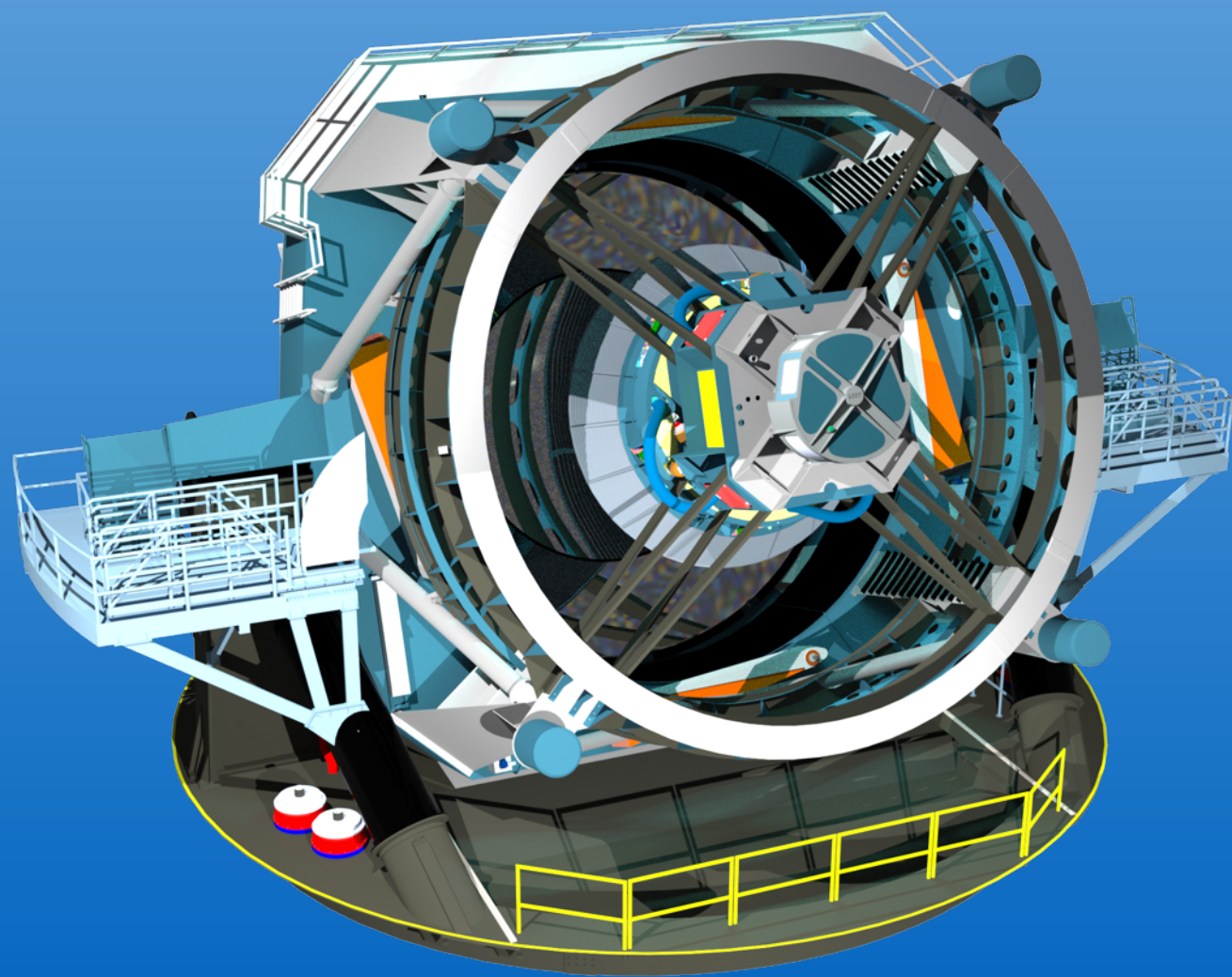


Evaluating the LSST Science Pipelines with Precursor Datasets

David L. Nidever

LSST Data Management Survey Science Lead
Steward Observatory



LSST
Large Synoptic Survey Telescope



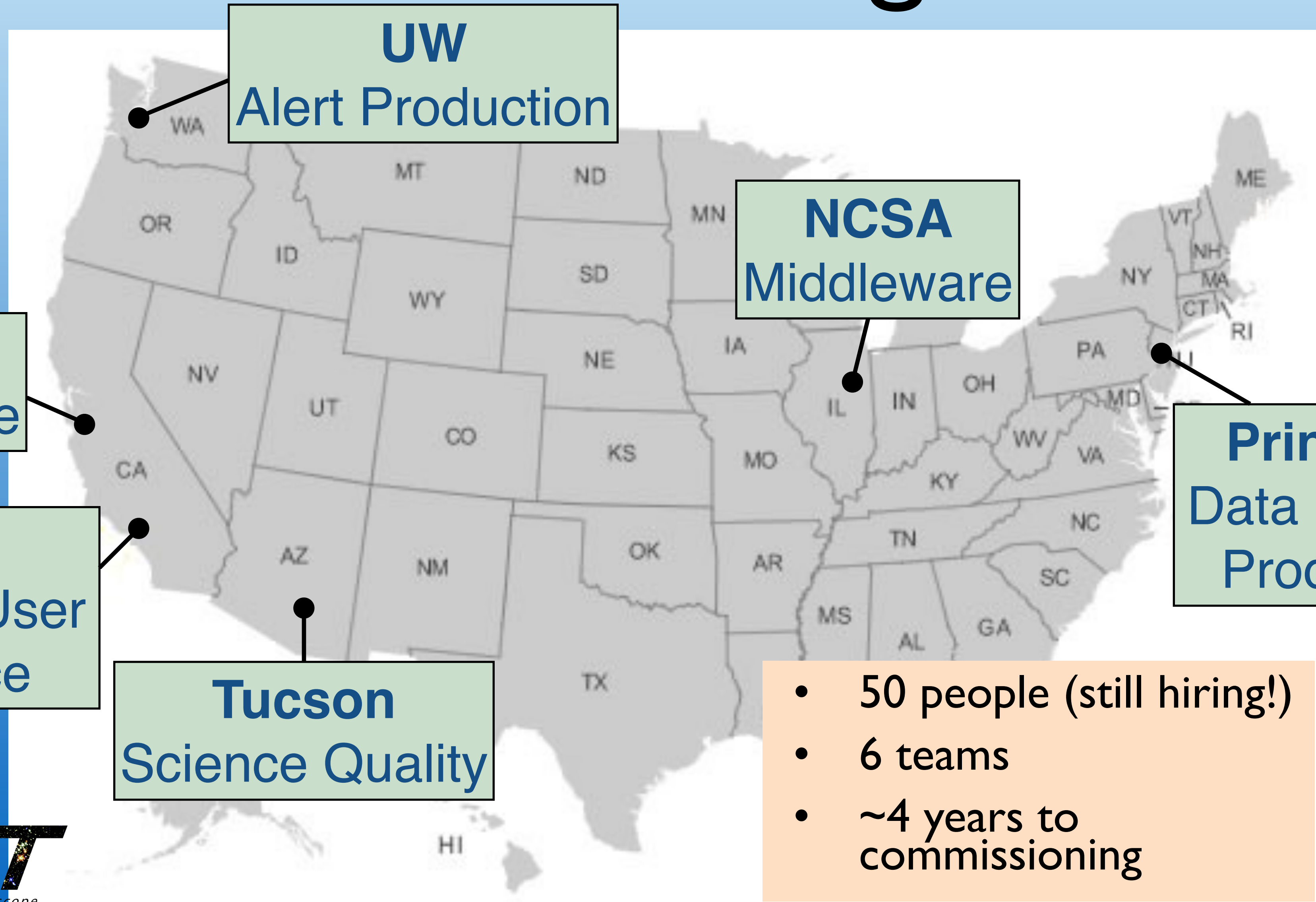
LSST: a digital color movie of the Universe...

