OBSERVING TDEs IN THE ERA OF LSST

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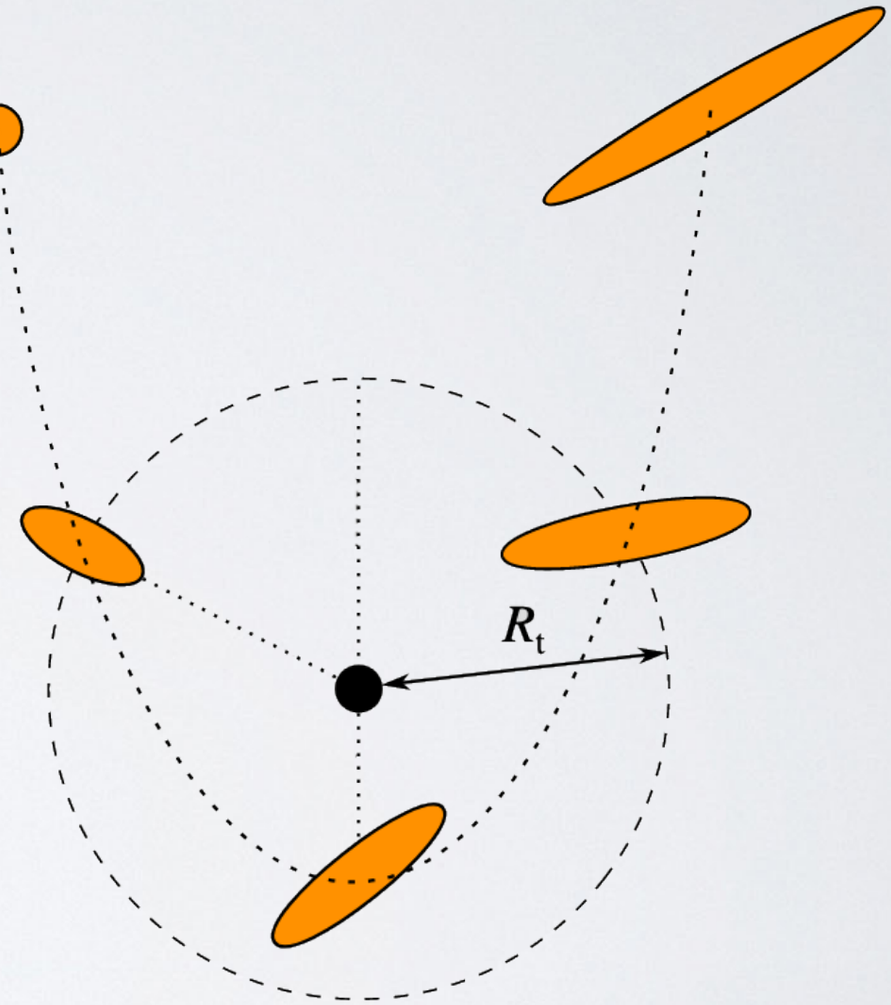
Credit: Aurora Clerici

