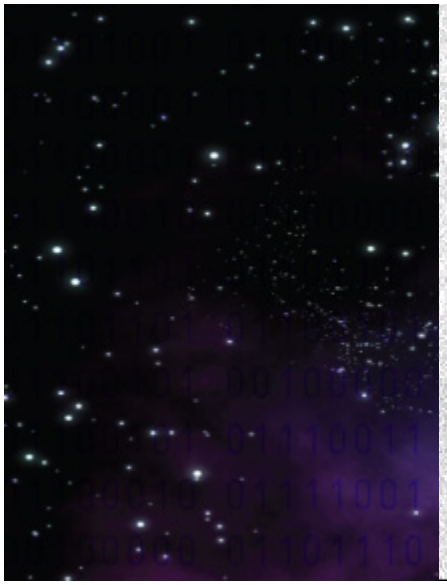
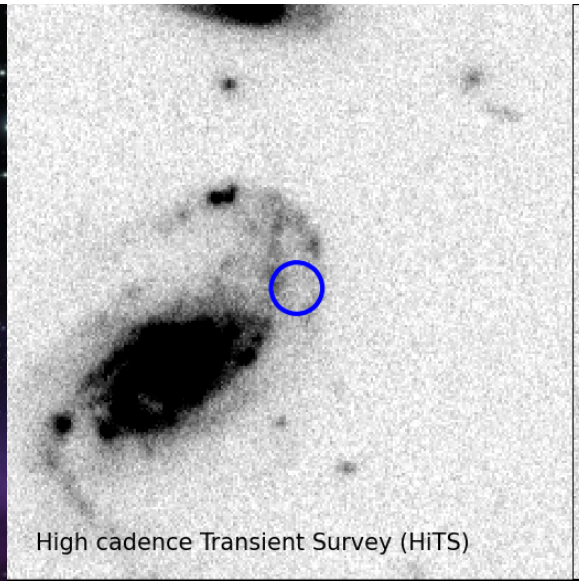
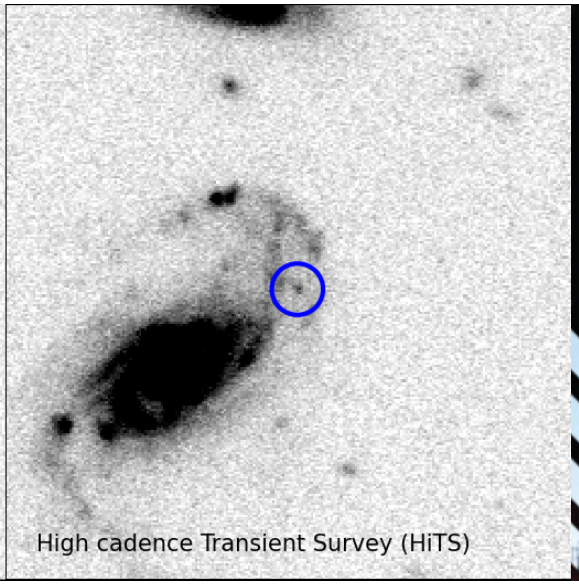
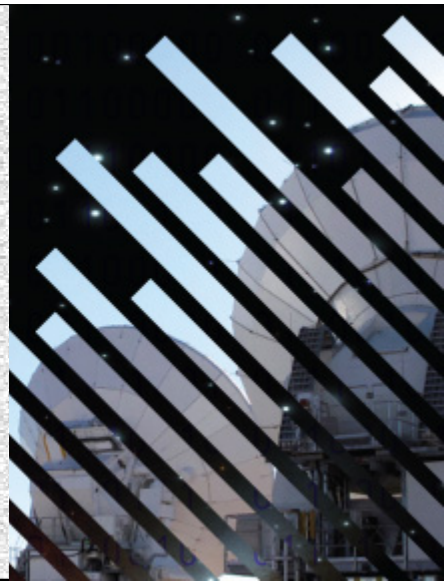







The High cadence Transient Survey (HiTS)

F. Förster, J.C. Maureira, J. San Martín, M. Hamuy, J. Martínez, P. Huijse, G. Cabrera, L. Galbany, Th. De Jaeger, S. González-Gaitán, J. Anderson, H. Kunkarayakti, G. Pignata, F. Bufano, J. Littín, F. Olivares, G. Medina, R.C. Smith, A.K. Vivas, P. Estévez, R. Muñoz, E. Vera

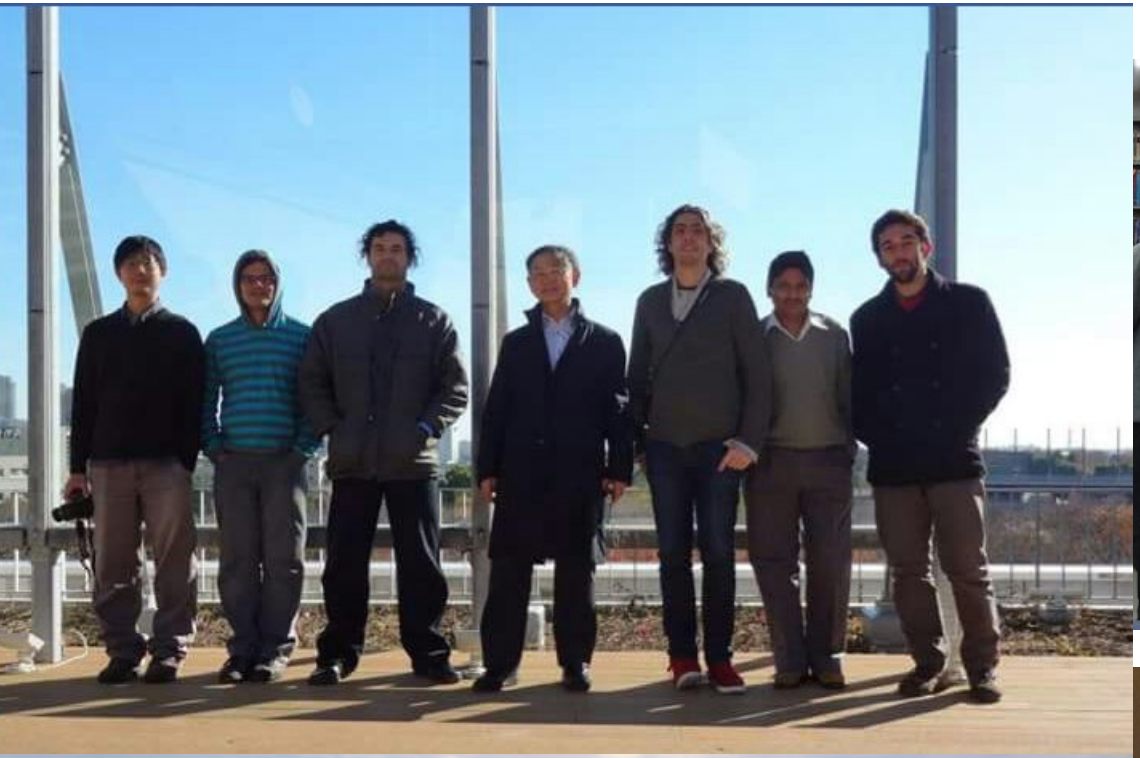
Förster et al., ApJ accepted, arXiv:1609.03567

