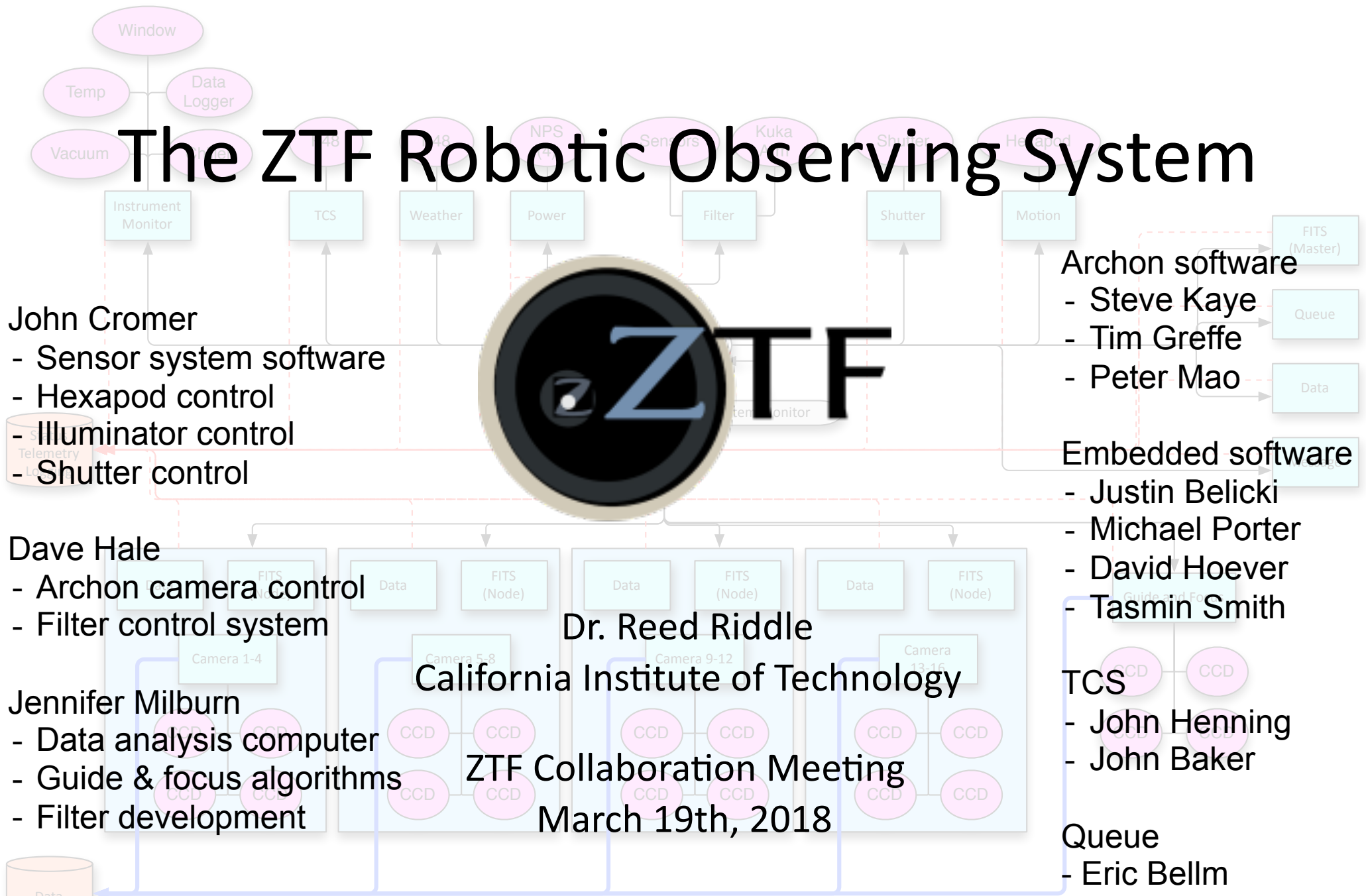


The ZTF Robotic Observing System



ZTF Software Architecture

- Adopt successful **Robo-AO** robotic system
 - Heritage is a big advantage
- Upgrade **Robo-AO** technology
 - Improve robotic system interfaces
 - Improve error handling
 - Multiple computer support for camera system
- Add ZTF specific control operations
 - Mosaic synchronization and readout
 - ZTF Filter Exchange System

