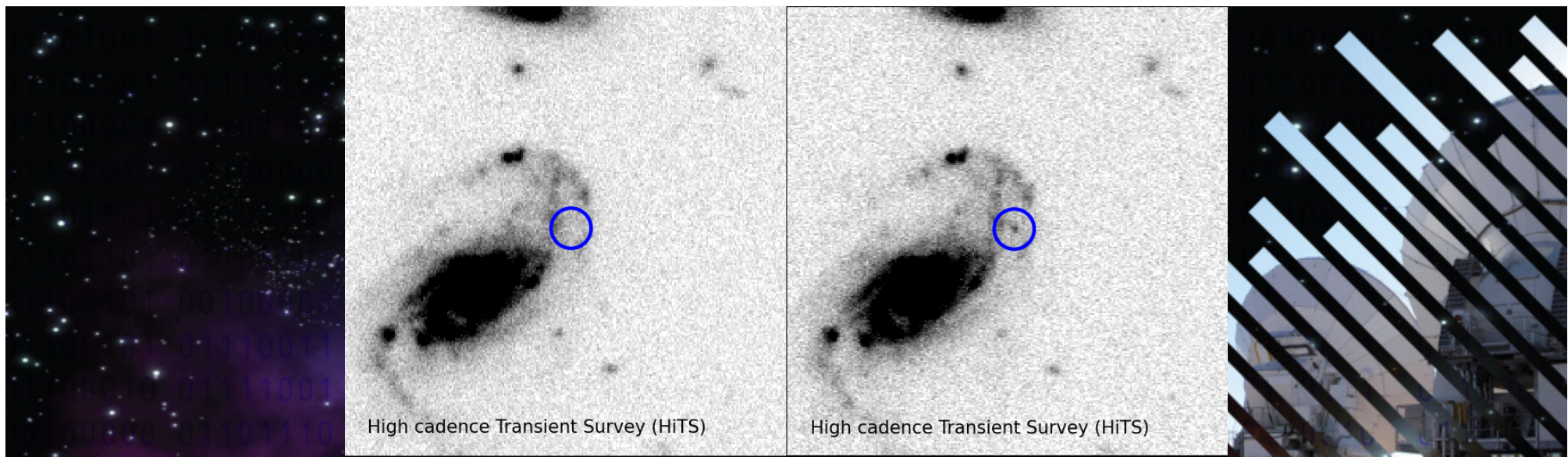
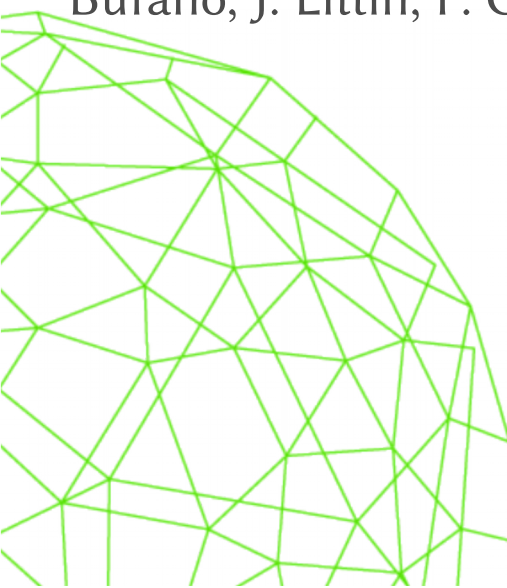




The High cadence Transient Survey (HiTS)

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



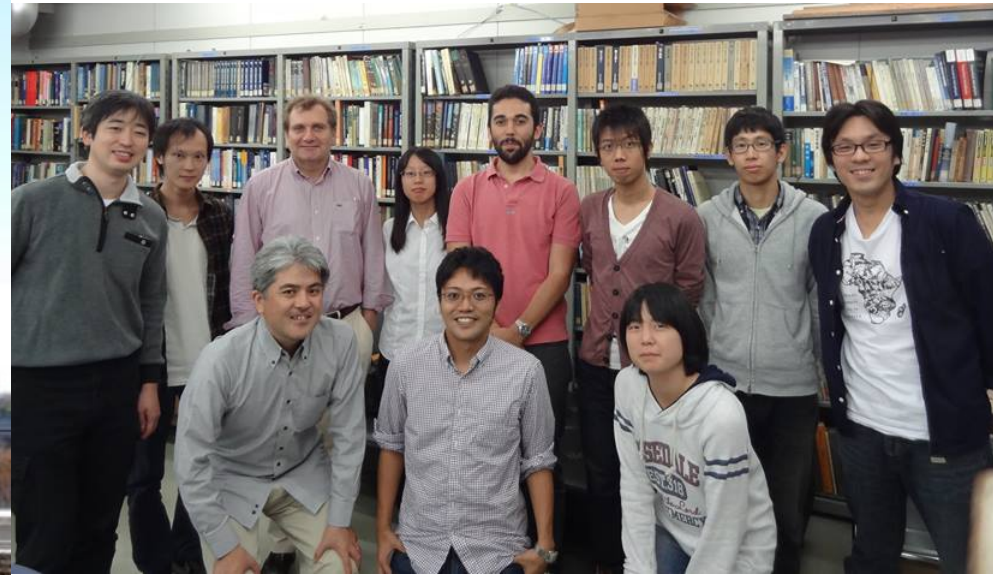
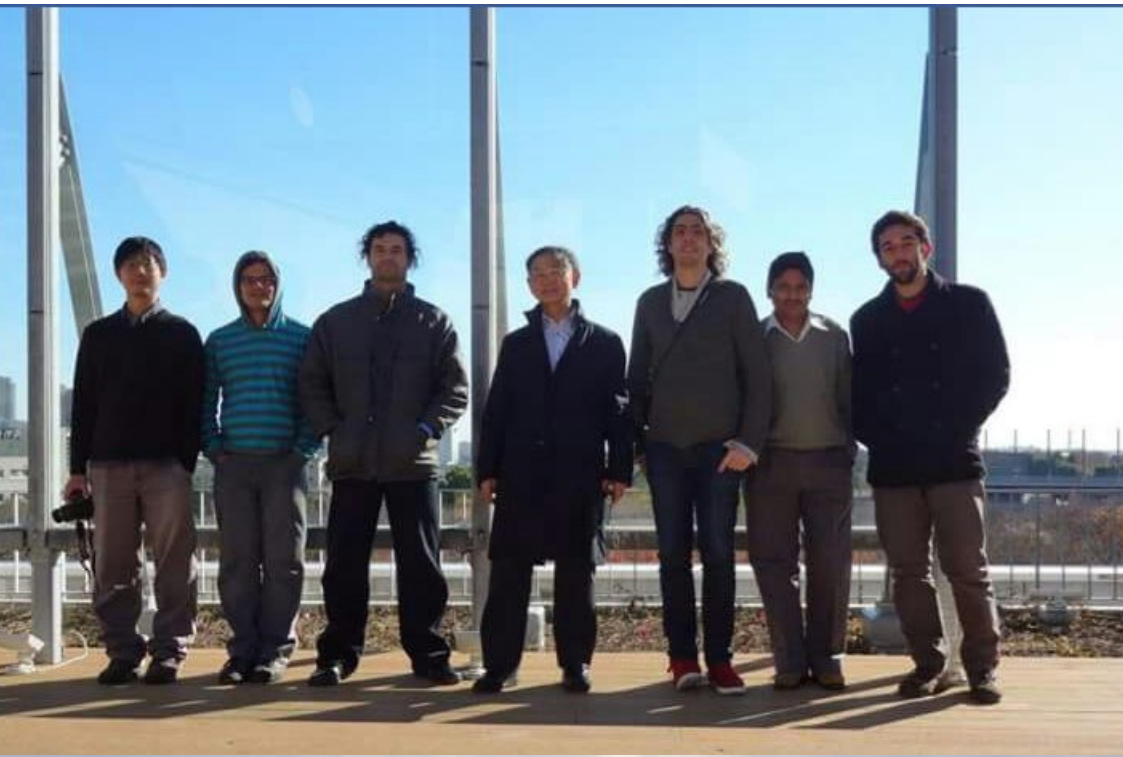
CMM
Center for
Mathematical
Modeling