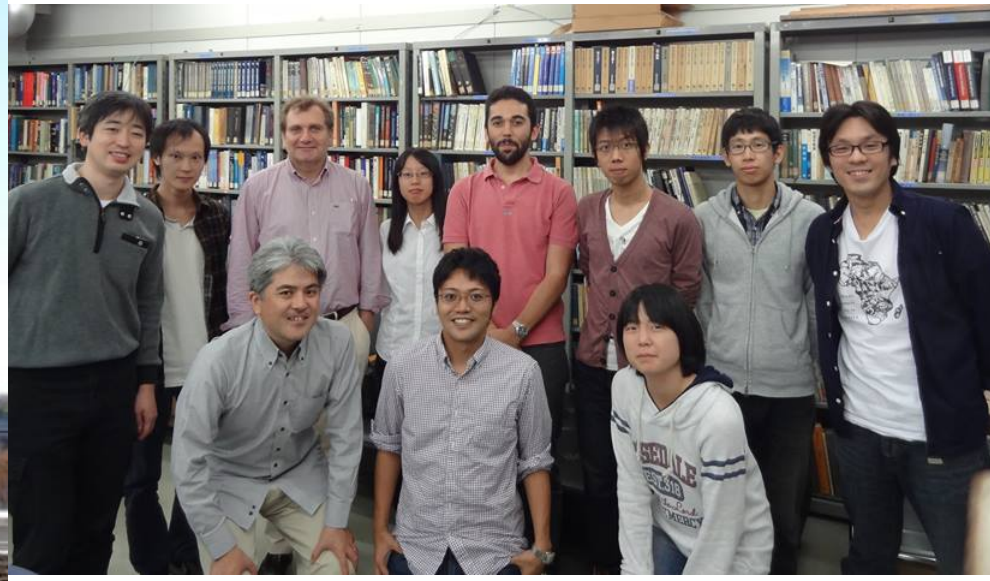
CMM Center for Mathematical Modeling

NLHPC National Laboratory for High Performance Computing Chile

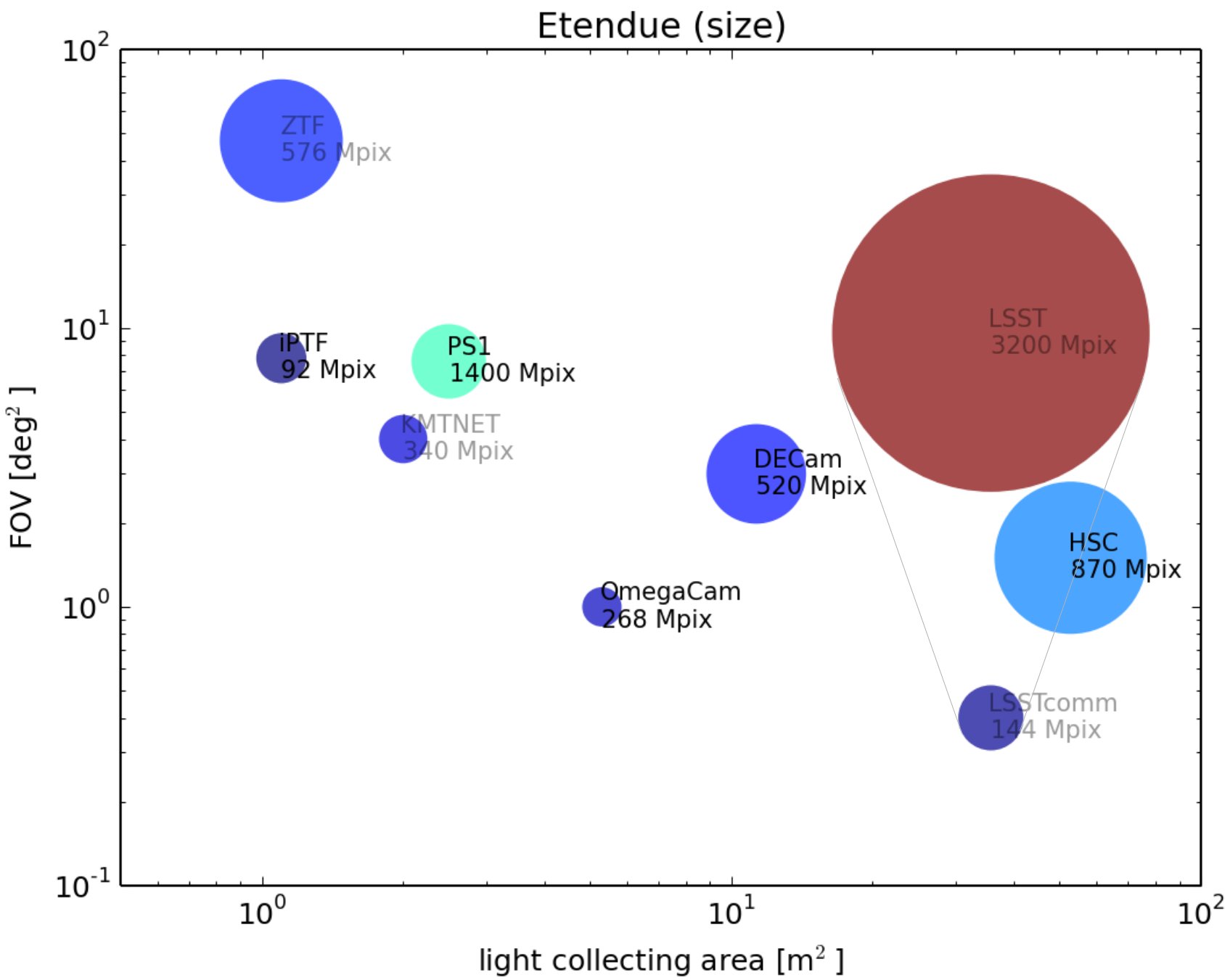
MILLENNIUM INSTITUTE OF ASTROPHYSICS

CONICYT Ministerio de Educación Gobierno de Chile

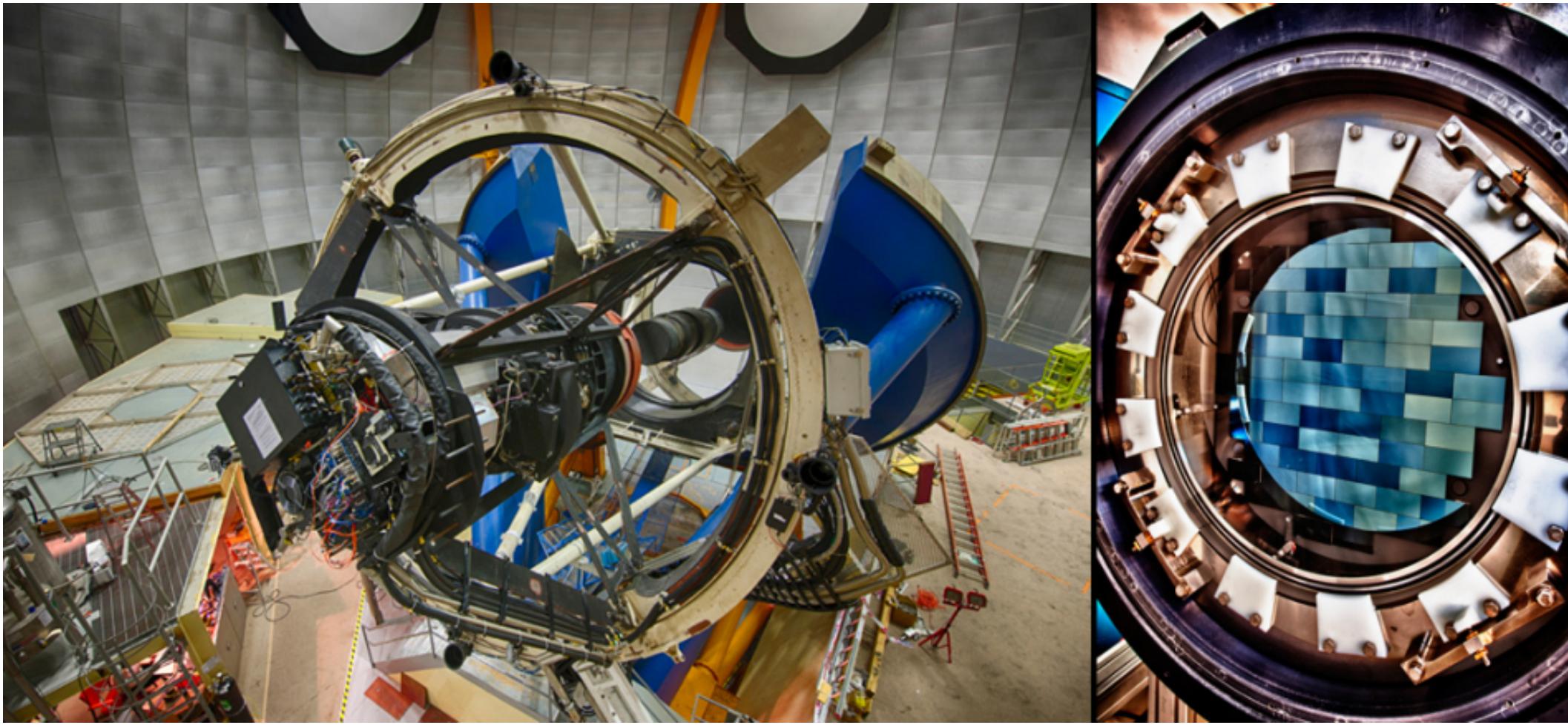




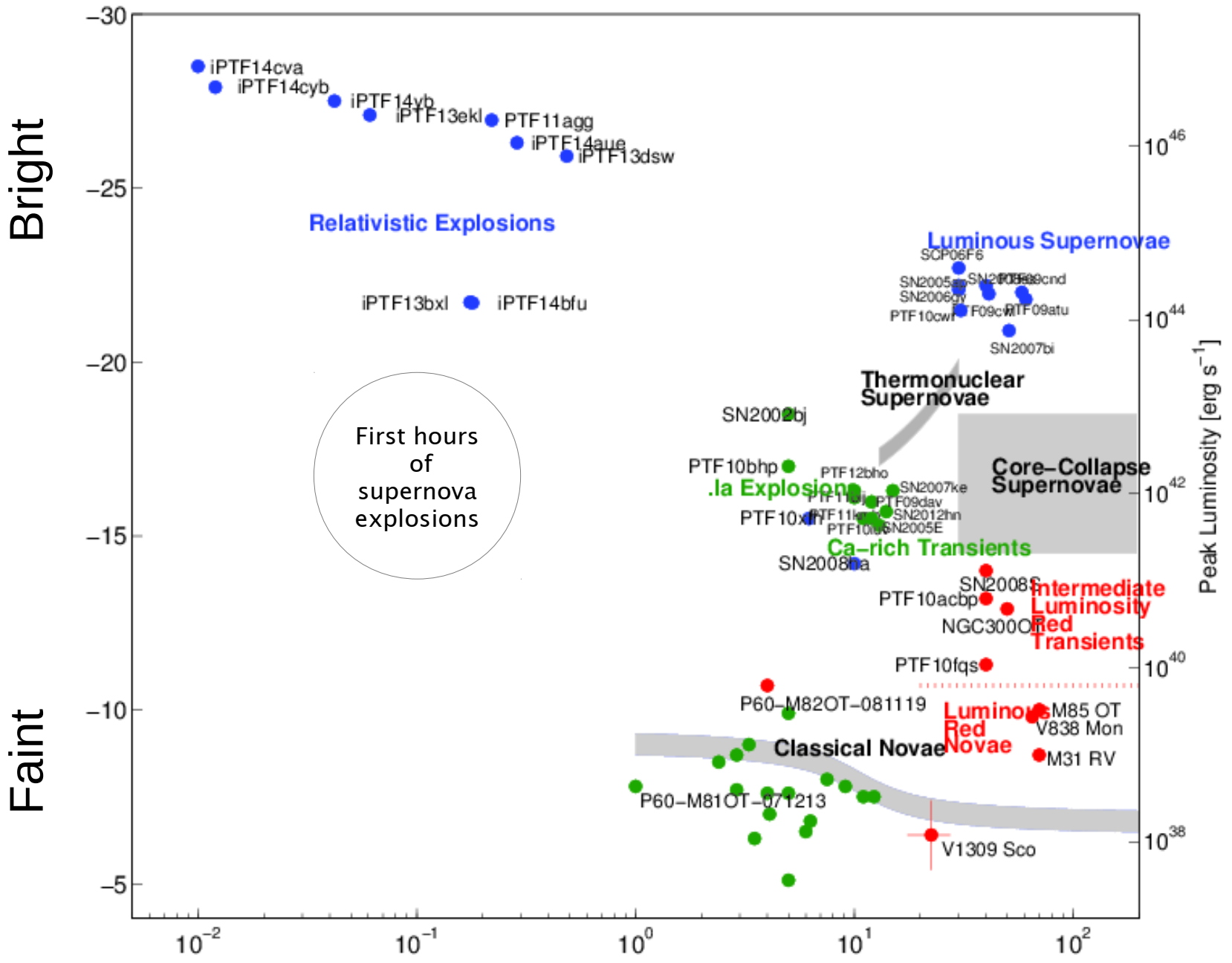
Etendue and number of pixels



Dark Energy Camera (DECam)

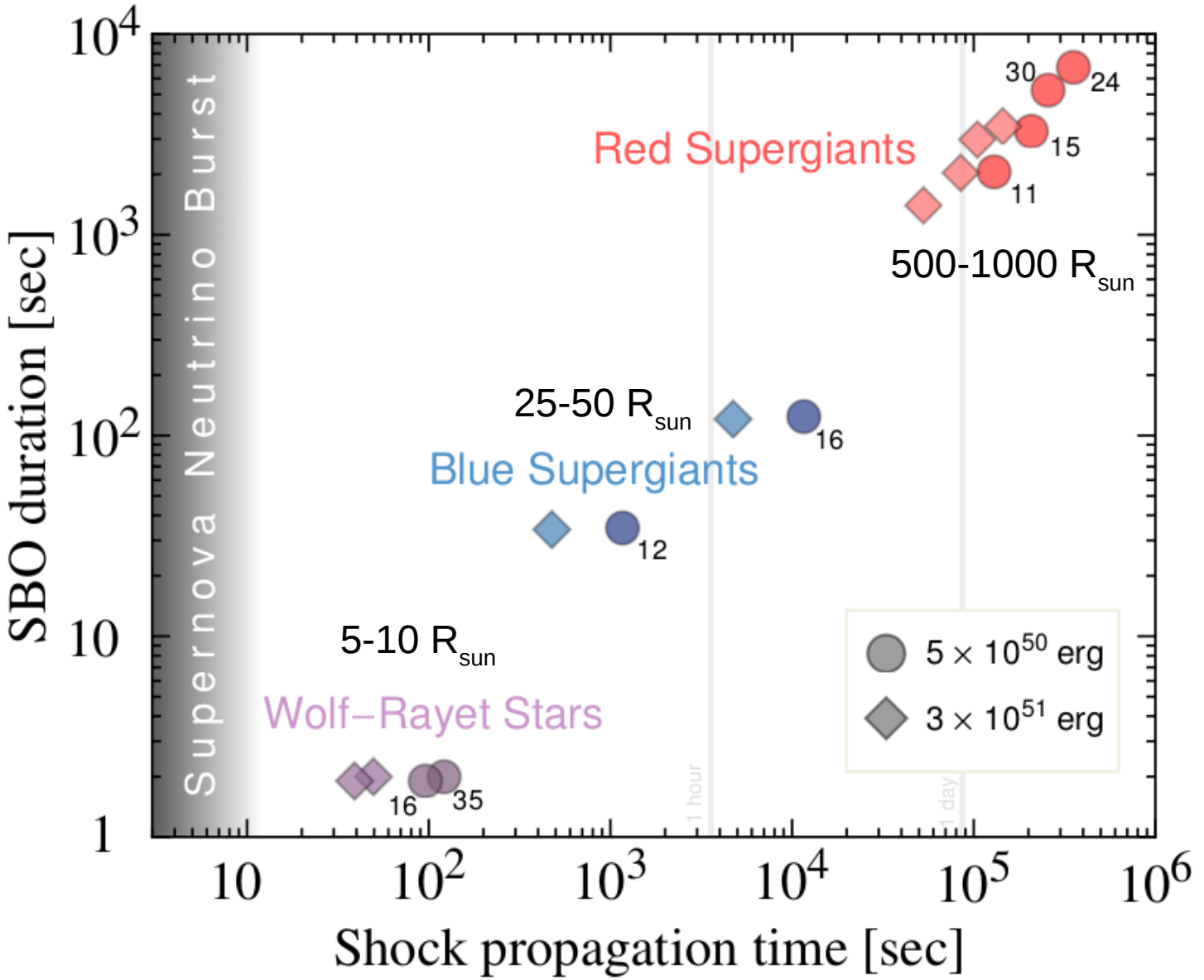


The sky is not static!



