The Zwicky Transient Facility (ZTF)

Eric Bellm
on behalf of the ZTF collaboration

ZTF builds on PTF experience at Palomar.
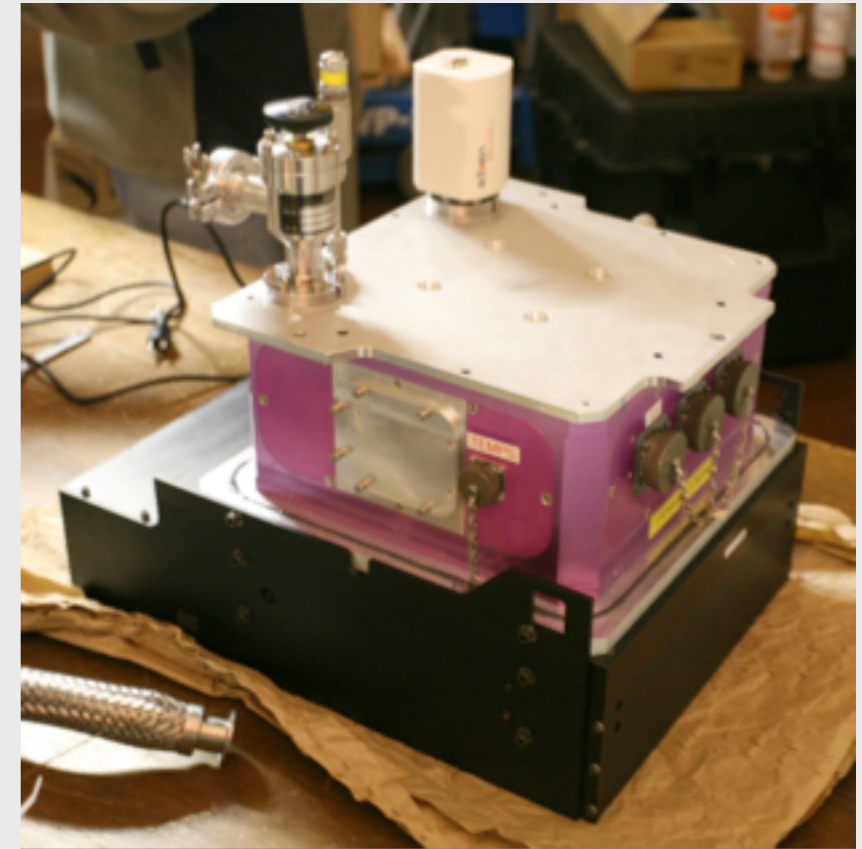

P48: Discovery

P60: Followup

P200: Classification

Moderate aperture survey matched to followup resources.

The PTF survey family has three phases.

PTF *yesterday*

The Palomar Transient Factory
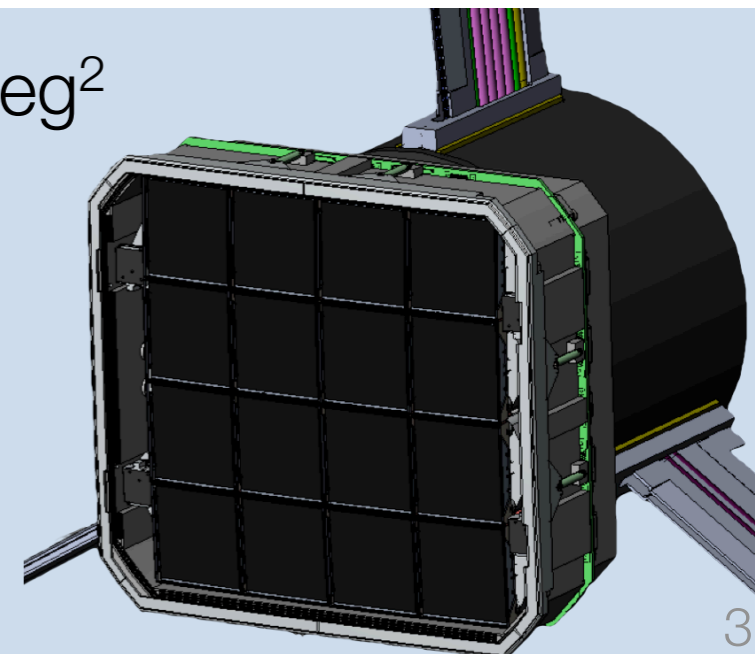(2009-2012) ~60 papers, 1850 citations
General synoptic transient survey

iPTF *today*

Intermediate Palomar Transient Factory
(2013-2015)
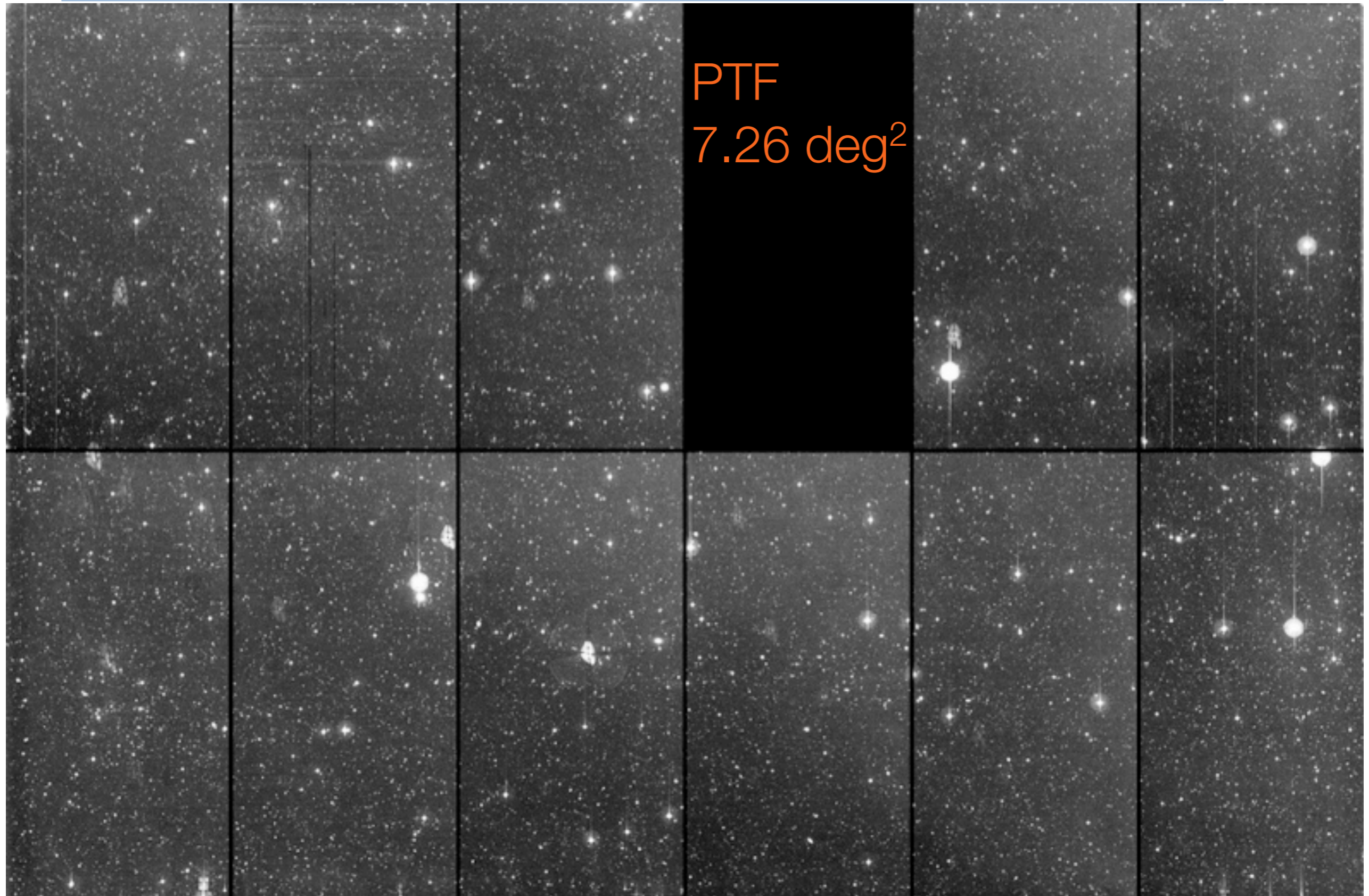*Focused mini-surveys*

