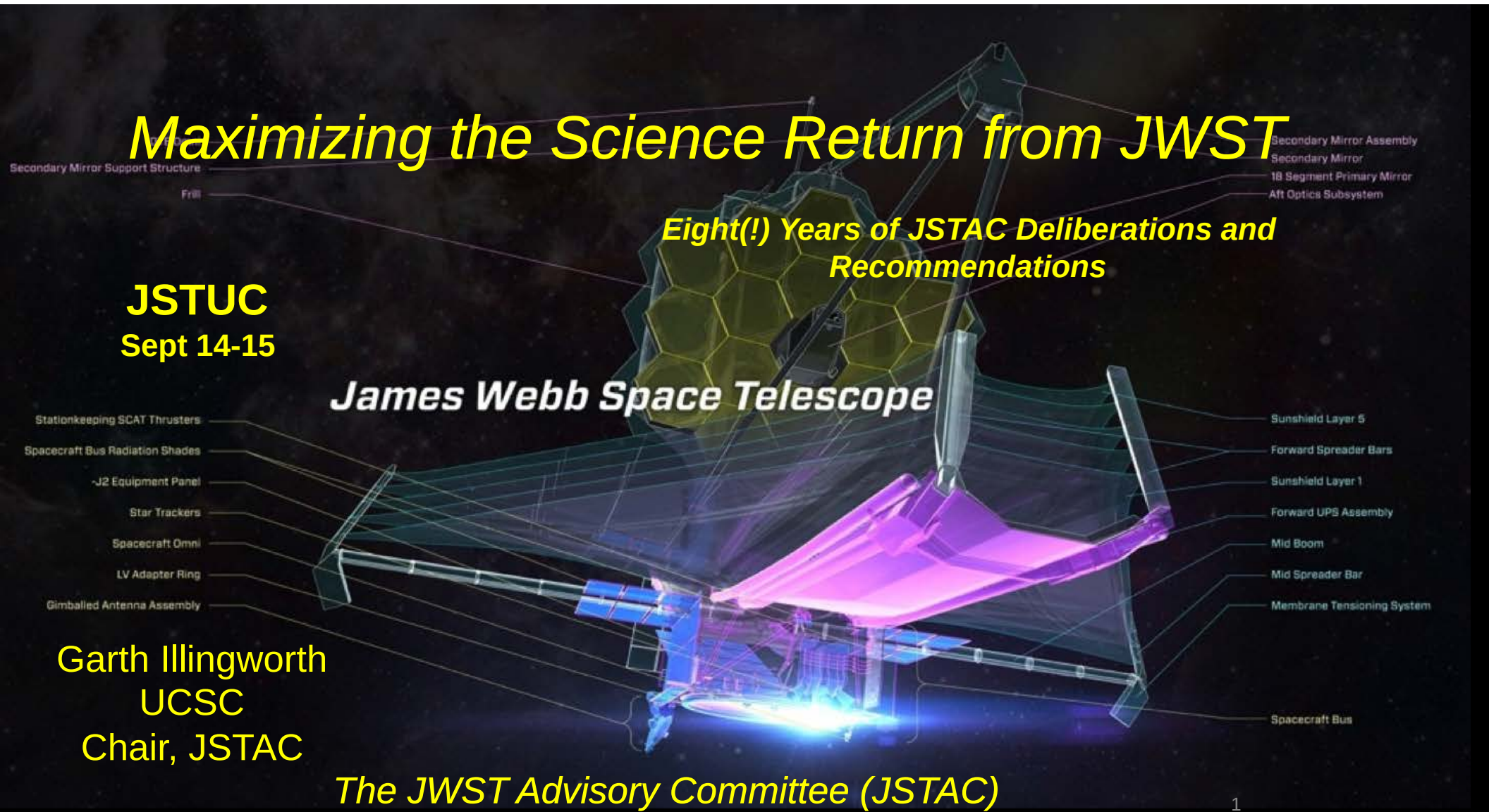
# *Maximizing the Science Return from JWST*

***Eight(!) Years of JSTAC Deliberations and Recommendations***

**JSTUC**
**Sept 14-15**




Garth Illingworth
UCSC
Chair, JSTAC

*The JWST Advisory Committee (JSTAC)*

# *Context*

JWST is one of the most technically demanding and expensive science programs ever undertaken.

