ODI - Pipeline, Portal and Archive (ODI-PPA) and the Virtual Observatory (VO)

IVOA 2012 – May 24 2012

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Outline

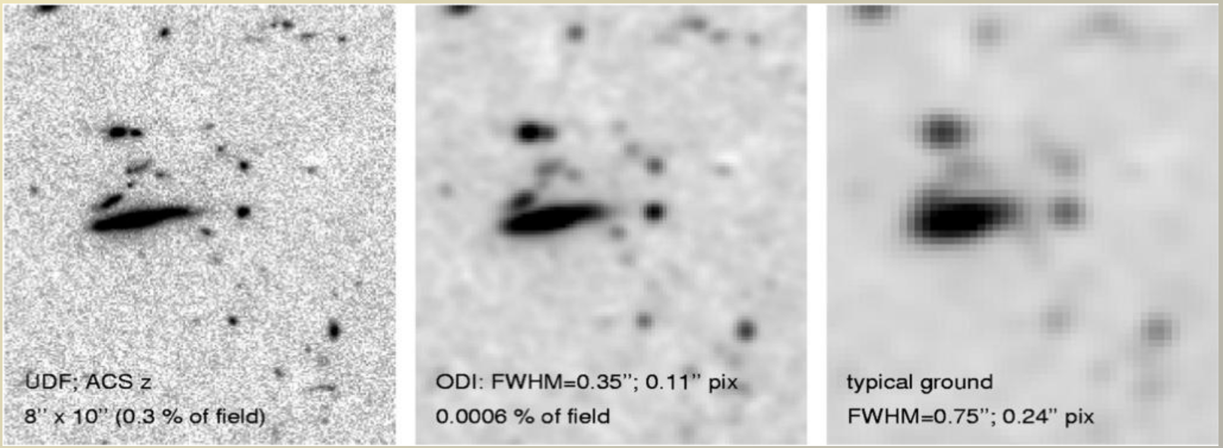
- Introduce
  - ODI (and “pODI”)
  - ODI-PPA
- Design
- VO Connections
  - Confirmed
  - Wishlist

What is ODI?

- New camera being built, to be installed on WIYN 3.5m telescope on Kitt Peak (near Tucson, AZ, USA)
- One square degree field of view
- Will be operated by WIYN, INC. a collaboration between University of Wisconsin, Indiana University, Yale University, NOAO.

What sets ODI apart?

- **General facility instrument**
  - Not embedded into infrastructure of a large survey
  - Open access through NOAO for non-partner users
  - Median seeing in red bands <0.6”; best conditions <0.4”.
  - Image quality & field of view opens window to new science applications
  - Narrow band filter imaging



Left: Image quality from space.
Middle: Image quality with ODI in red filter
Right: Typical ground image
Need ~500 HST ACS fields for 1 ODI image.