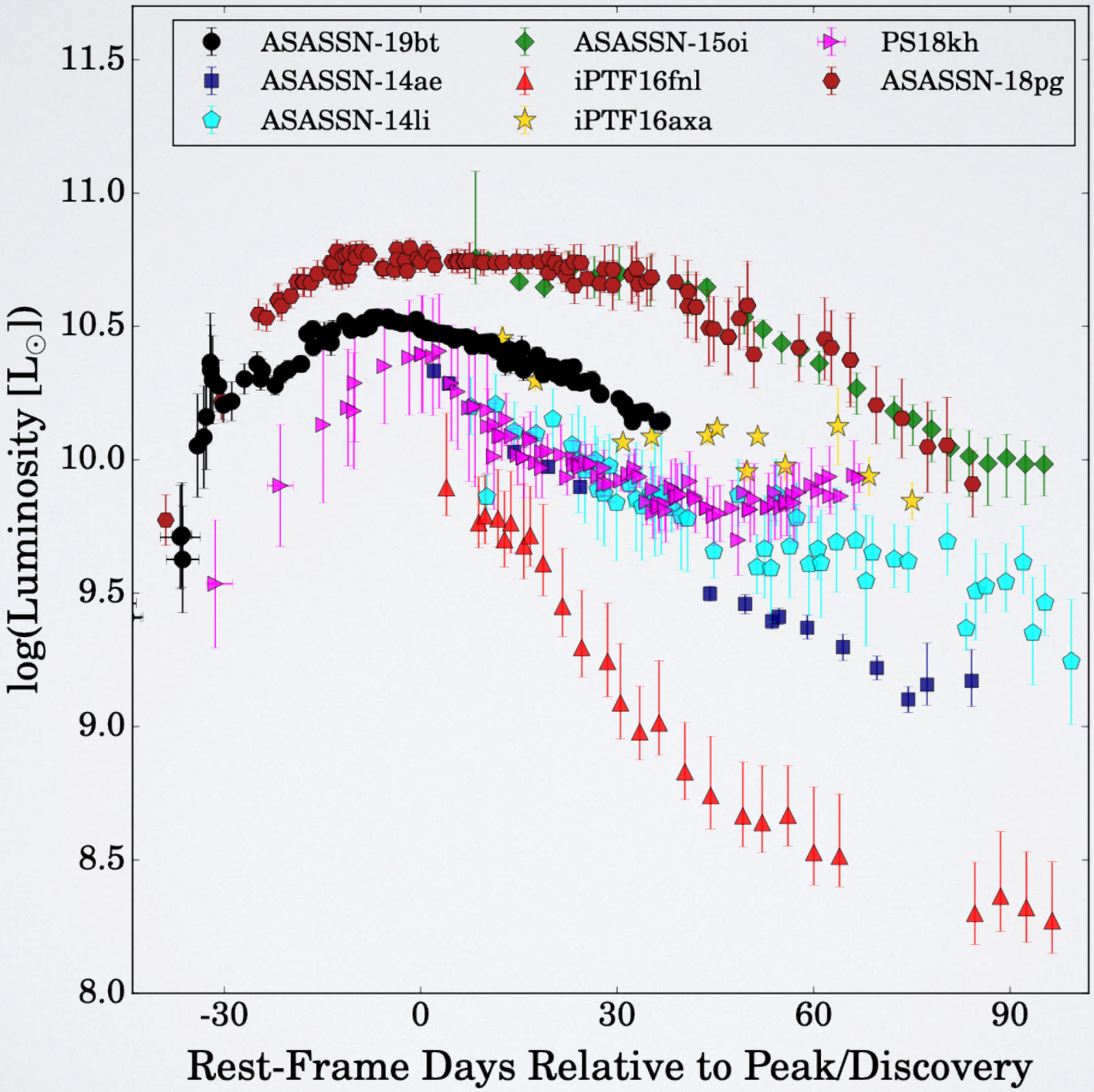
Stellar disruptions by SMBHs

- Star passes inside Roche radius (R_t)
- Bound vs. unbound debris
- Fallback rate ~$t^{-5/3}$
- one / galaxy / 100000 years
- Probes of SMBHs and their mass



Bonnerot (2017)

Light curves: steep decay + evidence for accretion disk at late times



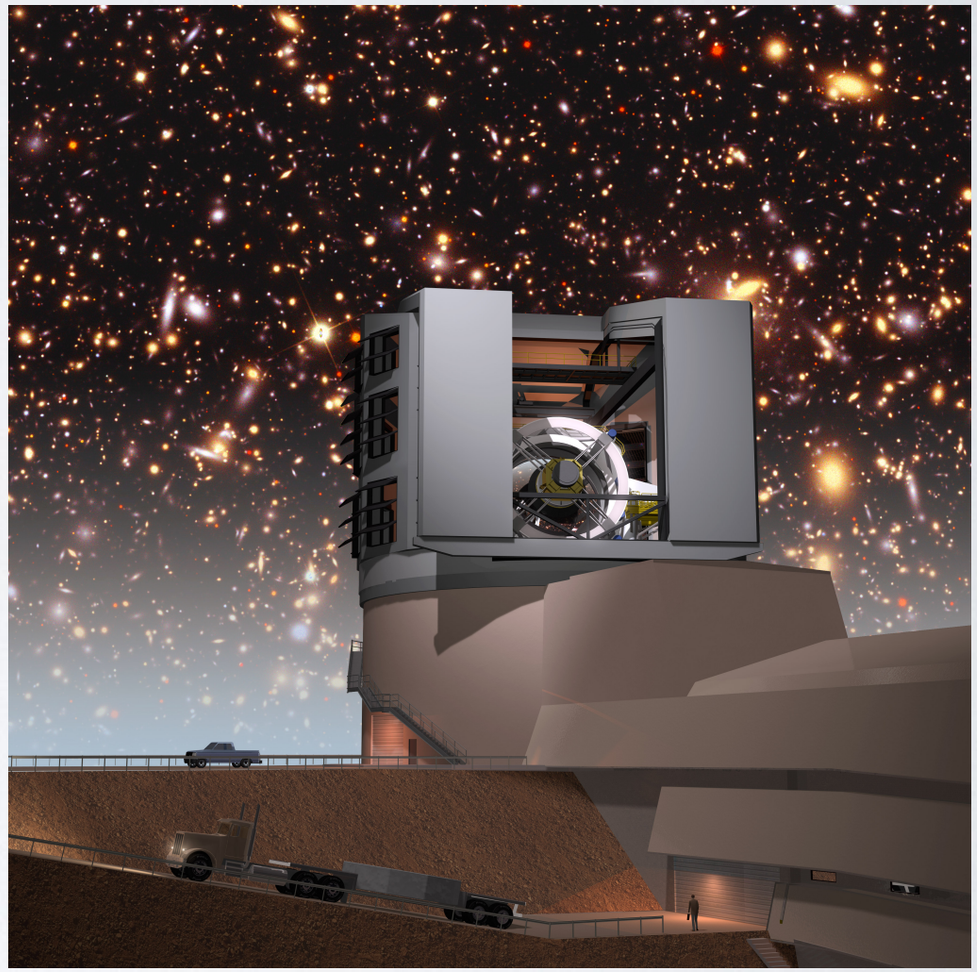
Holoien et al. (2019)

