# What is "SSA"?

- **Space Situational Awareness (SSA) is maintaining awareness of what is going on in Earth orbit with man-made satellites, rocket bodies, and debris**
  - Civil Space, Military (blue, grey, and red)
  - Radars and optical telescopes
  - Worldwide dynamically scheduled networks of diverse sensors
  - Centralized data processing and analysis
- **In the Steward Observatory context...**
  - Developing and adapting astronomical telescopes and techniques for discovering and characterizing satellites and debris on orbit
  - Survey astronomy, real time astrometry, photometry, imaging


Pomenis 180 mm SSA Astrograph
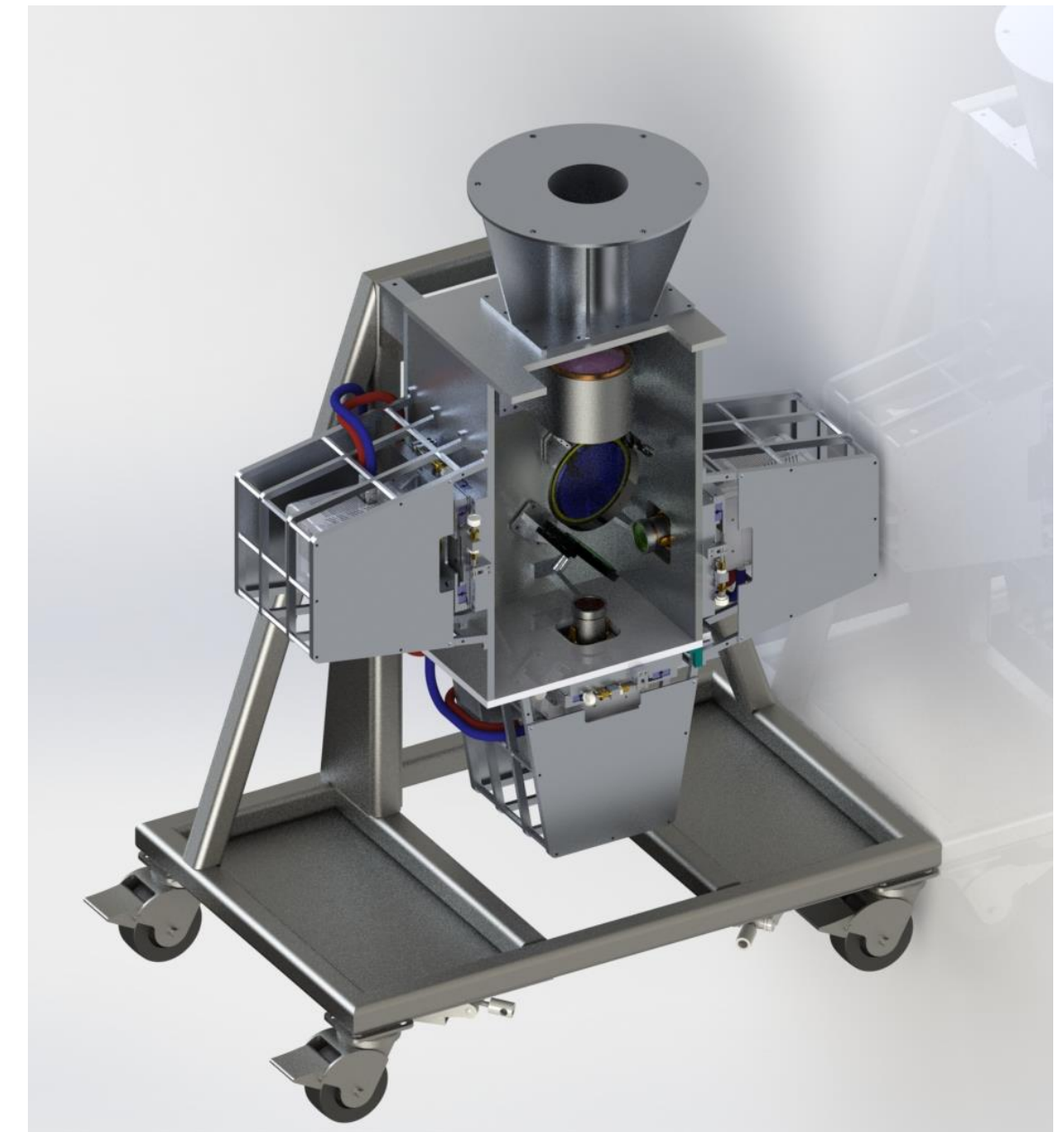
Chimera High-Speed 3-Channel Photometer

Astronomical vs. Space Surveillance Telescopes

Astronomical Systems

- Multiple instrument configurations
- Offline data processing
- Limited non-sidereal tracking

- Slow low noise imagers
- Mount and dome dynamics limited
- Often diffraction limited optics
- Optimized for pristine conditions

