SkyMapper Transient Program

Fang Yuan

Stefan Keller, Patrick Tisserand,

Gary Da Costa, Mike Bessell, and Paul Francis

Daniel Bayliss, Richard Scalzo,, Michael Childress, Brian Schmidt

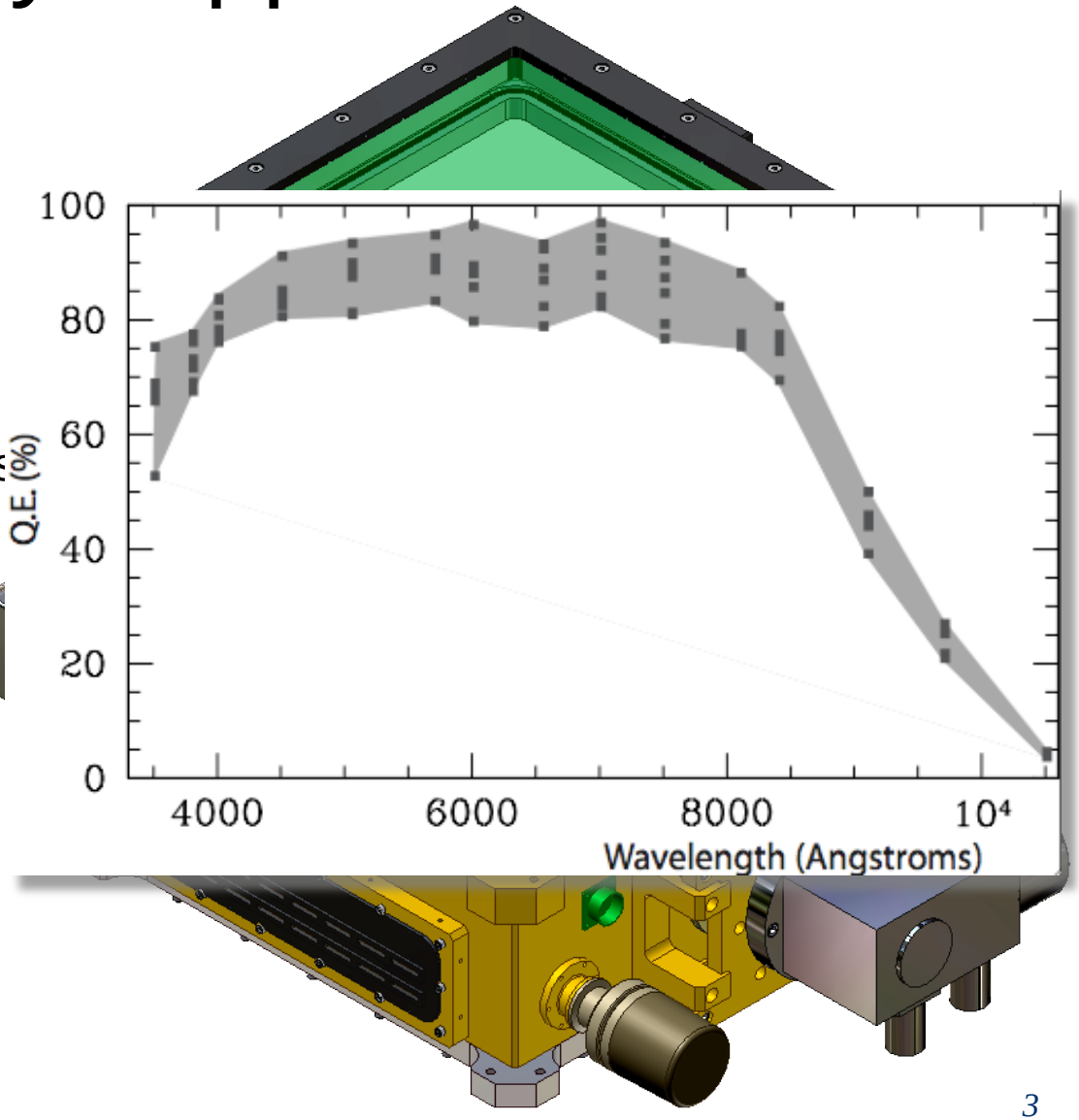
SkyMapper

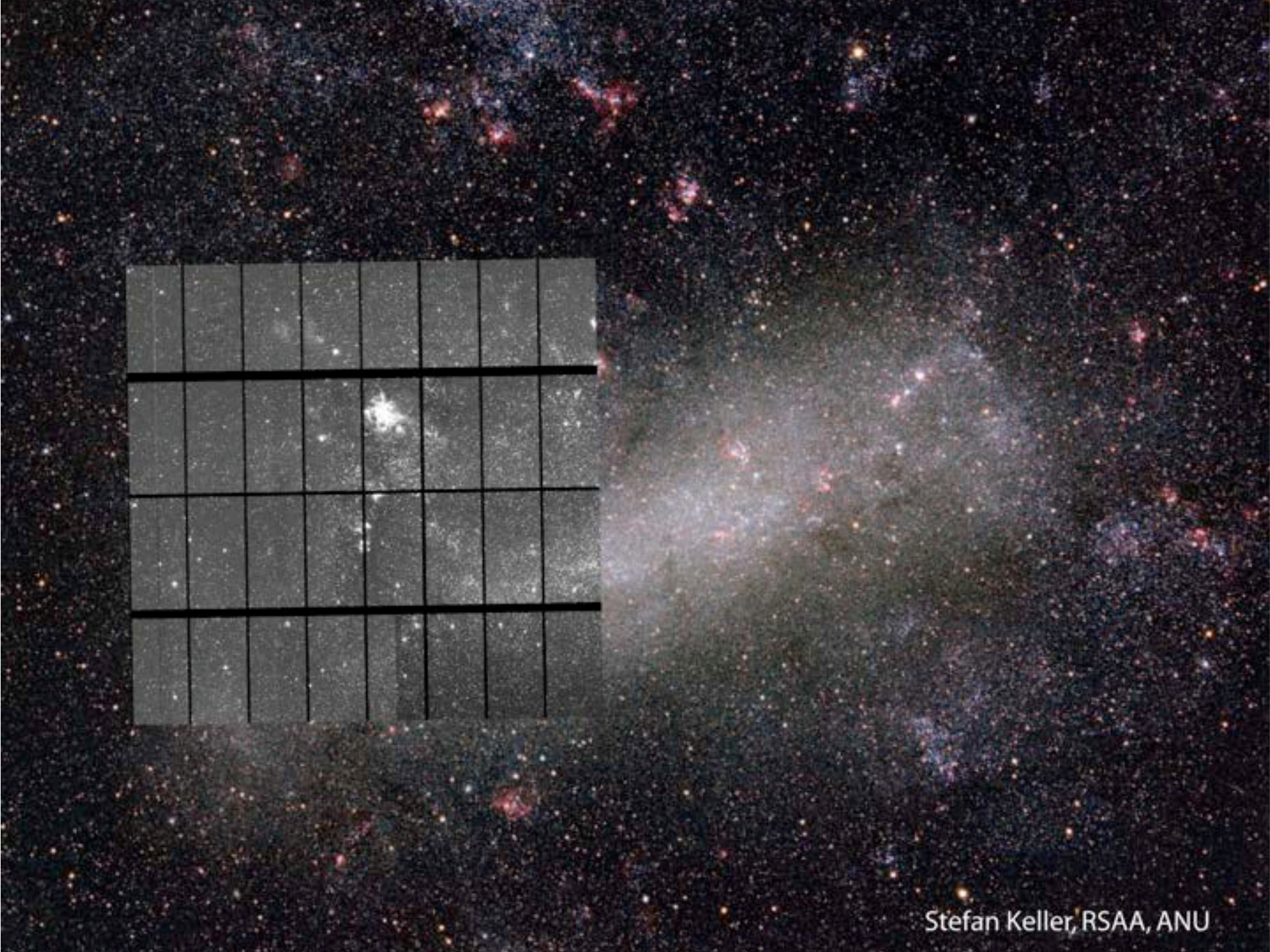
- 1.35m telescope with a 5.7 sq. degree field of view
- Fully Autonomous observing
- To conduct the Southern Sky Survey:
  - Five year
  - Multi-colour (6 filters)
  - Multi-epoch (6 exposures, each filter)
  - 2□ steradians
  - Limiting mag. g~23
- Aiming for regular operations this year
- Summary of program: Keller et al. 2007 PASA 24,1

Total Cost: Hardware $15M Software: $1.8M
Dedicated Science/Operations: ~ $0.6M/yr

The SkyMapper CCDs

- 32 E2V CCD44-82 devices:
  2048x4096 15 micron pixel CCDs
  - Broadband coated
  - 40 micron (thick) devices
  - Reduced fringing, inc. red response, without bad blue
- 16384x16384 0.5” pixels
- Using new Pan Starrs controllers (Onaka at IfA)
- Readout in ~12 seconds through 4 channels (64x350 kpix/s)
- Readnoise ~5-7e-

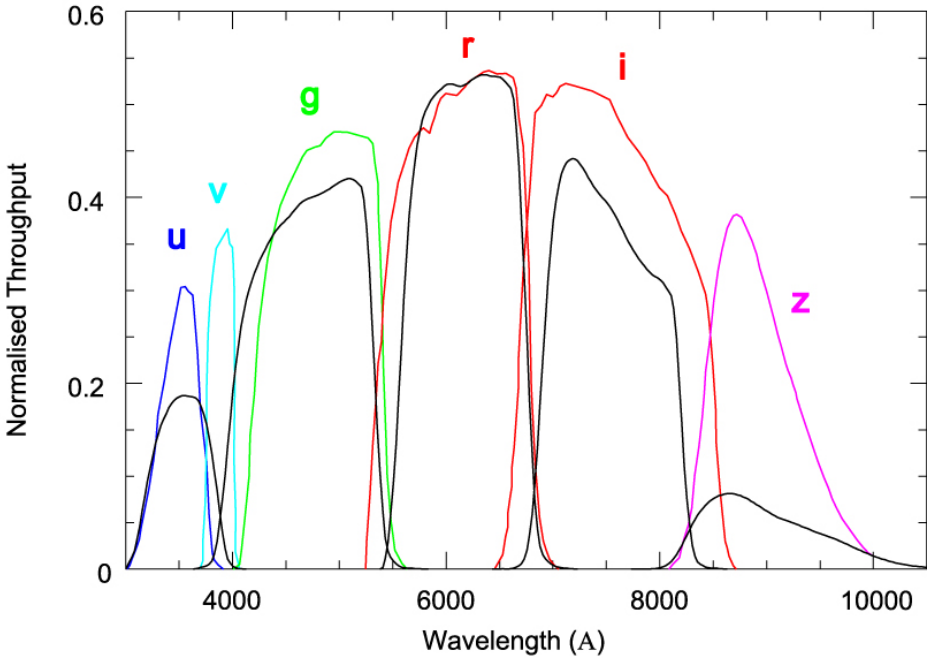



Stefan Keller, RSAA, ANU

SkyMapper

Optimised for Stellar Astrophysics

- Encoded in the spectrum of each star
- Using filters we can isolate portions of the spectrum
- In designing our survey we sought to optimise our ability to determine the three important stellar parameters (T,log(g), Z)
- so SkyMapper not only compliments survey efforts in the northern hemisphere but enables us to tackle important astrophysics in an exciting new way.