CFHT 12k: 7.26 deg^2

ZTF *tomorrow*

The Zwicky Transient Facility
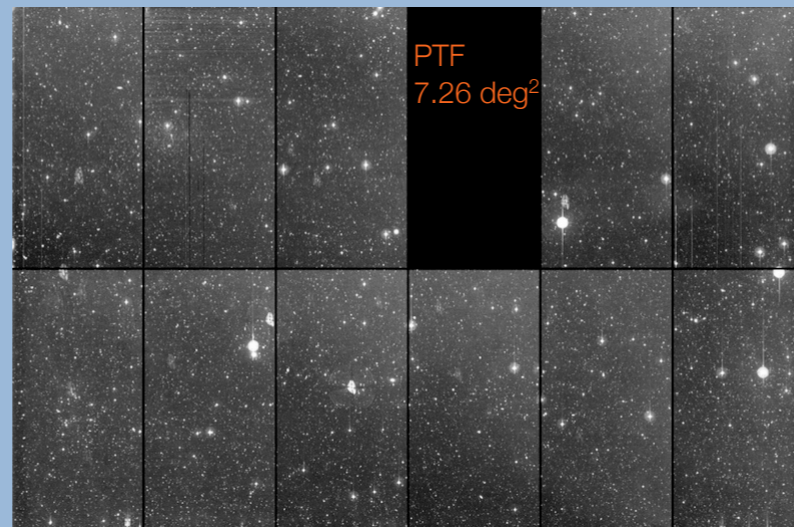(2017-2019)
High-cadence survey

new 47 deg^2
camera
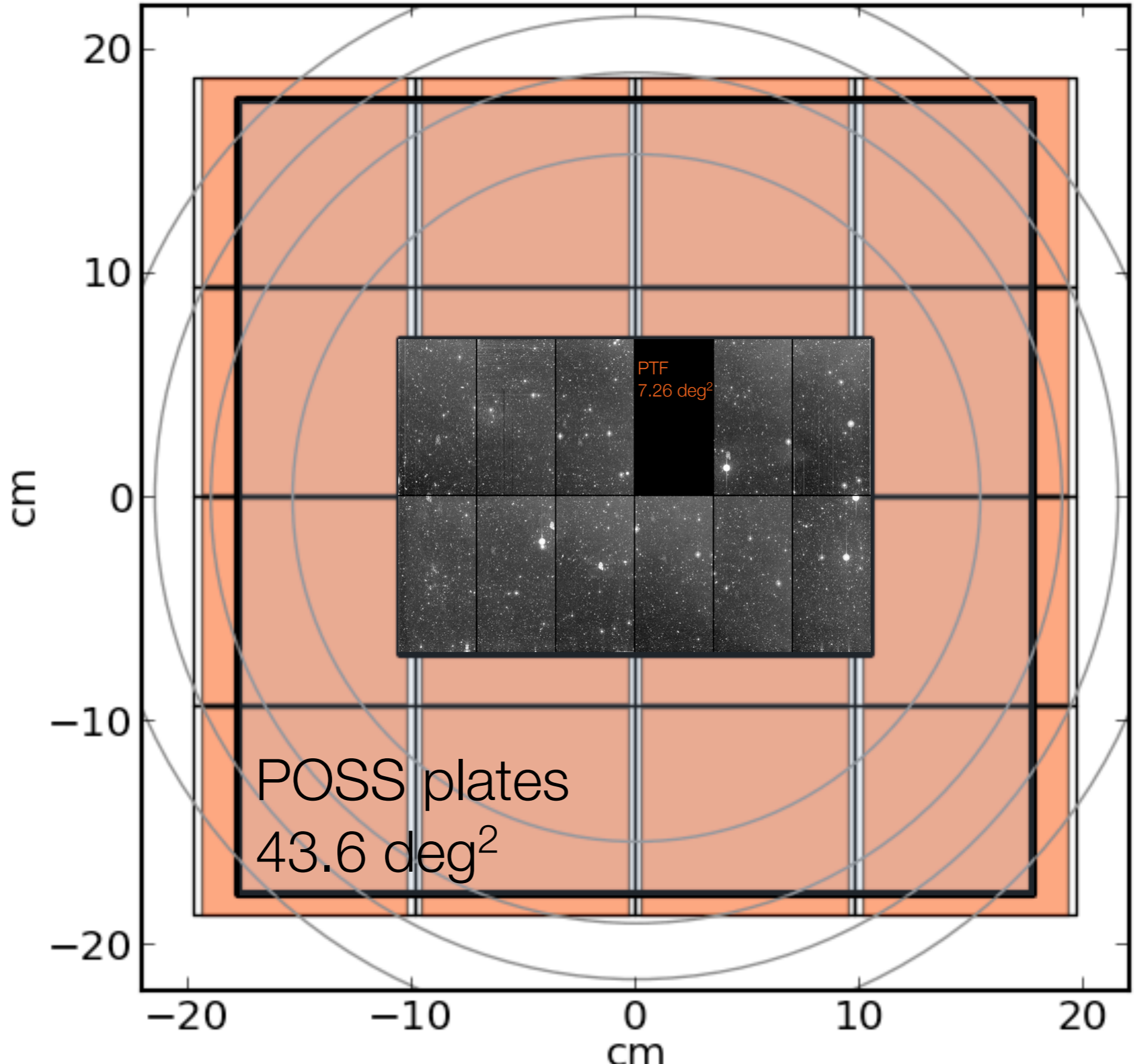
A new camera will fill the P48 focal plane.

PTF
7.26 deg^2
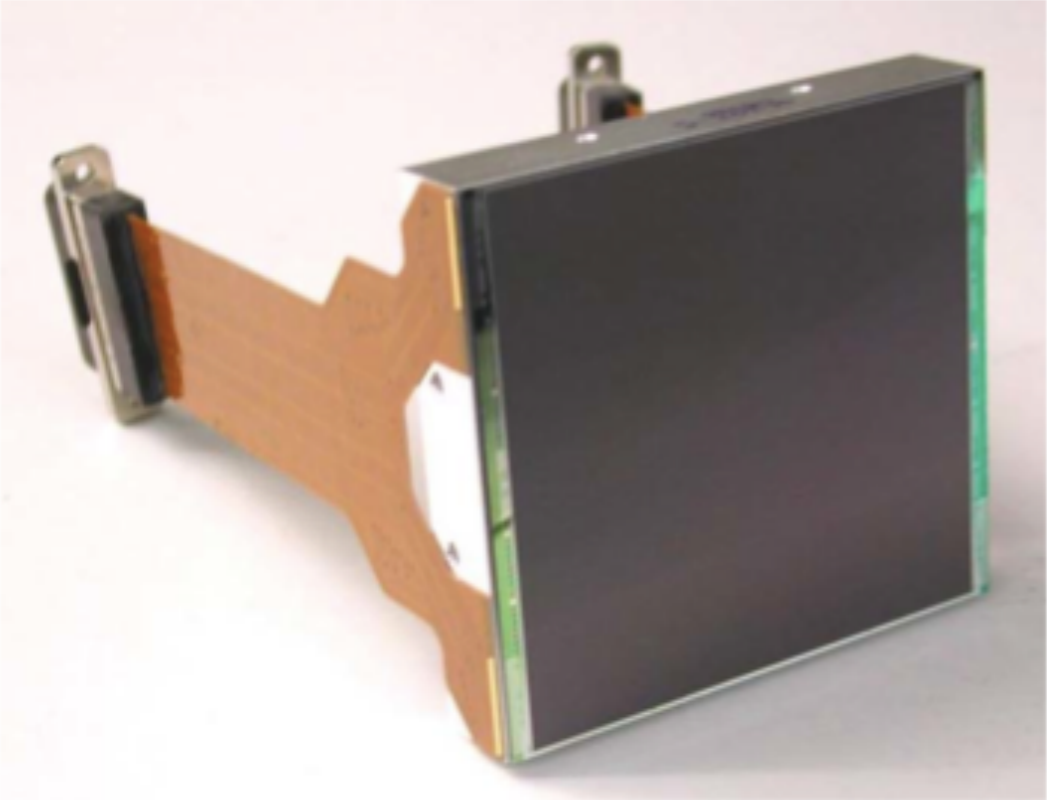
A new camera will fill the P48 focal plane.

