LLRF Solutions at SNS

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- **Introduction:**
  SNS is a long-pulse (1 ms) machine.
  FPGA handles activity (including PI feedback) within the pulse
  Host CPU handles pulse-to-pulse processing, including network access

- **History:**
  Three generations of working hardware
  Four generations of working firmware
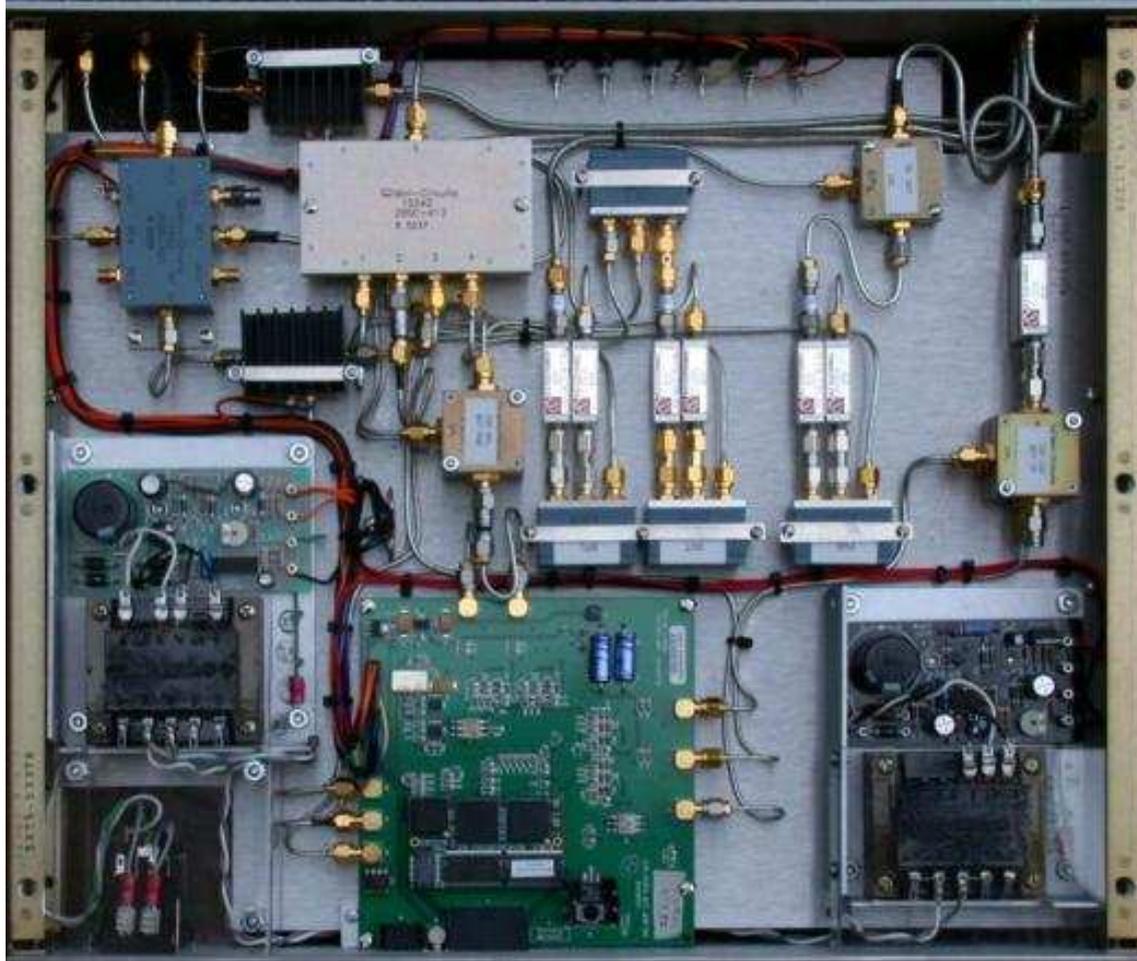 Three generations of working software
  - xcas/arm-Linux
  - pcas/arm-Linux
  - trunk/powerpc-vxWorks
  Great effort after everything "working" to build higher-level automation

