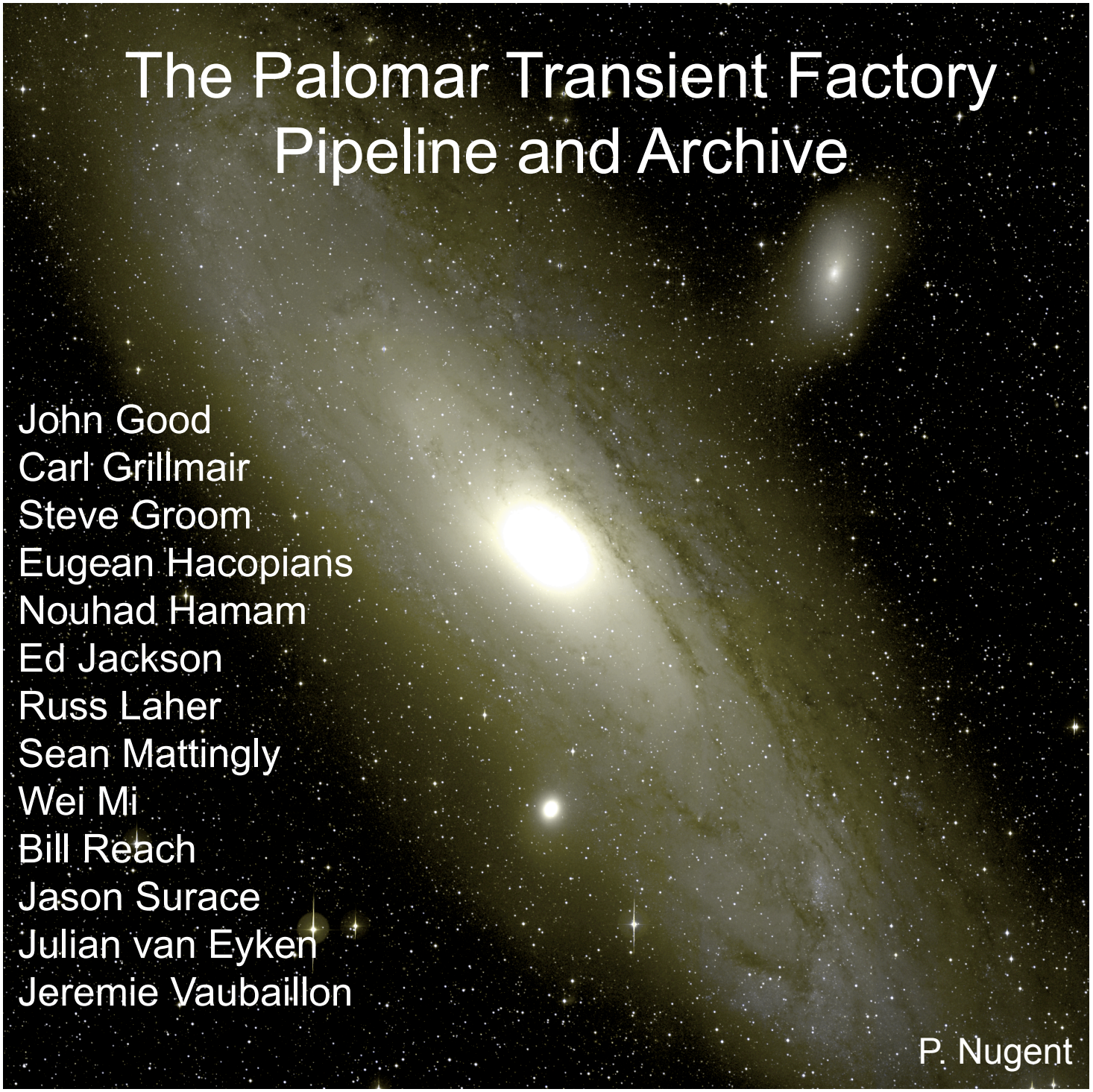
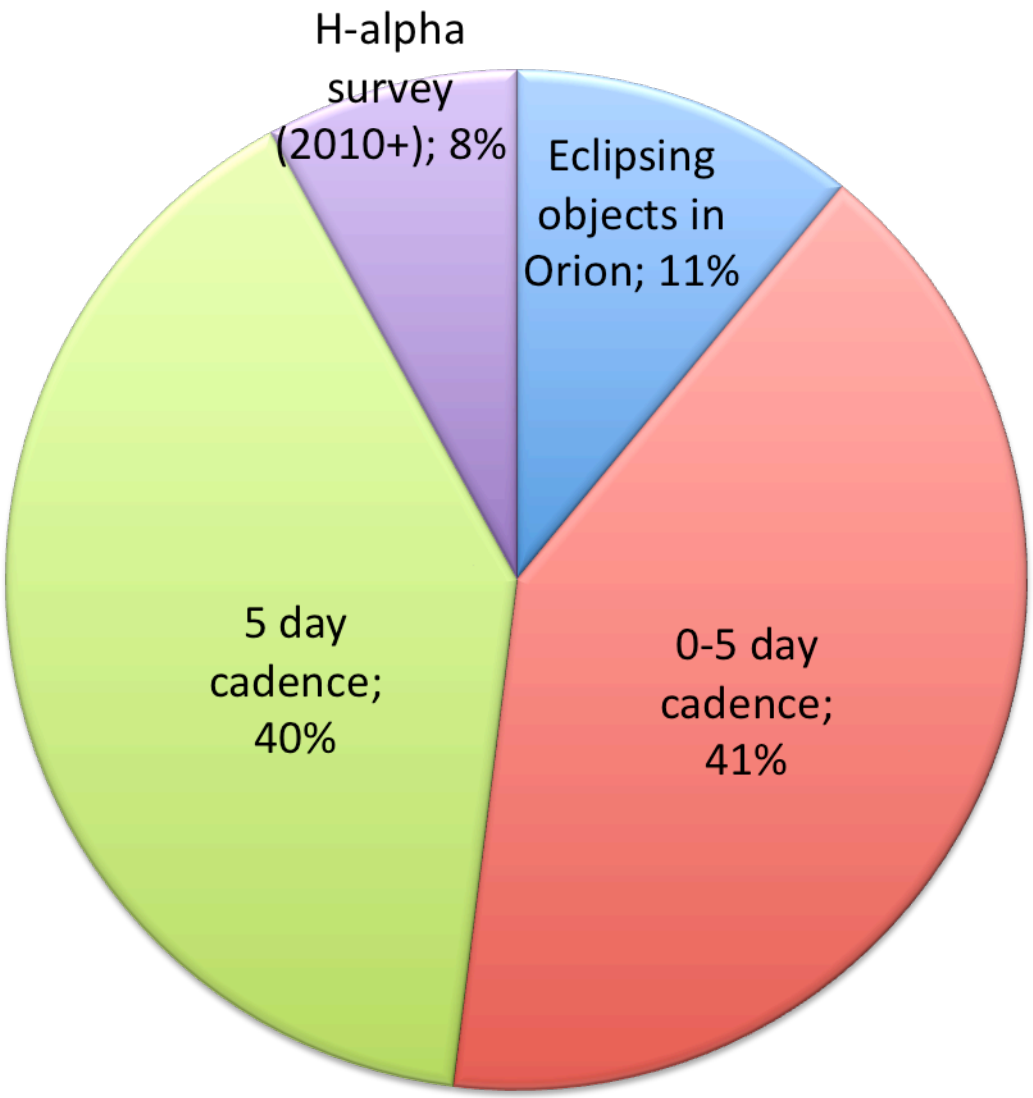