The technology and management challenges that are being overcome by the JWST project at NASA, and within the contractors and NASA's partners, ESA and CSA, are dramatic examples of  the technical prowess that exists within the US and its partners, Europe and Canada.

***It is imperative that we develop and enable operational approaches that are comparably cutting edge and maximize the science return from this mission given the level of public funding, international visibility and national pride, particularly given JWST's limited lifetime (5 yrs required; 10 yrs goal).***

# *JSTAC's Inception*

JSTAC started at a time when the launch date was still officially 2012, but there were already hints that 2014 was more likely. However, even 2014 came to be in doubt because of slow progress from continuing budget challenges. While JSTAC's focus was on scientifically-effective operations ("maximizing the science return"), events overtook a lot of our early deliberations.

*The challenges of the progress to launch and the launch schedule resulted in a letter to the NASA Administrator from Senator Mikulski asking for an independent team to be set up. This was the Independent Comprehensive Review Panel (ICRP). Three months of intense effort led to a report that said the earliest launch could be was in 2016 and that JWST would cost ~$6B.*

*The end result of the ICRP report, a excellent NASA budget/schedule replan in 2011, and a death experience (also in 2011), was a political consensus that the program should go ahead, even though JWST would cost $8B and would launch in late 2018. This did not come immediately but was somewhat broadly accepted by the Administration during 2012.*

It was within this new framework that much of JSTAC's deliberations occurred, though some of JSTAC's early recommendations were (and are) still highly relevant.

# *The JWST Advisory Committee (JSTAC) Charter*

"The committee is charged with advising the STScI Director on the optimum strategies and priorities, consistent with NASA policy and international agreements, for the operations of the James Webb Space Telescope in order to maximize its scientific productivity."

See the JSTAC STScI website

# *JSTAC Charter*

"The areas that the JSTAC will advise on include:

- Capabilities at launch to maximize science return, including archive, data analysis tools, and observing modes
- Prioritization of the capabilities offered at launch
- Observing time allocation strategies, including the balance between large and small programs
- The readiness status of the JWST Science and Operation Center
- Policy implementation, including items such as resolution of conflicts, and availability, timing and level of support of observing modes for GO and GTO observers"

# JSTAC members

## JSTAC members (* new members in 2015/16)

- Roberto Abraham — University of Toronto
- Neta Bahcall — Princeton University
- Natalie Batalha* — NASA Ames Research Center
- Stefi Baum — Rochester Institute of Technology
- Roger Brissenden — Smithsonian Astrophysical Observatory
- Timothy Heckman — Johns Hopkins University
- Kelsey Johnson* — University of Virginia
- Heather Knutson* — Caltech
- Malcolm Longair — Cavendish Laboratory, University of Cambridge
- Garth Illingworth — University of California, Santa Cruz
- Christopher McKee — University of California, Berkeley
- Bradley Peterson — Ohio State University
- Joseph Rothenberg — JHR Consulting
- Sara Seager — Massachusetts Institute of Technology
- Lisa Storrie-Lombardi — Spitzer Science Center, Caltech
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## JSTAC Ex-officio observers from the Space Agencies

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| Hashima Hasan | NASA HQ |
| John Mather | NASA GSFC |
| Mark McCaughrean | ESA |
| Alain Ouellet / Jean Dupuis | CSA |
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## Key STScI Interfaces

| | |
|---|---|
| Massimo Stiavelli | JWST Mission Office Head |
| Neill Reid | Science Mission Office Head |
| Nikole Lewis | JWST MO Project Scientist |
| Jason Kalirai | JSTAC Executive Secretary (1) |
| Janice Lee | JSTAC Executive Secretary (2) |