SkyMapper

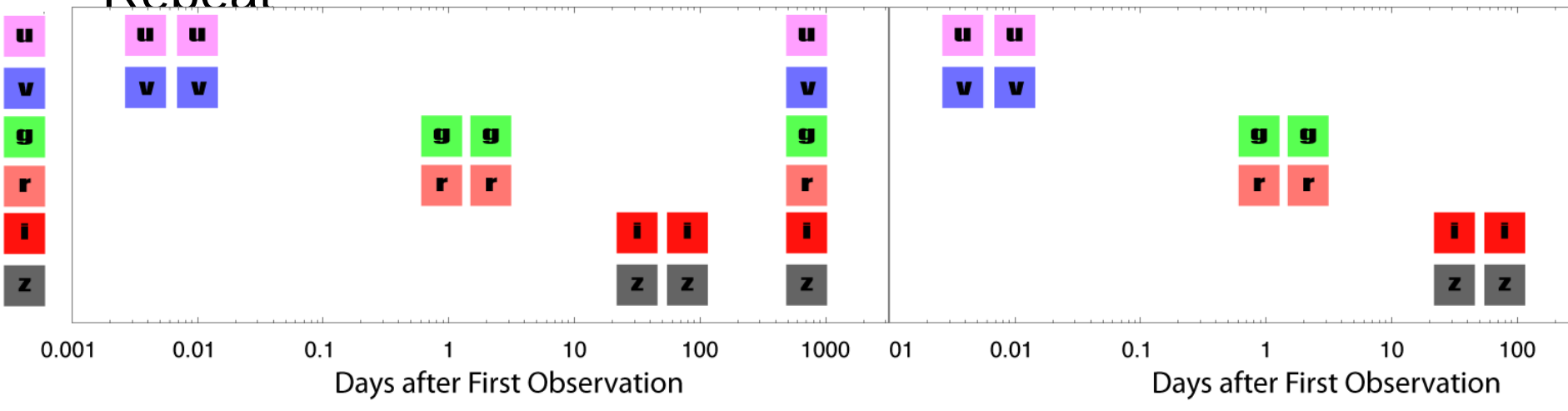
Expected Survey Limits

	u	*v*	*g*	*r*	*i*	*z*
1 epoch	21.5	21.3	21.9	21.6	21.0	20.6
6 epochs	22.9	22.7	22.9	22.6	22.0	21.5
Sloan Digital Sky Survey comparison	22.0	n/a	22.2	22.2	21.3	20.5

AB mag. for signal-to-noise = 5 from 110s exposures

Cadence

- 1st epoch : all filters consecutively (colour + short term variability in uv)
- 3 first epochs in (g,r) in less than 7 days : for Astrometric and photometric short term variation (TNO + RRlyrae/Cepheids+young SN):
- (i,z) spread out to measure parallax over the year.
  - in total, 160,000 sq-degrees observed per year to g~22
- Take care : distance of the Moon, Planets, Sky conditions, Satellites...
- Repeat



Calibration

- Conduct a Shallow Survey
  - in photometric conditions cover the southern sky with 3 exposures: 8-15th mag
- Anchor the deeper Main Survey to the Five-Second photometry and astrometry
  - Enables the Main Survey to proceed under non-photometric conditions.
- Self Calibration via overlaps, colour of main sequence (in low dust areas) and on photometric nights.

Calibration

- Primary Standards

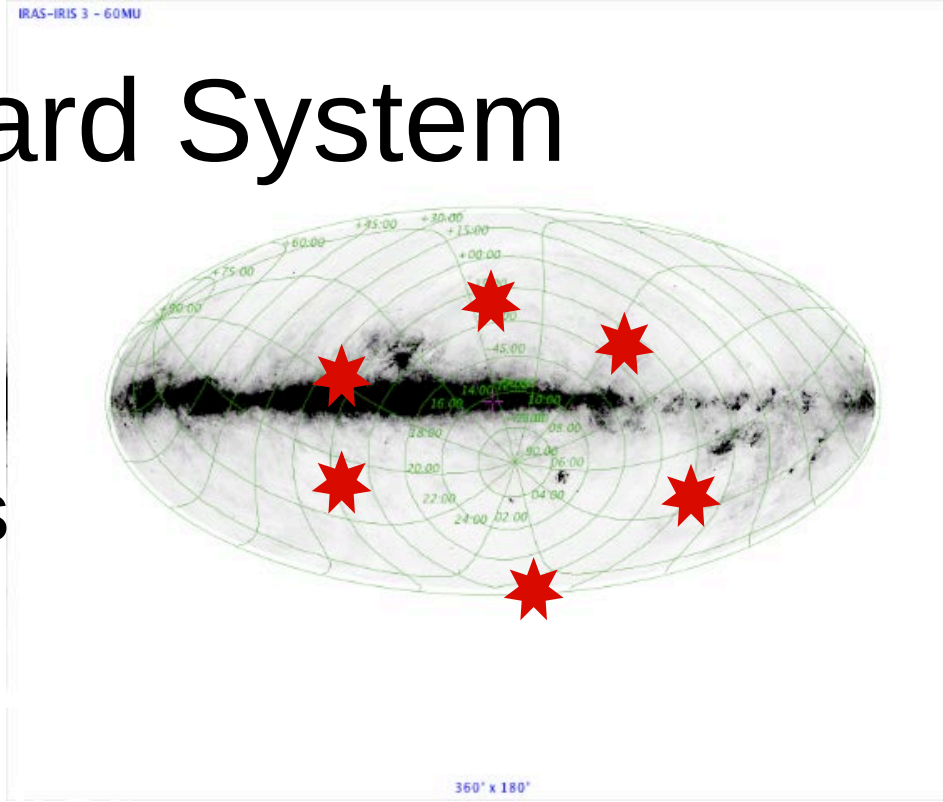
  HST-based spectrophotometric standards

  – Normalised by Hipparchos B and V photometry via Bessell (2000)

  – Provides spectrophotometric standards across the sky

- 6 secondary standard fields chosen with Primary standards in them. These fields observed with dithers and rotations to produce a photometric flat field, with all stars calibrated to primary standards
- HST Program hopes to provide network of stars across North and South Sky with spectrophotometry better than 0.5% over optical and 1% from UV through NIR.
- Fundamental Calibration by comparison to Models of several White Dwarf and Weak-line F-stars

New Standard System

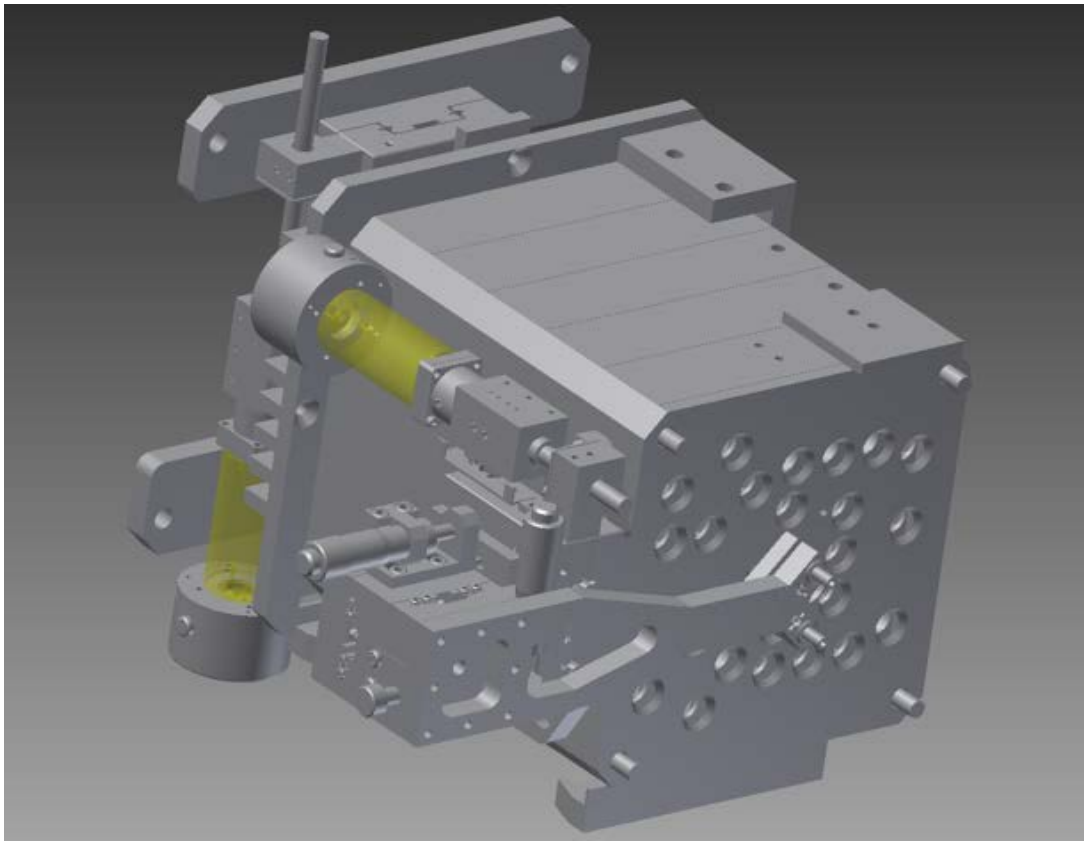


- 6-colour photometry will be reduced as soon as possible.
- 6-colours should provide accurate transformations to most other systems
- Standard Stars in every southern field

