# LHC RF Meeting 10<sup>th</sup> December 2004

**Present:** Luca Arnaudon, Philippe Baudrenghien, Olivier Brunner, Andy Butterworth, Edmond Ciapala, Wolfgang Höfle, Trevor Linnecar, Pierre Maesen, Jean-Claude Perrier, Joachim Tückmantel, Daniel Valuch, FrodeWeierud.

#### 1. ACS Modules and SM18 (Pierre)

• Module 5: Cycling has finished, measurements will be done in January, after Cryo start-up in SM18.

• **Module 3:** Has had its couplers removed (see below) and been fitted with couplers MC111, 112, 114 and 115 in the clean room. The module will now be leak-tested.

• **352 MHz:** The Soleil module has been conditioned to 60kW on both couplers. The work has successfully followed the tight planning.

#### 2. ACS Couplers (News from Eric)

• **Module 3 Couplers:** The couplers removed from this module have been inspected. The damage to the ceramic of coupler MC101 (ex-cavity A), which had suffered the arcing, is not too serious at first sight. This coupler will now be power tested in its present condition in SA2. The couplers of cavities B and D (MC102 and 103) are in good condition; there is only some slight discolouration on the antenna of MC103, probably caused by heating. The antenna of coupler MC104 (ex-cavity C) shows some small spots on its antenna, probably due to small arcs. The history of conditioning of Cavity C should therefore be checked. The antenna of MC104 will be fitted to MC101 for the SA2 power test.

• **SA2 Conditioning:** Couplers MC116 and 117 have reached 200 kW pulsed after one week; the progress has been good.

• **Planning:** Couplers MC116 and 117, together with MC102 and 103 (to be renamed 118 and 119) will be used for module 5, which will follow module 3. All ceramics, main window and polarization, have been delivered.

## 3. ACS Power (Olivier)

• **Klystrons:** Klystrons 13 and 14 will be tested by mid-January. Klystron 1 (tuning mechanism on one cavity blocked) will be returned to Thales.

• Noise measurements in SM18 (Daniel/Olivier): Tests with the reduced value divider and no tetrode have been continued in SM18. The power was taken to 250 kW. The ripple on the RF power is about 1 % (mostly 50 Hz).

• **Discussions with AB-PO on ripple:** Less than 1 % pp voltage ripple is difficult to achieve on the klystron power converter. It is roughly what we have in SM18. Some LEP converters were worse. Nevertheless it should be possible to get all the LHC converters to the performance of SM18 supply. Noise and ripple measurement are difficult in SM18. Floating measurements and measurements with respect to common ground are different. Active filtering schemes, similar to the compensating system presented by Daniel last week, are an option to get improved performance. This will be followed up with A. Beuret, R. Genand and F. Bordry (AB-PO).

## 4. Noise specs for ACS (Trevor)

• **SPS experience:** If the LHC beam is maintained at 26 GeV injection in the SPS, there is a decay of about 2 % per 10 seconds, for the first bunch. There is an additional effect whereby the trailing bunches suffer faster decay, increasingly with their position. The amplitude of last bunch decays to roughly one half that of the first bunch after 30 minutes. The spectra of the individual bunches show some features; there is a 'hole' at around 395 Hz, with a peak at twice that frequency. The frequencies change with the voltage. It is not clear to what extent these effects can be attributed to RF noise, but clearly this performance would not be acceptable in LHC.

• **Ppbar experience and scaling to LHC:** Lifetimes of 100 hours were obtained for pp bar in SPS. The intensity was low, so lifetime was mainly influenced by noise. Scaled to LHC the corresponding level of phase noise around the synchrotron frequency would be  $0.5E-8 \text{ rad}/\sqrt{\text{Hz}}$ . Klystron theory predicts around 10 ° per % voltage ripple. (8.4 ° per % for LHC klystron H. Frischholz's write-up). We have 400 V ripple on 54 kV, i.e. 0.7 %, giving 6-7 °, which we have actually measured. To get to the scaled level of noise needed for 100 hours lifetime we need a factor of 10,000 better. With all feedback systems working at maximum - klystron loop giving 100x, RF feedback 10x and 1-turn feedback 10x, this is just made. The situation is therefore not impossible, but we need to take as many measures as possible to reduce the source of the ripple. These include the already proposed ideas:

- Bigger capacitor
- Lower resistors
- Power supply improvements, as far as possible
- DC supply for tetrode heater
- Suppression of tetrode?
- Compensation systems (See above)

## 5. Coaxial Cables (Wolfgang & Jean-Claude)

• The quantities of flexwell cables and types are now defined exactly. Including the request from AB-BDI there are 500 cables and a total length of 900 km. A larger number than originally expected have to be phase compensated. These cables are US manufactured, but the overall contribution to the cost should not exceed the required fraction for non-member state origin. There will be a discussion with prospective suppliers on  $17^{th}$  December.

#### 6. ADT (Wolfgang)

• Grid supplies: All Ig1 and Ig2, have been delivered and will be tested soon.

• Dubna The specific resistivity in the cooling circuit for the amplifier has now been brought up to 4 MOhms/m, within the required specs for the tetrodes.

## 7. UX45 Integration and Installation (Olivier)

• He safety and vent lines: A meeting with cryo and installation specialists was held on 6<sup>th</sup> December. Routing of 200mm safety release lines from each of the SC modules is possible by slightly changing the design of the tunnel wall in horizontally extending certain waveguide holes. This can be done as a last-minute change before the wall is built. Other passages to allow the 70mm returns to the UX45 vent line would have to be drilled later. extending . A collector could be installed for these return lines in between the tunnel and shielding walls, with a single return to the vent line following the path of the QRL. Further discussion on the cryo layout will follow as there will be a special session on IR4 cryo system at the coming LHC Performance Workshop.

• **RF zone – radiation and shielding:** This will be followed up with TS-RP early in 2005, with input from the responsibles in LEP. (Action: Olivier/Ed)

#### 8. LLRF

• **Injection:** There will be meeting with J. Lewis to discuss injection and the implications of 'online' changes in the filling sequence in the event of rejected batches.

• Fibre links: A sample of the 3 GHz module we intend to put on a special VME transmission module will be delivered next week.

• LHC Ions in SPS: The present recapture system will not be suitable for LHC beam and a new system will have to be designed. We have to see what will be needed in 2006.

Next Meeting: Friday 7<sup>th</sup> January at 08:45 in the JBA Room 864-2-B14.

E. Ciapala, 6<sup>th</sup> January 2005.