 **NLHPC**
National Laboratory
for High Performance
Computing
Chile

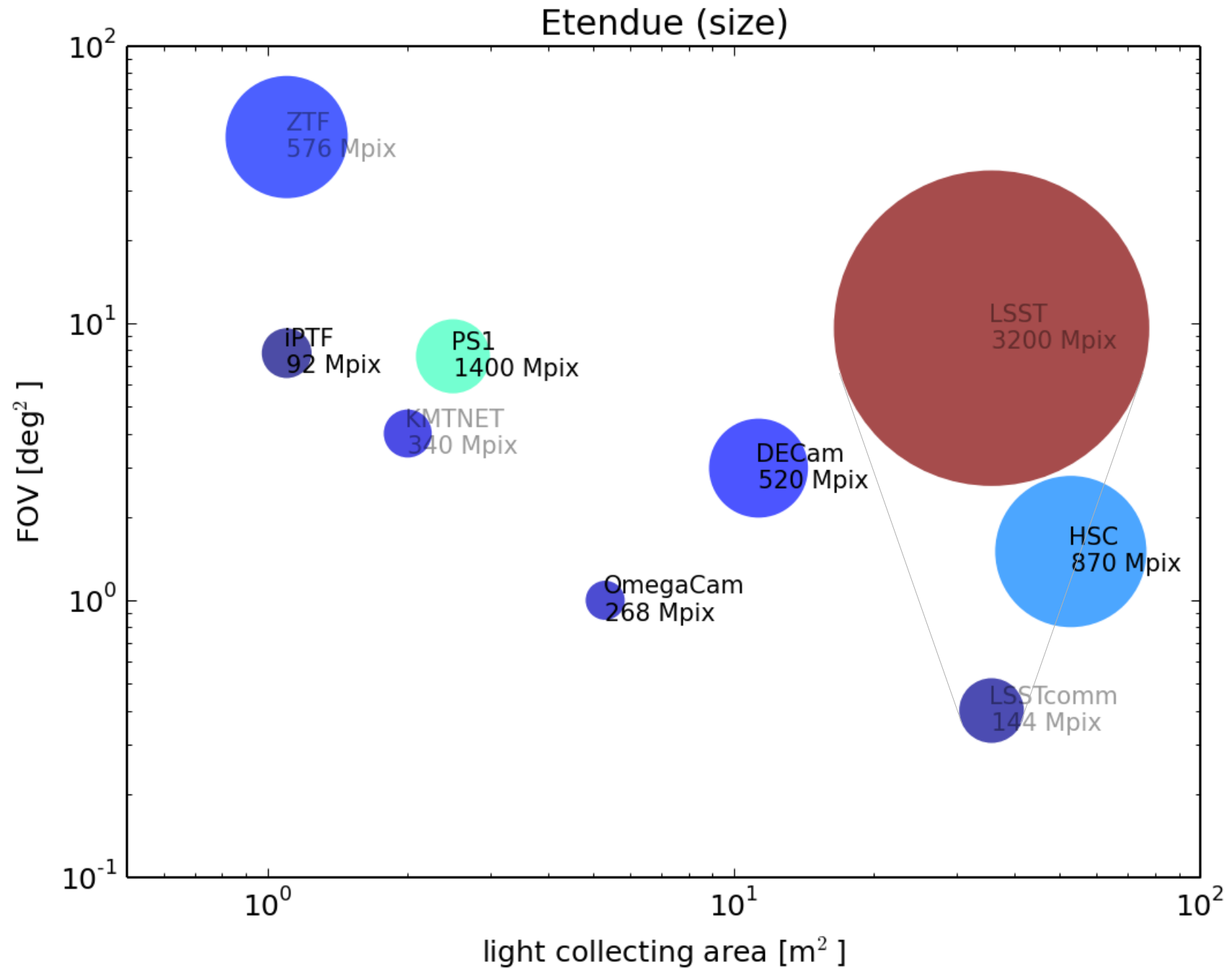

MILLENNIUM
INSTITUTE OF
ASTROPHYSICS

 **CONICYT**
Ministerio de
Educación

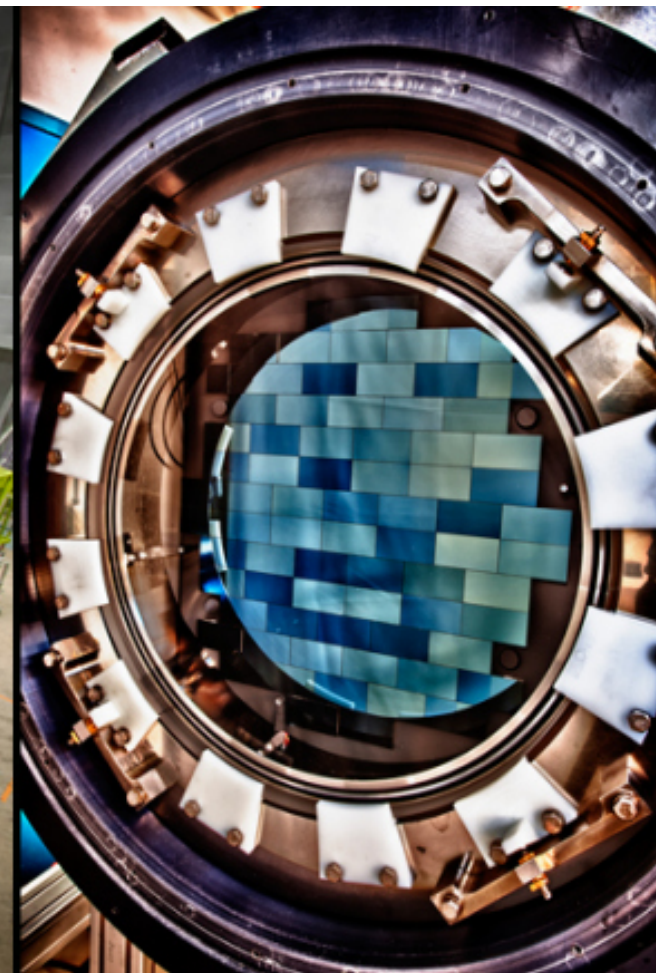
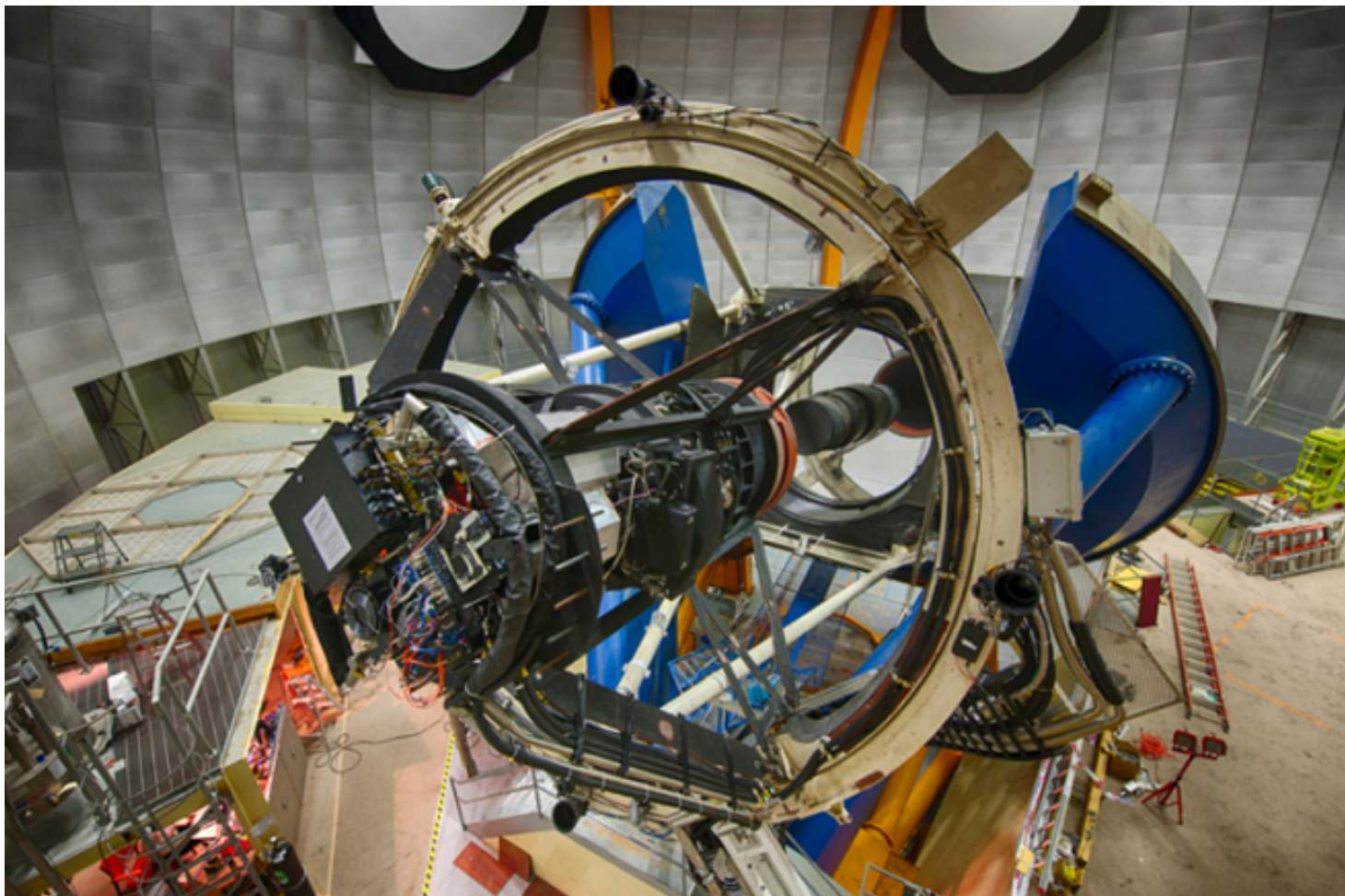
Gobierno de Chile



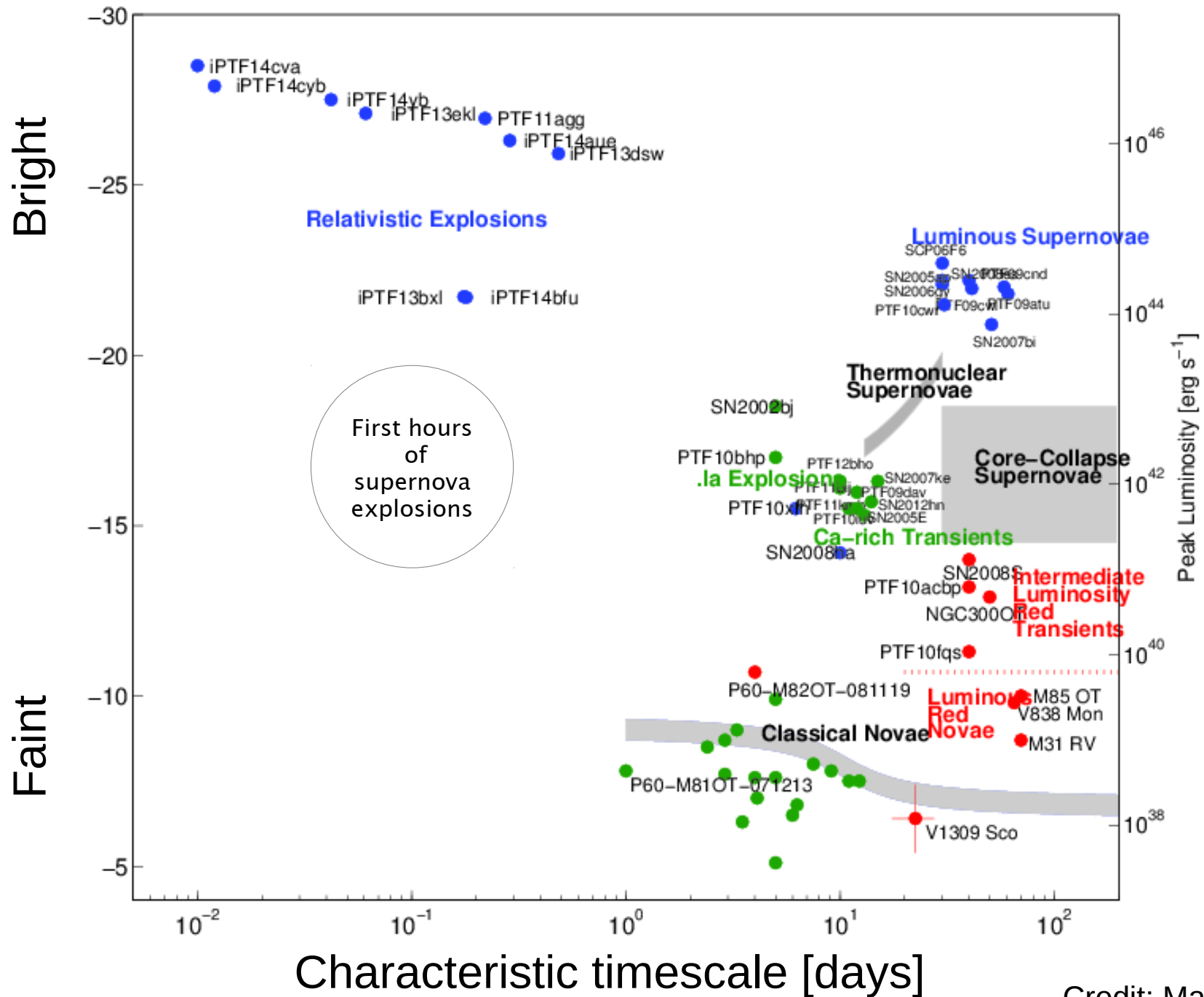
Etendue and number of pixels



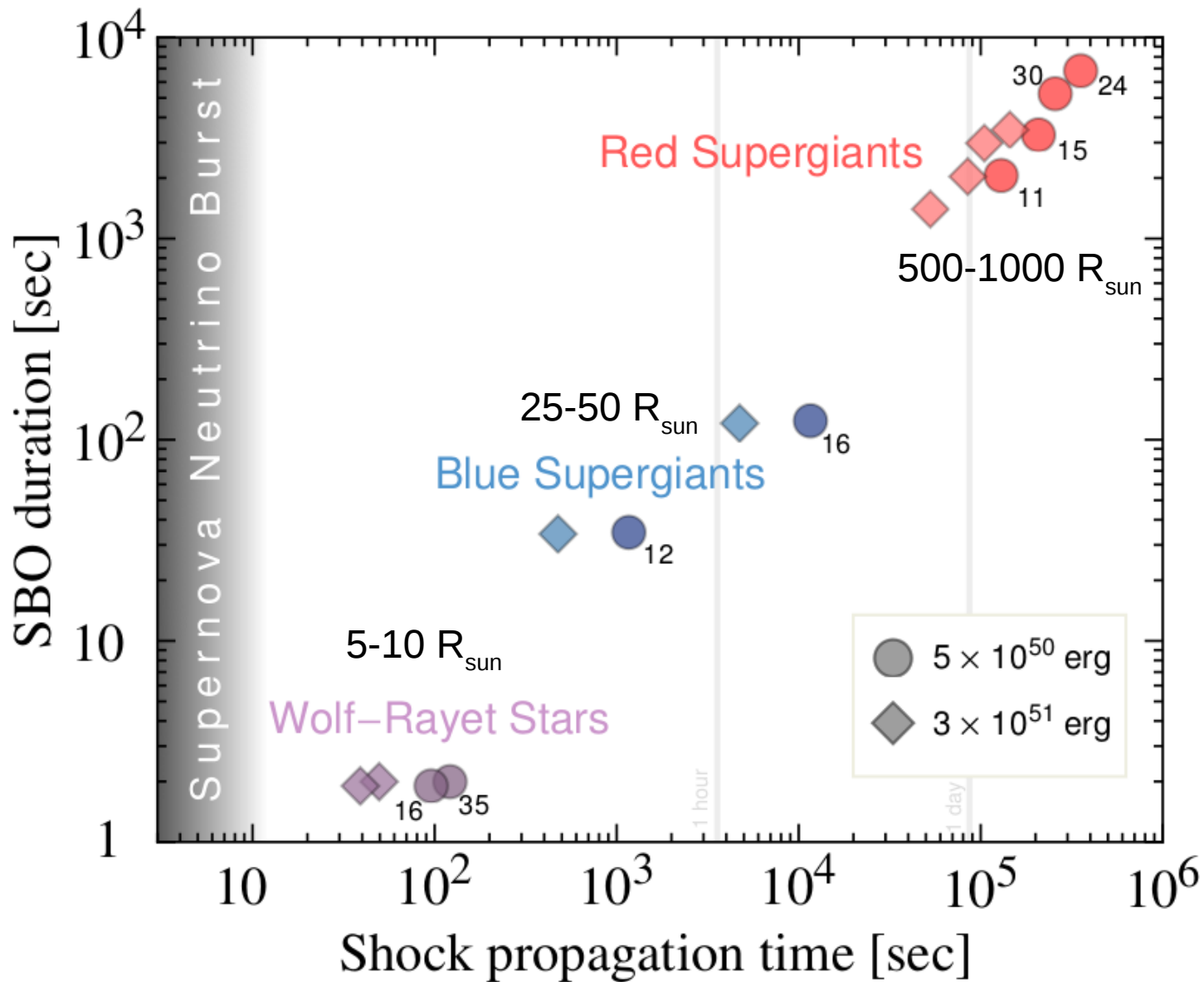
Dark Energy Camera (DECam)



