Status of the NSTX control system

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Outline

- FY04 achievements
- FY05 priorities
- Hardware overview and FY05 changes
- Software overview and changes
- Issues possible actions for the future
- Summary

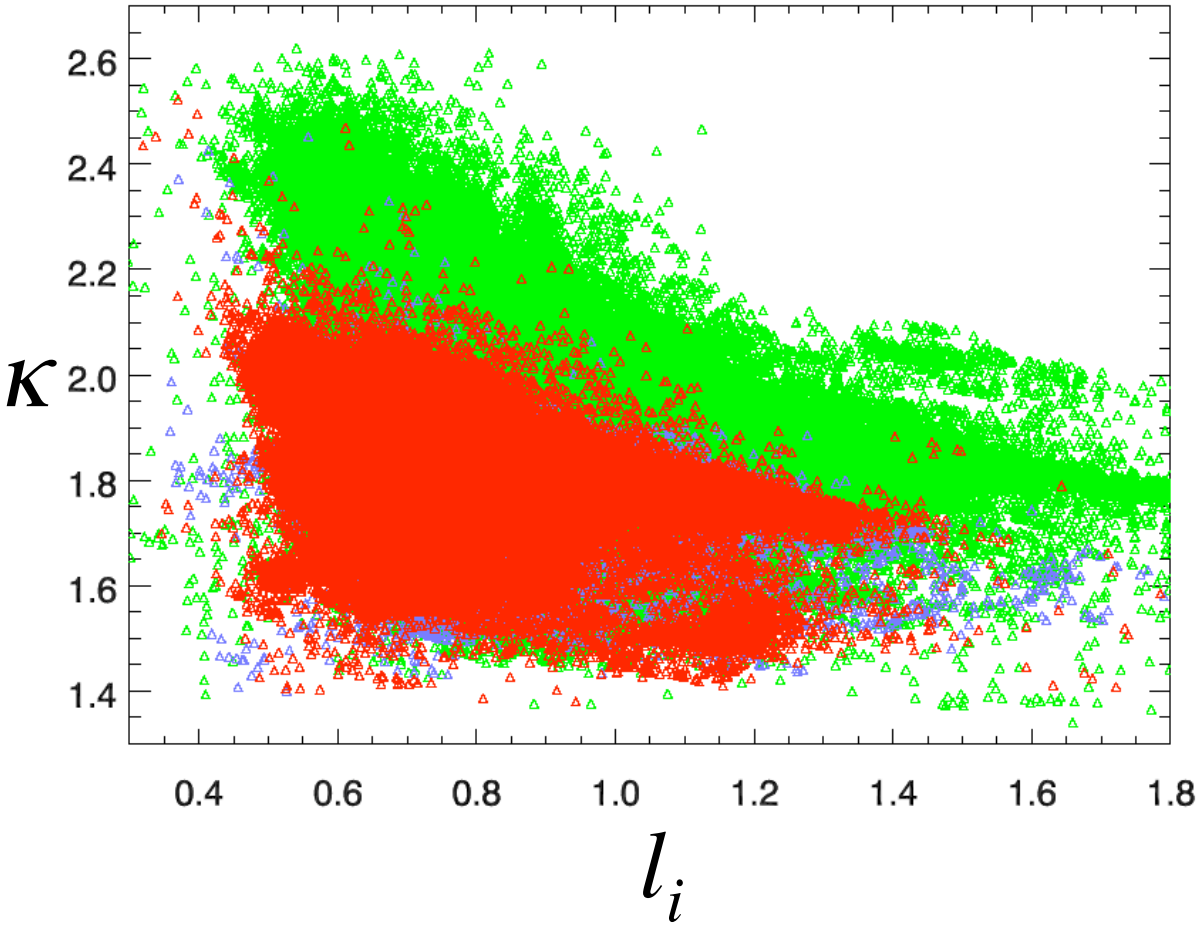
2003 System upgrade

- Memory management software rewritten to optimize speed for new hardware configuration
- Replaced 9U Sky II computer with 6U board
- Sky II operating system upgraded
- Host operating system (Solaris) upgraded
- PCS upgraded
- Replaced FPDP i/o cards on both Sky II computers (upgraded operating system)
- Built FIMM for data input
- Built FPDP-PCLIM for data output
- Rewired PClink into 4 parallel serial lines

