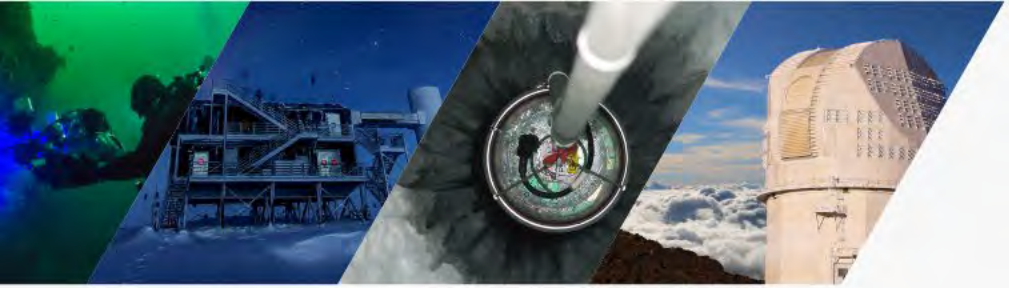
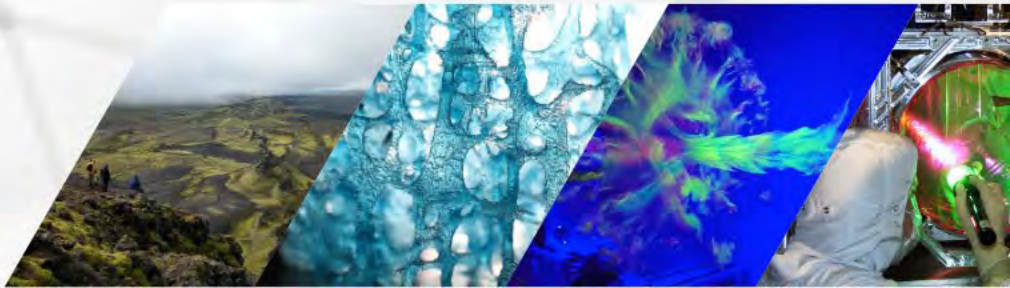


# 2022 NSF RESEARCH INFRASTRUCTURE WEBINAR SERIES

## February Webinar Part 1:
## Metrics for Research Infrastructure Performance
## 11:00am – 12:30pm



# Morning Session: Metrics for Research Infrastructure Performance
## 11:00am – 12:30pm

**Panel Discussion on Metrics for Research Infrastructure Performance**

- Panel Discussion on Best practices for collecting, calculating, and reporting metrics. Can we develop a uniform approach across all Major and Mid-scale Research Infrastructure?
- Good performance metrics help demonstrate whether a facility is reaching its goals. Panelists will discuss different performance metrics for Major and Mid-scale Research Infrastructure facilities. How metrics can improve operations and facilities management.
  - Panelists introduce themselves presenting slides briefly offering perspective on Performance Metrics (5 mins X7)
  - Moderator will ask predeveloped questions to the panelists (30 - 40 mins)
  - Moderator will ask panelists questions from attendees (10 mins)

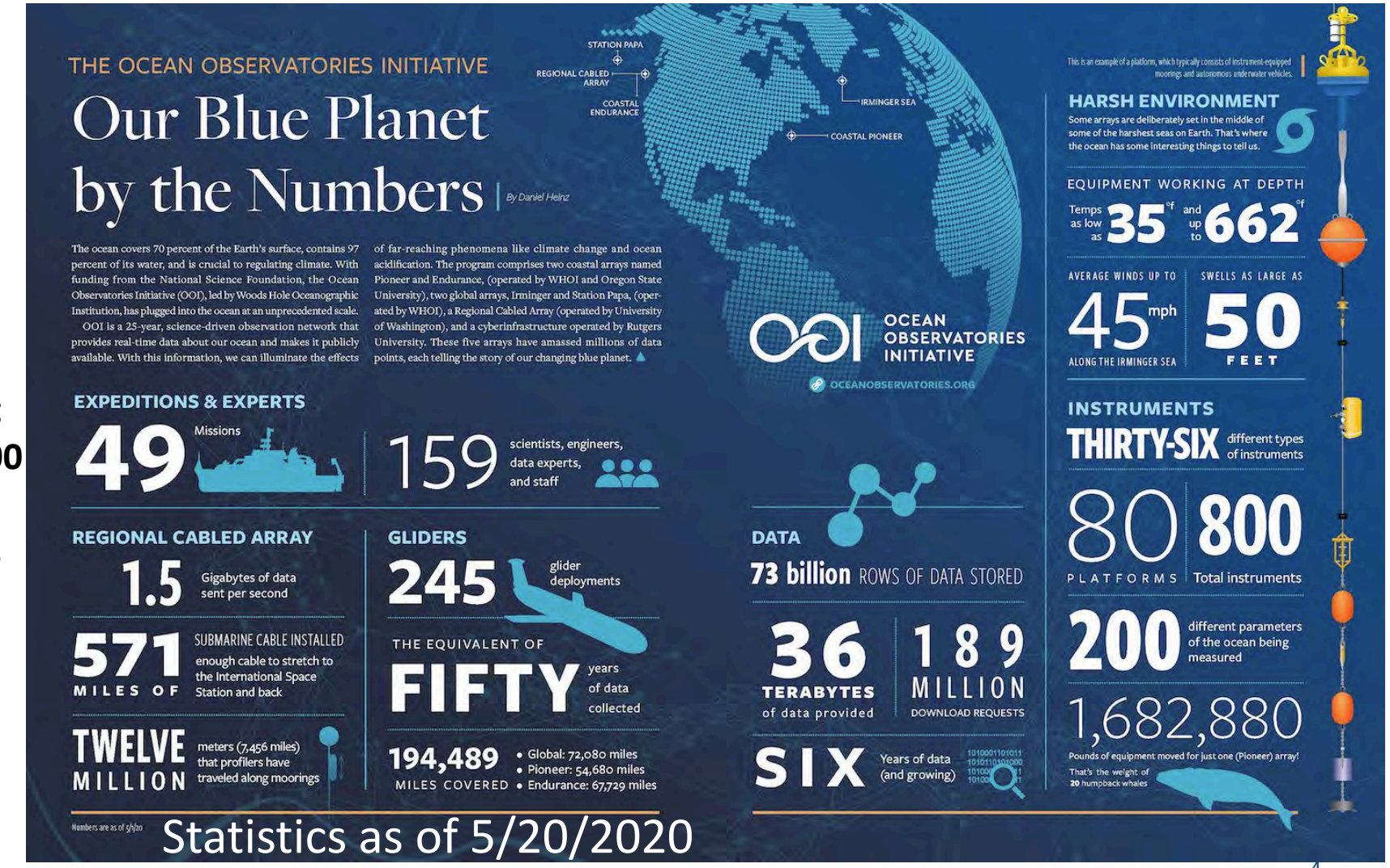
# Morning Session: Metrics for Research Infrastructure Performance
## 11:00am – 12:30pm

- **Panel includes**
  - **Matt Palanza**, Ocean Observatories Initiative Program Engineer, Woods Hole Oceanographic Institution
  - **Tony Beasley**, Director, National Radio Astronomy Observatory
  - **Benjamin Brown**, Director of Facilities Division, Office of Advanced Scientific Computing Research, U.S. DOE.
  - **Vanda Grubišić**, Lab Director, Earth Observing Lab, National Center for Atmospheric Research
  - **Joan Burkepile**, Project Scientist, High Altitude Observatory, National Center for Atmospheric Research
  - **Dan Wilson,** Associate Director, Natural Hazards Engineering Research Infrastructure at UC Davis
  - **Andreas Kaufer**, Director of Operations, European Southern Observatory

# **Matthew Palanza**, Ocean Observatories Initiative Program Engineer, Woods Hole Oceanographic Institution

**The Ocean Observatories Initiative is a persistent global network of arrays that deliver real-time data from more than 800 instruments to address critical science questions regarding the world's oceans.**

**OOI data are freely available online to anyone with an Internet connection.**




Statistics as of 5/20/2020

# OOI Performance Metrics: Capability Maturity Model

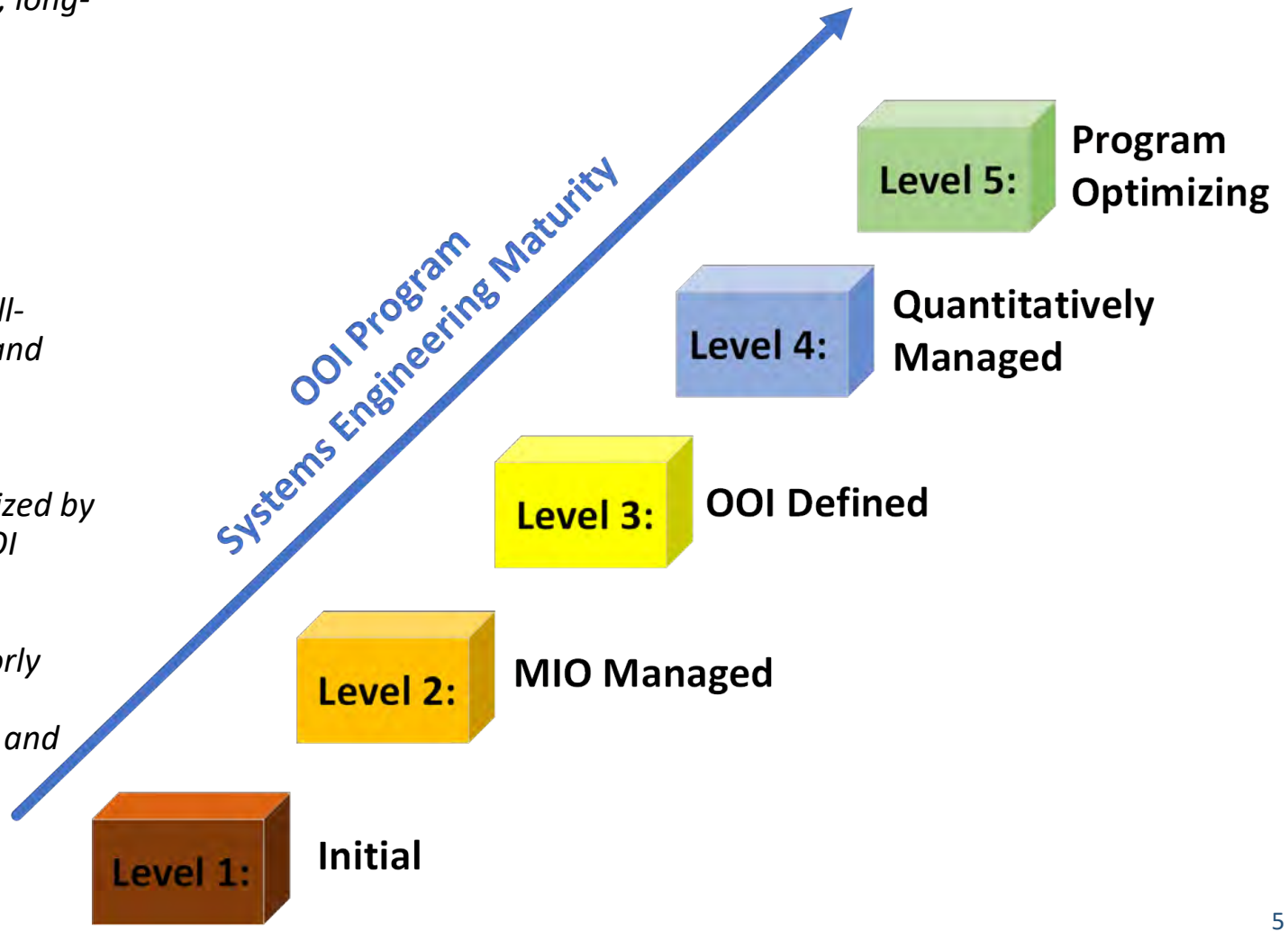
**Level 5:** *OOI Program processes are; coordinated across MIO's, stable and flexible and focusing on; continued improvement, long-term planning, and flexibility to respond to changes.*

**Level 4:** *OOI Program Level processes are measured and controlled. The OOI Program is using quantitative data and metrics to inform predictable processes that meet OOI Programmatic goals.*

**Level 3:** *MIO Level processes are well-characterized and well-understood. OOI Program is more proactive than reactive, and there are OOI-wide processes and standards that provide guidance.*

**Level 2:** *MIO processes are not based on metrics, characterized by needs of individual projects, and are frequently reactive. OOI Program processes are either not defined or reactive.*

**Level 1:** *MIO Level processes are seen as unpredictable, poorly controlled, and reactive. OOI Program Level processes are unpredictable or non-existent which leads to increased risks and inefficiency.*



# OOI Systems Engineering Performance Metrics

| Systems Engineering Processes | OOI 1.0 | OOI 2.0 | PY1 Q1 | PY1 Q2 | PY1 Q3 | PY1 Q4 | PY2 Q1 | PY2 Q2 | PY2 Q3 | PY2 Q4 | PY3 Q1 | PY3 Q2 | PY3 Q3 | PY3 Q4 | PY4 Q1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cross OOI Working Groups | 1 | 2 | 2 | 3 | 3 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Program-wide Technical Reviews | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 5 |
| System Engineering Metrics | 1 | 1 | 2 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Configuration Management | 2 | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Key Performance Parameters and Technical Performance Measurements | 1 | 1 | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Reliability, Maintainability, and Availability (RMA) | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| System Performance Tracking | 1 | 1 | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 |
| Program Technical Reviews | 1 | 1 | 1 | 1 | 2 | 3 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Obsolescence and End of Life | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 5 |
| Sensor Performance Tracking | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| Vendor Performance | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 |
| Technical Refresh | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 5 |
| OOI Quality Plan | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |
| Risk and Opportunity Management | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 4 | 5 |
| Issue Resolution and Tracking | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 4 | 5 |
| Process for Adding Instruments | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 |
| Process for Modifying Instrument Sampling | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 |
| Failure Review & Corrective Action | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 |
| Control Processes | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 |
| Outcomes Management | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 |
| Tradeoff Analysis | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 |
| Test and Evaluation Process | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 |
| Requirements Management | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Failure Analyses | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |

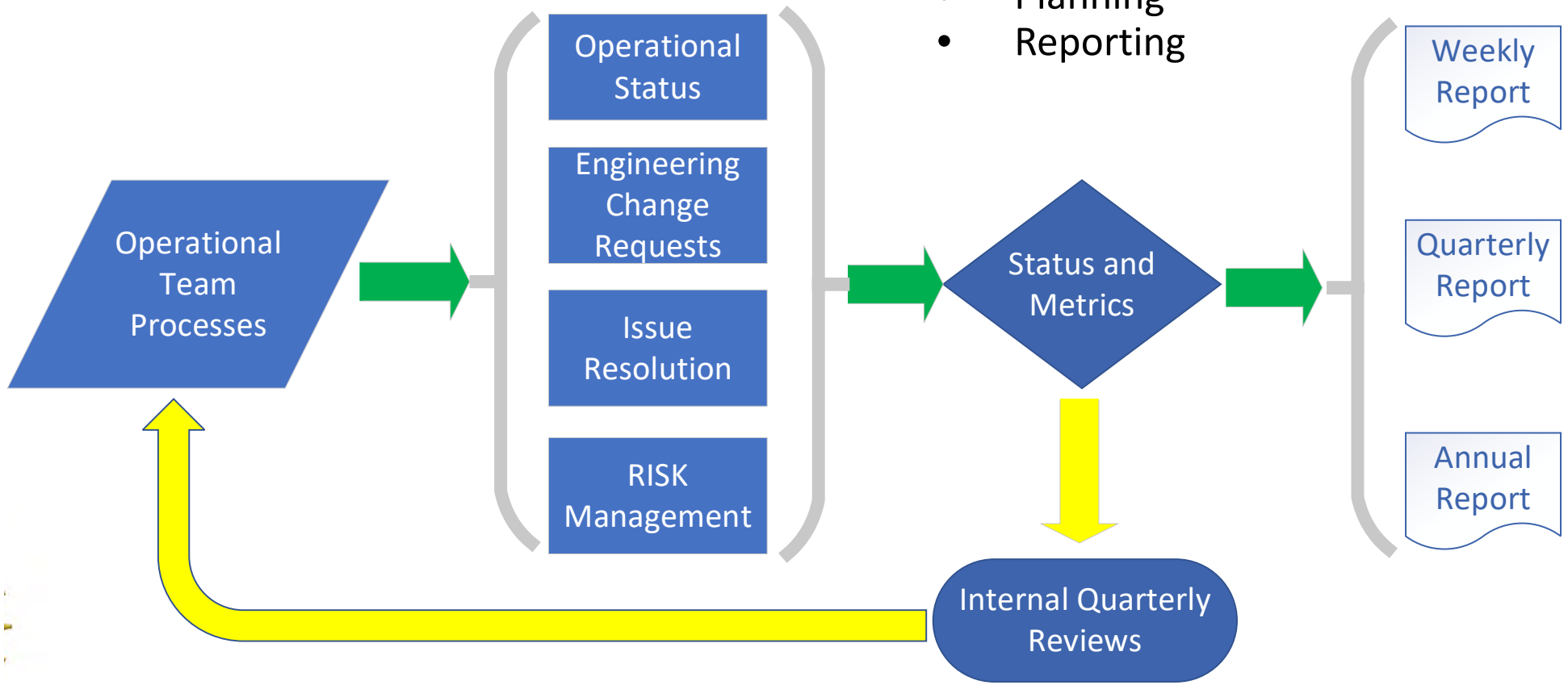
# OOI Systems Engineering Processes

MIO Level:
- Status Tracking
- Prediction

Program Level:
- Tracking
- Prediction

Program Level:
- Evaluation
- Coordination
- Planning
- Reporting

NSF Level:
- Reporting



# OOI Systems Engineering Performance Metrics Progression

**Strategic Change Implementation:**

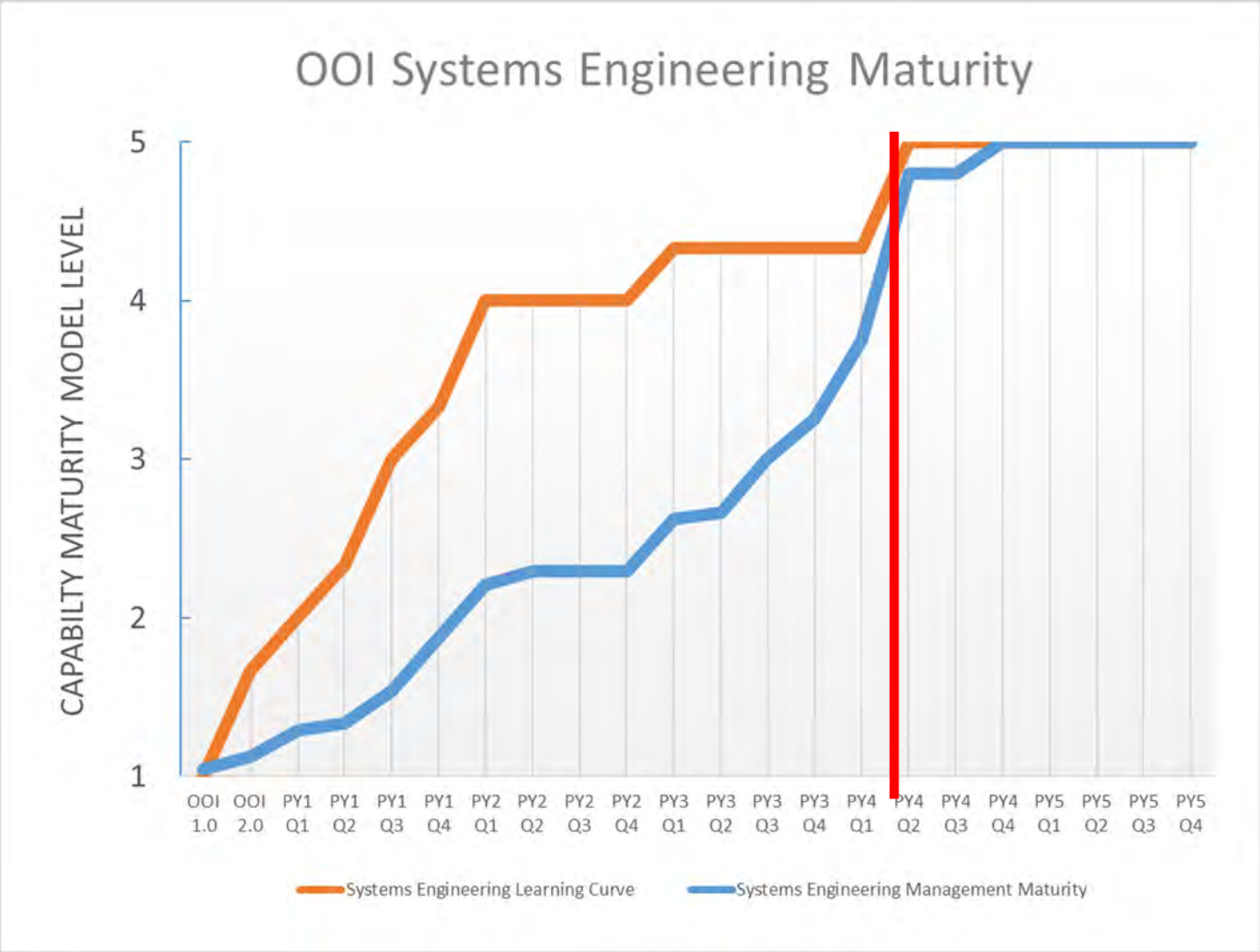
*Maturity Raised by Very Specific, Directed Actions.*

**Systems Engineering Learning Curve:**

*Average Effectiveness: Working Groups and Quarterly Reviews*

**Systems Engineering Management Maturity:**

*Average Effectiveness of Defined Processes*



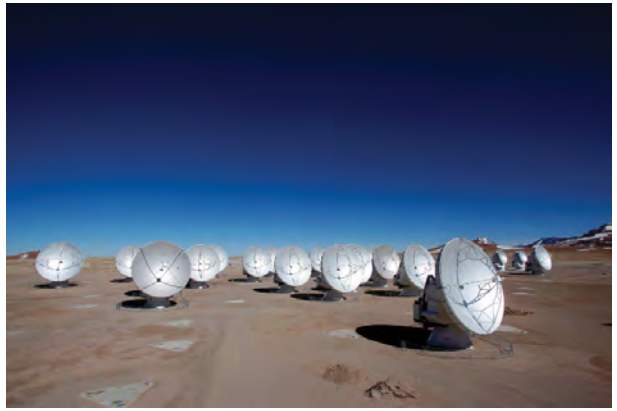
# **Tony Beasley**, Director, National Radio Astronomy Observatory

Tony Beasley is the Director of the National Radio Astronomy Observatory and AUI Vice President for Radio Astronomy Operations.

- The National Radio Astronomy Observatory (NRAO) is a research and development center of the NSF operated under cooperative agreement by Associated Universities, Inc for the purpose of radio astronomy.
- After receiving his Doctorate in Astrophysics from the University of Sydney, Tony joined NRAO as a Postdoctoral Fellow in 1991. Tony was appointed Deputy Assistant Director in 1997 and then Assistant Director from 1998 to 2000. He served as Project Manager for the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile. He was appointed NRAO Director in February 2012.

Very Large Array

The Atacama Large Millimeter/submillimeter Array. Teams from North America, East Asia, and Europe merged projects to develop this breakthrough scientific instrument in northern Chile.



# NRAO/GBO Performance Metrics

Tony Beasley

# Robert C. Byrd Green Bank Telescope


Jansky Very Large Array

# Very Long Baseline Array

# Atacama Large Millimeter/submm Array - ALMA

# NRAO/GBO

- **Management requires Measurement, in a Framework…**

- Observatories = Telescope Operations + Development Projects
  *75%* *25%*

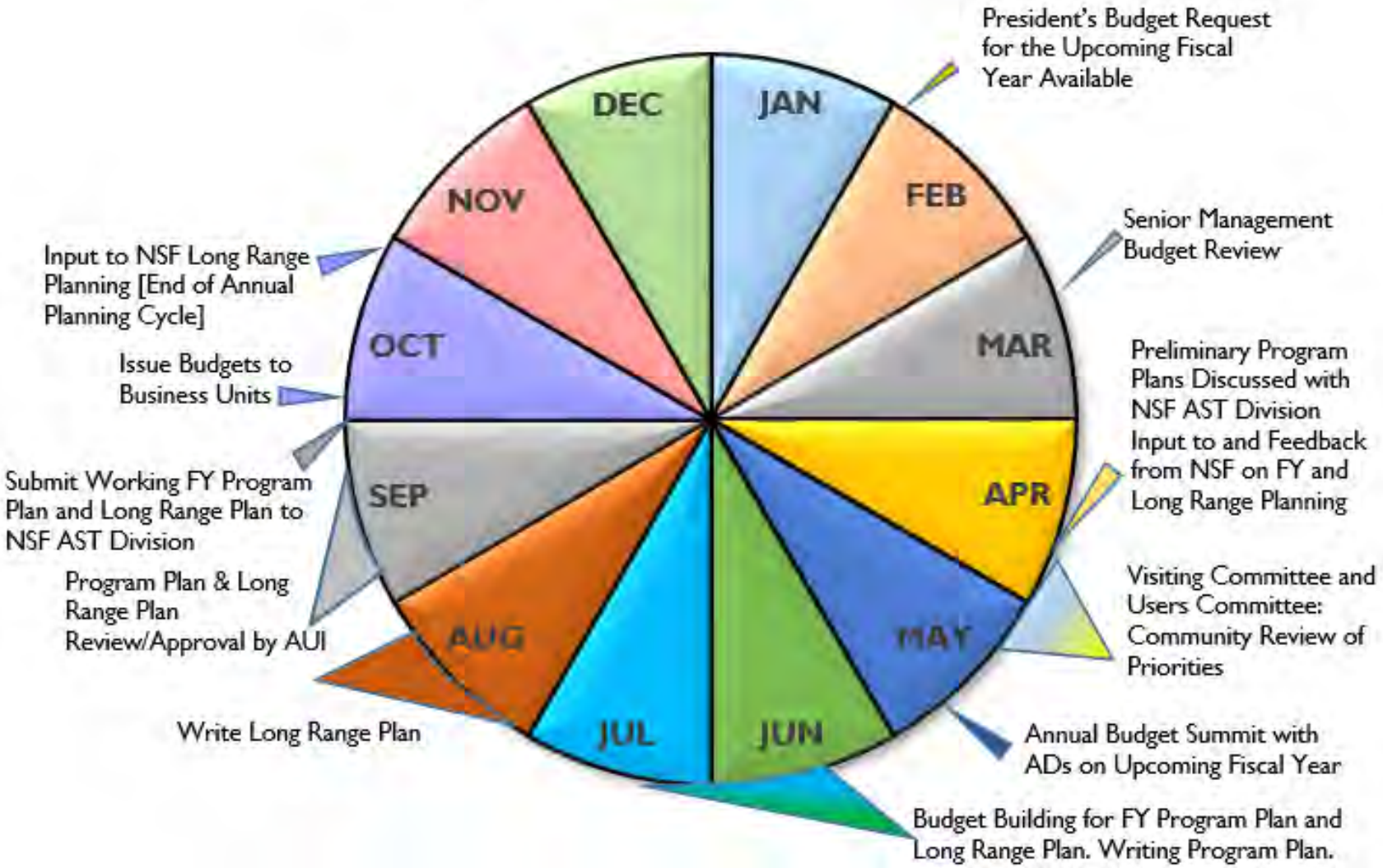
- NRAO/GBO: Operations implemented as series of 1-yr projects

