LHC RF Meeting

22nd December 2006

Participants: Luca Arnaudon, Olivier Brunner, Andy Butterworth, Edmond Ciapala, Wolfgang Hofle, Trevor Linnecar, Pierre Maesen, John Molendijk, Eric Montesinos, Elena Shaposhnikova, Frode Weierud.

1. ADT (Eric/Wolfgang)

Eric presented some **pictures** of the amplifiers and of the ADT installation in UX45:

- **Amplifiers:** A first batch of four amplifiers has been fully tested. The total number to be tested is 20. We have resistors and flexible water hoses for 4 amplifiers. The series will be retro-fitted early next year, with final B867 testing in March 2007. Testing in the machine is tentatively planned for September.
- **Supports in RUX45:** The amplifier supports have been put in place by the Russian team. Space is adequate and there were no difficulties with the floor height. A ramp on the floor allows the amplifiers to be easily slid into place.
- **Documentation:** A large number of drawings have been updated and will be put in EDMS.

2. UX45/RUX45/SR4 installation/commissioning (Olivier et al.)

Olivier presented some **pictures**:

- **SR4 Flexwell cables:** The very large 1⅝ inch Flexwell cables from the APWs have been very badly connected to the patch panels, with some connector screw threads crossed. The connectors will need to be changed and the cables properly aligned and re-fitted.
- **ADT cables:** Some ⅜ cables in RUX45 have been found broken near their connectors, probably due to careless handling when being moved out of the way for other work. Fortunately they can be easily repaired.
- **ACS Antenna and HOM cables in RUX45:** Connectors are now nearly all fitted and the cables connected to the modules. The work has been done by our FSU team. It should be fully completed early next year.
- **Earth connections - UX45 to tunnel:** The work is progressing (TS-EL) and should be finished in January.
- **Water cooling systems:** This is now being organized with the help of S. Grillot. We are in the process of preparing for the static pressure test, which we expect to be done in January. Some minor modifications will be needed – some bunker connections will be changed and some new pressure sensors are to be replaced with sensors able to take 24 bar. (TS-CV). This work is now urgent.
- **Control system:** Testing of the ACS control systems is well advanced and we are already nearing completion of the first test phase, as defined in the hardware commissioning schedule. The main job at present is testing of the interlock systems; this is now about 80 % complete. The network is now fully operational and use of portable PCs with wireless links has been found very useful during these tests. The access system interface hardware has also been tested successfully, including that for the doors to the UX45 upper levels.
- **ACS Power Converters:** The new controls interface has been tested in SM18. All SR4 converters have had the new control crates installed by AB-PO. They are currently checking the converters. In the meantime the HV cables to the surface and the bunker connections are being re-checked using a low current HV supply at 60 kV. We expect to be able to put 10 kV on the klystrons in early March; this will depend however on completion and test of all water cooling systems.

The question was raised about safety once remote access is possible. On one hand the PLC software allows access from only one source at a time. However for safety, since all equipment can be driven by the CCC using automatic sequences, it is essential that precautions are taken before any intervention on HV or other electrical equipment. For the HV power converters the MCBs must be blocked by the hardwired interlock of the local emergency stop and an earthing short put in place in the bunker before any intervention on the klystrons, bunker equipment, HV cables or junction boxes.

- **Tentative installation schedule for early 2007 -** Some main points:
  - Finishing of all flexwell connections to ACS modules and klystrons by mid-February.
  - Installation of warm recovery He heaters near ACS from 3rd week in January to end of February.
  - Ongoing vacuum chamber installation in LSS4, starting from outside, finishing at IP with ACS module interconnects, then bakeout in sector 4-5 by end of February.

3. SR4

- **Control Area Enclosure:** This has now been put in place. We will obtain an estimate for a roof.

4. ACS Couplers and SM18

- **Couplers 132 and 133:** Conditioning is now finished in SA2. A vacuum leak occurred (probably during transport) on a vacuum gauge flange. This was repaired and there is no risk of pollution of the couplers.
- **Couplers 131 and 134:** Both are ready to be fitted to the test cavity, probably during the first working week of 2007.
- **Module 4 *(Europa):*** Now completed. The cryo test (He levels) is planned for January, after the LLRF tests (see below). Couplers will be fitted as soon as MC131 and 134 have finished conditioning the module will be power tested in the bunker.

Single cavity module LHC21: Klystron tests were completed, the waveguide short taken out and LLRF tests (Conditioning Module) started – see below.

5. LLRF/Controls/Software

- **Conditioning DDS module test:** John showed the **GUI** (Graphical User Interface) for the conditioning control application. He presented the various modes of operation of the system and outlined results achieved in the recent first short testing period.

The control of the dual DDS and the fast control logic for the conditioning RF/vacuum loops follow very closely the principles developed by Eric in SM18 and SA2 to provide the most efficient and safe conditioning for both coupler and cavity. In the new DDS, RF amplitudes and slow and fast modulation sweeps can be remotely programmed. The new conditioning loop is implemented in a separate CPLD, designed to be fail-safe. Vacuum loop parameters, offset, gain and vacuum limit are available via the VME interface. Pulses are generated in the FPGA, pulse length, and pulse train envelope parameters (length, rise/fall times) can also be set as required over VME. In operation the system parameters are slowly changed in an optimum way as conditioning progresses, again following the SM18 experience. This part of the control is done by 'front-end' software residing in the VME CPU of the cavity controller, using FESA together with the appropriate drivers to access the hardware. An important feature is the logging of RF and vacuum. RF power is buffered in the tuner front end and the average taken over the length of each pulse. Vacuum is measured each 20 ms, the period between pulses. Both short term and long term history plots of power and vacuum are displayed on the GUI. The control application has been done in LabView (the basis for the large part of our specialist software) making use of the LabView / FESA interface developed in the group.

Thanks to careful design and thorough testing in the lab no major problems were encountered in setting up the hardware or the software in SM18, nor in starting tests and operating with the real cavity. The system was also left running for two overnight periods, the first ended after 3 hours with a FESA problem (to be investigated). The second ran continuously overnight. Tests will continue next year and will include tuning during cavity conditioning.

The project makes use a number of key RF, controls and software elements to be used for the LHC LLRF system and the results are very encouraging.

6. AoB

- A highly successful year in all LHC RF work was rounded off with a glass of champagne.

Next Meeting: Friday **19th January** at 08:45 in the JBA room.

E. Ciapala, 10th January 2007.