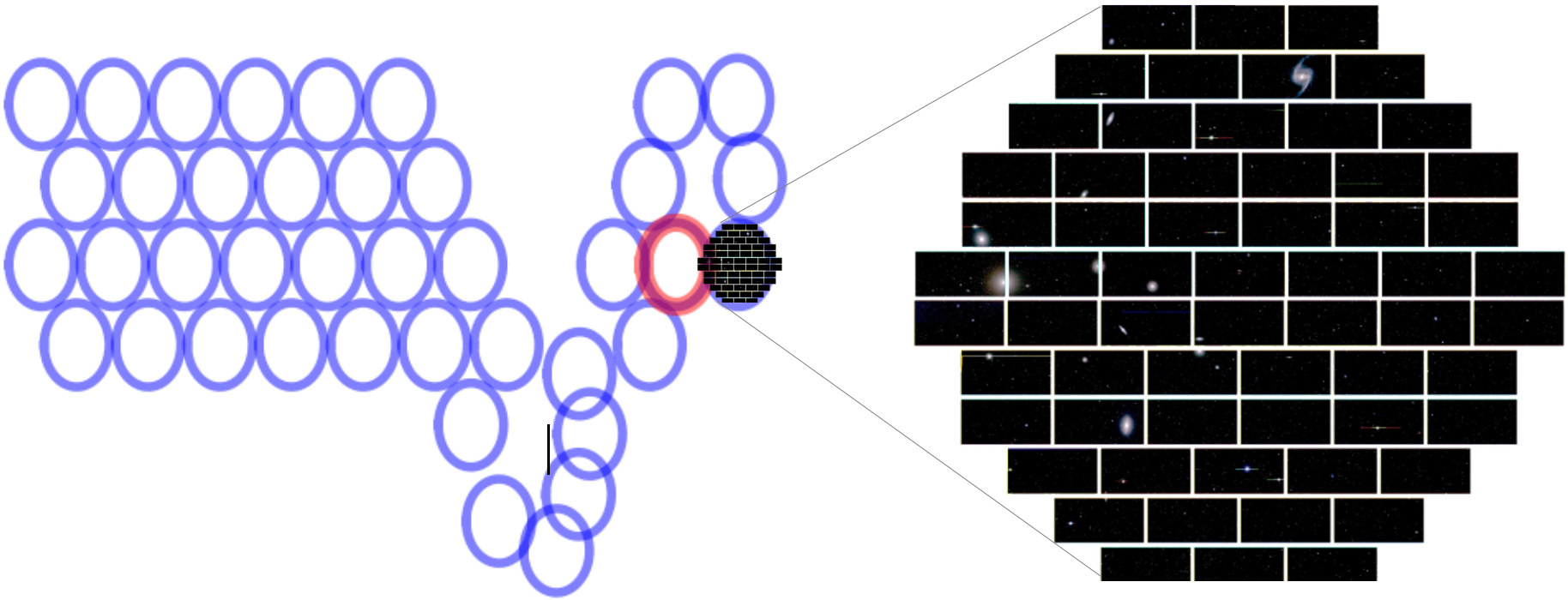
Credit: Mansi Kasliwal

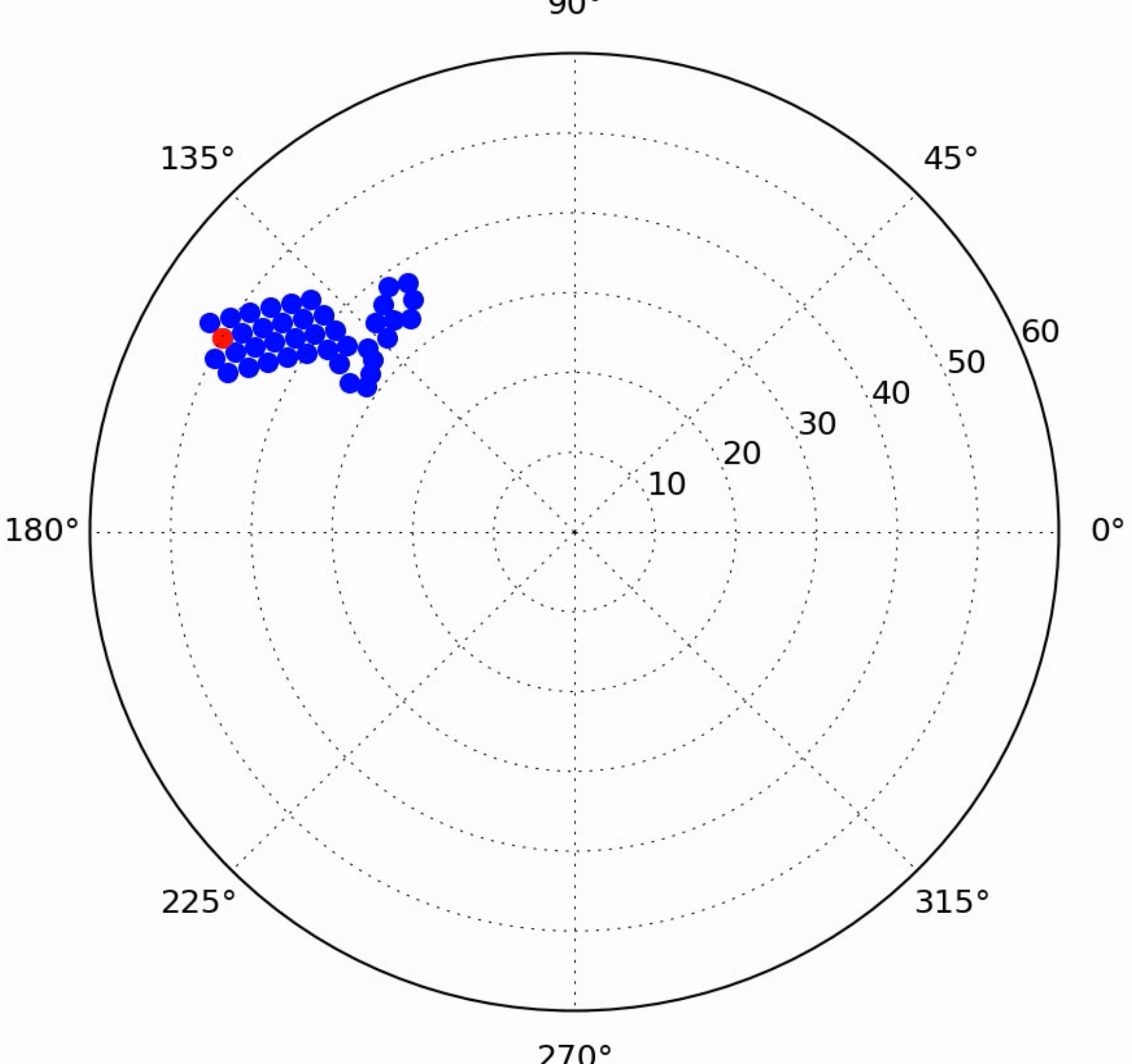
Supernova shock breakout (SBO) timescales

