J1 ATMS Readiness

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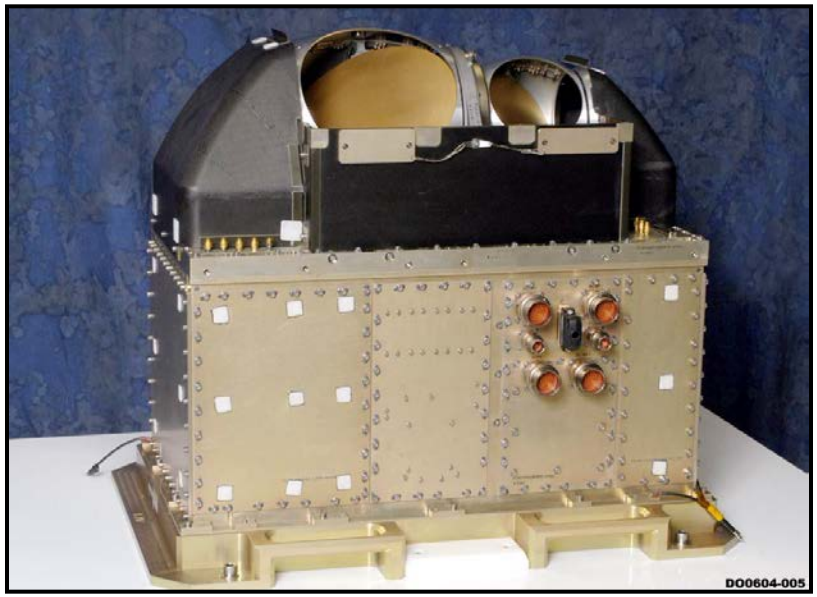
Outline

- Differences between S-NPP and JPSS-1 flight units
  - Known issues with S-NPP unit
  - Modifications to J1 unit
- JPSS-1 flight unit status
  - Prelaunch testing
  - Rework & regression testing
  - Notional schedule
- Summary

Context

- To provide more context for understanding J1 ATMS readiness, of course the starting point is the S-NPP flight unit
- In particular, the following slides show a sampling of issues discovered on the S-NPP build, and what was modified for the J1 build to try to improve things
- It is not meant to be an exhaustive list
- S-NPP ATMS is working well



Known Issues from S-NPP ATMS

1. Scan drive issue

- Non-ideal materials used; accelerated wear → risk of degraded scan, even total stopping of scan
- 2-year investigation of lifetime extension strategies
- "scan reversal" strategy selected
- Scan reversal is currently being tested on orbit
  - o Daily
  - o Above 75 N latitude to limit NWP impact