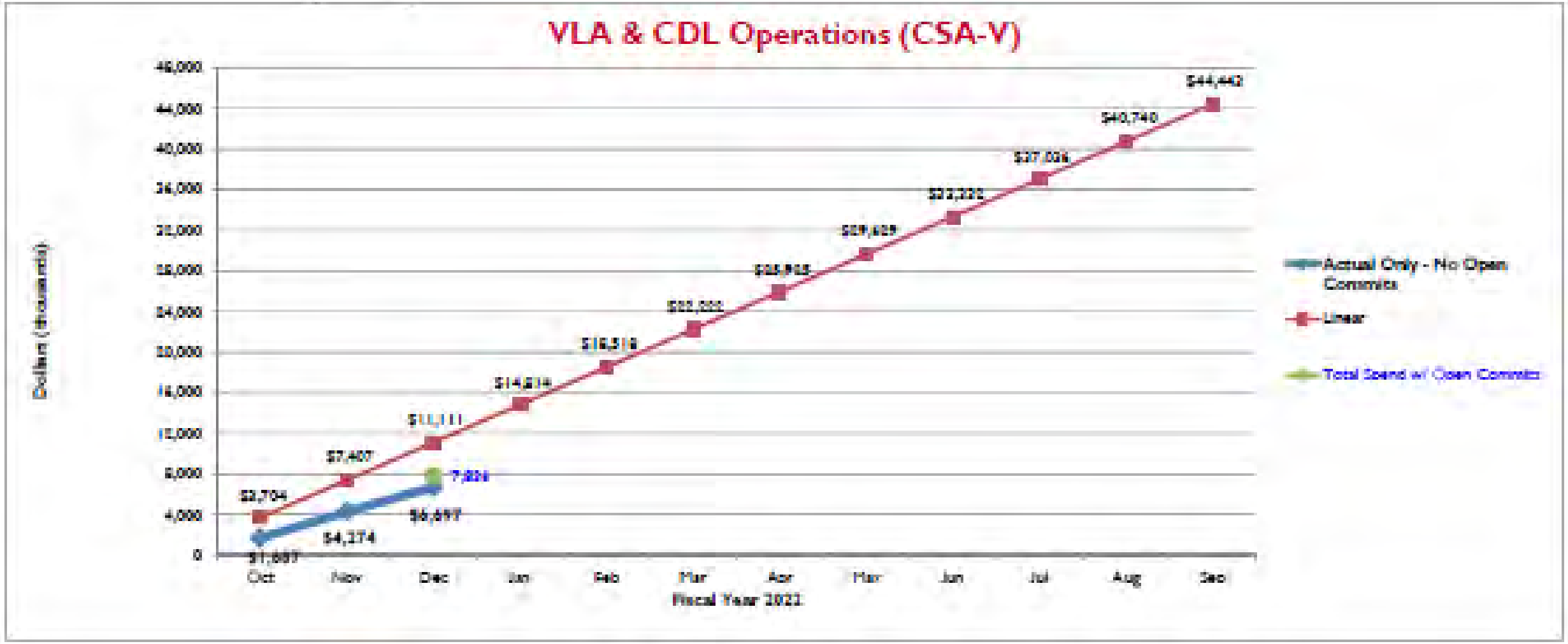
- Risks: watching science impacts, assess [Impact * Probability].

# Operations

- AUI: Mgt organization – explored Balanced Scorecard...
- Standard estimation/tracking cycle, documents in Program Operating Plan.
- Track milestones/spend on a monthly basis.

# NRAO ANNUAL PLANNING CYCLE






**Direct Budget: Large Operations ~linear via FTE costs**
**Maintain slight underspent as Operations Contingency**

# NRAO Quarterly Status Update
## October - December 2021
## QSU1 FY2022

| | | | Q1 Performance Assessment | | |
|---|---|---|---|---|---|
| POP Milestone | Milestone | Completion Date | Cost | Schedule | Scope |
| 2.5 | **NA ALMA Operations** | | | | |
| | ***Operations*** | | | | |
| 1 | Advertise for new ALMA Ambassadors | 12/31/2021 | | | |
| 2 | Host Alberto Bolatto on NAASC sabbatical visit (w/ SSR and ngVLA) | 12/31/2021 | | | |
| 4 | Analyze the data from the 2020 AAS user survey and develop strategic plan | 12/31/2021 | | | |
| | ***Development*** | | | | |
| 10 | Submit B6v2 Development Project to ALMA Board | 12/31/2021 | | | |
| 11 | Submit APP3 Project to ALMA Director | 12/31/2021 | | | |
| | ***Maintenance, Renewal and Warranty Claims*** | | | | |
| 13 | Final Acceptance Review of Receiver Cabin Wall Heater System with ALMA JAO | 12/31/2021 | | | |
| 15 | AOS-TB Repair Project Contract Award | 12/31/2021 | | | |
| | ***Chile Office*** | | | | |
| 20 | Remobilize multicancha contractor and resume construction | 12/31/2021 | | | |
| 3.4 | **New Mexico Operations** | | | | |
| | ***Very Large Array*** | | | | |
| | ***Operations*** | | | | |
| 1 | Define VLA GO and SRO capabilities for Semester 2022B | 12/31/2021 | | | |
| 12 | VLITE training for Operators | 12/31/2021 | | | |
| | ***Technical Upgrades and Enhancements*** | | | | |
| 33 | Install buffer tank system control electronics | 12/31/2021 | | | |

# POP MILESTONE # 4.3.4

## Central Development Laboratory

### Design, fabrication, and testing of ALMA Band 6v2 OMT

Cost
Schedule
Scope

**COST:**

| Labor Actuals | Expected |
|---|---|
| $ | $ |
| **Material Actuals** | **Expected** |
| $ | $ |
| **Travel Actuals** | **Expected** |
| $ | $ |

**SCOPE:**

In order to pursue/investigate all options available for building the best ALMA Band6 V2 receiver, we decided to take on fabricating and testing two additional novel OMT designs from the new research engineers who recently joined CDL.

After testing the three designs, one of them will be chosen based on performance. The first novel design, a reverse coupler OMT, has been completed, fabricated and is being evaluated. The fabrication of the second, a double-ridged OMT fabrication has been completed in the shop, it is undergoing electroplating, while the Dunning/Erickson brow three OMT has been designed but remains to be fabricated.

**SCHEDULE:**

| Milestone | Schedule | Target |
|---|---|---|
| 1. Design, fabrication, and testing of ALMA Band 6v2 OMT. | 6/30/2021 (previously revised to 12/31/2021) | 6/30/2022 |

**RISK & MITIGATION:**

| Risk | Mitigation |
|---|---|
| 1. Not applicable | |

QSU1 FY2022

## NRAO RISK REGISTER

**PURPOSE:** This risk register will be used to review risks and opportunities identified by each department/division/site. Any very high or high risks will require a very detailed assessment, and plans on how these will be addressed (mitigation). These will be compiled and presented at each quarterly review, during the program plan, and at the yearly budget summit. Details can be found in the Risk Management SOP on Sharepoint\Processes & Policies\Observatory Risk Management\

Below are the tables describing the methodology to apply to your estimates for risk exposure - first the impact and second the probability.

COMPOSITE SCORE FOR Risk Exposure= Probability Score * (Cost Impact Score + Schedule Impact Score + Scope Impact Score)

| | |
|---|---|
| LOW | RE < 10 |
| MEDIUM | 10 >= RE < 30 |
| HIGH | 30 >= RE <= 45 |
| VERY HIGH | RE > 45 |

Impact Score definitions

| Cost Impact (financial, budget, etc.) | Schedule Impact (dates, milestones, timelines, durations, etc.) | Scope Impact (requirements, deliverables, activities, etc.) | Impact Score |
|---|---|---|---|
| <1% over or under baseline budget | <1% over or under baseline schedule | Meets full specifications; or will meet full expectations | 1 |
| up to 5% over or under | up to 5% over or under | Plus or minus 5% specifications; or will not meet full expectations | 2 |
| up to 10% over or under | up to 10% over or under | Plus or minus 10% specifications; or will not meet full expectations to a greater degree | 3 |
| greater than 15% over or under | greater than 15% over or under | Does not meet specifications/expectations | 4 |

Probability Score

| Impact level | Probability | Probability Score |
|---|---|---|
| Low | < 10% | 1 |
| Medium | 30% | 2 |
| High | 50% | 3 |
| Very High | 80% or higher | 4 |

| CODE | RISK CATEGORIES: |
|---|---|
| Y | Strategic |
| O | Operations (e.g. increasing power/utility costs, etc.) |
| I | Infrastructure Operations, Maintenance & Renewal (e.g. aging, lifecycle, lack of redundancy, etc.) |
| W | Workforce or Staffing (succession, retention, recruitment, training) |
| M | Morale |
| R | Resource sufficiency (e.g., not enough $, not enough staff) |
| D | Document management |
| C | Compliance (e.g. failure of process, planning errors, etc.) |
| Q | Reputation |
| S | Safety |

Choose as many as apply, separate by commas (e.g., S,W)

Owner: Bill P. Hassing LAST UPDATED: January 2022

| Risk ID | Risk Category | Risk Title | Description | Risk Analysis: Probability Score (1-4) | Risk Analysis: Cost Impact Score (1-4) | Risk Analysis: Schedule Impact Score (1-4) | Risk Analysis: Scope Impact Score (1-4) | Risk Analysis: Opportunity Score | Risk Analysis: Risk Exposure Score (Opportunity Score) | Risk Analysis: Ranking (Number of Risks) | Risk Analysis: Value at Risk | Risk Treatment: Risk Strategy Category | Risk Treatment: Risk Strategy | Risk Treatment: Estimated Cost of Risk Strategy Implementation | Risk Treatment: Target Risk Retirement Date | Risk Treatment: Retired? | Risk Treatment: Date Retired | Risk Treatment: Reason Retired | Risk Treatment: POC | Risk Treatment: Trigger | Risk Treatment: Fall Back Plan | Risk Treatment: Related POP Milestone | Risk Treatment: Current Status |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NMOPS-14 | O, I, Q | Inability to fulfill Observatory objectives due to pandemic conditions. | Though mitigation measures have been enacted during the Covid-19 pandemic, a significant risk exists should an employee contract the virus. Through contact association, this could result in the temporary shut down of the Electronics and Engineering Services divisions for several weeks. | 4 | 3 | 4 | 4 | 44 | High | 1 | Value of observing time and value of NRAO reputation in ability to provide advertised capability. Loss of observing time valued at $14k per day on average. | Accept, Mitigate | Protocols and procedures are in place to significantly reduce the probability of virus transmission in the workplace. | | 2022 | No | | | NM AD | | | | 7/2020: Added to risk register.<br>1/2021: Protocols and work plans developed and revised as warranted to reduce the risk of spreading the COVID-19 virus at the VLA, DSOC, and VLBA sites.<br>1/2022: Workforce now fully vaccinated. |
| NMOPS-16 | O, I, Q | Inability to expeditiously address Repair and Maintenance Activities due to COVID-19 Vaccine Policy | Several NRAO staff, particularly those stationed at the VLA, may refuse to be vaccinated and therefore will be terminated in early September. This will likely result in delays across several departments. | 4 | 3 | 4 | 3 | 40 | High | 2 | Value of observing time and value of NRAO reputation in ability to provide advertised capability. Loss of observing time valued at $38K per day on average. | Accept, Mitigate | Advertise for likely vacancies in August 2021, identify remaining staff and contractors with skillsets who can fill in for departing colleagues, crosstrain where practical. | | 2022 | No | | | NM AD | Staff who have not indicated they have received or will receive the COVID-19 vaccine by early August will have their positions advertised. | | | 7/2021: Added to risk register. Due to COVID-19 vaccine requirement for staff, there exists a certain risk of losing tens of staff, many who are in key positions, at the VLA and at the DSOC.<br>1/2022: Hiring ongoing |
| NMOPS-15 | O, I, Q | Damage to equipment and/or interruption to Operations due to single point equipment failures. | The fire alarm system failure in July 2021 resulted in a hard shutdown of the WIDAR and subsequent interruption of observations. The failure of other support systems across the site could have similar results. | 3 | 4 | 4 | 4 | 36 | High | 3 | Value of observing time and value of NRAO reputation in ability to provide advertised capability. Loss of observing time valued at $38K per day on average. | Mitigate | Task the Electronics and Engineering Services Divisions to consider single points of failure and suggest mitigation strategies. Expand exercise to other departments if needed. | | 2022 | No | | | NM Deputy AD | | | | 7/2021: Added to risk register after failure of WIDAR fire alarm system resulted in hard shut down of the correlator. Reassess risk by 11/2021.<br>1/2022: Initial list started by CL, will be picked up by EF in Q2. Currently has VLA items identified and none in DSOC. |
| VLA-ES26 | I, Y | Declining antenna performance due to FRM performance and increased failure rate. | $110K per antenna on average is needed for components to upgrade the FRMs. This work happens at the same time as the ACU upgrades. The work was not considered and the cost was not known at the time the ACU cost estimates were provided during the AUI re-competition. | 4 | 3 | 3 | 3 | 36 | High | 4 | Value of declining antenna performance (science impact) | Mitigate | Continue to repair FRMs as part of ACU upgrade. | $30,000 per year for eight years (included in the recompetition) | 2017 and beyond | No | | | Engineering Services and Electronics Division Heads | Like new ACUs are being installed | Reprioritize other ES Division maintenance | | 7/8/18: Received funding ($30K) for FY19 FRM repairs at FY19 Budget Summit.<br>7/19: Allocated $60K from NM OPs to purchase sufficient components for FY20 and FY21.<br>7/2020: FRM repairs/refurbishments keeping pace with ACU replacements.<br>1/2021: Pandemic has resulted in ACU and FRM upgrades not meeting schedule. With sufficient spares for older units and the new units, there is little risk that an ACU will be out of service for any length of time.<br>7/2021: Sufficient gears are on hand for the next few FRM upgrades, but [illegible] |
| VLA-ES15 | I, O, S | VLA track crosstie failures (increased material costs) | Aging Wye crossties lead to rail failure, worst case scenario will produce the loss of an antenna. | 3 | 4 | 3 | 4 | 33 | High | 5 | $10,000,000.00 | Mitigate | Implement Holland Track Survey Strategy. Included in recompetition. | $500,000 / year M&S cost | 2026 | No | | | NM Engineering Services Division Head | Cross ties fail, making track impassable for re-configuration. | Observe with antennas at current location until cross ties can be replaced. | Several | 4/1/18: Additional 5000 ties replaced by FY2017 (FY17 acceleration).<br>Ultrasonic track inspection planned/funded for FY20. 7/19: Additional 5000 ties replaced in FY18. On schedule to replace another 5000 in FY19.<br>Descoped ultrasonic track inspection scheduled for FY20.<br>11/2019: 5000 ties replace in FY19. Risk remains high. |
| NMOPS-02 | S | Damage to personnel or infrastructure due to inadequate site physical security. Inadequate law enforcement presence and response time. | In case of a Security event, we require a contingency plan in place. | 3 | 3 | 4 | 4 | 33 | High | 6 | The value of Personnel Safety | Mitigate | Develop and implement a site security plan. | Pending cost estimation | 2022 | No | | | NM AD | Security breach occurs a the VLA, DSOC, or a VLBA site. | Staff contact local law enforcement and follow ES&S recommendation of "flee, hide, fight" | Several across multiple departments | 2/2016: The PR break-in has illuminated the need for general site security across the observatory.<br>11/2019: Consultant brought in for security review. Report pending.<br>7/2020: NM Ops is investigating ways to improve site security. Methods may include gates, security cameras, and improved building locks.<br>7/2021: Materials for VLA site gates obtained using salary savings. These will be installed in FY2022.<br>1/2022: Installation planned for Q3-Q4 FY22 Installation of 7 gates at VLA. |
| VLA-ES09 | R, W | Lowered staff productivity due to no VLA Administrative assistant | Without an admin assistant at VLA site, site management has been impacted due to loss of day to day help, site staff now have to drive to DSOC for petty cash and other administrative actions, and operators have had an increase to their workload due to assuming some public facing duties typically held by an admin. | 4 | 2 | 3 | 3 | 33 | High | 7 | Delay in supporting business activities, staff morale at risk | Mitigate | Hire new administrative assistant. | $75k | 2022 | No | | | Science, Engineering Services Division Head | | | | 1/2022: Added to risk register. |
| VLA-SCI-07 | O, W, Q, M | Insufficient scientific staff levels to support VLA operations | Data quality declining, will impact SILDP because more DAs needed to manually flag/calibrate. Delayed implementation of new observing modes, increased unhappiness of users. | 4 | 2 | 2 | 3 | 28 | Medium | 8 | Credibility with the community in NRAO's ability to deliver high quality data | Mitigate | Prioritize data quality over new capabilities. Redirect observatory funds to hire additional scientific staff. | $100k/yr. per additional hire | 2022 | No | | | NM Science Support Division Head | Evaluation of pipeline results | Transfer effort from user support to telescope support | | Monitoring data quality via weekly end-to-end tests.<br>7/2020: This is an ongoing risk which is actively managed by Science and NM Ops.<br>01/2022: Ongoing with hiring of replacements. |
| VLA-ES06 | W, Y, M, Q | Inability to use cranes for basic tasks due to lack of trained operators. | Operation of cranes requires a minimum certification level, without which will result in the inability to perform basic tasks at the VLA. | 3 | 2 | 2 | 4 | 27 | Medium | 9 | Productivity decrease for site maintenance operations | Mitigate | Train several VLA staff in crane operations. | $25K for two staff | 2022 | No | | | NM Engineering Services Division Head | Inability to perform our own crane work | Hire outside talent until local staff are certified. | Several | 2/2020: A single certified crane operator is available at the VLA.<br>4/2020: $25K in FY2021 funds to train 2 crane operators awarded at the 4/2020 Budget Summit.<br>1/2021: Additional crane certifications delayed due to pandemic travel restrictions. Likely to request carryover of funds into FY22.<br>7/2021: Funds for training to be carried over into FY2022. Risk remains. |
| VLA-ED03 | I, O | Use of spares for MSIP antenna qualification electronics contributes to operations downtime. | MSIP project relies upon extensive use of spare electronics modules within antennas and WIDAR to support antenna qualification over 64 months. | 3 | 3 | 3 | 3 | 27 | Medium | 10 | $350,000 | Accept | Monitor spare usage and accept potential, temporary increase in unavailable antennas. Value at risk represents the cost of an additional set of receiver spares and additional LOIF hardware. | 0 - 350000 (accept or mitigate) | 2025 | No | | | Electronics Division Head | Loss of sufficient spares to operate all antennas or correlate with 29 antennas | Pull single band (X or Q)or antenna from array. Could use C band for pointing until X is repaired. | | 1/2022: Added to Risk Register. Risk initiated as MSIP project further defines conceptual design around heavy usage of existing VLA spares. |

