Detector considerations for WFI

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Overview

1. WFIRST science data are ITAR and EAR exempt (can be handled like Hubble and JWST data…)

2. Sample H4RG-10 science data available at this meeting

3. Snapshot of current WFIRST Project thinking for H4RG-10 characterization

4. Additional things to ponder…

WFIRST Science Data now ITAR and EAR Exempt

- On 6 April, 2016, we submitted a request for, “Blanket Exemption to Release WFIRST Science Data” to the GSFC Export Control Office
- Export Control approved our request on 11/11/16
- WFIRST science data now ITAR and EAR exempt
- Covers essentially all FITS files that we are used to working with (astronomical images, characterization data, calibration data, performance acceptance test data, *etc.*)

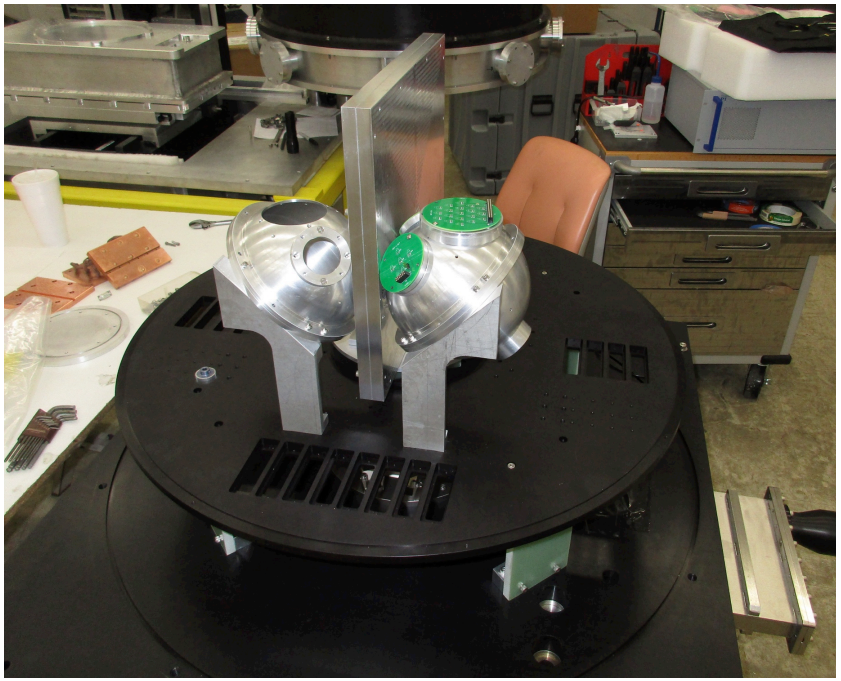
Sample Data

- We are providing sample data at this meeting
  - 3 dark cubes
  - 3 illuminated cubes
  - Persistence data
- The archive includes a README file. Please read it. These are prototype data. The FITS headers are not as comprehensive as they will be for flight
- As the ink is not yet dry on our Blanket Exemption, procedures are not yet in place to support downloading FITS data
- For the time being, coordinate with me if you would like more data. I will coordinate these requests with the DCL
- If you have questions about the data, please coordinate with me. If I cannot answer your question, I will forward it to somebody on the DCL team who can

Characterization Snapshot

- **Help needed from FSWG to write the characterization requirements**

- The following charts provide a snapshot of what is being done today
- Project Office is aware that characterization will probably include
  - Additional characterization tests that are not currently being done on the prototype H4RG-10s
  - Additional characterization tests at higher levels of integration than the H4RG-10
- In addition to defining characterization tests, we should also be describing the algorithms to be use. Even basic things like reference correction or a linearity correction can skew results



Relative calibration system (RCS)