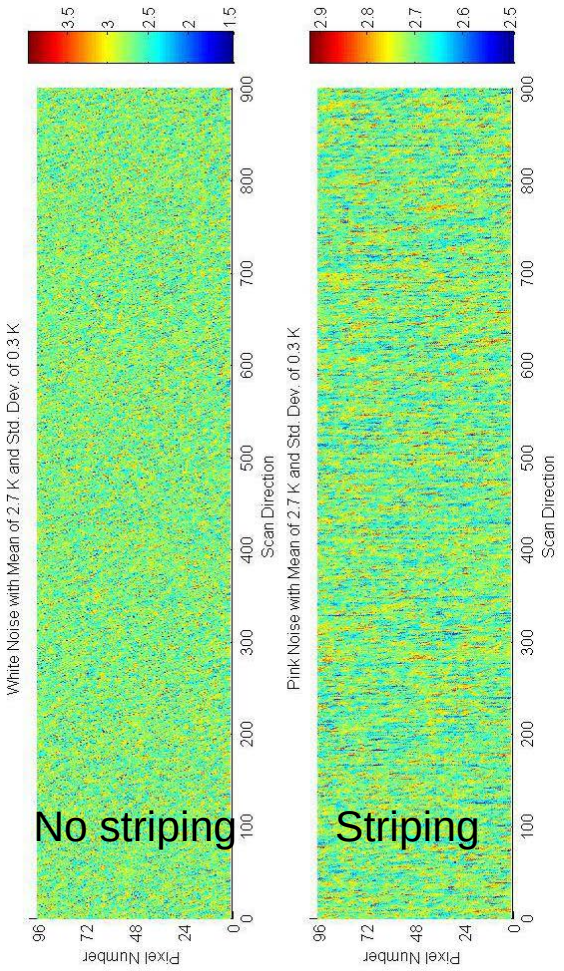
Modifications Made to J1 ATMS

- Bearings re-designed
- Should not be an issue for J1+

Known Issues from S-NPP ATMS

2. Increased 1/f noise vs. AMSU ("striping")

- 1/f noise is present in all electronic measurements; the source is "understood," and in the hardware
- Studies have since found "striping" in AMSU and MHS data, so it's not unique to ATMS
- Hardware modifications to the S-NPP flight unit are not an option
- The only option for S-NPP is to adjust averaging of cal parameters to better match noise power spectrum & limit the effects of 1/f on ATMS



Is striping a problem?

- ATMS striping is an order 0.1K size issue—i.e., small.