LSST in one sentence:

An optical/near-IR survey of half the sky in ugrizy bands to $r \sim 27.5$ based on ~ 1000 visits over a 10-year period:

A catalog of 20 billion stars and 20 billion galaxies with exquisite photometry, astrometry and image quality!

LSST Data Management



- 50 people (still hiring!)
- 6 teams
- ~4 years to commissioning

Science Quality Assurance

- Need to verify that the LSST pipeline software (“the stack”) works and produces reliable data products
- Use precursor “verification” datasets
- Our own “data challenge”

Verification Datasets

- Want to test in regimes of primary science drivers:
 - Dark Energy, Solar System, Transients, Milky Way
- Test two main categories of data products:
 - Level 1, Alert Production (difference imaging, transients)
 - Level 2, Data Release Production (deep stacks, “static” sky)
- Want datasets taken in different environments (e.g. crowded/sparse regions, good/bad seeing, etc.).
- **We need multiple datasets since no existing survey spans all these regimes the way LSST will.**

Verification Datasets

DECam

- COSMOS field (PI: Dey): deep (~ 26 AB mag), 3 sq. deg., ugrizY
- Bulge survey (PI: Saha): ugriz, 6 fields, crowded, many epochs
- Solar system objects (PI: Allen): ~ 4000 60s r-band images
- HiTS survey (PI: Forster): transients/SNe, ~ 30 epochs in 40 fields
- SMASH survey (PI: Nidever): deep (~ 24.5), ugriz, 180 fields, MCs

CFHT CFHT Lensing Survey: deep, ~ 25 mag, ugriz, 154 sq. deg, weak lensing

HSC HSC COSMOS field: great seeing, very deep, March 2016

Simulations “Twinkles” data: variability/transients

Verification Datasets

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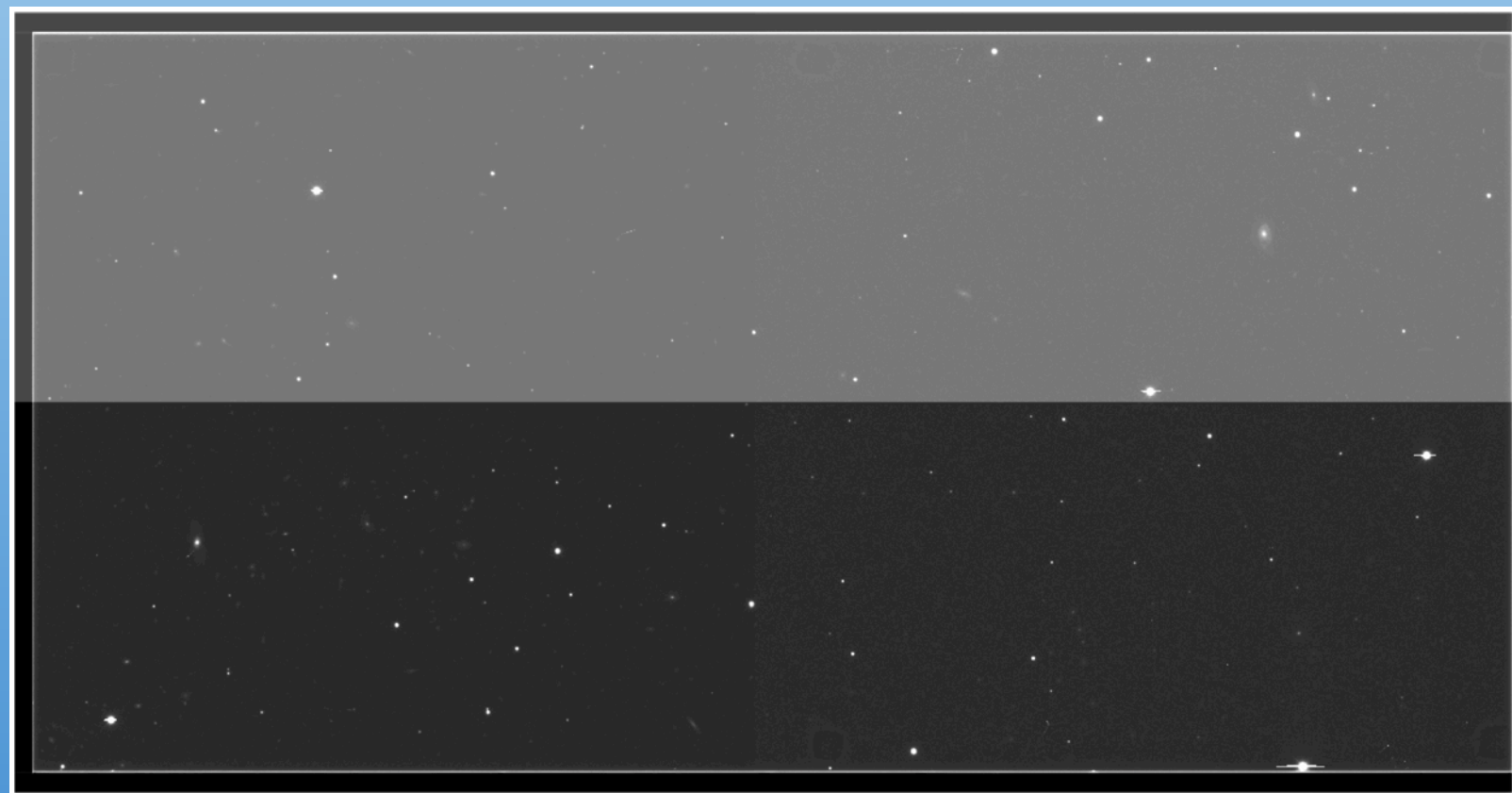
HSC HSC COSMOS field: great seeing, very deep, March 2016