PTF
7.26 deg^2

POSS plates
43.6 deg^2

A new camera will fill the P48 focal plane.

PTF
7.26 deg^2

POSS plates
43.6 deg^2

Affordable wafer-scale CCDs make ZTF possible.

[CCD231-84 is illustrated here; CCD231-C6 is similar]

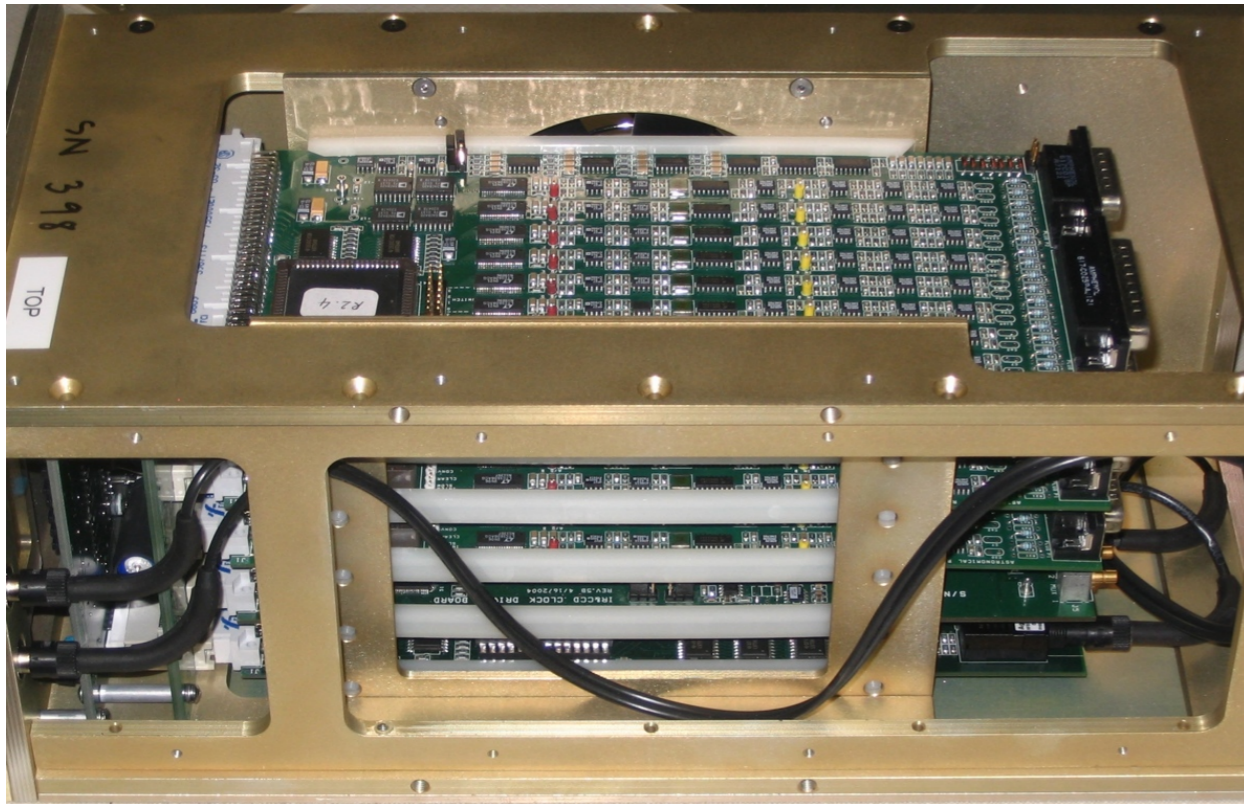| e2v	
dimension	9.2 x 9.2 cm
pixels	6.1k x 6.1k
pixel size	15 micron
pixel scale	1"/pixel
outputs	4

5 CCDs fabricated and delivered.

Moore's Law reduces overhead.

PTF
2000-era Leach Gen-II controller
36 second readout of 96 Mpx

ZTF
2014-era (e.g., STA Archon)
10 second readout of 576 Mpx

"Volumetric survey speed" is a useful figure of merit.

Volumetric survey speed:

$$\dot{V}_M = \frac{\Omega_{\text{fov}}}{4\pi} \frac{V_{\text{c}}(z_{\text{lim}})}{t_{\text{exp}} + t_{\text{OH}}}$$
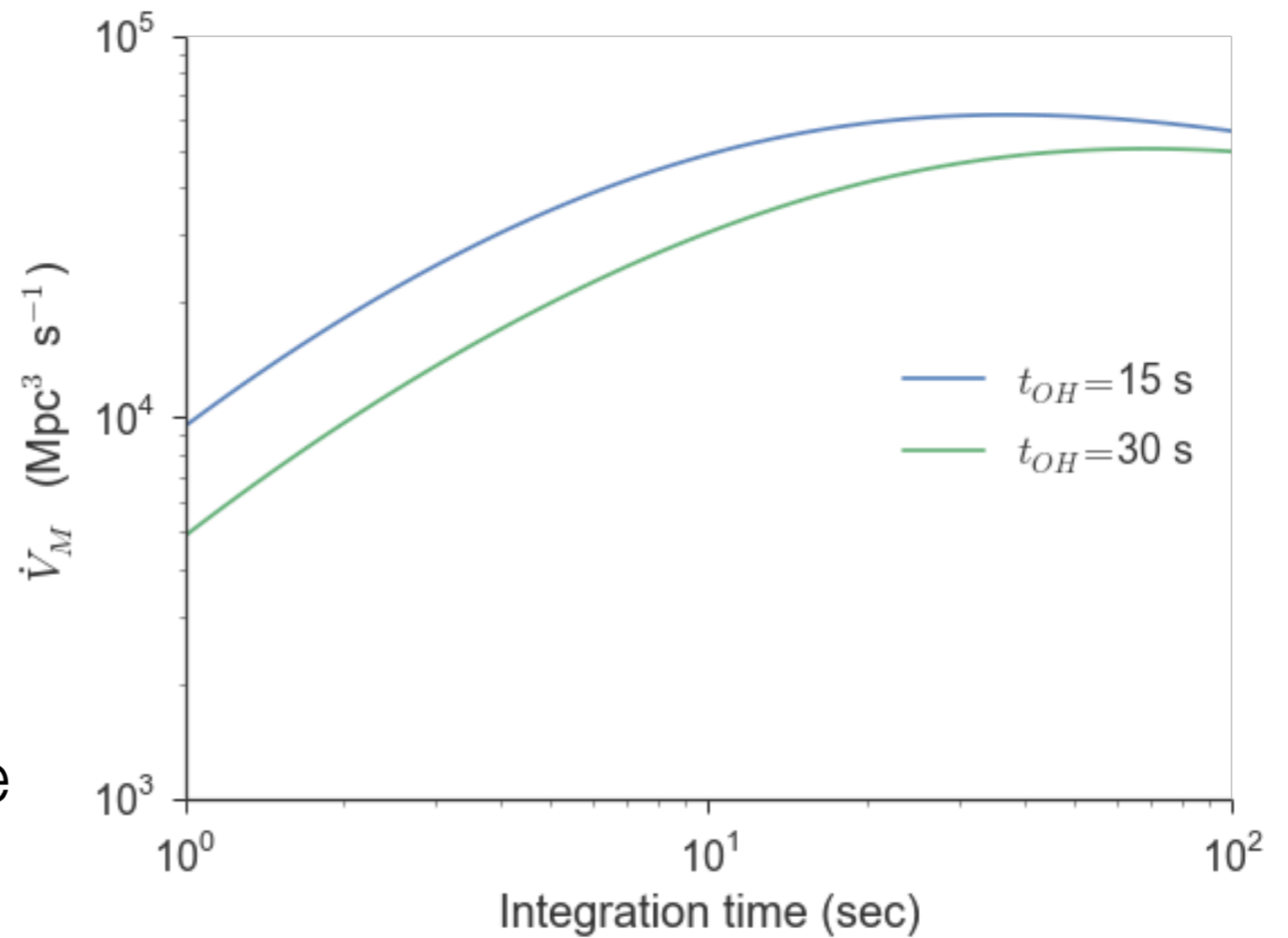
Spatial volume within which a transient of fixed absolute magnitude can be detected, divided by exposure + overhead time

