

# History of cRio hardware choice and initial software development

ATOMMS Software Review  
October 25, 2010

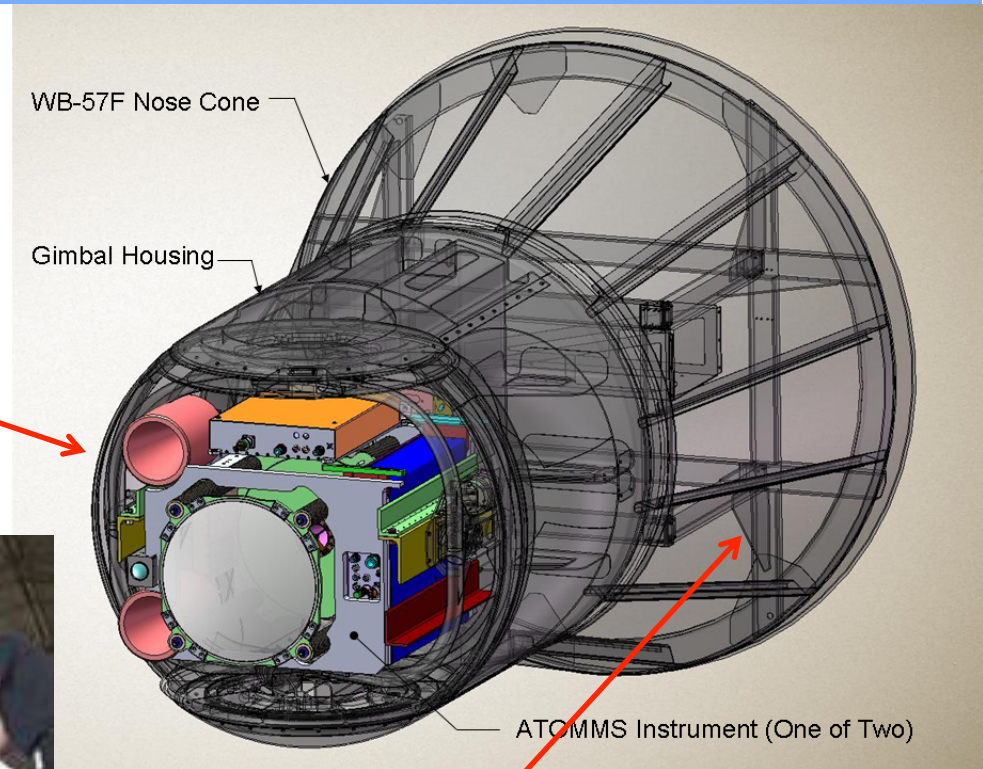
WAVES Gimbal  
50 mbar

WB-57F Nose Cone

Gimbal Housing

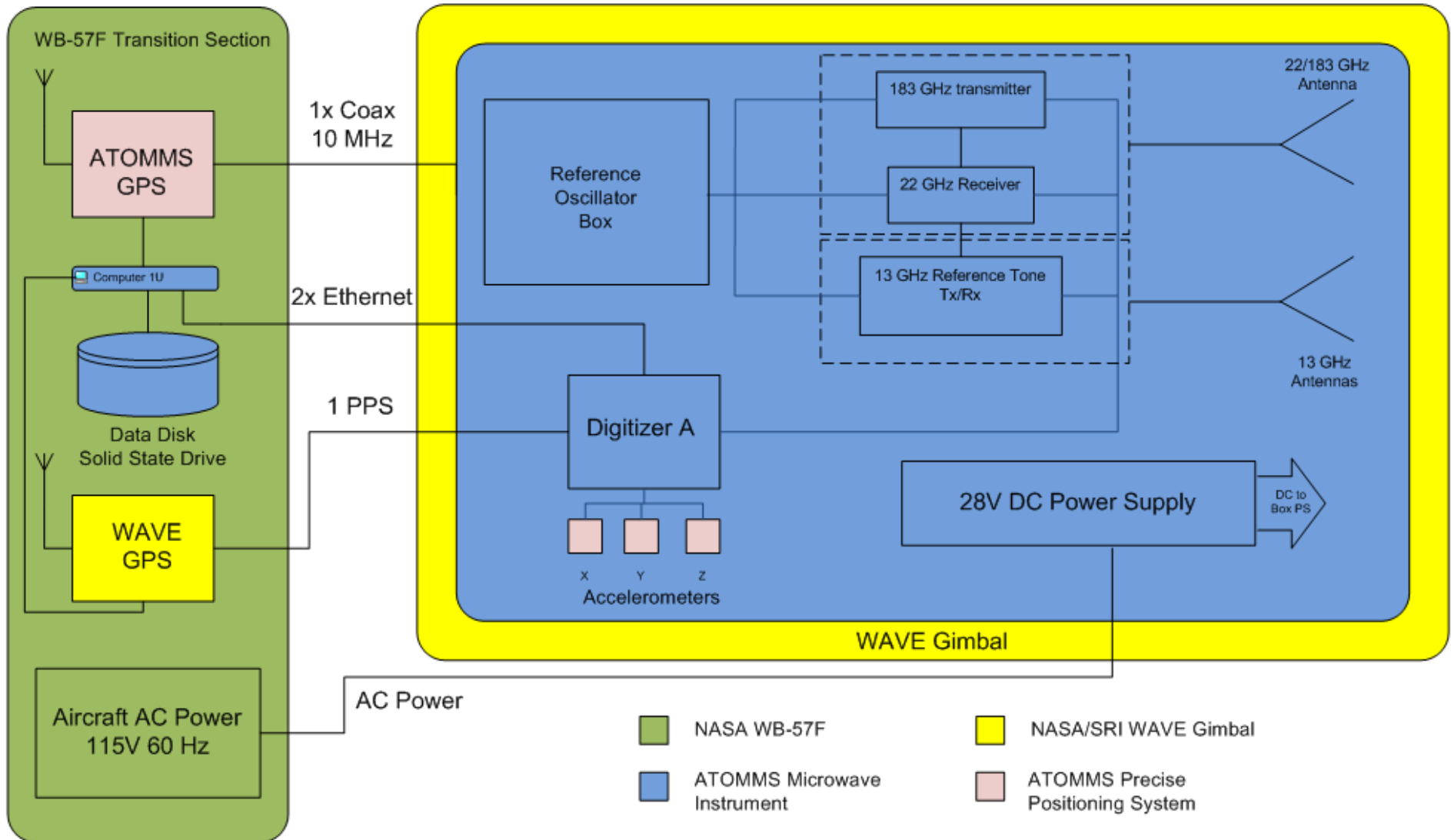
ATOMMS Instrument (One of Two)