Control system upgrade increased NSTX operating space

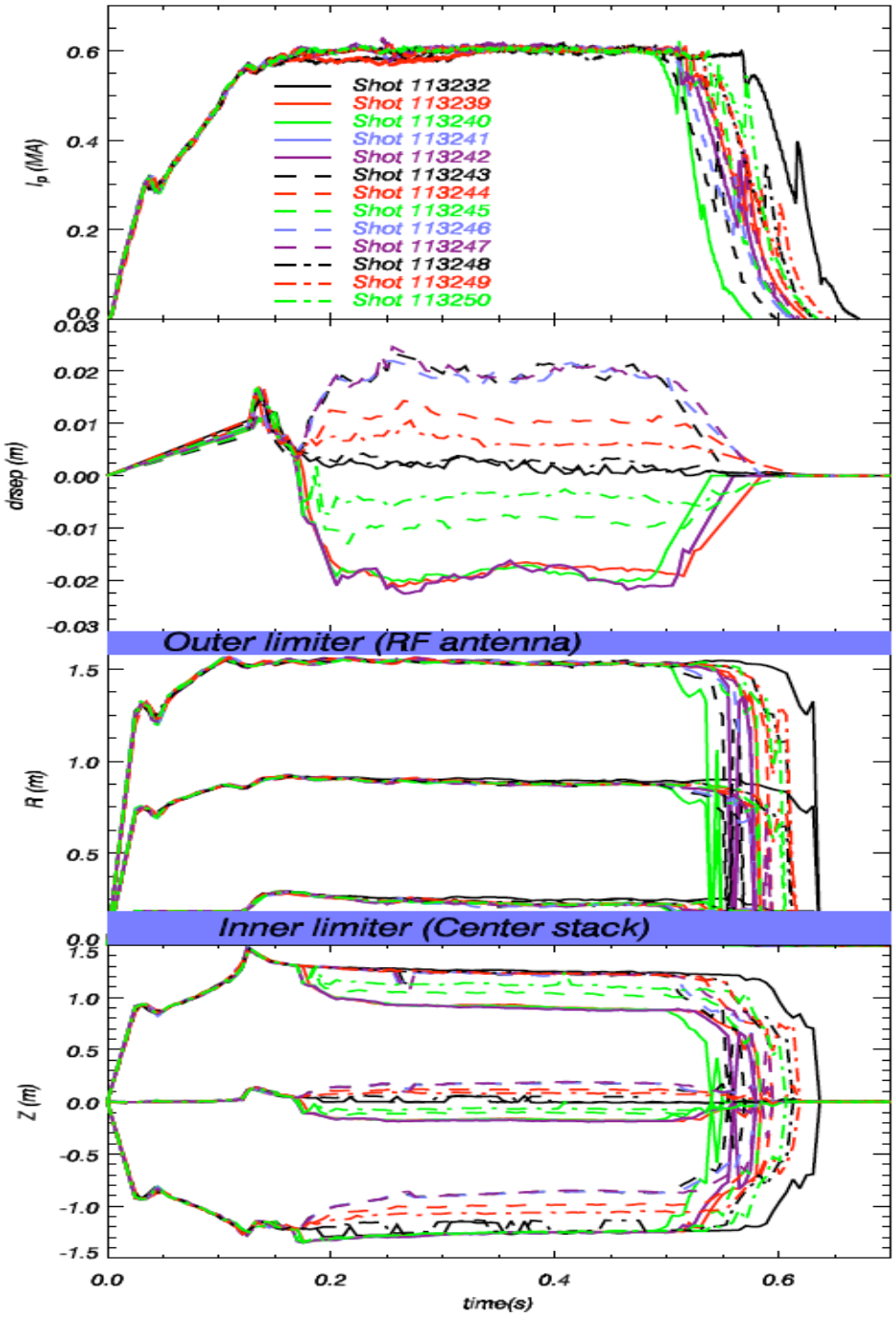
- Control latency reduced to 1/4 previous value - improved vertical control
- Achievable plasma elongation increased ~20% (at fixed l_i)
- Increased elongation has broadened operating space (pulse length, β)