Optical TDEs: status

- To date ~ few tens of optical TDEs
  - most with spectra and UV follow-up
  - detected by surveys (SDSS, PTF, iPTF, PanSTARRS, ASASSN, ATLAS, Gaia, ZTF ...)
- Detection rate ~10/year

LSST and Transients

- Wide FOV 9.6 deg^2, 3.2 Gpx camera
- 18 000 deg^2 of sky area
- Revisit rate ~ 1 - 3 days
- Expected > 100000 transients/night
- 1000 TDEs/year (van Velzen et al. 2011, Bricman & Gomboc 2019)



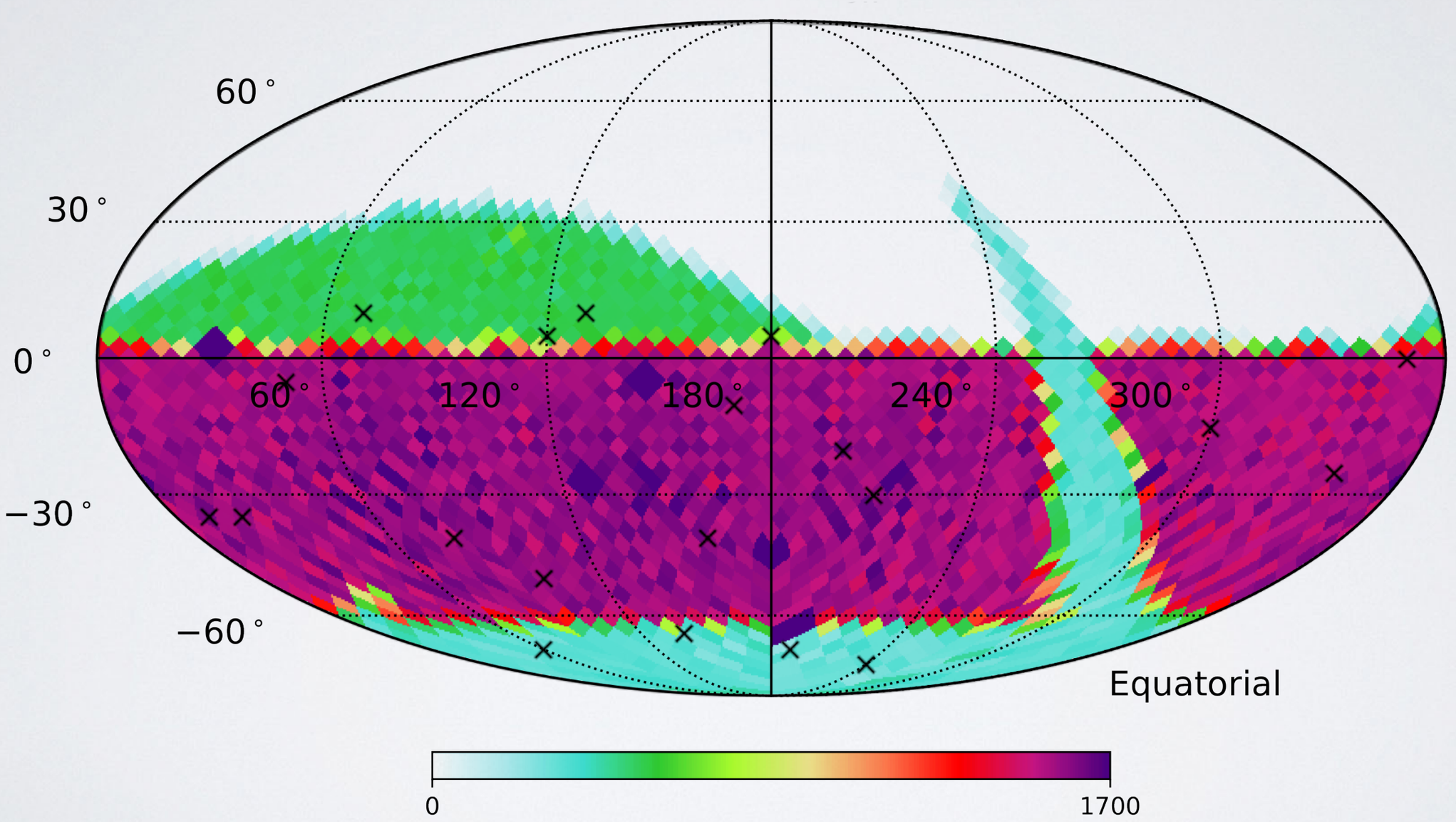
Credit: LSST Project/NSF/AURA

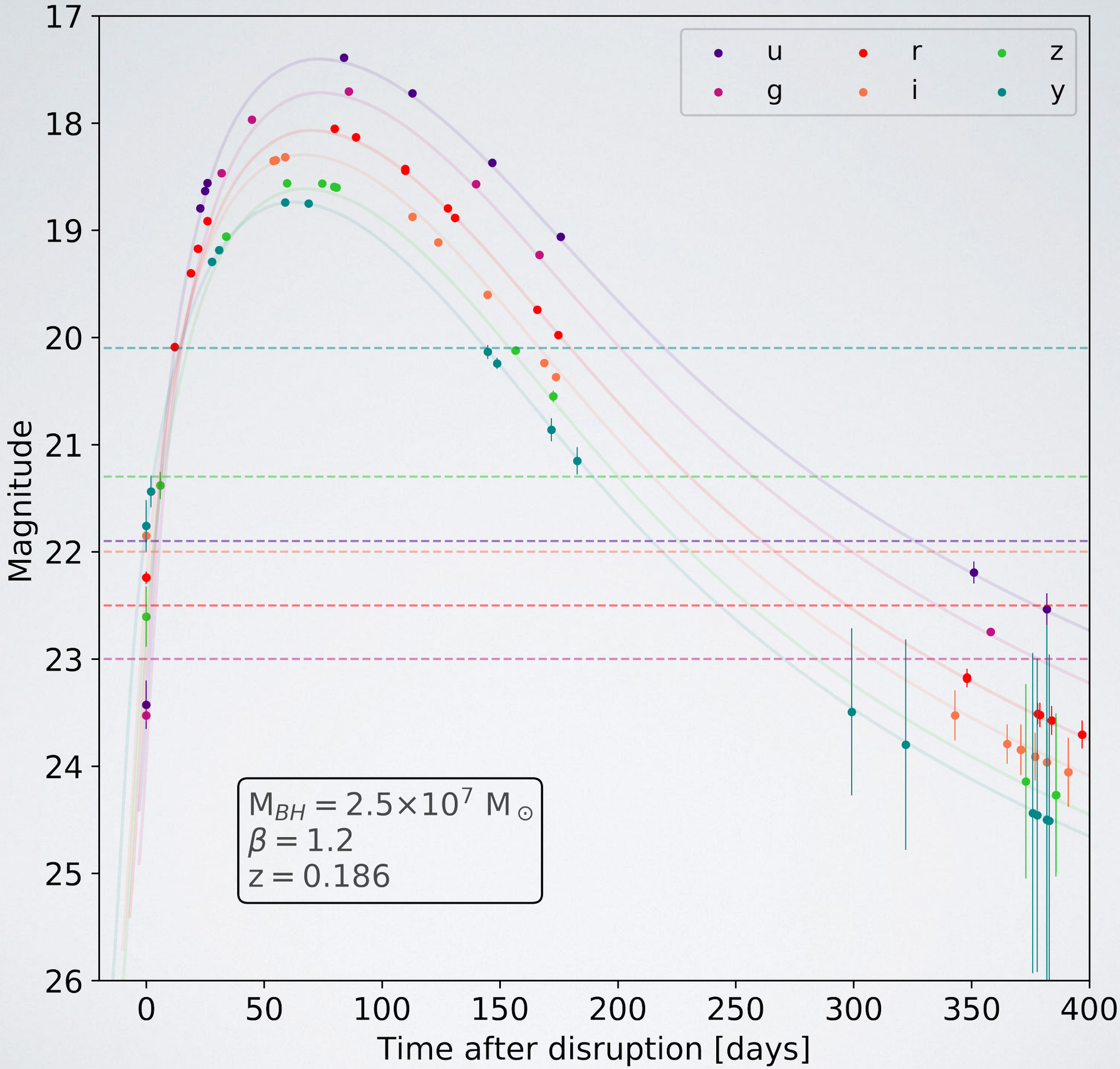
Simulations of TDE observations

Bricman&Gomboc 2019, arXiv:1906.08235

- Host galaxies from CatSim
- Change M_{BH} and r_p/r_t
- SEDs from MOSFiT (Guillochon et al. 2018, Mockler et al. 2019)