Calibration Plans

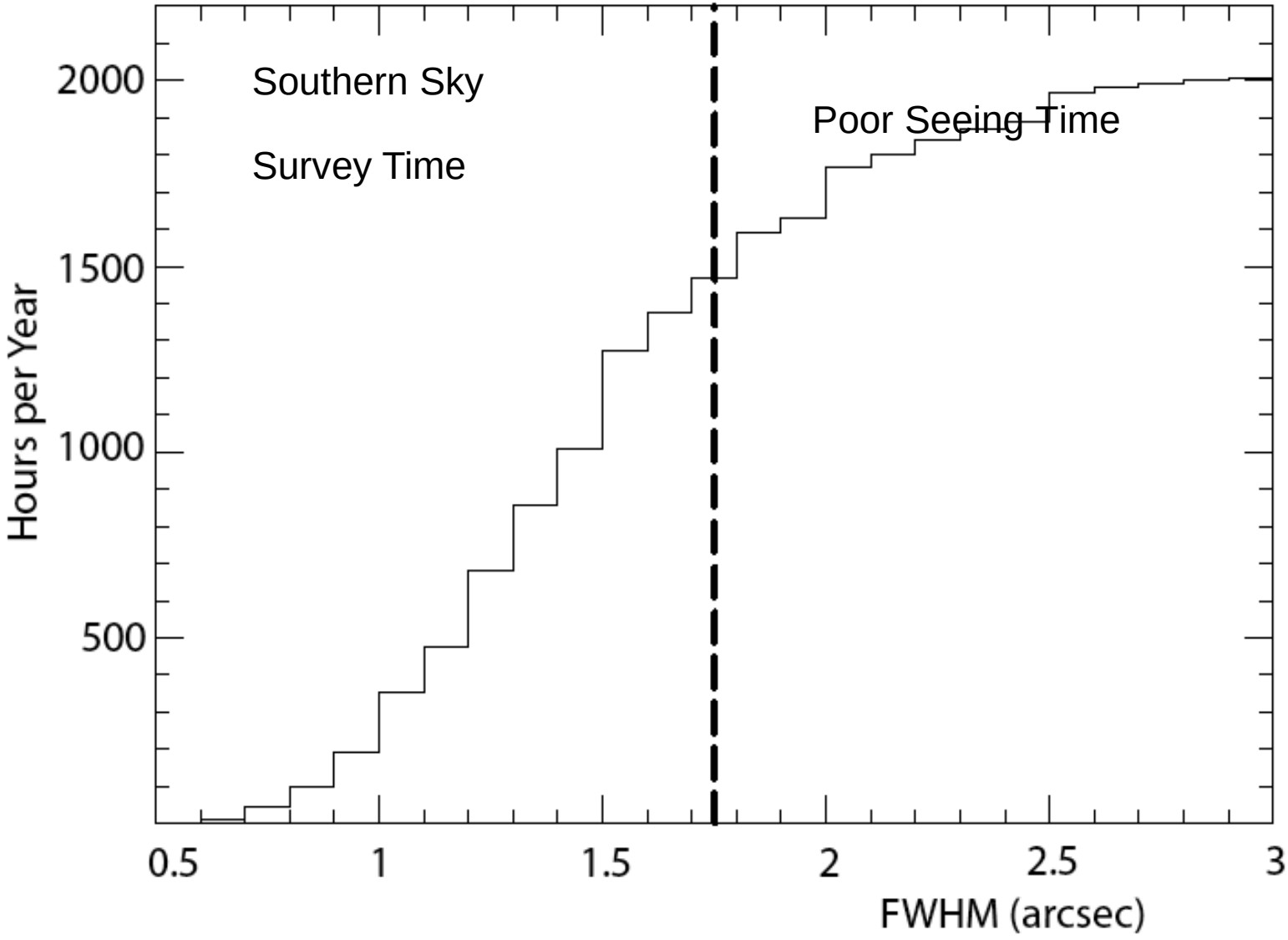
SkyDice - PI Nicolas Regnault - LPNHE

- >20 LEDs covering 0.3-1μ
- observed through telescope with NIS calibrated photo diode
- absolute calibration and monitoring of optics



up to 25% of time for other things

- GRB, Gravity Wave, Radio Transient TOOs
- SN Search override
- High Cadence Variability surveys


Southern Sky
Survey Time
Poor Seeing Time
Hours per Year
2000
1500
1000
500
0.5
1
1.5
2
2.5
3
FWHM (arcsec)

Supernova Poor Seeing Progam (>1.7”)

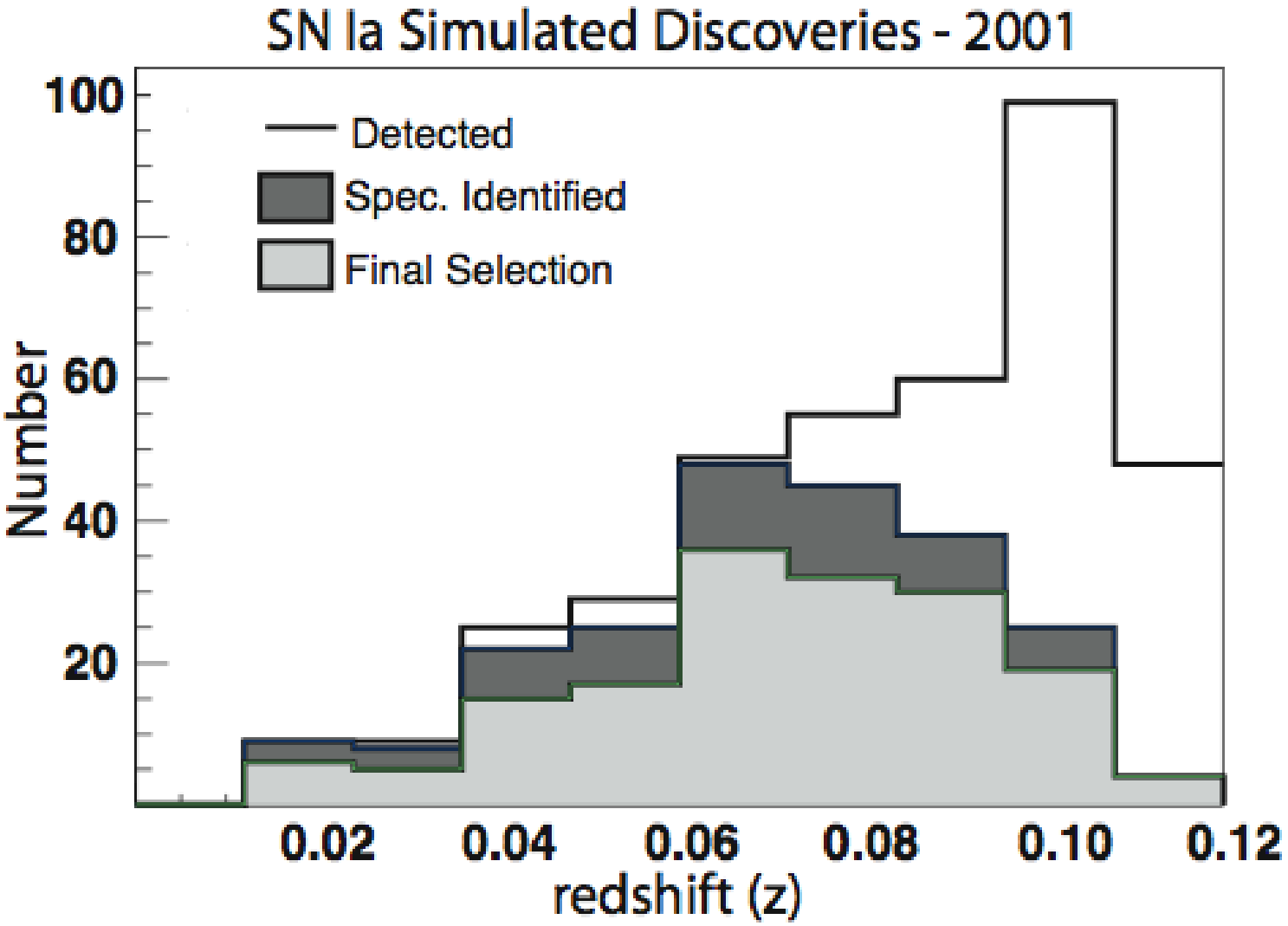
In Collaboration With LPNHE - (Paris VI)

- 1250 sq-degrees v,g,r,i to g~19. Augment with some good seeing data to achieve a 3-4 day cadence.
- (125,000 sq degrees per year with a 3-4 day cadence to v,g,r,i~19)
- Fields still be determined - balance between very far south (easy to observe), and coverage for peculiar velocity surveys (like to go North and into the