Simulations “Twinkles” data: variability/transients

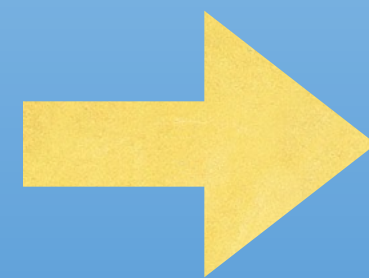
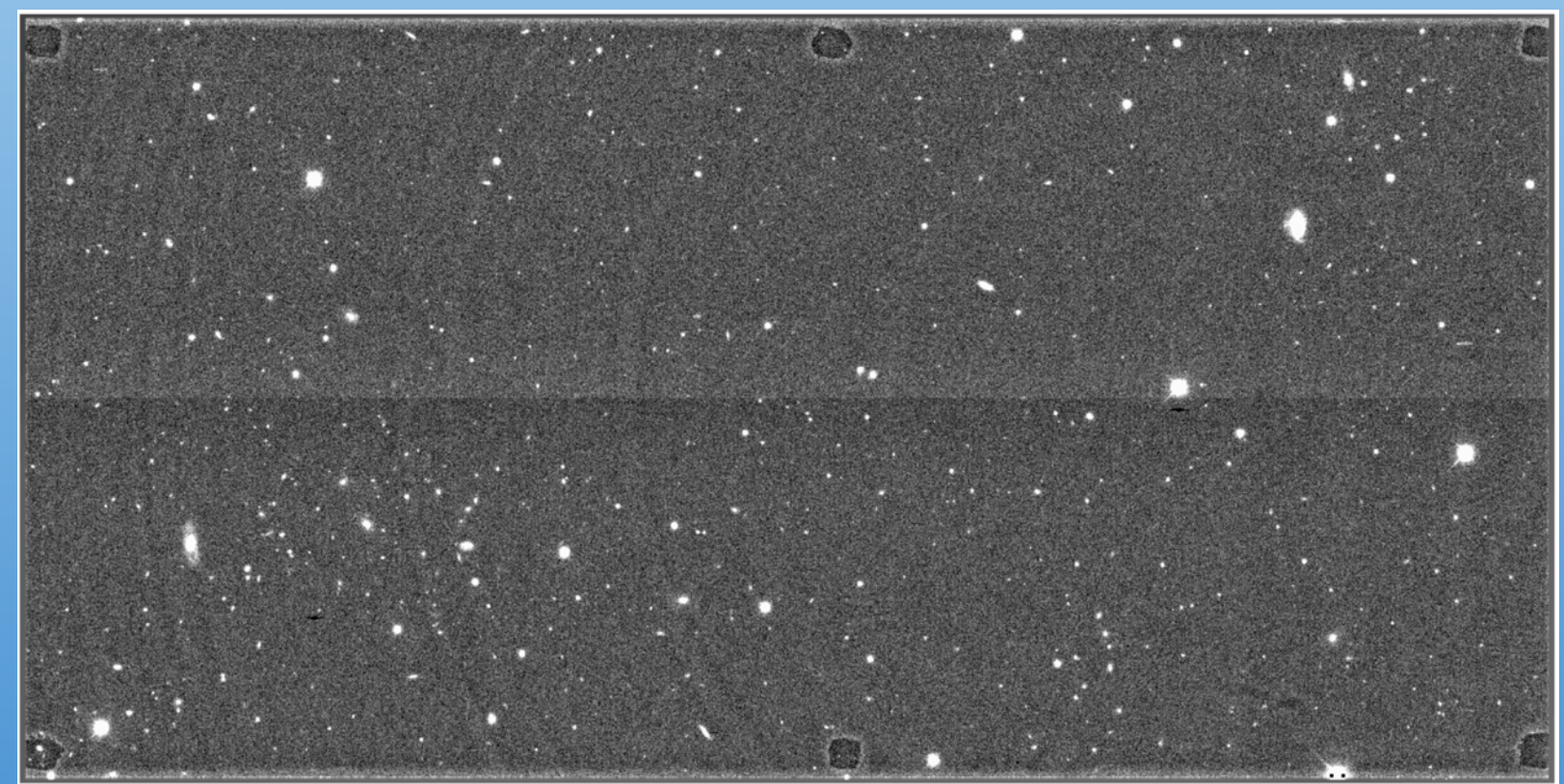
Setting Up the DECam Obs Package