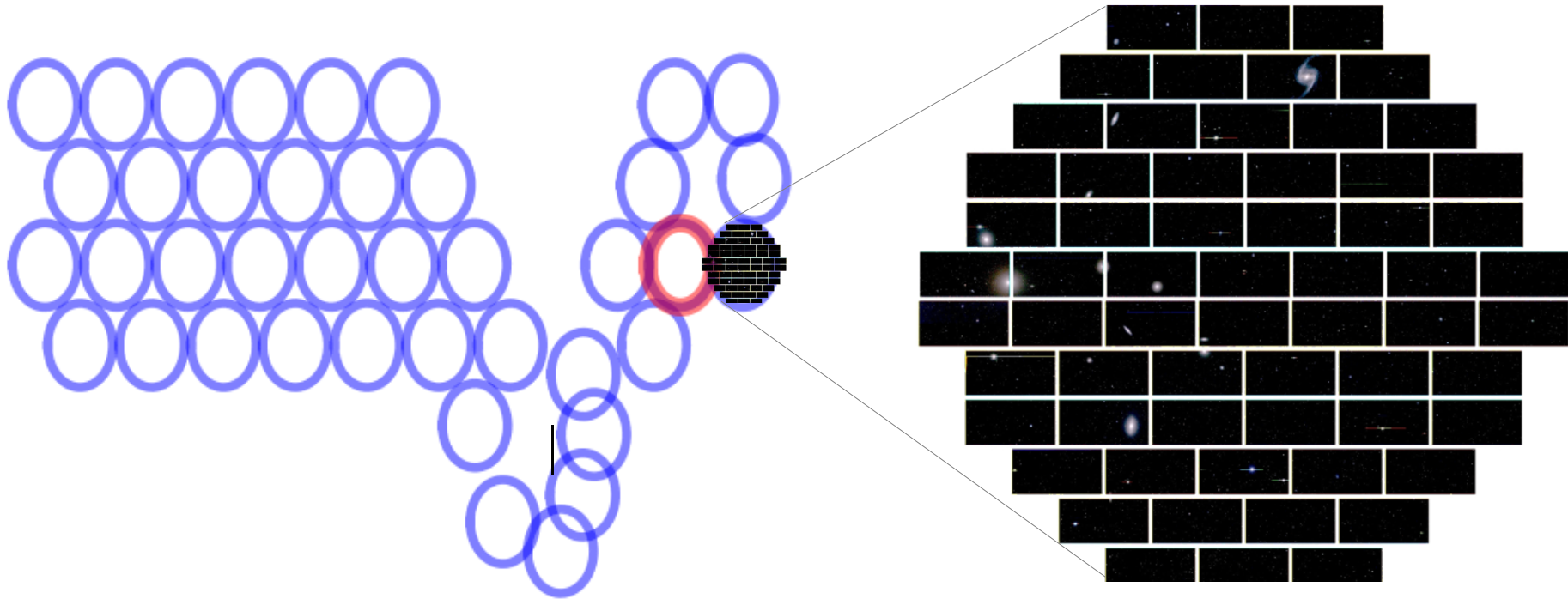
The sky is not static!

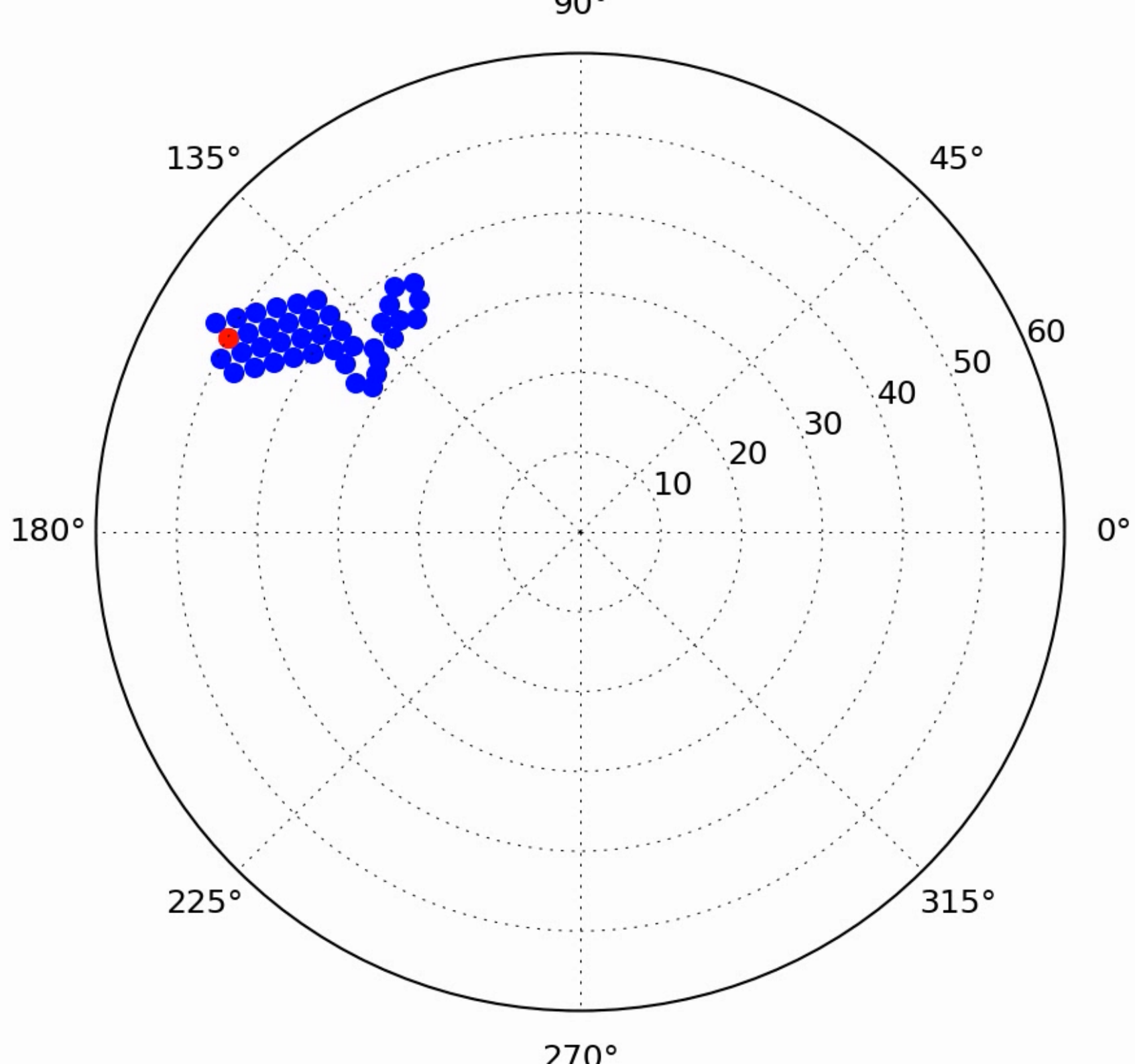


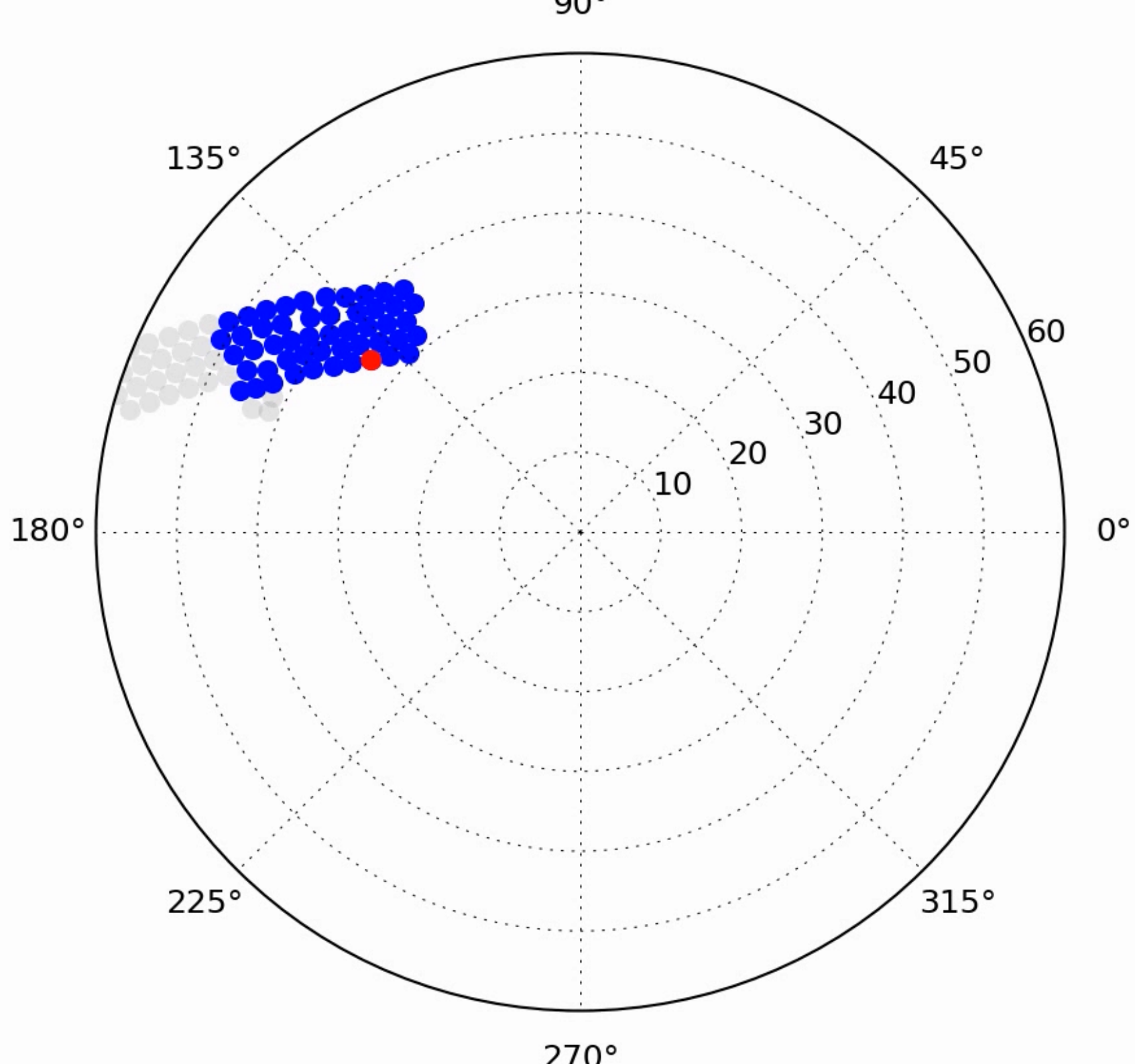
Supernova shock breakout (SBO) timescales