# The JWST Advisory Committee (JSTAC)

# *JSTAC recommendations in the context of "maximizing JWST science"*

Letters and Presentations on the JSTAC STScI website

- JSTAC Letter on Defining JWST Observing Time (Dec 28th, 2009)
- JSTAC Letter on JWST Scientific Productivity and Capabilities (Feb 25, 2010)
- JSTAC Letter on Legacy Science with JWST (Jun 21st, 2010)
- JSTAC Letter to Dr. J. P. Holdren, Director of of the Office of Science and Technology (Jan 21st, 2011)
- JSTAC Letter to Secretary Hillary Rodham Clinton and Dr. John P. Holdren (Jan 30th, 2012)
- A Presentation from the JSTAC to the JWST SWG on JWST Proprietary Times (Jul 22nd, 2013)
- JSTAC Letter on JWST's Guest Observer Grant Funding Level (Jul 28th, 2013)
- JSTAC Letter on a JWST Early Release Science Program and Community Fields (Mar 26th, 2014)
- JSTAC Letter on the JWST Proprietary Time for GO Observations (Mar 27th, 2014)
- A Presentation from the JSTAC to the JWST SWG on Spitzer Science Planning (Apr 1st, 2014)
- A Presentation from the JSTAC to the JWST SWG on Several Committee Recommendations (Apr 01st, 2014)
- JSTAC Letter on JWST Overheads, Grant Funding, Proposal Selection, and Duplication Policy (Nov 30th, 2014)
- JSTAC Letter on JWST Parallel Science Observations (Jan 7th, 2015)
- JSTAC Letter and Assessment of GO Funding Level Needs for JWST (May 22nd, 2015)
- JSTAC Letter on the Formation of a JWST Data Processing Working Group (Dec 22nd, 2015)
- JSTAC Letter on Releasing the JWST Exposure Time Calculator (Feb 16th, 2016)
- JSTAC Cover Letter and Status Presentation Related to Proprietary Time (Apr 14th, 2016)
- JSTAC Recommendations for Cycle 1 GO Proposals (May 28th, 2016)
- JSTAC Letter on Early Release Science Proposals (December 19th, 2016)
- JSTAC Recommendations on Laboratory Astrophysics (December 15th, 2016)
- JSTAC Letter on Certification of Operations Scripts System (OSS) Software (December 12th, 2016)

# *JSTAC recommendations in the context of "maximizing JWST science"*

STScI Newsletter articles about JSTAC activities

The *JWST* Advisory Committee (JSTAC): Maximizing the Scientific Productivity of *JWST*
http://newsletter.stsci.edu/the-jwst-advisory-committee

The *JWST* Advisory Committee (JSTAC): Recommendations for *JWST* Cycle 1 Proposals
http://newsletter.stsci.edu/jstac-recommendations-for-jwst-cycle-1

The *JWST* Advisory Committee (JSTAC): The Impact of a Long 12-Month Proprietary Period
http://newsletter.stsci.edu/jstac-proprietary-period

As an aside for interest there is a newsletter article on the early days of JWST:
*NGST*: The Early Days of *JWST*

## *JSTAC recommendations in the context of "maximizing JWST science"*

The JSTAC has been discussing and recommending a number of ways to enhance and maximize the science return from JWST. An overview was in the June 2016 STScI Newsletter and the JSTAC website has 18 letters on many topics, including:

First Look/Early Release Science program (ERS);
Proposal selection process – Cycle 1 Call for Proposals;
The needed level of GO funding;
Length of the proprietary period;
Development of data analysis tools and pipelines;
"Community" fields;
Parallel observations;
Observing overheads.

Will comment on ERS and Proposals and address:

GO funding; proprietary period; data analysis.

# *First Look/Early Release Science (ERS) Observations*

# *JSTAC recommendation regarding ERS*

***Initial JSTAC recommendation for a "First Look" program was made in early 2010. The broad goals of this program were very similar to what ultimately became the ERS program.***

***But the details evolved. A second letter focused on ERS program in early 2014 and then the details were clarified in a final letter in December 2016. The "devil is in the details".***

*"The JSTAC recommends that STScI work with the community to plan for implementation of an Early Release Science (ERS) program that will provide non-proprietary, open access data to the community on a wide range of science programs and modes that:*

*(i) demonstrate the scientific capabilities of JWST,*
*(ii) quantify the observational capabilities and*
*(iii) position the astronomy community to submit Cycle 2 proposals that are based on real-world experience with JWST,*

*thereby allowing the community to exploit the full potential of JWST very early in its* ***5-year life.****"*

# *JSTAC recommendation regarding ERS*

*(from Mar 26 2014 letter)*

**The JSTAC identified the primary goals of an ERS program to be:**

(i) educate the community as to the scientific capabilities of JWST's key instruments and modes;
**(ii) ensure rapid data availability so that the community can generate proposals for Cycle 2 that take maximal advantage of JWST's new and uniquely powerful capabilities (since the Cycle 2 deadline is part way through Cycle 1);**
(iii) involve the community in the planning of the ERS program.

