The Zwicky Transient Facility

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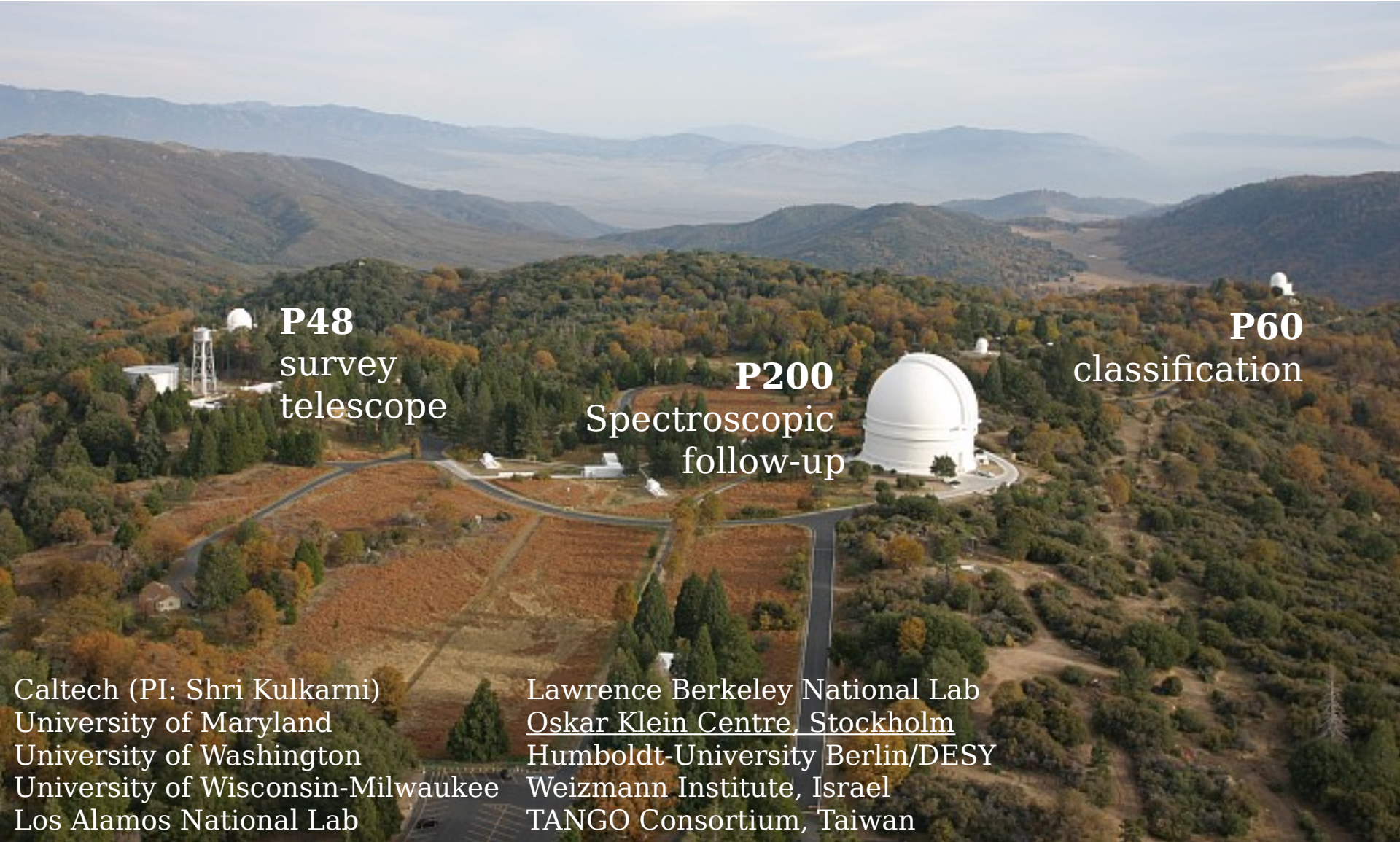
Photo: I. Arcavi

