

A Light for Science



European Synchrotron Radiation Facility

# The Upgrade Programme for the ESRF Accelerator Control System

- The ESRF Upgrade Programme
- The X-Ray Source Improvements
- The Control System Upgrade
- Conclusion

# The ESRF Upgrade Programme

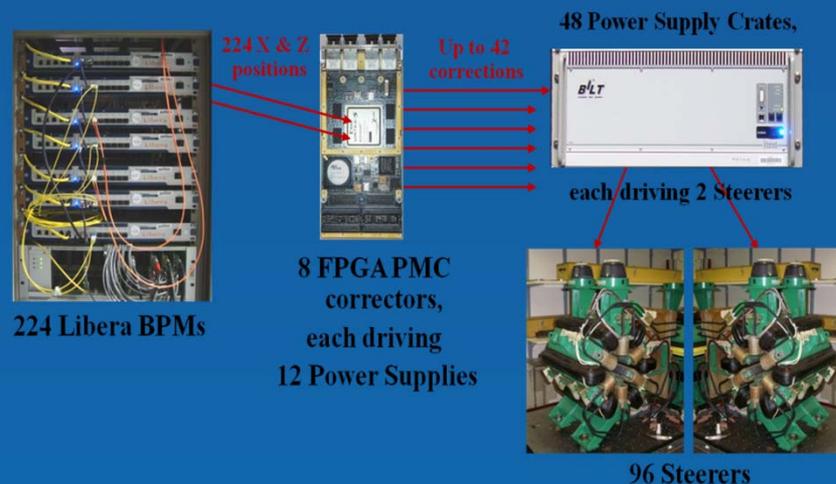
- In 2008, the Council of the ESRF launched the ESRF Upgrade Programme 2009 - 2018
- Funding for a first phase of the Upgrade (2009 to 2015) has been secured to deliver:
  - Eight new long beamlines, mainly with nano-focus
  - Refurbishment of many existing beamlines to maintain them at world-class level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



# The 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

Steering magnets power supplies → 10kHz data flow



# The X-Ray Source Improvements

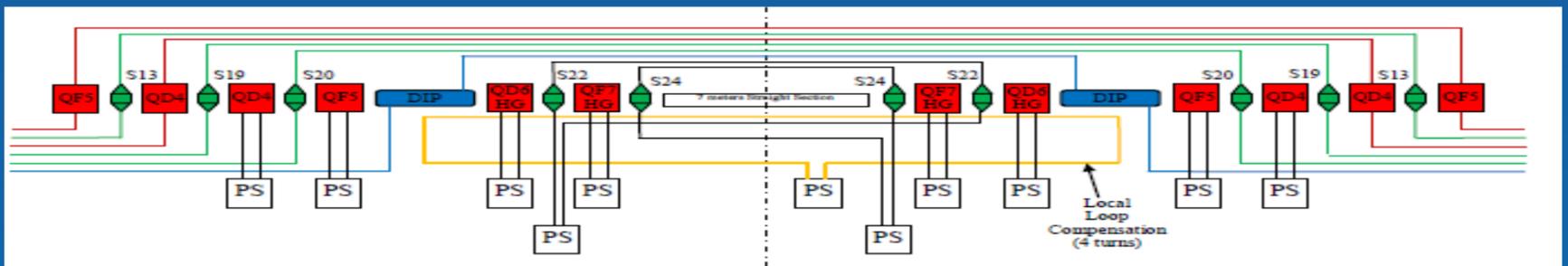
- *BPMs and Fast Orbit Feedback*
  - Currently under commissioning
  - Should be operational at the end of 2011
  - **Improves the beam stability for nano-focus beamlines**
- *MOPKS010 : Fast Orbit Correction for the ESRF Storage Ring*
- *MOPKS014 : Architecture and Control of the Fast Orbit Correction 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**