* Slide courtesy Todd Boroson

van Dokkum

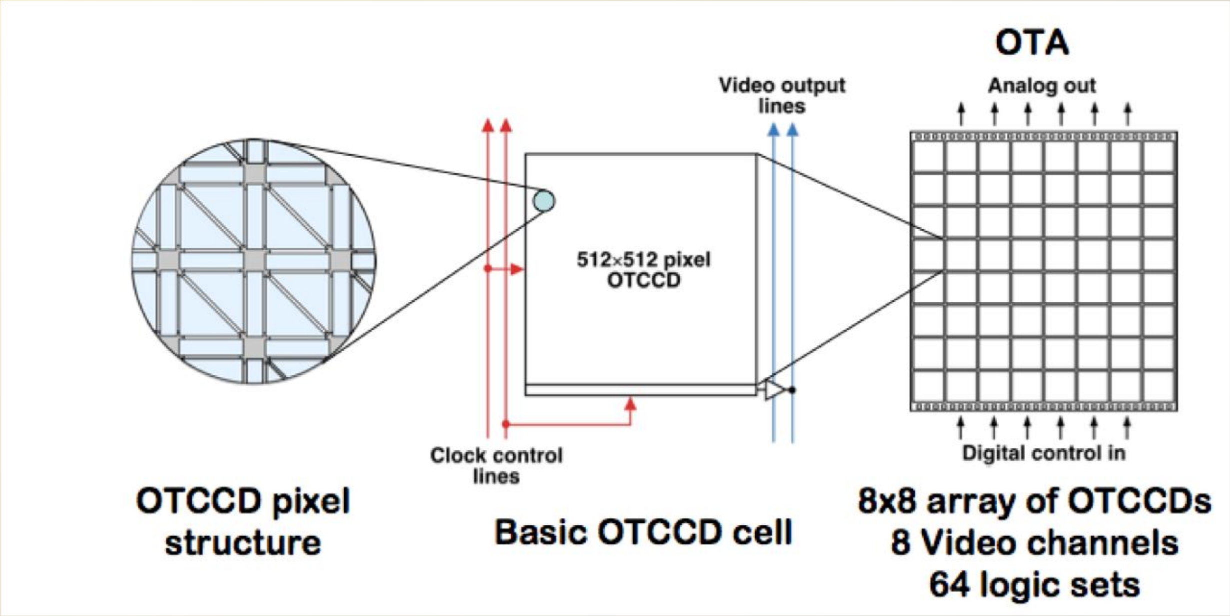
Key Requirements

- Field of view – one degree square,1º unvignetted circle
- Image quality expectation: best DIQ 0.3” in z’ DIQ, 0.5” in g’ and u’, airmass up to 1.5
- Images properly sampled, active tip/tilt compensation
- 9 filters loaded in instrument
- Cadences, efficiency requirements, overhead < 20sec.
- Permanently mounted at Nasmyth port

* Slide courtesy Todd Boroson

Orthogonal Transfer Array CCD

- **On-chip charge shifting** to compensate image motion.
  - Same technique as in PanSTARRS (Close collaboration with PanSTARRS camera team)
  - 64 OTAs → 64x64 cells



Paradigm Shift

- **This should be familiar to most of you**
- …
- Introducing a new way of dealing with data from ground based telescopes
  - ODI is available to the entire community
  - Remote processing and archiving of data, leveraging national cyberinfrastructure
  - Consistent basic calibration processing (detrending, stacking)
  - Advanced user-driven data reduction on remote compute resources
  - Incorporate archive data
  - Most users will download only a small subset of the data

What is ODI-PPA?

- Web-based **Science Gateway** called the ODI Pipeline, Portal, and Archive (**ODI-PPA**)
  - required data-processing pipelines
  - the archival data and metadata management system.
- Framework to incorporate advanced reduction and analysis tools
- Leverage
  - NSF-funded **XSEDE** – provides computing, mass storage, and networking resources.
  - Data Capacitor system at PTI
    - large high speed disk cache to store data temporarily
  - Long term archive: Scholarly Data Archive tape system at PTI