Michael Childress

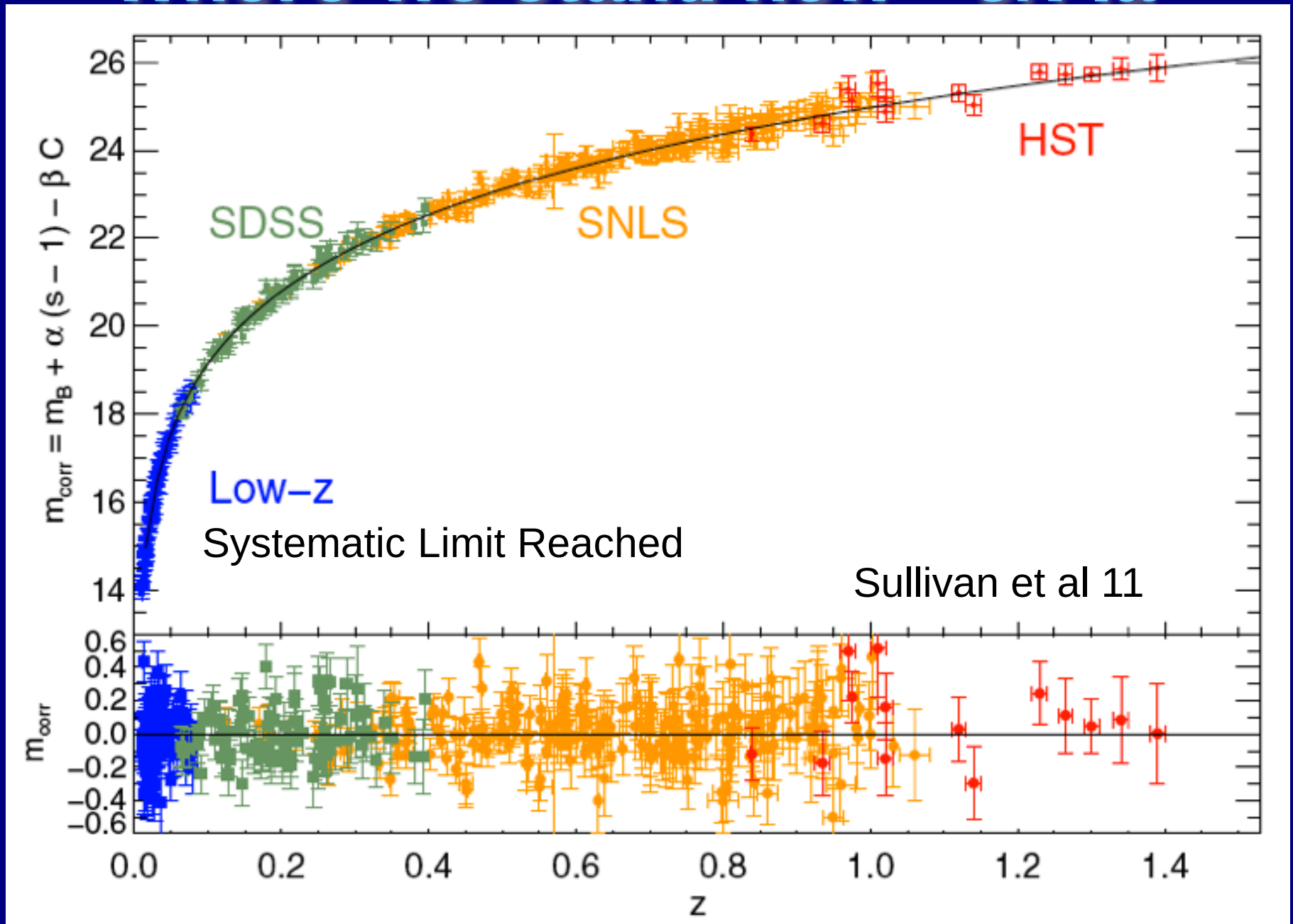
Fang Yuan

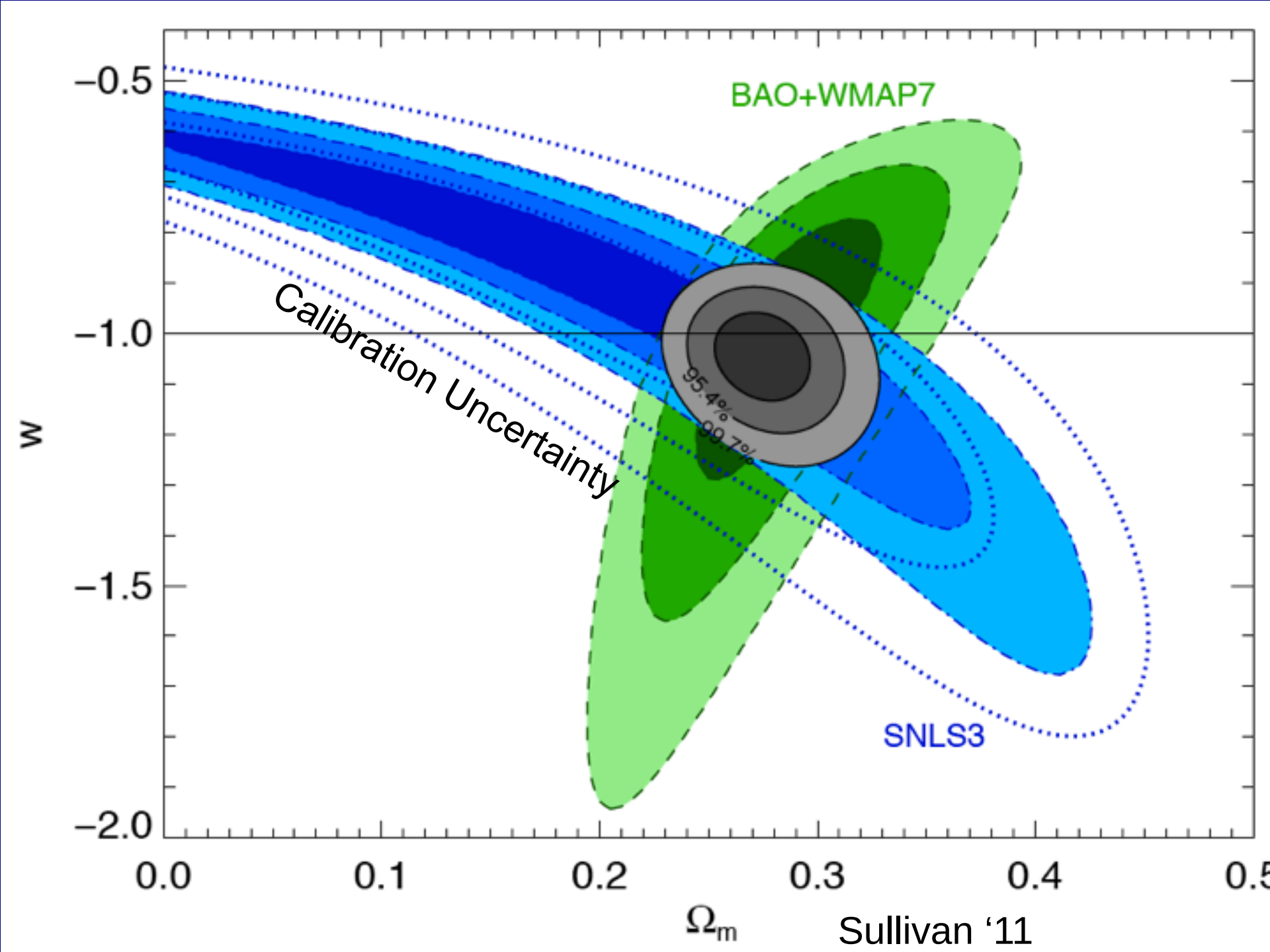
Richard Scalzo



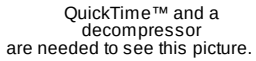
Regnault and Guy (LPNHE)

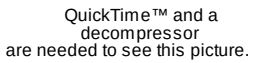
Where we Stand now - SN Ia



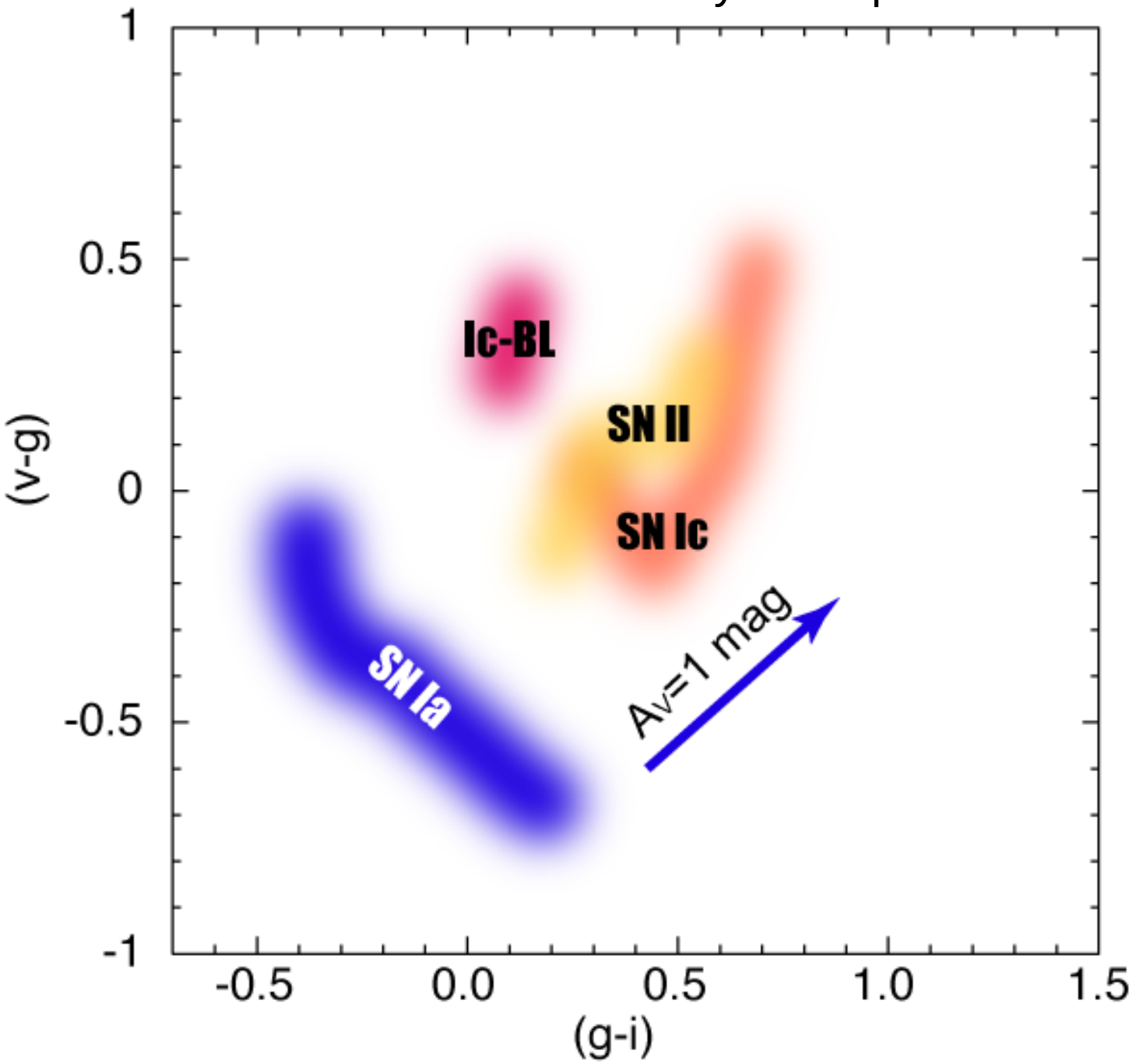

BAO+WMAP7
Calibration Uncertainty
95.4%
68.7%
SNLS3
w
Ω_m
−0.5
−1.0
−1.5
−2.0
0.0
0.1
0.2
0.3
0.4
0.5
Sullivan ‘11