- Hsin-Fang Chiang, developing DECam ISR

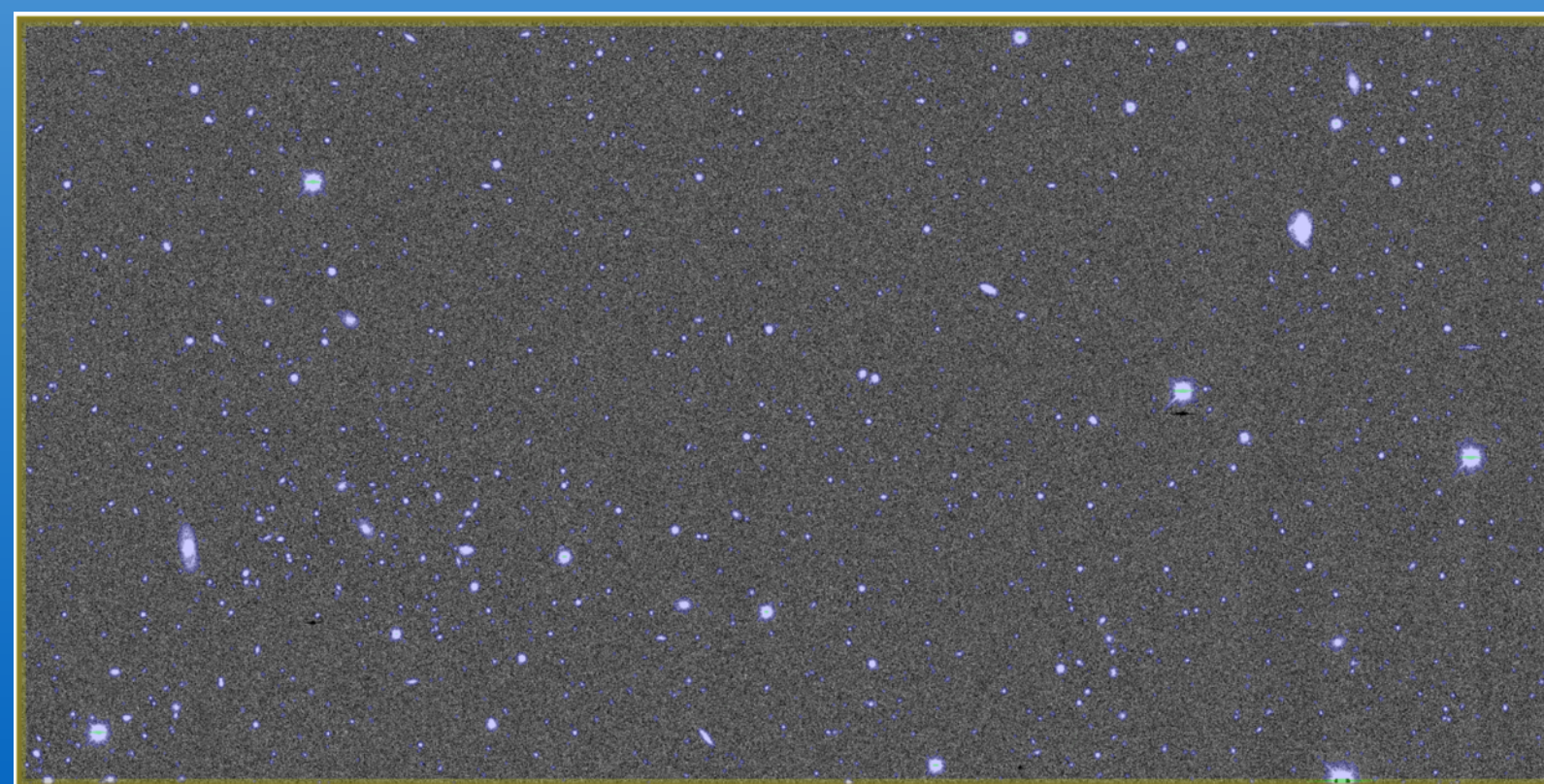
Raw



ISR: overscan, bias, defect



post-ISR: flat, interp



Hsin-Fang Chiang (NCSA)



Colin Slater (UW)

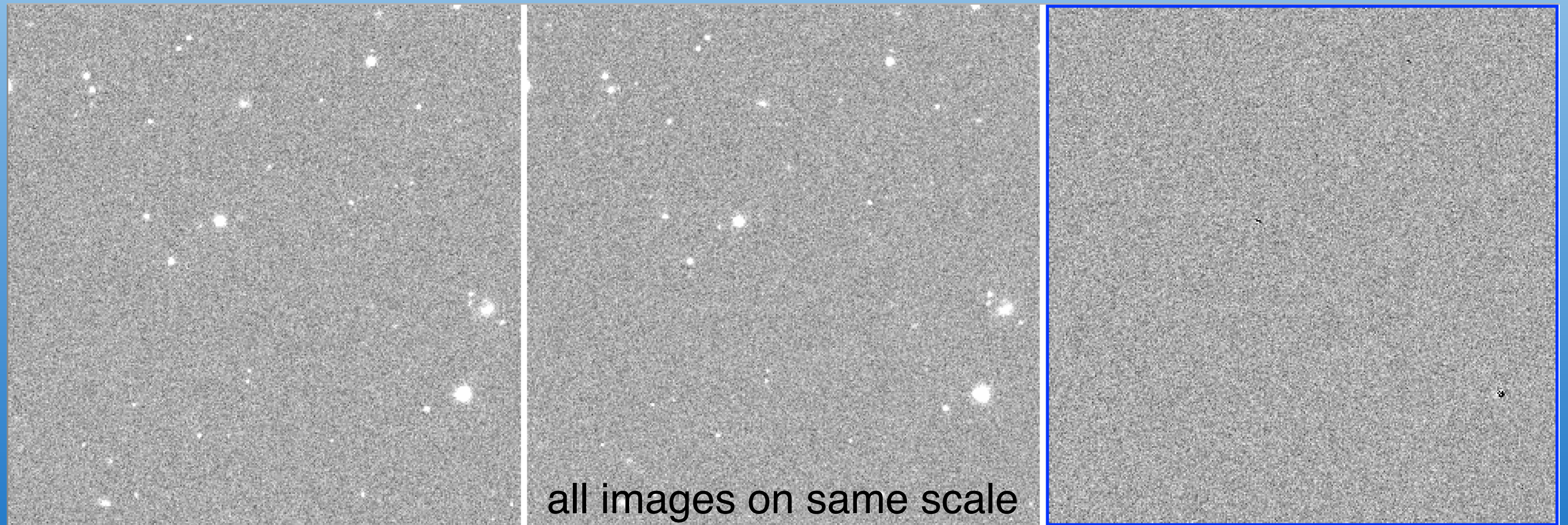
AP - Image Differencing

- Allen/NEO data

Template

Exposure

Difference Image



- very good image subtractions



Colin Slater (UW)

AP - Image Differencing

- Allen/NEO data

Template

Exposure

Difference Image





Colin Slater (UW)

