The PTF Orion Program

Julian van Eyken
NExScI, Caltech

David Ciardi (P.I.), Rachael Akeson,[1] Charles Beichman,[1] Andy Boden,[1] Kaspar von Braun,[1] Stephen Kane,[1] Peter Plavchan,[1] Solange Ramirez,[1] Louisa Rebull,[2] John Stauffer[2], and the PTF collaboration

[1]NExScI, Caltech; [2]Spitzer Science Center, Caltech.

Sagan Symposium, November 2009

Outline

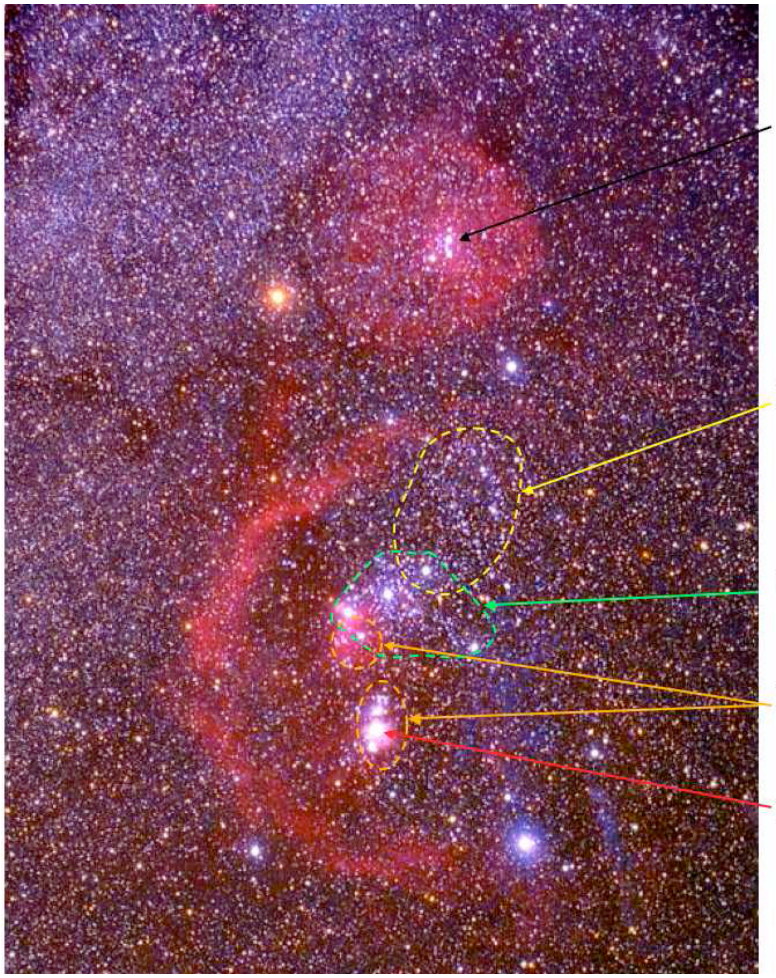
- Science goals
- Observing strategy
- Choosing a field
- Differential pipeline
- Test data results

Palomar Transient Factory

- New wide field camera, on Palomar 48"
- 7.7 deg^2 FOV, 1" pixels
- Search for transients
- Realtime classification
- Automated remote operation/followup

PTF Orion

- Planet-search/stellar astrophysics around young stars
- 40 nights/yr for 3 years.



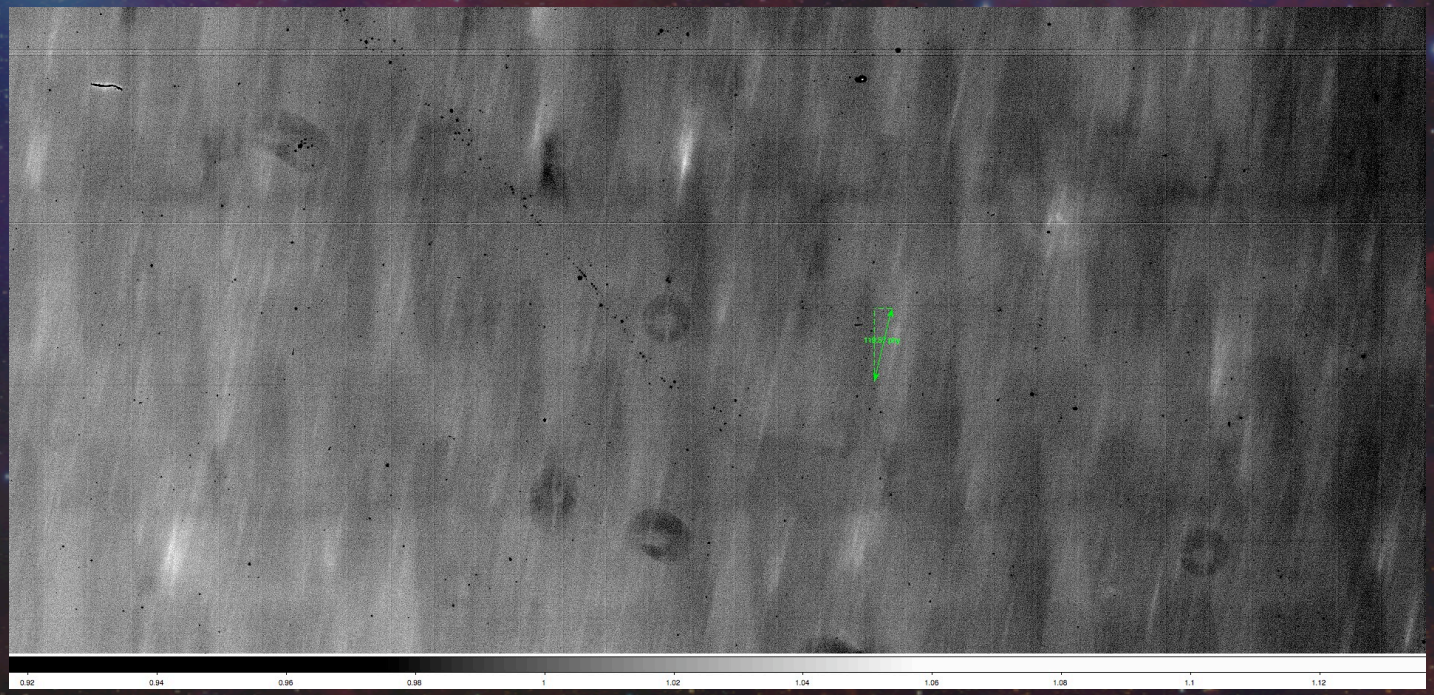
Approx. ages of Orion OB1 association subgroups (from Bally, 2008)