Vertical stability diagram
Every EFIT from the entire NSTX database

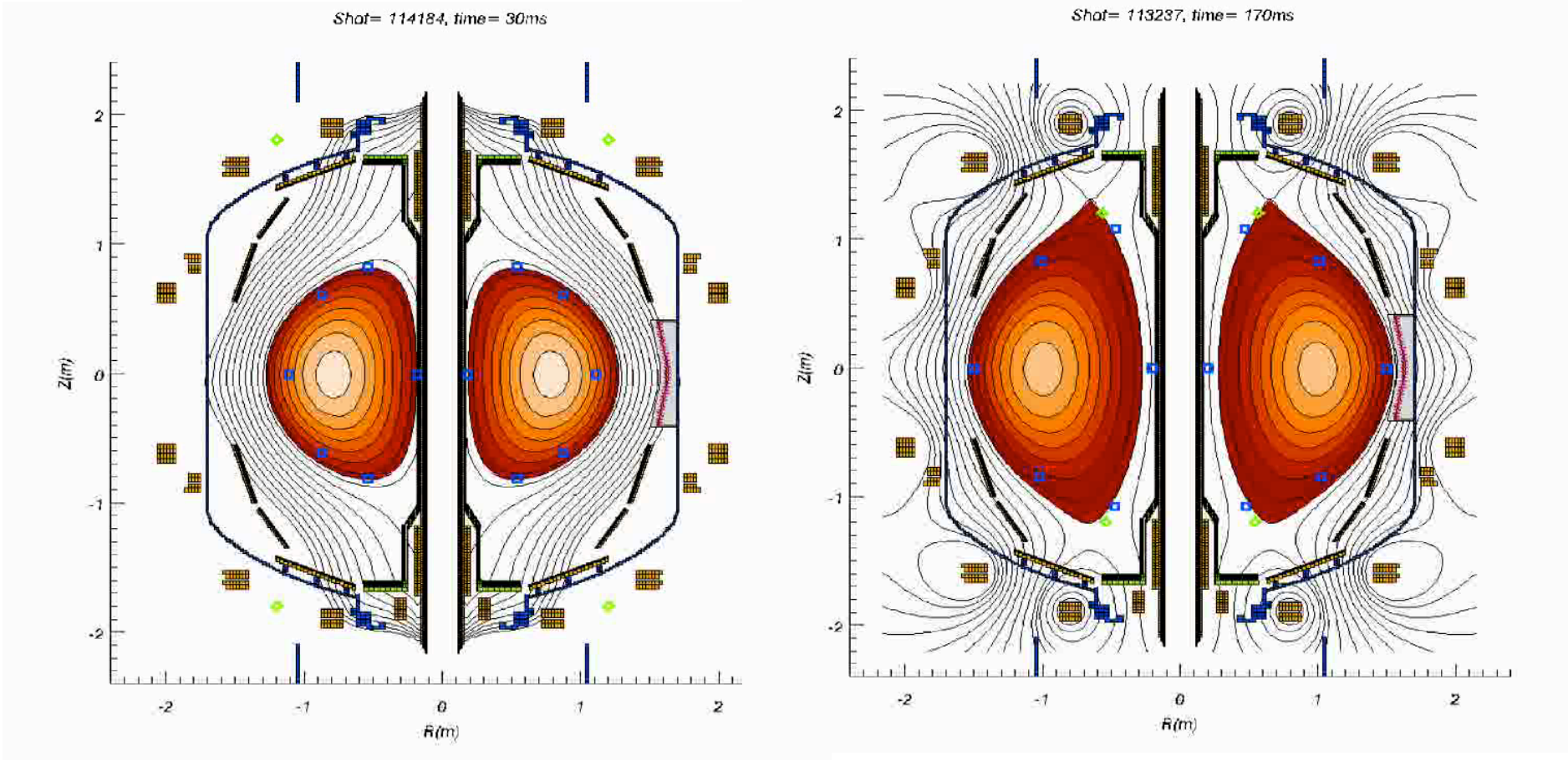


rtEFIT works during I_p flattop

- rtEFIT has provided precise control capability for many experiments, used in 40% of shots during FY04 run
- Further development work required (run time)