# Performance Metrics Scheme

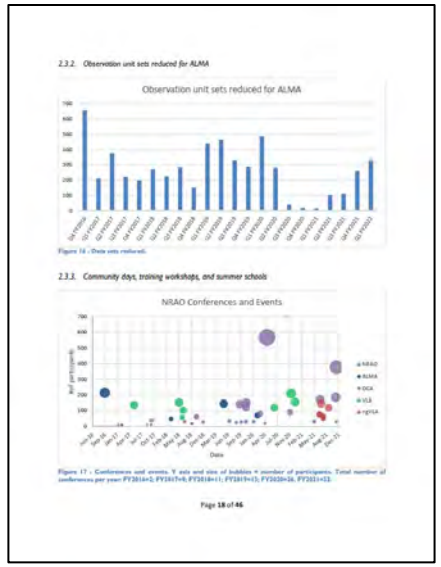
| Title: NRAO Metrics Report Q1 FY2022 | Author: Director's Office | Date: 2/1/2022 |
|---|---|---|
| NRAO Doc #: DO NRAO-83-3082 | | Version: 5.1 |

NRAO Performance Evaluation and Management Report (PEMR) for Q1 FY2022

| PREPARED BY | ORGANIZATION | DATE |
|---|---|---|
| Director's Office | NRAO | 2/1/2022 |

| APPROVALS (Name and Signature) | | ORGANIZATION |
|---|---|---|
| Nicole Thisdell | Nicole Thisdell Digitally signed by Nicole Thisdell Date: 2022.02.03 11:18:51 -05'00' | NRAO |
| Tony Beasley | Digitally signed by Tony Beasley Date: 2022.02.03 13:01:27 -05'00' | NRAO |
| Dave Curren | | AUI |






- Set of 57 metrics across all departments, external deliverables
- Defined in "Performance Evaluation Mgt Plan" (agreed w/ NSF)

- **Experience**
  - **Useful snapshot of Observatory performance**
  - **Metrics should be simple to understand and acquire, whenever possible.**

| Title: NRAO Perf. Metrics Plan | Author: Director's Office | Date: 2018.05.01 |
|---|---|---|
| NRAO Doc #: DO | | Version: 4.4 |

NRAO Performance Evaluation and Management Plan
(PEMP)

| PREPARED BY | ORGANIZATION | DATE |
|---|---|---|
| Director's Office | NRAO | 2018-05-01 |

| APPROVALS (Name and Signature) | ORGANIZATION |
|---|---|
| Nicole Thisdell Nicole Thisdell Digitally signed by Nicole Thisdell Date: 2018.05.17 14:33:28 -04'00' | NRAO |
| Tony Beasley | NRAO |
| Dave Curren | AUI |

## 2. List of Key Performance Indicators

### 2.1. Observatory Outputs

*2.1.1. Refereed publications and NRAO refereed author papers*
*Description/definition: Number of refereed papers using NA ALMA and VLA data*
*BSC: Customer*
*Reporting interval: Annual, January*
*Units: Number*
*Dept/Point of Contact: NA ALMA/ Jewell, SSR/Ball*
*Acceptable range/trend: Increasing*
*Exception actions: Advice from User and Visiting Committees*
*Notes:*

*2.1.2. NRAO PI proposals for NA ALMA and VLA*
*Description/definition: Number of proposals*
*BSC: Learning*
*Reporting interval: Semester*
*Units: Number*
*Dept/Point of Contact: SSR/Ball*
*Acceptable range/trend: Maintain*
*Exception actions: Advice from Visiting Committee*
*Notes:*

*2.1.3. Citations for ALMA and VLA*
*Description/definition: Cumulative citation count*
*BSC: Customer*
*Reporting interval: Annual*
*Units: Number*
*Dept/Point of Contact: NA ALMA/ Jewell, SSR/Ball*
*Acceptable range/trend: Increase*
*Exception actions: Advice from Visiting Committee*

*2.1.4. Technology developments*
*CDL and NM*
*Description/definition: Number and value of significant upgrades and external deliverables underway*
*- Internal = quarterly*
*- Work for others = quarterly*
*BSC: Customer*
*Units: Number*
*Dept/Point of Contact: CDL/Hawkins*
*Acceptable range/trend: more than one*
*Exception actions: Advice from Visiting Committee*
*Notes:*

Page 6 of 19

# Performance Evaluation & Management Plan

# Summary

- NRAO/GBO: Detailed Development & Operations estimation, tracking, reporting processes.
- Dedicated staff (2) dealing with reporting, statistics.
- Annual cycle of processes (sending/receiving information) well-established and actually maps to our efforts.
- Not perfect
  - Poor initial estimates, unstated assumptions
  - External influences
- NRAO/GBO performance reporting – for both Dev/Ops – are useful tools, providing key insights.

NRAO

GREEN BANK OBSERVATORY

NSF

AUI

U.S. DEPARTMENT OF ENERGY | Office of Science

# **Benjamin Brown**, Ph.D., Director of Facilities Division
## Office of Advanced Scientific Computing Research (ASCR)
## Department of Energy

- Ben Brown leads ASCR's Facilities Division, which conceives, constructs, and operates world-leading open access supercomputing, data, and networking facilities to enable the DOE mission and the national research enterprise.
- The Division's $575M annual budget supports High Performance Computing and Leadership Computing Facilities at Lawrence Berkeley, Oak Ridge, and Argonne National Laboratories; and the Energy Sciences Network (ESnet), which delivers high performance data transport capabilities for large-scale science.
- From 2014-21 Ben was the founding program manager for the Department's Project Leadership Institute, which is devoted to training the next generation of DOE project leaders.
- Prior to joining the DOE in 2008, Ben conducted research on optical control of quantum systems and quantum information science and served as an AAAS Congressional Fellow at the U.S. Senate.
- He holds a bachelor's degree in physics from Harvard University and a Ph.D. in optics from the University of Rochester.

U.S. DEPARTMENT OF ENERGY | Office of Science

# Thoughts on Facility Performance Metrics

## NSF Research Infrastructure Webinar Series
## February 16, 2022

**Benjamin Brown, Ph.D.**

Director, Facilities Division

Office of Advanced Scientific Computing Research

# metrics Salience & Reduction

# metrics Trust & POWER

# Adam Grant's podcast WorkLife, explored issues of trust and power in the episode "Relationships at work" with Esther Perel

@ time mark 5:22:

"There is no relationship that doesn't have a power dimension…

it's just part of the fabric of relationships."

Dynamic tensions:

expectations / dependency / reliance / transparency / surveillance

Metrics are a primary artefact of institutional partners reckoning with these tensions.

**TED podcast link:** https://tinyurl.com/yckn2cz2

# Alignment
# Trust
# Power

**Sustained operational excellence requires <u>alignment</u> between the partners (sponsor/performer).**

**Metrics are a tool to structure the cadence of conversation.**
**Whether the alignment is trust-based or power-based is up to the partners.**

# ASCR Facilities: Examples of metrics and their adjudication

| Metric type | Monitoring timescale | Review timescale | Review (deep conversation) venue |
|---|---|---|---|
| **Uptime** | Monthly | Annual | Annual operations review |
| **Utilization** | Monthly | Annual | Annual operations review |
| **Allocation of resources** to end users in accordance with established policies | Monthly | Annual | Annual operations review |
| **Financial** (cash flow, spend plan, outyear planning) | Monthly | Semi-annual | “Budget Deep Dive” |
| **Project performance** | Monthly | ~Annual | External peer review, a.k.a., Independent Project Review |

# **Vanda Grubišić**, Director, Earth Observing Laboratory, National Center for Atmospheric Research

Dr. Vanda Grubišić is the Director of the NCAR Earth Observing Laboratory and an Associate Director of NCAR (FFRDC). Prior to joining EOL in 2011, Dr. Grubišić was on the faculty of the University of Vienna (Austria) and the Desert Research Institute (US). She holds Ph.D. in atmospheric sciences from Yale University.