- Note: there is currently no requirement with respect to striping
- ATMS meets its *existing* specs even with striping because *existing* specs do not address striping
- NWP centers say striping is a problem, but have yet to develop a good quantitative metric, so a precise discussion is difficult.
- An NWP striping metric might be an end-to-end metric like:
  'X kelvins of striping cause Y % degradation of weather forecast skill.'
- In the absence of a quantitative analysis of striping impact on NWP forecast skill, the flight project is unlikely to be receptive to requests for a new requirement on striping

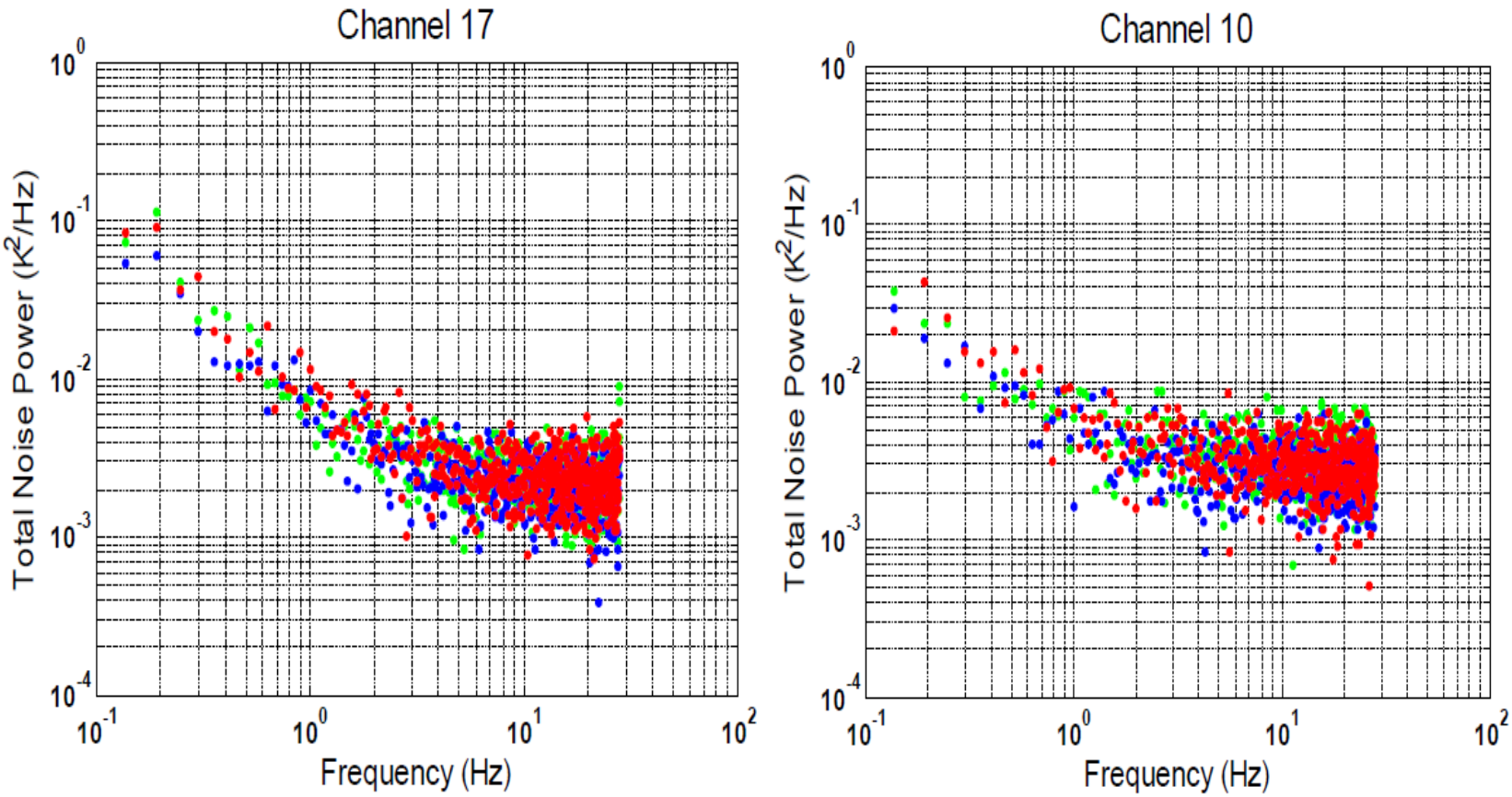
What can be done about striping?