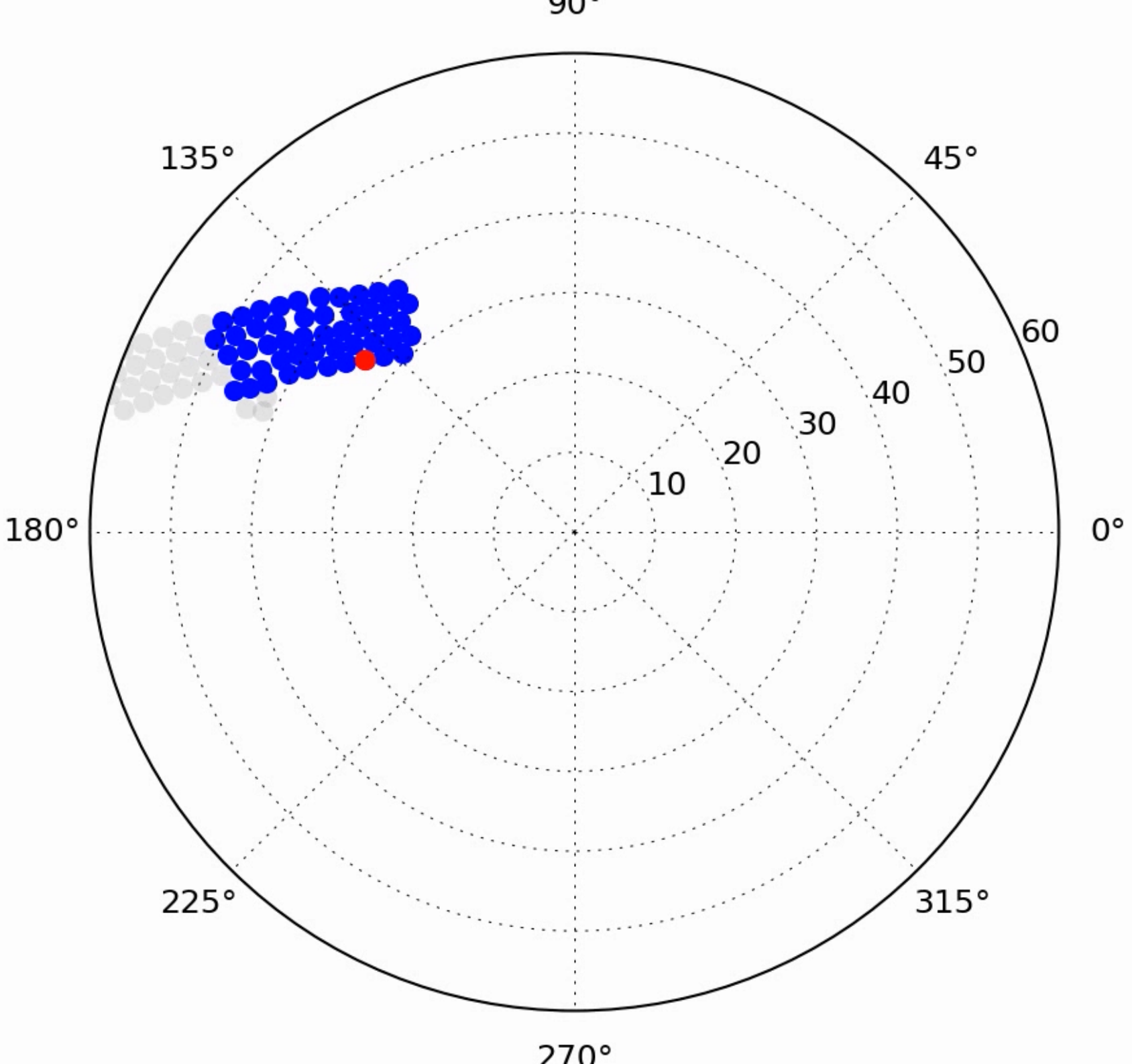


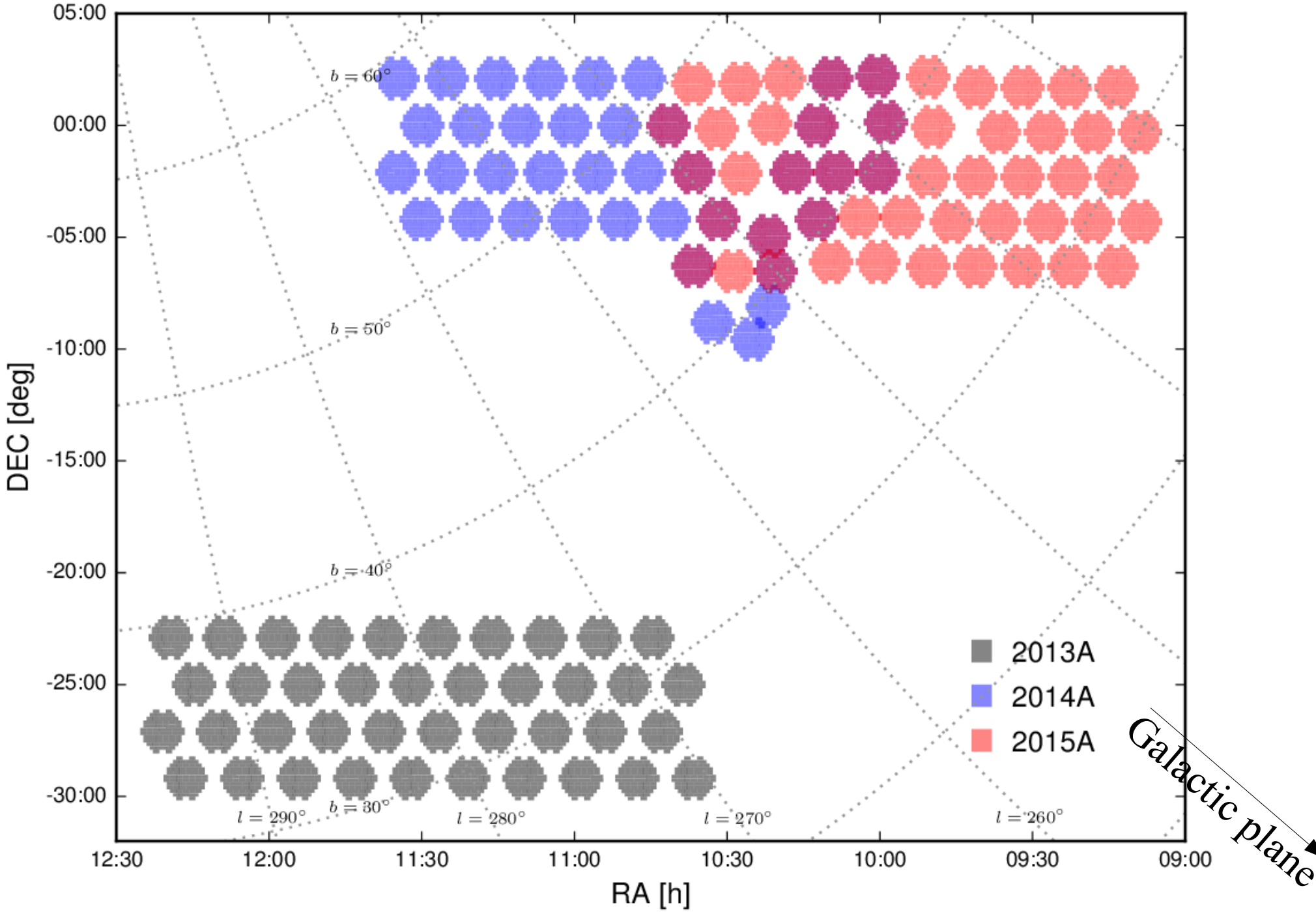
Kistler, Haxton & Yüksel 2014

HiTS: searching for shock breakouts in the optical

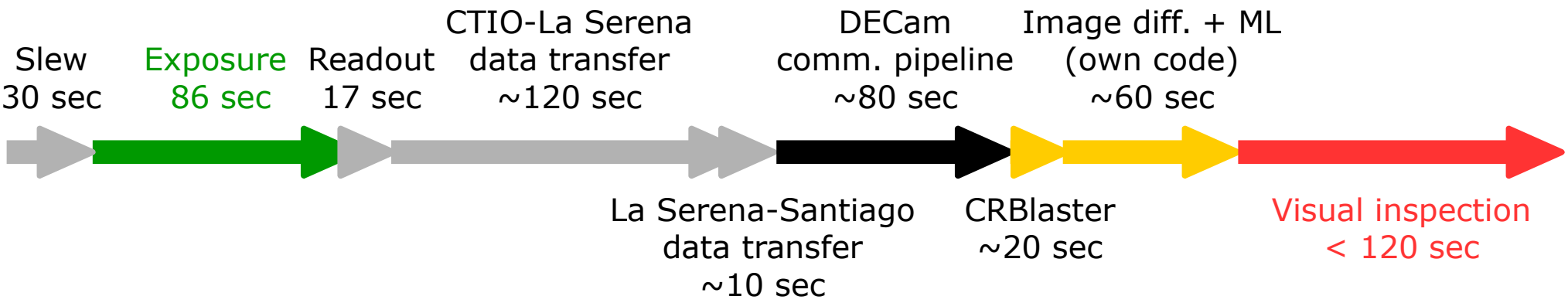



90°
135°
45°
60
50
40
30
20
10
180°
0°
225°
315°
270°

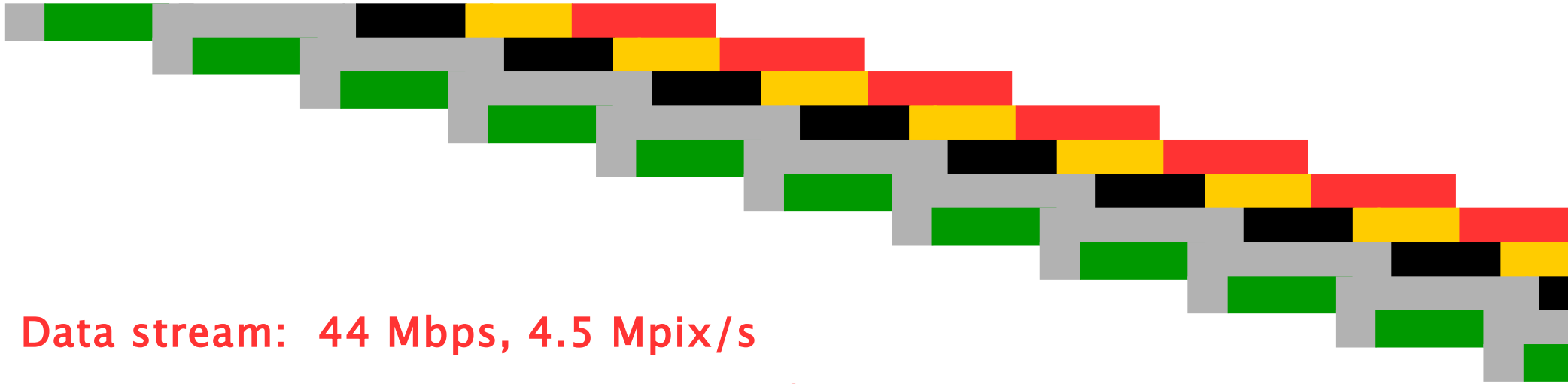

90°
135°
45°
60
50
40
30
20
10
180°
0°
225°
315°
270°


05:00
00:00
-05:00
-10:00
-15:00
-20:00
-25:00
-30:00
DEC [deg]
12:30
12:00
11:30
11:00
10:30
10:00
09:30
09:00
RA [h]
$b = 60°$
$b = 50°$
$b = 40°$
$b = 30°$
$l = 290°$
$l = 280°$
$l = 270°$
$l = 260°$
2013A
2014A
2015A
Galactic plane

Pipeline flow outline



~5-6 min lag

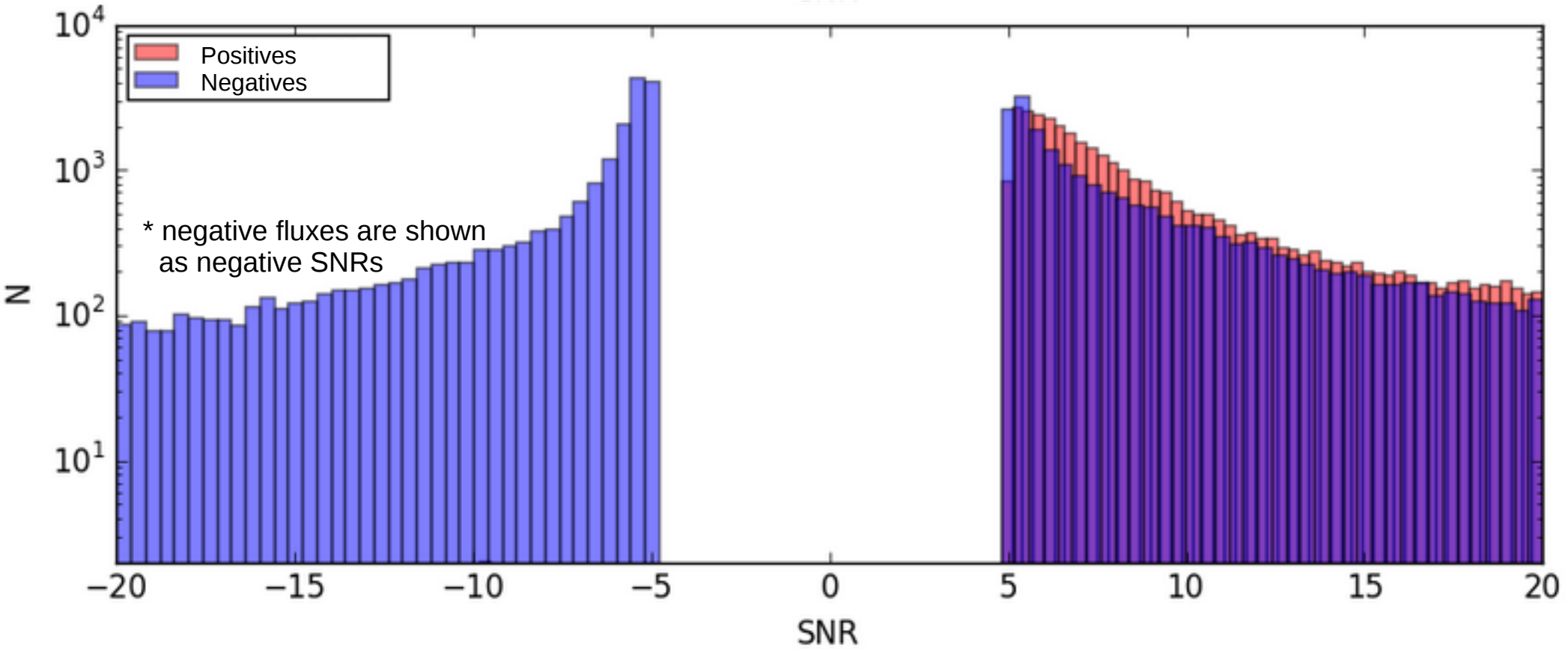


Data stream: 44 Mbps, 4.5 Mpix/s

~10^{12} pixels, ~10^{8} candidates, ~10^{6} filtered candidates

~10^{4} visual inspections, 125 SNe

Training sample SNR distribution



Positives: insert observed stars, scaled down to mimic bogus SNR distribution.
Negatives: everything else, accept some contamination from true transients.

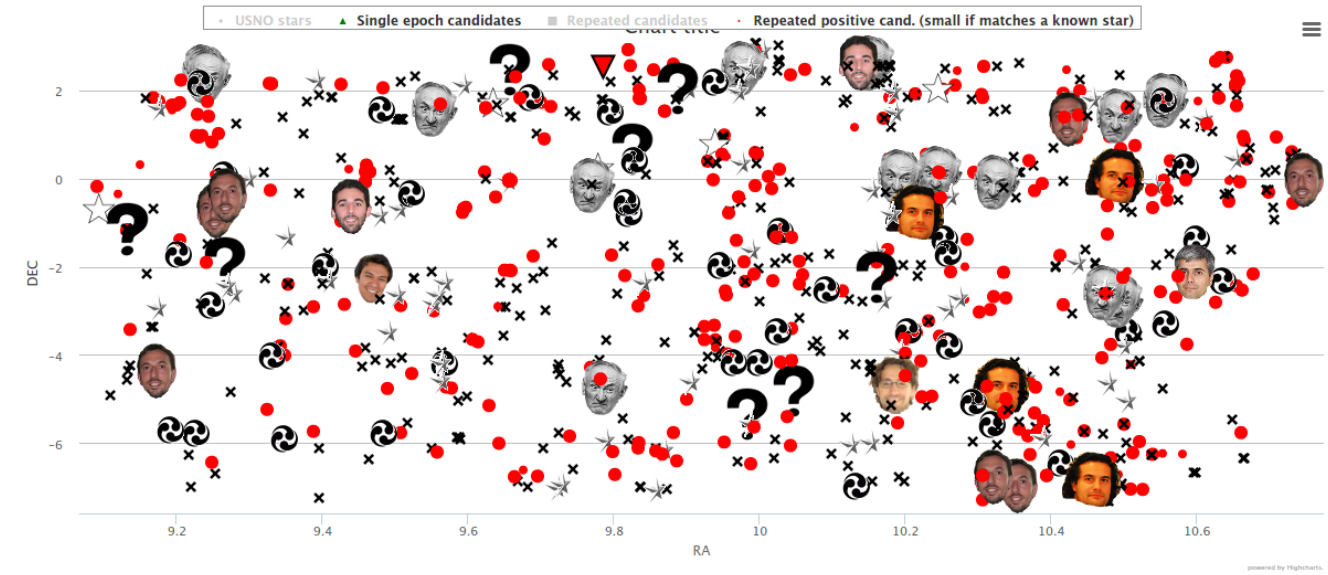
Use dimensionless features for a more *universal* classifier: based on **difference image (+ *PSF*), SNR image of the difference, unsubtracted image stamps, density of candidates**

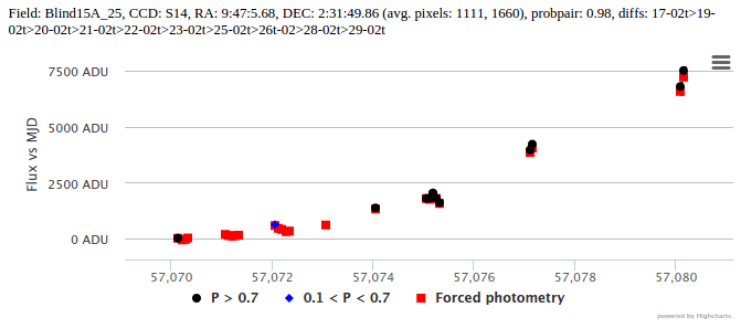
Visualization

1 Tpix after image subtraction and machine learning

Semester: Blind15A ▾ Field: all ▾ CCD: all ▾ Reference epoch: 02 ▾ Threshold: 0.85 getData!!!

Observer : FF - Logou

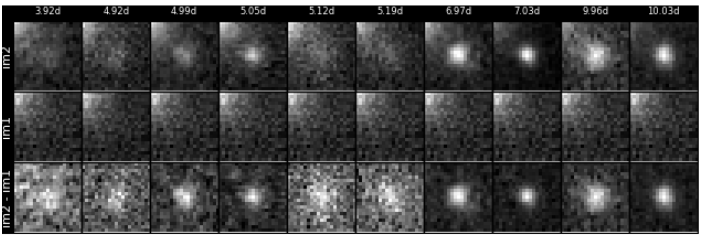




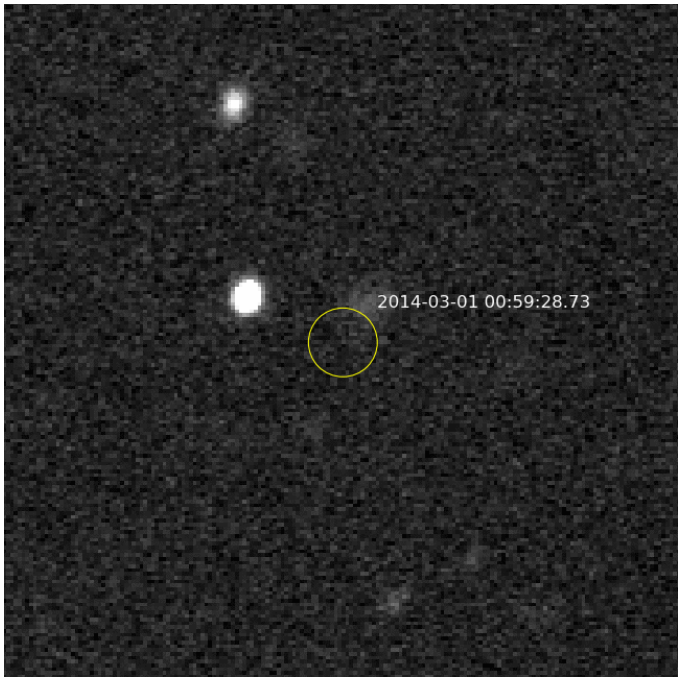
Bad Calibr. | Cosmic Ray
Conv.Problem | Bad Pixels
Asteroid | WTF
SN Good Cand. | SN Possible Cand.
VS Good Cand. | VS Possible Cand.