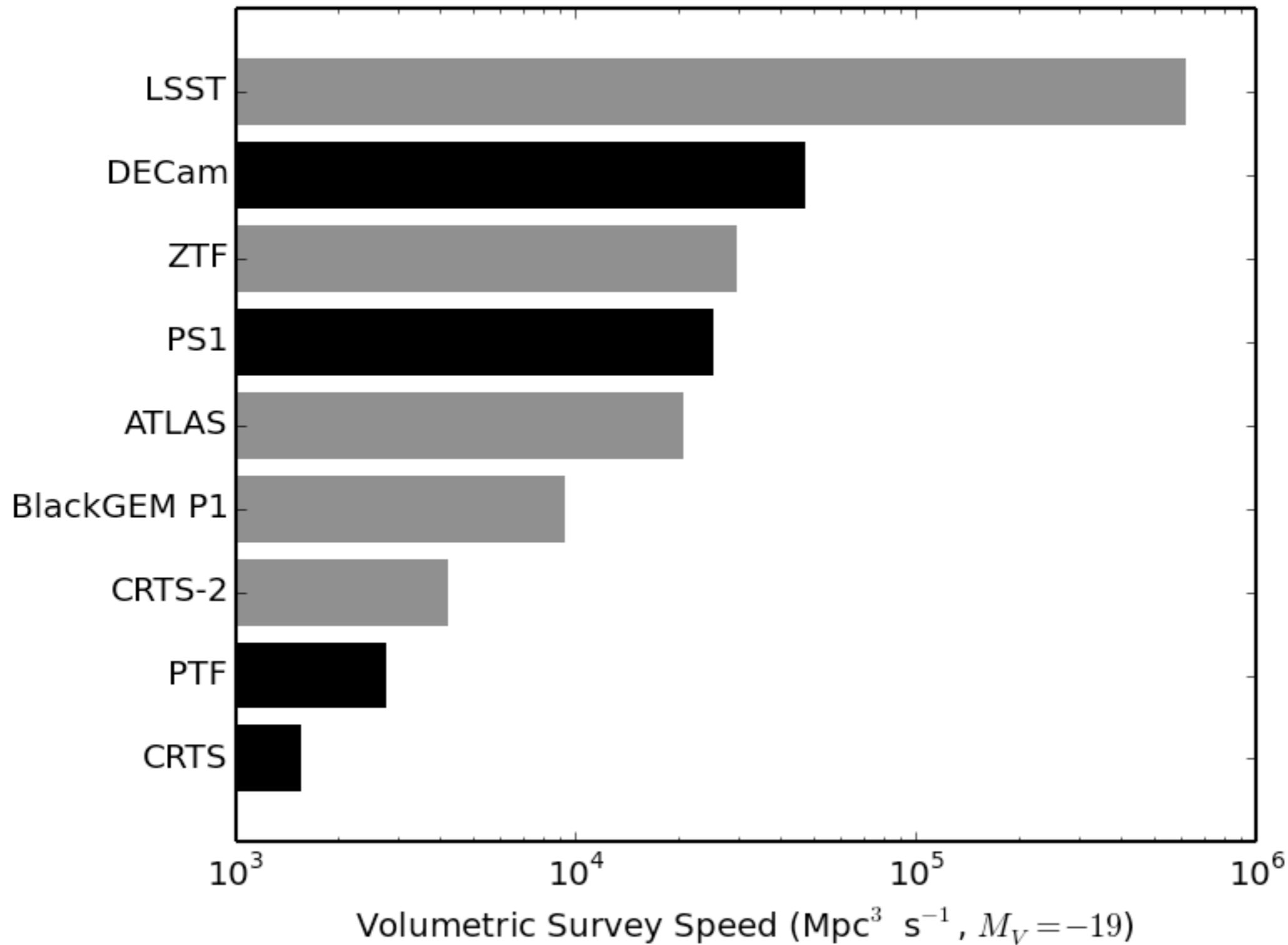roughly **proportional to transient detection rate**

captures:
    field of view
    limiting magnitude
        aperture
        image quality
        sky background
        throughputs
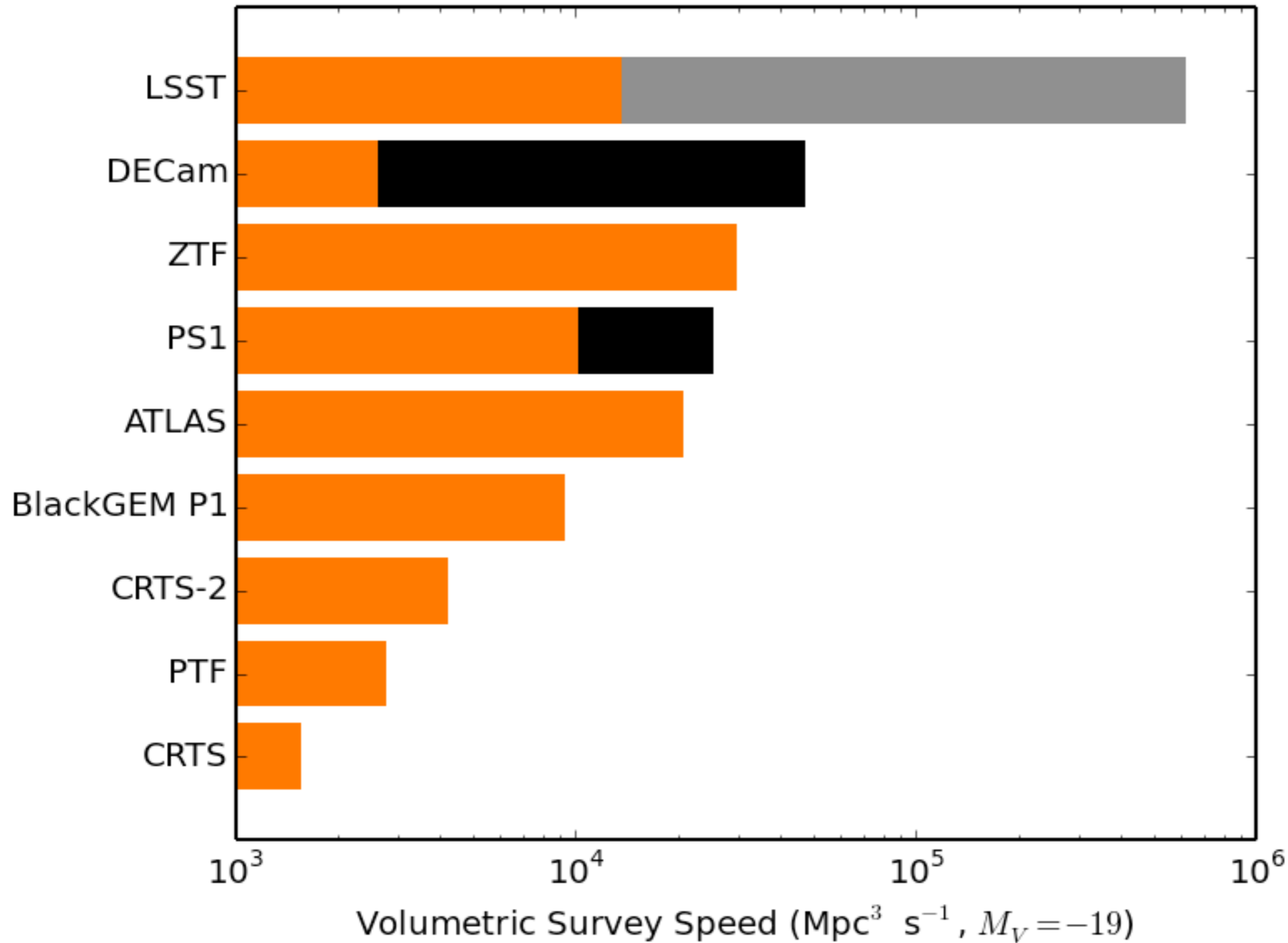   readout & slew overheads