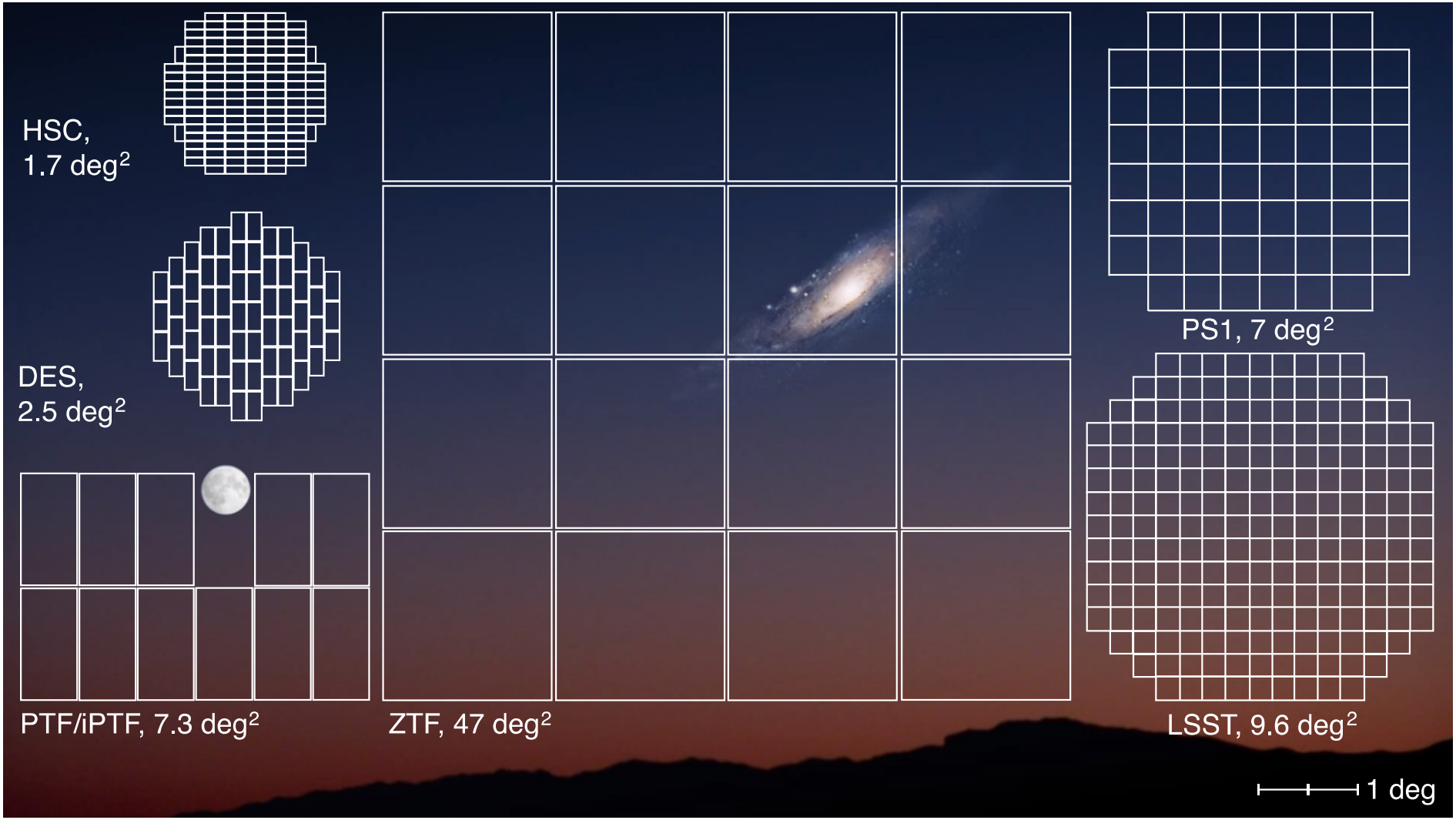
Zwicky Transient Facility (ZTF)