Observing strategy minion_1016




u
g
r
i
z
y
Magnitude
Time after disruption [days]
$M_{BH} = 2.5 \times 10^7\ M_\odot$
$\beta = 1.2$
$z = 0.186$

Number of detected TDEs

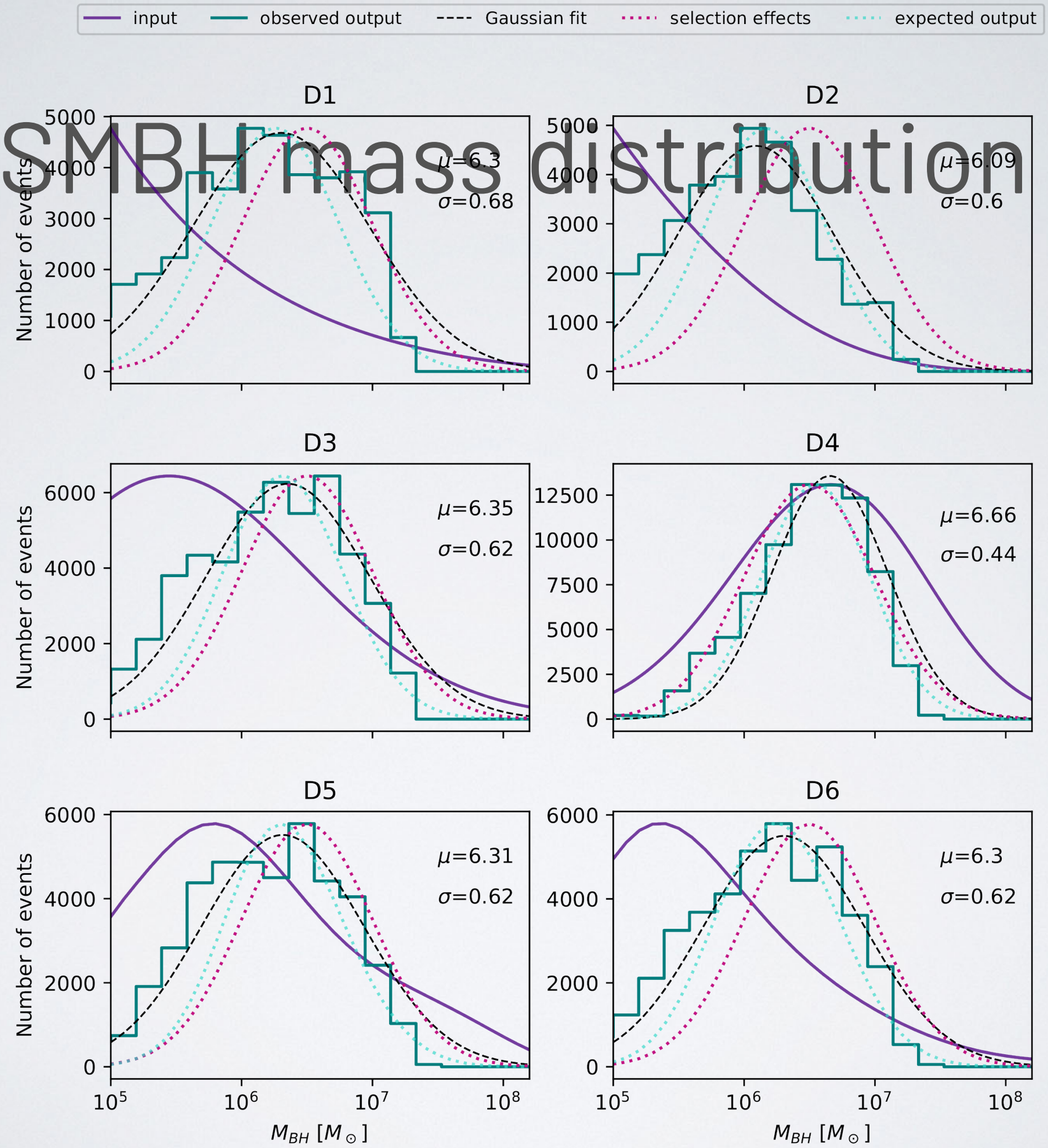
SMBH mass distribution	10+ data points above lim-2 magnitude
D1	40700 ± 200
D2	35300 ± 200
D3	50700 ± 400
D4	81200 ± 500
D5	44300 ± 200
D6	44000 ± 200