The Palomar Transient Factory
Pipeline and Archive
John Good
Carl Grillmair
Steve Groom
Eugean Hacopians
Nouhad Hamam
Ed Jackson
Russ Laher
Sean Mattingly
Wei Mi
Bill Reach
Jason Surace
Julian van Eyken
Jeremie Vaubaillon
P. Nugent

The Palomar Transient Factory

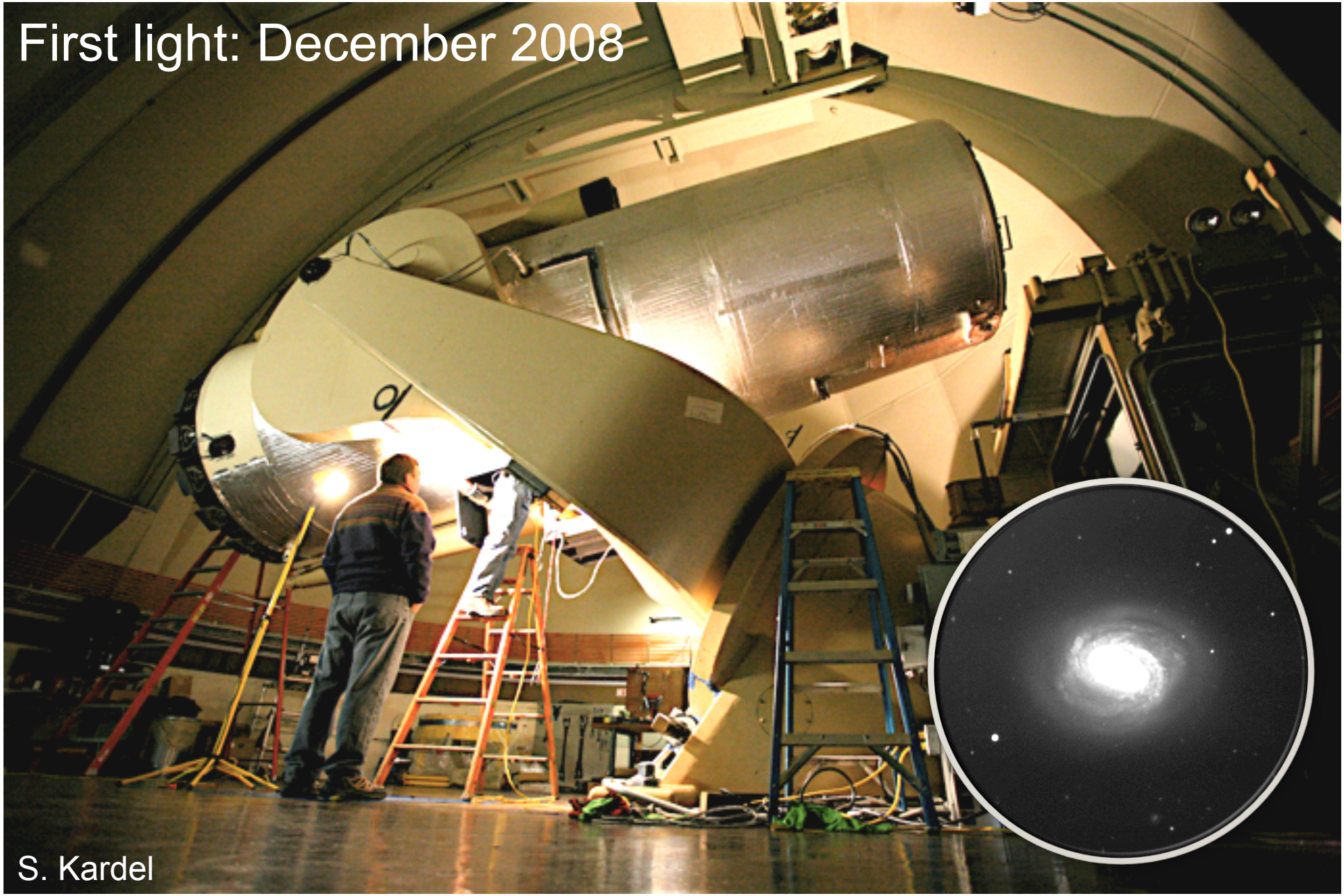
- Wide-angle, variable cadence sky survey
  - 7.8 square degree imager (1” sampling)
  - Uses 80% of Palomar 1.2m Oschin telescope time for five years
- Realtime transient detection
- Realtime, automated transient classification
- Automated followup using multiple facilities
- Searchable archive of every detected source in every frame