implies optimal exposure time

ZTF will have world-leading speed in finding spectroscopically-accessible transients.

Volumetric Survey Speed (Mpc^3 s^{-1}, $M_V = -19$)

ZTF will have world-leading speed in finding spectroscopically-accessible transients.

Volumetric Survey Speed (Mpc^3 s^{-1}, $M_V = -19$)

ZTF will survey an order of magnitude faster than 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**

3800 deg^2/hour
⇒ 3π survey in 8 hours

~300 observations/field/year
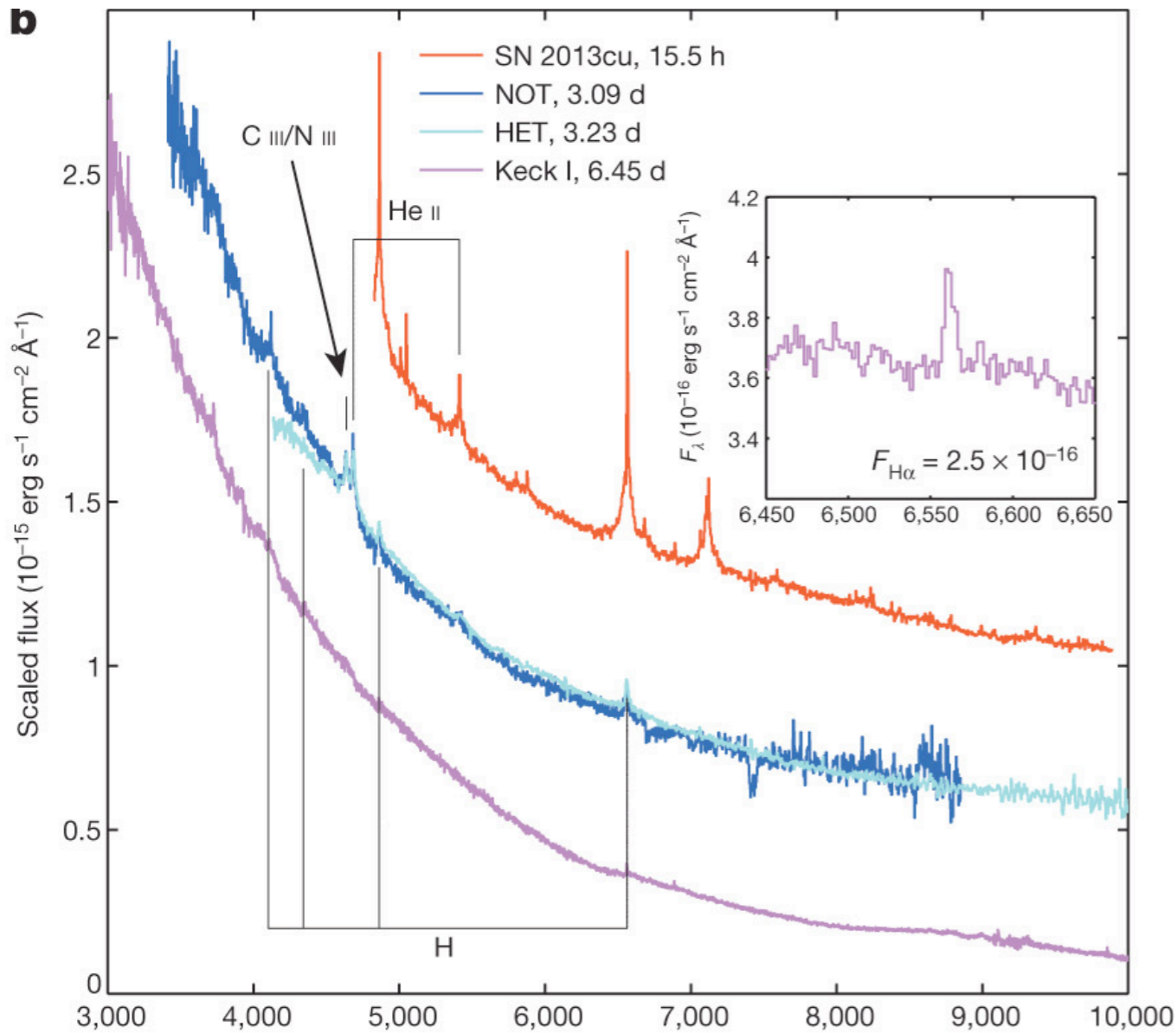for uniform survey
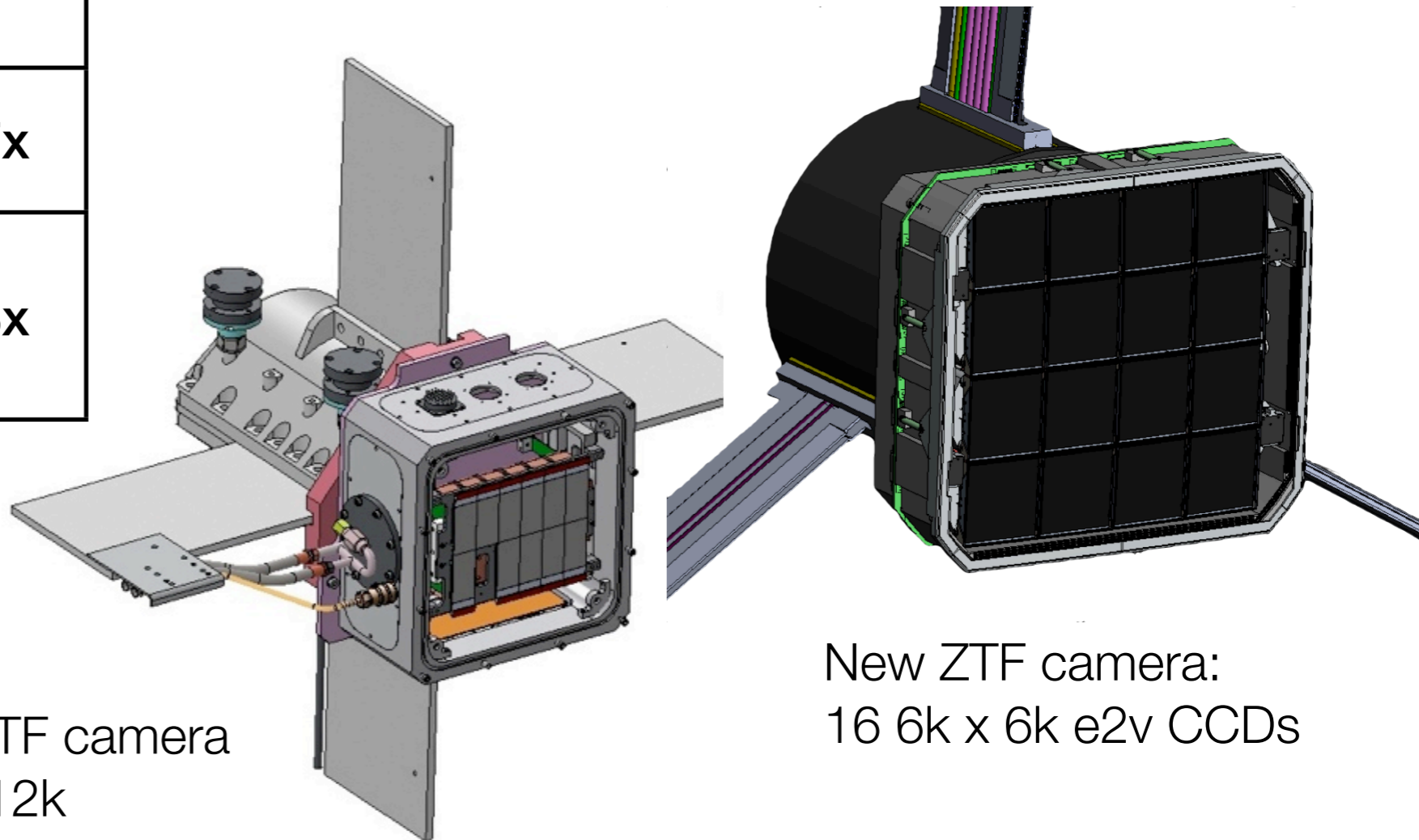
Existing PTF camera
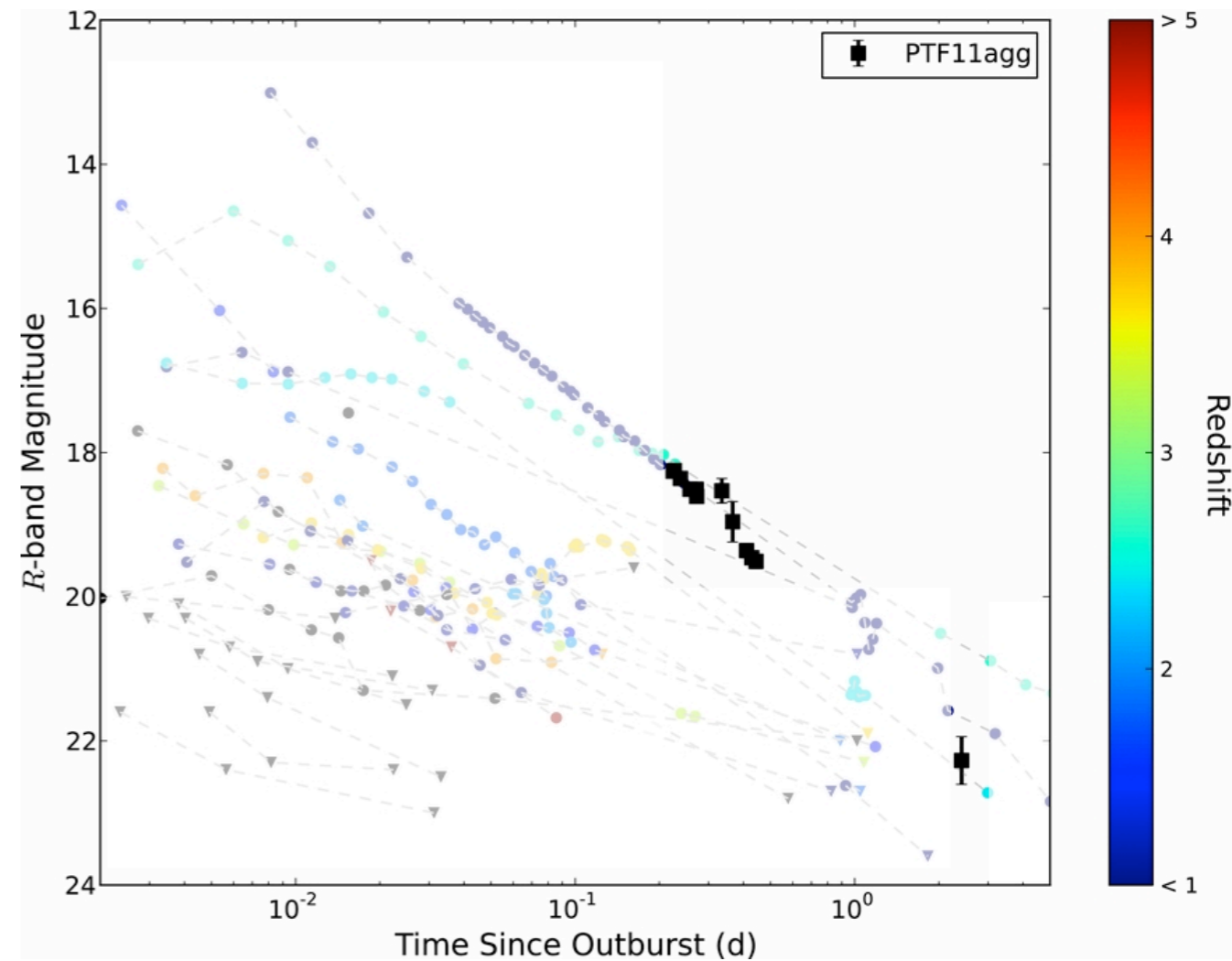MOSAIC 12k