WB-57F Transition  
Section (300-400 mbar)



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# Original Digitization Plan

- In the original ATOMMS proposal, we had planned to use NI PXI hardware located in the WB-57 transition section.
  - IF would be sent to transition section by coax cable
- Transition section is pressurized to 1/3 atm, suitable for most computer equipment (except hard drives).
- Environment sees smaller temperature swings than the WAVES gimbal.

## Issue that forced a change in plan

- Cabling in the WAVES gimbal is essentially unchangeable.
  - 4x custom aerospace ribbon cables with various copper wires and 1x 75 ohm video coax
  - Cost to change wiring is minimum \$250k, if NASA will allow it at all. They do not want ATOMMS to permanently change their system.
  - No suitable cabling available in wrap to send IF signals back to transition section.

## Compact RIO hardware

- David Thompson at NOAA strongly suggested we find a way to use the Compact RIO hardware.
  - Has been proven to work on the WB-57 at 65 kft at 50 mbar pressure on more than one NOAA experiment (by D.T.).
  - Fundamentally real time; should have good timing
  - Compact, light and low power.
    - Could straightforwardly be integrated with the ATOMMS instrument in the WAVES gimbal.

## Basic ATOMMS requirements

- Able to digitize 9x signals at 100 kS/s (ATOMMS A) or 2x 800 kS/s + 1x 100 kS/s signals (ATOMMS B) plus digital I/O, 3 axis accelerometer and analog housekeeping signals.
- 100% duty cycle: no missed samples, stream all data to SSD for 6-8 hour experiment.
- Simultaneous sampling for all science signals.
- Sampling synchronized to external clock for science channels

## Compact Rio seemed to fit the bill

- Simultaneous sampling 4ch digitizers available at 100 kS/s.
- 1ch 800 kS/s digitizers available.
- Simultaneous sampling between modules is straightforward.
- Once FPGA code compiles, reliable RT operation for long time periods should work well.
- Synchronization with external clock possible, but only through software. 20ns jitter penalty.