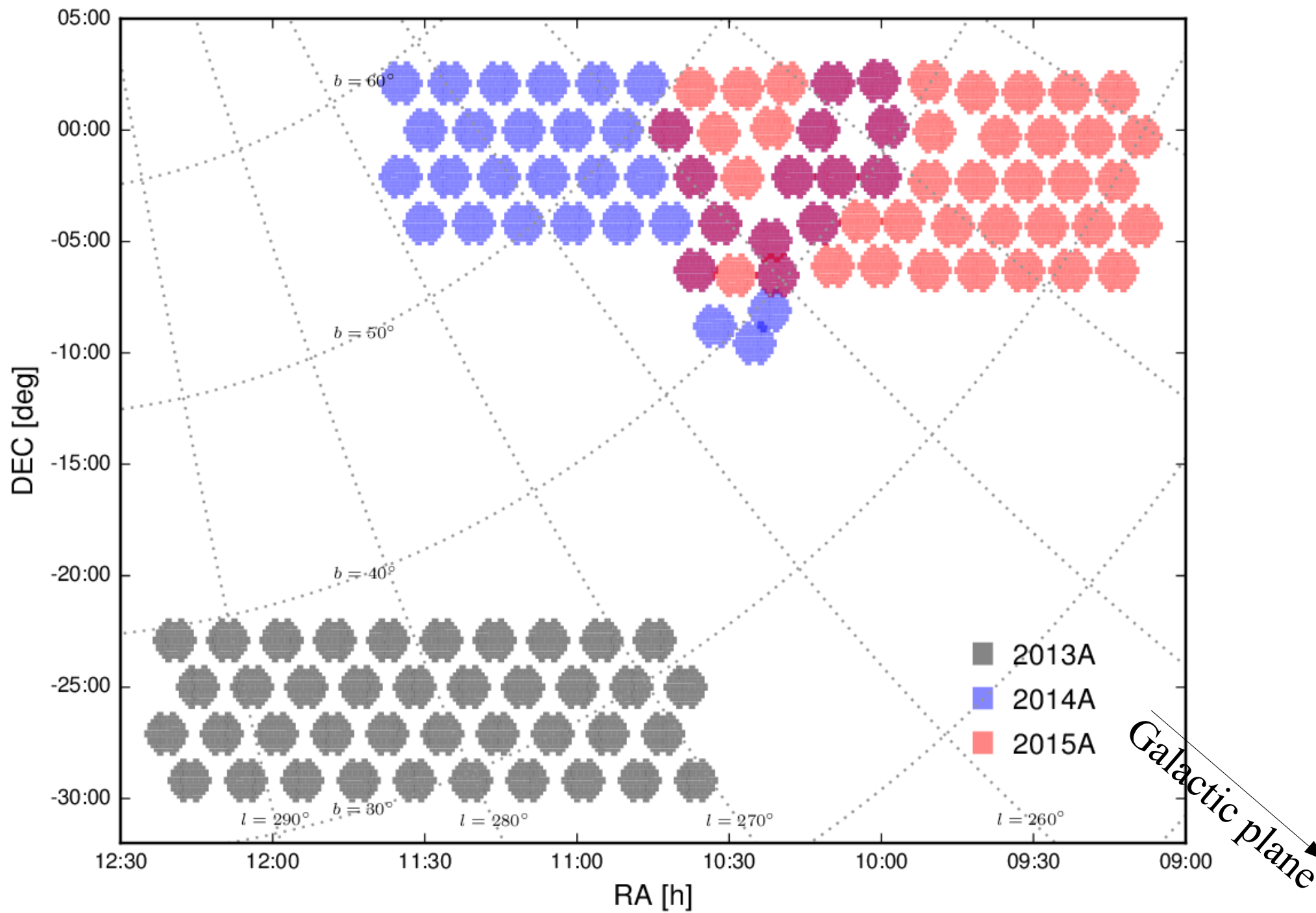


HiTS: searching for shock breakouts in the optical

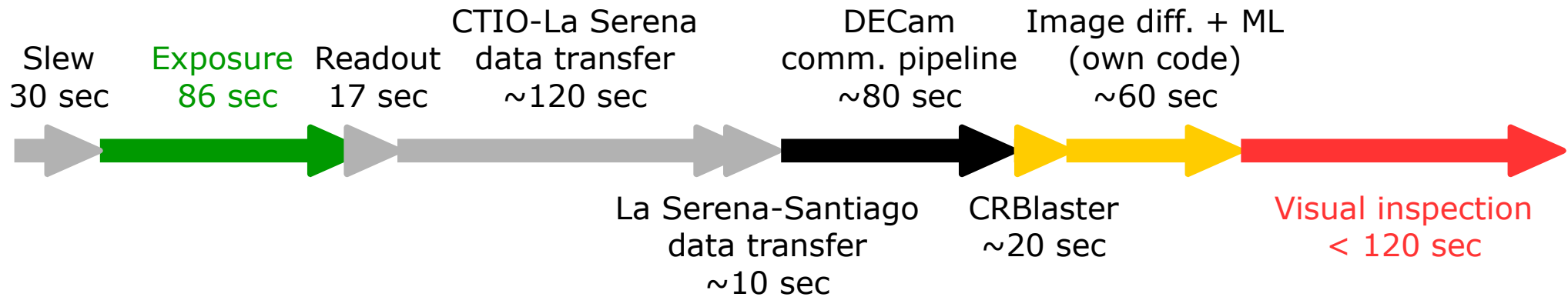








Pipeline flow outline



~5-6 min lag

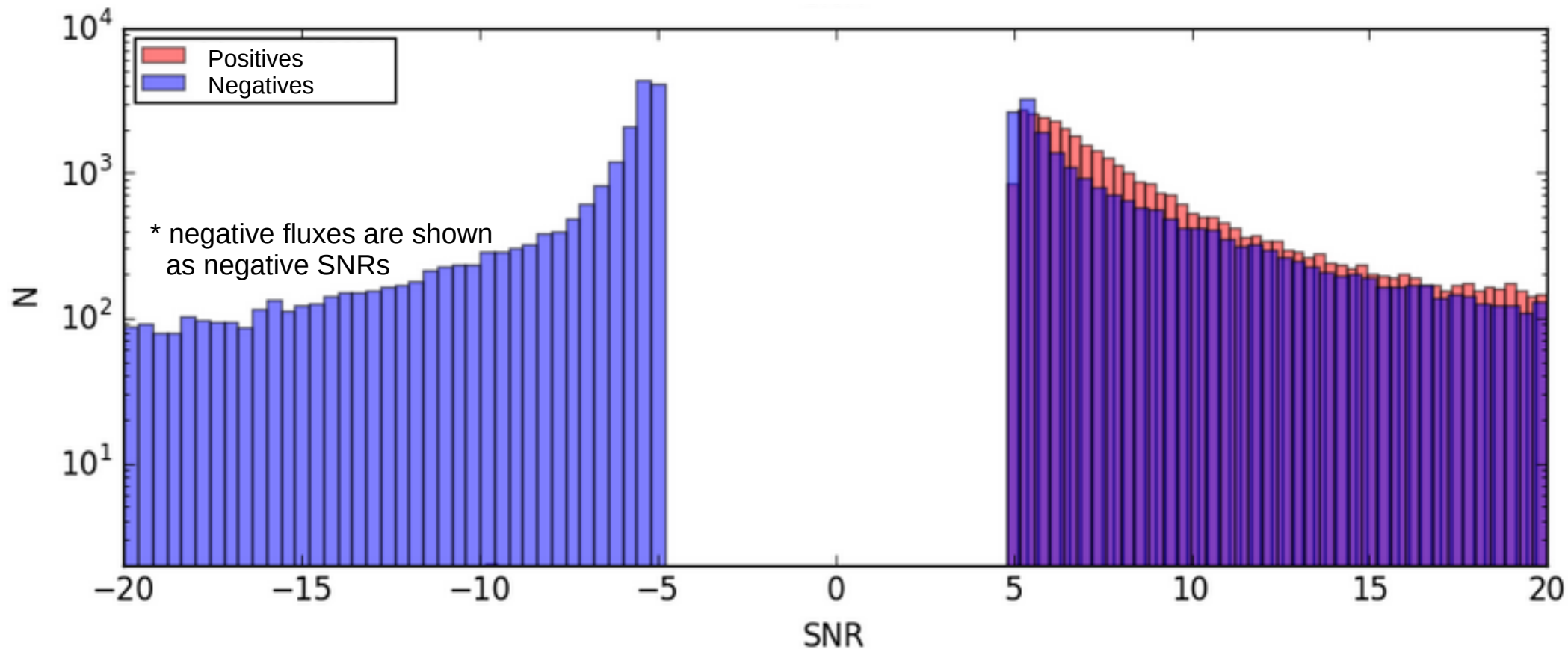


Data stream: 44 Mbps, 4.5 Mpix/s

$\sim 10^{12}$ pixels, $\sim 10^8$ candidates, $\sim 10^6$ filtered candidates

$\sim 10^4$ 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.

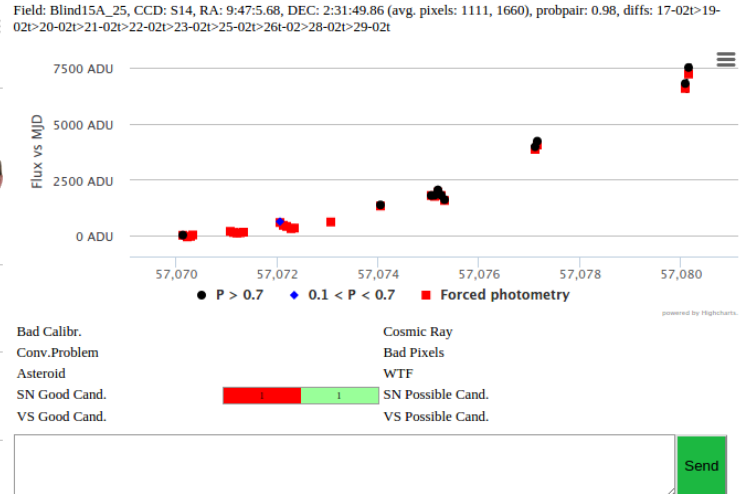
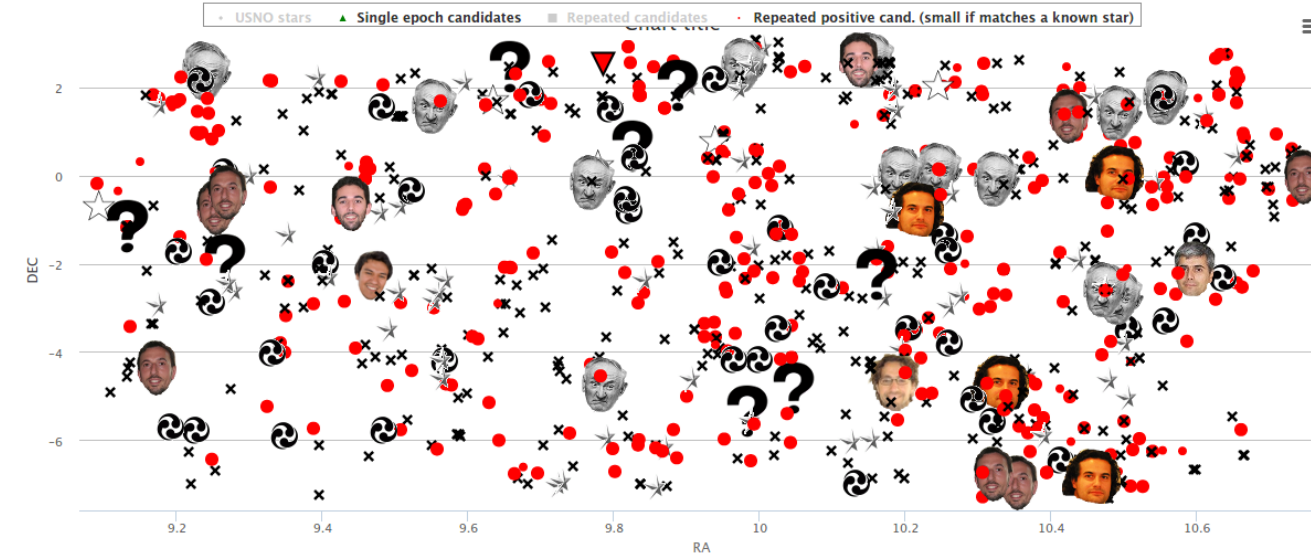
Use dimensionless features for a more *universal* classifier: based on **difference image (+ PSF)**, **SNR image of the difference**, **unsubtracted image stamps**, **density of candidates**

Visualization

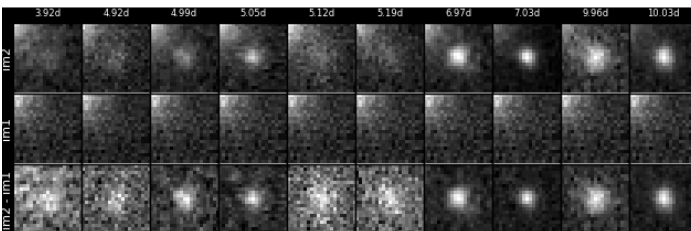
1 Tpix after image subtraction and machine learning

Semester: **Blind15A** Field: **all** CCD: **all** Reference epoch: **02** Threshold: **0.85** [getData!!!](#)