Science Goals

- Detect exoplanets around stars of ages 5 - 10 Myr
  - Giant planet formation & migration timescales are an open topic
  - Radial velocity variability limits RV precision
  - Extinction limits number of stars within brightness limit of RV techniques
  - Large PTF FOV enables survey of thousands of stars
- Stellar astrophysics
  - Identification and characterization of eclipsing binary systems suitable for testing of star formation/evolution models
  - Characterization of activity and rotational periods of young stars.
  - Identification and characterization of new young stellar objects via variability.
- Other science by PTF collaboration as interest drives

Observing Strategy

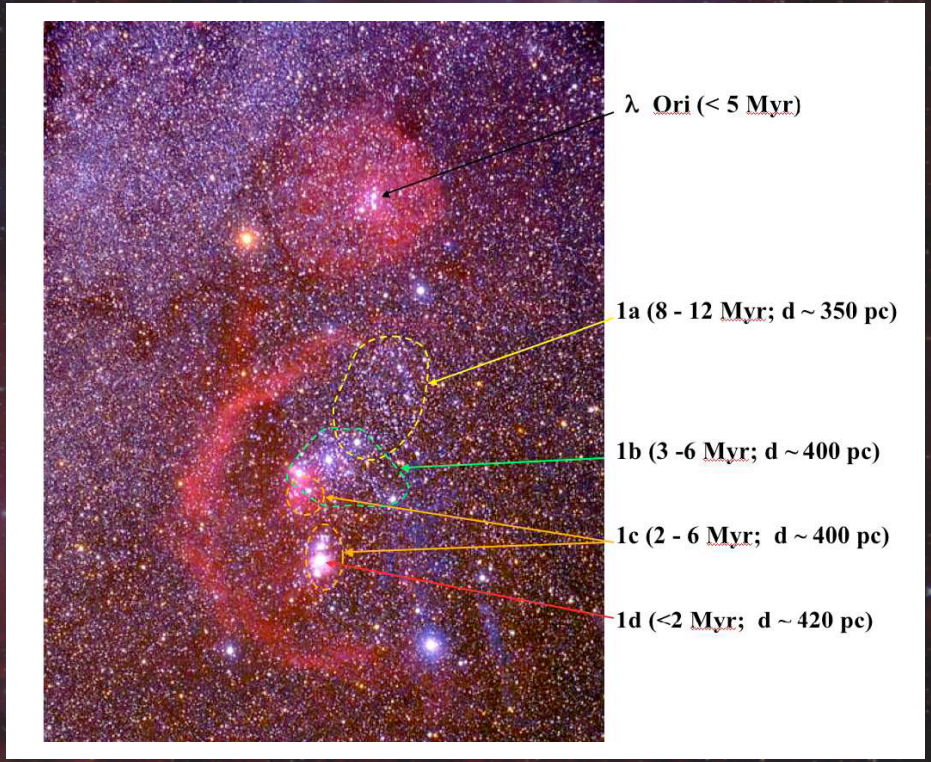
- Single field in Orion
  - Continuous coverage, ~30sec exposures
  - 40 nights, R filter
  - Single g' & Hα frames
- Room for other observing on same night – *important for flatfielding.*
- Need **defocus observing mode**
- **Need autoguiding/auto-exposure time**



Automatic pipeline flatfield – star streaks….