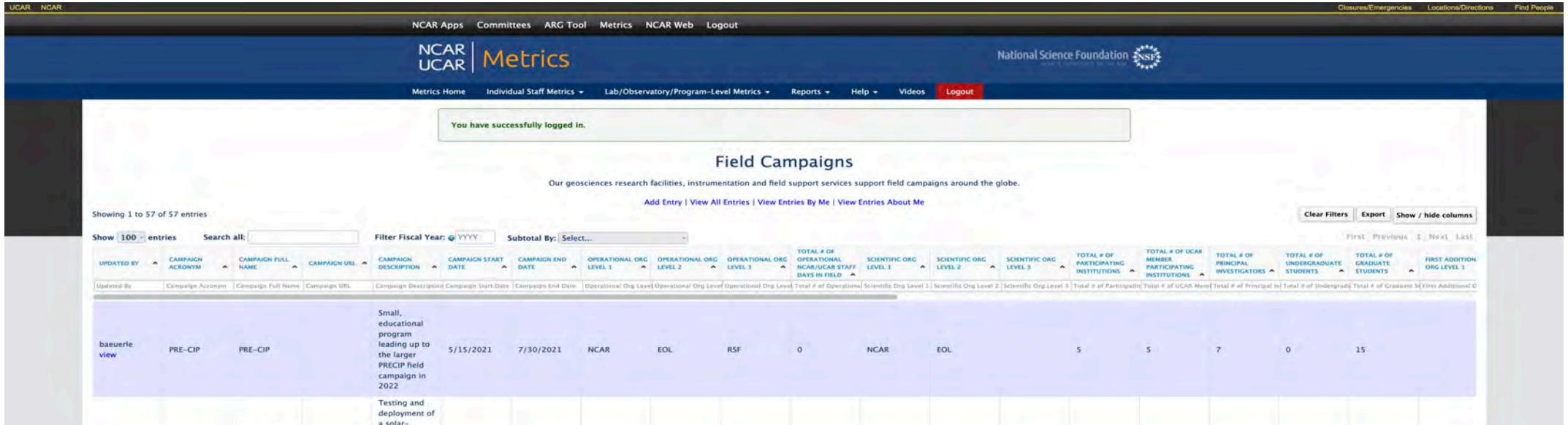
- EOL Mission is to develop and deploy observing facilities and provide expertise and data services needed to advance scientific understanding of the Earth system, primarily of the Earth's atmosphere.
- EOL manages and operates the largest portion of NSF Lower Atmosphere Observing Facilities (LAOF) and deploys them in support of NSF-funded observational science field campaigns.

LAOF LOWER ATMOSPHERE OBSERVING FACILITIES

# NCAR/EOL Performance Metrics

## Performance Metrics: Definition and Reporting Requirements

1) Facility Usage: Description and statistics of usage of major NCAR facilities is a requirement of the NSF CA/CSA with UCAR for the management of NCAR
2) Service to the Community and Data Usage: Laboratory/NCAR level tracking and evaluation, also NSF evaluation as part of the NCAR 5-year reviews (SVTs)
3) Operational Status of Field Campaign Support: EOL-level tracking and evaluation with monthly reporting to NSF



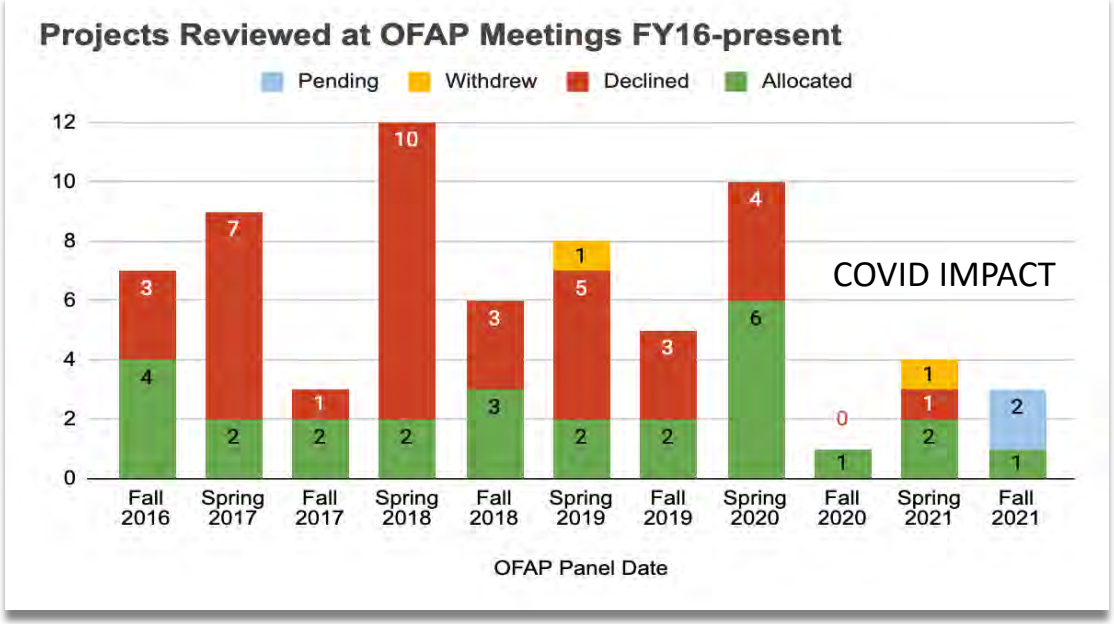
# NCAR/EOL Performance Metrics

## Tracking Facility Usage:

a) Allocations (requests/declines) for individual LAOF,
b) Individual projects/field campaigns,
c) Number of LAOF users and/or facilities requestors (PIs),
d) Number, type (R1, R2, MSI, etc.), and geographic distribution of US universities served,
e) Number of students involved in NCAR supported campaigns,
f) International collaborators in projects using LAOF.

**BROADER IMPACTS**

**LAOF users/requestors of facilities (2016-present):** 228 PIs from 60 US universities across 34 US states, plus additional collaborators from 8 US agencies, 12 US research labs and 52 institutions across 22 countries



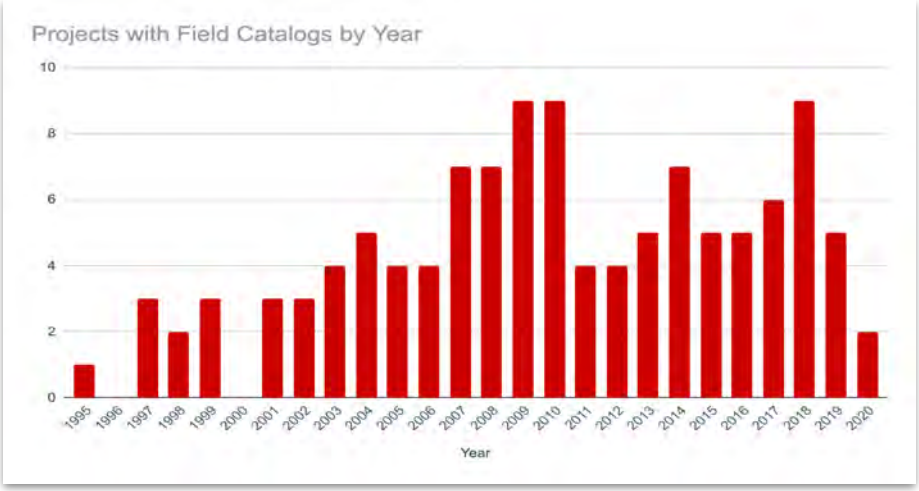


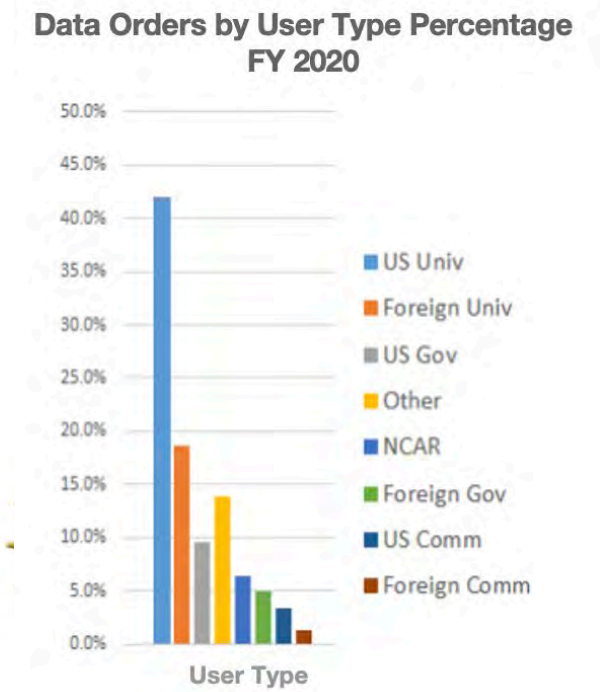
NSF-FUNDED NCAR-SUPPORTED FIELD CAMPAIGNS FY16-FY23

# NCAR/EOL Performance Metrics: Tracking Services Usage

## Tracking Services Usage:

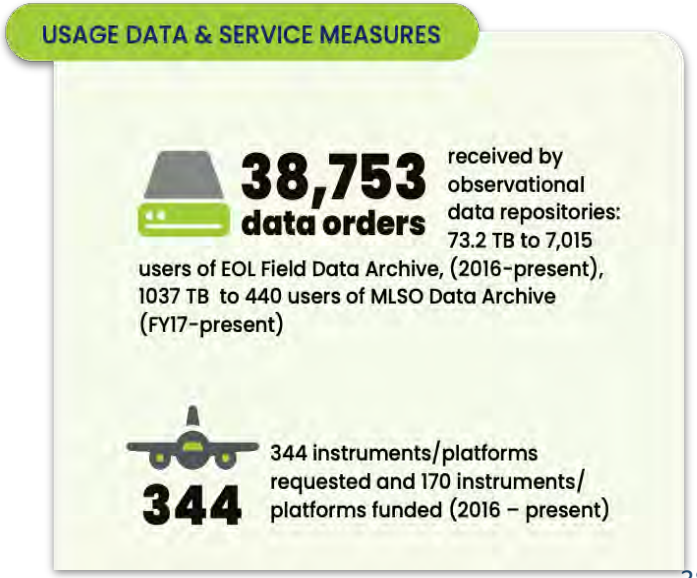
a) Requests for data services (Field Catalog),
b) Requests for design and fabrication services,
c) Registered users of software (LROSE),
d) Satisfaction surveys of field campaign PIs.




## EOL Field Data Archive (FDA) (data freely available) Tracking:

a) Data orders,
b) Data users and user type,
c) FDA size and growth,
d) DOIs assigned to datasets.



# NCAR/EOL Performance Metrics: Operations

## Project Summary

| | | | |
|---|---|---|---|
| Project | CFACT FY22 | Report Date | 2/14/2022 |
| Phase | Control/Monitor | Project Dates | 02/08/2021 - 08/08/2023 |
| EOL Project Type | Field Campaign | Deployment Dates | 01/07/2022 - 02/23/2022 |
| EOL Funding Source | NSF Deployment | Project Manager | Oncley, Steven |
| LAOF | NCAR Integrated Sounding System (ISS); NCAR Integrated Surface Flux System (ISFS) | EOL Support Services | Data archival; Data management; Field Catalog; Operations center |

## Significant Project Changes

| Change Request Status | Title | Area of Change | Description of Change | Justification | Approval Date |
|---|---|---|---|---|---|
| Approved | | | | | |
| | MPD request retracted | Scope | The PIs withdraw request for MPD (1 system) | MPD performance in anticipated weather conditions questionable | 3/2/2021 |

## Project Health

| | | | |
|---|---|---|---|
| Overall | Green [On Track] | Overall Comments | Operations going well; no major issues |
| Scope | Green [On Track] | Scope Comments | |
| Cost | Green [On Track] | Cost Comments | |
| Schedule | Green [On Track] | Schedule Comments | |
| Resource | Yellow [Moderate Concern] | Resource Comments | Staffing (resignation; medical) |

## Milestones

| Target Date | Title |
|---|---|
| 2/23/2022 | Field Operations End |
| 3/9/2022 | Teardown Completed |
| 8/8/2023 | Release QC'd data |

## Status Summary

Status

2022 Feb 14 | Status Update - Baeuerle, Brigitte 2/14/2022 1:02 PM MST

**Operations:** Overall, CFACT is going well. After a period of very cold temperatures, temperatures increased with little to no new snow. The PIs have called 6 out of 10 IOPs (Jan 11/12; Jan 16/17; Jan 19/20; Feb 3/4; Feb 9/10; Feb 12/13). An outreach event for 60 middle school students took place on 11 February. Last day of operations is 23 February.

**Instrumentation:** In early February, ISS had issues with the wind lidar software database, which was down for a couple of days. Those problems have been resolved since. ISFS will have to look closely at soil sensor data as there is a daily freeze cycle, which was not anticipated. PI-provided tethersonde operations were finally approved but only up to 250 ft rather than the 500 ft originally envisioned.

**Staffing:** There is some concerns about staffing as two CFACT support staff are out on medical leave and one staff just resigned. EOL is exploring the assignment of additional staff from other groups to assist with CFACT teardown.