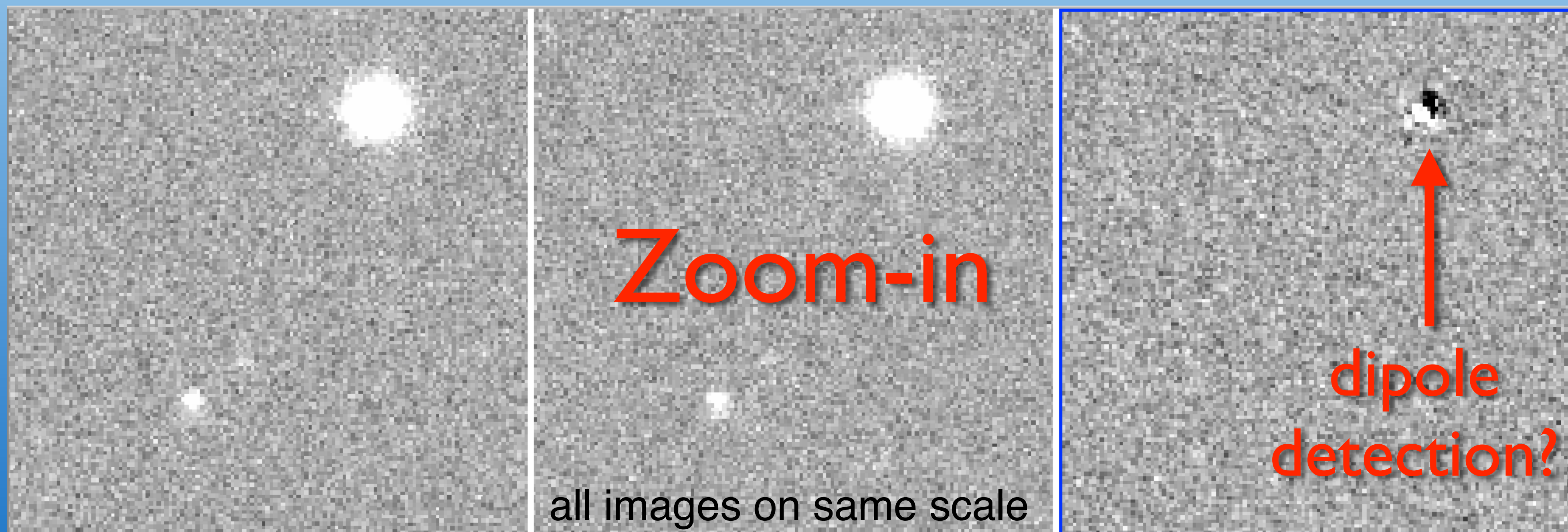
AP - Image Differencing

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Colin Slater (UW)

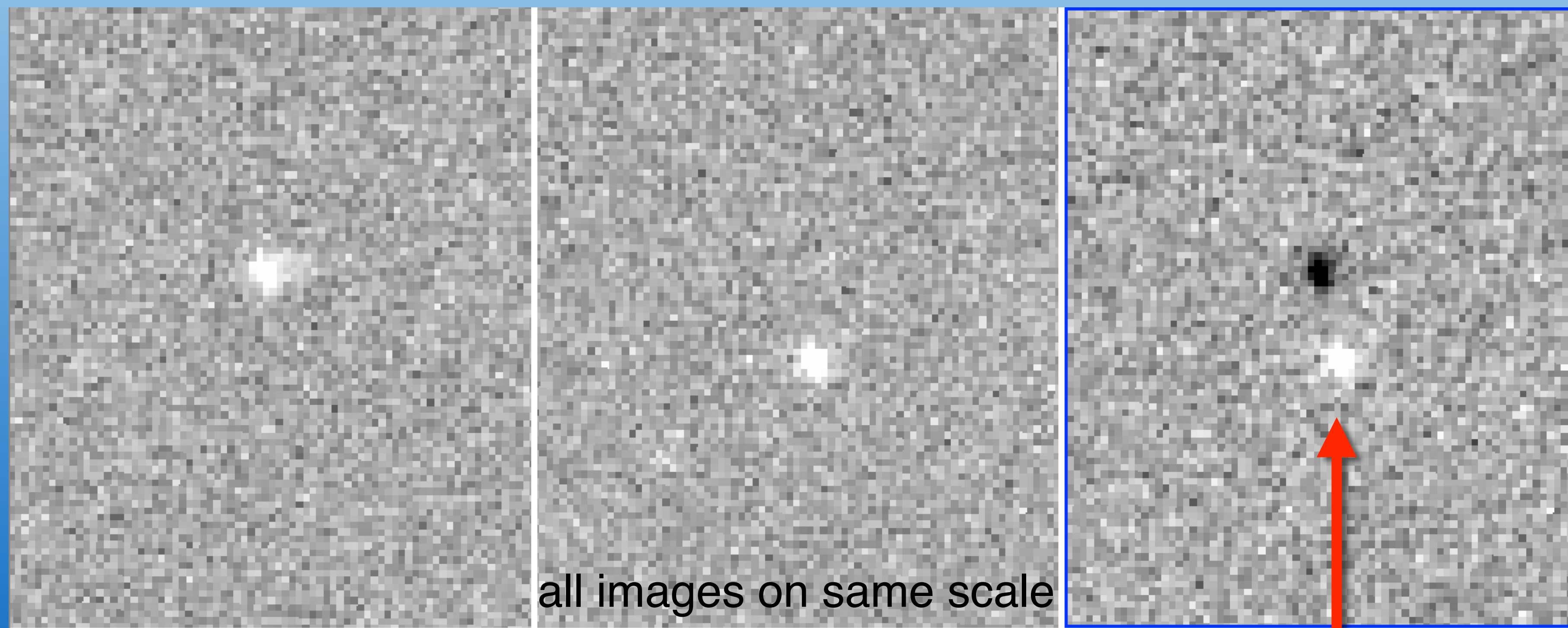
AP - Image Differencing

- Allen/NEO data

Template

Exposure

Difference Image



all images on same scale

moving object!



Colin Slater (UW)

AP - Image Differencing

- We have a working image differencing pipeline
- Developing model of false positive rate
 - function of different observing conditions, and
 - spatial correlation with bright stars
 - will then be used to estimate our ability to link solar system objects