- **Generation 1 & 2:**
  4700-cell FPGA, 200 MHz StrongARM SBC, 100 MB/s Ethernet PCas/XCas EPICS on Linux
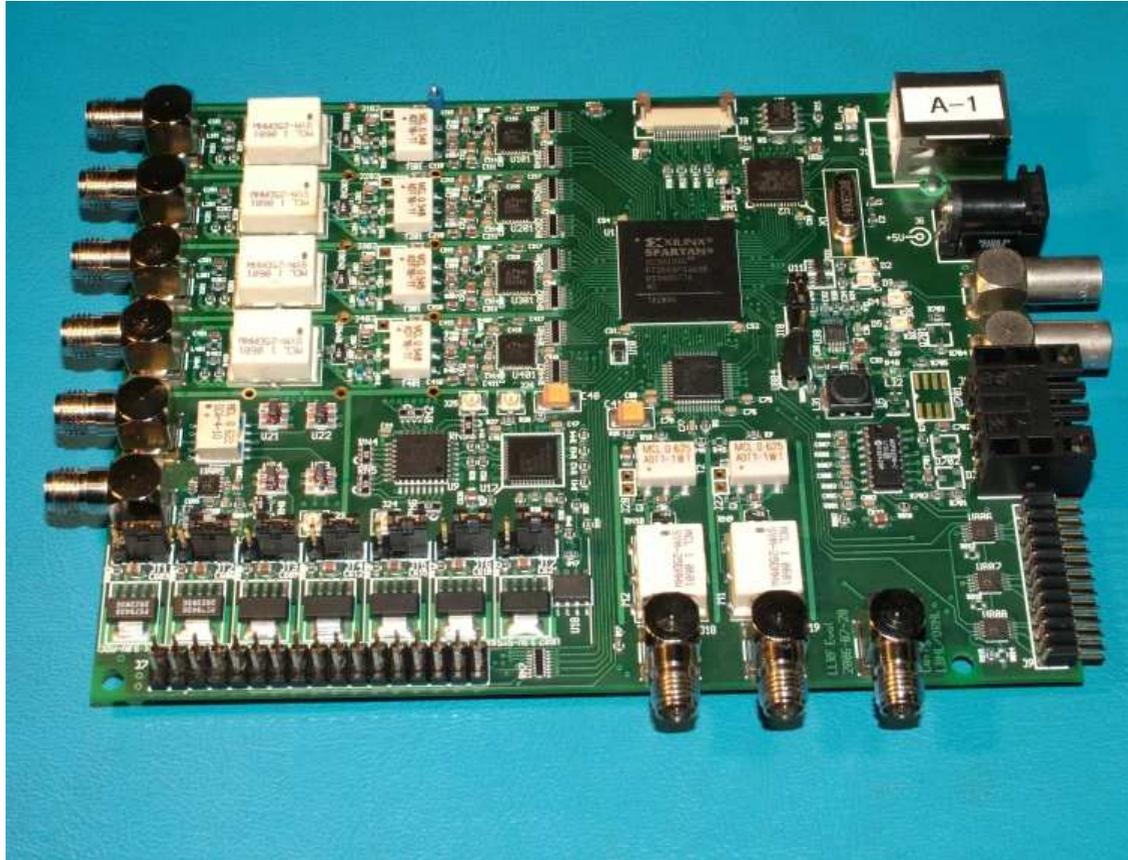
- **Generation 3:**
  15000-cell FPGA, 300 MHz PowerPC VME, 100 MB/s Ethernet Core EPICS on vxWorks

- **Generation 4:**
  15000-cell FPGA, 48 MHz 8051, 280 MB/s USB 2.0 Higher level software delegated to host PC

- **Missing (coming up next?):**
  Real-time communication

- **Lessons:**
  Evolution is good
  Details matter: e.g., structure for relibility at low level, no races or data incoherence
  Testing, testing, testing!