Sample Light Curves

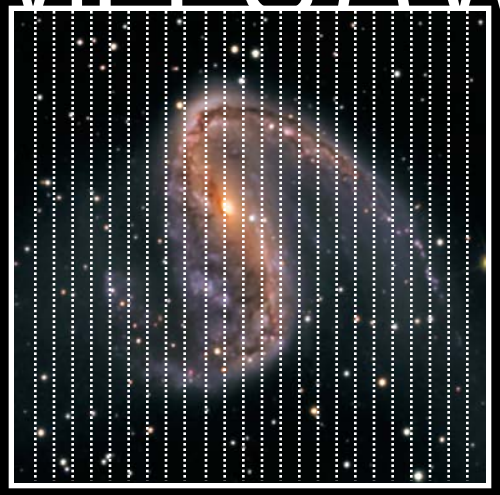


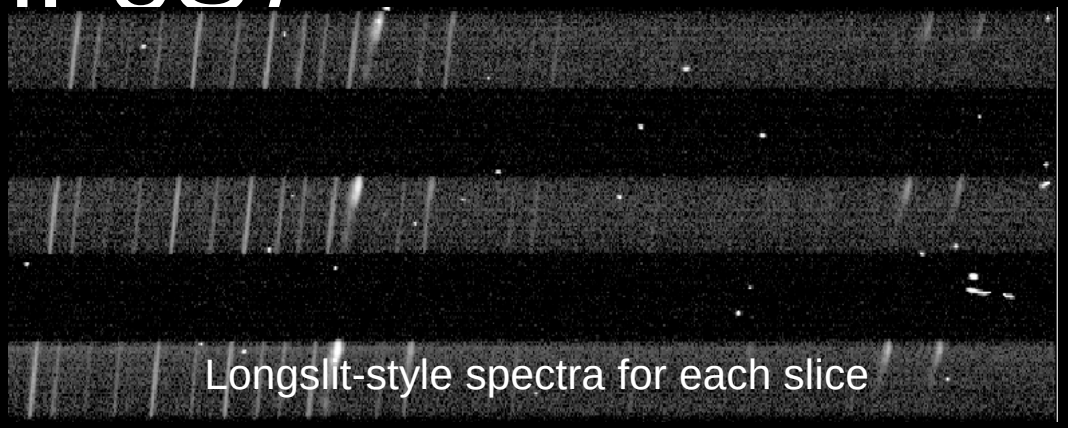


Regnault and Guy (LPNHE)


SN colours within 30 days of explosion
Ic-BL
SN II
SN Ic
SN Ia
Av=1 mag
(v-g)
(g-i)
1
0.5
0
-0.5
-1
-0.5
0.0
0.5
1.0
1.5

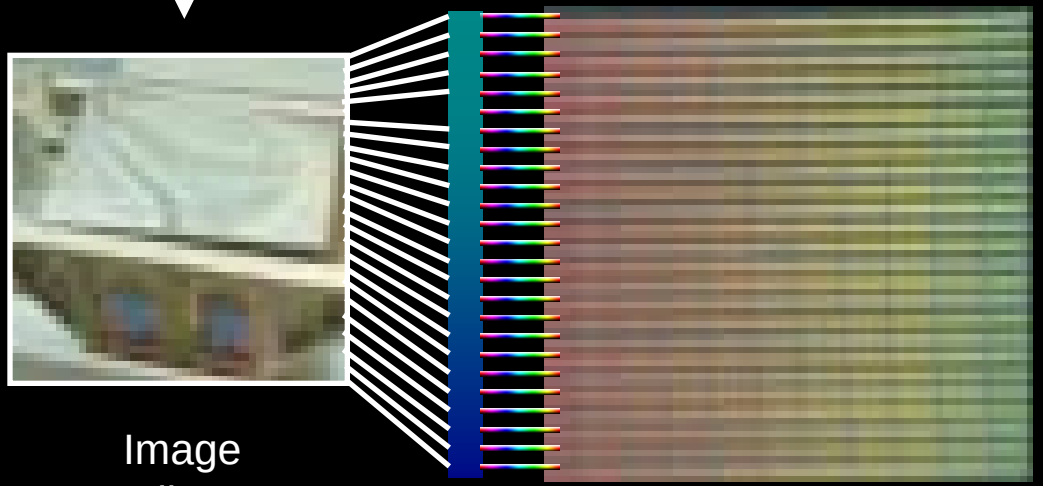
The Wide Field Spectrograph (WiFES) (WiFeS)