- For S-NPP
  - we can't change the hardware, so the only option is modifying the ground algorithm
  - ATMS SDR team has explored adjusting cal parameter averaging
  - Long stares would provide striping-related data

- For J1
  - Too late for hardware changes
  - So main option is to change ground algorithm, like for S-NPP
  - Addn'l ground measurements and on-orbit stares would help
    - The ground measurements (stares) are being done
    - The on-orbit stares have been requested, including deep space

- For J2+
  - Addn'l ground measurements recommended
  - On-orbit stares would be great
  - Beyond that, TBD

Noise Power Spectrum



S-NPP ATMS power spectral densities (green = cold plate temp. of 5.3 C, red is 10.1 C, and blue is 0.7 C). The pink noise (1/f component) is independent of the instrument's temperature. The sensor-level measurements were taken in 9/2005 (green) and the satellite-level testing in 4/2011 (red, blue).

3. Antenna characterizations

- Issues with test facility and methodology used for S-NPP, especially for G-band (183 GHz) channels
- J1 beam efficiency slightly below spec (94% vs. 95%); waiver approved, plus additional tests showed 95% was met

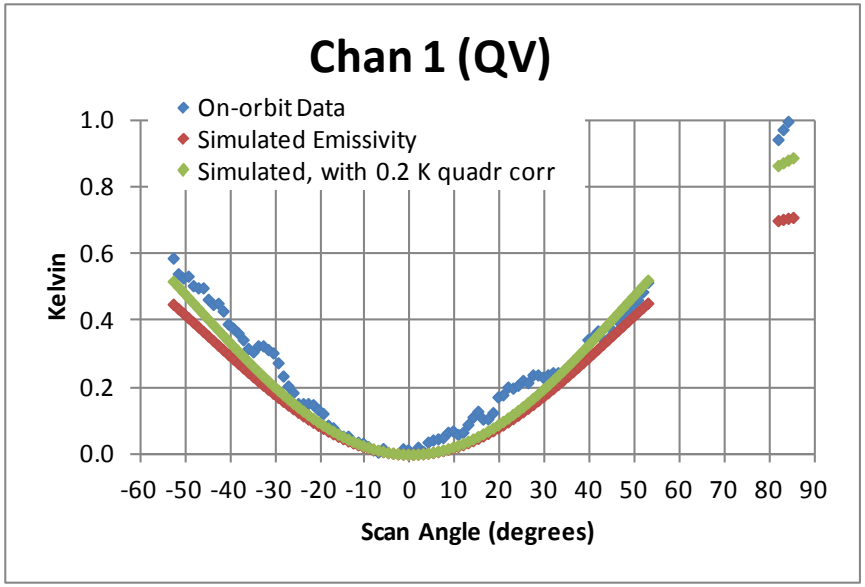
4. Reflector emissivity

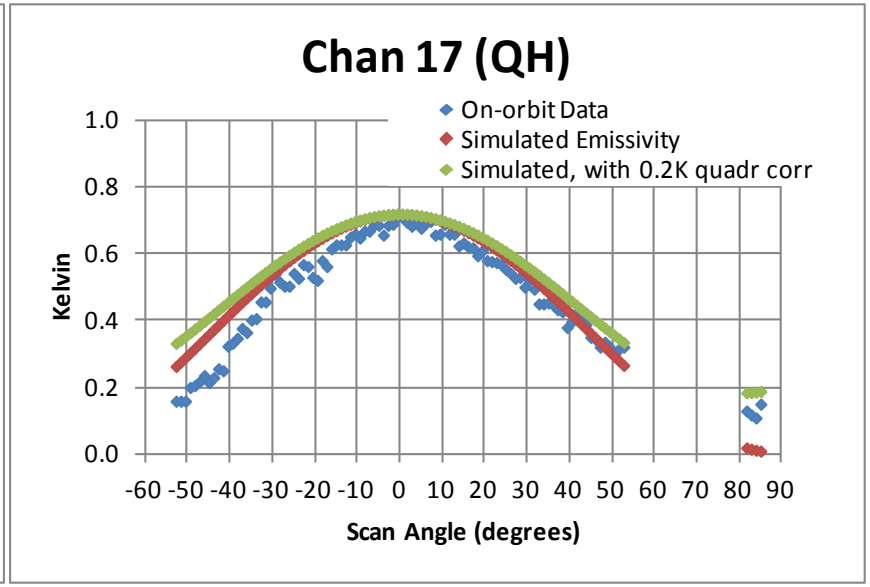
- Due to specific construction of reflector (Be-Ni-Au)
- Affects S-NPP and J1 flight units
- Results in scan angle dependent scale factor in TB ("smiles" and "frowns")
- Physical mechanism verified by special ground test
- Only option for S-NPP is algorithm adjustment

Modifications Made to J1 ATMS

- Discovered too late in J1 build to change J1 hardware
- But same algorithm adjustment as S-NPP will be done
- Not part of J1 re-work, so earliest fix opportunity will be on J2 flight unit

Scan-Dependent Bias from Reflector Emissivity





Scan-dependent bias, obtained from S-NPP calibration/validation pitch maneuver, compared to simulated effect of reflector emissivity. Theory confirmed via special ground tests.