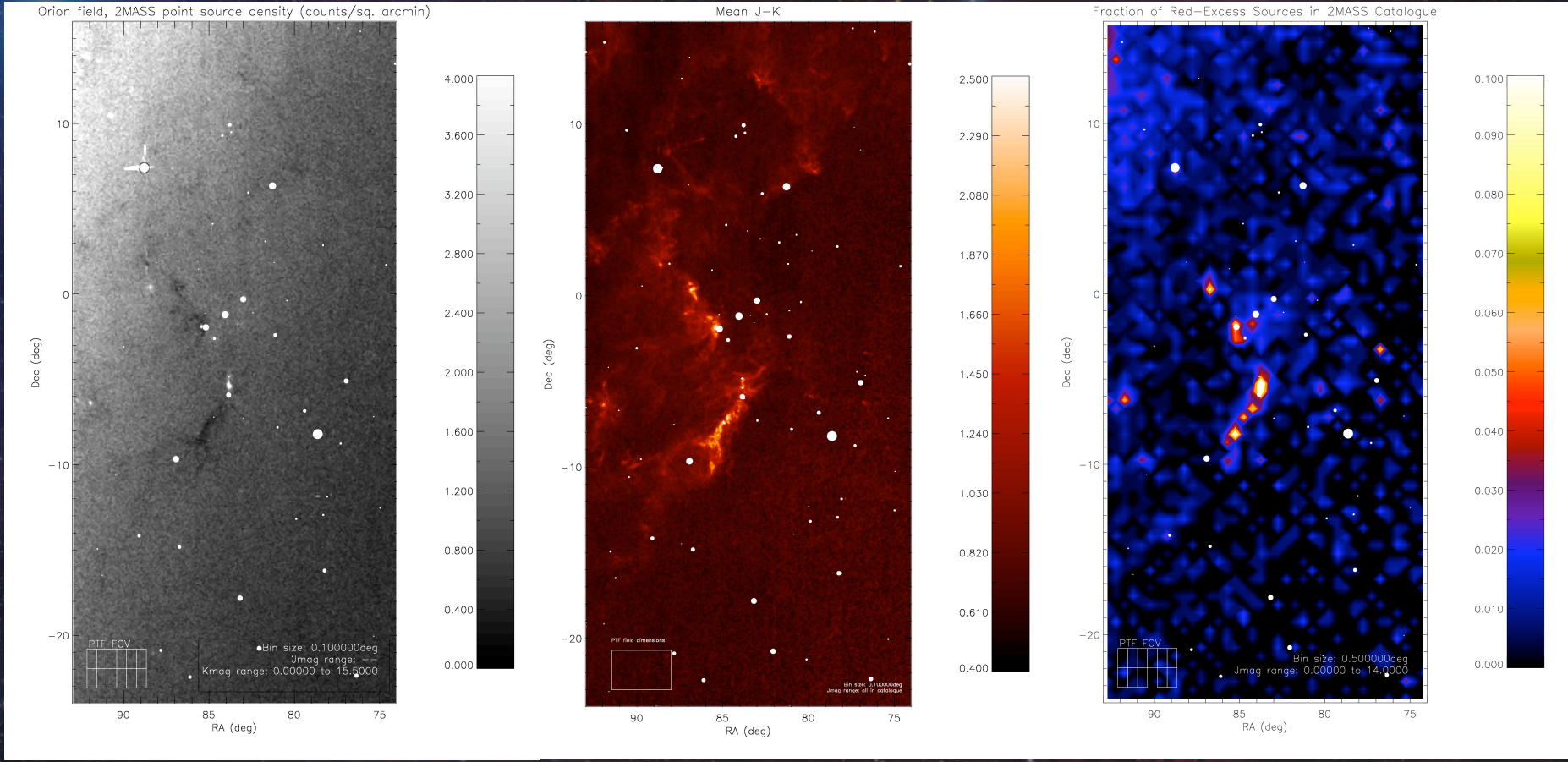
Choosing a Field

- Select stars ~5-10 Myr old
- Need to balance
  - Age
  - Spatial density
  - Magnitude distribution
  - Intrinsic variability
  - Not too redenned
- Expect ~50-100,000 stars
  - ~30 sec exposures
  - $14 \leq r \leq 19$ mag
  - ~15-30% with <1-2% precision



Approx. ages of Orion OB1 association subgroups (from Bally, 2008)