AP - Image Differencing

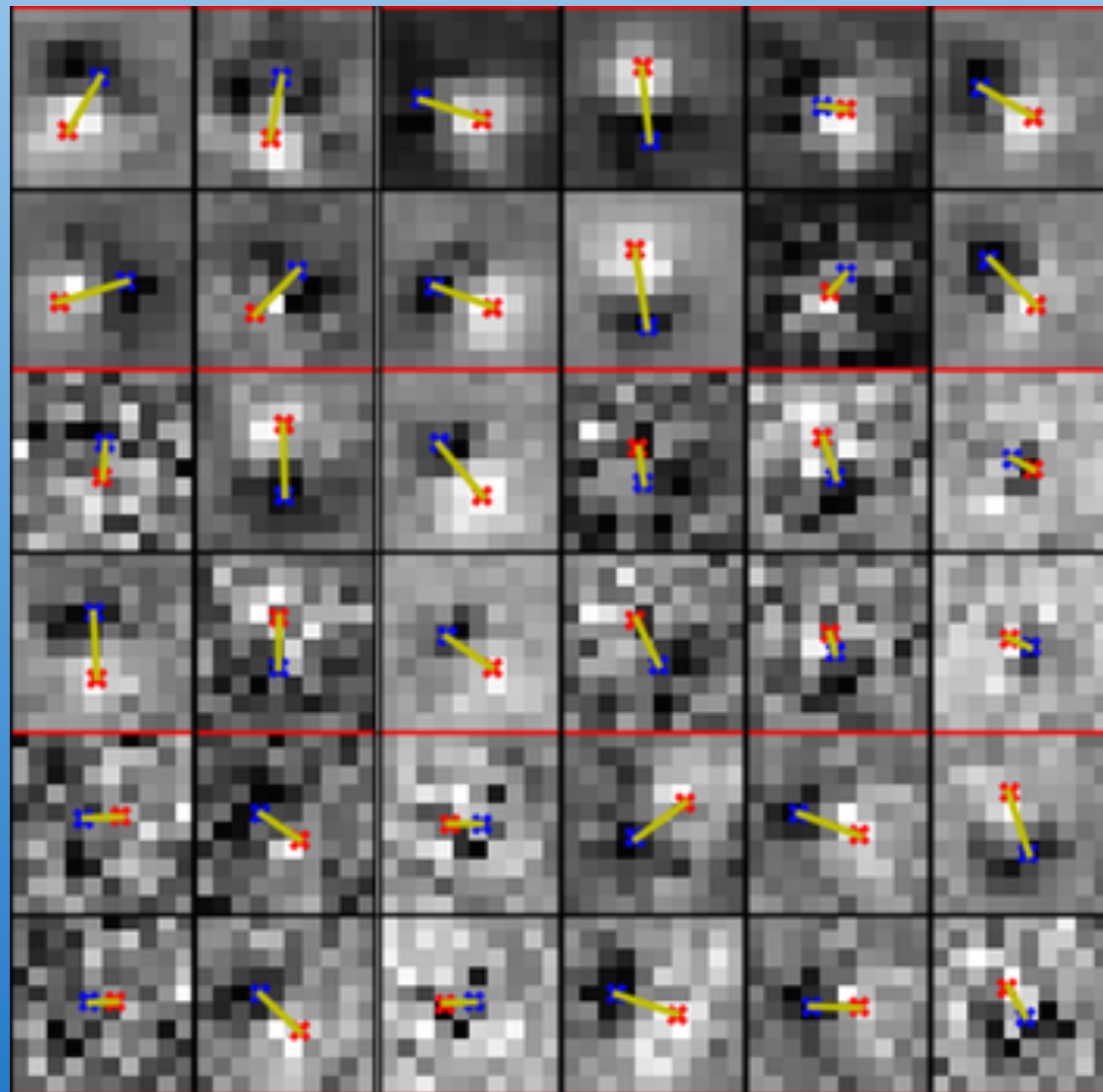


- HiTS survey

Francisco Forster (CMM)

Yusra AlSayyad (UW)

Example dipoles around bright stars



top: LSST pipeline; bottom: HiTS pipeline

- No ADC on DECam
- Big airmass difference
- Lots of dipoles
- Systematics in the difference images



AP - Image Differencing

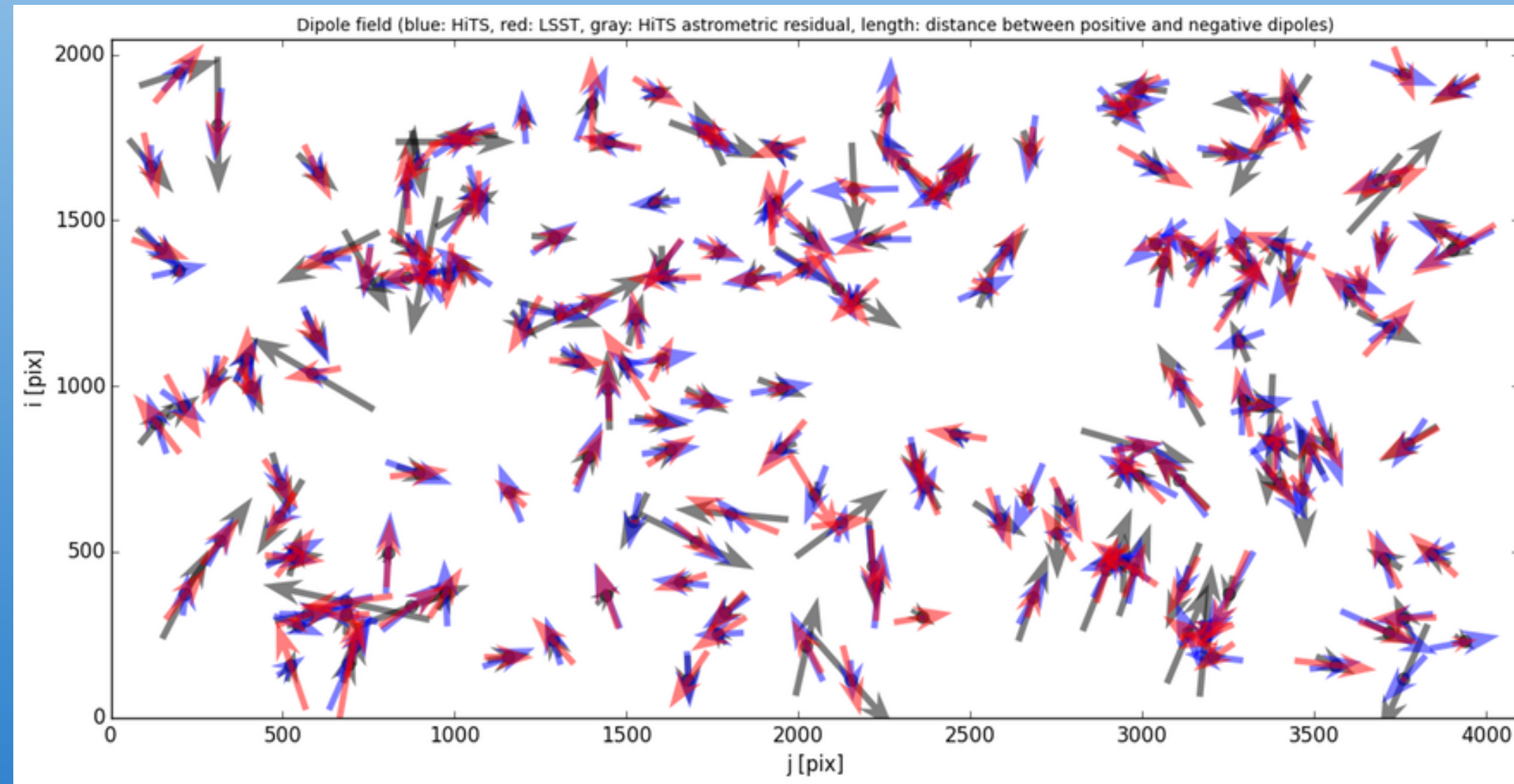


- HiTS survey

Francisco Forster (CMM)

Yusra AlSayyad (UW)

Dipoles and astrometric residuals



Dipoles (Hits, LSST) astrometric residuals

- Dipole direction correlated with astrometric residuals
- Indicates astrometry problems