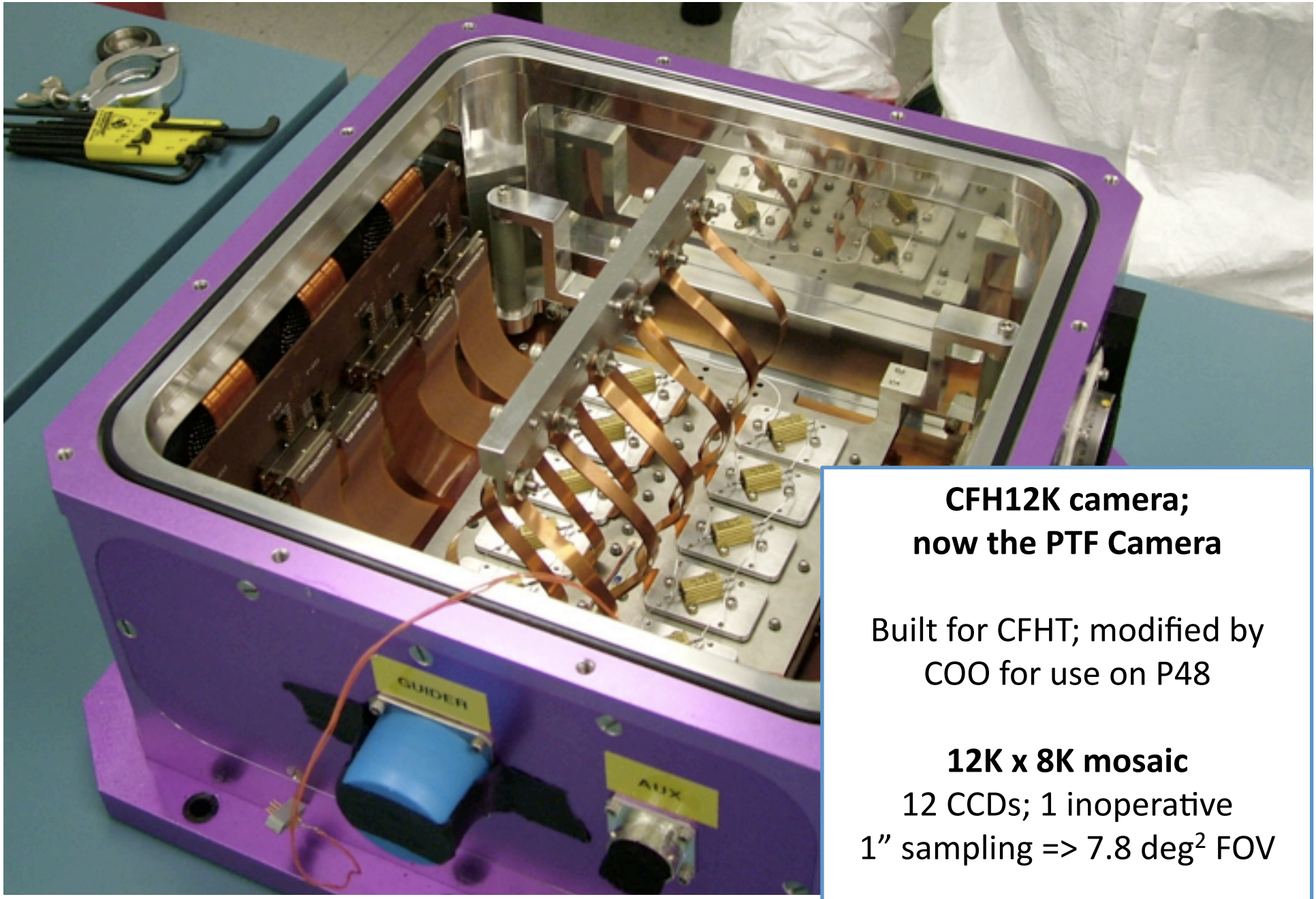
PTF Key Projects	
Various SNe	Dwarf novae
Transients in nearby galaxies	Core collapse SNe
RR Lyrae	Solar system objs
CVs	AGN
AM CVn	Blazars
Galactic dynamics	LIGO & Neutrino transients
Flare stars	Hostless transients
Nearby star kinematics	Orphan GRB afterglows
Rotation in clusters	Eclipsing stars and planets
Tidal events	H-alpha ½ sky survey