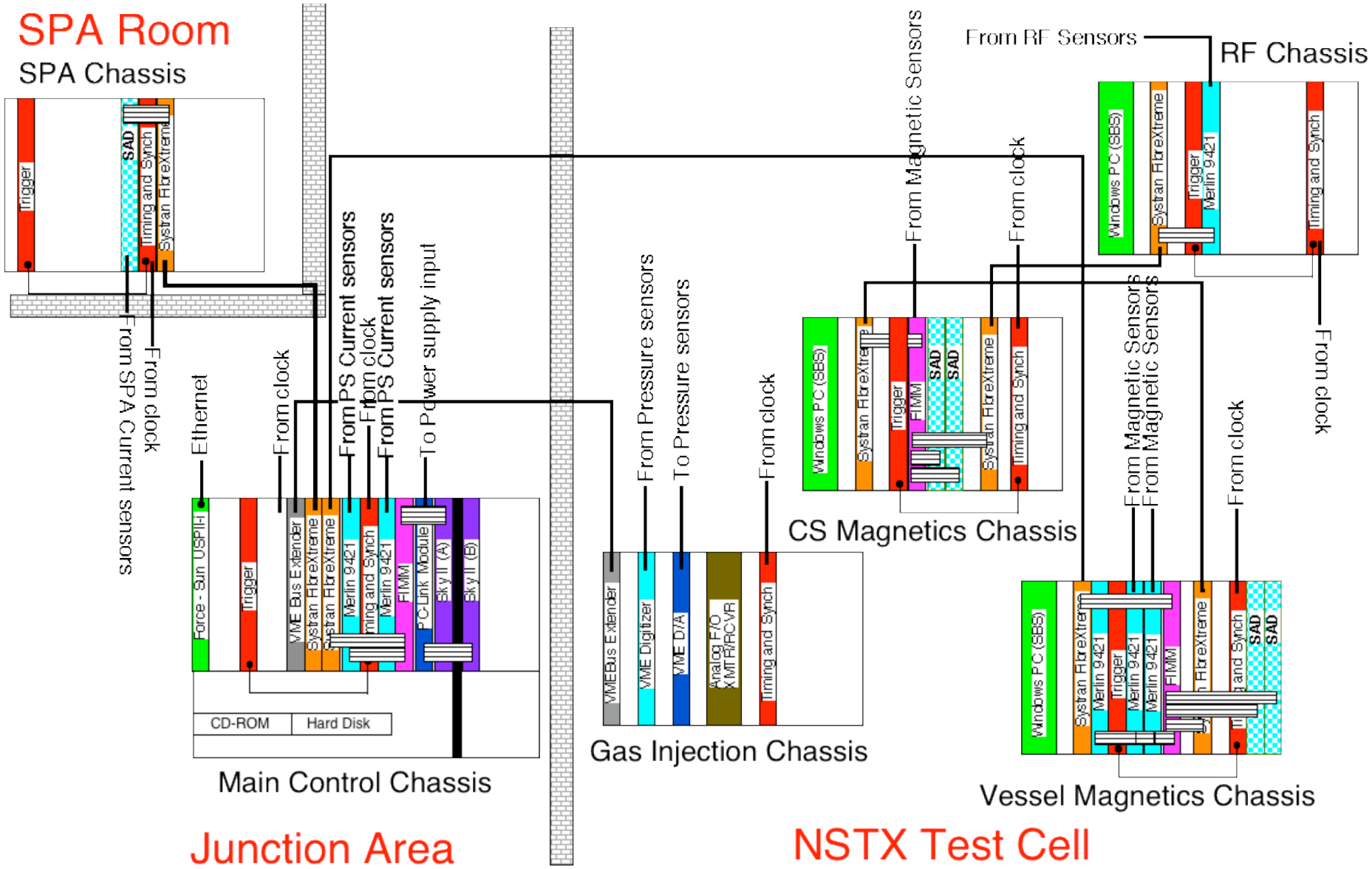
Examples



Current Priorities

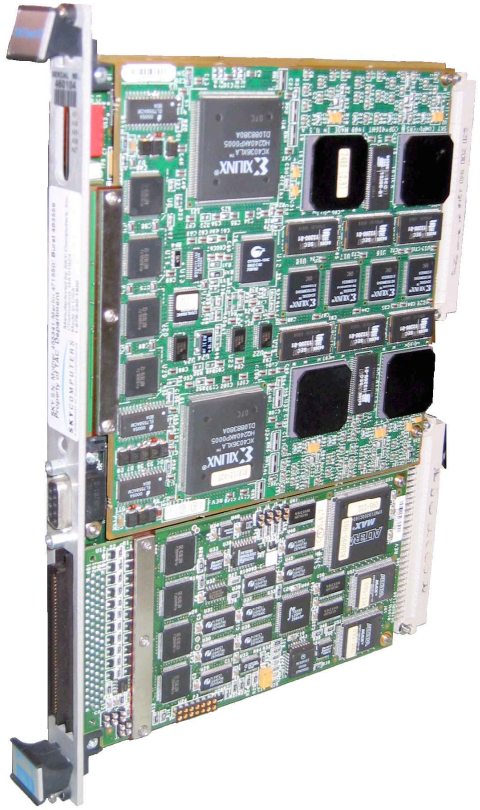
- SPA control is the single biggest control effort ~90% of effort
- Add new data channels for improved equilibrium reconstruction and update rtEFIT setup to include new PF1A and better vessel measurements
- Add real-time latency measurement (delayed until after run starts)