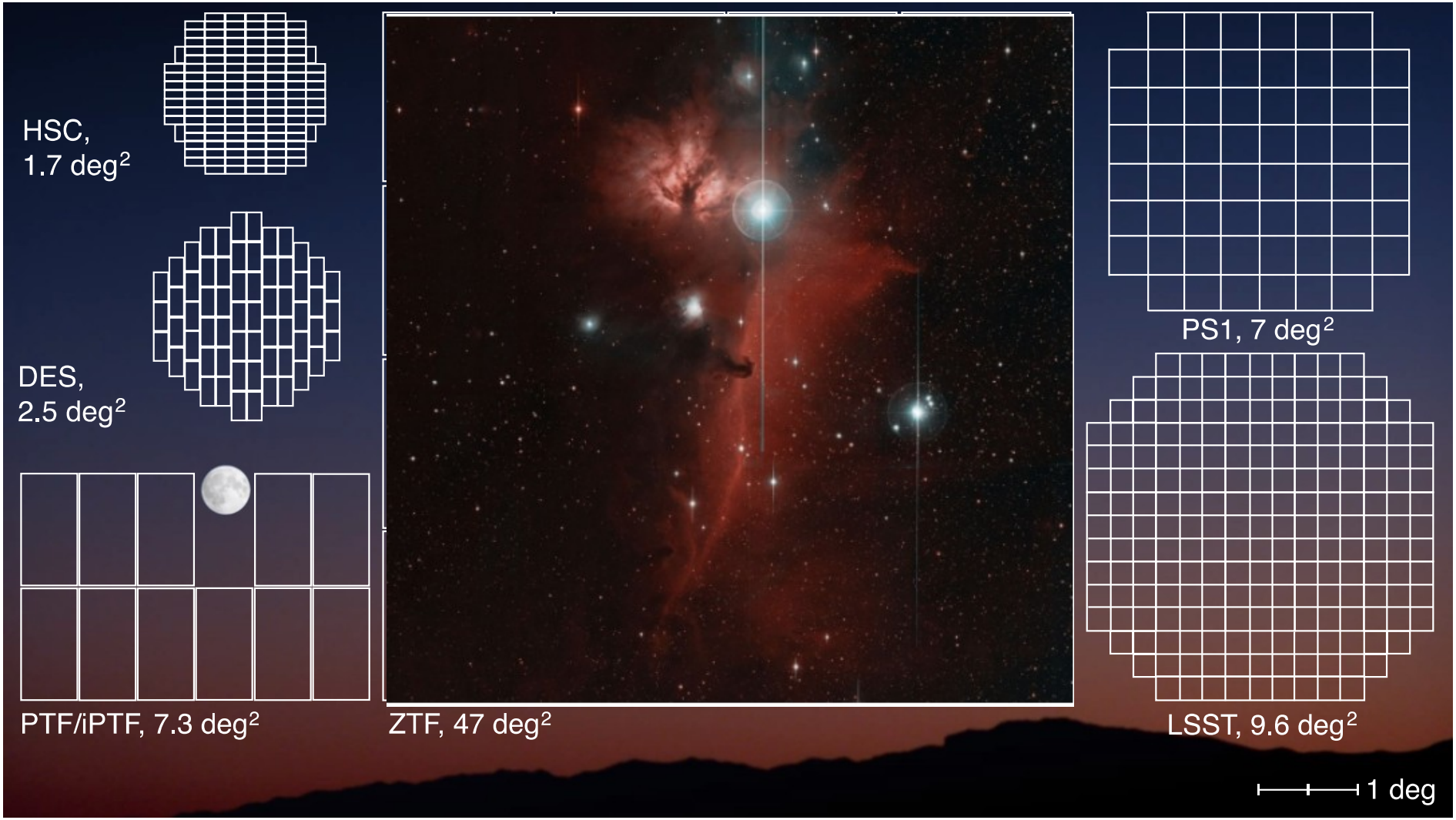
Caltech (PI: Shri Kulkarni)
University of Maryland
University of Washington
University of Wisconsin-Milwaukee
Los Alamos National Lab

Lawrence Berkeley National Lab
Oskar Klein Centre, Stockholm
Humboldt-University Berlin/DESY
Weizmann Institute, Israel
TANGO Consortium, Taiwan

ZTF FoV compared to other surveys



First light: November 15, 2017



Partnership organized in Science Working Groups

- **Multi-messenger astronomy:** EM counterparts of GW, gamma rays and neutrino sources
- AGN & TDEs
- Cosmology with supernovae and gravitational lensing
- Physics of supernovae and relativistic explosions
- Solar System Bodies
- Stellar Science