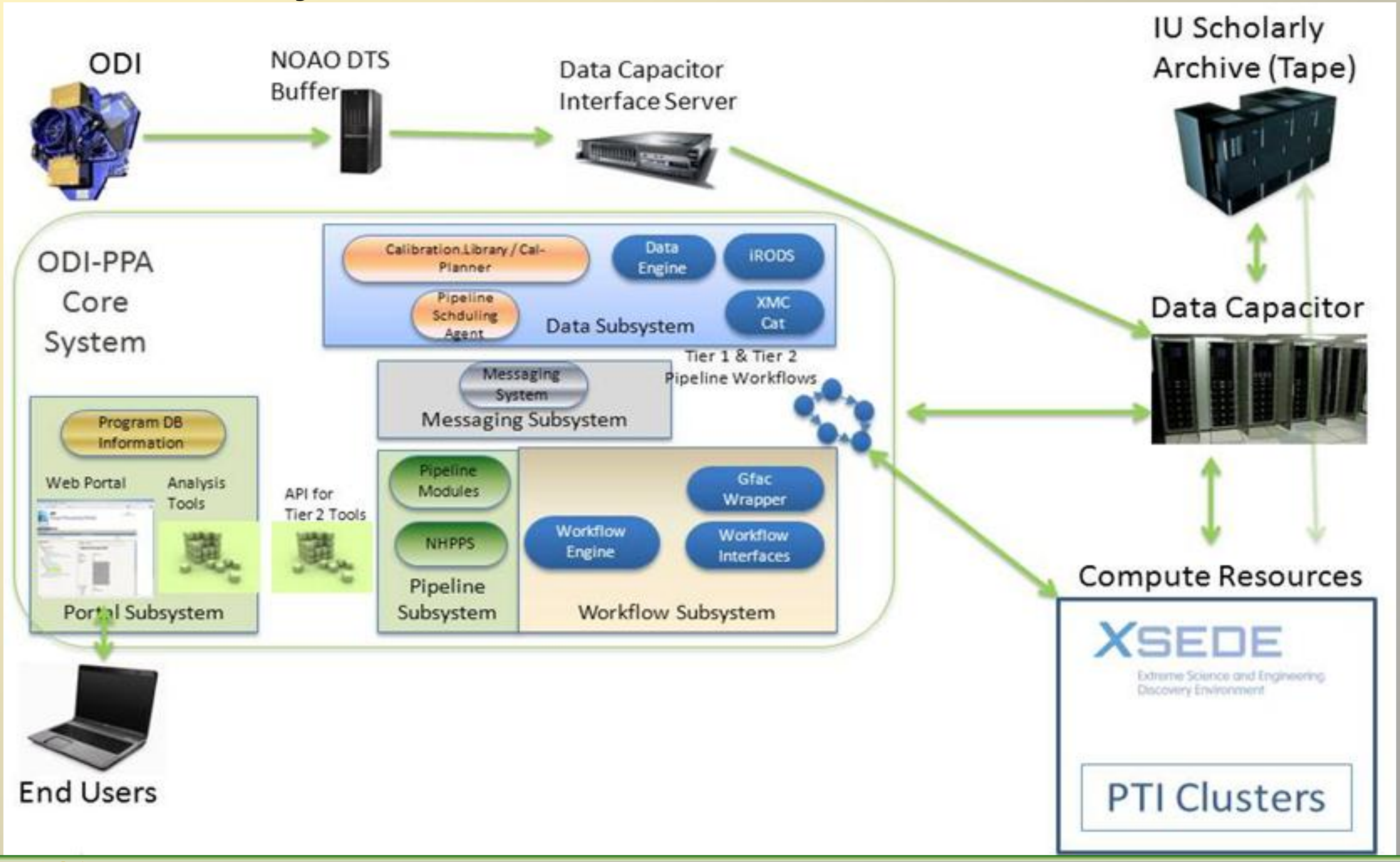
ODI-PPA will offer …

- Features based on
  - Pipeline And Archive Science Requirements (PASRD) and
  - Requests collected in User-Engagement Workshops in summer 2012
- Need to serve
  - Stakeholder users including scientists from partner institutions
  - Archival users
- Wide range of user base – CS novices to CS hackers!

ODI-PPA Team

- Collaboration between:
  - Pervasive Technology Institute (PTI)
    - Capitalize on the expertise of PTI members who have led the effort to provide scientists in many different fields with “user-friendly” access to super-computing facilities
      - Example: LEAD
  - NOAO Science Data Management (SDM) program
    - Build on the experience of SDM and the legacy of IRAF and NHPPS
      - Example: Mosaic and NewFirm pipelines
  - WIYN
    - Experience running telescopes, and supporting Astronomy scientific community

System Architecture Schematic



Technical Components

- Open Grid Computing Environments (OGCE) grid middleware
- XMCCat Metadata Cataloguing service
- iRODS data movement
- IRAF, NHPPS for astronomical data reduction
- Portal (PHP/Zend, JavaScript/jQuery)
- Data Engine for data and metadata processing
- VOTables for several interfaces between components

- Goal is to reuse as many standard/open source components as possible
  - Continuing to try to identify other modules/components that can be merged in

ODI-PPA will offer (via Portal)