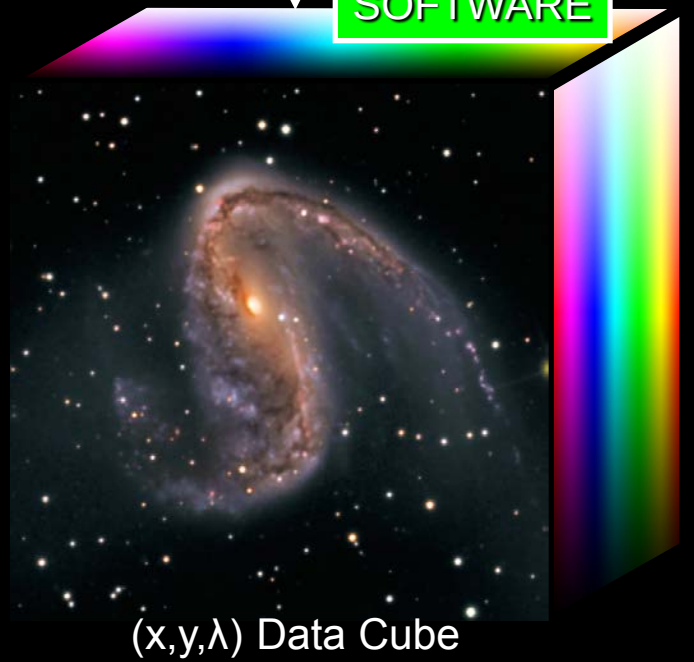




35% Throughput

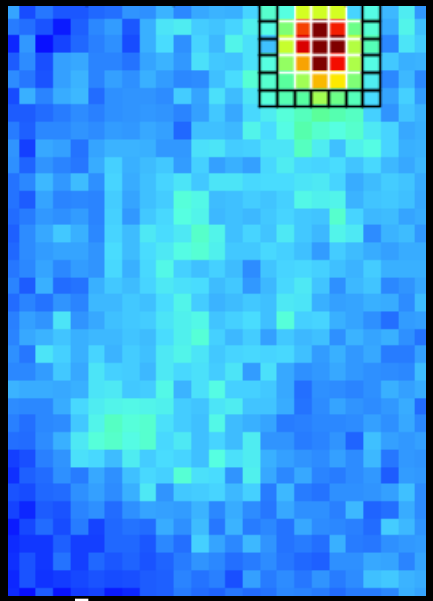
SOFTWARE





- Provides 320-950nm at R=3000 over 25”x31” FOV at 1.1”/p

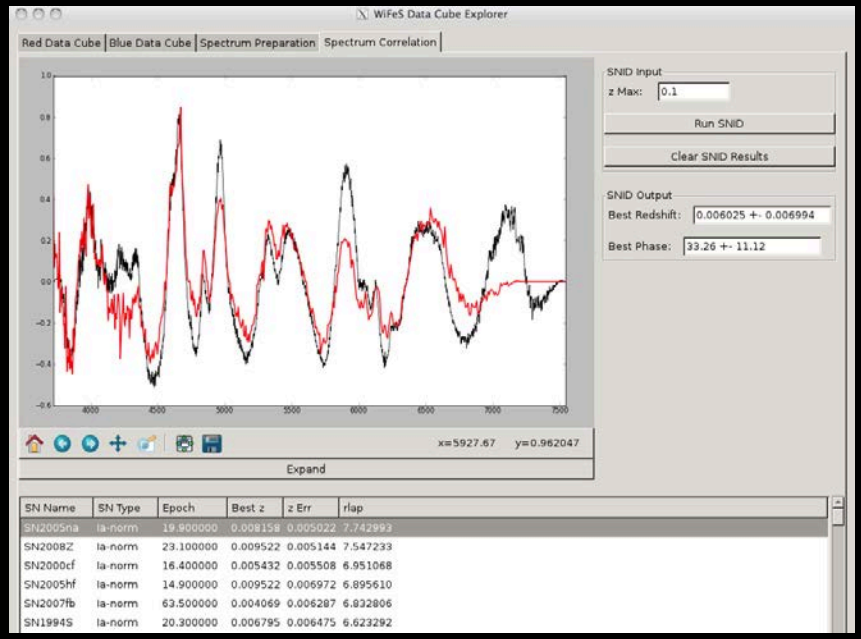
SkyMapper Supernovae with WiFeS



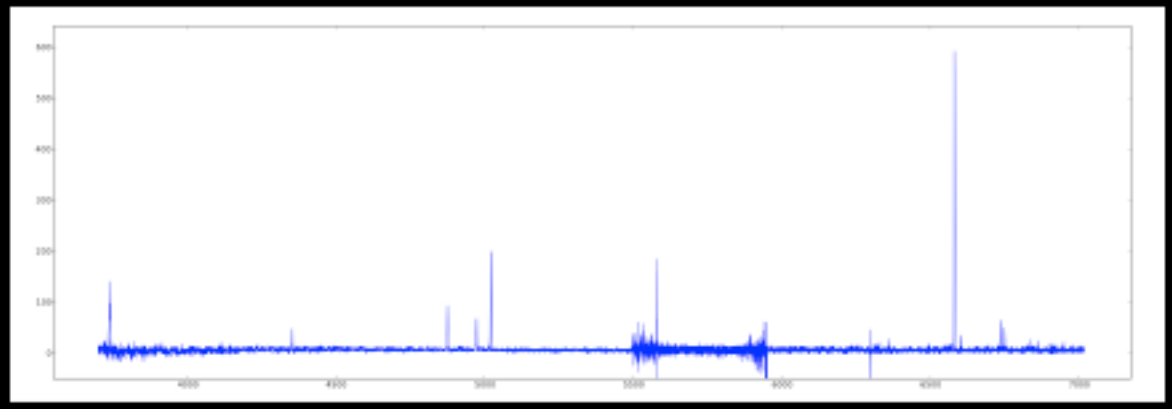
Extract SN spectrum

Cross-correlate with known SN spectra

SN type and redshift

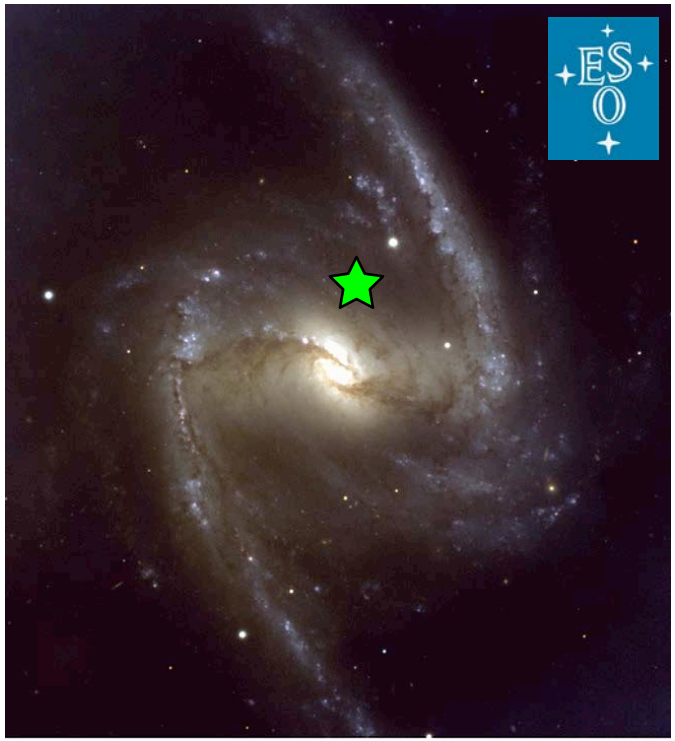


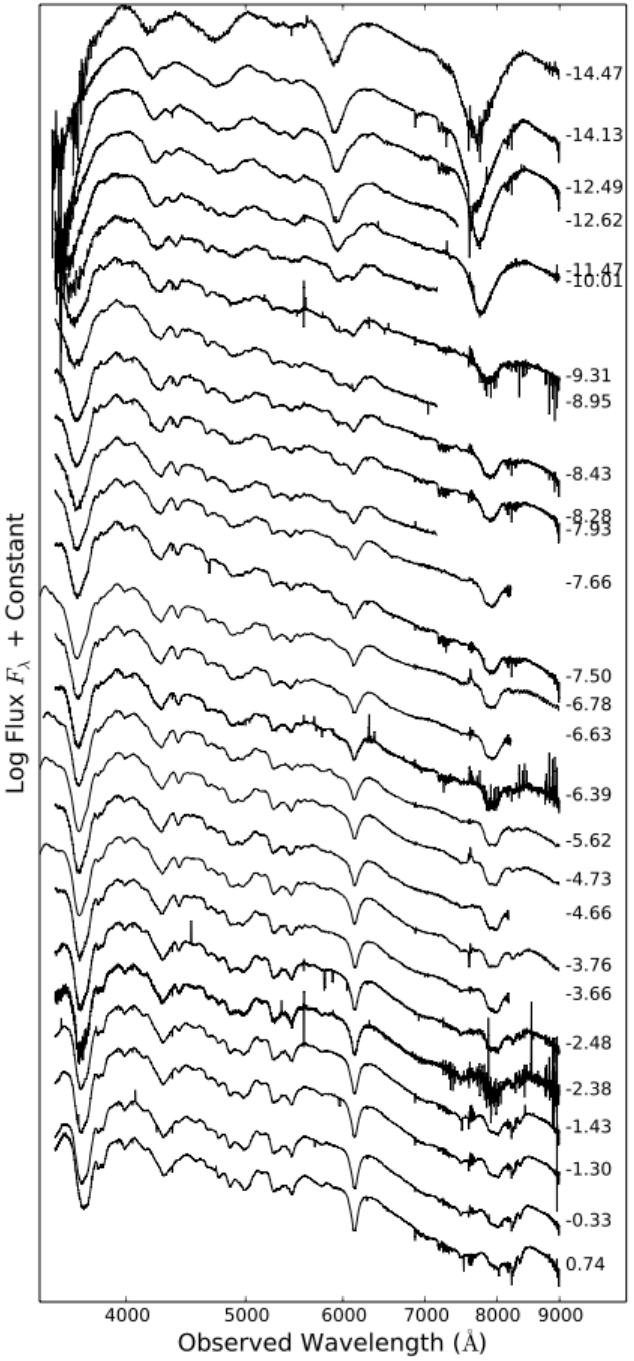
Spatially-resolved SN host galaxy spectra for free!



SN 2012fr in NGC 1365

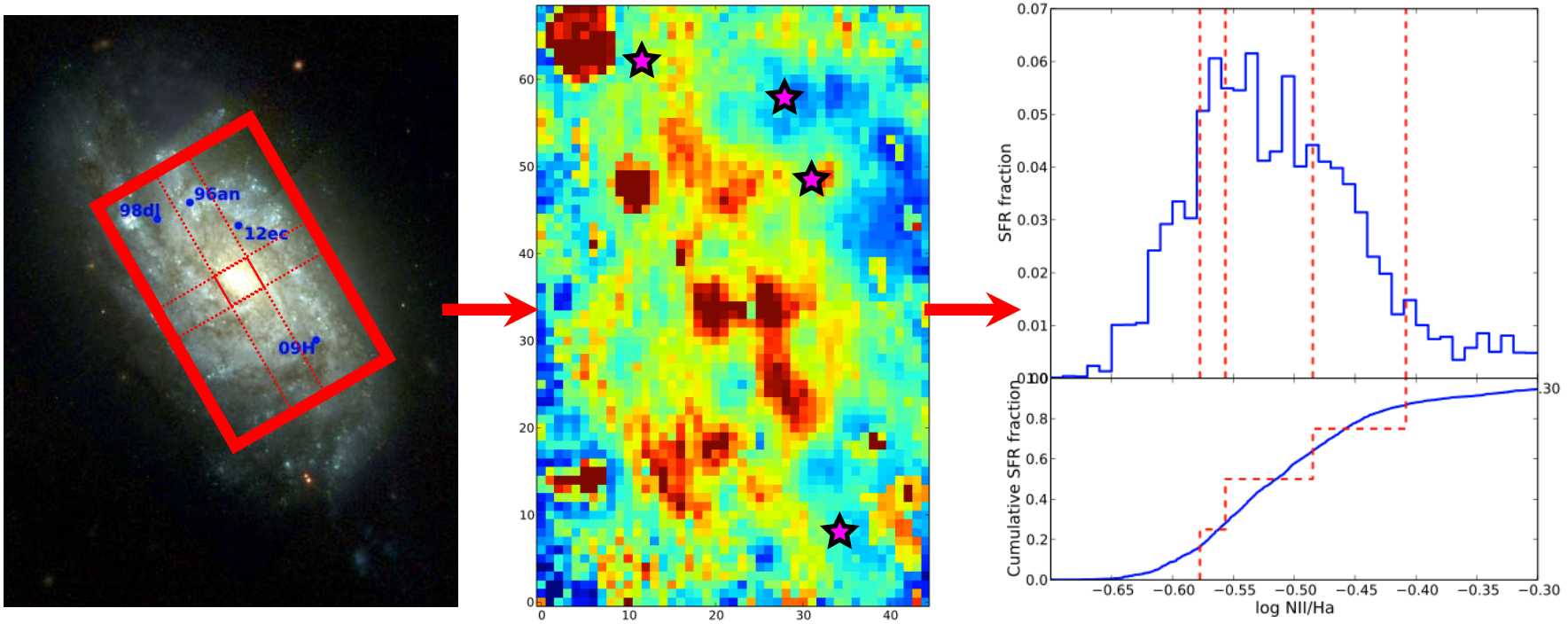
- New SN Ia in HST Key Project galaxy NGC 1365 - with Cepheid distance
- Discovered Oct 27, probably less than 1 day after explosion
- 25 spectra before maximum light on Nov. 12





SN Environments with WiFeS

- Map out SN host galaxy with WiFeS integral field spectrograph, calculate metallicity at each point in galaxy
- Compare SN site metallicities to cumulative host metallicity distribution, assign a “cumulative metallicity score”
- Places SN site metallicities in meaningful context, can detect statistical preference for high or low metallicity