ZTF Survey Plan

- ZTF P48 time shared between "partnership" (10 institutions), NSF *public* survey ("MSIP") and Caltech private time (40%, 40%, 20%). Funded for 3 years
- ZTF P60 Spectroscopic time 65/35% split partnership/Caltech
- MSIP year 1: a "mini LSST" g,r survey of all Northern sky every 3 nights, including sweep of Galactic plane
- Partnership year 1: High-cadence observations of 1/10 of the Northern extragalactic sky, 5-6 visits/night + i-band survey with 4-day cadence of ½ sky, 9 months
- Dedicated inner Galactic plane continuous monitoring for 2 summer weeks
- Solar System Science program for ~1 month

Expected *Yearly* yield of *spectroscopically* identified SN

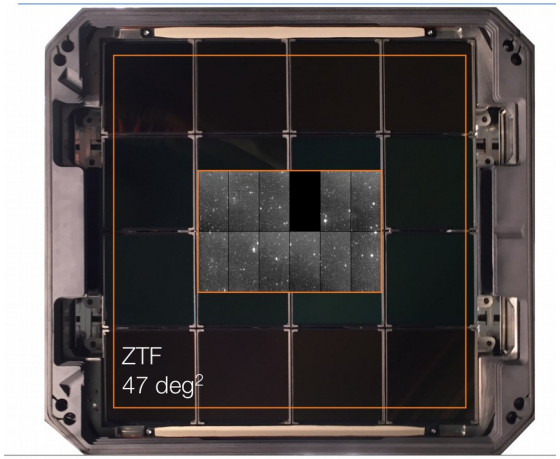
Transients with g < 18.5 mag will be classified using the SEDmachine on P60

SN Type	SNe in 12 months	Median redshift
Ia	1000	0.053
Ibc	220	0.048
IIP/L	375	0.028
IIn	120	0.049
Total CC	715	

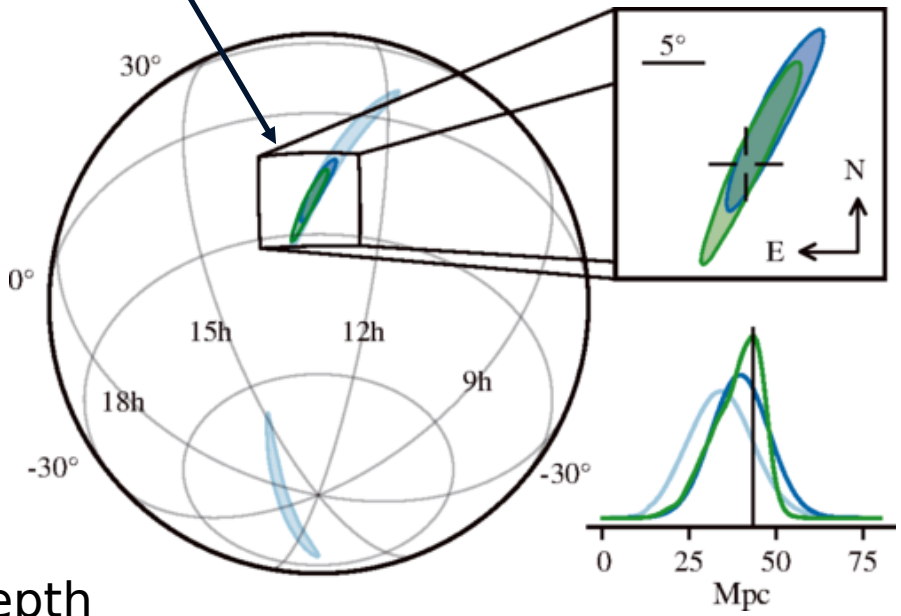
Numbers from lightcurve simulations (Feindt et al. in prep.)