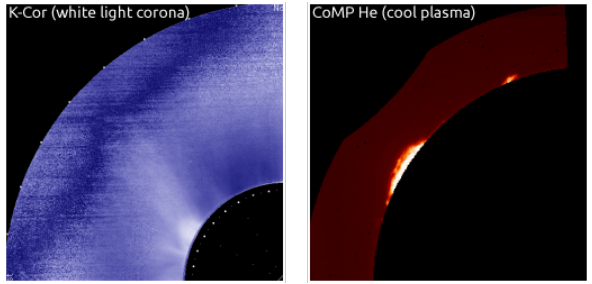
## Major Current Issues

| Title | Priority | Description | Resolution Plan | Type (Primary) | Issue Status | Target Date |
|---|---|---|---|---|---|---|

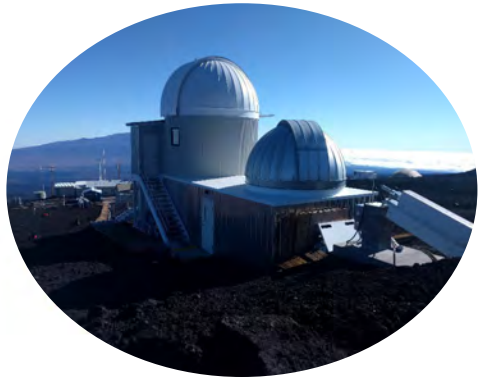
Tracking:

Scope
Cost
Schedule
Resource

# **Joan Burkepile**, Project Scientist, High Altitude Observatory, National Center for Atmospheric Research




Mauna Loa Solar Observatory



- Joan Burkepile is a Project Scientist at the High Altitude Observatory (HAO) of NCAR. Degree in Physics from the University of Colorado, Boulder. Studies Coronal Mass Ejections (CMEs), and the evolution of the solar corona. Principal Investigator for the COSMO K-Coronagraph. Manages the Mauna Loa Solar Observatory.
- HAO's mission is to perform world-leading science that improves understanding and forecast capability of space weather hazards and their impacts on the Earth, people, and technology.
- HAO's vision is to provide scientific leadership, observations, and interpretative capabilities to serve the university and broader community. It supports the engagement, education, and training of early-career scientists.
- HAO works with the community to develop and advance models of the Sun and the Earth's atmosphere, from the upper thermosphere to the Earth's surface.
- HAO develops innovative instrumentation for solar and upper atmosphere research and the Mauna Loa Solar Observatory (MLSO).
- METRICS COLLECTION: HAO registration; log data downloads; use DOIs, manual search of publications; Google analytics

# HAO Data Metrics Track:


**Observational** data: ***MLSO*** (solar), ***CSAC*** (solar- Hinode), ***FPIs*** (thermosphere), ***Eclipse*** expeditions

**Model** data: ***TGCMs*** (thermosphere), ***MURaM*** (solar)

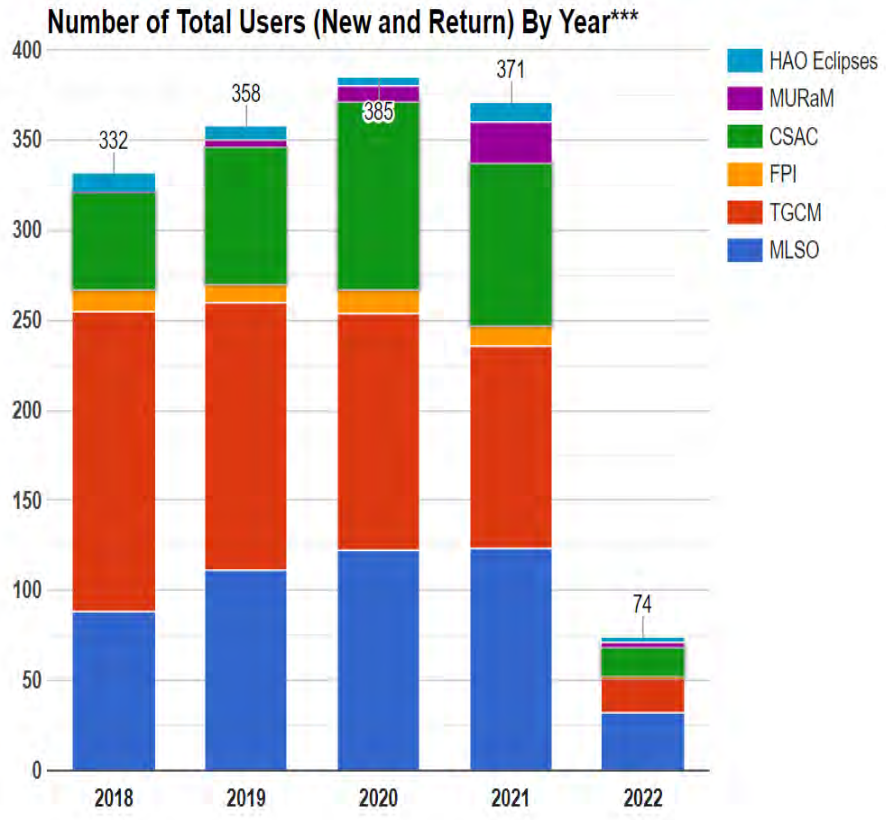
- **Publications:** ***Most useful.*** Provides: Who; What data; How data are used
- **Number of Science Users***:* ***Useful.*** Provides Who; trends; New vs return users
- **User Institution Type** ***Useful.*** e.g. University, laboratory, K-12, public
- **Type of Data Downloaded:** ***Useful.*** Provides What data; trends
- **Number of Downloads:** ***Less useful.*** Trends don't tell the whole story. We work to improve data searches so user can select data more efficiently, resulting in fewer downloads *but easier for the user*

**Google Analytics reports:** ***Useful for tracking general public***

- Identifies pages most frequently visited. ***Most Useful.***
  Education pages are most popular, then Mauna Loa, HAO science

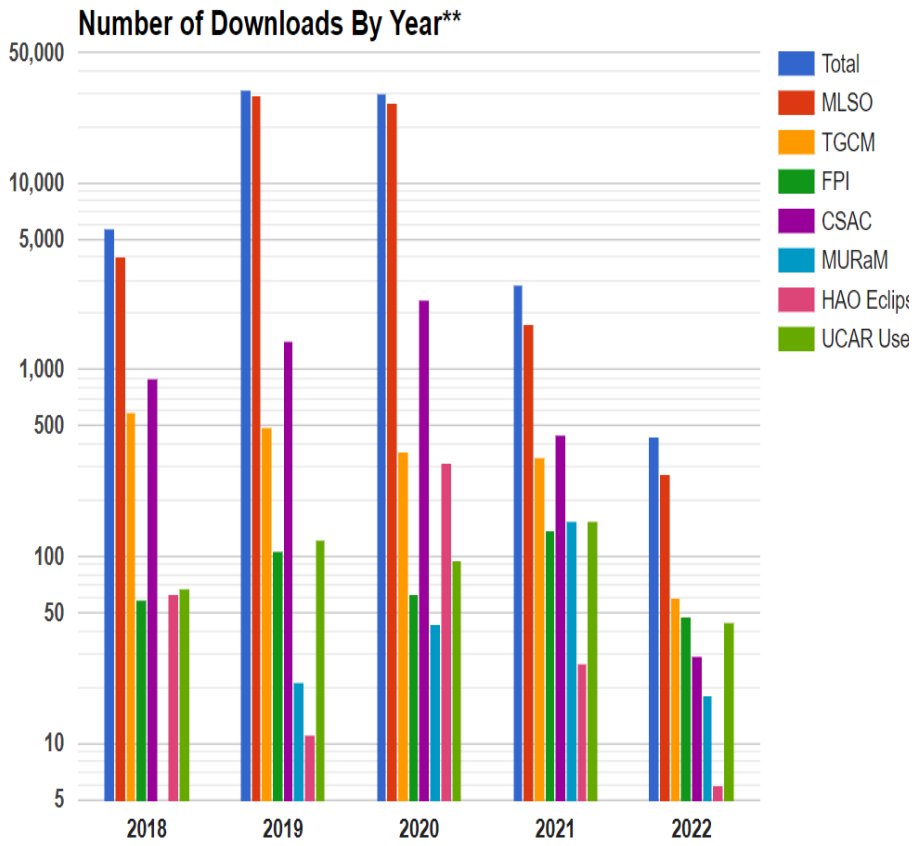
# Examples of HAO Data Metrics

Total users: 1242  Users on mailing list: 487  Total UCAR users: 51



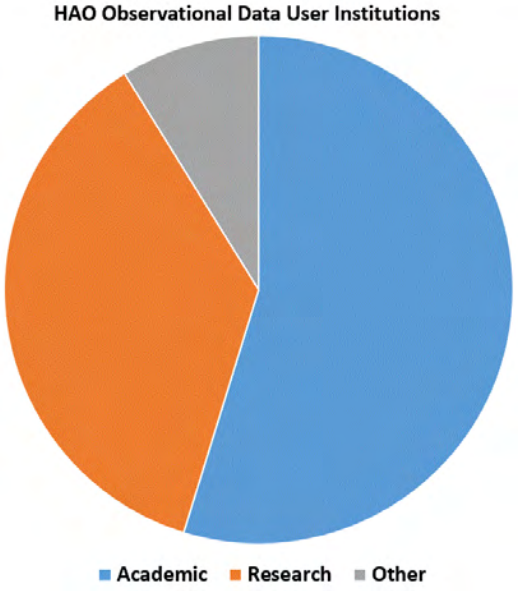

2022 data as of Feb 13.  2022 is on track for having the largest number of annual users

Total downloads: 70217  Total UCAR downloads: 486




2022 data as of Feb 13.  2022 is on track for more downloads than 2021

HAO web page sessions by user country: Jan 2022

# Dan Wilson, Associate Director, Natural Hazards Engineering Research Infrastructure at UC Davis

Dan Wilson, associate director of the UC Davis Center for Geotechnical Modeling, is interested in hypergravity testing, centrifuge modeling, geotechnical earthquake engineering, instrumentation and data acquisition, and equipment development.

- The CGM operates the NHERI centrifuges, providing users access to world-class geotechnical modeling facilities, including 9-m and 1-m radius centrifuges with shaking tables, to enable major advances in the ability to predict and improve the performance of soil and soil-structure systems.

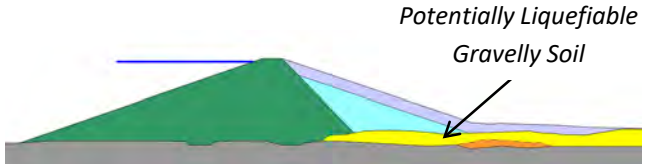
- The Natural Hazards Engineering Research Infrastructure (NHERI) program is a nation-wide, shared-use network of facilities tailored for natural hazards research communities. Investigators employ NHERI sites to test innovative ideas for mitigating damage from earthquakes, windstorms, tsunamis, storm surge, and other natural hazards.

***The NHERI network represents a collaboration between 12 NSF awards***

# Hypergravity testing for geotechnical hazards

***Research Topic:*** *Effect of gravelly soil properties on embankment performance under earthquake loading.*

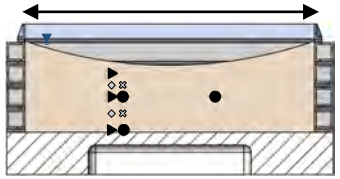
***Hypothesis:*** *As soil gradation becomes broader, resistance to liquefaction increases, resulting in decreased deformations in dams.*

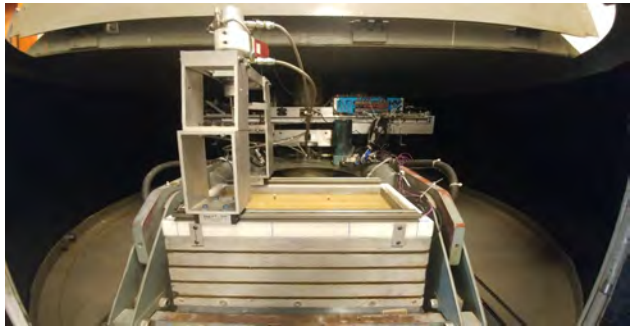



*Bouquet Canyon Dam*

***Small Centrifuge:*** *Component level focused tests examining aspects of system with simplified geometries and limited instrumentation.*

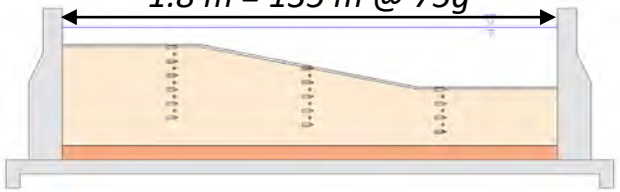
*~0.3 m = 22m @ 75g*

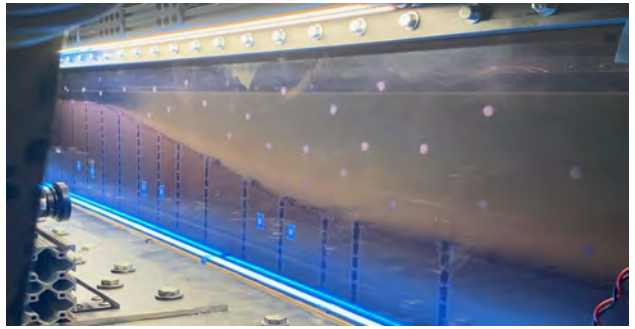





***Large Centrifuge:*** *System level focus using complex boundary-value models with dense instrumentation and detailed realistic geometry.*

*~1.8 m = 135 m @ 75g*






***(NSF CMMI-1916152)***

# The CGM supports users performing research

- **Operational vision** is **to provide** users with world-class geotechnical centrifuge modeling **resources, services, and staffing** to enable major scientific and engineering advances in the ability to predict and improve the performance of soil and soil-structure systems during earthquake, wave, wind and storm surge loadings.
  - Operations funding to support users, not do research
- The CGM has six strategic goals for operations and management
  - Help users improve their science through personalized support
  - Provide open and equal access to world-class resources, services, and staffing
  - Promote an organizational culture of safety and risk awareness
  - Develop members of the next-generation workforce
  - Increase the breadth and diversity of our user base
  - Be effective and efficient stewards of our resources in service to society
- Metrics and targets are mapped to goals and objectives

# Operational metrics strategy

Two-level system for assessing operations and ensuring resource allocations align with strategic goals and objectives

- Lower-level metrics mapped directly to goals and objectives
  - Diverse data used as internal management tool
- Upper-level metrics reflect performance in aggregate
  - Streamlined metrics are appropriate for external stakeholder review

Third set of metrics used to manage program income and cost recovery

- Deliverable metrics mapped to the costs to provide services

| Cost and Income | Performance Assessment | External Reporting |
|---|---|---|
| Are we recovering costs / program income? | Are we reaching our goals? | Are we delivering as promised? |
| Metrics for deliverables mapped to costs to provide services | Metrics and targets mapped to goals and objectives | Metrics and targets to provide transparency in operations |
| Capacity metrics must be internally consistent with the local business model | Quarterly review by leadership to assess health of facility | Summative metrics in periodic sponsor reports |

# Example metrics at the CGM

Example lower-level metrics

- High impact test results (list of first-evers, research awards, adoption in practice)
- Test logs (tests completed, days of machine use, type of use, sensor inventory logs, etc.)
- Maintenance and health monitoring records
- User surveys

Example upper-level metrics

- Science day: one or more projects active on site (one per calendar day)
- Project days: each day a project team is active on site (unlimited per calendar day)
- Number of tests (weighted by type)
- Number of days machines were operated

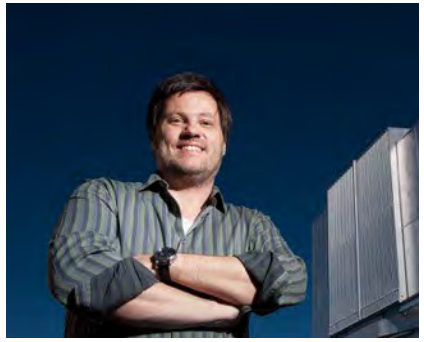
The CGM uses these metrics to determine if we are maintaining an effective balance of demands on staff for supporting science and performing maintenance while protecting capacity for the site to pursue opportunities to reduce risk

- E.g., a low number of Science Days indicates users are not on site
- E.g., a high ratio of project days to science days indicates users are working in parallel and our facility scheduling protocol is working effectively and efficiently.