Choosing a field – 2MASS catalogue

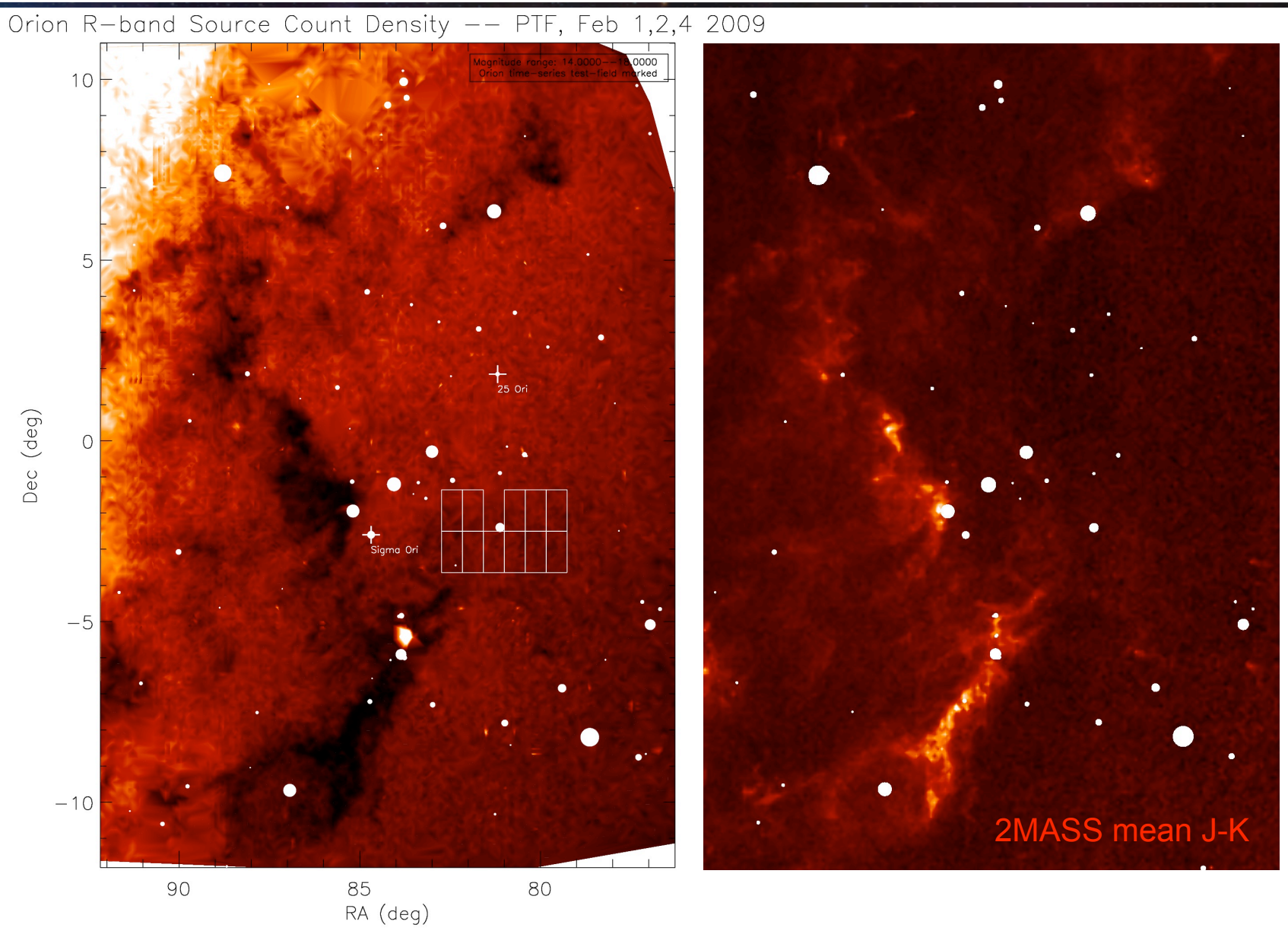


Source count density

Mean J-K

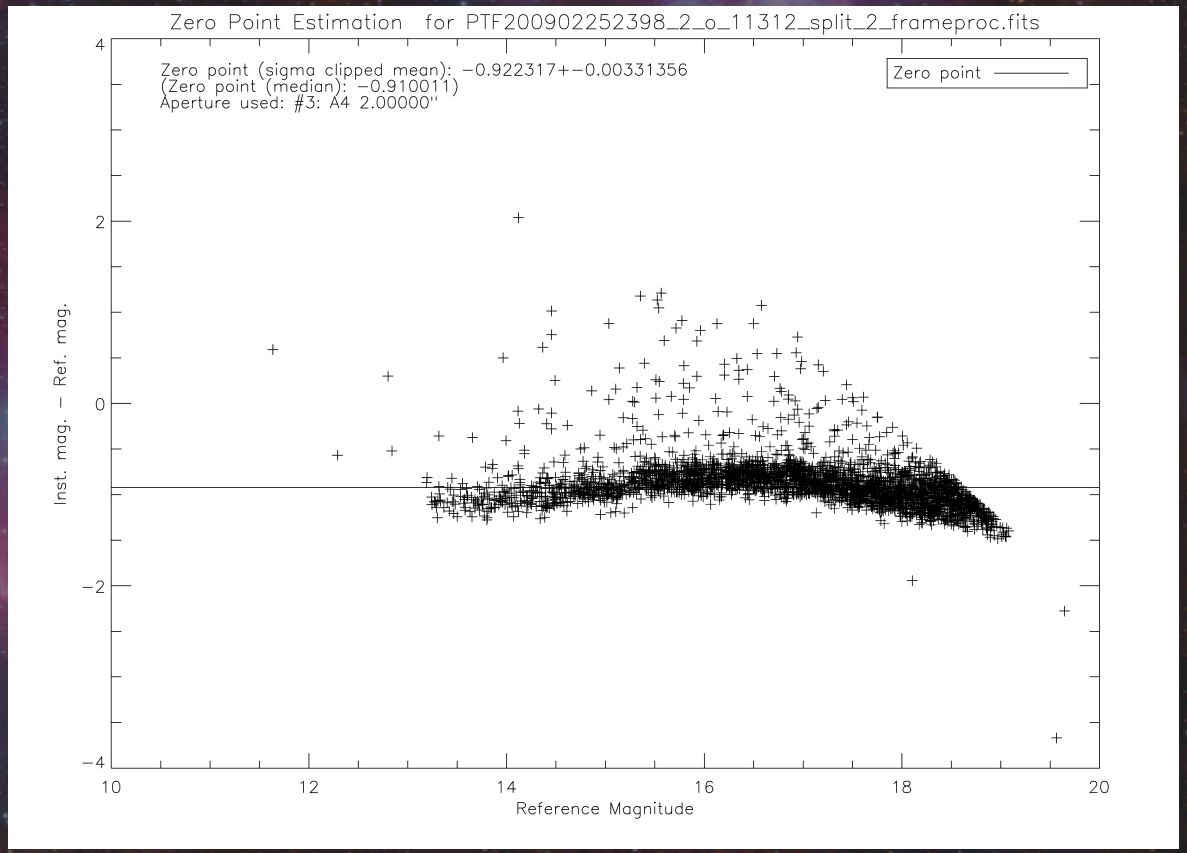
Fraction w/ red-excess

Orion Test Data

