

## LHC RF Meeting 10<sup>th</sup> September 2003

**Present:** Luca Arnaudon, Philippe Baudrenghien, Olivier Brunner, Andy Butterworth, Elena Chapochnikova, Edmond Ciapala, Wolfgang Höfle, Trevor Linnecar, Joachim Tückmantel, Daniel Valuch.

**Excused/Absent:** Thomas Bohl, Roberto Losito, Eric Montesinos, Volker Rödel.

### Agenda:

- 1) SM18 - Power tests (Olivier) and Modules
- 2) ADT news (Wolfgang)
- 3) Radiation studies - results (Andy)
- 4) Other follow up from last meeting
- 5) Round Table / AoB

### 1) SM18 (and H112)

- **Power tests** (Olivier). Last week saw conclusion of PC and HV tests (G. Pecheur). The PC shows a ripple (600 Hz mainly) of only 0.8 %, eight times lower than in H112. The AFT load has been re-installed and the cooling water pressure safety valve is in place. The klystron has delivered full power to a short. A new arc detection system is in place (B. Lambert). Diodes are now mounted directly on the waveguide, instead of via fibre connections. Two are installed for each critical point. The detection logic requires signals from both, to avoid false trips. A test light emitting diode is also fitted nearby. The pre-driver output for the klystron drive amplifier has had to be boosted by 3 dB to 1 Watt to allow for cable attenuation.

- **Module 3 preparation:** The clean room compressor has been repaired and the clean room was left running over the weekend. Module 3 has been installed and to date two couplers have been installed. The other two should be in place by the end of the week. The fitting of the remaining coupler parts outside the clean room will take some days, after which leak testing will be done and bake-out started. The target date for the start of power tests remains for the end of September.

### 2) ADT (Wolfgang)

- **Power Converters:** The closing date for replies to tender for Ug1 and Ug2 supplies is 20<sup>th</sup> October. The specifications for anode supplies have been completed this week. Delivery is planned for September 2004.

- **ADT Kicker Tanks:** Improvement of the poor welding quality will be followed up

- **Main Feedthroughs:** Offers have been received. Tests on corrosion resistance (using nitric acid) may need to be done.

- **Cooling water:** J-F Malo has looked at LEP material in ISR, i.e. flow meters and pipes. A specification of the requirements is needed in order to proceed now with the actual design: pipe sections, layout, connections. (**Action:** Wolfgang) The installation in B867 should be decided with Eric.

- **Driver amplifiers:** A design review with the manufacturer will be held in week 44 (end of October). Preliminary documentation will be sent to those concerned.

### 3) Radiation studies - results (Andy)

The radiation of concern is high-energy neutrons resulting from beam gas collisions in the IP region, producing single event upsets in the electronics, mainly CMOS memory cells which contain the FPGA configurations. The [results of the IR4 simulations](#) were presented. The contributions from the various elements - i.e. warm vacuum chambers, ACS cavities, APW, second beam tube - have been considered individually. The contribution from each of these source regions depends on the gas composition and density, given by the pressure and temperature. The estimates of the vacuum levels are worst case, by a factor of up to 10. Nominal beam intensity has been taken. The total estimate in the rack area is around 4E05 /cm<sup>2</sup>/year. Most of this comes from the SC cavities, based on an assumed vacuum of 10E-10 Torr taken from SM18 experience. For a typical device the cross-section for single

event upset (SEU) is around  $1\text{E-}13 \text{ cm}^2/\text{bit}$  (quoted for protons). For a fluence of  $4\text{E}05 \text{ /cm}^2/\text{year}$  the resulting error rate is about  $4\text{E-}8/\text{bit}/\text{year}$ . Thus for a 2M gate FPGA with 6 bits per gate we would have 0.4 bit errors/device/year. Something less than 10% of these bit errors are likely to lead to device malfunction, as most configuration bits are not used in a typical design, which gives us a final figure of about 0.04 failures per device per year.

For the APW with a vacuum of  $10\text{E-}7$  Torr, a fluence of  $1\text{E}03 \text{ /cm}^2/\text{year}$  is estimated in the LLRF racks area (worst case rack), which is negligible compared to the other contributions. This is due to the positioning of the APW downstream of the IR, with the actual levels coming only from backscattering.

#### **Conclusions:**

- The levels estimated, bearing in mind the pessimistic estimations of vacuum levels, and allowing a reasonable safety margin, do not compel us to re-locate the LLRF electronics.
- We should however keep a back up solution of situating the LLRF crates (2 per klystron) in the klystron local racks (space is available). Space should be allowed for cables from the tunnel. This configuration should also be tested in SM18.
- We should try as far as reasonably possible to use components with least radiation sensitivity. This includes power supplies.
- Tests should be done on real hardware to quantify the degree of malfunction resulting from SE upsets. Candidates are the LLRF tuner card and the existing PowerPC CPU module which will control the LLRF VME crates.
- Keep APWs downstream of the IR.

#### **4) Other follow-up from last meeting**

- **EVM:** Spare klystrons and some 200 MHz cavities have been transferred to the spares budget code 95540 and the necessary changes put in CET. A number of smaller items have been put back on their normal codes, to simplify follow up.

#### **5) AoB/Round Table**

- **Soleil - tests in SM18:** A meeting was recently held to establish requirements and our contribution to the proposed tests in SM18. The 352 MHz klystron control system has to be made similar to that of the recently introduced 400 MHz klystron system. This has to be done in any case and consists of duplication of 1-2 crates of electronics. For the Soleil module itself a complete system would have to be built, as the module has many differences with respect to the 400 MHz modules. (Tuning, cryogenics, etc.) It may be simpler to integrate the existing system already provided by Saclay. The cost and manpower for both options should be estimated (**Action:** Luca)

- **H112 Klystron tests:** (Olivier) Klystron 4 has been reception tested. A procedure for adjusting the spurious resonance peak has been established with the manufacturer and was used successfully on this klystron.

- **ACS Couplers:** (info from Eric) Three more ceramics have been received. Together with a remaining one, assembly of the next set of four couplers has begun.

- **FipIO cabling:** (Luca) Long distances could be left to CO group. Cables would have to be specified. These cables should form part of the overall RF cabling list being compiled by J-C Perrier. In order to avoid contradicting requests to other groups it is important that this cabling data is completed as quickly as possible, so that it can be checked by everyone and then made generally available. The form should be as close as possible to the ST-EL DiC format, even if some information is still missing (**Action:** J-C Perrier)

- **RF Devices:** Daniel has completed measurements on RF components and will present them at the next meeting.

#### **Next Meeting:**

(Provisionally) Wednesday 24<sup>th</sup> September 2000

E. Ciapala, 16<sup>th</sup> September 2003