14 papers cited more than 100 times, and 36 additional papers cited between 50 and 100 times. 40% of the citations have been in the last year.
  - The York et al (2000) paper has been cited 506 times, which puts it as a “renowned” paper and in the top several hundred astronomy papers of all time.
- In addition, there have been 829 un-refereed papers (e.g., lots of AAS abstracts!) with 'SDSS' or 'Sloan' in the title and/or abstract.

Collaboration Papers in 2004

- **From SDSS publications page: 41 journal papers (submitted or in press) by collaboration members with 2004 astro-ph paper numbers (hence does not include 2003-submitted papers published in 2004)**
- **Large-scale structure, clusters, weak lensing: 11**
  - **Cosmological parameters, neutrino mass, ROSAT-SDSS clusters, galaxy-galaxy lensing, 3-pt correlation function, Lyman forest power spectrum, WMAP-SDSS cross correlations, galaxy bias, clustering vs. luminosity/color**
- **Galaxies, galaxy populations: 8**
  - **Galaxy properties vs. environment, Andromeda NE and IX, galaxy eigenspectra, LRG photo-z's, value-added catalog, low-luminosity galaxies, void galaxies**
- **Quasars: 6**
  - **Quasar catalog, 14.62" quad lens, new z>5.7 quasars, photo-z's, dust reddening, quasar eigenspectra**

Collaboration Papers in 2004 (cont'd)

- **Stars, galactic structure: 11**
  - **White dwarf catalog, L and T dwarfs, carbon stars, proper motion catalog, cataclysmic variables, protostars, cool stars**
- **Solar system: 1**
  - **Near earth objects**
- **Technical and data release: 4**
  - **DR2, DR3, low-latitude fields, photometry data QA**

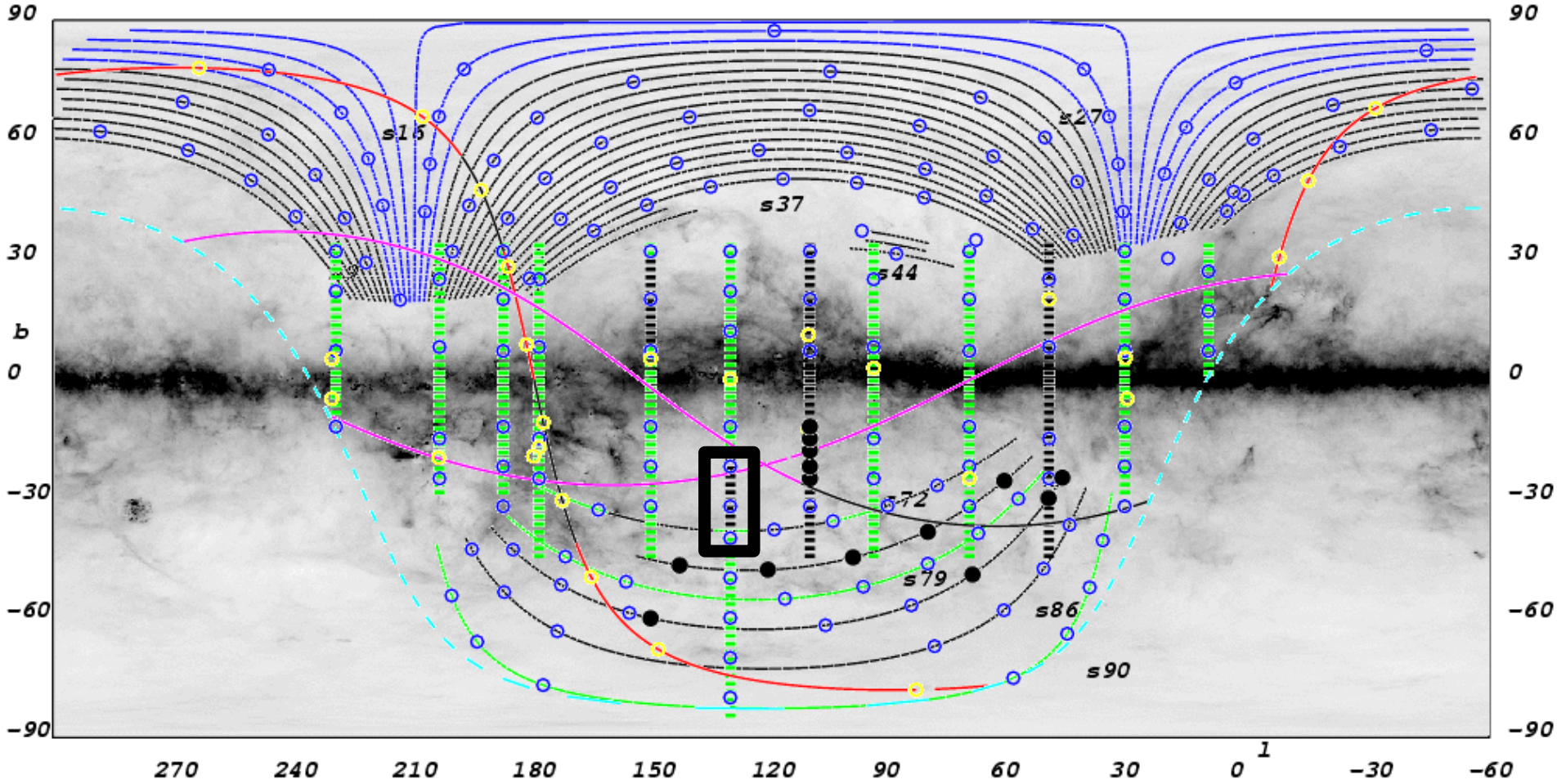
SDSS-II (2005-2008)