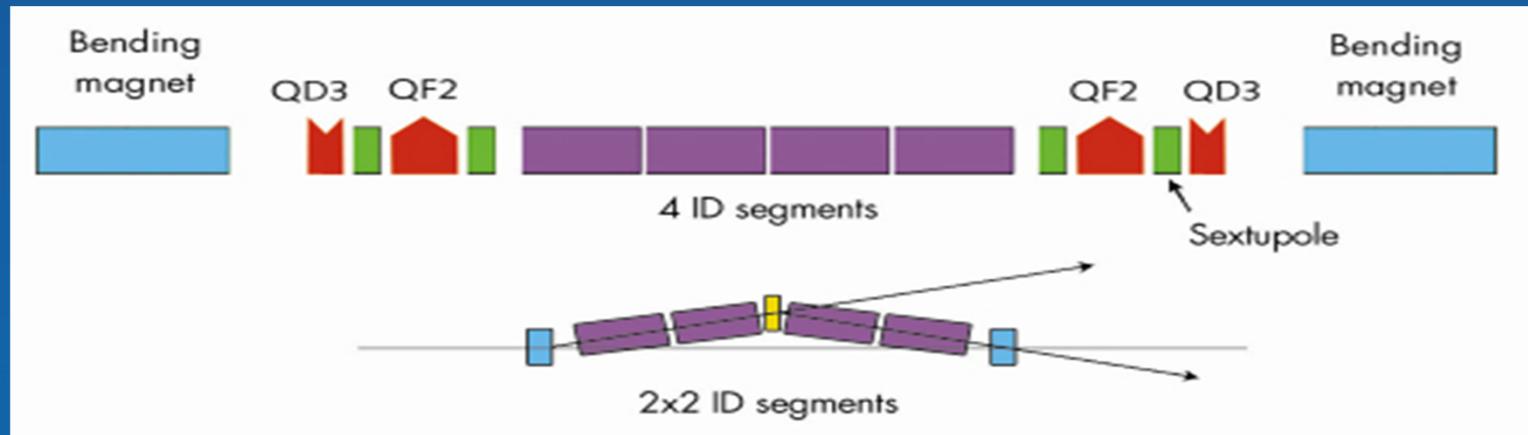
# The X-Ray Source Improvements

- *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*



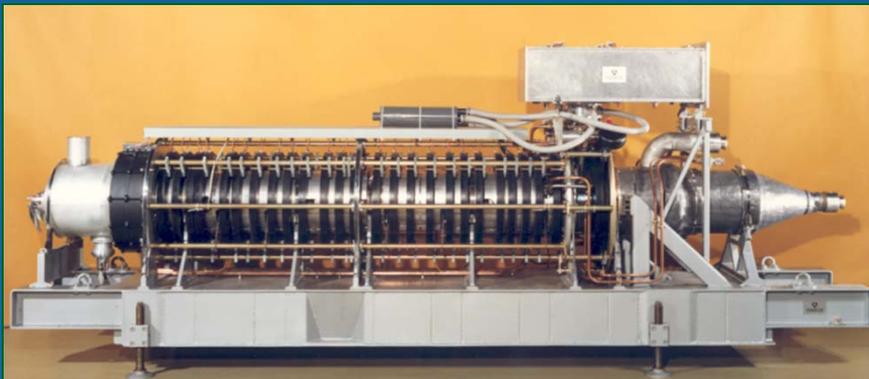
# The X-Ray Source Improvements

- *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**

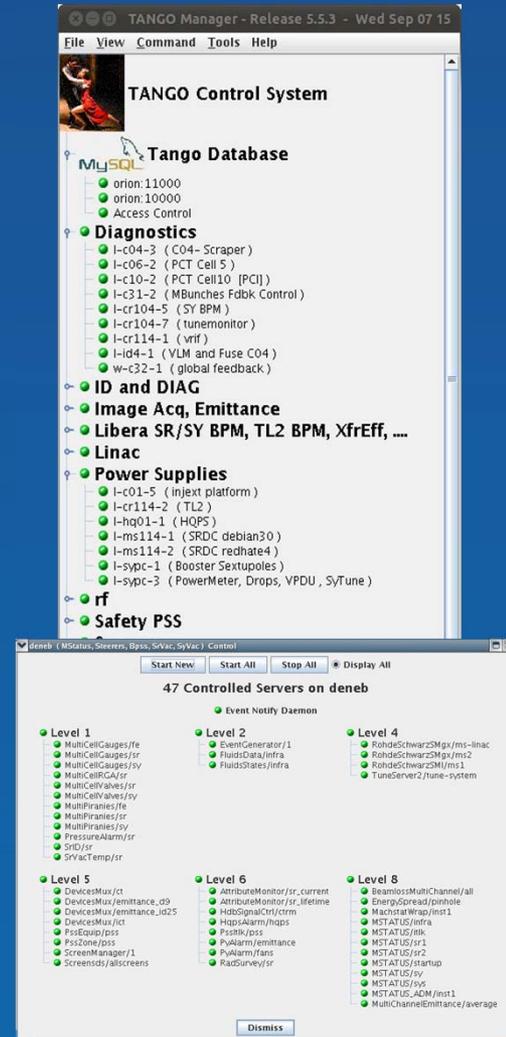


# Control System Upgrade

- 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

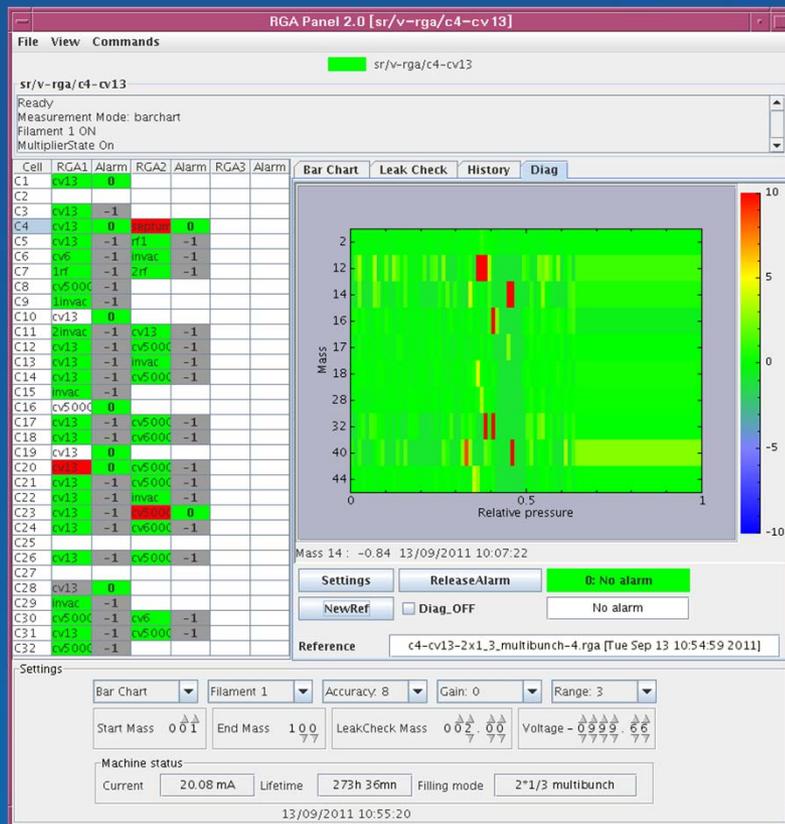