However, only a few GW170817-like events are expected to be detected by chance

ZTF ToO observations



Localization of GW170817 was smaller than ZTF FoV



Abbot et al. (2017), PRL 119, 161101

- 10% of time for followup of GW, gamma rays and neutrinos
- ToO observations will be longer exposures (up to 10 min) to a depth of ~ 22 mag (normally 20.5 mag)
- Expect ~ 10 previously undetected SNe per field

Tools to manage >O(10^5) optical transients

GW170817 nearby and with good locatlization – will not always be the case

AMPEL framework developed at HU Berlin to:

- Reject previously existing transients
- Match galaxies of new transients with catalogs and determine photo-z for others
- Automatic trigger of notices and follow-up observations
- Could be used to combine data from different sources – connected to TNS and not tied to ZTF

Rapid Followup: GROWTH

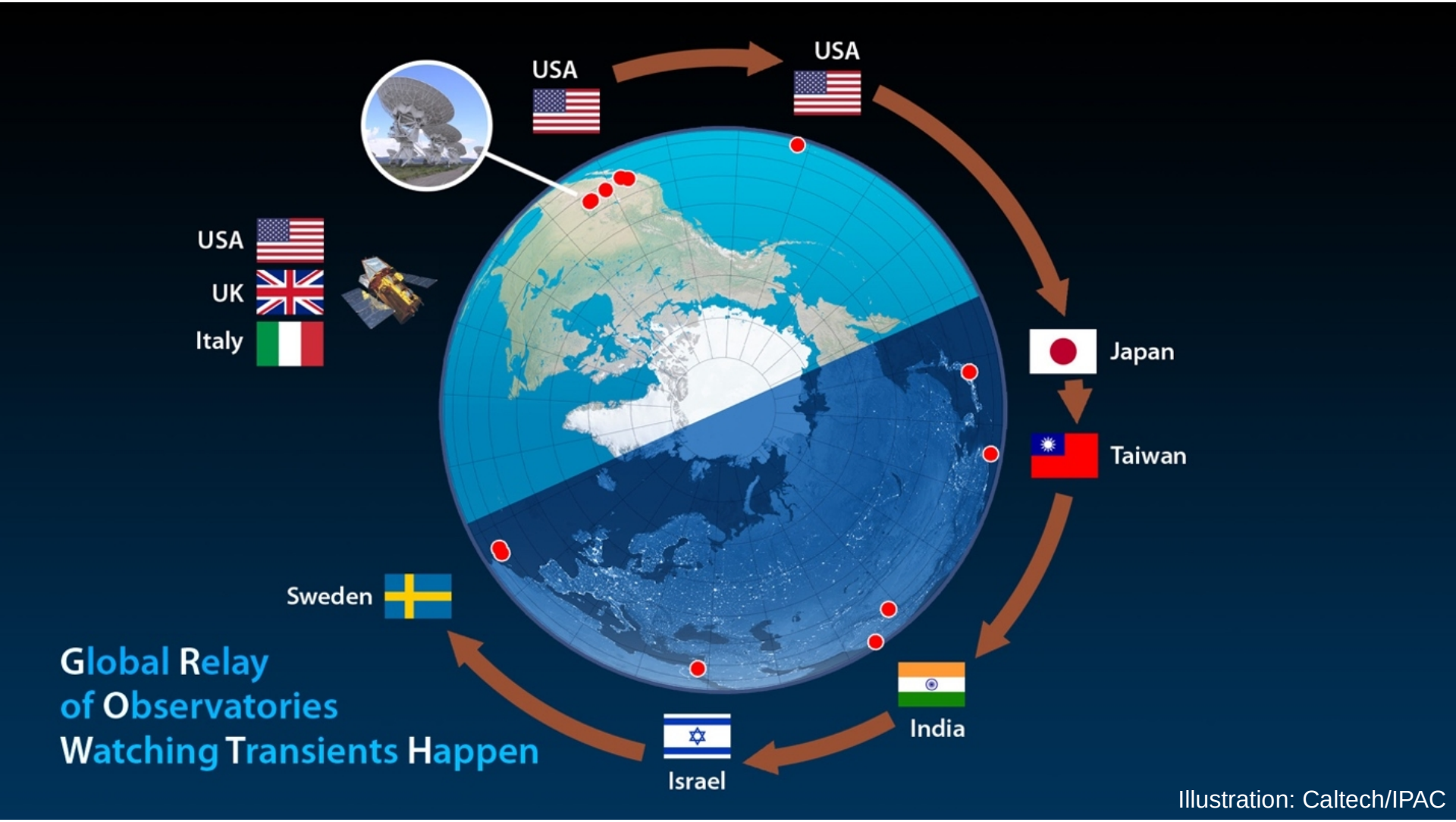


Illustration: Caltech/IPAC

Summary & Conclusions