- **Legacy Survey**
  - **Fill the gap in the North Galactic Cap: ~few hundred sq. deg. imaging and ~500 spectroscopic plates**
  - **Unique, high photometric precision, homogeneous legacy data set for future science**
  - **Filled volume to improve large-scale structure studies**
- **SEGUE**
  - **Imaging and spectroscopy into the Milky Way: 3900 sq. deg. imaging and 400 spectroscopic plates**
  - **Goals to study the structure and evolution of our galaxy and to probe the dark matter halo of the Milky Way**
- **Supernova Survey**
  - **200 Type Ia supernovae with high-quality light curves, in the redshift gap z=0.05-0.35, to probe dark energy**

Fall 2004 Observing Season

- **SEGUE imaging/spectroscopy and supernova survey observations have begun this Fall observing season**

- **Fermilab scientists are taking a leading role in data analysis, data processing, and observations for both programs**

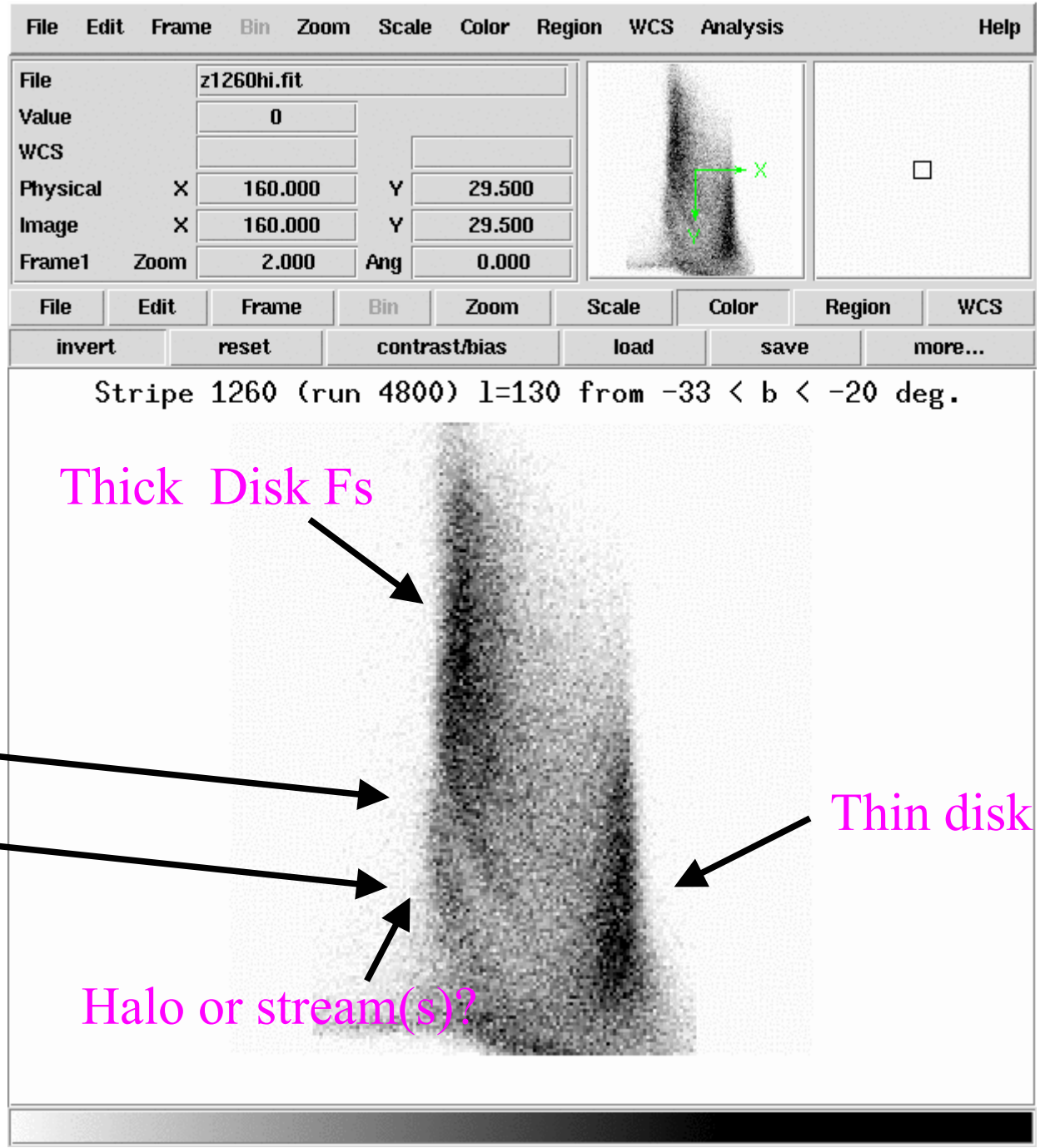


SDSS/SEGUE as of November 10, 2004
Black= completed stripe or plate pair

750/3900 sq deg imaging: 19% of SEGUE complete,
29/400 plates 7% of SEGUE complete.