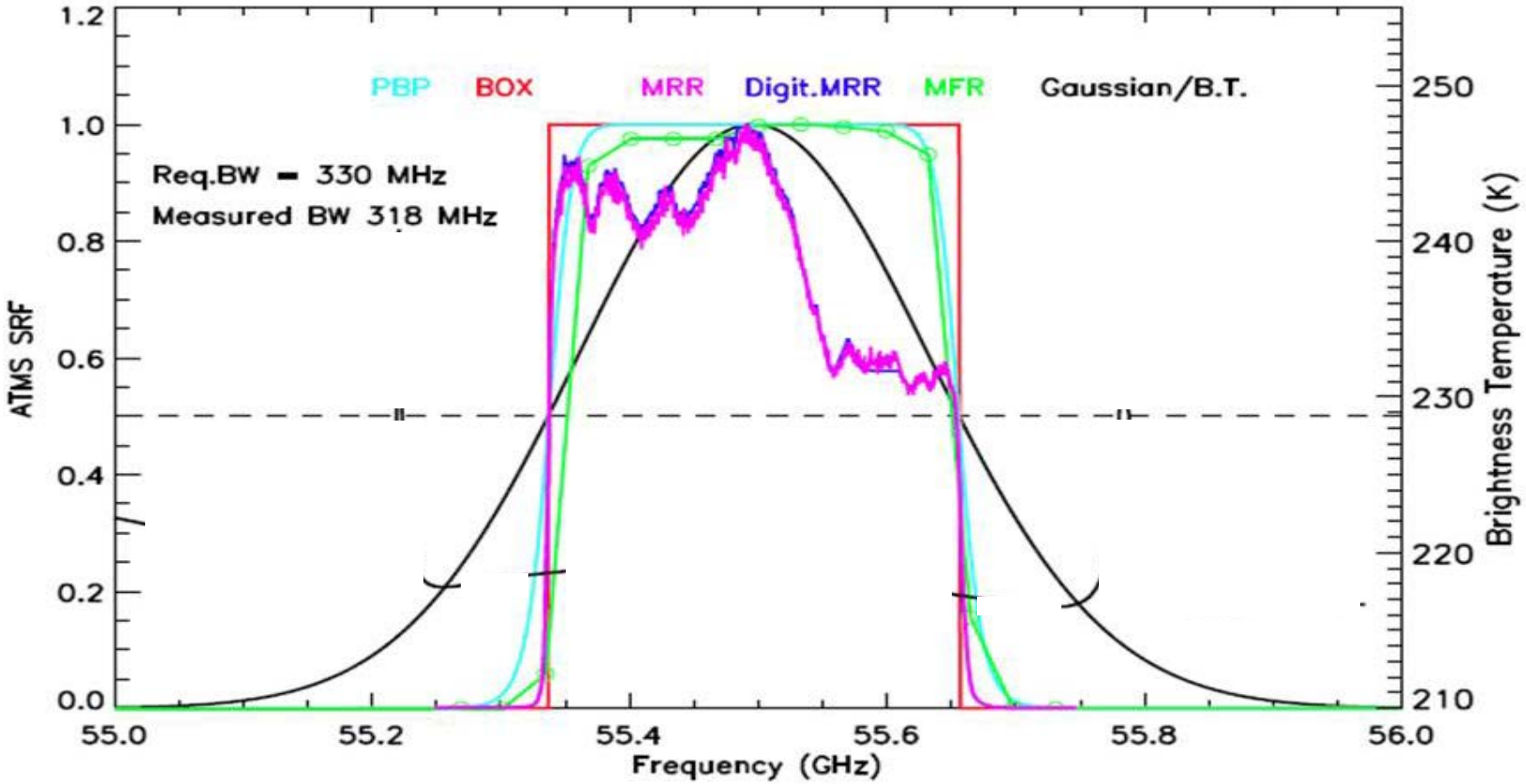
5. Spectral Response Functions

- S-NPP SRF data were inconsistently recorded, and not always in digital form
- An extensive data recovery effort yielded digital SRF data for S-NPP; data publicly available

Modifications Made to J1 ATMS

- J1+ deliverables changed to require data in consistent digital form
- J1 SRF data were taken during TVAC 1, and will be available to NWP community

Spectral Response Functions



Ideal SRF (BOX) is in red. , The Perfect (electronically achievable) SRF (PBP) is in light blue. S-NPP measured filter response (MFR) and measured receiver-level SRF (MRR) are in green and purple, respectively. A Gaussian filter function with the is in black.

