The Upgrade Programme for the ESRF Accelerator Control System

• The ESRF Upgrade Programme
• The X-Ray Source Improvements
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• Conclusion
The ESRF Upgrade Programme

• In 2008, the Council of the ESRF launched the ESRF Upgrade Programme 2009 - 2018
• Funding for a first phase of the Upgrade (2009 to 2015) has been secured to deliver:
  • Eight new long beamlines, mainly with nano-focus
  • Refurbishment of many existing beamlines to maintain them at world-class level
  • Continued leadership for X-ray beam availability, stability and brilliance
  • Major new developments in synchrotron radiation instrumentation
The ESRF Upgrade Programme

• Construction works for the experimental hall extension will start in November 2011
The X-Ray Source Improvements

- **BPMs and Fast Orbit Feedback**
  - Beam position monitoring system replaced at the end of 2009 with 224 Libera measurement systems
  - Exchanged all 96 steerer power supplies in 2010
  - Installed a fast and redundant communication network
  - 8 FPGAs to calculate corrections at a 10KHz rate
The X-Ray Source Improvements

• **BPMs and Fast Orbit Feedback**
  • Currently under commissioning
  • Should be operational at the end of 2011
  • **Improves the beam stability for nano-focus beamlines**

• **MOPKS010 : Fast Orbit Correction for the ESRF Storage Ring**
• **MOPKS014 : Architecture and Control of the Fast Orbit Correction for the ESRF Storage Ring**
The X-Ray Source Improvements

• **Ultra-Small Vertical Emittance**
  - High precision Libera beam position monitors
  - New algorithm for coupling correction for the storage ring
  - A vertical emittance of $\varepsilon_z = 4.4 \pm 0.7$ pm could be reached

• 32 new skew quadrupole magnets have been installed (2011)
  - Correct the coupling induced by insertion device movements
• The goal is an ultra small vertical emittance of $\varepsilon_z = 2$ pm.
• First tests are promising
• **Increase brilliance and reduce divergence**
The X-Ray Source Improvements

- **6 or 7m Straight Sections**
  - Today 5m straight sections with family wise power supply steering
  - Power supplies need to be controlled individually
  - The beam steering algorithms had to be revised
The X-Ray Source Improvements

- **6 or 7m Straight Sections**
  - 4 insertion device segments instead of 3
  - Canted undulator approach
    - 2 insertion device segments per beamline
  - Insertion device flexibility or higher brilliance
The X-Ray Source Improvements

- High Power Solid State Radio Frequency (RF) Amplifiers
  - The RF system is the sub-system with the highest failure rate
  - Replacement of the klystron based RF transmitters with solid state RF amplifiers
    - High redundancy, less power consumption, less tuning effort
    - Installation of the first amplifier is in progress
  - Operation reliability
Control System Upgrade

• Move to a Tango-only Control System
  • Taco developed in the 1990
  • Tango is a collaborative development
    • More features
    • More development and survey tools
  • 2010 still 45% of Taco devices
  • Software redesign of large sub-systems
    • Vacuum, front-ends, insertion devices
      • Long shutdown period from December 2011 until May 2012
  • Reach 80% of Tango devices in 2012
  • Easier maintenance and higher reliability
Control System Upgrade

• Increase the Reliability
  • Tango administration system
    • Overview of all device servers running on control system hosts
    • Configuration and optimization tools
    • Failure statistics to identify infrequently occurring software crashes
  • WEPKN002 : Tango Control System Management Tool

• Survey of all control computers with NAGIOS
  • Detection of CPU, memory or disk problems
Control System Upgrade

• More high-level analysis tools
  • Allow better diagnostics or prediction of problems on the accelerator complex
  • An example is the vacuum leak detection system
    • Based on the residual gas analysers (RGA) installed on the storage ring
    • Detect air leaks, water leaks and any abnormal out-gaging
    • GUI enables the handling of all RGAs around the storage ring
    • Provides complex alarm configuration
    • Online and post-mortem data analysis.
Control System Upgrade

Vacuum leak detection GUI

Air leak footprint:
Masses 14, 28 and 40 (N, N2, and Ar)
Conclusion

• Conducting the upgrade in parallel to full user operation and maintaining the high stability and reliability of the X-ray source is very demanding
• The challenge is to restart the accelerator complex, after 5 month of shutdown, with the same reliability
• All the different modifications and improvements on the X-ray source as well as on the control system will hopefully lead to a successful implementation of the new beamlines.