from B. Yanny

from B. Yanny

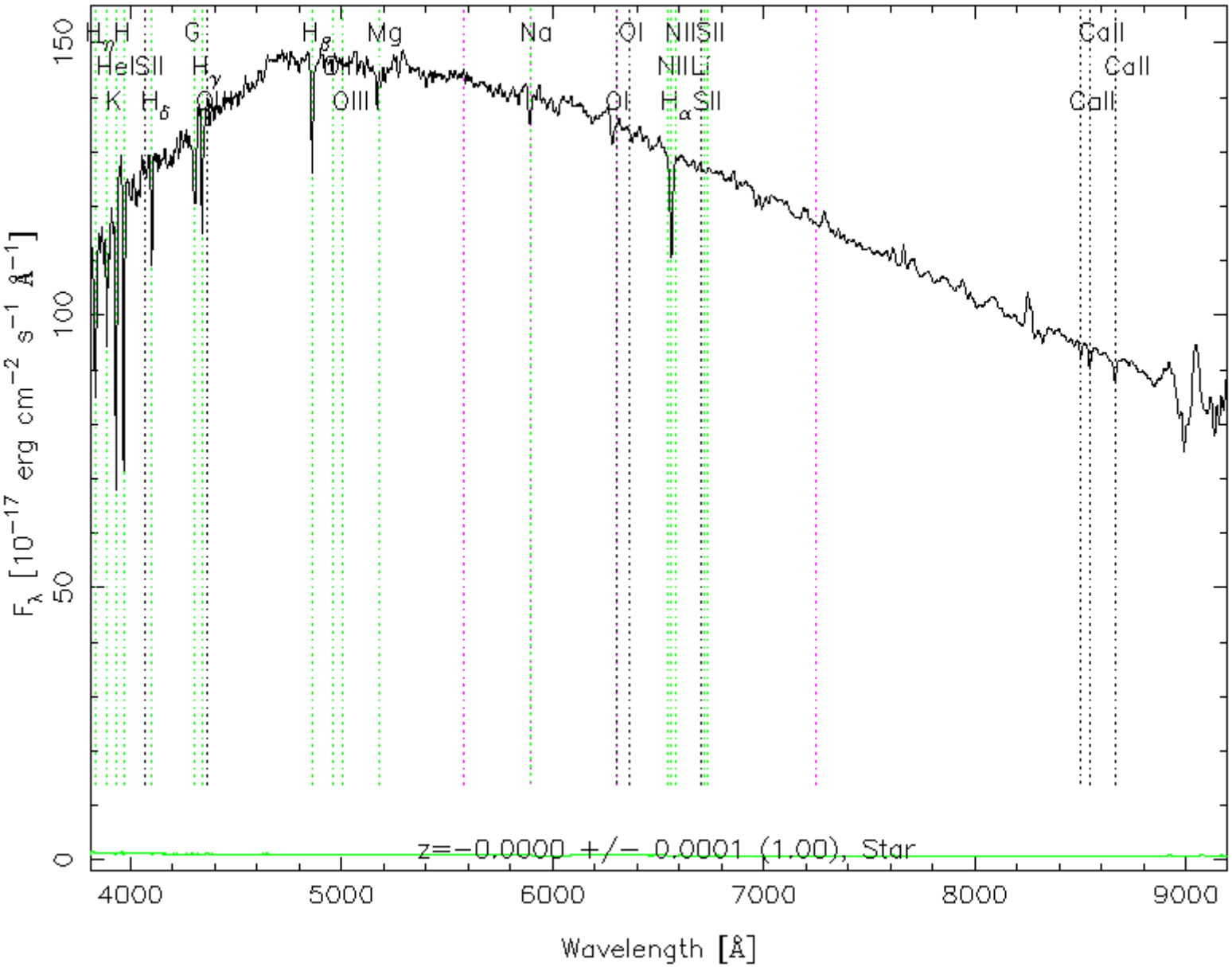


Dual turnoffs, indicates stream(s?) at 10 and 20 kpc from the sun.