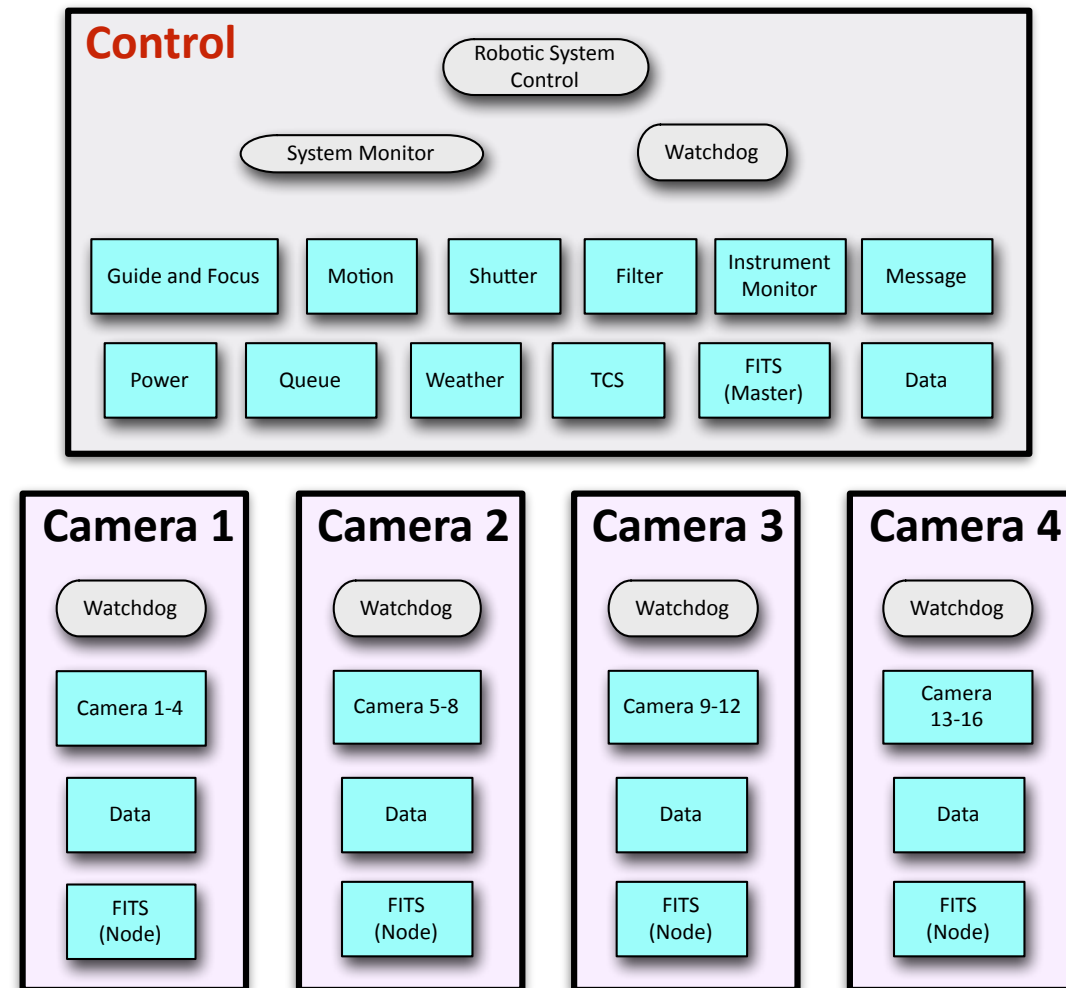


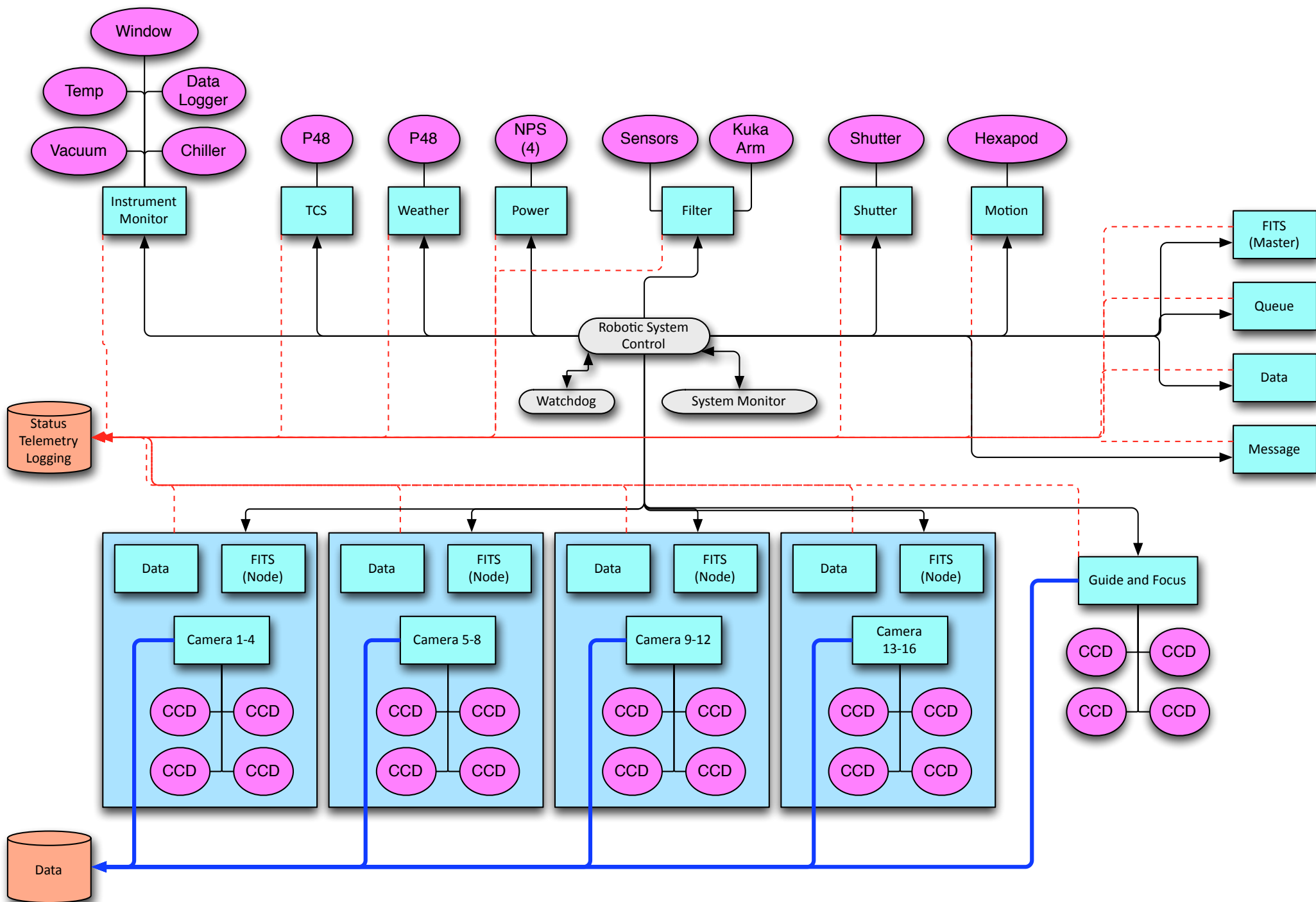
ZTF Software Challenges

- ZTF overhead requirement: 15 seconds
 - CCDs took 30-35s to read out, write data!
- Guide and focus operation
- Filter exchange system
- Data synchronization
- FITS header synchronization across five computers
- Instrument & telescope safety