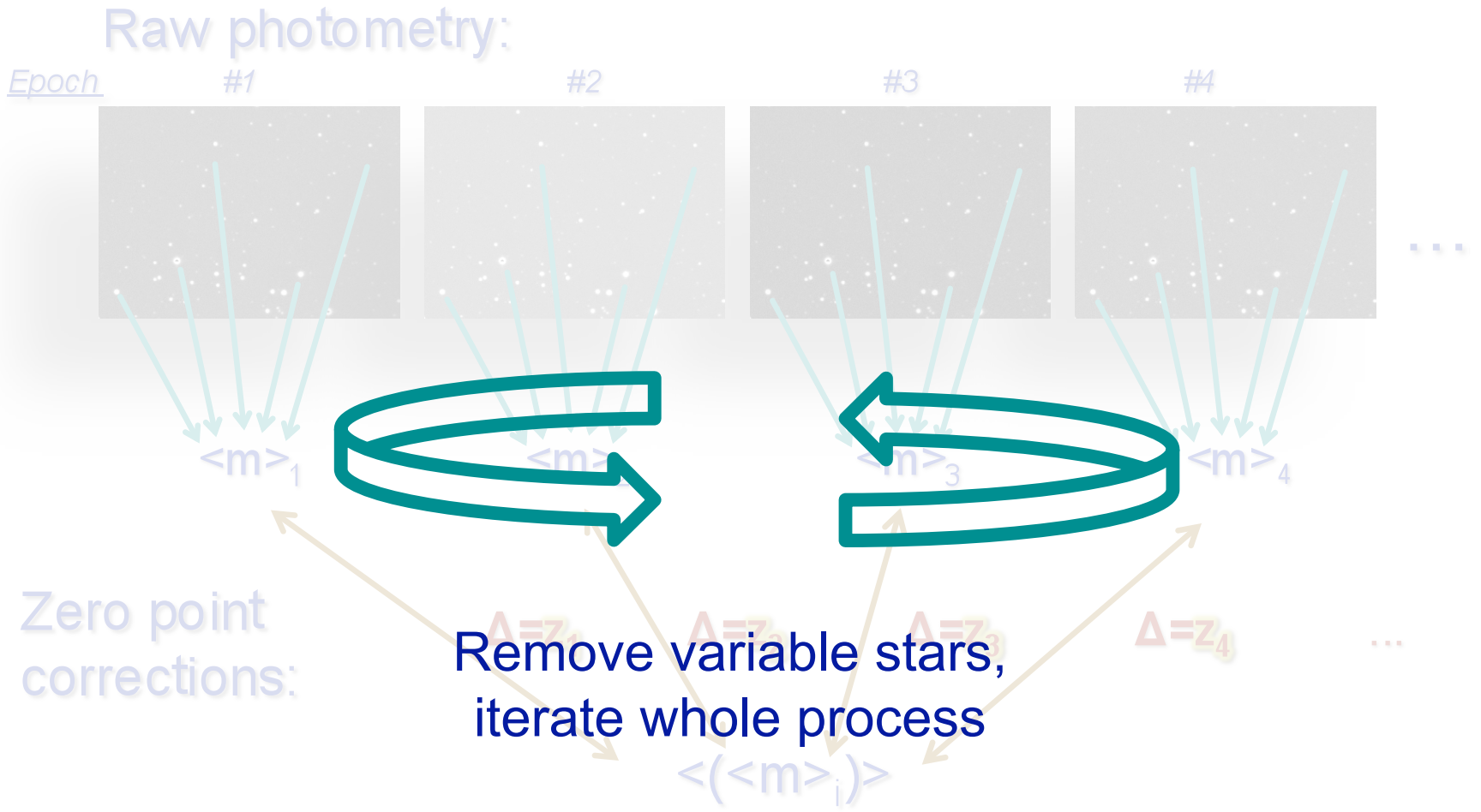


Pipeline – raw photometry

- Image processing, astrometry – IPAC PTF pipeline
- Raw aperture photometry – IDL DAOPHOT
- Initial zero-point correction – match against USNO-B