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

ZTF will break new ground in the study of transients.
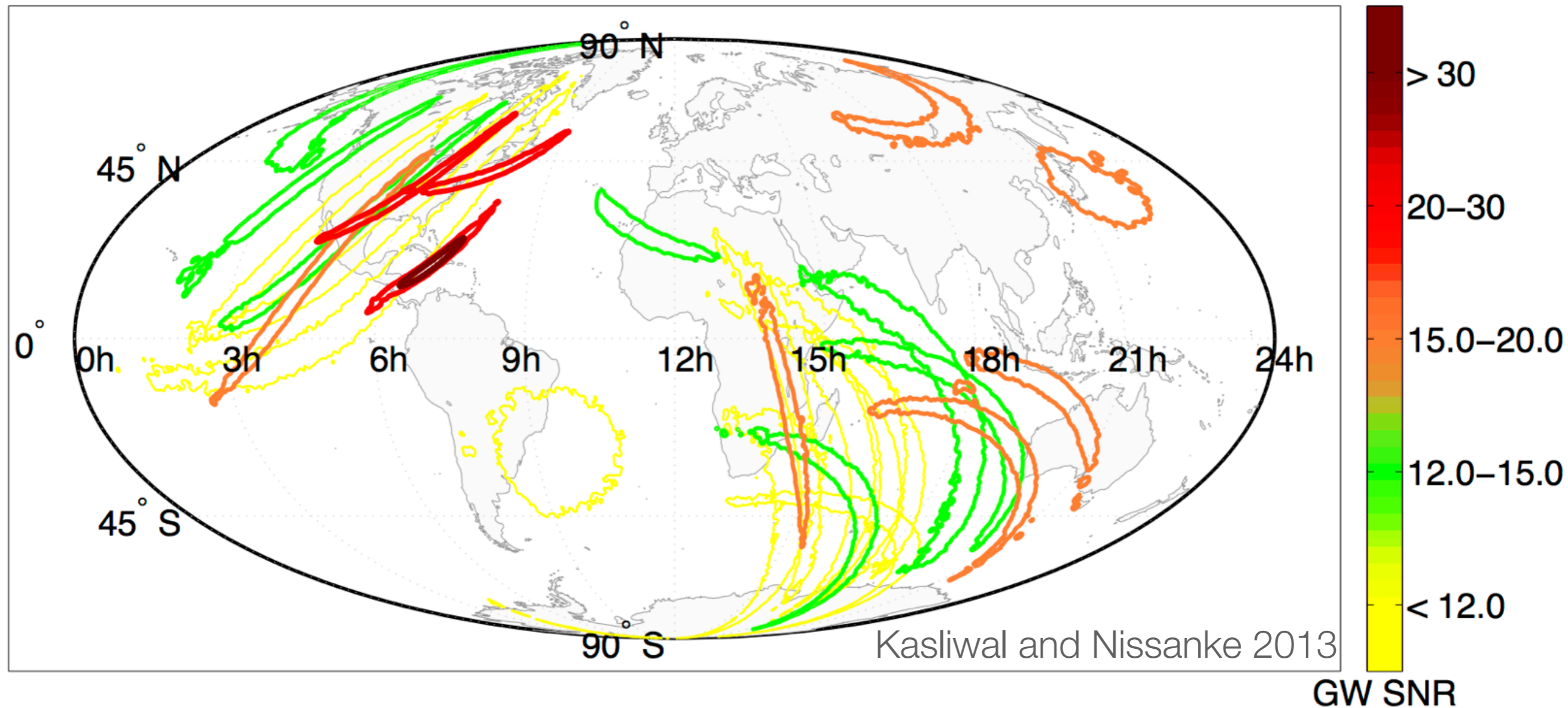
iPTF13ast/SN2013cu (IIb)
Gal-Yam+ 2014