Number of detected TDEs

SMBH mass distribution	10+ data points above lim-2 magnitude	2+ pre-peak, 5+ post-peak data points at z < 0.2
D1	40700 ± 200	2180 ± 10
D2	35300 ± 200	2830 ± 20
D3	50700 ± 400	2940 ± 20
D4	81200 ± 500	2620 ± 20
D5	44300 ± 200	2830 ± 10
D6	44000 ± 200	2790 ± 10

Requirements which allow for follow-up observations reduce the number of detected TDEs by a factor of ~15! Photometric identification will be essential.

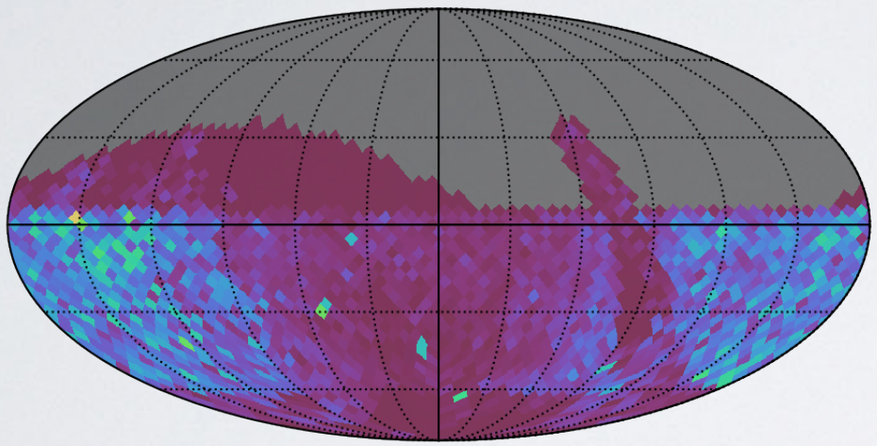
SMBH mass distribution

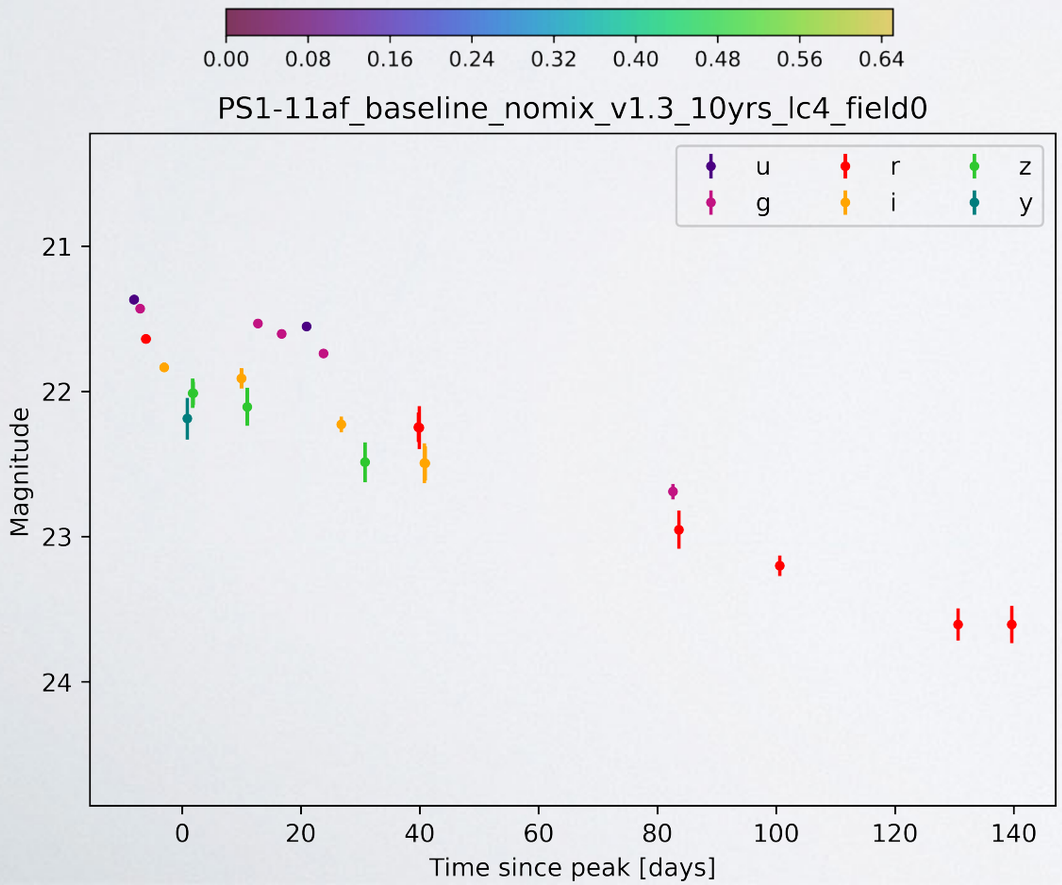


> 80 proposed cadences

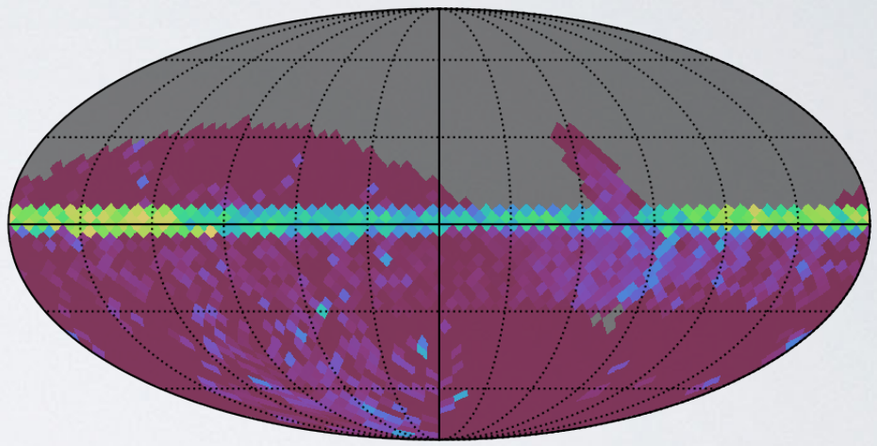
TVS MAF Task Force

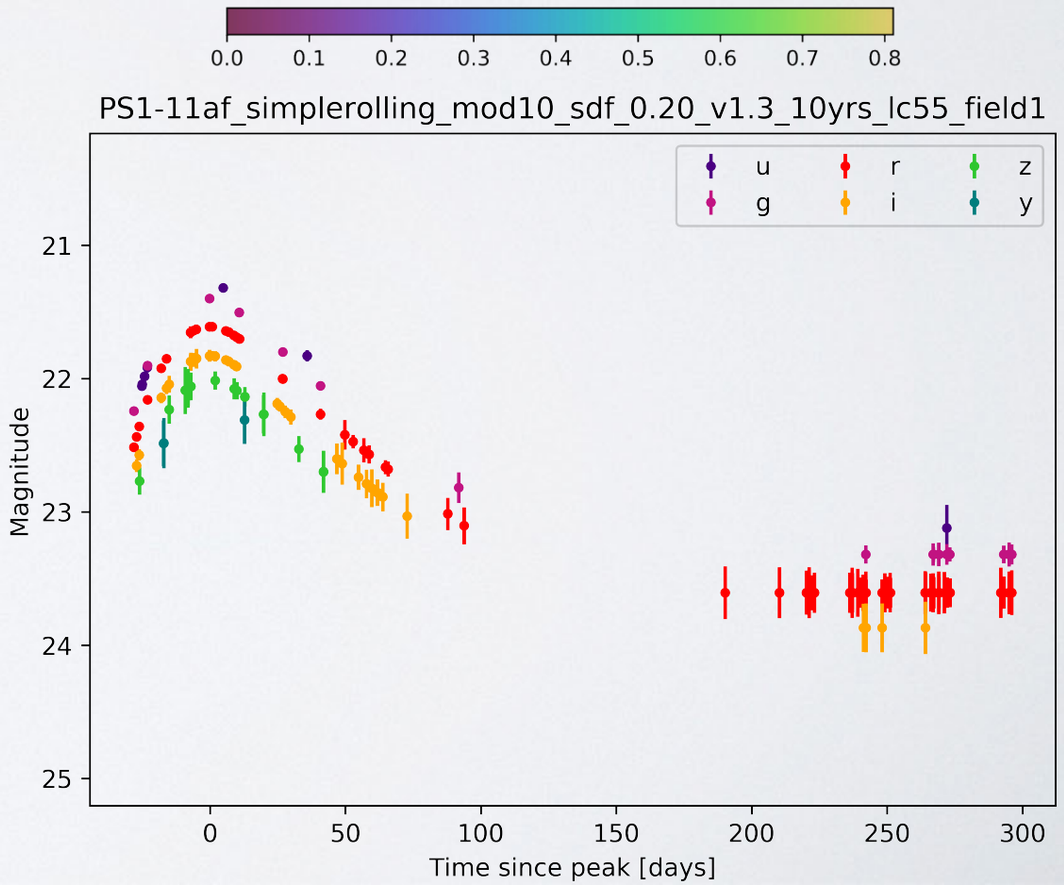
Baseline: observe the whole sky





Rolling: divide the sky in strips



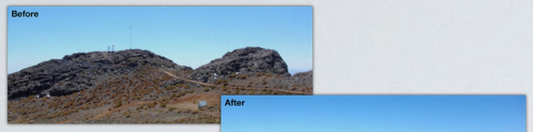


Performance for TDEs differs

TVS MAF Task Force

Cadence	Fraction of TDEs detected
baseline	0.031
