# LHC RF Meeting
14th May 2004

**Present:** Luca Arnaudon, Philippe Baudrenghien, Olivier Brunner, Edmond Ciapala, Trevor Linnecar, Eric Montesinos, Roberto Losito, Joachim Tückmantel, Daniel Valuch.

**1) Low Level RF** (Philippe) Before describing the ACS RF feedback module Philippe presented the present overall status of the development program of the LHC Low Level RF and the equipment to be tested in SM18.

**2) RF feedback module for ACS** (Philippe)

- **Description:** Philippe presented the overall block diagrams of the RF feedback systems (Cavity controller Crate 1). The RF feedback is in two parallel parts, analog and digital, both based on IQ demodulation and modulation. The analog part is normally ac coupled and does not act on the fundamental but on revolution frequency harmonics up to 500 kHz on either side of the fundamental. The open loop gain at the first revolution sideband is 23 dB. The digital part acts only on the fundamental to provide precise RF voltage control, with an open loop gain of 43 dB. Integration is avoided in the digital filter, to avoid saturation on step inputs; instead there is a digital low pass filter and the gain element is an analog amplifier after D/A conversion. The Analog part can be used on its own by by-passing the ac coupling capacitors (on the board); this is foreseen for the tests in SM18. The dc open-loop gain is 130 in this case.
- **Layout:** There are two identical RF feedback modules, one for I and one for Q, each with the analog and digital paths. The analog demodulator is a separate module, already operational. The I or Q data for the digital loop on each module comes from the set point module over fast LVDS links (40 Ms/s 16 bit) on the crate backplane. The digital output signals are converted to analog and summed, on the module, with the analog I or Q loop outputs. The RF modulator is again a separate module. A digital input is provided to the digital loop for the injection of compensating signals to minimize klystron power transients over the revolution period.
- **Polar Loop:** The analog system cannot handle the wide variation in klystron output phase over its operating range. For this reason there is a separate digital loop around the klystron. This compares signals from the klystron output, using an IQ demodulator identical to that on the tuner front end module, with klystron input taken by digitizing the analog I and Q signals to the RF modulator. Both gain and phase shift are compensated. For the klystrons measured so far the gain drops by 5 dB and the phase drifts by 25 degrees when the CW output power is raised from 200 kW to 300 kW. The loop is also intended to provide reduction in phase ripple from the klystron power converter. Our target is a reduction of 60 dB from DC to 600 Hz (12 times 50 Hz).
- **Status and planned testing:** First tests will be done on the analog loop. It is expected that this could be towards the end of June or the beginning of July. The other required modules, i.e. clock generation and clock distribution have now been received and are under test. Test of the digital loop would require the set point generation module, still to be designed. It is also preferred to proceed first with tests on the digital IQ demodulator in the tuner front end, on a 'real' cavity system in SM18.

**3) SA2 and ACS couplers** (Eric)

- **New klystron:** Congratulations were given to everyone who participated in the successful 'crash program' to install the LHC klystron. Installing the klystron and all other equipment gave valuable experience for the future and also permitted a thorough 'overhaul' of the installation.
- **Conditioning:** The present set of couplers (107 & 108) has quickly reached 100 kW cw. It is estimated that it will take 1 to 2 weeks to reach 300 kW cw. The power reached before the klystron replacement was 200 kW cw. Some calibration of the klystron current is still needed.
- **Couplers:** The polarization ceramic for coupler 110 is delayed. However a batch of six ceramics is now in preparation.

**4) SM18** (Roberto)

- **Bunker & Waveguides:** The waveguide switch modifications were completed successfully and rapidly, thanks to the efforts of Eric and Olivier's teams. The height of the supports will need to be adjusted. (The bunker doors were already completed last week).
- **Module installation:** Following the above point the question of installation in LHC was raised and a reminder of the need to establish the procedure with the alignment specialists.

**(Action: Ed, Pierre)**

- **Cycling:** Module 2 cycling started last week; it is expected to take until mid-June when a decision will be made on putting module 3 back or starting with module 1 conditioning.

**5) Klystron and circulator acceptance** (Olivier)

- **Klystron 9**, returned to the manufacturer has been checked by them. They acknowledge that the blockage of the cooling around the first cavity occurred during manufacture and was probably not noticed due to use of higher water pressure.
- **Circulator/Loads**: Number eight has been tested. The work has been speeded up thanks to Daniel's installation of motorized movement of the sliding short used to vary the phase of circulator output port reflected power. The circulator temperature compensation unit (TCU) needed setting up.

**6) ADT (**Little news due to absence of Wolfgang)

- **Drive Amplifiers:** The controls interface was checked and anomalies with respect to the specification were noted and communicated to the manufacturer. The main problem is the requested pulsed operation of DC ON/OFF, which has been implemented simply as a rising edge transition. This is being followed up with the manufacturer. Tests will also be done to see if the present situation would be acceptable. **(Action: Ed, Luca)**

**7) UX45 Layout and Cooling and Ventilation: (Volker)**

- Following presentation of the ECR LHC-LJA4-EC-001 in the TCR, the cost impact of our modified layout on cooling and ventilation has been estimated by TS-CV and included in the ECR. The figure, 500 kCHF, seems excessive since the only new additions are the Faraday cages, which only need chilled water. The cost breakdown should be analyzed with TS-CV.

**(Action: Volker)**

**8) SR4**

- Work is ongoing to have a final layout for SR4. Exact rack requirements have been re-estimated. The size and construction of the control room should now be agreed.

**(Action: J-C Perrier, with Volker, Philippe and Wolfgang)**

**9) Commissioning** (Olivier)

- The testing equipment and infrastructure as far as possible before powering has now been introduced into the commissioning planning. An updated commissioning planning document has been circulated by Olivier for comments. **(Action All)**

**10) Equipment Layout and Naming** (Volker)

- The layout diagram **LHCLJ4GAQ0007** showing the RUX45 equipment with installation and operation names is now in CDD. However details of the naming convention still need to be cleared up. **(Action: Ed, Volker)**

**Next Meeting:** Friday 28th May 2004 at 08:45 in the JB Adams Room 864-2-B14.

E. Ciapala, 24th May 2004.