Cenko+ 2013

ZTF will discover a supernova
< 24 hours old *every night*

ZTF will:
Discover 5 GRB orphan
afterglows each year
Discover >20 PTF11agg-like
dirty fireballs each year
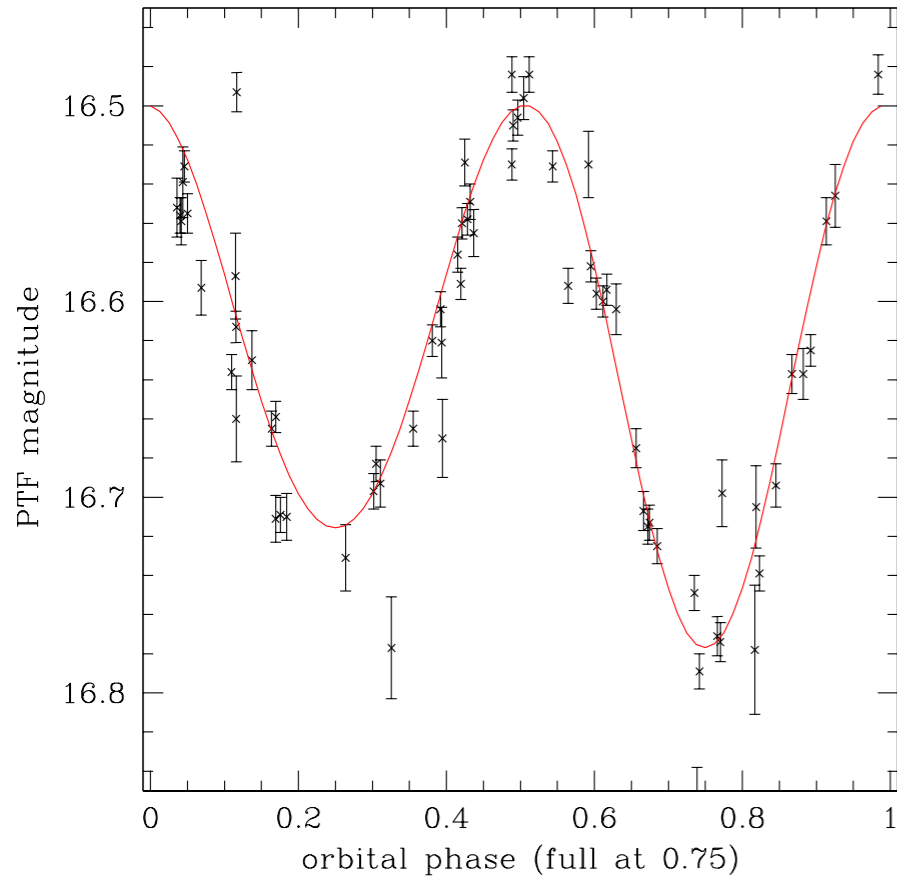
EM counterparts to GW sources will reveal key physics.

Kasliwal and Nissanke 2013

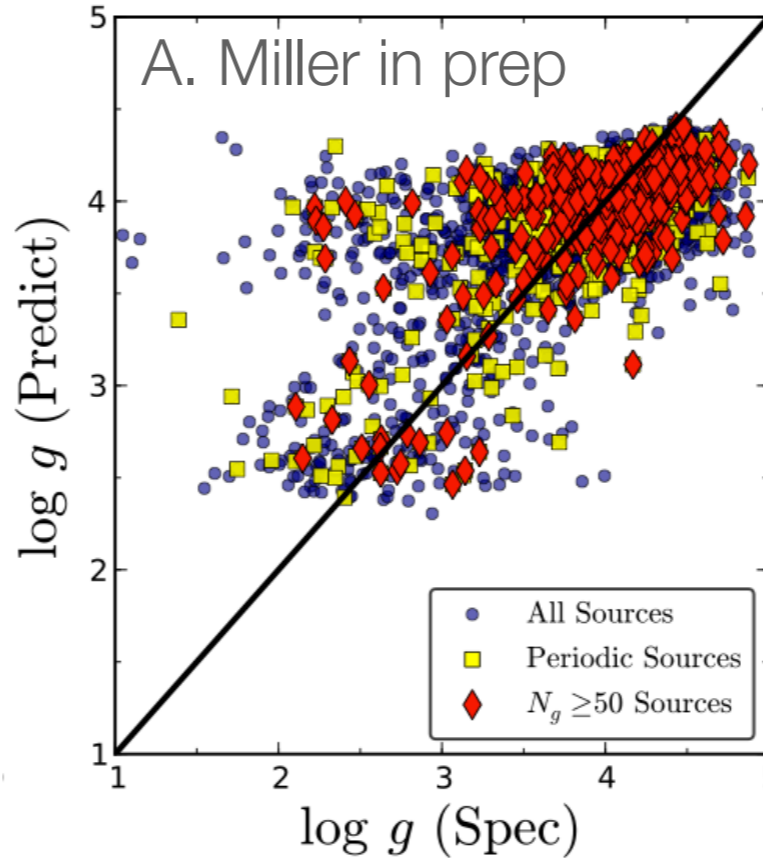ZTF is well-positioned to search for GW counterparts

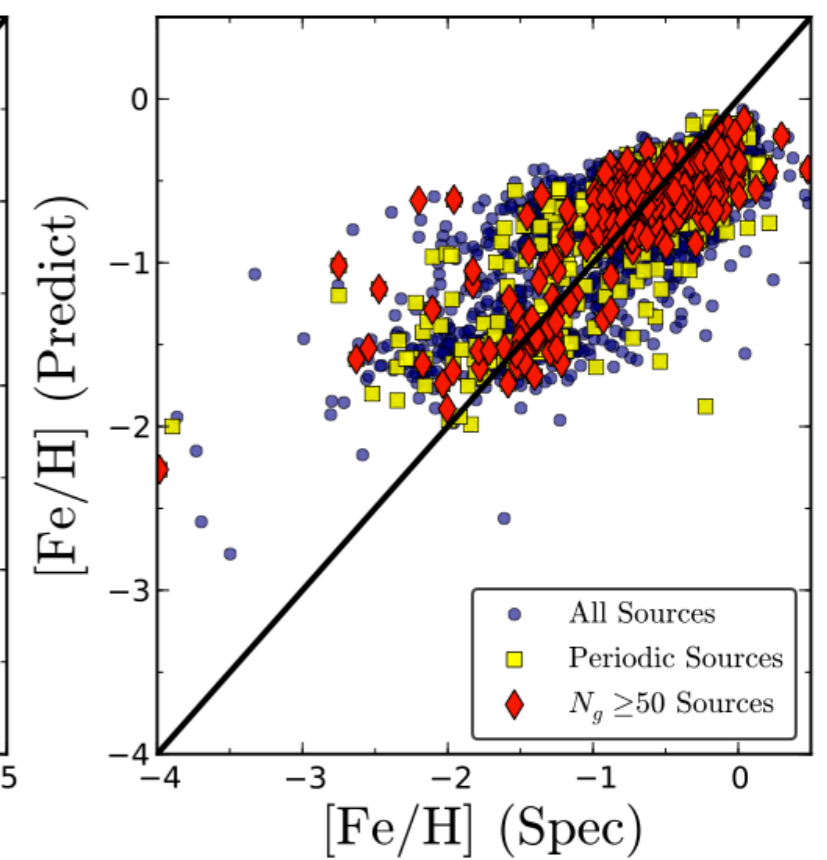# ZTF's variability catalogs will enable great science.