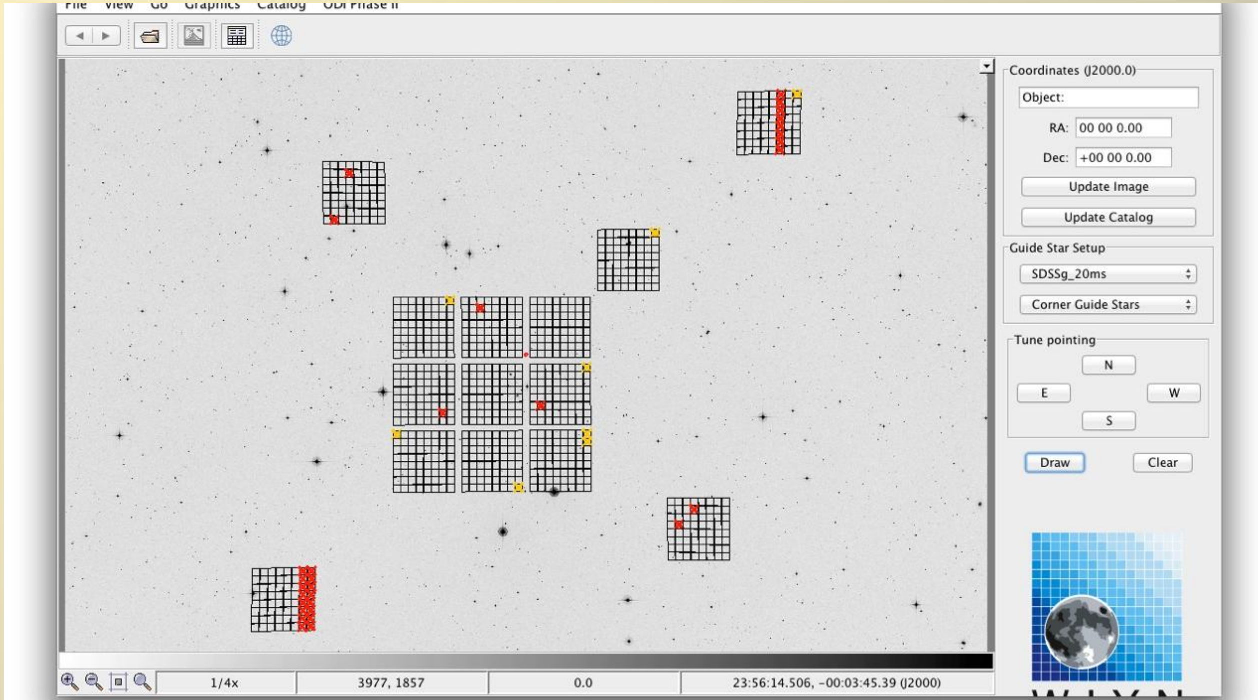
- Single Sign-on (OpenID … iVOA, Google) + Role Management
- Data Browser: File browser; Organize, Filter, Sort; Search; Catalogues
  - Faceted Search
- Image Viewer: Use loss PNG tiles
- Simple tool-access: Action performed on real FITS images on the back-end
- Select and download or add cut-outs to one's workspace
  - FTP ; Stripped FTP later ; Globus Online if applicable even later.
- Workflows: pre-packaged workflows to create a job on their data or custom workflows

- Hierarchical compute resource use – plan is to
  - Perform quick tasks on portal server or a web-service provider server.
  - Intermediate time-consuming tasks on local cluster

Modified Plans (Instrument project split)

- WIYN changed plans in mid-2011
- Split project into two phases: partial focal plane ODI (pODI) and full ODI

pODI OTA Population



- Differences between ODI and pODI
  - Data volume and rate
  - Local guide mode

* Slide courtesy Todd Boroson

* Image by D. Harbeck --- red cells non-functional; yellow cells non-functional in OTA mode

pODI: Rescoping into Phases 1 and 2

- What must be in Phase 1
  - Automatic data transfer from instrument to PPA system
  - Automatic pipeline reduction to remove instrumental signature for static imaging and coherent guide modes
  - Full archive for data and metadata
  - Portal with limited functionality (should demonstrate capability to use advanced analysis applications)
  - Browsing, visualization of both raw and pipeline-reduced data
  - Ability to download archived data
- What can be put off to Phase 2
  - Most advanced analysis applications (need to provide downloadable data products)
  - Support for local guide mode
  - Ability to run on XSEDE
  - Advanced VO-related capabilities