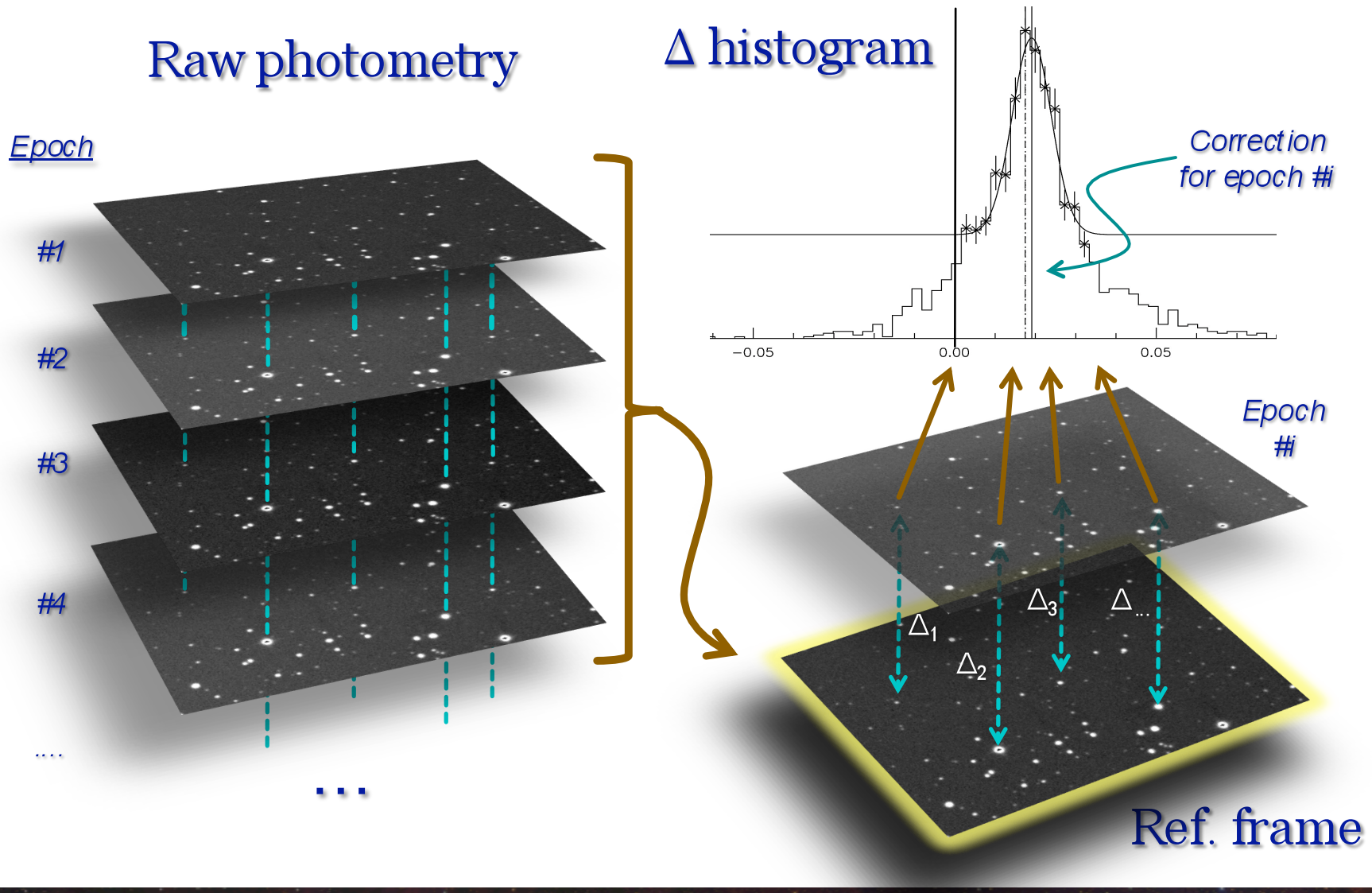


Differential Photometry - traditionally

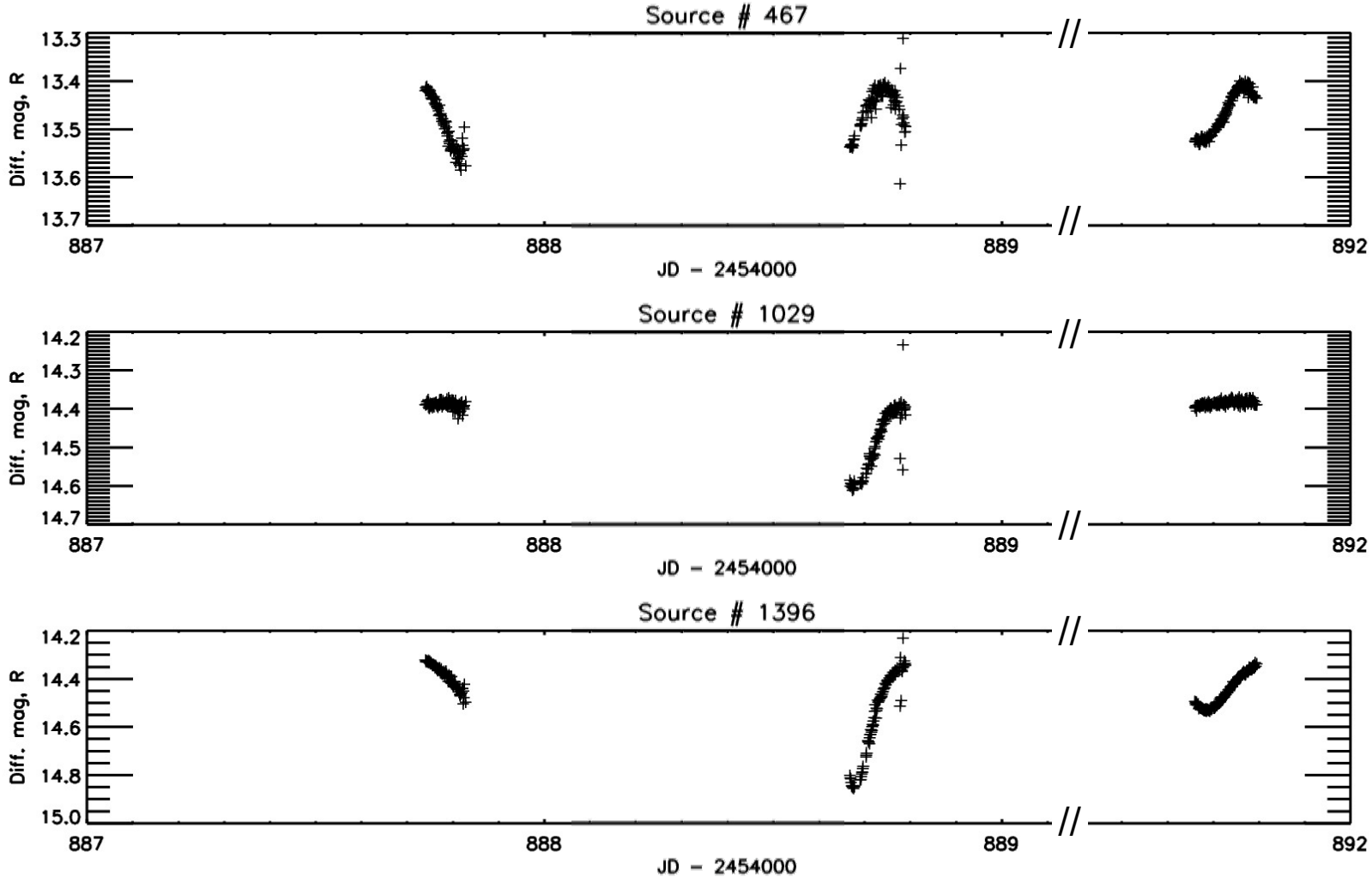