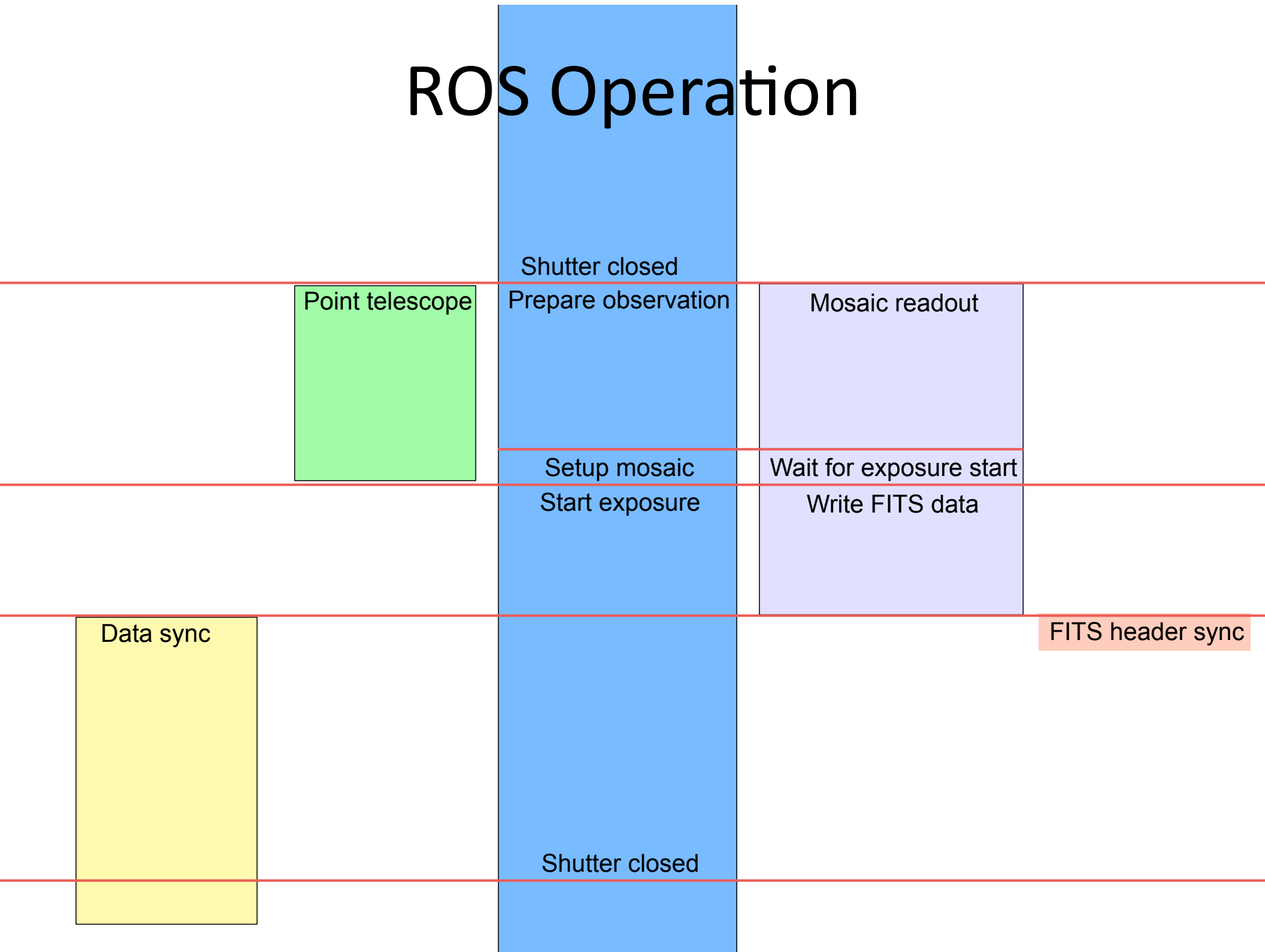
Computer System Architecture

- Control computer contains most functions
 - Interfaces to hardware
 - Robotic control system
 - Computer not overloaded
- Computers have one CCD controller each
- About 30 daemons
 - Multiple threads for control, status, watchdogs
- Modular architecture
- Five spare computers





ROS Operation



Data Synchronization

- Data synchronization daemon
 - Manages transfer of data to external site
 - ROS only transfers relevant data to IPAC
- Once image files are created:
 - ROS tells data system what files to look for
 - Data system adds new files to **synchronize** list
 - Files compressed using fpack, Rice compression
 - Attempts to transfer 3 times
 - If successful, add to **completed** list
 - If transfer fails, add to **failed** list
 - When synchronize list is empty, retry failed list images
- Sync takes about 25 seconds for all mosaic images
 - ~45s after shutter closes, all images are at IPAC

ROS Performance

2018-03-09, period of short slews, 30s observations

189 observations in 124 minutes, ~91 observations per hour

Observing thread: 39.485 ± 0.121

Prepare observation: 8.838 ± 0.120

Science observation: 30.640 ± 0.018

Data thread: 18.378 ± 0.140

Data readout: 8.317 ± 0.103

Data wait: 0.641 ± 0.078

Data write: 9.403 ± 0.046



- Overhead requirement: 15 seconds
- Overhead goal: 10 seconds
- **Measured overhead: 9.485!**
- Not done yet, still possible places to optimize operations...
 - May not be worth the effort...

Next Steps

- ZTF is mostly operational
 - 55,047 successfully completed queue observations in 110 nights
 - Limited to single filter per night
- Filter exchanger commissioning
 - Passed queue observing test of 300 successful exchanges
 - 254 of these were in one day in a row
- Guide & focus system in progress
 - Camera interface working
 - Need algorithms, integration into ROS
- Error management, watchdog, alerts, optimization
- ROS 1.0 expected in June

Thank you!