Existing Test Concept

- Project office has put together a test concept that involves 3 phases: (1) development, (2) qualification, and (3) flight build
- Currently somewhere in the transition from development to qualification
- Extensive overlap across phases in the kinds of performance testing and characterization that are envisioned
- Concept describes screen testing at a vendor followed by performance testing and characterization in NASA GSFC Detector Characterization Laboratory (DCL)
- Following charts provide a snapshot of the kinds of tests that are currently envisioned or being done

Screen Testing at Detector Vendor

- ROIC Power Consumption
- Warm Interconnect Operability
- Transimpedance Gain
- Dark Current
- CDS and Fowler-n Noise
- Quantum Efficiency
- Full Well
- Raw Bias Image
- Flat Field Image
- CDS Noise Image
- Window Mode Operation (show that it works)

Performance Testing in GSFC DCL

- Transimpedance Gain
- Dark Current
- CDS and Fowler-n Noise
- Total Noise
- Quantum Efficiency
- Full Well/Linearity
- Persistence
- Inter-Pixel Capacitance
- Charge Diffusion
- Snowball Rate

Characterization Testing in DCL

- For now, characterization is being done to inform detector design trades
- Not clear how many of these would carry over into characterization for flight, although some (*e.g.* linearity, persistence vs flux) would

Test	Description	Status
Buffered vs. Unbuffered Output Mode	Determine constraints to cabling and pixel rate	Deferred to a later phase
Noise vs. Pixel Rate	Examine CDS and total noise for 100, 125, 150, 175, 200 kHz pixel rates.	Data in hand
Guide Window Noise And Coupling	Quantify noise impacts on imaging area for a flight- representative guide window implementation.	Data in hand
Readout Mode Noise Optimization	Determine baseline reference channel and reference pixel schemes.	Data in hand
Quantum Yield (Detective Quantum Efficiency)	May affect the RQE specifications shortwards of ~1 μm.	Planning
Reciprocity Failure	Flux dependent QE effects and mitigation strategies.	Planning
Intrapixel Response	QE variations within a pixel.	Planning
Out-of-Band Rejection	QE response beyond the long-wavelength cutoff (through the thermal IR).	Early planning
Overlight Response	Permanent or semipermanent effects from overlight exposure (mostly affecting I&T).	Early planning
Short Wavelength Exposure Degradation	Stability of QE to short wavelength light exposure.	Early planning
Photometric Stability	Stability of QE over time.	Follows QE
Baseline Dependence on Temperature	Stability of bias over temperature to set temperature stability requirements.	Data in hand. May need to be redone with new detector.
Baseline Dependence on Temperature Drift Rate	Stability of bias for different temperature drift rates.	Planning
Modulation Transfer Function (MTF)	Quantify spatial resolution performance.	Early planning
Bias Voltage to Output Transfer Functions	Susceptibility information to set requirements on bias stability.	Data in hand
Random Telegraph Signal (RTS) Noise Properties	Determine the level of RTS noise and ensure that it will have the expected effects on the noise properties of the data.	Proposed for deletion
Persistence Dependence on Integrated Flux	Determine whether the persistence is dependent on the flux level.	Test implemented. Will be done on all flight candidate detectors
Linearity	Explore linearity correction	Data in hand, but more work needed
Crosstalk Uniformity	This is a flowdown from the weak lensing ellipticity accuracy requirements.	In progress
Chopping Readout Noise Reduction	This is a test to determine the optimal readout mode for noise reduction.	Data in hand
Dynamic Pixel Reset	This test determines the properties of a dynamic reset scheme during an integration to avoid exceeding full well.	Cannot be done with current SCE

Additional Things to Ponder…

- The data are FITS files with extensions (each 4096x4096 pixel frame resides in its own FITS extension). Is this what we want?
- Irrespective of the format, some details (header keywords, *etc.*) will change before flight.Can we find a way for our tools to always work, even as the input data evolve and mature?
- What are our thoughts on how to best share software?
- How do we want to work toward agreement on basic algorithms for things like reference correction, linearity correction, *etc*?