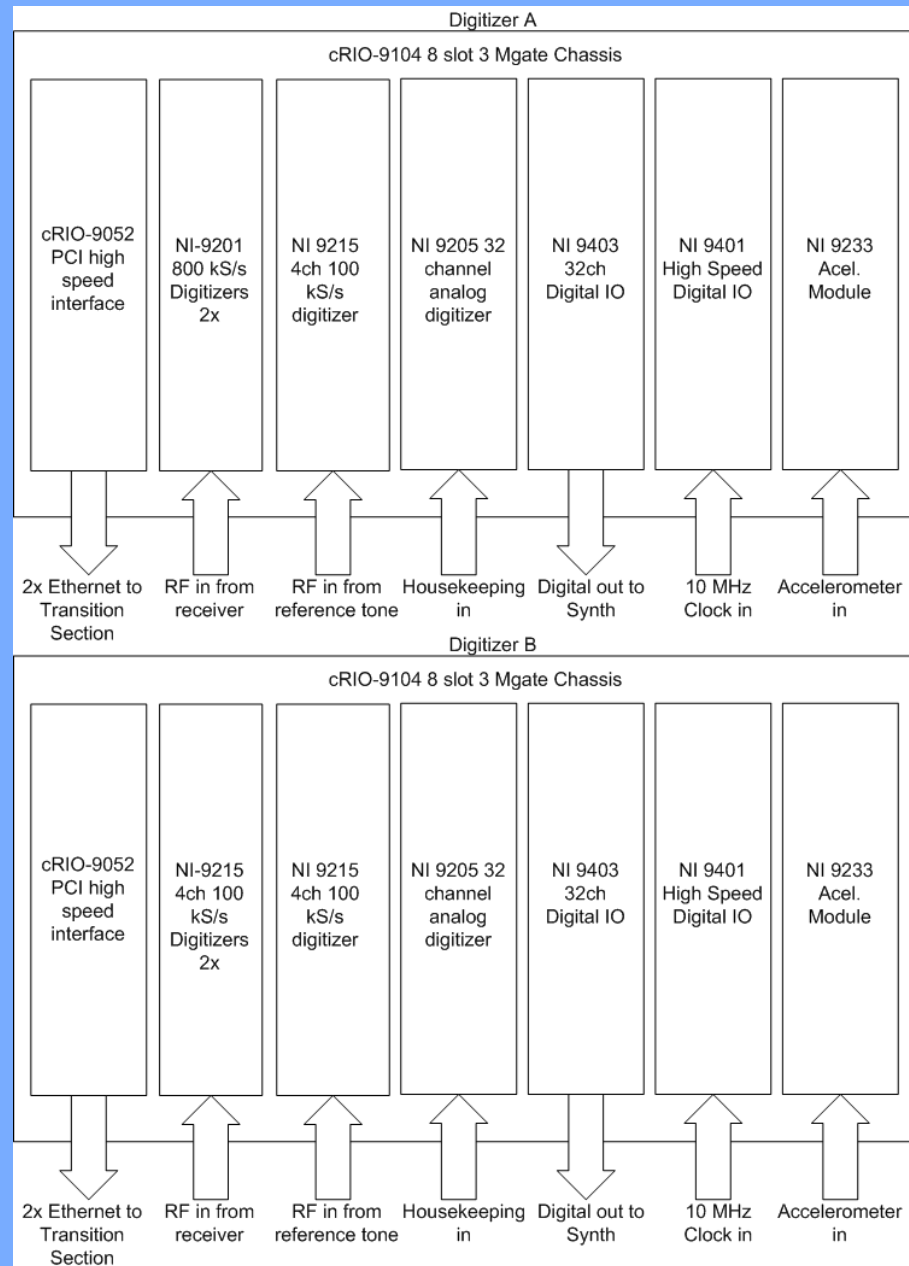


## cRio architecture

- Chose 8 slot rio chassis with 3MGate FPGA.
  - Could fit all the necessary modules for ATOMMS A and ATOMMS B.
- Starfabric interface to computer
  - Should simplify code writing compared to normal cRio controller (one less piece of code).
  - Ethernet available in wrap that meets Starfabric spec.
- Flight computers in transition section with SSDs running Labview RTOS would collect and store data, plus provide event scheduling.

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# Software Development

- The ATOMMS team (pre Robert S.) did not have the labview experience required to develop the ATOMMS Software.
- Buddy Curtis at NI recommended Intaq as a consultant who could help us develop the software.
- Intaq and the UofA agreed on a SOW to develop the core realtime datalogger code with external synchronization. UofA would add all the “bells and whistles” later.

# Software Development

- The experience with Intaq was not a good one.
  - Software was delivered very late, and we had to press very hard to get code delivered that met all of the SOW points.
- In initial testing (by Brian Wheelwright) the software seemed to work, but we later found severe problems after data analysis by Rob K. and Dale W.:
  - External clock synchronization did not work at all. Data transfer over starfabric was being synchronized, not the sampling.
  - Tuning the ATOMMS RF synthesizers over digital IO was painfully slow (several seconds needed to complete a tuning command). Should be essentially instant.
- Rather than go back to Intaq, we decided to enlist the help of Robert S. to help fix the code written by Intaq.

## Things to keep in mind for possible HW changes

- Space and mass are very limited in the gimbal and on the ATOMMS instruments.
  - Mechanical redesign could be very expensive and time consuming.
- Hardware in gimbal must survive 50 mbar pressure
  - Will probably require testing in a custom pressure vessel (that does not exist). If the HW is small, it could be tested in our existing pressure vessel.
  - This testing is also time consuming
- Wiring in WAVES cable wrap is not changeable on our budget.
  - Have to live with existing wiring and cable length (~25 ft)