* Slide courtesy Todd Boroson

ODI-PPA and VO…

- Moving on …

ODI-PPA and VO

- In general, we are trying to be **VO-compatible** (design choice) as opposed to VO-compliant (after-thought)
  - Modular design of various components with Interface Control Documents (ICDs)

- However… pODI vs. full ODI phasing, *combined* with limited personnel resources, adds a wrinkle into our plans … We have split our plans into capabilities…
  - At the beginning of pODI operations (spring 2013)
  - Developed during the pODI era (late 2013)
  - Deferred until the full focal plane ODI stage (???)
- In subsequent slides, we will talk about a range of plans we have in mind.
  - Demarcate timeline

* VO-* terminology courtesy of Mike Fitzpatrick.

ODI-PPA and VO: VOTables

- VOTables passed around as part of several interfaces between components

- Data Engine ←→ Calibration-Planner
  - To orchestrate AuCaP workflow
- Data Engine ←→ Workflow Subsystem
  - Execute individual umbrella workflow steps; include information about files staged in/out from/to archive
- Workflow Subsystem←→ NHPPS Pipeline Subsystem

- Use existing standard libraries for VOTable processing
  - For example: Using STIL Java library to handle VOTables within Data subsystem

ODI-PPA: VO Access (Scope)

- General plan is to …
- Single Sign-On for proprietary data access
- Provide and register appropriate VO web-services for the system; Allow the discovery of data in the system by other VO applications through these services
- System support for specific data query and access web-services appropriate to the type of data to be published
  - Insure that the above web-services comply with the VO specification, and return data in a format that is compliant with the VO specification for the protocol being used

ODI-PPA: VO Access (Stages)

- Develop a Simple Image Access (SIA) service and provide appropriate metadata for searches (position, time, etc.)
  - Develop a Cut-out service
- Develop a Simple Cone Search (SCS) catalog service
  - When?
- ADQL queries using Table Access Protocol (TAP) in the future?

ODI-PPA: VO Access (Stages)

- Initially, public archive data (or proprietary data via SSO) will be made available via Data Access Layer (DAL)
  - Likely: Cut-out availability

- By late 2013, ODI-PPA will include ability to generate catalogues using SourceExtractor (or similar application)
  - Combined with survey projects (example: Yale survey) and public archive data availability after proprietary access period

    → Potential for VO use via Cone Search

ODI-PPA: VO Access (Stages)

- To summarize
- VO hopes/ambitions vs. VO plans in near future (or later)

Project Team Members!

This project would not be possible without …

The Core ODI-PPA Development Team!

- Frank Valdes (NOAO)
- Jeffrey Cox (PTI)
- Mike Young (PTI)
- Raminderjeet Singh (PTI)
- Rob Swaters (NOAO)
- Soichi Hayashi (PTI)

Former Core Team Members

- Suresh Marru (PTI)
- Yiming Sun (PTI)

ODI Instrument Collaborators

- Andrey Yeatts (WIYN)
- Daniel Harbeck (WIYN)

Advisory Members

- Mark Dickinson (NOAO)
- Marlon Pierce (PTI)
- Matt Link (PTI)
- Robert Henschel (PTI)
- Scott McCaulay (PTI – former RT director)

Project Executive Group

- Arvind Gopu (PTI)
- Betty Stobie, Todd Boroson (NOAO)
- Dick Shaw, Kevin Archbold, Pat Knezek (WIYN)

Questions?