- ZTF is a new exciting discovery engine, 12 times faster than its precursor (PTF/iPTF). Three filters (gri), iPTF was single band
- Large FoV allows covering GW localizations with only a few pointings
- Robotic spectroscopic follow-up of g < 18.5 mag transients, fainter targets need bigger telescopes
- New approaches needed for handling high-rates of transients. ZTF is a stepping stone for LSST.
- Survey starts in second half of February. Fingers crossed!


Thank you!
I. Arcavi

Extra slides

ZTF vs. (i)PTF

	PTF	ZTF
Active Area	7.26 deg^2	47 deg^2
Overhead Time	46 sec	<15 sec
Optimal Exposure Time	60 sec	30 sec
Relative Areal Survey Rate	1x	**14.7x**
Relative Volumetric Survey Rate	1x	**12.3x**

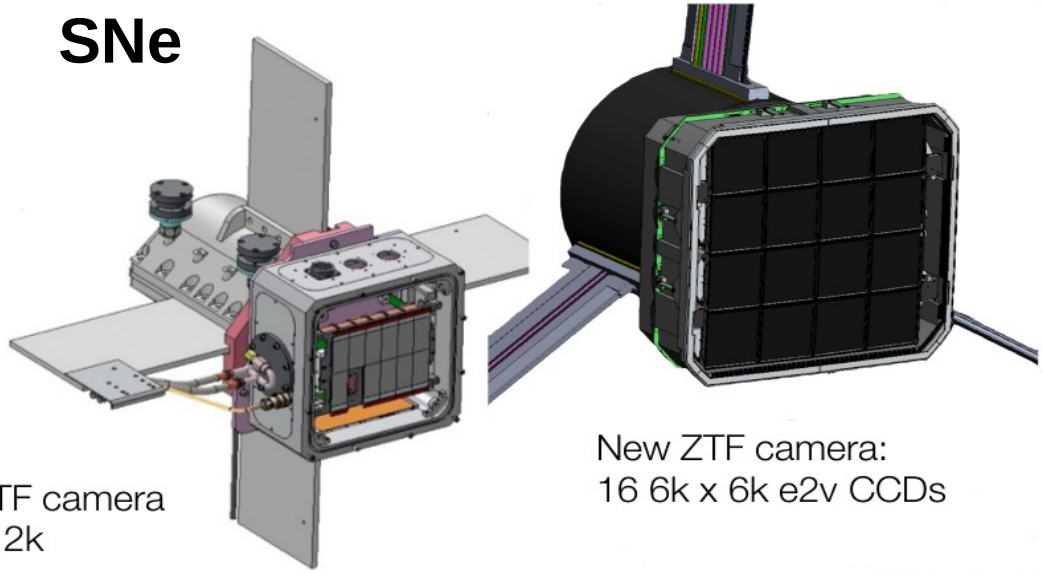
3750 deg^2/hour

➔3π survey in 8 hours

>250 observation/field/year

for uniform survey

Will observe thousands of SNe



Existing PTF camera
MOSAIC 12k

New ZTF camera:
16 6k x 6k e2v CCDs

“Blind searches” (no GW trigger)