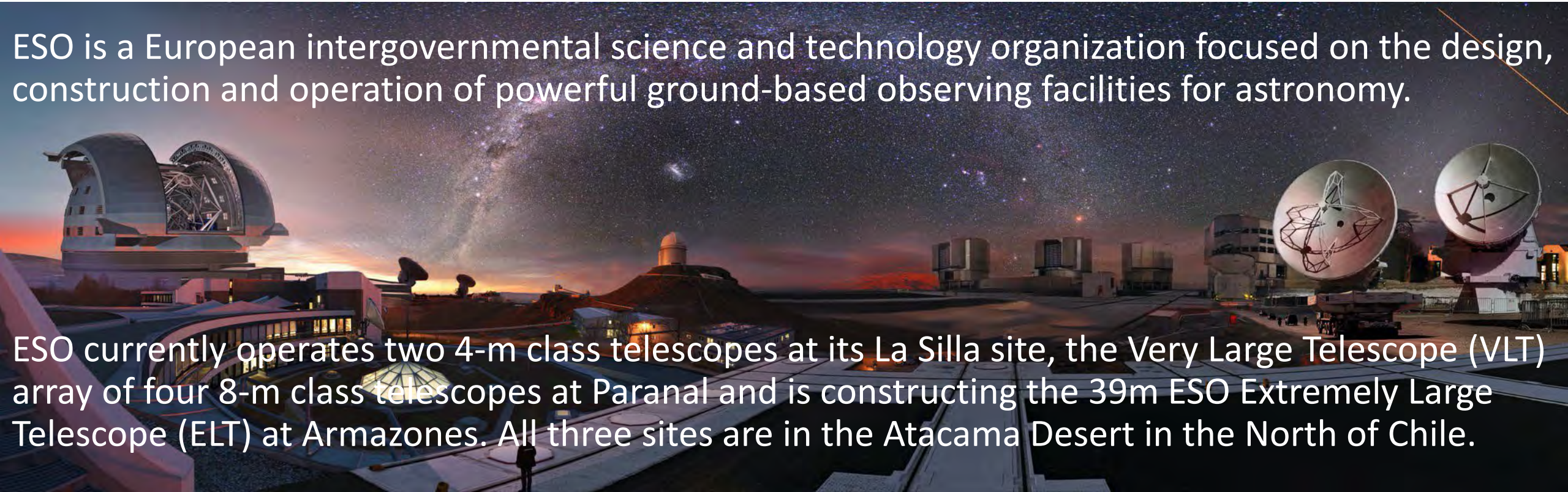
# Lessons learned in metrics management

- Identify the data consumers to define requirements / targeted knowledge
  - Avoid tracking data that will not be consumed
- Data collector needs to describe how best to interpret the metrics presented
  - Data can have multiple consumers; make sure goals are aligned
  - Avoid metrics with implicit interpretations that don’t align with desired interpretation
- Collecting and presenting data
  - Expect to use aggregate metrics for high-level consumption
  - Avoid over analysis – reviews should trigger discussions, not automatic decisions

# Andreas Kaufer, Director of Operations, European Southern Observatory



Andreas Kaufer is Director of Operations at the European Southern Observatory (ESO) since 2008 and is responsible for the end-to-end operations of the ESO optical/infrared observatories in Chile and the European contribution to the operation of the ALMA sub-mm observatory.

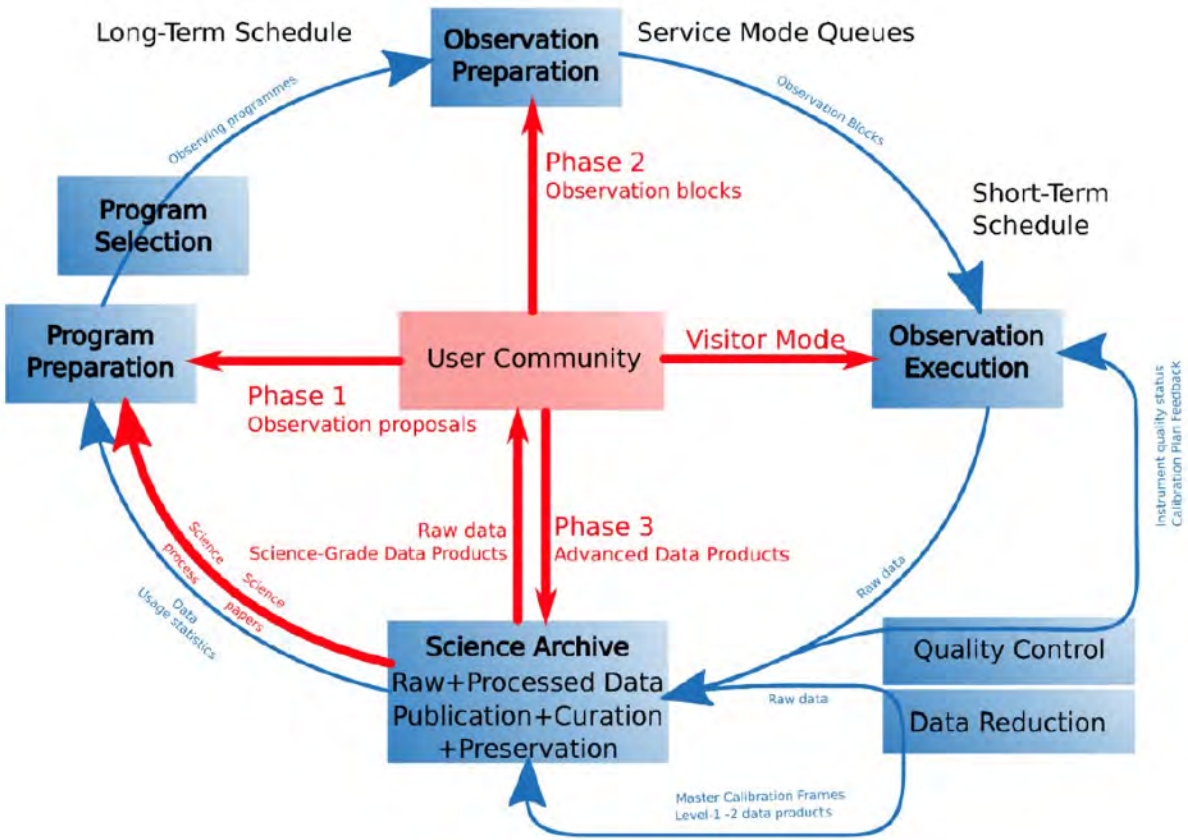


ESO is a European intergovernmental science and technology organization focused on the design, construction and operation of powerful ground-based observing facilities for astronomy.

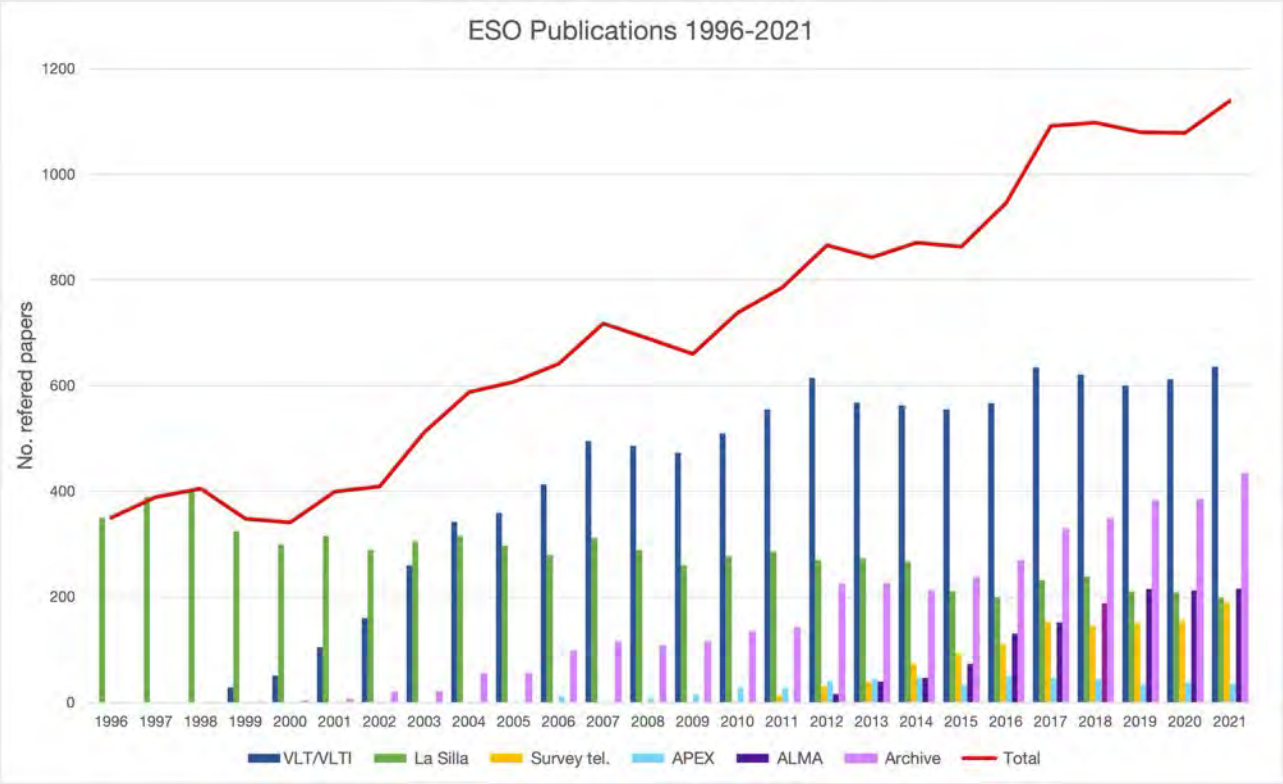
ESO currently operates two 4-m class telescopes at its La Silla site, the Very Large Telescope (VLT) array of four 8-m class telescopes at Paranal and is constructing the 39m ESO Extremely Large Telescope (ELT) at Armazones. All three sites are in the Atacama Desert in the North of Chile.

# ESO Observatories Performance Metrics

- Operations performance metrics are defined around the delivery of quality-controlled scientific data sets to user community to enable Science



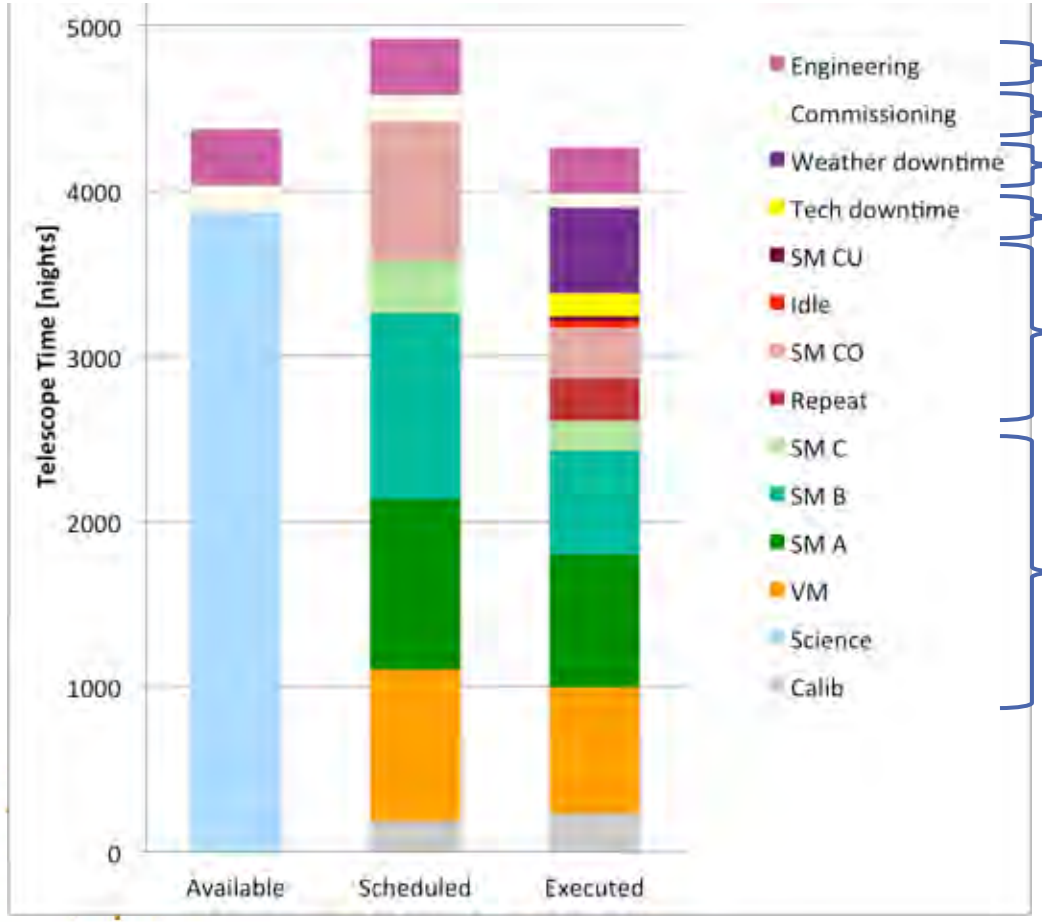

end-to-end dataflow process




Science productivity

# ESO Observatories Performance Metrics

- Observatory Operations focusses on maximizing the data productivity and minimizing the scientific observing time losses




Technical time for planned maintenance (7%)

Time investment for new capabilities (3%)