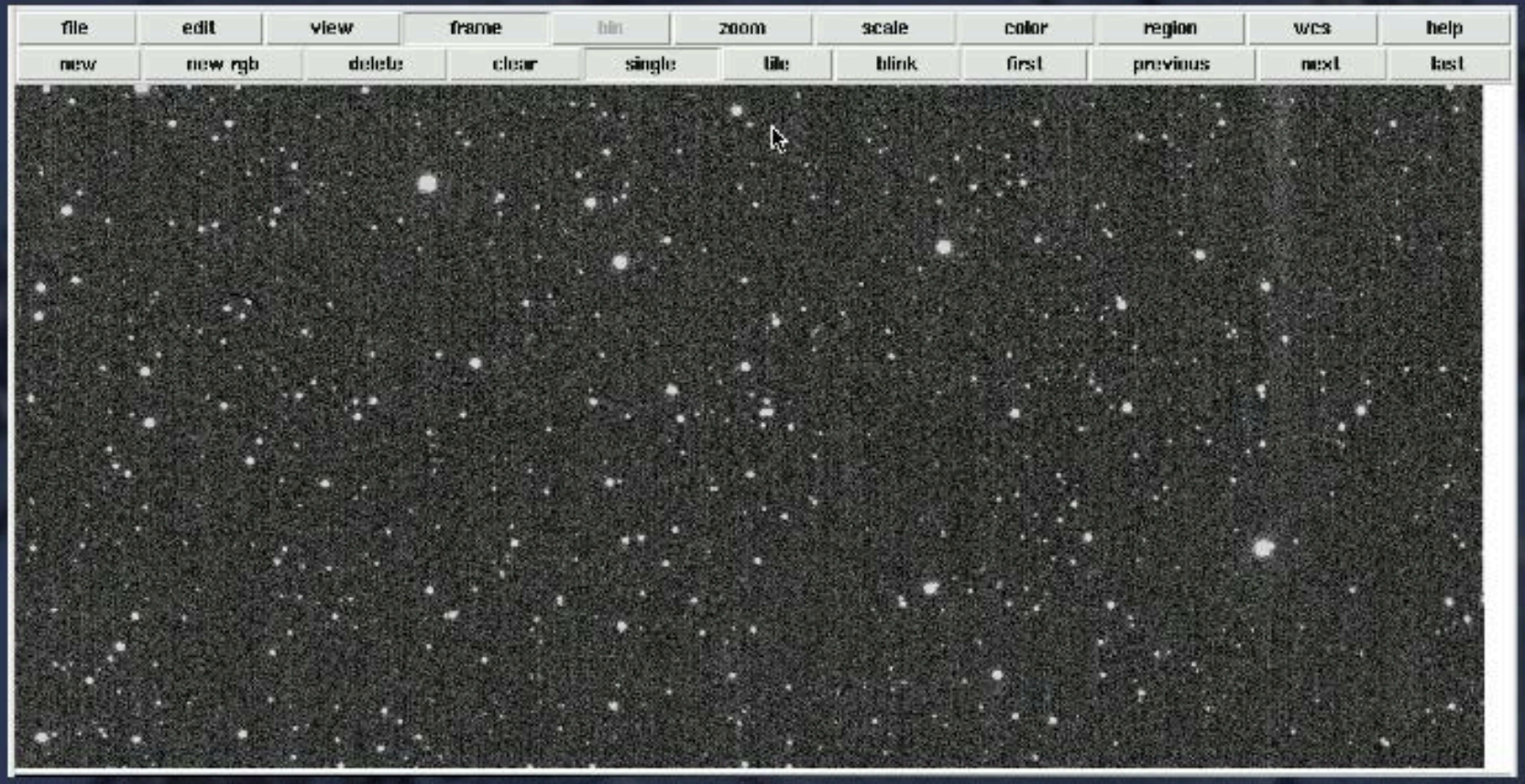


150 Supernovae per Year

- Magnitude Limited (m_r=19^m) - with complete spectroscopy
- Host Galaxy information on Large Fraction of Objects at site of SN
- Precisely Calibrated 4-colour light curves of all objects
- Spectroscopic series on selected objects
- IR photometry on selected objects

Progress

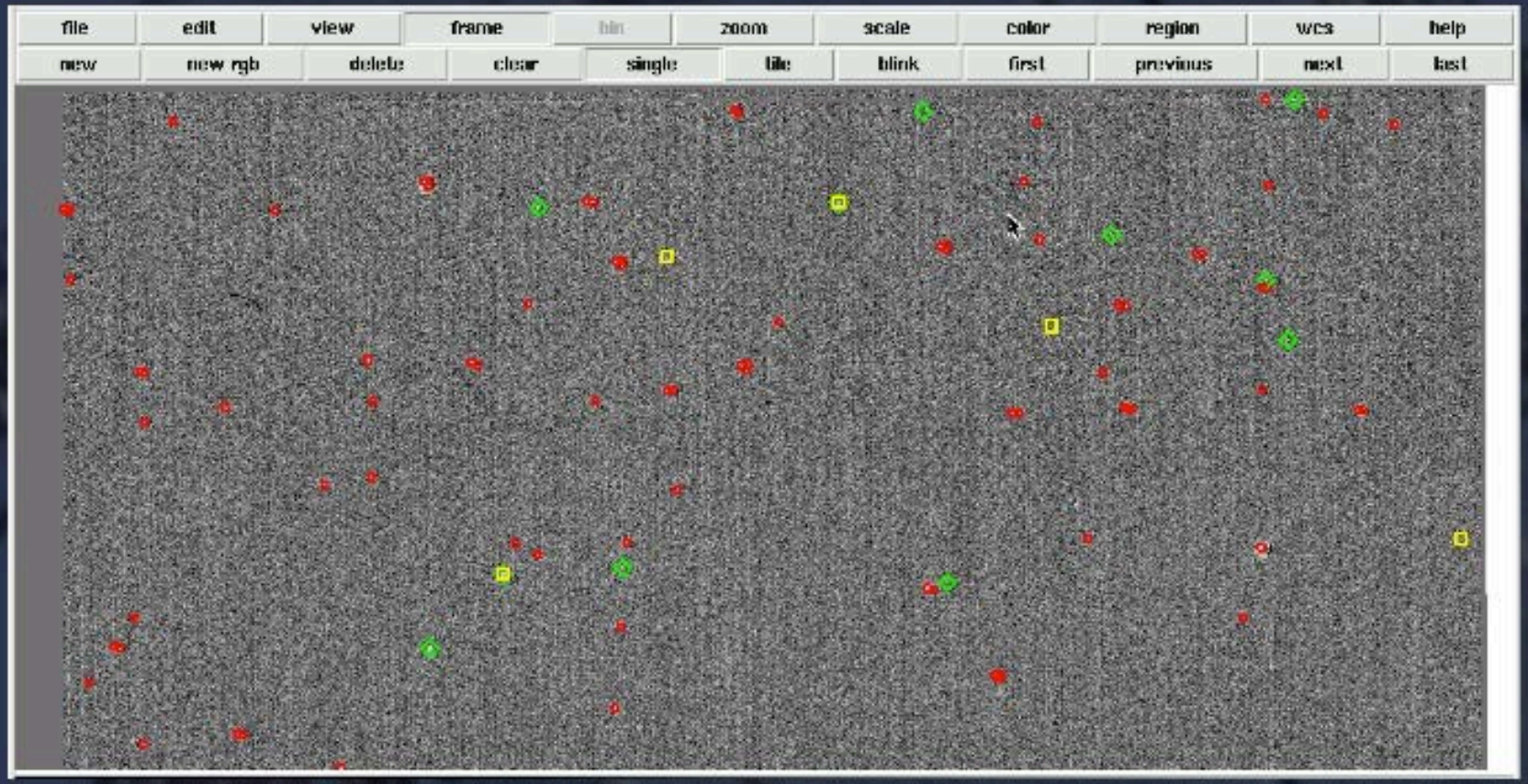
Test data are pretty clean!



Detections: ◇ **Real,** ○ **Bogus,** ❑ **known asteroids**

About 30 Bogus for each Real (mostly bright stars + CRs)

Test data are pretty clean!