P48
primary survey
telescope
P60
primary
followup
telescope

First light: December 2008



S. Kardel

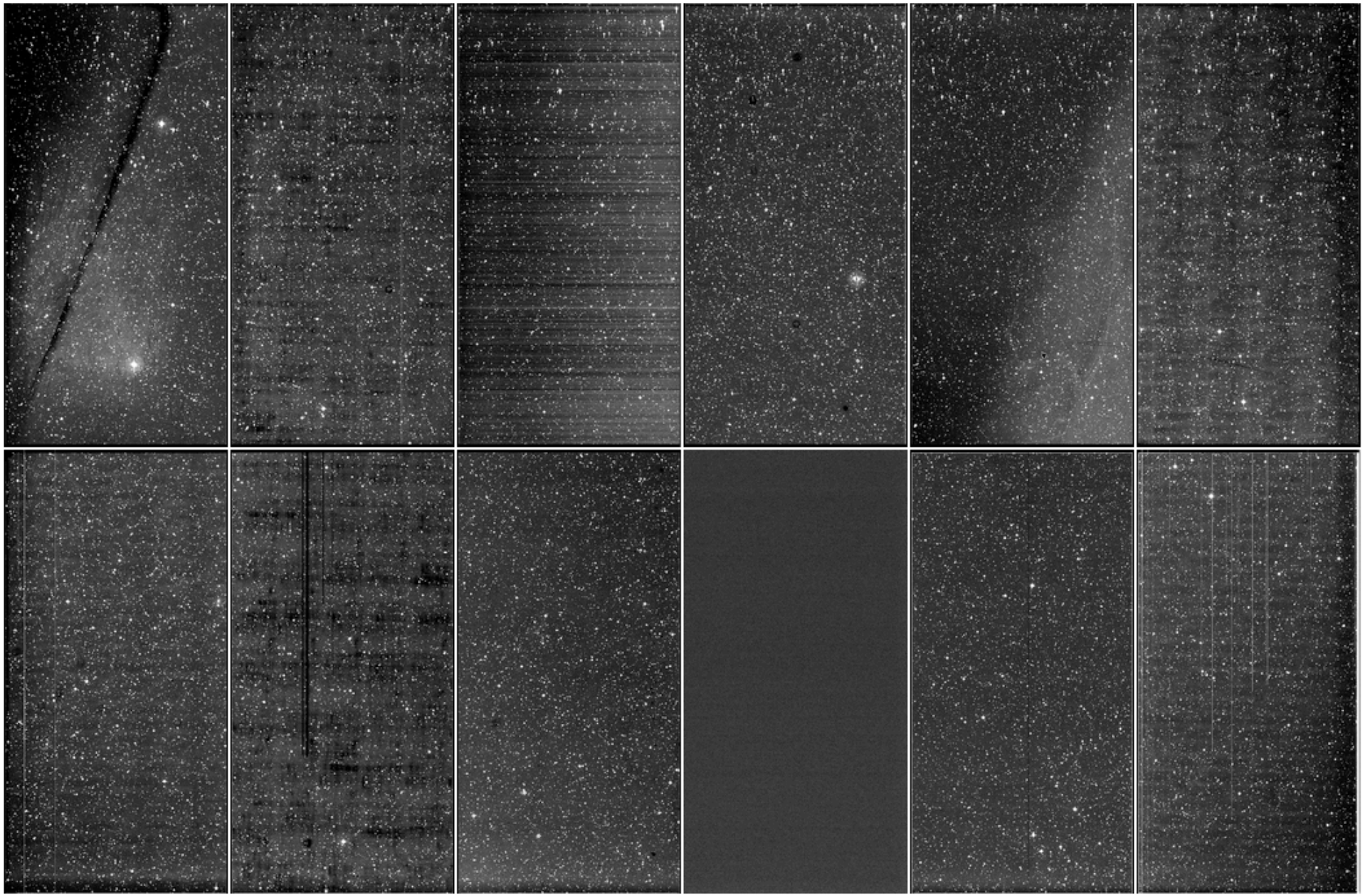


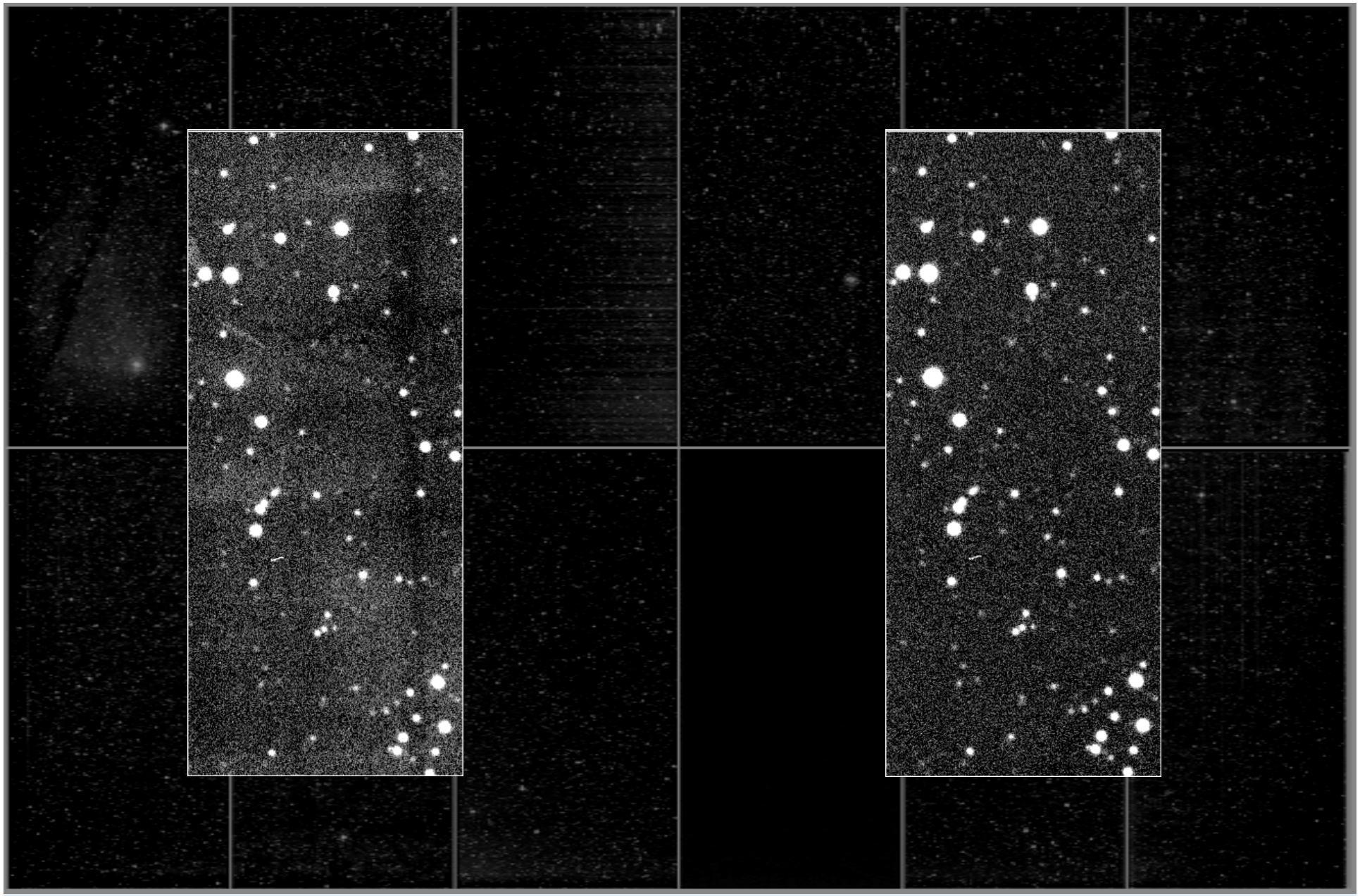
CFH12K camera;
now the PTF Camera

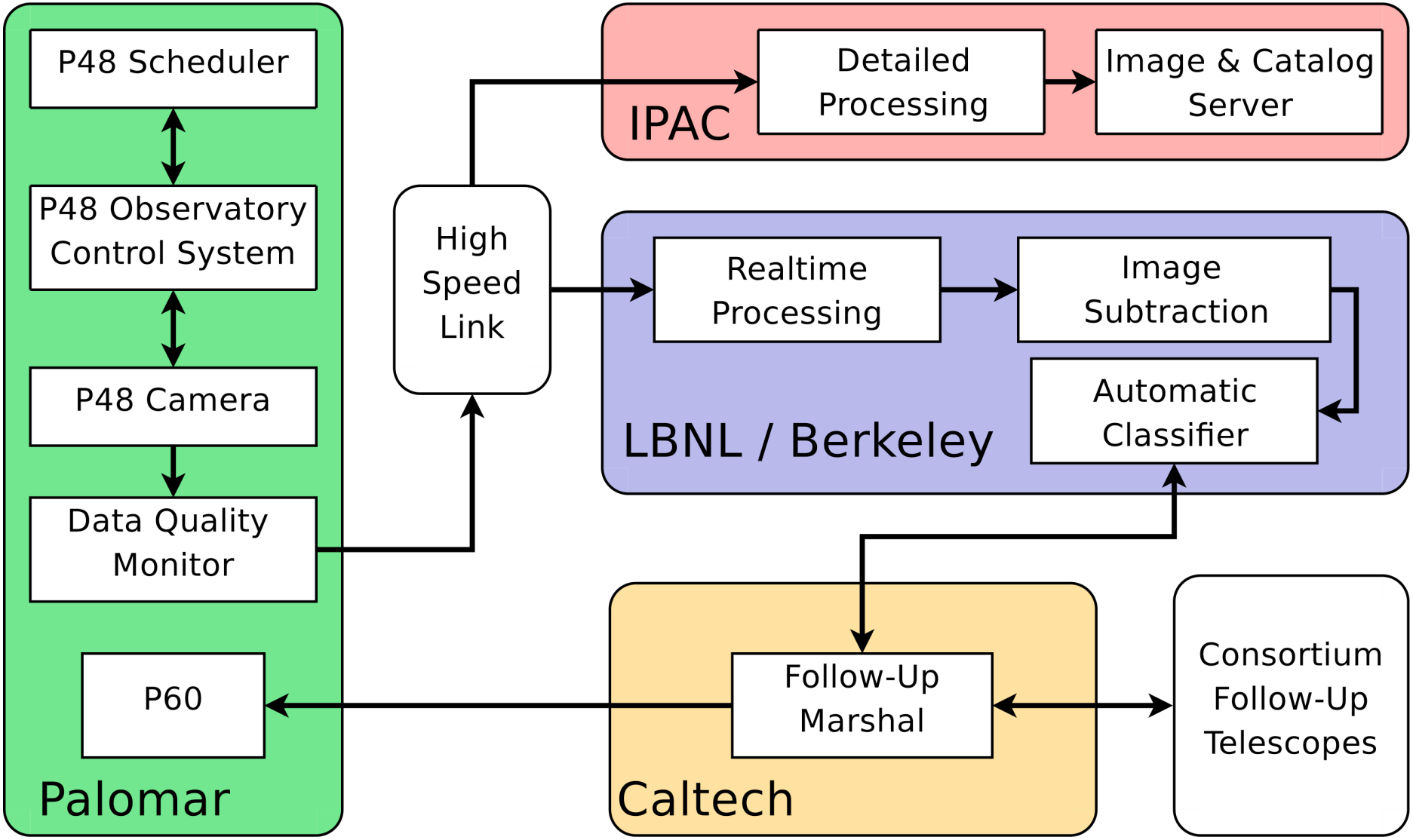