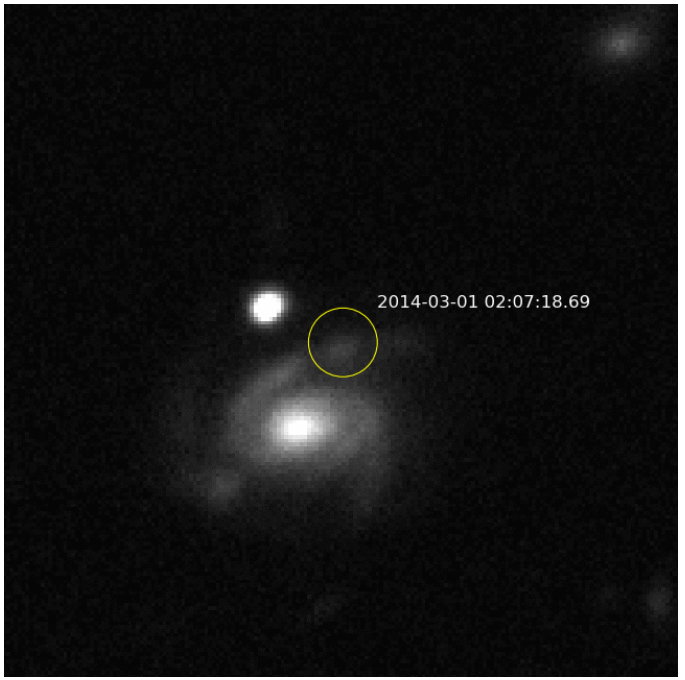
Send

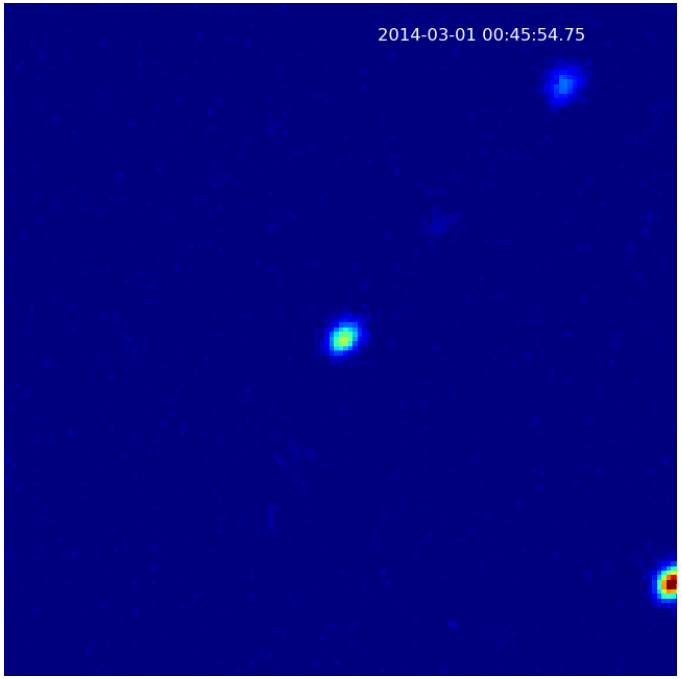
Field: Blind15A_25, CCD: S14, RA: 9:47:5.68, DEC: 2:31:49.86 (pixels: 1111, 1660).. Diffs: 17-02t>19-02t>20-02t>21-02t>22-02t>23-02t>25-02t>26t-02>28-02t>29-02t. Key :146.774:2.531, Light curve, animation and finding chart

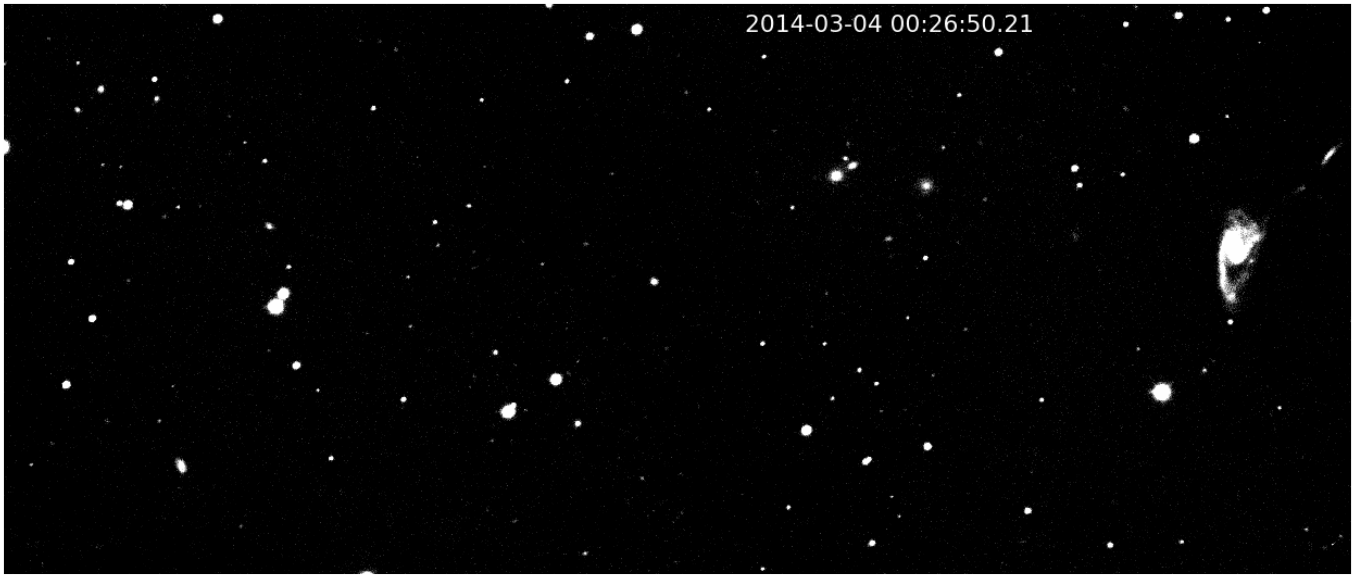


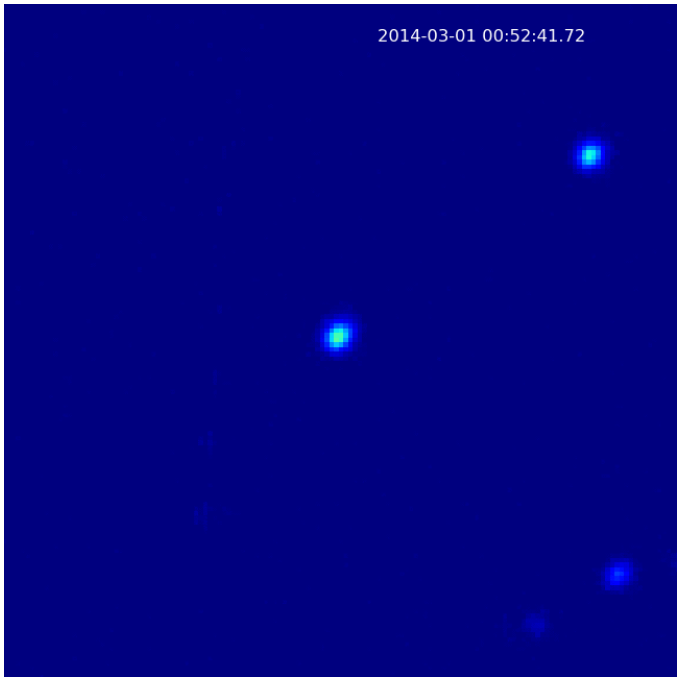
[Juan Carlos Maureira] Posible Shock Break out!
[FF] SN candidate Teahine