AP - Image Differencing

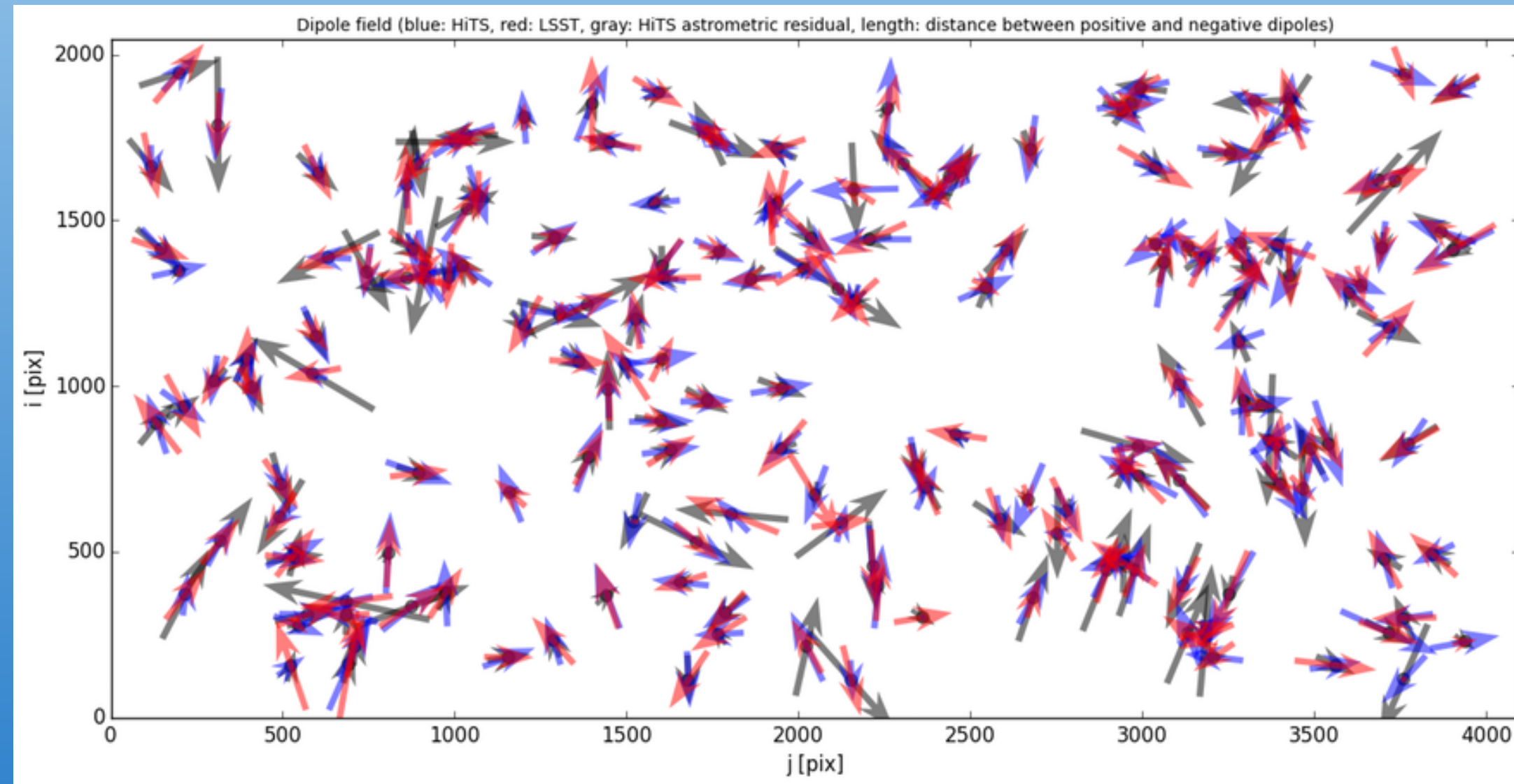


- HiTS survey

Francisco Forster (CMM)

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Dipoles and astrometric residuals



Dipoles (Hits, LSST) astrometric residuals

- Results suggest more careful astrometric solution needed, taking color and refraction into account

Simultaneous Astrometry

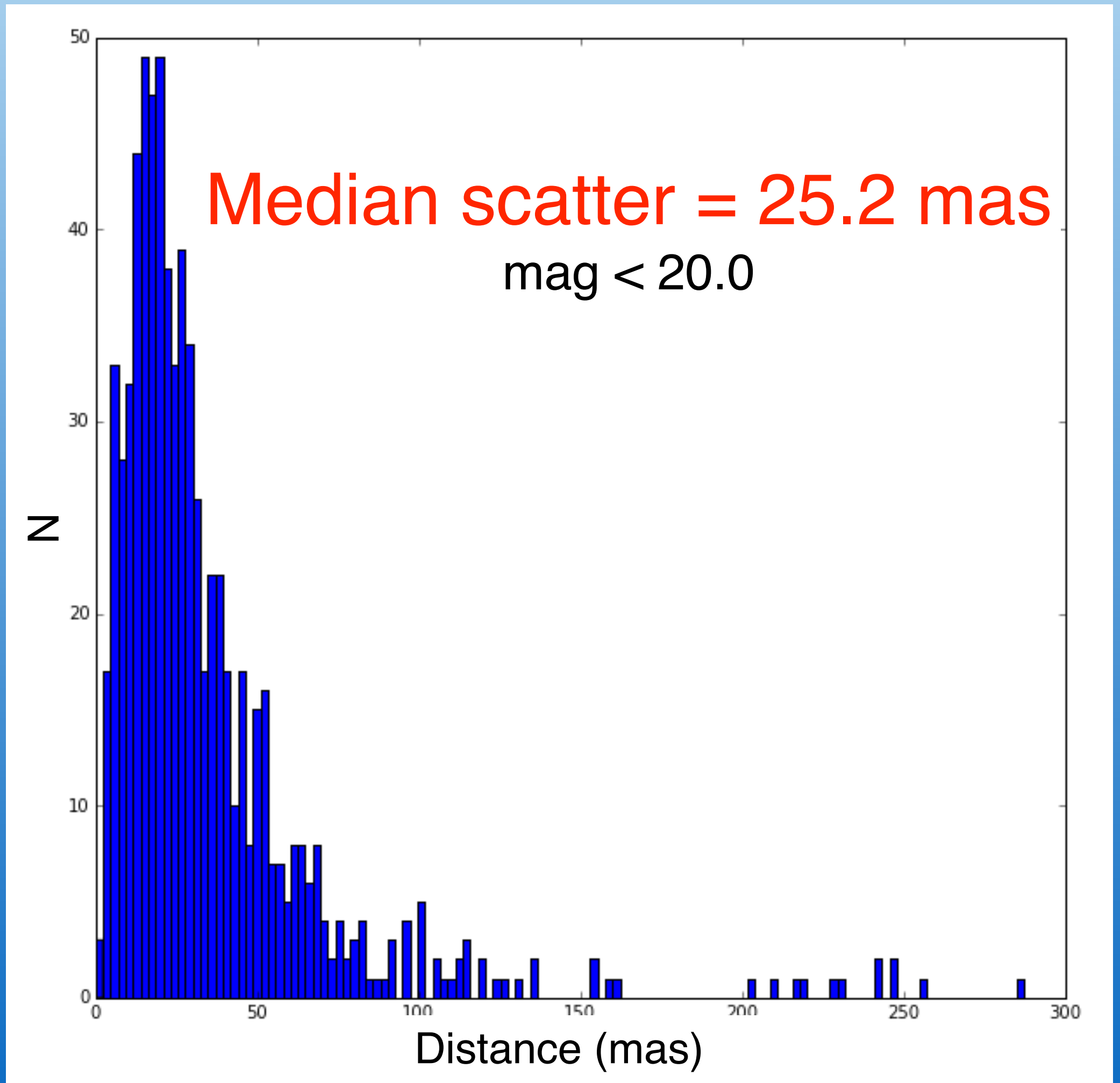
- Simultaneous astrometric fitting software
Pierre Astier (LPNHE Paris) and Dominique Boutigny (IN2P3, France)
- uses data from multiple exposures of a field and reference catalog to solve astrometry