NSTX control system - 2005

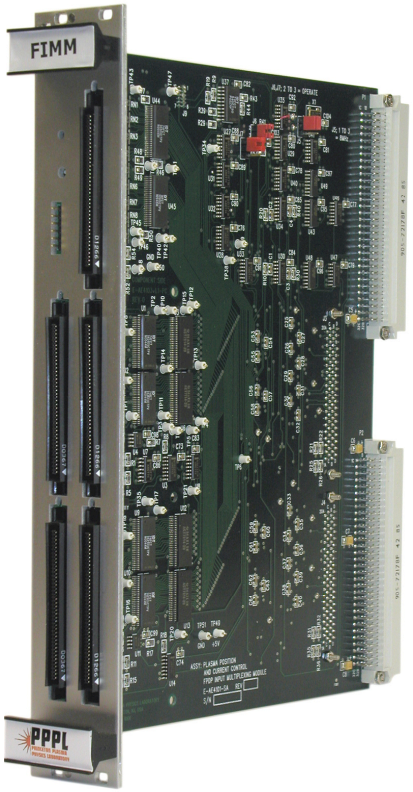


Hardware standards ease development

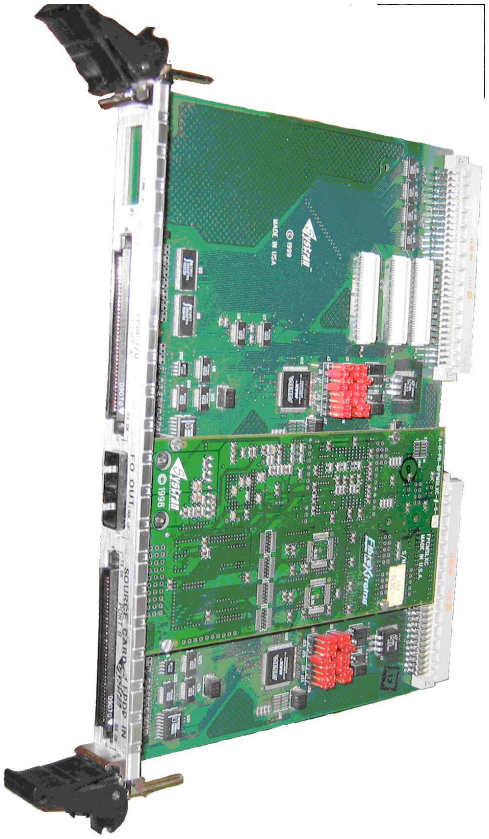
Input modules



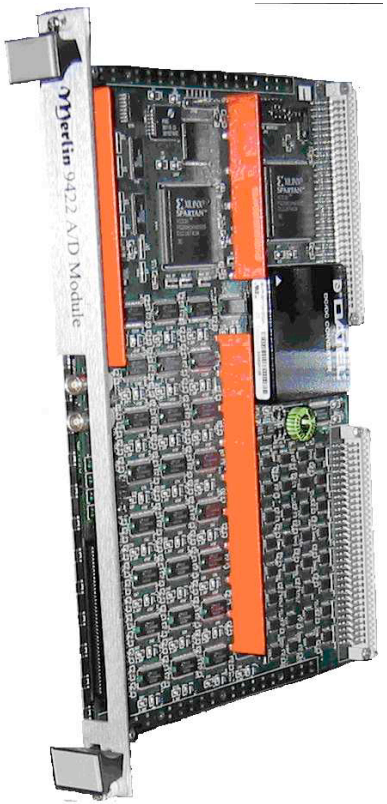
Sky II computer w/ FPDP Direct Memory Access



FPDP Input Multiplexing Module (PPPL) - combines Signals from four FPDP sources
(can be daisy chained)