Additional slides about ODI instrument

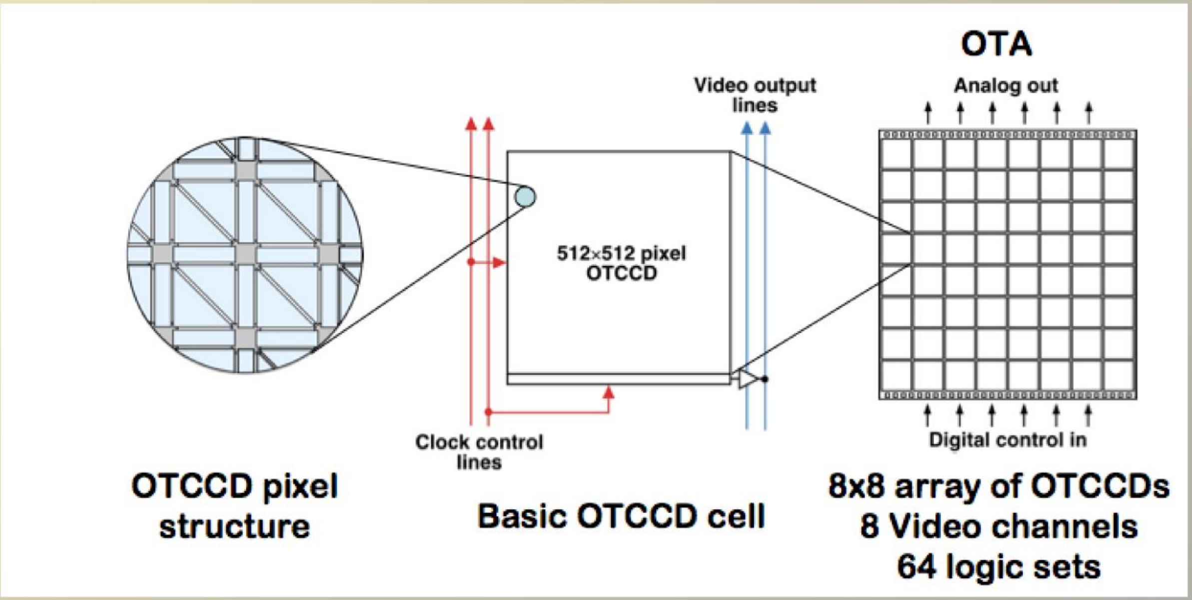
- For those who may be curious

In a Nutshell

- 1 degree square field-of-view optical imager on 3.5m telescope
- Focal Plane
  - 0.11 arcsec square pixels
  - 85% filling factor
- Data volume and rate
  - Approximately one billion pixels (200 million in pODI)
  - Readout in 20 seconds
  - Expect 150-200 images per night average
- Detectors
  - Orthogonal transfer arrays
    - Real-time shifting to remove image motion
      - Light that ends up in a given pixel may have been detected by other pixels
    - 4096 independent “cells” that can be shifted differently
      - Must retain knowledge of shift history of each cell
- Nasmyth (f/6.3) focus of telescope
  - Scattered and stray light are concerns
  - Narrow-band filters possible (9 filters in instrument at any time)

Orthogonal Transfer Array CCD

- Each die contains an 8x8 array of OTA cells (480x496 pixels each)
  - Each pixel is 12µm square, or 0.11” on sky.
  - Pixel structure allows shifting charge in X and Y direction
  - Gaps between cells are 2”-3” (y and x direction).
  - Developed via close collaboration with PS camera team.



OTA Detail

- By choice of clocking:
  - Cells can integrate science image and be read out at the end of exposure.
  - Shifts can be applied to the charge image in a cell while integrating.
  - Some cells can be read out while others are integrating.
- Video-rate readout of some cells (with bright star) & science integration in remaining cells with application of OT shifts allows tip/tilt correction.
  - Sense image motion from bright stars, apply correction to integrating cells.
  - Apply correction of nearest guide star: compensate atmosphere.
  - Apply averaged motion of all guide stars: compensate telescope shake.
- Isokinetic patch size ~ 4’x4’, need ~250 guide stars over 1º.
  - Limited by bright stars on sky. Average correction possible everywhere on sky.