baseline_nomix	0.009
altLike*	0.083
rolling_mod2*	0.043
rolling_mod5*	0.052
wfd_only	0.069

Requirements for the detection: 1+ data point at $t < t_{peak}$ - 5 days, 3+ data points in different filters within $t_{peak} \pm 5$ days, 2+ data points in different filters within t_{peak} + 2 weeks.



Rough site level complete

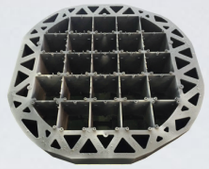
DOE CD-1 review

NSF MREFC funding begins

DOE CD-2 review

DOE CD-3 review

SLAC I&T facility ready



Focal Plane Grid Received

50% Sensor Production Complete

Light up LSST network

Summit substantial completion

Auxiliary Telescope data processing system available

Camera L1-L2 assembly complete

Telescope & Site substantial completion, System integration & test start

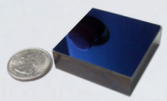
Data Access Services available at US DAC

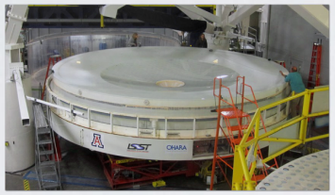
System First Light

Full science operations Survey Begins

Calendar Year 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

Prototype science sensor received





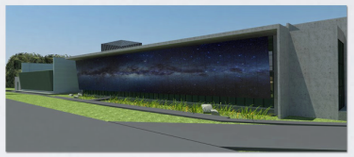
Primary mirror complete

First Stone

Lower enclosure ready for dome

First production science raft complete

First Prototype Science Platform

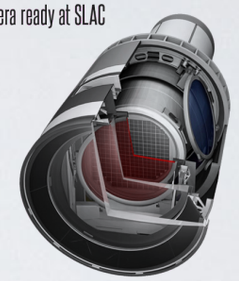


Base facility complete

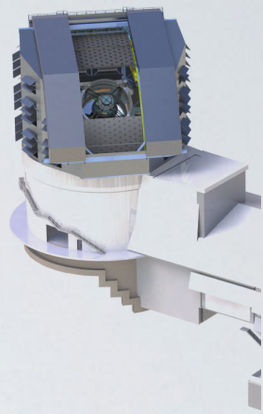
Commissioning Camera ready for testing

Camera ready at SLAC

Engineering first light



Science verification complete



- Overlap of Gaia and LSST for ~1 year
  - historic activity
  - astrometric position
  - host spectra and colors

Conclusions

- 3500 - 8000 TDEs/year expected with LSST.
- 10% at $z < 0.2$: we need to be able to classify TDEs photometrically.
- Rolling cadence is better.

LSST in October 2019, credit: LSST Project/NSF/AURA