Systran Serial FPDP F/O transmitter/receiver 1Gbit/s 5 km transmission



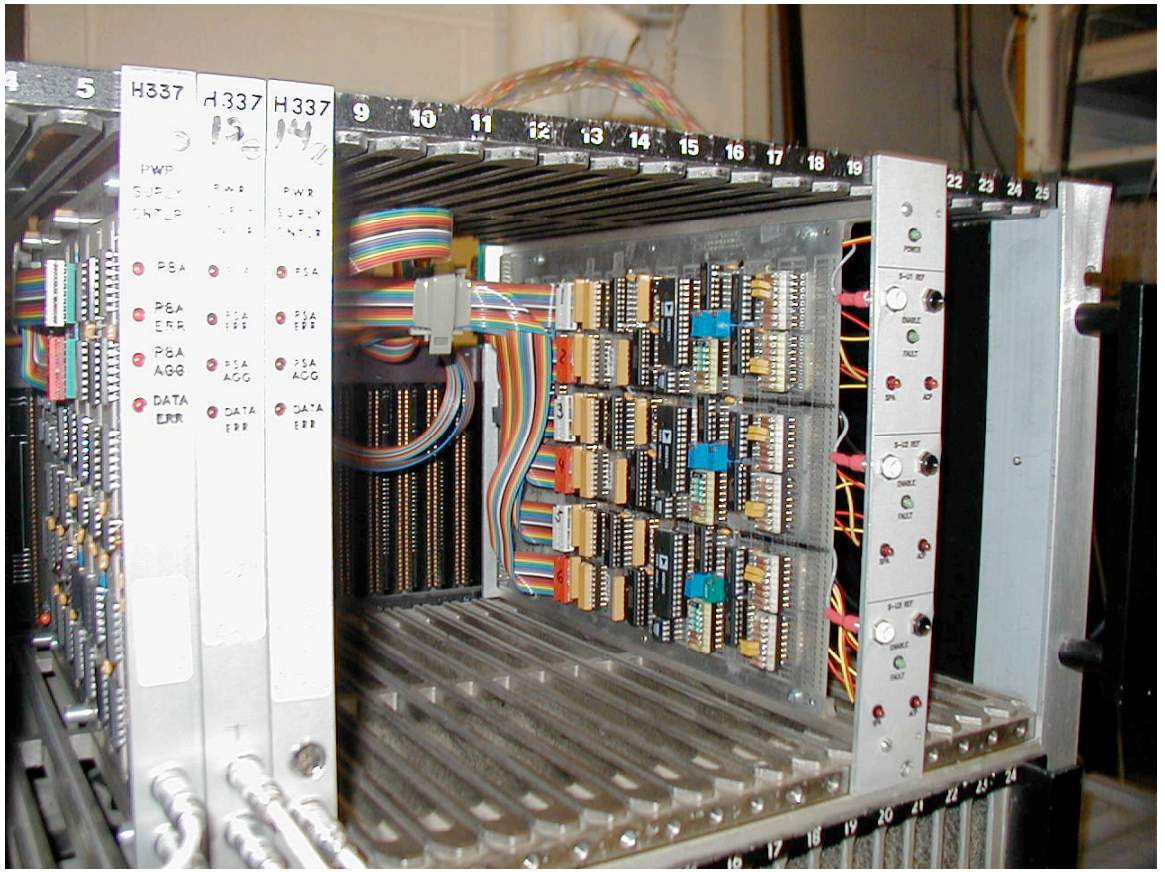
Merlin 9422 16-bit Digitizer w/ FPDP 0.5Gbit/s-3μsec latency (can be daisy chained)
PPPL digitizer (SAD) expected soon

Outputs

- PCLIM output module developed at PPPL interfaces 1Gbit/s FPDP to the Power Conversion Link (PCLink) (34 bit communication protocol developed at PPPL in 1974)
- Split the serial link into 4 parallel links to reduce transmission latency to supplies

SPA Interface Module (SPAIM)

- Module to interface between computer output and SPA completed and tested - driven from Sky computer
- Reuses TFTR and PCLIM control modules for data routing