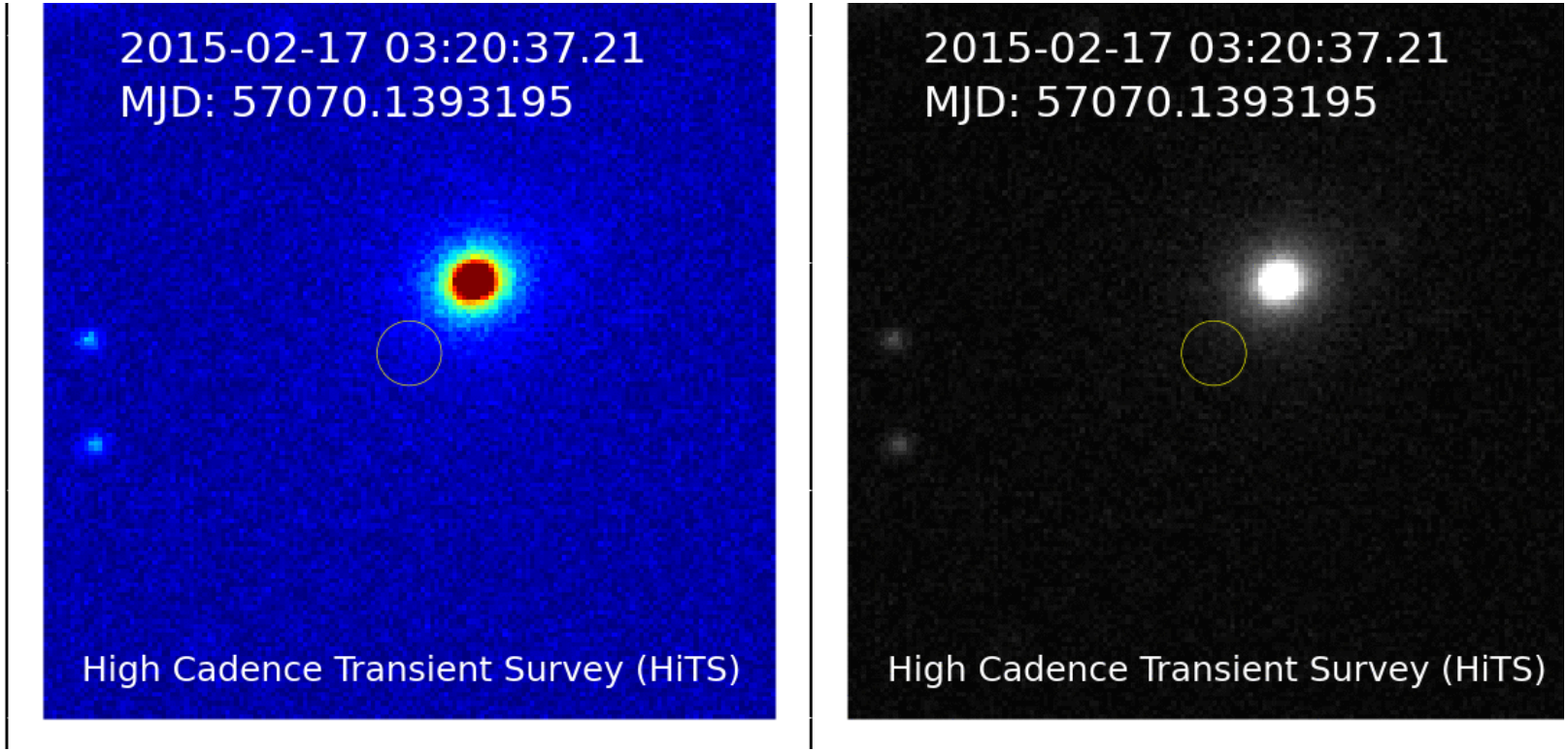


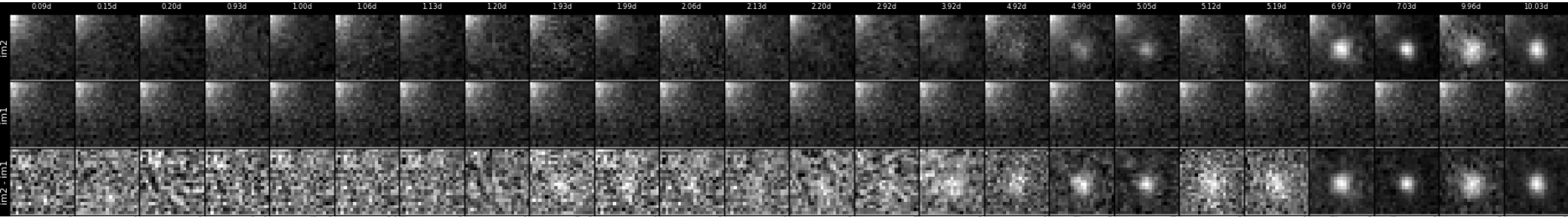






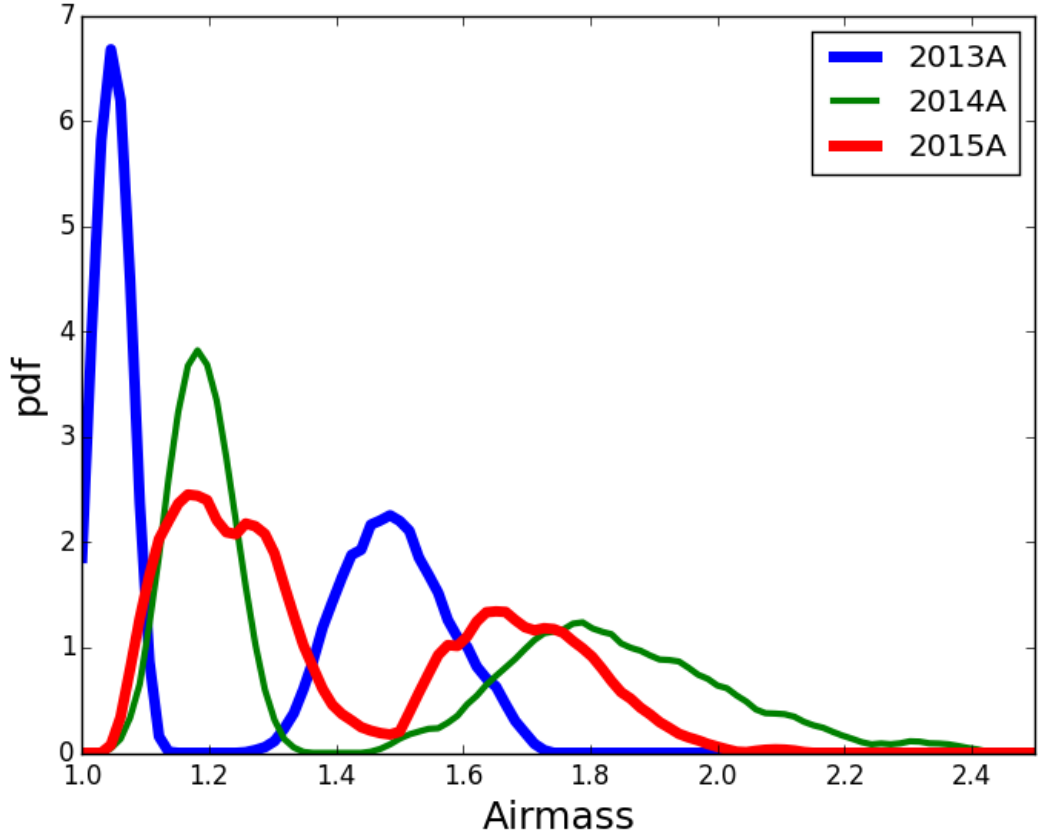
ATELs 5949, 5956

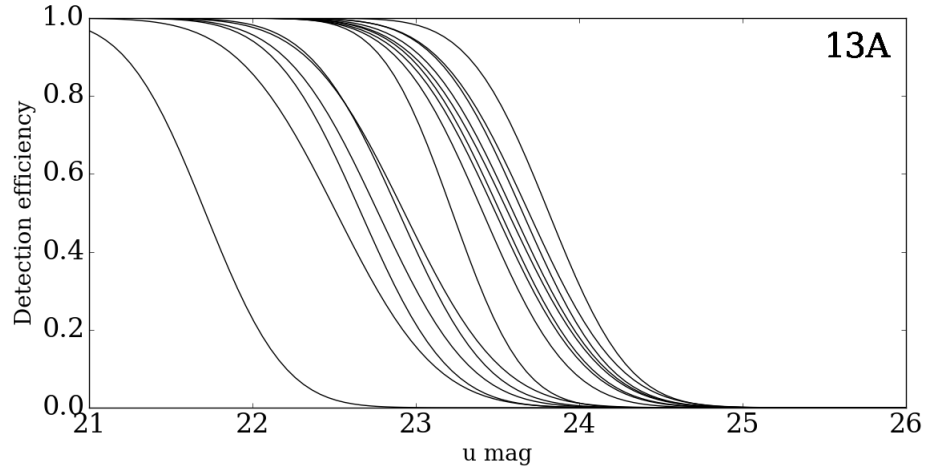


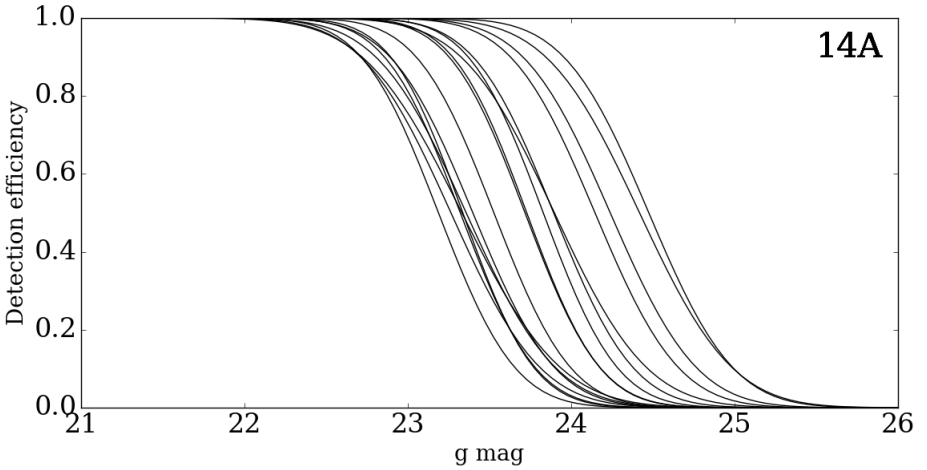


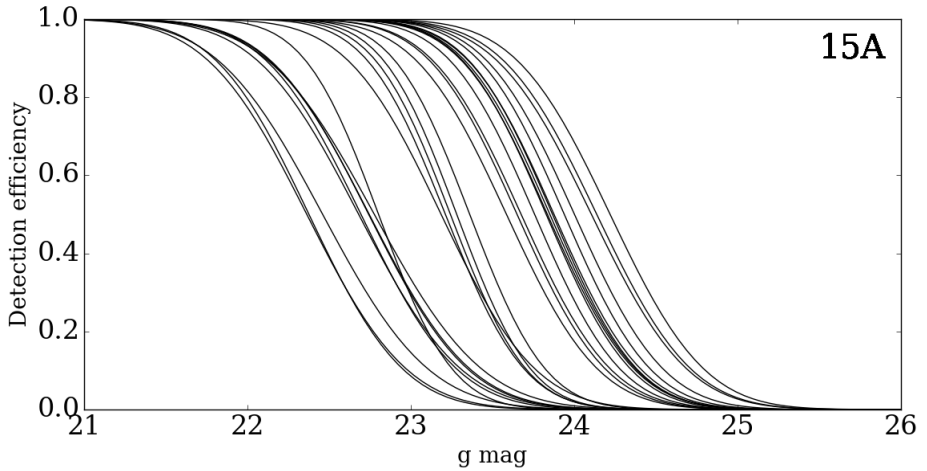
ATELs 7099, 7108, 7115, 7122, 7131, 7146, 7148, 7149

Airmass distribution and survey depth



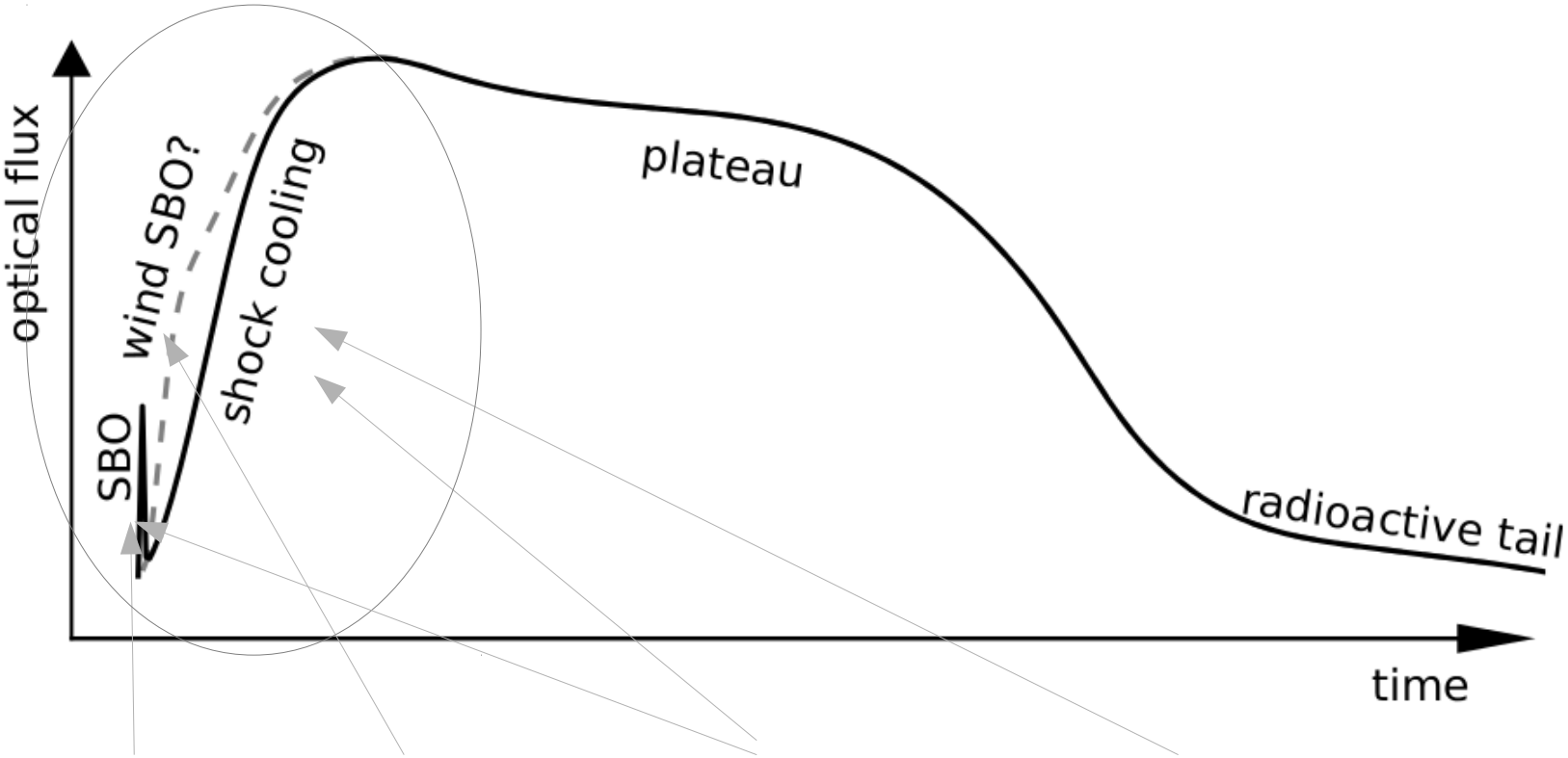






Modified DECam ETC available at
http://www.github.com/fforster/HiTS-public

Optical evolution of red supergiant supernova

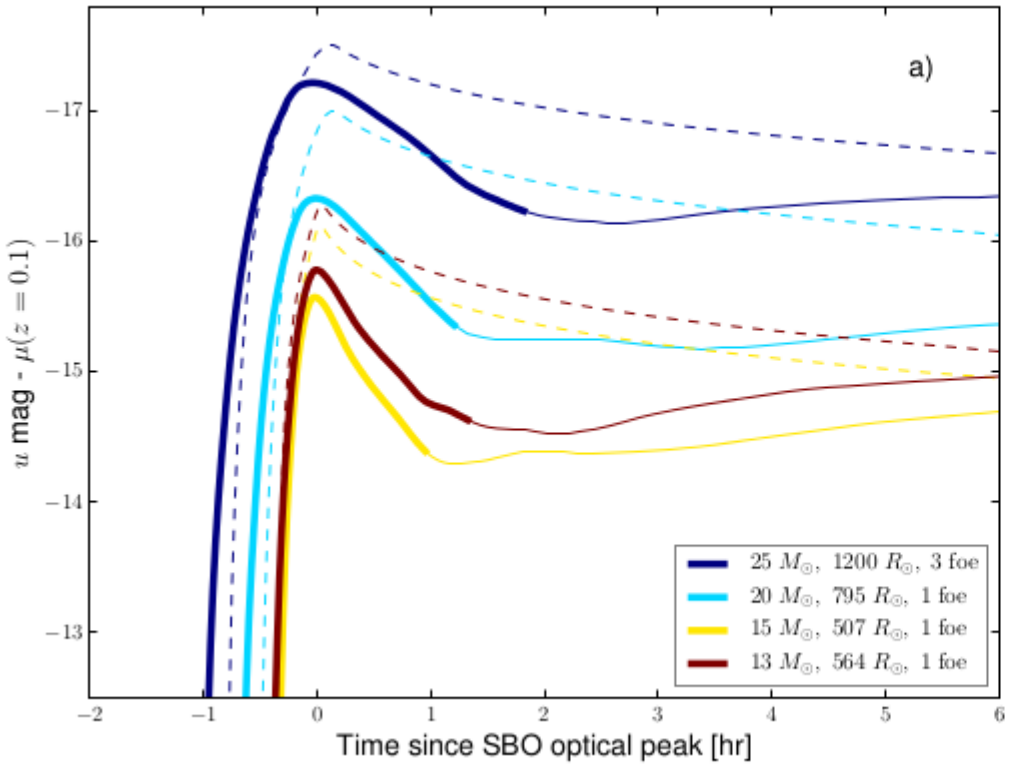


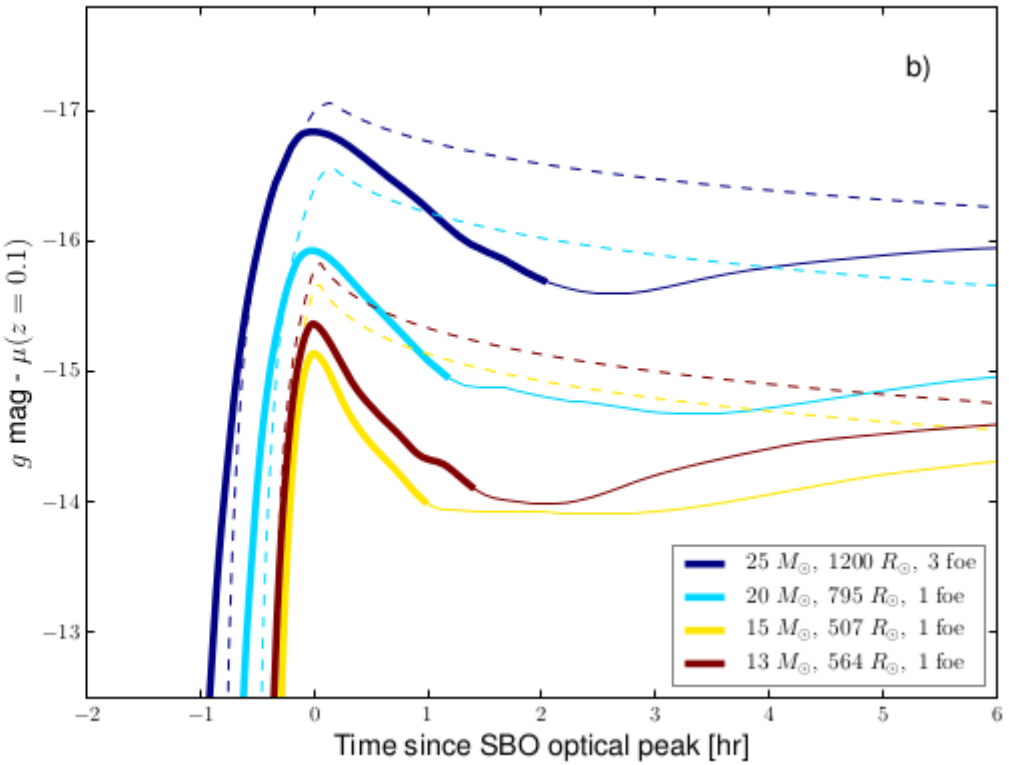
Tominaga et al. 2011, Moriya et al. 2011, Nakir & Sari 2010, Rabinak & Waxman 2011