Losses due to atmospheric instabilities (10%)

Losses due to system failures (3%)

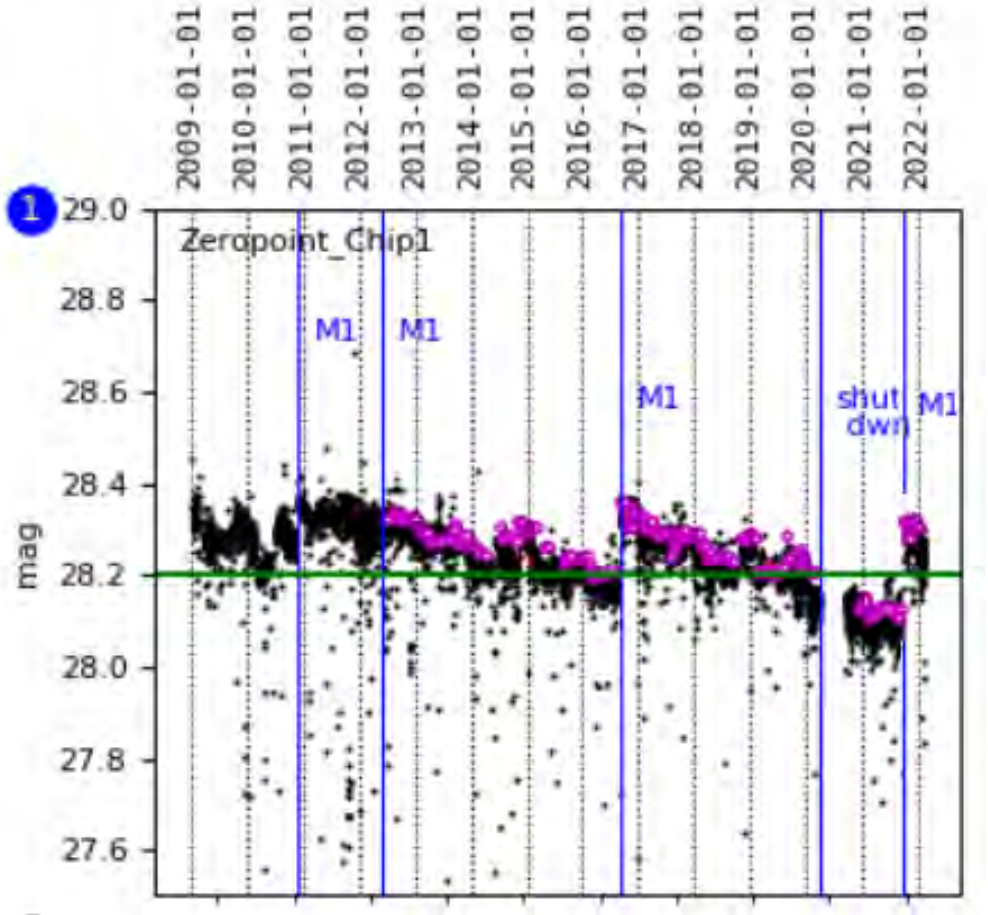
Losses due to scheduling and execution inefficiencies (7%)

Science time (70%)

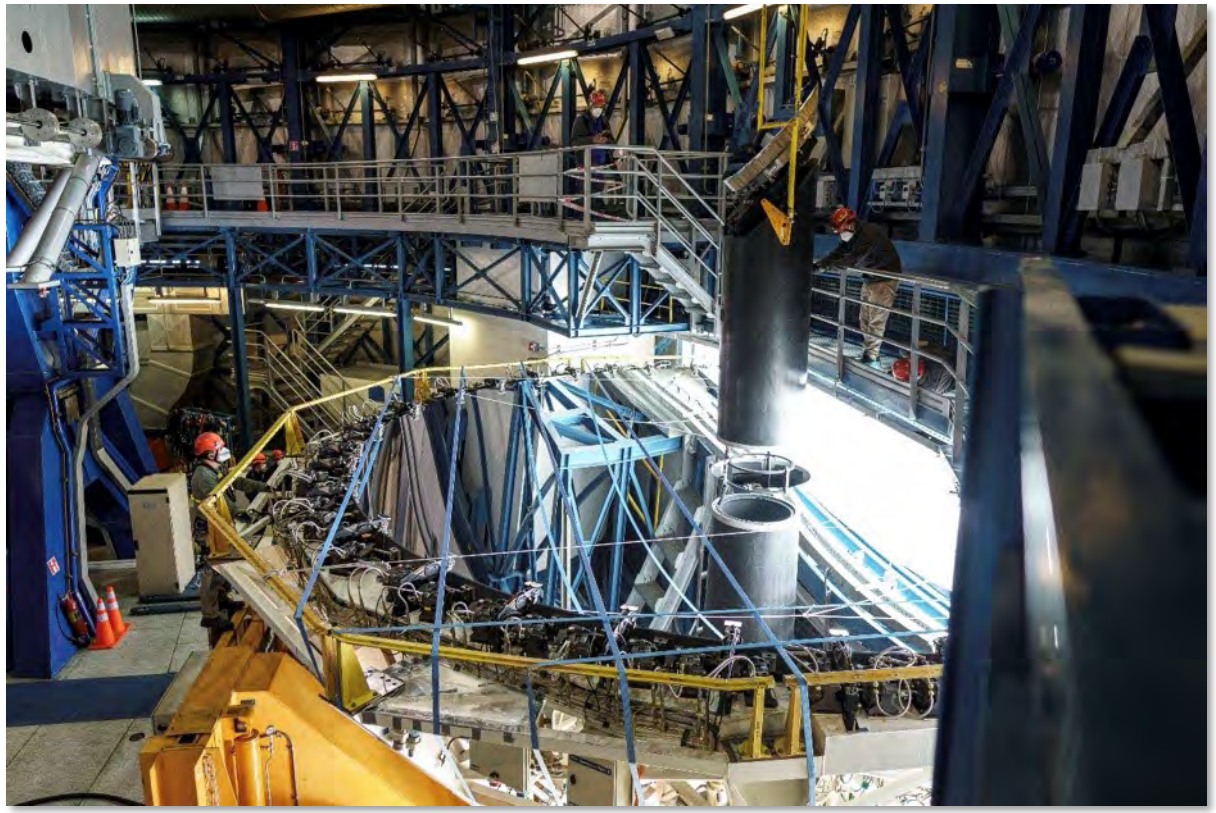
VLT observation execution performance

# ESO Observatories Performance Metrics

- Observatory System Engineering focusses on performance monitoring and triggers corrective actions




Telescope+instrument system performance



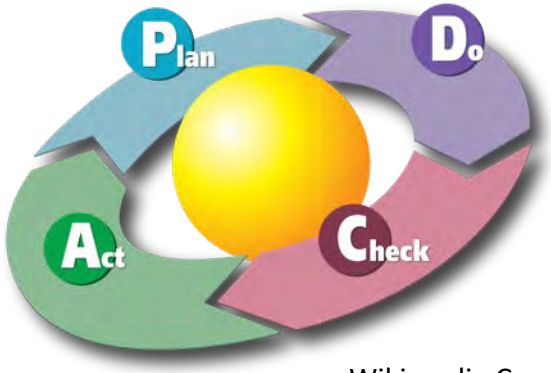
Corrective maintenance (M1 mirror recoating)

# ESO Observatories Performance Metrics

- Observatory Performance Metrics are used for
  - Tracking of operational status and performance of all systems including infrastructure and facilities.
    - For critical systems, KPIs are defined.
    - Targets for KPIs are set to performance “as commissioned”.
    - Deviations from targets trigger corrective actions.
    - Slowly moving towards performance predictions.
  - Observatory Management
    - Resource planning cycle
    - Observatory scheduling
    - Cost-benefit analysis for new proposed projects
    - Reporting on operational performance (quarterly, annually)

# ESO Observatories Performance Metrics

- Observatory Performance Metrics are used for
  - Development of operational processes
    - Continuous improvement following PDCA cycle
  - Development of new operations models for new facilities
    - Integration of new ESO ELT and CTA-S facilities into the future Paranal—Armazones Observatory

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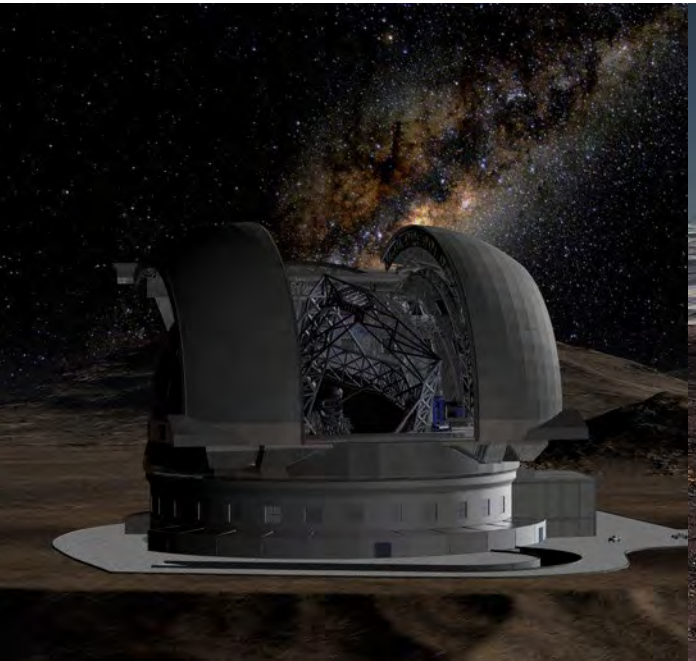

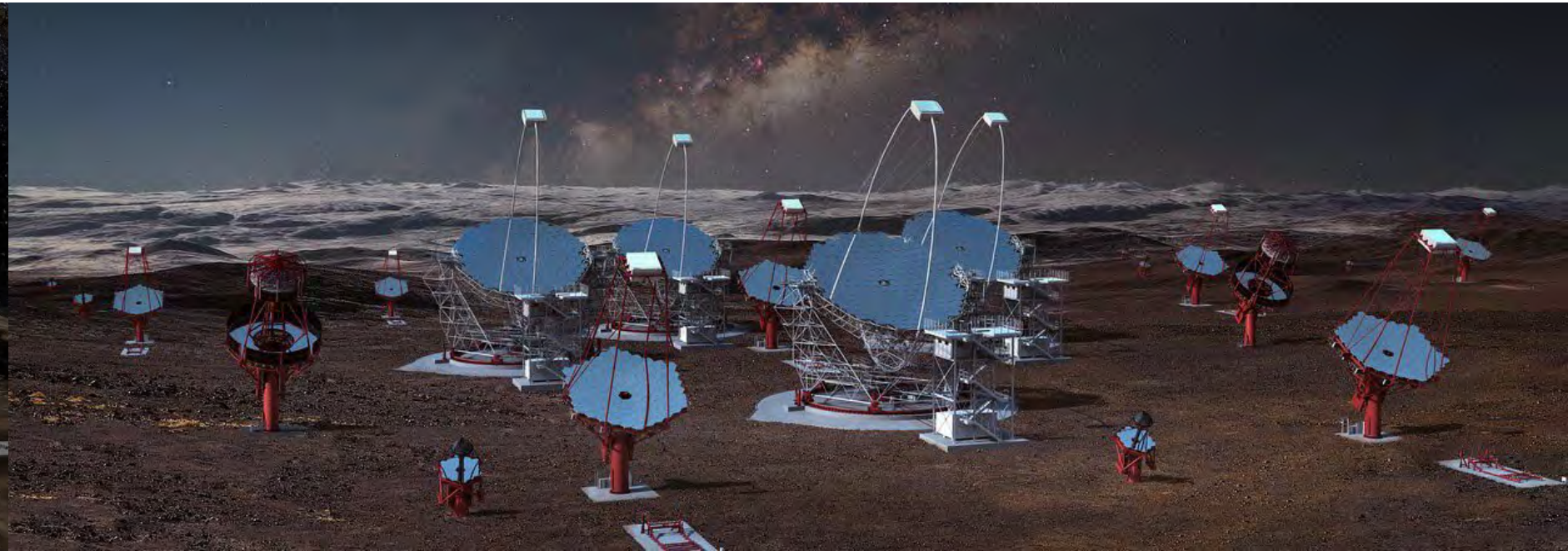

# End of Panelists Introduction and Presentations

# It’s Time for Questions

# Metrics for Research Infrastructure Performance
# 11:00am – 12:30pm

Bank of Questions for Performance Metrics panelists

1. **How are Performance Metrics defined and used at your organization?**
2. **What are the Performance Metrics reporting mechanisms, i.e. internally, or to external funding agency or stakeholders?**
3. **How do you relate financial data and accomplishments to performance goals and objectives?**

# Metrics for Research Infrastructure Performance
# 11:00am – 12:30pm

Bank of Questions for Performance Metrics panelists

4. **How are Performance Metrics used to inform decision making?**
5. **How do you tell if your Performance metrics are useful and meaningful?**
6. **What are the unique challenges related to Performance Metrics at your organization?**

# Questions

- **What are the unique challenges related to Performance Metrics at your organization?**
  - **Multiple widely-distributed domestic sites (travel, shipping, communications, cultures)… communication gaps.**
  - **Amplified COVID impacts from high-travel operations.**
  - **Workforce demographics – attitudes…**
  - **International partners – different cultures & values, different fiscal frameworks, misaligned fiscal years, differential inflation & pricing, variations in procurement approaches.**

- **Unique Advantage – total senior management buy-in to framework and processes, no exceptions tolerated.**

# Metrics for Research Infrastructure Performance
# 11:00am – 12:30pm

Panel Discussion on Best practices for collecting, calculating, and reporting metrics. Can we develop a uniform approach across all Major and Mid-scale Research Infrastructure?

## Many thanks to all of today's participants

If you have a question that cannot be answered during this panel discussion, please email it to RIOutreach@nsf.gov.

**Reminder that we will have a webinar session on Science Impact Metrics this afternoon starting at 2pm**