Controls for RF equipment

AB/CO Review

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Outline

- Controls requirements for LHC RF systems
- Other RF controls issues
  - SPS timing upgrade
  - CPS, LEIR, LINAC, CTF3
- Conclusions and final remarks

LHC RF systems

Power & Low-Level systems for ACS (400 MHz acceleration) and ADT (transverse damper) (starting installation now, commissioning Oct. 2006)

- Low Level systems (VME, total of 61 crates)
  - ACS Cavity control (RF feedback, tuning)
  - ADT Low-Level (transverse feedback)
  - Beam control & RF synchro
  - Fast timing distribution to kickers, dump, experiments (taken over from CO)
  - Function generation via FGCs from AB/PO
- Power systems (Schneider PLCs)
  - ACS: driver amps, klystrons, waveguides, circulators, cavities, cryo interface
  - ADT: driver amps, tetrode power amplifiers & high voltage supplies, kickers
- Diagnostic and instrumentation systems
  - Analogue digitizers (100 kS/s - 100 MS/s) for ACS & ADT power systems (cPCI)
  - Interlock diagnostics, timestamping and Post Mortem (VME)
  - Longitudinal wideband pickups (APW), including fast (8 GS/s) digitizers (cPCI)

We have standardized on AB/CO solutions wherever possible:

- VME + LynxOS + FESA for Low-level systems
- FESA + IEPLC for PLC supervision systems
- cPCI + Linux + FESA + OASIS interfaces for analogue signal diagnostics

LHC RF controls

Hardware testing now in SM18 and 867, commissioning starts Oct 2006
AB/CO deliverables agreed with A. Daneels et al. in September 2003:

- Infrastructure & hardware:
  - in UX45 and SR4: network, timing, remote monitoring & reboot, remote terminal servers, WorldFIP & gateways for FGCs, beam interlocks, safe beam parameters
    - mostly specified but still to be finalised and implemented
  - special Low-Level RF VME crates built by AB/RF, but AB/CO provides the PowerPC CPUs (55 crates)
    - prototypes operational in SM18
  - AB/CO standard VME & cPCI crates + CPUs (6 + 7 crates)
  - timing receiver modules for all the above (CTRP)
- ☺ No problems expected here (with continuing support from CO)

- Front-end software:
  - being developed by AB/RF for all systems under the FESA framework
  - with support & maintenance from AB/CO for:
  - Driver development tools for VME boards (A. Gagnaire, Y, Georgiyevskiy)
  - FESA development for VME systems (M. Arruat, JL. Nougaret)
  - FESA/PLC & IEPLC development for PLC systems (A. Radeva, F. Locci)

LHC RF controls: FESA & IEPLC

- FESA developments so far:
  - ACS Low-Level: tuner system (VME) running in SM18
  - LEIR Beam control (VME) in development
  - ADT power system (PLC) in development
- We have not yet deployed a FESA system on an operational machine, but…
- ☺ From our (limited) experience with FESA we now believe it to be solid and have the required functionality
  - no local control in LHC → **we will rely 100% on FESA even for commissioning**
- ☺ Good contacts & collaboration with AB/CO people
  - how to get help: quickest way is to contact the expert directly
- ☹ BUT: still need better basic documentation for equipment developers!

LHC RF controls: FESA & IEPLC

- ☹ Tools are good for testing by CO developers but not optimized for users:
- input of PLC fields in FESA and IEPLC is laborious and **error-prone**
  - needs an import tool from text file or Excel for example
  - simplified procedure for compilation and deployment of PLC classes?
- configuring a test class with 2 variables is easy; a real class with 250 variables is a different matter
  - Java tools get **very** slow
  - huge scope for error when entering data fields separately in FESA and IEPLC databases

- Automatic synchronisation of FESA and IEPLC configuration DBs should be provided as soon as possible !

LHC RF controls

- Software services
  - Alarms, logging
    - covered by LASER, LHC Logging System
  - Post-mortem
    - extensive facilities built in to the equipment
    - handling at higher level still to be defined
  - Analogue signal monitoring
    - AB/RF will implement OASIS interfaces for equipment
    - AB/CO provides OASIS middle tier + applications
    - many analogue signals will also be used for PM purposes
- Application software
  - Software for operation
    - state control, sequencing, settings management, fixed displays (built on LSA)
    - applications and middle tier software are AB/OP and AB/CO responsibility
  - AB/CO support for development of specialist application software
    - LabView has been extensively used in RF for rapid development of specialist control and test applications
    - Java for key specialist applications in the longer term