- Advanced astronomical instrumentation
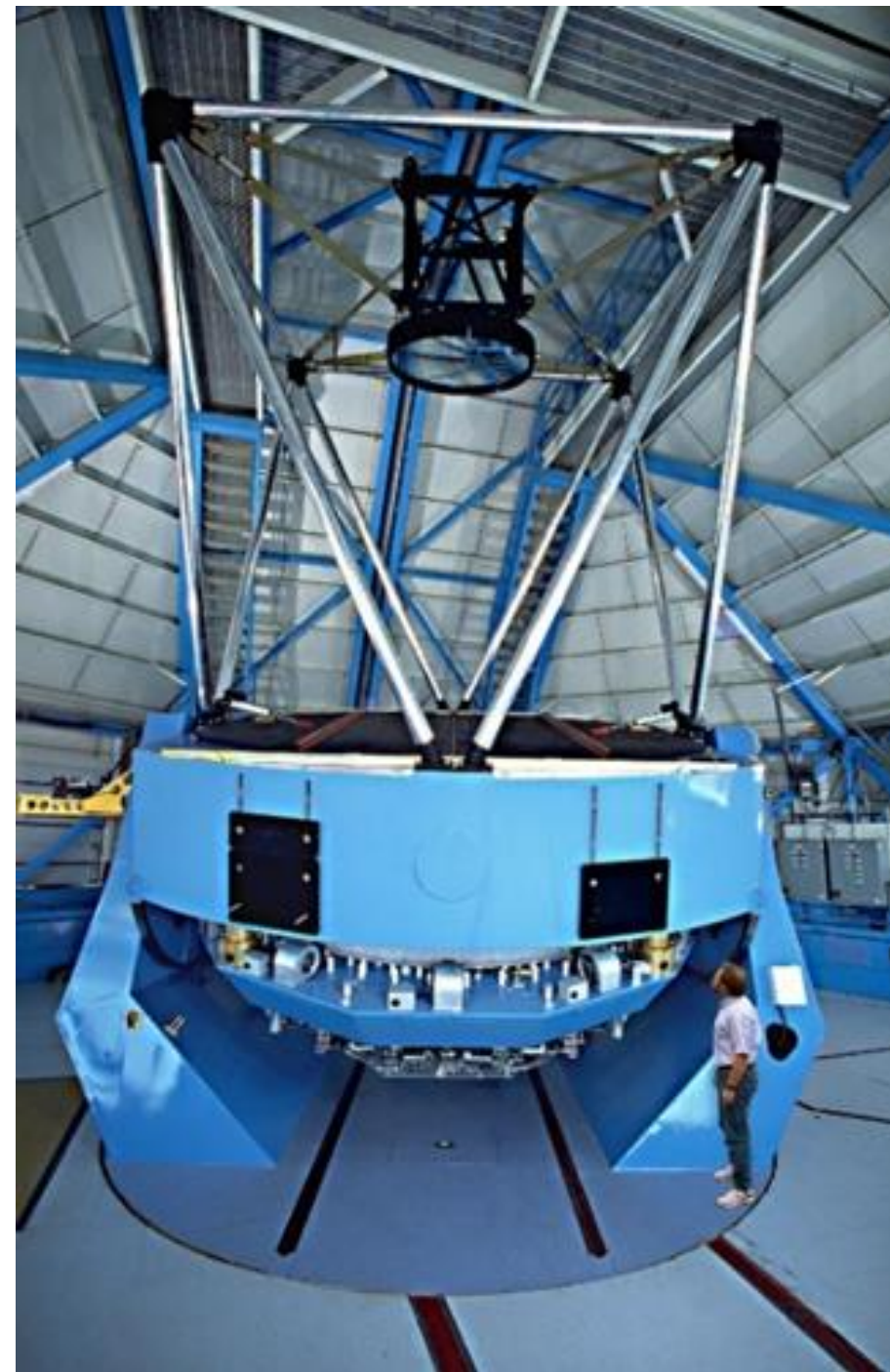
WIYN 3.5 m Telescope

Space Surveillance Systems

- Single instrument configuration
- Integrated data collection/data processing pipeline
- SSA specific pointing and tracking

- Fast readout imagers
- Highly agile mount and dome systems
- Typically seeing limited optics
- Optimized for average conditions and background

DARPA Space Surveillance Telescope (3.5 m f/1)

10/10/2017

Enabling SSA on Steward Telescopes

- **Three separate components to enable Steward telescopes for SSA**

  - **Leverage NG rollout to incrementally deploy basic satellite tracking and search capabilities to telescopes as mount dynamics allows**

  - **Leverage ARTN development to allow queue scheduling and improve access to Steward telescopes for SSA measurements**

    Mountain Operations

  - **Adapt existing astrometric and photometric processing pipelines to Steward instruments**

    Evaluating several options and leveraging other startup activities including Chimera and other external collaborations

- **Basic SSA planning and analysis tools also needed**

  - **Observation planning (currently using STK, evaluating GMAT)**

  - **Orbit determination (IOD/DOC)**

NG   "New Generation", the updated low level control system being deployed to Steward Telescopes. Includes TLE tracking capabilities

ARTN   Arizona Robotic Telescope Network

Chimera   E.Pearce startup SSA specific high speed photometer

Incremental Capabilities to Support Satellite Tracking

THE UNIVERSITY OF ARIZONA

Tracking and Control

Processing/Planning

Current NG
21" and Kuiper

Basic TLE tracking at 100 Hz

Planned NG
upgrades

Advanced Tracking Features
  Fixed time along bias–fixed LEO co-orbital serach
  Variable time along bias–sliding LEO co-orbital search
  TLE coordinate system biases (Δt, $\Delta \Psi$) – handoff

Requires both NG
upgrades and RTS-2
scripts

Search Features
  Raster and spiral scans
  (HA,Dec), (Az,El), and orbit along, across orientations
  Predefined GEO scans

Closed Loop Satellite Tracking

Currently no integrated astrometric or photmetric processing pipeline

Offline processing now being used

- NAU asteroid photometry pipeline (PP)
- LMCO UKIRT pipeline

- STK (planning and visualization)