Detections: ◇ **Real,** ○ **Bogus,** ❑ **known asteroids**

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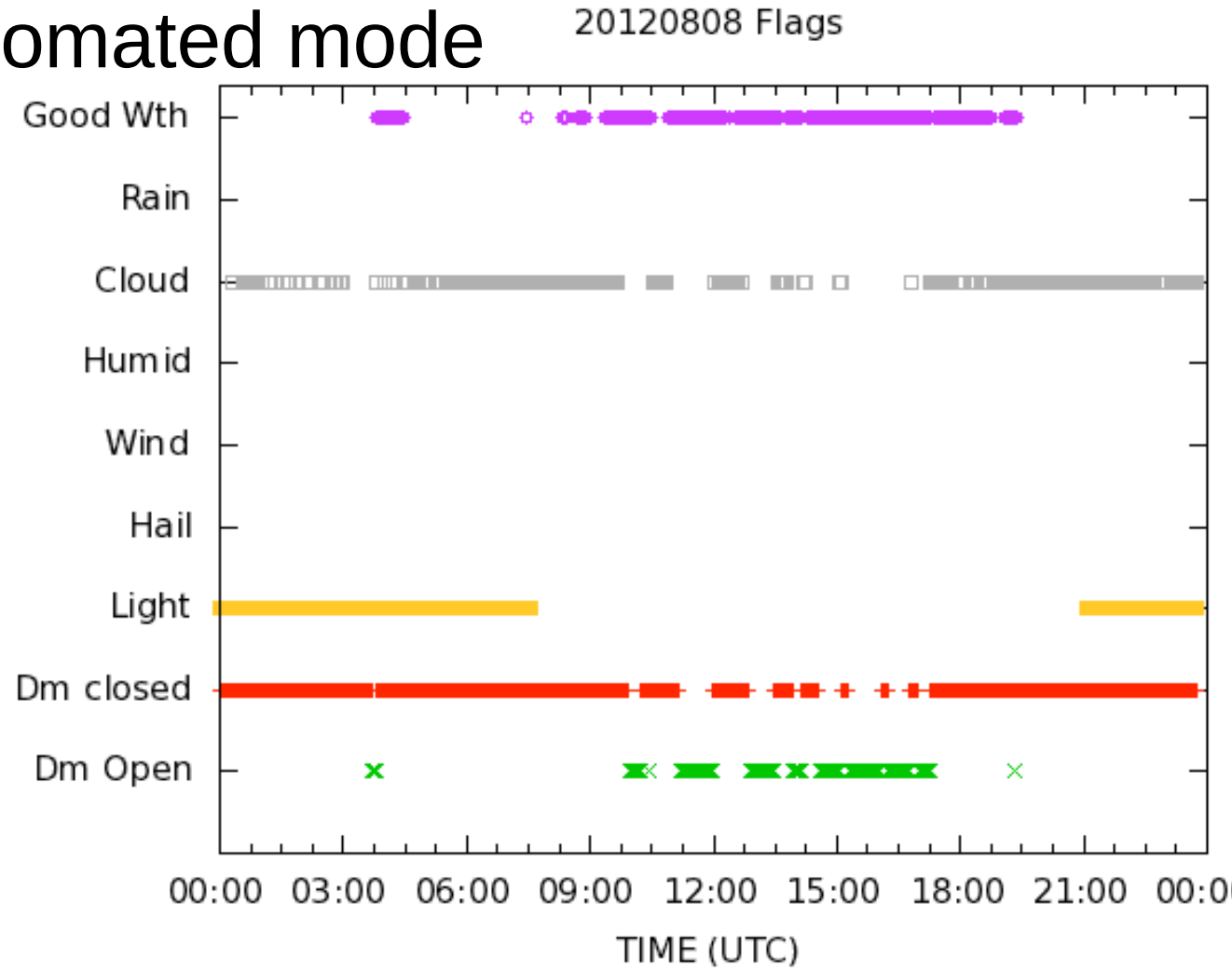
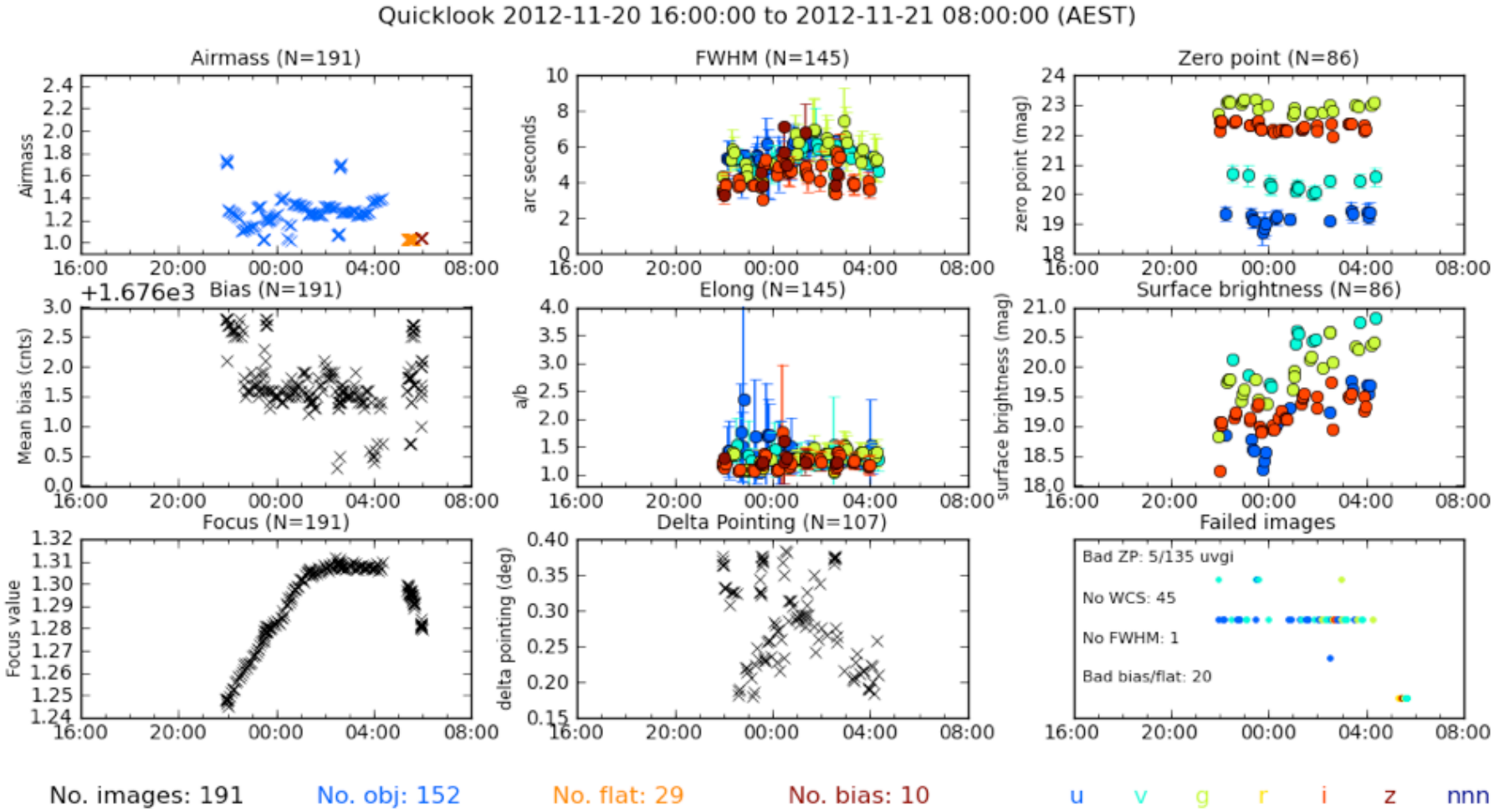
Current State

- Telescope is operating in fully automated mode



SkyMapper

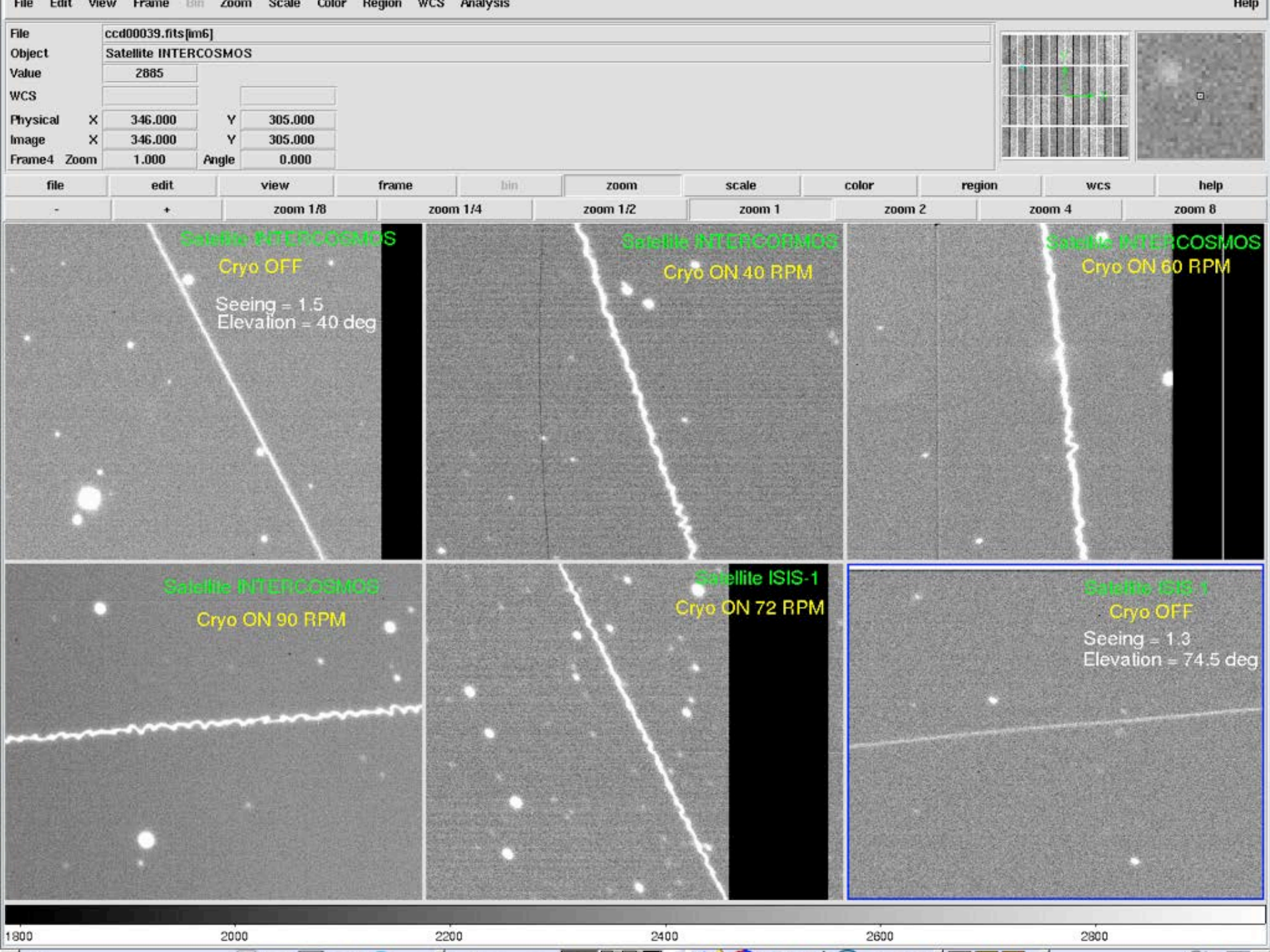


Australian National University

CAASTRO ALL-SKY ASTROPHYSICS

Current State

- Telescope's Optics meet spec and have remained collimated for 18months.
- So Stable, but...


File Edit View Frame Bin Zoom Scale Color Region WCS Analysis Help
File ccd00039.fits[im6]
Object Satellite INTERCOSMOS
Value 2885
WCS
Physical X 346.000 Y 305.000
Image X 346.000 Y 305.000
Frame4 Zoom 1.000 Angle 0.000
file edit view frame bin zoom scale color region wcs help
- + zoom 1/8 zoom 1/4 zoom 1/2 zoom 1 zoom 2 zoom 4 zoom 8
Satellite INTERCOSMOS
Cryo OFF
Seeing = 1.5
Elevation = 40 deg
Satellite INTERCOSMOS
Cryo ON 40 RPM
Satellite INTERCOSMOS
Cryo ON 60 RPM
Satellite INTERCOSMOS
Cryo ON 90 RPM
Satellite ISIS-1
Cryo ON 72 RPM
Satellite ISIS-1
Cryo OFF
Seeing = 1.3
Elevation = 74.5 deg
1800 2000 2200 2400 2600 2800

- We will release our SN discoveries to community via
- We will release typing information from spectra
- Light curves and spectra remain proprietary to our survey until published
- We are working with PESSTO, and spectra taken for PESSTO will be released via PESSTO