Remove variable stars,
iterate whole process

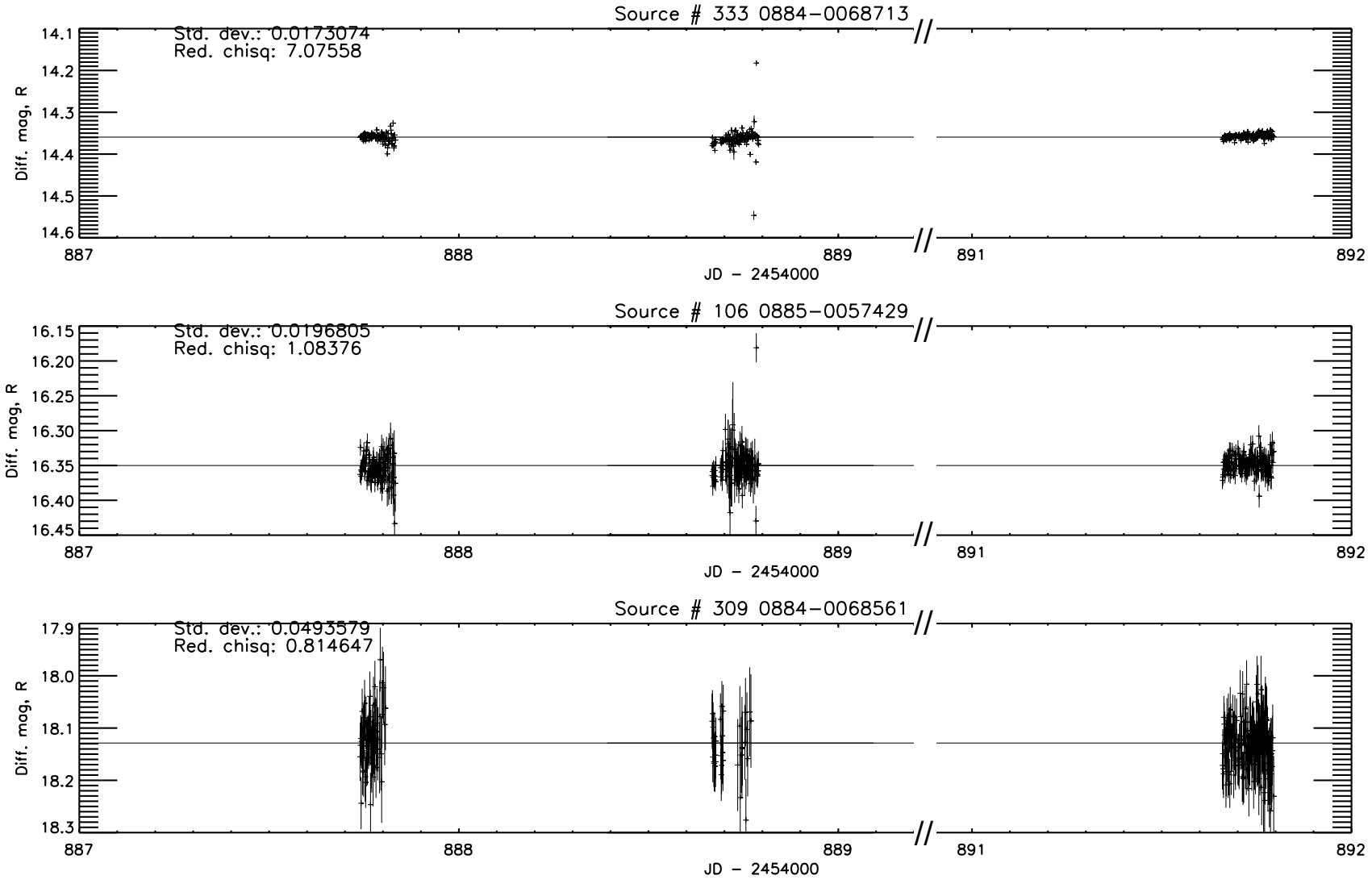
Differential Photometry – alternatively…