# Control System Upgrade

- 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-gazing
    - GUI enables the handling of all RGAs around the storage ring
    - Provides complex alarm configuration
    - Online and post-mortem data analysis.

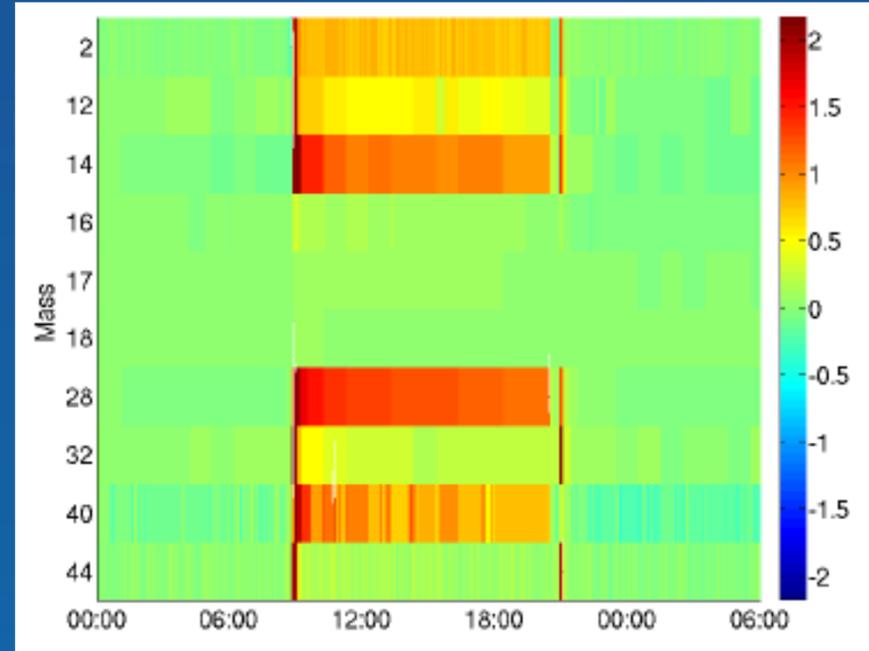
# Control System Upgrade

## Vacuum leak detection GUI



## Air leak footprint:

Masses 14, 28 and 40 (N, N<sub>2</sub>, 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.