No detections expected in past surveys

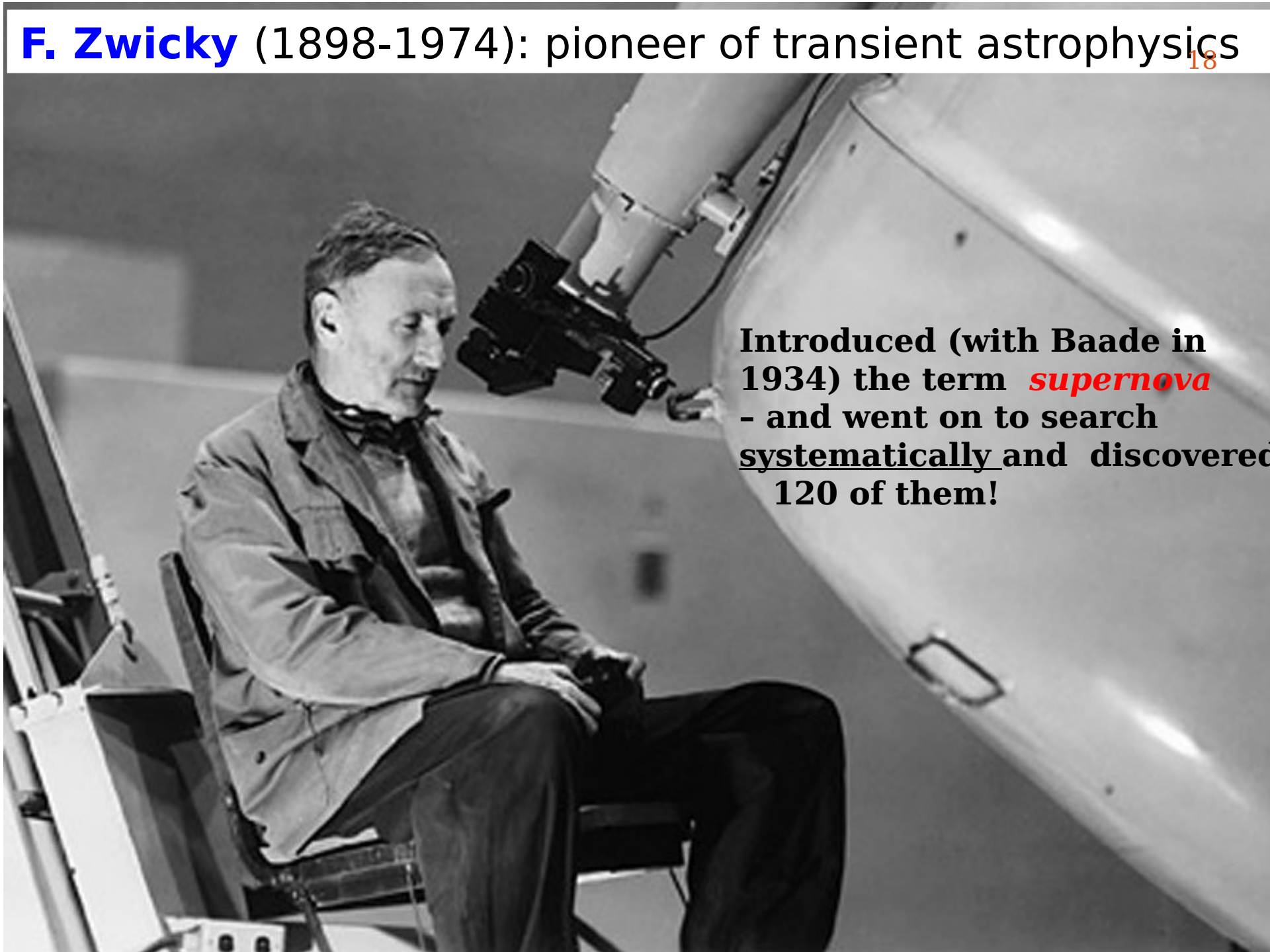
TABLE 2
EXPECTED NUMBER OF KNE FOUND IN EACH SAMPLE.

Survey	# KNe[a]	Survey Years	KN Redshift Range
SDSS	0.13	2	0.02 – 0.05
SNLS	0.11	4	0.05 – 0.20
PS1	0.22	4	0.03 – 0.11
DES	0.26	5	0.05 – 0.20
ASAS-SN	< 0.001	3	—
SMT	0.001	5	0.01 – 0.01
ATLAS	8.3	5	0.01 – 0.03
ZTF	10.6	5	0.01 – 0.04
LSST WFD	69	10	0.02 – 0.25
LSST DDF	5.5	10	0.05 – 0.25
WFIRST	16.0	2	0.1 – 0.8

[a]Total for entire duration of survey.

Scolnic et al, arXiv:1710.05845

F. Zwicky (1898-1974): pioneer of transient astrophysics



Introduced (with Baade in 1934) the term *supernova* – and went on to search systematically and discovered 120 of them!

P48 (Samuel Oschin Telescope)

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