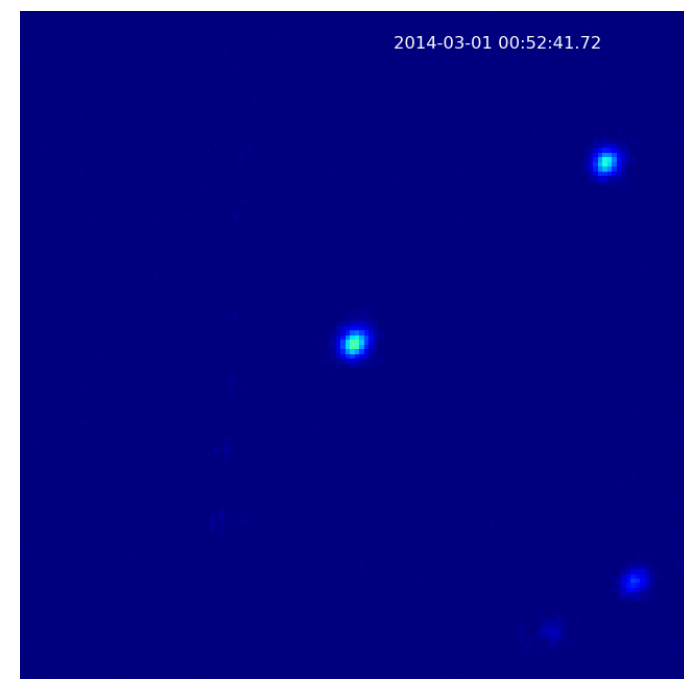
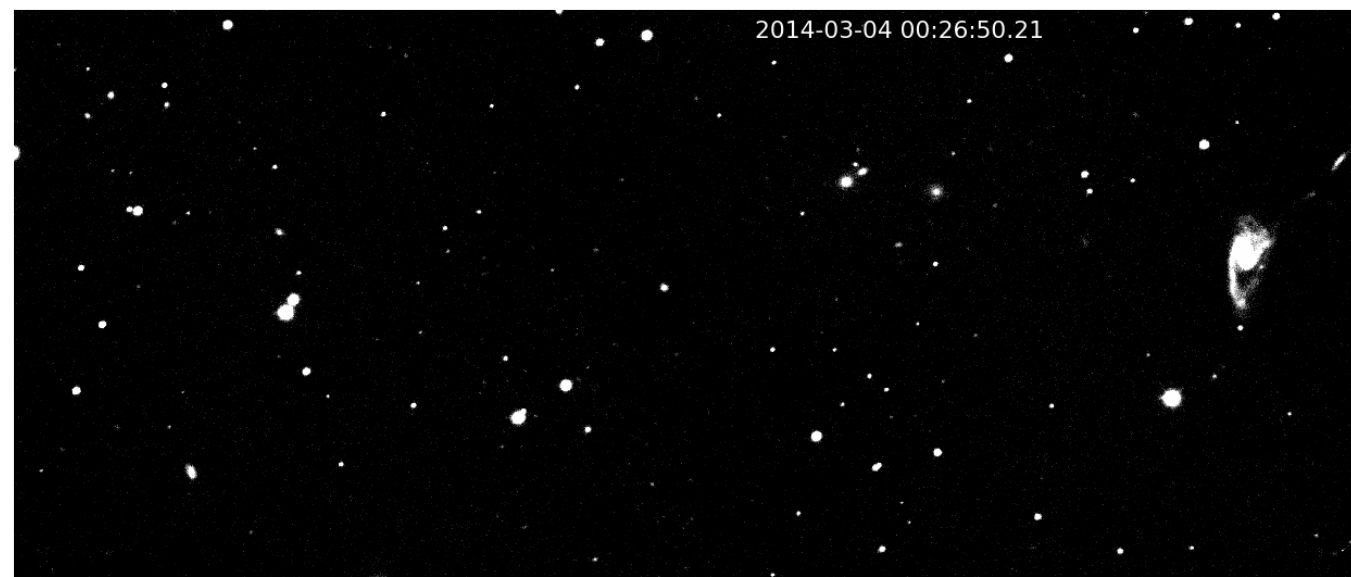
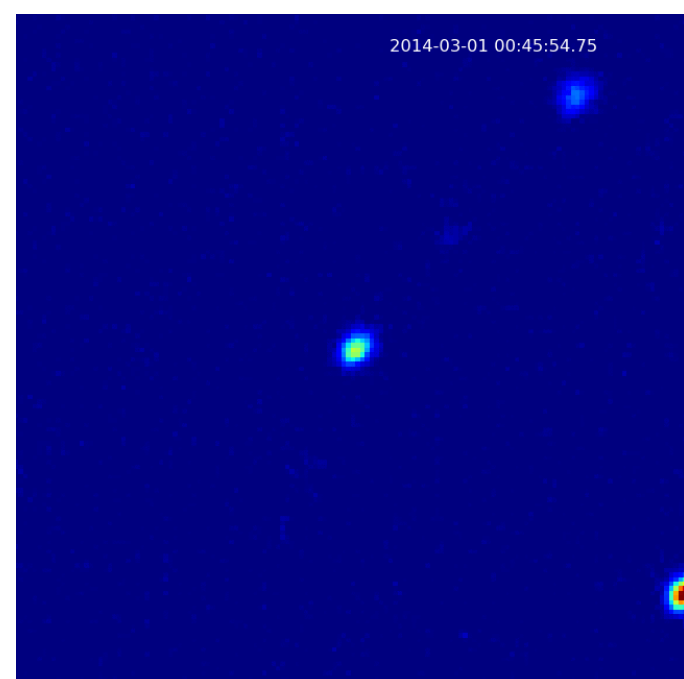
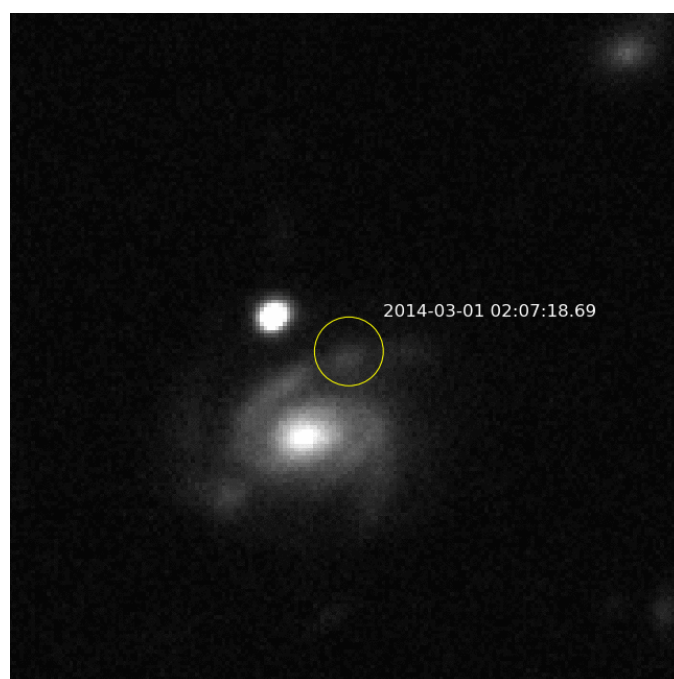
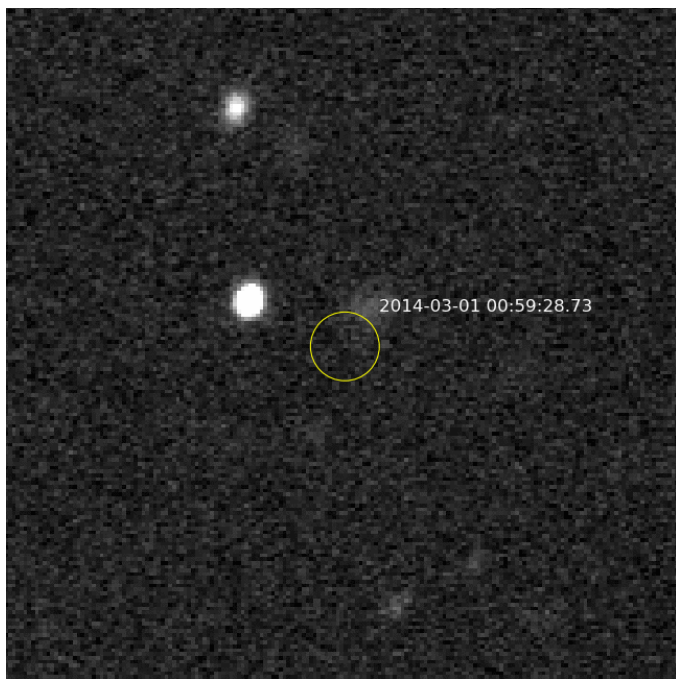
Observer : FF - [Logout](#)



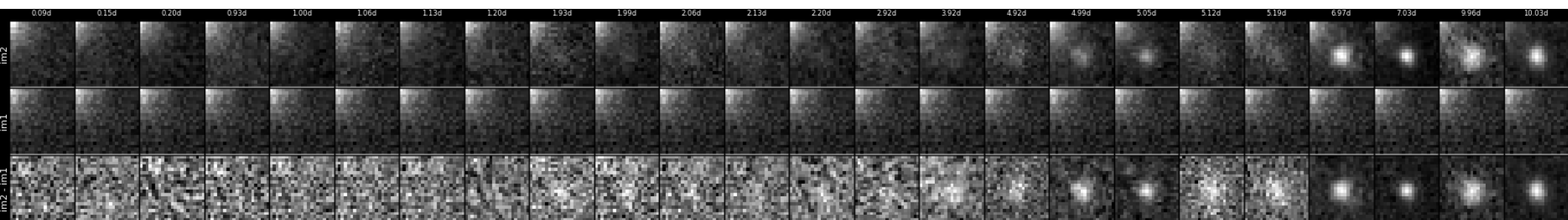
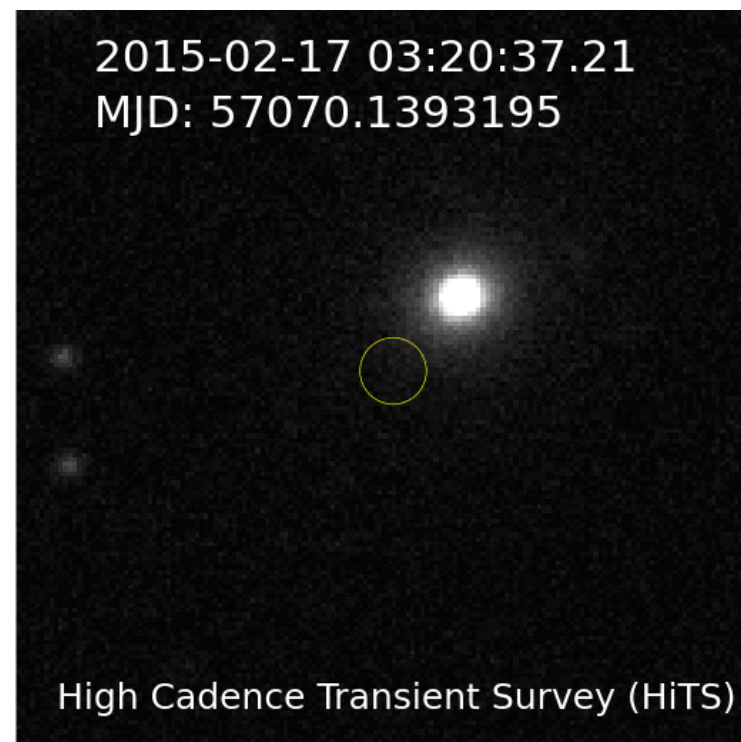
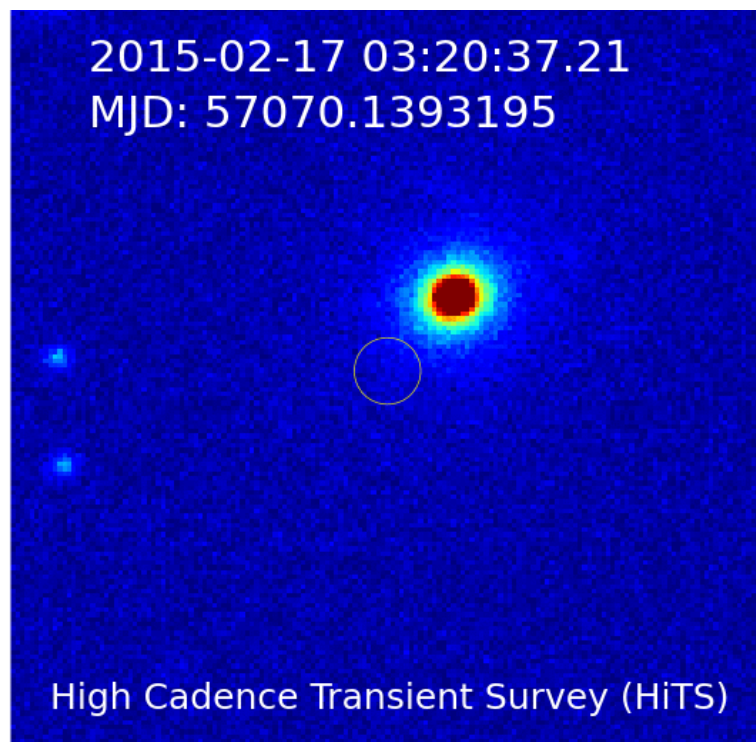
Field: Blind15A_25, CCD: S14, RA: 9:47:5.68, DEC: 2:31:49.86 (pixels: 1111, 1660).. Diffs: 17-02t>19-02t>20-02t>21-02t>22-02t>23-02t>25-02t>26t-02>28-02t>29-02t. Key :146.774:2.531, [Light curve, animation and finding chart](#)