Time evolution: ~ $R^{-0.6}$, ~ $E/M^{-0.06}$

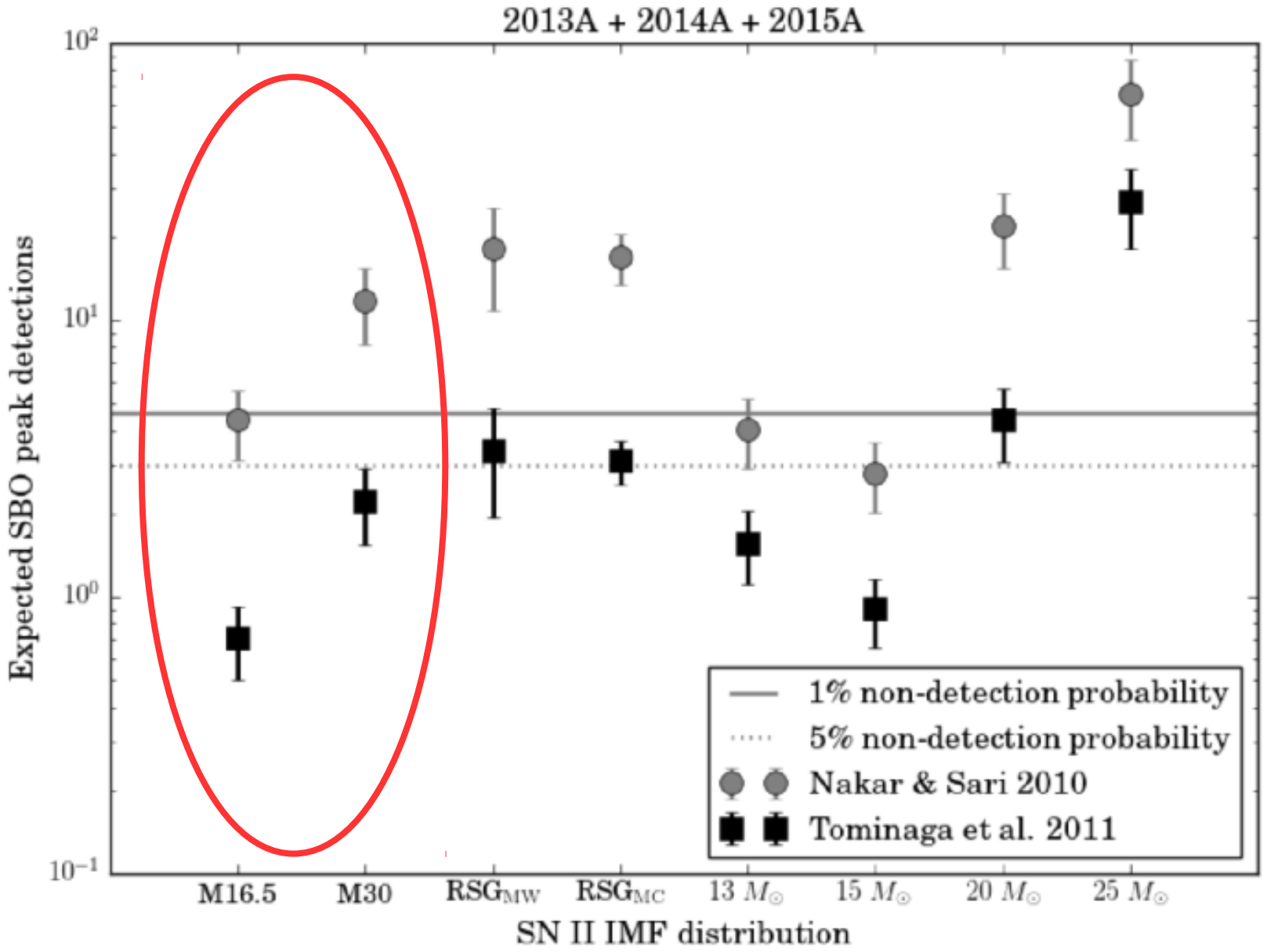
Brightness: ~ $R\ E/M$

Shock breakout:
Tominaga et al. 2011 vs Nakar & Sari



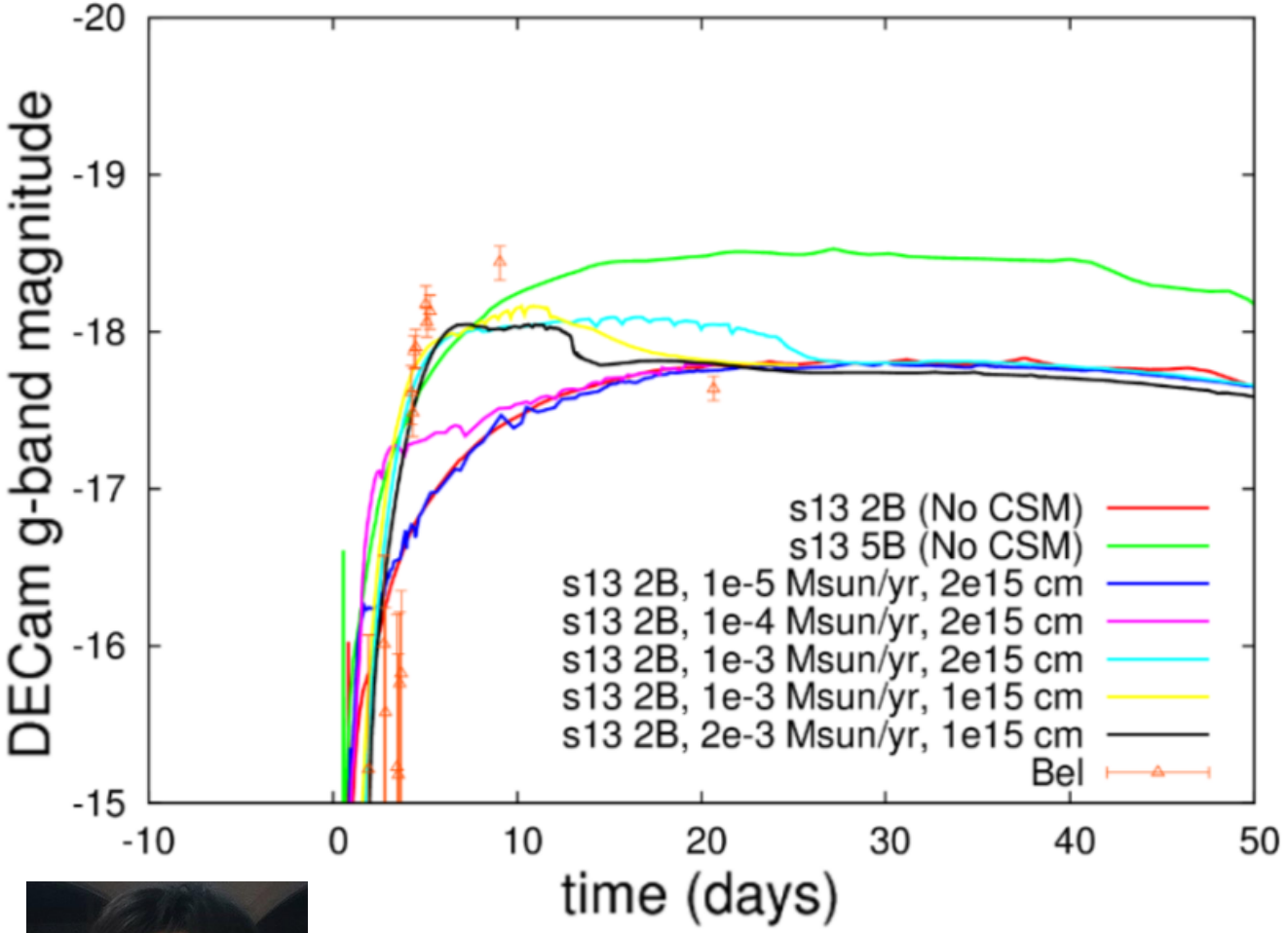


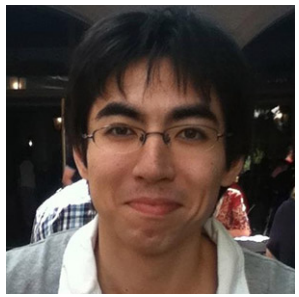
Shock breakout constraints



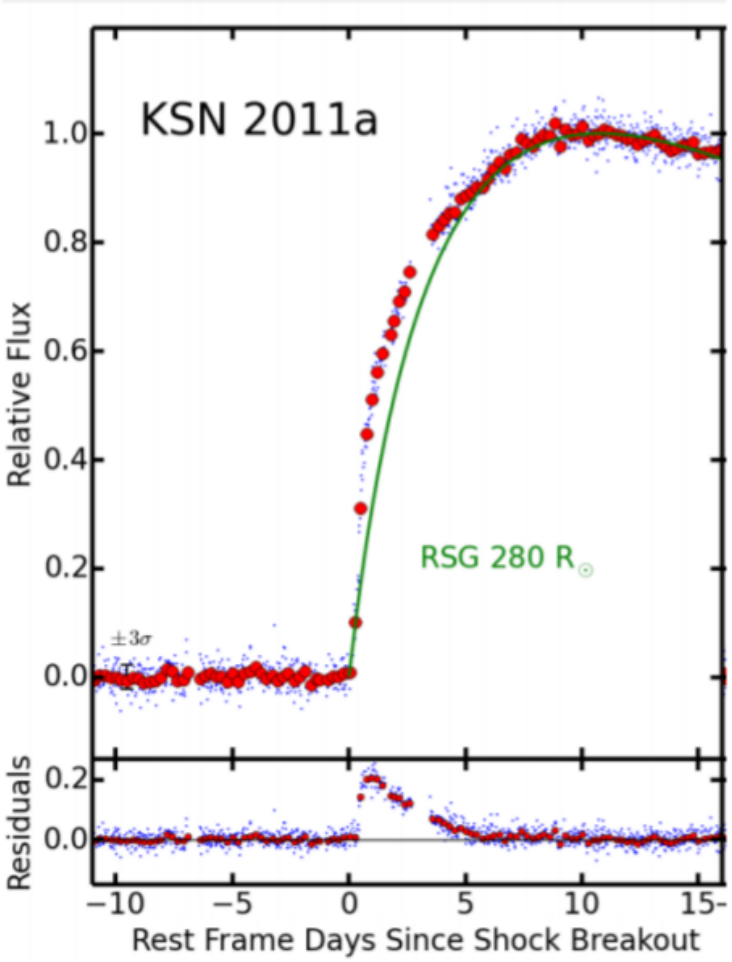
Förster et al., ApJ accepted, arXiv:1609.03567

Excess emission at early times: high density (confined) nearby CSM?