Built for CFHT; modified by COO for use on P48

12K x 8K mosaic
12 CCDs; 1 inoperative
1” sampling => 7.8 deg^2 FOV

Reaches m_r=21 in 60s





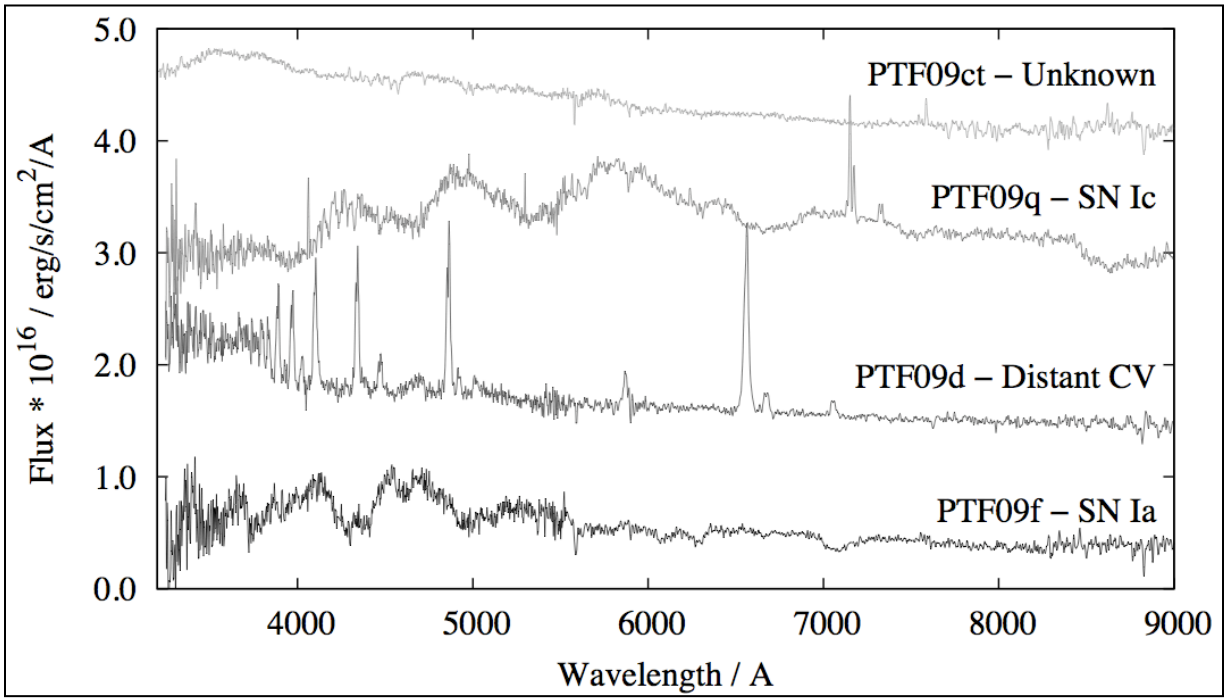

P48 Scheduler
P48 Observatory Control System
P48 Camera
Data Quality Monitor
P60
Palomar
High Speed Link
IPAC
Detailed Processing
Image & Catalog Server
LBNL / Berkeley
Realtime Processing
Image Subtraction
Automatic Classifier
Caltech
Follow-Up Marshal
Consortium Follow-Up Telescopes