PSR J2129−04

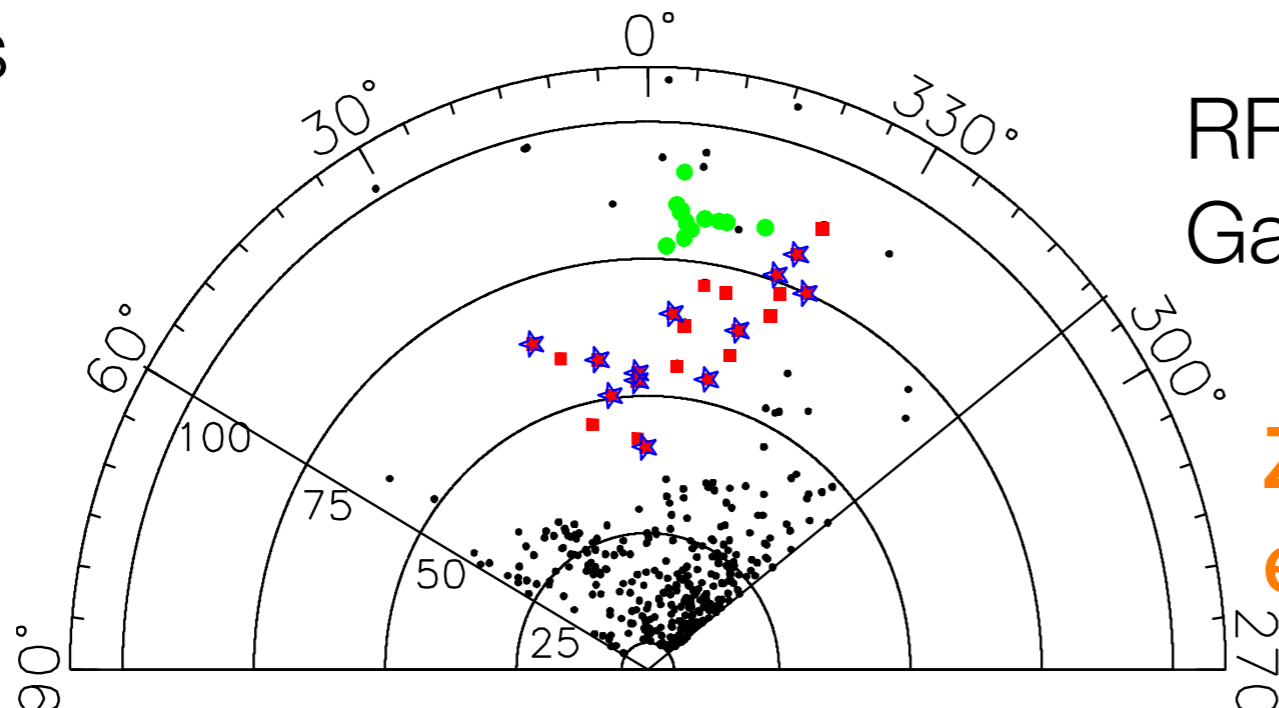A. Miller in prep

identifies compact binaries

variability predicts stellar parameters

B. Sesar

RR Lyr trace Galactic Structure

ZTF will obtain ~300 epochs each year over 3 pi

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ZTF provides the US community a stepping stone to LSST.

PTF: 4×10^4 events/night
ZTF: 3×10^5 events/night
LSST: 2×10^6 events/night

Technical	develop algorithms & software for detection & classification
Scientific	discover new transient & variable phenomena
Organizational	organize collaborations and followup strategies with real data
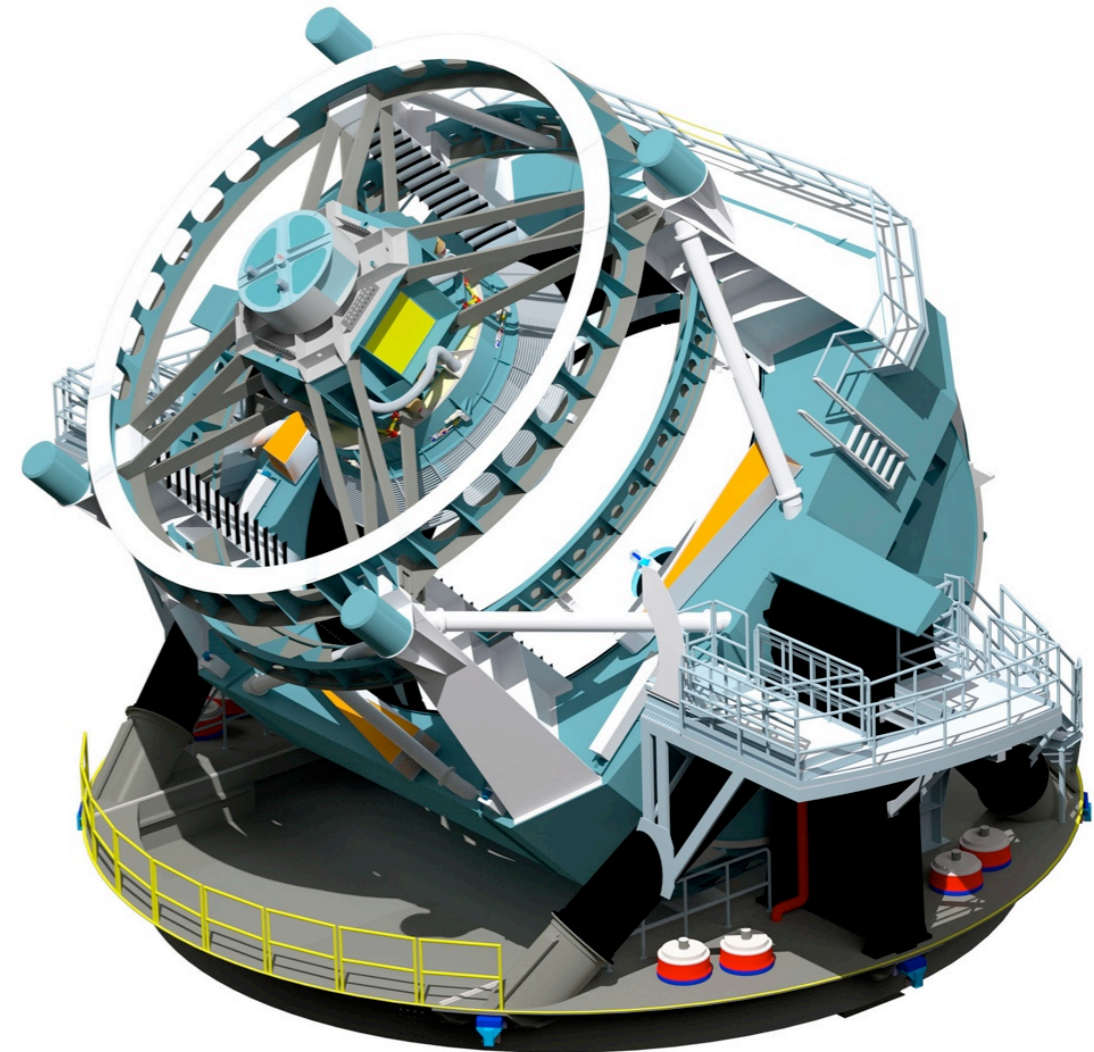
NSF-sponsored summer schools and direct student involvement in ZTF development will prepare a new generation of researchers!