**The JSTAC noted that to achieve these goals, the ERS program should:**

(i) provide a wide range of scientifically-interesting datasets that will enhance the science proposals for Cycle 2;
**(ii) exercise a wide range of the expected–to–be most used modes for a range of science topics;**
(iii) be carried out very early in the first cycle;
(iv) begin the planning process in an early, open way with proposals from community members.

**The Dec 19 2016 letter was more detailed (as per: the "devil is in the details").**

# *Proposal Process Recommendations – Cycle 1*

# *Cycle 1 Proposals*

***JSTAC recommends that programs be "balanced" across the broad categories of small, medium and large programs, as per recent Great Observatory practice, with procedures to ensure that an appropriate balance is obtained.***

JSTAC felt that the experience with the Great Observatories has proven that such balanced approaches were scientifically-productive and an effective scientific use of resource-intensive, observatory-level space missions.

***JSTAC recommends that very large programs, large multi-cycle programs, and "Key projects" should not be part of the baseline for Cycle 1.***

Such programs, involving a huge investment of time, were seen by the JSTAC as unwise for selection before launch in Cycle 1, when the performance of the telescope and its instruments have not been measured on- orbit.

The detailed background for these recommendations, as well as some clarifying "findings", are discussed in the May 28 2016 JSTAC letter and in the STScI October 2016 Newsletter.

# *GO funding level*

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From the letter detailing the 2013 JSTAC GO Funding recommendations

*In summary the JSTAC:*

***1) clearly felt that an augmentation of GO funding for JWST relative to that for HST and Spitzer was needed;***

*2) endorsed the factors that had been chosen to evaluate the degree of augmentation;*

*3) was concerned that the current augmentation factor for Complexity was too low;*

*4) suggested that* ***consideration be given to the crucial aspect of "time criticality" that results from the five-year mission lifetime;*** *this could be accommodated within this set (under Learning curve?) or by augmenting the number of factors;*

*5) understood that the overall augmentation would come from multiplying the above factors, adjusted for any changes resulting from the JSTAC discussion.*

# *GO funding level*

In 2015 a detailed assessment was done by a subcommittee consisting of three JSTAC members with deep experience with the Spitzer, Chandra and HST Science Centers, with input from personnel at each of those centers.

After much discussion, this assessment was accepted by JSTAC and a May 22 2015 letter recommends a substantially enhanced GO funding level relative to HST (the May 22 2015 letter has the subcommittee report attached as an appendix).

*Essentially the JSTAC recommended a GO budget that was a little over double the HST GO budget. Given the complexity of JWST the JSTAC felt that this was well-justified, especially for a mission that has an LCC well over $8B. But the recommended GO budget challenges NASA at this time given the stated LCC of $8.835B.* ***It is crucial that we continue to work with NASA to get a GO funding level in the ballpark of what JSTAC recommended.***

**May 22, 2015:** JSTAC assessment regarding GO, Archival and Theory funding:

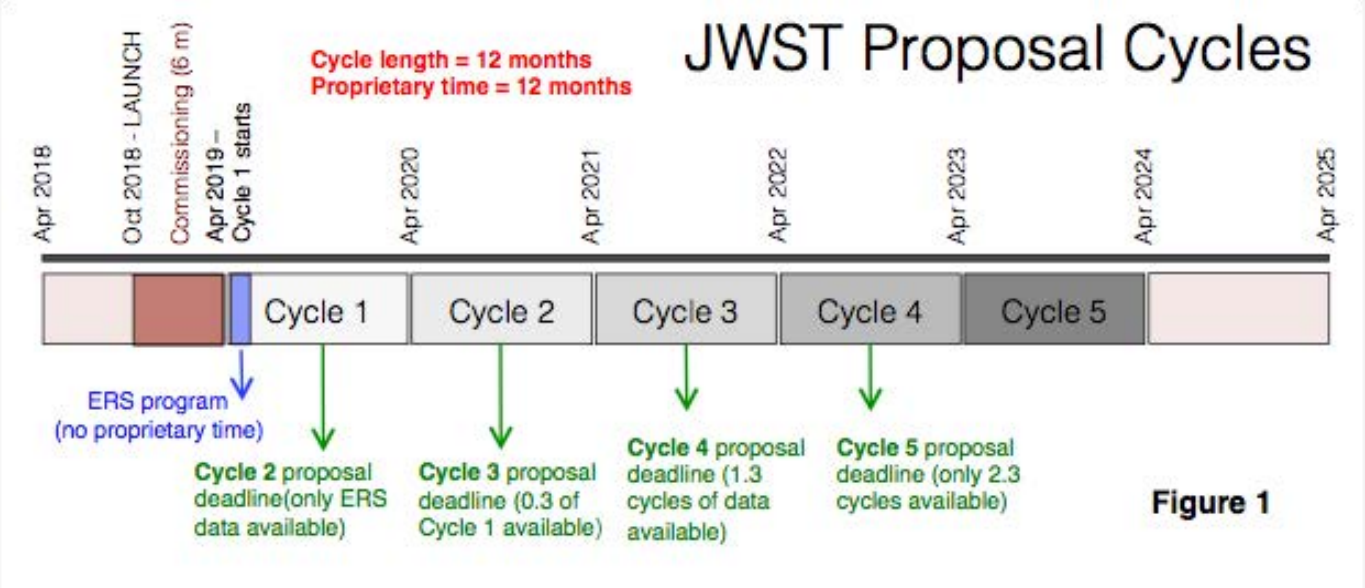
1. We recommend an annual GO funding level of $60 million ($FY19).
2. We recommend an additional $4 million in annual funding for the Archive and Theory programs starting in Cycle 1 and continuing through the life of the mission.
3. We recommend substantial funding of post-mission archival research for a minimum of 2 years.