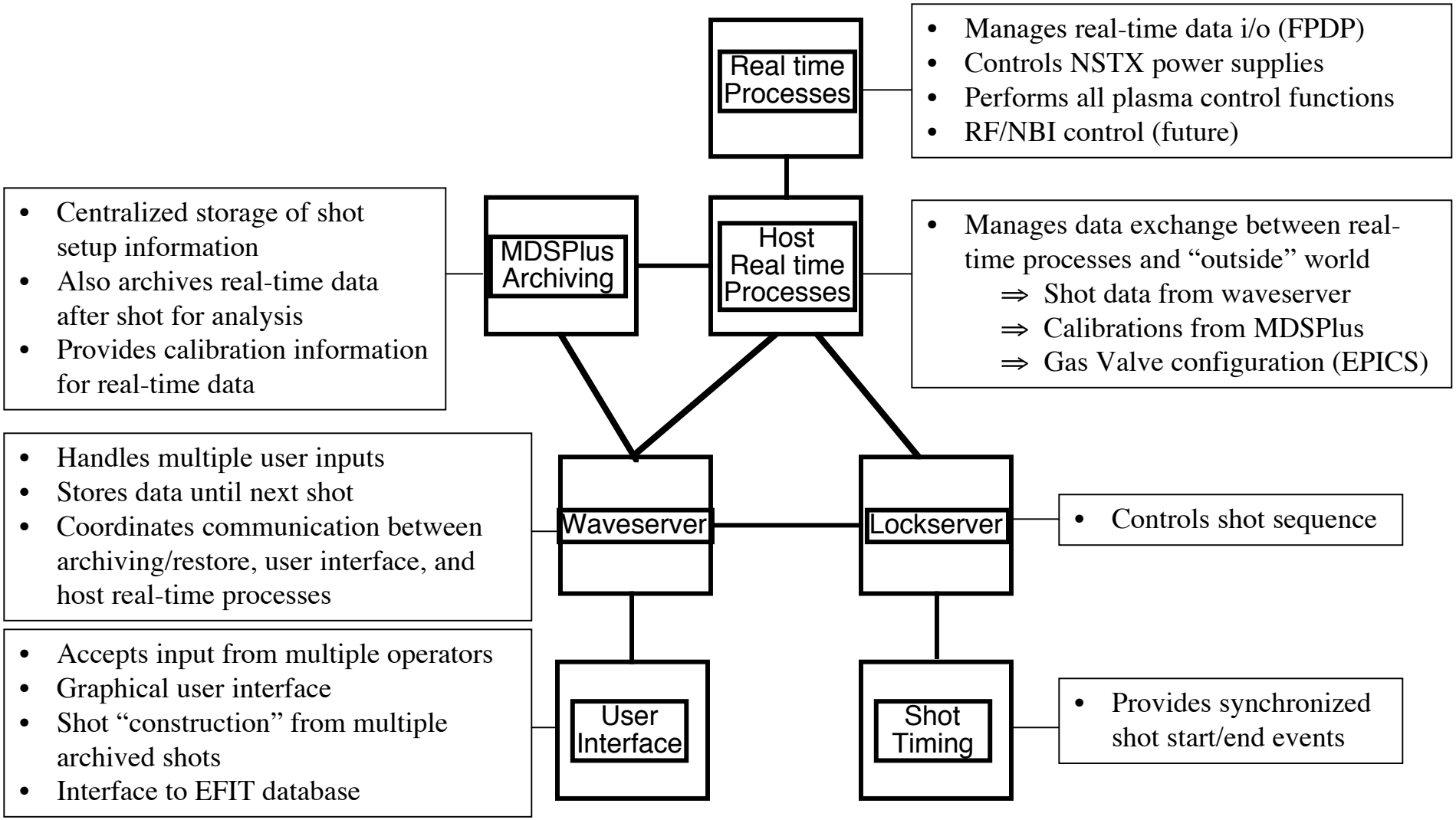


SPA is here, and cables are being run

Hardware tasks

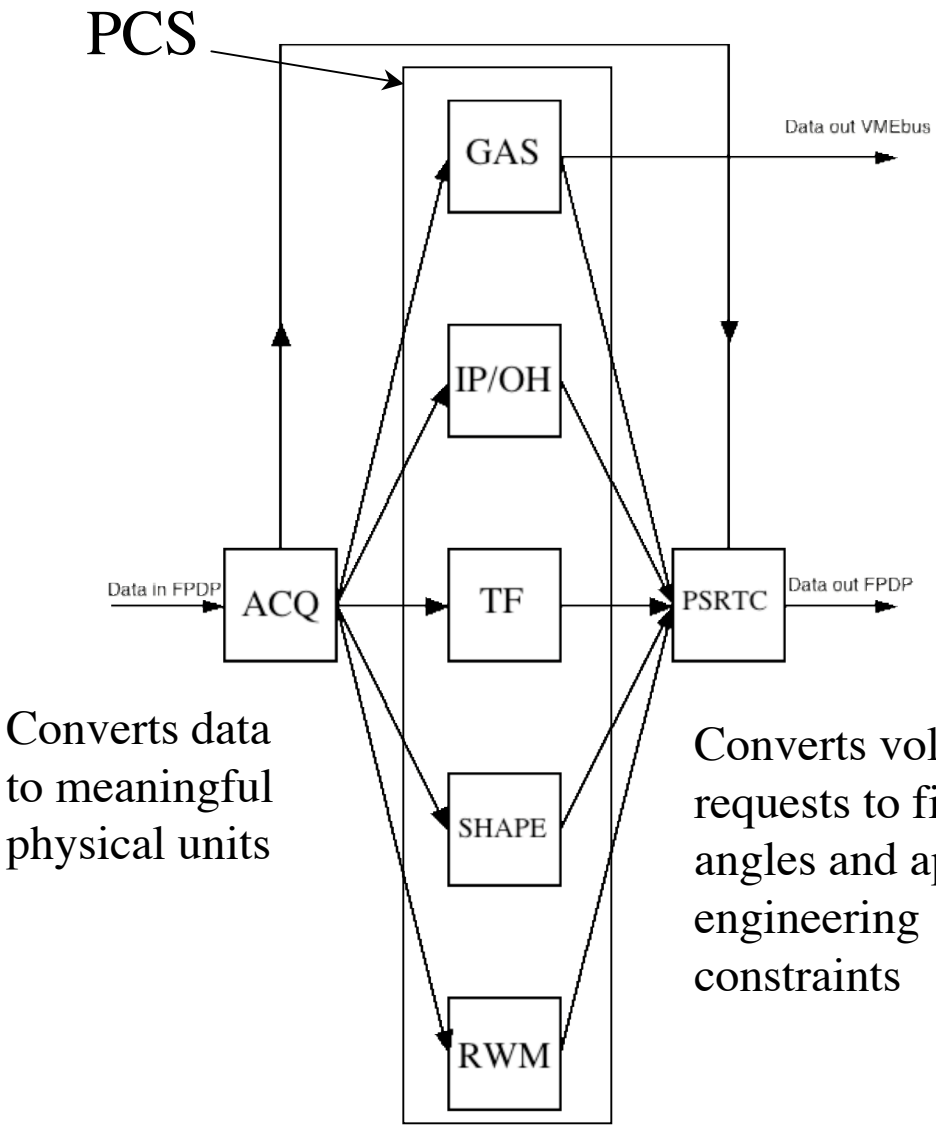
1. Magnetics signal cabling – TBD (Menard/Gates/Marsala)
2. Patch panels - TBD (Menard/Gates/Marsala)
3. Integrator mods – Complete (Lawson)
4. Filter boards – TBD (Lawson/Marsala)
5. New digitizer – First 2 units scheduled to arrive Dec. 17 (Marsala)
6. New Systran modules – Ordered - to arrive in December (Oliaro)
7. SPAIM – Complete (Marsala/Gibney/Rossi)
8. 3rd FIMM – needs deeper FIFO (Marsala)
9. Spa charging signal – TBD (Neumeyer)

Flexible Software Infrastructure



Real time information flow

- NSTX control stream is (nearly) centralized through the PCS via the FPDP data stream
- Addition of new SPA requires modification of the software in the ACQ-RWM-PSRTC branch of control



Software tasks

1. SPAIM driver software – Complete (Gibney)
2. PSRTC mods (for SPA)
    a) 3 new channels in PSRTC – Code runs, requires more testing (Gibney)
    b) SPA charging control requirements – Some progress on specs, mostly TBD (Marsala/Neumeyer)
    c) Software to check SPA mode bit – TBD (Dong/Gibney)
    d) TF*PF interlock software – TBD (Gibney)
3. RWM algorithms
    a) Preprogrammed coil currents – (Ludescher)
    c) Separate algorithm to process sensor data (Menard/Mastrovito)
4. Data acquisition modifications (eq. magnetics, RWM magnetics, RWM processing, SPA currents) – (Mastrovito/Menard/Gates)
5. Update rtEFIT Green's tables and measurements tables – (Gates/Sabbagh)

Potential Issue

- Will additional data channels increase latency? (Yes, but how much?)
  - Solution: Have exit strategy for additional data channels
- Not viable in the long term…

Other priorities

- Several important activities are not (yet) being pursued due to limited resources
  - NBI control/ β feedback
    - Important for steady state
  - Control computer upgrade
    - Important for latency reduction and shape control during current ramp
    - Could become critical if latency increases dramatically with added data channels
  - Density feedback control
    - Awaiting wall conditioning/pumping and a effective controllable gas valve

Other priorities (cont.)

- RWM feedback control algorithms
  - Error field compensation
  - RWM sensor processing
  - RWM feedback
- Thomson scattering (partial kinetic rtEFIT)
- MSE for rtEFIT (needs reliable data)

Summary

- Control upgrades dominated by new SPA related activities
- Good progress has been made towards SPA control
- rtEFIT also will be improved