Dominique Boutigny (IN2P3)

DRP - CFHT Data

- CFHT Galaxy Cluster - Dominique Boutigny
- astrometric solution using reference catalog only (one chip at a time)

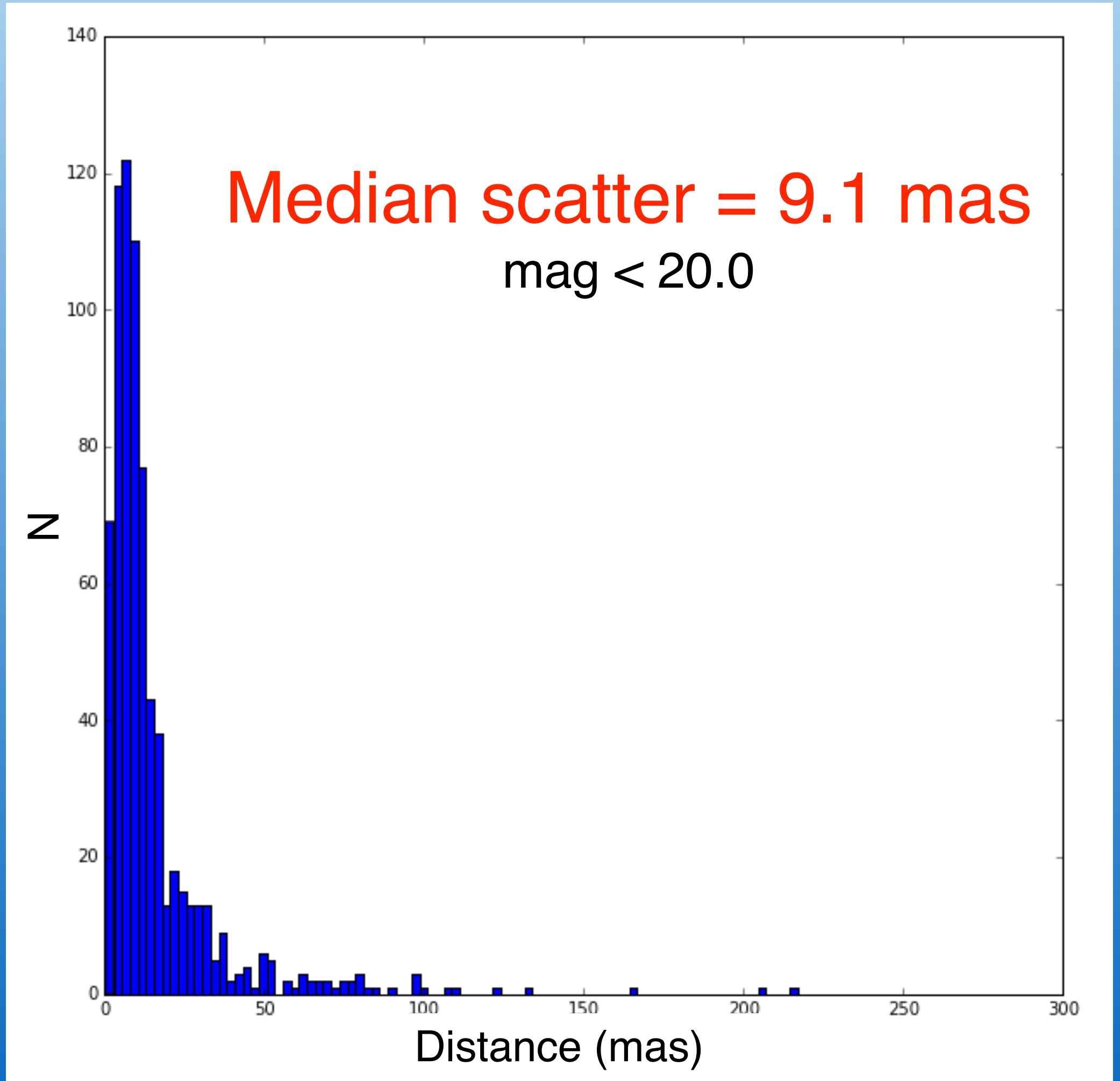




Dominique Boutigny (IN2P3)

DRP - CFHT Data

- CFHT Galaxy Cluster - Dominique Boutigny
- astrometric solution with simultaneous fitting
- meeting performance metric on relative astrometry!



Conclusions

- Testing the LSST DM software stack
- Verification datasets: DECam, CFHT, HSC
- Positive progress so far:
 - Working DECam obs package
 - Working image differencing pipeline
 - ~ 9 mas astrometric precision with simultaneous astrometry fitting
- Issues still to work on:
 - Image differencing issues from DCR

Get Involved!

- Weekly BlueJeans meetings, reminders sent to dm-devel@lists.lsst.org
- Track our progress on Confluence wiki:
[https://confluence.lsstcorp.org/display/SQRE/
Verification+Datasets](https://confluence.lsstcorp.org/display/SQRE/Verification+Datasets)