# *Proprietary/Exclusive Use Time*

***With a one-year proprietary period the first proposal cycle where all of the Cycle 1 data can be evaluated and followed up by the community is Cycle 4***

***(discussed in Feb 25 2010 letter)***

# The impact of a 12-month proprietary period




- **Cycle 4 is the first cycle where all of the JWST Cycle 1 data can be used for follow-up**
- For Cycle 3, only **~1/3** of the Cycle 1 data would be available

- **if a problem occurs with an instrument or the mission after a few years *nobody except the original team* will ever have seen that Cycle 1 data (and done any well-informed followup or be in a competitive position to propose)**

***12-months will impact the science return from the mission***

## *JSTAC concerns re the impact of a 12-month proprietary period*

Clearly the greatest science return will come from the new discoveries on JWST, provided the broad astronomical community is able to follow-up rapidly on new results from JWST datasets.

Rapid access to data, with time to process it and obtain results before the next call-for-proposals is critical to effective iteration. Observations over several cycles will enable JWST to explore new discoveries in depth during its 5-year required life.

JSTAC concluded after further discussion and analysis that a one year proprietary period is just not appropriate for JWST and recommended a shorter period.

# proprietary period

The proprietary period represents a balance between the benefits to the proposal team and the benefits to the community as a whole. 12 months has been typical in astrophysics, but zero or close to zero is normal in other fields (Earth Sciences, Heliophysics, Planetary).

The political and the social environment is leading towards more open data access for taxpayer-supported programs which will inevitably push the proprietary time to shorter periods, if not zero.

# *12 months proprietary period is unusual*

Major Astrophysics missions have routinely used 12 months proprietary periods for most data (but zero for Large, Legacy, Treasury and DD time ). However, such a lengthy period is extremely unusual across the NASA Science Mission Directorate (SMD).

1) All **Heliophysics** and all **Earth Science** missions are zero proprietary period (internationally agreed — NASA, ESA, JAXA).
2) **Planetary** are 0 to 6 months — major programs zero typically.
3) Many **Astrophysics** programs are already zero (Fermi), as will be WFIRST. HST is now
6 months. Spitzer is now at 0.

*It is interesting that a 12 month proprietary/exclusive use period is rather anomalous within SMD at NASA. It is also inconsistent with current national trends to open data access — i.e., zero proprietary period.*

# *JSTAC recommendation*

After much discussion of numerous alternative models JSTAC endorsed a proprietary period of 6 months (and 0 months in Cycle 1). See the JSTAC's March 27 2014 letter and the 2016 April 14 update.

*The JSTAC recommends that STScI implement a proprietary/exclusive access period for GOs for JWST that is 6 months throughout its life, modified just for Cycle 1 to a default of 0 months, with the option for proposers to request up to 6 months, so as to ensure that some data is available quickly from Cycle 1 programs for Cycle 2 proposers.*

*The JSTAC reaffirms its July 21, 2010 recommendation that the proprietary/exclusive access period for Large/Treasury/Legacy and Director's Discretionary programs remain at 0 months, as is the current situation for HST.*

## *6 months helps counter the "GTO advantage"*

The GTO 12-month proprietary period is not an argument to have everybody else also be on 12 months. In fact, the approach that will help reduce the GTO competitive advantage is to ensure open, accessible GO data.