Summary of Example Modifications to J1 ATMS

- Scan drive
  - Bearing design changed to address wear out risk
- Striping
  - Discovered too late to change J1 hardware
  - Use same algorithm adjustment as on S-NPP
  - Additional ground characterization (stares)
  - Also requested on-orbit stares & deep space viewing maneuvers
- Antenna characterization
  - Improved antenna measurement facility & methodology
  - Particularly benefits G-band
- Reflector emissivity
  - Too late to change J1 hardware
  - Use same algorithm adjustment as on S-NPP
- Spectral Response Functions
  - Digital, consistent
  - Otherwise same measurement approach as for S-NPP

Examples only;
Not a complete list

J1 Prelaunch Testing before today

- Prelaunch testing/measurements began Oct 2012
- Environmental tests began May 2013
- TVAC “round 1” began Feb 2014
- Many performance measurements were fine, but
- Significant issues were found
- Decision made Jun 2014 to halt prelaunch testing & perform re-work
- Additional issues were found during re-work
- Eventually 20 of 22 channels were re-worked
- Not all parts of instrument were affected
  - Antenna subsystem not part of re-work
  - Antenna characterization considered complete

J1 ATMS Prelaunch Testing 2015

- Pre-Environmental Review (delta-TRR) to perform “regression” testing (repeat TVAC & other environmental tests) was held Aug 19, 2015; result: go ahead
- Vibration regression testing successfully completed
- EMI/EMC regression testing occurring this week
- Regression TVAC (“round 2”) to begin early Sept
- TVAC round 2 should conclude in mid-Oct
- Post-TVAC regression testing through end of Oct
- Pre-ship review in early Nov
- J1 ATMS on J1 spacecraft by Dec

Summary of ATMS Status

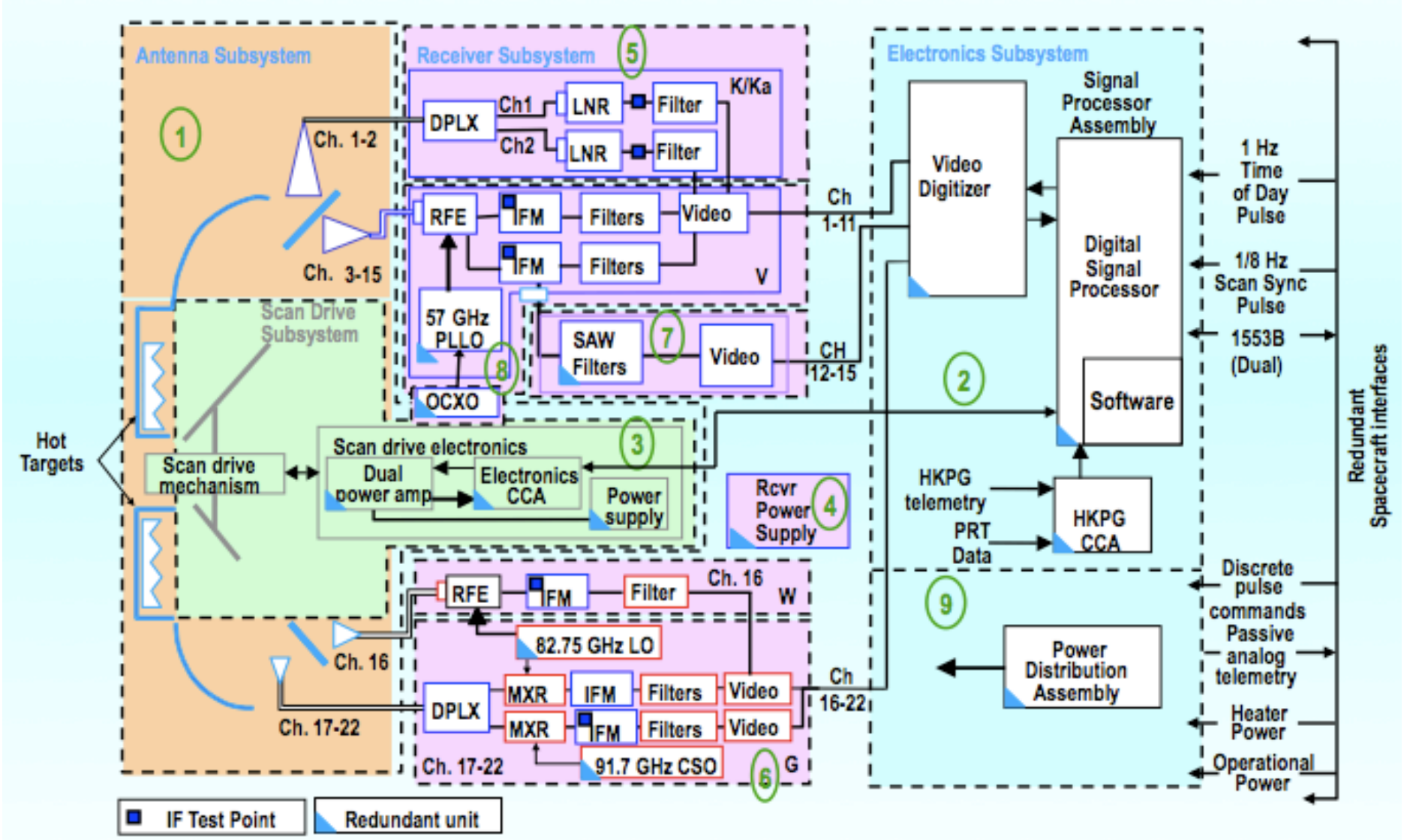
- S-NPP flight unit status
  - Post-launch validation activities have confirmed S-NPP ATMS is meeting or exceeding its performance specifications (see papers in S-NPP special issue of JGR)
  - On-orbit testing of scan drive mitigation (reversals) is in progress