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

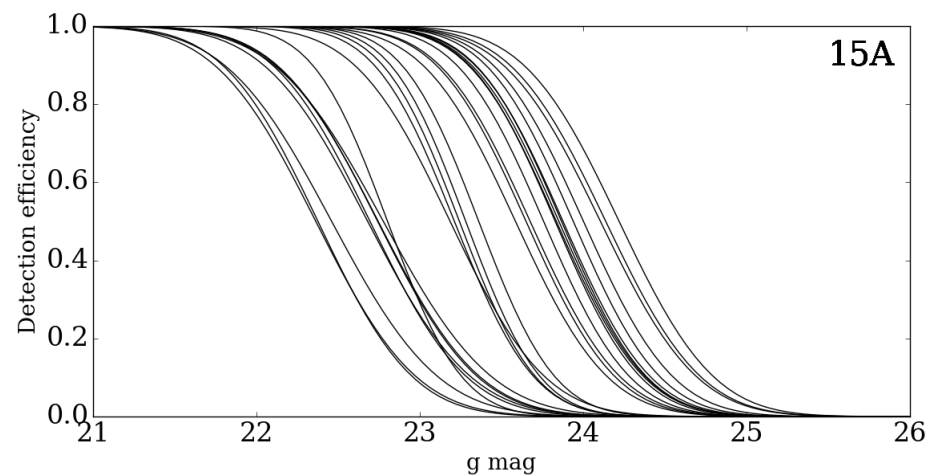
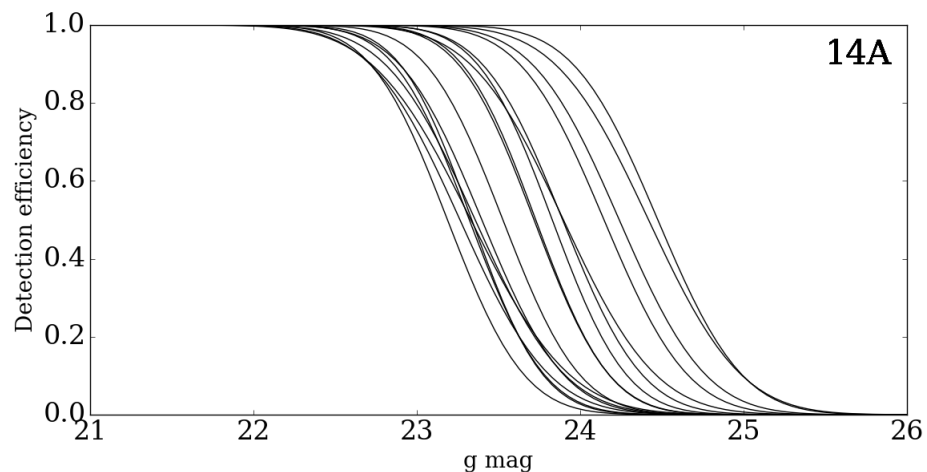
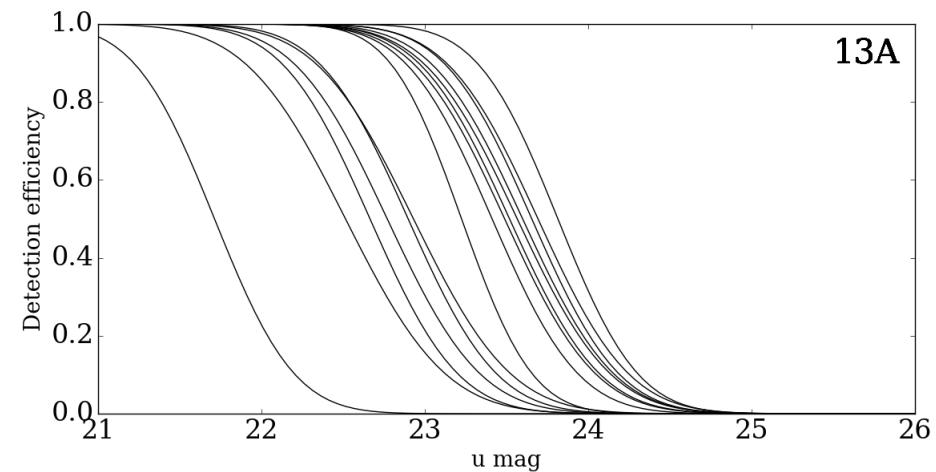
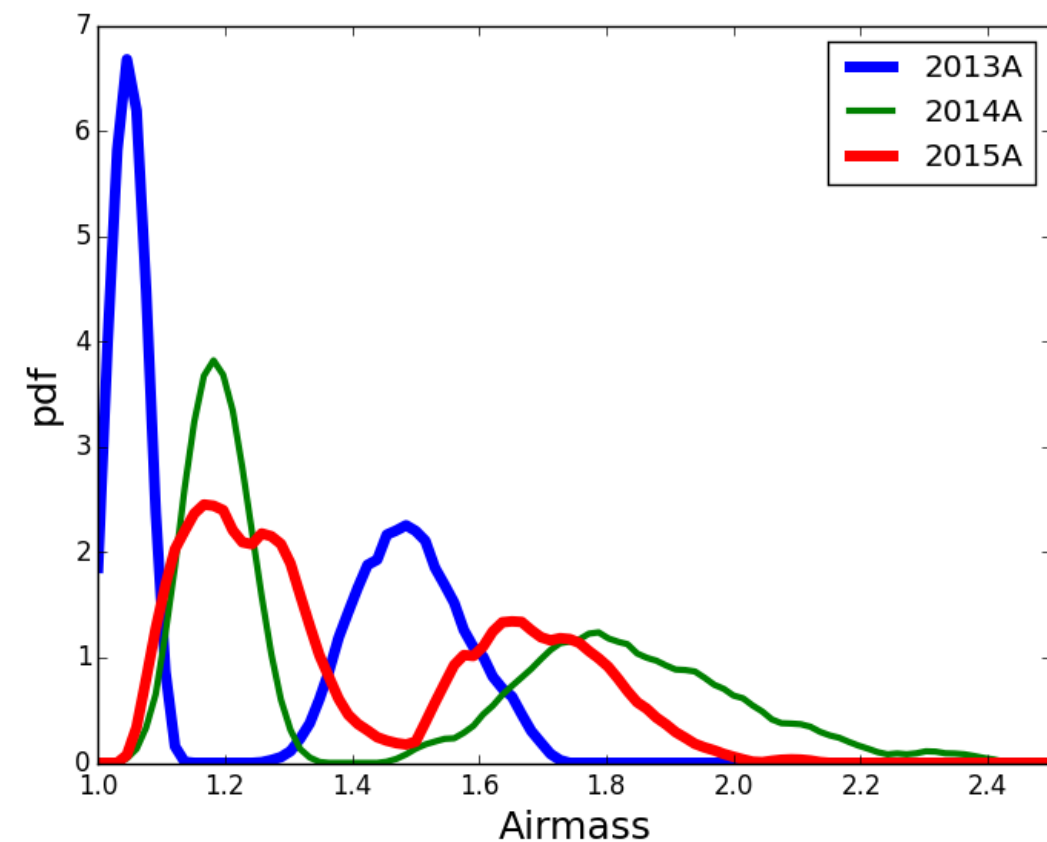


ATELs 5949, 5956



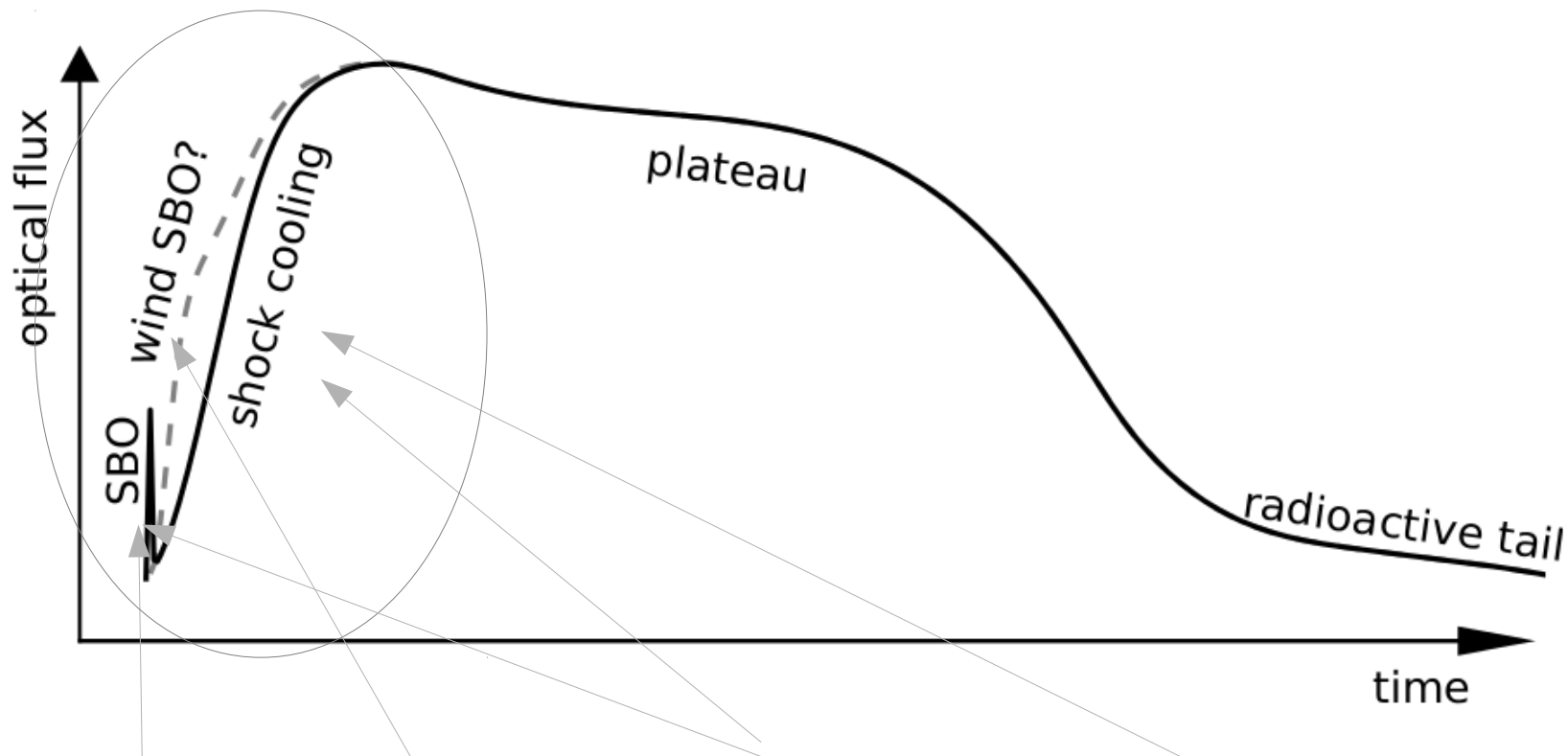
ATELs 7099, 7108, 7115, 7122, 7131, 7146, 7148, 7149