The way the community becomes fully competitive with the GTOs is to have open datasets available as soon as possible so that the GO community can build up new target sets, new survey areas and experience with all the modes.

***The competitive advantages of 12 month GTO time are best offset by maximizing readily available data for the GO community with shorter 6 month and 0 month datasets.***

## *the “have vs have-nots” situation*

A long proprietary period can also lead to a "have" vs "have nots" situation for such missions. Those who are able to get data in Cycle 1 on key topics or sources can use the knowledge gained to out-compete others who cannot see the actual data before subsequent GO proposal cycles. And this can continue for many cycles.

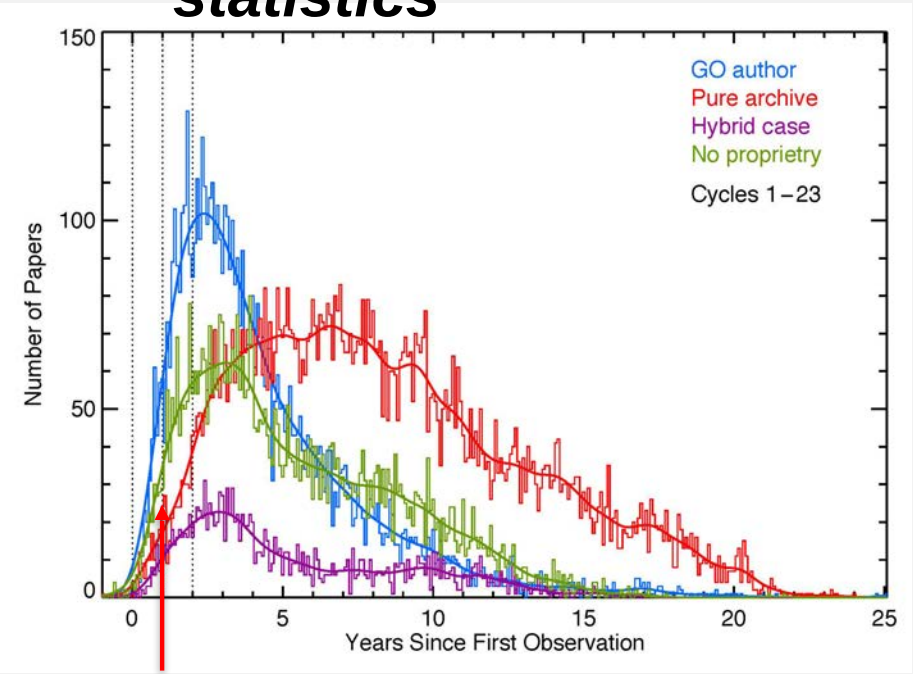
Such a limitation is not conducive to the best scientific outcomes.  Broad communities of innovative scientists evaluating datasets and planning for new tests and observations in a competitive environment will clearly enhance the scientific productivity of a mission.

Long proprietary periods are exclusionary, and are not conducive to maximizing the science return from JWST.

***A long proprietary period will impact the overall science productivity of JWST***

most tellingly, the publication data indicate that the time from data being taken to publication is typically >2 years.

***the publication statistics***




for HST the median time from first observation to first paper for GO programs is ~2.3 years

i.e. 2.3X a 12-month proprietary period

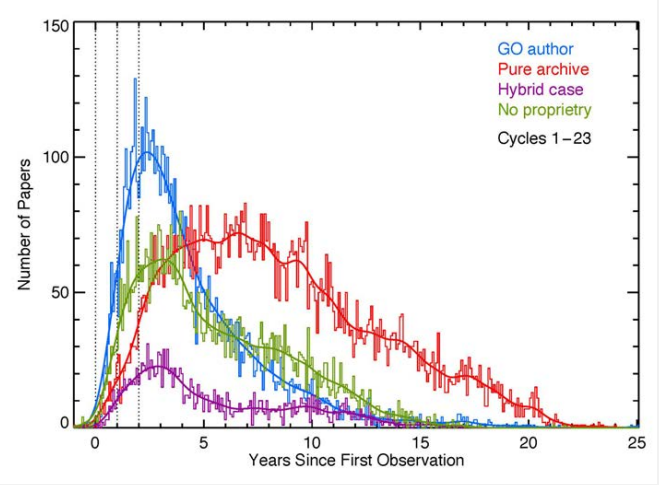
Chandra: 2.36 years; Spitzer: 2–3 years

the peak is at ~2 yrs but the mean/median is > 2 yrs. These charts include data with different proprietary periods (0 to 12 months).