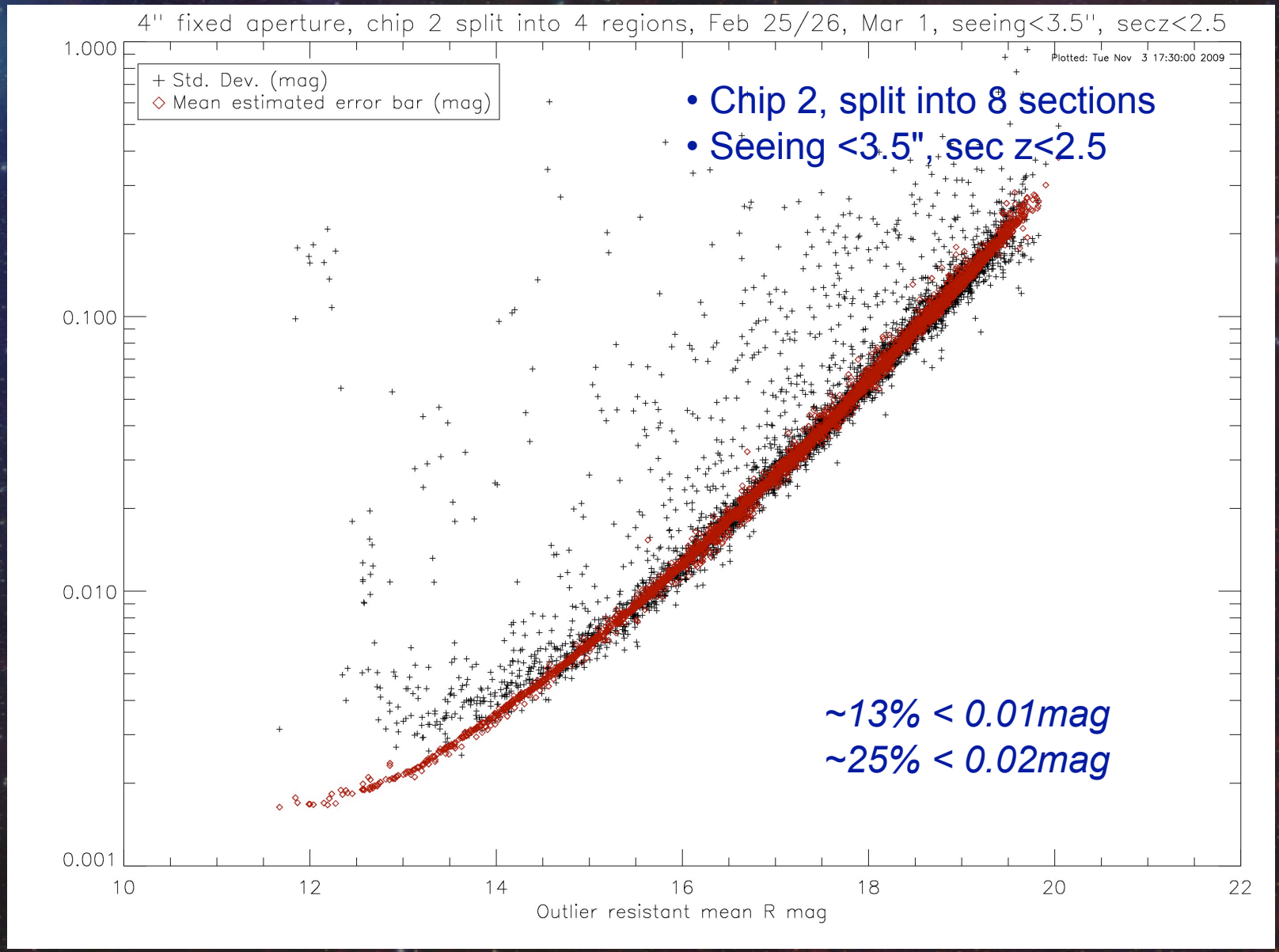
Test Data Results – Variables



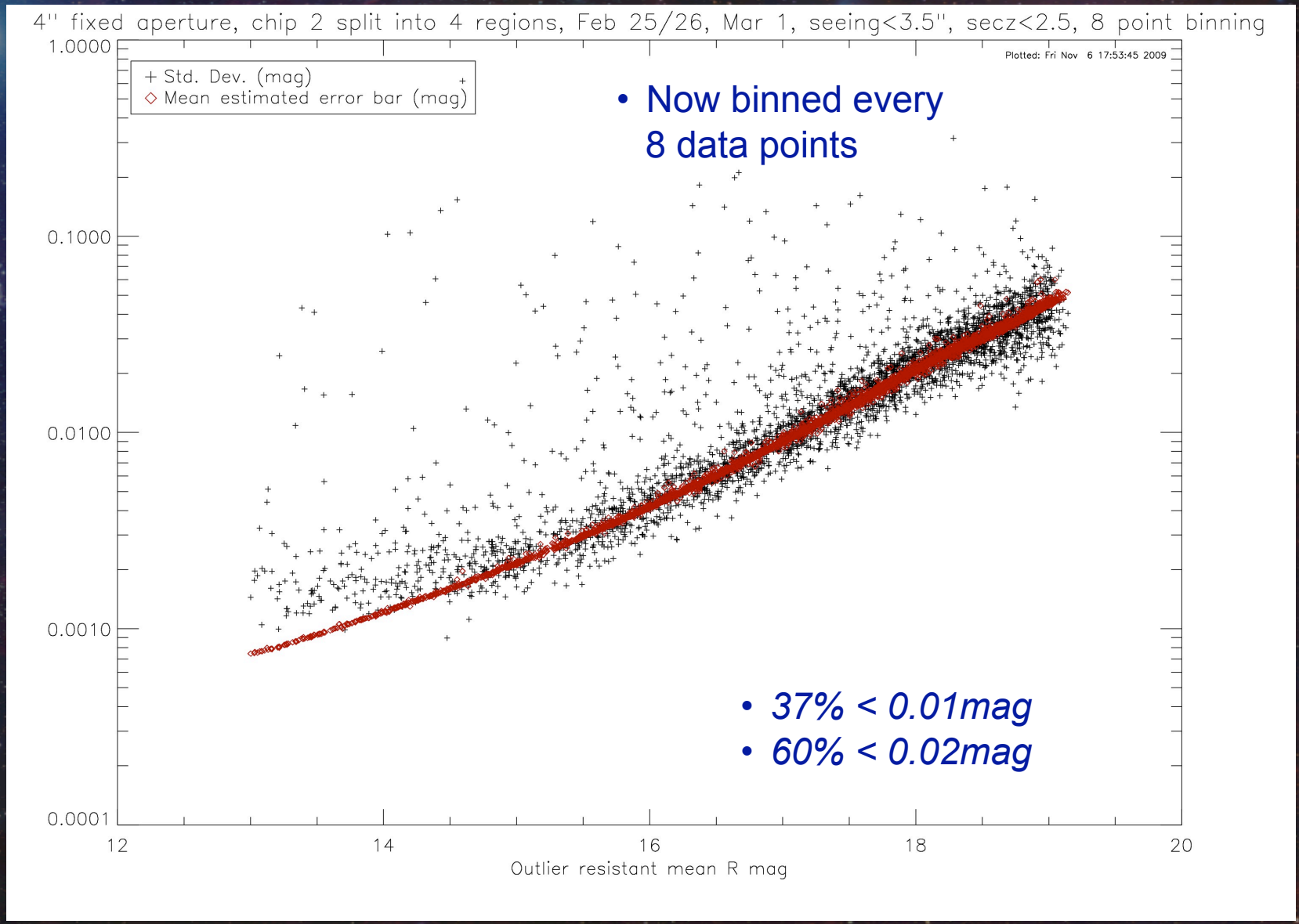
Test Data Results – Stable Stars



Test Data Results – Precision



Test Data Results – Precision



Summary

- **PTF Orion to search ~50-100,000** stars for 40 consecutive nights/yr for young planets/other YSO astrophysics
- **Preliminary pipeline in place** (~3mmag on commissioning data)
- Working on selection of final science field
- Guiding software being written
- **First observations starting ~Dec 1**