Airmass distribution and survey depth



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

Optical evolution of red supergiant supernova

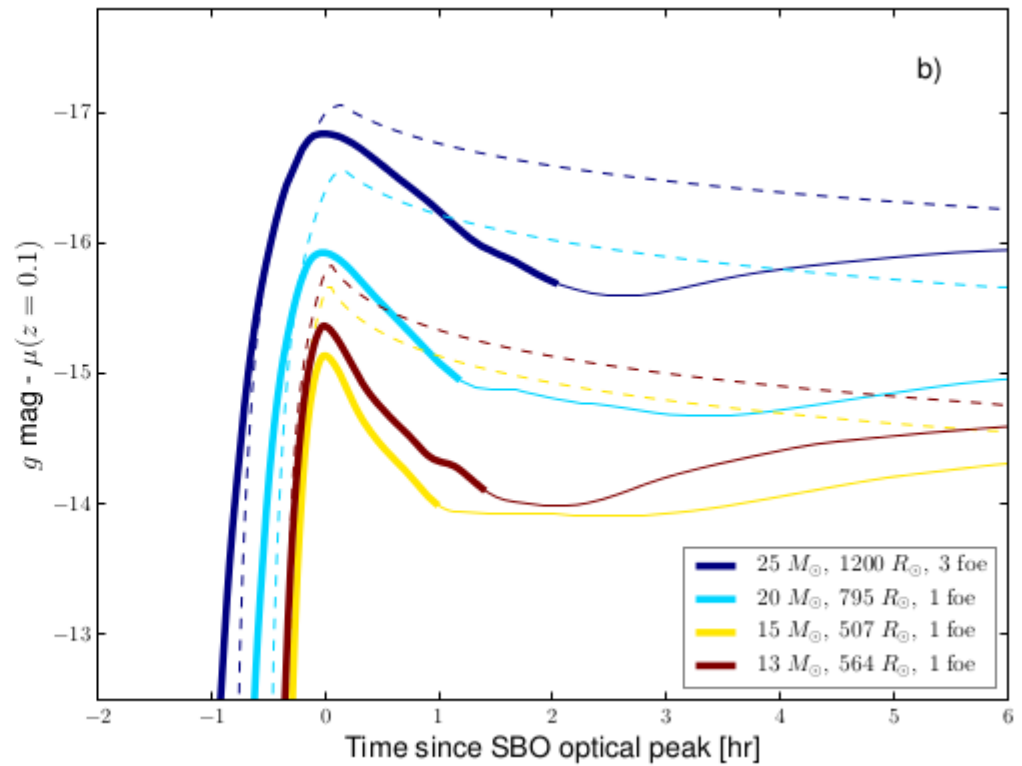
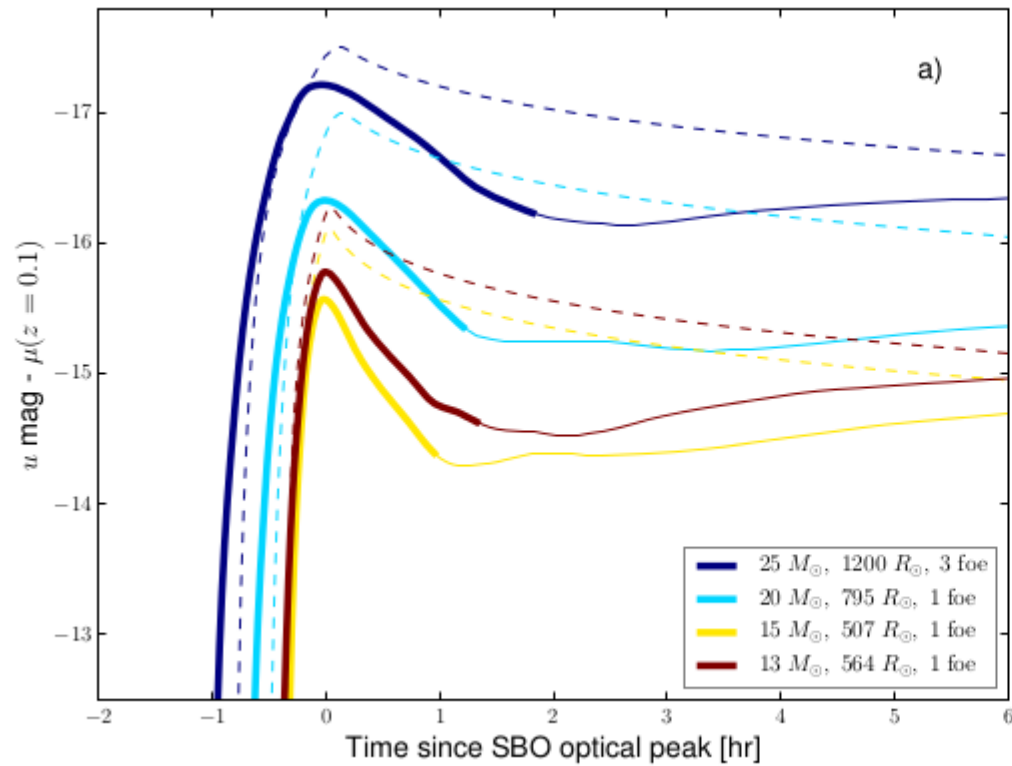


Tominaga et al. 2011, Moriya et al. 2011, Nakir & Sari 2010, Rabinak & Waxman 2011

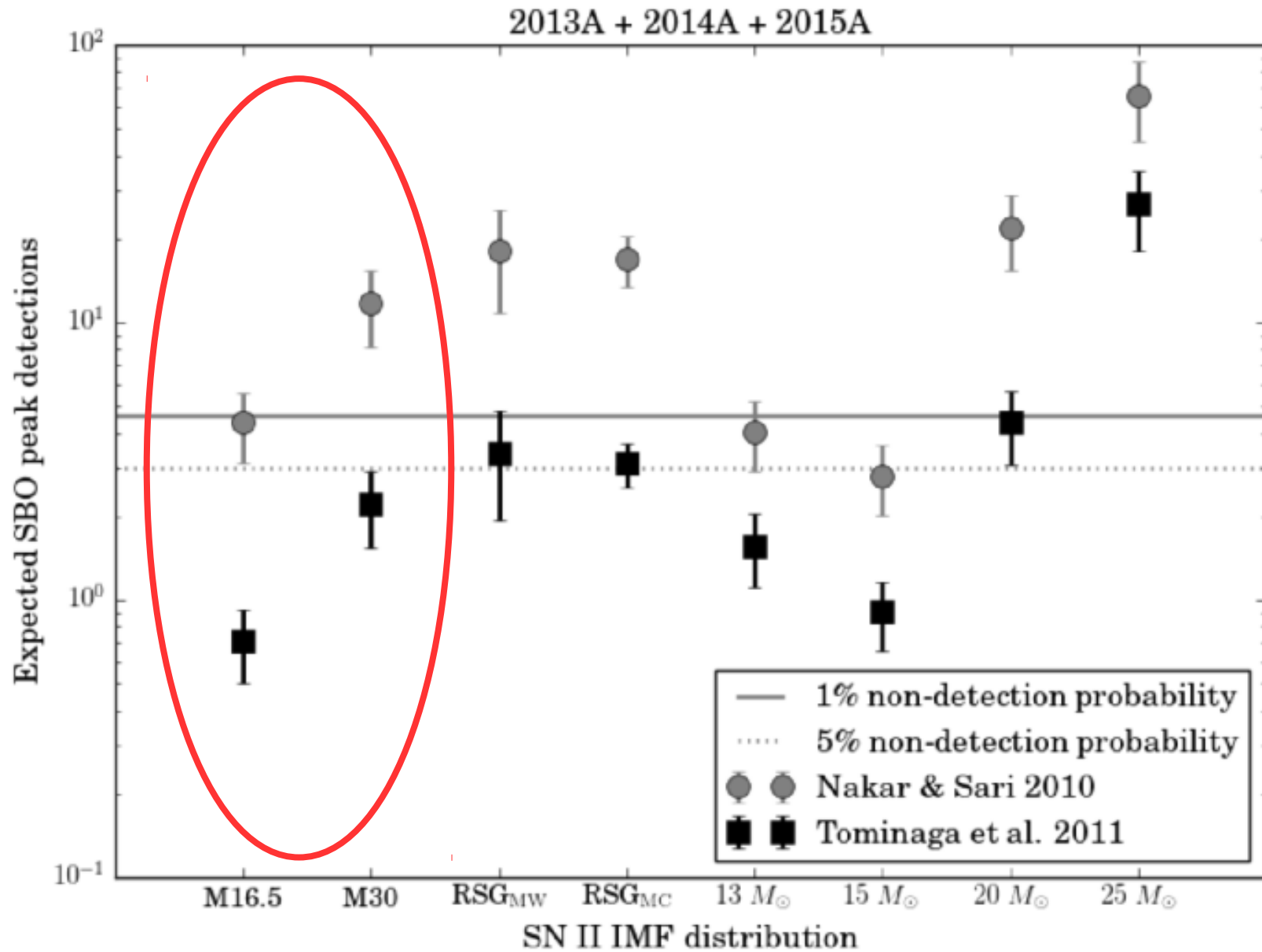
Time evolution: $\sim R^{-0.6}$, $\sim E/M^{-0.06}$

Brightness: $\sim R E/M$

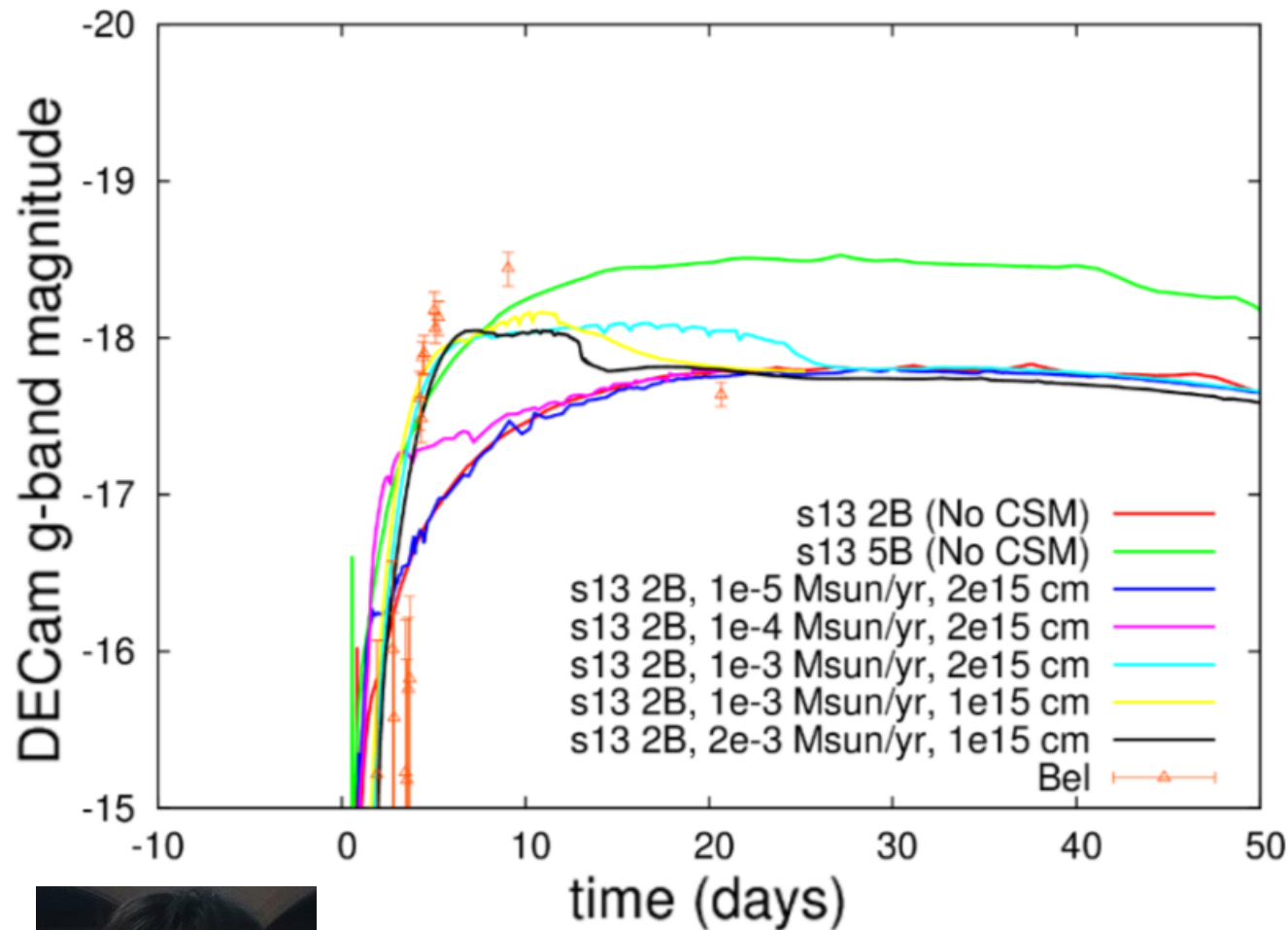
Shock breakout: Tominaga et al. 2011 vs Nakar & Sari