Color-Magnitude (g-r,g) diagram for Strip 1260N

RA=357.16767, DEC=35.44417, MJD=53262, Plate=1880, Fiber=288

from B. Yanny



Low metalicity candidate, [Fe/H] = -2.6, g=15.8, g-r=0.47

Pop III exploration, gradients in inner/outer halo

SDSS Supernova Survey

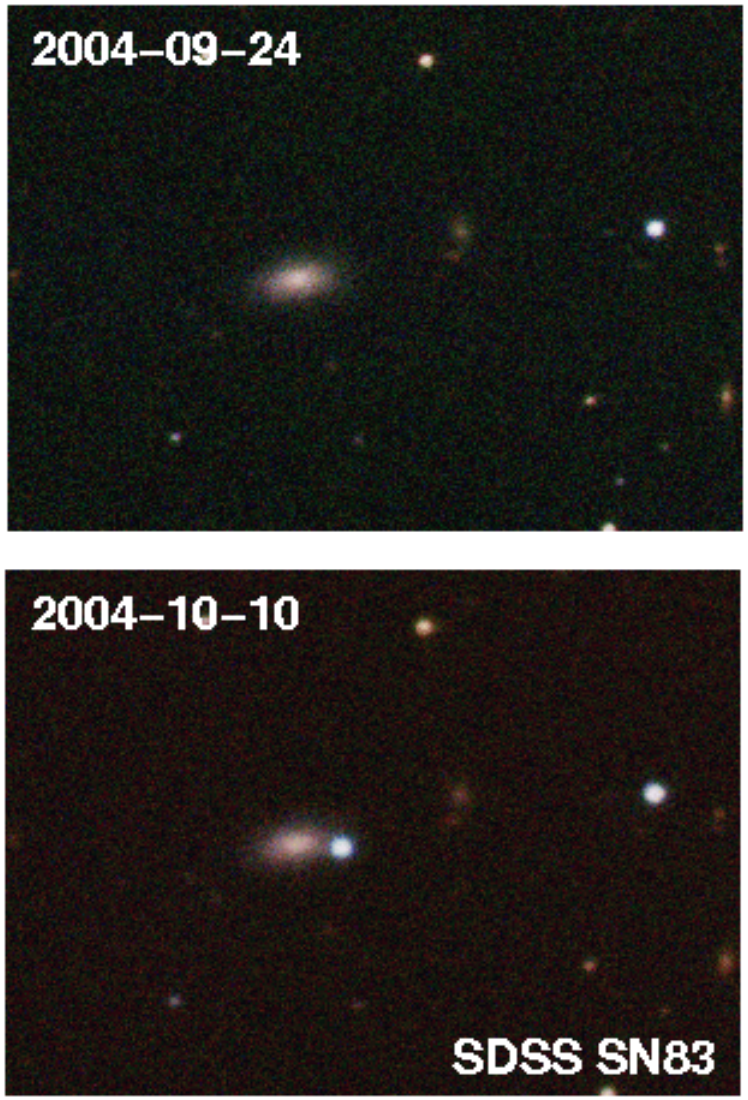
- **Science Goals**
  - **Probe dark energy in redshift regime less sensitive to evolution than deeper surveys: $\sigma(w) \sim 0.1\text{-}0.15$**
  - **Study SN Ia systematics (critical for SN cosmology) with high photometric accuracy**
- **Program**
  - **Repeat scans of equatorial stripe 82 for three 3-month runs (Sep-Nov, 2005-7) as weather permits**
  - **Frame subtraction in multiple bands for SN selection**
  - **Follow-up spectroscopy for SN typing, redshifts, and k-corrections**
  - **Obtain ~200 high-quality, densely sampled SN Ia ugriz light curves in the redshift desert z=0.05-0.35**