PTF Project Schedule

Project startup	**Summer**	**2007**
First light	**13 Dec**	**2008**
Commissioning start	**12 Jan**	**2009**
1st Science experiment start	**15 Feb**	**2009**
1st Confirmed transient detection	**2 March**	**2009**
Commissioning end	**May**	**2009**

PTF discoveries to date

Transient type	#
SN 1a	23
SN II	6
SN IIn	1
SN Ic	1
Unknown SN	1
CV	3
Rather weird	1



- All from < 6 nights of data during commissioning (low efficiency)
- Released in ATels 1964, 1983, 2005

IPAC Data Volumes

- In production mode, PTF will generate ~60GB of raw data per night on average.
- Peak volumes will approach ~100 GB on clear winter nights.
- All raw and processed data will be stored at IPAC.
- A total of ~300 TB of raw and processed imaging data will be stored over course of the 5-year survey.

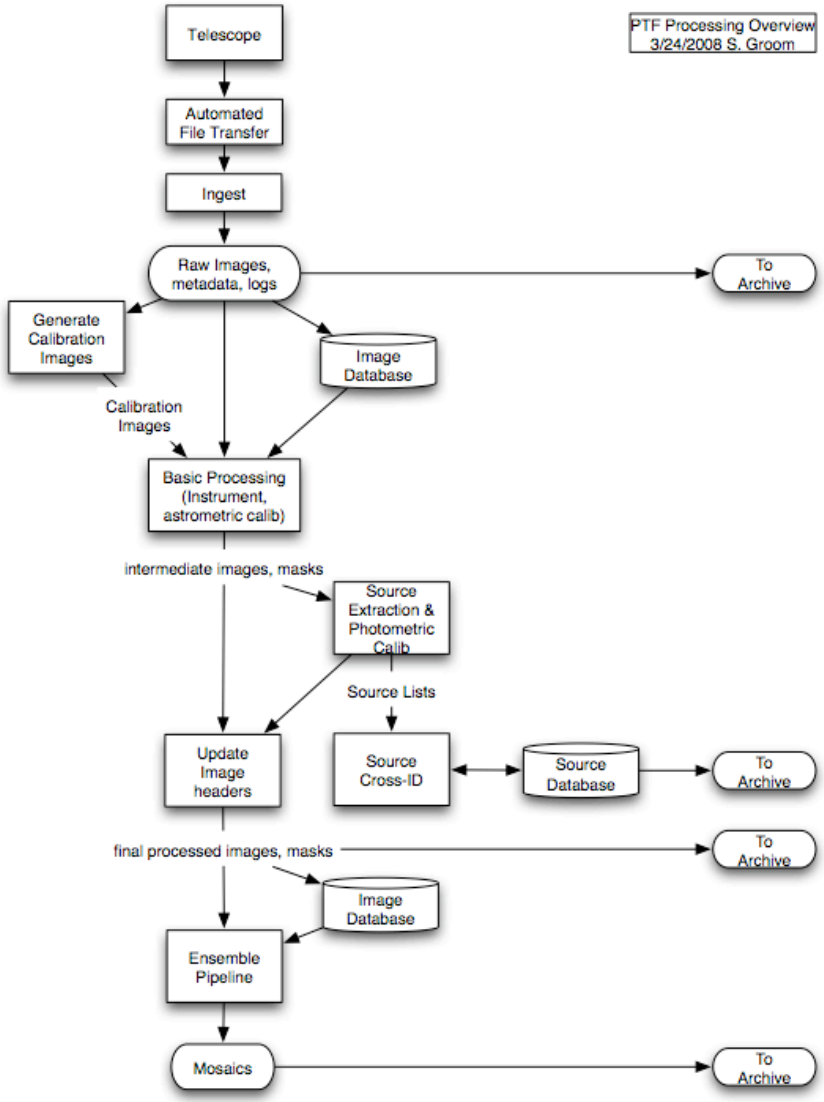
	2MASS	SDSS	HST	Spitzer
Images	40x	40x	10x	16x
Database Records	60x	140x	N/A	N/A

PAN-STARRS will produce data at a much higher rate (camera has 10x as many pixels), but discards nearly all of it.