Other RF developments 2005-2007

- SPS
  - Timing upgrade in Faraday Cage & BA2 (startup 2006)
- CPS
  - Transverse dampers (April 2006)
- LEIR
  - Power & Low-Level systems (commissioning now)
- LINAC RF
  - Digital Low-Level cavity control (testing now)
  - Test stand 3MeV (commissioning start 2008)
- CTF3
  - Combiner ring & transfer lines (2006, 2007)

SPS: Timing upgrade (Urs Wehrle)

- For startup 2006:
- Removal of TG3 modules
  - replacement with CTRVs
- Hardware installation currently being prepared
  - 7 VME crates + CTRVs + specific interface HW + cabling
- Software:
  - private database with ~300 local timings + archives
  - accessed via a specialist Java application
  - used both by RF specialists and OP
- need AB/CO support for
  - migrating timings from AB/RF timing database into FESA
  - configuring new timings (until now done by RF specialists)
  - training RF specialist users to use Knobs, Working Sets, PPM Archives etc.

CPS: Transverse Dampers (A. Blas)

- Commissioning foreseen for April 2006

- Damper power system (L. Arnaudon)
  - Schneider PLC + FESA (developed by AB/RF)
  - will need AB/CO support for integration into PS control environment

- Low-Level systems
  - Analogue feedback
    - requires some standard CO hardware: GFAS, IOR, NAOS
  - Digital feedback
    - based on LHC hardware (VME)
    - 1 or 2 RF-special VME crates with CPUs + timing receivers
    - FESA front-end software (AB/RF responsibility)

LEIR

- Commissioning now

- RF power system (PLC Schneider) (P. Maesen)
  - remote interface with GM + IEPLC for subset of control functionality (currently working)
  - full control functionality available via local console
  - migrate to FESA soon (?)

- Low-Level/Beam Control (VME) (M-E. Angoletta)
  - new all-digital system based on DSP hardware from BNL (now being tested in PSB)
    - (“backup” analog system currently being used for LEIR commissioning)
  - many control system components emulated inside the DSP software
    - “soft timings”, “soft GFAS”, “soft OASIS”

LEIR

- Software for Beam Control
  - VME board driver developed by CO/FC
  - FESA equipment software being developed in AB/RF
  - GUI application for operation being developed in CO/AP using ISOLDE-style synoptics
    - AB/CO must assure the long-term maintenance of the synoptic editor (imminent retirement of the author)
    - maintenance of the application itself (AB/CO or AB/OP)
  - LSA application software
    - need support for GFAS “internal stop” in Trim package (end Oct. 2005)

LINAC RF (M. Vretenar)

- New digital Low-Level controller (testing now for LINAC3) (J. Broere)
  - FPGA-based board developed in collaboration between AB/CO and AB/RF
  - Front-end software implemented in GM (I. Kozsar)
    - Further development and migration to FESA underway
  - GUI application written in Java (I. Kozsar)

- PLCs: issues for remote Linac operation from CCC (startup 2006)
  1. Provide a backup/restore facility for the PLC configuration data for use by the operator in case of a hard reset of the PLCs
  2. Support needed for improvements to Excel / Visual Basic / OPC tools used for settings management and diagnostics

- 3 MeV beam test stand (beam operation at start of 2008) (C. Rossi, CO linkman J. Serrano)
  - Ion source, RF amplifiers/cavities, klystrons (LHC-type controls), RFQ & diagnostics, magnetic line power converters…, all requiring full CO interfaces (should already be in AB/CO work plan)

CTF3 (Frank Tecker, CO linkman: Stephane Deghaye)

- Controls support for future extensions of CTF3
  - Combiner Ring & transfer line (2006)
  - Photoinjector (2007)
  - mostly standard CO equipments
  - also rely on AB/CO for development of drivers for non-standard equipments

- Some specific hardware issues
  - stepping motor support (already ongoing)
    - new PLC based interface
  - magnet protection interlocks (for new magnets in the transfer line extension and Combiner Ring)
    - in future all magnet interlocks will be taken over by AB/CO

Conclusions and final remarks

- LHC: the controls architecture for RF equipment is well-defined
  - we believe AB/CO services cover our requirements
  - we are fully reliant on AB/CO support
  - FESA & PLC tools need streamlining. Reliability is essential.
  - some areas remain to be defined technically, and from a responsibility point of view: e.g. Post Mortem
- Injector chain: SPS timing upgrade is the most critical issue
  - migration of timings to new FESA system + subsequent learning curve
- LHC is our biggest project but many other developments in the next 2 years also require significant input from AB/CO, and existing systems have to be supported
  - We are in favour of the idea of controls link persons for specific ongoing projects (as in CTF3 and SPL) as an efficient way of maintaining communication between CO and equipment groups