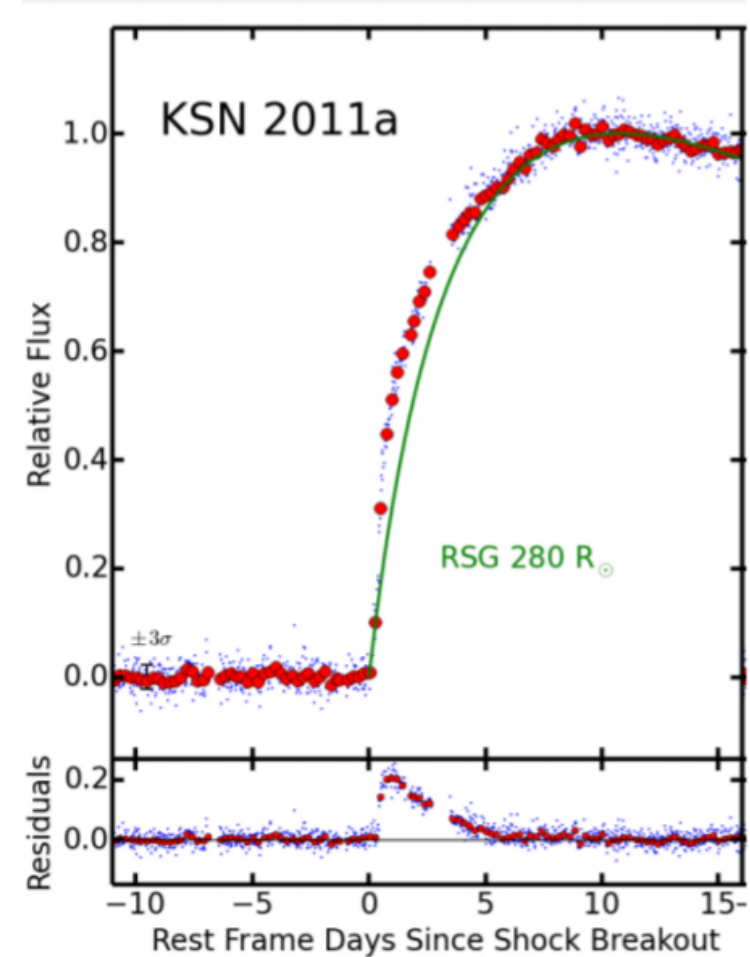
Shock breakout constraints



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



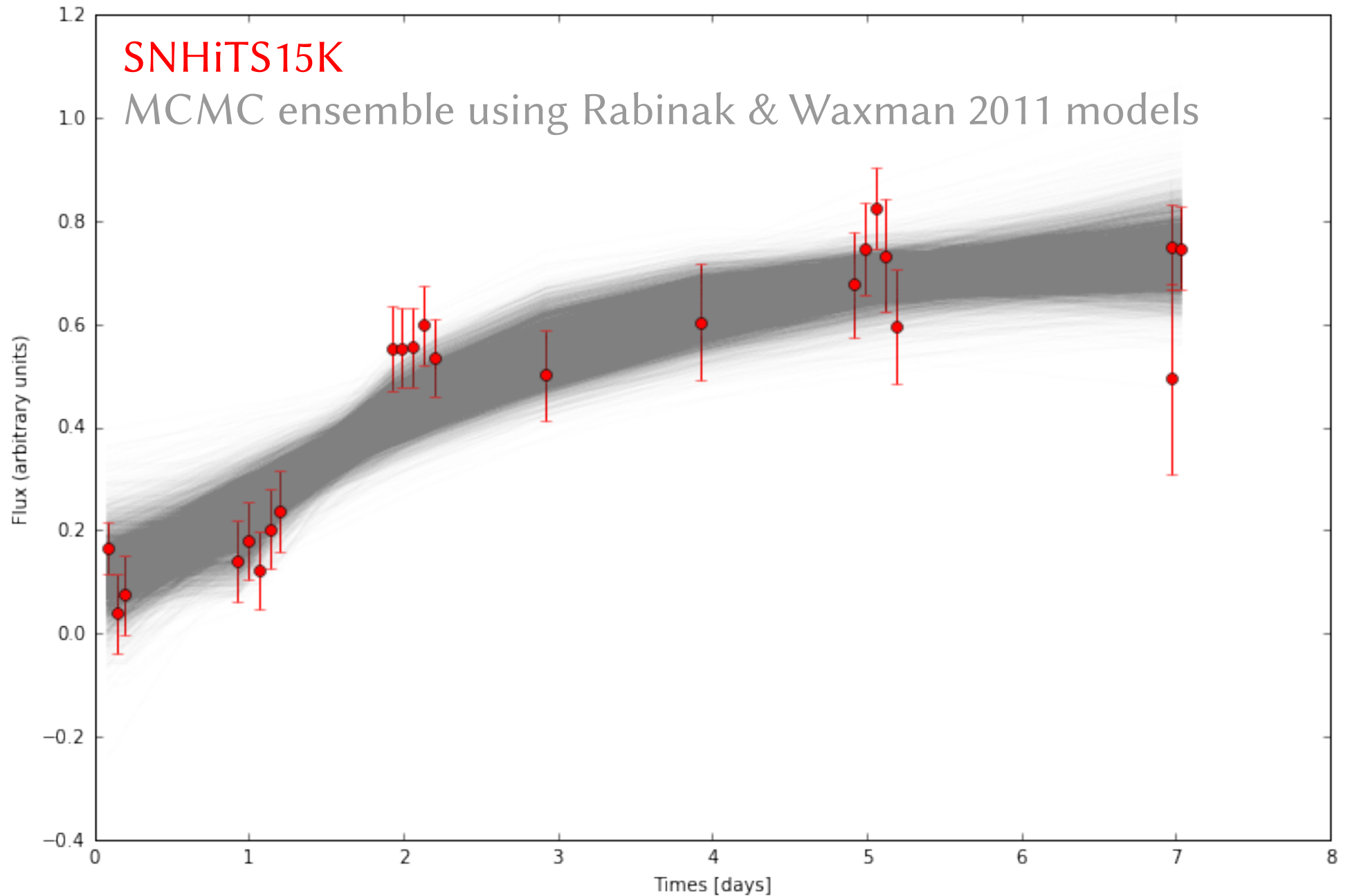
SNHITS14B (Bel), models from T. Moriya
Confined mass loss $\sim 10^{-3}$ Msun/yr



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



Excess emission at early times

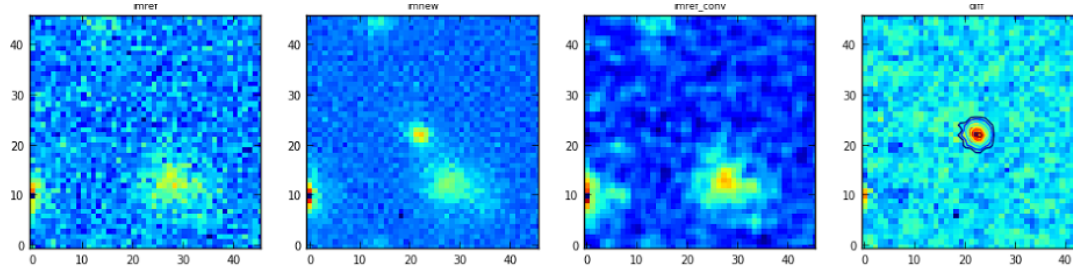


Other science

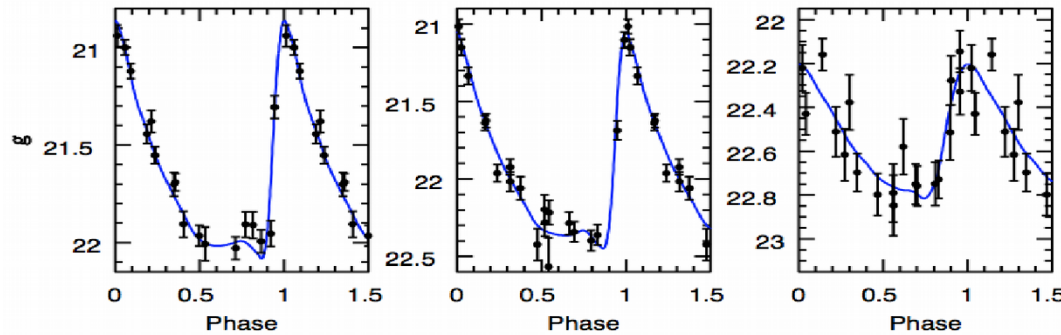
DECam

SOI

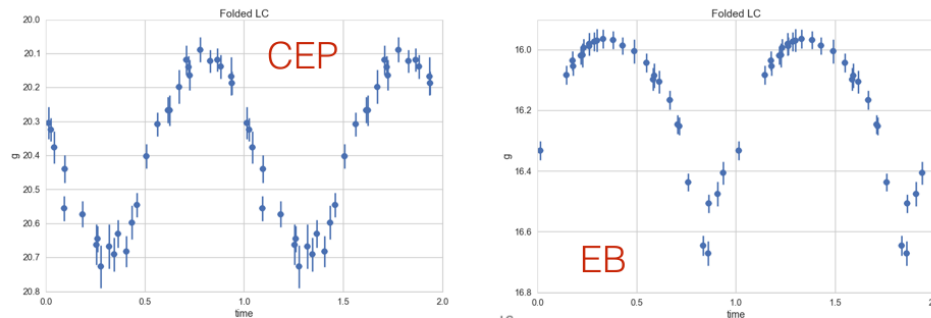
DECam conv. Difference



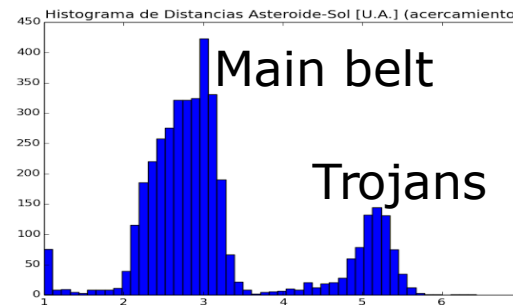
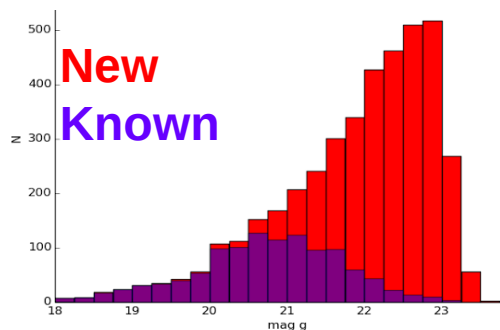
Alessandro Razza:
Combining Decam with
other telescopes



Gustavo Medina:
Most distant RR Lyrae in the
galaxy



Jorge Martínez:
Classifying every transient
object, astroinformatics

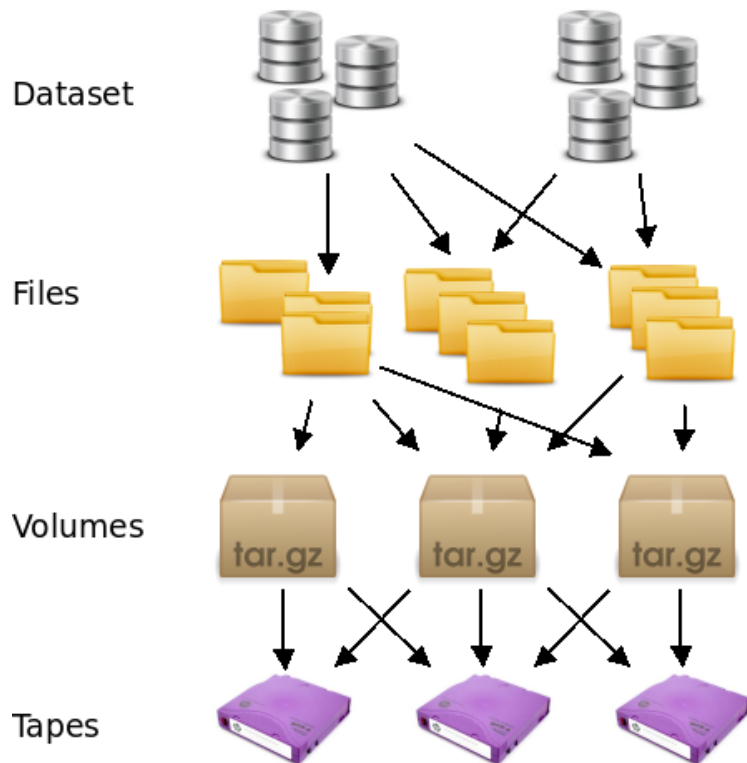


José Peña
Detecting and
characterizing asteroids

Quimal archiving system



Juan Carlos
Maureira



Quimal Archiving System::Dashboard

Logged as: jcm
[Logout](#)

My Account
My Datasets
Data Explorer
My Shares

Data Explorer

Name	Permissions	Modified	Size	Kind
decam	read and write	Sep 14, 2016 06:12 PM	13 b	Plain text
.tmb	read and write	Jul 12, 2013 03:37 PM	66 KB	Plain text
DECAM	read and write	Mar 12, 2013 10:32 PM	278.40 MB	Application
DECAM-13A	read and write	Mar 12, 2013 10:38 PM	271.48 MB	Application
decam13a-mt	read and write	Mar 12, 2013 10:41 PM	271.38 MB	Application
decam13a-process	read and write	Mar 12, 2013 10:42 PM	271.41 MB	Application
decam13a-process_xtalk	read and write	Mar 12, 2013 10:44 PM	271.38 MB	Application
astro-1	read and write	Mar 12, 2013 10:51 PM	271.40 MB	Application
HITS_followup	read and write	Mar 12, 2013 10:57 PM	646.30 MB	Application
amusing	read and write	Mar 12, 2013 11:02 PM	646.18 MB	Application
supernova	read and write	Mar 12, 2013 11:04 PM	646.08 MB	Application
ksp	read and write	Mar 12, 2013 11:06 PM	646.13 MB	Application
DECam_00185668.fits.gz	read and write	Mar 12, 2013 11:13 PM	645.88 MB	Application
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DECam_00185676.fits.gz	read and write			
DECam_00185677.fits.gz	read and write			
DECam_00185680.fits.gz	read and write			
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DECam_00185683.fits.gz	read and write			
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DECam_00185696.fits.gz	read and write			
DECam_00185697.fits.gz	read and write			

decam/DECAM/DECAM-13A

Items: 388, size: 124.30 GB

User Identified by: DC=University of Chile, O=Center for Mathematical Modeling, OU=Quimal Project, CN=Juan Carlos Maureira Bravo
Portal ONLINE

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Center for Mathematical Modeling - University of Chile

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

A wide-angle landscape photograph showing a vibrant turquoise lake in the middle ground. In the background, a range of jagged, snow-dusted mountains rises against a clear blue sky with scattered white clouds. The foreground consists of a grassy, hilly slope with patches of green and yellow vegetation. The Japanese text "ありがとうございます" is centered over the lake.

ありがとうございます