Fall 2004 Supernova Campaign

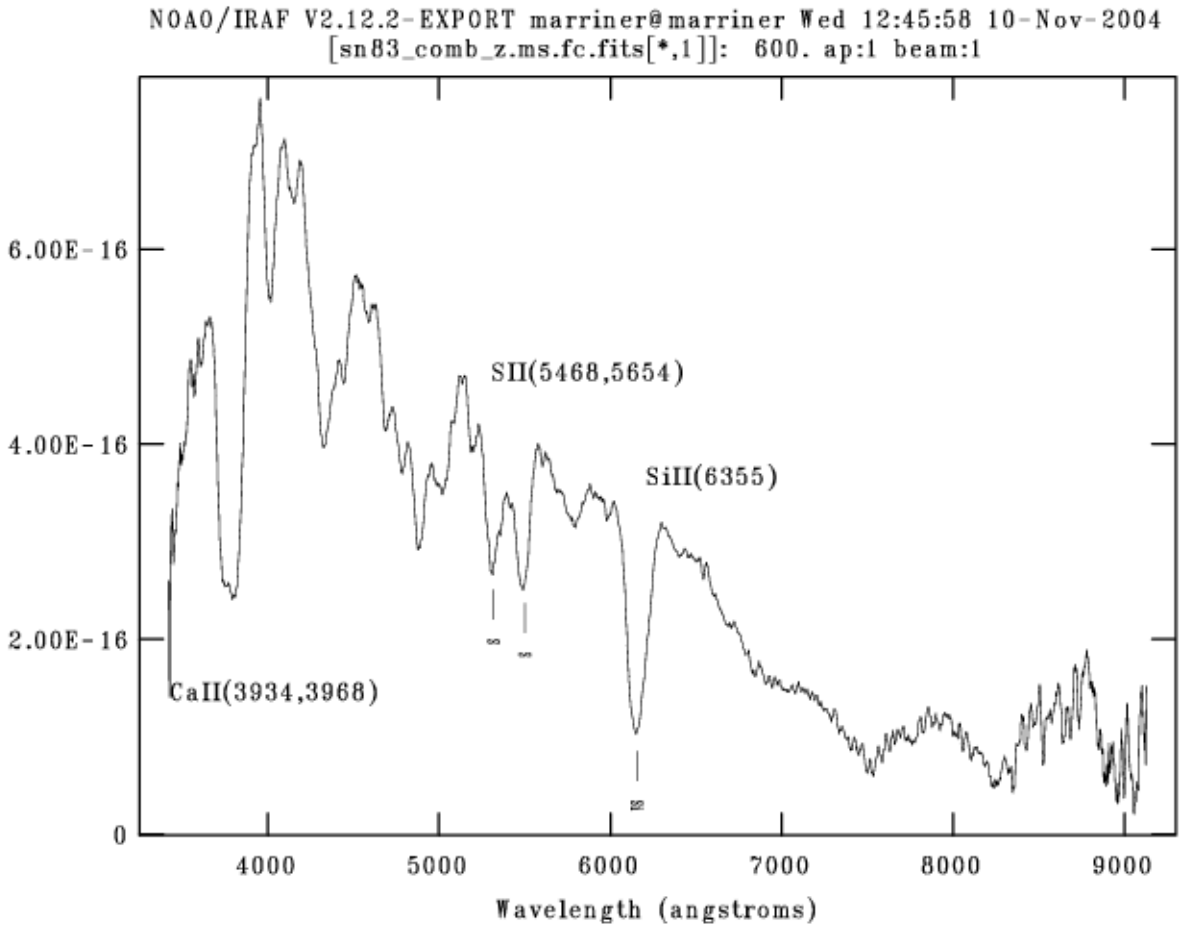
- **Early science and test run: 20 nights late Sep-mid Nov on stripe 82N**
- **Science Goal**
  - **~10 well-measured SN Ia light curves with confirmed SN types and redshifts**
- **Engineering Goals**
  - **Rapid processing and selection of candidates for follow-up**
  - **Carry out coordinated follow-up observations: spectroscopy at APO 3.5m and HET, additional imaging at APO 3.5m and NMSU 1m**
  - **Study detection efficiency and photometric accuracy under varying conditions**

SDSS SN83: Type Ia at redshift z=0.05

SDSS 2.5m imaging



Follow-up spectrum from APO 3.5m



Status of SEGUE and SN Survey

- **SEGUE**
  - **750 sq. deg. imaging and 29 spectroscopic plates obtained; data available to all SDSS participants for analysis and papers**
  - **Exciting science, particularly in the study of the dark matter halo surrounding our Milky Way as traced by stars, and in the search for the earliest generation of stars**

- **Supernova Survey**
  - **11 of 18 nights scheduled so far resulted in useful data; total 1300 sq. deg. imaging obtained on stripe 82**
  - **Observations, data processing, candidate selection, and follow-up spectroscopy working during Fall 2004 campaign**
  - **Results promising, and work is ongoing to better understand detection efficiency and improve SN photometry**

from S. Kent

EAG Balancing Act

- EAG currently has 9 scientists, 3.5 CP FNAL funded and working on astrophysics.
- Next few years
  - SDSS: 4.2 Scientists, 3 CPs
  - SNAP: 1.25 Scientists, 0.5 CP
  - DES: 1.85 Scientists, 0 CP
  - Research: 1.7 Scientists
- Remaining people for SDSS are either existing non-EAG scientists, existing CD people not in EAG or existing or planned CPs in EAG funded by ARC

SDSS-II Funding

$ 5.4 M	Sloan Foundation
$ 5.4 M	NSF
$ 2.5 M	Partner Institutions
$ 1.6 M (1.2 FNAL)	In-Kind
$ 14.9 M	Total

Summary

- **SDSS-I is making steady progress going into its last year of operations**
  - **Public release of DR3 was on schedule and SDSS data is being widely used by the astronomy community**
  - **SDSS results and papers numerous, diverse, and exciting**

- **SDSS-II SEGUE and Supernova Survey programs have successfully started initial observations and test runs during the Fall 2004 observing season**