IPAC Hardware

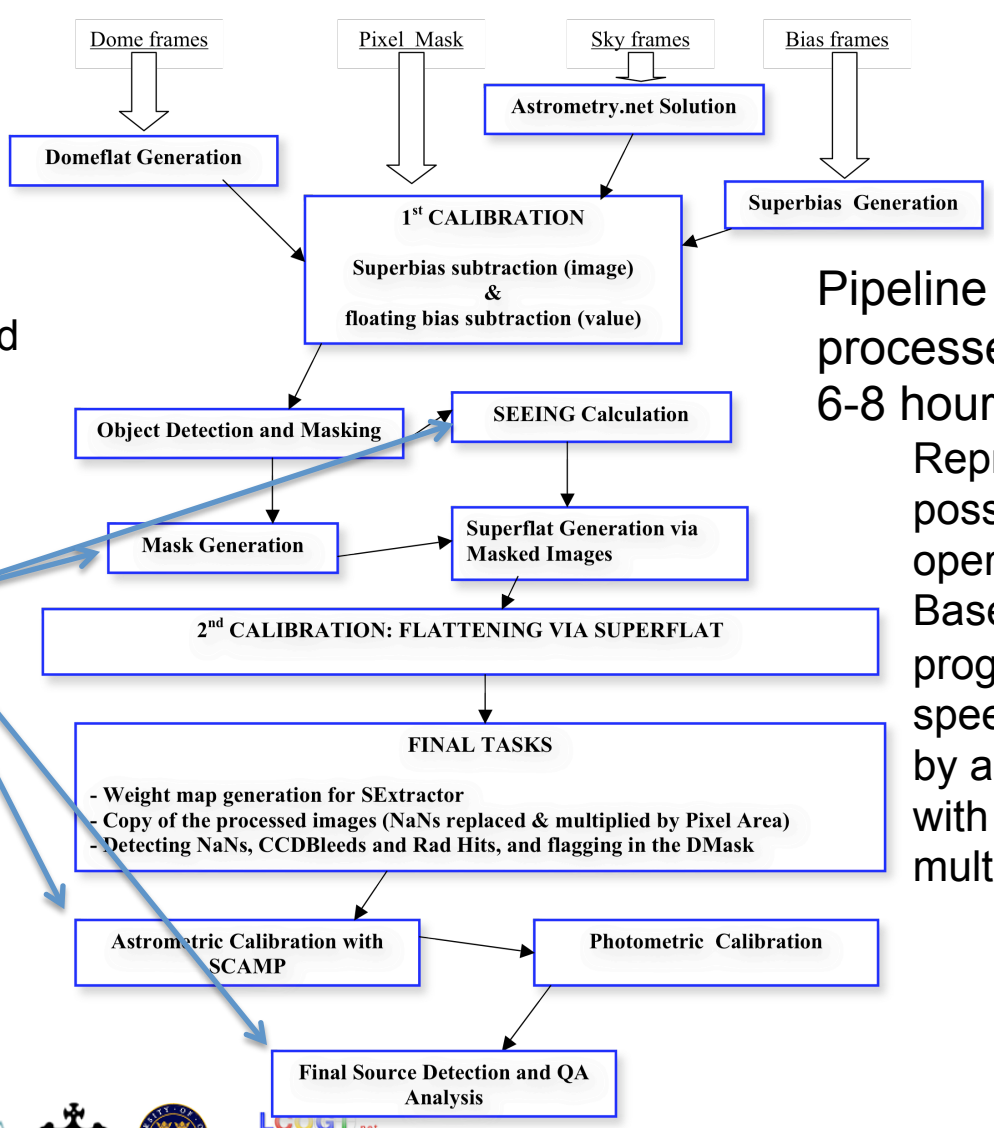
- PTF Pipeline hardware currently includes:
  - 12 Sunfire x4150 8-core pipeline drones
  - 2 Sunfire x4150 DBMS servers
  - 1 Sunfire x4150 operations file server (software, sandboxes)
  - 2 Nexsan SATAbeasts 42TB connected to IRSA file server for raw and processed data (currently on-loan from Spitzer – will be replaced in 100TB increments next year)
  - 2 Sun 2540 6TB raid arrays for DBMS storage
  - 4 Nexsan SATAblades for primary file server (software, sandboxes)
  - 2 Nexsan SATAblades for secondary database
- Will require an additional 260 TB of storage to complete the survey.
- Redundancy for failover capacity of both cpu and disks. Worst case is a database failure, but the archive and working databases can be rebuilt from each other.

Overall Data Flow



Pipeline

modules written in C. These carry out basic functions, and are a combination of in-house and community software (notably Sextractor, Scamp, and Astrometry.net)



Sextractor

Pipeline currently processes a night's data in 6-8 hours.

Reprocessing will be possible during normal operations.

Based on tests in progress, processing speed will likely improve by a factor of two or more with the application of multi-threading.

Calibration

- Though there are no set requirements, the goal is to obtain 2% photometry consistently.
- Analysis of pipeline-generated flat fields currently indicates stability of 0.5-1%.
- Photometric calibration will be carried out using either observed SDSS fields, or if possible, saturated Tycho stars.
  - By virtue of their high surface density and all-sky distribution, Tycho stars may enable us to obtain accurate photometry even on traditionally non-photometric nights.
- If SDSS fields are used, non-SDSS fields will be calibrated by computing nightly extinction coefficients.

Database

- While IRSA continues to use Informix, the PTF operations database is being run under Enterprise PostgreSQL
  - Development has been under mixed database architecture.
- The primary Sources table will contain astrometry and photometry of every source detection over the course of the survey.
  - This table, with between 20 and 40 billion rows, will be among the largest tables ever created.
  - Load testing underway to address speed/scalability issues.
- A source association pipeline, run nightly, will generate a Merged Sources table, which will provide time-series photometry for every source detected.
  - This is expected to be the primary science output of the IPAC pipeline.
  - Exploring techniques under development for LSST for handling this *quickly*

IRSA Interface

IRSA will provide a Gator-like interface to enable collaboration astronomers (and later the public) to retrieve raw and processed images, image cut-outs, supermosaics, and query tables by position, color, degree of variability, time, etc.