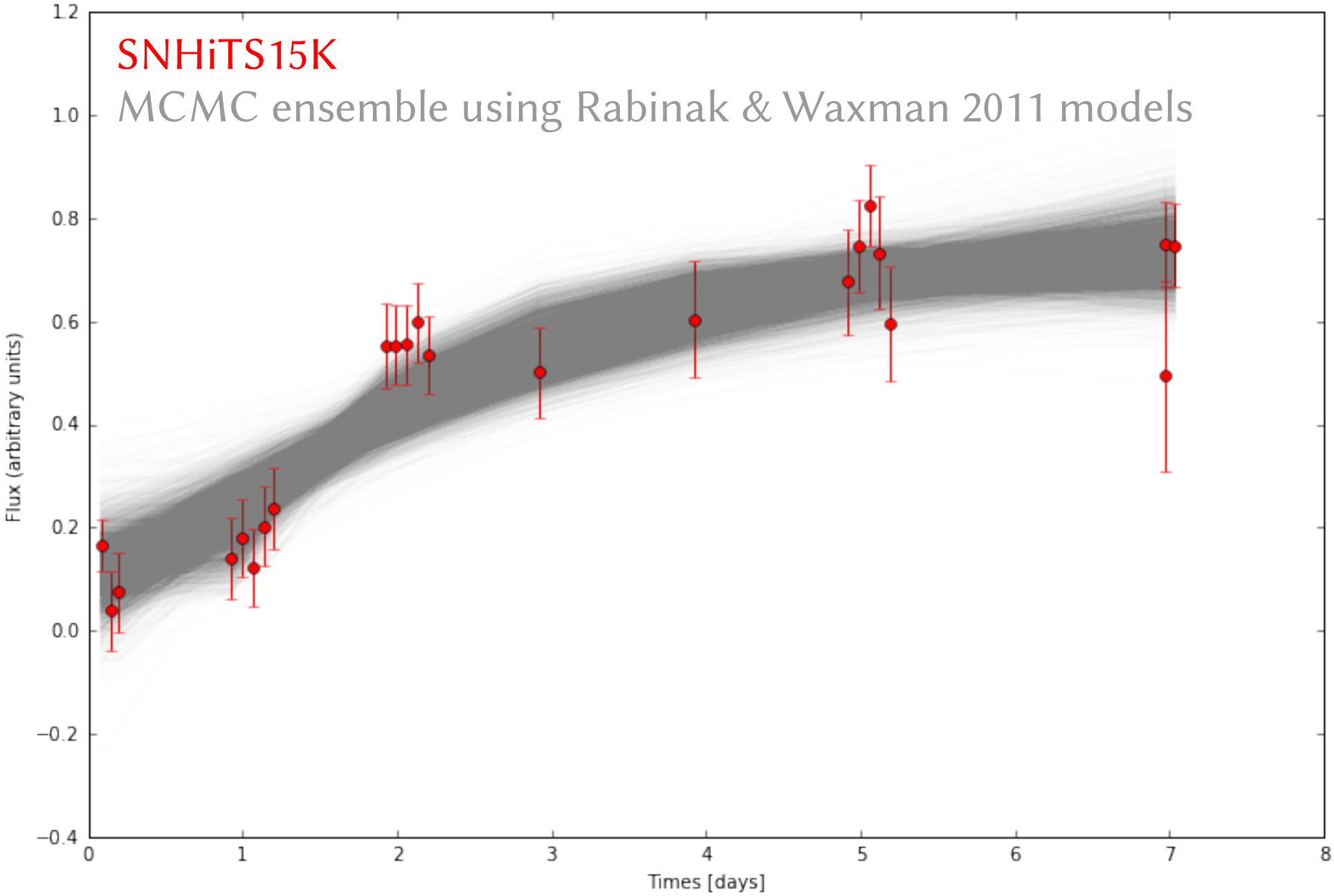
SNHiTS14B (Bel), models from T. Moriya
Confined mass loss ~10^{-3} Msun/yr



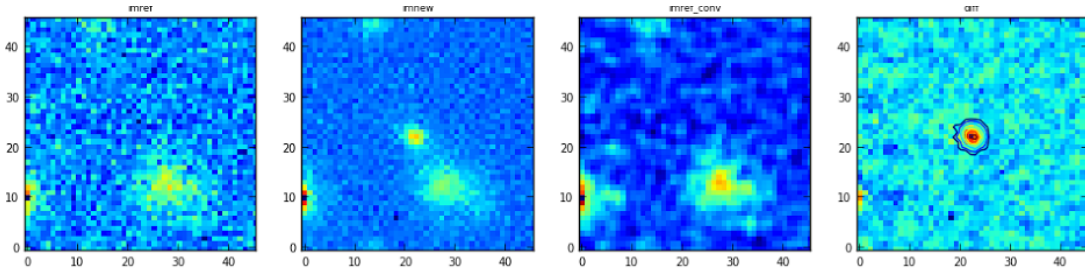
Garnavich et al. 2016
Mass loss ~10^{-4} Msun/yr

See also González-Gaitán 2015, Khazov et al. 2016

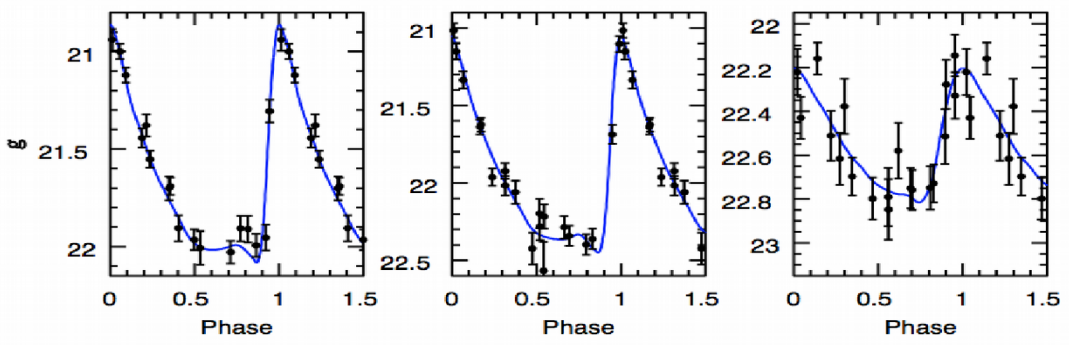
Excess emission at early times



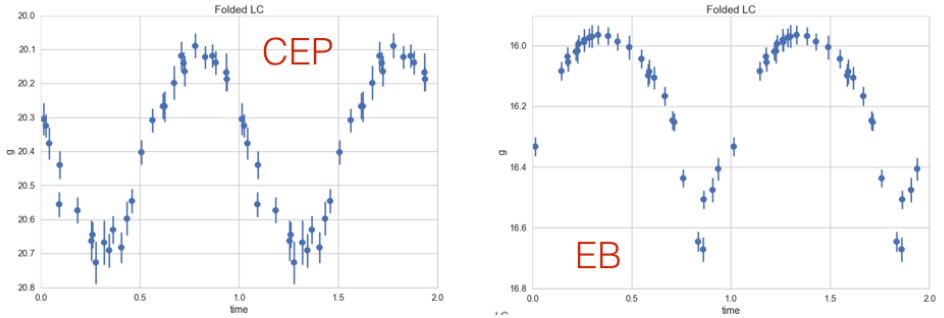
Other science



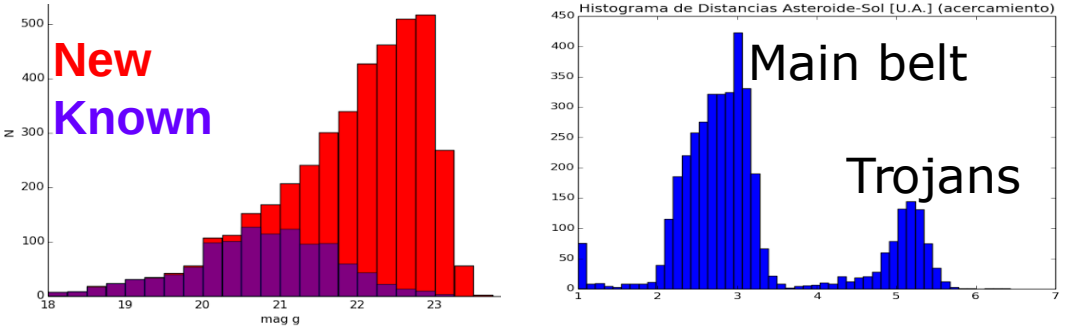
Alessandro Razza:
Combining Decam with other telescopes



Gustavo Medina:
Most distant RR Lyrae in the galaxy



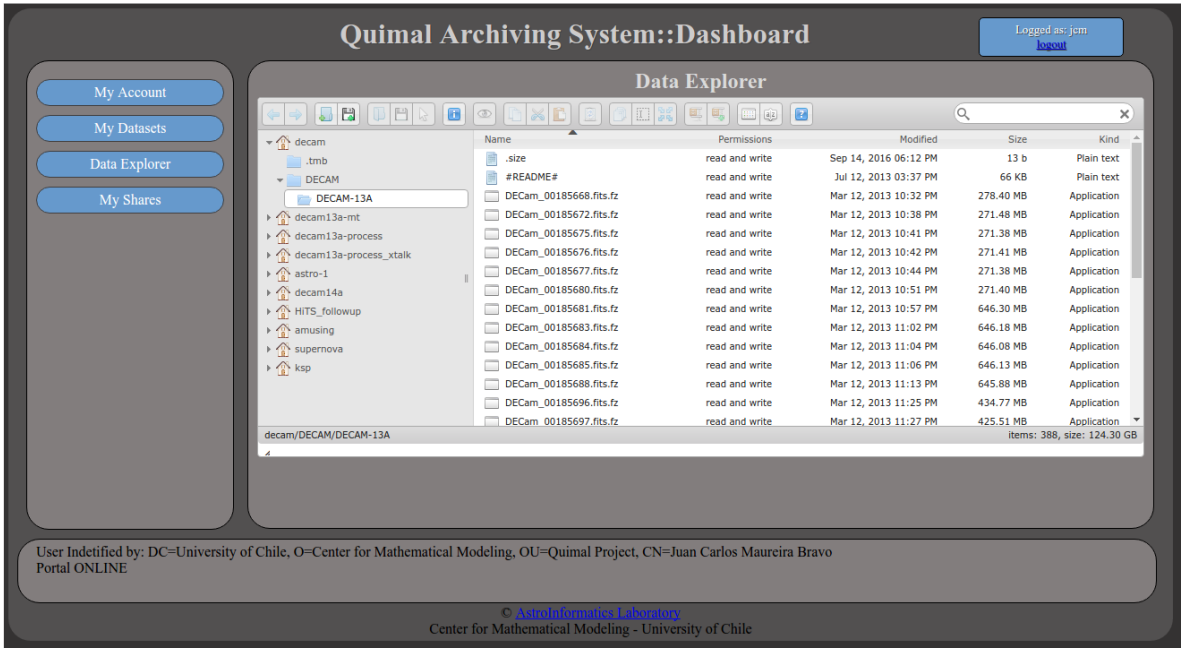
Jorge Martínez:
Classifying every transient object, astroinformatics

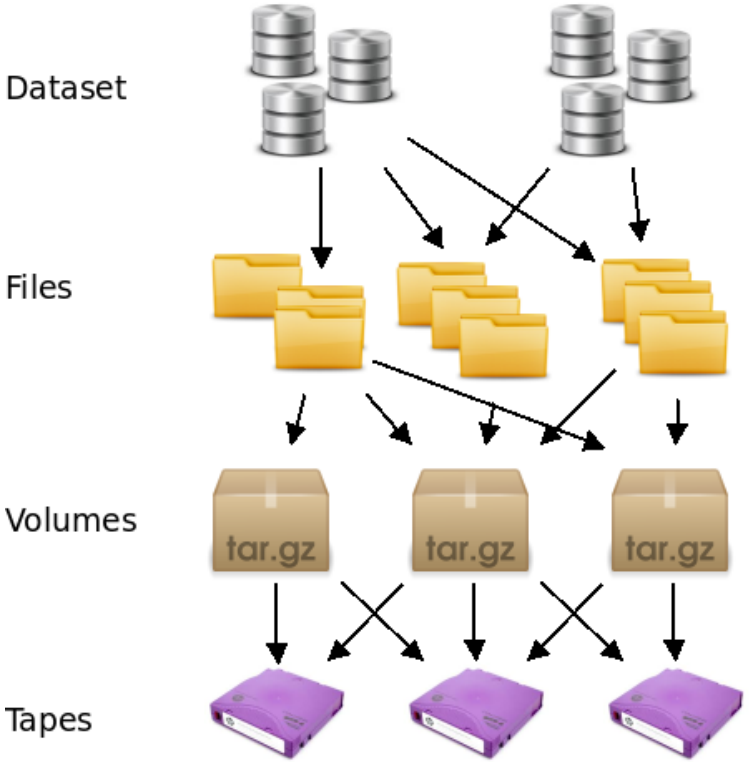


José Peña
Detecting and characterizing asteroids

Quimal archiving system

Juan Carlos Maureira





LTO6 – 2.5 TB raw, 6.25 TB 2:5:1 compression
LTFS – Linear Tape File system
PKI – Public Key Infrastructure

Summary

First real time high cadence survey with DECam (Mar 2014, Feb 2015)

No shock breakout (SBO) detections, but 100+ supernova candidates found, some during first days after shock emergence.

Tominaga et al. 2011 models cannot be rejected for the most likely SN IIP IMF distribution, Nakar & Sari 2010 can be marginally rejected.

Excess emission at early times seen in the data, high density confined CSM?
Study of excess emission in SN Ia in progress.

Analysis led to **modified exposure time calculator** including the effect of airmass (http://www.github.com/fforster/HiTS-public)

HiTS public catalogue 2017 (calibrations!). Many astronomical applications.

Future: physical params. from early light curves. One day cadence + multicolor strategy


ありがとうございますいます