## *the publication statistics are telling us that proprietary time is not a key factor*

This clearly indicates that protecting data through publication is ***not*** a priority for most PIs

The time to publication is essentially the same, regardless of type and proprietary time (archival data is even longer, as expected).




*A 6-month proprietary period will not impact the publication timescales for individual research programs, yet it will have a substantial positive impact on the quality and timeliness of the science proposed and carried out in each JWST cycle.*

## *Status*

In an age of “big data” and data mining, where open datasets are being widely seen as providing future opportunities in the scientific realm (as well as broadly providing a wide range of business opportunities and enhancements in the effectiveness of government programs), it does seem anomalous to have a NASA/ESA/CSA flagship international mission retaining one of the longest proprietary periods of any science program.

*There is clear support within NASA for reducing the proprietary period to 6-months (the JWST SWG endorsed a 6-month period, and the Astrophysics Advisory Committee supported this essentially unanimously with only one no vote). The Canadian community would like to move to 6 months. The challenge for now is the MoU with ESA which stipulates 12-month. It is not realistic to change this.*

***more imaginative solutions might be the way forward (e.g., asking the proposers to state on the cover page their preferred proprietary period up to 12 months).***

For more detail see the the JSTAC’s 2016 April 14 update and the Dec 2016 newsletter article.

# *Data Processing*

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Data processing is an ongoing activity. The JSTAC has given this aspect a great deal of attention over the years, given the remarkable capabilities of JWST's instruments, the number of modes of operation, the complexity of many of those capabilities and modes, and the nature of the datasets.

Clearly processing JWST science data is a needed capability, and much has been done, but JSTAC also recognized that the software development activities at STScI were higher priority, prioritized broadly into (my categorization):

1) Mission critical software
2) Science operations critical software
3) Science data processing software

More has been needed in category (3). Fortunately, as flight critical software systems are moving towards their flight deliveries and the software freeze next year, increasing attention can be given to (3) the data processing capabilities (with recognition of resource constraints).

**The timing is ideal for JSTUC to use the broad experience and interests of its members and to provide guidance to the data processing development activities at STScI.**

# *The JSTAC Data Processing Working Group (JDPWG)*

**The Charge for the JDPWG as laid out in the Dec 22, 2015 JSTAC letter**

*The JSTAC Data Processing Working Group (JDPWG) is tasked to evaluate STScI progress on the developments in a number of areas related to data processing for JWST data, including, for example, calibrations, pipelines, data analysis tools and archiving. The JDPWG should:*

1) *Evaluate the current state of the developments related to the broad areas of calibrations, pipelines, data analysis tools, archiving and documentation;*

2) *Consider the planned developments that will provide more mature capabilities by launch (i.e., beyond baseline builds to more enhanced builds that will provide needed capability for science data analysis – such as from 7.0 to 7.1 );*

3) ***Evaluate the priorities for the developments;***

4) *Meet on a regular basis: it is expected that meetings will occur on a regular basis by video link, typically on 2-3 month timescales, but the working group and STScI should also initiate more frequent discussions if needed. Email updates could be used to keep the working group current;*

5) *Report at JSTAC meetings: the working group Chair should report to JSTAC at each of its meetings.*

# *Thoughts for JSTUC*

*JSTAC has spent many years thinking about how to "maximize the science return" and providing recommendations, but we were a small group.*
*Have we missed some important aspect?*

*Broadly, the open areas that represent "unfinished business" for JSTAC are the GO funding level, a reduced proprietary period, and data processing capabilities.*

*JSTUC can particularly help provide STScI guidance and insights on data processing developments with its breadth of experience. While we are close to launch, there is a solid basis at STScI already on which to build. And much can be done.* ***But resource and time limitations will necessitate careful consideration of priorities****.*

*Subcommittees focused in key areas may be an effective tool also.*

***Not only will your efforts help JWST, but the greater the scientific success of JWST, the more likely we are to secure support and funding for future flagship missions.***

# *Maximizing the Science Return from JWST*


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**less than 2 years to the first open access public ERS JWST data!**

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