- J1 flight unit status
  - just completed 1 year of re-work, and begun environmental re-testing
  - If environmentals are problem-free, J1 unit installs on s/c in Nov
  - J1 observatory-level tests partly done using EDU as stand-in
  - J1 observatory-level TVAC probably in early CY2016
  - If those tests stay on schedule, then launch date is looking good

- J2 flight unit status
- procurements have begun

BACKUP

ATMS System Diagram



Spectral Differences: ATMS vs. AMSU/MHS

Left: AMSU/MHS

Right: ATMS

	Ch	GHz	Pol	Ch	GHz	Pol
AMSU-A	1	23.8	QV	1	23.8	QV
	2	31.399	QV	2	31.4	QV
	3	50.299	QV	3	50.3	QH
				4	51.76	QH
	4	52.8	QV	5	52.8	QH
	5	53.595 ± 0.115	QH	6	53.596 ± 0.115	QH
	6	54.4	QH	7	54.4	QH
	7	54.94	QV	8	54.94	QH
	8	55.5	QH	9	55.5	QH
	9	fo = 57.29	QH	10	fo = 57.29	QH
	10	fo ± 0.217	QH	11	fo±0.3222±0.217	QH
	11	fo±0.3222±0.048	QH	12	fo± 0.3222±0.048	QH
	12	fo ±0.3222±0.022	QH	13	fo±0.3222±0.022	QH
	13	fo± 0.3222±0.010	QH	14	fo±0.3222 ±0.010	QH
	14	fo±0.3222±0.0045	QH	15	fo± 0.3222±0.0045	QH
MHS	15	89.0	QV			
	16	89.0	QV	16	88.2	QV
	17	157.0	QV	17	165.5	QH
	18	183.31 ± 1	QH	18	183.31 ± 7	QH
	19	183.31 ± 3	QH	19	183.31 ± 4.5	QH
	20	191.31	QV	20	183.31 ± 3	QH
				21	183.31 ± 1.8	QH
				22	183.31 ± 1	QH

ATMS has 22 channels and AMSU/MHS have 20, with polarization differences between some channels

- **QV = Quasi-vertical; polarization vector is parallel to the scan plane at nadir**
- **QH = Quasi-horizontal; polarization vector is perpendicular to the scan plane at nadir**

- Exact match to AMSU/MHS
- Only Polarization different
- Unique Passband
- Unique Passband, and Pol. different from closest AMSU/MHS channels